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Parameterization-based tracking for the P2 experiment.

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The P2 experiment in Mainz (Germany) aims to determine the weak mixing angle at low momentum transfer with an unprecedented precision. The approach of P2 is to measure the parity-violating asymmetry of elastic electron-proton scattering, from which the weak charge of the proton, and so the weak mixing angle can be evaluated.

In P2, an electron beam (150 µA, 155 MeV/c^2) of alternating polarization will be scattered on a 60 cm long liquid H_2 target, and the total current of the elastically scattered electrons will be measured with a fused silica Cherenkov detector. A tracking system is necessary to measure the momentum transfer distribution of the elastically scattered electrons, to validate the simulated acceptance of the Cherenkov detector, and to get a control over other systematic uncertainties. Although the tracking system is not required to work at the full beam rate, every attempt is made to achieve the highest possible rate capability.

The tracking system will consist of 4 layers of high-voltage monolithic active pixel sensors (HV-MAPS), with 80 x 80 µm^2 pixel size, time resolution about 10 ns, and rate capability about 30 MHz/cm^2 (DAQ-limited).

At the full beam rate every reconstruction frame (45 ns long) will contain around 800 signal tracks, and 16 000 background hits from Bremsstrahlung photons. In order to cope with the extreme combinatorial background on-line, a parameterization-based tracking is developed.

Performance evaluations on simulated data show that the parameterization-based tracking requires to fit not more than 2 track candidates per one signal track at the full beam rate (whereas a simple implementation of track following requires to fit more than 100 candidates per signal track already at 2% of the full beam intensity). Moreover, the parameterization-based approach enables to replace the computation-heavy rigorous fit in the inhomogeneous field by an evaluation of a 3-rd order polynomial in a 3-dimensional space, with a negligible loss in accuracy.

The implementation, as well as the performance evaluations of the parameterization-based tracking will be presented.

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