First investigation of timing opportunities in ATLAS beyond Run 4

The Inner Detector of the ATLAS Experiment will be upgraded to a full-silicon Inner Tracker (ITk) to cope with the extreme conditions of the High-Luminosity phase of the Large Hadron Collider, currently foreseen to take place towards the end of 2027.
ATLAS will also be installing a High Granularity Timing Detector in the forward pseudorapidity region, which will help mitigate the effects of pileup interactions and distinguish between collisions occurring close in space but well-separated in time.
Due to the high radiation dose in proximity of the interaction point, the two innermost pixel layers of the ITk will have to be replaced after a certain number of years of data taking.

This represents a unique and exciting opportunity to bring in technological innovation and fully exploit the potential of HL-LHC by including fast-timing through 4-dimensional (4D) tracking in the ATLAS barrel region. Even a single pixel barrel layer with timing capabilities could be a vast improvement in terms of performance and physics results.

The project focuses on the detailed simulation studies that are needed to evaluate the potential of such detector layout and eventually probe its feasibility, giving to the selected Doctoral Student the possibility of playing a key role on this topic since the start. In particular, the student will develop a framework to investigate which of the two replaceable layers of the ITk (if not both) will be suitable for the usage of 4D tracking technology and what time resolution will be needed to substantially boost the ATLAS performance. The amount of material introduced in the tracker by the usage of 4D silicon modules will also be evaluated and its impact on track reconstruction as well as more complex objects such as b-jets will be assessed.
If the outcome of the project confirms the potential of 4D tracking in ATLAS, the student will be contributing to silicon detector R&D targeting the technology needed to meet the requirements of the above-described ITk upgrade as well as its applicability to future detector scenarios.

A solid background in programming (e.g. C/C++ and Python) is required. Prior experience with LHC event reconstruction and/or silicon detector technologies is desirable.

For any questions, please contact Dr. Valentina Cairo (valentina.maria.cairo@cern.ch).

References:

ITk Pixel TDR; ITK Strip TDR; HGTD TDR