Test beam facilities at CERN and DESY

LCWS 2008 Chicago

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Courtesy:

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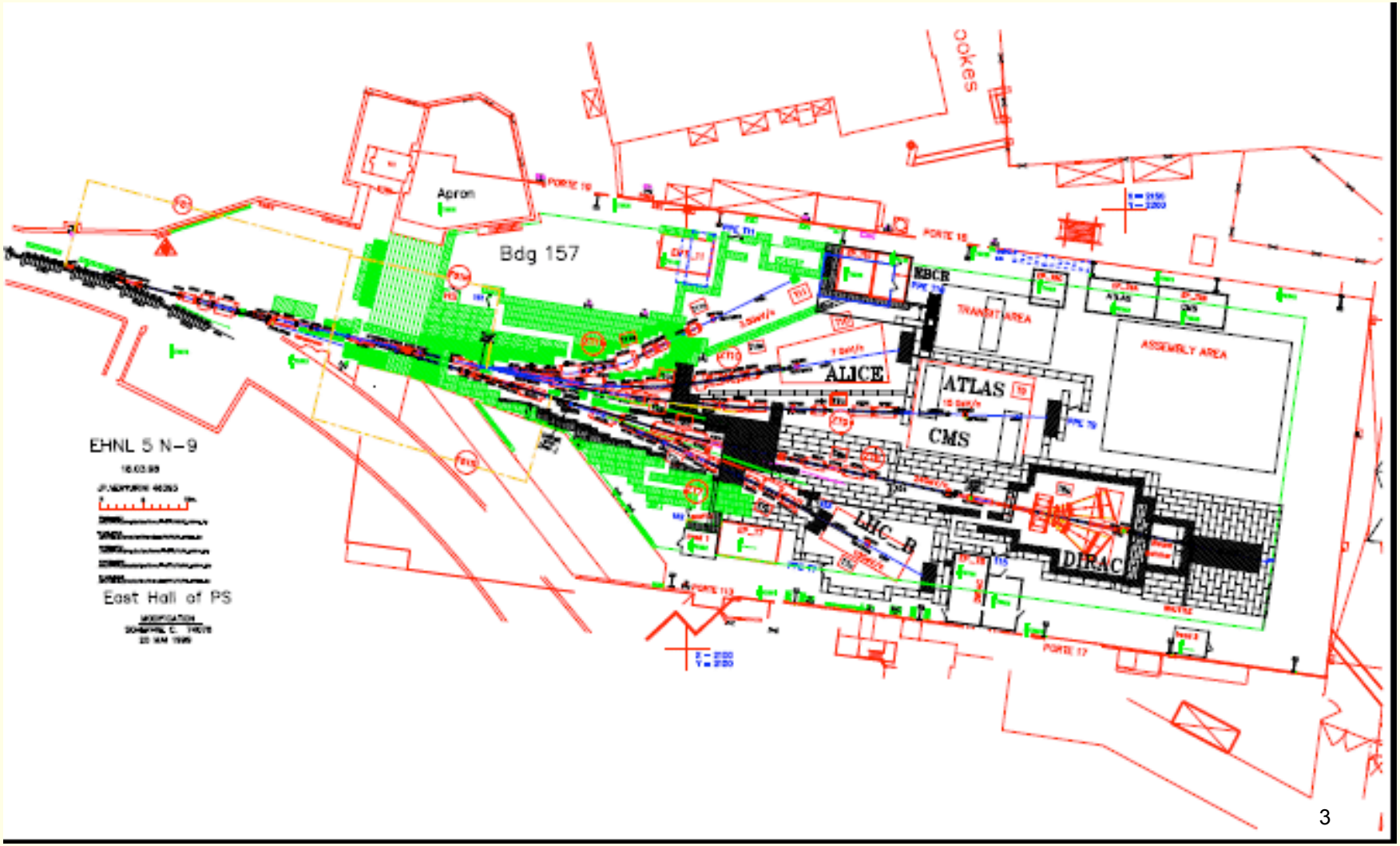
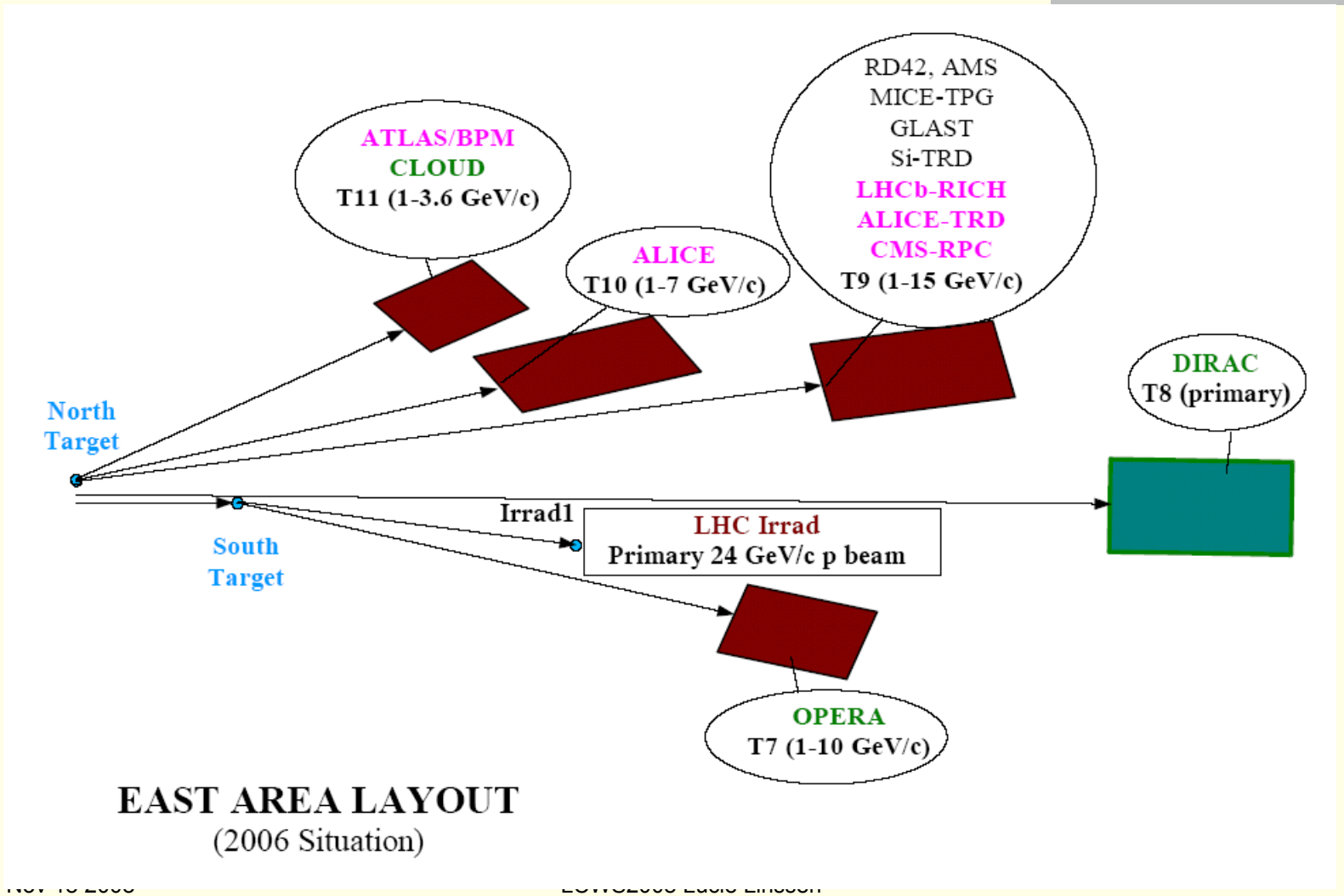
Test Beams for detector R&D at CERN

- The PS East Area
- The SPS North Area
- Irradiation facilities
- Large volume magnets

The PS East Area



The PS East Area



Beam Characteristics

T7	The T7 beam is a secondary beam that delivers secondary particles up to 10 GeV/c at a production angle of 0 degrees.
T8	The T8 beam is a primary beam that delivers primary protons to the DIRAC experiment. Normally the beam momentum is 24 GeV/c.
T9	The T9 beam is a secondary beam that delivers secondary particles up to 15 GeV/c at a production angle of 0 degrees.
T10	The T10 beam is a secondary beam that delivers secondary particles up to 7 GeV/c at a production angle of 61.6 milliradians.
T11	The T11 beam is a secondary beam that delivers secondary particles up to 3.5 GeV/c at a production angle of 149.2 milliradians.

Infrastructure

The PS East Area

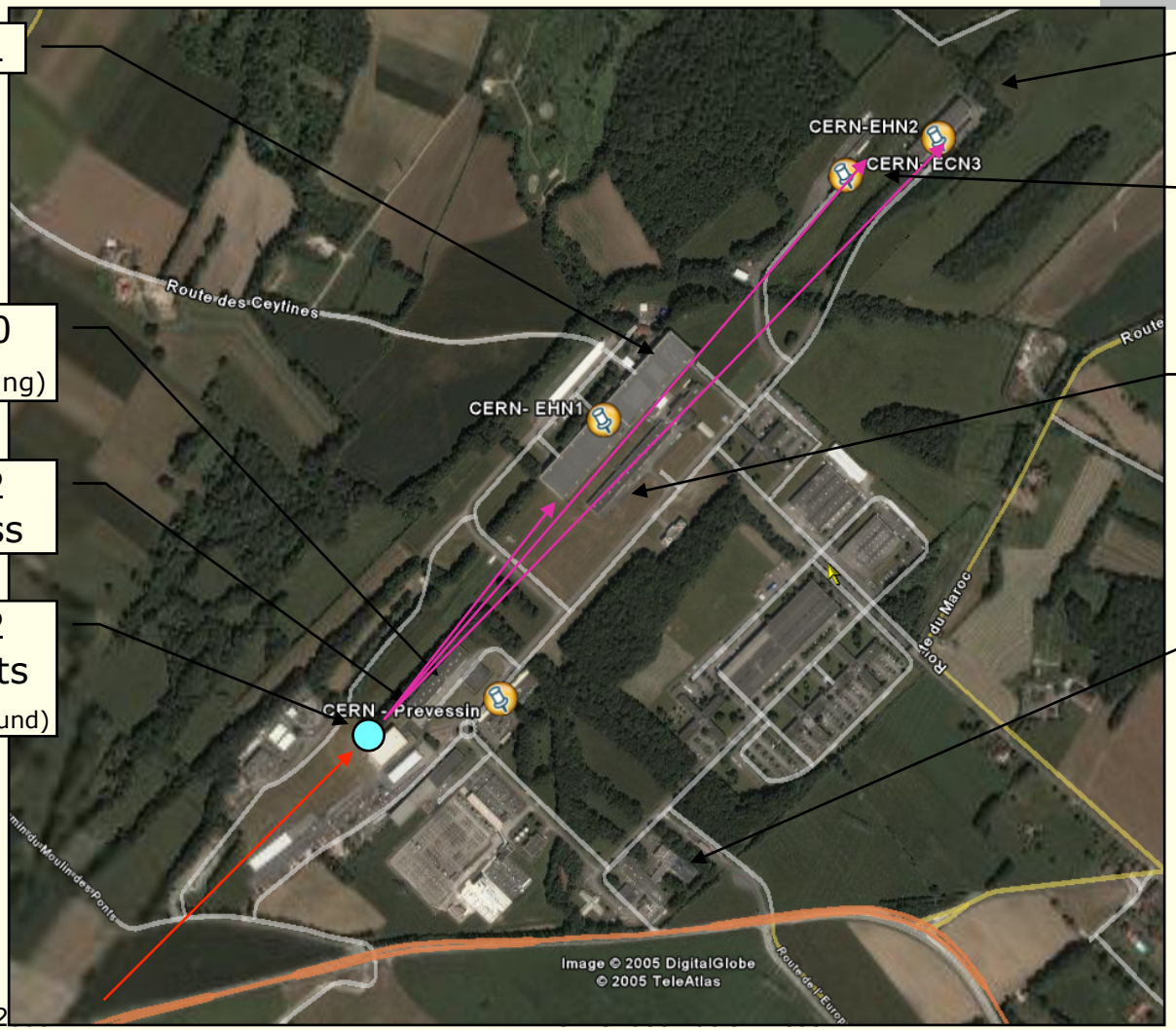
What is (could be) provided

- Counting houses (barracks) with racks and network connections
- Beam instrumentation:
  - Scintillator for beam intensity measurement
  - XDWC for beam profile measurement
  - Threshold Cherenkov counter for particle ID
- Scanning table (XSCA) – shared with SPS North Area users
- Magnets - see slides later

What is not there!

- Infrastructure for large detectors – size of areas
- Cryogenics

The SPS North Area



EHN1

BA80
(ps building)

TCC2
access

TCC2
targets
(underground)

EHN2
(COMPASS)

ECN3
(NA48)

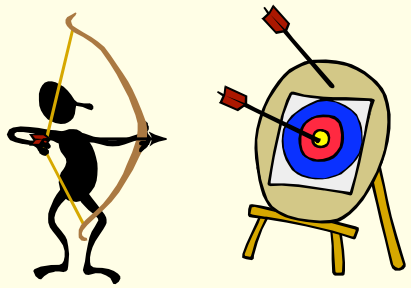
BA81
(ps building)

CCC

Introduction

The SPS North Area Beams (slow extraction, continuous beam)

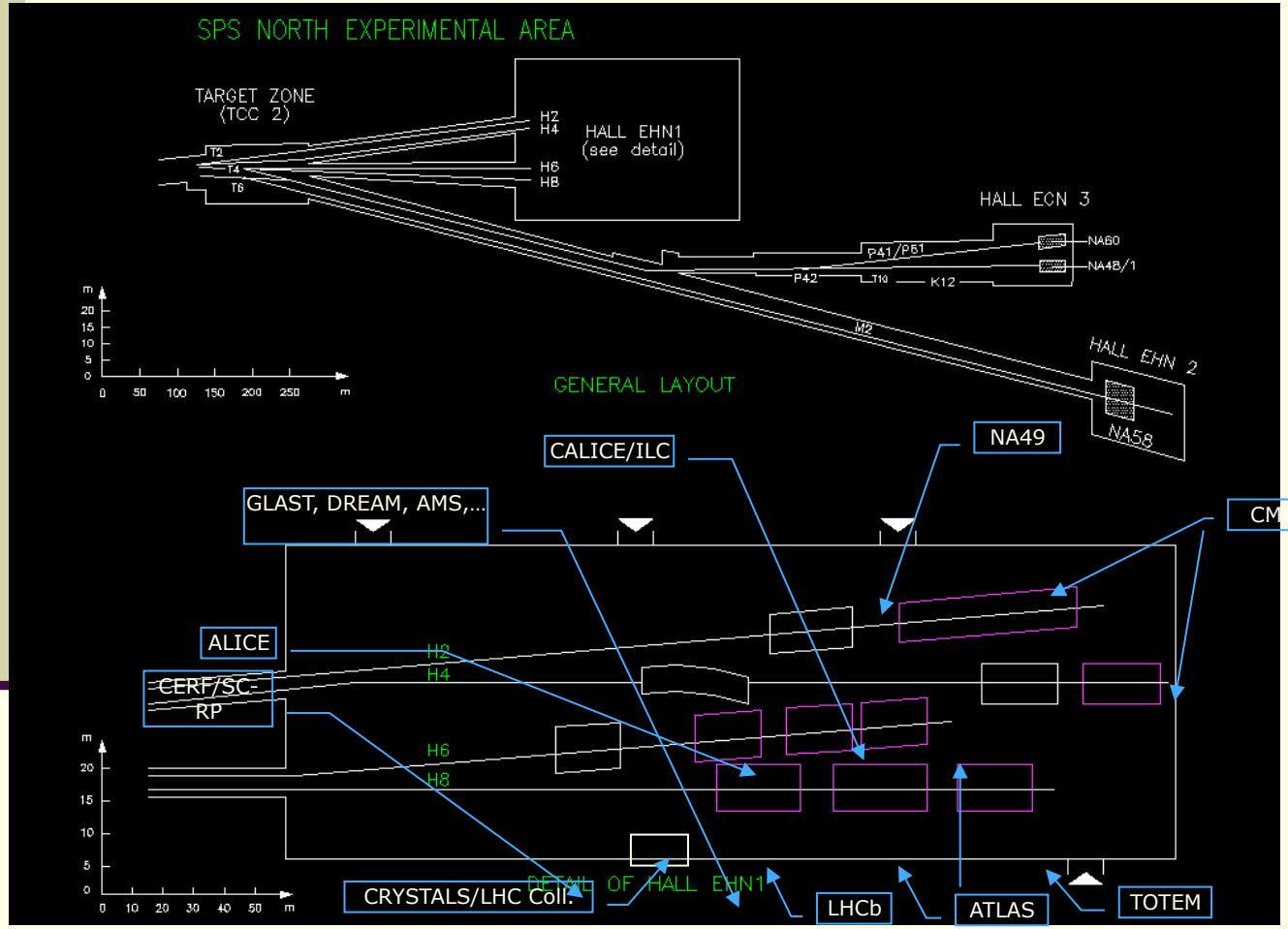
- The three proton beams are directed onto the primary targets:
  - T2 → **H2** and **H4** beam lines
  - T4 → **H6**, **H8**, and **P0** beam lines
  - T6 → **M2** beam line



and Experimental Areas:

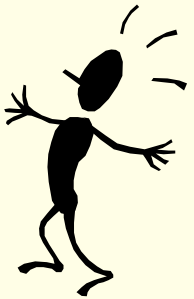
- **ECN3**: underground experimental hall, can receive the primary proton beam with high intensity in ECN3
- **EHN1**: surface experimental hall, can receive secondary beams and/or attenuated primary proton beams
- **EHN2**: surface experimental hall, receives the secondary beams or intense muon beam

Experimental Areas



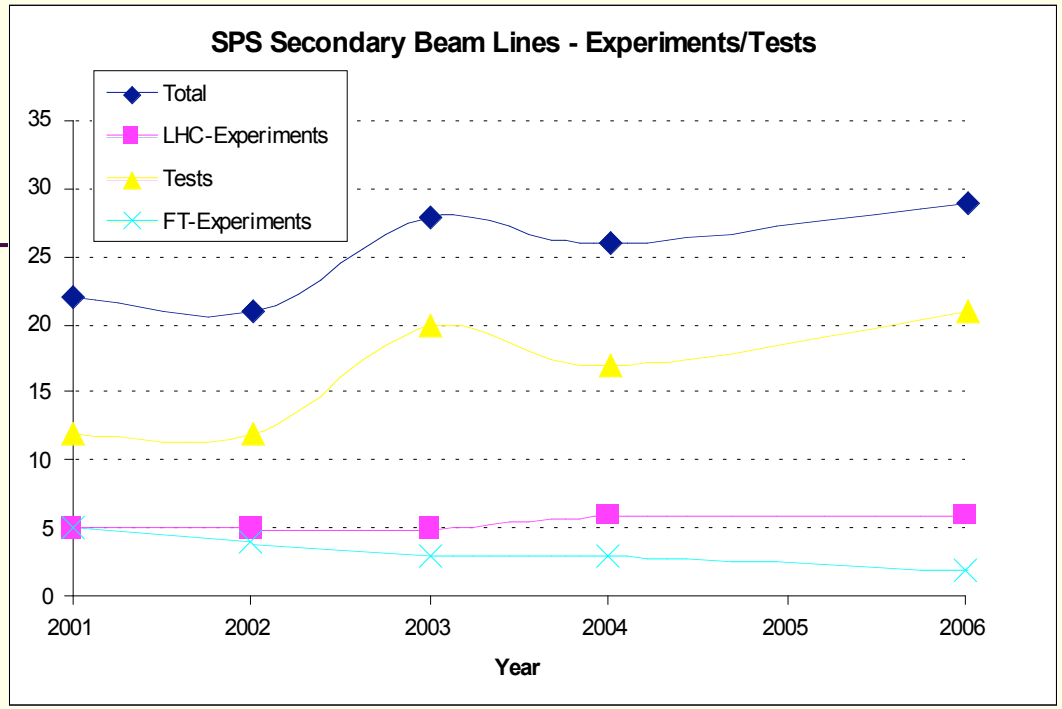
- **6.5 Km** of beam lines
- About **1000** equipment installed

https://edms.cern.ch/cdd/plsql/c4w.no_login?jump=FOLDER&p1=83193



The SPS North Area

User statistics



In 2008:
32 SPS user groups,
of which ~50% for LHC

Linear collider SPS test beam use in 2008:

- Vertex/tracking (EUDET, DEPFET, LCFI…):
  - 6 groups, 65 days at SPS, 10 days at PS
  - Good synergy between groups, big use of EUDET telescope
- Calorimetry
  - Digital HCAL tests (RPC and Micromegas)
  - 10 days at SPS, 30 days at PS

The SPS North Area

The EHN1 beams

- The SPS North Area was originally designed to house long-lasting experiments
  - demands for high quality of beams: high intensity, high energy, high resolution
- In the recent years most of the users are “tests”
  - in particular of LHC detectors with permanent or “semi-permanent” BIG installations
  - users from experiments (linear collider, astroparticle)
- The test users have very different requirements from the big experiments:
  - scan the full energy range ; typically [10, 300] GeV/c
    - with sometimes increased precision (linearity) requirements
  - use beams of all particle types {electrons, pions, protons, muons}
    - with as good as possible separation and identification
  - and, sometimes request high (or very high) rates

and all that during the few (or even one!) week(s) of their allocated time!

Rapidly changing environment, quite demanding on beam conditions and tunes

The EHN1 beams

The SPS North Area

Target	Beam	Characteristics
T2	H2	High-energy, high-resolution secondary beam. Alternatively can be used to transport: attenuated primary beam of protons, electrons from γ-conversion, polarized protons for Λ^0 decay, enriched low-intensity beam of anti-protons, or K^+ Main parameters: P_{max}= 400 (450) GeV/c, Acc.=1.5 μSr, $\Delta p/p_{max}$= ±2.0 %
	H4	High-energy, high-resolution secondary beam. Alternatively can be used to transport: primary protons, electrons from γ-conversion, polarized protons for Λ^0 decay, enriched low-intensity beam of anti-protons, or K^+ Main parameters: P_{max}= 330 (450) GeV/c, Acc.=1.5 μSr, $\Delta p/p_{max}$= ±1.4 %
T4	H6	High-energy secondary beam. Main parameters: P_{max}= 203 GeV/c, Acc.= 2.0 μSr, $\Delta p/p_{max}$= ±1.5 %
	H8	High-energy, high-resolution secondary beam. Alternatively can be used to transport an attenuated primary proton beam Main parameters: P_{max}= 400(450) GeV/c, Acc.= 2.5 μSr, $\Delta p/p_{max}$= ±1.5 %

Infrastructure

What is (could be) provided

- Counting houses (barracks) with racks and network connections
- Beam instrumentation:
  - Scintillator for beam intensity measurement
  - XDWC for beam profile measurement
  - Threshold Cherenkov counter for particle ID
  - CEDAR counter for particle ID
  - Electromagnetic calorimeter for particle ID
  - Spectrometer for beam momentum measurement
- Scanning table (XSCA)
- Magnets - see slides later
- Cryogenics installation

Irradiation Facilities

http://irradiation-facilities.web.cern.ch/irradiation-facilities/

- PS East Area : T7 line
  - Protons and mixed field irradiation
  - 1-10*10^{13} protons/(cm^2hr) on a 2*2 cm^2 surface
  - 3-10*10^{11} neutrons/(cm^2hr) on a 30*30 cm^2 surface (1 MeV equiv.)
- SPS North Area: CERF facility
  - Mixed field irradiation
  - In H6 beam line : <1*10^8 ppp @120 GeV/c
- GIF
  - 137Cs source irradiation over large surfaces, 740 MBq (in 1997)
  - Combined with SPS West area beam (until 2004)

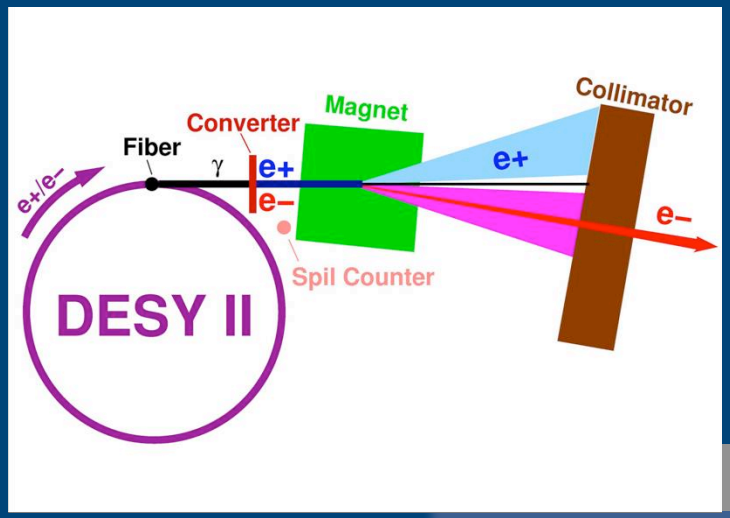
Plans for improved facilities (protons, mixed-field, GIF++), mid 2010

CERN test beam magnets

- **PS east hall:**
  - TPC-90 magnet (last used by HARP), solenoid diam. cm, 224 cm long, 0.7 T (~1.3 T in pulsed mode).
- **EHN1, H2 beam line:**
  - M1 magnet, superconducting, large dipole, 82 cm gap, 1.4 m diameter, Field 3T,used by CMS
  - MNP22A, C-shaped classical dipole, 50 cm gap, 1 m width, 1 m depth, 1.37 T (presently 0.7 T)
- **EHN1, H4 beam line:**
  - Goliath (last user NA57), large classical dipole, ~160*240*360 cm, 0.85 T field
- **EHN1, H8 beam line:**
  - Superconducting dipole, diam. 1.6 m, ~4 m overall length, 1.56 T field at 5000A, used by ATLAS, contains a rail system for inserting detectors

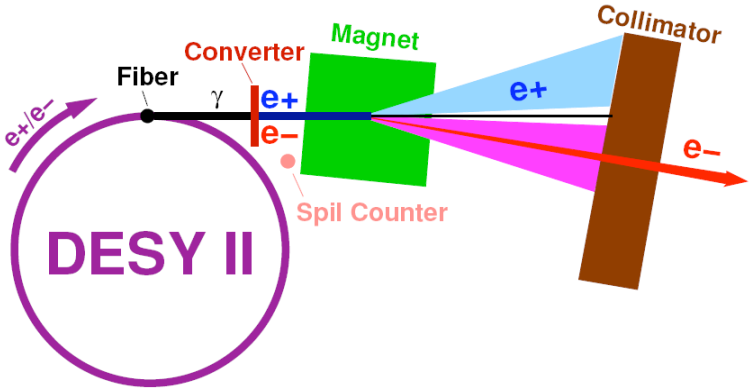
http://project-fp7-detectors.web.cern.ch/project-FP7-detectors/TEST%20BEAM%20LINKS.htm

DESY Test Beam Facilities
- Status and Plan



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.

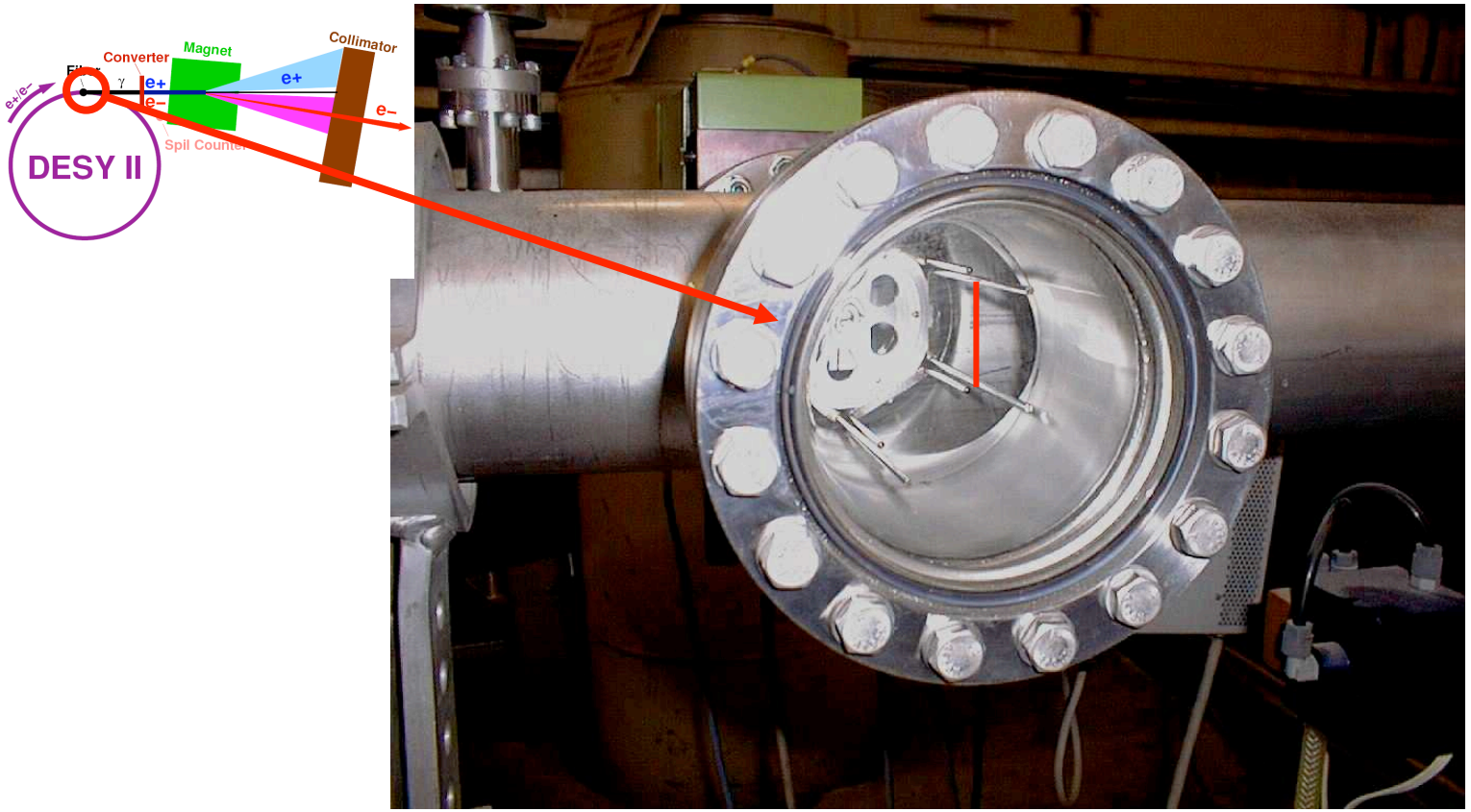


- Photons are converted to electron/positron pairs with a metal plate.
- Beam is spread out into a horizontal fan with a dipole magnet. Collimator cuts out final beam.

- DESYII: Mainly injector for DORIS and PETRA (synchrotron sources).
  - Test beam runs in PETRA mode: every fourth cycle (320ms) single bunches with $3*10^{10}$ electrons ($1*10^{10}$ positrons) at 7GeV

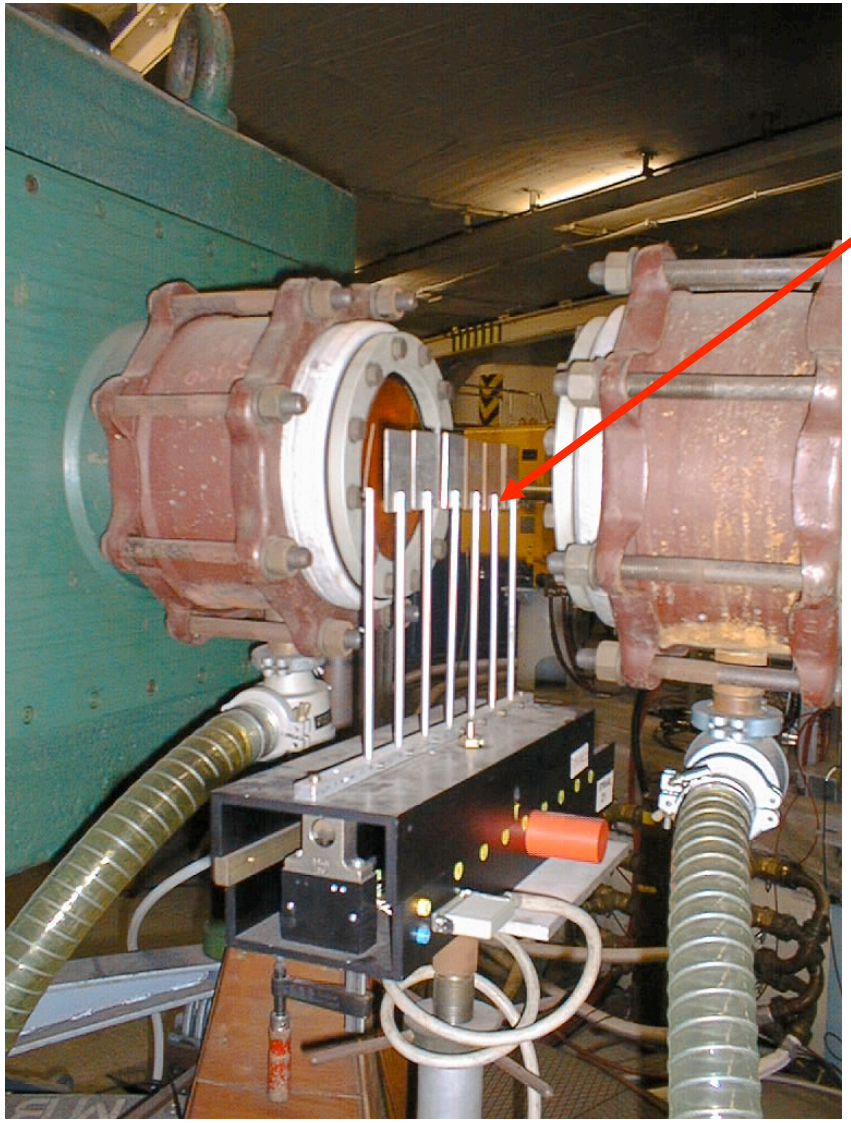
- The revolution frequency is 1 MHz, the RF frequency 500 MHz, and the bunch length around 30 ps. The average radius is 46.6 m

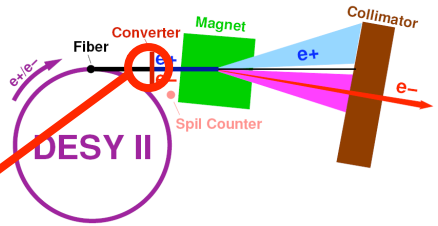
Carbon Fibre (Primary Target)



- 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.

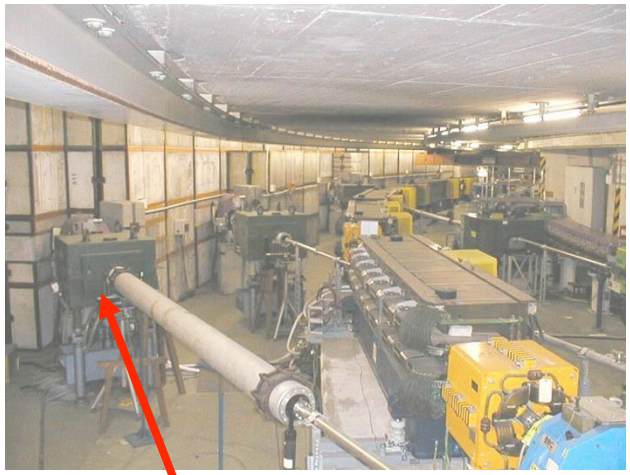
Conversion Target (Secondary Target)



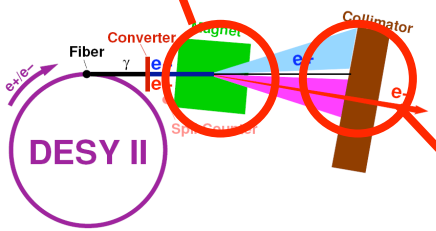


- There are different conversion targets available:
  - Al, Cu,
- The selection of the conversion target is under control of the testbeam user

Selection Magnet Location



Final collimator
in area

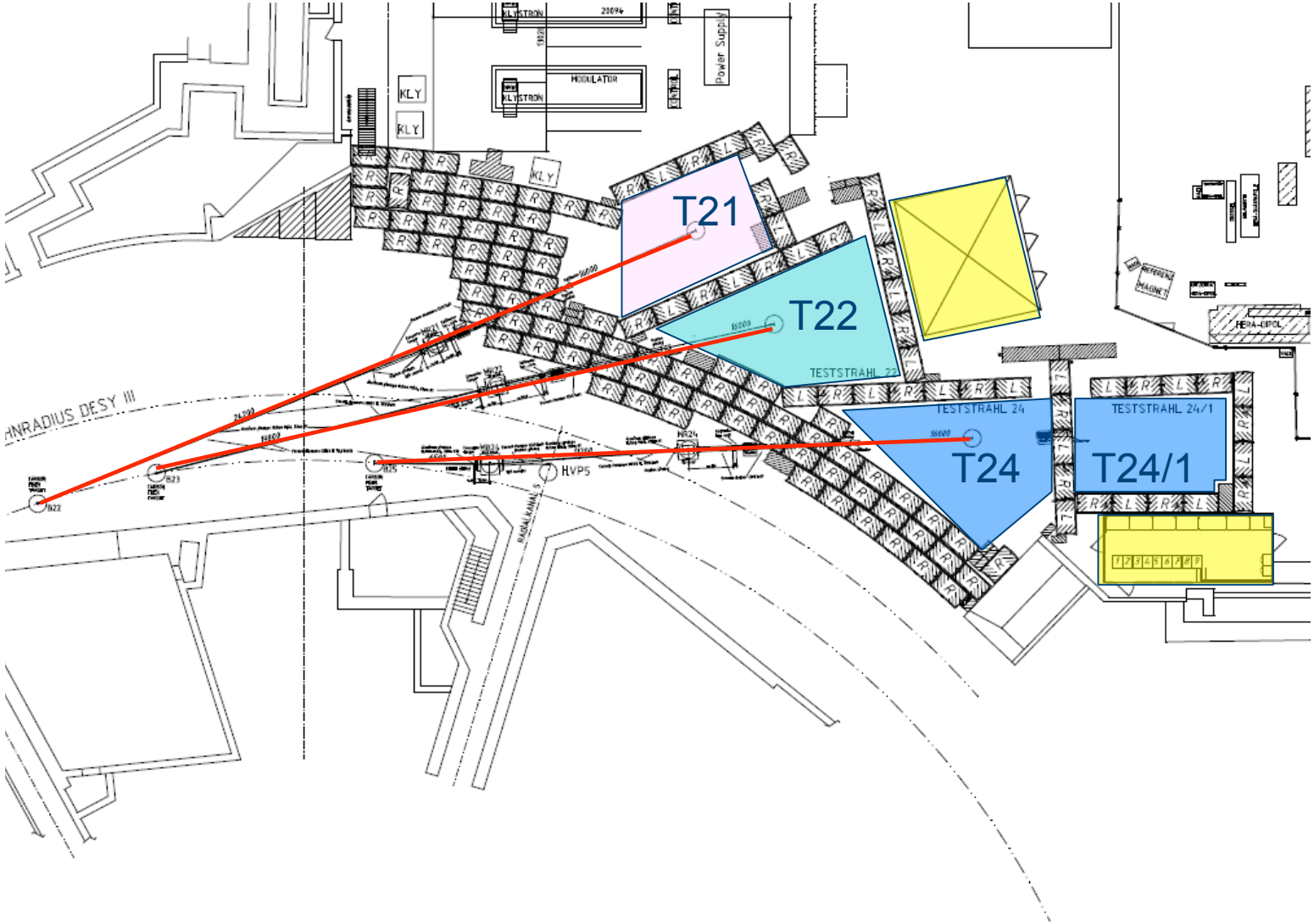


Magnet

Collimator

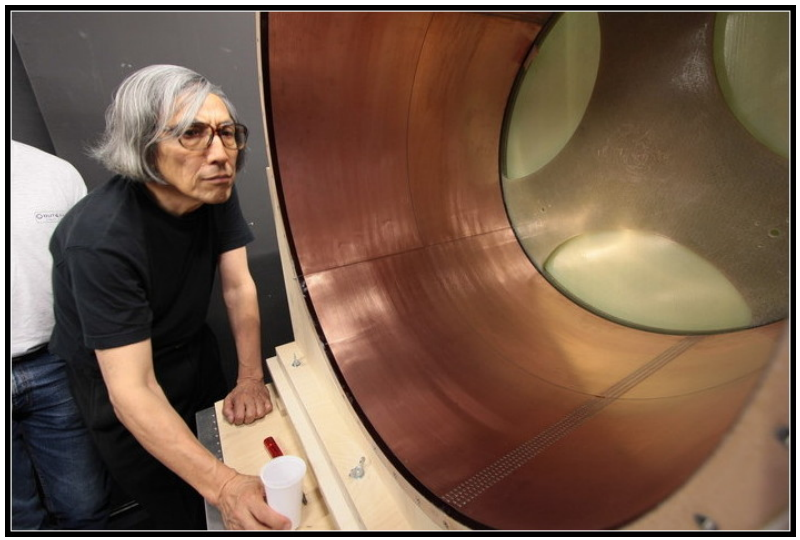
Beam shutter

DESY testbeam Layout



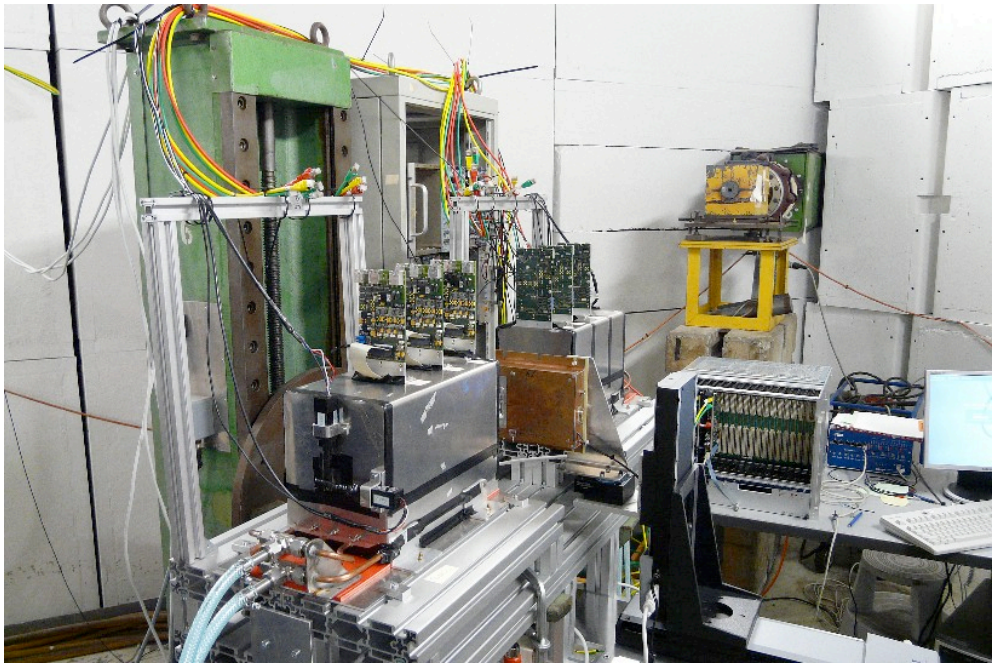
Facilities for Test Beam Users

- All three testbeam lines have
  - Interlock systems
  - Magnet control
  - Patch panels with preinstalled cables
  - Gas warning systems
  - Fast internet connection (DHCP)
- You can ask for:
  - Translation stages
  - Premixed gases
  - Superconducting Magnet (1T)
  - Beam Telescopes:
    - MVD Telescope
    - EUDET Telescope
- You have to bring:
  - Your Data Acquisition incl. computers
  - Trigger scintillators



Test Beam Area 21

- Recently refurbished -> New home of EUDET telescope



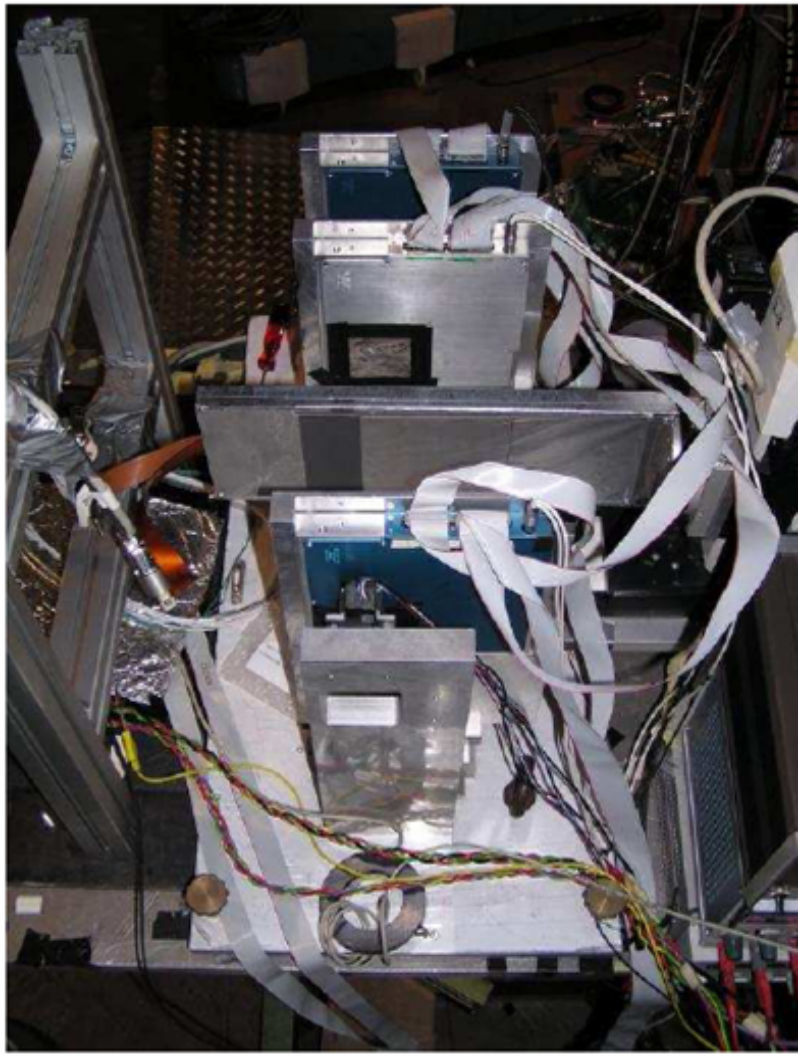
- Pixel beam telescope:
  - 6 layers of Monolithic Active Pixel Sensor (MAPS) detectors
  - DEPFET and ISIS pixel detectors for validation
  - DAQ system
  - Demonstrator telescope in use since summer 2007

More information

WWW.EUDET.ORG

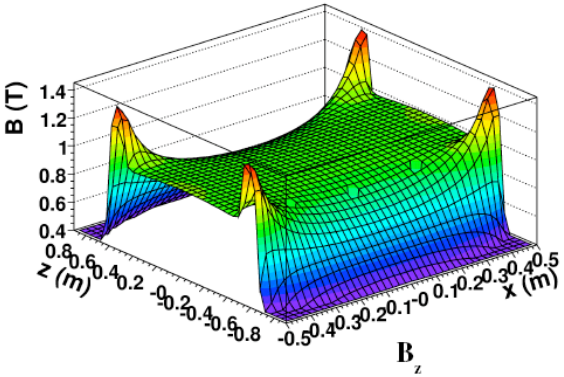
Testbeam 22: ZEUS Telescope

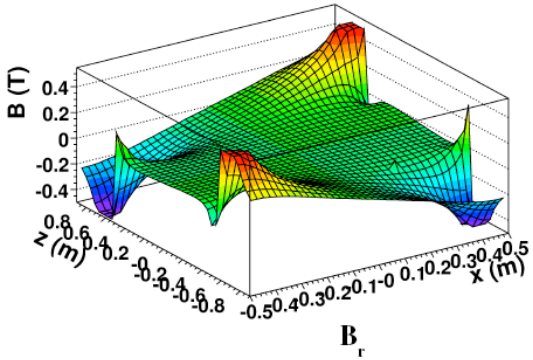
- Location of ZEUS MVD telescope (built in 1998)
- Telescope parameters:
  - 300 μm thick single-sided Si strip sensors
  - Each plane with 2 sensors prependicular to each other
  - Strip pitch: 25μm
  - Readout pitch: 50μm
  - Active area: 32x32 mm^2
  - Trigger window: 8x8 mm^2
- Plans for next years:
  - keep telescope running
  - Upgrade DAQ to EUDET like system



Testbeam 24: EUDET

- Large bore magnet:
  - 1Tesla, Ø≈85 cm, stand-alone He cooling, supplied by KEK
  - infrastructure(control, fieldmapping, etc.) through EUDET
  - Magnet fully instrumented at DESY and ready for use





Availability and Summary

- DESY test beam is running throughout the year 2009 except January
- Machine study weeks every 6 weeks planned -> detailed schedule available
- Users can apply for beam time through DESY test beam coordinators -> up to three weeks possible, longer terms negotiable

You can apply for test beam time at DESY

testbeam.desy.de

Or contact: testbeam-coor@desy.de

- 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