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The ATLAS Forward Proton Time-of-Flight detector: results, experiences and plans

The Time-of-Flight (ToF) detectors of the ATLAS Forward Proton (AFP) system are designed to measure the primary vertex z -position of the $pp \rightarrow pXp$ processes by comparing the arrival times measured in the ToF of the two intact protons in the final state. We present the results obtained from a performance study of the AFP ToF detector operation in 2017 and discuss plans for LHC Run 3 as well as for an eventual future upgrade of the ToF detectors.

In 2017, time resolutions of individual channels ranging between 20 ps and 40 ps were extracted. Even though the AFP ToF efficiency is below 10%, the overall time resolution of each ToF detector is found to be $20(26) \pm 4(5)$ ps for side A(C). This represents a superb time resolution for a detector operating at few millimeters from the LHC beams.

Events from ATLAS physics runs at moderate pile-up taken at the end of 2017 are selected with signals in ToF stations at both sides of ATLAS. The difference of the primary vertex z -position measured by ATLAS and the value obtained by the AFP ToFs is studied. The distribution of the time difference constitutes of a background component from combinatorics due to non-negligible pile-up, and significantly narrower signal component from events where protons from the same interaction are detected in ToF. The fits performed to the distribution of the reconstructed time difference yield the vertex position resolution (of about 6 mm \pm 1 mm at best) that is in agreement with the expectation based on single-ToF channel resolutions.

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