FCPPL-CSC PhD proposal - 2015

Thesis title: **Study of hard Multiple Parton Interactions in final states with photons and heavy flavors using the ALICE detector at the Large Hadron Collider**

Type of proposed PhD diploma: French□ Chinese x French & Chinese □ (tick correct answer)

French host laboratory: **LPSC - Grenoble**

Chinese laboratory (if applicable): **CCNU - Wuhan**

Thesis advisor(s) and email(s):

- Prof. Paolo Bartalini paolo.bartalini@cern.ch, CCNU – Wuhan

- Prof. Rachid Guernane guernane@lpsc.in2p3.fr, LPSC – Grenoble

- Prof. Ingo Schienbein schien@lpsc.in2p3.fr, LPSC – Grenoble

Planned date of start of stay in French lab: **as soon as possible**

Planned duration of stay in French lab (months): **12**

Expected date of thesis defense: **2017-2018**

Detailed description of the thesis subject: **In this study we focus on hard Multiple Parton Interactions (MPI), i.e. on processes with two or more separate hard scatterings in a single hadron-hadron or hadron-nucleus collision. The hard MPI may fake new physics or evidence of flow effects in dense matter, therefore its study is crucial to consolidate the knowledge of the corresponding relevant backgrounds. Investigating the hard MPI also provides a deep information on the hadronic structure of protons and nuclei. The study reported in this thesis constitutes a pilot project targeted on the data collected in the forthcoming RUN 2 that will deliver a much higher statistics compared to the former LHC runs. Further developments are foreseen at a later stage, the long term goal being to improve the knowledge of the initial state in hadron-hadron and hadron-nucleos interactions in particular for what concerns the MPI role.**

The hard MPI properties in proton-proton and proton-nucleus collisions are studied measuring the extra jet production in direct photon events at different centre of mass energies and at different energy scales of the two hardest partonic interactions. Selecting extra jets with heavy flavor tagging significantly reduces the background from Single Parton Interactions. In order to keep an acceptable statistics for the rather rare events with two or more hard interactions in the same hadron-hadron or hadron-nucleus interaction it is essential to select photon and jets slightly above the perturbative p_T threshold : this kinematic range turns out to be particularly well suited for the ALICE reach. Events with multiple quarkonia and multiple open charm or open beauty production are also investigated to further study the process- and energy scale- dependency of the MPI : here the unique ALICE particle identification features are also exploited.

The theoretical part of this research project mostly deals with the introduction of a new MPI model where the effective cross section is fully explicit. Accordingly, in a Monte Carlo implementation, the additional information can be represented by tuneable parameters achieving a direct indication on unknown properties of the hadron structure. The model is a natural basis for an extension to the case of proton-nucleus collisions, where the effects of MPI are sizably enhanced and which, due to the increased complexity of the target, allow access to even deeper properties of the non perturbative hadronic structure.

Candidates' requested qualifications: **young MSC with good curriculum studiorum, interested in an interdisciplinary PhD thesis in experimental/theoretical nuclear/particle physics.**

Tentative timeline of the PhD preparation: **3-4 years. The main task of the PhD student in 2015 will be to optimize the experimental methodologies in view of the RUN 2 data, in particular for what concerns the photon identification with the ALICE calorimeters (EMCal/DCal + PHOS), the heavy flavors identification with b-tagging algorithms and the exclusive reconstruction of b-hadron decays.**

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A significant amount of time will be invested in the development of the simulation tool mentioned in the TH part of the thesis description. Visiting the LPC – Grenoble laboratory will be essential to accomplish these two tasks that will be supervised by Prof. Guernane and Prof. Schienbein, respectively.

During the first twelve months the candidate will be based at CERN with regular visits to LPSC-Grenoble. Stationing at CERN will guarantee the continuous feedback of the relevant ALICE Physics Working Groups along with the supervision of Prof. Bartalini, who will advise on the MPI-related aspects of the thesis and will take care of editing the papers advertising the outcome of these studies.

In the future the candidate is expected to take a leading role in the continuous assessment of the ALICE physics reach for MPI processes both by the analysis of Run 2 data and detailed MC simulations in the context of the ALICE upgrade program which is also specifically dedicated to the high precision measurements of such rare probes at low p_T.

Publications related to the PhD subject:

P. Bartalini et al. **arXiv:1410.6664** and references therein ; F. Antinori et al. arXiv:1409.2981.