COMPASS: Status and Perspectives

Jörg PRETZ

on behalf of the

COMPASS collaboration

La Thuile, March 2003

Physikalisches Institut, Universität Bonn

COmmon

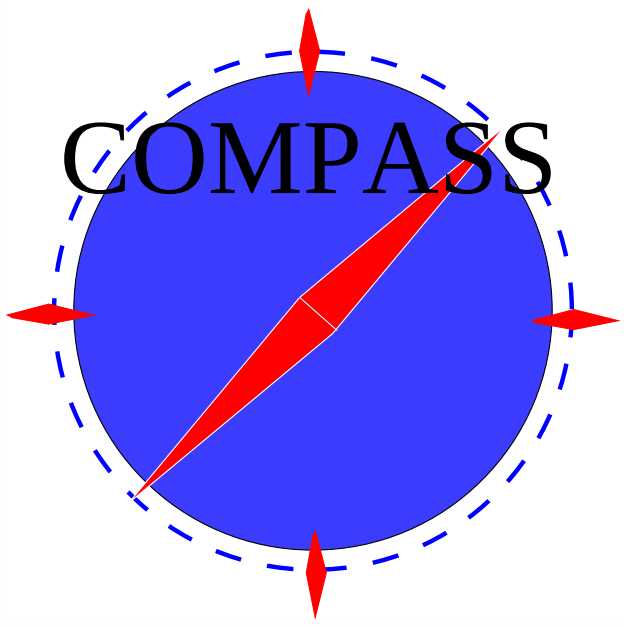
Muon and

Proton

Apparatus for

Structure and

Spectroscopy



$\approx$ 200 physicists

$\approx$ 35 institutes,

at CERN SPS μ beam

Physics Goals

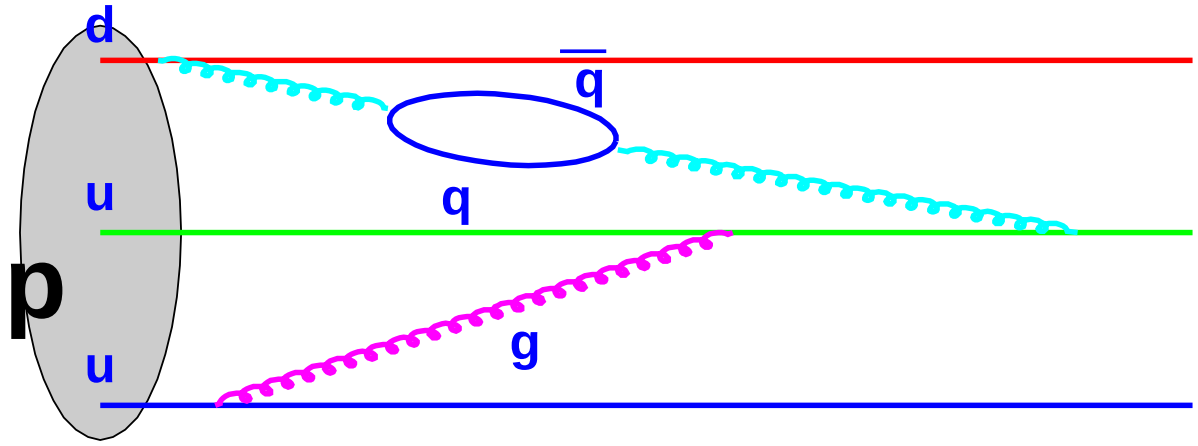
Structure
(with μ beam)

- $\Delta G(x)$
- $\Delta q(x)$
- $\Delta_T q(x)$

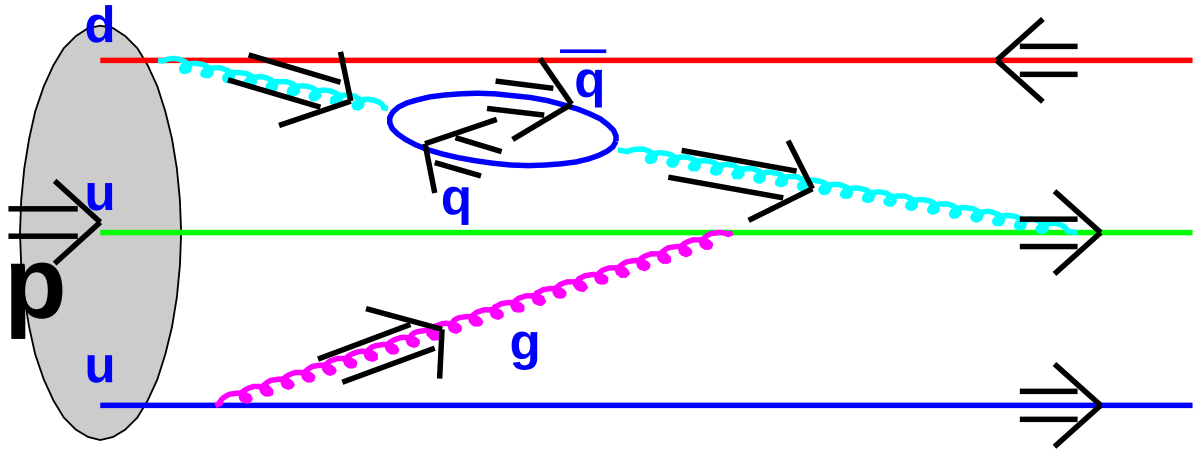
Spectroscopy
(with hadron beam)

- π and K polarizability
- Glue Balls,Hybrid Mesons
- doubled charmed baryons

Where does the Nucleon Spin come from?



Where does the Nucleon Spin come from?



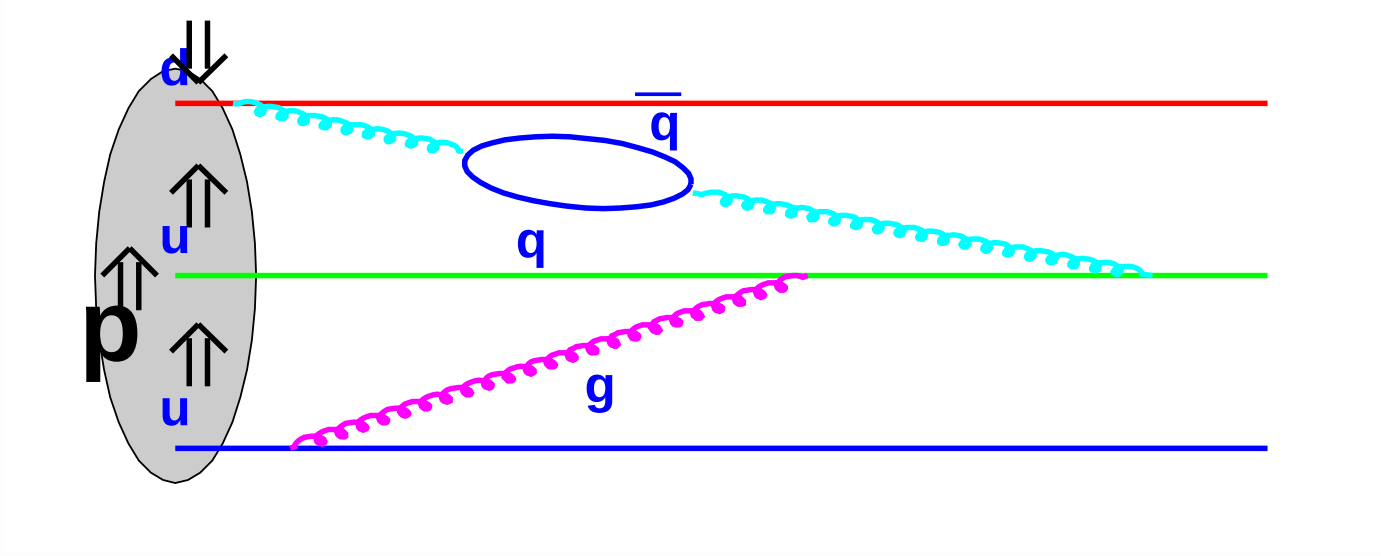
$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + \Delta G + L_q + L_g$$

$$\Delta\Sigma = \Delta u + \Delta\bar{u} + \Delta d + \Delta\bar{d} + \Delta s + \Delta\bar{s}$$

$$\Delta u = u^{\uparrow} - u^{\downarrow}, \Delta G = G^{\uparrow} - G^{\downarrow}$$

$L_q(L_G)$: orbital angular momentum of quarks (gluons)

Where does the Nucleon Spin come from?



$\Delta_T q$: net number of quarks, q, carrying spin parallel to transverse polarized nucleon.

The Nucleon Spin Puzzle

Static Quark Model: $\Delta\Sigma = 1$

Weak Baryon decays: $\Delta\Sigma = 0.58 \pm 0.03$

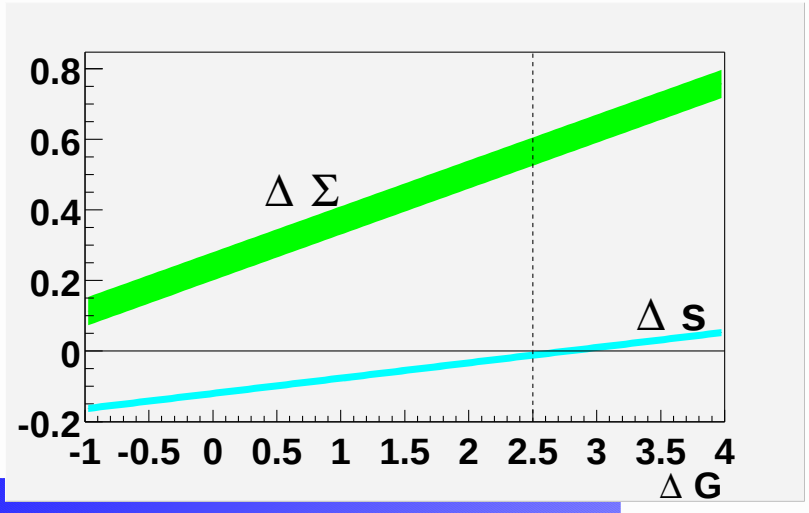
(Assumption $\Delta s = 0$)

DIS : $\Delta\Sigma = 0.24 \pm 0.03$

$\Delta s = -0.11 \pm 0.01$

But **axial anomaly** makes interpretation of $\Delta\Sigma$ difficult:

$\Delta\Sigma \rightarrow \Delta\Sigma - \frac{3\alpha_s}{2\pi}\Delta G$, $\Delta s \rightarrow \Delta s - \frac{\alpha_s}{2\pi}\Delta G$



For $\Delta G \approx 2.5 \rightarrow$,

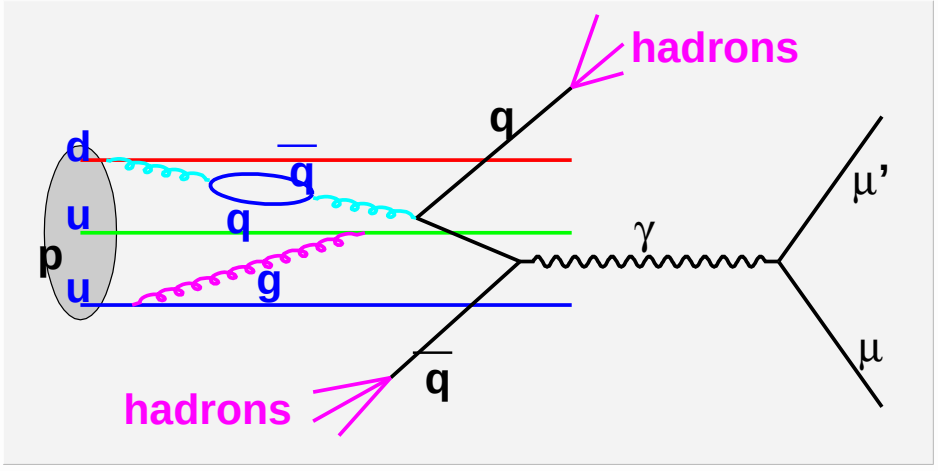
$\Delta\Sigma \approx 0.6$ and $\Delta s \approx 0$

$\rightarrow$ Measure ΔG !!!

How to measure ΔG?

Use hadronic final state in DIS to tag gluon!

$$\mu + N \rightarrow \mu' + \text{hadrons} + X$$



Two complementary methods:

- Open charm production
  $D^0 = (c\bar{u}) \rightarrow K^- + \pi^+ (4\%)$
- High p_T hadron production

π^+ tag u,$\bar{d}$ -quark $\rightarrow \Delta u \& \Delta \bar{d}$

π^- tag $\bar{u}$,d -quark $\rightarrow \Delta \bar{u} \& \Delta d$

K^+, K^-, K_s to tag s-quark! $\rightarrow \Delta s$

How to measure ΔG?

Double Spin Asymmetry (A_{LL}):

$$A^{\gamma N \to c\bar{c}} = \frac{\sigma^{\uparrow\downarrow} - \sigma^{\uparrow\uparrow}}{\sigma^{\uparrow\downarrow} + \sigma^{\uparrow\uparrow}} = < a^{PGF} > < \frac{\Delta G}{G} >$$

$$A^{\gamma N \to \text{hadrons}} \propto \Delta q / q$$

Single Spin Asymmetry (A_{UT}):

$$N^{\pi}(\Phi_{\pi} + \Phi_S) \propto \sin(\Phi_{\pi} + \Phi_S)\Delta_T q$$

For ΔG measurement:

Exploit full kinematic range

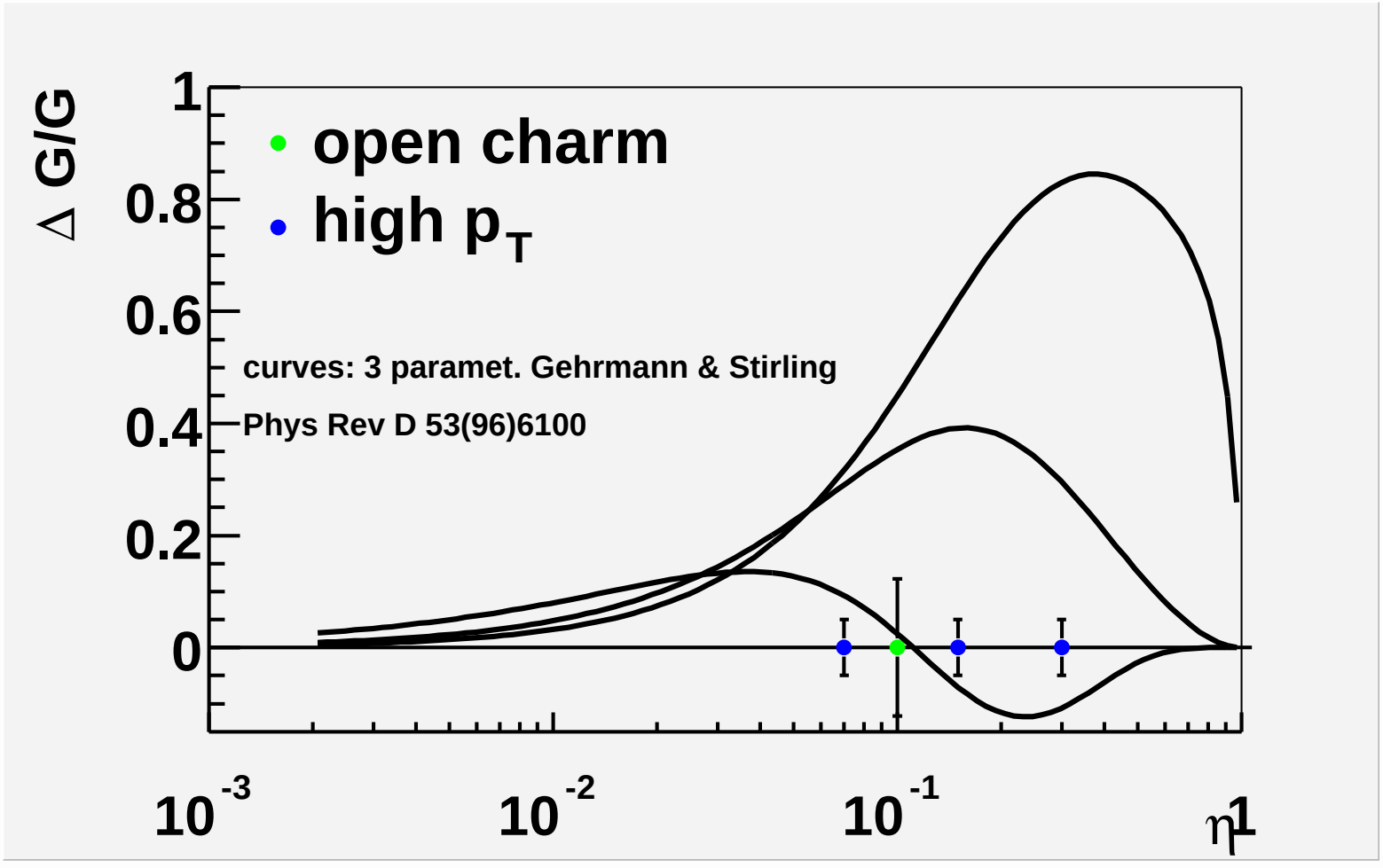
down to Q^2 = 0 (i.e. $\theta_{\mu} = 0$).

Scale = $(2m_c)^2$ allows interpretation pQCD even at low Q^2.

Expected precision on ΔG

Statistical accuracy for 1 year of running

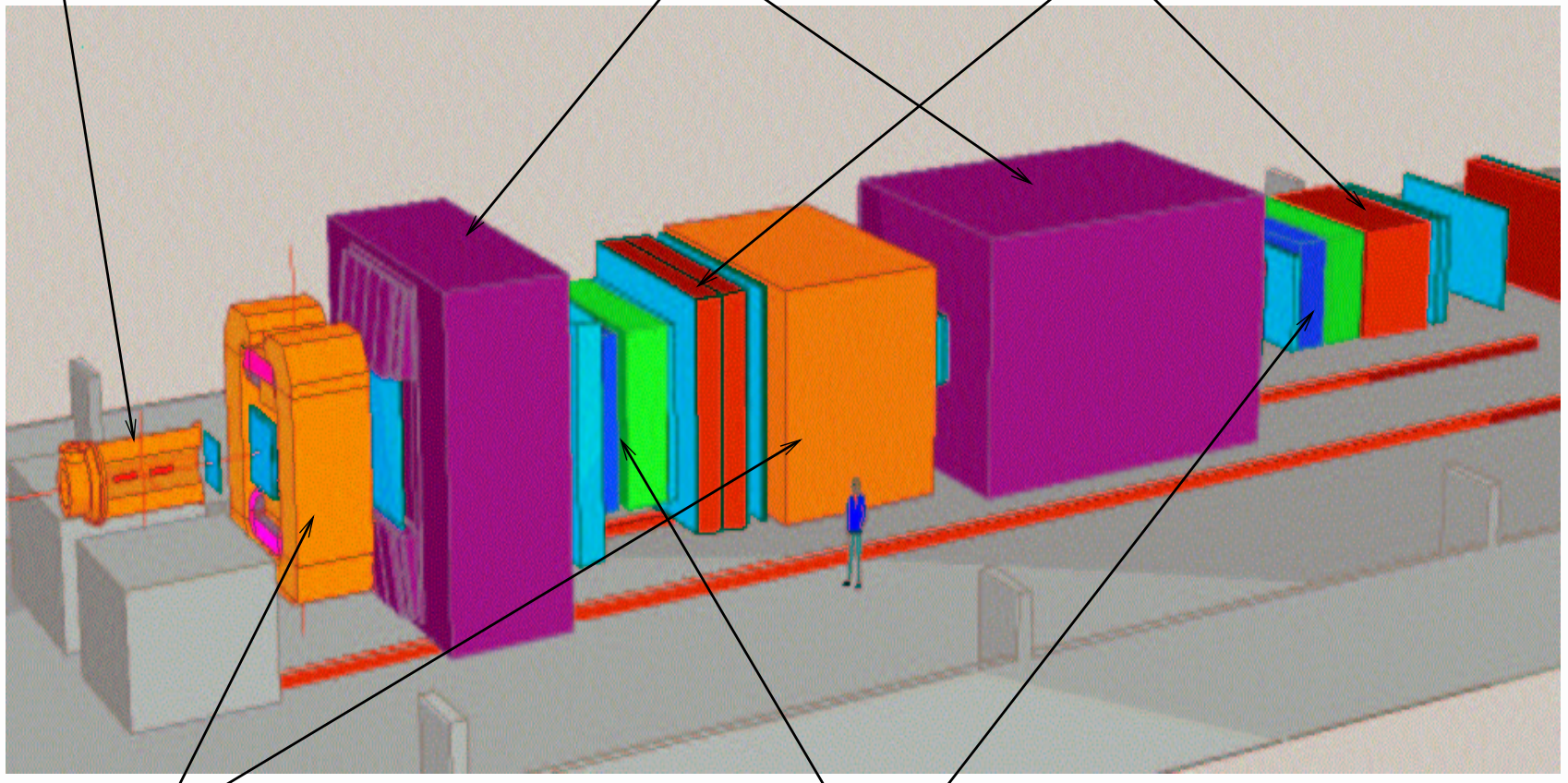
(1 year $\hat{=}$ 150 days, 25% eff. SPS + spectrometer)



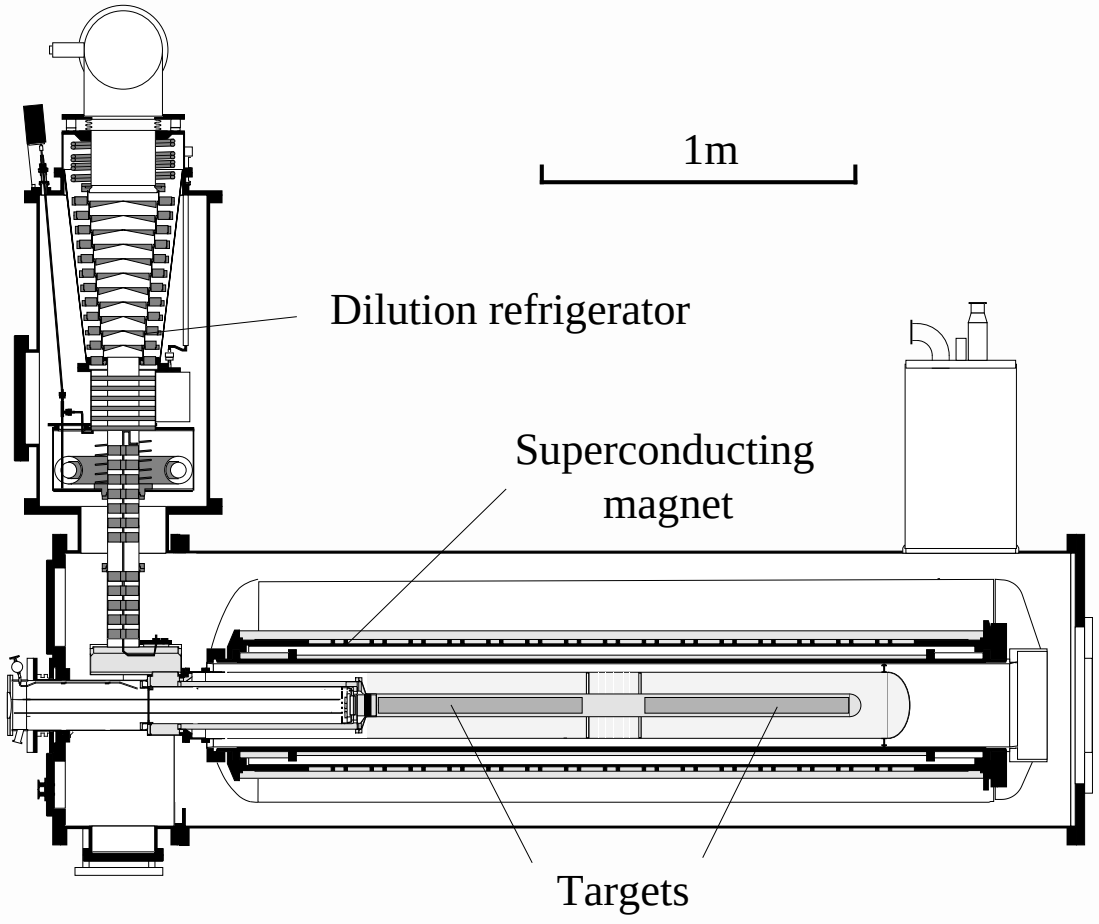
Requirements

- Polarized, high energy (100-200 GeV) lepton beam $\longrightarrow$ CERN muon beam
- Polarized Target
- Spectrometer
  - large acceptance (down to $\theta_\mu = 0$)
  - Particle ID

The COMPASS Spectrometer

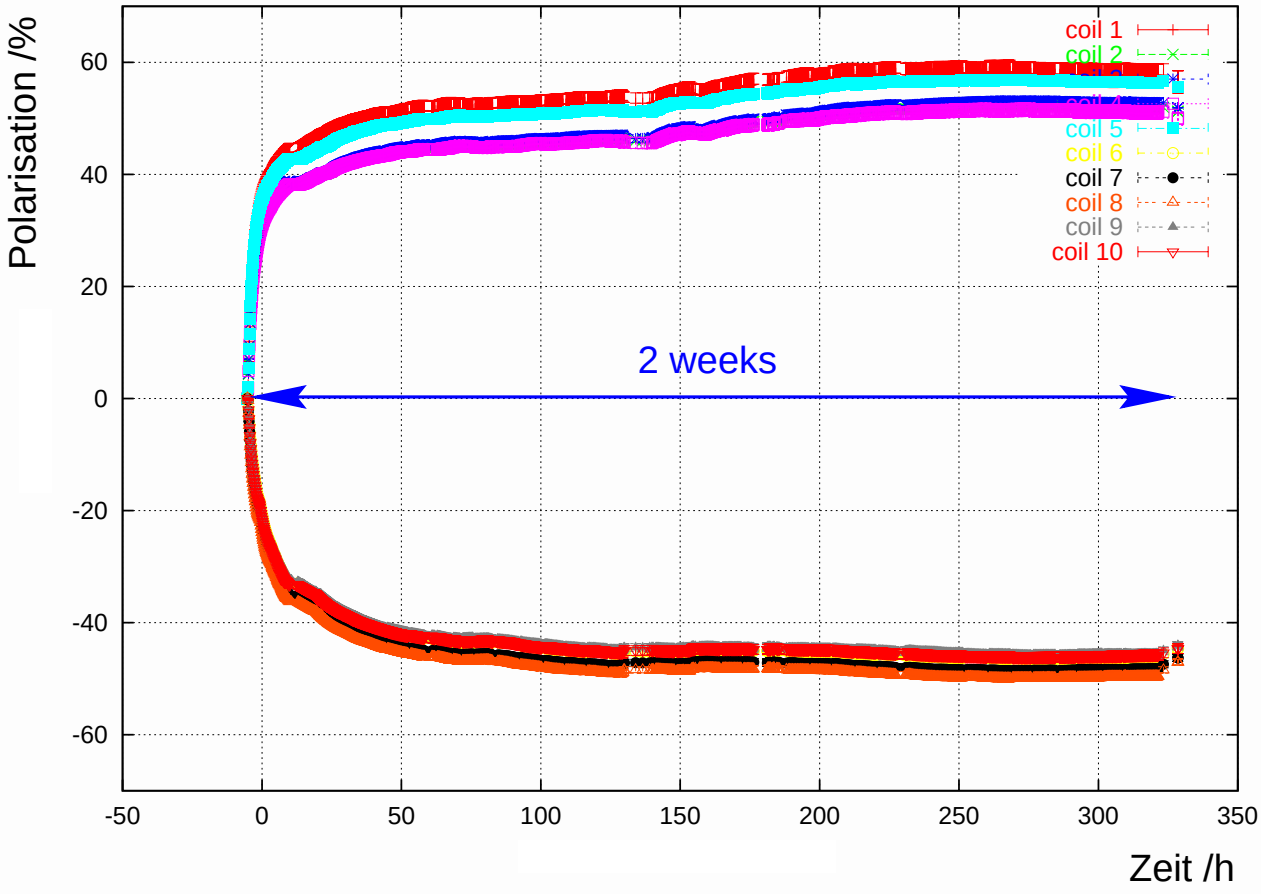


Target



- solid sate target
  ^{6}LiD, Pol = 0.5, f=0.5
  NH_3, Pol = 0.85, f=0.18
- two cells oppositely polarized
- Solenoid (B=2.5 T)
- Dipole (B=0.5 T)
- ^{3}He-^{4}He cryostat (T_{min} = 50 mK)
- **D**ynamic **N**uclear **P**olarisation
- pol. measurement with 10 NMR coils (σ_P/P = 0.03)

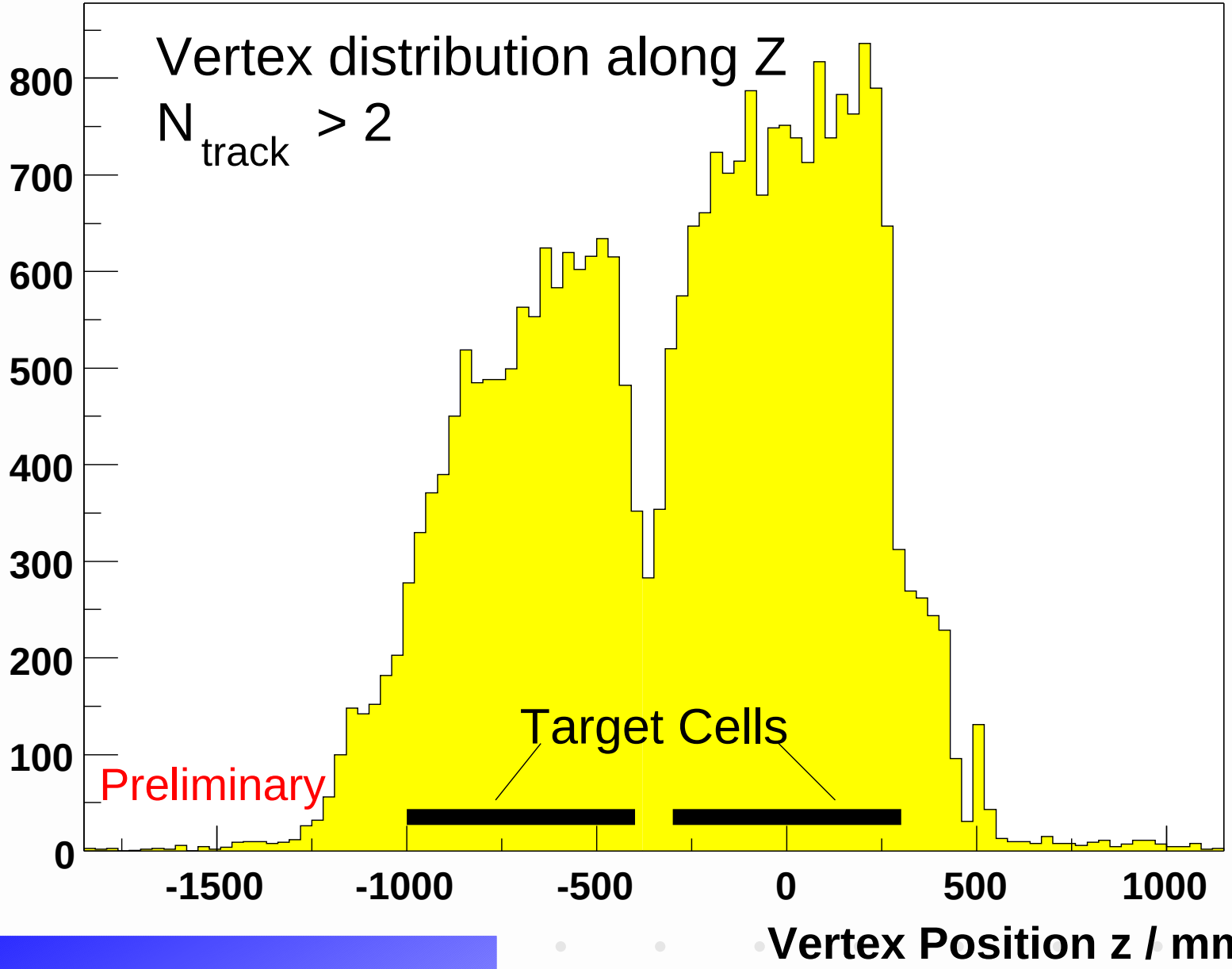
Target Polarization



Data Taking 2002

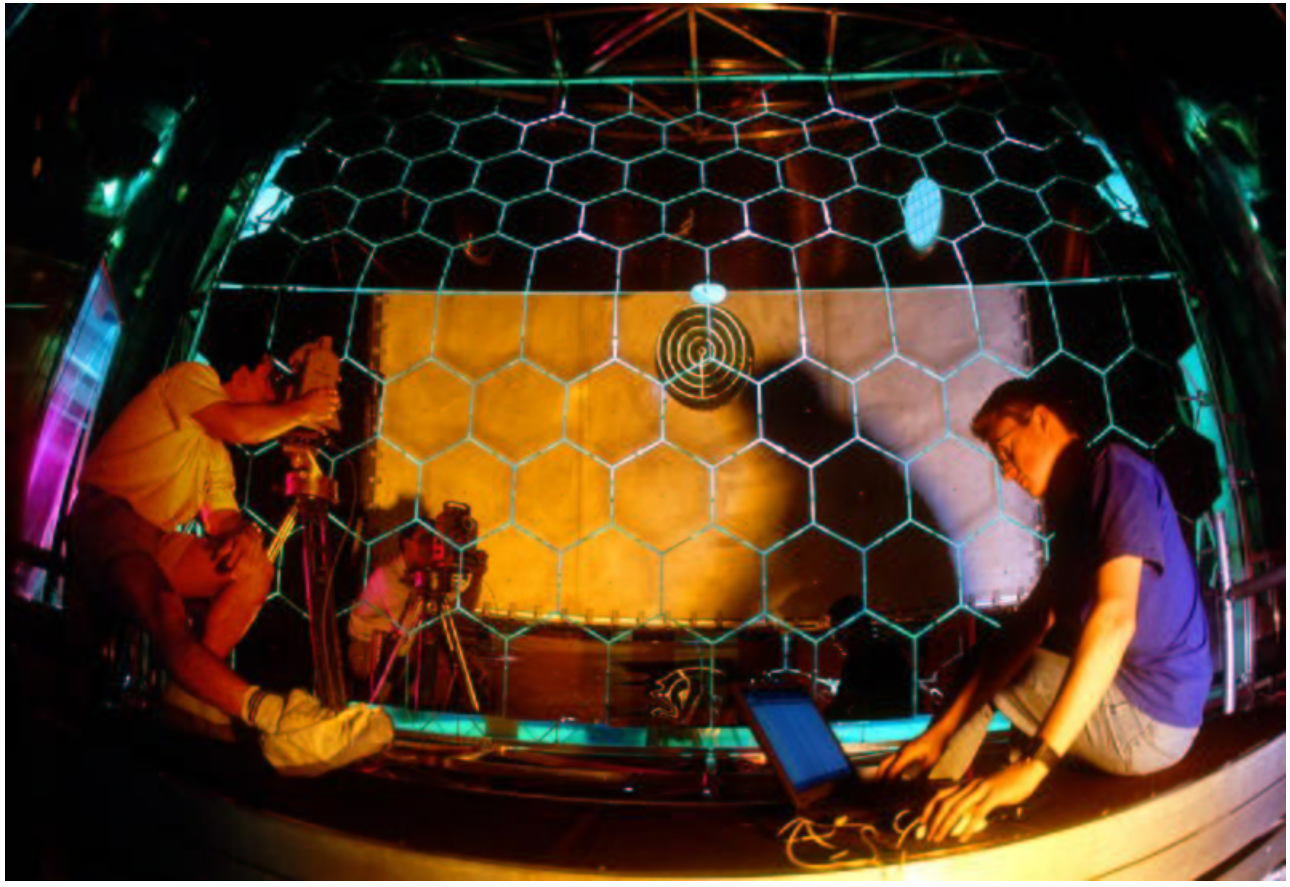
- fisrt physics run in 2002
- 76 days of data taking
- 5×10^9 events on tape $\hat{=}$ 300 TByte
  - 80% in longitudinal target polarization
    $\longrightarrow \Delta G$, $\Delta q, q = u, d, s, \bar{u}, \bar{d}, \bar{s}$
  - 20% in transverse target polarization
    $\longrightarrow \Delta_T q$

Vertex Reconstruction

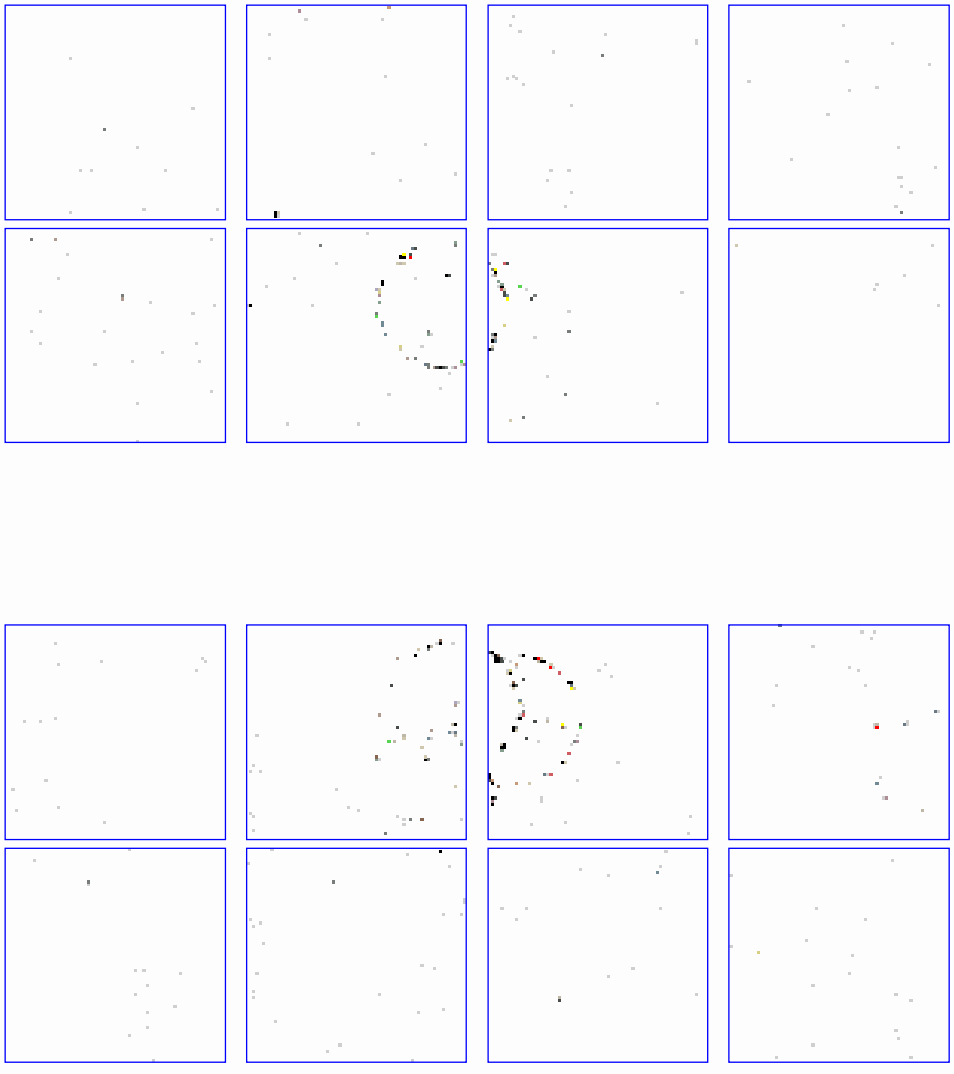


RICH

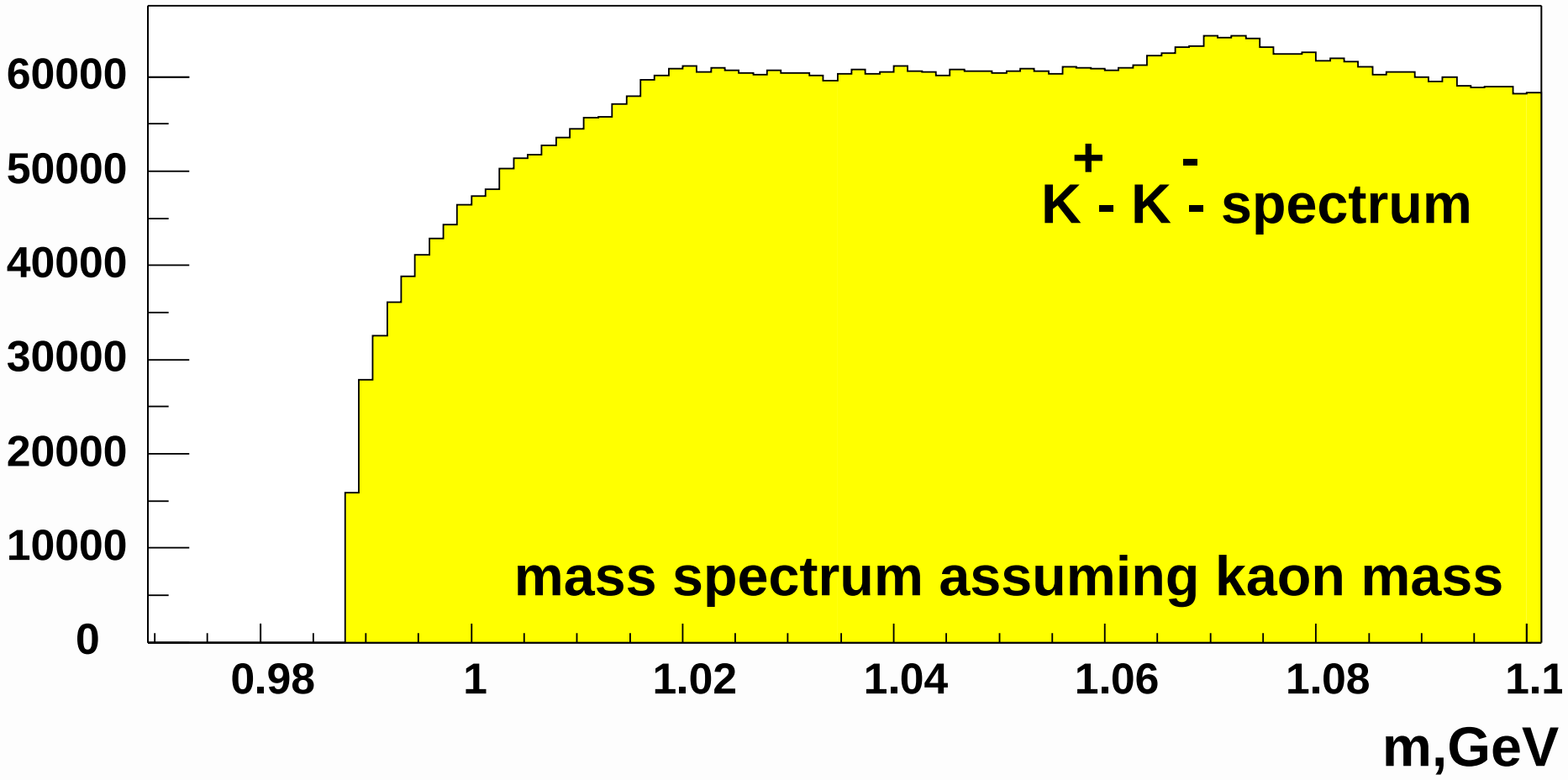
- radiator gas: C_4F_{10} (80 m^3)
- 116 mirrors
- MWPC with CsI cathodes
- π/K/p separation up to 50 GeV



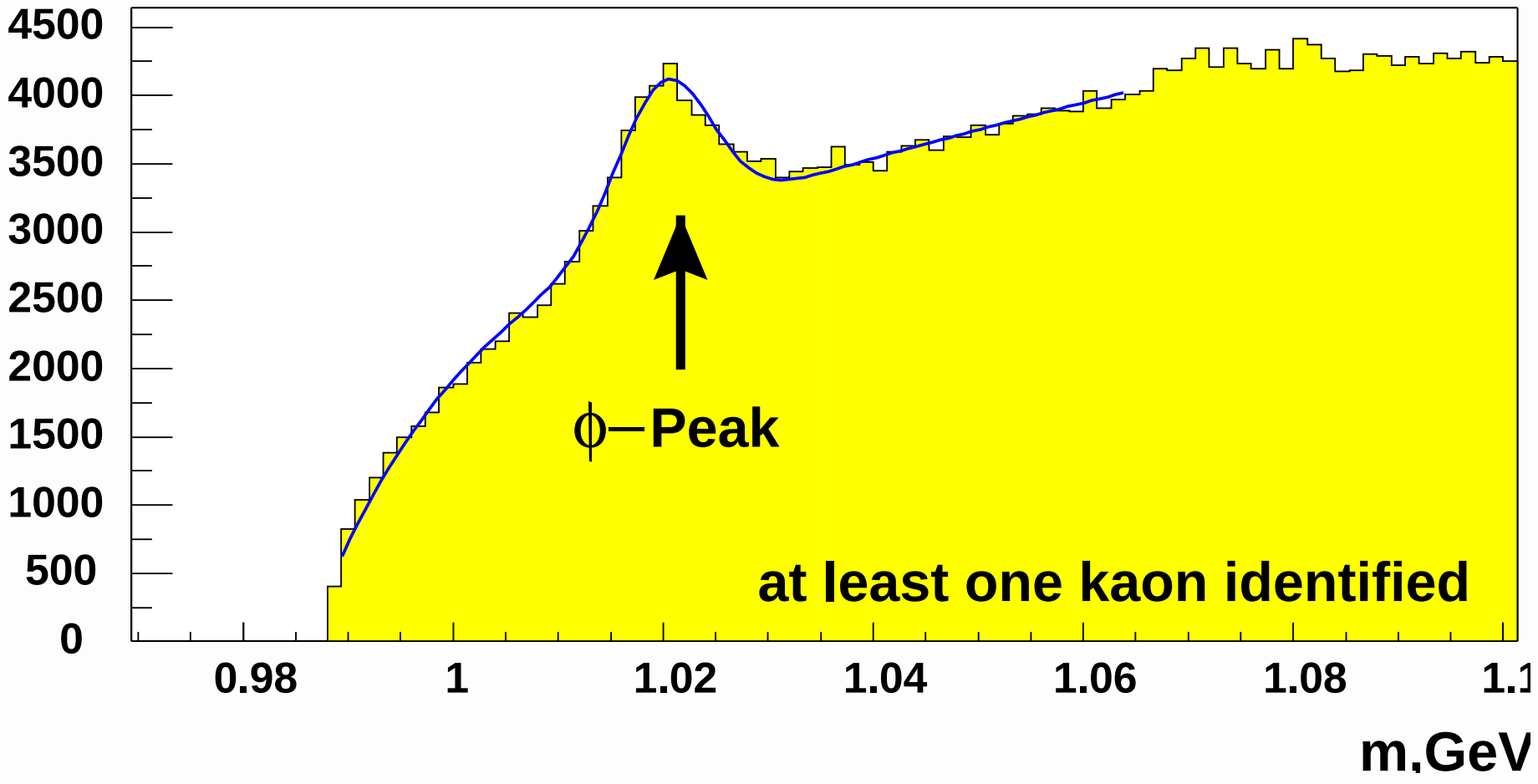
RICH Rings



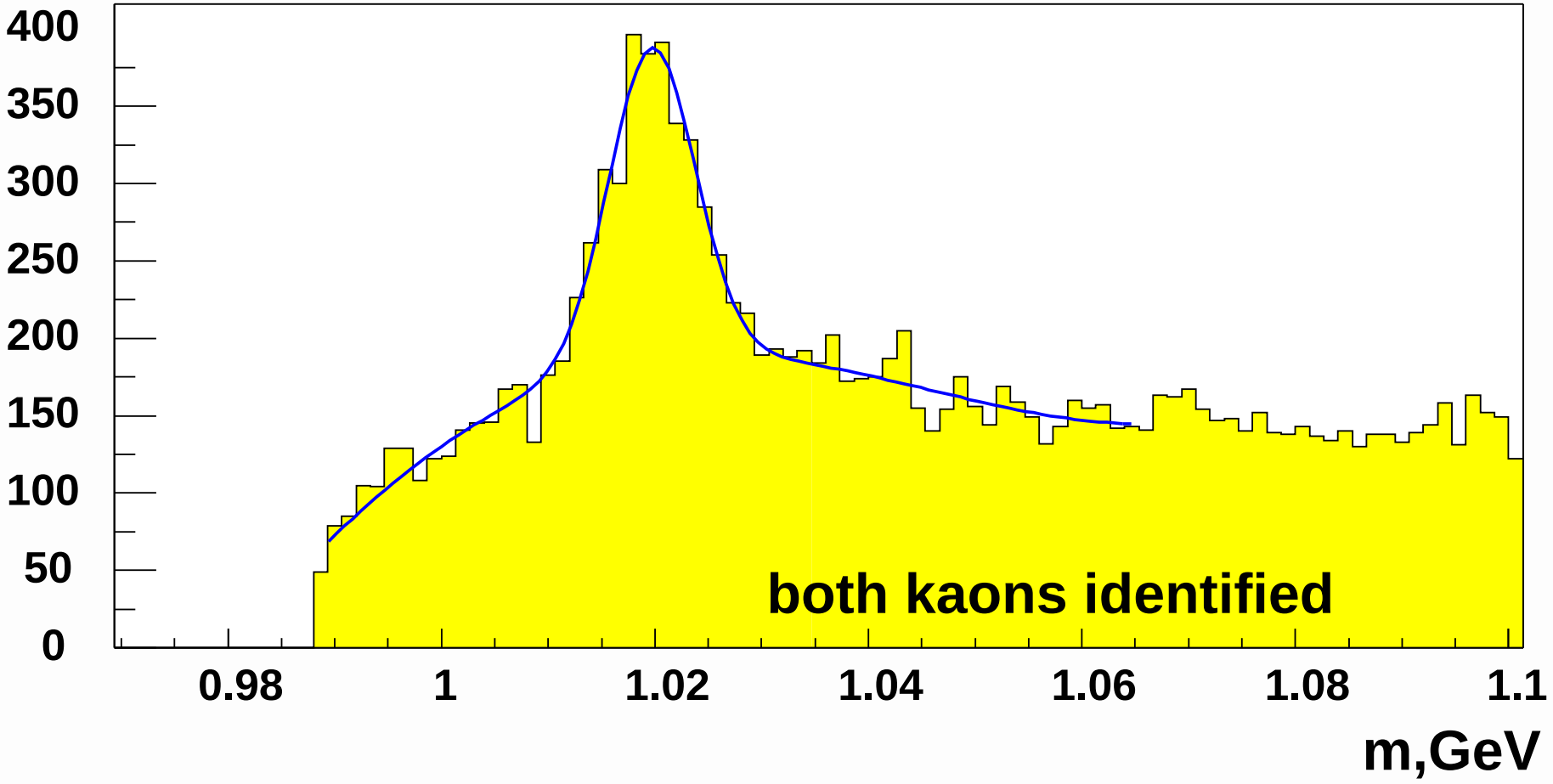
RICH at work


60000
50000
40000
30000
20000
10000
0
0.98
1
1.02
1.04
1.06
1.08
1.1
m,GeV
K+ - K- - spectrum
mass spectrum assuming kaon mass

RICH at work

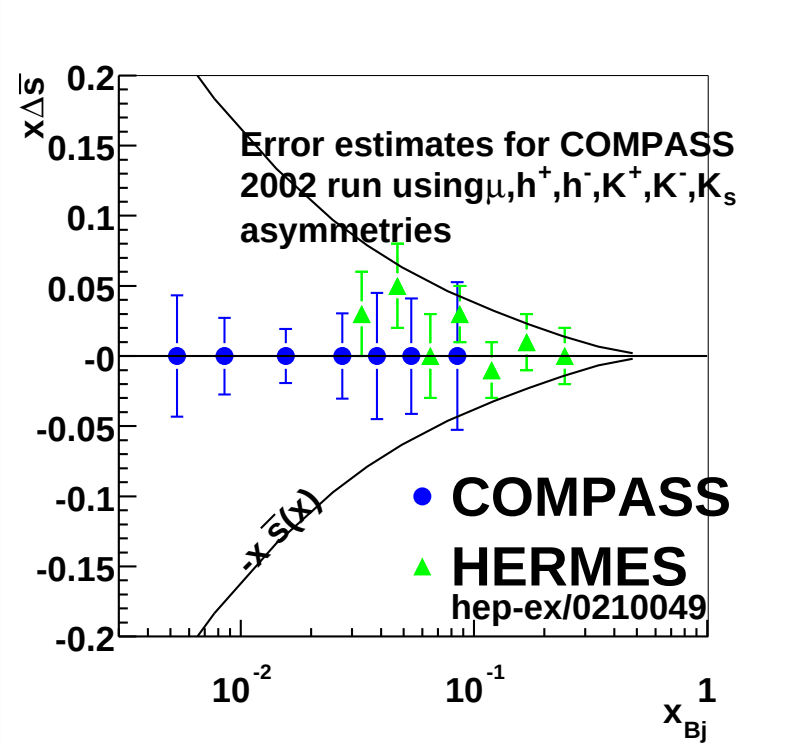

4500
4000
3500
3000
2500
2000
1500
1000
500
0
0.98
1
1.02
1.04
1.06
1.08
1.1
m.GeV
ϕ–Peak
at least one kaon identified

RICH at work

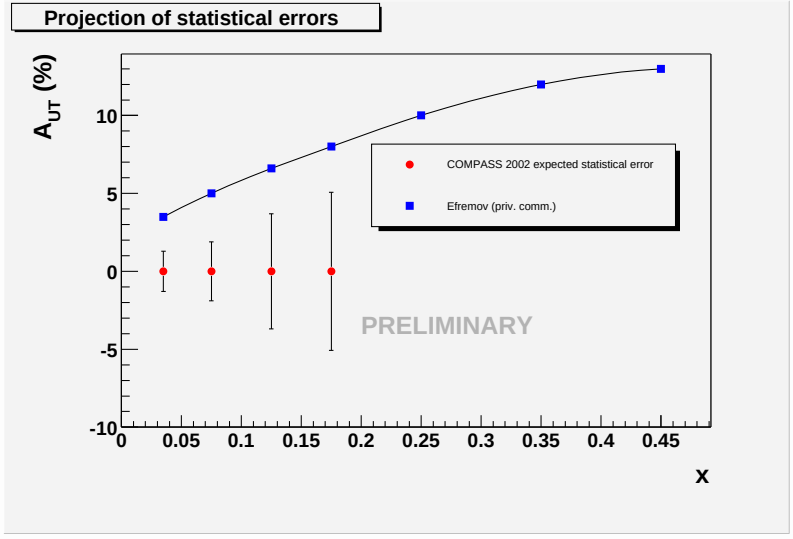

400
350
300
250
200
150
100
50
0
0.98
1
1.02
1.04
1.06
1.08
1.1
m,GeV
both kaons identified

Estimates based on 2002 data

- Δs:



- $\Delta_T q$:



- ΔG: no estimate yet

The Future

- Production of all 2002 data $\rightarrow D^0$ signal $\rightarrow \Delta G$
- 2003 run starts in May
- Another μ run 2004
- Run with hadron beam for 4 weeks in 2003 or 2004
- Projects to continue run after SPS shutdown in 2005

Tracking Detectors

- VSAT
  - Scintillating Fibers
  - Silicon

Tracking Detectors

- VSAT
  - Scintillating Fibers
  - Silicon
- SAT
  - GEM
  - MICRO MEGAS

Tracking Detectors

- VSAT
  - Scintillating Fibers
  - Silicon
- SAT
  - GEM
  - MICRO MEGAS
- LAT
  - MWPC
  - Drift chambers
  - Straws

Tracking Detectors

- VSAT
  - Scintillating Fibers
  - Silicon
- SAT
  - GEM
  - MICRO MEGAS
- LAT
  - MWPC
  - Drift chambers
  - Straws
- particle id.
  - RICH
  - ECAL/HCAL
  - μ identification