HIF report
contribution to the SPSC meeting
Villars -2004

Hadronic Physics working group

Our (simple) general vision

- We believe we are facing an era where our understanding of particle physics is *likely* to be subject to **big changes** (*and confusion?!).*
- We do not know exactly where Nature will take us. We have to be equipped with theory and experiments **to address whatever scenario** may appear.
  - recent examples from beauty factories
  - *large* direct CPV
  - *unexpected* states in charm spectroscopy
- **Strategy**: **diverse** and **flexible** system to cover the entire field of particle physics, mantaining an excellent world-wide level of competitivity.

QCD and strong interactions

- **Strong interaction** studies will play a **crucial role**: QCD is ubiquitous in high-energy physics!

Once new particles are discovered at LHC, it will be mandatory to explore parameters, mixing patterns, i.e., we need an **unprecedented ability** to interpret the **strong interaction** structure of **final states**

Synergy: kaon system, heavy flavour, spectroscopy, pdf...

- Many **intellectual puzzles** still **open in QCD**
  - Confinement, chiral symmetry breaking, vacuum structure, hadron masses, origin of spin etc.

QCD and strong interactions ...cont'd.

- **Parton distribution functions** (nucleon structure): a **grand project of QDC** over the last decades!

  Complex enterprise involving theoretical and experimental challenges

  Validation of QCD input parameters (PDF's, α_s) in view of the early stage of LHC

- LHC itself will then provide a new frontier for QCD

The boundary between QCD for its own sake, and QCD as a servant for new physics is thin...QCD is anyway challenging!!

In this philosophy....

.......a few considerations about possible measurements

- **Some (selected) topics in**
  - Light and heavy hadron spectroscopy
  - Studies of nucleon structure (DIS, Drell-Yan)
  - SM measurements with Heavy Flavours

work in progress

Thanks to the chairpersons of the session hosting this talk, which will be "transverse" to various sessions

- **Within the framework of**
  - A Super-PS (a few 10^{14} p/s)
  - A Super-SPS @ 1 TeV (10^{14} p/pulse every 10 s)

  (approx. 100 x Tevatron)

W.Scandale
La Biodola HIF2004

- **In the time schedule of**
  - 2012-2015 ...in the absence of a crystal ball we can only use imagination and daring

Open possibilities @ high intensity facilities for hadronic physics

Possibilities to provide many different beams and to address many different physics topics, advantages:

- FLEXIBILITY
- MODULARITY

- Antiproton beams
  (“low” energy, high intensity, good Δp/p)

-Hadron and photon beams (high energy high intensity)
  - hadroproduction with fixed target
  - photoproduction with fixed target

→ Light-State spectroscopy
Charmonium
Bottomium
Exotics (in a wide mass range)
Mixing & Rare decays
Heavy-Flavour Spectroscopy

- Lepton beams → ΔG, h_1, GPD’s

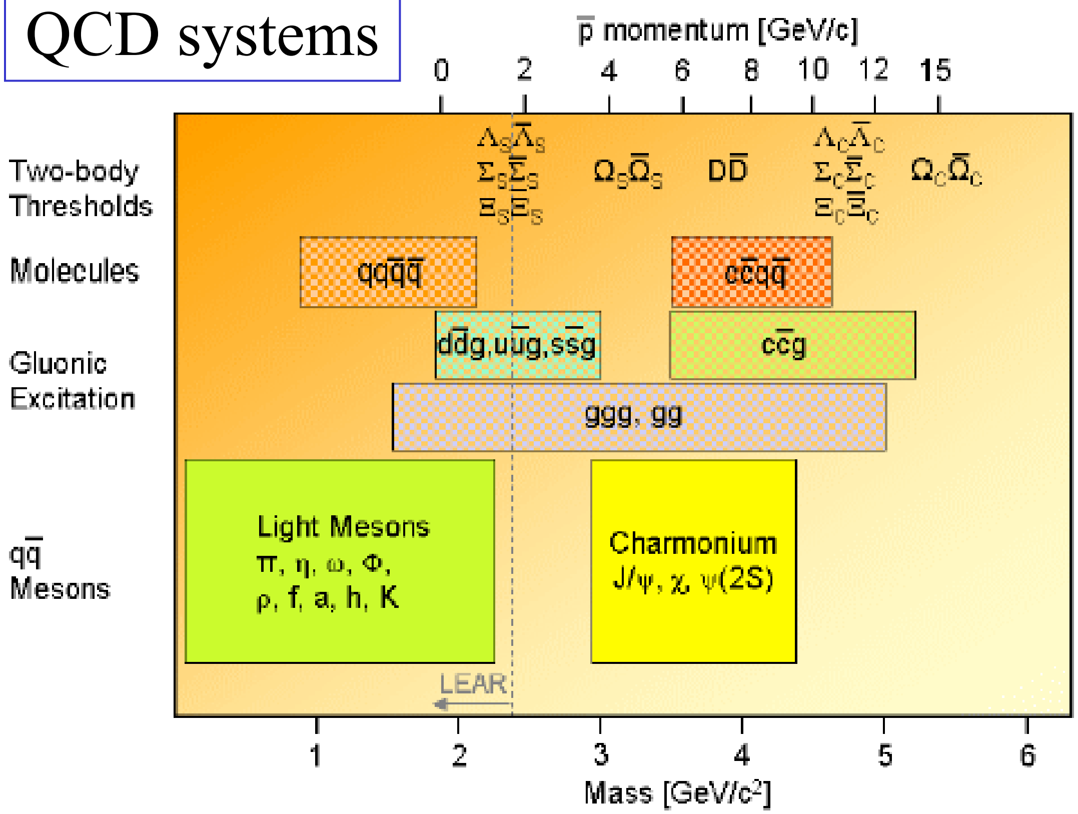
Study of QCD states

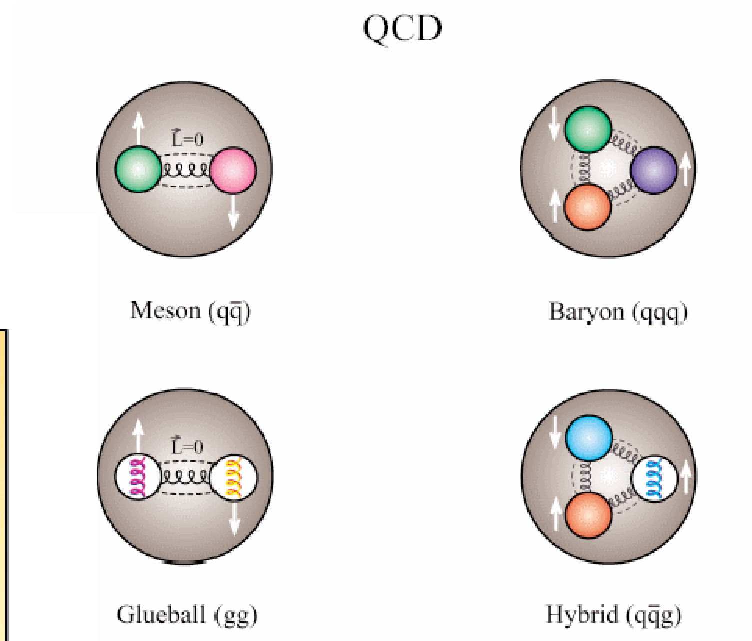
Search for foreseen states, look for exotics (not yet established !!):

→ Light states

→ Heavy states

QCD systems



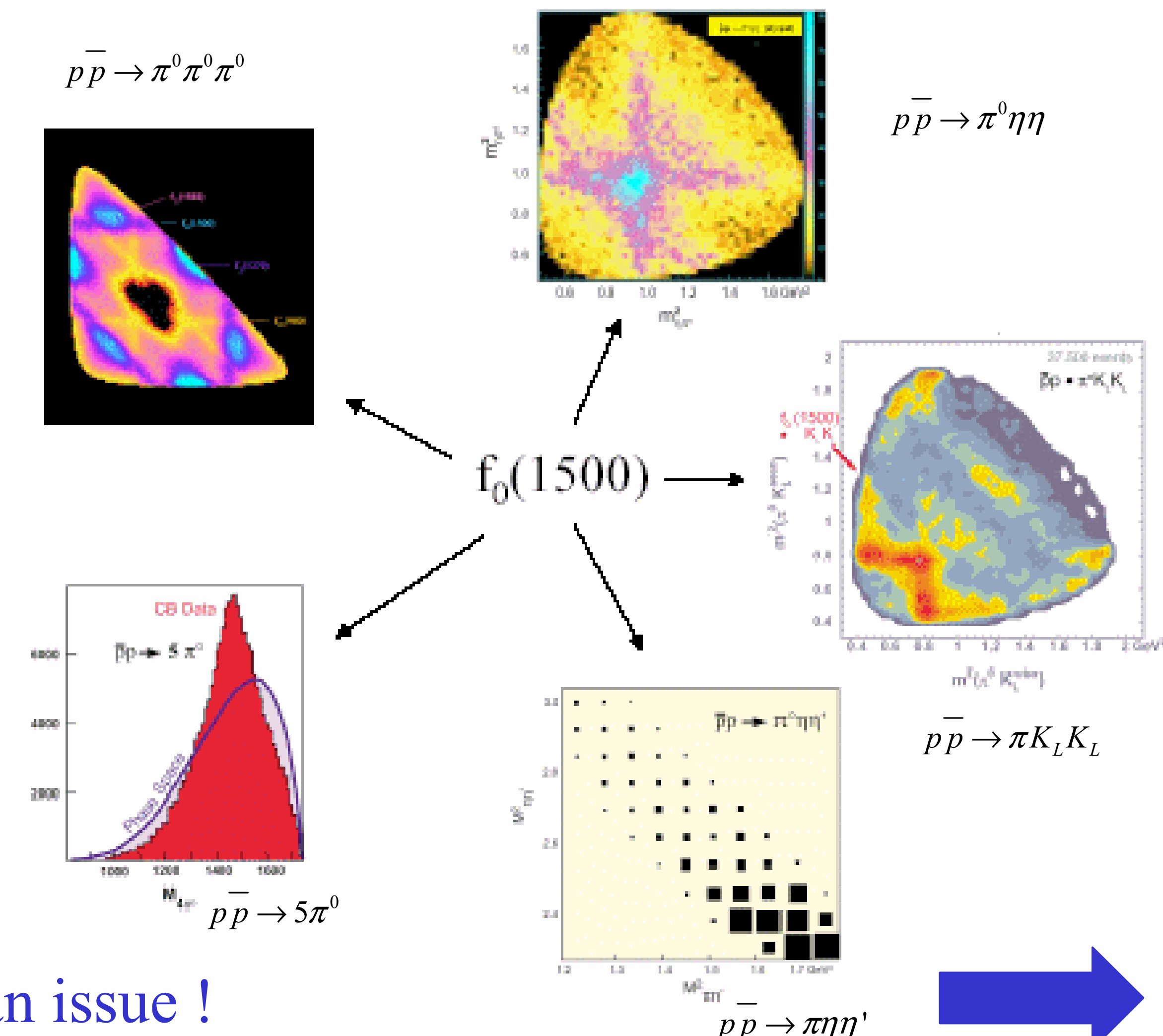


Many different experimental approaches.

Coupled-channel analysis

An example from ppbar annihilation at rest → Search for exotics

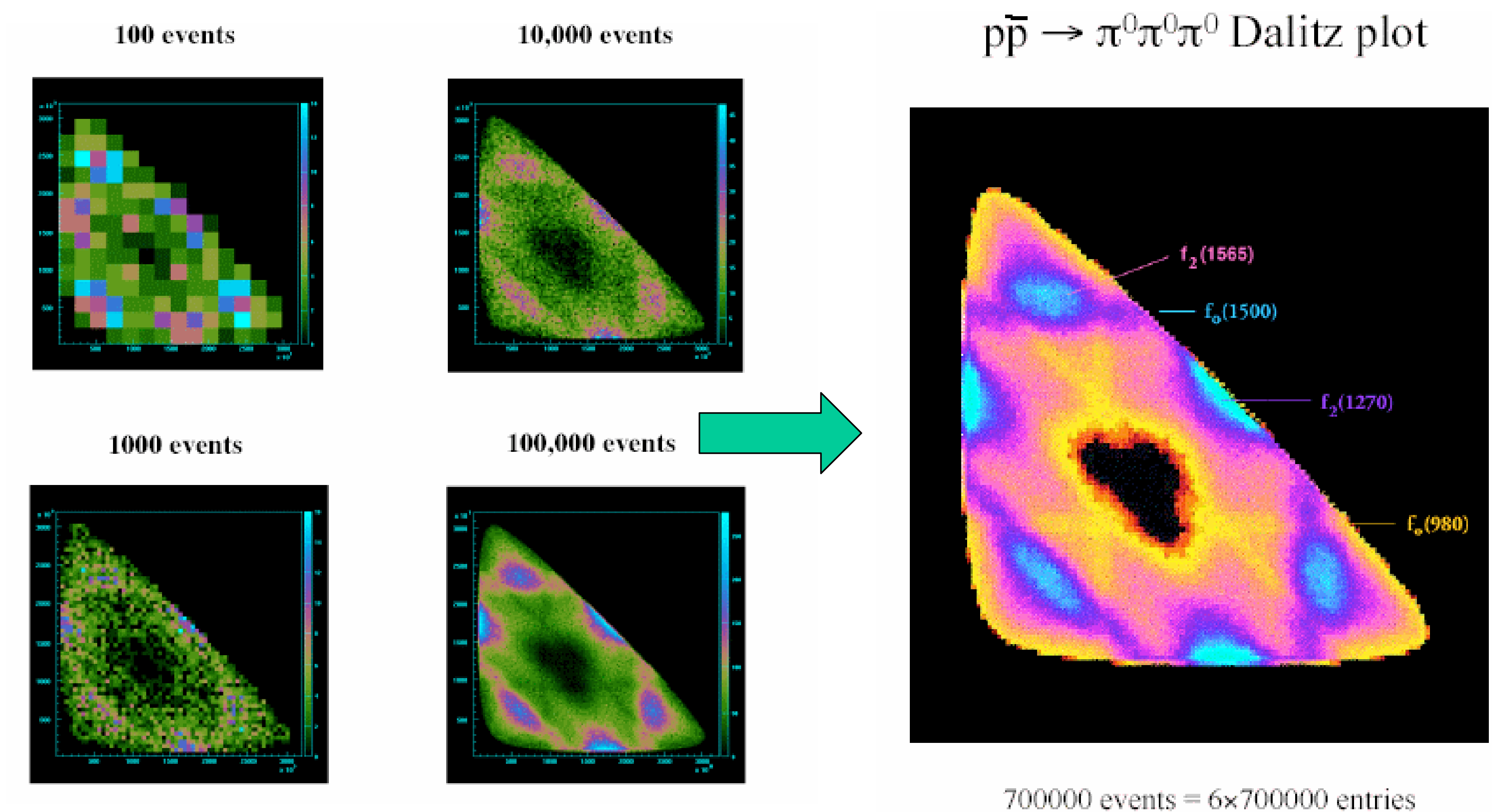
The real issue here
is analysis
For the quantum numbers
and the decay width
determination, coupled channel
and spin-parity analyses are
mandatory !



Many states, different
efficiencies etc...

→ But also statistics is an issue !

Structure evolution vs. statistics



From Crystal Barrel

The Renaissance of Hadron Spectroscopy

A number of new narrow states just in the last two years!

η'_c : Belle, CLEO, BaBar

Narrow D_{sJ} :BaBar, CLEO, Belle

X(3872) :Belle, CDF,D0,BaBar

$\Theta^+(1540)$ ......a confused experimental scenario

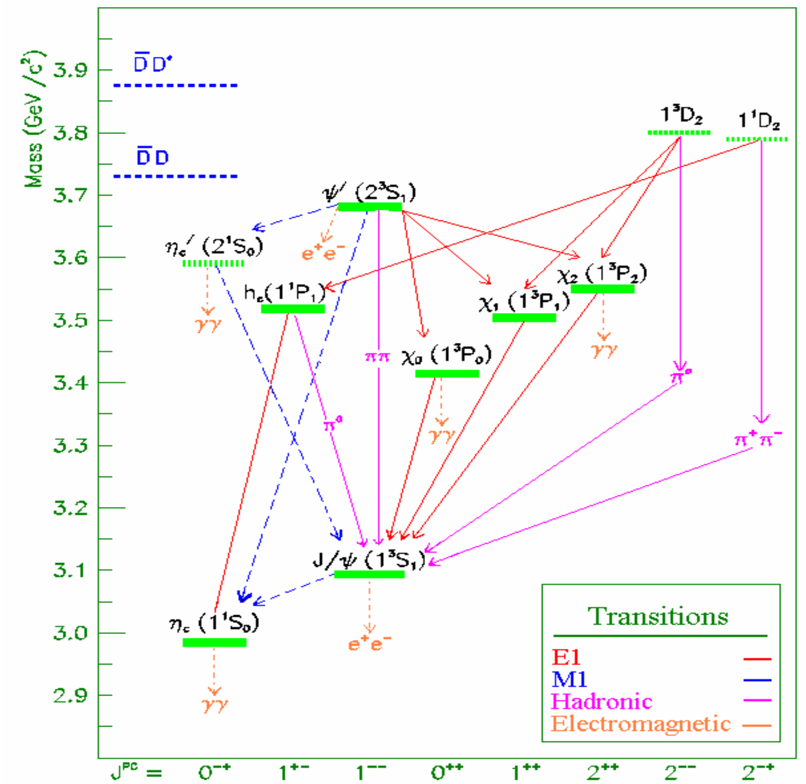
Evidence not confirmed

Ξ^+_{cc} Selex

$D^+_{SJ}(2632)$ Selex

Charmonium

- Charmonium states are being seen in
  - e+e- annihilation
  - B decay
  - two-photon collisions,
  - hadronic production
  - $\bar{p}p$ annihilation

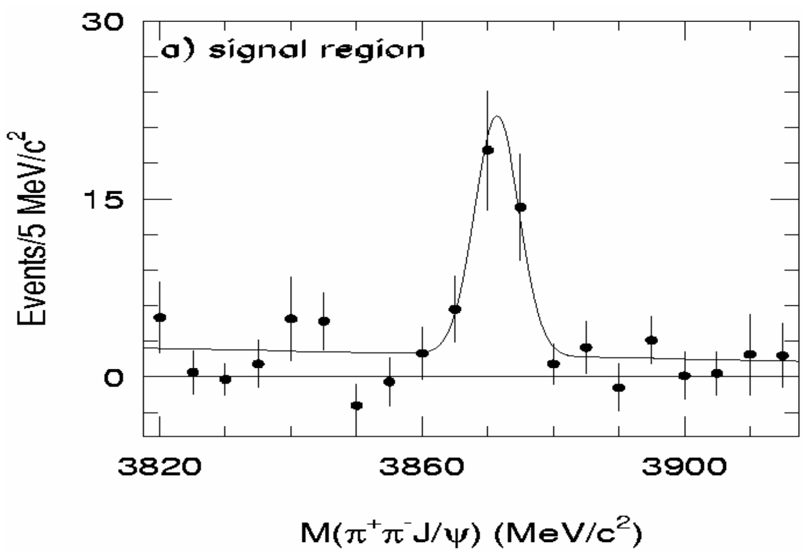


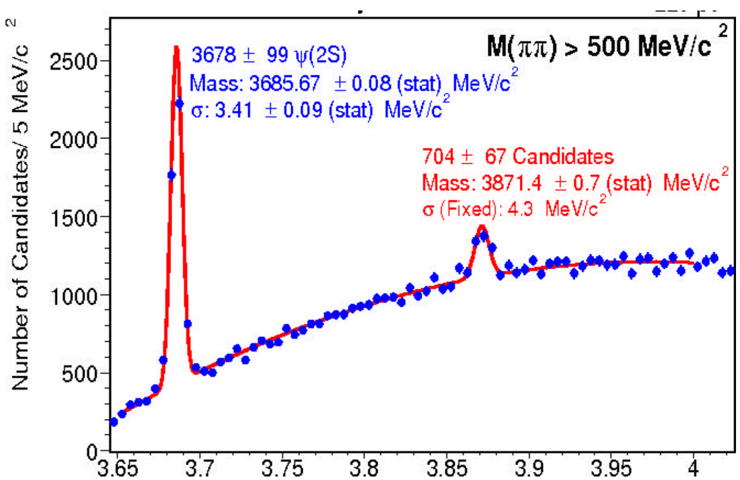
It is access to a very broad variety of quantum number J^{PC} , many cross-checks, robust evidence and systematics controls of measurements that make the field lively and interesting!

The X(3872)

New state discovered by Belle in
$B^{\pm} \to K^{\pm} (J/\psi\pi^{+}\pi^{-})$, $J/\psi \to \mu^{+}\mu^{-}$ or $e^{+}e^{-}$

X(3872) seen also by CDF/D0/BaBar





M = 3872.0 ± 0.6 ± 0.5 MeV
Γ< 2.3 MeV (90 % C.L.)

M = 3871.4 ± 0.7 ± 0.4 MeV

Many theoretical papers exist: a conventional charmonium state,a $D\bar{D}^*$ molecule, an exotic state? Experimental measurements (quantum numbers) are crucial.

Charmonium ...cont'd.

- **Above the D-$\overline{\text{D}}$ threshold** at 3.73 GeV; the energy region is **very poorly known**. *Yet this region is rich in new physics.*
  - This is the region where the **first radial excitations of the singlet and triplet P states** are expected to exist.
  - It is in this region that the narrow D-states occur.
- **Below the D-$\overline{\text{D}}$ threshold** : the less established $\mathbf{h_c(^1P_1)}$
  - Precise measurements of the parameters of the $h_c(^1P_1)$ give extremely important information on the **spin-dependent** component of the **$q\overline{q}$ confining potential**.
  - The detection and measurement of this resonance require high statistics and excellent beam resolution.
  - **Central part of experimental program of PANDA at GSI**

(hundreds of thousands of J/ψ produced per day!)

Heavy Flavours and Physics beyond the Standard Model

- Beauty is (will be) widely uncovered with dedicated facilities.
- Only more recently **charm** has attracted interest as a **clue for New Physics**
  - this is due to the excellent statistics and quality of the data!
  - investigation of rare or unexpected phenomena
  - fixed target experiments have been competitive

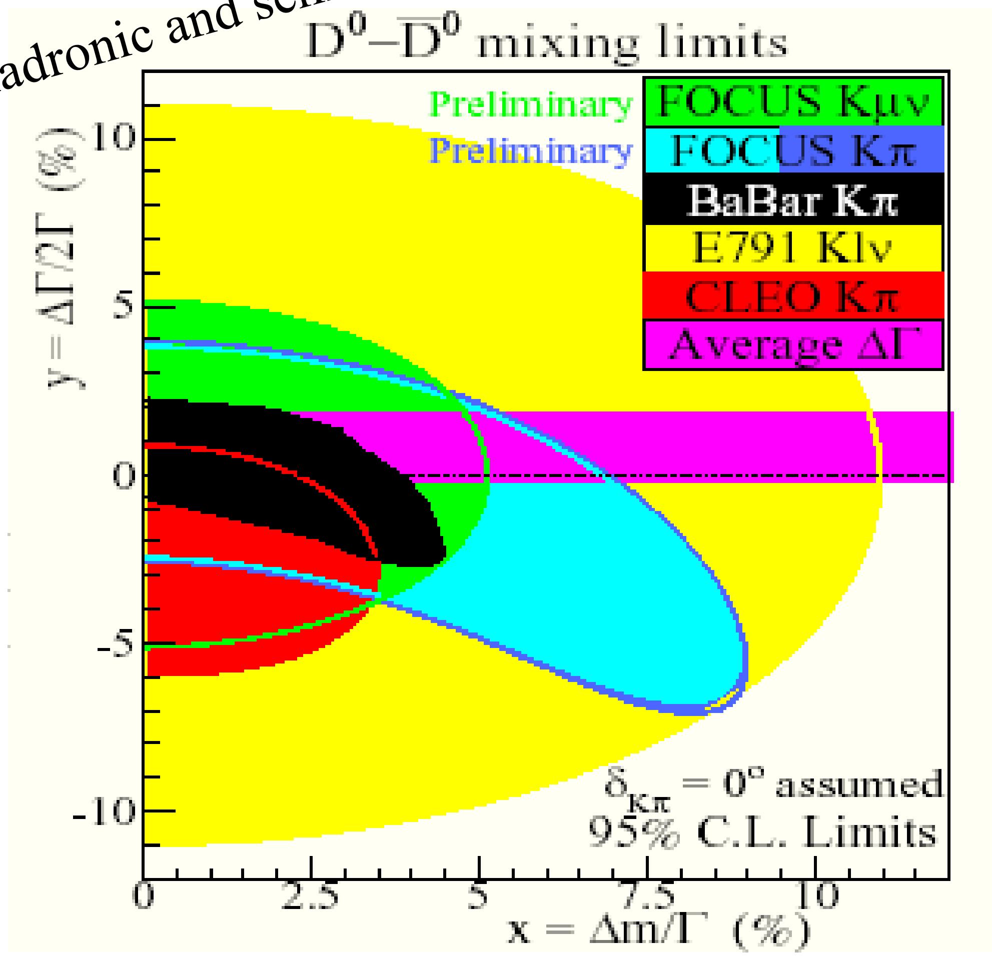
→ **Mixing**

→ **Forbidden and rare decays**

Mixing review

Hot topic of the moment!

Hadronic and semileptonic decays



New limits expected from B-factories (ICHEP04)

CLEO-c

$$r_D = (x^2 + y^2)/2 < 10^{-4}$$

@ 95% C.L

It will be interesting to see if mixing does occur at the percent level.

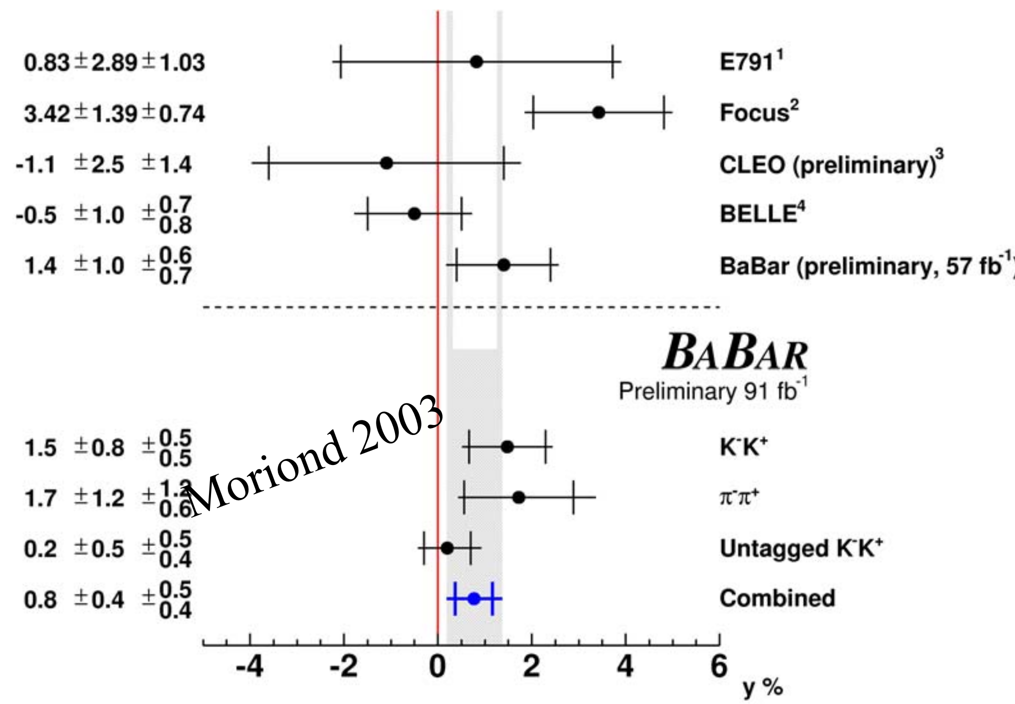
BTeV: r_D □ 10^{-5}

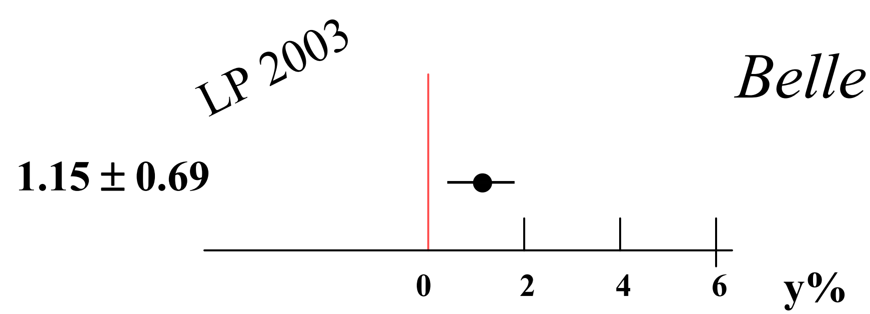
Mixing review ...cont'd.

D^0-$\overline{D^0}$ lifetime difference

2002

All experiments are engaging themselves in this measurement!
We shall see how it evolves!





Forbidden and rare decays

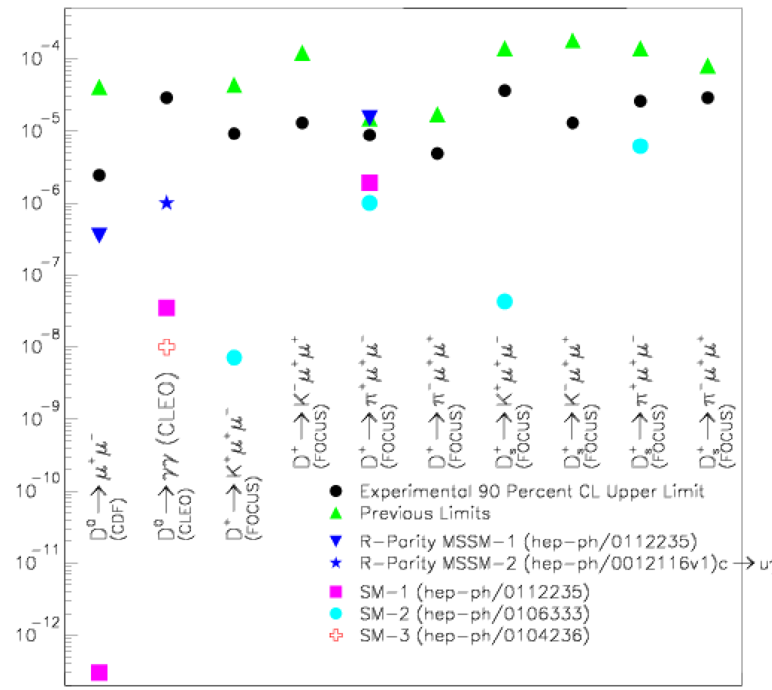
- lepton number violating decays
- investigation of long-range effects and SM extension

Statistics is *conditio sine qua non!*

$$D^+, D_s^+ \to h^\pm \mu^\mp \mu^+$$

$$(h = \pi, K)$$

FOCUS improved results by a factor of 1.7 –14: approaching theoretical predictions for some of the modes but still far for the majority



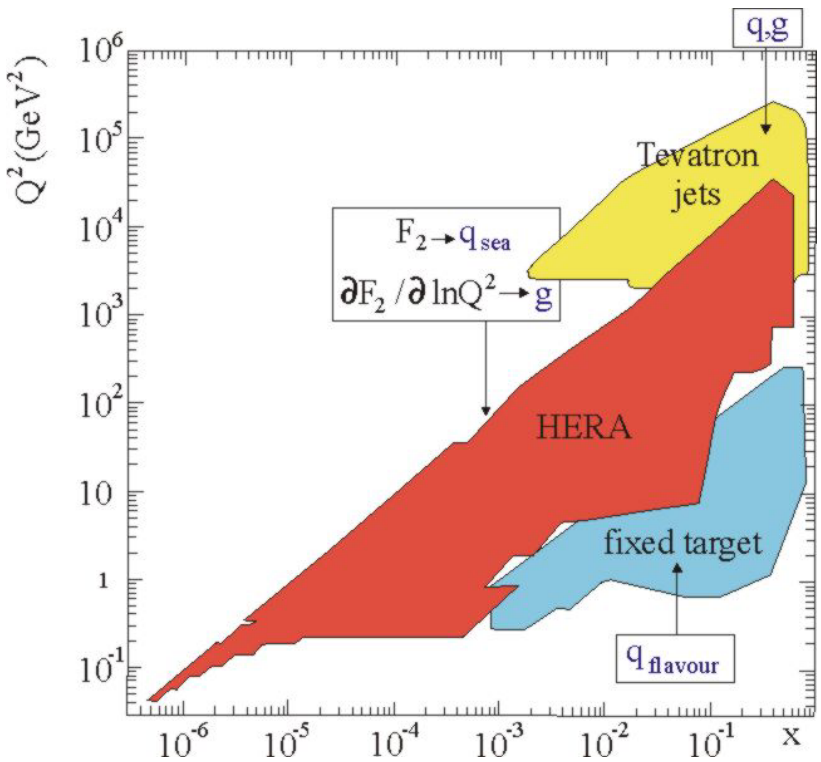
CDF Br($D^0 \to \mu^+\mu^-$)<2.4 $\times 10^{-6}$ @ 90% C.L. (65 pb^{-1} data)

Hera –B Br($D^0 \to \mu^+\mu^-$)<2 $\times 10^{-6}$ @ 90% C.L

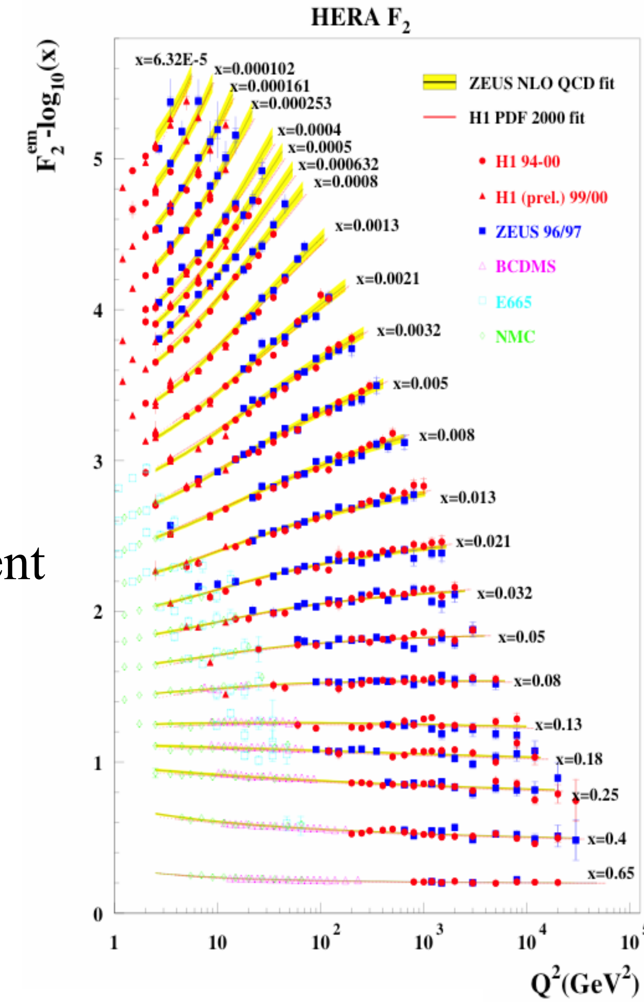
CDF and D0 can trigger on dimuons $\to$ promising

CLEO-c sensitivity 10^{-6}

Parton Distribution Functions



- F_2 vs. Q^2 →
- Data span 4 decades of Q^2 measurement
- SM gives excellent description



A powerful, diverse exploration!

HERA ep, Fixed-target DIS ep, ed, νN; Drell-Yan, W asym, Tevatron jets

typical F_2 accuracy: 2-3%
could reach 1% in 2007
(by adding ~600 pb^{-1})

Some questions

- High Q^2 puzzle: is the F_2 rise challenging the Froissart limit?
- Low Q^2 puzzle: why g (and even F_L) come out negative in the fits?
- Is there a really sharp transition in the F_2 behaviour around $Q^2 = 0.5$ GeV^2?
- ...

What will happen after 2007?

- Will this field come to its end?
- If not with HERA will it continue with another e-p collider?
- Will it be resumed in the far future?
- Accurate Parton Distribution Functions are anyhow needed: can LHC do all by itself??

Propagation of PDF uncertainty on heavy-flavour production cross-sections

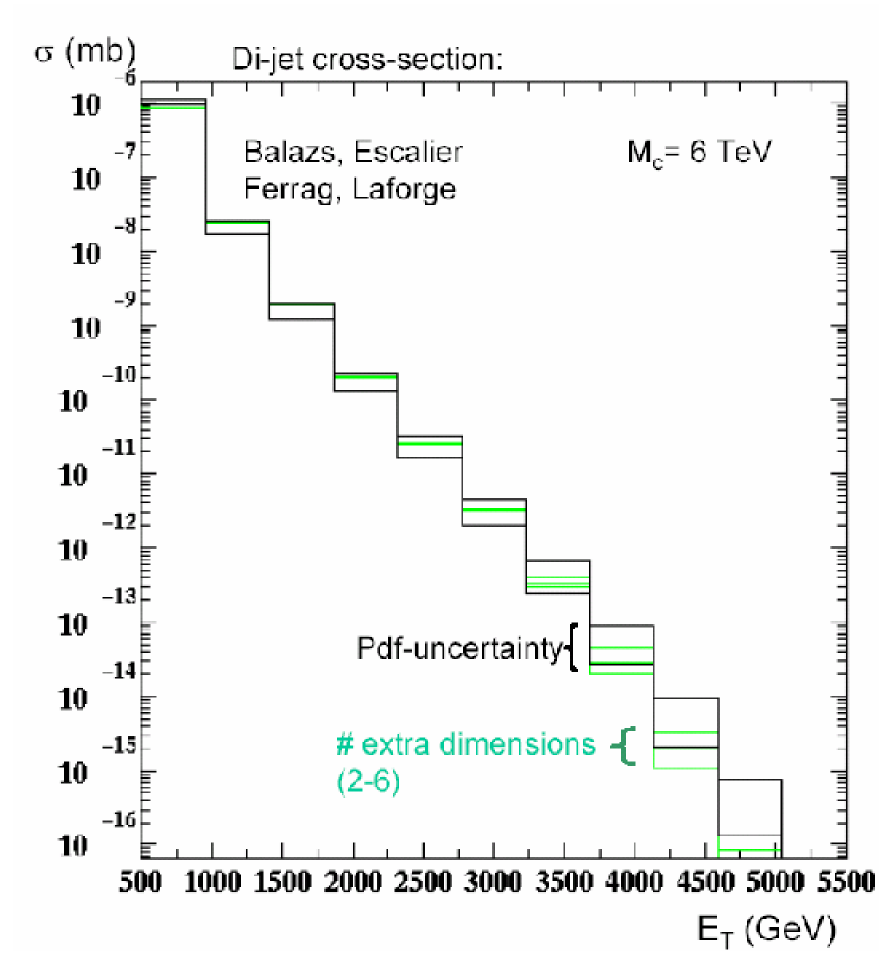
Estimate of 2-sigma (?) uncertainties

PDFs / Scales	Tevatron	LHC
Bottom (PDFs)	±10-15%	±15-20%
Bottom (Scales)	±35%	±40%
Top (PDFs)	±5-10%	±3-6%
Top (Scales)	±5%	±12%

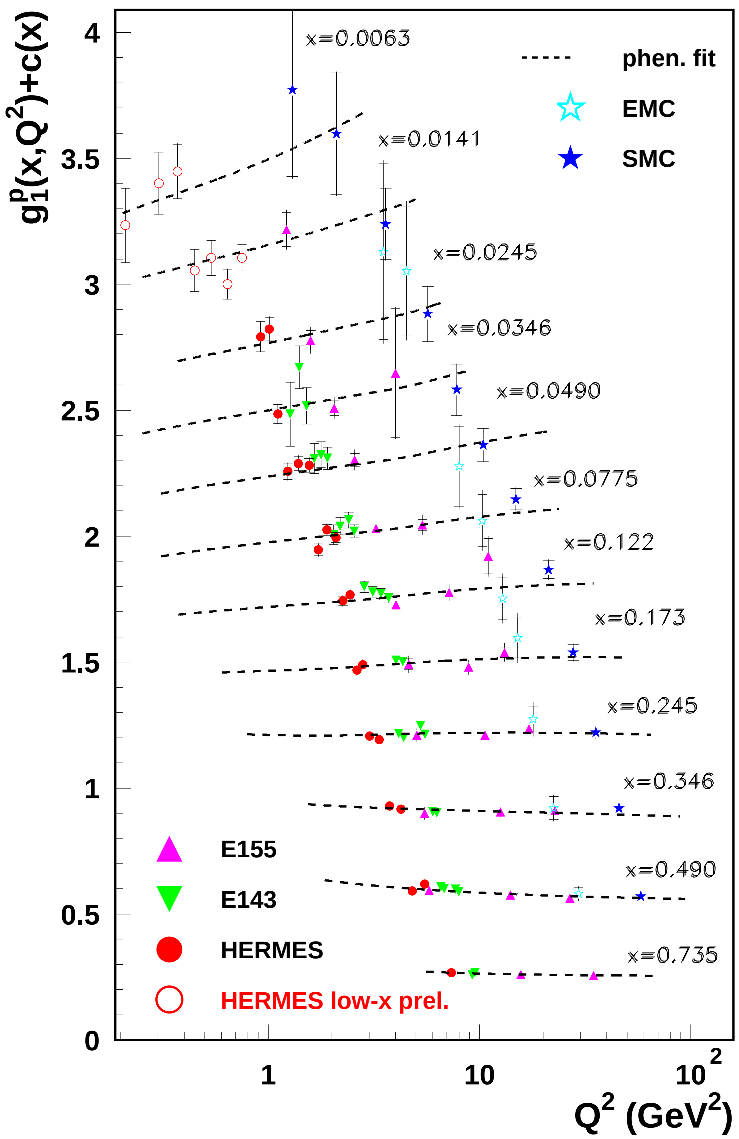
hep-ph/0303085, hep-ph/0312194

Frixione, Mangano, Nason, Ridolfi

and on di-jet cross-sections



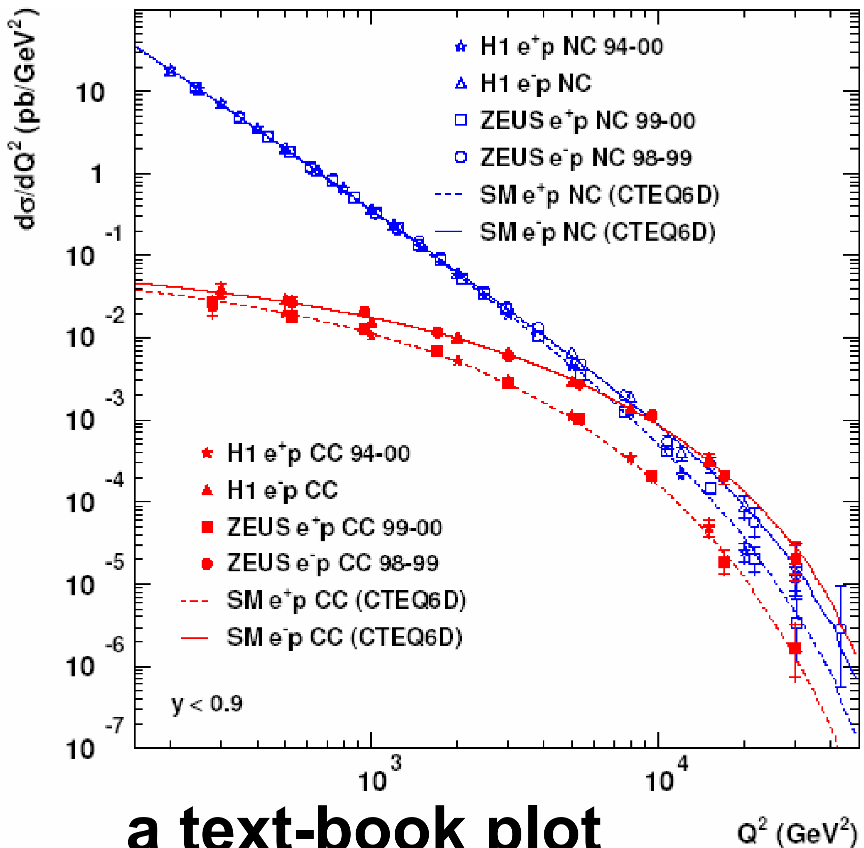
Parton Distribution Functions...cont'd.



- polarised PDFs are fundamental but data are fewer and less precise.
- the singlet axial charge suppression is confirmed; Δu, Δd measurement at 10%, Δs, $\Delta\bar{q}$, ΔG unconstrained, $\Delta_T q$ unknown.
- great progress from SIDIS experiments (HERMES, COMPASS, JLAB) + RHIC.
- COMPASS remaining the only high-energy DIS experiment after 2007.

Hera achivement

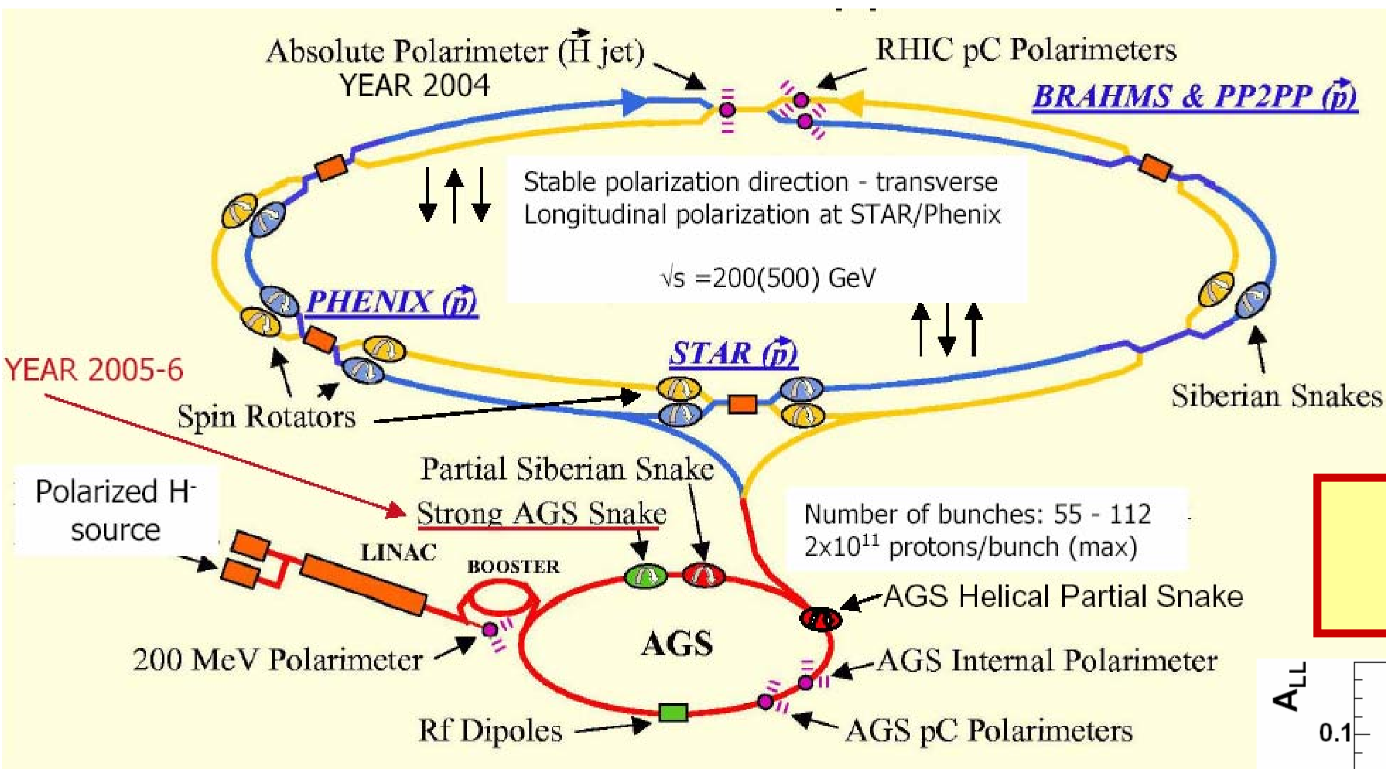
electro-weak unification:



a text-book plot

lepton beam:	e^+,	e^-,	$\vec{e}^{\,+}_R$,	$\vec{e}^{\,+}_L$
int. **L** (pb^{-1})/exp.:	**100**	**15**	**30**	**30**

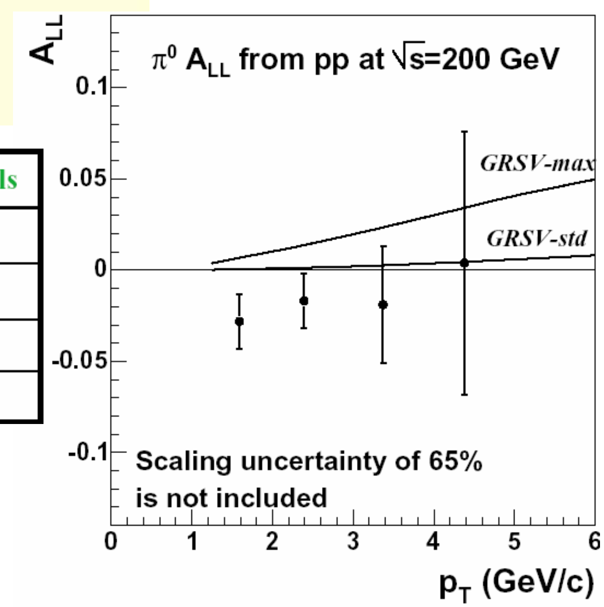
RHIC – the first polarised pp collider



PHENIX

hep-ex/0404027

pp Run	2002	2003	2004	2005 Expected	> 2006 LongTermGoals	
CM Energy	200 GeV				200 GeV	500 GeV
$\langle P_b \rangle$ and direction at STAR	0.15 T	0.3 T/L	0.4 L	0.45 L/T	0.7 L/T	0.7 L/T
L_{max} [10^{30} $s^{-1}cm^{-2}$]	2	6	6	16	80	200
L_{int} [pb^{-1}] at STAR	0.3	0.5 / 0.4	0.4	14 / 8	320	800

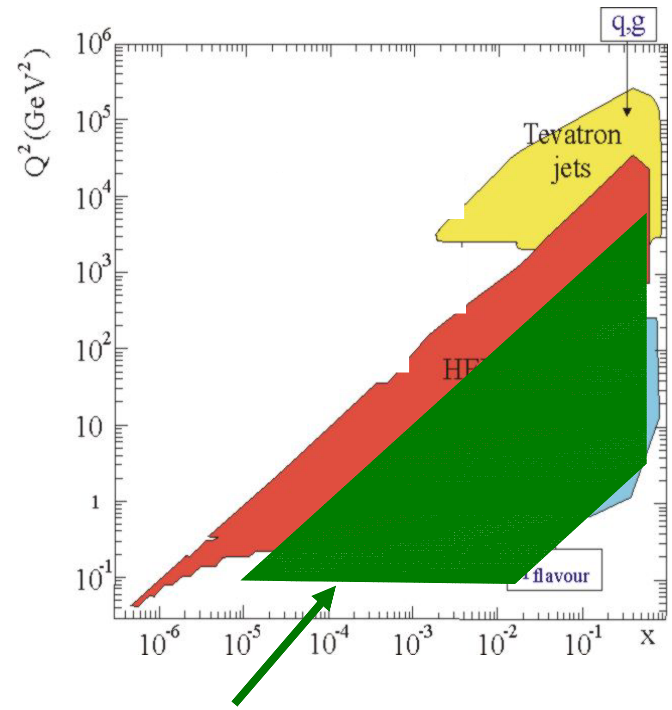


is progressing

eRHIC

- First polarized DIS experiments in collider mode: center of mass energy 100 GeV

10 GeV pol. $e^{\pm}$ linac
+ 0.5 Ampere $e^{\pm}$ ring
70 % longitudinal polarization
L= $2x10^{32}$ -10^{33}



eRHIC: $10^{-4} < x < 0.7$

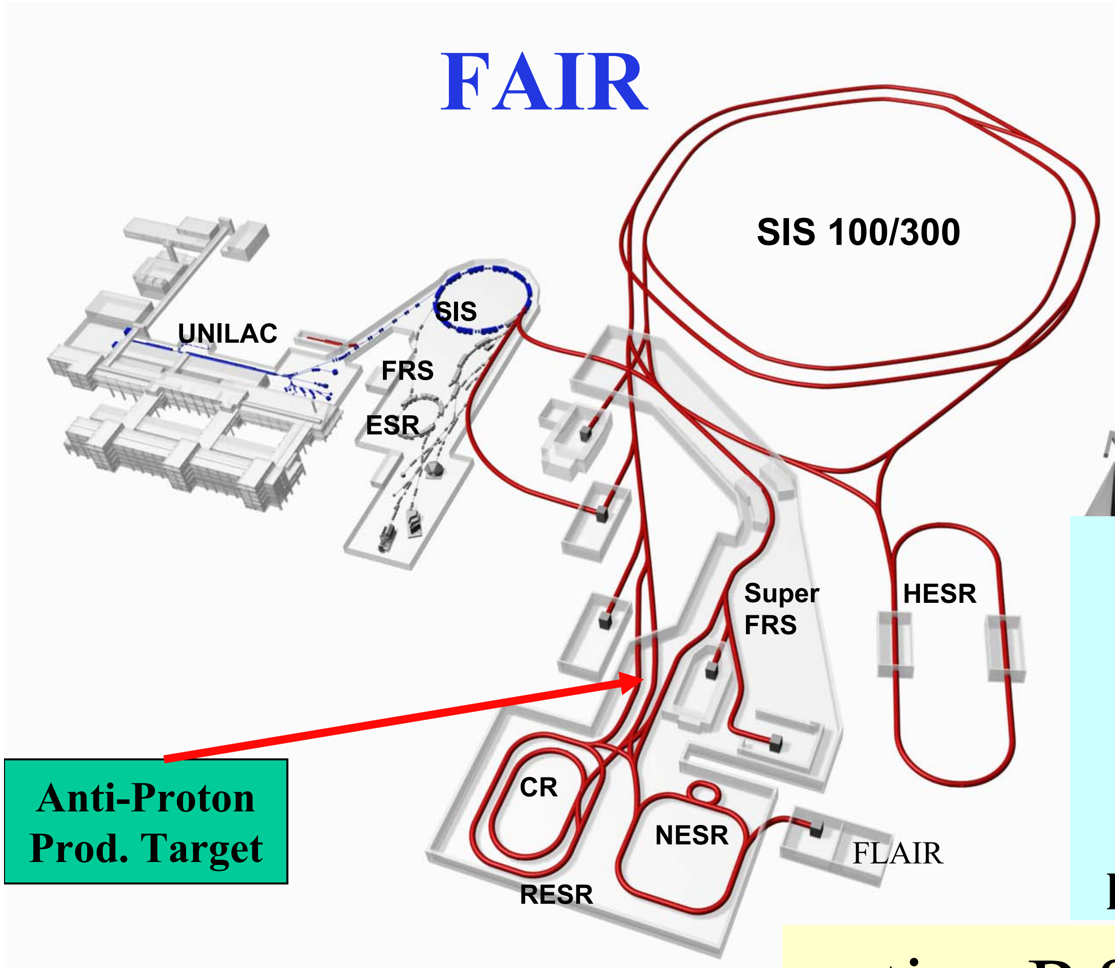
for $1 < Q^2 < 10^4$

- Final Design Ready 2010 (CD3)
- 5 years construction

First collisions with limited detector 2015?

Will also JLab upgrade its beam further and further?

GSI: bulding an International Facility for Antiproton and Ion Research



HESR (High Energy Storage Ring)

Length 442 m   Br = 50 Tm
N_{stored} = 5 x 10^{10} anti-protons

High luminosity mode

Luminosity = **2 x 10^{32} cm^{-2}s^{-1}**
∂p/p ~ 10^{-4} (stochastic- cooling)

High resolution mode

∂p/p ~ 10^{-5} (electron cooling < 8 GeV/*c*)
Luminosity = **10^{31} cm^{-2}s^{-1}**

The International Steering Committee considers spin physics of extreme interest and the building of an antiproton polarized beam as a unique possibility for the FAIR project.

- **Antiproton production similar to CERN,**
- **Production rate 10^7/sec at 30 GeV**
- **Anti-Proton$_{beam}$ = 1.5 - 15 GeV/*c***

active R&D ongoing

PAX+ASSIA

Cern Super-PS and SPS

- How can “high intensity” at CERN be beneficial for the hadronic program?

If super PS

- **plus antiprotons**
  - Light-state spectroscopy
  - Charmonium

  - **Bottomonium** ?

à la PANDA
HESR
Production rate $2x10^7$/sec
P_{beam}=1-15 GeV/c
$N_{stored}=5x10^{10}\ \bar{p}$
$L=2x10^{32}cm^{-2}s^{-1}$

.test models: LQCD, effective theories of strong interactions, potential models in the heavy-quark sector
.complements e+e⁻ studies on such a system
.can measure more precisely masses and widths of P states
unique alternative in η_b searches

PS	10^{13} p/sec @ 26 GeV/c
Super-PS	$6x10^{14}$ p/sec @ 30 GeV/c
SIS100/200 (GSI)	10^{13} p/sec @29GeV/c

$b\bar{b}$ in $p\bar{p}$?

What do we know?

- Scarse and old literature, rough estimates:

P. Dalpiaz, M. Fabbri and E. Luppi
Fine Bottomonium Spectroscopy in ppbar Annihilation, Proceedings of the Workshop on Nucleon-Antinucleon Interactions, (Moscow, ITEP, 8-11 July 1991) pag. 1486

Branching ratios

$$\frac{Br(b\bar{b} \to p\bar{p})}{Br(c\bar{c} \to p\bar{p})} \approx \left(\frac{m_c}{m_b}\right)^8 \approx 10^{-4} \qquad J^{PC} = 1^{--}, 1^{++}, 2^{++}$$

$$\frac{Br(b\bar{b} \to p\bar{p})}{Br(c\bar{c} \to p\bar{p})} \approx \left(\frac{m_c}{m_b}\right)^{10} \approx 10^{-5} \qquad J^{PC} = 0^{-+}, 0^{++}, 1^{+-}$$

Cross sections

$$\sigma(p\bar{p} \to \eta_b) \approx 2\,pb$$

$$\sigma(p\bar{p} \to \Upsilon) \approx 100\,pb$$

$$\sigma(p\bar{p} \to \chi_b) \approx 10\,pb$$

- Hopefully, new limits will be *(soon)* set
  - CLEO III Υ(1,2,3S) →ppbar (≈ 10^{-6})
  - CLEO-c ψ(3770) →ppbar (≈ 10^{-6})

$b\bar{b}$ in $p\bar{p}$?

A word of caution

- Many experimental challenges foreseen:
  - Luminosities about 10^{32} will give ~10 Mhz hadronic rates
  - Detection of exclusive EM channels: very fast detectors, excellent e and μ ID.
  - Narrow resonance width require ultracool pbar beams $dP/P<10^{-4}$

- Machine requirements:

  interaction rate is high enough to require debunched beams

  - minicollider : 5+5 GeV ppbar collider with state of the art cooling
  - fixed target: storage of antiprotons with E_{beam} ~ 45 to 55 GeV.

    Acceleration or deceleration to the resonance energy

If a Super SPS

- **and secondary beams**

Fixed-target program of Fermilab with about 100x statistics

Photoproduction: 100 x FOCUS, i.e. 10^8 reconstructed charm in a very clean environment

mixing–rare decays (cfr.CLEO-c)

Hadroproduction: 100 x SELEX

Help to confirm or not double-charm et al. (analysis issues)

SELEX:

$$\Xi_{cc}^{+} \rightarrow \Lambda_c^{+} K^{-} \pi^{+} \qquad \sim 15 \qquad \Rightarrow \quad (1500)$$

$$D_{sJ}^{+}(2632) \rightarrow D^0 K^{+} \qquad \sim 15 \qquad \Rightarrow \quad (1500)$$

$$D_{sJ}^{+}(2632) \rightarrow D_s^{+} \eta \qquad \sim 45 \qquad \Rightarrow \quad (4500)$$

what about background?!

Heavy Flavours & light mesons

- **An interesting interplay**:
  - On the one hand Heavy Flavour decays represent a new source of info on light hadrons
  - On the other Heavy Flavour interpretation require understanding of strong effects in the final states
  - A nice example of synergy and joint effort between two communities...promising. Surprises?
- **Examples**: $D \to \pi\pi\pi$ ($f_0(980)$, σ, etc.)

  $D \to KK\pi$ (f_0/a_0 mixing ...and CP)

  $B \to \pi\pi\pi$ ($\rho\pi$ and the CKM α angle)

  □ $B \to \phi K_s$ and New physics (f_0/a_0..)

Photoproduction of light quarks at fixed target

- **Photoproduction and Light Quark Spectroscopy** (à la FOCUS):
  -- ρ, ω, φ production, as expected …*the photon behaves as a vector meson*
  -- but also the 1^{+-} $b_1(1235)$, for instance
  -- associated production of scalars (f_0, etc) with ϕ
  -- mysteries with the higher-mass "vectors": X(1750) & ρ(1900)

- **Super SPS 10^{13} Hz protons** → 10^7 Hz photons on target with energy 150 GeV, $\sqrt{s}$ =17GeV

→ **100 x FOCUS at the very least *(DAQ limited)***

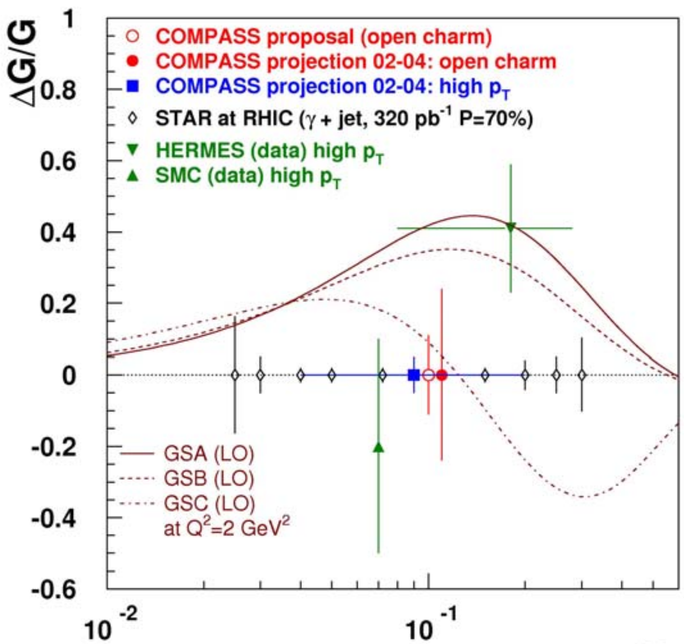
- Active programme of low-energy photoproduction at Jlab (Expt. at Hall D)

If a Super SPS ...cont'd.

and lepton beams:

1) The gluon helicity distribution

Expected error on *ΔG/G*



ΔG/G accuracy ~ 0.1 by the end of the decade from COMPASS open charm

RHIC could provide complementary measurement from prompt photon + jet and 2 jet events, with accuracy similar to COMPASS: a lot to learn from the comparison.

ΔG/G from open charm is limited by statistics: with SuperSPS in principle $\delta(\Delta G/G) < 0.03$ in 1 year

If a Super SPS ...cont'd.

and lepton beams:

2) Transversity

Great evolution of theoretical landscape in recent years: many properties clarified.

Experimental effort is increasing: exploratory measurements being carried by HERMES, COMPASS and JLab.

Collins and Sivers asymmetries becoming more precise: first indications on h_1 soon.

Tensor charge extremely interesting (Lattice comparison) but only after long and great effort

Asymmetry is small, high intensity is a must: higher luminosity DIS *and polarised pbar-p coll.*

If a Super SPS ...cont'd.

and lepton beams:

3) Generalized Parton Distributions

Novel unified framework for the description of hadron structure

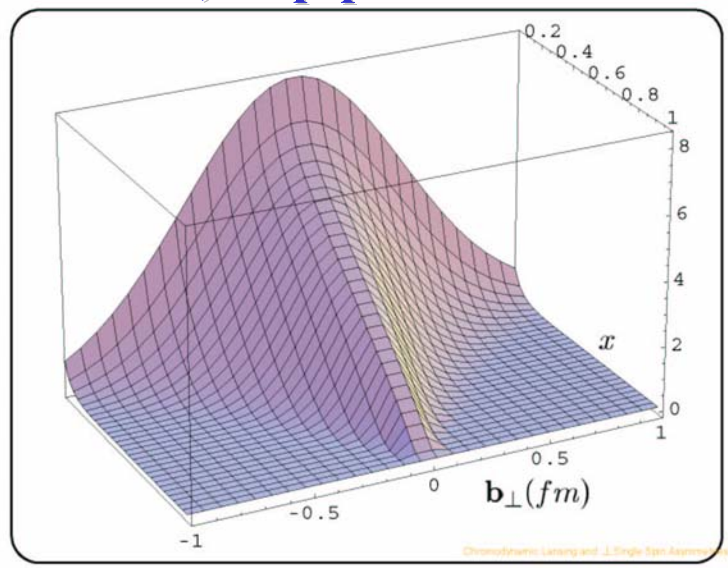
PDF's ⟷ form factors

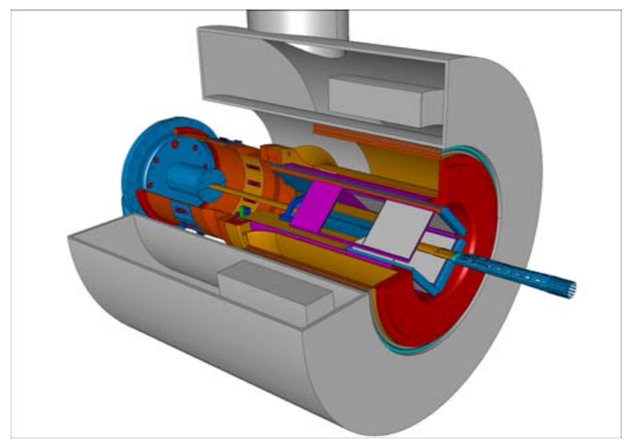
transv. localisation ⟷ partonic orbital angular momentum

Accessible via DVCS and
Hard Exclusive Meson Production (HEMP)

Pioneering meas.: ZEUS, H1, CLAS, …
HERMES will devote last years of data taking

Burkardt, hep-ph/0207047

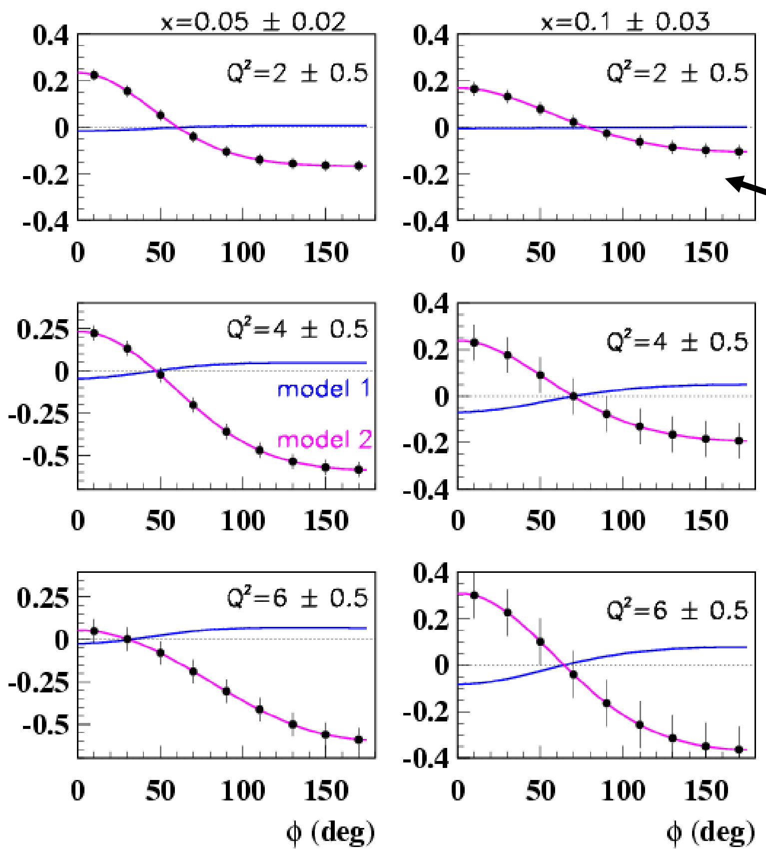


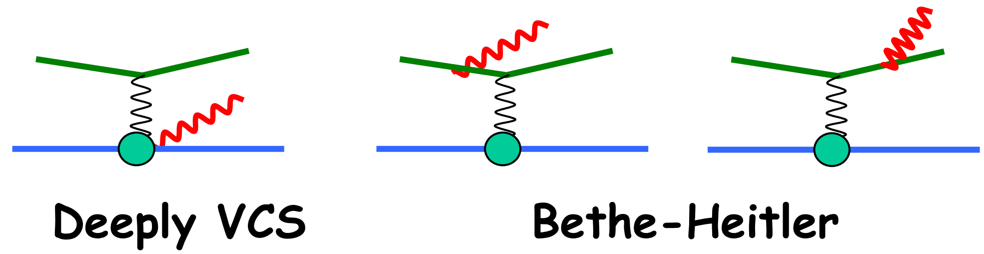


HERMES Recoil-Detector

GPD's

beam charge asymmetry, 100 GeV μ





COMPASS is proposing DVCS beam charge asymmetry: indications on transverse space localisation of partons

Model 1 : simplest ansatz
Model 2 : from Goeke et al.
(L. Mossé, M. Vanderhaegen

With Super SPS: comprehensive HEMP measurement providing model independent extraction of GPDs and parton angular momentum

Dreaming about DIS at the high-energy frontier

Linear extrapolation in time gives for 2012:

√s ~ 1 TeV →

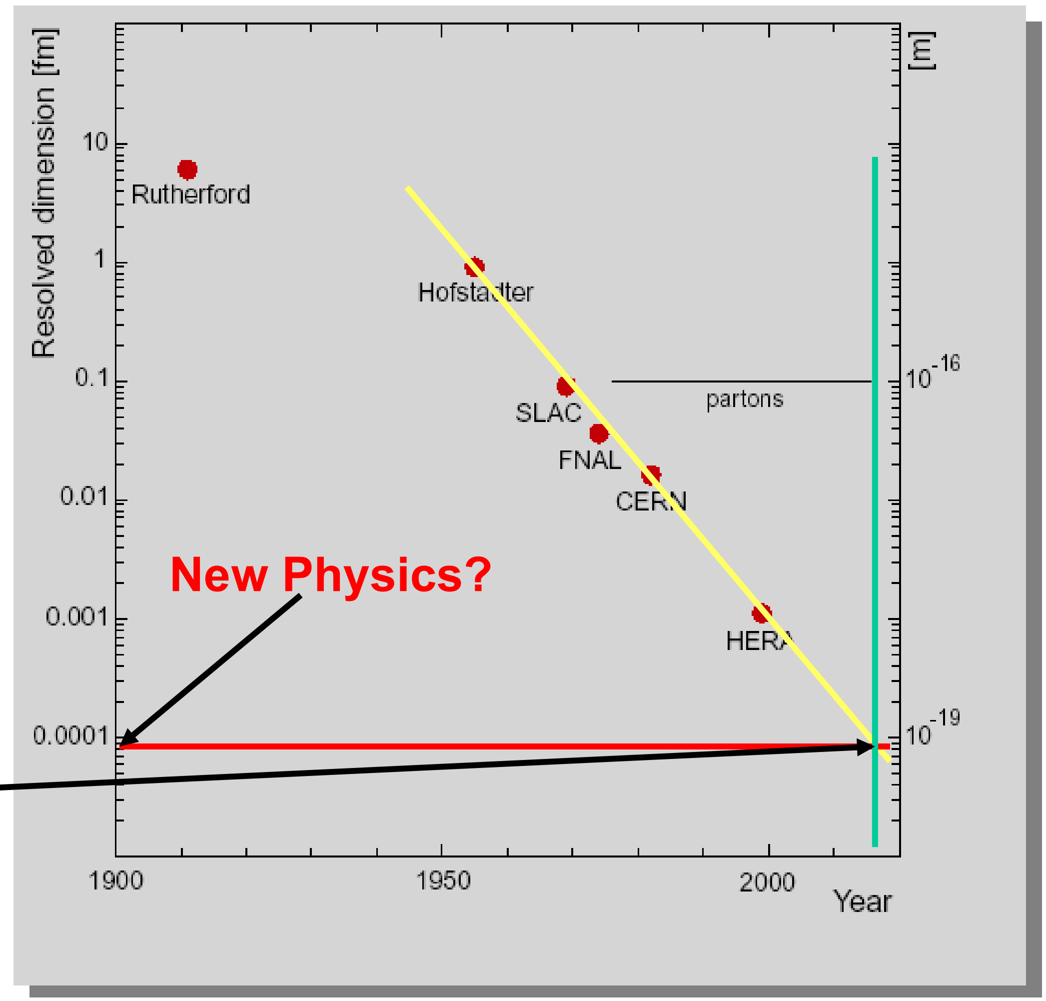
LHC + 36 GeV lepton beam (ELFE-like)

Linear extrapolation in time gives for 2016:

√s ~ 2TeV

→ LHC + 140 GeV lepton beam

→ Tevatron or SuperSPS + 1 TeV lepton beam

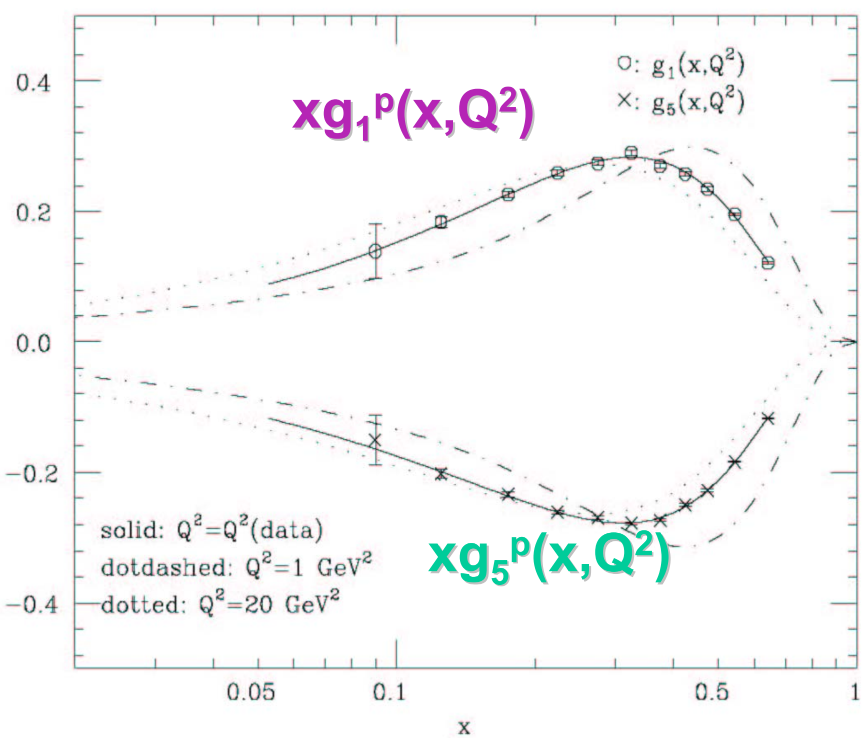


A step further ... a NuFactory Fantastic opportunities: proton g_1 and g_5 from ν pol. DIS

CERN/ECFA QCD/DIS working group

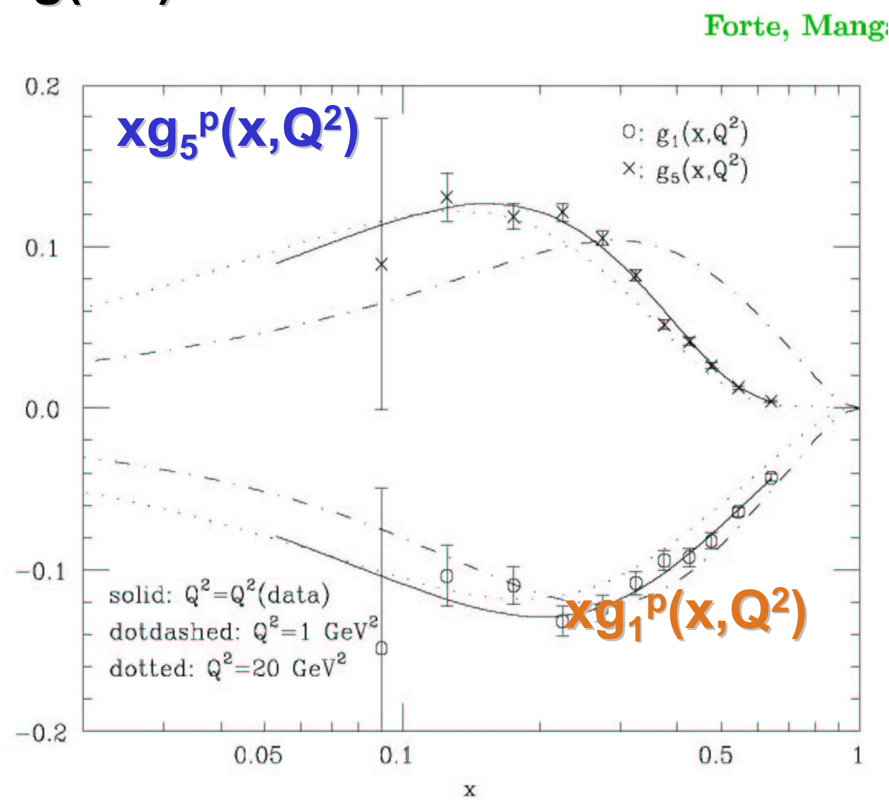
Forte, Mangano, Ridolfi

xg(W$^-$)



$4\ \mathrm{GeV}^2 \le Q^2 \le 8\ \mathrm{GeV}^2$

xg(W$^+$)



$4\ \mathrm{GeV}^2 \le Q^2 \le 8\ \mathrm{GeV}^2$

Conclusions

- **Strong interaction effects** have important (crucial) impact on **many different measurements** and **New Physics** searches
- Many short/medium term projects already planned
  - GSI-JLab-CLEO-c, BTeV/LHC-b
- Where will we be in 10 years from now?

Go to slide number 2

- A vast program in the field of hadronic physics will be possible with a **diverse and flexible system** **Super PS and SPS**

backup

Bottomonium from ppbar

Physics Goals:
- complements e+e- studies on such system.
- can measure more precisely masses and widths of P states
- unique alternative in etab searches

Physics challenges:
- Luminosities about 1.E32 will give ~10 Mhz hadronic rates:
- Detection of exclusive EM channels : very fast detectors, excellent electron + muon ID.
- Narrow resonance width require ultracool pbar beams dP/P<1.E-4
- Peak Cross Sections (detecting EM final states) will be:
  - Upsilons: ~0.1 pb (BRin/1.E-6)/(dP/P/1.E-4)
  - Chi-B: ~1 pb (BRin/1.E-6)
  - Eta-B: ~.05 pb (BRin/1.E-6) * (BRout/1.E-3)

---> CLEO can measure BRin at 1.E-6 with currently available data 29 M Y(1S), 9 M Y(2S), 6 M Y(3S).

---> Dalpiaz et al: bbbar/ccbar ~ 10-4 => BR ~ 1.e-7 or below.

- Machine requirements: interaction rate is high enough to require debunched beams
  - minicollider : 5+5 GeV ppbar collider with state of the art cooling
  - fixed target: storage of pbars with Ebeam ~ 45 to 55 GeV. Acceleration or deceleration to the resonance energy

The experimental scenario at glance

$N\,^{2S+1}L_J$	J^{PC}	$u\bar{d}, u\bar{u}, d\bar{d}$ $I=1$	$u\bar{u}, d\bar{d}, s\bar{s}$ $I=0$	$c\bar{c}$ $I=0$	$b\bar{b}$ $I=0$	$\bar{s}u, \bar{s}d$ $I=1/2$	$c\bar{u}, c\bar{d}$ $I=1/2$	$c\bar{s}$ $I=0$	$\bar{b}u, \bar{b}d$ $I=1/2$	$\bar{b}s$ $I=0$	$\bar{b}c$ $I=0$
$1\,^1S_0$	0^{-+}	π	η, η'	$\eta_c(1S)$	$\eta_b(1S)$	K	D	D_s	B	B_s	B_c
$1\,^3S_1$	1^{--}	ρ	ω, ϕ	$J/\psi(1S)$	$\Upsilon(1S)$	$K^*(892)$	$D^*(2010)$	D_s^*	B^*	B_s^*	
$1\,^1P_1$	1^{+-}	$b_1(1235)$	$h_1(1170), h_1(1380)$	$h_c(1P)$		$K_{1B}{}^{\dagger}$	$D_1(2420)$	$D_{s1}(2536)$			
$1\,^3P_0$	0^{++}	$a_0(1450)^*$	$f_0(1370)^*, f_0(1710)^*$	$\chi_{c0}(1P)$	$\chi_{b0}(1P)$	$K_0^*(1430)$		**Ds(2.32)**			
$1\,^3P_1$	1^{++}	$a_1(1260)$	$f_1(1285), f_1(1420)$	$\chi_{c1}(1P)$	$\chi_{b1}(1P)$	$K_{1A}{}^{\dagger}$		**Ds(2.46)**			
$1\,^3P_2$	2^{++}	$a_2(1320)$	$f_2(1270), f_2'(1525)$	$\chi_{c2}(1P)$	$\chi_{b2}(1P)$	$K_2^*(1430)$	$D_2^*(2460)$	**Ds(2.57)**			
$1\,^1D_2$	2^{-+}	$\pi_2(1670)$	$\eta_2(1645), \eta_2(1870)$			$K_2(1770)$					
$1\,^3D_1$	1^{--}	$\rho(1700)$	$\omega(1650)$	$\psi(3770)$		$K^*(1680)^{\ddagger}$					
$1\,^3D_2$	2^{--}					$K_2(1820)$					
$1\,^3D_3$	3^{--}	$\rho_3(1690)$	$\omega_3(1670), \phi_3(1850)$			$K_3^*(1780)$					
$1\,^3F_4$	4^{++}	$a_4(2040)$	$f_4(2050), f_4(2220)$			$K_4^*(2045)$					
$2\,^1S_0$	0^{-+}	$\pi(1300)$	$\eta(1295), \eta(1440)$	$\eta_c(2S)$		$K(1460)$					
$2\,^3S_1$	1^{--}	$\rho(1450)$	$\omega(1420), \phi(1680)$	$\psi(2S)$	$\Upsilon(2S)$	$K^*(1410)^{\ddagger}$					
$2\,^3P_2$	2^{++}	$a_2(1700)$	$f_2(1950), f_2(2010)$		$\chi_{b2}(2P)$	$K_2^*(1980)$					
$3\,^1S_0$	0^{-+}	$\pi(1800)$	$\eta(1760)$			$K(1830)$					

Probably narrow

Charmonium:dedicated facilities at short/medium term

CLEO-c :

30 M $\psi(3770)$ [run 2004]
1.5 M $\psi(4140)$ [run 2005]
~1G J/ψ [run 2006]

BES-III (2007-2009?, with CsI Ecal):

10 G J/ψ , 3 G $\psi(2S)$ per year
25 M $\psi(3770)$ per year

BaBar/Belle (from now up to 2006-7):

500 fb^{-1} each

Panda@GSI (2011?-):

up to 3 fb^{-1}.

Possible evolution of QCD spin physics

- Progress expected from COMPASS + HERMES + RHIC Spin + JLAB will provide accurate Δq; $\Delta G/G$ at a precision of about 0.1 and first indications for $\Delta_T u$, $\Delta_T d$.
- Medium term (~2014) COMPASS has the possibility to provide first indication for u quark total angular momentum from GPD's, RHIC can measure very precisely Δu, Δd, GSI will contribute on $\Delta_T u$, $\Delta_T d$.
- Long term: very accurate ΔG and (and very accuate α_s from Γ_{Bj}) at Super SPS, precise transversity distributions, first full set of GPD's, contributions from GSI and possibly eRHIC and upgraded JLAB.
- Very long term: Neutrino factory (and TeV lepton-proton collider) should open new extraordinary perspectives.