Summary of Heavy Flavour Working Group (Experimental)

Paul Thompson, Uri Karshon, Ingo Schienbein

- Experimental techniques
- B_s mixing at Tevatron
- open b production
- open c production
- Heavy flavour at RHIC
- B-Factories
- Future

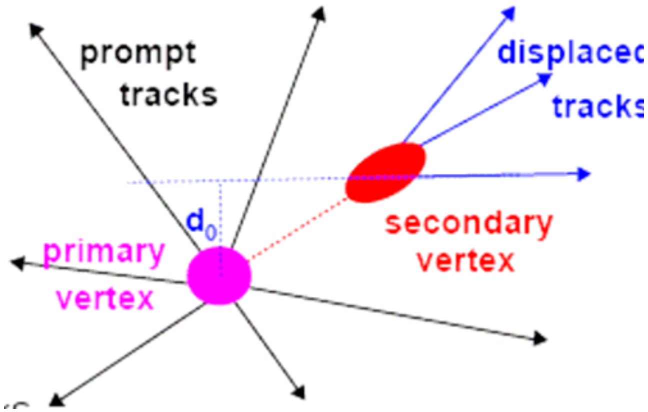
20 Experimental talks

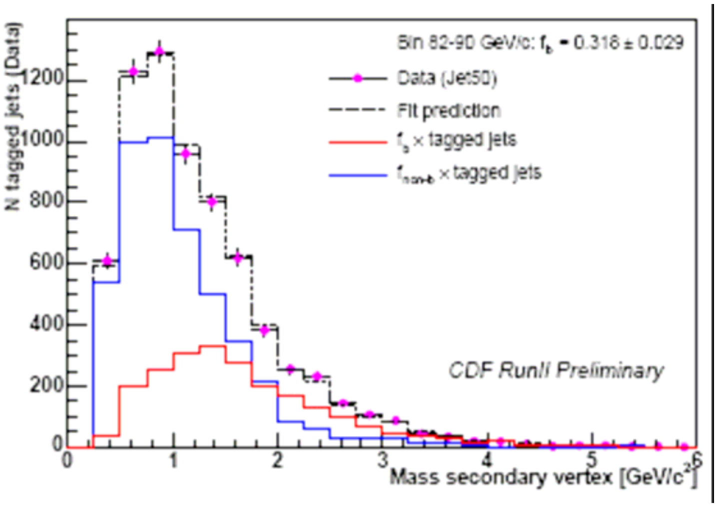
2 joint HFS sessions

1 joint SF session

Sorry, not all talks could be fitted in

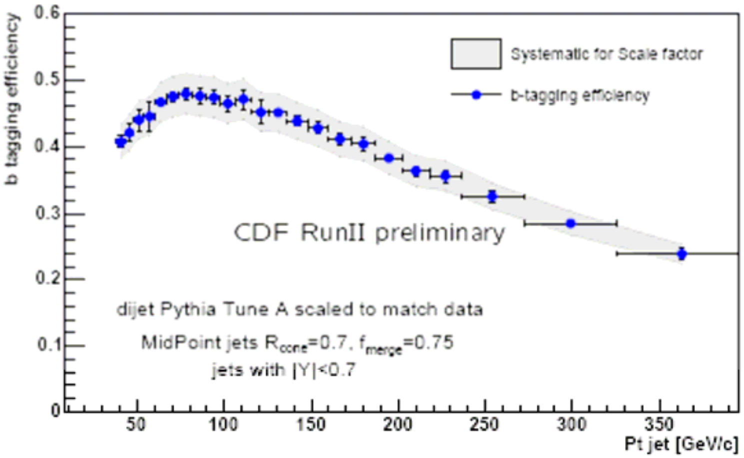
Heavy flavour tagging





E.g. explicit secondary vertex reconstruction

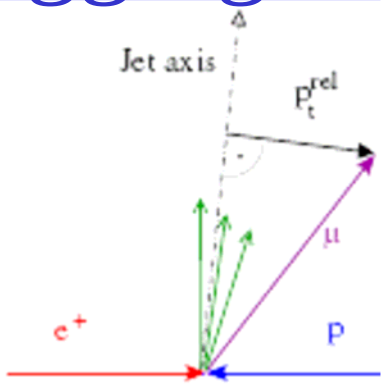
Fit secondary vertex mass distribution



Heavy flavour tagging

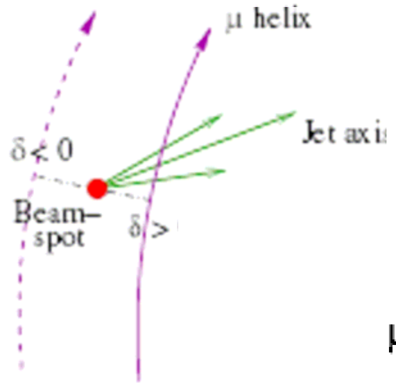
Component of μ momentum transverse to jet axis, $p_{\perp}^{rel}$

- Large for B decays because of large B mass



Signed μ impact parameter, δ

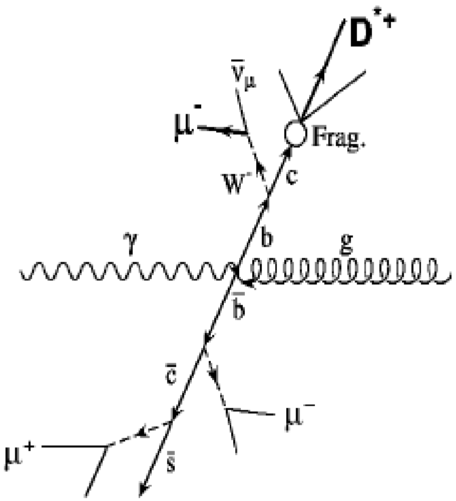
- Symmetrically distributed around zero for light flavours
- Positive tail for beauty and charm due to life-time



Fit most sensitive variables with MC templates

D*-μ and μ-μ correlations

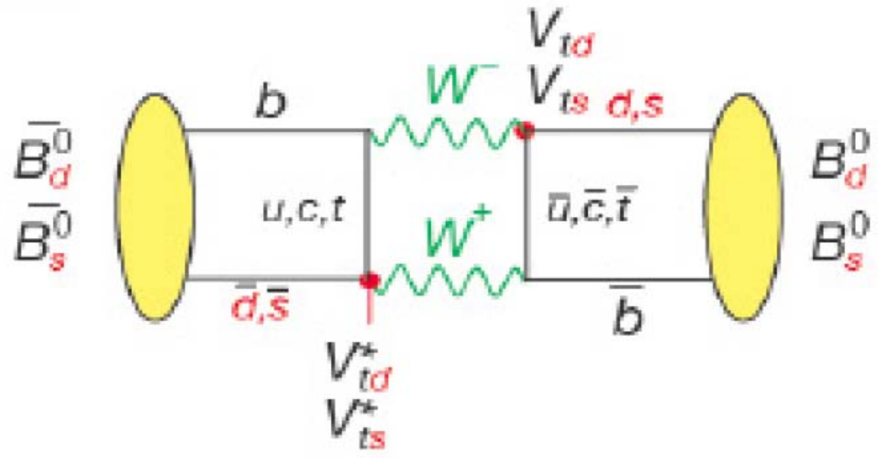
Correlations between hemispheres provide info on c + b



Employ wide range complementary methods

B_s Mixing

Thorsten Kuhl(D0)



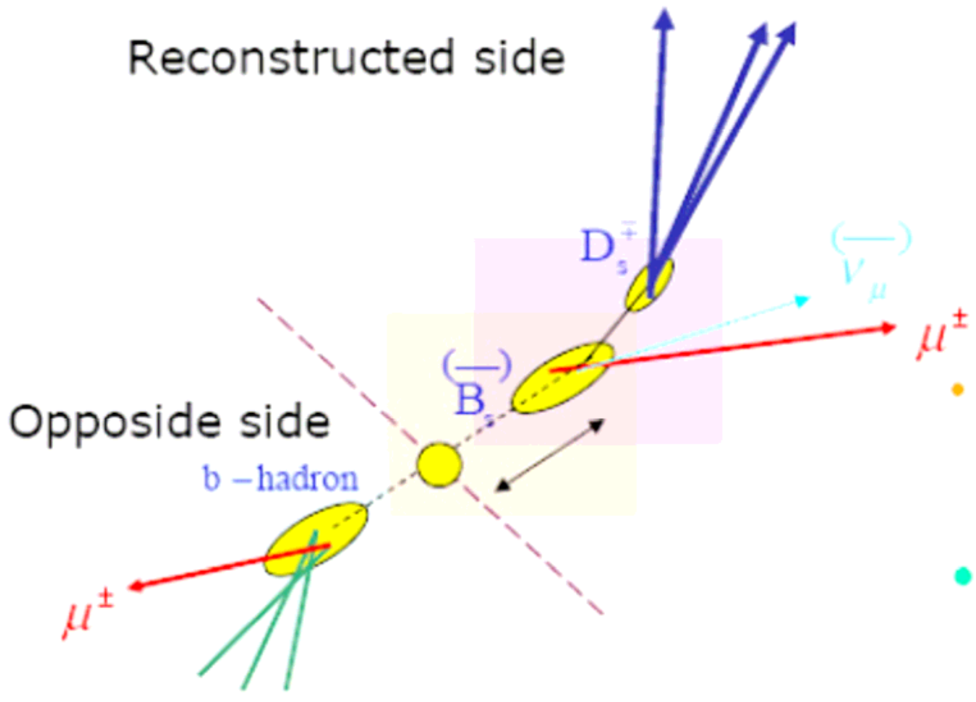
B_S mixing measurement only at Tevatron due to COM of B-factories

Frequency of oscillations between mass eigenstates $\Delta m_s = M_H - M_L$ higher than for Δm_d

Measure the CKM matrix element V_{ts}

Technique

$D_S \to \Phi\pi \to K^+K^-\pi$



- Final state reconstruction:
  - b-flavor at decay
  - b momentum (missing: p_ν)

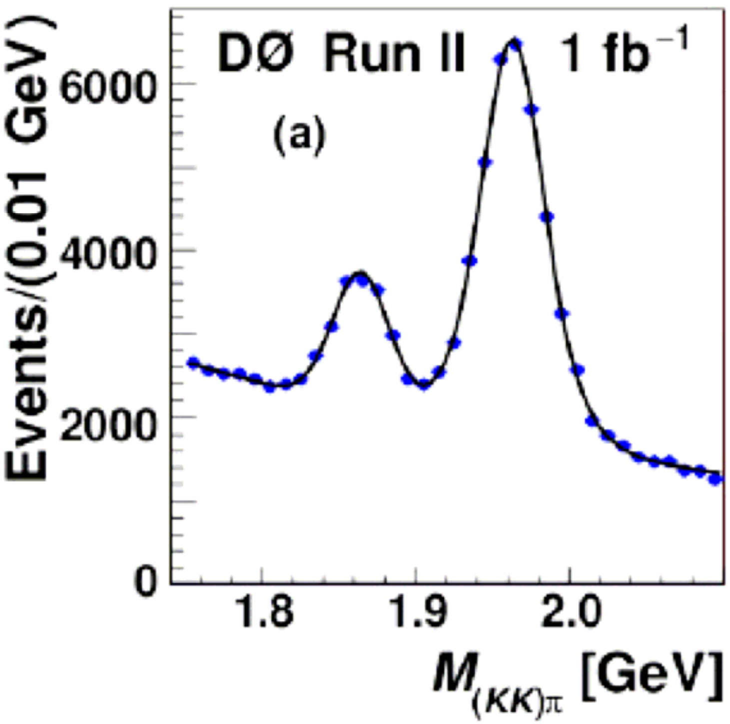
- proper lifetime $c\tau = m_B \frac{L_{xy}}{P_T(B)}$

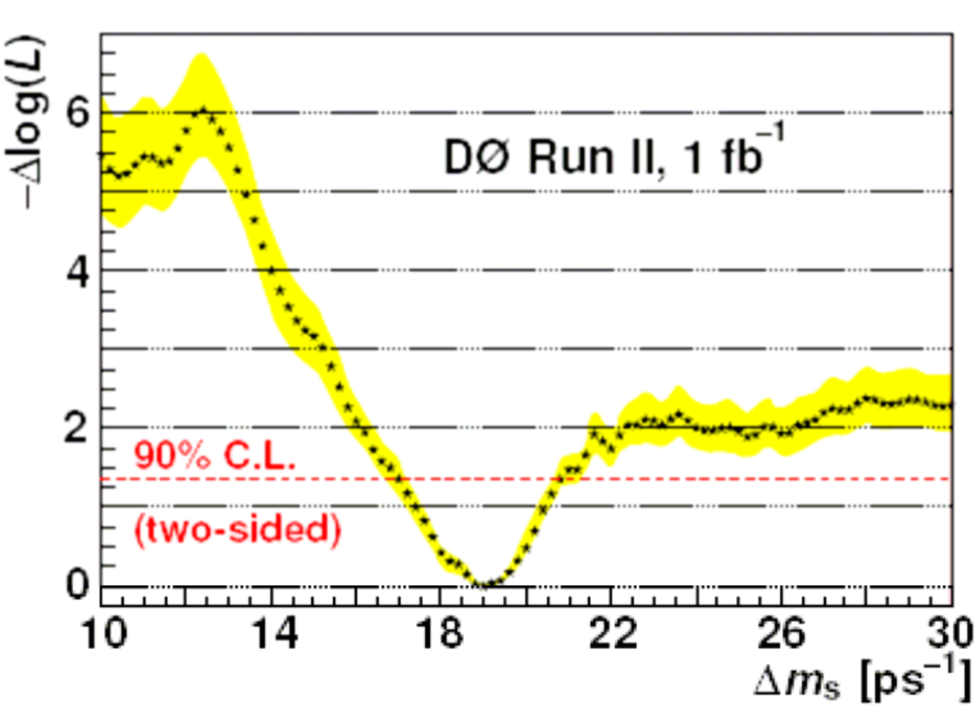
- Initial state (opposide side):
  - lepton charge
  - sec. vtx/lepton jet charge

$$\text{Asymmetry}(t) = \frac{N(t)_{unmixed} - N(t)_{mixed}}{N(t)_{unmixed} + N(t)_{mixed}}$$

$$\text{Asymmetry}(t) = A \cdot D \cdot \cos(\Delta m \cdot t)$$

D0 Result

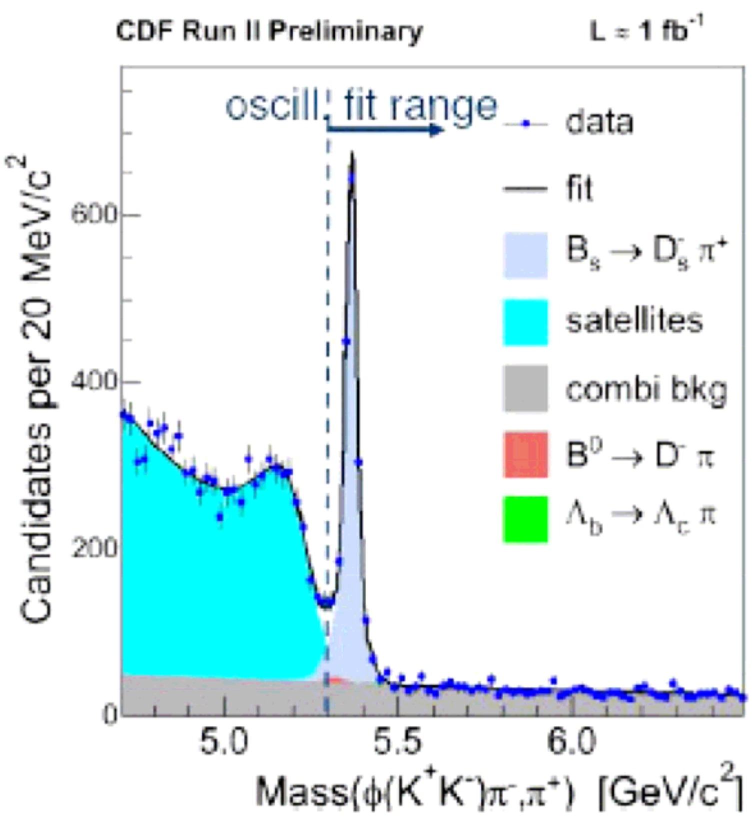


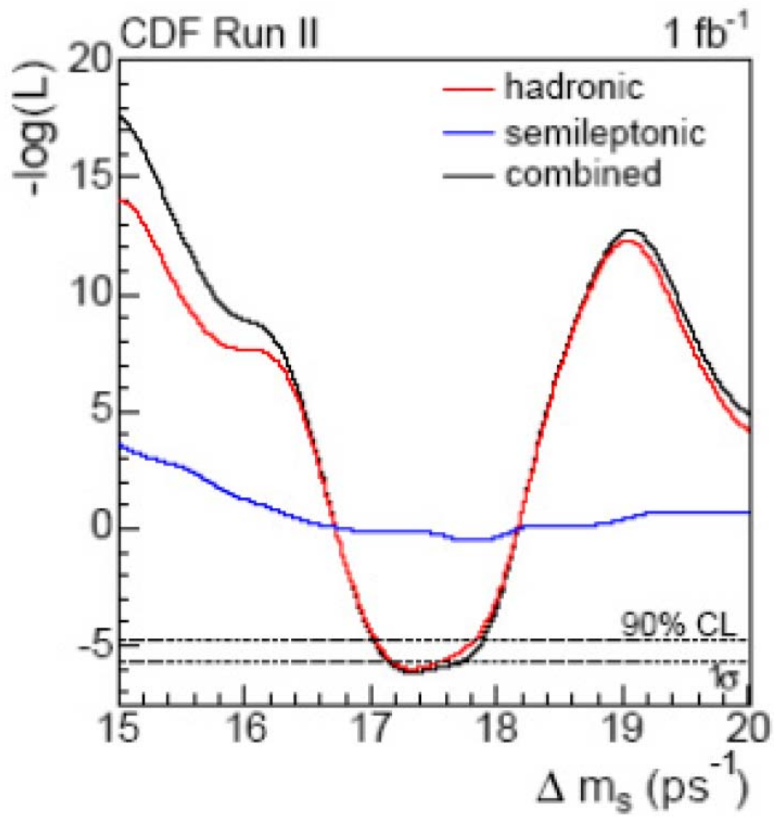


(arXiv:hep-ex/0603029 v1 15 Mar 2006)

$17ps^{-1} < \Delta m_s < 21ps^{-1}$
(90% CL assuming Gaussian error)

CDF Result





Reconstruction of explicit hadronic decay channels

Impact parameter trigger

$17 < \Delta m_S < 21$ ps^{-1} at 90% CL (DØ)

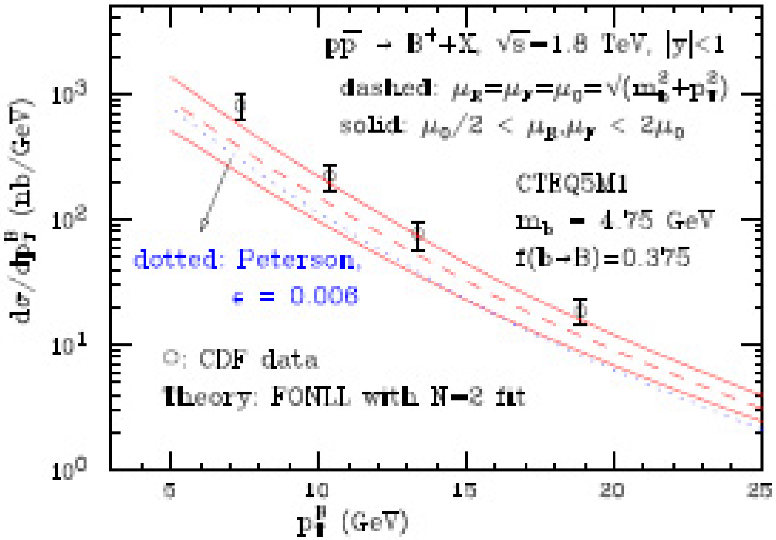
$\Delta m_S = 17.33^{+0.42}(stat) \pm 0.07(syst) ps^{-1}$,

$17.00 < \Delta m_S < 17.91$ ps^{-1} at 90% CL ,

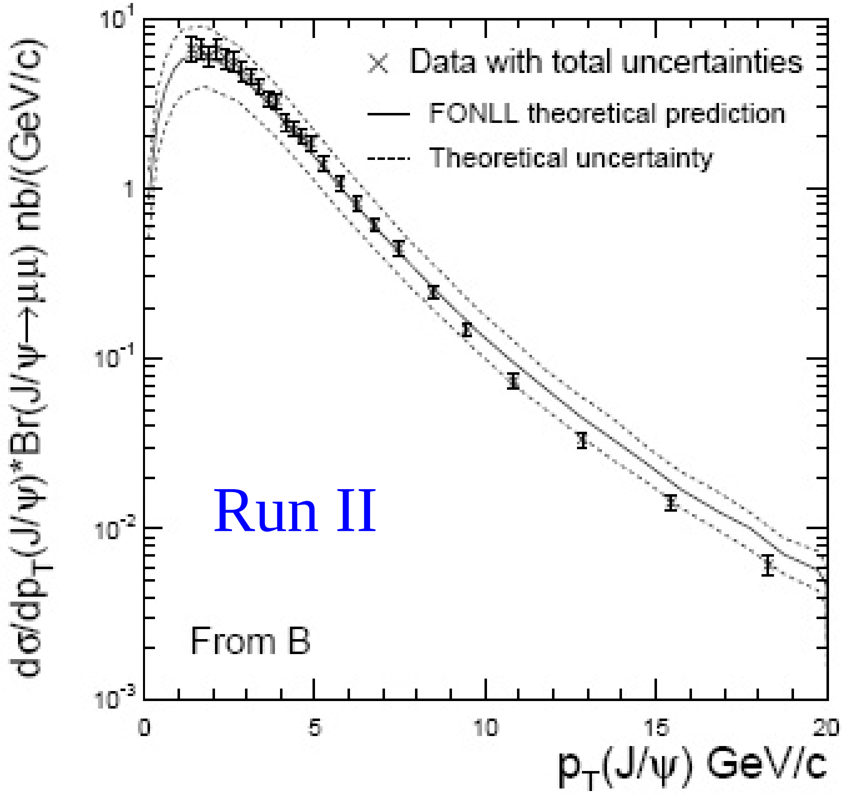
$16.94 < \Delta m_S < 17.97$ ps^{-1} at 95% CL (CDF)

$(V_{td}/Vts = 0.208^{+0.008}_{-0.007})$

b production at Tevatron



Run I

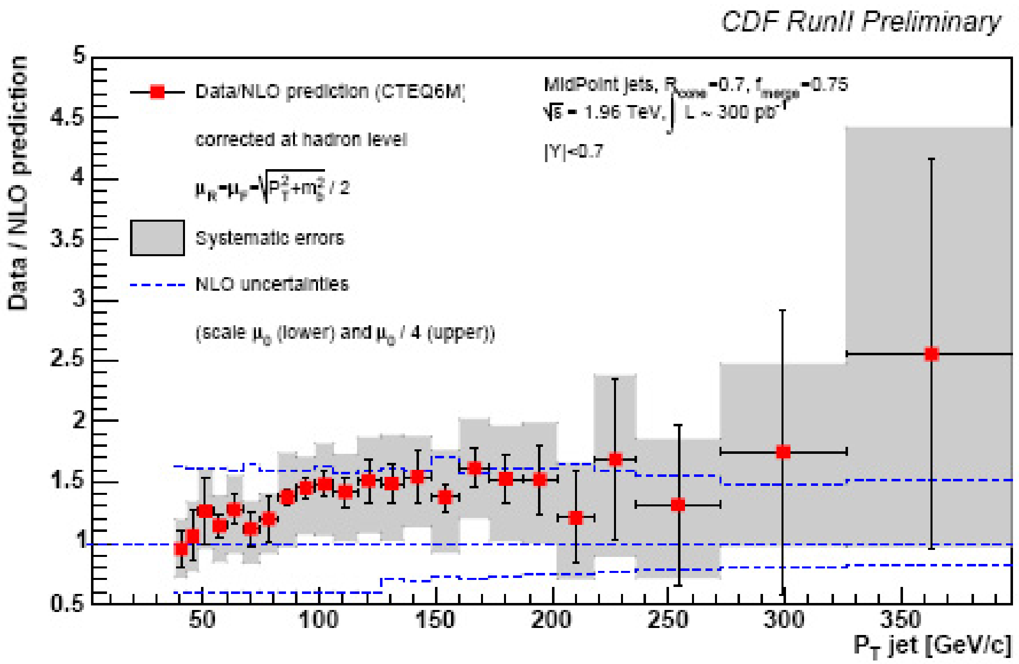


Tuned fragmentation

Data often higher but description within scale uncertainties

b jets at Tevatron

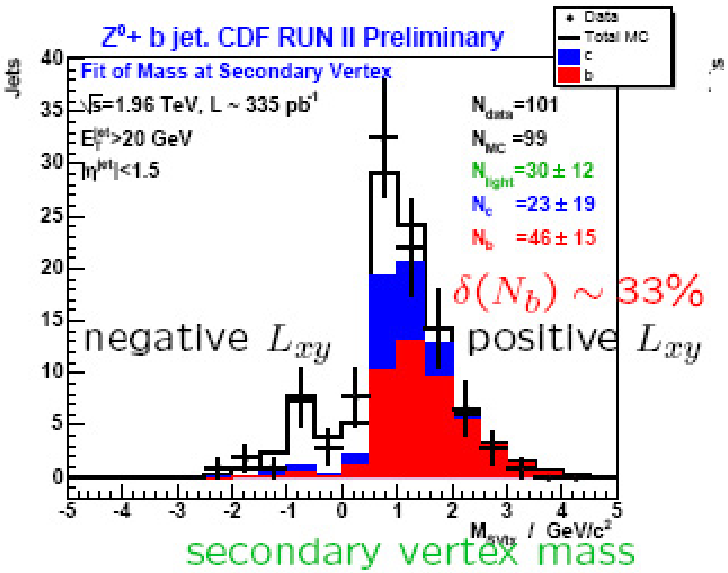
Daniel Jeans(CDF)



Agreement with (massive) NLO QCD within uncertainties

Large data and theory uncertainties -> improved by measuring b fraction?

Z+b-jets at Tevatron



Sensitive to different QCD processes

Statistics limit precision

Agreement with (massless) NLO QCD

high scale $m_Z \Rightarrow$ small theory scale uncertainty

	CDF RunII measurement	NLO (MCFM)
$\sigma(Z^0 + b - jet)/\sigma(Z^0 + jet)$	$0.0237 \pm 0.0078 \pm 0.0033$	0.0185
$\sigma(Z^0 + b - jet)/\sigma(Z^0)$	$0.0038 \pm 0.0012 \pm 0.0005$	0.0021
$\sigma(Z^0 + b - jet)$	$0.96 \pm 0.32 \pm 0.14$ pb	0.52 pb

Compatibility of Tevatron data

Fabio Happacher (INFN), Frascati

hep-ph/0509348

Single b quark data. Ratio to same theory (MC).

channel (ex.)	R for p_T^{min} (GeV/c) =					
	6	8-10	12-15	19-21	≈29	≈40
$J/\Psi K^+$ (CDF)		4.0±15%	(3.4)			
$J/\Psi K^+$ (CDF)		2.9±23%	(1.9)			
μX (CDF)				2.5±26%	(1.9)	
eX (CDF)			2.4±23%			
eD^o (CDF)				2.1±34%		
$J/\Psi X$ (CDF)		4.0±10%	(3.4)			
$J/\Psi X$ (CDF2)		3.1±9%	(2.7)			
μX (DØ)	2.1±27%		(1.7)			
μX (DØ)	2.5±25%		(3.5)			
b jets(μ) (DØ)				2.4±20%		(2.0)

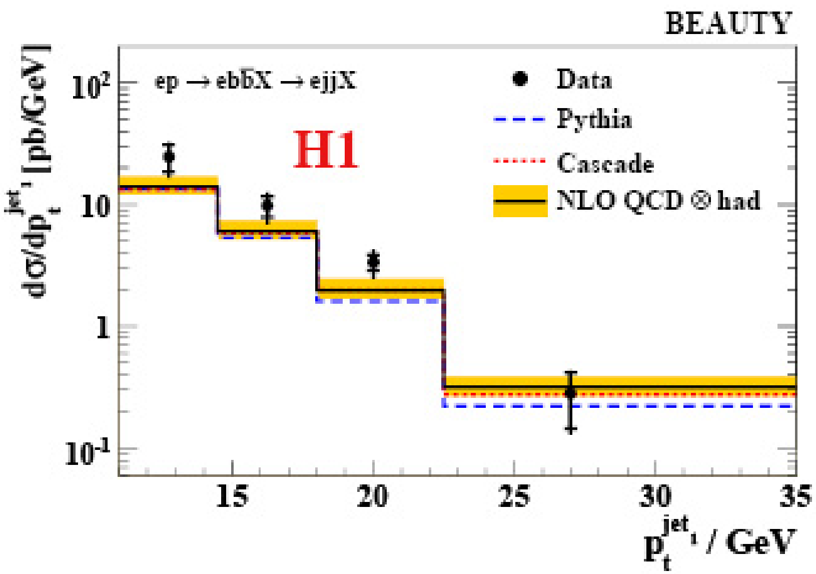
Consistent picture between processes?

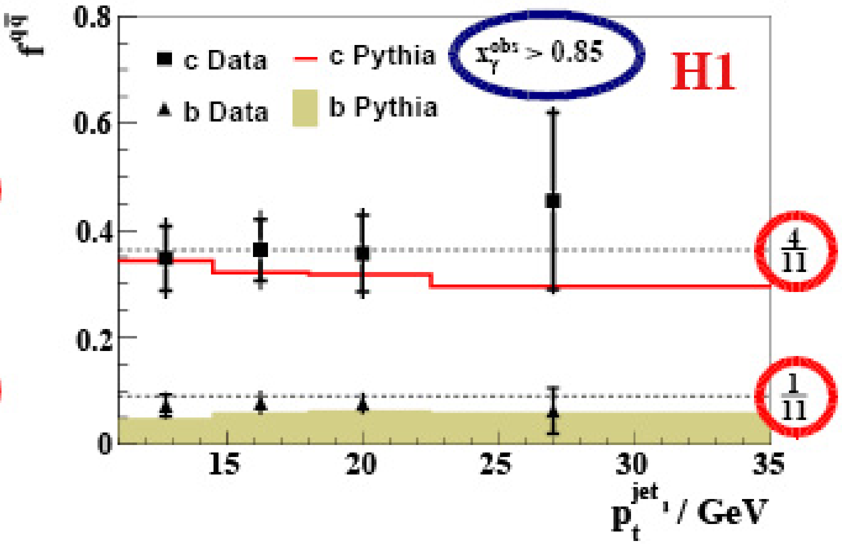
Run II final data…

b jets at HERA

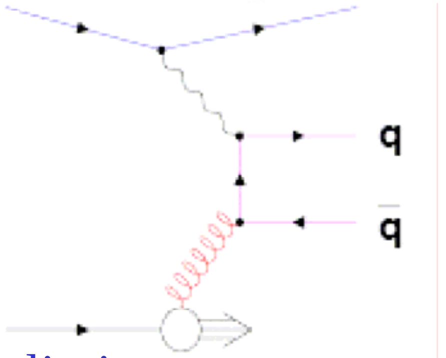
Lars Finke(H1)

Using impact parameter of tracks in jets (Final data)





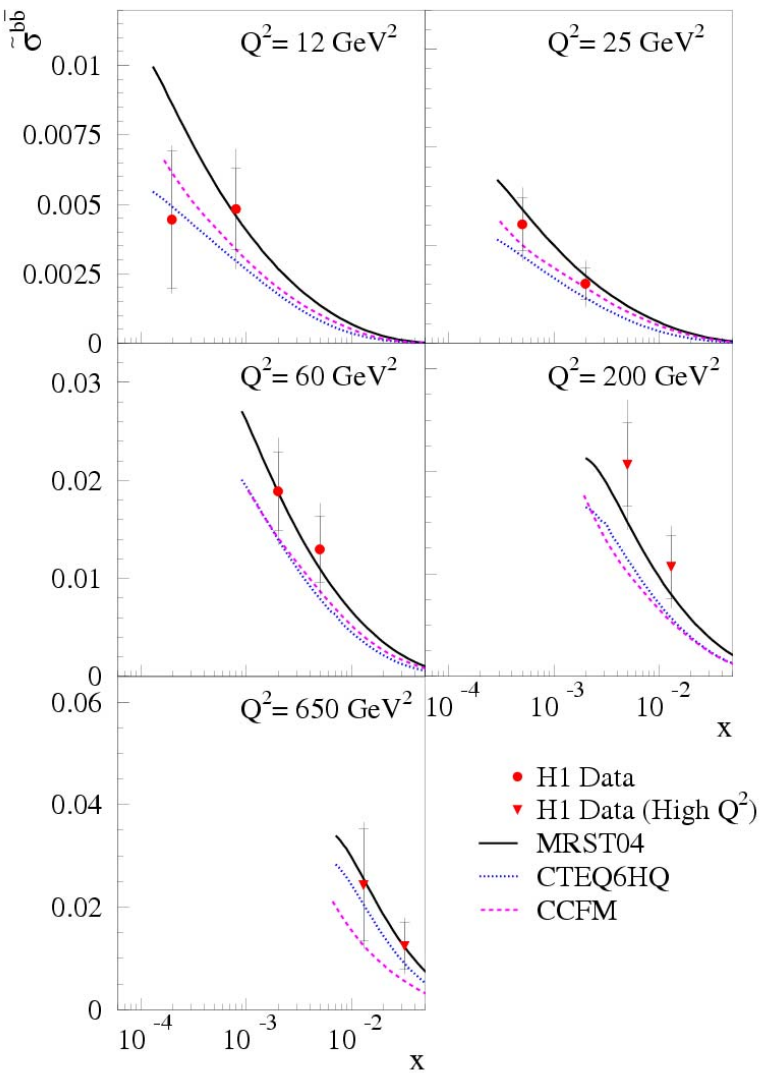
$Q^2 < 1$ GeV^2, $0.15 < y < 0.8$, $p_t^{jet} > 11$ (8) GeV, $-0.9 < \eta^{jet} < 1.3$



- Measurement to high p_T
- Compatibility with theory although data are higher
- b fraction consistent with (massless) charge counting limit

F_2^{bb}

Paul Laycock(H1)



Final HERA-I low Q^2 data

Displaced tracks method allows access to lower p_T reducing extrapolation

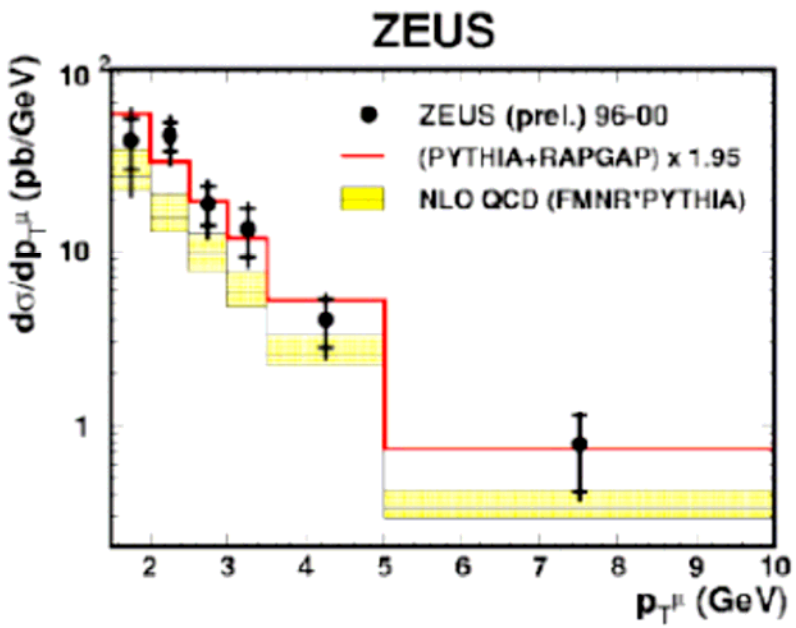
Large uncertainty in QCD

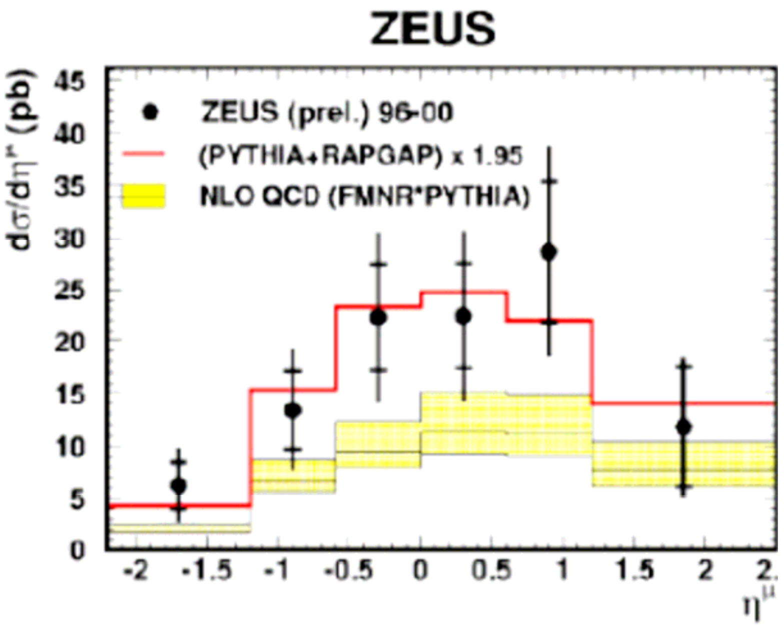
Data consistent with all predictions

Require HERA-II data to improve precision and constrain schemes/PDFs

b from D*-μ and μ–μ correlations

Adriana E. Nuncio-Quiroz(ZEUS)





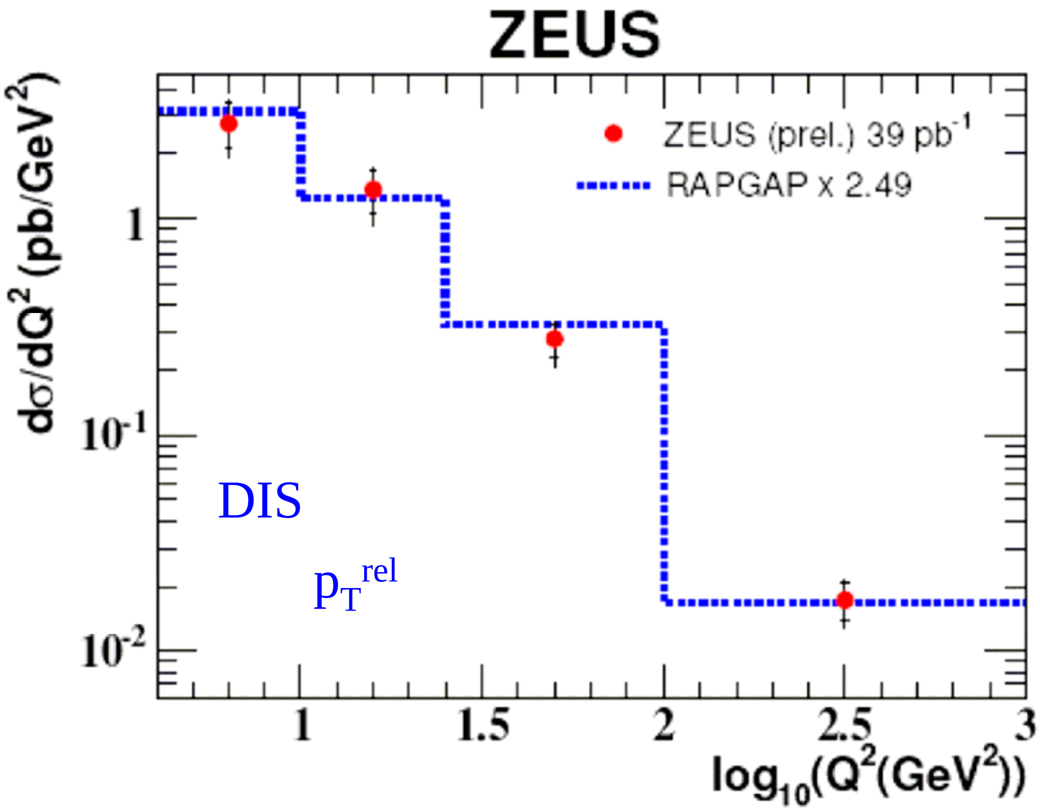
New interface of NLO QCD program to PYTHIA

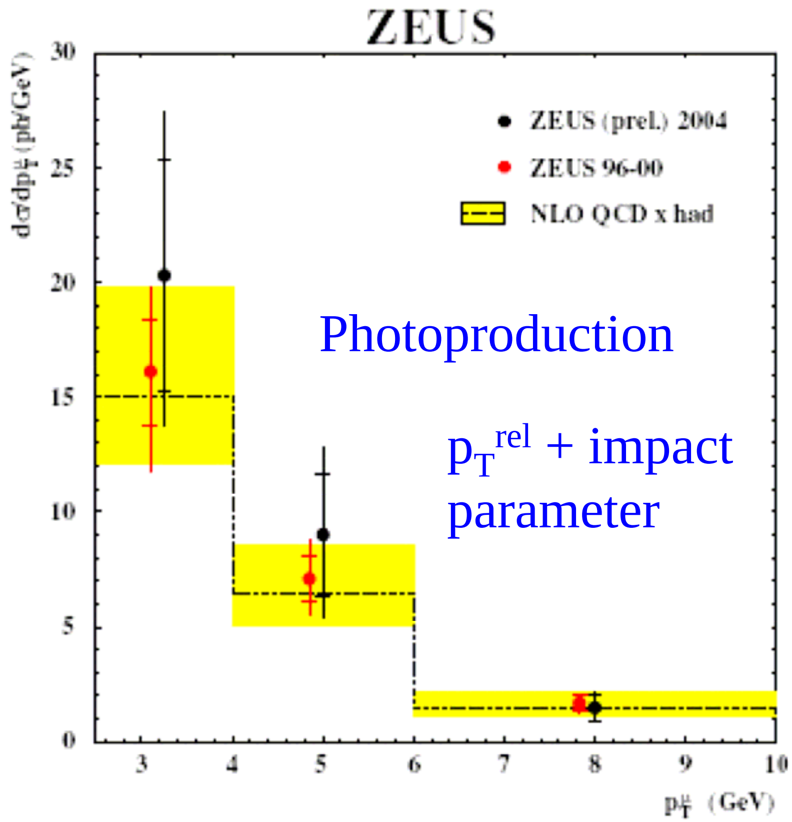
Consistent with although higher than NLO QCD

Consistent with H1 published data when interpolated to same phase space

b at HERA-II

Oliver M. Kind(ZEUS)

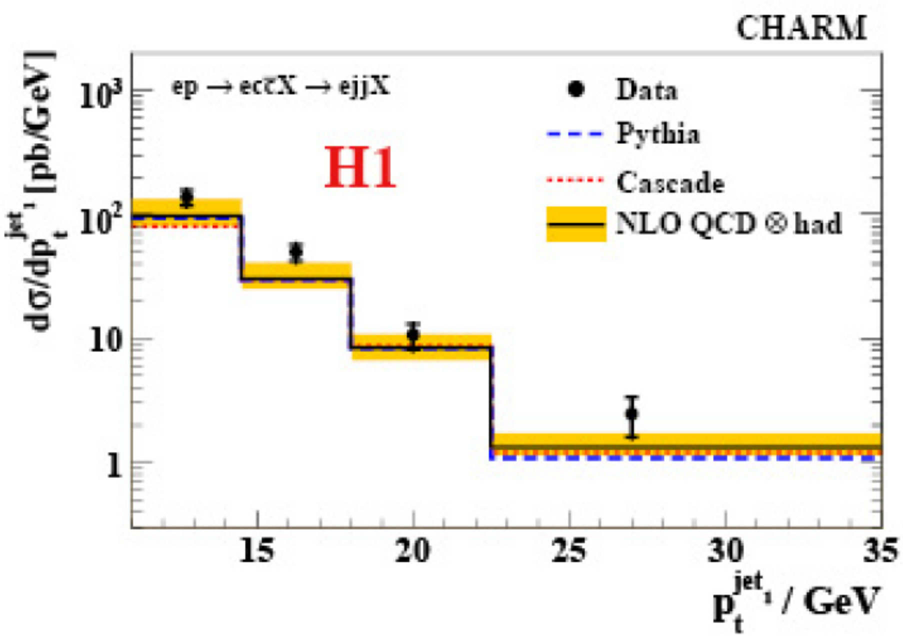


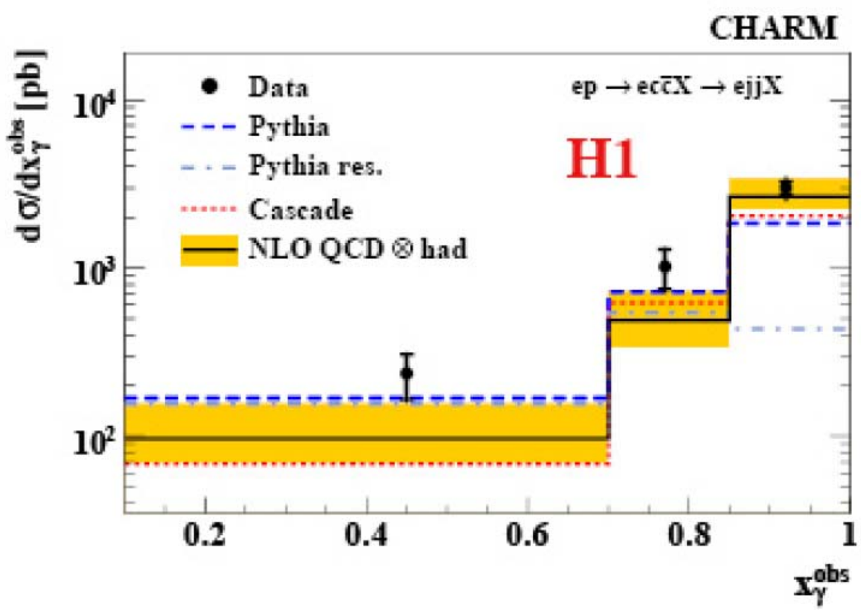


HERA-II (only small fraction of data) consistent with HERA-I and QCD

Use of ZEUS silicon detector, looking forward to precise HERA-II results

Open charm production

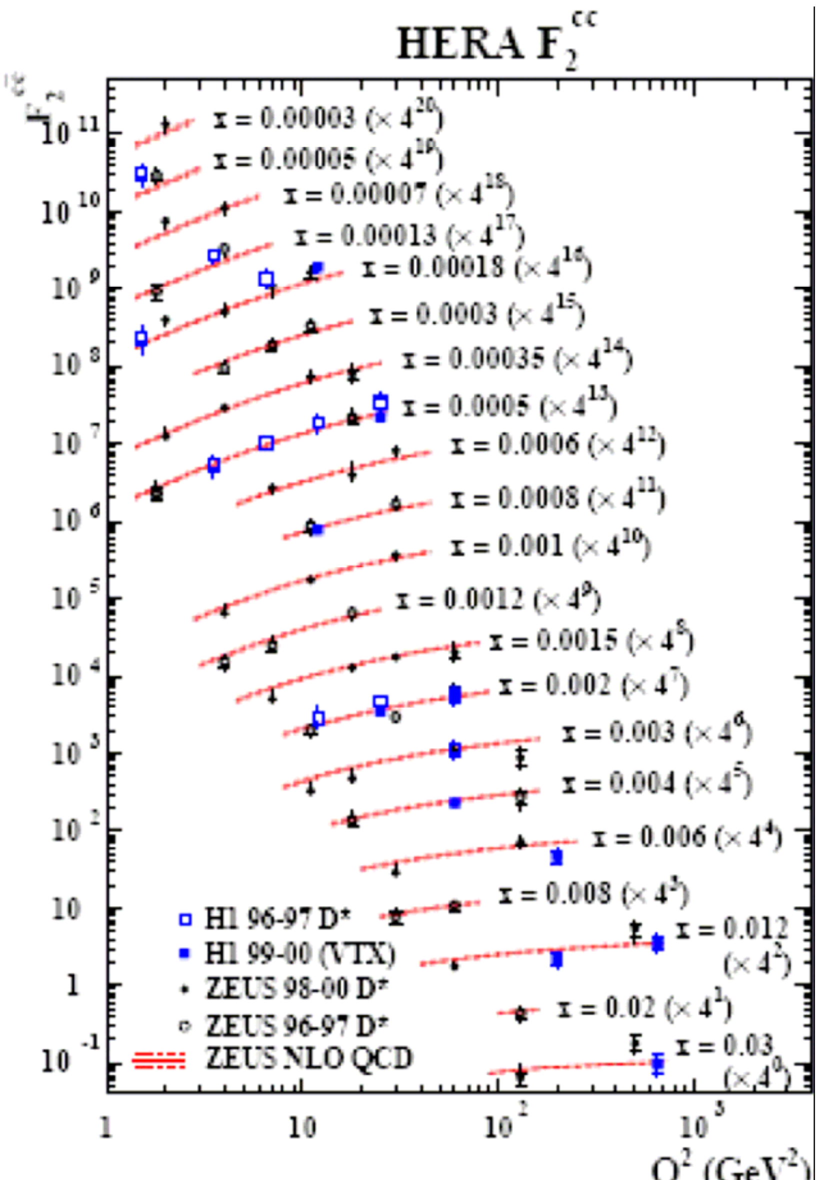




NLO consistent with data

Not all details described at low x_γ(consistent picture with ZEUS D^*+jets)

F_2^{cc}



Consistent results between displaced tracks (VTX) and D^* methods

Similar overall statistical plus systematic errors for 2 methods

Aim to measure over wide range as possible to constrain PDF

charm fragmentation at HERA-I

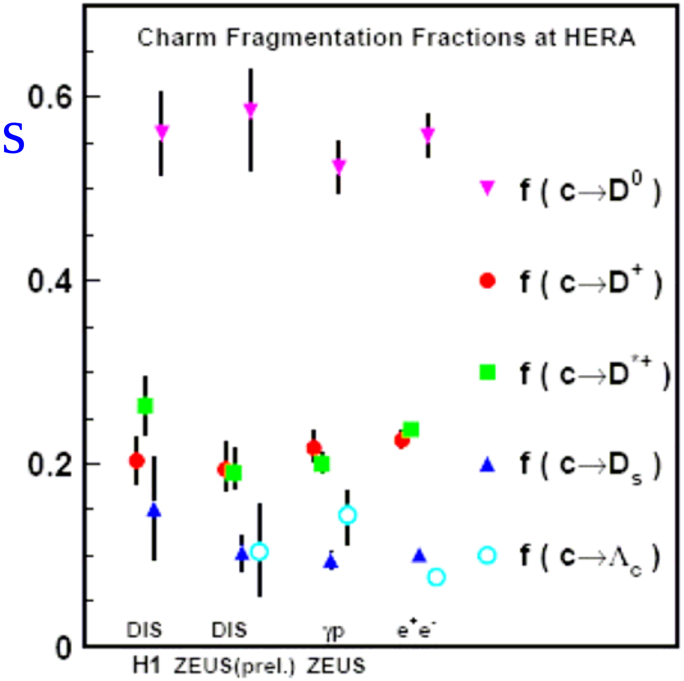
William Dunne(ZEUS)

Large data sets allow for high statistics studies of c mesons/baryons

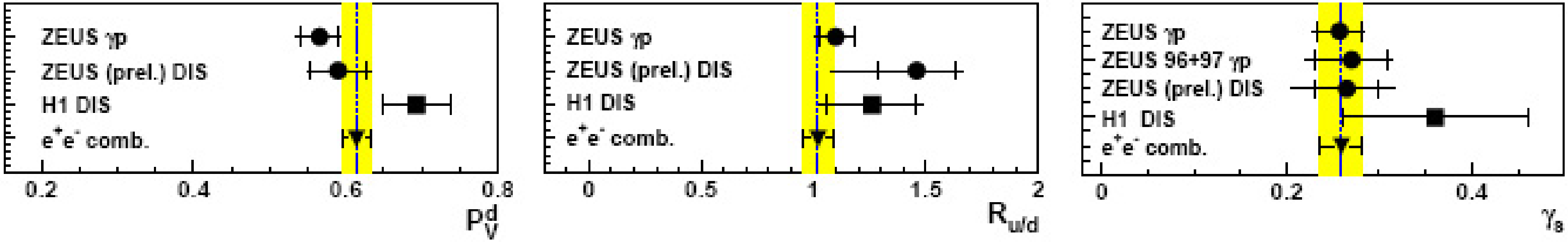
Consistent with fragmentation universality

Combine final data for improved precision?

(Final ZEUS γp data)



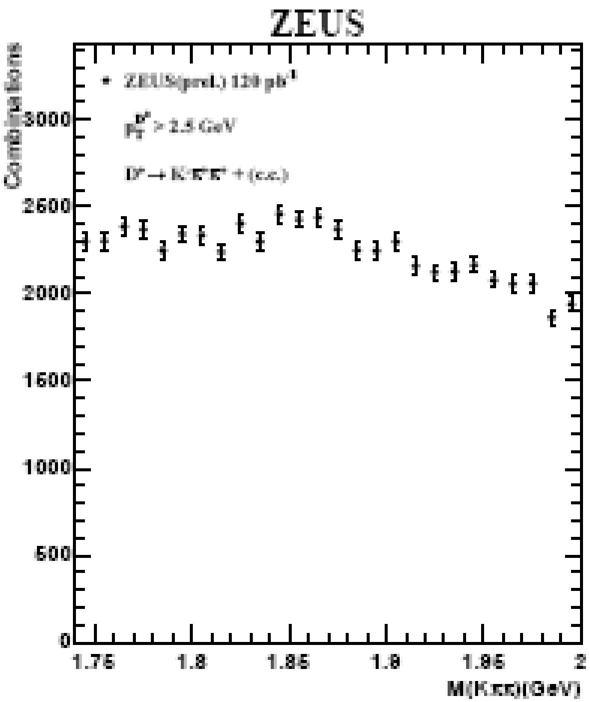
Fragmentation ratios

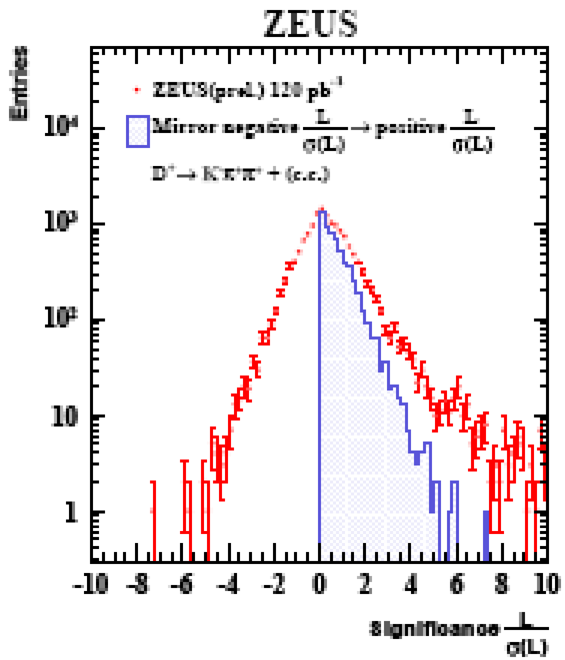


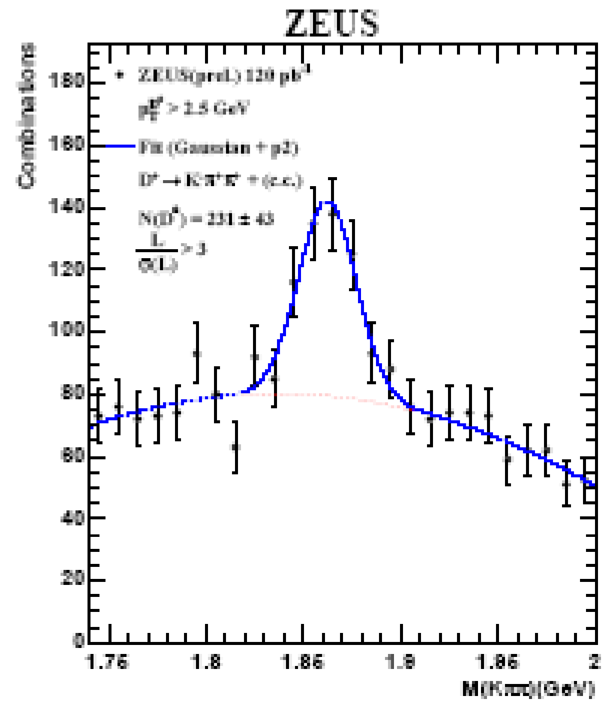
Can be measured at Tevatron

charm production at HERA-II

Falk Karstens(ZEUS)







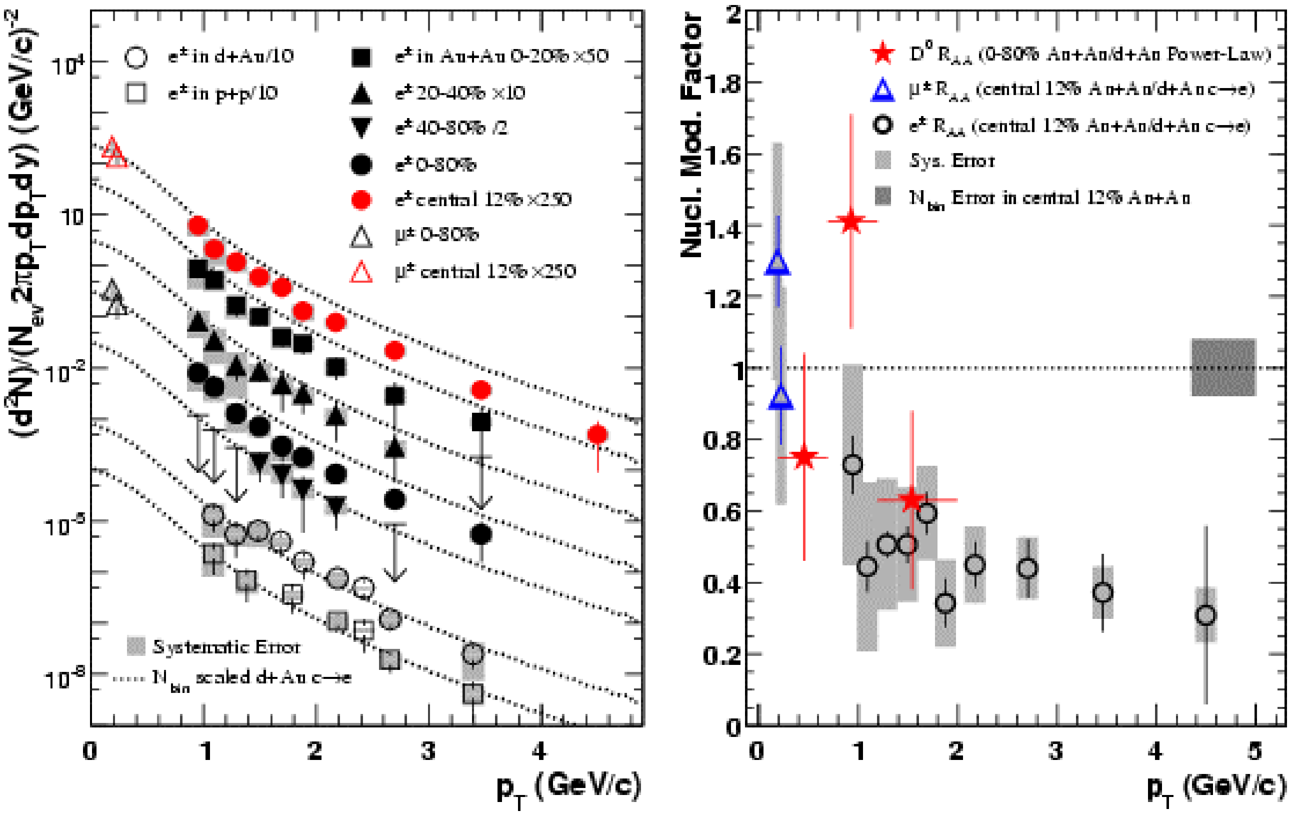
Apply cut on secondary vertex decay length

Substantial reduction in background

Much more charm data to come from HERA

Heavy Flavour at RHIC

Manuel Calderon (STAR)



Charm results at large rapidity from PHENIX also shown (X.Wang)

Measure e,μ,D^0 in Au+Au collisions for central rapidity

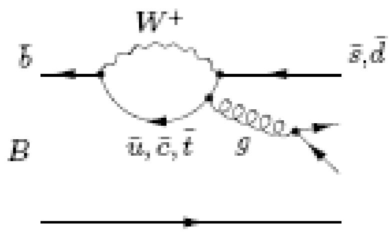
Study suppression w.r.t. p+p depends on “hot” medium and probe mass

Suppression not expected for HF although difficult without tagging b (future->upgrades)

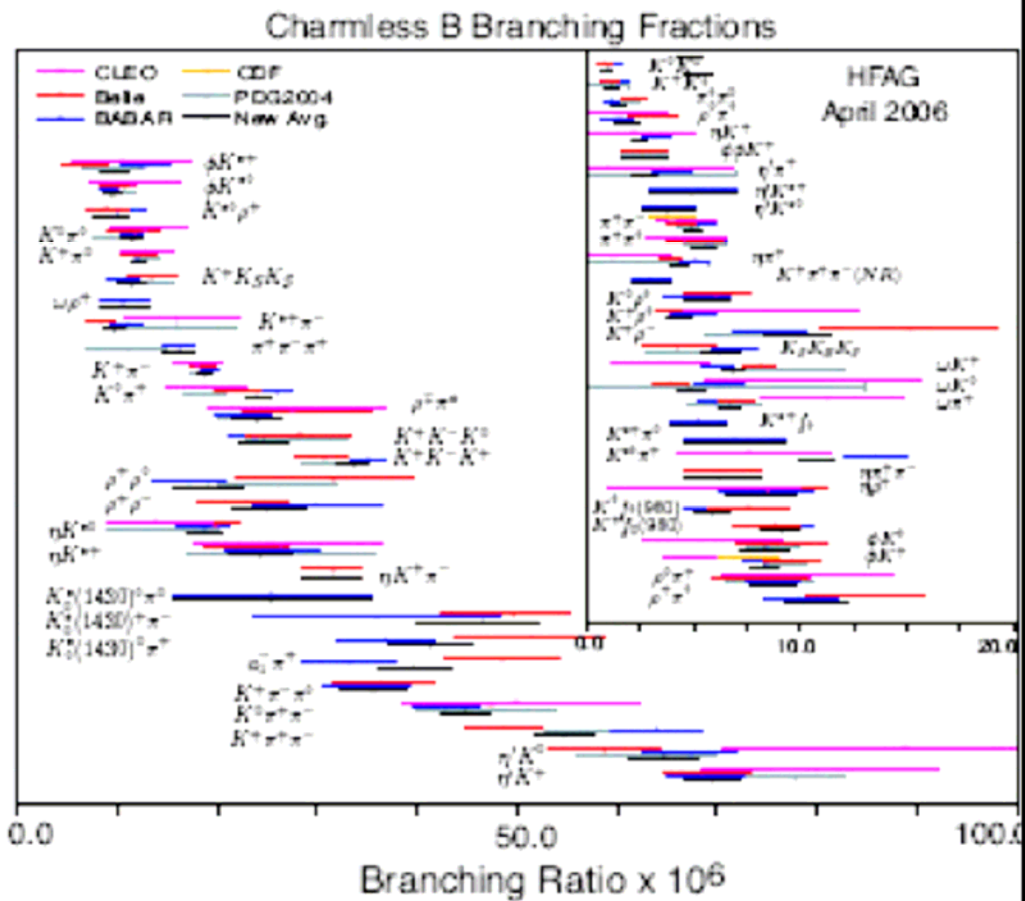
Rare charmless B decays

Wolfgang Gradl(BaBar/Belle)

Joint HF+ HFS Session



- Many new and updated results from both B factories
- Rare charmless B decays help to improve understanding of Standard Model amplitudes
- More interesting results to come with more data



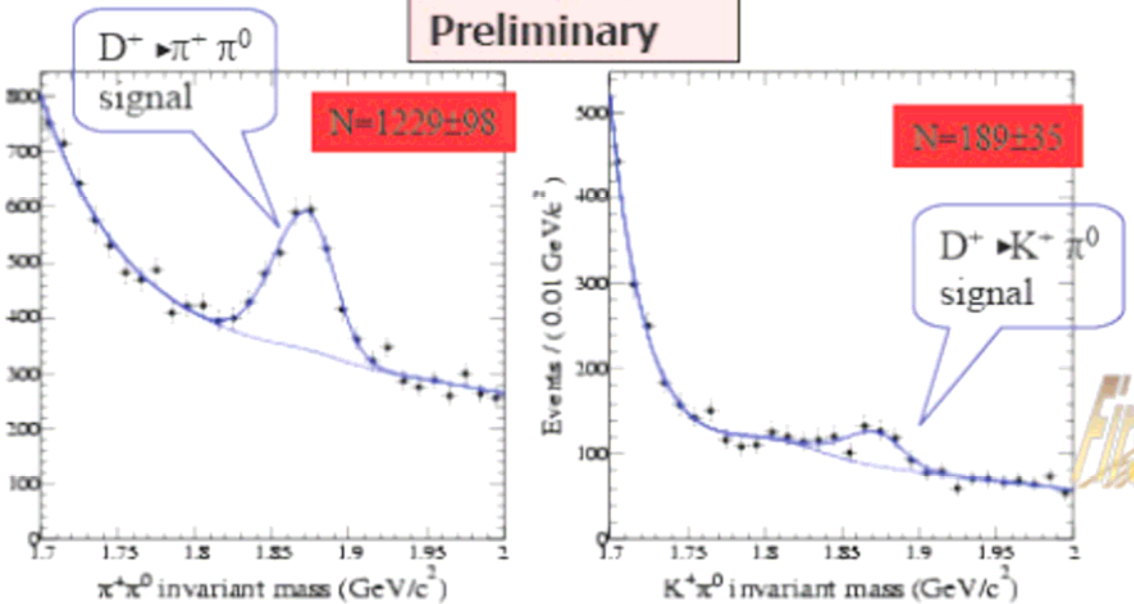
Charm at B-Factories

M. Saleem(BaBar)

BABAR Preliminary

$D^+ \longrightarrow K^+/\pi^+ \, \pi^0$ B.F.

BABAR: 124 fb^{-1}
To Be submitted to PRL



First Observation

BABAR Preliminary

$$B(D^+ \to K^+\pi^0) = (0.246 \pm 0.046_{stat} \pm 0.024_{syst} \pm 0.016_{[D^+ \to K^-\pi^+\pi^+]}) \times 10^{-3}$$

$$B(D^+ \to \pi^+\pi^0) = (1.22 \pm 0.10_{stat} \pm 0.08_{syst} \pm 0.08_{[D^+ \to K^-\pi^+\pi^+]}) \times 10^{-3}$$

Using $D^+ \to K^-\pi^+\pi^+$
World avg.: 0.092±0.006

Significant improvement in $B(D^+ \to \pi^+\pi^0)$: $(2.6 \pm 0.7) \times 10^{-3}$ [PDG]

Also, D_{SJ}, D mixing and lepton decay. Plus, talks on charm at Belle(Kichimi), Quarkonium at BaBar(Vitale), HF at HERA-B(Spighi), B resonances at D0(Gele),,.

Towards the LHC

Claudia Ciocca (CMS)

Studies of top pair production in hadronic channels

Selection	Requirement	$\hat{\sigma}$ $t\bar{t}$ [pb]	$\hat{\sigma}$ QCD [pb]	S/B	ϵ $t\bar{t}$ (%)
Trigger	HLT b-jets + n-jets	64	11600	1/180	16.8
Kinematical	$6 \leq N_{jet} \leq 8$	59	7900	1/130	15.5
	$E_T \geq 25$ GeV	33	1650	1/50	8.7
	neural net	15.2	91	1/6	4.0
b-tagging	1 b-tag	14.5	61	1/4	3.8
	2 b-tag	10.1	20	1/2	2.7

Selection	L = 1 fb^{-1}				
	$t\bar{t}$ events	QCD events	ϵ (%)	$\Delta\sigma_{stat}$ [pb]	$(\Delta\sigma/\sigma)_{stat}$ (%)
1 b-tag	19000	61000	2.3	12	1.4
2 b-tag	13000	20000	1.6	11	1.3

Plus Matthew Wing on relevance of HERA for LHC (HERA-LHC Workshop)

Summary

• Wealth of heavy flavour information from HERA, Tevatron, B-factories, RHIC,…

• Heavy flavours provide direct access to gluon measured indirectly from fits to inclusive data.

• QCD is a success! Differences only in corners of phase space.

• HF sensitive to weak processes and new physics

• HF is a low cross section process and will benefit from machine upgrades E.g. B_s at Tevatron Run-II, HERA-II

• Much more to come…