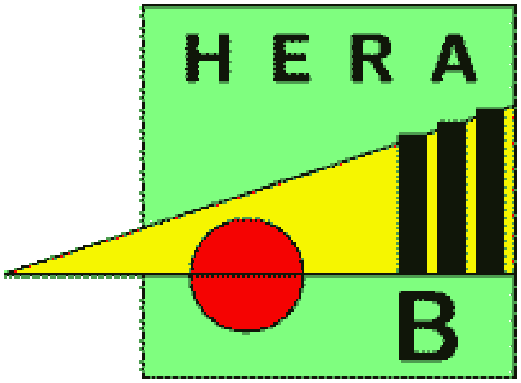


International Europhysics Conference on High Energy Physics

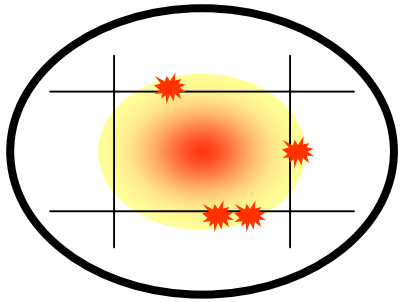
The HERA-B Experiment Overview

Fedor D. Ratnikov (DESY, Hamburg)

For the HERA-B collaboration

July 15-21, Tampere, Finland

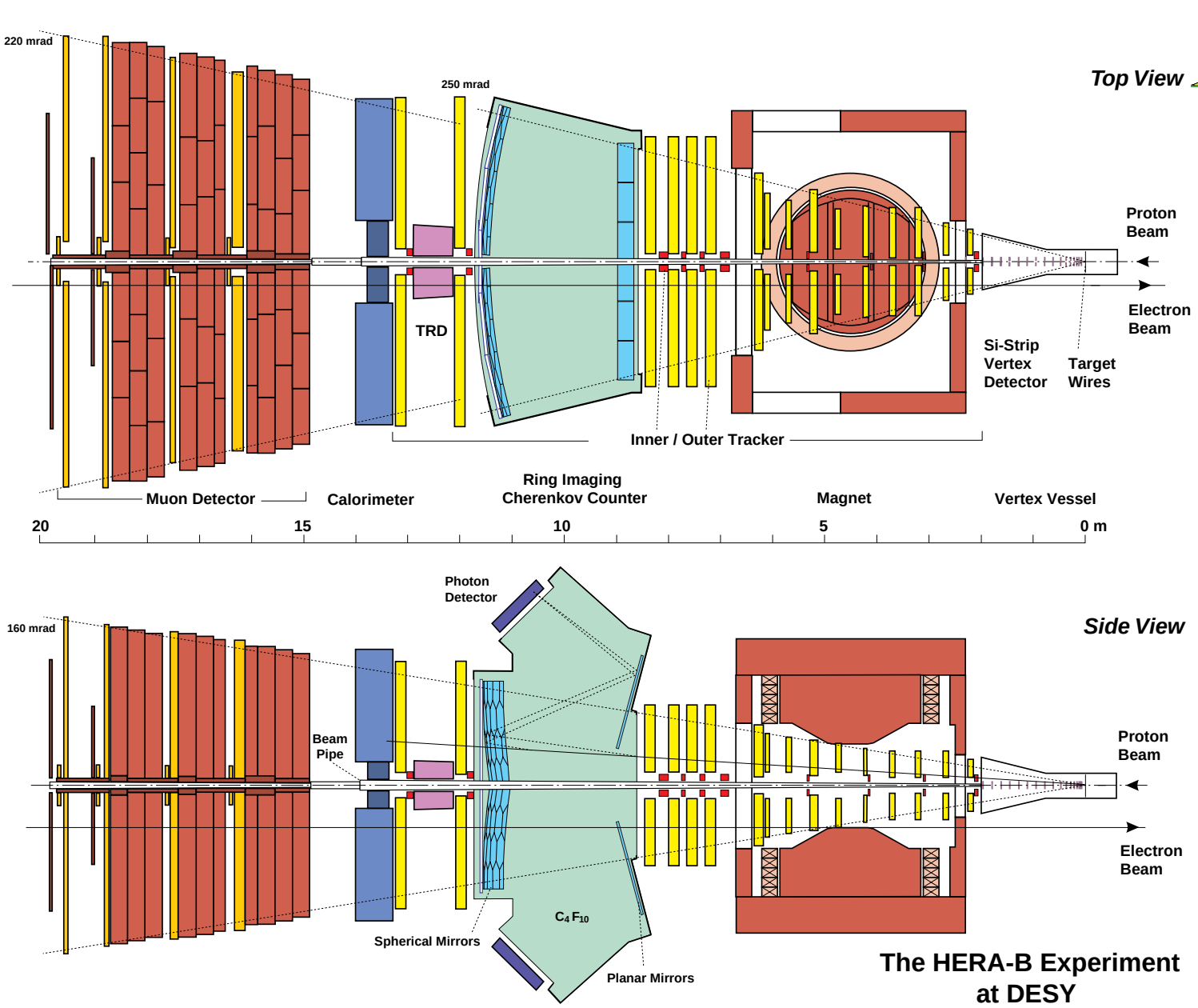
HERA-B: B-factory in Europe



- Fixed wire targets in the HERA machine proton beam halo

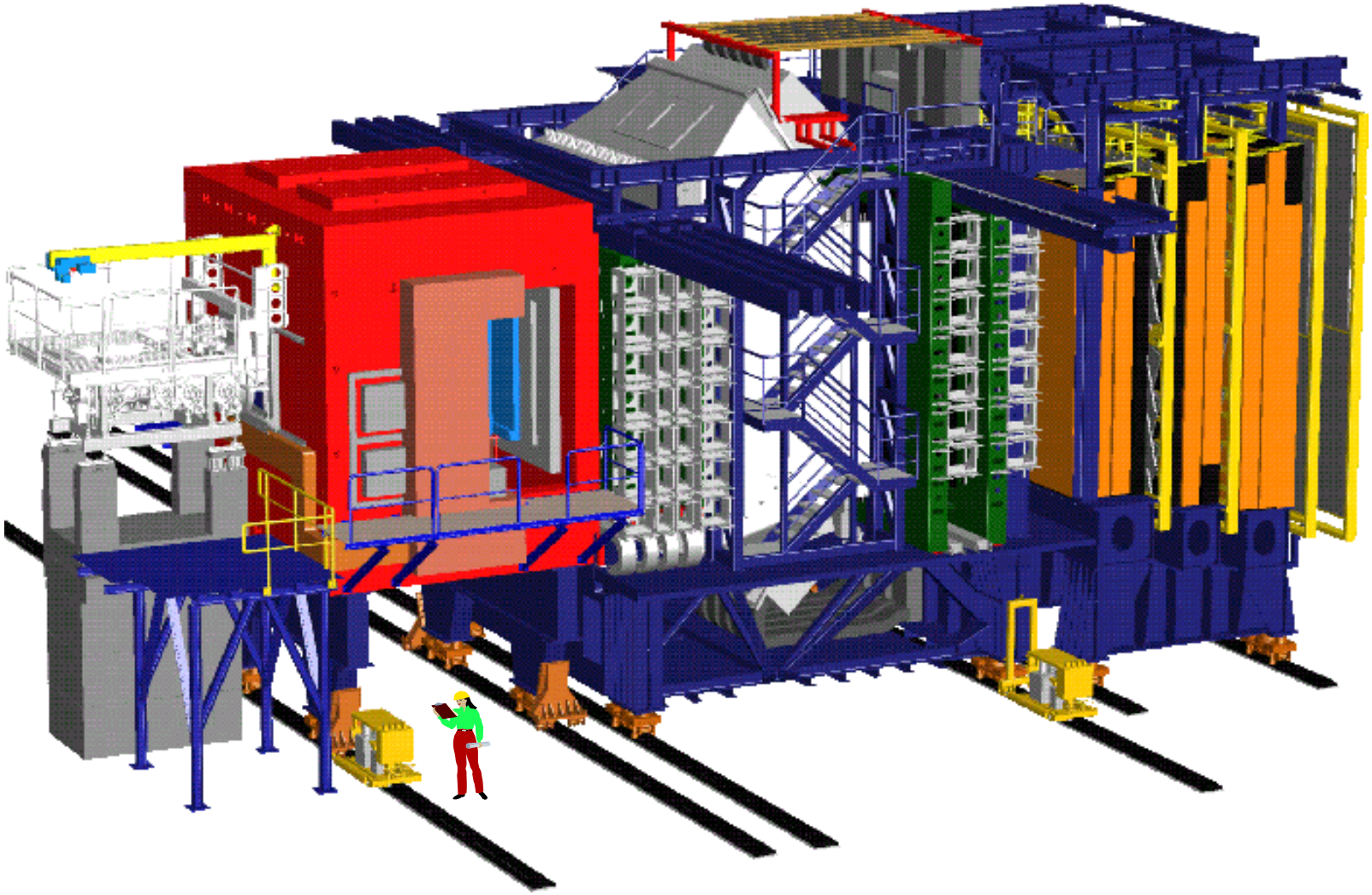
- p (920 GeV) + N (target) $\rightarrow X + b\bar{b}$
- bunch crossing (BX) every 96 *nsec*
- $\approx$ <4> Proton-Nucleon interactions per BX
- $\sigma_{b\bar{b}} / \sigma_{inel} \approx (0.5...1.5) \cdot 10^{-6}$

$b\bar{b}$ **production rate: 20…60 Hz**

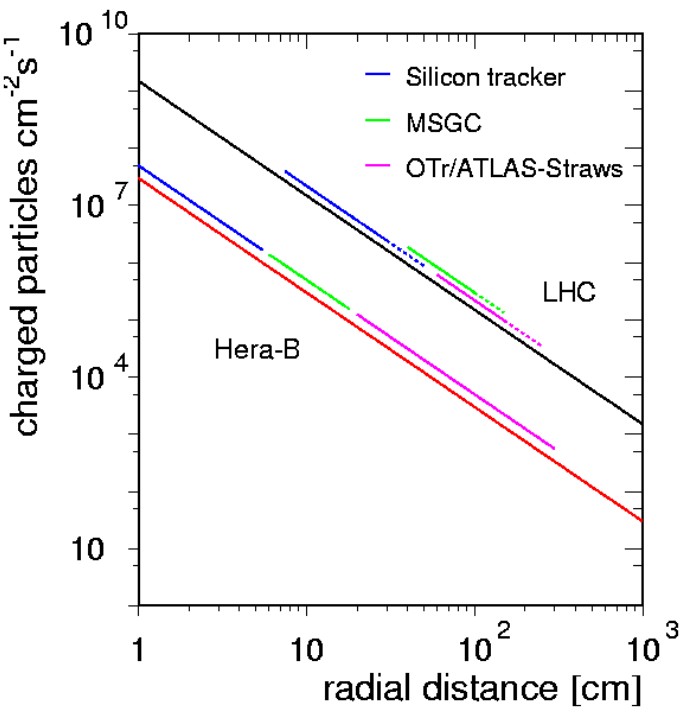


The HERA-B Experiment at DESY

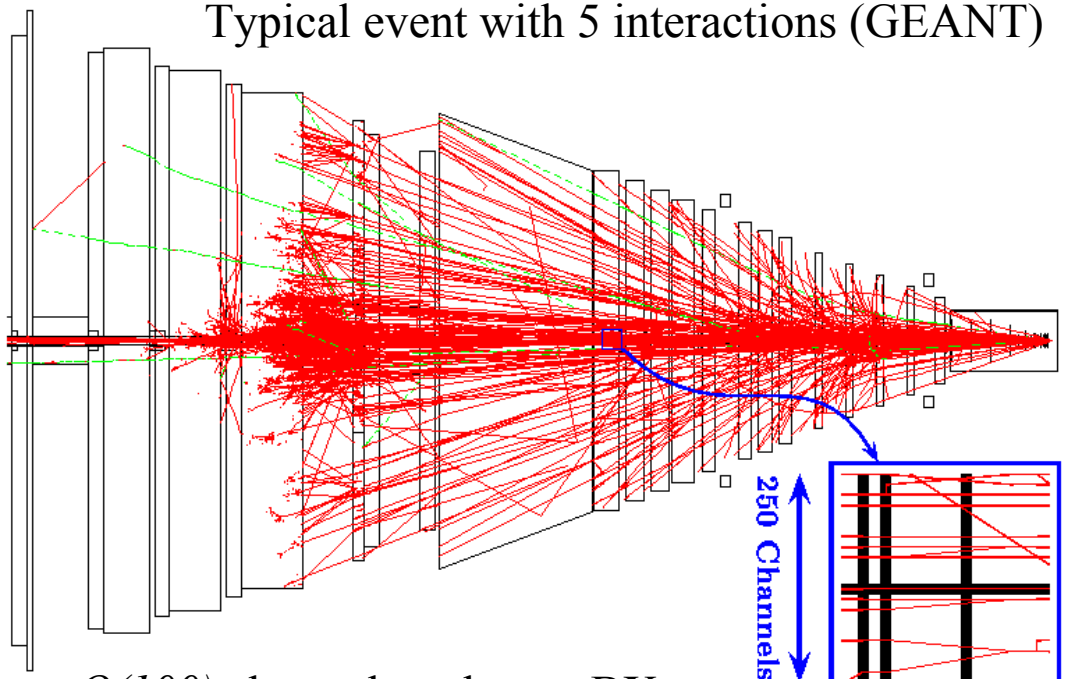
Fedor.Ratnikov@desy.de



HERA-B operates in hard conditions



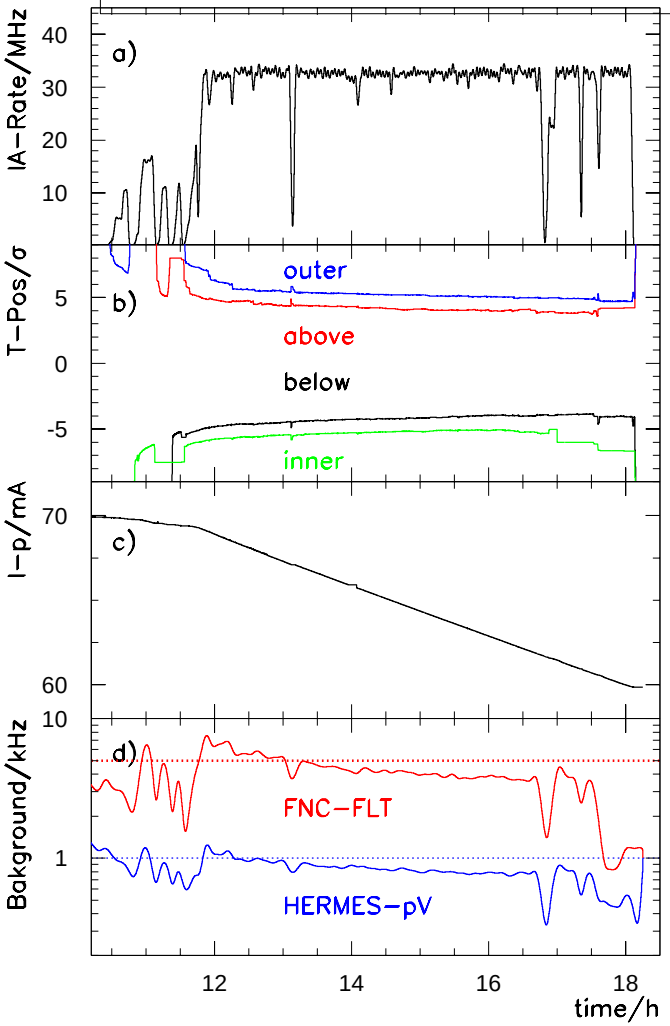
Typical event with 5 interactions (GEANT)

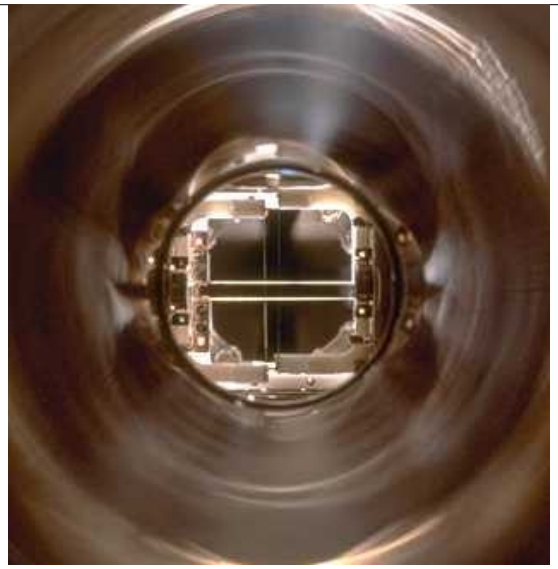


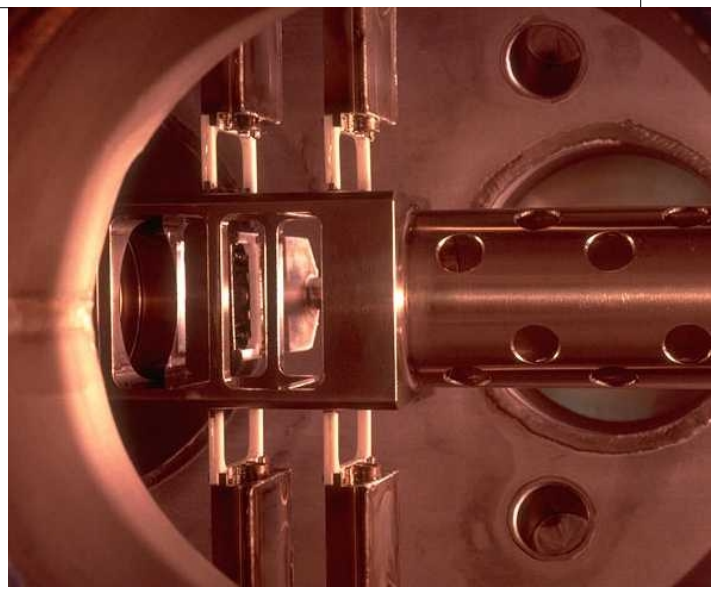
O(100) charged tracks per BX

Detector components see particle flux compatible to LHC five years earlier then LHC experiments

Wire target in the proton beam halo

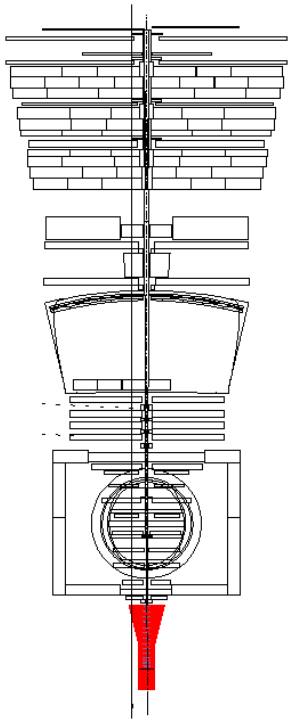


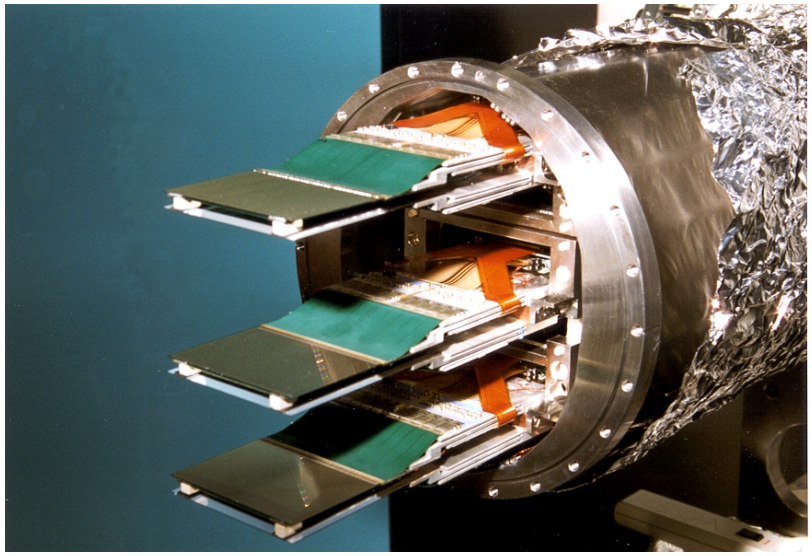


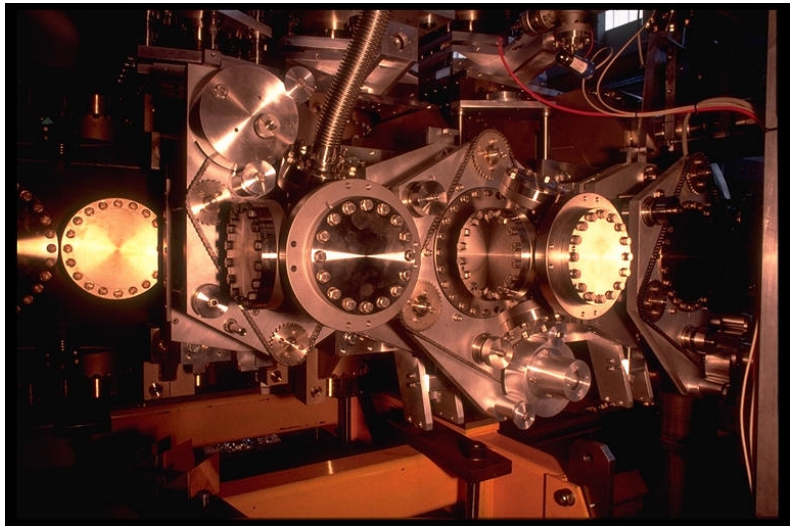


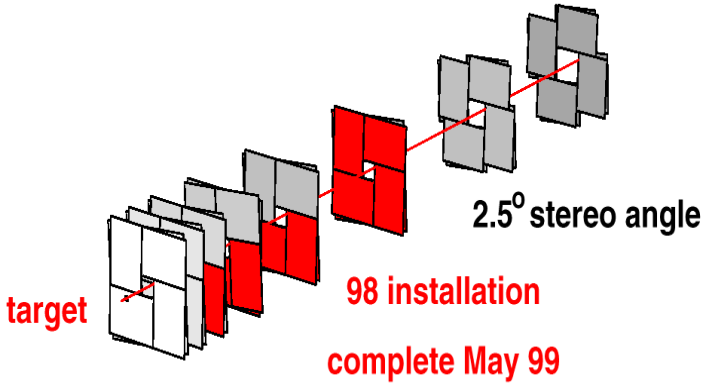
- high rates (40 MHz) achieved, $\varepsilon_T > 60\%$
- reliable, secure multiwire automatic
- small background at other experiments

Silicon Vertex Detector System

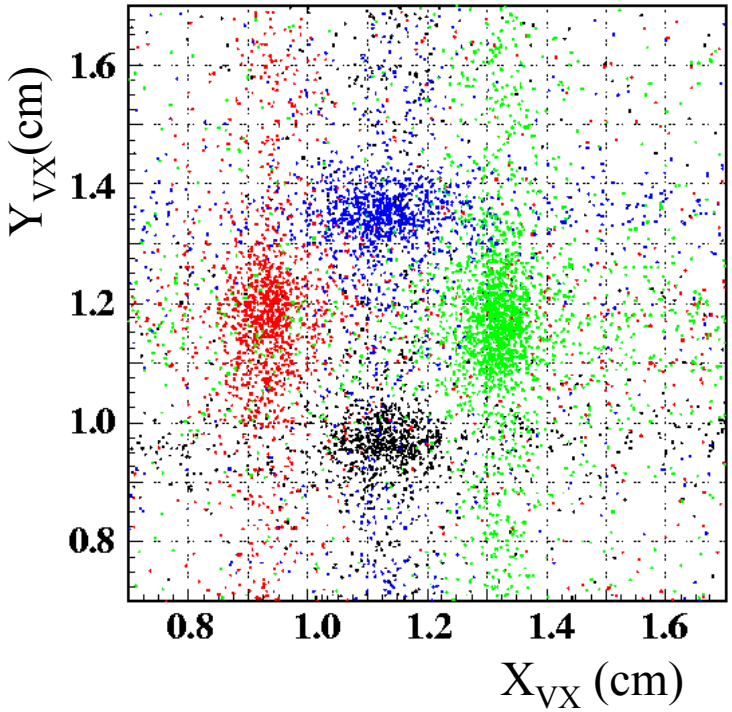


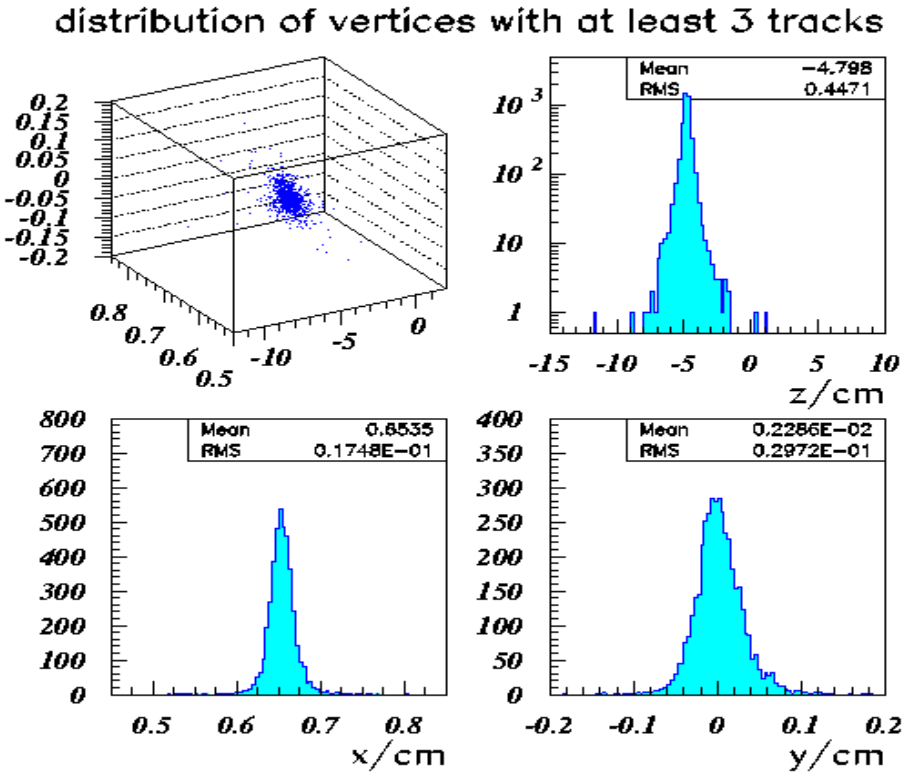






Vertex reconstruction



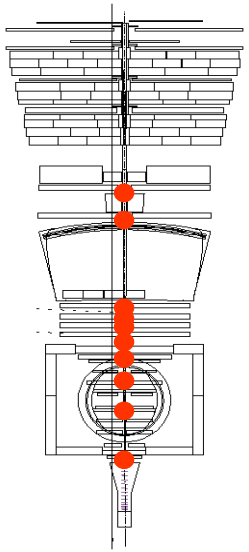


The VDS is able
to reconstruct the vertex position

No correction
for target movement!

Fedor.Ratnikov@desy.de

MSGC inner tracker

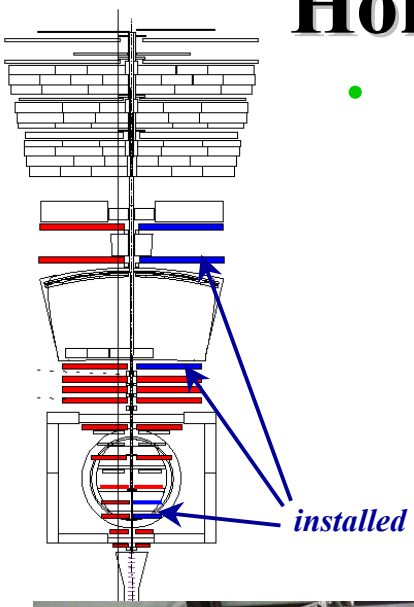


- MSGC'94 - early prototypes: radiation hard device, suitable for the HERA-B conditions
- MSGC'96: discharges induced by heavy ionizing particles destroy strips
  - ✔ apply GEM pre-amplification to reduce MSGC gain
  - ✔ diamond-like coating of the plates
- MSGC'98: rapid aging of chambers
  - ✔ appropriate gas mixture is found

We have learn a lot about this new type of physics detector

Existing GEM-MSGC technology is acceptable for HERA-B

Honeycomb Drift Chamber Outer Tracker



- HDC'95: self-supporting Pokalon-C modules with open gas volume and $Ar\text{-}CH_4\text{-}CF_4$ gas mixture

  But: 0.5 C/cm per year (!) accumulated charge

  ➜ many problems with radiation hardness and aging (Malter effect etc)

  ☹ lifetime at HERA-B < 10 hours

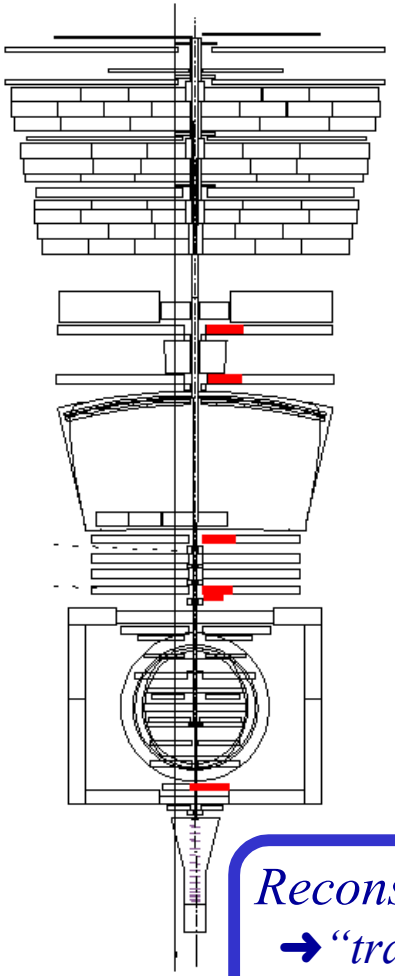
A lot of efforts, R&D have successfully lead to:

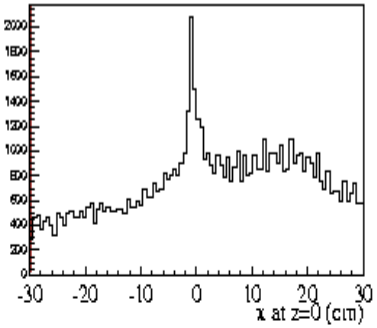
- HDC'99: gold-plated cathode surface, $Ar\text{-}CO_2\text{-}CF_4$ gas mixture, a lot of other improvements

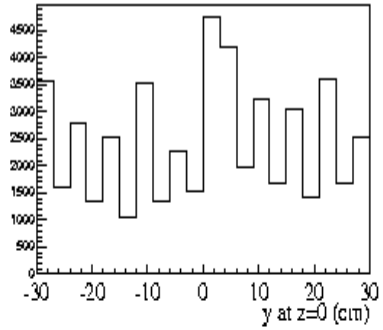
  ☺ lifetime at HERA-B > 2 years

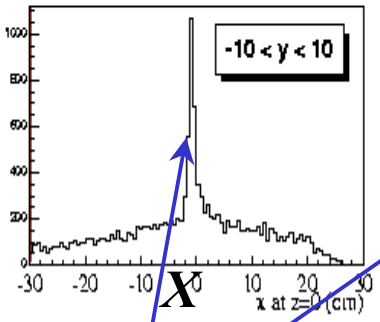
- OTR: 1000 m^2, 120000 channels
- 1/3 is installed now
- 2/3 to be installed during short shutdowns before Y2K

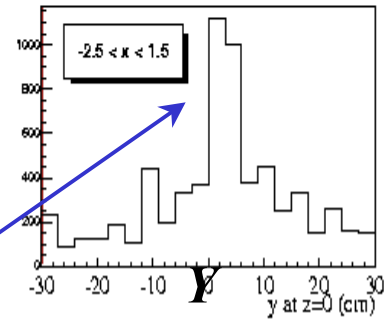
Outer Tracker Commissioning: Spring'99

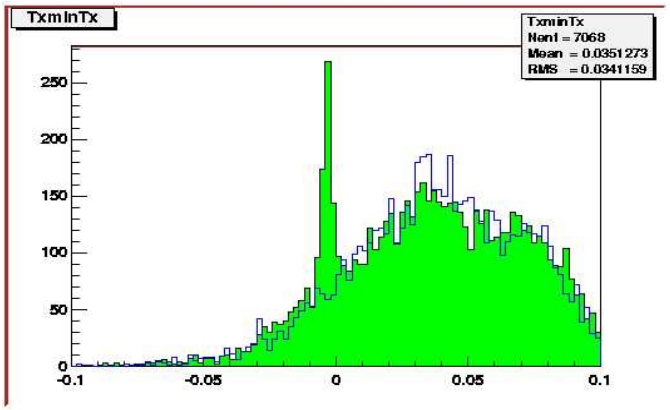


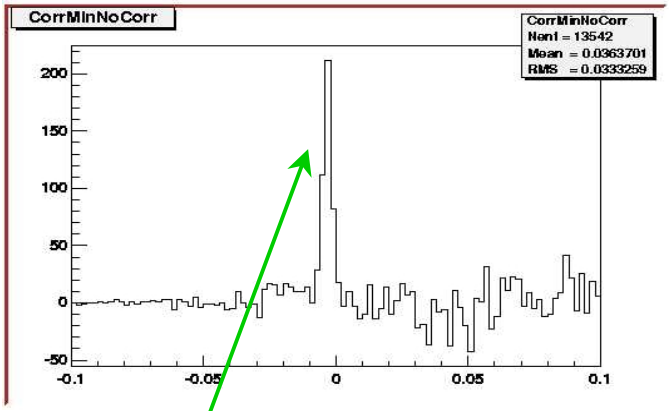












Reconstructed Target Spot:

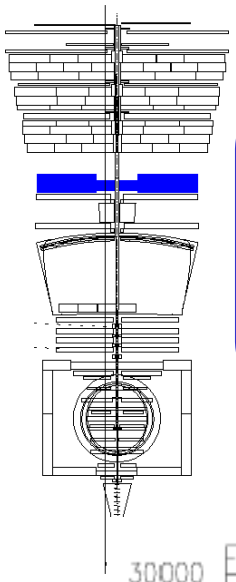
➜ *"tracks", containing > 1 space point are extrapolated to Z=0*

Correlation with Vertex Detector:

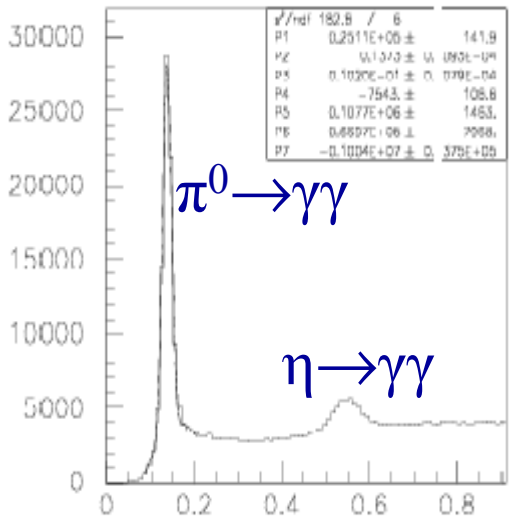
➜ *angle between OTR "tracks" and VDS tracks*

Fedor.Ratnikov@desy.de

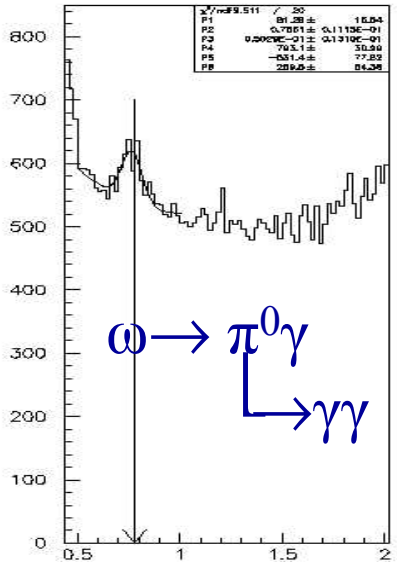
Electromagnetic Calorimeter



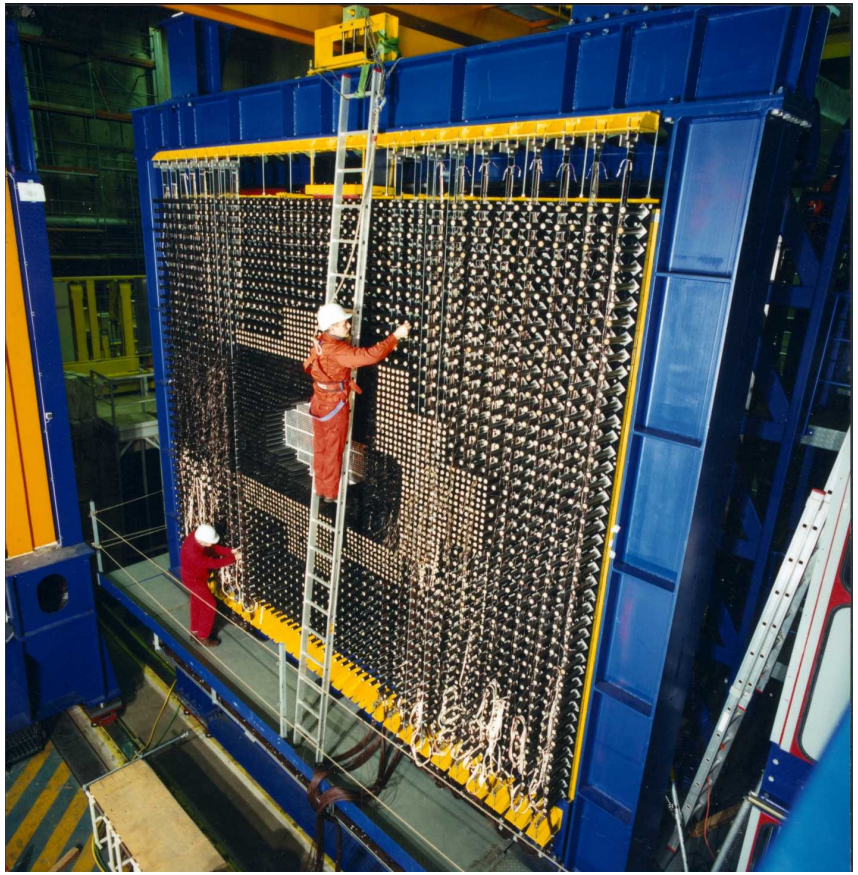
- Shashlik calorimeter of 3 different granularities
- Standalone calibration using π^0 signal
- Able to see physics signals



2 clusters invariant mass

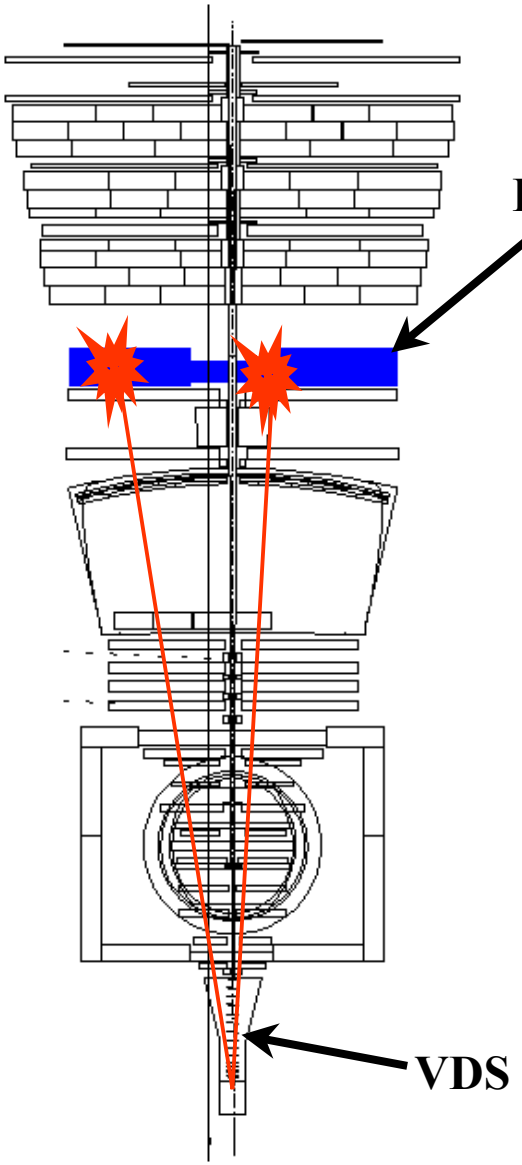


3 clusters invariant mass



Fedor.Ratnikov@desy.de

E.M.Calorimeter - Vertex Detector Correlations

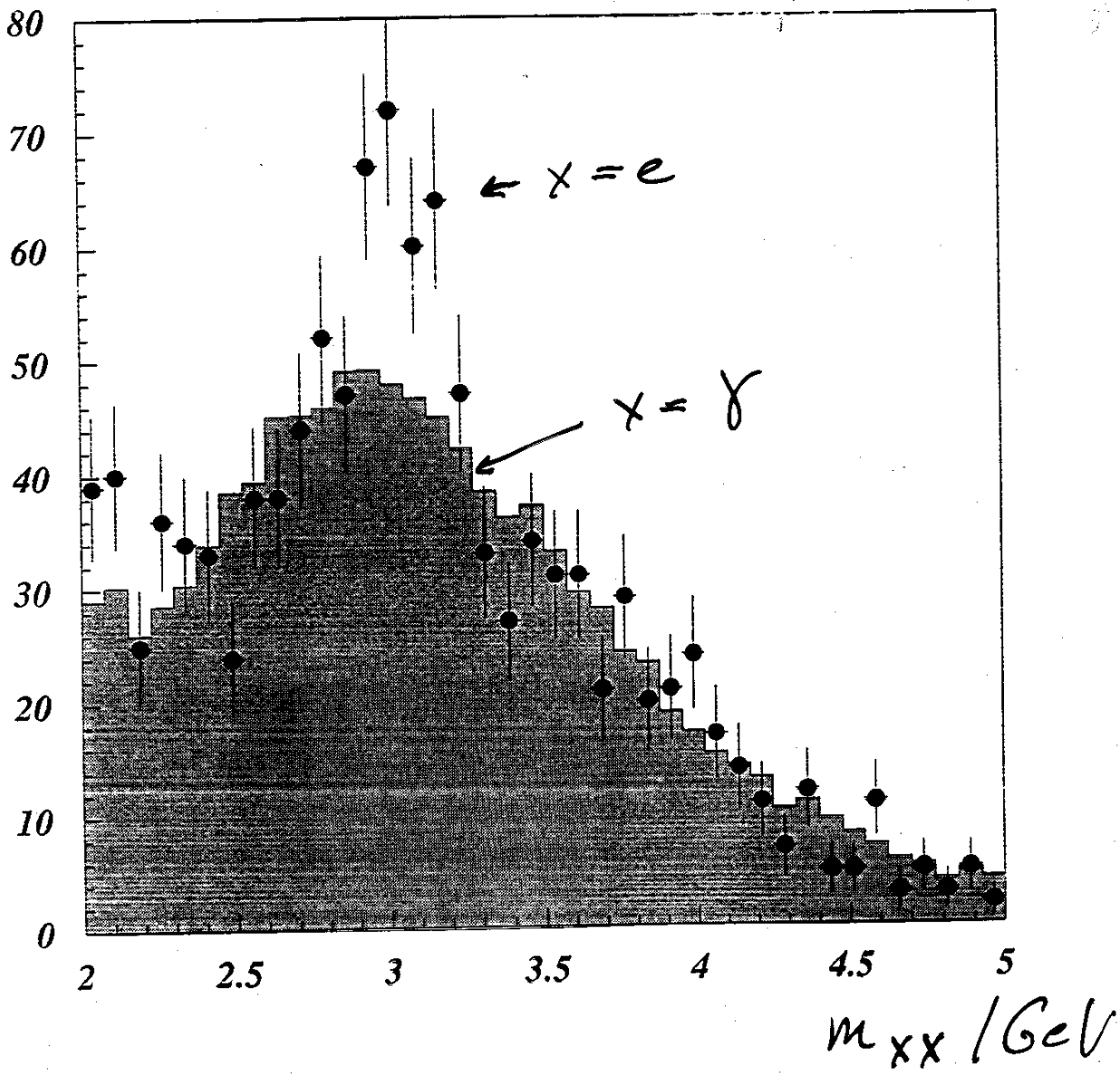


- Search for J/ψ in ECAL two-cluster spectra?
  - ☹ Huge background from the $\pi^0 \rightarrow \gamma\gamma$
  - ☺ Matching with VDS cleans up the samples
- Procedure
  - ➜ reconstruct vertex position by the VDS
  - ➜ Look for two energetic (E>1.5GeV) clusters in the ECAL
  - ➜ Build road from the ECAL cluster back to the reconstructed vertex
  - ➜ require VDS hits in the intersected VDS planes
  - ➜ reconstruct two-body invariant mass

Vertex Detector - E.M. Calorimeter Correlations

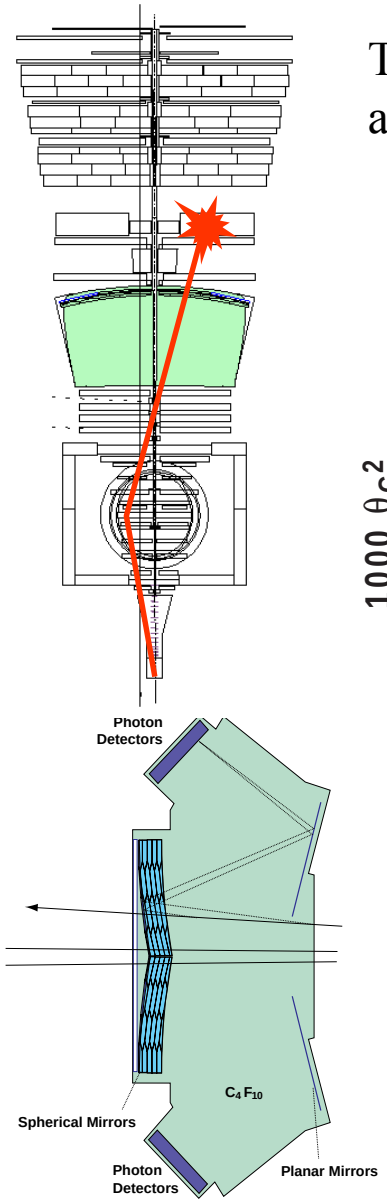
- Photon suppression in Electro-magnetic Calorimeter by requiring hits in Vertex Detector
  ⇒ observation of J/Ψ signal in invariant mass of electron-positron pairs

PRELIMINARY!

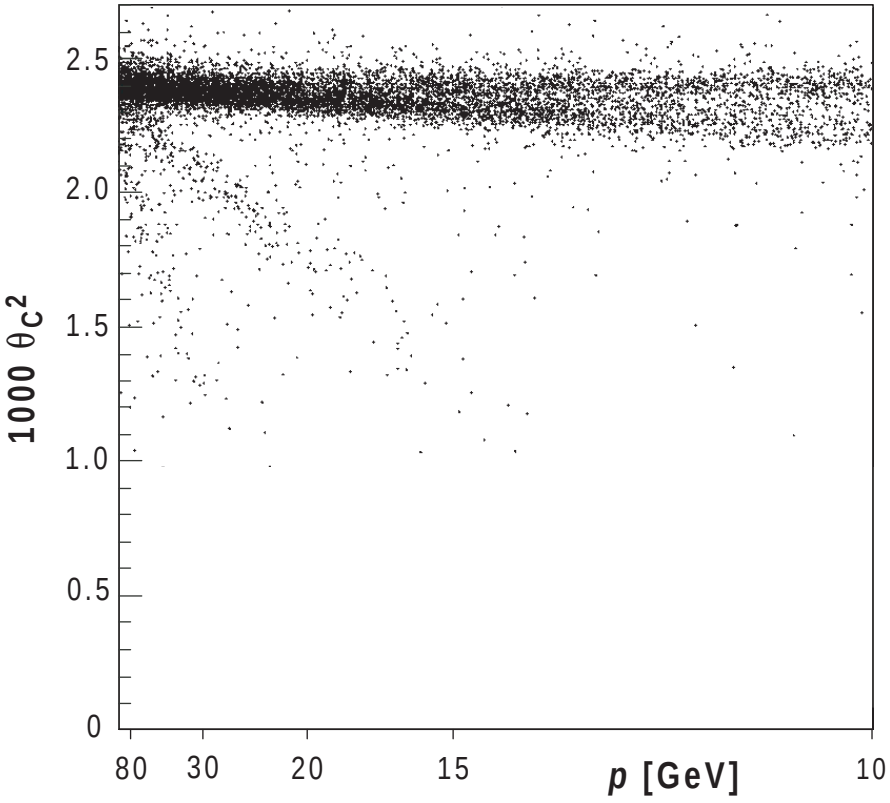


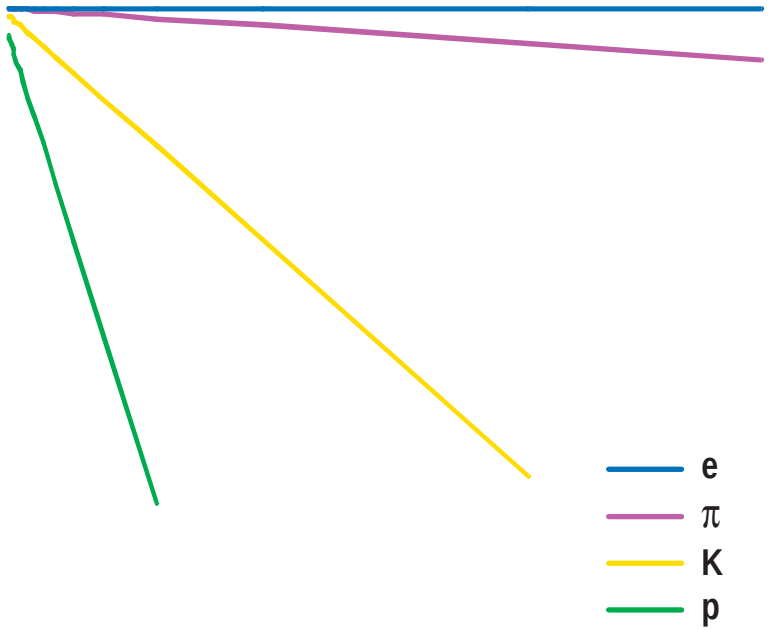
M. Schmelling

RICH particle identification



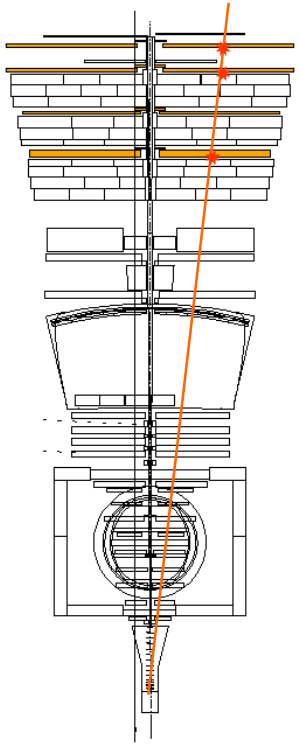
Track coordinate (ECAL) + angle (RICH)
are combined to measure particle momentum



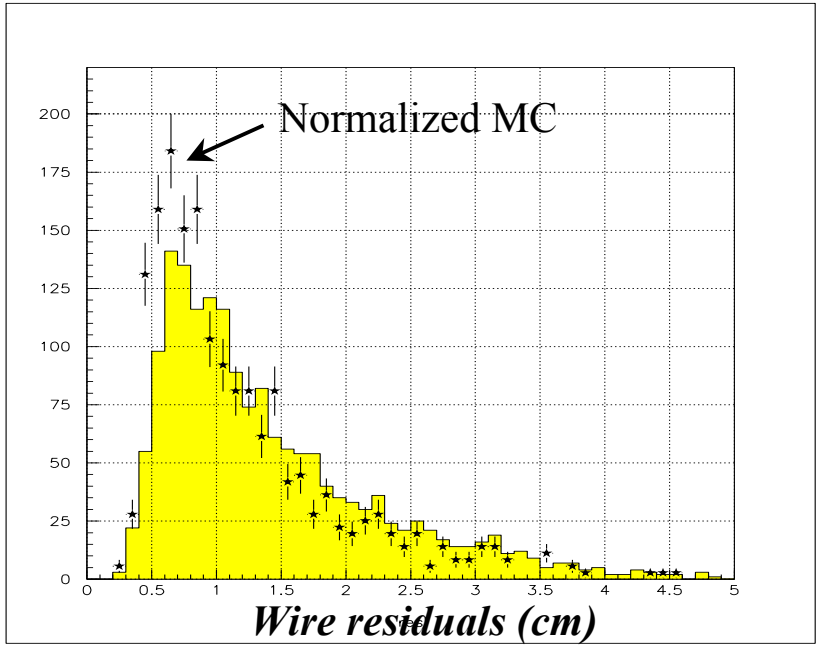


RICH is able to identify particles

Muon System



Internal track reconstruction:
hits in MU4 and MU3
are extrapolated to MU1

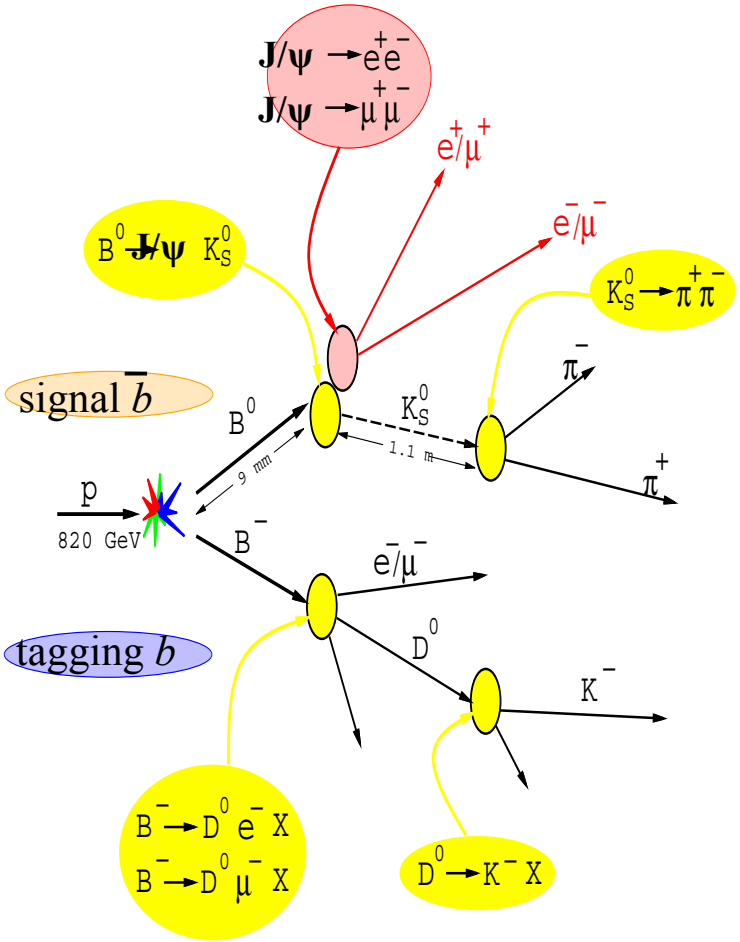


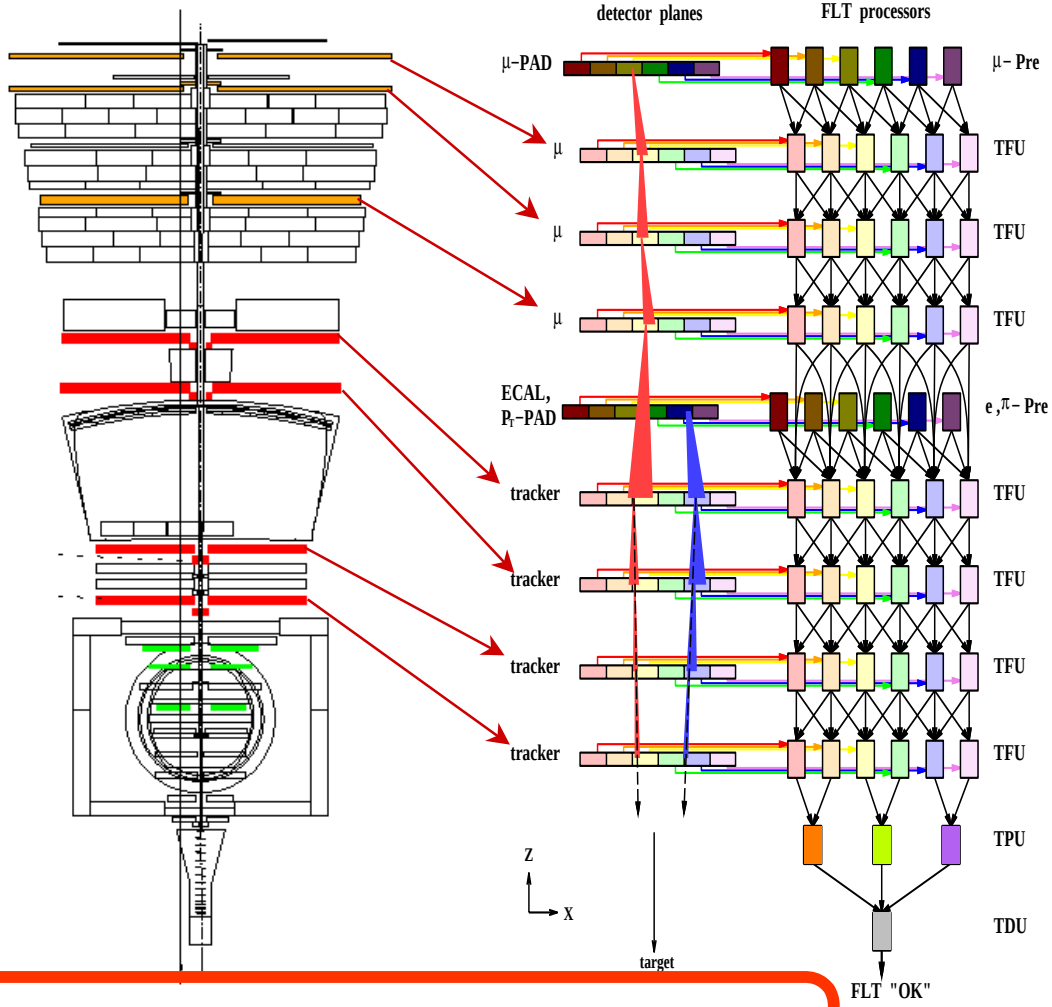
Muon system detects muon tracks

Fedor.Ratnikov@desy.de

First Level Trigger

The golden decay: $B^0 \rightarrow J/\psi\, K^0_S$

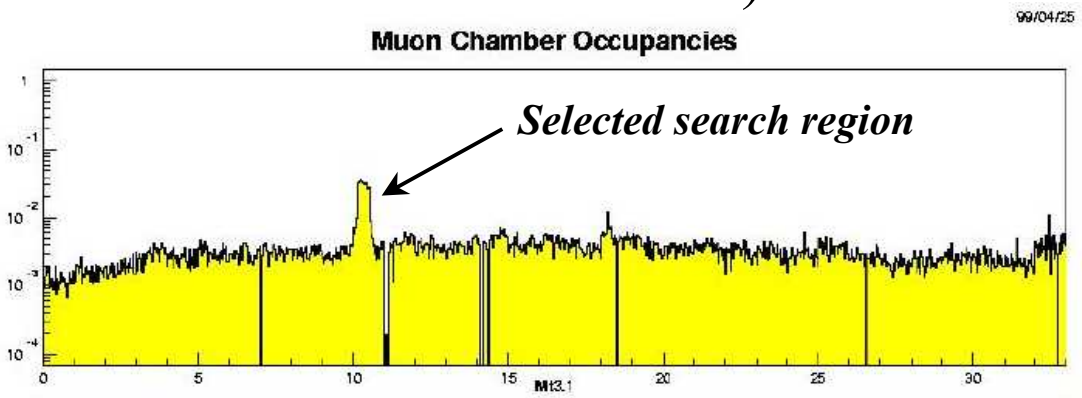




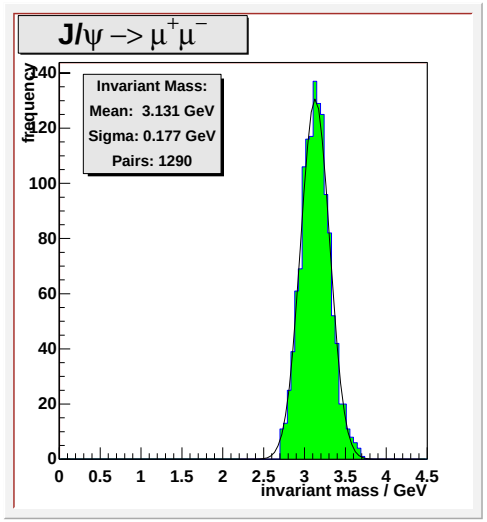
The system is optimized to reconstruct J/ψ on the Trigger Level 1 (decision time < 128*BX = 12μs)

FLT commissioning

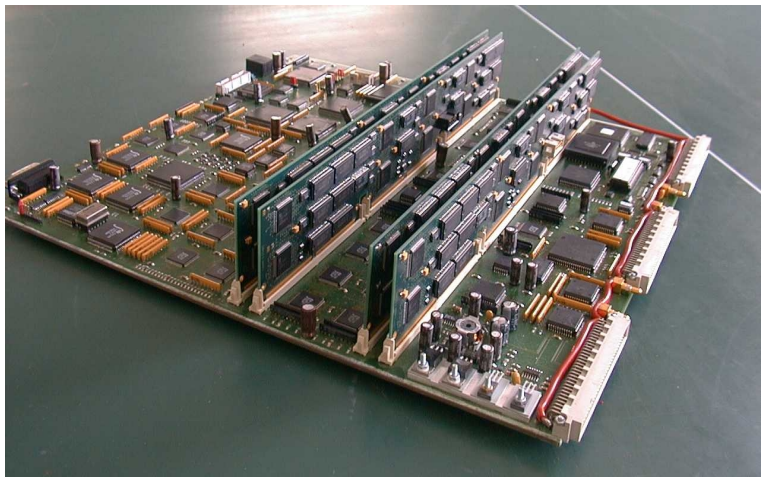
Tracking processor (17 of 70 needed are available):



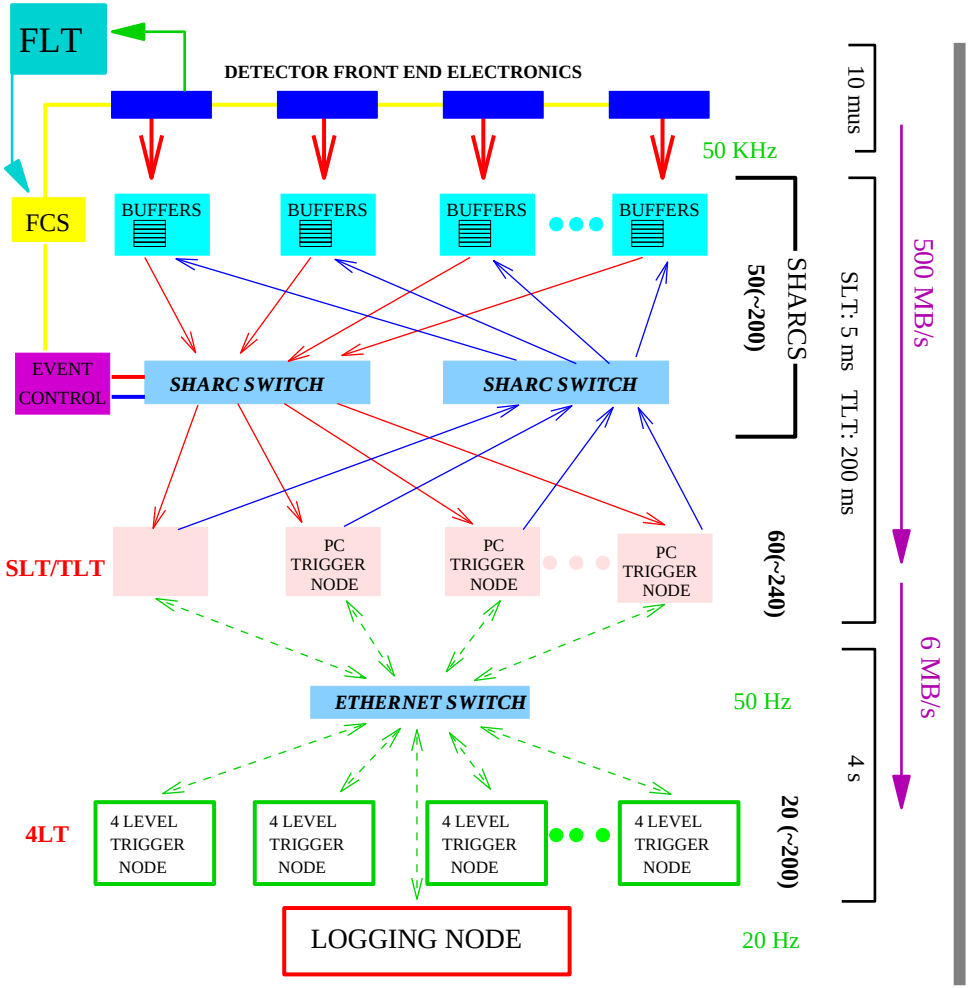
Full system will be ready before Y2K



Simulation result

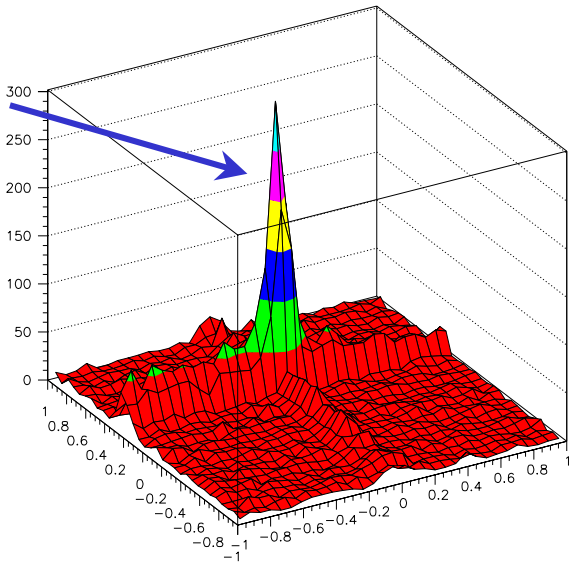


Data path



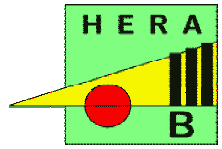
Second level trigger track reconstruction: only requested VDS data are transferred through the switch

Target spot reproduced online



Data path and SLT code were tested and were working properly

Summary



- HERA-B is the first detector operating at LHC-like conditions
- Operational problems in several areas of detectors were encountered and working solution have been found
- Several parts of the detector have been routinely running in the HERA-B environment for several months
- Completion and full commissioning of the detector is planned by the end of 1999

☺ we are looking forward to see the first $B^0 \rightarrow J/\psi K^0_S$ events