Heavy Flavour WG Summary - Experiment

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University of Hamburg

DIS 2007, Munich, 20.4.2007

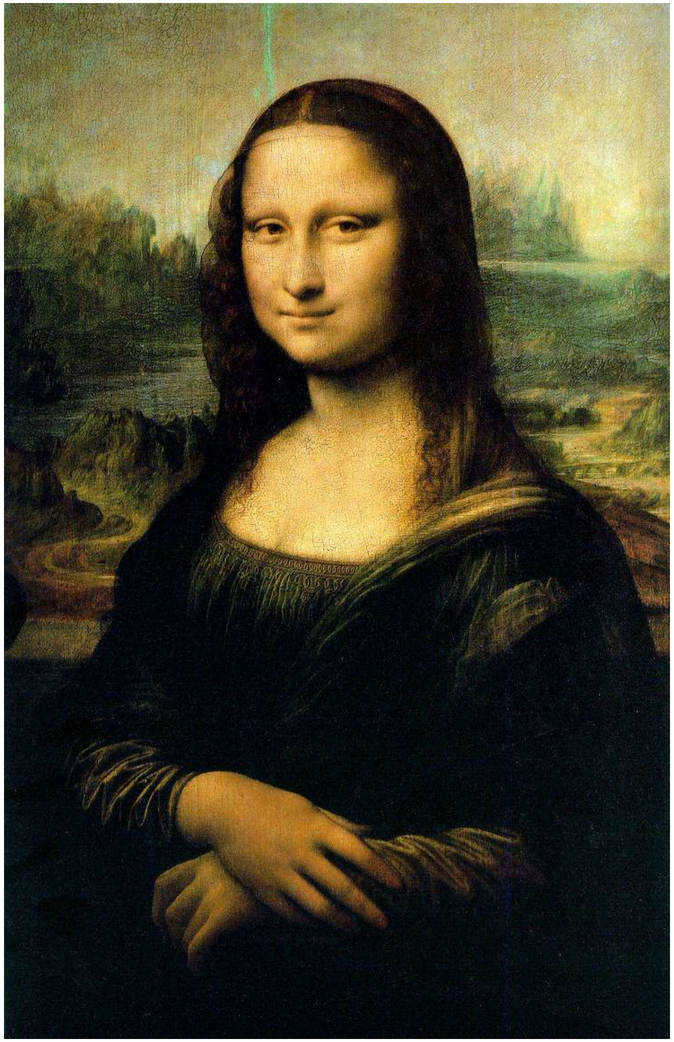
Overview

- Charm and Bottom Production (γp, ep, ppbar)
- Charmonium and Bottomium Production
- Heavy ion results
- Spectroscopy and (Rare) Decays
- Mixing
- Looking ahead

- 8 Sessions (1 joint session)
- More than 13 hours (but very little overtime => thanx to speakers!)
- 33 talks (27 experimental)

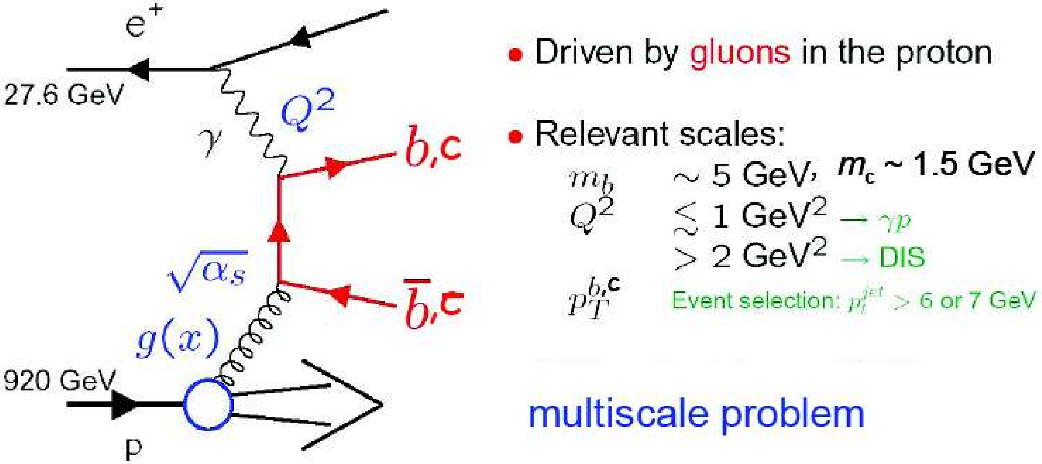
There's no way I can do justice to all the results

Charm and Beauty Production

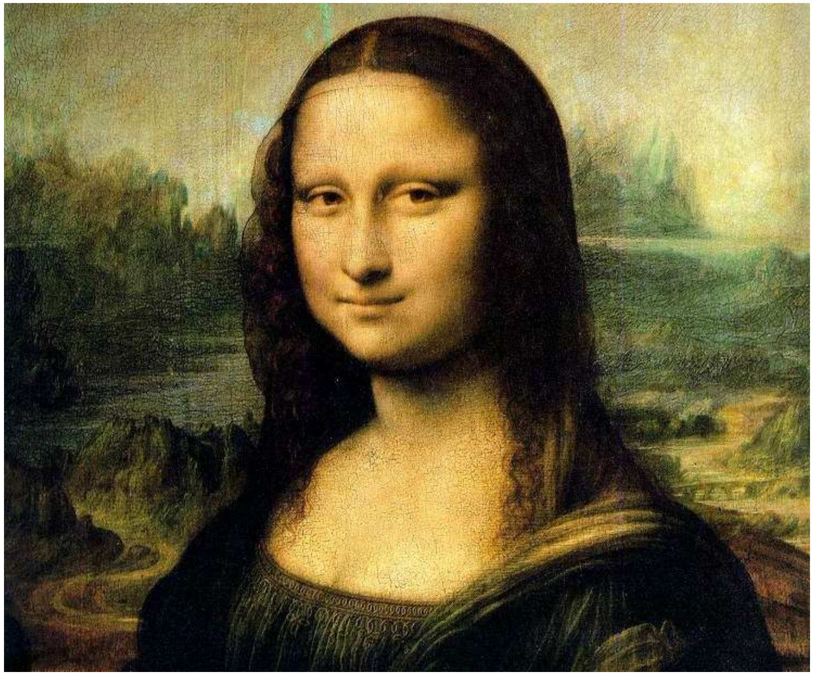


Charm and Beauty Production

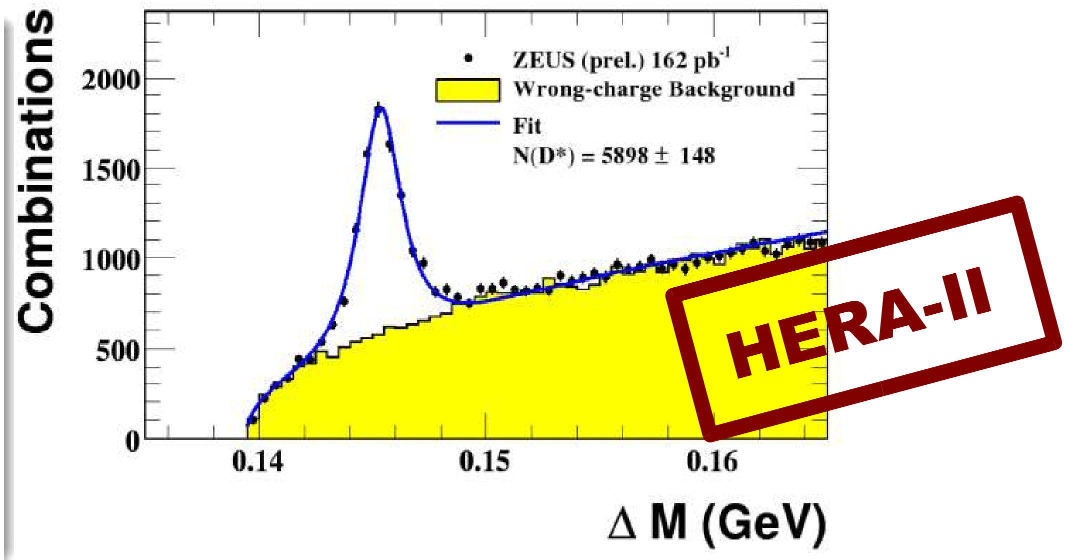
- Charm and Beauty produced from gluons
- Mass provides a scale, but complicates things when other scales enter
- Test production models => at LHC, top production will also become a multi-scale problem!
- Learn how to use HF production data in pdf fits



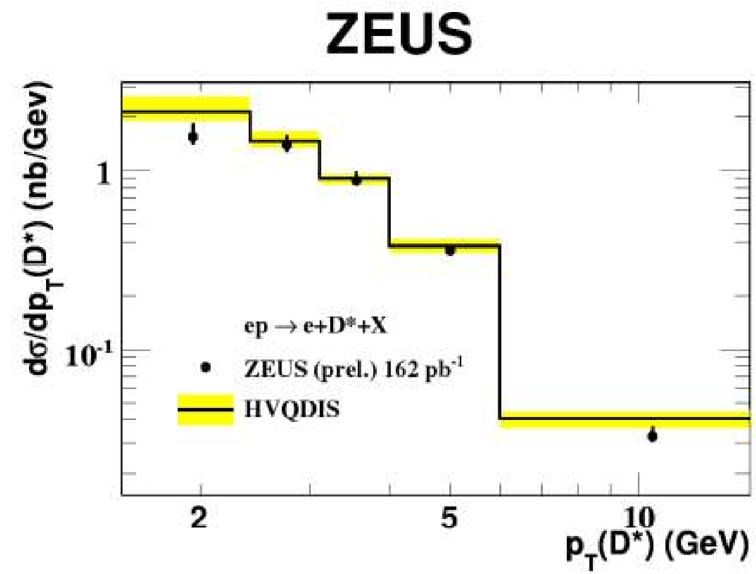
Charm

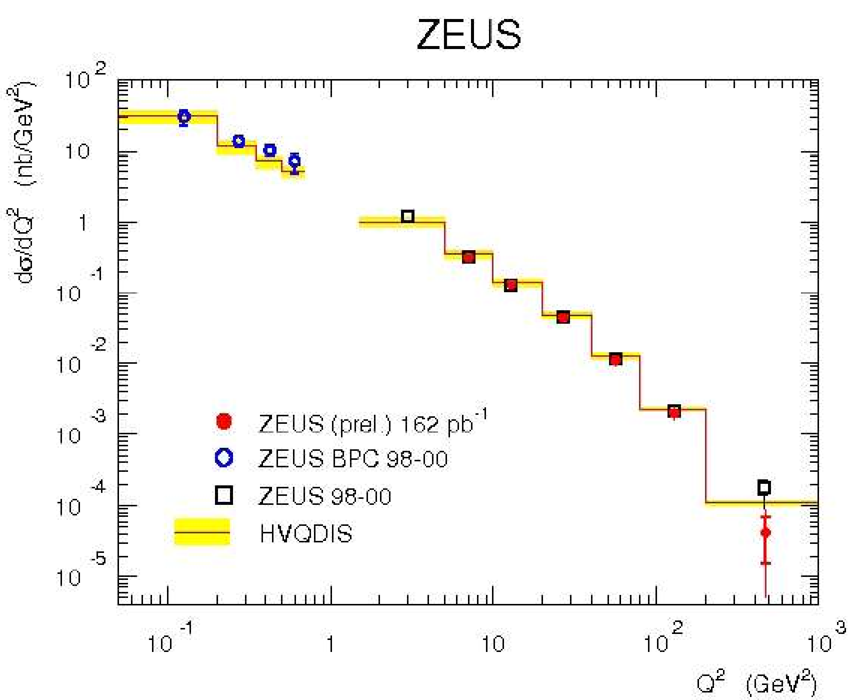


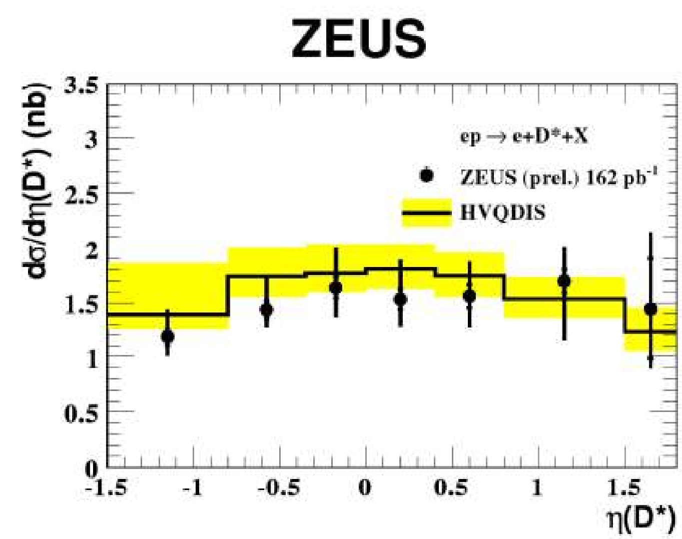
Charm in DIS from ZEUS



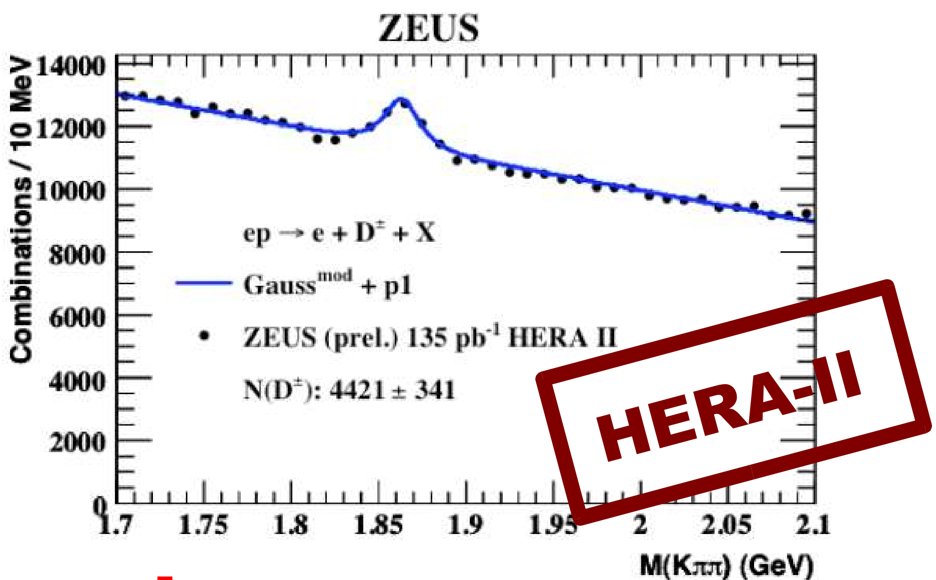
Hartmut Stadie (ZEUS)



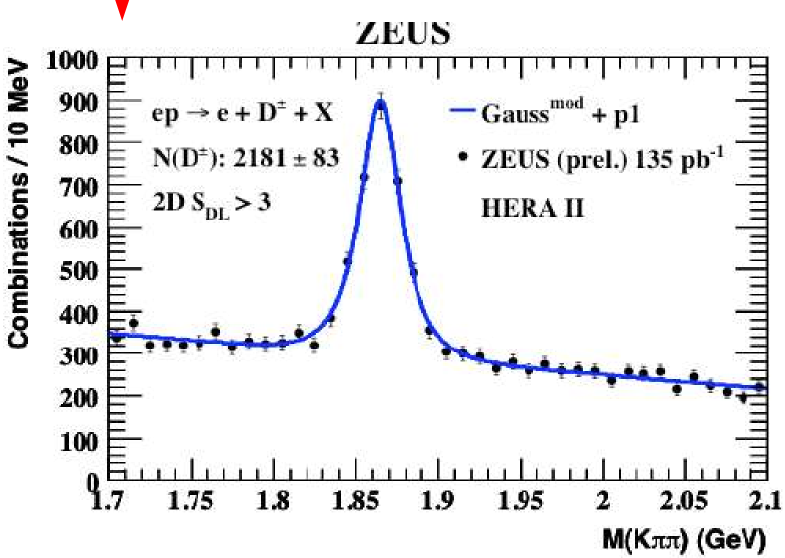




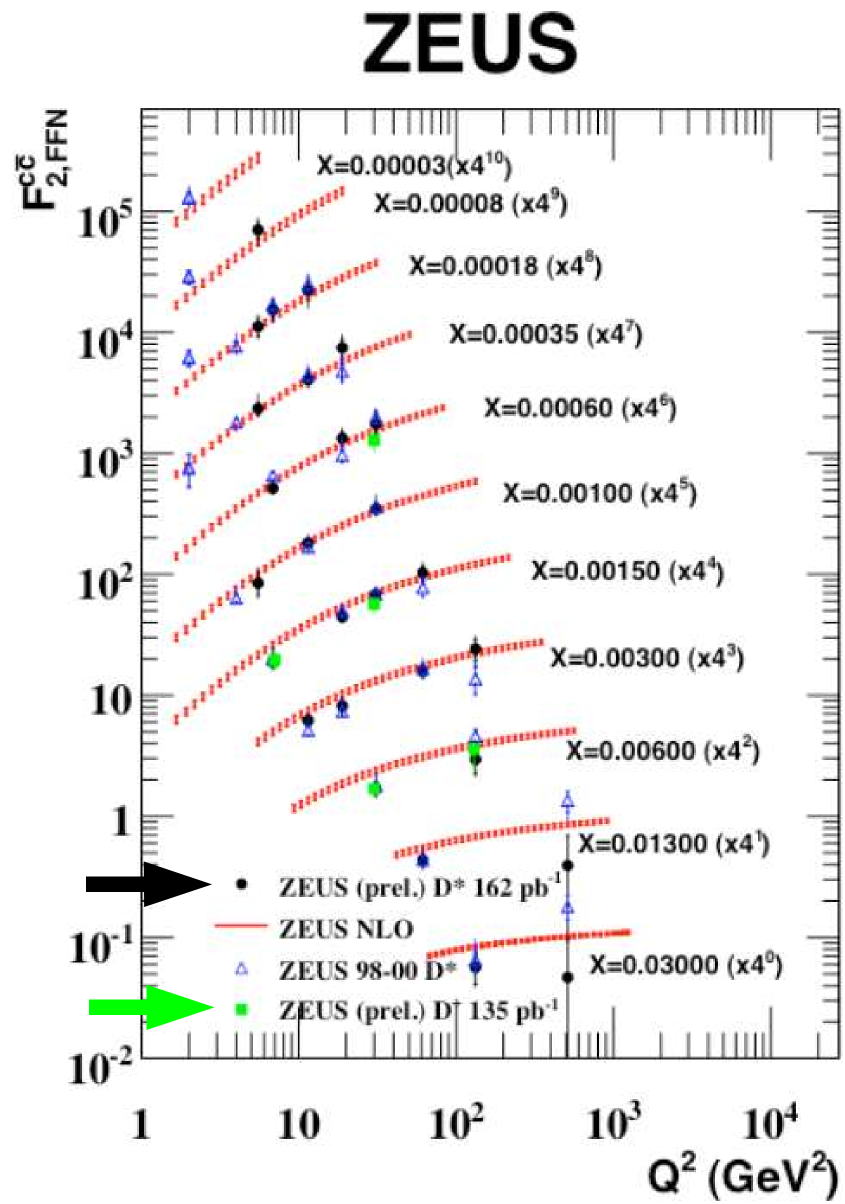
D+ Cross Sections in DIS with ZEUS MVD



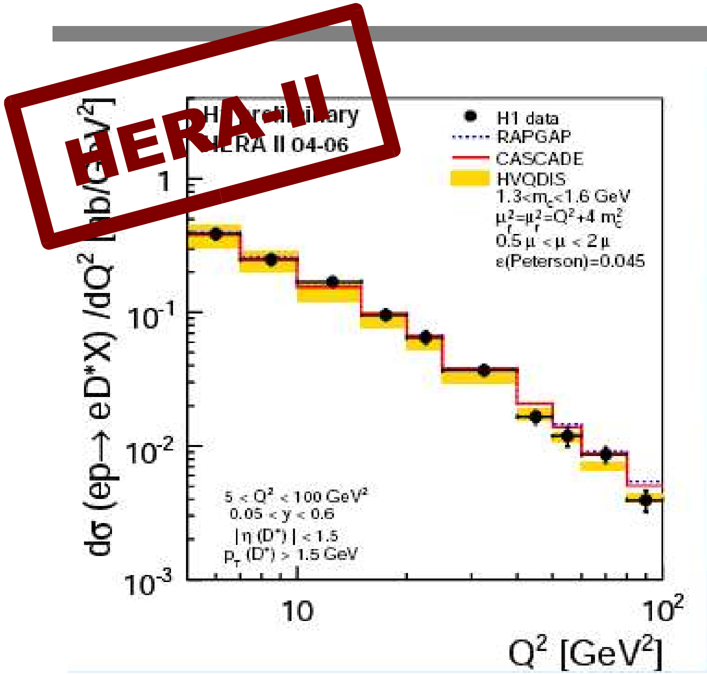
Decay length significance > 3



Dan Nicholass (ZEUS)

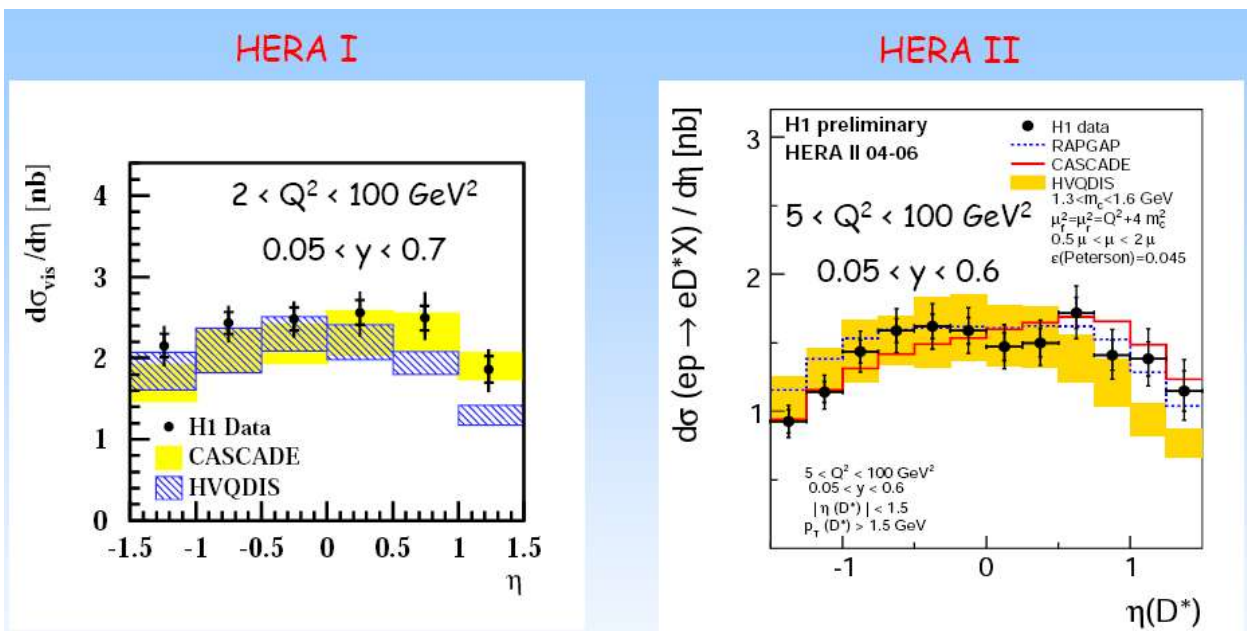


Charm in DIS from H1



H1 and ZEUS:

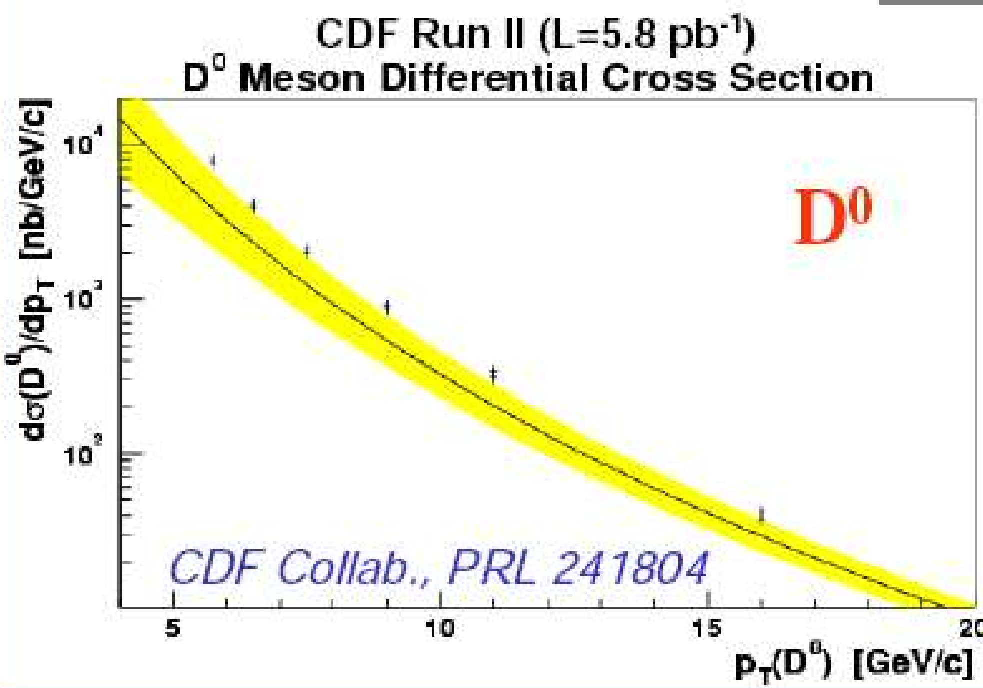
- Good agreement with NLO QCD calculations (HVQDIS)
- Data more precise than calculations:
  - Variations of m_c, μ_R, μ_F, FragFkt
  - How can we get more out of NLO predictions? => Discussion with theorists

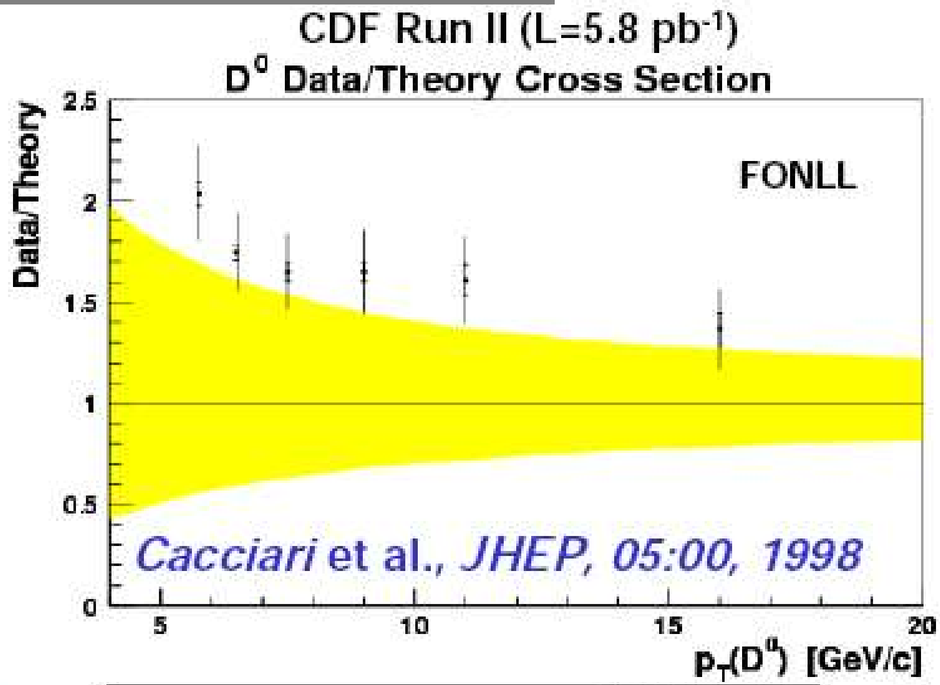


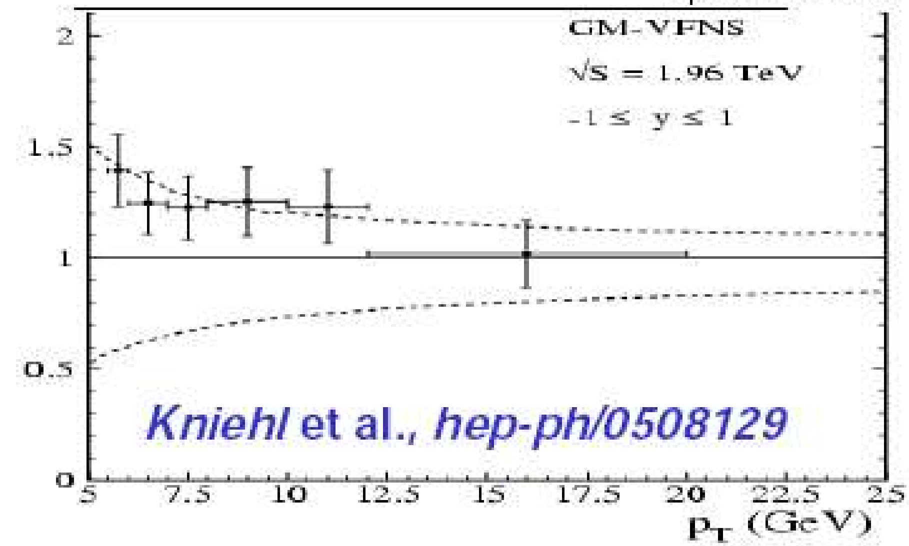
Katerina Lipka (H1)

Charm at Tevatron

Burkhard Reisert (CDF, D0)







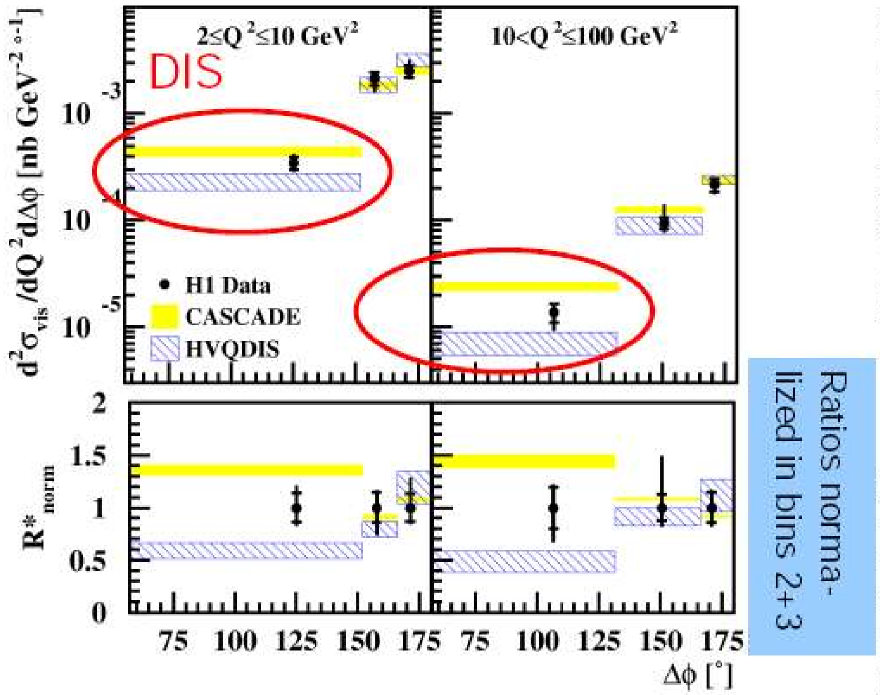
Inclusive charm (D^0, $D^{*\pm}$, D^+, D_s^+) cross sections was one of the first CDF Run II results

- factor ~2 higher than expected
- progress in theory reduced deviation
- measurement systematically limited

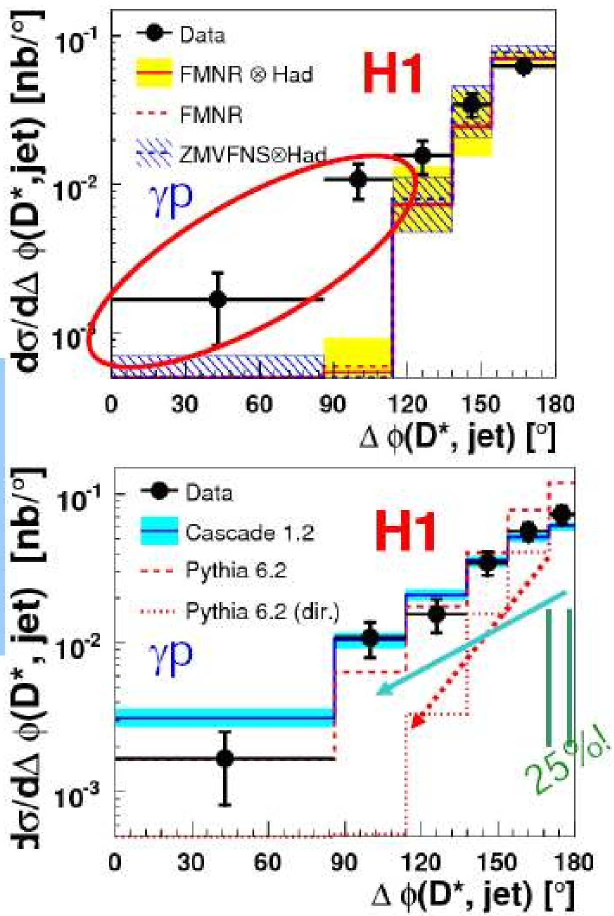
D* plus Jet in Photoproduction

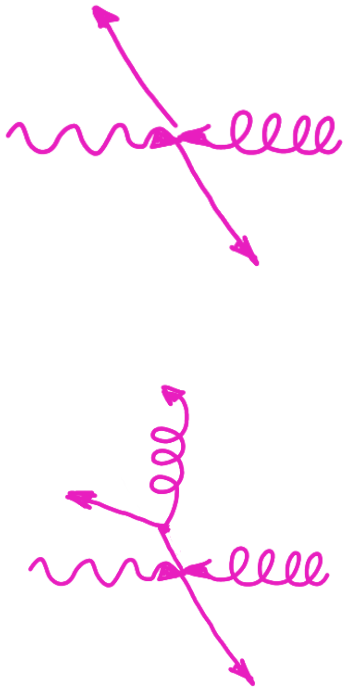
Sebastian Schmidt (H1)

- Jet gives handle on second (charm) quark
- Can test NLO QCD effects, e.g. with Δφ



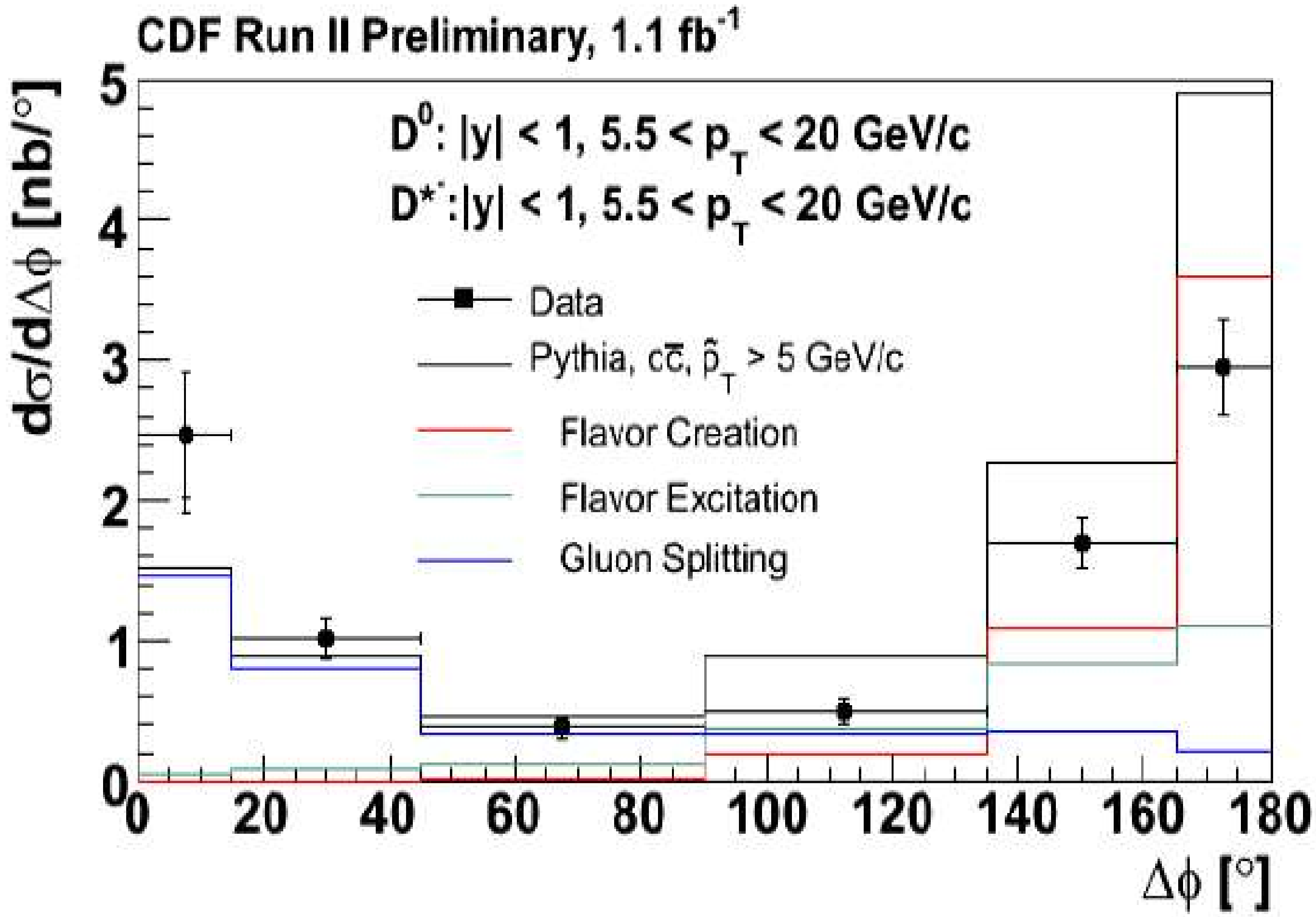
- Δφ: difference in the azimuthal angle
- Large higher order contributions
- CASCADE too broad
- Some contribution missing for HVQDIS beyond NLO





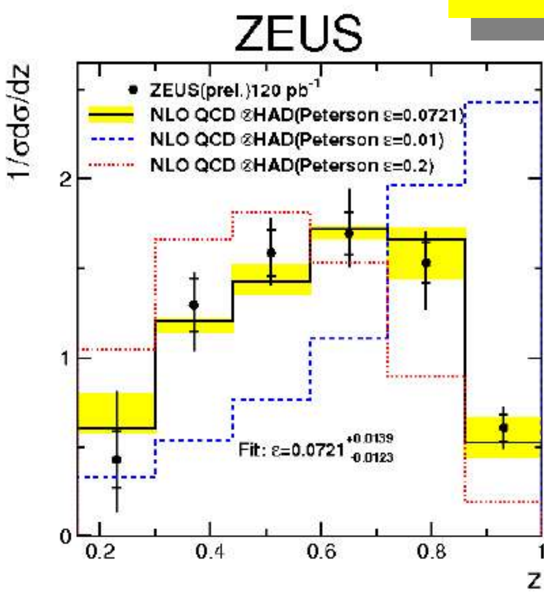
Double Charm at Tevatron

Burkhard Reisert (CDF)



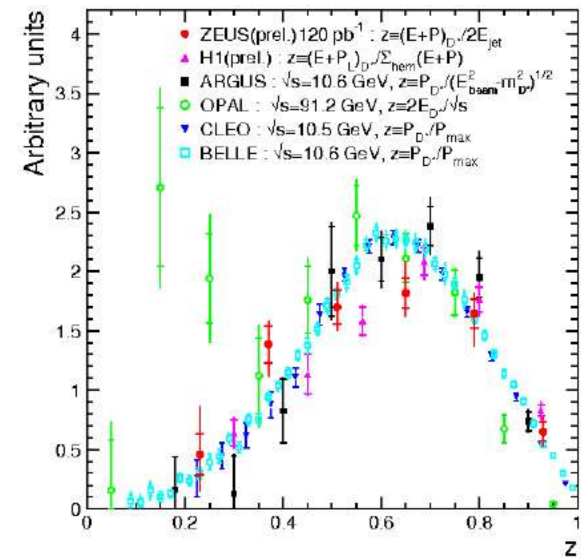
Charm Fragmentation

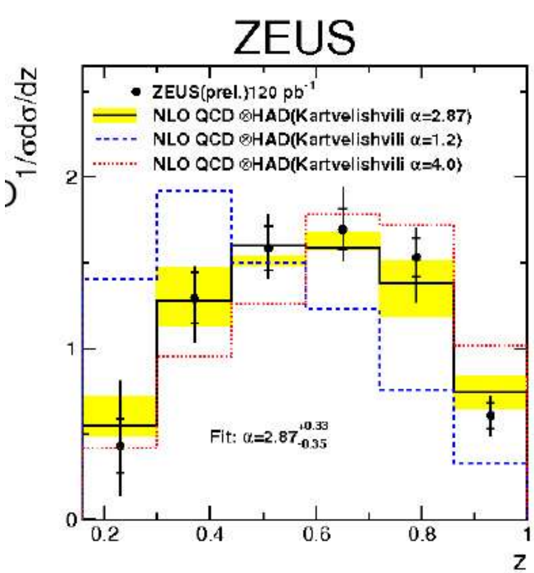
Shuangshi Fang (ZEUS)



Peterson

$\varepsilon = 0.0721^{+0.0139}_{-0.0123}$



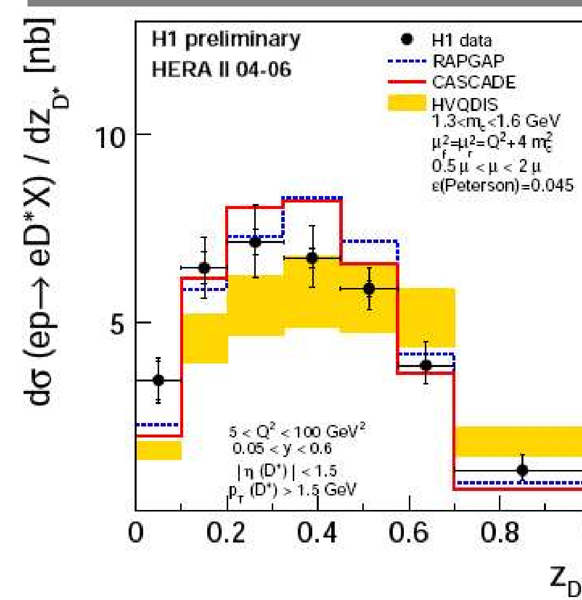


Kartvelishvili

$\alpha = 2.87^{+0.33}_{-0.35}$

$\varepsilon = 0.045$
too hard

Katerina Lipka (H1)



Issues between Experiment and Theory

- Experiments measure more and more specific and precise cross sections:
  - D*+jet(s), 2 charm/bottom jets
  - Single, double differential cross sections
  - Expt's often better than NLO predictions
- Worry about scales (m_c, μ_R, μ_F) and Fragmentation Functions

=> We need:

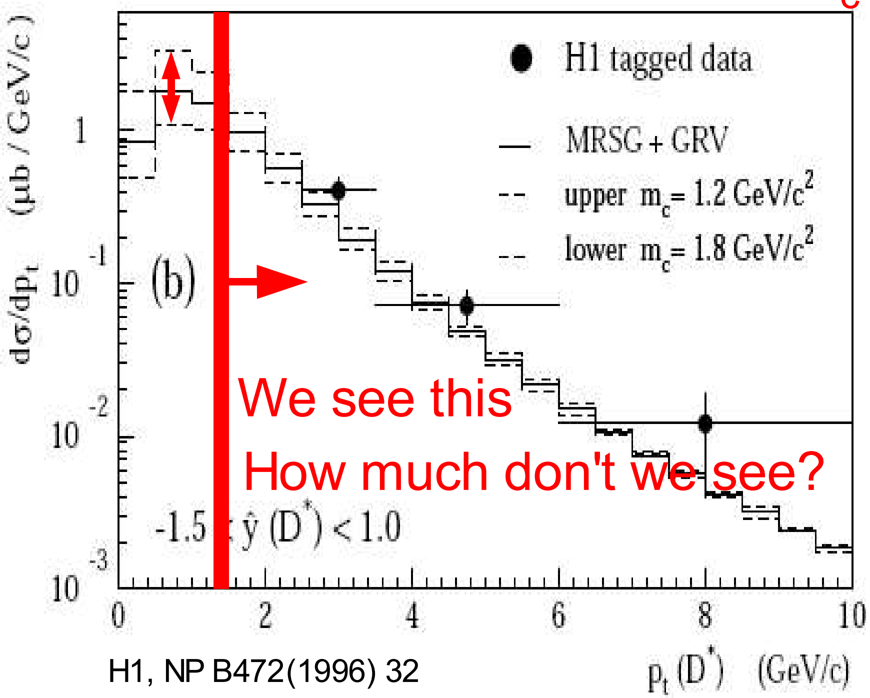
- QCD calculations for those quantities
- Consistent treatment of m_c, m_b in pdf extraction and application
- Full NLO MC with matched parton showers for optimal correction of the data

Theory and Experiment need:

- To agree an observables that can be measured with little theory error and can be calculated reliably for inclusion in global pdf fits

=> is F_2^{cc} really the best observable?

Unseen x-section varies with m_c



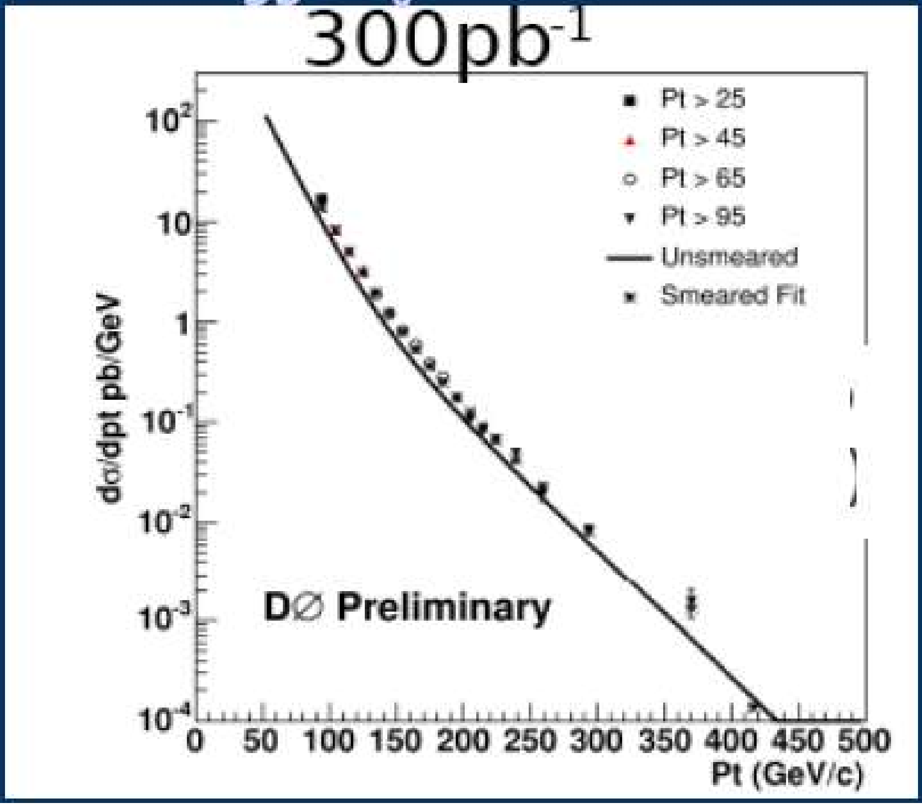
H1, NP B472(1996) 32

Beauty

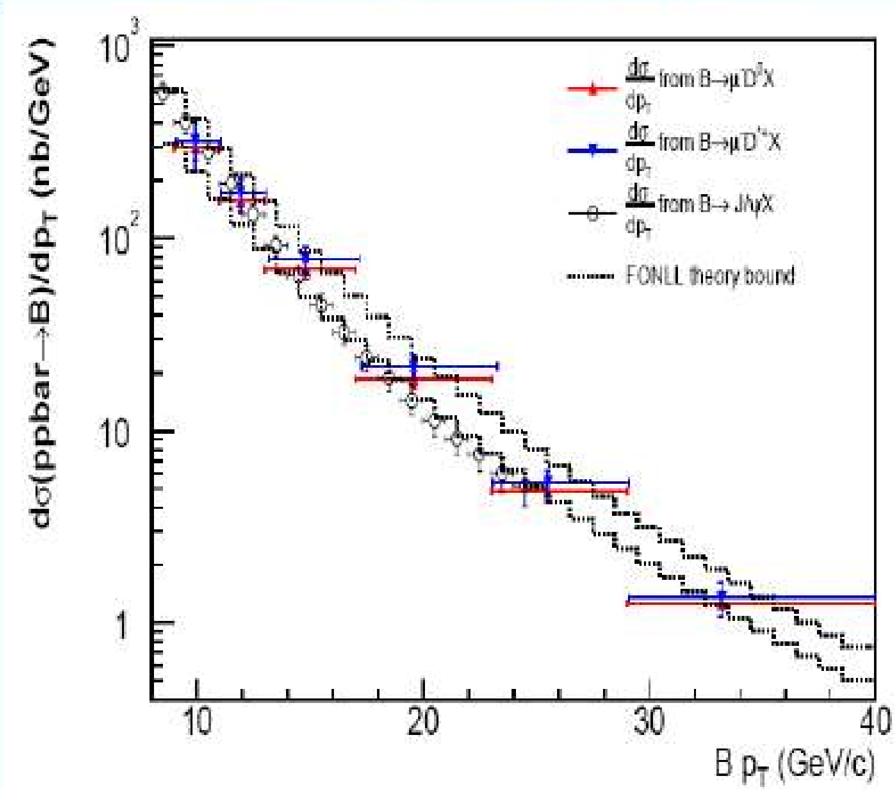
Beauty at Tevatron

Burkhard Reisert (CDF, D0)

- D0: new measurement of muon tagged jet cross sections



- CDF measurement of inclusive B cross section

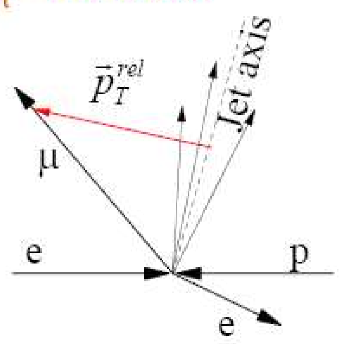


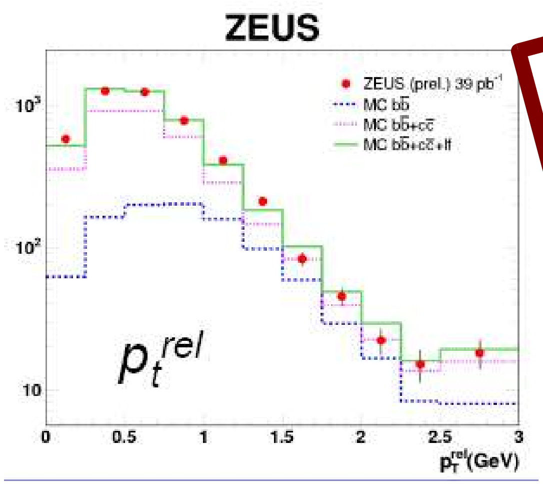
Beauty Cross Section in DIS at ZEUS

$e\,p \rightarrow e\,b\bar{b}\,X \rightarrow e\,\mu\,jet\,X'$

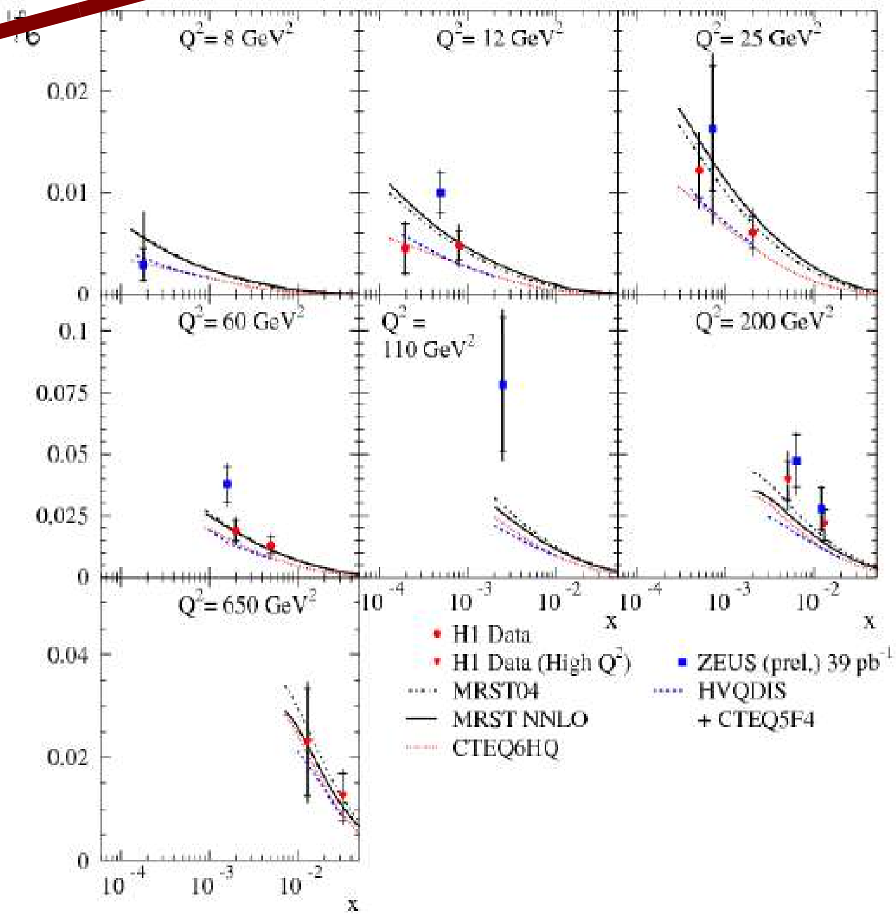
Benjamin Kahle (ZEUS)

p_t^{rel} method:





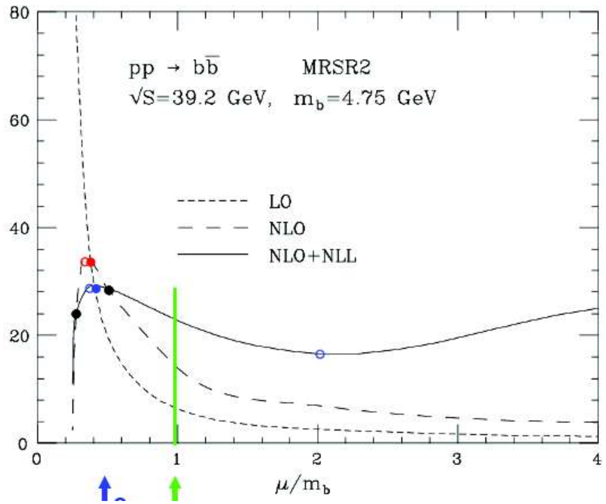
HERA-II



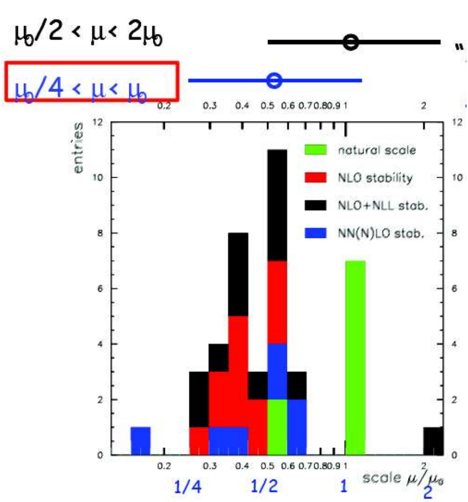
- First F_2^{bb} from ZEUS
- Only 10% of data sample analysed
- Higher than H1 data (and predictions), but still compatible

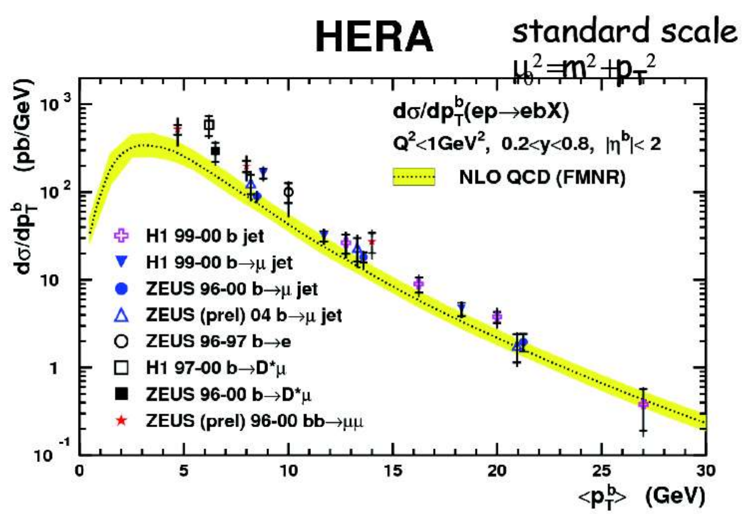
HF Production and the Optimal Scale

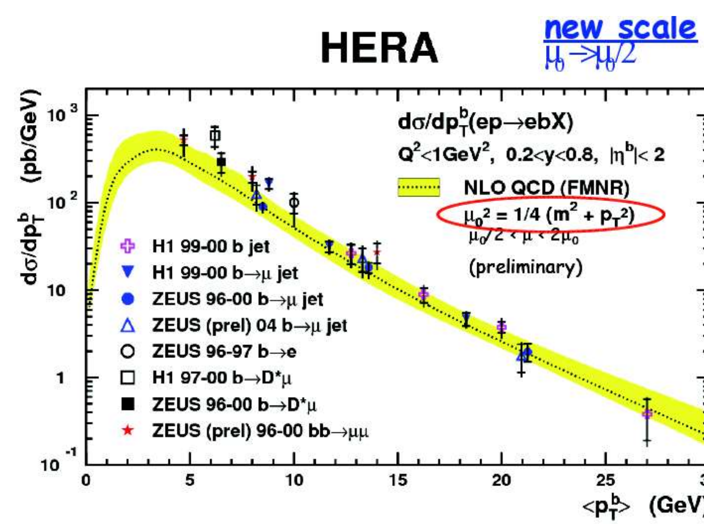
Achim Geiser



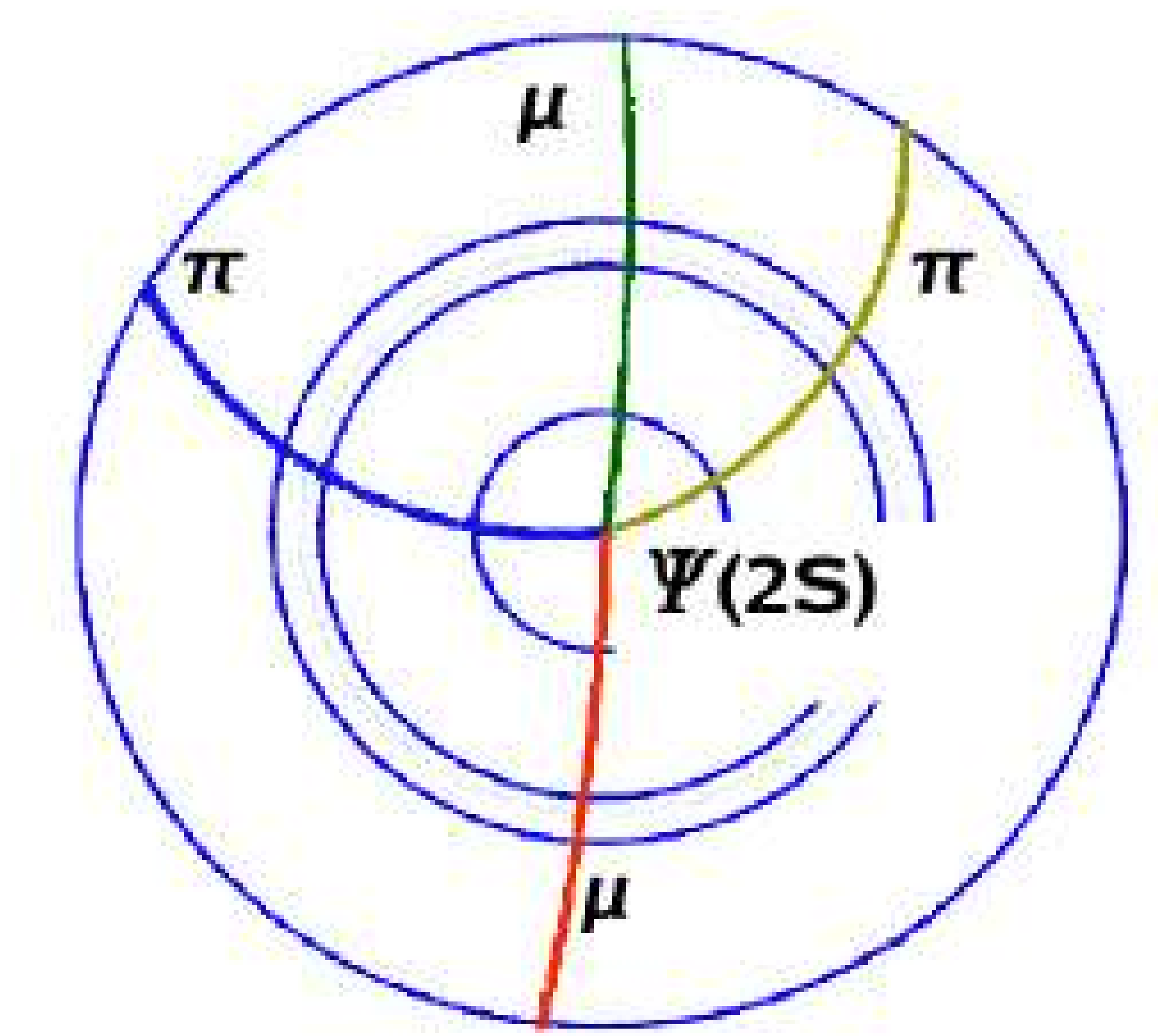
- "Optimal scale:" Where adding the next order doesn't change the result
- Observation for many processes: Best scale is ~1/2 natural scale
- Proposal: Use $\frac{1}{4}\mu_0 < \mu < \mu_0$ instead of $\frac{1}{2}\mu_0 < \mu < 2\mu_0$
- Improves description of data





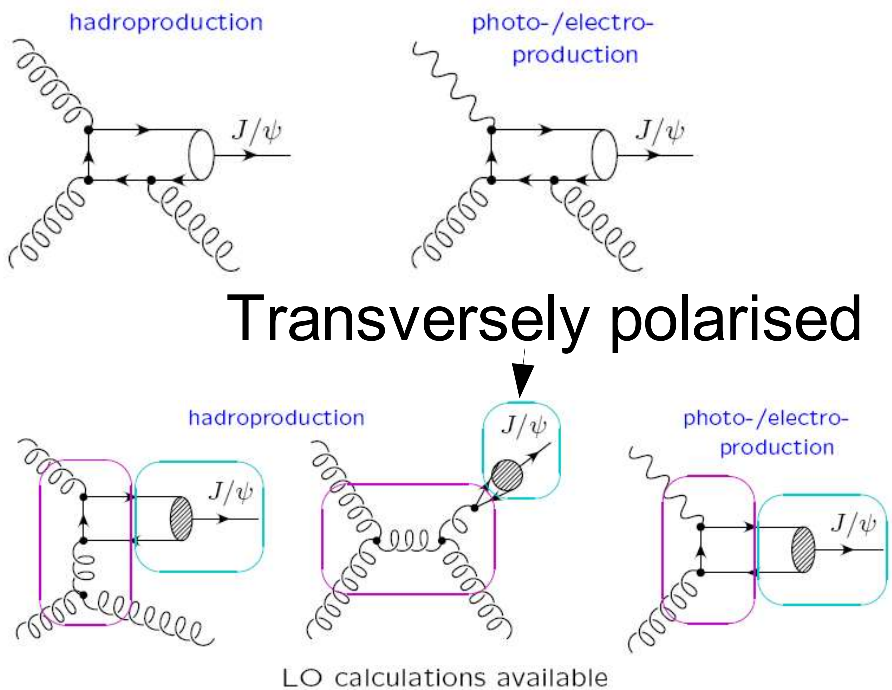


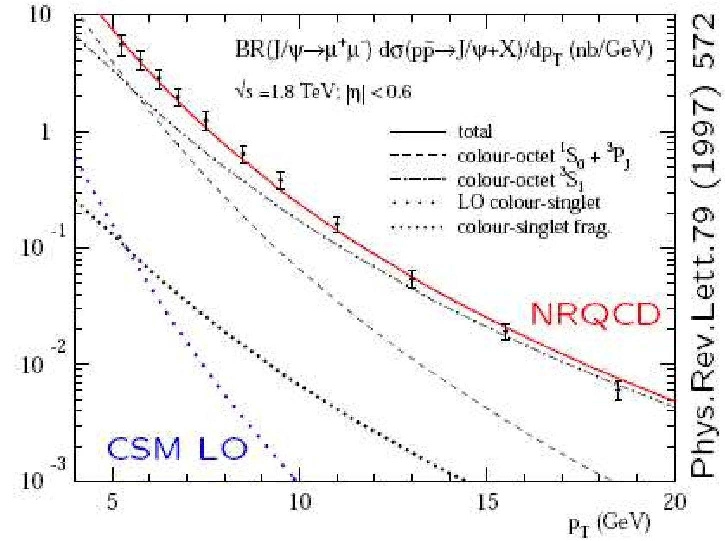
Charmonium and Bottomium Production

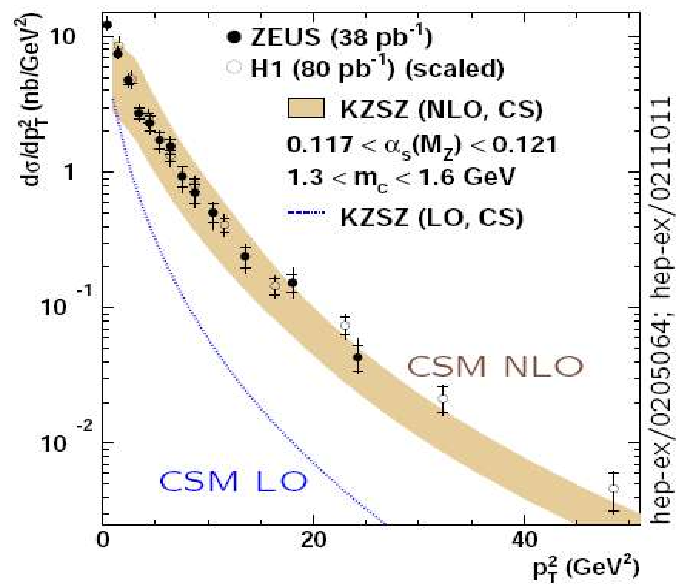


Charmonium Production: Overview

Katja Krüger



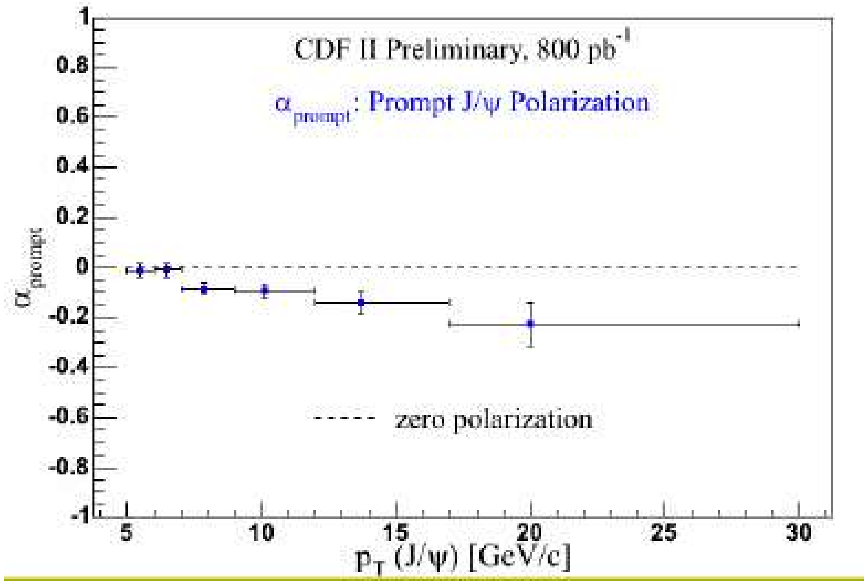


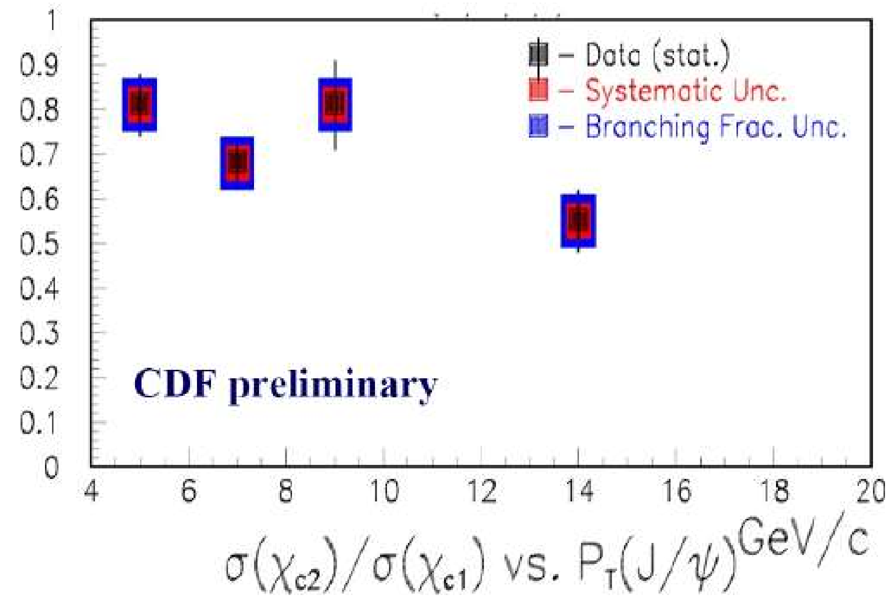


- NRQCD in LO needs large CO contributions to explain Tevatron J/ψ production
- Photoproduction at HERA: Color Singlet model in NLO explains data w/o CO contributions
- "Smoking gun" for large CO contributions: Transverse polarization

Charmonium at CDF

Burkhard Reisert (CDF)





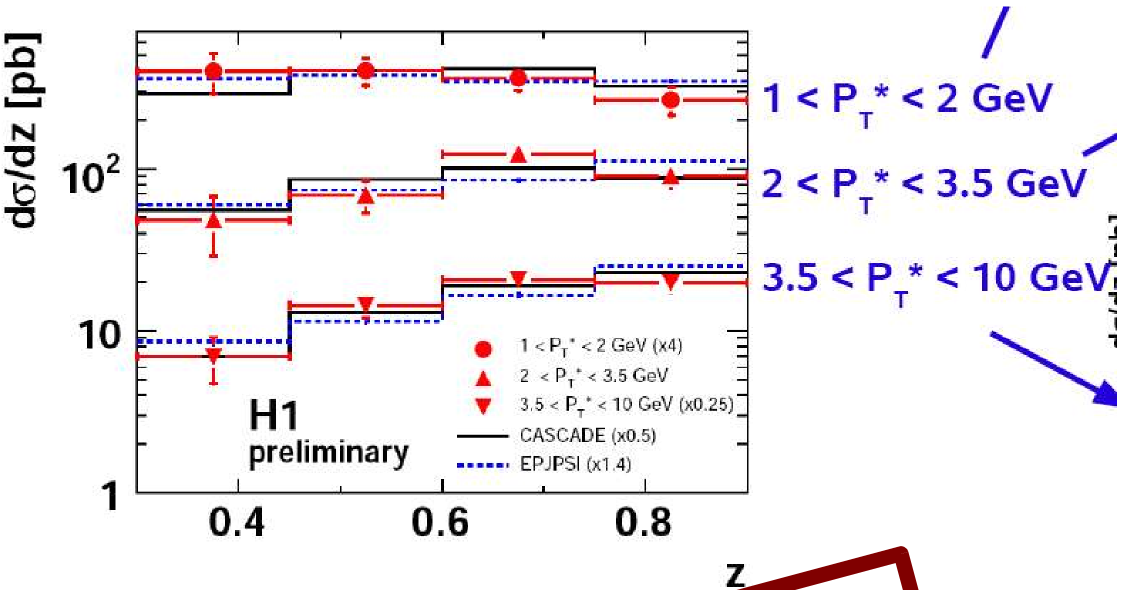
$$\frac{\sigma(\chi_{c2})}{\sigma(\chi_{c1})} = 0.70 \pm 0.04(stat.) \pm 0.03(syst.) \pm 0.06(B.F.)$$

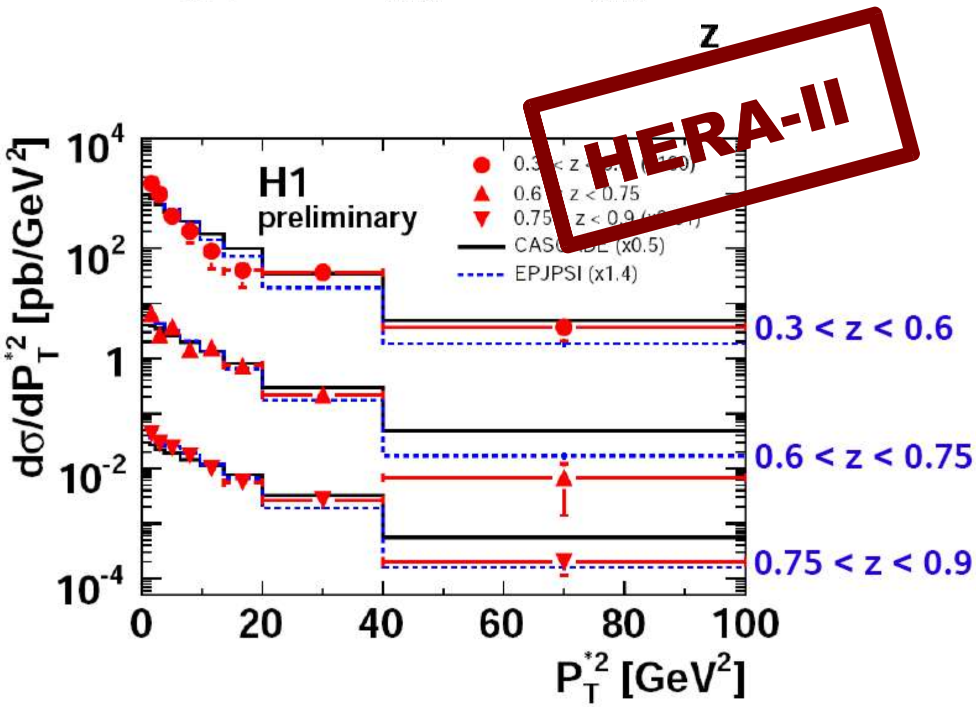
for $4 < p_T(\chi_{cJ}) < 20$ GeV/c

- Color Octet predicts 5/3 (counting of Spin states)

- J/ψ slightly longitudinally polarized, not transversely
- χ_c production ratios different from NRQCD expectations
- NRQCD with large CO contributions not a good explanation for Tevatron J/ψ production cross sections?
- Missing: NLO Color Singlet Model calculations for Electroproduction (DIS at HERA) and Hadroproduction (Tevatron)

J/ψ Production in DIS at HERA





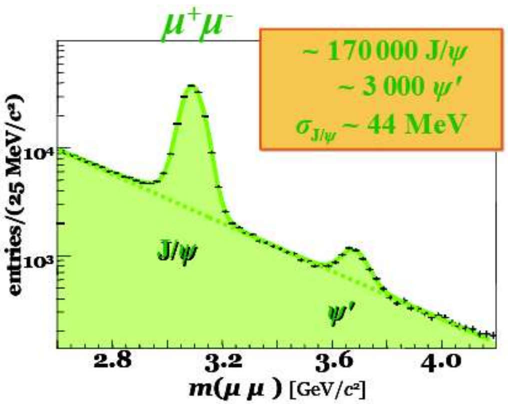
Michael Steder (H1)

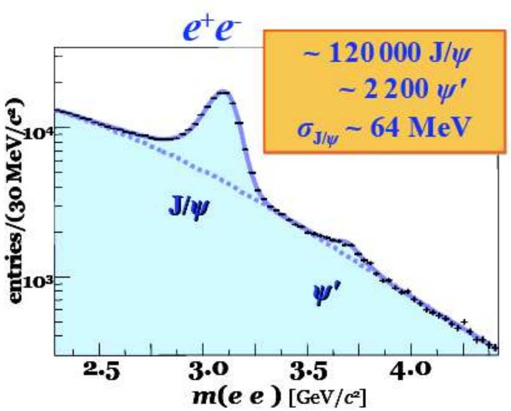
- Double differential distributions described well in shape by Color Singlet MC
- Any Color Octet contribution must be small or similar in shape

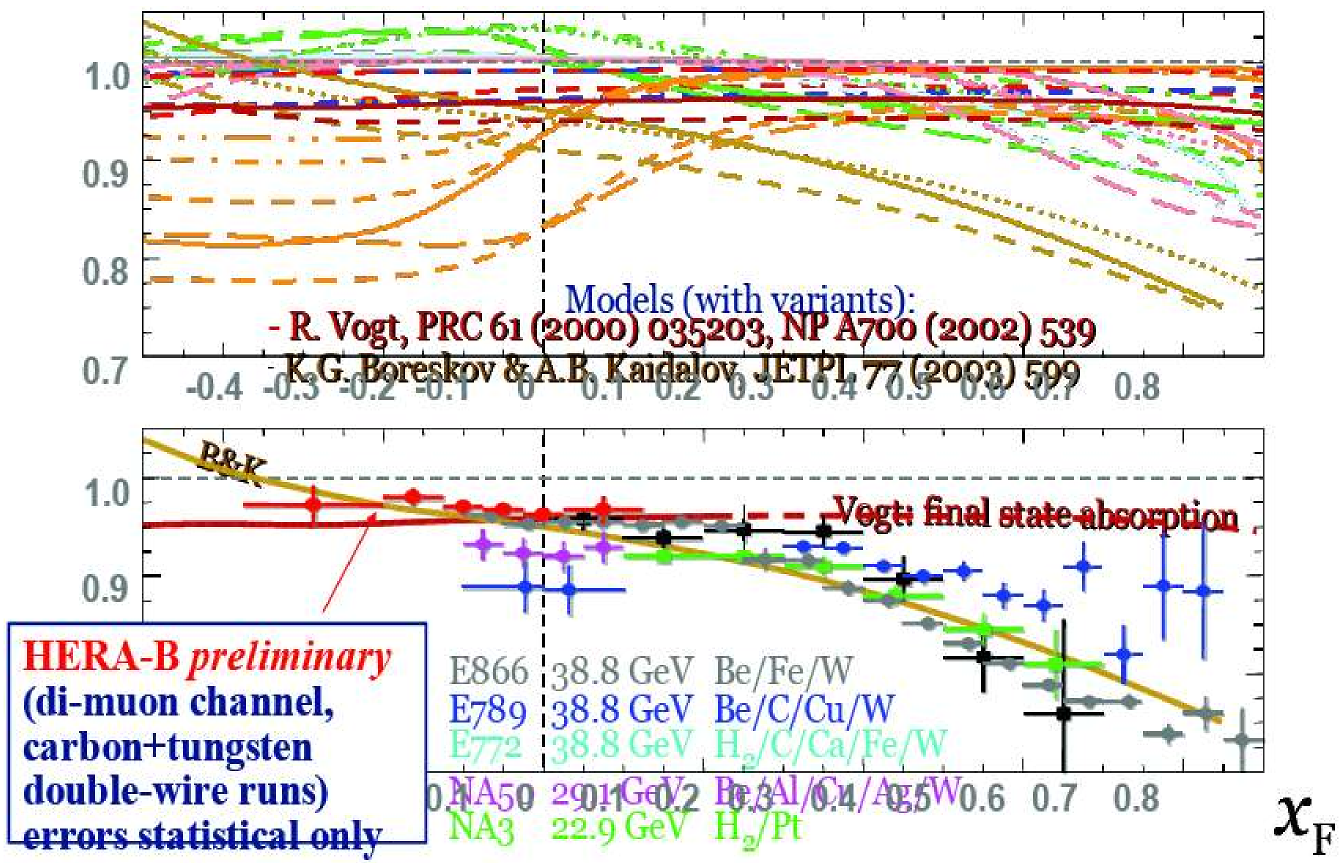
Charmonium Results from HERA-B

Martin zur Nedden (HERA-B)

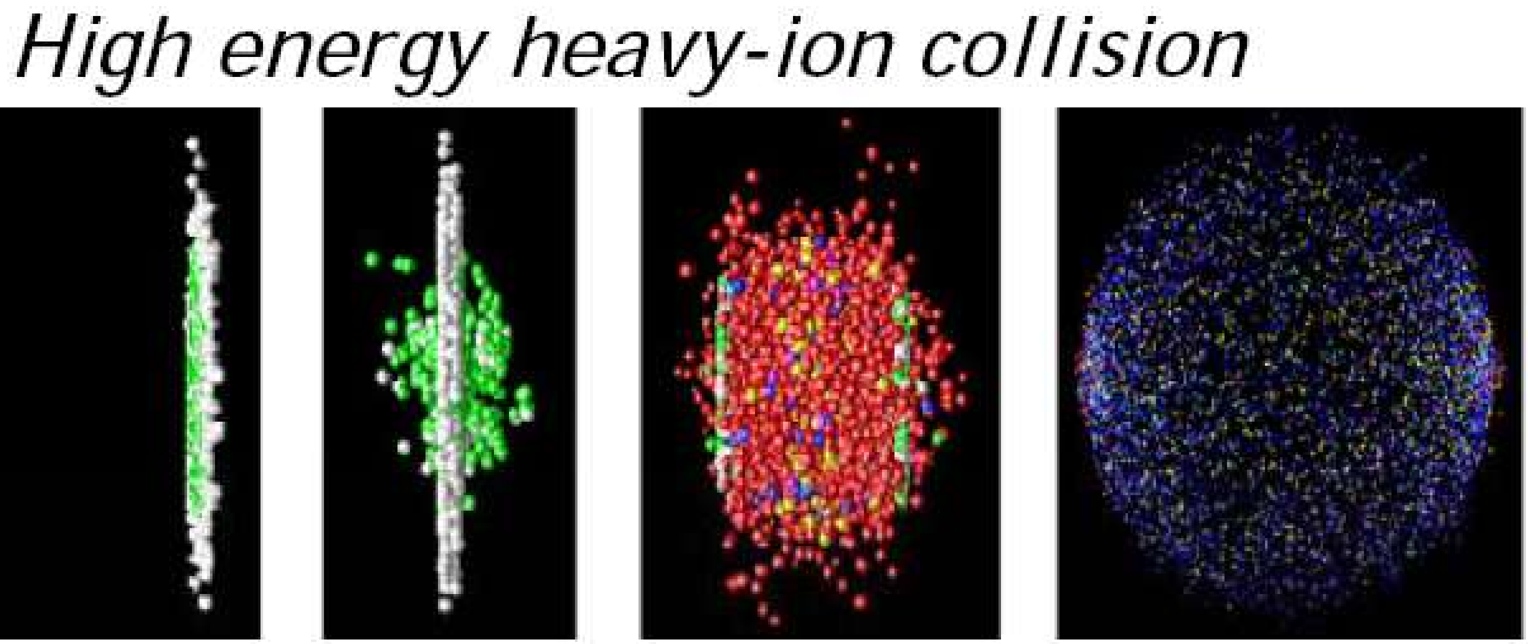
- A dependence of J/ψ production measured at nex x_F range
- Better distinction between different models







Heavy Ion Results



Apologies: I'm out of my depth here...
cf. plenary talk by William Zajc

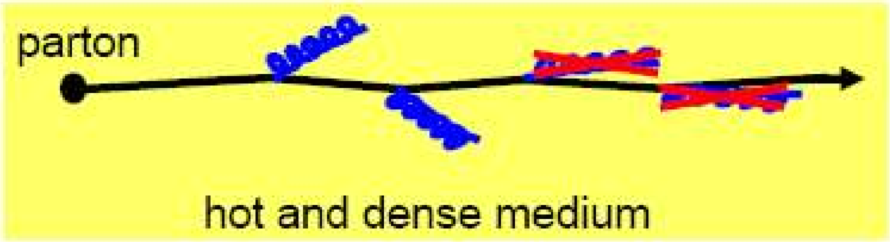
In-Medium Energy Loss of Heavy Quarks

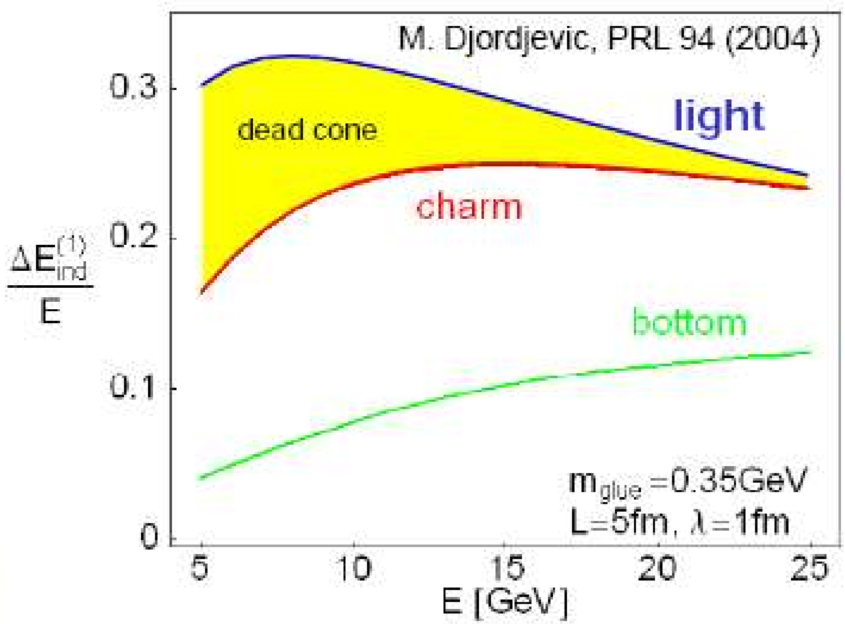
Andre Mischke (STAR)

- Due to their large mass heavy quarks are primarily produced by gluon fusion
  → production rates can be calculated by pQCD
  → sensitivity to initial state gluon distribution
  M. Gyulassy and Z. Lin, PRC 51, 2177 (1995)

- Heavy quarks loose less energy due to suppression of small angle gluon radiation (dead-cone effect)
  Dokshitzer and Kharzeev, PLB 519, 199 (2001)

- Amount of collisional and radiative energy losses seems to be similar
  M.G. Mustafa, PRC72, 014905 and
  A.K. Dutt-Mazumder et al., PRD71, 094016 (2005)

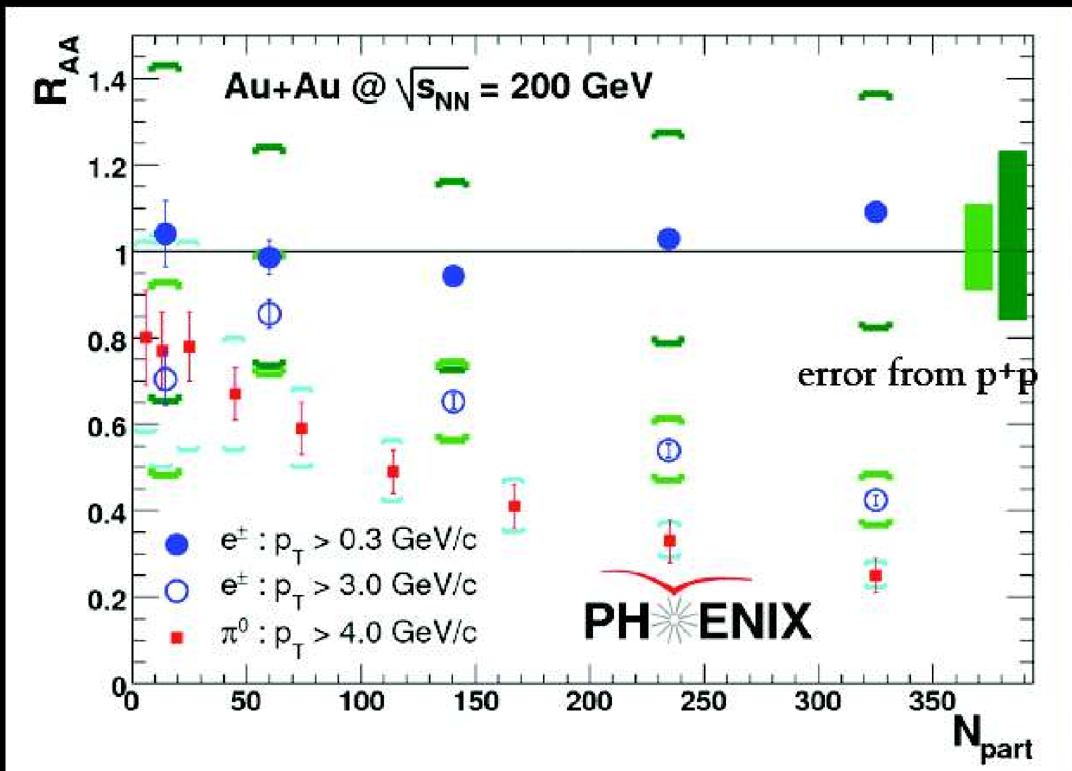




Heavy Quark Production in AuAu Collisions

Donald Hornback (Phenix)

Heavy flavor was not expected to show strong suppression



nucl-ex/0611018

However, high p_T single electrons do show strong suppression (charm coming from D's).

Heavy flavor suppression better accommodated by theory with addition of elastic energy loss and geometrical path length fluctuations — Wicks, et al. nucl-th/0512076

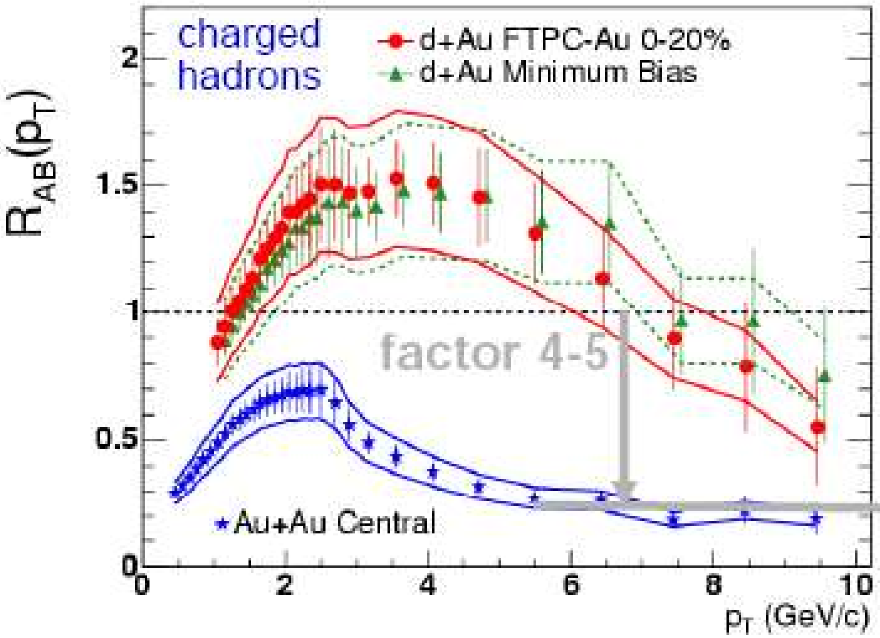
Integrated heavy flavor electrons exhibit binary scaling.

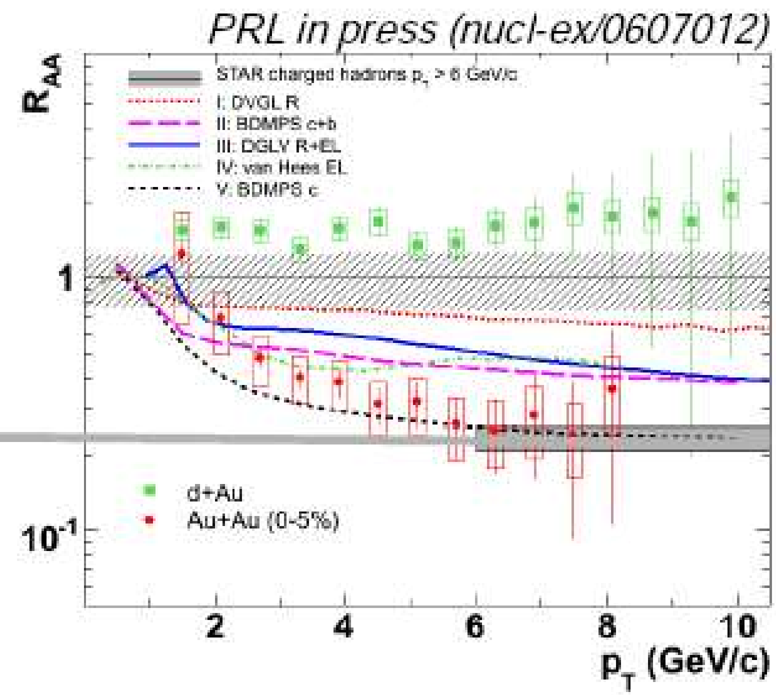
Electrons must fly through quark gluon soup
=> supression indicates that charm quarks interact with medium before they leave it

Supression of Electrons from Charm Decays

Andre Mischke (STAR)

Au+Au at $\sqrt{s_{NN}}$ = 200 GeV





Nuclear modification factor:

$$R_{AA}(p_T) = \frac{d^2 N^{AA} / dp_T d\eta}{T_{AA} d^2\sigma^{NN} / dp_T d\eta}$$

where $T_{AA} = N_{Coll} / \sigma^{NN}_{inelast}$

- Non-photonic electrons at high-p_T are suppressed to the same extent as light quark hadrons in Au+Au
- Not expected due to dead-cone effect

J/ψ Suppression in AuAu Collisions

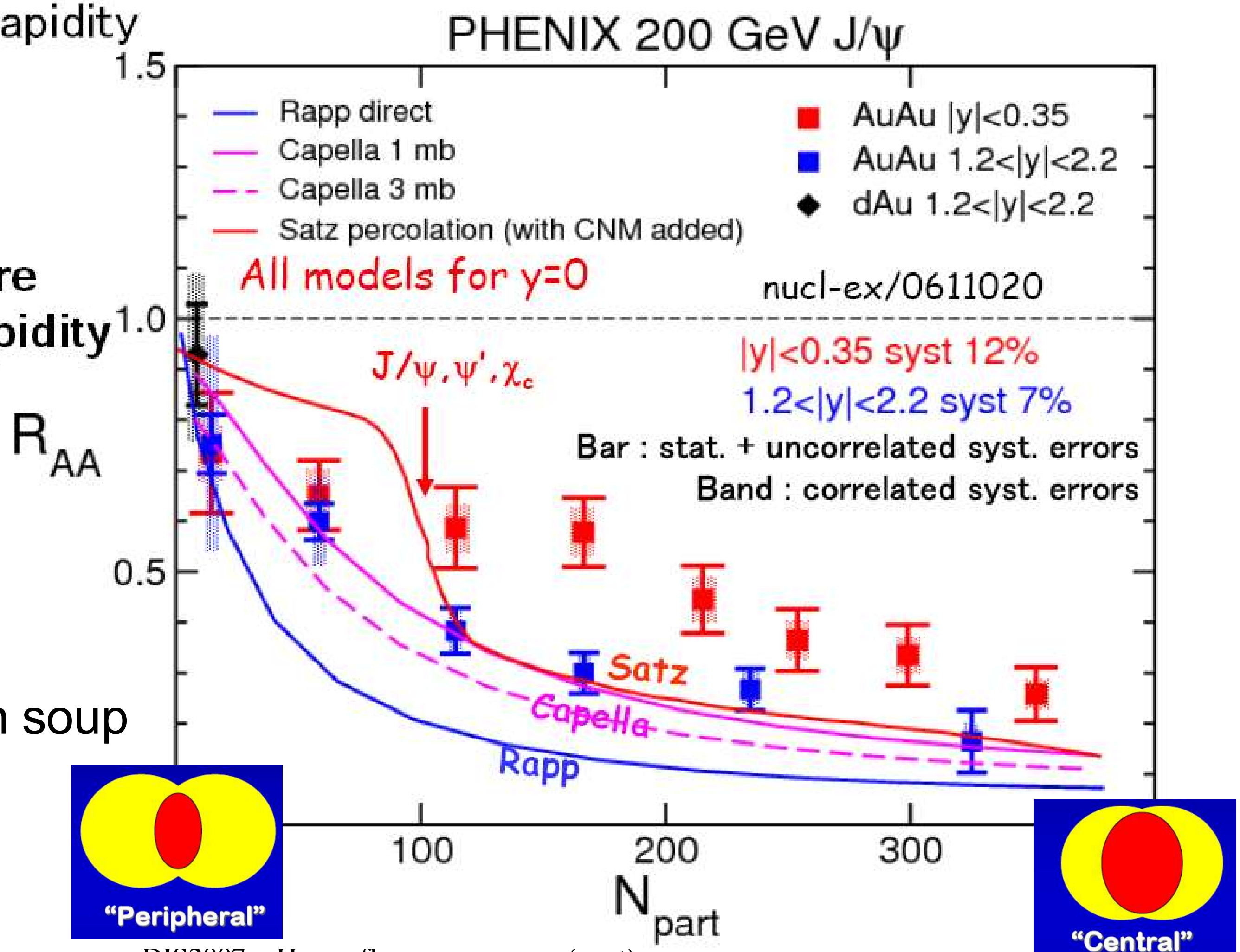
Ermias Atomssa (PHENIX)

- Test with RHIC data models that worked at SPS
  - Most models are strongly challenged by the rapidity trend, and less suppression at mid rapidity

All calculations shown here give predictions at mid rapidity

R_{AA}: Suppression of production x-section w.r.t. pp collisions

J/ψ dissolves in quark-gluon soup



Heavy Quarks Flow!

PHENIX

Donald Hornback (Phenix)

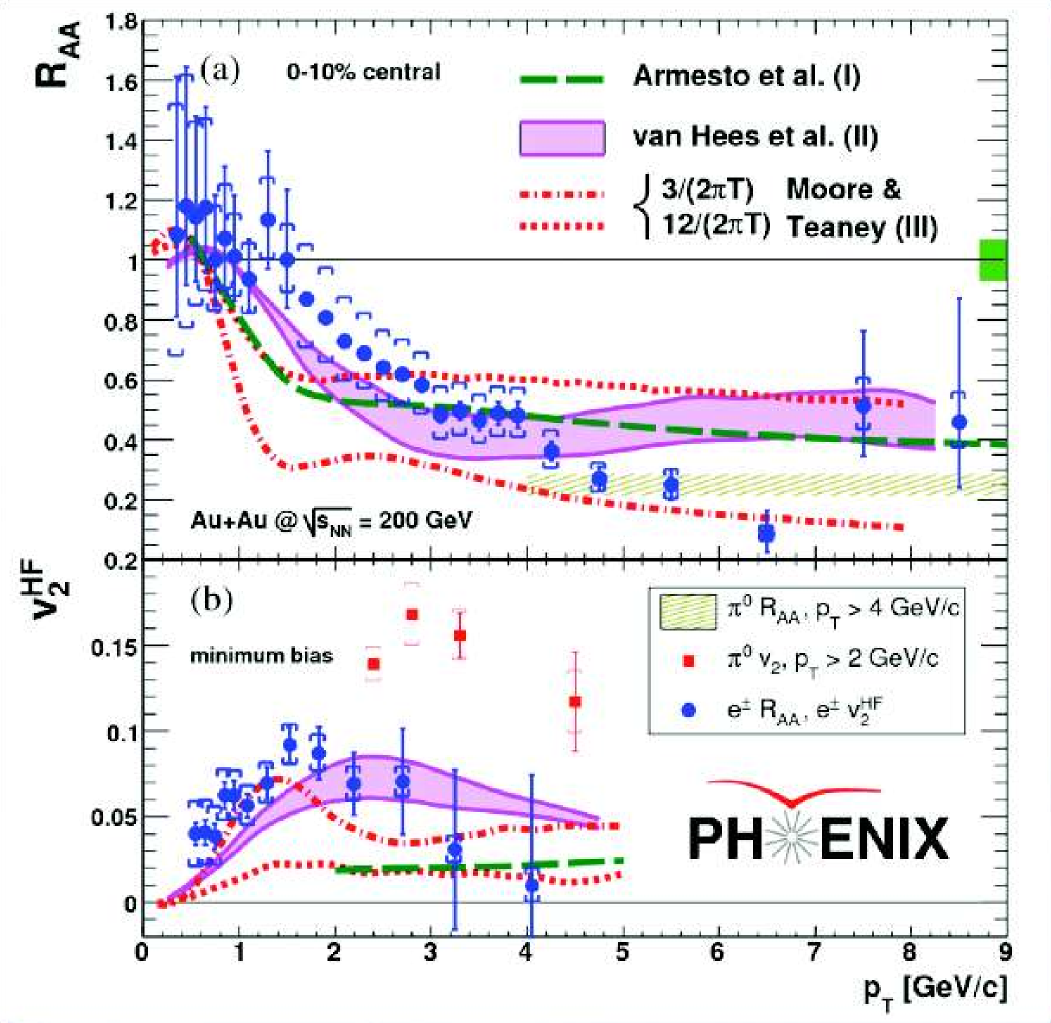
R_{AA} and v_2 comparisons with theoretical calculations

Charm flows, suggesting early thermalization of the medium

Simultaneous R_{AA} and v_2 hydro model comparisons suggest small HQ relaxation time and/ or diffusion coefficient, D.

$$D \propto \eta/(sT)$$

AdS/CFT conjectures a quantum lower bound for η/s suggesting the medium is a near perfect liquid: $\frac{4\pi\eta}{s} \rightarrow 1$



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Spectroscopy and (Rare) Decays

- Filling the Particle Data Book:
  The expected
- "Who ordered this?":
  The unexpected
- Rare Decays

A tidal wave of new results, with lots of peaks!

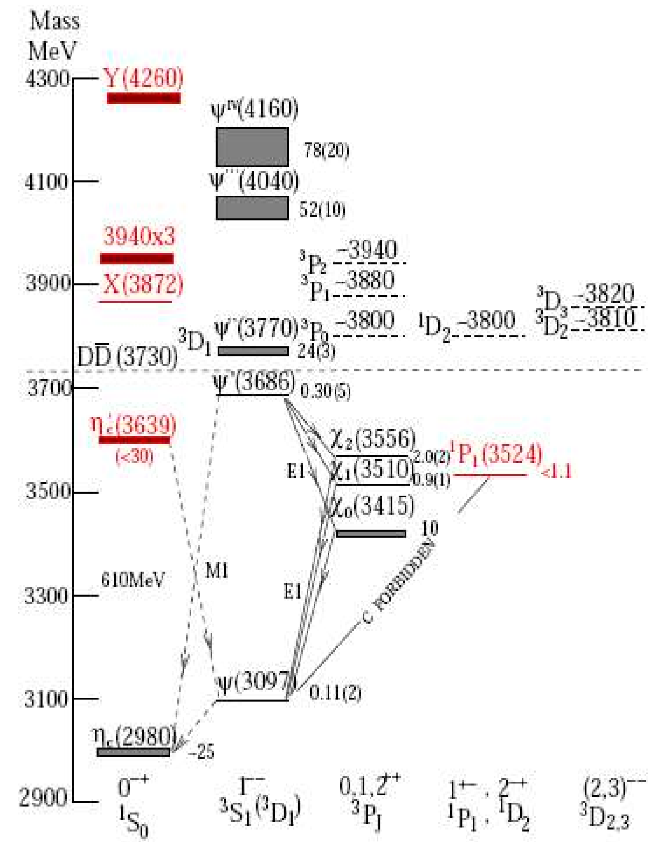
The Expected

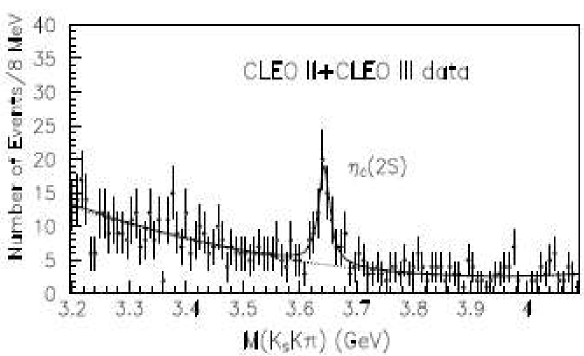
New Expected States

New Mesons: Charmonium System

Completion of the set of bound (sub-DD-threshold) charmonium states by CLEO:

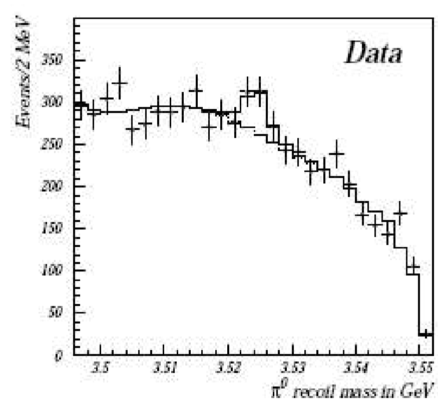
- η_c' confirmed
- h_c discovered, mass degenare with center-of-gravity of $\chi_{c0/1/2}$ states
- Much more data to come





CLEO II+III: 27 fb^{-1} $(\gamma\gamma \to K_S K\pi)$

PRL 92, 142001 (2004)

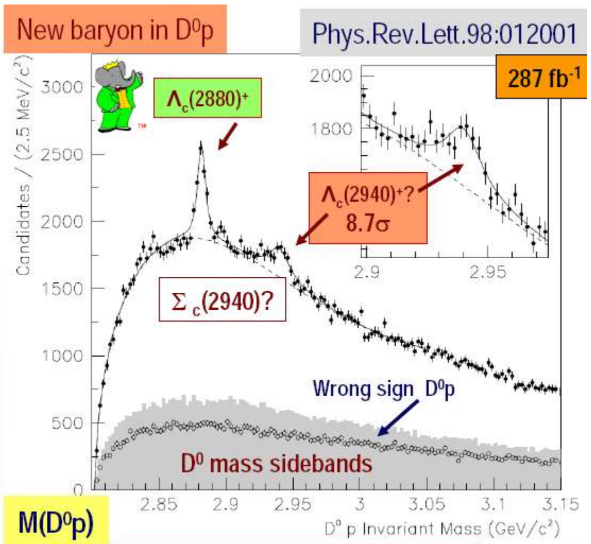


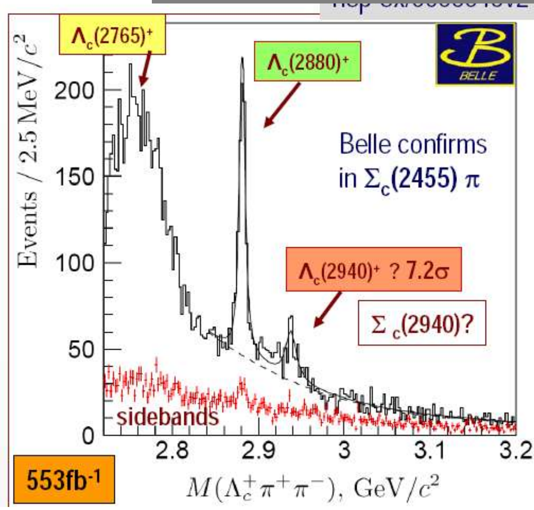
$M(h_c) = 3524.4 \pm 0.6 \pm 0.4$ MeV, or

Kamal K. Seth (CLEO)

New c Baryons: $\Lambda_c(2940)$, $\Xi_c(2980)$, $\Xi_c(3077)$, Ω_c^*

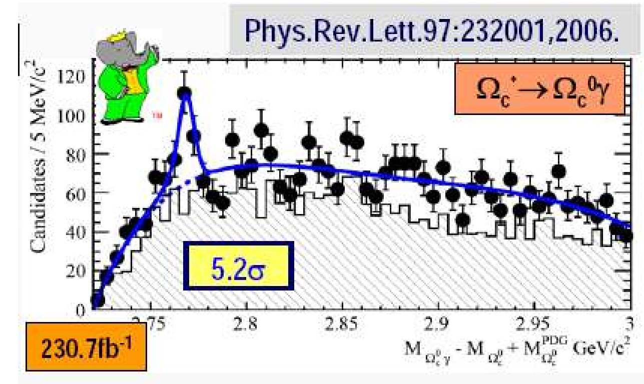
Galina Pakhlova (BaBar, Belle)

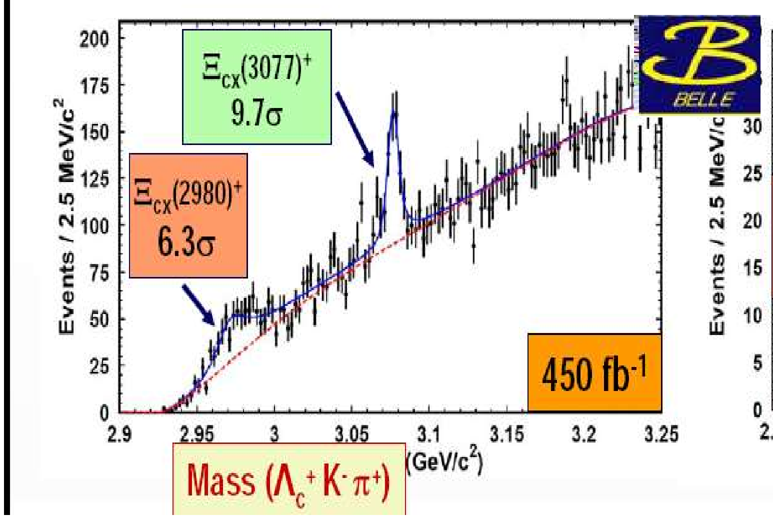


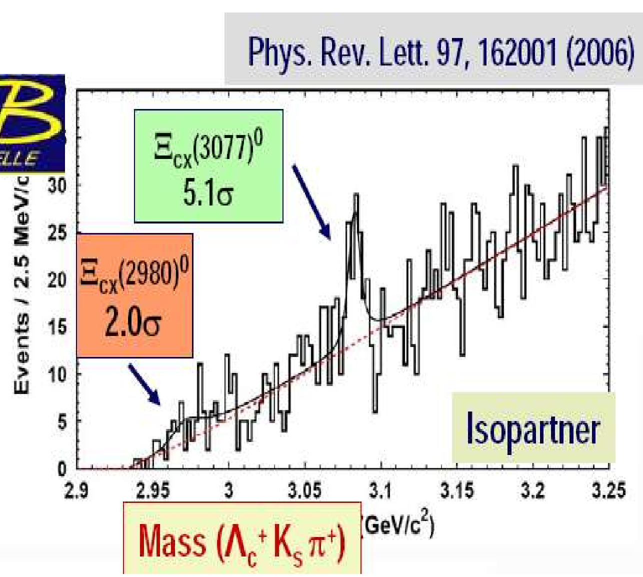


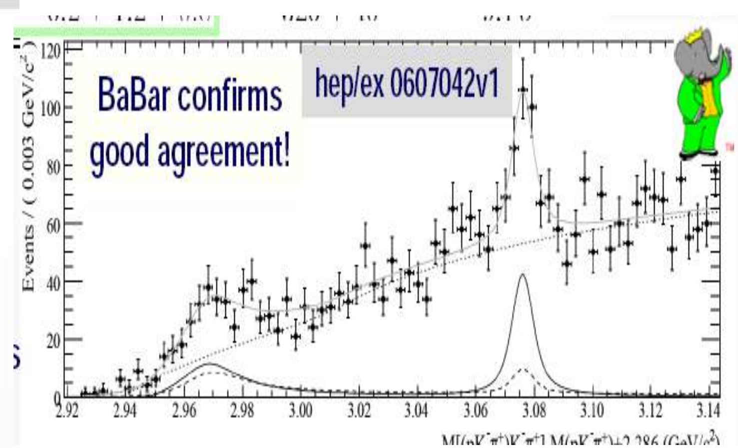
First observation of Ω_c^* (css) , $J^P = 3/2^+$

$M(\Omega_c^*) - M(\Omega_c^0) = (70.8 \pm 1.0 \pm 1.1)\text{MeV}/c^2$



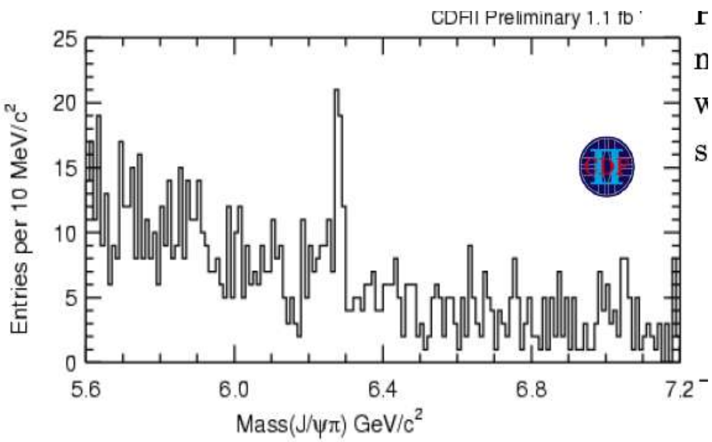


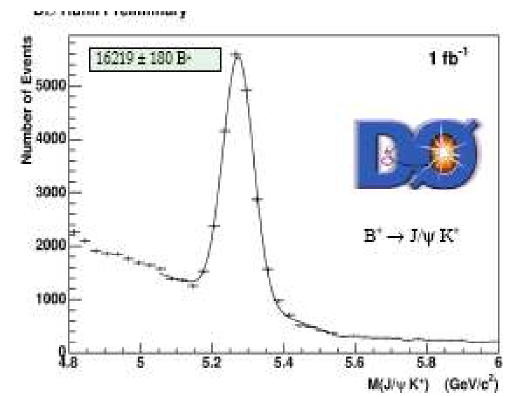




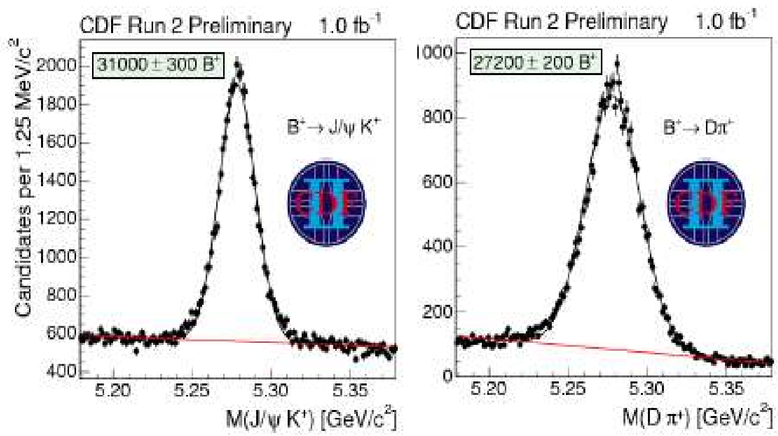
B Mesons

Martin Heck (CDF, D0)



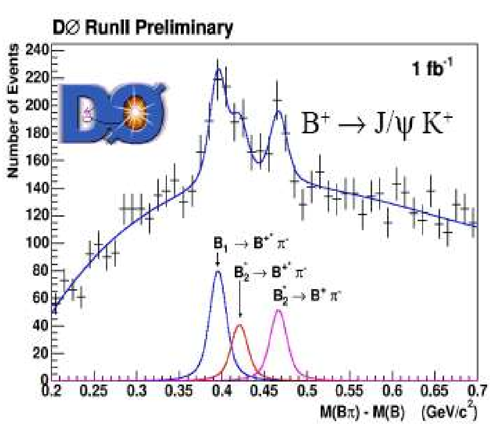


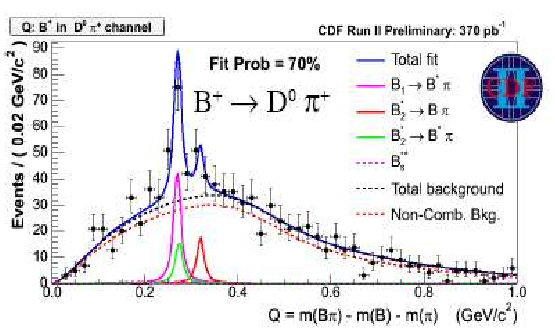
Direct B_c observation in J/ψ π
=> precise mass measurement



Direct B** observation

$B^{**} \to B^{(*)+}\,\pi$, $B^{*+} \to B^{+}\gamma$ (γ undetected)





Direct B_s** observation

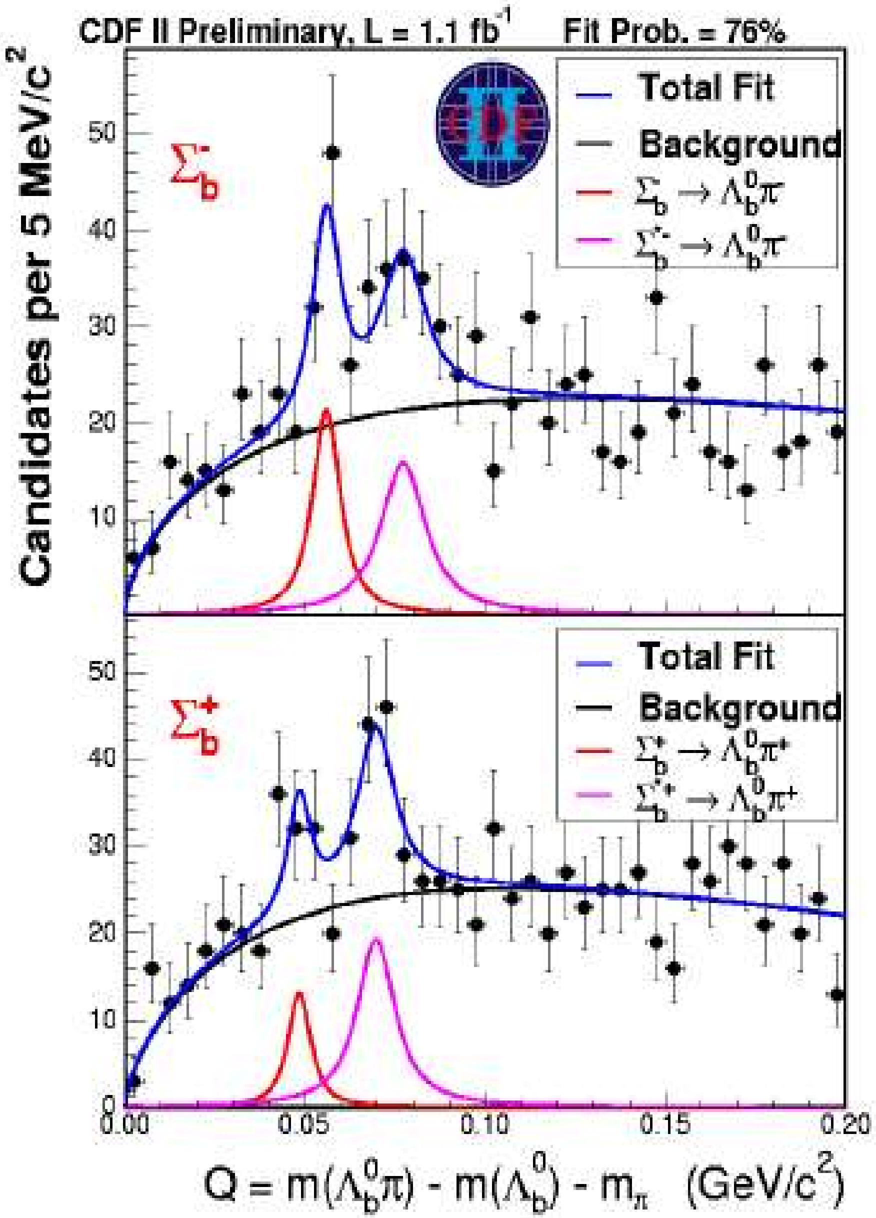
use of Likelihood ratios

($B^+ \to J/\psi\, K^+$ not shown)

B Baryons

Martin Heck (CDF)

- First observation of charged Σ_b states by CDF



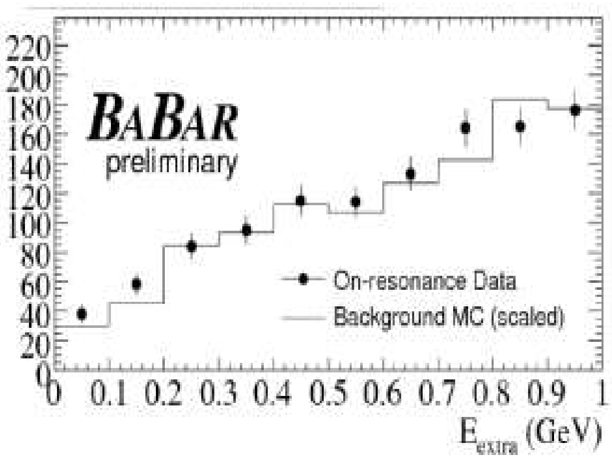
Rare Decays

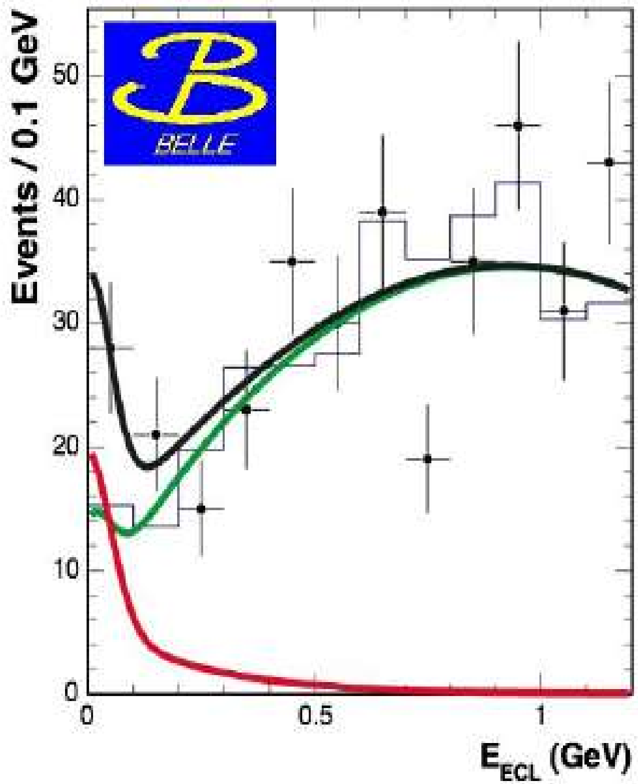
$B^+ \to \tau^+ \nu$: Sensitive to $|V_{ub}|$

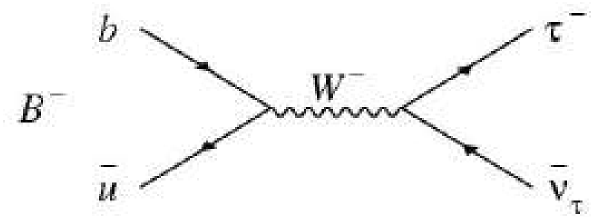
Ivo Eschrich (BaBar, Belle)

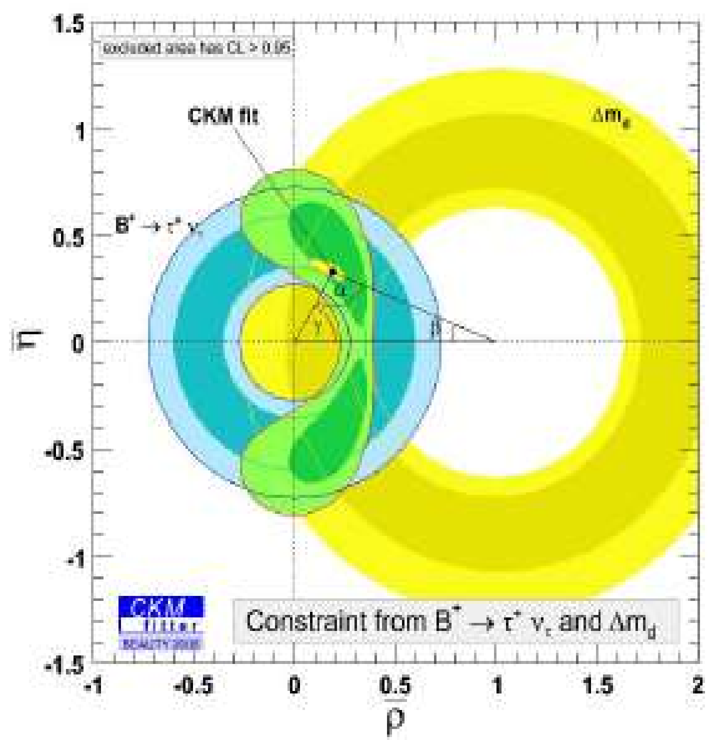
Combined *BABAR*/BELLE

$\mathcal{B}(B^+ \to \tau^+ \nu) = (1.31 \pm 0.48) \times 10^{-4}$ $(2.5\,\sigma)$









BABAR [hep-ex/0608019]

$\mathcal{B} = (0.88^{+0.68}_{-0.67} \pm 0.11) \times 10^{-4}$

$< 1.80 \times 10^{-4}$ (90% CL)

320 M $B\bar{B}$

Belle [PRL 97, 251802 (2006)]

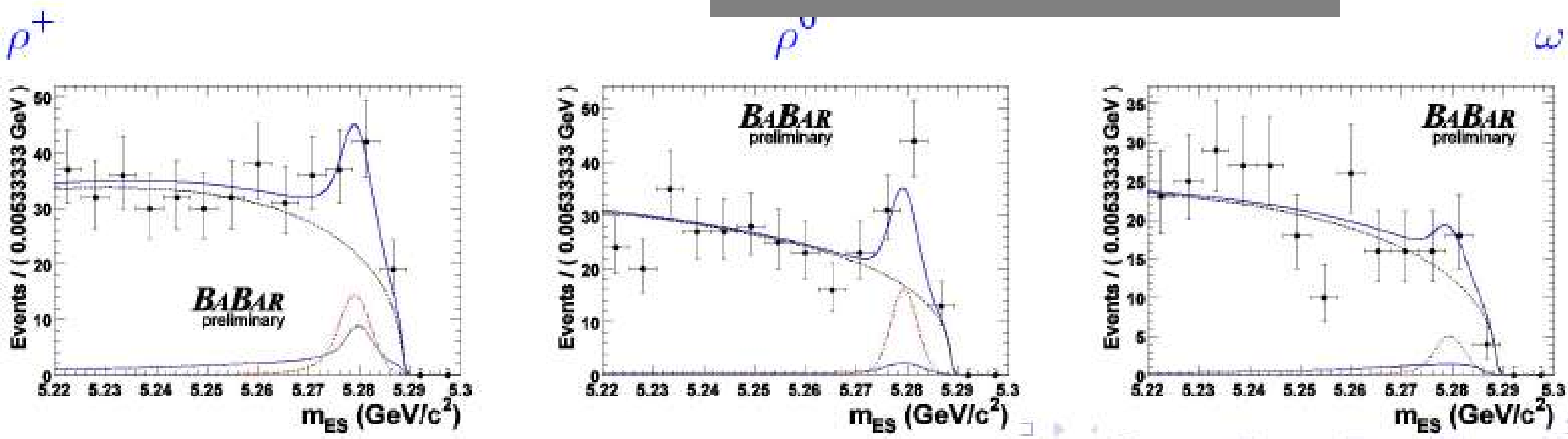
$\mathcal{B} = (1.79^{+0.56}_{-0.49}\ {}^{+0.39}_{-0.46}) \times 10^{-4}$

Significance $3.5\,\sigma$

449 M $B\bar{B}$

B->dγ and $|V_{td}/V_{ts}|$

Ivo Eschrich (BaBar, Belle)



BABAR	316 fb^{-1} [PRL 98:151802 (2007)]	
Mode	$\mathcal{B}\times 10^{-6}$	σ
$B^+ \to \rho^+\gamma$	$1.10^{+0.37}_{-0.33} \pm 0.09$	3.8
$B^0 \to \rho^0\gamma$	$0.79^{+0.22}_{-0.20} \pm 0.06$	4.9
$B^0 \to \omega\gamma$	$0.40^{+0.24}_{-0.20} \pm 0.03$	2.3
$B \to (\rho/\omega)\gamma$	$1.25^{+0.25}_{-0.24} \pm 0.09$	6.4

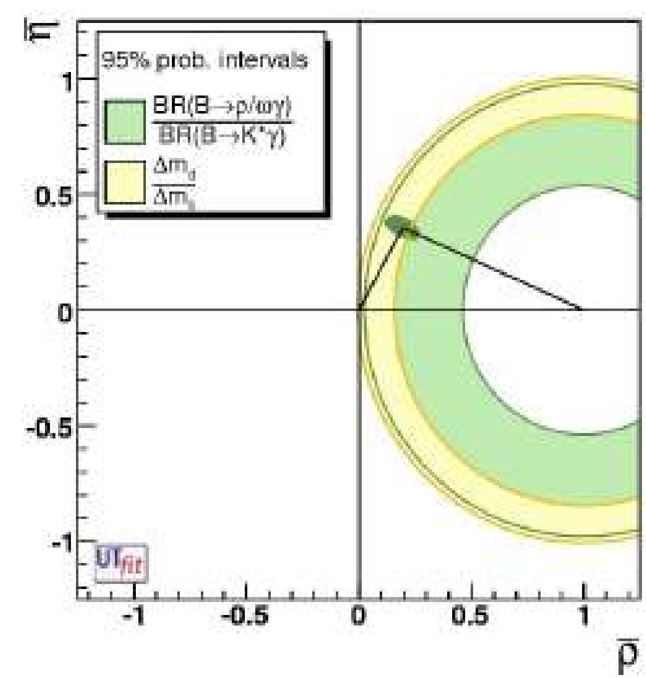
BELLE	386 fb^{-1} [PRL 96:221601 (2006)]	
Mode	$\mathcal{B}\times 10^{-6}$	σ
$B^+ \to \rho^+\gamma$	$0.55^{+0.42}_{-0.36}{}^{+0.09}_{-0.08}$	1.6
$B^0 \to \rho^0\gamma$	$1.25^{+0.37}_{-0.33}{}^{+0.07}_{-0.06}$	5.2
$B^0 \to \omega\gamma$	$0.56^{+0.34}_{-0.27}{}^{+0.05}_{-0.10}$	2.3
$B \to (\rho/\omega)\gamma$	$1.32^{+0.34}_{-0.31}{}^{+0.10}_{-0.09}$	5.1

B-Factories combined

$$\mathcal{B}(B \to (\rho/\omega)\gamma) = (1.28^{+0.20}_{-0.20} \pm 0.06) \times 10^{-6}$$

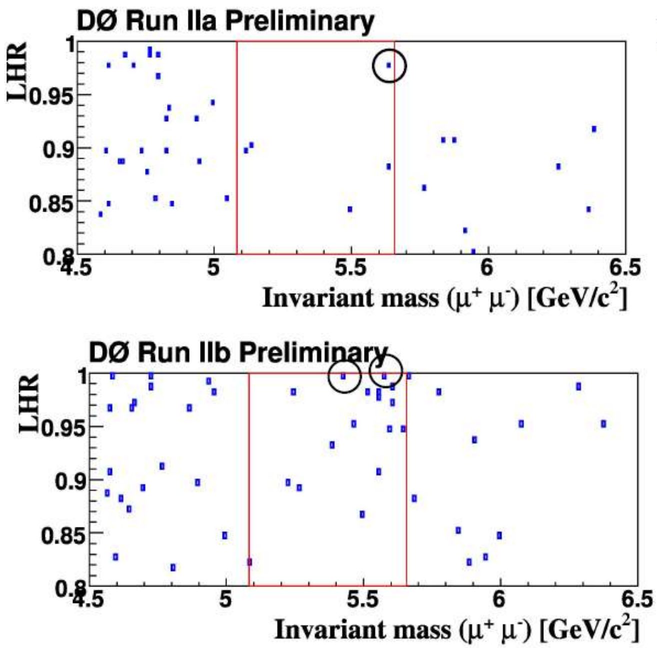
BELLE and BABAR combined

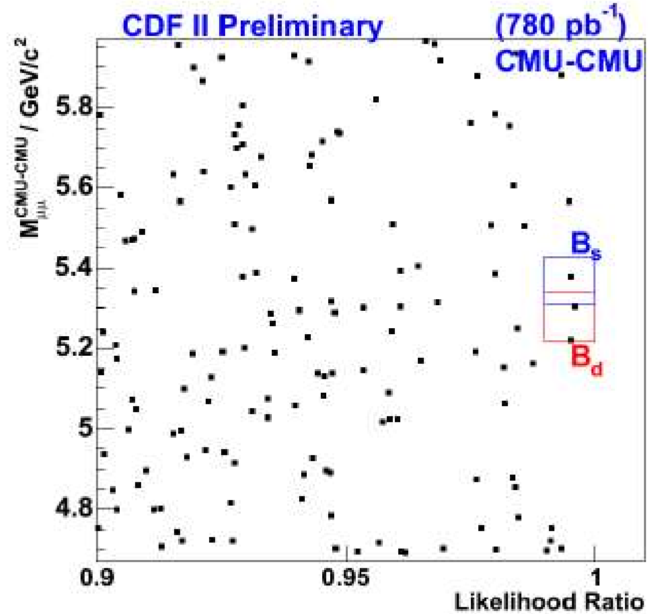
$$|V_{td}/V_{ts}| = 0.202^{+0.017}_{-0.016}(exp) \pm 0.015(th)$$

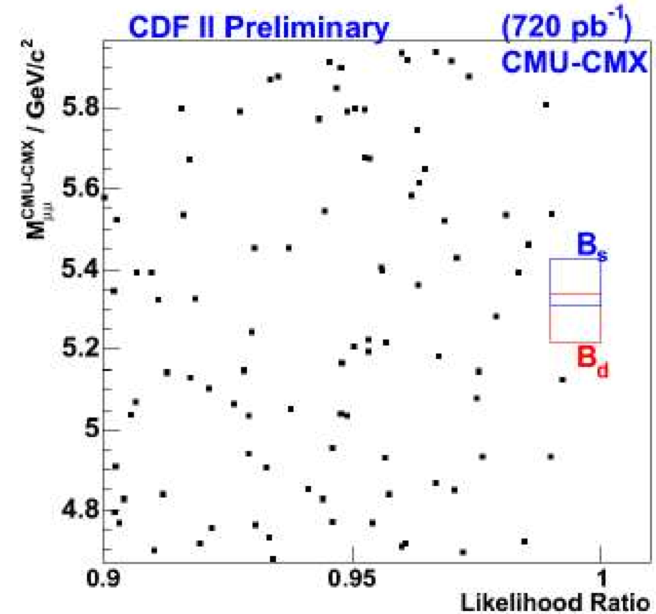


The Next Race: $B_{s/d}$ -> μμ

Marj Corcoran (CDF, D0)







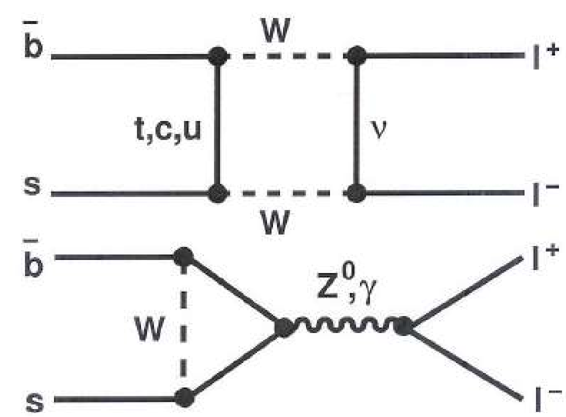
Limits:

D0: BR(B_s->μμ)<9.3 ·10^{-8} (27x SM)

CDF: BR(B_s->μμ)<1.0 ·10^{-7} (29x SM)

Comb:BR(B_s->μμ)<5.8 ·10^{-8} (17x SM) (unofficial)

CDF: BR(B_d->μμ)<1.0 ·10^{-10} (230x SM)



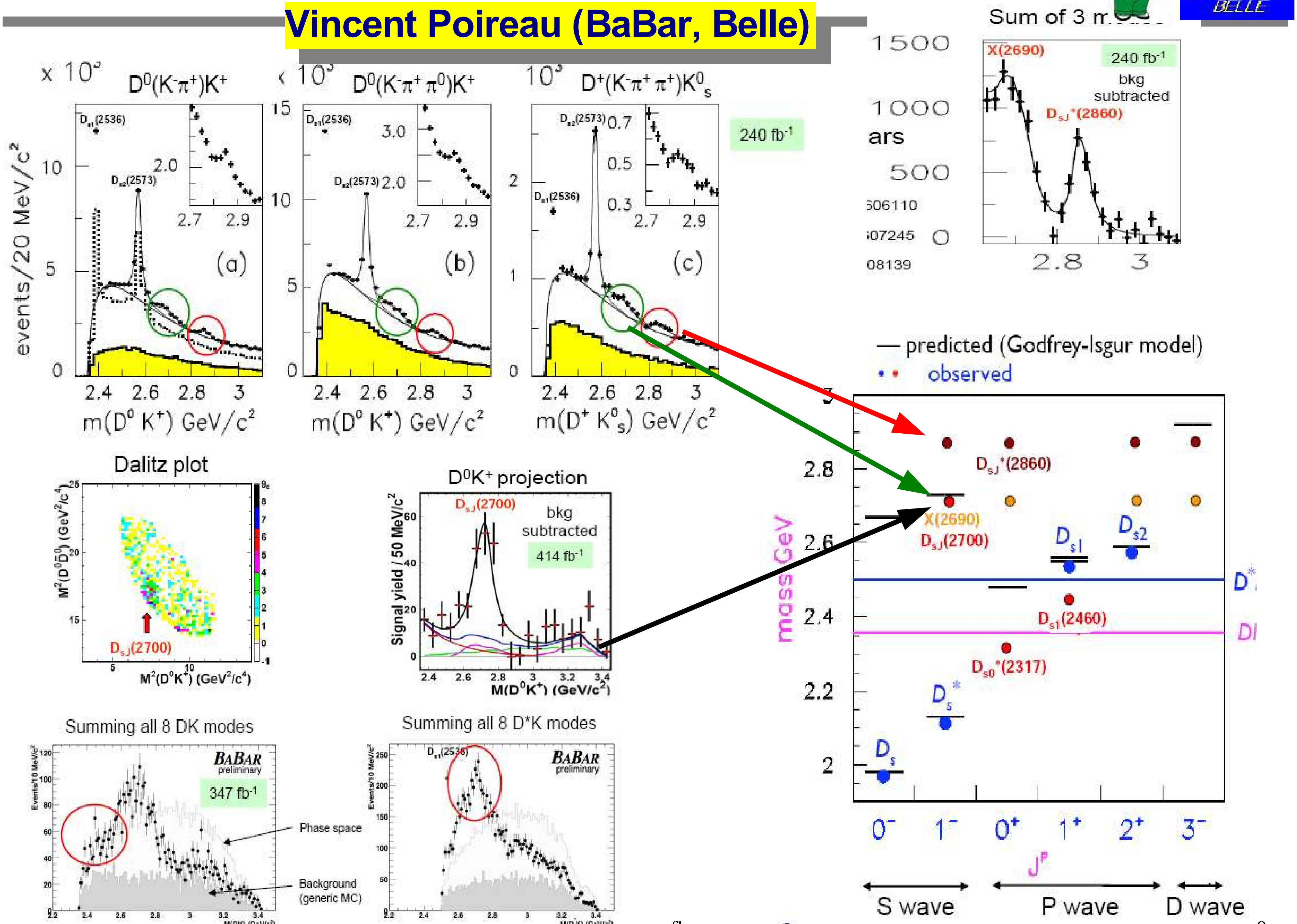
New Unexpected States

Isidor Rabi 1947: “Who ordered this?”

There's more in heaven and in earth than is written in your Particle Data Book!

New D_s States: X(2690), D_s (2700), D_s (2860)

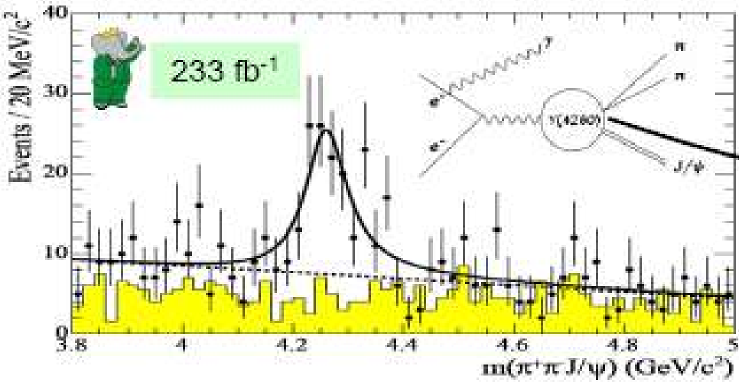
Vincent Poireau (BaBar, Belle)

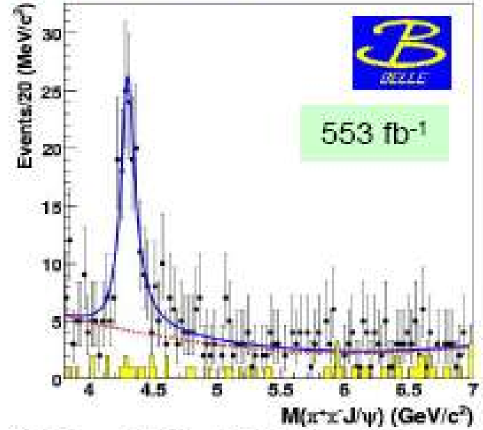


Y(4260)

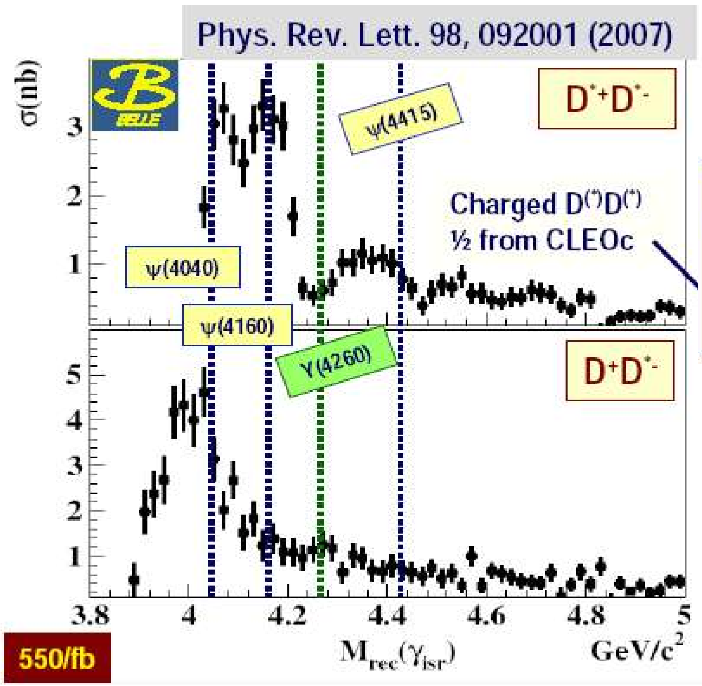
Vincent Poireau (BaBar, Belle)

- New resonance discovered in $e^+e^- \to \gamma_{ISR}(J/\psi\pi^+\pi^-)$ by BaBar





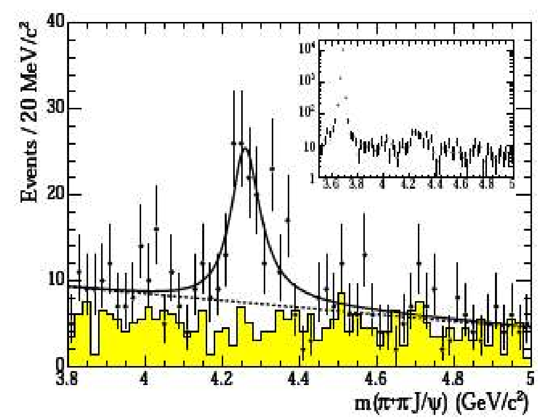
- BaBar measures: $M = (4259 \pm 8)$ MeV/c², $\Gamma = (88 \pm 23)$ MeV
- Belle measures: $M = (4295 \pm 10\ ^{+10}_{-3})$ MeV/c², $\Gamma = (133\ ^{+26}_{-22}\ ^{+13}_{-6})$ MeV
- Confirmed by CLEO: $M = (4283\ ^{+17}_{-16} \pm 4)$ MeV/c²



Galina Pakhlova (Belle)

<u>Y(4260) signal</u>
D*D : hint
D*D* : clear dip (similar to incl. R)
DD : no signal

Kamal K. Seth (CLEO)



$M(Y(4260)) = 4259 \pm 8^{+2}_{-6}$ MeV

$\Gamma(Y(4260)) = 88 \pm 23^{+6}_{-4}$ MeV

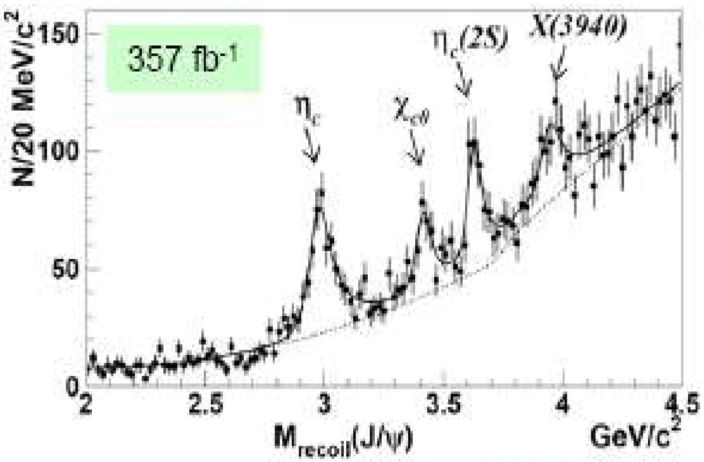
$\mathcal{L} = 233$ fb^{-1}

X(3940), Y(3940), Z(3930)

Vincent Poireau (Belle)

X(3940)

New state seen in $e^+e^- \to J/\psi\ X$

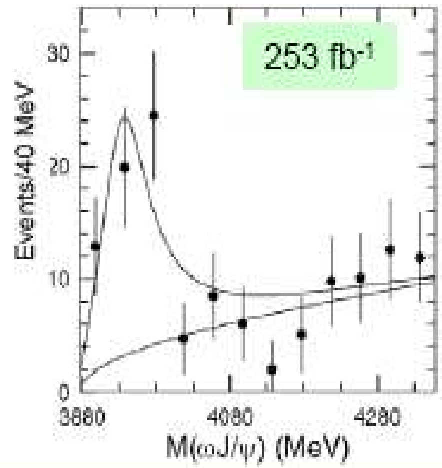


Also, observed $X \to \bar{D}D^*$, but not $X \to \bar{D}D$

$M = (3943 \pm 6 \pm 6)$ MeV/c^2
$\Gamma = (15.4 \pm 10.1)$ MeV
$c\bar{c}$ state $\eta_c(3S)$ $[3^1S_0]$?

Y(3940)

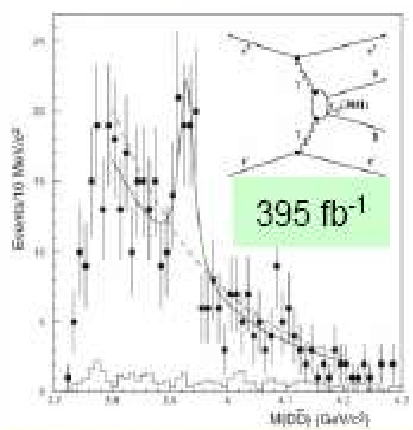
Near threshold enhancement in $B \to J/\psi\omega K$



$M = (3943 \pm 11 \pm 13)$ MeV/c^2
$\Gamma = (87 \pm 22 \pm 26)$ MeV
$c\bar{c}$ state χ'_{c1} $[2^3P_1]$?

Z(3930)

New resonance state in $\gamma\gamma \to \bar{D}D$



$M = (3929 \pm 5 \pm 2)$ MeV/c^2
$\Gamma = (29 \pm 10 \pm 2)$ MeV
$c\bar{c}$ state χ'_{c2} $[2^3P_2]$?

Belle: hep-ex/0507019
Belle: Phys. Rev. Lett. 94 (2005) 182002
Belle: Phys. Rev. Lett. 96 (2006) 082003

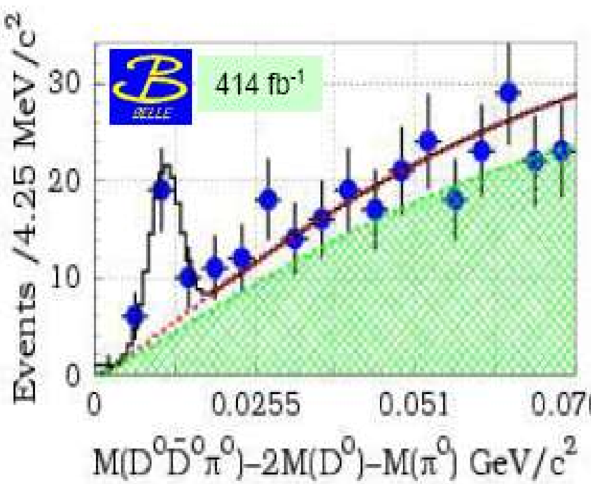
12 V. Poireau DIS 2007 April 2007

X(3872) Remains a Mystery

Kamal K. Seth (CLEO)

$D^0\bar{D}^*$ molecule interpretation: Binding energy EB=-0.6±0.6MeV after new CLEO measurement of D^0 mass, BUT:

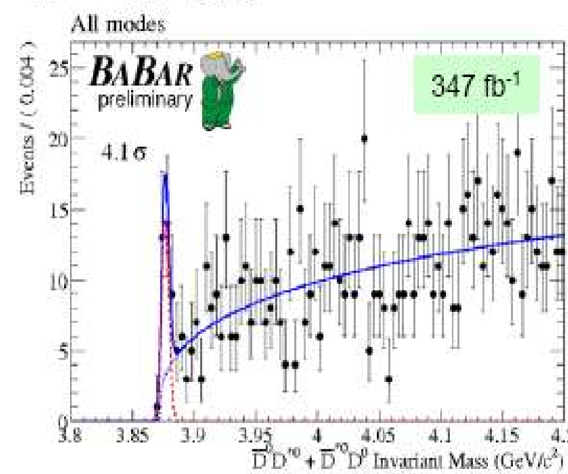
- Belle: looking at $B \to \bar{D}^0 D^0 \pi^0 K$



- Excess in the $\bar{D}^0 D^0 \pi^0$ invariant mass
  - $M = 3875.4 \pm 0.7\ ^{+1.2}_{-2.0}$ MeV/c^2

Vincent Poireau (Belle)

- BaBar: looking at $B \to \bar{D}^0 D^{*0} K$ ($D^{*0} \to D^0\pi^0/\gamma$)



New result preliminary

- Excess in the $\bar{D}^0 D^{*0}$ invariant mass
  - $M = 3875.6 \pm 0.7\ ^{+1.4}_{-1.5}$ MeV/c^2

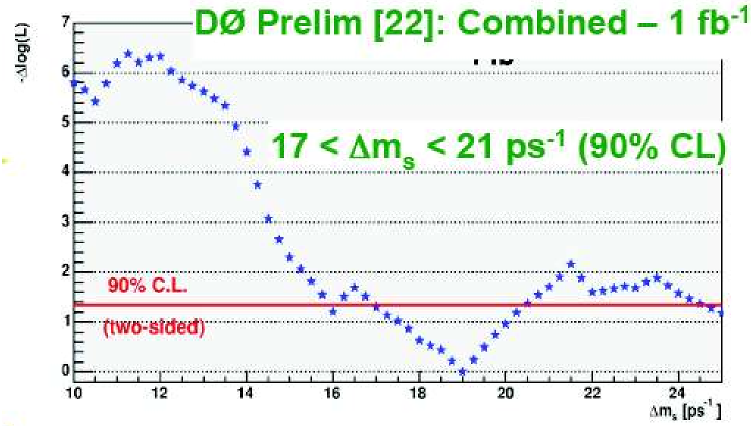
- Masses between **Belle** and **BaBar** in good agreement
- 2.5σ away from the X(3872) world average!
- If X(3872), $J^P = 2^+$ disfavored

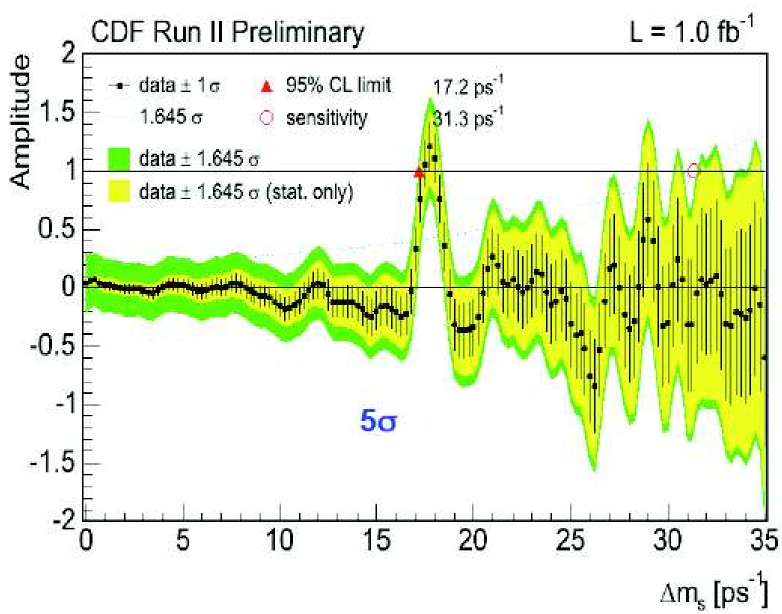
hep-ex/0606055

Mixing

- B_s Mixing: CDF and D0
- D^0 Mixing: BaBar and Belle

Finally: B_s Oscillations. Measuring Δm_s

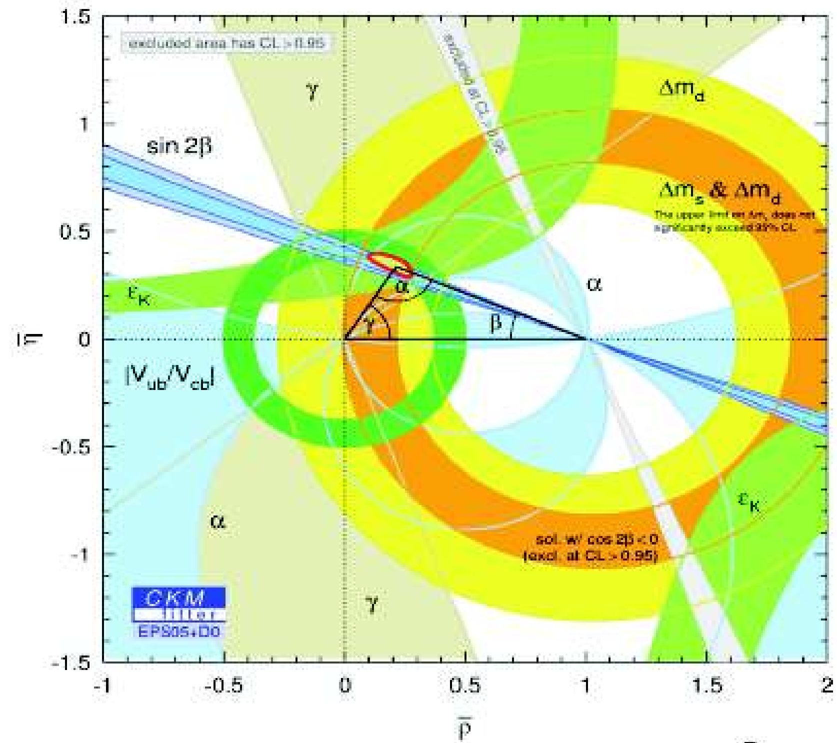




$\Delta m_s = 17.77 \pm 0.10 \pm 0.07$ ps^{-1}

CDF Collab. PRL 97 062003 (2006)

Robert Kehoe (CDF, D0)



$$\frac{\Delta m_s}{\Delta m_d} = \frac{m_{B_s}}{m_{B_d}} \xi^2 \left| \frac{V_{ts}}{V_{td}} \right|^2$$

$$\left| \frac{V_{td}}{V_{ts}} \right| = 0.2060 \pm 0.007\,(\text{exp})^{+0.0081}_{-0.0060}\,(\text{theo})$$

More: Measurements of $\Delta\Gamma_s$ and φ_s

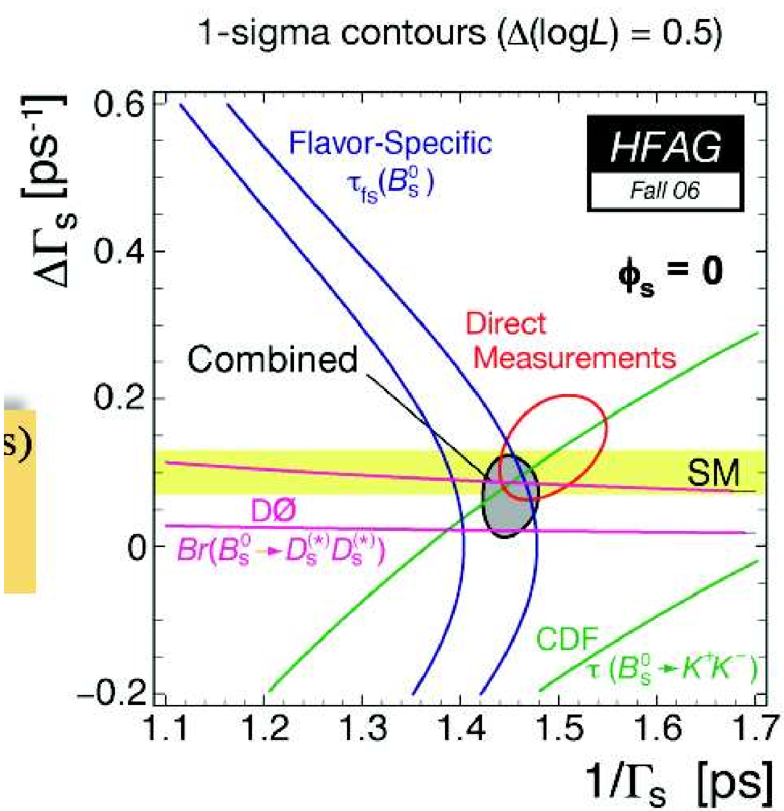
Robert Kehoe (CDF, D0)

$BR(B_s \to D_s^{(*)} D_s^{(*)})$ AND $\Delta\Gamma_s$

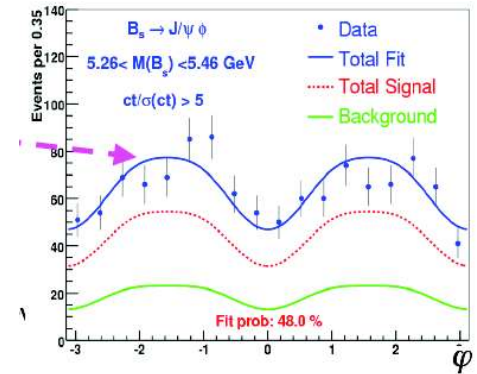
$$BR(B_s \to D_s^{(*)} D_s^{(*)}) = 0.039^{+0.019}_{-0.017}(\text{stat})^{+0.016}_{-0.017}(\text{sys})$$

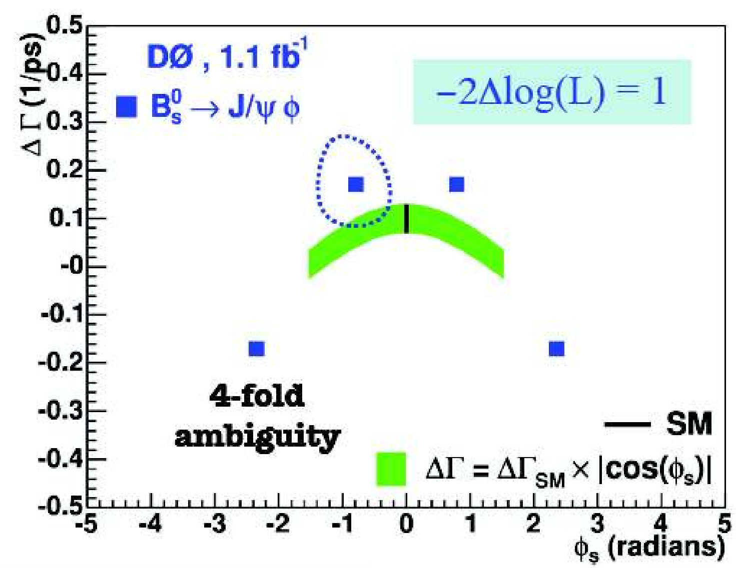
$$\frac{\Delta\Gamma_{CP}}{\Gamma} = 0.079^{+0.038}_{-0.035}(\text{stat})^{+0.031}_{-0.030}(\text{sys})$$

D0 Collab. hep-ex/0702049, subm. to PRL



$B_s \to J/\psi\ \phi$





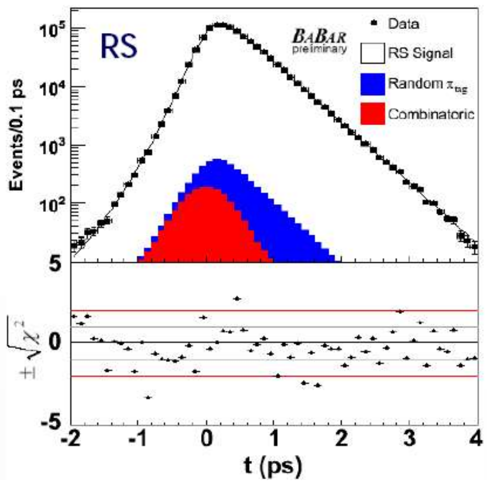
$$\Delta\Gamma_s = 0.17 \pm 0.09 \pm 0.02\, ps^{-1}$$

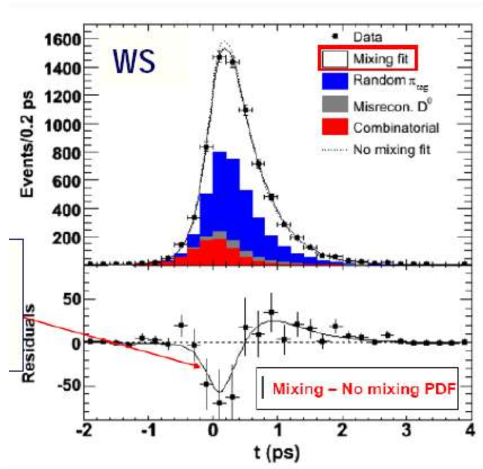
$$\phi_s = -0.79 \pm 0.56^{+0.14}_{-0.01}$$

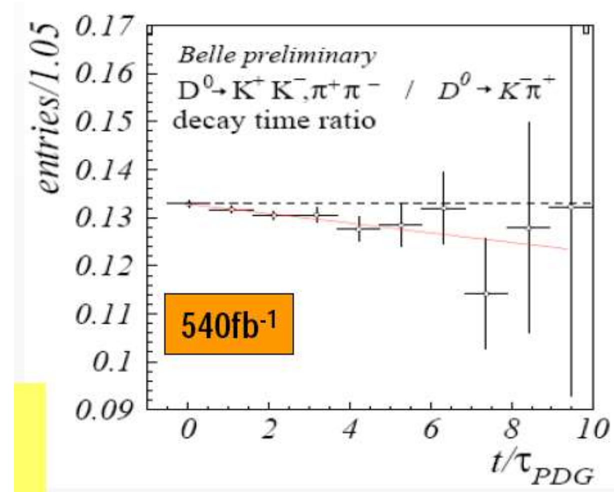
D0 Collab. hep-ex/0701012 submitted

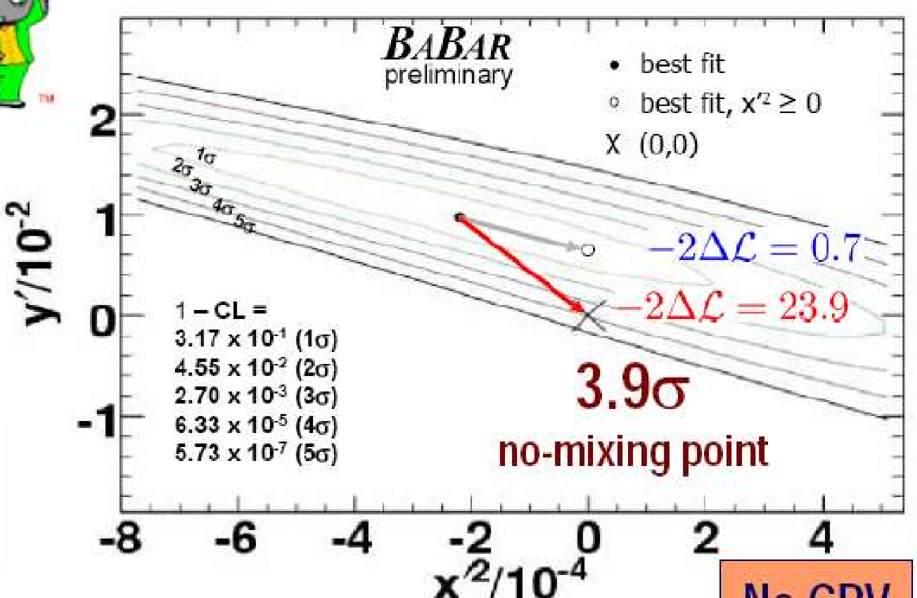
Finally: D^0 Mixing

Galina Pakhlova (BaBar, Belle)



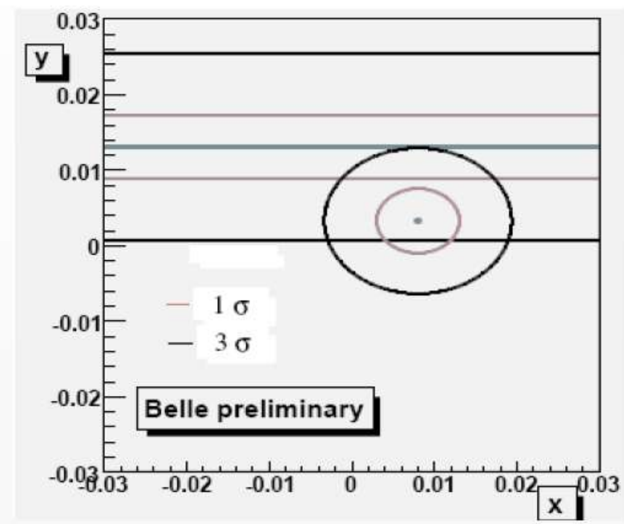






mixing CL contours

No CPV

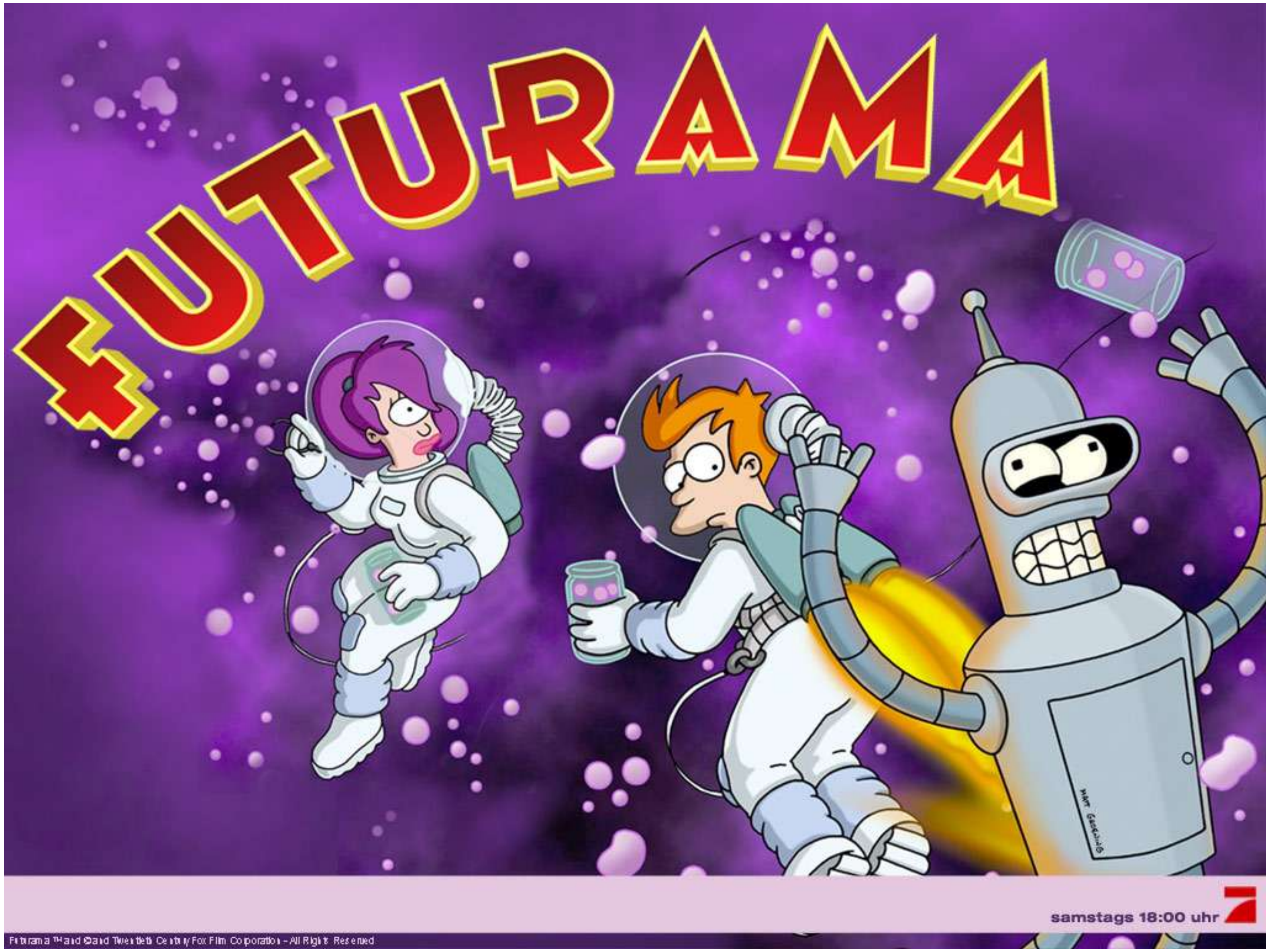


3.2σ above zero
Evidence of D^0 - $\overline{D}^0$ mixing !!!

No evidence for CP violation

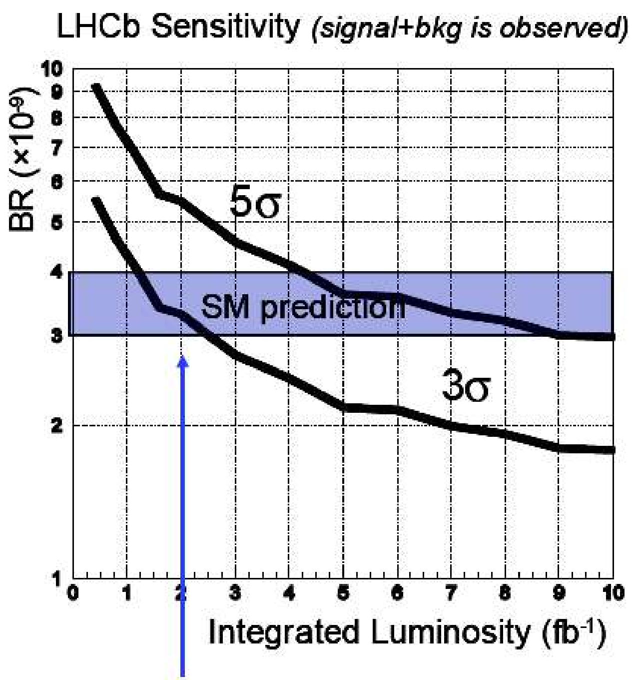
Looking Ahead Into the Future

- The near Future: Atlas, CMS, LHC-b
- The (hopefully not too) far future: ILC



$B_{s/d}$ -> μμ at LHC

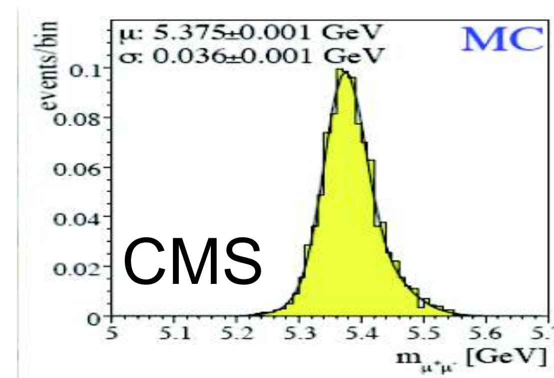
Emanuele Santovetti (LHC-b)



with $L=2fb^{-1}$
3σ observation if at SM value

Attila Krasznahorkay (ATLAS, CMS)

BR used in MC		Luminosity	Signal	Background*
B_s -> μμ $3.5x10^{-9}$	Final detector studies 2006-2007	$3y@10^{33}cm^{-2}s^{-1}$ $(30fb^{-1})$	21	~60
			Upper limit $6.6x10^{-9}$	90% CL
	Early detector studies 2000	$1y@10^{34}cm^{-2}s^{-1}$ $(100\ fb^{-1})$	92	~900
B_d -> μμ $0.9x10^{-10}$			Upper limit $3x10^{-10}$	95% CL



- CDF, D0: BR(B_s->μμ)<100 $\cdot 10^{-9}$ (29 x SM) with ~$0.7fb^{-1}$
- LHC-b: BR(B_s->μμ)< 3 $\cdot 10^{-9}$ (0.8 x SM) with $2fb^{-1}$ = 1 year
- Atlas: BR(B_s->μμ)< 7 $\cdot 10^{-9}$ (2 x SM) with $30fb^{-1}$ = 3 years
- CMS: BR(B_s->μμ)< 14 $\cdot 10^{-9}$ (4 x SM) with $10fb^{-1}$ = 1 year

Angle γ of the Unitarity Triangle

Emanuele Santovetti (LHC-b)

Summary of performances on γ

B mode	D mode	Method	σ(γ)
$B^+ \to DK^+$	$K\pi + KK/\pi\pi + K\pi\pi\pi$	ADS+GLW	5°-15°
$B^+ \to D^*K^+$	$K\pi$	ADS+GLW	under study
$B^+ \to DK^+$	$K_S\pi\pi$	Dalitz	15°
$B^+ \to DK^+$	$KK\pi\pi$	4-body "Dalitz"	15°
$B^+ \to DK^+$	$K\pi\pi\pi$	4-body "Dalitz"	under study
$B^0 \to DK^{*0}$	$K\pi + KK + \pi\pi$	ADS+GLW	7°-10°
$B^0 \to DK^{*0}$	$K_S\pi\pi$	Dalitz	under study
$B_S \to D_sK$	$KK\pi$	tagged, A(t)	13°
$B \to \pi\pi, KK$			4°-10°

Signal only, no accept. effect

Combining all modes, with a nominal year of data (2 fb^{-1}), LHCb will be able to extract γ with ~ 4° resolution, and compare the $B \to DK$ direct measurement with the indirect determination ($B^0 \to \pi^+\pi^-$, $B_s \to K^+K^-$) to make a stringent test of the SM

Δm_s Measurement at Atlas

Attila Krasznahorkay (ATLAS)

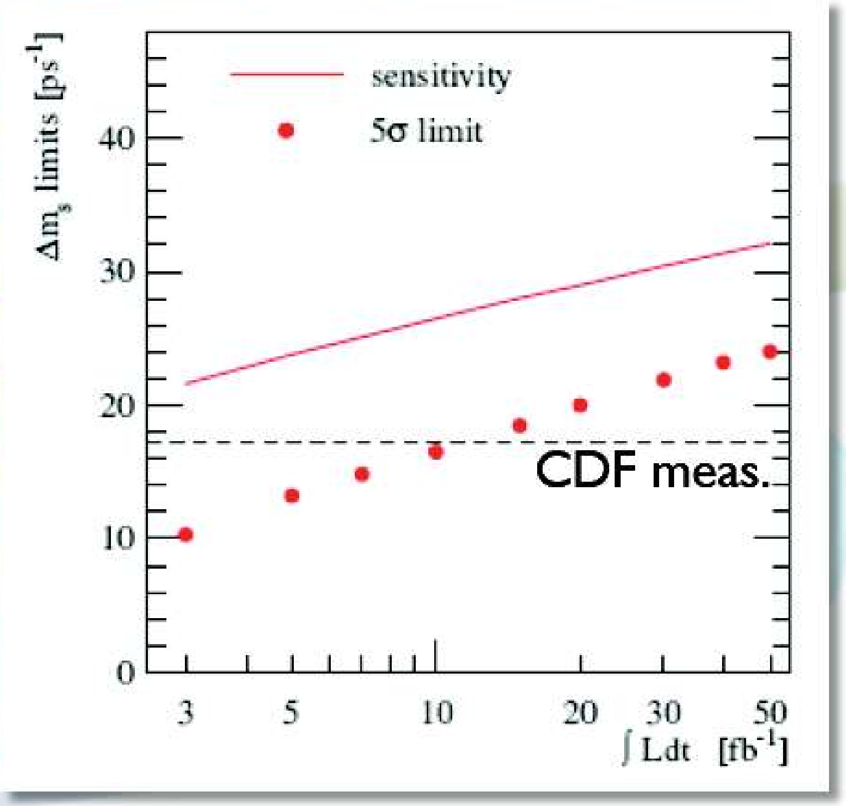
- In $B^0_s \to D_s\pi$, $B^0_s \to D_s a_1$ the probability to detect an initially pure B^0_s as B^0_s (p_+) or as $\bar{B}^0_s$ (p_-) is:

$$p_\pm(t) = e^{-\Gamma t}(\cosh \frac{\Delta\Gamma_s}{2} t \pm \cos \Delta m_s t)\frac{\Gamma^2 - \Delta\Gamma_s^2}{2\Gamma}$$

- Δm_s can be derived from:

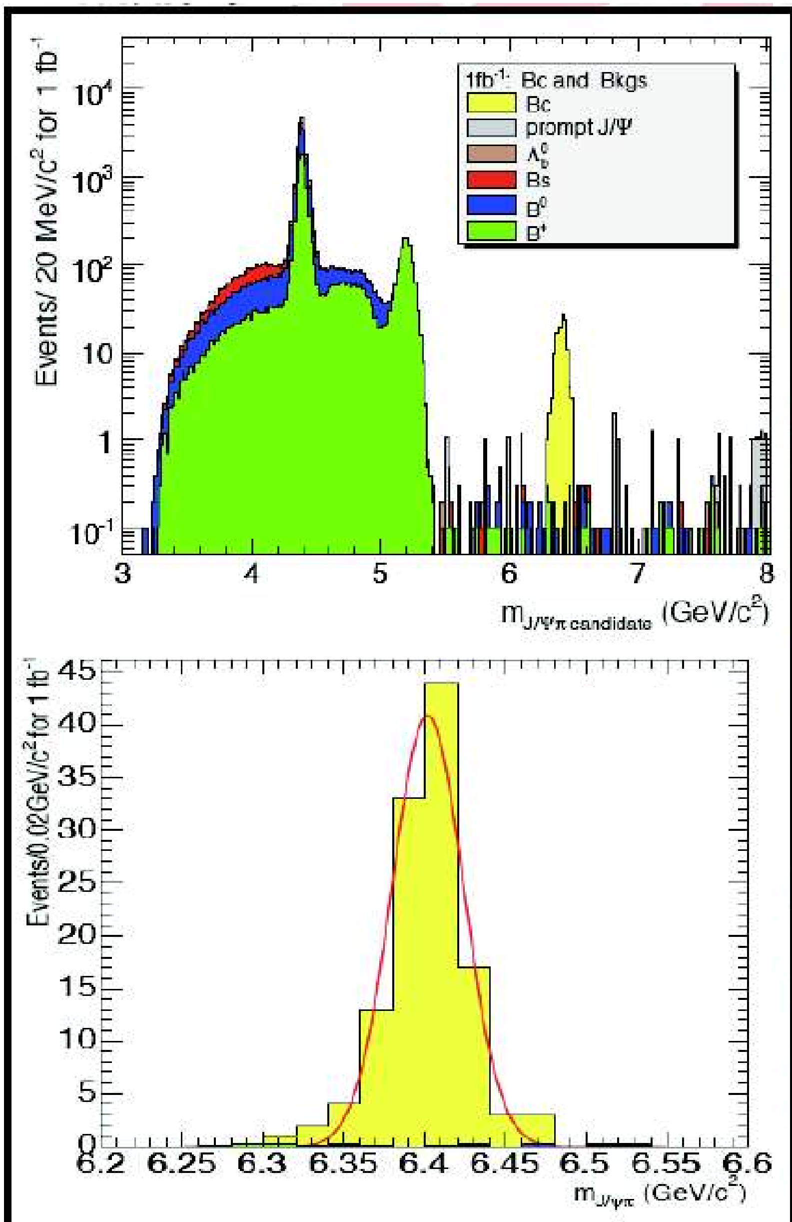
$$\frac{p_+(t) - p_-(t)}{p_+(t) + p_-(t)} = \frac{\cos \Delta m_s t}{\cosh \frac{\Delta\Gamma_s}{2} t}$$

- The projection of ATLAS's sensitivity to Δm_s can be seen on the right. A 5σ limit could be obtained for CDF's measurement already with 10 fb^{-1}



Measurement of B_c Mass at CMS

Attila Krasznahorkay (CMS)



- Studying B_c can help understanding heavy quark dynamics
- Different theoretical descriptions give B_c properties with large uncertainties
- CMS studied the channel: $B_c \to J/\psi\pi$
- 120 such events are expected to be selected with 1 fb^{-1} of data
- Expected resolutions:
  - mass: 22.0(stat.), 14.9(syst.) MeV/c^2
  - cτ: 13.1(stat.), 3.0(syst.) μm

13

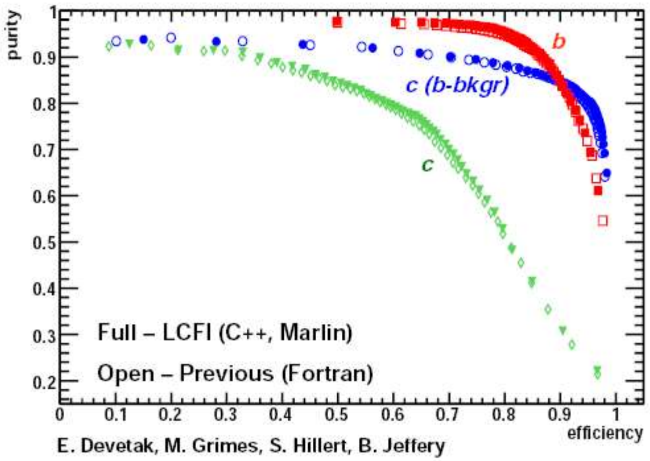
PDG06: 6286 ±5 MeV

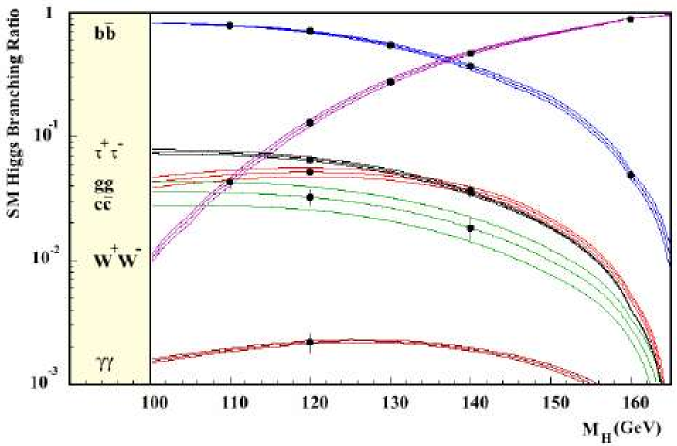
New CDF value: 6276.5±4.0±2.7 MeV

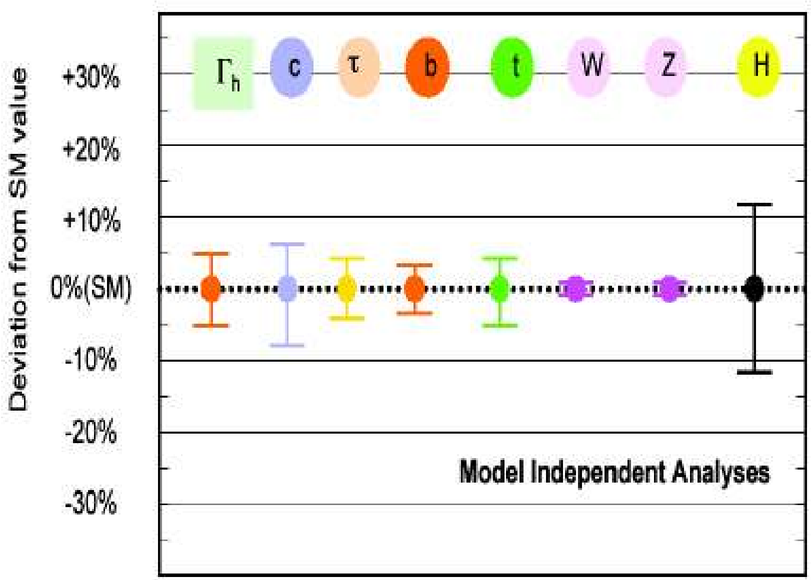
Physics with Heavy Flavours at ILC

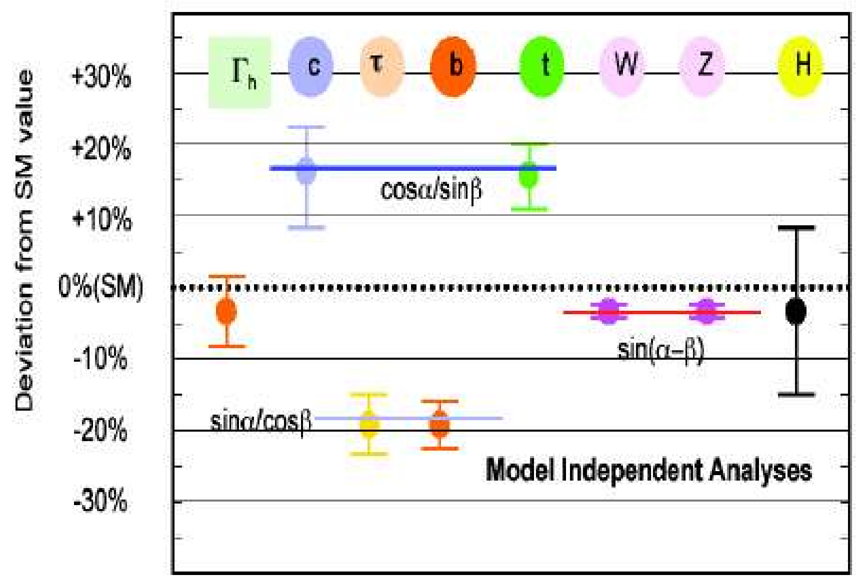
Tim Greenshaw (ILC)

- Extremely good flavour separation aimed at and achievable at ILC
- Needed to measure Higgs couplings









Conclusions and Outlook

- Heavy flavour production measurements enters the precision era
  => Incentive for more theory and phenomenology work
  => Need better techniques to incorporate measurements into pdf fits
- Interplay between Tevatron and HERA data often important,
  e.g. in charmonium production
- Heavy ions:
  Charm interacts with the quark-gluon-medium and flows with it
- The particle data book becomes more and more complete,
  solid evidence for unexpected states
- Mixing established in all neutral systems: K^0, $\mathbf{D^0}$, B^0, $\mathbf{B_s^0}$
- The race is on for B->μμ!
- Much more to come from HERA, Tevatron, Belle and BaBar
  before LHC takes over and ILC is built