Contribution ID: **102** Type: **Oral Presentation**

The W boson as a probe for the initial state of hadron collisions at the LHC

Thursday 10 July 2025 11:50 (20 minutes)

The charged vector boson ($W^{\pm}$) is produced in the hard partonic scattering of relativistic hadronic collisions, where its production cross-section can be calculated theoretically from perturbation theory and the relevant hadronic parton distribution functions (PDFs). Since it does not interact strongly and decays leptonically, the W boson serves as an ideal probe of the initial state of the collision - such as the contributing quark PDFs. In this presentation, the focus will be on the production of $W^{\pm}$ in the forward rapidity region of simulated relativistic proton-proton collisions, where the POWHEG and Pythia event generators are used to simulate the events of interest. The $W^{\pm}$ production is studied via the muonic decay channel as $W^{+} \rightarrow \mu^{+}\nu_{\mu}$ and $W^{-} \rightarrow \mu^{-}\bar{\nu}_{\mu}$, where the muon can be measured with the ALICE Muon Spectrometer in the forward rapidity region of $2.5 < y < 4.0$. The primary charged-particle multiplicity is introduced as an additional observable of interest to study the initial state - where the self-normalised W$\rightarrow \mu$ production as a function of the self-normalised multiplicity is defined and studied specifically. It is demonstrated that the study in proton-proton collisions can serve as a meaningful baseline measurement for other hadronic collision systems, where an outlook is presented to do the same study in proton-lead and lead-lead collisions with Run 3 data from ALICE.

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Session Classification: Nuclear, Particle and Radiation Physics-2

Track Classification: Track B - Nuclear, Particle and Radiation Physics