A Massive Open Online Course on Particle Accelerators

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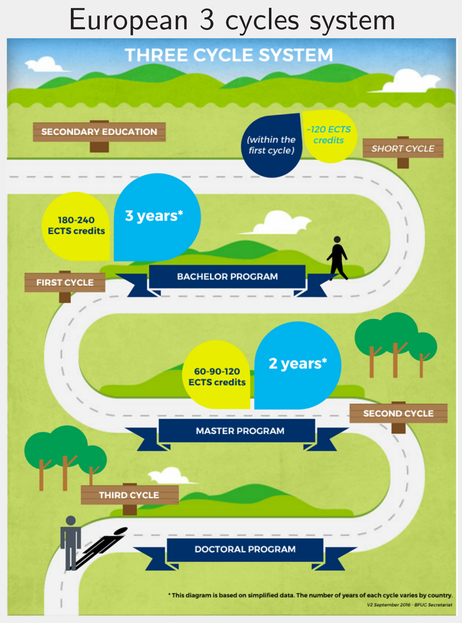
This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.

Introduction

The TIARA (Test Infrastructure and Accelerator Research Area) project funded by the European Union 7th framework programme made a survey of provision of education and training in accelerator science in Europe. This survey was followed by recommendation that highlighted the need for more training opportunities targeting undergraduate-level students. This need is now being addressed by the European Union H2020 project ARIES (Accelerator Research and Innovation for European Science and Society) via the preparation of a Massive Open Online Course (MOOC) on particle accelerator science and engineering. We present here the current status of this project, the main elements of the syllabus, how it will be delivered, and the schedule for providing the course.

Target audience

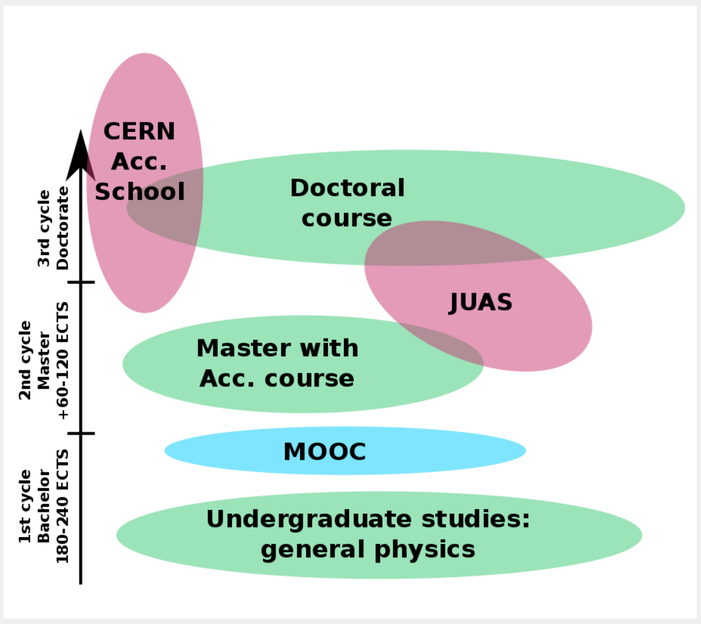
European 3 cycles system



— The first cycle, also called bachelor program, usually lasts 3 years and during that cycle the student must earn between 180 and 240 ECTS.
— The second cycle, also called master program, usually lasts 1 or 2 years and during that cycle the student must earn between 60 and 120 ECTS.
— The third cycle is the doctoral program.

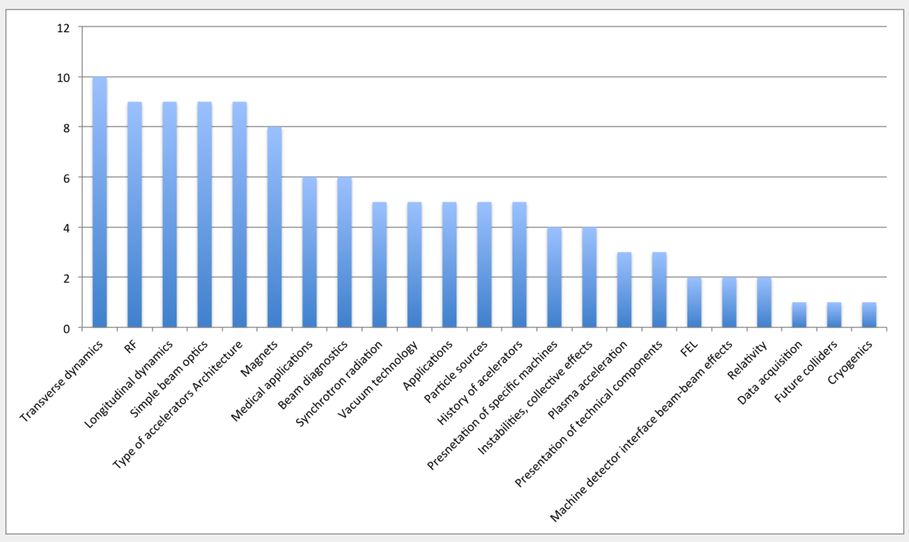
Target audience: students at the end of the first cycle or at the beginning of the second cycle, that is students having earned between 200 and 300 ECTS in physics or related subjects.

European Accelerator Education



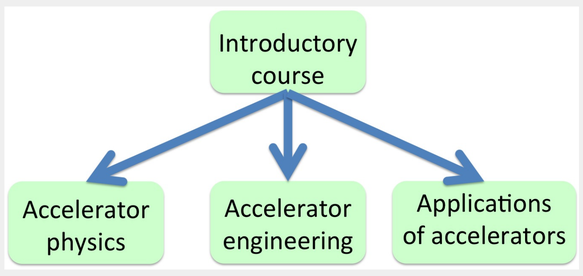
In Europe there are already several actors in the Accelerators Education Landscape:
— The Joint Universities Accelerator School (JUAS)
— The CERN Accelerator School (CAS)
— The Nordic Particle Accelerator Program (NPAP) who is also producing a MOOC.
— Several Universities have their own in-house training program for master or PhD student.

Survey of European Syllabus



Most often taught subjects: Transverse dynamics, RF, Longitudinal dynamics, Simple beam optics, Accelerators Architecture, and Magnets (all appear in more than 50% of the syllabi surveyed).

Proposed Syllabus



Introduction to accelerators	Accelerator Physics	Accelerator Engineering	Applications of accelerators
4 hours	6 hours	6 hours	6 hours
An introductory course about accelerators.	*Aimed at physics students who would like to understand what particle accelerators are, how they work, what happens inside the accelerators and what limits the performance of modern accelerators. The focus here is on physical processes.*	*Aimed at engineering students who would like to understand what particle accelerators are, how they work, what happens inside the accelerators and what limits the performances of modern accelerators. The focus here is on the engineering aspects of accelerators.*	*For students who would like to learn what accelerators are, how there are used and how they impact our society.*
Topics			
What is an accelerator ?	Maxwell equations and application to the propagation of electromagnetic waves at radio frequencies.		Synchrotron radiation physics.
Applications of accelerators and the future.	Statistical physics applied to an electron gas; collective effects.	Diagnostics, uncertainty in measurements, propagation of charged particles through matter and radiation emitted by particles.	
Electromagnetism with no pre-requisites.	Colliders (accelerators for High Energy Physics; accelerators for Nuclear Physics), neutrons facilities and synchrotron radiation facilities	Advanced topics in radio-frequency and high voltages.	Colliders (accelerators for High Energy Physics; accelerators for Nuclear Physics), neutrons facilities and synchrotron radiation facilities
Relativity with no pre-requisites.	Medical applications and other applications.	Magnet design and cryogenics.	Overview and operation of medical accelerators and other small facilities.
	Future European and international facilities and their applications.	Vacuum technology and mechanical engineering for accelerators.	Future European and international facilities and their applications.
	The future: higher gradient, higher intensities, higher reliability, laser-plasma acceleration, ...		Machine detectors interface at colliders, synchrotron light sources and neutron sources.
	Radioprotection and safety at particle accelerators		

Timetable

— May 2018: decide on the detailed syllabus and lecturers for the introductory course.
— Autumn 2018: Preparation of the course material.
— Winter 2019: Recording of the video.
— Autumn 2019 or Spring 2020: First module of the course ready.