

# **19th International Conference on Cyclotrons and their Applications**

## **(CYCLOTRONS 2010)**

**Lanzhou, China**  
**6-10 September 2010**

**ISBN: 978-1-63266-464-8**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

***License***

This work is licensed under a Creative Commons Attribution 3.0 Unported license:  
<http://creativecommons.org/licenses/by/3.0/>

**You are free to:**

Share - Copy and redistribute the material in any medium or format.  
Adapt – Remix, transform, and build upon the material for any purpose, even commercially.  
The licensor cannot revoke these freedoms as long as you follow the license terms.

**Under the following terms:**

Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

Printed by Curran Associates, Inc. (2014)

Published by:

JACoW - Joint Accelerator Conferences Website  
c/o Christine Petit-Jean-Genaz  
CERN BE  
CH - 1211 Geneva 23

Phone: 41 22 767 32 75  
[christine.petit-jean-genaz@cern.ch](mailto:christine.petit-jean-genaz@cern.ch)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

## Contents

<b>Preface</b>	<b>i</b>
Foreword . . . . .	iii
Contents . . . . .	v
Committees . . . . .	ix
Pictures . . . . .	x
MOM1CIO02 – Eighty Years of Cyclotrons . . . . .	1
MOM2CIO01 – Review of High Power Cyclotrons for Heavy Ion Beams . . . . .	9
MOM2CIO02 – Intense Beam Operation at GANIL . . . . .	16
MOM2CCO03 – Progress towards High Intensity Heavy Ion Beams at the AGOR-Facility . . . . .	21
MOM2CCO04 – Recent Progress on the Facility Upgrade for Accelerated Radioactive Beams at Texas A&M . . . . .	24
MOA1CIO01 – Intense Beam Operation of the NSCL/MSU Cyclotrons . . . . .	27
MOA1CIO02 – High Intensity Cyclotrons for Super Heavy Elements Research of FLNR JINR . . . . .	33
MOA2CIO01 – HIRFL-CSR Facility Status and Development . . . . .	37
MOA2CCO02 – Current Status of the Cyclotron Facilities and Future Projects at iThemba Labs . . . . .	42
MOA2CCO03 – Status of the LBNL 88-Inch Cyclotron High-Voltage Injection Upgrade Project . . . . .	45
MOPCP002 – The Isochronous Magnetic Field Optimization of HITFiL Cyclotron . . . . .	48
MOPCP003 – Application of Cyclotrons in Brachytherapy . . . . .	51
MOPCP005 – Kharkov Compact Cyclotron CV-28: Present and Future Status . . . . .	54
MOPCP008 – Control System of Cryogenic Plant for Superconducting Cyclotron at VECC . . . . .	57
MOPCP009 – Development of Power Supplies for 3-Φ, 240 kW RF System with Crowbar Protection for Superconducting Cyclotron at VECC . . . . .	60
MOPCP010 – Activities at the COSY/Jülich Injector Cyclotron JULIC . . . . .	63
MOPCP011 – 25 Years of Continuous Operation of the Seattle Clinical Cyclotron Facility . . . . .	66
MOPCP013 – Magnetic Field Calculation and Magnet Shimming Simulation for the CYCHU-10 Cyclotron . . . . .	69
MOPCP014 – Activation of a 250 MeV SC-cyclotron for Protontherapy . . . . .	72
MOPCP015 – Status of the HZB# Cyclotron: Eye Tumour Therapy in Berlin . . . . .	75
MOPCP016 – Present Status of the RCNP Cyclotron Facility . . . . .	78
MOPCP017 – New High Intensity Compact Negative Hydrogen Ion Cyclotrons . . . . .	81
MOPCP018 – Experience of Cyclotron Operation with Beam Sharing at TSL, Uppsala . . . . .	84
MOPCP019 – Present Status of JAEA AVF Cyclotron Facility . . . . .	87
MOPCP020 – Beam Extraction of the Heavy Ions from the U-400M Cyclotron . . . . .	90
MOPCP021 – Automated Operation and Optimization of the VARIAN 250 MeV Superconducting Compact Proton Cyclotron . . . . .	93
MOPCP022 – Present Operational Status of NIRS Cyclotrons (AVF930, HM18) . . . . .	96
MOPCP024 – Design of RF System for Compact AVF Cyclotron . . . . .	99
MOPCP025 – Construction of New Injector LINAC at RIBF . . . . .	102
MOPCP026 – Beam Extraction System for CYCIAE-14 . . . . .	105
MOPCP028 – Facility for Modification and Analysis of Materials with Ion Beams (FAMA) . . . . .	108
MOPCP030 – The Injection Line and Central Region Design of CYCIAE-70 . . . . .	111
MOPCP031 – Physics Design and Calculation of CYCIAE-70 Extraction System . . . . .	114
MOPCP032 – Design Study of Compact Cyclotron For Injection of K=100 SSC . . . . .	117
MOPCP033 – Magnet Design of 70 MeV Separate Sector Cyclotron (KoRIA) . . . . .	120
MOPCP034 – Beam Optics Study of a Fragment Separator for the Planned Rare Isotope Beam Facility in Korea . . . . .	123
MOPCP037 – Central Region Design of a Baby Cyclotron . . . . .	126
MOPCP038 – Design Optimization of the Spiral Inflector for a High Current Compact Cyclotron . . . . .	129
MOPCP041 – Beam Tuning in Kolkata Superconducting Cyclotron . . . . .	132
MOPCP042 – Determination of Isochronous Field Using Magnetic Field Map . . . . .	135
MOPCP043 – Modification of the Central Region in the RIKEN AVF Cyclotron for Acceleration at the H=1 RF Harmonic . . . . .	138
MOPCP044 – New Magnetic Einzel Lens and Its Beam Optical Features . . . . .	141
MOPCP045 – Towards Quantitative Predictions of High Power Cyclotrons . . . . .	144
MOPCP047 – Analysis of Beam Quality Optimization of Bucket Ion Source . . . . .	147
MOPCP049 – Ion Source Related Research Work at JYFL . . . . .	150

MOPCP050 – Studies of ECRIS Ion Beam Formation and Quality at the Department of Physics, University of Jyväskylä . . . . .	153
MOPCP053 – ECR Ion Source Development at the AGOR Facility . . . . .	156
MOPCP057 – A Compact Solution for DDS-Generator, Turn-on and Protections in RF Accelerator Systems . . . . .	159
MOPCP058 – Commissioning Experience of the RF System of K500 Superconducting Cyclotron at VECC . . . . .	162
MOPCP059 – Theoretical Analysis and Fabrication of Coupling Capacitor for K500 Superconducting Cyclotron at Kolkata . . . . .	165
MOPCP060 – Design, Construction and Commissioning of the 100kW RF Amplifier for CYCIAE-100 . . . . .	168
MOPCP061 – RF Cavity Simulations for Superconducting C400 Cyclotron . . . . .	171
MOPCP062 – TRIUMF Cyclotron Booster Frequency Tuning System . . . . .	174
MOPCP064 – Amplifier Test Stand for the CRM Cyclotron . . . . .	177
MOPCP065 – Closed Loop RF Tuning for Superconducting Cyclotron at VECC . . . . .	180
MOPCP067 – Design and Primary Test of Full Scale Cavity of CYCIAE-100 . . . . .	183
MOPCP068 – Stable Operation of RF Systems for RIBF . . . . .	186
MOPCP070 – Design of IBA Cyclone 30XP Cyclotron Magnet . . . . .	189
MOPCP072 – Design of IBA Cyclone 11 Cyclotron Magnet . . . . .	192
MOPCP073 – The Vacuum System of HIRFL Cyclotrons . . . . .	195
MOPCP074 – Upgrade of the IBA Cyclone 3D Cyclotron . . . . .	197
MOPCP075 – Cyclotron Vacuum Model and H <sup>-</sup> Gas Stripping Losses . . . . .	200
MOPCP076 – Operational Experience of Superconducting Cyclotron Magnet at VECC, Kolkata . . . . .	203
MOPCP077 – Median Plane Effects and Measurement Method for Radial Component of Magnetic Field in AVF Cyclotrons . . . . .	206
MOPCP078 – Study of Magnetic Field Imperfections of Kolkata Superconducting Cyclotron . . . . .	209
MOPCP079 – Optimization of Sector Geometry of a Compact Cyclotron by Random Search Method . . . . .	212
MOPCP081 – Design Study of Magnetic Channel at NIRS-AVF930 . . . . .	215
MOPCP082 – Design Study of AVF Magnet for Compact Cyclotron . . . . .	218
MOPCP083 – Vacuum Simulation for Heavy Ion Beams in the AGOR-Cyclotron . . . . .	221
MOPCP085 – Application of HTS Wire to Magnets . . . . .	224
MOPCP087 – Beamloss Monitoring and Control for High Intensity Beams at the AGOR-Facility . . . . .	227
MOPCP088 – The Simulation on Beam Interaction with Background Particles . . . . .	230
MOPCP090 – Progress in Formation of Single-Pulse Beams by a Chopping System at the JAEA/TIARA facility . . . . .	233
MOPCP091 – Status of Beam Diagnostic Components for Superconducting Cyclotron at Kolkata . . . . .	236
MOPCP092 – Study on PXI and PAC-Based HIL Simulation Control System of CYCHU-10 Cyclotron . . . . .	239
MOPCP093 – Beam Extraction System and External Beam Line of Kolkata Superconducting Cyclotron . . . . .	242
MOPCP094 – Consistency in Measurement of Beam Phase and Beam Intensity Using Lock-in Amplifier and Oscilloscope Systems . . . . .	245
MOPCP095 – Experiment and Analysis: Partial Loss of Insulation Vacuum in K-500 Superconducting Cyclotron During Energization . . . . .	248
MOPCP098 – Influence of RF Magnetic Field on Ion Dynamics in IBA C400 Cyclotron . . . . .	251
MOPCP100 – Axial Injection Beam Line of a Compact Cyclotron . . . . .	254
MOPCP101 – Beam Extraction System of Compact Cyclotron . . . . .	256
MOPCP102 – Transmission Efficiency Study of SSC . . . . .	258
MOPCP105 – Research on Acceptance of SSC . . . . .	260
MOPCP106 – Beam-Phase Measurement System for HIRFL . . . . .	263
MOPCP107 – A Design of Switch Magnet Power Supply . . . . .	266
MOPCP108 – Design of High Energy Hadron FFAGs for ADSR and other Applications . . . . .	269
MOPCP109 – The Design of Transverse Emittance Measurement at HIRFL-CSR . . . . .	272
TUM1CIO01 – Towards the 2MW Cyclotron and Latest Developments at PSI . . . . .	275
TUM1CCO03 – Reliable Production of Multiple High Intensity Beams with the 500 MeV TRIUMF Cyclotron . . . . .	280
TUM1CCO04 – The VARIAN 250 MeV Superconducting Compact Proton Cyclotron: Medical Operation of the 2nd Machine, Production and Commissioning Status of Machines No. 3 to 7 . . . . .	283
TUM2CIO01 – Status of RIBF Accelerators at RIKEN . . . . .	286
TUM2CCO02 – First Beam Acceleration in Kolkata Superconducting Cyclotron and Its Present Status . . . . .	292
TUM2CCO03 – Commissioning of the JYFL MCC30/15 Cyclotron . . . . .	295
TUA1CIO01 – A Multi MegaWatt Cyclotron Complex to Search for CP Violation in the Neutrino Sector . . . . .	298

TUA1CCO04 – Design study of 70 MeV Separate Sector Cyclotron for KoRIA project . . . . .	304
TUA2CIO01 – Progress on Construction of CYCIAE-100 . . . . .	308
TUA2CCO02 – Induction Sector Cyclotron for Cluster Ions . . . . .	314
TUA2CCO03 – Design and Construction Progress of a 7MeV/u Cyclotron . . . . .	317
WEM1CIO02 – 28 GHz SC-ECRIS at RIBF . . . . .	321
WEM1CIO03 – New Tools for the Improvement of Beam Brightness in ECR Ion Sources . . . . .	327
WEM2CIO01 – High Power RF Systems and Resonators for Sector Cyclotrons . . . . .	332
WEM2CCO02 – Operating Experience with the RF System for Superconducting Ring Cyclotron of RIBF . . . . .	338
WEM2CCO03 – Disturbance Effects Caused by RF Power Leaking Out From Cavities in the PSI Ringcyclotron . . . . .	341
WEM2CIO04 – Beam Diagnostics for Cyclotrons . . . . .	344
WEM2CCO05 – Beam Diagnostics for RIBF in RIKEN . . . . .	351
THM1CIO01 – Post-acceleration of High Intensity RIB through the CIME Cyclotron in the Frame of the SPIRAL2 Project at GANIL . . . . .	354
THM1CIO02 – Acceleration above the Coulomb Barrier - Completion of the ISAC-II Project at TRIUMF . .	359
THM1CIO04 – Progress towards New RI and Higher RIB Intensities at TRIUMF . . . . .	365
THM2CCO03 – Stripper Foil Developments at NSCL/MSU . . . . .	373
THA1CIO01 – FFAG Developments in Japan . . . . .	376
THA1CIO02 – First Commissioning Results from the Non-Scaling FFAG Accelerator, EMMA . . . . .	384
THA1CIO03 – Innovations in Fixed-Field Accelerators: Design and Simulation . . . . .	389
THA1CCO04 – Cyclotron and FFAG Studies Using Cyclotron Codes . . . . .	395
FRM1CIO01 – Review on Cyclotrons for Cancer Therapy . . . . .	398
FRM1CIO03 – IBA-JINR 400 MeV/u Superconducting Cyclotron for Hadron Therapy . . . . .	404
FRM1CIO04 – Fast Scanning Techniques for Cancer Therapy with Hadrons - a Domain of Cyclotrons .	410
FRM1CCO05 – Advocacy for a Dedicated 70 MeV Proton Therapy Facility . . . . .	416
FRM2CIO01 – Review of Cyclotrons Used in the Production of Radio-Isotopes for Biomedical Applications	419
FRM2CIO02 – Medical Cyclotron and Development in China . . . . .	425
FRM2CCO04 – BNCT System Using 30 MeV H <sup>-</sup> Cyclotron . . . . .	430
<b>Appendices</b> . . . . .	<b>433</b>
List of Authors . . . . .	433
Institutes List . . . . .	439
Participants List . . . . .	446