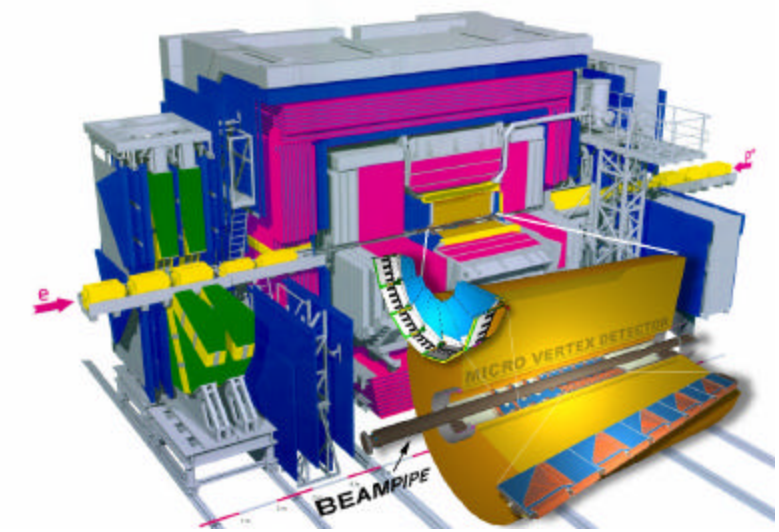
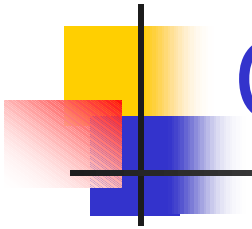
ZEUS Status and Future

Durham Workshop

6.12.2001

Uwe Schneekloth

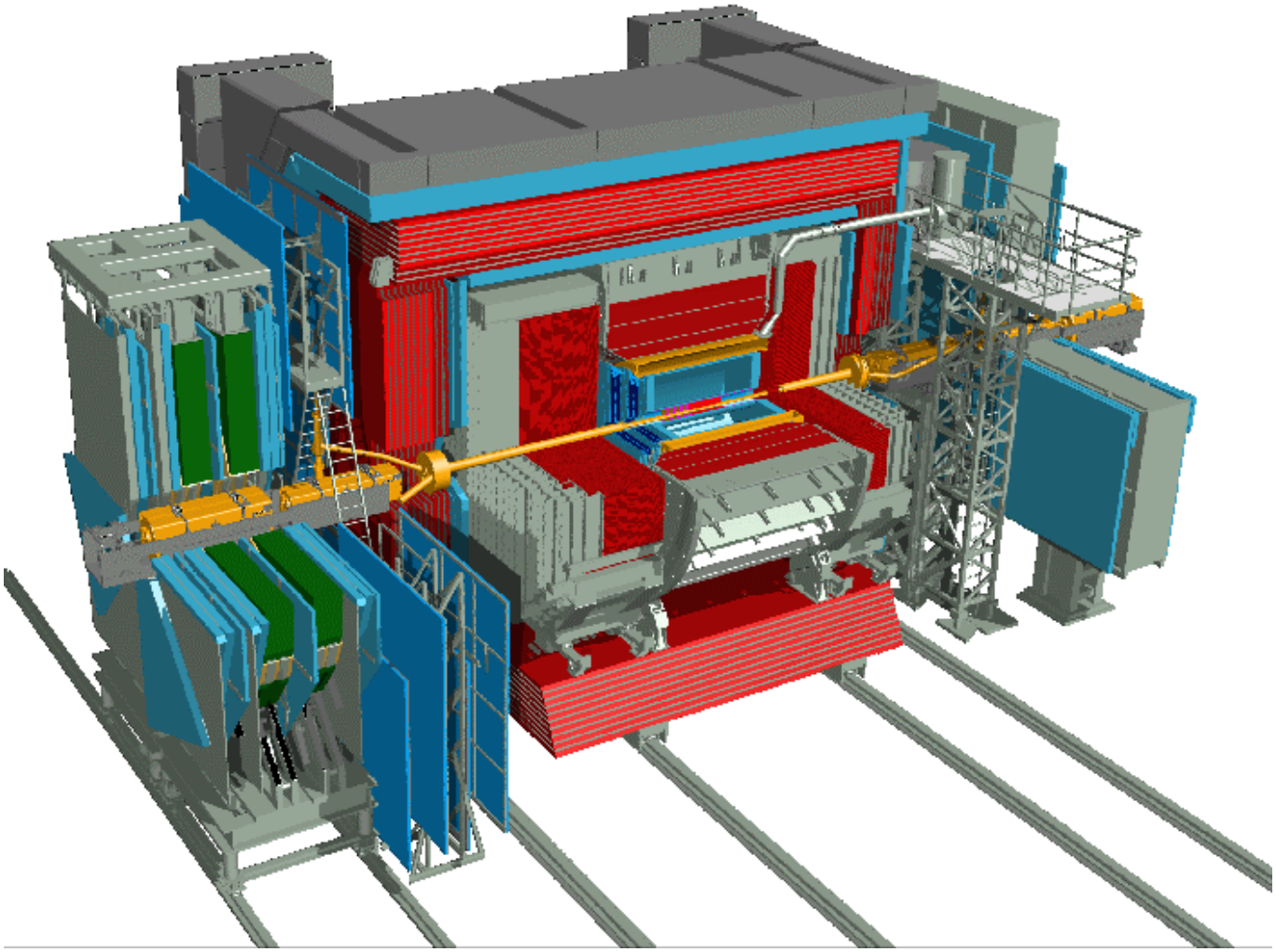




Outline

- Overview of ZEUS Detector
- Detector Modifications 2000/2001
  - Removed Detector Components
    - Leading Proton Spectrometer, Forward Plug Calorimeter, Beam Pipe Calorimeters
  - New Detector Components
    - Beam Line, Micro Vertex Detector, Straw Tube Tracker, Luminosity Monitor
- Performance - Signs of Aging ?
- Future of the Detector

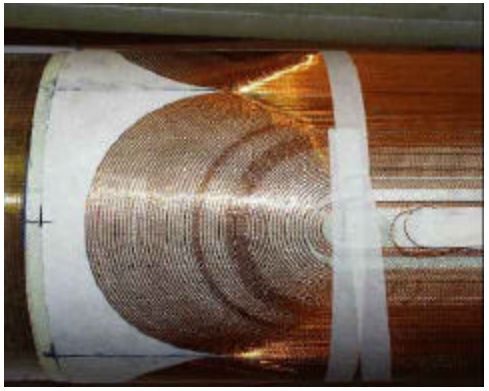
The ZEUS Detector

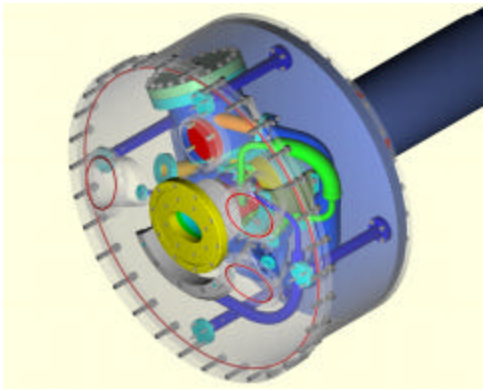


HERA Luminosity Upgrade

- Increase luminosity from
  1.5 to $7*10^{31}$ cm^{-2} s^{-1}
- Stronger focussing of electron and proton beams
- Focusing elements closer to IP
- Earlier separation of both beams
- Final HERA magnets (super-conducting) inside detector volume

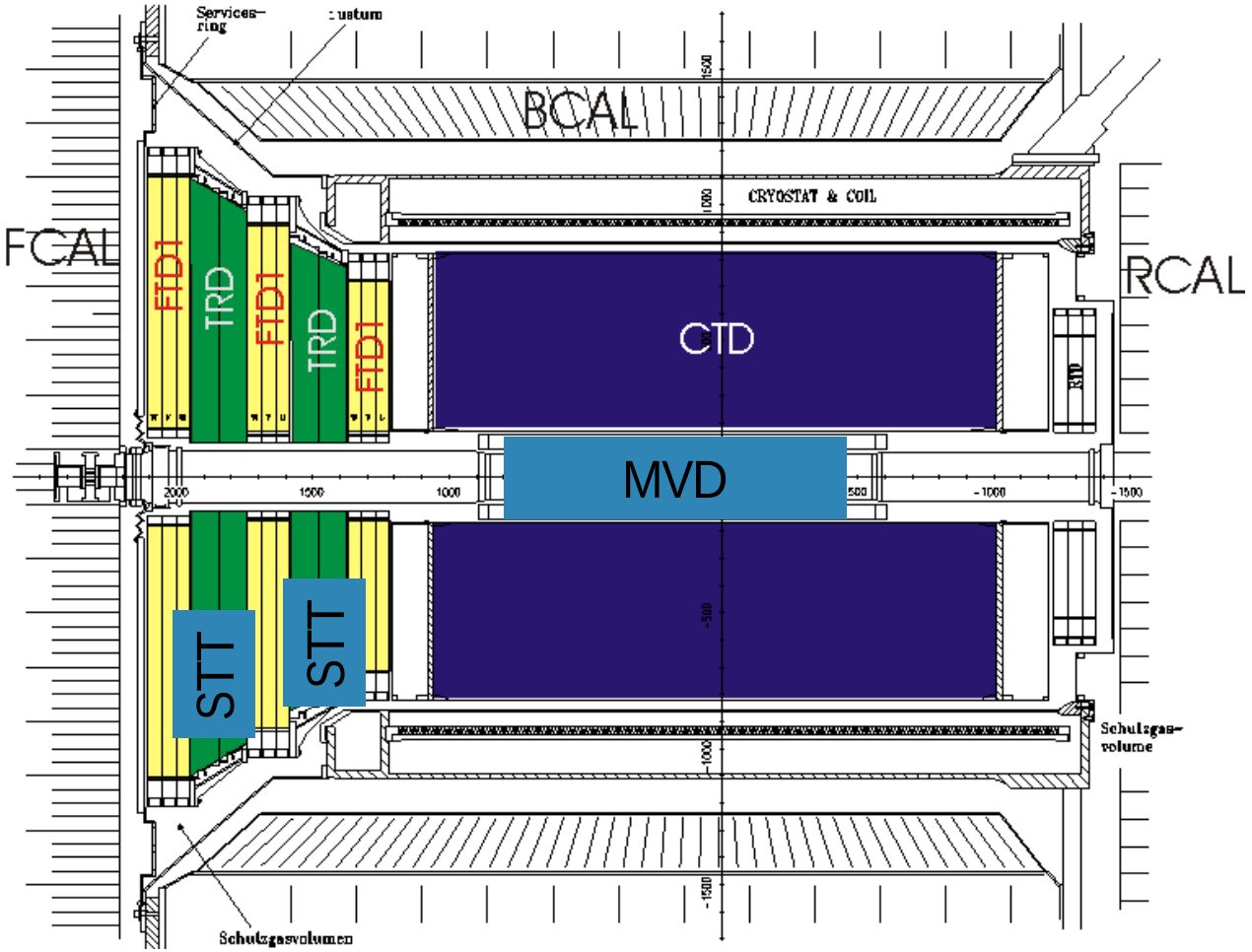
- Status
  - Hardware completed July 2001
  - HERA commissioning since August
  - Achieved design specific luminosity (with low currents)
  - Working on optimizing synchrotron radiation background





ZEUS Inner Detector

- Tracking Detectors:
  - CTD for $\theta > 25^0$
  - CTD+FTD for $14^0 < \theta < 25^0$
  - FTD only for $8^0 < \theta < 14^0$
- CTD:
  - 72 layers
  - Stereo angle $\pm 5^0$
  - Good efficiency down to 25^0
- TRDs replaced by Straw Tube Tracker

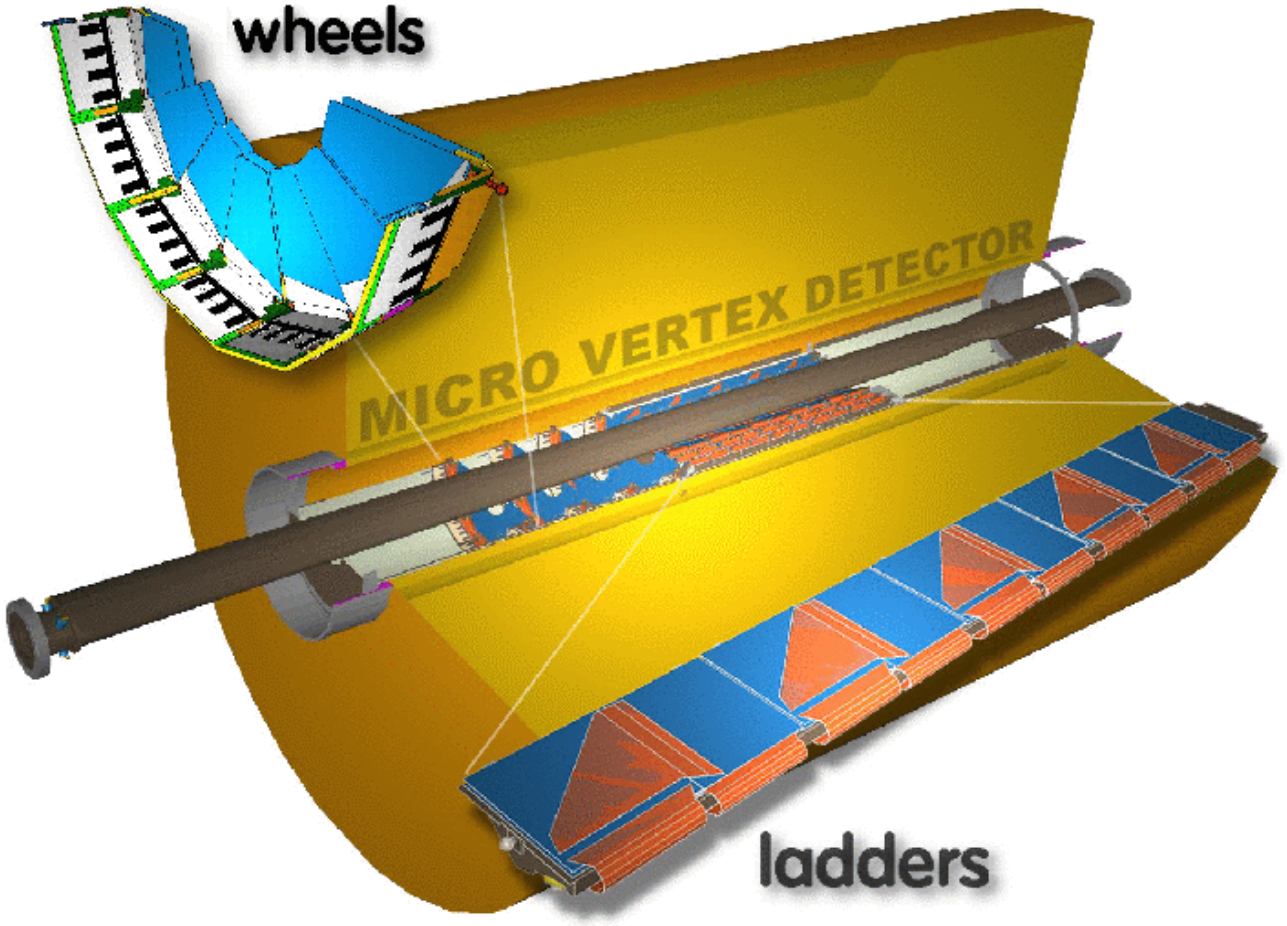


Tracking at High Luminosity

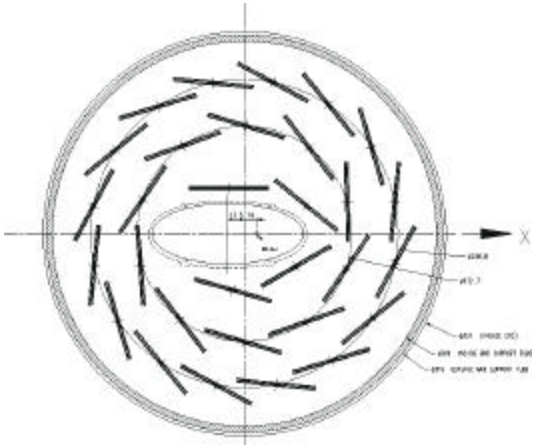
- Central Environment
  - Very good momentum resolution
  - Secondary vertex tagging
  - Difficult to access
- Solutions
  - Silicon strips close to beam
  - 20 µm pitch
    120 µm readout
  - Full system test

- Forward Environment
  - High track density
  - Highest close to beam axis
  - Large and variable backgrounds
- Solutions
  - Large number of wires
  - Shortest cells where occupancy highest
  - Robust reconstruction
  - 4 views instead of 3
  - Sacrifice particle ID for track finding in FDET

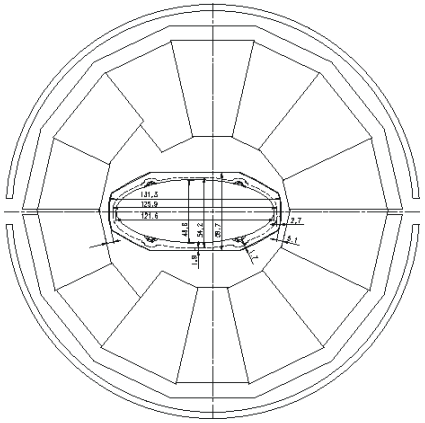
Micro Vertex Detector



barrel

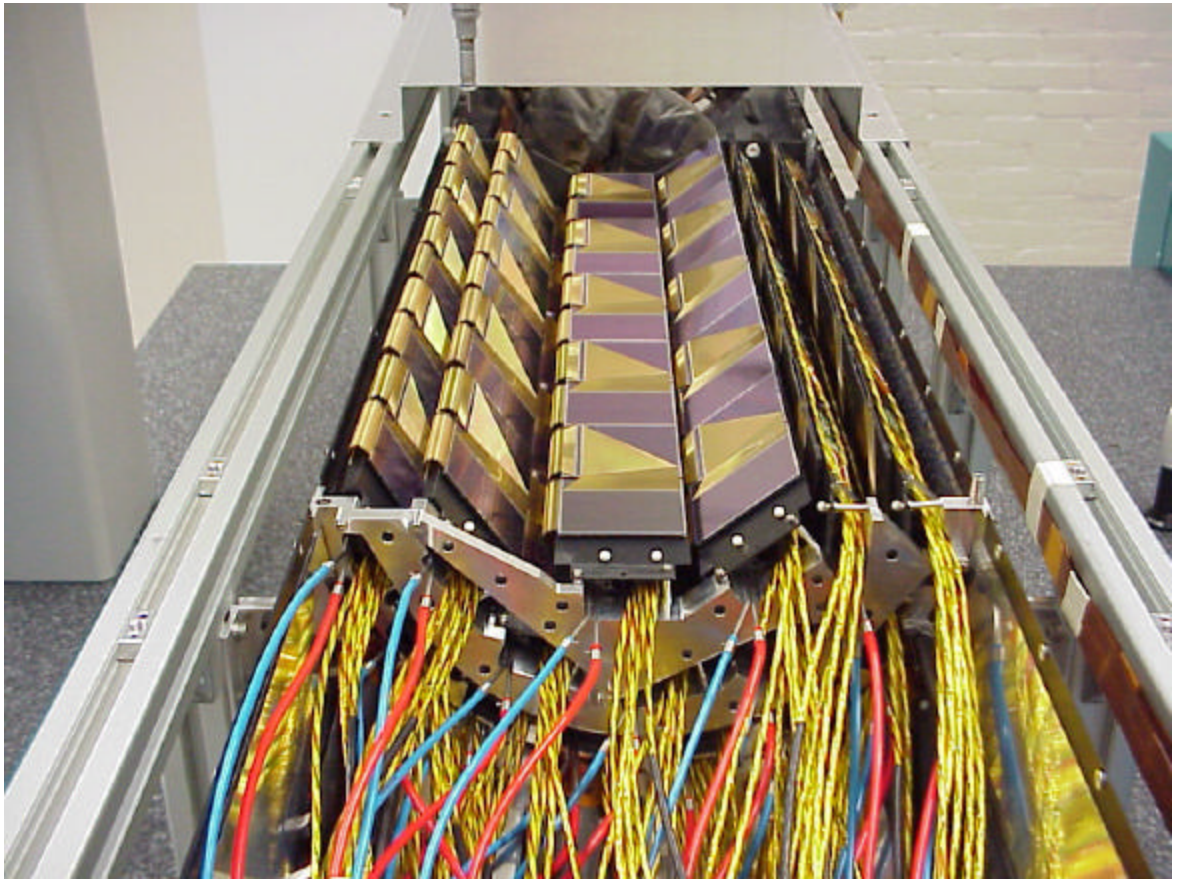


wheels



Micro Vertex Detector Assembly

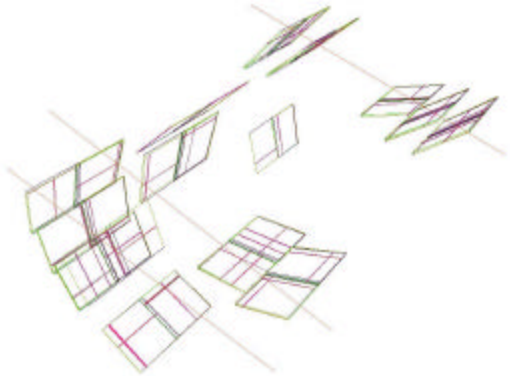
22 Nov 2000: 15 ladders (75000 channels) installed...



Status

- MVD installed in ZEUS March 2001
- Detector commissioned
- Ready for data taking

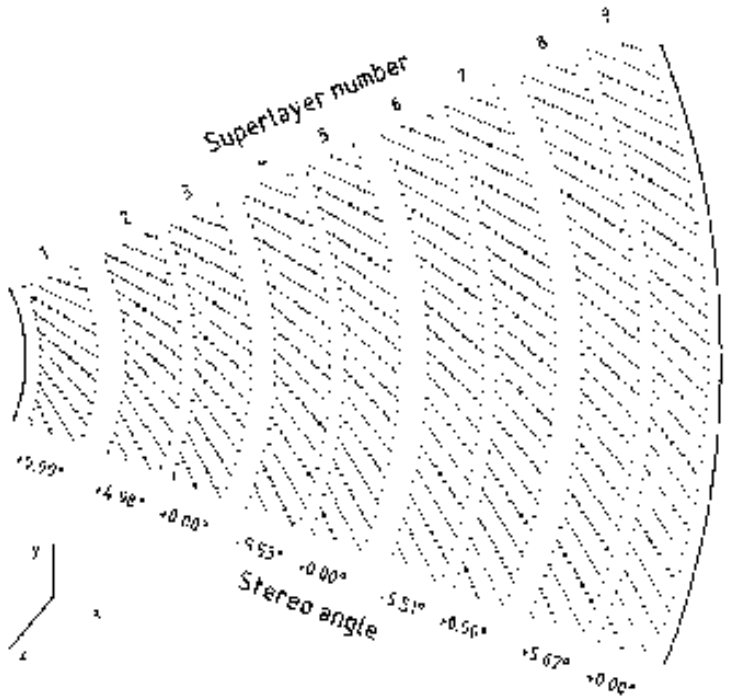
Cosmics



Central Tracking Detector

- Mini jet chamber cells geometry
- Resolution: $s_{p_t} / p_t = 0.0058\ p_t \otimes 0.0065 \otimes 0.0014 / p_t \quad p_t\ in\ GeV$

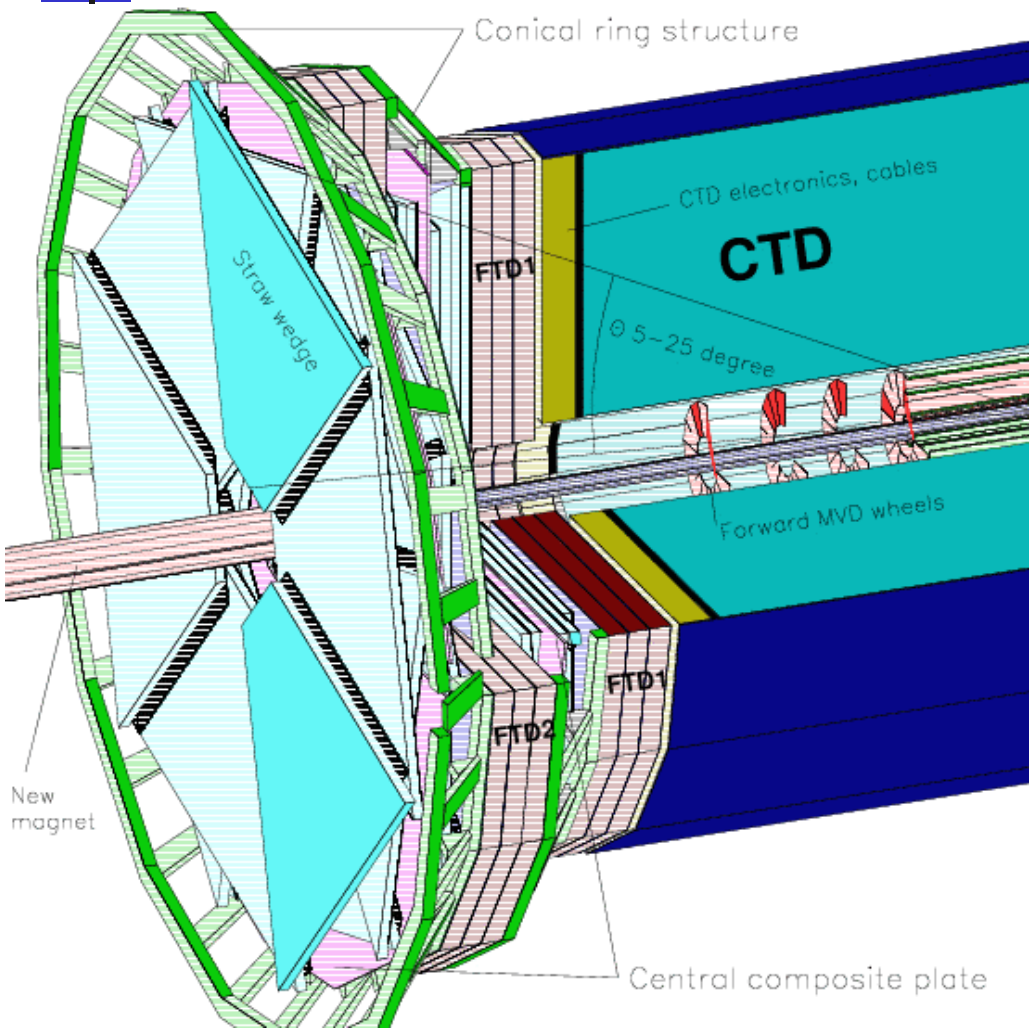
$$s\ (dE / dx) \approx 10\%$$



Long-term aging study

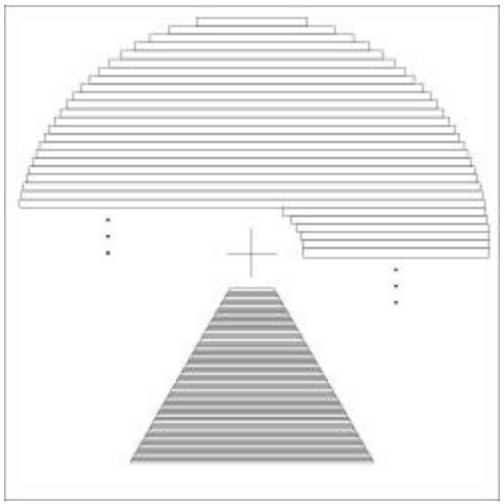
- 1992-1997 no signs of aging
- End of 1997 some non-beam induced HV trips
- More serious in 2000
- Added small quantity of water to gas
- Completely cured HV trips
- CTD performing without problems

Straw Tube Tracker



Replaced TRD by STT

Improving FDET geometry

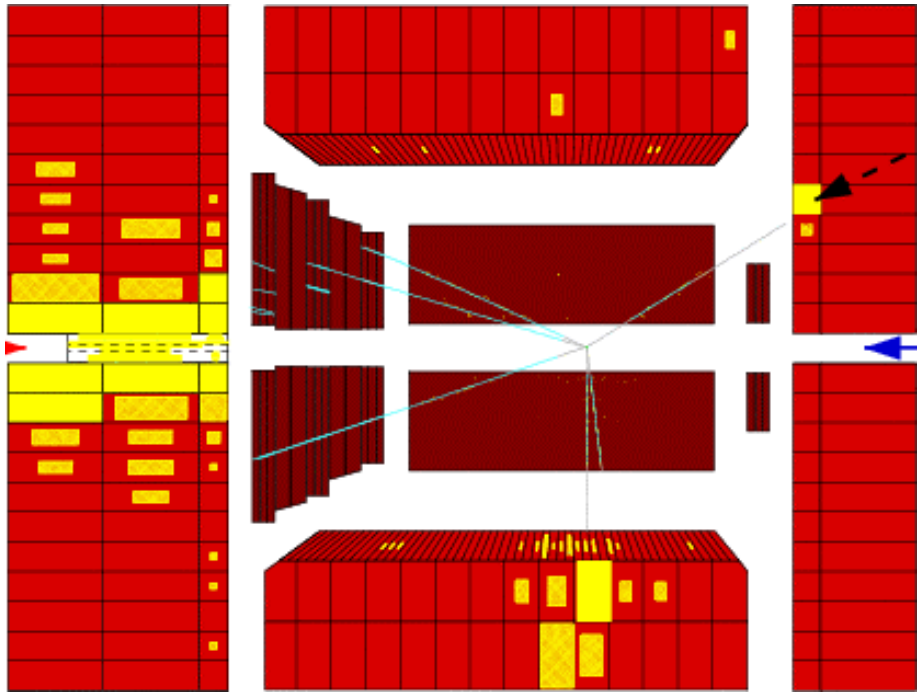


FTD,TRD cells

STT straws

- 7.5mm diameter straws
- Improved pattern recognition
- Good tracking
- Good radiation hardness

Uranium Scintillating Calorimeter



- No signs of radiation damage
  (total dose 90Gy, expect damage at 3kGy)
- Number of noisy cells increased (0.1% level)
- Upgrade of BCAL HV system in progress

Calorimeter properties

- compensating, e/h ratio =1.0
- linear response to electrons and hadrons
- energy resolution:

  electrons

$$\sigma_E / E = 18\% / \sqrt{E / GeV} \otimes 2\%$$

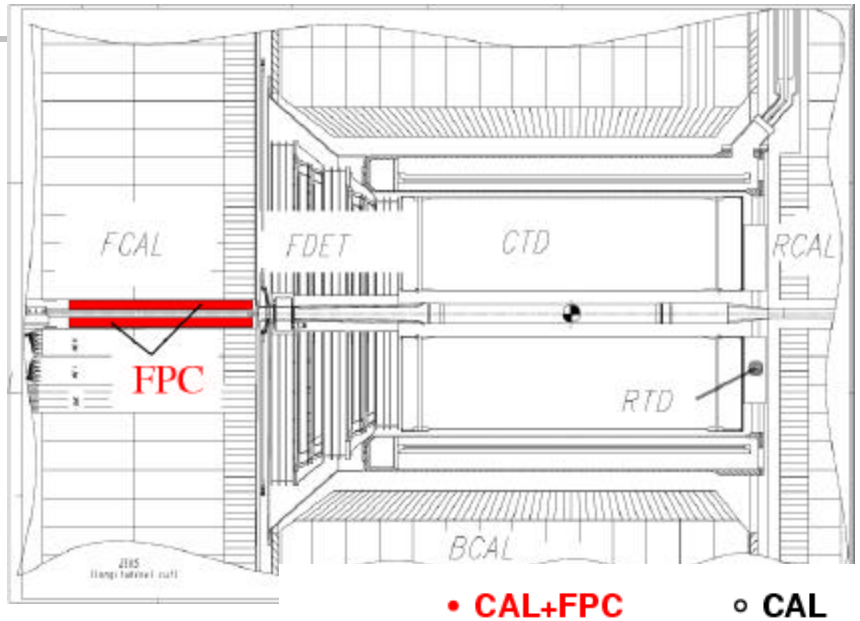
  hadrons

$$\sigma_E / E = 35\% / \sqrt{E / GeV} \otimes 1\%$$

- timing resolution 1ns

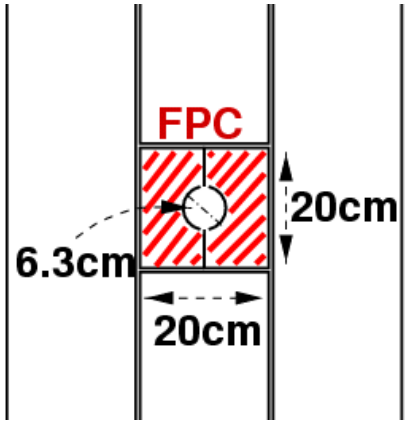
Acceptance of Calorimeter

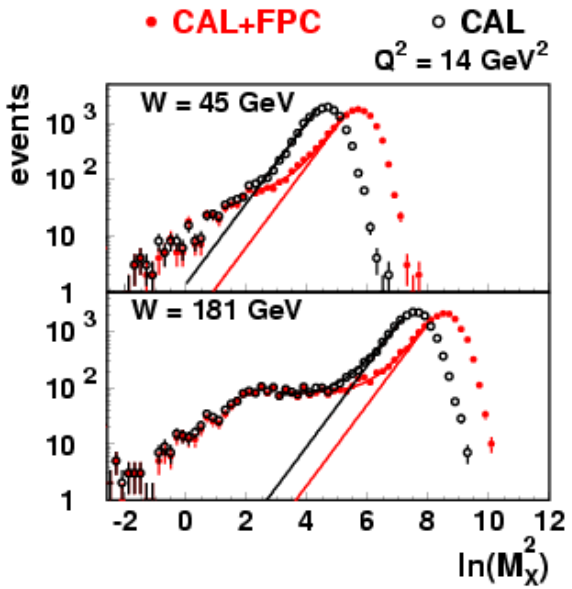
Covers 99.8% of full solid angle



Beam pipe holes:

- originally 20 x 20cm
- 1995 RCAL 20 x 8cm + beam pipe calorimeters (low x physics)
- 1997 FPC 6.3cm (diffraction)
- 2001
  - FCAL 20 x 20cm
  - RCAL 20 x 23.6cm (superconducting HERA magnets)





New Luminosity Monitor

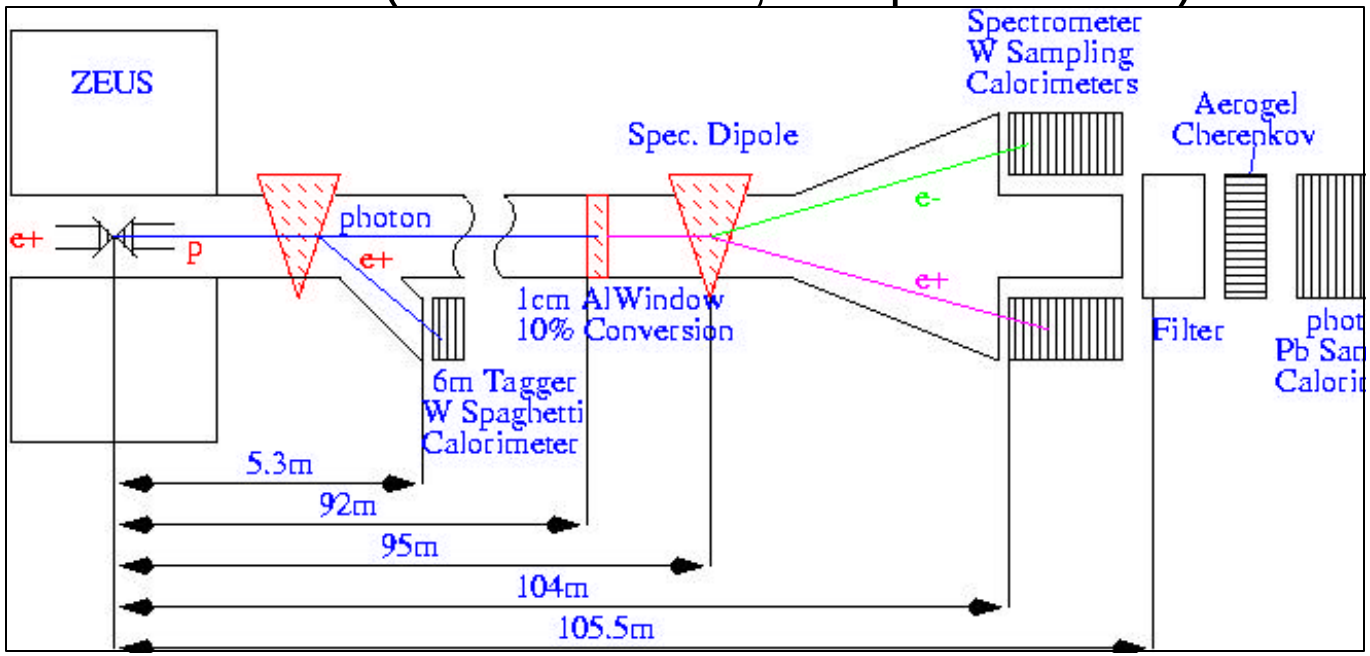
- Measure rate of photons: $ep \rightarrow epg$
- Challenge
  - Rate of bremsstrahlung photons increase by factor of 5
  - Rate of synchrotron radiation photons increase by factor of 7 with higher energy
  - Photon calorimeter would be damaged in a few months
- Upgrade
  - Build radiation hard calorimeter with increased filter thickness (filter reduces energy resolution)
  - Active filter
    - Cerenkov detectors only sensitive to high energy photons (not sensitive to synchrotron radiation)
    - correct for energy loss in filter

Pair Spectrometer

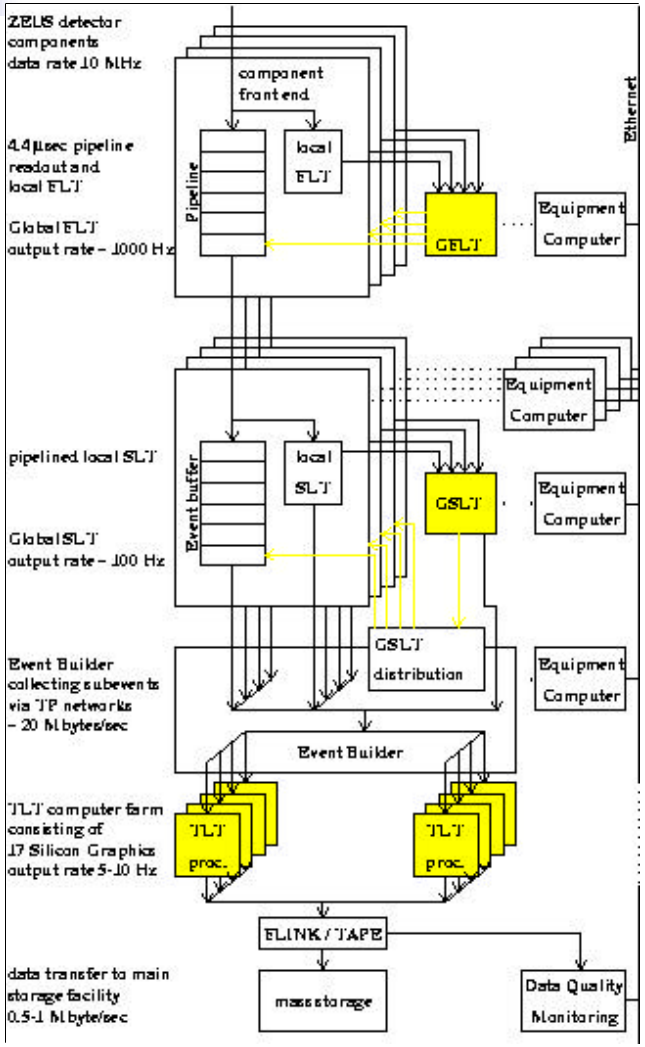
Luminosity measurement still difficult: high rate, pile-up,...

Additional complementary method

- Conversions in exit window (rate only 10%) $g \rightarrow e^+e^-$
- Dipole magnet
- 2 detectors (reuse old BPCs, acceptance 30%)



Trigger and Data Acquisition System



Very flexible and powerful 3 level trigger

Trigger Upgrade 2000/2001

First Level Trigger

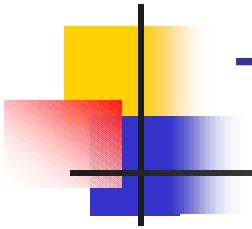
- Implemented Fast Clear
  (global beam gas abort, ...)

Second Level Trigger

- New Global Tracking Trigger
  MVD, CTD, STT tracking:
  - including very forward region
  - better vertex determination
  - new physics filters

Third Level Trigger and Event Builder

- Replaced transputers/SGIs by PCs



The Future ...???

Present status

- Detector in good condition, performing to specifications
- No significant signs of aging
- Presently, no further detector upgrades planned
- Would expect detector still operational in 2006

Questions, uncertainties:

- HERA II background conditions?
  - MVD radiation damage? CTD aging?
- Spare parts for electronics?
- Manpower and expertise?