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Progress towards A Fixed-Target ExpeRiment at the LHC: AFTER@LHC

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If used in the fixed-target mode, the multi-TeV LHC beams will allow the most energetic fixed-target experiments ever performed, including studies of high precision pp, pd and pA collisions at sqrt(s_NN) ~ 115 GeV as well as Pb-p and PbA collisions at sqrt(s_NN) ~ 72 GeV. In particular, AFTER@LHC – for A Fixed-Target ExperRiment – can greatly complement [1] existing collider experiments, in particular that of Brookhaven's Relativistic Heavy Ion Collider (RHIC) and the proposed electron-ion colliders (EIC).
We thus discuss the conception of a multi-purpose fixed-target experiment with the proton or lead-ion LHC beams extracted by a bent crystal. This mature extraction technique, which is being studied as a smart collimator solution for the LHC [2], offers an ideal way to obtain a clean and very collimated high-energy beam, without altering the performance of the LHC [2-4].

We have shown that the instantaneous luminosity achievable with AFTER using typical targets would surpass that of RHIC by more than 3 orders of magnitude. This provides a quarkonium, prompt photon and heavy-flavour observatory [1, 5] in pp and pA collisions where, by instrumenting the target-rapidity region, gluon and heavy-quark distributions of the proton, the neutron and the nuclei can be accessed at large x and even at x larger than unity in the nuclear case. In addition, the fixed-target mode has the advantage to allow for spin measurements with a polarized target [6] and for access over the full backward rapidity domain up to x_F close to (-1) [7]. The nuclear target-species versatility provides a unique opportunity to study the nuclear matter versus the hot and dense matter formed in heavy-ion collisions. Modern detection technology will allow for the study of quarkonium excited states, in particular chi_c and chi_b resonances as well as exotic states such as the Z^c pentaquark and double-charmed baryons thanks to the boost of the fixed-target mode [8].

In this talk, we will also show the results of the first fast simulations based on a LHCb-like detector used in the fixed-target mode at LHC. We will also discuss the connection with existing and future data from the LHCb SMOG runs, which can be considered as a low-density internal gas target.

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