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Management of reconstruction and selection algorithms for the upgrade LHCb data processing, and tests of lepton universality

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Equipe thématique «Asymétrie Matière Antimatière»; expérience: LHCb

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Titre : Management of reconstruction and selection algorithms for the upgrade LHCb data processing, and tests of lepton universality

The LHCb experiment at CERN analyzes data from the proton-proton collisions delivered by the Large Hadron Collider (LHC). Its mission is to carry out precision tests of the Standard Model of particle physics by measuring properties of the full range of hadrons produced at the LHC. The LPNHE LHCb group consists of seven permanent staff, a postdoc and two PhD students, with two further postdocs and two other students joining the group in autumn 2017.

The LHCb experiment currently processes around 50 GB of data per second, and must reduce this data volume by a factor 100 in real-time to allow the most interesting signals to be preserved for further analysis. This reduction is carried out by a system of around 500 classifiers running in parallel, which use information provided by the detector reconstruction to separate different kinds of signal from backgrounds. LHCb will be upgraded between 2019-2021, enabling it to process 5 TB of data per second, increasing the required data volume reduction to 1000, and the number of classifiers to 1000. This scale makes the LHCb upgrade one of the biggest data challenges anywhere in the world.

The problem of optimizing this real-time data analysis system is not only a physics one, but also a management one. The LHCb detector consists of many components which provide information about the nature of each proton-proton collision, and each component's reconstruction takes a certain amount of CPU time to perform. Because the total CPU and output data rate budgets are fixed, the different signals and classifiers compete for processing resources, and the overall system must be designed to maximize the physics output of the collaboration while respecting the often contradictory physics and funding interests of the participating institutes and labs. This problem has many similarities with the problem of managing&optimizing a company's product offerings for different consumer markets, and is naturally suited to the structure offered by a joint research-management PhD course.

The successful candidate will join the LHCb group and develop an automated optimization of the real-time data analysis system for the LHCb upgrade, which will take into account the collaboration's physics priorities as well as the reconstruction and data rate costs of each signal. In addition, the successful candidate will use the data collected by the current LHCb detector to study lepton universality in highly excited $b \rightarrow c$ transitions (for example $B_s \rightarrow D_s^* \ell \nu$, or $B \rightarrow D^{**} \ell \nu$), which are as of yet poorly known and which rely on finely tuned real-time classifiers to achieve maximal sensitivity. In this work the candidate will benefit from the existing reconstruction and real-time analysis expertise in the LHCb group, already involved in reconstruction for the LHCb Scintillating Fiber tracker project, as well as from a close interaction with the existing ANR and ERC teams which are working on closely related physics and detector topics.

Lieu de travail : LPNHE - Paris

Déplacements éventuels: séjours réguliers de courte durée au CERN

Documentation:

- page web de l'expérience LHCb (<http://lhcb.web.cern.ch/lhcb/>)
- page web du LPNHE (<http://www-lpnhep.in2p3.fr/>)
- LHCb Trigger and Online Upgrade Technical Design Report (<https://cds.cern.ch/record/1701361?ln=en>)
- LHCb Tracker Upgrade Technical Design Report (<https://cds.cern.ch/record/1647400?ln=en>)
- Article on the lepton flavor universality test R_{K^*} (arXiv:1705.05802)
- Article on the lepton flavor universality test R_{D^*} (Phys. Rev. Lett. 115 (2015) 159901)

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