Contribution ID: **119** Type: **Poster**

Novel Si-Sensor technology for high resolution and high repetition-rate experiments at accelerator facilities

Thursday, 20 September 2018 18:00 (15 minutes)

Linear array detectors with high spatial resolution and MHz frame-rates are essential for high-rate experiments at accelerator facilities. We have developed KALYPSO, a line array detector with 1024 pixels operating at 10 Mfps. To improve the spatial resolution and sensitivity at different wavelengths, novel Si microstrip sensors have been developed with a pitch of 25 µm. Furthermore, to enable measurements of the beam profile with a repetition time of 2 ns, a sensor based on Low Gain Avalanche Detector (LGAD) coupled with a SiGe readout is under development. The detector system and the characterization of the sensors will be presented.

Summary

KALYPSO is a linear array detector system developed for high-rate experiments at synchrotron light sources and accelerator facilities. The detector system is now employed in different experiments requiring high-resolution, single-shot measurements at MHz rates and different wavelengths.

The detector consists of a linear array sensor connected to a readout ASIC through high-density wire-bonding interconnections. Novel Si micro-strip sensors with a pitch down to 25 µm have been designed at KIT and fabricated by Fondazione Bruno Kessler (FBK). To optimize the sensitivity of the detector at different wavelengths namely the visible, near infra-red (NIR) and near ultra-violet (NUV), different anti-reflective coating (ARC) layers have been applied to the sensor. The present version of KALYPSO consists of a Si sensor with 1024 pixels connected to eight GOTTHARD ASIC readouts, four on each side of the sensor. The outputs of the GOTTHARD readouts are divided among two ADC's.

However, traditional Si micro-strip sensors having a charge collection time of approximately 15 ns limits single-shot measurements at higher frame-rates (repetition time of 2 ns). Hence, novel microstrip detectors with fast charge collection are required. Therefore, we propose to employ a thinned LGAD for ultra-high rate imaging applications. The proposed sensor offers a moderate internal signal multiplication while maintaining a low shot noise contribution. TCAD simulations show that it is possible to have a charge collection time of a few ns.

The detector system with the novel sensors will be commissioned at KARA (Karlsruhe Research Accelerator) in 2018 and subsequently, at other facilities. In this contribution we present the performance of the detector system with the new sensors and the ongoing technical developments.

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Session Classification: Posters

Track Classification: Systems, Planning, Installation, Commissioning and Running Experience