PhD course in Physics, Astrophysics, and Applied Physics - Università degli Studi di Milano
PhD cicle 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	Stefano Carrazza
List of the teachers of the course	Silvia Zanoli; Oxford University; silvia.zanoli@physics.ox.ac.uk
Training objectives	The course provides an overview of Monte Carlo event generators for particle collisions. It will focus on parton shower algorithms, covering the fundamentals as well as recent developments aimed at achieving accurate and reliable simulations. Methods for combining fixed-order calculations with parton showers will be discussed, including a detailed analysis of NLO matching techniques and selected highlights on NNLO matching. A brief overview of hadronisation models will also be presented.
Prerequisites	Quantum Field Theory, Particle Physics, QCD and electroweak interactions.
Detailed course program	1) Basics of parton showers — initial- and final-state radiation 2) Recent improvements on parton showers, and connection to resummation 3) NLO matching (powheg, MC@NLO) 4) NNLO matching (MiNNLOps and GENEVA) — selected highlights 5) Hadronisation models — the Lund string model and the Cluster model
Examination modalities	Oral examination plus exercises to be solved individually.
Preliminary schedule	March/April Course enrolment deadline: December 27, 2025.