EXTRACTING DIFFRACTIVE PROTONS AND BACKGROUND ANALYSIS FROM ATLAS FORWARD PROTON DETECTORS

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The ATLAS experiment at CERN utilizes high-energy collisions between protons to investigate fundamental particles and forces. In certain processes, the so-called "diffractive interactions", the LHC protons may collide in a very unique manner and remain intact. They preserve their original state and scatter at extremely small angles (a few hundred microradians) before continuing their trajectory into the LHC beampipe [1]. To measure these protons, a set of ATLAS Forward Protons Detectors (Fig. 1, Left) are located around 210 meters away from the ATLAS. By studying the collisions with the forward proton scattering, scientists can gain insights into the underlying nature of diffraction, enhancing our comprehension of the sub-atomic scale, potentially unveiling new particles or forces beyond the Standard Model.

The signal recorded by the AFP detectors contains multiple components. Alongside the diffractive proton, there are additional contributions in the recorded data, including particles generated by the interaction of the diffractive proton with the beampipe and beam instrumentation along the ATLAS Interaction Point-detector path, the signal originating from the primary beam, and particle showers generated by the forward proton when it interacts with the AFP detector components (Fig. 1, Right). Extracting the proton signal involves extensive analysis of background sources in terms of their origin, multiplicity or spatial distribution and implementation of methods that will lead to the identification of the background in the data. An analysis was carried out both for Monte Carlo simulation and experimental data from AFP detectors collected during LHC run in 2022.

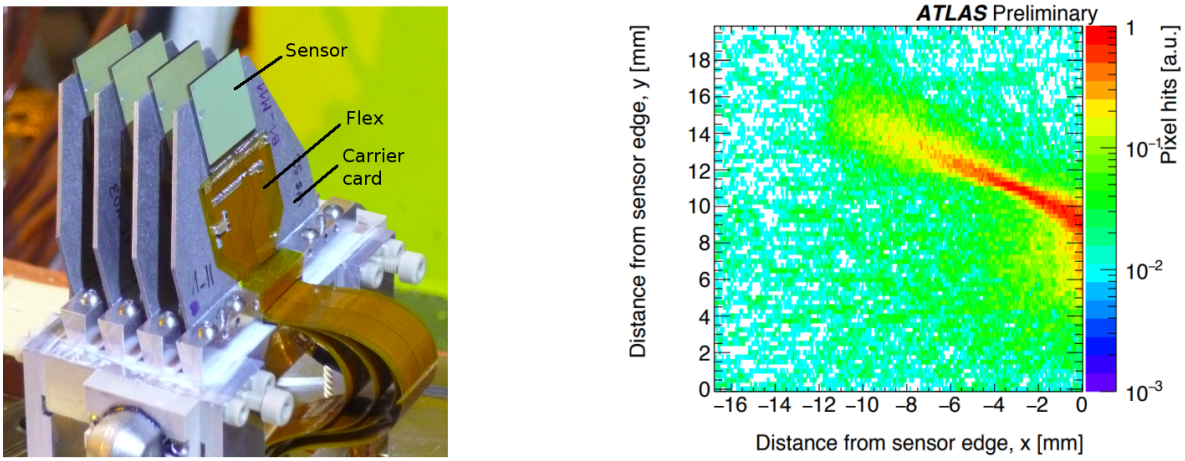

Fig. 1. **Left:** The AFP detector [2]. **Right:** Normalized pixel hit-maps in one of the AFP detector. The diagonal pattern corresponds to the detected diffractive proton [3].

[1] Maciej Lewicki, Overview of ATLAS Forward Proton detectors for LHC Run 3 and plans for the HL-LHC
[2] S. Grinstein et.al., Module production of the one-arm AFP 3D pixel tracker. JINST, 12(01):C01086, 2017. Comments: PIXEL 2016 proceedings; Submitted to JINST
[3] Paula Agnieszka Erland. ATLAS Forward Proton detectors status and plans. Status of AFP. Technical report, CERN, Geneva, 2019.