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Advancing the precision of proton-proton and proton-nucleus collision studies with A Fixed-Target ExpeRiment at the LHC (AFTER@LHC)

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We discuss the physics opportunities [1] which are offered by a next generation and multi-purpose fixed-target experiment exploiting the LHC beams. The multi-TeV LHC proton beam grants the most energetic fixed-target experiment ever performed, to study pp, pd and pA collisions at sqrt(s_NN) ~ 115 GeV. AFTER@LHC – for A Fixed-Target ExperRiment – gives access to new domains of particle and nuclear physics complementing that of collider experiments, in particular RHIC and the projects of electron-ion colliders.

With an internal (polarised) gas target or the "splitted" by a bent crystal, the typical instantaneous luminosity achievable with AFTER@LHC in pp and pA mode [1,2] surpasses that of RHIC by more than 3 orders of magnitude and is comparable to that of the LHC collider mode.

This provides a quarkonium, prompt photon and heavy-flavour observatory [1,3] in pp and pA collisions where, by instrumenting the target-rapidity region
or by using detectors such as LHCb and the ALICE muon arm, 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. 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. With a reduced background compared to the collider mode, this will allow for the study of quarkonium excited states, in particular the chi(c) and chi(b) resonances. This will allow one to study gluon TMDs as suggested for instance in [4]. The fixed-target mode also has the advantage to allow for spin measurements with polarised targets, for instance single transverse-spin asymmetries for Drell-Yan pair production [5-7]. We will review all these aspects and show our latest simulation results.

References

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