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TDCpix - Pixel Read-out ASIC with 100 ps Time-tagging Capability for the NA62 Gigatracker Experiment

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Abstract

The TDCpix is a pixel readout ASIC designed for the NA62 Gigatracker detector at the CERN Super Proton Synchrotron. Each of the three hybrid pixel Gigatracker detector stations provides tracking and time stamping of individual particles with a time resolution of 200 ps rms. The TDCpix features 45×40 square pixels of $300 \times 300 \mu\text{m}^2$ and a peripheral region including an array of 720 TDC channels providing a time binning of 100 ps. This contribution will describe the complete design, test results and integration of the TDCpix ASIC.

Summary

The TDCpix is a pixel readout ASIC designed for the NA62 Gigatracker detector at the CERN Super Proton Synchrotron. Each of the three Gigatracker detector stations, directly placed in the beam vacuum, provides on-beam tracking and time stamping of individual particles with a time resolution of 200 ps rms. The peak flux of particles crossing the detector modules reaches 1.27 MHz/mm^2 for a total rate of about 0.75 GHz. Ten TDCpix chips will be bump-bonded to every silicon pixel sensor. The TDCpix chip has been designed in a 130 nm CMOS technology and features 45×40 square pixels of $300 \times 300 \mu\text{m}^2$. In pixel time-over-threshold discriminators are used to compensate the time walk due to the sensor signal rise time being slow compared to the required timing precision. An array of 720 TDC channels in the ASIC periphery records the signal arrival time and pulse width. The read-out of the ASIC works trigger-less, sending all registered hits on four high speed serializers with a maximum bandwidth of 12.8 Gbit/s or 210 Mhits/s.

This contribution will describe the complete design, test results and integration of the TDCpix ASIC. The test results demonstrate the key performance figures such as a time resolution of the front-end ASIC processing chain of less than 100 ps rms and the capability of time stamping charged particles with planar silicon sensors with an overall resolution below 200 ps rms.

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