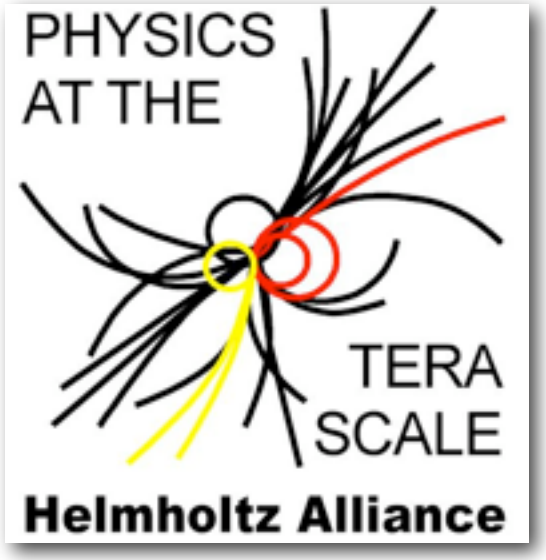
News from EUDET and AIDA - slight focus on Pixels

Ingrid-Maria Gregor, DESY

Allianz Annual Meeting 2011
December 8th 2011
Bonn



Last News From EUDET

- EUDE endet December 2010
- 200 EUDET memos were written -> a lot of information
- Final Annual Report was submitted in February 2011
- all activities & tasks achieved their goals and milestones

- A final report of all activities is being prepared and will be submitted to the arxive

… And Now AIDA !

Advancing European Detector Development

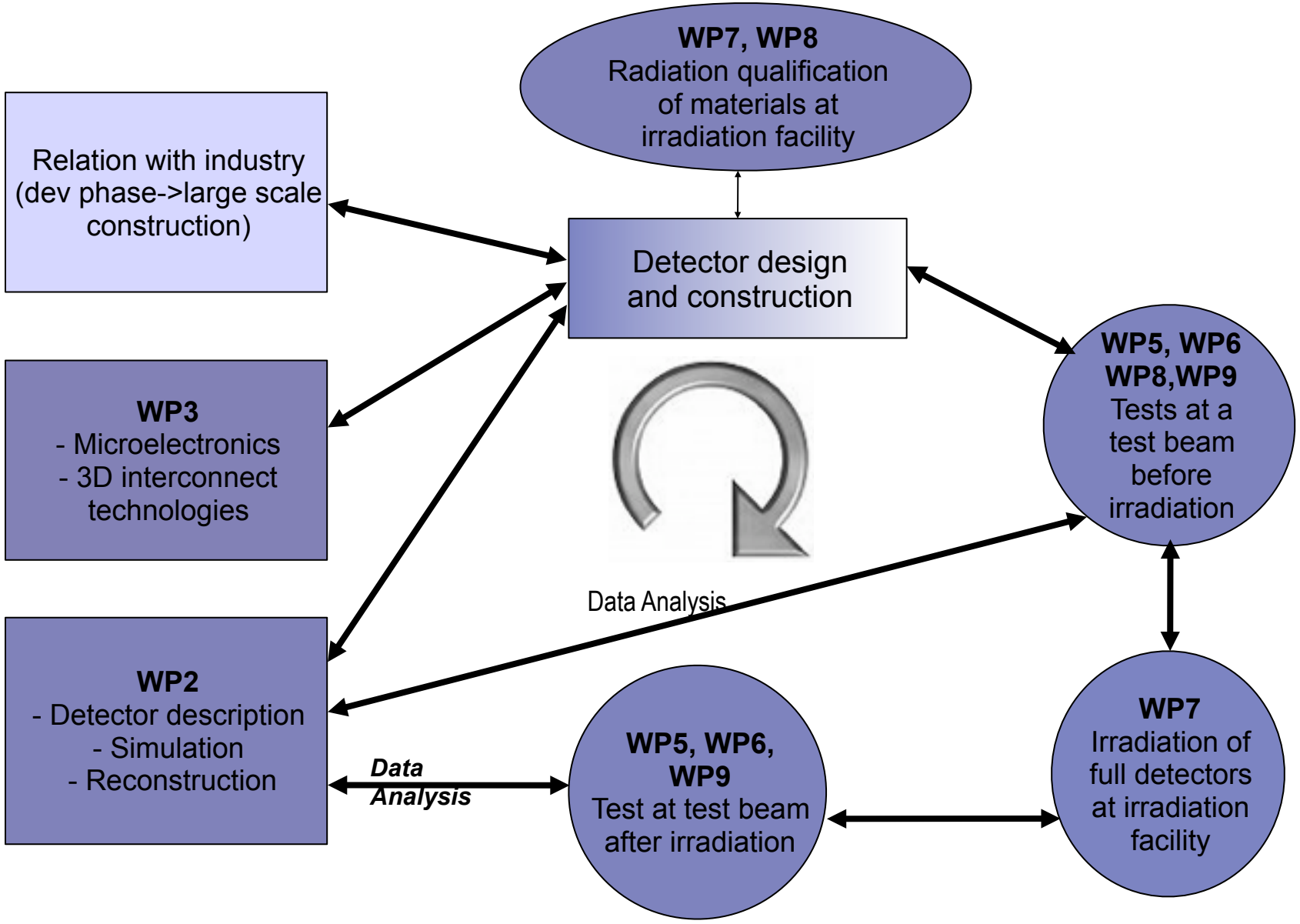
- Addresses infrastructures required for detector development for future particle physics experiments.
- Targets user communities preparing experiments at future accelerators: HL-LHC (luminosity-upgraded LHC), future Linear Colliders (ILC and CLIC), future accelerator-driven neutrino facilities or future B-physics facilities (e.g. Super-B).

- 4 year project started February 2011: More than 80 institutes and laboratories from 23 European countries are involved.
- 26 million Euro project receives 8 million Euros from the EU under the FP7 Research Infrastructures programme.

- **Aim: to upgrade, improve and integrate key European research infrastructures and develop advanced detector technologies for future particle accelerators.**

AIDA

A lot of Activities



Overview AIDA

WP1: Project management and communication
Scientific coordinator Laurent Serin, LAL-CNRS, Deputies : T. Behnke (DESY) & P. Soler (STFC)
Svet Stavrev, CERN administrative coordinator

Networking	Transnational access	Joint research
WP2: Common software tools (Frank Gaede, DESY, Pere Mato, CERN)	**WP5: Transnational access DESY** (Ingrid Gregor, DESY)	**WP8: Improvement and equipment of irradiation and test beamlines** (Michael Moll, CERN)
WP3: Microelectronics and interconnection technology (Hans-Gunter Moser, MPG, Valerio Re, UNIBG)	**WP6: Transnational access CERN** (Horst Breuker, CERN)	**WP9: Advanced infrastructure for detector R&D** (Marcel Vos, IFIC Valencia, Vincent Boudry, LLR-CNRS)
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One Important Feature: TA

- **As in EUDET it is possible to get travel support when using the provided infrastructure**
  - DESY test beam (WP5): 1-6 GeV electrons, longer periods available
  - CERN test beam (WP6): electrons and hadrons up to 160GeV, 1-2 weeks
  - Irradiation facilities (WP7): JSI, Slovenia; UCL, Belgium; KIT, Germany
- Eligibility:
  - both the user group leader and the majority of the users must work in an institution established in a Member State or Associated State;
  - must work in a country other than the country where the legal entity operating the infrastructure is(are) established => Germans can not apply for DESY TA ...
  - only research teams that are entitled to publish the results of their project performed at the facility in the open press may apply for access to a participating infrastructure.
  - in very special cases one member of the group can come from outside Europe
- Formalities reduces
  - check for availability (with coordinators)
  - fill out form and send to AIDA-info@cern.ch
  - for details: http://aida.web.cern.ch/aida/activities/access/apply/

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Don't forget ! Requests for CERN test beams latest by December 20th !!

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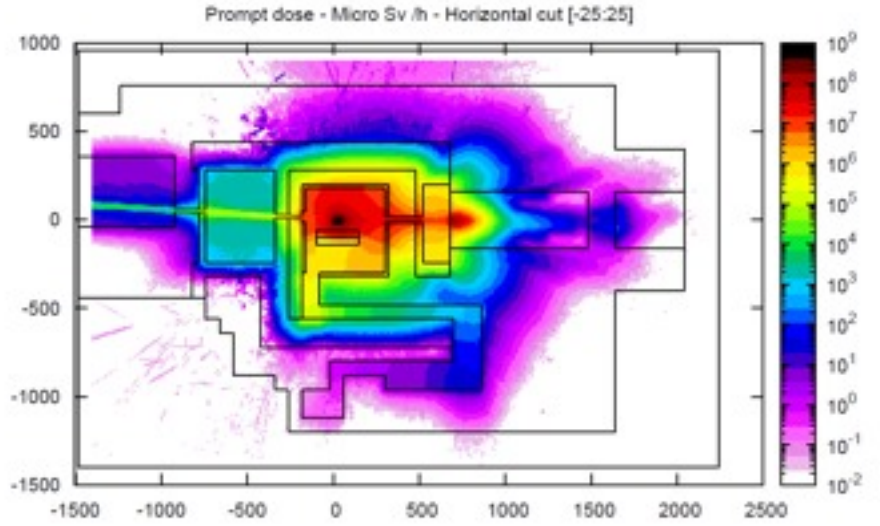
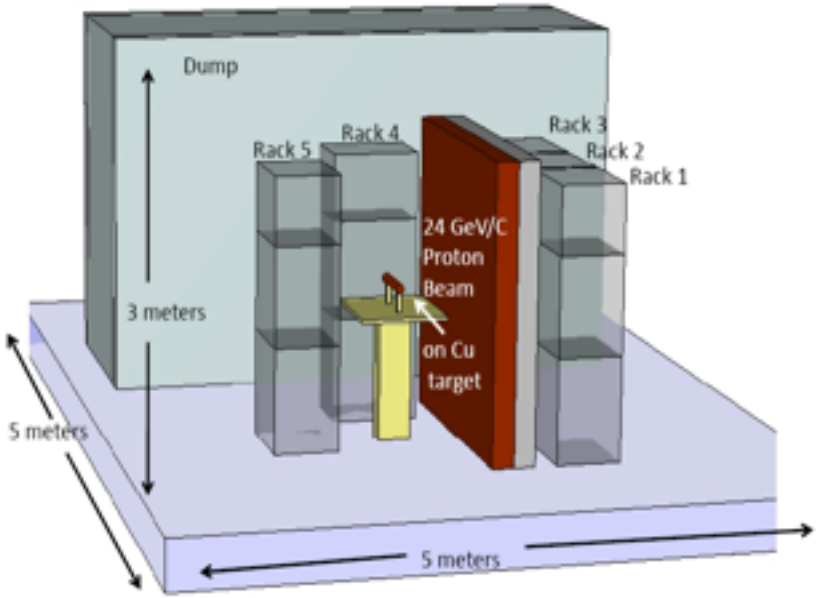
WP8: Improvement and equipment of irradiation and test beam lines

Michael Moll

- 8.1. Coordination and Communication
- 8.2. Test beams infrastructure at CERN and Frascati: feasibility, design and implementation study on a low energy beam to the range of 1 to 10 GeV.
- 8.3. Upgrade of CERN PS proton and neutron irradiation facilities
  - Improvement of existing irradiation facilities at CERN PS
  - Elaboration and evaluation of upgrade scenarios
  - Design and test of common infrastructure for the facility



Fluka simulations (E.Lebbos, EN)

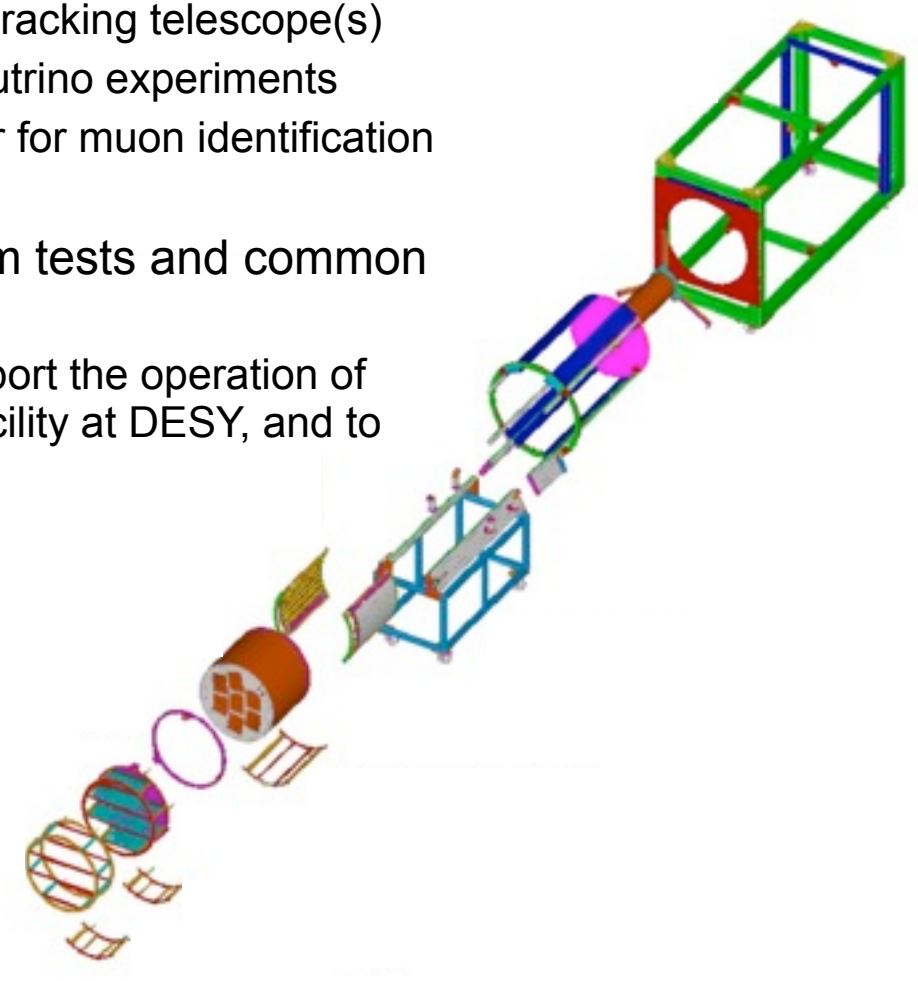


Layout of Mixed Field Area

WP8: Improvement and equipment of irradiation and test beam lines

Michael Moll

- 8.4. Qualification of components and common database
- 8.5. General infrastructure for test beam and irradiation lines
  - Commissioning and operated beam tracking telescope(s)
  - Develop and test TASD target for neutrino experiments
  - Develop and test MIND spectrometer for muon identification
  - GIFF++ user infrastructure
- 8.6. Coordination of combined beam tests and common DAQ
  - Ongoing and continuing work to support the operation of the former EUDET, now AIDA test facility at DESY, and to constant improvement of the setup.



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WP9: Advanced Infrastructure for detector R&D

- 9.1: Coordination and Communication
- 9.2: Gaseous detector facilities
  - upgrade an existing MPGD prototype which was constructed as part of the EUDET project in order to serve as a MGPD facility test area for a larger user community
  - common read-out system will be also developed and provided as part of the facility
  - upgrade workshop
- 9.3: Precision Pixel Detector Infrastructure
- 9.4: Silicon Tracking
  - large area tracking device to study granular calorimeter prototypes
- 9.5: Granular calorimeter studies infrastructure

similar programme as in EUDET, but much more overlap with the LHC community

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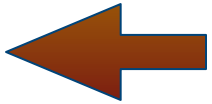
- 9.3: Precision Pixel Detector Infrastructure 
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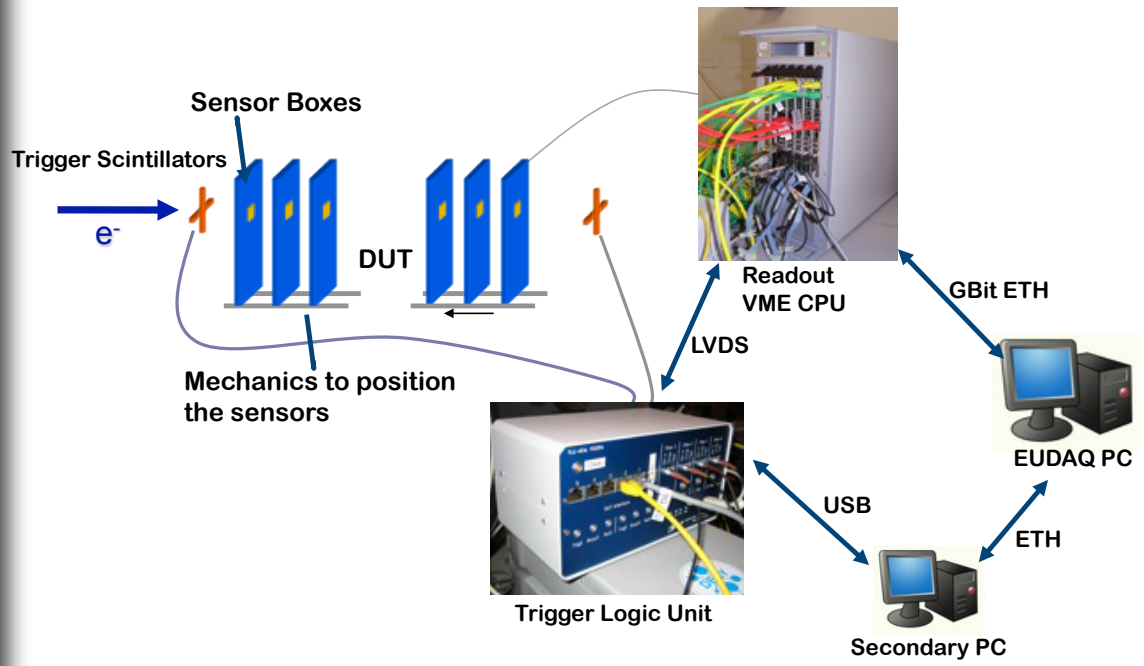
Reminder: EUDET Telescope



What is a beam telescope?

- A tool to define the exact track of a particle in a test 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).

Generally applicable:

- Detectors under test: from small pixel sensors to larger detectors
- Movement of device under test (DUT) to scan larger surface
- Large range of conditions: cooling, positioning, (B-Field)
- Easy to use: well defined/described interface
- Very high precision: <3 µm precision even at smaller energies
- Movable!

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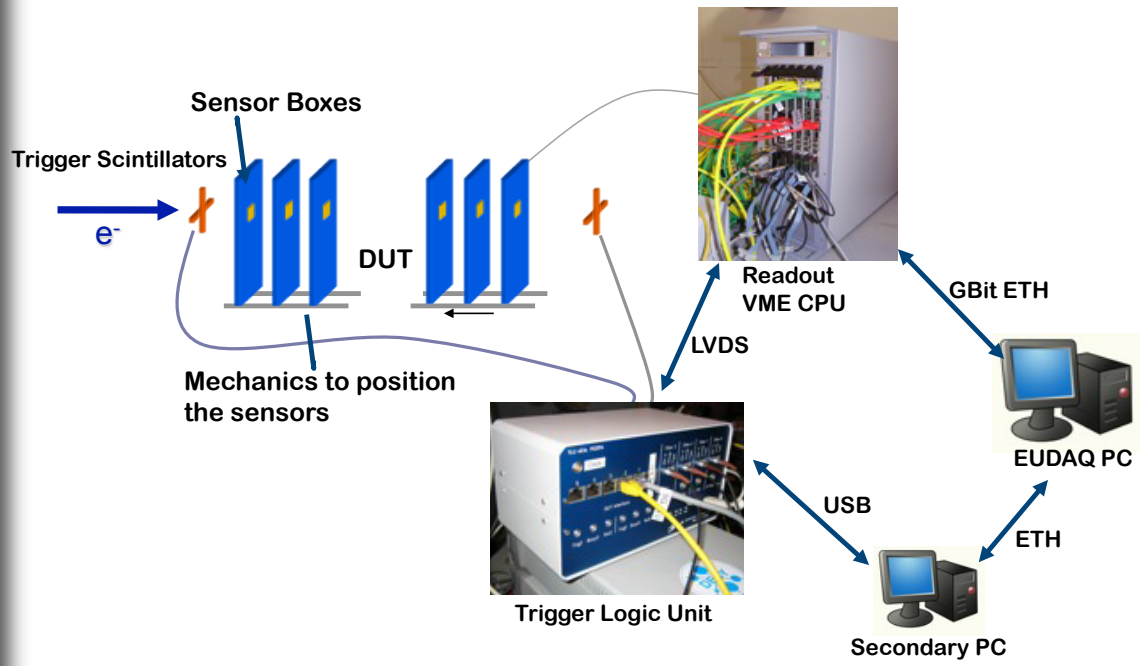

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Done !

Season 2011

- EUDET telescope used by many groups in 2011
  - ATLAS Pixel (3D, PPS, IBL and Diamond)
  - DEPFET, SiLC,...
- Telescope was running extremely smoothly over the season
- Finally had two weeks time to take data for telescope studies (remotely)
- Telescope arrived back at DESY last Monday 8:45 …

- Users scheduled for February till April at DESY
- New users: CMS pixels
- Plan to ship it back to CERN April/May 2012

Photo: Ingo Bloch

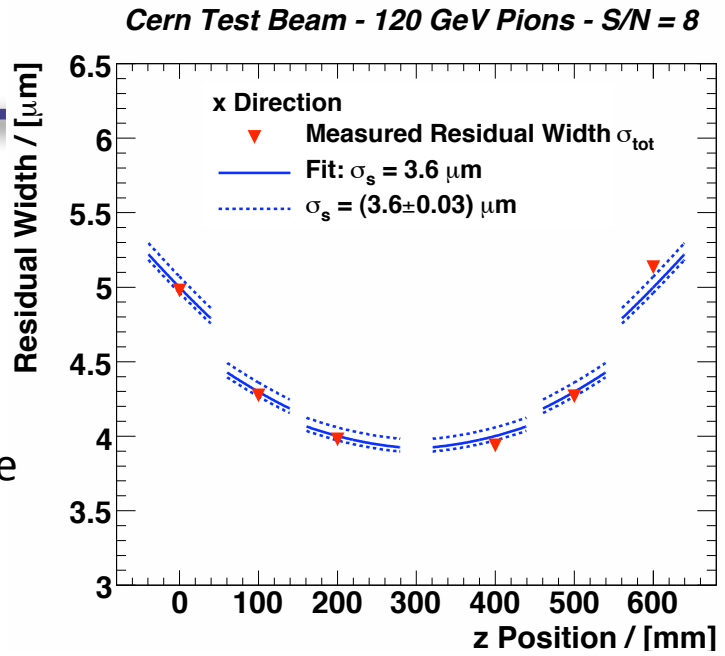
Neulich am SPS ….

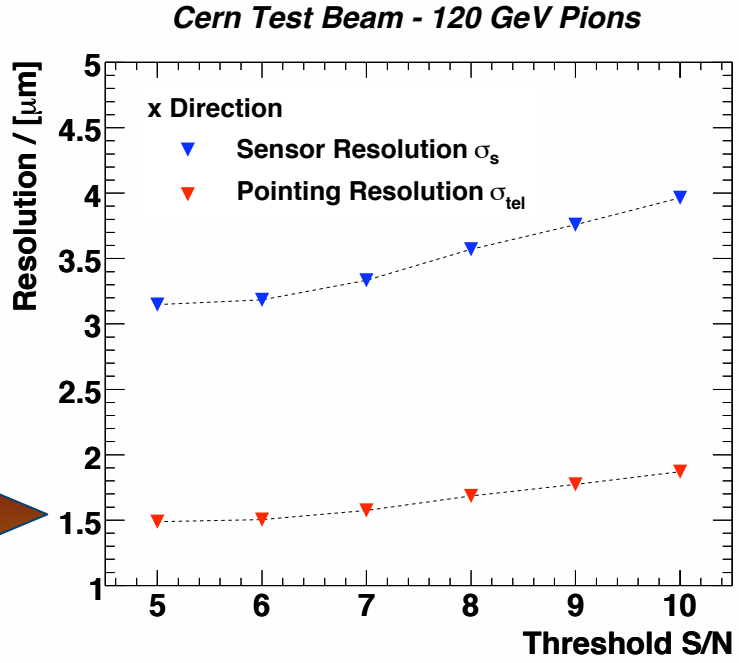
Performance 2011

- Dedicated data to measure performance of telescope (120 GeV pions, SPS Aug. 2011)
- 6 planes with Mimosa26 (50um thin, 18.4 um pitch)
- Included 5 planes in track fit and treated 6th plane as DUT -> measured resolution of all 6 planes
- Extract intrinsic resolution for each threshold setting
- Pointing resolution below 2um!

- Data taken and analysed by summer students in August 2011

DESY summer students 2011:
Cora Fischer
Silvan Kuttimalai
Ilya Khvastunov
...



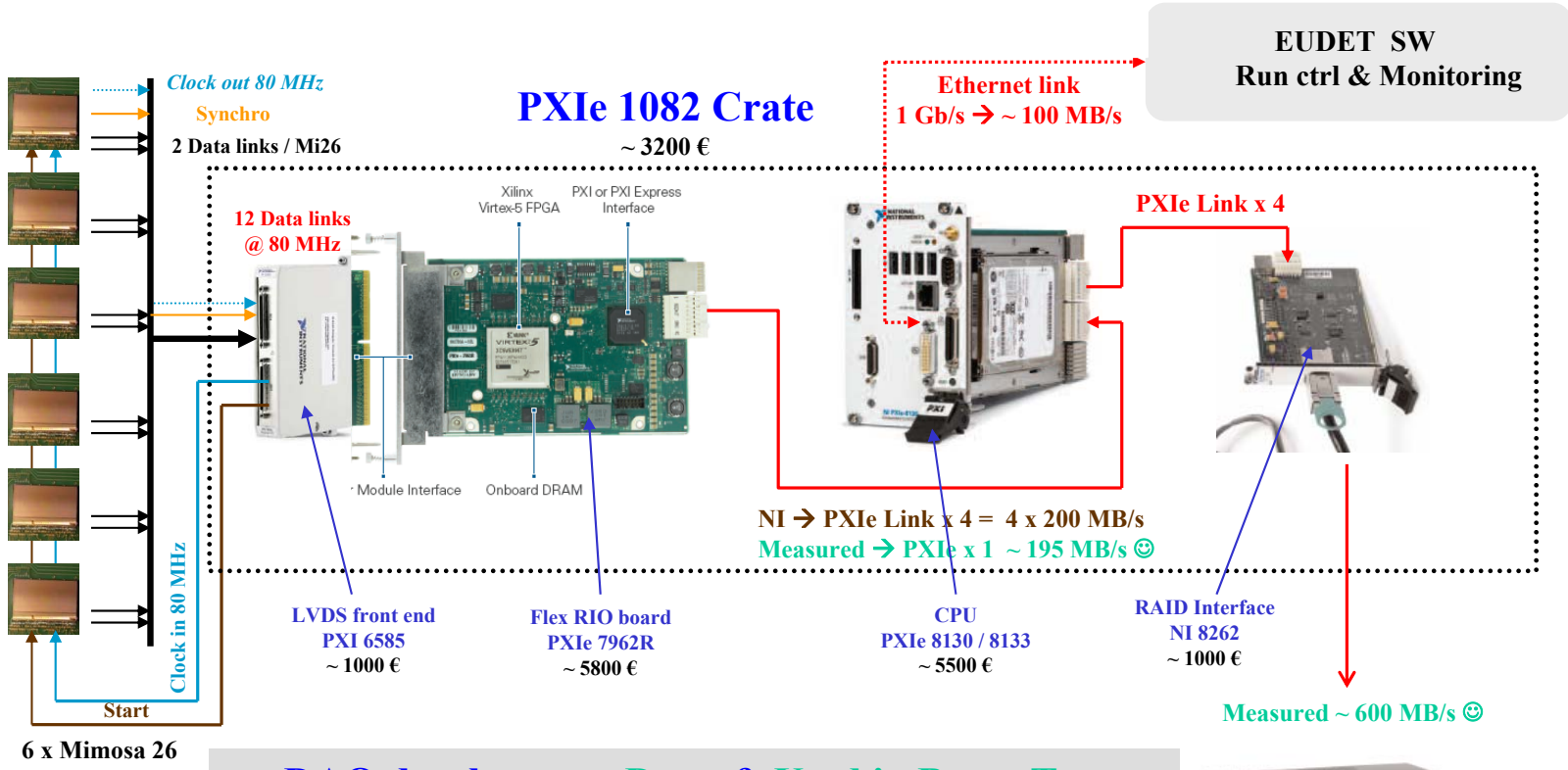


<2um!!

Upgrade of System in 2011

much faster …
ready for the future

- EUDET standard DAQ hardware (VME based)
- New system commercially available
- System set up by Strasbourg, connection to EUDAQ done by DESY



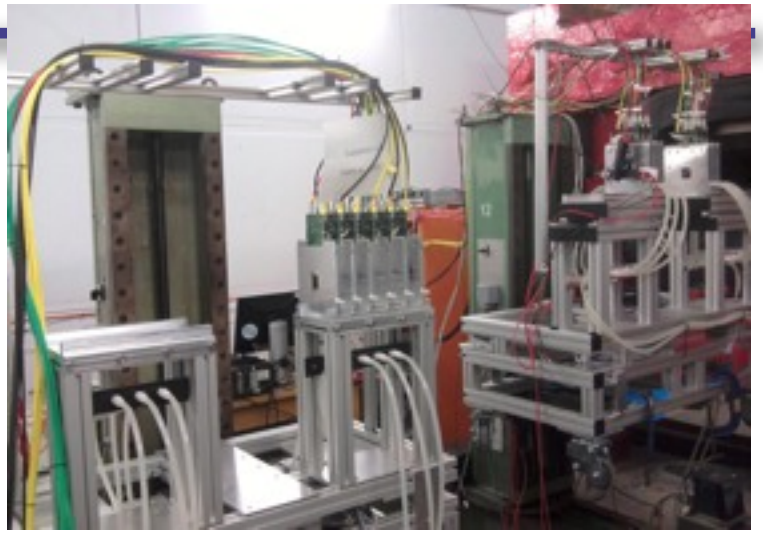
DAQ development Done & Used in Beam Test

- Telescope 6 x Mimosa 26 = 12 links @ 80 MHz = 120 MB/s
- Telescope 6 x Ultimate = 12 links @ 160 MHz = 240 MB/s

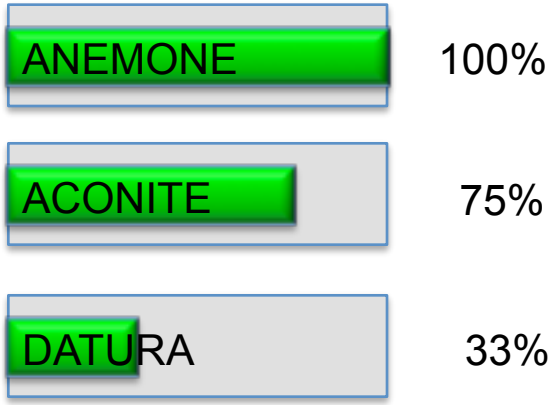
RAID Disk - 3 TB
HDD 8264

Telescope Copies

- From relative early on, we were discussing the possibility to copy the telescope
- Most important feature of EUDET copies: new DAQ hardware -> based on a commercial system (National Instruments PXIe)
- Trigger rate increased from 700Hz to >4kHz
- More than one trigger per frame possible



Telescope production line a la AIRBUS ...



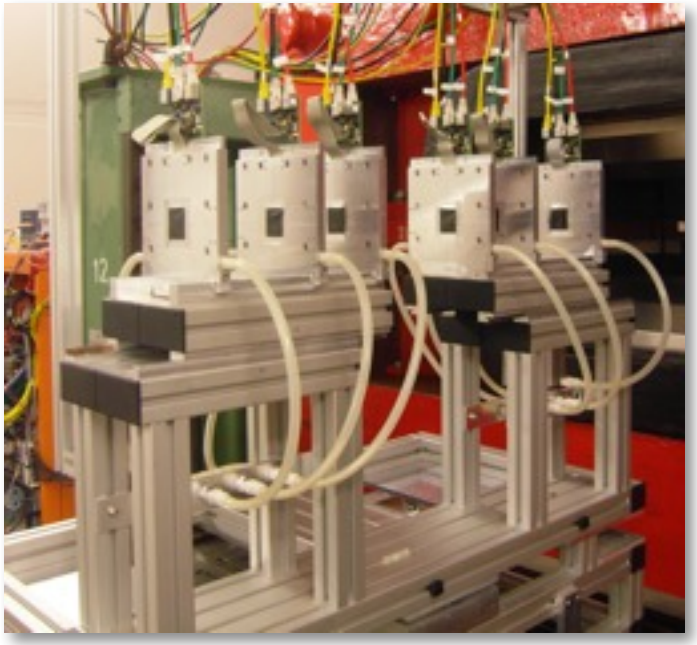
- Enables “easy” copies
  - Bonn copy (ANEMONE)
  - ATLAS copy (ACONITE)
  - DESY test beam (DATURA)
- Goal: to have **exactly** the same infrastructure at DESY test beam and CERN SPS test beam beams (spring 2012)

PHYSICS AT THE TERA SCALE Helmholtz Alliance

WP9: Advanced Infrastructure for Detector R&D

We have:

- 6 plane telescope (Mimosa26)
- pointing resolution ~1.5 um
- thin material
- 2x1 cm^2 active area
- trigger rate ~700Hz (EUDET)
- EUDAQ
- XY table



Want to add:

- LHC style reference planes (Timepix, FE-I4)
- keep pointing resolution ~1.5 um
- thin material (sometimes…)
- 4x6 cm^2 active area
- trigger rate ~10 kHz
- CO_2 cooling
- HV system and monitoring
- ….

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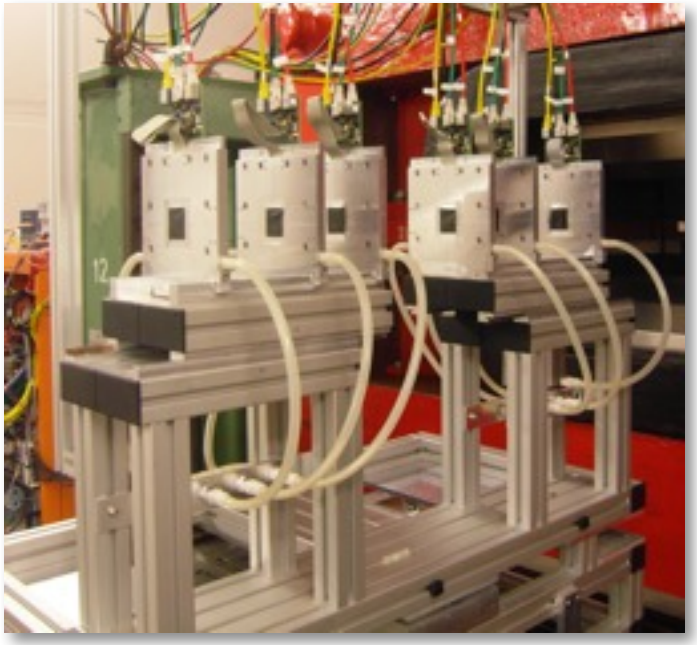

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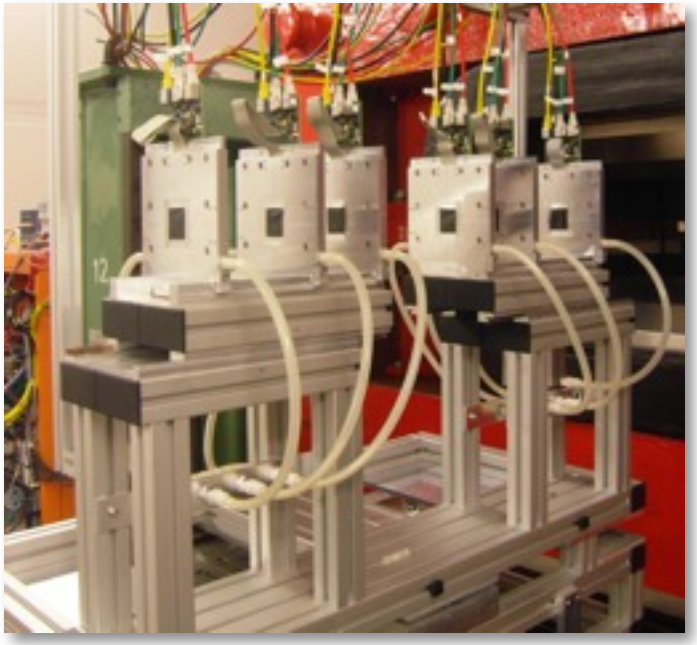

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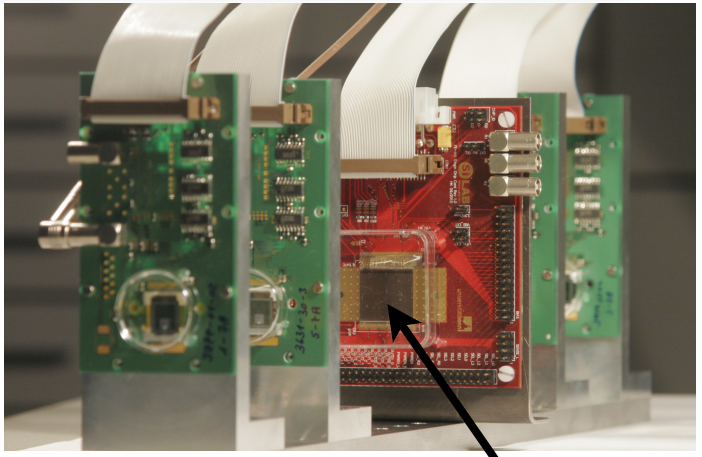
- ….

Maybe not all at the same time …

- modular flexible system
- down compatible

ATLAS FE-I4 Planes

- FE-I4 module based reference planes for a telescope with
  - high rate and high occupancy capability
  - large area ~4cm^2
  - high radiation tolerance (5 x 10^{15} n_{eq}/cm^2)
  - has been designed for ATLAS IBL
  - thoroughly been tested since one year

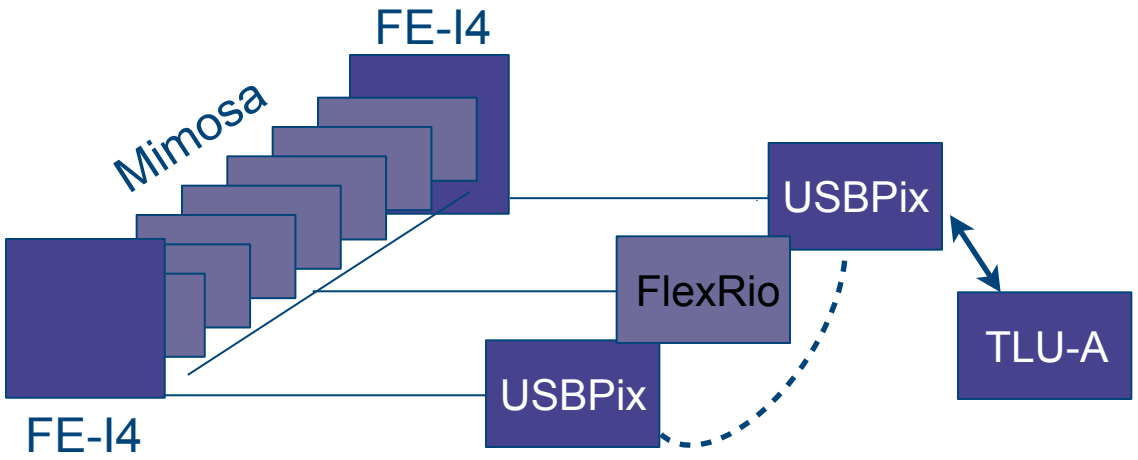


- R/O fully integrated in common infrastructure of the „AIDA telescope“ framework:
  - DAQ-software based on the EUDAQ package
  - uses TLU signal

- same readout concept (producer, online monitoring etc.)
- Current status
  - ATLAS FE-I3 and FE-I4 assemblies have been successfully integrated into the EUDET telescope as DUT
  - FE-I4 assemblies have been used heavily with the EUDET telescope in 2011

Track Tagging - First steps

- In order to take full advantage of the fast read out system for the Mimosa, track tagging would be necessary
- one solution: use fibre hodoscope
- nicer solution: ATLAS FE-I4 - self trigger option; region of interest selection



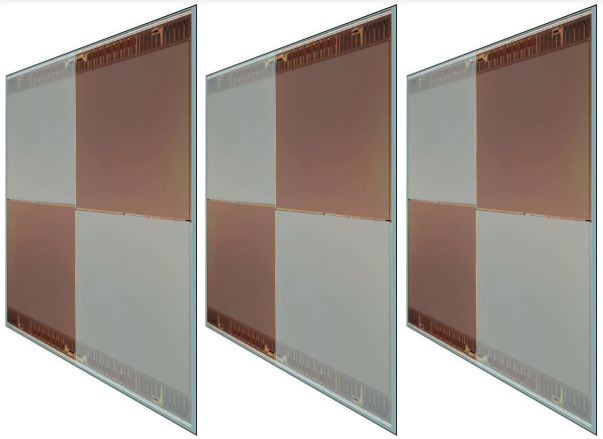
- USB-Pix triggers system
- TLU needs to be modified to accept trigger from DUT

- Telescope is triggered by hits in FE-I4; hit information is stored from Mimosas and FE-I4
- accept more than one trigger per Mimosa frame
- limited by speed of 10 kHz given by USB-Pix (not really slow)

Nice combination high resolution Mimosa and LHC speed FE-I4
=> higher speed and LHC style triggering done

Single Arm Large Area Telescope (SALAT)

- Next generation of Mimosas will be much larger
- Prominent features of SALAT :
  - very low material budget : 50 µm Si
  - high resolution : `4 µm in X & Y ⇛ beam particle impact position on DUT known within ~2µm(~1µm on reduced area)
  - large detection area : 4×6 cm^2
- Production of sensors in two steps:
  - Start with demonstrator based on MIMOSA-28 sensors
  - 4 chips of each 2x2 cm^2 placed on Mylar foil (small gaps)
  - Replace demonstrator sensors with final chips in 2014/15 : final configuration of SALAT available for BT users by 2015
  - active area ~4×6 cm2



SALAT

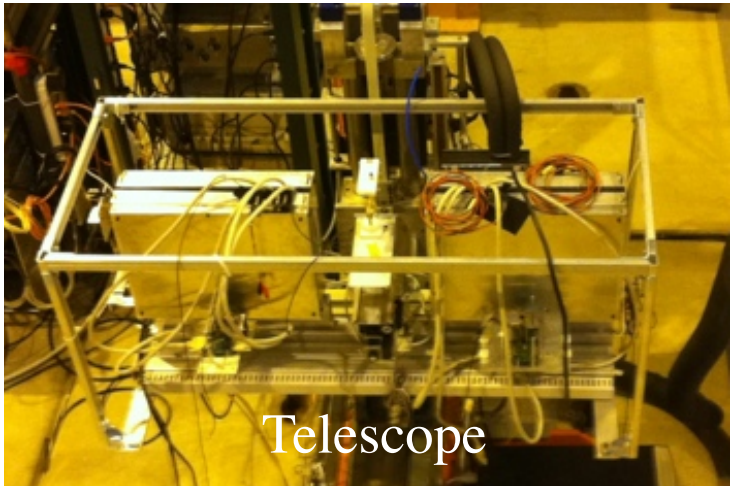
Mimosa28:

- active area: 960 columns of 928 pixels (19.9×19.2 mm2)
- pitch: 20.7 µm -> ~ 0.9 million pixels

Use 4 chip FE-I4 modules for trigger => large area telescope done

The Timepix Telescope

- Development started in 2009, successful operation in 2010, upgraded DAQ and infrastructure in 2011
  - Since the TimePix chip is read out on a frame basis, the global shutter to the telescope is held open for several (hundred) particles:
  - Crossed (co-incident) scintillator signal opens the global telescope shutter
  - While the shutter is open, scintillator triggers are passed on to the DUT (for generic trigger based readouts). Raw triggers can be sent, or triggers synchronous to a clock (such as 40 MHz LHC-style)
- After recording N triggers, or a shutter length of X, the shutter is closed and the whole telescope is read out
- Successful integration with FE-I4 recently (different DAQ concept)



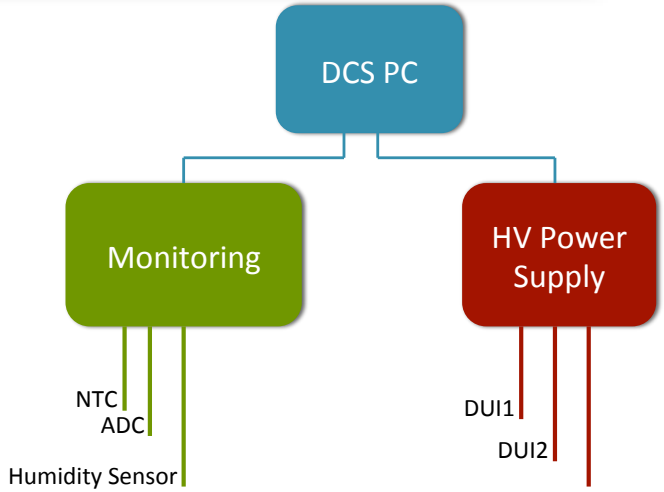
=> integration with existing TLU centered system not straight forward

- Timepix telescope is added to AIDA infrastructure as it is
- Possibilities to extend EUDAQ - TLU and Timepix system to provide user the same environment as with the current telescope are under study

Additional Infrastructure

HV System

- HV system for the use in the test beam ordered
- Individually floating 8 channels/module
- First modules defined for ATLAS pixels
- Different modules can easily be added
- Currently collecting the HV needs of the users



Monitoring

- Based on ELMB (Embedded Local Monitoring Board)
- Front end IO unit developed by ATLAS, CERN wide in use
- System will come with Windows PC and installed PVSS
- First parts available March 2012

CO2 Cooling

- A similar system as used with the Timepix telescope will be provided within AIDA

Conclusions

- EUDET was very successful and also a lot of fun
- AIDA is much more complex, more institutes and therefore more challenging
  - combining communities from LHC, LC and neutrino physics
- Transnational access travel support available for the community and people should really apply for this
  - CERN test beams
  - DESY test beams
  - Irradiation facilities
- Three copies of the EUDET telescope will be build, providing some availability around different test beam facilities
- A more advanced but down compatible test beam infrastructure will be build and provided within AIDA

If you want to know more ....

- AIDA Annual Meeting end of March at DESY
- Open to everybody

- https://indico.cern.ch/conferenceDisplay.py?confId=158341