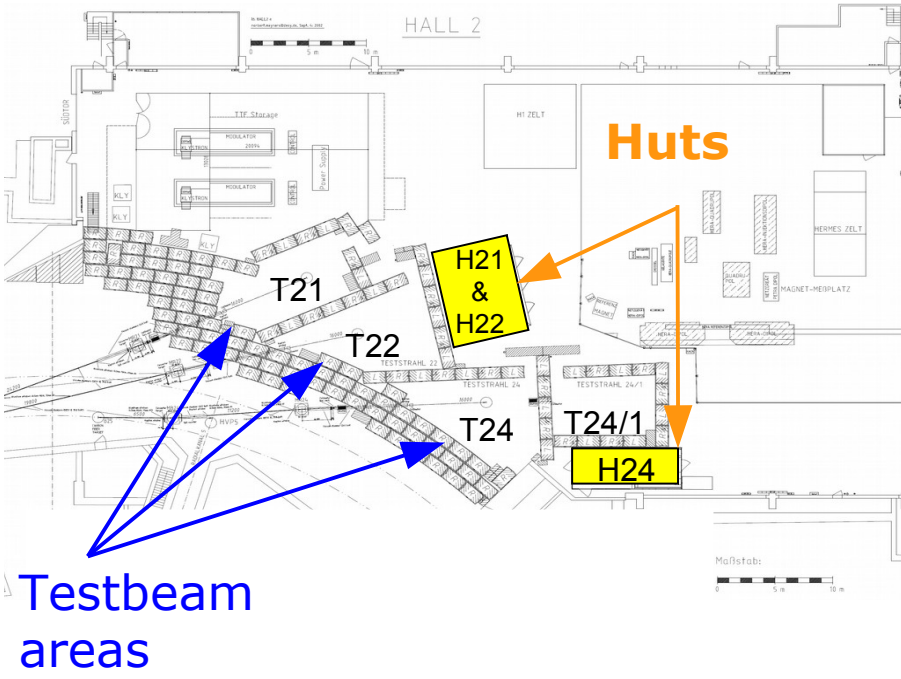
PCMAG Solenoid Upgrade at DESY Testbeam Area T24/1

AIDA Annual Meeting, March 27, 2014

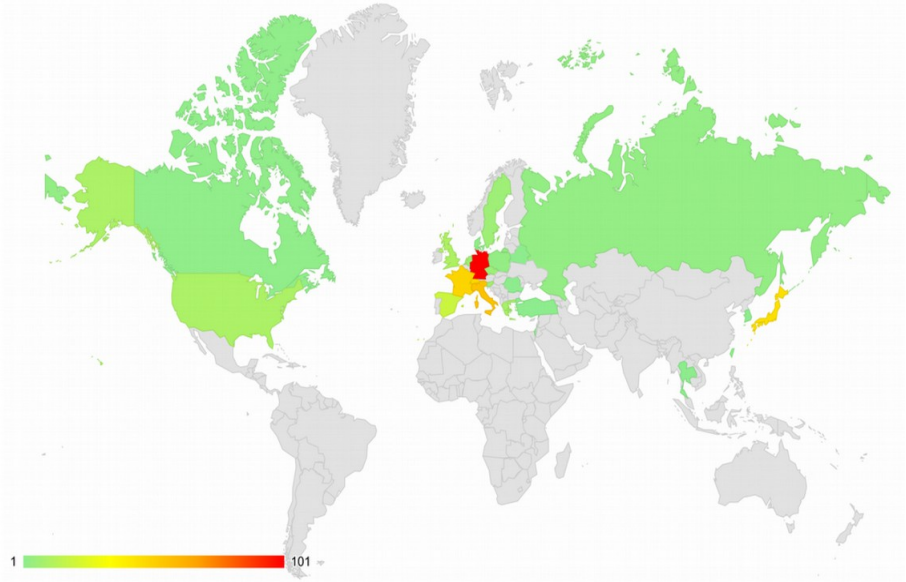
R. Diener, DESY

DESY II Testbeam

- DESY II Testbeam facility offers
  - 3 beam lines with 1-6 GeV electrons
  - Infrastructure
    - Testbeam telescopes
    - Solenoid and Dipole magnets
  - Open to the entire community
  - High uptime, very reliable running

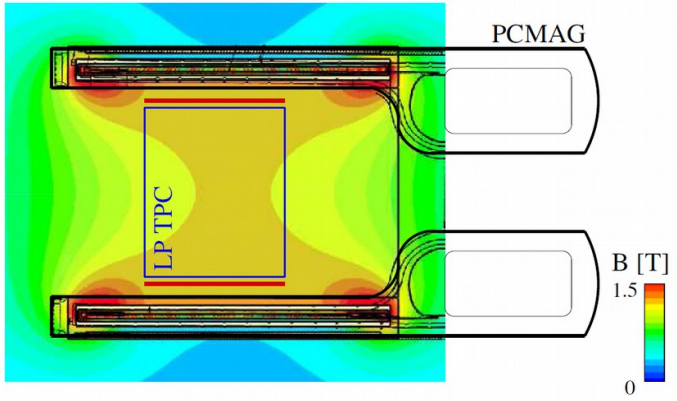


- Usage 2013
  - Over 400 groups from 24 countries
    - Germany 25%
    - EU 43%
    - Outside EU 32%

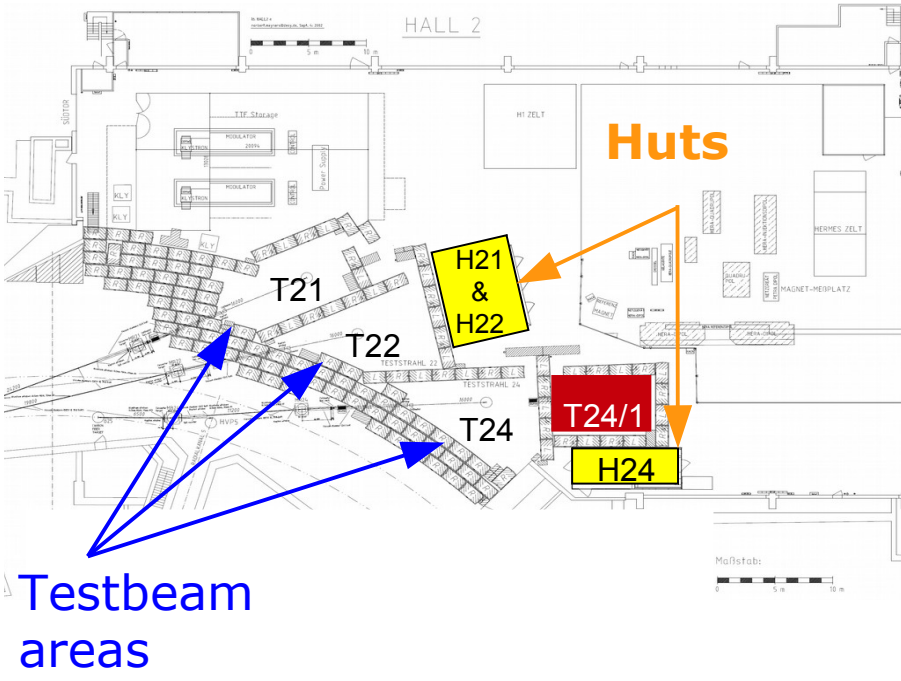


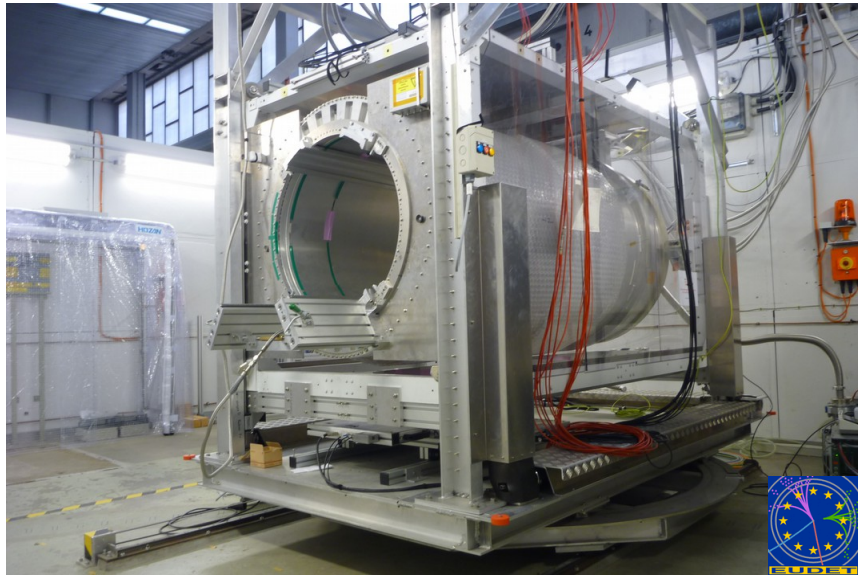
PCMAG @ Testbeam Area 24/1

- **P**ersistent **C**urrent, superconducting **MAG**net (designed for airborne experiments)
  - Thin coil and wall ($0.2X_0$), no return yoke



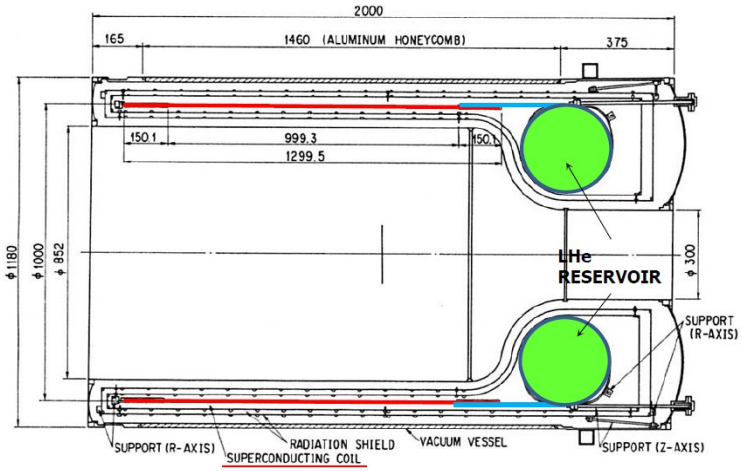
  - Liquid Helium reservoir
  - Moved to DESY in Dec 2006 (EUDET)
- Dimensions and data:
  - Coil: ∅ 1.0 m, ↔ 1.3 m, weight: ~460 kg
  - Usable space: ∅ ~85 cm
  - Central magnetic field: up to 1.2T
  - Operational current: ~430A (1T)
  - Mounted in movable stage



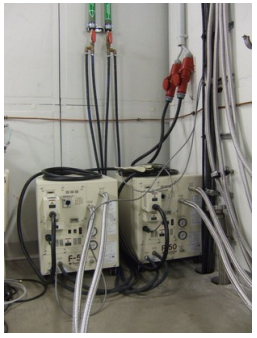
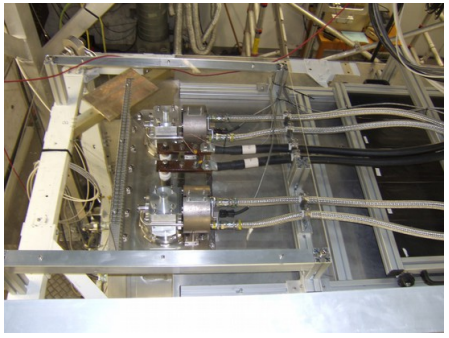


PCMAG Upgrade

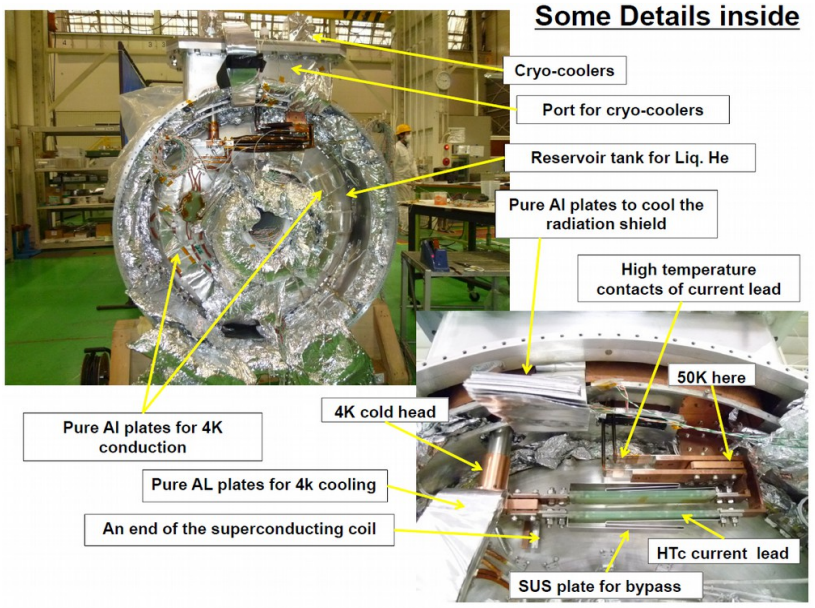
- Before modification: filling manually with liquid Helium
  - Expert work with many steps
  - Longer running times (many fillings):
    increasing probability of pipe blocking due to small amounts of air/humidity in the system with every fill
  - Persistent current mode:
    complicated ramping procedure with dis-/connecting power and warming up/cooling down parts of the system



- Upgrade in AIDA (with contributions from KEK & DESY)
  - PCMAG without liquid Helium using cryo coolers (closed circuit system)

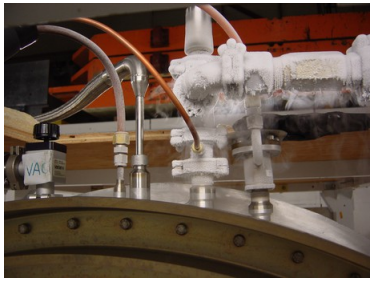




  - Mid 2011- Early 2012 Modification
  - Mid 2012: first excitation @ DESY
  - Reliably working since then

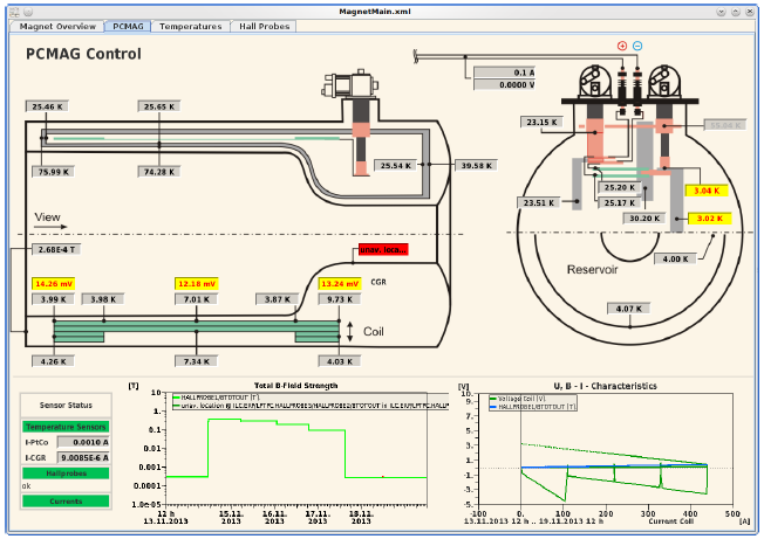


PCMAG Upgrade

- Improvements of PCMAG closed circuit cooling system
  - No filling, save liquid Helium (1000l for initial cooling and ~250l/week)
  - Simple *switch-on* procedure - 9 days to cool down from room temperature
  - Standard way of operation (no persistent current mode)
    → increased safety and ease of operation
    → users can ramp magnet
  - No pipe blocking :
    Long, continuous running periods possible
    (essential last and this year)

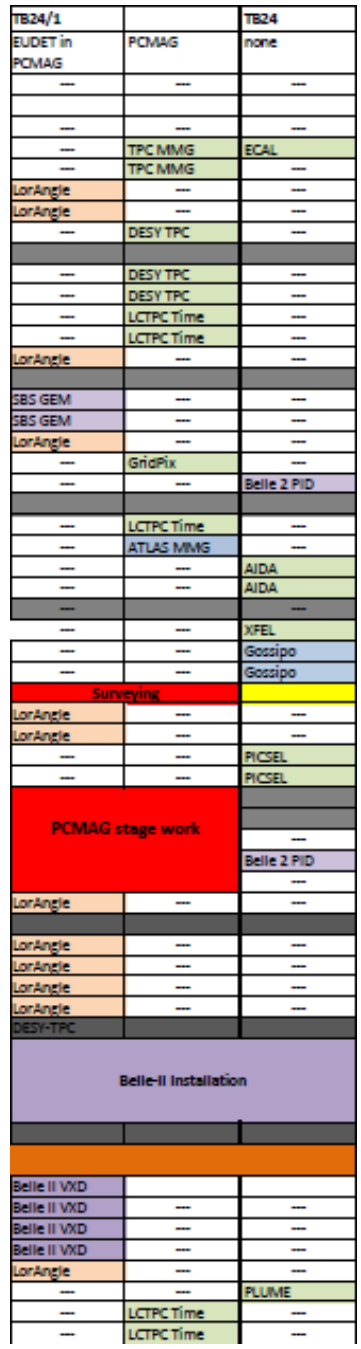


- Ongoing improvements during testbeam shutdown
  - Maintenance of cooling heads
    (every 10,000h, ~10k€ + technician)
  - Further integration into slow control system
  - Finish setup of movable stage
    (delayed due to high usage last year)
    - improve user friendliness + safety
    - more precision + position measurement of DUT



Testbeam Usage

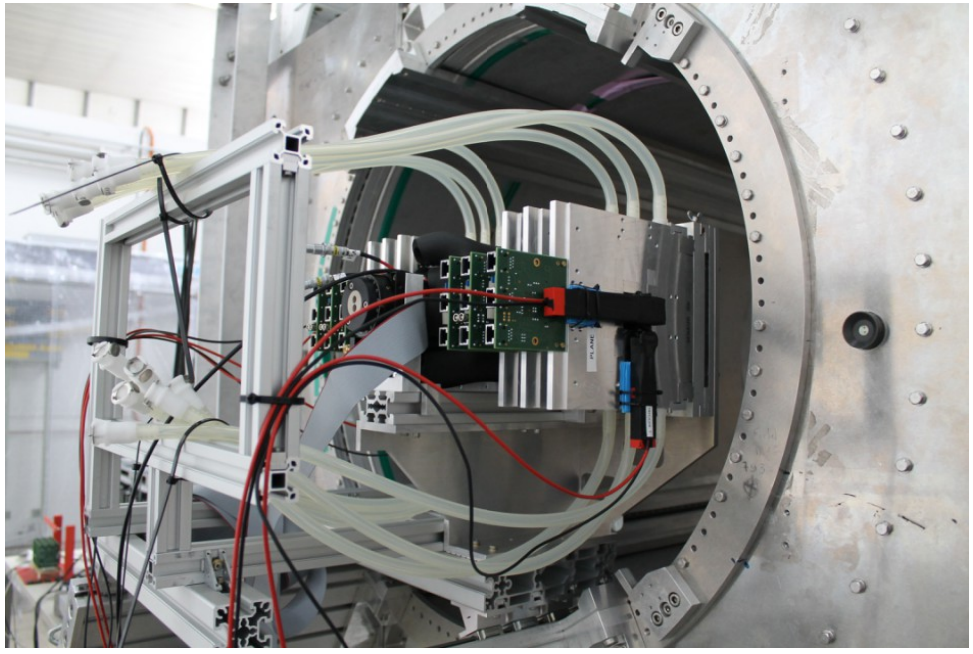
- High demand on beam time at DESY II in 2013/14
- Since 2008 LCTPC main user
- T24/1 magnet setup now also used by non-LCTPC groups:
  - ATLAS upgrade:
    - Measurement of Lorentz angle and charge collection efficiency of silicon microstrip detectors
    - Micromegas chambers for ATLAS Small Wheel upgrade
  - GEM tracker chambers for SBS (Super Bigbite Spectrometer) @ JLAB
  - Belle II Vertex detector



ATLAS Silicon Strip Sensors

- Measurement of
  - Lorentz angle
  - Charge collection efficiency (complement measurements with source)

  of 12 ATLAS silicon microstrip test sensors for the phase2 upgrade (10 irradiated with neutrons at different fluences)
- First use of EUDET/AIDA 6 layer pixel telescope in PCMAG
- 18 weeks of beam time in 2013/14



ATLAS Small Wheel - Micromegas

- Micromegas chambers of the newly designed New Small Wheel (NSW) of ATLAS
- Magnetic field 0-0.3T; different orientation with respect to chamber planes

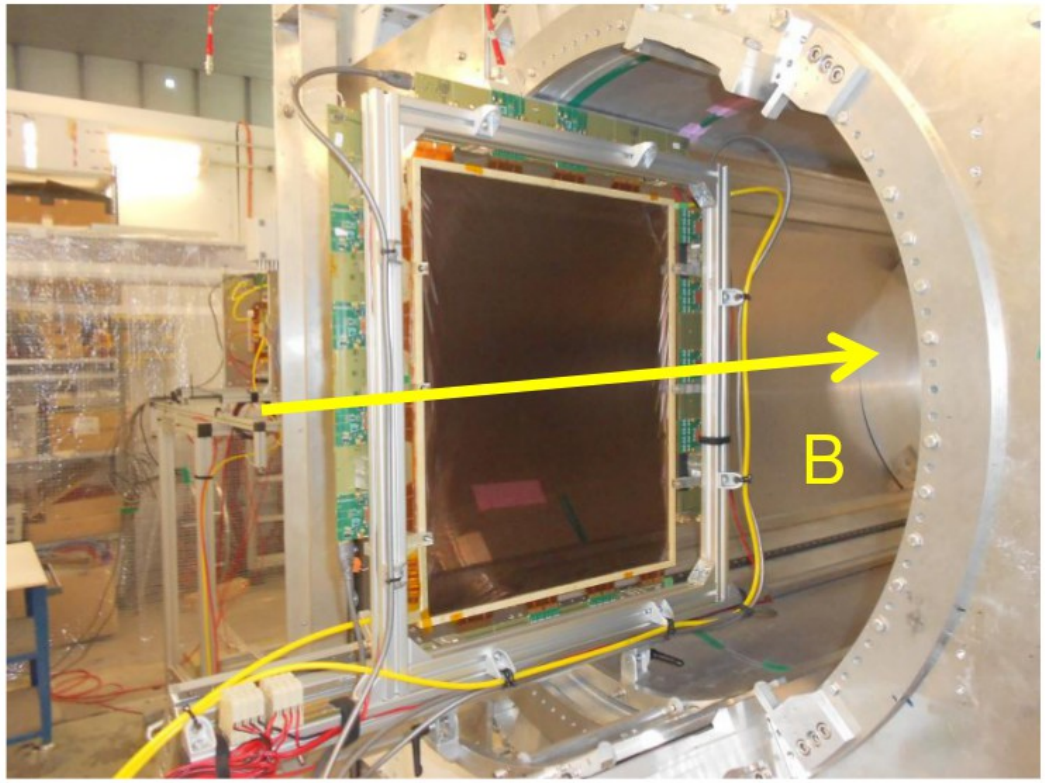
- Study effects of magnetic field on spatial resolution and efficiency:
  - Lorentz angle
  - Drift velocity

  for different magnetic field settings
- Comparison with Monte Carlo studies

- 10 days beam time

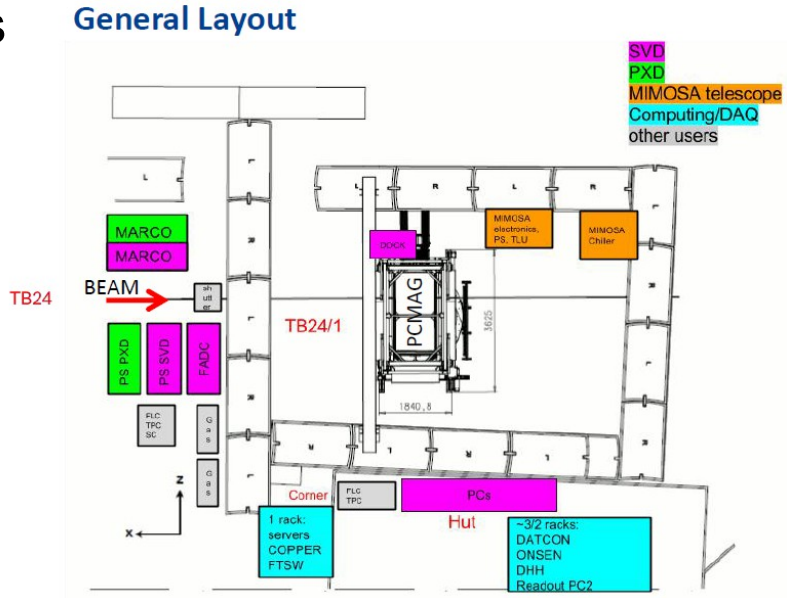
SBS GEM Tracker / JLab

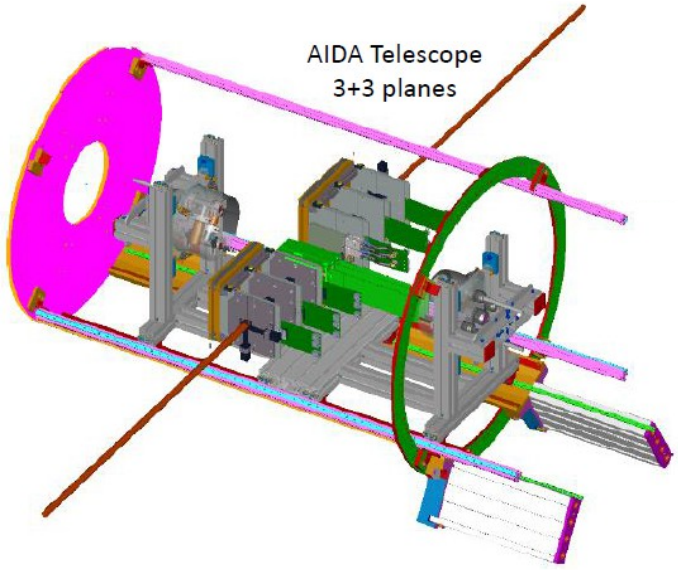
- Development and construction of a new large-area lightweight tracker based on the GEM technology for the upcoming experiments in Hall A at Jefferson Lab
- The tracker will consist of 6 GEM chambers with 2 dimensional strip readout
- 40x50 cm^2 triple GEM modules to test a small scale fully equipped final tracker under beam conditions with magnetic field up to 500 Gauss
- 2 weeks beam time

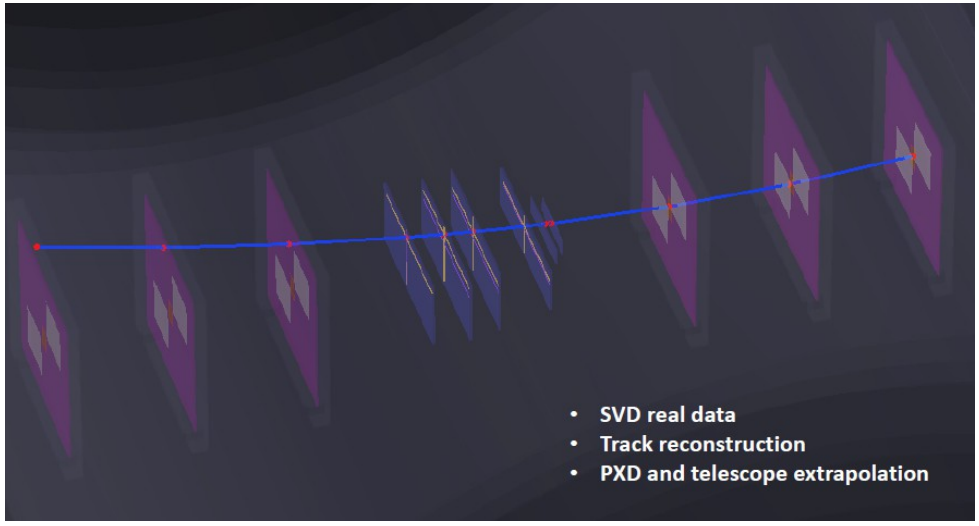


Belle II Vertex Detector

- Validate current design and start the production of the final generation of sensors for the Belle II pixel detector.
- Integration test of the two final detector technologies to be used in the vertex detector of Belle II (DEPFET pixels and silicon strips) including DAQ, data reduction, slow control + interlock systems and 2PCO2 cooling
- 1 PXD and 4 SVD layers tested (using EUDET/AIDA telescope)
- 6 weeks setup, 4 weeks beam time



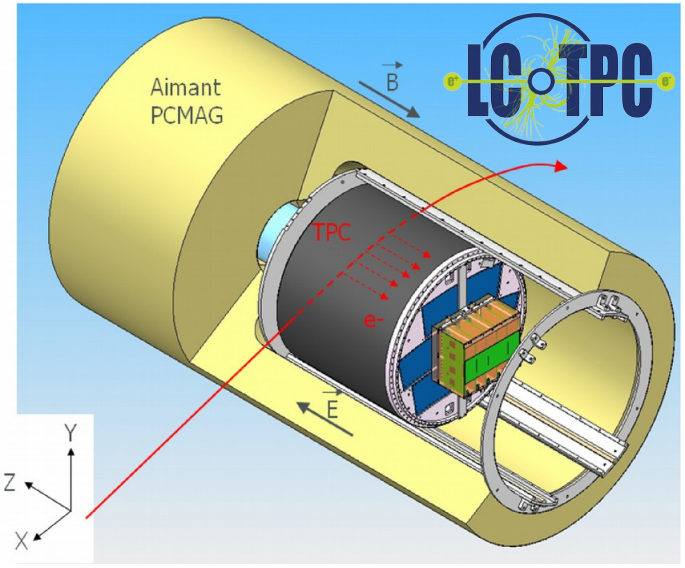


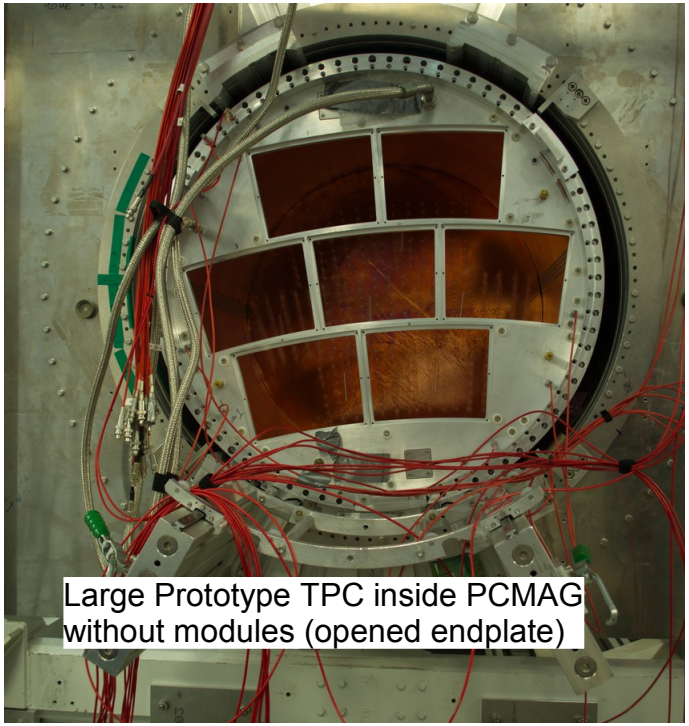


LCTPC Studies at T24/1

- LCTPC Setup in T24
  - Large TPC Prototype:
    - Light weight; made of composite materials
    - Sensitive Volume: ∅ 72cm, L= ~58cm
  - Modular end plate
    - Up to 7 read-out modules
    - Size/shape similar as foreseen for the final detector
- HV, gas and slow control systems
- Cosmic and beam trigger
- Laser calibration system (photo dot cathode)
- Wishlist: external silicon tracker inside magnet

- 11 weeks beam time in total

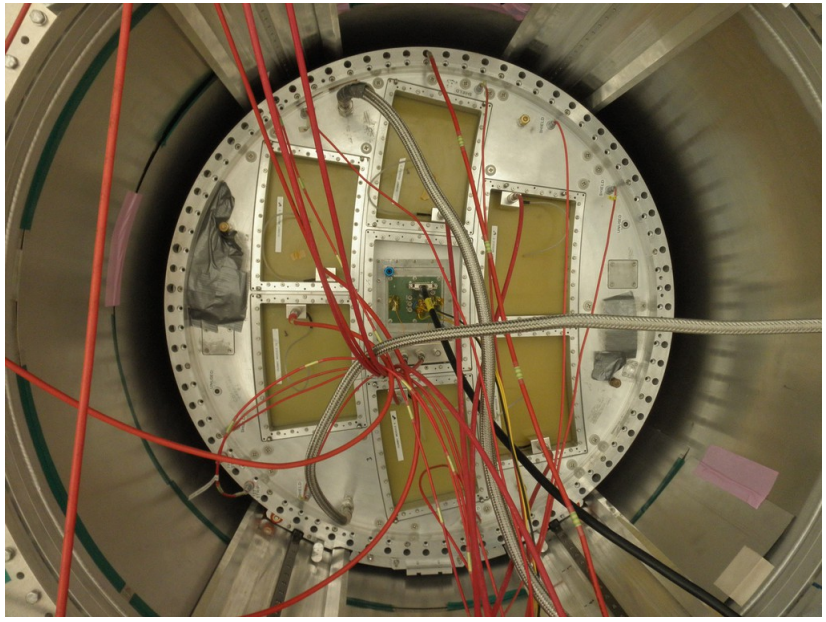


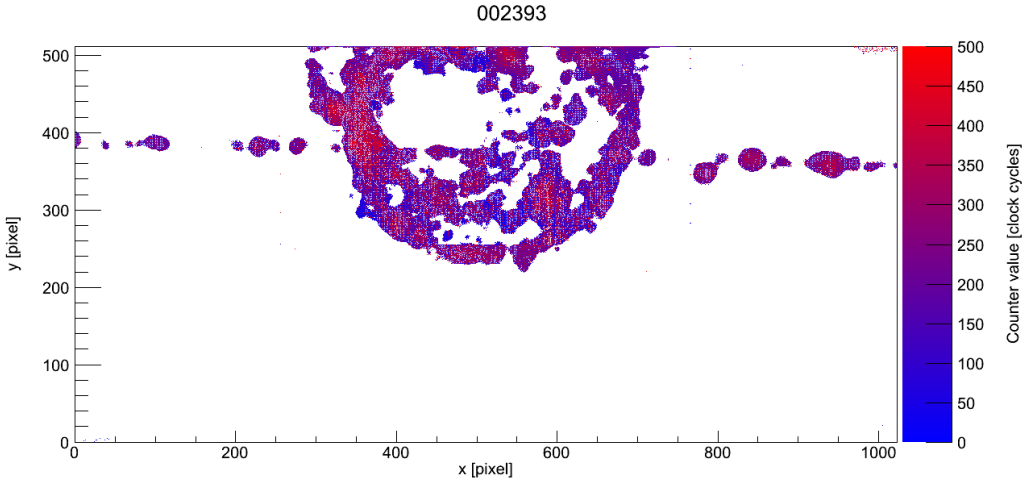


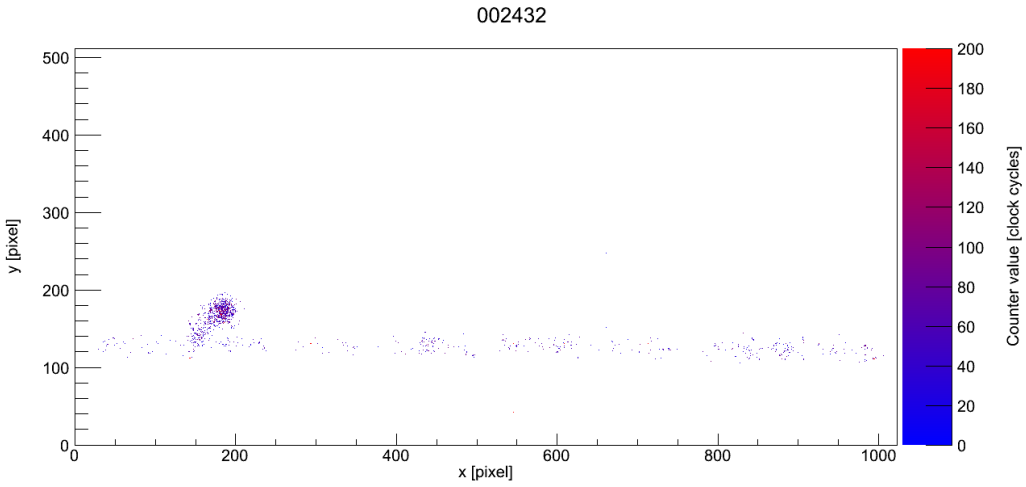
Large Prototype TPC inside PCMAG without modules (opened endplate)

U Bonn TimePix Modules

- TimePix Octoboards, 2 modules:
  - Ingrid Octoboard (Micromegas post-processed, pixel aligned on TimePix chip)
  - Triple GEM amplification above TimePix Octoboard
  - New (scalable) readout system
  - 2 weeks beam time

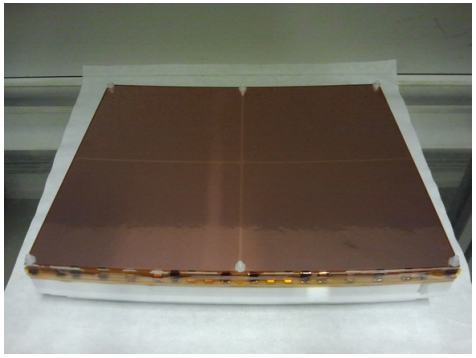
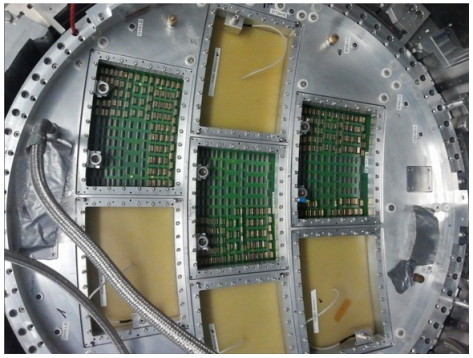
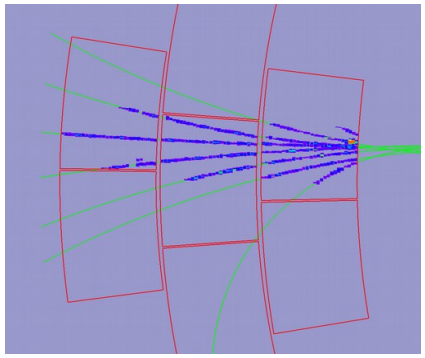




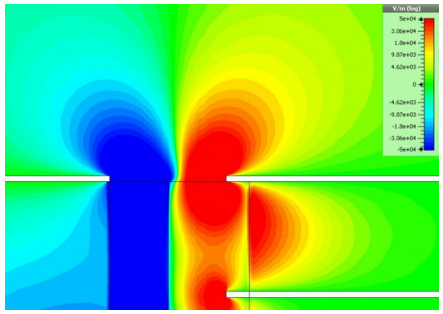
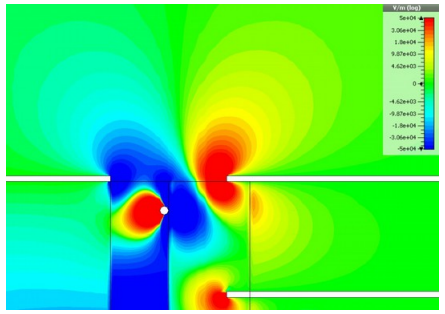


DESY GEM Modules

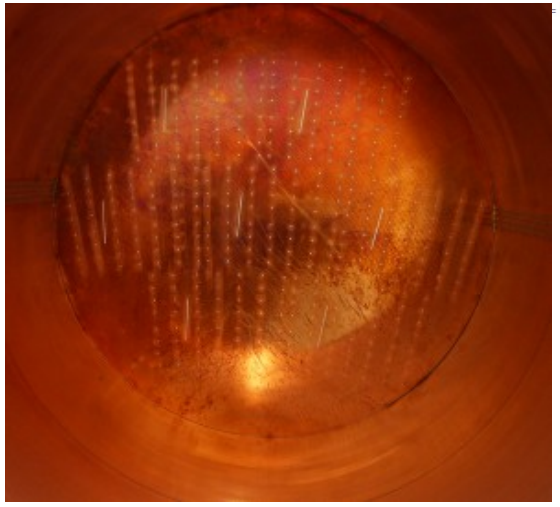
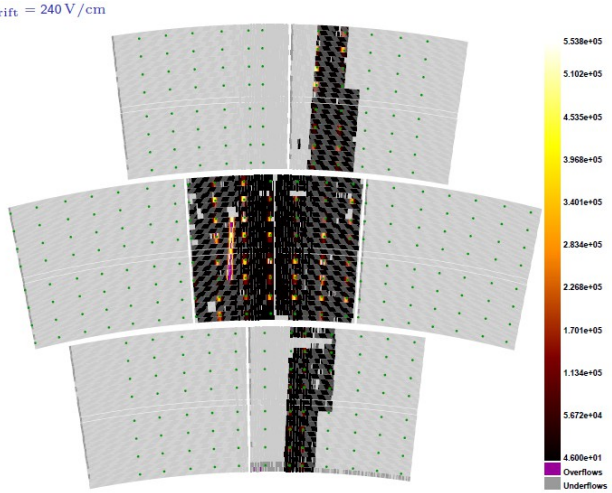
- 3 readout modules with triple GEM amplification with pad readout (ALTRO)

- Guard ring to minimize field distortions at module boarders

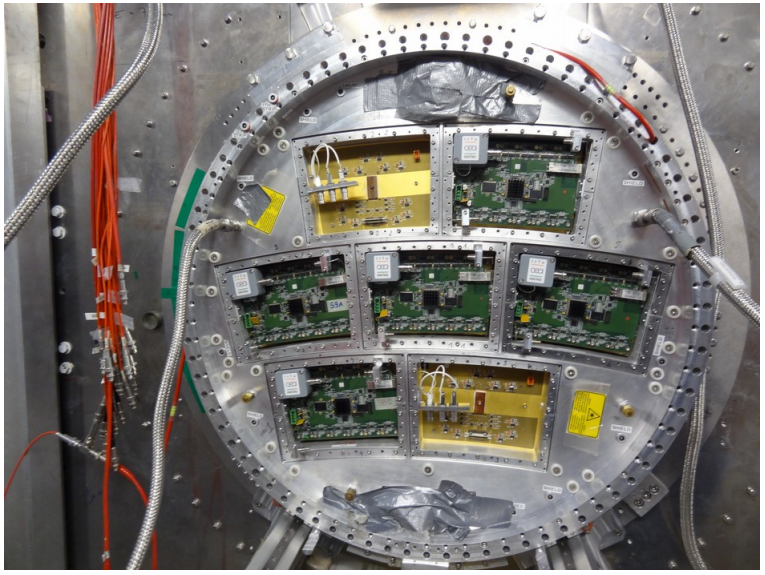
- Measurements of laser photo dots for field distortion studies

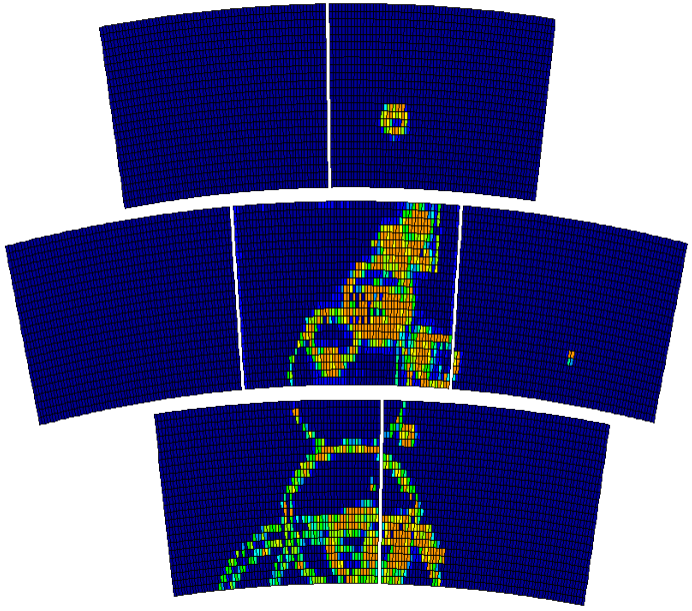



- 4 weeks beam time
  + 1 week laser measurements

Micromegas Modules

- 7 modules with Micromegas amplification
  + resistive layer to spread charge on pad layer
- Integrated AFTER readout

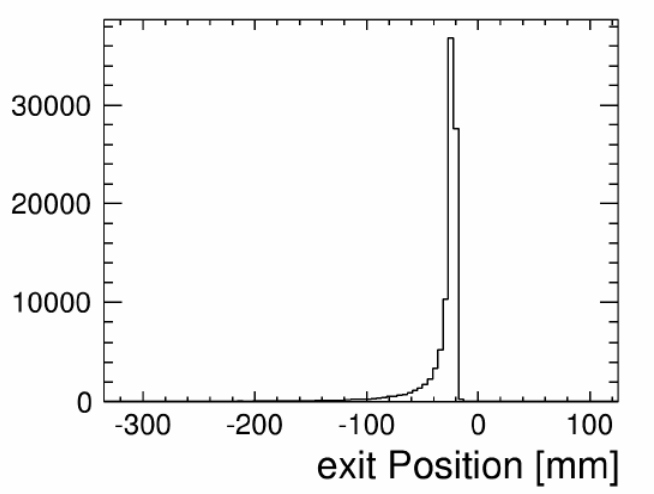


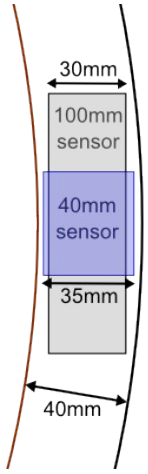


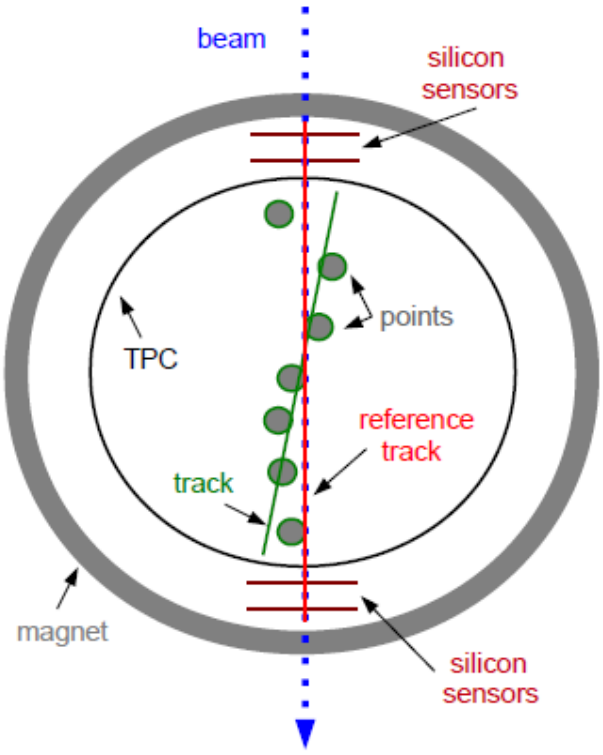
- 5 weeks of beam time
  - 2 weeks with integrated readout
  - 1 week with ALTRO readout
  - 2 weeks with new 2PCO2 cooling
    (incl. Tests with 2 Octopuce modules & laser data taking)
- More in P. Colas' presentation

Outlook

- Short term:
  - Maintenance + movable stage improvements
  - Slow control system extension (e.g. data from Helium compressors)
- Long term
  - External silicon tracker (AIDA2)
    - High priority for LCTPC (essential for momentum measurements)
    - Need to cover about 10cm at exit point
    - 2 layers in space between TPC and magnet
    - Order of 10µm resolution







Conclusion

- PCMAG upgrade went without problems and according to schedule
  Budget has been used completely
- Modified PCMAG:
  - Runs without problems, much less servicing/maintenance work
  - Improves the usability and user-friendliness of the setup
  - Increased safety
- Improved setup well requested and PCMAG upgrade happened at the right time:
  - Used 42 weeks in 2013/14
  - Nearly continuous operation periods would not have been possible with liquid Helium operation of PCMAG