A fast region of interest trigger and timing layer for the EUDET Telescopes


Test beams are essential for detector R&D to test developments as close as possible to a final experiment. Tracking telescopes are used as a reference system in time and space to pinpoint a particle’s trajectory enabling studies on devices under test. The DESY II test beam [0] areas provide multiple 10 kHz particle rate and are equipped with three EUDET-style telescopes [1], based on MIMOSA26 sensors [2]. They provide excellent spatial resolution, but up to 230 µs integration time, leading to events with multiple track per trigger. These ambiguities can be resolved with a trigger and timing layer. An HV-MAPS based layer with region of interest trigger with <50 ns delay and a jitter < 5 ns is proposed, studied and qualified for the usage at the DESY’II test beam.

TelePix prototype has shown, that it is capable to fulfill all requirements to serve as a fast timing and ROI trigger plane for the DESY telescopes. Compared to previous sensors, the signal amplitude has greatly improved and wide operational regions with efficiencies above 99 % are observed. In the process unprecedented time resolutions below 3 ns have been determined. A full scale sensor is above 99 % are observed. In the process unprecedented time resolution, but to 230 µs integration time, leading to events with multiple track per trigger. These ambiguities can be resolved with a trigger and timing layer. An HV-MAPS based layer with region of interest trigger with <50 ns delay and a jitter < 5 ns is proposed, studied and qualified for the usage at the DESY’II test beam.

Conclusions and Outlook

The TelePix prototype has shown, that it is capable to fulfill all requirements to serve as a fast timing and ROI trigger plane for the DESY telescopes. Compared to previous sensors, the signal amplitude has greatly improved and wide operational regions with efficiencies above 99 % are observed. In the process unprecedented time resolutions below 3 ns have been determined. A full scale sensor is already submitted, expected back later this year and will be put in user operation in the coming 12 months.

References and Contacts


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Test Beam Measurements

• Studied with a 4 GeV electron beam at DESY II, data reconstruction with Corryvreckan [4]
• Efficiencies of > 99.9 % at ~ 0.01 Hz noise (~2.5e-10 per bunch crossing at 40MHz)
• Efficiency decreases first in corners due to charge sharing
• Clear difference in the pixel designs visible, mainly in the efficiency plateau size. Time/spatial resolution, cluster size similar
• Time resolution of ~2.4 ns determined

Region of Interest Trigger

• Measured response of the fast hit OR for a full column of Run2020 NMOS
• 4 GeV electrons as MIP signal source
• Delay/ Jitter with respect to trigger scintillator for three bias voltages
• Reaching an absolute delay of below 22 ns and a jitter below 3.8 ns at thresholds without fake hits

Injection based analog characterisation

• Injecting fixed charge (400mV/8µs) into pixel cell
• Testing response on oscilloscope for different thresholds
• Extracting s-curve to determine average signal and noise
• Superior performance of Run2020-NMOS amplifier at used settings

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