

ROI Trigger plane

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Overview



- Motivation
- ROI Trigger plane
- Commissioning of ROI trigger plane integration to AIDA telescope with DEPFET DUT

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The trigger is a coincidence of the two scintillators.



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For prototype studies a DUT is placed in the middle ^N to measure its properties.



Frame time $2*115\mu s \rightarrow Maximum rate < 5 kHz$

 \rightarrow For small DUTs – compared to the acceptance - many empty events are recorded. \rightarrow To speed up the DAQ a more efficient trigger is needed.

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Example estimation of time needed to acquire 5 million events with a hit in the DUT

- Trigger rate 5 kHz → 15 minutes for 5 million triggers
- Area of DUT 1/20 of telescope acceptance → 5 h



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New trigger system using a FE-I4 reference plane instead of a scintillator

→possibility to choose a Region of Interest (ROI)



\rightarrow ROI leads to a more efficient data acquisition.

The FE-I4 reference plane



Sensor: planar or 3D silicon pixel \geq

- 200 μ m thick \rightarrow Signal of \sim 16 ke for MIPs
- Full depletion at 60 V \rightarrow charge collection by drift
- Mature technology used in ATLAS Pixel Detector
- Readout ASIC: FE-I4 A or FE-I4 B
 - Pixel size: 50 x 250 µm² ٠
 - Pixel matrix: 80 columns x 336 rows
 - Active area: 16.8 mm x 20 mm
 - Configurable wired Or over discriminator output of full matrix \rightarrow HitOr
- Hybrid Pixel Detector
 - Sensor bump-bonded to FE-I4(A/B)
 - Noise ~150 e^- @ a detection threshold of 3000 e^-
 - Will be used for the fourth pixel layer of ATLAS Pixel (IBL)
- Support and Operation
 - Glued and wirebonded to a single chip card
 - USBPix System used for configuration (STControl or PyBar)



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HitOr signal generation in FE-I4



Charge sensitve **Pixel Circuitry** preamplifier Constant (adjustable) current Injection feedback pre-amp circuit Discriminator time pixel C, Discriminator with adjustable address stamp Cp threshold memory Circuitry to measure Time over ٠ digital read-out part Threshold Bump-Pad Analog and digital injection points ٠ HitOr for calibration VDD Column 0 Column 1 Matrix circuitry HitOr,pixel 1 Each pixels discrimator output is or-ed together HitOr, pixel 2 > HitOr Is high if one of the activated pixels sees a hit (low otherwise) Length adjustable with threshold ٠ Cols 2.3 Cols 4.5 and feedback current overall HitOr VDD

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Region of interest (ROI)

universität**bonn**

FE-I4s HitOr signal is an advantageous trigger signal

- ➤ Fast: pixel and matrix circuitry designed for LHC → 25 ns time stamping
- Programmable sensitive region (ROI)
- Easily integrated into existing AIDA framework
 - Treat ROI trigger signal as if scintillator signal
 - No additional software development needed





Trigger mask

Trigger scheme of EUDAQ: status of TLU





Remember: For scintillators the threshold needs to be negative!

Integration test with DEPFET DUT



Motivation: Explore the possibility of increasing the track efficiency of a small DUT by using the ROI trigger.





Trigger on coincidence of first scintillator and HitOr

Setting up the ROI



1.Step: align FE-I4 trigger plane with laser system to AIDA telescope



2.Step: take data and align more precise using correlation plots of online monitor



3.Step: select ROI and check iteratively if track efficiency increases/decreases

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Results from DAQ with DEPFET triggerd by ROI





- ightarrow ROI extended and overlapping the DEPFET area
- → More than 80% DAQ efficiency observed
- → Compared to the standard trigger configuration where 20% are reached the ROI trigger leads to an increase in DAQ efficiency of a factor 4
- ightarrow This made **in pixel** studies with the DEPFET possible

Arbitrary ROI shapes are possible



ROI Trigger mask as selected by FE-I4 reference plane





Sr 90 source test

Hitmap of DEPFET triggered by FE-I4 trigger plane









Last beam test campaign with two HV-HR-CMOS prototypes





Summary



- HitOr can be used as Trigger for the AIDA Telescope
 - Fast signal taken from FE-I4
 - Programmable region of interest to match the DUT area
- Integration of the ROI Trigger into AIDA framework
- Comissioning done with DEPFET in the 2012 beam test campaign
- ROI was used by Bonn group in 2014 beam tests
- Developments and testing towards a quad module ROI ongoing



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