DESY Test Beams

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Outline

- Why test beam?
- The DESY Test beam
- Infrastructure
- Summary

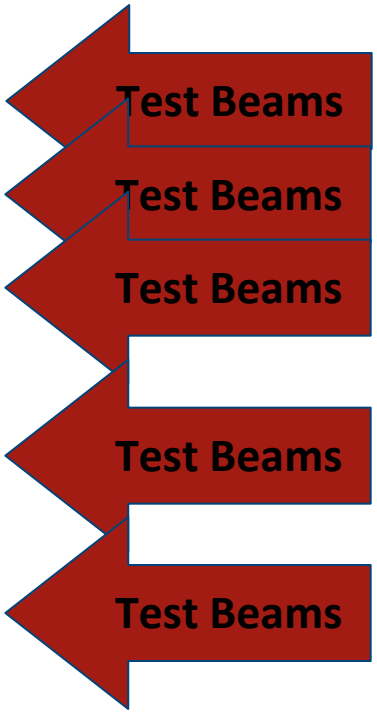
DESY/KEK Meeting
DESY
March 20th 2012

Why Test Beam?

Life is a Test Beam ...

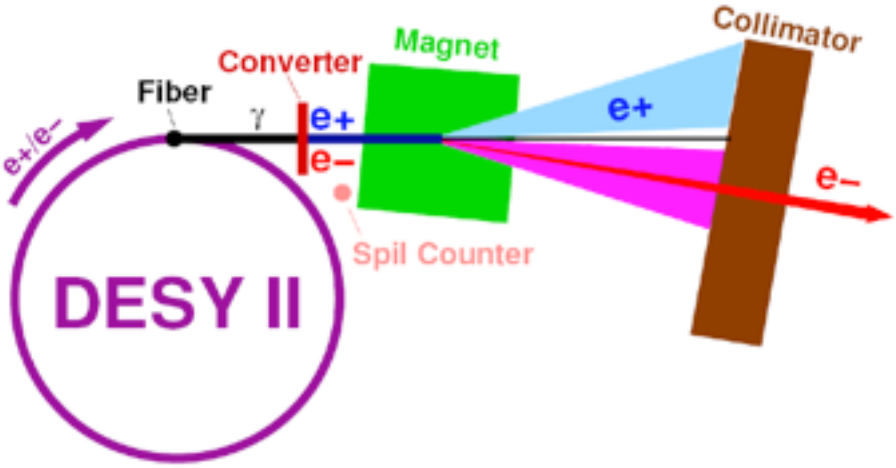
- Detectors for High Energy Physics need to go through a very extensive test beam program during R&D phase, conception and commissioning.
- All physical properties (efficiency, spacial resolution, energy resolution …) have to be measured precisely at at least one beam line.

- R&D and Detector conception
- Conceptual design, choice of detectors/ technologies
- Technical design, prototypes construction and testing
- Detector construction
- Calibrations
- Commissioning
- Data taking
- Analysis, systematics studies



The DESY Electron Test Beam

DESY Test Beam



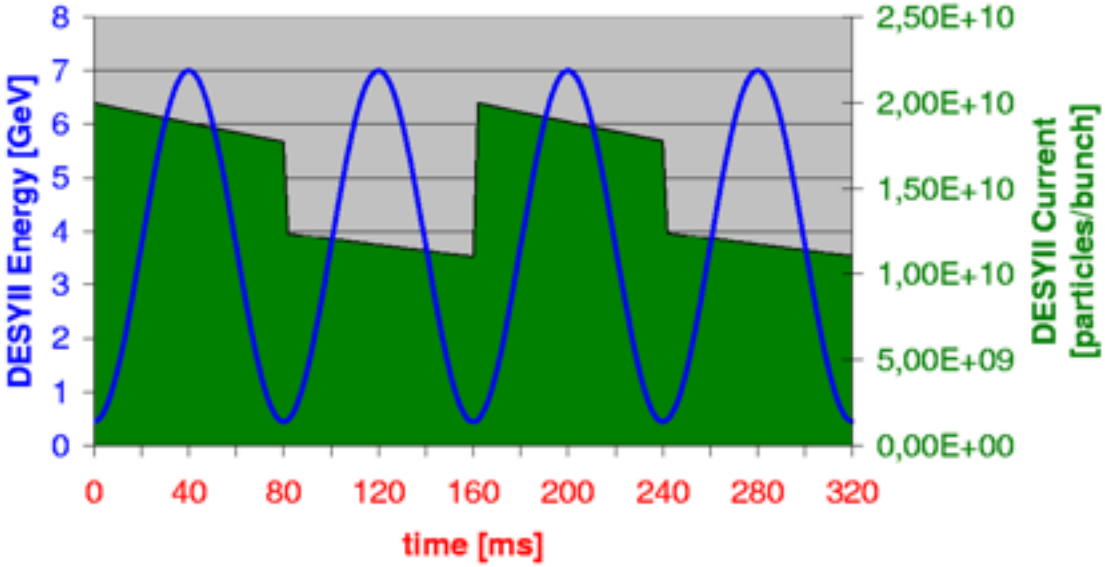
- DESY provides three test beam lines with 1-6 GeV/c electrons
- Very simple system, no beam optics, only momentum selection via magnet.
- Bremsstrahlung beam generated by a carbon fibre in the circulating beam of the electron/ positron synchrotron DESY II.

- Photons are converted to electron/positron pairs with a metal plate.
- Beam is spread out into a horizontal fan with a dipole magnet. Collimator cuts out final beam.

- DESYII: Mainly injector for DORIS and PETRA (synchrotron sources).
- The revolution frequency is 1 MHz, the RF frequency 500 MHz, and the bunch length around 30 ps. The average radius is 46.6 m
- For DORIS: DESYII delivers every second cycle (160ms) single bunches with about $1*10^9$ positrons at 4.5GeV (DORIS requires a slower injection)
- For PETRA III: DESYII delivers every fourth cycle (320ms) single bunches with $1*10^{10}$ positrons at 6GeV (Top-Up every 3min with 1*10**9 positrons)

DESY Test Beam

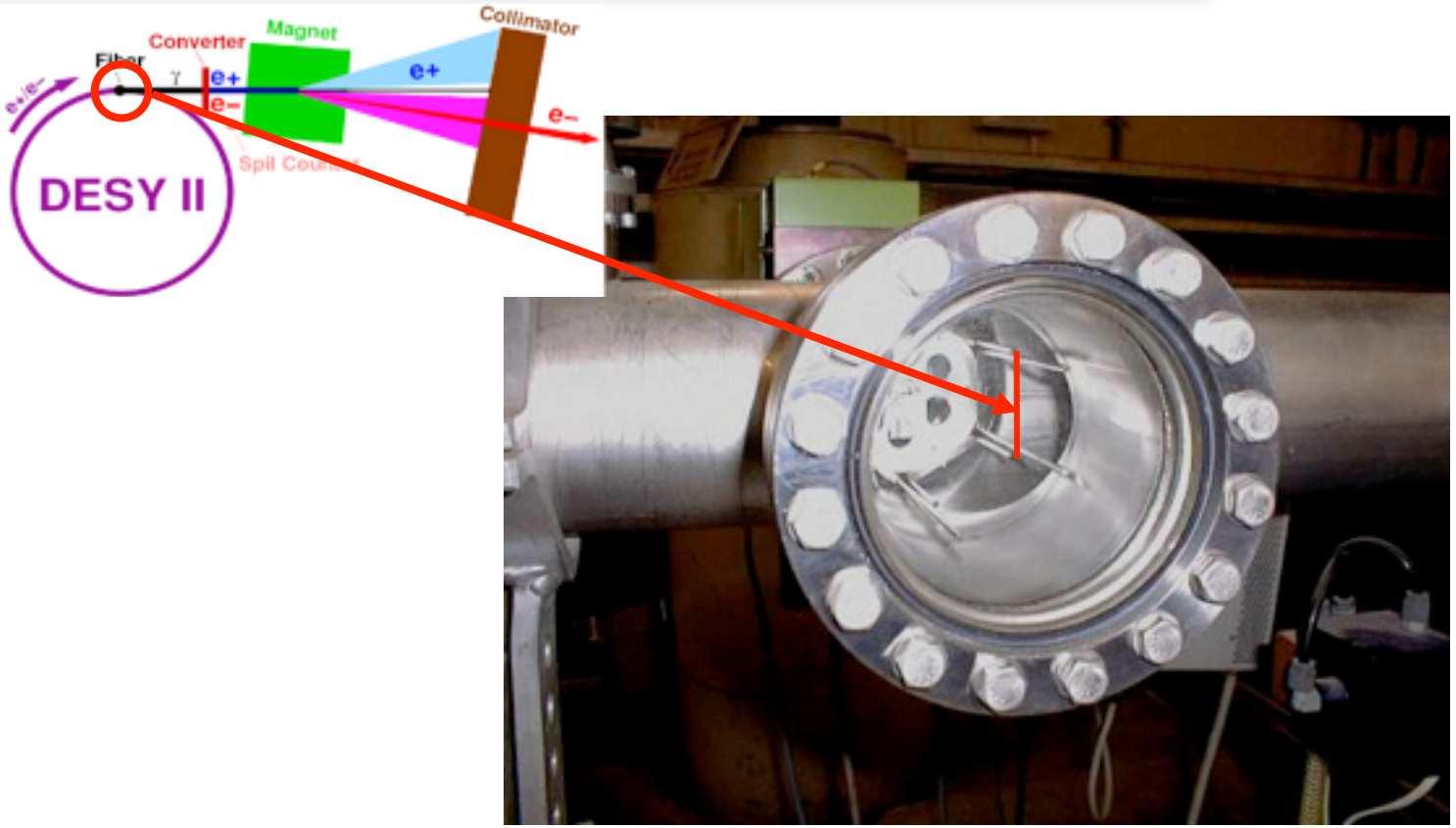
- Test beam runs in PETRAIII mode mode with an extraction on the falling slope (at 6GeV; with reduce beam current during top-up)
- On the falling slope to increase the time useful for test beam generation.
- Due to top-up DESYII is running day and night -> **always test beam usage possible**



Ideal DESY II Cycle (no extraction)

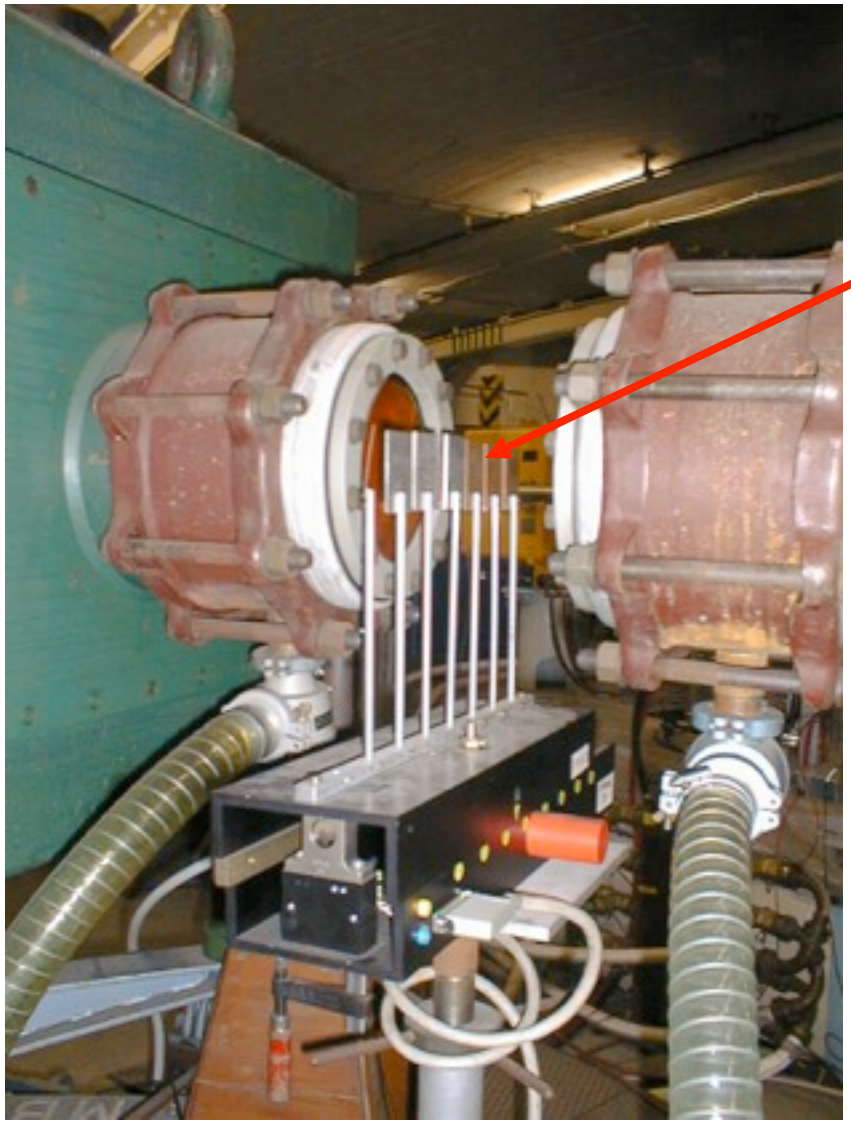
- The particle rates in the test beam are influenced by many parameters.
- Ideally, the maximum rate around 1 kHz (3 GeV, 3mm Cu convert, Collimator ca. 5mm x 5mm).

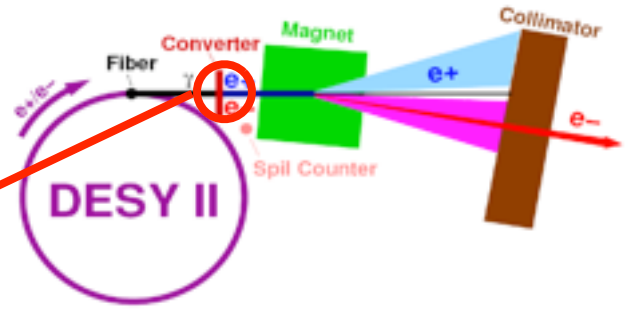
Carbon Fibre (Primary Target)



- The carbon fibre has a thickness of 6-10 µm.
- Six fibres are prepared inside the fibre holder. By rotation of the inner part, a broken fibre can be replaced without opening the machine vacuum.
- Carbon fibre rotation system will be modernized this year.

Conversion Target (Secondary Target)

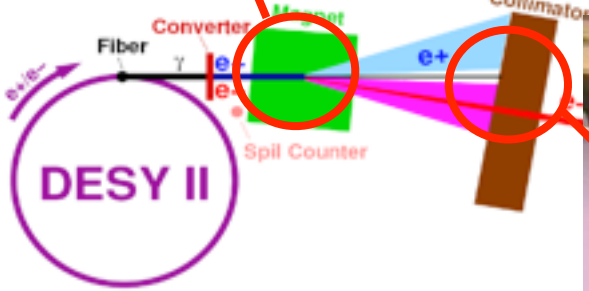




- There are different conversion targets available:
  Al, Cu,
- The selection of the conversion target is under control of the test beam user.
- System will be modernized in this year.

Selection Magnet Location

Magnet

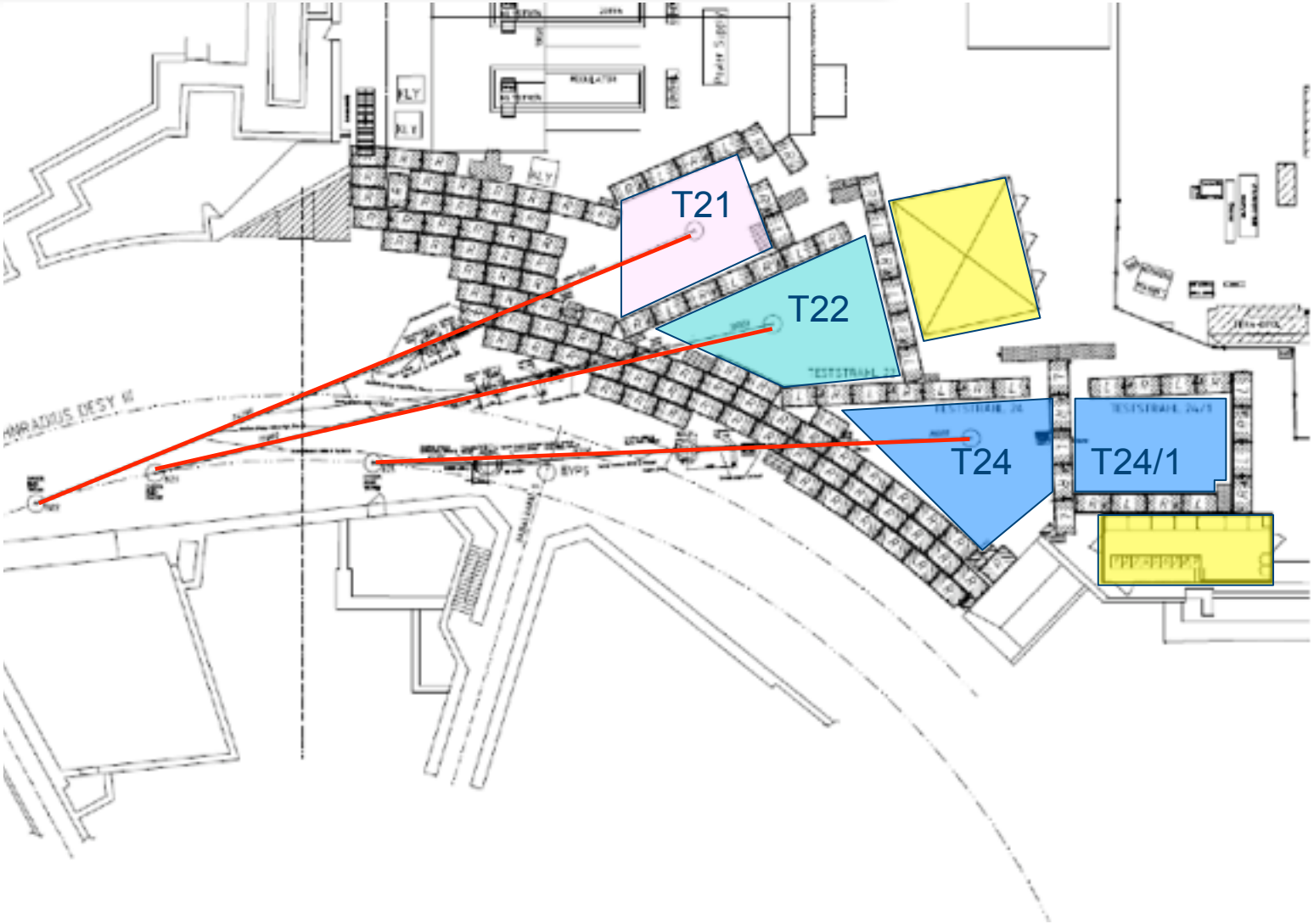


Final collimator in area

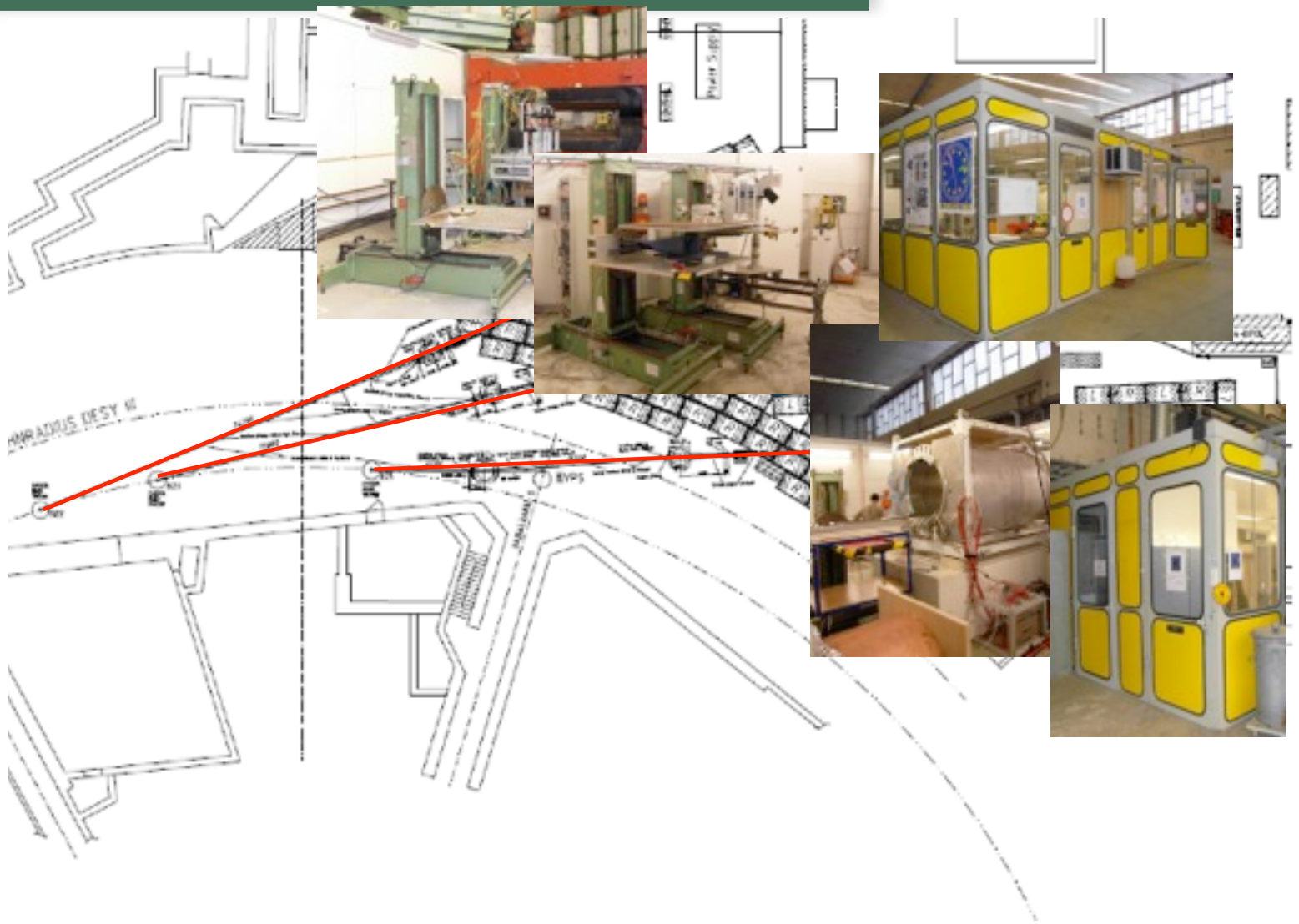
Collimator

Beam shutter

Test beam Layout



Test beam Layout



Facilities for Test Beam User

- All three test beam lines have
  - Interlock systems
  - Magnet control to select momentum
  - Patch panels with pre-installed cables
  - Gas warning systems
  - Fast internet connection (DHCP)
  - Trigger scintillators

- The user can ask for:
  - Translation stages
  - Premixed gases
  - Superconducting Magnet (1T)
  - Beam Telescopes

- The users typically bring:
  - Data Acquisition incl. computers
  - Trigger scintillators

Test Beam Area 21

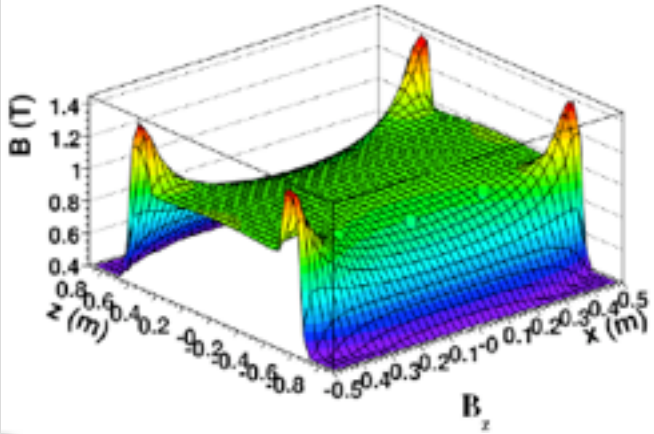
- Recently refurbished -> Home of EUDET telescope (when at DESY)

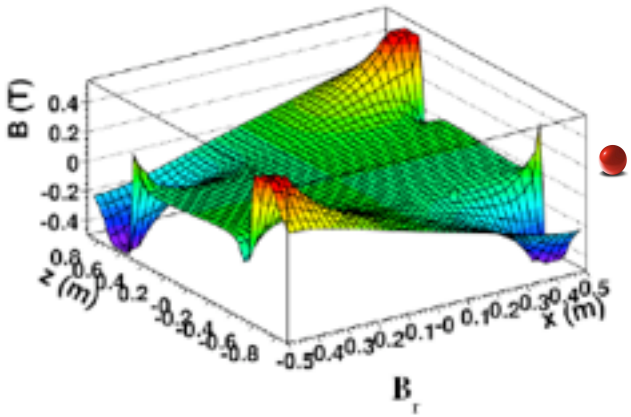
- Pixel beam telescope permanently available
- more space usually used for calorimeter (CALICE) tests

Test Beam 22: ZEUS Telescope

- Location of ZEUS MVD telescope (build in 1998)
- Telescope parameters:
  - 300 µm thick single-sided Si strip sensors
  - Each plane with 2 sensors perpendicular to each other
  - Strip pitch: 25µm; Readout pitch: 50µm
  - DAQ was upgraded to EUDET like system (EUDAQ)
- Plans for next years:
  - keep telescope running

Test Beam 24: EUDET/AIDA

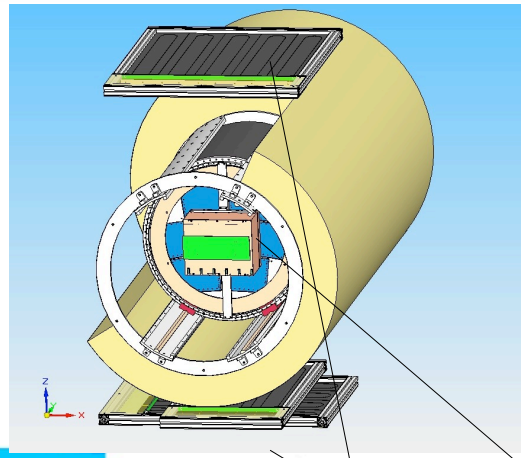


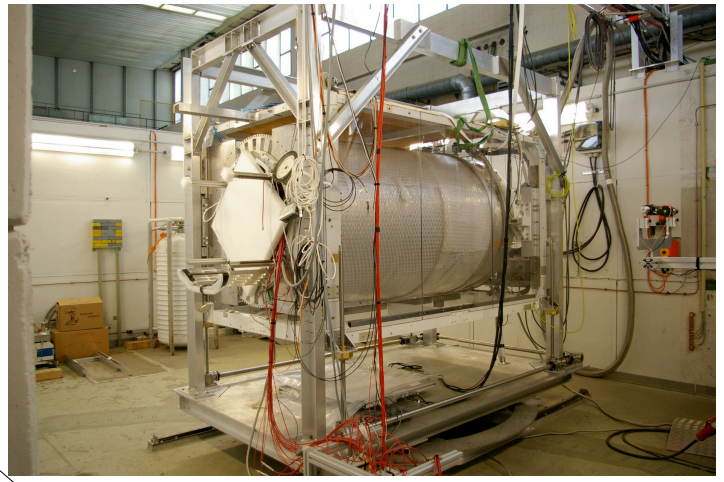


- **Large bore magnet:**
  - 1Tesla, Ø≈85 cm, stand-alone He cooling, supplied by **KEK**
  - Infrastructure (control, field mapping, etc.) through EUDET/AIDA
  - Magnet was send to KEK for the improvement of the cooling system
    - built-in helium reservoir has been removed
    - closed circuit cryogenic cooling system installed
    - allows for a safer and more efficient operation
  - Returns to DESY in April

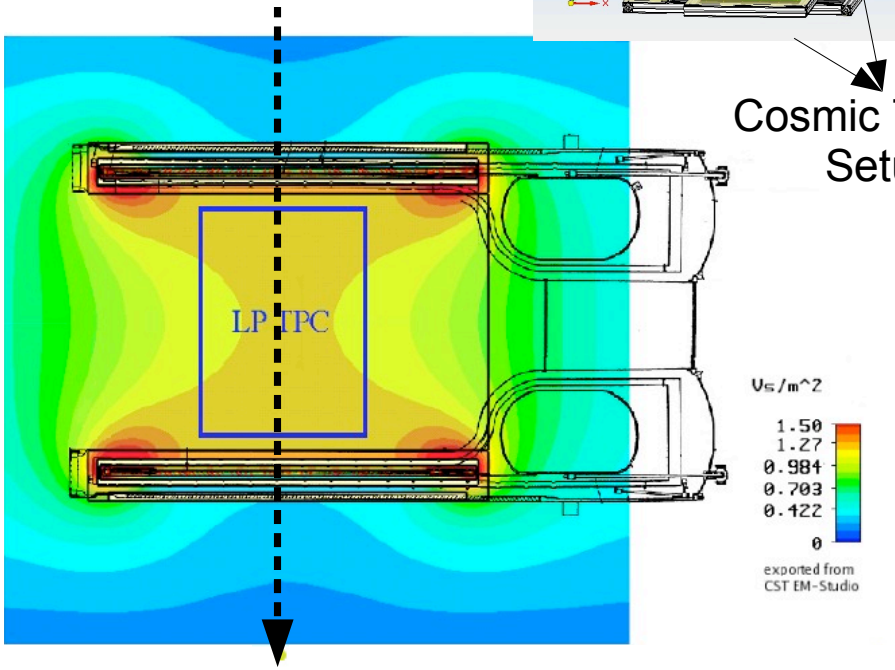
Magnet and TPC Field Cage in TB24

- PCMAG: super conducting magnet, up to 1.25 T
- TPC field cage

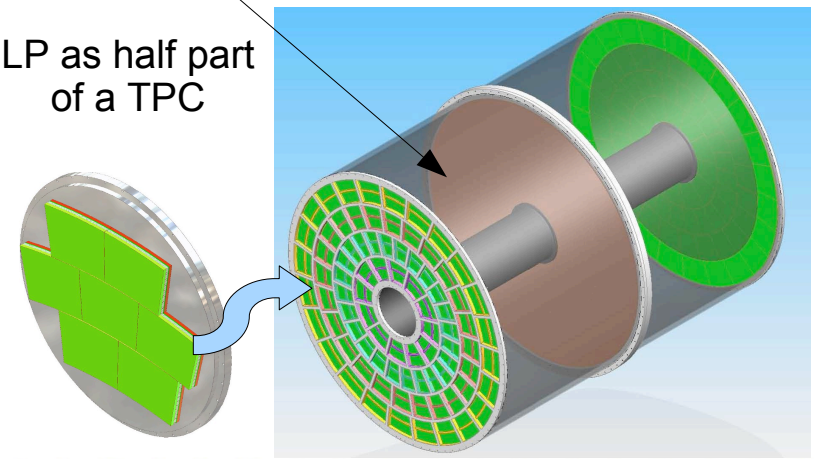




Cosmic Trigger Setup



LP as half part of a TPC



The EUDET Pixel Telescope

Beam Telescope Requirements

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).

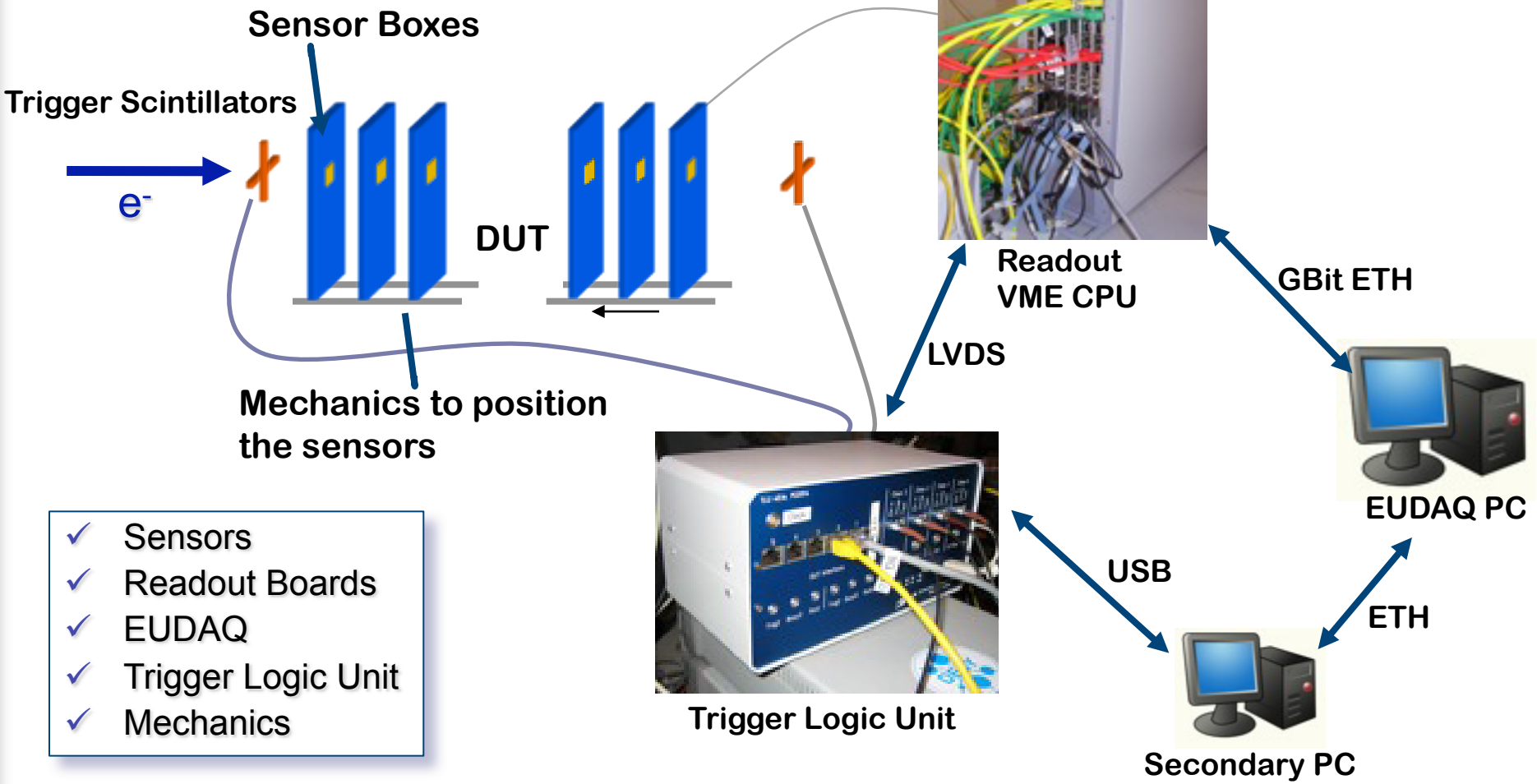
Generally applicable:

- DUTs: 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!

Two staged approach

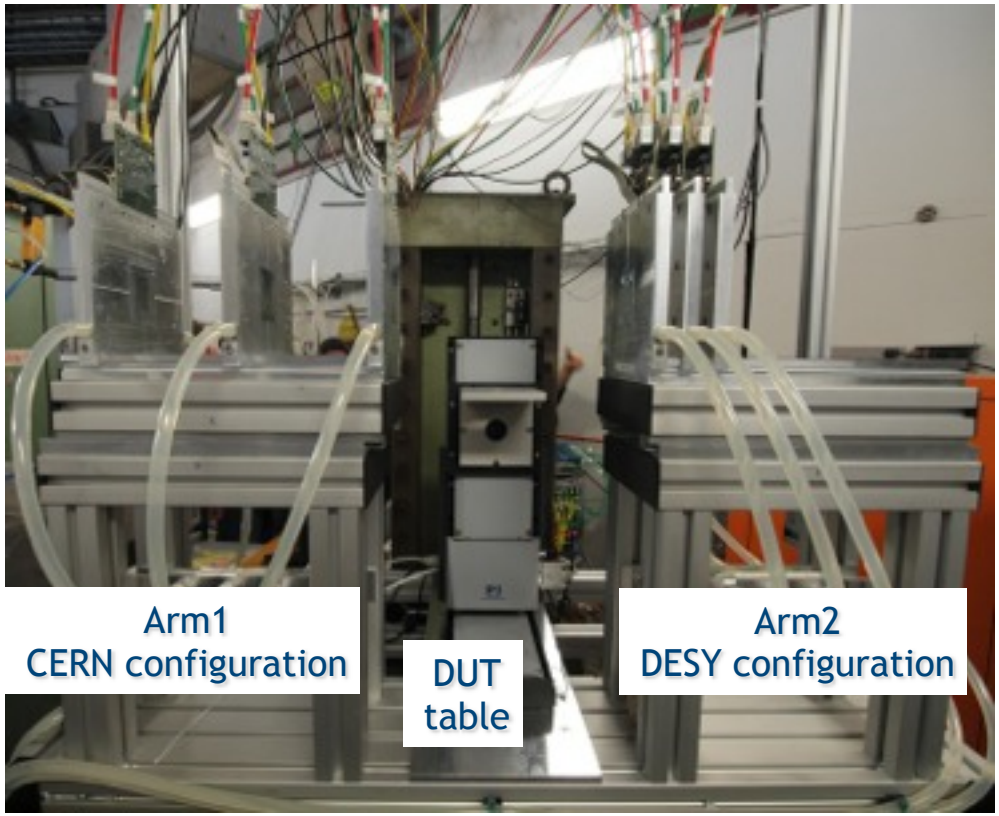
- Demonstrator telescope with analog sensors as soon as possible (available 18 months after start of EUDET)
- Final Telescope with digital sensors, final resolution and high readout rate (available since September 2009).

Telescope Ingredients



- ✓ Sensors
- ✓ Readout Boards
- ✓ EUDAQ
- ✓ Trigger Logic Unit
- ✓ Mechanics

Extremely Successful

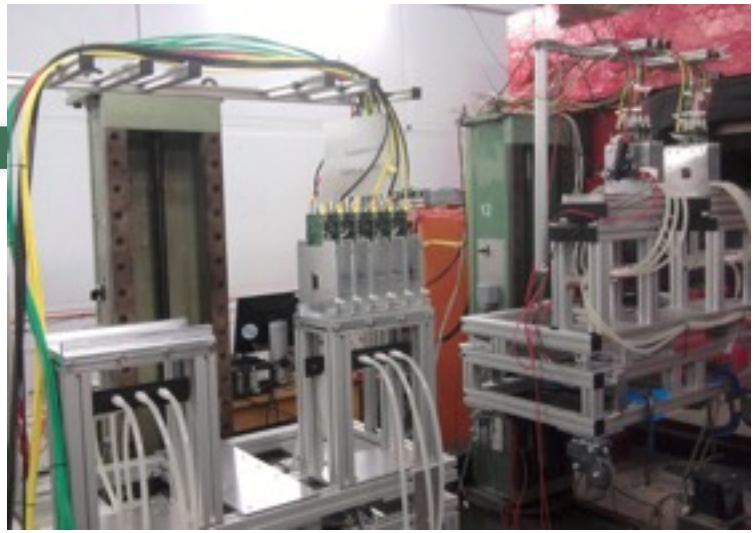


- Sensors: Mimosa26 with 18.4 um pitch, thinned to 50um
- Readout system: VME based (EUDET version)

- EUDAQ: DAQ software concept to easily interlink many readout systems running synchronous
- EUTelescope: software to analyse the data on short time scale

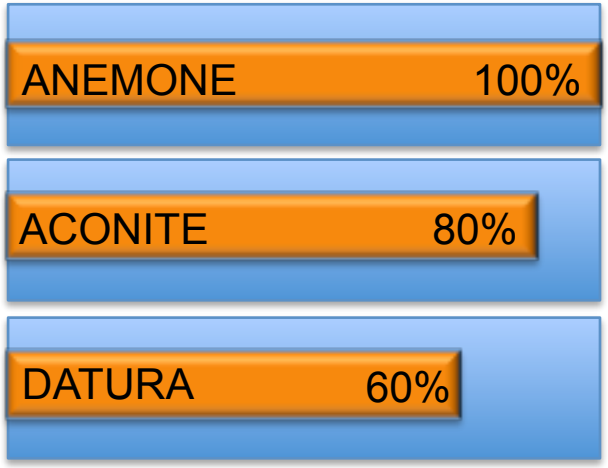
- EUDET telescope is being used by many user groups at DESY and CERN since spring 2007
- Upgrade of system planned within AIDA (more sensor technologies)
- **Open to every body !!**

Telescope Copies



Telescope production line a la AIRBUS ...

- 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)
- Improves speed (up to 4kHz) and gives possibilities to implement smarter trigger



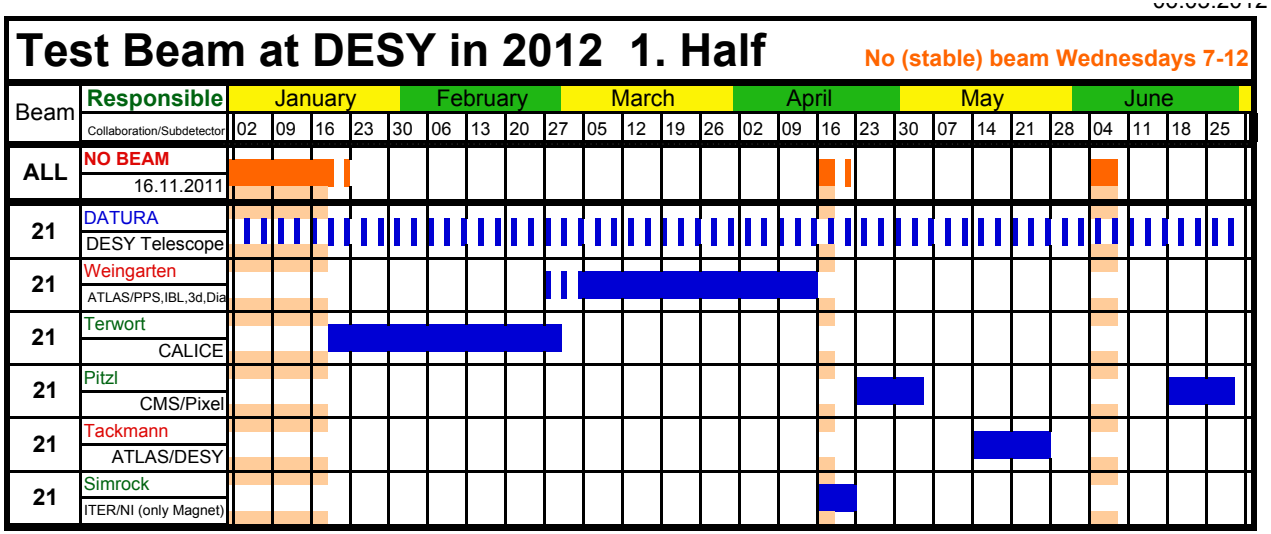
- Enables “easy” copies
  - Bonn copy (ANEMONE)
  - ATLAS copy (ACONITE)
  - DESY test beam (DATURA)
  - ….
- Goal: to have exactly the same infrastructure at DESY test beam and CERN SPS test beam beams (spring 2012) and other places

Access to DESY Test Beam

- DESY electron test beam is open to the community
- Beam time request relatively informal: request link to be filled out, further contact via e-mail
- Typically longer test beam periods are available, allow (semi-) permanent setups

- In 2013 a special year: SPS shutdown includes all test beam facilities at CERN
- First survey of possible users indicate a very busy year but still some open slots

- For 2013 we will ask early on for possible users ….



Typical schedule for one beam line ...

Summary

- DESY provides three test beam lines with 1-6GeV/c electrons
- Very simple system, no beam optics, only momentum selection via magnet
- Perfect facility for proof of principle studies, efficiency studies and also resolution studies
- Infrastructure simple and flexible
- In 2013: DESY test beam one of the few facilities available for the community -> expect many users from around the world

For details:

TESTBEAM.DESY.DE

Or contact: testbeam-coor@desy.de

- From now on a copy of the EUDET/AIDA telescope will be available to the users: with a bit of lead time it is simple to use and provides high accuracy tracking.