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PE Mini Lectures #5
Introduction

18.09.2019

Mini Lectures: Proposed Topics (May 2019)

Beam & Accelerator physics

How to describe a particle beam? 1)
- Phase-space, Liouville theorem, emittance, optical functions (α, β, γ), σ

How do accelerators work? 2)
- Beams production: ion sources
- Beam transport, FODO lattice
- Beam acceleration: linacs and acc. cavities
- Beam collision: synchrotron, collider, luminosity, β^* 5)
- Acc. hardware: beam dump, cavities, …

What types of magnets do we need? And how do we get them? 3)
- Dipoles, quadrupoles, and more: beam-dynamics and hardware realization
- Kicker and septa

Magnets

How do superconducting acc. magnets work? 4)
- Basics of superconductivity
- Basics of superconducting magnet and cable design
- Why use superfluid helium?

Why and how to protect a s.c. magnet?
- How to quench a s.c. magnet?
- How to protect a s.c. magnet?
- Quench/damage limits

What can go wrong? Beam-related failures
- Failure classification (risk, slow/fast/ultrafast failures)
- Failure examples: magnet powering, injection/extraction failures, UFOs, QH firing
- Failure criticality for different machines

How does the CERN accelerator complex work?
- Injectors: LINACs, PSB, PS, SPS
- LHC operation and cycle
- LHC availability and faults

Reliability and availability 6)
- Basic definitions (for CERN and other accelerators)
- Introduction to risk assessment
- Lifetime distributions and bathtub curve

Reliability & Availability

What happens if the beam is lost?
- Beam-matter interaction
- Hydrodynamic tunnelling

MP Systems
- Main MP systems at LHC (BIS, PIC, WIC, QPS, LBDS, COLL)
- Electronics for MP

Machine Protection

Special Topics… Visits…

Computational Methods

- Coding conventions and good practice / Object-oriented programming 0)
- Basics of co-simulation
- Introduction to machine learning
- How to simulate a particle beam? How to simulate a magnetic field?

Where are we?

1) Coding convention and good practice	✓	Computational Methods
2) How to describe a particle beam? • Concept of phase space/Liouville theorem • Emittance • Beta function and Twiss parameters	✓	Beam & Accelerator Physics
3) How to produce a particle beam? • Ion sources • Space charge	✓	Beam & Accelerator Physics
4) How to accelerate a particle beam? • RF acceleration (LINACS and RF cavities)	✓	Beam & Accelerator Physics
5) SWAN Notebooks • Using SWAN for scripting and documentation	**today**	Computational Methods
- How to transport a particle beam? • How to deflect a beam? • How to focus a beam? • Magnet types and their beam-dynamics functions	Next (?)	Beam & Accelerator Physics