



Prospects for $\Delta G/G$ in COMPASS

- Compass Physics objectives
- Experiment layout
- 2002 data: status of analysis
- Prospects for $\Delta G/G$



Spin structure of the nucleon

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

EMC, SMC, SLAC, HERMES : $\Delta\Sigma_q \approx \mathbf{0.3 \pm 0.1}$

• How is the rest of the nucleon spin (0.35) shared between ΔG and orbital momentum?

• Or $\Delta\Sigma_q \neq 0.3$ (asymmetry $\rightarrow \Delta\Sigma_q - \frac{3\alpha_s}{2\pi} \Delta G$)

→ Measure ΔG (Photon gluon fusion)
 $L_q + L_g$ (Generalized Parton Distributions)



Physics at COMPASS

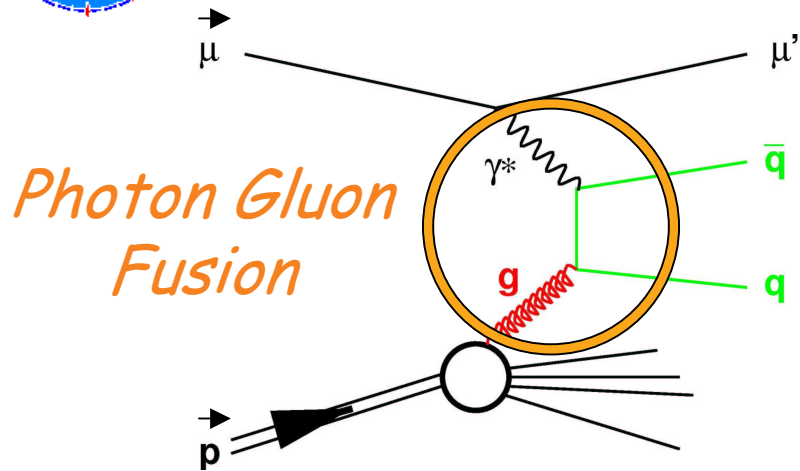
*Common Muon and Proton Apparatus for
Structure and Spectroscopy*

Nucleon Spin Structure:

- Gluon polarization $\Delta G(\eta_G)/G$
- Polarised flavour dependent parton distributions $\Delta q(x)$
- Λ Polarization (ΔD^{Λ}_q)
- Transverse-spin distribution functions $\Delta_T q(x)$



Determination of $\Delta G/G$



E161: $\gamma g \rightarrow c\bar{c}$

any D or $\Lambda_C \rightarrow$ high $p_T \mu$

*RHIC: e.g. $qg \rightarrow \gamma q$
prompt photon + jet*

Compass: $\gamma^ g \rightarrow q\bar{q}$*

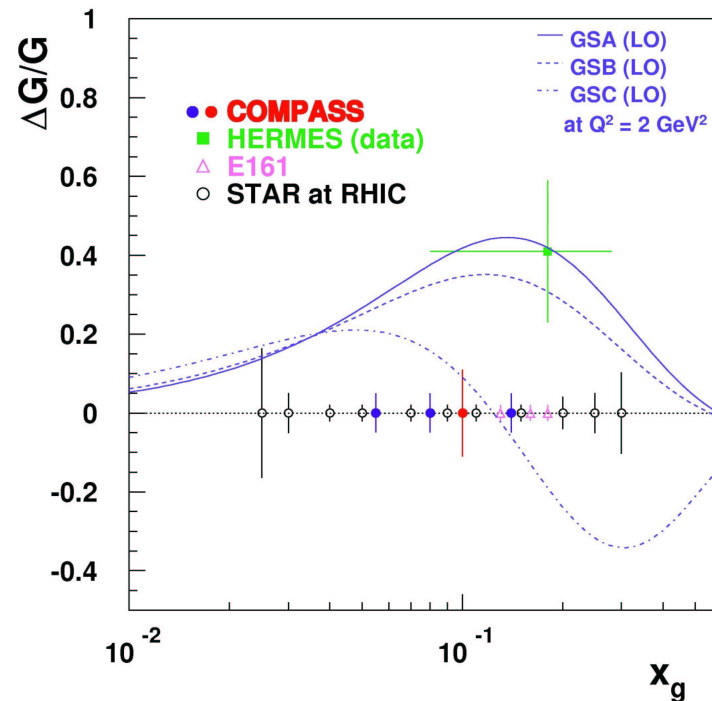
• $q=c$: Open charm production

$D^0(\bar{D}^0) \rightarrow K^-\pi^+(K^+\pi^-)$

$D^* \rightarrow D^0\pi_s$

• $q=u,d,s$: high p_T pairs

$p_T \geq 1 \text{ Gev} / c$



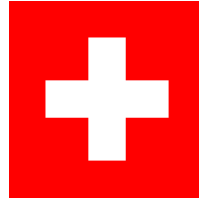


COMPASS Collaboration

More than 220 physicists from 30 Institutes



Дубна (LPP and LNP),
Москва (INR, LPI,
State University),
Протвино

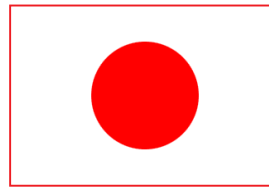


CERN

Bielefeld, Bochum,
Bonn (ISKP & PI),
Erlangen, Freiburg,
Heidelberg, Mainz,
München (LMU & TU)



Warsawa (SINS),
Warsawa (TU)



Nagoya

Helsinki

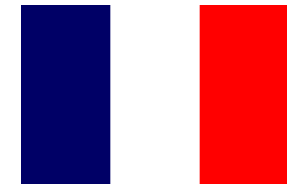


Praha



Lisboa

Saclay

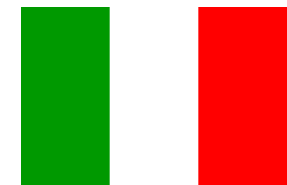


Burdwan,
Calcutta



Tel Aviv

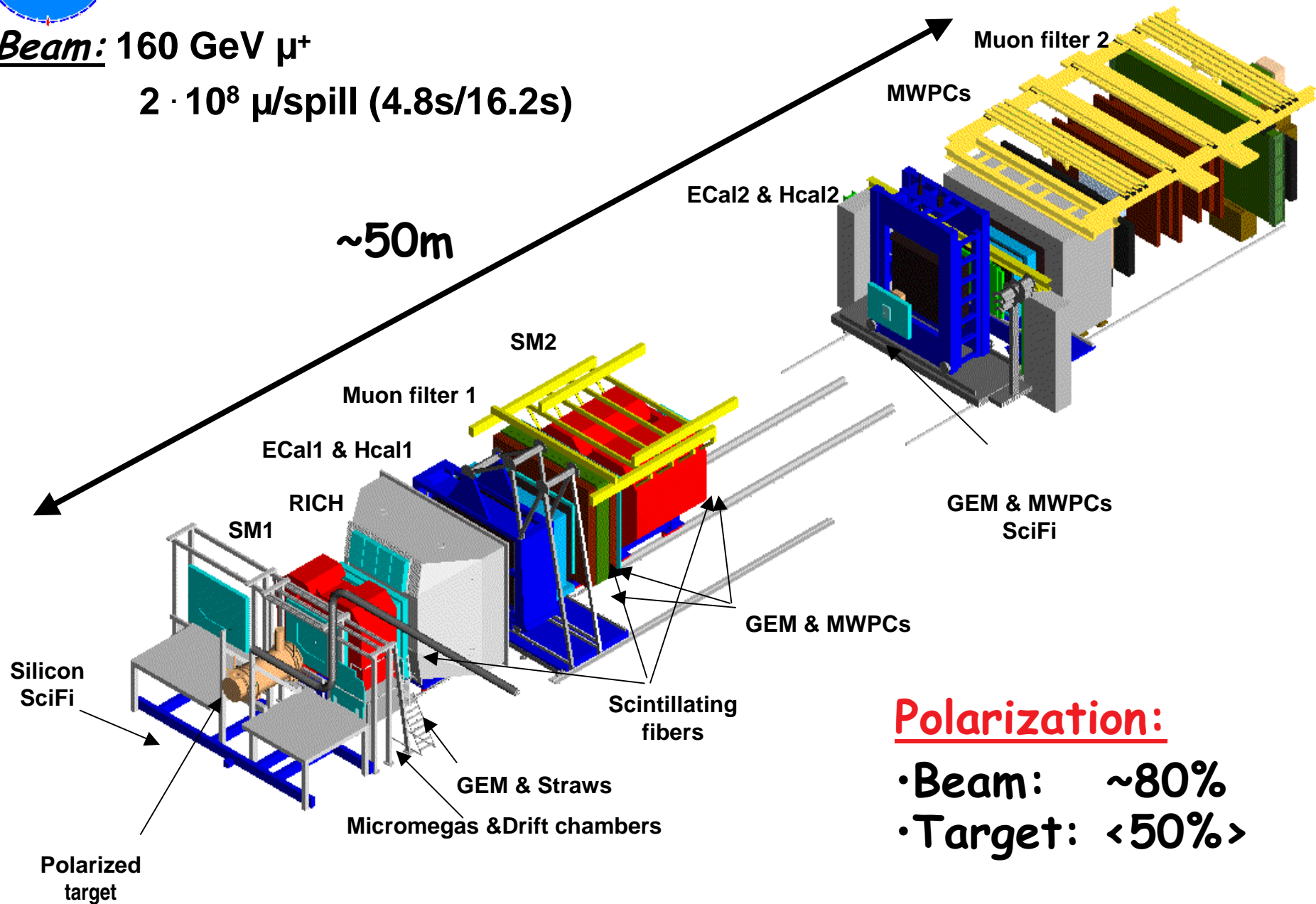
Torino
(University, INFN),
Trieste
(University, INFN)





COMPASS spectrometer

Beam: 160 GeV μ^+
 $2 \cdot 10^8$ μ /spill (4.8s/16.2s)



Polarization:

- Beam: ~80%
- Target: <50%>



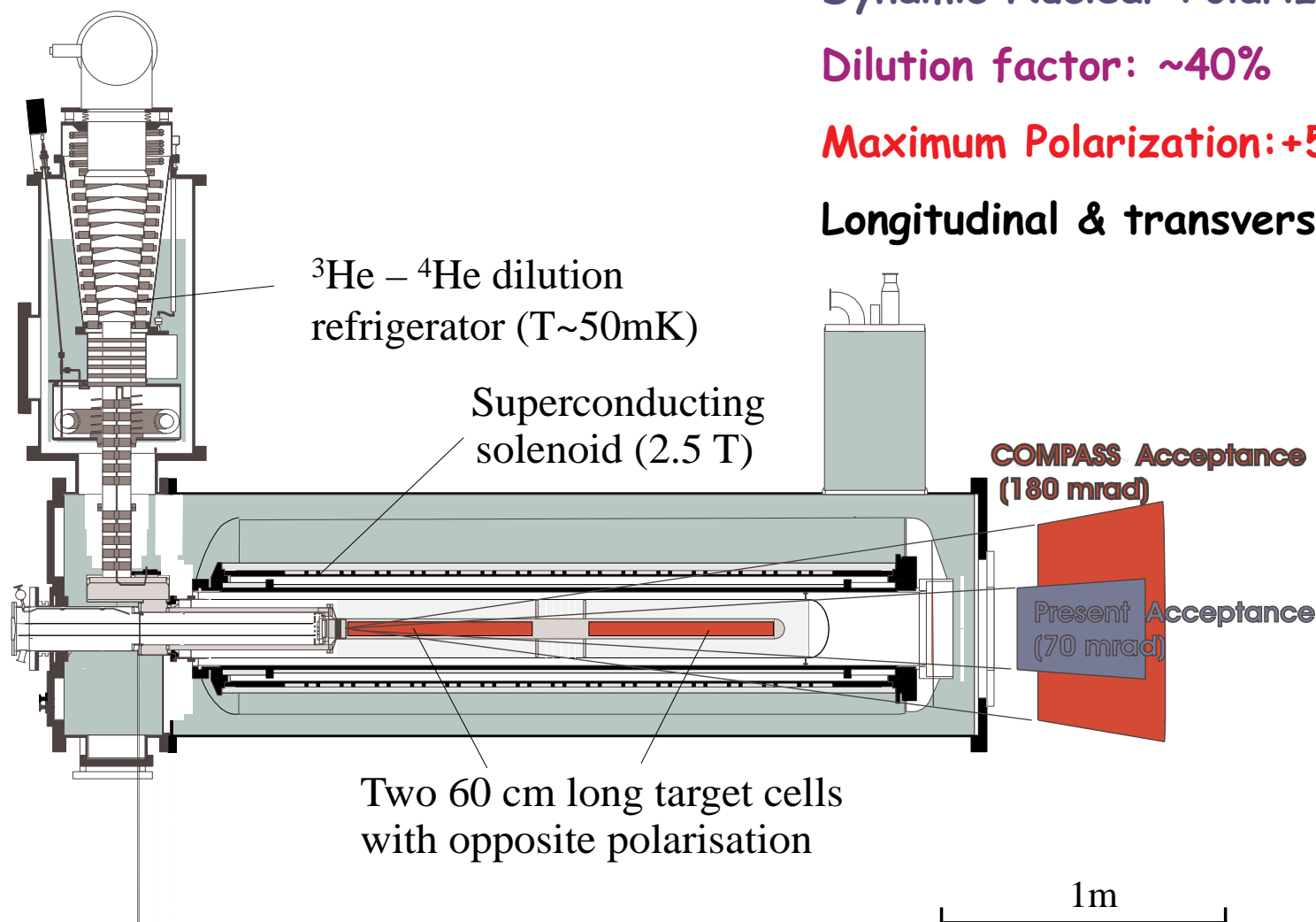
Compass ${}^6\text{LiD}$ Polarized target

Dynamic Nuclear Polarization

Dilution factor: ~40%

Maximum Polarization: +57%

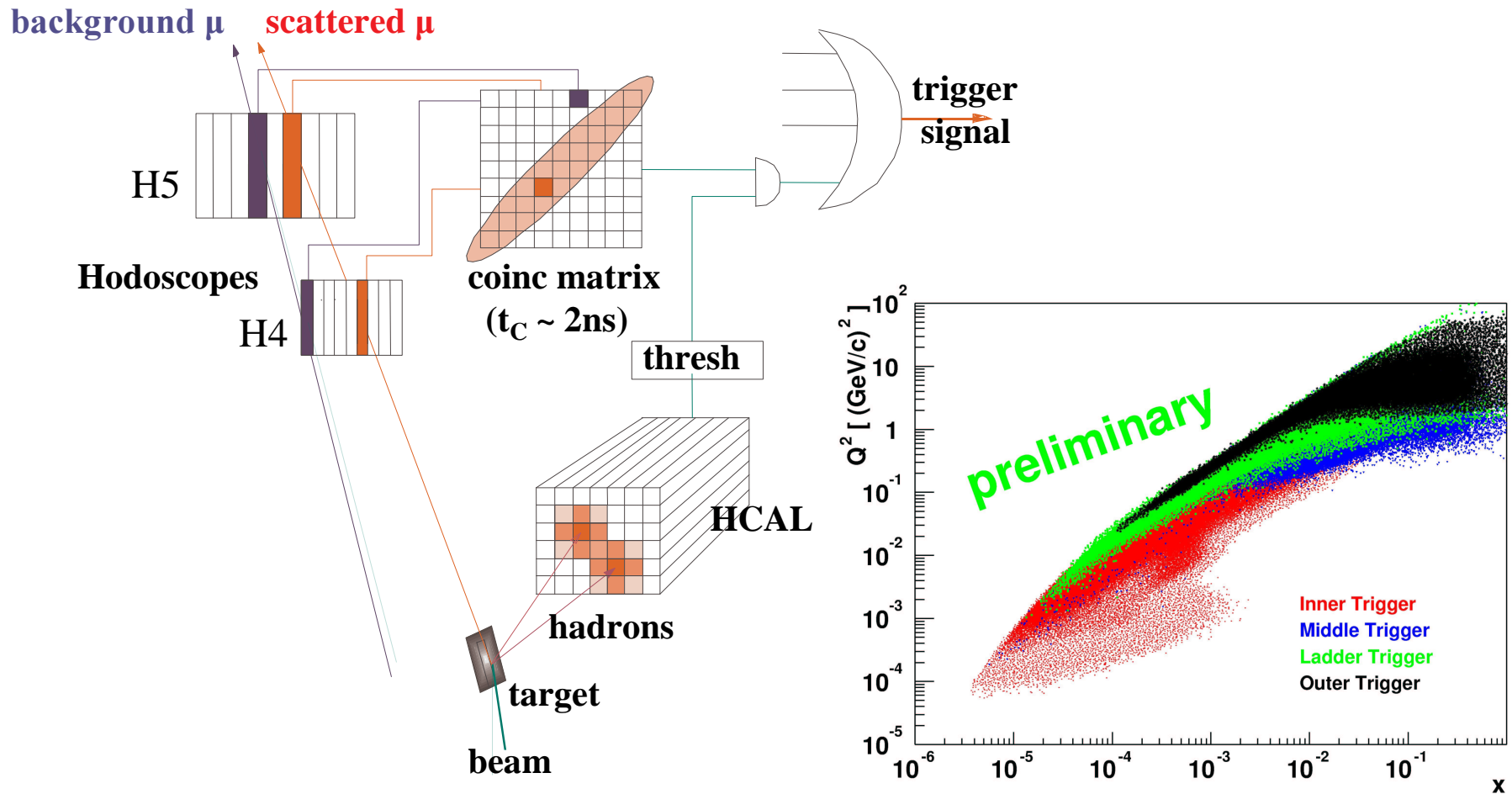
Longitudinal & transverse pol.





Compass trigger

Trigger : $(H4 * H5) * (Hcal1 \cup Hcal2)$



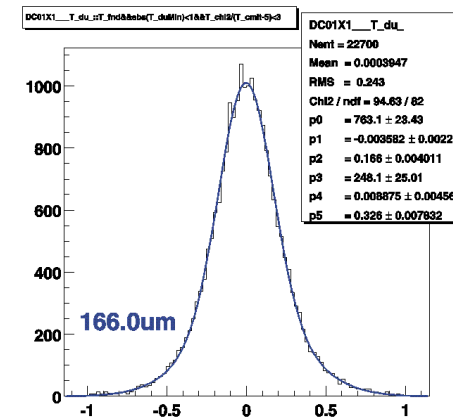
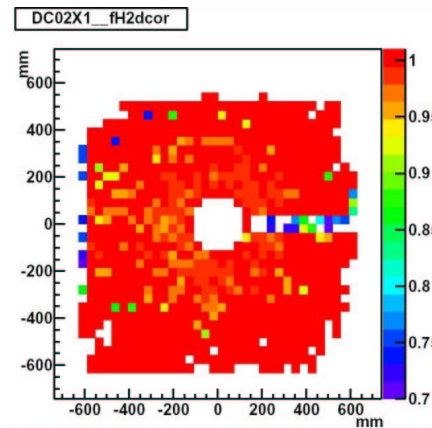
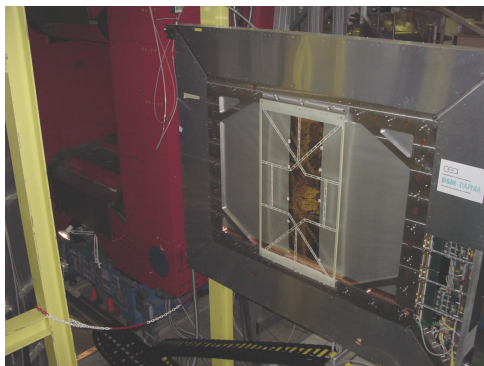


Trackers performance for 2002 run

<u>Detector</u>	<u>Coord</u>	<u>Efficiency</u>	<u>Resolution</u>	<u>Timing</u>
Scintillating fibers	21	94%	130 μm	0.45 ns
MicroMegas	12	95-98%	70 μm	8 ns
Drift Chambers	24	94-97%	170 μm	
Straw tubes	18	> 90%	~ 270 μm	
GEM detector	40	95-98%	50 μm	12 ns
MWPC	32	97-99%		

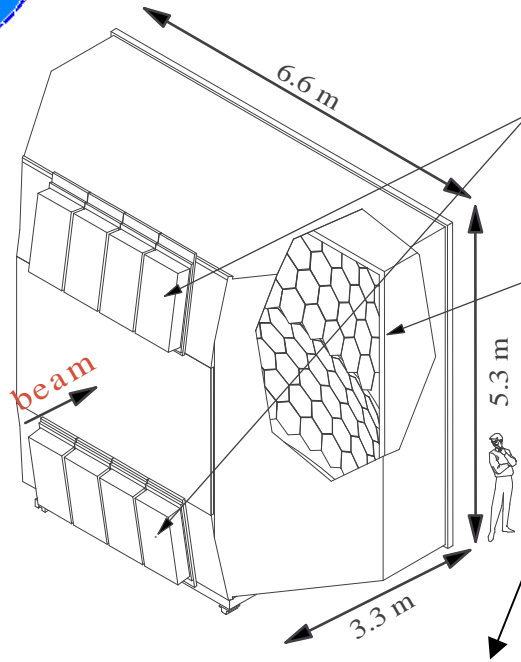
overall tracking efficiency : 80 to 95 % / p

DC





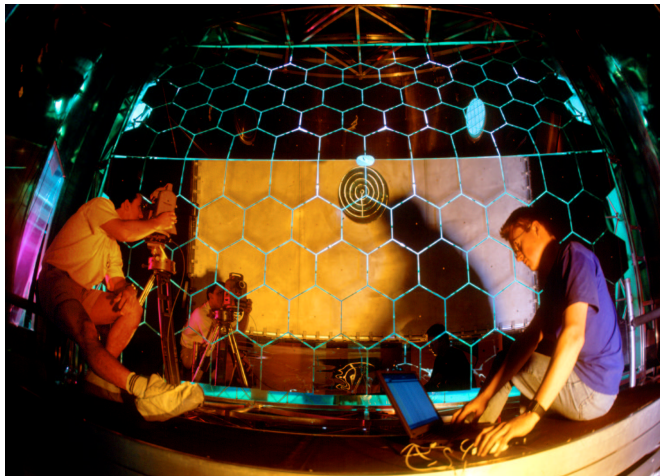
RICH characteristics



5.3 m² MWPCs with CsI-Photocathodes
84000 analog readout channels (Gassiplex)

80 m³ C₄F₁₀ ultra high cleaning

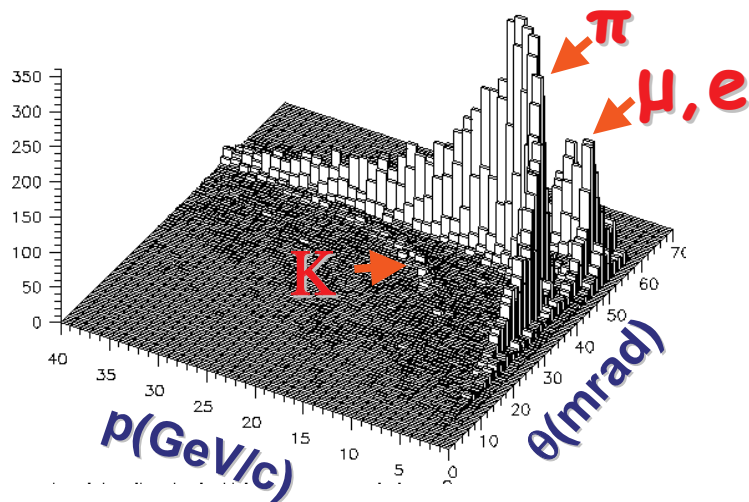
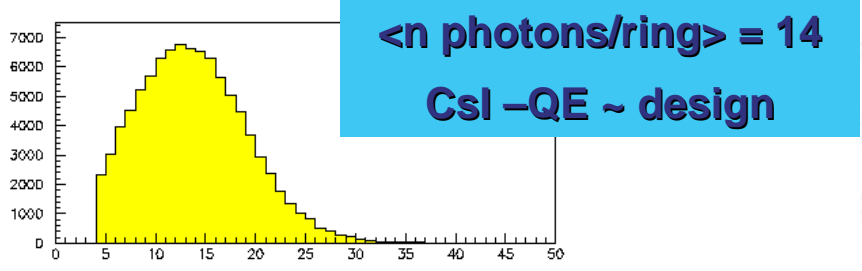
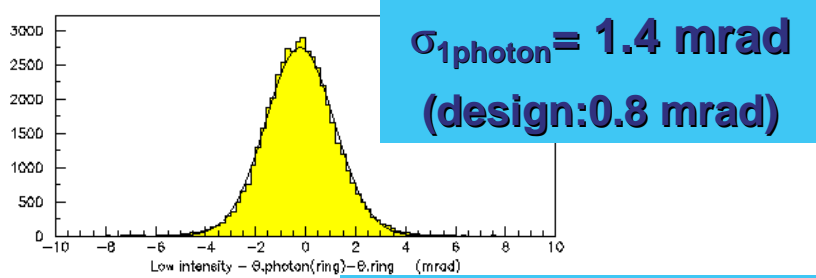
116 VUV mirrors 21 m²



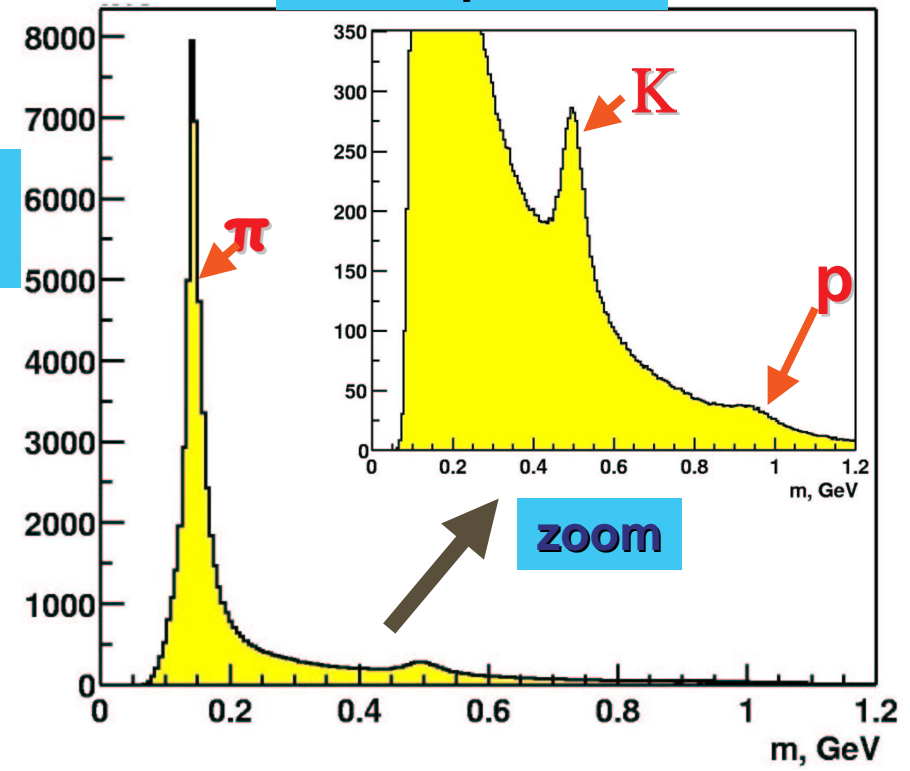


RICH PID performance

PHOTON ANGLE RESOLUTION



mass spectrum





2002 Data sample

Statistics:

- Target polarized longitudinally: $\sim 1.2 \text{ fb}^{-1}$
- Target polarized transversely: $\sim 0.3 \text{ fb}^{-1}$
- $\sim 4 \cdot 10^9$ good events, 270 Tb data

Reconstruction:

- Average time to process one event: 600ms/ev
- $4 \cdot 10^9 \text{ ev} * 0.6\text{s/ev} \sim 200 \text{ days on } 200 \text{ CPUs}$
(with 50% overhead for tape access and farm uptime)

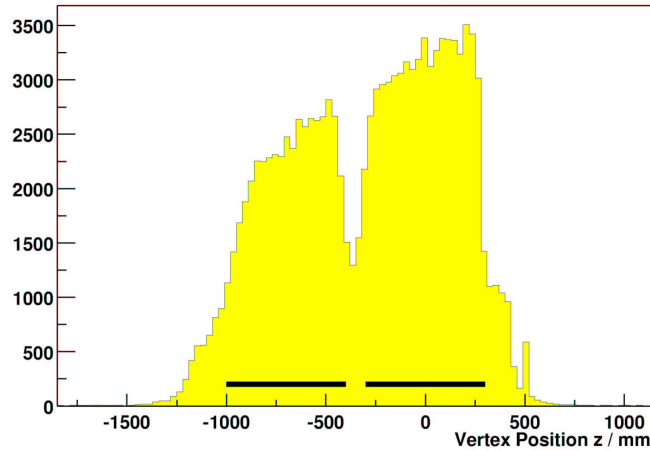
Analysis:

- Calibration of trackers (T_0, RT) + alignment OK,
- Calibration of RICH in progress
- So far, 1st pass analysis for 16% long. and 66% transv.

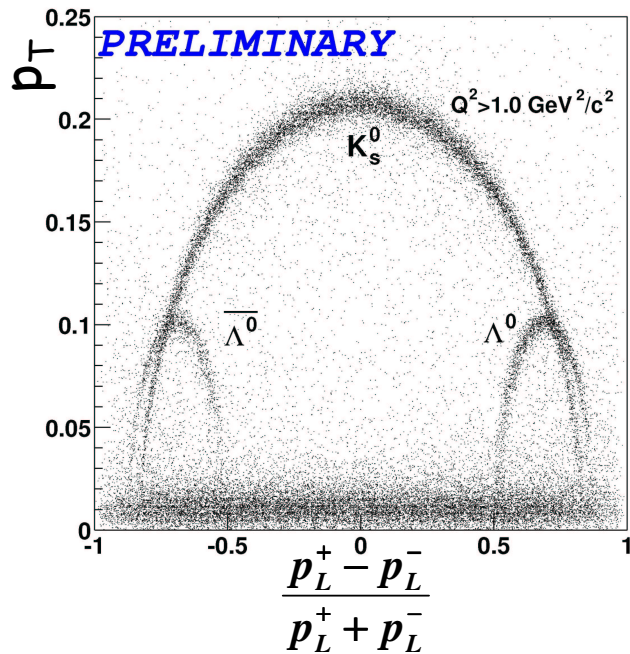
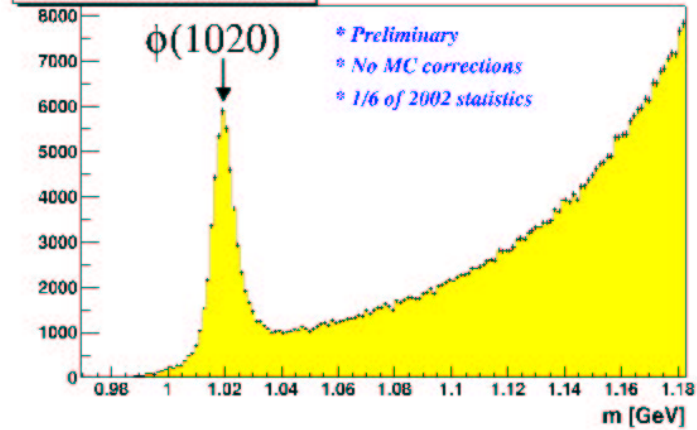


Some reconstruction figures

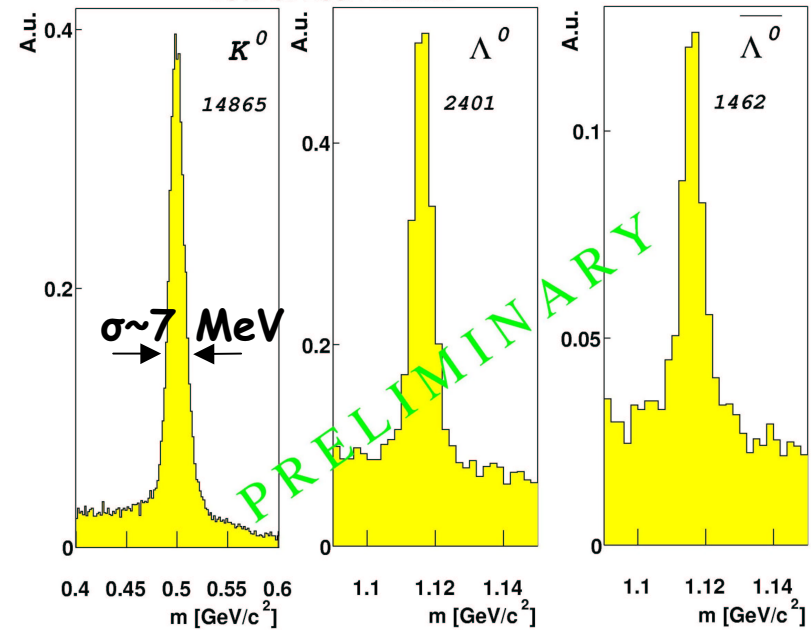
Vertex distribution along Z, $N_{\text{trk}} > 2$



K^+K^- invariant mass.



10% of 2002 DATA



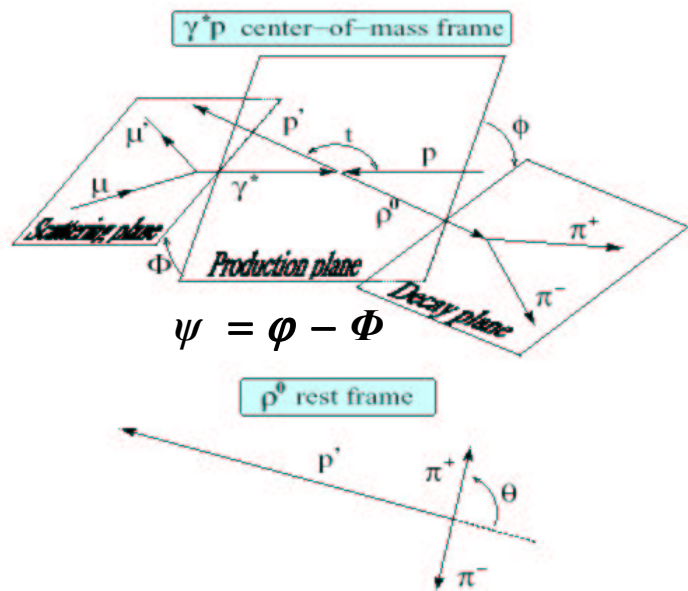


Summary of physics investigated so far

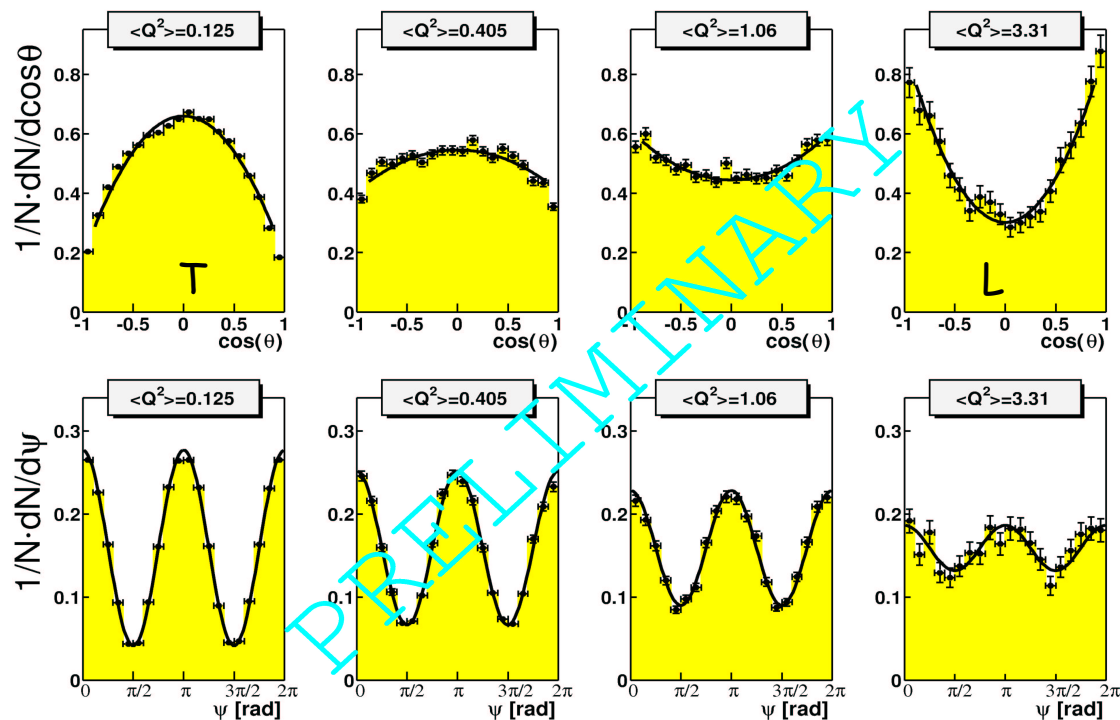
- ρ^0 , φ decay angular distributions (A. Korzenev)
- Λ and Λ hyperon polarizations (V. Alexhakin)
- Flavor decomposition of pPDF (SI-pDIS)
- Transversity from Collins asymmetry (P. Pagano)
- $\Delta G/G$ from high p_T pairs
- $\Delta G/G$ from open charm decay



Exclusive ρ^0 production : angular decay distributions



No acceptance corr., 1/6 of 2002 stat.
 $E_{\mu'} > 20 \text{ GeV}$, $\nu > 30 \text{ GeV}$, $\Delta E_{\text{miss}} < 2.5 \text{ GeV}$



$$W(\cos \Theta) = \frac{3}{4} \left[(1 - r_{00}^{04}) + (3r_{00}^{04} - 1) \cos^2 \Theta \right]$$

$$W(\psi) = \frac{1}{2\pi} \left[1 + 2\epsilon r_{1-1}^1 \cos 2\psi \right]$$

$$SCHC + \text{parity in } t \rightarrow r_{1-1}^1 = \frac{1}{2} (1 - r_{00}^{04})$$

High precision measurement of density matrix elements
and double spin asymmetry



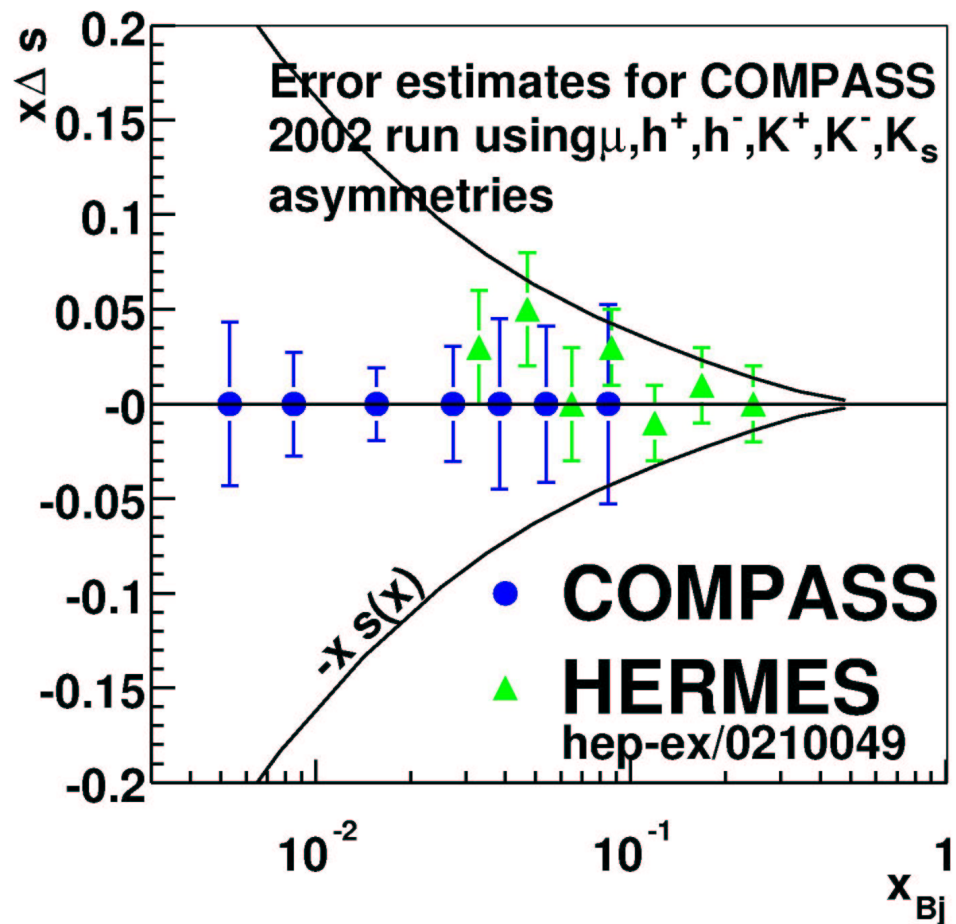
Flavour decomposition of $\Delta\Sigma$

- *Extraction of Δq from semi-inclusive at $Q^2 > 1 \text{ GeV}^2$*
- *Combine Compass d data with SMC p and d*
- *K identified in RICH*
- *hyp: $\Delta s = \Delta \bar{s}$*

COMPASS: $x_{min} = 0.003$

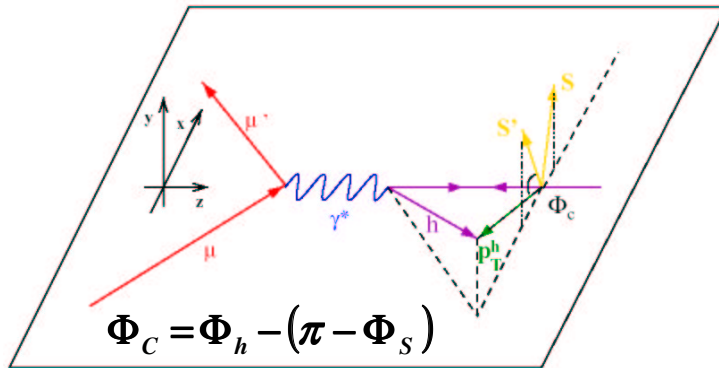
HERMES: $x_{min} = 0.02$

RHIC: $x_{min} = 0.04$





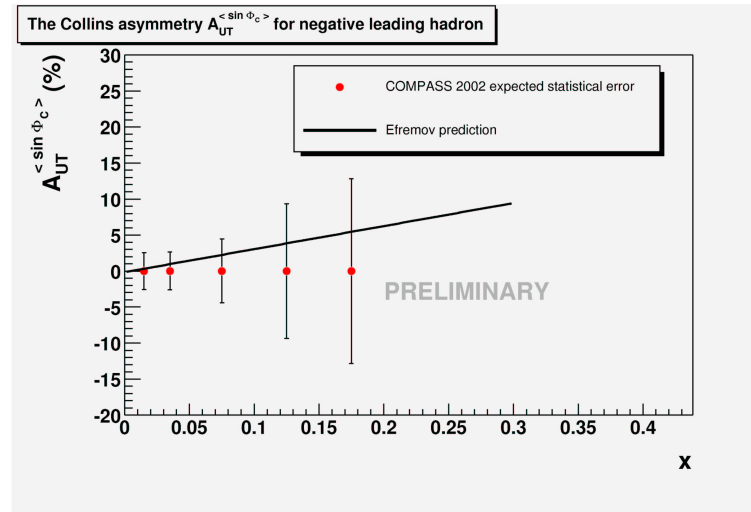
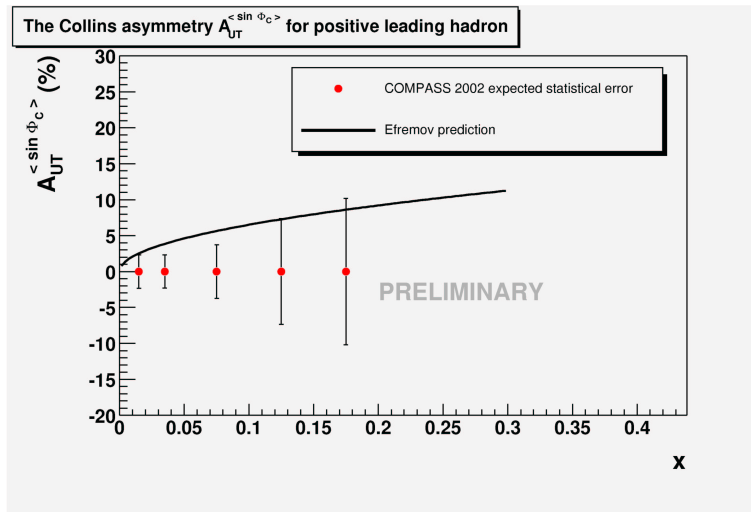
Transversity from Collins asymmetry



~ 10 Million DIS events with transverse polarization:

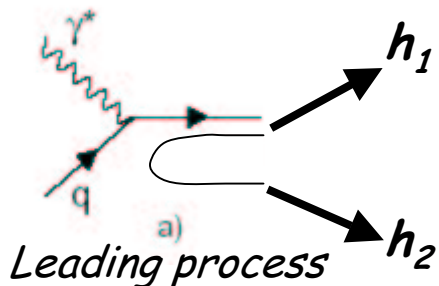
$Q^2 > 1 \text{ GeV}^2$; $0.1 < y < 0.9$
 $z^h > 0.25$; $p_T^h > 0.1 \text{ GeV}/c$

$$N_{\uparrow\downarrow}(\Phi_C) \propto (1 \pm \text{coeff.} \cdot H(x) \sin \Phi_C)$$



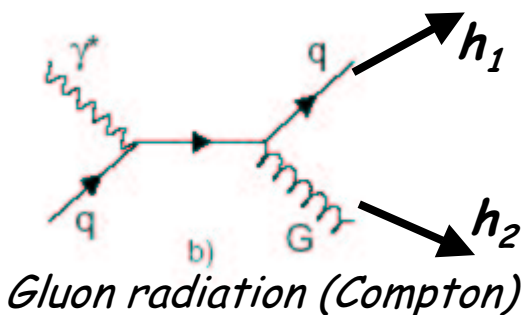


$\Delta G/G$ from high p_T pairs



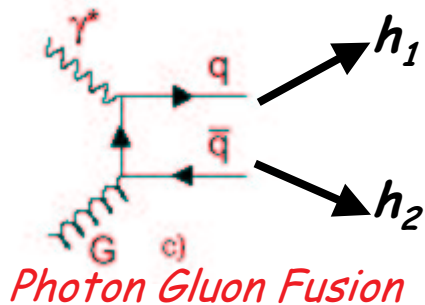
Measured asymmetry

$$A = \frac{N_+ - N_-}{N_+ + N_-} = P_\mu P_T f A^{\mu N \rightarrow hhN}$$



$$A^{\mu N \rightarrow hhN} = A_1 \langle a_{LL} \rangle^{LP} R_{LP} + A_1 \langle a_{LL} \rangle^{GR} R_{GR} + \frac{\Delta G}{G} \langle a_{LL} \rangle^{PGF} R_{PGF}$$

$\langle a_{LL} \rangle^{process}$: analysing power of process



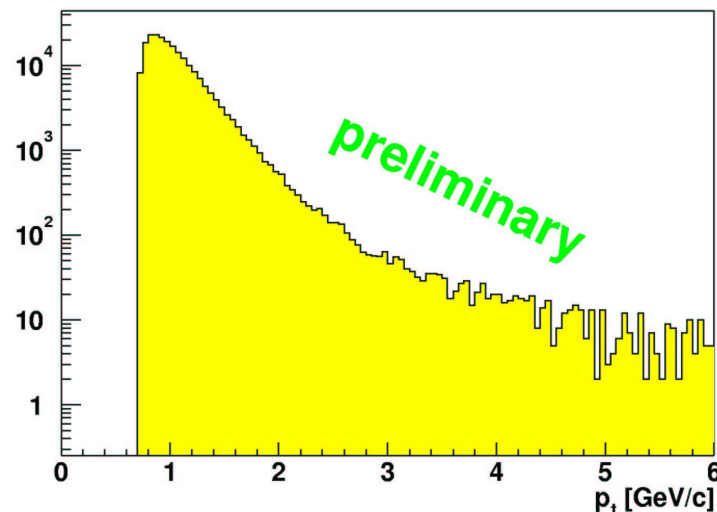
$$A_1 = g_1 / F_1 ; R_{process} = \sigma_{process} / \sigma_{TOT}$$



$\Delta G/G$ from high p_T pairs

Experimental cuts:

- $\mu, \mu' + 2$ hadrons, $p_T > 0.7 \text{ GeV}/c$
- $0.4 < \gamma < 0.9$
- x_F hadrons > 0.1 (current fragm.)
- $p_{T,1}^2 + p_{T,2}^2 > 2.5 (\text{GeV}/c)^2$



Expected error for 2002 data:

$$\delta\left(\frac{\Delta G}{G}\right)_{stat} = \frac{1}{\langle a_{LL} \rangle^{PGF} R_{PGF} P_\mu P_T f \sqrt{N}}$$

$Q^2 > 1 \text{ GeV}^2$: *LEPTO* $\rightarrow R_{PGF} \approx 1/3$

all Q^2 : no hard scale at $\gamma^* q$ vertex

$\gamma^* [q\bar{q}] + q$ not negligible

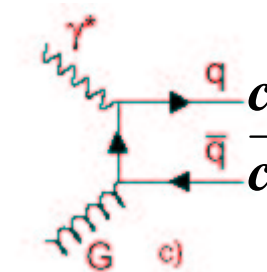
	$N_{events} (2002)$	$\delta\left(\frac{\Delta G}{G}\right)_{stat}$
$Q^2 > 1 \text{ GeV}^2$	≈ 18000	0.31
all Q^2	≈ 160000	~ 0.1



$\Delta G/G$ from charm production

Experimental cuts:

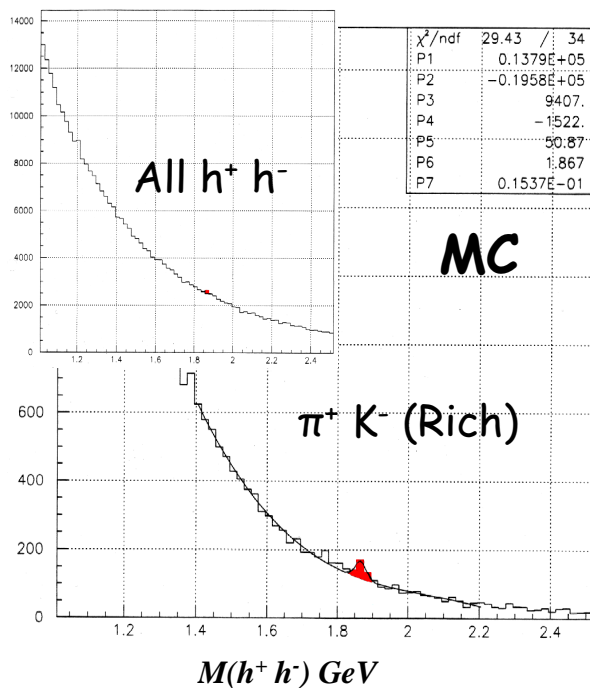
- $\mu, \mu' + K^- + \pi^+$ (Rich ID)
- $z_D > 0.25$
- $|\cos \Theta_K^*| < 0.5$



Photon Gluon Fusion

$$D^0 (\overline{D}^0) \rightarrow K^- \pi^+ (K^+ \pi^-)$$

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



Expected statistics for 2002 data:
(according to proposal)

→ we expect $\approx 24000 D^0$,
 $\approx 7000 D^{*+}$
at $\langle \eta_G \rangle \sim 0.15$



Conclusion and outlook

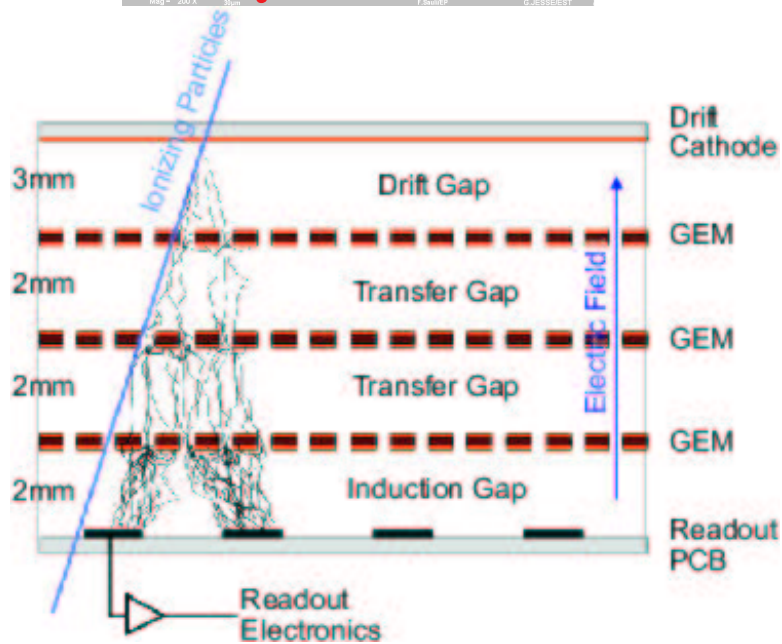
- 2002 run: 1.2 fb^{-1} long. + 0.3 fb^{-1} trans.
- Phase 1 setup fully operational
- Preliminary results for:
vector mesons, Λ polarization, transversity
- Prospects for $\Delta G/G$ in 2004 (based on 2002 stat):
- $\rightarrow \delta(\Delta G/G)_{\text{stat}} \sim 0.15$ for high p_T events $Q^2 > 1 \text{ GeV}^2$
(~ 0.05 for all Q^2)



MicroStrip Gaseous Chambers

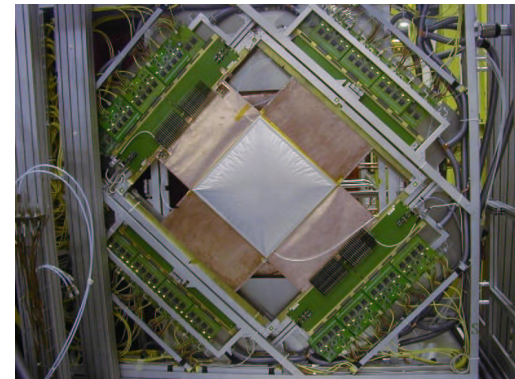
GEM (Munich, CERN)

- 40 planes, 30cm x 30cm
- two dimensional read-out
- spatial resolution $\sim 50 \mu\text{m}$
- time resolution $\sim 12 \text{ ns}$
- efficiency $\sim 96 - 97\%$



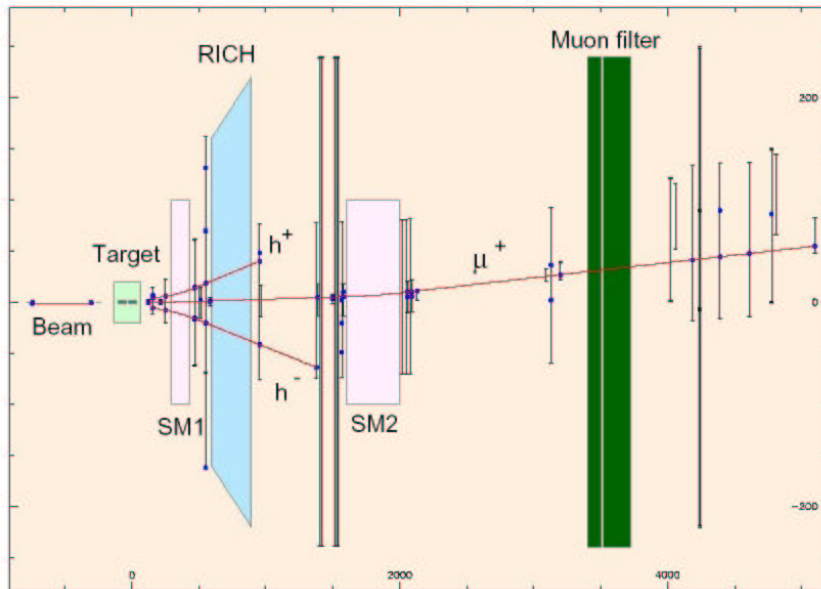
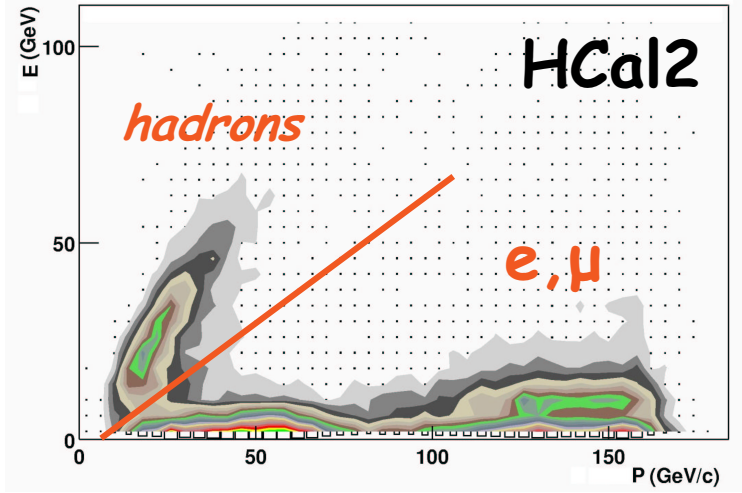
MicroMegas (Saclay)

- 12 planes, 40cm x 40 cm
- High flux (300 kHz/strip)
- spatial resolution $\sim 70 \mu\text{m}$
- time resolution $\sim 8 \text{ ns}$
- efficiency $\sim 96 - 97\%$





Mu/hadron ID





Λ polarization

Secondary vertex outside target
 1/6 of 2002 statistics
 $Q^2 > 1 \text{ GeV}^2$, $0.2 < y < 0.9$

u_X along γ^* in Λ c.m.

$$u_Y = u_X \times u_{\text{Target}}$$

$$\frac{dN}{N \cos \Theta_i} = \frac{1}{2} (1 + \alpha P_i \cos \Theta_i)$$

Λ decay parameter :

$$\alpha = 0.642 \pm 0.013$$

- Λ spin structure
- s-s symmetry of nucleon sea

