Particle Shower Reconstruction in High Multiplicity Environments at the CMS experiment

PhD Thesis at CERN in Applied Physics

This PhD position is based at CERN as part of the CERN Doctoral student programme.
See: https://careers.cern/students

The Compact Muon Solenoid (CMS) experiment at CERN is one of two general-purpose particle physics experiments at CERN's Large Hadron Collider (LHC) - known in particular for the discovery of the Higgs Boson in 2012. Run by a collaboration of more than 4000 physicists and engineers it is one of the largest scientific endeavours world-wide.
From 2027, the High Luminosity phase of the LHC (HL-LHC) will provide an unprecedented instantaneous luminosity up to 7.5 times higher than the current one. Proton-proton collisions at such high luminosity (at the HL-LHC with a pile-up of 200 and more, and at the potential longer-term FCC-ee and FCC-hh colliders) will pose significant challenges for radiation tolerance and event pileup on detectors, especially for forward calorimetry. For this reason, the CMS collaboration is designing a High Granularity Calorimeter (HGCAL) to replace the existing endcap calorimeters as part of its HL-LHC upgrade programme. HGCAL will feature unprecedented fine transverse and longitudinal segmentation for both the electromagnetic and the hadronic compartments.
Given the anticipated complexity of collisions at the HL-LHC, traditional reconstruction algorithms are expected to fail. Additionally, information from other subsystems in CMS such as the tracking and timing detectors must be taken into account in particle shower reconstruction in HGCAL. Therefore, new techniques and clustering algorithms from various fields such as computational geometry, graph theory, and machine learning must be carefully planned for and designed keeping in mind that the implementation of the solution must be compatible with modern computer architectures, such as GPUs.
The successful candidate will work with an international CERN-based team on the design and development of fast and robust pattern recognition algorithms in calorimeters and will further be involved in testing and enhancing the existing ones.
The successful candidate has a background in (particle) physics and has already gained experience in software development in C++ and python, ideally using modern tools and development techniques such as git & CI. Some basic knowledge in statistics and machine learning will be of advantage. Moreover, the successful candidate works well in groups and participates fully and actively in team activities.

The deadline for applications for the December 2021 selection committee is 11th October 2021.

If interested, and for any further information, please contact Dr. Brondolin Erica (erica.brondolin@cern.ch) as soon as possible.