Status of the COMPASS Experiment

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on behalf of the

COMPASS Collaboration

The Outline of the Talk

- The physical motivation of COMPASS
- The experimental set–up
- Survey of the detector performances
- Achievements run 2001
- Prospects for the run in 2002 and Summary

The Physics with COMPASS

$$\begin{aligned} \text{COMPASS} &= \text{polarised semi-inclusive DIS} \\ &+ \text{Hadron spectroscopy} \end{aligned}$$

The DIS Program

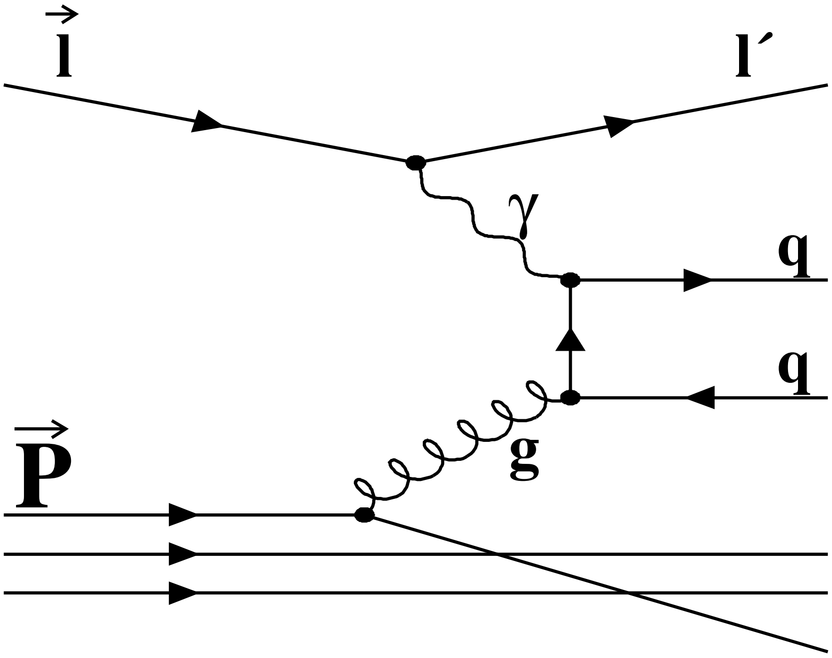
- Gluon Polarisation ($\frac{\Delta G}{G}$)
- Polarised flavour dependent parton distributions:

  $\Delta \mathrm{u}_v$, $\Delta \mathrm{d}_v$
  $\Delta \bar{\mathrm{q}}$, $\Delta \bar{\mathrm{s}}$
- Λ–Polarisation $\left(\Delta \mathrm{D}_q^\Lambda\right)$
- Transversity (h_1)

Most wanted: $\frac{\Delta G}{G}$

Determination of ΔG

- Photon–Gluon–Fusion ($g\gamma \longrightarrow \mathrm{q}\bar{\mathrm{q}}$)



- Open Charm Production (q=c,$\mathrm{c}\bar{\mathrm{c}} \longrightarrow$D oder Λ_c):

  Fragmentation: 1.2 D^0 per Event

  Golden decay: $D^0 \longrightarrow \pi^+ K^-$ (B.R. 4%)

  additional: $D^* \longrightarrow D^0\pi$

- Hadron pairs with high transversal momentum (q=u,d,s):

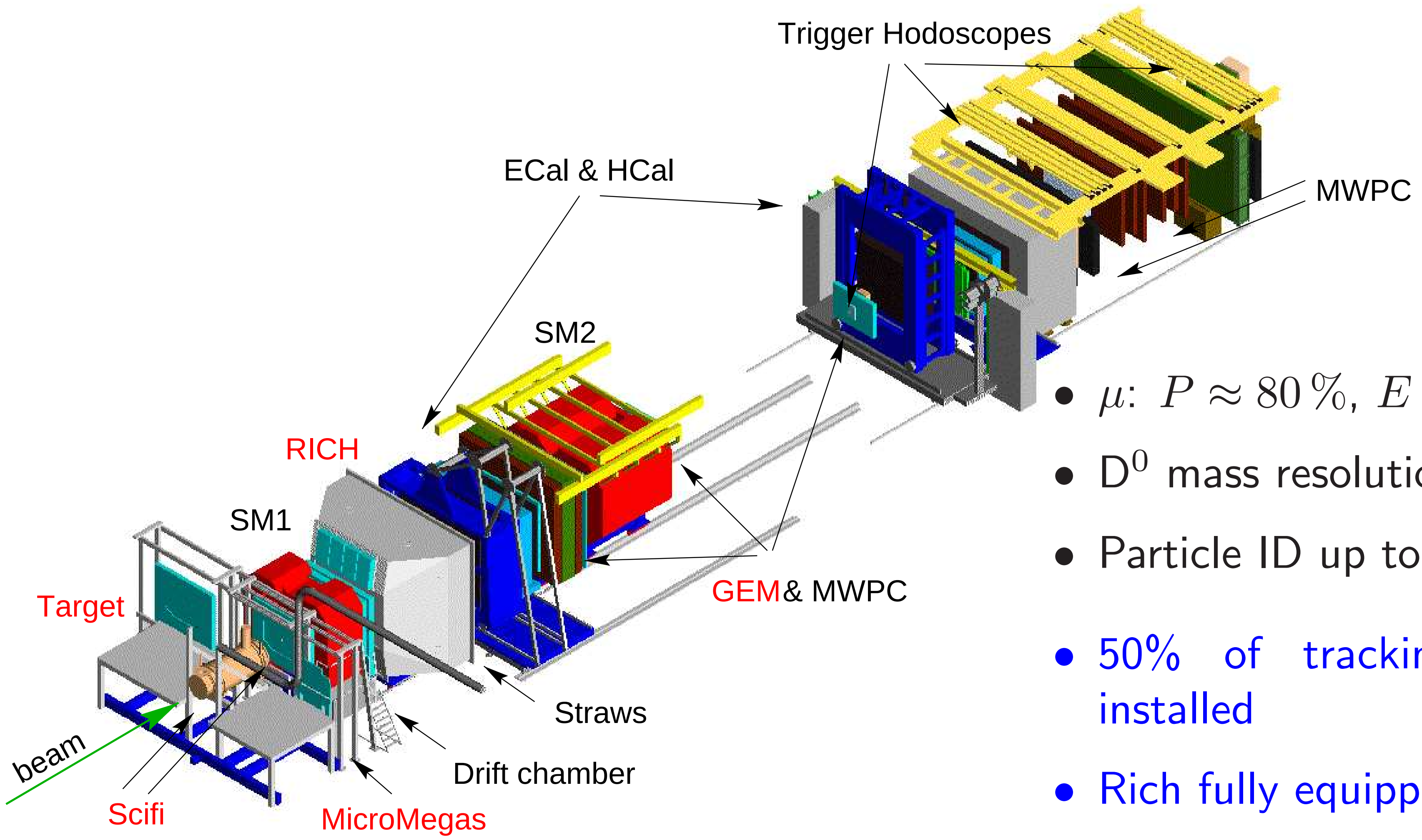
  Opposite charge: h^+h^-

  Back to back: $\Delta\phi = 180^\circ \pm 30^\circ$

  Transversal momentum: $p_T > 1$ GeV/c

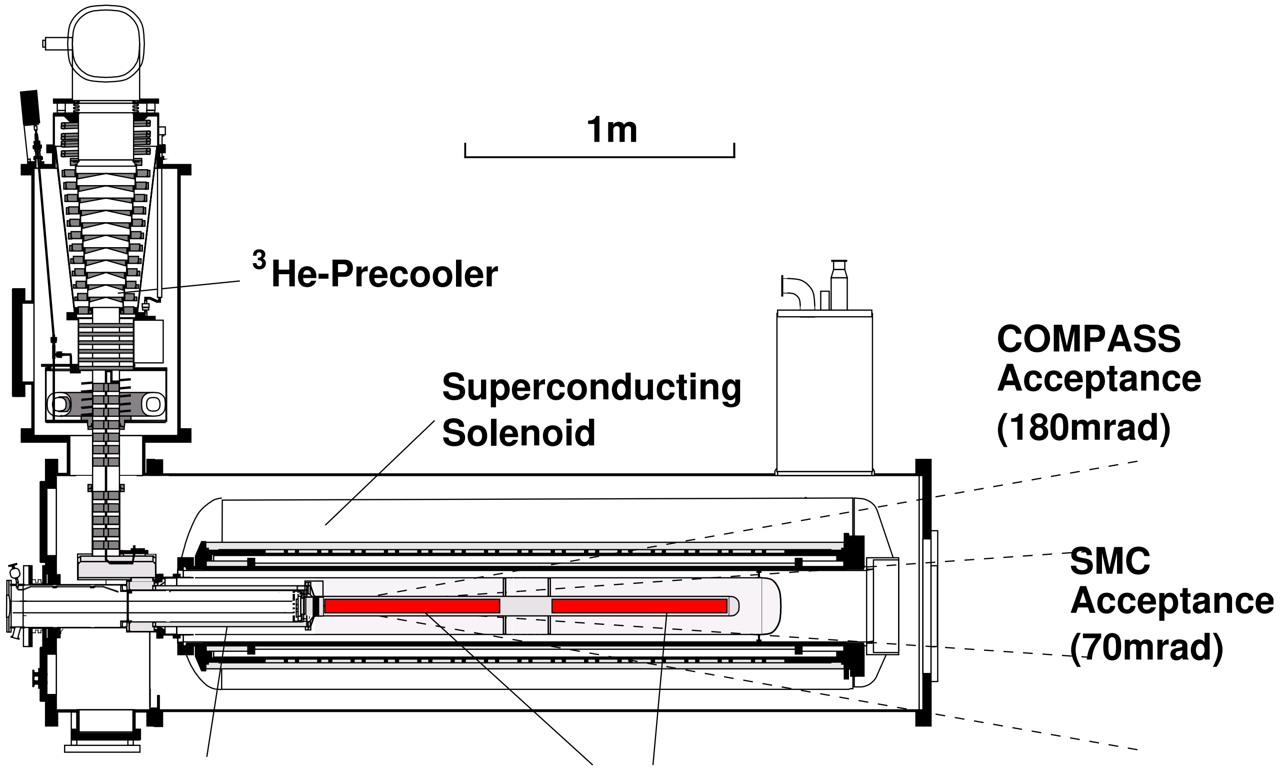
  additional: K^+K^-

The COMPASS Spectrometer in 2001



- μ: $P \approx 80\,\%$, $E = 160\,\mathrm{GeV}$
- D^0 mass resolution 15 MeV
- Particle ID up to 60 GeV/c
- 50% of tracking detectors installed
- Rich fully equipped
- Full ΔG trigger available

The Polarised Target

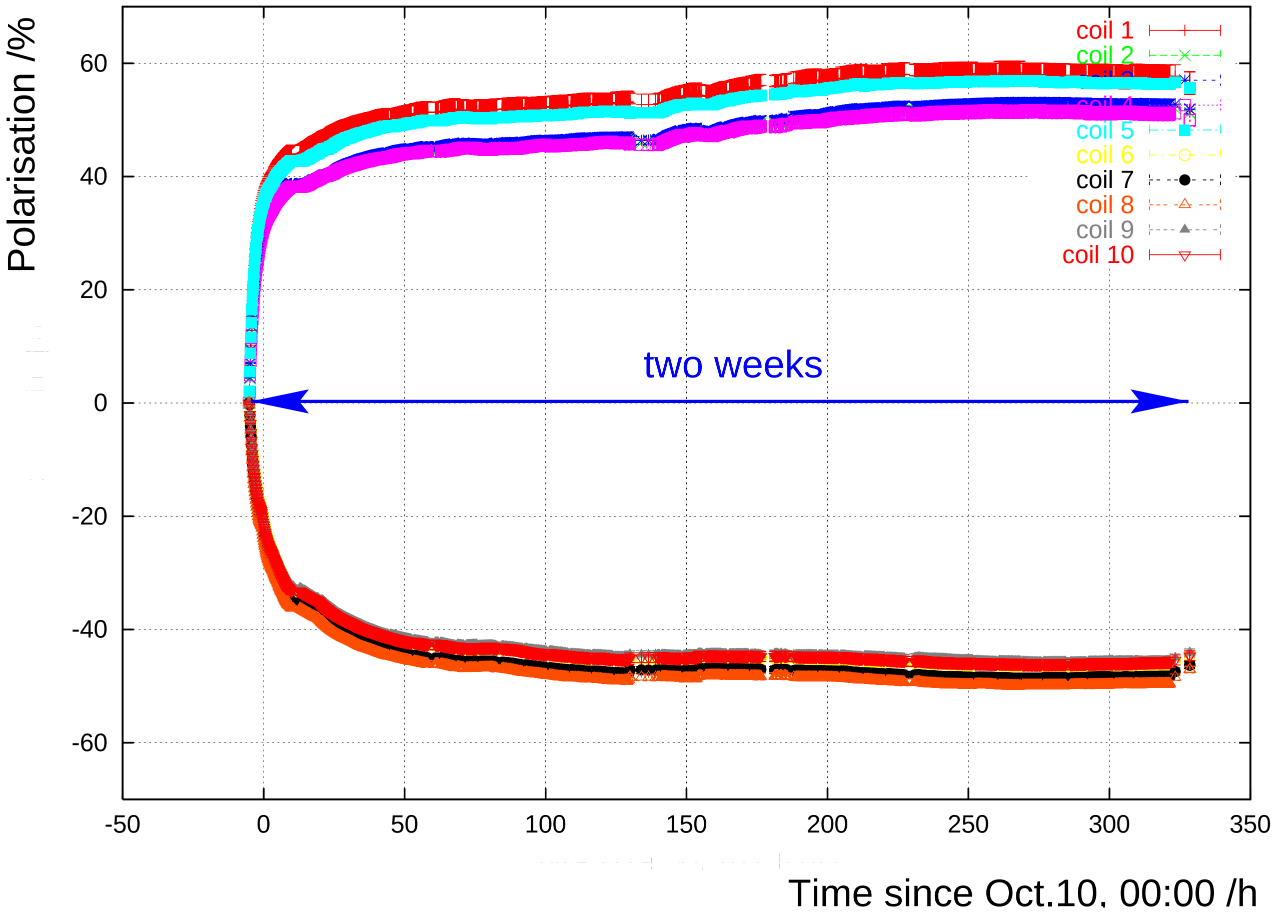


- Two 60 cm long target cells with opposite polarisation.
- Target material ^{6}LiD ($P = 55\,\%$, $f = 0.5$)
- 2.5 T Solenoid field (Homogeneity: $\pm 1.5 \cdot 10^{-5}$)
- ^{3}He/^{4}He dilution refrigerator ($T_{min} \approx$ 50 mK)
- COMPASS magnet not available $\Rightarrow$ SMC Magnet used.

  $\Rightarrow$ Hadron acceptance 70 mrad.

  $\Rightarrow$ at 160 GeV 20 % less D^0.

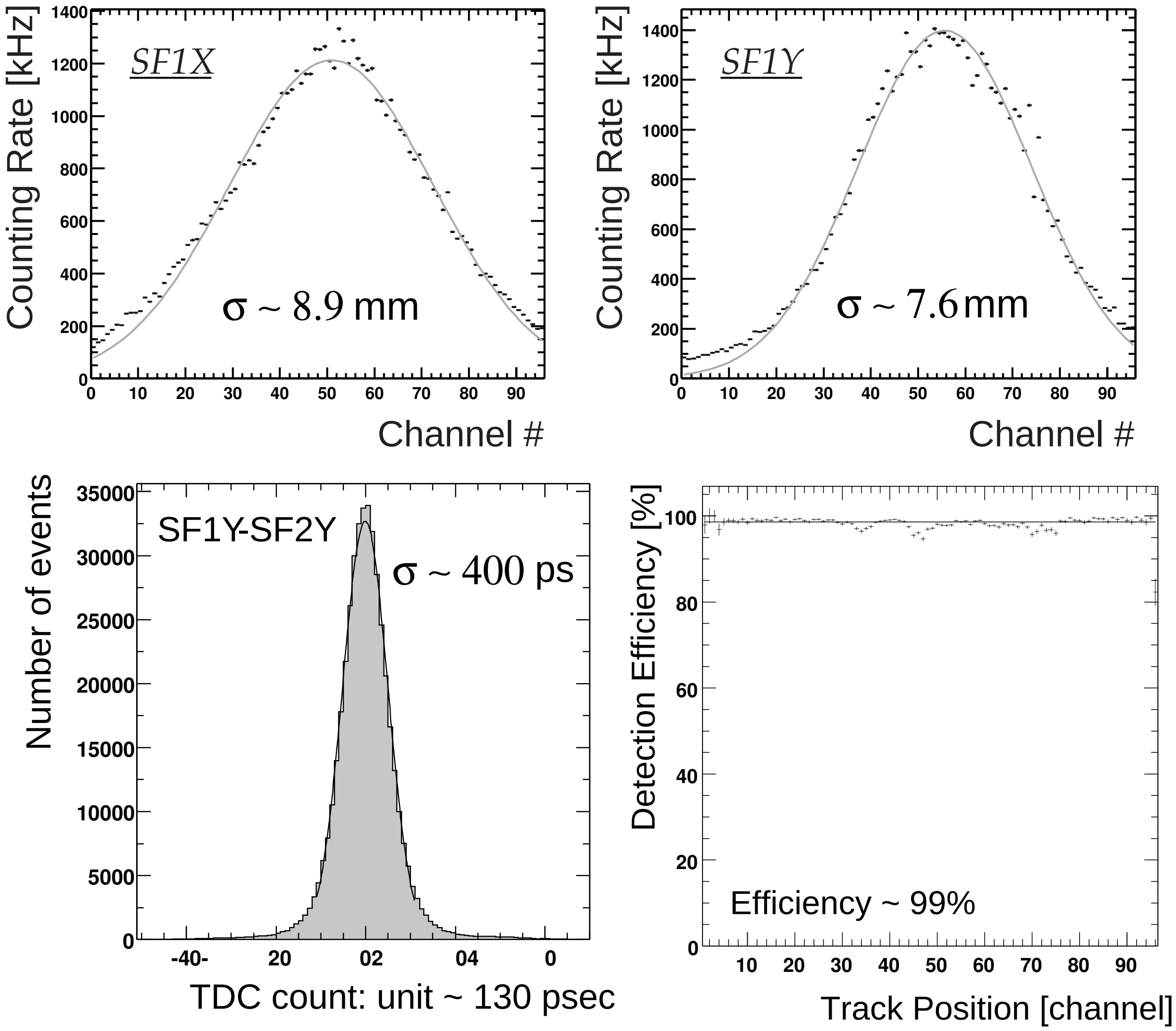
The Polarized ^{6}LiD Target



- Preliminary polarisation values: $P_{\text{max}} = 55\,\%$.
- Spin relaxation times:
  - Longitudinal spin (2.5 T field): too long to be measured
  - Transverse spin (0.5 T field): 2000 hours
    $\Rightarrow$ transversity, g_2.

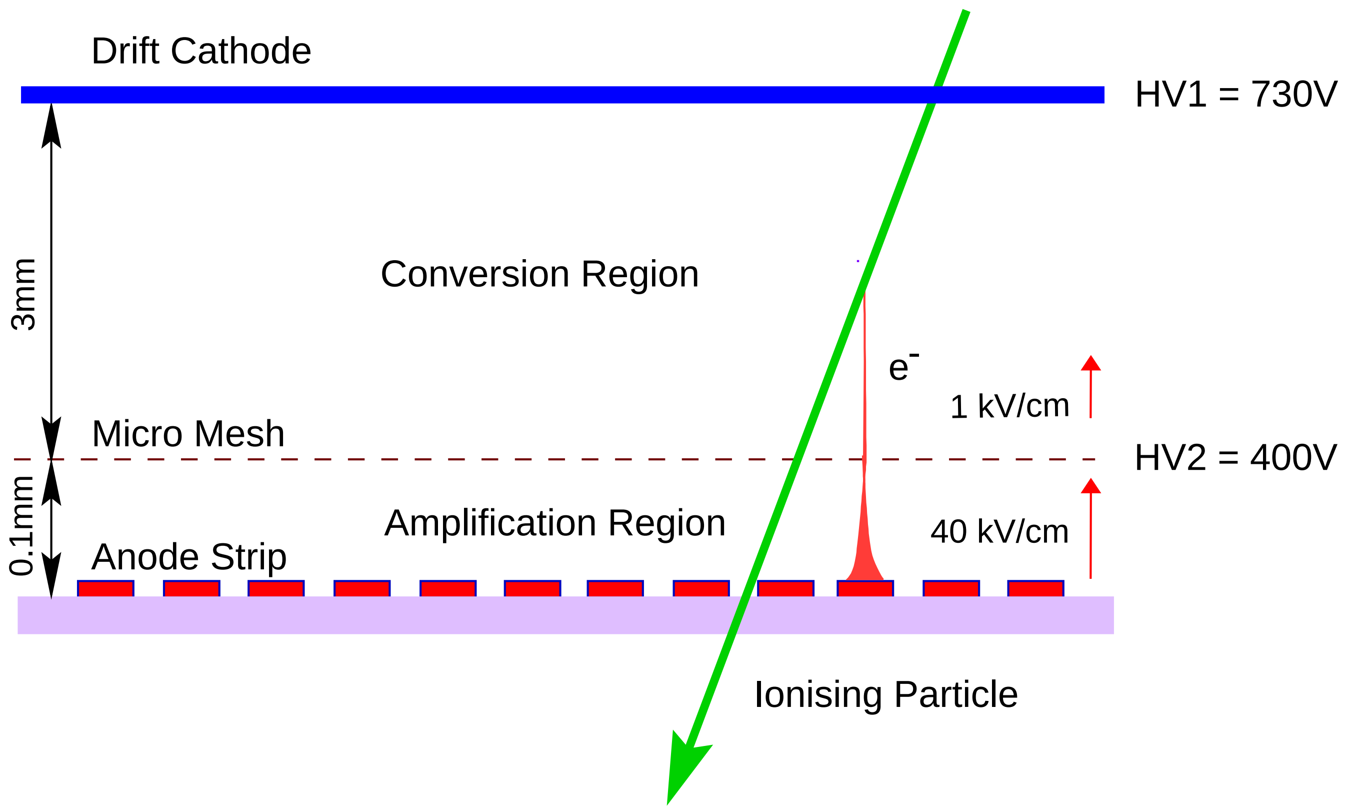
Scintillating Fiber Detectors

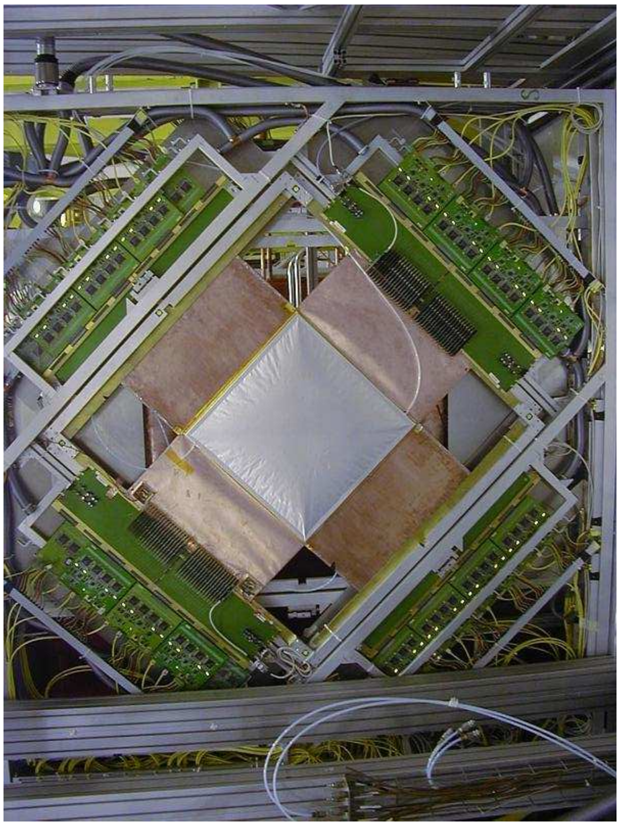
- 8 Stations of scintillating fibers for tracking in the beam.
- Active area $40 \times 40\,\text{mm}^2$ to $123 \times 123\,\text{mm}^2$.
- fiber diameter 0.5 mm to 1 mm.



- Enormous rate capability: 5 MHz per fiber.
- Time resolution: 400 ps.
- Spatial resolution: 130 μm.

Micro Mesh Gas Detectors (μM)

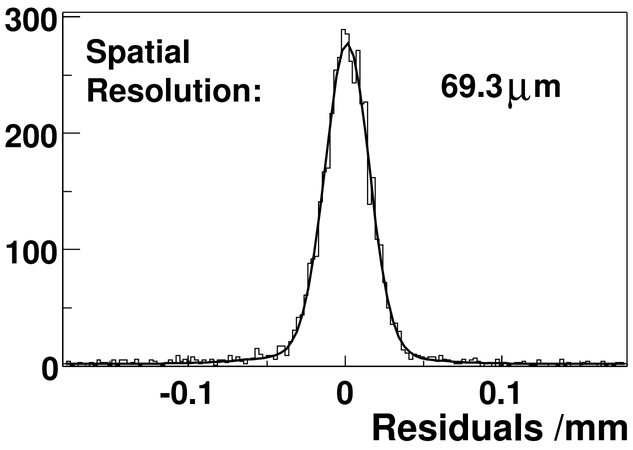


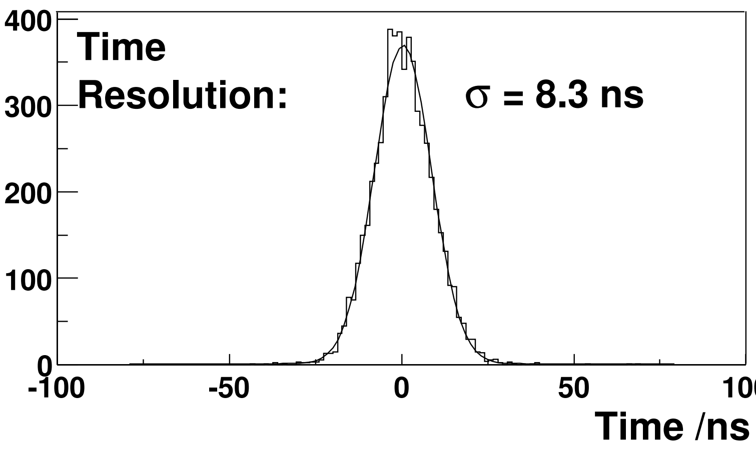


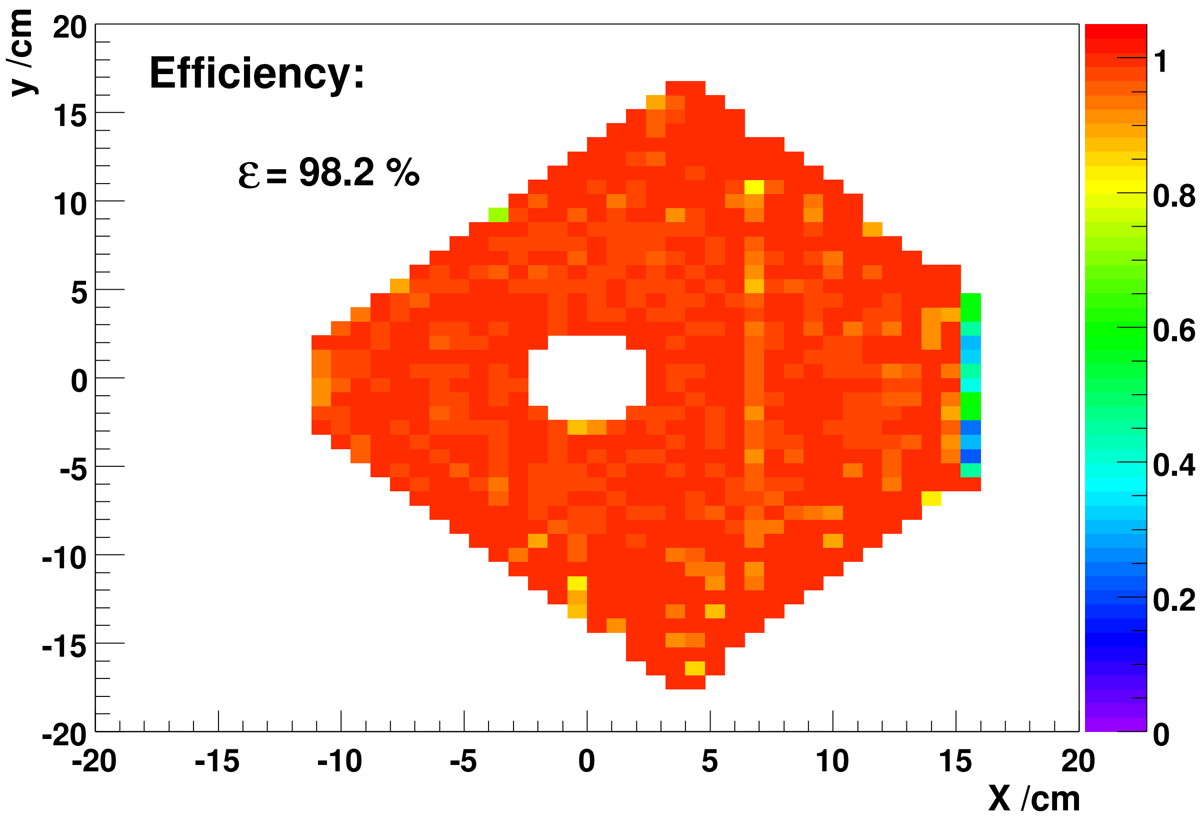
New type of gaseous detectors designed to obtain:

- High rate capability (100 kHz/strip),
- Good spatial resolution ($\leq 100\,\mu$m).
- Active Area $40\times40\,\text{cm}^2$.
- 5 cm diameter dead zone.
- 2 Stations (3 planes each) installed (50 %).

Micro Mesh Gas Detectors (μM)

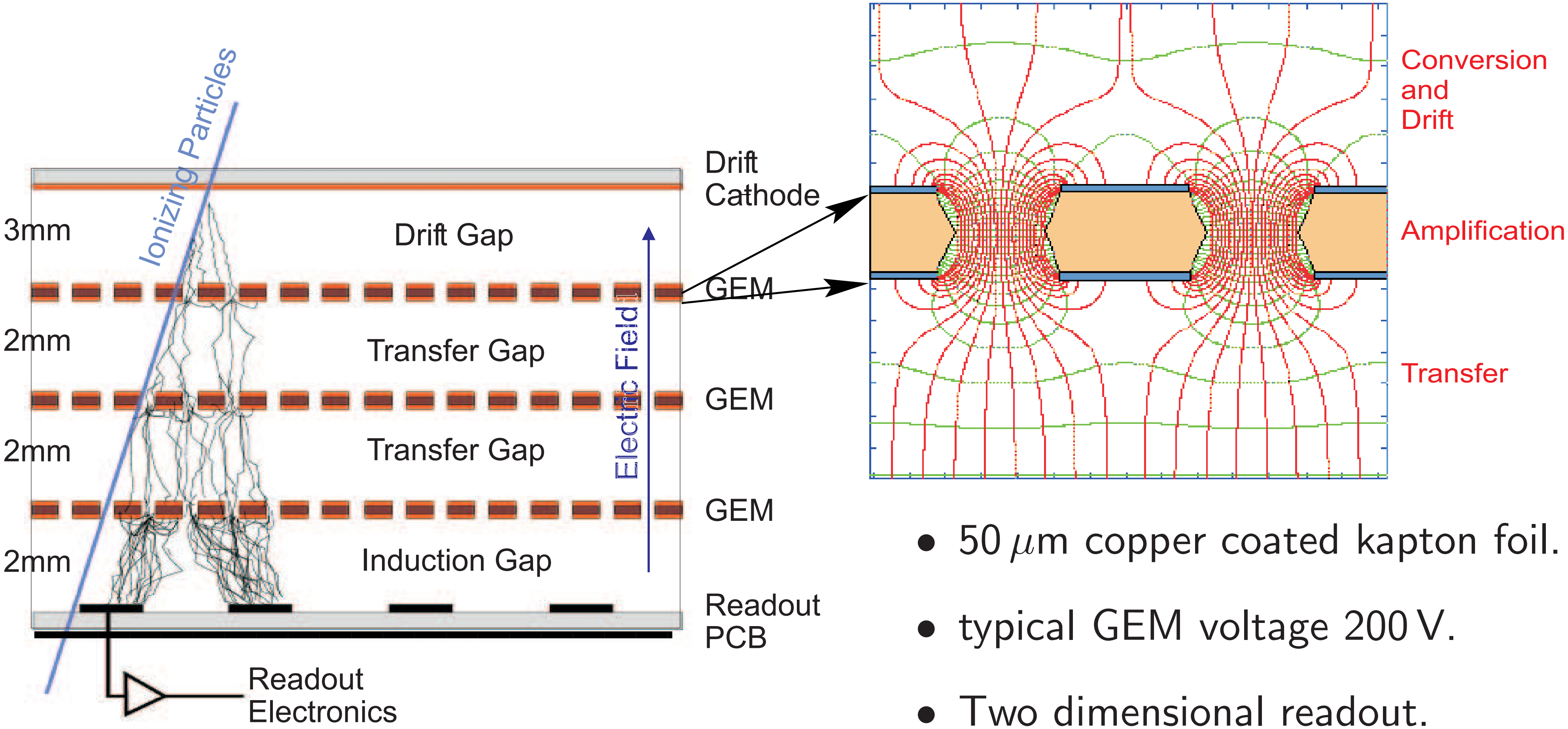






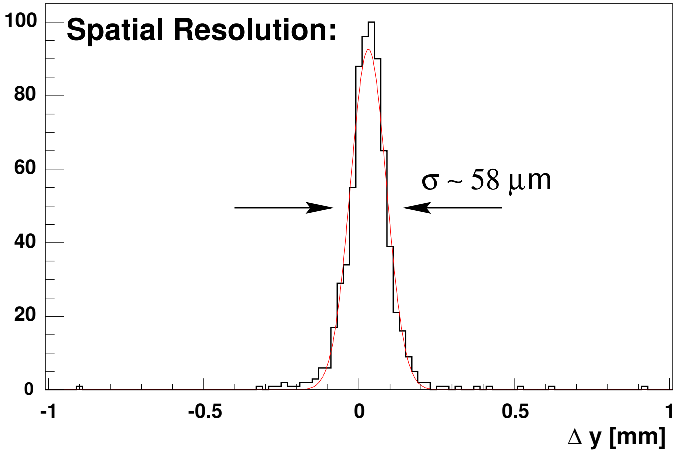
- Spatial Resolution below 70 μm.
- Time Resolution below 10 ns.
- Efficency higher than 97 %.

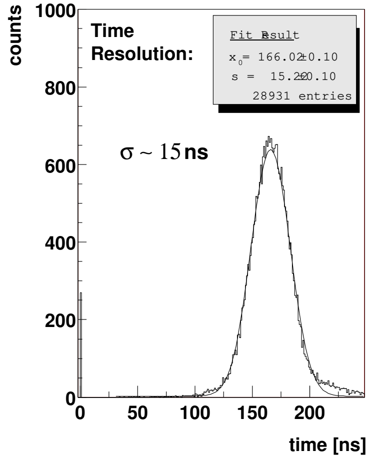
Gas–Electron–Multiplier (GEM)



- 50 μm copper coated kapton foil.
- typical GEM voltage 200 V.
- Two dimensional readout.
- Excellent spatial resolution.

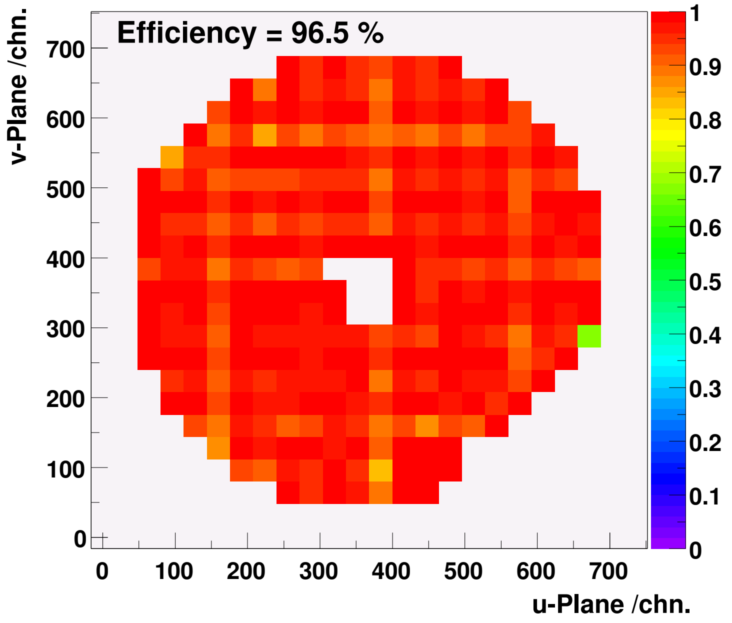
Gas–Electron–Multiplier (GEM)

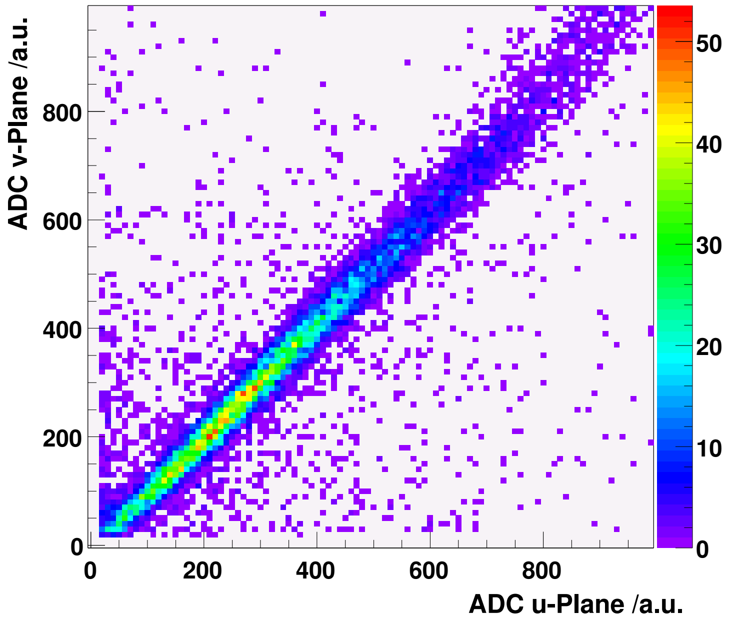




- Spatial Resolution 60 μm.
- Efficency above 96 %.
- ADC values of the two readout coordinates correlate.

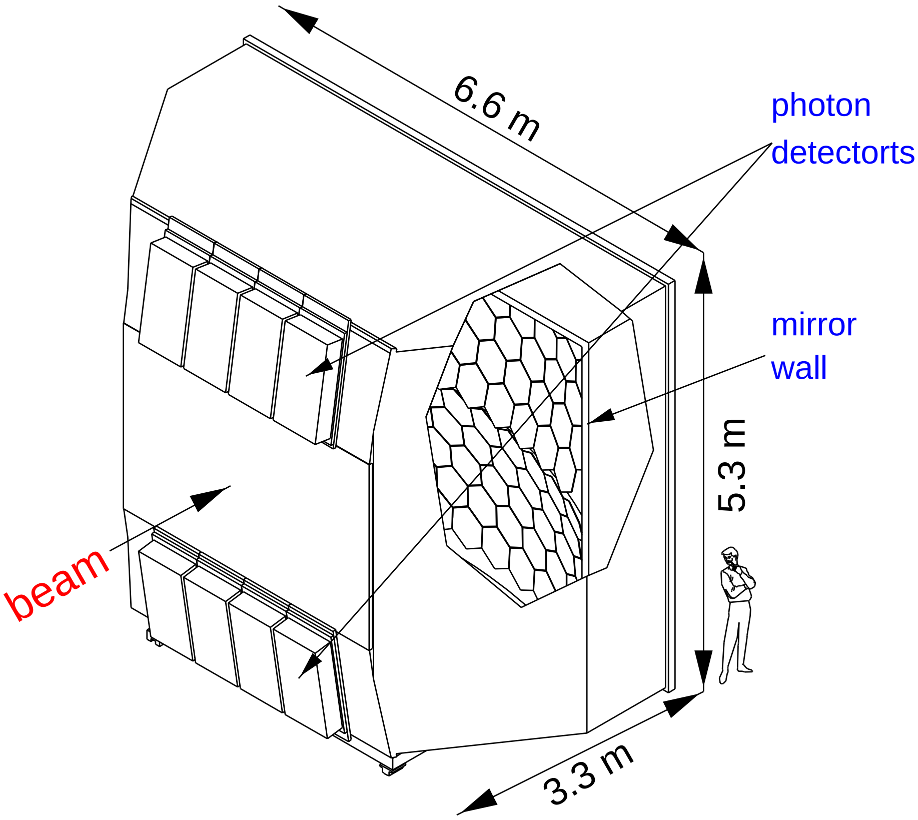
  $\Rightarrow$ pixel readout.





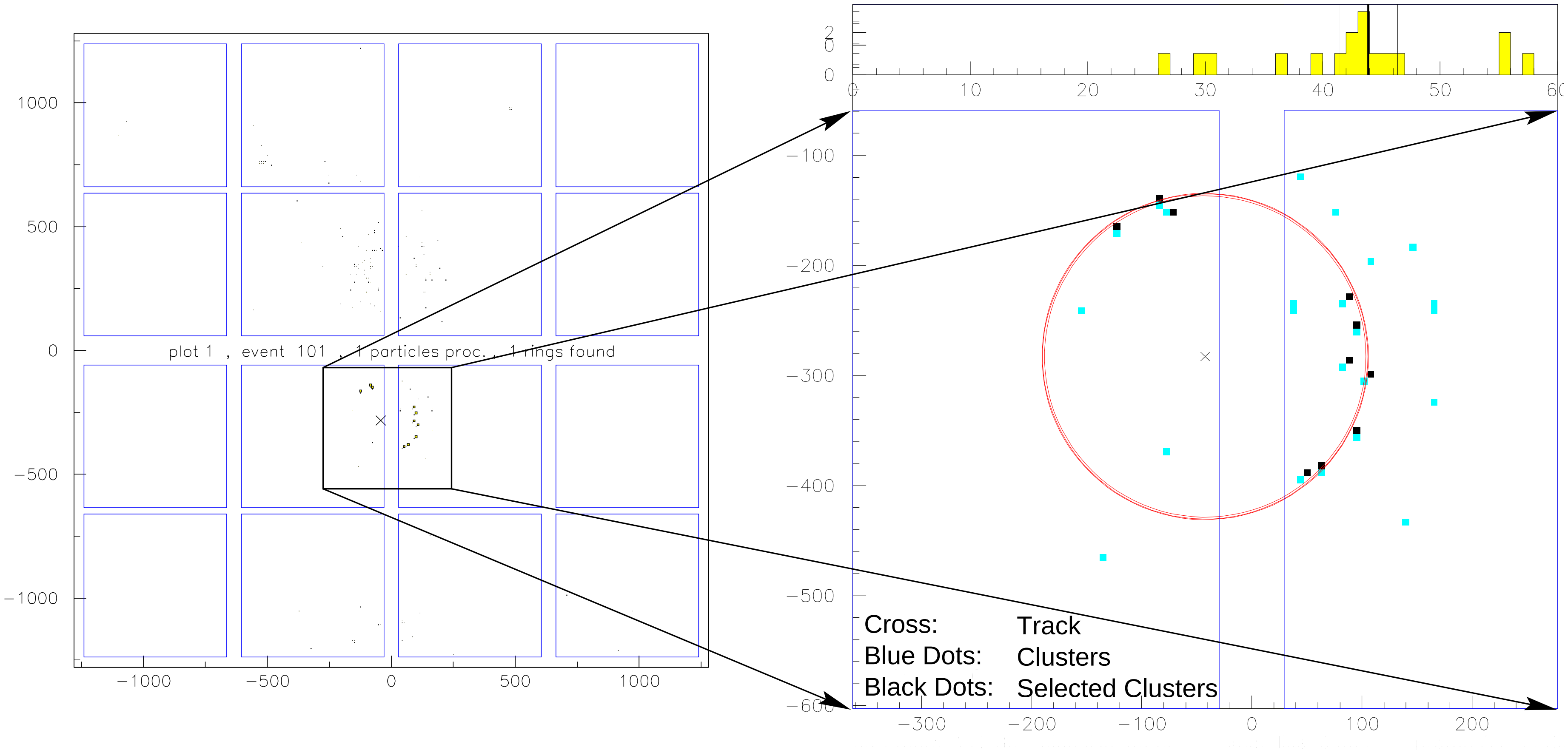
Ring Imaging Cherenkov (RICH1)

- Radiator Gas: C_4F_{10} (90 m^3) n=1.00153.
- 2 spherical mirror walls (60 mirrors each).
- Photon detection: MWPC with CsI cathodes. (granularity: 8×8 mm^2).
- 83 000 readout channels.
- π/K/p separation up to 60 GeV.
- Fully equipped in 2001, but only 50 % C_4F_{10}.

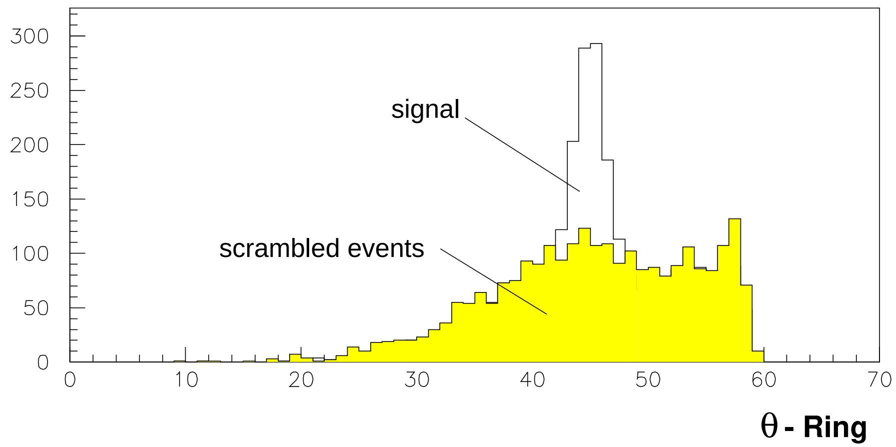


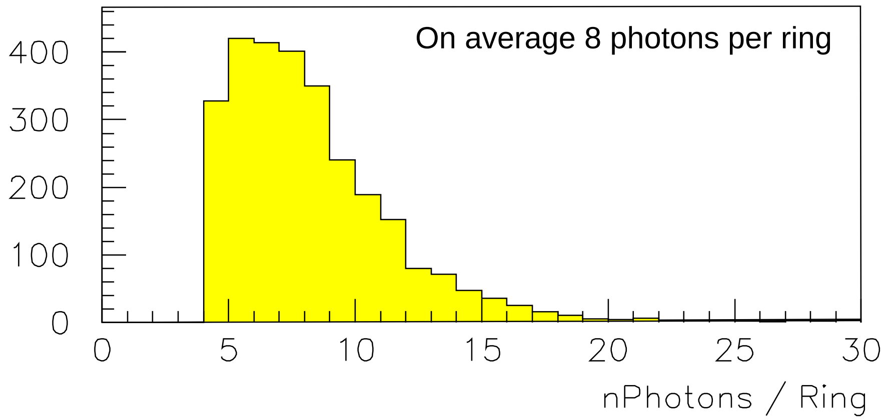
Ring Imaging Cherenkov (RICH1)

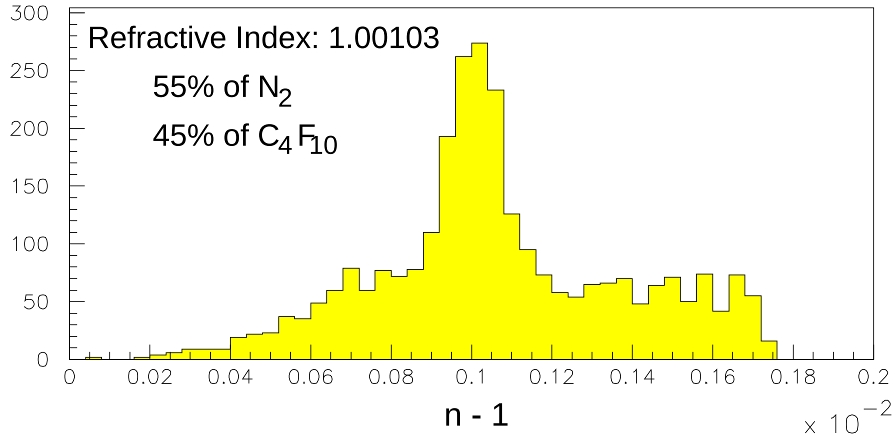
Ring Event:



Ring Imaging Cherenkov (RICH1)

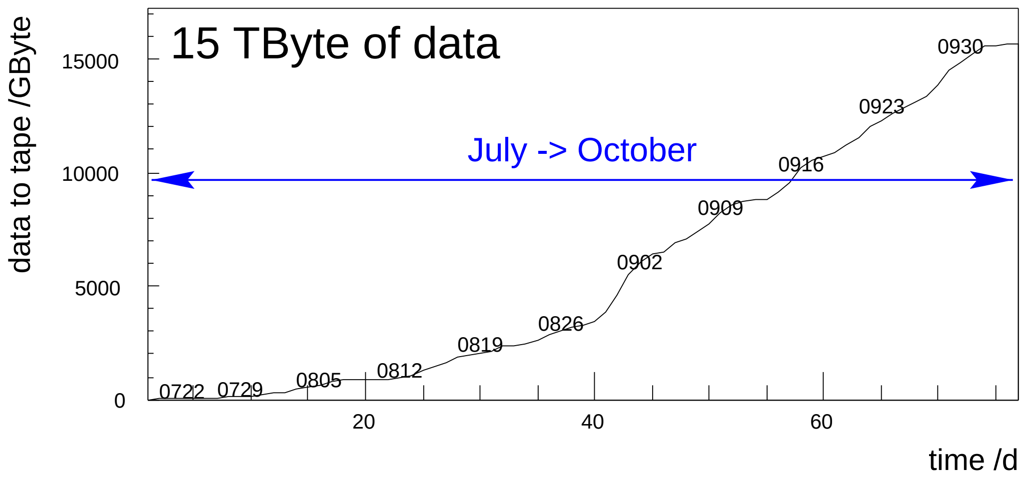


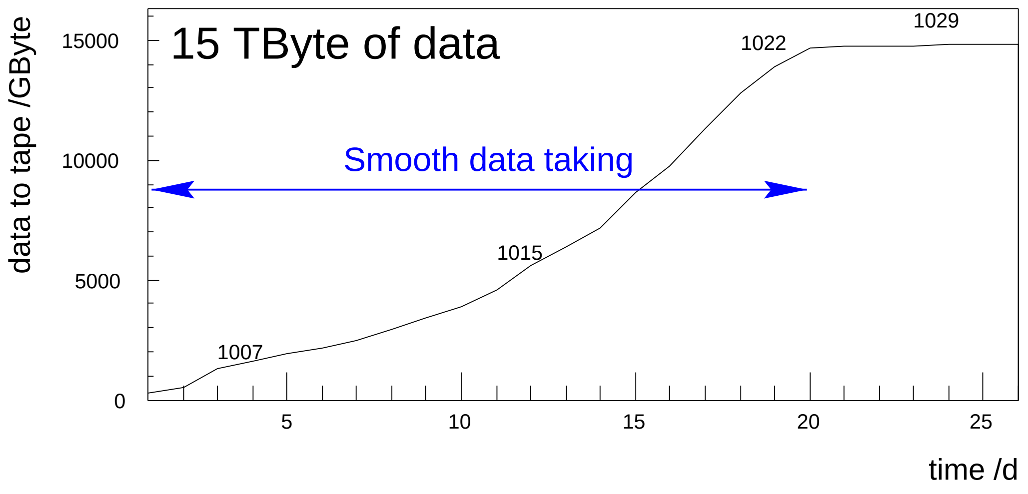




- Background due to chamber memory.
- The measured refractive index is compatible with mixture of 55 % N_2 and 45 %C_4F_{10}.
- Reconstructed rings are on average formed by 8 photons.

2001 Data Taking Period

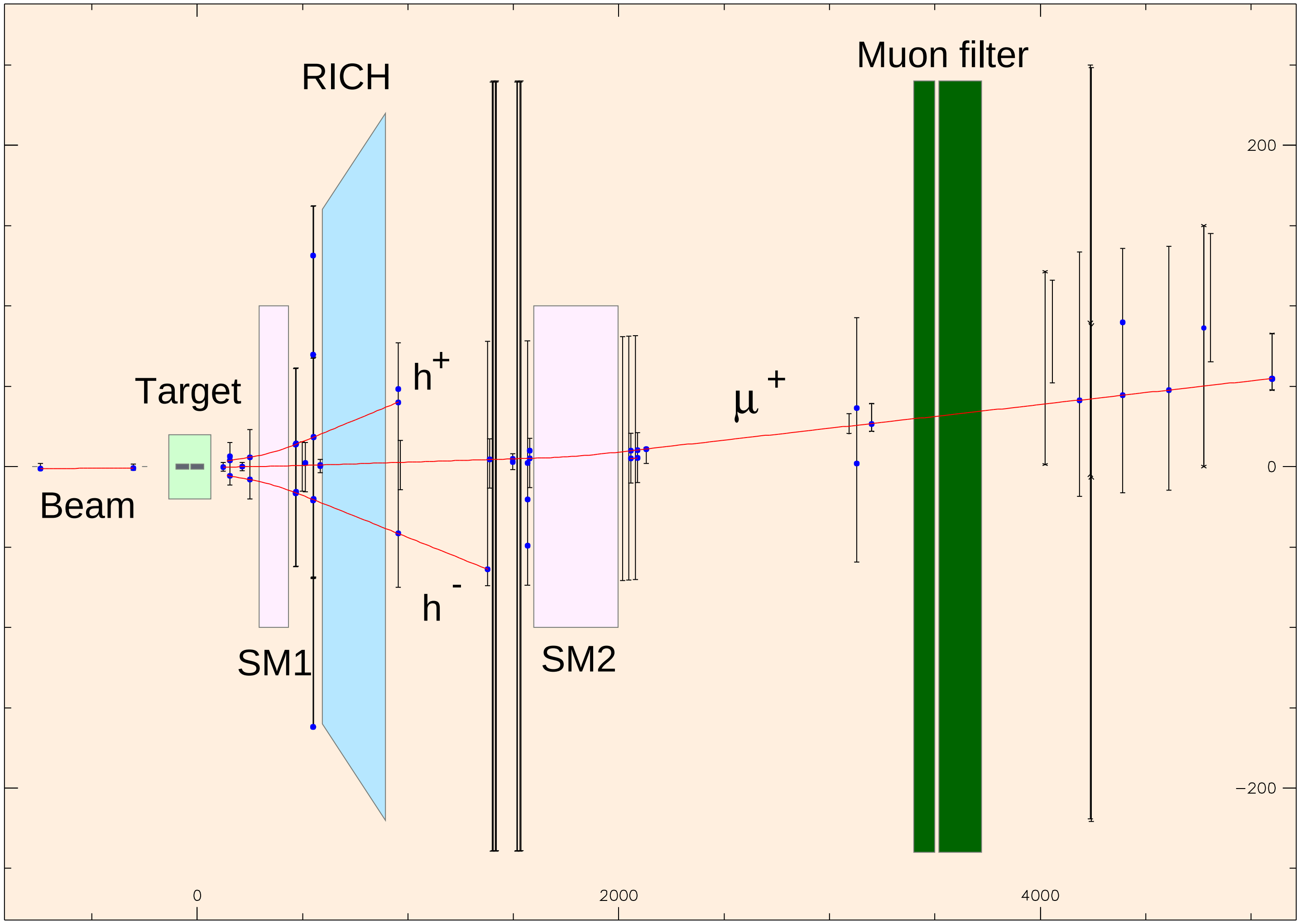




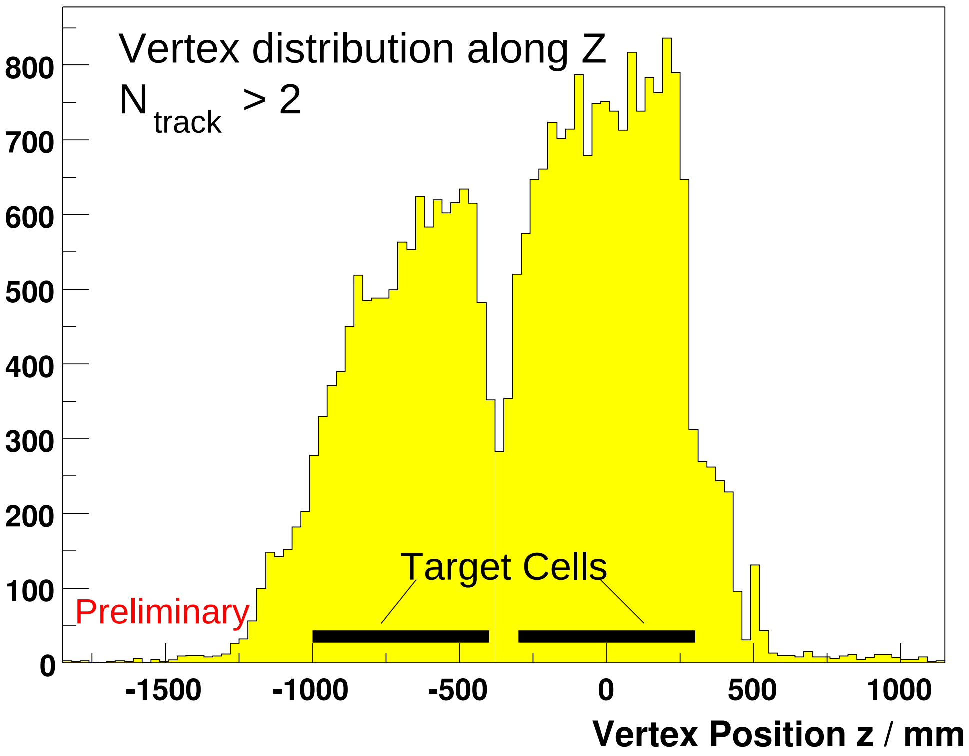
- Set–up period:
  - Installation and commissioning of new detectors.
  - Online system fully commissioned and adjusted.
  - Alignment procedures tested.
  - First look at the data.

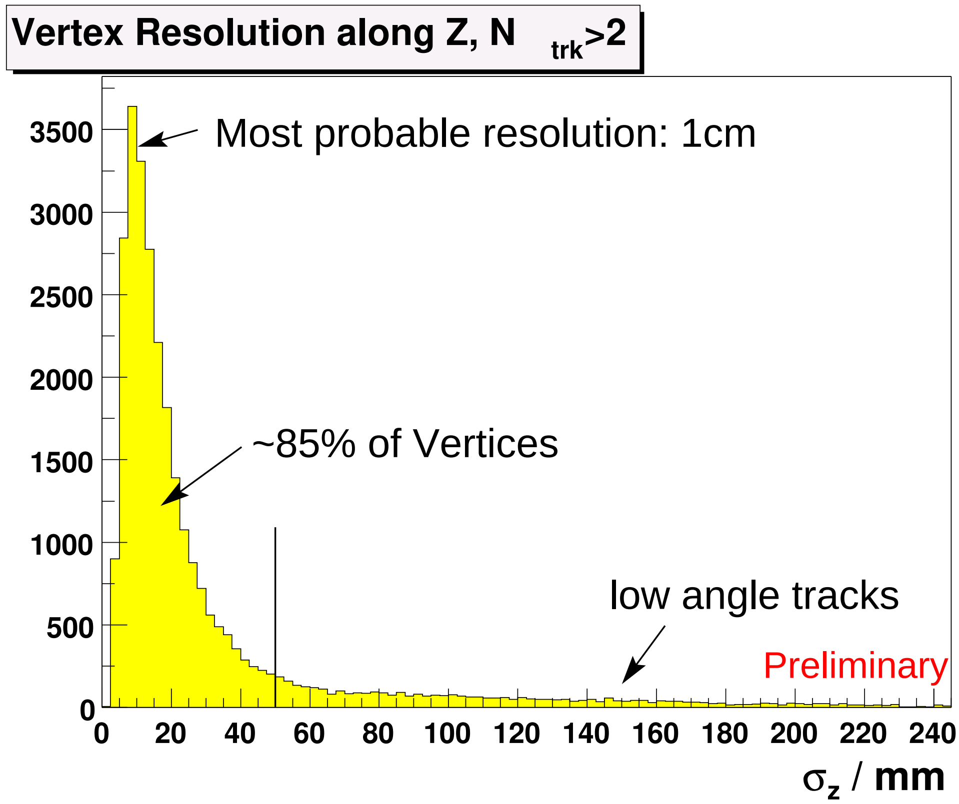
- Two weeks of data taking
  - Event size close to nominal (30 kByte).
  - Event rate close to nominal (20 000 Trigger/spill).
  $\Rightarrow$ Data rate 35 MByte/s.

2001 Event Display

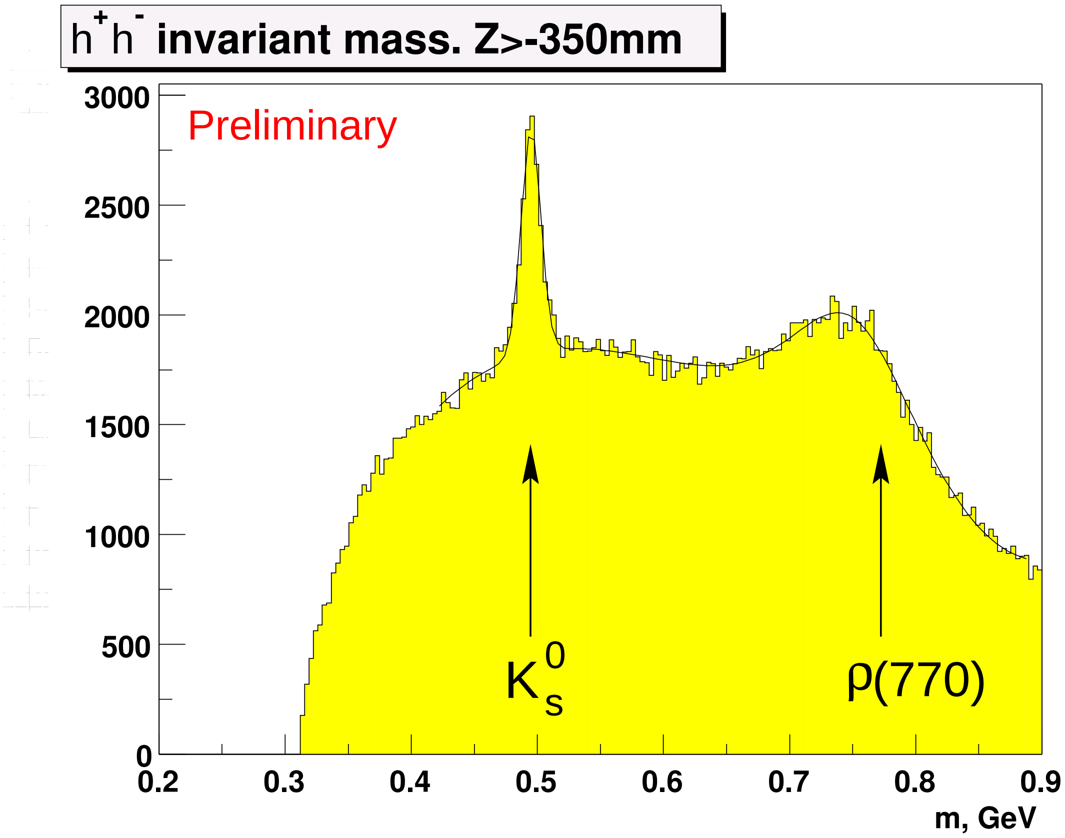


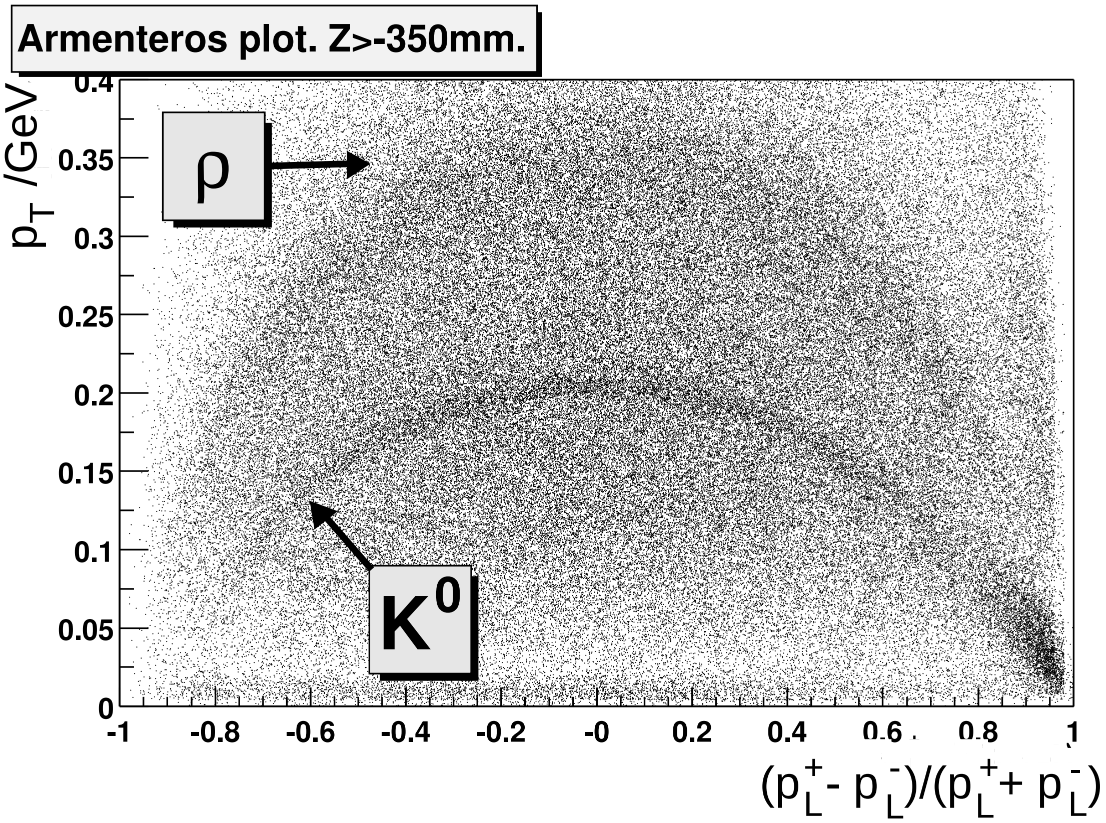
Vertex Reconstruction



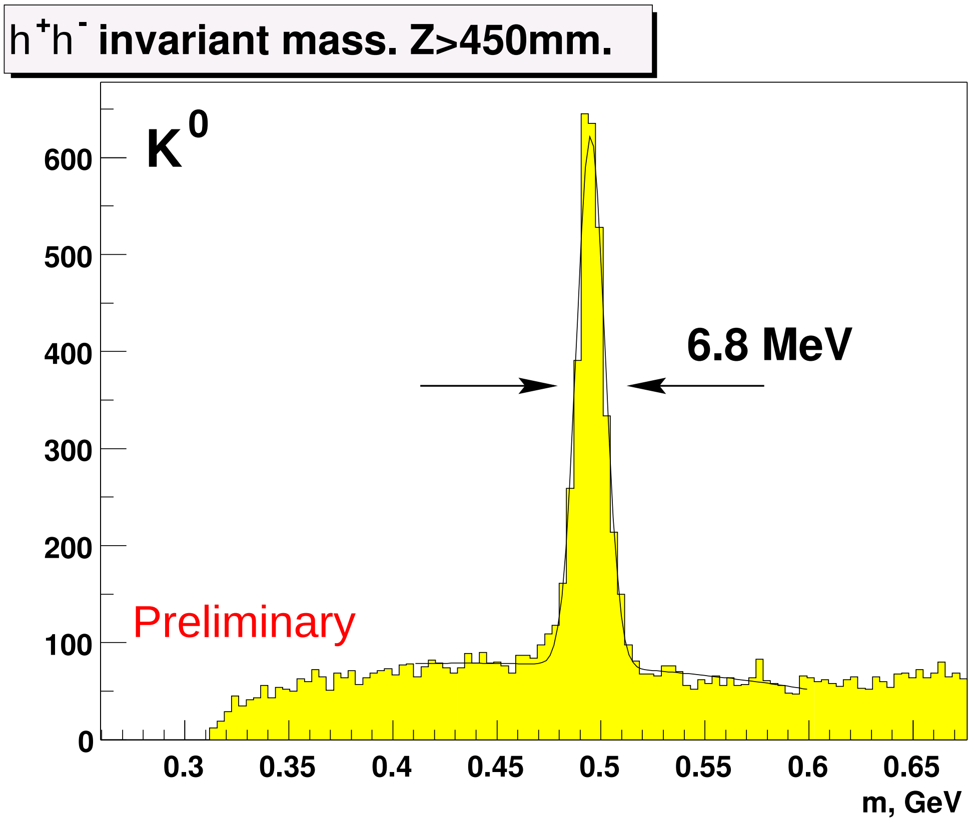


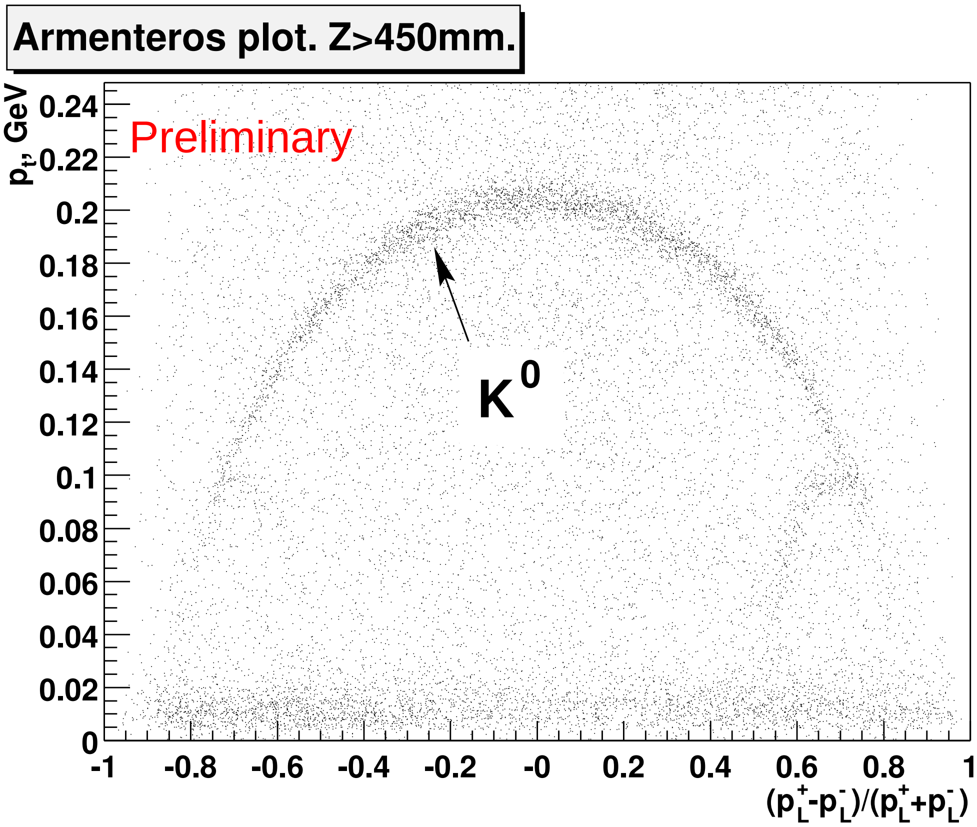
Invariant Mass Reconstruction





Invariant Mass Reconstruction





Prospects for 2002

- Setup will be completed. Main improvements:
  - More Tracking Detectors:
    $\Rightarrow$ redundancy $\Rightarrow$ better tracking efficiency.
    $\Rightarrow$ more Hadrons $\Rightarrow$ better vertex resolution.
  - Larger Acceptance
    - Additional Drift Chambers.
    - Additional trigger hodoscopes.
      DIS events up to $Q^2 = 50\,GeV^2$

- Target: ^{6}LiD with SMC magnet like in 2001.

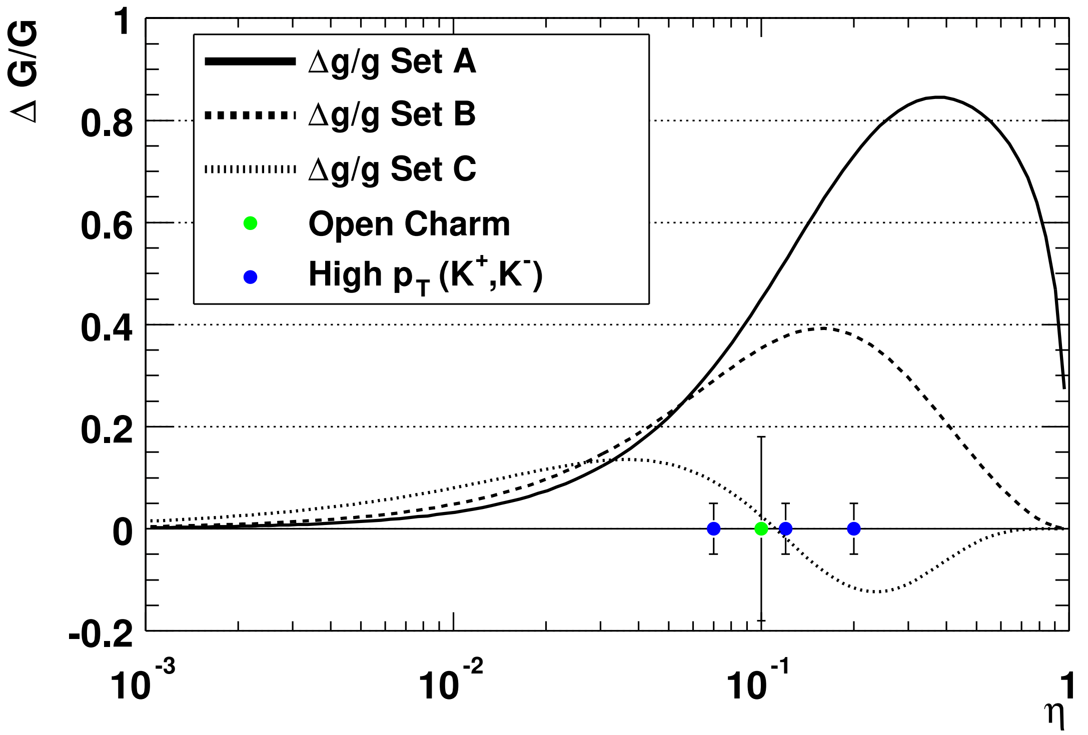
- 100 days of polarised muon beam.

Projected Results

Statistical accuracy after 80 days of ^{6}LiD data taking with 160 GeV muons and SMC–Magnet

- Open Charm Production:
  - Low systematical error.
  - 16 k reconstructed charm events $\Rightarrow \delta\left(\frac{\Delta G}{G}\right)_{st} \approx 0.18$.
  - One data point at $\langle\eta\rangle \approx 0.1$.

- High p_T Hadrons:
  - Compton background.
  - 28 k K^+K^- and 32 k h^+h^- $\Rightarrow$ low statistical error.
  - η reconstructed $\Rightarrow$ Three data points $0.04 < \eta < 0.2$.



Summary

- The muon part of COMPASS covers a large spin physics program, with special emphasis on the gluon polarisation measurement.
- In 2001 large parts of the initial layout of COMPASS were successfully commissioned. The various novel detector principles were proven to work.
- On the basis of the 2001 data big progress in the offline analysis sector was achieved.

  COMPASS will be ready for physics data in this years run.