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TelePix2: A HVCMOS pixel sensor for Fast Timing and Region of Interest Triggering

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The DESY II Test Beam Facility offers electrons with a user selectable momentum ranging from 1-6 GeV alongside beam telescopes as precise reference tracking systems. Whilst providing a very high spatial resolution, they provide no timestamps for individual hits within the readout frame. The length of this readout frame means the telescopes frequently read out hits from multiple electrons together, without an additional segmented timing layer, it becomes impossible to assign tracks to specific triggers. Additionally a size mismatch between the trigger of the telescope and the test device leads to inefficient data taking. To overcome this, a configurable region of interest trigger is needed.

TelePix2 is a High Voltage Monolithic Active Pixel Sensor (HV-MAPS); it provides both fast timing with a timestamp of 4 ns and a fast digital single ended trigger output with a configurable region of interest down to the level of individual pixels.

The sensor, implemented in the 180 nm HV-CMOS process of TSI, has a pixel matrix of 120 columns by 400 rows with a pixel size of 165 x 25 μm leading to an active area of size 19.8 x 10 mm^2. Both an amplifier and comparator are housed within the pixel electrode. Three tune bits can be set on a per pixel basis to apply an offset to the comparator threshold for trimming purposes. The range of the offset these tune bits apply is controlled by a separate global DAC parameter.

The discriminated hit signal is transferred to the periphery. Here timestamps are assigned to the rising and falling edge, allowing for offline timewalk and delay corrections. The readout of hits is executed in a data driven column drain scheme via a 1.25 GBit/s link. The DAQ of TelePix2 is based on the HV-MAPS DAQ developed in Heidelberg and is fully integrated with EUDAQ2 and the AIDA-TLU.

Here, characterisation results of TelePix2 are presented based on the latest test beam measurements. A time resolution, without additional corrections for time-walk and pixel to pixel fluctuations, below 4 ns was found at an efficiency above 99% at a depletion voltage of -85 V. The time resolution of the trigger output from TelePix2 is around 2.5 ns. TelePix2 is utilised by users successfully and is currently transitioning to regular user infrastructure at the DESY II Test Beam Facility.

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