PHYS-750

Advanced Accelerator Concepts

Ischebeck Rasmus

Cursus	Sem.	Type
Physics		Obl.

Language of teaching	English
Credits	1
Session	
Exam	Written
Workload	30h
Hours	**14**
Courses	8
Exercises	6
Number of positions	

Frequency

Every year

Remark

Next time: Fall

Summary

Particle accelerators have numerous applications in science, medicine and industry. This course will give you an introduction to present research in accelerator physics. Topics range from recent developments on particle accelerators to research on novel accelerator concepts.

Content

Particle accelerators are essential tools in the discovery of new particles. Today, they are used for a variety of applications, ranging from pure and applied science to medicine and industry. Synchrotrons and free electron lasers are the brightest X-ray sources on the planet, whose short wavelength allows studying matter with atomic resolution. Electron microscopes benefit from small de Broglie wavelength and their large interaction with matter. In medicine, accelerators are used for diagnostics as well as treatement of diseases. Industrial applications include ion implantation for semiconductor circuits, sterilization, and material treatment.
Every new generation of accelerator concepts has resulted in new applications, without leading to obsolescence of established technologies. Indeed, most accelerators used by industry are based on DC acceleration, while radio frequency accelerators are used to achieve particle energies above 1 MeV. The avent of superconducting accelerators, as well as novel concepts based on lasers and plasma wakefields, will result in novel applications of accelerator technology.
In this course, I will cover the physics underlying accelerator research and present current research topics in these areas:

1. Accelerators at the energy frontier
2. Accelerators in medicine and industry
3. Advanced concepts in light sources: free electron lasers and diffraction limited storage rings
4. Electron beam manipulation: shaping of the electron bunches
5. High-gradient acceleration in plasma wakefields
6. Dielectric laser accelerators, terahertz acceleration
7. Current challenges in beam instrumentation
8. Accelerators for imaging and electron crystallography

You should bring a solid understanding of special relativity and electromagnetism, and be familiar with the basic concepts of accelerator physics. We can then explore advanced concepts in this exciting domain at the intersection between engineering and basic science.

Keywords

Accelerator Physics

Learning Prerequisites

Recommended courses

Introduction to particle accelerators (Rivkin, PHYS-448), or Synchrotrons and Free Electron Lasers (Willmott, CEDE/edx)

Expected student activities

…to understand the present challenges in particle accelerator research, and have an overview of possible paths towards future accelerators. Possibly some of the students will develop their own ideas on how to bring forward accelerator research!

Resources

Bibliography

https://agenda.infn.it/event/12611/timetable/?view=standard
https://aac2018.txcorp.com/event/1/timetable/#20180813.detailed