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The MuPix Monolithic Active Pixel Sensor for the Mu3e Experiment

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Mu3e is a novel experiment searching for charged lepton flavor violation in the rare decay $\mu \rightarrow eee$. In order to reject both combinatorial and physics background, decay vertex position, decay time and particle momenta have to be precisely measured. A pixel tracker based on 50 μm thin high voltage monolithic active pixel sensors (HV-MAPS) in a magnetic field will deliver precise vertex and momentum information. Test beam results obtained with the MuPix HV-MAPS chip developed for the Mu3e pixel tracker will be presented.

Summary

The MuPix monolithic active pixel sensor for the Mu3e experiment

The Mu3e experiment searches for charged lepton flavor violation in the rare decay $\mu \rightarrow eee$. Since the decay $\mu \rightarrow eee$ is extremely suppressed in the standard model with $\text{BR} < 10^{-54}$ any observation would be a clear sign of new physics. In order to measure or exclude this decay with a sensitivity of better than 10^{-16} , more than 10^9 muons/s have to be observed for several running years. The background for this measurements is either combinatorial or stems from the radiative decay $\mu \rightarrow eee\nu\nu$. In order to reject background, decay vertex position, decay time and particle momenta have to be precisely measured. The high vertex and momentum resolution is achieved with the help of a novel pixel tracker based on high voltage monolithic active pixel sensors (HV-MAPS) thinned to 50 μm which is operated in a magnetic field of 1T. The HV-MAPS chips developed for the Mu3e experiment, the MuPix chips, combine good analog performance with built in digital readout electronics.

In this presentation results from the development of the MuPix ASIC will be shown. The latest MuPix prototypes combine pixels of 80 $\mu\text{m} \times 103 \mu\text{m}$ size, two stage charge sensitive amplifiers and digital readout logic for hit arbitration. Measurements from test beam campaigns both at DESY and PSI will be presented. These measurements give evidence of very good detection efficiency well above 99%, a signal to noise ratio of above 20, good spatial resolution and sub 20 ns time resolution for single pixel hits. High rate tests have shown that the MuPix chip can be read out at event rates of over one MHz.

An outlook will describe the roadmap to a full-size 1x2 cm^2 prototype with full zero suppression and high speed serial data outputs.

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