The COMPASS Experiment at

by

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DIS 97 CHICAGO 14-18 APRIL

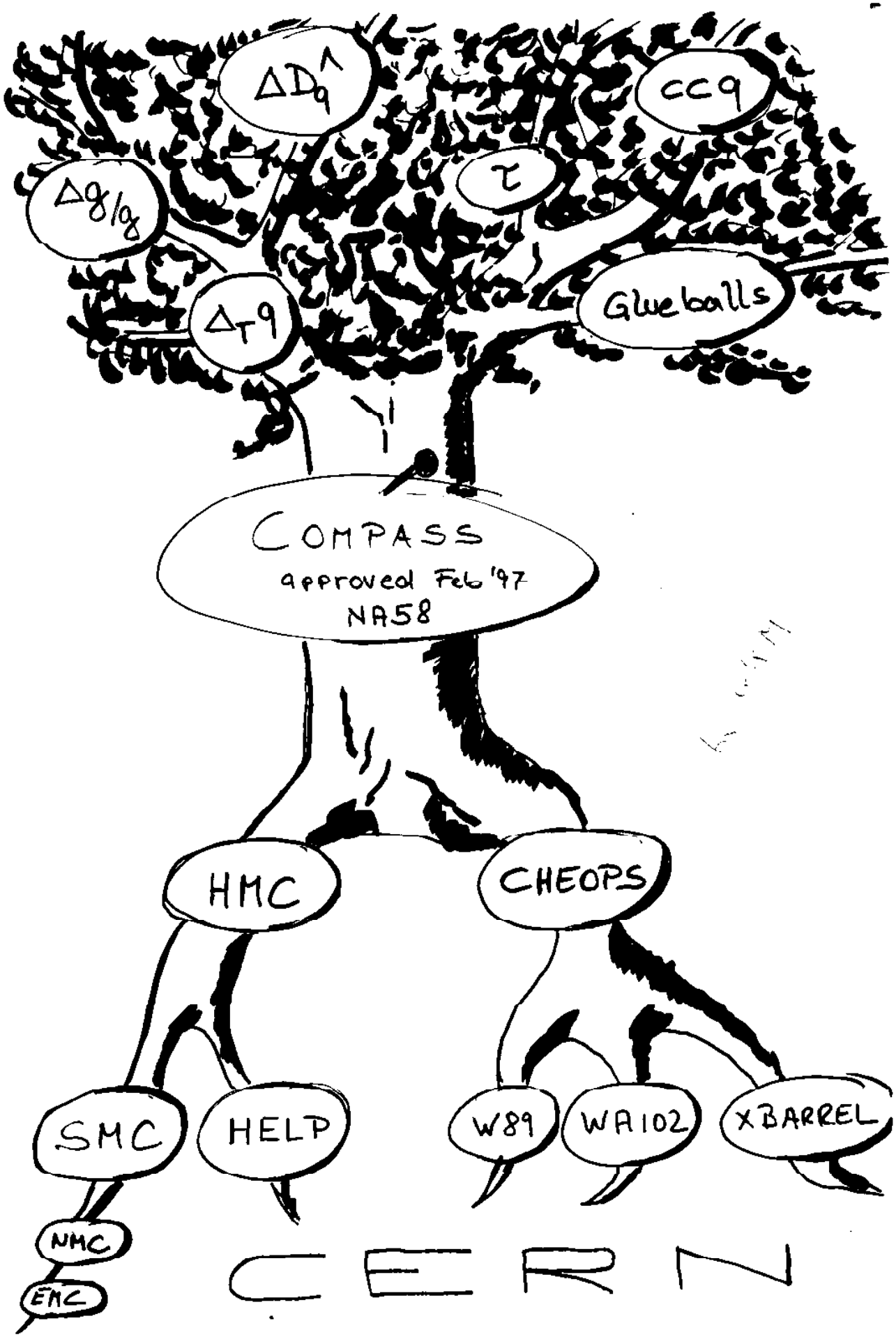
The COMPASS Collaboration

Common Muon and Proton Apparatus for Structure and Spectroscopy

Belgium, Finland, Germany, Great Britain, Israel, Italy, Japan, Poland, Russia, Switzerland, USA

Bielefeld, Bochum, Bonn, Bristol, Brussels, Chiba, Dubna, Erlangen, Freiburg, Heidelberg, Helsinki, Mainz, Miyazaki, Mons, Moscow, Munich, Nagoya, Osaka, Protvino, Rutgers, Sendai, Tel Aviv, Torino, Trieste, Warsaw, Tsukuba, Yamagata, Zürich

- 33 Institutes
- 168 Physicists



$\Delta D_q^\wedge$
ccq
$\Delta g/g$
τ
$\Delta_T q$
Glueballs
COMPASS
approved Feb '97
NA58
HMC
CHEOPS
SMC
HELP
W89
WA102
XBARREL
NMC
EMC
CERN

COMPASS PROGRAM WITH $\vec{\mu}$ONS

- $\Delta G/G$ GLUON POLARIZATION
  OPEN CHARM
  HIGH P_T HADRONS (NEW)

- Δu_v, Δd_v, $\Delta \bar{q}$, $\Delta \bar{s}$ FLAVOR DECOMPOSITION g_1
  SEMI-INCLUSIVE $\pi^{+/-}$, $K^{+/-}$, K^{0*}

- ΔD_q^{Λ} POLARIZED FRAG. FUNCT.
  Λ POLARIZATION ($x_F > 0$)

- $h_1(x)$ TRANSVERSITY
  SEMI-INCLUSIVE $\pi^{+/-}$ WITH $\perp$ POL. TARGE

- $g_1(x)$, $g_2(x)$

PARAMETERS OF EXPERIMENT

μ beam: $E = 100$ GeV (200)
$P \sim 80\%$
Int. 2×10^8 μ/spill

target:	LiD	$P \sim 50\%$	$\langle P \rangle / N \sim 25\%$	(deuteron)
	NH_3	$P \sim 85\%$	$\langle P \rangle / N \sim 15\%$	(proton)

$L = \int \mathcal{L}\, dt \simeq 2\ fb^{-1}$ /year

COMPASS PROGRAMME

WITH HADRON BEAMS

p, π up to 300 GeV (first stage)

- STUDY OF GLUONIC SYSTEMS pp

  - GLUEBALLS

  0^{++} ~ 1500 - 1800 MeV ? $f_0(1500)$?

  LATTICE QCD: mass tensor/scalar ~ 1.5

  ⇒ Tensor glueball ~ 2.3 GeV

⇒ NEED HIGH STATISTICS SAMPLE

- to verify $f_0(1500)$
- extend Spectroscopy to 2.5 GeV

Improvements wrt WA102 (GAMS)

5 times larger acceptance

10 times higher beam intensity

HADRON BEAMS CONT^D

- CHARMED HADRONS Λ_c, Ξ_c

  - SEMI LEPTONIC DECAYS OF CHARMED BARYONS

    HQET

  - Lifetimes

  - Production mechanisms

  - Double CHARMED BARYONS Ω_{cc}, Ξ_{cc} NOT YET OBSERVED

  - aim at 10^7 reconstructed charmed hadrons

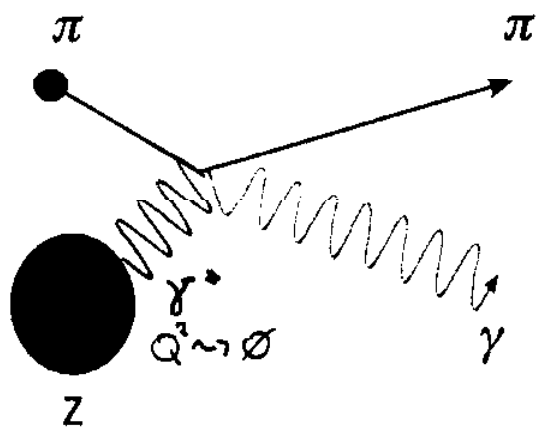
- PRIMAKOFF reactions (π, K beams)

  π, K Polarizibilities

- MAYBE STUDY Λ_c^+ production with a polarized target

Primakoff scattering in COMPASS

Compton scattering in inverse kinematics



study γ -scattering on unstable projectiles

- Predictions from χPT
- measure polarizabilities by deviation from $\sigma_{Compton}$
- determine polarizibilty α to ~ 5%

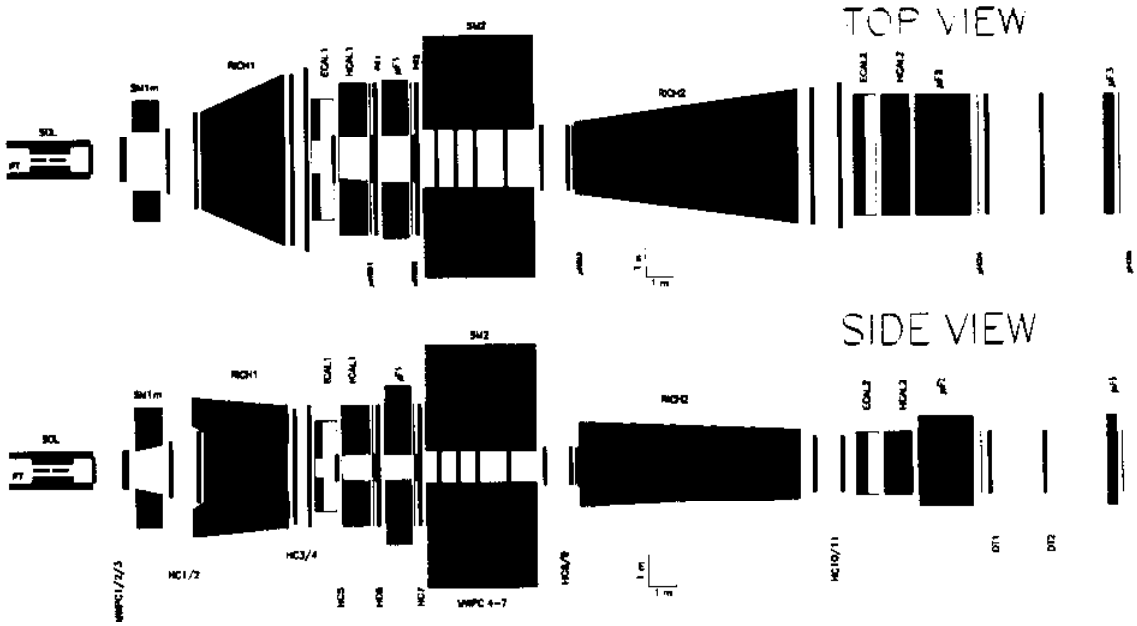
- measure $\pi\gamma \rightarrow \pi\pi$ (chiral anomaly)
- statistics : about 50 • present statistics

Time: 5-10 days of effective running on heavy target

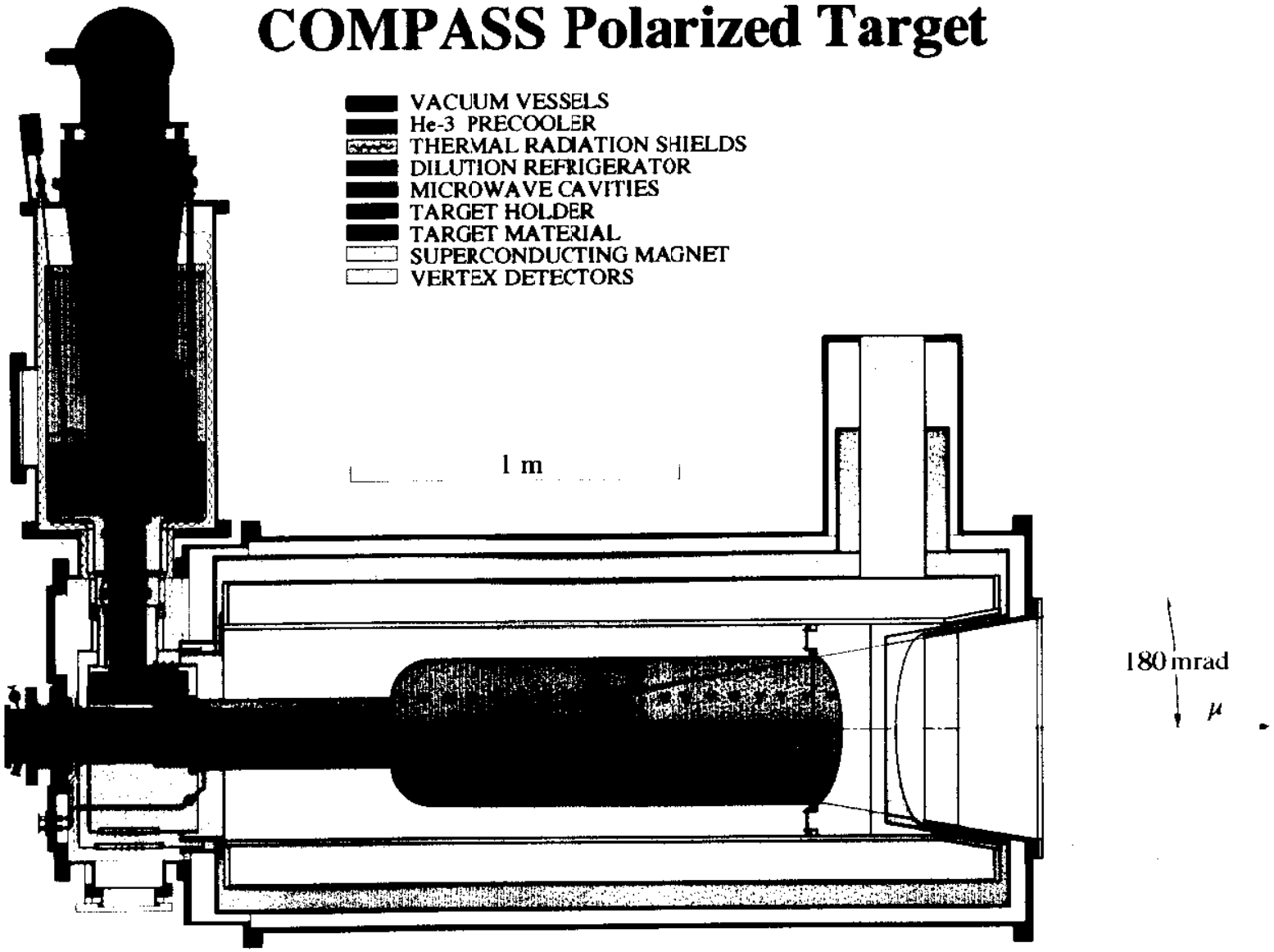
THE COMPASS SPECTROMETER

- Spectrometer Components

  Tracking detectors, Rich Detectors,
  electromagnetic and hadronic Calorimeters,
  Magnets, Muon filters (iron)

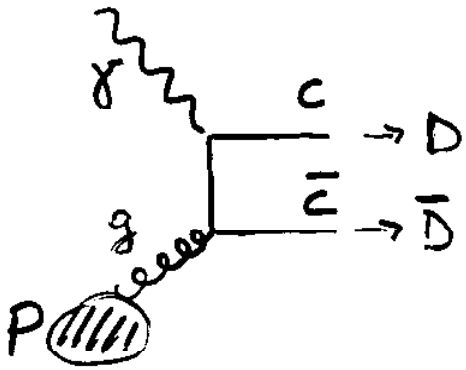


COMPASS Polarized Target



OPEN CHARM & PGF

O.C. WELL DESCRIBED BY PHOTON-GLUON FUSION



CLEAN HARD PROCESS
ONE LARGE SCALE $\hat{s}$
$\hat{s} \geq 4 m_c^2 \sim 10\ \mathrm{GeV}^2$

$$\sigma^{\gamma P \to c\bar{c}} \propto \int G\, \hat{\sigma}$$

OPEN CHARM PRODUCTION

- LARGE CROSS SECTION, 4 % OF $\sigma^{\gamma P}_{TOT}$ @ 60G
- NO (LARGE) DIFFRACTIVE CONTRIB.
- (ALMOST) NO CONSTITUENT CHARM
- SMALL CONTRIB. RESOLVED PHOTON (FEW %)

POLARIZED

$$\hat{\sigma}^{\uparrow\uparrow} \neq \hat{\sigma}^{\uparrow\downarrow} \longrightarrow \Delta G$$

γg SUBPROCESS KNOWN
UNPOLARIZED NLO
POLARIZED LO !

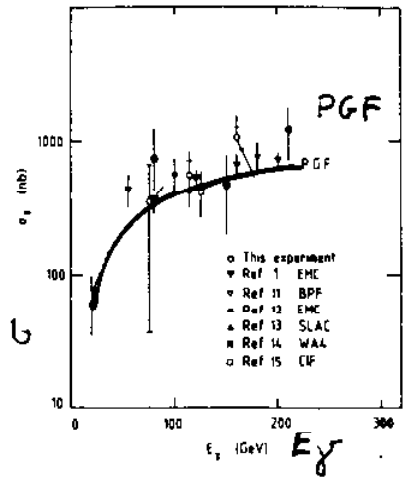
LEPTO PRODUCTION

$$\sigma^{\mu P \to c\bar{c}} = \Gamma(E; Q^2, \nu) \cdot \frac{\sigma^{\gamma P \to c\bar{c}}}{[1 + Q^2/M_0^2]^2}$$

OPEN CHARM: DATA VS. THEORY

PHOTO PRODUCTION CROSS SECTION:

$\sigma = \int G \, \hat{\sigma}_{L.O.}$



EMC

Z. Phys. C 35 (87

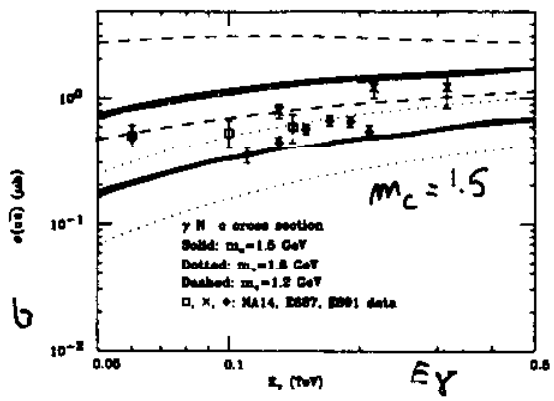
L.O. ANALYSIS

($\Lambda_{QCD} = 250$)

Frixione et al.

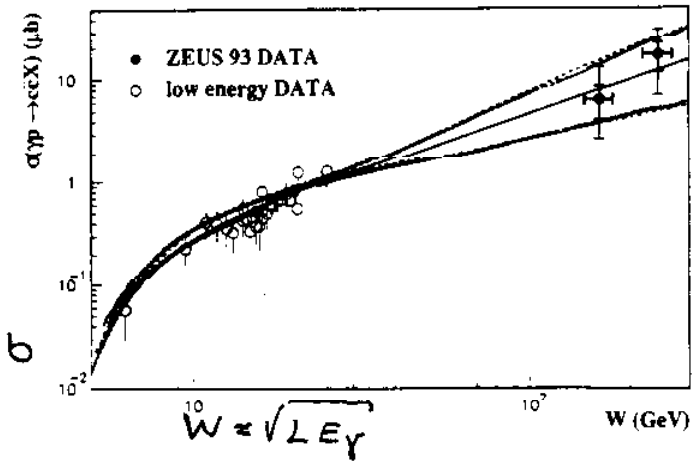
NPB 431 (94) 453

N.L.O. ANALYSIS



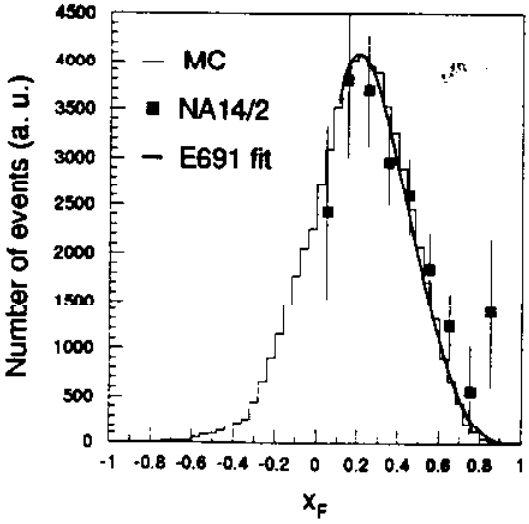
ZEUS

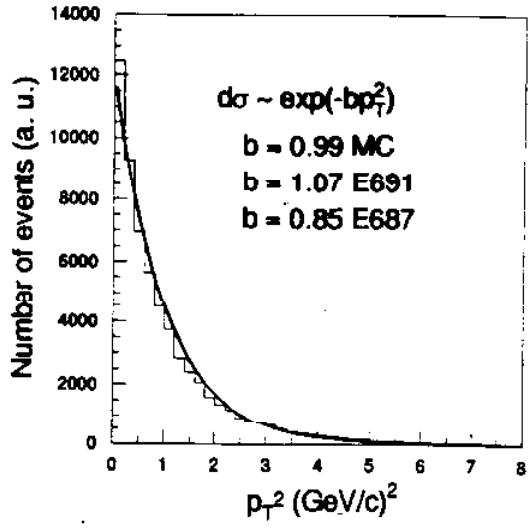
PLB 349 (95) 225



INCLUSIVE D^0 SPECTRA

L.O. MONTECARLO (MASSIVE MATRIX EL.
+ LUND FRAGMENTATION ($m_c = 1.5$ GeV
(AROMA + JETSET) $K_T \sim 440$ MeV)





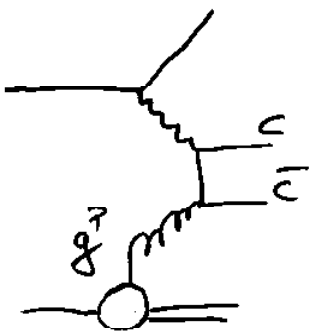
DATA WELL REPRODUCED

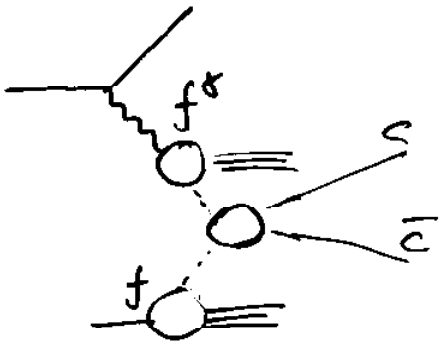
- NO INTRINSIC CHARM
- NO DIFFRACTIVE COMPONENT
- NO RESOLVED COMPONENT

"RESOLVED" PHOTON CONTRIB$^{\underline{N}}$

GLück, Reya, Stratmann hep-ph/9605297

$ep \to e c\bar{c} X$ LO

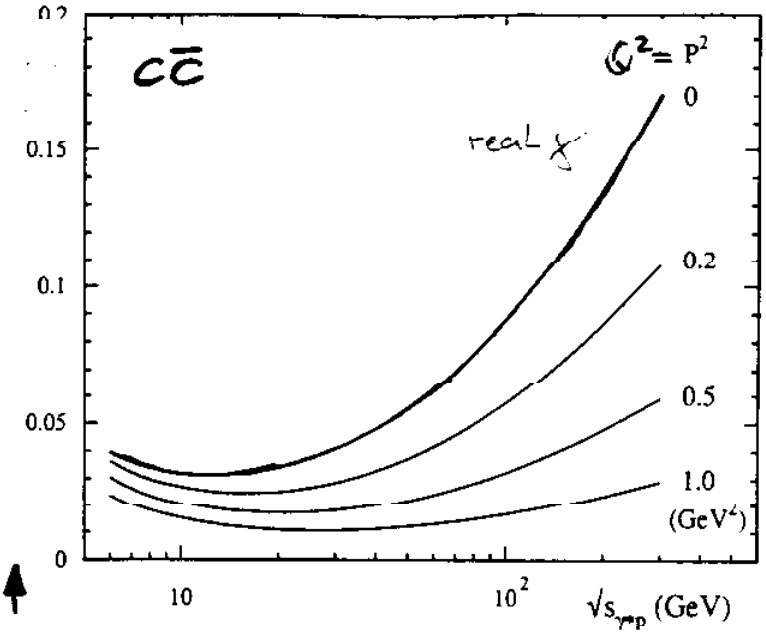




DIRECT $g^p \gamma \to c\bar{c}$ RESOLVED $f f^\gamma \to c\bar{c}$

RESOLVED / DIRECT

5 % →



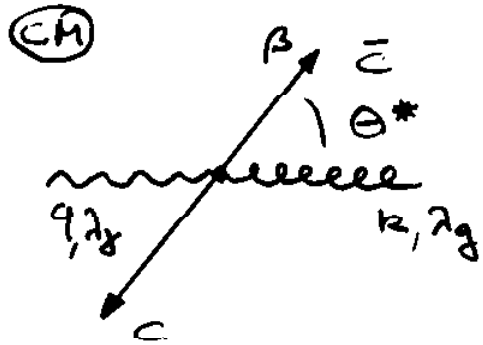
$2m_c$

Threshold

x_γ

- RESOLVED CONTRIBUTION: SMALL

PHOTON GLUON CROSS SECTION



LO

$\hat{s} = (q+k)^2$

CROSS SECTION $\gamma g \to c\bar{c}$

$$\sigma^{c\bar{c}}(\hat{s}) = \underbrace{\sigma(\hat{s})}_{\frac{1}{2}(\sigma^+ + \sigma^-)} + \underbrace{\lambda_\gamma \lambda_g}_{\pm 1} \underbrace{\Delta\sigma(s)}_{\frac{1}{2}(\sigma^+ - \sigma^-)}$$

$$\Delta\sigma(\hat{s}) = \frac{4}{9}\,\frac{2\pi\alpha\alpha_s}{\hat{s}}\left[3\beta - \ln\frac{1+\beta}{1-\beta}\right]$$

$$\sigma(\hat{s}) = \frac{4}{9}\,\frac{2\pi\alpha\alpha_s}{\hat{s}}\left[-\beta(2-\beta)^2 + \frac{1}{2}(3-\beta^4)\ln\frac{1+\beta}{1-\beta}\right.$$

- (QUASI) REAL PHOTONS
- LEADING ORDER
- INTEGRATED OVER θ^*
- CM VELOCITY

$$\beta = \sqrt{1 - 4\frac{m_c^2}{\hat{s}}}$$

ASYMMETRY $A^{c\bar{c}}_{\gamma p}$ & $\frac{\Delta G}{G}$

GLUON MOMENTUM FRACTION $x_g = \frac{\hat{s}}{2MEy}$

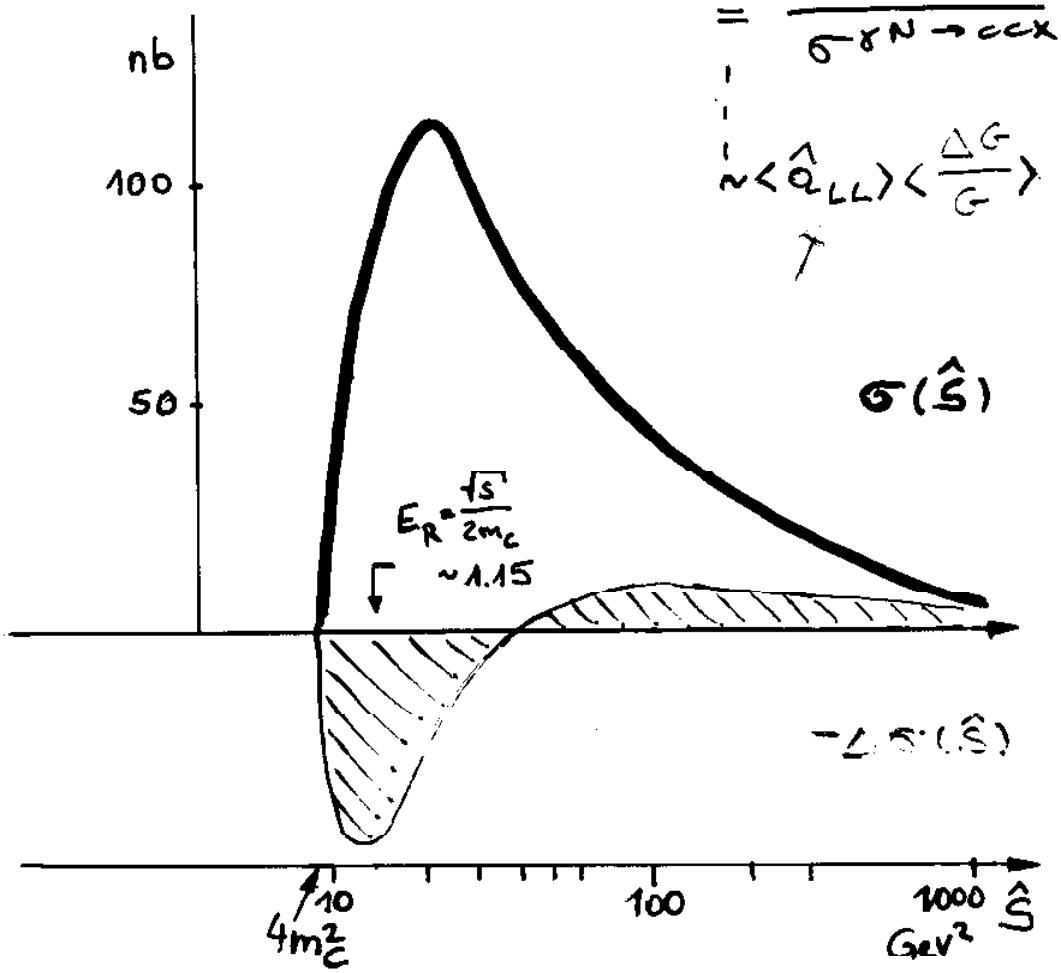
VELOCITY OF CHARM QUARK $\beta = \sqrt{1-4m_c^2/\hat{s}}$

$y = \nu/E$

$$A^{c\bar{c}}_{\gamma p}(E,y) = \frac{\int_{4m_c^2}^{2MEy} d\hat{s}\ \Delta\sigma(\hat{s})\ \Delta g(x_g,\hat{s})}{\int_{4m_c^2}^{2MEy} d\hat{s}\ \sigma(\hat{s})\ g(x_g,\hat{s})}$$

$$= \frac{\Delta\sigma^{\gamma N\to ccX}}{\sigma^{\gamma N\to ccX}}$$

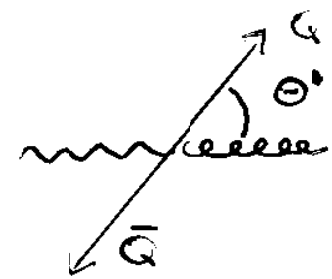
$$\sim \langle \hat{a}_{LL}\rangle \langle \frac{\Delta G}{G}\rangle$$

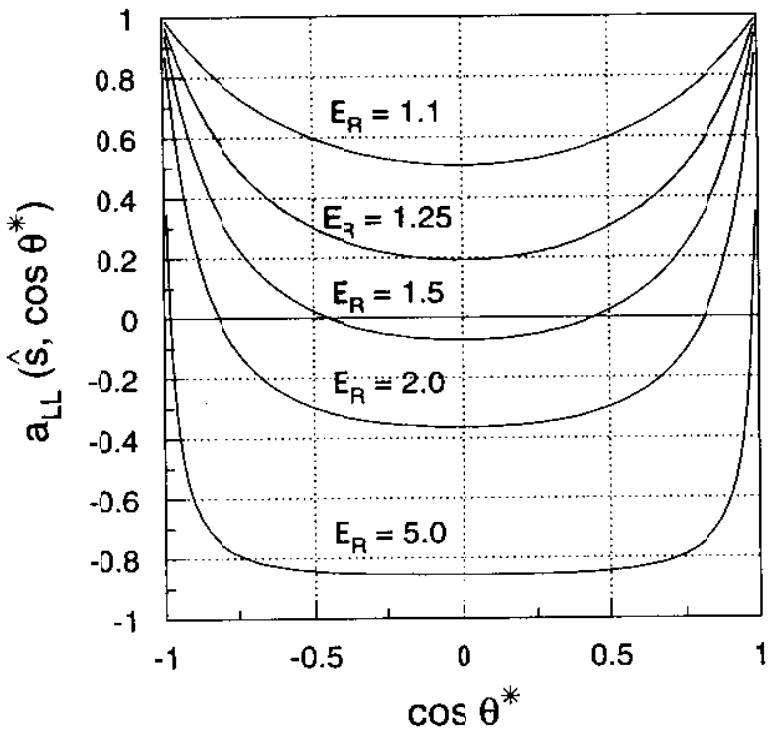


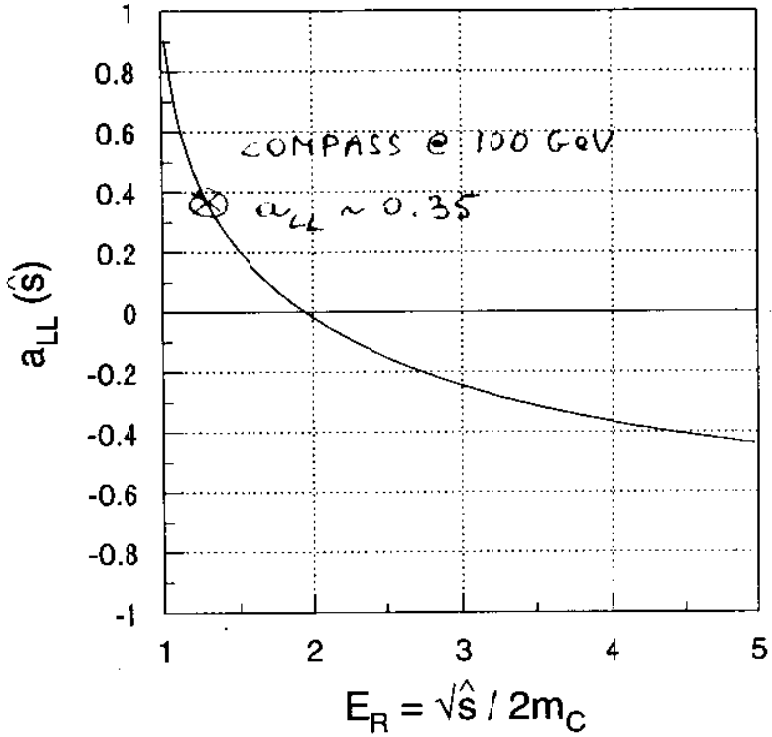
0.8 0.95 0.99 $\beta = \sqrt{1-4m_c^2/\hat{s}}$

SPIN ASYMMETRY $\hat{a}_{LL} = \frac{\Delta\hat{\sigma}}{\hat{\sigma}}$

$Q^2 = \emptyset$ REAL γ

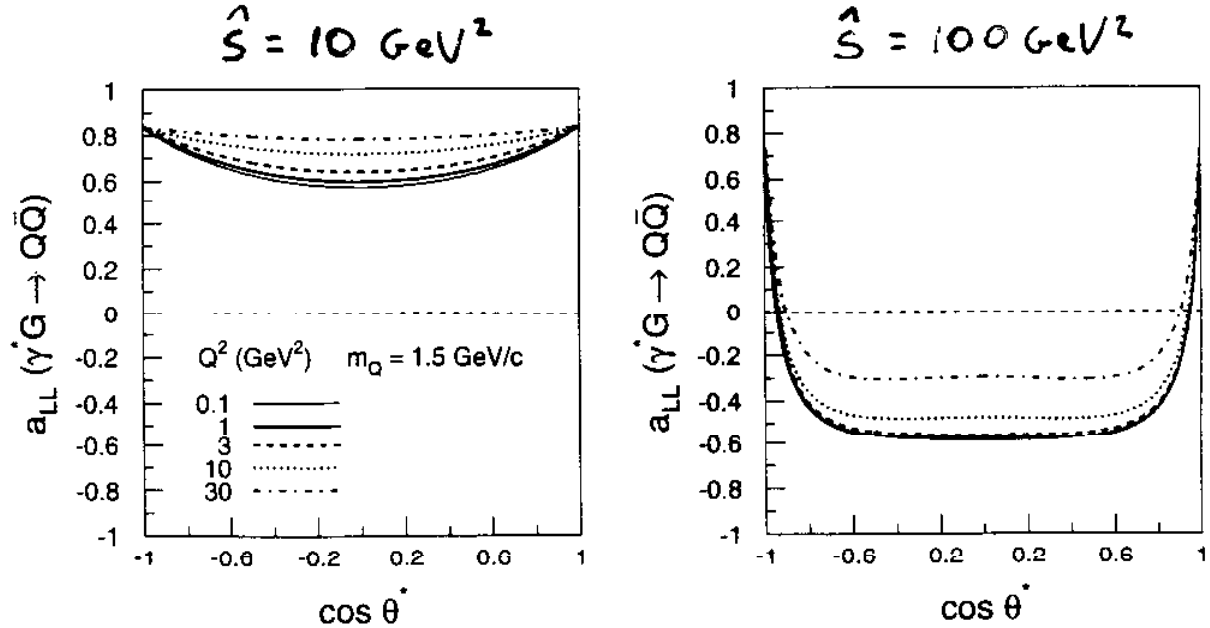






SPIN ASYMMETRY $\hat{a}_{LL}$

Q^2 DEPENDENCE



$y = 0.7$ $\quad D(y) \approx 0.84$

GLUON POLARISATION

FOR $x \to 0$ EXPECT $\frac{\Delta g(x)}{g(x)} \to x$ Brodsky, Burkardt, Schmidt 1994

COHERENCE ARGUMENTS

hep-ph 94013

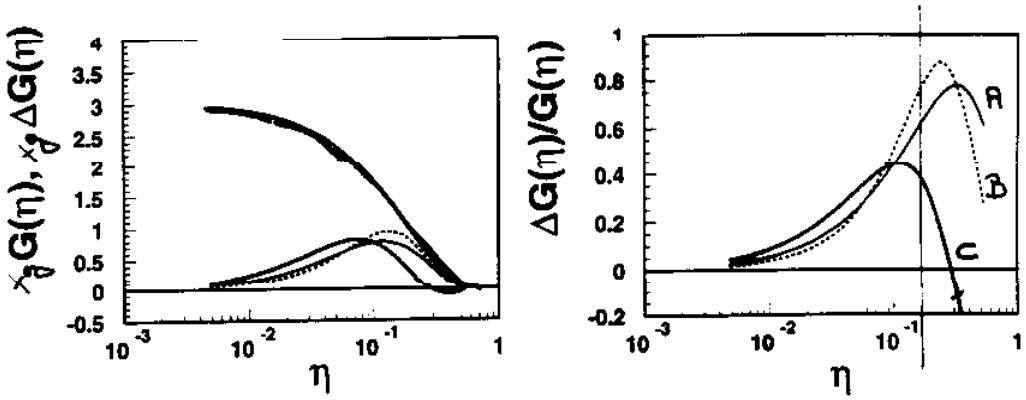
SIMILAR BEHAVIOUR OF ALL AVAILABLE MODELS/PARAMETRISATIONS OF Δg.

$\Rightarrow$ WE USE SETS A, B, C OF GEHRMANN & STIRLING ZP 1995

NORMALISATION $\int \Delta g(x)\,dx = 2$

$Q^2 = 4\ \mathrm{GeV}^2$

$x_g \Delta g,\ x_g g$ $\qquad$ $\Delta g / g$



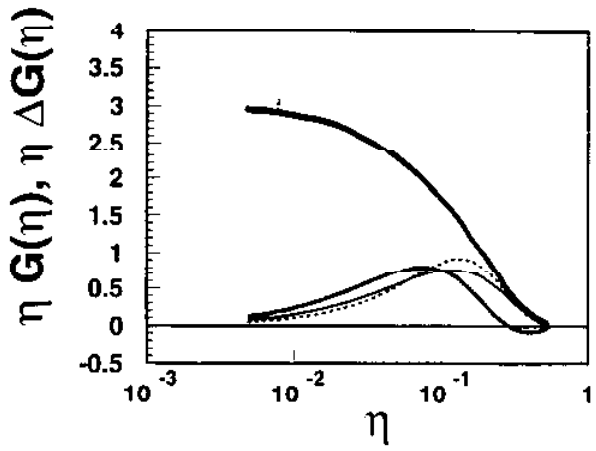
$\frac{\Delta G}{G} \gtrsim 0.5\ ;\ x_g = 0.15$

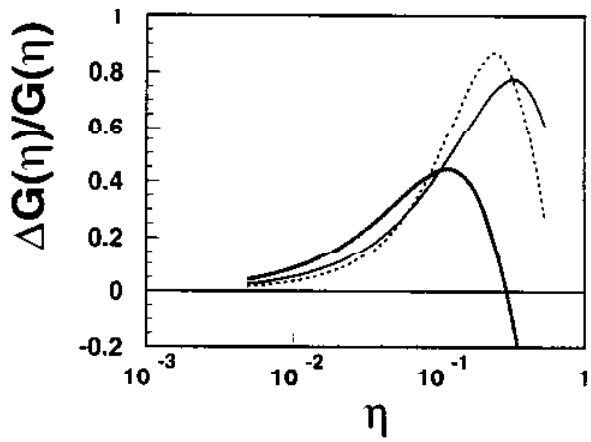
INTERESTING REGION:

$x_g \approx 0.15 \quad \hat{s} > 9\ \mathrm{GeV}^2$

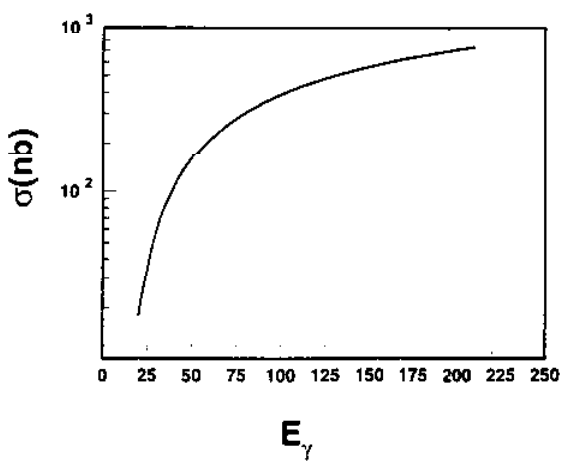
Gherman - Stirling '94 parametrisation of $\Delta G($

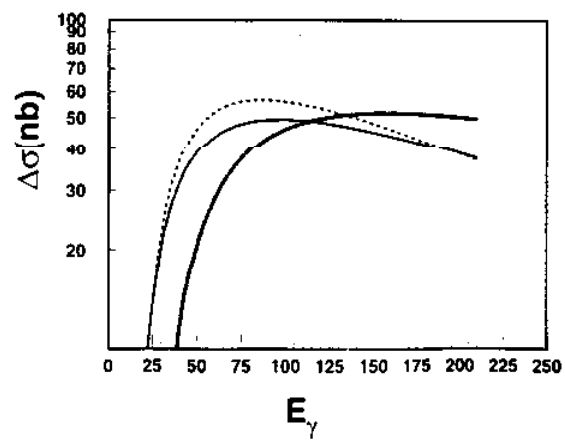
$\int \Delta G(\eta)\, d\eta \simeq 1.95$ @ $Q^2 = 4$ + D.O.F.F.





$$\sigma_0 = \int \hat{\sigma}(\hat{s}) \cdot G(\eta) \qquad \Delta\sigma = \int \Delta\hat{\sigma}(\hat{s}) \cdot \Delta G(\eta)$$

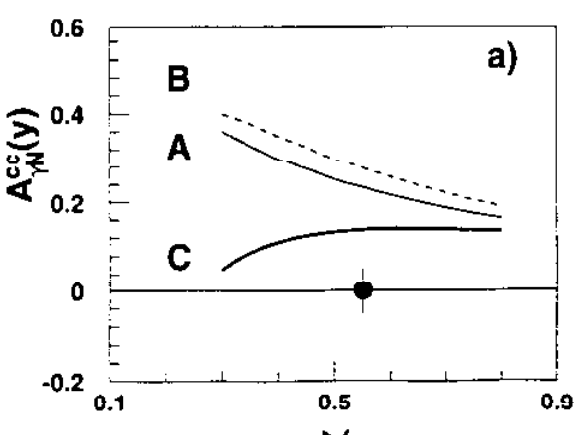


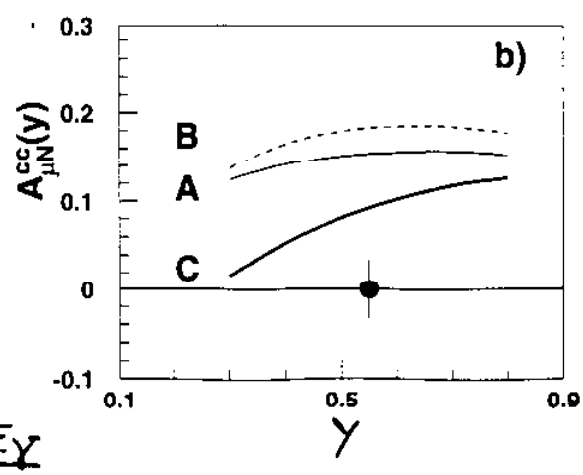


$$A_{LL}^{\gamma P} = \frac{\Delta\sigma}{\sigma_0}$$

COMPASS 100 GeV μ^- $\quad A_{LL}^{\mu P} = \bar{D}\, A_{LL}^{\gamma P}$

$D^0 \to K^-\pi^+$ c.c. only





$$y = \frac{E_\gamma}{E_\mu}$$

MEASURED Asym. A^{exp}

$$A^{exp} = \frac{N_{cc}^{\uparrow\downarrow} - N_{cc}^{\uparrow\uparrow}}{N_{cc}^{\uparrow\downarrow} + N_{cc}^{\uparrow\uparrow}}$$

target spin $\uparrow$
muon spin $\uparrow$

$$= P_\mu \cdot P_t \cdot f \cdot A_{\mu p}^{cc}(y)$$

P_μ, P_t muon/target polarisation
f dilution factor of target material

$$A_{\mu p}^{cc} = D \, A_{\gamma p}^{cc}$$

Depolarisation factor of γ^*

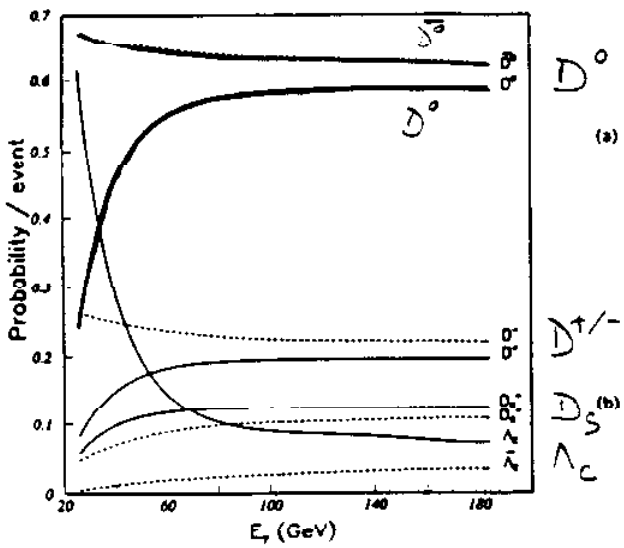
$$D(y) = \frac{1-(1-y)^2}{1+(1-y)^2}$$

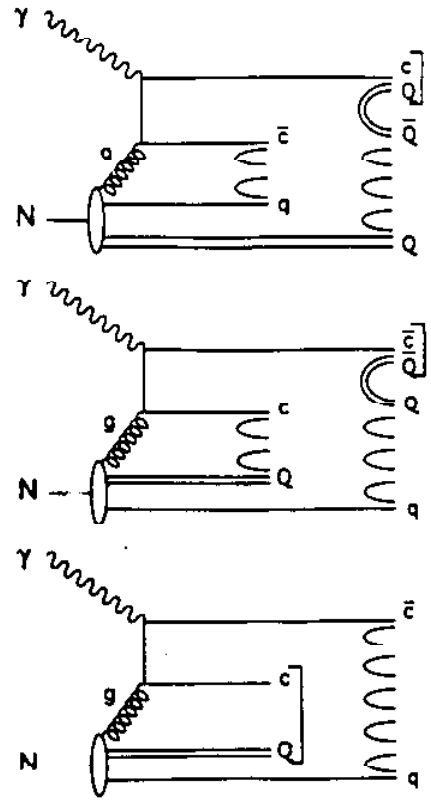
$$y = E_\gamma / E_\mu$$

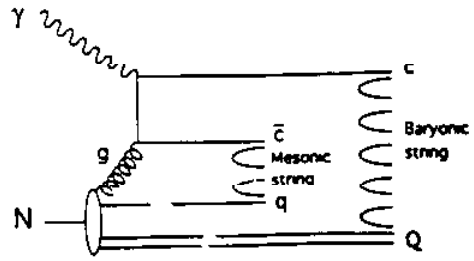
choose E_μ only slightly $> E_\gamma^{opt} = 60\,GeV$

$$\boxed{E_\mu \sim 100\,GeV}$$

HADRONIZATION OF $c\bar{c}$







PRIMARY		FINAL
D^0 ~ 10%		D^0 ~ 60%
D^+ ~ 10%		D^+ ~ 20%
D^{0*} ~ 30%	$\rightarrow D^0\pi^0,\ D^0\gamma$	
D^{+*} ~ 30%	$\rightarrow \frac{2}{3} D^0\pi^+ + \frac{1}{3} D^+\pi^0$	
D_s ~ 10%		D_s ~ 10%
Λ_c ~ 10%		Λ_c ~ 10%

- $D_s^{*}(\bar{D}_s^{*})$ dominate ~ 60%

- D^0 decays: $D^0 \rightarrow K^-\pi^+$ 4% ← easy to detect
  $D^0 \rightarrow K^-\pi^0\pi^+$ 13.8%
  $D^0 \rightarrow K^-\pi^+\pi^+\pi^-$ 8.1%

$c\bar{c} \rightarrow \mu^+\mu^-$

RECONSTRUCTION OF D^0

- CLEANEST DECAY CHANNEL

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

BR 0.04

- IDENTIFY K, π

PROBLEM: COMBINATORIAL BACKGROUND
DECAY VERTEX CANNOT BE DETERMINED
(MULTI SC. IN TARGET)

- ACCEPTANCE CUTS $|\cos \theta_K^*| < 0.5$, $z > 0.25$
$35 < \nu < 85$ GeV → PLOT

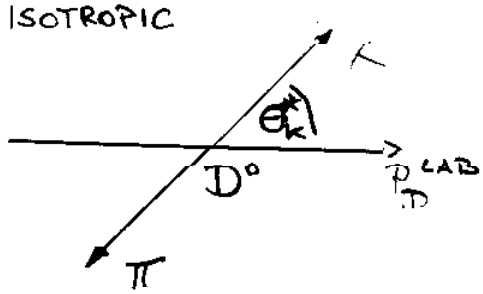
	SIGNAL D^0 $\bar{D}^0$	COMBINATORIAL BG
D^0/event	1.23	—
Accept cuts	0.29	0.00023
Multipl Sc.	0.76	0.80
BR	0.04	—
SHADOWING	—	0.95
REMAINING	0.011	0.00017
EVENTS/DAY	877	3450

$$S/B = 1/3.9$$

without acceptance cuts 1:26

ACCEPTANCE CUTS

CM
ISOTROPIC

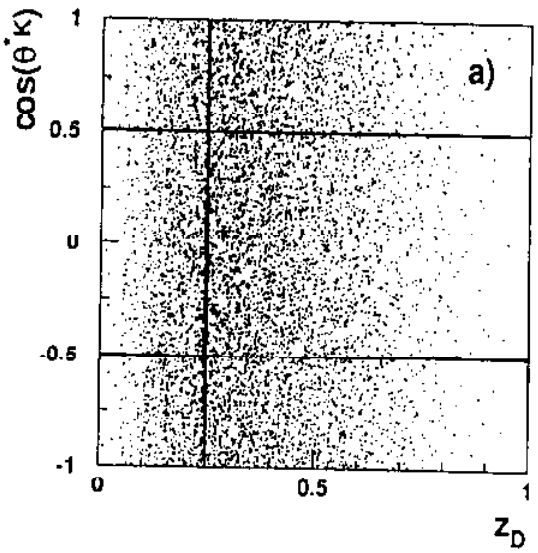


$p^* = 860$ MeV/c

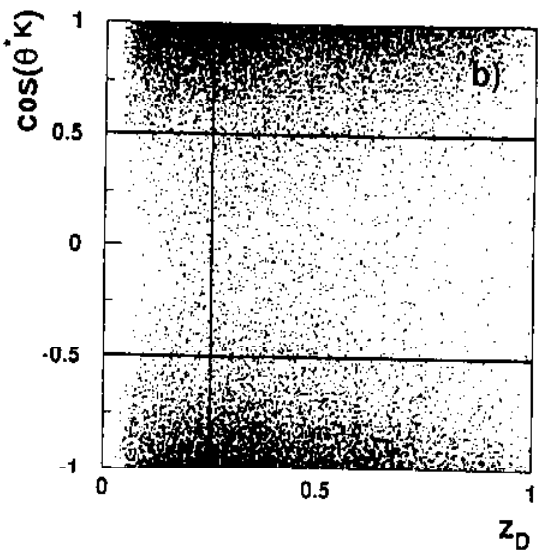
- $|\cos\theta_K^*| \leq 0.5$
- $z > 0.25$
- MASS WINDOW ± 20 MeV $\sigma_m = 10$ MeV
- $35 < \nu < 85$ GeV

MONTE CARLO

D^0-DECAYS

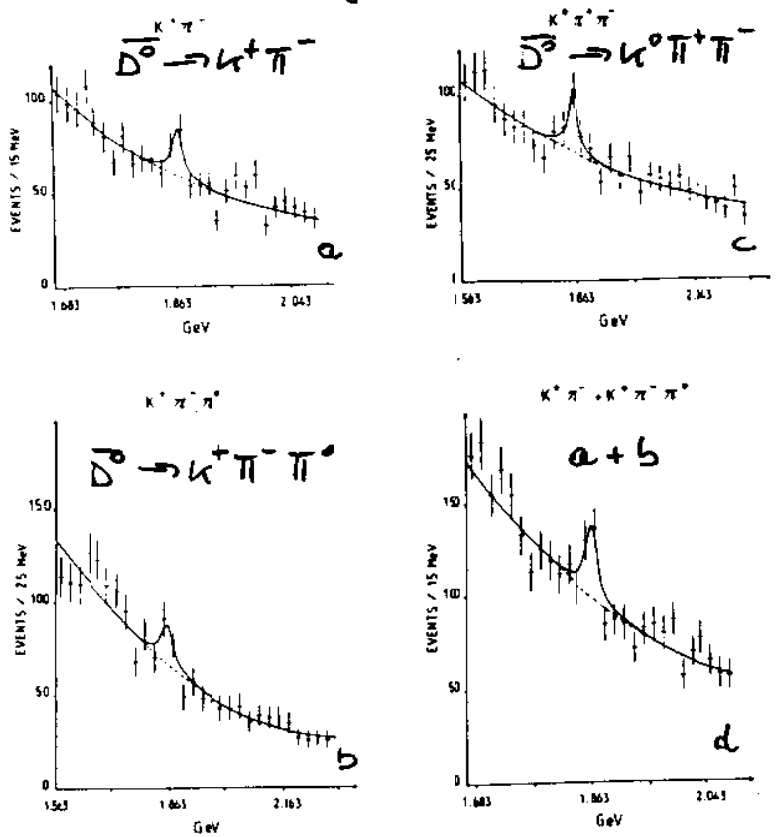


Combinatorial BG



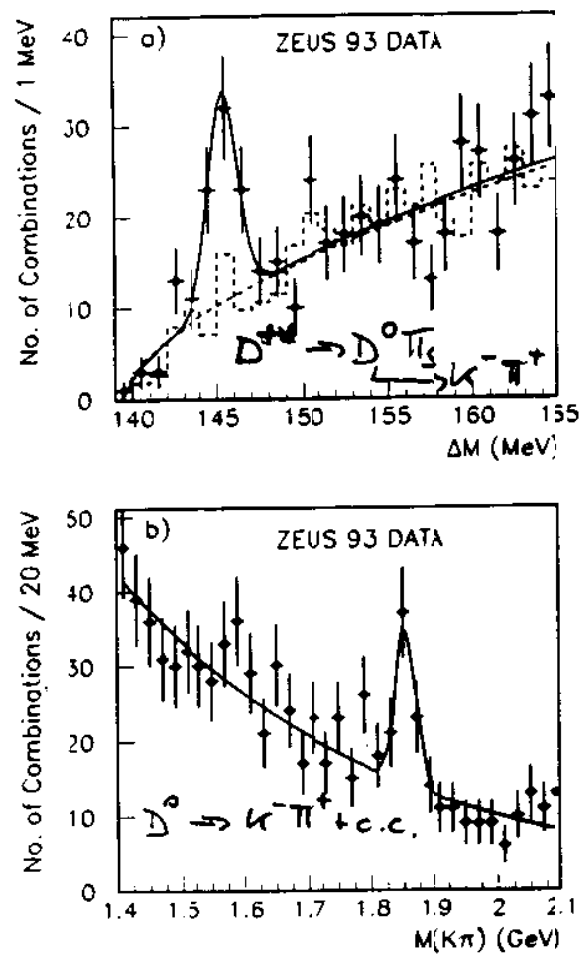
CHARM IDENTIFICATION ($D^0 \to K^- \pi^+$ + c.c.) NO SECONDARY VERTEX

γp (E_γ 40-70 GeV) WA4



PL 94B (1980) 113

e p ZEUS



PL 349B (1985) 225

RATE ESTIMATES

$\mu N \to c\bar{c} X$

$$\frac{d^2\sigma^{\mu N}}{dQ^2 d\nu} = \Gamma(E, Q^2, \nu)\ \sigma^{\gamma^* N}(Q^2, \nu)$$

$$\frac{\alpha}{2\pi}\ \frac{2(1-y)+y^2+Q^2/2E^2}{Q^2(Q^2+\nu^2)^{1/2}}$$

PHOTON FLUX

$$\frac{\sigma^{\gamma N}(\nu)}{\left(1+Q^2/M^2\right)^2}$$ → PLOT

$M = 3.9$ GeV fitted to EM data

$\sigma^{\gamma N}$ REAL PHOTON CROSS SECTION MEASURED BY SEVERAL EXPERIMENTS IN AGREEMENT WITH CALCULATION FROM GLUON $g(x_g)$! $m_c = 1.5$ GeV

EXPECT FOR $35 < \nu < 85$ GeV about

82 000 CHARM EVENTS / DAY 1.9 nb

20'000'000 DIS EVENTS / DAY 463 nb

$\mathcal{L} = 4.3 \cdot 10^{37}\ cm^{-2}\, day^{-1} = 5 \cdot 10^{32} / cm^2 s$

$= 43\ pb^{-1}/day$

PARAMETERS OF THE EXPERIMENT

MUON BEAM 100 GeV, 80%, $2 \cdot 10^8$/spill 5x "SMC"

TARGET 2 x 60 cm (TWIN CELL)
3 cm ϕ

MATERIAL NH_3, 85%, f = 0.176, ^6LiD, [illegible]%, f = [illegible]

Acceptance ± 180 mrad, $\Delta p/p = 1-2\%$

particle ID 3σ K, π separation, > 3 GeV/c

NOMINAL LUMINOSITY $5.0 \cdot 10^{32}\ cm^{-2}\ s^{-1}$

Assuming OVERALL EFFICIENCY 0.25 beam Spectrom.

2.5 years { 1 year (150 days) NH_3
1.5 years ^6LiD

66 K reconstructed $D^0 \to K\pi$
250 K Background

$$\boxed{\delta A^{cc}_{\gamma N} = 0.076} \;\hat{=}\; \delta\left(\frac{\Delta g}{g}\right) = 0.21$$

$$\delta A^{cc}_{\gamma N} = \frac{1}{P_B P_t f D} \frac{1}{\sqrt{N^S}} \sqrt{1 + \frac{N^B}{N^S}}$$

FURTHER TRICKS

D^* TAGGING $D^{+*} \longrightarrow D^0 + \pi^+$

30% of D^0s

$$\Delta M = m(\pi^+\pi^+K^-) - m(\pi^+K^-) = 145\ \text{MeV}$$

- Detect SOFT PION > 1 GeV/c
- CUT $\Delta M \pm 5$ MeV
- ESSENTIALLY BACKGROUND FREE
- RELEASE z AND $\cos\theta_K^*$ CUTS

$$\delta A_{\gamma N}^{cc} = 0.051$$

$$\delta \frac{\Delta g}{g} = 0.14$$

P_T CUT $\quad P_T(D^0) < 1.0$ GeV/c

- INCREASES ANALYSING POWER

$$\boxed{\delta \frac{\Delta g}{g} = 0.11}$$

OTHER CHANNELS TO BE INVESTIGATED:

$D^0 \to K^-\pi^+\pi^0$ 13.8%

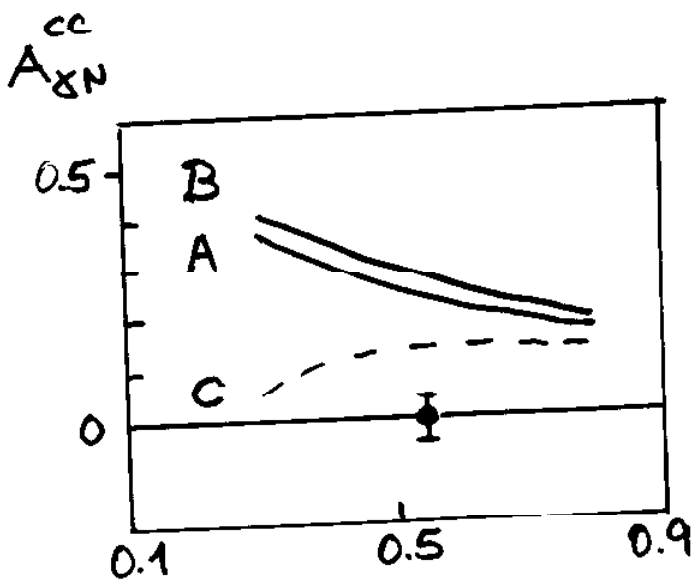
$D^0 \to K^-\pi^+\pi^+\pi^-$ 8.1%

$D^+ \to K^-\pi^+\pi^+$ 9.1%

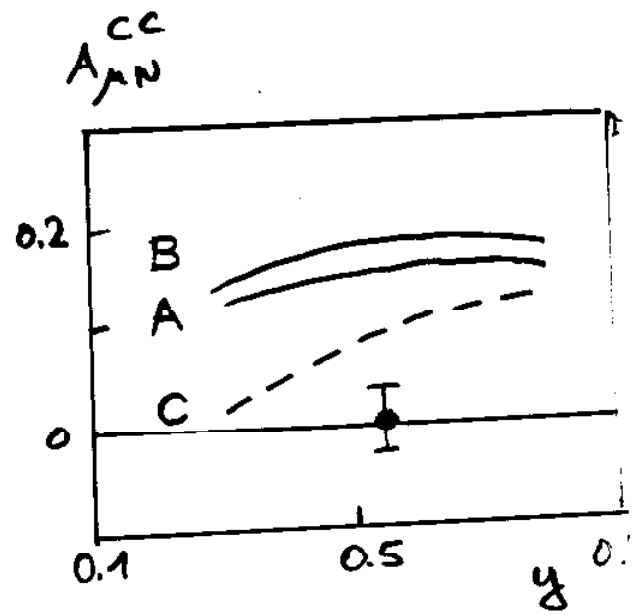
$\to$ J/ψ Production

K-FACTOR 2 FOR $Q^2 > 10$ GeV^2!

PHOTON ASYMMETRY



MUON ASYMMETRY



GLUON: Gehrmann & Stirling z PHYS C65 (1995) 461

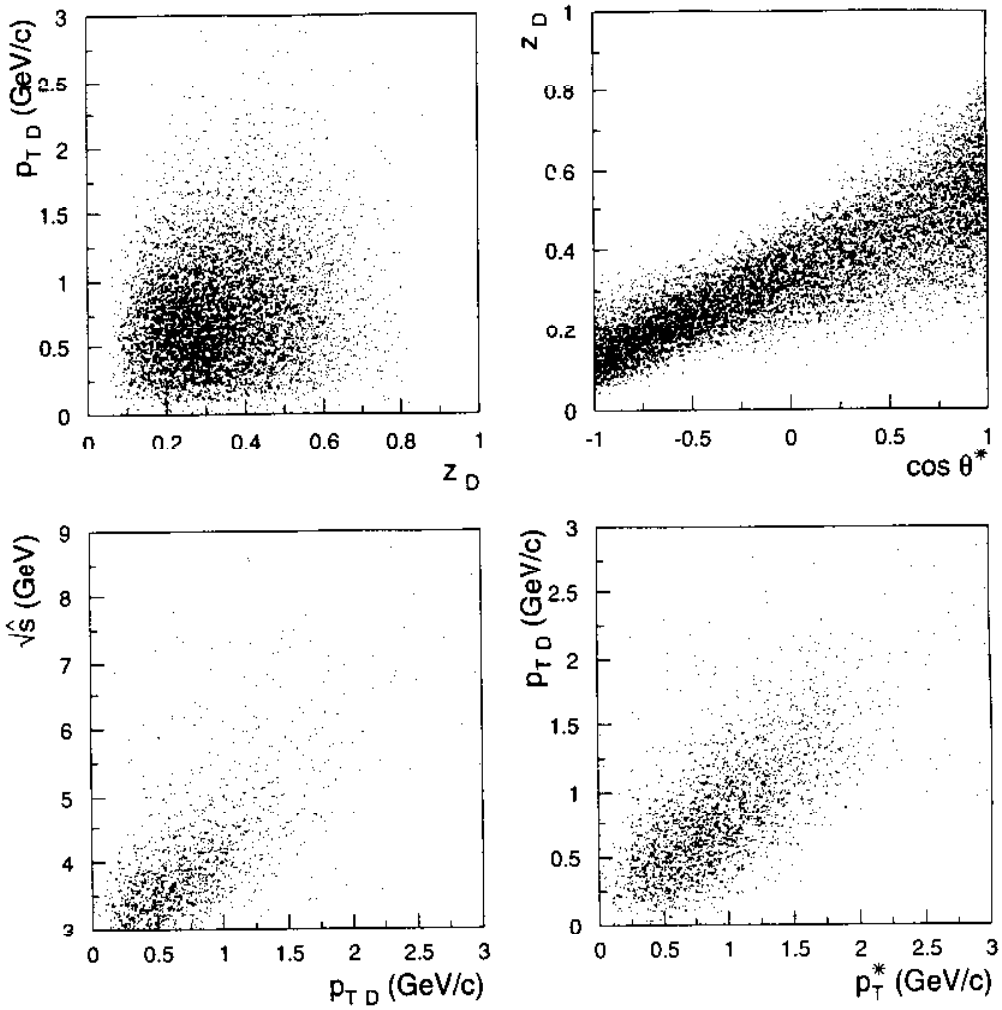
observable $A_{\gamma g} \sim 0.02$

Large

C.M. vs. LAB. KINEMATICS CORRELATIONS

ONE CHARM HADRON DETECTED

$\rightarrow \int$ OVER C.M. PGF KINEMATICS $\langle \frac{\Delta G}{G} \rangle_\eta$



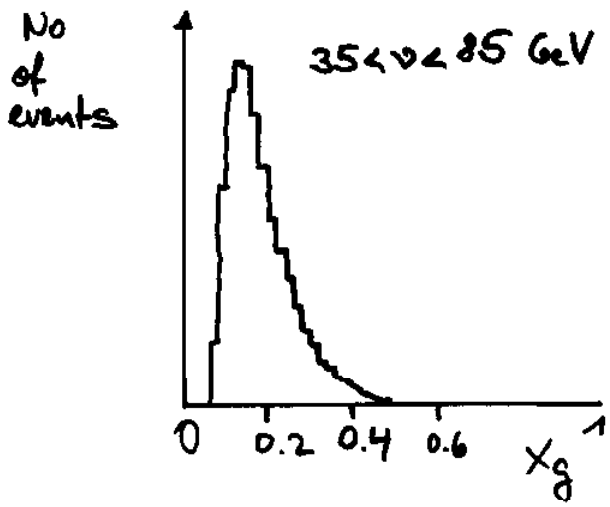
SOME CORRELATION BETWEEN C.M. VARIABLES $\hat{s}, \theta^*, \phi$ AND LABORATORY OBSERVABLES z, p_T REMAINS

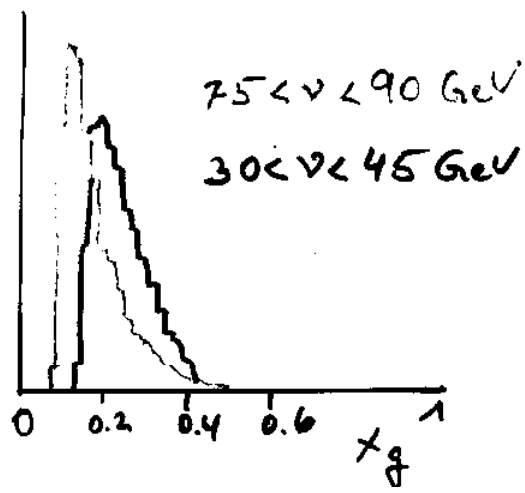
$\rightarrow \langle \frac{\Delta G}{G} \rangle_\eta$ OVER SMALLER η RANGE

$\rightarrow$ ENHANCE $\langle a_{LL} \rangle$ (BETTER SENSITIVITY ON $\Delta G/G$)

GLUON x_g (MOMENTUM FRACTION)

- AT 100 GeV μ beam





$X_{PEAK} = 0.14$

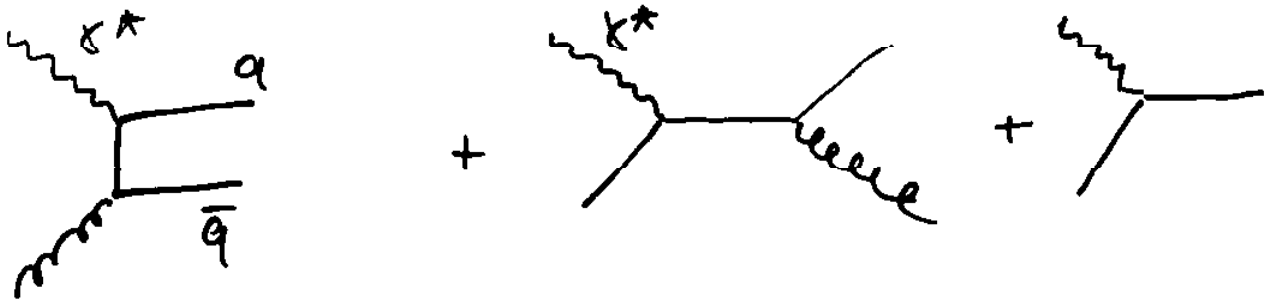
$X_{min} = 0.07$

$X_{peak} = 0.10$

$X_{peak} = 0.22$

- calculated with unpolarised $g(x)$
- OPTION 200 GeV E_μ $x_g \Rightarrow x_g/2$

"NEW": HIGH P_T KAONS



PGF COMPTON LO

- HERE: PRELIMINARY STUDY OF K^+K^- pairs FOR COMPASS (200 GeV)

A. BRAVAR
A. Kotzinian
D. V. HARRACH

- SIMILAR TO 2+1 jets at HERA
- SUBPRESS COMPTON CONTRIBUTION
- JETSET + LEPTO
  - 2 HIGH P_T HADRONS
  - OPPOSITE CHARGE
  - "FLAVOUR TAGGING" $s\bar{s} \to K^+K^-$

	S:B	LO	COMPT	PGF	TOT
all	1:5	0.60	0.22	0.18	1
a) K^+K^-	1:2.5	0.42	0.29	0.29	0.025
b) K^+K^-	2:1	0.05	0.30	0.65	$1.5 \cdot 10^{-4}$
c) h^+h^-	1:1	0.05	0.49	0.46	$2 \cdot 10^{-3}$

a) $P_T > 0.5$ GeV b) $P_T > 0.8$ GeV, $m_{K^+K^-} > 3$ GeV, $z > 0.$

c) like b)

RESULT OF PRELIMINARY STUDY

ESTIMATES USING GS96, GRV 94 LO BRAUAR et al.

200 GeV E_μ

$0.52 < y < 0.9$

$\delta A_{LL}^{KK} \sim 0.02$

$\delta A_{LL}^{hh} \sim 0.005$

STATISTICAL ERROR ONLY

$$A_1 = A_{LL} = \langle a_{LL}^{PGF} \rangle \langle \frac{\Delta g}{g} \rangle \frac{\sigma^{PGF}}{\sigma_{tot}} + \langle a_{LL}^{COMP} \rangle \langle \frac{\Delta u}{u} \rangle \frac{\sigma^{COMP}}{\sigma_{tot}}$$

$$-1 \quad 0.36 \quad 0.3 \qquad 0.5 \quad 0.25 \quad 0.65$$

$x_g = 0.1$, $Q^2 = 10\,GeV^2$

ROUGH ESTIMATE:

$\delta \left(\frac{\Delta g}{g}\right)_{KK} \sim 0.04$

$\delta \left(\frac{\Delta g}{g}\right)_{hh} \sim 0.10$

STATISTICS AND COMPTON

LOOKS PROMISING!

Further MC STUDIES NEEDED! + SYST ERROR

NOTE: A^{cc} and A^{kk} have opposite sign!

Flavour Separation

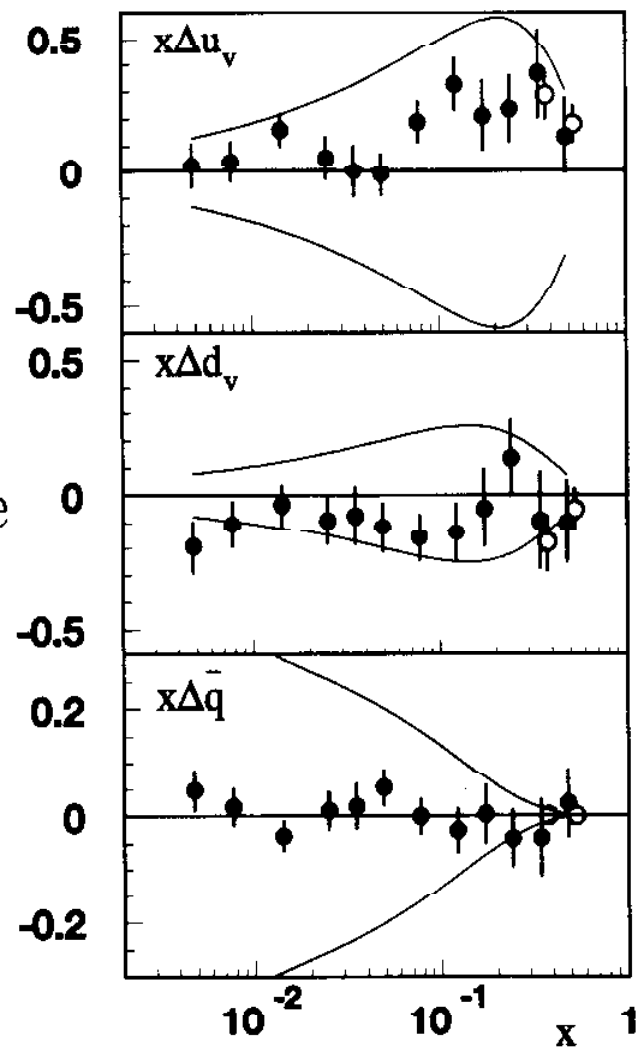
- $\mu N \to \mu' h^{\pm} X$
- $\frac{dN^h}{dz}(x,z) = \sum e_i^2 q_i(x) D_i^h(z); \quad z = \frac{E_h}{\nu}$
- favoured $D_u^{\pi^+}$ > unfavoured $D_{\bar{u}}^{\pi^+}$ (from EMC)
- π^+ & π^- data from d & p targets
- $\Rightarrow$ flavour and q & $\bar{q}$ separation!

SMC

up valence
$\Delta u - \Delta\bar{u}$

down valence
$\Delta d - \Delta\bar{d}$

sea
$\Delta\bar{u} = \Delta\bar{d} = \Delta\bar{q}$



Integral $0 < x < 1$

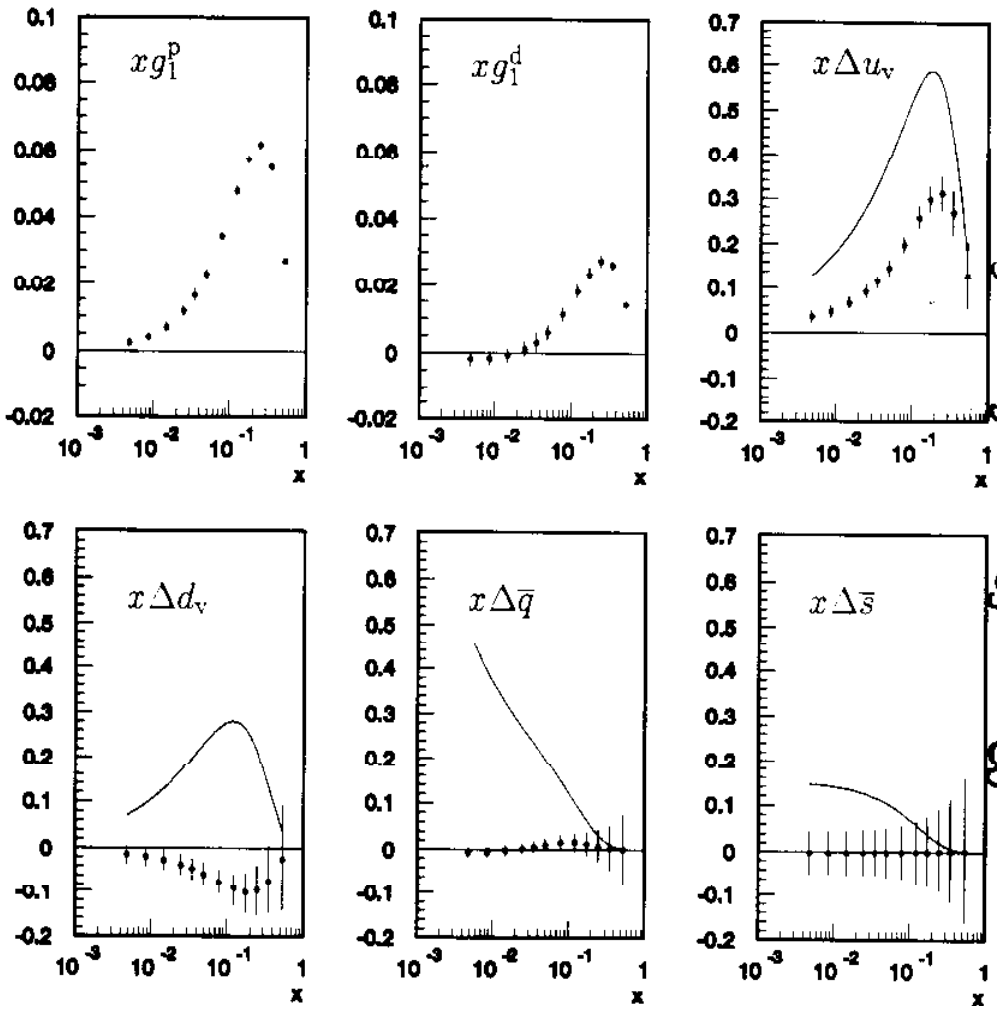
> 0
$0.85 \pm 0.14 \pm 0.12$

< 0
$-0.58 \pm 0.16 \pm 0.11$

~ 0
$0.02 \pm 0.06 \pm 0.03$

Flavour Separation

- COMPASS projections



$\int \Delta u_v \, dx = 0.$

$\int \Delta d_v \, dx = 0.$

$\int \Delta \bar{q} \, dx = 0.$

$\int \Delta \bar{s} \, dx = 0.$

- Fragmentation and Fracture Functions

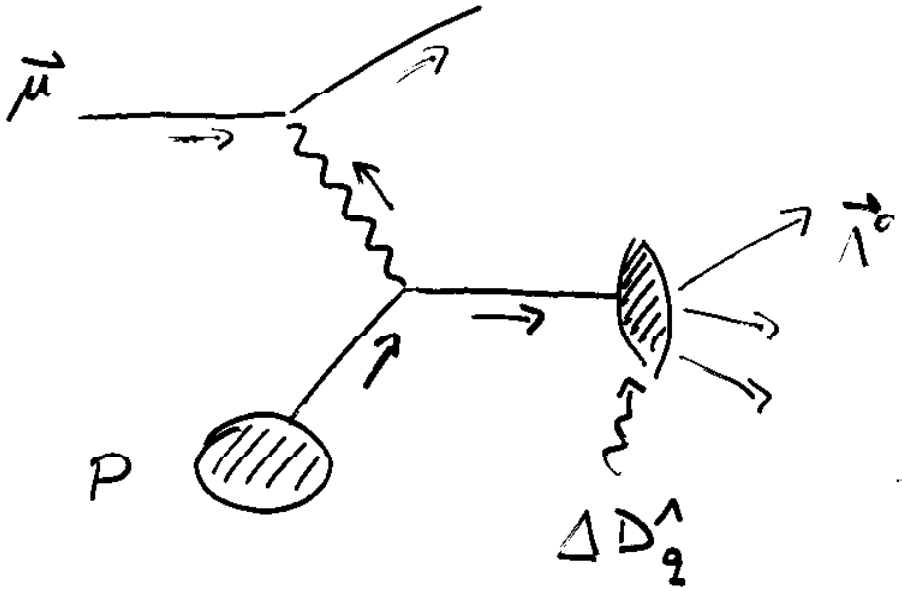
  NLO calculations are now available

  de Florian, Garcià Canal, Sassot, NPB 470 (1996) 195

  de Florian, Sassot, hep-ph/9703228

  Stratmann, Vogelsang, hep-ph/9612250

Λ ($\bar{\Lambda}$) POLARIZATION



$$P_{\parallel}^{\Lambda}(x,y,z) = \frac{\sum e_q^2 \left[P_B D(y)\, q(x) + P_T \Delta q(x) \right] \Delta D_q^{\Lambda}(z)}{\sum e_q^2 \left[q(x) + P_B D(y) P_T \Delta q(x) \right] D_q^{\Lambda}(z)}$$

$$D_q^{\Lambda} = D_q^{+\Lambda} + D_q^{-\Lambda}$$

$$\Delta D_q^{\Lambda} = D_q^{+\Lambda} - D_q^{-\Lambda}$$

+, − parallel (anti-) spins
q, Λ

$$\Delta D_q^{\Lambda}(z) = C_q^{\Lambda}(z)\, D_q^{\Lambda}(z)$$

$C_q^{\Lambda}(z)$ – spin transfer coefficient

→ MODELS FOR C_q^{Λ}

SPIN TRANSFER COEFFICIENTS

- FRAGMENTATION FUNCTIONS $q \to \Lambda$

$$D_q^\Lambda = D_q^{+\Lambda} + D_q^{-\Lambda}$$

$$\Delta D_q^\Lambda = D_q^{+\Lambda} - D_q^{-\Lambda}$$

+ parallel spins of q, Λ
− anti parallel

- SPIN TRANSFER COEFFICIENTS C_q^Λ

$$\Delta D_q^\Lambda(z) = C_q^\Lambda(z)\, D_q^\Lambda(z)$$

- Burkhardt - Jaffe (PRL 70 (1993) 2537, hep-ph/9605445

$$\Delta u^\Lambda = \Delta d^\Lambda = \tfrac{1}{3}(\Delta\Sigma - D); \quad \Delta s^\Lambda = \tfrac{1}{3}(\Delta\Sigma + 2D)$$

RELATED QUANTITIES ΔD_q^Λ and Δq^Λ

Assume: $C_q^\Lambda(z) = \Delta q^\Lambda = \int_0^1 \Delta q^\Lambda(x)\,dx$

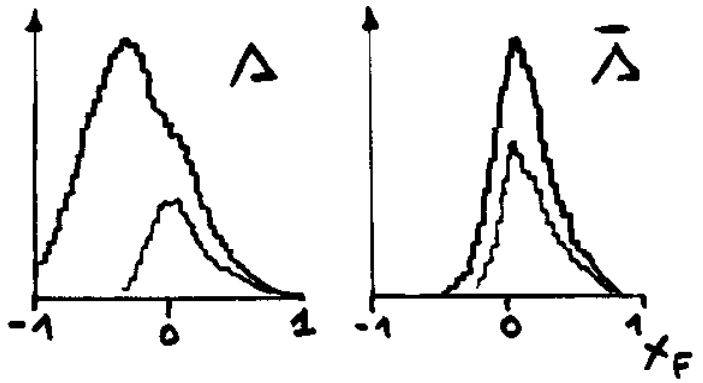
- Bigi, Gustafson, Häkkinen SU(6) NC 41A, 43
PL B303, 350

		C_u^Λ	C_d^Λ	C_s^Λ	$C_{\bar q}^\Lambda$	
NAIVE →	direct	0	0	1	0	BGH
	Σ^0	$-2/9$	$-2/9$	$1/9$	0	BGH
	Σ^{1385}	$5/9$	$5/9$	$5/9$	0	BGH
	Ξ	-0.3	-0.3	0.6	0	BGH
		-0.2	-0.2	0.6	0	B-J 1
		-0.14	-0.14	0.66	-0.06	B-J 2

LAMBDA POLARISATION

COMPASS PROPOSAL &
Kotzinian, Bravar, v. Harrach
hep-ph/9701338

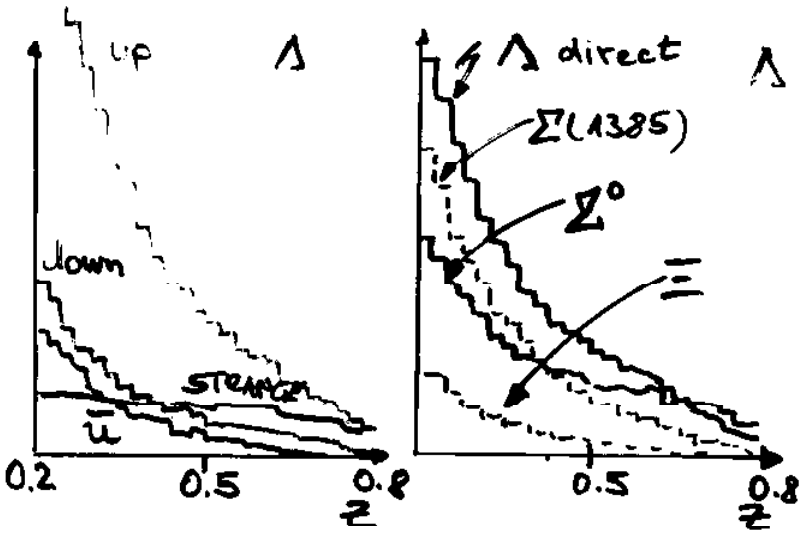
- LEPTO, JETSET MONTECARLO
- MRSA'



x_F DISTRIBUTIONS

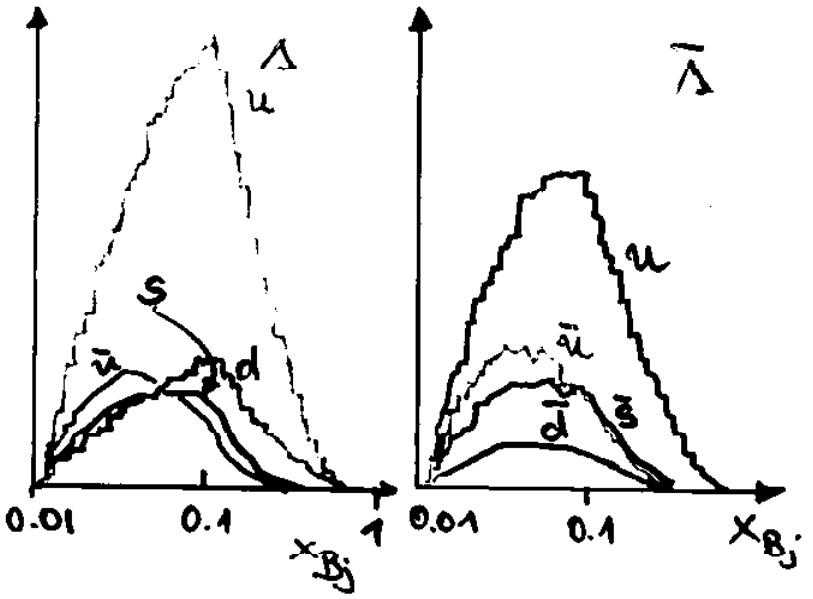
— generated
--- accepted COMPASS
$E_\mu = 100$ GeV

- COMPASS ACCEPTANCE MAINLY IN CURRENT FRAG REGION, $x_F > 0$



z DISTRIBUTIONS
$x_F > 0.$ (200 GeV)

- Λ Production dominated by u quarks apart from large z



x_{Bj} DISTRIBUTIONS

- Λ PRODUCTION dominated by u quarks apart from very small x

LONGITUDINAL Λ POLARISATION

hep-ph/9701384

ELECTRO PRODUCTION:

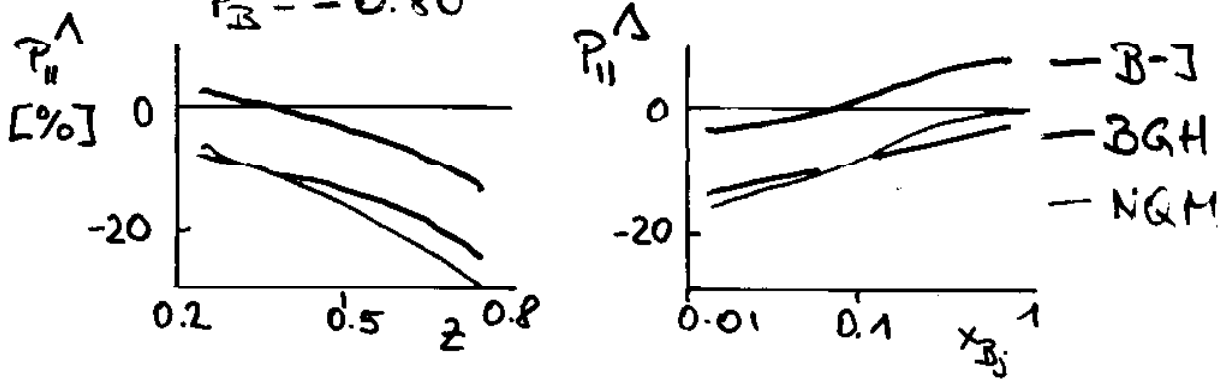
$$P_{\parallel}^{\Lambda}(x,y,z) = \frac{\sum e_q^2 \left\{ P_B D\, q(x) + \cancel{P_T \Delta q(x)} \right\} \Delta D_q^{\Lambda}(z)}{\sum e_q^2 \left\{ q(x) + \cancel{P_B D P_T \Delta q(x)} \right\} D_q^{\Lambda}(z)}$$

along $\vec{q}$

vanish for unpol. target

- UNPOLARISED TARGET

$P_B = -0.80$



- average Polarisations: $E = 200$ GeV, $x_F > 0$, $z > 0.2$

Λ	-0.12	-0.12	-0.01
$\bar{\Lambda}$	-0.16	-0.13	-0.05

- EXPECTED PRECISION ON $P_{\parallel}^{\Lambda}$ FROM COMPASS

  RECONSTRUCTED $\Lambda \sim 2 \cdot 10^5$ /year $x_F > 0$

  $\Rightarrow$ few % / bin ($4 \cdot 10^3$ /year $-0.2 < x_F < 0$)

- POLARISED TARGET ($P_T = 1$, $f = 1$)

  e.g. $\Delta P^{\Lambda} = P_{\uparrow}^{\Lambda} - P_{\downarrow}^{\Lambda}$ ← LONGIT. P_T

  Expect $\Delta P^{\Lambda} \sim 0$ for GRSV and GS PDF

  $\Delta P^{\Lambda} \sim 0.05 - 0.10$ BBS PDF

  REDUCED BY P_T and f by $\sim \frac{1}{4}$

  $\Rightarrow$ Difficult to see

  NOT SUITED TO MEASURE Δq !

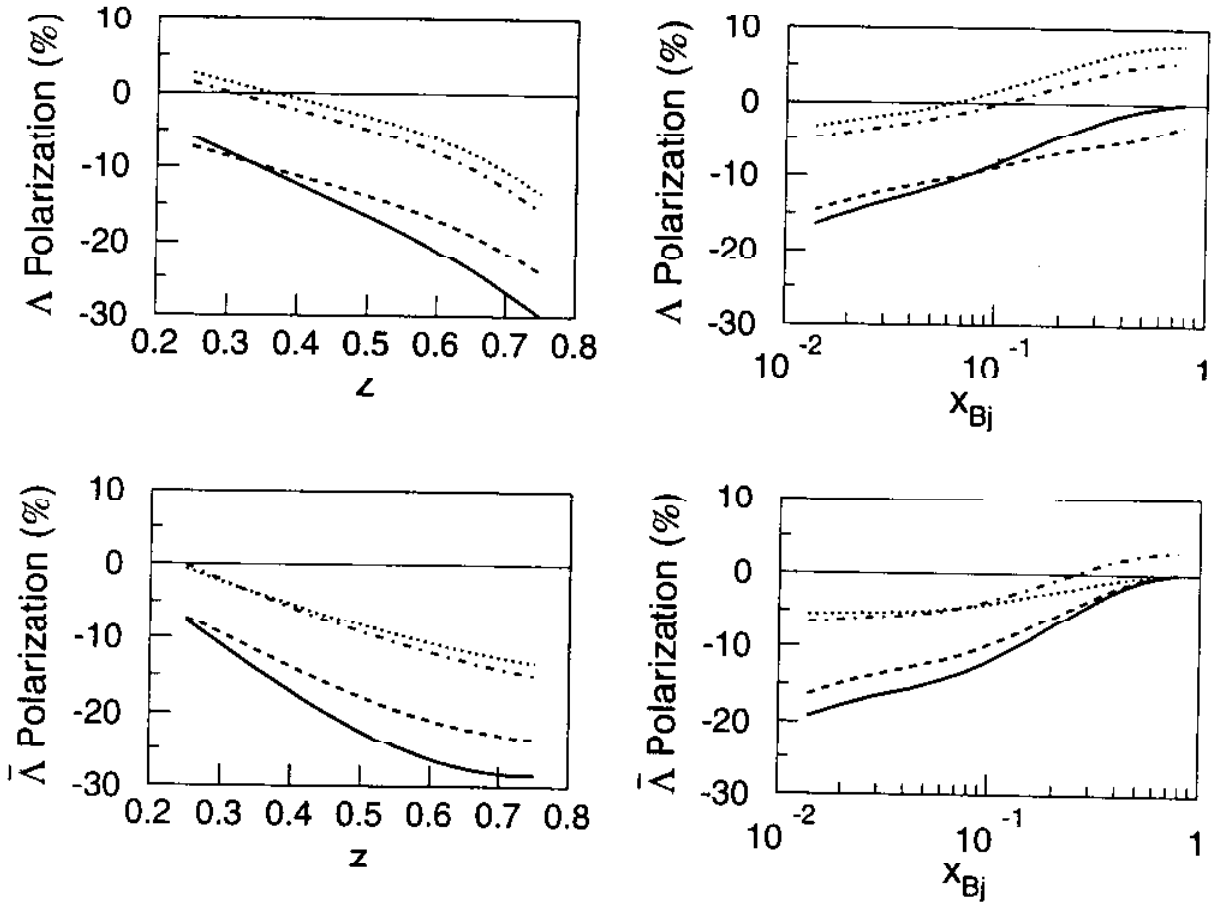
(Λ, $\bar{\Lambda}$) POLARIZATION (UNPOL. TARGET)

PREDICTIONS

E_{beam} = 200 GeV; $0.5 < y < 0.9$; isoscalar target unpolarized

$P_b = -80\%$

$x_F > 0$ & $z > 0.2$



——— NQM

- - - - BGH

-·-·- B-J 2

····· B-J 1

TRANSVERSITY $h_1(x)$

Jaffe & Ji
PRL 67 (1991) 552
NPB 375 (1992) 5

$$h_1(x) = \frac{1}{2} \sum_f e_f^2 \left[\Delta_T q(x) + \Delta_T \bar{q}(x) \right]$$

not accessible in inclusive DIS (odd chirality)
but accessible in semi-inclusive DIS

NEED: Transverse polarisation of target
MEASUREMENT OF Polarisation of struck quark
e.g. Collins effect

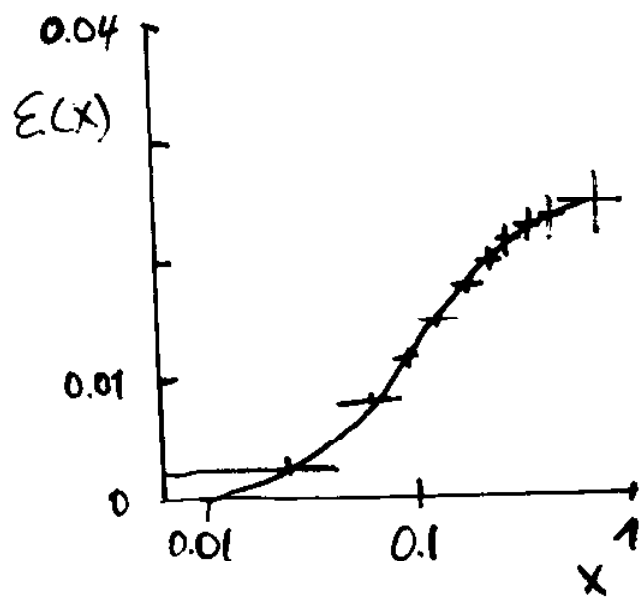
e.g. π^+ & π^-

$$A^p = \underbrace{P_T \cdot D_{nn} f \cdot \frac{2x\, h_1}{F_2}}_{\mathcal{E}(x)} \; a_c \sin \phi_c$$

assumed model ≈ 0.2
Artru

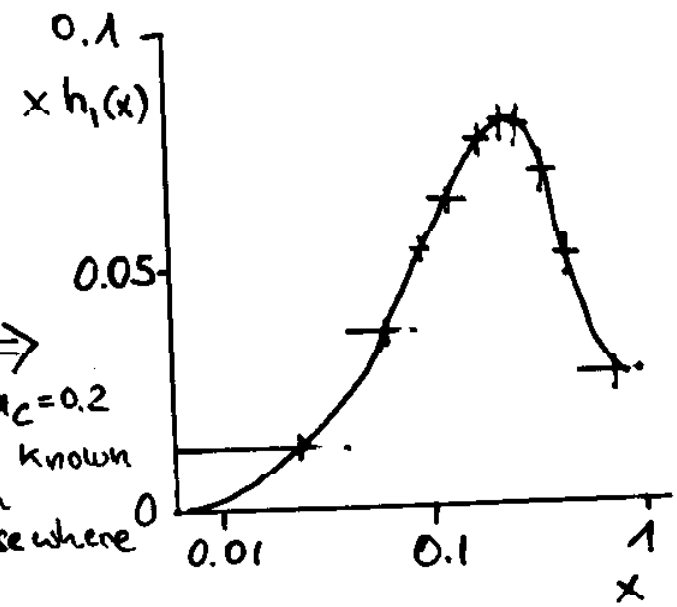
$\phi_c = \phi^h + \phi^s$ azimuthal angle of hadron and initial quark

$h_1 \sim g_1$



30 days data taking

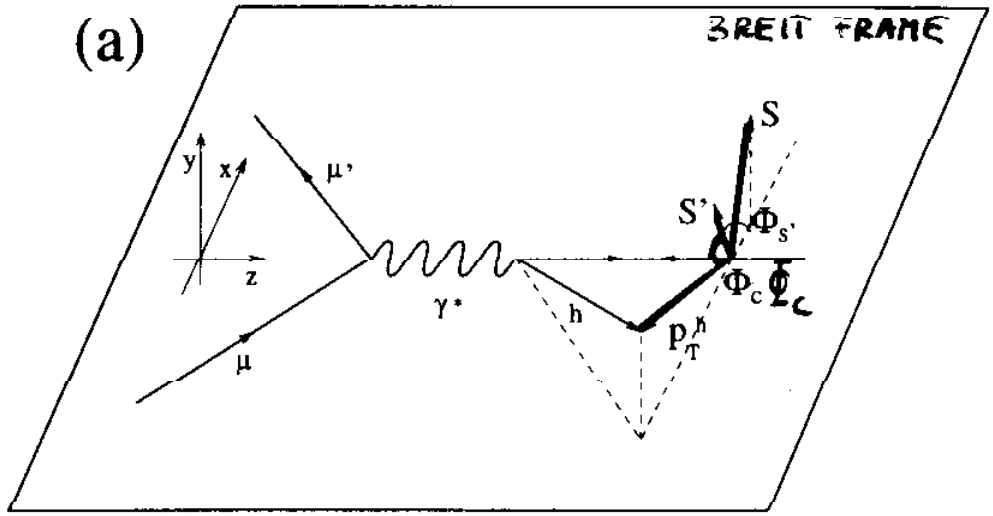
$\Rightarrow$ if $a_c = 0.2$ and known from elsewhere



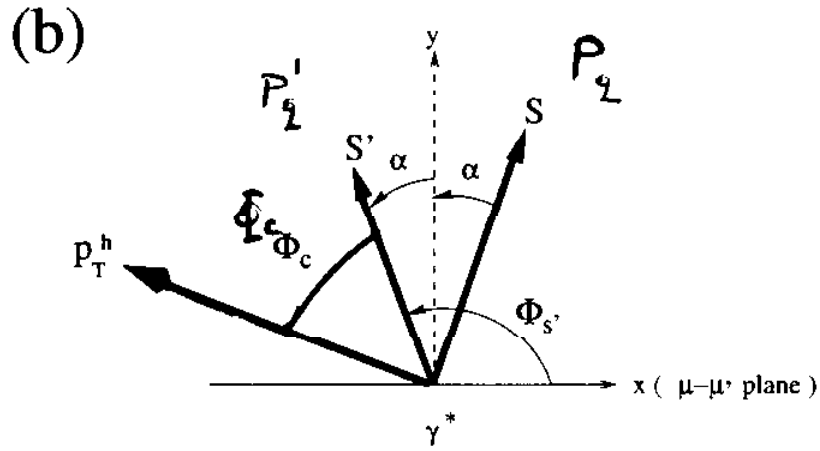
$z > 0.1$, $E' > 5$ GeV, $\nu > 15$ GeV

"COLLINS EFFECT"

$$\mathcal{D}^h_{q\uparrow}(z, \vec{p}^h_q) = D^h_q(z, p^h_q) + \Delta D^h_q(z, p^h_q) \sin\Phi$$



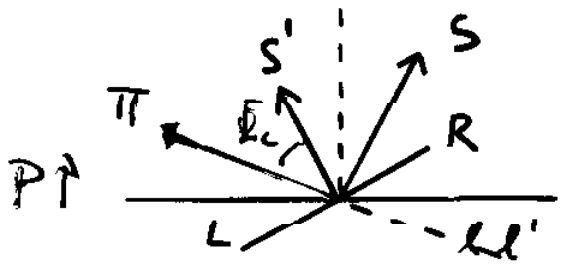
Φ_c - "COLLINS ANGLE"



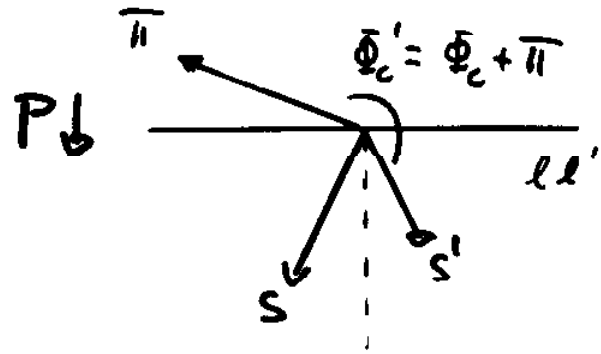
$P_q' = D_{NN} P_q$ (QED) $\qquad P_q' < P_q$

$$D_{NN}(y) = 2(1-y) / [1 + (1-y)^2]$$

THE $\perp$ ASYMMETRY



$\sin \Phi_c$



$\sin \Phi_c' = -\sin \Phi_c$

$$N(\Phi_c) \propto (1 + \varepsilon \sin \Phi_c)$$

$\Longrightarrow$ AZIMUTHAL ASYMMETRY (LEFT-RIGHT)

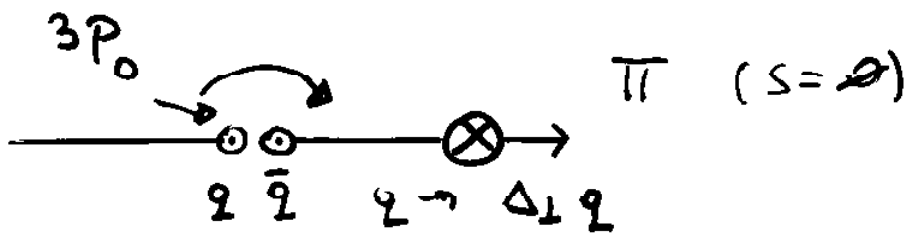
$$\varepsilon(\Phi_c) = \frac{N^+(\Phi_c) - N^-(\Phi_c + \pi)}{N^+ + N^-}$$

$$= \langle P_T \rangle \cdot D_{NN} \cdot H(x)\, a_c \cdot \sin \Phi_c$$

$$H(x) \sim \frac{\Delta_\perp u(x)}{u(x)} \sim \frac{2x\, h_1(x)}{F_2}$$

$$a_c = \frac{\Delta_\perp D}{D} \qquad (\sim 0.2) \qquad \text{NONPERTURBATIVE!}$$

<u>ORIGIN a_c</u> : "OLD" LUND STRING MODEL



$S \odot \to L \otimes$] LOCALLY CONSERVED

ALTERNATIVE FOR h_1

Mulder, Tangerman (1995)
NPB 461 (1996) 197

- MEASURE TRANSVERSE Λ Polarisation

$$\Delta P_T^{\Lambda} \sim D(y) \frac{\sum e_f^2 \, \Delta_T q^f \cdot \Delta D_{Tq}^{\Lambda}}{\sum e_f^2 \, q_f}$$

- $\Delta D_{Tq}^{\Lambda} \rightarrow \hat{h}_1^f$ (Mulders, Tangerman)

TWIST-2 Fragmentation Function

- Like for COLLINS ASYMMETRIC

NEEDED Transverse Target POL.
NO BEAM POL.

SUMMARY

- Compass is approved and will start data taking in 2000
- First results will be obtained before 2003 (Δg, Meson spectroscopy)
- Apart from open charm high P_T kaon pairs could be a good signal for Δg
- Large physics programme

  $\Delta_T q$, $\Delta D_q^{\wedge}$, h_1

  DVCS?