C. Wiesner

PE Mini Lectures #7
Introduction

20.02.2020
Today

**7th PE Mini Lecture**

- **10:30**
  - **PE Mini Lectures: Introduction and further planning**
  - **Speaker:** Christoph Wiesner (CERN)

- **10:40**
  - **Introduction Hugo Pelomares**

- **10:50**
  - **Introduction Mathis Bancel**

- **11:00**
  - **Advanced Programming in Python – Part 2**
  - **Speaker:** Michal Maciejewski (CERN)
MPE-PE Section

MPE-PE section consists of 3 main branches:

- **Circuit Modeling**
  - Protection studies (LHC, HiLumi, FCC)
  - LHC circuit issues (shorts, voltage transients, etc)
  - CLIQ analysis
  - STEAM

- **Beam Impact & Machine Protection**
  - Damage limits on superconductors
  - Machine protection (LHC, HiLumi, FCC, CLIC)
  - Hydrodynamic tunnelling
  - Diamond BLM’s

- **Reliability & Availability**
  - R&A on LHC, HL-LHC, FCC
  - R&A on linear colliders
  - Accelerator Fault Tracking
  - AvailSim

**PE section meetings:**
- Present and discuss ongoing studies and topics
- Often there is not enough time to present underlying concepts and used tools

**PE mini lectures:**
- Learn and share (basic) knowledge and technical tools within the section
- More efficient communication and collaboration between the section members and, thus, increase synergies

Most studies require numerical and computational tools and methods

https://twiki.cern.ch/twiki/bin/viewauth/TEMPEPE/
**Mini Lectures: Where are we?**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Course</th>
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<tr>
<td>1) Coding convention and good practice</td>
<td>Computational Methods</td>
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<tr>
<td>2) How to describe a particle beam?</td>
<td>Beam &amp; Accelerator Physics</td>
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<tr>
<td>• Concept of phase space/Liouville theorem</td>
<td>Beam &amp; Accelerator Physics</td>
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<td>• Emittance</td>
<td>Beam &amp; Accelerator Physics</td>
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<td>• Beta function and Twiss parameters</td>
<td>Beam &amp; Accelerator Physics</td>
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<td>3) How to produce a particle beam?</td>
<td>Beam &amp; Accelerator Physics</td>
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<tr>
<td>• Ion sources</td>
<td>Beam &amp; Accelerator Physics</td>
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<td>• Space charge</td>
<td>Beam &amp; Accelerator Physics</td>
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<td>4) How to accelerate a particle beam?</td>
<td>Beam &amp; Accelerator Physics</td>
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<td>• RF acceleration (Linacs and RF cavities)</td>
<td>Beam &amp; Accelerator Physics</td>
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<td>5) SWAN Notebooks</td>
<td>Computational Methods</td>
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<tr>
<td>• Using SWAN for scripting and documentation</td>
<td>Computational Methods</td>
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<tr>
<td>6/7) Python: Advanced Programming in python</td>
<td>Part II – today</td>
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<tr>
<td>You can find the presentation on the indico pages for 2019 and 2020</td>
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Mini Lectures: Next topics

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<tr>
<th>Topic</th>
<th>Presenter</th>
<th>Department</th>
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<tr>
<td>How to transport a particle beam?</td>
<td>Christoph</td>
<td>Beam &amp; Accelerator Physics</td>
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<tr>
<td>Magnet types and their beam-dynamics functions</td>
<td>Christoph</td>
<td>Beam &amp; Accelerator Physics / Magnets</td>
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<tr>
<td>Introduction to superconductivity and s.c. magnets</td>
<td>Lorenzo</td>
<td>Magnets</td>
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<tr>
<td>How to build a s.c. magnet?</td>
<td>Arjan</td>
<td>Magnets</td>
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<tr>
<td>How to protect a s.c. magnet?</td>
<td>Emmanuele</td>
<td>Magnets</td>
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<tr>
<td>Introduction to reliability and availability studies for accelerators</td>
<td>Thomas</td>
<td>Availability</td>
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Volunteers welcome! 😊
Backup
## Beam & Accelerator physics

### How to describe a particle beam?
- Phase-space, Liouville theorem, emittance, optical functions ($\alpha$, $\beta$, $\gamma$, $\sigma$)

### How do accelerators work?
- Beams production: ion sources
- Beam transport, FODO lattice
- Beam acceleration: linacs and acc. cavities
- Beam collision: synchrotron, collider, luminosity, $\beta^*$
- Acc. hardware: beam dump, cavities, ...

### 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

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

### Machine Protection

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

## Magnets

### How do superconducting acc. magnets work?
- Basics of superconductivity
- Basics of superconducting magnet
- Superconducting 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

## Reliability and availability

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

## Special Topics... Visits...