2019

Book of Abstracts

JOINT US-CERN-JAPAN-RUSSIA ACCELERATOR SCHOOL
ON ION COLLIDERS

28 OCTOBER - 7 NOVEMBER 2019

29/10/2019

10:00–10:50

Modern challenges in HEP: motivation for high energy ion collision

Evgeni Kolomeitsev (JINR)

Relativistic nuclear physics; Phase diagrams of strongly interacting matter
History of experiments on heavy ion collisions: Bevalac, SIS, SPS, RHIC, ALICE
Chiral symmetry breaking and restoration
Strangeness enhancement
Confinement-deconfinement phase transition (hadronization)
Chemical and kinetic freeze-out
Resonances
QCD diagram, mixed phase, critical point, new phases
Creation of dense matter in the lab
Future experiments FAIR, NICA

29/10/2019

11:30–12:20

Recap of transverse particle dynamics

Dmitry Shwartz (BINP)

Equations of motion
Equations of trajectories, periodicity in “s”
Equations in linear approximation
Strong focusing, Hill's equation
Stability conditions, Twiss parameters
Perturbations of the guide field
Tolerance to field imperfections
Resonances in betatron motion
Operation near linear coupling resonances
Cooling and stationary beam parameters
Optics of an efficient ion collider
Beam diagnostics needed to optimise the machine optics model

29/10/2019

14:00–14:50

Recap of longitudinal beam dynamics, RF-gymnastics

Elena Shaposhnikova (CERN)

Acceleration
Longitudinal beam dynamics: equations of motion, longitudinal phase space
RF gymnastics/manipulations: CERN ion complex, Bunch rotation, bunch shaping, controlled emittance blow-up, bunch splitting, momentum slip-stacking

29/10/2019

15:00–15:50

Overview of the electron-ion colliders projects

Peter Shatunov (BINP)

Motivation for electron-ion colliders at various energies and physics requirements
Approaches to the interaction region design
Paths to high luminosity
Beam preparation chains for hadrons and electrons
Examples of designs (eRHIC, JLEIC, LHeC, eLISE, etc.)

30/10/2019
9:00–9:50
Towards nuclear physics in electron-radioactive ion collisions

Leonid Grigorenko (JINR)

Hot topics in low-energy nuclear physics
Chart of nuclides, nuclear driplines, exotic radioactive nuclei near driplines
Radioactive ion beams (RIBs), “RIB factories” around the World
DERICA (Dubna Electron-Radioactive Ion Collider fAcility) project
High-current superconducting cw-LINAC
In-flight production of RIBs, fragment-separators, RIB reactions at intermediate energies
Gas cell stopping of RIBs, ion trap, charge breeder
RIB reacceleration by pulsed LINAC, reactions with reaccelerated RIBs
Physics of RIBs in storage rings
Electron-RIB collider facility, luminosity of collider experiments

30/10/2019
10:00–10:50
Nonlinear dynamics

Kazuhito Ohmi (KEK)

We discuss nonlinear dynamics in circular accelerators.
1. Hamiltonian approach for betatron/synchrotron motion
2. One turn map for a revolution in circular accelerators
3. Resonances for betatron/synchrotron motion.
4. Emittance growth (due to beam-beam and space charge force)
5. Dynamic aperture

30/10/2019
11:30–12:50
Asymmetric colliders I: collision energy & Luminosity

Igor Meshkov (JINR)

Formulas for a collider luminosity: general case and three particular cases: two identical axially symmetric bunches, the collision of a bunch with a coasting beam, and the collision of two coating beams. Collider on intersecting beams, “crab crossing” and “crab waist” techniques. The formula is valid for colliding both counter propagating and co-propagating (“merging”) beams.
Space charge limitations in colliders: “beam space charge (Laslett) effect” and “beam-beam effect”
Optimization of beam intensity in a collider.

30/10/2019
14:00–14:50
Linacs: RFQ, DTL

Sergei Polosov (MEPhI)

Linear accelerator (linac)
Drift tube linac
RF focusing linac
Radio frequency quadrupole
Beam dynamics
Accelerating cavities
Superconducting cavities

30/10/2019
15:00–15:50
Performance highlights from the ISR

Fritz Caspers (CERN)

ISR beam parameters and machine layout, historical context, Physics objectives
Operation with counter rotating p beams and with ion beams.
Luminosity performance, backgrounds, crossing angles
Coasting beams and bunched beams operation
Technological challenges and achievements (vacuum, beam instrumentation…)

31/10/2019
9:00–9:50
Vacuum technologies

Kyo Shibata (KEK)

Introduction to vacuum science and technology
- Definition of vacuum and pressure
- Equation of state of ideal gas
- Conductance, pumping speed, gas flow rate
- Pump-down equation
- Outgassing in vacuum chambers
- Vacuum devices

Vacuum system for accelerators
- Difference from general vacuum system
- Beam-residual gas interactions
- Vacuum system of SuperKEKB

31/10/2019
10:00–10:50
Ion sources

Eugeni E. Donets (JINR)

Sources of multicharged ions: Electron Beam Ion Sources (EBIS), Electron String Ion Sources (ESIS), Electron Cyclotron Resonance ion sources (ECR), Laser ion sources; - principles of operation, obtained parameters, perspectives…
Ion sources on injection complex of modern synchrotrons: RHIC (BNL), NICA (JINR), FAIR…
Ion sources on injection complex of modern cyclotrons
Ion sources as charge breeders of rare and short-lived radioactive isotopes
Ion sources for cancer therapy accelerators
Ion sources/traps for non-accelerator high precision experiments with slow highly charged heavy ions in atomic, plasma and nuclear physics

31/10/2019
11:30–12:30
Asymmetric colliders II: space charge & luminosity optimization

Igor Meshkov (JINR)

Formulas for a collider luminosity: general case and three particular cases: two identical axially symmetric bunches, the collision of a bunch with a coasting beam, and the collision of two coating beams. Collider on intersecting beams, “crab crossing” and “crab waist” techniques. The formula is valid for colliding both counter propagating and co-propagating (“merging”) beams.

31/10/2019
11:30–12:30
Designing a collider. NICA collider — a real life example

Anatoly Sidorin (JINR)

Center of mass energy, luminosity, interaction point, space charge tune shift, beam-beam parameter
Luminosity life-time, luminosity preservation, intrabeam scattering, beam cooling, electron cooling, stochastic cooling
Low energy heavy ion collider, beam storage, short bunch formation
Optimization of NICA collider parameters, ring circumference, focusing structure, acceptance

1/11/2019
9:00–9:50
Electron clouds

Alexandr Krasnov (BINP)

The term ‘Electron Cloud (EC)’ refers to an accumulation of low energy electrons in the space of high-energy particles beam propagation. Electron Clouds can be dense enough to affect an accelerator operation, e.g., by causing the beam loss, emittance growth, increase in the vacuum pressure, heating of the beam pipe walls or on the accuracy/stability of beam diagnostics. The lecture includes information regarding main causes and dynamic of the EC build-up, key parameters for the EC computer simulation, EC influence on vacuum conditions, EC experimental investigation and experience of the EC mitigation. There are also given some details of the design of the LHC and SuperKEKB beam pipes and experimental results obtained at laboratory conditions and on the SPS (CERN) ring.

1/11/2019
9:00–9:50
Tools for lattice design

Mark Boland (CLS)

The Goal of Lattice Design
Basic Physics of Lattice Design
Practical Tools
Specific Codes and References

1/11/2019
11:30–12:20
RF-systems

Mikhail Lalayan (MEPhI)

Electromagnetic fields, acceleration in RF fields, RF systems of linear accelerators, RF systems of circular accelerators and storage rings, power sources, features of superconducting accelerators feeding

1/11/2019
14:00–14:50
Collective effects

Yoshihiro Shobuda (JAEA)

Electromagnetic interaction of a beam with surrounding environment
Coupling impedances
Beam instabilities excited by the coupling impedances
Vlasov approach to estimate the beam growth rate
Application to the 3 GeV Rapid Cycling Synchrotron (RCS) in Japan Proton Accelerator Research Complex (J-PARC)
How to specify the dominant impedance at the RCS both in theoretical and measurement approaches
How to suppress the impedance
How to maneuver the beams by optimizing the beam parameters

1/11/2019
15:00–15:50
Outlook: accelerator tasks for physics beyond SM

Eugeny Levichev (BINP)

Discovery of the Higgs boson at LHC had completed the Standard Model of Particle Physics, the theory describing the laws governing most of the known Universe. However, although the Standard Model accurately describes the phenomena within its domain, it is still incomplete and cannot explain such observation as evidence for dark matter, prevalence of matter over antimatter, the neutrino masses, etc. New accelerators and colliders with higher energy and luminosity can help in study of particle physics beyond the SM. Development of new generation particle accelerators requires novel approaches in design of installation as well as new technologies, equipment, systems and components. Several new accelerator proposals going beyond the SM are discussed in the lecture.

3/11/2019
9:00–9:50
Injection and extraction

Verena Kain (CERN)

Introductory slides: kickers, septa and normalised phase-space. Injection methods: single-turn hadron injection, injection errors, filamentation and blow-up, multi-turn hadron injection, charge-exchange H- injection, lepton injection. Extraction methods: single-turn (fast) extraction, non-resonant and resonant multi-turn (fast) extraction, resonant multi-turn (slow) extraction

3/11/2019
10:00–10:50
Superconducting magnets for particles accelerators

Sergei Kostromin (JINR)

Magnetic field, superconductivity, superconducting wires, superconducting cables, Nuclotron-cable, Nuclotron-magnets, Cosine-theta magnets, Geometrical-tolerances, Cryostats, High-temperature superconductors, Production technology

3/11/2019
11:30–12:20
Beam instrumentation & diagnostics I

Manfred Wendt (CERN)

Basic definitions, accuracy, precision, resolution
Overview of beam instrumentation
Detailed functionality of:
- beam position monitors
- beam current monitors
- transverse profile measurements, emittance measurements
- longitudinal profile measurements
- luminosity monitoring
- beam loss monitoring

Examples of interesting beam diagnostics:
- Orbit corrections
- Measurements of phase advance and value of the beta-function
- Time resolved tune diagnostics
- Amplitude detuning
- Equipment Fault diagnostic

3/11/2019
14:00–14:50
Collider luminosity simulation

Dmitry Shatilov (BINP)

Why do we need beam-beam simulations, which questions can be answered and which problems to solve.
Brief description of the tracking technique, including interaction with the oncoming beam and the effects of space charge.
Various models and various problem statements. Depending on this - what information can be extracted (with examples).

3/11/2019
10:00–10:50
Performance highlights from the RHIC

Mei Bai (GSI)

RHIC parameters with nuclear beams, short history, physics requirements
Overview of injector complex, operational cycle
Performance limitations, IBS, luminosity evolution, transition crossing
Review of major steps in increasing luminosity, especially bunched beam stochastic cooling

4/11/2019

9:00–9:50

Simulation tools: interaction with matter

Francesco Cerutti (CERN)

Interaction types and modeling
Sources and effects

4/11/2019

10:00–10:50

Linear imperfections and corrections I

Eliana Gianfelice-Wendt

Closed Orbit Perturbations: sources, corrections

4/11/2019

11:30–12:20

Collimation of nuclear beams

Roderick Bruce (CERN)

Review of collimation for protons
Differences with heavy-ion beams
Nuclear reactions in collimators: fragmentation and electromagnetic dissociation
Loss patterns and collimation efficiency
Quench tests
Mitigation measures in LHC

4/11/2019

14:00–14:50

Beam instrumentation & diagnostics II

Manfred Wendt (CERN)

Basic definitions, accuracy, precision, resolution
Overview of beam instrumentation
Detailed functionality of:
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- longitudinal profile measurements
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Examples of interesting beam diagnostics:
- Orbit corrections
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- Amplitude detuning
- Equipment Fault diagnostic

5/11/2019
9:00–9:50
Simulation tools: interaction with matter
Francesco Cerutti (CERN)
Interaction types and modeling
Sources and effects

5/11/2019
10:00–10:50
Linear imperfections and corrections II
Eliana Gianfelice-Wendt
Optics Perturbations: gradient errors, detection and correction, linear coupling: sources, detection and correction

5/11/2019
11:30–12:20
Schottky diagnostic
Manfred Wendt (CERN)
Introduction into Schottky Signals
Simplified Theory of Schottky Beam Signals
Longitudinal, unbunched beam
A few measurement examples
Transversal, unbunched beam
RMS emittance measurement setup for ion beams
Longitudinal, bunched beam
Transversal, bunched beam
Example: The LHC Schottky Pickup
Overview and some details on the hardware
Examples of beam measurements

5/11/2019
14:00–14:50
Emittance preservation
Verena Kain (CERN)
The emittance growth measuring is a difficult task with high intensity beams and changing energies. Accuracy and limitations of the LHC transverse profile monitors will be discussed.

5/11/2019
15:00–15:50
Performance highlights from the LHC
Schaumann Michaela (CERN)
Definitions of energy, emittance, luminosity for ion colliders
LHC parameters with nuclear beams, short history, physics requirements
Overview of injector complex
Operational cycle
Performance limitations, IBS, radiation damping
Ultra peripheral collisions, secondary beams from bound-free pair production and electromagnetic dissociation of nuclei and how they affect luminosity evolution
Luminosity limit from magnet quenches and mitigation techniques used in LHC
Bunch filling schemes, luminosity sharing and levelling

6/11/2019

9:00–9:50

Trends and prospects of accelerator physics and technology in Russia

Grigory Trubnikov (JINR)

Particle accelerator development application in Russia – brief history and status
New accelerator facility projects in Russia:
accelerator for high energy and nuclear physics
accelerator driven neutron sources
synchrotron radiation sources
applied accelerators for basic research, industry and medicine

6/11/2019

10:00–10:50

Electron cooling

Vladimir Reva (BINP)

Basics of cooling process
Electron cooling, basics of electron cooling, short history of electron cooling investigation
Electron cooling force, magnetized cooling
Electron cooling system for different energy, basic elements and its purpose
Example of electron cooling processes

6/11/2019

11:30–12:20

Bunched beam stochastic cooling

Markus Steck (GSI)

Principle of the stochastic cooling method (SCM), history of invention and remarkable applications
Longitudinal and transverse (“Palmer”, TOF, “Filter”) SCM
Peculiarity of bunched beam (BB) SCM
Examples of BB SCM test and plans for its application (RHIC, FAIR, NICA)