Karlsruhe Institute of Technology

KIT ASIC and Detector Laboratory

Characterization Results of HVCMOS Sensor for ATLAS

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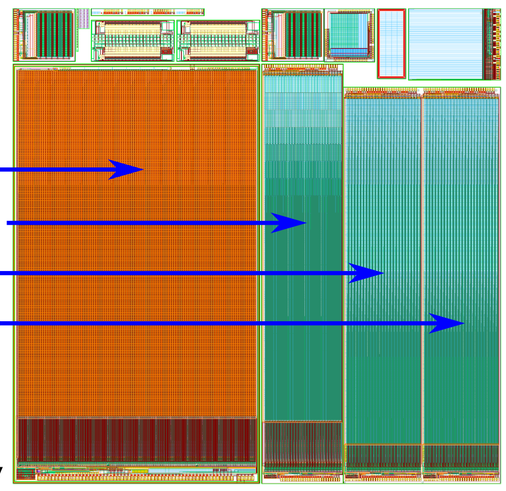
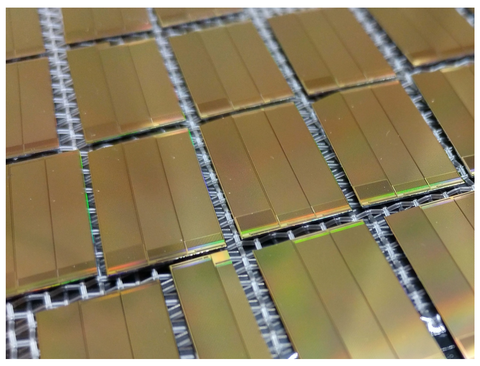
Submission Overview

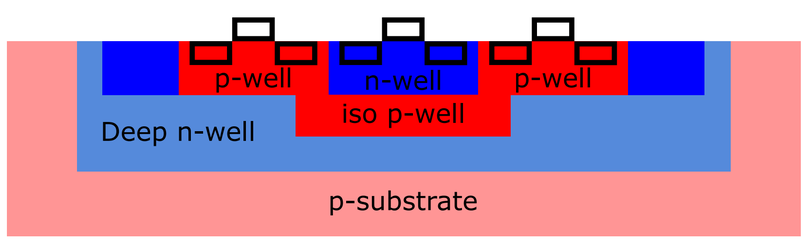
- AMS aH18 (HVCMOS 180 nm)
- Substrate with different resistivities: 20, 80, 300, 1000 Ωcm
- Radiation tolerant design
- MuPix8 (Poster A. Weber)
- ATLASpix_M2 (Poster M. Prathapan)
- ATLASpix_Simple 1
- ATLASpix_Simple 2 (isolated PMOS)
- Smaller chips:
  CCPD1 (FEI4), Switcher (Belle II), CCPD2 (RD53), HPixel (microscope), Clic sensor, teststructures



ATLASpix_Simple 1 & 2

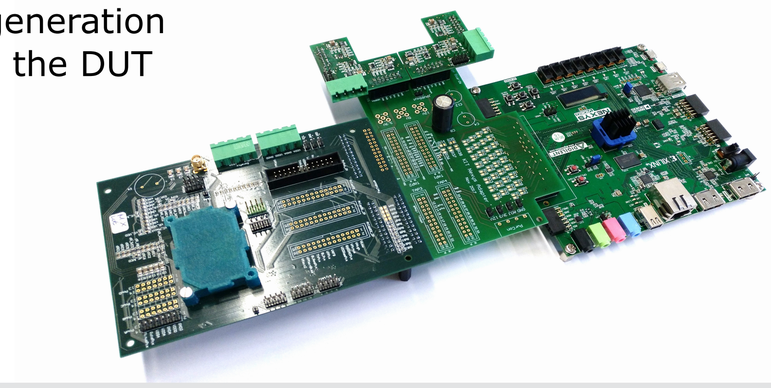
- Matrix size: ~0.3 cm x 2 cm
- 25 x 400 pixels
- Pixel size: 130 µm x 40 µm
- Amplifier in pixel
- 1-to-1 connection to digital periphery
- Triggerless column drain readout
- Timestamp: 10 bit
- Secondary timestamp: 6 bit for time over threshold (ToT) measurement
- One readout link per matrix
- Debug outputs: Amplifier Output, HitBus
- Isolated PMOS option:
  n-wells containing PMOS transistors are isolated from deep n-well by 'iso-p-well'





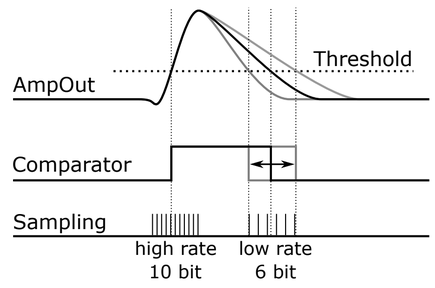
The Measurement Setup

- NexysVideo FPGA Board (Artix 7)
- Multipurpose Adapter Board (MAB)
- Daughter boards for voltage and test signal generation
- Carrier PCB with the DUT



Novel ToT Measurement

- Adaptive sampling rate
- Rising edge: low jitter, high sample rate with 10 bit precision
- Falling edge: high jitter, low sample rate with 6 bit precision
- Improved resolution at same data size

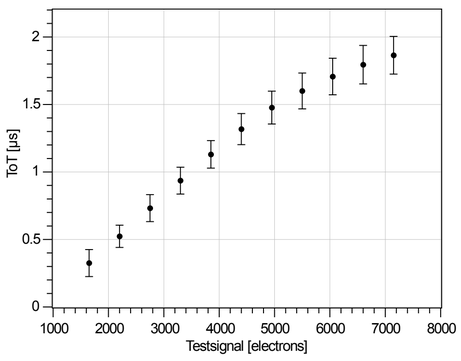


Measurements

- Fully monolithic measurement
- 800 MHz operational speed
- 200-400 Ωcm resistivitiy

Linearity test

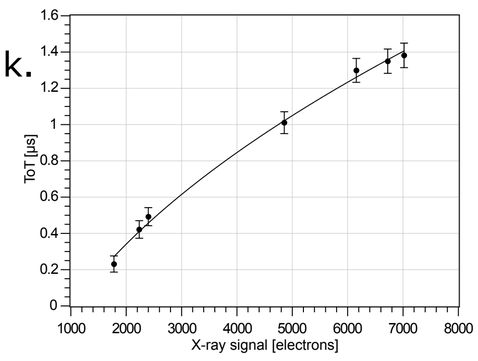
- Testsignal injections to obtain ToT over signal height characteristics. ToT shows a square root behavior. It can be used to correct for time walk.



X-ray calibration

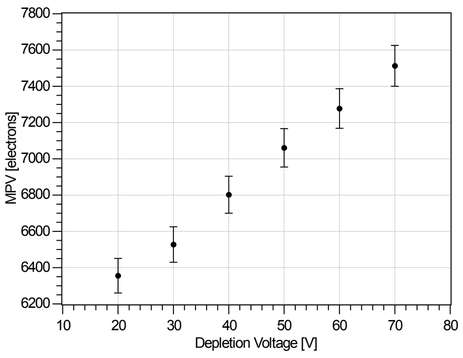
- ToT measurement by X-ray fluorescence

Element	#e⁻ in Si
Fe	1778
Cu	2235
Zn	2399
Mo	4855
Ag	6156
In	6724
Sn	7018



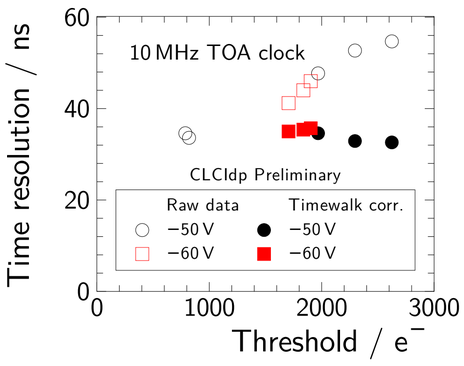
Minimum Ionizing Particle (^{90}Sr)

- The MPV (ToT) of MIPs is measured as a function of the depletion voltage. At 70V the signal is 7500e.
- This means an increase of ~60% compared to a sensor with 80 Ωcm



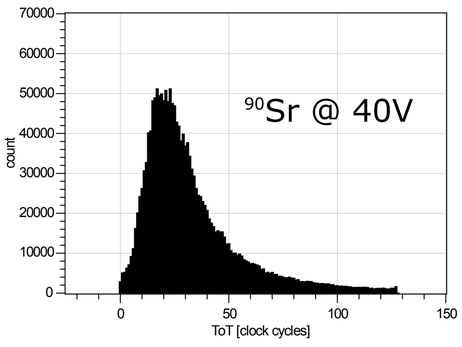
Testbeam results

- In 2017 a beam test at SPS (CERN) was conducted.
- Efficiency of 99.5% was measured.
- Time resolution of 45 ns sigma before and 33 ns after time walk correction using ToT. Time resolution limited by clock speed (100 ns). Thereby the theoretical limit is 28.9 ns.



Conclusion & Outlook

- The sensors work as expected.
- The measured efficiency is >99%.
- ToT can be used to compensate for the time walk.
- Time walk measurements on a sensor at full speed of operation using precision laser pulses is planned.



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