

# High Resolution EUDET telescope (status and development plans)

Igor Rubinskiy, DESY

- EUDET telescope ingredients  
= MAPS (Mimosa26) x6 + VME/NI + TLU + EUDAQ
- The telescope copies status  
+ 1@DESY, 1@Bonn, 1@CERN
- Development plans



20<sup>th</sup> RD50 Workshop on Radiation hard semiconductor devices  
for very high luminosity colliders

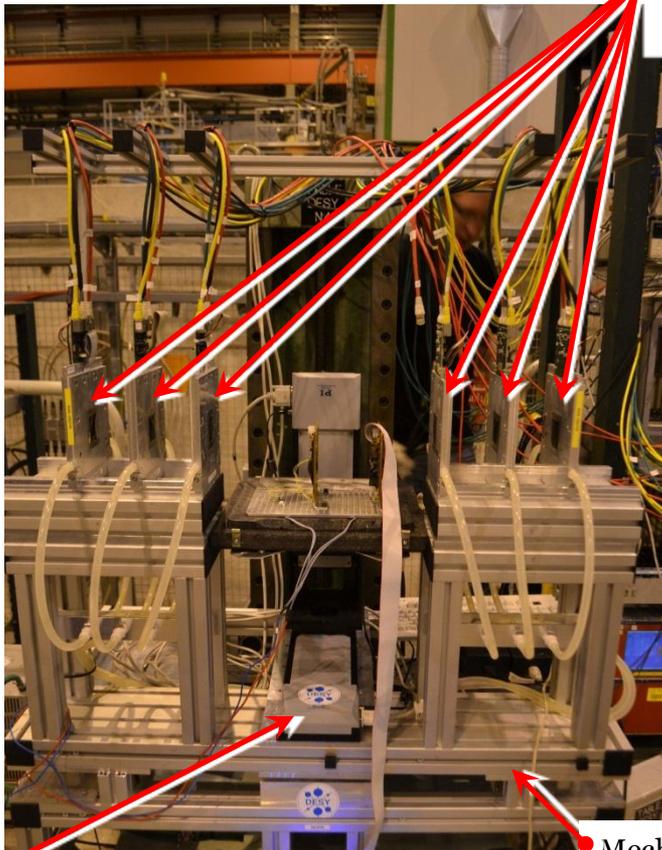
Bari, Italy



# EUDET telescope @ DESY ⇔ CERN

(EUropean DETectors, FP6 project)

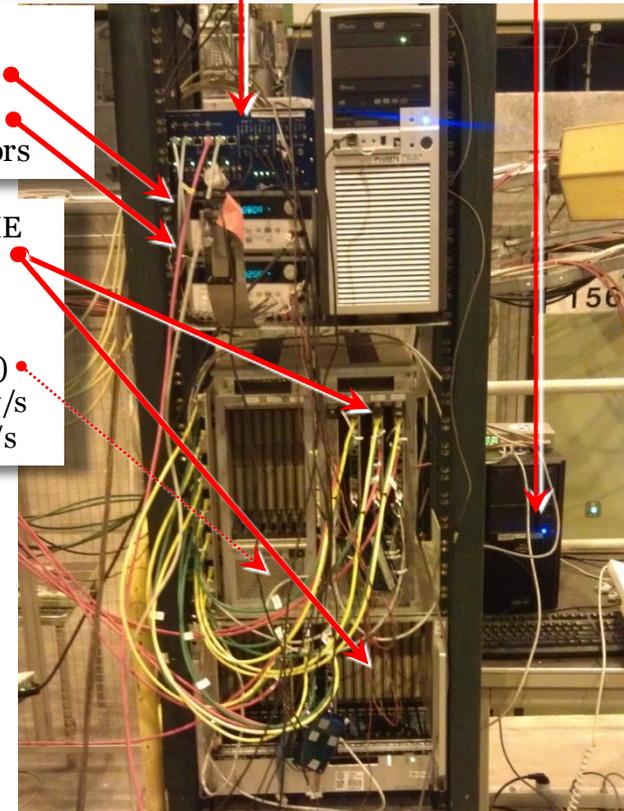
- 6 MAPS sensors (IPHC Strasbourg)
- Mimosa26
  - $18.4 \times 18.4 \mu\text{m}^2$
  - 1152 columns x 576 rows ( $2 \times 1 \text{ cm}^2$ )
  - $50 \mu\text{m}$  thickness
  - rolling shutter = continuous readout = deadtime free
  - $115.2 \mu\text{s}$  integration time/frame (8.68 kFrames in 1 second)



- Trigger Logic Unit (TLU)
- 4 inputs from PMTs
  - 6 RJ45 (+ 2 NIM, 2 TTL) sockets to communicate with the readout systems by exchange trigger/busy signals
  - +15V to power 4 PMTs
  - control via linux PC (USB)

- Power supplies
- +8V: power the sensors
  - +6V: JTAG boards to configure Mimosa sensors

- Sensors readout with a 64bit VME based boards
- EUDRB = "EUdet Data Reduction Board"
  - 2 crates (+1 spare)
  - if 6 EUDRBs/1 VME = 500 Ev/s
  - if 3 EUDRB/2 VME = 850 Ev/s



- Device Under Test (DUT) positioning
- by Physikalische Instrumente
  - precision positioning XY stage
    - $0.1 \mu\text{m}$  precision
  - 1 rotation stage in the setup
    - $32 \mu\text{rad}$  precision
  - few kg of weight possible
  - control over Windows PC

- Mechanical support
- based on Al profiles
  - very rigid
  - $\sim 1 \mu\text{m}$  precision rotation in horizontal plane
  - 350 mm gap between the arms
  - for XY stage + DUT platform

# EUDET telescope @ DESY $\leftrightarrow$ CERN

(EUropean DETectors, FP6 project)

On record since 2006

- EUDET project 2006-2010
- number of groups requesting beam with the telescope doubles every year [saturating in 2011]
- in beam at DESY & CERN (from Nov. @DESY, from May @CERN)

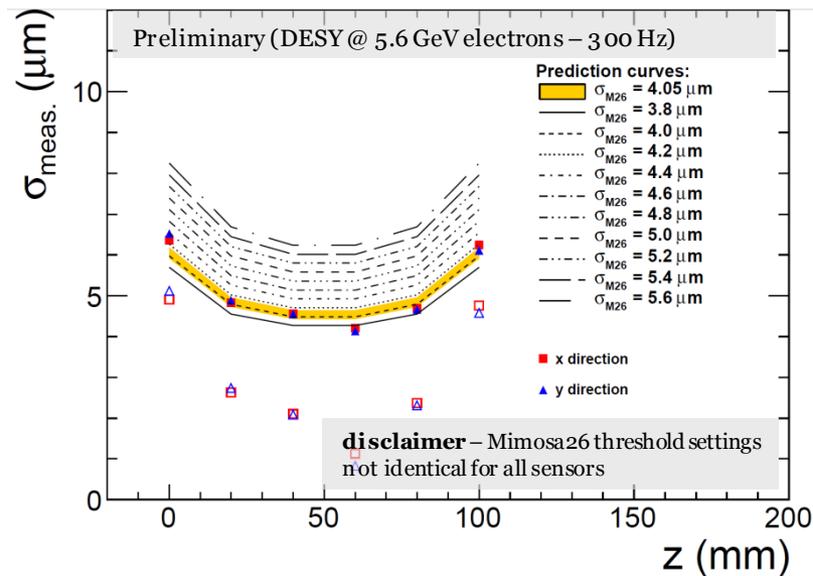
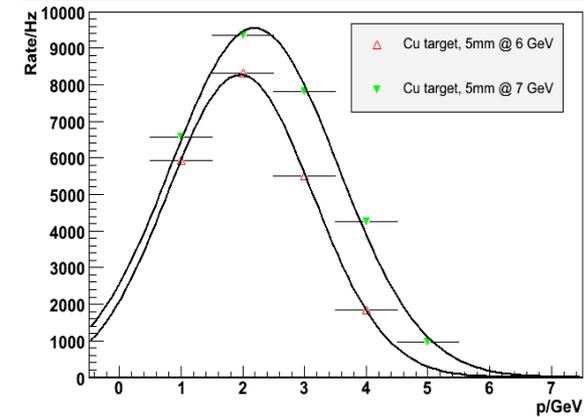
## CERN

- pions @ 120 GeV
- $\sim 0.6$  Mparticles per spill
- spill  $\sim 10$  sec, pause  $\sim 40$  sec

## DESY

- $e^+$  or  $e^-$  spectrum up to 6 GeV
- intensity depends on the beam momentum
- continuous spill
- selecting particles with  $dp/p \sim 0.01$

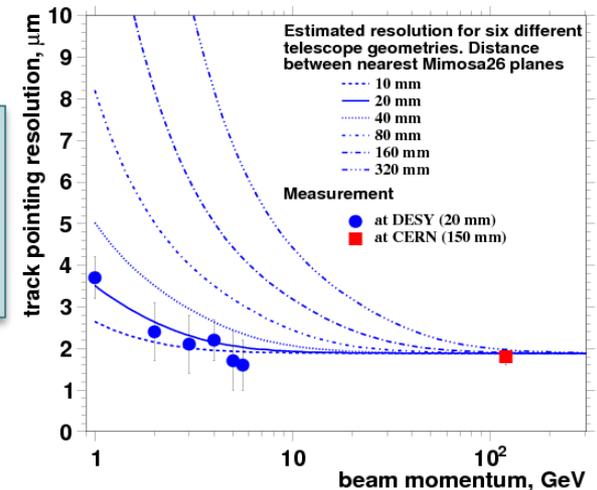
## DESY (testbeam area 21, $e^+$ )



## Telescope pointing resolution:

- $< 2 \mu\text{m}$  at CERN – for “free”
- at DESY – requires a bit of thinking on mounting

## Estimated and measured resolution for equidistant setup with 6 planes



# DATURA telescope @ DESY [1-6 GeV e/positrons]

(Desy Allianz Telescope with Ultrafast Readout)



## DATURA at DESY

- TestBeam hall #21
- “permanent position”
- belongs to DESY (ATLAS+CMS+FLC)
- ~1 T magnet in the background

Contact: Ingrid Gregor, IR

## New readout based on National Instruments

- NI FlexRIO PXIe 7962R upto 200 MB/s (x4 links)
- RAID disk 3 TB – can write 600 MB/s



## Readout Options:

1. x2 frames  
 $< 4.34 \text{ kFrames/s}$   
 “EUDET style”
2. all frames  
 $= 8.68 \text{ kFrames/s}$

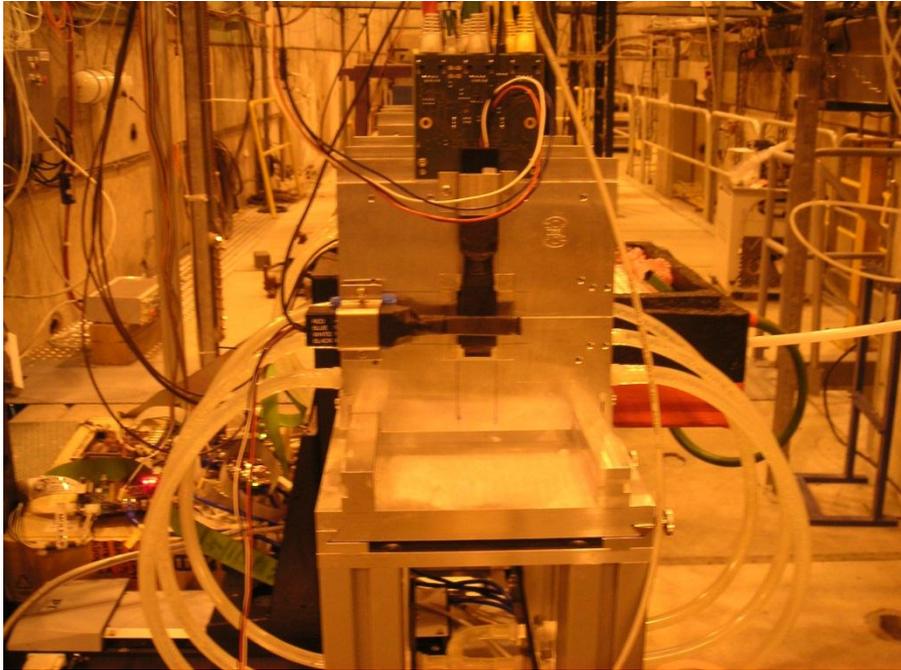


## PCMAG

- DESY - TB24
- superconducting
- 1 T
- **does not** belong to the telescope
- available on request

## ACONITE telescope @ CERN SPS, 120 GeV pions

(Atlas Copy of National Instruments based Telescope)



ACONITE at

- CERN H6A
- “permanent position”
- belongs to ATLAS experiment/ R&D groups

Contact: Henric Wilkens, Ingrid Gregor, IR



Current active ATLAS pixel groups

- Planar Pixel Sensors
- 3D [IBL, AFP]
- Diamond pixels

For:

- Insertable B-Layer [PPS+3D]
- Diamond Beam Monitor [Dia]
- Atlas Forward Physics [3D]



# ANEMONE telescope @ Bonn [ELSA, ~1-3 GeV electrons]

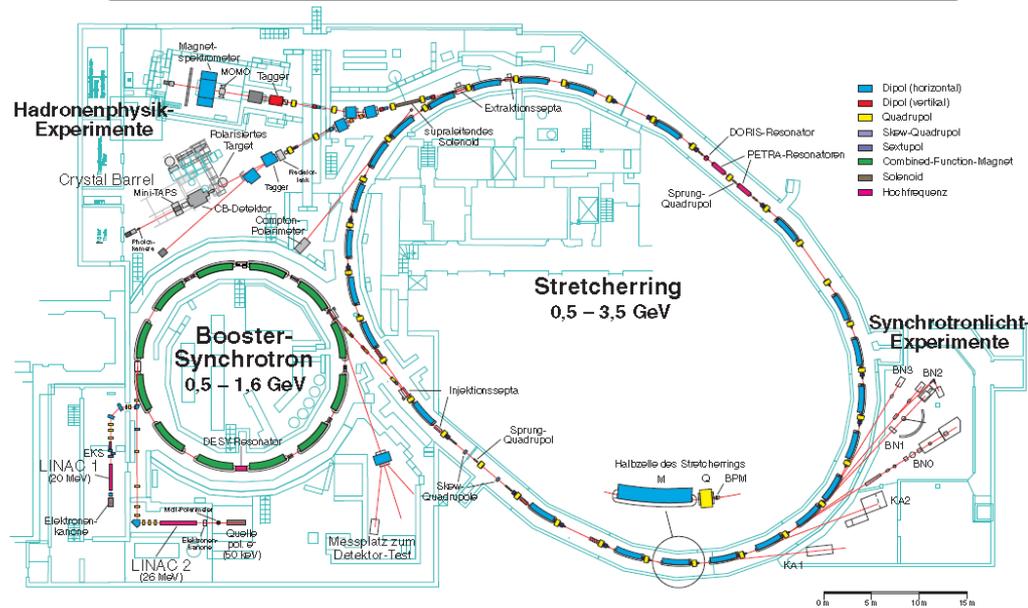
(AlliaNz Eudet Mimosa bONn tElescope)

Exact copy of the DATURA and ACONITE telescopes

- 6 Mimosa26 sensors
- NI FlexRIO PXIe 7962R
- TLU
- EUDAQ



## Elektronen-Stretcher-Anlage (ELSA)

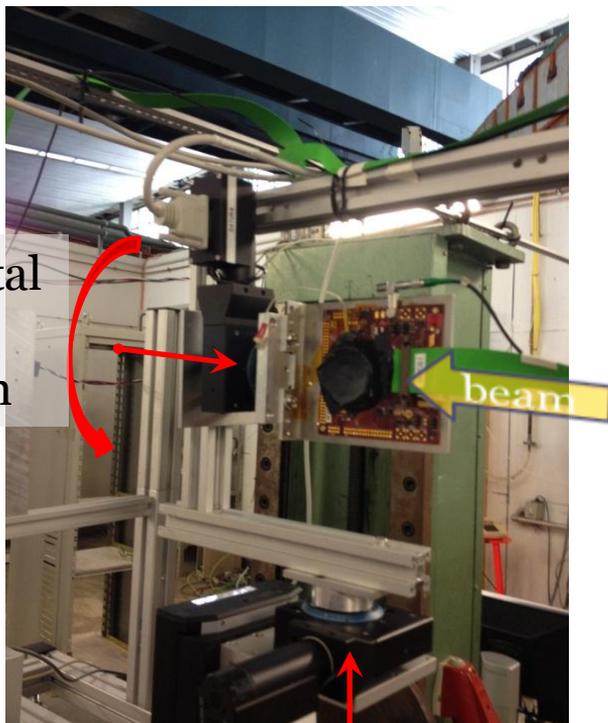


Vincent Van Gogh  
"Vase Mit Margeriten  
Und Anemonen",  
1887

Contact: Norbert Wermes, Fabian Huening

## Angles scans - PI rotation stage

### Example of a setup at DESY

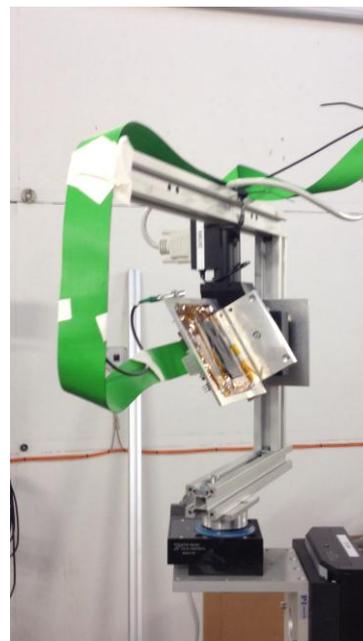


Horizontal  
axis  
rotation

Vertical axis  
rotation

### One PI rotation stage

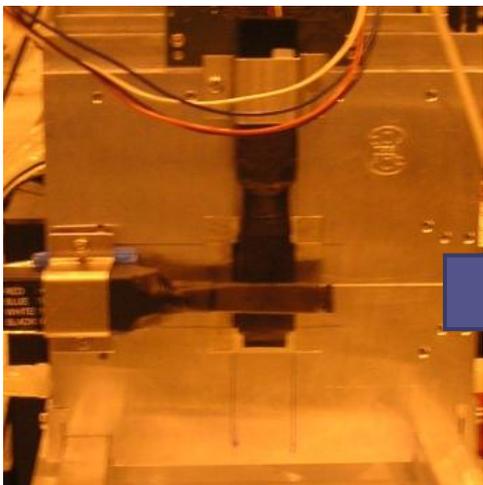
- 32  $\mu$ rad precision
- one rotation stage in EUDET, DATURA, ACONITE
- manual control from Windows
- script control via LabView [in works]
- Unlimited rotation
  - On the photo  $\pm 90^\circ \times \pm 90^\circ$



# Development plans – FEI4 as Intelligent Trigger

universität **bonn**

## Region of interest trigger signal → HitOr



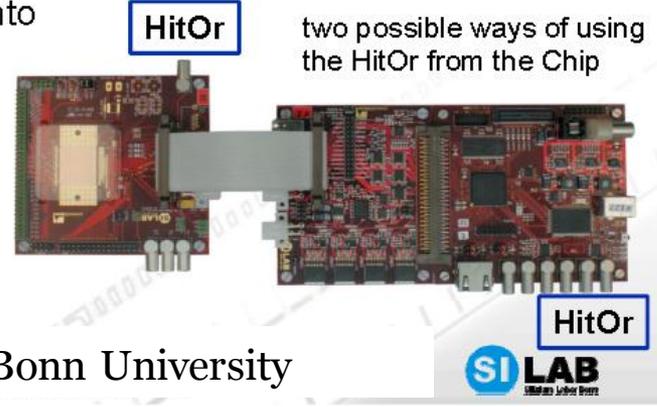
current triggering  
rigid 2x1 cm<sup>2</sup>  
need it to be adjustable



- FE-I4 features a fast HitOr signal
  - each pixels HitOr can be switched on/off
  - can define 'region of interest'
  - new tool in STControl allows easier mask generation



- Need to **integrate** HitOr signal into **triggering scheme of EUDAQ:**
  - connection to TLU
  - software implementation



by Theresa Oberman, Bonn University

FEI4 + USBPIX (readout) integration in EUDAQ is complete

- Using FEI4 as Intelligent Trigger tests successful
- further integration in NI system being investigated

## Summary

### EUDET telescope

- 6 thinned Mimosas26 sensors provide pointing resolution  $\sim 2 \mu\text{m}$  at DUT
- NI PXIe based readout allows continuous readout of Mimosas sensors

Identical copies with completely identical DUT-interface at

- DESY, CERN, and Bonn

Not mentioned in this talk

- new TLU with 1 ns time stamping
- EUDAQ provides common DAQ for DUT triggering and readout integration
  - possible redesign needed for asynchronous DUTs readout
- New large area (2x2 and 4x6 cm<sup>2</sup>) Mimosas sensors
- FEI4 and Timepix based sensors integration

# Backup

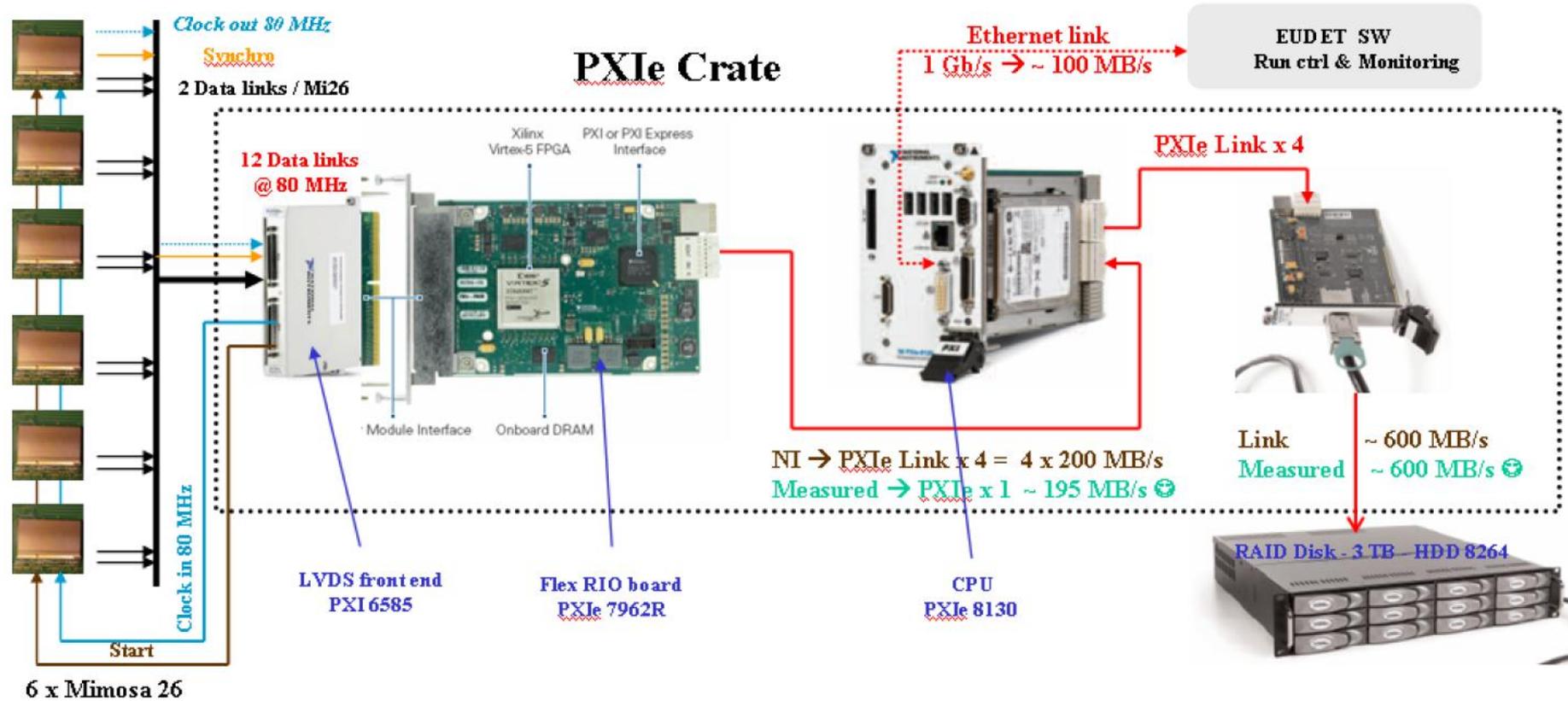


Figure 6 : EUDET Telescope DAQ based on PXIe Flex RIO architecture

PIXELS SENSORS CHARACTERIZATION IN BEAM TEST  
G.Claus, C.Santos, IPHC Strasbourg France - On behalf of PICSEL & Microelectronic groups.