Measurement of the Run-II Inclusive J/ψ Cross-section Blessing Part II

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CDFNOTE 6288

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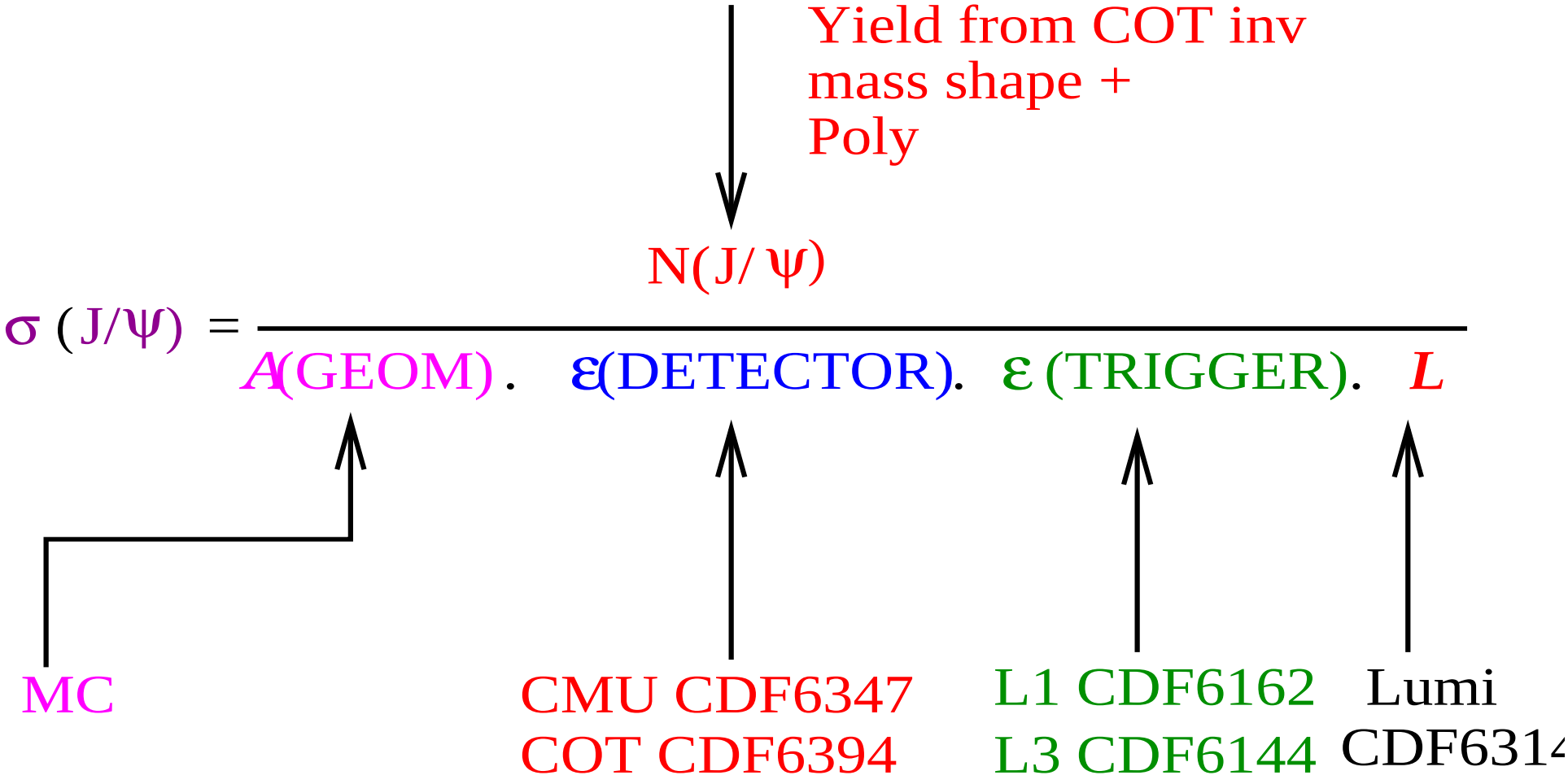
Measuring $\sigma(p\bar{p} \to J/\psi X).Br(J/\psi \to \mu\mu)$



The differential cross-section is measured in 30 $p_T(J/\psi)$ bins from 0 - 17 GeV/c.

New Reco. Efficiencies

J/ψ Selection	Efficiency	Reference
L1/L3&Offline	$\epsilon^{\mu}_{L1} = (0.9774 \pm 0.0020) freq\left(\frac{(1.10\pm0.11)-1/p_T}{(0.390\pm0.085)}\right)$	CDFNOTE 6162
$\chi^2(\Delta r\phi)_{CMU} < 9$	$\epsilon_{\chi^2} = (1.0018 \pm 0.0003) - (0.0024 \pm 0.0001)p_T$	CDFNOTE 6114
L3&Offline/Offline	$\epsilon^{\mu}_{L3} = 0.997 \pm 0.001(stat) \pm 0.002(syst)$	CDFNOTE 6144
COT Offline	$\epsilon_{COT}(p^{\mu}_T > 1.5\text{GeV/c}) = 99.68 \pm 0.04^{+0.21}_{-0.87}\%$	CDFNOTE 6394
	(was $100 \pm 0.0\%$)	
Muon Offline	$\epsilon_{CMU} = 98.6 \pm 0.3 \pm 1.0\%$	CDFNOTE 6347
	(was $98.4 \pm 0.9 \pm 0.2\%$)	
$z_0(\mu) < 90cm$	$\epsilon_{z0} = 99.43 \pm 0.16\%$	J/ψs muons
$\lvert z_{0\mu_1} - z_{0\mu_2}\rvert < 5$ cm	$\epsilon_{\Delta z} = 1.0013 \pm 0.0011$	D. Litvintsev

$$\epsilon_{rec} = \epsilon^2_{COT} \cdot \epsilon^2_{CMU} \cdot \epsilon^2_{L3} \cdot \epsilon_{z_0} \cdot \epsilon_{\Delta_z} = 95.6^{+2.1}_{-2.7}\% \ (\ was\ 95.8 \pm 1.9\%)$$

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Q1: Value of x-sec in 0-0.25 GeV/c bin

Q1: Why is the first point on the $d\sigma/dp_T$ low?

A1: The generated pt spectrum is reweighed to match the x-section shape to obtain a systematic uncertainty. We find a 3% contrubution. Found weight function was -ve in the lowest bin. Larger MC statistics were generated and smaller pt bin sizes used to calculate acceptance. Finer binning $\Leftrightarrow$ same as reweighing input spectrum.

p_T bin size (MeV/c)	$d\sigma/dp_T$ from 0.0-0.25 GeV/c
50 (new)	9.1 (new)
100	9.0
200	8.4
250* (bless)	7.2 (bless)

Systematic uncertainty of 30% (instead of 3%) in lowest bin in x-section. Total cross-section increased by 1%

Updated syst uncertainties BLESS

Source	Systematic uncertainty
J/ψ Polarization	$\pm 4 - 10\%$ (p_T dependent)
J/ψ Spectrum*	$\pm 3 - 30\%$ (p_T dependent)
SVXII material	-3% *to* $+6\%$ (p_T dependent)
L1 trigger efficiency	-7.0% *to* $+13\%$ (p_T dependent)
Mass fits	-0.7% *to* $+13\%$ (p_T dependent)
Momentum scale !	-0.08% *to* $+0.7\%$ (p_T dependent)
Luminosity*	$\pm 5.9\%$
Reconstruction eff.*	$+2.1\ -2.7\%$
CMU Simulation	$\pm 1.4\%$
Data quality (bad runs)	$\pm 1.0\%$
L1 trigger efficiency !	$\pm 0.2\%$
Total	$^{+6.5}_{-6.7}\% \oplus \epsilon(p_T^{J/\psi})$

* Updated

! Included in measurement but were not listed before

Q2: Propagation of errors

Q2: How are the errors on the total crossection propagated?

Blessing Part I: The total crosssection is a sum of the cross-sections in each pt bin. The momentum dependent systematic and statistical uncertainties were treated as *uncorrelated* and added in quadrature for the blessing:

$$\sigma(p\bar{p} \to J/\psi X, \mid y(J/\psi) \mid < 0.6) \cdot Br(J/\psi \to \mu\mu) = 239.2 \pm 1.5(stat)^{+8.3 \oplus 14.6}_{-6.4 \oplus 14.6}(syst)$$

Seperate correlated from uncorrelated: Since *some* of the p_T dependant systematic uncertainties are *correlated*, the most conservative estimate of the systematic error on the total cross-section is the straight sum of the pt dependant uncertainties $\oplus$ p_T independent uncertainty :

$$\epsilon^{stat}_{tot\ \sigma.Br} = \sqrt{\sum_{i=1}^{i=N_{bins}} (\epsilon^{stat}_i)^2} = 1.3 \quad (1)$$

$$\epsilon^{syst}_{tot\ \sigma.Br} = \left\{ \sum_{i=1}^{i=N_{bins}} \epsilon^{syst}_i(p_T) \right\} \oplus^{+15.6}_{-16.1} =^{+34.8}_{-28.2} \quad (2)$$

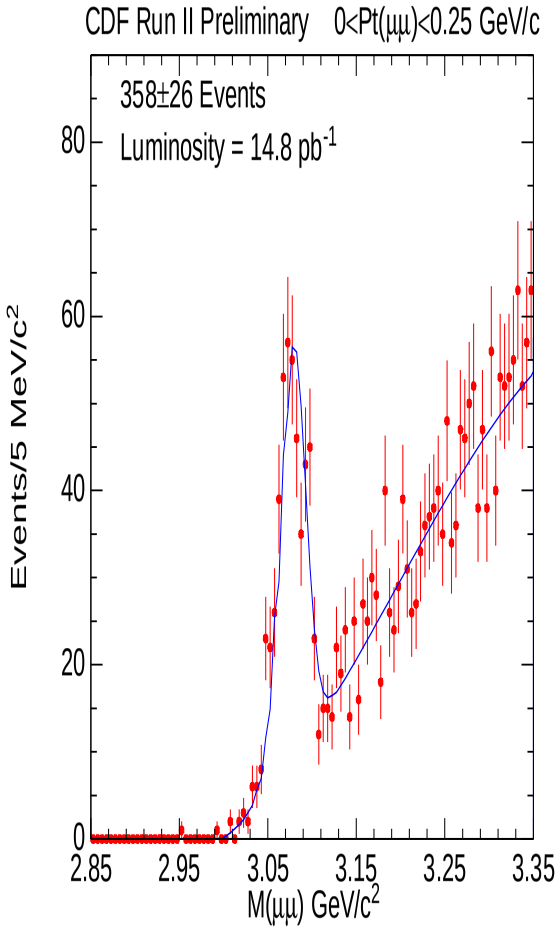
Total Cross-section BLESS

Total crossection was $239.2 \pm 1.5(stat)^{+33.9}_{-27.3}$ is now:

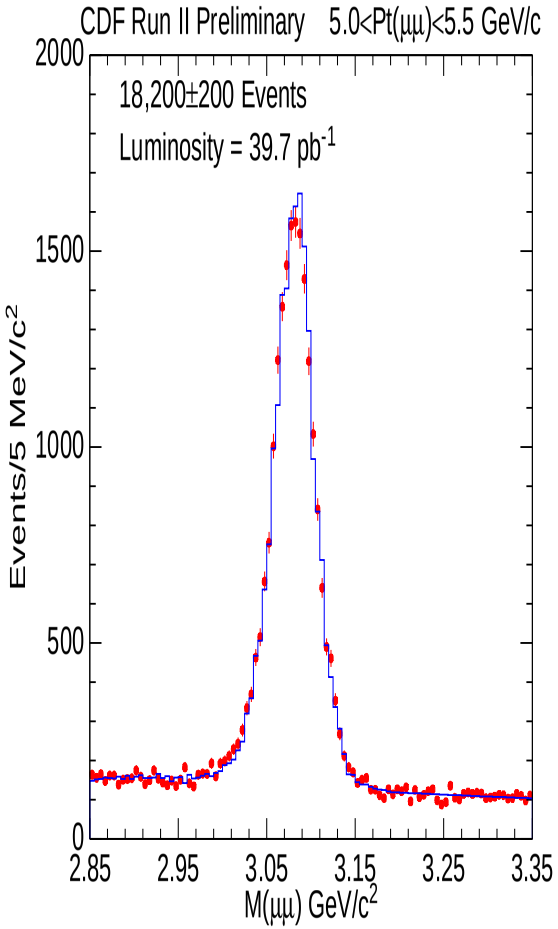
$$\sigma(J/\psi) \equiv \sigma(p\overline{p} \rightarrow J/\psi X, \mid y(J/\psi) \mid < 0.6) = 240 \pm 1(stat)^{+35}_{-28}(syst) \text{ nb}$$

J/ψ Yield - BLESSED

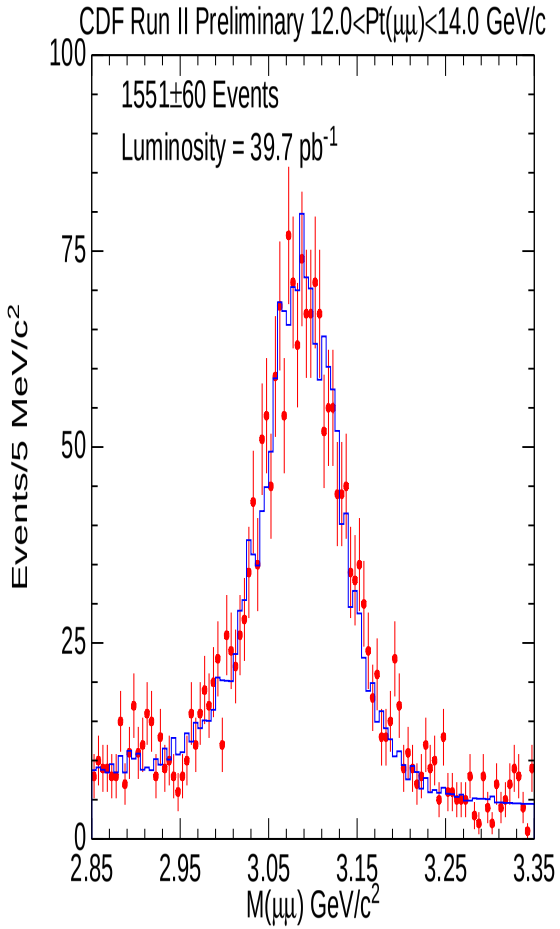
In each momentum bin, use CotSim mass shape + Chebyshev polynomial.



$0 < p_T(J/\psi) < 0.25 GeV/c$

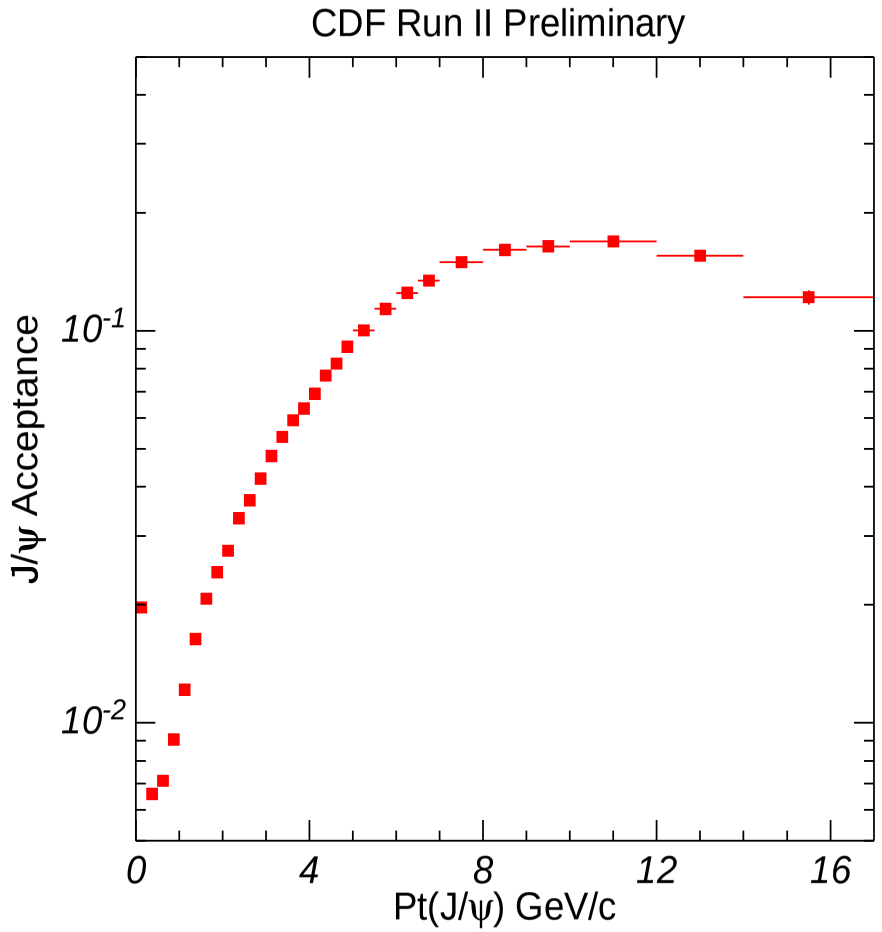


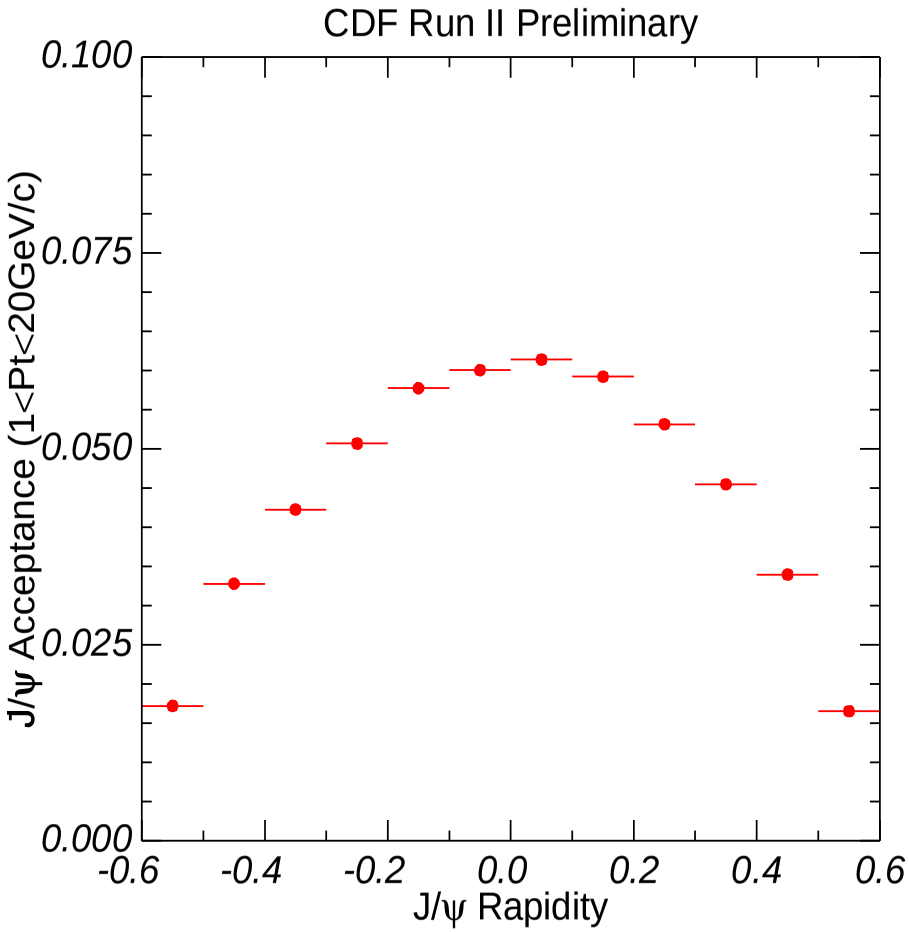
$5.0 < p_T(J/\psi) < 5.5 GeV/c$



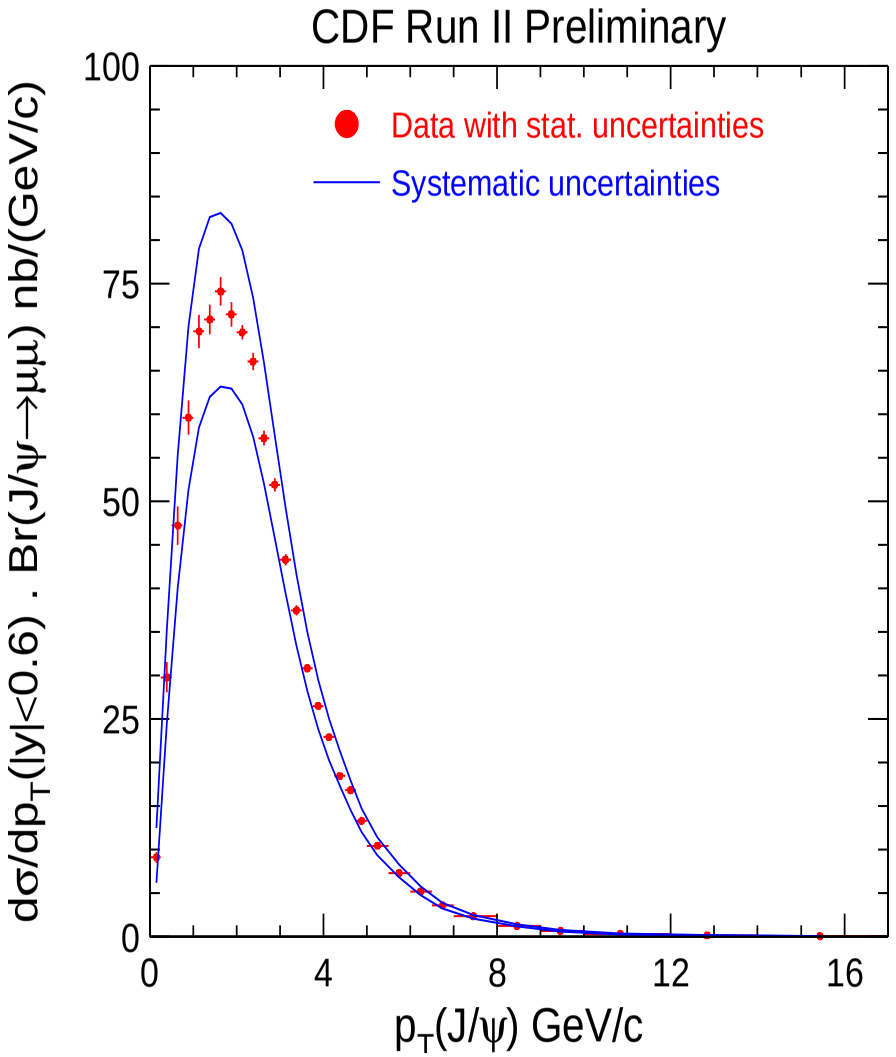
$10.0 < p_T(J/\psi) < 12.0 GeV/c$

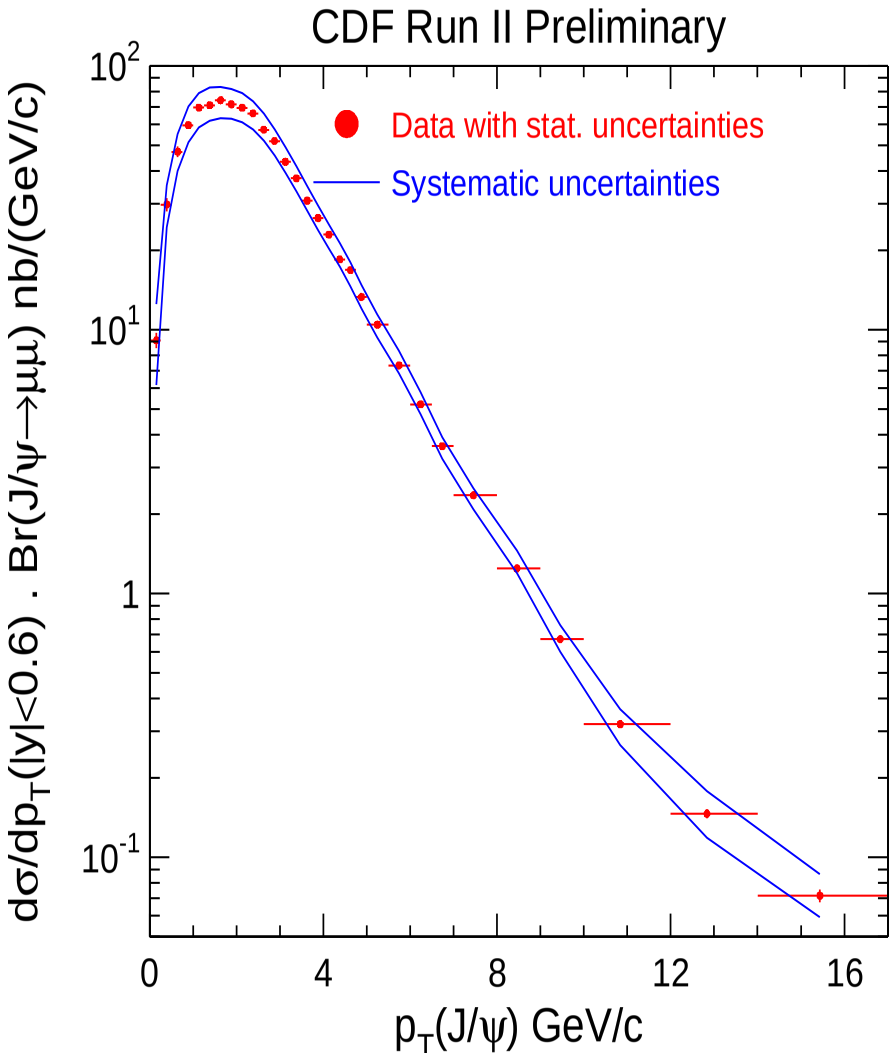
$\mathcal{A}(p_T(J/\psi), |y| < 0.6)$ **BLESSED**



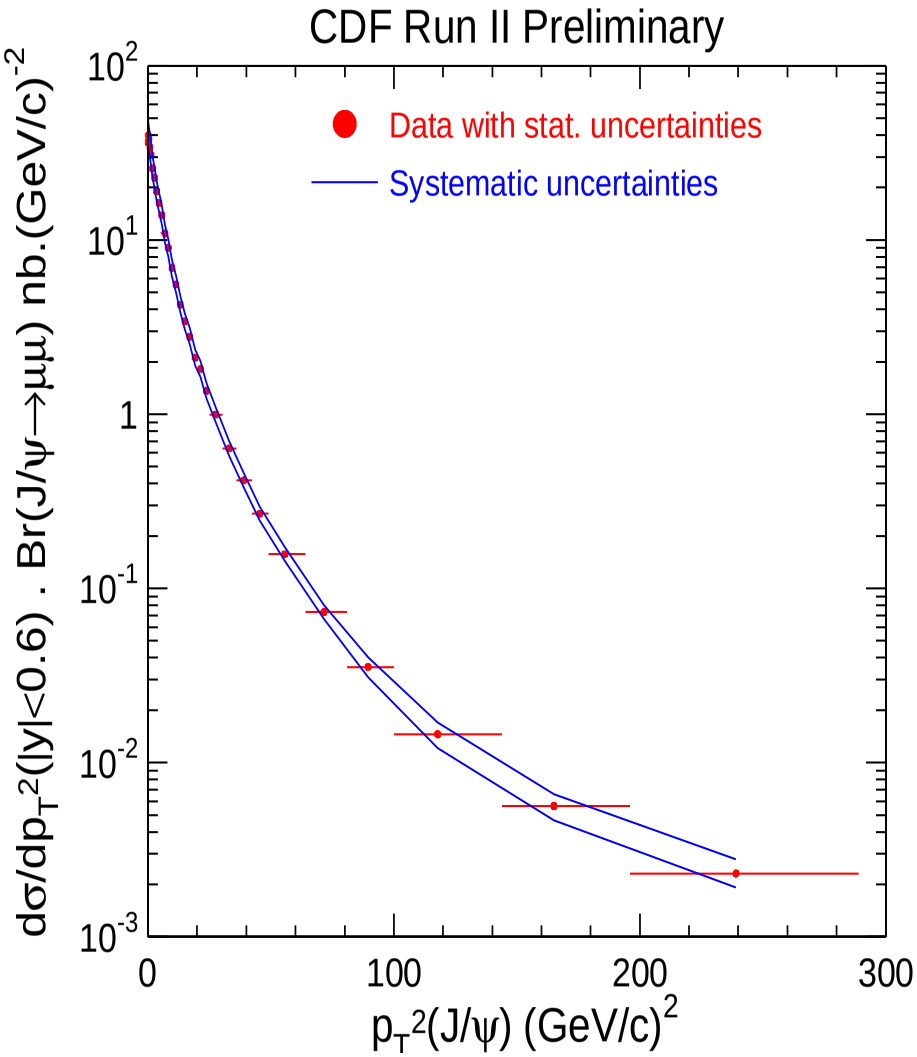


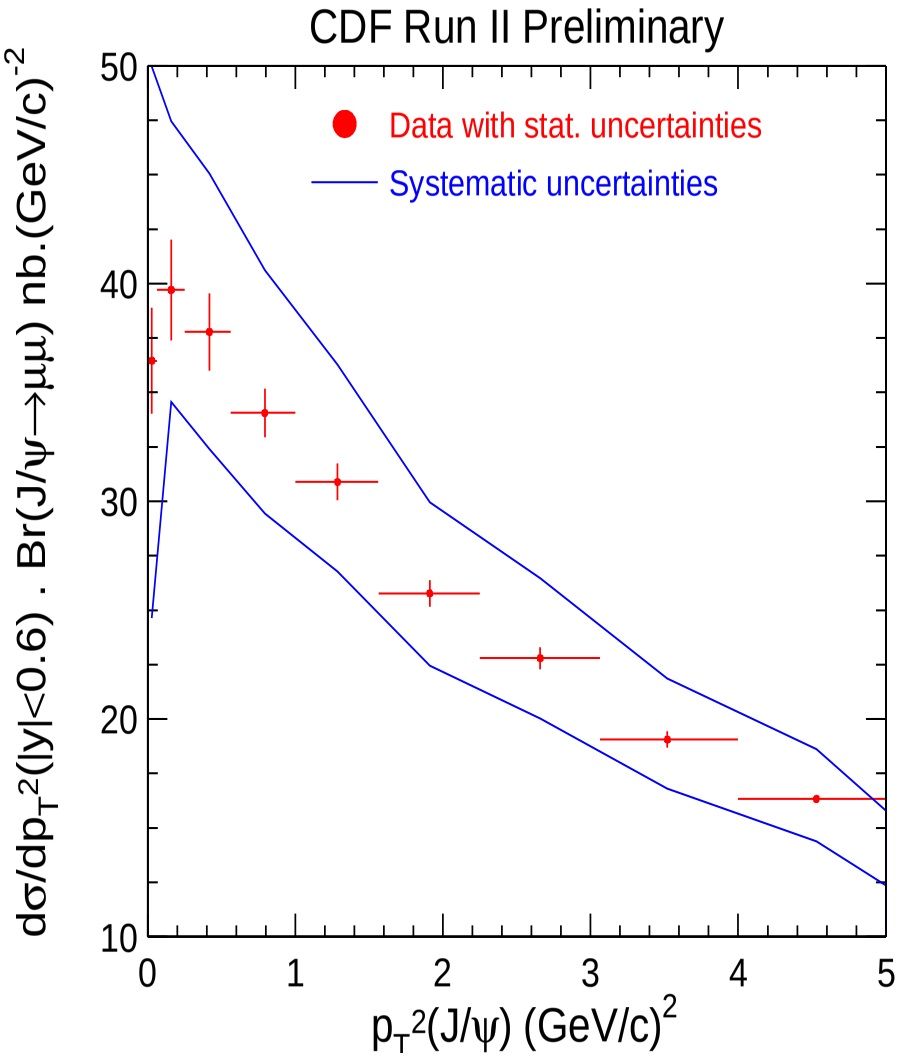
Differential Cross-section - BLESS





Plot of $d\sigma/dp_T^2$ - BLESS





Differential Cross-section Numbers - BLESS

$p_T(J/\psi)$ GeV/c	$< p_T >$ ($< p_T^2 >$)	$\frac{d\sigma}{dp_T} \cdot \mathcal{B}$ nb/(GeV/c)	$\frac{d\sigma}{dp_T^2} \cdot \mathcal{B}$ nb.(GeV/c)$^{-2}$
$0.0 - 0.25$	0.15(0.027)	$9.10 \pm 0.6^{+3.33}_{-2.89}$	$36.5 \pm 2.4^{+13.3}_{-11.6}$
$0.25 - 0.5$	0.39(0.16)	$29.8 \pm 1.7^{+5.48}_{-3.30}$	$39.7 \pm 2.3^{+7.3}_{-4.4}$
$0.5 - 0.75$	0.64(0.42)	$47.2 \pm 2.2^{+8.56}_{-5.9}$	$37.8 \pm 1.8^{+6.9}_{-4.8}$
$0.75 - 1.0$	0.89(0.79)	$59.6 \pm 2.0^{+10.8}_{-7.0}$	$34.1 \pm 1.1^{+6.2}_{-4.0}$
$1.0 - 1.25$	1.13(1.29)	$69.5 \pm 1.9^{+11.2}_{-8.0}$	$30.9 \pm 0.9^{+5.0}_{-3.6}$
$1.25 - 1.5$	1.38(1.91)	$70.9 \pm 1.7^{+10.6}_{-7.8}$	$25.8 \pm 0.6^{+3.8}_{-2.8}$
$1.5 - 1.75$	1.63(2.66)	$74.1 \pm 1.6^{+10.9}_{-7.5}$	$22.8 \pm 0.5^{+3.4}_{-2.3}$
$1.75 - 2.0$	1.87(3.52)	$71.5 \pm 1.4^{+9.4}_{-7.0}$	$19.1 \pm 0.4^{+2.5}_{-1.9}$
$2.0 - 2.25$	2.13(4.53)	$69.4 \pm 0.8^{+8.6}_{-6.8}$	$16.3 \pm 0.2^{+2.0}_{-1.6}$

Differential Cross-section Numbers - BLESS

$p_T(J/\psi)$ GeV/c	$< p_T >$ ($< p_T^2 >$)	$\frac{d\sigma}{dp_T} \cdot \mathcal{B}$ nb/(GeV/c)	$\frac{d\sigma}{dp_T^2} \cdot \mathcal{B}$ nb.(GeV/c)$^{-2}$
$2.25 - 2.5$	$2.38(5.65)$	$66.0 \pm 1.0^{+7.8}_{-5.9}$	$13.9 \pm 0.2^{+1.6}_{-1.2}$
$2.5 - 2.75$	$2.62(6.89)$	$57.2 \pm 0.9^{+6.4}_{-4.9}$	$10.9 \pm 0.2^{+1.2}_{-0.93}$
$2.75 - 3.0$	$2.87(8.26)$	$51.9 \pm 0.8^{+5.5}_{-4.3}$	$9.03 \pm 0.13^{+0.96}_{-0.74}$
$3.0 - 3.25$	$3.12(9.76)$	$43.3 \pm 0.7^{+4.4}_{-3.4}$	$6.93 \pm 0.11^{+0.70}_{-0.55}$
$3.25 - 3.5$	$3.38(11.4)$	$37.5 \pm 0.8^{+3.7}_{-2.9}$	$5.55 \pm 0.09^{+0.54}_{-0.43}$
$3.5 - 3.75$	$3.62(13.1)$	$30.8 \pm 0.5^{+2.9}_{-2.3}$	$4.25 \pm 0.07^{+0.40}_{-0.32}$
$3.75 - 4.0$	$3.87(15.0)$	$26.5 \pm 0.4^{+2.4}_{-1.9}$	$3.42 \pm 0.06^{+0.31}_{-0.25}$
$4.0 - 4.25$	$4.12(17.0)$	$22.9 \pm 0.4^{+2.1}_{-1.7}$	$2.78 \pm 0.05^{+0.25}_{-0.21}$
$4.25 - 4.5$	$4.38(19.2)$	$18.5 \pm 0.3^{+1.7}_{-1.4}$	$2.11 \pm 0.04^{+0.19}_{-0.15}$
$4.5 - 4.75$	$4.62(21.4)$	$16.8 \pm 0.3^{+1.5}_{-1.2}$	$1.82 \pm 0.03^{+0.16}_{-0.13}$
$4.75 - 5.0$	$4.88(23.8)$	$13.3 \pm 0.3^{+1.1}_{-0.9}$	$1.36 \pm 0.03^{+0.12}_{-0.09}$

Differential Cross-section Numbers - BLESS

$p_T(J/\psi)$ GeV/c	$< p_T >$ ($< p_T^2 >$)	$\frac{d\sigma}{dp_T} \cdot \mathcal{B}$ nb/(GeV/c)	$\frac{d\sigma}{dp_T^2} \cdot \mathcal{B}$ nb.(GeV/c)$^{-2}$
$5.0 - 5.5$	$5.24(27.5)$	$10.4 \pm 0.15^{+0.9}_{-0.71}$	$0.995 \pm 0.014^{+0.082}_{-0.068}$
$5.5 - 6.0$	$5.74(33.0)$	$7.32 \pm 0.12^{+0.58}_{-0.48}$	$0.636 \pm 0.010^{+0.050}_{-0.042}$
$6.0 - 6.5$	$6.24(38.9)$	$5.21 \pm 0.09^{+0.39}_{-0.33}$	$0.417 \pm 0.0074^{+0.031}_{-0.026}$
$6.5 - 7.0$	$6.74(45.5)$	$3.62 \pm 0.07^{+0.26}_{-0.22}$	$0.268 \pm 0.0052^{+0.019}_{-0.016}$
$7.0 - 8.0$	$7.45(55.7)$	$2.36 \pm 0.04^{+0.16}_{-0.14}$	$0.157 \pm 0.0025^{+0.011}_{-0.009}$
$8.0 - 9.0$	$8.46(71.6)$	$1.24 \pm 0.03^{+0.08}_{-0.07}$	$0.0732 \pm 0.002^{+0.005}_{-0.004}$
$9.0 - 10.0$	$9.46(89.5)$	$0.672 \pm 0.018^{+0.077}_{-0.074}$	$0.0354 \pm 0.001^{+0.004}_{-0.004}$
$10.0 - 12.0$	$10.8(118)$	$0.320 \pm 0.009^{+0.051}_{-0.050}$	$0.0145 \pm 0.0004^{+0.0023}_{-0.0023}$
$12.0 - 14.0$	$12.8(165)$	$0.146 \pm 0.006^{+0.023}_{-0.023}$	$0.0056 \pm 0.0002^{+0.0009}_{-0.0009}$
$14.0 - 17.0$	$15.4(239)$	$0.072 \pm 0.004^{+0.014}_{-0.011}$	$0.0023 \pm 0.0001^{+0.0005}_{-0.0004}$
$17 - 20.0$	$18.5(343)$	< 0.07	< 0.002

Systematics listed are p_T dependent systematic uncertainties only.