Proposal for ACFA School on Superconducting Technology and Cryogenics for Accelerators in 2015

J. Gao

IHEP

ACFA meeting Jan. 31, 2015, Dongguan, Guangdong, China

Contents

•Brief review of the Asian Accelerator School in 1999

Proposal for ACFA School on
 Superconducting Technology and
 Cryogenics for Accelerators in 2015

Physics and Engineering of High-Performance Electron Storage Rings and Application of Superconducting Technology



Asian Accelerator School in 1999 has had a great success

Organizer

Shi-ichi Kurokawa, Chuang Zhang, Kenji Hosoyama, Zhiyuan Guo, Yoko Hayashi and Rucheng Hou

Program in accelerator physics

CONTENTS

xi

Preface vii	
Lectures	
Qing Qin	
Transverse Motion of Charged Particles 1	
Imperfections, Chromaticity and Linear Coupling 16	
Guo Zhiyuan	
Longitudinal Motion of a Particle in a Circular Accelerator	
An Introduction to the Dynamic Aperture 41	
Zhao Zhentang	
Synchrotron Radiation and Beam Dimensions	
Chang Chuang	
Electron-Positron Colliders	
Vang Shuhong	
Introduction to the Injector Linac for Electron Ring Accelerators	
uo Xiaoan	
Instructions for Injection into the Storage Ring 109	
azunori Akai	
RF System for Electron Storage Rings 118	
fasanori Kobayashi	
Vacuum System of the Electron Storage Ring 150	
phn D. Fox	
Beam Instrumentation and Feedback	
lexander W. Chao	
Beam Instabilities	
laury Tigner	
Fundamentals of Superconductivity	

Program in SC Technology

Martin N. Wilson Superconducting Magnets for Accelerators	299
Conductors for Accelerator Magnets	
Ouenching, Current Leads and a Look at Some Superconducting	
Accelerators	
Takaaki Furuya	
Superconducting Cavity	348
Kenji Hosoyama	
Cryogenic Systems	394
Seminars	
Ken Kikuchi	
History of High Energy Accelerators in Japan	457
Hands-on Training	
Kenji Hosoyama et al.	
Makikng Superconducting Solenoid Magnet	471
Koh Agatsuma	
Basic Design of Solenoid Superconducting Magnet	
for Hands on Training	486
Politicali Europa et al	
Experiment on a Superconducting Cavity	495
Student Reports on Hands-on Training	
Report from Group A	513
Report from Group B	519
Report from Group C	526
Report from Group D	531
Report from Group E	539
Program	549
List of Participants	551

TRANSVERSE MOTION OF CHARGED PARTICLES

1

QING QIN

Institute of High Energy Physics, Beijing, 100039, P.R. China E-mail: <u>ging@mail.ihep.ac.cn</u>

The transverse motion of charged particles in a synchrotron facility is our main subject, along with descriptions of basic magnets, solutions of Hill's equation, Liouville's theorem, elementary Hamiltonian treatment, etc.

1 Introduction

In this fundamental course on accelerators, we focus on the storage ring of a synchrotron. In such a machine, dipoles, or bending magnets, keep the revolution of the charged particle beams within a vacuum chamber. This confines them in a closed orbit. The strong focusing principle needs quadrupoles to make beams oscillate around the closed orbit, i.e., the betatron motion. Such an arrangement of dipoles and quadrupoles for a certain purpose is called the accelerator "lattice".

Charged particle beams are stored in high energy rings with transverse and longitudinal motions. The transverse particle motion can be divided into two parts: a closed orbit and a small-amplitude oscillation around the closed orbit.

In the following sections, we will introduce the basic knowledge of the transverse motion of charged beams in circular accelerators.

2 Coordinate System

The bending field produced by dipoles is usually vertically directed, which makes the charged particle follow a curved path in the horizontal plane. Fig 1 simply shows a curvilinear coordinate system for particle motion in a synchrotron.



Figure 1 Curvilinear coordinate system for charged particles

Proposal for ACFA School on Superconducting Technology and Cryogenics for Accelerators in 2015

•Accelerators for high energy physics: ILC, CEPC/SppC, Neutrino Factory...

•Nuclear physics: Heavy ion...

•Light sources: XFEL, ERL, Synchrotron radiation facilities...

•Accelerator applications: ADS, Spallation neutron sources...

•In short, they are all based on superconducting accelerators and using superconducting technology with large scale cryogenic systems...

•There are strong need to have well trained specialists working the SC technology and cryogenic systems by working environment and preferably through systematic training schools....

•ACFA has good resources to provide

ACFA School on Superconducting Technology & Cryogenics for Accelerators First Preparation-LOC Meeting Minutes IHEP, Oct. 28, 2014

Attendees: Jie Gao (Chairman), Yi Sun, Zhongquan Li, Rui Ge, Zian Zhu, Qingjin Xu, Jiyuan Zhai, Yilin Liu, Carlo Pagani, Akira Yamamoto.

Conclusions:

•International Organizing Committee: tbd, include directors of major labs

•Curriculum Committee: tbd

Local Organizing Committee: J. Gao (IHEP) (Chair), W.M. Pan (IHEP), Q. Qin (IHEP), S.P. Li (IHEP), Y. Sun (IHEP), Z.Q. Li (IHEP), J.Y. Zhai (IHEP), Q.J. Xu (IHEP), Z.A. Zhu (IHEP), R. Ge (IHEP), Y.L. Liu (IHEP)
Host: IHEP

•Location: tbd, in Beijing

•Time: tbd, late 2015

•Duration: 2 weeks (one week lecture courses and one week hands-on courses)

•Sponsors: tbd

•Lecturers: tbd by curriculum committee

•Student number: 50 max (application and selection, with quota for each country). Student financial aid: tbd.

•Homework, examination and award: recommended.

•Proceedings (as CERN accelerator school): tbd

•Lecture courses:

•Topics: Basic accelerator physics, electrodynamics and thermodynamics, RF engineering, cryogenics engineering, superconducting cavity and magnets, etc.

•Some recommended courses in the program

•Hands-on courses: ~10-students groups in parallel

•SC cavity fabrication (deep drawing, etc.)

•SC cavity RF measurement (coupling measurement, field flatness tuning etc. at room temperature with network analyzer)

•SC cavity testing (2K in IHEP Building#1, cavity type tbd, including cable calibration, cooling down from 4.5K to 2K, testing and data analysis)

•SC magnet coil winding (race track dipole, quadrupole, solenoid)

•SC magnet measurement (LTS@4.5K& HTS@80K in small Dewar in IHEP SRF Lab)

•Cryogenic experiments (tbd)

•Others

Draft Program for ACFA School on Superconductivity & Cryogenics for Accelerators Beijing, China, 2015

First Week: Lecture Courses (preliminary

Time	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday
09:00 10:30	ARRIVAL DAY Registration	Introduction and Basic Accelerator Physics (Linac)	Basic Theory of Superconductivity	Cryogenics (engineering)	Excursion	Superconducting Cavity (Testing and Performance)	Superconducting magnet (Test & field measurement)	Instrumentation
	1		Coffee				Coffee	
11:00 12:30		Introduction and Basic Accelerator Physics (Storage ring)	Superconducting materials (Nb, LTS, HTS)	Cryogenics (engineering)		Superconducting Cavity (HOM and input coupler, tuner, LLRF)	Superconducting magnet (quench protection)	Superconducting Insertion Devices
	1		Lunch				Lunch	
14:30 16:00		Electromagnetic Theory	Cryogenics (theory)	Superconducting Cavity (Design)		Superconducting magnet (Design)	Cryomodule (Cavity)	Special lecture
	1		Coffee			Coffee		
16:30 18:00		RF Engineering	Cryogenics (theory)	Superconducting Cavity (Fabrication & Processing)		Superconducting magnet (Fabrication)	Cryostat (Magnet)	Exam
18:30	Dinner	Dinner	Dinner	Dinner	Banquet	Dinner	Dinner	Dinner

Second Week: Hands-on Courses

Time	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	
09:00 12:30							DEPARTURE	
	Lunch							
14:30 18:00								
18:30	Dinner	Dinner	Dinner	Dinner	Dinner	Dinner		

Preliminary budget estimation

Budget of Asian School on Superconductivity & Cryogenics for Accelerators					
	al	l in CNY			
Students number	50				
Lecturer number	10				
Domectic lecturer number	5				
Oversea lecturer number	5				
Expense Category	Amount/person	Days	Sum	Notes	
Students					
Lodging	150	14	2,100	two students share one twin room	
Coffee (two)	60	6	360		
Lunch	80	13	1,040		
Dinner	80	13	1,040		
Sum for one student			4,540		
Sum for all students			227,000		
Lecturers					
Lodging	350	2	700	lecturer in one room	
Coffee (two)	60	2	120		
Lunch	80	2	160		
Dinner	80	2	160		
Airfare	5000	1	5,000		
Sum for one domectic lecturer			1,140		
Sum for one oversea lecturer			6,140		
Sum for domectic lecturers			5,700		
Sum for oversea lecturers			30,700		
Sum for all lecturers			36,400		
Classroom	1000	12	12,000		
Banquet			10,000		
Training			100,000		
Excursion			10,000		
Other					
Total			395,400		

Place, date and Sponsors

•IHEP

•November 2015 (check with other event)

•Sponsors: Key labs, and industries

Committees (1) (TBD)

International Advisory Committee:

- Y.F. Wang (IHEP) (Chair) (yfwang@ihep.ac.cn)
- K.X. Liu (PKU) (kxliu@pku.edu.cn)
- G.X. Xiao (IMP) (xiaogq@<u>impcas.ac.cn</u>)
- A. Suzuki (KEK) (atsuto.suzuki@kek.jp)
- Director of Jparc (name and email?) Dr. Yujiro IKEDAE-mail: yujiro.ikeda@j-parc.jp>
- S. Kurokawa (KEK) (shin-ichi.kurokawa@cosylab.com)
- D. Kanjilal, Director IUAC (India) (dk@iuac.res.in)
- P.D Gupta , Director RRCAT (India ACFA Member) (<u>pdgupta@rrcat.gov.in</u>)
- Sun-Kee Kim, Director RISP (<u>skkim@hep1.snu.ac.kr</u>, <u>skkim@ibs.re.kr</u>)
- W. Namkung (PAL) (<u>namkung@postech.ac.kr</u>)
- ShangjrGwo, Director of the National Synchrotron Radiation Research Center (NSRRC). (<u>gwo@nsrrc.org.tw</u>)
- Russia (Novosibirsk): Oleg Meshkov (O.I.Meshkov@inp.nsk.su) is an ACFA.

Committees (2)

Local Organizing Committee:

J. Gao (IHEP) (Chair) W.M. Pan (IHEP) Q. Qin (IHEP) S.P. Li (IHEP) Y. Sun (IHEP) J.Y. Zhai (IHEP) Q.J. Xu (IHEP) Z.A. Zhu (IHEP) R. Ge (IHEP) Z.Q. Li (IHEP) Y.L. Liu (IHEP)

Committees (3) (TBD)

International Program Committee (source of names to be finalized):

J. Gao (Chair, IHEP) T.S. Datta (Co-Chair) Y. He (IMP) J.F. Liu (SSRF) J.K. Hao (PKU) S.P. Li (IHEP) J.Y. Zhai (IHEP) A. Yamamoto (KEK) H. Hayano E. Kako Takaki Furuya (Cavity) email:? Hirotaka Nakai(Cryogenics) email:? Norita Ohuchi (Cryomodule), Anybody from JPARC ? email:? SuperKEK-B:???name and email? Korea : Dr Yong- Sub- Cho (Head KOMAC) email:? In-so Ko (isko@postech.ac.kr) (PAL) Dang - O- Jean (Head RAON Project) email:? ???(Jparc) name and email:? Taiwan :Dr C S Hwang (Head Instrumentation & Cryogenics Division), NSRRC. (ACFA Member) email:? Guo-Huei LUO (luo@nsrrc.org.tw) Dr. NiklayAgapov (JINR) email:? Dr, Eun-san KIM of Kyungpook National University (eskim1@knu.ac.kr)

Other aspects to be discussed

As proposed originally by T. Datta: Number of Students : May be 50 : China ; 25, Japan / Korea ; Max 15, India : Max 5, Taiwan, Russia, Thailand, Singapore, Australia : Max 5-6

Funds : Supported by CAS , Universities (China), JSPS (Japan) , DST (India) , KBRI (Korea), etc...

Thank you for your attention