PhD course in Physics, Astrophysics, and Applied Physics - Università degli Studi di Milano
PhD cicle 40 (2024-2025)

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	Stefano Carrazza
List of the teachers of the course *[surname/name; affiliation; e-mail]*	Silvia Ferrario Ravasio; CERN; 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 *[please insert details and also **state whether the course has advanced contents** suitable for students with prior knowledge of the topics or is also suitable for students without prior knowledge]*	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 *[please indicate the weeks when the lectures will be given]*	7-10 January 2025 or 22-25 April 2025