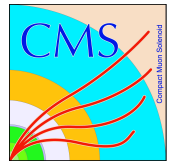
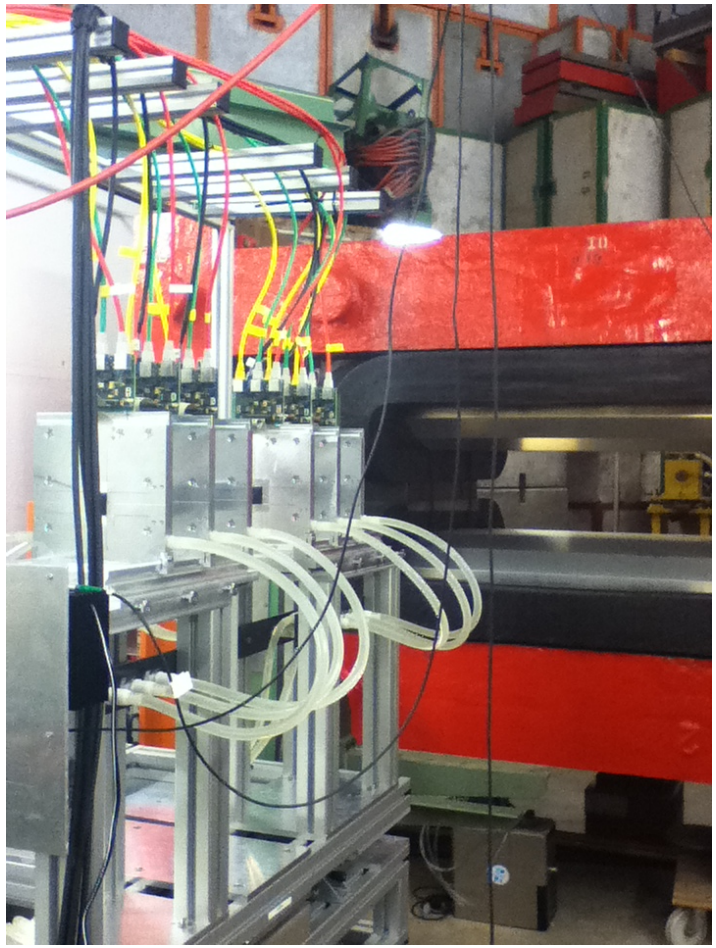


Introduction and Status of the AIDA Pixel Telescope @ DESY

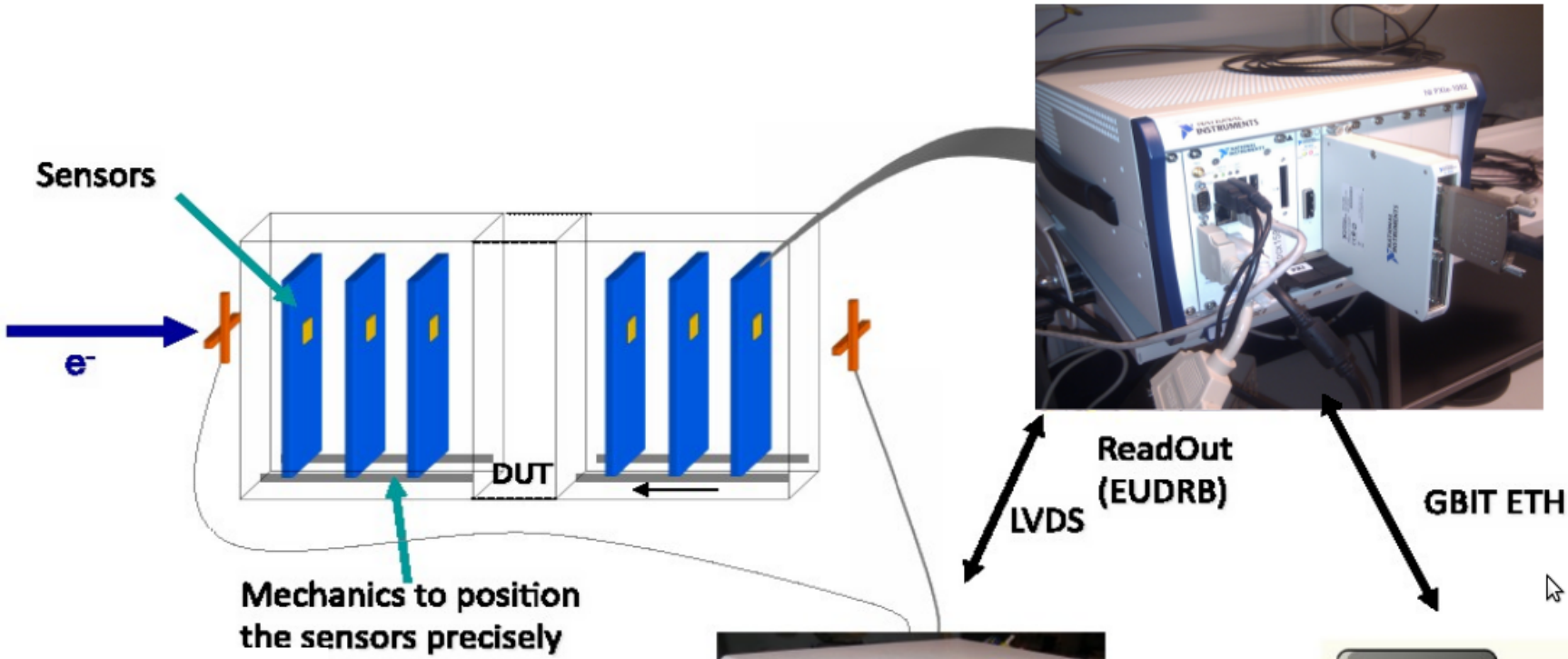
Hanno Perrey

DESY-CMS Tracker Upgrade Meeting, 01.11.2011

- A tool to define the exact track of a particle in a beam very precisely
- Used for detailed studies of newly developed detectors
- Pointing resolution should be better than the expected intrinsic resolution of the Device Under Test (DUT)
- DUTs: small pixel sensors to larger detectors
- Flexible design:
  - distances of planes variable from 10 to 150 mm
  - DUT position: gap between arms variable between few cm up to 35 cm
- Low material budget



Hardware Components

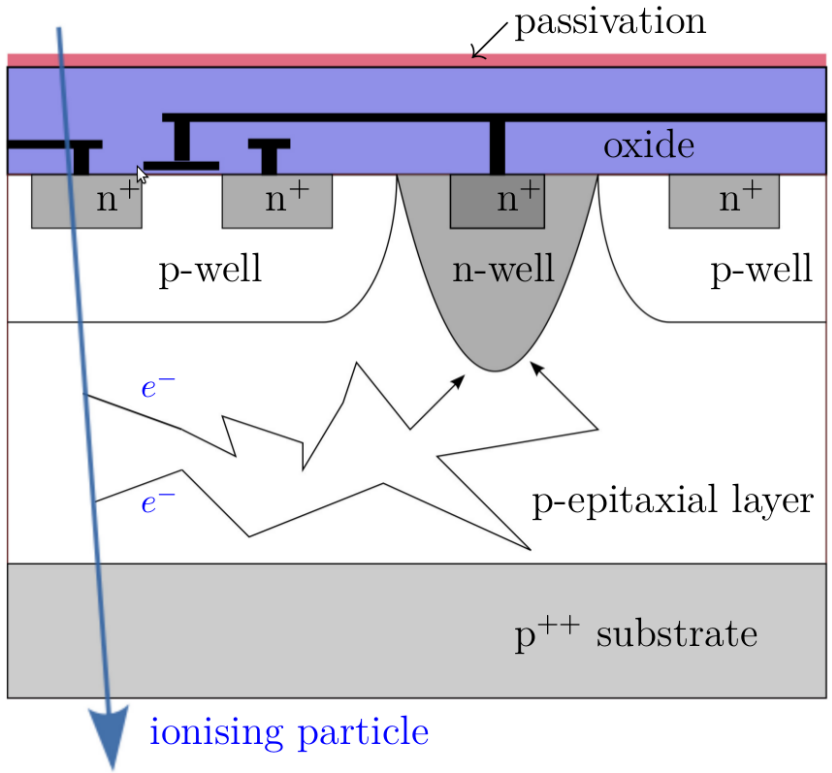


Hardware

- Mechanics
- Sensors
- Trigger Logic Unit (TLU)
- DAQ

Mimosa26 Sensors

- by IPHC Strasbourg
- MAPS – Monolithic Active Pixel Sensor
- signal processing µ-circuits integrated on sensor substrate
- Pixel size: $18.4 \times 18.4\,\mu\mathrm{m}^2$
- Excellent ($\approx 1\,\mu\mathrm{m}$) spatial resolution
- Readout in rolling shutter mode
- At $80\,\mathrm{MHz} \rightarrow 112.5\,\mu\mathrm{s}$ per frame
- No dead-time, continuous readout
- Digital readout
- On-pixel amplification
- 1 discriminator per column width
- Built-in data sparsification
- Current version of Mimosa26:
  - High resistivity epitaxial
  - Back-thinned down to $50\,\mu\mathrm{m}$



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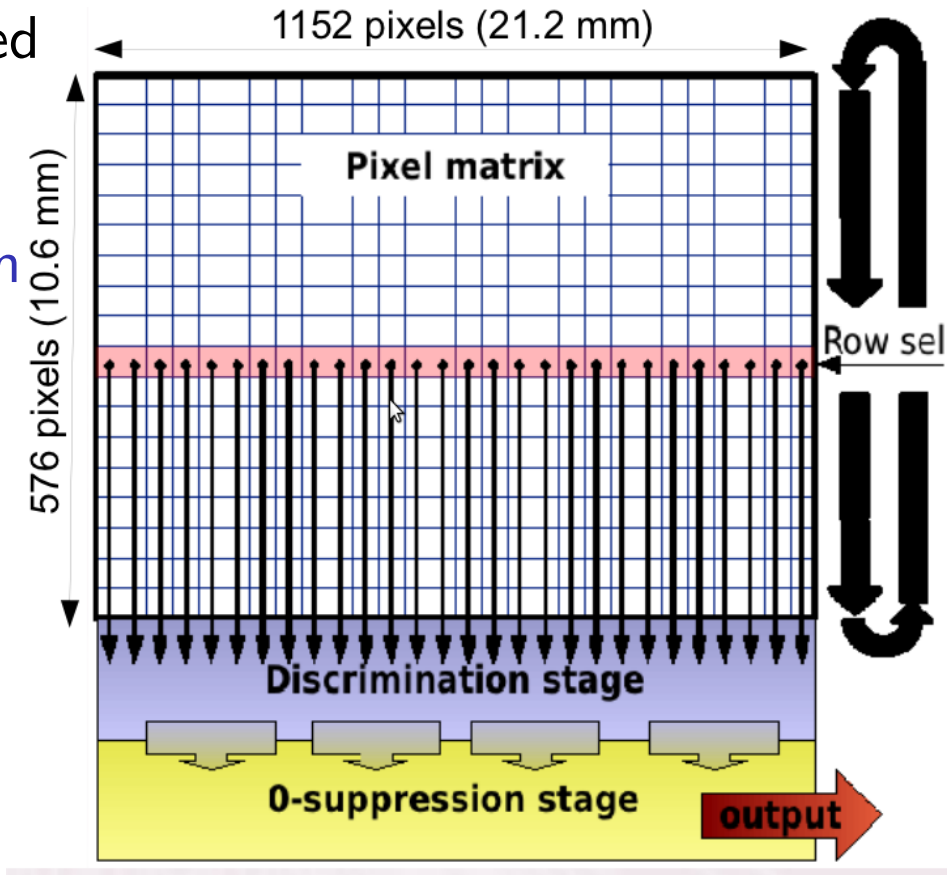
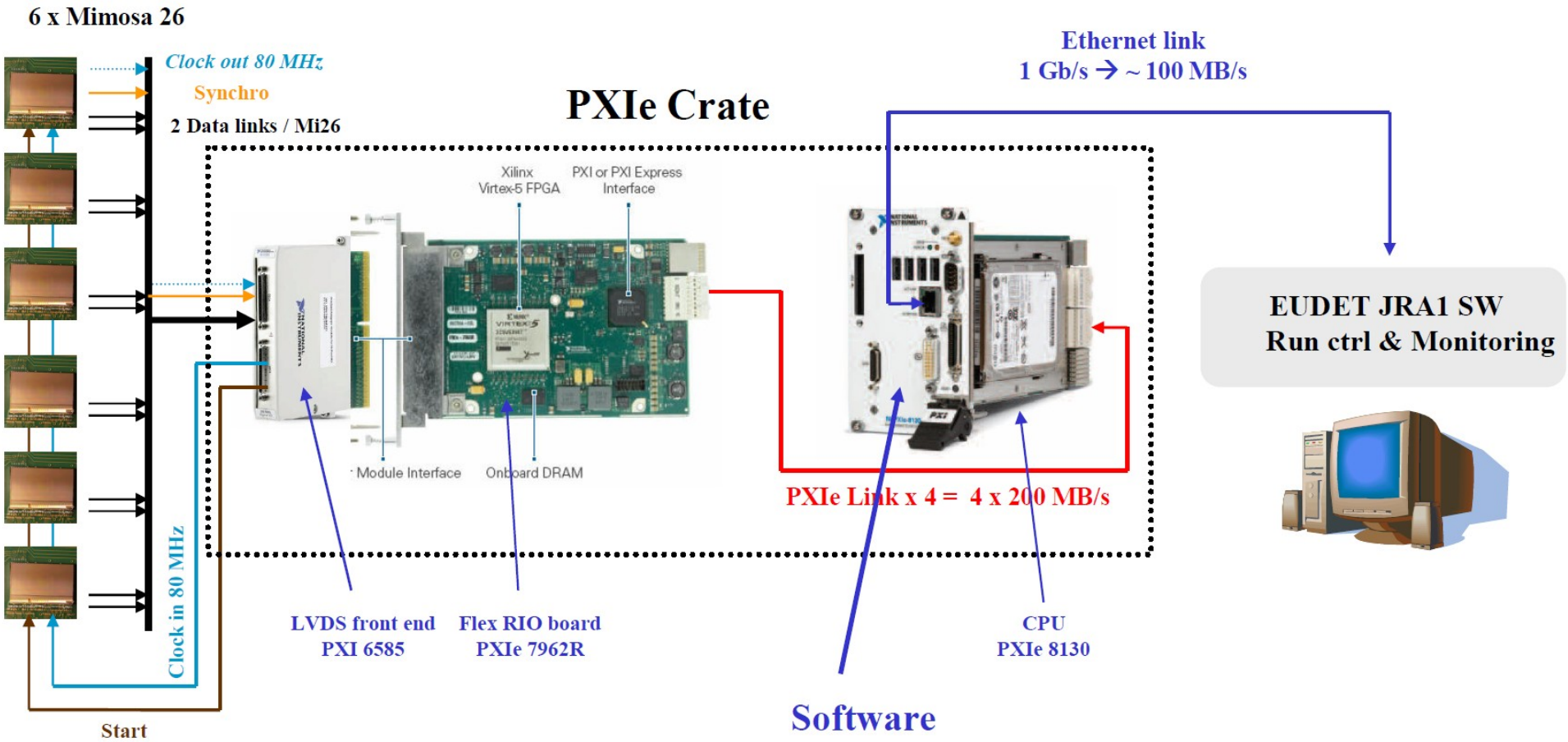


Data Acquisition Setup

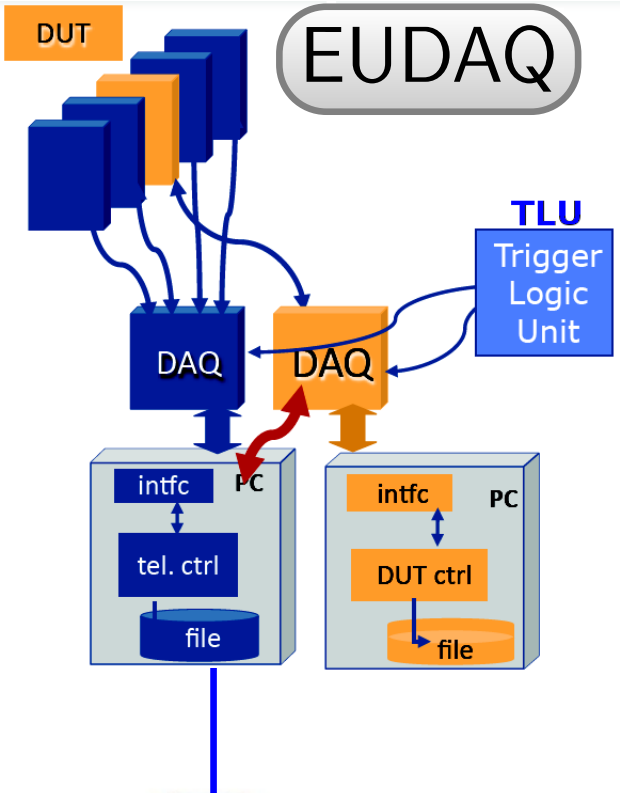


National Instrument Flex RIO PXIe crate

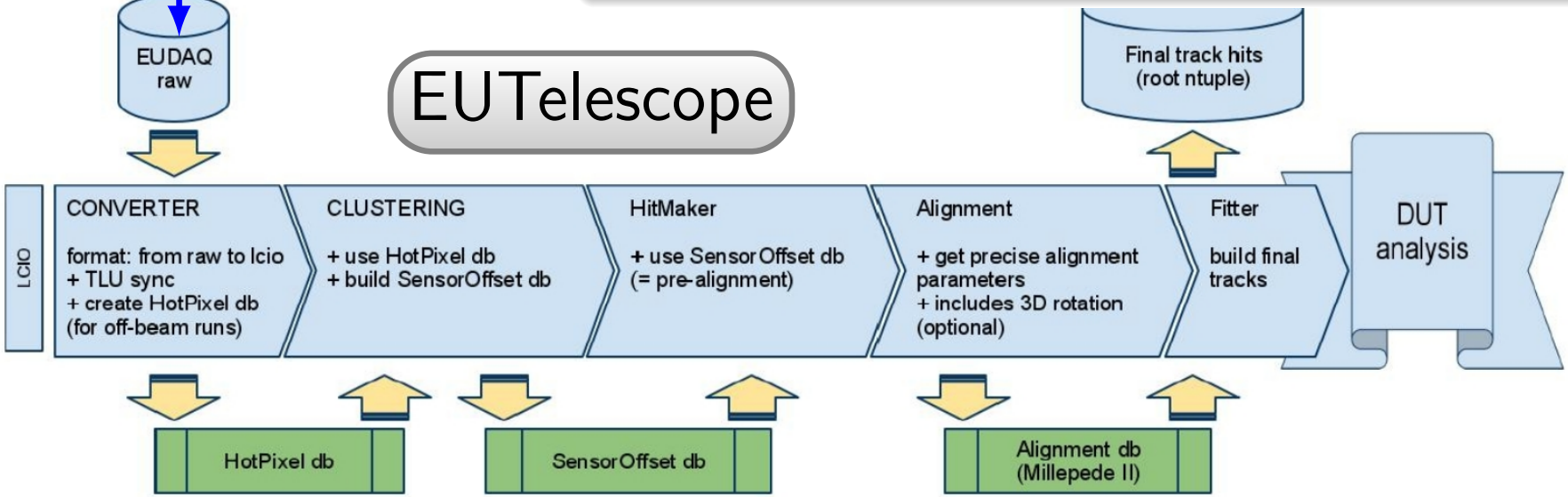
- fast (max 800 MB/s)
- allows reading Mimosa sensors without dropping frames

Trigger Logic Unit (TLU)

- generates trigger signal from up to four scintillator inputs
- connects up to six DUTs
- handshake with DUTs (optional):
  account for DUT busy signal and read out trigger number

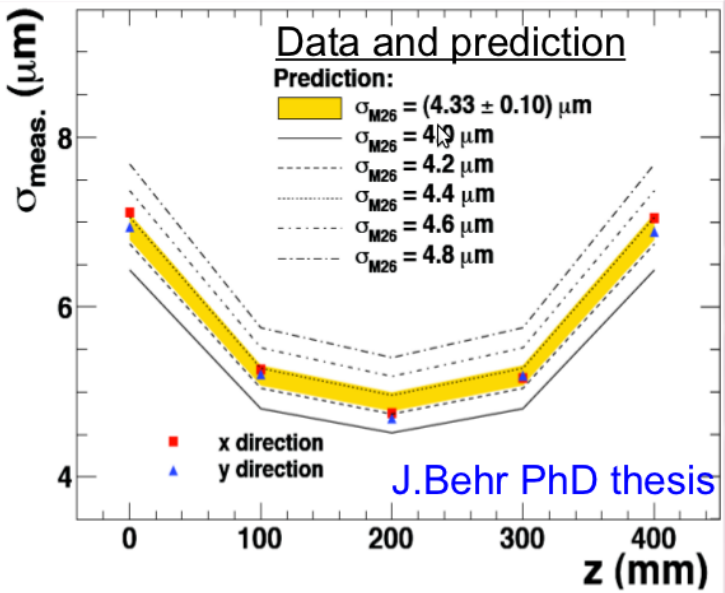


- EUDAQ system
  - DUT brings own DAQ
  - TLU handshake → sync'ed trigger
  - telescope data stream can include DUT
  - offers online monitor
- EUTelescope
  - track reconstruction software
  - stepwise transition from single pixel array to 3D coordinates of hits and fitted tracks in global frame
  - based on Marlin (ILCSoft)



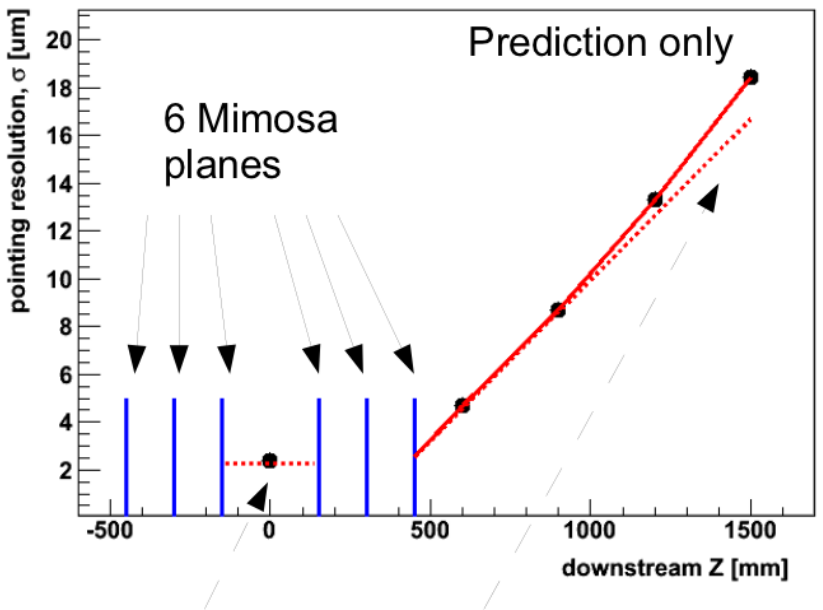
Telescope Performance

Pointing resolution in between the planes



$$\sigma^2_{meas} = \sigma^2_{m26} + \sigma^2_{pointing\text{-}resolution}$$

Track extrapolation accuracy far behind the telescope planes



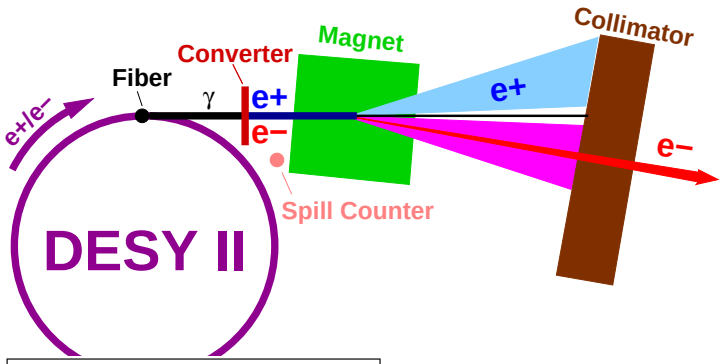
A DUT within the telescope arms
σ~2 μm

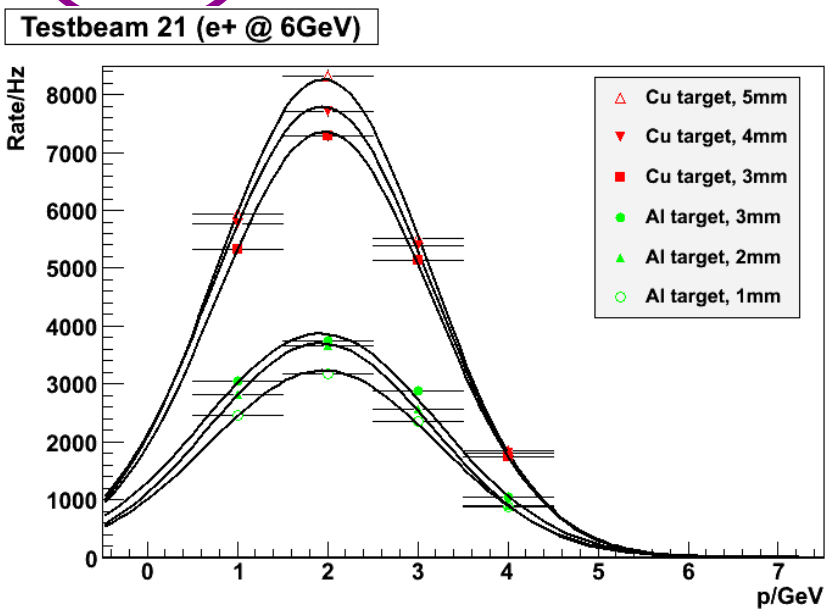
A DUT behind the telescope still can get a very reasonable track pointing resolution
σ < 20 μm

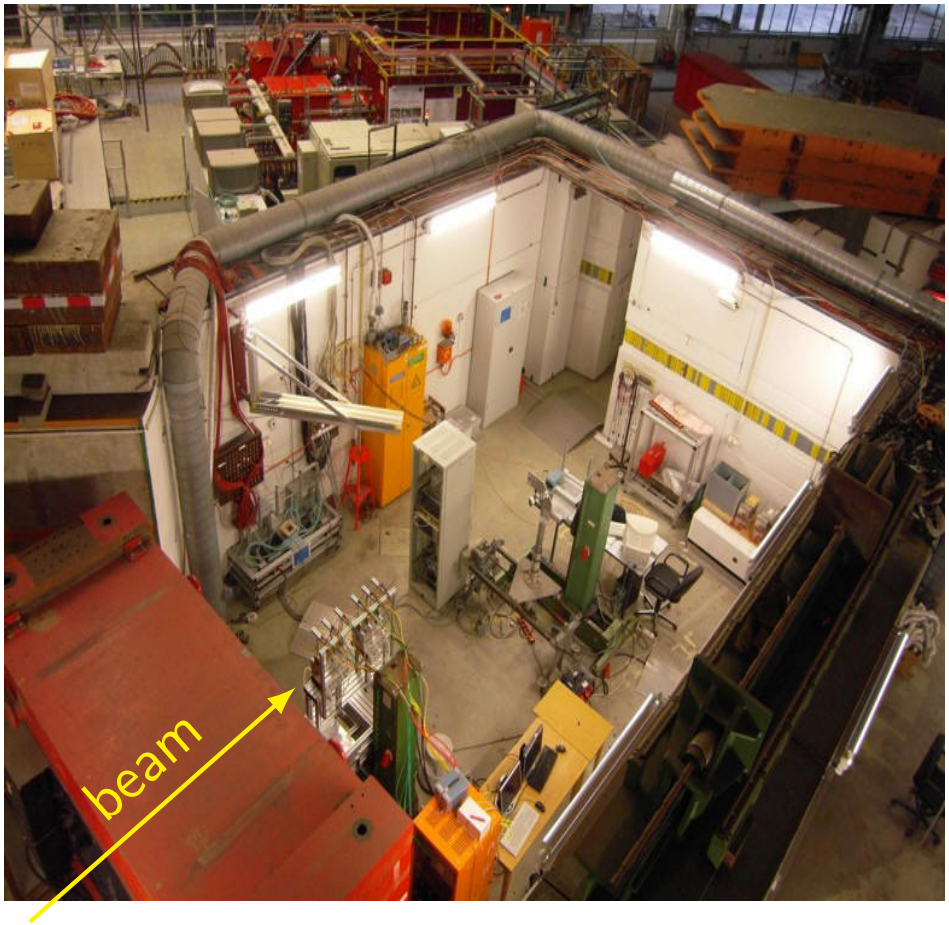
I.Rubinskiy, DESY | TIPP'2011 | 15

- data taken at CERN SPS (120 GeV pions)

Testbeam 21 @ DESY







- magnet current determines beam energy
- rates in the order of kHz for energies 1 – 3 GeV
- testbeam typically available to us over long periods of time

Telescope Copies for Everyone!

- For Bonn university, will stay in Bonn @ ELSA
  - currently here at testbeam 21
  - will stay at least for a couple of months, still being improved
- For ATLAS group, will stay at CERN SPS
  - sensors calibrated, all parts ready, will be assembled soon
- For DESY, will stay at testbeam 21 @ DESY
  - parts mostly ready/ordered

Currently working on & short-term plans

- Participate in improvements on the current (Bonn) telescope
- Take and analyze dedicated data to determine telescope performance
  - study the telescope pointing resolution with 1 to 6 GeV e at DESY and identify the ideal working point
  - learn the DAQ and analysis framework

Mid-term plans

- Integrate the CMS pixel sensors and test boards as DUT into the telescope framework
  - use trigger and clock provided by the telescope
  - develop *producer* component for full integration into telescope software
- Participate in the setup, calibration, and test of the additional telescope copies

Summary

- The AIDA pixel telescope offers a flexible framework to test detectors
- Pointing resolution for a DUT within the telescope arms $\sim 2\,\mu\mathrm{m}$
- Telescope and testbeam typically available to us on short notice