DESY Summer Student 2013

ATLAS FE-I4(A) Pixel Module as Trigger Plane for Beam Test Telescope

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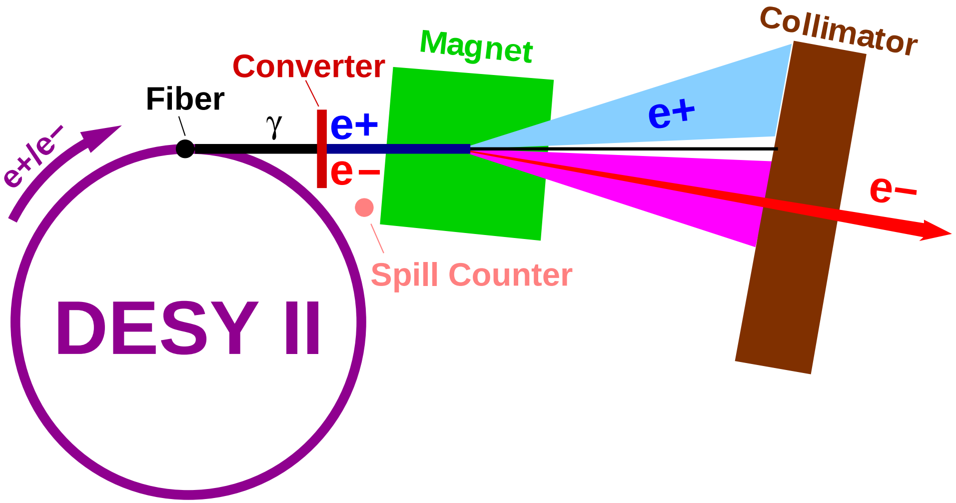
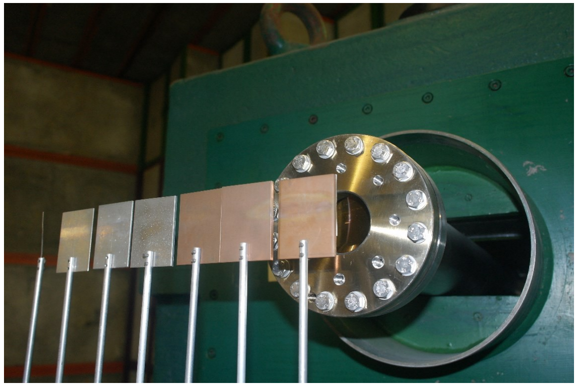
Summer Student Presentation
DESY Summer School 2013

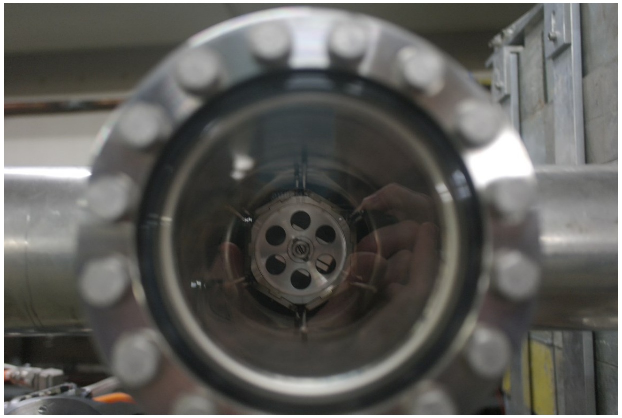
HELMHOLTZ ASSOCIATION | ATLAS EXPERIMENT | GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN | DESY

The Testbeam

- Electrons/Positrons shot onto carbon fibre
  - Bremsstrahlung
- Hits converter (Al/Cu)
  - Pair production
- Magnet fans out energy
- Lead Collimator
  - Energy selection

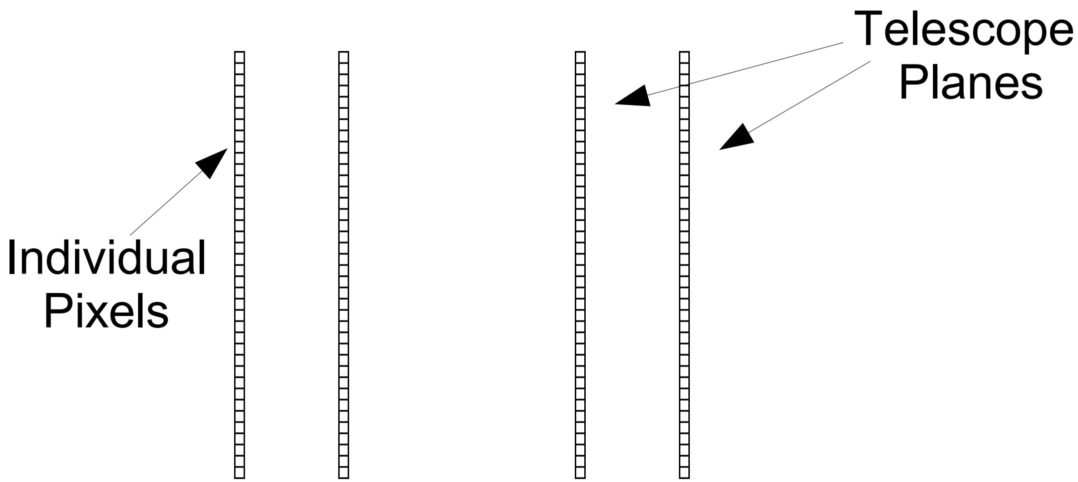






More on the energy selection in Paul Schütze's talk!

The Telescope – The Idea



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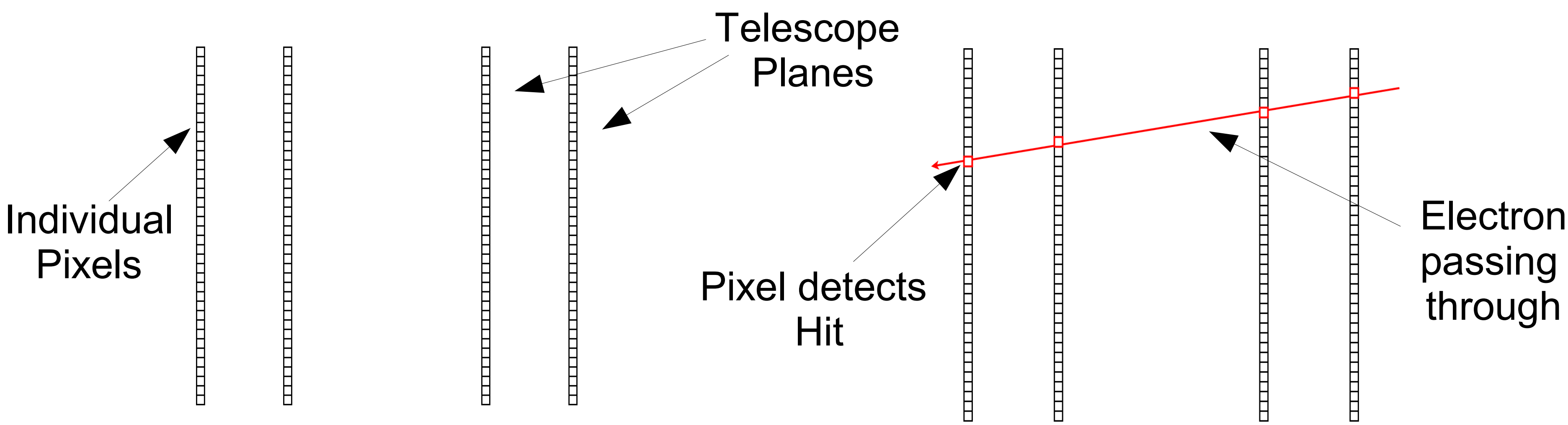

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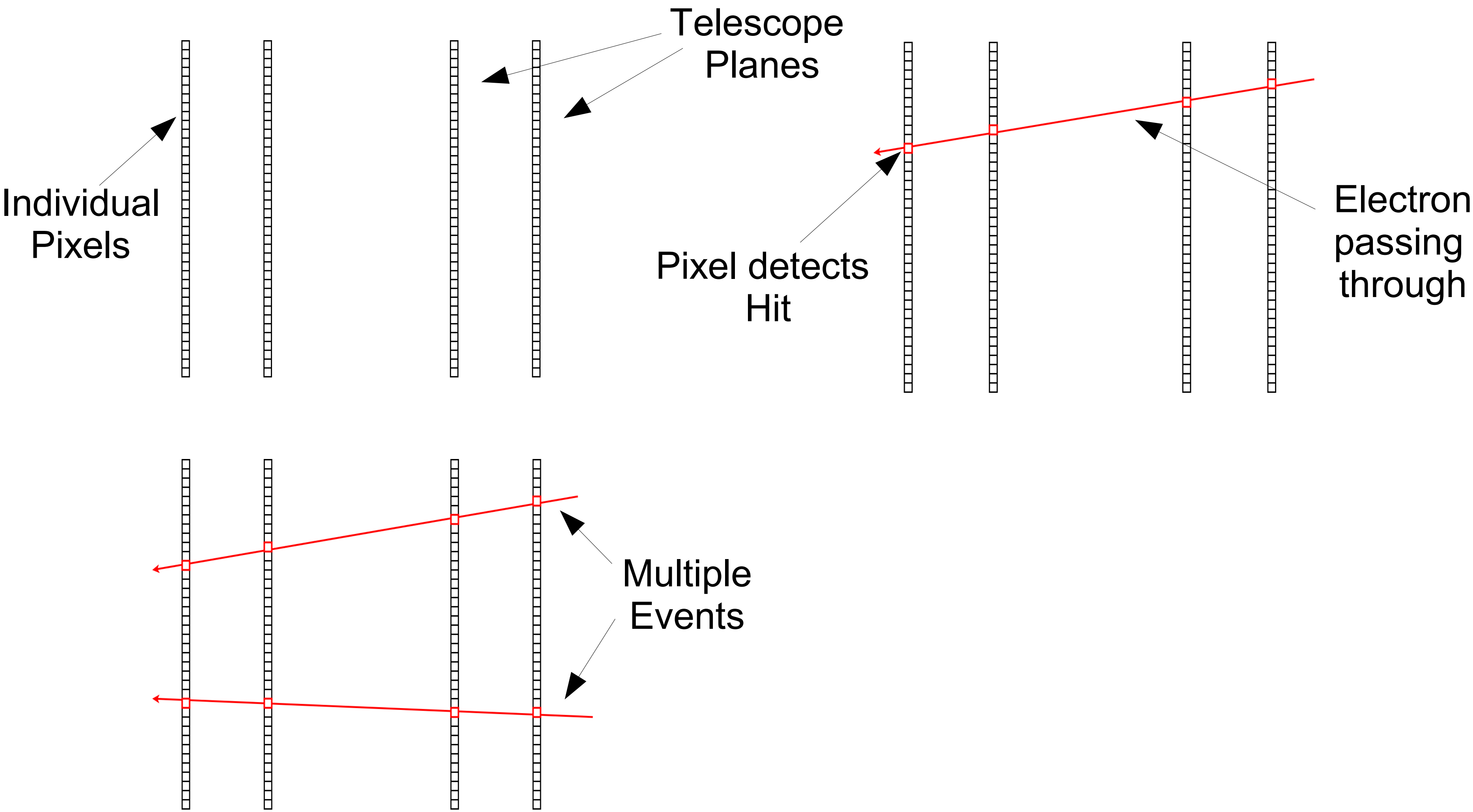
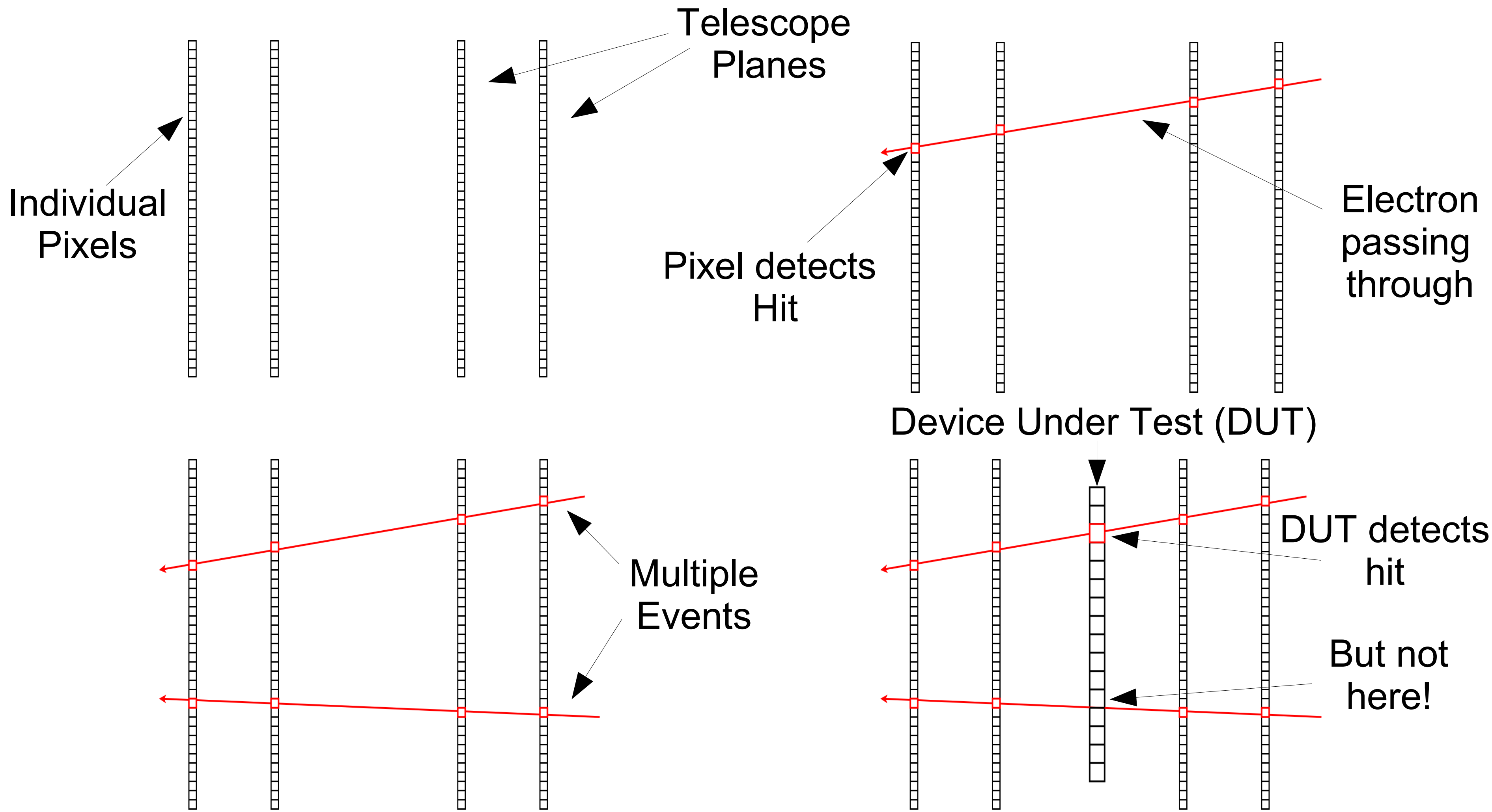
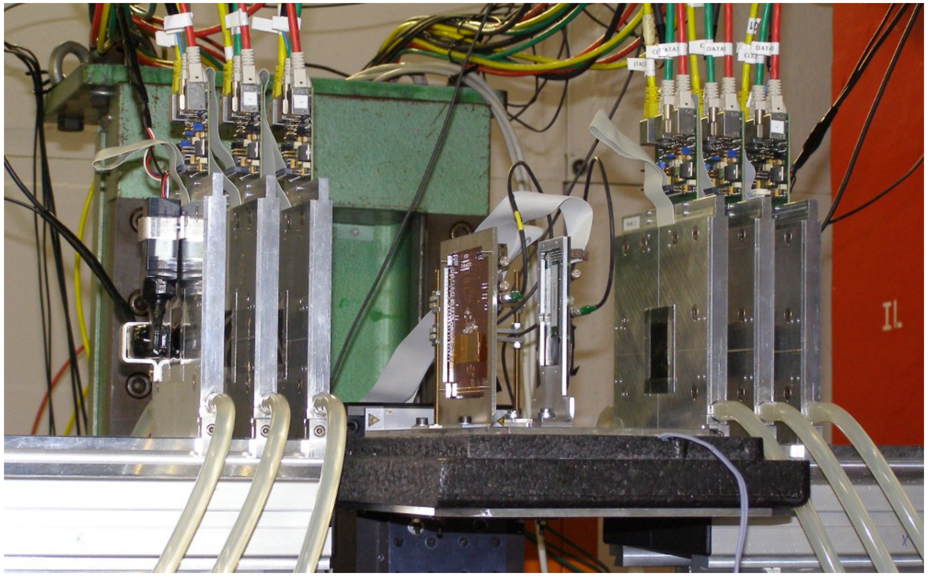


The Telescope – The Idea



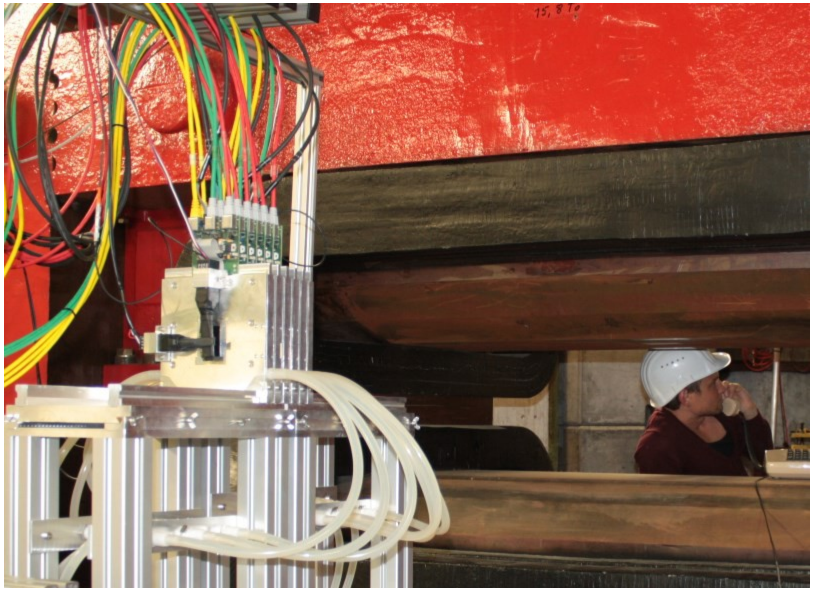
The Telescope – The Realisation

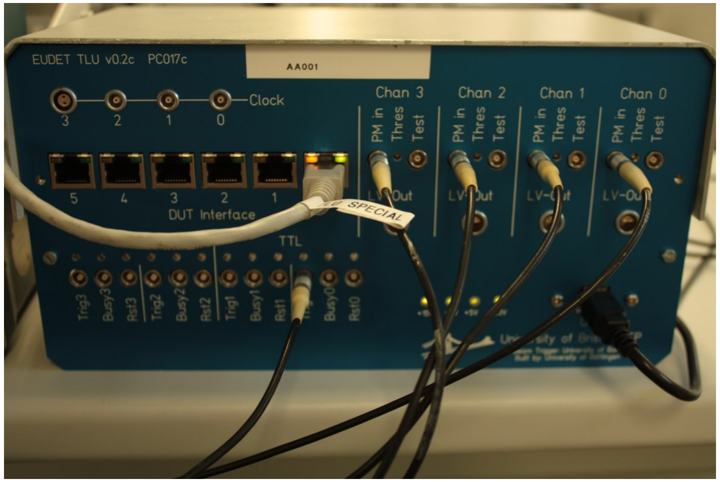
- Use Mimosa26 in the telescope planes
- They feature a very small pitch of only 18.4 µm in both directions
- Relative slow read-out of 115.2 µs (rolling shutter)
- 576 x 1152 pixels featuring roughly 1 x 2 cm² active area



DAQ-Overview: Triggering

- Make snapshots - only when particles cross
  - Only when particles from the beam cross – coincidence triggers!
- Use scintillators for detection
  - Up- and down-stream of the telescope planes
- Hardware to read out: Trigger Logic Unit (TLU)
  - Triggers on falling slope due to photomultiplier (PM) signal

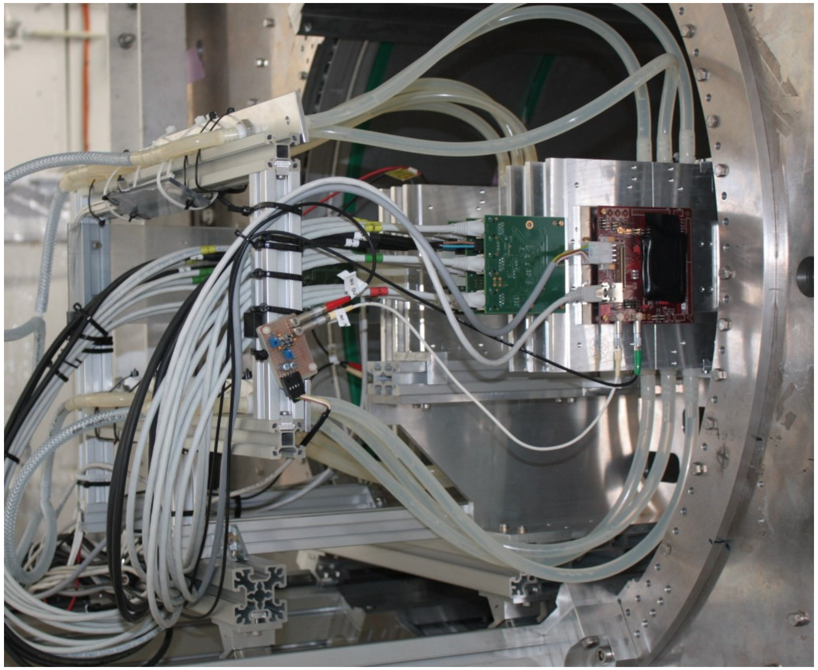


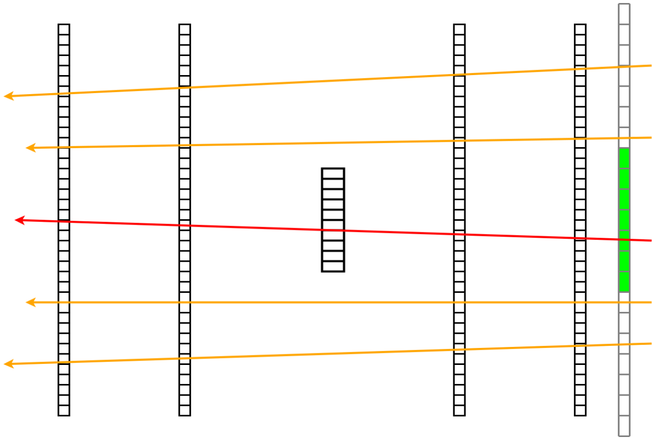


From PMTs to Trigger Plane

We want to replace the scintillators with ATLAS pixel detector:

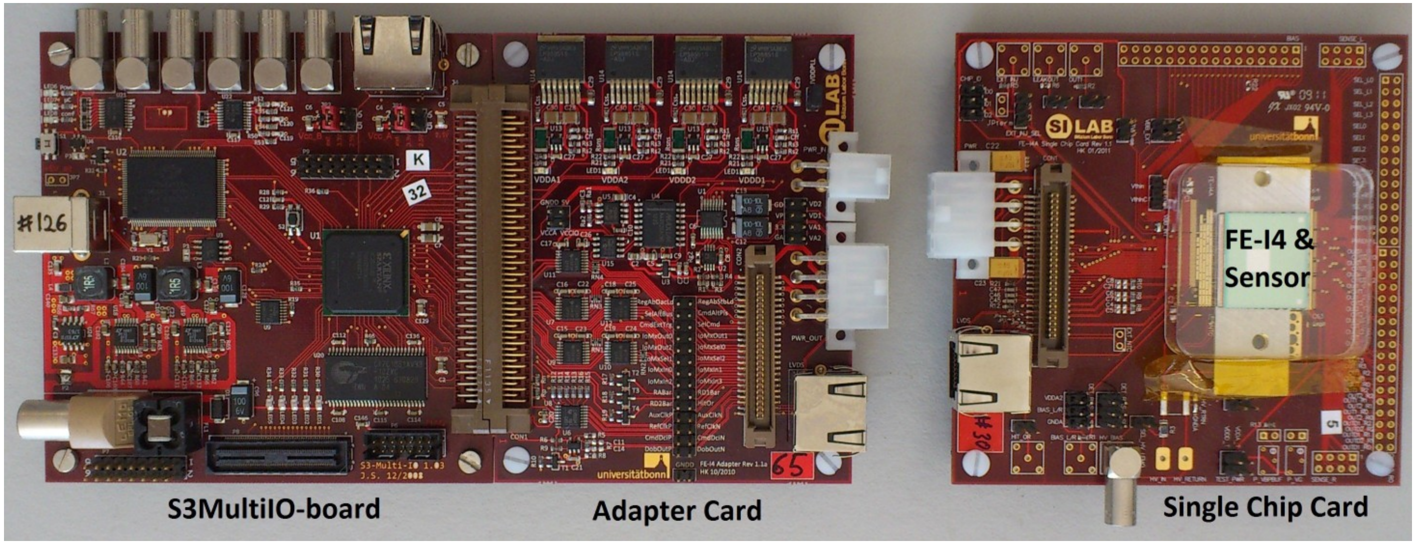
- This allows to select a flexible triggering area
  - Useful if device under test (DUT) is small
- They can be used in a magnetic field
  - Until now this was only possible with (fragile) silicon PMs with scintillators
- Additionally we have timing information





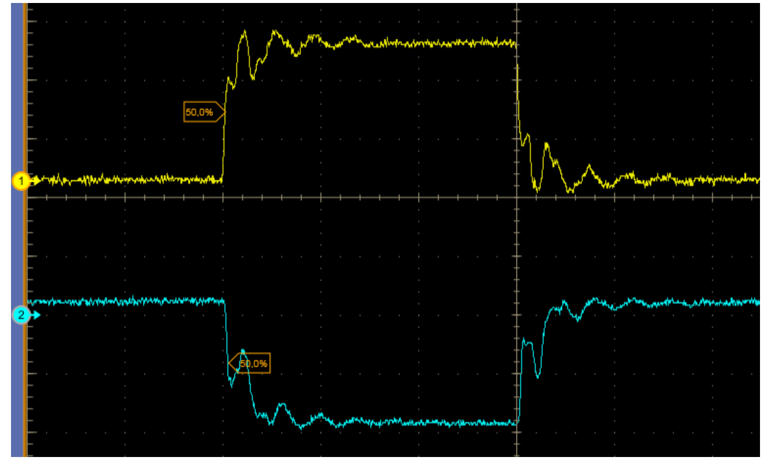
ATLAS Pixel Read-Out FE-I4(A)

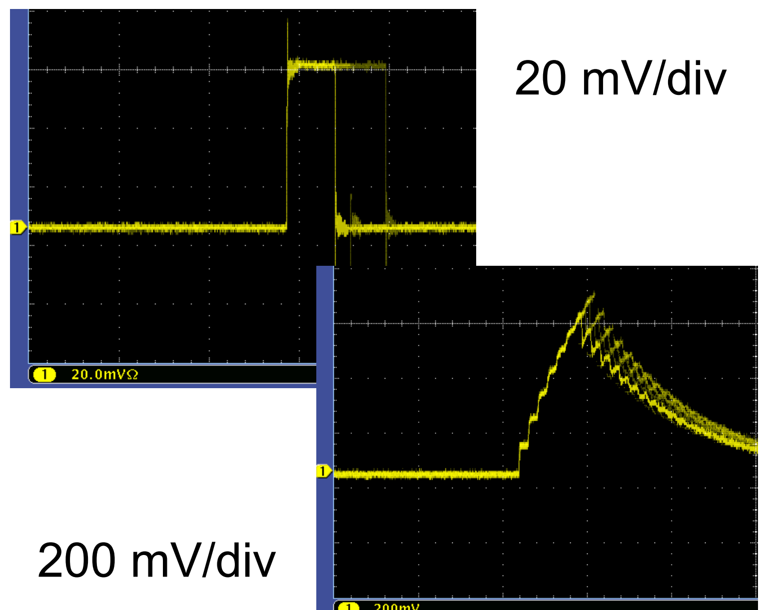
- Frontend for readout of upcoming hybrid ATLAS pixel detectors
  - For dealing with higher luminosity (e.g. Instertable B-Layer)
  - Decrease in material and power consumption
- Used with 50 x 250 µm² pitched pixels (336 x 80 pixels)
- Used hardware:



The Hitbus

- We get hit signals from the FE-I4
  - Actually we can select which pixels should contribute → region of interest selection
- Unfortunately we get a positive pulse
  - But we need a falling slope
- Thus we have to invert the signal
- Problems: 50 Ω termination give clean but small signal while high impedance gives rise to deformation, reflections etc.

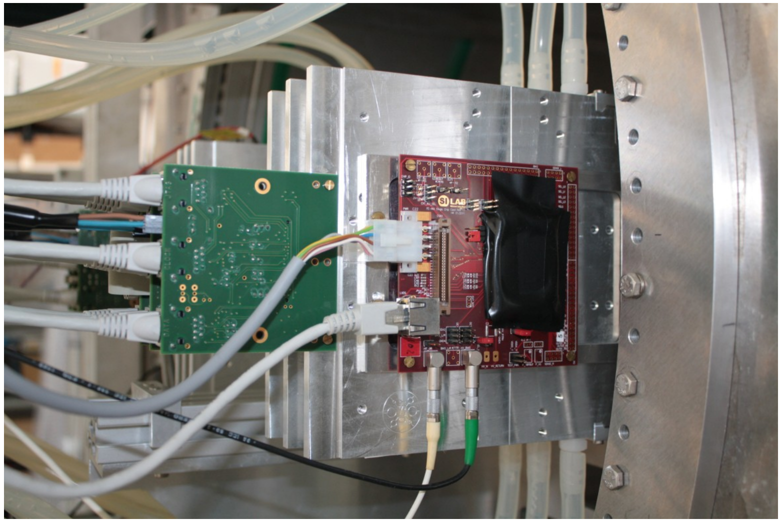


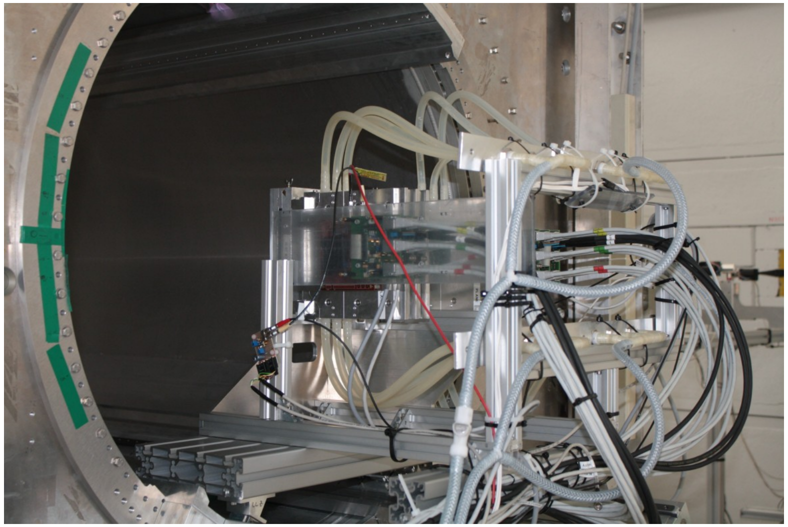


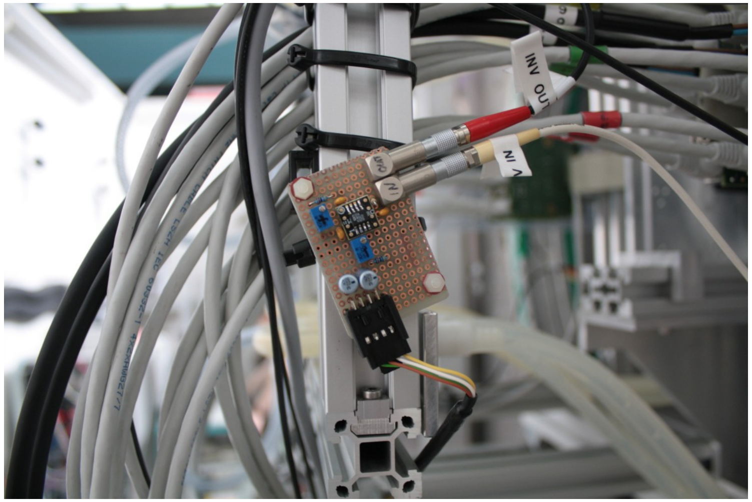
20 mV/div

200 mV/div

Putting it all together

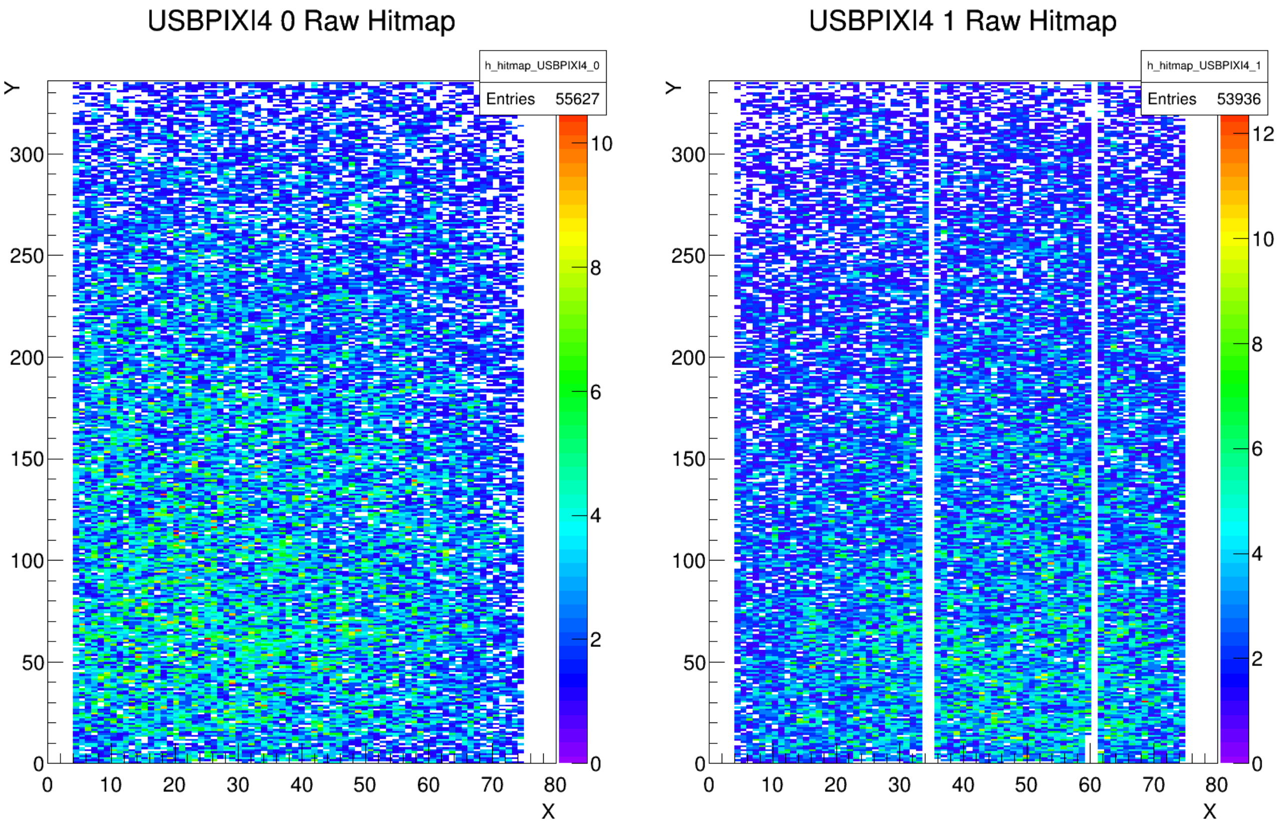






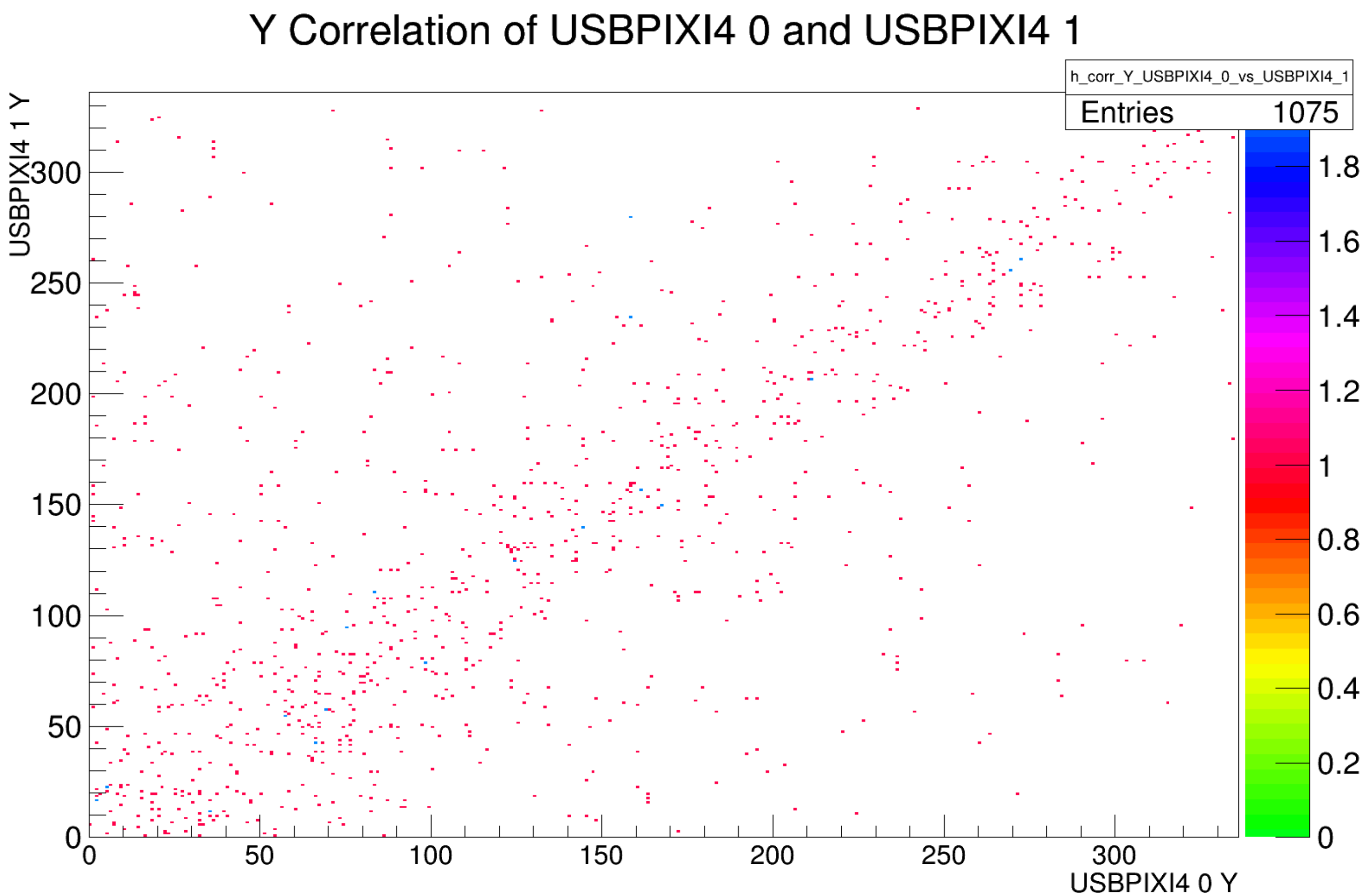
Everything in Operation

- Hitmaps from the OnlineMonitor



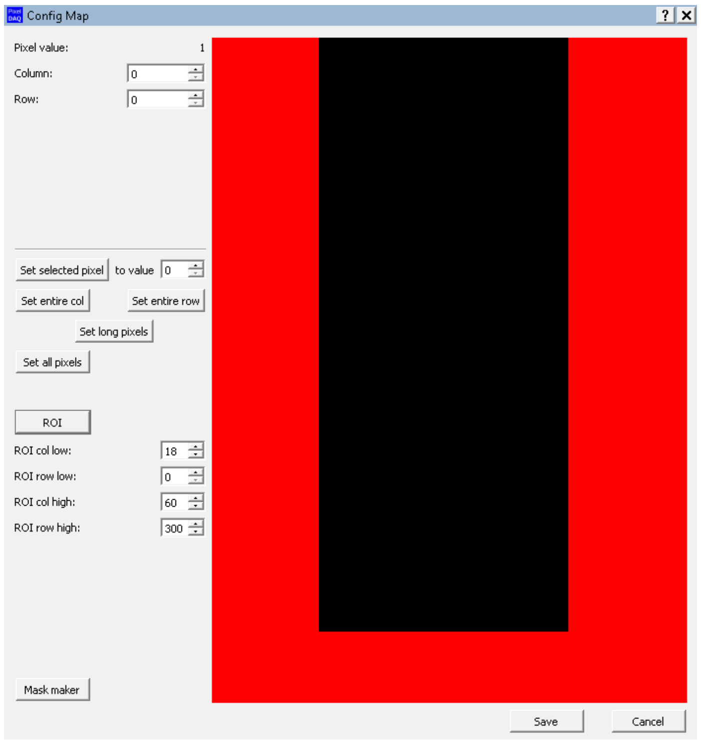
Everything in Operation

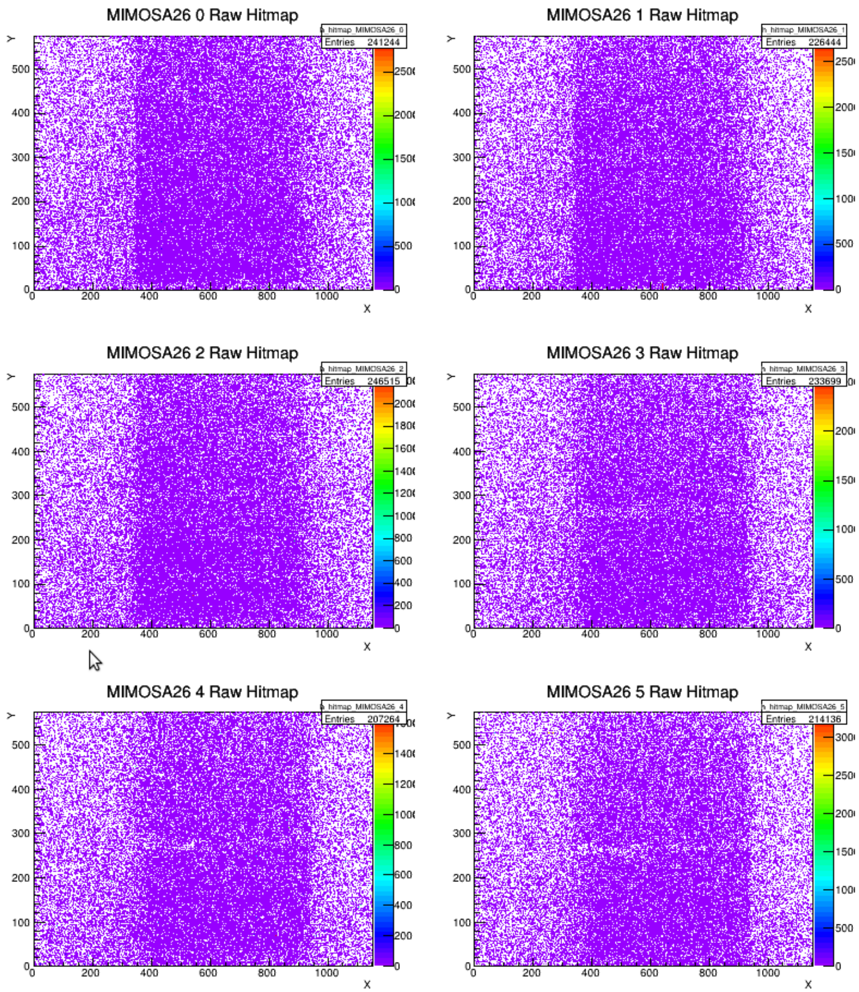
> Correlation from the OnlineMonitor



Region of Interest (ROI) Selection

- Region of interest selection and Mimosa26 Hitmaps





Outlook

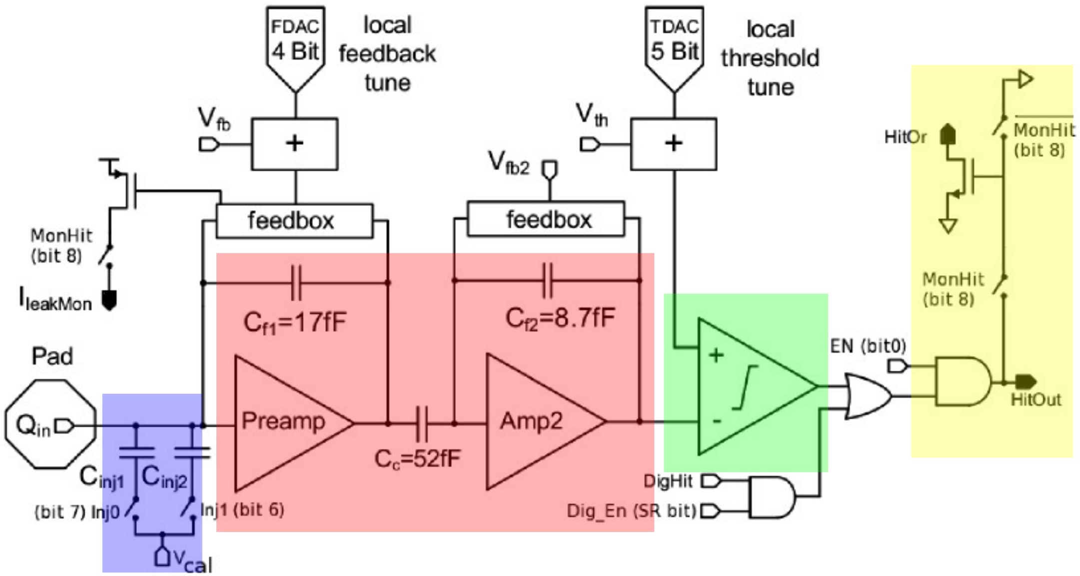
- Showed very good performance in magnetic field
- Easily operated by non FE-I4 experts
- Inverters still need some improvement
  - 50 Ω termination is required for clean signal
- FE-I4 timing information for track timestamping is in progress

THANKS FOR YOUR ATTENTION!

BACKUP

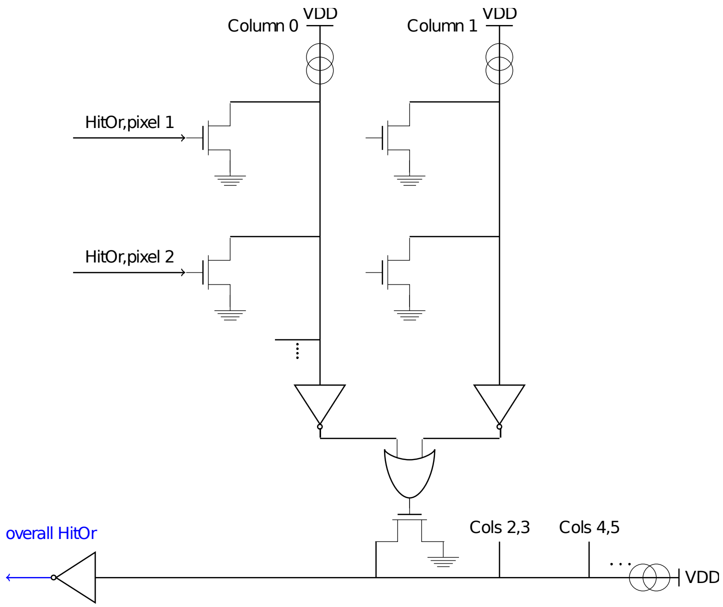
FE-I4 Analogue Readout

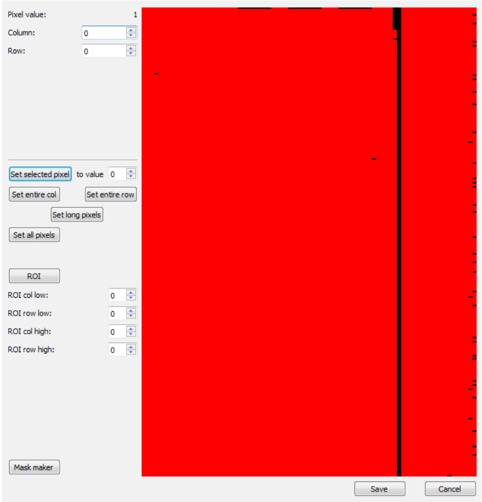
- Charge sensitive amplification in two stages
- Followed by a discriminator
- A lot of “control values” allow tuning of the amplifier
  - Important for us: threshold tuning via GDAC and TDAC
- Charge injection circuit
- HitOR and HitOUT



HitOR Creation and Inverting

- We can enable different pixels and tell them to contribute to the HitOR bus
- They act pixelwise as the gate of a NMOS
  - Pull-down transistors
- Two columns OR'ed together
- And same schematic (pull-down transistors) for double column readout
- Selection via the ILEAK mask



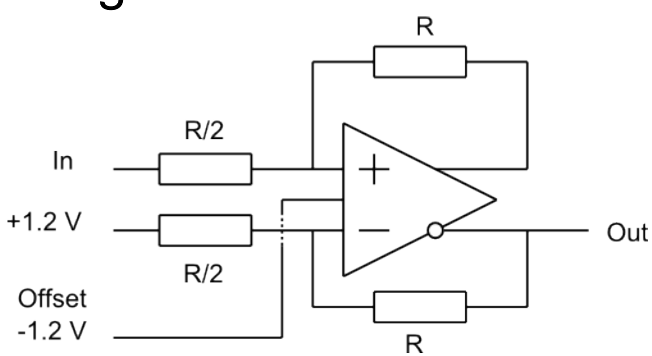


Screenshot of STControl software

The two Inverters

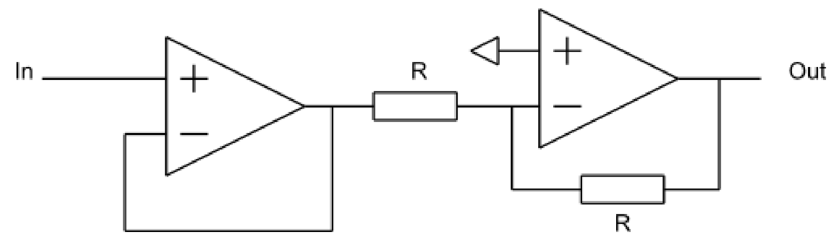
Inverter No. I

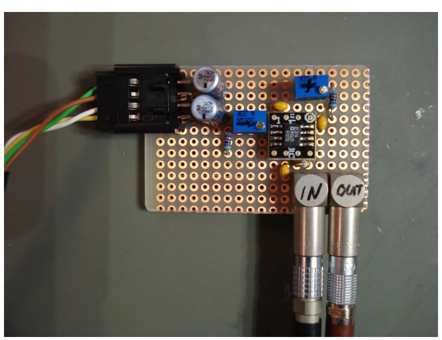
- High speed differential driver, AD8131
- Fixed gain of 2

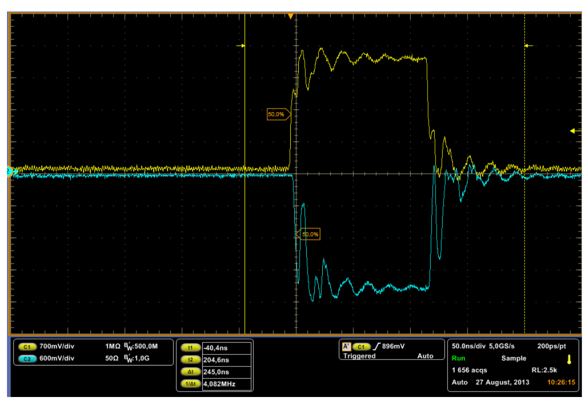


Inverter No. II

- 1 GHz fast FET op amp, AD8131
- Two stages, one unity gain and one inversion
- Very high impedance







Thanks Mathias Reinecke & Torsten Külper