



Course unit English denomination	Advanced lectures in Particle Physics and Quantum Field Theory
Teacher in charge (if defined)	R. Gröber, P. Paradisi
Teaching Hours	24
Number of ECTS credits allocated	3
Course period	February-June 2025
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (50% minimum of presence) ☐ No
Course unit contents	Mod A: Collider Physics 1. Hadron Colliders/e⁺ e⁻ colliders 2. Basics of QCD 3. Deep Inelastic Scattering, Parton Distribution functions 4. from the Lagrangian to the event 5. Higgs physics 6. The Standard Model and beyond at Colliders Mod B: Particle Physics Phenomenology at low-energy 1.) Flavor physics overview: theory vs. experiments 2.) Quark & Lepton flavor violation in the SM 3.) FCNC processes with and w/o CP violation 4.) Neutrino Physics: current status and future perspectives 5.) Leptonic dipoles: muon g-2, electron & neutron EDMs 6.) Flavor physics beyond the SM: models and predictions
Learning goals	The learning objective of the PhD course is to provide an advanced understanding of particle physics, with a particular focus on experimental and phenomenological processes in high-energy colliders and low-energy physics. In Module A, students will acquire a solid knowledge of hadron and e⁺e⁻ colliders, the fundamentals of QCD, and parton distribution functions, developing the ability to understand the transition from Lagrangian formulation to experimental events. Special emphasis will be placed on Higgs boson physics and the exploration of the Standard Model and its extensions in collider experiments. In Module B, students will be introduced to the phenomenology of low-energy flavor physics, with an overview of quark and lepton flavor violations in the Standard Model, CP violating processes, and neutrino physics. Advanced topics such as the muon's



	anomalous magnetic moment, electric dipole moments of the leptons and neutron, and models beyond the Standard Model with phenomenological predictions will also be covered. By the end of the course, students will be able to critically analyze and model complex processes within the framework of current physical theories and propose new theoretical solutions for physics beyond the Standard Model.
Teaching methods	Frontal lectures, open discussions on research topic
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	The course aims at PhD students in particle physics (theory and experiment). A basic knowledge of the Standard Model is of advantage.
Examination methods (in applicable)	Oral exam
Suggested readings	Collider Physics within the Standard Model, G. Altarelli; COLLIDER PHENOMENOLOGY, TASI lecture by Tao Han; More material will be given in the lectures.
Additional information	