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Monday, September 06, 2010

09:30 - 12:45 **Monday Plenary** Aula Magna
Chair: A. Renieri

PL.02 1 **Free Electron Lasers- A Historical Perspective**
George Neil
Jefferson Lab, United States
From their beginnings in the microwave tube industry, free electron lasers have developed into high peak and average power devices with output wavelengths extending from the microwave regime to X-rays. This paper will review that development and point out trends for future advances.

14:00 - 15:30 **Materials 1** Aula Magna
Chair: A. Marcelli

Mo-A2.1 2 **Electrodynamics of Confined Water in Nanospace**
Hiroshi Matsui; N. Toyota
Tohoku University, Japan
By the measurements of microwave conductivity, terahertz transmission and infrared spectroscopy, we clarify that the two-dimensionally confined water forms hexamer cluster in the MnO2 interlayer of Na-birnessite, and the hydration states around PO2- depend on the type of metallic ions of M-DNA.

Mo-A2.2 5 **Glass-Transition-Induced Lattice Mode Shifts in PVDF and HDPE Observed with Terahertz Time-Domain Spectroscopy**
S. Wietzke[1]; C. Jansen[1]; M. Reuter[1]; T. Jung[1]; D. Kraft[2]; S. Chatterjee[1]; M. Koch[1]
[1]Uni Marburg, Germany; [2]Süddeutsches Kunststoff-Zentrum, Germany
Semi-crystalline polymers, such as HDPE or PVDF, are composed of both amorphous and crystalline domains. Here, we apply terahertz time-domain

spectroscopy to study the impact of the glass transition taking place in the amorphous phase on lattice modes associated with the crystalline domains.

Mo-A2.3 7 **Water molecules driven by intense THz pulses**

M. Nagai; K. Tanaka
Kyoto University, Japan

We show THz nonlinearity of liquid water using intense monocycle THz pulse. Single pulse responses and THz pump-probe spectroscopy show that water molecules are coherently driven by THz pulse with breaking hydrogen bonding network.

Mo-A2.5 9 **Coherent Control of Spin Precessional Motion in Yttrium Orthoferrite with Impulsive Terahertz Pulse Excitations**

Keita Yamaguchi; M. Nakajima; T. Suemoto
The University of Tokyo, Japan

Coherent control of spin precession motion using double pulse excitation with THz magnetic pulses has been demonstrated. In addition to enhancement and extinction of the precession, intensity increase of transmitted THz pulse by energy transfer from spin systems was observed in the extinction case.

Mo-A2.6 11 **Probing Dielectric Relaxation Models of Polar Liquids using Terahertz Time-domain Pulsed Spectroscopy**

Y.W. SUN[1]; E. Pickwell-MacPherson[2]
[1]Department of Electronic Engineering, The Chinese University of Hong Kong, Hong Kong; [2]Department of Electronic & Computer Engineering, The Hong Kong University of Science and Technology, Hong Kong

The dielectric response of glycerol solution and pure glycerol were measured in terahertz range. It was found that the dielectric relaxation behavior of the glycerol solution is governed by two exponentials, whereas pure glycerol exhibits Davidson-Cole-type relaxation behavior.

14:00 - 15:30 Detectors 1 Aula Minor
Chair: R. Leoni

Mo-B2.1 13 **Room temperature Terahertz hot electron bolometric detector based on AlGaAs/GaAs two dimensional electron gas**

A.E.F. El Fatimy[1]; P.D.M. Mauskopf[1]; D.M. Morozov[1]; C.D. Dunscombe[1]; T.J. Jones[2]; K.W. Wood[2]
[1]School of School of Physics and Astronomy, Cardiff University, United Kingdom; [2]QMC Instruments Ltd, School of Physics and Astronomy, Cardiff University, Cardiff CF24 3AA, United Kingdom

in this paper, we present a hot-electron bolometric detector, which uses the nonlinearities of the heated two-dimensional electron gas medium in AlGaAs/GaAs at room temperature. The response was estimated at the 0.1-0.2

THz frequency range , showing possible application in sensing of THz radiation

Mo-B2.2 14 **THz Power Measurement Traceable to the International System of Units**

Andreas Steiger; B. Gutschwager; C. Monte; R. Müller; J. Hollandt
Physikalisch-Technische Bundesanstalt, Germany

THz power measurements traceable to the International System of Units were missing in the past. Investigations of two optical methods source- and detector-based radiometry led to the design of a new calibration facility for THz detectors with a molecular gas laser and a room-temperature radiometer.

Mo-B2.3 16 **Improving Photoconductive Receivers for 1.5 µm CW THz Systems**

D. Stanze; H. Roehle; R.J.B. Dietz; H.J. Hensel; D. Schmidt; H.G. Bach; M. Schell; B. Sartorius
Fraunhofer Heinrich Hertz Institute, Germany

Implementation of interdigital electrodes and etching isolating trenches has improved InGaAs/InAlAs photoconductive antennas. The signal-to-noise ratio of continuous wave systems at 1.5 µm has been increased up to 80 dB and its operation range up to 2.1 THz.

Mo-B2.4 18 **Optimization of high-sensitive THz-wave detection using nonlinear up-conversion in DAST crystal**

Hiroaki Minamide; T.N. Notake; M.T. Tang; Y.W. Wang; H.I. Ito
RIKEN ASI, Japan

In this report, the optimum performance of THz-wave detection using an organic DAST cystal was investigated in parameters such as the thickness of DAST, pump wavelength, and pumping intensity. Consequently, a higher sensitivity was obtained.

Mo-B2.5 19 **Wafer-bonded Ge:Ga blocked-impurity-band far-infrared detectors**

Yoshihiro Sawayama[1]; Y. Doi[1]; R. Kurayama[1]; E. Higurashi[1]; M. Patrashin[2]; I. Hosako[2]
[1]The University of Tokyo, Japan; [2]National Institute of Information and Communications Technology, Japan

We report the operation of a blocked-impurity-band (BIB) far-infrared (FIR) photodetector fabricated by surface activated bonding (SAB). The detector shows a high responsivity of ~10 A/W and extended cut-off wavelength compared to a conventional Ge:Ga photoconductor detector.

14:00 - 15:30 Resonator Devices Room 2
Chair: C. Zhang

Mo-C2.1 21 **Tight-binding description of transmission through crowded terahertz nanoresonators**

Y.M. Park; H.R. Park; H.S. Kim; J.S. Kyoung; K.J. Ahn; D.S. Kim
Seoul National University, Korea, Republic of

We present resonant transmission through rectangular hole array on a metallic film. Transmission spectra broaden with the resonance peaks shifting toward higher frequencies, as the period decreases. The broadening is caused by inter-resonator coupling effects similar to the tight binding model.

Mo-C2.2 24 **Dielectric characterization by means of whispering gallery mode resonators**

M. Fittipaldi[1]; E. Strambini[2]; M. Martinelli[2]; G. Annino[2]
[1]INSTM - Dipartimento di Chimica, Università di Firenze, Italy; [2]Istituto per i Processi Chimico-Fisici, CNR, Italy

The possibility to characterize the complex dielectric permittivity of low-loss materials at millimeter and submillimeter wavelengths by means of a technique based on whispering gallery mode dielectric resonators is discussed, together with some illustrative results.

Mo-C2.4 26 **Efficient coupling of THz radiation to microdisk resonators**

F. Eichhorn[1]; A. Patrascu[2]; G. Leo[2]; P.U. Jepsen[1]
[1]Technical University of Denmark, Denmark; [2]Universite Paris Diderot, France

We model the coupling of THz radiation between a microdisk (MD) resonator and free-space. This is relevant for a new class of THz emitters based on difference-frequency mixing between two laser modes in an MD resonator. We show efficient coupling between the MD TM mode and the free-space TE mode.

Mo-C2.5 27 **Electrical control terahertz radiation through nanoresonators on VO2**

Y.G. Jeong[1]; H. Bernien[1]; J.S. Kyoung[1]; H.S. Kim[1]; H.R. Park[1]; B.J. Kim[2]; H.T. Kim[2]; D.S. Kim[1]
[1]Seoul National University, Korea, Republic of; [2]ETRI, Korea, Republic of

We demonstrate electrical control of terahertz radiation through nanoresonators on VO2 thin film. By electrically induced insulator-to-metal phase transition, terahertz radiation can be switched-off. Transmission is decreased by two orders of magnitudes even when the film thickness is in nanoscale.

14:00 - 15:30 Quantum Cascade Lasers 1 Room 3
Chair: A. Tredicucci

Mo-D2.2 29 **Recent progress in THz QC lasers**

Giacomo Scalari
ETH, Switzerland

Recent progress in the design and realization of quantum cascade lasers emitting at THz frequencies will be discussed. High temperature, high power operation and broadband emitters are discussed. THz lasers oscillating in

micro-resonators with extremely small modal volumes will be also presented.

Mo-D2.3 31 **Terahertz pulse generation and amplification within terahertz quantum cascade lasers**

S. Dhillon[1]; S. Sawallich[1]; N. Jukam[1]; D. Oustinov[1]; J. Madeo[1]; R. Rungsawang[1]; S. Barbieri[2]; P. Filloux[2]; C. Sirtori[2]; X. Marcadet[3]; J. Tignon[1]
[1]Ecole Normale Supérieure, France; [2]Université Paris 7, France; [3]Alcatel-Thales III-V lab, France

Integrated THz pulse generation and amplification in THz QCLs is demonstrated. Intracavity narrowband THz pulses are generated at 2.1THz by exciting the facet of a THz quantum cascade laser with a resonant interband-intersubband transition and detected using electro-optic sampling.

Mo-D2.4 32 **Injection locking of Terahertz quantum cascade lasers via RF amplitude modulation up to 35GHz**

P. Gellie[1]; S. Barbieri[1]; J.F. Lampin[2]; P. Filloux[1]; C. Manquest[1]; C. Sirtori[1]; I. Sagne[3]; S.P. Khanna[4]; E.H. Linfield[4]; H.E. Beere[5]; D.A. Ritchie[5]
[1]University of Paris VII - CNRS, France; [2]Laboratoire IEMN, Université de Lille 1 and CNRS, France; [3]Laboratoire LPN, France; [4]School of Electronic and Electrical Engineering, University of Leeds, United Kingdom; [5]Cavendish Laboratory, University of Cambridge, United Kingdom

We demonstrate that the round-trip frequency of THz quantum cascade lasers can be injection-locked via RF amplitude modulation. Devices with roundtrip frequencies up to 35GHz showed locking bandwidths >200MHz. Inside the locking range the round-trip frequency is phase-locked to the RF-synthesizer.

14:00 - 15:30 Plasma based sources Room 7
Chair: X.C. Zhang

Mo-E2.1 34 **Demonstration of High Power Terahertz Sources Driven by Intense Femtosecond Lasers**

Yutong Li; C. Li; M. Zhou; X. Lin; F. Liu; F. Du; S. Wang; L. Chen; J. Ma; Z. Wang; Z. Wei; Z. Sheng; J. Zhang
Institute of Physics, CAS, China

We demonstrate an intense plasma-based THz source using ~5 TW femtosecond laser pulses to irradiate solid targets. The energy of a single THz pulse increases with the laser energy. The maximum THz energy can be as high as tens μJ/sr. The polarization of the THz pulse is measured to be linear.

Mo-E2.2 35 **Extreme-bandwidth THz Pulses from Laser-Generated Air Plasmas**

V. Blank; M.D. Thomson; H.G. Roskos
Physikalisches Institut, Goethe-Universität Frankfurt, Germany

We demonstrate the generation of coherent terahertz radiation with a continuous spectrum covering the range up to above 100 THz, using an air-plasma with sub-20-fs two-color optical excitation. The pulse energies obtained are sufficient to achieve peak fields of at least 60 MV/cm.

Mo-E2.3 37 **The Role of Multiphoton Ionization by Bicolor Laser Pulses in the Description of THz Pulse Generation from Laser Breakdown Plasma**

Alexander Shkurinov[1]; A.V. Borodin[1]; M.N. Esaulkov[1]; I.A. Kotelnikov[2]
[1]Department of Physics, M.V.Lomonosov Moscow State University, Russian Federation; [2]Budker Institute of Nuclear Physics, Russian Federation

The ITM is used to describe the MI of atoms of gases under the bicolor femtosecond laser irradiation. The obtained formulas are applied for the qualitative explanation of recent experiments on the generation of THz radiation from an optical breakdown in a focus spot of a femtosecond laser in a gas.

Mo-E2.4 38 **THz Generation in Plasmas Using Two-Color Laser Pulses**

Phillip Sprangle[1]; J. Penano[1]; D. Gordon[1]; B. Hafizi[2]; P. Serafim[3]
[1]Naval Research Laboratory, United States; [2]Icarus Research, Inc, United States; [3]Northeastern University, United States

We analyze the generation of THz radiation when an intense, short laser pulse is mixed with its frequency-doubled counterpart in plasma. We use the THz driving current to determine the electromagnetic field characteristics such as spectral intensity, electric field amplitude and directionality.

Mo-E2.5 39 **Broadband Terahertz Emission from Laser-Produced Plasmas**

Nikolay Vvedenskii; V.A. Kostin; A.A. Silaev
Institute of Applied Physics, Russian Academy of Sciences, Russian Federation

We present the review of recent studies of the phenomenon of terahertz waves generation caused by gas ionization with intense femtosecond laser pulses.

14:00 - 15:30 Free Electron Laser Room 11
Chair: J.M. Ortega

Mo-F2.1 40 **Third Harmonic Lasing on Terahertz NovoFEL**

V.V. Kubarev; G.N. Kulipanov; O.A. Shevchenko; N.A. Vinokurov
Budker Institute of Nuclear Physics, Russian Federation

NovoFEL has recently lased near 70 μm on the third harmonic of the fundamental frequency. By a choice of different optical resonator losses for fundamental and third harmonics and the resonator length, lasing can be forced to occur on both frequencies simultaneously or on either one alone

Mo-F2.2 43 **FEM with high-selective Bragg resonator based on coupling of propagating and cutoff waves**

N.Y. Peskov[1]; N.S. Ginzburg[1]; A.M. Malkin[1]; A.S. Sergeev[1]; V.Y. Zaslavsky[1]; I.V. Zotova[1]; I.I. Golubev[2]; S.M. Golubykh[2]; A.K. Kaminsky[2]; A.P. Kozlov[2]; E.A. Perelshtein[2]; S.N. Sedykh[2]
[1]Institute of Applied Physics RAS, Russian Federation; [2]Joint Institute for Nuclear Research, Russian Federation

Bragg FEM with feedback loop including quasi-cutoff wave was studied. Such feedback mechanism improves selectivity of the Bragg resonators and allows advance of FEM into short wavelengths up to THz-band. Operability of Bragg resonator of a novel type has been demonstrated in Ka-band JINR-IAP FEM.

Mo-F2.3 45 **Nonlinear Dynamics of a Terahertz Band FEL with Advanced Bragg Resonators.**

Andrey Malkin; N.S. Ginzburg; N.Y. Peskov; A.S. Sergeev; V.Y. Zaslavsky; I.V. Zotova
The Institute of Applied Physics of the Russian Academy of Sciences (IAP RAS), Russian Federation

Powerful THz band FEL utilizing coupling between the paraxial and the transverse wave beams on the advanced Bragg structures is studied. Modeling of nonlinear dynamics of suggested FEL scheme demonstrates possibility of single frequency regime establishment at the distance between plates of 40λ

Mo-F2.4 46 **Orotron operation at the second harmonic of the surface wave frequency**

V.L. Bratman; A.E. Fedotov; P.B. Makhalov
Institute of Applied Physics of RAS, Russian Federation

A possibility of the frequency doubling inside the orotron cavity is experimentally demonstrated at the frequency of 190 GHz. The excitation of the surface mode allows a significant reducing the operating current of the orotron mode that is important in the terahertz frequency range.

16:00 - 17:45 Materials 2 Aula Magna
Chair: R. Marcelli

Mo-A3.1 48 **THz Radiation by Optically Controlled Depolarization in $BiFeO_3$**

Masayoshi Tonouchi
Osaka University, Japan

Terahertz radiation has been observed from $BiFeO_3$ thin films via ultrafast modulation of spontaneous polarization upon carrier excitation with illumination of femtosecond laser pulses.

Mo-A3.2 50 **Near-field terahertz imaging of ferroelectric domains in barium titanate**

Filip Kadlec; M. Berta; P. Kuzel
Institute of Physics, Academy of Sciences Czech Rep., Czech Republic

We report on results of near-field pulsed THz imaging experiments with a metalized sapphire probe scanning a BaTiO3 multi-domain single crystal. The method is sensitive to the direction of spontaneous polarization, and spatial resolution is better than the dimensions of the probe at its extremity.

Mo-A3.3 52 **Terahertz Intersubband Transitions in the Conduction Band of Ge/SiGe Multi Quantum Wells**

Yan Busby[1]; G. Capellini[1]; F. Evangelisti[1]; M. Ortolani[2]; M. Virgilio[3]; G. Grosso[3]; G. Pizzi[3]; A. Nucara[4]; S. Lupi[4]; M. De Seta[1]
[1]Università di Roma Tre, Italy; [2]CNR Istituto di Fotonica e Nanotecnologie, Italy; [3]CNR-NEST-INFM, Pisa, Italy; [4]Università di Roma La Sapienza, Italy

We present Terahertz spectroscopy results in the 2-13 THz range on Ge/SiGe

Multi Quantum Wells showing clear evidence of bound to bound intersubband transitions in the Ge wells. These results may be relevant for the design of SiGe-based Quantum Cascade emitters in the THz range.

Mo-A3.4 54 **Infrared and THz study of the hole-doped Cu-O plane in its whole phase diagram**

D. Nicoletti[1]; P. Di Pietro[1]; O. Limaj[1]; P. Calvani[1]; S. Ono[2]; Y. Ando[3]; S. Lupi[1]
[1]University of Rome La Sapienza, Italy; [2]CRIEPI Institute, Tokyo, Japan; [3]Osaka University, Japan

This paper is a short review of our recent experiments on hole-doped superconducting cuprates. We investigated the in-plane IR and THz properties of a cuprate family over its whole phase diagram in order to obtain information on the mechanisms driving metallic-phase instabilities in these materials.

Mo-A3.5 56 **Transport properties of Free Carriers in Semiconductors Studied by THz Time-domain Magneto-optical Spectroscopic Ellipsometry**

Kenichi Yatsugi; N. Matsumoto; T. Nagashima; M. Hangyo
Osaka University, Japan

We have developed a technique to deduce effective mass, density and scattering time of free carriers independently with each other by using THz time-domain magneto-optical spectroscopic ellipsometry. The derivation of these parameters for an undoped n-type InAs wafer is demonstrated.

Mo-A3.6 58 **Calculation of Terahertz Active Normal Modes in Organic Crystals**

A.D. Burnett[1]; J. Kendrick[2]; J.E. Cunningham[1]; A.R. Pearson[3]; E.H. Linfield[1]; A.G. Davies[1]
[1]School of Electrical and Electronic Engineering, University of Leeds, United Kingdom; [2]Institute of Pharmaceutical Innovation, University of Bradford, United Kingdom; [3]Astbury Centre for Structural Molecular Biology, University of Leeds, United Kingdom

THz frequency spectra of a large number of organic compounds have characteristic spectral absorption features, the exact origin of which, in most cases, is unknown. This paper demonstrates the ability of solid-state density functional theory to calculate the origin of THz spectral features

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16:00 - 17:45 Instruments 1 Aula Minor
Chair: T. Ouchi

Mo-B3.1 60 **Telecom Technologies for THz Applications - Challenges and Chances**

B. Sartorius; H. Roehle; R. Dietz; D. Stanze; H. Kuenzel; M. Schell
Fraunhofer Heinrich-Hertz-Institut, Germany

THz at 1.5 µm is pushed for replacing Ti:sapphire by pulsed fiber lasers. But telecom technologies offer much more advantages. This paper describes key developments towards telecom based THz systems for real world applications.

Mo-B3.2 63 **Silicon Micromachining Technology for THz applications**

C. Jung; C. Lee; B. Thomas; G. Chattopadhyay; A. Peralta; R. Lin; J. Gill; I. Mehdi
Jet Propulsion Laboratory, United States

We report here the development of a wafer-level integrated submm-wave receiver front-end by using advanced semiconductor fabrication technologies.

We have developed a technique where Si-metal interfaces and wafer-stacking methodology are utilized to enable multi-pixel receiver in the THz range.

Mo-B3.3 66 **Silicon Based Microfluidic Device for THz Frequencies**

A.J. Baragwanath[1]; G.P. Swift[2]; D. Dai[1]; A.J. Gallant[1]; J.M. Chamberlain[1]
[1]Department of Physics Durham University, United Kingdom; [2]Department of Physics, Durham University, United Kingdom

In this paper we report on the design, fabrication and testing of a silicon based, microfluidic device, for transmission THz-TDS. Testing of the device is accomplished by analysis of primary alcohol/water mixtures. The analysis of biotin solutions has displayed sensitivity of the order of 3 nmol.

Mo-B3.4 68 **Developments of THz ESR Systems Using a SQUID Magnetometer and a Micro-Cantilever**

Hitoshi Ohta[1]; T. Sakurai[2]; M. Fujisawa[3]; S. Okubo[3]; E. Ohmichi[4]
[1]Kobe University, Molecular Photoscience Research Center, Japan; [2]Center for Support to Research and Education Activities, Kobe University, Japan; [3]Molecular Photoscience Research Center, Kobe Universty, Japan; [4]Faculty of Science, Kobe Universty, Japan

evelopments of our highly sensitive THz ESR systems are presented. One method is the ESR detection using a micro-cantilever, and we achieved the sensitivity of about 1011 spins/G up to 315 GHz. Another method is the ESR detection up to 315 GHz using a commercial SQUID magnetometer.

Mo-B3.5 70 **THz time domain spectroscopy based on OSCAT scheme**

Rafał Wilk[1]; T. Hochrein[2]; M. Mei[1]; R. Holzwarth[1]
[1]Menlo Systems GmbH, Germany; [2]Sueddeutsches Kunststoff-Zentrum, Germany

We present a THz spectrometer based on a novel scanning technique without any external moveable delay stage. The optical delay between the pump and probe pulses and thus the scanning range is controlled via the repetition rate of the laser source.

16:00 - 17:45 Imaging 1 Room 2
Chair: H. Han

Mo-C3.1 72 **Real-time terahertz color scanner**

T. Yasui[1]; T. Iwata[2]; T. Araki[1]
[1]Osaka University, Japan; [2]University of Tokushima, Japan

Real-time THz color scanner was proposed based on a combination of non-collinear electro-optical time-to-space conversion and line focusing of a THz beam. The proposed system has the potential to expand the application scope of THz spectral imaging based on its rapid image acquisition rate.

Mo-C3.2 75 **High Speed Imaging With Time Domain Terahertz**

Irl Duling; D. Zimdars; J. White; S. Williamson
Picometrix, LLC, United States

Time domain terahertz (TD-THz) imaging provides rich data about the item being imaged. By processing the reflected pulse, spectroscopic and internal structural information can be generated. The problem has always been speed. Recent advances allow images to be collected in seconds, rather than hours.

Mo-C3.3 76 **THz QCL - based active imaging applied to composite materials diagnostic**

F. Destic[1]; S. Massenot[1]; Y. Petitjean[1]; J.C. Mollier[1]; S. Barbieri[2]
[1]Universite de Toulouse, ISAE, France; [2]Universite Paris-Diderot, MPQ, France

This paper presents a CW raster-scanning THz imaging setup, based on a 2.5 THz Quantum Cascade Laser, used to perform Non-Destructive Testing of Kevlar and carbon fibre samples. Delamination defect in Kevlar showing a polarization dependence and a break in carbon fibres were detected.

Mo-C3.4 78 **Application of the InGaAs-based bow-tie diodes for Terahertz imaging**

I. Kašalynas; R. Simniškis; D. Seliuta; V. Tamošiūnas; G. Valušis
Centre for Physical Sciences and Technology, Semiconductor Physics Institute, Lithuania

The bow-tie InGaAs diode with broken symmetry was demonstrated for terahertz imaging at room temperature. The voltage-induced capacitance effects important for the diode operation in a real time mode were considered.

Mo-C3.5 80 **Sub-terahertz Imaging of a Painted Steel**

T. Kurabayashi[1]; S. Sakai[2]; K. Fujino[2]
[1]Iwate Prefectural University, Japan; [2]Nippon Expressway Research Institute Company Ltd., Japan

Sub-terahertz imaging of a painted steel plate as a method of nondestructive inspection was performed using a wave ranging from 100 to 200 GHz. An invisible rusty area covered with multiple paint layers on steel in actual use was effectively detected by power-reflection imaging.

Mo-C3.6 82 **CCD-camera-based electro-optical detection of nanosecond THz pulses from an optical parametric oscillator**

F.Z. Meng[1]; M.D. Thomson[1]; D. Molter[2]; T. Löffler[3]; J. Jonuscheit[2]; R. Beigang[2]; J. Bartschke[4]; T. Bauer[4]; M. Nittmann[4]; H.G. Roskos[1]
[1]Johann Wolfgang Goethe-Universität, Physikalisches Institut, Germany; [2]Department of Terahertz Measurement and Systems, Fraunhofer Institute for Physical Measurement Techn, Germany; [3]Physikalisches Institut, Johann Wolfgang Goethe-Universität, Germany; [4]Xiton Photonics GmbH, Germany

We report realization of a THz camera based on electro-optical detection of THz radiation from an optical parametric oscillator, using a silicon-based CCD camera as the optical detector. The dynamic range of 16.5 dB for a 6000-frame average (2-minute data acquisition time) is limited by laser noise.

16:00 - 17:45 Quantum Cascade Lasers 2 Room 3
Chair: G. Scamarcio

Mo-D3.1 84 **Phase-locking of 2.4 and 2.7 terahertz quantum cascade lasers to a femtosecond mode-locked Er-fiber laser**

S. Barbieri[1]; P. Gellie[1]; G. Santarelli[2]; M. Ravaro[1]; M. Amato[1]; C. Manquest[1]; C. Sirtori[1]; R. Colombelli[3]; S.P. Khanna[4]; E.H. Linfield[4]; H.E. Beere[5]; D.A. Ritchie[5]
[1]University of Paris VII - CNRS, France; [2]LNE-SYRTE, CNRS, UPMC, Observatoire de Paris, France; [3]IEF, Université Paris Sud and CNRS, France; [4]School of Electronic and Electrical Engineering, University of Leeds, United Kingdom; [5]Cavendish Laboratory, University of Cambridge, United Kingdom

We demonstrate the phase-locking of Quantum Cascade Lasers emitting at 2.4 and 2.7Terahertz, to the repetition rate of a commercial Er-doped fiber-fs-laser. We observe a linewidth of the beat-note signal with a signal-to-noise of 80dB in 1Hz bandwidth.

Mo-D3.2 87 **Gain switching of a terahertz quantum cascade laser for THz pulse amplification**

D. Oustinov[1]; N. Jukam[1]; R. Rungsawang[1]; J. Madeo[1]; S. Barbieri[2]; C. Manquest[2]; C. Sirtori[2]; S.P. Khanna[3]; E.H. Linfield[3]; A.G. Davies[3]; J. Tignon[1]; S. Dhillon[1]
[1]Ecole Normale Supérieure, France; [2]University Paris 7, France; [3]University of Leeds, United Kingdom

The population inversion of a terahertz quantum cascade laser is placed out of equilibrium using an integrated Auston switch. As a result, the dynamic gain of the laser is no longer clamped at threshold by the mirror losses, and large amplification of input terahertz probe pulses is observed.

Mo-D3.3 88 **Gain studies of phonon-depopulation based terahertz quantum cascade lasers using terahertz time domain spectroscopy**

S. Dhillon[1]; N. Jukam[1]; D. Oustinov[1]; J. Madeo[1]; R. Rungsawang[1]; R. Collombelli[2]; P. Dean[3]; M. Salih[3]; S.P. Khanna[3]; E.H. Linfield[3]; A.G. Davies[3]; J. Tignon[1]
[1]Ecole Normale Supérieure, France; [2]Université Paris Sud, France; [3]University of Leeds, United Kingdom

Gain and losses in a LO-phonon THz QCL are studied using TDS. At threshold the gain clamps at 25cm-1 and the gain FWHM is 0.6THz. At low biases, absorption features are observed below and above the laser frequency. They are shown to originate from the population of a parasitic electronic channel.

Mo-D3.4 89 **Terahertz Quantum Cascade Laser in the InGaAs/GaAsSb Material System**

C. Deutsch; A. Benz; H. Detz; M. Nobile; A.M. Andrews; P. Klang; W. Schrenk; G. Strasser; K. Unterrainer
Vienna University of Technology, Austria

We demonstrate a terahertz quantum cascade laser based on the aluminum-free InGaAs/GaAsSb material system. Processed in a double-metal waveguide configuration, devices reach operating temperatures up to 105 K and the

spectral emission lies between 3.6 and 4.1 THz.

Mo-D3.5 91 **Coupling strategies for two dimensional coherent semiconductor arrays**

C. Schwarzer[1]; E. Mujagic[1]; Y. Yao[2]; J. Chen[2]; C. Gmachl[2]; G. Strasser[1]
[1]Institute for Solid State Electronics, Vienna University of Technology, Vienna, 1040, Austria; [2]Department of Electrical Engineering, Princeton University, Princeton, New Jersey 08544, United States

We present fundamental approaches for realizing coherent two dimensional quantum cascade laser arrays by utilizing ring cavity surface emitting lasers. In this work we describe the design and fabrication as well as the electro-optical characterization.

Mo-D3.6 93 **Terahertz quantum cascade lasers with angled facets for monolithic integration**

M. Salih
LEEDS UNIVERSITY, United Kingdom

We report the performance of 3.5 THz quantum cascade lasers in which the laser cavities are formed by wet chemical etching and show that laser ridges can be obtained using angled facets. This opens up the possibility of monolithic integration of quantum cascade lasers into terahertz circuits.

16:00 - 17:45 Gyrotrons 1 Room 7
Chair: R.J. Temkin

Mo-E3.1 95 **Experimental demonstration of a W-band gyro-BWO using a helically corrugated waveguide**

A.D.R. Phelps[1]; C.R. Donaldson[2]; W. He[2]; F. Li[2]; L. Zhang[2]; A.W. Cross[2]; K. Ronald[2]; A.R. Young[2]; C.G. Whyte[2]
[1]university of strathclyde, United Kingdom; [2]University of Strathclyde, United Kingdom

A gyrotron backward wave oscillator (gyro-BWO) with a cusp electron gun and helically corrugated waveguide operating in the W-band frequency range is presented and experimentally demonstrated. The 1.5A, 40kV axis-encircling electron beam has been measured with the velocity ratio, alpha, calculated t

Mo-E3.2 98 **Experimental Studies of a Ka-band Second Harmonic Gyroklystron Amplifier**

Pu-Kun Liu
Institute of Electronics, Chinese Academy of Sciences, China

The recent experimental results of a Ka-band second harmonic gyroklystron amplifier are presented. The measured output power is 212kW, 3dB bandwidth is 155MHz, the efficiency is approximately 16% and the gain is about 24dB.

Mo-E3.3 99 **Design of a Permanent Magnet Gyrotron for Active Denial Systems**

Jeffrey Neilson; M.R. Read; R.L.I. Ives
Calabazas Creek Research, United States

Current W-Band active denial, non-lethal weapon systems use gyrotron sources requiring superconducting magnets. Calabazas Creek Research, Inc. is funded by the U.S. Department of Defense to develop a permanent magnet gyrotron as an alternate source.

16:00 - 17:45 Astronomy and Environmental Studies 1 Room 11
Chair: G. Sironi

Mo-F3.2 101 **Search for Continuum Solar Flare Radiation in the Terahertz Range**

Pierre Kaufmann[1]; V.S. Makhmutov[2]; Y.I. Stozhkov[2]; C.G. Gimenez de Castro[1]; J.P. Raulin[1]; A.S. Valio[1]; E. Correia[1]; T. Villela[3]; R. Marcon[4]; A. Marun[5]; P. Pereyra[5]
[1]Universidade Pesbiteriana Mackenzie, Brazil; [2]Lebedev Physical Institute, Russian Federation; [3]Instituto Nacional de Pesquisas Espaciais, Brazil; [4]Universidade Estadual de Campinas, Brazil; [5]Complejo Astronomico El Leoncito, Argentina

Solar bursts sub-THz fluxes increasing with frequency might evidence synchrotron emission from high energy electrons. Knowledge of THz spectral shape is essential to understand the emission mechanisms. THz radiometers are developed for a space mission on a long-duration balloon flight.

present plans for improving performance of future instruments of this kind.

Mo-F3.4 102 **Test Deployment of the PolarBear Experiment**

Paul Richards
University of California, United States

PolarBear is an experiment designed to measure the anisotropy of the polarization of the Cosmic Microwave Background Radiation. It uses a new 3.5 m ground based telescope and a large format array of dual-polarization, antenna-coupled TES bolometers with a frequency-domain multiplexed SQUID readout.

Mo-F3.5 103 **Measurement of the Complex Dielectric Constant of Volcanic Ash at Millimetre Wavelengths.**

Duncan Robertson; A.B. Rogers; D.G. Macfarlane
University of St Andrews, United Kingdom

A method for determining the dielectric permittivity of volcanic ash at millimetre wavelengths has been developed. This, and preliminary results showing good agreement with 19 GHz data, are presented.

Mo-F3.6 105 **Recent Progress in Commercial Cryogen-free THz Detectors and Large Format Arrays**

Ken Wood
QMC Instruments Ltd., United Kingdom

we present results of the recent incorporation of new superconducting THz detector technologies into novel cooling platforms which do not require liquid cryogens.

17:45 - 19:15 Monday Poster Chiostro

Mo-P.01 107 **Intensity modulation of terahertz quantum cascade lasers under below-bandgap optical excitation**

Norihiko Sekine; I. Hosako
National Institute of Information and Communications Technology, Japan

We have investigated the light-current characteristics of terahertz quantum cascade lasers using an external light whose energy is below the bandgap energy of the host material. It is found that light injection induces a large modulation depth, up to 100%.

Mo-P.02 108 **THz inter-Landau level emission in a quantum cascade structure**

François-Régis Jasnot[1]; L.A. de Vaulchier[2]; Y. Guldner[2]; A. Vasanelli[3]; C. Sirtori[3]; M. Beck[4]; J. Faist[4]
[1]Laboratoire Pierre Aigrain, France; [2]Laboratoire Pierre Aigrain, Ecole Normale Supérieure, France; [3]Laboratoire Matériaux et Phénomènes Quantiques, Université Denis Diderot Paris 7, France; [4]Institute of Quantum Electronics, ETH Zürich, Switzerland

We study a THz quantum cascade structure designed to allow population relaxation between crossing Landau levels from different subbands under perpendicular magnetic field. Electroluminescence measurements show intersubband luminescence as well as inter-Landau level emission (cyclotron emission).

Mo-P.03 110 **Spontaneous Emission from GaN/AlGaN based Terahertz Quantum Cascade Laser Structure grown on GaN Substrate**

W. Terashima; H. Hirayama
Terahertz Quantum Device Laboratory, RIKEN, Japan

We fabricated Nitrides-based THz-QCL structure grown on GaN substrate. The Output power for QCL on GaN substrate showed ten times higher value than that of QCL on MOCVD-GaN template. We for the first time observed THz spontaneous emission spectrum on the Nitrides-based THz-QCL on injection current.

Mo-P.04 112 **High temperature performance of a diagonal THz-QCL calculated with non-equilibrium Green fs function method**

Hiroaki Yasuda[1]; T. Kubis[2]; P. Vogl[3]; I. Hosako[1]; K. Hirakawa[4]
[1]NICT, Japan; [2]Purdue University, United States; [3]Technical University Munich, Germany; [4]University of Tokyo, Japan

We have calculated the performance of a novel diagonal design-based THz-QCLs with the non-equilibrium Green fs function method. The diagonal QCL has a THz gain even at 200 K. The main origin for this is that the non-radiative losses are better suppressed than the optical transition.

Mo-P.05 114 **THz quantum-cascade lasers with superconducting waveguides**

Alexander Benz; M. Brandstetter; C. Deutsch; G. Fasching; K. Unterrainer; A.M. Andrews; P. Klang; W. Schrenk; G. Strasser
Vienna University of Technology, Austria

We present THz quantum-cascade lasers in a superconducting double-metal waveguide. The active region is sandwiched between 300 nm thick Niobium layers. The current-voltage characterisitcs shows a pronounced photon kink at lasing threshold.

Mo-P.06 116 **THz photonic crystal quantum-cascade lasers: Frequency tuning during lasing operation**

Alexander Benz; M. Brandstetter; C. Deutsch; G. Fasching; K. Unterrainer; A.M. Andrews; P. Klang; W. Schrenk; G. Strasser
Vienna University of Technology, Austria

We present a new tuning scheme for THz quantum-cascade lasers based on active photonic crystal (PhC) resonators. An injected gas changes the resonance condition of the PhC and thereby the emission frequency of the device.

Mo-P.07 118 **Operation of a Ka-band harmonic multiplying gyrotron traveling wave tube**

J.R.L. Luo; Y.S. Zhang; W. Guo; M. Zhu; G.J. Yuan; J. Cui; Y.H. Zhang; L.H. Ren; J.X. Yang
Institute of Electronics, Chinese Academy of Sciences, China

A harmonic multiplying gyro-TWT are reported with coupled cavity and the precise control of focusing magnet field to improve the coupling between the fundamental and the harmonic and to adapt the sensitivity of the effect of focusing magnet field on the beam-wave interaction.

Mo-P.08 120 **Simulation of the axis-encircling Cusp electronic gun for Ka-band Gyro-TWT using three folded helical corrugation waveguide**

wenqiang Lei
Institute of Applied Electronics, China

The Cusp gun for Ka band Gyro-TWT is simulated by a 3D PIC code, in which the electronic velocity value is extracted to calculate the velocity ratio. The gun is optimized in 98kV voltage and 1A current, to obtain 1.1 velocity ratio and 5% spread. The result is used in helical waveguide Gyro-TWT.

Mo-P.09 122 **Simulation of a Four-stage Depressed Collector for a W-band Gyro-BWO**

L. Zhang[1]; W. He[1]; A.W. Cross[1]; A.D.R. Phelps[1]; C. Donaldson[1]; K. Ronald[1]; C. Donaldson[2]; K. Ronald[2]
[1]SUPA, Department of Physics, University of Strathclyde, United Kingdom; [2]University of Strathclyde, United Kingdom

To improve the overall efficiency of a W-band gyrotron backward wave oscillator (gyro-BWO) currently been built in university of Strathclyde, an energy recovery system using a four-stage depressed collector was simulated and designed.

Mo-P.10 124 **A W-Band Gyro-TWA using a Helically Corrugated Waveguide**

W. He; A.D.R. Phelps; C.D. Donaldson; A.W. Cross; K. Ronald; L. Zhang
SUPA, Department of Physics, University of Strathclyde, Glasgow, United Kingdom

A gyrotron travelling wave amplifier with a cusp electron gun and a helically corrugated waveguide operating in the W-band is presented. When driven by the 40 keV, 1.5 A e-beam, the amplifier was simulated to output 5-10 kW with a 3dB frequency bandwidth of 90-100 GHz and saturated gain of 40 dB.

Mo-P.11 126 **Simulations of Ka-band waveguide components for use in a gyro-travelling wave amplifier**

C.W. Robertson; A.D.R. Phelps; C.G. Whyte; A.R. Young; K. Ronald; A.W. Cross
University of Strathclyde, United Kingdom

Abstract—We present the results of a series of CST Microwave Studio computer simulations of waveguide components for a gyro-TWA operating in the Ka-band (26.5-40GHz) frequency range. The components studied include circular to helical waveguide transitions and microwave severs.

Mo-P.12 128 **Investigations on Wave Propagation in Launchers of Advanced Gyrotron Output Couplers**

J. Flamm[1]; J. Jin[1]; J. Neudorfer[2]; S. Roller[2]; M. Thumm[1]
[1]Karlsruhe Institute of Technology, Germany; [2]German Research School for Simulation Sciences GmbH, Germany

In this paper, we present the latest results on an FFT based method for fast calculation in a rippled-wall overmoded circular waveguide. These are compared with the results of a high-order discontinuous Galerkin method solving Maxwell's equations.

Mo-P.13 130 **Microwave Cherenkov Radiation from a Particle-in-flight to a Semi-infinite Layered Medium**

Levon Grigoryan[1]; A.R. Mkrtchyan[1]; H.F. Khachatryan[1]; S.R. Arzumanyan[1]; W. Wagner[2]
[1]Institute of Applied Problems in Physics, Armenia; [2]Forschungszentrum Dresden-Rossendorf, Institute of Radiation Physics, Germany

Some part of the microwave Cherenkov radiation from a particle-in-flight from vacuum to semi-infinite layered medium is redirected by the periodical structure of medium in the backward direction. This part of radiation is quasi-monochromatic.

Mo-P.16 132 **THz detectors with HgTe and InSb quantum wells**

F. Gouider[1]; Y.B. Vasilyev[2]; J. Könemann[3]; C. Brüne[4]; H. Buhmann[4]; P.D. Buckle[5]; G. Nachtwei[1]
[1]Institut für Angewandte Physik, Technische Universität Braunschweig, Germany; [2]A. F. Ioffe Physical Technical Institute, RU-194021 St. Petersburg,, Russian Federation; [3]Physikalisch-Technische Bundesanstalt, D-38116 Braunschweig,, Germany; [4]Fakultät für Physik und Astronomie, Julius-Maximilians-Universität Würzburg, Germany; [5]QinetiQ Ltd, Malvern WR14 3PS, United Kingdom

THz-frequencies in semiconductor quantum wells are of interest due to the potential for making devices that operate at THz frequencies. We present magnetotransport and magnetooptical data obtained in the magnetic field range $0 < B < 7$T at QH detectors patterned as Corbino rings on InSb and HgTe QWs.

photolithography fabrication process so as to minimize losses.

Mo-P.18 134 **Evaluation of a Terahertz Detector based on a Superconducting Tunnel Junction Coupled to a Thin Superconductor Film**

Seiichiro Ariyoshi[1]; T. Taino[2]; A. Dobroiu[1]; H. Sato[1]; H. Matsuo[3]; C. Otani[1]
[1]RIKEN, Japan; [2]Saitama University, Japan; [3]National Astronomical Observatory, Japan

The principle of a superconducting terahertz detector is verified. We have detected terahertz radiation based on the Cooper-pair breaking process, and confirmed that the sensitivity has a sharp increase around 0.7 THz, a value that is in agreement with the gap frequency of the superconducting Nb.

Mo-P.19 135 **Micromachined Arrays of Air-bridge GaAs Schottky Diodes for THz Cameras**

C.R. Casini Roberto[1]; D. Dominijanni[1]; M. Ortolani[1]; E. Giovine[1]; F. Gatta[2]; A. D'Amico[2]; V. Foglietti[1]
[1]CNR-IFN, Italy; [2]UNIVERSITY OF ROME "TOR VERGATA", Italy

We present the fabrication and test of arrays of GaAs Schottky diodes with sub-micrometric junction area and negligible parasitic capacitances working as rectifying detectors at sub-THz frequencies. GaAs Micromachining techniques are used to decrease the cross talking between adjacent diode detector

Mo-P.20 137 **A new method of terahertz detection: probe-energy electro-optic sampling**

G.K. Kitaeva[1]; S.P. Kovalev[1]; I.I. Naumova[1]; R.A. Akhmedzhanov[2]; I.E. Ilyakov[2]; B.V. Shishkin[2]; E.V. Suvorov[2]
[1]M. V. Lomonosov State University, Russian Federation; [2]Institute of Applied Physics, Russian Academy of Sciences, Russian Federation

Implementation of free-space electro-optic detection is reported, based on measuring the energy variation of a femtosecond laser pulse induced by a terahertz field. Scheme of detection is demonstrated using wide-aperture periodically poled Mg:Y:LiNbO3 (PPLN) crystals and a ZnTe crystal.

Mo-P.21 139 **Hot Electron Bolometer Waveguide Mixers for 1 to 3 THz**

P. Pütz; C.E. Honingh; K. Jacobs; M. Justen; F. Schomaker; M. Schultz; S. Wulff; J. Stutzki
1. Physikalisches Institut, KOSMA, Universität zu Köln, Germany

We report on measurement results of our latest waveguide mixer developments for the German Receiver for Astronomy at THz frequencies (GREAT), one of the first light instruments of the Stratospheric Observatory for Infrared Astronomy (SOFIA), and for the Stratospheric THz Observatory (STO).

Mo-P.22 141 **Optimization of Photoresponse and Crosstalk for Mid-wavelength InSb Infrared Focal Plane Arrays**

n. guo[1]; c. meng[2]; w.d. hu[1]; y.q. lv[2]; x.s. chen[1]; w. lu[1]
[1]Shanghai Institute of Technical Physics,Chinese Academy Sciences, China; [2]Luoyang Optoelectronic Institute, Luoyang, Henan, China

Effects of the pixel crosstalk on photoresponse for mid-wavelength InSb infrared focal plane arrays have been numerically studied. Our work shows that the pixel crosstalk increases with the increase of the height of pixel and the thickness of substrate.The optimal value can be found.

Mo-P.23 143 **Sensitive Detectors of Terahertz Radiation Based on Pb1-xSnxTe(In)**

Dmitry Khokhlov
Moscow State University, Russian Federation

Indium doped lead telluride-based photodetectors have demonstrated extremely high performance in the terahertz range. These materials reveal a number of advantageous features: “internal” accumulation of the incident radiation, high spatial and temporal stability, high radiation hardness and others

Mo-P.24 144 **Superconducting Integrated THz Receiver**

Andrey Khudchenko[1]; V.P. Koshelets[1]; P.N. Dmitriev[1]; L.V. Filippenko[1]; N.V. Kinev[1]; P. Kudryashov[1]; O.S. Kiselev[1]; M.Y. Torgashin[1]; G. de Lange[2]; L. de Jong[2]; P.A. Yagoubov[2]
[1]The Kotel’nikov Institute of Radio Engineering and Electronics, Russian Federation; [2]Netherlands Institute for Space Research, Netherlands

Abstract—A Superconducting Integrated Receiver (SIR) developed for balloon borne instrument TELIS covers frequency range 450-650 GHz. The DSB noise temperature was measured as low as 120 K. The SIR application for high resolution spectroscopy of breathed out air has been proven.

Mo-P.25 145 **Electrically Switchable Optical Response in Graphene**

C. Zhang; S. Sultan; R. Vickers; F. Gao
University of Wollongong, Australia

We carried out a theoretical and computation study of optical response of graphene over a wide frequency range, from terahertz to ultraviolet. It is shown that due to the massless Dirac Fermion properties, the optical response of graphene is electrically switchable.

Mo-P.26 147 **Terahertz luminescence under continuous wave interband excitation of semiconductors**

Alexamder Andrianov; A.V. Andrianov
A.F. Ioffe Physical Technical Institute, Russian Federation

We report on the observation of efficient terahertz emission from semiconductors (n-GaAs) under continuous-wave interband excitation at liquid helium temperatures. The external quantum yield of the emission is up to 0.3%.

Mo-P.27 149 **Identification of Textile Fiber by Terahertz Spectroscopy**

T. Kurabayashi[1]; F. Saitoh[2]; N. Watanabe[3]; T. Tanno[1]
[1]Iwate Prefectural University, Japan; [2]Research and Development Division, Koiwai Farm, Ltd., Japan; [3]Research Institute for Quality Living Co., Ltd., Japan

Absorption spectra of a majority of textile fibers are distinguishable by THz spectroscopy, even for fibers in the same category or species. The advantage of this technique is its sensitivity to the structural differences of the textile fibers, even if they consist largely of the same components.

Mo-P.28 151 **Validation of thick materials having high refractive indices as high-resistance silicon plates with THz-TDS**

Keiko Kitagishi
Otsuka Electronics Co. Ltd., Japan

Evaluation of complex refractive index of high-n materials was attempted by THz-TDS. The properties were estimated adequately when THz waves radiate

in parallel flux, while those were improper with converged waves. The system was designed to easily exchange the parallel/converged configuration.

Mo-P.29 153 **Neural Network-based Non-destructive Quantification of Thin Coating by Terahertz Pulsed Imaging in the Frequency Domain**

Yaochun Shen[1]; S. Zhong[2]; R.K. May[3]; M.J. Evans[4]; J.A. Zeitler[3]; D. Dey[5]
[1]University of Liverpool, United Kingdom; [2]Department of Electrical Engineering and Electronics, University of Liverpool, L69 3GJ, UK, United Kingdom; [3]Department of Chemical Engineering and Biotechnology, University of Cambridge, CB2 3RA, UK, United Kingdom; [4]TeraView Ltd., St. John¡¯s Innovation Park, Cambridge CB4 0WS, UK, United Kingdom; [5]Oystar Manesty, Merseyside L34 9JS, UK, United Kingdom

We present a Neural Network (NN) based method for determining the coating thickness from the FFT-amplitude of the measured terahertz waveform. The experimental results demonstrate that the NN-based method can be used to characterize the tablet coating with a thickness down to about 20 microns.

Mo-P.30 155 **Visualization of Carbon Black Distribution in Rubber Vulcanizates by Terahertz Time-Domain Spectroscopy**

Yasuyuki Hirakawa[1]; Y. Ohno[1]; T. Gondoh[1]; T. Mori[1]; K. Takeya[2]; M. Tonouchi[2]; H. Ohtake[3]; T. Hirosumi[3]
[1]Kurume National College of Technology, Japan; [2]Institute of Laser Engineering, Osaka University, Japan; [3]AISIN SEIKI Co., Ltd., Japan

The distribution of carbon black (CB) in rubber vulcanizates containing several additives such as carbon black, ZnO, etc. was estimated by terahertz time-domain spectroscopy. It was found that the CB distribution could be clearly visualized and the THz measurements indicated high reproducibility.

Mo-P.31 157 **Gyrotrons FU CW V and FU CW VIII for measurement of hyperfine structure of positronium**

Toshitaka Idehara[1]; Y. Urushizaki[1]; I. Ogawa[1]; R. Ikeda[1]; S. Sabchevski[1]; S. Asai[2]; T. Suehara[2]; A. Miyazaki[2]; T. Yamazaki[2]; T. Kobayashi[2]; T.H. Chang[3]
[1]University of Fukui, Japan; [2]The University of Tokyo, Japan; [3]National Tsing Hua University, Japan

For direct measurement on hyperfine structure of positronium, high power sub-THz radiation sources have been developed. Gyrotron FU CW V is a frequency fixed gyrotron operating at 203.3 GHz for the proof-of-principle experiment and Gyrotron FU CW VIII a frequency tunable to measure it directly.

Mo-P.32 159 **The Phonon Absorption Bands of KDP, NBP and PTB Crystals**

Bihui HOU[1]; W. Wang[2]
[1]Beijing University of Technology, China; [2]Graduate University of Chinese Academy of Sciences, China

The phonon absorption bands of three oxide crystals, KH2PO4(KDP), Na5B2P3O13 (NBP) and PbB4O7 (PTB), have been studied and compared from the ultraviolet-visible- infrared- THz transmission spectra.

Mo-P.33 161 **The Reflectance and Electrical Properties of Nanocrystalline Thulium**

Fengyan LIU; H. Hou
Beijing University of Technology, China

The reflectance spectra within 200nm- 2500nm wavelength range of the two nanocrystalline bulk metal thulium(Tm) samples were studied. The

reflectivities of Sample 1 and Sample 2 reach their minima 2.383% at 256nm and 3.439% at 214nm respectively.

Mo-P.34 163 **Study of CaCO3-containing Minerals by THz Spectroscopy**

M. Mizuno; K. Fukunaga; S. Saito; I. Hosako
National Institute of Information and Communications Technology, Japan

We measured the absorption spectra of the cuttlebone, which contains CaCO3 (~85%), in the terahertz band and compared them with those of natural CaCO3 (calcite). From these results, we state that absorption spectra can be used to identify various crystal states of the cuttlebone.

Mo-P.35 165 **Quantitative Measurement Captan and Riadimefon Residue by Terahertz Time-domain Spectroscopy**

Q. Wang
Dept. of Quality & Safety Engineering, China Jiliang University, China

THz-TDS was used to measure terahertz far-infrared spectral characteristics of two pestcides(captan, riadimefon) .From experimental results, a series of characteristic absorption peaks can be observed between 0.2 THz and 3.0 THz. It help to identify and quantitative measurement pestcide residue.

Mo-P.36 167 **Characterizing electronic properties of low and high conductivity materials in the THz regime**

B.B. Yang; S.L. Katz; K.J. Willis; I. Knezevic; S.C. Hagness; J.H. Booske
University of Wisconsin-Madison, United States

We present a combined experimental and computational study on effective electrical conductivity at terahertz frequencies. A high-Q quasi-optical resonator is used to experimentally verify the results of a novel EMC/FDTD/MD numerical model.

Mo-P.38 169 **Terahertz Spectroscopic Characterization of Paper**

T. Hattori; H. Kumon; H. Tamazumi
University of Tsukuba, Japan

THz-TDS of paper was performed. The real and imaginary indices depended on frequency, orientation, type of paper, and moisture content. The attenuation coefficient depended quadratically on frequency. Moisture content dependence was consistent with the complex permittivity of liquid water.

Mo-P.39 171 **First-principles study of atomic and electronic structures of amorphous HgTe**

H.X. Zhao; X.S. Chen; R.B. Dong; H.B. Shu; W. Lu
National Lab for Infrared Physics, Shanghai Institute of Technical Physics, Chinese Academy of Scien, China

The atomic and electronic structures of amorphous-HgTe have been studied. We formed the initial structures by replacing Si atoms in amorphous-Si. The electronic properties are analyzed through the density of states. The density-functional methods predict a small gap of 0.4-0.45 eV for amorphous HgTe

Mo-P.40 173 **THz-TDS of Filter Paper at Differing Humidities**

Elise Pogson[1]; A. Scott[1]; C.J. Garvey[2]; R.A. Lewis[1]
[1]University of Wollongong, Australia; [2]bAustralian Nuclear Science and Technology Organisation, Australia

Characterisation of filter paper using Terahertz Time Domain Spectroscopy is given at different humidities. This is achieved using saturated salt solutions. Measurements are also taken towards the saturated RH% at specific times

giving added information on equilibration times and sample properties.

Mo-P.42 175 **Highly Sensitive Determination of Coating Thickness by using the High Filling Factor in an Adiabatically Coupled Terahertz Waveguide**

M. Theuer[1]; R. Beigang[2]; D.R. Grischkowsky[1]
[1]Oklahoma State University, United States; [2]Fraunhofer IPM, Germany

THz-TDS can be used to detect the thickness of thin layers by pulse delay. The detection limit was considerably increased by using the high filling factor of a THz waveguide. The single pass delay was multiplied by a factor of more than 60 resolving dielectric layers down to 2 micron thickness.

Mo-P.43 177 **Sub-Terahertz Wave Frequency Converter Design for High Speed Data Transmission**

XianJin Deng; Z. Chen; C. Wang; J. Liu; S.Y. Wu
Institute of Electronic Engineering, CAEP, China

This paper presents a sub-terahertz frequency converter for high speed data transmission, which is composed of a V-band source, a D-band harmonic mixer using Schottky diode. It can be used as an upconverter or downconverter between 110 and 170 GHz, which eliminates the need for high LO source.

Mo-P.44 179 **Accurate, Continuously Tunable, Terahertz Synthesizer Based on Photomixing of Two Continuous-Wave Lasers Phase-Locked to Two Independent Fiber Combs**

K. Kawamoto[1]; H. Takahashi[2]; Y. Iwamoto[2]; K. Arai[2]; T. Yasui[1]; H. Inaba[3]; K. Minoshima[3]; T. Araki[1]
[1]Osaka University, Japan; [2]Tokyo Univ. Sci., Japan; [3]AIST, Japan

A continuously tunable, phase-locked, CW-THz generator has been demonstrated. This CW-THz generator is based on photomixing of an accurately tunable CW laser and a tightly fixed CW laser in the optical frequency region, phase-locked to two independent optical combs.

Mo-P.45 181 **Phase stability considerations in coherent CW THz photomixing systems**

T. Goebel; D. Schoenherr; C. Sydlo; M. Feiginov; P. Meissner; H.L. Hartnagel
Technische Universitaet Darmstadt, Germany

Wavelength stabilized lasers and the delay stage configuration can significantly influence the phase stability in coherent CW photomixing THz-systems. Depending on the system design, the phase drift can exceed several wavelengths and therefore make the system unsuitable for precise measurements.

Mo-P.46 182 **THz Balanced Electro-Optic Detection with Two Line-Scan Cameras**

Michael Herrmann[1]; C. Wiegand[2]; D. Molter[1]; J. Jonuscheit[1]; R. Beigang[2]
[1]Fraunhofer Institute for Physical Measurement Techniques IPM, Germany; [2]University of Kaiserslautern, Germany

We have built a THz system for one-dimensional imaging with a THz line focus and electro-optic detection with two line-scan cameras in a balanced arrangement. The system uses pulsed THz radiation from a fast-repetition-rate (80 MHz) femtosecond laser. The THz emitter antenna is electronically chopped.

Mo-P.47 184 **High-Repetition-Rate Optical Delay Line Using a Micromirror Array and Galvanometer Mirror**

H.K. Kitahara[1]; M.T. Tani[2]; M.H. Hangyo[1]
[1]Osaka university, Japan; [2]University of Fukui, Japan

We have developed a high-speed optical delay line for the terahertz time-domain spectroscopy system (THz-TDS). The delay line is composed of a galvanometer mirror and a mirror array. We have demonstrated the acquisition of the time-domain wave form by using the delay line and a THz-TDS system.

Mo-P.49 186 **Nanosecond Semiconductor Modulator of MM Waves Controlled by an Optical Laser**

Grigory Denisov[1]; M.L. Kulygin[2]; Y.V. Rodin[2]; B.V. Shishkin[2]; I.E. Ilyakov[2]
[1]Institute of Applied Physics/GYCOM, Russian Federation; [2]Institute of Applied Physics, Russian Federation

A report of success in numerical modeling and experimental investigation of a new type of microwave commutation device is presented. The modulator is intended to be used in coherent GHz spectroscopy rather than for powerful microwave power flow switching.

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Mo-P.51 188 **Development of a Fast Scan THz-TDS System by using a Repetition Rate Tunable Femtosecond Laser**

Takashi Furuya[1]; K. Horita[1]; C.T. Que[1]; K. Yamamoto[1]; F. Miyamaru[2]; S. Nishizawa[3]; M. Tani[1]
[1]Research Center for Development of Far-Infrared Region, University of Fukui, Japan; [2]Shinshu University, Japan; [3]Advanced Infrared Spectroscopy Co., Ltd., Japan

The long scanning time of a THz-TDS is a problem for quality control application in an industrial production line. In this study, we developed a fast scan system using a repetition rate tunable femtosecond laser. The scan time was around one hundred thousandth shorter than a mechanical delay system.

Mo-P.52 190 **Analysis of the High Frequency Spreading Resistance for Surface Channel Planar Schottky Diodes**

A.Y. Tang[1]; P. Sobis[2]; H. Zhao[1]; V. Drakinskiy[3]; T. Bryllert[1]; J. Stake[1]
[1]GigaHertz Centre, Physical Electronics Laboratory, Chalmers University of Technology, Sweden; [2]Omnisys Instruments AB, Sweden; [3]Physical Electronics Laboratory, Chalmers University of Technology, Sweden

Spreading resistance of a planar Schottky diode is studied as a function of the frequency and buffer layer thickness. The study shows an increase of effective high frequency resistance for a buffer layer thicker than skin depth, due to the parasitic capacitances induced current in buffer layer.

Mo-P.53 192 **Terahertz photomixing in Strained Silicon MODFET**

Y.M. meziani[1]; A. El Moutaouakil[2]; E. Velazquez[1]; E. Diez[1]; K. Fobelets[3]; T. Otsuji[2]
[1]Salamanca University, Spain; [2]RIEC, Tohoku University, Japan; [3]Electrical and Electronic Engineering Department, Imperial College London, United Kingdom

Strained-Si modulation doped field effect transistors have been studied as a photomixer within terahertz range. It was subjected to two CW lasers where $\Delta f=|f1-f2|=4$ THz. A clear signal was observed with maximum around Vg=-0.15V and interpreted as due to the oscillaions of the plasma waves.

Mo-P.55 194 **Monte Carlo study of ballistic effects in high speed InAs-based quantum hot electron transistor**

giulio sabatini[1]; C. Palermo[1]; P. Ziadé[1]; T. Laurent[1]; H. Marinchio[1]; H. Rodilla[2]; J. Mateos[2]; T. Gonzales[2]; R. Teissier[1]; L. Varani[1]
[1]Institut d'électronique du Sud – UMR CNRS 5214, France; [2]University of Salamanca, Spain

By means of a Monte Carlo simulation, we have studied the collector transit region of an innovative InAs/AlSb quantum hot electron transistor. This original vertical transport device has the potential to efficiently exploit the

unrivalled transport properties of InAs to reach THz frequencies.

Mo-P.57 196 **Enhancement of contrast and spatial resolution in confocal coherent terahertz imaging system.**

Alexander Andrianov; A.V. Andrianov
A.F. Ioffe Physical Technical Institute, Russian Federation

The effect of enhancement of image contrast and spatial resolution without the loss of the spectral composition of the radiation under investigation has been experimentally demonstrated for a terahertz far-field imaging system. The result has been achieved by using a technique of confocal filtering.

Mo-P.58 198 **Plasmonic Apertures for THz QCL Near-Field Imaging**

A.J. Baragwanath[1]; J.R. Freeman[2]; A.J. Gallant[3]; A. Zeitler[4]; H. Beere[2]; D.A. Ritchie[2]; J.M. Chamberlain[1]
[1]Department of Physics, Durham University, United Kingdom; [2]Cavendish Laboratory, University of Cambridge, United Kingdom; [3]School of Engineering and Computing Sciences, Durham University, United Kingdom; [4]Department of Chemical Engineering and Biotechnology, University of Cambridge, United Kingdom

In this paper we report on the fabrication and testing of sub-wavelength apertures surrounded by annular plasmonic structures, for use in near-field imaging with a QCL source. Preliminary results demonstrate greatly increased transmission when using the plasmonic aperture over a bare aperture.

Mo-P.59 200 **THz Radiation Based on Femtosecond Electron Bunches and THz Imaging**

J. Saisut[1]; K. Kusoljariyakul[1]; N. Kangrang[2]; P. Wichaisirimongkol[3]; C. Tengsirivattana[2]; P. Thamboon[3]; M.W. Rhodes[3]; C. Thongbai[1]
[1]Department of Physics and Materials Science, Chiang Mai University, Thailand; [2]ThEP Center, Commission on Higher Education, Thailand; [3]STIR, Chiang Mai University, Thailand

The THz radiation from femtosecond electron bunches is focused on a sample which will be scanned using xy-translation stages. The transmission intensity at different points of the sample are detected to construct a THz image. The THz images of samples were demonstrated using the THz imaging system.

Mo-P.60 202 **Non-bias inspection of electrical failures in LSI interconnects using LTEM prototype system**

Masatsugu Yamashita[1]; C. Otani[1]; T. Matsumoto[2]; Y. Midoh[3]; K. Miura[3]; K. Nikawa[3]; K. Nakamae[3]; M. Tonouchi[3]
[1]RIKEN ASI, Japan; [2]Hamamatsu Photonics, Japan; [3]Osaka University, Japan

LSI chips fabricated by 180nm process were measured by the LTEM prototype system. P-n junctions connected to the defective interconnect can be successfully identified under non-bias condition. These results indicate LTEM

can be a useful tool for the defect localization in LSI failure analysis.

Mo-P.61 204 **Non-destructive determination of the density distribution of polymer foam models with THz-pulses**

A. Brahm[1]; D. Schmidt[2]; S. Riehemann[1]; F.J. Woestmann[2]; A. Tuennermann[1]
[1]Fraunhofer IOF, Germany; [2]Fraunhofer IFAM, Germany

A study of density and glue distributions in polymer foam models for lost foam casting processes is reported. THz-pulse measurements were compared with destructive measurements according to the principle of buoyancy-floating method to guarantee high quality standards in lost foam casting processes.

Mo-P.62 206 **Volumetric analyses using terahertz-tomography techniques**

A. Brahm[1]; M. Kunz[2]; S. Riehemann[1]; G. Notni[1]; A. Tuennermann[1]
[1]Fraunhofer IOF, Germany; [2]Institute of Physics, Ilmenau University of Technology, Germany

We report about an algorithm approach to identify substances inside a sample using their complete characteristic absorption spectra from a tomographic measurement with ultrashort THz-pulses.

Mo-P.63 208 **A Monolithic Visible, Infrared and Terahertz 2D Detector**

M. Perenzoni[1]; N. Massari[1]; S. Pocas[2]; J. Meilhan[2]; F. Simoens[2]
[1]Fondazione Bruno Kessler, Italy; [2]CEA-Leti MINATEC, France

A monolithic multispectral detector for imaging in the visible, infrared and terahertz ranges has been designed for operation at room temperature. This sensor is composed of a CMOS readout integrated circuit with visible photodiodes and of IR and THz microbolometer pixels processed above the CMOS.

Mo-P.64 210 **Terahertz Imaging Using Intermediate Thermal Screen**

Alexander Klimov[1]; V.V. Kubarev[2]; V.N. Shumsky[1]
[1]Institute of Semiconductors Physics, Russian Federation; [2]Institute of Nuclear Physics, Russian Federation

Parameters of THz imaging system with the intermediate thermal screen are analyzed. Experimental data on the prototype which uses the highly sensitive PbSnTe:In film as IR photodetector and the microbolometer matrix as the thermal screen are also given

Mo-P.65 211 **Combined Passive and Active Millimeter-Wave Imaging System for Concealed Objects Detection**

Jordi Abril Aguilera; E. Nova Lavado; T. Broquetas; F. Torres; J. Romeu; L. Jofre
Polytechnic University of Catalunya, Spain

It is expected that the combination of the coherent and incoherent radiation in active and passive operation will offer improved detection and identification of concealed objects. An interferometric radiometer and an active mills-cross have been studied as near field imaging systems.

Mo-P.66 213 **Compressed terahertz imaging system using a spin disk**

Yaochun Shen[1]; H. Shen[2]; N. Newman[2]; L. Gan[3]; S. Zhong[2]
[1]University of Liverpool, United Kingdom; [2]Dept of Electrical Engineering and Electronics, University of Liverpool, Liverpool L69 3GJ, UK, United Kingdom; [3]Electronic and Computer Engineering, Brunel University, Uxbridge UB8 3PH, UK, United Kingdom

Based on the concept of compressive sensing, a spin disk with random patterns

was used to modulate the THz beam pattern, and THz image was subsequently reconstructed. Experimental results will be demonstrated using both BWO THz and thermal light sources covering both infrared and visible range.

Mo-P.67 215 **3D Spectroscopic Computed Tomography Imaging Using Terahertz Waves**

Eiji Kato[1]; S. Nishina[1]; A. Irisawa[1]; T. Yamashita[1]; M. Imamura[1]; K. Kawase[2]
[1]Advantest corporation, Japan; [2]Nagoya University, Japan

We have developed a three-dimensional spectroscopic imaging system that uses terahertz waves and is based on transmission computed tomography. Using this system, we demonstrate three-dimensional imaging, with identification for chemical components, by analyzing spectroscopic information.

Mo-P.68 217 **Design and Simulations of a THz Sensor Based on Micromachined Golay-cell for Imaging Applications**

H. Rashid; V. Desmaris; V. Belitsky
Chalmers University of Technology, Sweden

A novel sensor for room temperature THz imaging is presented. The sensor's response time (t) is optimized by tuning its structural design, using Monte-Carlo and transient FEM simulations. The final design offers a 3.5THz bandwidth (0.5-4THz) and t of 30ms, suitable for real time radio visualization

Mo-P.69 219 **Differential Scanning Optical Microscopy with a THz quantum cascade source**

R. Degl'Innocenti; M. Kumar; J.H. Xu; A. Tredicucci
NEST, Scuola Normale Superiore and Istituto Nanoscienze-CNR, Italy

We present a differential Near-field Scanning Optical Microscope (NSOM) operating in the THz spectral region. The system, which employs a quantum cascade laser emitting at $\lambda = 105$ μm as source, has been tested on metal and graphite objects, with a resolution of ~ $\lambda/10$.

Mo-P.70 221 **Room Temperature Imaging above one Terahertz by Field Effect Transistor as Detector**

Salman NADAR[1]; H. Videlier[2]; D. Coquillat[2]; O. Klimenko[2]; F. Teppe[2]; M. Sakowicz[2]; N. Dyanonova[2]; W. Knap[2]; D. Siluta[3]; I. Kasalynas[3]; G. Valusis[3]; S. NADAR[4]
[1]Groupe d'Etudes de Semiconducteurs (GES), France; [2]GES, France; [3]THz groupe, Semiconductor Physics Institute, Lithuania; [4]GES UM2, France

GaAs field effect-transistors are used for single-pixel imaging using frequencies above 1 THz at 300 K. Images obtained in transmission mode at 1.63 THz are recorded with spatial resolution of 300 μm. We demonstrate that, with applied drain to source current, the imaging at up to 2.5 THz is possible

Mo-P.71 222 **MMIC-based Receivers for MM-wave Radiometry**

Vessen Vassilev[1]; H. Zirath[2]; N. Wadefalk[2]; R. Kozhuharov[2]; M. Abbasi[3]; T. Pellikka[4]; A. Emrich[4]; I. Kallfass[5]; A. Leuther[5]
[1]Microwave Electronics Laboratory, Sweden; [2]Microwave Electronics Laboratory, Chalmers, Sweden; [3]Microwave Electronics Laborato, Sweden; [4]Omnisys Instruments AB, Sweden; [5]Fraunhofer Institute IAF, Germany

We present results of packaged mm-wave receiver components based on 100nm mHEMT technology. The components are to be used for observations of the atmospheric lines at 118 GHz and 183 GHz.

Mo-P.72 224 **Consideration of refraction losses for time-domain terahertz computed tomography**

Emmanuel Abraham[1]; A. Younus[2]; C. Aguerre[3]; P. Desbarats[3]; P. Mounaix[1]
[1]CPMOH - Université de Bordeaux, France; [2]CPMOH - Université de Bordeaux, Pakistan; [3]LaBRI - Université de Bordeaux, France

Terahertz computed tomography has been performed using a time-domain terahertz spectrometer. Refraction losses induced by the transmission of the terahertz radiation through the samples have been taken into account in order to reconstruct the three-dimensional aspect of complex shape objects.

Mo-P.73 226 **Discrete Sampling of Continuous Wave Terahertz Radiation**

M. Schwerdtfeger; M. Scheller; M. Stecher; O. Peters; M. Koch
Philipps-Universität Marburg, Germany

We present a cost efficient delay technique for terahertz spectrometers based on discrete phase shifting of the THz wave. This can be achieved by using a polymer disc with segments of different thickness. The approach is demonstrated by measurements with a six segment disc placed in the THz beam.

Mo-P.74 228 **Non-destructive inspection of opaque objects with a 3D millimeter-wave tomographic scanner**

Emmanuel Abraham[1]; A. Younus[2]; S. Salort[3]; J.P. Caumes[3]; P. Desbarats[4]; P. Mounaix[1]
[1]CPMOH - Université de Bordeaux, France; [2]CPMOH - Université de Bordeaux, Pakistan; [3]Alphanov - Université de Bordeaux, France; [4]LaBRI - Université de Bordeaux, France

Flexible monochromatic millimeter wave system coupled with an infrared temperature sensor demonstrates large size 3D visualization of manufactured opaque phantoms with different refractive index contrasts. Peculiarities such as boundary effects, refraction and diffraction losses will be discussed.

Mo-P.76 230 **A 340 GHz CW non-linear imaging system**

Robin Dahlbäck[1]; T. Rubaek[2]; T. Bryllert[1]; M. Persson[2]; J. Stake[1]
[1]Chalmers University of Technology, MC2, Physical Electronics Laboratory, Sweden; [2]Chalmers University of Technology, Department of Signals and Systems, Biomedical Engineering Divisio, Sweden

A CW sub-millimetre wave imaging system is presented. The system operates around 340GHz with a 6.5% relative bandwidth and uses a non-linear imaging algorithm.

Mo-P.77 232 **Development of Laser Scanning Terahertz Imaging System Using Organic Nonlinear Optical Crystal**

Kazunori Serita[1]; S. Mizuno[1]; H. Murakami[1]; I. Kawayama[1]; M. Tonouchi[1]; Y. Takahashi[2]; M. Yoshimura[2]; Y. Kitaoka[2]; Y. Mori[2]
[1]Institute of Laser Engineering, Osaka University, Japan; [2]Graduate School of Engineering, Osaka University, Japan

We constructed a laser scanning terahertz (THz) imaging system for high-speed imaging by using a galvano meter and an organic nonlinear optical crystal, DASC, as a two-dimensional THz emitter. Using this system, we succeeded in obtaining high-resolution THz images of a test sample.

Mo-P.78 234 **High Resolution Terahertz imaging (T-ray) with a Horn Antenna**

G.J. Kim; J.I. Kim; S.G. Jeon; W.K. Han
Korea Electrotechnology Research Institute, Korea, Republic of

We suggest a simple solution the limitation of spatial resolution for wavelength by using a horn antenna and verified detection limitation by THz imaging for a foreign object in flour.

Mo-P.79 236 **Si-MOSFETs Terahertz Photovoltaic Response in High Magnetic Field**

Hadley Videlier[1]; O. Klimenko[2]; M. Sakowicz[1]; N. Dyakonova[1]; F. Teppe[1]; C. Consejo[1]; D. Coquillata[1]; W. Knap[1]; J. Marczewski[3]; P. Grabiec[3]; J. Lusakowski[4]
[1]GES-UMR5650, Université Montpellier 2 and CNRS, France; [2]aGES-UMR5650, Université Montpellier 2 and CNRS, France; [3]Institute of Electron Technology, Poland; [4]Institute of Experimental Physics, Poland

Terahertz response of Silicon MOSFETs high magnetic fields is studied. Subjected to a Terahertz radiation, the MOSFET develops a dc drain-to-source voltage that exhibits a resonant structure corresponding to g factor ~2 and can be tentatively interpreted as related to spin effects.

Mo-P.80 238 **A preliminary study towards the implementation of MIMO radar system for Agriculture applications**

N. Ahmad; J.J. Soraghan
UNIVERSITY OF STRATHCLYDE, United Kingdom

The revolution of MIMO radar system has the potential to be applied in many areas of applications such as in agriculture sector. It is inspired from MIMO system in telecommunications and uses multiple antennas to observe the different aspect of targets, hence produce high resolution radar image.

Mo-P.81 240 **Terahertz Pulsed Imaging of Surface Variations on Pharmaceutical Tablets**

Axel Zeitler[1]; R.K. May[1]; M.J. Evans[2]; S. Zhong[3]; C. Byers[4]; L.F. Gladden[1]; Y.C. Shen[3]
[1]University of Cambridge, United Kingdom; [2]TeraView Ltd, Virgin Island (United Kingdom); [3]University of Liverpool, United Kingdom; [4]Oystar-Manesty, United Kingdom

We present an analysis of terahertz pulsed imaging measurements of pharmaceutical tablets compacted over a range of compression forces. Using THz imaging it was possible to observe, small-scale defects on tablet surfaces that may have relevance to the quality of tablet manufacture and performance.

Mo-P.82 242 **Terahertz Phase Image Reconstruction Using an Iterative Algorithm**

Y.X. Wang[1]; Z.Q. Chen[2]; Z.R. Zhao[2]; L. Zhang[2]; K.J. Kang[2]; J.K. Deng[1]
[1]Department of Physics, Tsinghua University, China; [2]Department of Engineering Physics, Tsinghua University, China

We present a terahertz phase contrast imaging technique based on the iterative phase retrieval method (the Gerchberg¨CSaxton iterative Fourier transform algorithm). Numerical simulations are performed to demonstrate this new imaging concept for conventional terahertz intensity measurement system.

Mo-P.83 244 **Compact CW-Sub THz Imaging System for Non-destructive Testing**

D.C. Seo; J.S. Jang; I.B. Kwon; D.J. Yoon
KRISS, Korea, Republic of

This paper presents compact CW sub-THz imaging system using terahertz transmitter (Tx) that generating 0.34 THz electromagnetic wave based on electronic device. Using this THz imaging system, we measured transmitting terahertz wave magnitude and phase information of samples for non destructive test.

Mo-P.85 246 **Analysis of Plasma Resonances in Terahertz Devices with Grating Gate**

Irina Khmyrova; R. Yamase; N. Watanabe
University of Aizu, Japan

Analytical model is developed and used to calculate spatial distribution of sheet electron density in the channel of grid-grating gated HEMT structure and resonant frequencies of plasma waves excited in the channel. It is shown that increasing number of gates results in spectrum broadening .

Tuesday, September 07, 2010

09:00 - 10:30 **Tuesday Plenary** Aula Magna
Chair: P. Richards

PL.06 248 **Infrared and Far Infrared radiation in the analysis of atmospheric components**
Donal Murtagh
Chalmers University of Technology
This presentation will present a summary of the work on atmospheric processes that has been made possible by a the launch of new infrared and mm-wave instruments during the last 10 years.

11:00 - 12:30 **Spectroscopy 1** Aula Magna
Chair: X. Shen

Tu-A1.1 249 **Photoreflectance spectroscopy with a Fourier-transform infrared spectrometer: from visible to far infrared**
Jun SHAO; W. Lu
National Laboratory for Infrared Physics, Shanghai Institute of Technical Physics, Chinese Academy o, China
Recent progress in photoreflectance spectroscopy at the Shanghai Institute of Technical Physics was reviewed, with the focus on the extension of functional spectral range for the first time from 5 μm to FIR of 20 μm and the application to narrow-gap semiconductors and nanostructure materials.

Tu-A1.2 252 **Detection of hydrogen cyanide in the smoke emitted from the combustion of nylon fabric with a continuous-wave THz spectrometer**
N. Shimizu; Y. Kado
NTT Microsystem Integration Labs., Japan
Smoke emitted from the combustion of nylon fabric is studied. Transmission loss of IR light in the smoke was much larger than that of THz waves. THz absorption spectra showed the existence of HCN in the smoke. These results prove the advantage of THz waves for remote gas sensing at disaster sites.

Tu-A1.3 255 **Comparing spectra from Time Domain Spectrometers and a polarizing Fourier Transform Spectrometer.**
Giorgio Savini[1]; I.C. Ho[2]; J. Dai[2]; X.C. Zhang[2]; C. Tucker[3]; P.A.R. Ade[3]; P.D. Mauskopf[3]; G. Zhao[4]
[1]University College London, United Kingdom; [2]Rensselaer Polytechnic Institute, United States; [3]Cardiff University, United Kingdom; [4]Capital Normal University Beijing, China
We have performed spectroscopic measurements on a set of materials and metal mesh grids with a THz Fourier transform spectrometer and two THz Time domain spectrometers and compared both the results and the noise properties of two different spectroscopic techniques.

Tu-A1.4 257 **Terahertz Spectroscopy of Double Metal Quantum Cascade Structures**

M. Martl; J. Darmo; D. Dietze; C. Deutsch; A. Benz; M. Brandstetter; K. Unterrainer; P. Klang; A.M. Andrews; W. Schrenk; G. Strasser; E. Gornik
Vienna University of Technology, Austria

The coupling of broadband Terahertz pulses into metal-metal terahertz quantum cascade lasers is presented. A characterization of terahertz generation on the subwavelength quantum cascade laser facet is investigated in configuration of two separately driven sections of quantum cascade laser.

11:00 - 12:30 Array Imaging Aula Minor
Chair: D. Robertson

Tu-B1.1 259 **A multi-element THz imaging system**

F. Eichhorn[1]; L. Høgstedt[1]; J.C.D. Buron[1]; R.K. Olsson[1]; A. Kusk[2]; J. Dall[2]; P.U. Jepsen[1]
[1]DTU Fotonik, Denmark; [2]DTU Space, Denmark

We report on a broadband multi-element THz imaging system based on fiber-coupled, integrated photoconductive emitters and detectors. 32 detectors and 32 emitters are arranged in a planar array. Advanced image reconstruction algorithms are employed to reconstruct an object in the imaging plane.

Tu-B1.2 262 **Multichannel THz imaging using arrays of photoconductive antennas**

S. Wohnsiedler[1]; M. Kolano[1]; J. Klier[1]; M. Herrmann[1]; J. Jonuscheit[1]; R. Beigang[1]; E. Peytavit[2]; J.F. Lampin[2]
[1]Fraunhofer Institute for Physical Measurement Techniques IPM, Germany; [2]Institute of Electronics, Microelectronics and Nanotechnology IEMN, France

In a new approach we report on a THz imaging system with arrays of horn-type photoconductive switches emitting in-plain. Aim is to combine the flexibility and sensitivity of THz antennas with the measurement speed of electro-optic sampling.

Tu-B1.3 264 **Imaging above 1 THz Limit with Si-MOSFET Detectors**

Franz Schuster[1]; H. Videlier[2]; M. Sakowicz[2]; F. Teppe[2]; D. Coquillat[2]; B. Dupont[1]; A. Siligaris[1]; L. Dussopt[1]; B. Giffard[1]; W. Knap[2]
[1]CEA-LETI, MINATEC, CEA-Grenoble, France; [2]Université Montpellier2 and CNRS UMR 5650, France

We demonstrate that a proper antenna and transistor design can provide high responsivity for Terahertz radiation and imaging capability even above the 1 THz limit with a low-cost 130 nm CMOS technology. This result opens the way to CMOS THz imagers with high spatial resolutions – down ~300 μm.

Tu-B1.4 266 **THz uncooled microbolometer array development for active imaging and spectroscopy applications**

François SIMOENS[1]; S. Pocas[2]; J. Meilhan[2]; J.L. Ouvrier-Buffet[2]; T. Maillou[3]; P. Gellié[4]; S. Barbieri[4]
[1]CEA Leti-MINATEC, France; [2]CEA-LETI, MINATEC, France; [3]CEA Le Ripault, France; [4]Université Paris 7, France

A first prototype of 320x240 antenna-coupled un-cooled a-Si micro-bolometers array has been designed and processed. Beam profiles emitted by THz QCLs have been imaged while different samples were introduced in the THz beam optical path. We report first essays of material identification.

Tu-B1.5 268 **Talbot effect in the terahertz spectral range**

Boris Knyazev[1]; V.S. Cherkassky[2]; Y.Y. Choporova[3]; V.V. Gerasimov[1]; M.G. Vlasenko[1]
[1]Budker Institute of Nuclear Physics, Russian Federation; [2]Novosibirsk State University, Russian Federation; [3]Novosibirsk State Technical University, Russian Federation

Talbot effect in the terahertz spectral range has been first observed and applied to metrology applications: measurement of distance, determination of radiation wavelength and detection in real-time of wavefront distortion.

11:00 - 12:30 Electronic Generation Room 2
Chair: R. Logan

Tu-C1.1 270 **THz Oscillators Using Resonant Tunneling Diodes at Room Temperature**

Masahiro Asada; S. Suzuki
Tokyo Institute of Technology, Japan

THz oscillators using resonant tunneling diodes are reported. Fundamental oscillation up to 0.95 THz was obtained until now. This is the highest fundamental frequency of room-temperature electronic single oscillators. Structures for high output power and spectral characteristics were also reported.

Tu-C1.2 273 **Increase of Fundamental Oscillation Frequency in Resonant Tunneling Diode with Thin Barrier and Graded Emitter Structures**

S. Suzuki[1]; A. Teranishi[1]; M. Asada[1]; H. Sugiyama[2]; H. Yokoyama[2]
[1]Tokyo Institute of Technology, Japan; [2]NTT Photonics lab., Japan

We obtained frequency increase of resonant tunneling diodes using graded emitter for improving the transit delay, and thin barrier structures for reduction of the tunneling time. The oscillation frequency of 951 GHz was observed for an RTD with 0.43-fÊm^2-mesa area and 20-fÊm-long antenna.

Tu-C1.3 275 **Measurements of THz emission from nanometric-size transistors**

J. Torres[1]; P. Nouvel[1]; H. Marinchio[1]; T. Laurent[1]; S. Blin[1]; L. Chusseau[1]; C. Palermo[1]; L. Varani[1]; P. Shiktorov[2]; E. Starikov[2]; V. Gruzinski[3]; F. Teppe[4]; D. Coquillat[4]

[1]Institut d'Electronique du Sud UMR 5214 - Universite Montpellier 2, France; [2]Semiconductor Physics Institute, A. Gostauto 11, 2600 Vilnius, Lithuania, Lithuania; [3]S, Lithuania; [4]Groupe d'Etude des Semiconducteurs UMR 5650 CNRS, Université Montpellier 2, 34095 Montpellier, Franc, France

Measurements of terahertz resonant emission due to the excitation of plasma waves by an optical beating inside AlGaAs/InGaAs/InP high electron mobility transistor is reported at 300 K and 200 K.

Tu-C1.4 277 **Tunable room temperature THz emission from AlGaN/GaN high electron mobility transistors**

Nina Dyakonova[1]; A. El Fatimy[2]; Y. Meziani[3]; T. Otsuji[4]; D. Coquillat[1]; W. Knap[1]; F. Teppe[1]; S. Vandenbrouk[5]; K. Madjour[5]; D. Theron[5]; C. Gaquiere[5]; M.A. Poisson[6]; S. Delage[6]

[1]GES, UMR5650, Université Montpellier II, France; [2]Cardiff School of Physics and Astronomy, Cardiff University, United Kingdom; [3]Departamento de Física Aplicada, Universidad de Salamanca, Spain; [4]RIEC, Tohoku University,, Japan; [5]IEMN, UMR CNRS 8520, Villeneuve d'Acsq, France; [6]Thalès, Thales Research and Technology, Orsay, France

We present experimental results on the Terahertz radiation from high electron mobility transistors at room temperature, which clearly show the tunability of the emission frequency by the gate voltage.

Tu-C1.5 279 **Theoretical Study on Terahertz Wave Detection and Radiation Based on Semiconductor Nano Structures**

W.D.C. Chu; S.Q.D. Duan; W.Z. Zhang

Institute of Applied Physics and Computational Mathematics, Beijing, China

We study the magnetic-field-modulated terahertz absorption spectra of a real GaAs quantum ring and present a possible way to realize tunable detection of terahertz ??elds. We also explore the terahertz radiation from high order harmonics in a coupled triple quantum dots driven by gigahertz waves.

11:00 - 12:30 Biology 1 Room 3

Chair: G.S. Park

Tu-D1.1 281 **In-Line Monitoring of Coating Thickness of Pharmaceutical Tablets during Production Scale Film Coating by Terahertz Imaging**

Axel Zeitler[1]; R.K. May[1]; M.J. Evans[2]; S. Zhong[3]; I. Warr[4]; L.F. Gladden[1]; Y.C. Shen[3]

[1]University of Cambridge, United Kingdom; [2]TeraView Ltd, United Kingdom; [3]University of Liverpool, United Kingdom; [4]Oystar-Manesty, United Kingdom

We present preliminary results from in-line terahertz pulsed imaging measurements of coating thickness on pharmaceutical tablets made during production-scale film coating. Results of real-time TPI measurements are compared to sample tablets removed at discrete time-intervals during production

Tu-D1.2 283 **Near-Infrared Spectroscopy for Non-destructive Coating Analysis Calibrated by Terahertz Pulsed Imaging**

Yaochun Shen[1]; S. Zhong[2]; H. Shen[2]; M.J. Evans[3]; R.K. May[4]; J.A. Zeitler[4]; I. Warr[5]
[1]University of Liverpool, United Kingdom; [2]Department of Electrical Engineering and Electronics, University of Liverpool, L69 3GJ, UK, United Kingdom; [3]TeraView Ltd., St. John¡¯s Innovation Park, Cambridge CB4 0WS, UK, United Kingdom; [4]Department of Chemical Engineering and Biotechnology, University of Cambridge, CB2 3RA, UK, United Kingdom; [5]Oystar Manesty, Merseyside L34 9JS, UK, United Kingdom

Near-infrared (NIR) spectroscopy needs a calibration model for analysis of tablet coating thickness. In this work, we demonstrate that Terahertz Pulsed Imaging can provide, in a nondestructive fashion, such coating thickness information for building the calibration model needed by the NIR technique.

Tu-D1.3 285 **Continuous-wave Terahertz Spectroscopic Imaging at over 1 THz for Pharmaceutical Applications**

K. Ajito[1]; H.J. Song[1]; A. Hirata[1]; A. Wakatsuki[1]; Y. Muramoto[2]; N. Shigekawa[2]; T. Kumashiro[3]; D. Asa[3]; T. Nagatsuma[3]; N. Kukutsu[1]; Y. Kado[1]
[1]NTT Microsystem Integration Labs., Japan; [2]NTT Photonics Labs., Japan; [3]Osaka Univ., Japan

Spectroscopic images were obtained using a system combining a tunable continuous-wave terahertz laser with an InP Schottky barrier diode detector integrating a broadband log-periodic antenna. The distribution of polymorphic forms in pharmaceutical tablets was observed in images at over 1 THz.

Tu-D1.4 287 **An analytical study of water concentration measurement in tissues with THz-wave**

Y.Y. Wang; H. Minamide; T. Ikari; M. Tang; T. Notake; H. Ito
Riken, Japan

THz wave is a viable tool for water content measurement due to its highly sensitivity to water. We analyzed the measurement errors of this method. The chosen basis for sample thickness and measuring frequency were presented. Measurements of water mapping were experimentally verified using TPO source

Tu-D1.5 289 **Terahertz Pulse Imaging of Human Lymph Nodes**

M. Lim[1]; E. Jung[1]; H. Choi[2]; H. Han[1]
[1]POSTECH, Korea, Republic of; [2]Asan Medical Center, University of Ulsan, Korea, Republic of

We present terahertz pulse imaging of human lymph nodes. By analyzing the reflected terahertz pulses from paraffin embedded lymph nodes, we have successfully demonstrated significant imaging contrast between metastatic and normal lymph nodes.

11:00 - 12:30 Gyrotrons 2 Room 7
Chair: M. Thumm

Tu-E1.1 290 **Recent Results of Development in Russia of 170 GHz Gyrotron for ITER**
Alexander Litvak
Institute of Applied Physics of RAS, Russian Federation
The industrial production prototype of the ITER gyrotron was tested at the new test stand in Kurchatov institute with power 1.02 MW in 200 second pulses, and 0.65MW in 800 second pulses. simultaneously at IAP a short pulse gyrotron with an increased size cavity was tested at power 1.5-2 MW.

Tu-E1.2 292 **Recent Results with the European 2 MW Coaxial-Cavity Pre-Prototype Gyrotron for ITER**
T. Rzesnicki; B. Piosczyk; A.R. Choudhury; S. Illy; J. Jin; S. Kern; A. Samartsev; A. Schlaich; M. Thumm
Karlsruhe Institute of Technology, Germany
A 2 MW, CW, 170 GHz coaxial-cavity gyrotron for ITER is under development within the European Gyrotron Consortium. A short pulse tube is used for verification of critical components, as electron gun, beam tunnel, cavity and quasi-optical system. The paper gives an update on recent activities.

Tu-E1.3 294 **To the Theory of High-power Gyrotrons with Uptapered Resonators**
Olgerts Dumbrajs[1]; G.S. Nusinovich[2]
[1]Institute of Solid State Physics, University of Latvia, Latvia; [2]University of Maryland, United States
The effect of a slight uptapering of the resonator wall on the efficiency enhancement and the purity of the radiation spectrum in the process of the gyrotron start-up and power modulation are studied for a typical high-power 170 GHz gyrotron which is currently under development in Europe for ITER.

Tu-E1.4 296 **Multi-Frequency ECRH at ASDEX Upgrade, Status and Plans**
Dietmar Wagner[1]; J. Stober[1]; F. Leuterer[1]; F. Monaco[1]; M. Münich[1]; D. Schmid-Lorch[1]; H. Schütz[1]; H. Zohm[1]; M. Thumm[2]; T. Scherer[2]; A. Meier[2]; G. Gantenbein[2]; J. Flamm[2]; W. Kasparek[3]; H. Höhnle[3]; C. Lechte[3]; A.G. Litvak[4]; G.G. Denisov[4]; A. Chirkov[4]; L.G. Popov[5]; V.O. Nichiporenko[5]; V.E. Myasnikov[5]; E.M. Tai[5]; E.A. Solyanova[5]; V.E. Malygin[5]
[1]IPP Garching, Germany; [2]KIT Karlsruhe, Germany; [3]IPF Stuttgart, Germany; [4]IAP Nizhny Novgorod, Russian Federation; [5]GYCOM, Russian Federation
The multi-frequency ECRH system at the ASDEX Upgrade tokamak employs depressed collector gyrotrons, step-tunable in the range 105-140 GHz. The system contains fast steerable launchers for remote steering of the beam during plasma discharges. The polarization can be controlled in feed-forward mode.

Tu-E1.5 298 **Collector Design Studies for a 1 MW Cylindrical-Cavity and a 4 MW Coaxial-Cavity Gyrotron**
S. Illy[1]; M. Beringer[1]; S. Kern[1]; M. Thumm[2]
[1]Karlsruhe Institute of Technology (KIT) / IHM, Germany; [2]Karlsruhe Institute of Technology (KIT) / IHM, IHE, Germany
In this paper we will present design studies for the collectors and collector sweeping systems of two different high power CW gyrotrons: a) The 1 MW 170 GHz cylindrical-cavity gyrotron for ITER, b) A 4 MW 170 GHz coaxial-

cavity gyrotron which at present is in the state of a design study.

Tu-E1.6 300 **Development of high power gyrotron for ITER application**

Keishi Sakamoto[1]; K. Kajiwara[1]; K. Takahashi[1]; Y. Oda[1]; A. Kasugai[1]; T. Kobayashi[1]; N. Kobayashi[1]; M. Henderson[2]; C. Darbos[2]
[1]Japan Atomic Energy Agency, Japan; [2]ITER Organization, France

Recent progress of 170GHz gyrotron development is presented. Demonstration of 800kW/600s repetitive operation, 5kHz power modulation at 1MW for 60s are presented. And a dual frequency gyrotron was fabricated and tested which operated at 170GHz and 137GHz.

11:00 - 12:30 Synchrotron Radiation Sources Room 11
Chair: U. Shade

Tu-F1.1 302 **Coherent Synchrotron Terahertz Radiation Using Electron Bunch Slicing**

I. Katayama[1]; H. Shimosato[2]; M. Bito[2]; K. Furusawa[2]; M. Adachi[3]; M. Shimada[4]; H. Zen[3]; S. Kimura[3]; N. Yamamoto[5]; M. Hosaka[5]; M. Katoh[3]; M. Ashida[6]
[1]Yokohama National University, Japan; [2]Osaka University, Japan; [3]Institute of Molecular Science, Japan; [4]KEK, Japan; [5]Nagoya University, Japan; [6]Osaka University, PRESTO JST, Japan

Coherent and strong terahertz wave is generated from a synchrotron storage ring using laser bunch slicing. The electric field is detected with the electro-optic sampling method using a Ti:sapphire oscillator for probe and a 24-m long large mode-area photonic crystal fiber for delivering it

Tu-F1.2 304 **Production of high power terahertz radiation through the SPARC Free-Electron Laser**

Stefano Lupi
Department of Physics, University of Rome La Sapienza, Italy

We present the TERASPARC project at the SPARC Free-Electron Laser. Sub-picosecond, nearly 100 microJ energy terahertz pulses extended until 5 THz are produced using a coherent transition radiation source. We discuss the possibility to produce exotic pulse shape and planned pump-probe experiment.

Tu-F1.3 306 **LINAC Based Coherent fs-THz Source at PAL**

Jaehun Park[1]; J. Lee[2]; H. Kang[1]; C. Kim[1]; S. Jung[1]; T. Joo[2]
[1]Pohang Accelerator Laboratory, Korea, Republic of; [2]Pohang University of Science and Technology, Korea, Republic of

The fs-THz beamline at PAL can supply ultrafast and intense fs-THz radiation from 75 MeV linac. The radiation covers up to 3 THz and the pulse width is less than 200 fs. This intense THz source has a great potential for new THz science.

Tu-F1.4 308 **The AILES Beamline for THz and IR spectroscopy**

P. Roy[1]; J.B. Brubach[1]; L. Manceron[2]; M. Rouzieres[1]; O. Pirali[3]; G. Creff[1]; W. Peng[1]; F. Kwabia-Tchana[4]
[1]Synchrotron-soleil, France; [2]LADIR, U. P. & M. Curie – CNRS, France; [3]LPPM, Orsay, France; [4]LISA-U. Paris XII- Créteil, France

The new infrared beamline (AILES) exploits infrared and THz synchrotron radiation from both edge emission and the constant field conventional source. The performances and the main research themes and future developments will

be presented.

Tu-F1.5 310 **Cerenkov Radiation from Plasmonic Metamaterials**

G.S. Park; J.K. So
Center for THz-Bio Application Systems, Department of Physics and Astronomy, Korea, Republic of

We explore the capability of various plasmonic metamaterials to generate Cerenkov radiation in the THz frequency range. The resulting Cerenkov radiation confirms the effective medium description of the considered metamaterials.

14:00 - 15:30 Detectors 2 Aula Magna
Chair: M.F. Kimmitt

Tu-A2.1 312 **Perspectives in the Design of Monolithic Focal Plane Arrays for Terahertz Active Spectroscopic Imaging**

Michele Ortolani[1]; E. Giovine[1]; A. Di Gaspare[1]; S. Cibella[1]; R. Leoni[1]; G. Torrioli[1]; F. Evangelisti[1]; V. Foglietti[1]; M.S. Vitiello[1]; G. Scamarcio[1]; A. Cetronio[2]; C. Lanzieri[2]; M. Peroni[2]; A. Doria[3]; E. Giovenale[3]; A. Petralia[3]; G.P. Gallerano[3]
[1]CNR-IFN, Italy; [2]SELEX S.I., Italy; [3]ENEA Frascati, Italy

Active spectroscopic imaging is based on arrays of broadband, short-response-time detectors observing a scene illuminated by a number of THz sources. We present system design, fabrication process and single-pixel test for 3 detector technologies: GaAs Schottky diodes, GaN transistors, Nb bolometers

Tu-A2.3 315 **Thin-Film Antennas for Terahertz Radiation Detectors**

Y. Yasuoka; T. Uchida
National Defense Academy, Japan

Receiving properties of thin-film antennas for antenna-coupled terahertz radiation detectors, especially receiving properties of thin-film slot antennas are discussed comparing the antenna theory and the data obtained at the frequencies of 5 GHz, 94 GHz, 700 GHz, 2.5 THz and 28 THz.

Tu-A2.4 317 **Plasmonic terahertz detectors/spectrometers**

Viacheslav Muravev; I.V. Kukushkin
Terasense Development Labs, Russian Federation

A miniature high speed THz and GHz electromagnetic radiation detector/spectrometer has been created. The operation principle is based on the excitation of distinct sets of plasma modes in the two-dimensional electron system of semiconductor heterostructure with embedded nonlinear defect.

Tu-A2.5 318 **Design and optimization of Microwave Kinetic Inductance Detectors**
M. Calvo[1]; C. Giordano[2]; A. Cruciani[1]; P. De Bernardis[1]
[1]Università di Roma La Sapienza, Italy; [2]Fondazione Bruno Kessler, Trento, Italy
We describe the design, optimization and optical tests of Microwave Kinetic Inductance Detectors for the mm and sub-mm wavelengths. Our detectors are based on a novel resonator design, and can be easily tuned to suit the different experimental needs by choosing the correct geometry.

14:00 - 15:30 Guiding Devices 1 & Thz Radiation Properties Aula Minor
Chair: A. Doria

Tu-B2.1 320 **Squeezing THz waves below /250 using plasmonic parallel-plate waveguides**
H. Zhan; R. Mendis; D.M. Mittleman
Rice University, United States
By tapering the width and the plate separation of a parallel-plate waveguide, we experimentally demonstrate THz confinement down to a spot-size of 10 μm (~λ/260) by 18 μm (~λ//145), corresponding to a mode area of 2.6×10-5 λ2

Tu-B2.2 323 **Return Loss Measurement of a Microfabricated Slow-Wave Structure for Backward-Wave Oscillation**
Chan-Wook Baik[1]; S.Y. Jun[2]; H.Y. Ahn[1]; S. Hong[1]; J.H. Lee[1]; S.G. Yu[2]; J.M. Kim[1]
[1]Samsung Advanced Institute of Technology, Korea, Republic of; [2]Department of Physics, Hankuk University of Foreign Studies, Korea, Republic of
A RF return loss was measured for a microfabricated W-band slow-wave structure. A deep reactive ion etching showed a good sidewall but inaccurately curved bottom surface. The result represents the etch rate was strongly dependent on the mask-opening area, which caused a frequency shift of about 5%.

Tu-B2.3 324 **Extension of Thompson Scattering Concept to Terahertz Region**
Dariush Sardari
Islamic Azad University, Iran
Thomson scattering is a phenomenon taking place for low energy X and gamma ray photons. Using existing data on terahertz reflection coefficient, it is shown that Thompson scattering is a plausible explanation for terahertz reflection from surfaces.

Tu-B2.4 326 **Ag/PS hollow cylindrical waveguides for transmission of THz pulses**
Oleg Mitrofanov[1]; T.K. Mavrogordatos[2]; R. James[1]; F.A. Fernandez[1]; J.A. Harrington[3]
[1]University College London, United Kingdom; [2]Cambridge University, United Kingdom; [3]Rutgers University, United States
Dielectric-lined silver waveguides provide a solution for guiding THz pulses which exhibits low losses, excellent mode quality and low dispersion. To understand the waveguide characteristics modal dispersion is analyzed using THz near-field microscopy, time-domain spectroscopy and numerical

modeling

Tu-B2.5 328 **High refractive index titania-doped polymers for THz hollow Bragg fibers: how absorption losses limit the index contrast**

B. Ung[1]; A. Dupuis[2]; M. Skorobogatiy[1]
[1]Ecole Polytechnique de Montreal, Canada; [2]Ecole Polytechnique, Canada

The bandgaps of Bragg fibers are tuned by the refractive index contrast and thicknesses of the multilayer dielectric reflector. We demonstrate that the design of reflectors based on composite polymers depends on finding a compromise between the increase in index contrast and the accompanying losses.

14:00 - 15:30 Laser Driven Sources 1 Room 2
Chair: D. Abbott

Tu-C2.1 330 **Mesa Structured Photoconductive Antennas for 1.5 µm: All-Fibre THz-TDS Spectroscopy Beyond 4 THz**

R.J.B. Dietz; H. Roehle; D. Stanze; V. Montanaro; H.J. Hensel; M. Schell; B. Sartorius
Fraunhofer Heinrich-Hertz-Institut, Germany

Photoconductive antennas based on InGaAs/InAlAs for operation at 1.5 µm are improved by employing special structuring techniques, i.e. mesa etching. The detected THz amplitude is increased by a factor of over 27. The spectra show a significantly increased bandwidth exceeding 4 THz.

Tu-C2.2 333 **THz Wave Generation Inside a Fiber Laser Pumped High-Finesse Ring-Cavity OPO**

Walter Hurlbut[1]; V.G.K. Kozlov[1]; K.L.V. Vodopyanov[2]
[1]Microtech Instruments, United States; [2]Stanford University, United States

We produce tunable (1.3-3 THz) narrow-band THz waves using a fiber-laser pumped near-degenerate type 0 PPLN OPO. Over 130 µW of narrowband THz waves were generated at 1.5 THz in a periodically-inverted gallium arsenide sample using intracavity difference frequency generation.

Tu-C2.3 335 **Experimental and theoretical study of photoconductive short electrical pulses generation at high repetition rate**

J.L. Coutaz; J.F. Roux
IMEP-LAHC, Universite de Savoie, France

We have studied the generation of ps electrical pulses at high repetition rate using photoconductive antenna. Experimentation and simulation show that screening of the biasing electrical field occurs much after the trapping time scale of the free carriers leading to a strong decrease of the signal.

Tu-C2.4 337 **Enhanced Terahertz Emission from Metaatom-Loaded Photoconductive Antennas**

K. Takano[1]; T. Kawabata[1]; K. Murata[2]; K. Masuda[3]; F. Miyamaru[4]; M. Hangyo[1]
[1]Osaka University, Japan; [2]AIST, Japan; [3]SIJTechnology, Inc., Japan; [4]Shinshu University, Japan

Photoconductive antennas loaded with metaatoms have been fabricated by the super-fine ink-jet printing technology to control terahertz emission characteristics. The resonant enhancement has been observed at the LC

resonant frequencies of the metaatom and it is analyzed by the FDTD simulation.

Tu-C2.5 339 **Terahertz Wave Generation from GaP Waveguide Emitter Pumped by Compact Photonic Crystal Fiber Femtosecond Laser**

F. Liu[1]; Y.F. Li[2]; L. Chai[2]; Y.J. Song[2]; C.L. Wang[1]; M.L. Hu[2]; Q.R. Xing[1]; C.Y. Wang[2]
[1]Ultrafast Laser Lab.,Center for Terahertz Wave, Tianjin University, China; [2]Ultrafast Laser Lab., Tianjin University, China

We present a terahertz pulse train generated from rectangular GaP waveguide emitter pumped by a photonic crystal fiber (PCF) femtosecond laser system, and studied the effects of the pump pulse shape working on the terahertz conversion efficiency and the generated THz spectrum.

14:00 - 15:30 Biology 2 Room 3
Chair: A. Ramundo Orlando

Tu-D2.1 341 **Molecular Imaging with Terahertz Waves**

Joo-Hiuk Son
University of Seoul, Korea, Republic of

A novel terahertz molecular imaging technique using nanoparticle probes is discussed in terms of sensitivity, resolution, and quantification. The in-vivo diagnostic results of cancers are also presented as an example.

Tu-D2.2 342 **Temperature and Hydration-Dependent THz Investigations on Proteins**

Martin Dressel; c. Stehle; W. Abuillan; B. Gompf
Universitat Stuttgart, Germany

The FIR absorption of proteins decreases with temperature and increases with hydration. The amount of water attached to the protein is calculated by a general sorption isotherm equation. Comparing with the measured absorption the specific dynamic of the hydration shell can be extracted.

Tu-D2.3 343 **Hydration Dynamics of Proteins Probed by THz Spectroscopy**

B.P. Born; M. Heyden; M. Havenith
Physikalische Chemie 2, Ruhr-Universitaet, Germany

We applied THz spectroscopy to study water dynamics around proteins. Unexpectedly we found extended dynamical hydration up to 20 Å from protein surfaces. Moreover by kinetic THz absorption (KITA) spectroscopy we figured out that protein and water network dynamics are coupled during protein folding.

Tu-D2.4 345 **Time Domain Terahertz Spectroscopy for investigating the dielectric relaxation dynamics of water in model membranes**

Domenico Paparo[1]; K.J. Tielrooij[2]; L. Piatkowski[2]; H.J. Bakker[2]; M. Bonn[2]
[1]CNR-SPIN, Italy; [2]FOM-AMOLF, Netherlands

We have investigated hydrated model membranes, formed by stacked bilayers of unsaturated lipids, by means of terahertz time-domain and infrared spectroscopy. When the membrane hydration level is decreased the appearance of new types of water dynamics is observed due to the lipid-water interactions

.

Tu-D2.5 347 **Study on hydrogen bonding patterns in biological molecules by reaction induced far infrared spectroscopy**

Petra Hellwig[1]; Y. El Khoury[2]; A. Trivella[2]; R. Hielscher[2]
[1]Université de Strasbourg, Institut de Chimie, France; [2]University of Strasbourg, France

The use of the far IR spectral range presents a novel approach for analysis of proteins. Here it is presented for the analysis of Fe–S vibrations (500–200 cm-1) and of the intra- and intermolecular H-bonding signature (300–50 cm-1) in Rieske proteins and lipids in function of T, redox state and pH.

14:00 - 15:30 Microscopy Room 7
Chair: R. Lewis

Tu-E2.1 349 **Chemical Imaging of -TAS using Terahertz Chemical Microscope**

Toshihiko Kiwa[1]; Y.M. Yuji Minami[1]; Y.K. Yusuke Kondo[1]; Y.H. Yohei Hashimoto[1]; I.K. Iwao Kawayama[2]; M.T. Masayoshi Tonouchi[2]; K.T. Keiji Tsukada[1]
[1]Graduate School of Natural Science & Technology, Okayama University, Japan; [2]Institute of Laser Engineering, Osaka University, Japan

A terahertz chemical microscope (TCM) has been carried out to visualize the chemical potential distribution in μ-TAS. The μ-TAS was fabricated on the sensing chip and the distribution of chemical potential was successfully visualized using TCM.

Tu-E2.2 351 **Pump and Probe THz Emission Microscope**

M. Tonouchi; S. Fujiwara; D. Kaneko; I. Kawayama; H. Murakami
Osaka University, Japan

Pump and probe THz emission microscope has been developed with a special resolution of less than 1 μm, and applied for the study of dynamic response of photoconductive antennas made of SI- GaAs, LT- GaAs, and Fe-InP.

Tu-E2.3 353 **Influence of the Dielectric Substrate on the Terahertz Electric Near-Field of a Hole in a Metal**

Aurele Adam[1]; L. Guestin[1]; P.C.M. Planken[2]
[1]Technical University of Delft, Netherlands; [2]technical University of Delft, Netherlands

We have studied theoretically and experimentally the influence of a dielectric substrate on the frequency-dependent terahertz electric near-field of a small hole in a metal layer. The thickness of the metal layers dramatically influences this result.

Tu-E2.4 354 **Scattering near-field microscopy in the THz region using a free-electron laser**

H.G.R. von Ribbeck[1]; M.T.W. Wenzel[1]; R.J. Rainer Jacob[2]; L.M.E. Eng[1]
[1]Institut für Angewandte Photophysik, Technische Universität Dresden, Germany, Germany; [2]Institut für Ionenstrahlphysik und Materialforschung, FZ Dresden-Rossendorf, Germany

We present scattering-type scanning near-field optical micro-spectroscopy (s-SNOM) investigations operated in the THz range with a wavelength independent spatial resolution of <150 nm. As a variable and monochromatic

radiation source we use the free-electron laser (FELBE) at Dresden-Rossendorf.

Tu-E2.5 355 **Image contrast of THz near-field microscope**

K. Moon; E. Jung; M. Lim; H. Han
POSTECH, Korea, Republic of

We present an apertureless THz pulse near field microscopy (THz-NFM) system. Approach curves are obtained for Au films and float-zone Si wafers, and are analyzed by using self-consistent image method (SCIM).

14:00 - 15:30 Vacuum Electron Devices Room 11
Chair: N. Luhmann

Tu-F2.1 357 **Design and Fabrication of Terahertz Extended Interaction Klystrons**

Richard Dobbs[1]; A. Roitman[1]; P. Horoyski[1]; M. Hyttinen[1]; D. Sweeney[1]; B. Steer[1]; K. Nguyen[2]; E. Wright[2]; D. Chernin[3]; A. Burke[3]; J. Calame[4]; B. Levush[4]; N.S. Barker[5]; J. Booske[6]; M. Blank[7]
[1]Communications & Power Indutries Canada, Canada; [2]Beam-Wave Research, United States; [3]Science Applications International Corp, United States; [4]Naval Research Laboratory, United States; [5]University of Virginia, United States; [6]University of Wisconsin, United States; [7]Communications & Power Industries, United States

The development of new terahertz power amplifiers at 0.67, 0.85 and 1.03 THz presents significant challenges in both design and fabrication. This paper describes the design challenges and methodology and an outline design of the new device and an analysis of fabrication techniques considered.

Tu-F2.2 360 **High Current Density, Reservoir Cathodes for High Frequency Applications**

R. Lawrence Ives[1]; L.R. Falce[2]; G. Collins[1]; D. Marsden[1]; G. Miram[1]; S. Schwartzkopf[3]; B. Smith[3]
[1]Calabazas Creek Research, Inc., United States; [2]Consultant, United States; [3]Ron Witherspoon, Inc., United States

Sintered tungsten wire, reservoir cathodes offer high current density operation with very long life time. The diffusion rate can be selected consistent with the current emission density. This presentation will describe the impact of this technology, and present the latest test results.

Tu-F2.3 362 **Modeling of the G-band Extended Interaction Klystron Using the Large-signal Code TESLA**

Igor Chernyavskiy[1]; A.N. Vlasov[2]; T.M. Antonsen[3]; D. Chernin[1]; B. Levush[2]; M. Hyttinen[4]; A. Roitman[4]; P. Horoyski[4]; R. Dobbs[4]; D. Berry[4]
[1]SAIC, United States; [2]Naval Research Laboratory, United States; [3]University of Maryland, United States; [4]CPI, Canada

Large-signal modeling of the 220 GHz Extended Interaction Klystron (EIK) were performed by using the klystron code TESLA. The results of TESLA simulations are discussed and compared with the known experimental data.

Tu-F2.4 364 **Numerical and Experimental Investigation of a 35 GHz 20-Vane Spatial-Harmonic Magnetron**

J.I. Kim[1]; S.G. Jeon[1]; G.J. Kim[1]; J.H. Kim[1]; V.D. Yeryomka[2]; A.S. Tishchenko[2]; V.D. Naumenko[3]
[1]Korea Electrotechnology Research Institute, Korea, Republic of; [2]Institute of Radio Physics and Electronics, Ukraine; [3]Institute of Radio Astronomy, Ukraine

A 35 GHz 3 kW spatial-harmonic magnetron employing 20-vane resonator is numerically and experimentally investigated. Simulated output power is 3.2 kW at beam voltage of 6.5 kV and anode current of 4 A using 3D PIC simulation. The measured resonant frequency for operation mode of p = 16 is 34.96 GHz.

Tu-F2.5 366 **Surface field cavity based on a two-dimensional cylindrical lattice**

Alan Phelps[1]; I.V. Konoplev[1]; L. Fisher[1]; A.W. Cross[1]; K. Ronald[1]; C.W. Robertson[1]; M. Thumm[2]
[1]University of Strathclyde, United Kingdom; [2]Karlsruhe Institute of Technology, Germany

A Ka-band cavity based on a two-dimensional periodic lattice is studied. The apparatus designed to excite the cavity is discussed. Coupling between the surface and volume fields is demonstrated and pulse propagation through the cavity is investigated. The measurements agree well with simulations.

16:00 - 17:45 Materials 3 Aula Magna
Chair: M. Tonouchi

Tu-A3.1 368 **Time-resolved terahertz spectroscopy of black silicon**

H.P. Porte[1]; D. Turchinovich[1]; S. Persheyev[2]; Y. Fan[2]; M.J. Rose[2]; P.U. Jepsen[1]
[1]DTU Fotonik - Department of Photonics Engineering, Technical University of Denmark, Denmark; [2]School of Engineering, Physics and Mathematics, University of Dundee, United Kingdom

The ultrafast photoconductivity dynamics of black silicon is measured by time-resolved terahertz spectroscopy. We show that the maximum photoconductivity as well as the decay time of the photoconductivity depends on the annealing method and fluence used in the production process.

Tu-A3.2 371 **Material parameter extraction in THz-TDS using a converging beam transfer function**

A.L. Chung[1]; Z. Mihoubi[1]; G.J. Daniell[1]; A.H. Quarterman[1]; K.G. Wilcox[1]; H.E. Beere[2]; D.A. Ritchie[2]; A.C. Tropper[1]; V. Apostolopoulos[1]
[1]University of Southampton, United Kingdom; [2]University of Cambridge, United Kingdom

We demonstrate a parameter extraction algorithm based on a theoretical transfer function which takes into account a converging THz beam. Using this we successfully extract material parameters from data obtained for a quartz sample with a THz time domain spectrometer.

Tu-A3.3 373 **Higher Order Conformation of Poly(3-hydroxyalkanoate)s Studied by Terahertz Time-Domain Spectroscopy**

Hiromichi Hoshina[1]; Y. Morisawa[2]; H. Sato[2]; Y. Ozaki[2]; C. Otani[1]
[1]RIKEN Advanced Science Institute, Japan; [2]Kwansei Gakuin University, Japan

Terahertz absorption spectra of Poly(3- hydroxybutyrate)s were measured. The orientation of the transition dipole moment was investigated by the polarization spectra. The temperature dependence of the spectra reflects the change in the hydrogen bonding distance of the crystalline structure.

Tu-A3.4 374 **Effectiveness of microwave electromagnetic shielding in carbon based epoxy nanocomposites**

Stefano Bellucci[1]; L. Coderoni[1]; F. Micciulla[1]; G. Rinaldi[2]; I. Sacco[1]; A. Paddubskaya[3]; D. Bychanok[3]; A. Plushch[3]; P. Kuzhir[3]; S. Maksimenko[3]; M. Shuba[3]; S. Slepyan[3]; J. Macutkevic[4]; D. Seliuta[4]; G. Valusis[4]; J. Banys[5]
[1]INFN-LNF, Italy; [2]University of Rome "Sapienza", Italy; [3]Belarusian State University, Belarus; [4]Semiconductor Physics Institute, Lithuania; [5]University of Vilnius, Lithuania

We report on the comparative study of the effectiveness of electromagnetic shielding provided by different forms of nanocarbon dispersed in resin.

Tu-A3.5 376 **Photon Helicity Driven Electric Currents in Graphene**

Sergey Ganichev[1]; J. Karch[1]; P. Olbrich[1]; M. Schmalzbauer[1]; C. Zoth[1]; C. Brinsteiner[1]; U. Wurstbauer[1]; M.M. Glazov[2]; S.A. Tarasenko[2]; D. Weiss[1]; J. Eroms[1]; R. Yakimova[3]; S. Lara-Avila[3]; S. Kubatkin[4]; E.L. Ivchenko[2]
[1]Terahertz Center, Germany; [2]Ioffe Physical-Techanical Institute, Russian Federation; [3]Linkoeping University, Sweden; [4]Chalmers University of Technology, Sweden

We observed photon helicity driven currents in graphene. Illuminating unbiased monolayer graphene samples with THz laser radiation at room temperature under oblique and normal incidence causes directed electric currents. This includes currents, which are solely driven by the light's helicity.

Tu-A3.6 377 **Dielectric RF properties of CVD diamond disks from sub-mm wave to THz frequencies**

T.A. Scherer; A. Scheuring; P. Probst; A. Stockhausen; K. Illin; M. Prof. Dr. Siegel; A. Meier; D. Strauss
KIT Karlsruhe, Germany

ITER torus windows with CVD diamond disks for high power heating applications (170 GHz, 1-2 MW) are being investigated by different low- and high power measurement setups in the frequency range of 90 to 170 GHz.

16:00 - 17:45 Near Field Devices 1 Aula Minor
Chair: J.L. Coutaz

Tu-B3.1 379 **Terahertz near-field imaging using a Y splitter and Sommerfeld wire waves on bare metal rods**
J.P. Guillet[1]; L. Chusseau[1]; R. Adam[1]; T. Laurent[1]; T. Grosjean[2]; A. Penarier[2]; D. Charraut[2]
[1]Institut d'Électronique du Sud, France; [2]FEMTO-ST, France
We describe a near-field experiment using a Y splitter supporting cw THz Sommerfeld wire modes coupled and decoupled with differential phase plates. Owing to a taper up to ~50 µm of one of the Y ends, a near-field imaging resolution of ~90 µm is demonstrated in agreement with calculations.

Tu-B3.2 382 **Resonance frequency shifts of rectangular holes on finite dielectric substrates**
H.R. Park[1]; S.M. Koo[1]; O.K. Suwal[2]; Y.M. Park[1]; J.S. Kyoung[1]; M.A. Seo[1]; S.S. Choi[2]; N.K. Park[1]; D.S. Kim[1]; K.J. Ahn[1]
[1]Seoul National University, Korea, Republic of; [2]Sun Moon University, Korea, Republic of
We observe that rectangular holes fabricated in a gold film with a sub-skindepth thickness show blue-shifted resonance frequencies as the width increases. Moreover, for rectangular holes on a finite substrate its thickness and the hole width are crucial factors determining the resonance frequency.

Tu-B3.3 384 **Frequency Selective Surfaces (FSS) and Metal Mesh Filters for THz Applications**
Carole Tucker; P.A.R. Ade
Cardiff University, United Kingdom
FSSs have been used for over 30 years to make filters in the far infrared and submm region, which can have low-, high- and band-pass properties. We present the current state of the art with respect to these quasi-optical components in the form of spectral data for fully realized, operational devices

Tu-B3.4 385 **Metal-mesh broadband anti-reflection coatings in the THz frequencies.**
Jin Zhang[1]; P.A.R. Ade[1]; P.D.M. Mauskopf[1]; G. Savini[2]
[1]Cardiff University, United Kingdom; [2]University College London, United Kingdom
We have recently designed, built and measured an alternative to the use of classical dielectric material in anti-reflection coatings. A metal-mesh pattern has been designed to cover a frequency band greater than 90%. We discuss measurements and illustrate the extension for bi-refringent materials.

Tu-B3.5 387 **Study of Optically Controlled Active Frequency Selective Surfaces with Organic Semiconductor**
H. Su; X. Liu; D. Li; X. Chen; R.S. Donnan; C.G. Parini; T. Kerouzis
Queen Mary, University of London, United Kingdom
Active Freuqency Selective Surfaces having tunable or reconfigurable frequency response received more and more attention. In this study, a new means of active FSS is reported. By printing the unit elements of FSS on an organic semiconductor, the optically controlled frequency response is achieved.

Tu-B3.6 389 **Design of Terahertz Tunable Filter Using Subwavelength Metallic Slit Arrays**

Sanaz Zarei
University of Michigan, United States

A high quality tunable filter at terahertz frequencies has been designed using subwavelength metallic slit arrays. The bandpass center frequency is tunable over the range of 0.592THz to 0.994THz. Tunning is achieved by relative vertical movement of the subwavelength metallic slit layers.

16:00 - 17:45 Laser Driven Sources 2 Room 2
Chair: J. Alton

Tu-C3.1 391 **Wide frequency range high resolution THz spectroscopy with using continuous-wave GaP THz Signal Generator and its application to defect detection**

Tetsuo Sasaki[1]; J.-.i. Nishizawa[1]; T. Tanabe[2]
[1]Sophia University, Japan; [2]Tohoku University, Japan

We developed automatic scanning GaP continuous wave THz Signal Generator and Spectrometer. The features of the spectrometer are higher resolution, higher measurement speed, smaller size, easier operation, etc. compared with the spectrometer using pulse-type THz Signal Generator as a light source.

Tu-C3.3 394 **THz Emission from a Femtosecond Laser Focus in a Bicolor Scheme in the Ionization-free Regime**

A.P. Shkurinov; A.V. Andreev; A.V. Borodin; M.N. Esaulkov; M.M. Nazarov; S.Y. Stremoukhov
Department of Physics, M.V.Lomonosov Moscow State University, Russian Federation

The interaction between high intensity ultrashort laser pulses and the atomic gas in the ionization-free regime leads to the emission of coherent, short pulse radiation at terahertz frequency. In this work we discuss a model for this effect and its experimental realization.

Tu-C3.4 396 **Terahertz generation in locally plasma-activated silicon nanophotonic waveguides**

M. Nagel[1]; M. Wächter[1]; C. Matheisen[1]; M. Waldow[1]; T. Wahlbrink[2]; J. Bolten[2]; H. Kurz[2]
[1]RWTH Aachen University, Germany; [2]AMO GmbH, Germany

We present a novel approach for efficient terahertz signal generation at silicon nanophotonic waveguides via electro-optic difference frequency generation

using telecom wavelengths excitation pulses. Second-order nonlinearity of silicon is achieved by plasma-activated surface modification.

Tu-C3.5 398 **Generation of THz Radiation in a Laser Spark**

Evgeny Suvorov
Institute of Applied Physicsa of Russian Academy of Sciences, Russian Federation

A brief review of experimental and theoretical activity in IAP RAS on the generation of THz radiation in a laser spark produced by femtosecond optical pulses has been presented.

16:00 - 17:45 Detectors 3 Room 3
Chair: A. Hadni

Tu-D3.1 400 **Terahertz Detection and Emission by Field Effect Transistors: influence of transistor geometry and high magnetic fields**

W. Knap[1]; D. Coquillat[1]; F. Teppe[2]; N. Dyakonova[2]
[1]GES, UMR5650, Universite Montpellier II, France; [2]GES, UMR5650, Université Montpellier II, France

We review the most important results concerning the physics and applications of FETs as Terahertz detectors and emitters [1, 2]. Particularly we stress recent results on THz detection and emission as a function of the FET's geometry and external quantizing magnetic fields.

Tu-D3.3 403 **An integrated 520-600 GHz sub-harmonic mixer and tripler combination based on GaAs MMIC membrane planar Schottky diodes**

A. Maestrini[1]; B. Thomas[2]; C. Lee[2]; R. Lin[2]; S. Sin[2]; I. Mehdi[2]
[1]Observatoire de Paris, LERMA, France; [2]NASA - Jet Propulsion Laboratory, United States

We present the design, development and test of an integrated 560 GHz sub-harmonic mixer and a 280 GHz frequency tripler based on GaAs MMIC planar Schottky diodes in a single cavity. The mixer/tripler block has been fabricated using conventional metal and silicon micromachining. Tests are presented.

Tu-D3.4 405 **AlGaN/GaN Heterostructure Transistors for the Generation and Detection of THz Radiation**

Ennio Giovine[1]; A. Di Gaspare[2]; M. Ortolani[2]; F. Evangelisti[2]; F. Foglietti[2]; A. Cetronio[3]; C. Lanzieri[3]; M. Peroni[3]; A. Doria[4]; E. Giovenale[4]; G.P. Gallerano[5]; I. Spassovsky[6]; D. Dominijanni[7]
[1]CNR- Istituto di Fotonica e Nanotecnologie, Italy; [2]CNR - Istituto di Fotonica e Nanotecnologie, Rome, Italy; [3]SELEX Sistemi Integrati, Italy; [4]ENEA - Centro Ricerche Frascati, Italy; [5]ENEA, Italy; [6]ENEA- Centro Ricerche Frascati, Rome, Italy; [7]CNR- Istituto di Fotonica e Nanotecnologie, Rome, Italy

AlGaN/GaN heterostructure is an excellent candidate for sub-mm wave power amplifiers, which can serve as integrated power source for THz frequency multipliers. We discuss the operation of AlGaN/GaN transistors as THz detectors, which provides information on the electron systems at THz frequencies.

Tu-D3.5 407 **Room Temperature Terahertz Detection in High-Electron-Mobility Transistor Structure using InAlAs/InGaAs/InP Material Systems**

A. El Moutaouakil[1]; T. Suemitsu[1]; T. Otsuji[1]; D. Coquillat[2]; W. Knap[2]
[1]Research Institute of Electrical Communication, Tohoku University, Japan; [2]Groupe d'Etude des Semiconducteurs (GES), Montpellier 2 University, France

We report on non-resonant terahertz detection using the rectification mechanism of the two-dimensional plasmons in InAlAs/InGaAs/InP high-electron-mobility transistors at 300K, demonstrating excellent sensitivity/noise performances of ~125 V/W and ~10-11 W/Hz0.5 for 0.30THz radiation.

Tu-D3.6 409 **A Wide-Band Wavelength-Tunable Terahertz Detector Using a Graphene Transistor**

Yukio Kawano; K. Ishibashi
RIKEN, Advanced Device Laboratory, Japan

We report on a novel type of wavelength-tunable terahertz (THz) detector based on a graphene transistor. We have demonstrated that the graphene under a magnetic field has the ability to detect THz waves in a wide range of 1.6-33THz. Further enhancement of the detection performance will be discussed.

16:00 - 17:45 Gyrotrons 3 Room 7
Chair: A. Phelps

Tu-E3.1 410 **140 GHz, 1 MW CW Gyrotron Development for the ECH System of the Stellarator W7-X**

Gerd Gantenbein[1]; V. Erckmann[2]; S. Illy[1]; S. Kern[1]; W. Kasparek[3]; C. Lechte[3]; W. Leonhardt[1]; C. Lievin[4]; A. Samartsev[1]; A. Schlaich[1]; M. Schmid[1]; M. Thumm[1]
[1]Karlsruhe Institute of Technology (KIT), Association EURATOM-KIT, Germany; [2]Max-Planck-Institut fuer Plasmaphysik, Teilinstitut Greifswald, Association EURATOM, Germany; [3]Universitaet Stuttgart, Institut fuer Plasmaforschung, Germany; [4]Thales Electron Devices, France

A 10 MW, 140 GHz ECRH system is currently under construction for the stellarator W7-X. The RF power will be provided by 10 gyrotrons. A

European collaboration has been established to develop and build the 10 gyrotrons each with an output power of 1 MW for continuous wave (CW) operation.

Tu-E3.2 413 **Amplification of Picosecond Pulses in a 140 GHz Gyro-TWT**

Emilio Nanni; H.J. Kim; M.A. Shapiro; R.J. Temkin; P. Woskov
Massachusetts Institute of Technology, United States

We report amplification of pulses as short as 400 ps in a 1 kW, 140 GHz gyro-TWT. The pulses are broadened by group velocity dispersion and spectral narrowing due to finite gain bandwidth. To our knowledge, this is the first observation of picosecond pulse amplification in a vacuum electron device.

Tu-E3.3 416 **Collector loading during high frequency power modulation**

Harald Braune[1]; V. Erckmann[1]; S. Illy[2]; H.P. Laqua[1]; G. Michel[1]; F. Noke[1]; F. Purps[1]
[1]Max-Planck-Institut für Plasmaphysik Greifswald, Germany; [2]Karlsruher Institute of Technology (KIT), Germany

The high frequency power modulation of cw gyrotrons with an output power up to 1MW is limited by collector loading. 2 power modulation schemes are applied and waste power remains which must be dissipated in the collector. Different sweep technologies have been developed in order to avoid overheating

Tu-E3.4 418 **Numerical Simulation of Low-Frequency Collective Processes in Gyrotron Electron Beams**

O. Louksha
St. Petersburg State Polytechnical University, Russian Federation

We simulate collective processes in the electron space charge trapped between the cathode and the magnetic mirror in gyrotrons. The characteristics of parasitic low-frequency oscillations in the trap and their influence on the parameters of the electron beam entering the cavity are studied.

Tu-E3.5 420 **Operational capabilities studies of the 140GHz/1MW/TE28,8 W7-X gyrotron operated at 126GHz/TE26,7 in view of the upgrade of the TCV EC-system**

Stefano Alberti; J.P. Hogge; I. Pagonakis; T.M. Tran; M.Q. Tran
CRPP/EPFL, Switzerland

A detailed study of the operational capabilities of the W7-X gyrotron operated at 126GHz/TE26,7 is presented. This study is associated with the foreseen upgrade of TCV in which it is planned to add to the present EC system 3MW of additional rf power bringing the total EC-power to 7.5MW.

16:00 - 17:45 Ultra Fast Measurements Room 11
Chair: D. Mittleman

Tu-F3.1 422 **Longitudinal Fields in Focused Radially Polarized Terahertz Beams**

Stephan Winnerl; R. Hubrich; F. Peter; H. Schneider; M. Helm
FZ Dresden-Rossendorf, Germany

We study the spatial and temporal structure of focused THz beams of radial polarization. Strong longitudinal field components localized at the axis of propagation are observed. The phase of the longitudinal field components is shifted by $\pi/2$ with respect to the transverse field components.

Tu-F3.2 424 **Measurement of higher-order exciton resonances in GaAs quantum wells via shift-current-THz-spectroscopy at room temperature**

Shekhar Priyadarshi[1]; K. Pierz[1]; U. Siegner[1]; P. Dawson[2]; M. Bieler[1]
[1]Physikalisch-Technische Bundesanstalt, Germany; [2]School of Physics and Astronomy, University of Manchester, United Kingdom

We generate ultrafast photocurrents in GaAs quantum wells and measure the simultaneously emitted THz radiation. This THz spectroscopy allows for the detection of higher-order exciton resonances at room temperature. This method can be more sensitive than conventional photoluminescence experiments.

Tu-F3.3 426 **Intraexciton terahertz nonlinear optics in semiconductor quantum wells: sideband generation and AC Stark splitting**

Manfred Helm[1]; M. Wagner[1]; H. Schneider[1]; D. Stehr[1]; S. Winnerl[1]; A.M. Andrews[2]; S. Schartner[2]; G. Strasser[2]
[1]Forschungszentrum Dresden-Rossendorf, Germany; [2]TU Wien, Austria

We investigate nonlinear optics related to the intra-excitonic 1s-2p heavy-hole transition in GaAs/AlGaAs quantum wells. Tuning intense terahertz (THz) light around this resonance we report (i) efficient second order sideband generation and (ii) first clear evidence of the Autler-Townes effect.

Tu-F3.4 428 **Pulsed cyclotron resonance measurements with a rapid-scanning, fiber-coupled THz TDS system**

D. Molter[1]; S. Georges[2]; M. Goiran[2]; F. Keilmann[3]; R. Beigang[1]; J. Leotin[4]
[1]Fraunhofer Institute for Physical Measurement Techniques IPM, Germany; [2]Laboratoire National des Champs MAgnetiques Intenses, France; [3]Max Plank Institute of Quantum Optics, Germany; [4]Laboratoire National des Champs Magnetiques Intenses, France

We present time-resolved cyclotron resonance spectra of holes in p-germanium measured during a single magnetic field pulse by using a rapid-scanning, fiber-coupled THz time-domain spectroscopy system.

Tu-F3.5 430 **Time-Resolved THz-Spectroscopy of InAs Nano-Wires**

S.S. Prabhu
Tata Institute of Fundamental Research, India

We study the emission mechanisms of THz radiation from InAs nanowires (NWs) using femtosecond infra-red (IR) pump beam and THz probe in a time-resolved reflection geometry setup at room temperature. We compare the spectra of InAs NWs with that of a p-InAs crystal which is standard THz emitter.

Tu-F3.6 431 **Equivalent Circuit Analysis of a Planar Helix Slow-Wave Structure for Application in High Frequency Traveling-Wave Tubes**

S.K. Datta
Microwave Tube Research & Development Centre, India

A planar helix slow-wave structure was analyzed for its equivalent circuit parameters. For identical situations with respect to the structure parameters, the planar helix shows a greater promise for higher device efficiency over a wider frequency range than the circular helix.

17:45 - 19:15 Tuesday Poster Chiostro

Tu-P.01 433 **Influence of Possible Reflections on the Operation of the European Cylindrical Cavity Gyrotron for ITER**

Olgerts Dumbrajs
Institute of Solid State Physics, University of Latvia, Latvia

Influence of reflections on operation of gyrotrons with radial output is studied both theoretically and experimentally. By way of example the European ITER cylindrical cavity gyrotron operating in the TE32,09 mode at frequency 170 GHz is considered.

Tu-P.02 435 **Status of the EU 170 GHz/2 MW/CW Coaxial Cavity Gyrotron for ITER: The Dummy Gun Experiment**

I. Pagonakis[1]; S. Alberti[1]; S. Illy[2]; S. Kern[2]; C. Liévin[3]; B. Piosczyk[2]; J.-.P. Hogge[1]; Q.M.T. Tran, Q.M.[1]
[1]CRPP-EPFL, Switzerland; [2]IHM-KIT, Germany; [3]TED, France

A mock-up gun has been manufactured exact replica of the refurbishment first prototype EU 170 GHz/2MW/CW coaxial cavity gyrotron, but without emitter ring, in order to validate the voltage standoff stability. The experimental results will be presented.

Tu-P.04 437 **Progress of a Multi-Megawatt Gyrotron System for Electron Cyclotron Heating on the Large Helical Device**

Takashi Shimozuma[1]; S. Kubo[1]; Y. Yoshimura[1]; H. Igami[1]; H. Takahashi[1]; S. Kobayashi[1]; S. Ito[1]; Y. Mizumo[1]; K. Okada[1]; Y. Takita[1]; T. Mutoh[1]; H. Idei[2]; R. Minami[3]; T. Kariya[3]; T. Imai[3]
[1]National Institute for Fusion Science, Japan; [2]Kyushu University, Japan; [3]University of Tsukuba, Japan

In LHD, an ECH system for fusion-relevant plasma heating has been greatly progressed with the development of megawatt gyrotrons. Net power of 3.7 MW could be injected into LHD. For stable operation, a new position and profile monitor of the mmw-beams in evacuated transmission lines is developed.

Tu-P.05 439 **Multi-frequency Gyrotron for ASDEX Upgrade**

Vadim Myasnikov[1]; V.O. Nichiporenko[1]; L.G. Popov[1]; V.E. Myasnikov[1]; M.V. Agapova[1]; Y.N. Belov[1]; A.P. Gnedenkov[1]; V.N. Ilyin[1]; V.I. Irkhin[1]; I.V. Kazansky[1]; A.V. Kruglov[1]; V.G. Rukavishnikova[1]; N.A. Shamanova[1]; E.A. Soluyanova[1]; E.M. Tai[1]; S.V. Usachev[1]; A.G. Litvak[2]; A.V. Chirkov[2]; G.G. Denisov[2]; A.N. Kuftin[2]; V.I. Malygin[2]; V.E. Zapevalov[2]; H. Zohm[3]; J.K. Stober[3]; D.H. Wagner[3]; F. Leuterer[3]; F. Monaco[3]; M.J. Munich[3]; H. Schuetz[3]; V.E. Myasnikov[4]
[1]GYCOM, Russian Federation; [2]IAP RAS, Russian Federation; [3]IPP, Germany; [4]GYCOM Ltd, Russian Federation

Abstract — a multi-frequency gyrotron for modernization of ASDEX Upgrade ECRH system is under development in GYCOM/IAP by contract with IPP. The gyrotron must produce 10-s pulses with 1MW output power at 140GHz and over 800-kW power at 3 additional frequencies within 105-140GHz

frequency range.

Tu-P.07 440 **Radiation generation at 94 GHz with a pseudospark-sourced electron beam**

H. Yin[1]; D. Bowes[1]; A.W. Cross[1]; W. He[1]; K. Ronald[1]; A.D.R. Phelps[1]; D. Li[2]; J. Zhou[2]; X. Chen[2]
[1]University of Strathclyde, United Kingdom; [2]Queen Mary, University of London, United Kingdom

A small-scale pseudospark discharge is being investigated as the electron beam source for a klystron operating at 94GHz, and single-gap discharge experiments have been carried out. The klystron has been designed using the particle-in-cell (PiC) code MAGIC-2D with promising expected output.

Tu-P.08 442 **Numerical Study of Pseudospark Discharge Based Electron Beam and Propagation for Terahertz Source Generation**

Daohui Li[1]; X. Chen[1]; H. Yin[2]; D. Bowes[2]; W. He[2]; A.W. Cross[2]; K. Ronald[2]; A.D.R. Phelps[2]
[1]Queen Mary University of London, United Kingdom; [2]University of Strathclyde, United Kingdom

To feed demand of high power and compact THz source, pseudospark discharge driven microklystron has been designed to generate THz radiation. Pseudospark discharge can provide high current density electron beam with tiny size. Numberical study has been utilised to investigate the detailed process.

Tu-P.09 444 **Photo-electron gun generating sub-pico second bunch**

M.R. Asakawa[1]; S. Sone[1]; H. Yamamoto[1]; R. Sonomura[1]; S. Yamaguchi[1]; Y. Tsunawaki[2]
[1]Kansai University, Japan; [2]Osaka Sangyo University, Japan

A 50 kV photo-electron gun was developed to construct a powerful broad-band terahertz radiation source. A magnesium cathode was irradiated by a frequency tripled Ti:sapphire laser. Train of electron bunch of 50 pC was generated. The bunch produced the optical transition radiation at the beam dumper.

Tu-P.10 446 **Status of the THz activities at the MLS**

Ralph Müller[1]; A. Hoehl[1]; A. Serdyukov[1]; G. Ulm[1]; J. Feikes[2]; M. Ries[2]; G. Wüstefeld[2]
[1]Physikalisch-Technische Bundesanstalt, Germany; [2]Helmholtz-Zentrum Berlin, Germany

We report the status of the MLS as a source of powerful, stable, and pulsed THz radiation. Additionally we show results from the commissioning of the experimental stations and first measurements in the THz spectral range.

Tu-P.11 448 **Terahertz coherent synchrotron radiation at the synchrotron SOLEIL**
C. Evain; M.E. Couprie; A. Loulergue; L. Nadolski; M.A. Tordeux; J. Barros; L. Manceron; J.B. Brubach; G. Creff; P. Roy
Synchrotron SOLEIL, France
We present experimental and numerical results on Terahertz coherent synchrotron radiation obtained in the beamline AILES at the synchrotron SOLEIL. Depending on the storage ring configuration and on the electron bunch current we observed either stable or instable signals.

Tu-P.12 449 **Bunch anomalies in SR-IR time domain emission**
Gian Luigi Zangari
LNF-INFN Frascati, Italy
SHT analysis shows a direct evidence of a delayed component in the SR-IR spectra of e+/e- bunches at DAΦNE and HLS (Hefei). To avoid a relativistic paradox, we are forced to discard the "Rigid Bunch Model" and allow higher degrees of freedom (internal modes and/or "super-motions")

Tu-P.13 451 **Frequency-Dependent Response of Two-Contact Photoconductive Antenna**
H. Dong[1]; Y.D. Gong[1]; X.L. Tian[1]; S.P. Thong[2]; R. Bhuvaneswari[2]; M. Olivo[2]
[1]Institute for Infocomm Research, Singapore; [2]National Cancer Centre, Singapore
A two-contact photoconductive antenna has been experimentally found to be frequency-dependent and respond to the mixture of both polarization components of terahertz radiation. This effect leads to wrong polarization state measurement results. It may also result in a fake ¡°absorption peak¡±.

Tu-P.14 453 **Far infrared detection of pulsed lasers with AFM microcantilevers**
Jean-Michel Ortega[1]; F.G. glotin[2]; R.P. Prazeres[1]; A.D. Dazzi[3]
[1]CLIO/LCP/CNRS, France; [2]Univ. Paris-Sud, France; [3]Univ Paris-Sud, France
We have used an AFM microcantilever as a far infrared detector. When hit by a pulsed laser, the cantilever starts damped oscillations which amplitude can be recorded and laser spectra can be recorded at $\lambda > 25$ µm which is the limit of 77K HCT detectors.

Tu-P.15 455 **Characterization of SIS Array Mixers on Si Substrates at 350 GHz**
S. Andree; M. Justen; M. Schultz; C.E. Honingh; K. Jacobs; J. Stutzki
Universität zu Köln, Germany
We present performance measurements of Nb-Al2O3-Nb (SIS) mixers on Si-membranes for radio frequencies (280-380 GHz) with an IF band from 4 to 12 GHz. We use beamlead technology to mount the devices in waveguide mixerblocks. These mixers will be used in a 7 pixel focal plane array for astronomy.

Tu-P.16 457 **A Modal Approach to the Modeling of Rectangular Detector Horns and Cavities at THz Frequencies**
Stephen Doherty; N. Trappe; C. O'Sullivan; J.A. Murphy
NUI-Maynooth, Ireland
Far-IR space telescopes use horn antenna coupled bolometers for achieving high levels of sensitivity. Unfortunately at THz frequencies large cavity coupled horns prove significantly challenging to simulate accurately. This paper will outline alternative simulation concepts for such problems.

Tu-P.17 458 **A Thin-Film Spiral Antenna Coupled with Bi Microbolometer Operating at 100 GHz Band**

Son Le; T. Tachiki; T. Uchida; Y. Yasuoka
National Defense Academy, Japan

A thin-film 2-arm spiral antenna with Bi microbolometer operating at 100 GHz band was fabricated. In the video detection, detected voltages, which were proportional to the power of signal wave at 100 GHz and a bias current, were obtained. DC sensitivity of the microbolometer was about 35 W-1.

Tu-P.18 460 **Efficient detection of THz pulses using low-temperature-grown GaAs photoconductive antennas excited at 1560 nm**

Y. Kadoya[1]; K. Kajikawa[1]; T. Kataoka[1]; J. Kitagawa[1]; Y. Takemura[2]
[1]Hiroshima University, Japan; [2]Sumitomo Osaka Cement Co. Ltd., Japan

Low-temperature-grown GaAs photoconductive antenna was investigated as the detector of THz pulses for 1560 nm excitation. A S/N value higher than 50 dB obtained with a standard measurement condition suggests that the antenna can be used as a detector in 1560 nm-based commercial time domain systems.

Tu-P.19 461 **A 340 GHz 2SB Schottky Receiver for the STEAMR Limb Sounder**

Peter Sobis[1]; J. Stake[2]; A. Emrich[1]
[1]Omnisys Instruments AB, Sweden; [2]Chalmers University of Technology, Sweden

A low VSWR sideband separating receiver topology employing subharmonic Schottky diode mixers has been implemented at 340 GHz as an integrated module housing mixers, commercial LNA's and waveguide hybrids. Image rejection levels of around 20 dB and a receiver SSB noise of 9000 K are measured.

Tu-P.20 463 **Extremely Broadband Characterization of a Schottky Diode Based THz Detector**

Daniel Schoenherr[1]; C. Bleasdale[2]; T. Goebel[1]; C. Sydlo[1]; H.L. Hartnagel[1]; R. Lewis[2]; P. Meissner[1]
[1]Technische Universitaet Darmstadt, Germany; [2]University of Wollongong, Australia

A Schottky diode based module for direct detection of THz power provides fast measurement capabilities at room temperature. This paper presents the extremely broadband spectral characterization of a Schottky diode in comparison to a Golay cell in the frequency range from 0.1 THz up to 2 THz.

Tu-P.21 465 **Microwave heterodyne receiver based on AlGaAs/GaAs 2DEG bolometer**

Kai Wang; R. Ramaswamy; M. Bell; A. Sergeev; G. Strasser; A. Verevkin; V. Mitin
University at Buffalo, SUNY, United States

A hot-electron bolometric mixer, which uses the nonlinearities of the heated 2DEG medium in AlGaAs/GaAs heterostructure, is fabricated and characterized.It's shown that such hot electron bolometer is promising for THz detection, when integrated with a Quantum Cascade Laser as the local oscillator.

Tu-P.22 467 **Resonance detection of terahertz radiation in nanometer field-effect transistors with two-dimensional electron gas**

Kirill Maremyanin[1]; V.I. Gavrilenko[1]; S.V. Morozov[1]; D.M. Ermolaev[2]; V.E. Zemlyakov[2]; S.Y. Shapoval[2]; N.A. Maleev[3]; D.V. Fateev[4]; V.V. Popov[4]; F. Teppe[5]; W. Knap[5]
[1]Institute for Physics of Microstructures RAS, Russian Federation; [2]Institute of Microelectronic Technology and Ultra-High-Purity Materials RAS, Russian Federation; [3]Ioffe Physical-Technical Institute RAS, Russian Federation; [4]Kotelnikov Institute of Radio Engineering and Electronics RAS, Russian Federation; [5]Groupe d'Etude de Semiconducteurs, CNRS–Universite Montpellier 2, France

Resonance detection of THz radiation by nanometer FETs GaAs/AlGaAs and transistor structure GaAs/InGaAs with large area slit-grating gate has been measured. For these transistors peaks in the resonance photoresponse curve are tunable with gate voltages in accordance with the Dyakonov–Shur theory.

Tu-P.23 469 **Temperature dependence of dark current mechanisms in long-wavelength arsenic doped HgCdTe photovoltaic devices**

j. liang; w.d. hu; z.h. ye; x.s. chen; w. lu
Shanghai Institute of Technical Physics,Chinese Academy Sciences, China

A simultaneous-mode nonlinear resistance¨Cvoltage curve is applied in the analysis of dark current mechanisms in long-wavelength arsenic doped HgCdTe devices at various temperatures. Six characteristic parameters as function of temperature are extracted from measured current-voltage curves.

Tu-P.24 471 **High differential gain single photon avalanche photodiode with improved structure**

W.J. Wang; L. Lin; T.X. Li; N. Li; W.D. Hu; W. Lu; X.S. Chen
National Laboratory for Infrared Physics, Shanghai Institute of Technical Physics, Chinese Academy o, China

An InGaAs/InP single-photon avalanche photodiode (SPAD) with a high differential gain was achieved by changing the multiplication region thickness and the sheet charge density of the charge layer. A gain of more than 100 was obtained. The DCR is less than 1k with the frequency up to 250 kHz.

Tu-P.25 473 **Field Effect Transistors For Fast Terahertz Detection and Imaging**

S. Boubanga Tombet
RIEC TOHOKU UNVIVERSITY, Japan

Recent results on THz detection by FETs are reported. THz Imaging with FET and detection in quantizing magnetic field. Results of THz Imaging show that FETs arrays are good candidate for real time imaging. In magnetic field we report an enhancement of signal at the cyclotron resonance condition.

Tu-P.26 475 **Detection of high power THz radiation by GaAs High Electron Mobility and Si Field Effect Transistors**

C.J. Drexler[1]; N. Dyakonova[2]; M. Schafberger[1]; K. Karpierz[3]; J. Karch[1]; H. Videlier[2]; Y. Meziani[4]; P. Olbrich[1]; W. Knap[5]; S.D. Ganichev[1]
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We report on the observation of photocurrents in GaAs High Electron Mobility and Si Field Effect Transistors . We show that illuminating the samples with high power terahertz laser radiation causes electric currents. These currents are driven by plasmonic effects in two dimensional electron gases.

Tu-P.27 476 **Terahertz Detection by InGaAs HEMTs in Quantizing Magnetic Fields: relation between magnetoresistance and photovoltaic response**

Oleg klimenko[1]; Y.A. Mityagin[2]; H. Videlier[1]; S. Boubanga Tombet[3]; F. Teppe[1]; N.V. Dyakonova[1]; S.H. Nadar[1]; S.A. Savinov[2]; C. Consejo[1]; V.N. Murzin[2]; W. Knap[1]
[1]University Montpellier 2, France; [2]P.N. Lebedev Physical Institute of RAS, Russian Federation; [3]Tohoku University, Japan

THz detection by plasma wave mechanism in InGaAs HEMTs is studied in high/quantizing magnetic fields regime. The correlation between the photovoltaic response and magnetoresistance is revealed. It allows to explain the nature of strong oscillations observed in the transistor Terahertz photoresponse.

Tu-P.28 478 **Sub-Terahertz imaging with AlGaN/GaN MISFETs**

Dominique Coquillat[1]; S. Nadar[1]; O. Klimenko[1]; H. Videlier[1]; N. Dyakonova[1]; F. Teppe[1]; W. Knap[1]; K. Madjour[2]; G. Ducournau[2]; C. Gaquière[2]; M.A. Poisson[3]; J. Torres[4]; A. Dobroiu[5]; C. Otani[5]
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We evaluate the optical performance of AlGaN/GaN MISFETs as a non-resonant sub-terahertz, room temperature detector. The photoresponse and the noise equivalent power is determined and single-pixel, room temperature imaging demonstrated.

Tu-P.29 480 **Terahertz responsivity enhancement of silicon CMOS transistor-based detectors using a current bias**

S. Boppel[1]; A. Lisauskas[1]; F. Voltolina[2]; P. Haring Bolívar[2]; H.G. Roskos[1]
[1]Physikalisches Institut, Johann Wolfgang Goethe-Universität Frankfurt, Germany; [2]The Institute of High Frequency and Quantum Electronics, University of Siegen, Germany

We report on a responsivity enhancement of silicon CMOS transistor-based detectors for terahertz radiation by the application of a source-to-drain bias current.

Tu-P.30 481 **Localized THz detection in YBCO sensors patterned by heavy-ion lithography**

F. Laviano[1]; R. Gerbaldo[1]; G. Ghigo[1]; L. Gozzelino[1]; B. Minetti[1]; A. Rovelli[2]; E. Mezzetti[1]
[1]Politecnico di Torino and INFN-Sez.Torino, Italy; [2]INFN, Laboratori Nazionali del Sud, Catania, Italy

Measurements of the photoresponse of superconducting YBa2Cu3O7-x film devices to THz radiation are reported. The properties of the film were modulated in a functional way by High-Energy-Heavy-Ion lithography, an effective tool to locally enhance the response of the sensor to the infrared spectrum

Tu-P.31 483 **Characterization of Carbon Deposits during Heterogeneous Catalysis using Terahertz Time-Domain Spectroscopy**

Axel Zeitler[1]; M.N. de-Silva[1]; C.T. McElroy[1]; J. McGregor[1]; A.P.E. York[2]; L.F. Gladden[1]
[1]University of Cambridge, United Kingdom; [2]Johnson Matthey Technology centre, United Kingdom

Terahertz spectroscopy was used to quantitatively assess the degree of graphitic order in the hydrocarbonaceous deposits formed during the reaction of n-butane over the catalyst ZSM-5.

Tu-P.33 485 **The Photoresponse of HgCdTe Infrared Photodiodes with a Heavily Doped n Region**

X.S. Chen[1]; J. Wang[2]; W.D. Hu[3]; W. Lu[3]; F.Q. Xu[2]
[1]National Laboratory for Infrared Physics,Shanghai Institute of Technical Physics,Chinese Academy of, China; [2]National Synchrotron Radiation Laboratory, University of Science and Technology of China, China; [3]National Laboratory for Infrared Physics, Shanghai Institute of Technical Physics, Chinese Academy o, China

By taking into account the contributions: (i) the BM shift considering a non-parabolic conduction band, (ii) the BGN effect, and (iii) the Hg-vacancy-induced acceptor trap level, we have calculated the shift of the photoresponse between n and p regions of Hg<0.722>Cd<0.278>Te infrared photodiode.

Tu-P.34 487 **Nondestructive detection of delaminations in plastic weld joints**

O. Peters[1]; S. Wietzke[1]; C. Jansen[1]; M. Scheller[1]; M. Koch[2]
[1]Universität Marburg, Universität Braunschweig, Germany; [2]Universität Marburg, Germany

Nondestructive evaluation has an increased interest in the plastic industry. One of the tasks is the detection of delaminations in plastic weld joints. We present a technique to find delaminations employing contact-free, terahertz spectroscopy and an algorithm employing a cascaded fourier transform.

Tu-P.35 489 **Electric and magnetic dipole-dipole interaction of two plane split-ring resonators**

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[1]Shanghai Institute of Technical Physics, Chinese Academy of Sciences, China; [2]Pennsylvania State University, United States

Extinction cross section of two split-ring resonators is calculated by means of Finite-Difference-Time-Domain. The magnetic resonance of dimer shows blueshifts and redshifts with decreasing the distance between them. The finds

can be interpreted in terms of electric and magnetic dipole interaction

Tu-P.36 491 **Hybrid sol-gel materials with high transmittance in the THz region**

Paolo Prosposito[1]; L. Brigo[2]; G. Della Giustina[2]; A. Perucchi[3]; S. Lupi[4]; G. Brusatin[2]
[1]Università di Roma Tor Vergata, Italy; [2]Università degli Studi di Padova, Italy; [3]Sincrotrone Trieste S.C.p.A, Italy; [4]Università di Roma La Sapienza, Italy

We report on the transmission of hybrid organic-inorganic sol-gel materials in THz region. Their transmission is very good and comparable with the most transparent polymers. An attempt to explain the relationship between material compositional characteristics and their behaviour has been given.

Tu-P.37 493 **Absorption Spectra of High Purity Metallic and Semiconducting Single-Walled Carbon Nanotube Thin Films in a Broad Frequency Region**

M. Ichida[1]; S. Saito[2]; T. Nakano[1]; H. Ando[1]; Y. Feng[3]; Y. Miyata[4]; K. Yanagi[5]; H. Kataura[3]; S. Ogawa[1]
[1]Konan University, Japan; [2]National Institute for Information and Communications Technology, Japan; [3]Advanced Industrial Science and Technology, Japan; [4]Tokyo Metropolitan University, Japan; [5]Nagoya University, Japan

Absorption spectra of high purity metallic and semiconducting single-walled carbon nanotubes have been measured from THz to UV region. The broad absorption band around 100-1000 cm-1 of the metallic sample can correspond to the optical transition between small energy gap in gmetallic h nanotubes.

Tu-P.38 494 **High resolution measurements to determine the permittivity in artificial structures**

Christian Krebs; A. Hommes; D. Nüßler; R. Brauns
Fraunhofer FHR, Germany

The knowledge of material properties is a task for quality control applications. Therefore the determination of the permittivity år is essential to get insight in material volume information. The following paper describes a measurement method to determine år.

Tu-P.39 496 **Intense Terahertz Field-Induced Electroabsorption in Carbon Nanotubes**

Ryo Shimano; T.O. Ogawa; S.W. Watanabe
University of Tokyo, Japan

The effect of intense terahertz (THz) pulses on single-walled carbon nanotubes is investigated by THz -pump and optical-probe experiments. An ultrafast electroabsorption possessing a THz bandwidth is observed at exciton resonances near the optical communication wavelength and at room temperature.

Tu-P.41 498 **Photoconductivity of Pb1-XSnXTe(In) Narrow-Gap Semiconductors with Variable Composition and Microstructure in the Terahertz Range**

Ludmila Ryabova[1]; A. Dobrovolsky[1]; V. Chernichkin[1]; D. Khokhlov[1]; Z. Dashevsky[2]; V. Kasiyan[2]; A. Nicorici[3]; S. Ganichev[4]; S. Danilov[4]; V. Bel'kov[4]
[1]Moscow State University, Russian Federation; [2]Ben-Gurion University, Israel; [3]Institute of Applied Physics, Moldova, Republic of; [4]University of Regensburg, Germany

Photoconductive response at wavelengths up to 500 μm has been detected in Pb1-XSnXTe(In) solid solutions. The effect is observed both in the semi-

insulating state and at high levels of electron gas degeneracy. The film microstructure affects the photosensitivity strongly

Tu-P.42 500 **Accurate optical constants of ZnTe measured by THz-TDS with their standard deviations**

Saroj Tripathi[1]; M. Aoki[1]; T. Asahi[2]; I. Hosako[3]; N. Hiromoto[1]
[1]Shizuoka University, Japan; [2]Nippon Mining and Metals Co. Ltd., Japan; [3]National Institute of Information and Communication Technology, Japan

We measured the accurate optical constants of ZnTe using THz-TDS. Random errors in these constants are investigated by modeling the standard deviation in intensity and phase spectra and using the law of error propagation. Uncertainty in sample thickness is also included to compute resultant errors.

Tu-P.44 502 **Layer-by-layer photoluminescence and photoreflectance analysis of impurity distribution in HgCdTe**

J. Shao[1]; X. Lu[1]; Y. Wei[2]; J. Yang[2]
[1]National Laboratory for Infrared Physics, Shanghai Institute of Technical Physics, Chinese Academy o, China; [2]Research Center for Advanced Materials and Devices, Shanghai Institute of Technical Physics, Chinese, China

Layer-by-layer infrared photoluminescence and photoreflectance measurements are performed on an HgCdTe epliayer. The Cd composition and impurity states along the growth direction are examined, and the vertical distribution is discussed.

Tu-P.45 503 **Temperature Studies of Dielectric Loss in Silicon Carbide**

Charles Jones; Y. Gao
North Carolina Central University, United States

Results for the variation of loss tangent with temperature will be reported for crystalline Silicon Carbide and compared with theoretical expectations based on a two-phonon difference process.

Tu-P.46 504 **Terahertz induced nonlinear effects in doped Silicon observed by open-aperture Z-scan**

Gurpreet Kaur; P.Y. Han; X.C. Zhang
Rensselaer Polytechnic Institute, United States

We demonstrate the field dependent enhancement of transmission of intense Terahertz(THz) pulses in doped Silicon.The strong field-carriers interaction lead to intervalley scattering. The change in mobilities in different valleys leads to 18% enhancement in transmission at peak THz field of 135 kV/cm

Tu-P.47 506

Enhanced Transmission of Terahertz Waves through Subwavelength Apertures in Carbon Nanotube Network Films

Yeong-Hwan Ahn[1]; J.T. Hong[1]; D.J. Park[1]; F. Rotermund[1]; S. Lee[1]; D.S. Kim[2]; Y.H.A. Ahn[1]
[1]Ajou University, Korea, Republic of; [2]Seoul National University, Korea, Republic of

We demonstrate enhanced terahertz wave transmission through carbon nanotube films with subwavelength apertures. The peak frequency of the transmitted waves matches well with the shape resonance, mainly determined by the length of the apertures and the refractive index of surrounding media.

Tu-P.48 507

Polarization dependent terahertz band pass filters with asymmetric cross shaped hole arrays

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[1]Center for THz-Bio Application Systems, Department of Physics and Astronomy, Korea, Republic of; [2]Department of Physics and Astronomy, Seoul National University, Korea, Republic of

Polarization dependent transmission of terahertz wave through the asymmetric cross shaped hole array was measured. Experimental results show good agreement with the simulated results. This filter can be used to such applications as THz spectroscopy and biological sensing.

Tu-P.49 509

Dielectric Measurement of Low Loss-Tangent Dielectric near 100 GHz by a Simplified Hemispherical Open Resonator Technique

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Center for THz-Bio Application Systems, Korea, Republic of

A high Q-hemispherical open resonator with W-band vector network analyzer enables a precise and fast determination of the permittivity and loss tangent of low-loss dielectrics near 100GHz. The implemented frequency variation method showed standard deviation in dielectric measurements less than 0.06.

Tu-P.50 510

Precise measurements of optical constants of SiC in 40 to 120 m wavelength region

kazuya nakayama[1]; A.M. Matsubara[1]; S.O. Okajima[1]; K.K. Kawahata[2]; K.T. Tanaka[2]; T.A. Akiyama[2]; H.K. Kinoshita[3]; M.Y. Yoshimoto[3]; T.T. Takahashi[4]
[1]chubu university, Japan; [2]NIFS, Japan; [3]Kyoto Institute of Technology, Japan; [4]Mutsumi Corporation, Japan

Optical constants of SiC have been measured by using FIR lasers of 48, 57, 71, and 119 μm. The refractive index and absorption coefficient have been determined from the transmittance of a rotating SiC etalon. For the application of SiC to optical elements, it was compared with other materials.

Tu-P.51 512

Measurement of the complex refractive index of liquids in the terahertz range using ellipsometry

Adrian Dobroiu; C. Otani
RIKEN, Japan

We used ellipsometry to determine the complex index of refraction of liquids in the terahertz range. The method works by allowing a polarized terahertz wave to reflect on the interface between high-resistivity silicon and the liquid sample, and analyzing the polarization state of the reflected wave.

Tu-P.52 513 **Submillimeter wave sintering of pure alumina ceramics**

S. Mitsudo[1]; K. Watanabe[1]; K. Sako[1]; S. Tani[1]; N. Nakagawa[1]; T. Idehara[1]; T. Saito[1]; S. Sano[2]
[1]Research Center for Far-Infrared Region, University of Fukui, Japan; [2] National Institute of Advanced Industrial Science and Technology, Japan

The sub-millimeter (300 GHz) wave sintering of the alumina ceramics had been performed. The sub-millimeter wave sintering curve shows the sintering slower at the same temperature, for sub-millimeter wave processing as compared to millimeter wave processing.

Tu-P.53 515 **THz generation in lithium niobate crystal with tapered end placed within a hollow waveguide**

Anahit Nikoghosyan[1]; H.P. Roeser[2]
[1]Yerevan State University, Armenia; [2]Institute of Space Systems, University Stuttgart, Germany;

The results of the THz pulse generation by ps and fs laser pulses in LiNbO3 crystal are presented. Detection of THz pulse are performed at room temperature both by Schottky diode and ZnTe crystal. The quantum efficiency of energy conversion up to 28% of maximum value is obtained with Schottk

Tu-P.54 517 **Laser Driven Terahertz Dielectric Wedge Antenna Placed in Free Space or in Hollow Metallic Waveguide**

A.S. Nikoghosyan
Yerevan State University, Armenia

Results on effective generation of THz radiation in band 0.1-2.5 THz via optical rectification of femtosecond laser pulses in LiNbO3 plate tapered at the end are presented.

Tu-P.55 519 **Sub-Terahertz Transceiver Module Integrating Uni-Traveling-Carrier Photodiode, Schottky Barrier Diode, and Planar Circulator Circuit**

Hiroshi Ito[1]; K. Yoshino[2]; Y. Muramoto[2]; H. Yamamoto[1]; T. Ishibashi[3]
[1]Kitasato University, Japan; [2]NTT Photonics Laboratories, Japan; [3]NTT Electronics, Japan

A sub-terahertz transceiver module integrating a uni-traveling-carrier photodiode, a Schottky barrier diode, and a planar circulator circuit is developed. A resonant behavior with an isolation of about 14 dB is realized by the circulator circuit, demonstrating a transceiver function at 270 GHz.

Tu-P.56 521 **Terahertz radiation from air plasma, generated by linearly polarized femtosecond pulses with short focal length lens**

Daniil Fadeev; V.A. Mironov
Institute of Applied Physics Russian Academy of Sciences, Russian Federation

New theoretical approach for terahertz radiation from air plasma generated by linearly polarized laser pulses focused by short focal length lens is presented. The theory describes new experimental effect of non-symmetric radiation pattern determined by laser pulse polarization.

Tu-P.57 523 **Specific features of terahertz radiation from air plasma generated by both the first and the second optical harmonics**

Mironov Vyacheslav[1]; D.A. Fadeev[2]
[1]Institute of Applied Physics Russian Academy of Sciences, Russian Federation; [2]Instute of Applied Physics Russian Academy of Sciences, Russian Federation

The theory describing specific features of the source of terahertz waves generated due to the breakdown of air by both the first and the second harmonics of laser pulse is introduced. The approach considers inside physics of low frequency current formation during the ionization.

Tu-P.58 525 **Fine Tuning Terahertz Generation in Fanned-out Periodically Poled Stoichiometric Lithium Tantalate Crystal**

Nan Ei Yu[1]; K.S. Lee[1]; D.-.K. Ko[1]; S. Takekawa[2]; K. Kitamura[2]
[1]Gwangju Institute of Science and Technology, Korea, Republic of; [2]National Institute for Materials Science, Japan

Continuous tunable terahertz pulses were generated with a continuous grating-period change from 65 to 90 ¥ìm in periodically poled stoichiometric lithium tantalate crystal. Center frequency was tuned from 0.9 to 1.3 THz with as narrow as band-width of 21 GHz at crystal temperature of 130 K.

Tu-P.59 526 **Thickness dependence of intense terahertz emission from InAs thin films**

Y. Ishibashi[1]; S. Sasa[1]; T. Maemoto[1]; M. Inoue[1]; K. Takeya[2]; M. Tonouchi[2]
[1]Osaka Institute of Technology, Japan; [2]Osaka University, Japan

Intense terahertz emission was observed from InAs thin films grown on a GaAs substrate. The emission intensity increased as the film thickness increased up to 1 μm and became stronger than that from a p-type InAs substrate. The possible mechanism including the thickness dependence is presented.

Tu-P.60 528 **Emission of terahertz radiation from dipole photoconductive antennas with several geometrical parameters**

Fumiaki Miyamaru[1]; K.Y. Yamamoto[2]; T.F. Furuya[2]; S.N. Nishizawa[3]; M.T. Tani[2]
[1]Shinshu University, Japan; [2]Fukui University, Japan; [3]Advanced Infrared Spectroscopy Co., Ltd., Japan

The dependence of the emission spectrum of terahertz (THz) radiation on the geometrical parameters of the dipole antenna, and the relationship between these parameters and the temporal characteristics of the transient input field is reported.

Tu-P.61 530 **Frequency Stabilization of Photo-Mixing Generated Signal Using a Single Michelson Interferometer**

T. Laurent; S. Ginestar; S. Blin; L. Chusseau; C. Palermo; J. Torres; P. Nouvel; L. Varani
Institut d'Electronique du Sud, Université de Montpellier 2, France

We investigate the possibility to use a single interferometer, instead of two, to stabilize the frequency of a THz radiation generated by optical beating between two continuous- wave lasers.

Tu-P.62 532 **Tunable Terahertz Radiation Generated by using a Spatially Dispersed Femtosecond Optical Pulse**

K. Maki; C. Otani
Advanced Science Institute, RIKEN, Japan

The generation of terahertz (THz) radiation is demonstrated by using the spatial dispersion of an femtosecond optical pulse. The overlap of two dispersed beams with a spatial shift allows us to generate a monochromatic radiation on the basis of photo mixing, and additionally to tune its frequency.

Tu-P.63 534 **Stabilization of Terahertz Wave Generation by Using Chaotic oscillation in a Laser**

Fumiyoshi Kuwashima[1]; S. Taniguchi[2]; K. Nonaka[2]; M. Hangyou[3]; H. Iwasawa[4]
[1]Fukui University of Technology, Japan; [2]Kagoshima National College of Technology, Japan; [3]Osaka University, Japan; [4]Professor Emeritsu, Fukui University, Japan

Stabilization of a THz Wave using a chaotic oscillation in a multimode semiconductor laser with an optical delayed feedback by the external mirror is investigated. Stabilization and the wide spectrum of THz waves are so obtained by using a chaotic laser compared with that of using a CW laser.

Tu-P.64 536 **Dual wavelength cw microlaser for the generation of THz radiation.**

J.F. Roux[1]; F. Pallas[2]; E. Herault[1]; G. Grosa[2]; J.L. Coutaz[1]; A. Kevorkian[3]; F. Thibault[3]; G. Vitrant[2]
[1]IMEP-LAHC, Universite de Savoie, France; [2]IMEP-LAHC, INP Grenoble, France; [3]TEEM PHOTONICS, France

Dual wavelength compact microlaser operation is demonstrated in the cw regime using a c-cut Nd doped GdVO4 crystal. More than 200mW is obtained at these two wavelengths which are separated by 2.2nm leading to potential generation of 0.6THz radiation with this compact low-cost optical source.

Tu-P.66 537 **Efficient Optical Excitation of THz Plasmons on a Structured Metal Surface**

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[1]University of Nizhny Novgorod, Russian Federation; [2]Institute of Applied Physics RAS, Russian Federation

We propose to launch terahertz surface plasmons on corrugated metal surfaces by ultrashort laser pulses. The plasmons are emitted by nonlinear polarization created by the pulse in a strip of electro-optic medium deposited on the surface. The technique can be used for terahertz surface spectroscopy.

Tu-P.67 539 **CW THz generation by In0.53Ga0.47As photomixer with TEM-Horn antenna driven at 1.55 m wavelengths**

E. Peytavit[1]; F. Meng[2]; D. Gacemi[2]; J.F. Lampin[1]; T. Akalin[1]; J. Mangeney[2]
[1]IEMN, France; [2]UMR 8622/ Univ Paris Sud, France

We report cw generation delivered by ion-irradiated In0.53Ga0.47As photomixers coupled to TEM-horn antenna driven at ~1.55 µm wavelength. Output powers up to 0.1 µW at 700 GHz have been achieved. The output power in a regime of Ohmic transport or recombination-limited transport is analyzed.

Tu-P.68 541 **Transmission Lines Power Measurements for the 110 GHz Electron Cyclotron Heating System on DIII-D and Gyrotron Operational Performance**

M.C. Cengher; J. Lohr; D. Ponce; Y. Gorelov; C.P. Moeller
General Atomics, United States

Operational trends for the DIII-D 6 gyrotron ECH system are presented. Transmission line losses were measured & values near theoretical ones were attained for one line. Improved alignment and reduction of the number of miter bends will increase the power transmitted through the waveguide to DIII-D.

Tu-P.69 543 **Designs of New Components for ITER ECH & CD Transmission Lines**

Robert Olstad; J.L. Doane; C.P. Moeller; C.J. Murphy
General Atomics, United States

The 2 MW cw ITER ECH&CD transmission line components will require enhanced cooling and some new or modified designs. Transmission line components between the closure plate and the tritium barrier window have special design considerations to assure tritium retention. Design aspects will be presented.

Tu-P.70 545 **Status of the ITER Electron Cyclotron H&CD System**

Caroline Darbos[1]; F. Albajar[2]; S. Alberti[3]; T. Bonicelli[2]; A. Bruschi[4]; R. Chavan[3]; S. Cirant[4]; M. deBaar[5]; D. Farina[4]; T.P. Goodman[3]; J.P. Hogge[3]; W. Kasparek[6]; J.D. Landis[3]; A. Moro[4]; I. Paganakis[3]; P. Platania[4]; B.P. Blaum[6]; E. Poli[6]; G. Ramponi[4]; D. Ronden[5]; G. Saibene[2]; F. Sanchez[3]; C. Sozzi[4]; D. Strauss[7]; O. Sauter[3]; H. Zohm[6]; U. Baruah[8]; S.L. Rao[8]; M. Kushwah[8]; T. Scherer[7]; S. Kern[7]; N.P. Singh[8]; K. Kajiwara[9]; N. Kobayashi[9]; Y. Oda[9]; K. Sakamoto[9]; K. Takahashi[9]; G.D. Denisov[10]; T. Bigelow[11]; J. Caughman[11]; D. Rasmussen[11]; M. Shapiro[12]; R. Temkin[12]; B. Becket[13]; D. Cox[13]; F. Gandini[13]; T. Gassmann[13]; M.A. Henderson[13]; O. Jean[13]; C. Nazare[13]; T. Omori[13]; D. Purohit[13]
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The paper presents the status of the 20 MW ECH&CD system developed for ITER. Progress includes agreement on the first procurement arrangement, advancing the design of all components to conceptual or preliminary design stage, optimization of gyrotrons performances and finalization of launcher design.

Tu-P.72 547 **Quasi-Optical HE11-mode exciter for coupling into oversized Circular Corrugated Waveguide**

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[1]Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Japan; [2]Research Institute for Applied Mechanics, Kyushu University, Japan; [3]FURUKAWA C&B CO., LTD, Japan

QO HE11-mode exciter has been designed for a mode coupling into the CC waveguides. It contains a feed antenna system and QO mirror system. The main mode and the unwanted modes generated from the feed antenna are led to two quasi-optical mirrors. The mirror system can remove the unwanted HE12 mode.

Tu-P.73 549 **Time Resolved THz-Spectroscopy of As-Implanted GaAs**

Shriganesh Prabhu
Tata Institute of Fundamental Research, India

We study the carrier lifetime in As implanted semi-insulating GaAs (SI-GaAs) using various dosages of the As-ion. Using infra-red (IR) pump and THz as a probe, we study the time resolved transmission curves at room temperature and calculate the lifetimes of the carriers in the SI-GaAs:As.

Tu-P.74 550 **Femto-chemometrics: The signal processing of fast pulse transients.**

J. Bowen
University of Reading, United Kingdom

Traditional chemometrics techniques are augmented with algorithms tailored specifically for the de-noising and analysis of femtosecond duration pulse datasets. The new algorithms provide additional insights on sample responses to broadband excitation and multi-moded propagation phenomena.

Tu-P.75 552 **First Observation of a THz Photon Echo**

S.A. Lynch[1]; P.T. Greenland[1]; G. Aeppli[1]; N.Q. Vinh[2]; B. Redlich[3]; A.F.G. van der Meer[3]; C.R. Pidgeon[4]; B.N. Murdin[5]
[1]London Centre for Nanotechnology, University College London, United Kingdom; [2]University of California, Santa Barbara, United States; [3]FOM Institute for Plasma Physics, Netherlands; [4]Heriot-Watt University, United Kingdom; [5]Advanced Technology Institute, University of Surrey, United Kingdom

We demonstrate THz photon echoes from silicon doped with phosphorus donors. We provide experimental evidence showing that the echo emerges at the predicted angle and that it arrives at our detector at the predicted time. We use this to demonstrate coherent control of the silicon donor states.

Tu-P.76 554 **Analysis of optical THz-signals from mode-locked semiconductor laser by using a semiconductor optical amplifier-based detection**

Pascal Landais; R. Maldonado-Basilio; S. Latkowski
school of Electronic Engineering, Ireland

An all-optical approach based on nonlinear inter-actions inside a semiconductor optical amplifier for measuring the THz beat-tone of a passively mode-locked laser is proposed. This novel approach can be applied to beat-tone in the range from GHz to few THz.

Tu-P.77 556 **Nonlinear generation and detection of THz pulses in ZnTe with chirped femtosecond laser pulses**

D.N. Erschens[1]; D. Turchinovich[1]; P.U. Jepsen[2]
[1]Technical University of Denmark, Denmark; [2]Technical UNiversity of Denmark, Denmark

We show measurements and simulations of difference-frequency generation of THz pulses and subsequent free-space electro-optic sampling with prechirped femtosecond pulses in ZnTe. Negative prechirping enhances the efficiency due to compression of the laser pulse in the dispersive nonlinear crystal.

Tu-P.79 557 **Electronically Controlled Optical Sampling Terahertz Time-Domain Spectroscopy**

Y. Kim; D.S. Yee
Korea Research Institute of Standards and Science, Korea, Republic of

We present the first demonstration of high-speed terahertz time-domain spectroscopy using the electronically controlled optical sampling method. Employing two synchronized femtosecond Ti:sapphire lasers with a 100 MHz repetition frequency, the time delay is repetitively scanned via phase modulation.

Tu-P.81 559 **Design and Performance of ALMA Band 5 Receiver Cartridge**

V. Belitsky; I. Lapkin; B. Billade; A. Pavolotsky; E. Sundin; O. Nyström; D. Meledin; V. Desmaris; M. Strandberg; H. Rashid; G. Johnsen; D. Dochev; M. Fredrixon
Chalmers University of Technology, Sweden

Atacama Large Millimetre Array, Band 5 receiver cartridge covers 163 – 211 GHz. We present the design and performance of the ALMA Band 5 receiver. The interest to Band 5 is driven by the 183 GHz water line and the C+ 158μ line from objects at redshifts between 8.0 - 10.6 to appear in the band.

Tu-P.82 561 **Detection of Biochar Components for Soil Fertility using THz-TDS**

Elise Pogson[1]; J. Horvat[1]; R.A. Lewis[1]; S.D. Joseph[2]
[1]University of Wollongong, Australia; [2]University of NSW, Australia

Different forms of biochar can have greatly different properties as fertilizers, yet there is no effective screening method to distinguish them. Terahertz Time-

Domain Spectroscopy has been used to distinguish various biochars, including Sawdust char, BMC5 with lime char and Saligna char.

Tu-P.83 563 **Terahertz spectroscopy of polyaromatic hydrocarbons**

George Swift; N. Kaliteevskaya; K.L. Johnson; J.M. Chamberlain; A.J. Gallant
University of Durham, United Kingdom

In this work we are beginning to determine the terahertz dielectric properties of various polyaromatic hydrocarbons. Terahertz spectroscopy of such organic compounds has seen rather less work undertaken in recent years than that carried out in some other areas.

Tu-P.85 565 **Application of THz spectroscopy to pesticide detection**

T.S. Suzuki; Y.O. Ogawa; N.K. Kondo
Kyoto university, Japan

Application possibility of THz spectroscopy to pesticide inspection in agricultural products was studied. Several pesticides showed specific absorption in THz region, and a high correlation was obtained between the concentration and the second derivative value of spectra.

Tu-P.87 567 **Measurement Accuracy of S-parameters in W band at Cryogenic Temperature**

Mario Zannoni; A. Baù; M. Gervasi; A. Passerini; S. Spinelli; A. Tartari; G. Sironi
Univerity of Milano Bicocca, Italy

Room temperature VNA calibration to measure cryogenic devices can be inadequate when the loss of the unavoidable thermal decoupling line is order of magnitude higher than the DUT one. We present a cryogenic calibration set-up with an accuracy at the level of some tens of milli-dB for S21 parameter.

Tu-P.88 569 **Realization of refractive polarizing Fourier Transform Spectrometer for Cosmic Microwave Background polarization observation**

Yuan Luo[1]; M. Hattori[1]; N. Ebizuka[2]; T. Matsumura[3]; I.S. Ohta[4]
[1]Tohoku University, Japan; [2]Nagoya University, Japan; [3]California Institute of Technology, United States; [4]Kinki University, Japan

We proposed an application of the refractive polarizing Fourier Transform Spectrometer (r-FTS) to millimeter submillimeter wave multiband polarimetry. In this paper, the results of optical experiments in millimeter wavebands, aiming to verify the performance, will be reported.

Tu-P.89 571 **In-orbit performace and calibration of SMILES**

Satoshi Ochiai[1]; K. Kikuchi[2]; T. Nishibori[2]; T. Manabe[3]; H. Ozeki[4]; R. Sato[2]; T. Sano[2]; Y. Irimajiri[1]; M. Shiotani[5]
[1]National Institute of Information and Communications Technology (NICT), Japan; [2]Japan Aerospace Exploration Agency (JAXA), Japan; [3]Osaka Prefecture University, Japan; [4]Toho University, Japan; [5]Kyoto University, Japan

Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) is a sensor for atmospheric bservation at 640 GHz from the International Space Station. Since the launch in Sep. 2009, SMILES has been showing the excellent observation performance. The results of SMILES development are summarized.

Tu-P.91 573 **Development of Germanium BIB detector with surface activated bonding and Molecular-Beam Epitaxial crystal growth**

Takehiko Wada[1]; H. Kaneda[2]; R. Kano[2]; K. Wada[1]; T. Suzuki[1]; K. Watanabe[3]; Y. Kiriyama[2]
[1]Japan Aerospace Exploration Agency, Japan; [2]Nagoya University, Japan; [3]The university of Tokyo, Japan

We are developing Germanium BIB detector for future mid- and far-infrared astronomical missions. In order to obtain clear interface between blocking and IR active layers, we have tested two new method, Surface Activated Bonding (SAB) and Molecular Beam Epitaxial (MBE) crystal growth.

Tu-P.92 575 **Bunch-to-bunch Coherence of Coherent Synchrotron Radiation from the Electron Storage Ring BESSY II**

Ulrich Schade[1]; J.S. Lee[2]; M. Ortolani[3]; B. Marchetti[4]; T. Neitzke[5]
[1]Germany; [2]University of Tokyo, Japan; [3]CNR , Istituto di Fotonica e Nanotecnologie, Italy; [4]INFN - Roma "Tor Vergata", Italy; [5]Helmholtz Zentrum Berlin, Germany

CSR is powerful spectroscopic source in the THz range at storage rings. Instabilities in the electron distribution causes fluctuations in the emitted THz

radiation which can be studied by measuring the the bunch-to-bunch coherence.

Wednesday, September 08, 2010

09:00 - 10:30 **Wednesday Plenary** Aula Magna
Chair: T. Parker\P. Siegel

PL.07 576 **Whiskers, Hyperhemispheres, and a Honeymoon**
David Rutledge
California Institute of Technology, United States

PL.08 577 **Terahertz Quantum Optics with Solid-state Systems**
Alfred Leitenstorfer
University of Konstanz, Germany
Recent studies on ultrafast dynamics of solids and nanostructures using few-cycle electromagnetic transients in the far and mid IR spectral regions are presented. We are able to excite with phase-locked wave forms reaching peak amplitudes beyond 1 V/Å which are comparable to inner-atomic fields.

11:00 - 12:30 **Metamaterials 1** Aula Magna
Chair: F. Keilmann

We-A1.1 578 **Wedge-type negative index metamaterial at 0.5 THz**
E. Lheurette[1]; F. Garet[2]; S. Wang[1]; K. Blary[1]; J.L. Coutaz[2]; D. Lippens[1]
[1]IEMN - Université de Lille 1, France; [2]IMEP-LAHC, France
Negative refraction through a metamaterial is demonstrated at 0.5 THz. This characterization is based on refraction angle determination through a prism-like structure. The measurements are performed by means of a goniometric TDS system while a numerical assessment is carried by full wave EM anal

We-A1.2 581 **Multilayer Terahertz Metamaterials: Interactions Between Layers Within the Deep-Subwavelength Limit**
M.T. Reiten; A.K. Azad; A.J. Taylor; J.F. O'Hara; D. Roy Chowdhury
Los Alamos National Laboratory, United States
Layers of split-ring-resonators (SRR) are typically spaced > λres/30 in metamaterials. The fundamental resonance disappears for closely spaced layers (~λres/1000) behaving as a closed ring resonator for oppositely oriented SRRs and has minimum effect on SRRs oriented in the same direction

We-A1.3 583 **Terahertz Resonant Artificial Interface Layers**
Daniel Dietze; J. Darmo; M. Martl; K. Unterrainer
Vienna University of Technology, Austria
Planar metamaterials, so-called metasurfaces, can efficiently be described by a modified transfer matrix formalism, that takes into account anisotropic, conductive interfaces. This method is applied for evaluation of the transmission of THz pulses through different metasurface geometries.

We-A1.4 584 **Negatively refracting plasmonic devices at THz frequencies**
George Swift; N. Kaliteevskaya; D. Dai; M.A. Kaliteevski; A.J. Baragwanath; A.J. Gallant; J.M. Chamberlain
University of Durham, United Kingdom
In this paper, we present experimental results showing how appropriately designed and constructed artificial materials can be used to refract negatively terahertz frequency light without the need for the materials to have both a

negative permeability and a negative permittivity.

We-A1.5 586 **Composite Left- Right Handed Metamaterials at Terahertz Frequencies**

S. Wang[1]; F. Garet[2]; K. Blary[1]; E. Lheurette[1]; J.L. Coutaz[2]; D. Lippens[1]
[1]IEMN, France; [2]IMEP-LAHC, France

High-transmissivity left/right-handed metamaterials were fabricated and experimentally assessed at sub-millimeter wave lengths. From the frequency dependence of the scattering parameters, we show the possibility to close the gap between the left- and right-handed dispersion branches.

11:00 - 12:30 Near Field Devices 2 Aula Minor
Chair: G. Ghione

We-B1.1 588 **Precise analysis of Wood-Rayleigh anomalies in the terahertz transmission spectrum of a metallic hole array**

J.L. Coutaz
IMEP-LAHC, France

We derive a general expression for calculating the parameters of excitation of Wood and Rayleigh anomalies observed in the transmission spectrum of a hole array with square cells. An experimental validation of the model, using THz time domain spectroscopy, is performed.

We-B1.2 591 **Electromagnetic diffraction radiation of sub-wavelength holes array excited by a point charge**

Min Hu; Y.X. Zhang; S.G. Liu
University of Electronic Science and Technology of China University, China

The mechanism of this novel 3D diffraction radiation phenomenon is revealed. A rigorous theoretical solution is obtained for the problem of electromagnetic diffraction radiation of sub-wavelength holes array (SHA) excited by a point charge moving parallel to the one surface of SHA.

We-B1.3 593 **Highly Efficient Aperture Array Terahertz Band-Pass Filters**

D.S. Bulgarevich; M. Watanabe; M. Shiwa
National Institute for Materials Science, Japan

Microfabricated narrow band-pass filters were developed for terahertz spectral region. Their unique features were over 100% extraordinary optical transmittance, preservation of the incident light polarization, and independence of the transmittance strength on filter fs rotation angle.

We-B1.4 595 **Fabrication of Resonant THz Mesh Filters Employing the Ultrashort-Pulse UV Laser Radiation**

I. Kašalynas; G. Valušis; B. Voisiat; G. Račiukaitis; L. Minkevičius; V. Tamošiūnas; A. Bičiūnas; A. Krotkus
Centre for Physical Sciences and Technology, Lithuania

Resonant mesh filters for THz region were fabricated using ultrashort UV laser radiation. The arrays of cross-shape holes were processed in the stainless steel foil and molybdenum film on polyimide. The spectral performance of the filters was investigated experimentally and numerically.

We-B1.5 597 **Terahertz wire-grid polarizer by nanoimprinting lithography on high resistivity silicon substrate**

L. Zhang[1]; J.H. Teng[2]; H. Tanoto[2]; S.Y. Yew[2]; L.Y. Deng[3]; S.J. Chua[1]
[1]Singapore-MIT Alliance, National University of Singapore, Singapore; [2]Institute of Materials Research and Engineering, A*STAR, Singapore; [3]National University of Singapore, Singapore

Terahertz wire-grid polarizer with 500nm grating period on high resistivity silicon (100) is fabricated using nanoimprinting lithography (NIL). Preliminary results show a good polarization characteristic ranging from 0.5 to 5 THz. The method is high throughput and low cost.

11:00 - 12:30 Remote Sensing Room 2
Chair: M. Ortolani

We-C1.1 599 **THz Air Photonics for Standoff Detection**

J. Liu; B. Clough; J. Dai; X.C. Zhang
Rensselaer Polytechnic Institute, United States

By "seeing" the fluorescence or "hearing" the sound emitted by plasma, coherent detection of broadband THz waves by laser-induced plasma at standoff distance is feasible. We will report these recent developments in THz wave sensing with air-plasma photonics.

We-C1.2 602 **Validation of the AVTIS volcano imager radiometry – a comparison of infrared and millimetre wave thermal imagery**

David Macfarlane[1]; D.A. Robertson[1]; M.R. James[2]
[1]University of St Andrews, United Kingdom; [2]Lancaster University, United Kingdom

The AVTIS remote sensing instrument is a custom built millimetre wave sensor that has been developed as a practical field tool for remote sensing of volcanic terrain at active lava domes. We present validation of the MMW radiometry of a volcanic scene by comparison with coincident infrared imagery.

We-C1.3 605 **Active Video-Rate Camera with up to 32 Detector-Pixels at 812 GHz**

Wolff von Spiegel[1]; R. Henneberger[2]; A.K. Huhn[3]; P. Haring Bolivar[3]; H.G. Roskos[1]
[1]PI, Universität Frankfurt, Germany; [2]RP GmbH, 53340 Meckenheim, Germany; [3]Universität Siegen, 57076 Siegen, Germany

We present an fully electronic 812GHz camera with an acquisition-rate of 10fps (one per revolution of the scanning mirror). It's based on 8-pixel subharmonic-mixing detector-arrays. The rotational-scanning telescope is designed to cover a focusing range from 2-6 m. The typical resolution is 5 mm.

We-C1.4 606 **Video-rate THz Imaging Using a Microbolometer-based Camera**

M. Bolduc; L. Marchese; B. Tremblay; M. Doucet; H. Oulachgar; L. Le Noc; C. Alain; H. Jerominek; A. Bergeron; M. Terroux
INO, Canada

A THz 160 x 120 pixel array camera has been developed at INO. Real-time transmission and reflectance imaging at video rates of 30 frame/s were performed with a low-power 3 THz QCL. Various hidden objects were

imaged, proving feasibility of real-time THz imaging in security screening applications.

11:00 - 12:30 Millimetre Wave Systems Room 3
Chair: Y. Oda

We-D1.1 608 **Development of Alternative Concepts of Fast Switches and Combiners (FADIS-BC) for High-Power Millimeter-Wave Beams**

Alessandro Bruschi[1]; E. Alessi[1]; W. Bin[1]; O. D'Arcangelo[1]; V. Erckmann[2]; W. Kasparek[3]; A. Moro[1]; V. Muzzini[1]; M.I. Petelin[4]
[1]Istituto di Fisica del Plasma, CNR, Italy; [2]Max-Planck-Institut für Plasmaphysik (IPP), EURATOM-Association,, Germany; [3] Institut für Plasmaforschung, Universität Stuttgart, Germany; [4]Institute of Applied Physics, Russian Academy of Science, Nizhny Novgorod, Russian Federation

New devices and concepts for fast switching and combination of millimeter-wave beams at high power are being developed. From the first prototype measurements up to high-power running tests, their properties are increasingly known. The new concepts, their use and the status of research is reported.

We-D1.2 611 **Dual Wideband Monolithically Integrated Millimeter-Wave Passive Front-End Sub-Systems**

J.R. Mruk[1]; H. Levitt[2]; D.S. Filipovic[1]; H.Z. Zhou[1]
[1]University of Colorado, United States; [2]Navy Research Laboratory, United States

Recent advances in micromachining have enabled development of wideband millimeter-wave antennas with integrated beamformers presented in this paper. A combination of two radiators with respective filters, both having consistent radiation patterns, is used to cover Ku- through W-band frequencies.

We-D1.3 613 **Demonstration of the self-mixing effect with a planar Gunn diode at millimeter-wave frequency**

L.B. Lok[1]; C. Li[1]; A. Khalid[1]; N.J. Pilgrim[2]; G.M. Dunn[2]; D.R.S. Cumming[1]
[1]University of Glasgow, United Kingdom; [2]University of Aberdeen, United Kingdom

We demonstrate the operation of a truly planar Gunn diode working as a self-oscillating mixer at millimeter-wave frequency. The Gunn diode was fabricated in a GaAs/Al0.23Ga0.77As layer structure. An initial prototype yielded a measured conversion loss of around 20±2.5 dB between 30 GHz and 40 GHz.

We-D1.4 615 **Sub-Terahertz Spectroscopy Using CW Broad-Area Laser Diode**

O. Morikawa[1]; K. Takano[2]; M. Fujita[1]; M. Hangyo[2]
[1]Japan Coast Guard Academy, Japan; [2]Osaka University, Japan

A CW broad-area laser diode (BLD) is used as a light source in the THz-TDS instead of femtosecond pulse lasers to reduce the cost of the spectroscopic system. The rapid fluctuation in the light intensity is used for generation and detection of the sub-THz radiation.

We-D1.5 616 **Physical Optics Characterization of a THz Time Domain System: UWB Leaky Lens Antenna vs. Austin Switch**

Nuria Llombart[1]; A. Neto[2]; P.H. Siegel[3]
[1]Universidad Complutense de Madrid, Spain; [2]Technical University of Delft, Netherlands; [3]Caltech, United States

In this work we showed that a THz time domain system based on photoconductive antennas can be improved by more than one order of magnitude by using the leaky lens antenna. The system has been analyzed by implementing a physical optics method to characterize the silicon lens.

11:00 - 12:30 Gyrotrons 4 Room 7
Chair: A. Litvak

We-E1.1 618 **Generation of 5 kW/1 THz coherent radiation from pulsed magnetic field gyrotron**

M.Y. Glyavin; A.G. Luchinin; Y.V. Rodin
Institute of Applied Physics RAS, Russian Federation

High power gyrotron with an improved pulsed solenoid has been developed. The output power 5 kW at the frequency 1 THz and 0.5 kW at the frequency 1.3 THz obtained. After 3500 pulses with magnetic field intensity higher than 35T no any changes at the coil operation observed.

We-E1.2 621 **Millimeter waves for NMR enhancement**

Alessandro MACOR; E. De Rijk; S. Alberti; J.P. Ansermet; G. Boero
EPFL, Switzerland

By shining MMWs upon a sample, Dynamic Nuclear Polarization provides a way to enhance Nuclear Magnetic Resonance signals. We report on the two branches of our project: the EPFL effort to realize a tunable gyrotron and design consideration for coupling a MMW Gaussian beam to DNP/NMR resonators.

We-E1.3 623 **Theoretical investigation of a high efficiency and broadband sub-terahertz gyrotron**

N.C. Chen[1]; T.H. Chang[1]; C.P. Yuan[1]; T. Idehara[2]; I. Ogawa[2]
[1]Physics Department, National Tsing Hua University, Taiwan; [2]Research Center for Development of Far-Infrared Region, Fukui University (FIR FU), Japan

This study investigates the electron dynamics of gyrotron interaction in a tapered waveguide and proposes an interaction structure for a 0.2-THz TE02 reflective gyro-BWO to achieve high power, broad bandwidth, and suppression of mode competition.

We-E1.4 625 **Elaboration of 260 GHz second harmonic CW gyrotron with high stability of output parameters for DNP spectroscopy**

Vladimir Zapevalov; A.S. Fix; E. Kopelovich; S. Kornishin; A. Kotov; A. Kuftin; A. Sedov
Institute of Applied Physics of Russian Academy of Sciences, Russian Federation

Paper includes results of calculation, design, experiments and technical requirements for main subsystems of 258.6 GHz gyrotron with output power about 100 W with high stability of output parameters. The gyrotron setup is a

main part of a complex experimental system for NDP spectroscopy

We-E1.5 627 **Fundamental and Harmonic Mode Competition in the Gyrotron Oscillator**

Kwo Chu; S.H. Kao; C.C. Chiu; K.F. Pao
National Tsing Hua University, Taiwan

We present a theoretical study of the competition between fundamental and harmonic interactions in the gyrotoron oscillator. It is shown that the fundamental harmonic interaction possesses a significant advantage over the harmonic interaction. A physical interpretation is given.

11:00 - 12:30 Miniaturized Electronic Devices Room 11
Chair: C. Paoloni

We-F1.1 628 **European Research on THz Vacuum Amplifiers**

A. Di Carlo[1]; F. Brunetti[1]; C.S. Cojocarua[2]; D. Dolfi[3]; M. Dispenza[4]; A. de Rossi[3]; P. Guiset[3]; P. Lagagneux[3]; J.P. Schnell[3]; C. Paoloni[1]; M. Mineo[1]; G. Ulisse[1]; E. Tamburri[1]; M.L. Terranova[1]; A. Gohier[2]; A.M. Fiorello[4]; A. Durand[5]; R. Marchesin[5]; K. Pham[5]; M. Korantia[6]; V. Krozer[7]; V. Zhurbenko[7]; A. Secchi[4]; S. Megtert[8]; F. Bouamrane[8]
[1]University of Roma Tor Vergata, Rome, Italy; [2]LPICM - Ecole Polytechnique (UMR 7647) CNRS, Palaiseau, France; [3]Thales Research and Technology, Palaiseau, France; [4]Selex-SI, Rome, Italy; [5]Thales Electron Devices, Velizy, France; [6]Technical Institute of Denmark, Copenaghen, Denmark; [7]Physikalisches Institut, Universität Frankfurt, Frankfurt am Main, Germany; [8]UMR137 CNRS/Thales, Palaiseau, France

OPTHER (OPtically Driven TeraHertz AmplifiERs) project proposes a relevant leap in the field of THz amplification. The design and realization of 1 THz amplifier is the sum of the efforts of a consortium including the main subjects of the European academy and industry in vacuum electronics

We-F1.2 630 **Microfabricated Millimeter Wave Vacuum Electronic Devices**

A. Bera[1]; G.S. Park[1]; O. Kwon[1]; M. Sattorov[1]; A. Srivastava[1]; J.Y. Kim[2]; J.W. Yang[2]; J.H. Choi[2]; J.H. Kim[3]; S.S. Chang[3]; R.K. Barik[1]; A.K. Tanwar[1]; S.H. Park[1]; I.K. Baik[1]
[1]Center for THz-Bio Application Systems, Department of Physics and Astronomy, Korea, Republic of; [2]Agency for Defense Development (ADD), Korea, Republic of; [3]Pohang Accelerator Laboratory (PAL), Korea, Republic of

The beam-wave interaction circuit of 0.1 THz of Coupled Cavity Backward-wave Oscillator (CCBWO) is being under development based on two-step X-ray Lithography. The characteristics of the microfabrication method compared to conventional machining will be investigated through cold and hot tests.

We-F1.3 632 **Linear analysis and oscillation study on folded waveguide traveling wave tube for subterahertz radiation**

W.Y. Yang; Z.W. Dong; Y. Dong; H.J. Zhou
Institute of applied physics and computational mathematics, China

The Perturbed dispersion relation in folded waveguide TWT is derived and solved using MATLAB. Calculation results show that beam voltage affects the linear growth rate significantly. And the width of the cross section, as a free

parameter, affects the start oscillation conditions obviously.

We-F1.4 634 **Backward Wave Oscillator for THz Frequency Range Based on Double Corrugation Slow-Wave Structure**

Mauro Mineo[1]; D. Bariou[2]; J.F. David[2]; A.J. Durand[2]; C. Paoloni[1]
[1]University of Rome "Tor Vergata", Italy; [2]Thales Electron Devices SA, France

A BWO at 1 THz was designed and simulated. The introduction of the double corrugation rectangular waveguide SWS permits an effective interaction with cylindrical electron beams. The advantages of the BW operation permit remarkable performance up to 33 mW output power, in compact and realizable way.

We-F1.5 636 **Cherenkov Oscillators with Two-Dimensional Distributed Feedback**

N.S. Ginzburg; E.V. Ilyakov; I.S. Kulagin; N.Y. Peskov; A.S. Sergeev; V.Y. Zaslavsky
Institute of Applied Physics RAS, Russian Federation

Possibility to use 2D distributed feedback for generation of spatially coherent radiation by rectilinear electron beams in Cherenkov type devises is discussed. Theoretical and experimental studies of Ka-band coaxial BWO with external 2D Bragg structure which operates as a synchronizer is presented.

14:00 - 15:30 Tomography Aula Minor
Chair: T. Yasui

We-A2.1 638 **Classic holography, tomography and speckle-metrology using a high-power terahertz FEL and real-time image detectors**

Boris Knyazev[1]; A.L. Balandin[2]; V.S. Cherkassky[3]; Y.Y. Choporova[4]; V.V. Gerasimov[1]; A.A. Nikitin[3]; V.V. Pickalov[5]; M.G. Vlasenko[1]; D.G. Rodionov[4]; D.G. Esaev[6]; M.A. Dem'yanenko[6]; O.A. Shevchenko[1]
[1]Budker Institute of Nuclear Physics, Russian Federation; [2]Institute of Systems Dynamics and Control Theory, Russian Federation; [3]Novosibirsk State University, Russian Federation; [4]Novosibirsk State Technical University, Russian Federation; [5]Khristianovich Institute of Theoretical and Applied Mechanics, Russian Federation; [6]Rzhanov Institute of Semicomductor Physics, Russian Federation

Experiments on in-line and two-beam holography, as well as speckle photography and speckle interferometry, using high-power monochromatic radiation of a free electron laser have been carried out. Experimental and theoretical approach to tomography with monochromatic terahertz sources is presented.

We-A2.2 641 **Terahertz tomography system using fiber lasers and applications**

Toshihiko Ouchi[1]; K. Kajiki[1]; M. Shioda[1]; S. Kasai[1]; K. Kawase[2]; T. Itsuji[1]
[1]Canon Inc., Japan; [2]Nagoya University, Japan

High depth-resolution terahertz three-dimensional tomography was developed by monocycle-like terahertz pulses using ultra-short pulse fiber lasers. We designed novel photoconductive devices such as a thin-film LT-GaAs detector on Si substrates and an LT-InGaAs emitter for the monocycle waveforms.

We-A2.3 644 **Optical Coherence Tomography System in the Terahertz Region**
H.K. Kitahara[1]; M.T. Tani[2]; M.H. Hangyo[1]
[1]Osaka university, Japan; [2]University of Fukui, Japan
We have developed a terahertz frequency-domain optical coherence tomography system based on the frequency- domain spectroscopy using a photoconductive antenna and an external cavity diode laser. The observation of the axial reflectivity profile is demonstrated for a high-resistivity silicone plate.

We-A2.4 646 **Investigation of foam and glass fiber composite structures used in aerospace applications by all-electronic 3D Terahertz imaging**
Holger Quast; A. Keil; T. Loeffler
SynView GmbH, Germany
We investigate how all-electronic Terahertz / Millimeter wave imaging allows the evaluation of special material structures used in aerospace applications. Structures are foam material intended for the isolation of cryogenic tanks, and glass fiber composite samples intended for several applications.

14:00 - 15:30 Guiding Devices 2 Aula Minor
Chair: C.W. Baik

We-B2.1 648 **Terahertz Electromagnetic Crystal (EMXT) Based Waveguide and Horn Antenna**
Hao Xin; Z.R. Wu; W.R. Ng; M.E. Gehm
University of Arizona, United States
All-dielectric Terahertz waveguide and horn antenna based on hollow-core EMXT fiber are fabricated via THz rapid prototyping using polymer jetting technique. Characterization of the waveguide propagation loss shows a very good agreement with the simulation.

We-B2.2 650 **A Tunable Universal THz Filter using Artificial Dielectrics**
Mendis; A. Nag; F. Chen; D.M. Mittleman
Rice University, United States
Using parallel-plate waveguides that mimic artificial dielectrics, we demonstrate a universal filter that provides tunable, low-pass, high-pass, band-pass, and band-stop filtering functionalities in the THz region.

We-B2.3 652 **Broadband transmission of terahertz radiations in thin silica tube**
E. Nguema Agnandji; D.r. Georges Humbert; P.h.d. Denis Ferachou
XLIM : institut de recherche, France
Hollow-core thin silica tubes based on antiresonant guiding mechanism are studied with femtosecond terahertz (THz) setup. By controlling the parameters of the waveguide, broad transmission windows, up to 600 GHz, are demonstrated at terahertz frequencies

We-B2.4 654 **Hollow-core terahertz waveguide based on out-of-plane two-dimensional photonic band gad crystal cladding**
Denis Ferachou; E. Nguema; G. Humbert; J.L. Auguste; J.M. Blondy
Xlim Institut de recherche, France
We demonstrate the propagation of teraherz (THz) radiations through a hollow-core waveguide based on a two dimensional photonic band gap crystal cladding. The measurements are done with THz Time Domain Spectroscopy

(TDS).

We-B2.5 656 **Propagation loss measurements of porous THz subwavelength fibers**

A. Dupuis; A. Mazharova; F. Desevedavy; M. Skorobogatiy
Ecole Polytechnique of Montreal, Canada

We report on the THz spectral loss characteristics of porous subwavelength polyethylene fibers. Propagation losses (α<0.04cm-1) were found to be comparable to non-porous fibers of similar diameter. However, the transmission peaks of porous fibers were broader and shifted to higher frequencies.

We-B2.6 658 **Improved photonic crystal based 90 bends for THz transmission**

E. Degirmenci; F. Surre; P. Landais
RINCE, Dublin City University, Ireland

An improved design is proposed for 90° PhC bend waveguide. 2D numerical simulations are carried out for single-line defect in metallic band-gap crystals in square lattice structure. A significant improvement is achieved in terms of transmission (over 98 %) and bandwidth over 1 THz with the design.

14:00 - 15:30 Devices Room 2
Chair: P.H. Siegel

We-C2.1 660 **Microwave Crosstalk in Lumped Element Far-IR MKIDs**

O. Noroozian[1]; P.K. Day[2]; B.H. Eom[1]; H.G. LeDuc[2]; J. Zmuidzinas[1]
[1]California Institute of Technology, United States; [2]Jet Propulsion Laboratory, United States

We have made close-packed far-infrared MKID arrays with ~ 250 pixels using TiN on silicon. Measurements show a large scatter in quality factor arising from crosstalk. This is confirmed by pump-probe experiments and EM simulations. Our new shielded resonator designs show very low crosstalk levels.

We-C2.2 661 **VNA-Calibration and S-Parameter Characterization of Submillimeter Wave Integrated Membrane Circuits**

Huan Zhao
Chalmers University of Technology, Sweden

A TRL-calibration kit enabling S-parameter characterization of membrane circuits has been developed for the WR-03 band. The TRL-design features 3 ìm thick GaAs membrane circuits packaged in E-plane split waveguide blocks. Membrane circuits have been characterized after the calibration.

We-C2.3 663 **Simulation of electrical and optical characteristics for InP/InGaAs/InP p-i-n photodiodes**

x.d. wang; w.d. hu; x.s. chen; w. lu; h.j. tang; t. li; h.m. gong
Shanghai Institute of Technical Physics, Chinese Academy of Sciences, China

2D simulation of dark current and photoresponse for InP/InGaAs/InP photodiode is carried out by Sentaurus DEVICE. The simulation results are in good agreement with experiments confirming that generation-recombination effect is the dominant source of dark current at low bias.

We-C2.4 665 **Sub-Terahertz resistive mixing in a AlGaN/GaN HEMT**

K. Madjour; G. Ducournau; S. Lepilliet; T. Akalin; J.F. Lampin; M.A. Poisson; S. Delage; C. Gaquière
IEMN, France

An AlGaN/GaN based field effect transistor (FET) has been designed, fabricated, and used as a resistive mixer for heterodyne detection in the 140-220 GHz frequency range. Optimum biasing conditions, conversion losses and linearity are investigated.

We-C2.5 667 **Optimization of THz pulses emitted by a InGaAs photoconductive switch**

A.S. Grimault-Jacquin; B.T. Tissafi; F.A. Aniel
Institut d'Electronique Fondamentale, France

We present some results concerning the optimization of the amplitude or of the band pass of the THz pulse generated by an InGaAs photoconductive inserted in a coplanar waveguide by using 3D modeling. The optical pulse intensity, pulse dimension,... compared to PC active gap is discussed

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14:00 - 15:30 Transmission Lines Room 3
Chair: G. Nusinovich

We-D2.1 669 **Study of High-Power Millimeter-Wave Beam Transmission for Microwave Beaming Propulsion**

Yasuhisa Oda[1]; T. Yamaguchi[2]; Y. Shimada[2]; K. Komurasaki[2]; K. Kajiwara[3]; K. Takahashi[3]; K. Sakamoto[3]
[1]801-1, Japan; [2]the university of Tokyo, Japan; [3]Japan Atomic Energy Agency, Japan

A high-power millimeter-wave beam transmission system for microwave beaming propulsion were designed and tested. A thruster with the transmission system consisted from a launcher and focusing mirrors was operated using a gyrotron. The thruster traveled for 3 m distance generating thrust force.

We-D2.2 671 **2 MW CW RF Load for Gyrotrons**

R. Lawrence Ives[1]; Y.N. Mizuhara[2]; J.M. Neilson[1]; P. Borchard[3]
[1]Calabazas Creek Research, Inc., United States; [2]Consultant, United States; [3]Dymenso, LLC, United States

Gyrotrons are in development to produce 2 MW CW of RF power in the mm-wave frequency range. Developers require RF loads to test these devices at full power, and similar loads will also be required for ITER. This presentation describes development of 2 MW CW RF load to meet these requirements.

We-D2.3 673 **Transmission Line for 258 GHz Gyrotron DNP Spectroscopy**

Grigory Denisov[1]; A.A. Bogdashov[1]; A.V. Chirkov[2]; V.I. Belousov[2]; S.Y. Kornishin[2]; E.M. Tai[3]
[1]Institute of Applied Physics/GYCOM, Russian Federation; [2]Institute of Applied Physics, Russian Federation; [3]GYCOM, Russian Federation

We report the design and test of the transmission line for DNP spectrometer with 258GHz gyrotron. The 16 meter line includes mode converter, HE11 waveguides, 5 mitre bends, variable attenuator, directional couplers, calorimeter and switch. Transmission is 70 15% with 15Watt in the pure HE11 mode.

We-D2.4 675 **Design of Low Loss Single-Mode Terahertz Bragg Fibers Based on a Confinement Loss Diagram**

Yunhua Zhang; I.D. Robertson
Institute of Microwaves and Photonics, University of Leeds, UK, United Kingdom

In this paper, the confinement loss diagram is combined with the modal filtering approach to design low loss single-mode terahertz Bragg fibers. The designed Bragg fiber can achieve propagation loss around 0.2 dB/m to 0.5 dB/m in the range of 0.7 THz to 1.4 THz, with only 10 layers of Bragg cladding

We-D2.5 677 **Wet Silicon Bulk Micromachined THz Waveguides for Low-Loss Integrated Sensor Applications**

Vladimir Matvejev; C. De Tandt; W. Ranson; J. Stiens
Vrije Universiteit Brussel (VUB), Belgium

Wet Si bulk micromachining enables producing hexagonally shaped waveguides (WH) with superior performance and are applicable to low THz frequency range. We discuss the fabrication process, hexagonal cross-section analysis, and balance between loss mitigation and operational frequency band of WH.

14:00 - 15:30 Detectors 4 Room 7
Chair: A. Luukanen

We-E2.1 679 **Superconducting hot-electron bolometer as THz mixer, direct detector and IR single-photon counter**

Gregory Goltsman
Moscow State Pedagogical University, Russian Federation

We present a new generation of superconducting single-photon detectors (SSPDs) and hot-electron superconducting sensors with record characteristic for many terahertz and optical applications.

We-E2.2 680 **Optical characterization of a superconducting hotspot air-bridge bolometer**

Sara Cibella[1]; M. Ortolani[1]; R. Leoni[1]; G. Torrioli[1]; L. Mahler[2]; J. Xu[2]; A. Tredicucci[2]; H.E. Beere[3]; D.A. Ritchie[3]; F. Chiarello[1]
[1]CNR/IFN, Italy; [2]NEST, CNR-INFM and Scuola Normale Superiore, Italy; [3]Cavendish Laboratory, University of Cambridge, United Kingdom

A superconducting hotspot air-bridge bolometer (SHAB) with an on-chip lithographic terahertz antenna has been fabricated and characterized both for passive and active signal detection.

We-E2.3 682 **Uncooled suspended bolometers based on La0.7Sr0.3Mn03 thin films**

Bruno Guillet[1]; S. Liu[1]; C. Fur[1]; S. Wu[1]; J.M. Routoure[1]; C. Adamo[2]; F. Lemarie[3]; D. Schlom[2]; L. Méchin[1]
[1]GREYC (CNRS-ENSICAEN-Université de Caen Basse Normandie), France; [2]Department of Materials Science and Engineering, Cornell University, United States; [3]CIMAP (CNRS-CEA-ENSICAEN-Université de Caen Basse Normandie), France

We report our results on uncooled La0.7Sr0.3Mn03 (LSMO) suspended bolometers fabricated using silicon micromachining techniques. Suspended

LSMO bridges showed very low effective thermal conductance (~10-7 W K-1) and very low NEP value (~ 1 pW Hz-1/2) at 300K.

We-E2.4 683 **Cryogen-free operation of a voltage-biased superconducting bolometer**

David Naylor[1]; D.J. Hayton[1]; Y. Zhang[1]; P. Mauskopf[2]; P.A.R. Ade[2]; C. Dunscombe[2]; K. Wood[3]; J. Cox[3]
[1]University of Lethbridge, Canada; [2]Cardiff University, United Kingdom; [3]QMC Instruments, United Kingdom

We report on the performance of a Nb voltage-biased superconducting bolometer cooled by a closed cycle pulse tube cooler. The VSB has a Tc ~ 8.1 K and an operating impedance of R ~ 600 Ω. A preliminary value for the system optical noise equivalent power (NEP) = 1.8 × 10 -12 WHz-1/2 and τ = 0.6 ms.

We-E2.5 685 **High sensitive superconductor-semiconductor-superconductor THz detector.**

D. Morozov[1]; P. Mauskopf[1]; P. Barry[1]; T. Brien[1]; M. Prest[2]; T. Whall[2]
[1]Cardiff University, United Kingdom; [2]University of Warwick, United Kingdom

We describe a high sensitivity THz detector based on the hot electron effect in a highly doped thin silicon semiconducting layer with tunnelling contacts to superconducting islands (S-Sm-S).

14:00 - 15:30 Novel Microdevices Room 11
Chair: A. Di Carlo

We-F2.1 686 **THz Microfabricated Vacuum Electronic Devices using Photonic Concepts**

Gun-Sik Park; J.K. So
Center for THz-Bio Application Systems, Department of Physics and Astronomy, Korea, Republic of

The advances in THz VEDs adopting novel photonic concepts such as photonic crystals or plasmonics for efficient beam-wave interaction between convection electrons and THz waves are explored.

We-F2.2 688 **Experimental studies of Volume FELs with a photonic crystal**

Alexandra Gurinovich; V.G. Baryshevsky; N.A. Belous; E.A. Gurnevich; V.A. Evdokimov; P.V. Molchanov
Research Institute for Nuclear Problems, Belarus

A Volume Free Electron Laser with a photonic crystal formed by metallic threads (or foils) periodically strained inside a cylindrical waveguide is studied. Operation of Volume Free Electron Laser is discussed for different configurations of the photonic crystal

We-F2.3 690 **A High-Frequency Monotron Employing Two-Dimensional, Dielectric Photonic-Crystal, Diode Resonator**

Seong-Tae Han
Korea Electrotechnology Research Institute, Korea, Republic of

We propose a monotron consisting of the parallel plates (cathode and anode) spaced by periodic dielectric-rods around the emitter (photonic crystal resonator), that is the diode and resonator all in one. The transit-time effect in the resonant diode is explored to develop a high frequency device.

We-F2.4 692 **Recent Advances in Beam Optics Analyzer**

Thuc Bui[1]; R.I. Ives[1]; M. Read[1]; M. Posth[2]
[1]Calabazas Creek Research, Inc., United States; [2]GUI Consultant, United States

Recent advances in Beam Optics Analyzer are reported to demonstrate its features and capabilities. Detailed results of several electron gun simulations and optimization will be presented.

We-F2.5 693 **MEMS Fabrications of Broadband Epsilon Negative (ENG) Metamaterial Electronic Circuit for 0.22 THz Sheet Beam TWT Application**

Young-Min Shin; A. Baig; A. Spear; J. Zhao; D. Gamzina; C.W. Domier
University of California - Davis, United States

In the course of the DARPA HiFIVE (High Frequency Integrated Vacuum Electronics) program, we have investigated various MEMS techniques for micro-fabrication of electronic circuits, a ultra wideband epsilon negative (ENG) metamaterial, built in a 0.22 THz traveling wave tube (TWT) amplifier.

16:00 - 17:45 Spectroscopy 2 Aula Magna
Chair: M. Dressel

We-A3.1 695 **Estimation of Hydration Numbers in Aqueous Solution using THz Time Domain Spectroscopy**

E. Jung; K. Moon; M. Lim; H. Han
POSTECH, Korea, Republic of

Hydration dynamics in aqueous solution has been characterized using terahertz time domain spectroscopy. Hydration water differs from bulk water and directly influences the protein dynamics. By precise measurement of dielectric constants of aqueous solutions we estimated hydration numbers accurately.

We-A3.2 697 **Terahertz Spectroscopy of Chemicals in the Liquid Phase**

Erik Bruendermann; M. Krueger; S. Funkner; H. Weingaertner; M. Havenith
Ruhr-University Bochum, Germany

The multi-modal approach of GHz dielectric, terahertz and infrared spectroscopy revealed absorption and dispersion of an ionic liquid and resulted in a data set spanning 7 to 8 orders of magnitude in frequency and in absorption. Ionic liquids show comparable high absorption such as liquid water.

We-A3.3 699 **Sub-Terahertz spectroscopy in superconductors and charge-ordered materials**

Paolo Calvani[1]; S. Lupi[1]; A. Nucara[1]; P. Maselli[1]; F.M. Vitucci[1]; C. Mirri[1]; L. Baldassarre[2]; M. Ortolani[3]
[1]Università La Sapienza, Italy; [2]Sincrotrone Trieste, Italy; [3]IFN-CNR, Roma, Italy

We review the results obtained on several innovating materials by the sub-Terahertz spectroscopy which uses Coherent synchrotron Radiation as a source, and we present new data on the multiferroic LuFeO.

We-A3.4 701 **Infrared magneto-spectroscopy using quantum cascade lasers**

Oleksiy Drachenko[1]; S. Winnerl[1]; H. Schneider[1]; M. Helm[1]; J. Leotin[2]
[1]Forschungszentrum Dresden-Rossendorf e. V., Germany; [2]Laboratoire Nationale des Champs Magnetiques Intenses, France

We present a magneto-transmission experimental set up covering spectral region from 5 to 120 μm. Interchangable quantum cascade lasers are used as an excitation sources. Performance of the setup is illustrated via cyclotron resonance studies of InGaAs/GaAs QWs under magnetic fields up to 60T

We-A3.5 703 **Comparative study of extraction of material parameters from THz time-domain spectroscopy performed in reflection and in transmission**

J.L. Coutaz[1]; B. Blampey[2]; F. Garet[2]
[1]IMEP-LAHC University of Savoie, France; [2]University of Savoie, France

We study the uncertainties of the refractive index and coefficient of absorption of materials in the far-infrared determined from THz time-domain spectroscopy performed in reflection and in transmission. We give rules to select the most appropriate experimental technique regarding studied samples.

We-A3.6 705 **Application of THz Spectroscopy to Time-Dependent Chemical-Physical Phenomena**

Augusto Marcelli[1]; P. Innocenzi[2]; L. Malfatti[2]; M. Piccinini[3]; U. Schade[4]
[1]INFN - LNF, Italy; [2]Sassari University, Italy; [3]Porto Conte Ricerche, Italy; [4]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Germany

We may investigate time-dependent phenomena in a non pump-probe configuration combining a SR THz source and a IR thermal source. A “proof of concepts” experiment of the evaporation of a deuterated water droplet cast on a diamond substrate was performed simultaneously in the IR and in the THz ranges.

16:00 - 17:45 Instruments 2 Aula Minor
Chair: R. Beccherelli

We-B3.1 706 **3D Imaging and Analysis System Using Terahertz Waves**

Motoki Imamura; S. Nishina; A. Irisawa; T. Yamashita; E. Kato
Advantest corporation, Japan

We have developed the 3D Imaging and Analysis System that uses terahertz waves, the world's first such system for practical applications. This system has an unprecedented capability for nondestructive three-dimensional spectroscopic analysis of the spatial distribution of constituents.

We-B3.2 709 **Monochromatic, Wide Tunable Terahertz-wave Spectrometer Working at Room Temperature**

G. GUO[1]; L. Lim[2]; P. Paulose[1]; G. Gong[1]; M. Minamide[3]; I. Ito[3]
[1]Institute for Infocomm Research, Singapore; [2]Nanyang Technological University, Singapore; [3]RIKEN Advanced Science Institute, Japan

Using a surface-emitted THz parametric oscillator, a MgO: LiNbO3-based frequency up-conversion detector and a special optical design for fast frequency tuning and achromatic THz-wave detection, we realized a room-temperature-operated THz frequency-domain spectrometer (THz-TDS)

We-B3.3 711 **Hybrid Continuous Wave Terahertz System**

Matthias Stecher; M. Scheller; M. Koch
Philipps-Universität Marburg, Germany

We present a hybrid continuous wave terahertz system, combining a two color photomixing system with a quasi time domain spectrometer, driven by a multimode laser diode. Overcoming the ambiguity of standard continuous wave thickness measurements is shown on different samples.

We-B3.4 713 **Stabilization of the frequency difference of optically synchronized THz waves for reducing spectrometer sensitivity fluctuation**

N. Shimizu[1]; N. Kukutsu[1]; Y. Kado[1]; A. Wakatsuki[2]; S. Kohjiro[3]
[1]NTT Microsystem Integration Labs., Japan; [2]NTT Photonics Labs., Japan; [3]AIST, Japan

We developed a frequency difference stabilizer for an optically synchronized dual-channel THz signal generator. The stabilizer reduces the amplitude fluctuation in spectrometer signal, enabling us to instantaneously observe the spectra, whose absorption characteristics change rapidly with time.

We-B3.5 715 **THz time domain spectroscopy system using 1.55 m laser pulses and phase modulation detection in DAST crystal**

P. Crozat[1]; J. Mangeney[1]; M. Martin[1]; P. Mounaix[2]
[1]Institut d'Electronique Fondamentale, France; [2]Centre de Physique Moleculaire Optique et Hertzienne, France

We report terahertz time-domain spectroscopy system based on Er:fiber laser at 1.55 µm wavelength. Ion-irradiated In0.53Ga0.47As photoconductive antenna is used as emitter. The detection is based on a phase modulation detection scheme in DAST electro-optic sensor.

We-B3.6 717 **Progress Towards an Ultracompact cw Terahertz Spectrometer**

Anselm Deninger[1]; D. Stanze[2]; S. Schindler[1]; M. Schlak[2]; B. Sartorius[2]; W. Kaenders[1]
[1]TOPTICA Photonics, Germany; [2]Fraunhofer Heinrich-Hertz Institute, Germany

A cw terahertz spectrometer operating without optical amplifiers and without mechanical delay line is presented. Fiber-coupled 1.5 µm DFB lasers in a butterfly housing drive a photodiode emitter, which provides 5 µW output at 0.5 THz. A coherent photoconductive receiver yields an SNR up to 75 dB.

16:00 - 17:45 Photomixing Generation Room 2
Chair: R. Beigang

We-C3.1 719 **Widely Tunable Dual-Mode Multisection Laser Diode for Continuous-Wave THz Generation**

Namje Kim[1]; Y.A. Leem[1]; J.H. Shin[1]; C.W. Lee[1]; S.P. Han[1]; M.Y. Jeon[1]; D.H. Lee[1]; D.S. Yee[2]; S.K. Noh[2]; K.H. Park[1]
[1]Electronics and Telecommunications Research Institute (ETRI), Korea, Republic of; [2]Korea Research Institute of Standards and Science (KRISS), Korea, Republic of

We demonstrate novel dual-mode laser for tunable continuous-wave (CW) THz generation with InGaAs-based photomixers. The beat frequency from this dual-mode multisection laser is continuously tuned from 0.30 to over 1.15

THz.

We-C3.2 721 **Subterahertz primary radiation source with ultra narrow spectrum: new application of femtosecond laser comb**

M.Y. Tretyakov; S.B. Bodrov; A.P. Shkaev; A.M. Kiselev; A.V. Andrianov; D.S. Makarov
Institute of Applied Physics of Russian Academy of Sciences, Russian Federation

The frequency of a primary subterahertz oscillator has been stabilized by phase lock with one of the component of the terahertz frequency comb produced by femtosecond laser pulses. Stabilization allows to reach radiation spectrum with very low phase noise and less than 10 Hz bandwidth.

We-C3.3 723 **Tunable Narrow Linewidth THz-Wave Generation using Dual-Wavelength Fiber Ring Laser and Organic DAST Crystal**

Ming Tang; T. Notake; H. Minamide; Y. Wang; H. Ito
RIKEN, Advanced Science Institute, Japan

We demonstrated a novel single longitudinal mode dual-wavelength fiber ring laser with continuously tunable wavelength spacing. Continuous-wave Terahertz radiation from sub-THz to 2 THz was generated through difference-frequency generation of two laser wavelengths in a nonlinear DAST crystal.

We-C3.4 725 **Continuous Wave Terahertz Photomixer from Low Temperature Grown GaAs with High Carrier Mobility**

J.H. Teng[1]; H. Tanoto[1]; Q.Y. Wu[1]; M. Sun[2]; Z.N. Chen[2]; T. Htoo[3]; S.J. Chua[4]; A. Gokarna[5]; J.F. Lampin[5]; E. Dogheche[5]
[1]Institute of Materials Research and Engineering, Singapore; [2]Institute for Infocomm Research, Singapore; [3]National University of Singapore, Singapore; [4]Institute of Materials Research and Engineering and National University of Singapore, Singapore; [5]Institut d'Electronique de Microélectronique et de Nanotechnologie, CNRS, France

Low temperature GaAs grown by MBE system exhibiting Hall carrier mobility of 5000 cm2/v.s. was fabricated into continuous-wave (CW) Terahertz (THz) photomixers utilizing dual dipole antenna with interdigitated structures. The CW THz photomixer characteristics are presented.

We-C3.5 727 **Continuous Terahertz Wave Emission Using Tunable Dual-Wavelength Erbium-doped Fiber Laser**

Min Yong Jeon[1]; N.J. Kim[2]; J.H. Shin[2]; C.W. Lee[2]; S.P. Han[2]; Y.A. Leem[2]; D.S. Yee[3]; S.K. Noh[3]; K.H. Park[2]
[1]Chungnam National University/ETRI, Korea, Republic of; [2]ETRI, Korea, Republic of; [3]KRISS, Korea, Republic of

We demonstrate a continuous THz emission using a low-temperature-grown InGaAs photomixer and a widely tunable dual-wavelength erbium-doped fiber laser as an optical beat source. The wavelength spacing can be tuned from 2.3 nm to 8.8 nm which corresponds to the CW THz frequency from 0.3 to 1.1 THz.

We-C3.6 729 **Narrow linewidth Terahertz Signal Generation using a Dual-Mode Semiconductor Fabry-Pérot Laser and a Uni-travelling Carrier Photodiode**

G. Ducournau[1]; A. Beck[1]; E. Peytavit[1]; T. Akalin[1]; J.F. Lampin[1]; S. Latkowski[2]; J. Parra-Cetina[2]; R. Maldonado-Basilio[2]; P. Landais[2]
[1]IEMN, France; [2]RINCE, Ireland

A narrowband terahertz signal (372 GHz) generated by a uni-travelling carrier photodiode (UTC-PD) interfaced with a dual-mode Fabry-Pérot laser diode is demonstrated. The linewidth and tunability of the emitted terahertz wave are analyzed, as a function of the laser bias.

16:00 - 17:45 Antennas Room 3
Chair: D. Rutledge

We-D3.1 731 **Design of a Submillimeter Microstrip Array for Beam-Scanning Applications**

R. Camblor; S. Ver Hoeye; G. Hotopan; C. Vázquez; M. Fernández; F. Las Heras
University of Oviedo, Spain

A microstrip array antenna with beam-steering capabilities is presented for imaging applications, working in the frequency range of 240-279 GHz a 33 degrees beam-scanning range is achieved. Beam-Scanning is obtained by making use of variation of the beam-pointing angle due to frequency scanning.

We-D3.2 734 **Terahertz Dipole Antenna in Fabry-Perot Cavity with two sidewalls to Enhance the Directivity**

G. Singh[1]; G. Singh[1]; K.R. Jha[2]; G. Singh[1]
[1]Jaypee University of Information Technology, India; [2]Shri Mata Vaishno Devi University, India

In this paper, the directivity enhancement mechanism of a dipole antenna placed in a Fabry-Perot type cavity is presented. The directivity of the antenna has been increased upto 19 dBi at 610 GHz.

We-D3.3 736 **Reconfigurable Vivaldi Antenna Array with Integrated Antipodal Finline Phase Shifter with Liquid Crystal for W-Band Applications**

Matthias Hoefle; M. Koeberle; M. Chen; A. Penirschke; R. Jakoby
TU Darmstadt, Microwave Engineering, Germany

This paper presents a new finline phase shifter with an antipodal Vivaldi antenna. The structure offers the potential to be used in a wideband array configuration for electronic beam steering. The individual phase shift is realized by applying a DC voltage to liquid crystal inside the finline.

We-D3.4 738 **Design of a Remote Steering ECRH launcher for the Stellerator Wendelstein 7-X**

B. Plaum[1]; W. Kasparek[1]; V. Erckmann[2]; H. Laqua[2]; C. Lechte[1]; M. Weißgerber[2]
[1]University of Stuttgart, Germany; [2]Max-Planck-Institut für Plasmaphysik, Germany

The overall design of the remote steering antenna, which is foreseen for the Stellerator Wendelstein 7-X, is presented. Issues, which arise from the integration of mitrebends and vacuum-valves, are discussed along with results

from calculations and low-power measurements.

We-D3. 5 740 **Development of CW Phased-array Antenna System for Electron Bernstein Heating and Current Drive Experiments in QUEST**

Hiroshi Idei
Kyushu University, Japan

The phased-array antenna for EBWH/CD has been developed in the QUEST. The fields evaluated by a Kirchhoff code were in agreement with measured ones. The thermal load/stress in the CW were analyzed with a finite element code. The phased array has been fast scanned to control the polarization angle.

We-D3. 6 742 **Terahertz Plasmonic Antennas: from Metals to Semiconductors**

Audrey Berrier[1]; R. Ulbricht[1]; D. Polke[2]; P. Haring Bolivar[2]; M. Bonn[1]; J. Gomez Rivas[1]
[1]FOM institute AMOLF, Netherlands; [2]Siegen university, Germany

Plasmonic antennas at THz frequencies are promising candidates to enhance the sensitivity of THz detectors. The resonances of metallic and semiconductor antennas are compared. Experiments show the powerful advantage of semiconductors as a means for active control over the localized surface plasmons.

16:00 - 17:45 Detectors 5 Room 7
Chair: E. Lheurette

We-E3.1 743 **On-chip terahertz photon manipulation**

Kenji Ikushima[1]; K. Kunitani[1]; D. Asaoka[2]; S. Komiyama[2]; T. Ueda[2]; K. Hirakawa[2]
[1]Tokyo University of Agriculture and Technology, Japan; [2]University of Tokyo, Japan

An on-chip terahertz photon manipulation is implemented on a GaAs/AlGaAs single heterostructure crystal. In this device, terahertz photons emitted from a microscopic area are propagated on a coplanar waveguide and counted by a quantum-dot single photon detector fabricated on the same chip.

We-E3.4 746 **Optical MEMS Technologies for Multi-Spectral Infrared Sensors**

Lorenzo Faraone[1]; J.S. Milne[2]; J. Antoszewski[2]; J.M. Dell[2]
[1]The University of Western Australia, Australia; [2]UWA, Australia

The technology for Multi-Spectral Infrared Sensors is presented. It includes the concept, modeling, experimental results as well as demonstration of the infrared sensor capable of low-voltage tuning across the SWIR and MWIR wavelength bands.

We-E3.5 748 **Photodetection Mechanisms in Floating Gate Photoconductors with Far-Infrared Quantum Well Intersubband Transitions**

E. Ledwosinska; T. Szkopek
McGill University, Canada

We demonstrate two mechanisms of far-IR detection in GaAs/AlGaAs quantum wells operating as floating gate photoconductors: electron trapping in an adjacent quantum well or a DX centre layer, leading to responsivities of 100A/W and 500A/J at operating temperatures of up to 30K and 100K, respectively.

We-E3.6 750 **Development of MEMS Microbolometer Detector for THz Applications**

E.H. Oulachgar; L. Marchese; C. Alain; P. Topart; B. Tremblay; S. Ilias; M. Bolduc; F. Williamson; G. Baldenberger; F. Genereux; J. Osouf; L. Le Noc; T. Pope; H. Jerominek; A. Bergeron
Institut National d'Optique (INO), Canada

INO has been actively working on extending its microbolometer technology to THz applications. Several techniques have been developed recently to improve the performance of microbolometer. This article will present these techniques and discuss some potential applications of INO THz microbolometer.

16:00 - 17:45 Astronomy and Environmental Studies 2 Room 11
Chair: K. Wood

We-F3.1 752 **Characterising and calibrating the SCUBA-2 superconducting bolometer arrays for science observing**

D. Bintley[1]; M.J. MacIntosh[2]; W.S. Holland[2]; D. Berry[1]; J.T. Dempsey[1]; P. Friberg[1]; T. Jenness[1]; D. Kelly[2]; X. Gao[2]; P.A.R. Ade[3]; W. Grainger[3]; L. Moncelsi[3]; K.D. Irwin[4]; G.C. Hilton[4]; M. Niemack[4]; C.D. Reitsema[4]; M.I. Hollister[5]; A. Woodcraft[5]; M. Amiri[6]; B. Burger[6]; E. Chapin[6]; A. Gibb[6]; M. Halpern[6]; D. Scott[6]; M. Hasselfield[6]; H.S. Thomas[1]
[1]Joint Astronomy Centre, United States; [2]UK Astronomy Technology Centre, United Kingdom; [3]Cardiff University, United Kingdom; [4]NIST, United States; [5]University of Edinburgh, United Kingdom; [6]University of British Columbia, Canada

SCUBA-2 is a 10,000 pixel wide field sub-millimeter camera which started science observing on James Clerk Maxwell Telescope (JCMT) in the spring of 2010. We present the results of characterising individual 1280 bolometer science grade sub-arrays, as well as experience from operating the instrument.

We-F3.2 755 **Superconducting Lumped Element Kinetic Inductance Resonators for millimeter, sub-millimeter and far infrared detection.**

Simon Doyle[1]; P. Mauskopf[1]; A. Monfardini[2]; L. Swenson[2]; S. Withington[3]; D. Goldie[3]
[1]Cardiff University, United Kingdom; [2]nstitut NEEL, CNRS & Université Joseph Fourier, France; [3]Cambridge University, United Kingdom

The Lumped Element Kinetic Inductance Detector (LEKID) is a superconducting detector suitable for use from the mm to FIR wavebands. Due to its simple design the LEKID can easily be fabricated into large multiplexed arrays. This presentation will provide an overview of the LEKID and its applications.

We-F3.3 757 **THz synthesizer for high resolution spectroscopy**

Francis Hindle; G. Mouret; C. Yang; A. Cuisset; R. Bocquet
Laboratoire de Physico-Chimie de l'Atmosphère, UMR CNRS 8101, France

A THz synthesizer has been realized by phase locking the photomixer pump lasers to a frequency comb effectively locking the THz emission frequency of the source. This allowed the centre frequency of a molecular transition at 813 GHz to be measured with an accuracy of 20 kHz, (10-8)

We-F3.4 759 **Estimators for the performances of the optical combiner of an adding interferometer**

Sebastiano Spinelli[1]; M. Gervasi[1]; A. Tartari[1]; M. Zannoni[1]; C. O'Sullivan[2]; D. Bennet[2]; G. Curran[2]
[1]Università di Milano Bicocca, Italy; [2]National University of Ireland, Ireland

The definition of an optical system used as a signal combiner (Fizeau-like combiner) for a millimeter wave adding interferometer is described. A couple of reliable estimators of its performances is introduced and applied to a test system.

We-F3.5 761 **Development of single-material multi-layer interference filter with sub-wavelength structure for cryogenic infrared astronomical missions**

T. Wada[1]; H. Makitsubo[2]; M. Mita[1]
[1]Japan Aerospace Exploration Agency, Japan; [2]The University of Tokyo, Japan

We are developing single-material (all-silicon) interference filter for cryogenic infrared instrumentation. Layers with different refractive indices and multi-layer structure are realized by sub-wavelength structure fabricated by photo lithography and wafer bonding technique, respectively.

We-F3.6 763 **Development of a far-infrared Ge:Ga monolithic array detector for SPICA (Space Infrared Telescope for Cosmology and Astrophysics)**

S.K. Kamiya[1]; M.S. Shirahata[2]; S.M. Matsuura[2]; Y.S. Sawayama[1]; Y.D. Doi[1]; M.K. Kawada[2]; T.N. Nakagawa[2]; Y.C. Creten[3]; B.O. Okcan[3]; W.R. Raab[4]
[1]The University of Tokyo, Japan; [2]JAXA/ISAS, Japan; [3]IMEC, Belgium; [4]MPE-Garching, Germany

We are developing a monolithic Ge:Ga array far-infrared detector for the future space telescope SPICA. We demonstrate the performance of our detector by showing the test results of a 5x5 prototype array. It had worked properly and showed the expected performance.

17:45 - 19:15 Wednesday Poster Chiostro

We-P.03 765 **Plasma magneto-compressional cyclotron maser**

Sergey Golubel; D.A. Mansfeld; A.G. Shalashov; A.V. Vodopyanov
IAP RAS, Russian Federation

A possibility for development of sources of pulsed electromagnetic radiation based on adiabatic magnetic compression of non-equilibrium plasma confined in a mirror magnetic configuration is discussed.

We-P.04 767 **Study of W-band Sheet Beam Klystron**

Yong Wang; C.J. Ruan; S.Z. Wang; W. Ruan
Institute of Electronics, Chinese Academy of Sciences, China

Simulations of W-band Sheet Beam Klystron (SBK) were done and a beam stick was fabricated. Under the beam voltage of 60kV and current of 2.6A, the beam transmission has achieved 99%. In this paper the results of both simulation and experiment are described.

We-P.05 768 **The Preliminary Experiment of Ka-band Pulsed Folded Waveguide Extended Interaction Oscillator**

zhen hua Wu; K.C. zhang; S.G. Liu
University of Electronic Science and Technology of China, China

The experiment of a Ka-band folded waveguide extended interaction oscillator (FWEIO) tube, consisting of 21-gap resonator, is reported in this paper. In the FWEIO experiment, the tube generates about 330W output power at 35.5GHz with the bandwidth 180MHz, the interaction efficiency of 23%.

We-P.06 770 **UV-LIGA and DRIE Grating Microfabrication and Testing for Sheet Beam Amplifiers at 220 GHz**

C.D. Joye[1]; J.P. Calame[1]; M. Garven[2]; D. Park[1]; R. Bass[1]; B. Levush[1]
[1]Naval Research Laboratory, United States; [2]SAIC, United States

Slow-wave sheet beam amplifiers are under development to demonstrate 50 watts CW at 220 GHz. We report on the microfabrication of amplifier gratings based on Ultraviolet Lithography techniques using the SU-8 Photoresist for thick films. Deep Reactive Ion etching has also been investigated.

We-P.08 772 **Low capacitance vacuum microtriode for high frequency operation**

Giacomo Ulisse; F. Brunetti; A. Di Carlo
University of Rome Tor Vergata, Italy

In this work a new triode geometry has been designed to reduce the this cathode-gate capacitance with respect to the classic Spindt Type microtriodes. With this configuration, the cut off frequency has been increased up to 160 GHz, about 3 times bigger when compared to the standard configuration.

We-P.09 774 **A Vector Finite Element Helmholtz Solver**

Thuc Bui[1]; M. Read[1]; R.L. Ives[1]; H. Freund[2]
[1]Calabazas Creek Research, Inc., United States; [2]Science Applications International Corp., United States

The vector finite element method is used to solve the inhomogeneous Helmholtz equation to obtain the 3D circuit fields in resonant cavities. Numerical results will be shown for cylindrical and rectangular geometries to confirm the theoretical error estimates.

We-P.10 776 **Square Helix TWT for THz Frequencies**

Mikko Kotiranta[1]; V. Krozer[1]; V. Zhurbenko[2]
[1]Goethe-Universität Frankfurt am Main, Germany; [2]Technical University of Denmark, Denmark

A traveling-wave tube (TWT) for THz frequencies has been designed and simulated. The slow-wave structure (SWS) of the TWT is a helix with a square form and therefore compatible with the technology. 3-D particle-in-cell simulations indicate a gain of 20 dB at a frequency of 900 GHz.

We-P.11 778 **Parametric Study on the Effect of the Dielectric and Geometric Properties on the Parasitic Oscillations in Gyrotron Beam Tunnels**

G.P. Latsas[1]; I.G. Tigelis[1]; M.D. Moraitou[1]; S. Kern[2]; J.L. Vomvoridis[3]; Z.C. Ioannidis[1]
[1]University of Athens, Faculty of Physics, Greece; [2]Karlsruhe Institute of Technology (KIT), Institute of Pulsed Power and Microwave Technology (IHM), Germany; [3]National Technical University of Athens, School of Electrical and Computer Engineering, Greece

Using the numerical code Fishbone, developed to study the parasitic oscillations in gyrotron (conventional and coaxial) beam tunnels, a parametric study is performed on the effect of the dielectric material as well as of the slot geometry on the growth rate of the developed parasitic modes.

We-P.12 780 **Effect of Electric Field Distribution in the Magnetron-Injection Gun Region on Electron Beam Characteristics in Gyrotrons**

O. Louksha; D. Samsonov; G. Sominski; A. Tsapov
St. Petersburg State Polytechnical University, Russian Federation

A method for control of electric field distribution in the near-cathode region of a magnetron-injection gun has been developed. The possibility to improve quality of the helical electron beam by regulated non-uniformities of electric field is studied experimentally and using computer modeling.

We-P.13 782 **Gyrotrons FU FU CW VII for 600 MHz and 300 MHz DNP-NMR spectroscopy**

Toshitaka Idehara[1]; K. Kosuga[1]; L. Agusu[1]; I. Ogawa[1]; R. Dupree[2]; H. Takahashi[2]; M.E. Mark[2]
[1]University of Fukui, Japan; [2]University of Warwick, United Kingdom

For DNP-NMR spectroscopy, we need high power sub-THz radiation sources with the output power of several tens watts. We have developed Gyrotrons FU CW VII operating in 200 GHz band and 400 GHz band as radiation source for 600 MHz and 300 MHz DNP-NMR spectroscopy.

We-P.14 784 **Simulation and Experimental Investigations on Dynamic After Cavity Interaction (ACI)**

Stefan Kern[1]; K.A. Avramidis[2]; O. Dumbrajs[3]; G. Gantenbein[1]; S. Illy[1]; A. Samartsev[1]; A. Schlaich[1]; M. Thumm[1]; A.R. Choudhury[1]
[1]Karlsruhe Institute of Technology, Germany; [2]SECE, National Technical University of Athens, Greece; [3] ISSP, University of Latvia, Latvia

Stationary after cavity interaction (ACI) in high power gyrotrons is known as influence factor on efficiency. But it can also result in oscillations, which modulate the generated millimeter-wave or inhibit their generation. Investigations on such dynamic processes are presented.

We-P.16 786 **Mode Identification of a gyrotron oscillation by utilizing an IR camera**

Yoshinori Tatematsu; T. Saito; T. Ozeki; S. Hashimoto
Research Center for Development of Far-Infrared Region, University of Fukui, Japan

Oscillation modes in the gyrotron FU CW I were successfully identified with an infrared camera. The position of temperature increase on the target depends on the oscillation mode. A clear relation holds between the position and m/χ'mn of the oscillation mode.

We-P.17 788 **Gyrotron Interaction Simulations with Tapered Magnetostatic Field**

K.A. Avramides[1]; O. Dumbrajs[2]; J.L. Vomvoridis[1]; S. Kern[3]
[1]National Technical University of Athens, Greece; [2]ISSP, University of Latvia, Latvia; [3]Karlsruhe Institute of Technology, Campus North, IHM, Germany

We investigate the interaction of the electron beam with the RF wave in a

gyrotron, in the presence of an axially tapered magnetic field. The simulation results of three interaction codes are compared and the different modelings are discussed.

We-P.19 790 **Generating Pure Circular TEmn Modes**

Tsun-Hsu Chang
National Tsing Hua University, Taiwan

This work presents a methodology of exciting a pure circular TEmn modes using cascaded Y-type power dividers at low terahertz region. The measured transmissions are high and the bandwidths are broad. These Y-type converters are structurally simple but the machining errors are critical.

We-P.20 792 **Electron gun design for large orbit axis encircling beams**

C.G. Whyte; A.R. Young; C.W. Robertson; A.D.R. Phelps; W. He; A.W. Cross; K. Ronald
University of Strathclyde, United Kingdom

Large orbit axis encircling electron beams provide improved coupling and mode selectivity in certain gyro-devices. Three alternate gun designs for producing large orbit axis encircling electron beams are described and compared. Experimental results for one of these designs are presented.

We-P.21 794 **Investigate the interaction between a sheet electron beam and a Gaussian gyrotron beam, with the aim of significantly amplifying the RF beam.**

Giorgos Anastassiou; J.L. Vomvoridis
National Technical University of Athens, Greece

The Gaussian RF beam of a gyrotron can be applied as an input for the interaction with a high-current sheet electron-beam drifting along an external magnetic field, with the aim of generating an even higher RF power and without the need for feedback from the walls of any cavity or resonator.

We-P.23 796 **Fiber-coupled terahertz endoscope system for human body**

T.I. Jeon[1]; Y.B. Ji[1]; S.H. Kim[1]; E.S. Lee[1]; J.H. Son[2]
[1]Korea Maritime Univ., Korea, Republic of; [2]University of Seoul, Korea, Republic of

we have made a miniaturized optical fiber coupled THz endoscope system for human body. The cross section of the endoscope head is (2 ¡¿ 4 mm) ¡¿ 6 mm, which is small enough to be inserted into a human body. For a feasibility test, we measure reflective THz signals from several samples.

We-P.24 798 **Electro-optic field and power detector of a new generation**

Juraj Darmo; K. Unterrainer
Vienna University of Technology, Austria

An electro-optic detector of electromagnetic waves with boosted performance is presented. Detector utilizes a quasi phase-matching and a heterodyne detection technique to achieve an order of magnitude better responsivity.

We-P.27 800 **Investigations of room temperature bolometers for THz applications**

Sofiane Ben Mbarek[1]; T. Baron[1]; S. Euphrasie[1]; D. Briand[2]; B. Cretin[1]; P. Vairac[1]; R. Adam[3]; L. Chusseau[3]; J.P. Guillet[3]; A. Penarier[3]
[1]FEMTO-ST, dép MN2S, France; [2]Ecole Polytechnique Fédérale de Lausanne, Switzerland; [3]IES Montpellier, France

We investigate in this work the performance of two configurations of room temperature bolometers dedicated to THz applications. Fabrication processes, noise level, sensitivity and resolution characterizations are presented. Results emphasize the efficiency of the proposed approach.

We-P.29 802 **Realization of Wide-Bandwidth and Dual-Frequency Artificial Magnetic Conductor by Metamaterials**

Tong Zhang; J.Y. Qin
Department of Radio Engineering, Southeast University, China

The design, simulation and analysis of artificial magnetic conductors (AMCs) are presented. The full-wave simulation results verify that the magnetic conductor is successfully accomplished at central frequencies 7 GHz and 16.5GHz with the bandwidth of 2.4GHz and 4.3GHz.

We-P.30 804 **Electrical Properties of VOx Bolometer Thin Films Prepared by Metal-Organic Decomposition**

L.N. Son; T. Tachiki; T. Uchida
National Defense Academy, Japan

Well axis-oriented V2O5 thin films were fabricated by MOD. V2O5 films were reduced to VOx films under a temperature of 530°C and pressures of 1.2-3.0 Pa in O2. VOx films indicated an abrupt transition around 55°C with a resistivity change of 3 orders and TCR of 2.1-2.2 %/K at 300 K.

We-P.31 806 **THz metamaterials using aligned metallic or semiconductor nanowires**

A. Mazhorova[1]; J.F. Gu[1]; S. Gorgutsa[1]; M. Peccianti[2]; R. Morandotti[2]; T. Ozaki[3]; M. Tang[3]; H. Minamide[3]; H. Ito[3]; M. Skorobogatiy[1]
[1]Ecole Polytechnique de Montreal, Génie Physique, Canada; [2]INRS, Varennes, Canada; [3]RIKEN, Japan

We study the transmission of THz radiation through metamaterial films containing metallic or semiconductor nanowires. The nanowire arrays are made by the stack-and-draw fiber fabrication technique. Metal embedded films exhibit polarizing properties, in contrast with those containing semiconductor.

We-P.32 808 **Terahertz Plasmonic Structures Based on Metal-insulator Phase Transition Materials**

C.L. Wang; Z. Tian; Q.R. Xing; F. Liu; Y.F. Li; L. Chai; C.Y. Wang
Tianjin University, China

We demonstrate thermally tunable plasmonic structures base on a metal-insulator transition material with active control over their resonant transmission induced by surface plasmon polaritons (SPPs). The THz transmission property is found to be strongly dependent on the external excitations.

We-P.33 809 **Dielectric behavior of water in THz influenced by alkali and alkaline-earth halides**

Satoshi Yamauchi[1]; K. Takayama[1]; Y. Imai[1]; K. Takeya[2]; M. Tonouchi[2]
[1]Ibaraki University, Japan; [2]Osaka University, Japan

A transmission type THz-TDS was applied to study dielectric behavior of water including NaCl and MgCl2. Imaginary part of the complex permittivity and the dielectric slow relaxation time below 1THz were evaluated and disclosed that they are dependent on the type of impurity and the concentration.

We-P.34 811 **Dynamical Franz-Keldysh Effect in GaAs Induced by Monocycle Terahertz Pulse**

Keisuke Shinokita[1]; H.H. Hirori[2]; M.N. Nagai[2]; N.S. Sato[3]; Y.K. Kadoya[3]; K.T. Tanaka[2]
[1]Department of Physics, Graduate School of Science, Kyoto University, Japan; [2]Kyoto University, Japan; [3]Hiroshima University, Japan

We studied electron-hole behaviors interacted with intense THz pulse in GaAs MQW. THz pulse causes strong modulations of exciton in absorption spectrum. For high THz electric fields, hh exciton energy shows blueshift proportional to THz electric field squared, due to dynamical Franz-Keldysh effect.

We-P.36 812 **High Q-factor Planar Terahertz Metamaterials**

I. Al-Naib; C. Jansen; N. Born; M. Koch
Philipps-Universität Marburg, Germany

We propose asymmetric D-split resonators, which feature a very high Q-factor, as unit cells for terahertz filters and sensors. Compared to asymmetric double split resonators, the asymmetric D-split resonators exhibit twice as high Q-factors.

We-P.38 814 **Multiple THz Surface Plasmon Resonances of Periodic Split Ring Arrays in Silicon**

S. Saha[1]; J. Alton[2]; Y. Ma[1]; D.R.S. Cumming[1]; J. Grant[1]
[1]UNIVERSITY OF GLASGOW, United Kingdom; [2]TERAVIEW LTD., United Kingdom

FDTD simulations of periodic split ring resonators in highly doped silicon show multiple THz surface plasmon resonances (SPR). The SPR frequency position may be tuned by modifying the split ring wall width and/or the split angle. These frequency tunable resonators are efficient THz detectors.

We-P.39 816 **Millimeter-wave diffraction of a micro-fabricated crystal structure**

Ching-Pin Yuan
Department of Physics, National Tsing Hua University, Taiwan

A two-dimensional, table-top diffraction system is developed in 20x20 cm size

with a 94GHz (~3.2 mm) terahertz source. The crystalline structure was micro-fabricated using UV-lithograph with height of 1.0 mm, radius of 0.2 mm, and lattice separation of 2.25 mm.

We-P.41 818 **Sub Wavelength Structured Filters for Terahertz Region**

S. HAYASHI[1]; T. ISEKI[2]; H. HIRAI[2]; K. SAKAI[2]; Y. OGAWA[3]; K. KAWASE[4]
[1]RIKEN, Japan; [2]RICOH, Japan; [3]Kyoto University, Japan; [4]Nagoya University and RIKEN, Japan

The transmission and refection characteristics of a terahertz wave through sub wavelength structured (SWS) filters are investigated. The SWS filters are grating made by plastic. We designed the SWS filters as a wavelength selective optics and measured transmission and refection spectra.

We-P.42 820 **Trilayer Electron-beam Lithography and Surface Preparation for Sub-micron Schottky Contacts on GaAs Heterostructures**

Donatella Dominijanni[1]; R. Casini[1]; V. Foglietti[1]; M. Ortolani[1]; C. Lanzieri[2]; M. Peroni[2]; P. Romanini[2]; A. Notargiacomo[3]; E. Giovine[3]
[1]CNR-Istituto di Fotonica e Nanotecnologie, Italy; [2]SELEX Sistemi Integrati, Rome, Italy; [3]CNR - Istituto di Fotonica e Nanotecnologie, Rome, Italy

Foreseen operation at sub-THz frequencies of Schottky contacts for diodes and transistor gates on GaAs based heterostructures requires area reduction down to 0.1x1 microns, and wet chemical processes. We report on the compatibility of Trilayer Electron-beam Lithography with such wet processes.

We-P.43 822 **Spectral analysis of subterahertz resonant system by Josephson admittance spectroscopy**

Irina Gundareva[1]; O.Y. Volkov[2]; Y.Y. Divin[3]; V.N. Gubankov[4]; V.V. Pavlovskiy[4]
[1]Kotel'nikov Institute of Radioengineering and Electronics, Russian Federation; [2]Kotel'nkov Institute of Radioengineering and Electronics RAS, Russian Federation; [3]Forschungszentrum Jülich, Germany; [4]Kotel'nikov Institute of Radioengineering and Electronics RAS, Russian Federation

Josephson admittance spectroscopy was used for spectral analysis of electromagnetic structure, based on broadband antenna with modified log-periodic geometry, which provides pronounced resonance at 114 GHz. Measured spectral characteristics of this structure were compared with simulated ones.

We-P.44 824 **Terahertz Form Birefringent Devices**

Maik Scheller[1]; C. Jördens[2]; M. Koch[1]
[1]Philipps-Universität Marburg, Germany; [2]TU Braunschweig, Germany

We present photonic crystals exhibiting a pronounced form birefringence at terahertz frequencies. These crystals can be employed as volumetric birefringent elements for a broad frequency range. Along with a theoretical

discussion we demonstrate measurement results of a polymeric crystal.

We-P.45 826 **Development of mechanically detected ESR in terahertz region**

S.H. Hirano[1]; N.M. Mizuno[1]; E.O. Ohmichi[1]; H.O. Ohta[2]
[1]Graduationg school of Kobe University, Japan; [2]Molecular Photoscience Research Center, Kobe University, Japan

We have developed a high-frequency ESR technique using a cantilever. In this method, magnetization change caused by ESR is detected as cantilever deflection. In this study, spin sensitivity as high as 109 spins/Gauss was achieved. Signal detection at 315 GHz was also succeeded.

We-P.46 828 **THz surface plasmon reflection on a corrugated metal surface**

Maxim Nazarov[1]; A.A. Angeluts[1]; A.P. Shkurinov[1]; J.L. Coutaz[2]
[1] Physics Department of M.V.Lomonosov Moscow State University, Russian Federation; [2]IMEP-LAHC, UMR CNRS 5130, Université de Savoie, France

Bragg reflection of surface THz plasmon (SP) on a grating is studied using SP broadband excitation by a prism. The SP spectra transmitted through the grating exhibit minima thanks to Bragg phenomena. Reflection efficiency and bandwidth of those minima are studied for different grating groove shapes

We-P.47 830 **Field localization of a broadband THz surface plasmon**

Maxim Nazarov[1]; A.P. Shkurinov[1]; A.Y. Ryabov[1]; E.A. Bezus[2]
[1]Physics Department of M.V.Lomonosov Moscow State University, Russian Federation; [2]Image Processing Systems Institute of the Russian Academy of Science, Russian Federation

We perform a broadband excitation of surface THz plasmon in Otto prism configuration. Spectral dependencies of penetration depth and propagation length are studied. Propagation through a dielectric slab of various thickness is discussed.

We-P.48 832 **Anti-reflection coated lenses for THz applications**

Giorgio Savini[1]; P. Hargrave[2]
[1]University College London, United Kingdom; [2]Cardiff University, United Kingdom

We have developed a repeatable and reliable technique for anti-reflection coating large lenses for use at THz frequencies. Small lenses are already in use on two satellites. Comparison of experimental and modelled performance of larger (up to 350 mm diam.) highly-curved lenses is discussed.

We-P.49 834 **Open single-mode cavities for millimeter and submillimeter wavelengths**

M. Fittipaldi[1]; M. Martinelli[2]; G. Annino[2]
[1]INSTM - Dipartimento di Chimica, Università di Firenze, Italy; [2]Istituto per i Processi Chimico-Fisici, CNR, Italy

The development of single-mode cavities with high conversion factor based on the concept of non-radiative structure is presented, together with the first experimental results at the border between the millimeter and the submillimeter wavelengths and beyond.

We-P.50 836 **Substrateless micrometric metal mesh for mid-infrared plasmonic sensors**

Odeta Limaj[1]; F.M. Mattioli[2]; M.O. Ortolani[2]; R.L. Leoni[2]; S.L. Lupi[1]
[1]CNR-IOM Laboratorio Tasc, Dipartimento di Fisica, Università di Roma “La Sapienza”, Italy; [2]CNR-Istituto di Fotonica e Nanotecnologie, via Cineto Romano 42, 00156 Rome, Italy

Large area substrateless films periodically patterned were fabricated. The

measured mid-infrared (IR) spectra display resonant features with high Q-factor due to the interaction of the radiation with Surface Plasmon (SP) modes on both faces of the film. The devices can be used for SP-based sensors.

We-P.52 838 **Enhancement of THz field in a gap of dipole antenna**

Y. Kadoya[1]; H. Tanaka[1]; Y. Sugitani[1]; J. Kitagawa[1]; F. Blanchard[2]; H. Hirori[2]; A. Doi[3]; M. Nagai[2]; K. Tanaka[2]
[1]Hiroshima University, Japan; [2]Kyoto University, Japan; [3]Olympus Corporation, Japan

We investigated the THz field enhancement in dipole antennas. Numerical simulation showed an enhancement factor of 70 in a 150 μm-long antenna at 1 THz. The simplicity of the structure may fit to the intense THz field-material interaction research, attracting a lot of recent interests.

We-P.53 839 **Two-Dimensional Photonic Crystals Fabricated by Wet Etching of Silicon**

J.I. Kim[1]; S.G. Jeon[1]; G.J. Kim[1]; J.H. Kim[1]; H.H. Lee[2]; S.H. Park[3]
[1]Korea Electrotechnology Research Institute, Korea, Republic of; [2]Chosun University, Korea, Republic of; [3]Yeungnam University, Korea, Republic of

Two-dimensional photonic crystals (PCs) are fabricated by using the wet chemical etching of high-resistivity silicon. The formation of the photonic-band-gap at a frequency of about 100 GHz is demonstrated by the measured and the 3D FDTD simulated transmittance of the transverse-magnetic (TM) mode.

We-P.55 841 **Frequency Propagation Characteristics for Two-Dimensional Photonic Crystals Using Terahertz-Time Domain Spectroscopy (THz-TDS)**

G.J. Kim; J.I. Kim; S.G. Jeon; J.H. Kim
Korea Electrotechnology Research Institute, Korea, Republic of

We report frequency propagation characteristics for two-dimensional photonic crystal using terahertz time-domain spectroscopy. The transmission frequency spectrum obtained by the 3D FDTD simulation and the experiment, and the frequency range of stop bands is in good agreement with the results

We-P.56 843 **Investigation of reflection-type cone condenser used for THz detectors**

M. Aoki[1]; S. Tripathi[2]; N. Hiromoto[2]
[1]Shizuoka Universtiy, Japan; [2]Shizuoka University, Japan

We have made a THz triangle cone condenser which is lower in cost and easier to fabricate and has higher efficiency than Winston cone. The sharpness of field of view (FOV) can be improved by attaching a baffle to the condenser.

We-P.57 845 **Wire-grid polarizer in the terahertz region fabricated by nanoinprint technology**

K. Takano[1]; I. Morimoto[2]; H. Yokoyama[3]; M. Hangyo[1]
[1]Osaka University, Japan; [2]ASAHI KASEI Corp., Japan; [3]ASAHI KASEI E-MATERIALS Corp., Japan

Wire-grid polarizers in the terahertz region have been fabricated by nanoinprint technology on flexible substrates. They show ideal polarization property whereas the cost is very low.

We-P.58 847 **Pinch harmonic analogue of terahertz nanoresonator control using metal nano-rods**

H.R. Park[1]; S.M. Koo[1]; Y.M. Park[1]; M.A. Seo[1]; O.K. Suwal[2]; Q. Park[3]; S.S. Choi[2]; N.K. Park[1]; K.J. Ahn[1]; D.S. Kim[1]
[1]Seoul National University, Korea, Republic of; [2]Sun Moon University, Korea, Republic of; [3]Korea University, Korea, Republic of

We demonstrate that platinum nano-rods across the gap of a nanoresonator shift or overdamp the resonance depending on the rod-size. Moreover, what is striking is that the smallest nano-rods almost completely turn off both the fundamental and higher mode resonances, analogous to the pinch harmonics.

We-P.59 849 **Broadband polymer microstructured THz fiber coupler with down-doped cores**

K. Nielsen[1]; H.K. Rasmussen[2]; O. Bang[2]; P.U. Jepsen[1]
[1]Technical UNiversity of Denmark, Denmark; [2]Technical University of Denmark, Denmark

We demonstrate a broadband THz directional coupler based on a dual core photonic crystal fiber (PCF) design with mechanically down-doped core regions. For a center frequency of 1.3 THz we demonstrate a bandwidth of 0.65 THz.

We-P.60 850 **Frequency Modulation for Continuous Wave Terahertz Spectroscopy**

Maik Scheller[1]; T. Kinder[2]; O. Peters[1]; T. Müller-Wirts[2]; M. Koch[1]
[1]Philipps-Universität Marburg, Germany; [2]TEM Messtechnik GmbH, Germany

We propose a frequency modulation for continuous wave terahertz spectroscopy to replace conventional delay lines. We show that this technique in combination with a lock-in amplifier allows for a single sampling point detection of the amplitude and phase of the terahertz signal.

a resolution and reproducibility of the order of 1 degree up to 300 GHz.

We-P.62 852 **Broadband THz Vacuum Window using Impedance Matching Approach**

A. Srivastava; O.J. Kwon; M. Sattorov; A. Sharma; A. Tanwar; G.S. Park
Center for THz-Bio Application Systems, Korea, Republic of

A practical pillbox window design was performed using impedance matching approach for use in THz vacuum electron devices. The fabricated W-band miniature window assembly showed broad frequency band ~ 8 GHz for VWSR less than 1.22

We-P.63 853 **Comparative simulation study of ZnTe heating effects in focused THz radiation generation**

H. Lin[1]; B.M. Fischer[2]; D. Abbott[1]
[1]The University of Adelaide, Australia; [2]Institut Franco-Allemand de Recherches de Saint Louis, France

With prolonged intense exposure of an optical beam on the ZnTe crystal, the problem of crystal photodamage becomes increasingly relevant. In reducing the risk of damage, practically this has meant a decrease in optical power density. The heating effects with a reduced power density are investigated.

We-P.64 855 **Terahertz Emission from InAs and InSb under a 1.55 m Laser Excitation**

Christopher Que; H. Nakajima; M. Tani
Research Center for Development of Far-Infrared Region, University of Fukui, Japan

Terahertz (THz) emission from a 1.55 μm laser excitation on InAs and InSb was investigated. InAs still showed a much higher emission as compared to InSb that differs from earlier reports. Semiconductor quality or different surface conditions could be the cause of this unexpected result.

We-P.65 857 **Wavelength Tunable Characteristics of Mid-Infrared Intracavity 3-micron Waveband Light Source with 805-nm-band Laser Diode Excitation**

N. Yamamoto[1]; K. Akahane[1]; T. Kawanishi[1]; N. Yamamoto[2]; R. Naitou[2]; H. Sotobayashi[2]
[1]National Institute of Information and Communications Technology, Japan; [2]Aoyama Gakuin University, Japan

A wavelength tunable mid-infrared 3-micron waveband light source with an effective intracavity system is successfully demonstrated using a high-performance 805-nm-band laser diode excitation. Advantages include wide-tunability (approx. 90-nm), simple wavelength controllability, and small footprint.

We-P.66 859 **Terahertz Emission from Lithium Ternary Chalcopyrite Crystals**

Kei Takeya[1]; Y. Takemoto[1]; T. Matsukawa[2]; M. Yoshimura[2]; I. Kawayama[1]; H. Murakami[1]; Y. Mori[2]; M. Tonouchi[1]
[1]Institute of Laser Engineering, Osaka University, Japan; [2]Graduate School of Engineering, Osaka University, Japan

We have investigated the terahertz (THz) emission from lithium ternary chalcopyrite crystals illuminated by 1560-nm femtosecond pump laser pulses. Monocyclic THz emission and narrowband THz emission from the coherent phonons in LiInSe2 and LiGaSe2 were observed at 2.87 and 3.45 THz, respectively.

We-P.67 861 **Propagation of THz Field through a Tapered Parallel-plate Waveguide**

T.I. Jeon; E.S. Lee; Y.B. Ji
Korea Maritime University, Korea, Republic of

We present terahertz field propagation through input- and output-side tapered parallel-plate waveguide (TPPWG). Coupling of the TPPWG having a 3¡Æ slop angle improved the measured THz amplitude by over 100%, unlike the cylindrical silicon lens used in the PPWG.

We-P.68 863 **Enhanced Terahertz Transmission of GaN Quantum Wells**

J. Torres[1]; T. Laurent[1]; R. Sharma[1]; P. Nouvel[1]; S. Blin[1]; L. Chusseau[1]; C. Palermo[1]; L. Varani[1]; Y. Cordier[2]; M. Chmielowska[2]; J.P. Faurie[3]; B. Beaumont[3]; E. Starikov[4]; E. Shiktorov[4]; V. Gruzinski[4]
[1]Institut d'Electronique du Sud UMR 5214 - Universite Montpellier 2, France; [2]Centre de Recherche sur l'Hétéro-Epitaxie et ses Applications, UPR 10 - CNRS, rue Bernard Grégory, 0, France; [3]Lumilog, 2720, Chemin Saint Bernard, Les Moulins I, 06220 Vallauris, France, France; [4]Semiconductor Physics Institute, A. Gostauto 11, 2600 Vilnius, Lithuania, Lithuania

Terahetz transmission spectra at 15 K of GaN HEMTs are investigated. Enhanced signals in the transmission spectra interpreted as preliminary indications of the activation of the OPTTR mechanism can be considered as a relevant step in the development of devices capable to produce THz radiations.

We-P.70 865 **Terahertz Emission from InP Photoconductive Antenna Excited by a 1.56 m Femtosecond Fiber Laser**

K. Serita; G. Chen; S. Mizuno; H. Murakami; I. Kawayama; M. Tonouchi
Institute of Laser Engineering, Osaka University, Japan

Terahertz (THz) emission property of Fe-implanted InP photoconductive antenna (PCA) has been studied by 1.56 μm wavelength excitation. The obtained experimental data by THz time-domain spectroscopy measurements shows that the possibility of two-photon excitation in the THz emission process.

We-P.72 867 **THz radiation from InAs surfaces with photonic crystal structures under optical excitation**

C.S. Kee; C. Kang; H.K. Yoo; I.B. Sohn
Advanced Photonics Research Institute/ GIST, Korea, Republic of

We investigated the characteristics of THz radiation from a n-type InAs wafer with a triangular array of air holes under optical excitation. We observed the power enhancement of THz radiation from the InAs surface surrounded by the air holes in a frequency range

We-P.74 868 **THz radiation from GaAs surfaces with metallic nano-dot arrays under optical excitation**

C. Kang[1]; H.K. Yoo[1]; J.W. Lee[1]; C.S. Kee[1]; H.S. Jung[2]; G.Y. Jung[2]
[1]Advanced Photonics Research Institute/ GIST, Korea, Republic of;
[2]Department of Materials Science and Engineering/ GIST, Korea, Republic of

We present characteristics of THz radiation from GaAs wafers with metallic nano-dot arrays under optical excitation. Metallic nano-dots were introduced by a nano-imprinting technique. We found that the metallic nano-dot arrays can make the bandwidth of THz radiation from GaAs surfaces narrow.

We-P.76 869 **Transverse dynamics of the surface wave excited by wide electron beam**

A.E. Fedotov; P.B. Makhalov
Institute of Applied Physics of RAS, Russian Federation

According to simulations, a stationary single-mode operation of the surface-wave microwave generator excited by a wide beam is possible up to the beam width of at lest 10 wavelengths.

We-P.77 871 **A Terahertz Light Emitter of a Semiconductor-Multilayer Coupled Cavity by Frequency Mixing Signal Generation**

T. Isu; F. Tanaka; T. Takimoto; K. Morita; T. Kitada
The University of Tokushima, Japan

A coupled-cavity structure for terahertz light emitting devices is proposed. Strong sum frequency signal of the two cavity modes was observed. We found that an asymmetric structure was essential to emit a difference frequency light by a simulation of the optical field in the cavity.

We-P.78 873 **390-480 GHz Photon-assisted tunneling steps generated by parallel Josephson tunnel junction arrays**

Faouzi Boussaha[1]; A. Feret[2]; C. Chaumont[2]; L. Pelay[2]; M. Batrung[2]; B. Lecomte[2]; M. Salez[3]; F. Dauplay[2]; J.M. Krieg[2]; G. Beaudin[2]; L. Lapierre[4]; D. Bouville[5]
[1]JPL, United States; [2]Observatoire de Paris, France; [3]Obervatoire de Paris, France; [4]CNES, France; [5]IEF - Orsay, France

We report on the first direct detection of submillimeter waves emitted by small parallel tunnel junction arrays. They are specially suited for applications such as clock for RSFQ electronics or as local oscillator for THz superconducting

integrated receivers.

We-P.79 875 **Terahertz Generation with Tilted-Front Laser Pulses: Dynamical Theory Predicts the Ways to Higher Terahertz Yield**

M.I. Bakunov[1]; S.B. Bodrov[2]; M.V. Tsarev[1]; E.A. Mashkovich[1]
[1]University of Nizhny Novgorod, Russian Federation; [2]Institute of Applied Physics, Russian Federation

A dynamical theory of terahertz emission from a femtosecond laser pulse with tilted intensity front in an electro-optic crystal is developed. Applying the theory to GaAs pumped by a fiber laser and cryogenically cooled LiNbO3 pumped by a Ti:sapphire laser predicts the ways to higher terahertz yield.

We-P.80 877 **A monolithic 280 GHz HBV frequency tripler**

Tomas Bryllert[1]; A.Ö. Olsen[2]; J. Vukusic[3]; J. Stake[3]
[1]Chalmers University of Technology; [2]Wasa Millimeter Wave AB, Sweden; [3]Chalmers University of Technology, Sweden

We present the design and measurements of a Heterostructure Barrier Varactor based frequency tripler for 280 GHz. The tripler is fabricated as a monolithic circuit on an InP substrate. Several circuit versions for input power levels between 100 mW and 1 W have been designed.

We-P.82 878 **THz Surface Plasmons on 1D Plasmonic Metamaterials with Disorder**

G.S. Park; J.K. So
Center for THz-Bio Application Systems, Department of Physics and Astronomy, Korea, Republic of

The excitation of propagating THz surface plasmons on 1D plasmonic metamaterials with disorder is studied using convection electrons. The introduction of disorder is found to support non-Bloch surface plasmons and reduce the mode competition between the excited surface plasmons.

We-P.84 879 **Antenna Measurement System Operating at W and J Millimeter Wave Bands**

A. Muñoz-Acevedo[1]; M. Sierra-Castañer[2]; J.L. Besada[2]
[1]ETSI Telecomunicación, Spain; [2]Technical University of Madrid, Spain

A millimeter wave antenna measurement system is presented. The frequencies of operation are around 100 GHz and 300 GHz (W/J Bands). The facility is a single reflector compact range system. Design tasks deal with the serrated reflector and the corresponding millimeter wave instrumentation design.

We-P.85 881 **Design of Sierpinski Carpet Antenna using two different feeding mechanisms for WLAN applications**

A. Aggarwal[1]; M.V.K. Kartikeyan[2]
[1]Indian Institute of Technology Roorkee, India; [2]IIT Roorkee, India

In this work, a printed antenna for WLAN application is designed, which is working at 2.4 GHz and 5.2 GHz. The printed antenna uses the fractal geometry i.e., sierpinski carpet to design the antenna. This paper discusses the

design steps to achieve the desired resonance characteristics.

We.P-86 884 **On the Size Reduction of Microstrip Antennas with DGS**

Machavaram Kartikeyan; A.K.A. Arya
IIT Roorkee, India

The Electromagnetic bandgap (EBG) structures have been used to improve the performance of the antennas. In this work, an extensive design study of some specific antennas will be presented.

We-P.87 887 **Design Studies of Stacked U-Slot Microstrip Patch Antenna for Dual Band Operation**

H.T. Harshvardhan Tiwari; M.V.K. Kartikeyan Machavaram
IIT Roorkee, India

In this work, an extensive design study of a stacked U-slot microstrip patch antenna for dual band operation will be presented. This antenna consists of two stacked microstrip patches, both having U-slots embedded in them.

We-P.88 889 **Four-Leaf Clover-Shaped Antenna on an Extended Hemispherical Lens for a High-Output-Power THz Photomixer**

T.K. Nguyen[1]; I. Park[1]; I. Woo[1]; H. Lim[1]; H. Han[2]
[1]Ajou University, Korea, Republic of; [2]POSTECH, Korea, Republic of

A four-leaf-clover-shaped antenna composed of a highly resonant radiation element and a stable DC feed element and mounted on an extended hemispherical lens is described. The proposed antenna was optimized to have maximum total efficiency and maximum directivity on an extended hemispherical lens.

We-P.89 891 **Study for high transmission efficiency in long distance transmission line**

Yasuhisa Oda; K. Kajiwara; K. Takahashi; K. Sakamoto
Japan Atomic Energy Agency, Japan

The transmission mode purity in ITER relevant long distance transmission line was measured. Although the transmission power included 95% HE11 at the input of the transmission line, HE11 power was reduced as 91% after long distance transmission because of mode conversion loss.

We-P.90 893 **Designing of High-Q Slow-Wave Coplanar Strips for CMOS MMICs**

Ali Karami Horestani; S. Al-Sarawi; D. Abbott
The University of Adelaide, Australia

The effect of geometric dimensions of slow-wave coplanar strips on Q-factor, Zc, and on-chip wavelength are studied. Based on extracted guidelines, slow-wave coplanar strips are designed for a 50Ω characteristic impedance and Q of 31 for operation in the mm-wave regime at 60GHz.

We-P.91 895 **Easily - Manufacturable Waveguide to Microstrip Submm-Wave Transition**

R. Camblor; S. Ver Hoeye; G. Hotopan; C. Vázquez; M. Fernández; F. Las Heras
University of Oviedo, Spain

An easily manufacturable waveguide to microstrip transition is presented for the 300 GHz frequency band. The transition can be tuned by varying the position of the short-circuit of the waveguide. The transition has been manufactured using PCB laser prototyping machinery.

We-P.92 897 **Radiation pattern measurements of an integrated TEM horn antenna**

Jean-Francois Lampin; G. Ducournau; A. Beck; D. Ducatteau; E. Peytavit; T. Akalin
IEMN, France

A TEM horn antenna is integrated with a uni-travelling-carrier photodiode. Its radiation pattern is measured from 280 to 540 GHz thanks to a 1.55 µm photomixing set-up and a sub-harmonic mixer. The direction of the main lobe shifts to a lower incidence when the frequency is increased.

We-P.95 899 **Design Optimization of Meta-Material Transmission Lines for Linear and Non-Linear Microwave Signal Processing**

R. Marcelli[1]; S. Simion[2]; G. Bartolucci[3]; E. Proietti[4]; G. De Angelis[4]; A. Lucibello[4]
[1]CNR-IMM Roma, Italy; [2]National Institute for Research and Development in Microtechnologies, Romania; [3]University of Rome "Tor Vergata", Department of Electronics Engineering, Italy; [4]CNR – IMM Roma, Italy

The possibility to use CRLH (Composite Right-/Left-Handed) cells to realize both distributed wide-band filters for linear signal processing and non-linear devices like frequency doublers is investigated analytically and numerically.

We-P.96 901 **The transmission properties of terahertz waves through metal-dielectric-metal structure**

Xiao-Yong He
Henan University of Technology, China

The two-dimensional transmission properties of terahertz waves through MDM structure have been investigated by using a two-step transfer matrix method. As the dielectric strip length increases, the propagation loss shows a peak, which are very useful to find the optimal sample size.

We-P.99 902 **THz Surface Plasmon Polaritons Propagation along Metal Nanowire**

L. Zhao
Chinese Academic of Engineering Physics, China

Terahertz (THz) surface plasmon polaritons (SPPs) propagation along metal wire of nanometer scale is studied. An analytical theory is deduced to describe the propagation properties of THz SPPs. Propagation properties are discussed based on this model.

Thursday, September 09, 2010

09:00 - 10:30 **Thursday Plenary** Aula Magna
Chair: K. Fukunaga

PL.09 904 **The Future of Medical Imaging**
Vincent Wallace[1]; E. Pickwell-MacPherson[2]; C. Reid[2]
[1]University of Western Australia, Australia; [2]Hong Kong University of Science and Technology, Hong Kong
Medical physics is advancing rapidly, making use of many imaging/spectroscopic techniques across the electromagnetic spectrum. There are many cases where the demand for a medical imaging technique that is safe and non-invasive has not been met. Can terahertz meet that need?

PL.10 906 **Exploitation of the entire electromagnetic spectrum in art conservation studies**
Mauro Bacci
IFAC-CNR, Italy
The use of electromagnetic waves to investigate works of art is reviewed considering the whole interval from X-rays up to radiofrequencies paying particular attention to non-invasive and transportable instrumentation

11:00 - 12:30 **Materials 4** Aula Magna
Chair: P. Calvani

Th-A1.1 910 **Developing InP-based solar cells: time-resolved terahertz measurements of photoconductivity and carrier multiplication efficiencies**
Ben Spencer[1]; D.M. Graham[1]; C. Lange[2]; S. Chattopadhyay[3]; W.R. Flavell[1]
[1]Photon Science Institute, University of Manchester, United Kingdom; [2]University of Toronto, Canada; [3]Cockcroft Institute, United Kingdom
Time-resolved terahertz spectroscopic studies were carried out on bulk InP to measure photoconductivity on the picosecond timescale. The carrier multiplication quantum yields clearly demonstrate the potential benefit of colloidal InP-based next-generation solar cells.

Th-A1.2 913 **Pump/probe THz Spectroscopy of the Conductivity of TTF-TCNQ Films**
H.G. Roskos[1]; J. Nishitani[2]; V. Blank[1]; F.Z. Meng[1]; M.D. Thomson[1]; T. Nagashima[2]; M. Hangyo[2]; V. Solovyeva[1]; M. Huth[1]
[1]Physikalisches Institut, Goethe-Universität Frankfurt, Germany; [2]Institute of Laser Engineering, Osaka University, Japan
We perform optical-pump/THz-probe measurements on TTF-TCNQ films in the metallic state to study the picosecond conductivity dynamics. The data suggest charge-density-wave formation on a time scale of 10 ps following an ultrafast thermali-zation process.

Th-A1.3 914 **THz studies of multigap superconductors**

Andrea Perucchi[1]; S. Lupi[2]; M. Ortolani[3]; D. Nicoletti[4]; D. Di Castro[5]; M. Putti[6]; C. Ferdeghini[7]; P. Dore[4]; L. Baldassarre[1]
[1]Sincrotrone Trieste S.C.p.A., Italy; [2]CNR-IOM and Laboratorio TASC and Universita di Roma "Sapienza", Italy; [3]CNR-Istituto di Fotonica e Nanotecnologie, Italy; [4]CNR-SPIN and Universita di Roma "Sapienza", Italy; [5]CNR-SPIN and Universita di Roma Tor Vergata, Italy; [6]CNR-SPIN and Universita di Genova, Italy; [7]CNR-SPIN and Universita di Genova, Israel

We report on THz reflectivity results on multigap superconductors: The prototype multiband superconductor MgB2, the A-15 compound V3Si, and Co-doped BaFe2As2. Our results highlight the applicability of a parallel resistor model to describe the THz properties of multigap superconductors

Th-A1.4 916 **High Pressure Infrared Studies of Correlated Electron Materials using Synchrotron Radiation**

Hidekazu Okamura[1]; M. Matsunami[2]; K. Shoji[1]; T. Nanba[1]
[1]Kobe University, Japan; [2]University of Tokyo, Japan

We have studied the IR reflectance of correlated electron materials under high pressure to 20 GPa, using synchrotron radiation as a highly bright IR source. We will describe the instrumentation for this challenging experiment, and recent results on heavy electron and superconducting materials.

Th-A1.5 918 **THz spectroscopy of Ceramics and Polycrystalline Materials for Characterization of Microwave Dielectric Properties**

K.M. Siegrist[1]; D.F. Plusquellic[2]; M.E. Thomas[1]
[1]Johns Hopkins University, United States; [2]National Institute of Standards and Technology, United States

Microwave dielectric properties of ceramic and polycrystalline materials are governed by temperature dependent multi-phonon difference frequency bands in the THz. Measurements of the lower absorption band edge are combined with a classical oscillator model to successfully characterize MW dielectric.

Th-A1.6 920 **Study on Random Errors in THz Signal and Optical Constants Observed with THz Time-Domain Spectroscopy**

Norihisa Hiromoto; S.R. Tripathi; M. Takeda; M. Aoki
Shizuoka University, Japan

We have observed random errors in THz intensity and phase spectra measured with THz-TDS, which are almost proportional to THz intensity and phase respectively and common for reference and sample. We discuss the characteristics of random errors and application to improving accuracy of THz-TDS.

11:00 - 12:30 Biology 3 Aula Minor
Chair: S. Joo-Hiuk

Th-B1.1 922 **Can Neurons Sense Millimeter-Waves?**

Peter Siegel[1]; V. Pikov[2]
[1]California Institute of Technology, United States; [2]Huntington Medical Research Institutes, United States

We present the first direct evidence of real time, millimeter-wave (60 GHz) induced changes in cortical slice individual neuronal activity at RF exposure levels (<300nW/cm2) more than 1000X below the MPE. The results have implications for non-contact stimulation of neurons in vivo.

Th-B1.2 924 **Investigating the Role of Water Content on the Terahertz Properties of Rat Liver Cirrhosis**

S.Y. Huang[1]; S.M.Y. Sy[1]; E. Pickwell-MacPherson[2]
[1]Department of Electronic Engineering, The Chinese University of Hong Kong, Hong Kong; [2]Hong Kong University of Science and Technology, Hong Kong

We previously reported the dielectric properties of normal and diseased rat liver tissues by THz pulsed imaging. In this work further experiments were carried on to understand the observed differences in the optical parameters by looking into the water contents of the normal and cirrhotic specimen

Th-B1.3 926 **THz Imaging of Skin Tissue - Exploiting the Strong Reflectivity of Liquid Water**

Elliott Brown[1]; Z.D. Taylor[2]; P. Tewari[2]; R.S. Singh[2]; M.O. Culjat[2]; D.B. Bennett[2]; W.S. Grundfest[2]
[1]Wright State University, United States; [2]UCLA, United States

We present a novel system for imaging burns and other lesions of human skin tissue utilizing the acute sensitivity of THz radiation to water concentration. We have engineered and delivered (to UCLA Medical School) a THz impulse radar that carries out reflective, 2D imaging by mechanical scanning.

Th-B1.4 928 **Terahertz Imaging of Paraffin-Embedded VX2 Hepatoma Model**

Jaeyeon Park[1]; H.J. Choi[2]; H. Lim[3]; J.H. Son[1]
[1]University of Seoul, Korea, Republic of; [2]University of Ulsan, Korea, Republic of; [3]Ajou University, Korea, Republic of

We evaluated the diagnostic feasibility of THz imaging technique for the VX2 tumor with spectroscopic information.

Th-B1.5 929 **Investigation of spectral features of progesterone, 17-hydroxyprogesterone and cortisone in THz range**

Olga Cherkasova[1]; M.M. Nazarov[2]; D.A. Sapozhnikov[2]; A.P. Shkurinov[2]; V.A. Volodin[3]; V.A. Minaeva[4]; V.F. Minaev[4]; G.V. Baryshnikov[4]
[1]Institute of Laser Physics SB RAS, Russian Federation; [2]ILC M.V.Lomonosov Moscow State University, Russian Federation; [3]cInstitute of Semiconductor Physics SB RAS, Novosibirsk State University, Russian Federation; [4]Bogdan Khmelnitskij National University, Ukraine

The THz and Raman spectra of progesterone, 17α-hydroxyprogesterone and cortisone in the region of low-frequency infrared vibrations have been measured. Several intensive bands have unusual temperature dependence. Vibration frequencies are calculated by density functional theory.

11:00 - 12:30 Art conservation and diagnostics Room 2
Chair: K. Fukunaga

Th-C1.1 931 **Terahertz investigation of Egyptian artifacts**

julien labaune[1]; J.B. Jackson[2]; S. Pagès-Camagna[3]; M. Menu[3]; G.A. Mourou[2]
[1]ILE-C2RMF, France; [2]ILE, France; [3]C2RMF, France

THz TDS can be use to image optically opaque objects or detect different materials. In this presentation we propose to use terahertz to analyze different types of Egyptian artifact

Th-C1.2 934 **THz spectroscopy and chemometrics for quantitative determination of chemical properties and dating of historic paper**

T. Trafela[1]; M. Mizuno[2]; K. Fukunaga[2]; M. Strlic[3]
[1]Faculty of Chemistry and Chemical Technology, Slovenia; [2]National Institute of Information and Communications Technology, Japan; [3]University College London, United Kingdom

THz spectroscopy and chemometrics have been used for determination of chemical properties of historic paper. For the first time, the potential of the THz technique for quantitative chemical characterisation of complex natural organic materials has been demonstrated.

Th-C1.3 936 **Feasibility of millimeter wave imaging as tool for nondestructive inspection of wood and wooden structures**

Yoshihisa FUJII[1]; Y. Fujiwara[2]; S. Tanaka[2]; S. Okumura[2]; H. Togo[3]; A. Mochizuki[3]; N. Kukutsu[3]
[1]Graduate School og Agriculture, Kyoto University, Japan; [2]Kyoto University, Japan; [3]NTT Microsystem Integration Laboratories, Japan

Dielectric properties of wood were estimated by millimeter wave of 100GHz. The influence of cellular structure, moisture content and inner defect on the imaging was clarified. The feasibility of the millimeter imaging for nondestructive evaluation of wood and wooden structure was confirmed

Th-C1.4 938 **Terahertz-pulse imaging for non-destructive analysis of layered art paintings**

E. Abraham[1]; A. Younus[2]; J.C. Delagnes[1]; P. Mounaix[1]
[1]CPMOH - Université de Bordeaux, France; [2]CPMOH - Université de Bordeaux, Pakistan

Terahertz-pulsed imaging is employed to reveal primary graphite sketches covered with multiple layers of paintings. Buried layer information, such as handmade sketches drawn with pencil leads were identified by both reflection and transmission 2D imaging.

Th-C1.5 940 **A simple electromagnetic model for buried interface detection via THz holographic data**

F. Soldovieri[1]; I. Catapano[2]; L. Crocco[1]; M.R. Scarfi[1]; A. Doria[3]; G.P. Gallerano[3]; E. Giovenale[3]; A. Petralia[3]
[1]IREA-CNR, Italy; [2]irea-cnr, Italy; [3]ENEA, Italy

This work presents a simple electromagnetic model to deal with the reflection from a buried interface and to provide the basis of a reconstruction strategy whose data are given in terms of the intensity of the THz interference signal.

11:00 - 12:30 Lasers Room 3
Chair: R. Miles

Th-D1.1 942 **Emission of Terahertz Radiation from Two-Dimensional Electron Systems in Semiconductor Nano-Heterostructures**
Taiichi Otsuji
Tohoku University, Japan
This paper reviews recent advances in THz emission from 2D electron systems in semiconductor nano-heterostructures. The topics cover the broadband THz emission from 2D plasmons in III-V heterojunction transistors and amplified stimulated THz emission from fs-laser pumped graphene heterostructures.

Th-D1.2 945 **Multi-frequency terahertz stimulated emission from optically pumped co-doped silicon crystals**
Sergey Pavlov[1]; R. Eichholz[1]; N.V. Abrosimov[2]; B. Redlich[3]; H.W. Hübers[4]
[1]German Aerospace Center, Germany; [2]Leibniz Institute of Crystal Growth, Germany; [3]FOM Institute for Plasma Physics, Netherlands; [4]German Aerospace Center and Technische Universität Berlin, Germany
Stimulated terahertz emission at different frequencies between 4.5 THz and 6.4 THz has been realized from a single silicon crystal doped simultaneously by two hydrogen-like donor centers, which were optically excited on intracenter transitions at low lattice temperature.

Th-D1.3 946 **Stress dependent frequency shift in Si:Bi and Si:Sb THz lasers**
Roman Zhukavin[1]; K.A. Kovalevsky[1]; V.N. Shastin[1]; S.G. Pavlov[2]; H.W. Hübers[2]; H. Riemann[3]; N.V. Abrosimov[3]
[1]Institute for Physics of Microstructures, Russian Federation; [2]Institute of Planetary Research, Germany; [3]Institute for Crystal Growth, Germany
It has been shown that external stress applied to bulk silicon doped by Bi and Sb influences on output emission spectrum under CO2 laser pumping. For small stress spin-orbit coupling of working states can be tuned. The details of changing depend on donor and crystallographic axis.

Th-D1.4 948 **Gain and efficiency of THz donor lasing in axially stressed silicon**
Valery Shastin[1]; R. Zhukavin[1]; K. Kovalevsky[1]; V. Tsyplenkov[1]; S.G. Pavlov[2]; H.W. Hübers[2]
[1]Institute for Physics of Microstructures, Russian Federation; [2]Institute of Planetary Research, Germany
Results of experimental study of terahertz (4–6 THz) laser action of optically excited group-V donors (phosphor P, antimony Sb, arsenic As, bismuth Bi) in axially compressed silicon crystal which is observed at liquid helium temperatures are presented and discussed.

Th-D1.5 950 **Performance of a compact, continuous-wave terahertz source based on a quantum-cascade laser**
Heiko Richter
German Aerospace Center (DLR), Germany
We report on the development of a compact, easy-to-use terahertz radiation source, which combines a quantum-cascade laser (QCL) with a compact, low-input-power Stirling cooler. The applicability of the system is demonstrated by imaging and molecular-spectroscopy experiment

11:00 - 12:30 Gyrotrons 5 Room 7
Chair: M.Q. Tran

Th-E1.1 951 **THz Gyrotron FU CW Series for high power THz technologies**
Toshitaka Idehara; T. Saito; I. Ogawa; S. Mitsudo; Y. Tatematsu; R. Ikeda; J. Mudiganti; K. Kosuga
University of Fukui, Japan
Development of high frequency cw gyrotrons (Gyrotron FU CW Series) as high power far-infrared radiation sources was advanced in FIR FU. In this paper, we would introduce the development and applications of high frequency gyrotrons in FIR FU, including application to high power THz technologi

Th-E1.2 954 **High-harmonic sectioned-cavity THz gyrotrons**
Andrey Savilov; I.V. Bandurkin; V.L. Bratman; Y.K. Kalynov; N.A. Zavolsky
Institute of Applied Physics, Russian Federation
A third-harmonic large-orbit THz gyrotron with a sectioned cavity, which combines a long electron-wave interaction region and a relatively low diffraction Q-factor, is described. A similar scheme can be used to realise a self-exciting two-wave gyrotron with frequency multiplication.

Th-E1.3 957 **Development of continuously frequency tunable gyrotrons FU CW VI and FU CW VI A for application to 600 MHz DNP-NMR spectroscopy.**
R. Ikeda[1]; T. Idehara[1]; I. Ogawa[1]; K. Kosuga[1]; T. Saito[1]; Y. Matsuki[2]; K. Ueda[2]; T. Fujiwara[2]; T.H. Chang[3]
[1]Research Center for Development of Far-Infrared Region, University of Fukui, Japan; [2]Institute for Protein Research, Osaka University, Japan; [3]Department of Physics, National Tsing Hua University, Taiwan
Gyrotron is needed to analyze the structures of complex proteins by DNP-NMR spectroscopy. We have been developing gyrotrons having boardband frequency tunability using a long cavity. Prototype gyrotron was achieved with a tuning range of 1.6 GHz and exceeded output power of 10 W.

Th-E1.4 959 **Electromagnetic Pulse Self-Compression under Cyclotron Resonance Absorption by Plasma or Electron Beam**
Naum GInzburg; I. Zotova; A. Sergeev
Institute of Applied Physics RAS, Russian Federation
Based on analogy to well known process of self-induced transparency of optical pulse propagating through passive two-level media we describe effect of electromagnetic pulse self–compression under conditions of cyclotron resonance absorption by plasma or electron beams.

Th-E1.5 961 **Development of high power sub terahertz gyrotrons for application to CTS measurement**
T. Saito[1]; Y. Tatematsu[1]; S. Ogasawara[1]; N. Yamada[1]; A. Fujii[1]; T. Idehara[1]; V.N. Manuilov[2]
[1]University of Fukui, Japan; [2]Nizhny Novgorod State University, Russian Federation
High power sub terahertz gyrotron are under development in FIR-FU for application to CTS. Succeeding to more than 50 kW second harmonic (SH) oscillation at 350 GHz with a demountable tube, SH oscillation exceeding 60 kW at 390 GHz was obtained with a newly fabricated sealed off gyrotron.

11:00 - 12:30 Communications Room 11
Chair: F. Palma

Th-F1.1 963 **Moving target indication with high resolution at long stand off ranges using minimal sampling rates in linear FMCW radar.**
Duncan Robertson; R.J.C. Middleton; D.G. Macfarlane
University of St Andrews, United Kingdom
Combinations of high range resolution, long stand-off ranges, and the requirement for moving target indication in LFMCW radars tend to increase the required IF signal sampling rate. A technique using down-conversion by subsampling and aliasing to reduce the required IF sampling rate is demonstrated.

Th-F1.3 966 **A Comparison of Indoor Channel Measurements and Ray Tracing Simulations at 300 GHz**
Sebastian Priebe
Technische Universtität Braunschweig, Institut für Nachrichtentechnik, Germany
This paper presents ultra broadband channel measurements in a typical office room. The measured channel impulse response and transfer function is compared to the results obtained by a ray tracing simulation. Additionally, we show reflection losses of the building materials in the room.

Th-F1.4 968 **A 300 GHz 45º Hybrid Coupler for THz Wireless Communications using Subharmonic Mixers**
M.Y.W. Chia; C.K. Ang; E.C.A. Tan; J.J. Yao
Institute for Infocomm Research, Singapore
A 300 GHz hybrid coupler with 45º phase difference for subharmonic mixers in THz transceiver is presented. It consists of a branch-line coupler with a stub loaded phase shifter fabricated with 10 microns tolerances. The magnitude and phase imbalances are less than 0.5dB and 3º from 285 to 325 GHz.

Th-F1.5 970 **SAFIRE: A real time close range millimetre wave exhibition radar**
David Macfarlane; D.A. Robertson
University of St Andrews, United Kingdom
The MMW Group at St Andrews has constructed a fast scanning, high resolution 94GHz FMCW exhibition radar named SAFIRE. We present operational performance and outline the trade offs between scanning speeds, FMCW sweep times, range resolution, data sampling, processing and display requirements.

14:00 - 15:30 Thursday Poster Chiostro

Th-P.01 972 **A new artists Ematerials spectroscopic archive in the THz region**

M. Picollo[1]; C. Cucci[1]; K. Fukunaga[2]; M. Mitsuno[2]; K. Yamamoto[3]; H. Sotobayashi[4]
[1]IFAC-CNR, Italy; [2]NICT, Japan; [3]Aoyama Gakuin University, Japan; [4]Aoyama Gakuin University, Kanagawa, Japan

In the present communication a new collection of THz spectra of artists Ematerials along with the definition of procedures followed in preparing the samples and in acquiring the spectra will be presented. In particular, white and blue artists Epigments in the 0.1-20 THz region will be shown.

Th-P.02 974 **Terahertz imaging for deterioration detection of East Asian artworks**

Kaori Fukunaga[1]; Y. Kohdzuma[2]; M.J. Kim[3]; Y. Fujii[3]; Y. Fujiwara[3]
[1]NICT, Japan; [2]Nara National Research Institute for Cultural Properties, Japan; [3]Kyoto University, Japan

Terahertz imaging was applied to examine East Asian artworks. The reflection image indicates a material map, and detached area is clearly observed as the distribution of air gaps. These results prove that terahertz imaging can be a new diagnosis tool of deterioration of artworks.

Th-P.03 976 **Studying biodegradation of mosaics using THz and mm-wave radiation**

Alberto Petralia[1]; V. Surrenti[1]; G.P. Gallerano[1]; A. Doria[1]; E. Giovenale[1]; G. Messina[1]; I. Spassovsky[1]; G. Miceli[2]; E. Guarneri[2]; L.M. Vinci[2]
[1]ENEA, Italy; [2]CRPR, Italy

We propose a novel diagnostic technique to study the biological degradation of the mosaics in Piazza Armerina (Italy). Starting from an analysis of biological material affecting the mosaics we want to prove the possibility of detecting its presence under the mosaics without removing the tesserae.

Th-P.04 978 **Examination of pigments by using FT-THz**

K...Y. Yamamoto[1]; K. Fukunaga[2]; M. Mizuno[2]; I. Hosako[2]; M. Picollo[3]; H. Sotobayashi[1]
[1]Aoyama Gakuin University, Japan; [2]National Institute of Information and Communications Technology, Japan; [3]Istituto di Fisica Applicata gNello Carrara h (IFAC-CNR), Italy

Terahertz (THz) spectra of Malachite, Which is copper based natural mineral, was measured by a FT-THz in the 3-20 THz region. We observed finger print spectra of the pigment and discuss the influence of grain size of the pigment. The issues of specimen for quantitative analyses are also discussed.

Th-P.05 980 **An innovative non invasive technique for treatment of works of art. MM and THz waves for diagnostics and conservation**

Bruno Bisceglia[1]; A. Doria[2]; G.P. Gallerano[2]; E. Giovenale[2]; G. Messina[2]; A. Petralia[2]; I. Spassovsky[2]
[1]Salerno University - Dept of Information and Electrical Engineering, Italy; [2]ENEA, Italy

A novel non invasive technique and some suitable apparatus for treatment of artworks are introduced. Different phases of any interventions are described, some results are described and discussed. Recent applications on ancient wood artifacts revealed interesting potential future developments for the analysis and

complete disinfestations.

Th-P.06 982 **Millimeter continuous wave imaging for non-destructive investigation of artistic materials**

Emmanuel Abraham[1]; A. Younus[2]; S. Salort[3]; J.P. Caumes[3]; P. Mounaix[1]
[1]CPMOH - Université de Bordeaux, France; [2]CPMOH - Université de Bordeaux, Pakistan; [3]Alphanov, France

A monochromatic millimeter wave system coupled with an infrared temperature sensor has been used to investigate pictorial artworks. The flexibility of the system makes it possible to rapidly reveal buried layer information such as a graphite handmade sketch covered by paintings.

Th-P.07 984 **A Study of TPI of Human Skin under Different Temperature and Humidity**

M.Y. Sy[1]; Y.T. Zhang[1]; E. Pickwell-MacPherson[2]
[1]The Chinese University of Hong Kong, Hong Kong; [2]Hong Kong University of Science and Technology, Hong Kong

The design of a portable probe in the TPI system by TeraView has improved the flexibility of the TPI system. In this paper we present recent work using the THz probe to measure the skin in different positions on the face and hand on three subjects in vivo under both warm and cold weather

Th-P.08 986 **Investigation of Pig Ear Skin by IR-Imaging and Far-IR Spectroscopy**

Ole Faurskov Nielsen[1]; T.M. Greve[2]; A. Engdahl[3]
[1]Department of Chemistry, university of Copenhagen, Denmark; [2]LEO-Pharma, Denmark; [3]MAX-lab, Sweden

Synchrotron radiation is used in ATR-Far-IR investigations of pig ear skin. Characteristic protein and water bands are assigned. The results are compared to low-wavenumber Raman spectra. IR-imaging is performed to show the distribution of water, proteins and lipids for pig ear tissue slices.

Th-P.09 988 **Monitoring of Wound Healing by Millimetre Wave Imaging**

Helmut Essen[1]; D. Nuessler[1]; C. Krebs[1]; J.M. Essen[1]; A. Hommes[1]; N. Fatihi[1]; T. Buzug[2]
[1]Fraunhofer FHR, Germany; [2]University Lübeck, Germany

Mm-waves offer the capability to look trough dielectric material. Wound healing processes often have to take place under a cover like a plaster of Paris bandages, which have to be removed for inspection. Investigations were done to evaluate the possibility of wound monitoring through plasters.

Th-P.10 990 **Multi-objective Experiment using Ultrashort-Pulse Radar System for Breast Cancer Detection**

Zhang Dan
Art, Science and Technology Center for Cooperative Research, Kyushu University, Japan

Experiment of breast cancer detection has been performed using an ultrashort-pulse radar. Breast models for the experiment are made from cooking oil or use a commercial made phatom. We measure reflection data in order to reconstruct images of the breast models with different dielectrics object.

Th-P.11 992 **Combination treatment of hyperthermia and photodynamic for experimental tumor model using gyrotron (107, 203 GHz)**

N. Miyoshi; I. Hidehara
National University of Fukui, Japan

We applied the combination therapy of the hyperthermia treatment using gyrotron and the photodynamic treatment (PDT) with a photosensitizer and laser irradiated the experimental tumor model. It was very good treatment effect although reducing the dose of the gyrotron.

Th-P.12 993 **A THz imaging Fourier Transform Spectrometer (FTS) as a potential diagnostic for tissue damage and healing.**

Carole Tucker[1]; P.A.R. Ade[1]; D. Naylor[2]; K. Curtis[1]
[1]Cardiff University, United Kingdom; [2]University of Lethbridge, Canada

We present spectral data and derive optical constants for a range of tissues across the Thz range. We make use of the collagen absorption feature at ~11Thz to present the imminent possibility of using an imaging Fourier Transform Spectrometer (FTS) as a diagnostic tool for tissue damage and repair.

Th-P.13 994 **Facing the challenge of biosample imaging by FTIR with a synchrotron radiation source**

M. Cestelli Guidi[1]; C. Petibois[2]; M. Piccinini[3]; A. Marcelli[1]
[1]INFN Laboratori Nazionali di Frascati, Via E. Fermi 40, 00044 Frascati (RM), Italy; [2]Université de Bordeaux 2, CNRS UMR 5248 CBMN, B8 Avenue des facultés, F-33405, France; [3]Porto Conte Ricerche, SP 55, Porto Conte, Capo Caccia, km 8400, 07041 Alghero (SS), Italy

FTIR synchrotron radiation microspectroscopy is a powerful molecular probe of biological samples at cellular resolution. Here it is discussed how an optimized combination of IR instrumentation (FPA detectors) and SR optical systems could reach the expected advantages of a SR-based system.

Th-P.14 995 **Synchrotron Infrared Microspectroscopy at beamline 73 MAX-lab, Lund, Sweden.**

A. Engdahl
MAX-lab, Lund University, Sweden

The infrared beamline at MAX-lab in Lund is equipped with a Bruker Hyperion 3000 microscope combined with an IFS/66v FTIR instrument. In combination with a number of different detectors and objectives this makes it possible to study a large number of different samples.

Th-P.15 997 **Dielectric Properties of a Molecularly Thin Water Layer in THz Frequency Range**

G.S. Park[1]; S.J. Chang[1]; D.H. Choi[1]; H.R. Park[2]; D.S. Kim[2]; W.H. Jhe[3]
[1]Center for THz-Bio Application Systems, Department of Physics and Astronomy, Korea, Republic of; [2]Center for Subwavelength Optics, Department of Physics and Astronomy, Korea, Republic of; [3]Center for Nano-Liquids, Department of Physics and Astronomy, Korea, Republic of

We report measurement of a molecularly thin water layer by means of THz time-domain spectroscopy operated under transmission mode. Dielectric properties of capillary-held wetting water between two solid surfaces were measured as a function of the distance between two solid surfaces.

Th-P.16 998 **Solvation water of biomolecules seen through THz glasses**

M. Heyden; B. Born; M. Havenith
Ruhr-University Bochum, Germany

The THz absorption of the intermolecular vibrational modes of the hydrogen bond network of water has recently been found to define a dynamical solvation shell around solutes that extends beyond the first hydration layer. Here we study its properties using molecular dynamics simulations.

Th-P.17 1000 **High Sensitivity of the Sensing Technique using Metal Mesh Devices**

Takashi Kondo[1]; K. Takigawa[1]; S. Kamba[1]; Y. Ogawa[2]
[1]Murata Manufacturing Company, Ltd., Japan; [2]Graduate School of Agriculture, Kyoto University, Japan

Metal mesh devices working on higher frequency were examined for detecting the small amounts of a substance. The results indicated that the sensitivity working at 10THz is 50 times the height of that working at 1THz.

Th-P.18 1002 **Terahertz Time-Domain Spectroscopy (THz-TDS) Approach To the Quality Control on Pharmaceutical Products**

Seizi Nishizawa
Advanced Infrared Spectroscopy Co., LTD., Japan

Terahertz time-domain spectroscopy technique has recently been in progress with advantages over other conventional techniques and with a wide range of industrial applications. One of the latest industrial applications focusing on the quality control on pharmaceutical products will be described.

Th-P.19 1003 **Terahertz Spectral Measurements of a Homologous Organic Series**

C. Russell[1]; A.D. Burnett[1]; J.E. Cunningham[1]; A.R. Pearson[2]; E.H. Linfield[1]; A.G. Davies[1]
[1]School of Electrical and Electronic Engineering, University of Leeds, United Kingdom; [2]Astbury Centre for Structural Molecular Biology, University of Leeds, United Kingdom

We have studied the terahertz frequency spectra of a homologous organic series to investigate how a systematic molecular change directly affects the spectral modes. The spectra overall show similar absorption features, with the modes shifting to lower frequencies as the molecular mass increases

Th-P.20 1005 **Millimeter Wave Spectroscopy of Glucose and a Calcium-binding protein using a Vector Network Analyzer**

K. Shala; B. Yang; T.T. To; R.W. Pickersgill; N. Krauss; R.S. Donnan
Queen Marry, University of London, United Kingdom

Abstract—A Millimeter wave vector network analyzer is used to analyze pectate lyase and different concentration glucose solutions. Data reveal concentration–dependant spectra for glucose and Ca2+-sensitive spectra for pectate lyase.

Th-P.21 1007 **Characterization of Absorption Spectrum of Ethanol Gas for Use as Terahertz Alcohol Sensor**

Junichi Hamazaki; S. Saito; I. Hosako
National Institute of Information and Communications Technology, Japan

The absorption spectra of pure ethanol gas and ethanol gas mixed with air were characterized to examine the use of ethanol gas as a terahertz alcohol sensor. A comparison of the spectra of both gases showed that the absorbance of the latter gas was ~1.3 times greater than that of the former gas.

Th-P.22 1009 **Terahertz Spectroscopy of Ascorbic Acid Oxidase in Aqueous Solutions**

Christopher Que[1]; A. Ramundo-Orlando[2]; K. Yamamoto[1]; M. Tani[1]
[1]Research Center for Development of Far-Infrared Region, University of Fukui, Japan; [2]Institute of Neurobiology and Molecular Medicine, Consiglio Nazionale delle Ricerche, Italy

In this study, pure water or guanidine hydrochloride solution was added to ascorbic acid oxidase to obtain its native and denatured form, respectively. Results show that both native and denatured AAO in solution absorb THz weakly, though the denatured solution showed a higher absorbance.

Th-P.23 1011 **An Isolated Dual-Mode Converter for Dual-Channel Rotary Joint**

Nai-Ching Chen[1]; C.T. Wu[1]; C.Y. Yang[2]; T.H. Chang[1]
[1]Physics Department, National Tsing Hua University, Taiwan; [2]Electronic Systems Research Division, Chung-Shan Institute of Science and Technology, Taiwan

This study proposes a dual-mode converter for coupling the TE01 and TM01 modes in a circular waveguide. A pair of this converter could be connected with bearing and achieve a high isolation, broadband, dual-channel rotary joint for radar or satellite system.

Th-P.24 1013 **Extremely Wideband Multipath Propagation channel from 285 to 325 GHz for a typical desk-top environment**

M.Y.W. Chia; B. Luo; C.K. Ang
Institute for Infocomm Research, Singapore

Propagation study over 285 GHz to 325 GHz for extremely wideband channel in high speed wireless communication will be presented. The Thz channel is measured in clutter conditions typically of office desktop environment. Measurements and path loss models of the multipath channel will be discussed

Th-P.26 1014 **THz communication with a Quantum Cascade Laser source and a Hot Electron Bolometer detector**

A. El Fatimy[1]; Francesco Palma[2]; F.T. Teppe[3]; J.X. Xu[4]; J.V. Vachtomin[5]; A.T. Tredicucci[4]; G.G. Goltsman[5]; W.K. Knap[3]
[1]CNRS, Universitè Montpellier 2 (France), France; [2]NTT New Tera Technology s.r.l., Italy; [3]CNRS, Universitè Montpellier 2, France; [4]NEST, CNR-INFM and Scuola Normale Superiore di Pisa, Italy; [5]Moscow State Pedagogical University, Russian Federation

We present the experimental study of the direct emission/detection system based on the THz Quantum Cascade Laser as a source and Hot Electron Bolometer (HEB) detector-in view of its application as an optical communication system. We show that the system can efficiently transmit the QCL THz pulses.

Th-P.27 1016 **Simulation of a Ka-band "chebyshev" traveling wave tube on coupled cavity chain**

Dmitrij Komarov[1]; S.P. Morev[2]
[1]Federal State Unitary Enterprise "Research and Production Corporation "Toriy", Russian Federation; [2]Federal State Unitary Enterprise "Research and Production Corporation "Toriy",, Russian Federation

Abstract: The simulation's results of the Ka-band TWT with high electronic efficiency (~20%), the gain coefficient (~50dB) and a broad band operating frequency are presented.

Th-P.28 1017 **A 0.25µm SiGe Millimeter-wave Damping Pulse Transmitter Chip with On-chip Loop Antenna Array**

Nguyen Khanh[1]; M. Sasaki[2]; K. Asada[1]
[1]The Univ. of Tokyo, Japan; [2]VDEC, Japan

The paper presents a 100GHz - 120GHz pulse transmitter chip with a 54x24 on-chip loop antenna array for in-door millimeter wave (mm-wave) imaging applications. This 4mmx4mm transmitter for beam-forming purpose is designed and fabricated in 2.5V 0.25µm 4-metal layer SiGe BiCMOS technology.

Th-P.29 1019 **Terahertz Spectroscopy of Heavy and Superheavy Water Vapors**

S.S. Nabiev[1]; V.L. Vaks[2]; E.G. Domracheva[2]; L.A. Palkina[1]; E.A. Sobakinskaya[2]; M.B. Chernyaeva[2]
[1]Russian Research Centre "Kurchatov Institute", Russian Federation; [2]Institute for Physics of Microstructures RAS, Russian Federation

The paper reports on preliminary results of a study into a possibility of developing a fast method of atmospheric air analysis for the purpose of determination of the isotope composition of water vapors (H2 18O, HD16O, HTO) with the method of non-stationary terahertz (THz) range spectroscopy.

Th-P.31 1021 **5-fold helically corrugated waveguide dispersion measurements**

K. Ronald[1]; S.V. Samsonov[2]; M. McStravick[1]; S.V. Mishakin[2]; W. He[1]; G.G. Denisov[2]; C.G. Whyte[1]; V.L. Bratman[2]; A.W. Cross[1]; N.G. Kolganov[2]; A.R. Young[1]; A.D.R. Phelps[1]; C.W. Robertson[1]; P. MacInnes[1]
[1]SUPA, Department of Physics, University of Strathclyde, Glasgow, United Kingdom; [2]Institute of Applied Physics, Russian Academy of Sciences, Nizhny Novgorod, Russian Federation

Waveguide for microwave propagation with a 5-fold helical corrugation of the inner surface has the desirable properties of optimized dispersion, operation far from cut-off and high-breakdown electromagnetic field strength. This makes it an excellent medium for sweep-frequency pulse compression.

Th-P.32 1023 **Utilizing parallel plate waveguide modes for terahertz sensing**

F. Kernan; M. Wachsmuth; J.A. Higgins; B. Pejcinovic; L. Zurk; R. Campbell
Portland State University, United States

Parallel-plate waveguide sensors are investigated by characterizing TM and TE modes when filled with inhomogeneous and homogeneous samples. Effects of multi-mode TE propagation within PPW and radiation patterns are investigated. Lactose detection is demonstrated by TDS and CW-VNA techniques.

Th-P.34 1025 **Influence of phlegmatization on spectra of explosives in THz range**

M. Szustakowski; N. Palka; P. Zagrajek; W.M. Ciurapinski
Military University of Technology, Poland

We report on influence of phlegmatization of RDX and HMX on their spectra in 0.5-5.0 THz range. Measurements were carried out by means of Fourier Transform Spectrometry. Increase in attenuation is observed.

Th-P.35 1027 **Spectral sampling method for identification explosives**

M. Szustakowski; M. Piszczek; R. Ryniec
Military University of Technology, Poland

Technological capabilities are not mature enough to analyze a wide THz range. It is however possible to develop narrow-band cascade lasers for this band. In this paper, a new concept of compounds identification, which bases on 14-subspectral definite (theoretical) THz detectors, is presented.

Th-P.36 1029 **Concept of infrared sensor module for sniper detection system**

M. Kastek; R. Dulski; P. Trzaskawka; T. Sosnowski; H. Madura
Military University of Technology, Poland

The paper discusses technical possibilities to build system for sniper detection using infrared cameras. Concept of infrared sensor module for sniper activities detection was presented. The simulation of sniper detection ranges was done.

Th-P.37 1031 **Design Studies of a 100 kW, 60 GHz CW Gyrotron for Plasma Diagnostics**

Machavaram Kartikeyan[1]; R.J. Jain[2]
[1]IIT Roorkee, India; [2]Indian Institute of Technology Roorkee, India

This paper presents the design studies of a 60 GHz conventional cavity gyrotron, designed for the plasma diagnostics for an experimental Tokamak in India. Mode selection procedure has been carried out.

Th-P.38 1033 **Collective Thomson Scattering on FTU using a new ECRH launcher**

G. Grossetti[1]; A. Bruschi[1]; G. Granucci[1]; G. Grosso[1]; L. Lubyako[2]; V. Muzzini[1]; F.P. Orsitto[3]; U. Tartari[1]; A. Moro[4]
[1]IFP-CNR, Italy; [2]IAP, Russian Federation; [3]ENEA, Italy; [4]IFP - CNR, Italy

The past measurements carried out with the CTS diagnostic presently installed at FTU showed that a different and more flexible CTS geometry was required to overcome the problem of back reflections. A solution is given by the new ECRH launcher which will be installed at FTU.

Th-P.39 1035 **Differential-phase Reflectometry using Phased-array Antenna System in QUEST**

K. Nagata[1]; H. Idei[2]; M. Sakaguchi[1]; K. Dono[1]; Y. Wataya[1]; S. Kawasaki[2]; H. Zushi[2]; K. Hanada[2]; K. Nakamura[2]; M. Sakamoto[2]; M. Hasegawa[2]; Y. Higashizono[2]; Y. Takase[3]; T. Maekawa[4]; O. Mitarai[5]; Y. Kishimoto[4]; H. Nakashima[2]; A. Higashijima[2]
[1]Interdisciplinary Graduate School of Engineering Sciences, Kyushu University, Japan; [2]Research Institute for Applied Mechanics, Kyushu Univ., Japan; [3]Department of Complexity Sci. and Eng., Univ. of Tokyo, Japan; [4]Inst. of Industrial Sci. and Tech. Research, Tokai Univ., Japan; [5]Graduate School of Energy Science, Kyoto Univ., Japan

The differential-phase reflectometry has been developed to measure the density profile evolution, concerning electron Bernstein Wave (EBW) heating and current drive in the QUEST. The Phased Array Antenna (PAA) system was proposed for the reflectometry to improve the ratio of signal to noise.

Th-P.40 1037 **Terahertz radiation in an optical-field-induced ionization in air with a pulsed electrostatic field**

T.H. Higashiguchi[1]; Takeshi Higashiguchi[1]; T.O. Otsuka[2]; N.Y. Yugami[2]; R.K. Kodama[3]
[1]Ursunomiya University, Japan; [2]Utsunomiya University, Japan; [3]Osaka University, Japan

We have demonstrated that the THz radiation can be generate by the burst current induced an optical-field-induced ionization. The central frequencies of the radiation are observed to be 0.12 - 0.15 and 0.04- 0.05 THz at the pulse durations of 100 and 300 fs (FWHM).

Th-P.41 1039 **Experimental observation of frequency up conversion of terahertz using laser produced plasmas**

T.O. Otsuka[1]; F.S. Suzuki[1]; M.N. Nakata[1]; T.H. Higashiguchi[1]; N.Y. Yugami[1]; R.K. Kodama[2]
[1]Utsunomiya University, Japan; [2]Osaka University, Japan

We have observed frequency up conversion of terahertz radiation using a laser produced plasma. In our experiment the integrated power of a terahertz spectrum increased. We have confirmed that converted frequency depends on pumping laser energy i.e. plasma density.

Th-P.42 1041 **Effect of Prepulse on Intense THz Emission from Plasma Induced by Two-Color Laser Pulses**

Yasuo Minami; M.N. Nakajima; T.S. Suemoto
Institute for Solid State Physics, The University of Tokyo, Japan

In THz wave generation in air plasmas induced by laser pulses composed of fundamental and second-harmonic waves, we introduced a prepulse, 0-2 ns before the main pulse. The prepulse suppressed the THz wave generated by the main pulse. We analyzed the suppression factor as a function of time-delay.

Th-P.43 1043 **A laboratory study of mechanisms for auroral kilometric radiation generation**

K. Ronald[1]; D.C. Speirs[1]; S.L. McConville[1]; K.M. Gillespie[1]; A.D.R. Phelps[1]; R. Bingham[2]; A.W. Cross[1]; C.W. Robertson[1]; C.G. Whyte[1]; W. He[1]; R.A. Cairns[3]; I. Vorgul[3]; B.J. Kellett[4]
[1]University of Strathclyde, United Kingdom; [2]University of Strathclyde &

Rutherford Appleton Laboratory, United Kingdom; [3]University of St Andrews, United Kingdom; [4]Rutherford Appleton Laboratory, United Kingdom
An experimental simulation of the Earths Auroral Magnetosphere has been created. Experiments have been undertaken to study the processes by which the auroral cyclotron maser emission occurs

Th-P.44 1045 **Diagnosis of Atmospheric Pressure Plasmas by using Terahertz Time-Domain Spectroscopy**

Hideaki Kitahara[1]; A.A. Ando[1]; K.K. Kitano[1]; M.T. Tani[2]; M.H. Hangyo[1]; S.H. Hamaguchi[1]
[1]Osaka University, Japan; [2]University of Fukui, Japan
A parallel-plate atmospheric plasma generator has been built with the discharge electrodes that behave as a nondispersive terahertz (THz) waveguide for plasma diagnostics based on THz time-domain spectroscopy. An uniform glow-like atmospheric plasma is generated and THz waves propagate as designed.

Th-P.45 1047 **Heating of Si wafer using a sub-THz gyrotron FU CW V as a radiation source**

Toshitaka Idehara[1]; Y. Urushizaki[1]; M. Shimizu[2]
[1]University of Fukui, Japan; [2]Tokyo Electron LTD, Japan
Heating effect of sub-THz radiation on Si Wafer is studied by using a Gyrotron FU CW V as a sub-THz radiation source. Increasing rate of the temperature is measured for several frequencies between 75 GHz and 200 GHz. The highest increasing rate reaches 55 degree/sec at the frequency of 203.

Th-P.46 1049 **Development of a Compact Sub-Terahertz Second-Harmonic Gyrotron**

Toshitaka Idehara; S.S. Sabchevski
University of Fukui, Japan
A compact sub-THz second harmonic gyrotron with output parameters suitable for various spectroscopic studies is under development now at FIR FU Research Center. Here we present and the results of the initial computer-aided design (CAD) of this novel prospective member of the Gyrotron FU CW series.

Th-P.47 1051 **The contribution of higher-order spatial harmonics in eigenvalues and ohmic losses calculations in coaxial corrugated cavities**

Z.C. Ioannidis[1]; K. Avramides[2]; S. Kern[3]; G.P. Latsas[1]; I.G. Tigelis[1]
[1]University of Athens, Faculty of Physics, Greece; [2]National Technical University of Athens, Greece; [3]Karlsruhe Institute of Technology (KIT), Institute of Pulsed Power and Microwave Technology (IHM), Germany
The Spatial Harmonics Method has been used to study TE modes in a coaxial corrugated cavity. A numerical code has been developed to calculate eigenvalues, fields and ohmic losses on the walls. Numerical results are presented to clarify the influence of the higher–order modes to these calculations.

Th-P.48 1053 **Nonlinear Oscillation Behavior of a Gyrotron Traveling-Wave Amplifier**

Y.S. Yeh[1]; Z.Q. Wu[1]; J.M. Huang[1]; J.L. Shiao[1]; J.N. Jhou[1]; C.C. Chiu[2]; T.H. Chang[2]
[1]Southern Taiwan University, Taiwan; [2]National Tsing Hua University, Taiwan

Beyond the start-oscillation current of the gyro-TWA, the amplification transits to the nonlinearly driven oscillation where the driven frequency approaches to the start-oscillation frequency. The performance of the gyro-TWA can be enhanced in the nonlinearly driven oscillation.

Th-P.50 1055 **Experimental Results of a 0.42 THz Harmonic Gyrotron**

Y.Y. Yan; W.F. Fu; X.L. Li; X.Y. Yuan; S.L. Liu
THz Research Center, School of Physical Electronics, University of Electronic Science and Technology, China

We report primarily results of a 0.42 THz second harmonic gyrotron. In μs pulse length operation at 52kV and 3A, 4.4kW output power have been observed at the TE2,6 mode at 0.423 THz. Modes at fundamental, including the TE0,3 at 0.221 THz and the TE2,3 at 0.216 THz, have output powers up to 20kW.

Th-P.52 1057 **Development of THz Gyrotron FU CW III using a 20 T superconducting magnet**

K. Kosuga[1]; T. Idehara[1]; R. Ikeda[1]; Y. Tatematsu[1]; I. Ogawa[1]; S. Mitsudo[1]; T. Saito[1]; L. Agusu[2]; J.C. Mudiganti[1]; M. Thumm[3]
[1]FIR center, Univ. FUKUI, Japan; [2]Department of Physics, Haluoleo University, Indonesia; [3]Karlsruhe Institute of Thchnology, Association EURATOM-KIT, Institute für hochfrequenztecnik un, Germany

A Gytrotron FU CW III using a 20 T superconducting magnet has been developed as a radiation source in the THz region. In the first experiment, THz radiation was observed.

Th-P.53 1059 **Development of a sub-THz CW gyrotron for the millimeter wave pulsed ESR spectrometer**

Seitaro Mitsudo; N. Nakagawa; Y. Ohashi; T. Katayama; Y. Tatematsu; I. Ogawa; T. Idehara; T. Saito
Research Center for Far-Infrared Region, University of Fukui, Japan

We have developed a millimeter wave pulsed electron spin resonance (ESR) spectrometer by using a high power radiation source gyrotron. As the high power millimeter wave source, a CW operated sub-THz Gyrotron is constructed. Operating tests of Gyrotron has already carried out successfully.

Th-P.54 1061 **The Design of a ~390 GHz Gyrotron Based on a Cusp Electron Gun**
F. Li; W. He; A.D.R. Phelps; A.W. Cross; C.R. Donaldson; L. Zhang; K. Ronald
University of Strathclyde, United Kingdom
A ~390 GHz harmonic gyrotron based on a cusp electron gun was designed. The cavity has been designed to suspend the competition modes. Power drop and arise of competition modes were found while the beam thickness and beam spread were considered in the 3D MGIC PIC simulation

Th-P.55 1063 **Design of a frequency tunable 0.2 THz Gyrotron-Backward Wave Oscillator**
W.F. Fu; Y.Y. Yan; S.L. Liu
THz Research Center, School of Physical Electronics, University of Electronic Science and Technology, China
The preliminary design of a frequency tunable 0.2 THz gyrotron-BWO is presented. This gyrotron utilizes reflected structure, and simulations show that, the magnetic tuning bandwidth is over 1GHz, while power is over 1 kW, and the voltage tuning bandwidth is over 1GHz, while power is over 2kW.

Th-P.56 1065 **Hydrogen Bonding Networks in Solvent Mixture and their Impact on the Mobility of Molecules as Probed by THz-TDS and NMR spectroscopy**
J.A. Zeitler; R. Li; C. D'Agostino; J.H.P. Collins; E.J.P. Parrott; M.D. Mantle; L.F. Gladden
University of Cambridge, United Kingdom
Both THz-TDS and NMR techniques were employed to study the hydrogen bonding networks formed in 2-propanol/water mixtures. The composition of such solvent mixtures is shown to significantly impact on the mobility of the solute molecules.

Th-P.57 1067 **Comparison of Expressions for Terahertz Generation for Bulk Optical Rectification away from Normal Incidence**
Colin Bleasdale; R.A. Lewis
University of Wollongong, Australia
The purpose of the current work is to compare the expressions derived recently for bulk optical rectification to those already present in the literature at non-normal incidence to reconcile the differences between the expressions in these papers.

Th-P.58 1069 **Exploration of the origin of random error in spectrum intensity measured with THz-TDS**
M. Takeda; S.R. Tripathi; M. Aoki; N. Hiromoto
Shizuoka University, Japan
We examined the correlation between fluctuations of THz-pulse peak intensity and laser power to explore of the origin of random error in spectrum intensity measured with THz-TDS. This result indicates that the fluctuation of laser power will not be a predominant origin of the random error.

Th-P.59 1071 **Free Induction Decay of Ferromagnetic Resonance Observed by Time Domain THz Spectroscopy in Nano-Ferromagnet -GaxFe2-xO3**
M.N. Nakajima; A.N. Namai; S.O. Ohkoshi; T.S. Suemoto
The University of Tokyo, Japan
Radiation of circularly polarized sub-THz wave due to spin precession was observed at room temperature. Nearly perfect conversion of the linear to

circular polarized wave was realized around the natural resonances at 102 GHz. ε-type GaxFe2-xO3 are very prospective for magneto-optic devices.

Th-P.60 1073 **The THz Spectra and Analysis of Bi4Ge3O12 Crystal**

Wang Yali[1]; B.H. Hou[2]; H.Y. Wang[3]; G.Z. Zhao[3]; B.X. Yang[1]
[1] College of Materials Science and Optoelectronic Technology,Graduate University of Chinese Academy o, China; [2] College of Applied Sciences, Beijing University of Technology, China; [3]Department of Physics, Capital Normal University, China

The THz time domain spectra of Bi4Ge3O12 (BGO) crystal were measured. The optical dielectric and power absorption function were obtained. There was one strong absorption band in the range of 1.5-2.3 THz. The absorption and dielectric characters show that the phonon polariton arises in BGO crystal.

Th-P.61 1075 **Time-domain coherent Raman spectroscopy in THz frequency region**

Masakazu Hibi; T. Furuya; C.T. Que; M. Tani
Research Center for Development of Far-Infrared Region, University of Fukui, Japan

Time-domain coherent-Raman spectroscopy in the THz frequency region using a mode-locked femtosecond laser was studied. In this report, we attempted to detect the coherent Raman signal with an improved SNR owing to the averaging effect of the high-repetition frequency femtosecond laser.

Th-P.62 1077 **Terahertz Spectroscopy of Gas Hydrates**

K. Takeya[1]; I. Kawayama[2]; H. Murakami[2]; K. Ohgaki[3]; M. Tonouchi[2]
[1]Japan, Osaka University, Japan; [2]Institute of Laser Engineering, Osaka University, Japan; [3]Graduate School of Engineering Science, Osaka University, Japan

A characteristic absorption and the dielectric constants of gas hydrates are determined by terahertz (THz) time domain spectroscopy. THz spectroscopy is a potentially useful technique to study gas hydrates for both fundamental and application.

Th-P.63 1079 **Quantifying consumer perception of foodstuffs using THz spectrometry**

J. Bowen
University of Reading, United Kingdom

We discuss the potential of using THz spectrometry for the direct observation of phase transitions in foodstuffs, with the aim of quantifying consumer perception. Experimental results from phase transitions using a continuous wave spectrometer are reported.

Th-P.64 1081 **Mitigating Scattering Effects in THz-TDS Measurements**

Mayank Kaushik; B.W.H. Ng.; B.M. Fischer; D. Abbott
The University of Adelaide, Australia

Scattering is a major problem in precise measurements of quasi-optical parameters of material samples. In this paper, we review some popular scattering mitigating techniques and propose a novel method that allows calculating true absorption spectra for unknown thickness and granularity of a sample.

Th-P.65 1083 **The Effect of Optical Delay Line on THz Differential Time-Domain Spectroscopy**

Y.G. Loh[1]; K.W. Moon[1]; H.W. Han[1]; I.M. Park[2]
[1]POSTECH, Korea, Republic of; [2]Ajou University, Korea, Republic of

The effect of optical delay line on THz differential time-domain spectroscopy (THz-DTDS) was studied, and we found that the optical delay line can significantly distort the THz DTDS signals due to sampling noise in lock-in detection.

Th-P.66 1084 **Analysis of terahertz absorptions of structural isomers of tyrosine using a molecular orbital simulation and mid-infrared absorptions**

Tomoaki Sakamoto[1]; T. Tanabe[2]; T. Ohashi[2]; S. Yamagata[2]; Y. Oyama[2]; T. Kawanishi[1]; Y. Hiyama[1]
[1]National Institute of Health Sciences, Japan; [2]Tohoku University, Japan

Differences of terahertz spectral features of tyrosine and its structural isomers were examined. The inter- and intra-molecular absorptions in a terahertz region were calculated by the structural optimization simulation gGaussian 03 h at B3LYP/6-31G (d) level using the mid-IR absorptions.

Th-P.67 1086 **Absorption Spectroscopy for SiO2 Particles by Using the Coherent Radiation Light Source**

S. Okuda[1]; T. Takahashi[2]
[1]Radiation Research Center/Osaka Prefecture University, Japan;
[2]KURRI/Kyoto University, Japan

The coherent transition radiation light source has been established by using a linear accelerator (linac) at Kyoto Universtiy Research Reactor Institute (KURRI). This has been applied to the absorption spectroscopy for SiO2 fine particles at a wavenumber range of 4-12 cm-1

Th-P.68 1088 **A Preliminary Study of Hydrogenation of Oils Using Terahertz Time Domain Spectroscopy**

B.S.Y. Ung; B.W.H. Ng; D. Abbott
The University of Adelaide, Australia

We begin a preliminary investigation to determine the extent at which terahertz time domain spectroscopy is able to detect the hydrogenation of unsaturated fats and oils within a simulated home cooking environment.

Th-P.69 1089 **Electronic States of One-dimensional Ca1-xNaxCo2O4 Probed by IR-THz Spectroscopy**

Akinori Irizawa[1]; M. Isobe[2]; R. Kato[3]; G. Isoyama[3]
[1]Organization of Advanced Science and Technology, Kobe University, Japan;
[2]National Institute for Materials Science, Japan; [3]Osaka University, Japan

We have performed IR-THz spectroscopy on one-dimensional cobalt oxide Ca1-xNaxCo2O4. An insulating reflection in FIR region on CaCo2O4 (x=0) changed to a metallic one on Ca0.5Na0.5Co2O4 (x=0.5). Na substitution for Ca site affected as a hole doping.

Th-P.70 1090 **THz Spectroscopy to derive the optical Constants of Liquids**

Ulrich Schade[1]; B. Marchetti[2]; L.S. von Chrzanowski[3]; J. Beckmann[3]; A. Röseler[1]
[1]HZB, BESSY II, Germany; [2]INFN - Roma "Tor Vergata", Italy; [3]BAM, Fachgruppe VIII.3, Germany

THz stand-off detection of explosives and other hazardous liquids in public

areas becomes more and more relevant and with it the knowledge of their optical properties. We present here the results of THz transmission spectroscopy measurements of water-ethanol mixtures as a model.

Th-P.71 1092 **Terahertz radiation from coherent antiferromagnetic magnons excited by circularly polarized laser pulses**

Junichi Nishitani; T. Nagashima; M. Hangyo
Institute of Laser Engineering, Osaka University, Japan

We have observed terahertz radiation from coherent antiferromagnetic magnons excited by circularly polarized laser pulses. The polarity of the magnons is reversed by switching the helicity of the circular polarization. Inverse Faraday effect is a possible mechanism of the coherent magnon excitation.

Th-P.72 1094 **Si as an Emissive Optical Medium for the 3-12 ìm Band**

Volodymyr Malyutenko
Institute of Semiconductor Physics, Ukraine

Conventional methods of utilizing Si as light-emitting medium are limited to near-IR band (<2 ìm). Here we summarize our recent studies in silicon structures which efficiently and controllably emit in 3-12 ìm band, including novel device designs for LEDs, optical amplifiers, and radiative coolers

Th-P.73 1096 **A novel fiber-based Terahertz Source**

Y.D. Gong[1]; G.B. Ren[2]; H. Dong[1]; J.H. Teng[3]
[1]Institute for Infocomm Research, Singapore; [2]Central University for Nationalities, China; [3]Institute of Materials Research and Engineering, Singapore

One kind of novel fiber-based Terahertz source: opt-THz fiber is proposed, it is based on the 2nd order nonlinearity in the poled optical fiber, where optical fiber is used to transmit optical power and distributely generate Terahertz while outside Terahertz fiber is used to transmit Terahertz.

Th-P.74 1098 **Theoretical investigation and modeling of mid-infrared pulse generation in a GaAs crystal using 30 fs pulses from fiber-optical laser**

Anahit Nikoghosyan; D.L. Hovhannisyan; R.M. Martirosyan; A.S. Nikoghosyan; A.A. Hakhoumian; R.M. Laziev; G.D. Hovhannisyan
Yerevan State University, Armenia

The results of the THz radiation generation by 30 fs lasers pulses with the wavelengths of 1.98 and 1.55 ìm in GaAs are presented. The process of mid-infrared pulse generation obtained from spectral filtration of a supercontinuum formed in the pump-pulse spectrum at the output of GaAs is studied

Th-P.75 1100 **Theoretical analysis of conductivity and dielectric attenuations in millimeter-wave helical SWS**

Bao-Liang Hao; M.G. Huang; P.K. Liu; W. Liu
Institute of Electronics, Chinese Academy of Sciences, China

Conductivity and dielectric attenuation in millimeter-wave helical slow-wave structure (SWS) have been analyzed by a stratified dielectric helix tape and a 3D electromagnetic model.

Th-P.76 1102 **Heterodyne Detection of Output of Sub-THz RTD Oscillator Using InP-SBD Detector and RTD Local Oscillator**

K. Karashima; M. Shiraishi; K. Hinata; S. Suzuki; M. Asada
Tokyo Institute of Technology, Japan

We report on detection of output power from an RTD oscillator using a heterodyne receiver composed of an InP-SBD and an RTD local oscillator at around 430 GHz. Spectral linewidth of the RTD oscillators was estimated from the detected signal.

Th-P.77 1104 **Intersubband Cavity Polaritons: The Role of Mirror Dispersion**

M. Zaluzny; W. Zietkowski
Inst. of Physics, M. Curie-Sklodowska University, Poland

We theoretically discuss the influence of cavity mirror dispersion on properties of intersubband-cavity-polaritons (ICPs). We show that it modifies substantially characteristics of the ICPs and should be taken into account modeling infrared light emitters based on ICPs.

Th-P.78 1106 **Continuous-wave terahertz generation using a vertically integrated horn antenna photomixer**

E. Peytavit[1]; J.F. Lampin[1]; F. Hindle[2]; C. Yang[2]; G. Mouret[2]
[1]IEMN CNRS/Univ Lille1, France; [2]LPCA UMR CNRS 8101 Université du Littoral Côte d'Opale, France

A transverse Electromagnetic Horn Antenna is monolithically integrated with a low- temperature-grown GaAs vertical photoconductor forming a vertically integrated photomixer. Continuous-wave terahertz radiation is generated at frequencies up to 3.5 THz with a power level reaching 20 nW around 3 THz.

Th-P.79 1107 **Enhancement Approach of Ray-tracing Algorithm for Propagation prediction at the MM-Wave Band**

Myoung-Won Jung
Electronics and Telecommunications Research Institute, Korea, Republic of

In this paper, we make periodic/random rough surfaces with the KA method and set up the measurement system. After, we compared with simulation and measurement results. Finally, we are proposed enhancement method of ray-tracing algorithm for MM-wave band.

Th-P.80 1109 **Microwave Radiation from a Particle Revolving Along Shifted Equatorial Orbit About a Dielectric Ball**

L.S. Grigoryan; H.F. Khachatryan; S.R. Arzumanyan; M.L. Grigoryan
Institute of Applied Problems in Physics, Armenia

A relativistic electron uniformly rotating along a shifted equatorial orbit about a dielectric ball may generate microwave Cherenkov radiation tens of times more intense as that generated at the revolution in a continuous, infinite and transparent medium.

Th-P.81 1111 **Characterization of Semiconductor Materials as Terahertz Emitters under the Effect of In-Plane Magnetic Field**

K. Radhanpura; R.A. Lewis
University of Wollongong, Australia

The effect of magnetic field on emitted terahertz radiation is useful to determine the mechanism involved for THz generation. Semiconductor materials, which are potential sources of terahertz radiation, have been analyzed under the influence of in-plane magnetic field.

Th-P.82 1113 **Radially-polarized terahertz radiation from relativistic laser plasma of metal foil target**

S.N. Nashima
Osaka City University, Japan

We investigated the radiation distribution and polarization characteristics of terahertz (THz) waves from a Ti foil target that was vertical to the incident plane. We found that the polarization of THz waves that radiated vertically was not linear and the polarizing axis was rotated.

Th-P.83 1115 **Hydrodynamic simulation of heterodyne terahertz detection in a field effect transistor**

C. PALERMO[1]; H. Marinchio[1]; G. Sabatini[1]; P. Ziade[1]; P. Shiktorov[2]; E. Starikov[2]; V. Gruzinskis[2]; T. Laurent[1]; P. Nouvel[1]; J. Torres[1]; A. Penarier[1]; S. Blin[1]; L. Chusseau[1]; L. Varani[1]
[1]Institut d'Electronique du Sud - UMR UM2-CNRS 5214, France; [2]Semiconductor Physics Institute, Lithuania

We propose a hydrodynamic simulation of the heterodyne detection of terahertz signals in a High Electron Mobility Transistor in which the optical beating of two laser beams exciting plasma waves in the channel constitutes the THz local oscillator. We show the efficiency of such a mixer.

Th-P.84 1117 **An In0.23Ga0.77As-based pHEMT-like Planar Gunn Diode Operating at 116 GHz**

Chong Li[1]; A. Khalid[1]; L.B. Lok[1]; N.J. Pilgrim[2]; M.C. Holland[1]; G.M. Dunn[2]; D.R.S. Cumming[1]
[1]University of Glasgow, United Kingdom; [2]University of Aberdeen, United Kingdom

An In0.23Ga0.77As-based planar Gunn diode operating in its fundamental transit-time mode of oscillation at 116 GHz is demonstrated. The diode has a pseudomorhpic HEMT-like structure grown on a semi-insulating GaAs substrate. The layer design was assisted by using a drift-diffusion model.

Th-P.85 1119 **Intersubband population inversion and stimulated transitions between Landau levels in resonant tunneling multiple quantum well structures**

Yury Mityagin[1]; M.P. Telenkov[2]; P.F. Kartsev[3]
[1]P.N.Lebedev Physical Institute, Russian Federation; [2]P.N. Lebedev Physical Institute of RAS, Russian Federation; [3]National Research Nuclear University (Mephi), Russian Federation

The possibility is shown to achieve a population inversion in the system of Landau levels in resonant tunneling quantum well structures in a magnetic field. The mechanism allows the wide range tuning of the emitted terahertz frequency by the magnetic field strength variation

Th-P.86 1121 **Solution growth of an organic N-benzyl-2-methyl-4-nitroaniline (BNA) crystal for DFG-THz source**

T. Notake; M. Saito; M. Tang; Y. Wang; H. Minamide; H. Ito
RIKEN, Japan

A monochromatic THz radiation source with broadband tunability utilizing N-benzyl-2-methyl-4-nitroaniline (BNA) crystal has been developed. BNA quality was improved by applying solution growth method instead of melt method. BNA-THz source using difference frequency generation was further optimized.

Th-P.87 1123 **Phase Noise Characteristics of Millimeter Wave Generated by Mach-Zehnder-Modulator-Based Flat Come Generator**

Isao Morohashi[1]; T. Sakamoto[1]; H. Sotobayashi[2]; T. Kawanishi[1]; I. Hosako[1]
[1]Nat. Inst. Information and Communications Tech., Japan; [2]Aoyama Gakuin University, Japan

We demonstrate low phase noise characteristics of millimeter (MM) wave using Mach-Zehnder-modulator-based flat comb generator. MM waves are generated by beating optical two modes extracted from a comb signal. The rms phase noise of the signal measured at 37.5 GHz was 0.02 rad.

Th-P.88 1125 **Theoretical model of a spark-gap for microwave generation**

S. Sytova; V. Tikhomirov
Research Institute for Nuclear Problems of Belarusian State University, Belarus

Theoretical model of a sharpening spark-gap in an arbitrary electrical circuit is proposed. Simulation of operation of a spark-gap in the system including flux compression generator, transformer, explosive wires and microwave backward-wave tube is studied.

Th-P.89 1127 **Generation of shaped terahertz pulses**

S. Vidal; J. Degert; J. Oberle; E. Freysz
CPMOH-Université de Bordeaux, France

Phase-locked THz pulse pairs and tunable narrow-band THz pulses are generated by means of femtosecond optical pulse shaping combined with optical rectification in ZnTe crystal. THz spectra as narrow as 140 GHz and tunable between 0.5 and 2.5 THz are reported.

Th-P.90 1129 **Hydrodynamic study of electronic, optical and thermal excitation of plasma waves in HEMTs**

C. PALERMO[1]; H. Marinchio[1]; G. Sabatini[1]; P. Ziade[2]; T. Laurent[1]; P. Shiktorov[3]; E. Starikov[3]; V. Gruzinskis[3]; P. Nouvel[1]; J. Torres[1]; A. Penarier[1]; S. Blin[1]; L. Chusseau[1]; L. Varani[1]
[1]Institut d'Electronique du Sud - UMR UM2-CNRS 5214, France; [2]Laboratoire de Physique Appliquee, Universite Libanaise, Lebanon; [3]Semiconductor Physics Institute, Lithuania

We investigate with an hydrodynamic model the influence of collective plasma modes in a FET channel under different biasing conditions and by considering both cases of external optical and electronic excitations. The spectral density of drain voltage fluctuations is also calculated.

Th-P.91 1131 **Optical Parametric Oscillator for Continuous Wave Terahertz Generation by Optical Heterodyning**

Markku Vainio; M. Siltanen; L. Halonen
University of Helsinki, Finland

New continuous-wave singly resonant optical parametric oscillator (OPO) based on a bulk Bragg grating is presented. The OPO produces two coherent and spatially overlapping near-infrared beams with their frequency difference in the terahertz regime.

Th-P.92 1132 **Terahertz Emission from GaN Epilayers at Lateral Electric Field**

Vadim Shalygin[1]; L.E. Vorobjev[1]; D.A. Firsov[1]; V.Y. Panevin[1]; A.N. Sofronov[1]; G.A. Melentyev[1]; A.V. Antonov[2]; V.I. Gavrilenko[2]; S. Suihkonen[3]; P.T. Törma[3]; M. Ali[3]; H. Lipsanen[3]
[1]St. Petersburg State Polytechnic University, Russian Federation; [2]Institute for Physics of Microstructures, Nizhny Novgorod, Russian Federation; [3]Aalto University, School of Science and Technology, Espoo, Finland

Emission of terahertz radiation from GaN has been observed at electric field exceeding impurity breakdown threshold. Distinctive features of the emission spectra can be assigned to electron transitions between excited and ground states of donors and to hot electron transitions to the donor states.

Th-P.95 1134 **Rectangular waveguide with low metallic losses on side walls at THz**

Daniel Sánchez-Escuderos; M. Ferrando-Bataller; J.I. Herranz-Herruzo; M. Baquero-Escudero
Universidad Politécnica de Valencia, Spain

A rectangular waveguide for low-loss transmission at THz frequencies is proposed. The waveguide is based on the reflection of the fundamental mode on the side walls. By adding a stratified medium, a low impedance condition is obtained in the inner wall. Attenuation in side walls is eliminated.

Th-P.96 1136 **Evolutionary Algorithms for the Design of Specific Microwave/Millimeter Wave Components**

Kartikeyan Machavaram; D.G. Goel
IIT Roorkee, India

This paper presents the role of Evolutionary Algorithms for the design and optimization of specific microwave/millimeter wave components. For this, we have taken two problems: one is a nonlinear taper for a 1.0-1.3 MW, long-pulse gyrotron operating at 127.5 GHz and another is a compact MSA.

Friday, September 10, 2010

09:00 - 10:30 **Friday Plenary** Aula Magna
Chair: K. Sakai

PL.11 1139 **Visualization of fusion plasma physics via millimeter wave imaging techniques**
Hyeon Park
POSTECH - Center for Fusion Plasma, Korea, Republic of
Advances in microwave technology and innovative ideas have enabled visualization of complex physics of the magnetic fusion plasmas. ECEI system is a powerful tool for MHD physics in various devices and the potential of the MIR system has been reassessed and a system design for KSTAR is in progress.

11:00 - 12:30 **Spectroscopy 3** Aula Magna
Chair: M. Von Ortenberg

Fr-A1.1 1143 **Optimization of THz Wave Coupling into Samples in DNP/NMR Spectroscopy**
Emilio Nanni; A.B. Barnes; Y. Matsuki; P. Woskov; B. Corzilius; R.G. Griffin; R.J. Temkin
Massachusetts Institute of Technology, United States
A 10 W, 250 GHz gyrotron is used in DNP NMR Spectroscopy. The 250 GHz power must be optimally coupled into the sample. HFSS simulations show that the effective value of B1 in the sample in our experiments is about 11 μT/Watt. Simulations of new designs that increase the B1 value will be presented.

Fr-A1.2 1146 **SubTHz Spectrometer Based on a Radiation Source with Stochastic Phase**
Ekaterina Sobakinskaya; A.L. Pankratov; V.L. Vaks
Institute for Physics of Microstructures RAS, Russian Federation
Principle and modes of operation of subTHz spectrometer with noise source are described.

Fr-A1.3 1148 **Multiple-frequency imaging using a terahertz quantum cascade laser**
N.K. Saat; P. Dean; S.P. Khanna; M. Salih; A.G. Davies; E.H. Linfield
School of Electronic and Electrical Engineering, United Kingdom
We describe multiple-frequency imaging using a tunable THz QCL. The spatial resolution was found to be wavelength independent, which is explained by measurement of the far-field emission profile. Attenuation coefficients of polycrystalline samples were measured, and compared with TDS and FTS

Fr-A1.4 1150 **A New Single Shot Terahertz Time Domain Spectrometer for Rapid Product and Process Control**

Uli Schmidhammer; V. De Waele; P. Jeunesse
Laboratoire de Chimie Physique, France

A new simple time-domain THz spectrometer based on single-shot balanced detection of the electric field is presented. It allows for the recording of the full temporal THz profile at kHz acquisition rates. Its performances are demonstrated by measuring the fast drying process of acetone on Teflon.

Fr-A1.5 1152 **Spatial and Spectral properties of small area THz generation for sub-wavelength microscopy.**

A.C. Busacca[1]; F. Buccheri[1]; M. Peccianti[2]; R. Morandotti[3]; T. Ozaki[3]
[1]University of Palermo, Italy; [2]CNR, Italy; [3]INRS-EMT, Canada

A highly localized THz source is a promising candidate for sub-wavelength microscopy, due to its superior radiation power throughput with respect to others near-field techniques. Here, we report on the spatial and the spectral near-field properties of our highly localized THz source.

Fr-A1.6 1154 **Near-field spectra from broadband-infrared nanoscope**

F. Keilmann; S. Amarie
Max Planck Institute of Quantum Optics, Germany

We demonstrate 300 cm-1 wide MIR spectra of single pixels of 20 nm size, by coupling a fiber-laser-powered coherent spectrometer with a standard near-field microscope. Quantitative amplitude and phase spectra of phonon-resonant crystals will be compared with theory.

11:00 - 12:30 Metamaterial Devices Aula Minor
Chair: G. Righini

Fr-B1.1 1155 **Metamaterial-based Broadband Terahertz Modulators**

Sanaz Zarei
University of Michigan, United States

Broadband modulation of propagating terahertz waves at room temperature is demonstrated using subwavelength metallic slit arrays. Our designs enable the modulation of terahertz transmission by at least 55% at the modulation frequency.

Fr-B1.2 1158 **Bandpass Filters in the Terahertz Range based on Al-on-Si Metasurfaces**

Alessandra Di Gaspare[1]; M. Ortolani[2]; O. Limaj[3]; A. Nucara[3]; S. Lupi[3]; C. Rizza[1]; E. Palange[1]; P. Carelli[1]
[1]Dipartimento di Ingegneria Elettrica e dell'Informazione, Università dell'Aquila, Italy; [2]CNR - Istituto di Fotonica e Nanotecnologie, Italy; [3]Università di Roma "la Sapienza", Italy

We present the design, fabrication and experimental test of terahertz bandpass filters made of 2-dimensional arrays of Al slot dipoles on Si substrate. Filters are obtained through an inexpensive process with full freedom of design and can be easily implemented for applications in THz spectroscopy.

Fr-B1.3 1160 **High-Order THz Bandpass Filters Achieved by Multilayer Complementary Metamaterial Structures**

M.L. Lu; W.L. Li; E.R.B. Brown
University of California, Santa Barbara, United States

A high-order, broadband THz bandpass filter is realized by a complementary, multi-layer metamaterial structure. A bandpass filter was designed, fabricated, and tested up to 0.7 THz. The good agreement between experimental results and theoretical prediction validates the proposed filter.

Fr-B1.4 1162 **Ultrabroadband Metamaterial with Full Transmission Control**

J.S. Kyoung[1]; M.A. Seo[1]; H.R. Park[1]; H.S. Kim[1]; H. Bernien[1]; S.M. Koo[1]; B.J. Kim[2]; J.H. Choe[3]; Y.H. Ahn[4]; H.T. Kim[2]; N.K. Park[1]; Q. Park[3]; K.J. Ahn[1]; D.S. Kim[1]
[1]Seoul National University, Korea, Republic of; [2]ETRI, Korea, Republic of; [3]Korea University, Korea, Republic of; [4]Ajou University, Korea, Republic of

We study log periodic nanoresonators on VO2 thin film, amplifying available dynamic range for extinction and transmission. Over 1,000:1 extinction ratio for the nano-pattern is achieved when the film undergoes insulator-to-metal phase transition, compared with 10:1 ratio for the unpatterned cases.

Fr-B1.5 1164 **Fishnet metamaterials on thin polymer film for terahertz applications**

Patrick Mounaix[1]; R. Yahiaoui[1]; H. Němec[2]; F. Kadlec[2]; c. Kadlec[2]; J. Schilling[3]; M. Bari[4]
[1]CPMOH, France; [2]Institute of Physics, Academy of Sciences of the Czech Republic, Czech Republic; [3]ZIK "SiLi-nano", Martin-Luther-Universität Halle-Wittenberg, Freiherr-von-Fritsch Str. 3,, Germany; [4]Science and Technology Research Partners Ltd,, Ireland

Double sided photolithography method on ultrathin polymer and a laser micromachining technique were used to fabricate fishnet structures. We performed simulations and experiments by terahertz time domain spectroscopy respectively. The effective parameters were extracted with a single shot approach.

Fr-B1.6 1166 **THz Pulse Propagation through Woven-Steel-Mesh Metamaterials**

H.G. Roskos
Johann Wolfgang Goethe University, Physikalisches Institut,, Germany

We experimentally study single- and multi-layer woven metallic meshes and investigate their pass-band and dispersion characteristics. The structures are commercially available as precisely fabricated chemical particle filters, which facilitates their application as metamaterials.

11:00 - 12:30 Laser Driven Sources 3 Room 2
Chair: E. Suvorov

Fr-C1.1 1168 **Ultrabroadband Electric Field Generation and Detection from Far Infrared to Optical Communication Frequency**
Eiichi Matsubara[1]; M. Bitoh[1]; H. Shimosato[1]; M. Ashida[2]
[1]Osaka University, Japan; [2]Osaka University and PRESTO-JST, Japan
We generated ultrabroadband coherent infrared wave with a frequency range of 0.1-200 THz using difference frequency generation in crystals of DAST, GaSe, and dipole radiation from a photoconductive antenna. Also we detected the wave by time domain spectroscopy with a photoconductive antenna.

Fr-C1.2 1170 **A Critical Analysis of THz Applications and Compact Device Source Technologies: Challenges and Opportunities, and Common Truths**
Carter Armstrong
L-3 Communications Electron Devices, United States
The results of an analysis of THz applications and source device physics will be presented. This work was performed in support of a government review on Compact THz Sources held in 2007. Challenges and opportunities will be discussed.

Fr-C1.3 1171 **THz Generation in a Photo-Activated Periodically-Biased Semiconductor**
Joseph Penano[1]; P. Sprangle[1]; D. Gordon[1]; B. Hafizi[2]; A. Zigler[2]
[1]Naval Research Laboratory, United States; [2]Icarus Research, Inc., United States
A high-intensity short laser pulse, propagating obliquely to the surface of a periodically biased semiconductor array can photo-ionize the medium and generate a periodic current density. The transient current density can be a source of THz radiation over a wide frequency range.

Fr-C1.4 1172 **Control of Terahertz Wave Front using Arrayed Terahertz Emission Device**
K. Beppu; T. Sugimoto; T. Kiwa; K. Tsukada
Okayama university, Japan
Arrayed THz emission device was proposed to control the wave front of THz. The simulation results indicated the THz wave front can be tilted by changing the emission pattern of the device. The 4×4 arrayed device was fabricated and the emission pattern could be controlled by the bias voltages.

Fr-C1.5 1174 **Improved Performance of GaAs-based Terahertz Emitters**
C. Headley[1]; L. Fu[2]; P. Parkinson[1]; X. Xu[1]; J. Lloyd-Hughes[1]; C. Jagadish[2]; M.B. Johnston[1]
[1]Department of Physics, University of Oxford, United Kingdom; [2]Research School of Physics and Engineering, Australian National University, Australia
We have improved the stability and performance of terahertz photoconductive (Auston) switches using a combination of (NH4)2S surface passivation and silicon nitride (Si3N4) encapsulation. The passivation and encapsulation processes increased the average terahertz power generated four-fold.

Fr-C1.6 1175 **The Study on the Interaction between Mimicking Surface Plasmon and two-Electron beam in the 3-mirror quasi-optical Cavity**

Y.X. Zhang; M. Hu; P. Zhang; S.G. Liu
Terahertz Research Centre, University of Electron Science and Technology of China, China

Mimicking surface plasmons can be used to interact with two-electron beam to generate THz radiation. And the 3-mirror quasi-optical cavity has high Q and can collect the radiation energy efficiently, so the interaction in such special cavity may be a good way to generate THz.

11:00 - 12:30 Biology 4 Room 3
Chair: A. Markels

Fr-D1.1 1177 **Chemical microscopy and nanoscopy of bio-materials and living cells**

E. Bruendermann; D.A. Schmidt; I. Kopf; K. Meister; M. Filimon; M. Havenith
Ruhr-University Bochum, Germany

Raman microspectroscopy of human sperm cells and nearfield infrared microscopy of nanoscale biomaterials like nanografted DNA have been performed. A newly developed station for the ANKA-IR2 beamline combines several techniques to study the same sample at the same position.

Fr-D1.2 1179 **Terahertz time-domain spectroscopy on proteins, peptides, and small biological molecules**

Keisuke Tominaga; A. Kaneko; O. Kambara; F. Zhang; A. Tamura
Kobe University, Japan

Absorption coefficients and refractive indices of biologically important macromolecules such as myoglobin and small molecules such as adenosine triphosphate have been obtained in the low-frequency region by terahertz time-domain spectroscopy to understand molecular dynamics and interactions.

Fr-D1.3 1181 **Terahertz Time Domain Spectroscopy of Protein Single Crystals**

Katarzyna Tych[1]; A.D. Burnett[1]; C.D. Wood[1]; J.E. Cunningham[1]; A.R. Pearson[2]; E.H. Linfield[1]; A.G. Davies[1]
[1]School Electronic and Electrical Engineering, University of Leeds, United Kingdom; [2]Astbury Centre for Structural Molecular Biology, University of Leeds, United Kingdom

Broadband time-domain spectroscopy has been used to measure the terahertz absorption of single crystal proteins. A dehydration study of a single crystal of tetragonal hen egg-white lysozyme is presented as a proof of concept.

Fr-D1.4 1183 **Using Rattling Ions to Probe sub-ps Water Network Dynamics**

D.A. Schmidt[1]; Ö. Birer[2]; S. Funkner[1]; B.P. Born[1]; R. Gnanasekaran[3]; G.W. Schwaab[1]; D.M. Leitner[3]; M. Havenith[1]
[1]Department of Physical Chemistry II, Ruhr-University Bochum, Germany; [2]Department of Physical Chemistry II, Ruhr-University Bochum; Present Address: Department of Chemistr, Turkey; [3]Department of Chemistry, University of Nevada, United States

We present THz measurements on fifteen solvated alkali halide salts using narrow band THz absorption and broad band THz Fourier transform spectroscopies in order to shed new light on the controversy of salts as

kosmotropes (structure maker) or chaotropes (structure breaker).

Fr-D1.5 1185 **Terahertz spectroscopy of liquid water in frozen biological samples**

Hiromichi Hoshina[1]; A. Hayashi[1]; S. Ueno[2]; Y. Ogawa[3]; C. Otani[1]
[1]RIKEN Advanced Science Institute, Japan; [2]Tohoku University, Japan; [3]Kyoto University, Japan

Terahertz transmission spectra of frozen gelatin solution were measured. The observed spectrum shows that the scattering of ice crystal is negligibly small. The absorbance of liquid water in the sample was confirmed by subtracting those of ice and freeze dried gelatin from the observed spectrum.

11:00 - 12:30 Plasma heating and diagnostics Room 7
Chair: K. Sakamoto

Fr-E1.1 1186 **Utilization of collinear ECE detection/ECRH heating for active stabilization of plasma instabilities**

Waldo Bongers
FOM institute for plasma physics Rijnhuizen, Netherlands

On TEXTOR proof of principle was demonstrated of using ECE measured along the QO ECRH line-of-sight for MHD control. Progress of such a system on ASDEX-Upgrade, based on waveguides equipped with FADIS as diplexer in combination with an additional Mach-Zehnder–type absorptive filter, is presented.

Fr-E1.2 1190 **Electron Bernstein Wave Emission Diagnostics using Phased-array Antenna System in QUEST**

Hiroshi Idei
Kyushu University, Japan

The phased-array antenna has been developed for EBW emission diagnostics. The measured fields were in excellent agreements with those evaluated from the Kirchhoff integral. The broadband orthomode transducer was also developed to measure the wave polarization of the EBW emission.

Fr-E1.3 1193 **Terahertz scattering technique for measuring decay of plasma filament**

S.B. Bodrov; A.A. Murzanev; M.V. Tsarev; A.N. Stepanov
Institute of Applied Physics of Russian Academy of Sciences, Russian Federation

Terahertz scattering technique was proposed and used for investigation of dynamics of plasma density in a filament formed in air by femtosecond laser pulses. Two orders of magnitude for 2 ns decay of plasma density were obtained. The kinetic processes responsible for such a fast decay are discussed.

Fr-E1.4 1195 **Generation of Submillimeter Radiation by Strong Plasma Turbulence at Electron Beam – Plasma Interaction**

A.V. Arzhannikov[1]; A.V. Burdakov[2]; S.A. Kuznetsov[2]; M.A. Makarov[2]; K.I. Mekler[2]; V.V. Postupaev[2]; A.F. Rovenskikh[2]; V.F. Sklyarov[2]; S.L. Sinitsky[2]
[1]Budker Institute of Nuclear Physics and Novosibirsk State University, Russian Federation; [2]Budker Institute of Nuclear Physics SB RAS, Russian Federation

The paper presents the results of the experimental investigation of the process of conversion of two Langmuir oscillations in one electromagnetic wave with the frequency twice as large as the plasma Langmuir frequency.

11:00 - 12:30 Security and Stand-off Detection Room 11
Chair: I. Duling

Fr-F1.1 1197 **Terahertz radar cross section measurements**
Krzysztof Iwaszczuk[1]; H. Heiselberg[2]; P.U. Jepsen[1]
[1]DTU FOTONIK – Department of Photonics Engineering, Technical University of Denmark, Denmark; [2]Danish Defense Acquisition & Logistics Organization, Denmark
We present the result of terahertz radar cross section measurements on various objects including models of aircraft fighters. Application of a time domain system provides both values of radar cross section and ranging information.

Fr-F1.2 1200 **Hilbert spectroscopy for security screening of liquids**
Yuriy Divin[1]; M. Lyatti[1]; V. Pavlovskiy[2]; u. Poppe[1]; K. Urban[1]
[1]Forschungszentrum Juelich, Germany; [2]Institute of Radio Engineering and Electronics RAS, Russian Federation
To distinguish between liquids in security screening, we have applied Hilbert spectroscopy and high-Tc Josephson detectors. Compact set-ups have been developed and reflection spectra of various liquids in bottles have been measured in the spectral range of 15 - 400 GHz with scanning time of 0.2 s.

Fr-F1.3 1202 **An experimental 210 GHz radar system for 3D stand-off detection**
Jan Svedin[1]; S. Rudner[1]; G. Thordarsson[2]; N. Wadefalk[3]; S.E. Gunnarsson[3]; M. Abbasi[3]; H. Zirath[3]; J. Stake[3]; T. Bryllert[3]; J. Vukusic[3]
[1]FOI, Sweden; [2]SAAB Electronic Defense Systems, Sweden; [3]Chalmers University of Technology, Sweden
A 210 GHz radar system for studies of person scanning at stand-off distances is presented. The radar uses a mechanically scanned RX front-end based on an antenna-integrated MMIC. The TX part is based on an HBV quintupler. Image data compression is made using the FMCW and SAR principles.

Fr-F1.4 1204 **Development of THz Gyrotrons with Pulse Solenoids for Detecting Concealed Radioactive Materials**
Gregory Nusinovich[1]; R. Pu[1]; T.M. Antonsen[1]; O.V. Sinitsyn[1]; J. Rodgers[1]; V.L. Granatstein[1]; A. Mohamed[1]; J. Silverman[1]; M. Al-Sheikhly[1]; Y.S. Dimant[2]
[1]University of Maryland, United States; [2]Boston University, United States
The detection concept is based on focusing high-power THz wave beams generated by compact gyrotrons in small spots where the breakdown can be initiated. Results of the study of air ionization by concealed radioactive materials and design data of a 670 GHz gyrotron are reported.

Fr-F1.5 1206 **SubTHz and FTIR Spectroscopy of Explosive Vapors.**
E.A. Sobakinskaya[1]; V.L. Vaks[1]; S.S. Nabiev[2]; D.B. Stavrovskii[3]
[1]Institute for Physics of Microstructures RAS, Russian Federation; [2]Russian Research Centre “Kurchatov Institute, Russian Federation; [3]A.M.Prokhorov General Physics Institute RAS, Russian Federation
Discussed are experimental results of subTHz vapor phase spectroscopy over solid samples of explosives, such as commercial trinitrotoluene (TNT), nitroglycerine (NG) and cyclonite (RDX).