

# JRA1 – INFRASTRUCTURE, TESTBEAM RESULTS AND OUTLOOK



**EUNET Extended SteeringGroup Meeting**  
Hamburg

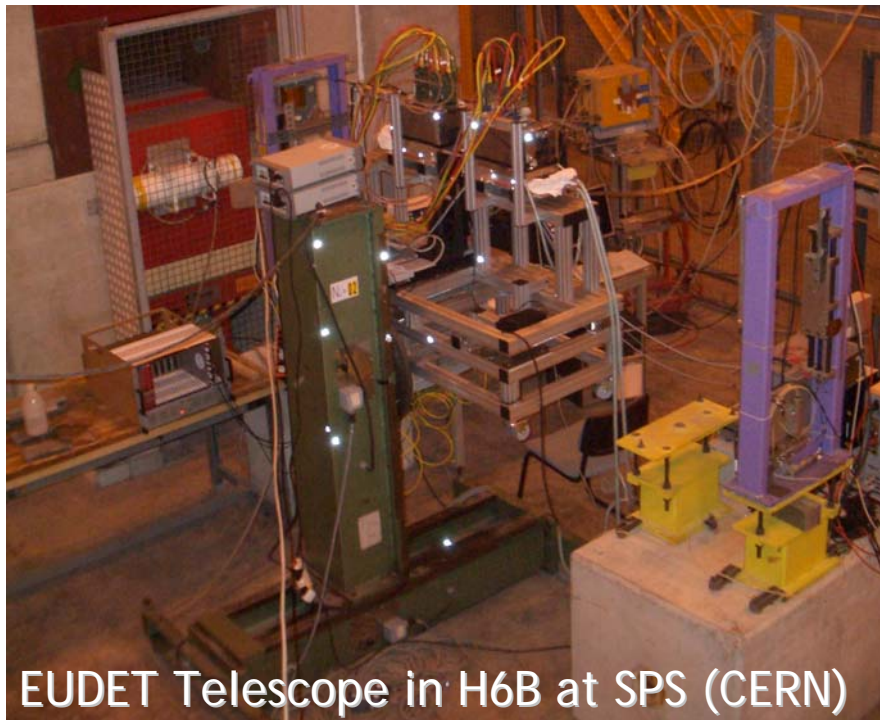
01. September 2008



Ingrid-Maria Gregor, DESY

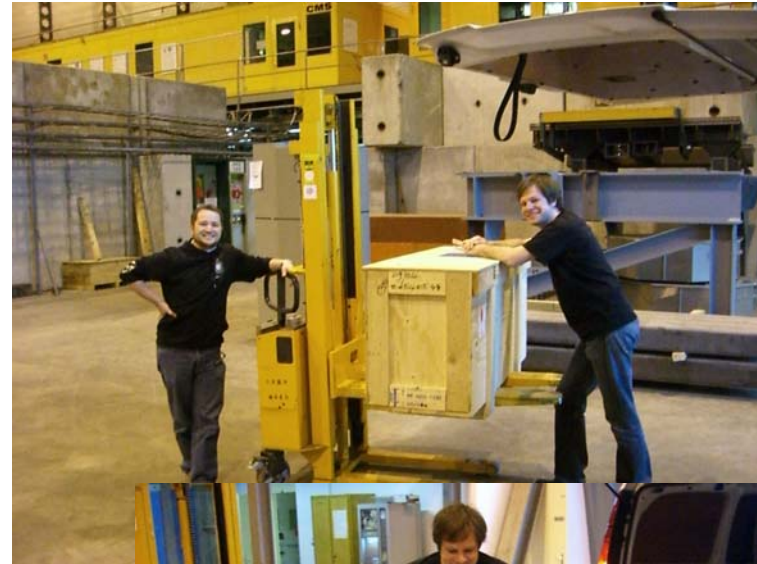
# INTRO

- In 2007 JRA1 **successfully** started the users business using the analog telescope
- 2008: very busy year -> 5 users
- In this talk: infrastructure, preliminary test beam results and outlook

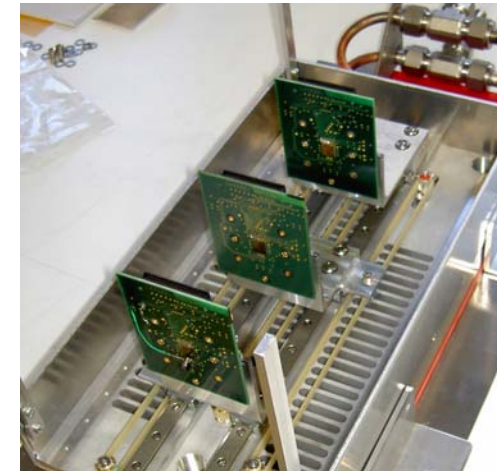
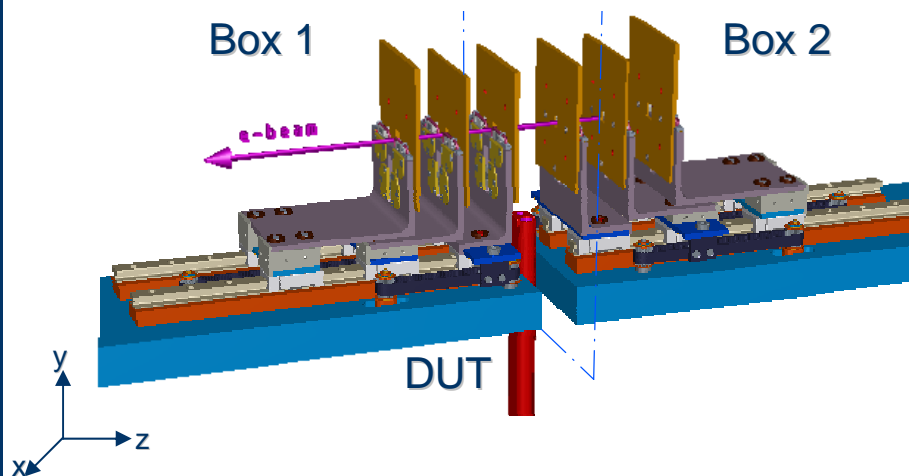


# INFRASTRUCTURE

- Infrastructure for JRA1 telescope is growing:
  - Mechanics
  - Cooling
  - Power supplies
  - Support XY table
  - DUT table
  - Computer for DUT positioner
  - Webpages
  - Analysis Software
  - Cables
  - Postdocs, Students ;-) ....



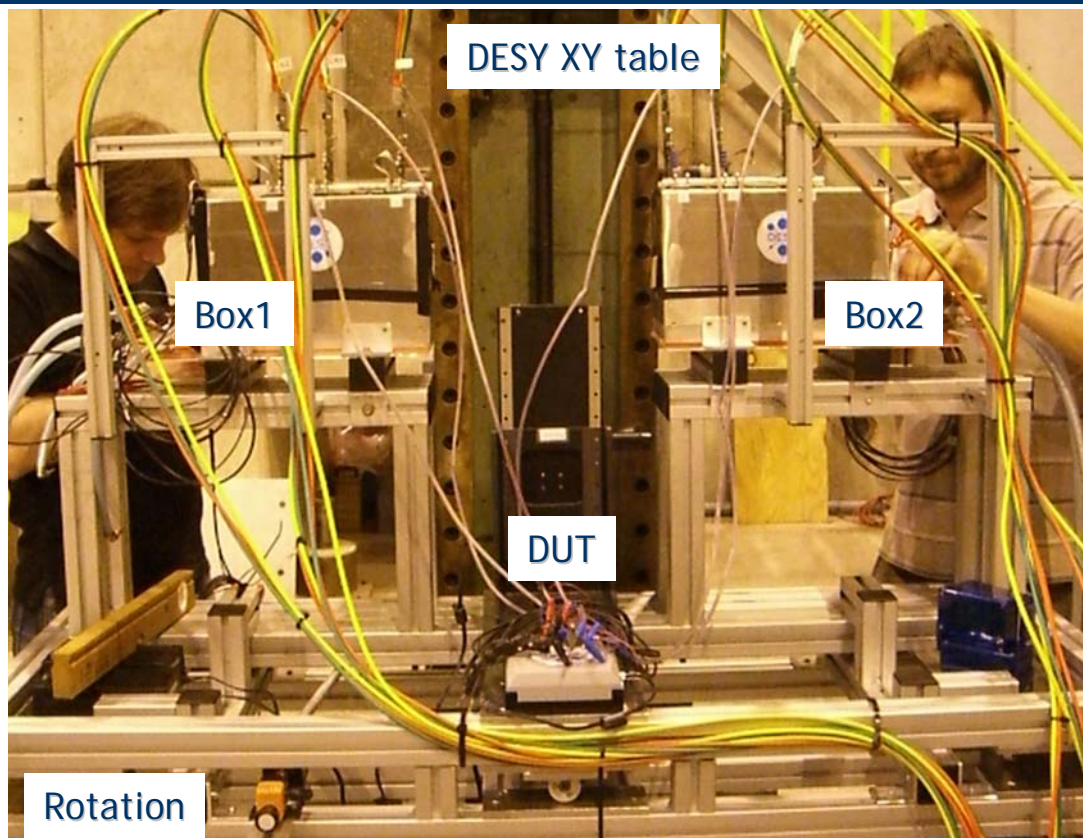
# TELESCOPE MECHANICS CONCEPT



- Box 1 and 2:
  - movable in z-direction, optical bench for three reference planes
  - distances between planes are variable between 2 and 150 mm
- DUT position:
  - Gap between Box 1 and 2: variable in size from a few cm up to 50 cm
  - DUT positioned on XYφ-table (optional)
- Optical benches inside box ease adjustment with respect to the beam



# THE REAL THING

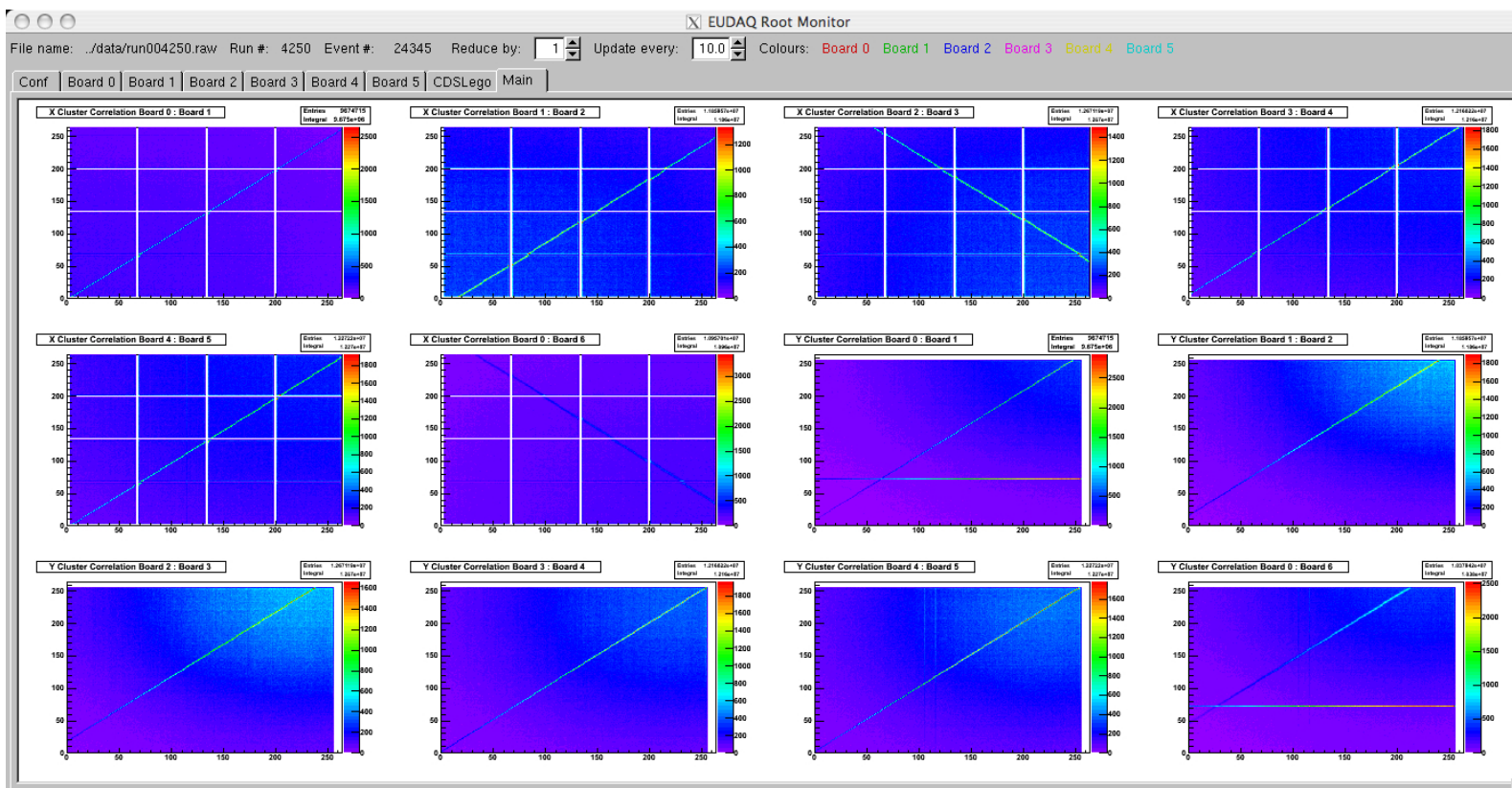


- Overall mechanics now rather big as we allow the insertion of rather large DUTs (e.g CALICE) with a size of up to 50cm
- “Rose&Krieger” mechanical profiles give the system a good flexibility while keeping a stable mechanics

- Rotation of generell telescope plane versus the beam axis (few degrees) improved the adjustment even further
- EUDET telescope sits on a big green DESY XY table to be moved in and out of beam (also at CERN)

# CURRENT PRECISION

- Alignment of telescope can be seen in online correlation plots



- Tedious adjustment of telescope into beam now much easier

# ROOM FOR IMPROVEMENT (MECHANICS)

- Box1 and Box2 still slightly misaligned (~1mm)
  - new support prepared by Carsten
- Position of sensor chips not known looking from outside
  - in case of small DUTs it is a bit tricky to make sure that the DUT is within active window -> alignment marks will be added
- Cooling is still an issue: we still have a rather large  $\Delta T$  between cooling device and sensors
  - Carsten is working on a new idea using heat pipes
- Telescope will be transported back to DESY around September 15<sup>th</sup>
  - will start to work on those issues right away



# WHAT DO WE OFFER TO THE USERS ?

## All-inclusive Package

- The two arm telescope with different geometries with the possibility to add one extra high resolution sensor plane.
  - The telescope comes with all the mechanics and the cooling system for the reference sensors.
  - Operating support: mainly remote but also local in some circumstances.
- The DAQ system; both hardware and software.
  - You can connect your device to our TLU, or (better) help is provided to integrate your R/O in our DAQ software.
- The analysis and reconstruction software.
  - As for the DAQ, you can rely on our output track file, or integrate your device in the main analysis stream.




# USERS INFORMATION WEBPAGE

- EUDET -> JRA1 -> Users Information

The screenshot shows a Mozilla Firefox browser window displaying the 'JRA 1 - Users Information' webpage. The browser's address bar shows the URL 'http://www.eudet.org/e13/e727'. The page has a left sidebar with a navigation menu for 'JRA1' containing links to 'Users Information', 'Documents', 'Testbeams', 'Team', and 'Meetings'. The main content area is titled 'JRA 1 - Users Information' and contains the following text:

Within EUDET JRA1 a high resolution telescope is being developed. This telescope is available to use it for tests at test beams, mainly at DESY or CERN. If you would like to use this telescope, please contact Ingrid-Maria Gregor ([Ingrid.gregor@desy.de](mailto:Ingrid.gregor@desy.de)) for more information. The application for the telescope within the Transnational Access of EUDET can be found [here](#).



The "package" we offer to the user comprises the telescope itself, trigger hardware, readout computer, DAQ software and analysis software. Please find detailed information below.

The telescope consists of two arms each equipped with three layers of pixel sensors. Between these arms the device under test (DUT) can be placed. A technical drawing of the whole mechanical setup can be found [here](#). The DUT can be moved in x and y direction using precise actuators (the beam axis is the z-axis), as well as rotated in small steps with respect to the beam axis.

- **Phone Numbers**  
A list with phone numbers can be found [here](#).
- **"Data Taking Manual"** ([link](#))  
This manual is intended to enable unexperienced users to take data using the pixel telescope.
- **EUDET running with DUT** ([link](#))  
This page summarises special commands for the case of DEPFET and MIMOROMA being the DUT.
- **DUT table movement** ([link](#))  
The DUT is mounted on an x-y-table, that can be moved from outside the experimental area with the MAC used for data taking.

The Windows taskbar at the bottom shows the 'start' button and several open applications: 'zenith40.desy.de - P...', 'Microsoft PowerPoint...', and 'JRA 1 - Users Inform...'. The system clock in the bottom right corner indicates '18:01'.

# USERS INFORMATION WEBPAGE

## ● Links with online help

### ■ Phone Numbers

A list with phone numbers can be found [here](#).

### ■ "Data Taking Manual" [\(link\)](#)

This manual is intended to enable unexperienced users to take data using the pixel telescope.

### ■ EUDET running with DUT [\(link\)](#)

This page summarises special commands for the case of DEPFET and MIMOROMA being the DUT.

### ■ DUT table movement [\(link\)](#)

The DUT is mounted on an x-y-table, that can be moved from outside the experimental area with the MAC used for data taking.

### ■ Some Remarks for the DAQ PC [\(link\)](#)

This page summarises the necessary actions after the restart of the MAC for setting up a Parallels Desktop with Linux and correct network connections.

### ■ Boot setup for the MVME6100 [\(link\)](#)

A description of the boot setup for the MVME6100.

### ■ "JRA1- Data Acquisition System" [\(link\)](#)

This memo describes the data acquisition system, giving an overview of actual hardware and software developments.

### ■ "EUDAQ Software" [\(link\)](#)

The DAQ software for the pixel telescope and some technical documentations can be found on the web page mentioned above.

### ■ "JRA1 Trigger Logic Unit" [\(link\)](#)[\(link\)](#)

These memos describe the JRA1 trigger logic unit.

# USERS INFORMATION WEBPAGE

- Links for the analysis software

- "EUTelescope Software"

- "EUTelescope: Tracking Software" ([link](#))

This memo describes the software tool performing all the off line procedures needed to extract from the data acquired DAQ the precise spatial information. The current status of the development of the tracking software tool named EUTek as well as foreseen future improvements are specified.

- "Software Tutorial" ([link](#))

In this tutorial a short step-by-step analysis is described using a set of example steering, raw and lcio files. All files mentioned in this tutorial are available [here](#).

- "EUTelescope Software" ([link](#))

On the EUTelescope documentation server explanations and examples that might be needed to run the EUTelescope processors within Marlin are given. The CVS repository can be found [here](#).

- Whenever we see a gap in the documentation we add the information directly on the webpage
- Feedback from the users was very helpful

# TEST BEAM CAMPAIGN 2008

- Five users within Transnational Access 2 -> all using the telescope at CERN (PS and SPS)

DATE	BEAM	USER	CONTACT
21.04 – 27.04.	Cadarache	IRSN	Wojtek Dulinski
28.05. – 04.06.	CERN SPS	SiLC	Thomas Bergauer
10.07. – 16.07.	CERN PS	CALICE	Imad Laktineh
17.07. – 30.07.	CERN PS	DEPFET	Julia Furletova
07.08. – 10.08.	CERN SPS	MimoRoma	Eleuterio Spiriti
14.08. – 26.08.	CERN SPS	DEPFET	Julia Furletova
27.08. – 03.09.	CERN SPS	ISIS	Jaap Velthuis
04.09. – 11.09.	CERN SPS	EUDET	Philipp Roloff

- Thanks to: Jörg Behr, Silvia Bonfanti, Antonio Bulgheroni, Isabell Melzer-Pellmann, Loretta Negrini, and especially Daniel Haas, Emlyn Corrin and Philipp Roloff

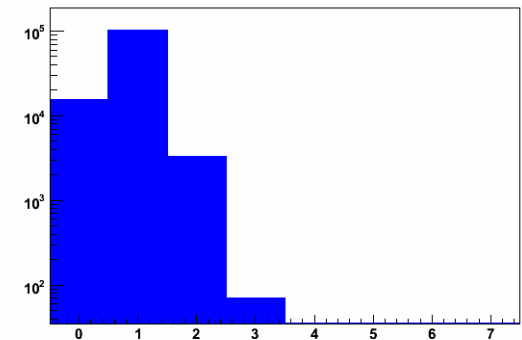


# PERFORMANCE OF EUDET TELESCOPE

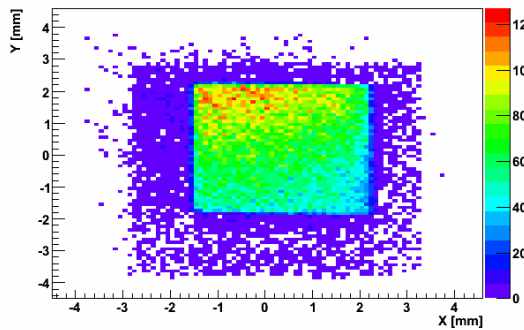
## ZERO SUPPRESSED WITH 6 PLANES

- In 2007 we could run maximum 5 planes due to a problem with the VME crate
- 2008: First time that we had 6 planes in zero suppressed mode running

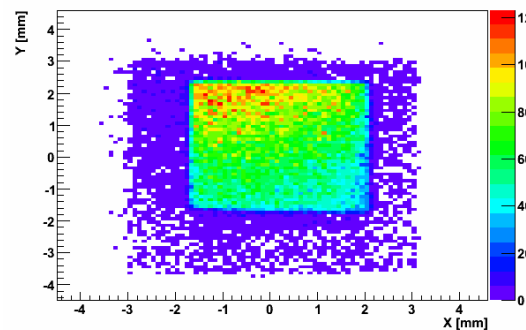
Number of tracks fitted per event



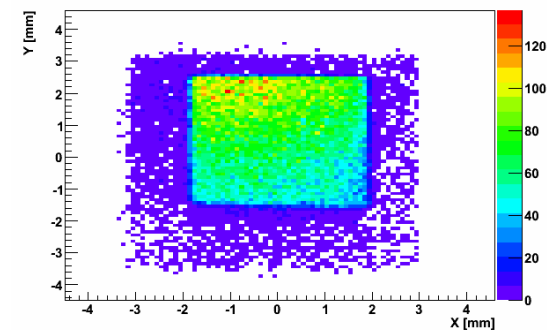
Track positions in Sensor 0



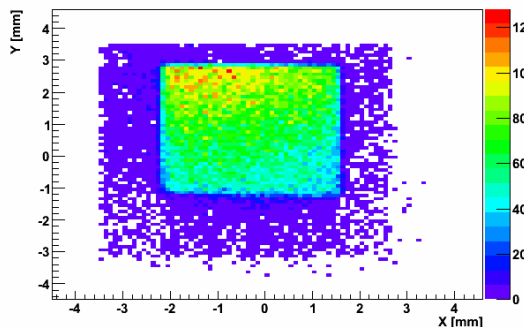
Track positions in Sensor 1



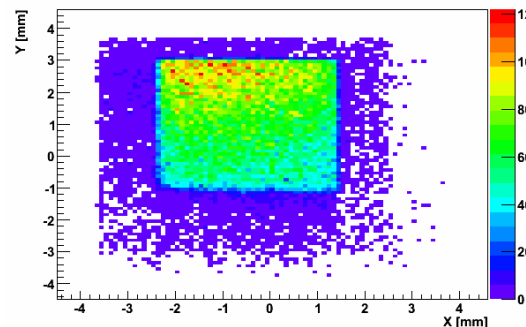
Track positions in Sensor 2



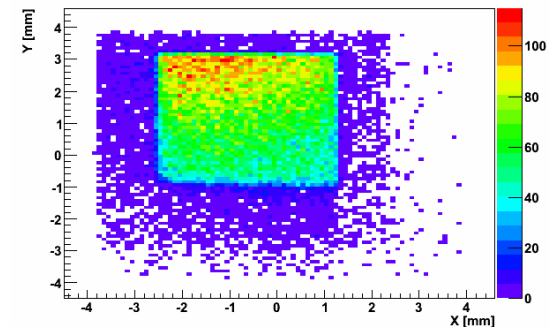
Track positions in Sensor 3



Track positions in Sensor 4



Track positions in Sensor 5



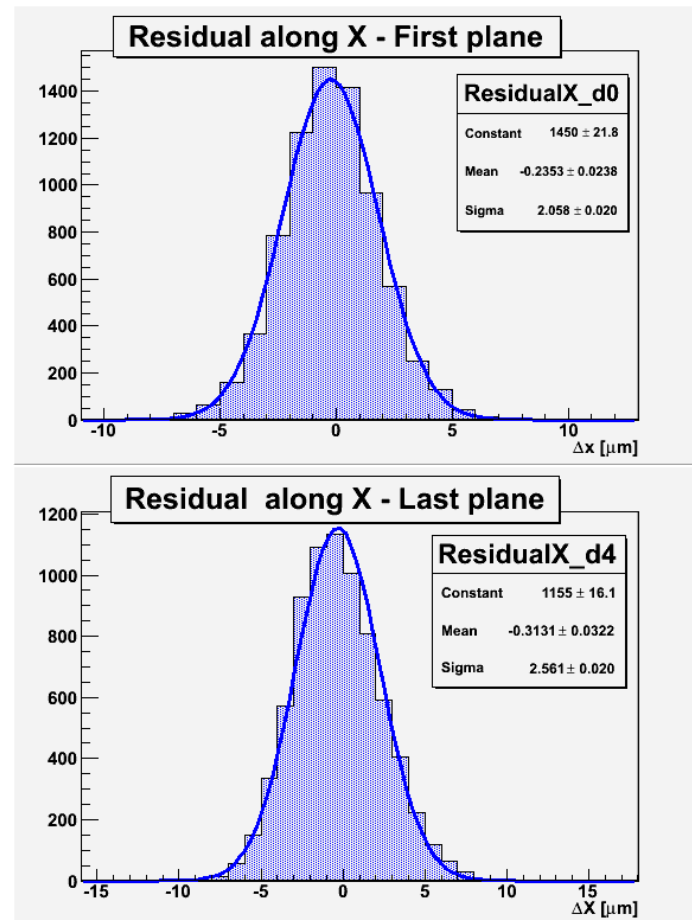
# PERFORMANCE OF EUDET TELESCOPE

## ALIGNMENT

- The alignment procedure based on MILLIPEDE II uses full tracks
- Typical values for the alignment constants
  - X and Y shifts: few 100 $\mu\text{m}$
  - Rotation around beam axis: few mrad

Plane	Residuals X average value [ $\mu\text{m}$ ]	Residuals Y average value [ $\mu\text{m}$ ]
0	$-0.003 \pm 0,002$	$-0.023 \pm 0,002$
1	$-0.015 \pm 0.004$	$0.036 \pm 0.005$
2	$0.032 \pm 0.004$	$0.005 \pm 0.005$
3	$-0.020 \pm 0.004$	$-0.005 \pm 0.005$
4	$0.001 \pm 0.002$	$0.002 \pm 0.002$

(3 GeV electrons at DESY- old)

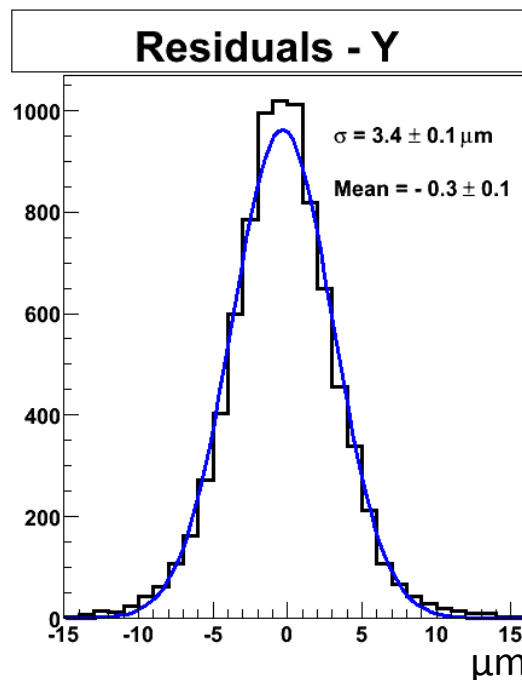
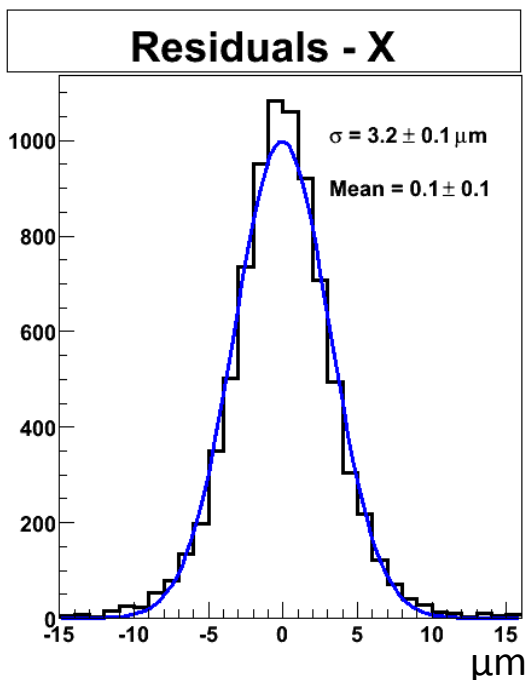


➔ Precision of alignment better than 0.05  $\mu\text{m}$ !

# PERFORMANCE OF EUDET TELESCOPE

## RESOLUTION

- With hadrons-> neglect multiple scattering
- Straight line fitting procedure using four planes only and extrapolating on the central one
- Fitting on x and y independently
- $\chi^2$  cut < 20

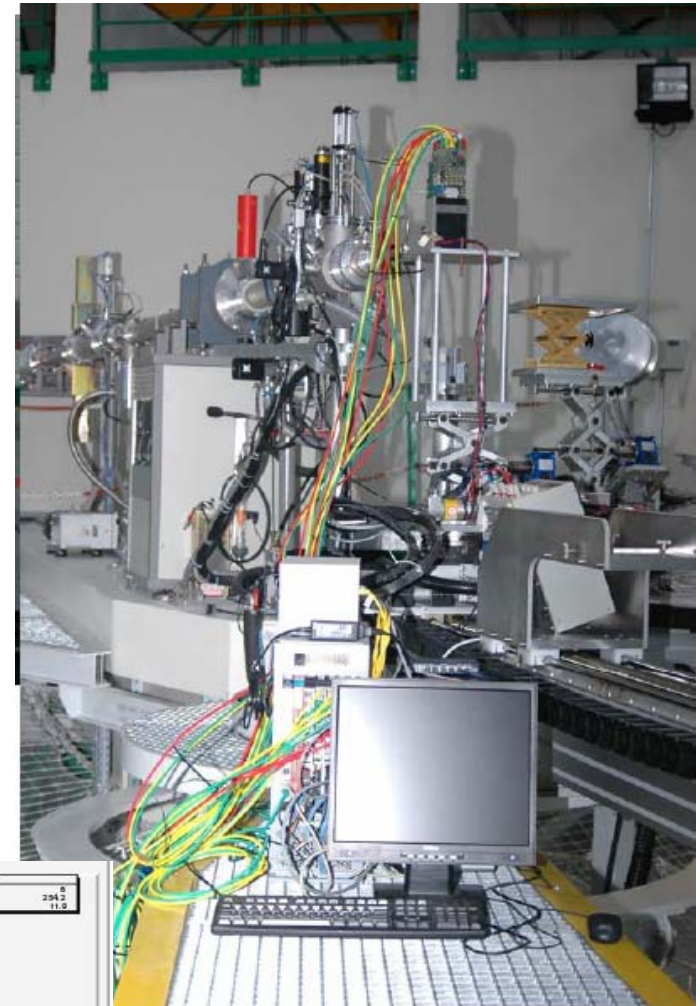
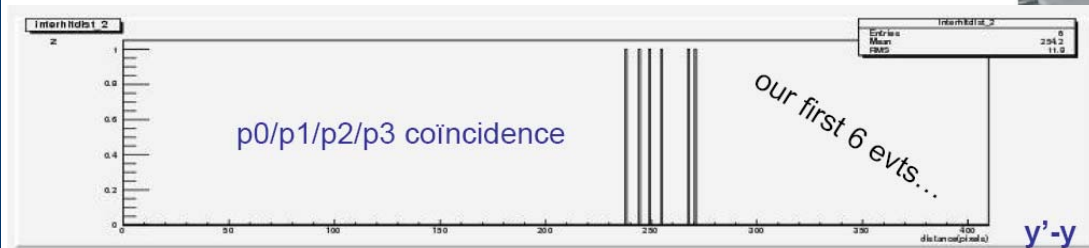
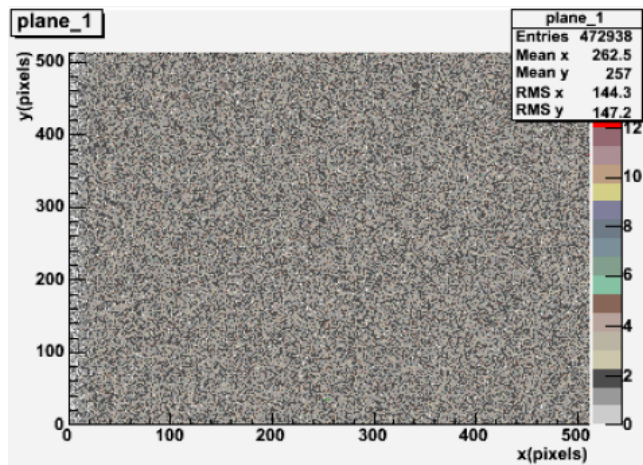


Observed width:  
 $\sigma = 3.3 \mu\text{m}$

Agrees with expectation:  
 $\sigma_{\text{MimoTEL}} = 3.0 \mu\text{m}$

# USER: IRSN IN CADARACHE

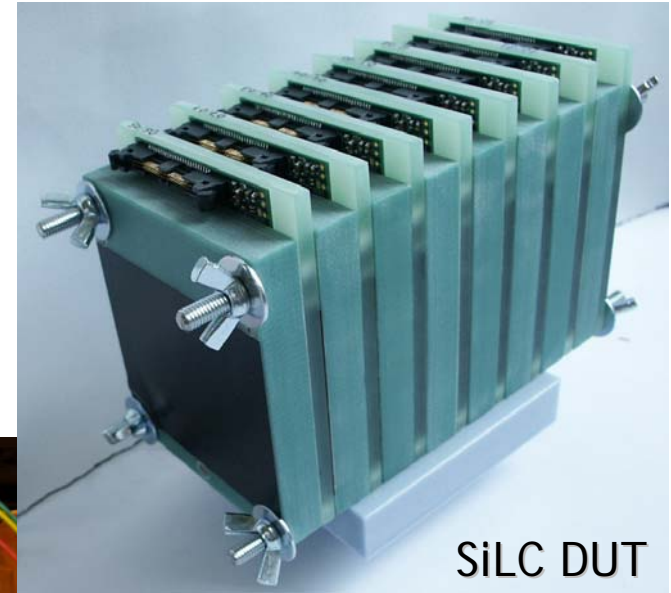
- Would like to use CMOS pixel sensor for neutron detection
- People from IPHC/RAMSES and IRSN/LMDN used the TAPI telescope with thinned Mimosa18 for a very first test
- EUDRB readout, DAQ software and team





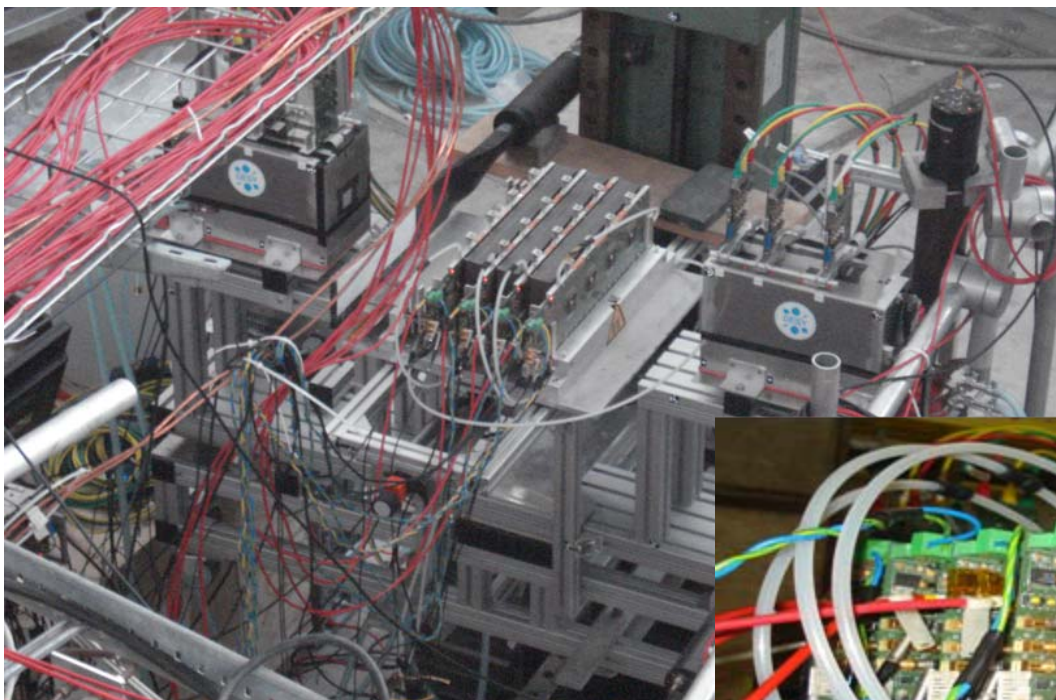
# USER: SiLC AT SPS

- Evaluate the best strip geometry of silicon strip sensors with 50 micron pitch to achieve the highest possible spatial resolution
- collected about **1.5M events** in several configurations
- Very happy with EUDET telescope
- More details in Amsterdam



# USER: CALICE – DHCAL AT PS

- to validate a **new concept** of a digital hadronic calorimeter
- sampling calorimeter constructed as a sequence of stainless steel absorbed plates and planes of **gaseous detectors with high granularity and digital readout**
- Gaseous detectors: GRPC and  $\mu$ MEGAs
- Readout: based on hardroc chip

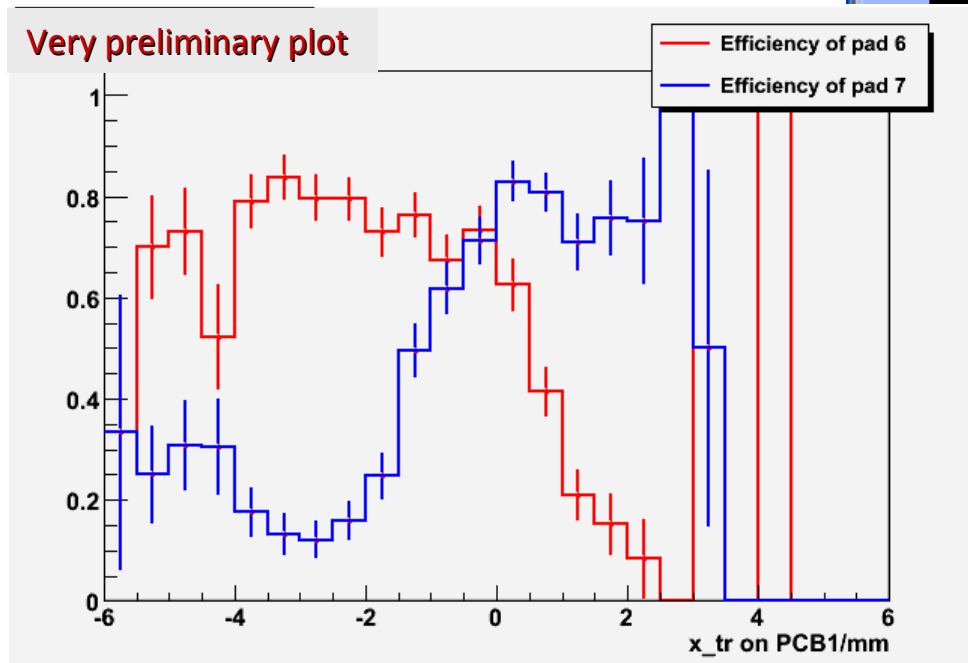


- study the efficiency and cross-talk in diff. beam conditions
- different gas mixtures and different high voltage values to optimise the detector response

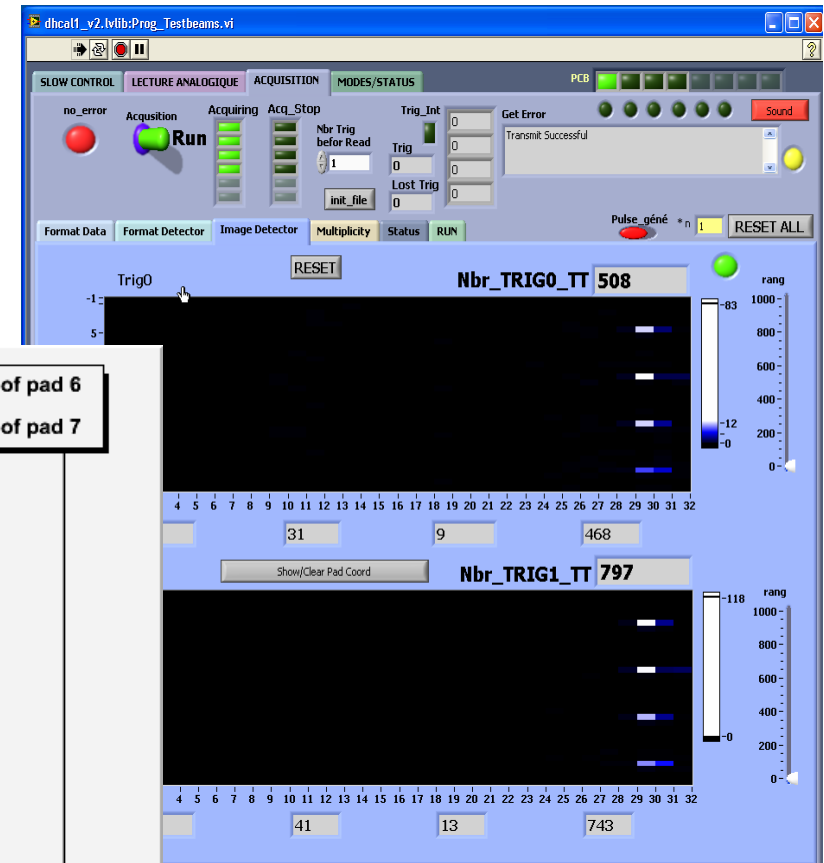


# USER: CALICE – PRELIMINARY RESULTS

- Unfortunately PS had a magnet problem and they had no beam during their allocated time
- Thanks to DEPFET CALICE could stay in PS and had the possibility to take good data



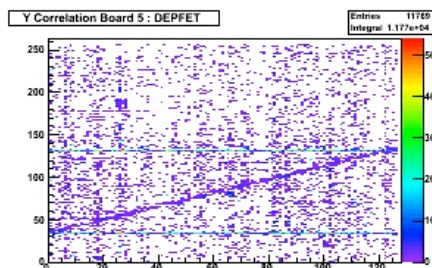
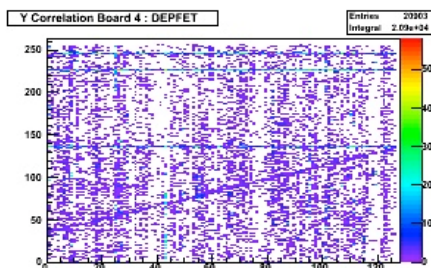
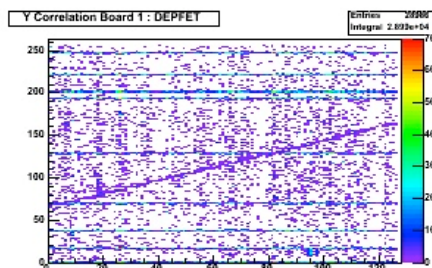
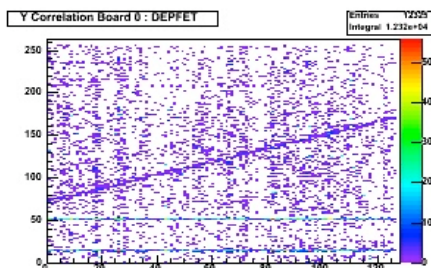
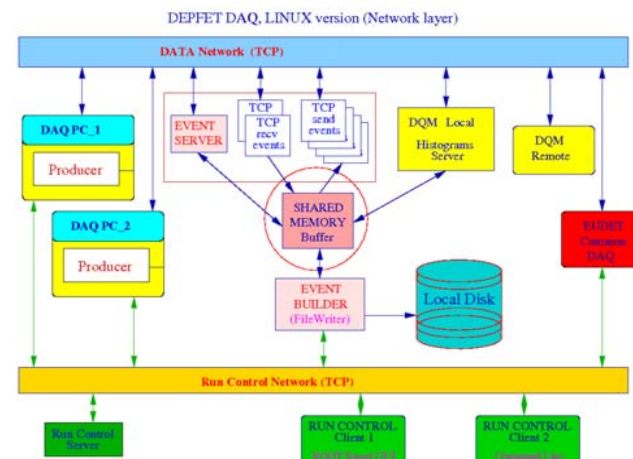
Two adjacent calorimeter pads; track information from EUDET telescope





# USER: DEPFET AT PS AND SPS

- At PS DEPFET efficiently worked on all little details for the user integration
- At SPS the main goal was measurements of efficiency, purity and intrinsic resolution
- DEPFET included on DAQ level -> own producer within EUDAQ -> one data stream
- 1 Million events as EUDET DUT !
- First results at Annual Meeting



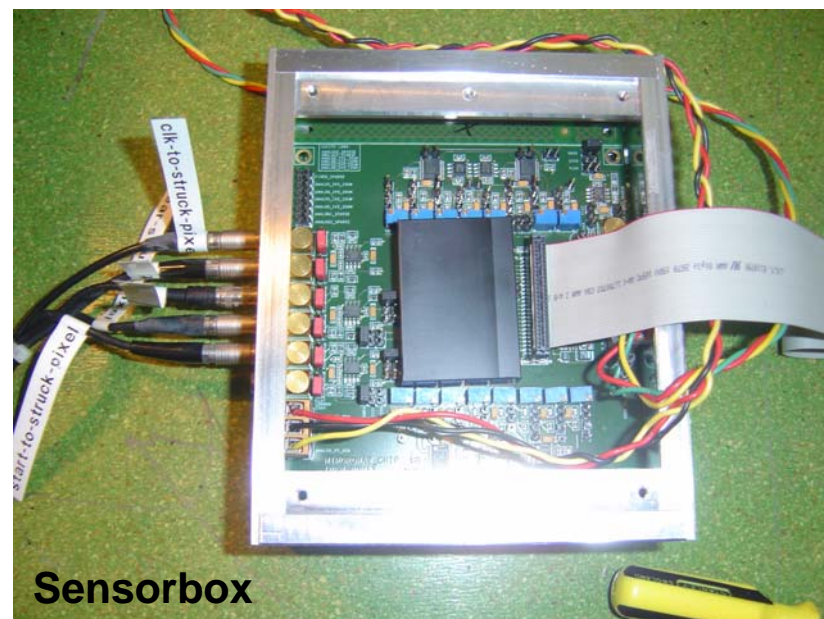
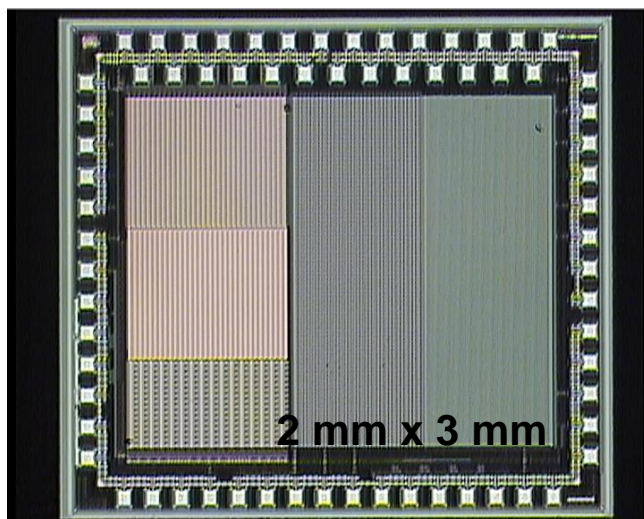
Correlartion plots in EUDAQ Root Monitor



# USER: MIMOROMA AT SPS

## Chip: mimoroma2

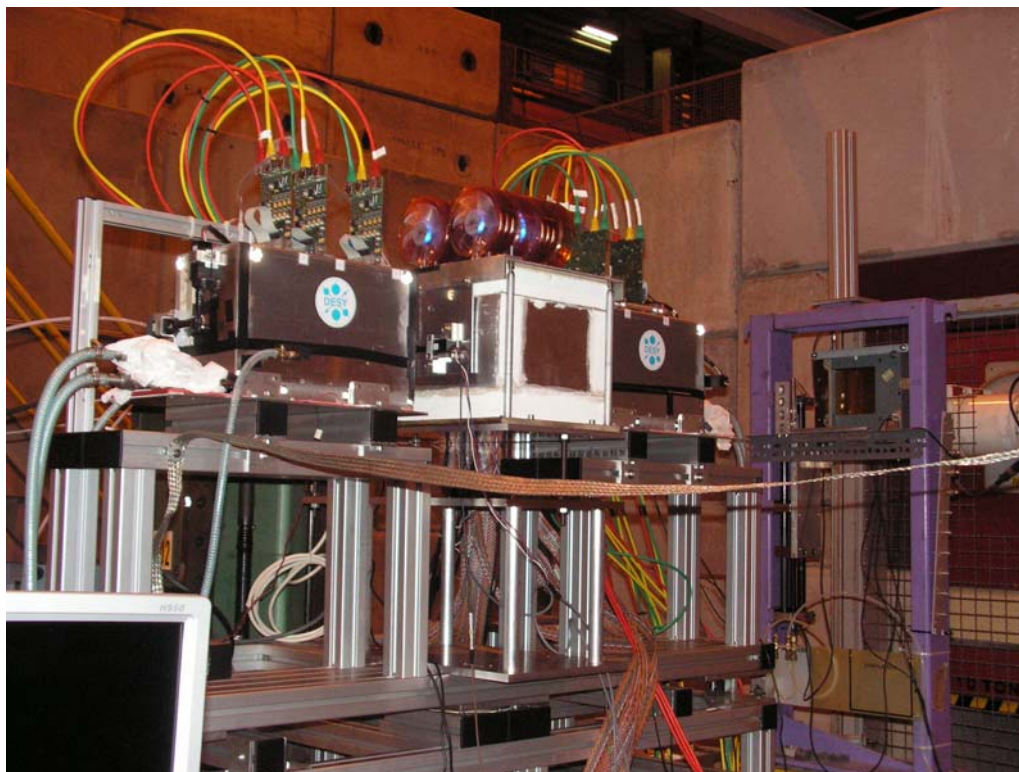
( STMicroelectronics 130nm technology )



- MimoRoma group managed to get the chip ready for beam in a very short time
- Switched from DEPFET to MimoRoma within hours
- MimoRoma producer (by Antonio Bulgheroni) implemented without problems
- First night 70k events
- Afterwards: SPS had a problem, no further data

# USER: ISIS AT SPS

- Self contained telescope @ DESY provided useful information.
- Want to run at CERN with high precision telescope and high momentum beam
  - Charge collection efficiency, charge sharing, hit-efficiency as function of position
- Use “p-well variant” ISIS



- Seems to be more tricky to synchronise

# WHAT DID WE LEARN THIS SUMMER

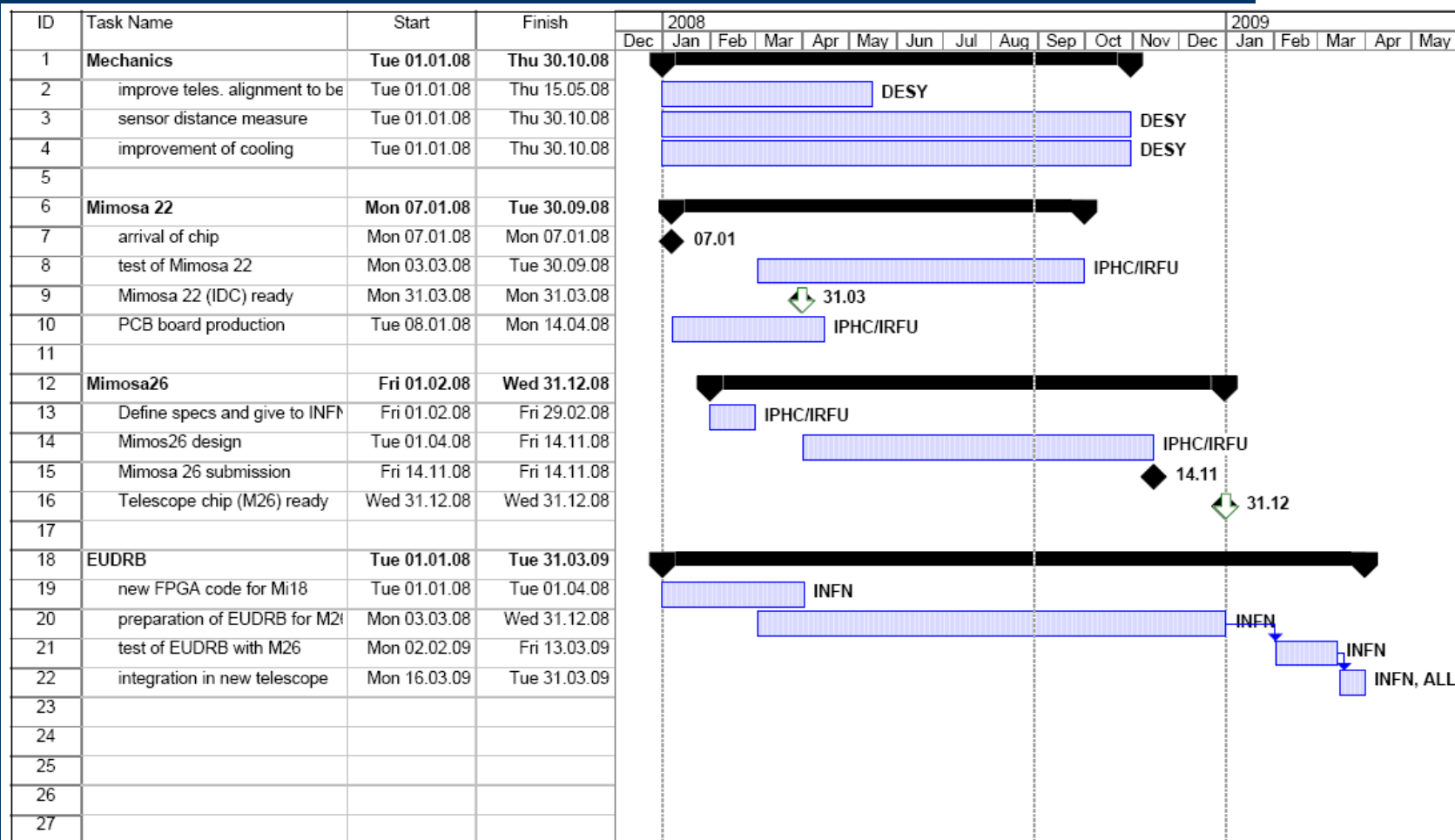
- To make the telescope a true infrastructure for outsiders is a lot of work!
- Items we have to keep in mind for next test beam campaign outside of DESY (2009):
  - Certify EUDRB firmware (at DESY test beam)
  - When moving to different location (e.g. CERN) allocate some time with standalone data taking before users arrive (3 days)
  - Even better documentation for user integration -> users mostly have problems with the integration of the TLU signals in their system
  - Created to-do list to help the start up



# EUDET TELESCOPE OUTLOOK

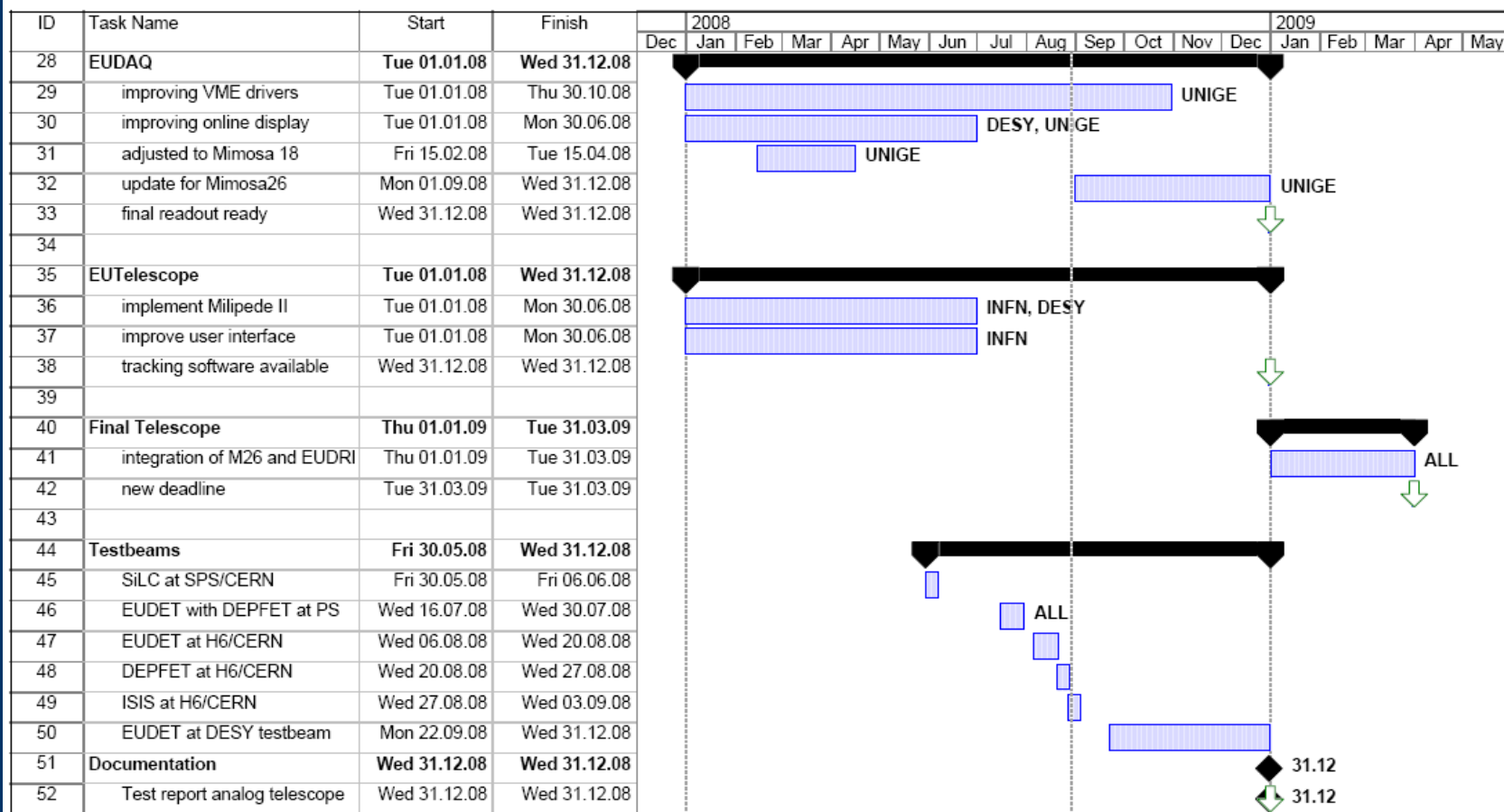
- The intensive users time with 5 users in a row (at CERN) will be finished in two weeks
- The telescope was 16 weeks at CERN, 13 weeks of them in data taking mode (a few million events)
- Telescope will be transported back to DESY
  - Work on mechanical improvements will start
  - Telescope will be set up in TB21 to be ready for more data taking
- Important next step: how much can we reduce the resolution by replacing one of the inner MimoTels by a Mimosa18 ?
  - Mimosa18 will be inserted as device under test at SPS
  - at DESY one of the inner planes will be replaced by Mimosa18
- Reports and memos: this year very bad (most of the details in memos last year)
  - 5 user memos should show up by end of the year
  - Alignment memo in progress ; will write a memo on users experience
  - some proceedings coming up (vertex2008, PSD08, PANIC08, NSS ....)
  - Write long report with the summary of the analog telescope (milestones month 36) -> make a NIM-A paper out of it as soon as possible
- Digital telescope: analog telescope will be upgraded by new chips and modified readout -> everything else stays the same => ready month 39

# TIMELINE



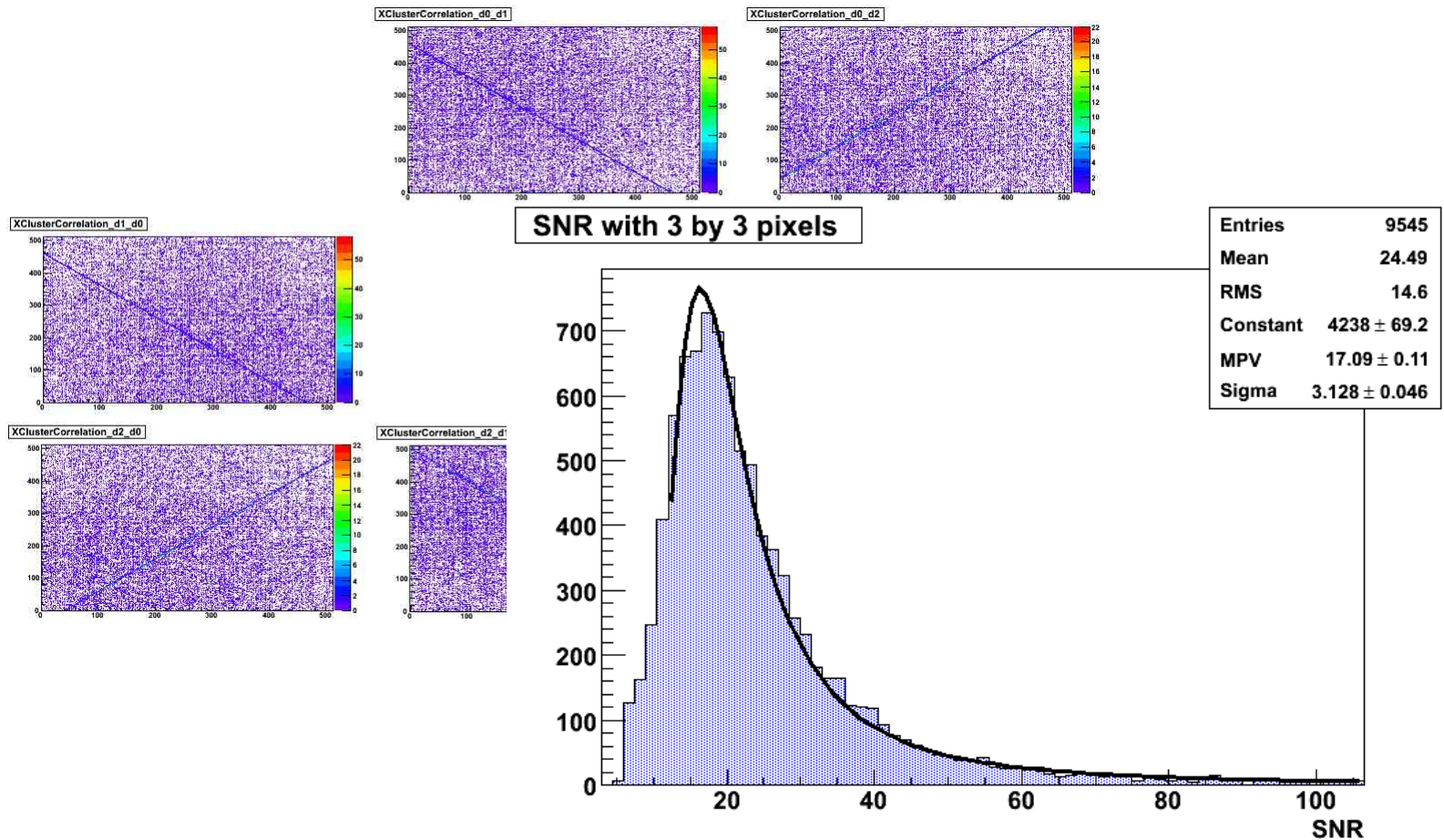


# TIMELINE



# TEST BEAM WITH MIMOSA18

- EUDRB readout was used with TAPI telescope in Cadarache and at SPS (to take alignment runs)



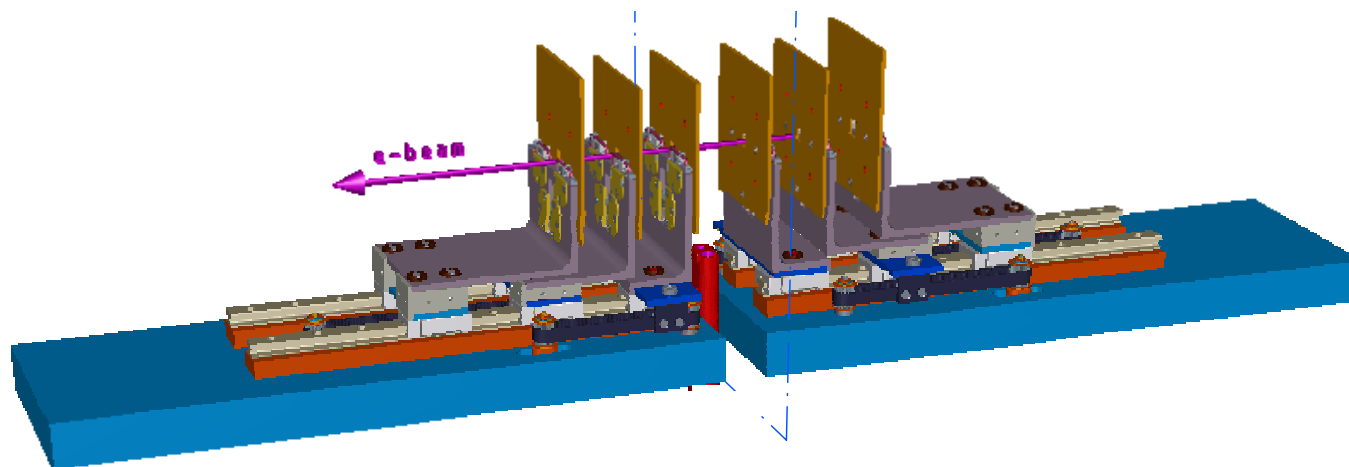
# HOW TO ACCESS THIS INFRASTRUCTURE

[WWW.EUDET.ORG](http://WWW.EUDET.ORG)

- You can apply for travel support through the **Transnational Access** and use the EUDET test beam infrastructure

[TESTBEAM.DESY.DE](http://TESTBEAM.DESY.DE)

- You can apply for test beam time at DESY



For more information contact: [INGRID.GREGOR@DESY.DE](mailto:INGRID.GREGOR@DESY.DE)