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ALICE Forward Calorimeter (FoCal): Physics program and performance

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The FoCal is a high-granularity forward calorimeter to be installed as an ALICE upgrade subsystem during the LHC Long Shutdown 3 and take data during the LHC Run 4.
It will cover a pseudorapidity interval of $3.4 < \eta < 5.8$, allowing to explore QCD at unprecedented low Bjorken-x of down to $\approx 10^{-6}$ – a regime where non-linear QCD dynamics are expected to be sizable.
It consists of a compact silicon-tungsten sampling electromagnetic calorimeter (FoCal-E) with pad and pixel longitudinal and transverse segmented readout layers to achieve high spatial resolution for discriminating between isolated photons and decay photon pairs. Its hadronic component (FoCal-H) is constructed from copper capillary tubes filled with scintillator fibers and used for isolation energy measurement and jets.

The FoCal detector extends the ALICE physics program with the capability, unique at the LHC, to investigate gluon Parton Distribution Functions (PDFs) in the low-x regime. This not only enables the study of non-linear QCD effects such as gluon saturation, but also allows to provide experimental constrains for (nuclear) PDFs in a region of phasespace where experimental data is scarce.The detector design allows carrying out these explorations using a multitude of probes, including direct photons, jets, as well as photo-production of vector mesons such as the J//psi in proton-Pb and Pb-Pb ultra-peripheral collisions.In addition, correlations of different probes can be studied, including gamma-jet, jet–jet and π^0–π^0 correlations.

In this presentation, we give an overview of the small-x physics program of the FoCal detector, as well as an overview of the expected performance of the detector for various observables. The latter is quantified using recent experimental results of ever-improving prototypes of the detector, which were operated at the Test Beam facilities of CERN in the years 2021–2023.
Furthermore, simulation studies are presented, which showcase the robustness of the detector design and its physics potential.

Category

Experiment

Collaboration (if applicable)

ALICE

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