

PHD PROGRAMME IN PHYSICS, ASTROPHYSICS, AND APPLIED PHYSICS
UNIVERSITÀ DEGLI STUDI DI MILANO
PhD Cycle 41 (2025-2026)

All lectures will be given in English.

Course title	Computational, simulation and machine learning methods in high energy physics and beyond: Monte Carlo methods.
Teacher in charge of the course	Carrazza Stefano
List of the teachers of the course	Ferrario Ravasio Silvia; University of Turin; silvia.ferrario.ravasio@cern.ch
Training objectives	The principles on which event generators for hadron colliders are built and the progress that has allowed to increase their precision and reliability will be illustrated. In particular, we talk about the showering algorithms, as well as their connection with analytic resummation. Methods for combining fixed-order calculations with shower generators will be illustrated, in particular how to incorporate higher accuracy in QCD while maintaining infra-red finite event weights and avoid double counting.
Prerequisites	Quantum Field Theory, Particle Physics, QCD and electroweak interactions.
Detailed course program	1) Mini review of NLO calculations 2) The coherent branching formalism in final-state parton showers (and in resummation) 3) Initial-state radiation 4) Dipole showers 5) NLO matching (matrix element corrections, powheg, mc@nlo) 6) Multi-jet merging (CKKW-L and its NLO extension, unitarised merging at LO, 7) NLO and NNLO)
Examination modalities	Oral examination plus exercises to be solved individually.
Preliminary schedule	1 st week of July Course enrolment deadline: December 27, 2025.