



Spin Physics from *COMPASS*

G. Mallot/CERN

On Behalf of the Compass Collaboration



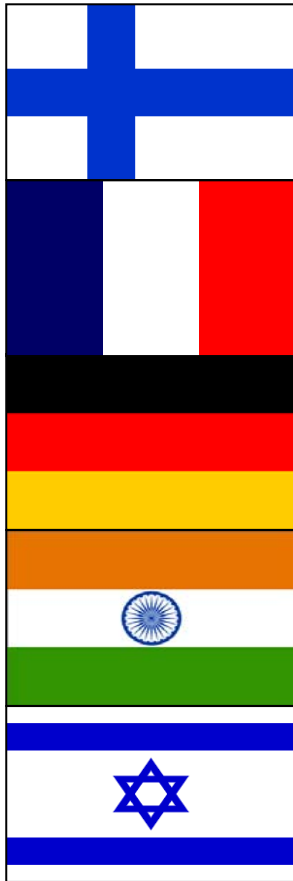
Spin 2003, Seattle 4-7 August, 2003

Contents



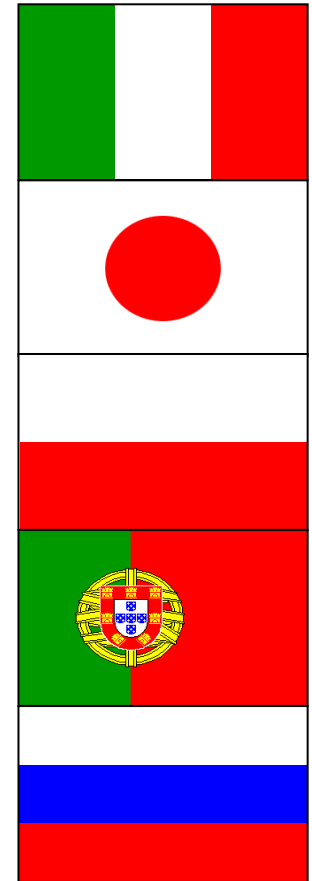
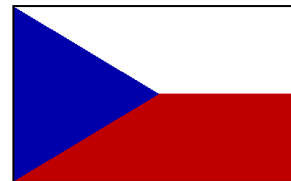
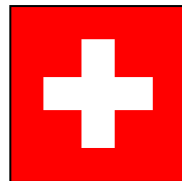
- Spectrometer and data taking 2002
- A first look at the 2002 data
 - Lambda
 - Exclusive ρ and φ , J/ψ
 - Transversity
 - Flavour separation
- Status of Δg at COMPASS
 - High- p_T hadron pairs
 - D^* signal
- Prospects

COMPASS

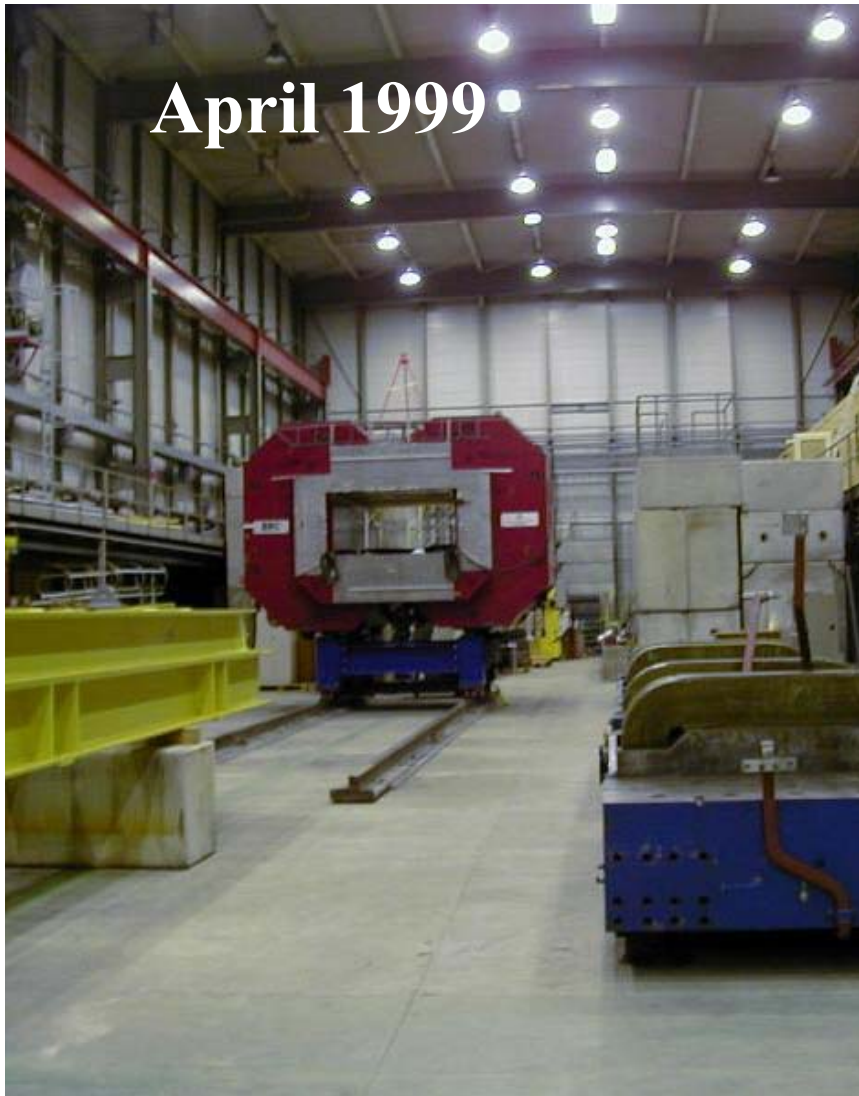


12 Countries
28 Institutes
>200 physicists

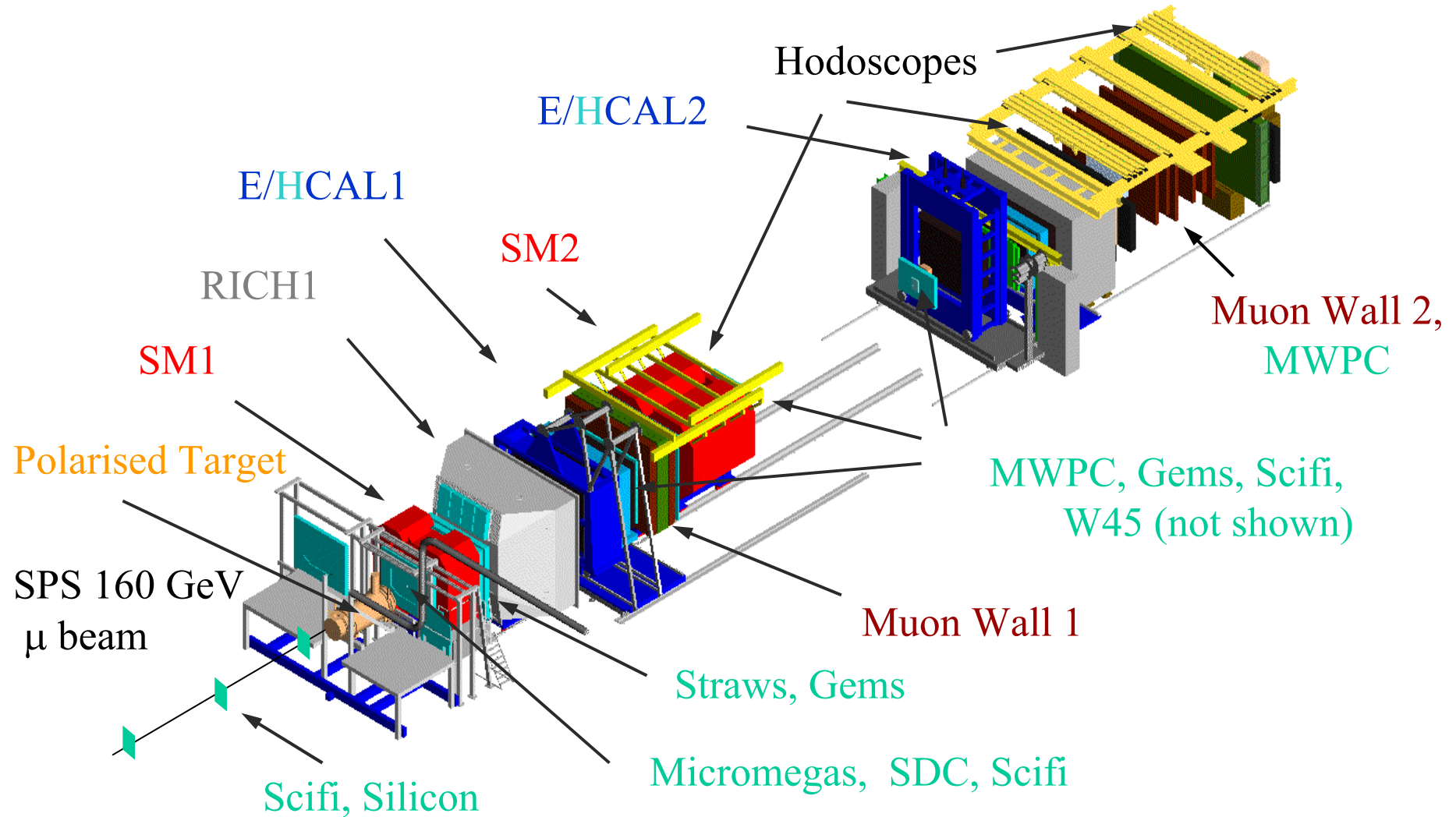
muon & hadron beam
programmes



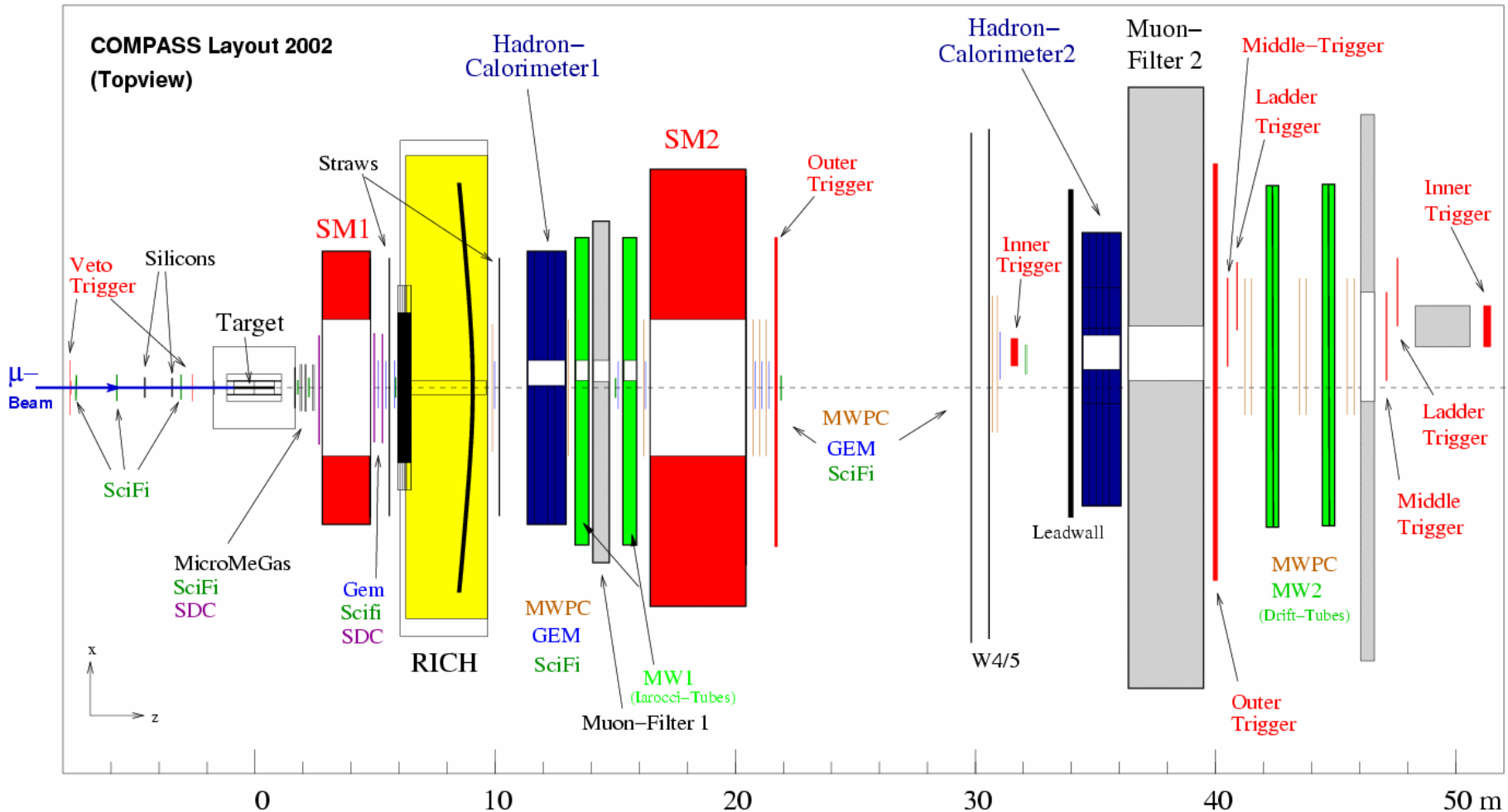
Preface



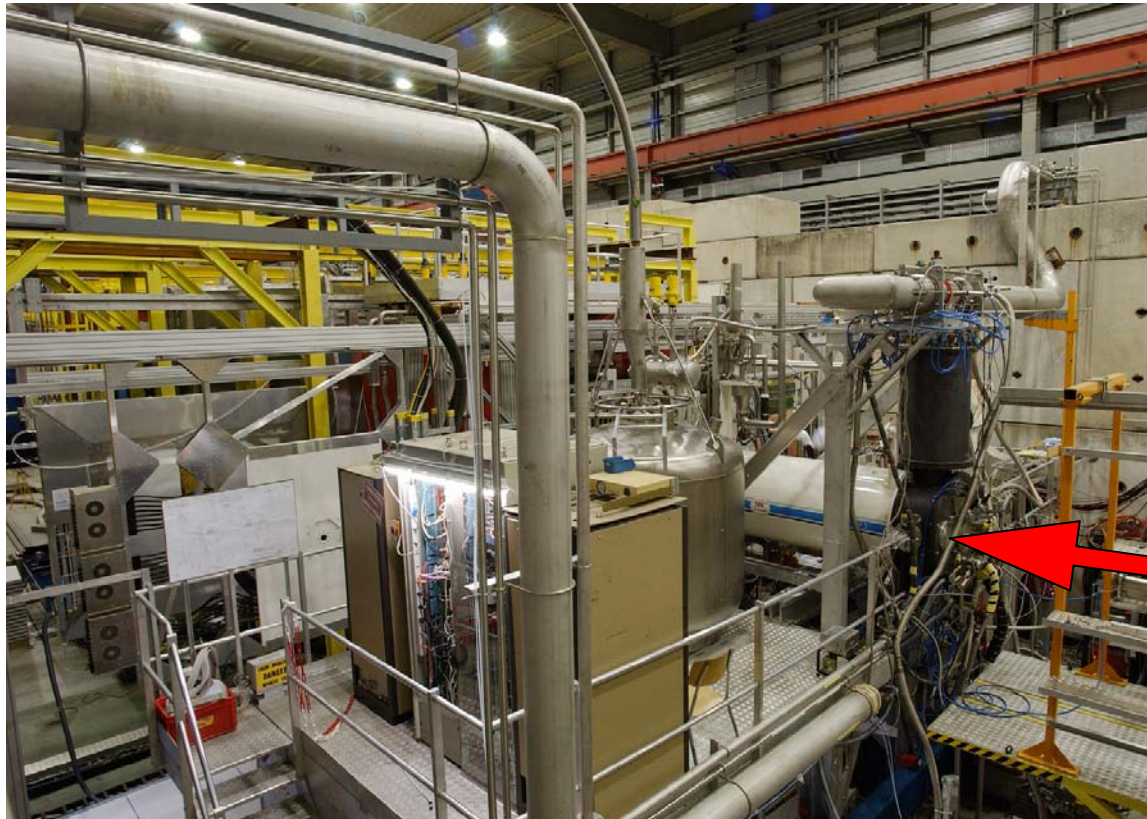
The COMPASS Spectrometer



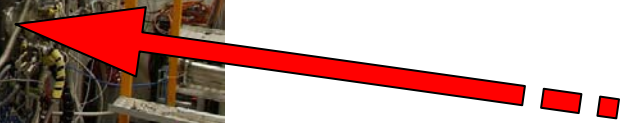
Spectrometer 2002



Polarised target

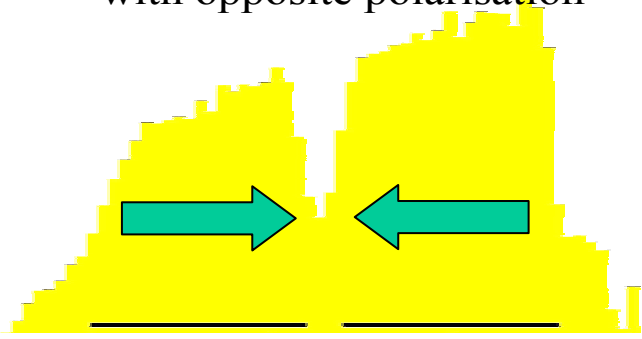
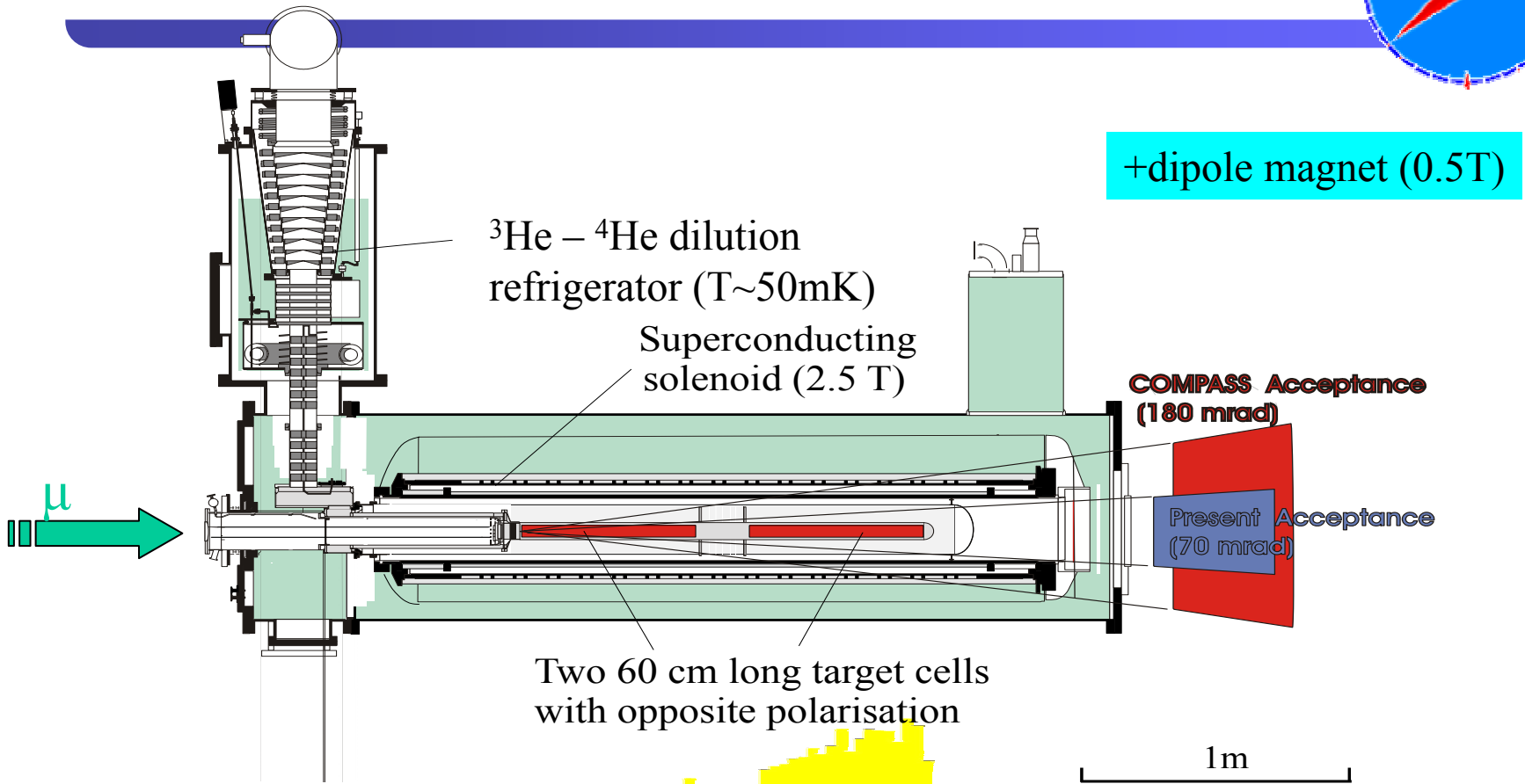


- ${}^6\text{LiD}$
- $\pm 50\%$ polarisation
- 50% dilution factor
- 2.5 T
- 50 mK



μ

Target system

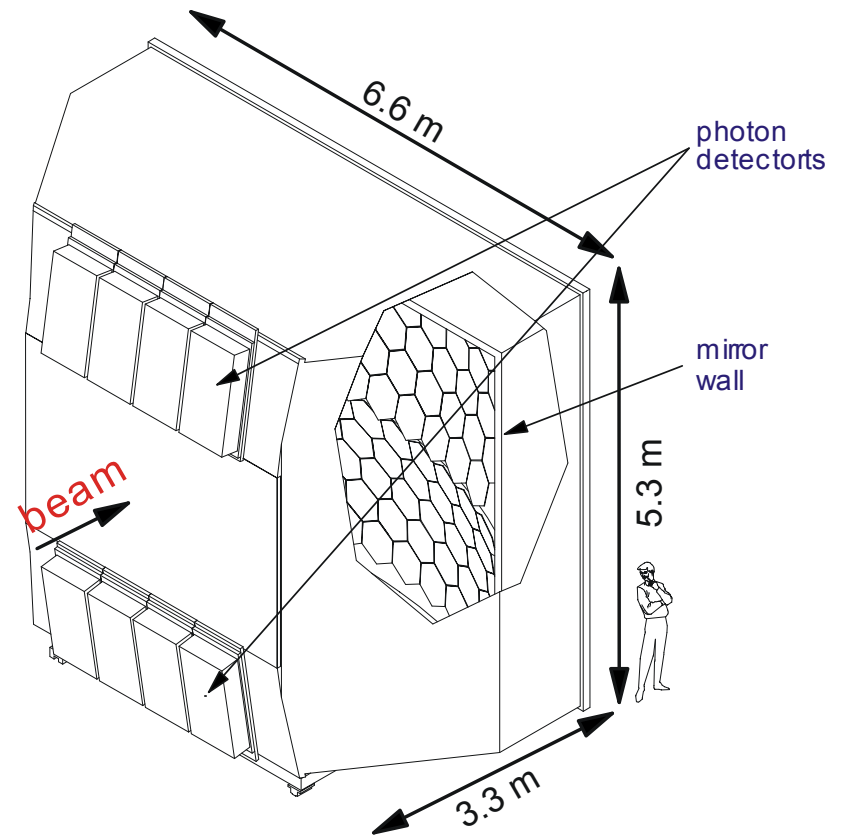


Reconstructed interaction vertices

RICH-1



- 80 m³ (3 m C₄F₁₀ radiator)
- 116 VUV mirrors
- 5.3 m² VUV detectors
 - MWPC CsI photo-sensitive cathodes
 - 8x8 mm² pads
- 84k analog r/o channels

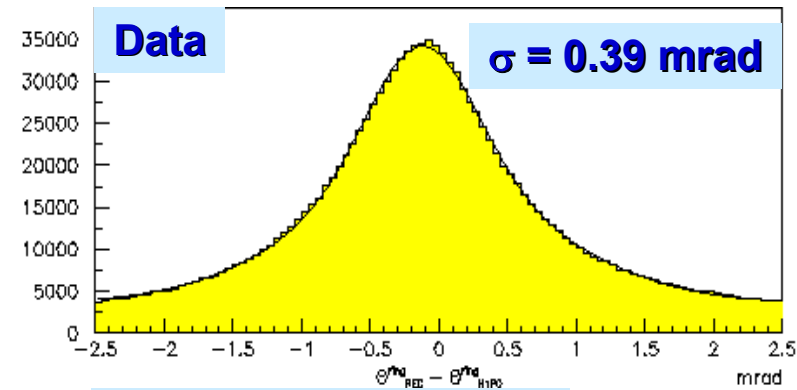
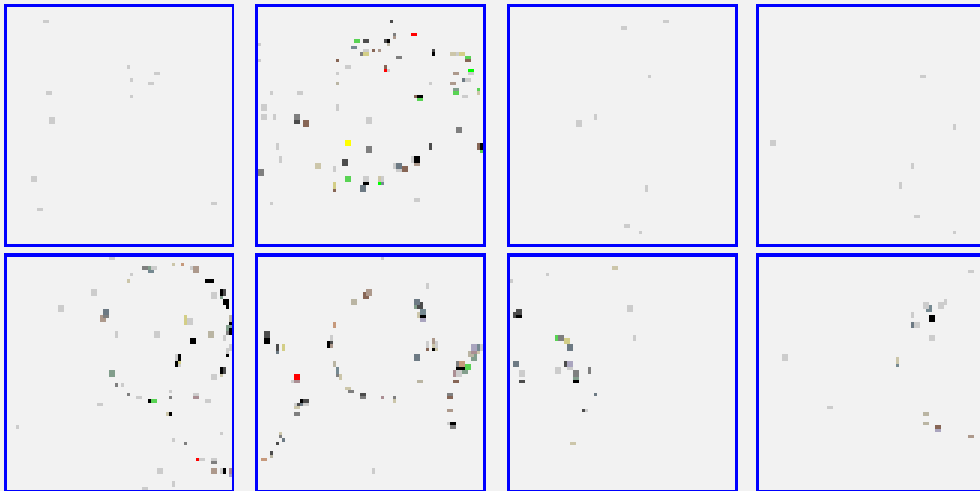


RICH-1 performance



single event, low intensity
80 % C₄ F₁₀, 2050V

Cherenkov angle for
rings with $\beta \simeq 1$



$\langle n \rangle = 15$ photons

MC:
 $\langle n \rangle = 25$ photons
 $\sigma = 0.23$ mrad

2002 Run

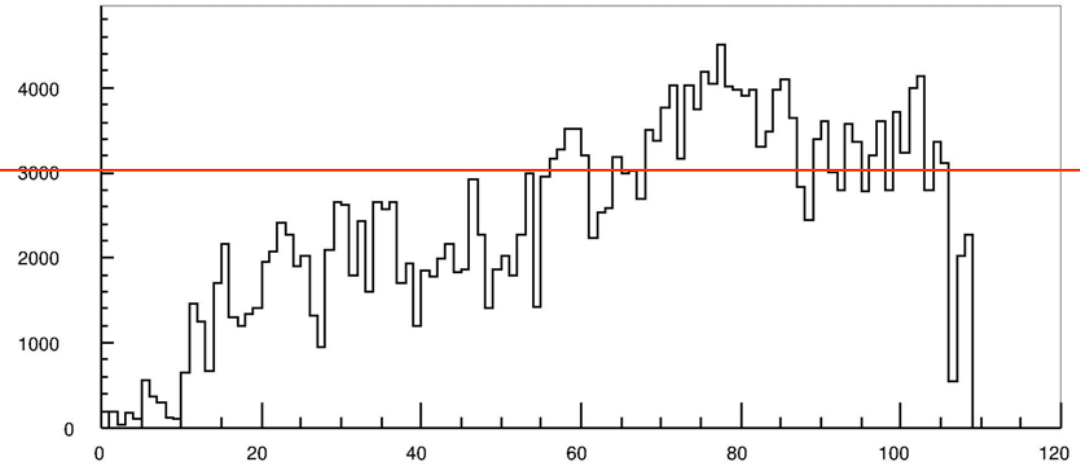


- ‘*initial spectrometer layout*’ essentially complete
- 160 GeV/c muons, $2 \cdot 10^8 \mu^+ / 4 \text{ s}$ every 16.8 s, $P_{\text{beam}} \cong 80 \%$
- ${}^6\text{LiD}$ target, $P_{\text{target}} \cong 50 \%$
- Polarisation reversal by magnet field rotation every 8 h
- 200 k readout channels, 35-40 kB/event
- data taking:
 - 24 days setup (about 2/3 of equipment new)
 - 57 days longitudinal target polarisation
 - 19 days transverse
- 5 billion events recorded, 260 TByte total

Central Data Recording

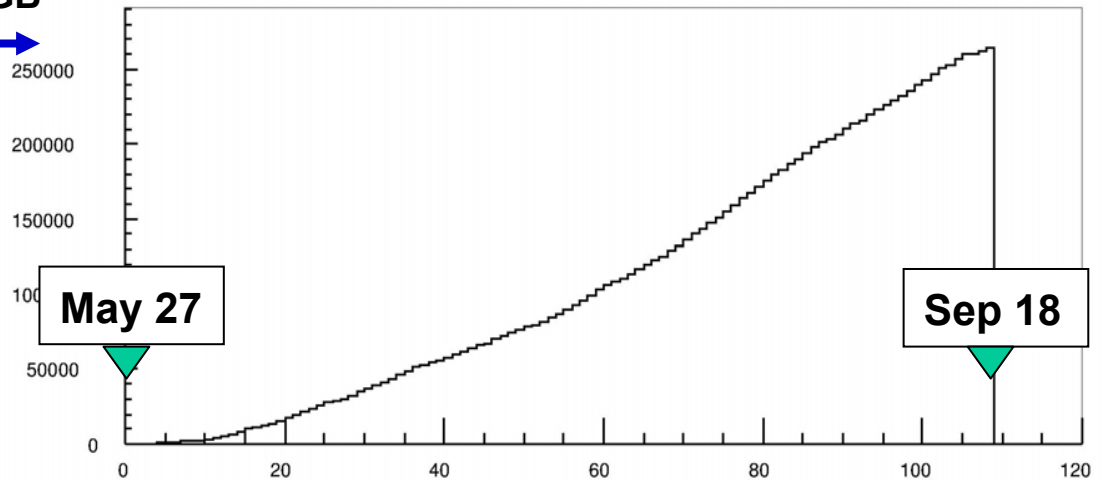


Design value: 35MB/s
3TB/day



260 TByte in ~100 days
5 billion events

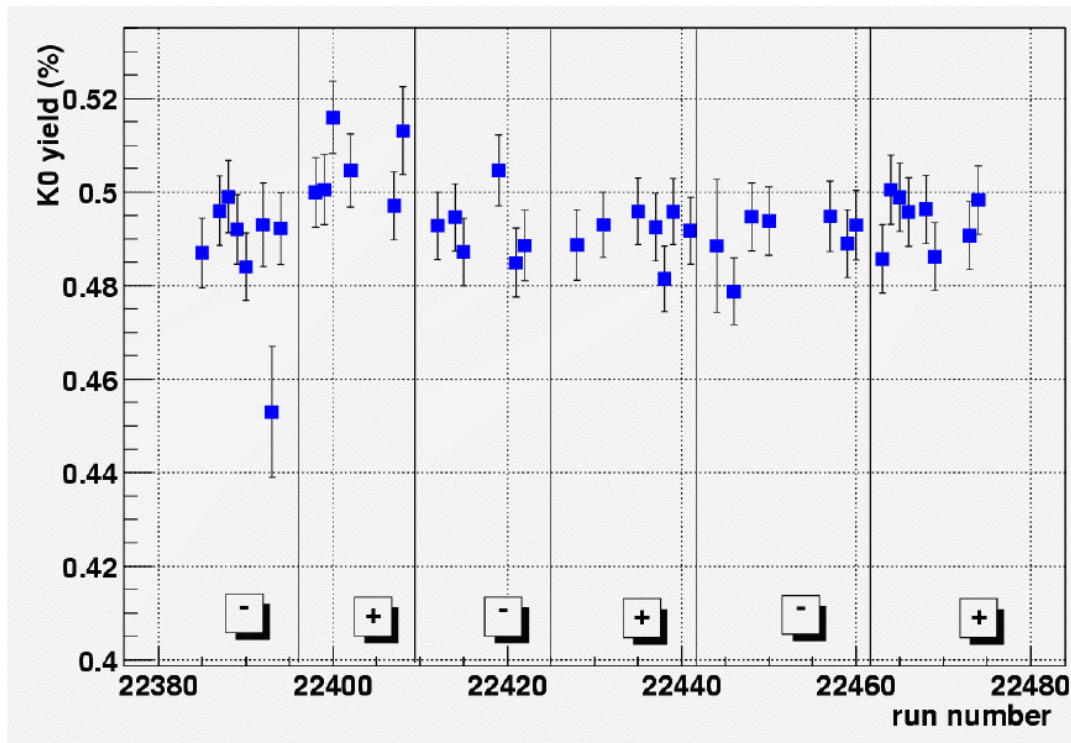
GB



Reconstruction stability



K^0 yield as function of run number



zero suppressed

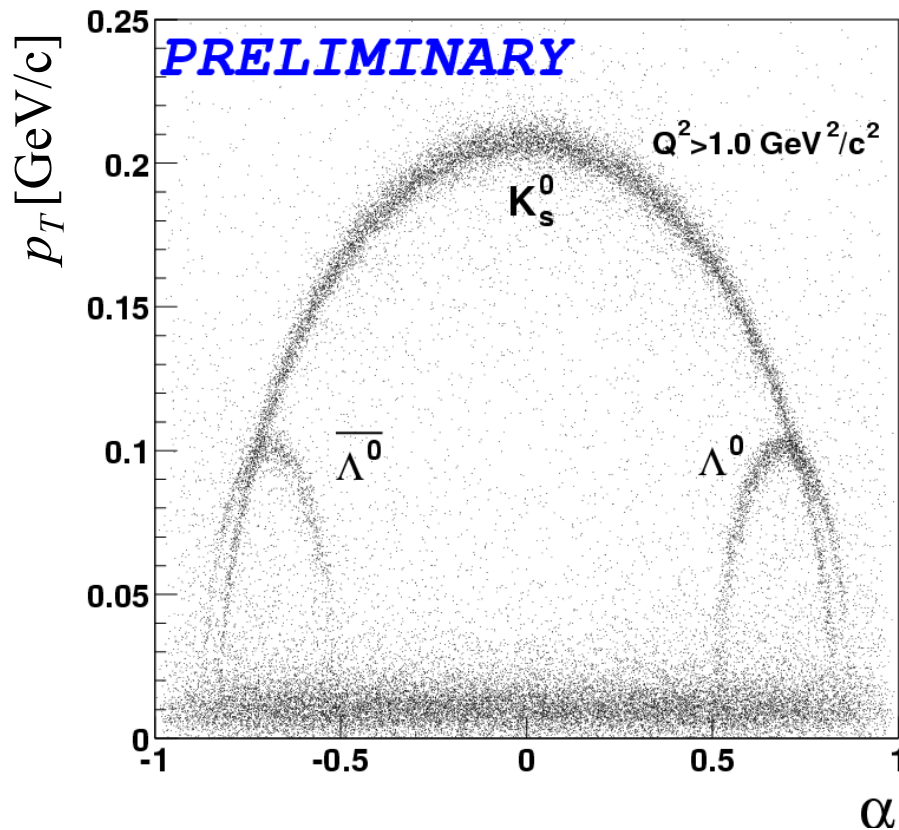
target polarisation

First Analysis Results



- Λ and $\bar{\Lambda}$ hyperon production
- Vector meson production ρ , ϕ and J/ψ
- $\Delta G/G$ from high- p_T hadron pairs
- Flavour decomposition of pol. PDF
- Transversity and Collins asymmetry

Lambda production



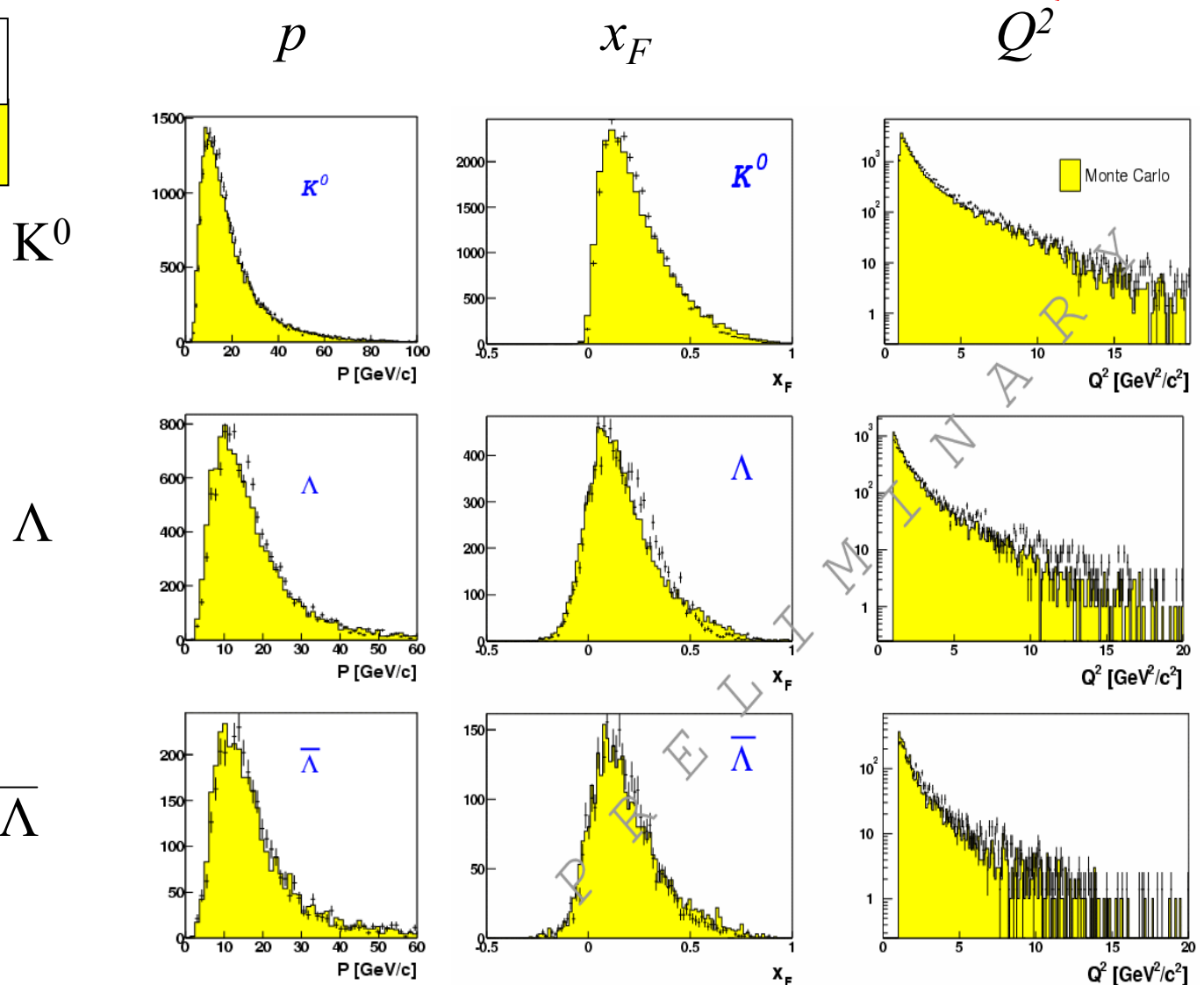
Armenteros-Podolanski

$$\alpha = \frac{P_L^+ - P_L^-}{P_L^+ + P_L^-}$$

Lambda data vs MC



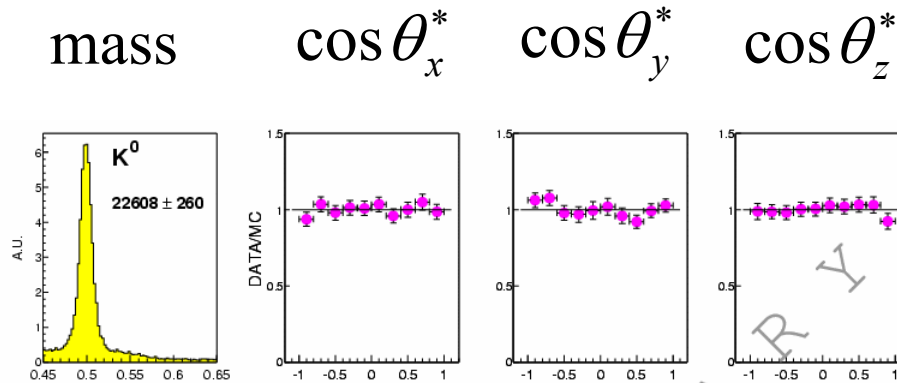
Data
Monte Carlo



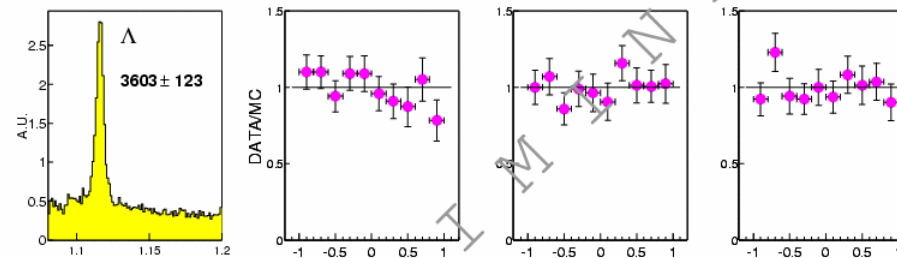
Lambda polarization?



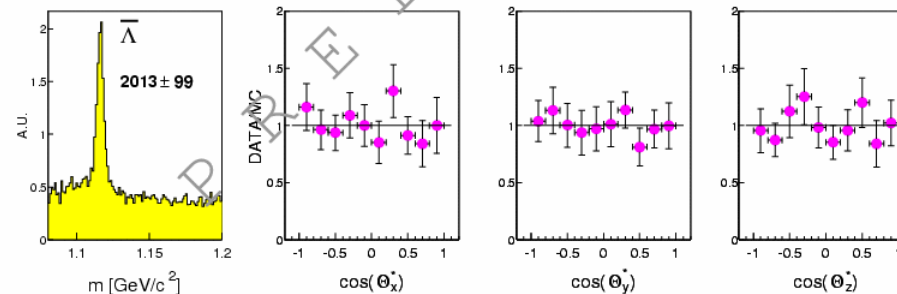
K^0



Λ



$\bar{\Lambda}$



1/6 of 2002
Statistics

$$Q^2 > 1 \text{ GeV}^2$$

$$0.2 < y < 0.9$$

good potential
for polarisation
measurement

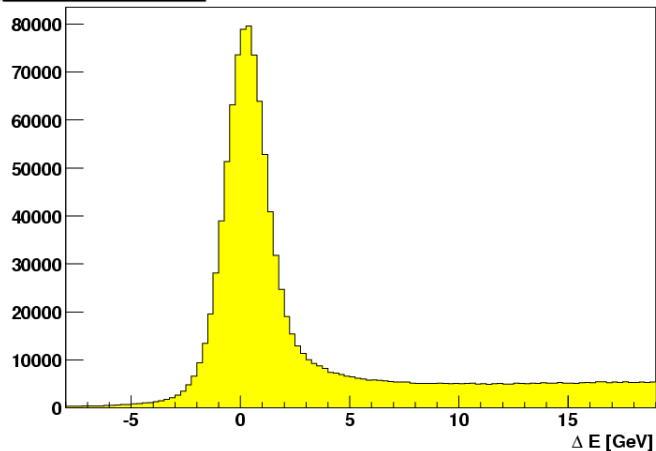
Exclusive ρ and ϕ production



E. Burtin, GPD session-1

meson	mass cut	statistics (1/6 of 2002)
ρ^0	$0.5 < m_{\pi\pi} < 1 \text{ GeV}$	$1.3 \cdot 10^6$
ϕ	$ m_{KK} - m_\phi < 9 \text{ MeV}$	$42 \cdot 10^3$

Missing Energy

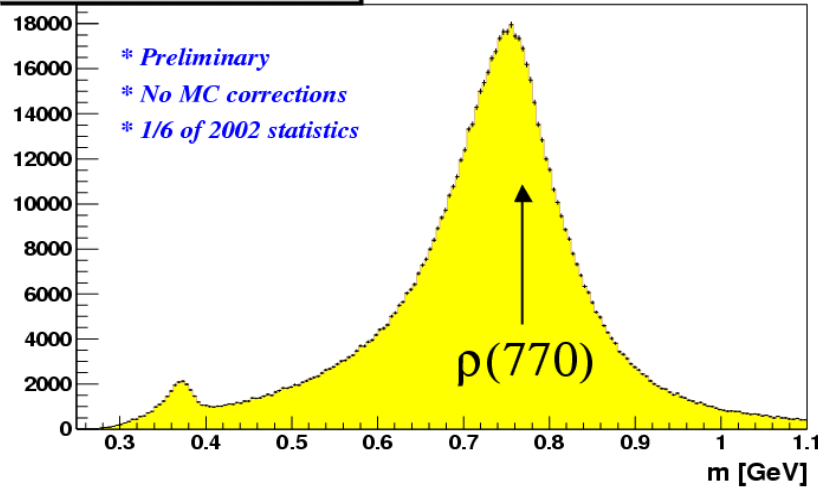


- $|t'| < 0.5 \text{ GeV}^2$
- $7.5 < W < 16 \text{ GeV}$
- $Q^2 > 10^{-3} \text{ GeV}^2$

Invariant masses

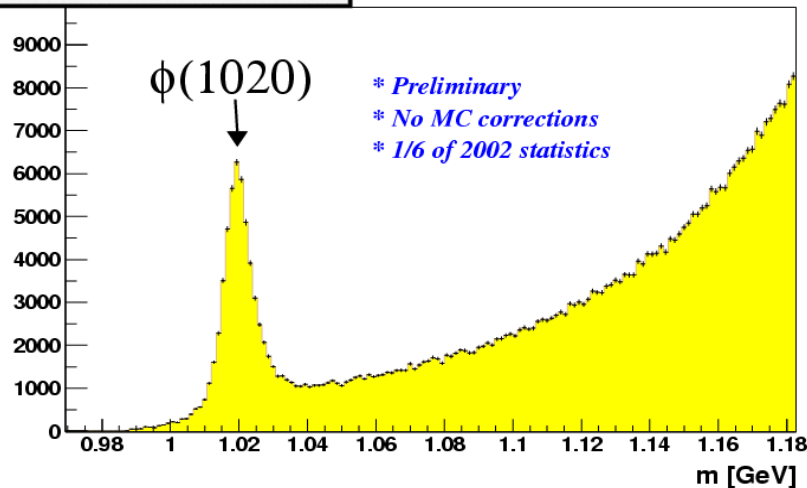


$\pi^+\pi^-$ invariant mass



- 16 % of total 2002 statistics
- no MC corrections yet

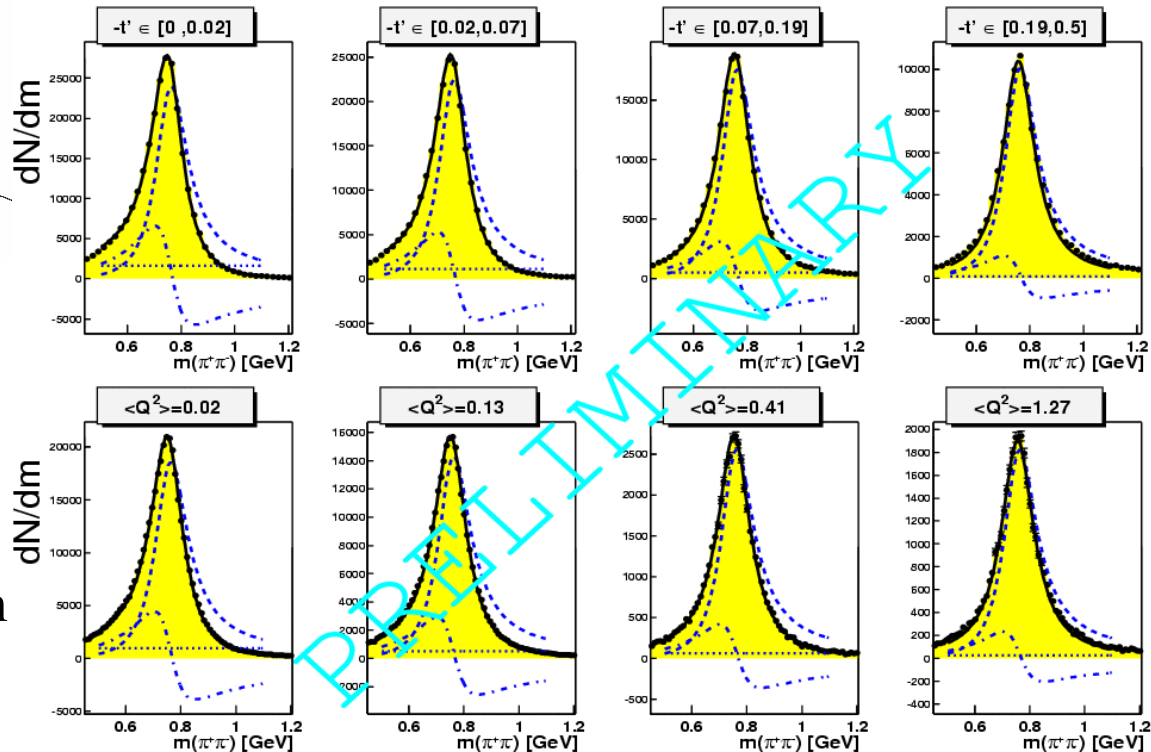
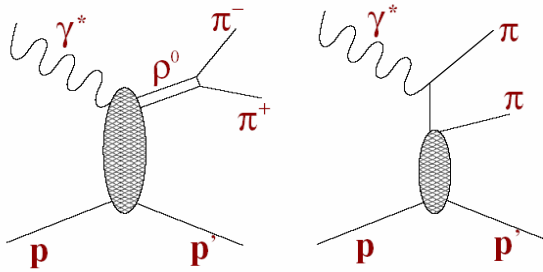
K^+K^- invariant mass.



Interference of ρ^0 and $\pi\pi$



E. Burtin, GPD session-1



$-t'$

$\langle Q^2 \rangle$

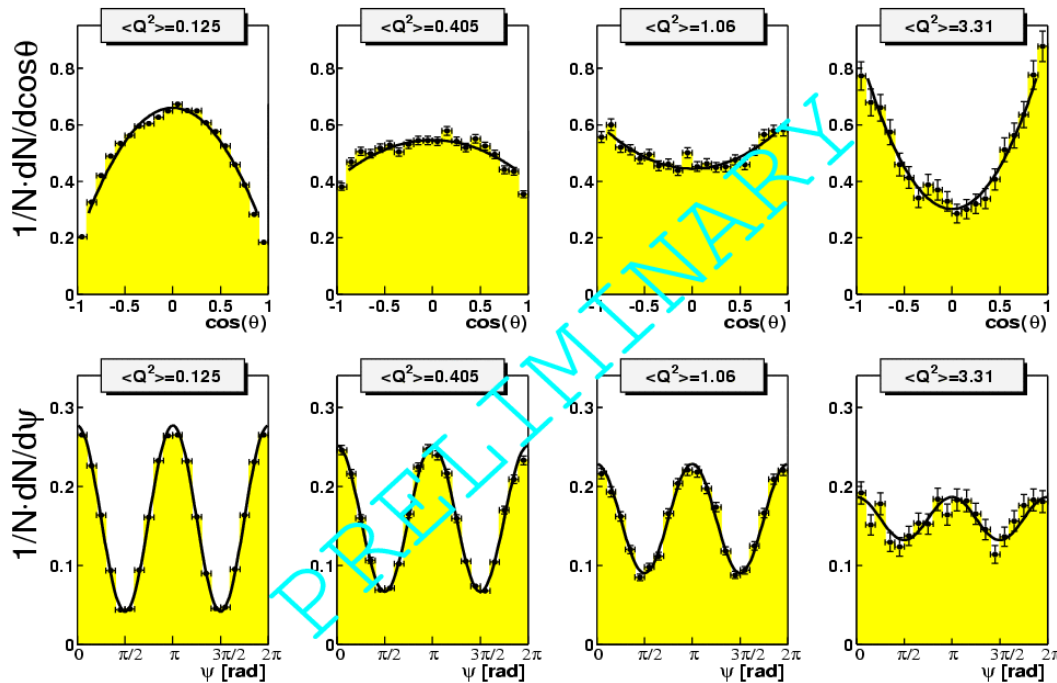
- Söding parametrization
- No accept. corr.

$Q^2, -t'$

Angular distributions

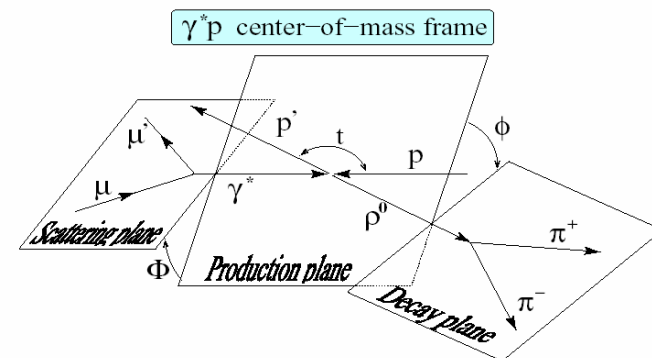


E. Burtin, GPD session-1



$p_T > 0.15 \text{ GeV}$

$Q^2 > 0.05 \text{ GeV}^2$

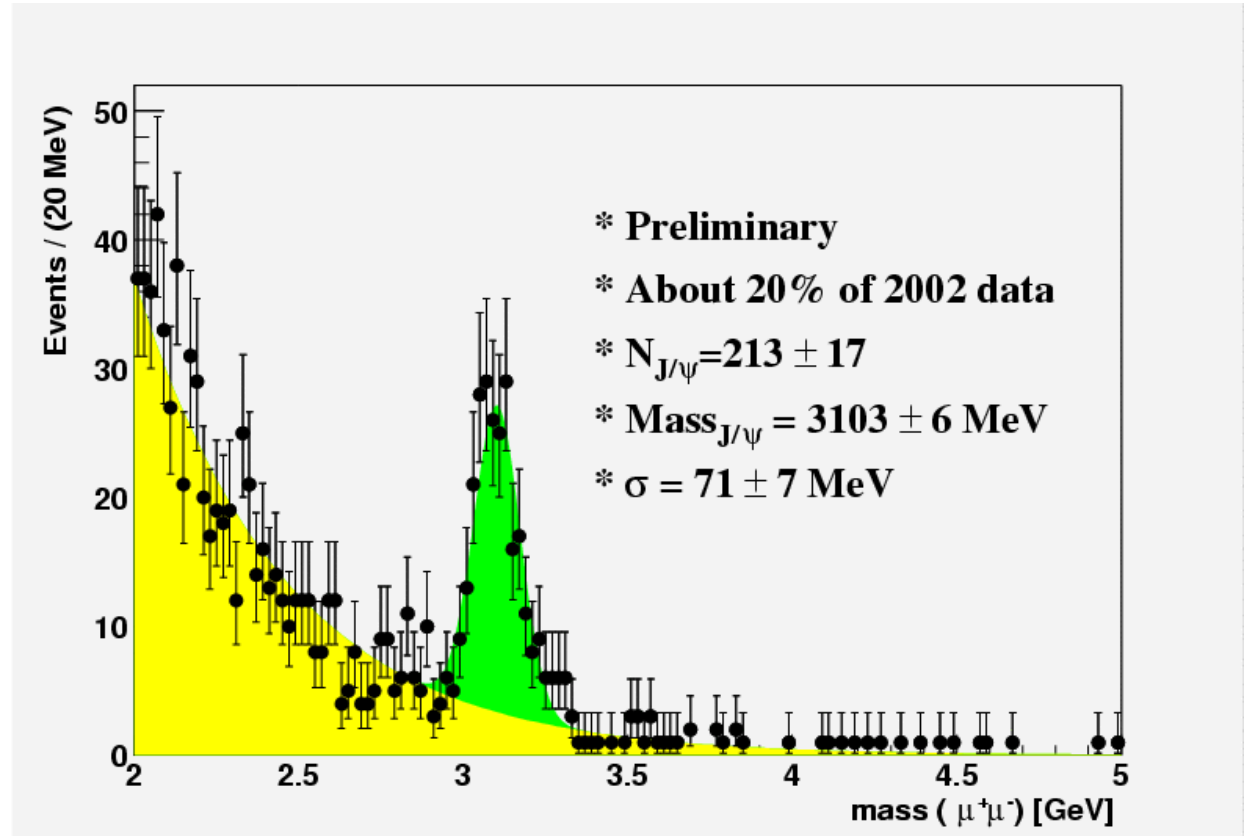


J/ψ production



$$J/\psi \Rightarrow \mu^+ \mu^-$$

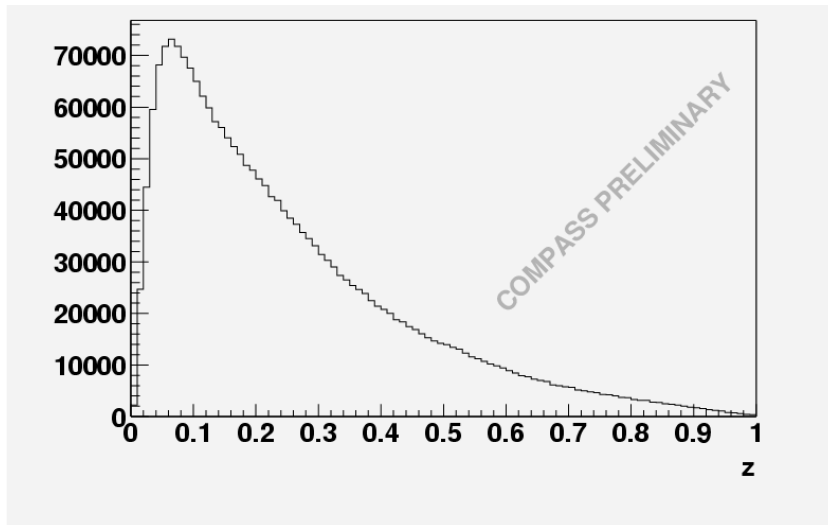
- First look
- mainly elastic



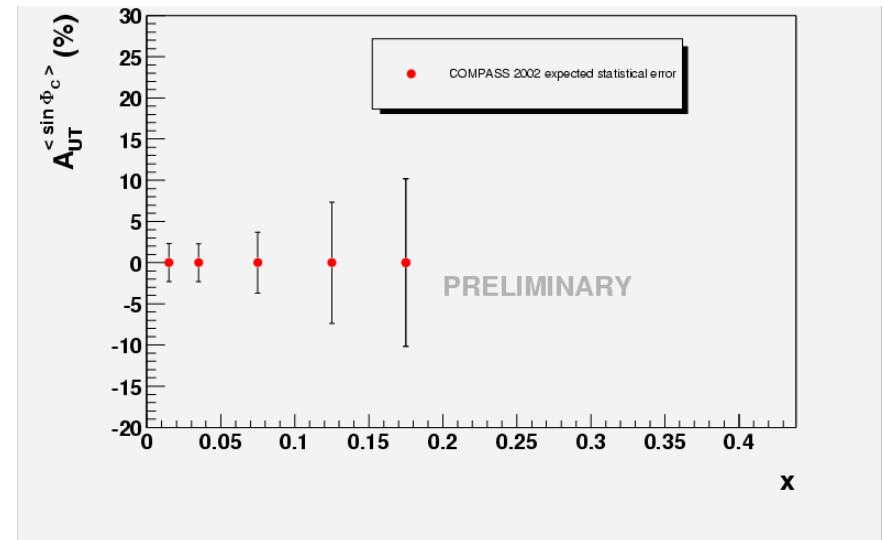
Collins asymmetry



Z-distribution of leading hadron

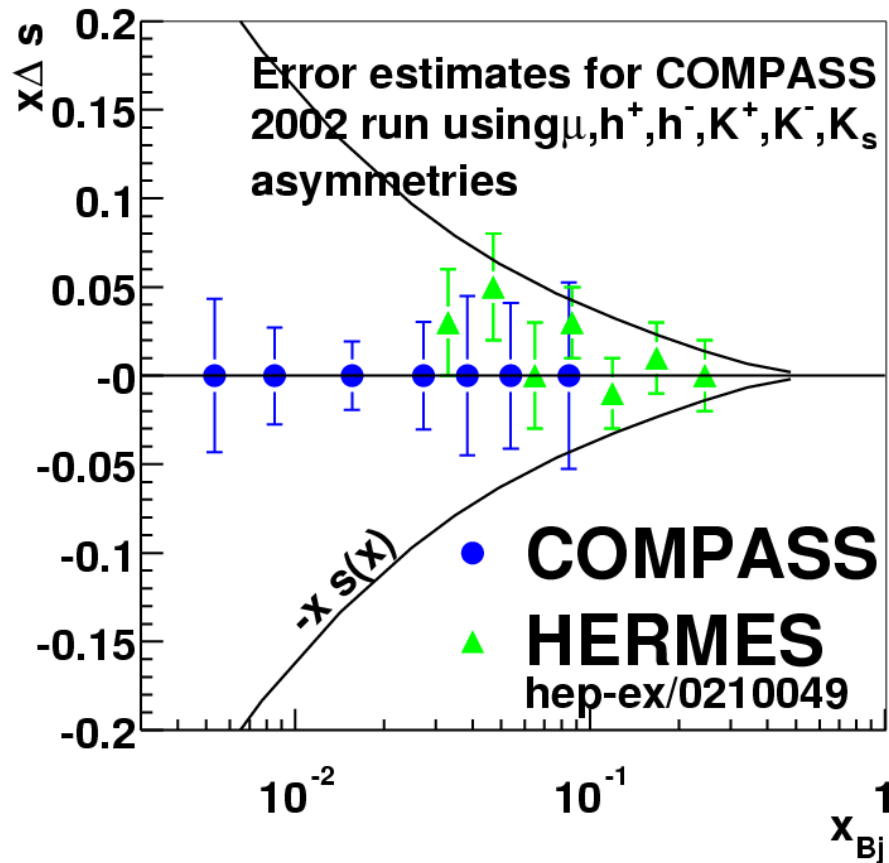


the Collins asymmetry A_{UT} for positive leading hadron



Estimated error from 2002 data, extrapolated from analysed sample

Flavour separation Δq

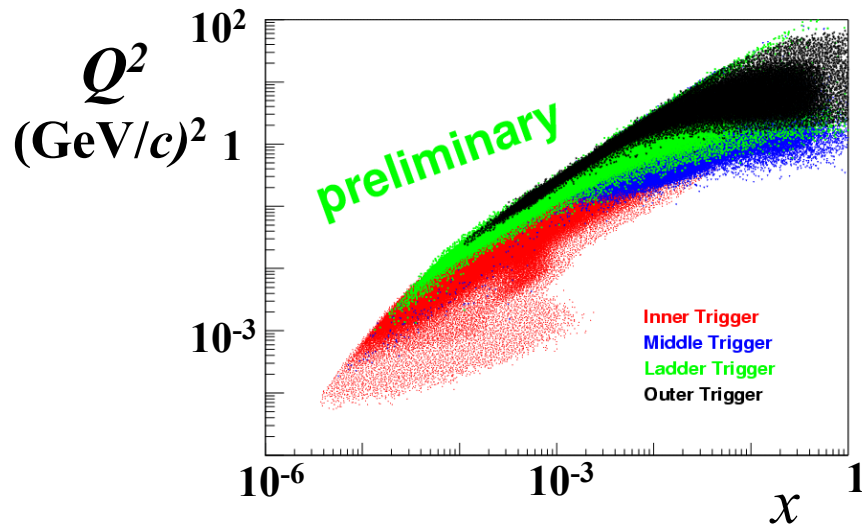


Looks very promising in particular for Δs !

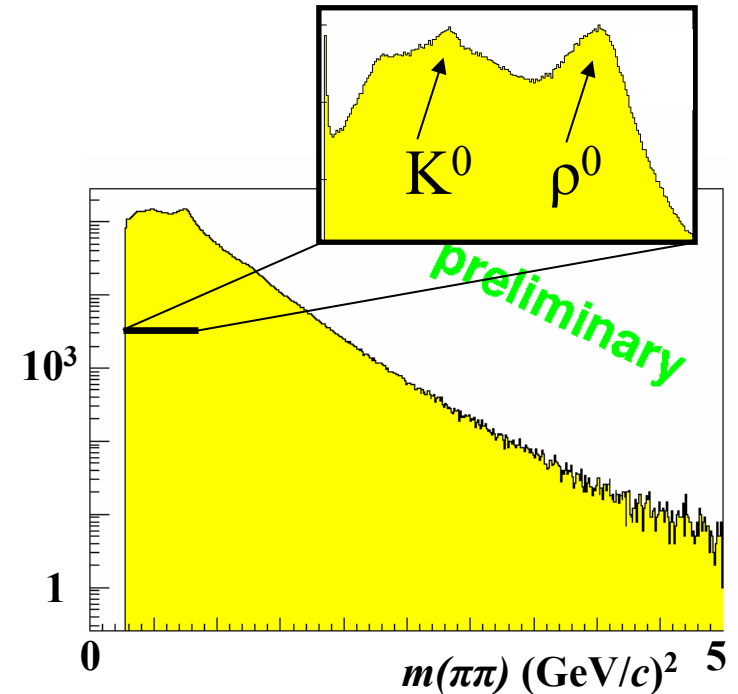
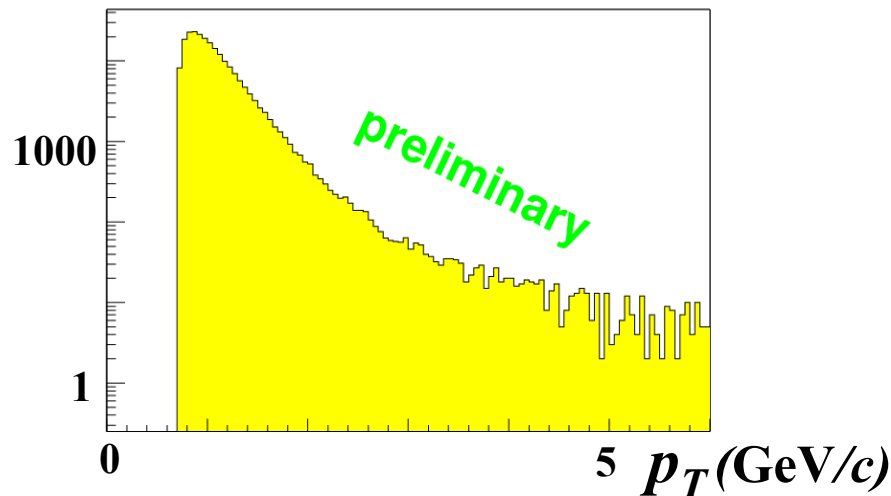
Can the first moment of Δs be **positive**?

Low- x data **essential**!

Δg : high- p_T hadron pairs *COMPASS*



- $\mu, \mu' + 2$ hadrons
- in plots only 5% of 2002 data



High- p_T hadron pairs



- for $\Delta G/G$ analysis we'll use
 - $0.4 < y < 0.9, x_F > 0.1$
 - $p_{T,1}^2 + p_{T,2}^2 > 2.5 \text{ (GeV}/c)^2$ ($p_{T,i} > 1.1 \text{ GeV}/c$)
- extrapolated to full 2002 statistics
 - $Q^2 > 1 \text{ GeV}^2$: 18000 events
 - all Q^2 : 160000 events

from 2002 data: $\delta(\Delta G/G) \cong 0.31$; $Q^2 > 1 \text{ GeV}^2$
 $\cong 0.1$; all Q^2

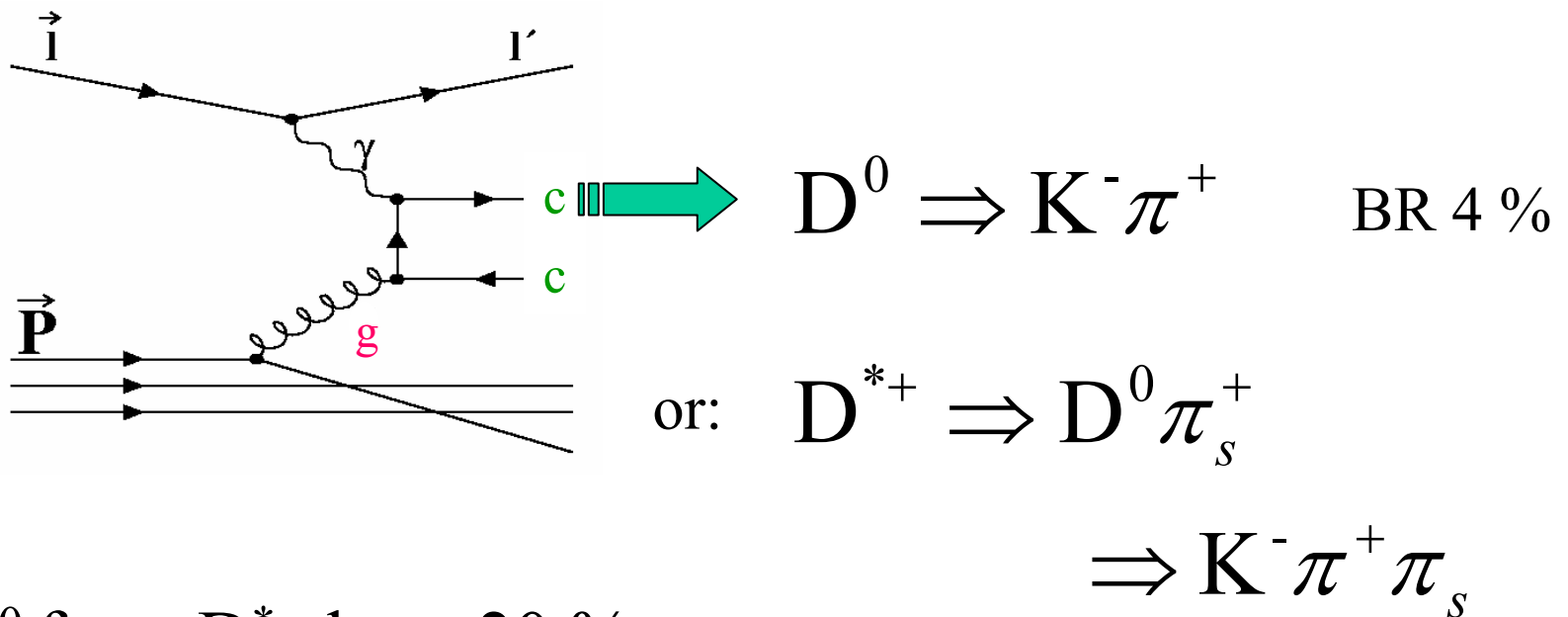
Can data with $Q^2 < 1 \text{ GeV}^2$ be interpreted (resolved photon)?

note: 2002 data correspond about to Hermes 1996-2000, Hermes used all data

Open charm



- Photon-gluon fusion: 1.2 D^0 per PGF $c\bar{c}$ event



D^0 from D^* about 20 %

Open charm, cuts



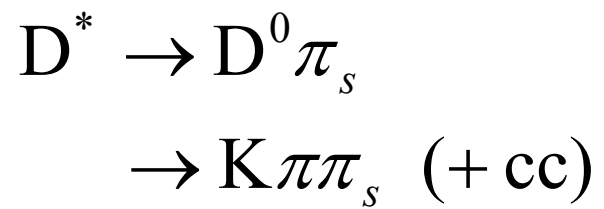
- most of 2002 data, prel. RICH and tracking
- $z_D > 0.2$ (background reduction)
- $|\cos(\theta^*)| < 0.85$ (background reduction)
- $10 < p_K < 35 \text{ GeV}/c$ (Rich πK sep.)
- define:

$$\Delta M_{K\pi\pi} = M_{K\pi\pi_s} - (M_{K\pi} + M_{\pi_s})$$

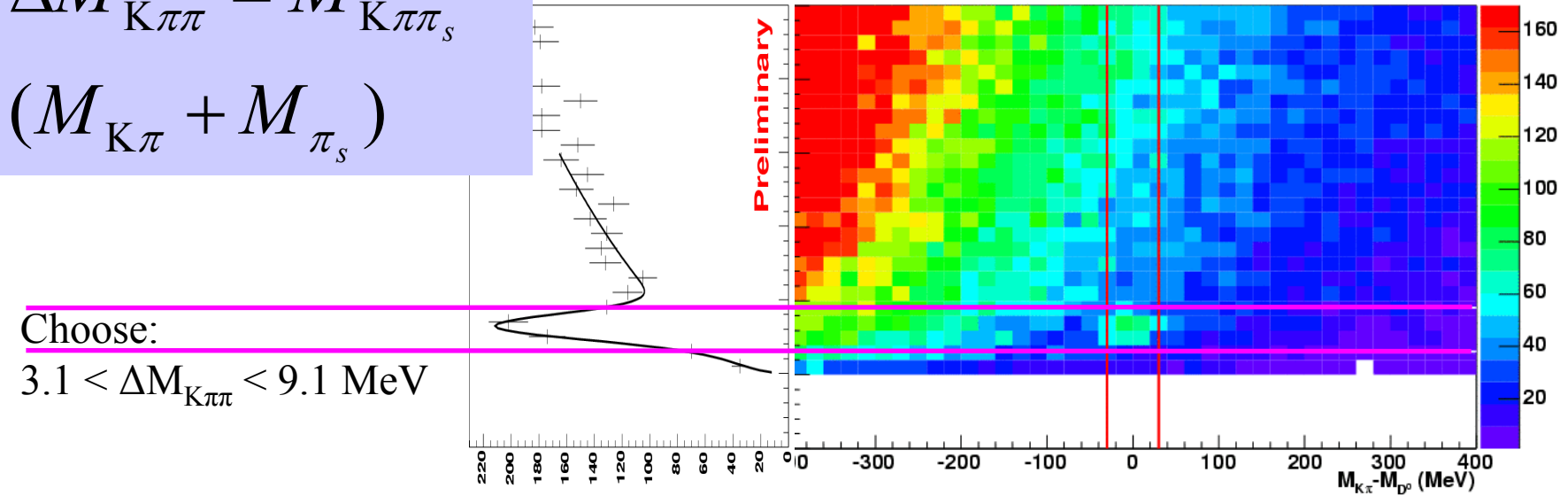
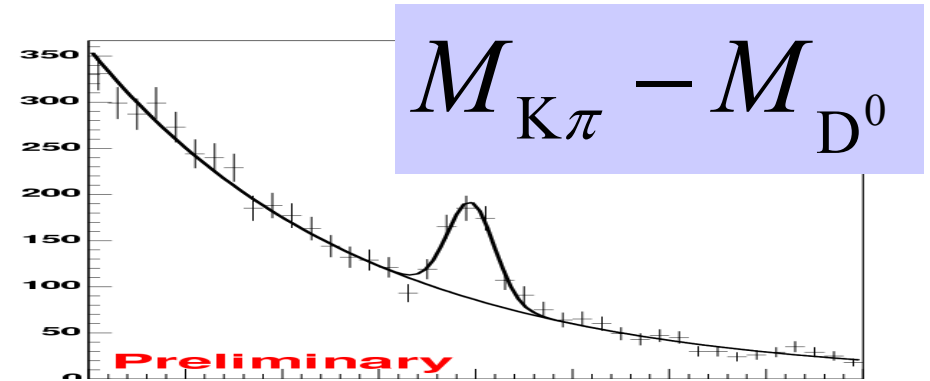
$$M(D^*) - [M(D^0) + M(\pi)]$$



$D^{*+} \rightarrow D^0 \pi_s^+$ tagging

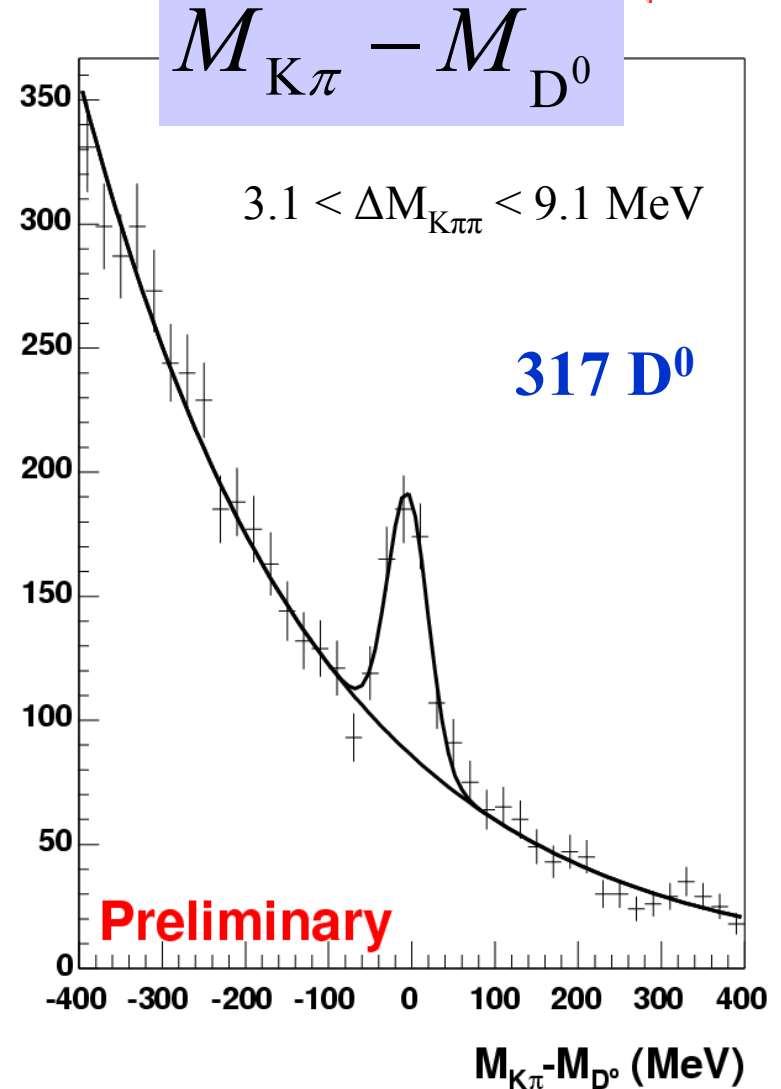
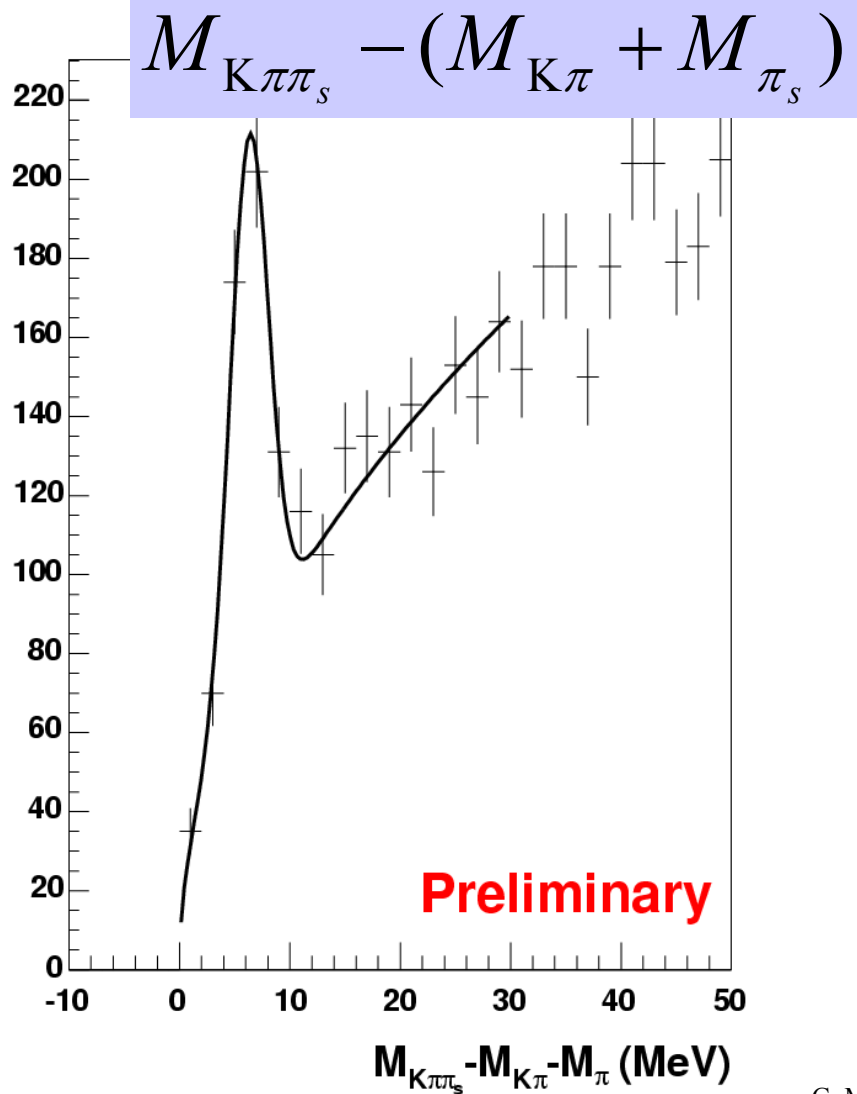


$$\Delta M_{K\pi\pi} = M_{K\pi\pi_s} - (M_{K\pi} + M_{\pi_s})$$



Choose:
 $3.1 < \Delta M_{K\pi\pi} < 9.1 \text{ MeV}$

$D^{*+} \rightarrow D^0 \pi_s^+$ tagging



Outlook



- 2003 muon run, poor beam up to now
- 2004 long SPS run of 150 days (?)
 - muon plus 4 week hadron pilot run (?)
 - new target magnet with larger acceptance (?)
- 2005 CERN accelerator shutdown
- 2006 – 2010
 - request in preparation
 - CERN council: **COMPASS should continue in 2006**
- more hardware to come: ECAL (π^0), RICH, DAQ,...

Summary



- COMPASS is up and running
- Lots of high statistics data to come
- First glance at open charm PGF with polarised target and beam
- Good perspectives for ΔG from high- p_T hadron pairs (π, K)
- Promising perspectives for running after 2005 and with LHC.