STATUS REPORT ON $J/\psi \to \mu\mu$ INVESTIGATIONS

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- DATA SAMPLES
  - see Basic Muon ID: J/psi web page
- OBSERVED SIGNALS
  - WAMUS - WAMUS — Stefan
  - WAMUS - FAMUS — Dania
  - FAMUS - FAMUS — many
- EXPECTED RESOLUTION
  ALIGNMENT EFFECTS — DZ, AZ
- CROSS SECTION ESTIMATION — FD, PB
  $J/\psi \to \mu\mu$; $p_T^{\mu} > 3$ GeV, $|\eta^{\mu}| < 2$
- THEORY PREDICTIONS — AZ
- FAMUS - WAMUS RATES — SS
  COMPARISONS — AZ
- UPSILON STUDIES — Serban
  $N^{\Upsilon}_{expec} \approx 200 \cdot \varepsilon / pb^{-1}$ — at the μ-ID meeting

J/psi ->mu mu data

Data samples:

- **Data set (4): All dimuon events up to run 143482, p10.11.00**
  ~40K events selected by requiring >1 Muonid objects (Stefan Soldner)
  Root file on d0mino: /prj_root/858/muid_1/daria/data/all_p101100.root
  } ≥2 Muon ID objects
- **Data set (3): All pre-shutdown dimuon events p10.07.01**
  6846 events selected from **all 5.8 million pre-shutdown events** (Frederic Deliot)
  selection based on MuoTrfit objects:
  whits_bc>0, shits_a>0,shits_bc>0
  location of the root file will be provided
  } ≥2 MuoTrfit objects

  Full background-subtracted signal (eps)
  pt(u)>3GeV (eps)
- **Data set (2): forward dimuon events (trigger bit 19), p10.07.01**
  (Superseeds data set (1) of 542 events)
  2170 events selected from **all 5.8 million pre-shutdown events** (Adam Yurkewicz)
  selection based on Muonid objects, abs(Idnseg=3))
  trigger "mu2pix" only
  Cuts (for both muons), require one pair per event:
  1 < abs(eta) < 2, pt>3 GeV
  more than 2 hits in A
  more than 3 hits in BC

  /prj_root/858/muid_1/daria/data/dimu_all_combined.raw
  /work/thwaite-clued0/dimuon-06-11-01.root

  /prj_root/858/muid_1/daria/data/dimu* output of d0reco, version pre-p10.10
  /prj_root/858/muid_1/daria/data/dimu_500_*.root, dimu_170.root corresponding root tuples

  Low mass dimuon event

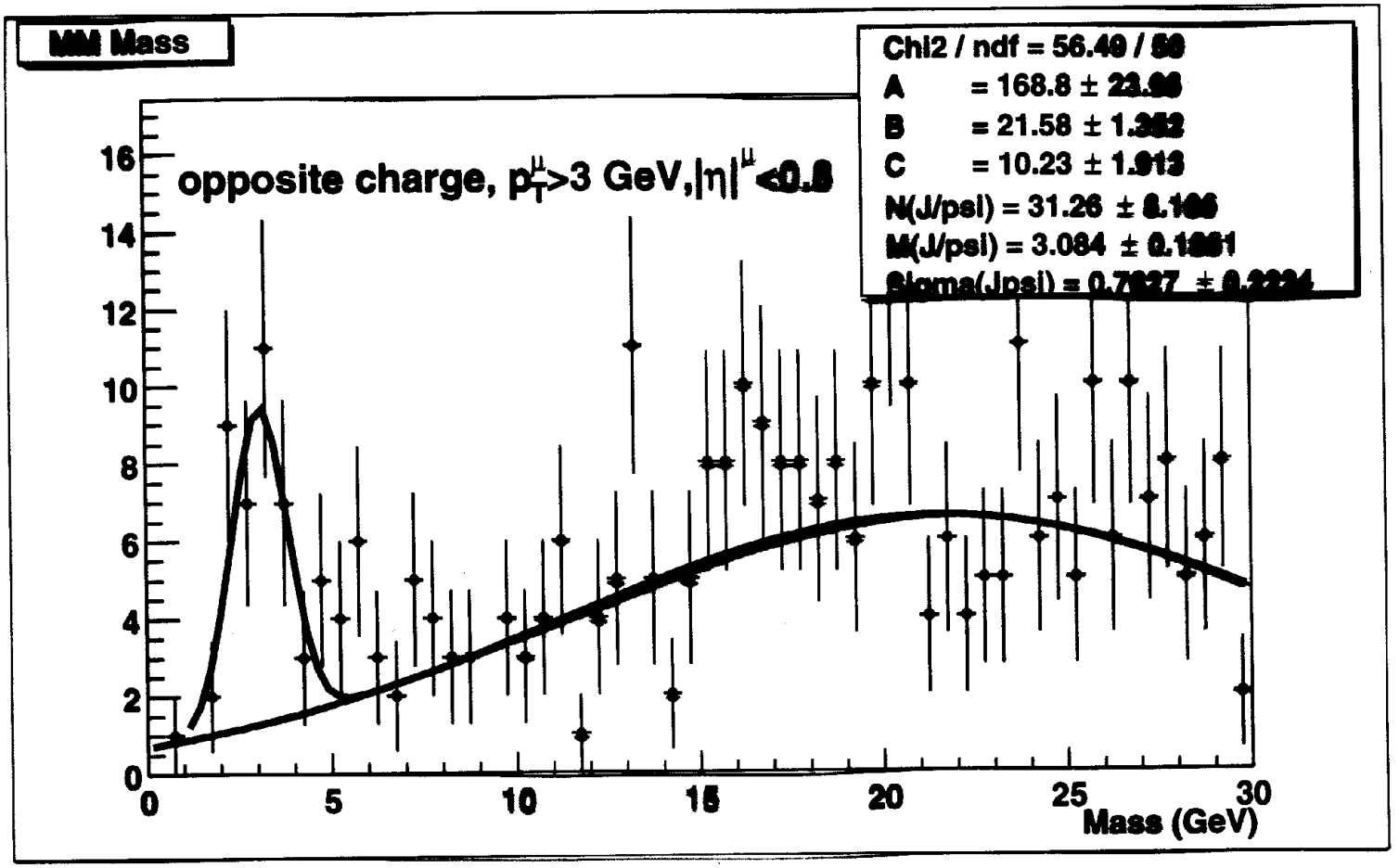
Analysis

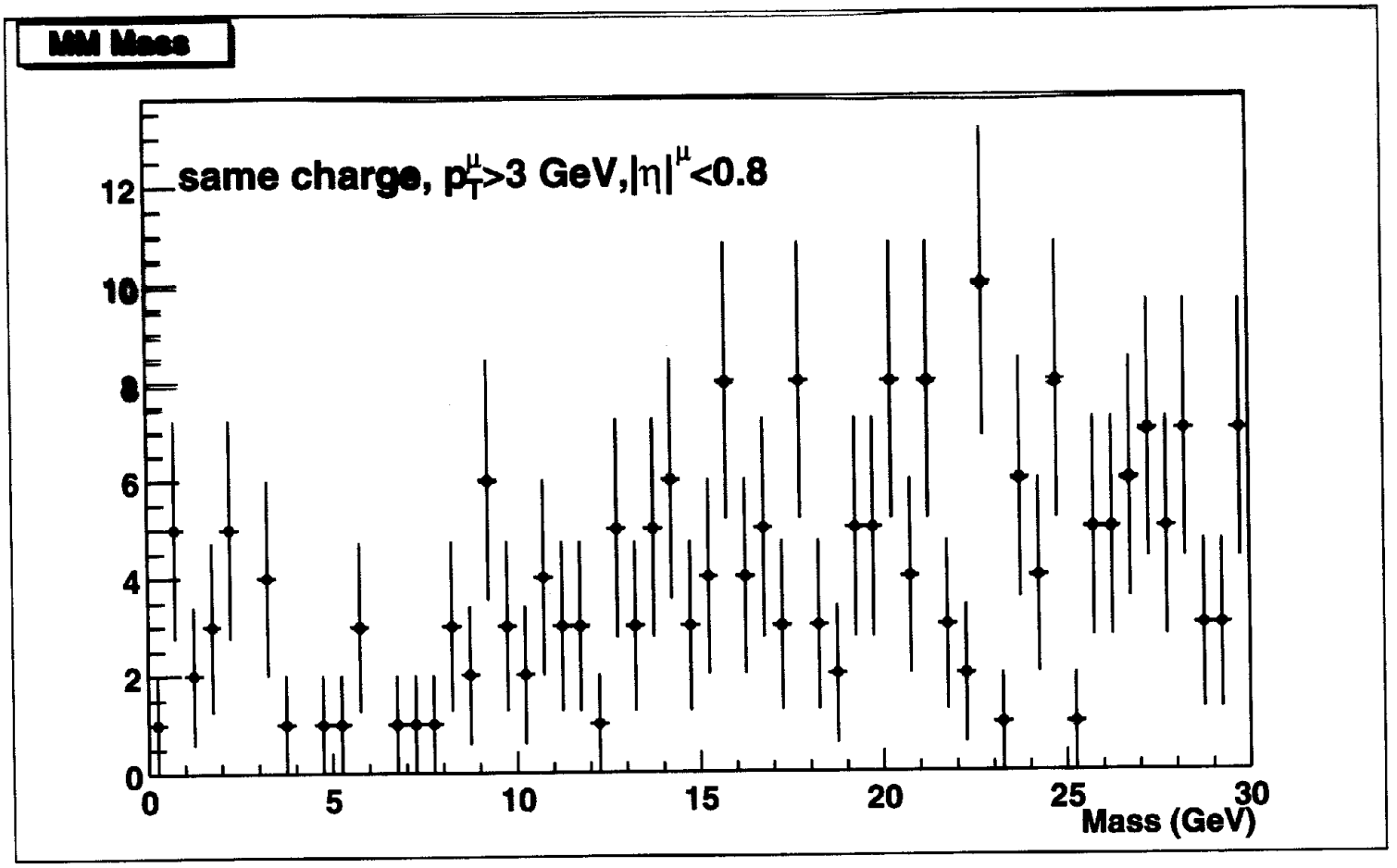
- **From data set (4): at least a J/psi signal in Wamus**
  Two analyses, (1) studying dimuons in Wamus, and (2) looking at the dimuon mass of pairs including at least one Wamus track, and at Famus-Famus pairs.

  (1) This figure shows M(uu) for 2 Wamus muons with (Muonid objects) Idnseg = -3
  The fit gives 30+-7 J/psi events with 2 muons in Wamus (Stefan Soldner)

  (2) This figure shows M(uu) for an opposite sign pair of MuoTrfit "medium" tracks, plus some anti-cosmic cleanup, for >0 Wamus tracks (top) and for 2 Famus tracks (bottom). The fitted numbers of J/psi events are, respectively:
  47+-9 events with >0 muons in Wamus, and
  785+-45 events with 2 muons in Famus (Daria)

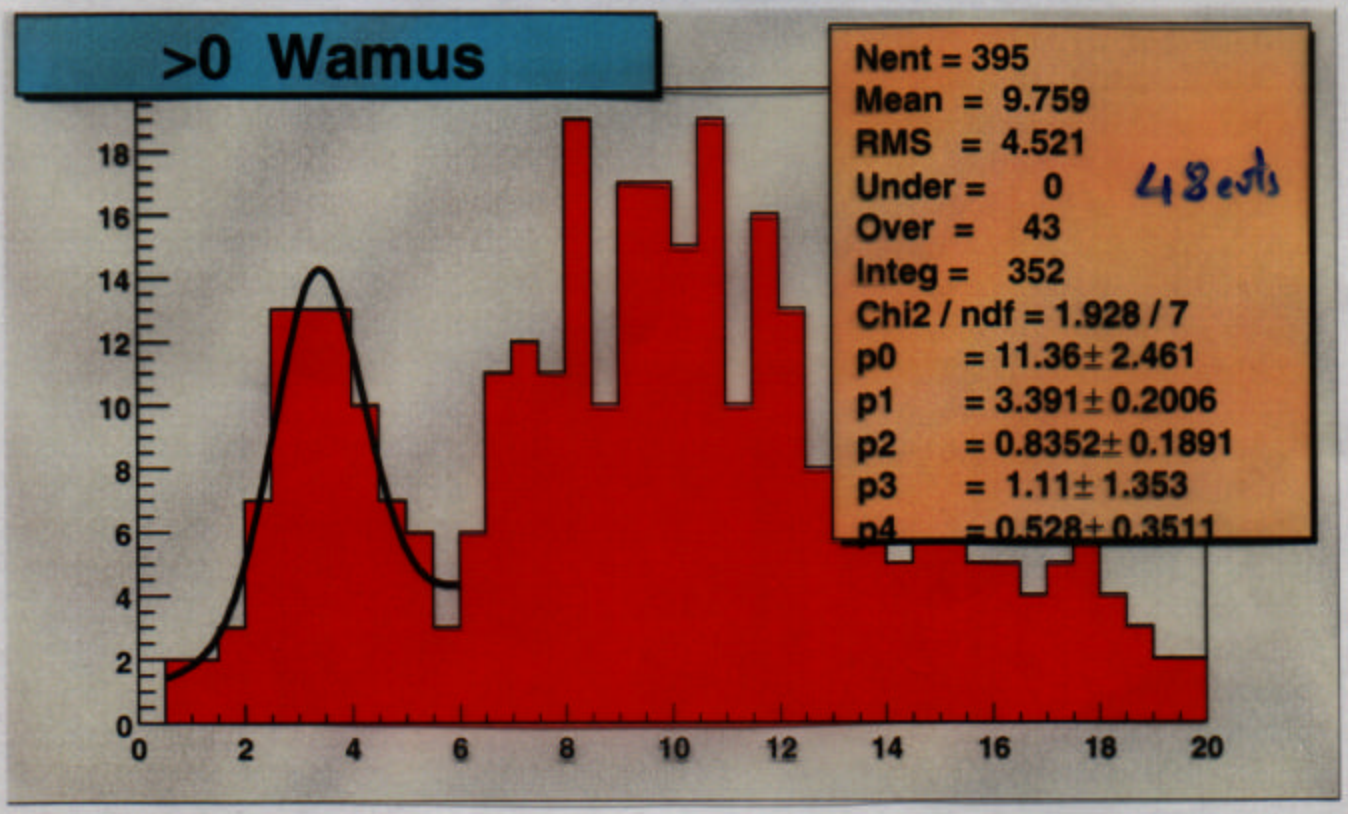
Stefan

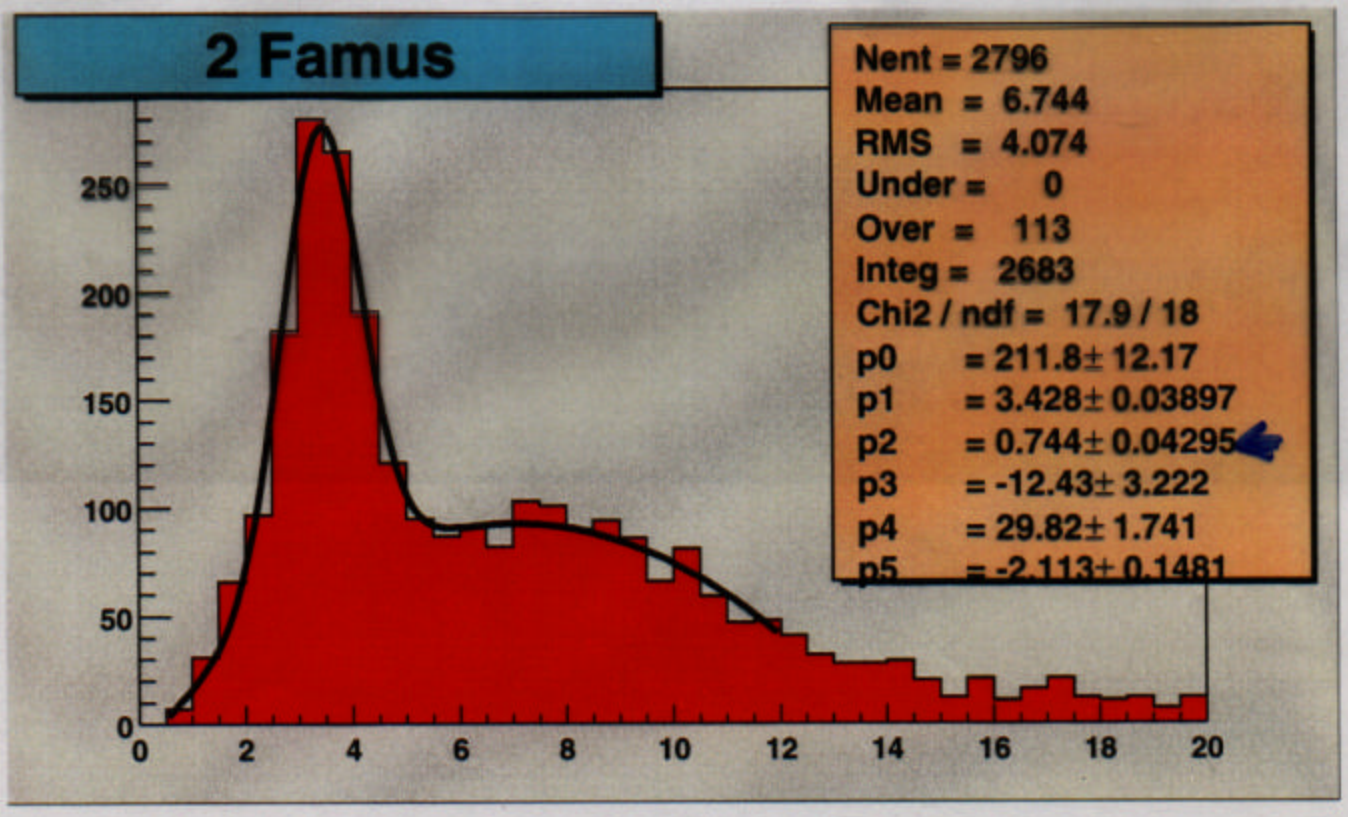

MM Mass
Chi2 / ndf = 56.49 / 50
A = 168.8 ± 23.96
B = 21.58 ± 1.352
C = 10.23 ± 1.913
N(J/psi) = 31.26 ± 8.166
M(J/psi) = 3.084 ± 0.1861
Sigma(Jpsi) = 0.7627 ± 0.2224
opposite charge, p_T^μ>3 GeV,$|\eta|^\mu$<0.8
Mass (GeV)


MM Mass
same charge, p_T^μ>3 GeV,$|\eta|^\mu$<0.8
Mass (GeV)

Wed Jan 23 15:19:53 2002

M(uu) pt(u)>3 GeV





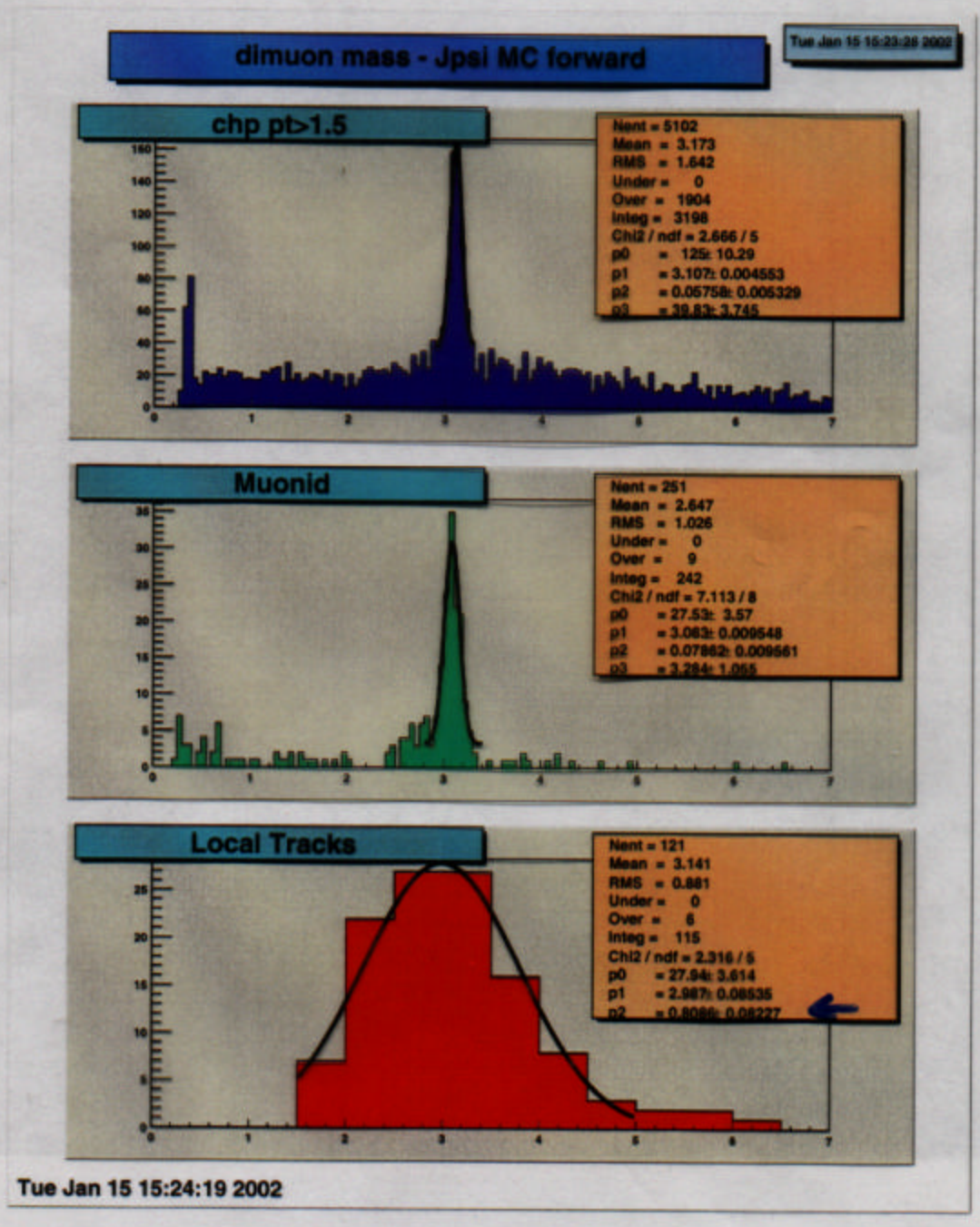
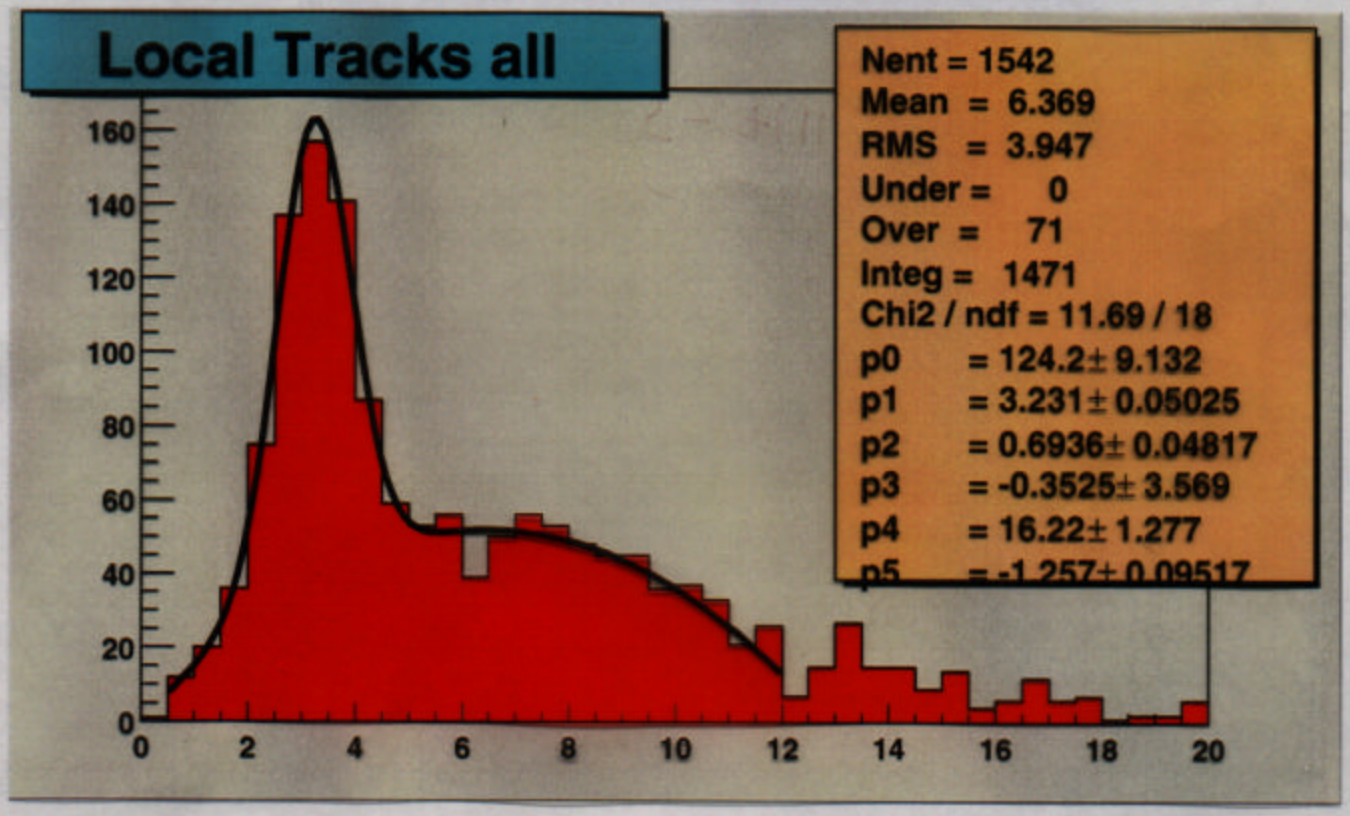
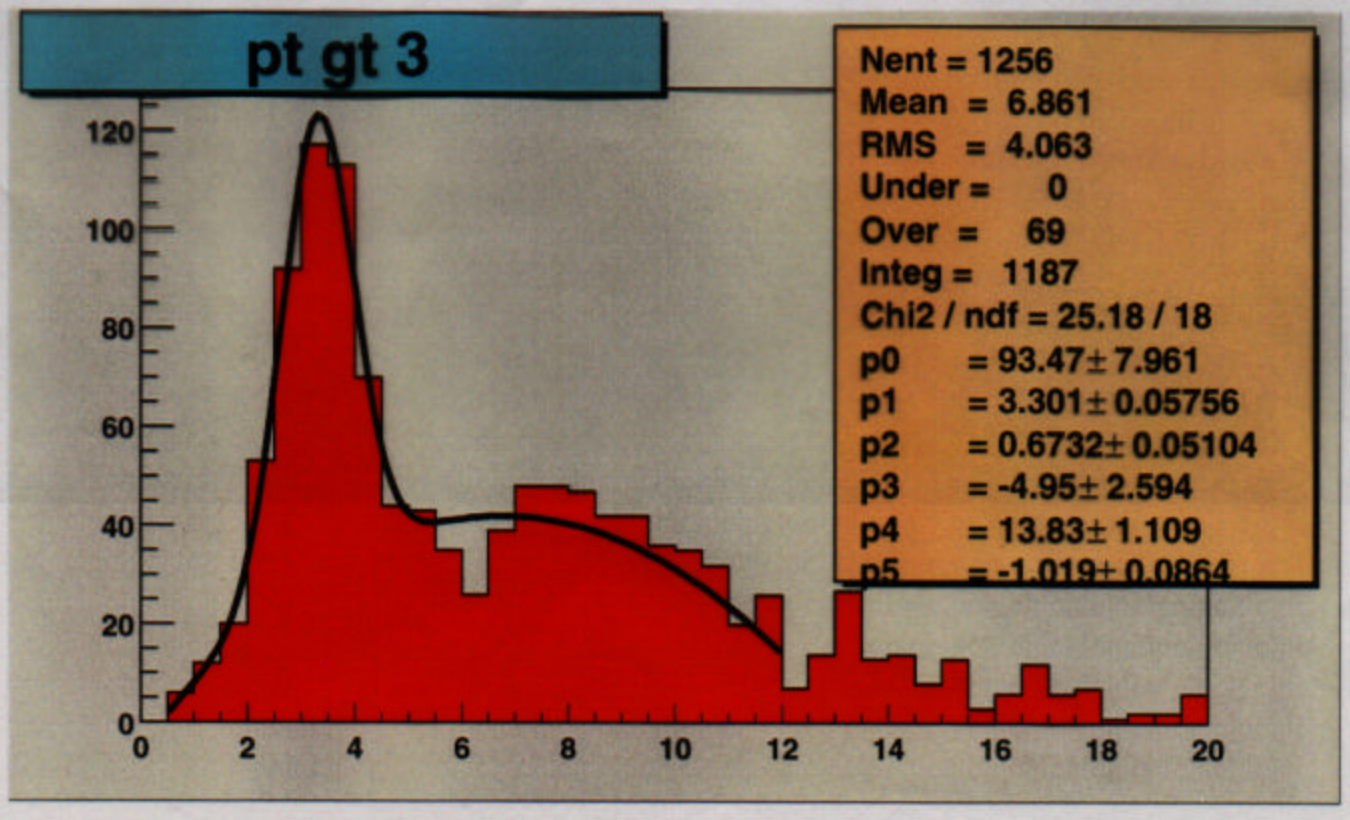


Figure 14: J/ψ signal reconstruction in MC, Famus. Top: opposite sign ChargedParticles, Center: MuonParticles, Bottom: Muon::Track

Tue Nov 13 13:48:49 2001

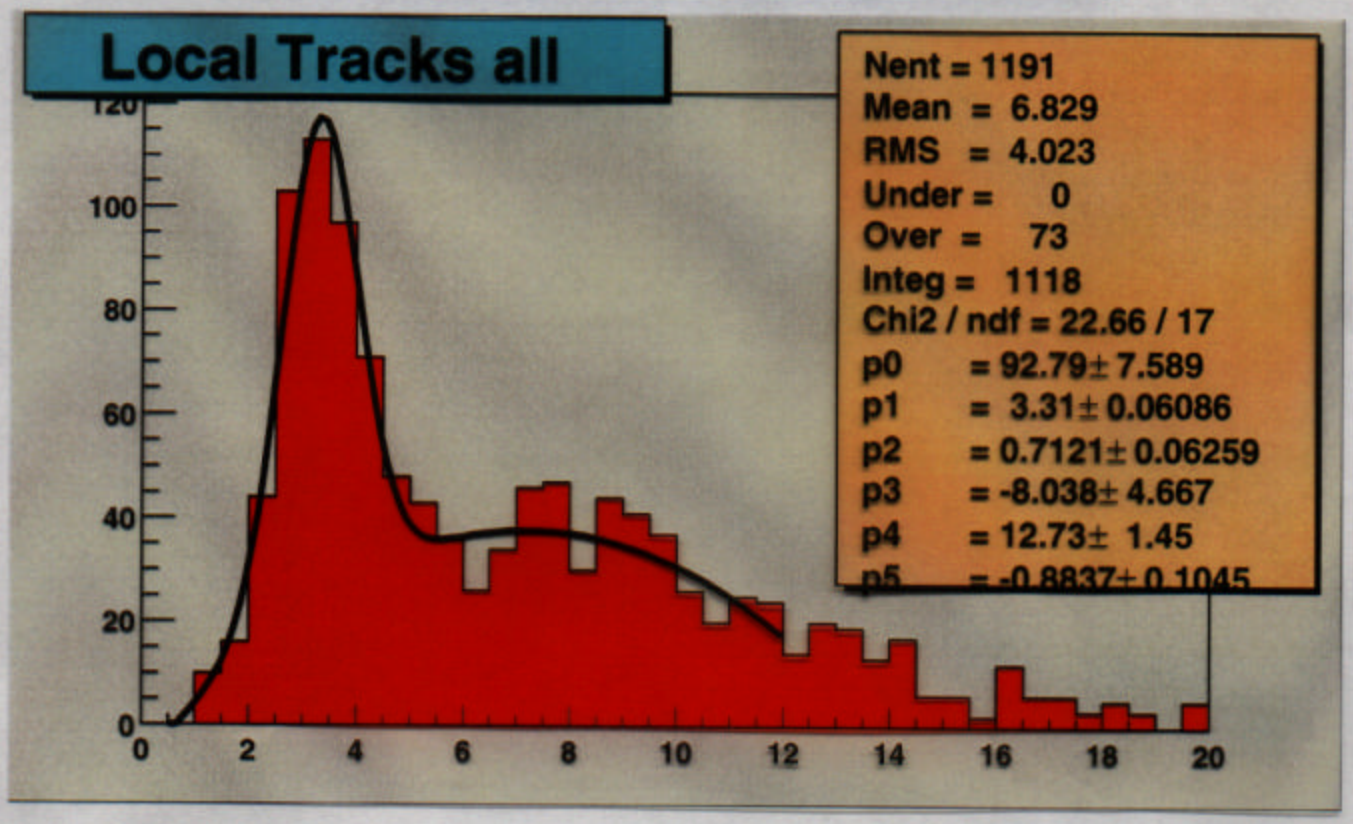
M(uu)

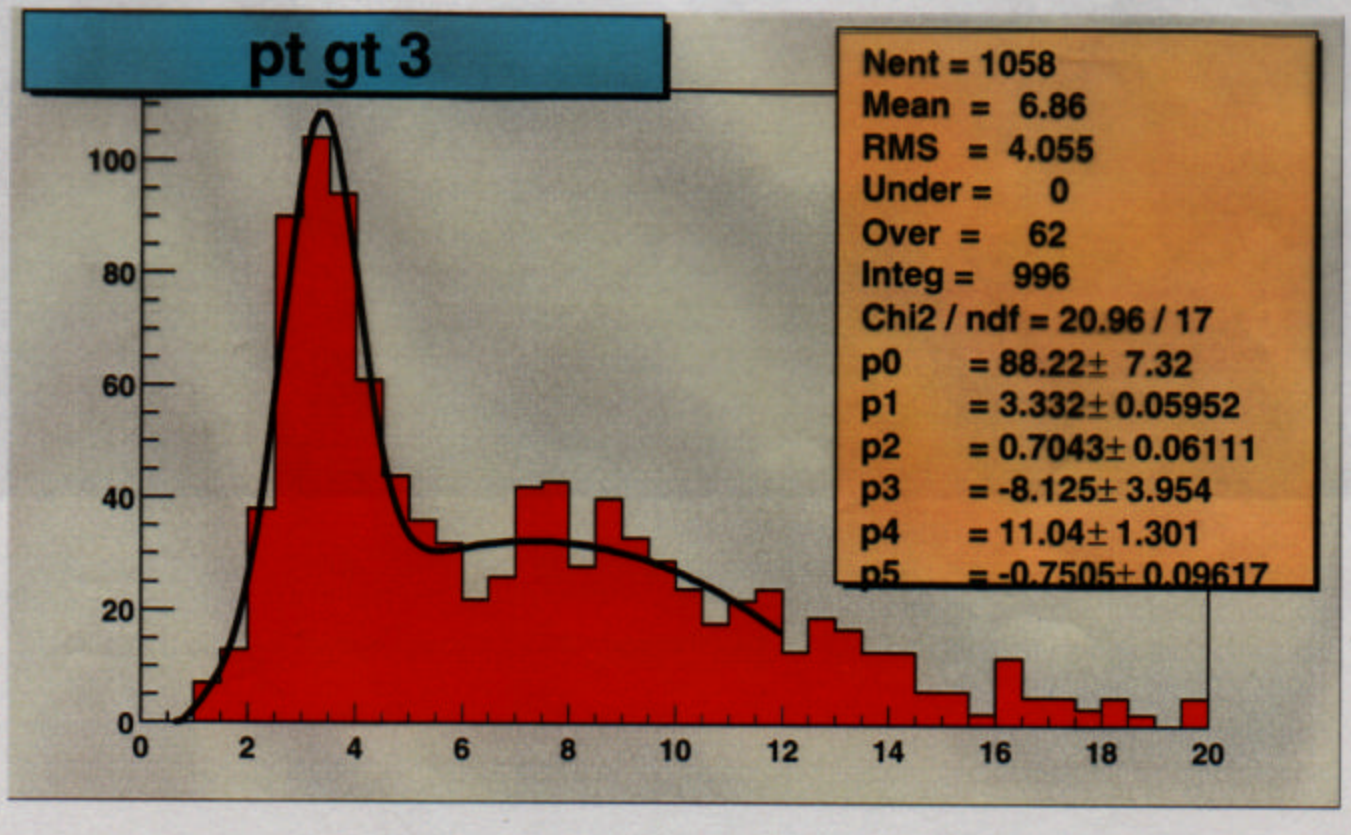




M(uu)

Mon Dec 10 17:54:58 2001





Cross-Section Estimation

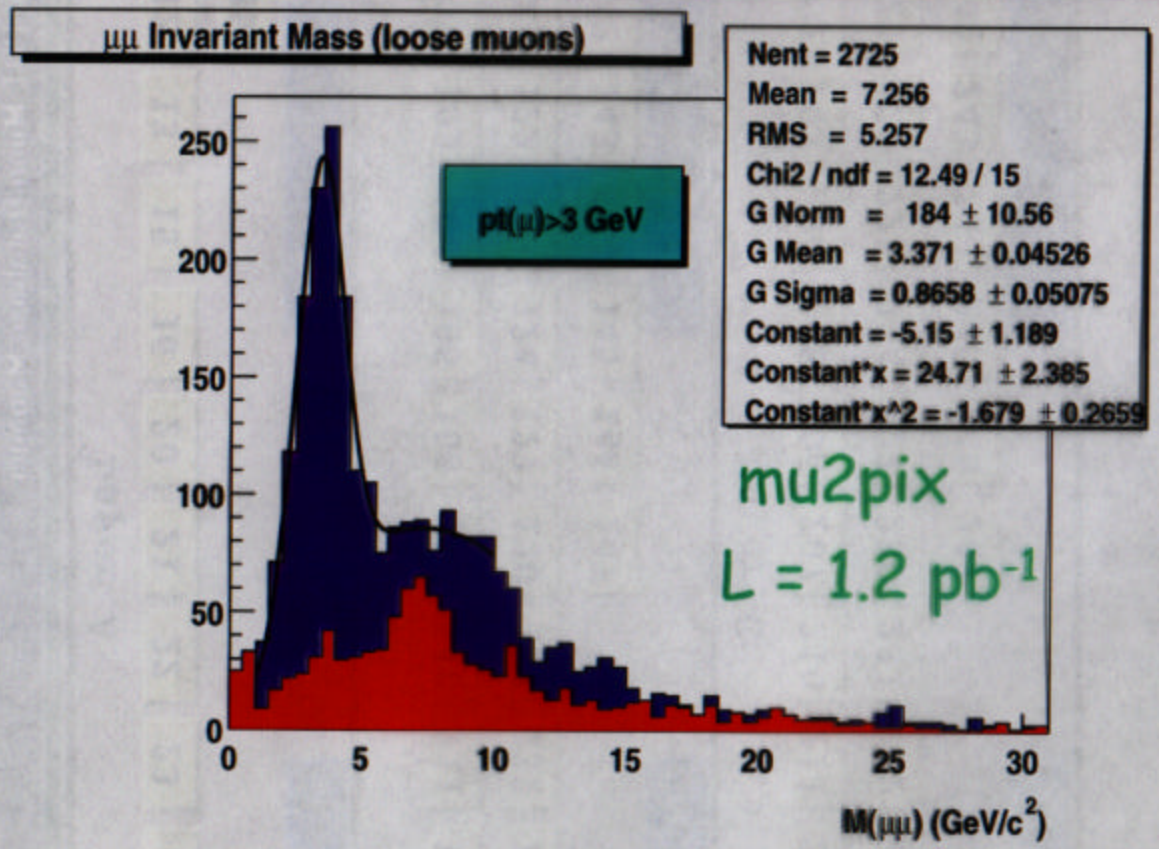
for J/ψ with both outcoming muons: Pt >3 GeV, 1<|η|<2

	Estimation	Error (stat)
candidates	795	8%
acceptance	~~0.73~~ 0.67	~~11%~~ 4 %
trigger	0.73	19%
reconstruction	0.41	24%
luminosity	1.2 pb^{-1}	20%
cross-section	2948 pb	39%

hyp: mu1pix 100%

??

Trigger Efficiency (2)



- ~ 1 Mevts processed: 2 loose reco muons without any scint. requirement
- hyp: all mu2pix would have fired mu1pix

$$\varepsilon_{mu2pix} = \frac{N_{mu2pix}}{N_{mu2pix} + \sum_i P_i \, N^i_{mu1pix}}$$

ε(mu2pix): 0.73 ± 0.14

Comparison with Theoritical Prediction

for J/ψ with both outcoming muons: Pt >3 GeV, $1<|\eta|<2$

- from Andrzej:

→ J/ψ from b → $\mu\mu$: 535 pb
→ prompt production: 1735 pb

} total: 2270 pb ± 15%

gluon fragmentation, gluon fusion, χ, ...

CDF measurement: 12%
Extrapolation to 2 TeV: 8%
MC statistics: 8%

Normalized to CDF RunI measurement: PRL 79,572 (1997)

- data:

→ LL: 2948 pb ± 39%

THEORY PREDICTIONS

- $b \to J/\psi + X$

$\frac{d\sigma}{dp_T^b}$ ← NLO QCD (MNR)

decay ISAJET 7.37

normalization: CDF $\sigma(p\bar{p} \to J/\psi X) \cdot BR = 17.4 \pm 0.1$ nb
$\times(1.2)$

$p_T^{J/\psi} > 5$ GeV, $|\eta^{J/\psi}| < 0.6$

$f_b = 19.2 \pm 0.2 \pm 0.4\%$

- prompt production

color octet model fit to CDF data

⇓ Cho, Leibovich

$\frac{d^2\sigma}{dp_T^{J/\psi}\, d\eta^{J/\psi}}$ ← histograms from Rick Jesik

decay } as above
normalization } $(1 - f_b)$

Color-Octet Model of Charmonium Production

- Braaten and Fleming added $Q\bar{Q}$ pair in a color octet state to the ONIUM cross section calculation.

  Braaten and Fleming, PRL 74, 3327(1995)

- Non-perturbative evolution into the color singlet state through soft gluon emission.

- Three non-perturbative matrix elements extracted from the fit to the CDF data on direct J/ψ ($\psi(2s)$) production:

$$M(^3P_1^{(8)})\ ;\ M(^1S_0^{(8)})\ ;\ M(^3S_1^{(8)})$$

  p_T dependence of the short distance coefficients corresponding to the $M(^3P_1^{(8)})$ and $M(^1S_0^{(8)})$ channels is identical. Fragmentation type contributions present in the $M(^3S_1^{(8)})$ channel only.

  Cho and Leibovich, PRD 53, 6203(1996)

- Other tests of NRQCD
  - COM predicts J/ψ from $g \to J/\psi X$ to be produced in the transversely polarized state.
  - charmonium production at fixed target energies
  - inclusive J/ψ production at HERA
  - prompt J/ψ production at LEP
  - associated production of a $J/\psi + \gamma$, double J/ψ production

- Recent review of theoretical issues:

  K. Sridhar, Hadron Collider Physics, Mumbai, India, January 1999

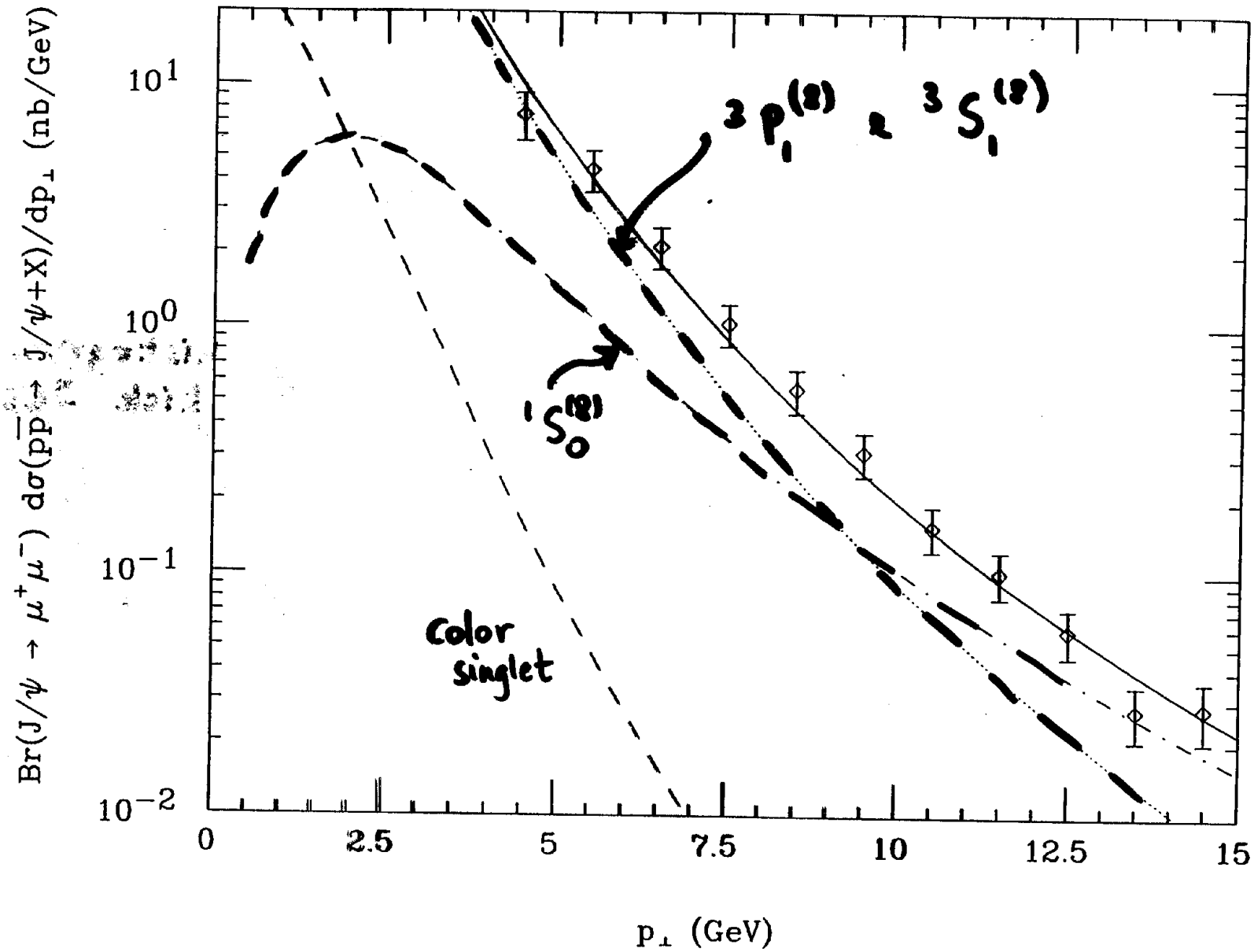
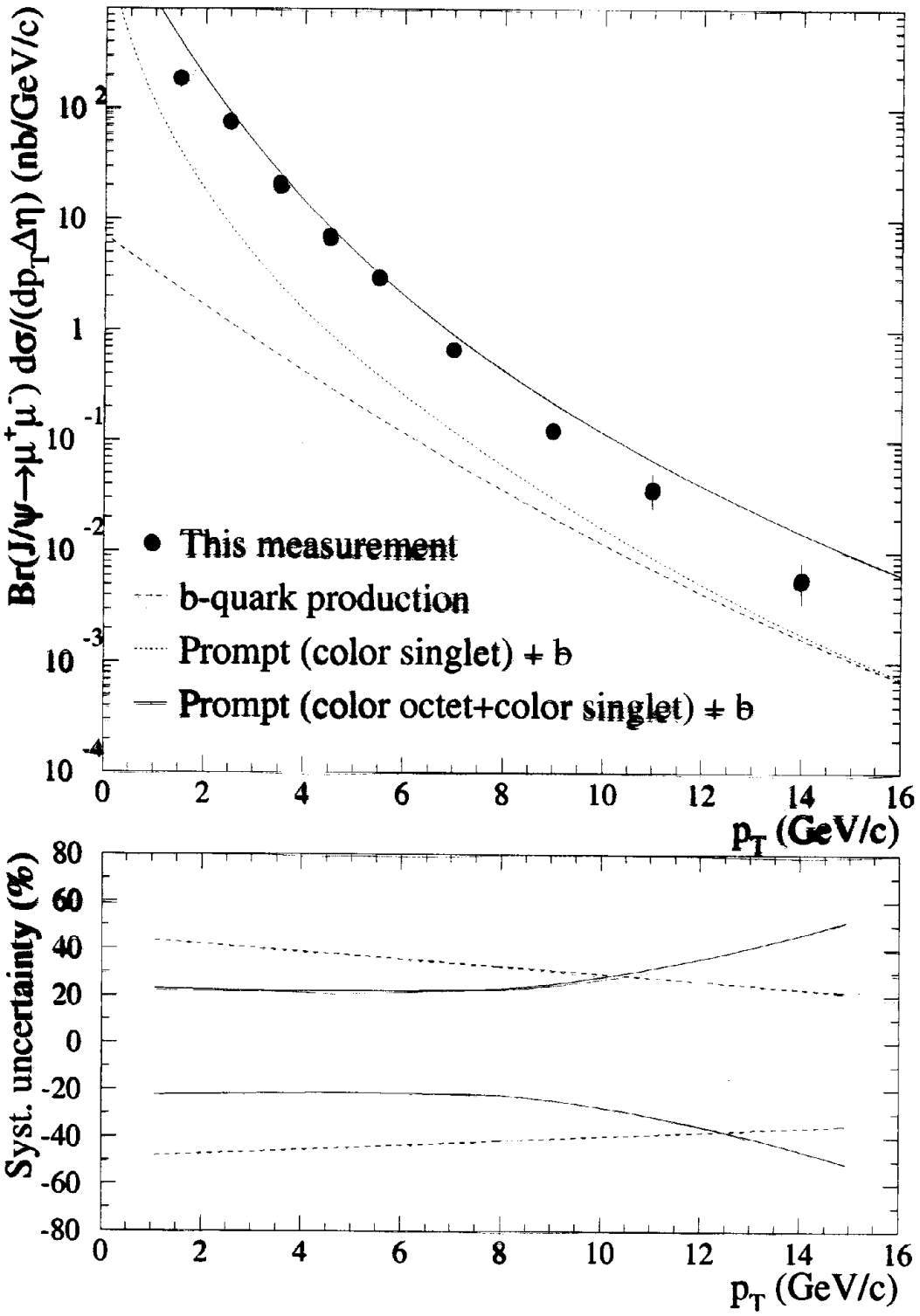


Figure 6

hep-ph/9511315 v2 8 Apr 96

p_T Dependence of Forward J/ψ Production



RELATIVE EXPECTATIONS FOR FORWARD & CENTRAL J/ψ s

- CROSS SECTIONS

	$p_T^\mu > 3$ GeV; $1<\lvert\eta^\mu\rvert<2$	$p_T^\mu > 3.5$ GeV, $\lvert\eta^\mu\rvert < 0.6$, ϕ cut
b prod	535 pb	250 pb
prompt	1735 pb	460 pb
	2270 pb	710 pb

← A FACTOR of 3 →

- MONTE CARLO (Stefan S) lidusey1 • 3

72 evts	11 evts

- POST SHUT DOWN DATA

$$\sim \underset{\pm 40}{600} : \underset{\pm 8}{30} \approx 20 \pm 7$$

However pre shutdown } $\varepsilon_{TT}^{FAM} \simeq 4 \times \varepsilon_{TT}^{WAM}$ (based on oct 1 & 2)