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

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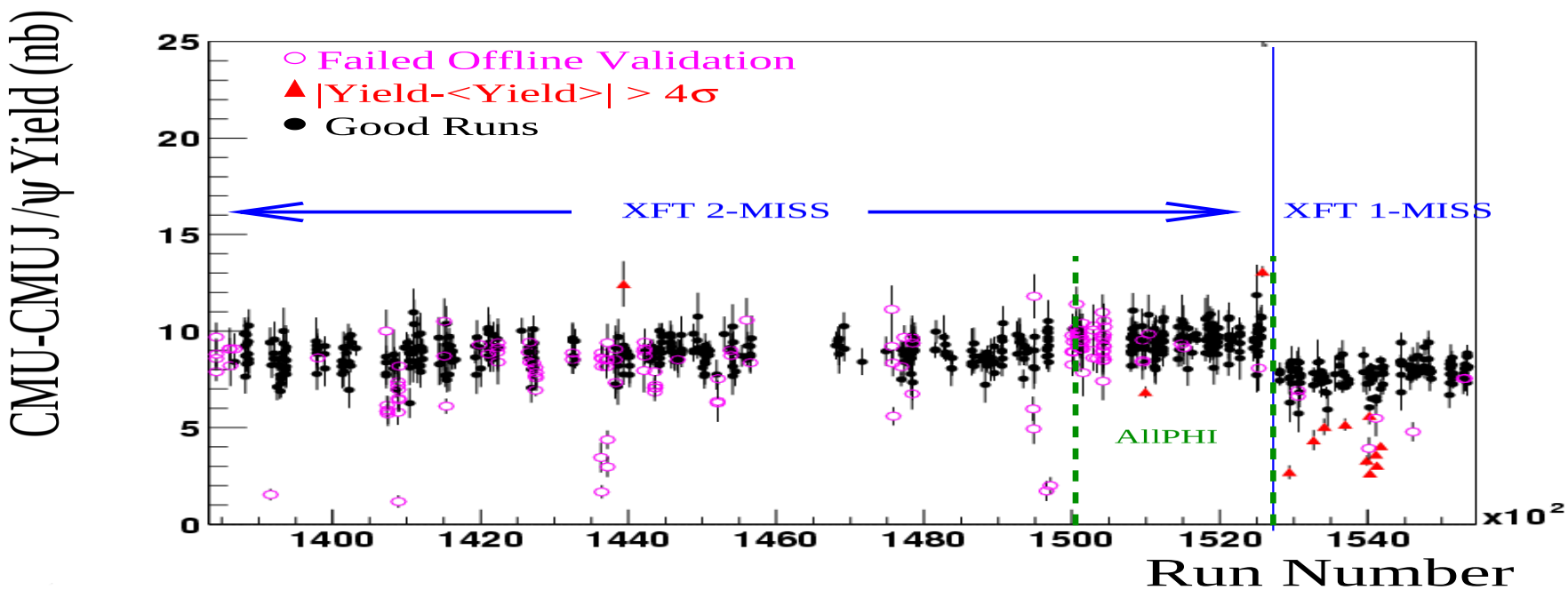
CDFNOTE 6288

B Group Meeting, 02/13/2003

Q1: Good Run Selection

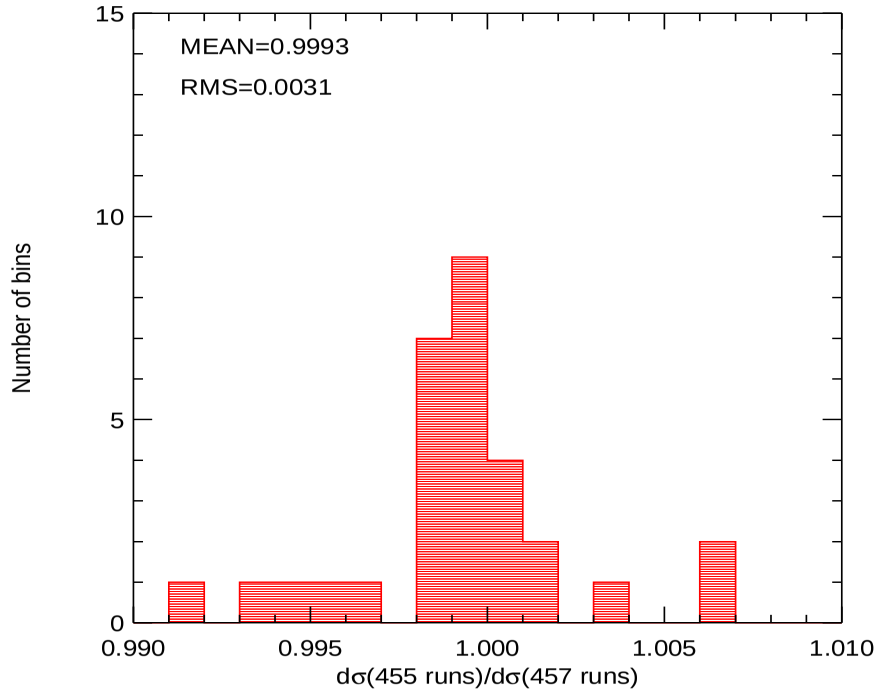
Christoph, Marjorie, William T: Excluding runs based on J/ψ yield will bias cross-section.

Good run updates from validation groups - picked up more good runs. Three out of five runs (at preblessing) with bad J/ψ yields are now known to be bad independently.



Q1: Good Run Selection

Chauvenets criterion: 0.03 runs expected to have yields $> 4\sigma$ from average in 457 runs. Two runs left. Recommendation from statistics group - assign systematic error on xsection from difference with and without "suspicious runs"



Variation in all 30 pt bins used for the cross-section is within $\pm 1\%$

Q2: Uncertainty on Lumi

Tony Liss: At last week's Joint Physics meeting we preblessed the ppbar inelastic cross section for use in the luminosity and it's uncertainty. They will be blessed, hopefully in two weeks. The CDF note number for the preblessing is 6314 . [If you want to use these numbers] please make sure that the central value of your lum is consistent with the 6% [add +1.9%] and make sure everyone knows what you've done and that it may yet change. I know it's not that big a deal, I'm just worried that with so little time if we're not careful we'll end up with at least two sets of numbers out there.

Used $39.0(DFC) \times 0.019 = 39.7 \pm 2.3$ pb^{-1}

Q3: Reco. Efficiencies

Error in calculation of J/ψ reco efficiency fixed. COT reco eff. set to $100 \pm 0\%$ (Marjorie) until further notice.

J/ψ Selection	Efficiency	Reference
L1/L3&Offline	$\epsilon^{\mu}_{L1} = (0.9774 \pm 0.0020) freq \left(\frac{(1.10 \pm 0.11) - 1/p_T}{(0.390 \pm 0.085)} \right)$	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	$\epsilon_{COT} = 100 \pm 0.0\%$	CDFNOTE 5983
Muon Offline	$\epsilon_{CMU} = 98.4 \pm 0.9 \pm 0.2\%$	CDFNOTE 6029
$z_0(\mu) < 90cm$	$\epsilon_{z0} = 99.43 \pm 0.16\%$	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

$$\epsilon_{rec} = \epsilon^2_{COT} \cdot \epsilon^2_{CMU} \cdot \epsilon^2_{L3} \cdot \underbrace{\epsilon_{z_0}}_{count\ once} \cdot \epsilon_{\Delta_z} = 95.8 \pm 1.9\% (\ was\ 94.7^{+1.5}_{-11}\%)$$

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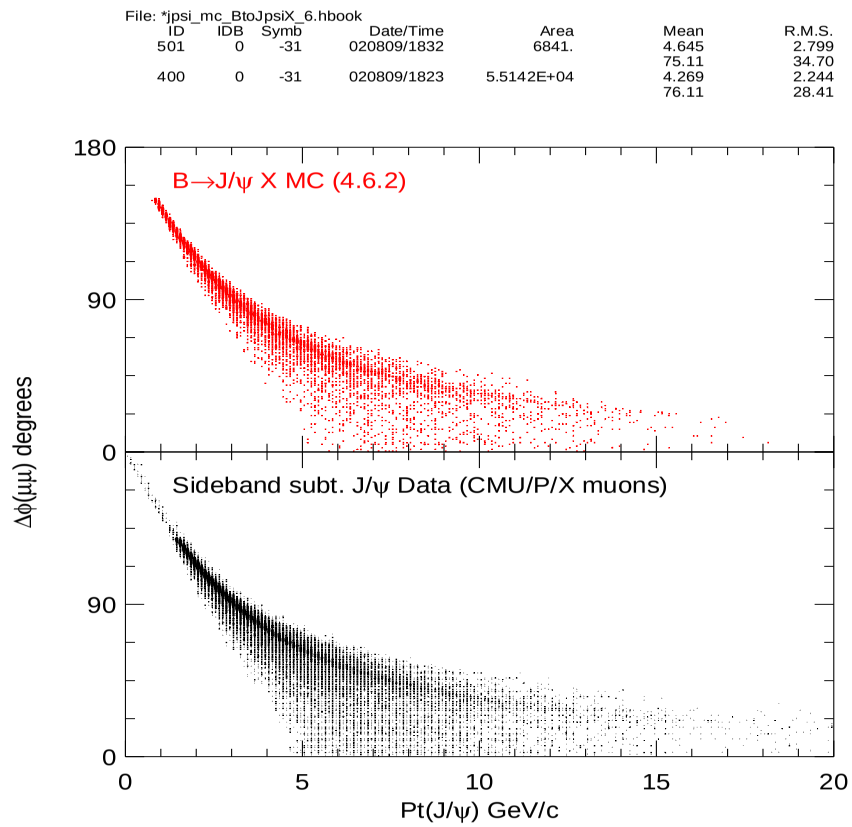
Q4: $\mu - \mu$ Reconstruction Correlations

William T: once you have figured out the individual track uncertainties you simply square them ....at high J/Psi pt it probably becomes a less good assumption. Do you have any plausibility study or quantifiable argument to put a ceiling on the amount of correlation ?

- 2-Tower seperation between stubs $\rightarrow$ no correlation in ϵ_{CMU}.
- For $p_T(J/\psi) < 5$ GeV/c, $\Delta\phi(\mu\mu) > 30^0 \rightarrow$ no correlation in $\epsilon_{COT}^{\mu-track}(p_T(J/\psi) < 5)$
- 2-stub seperation $\rightarrow$ high pt J/ψ muon tracks seperated by $> 5^0$(0.087 radians)



Q5: Calorimeter material uncertainty ?

Marojorie (and Jonathan L.): The number for calorimeter thickness in X0 is missing from the text. Can you put a limit on the size of this effect looking at the distribution of pt of muons that range out ?

After talking with Cal experts, the consensus is the Calorimeter and upstream material should be modeled pretty accurately in the MC. No systematic uncertainty will be assigned from this source unless we have good reason to mistrust the MC - which we dont at the moment.

Q6: J/ψ Alignment and mass line-shape

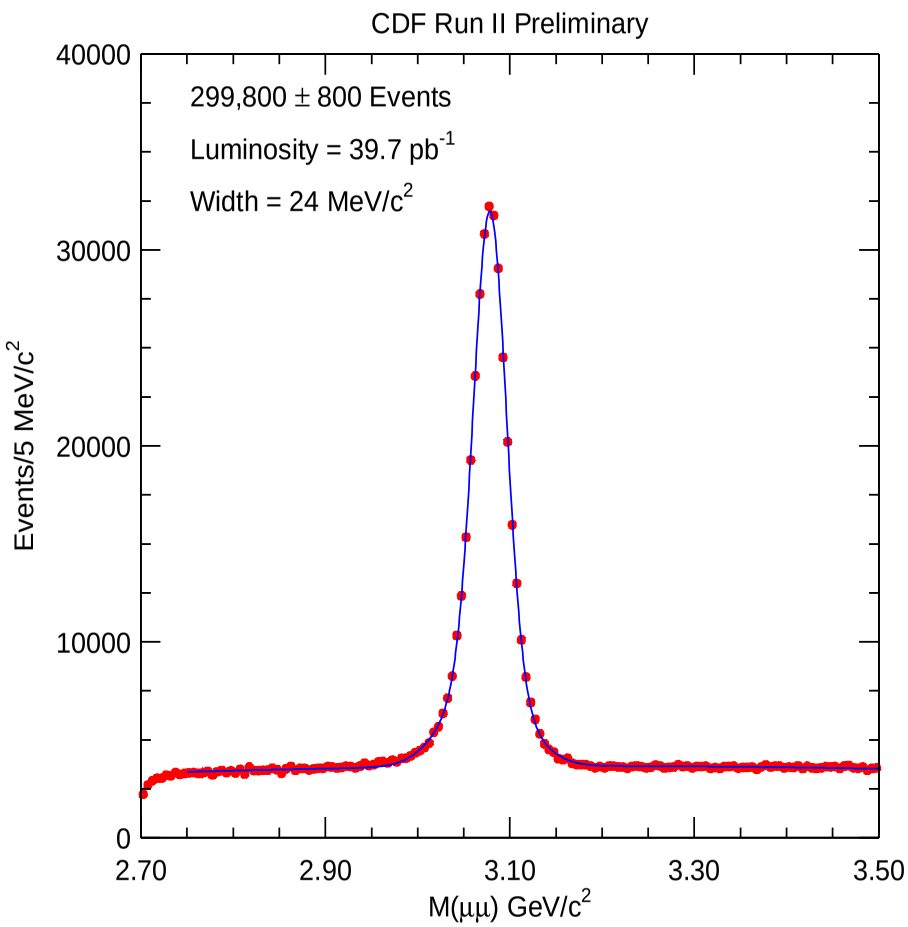
Rick T: How does the psi polarization affect radiation? I presume that the photon originates from an E1 transition in which case, the psi polarization is modified

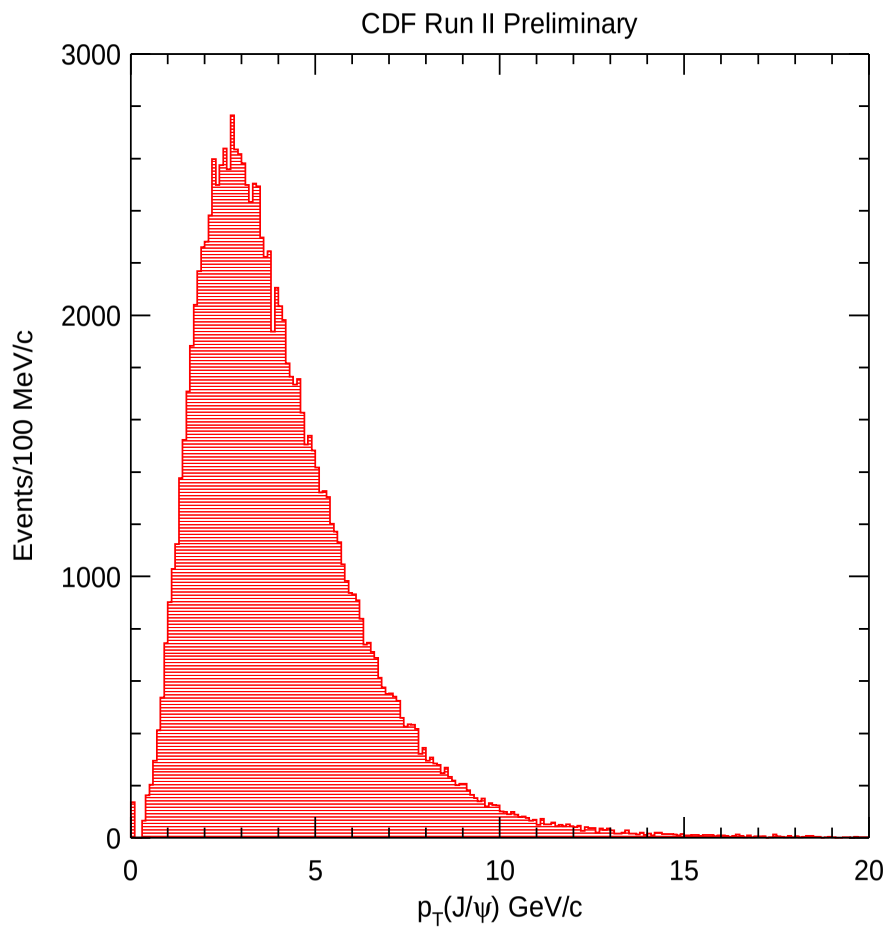
Alignment parameter $\alpha = 0$ was used to obtain the J/ψ mass line shape. Its consistent with Run I data. Systematic uncertaintes from the modeling of the COT resolution and SVXII material to get the line shape mask this effect.

Changes to x-sec since preblessing:

- *Accounting error found in J/ψ event selection = +12% increase in yield*
- Picked up 1pb^{-1} more of good runs.
- COT reconstruction efficiency is not included
- Reweigh 0-3 GeV/c flat MC p_T spectrum to match cross-section distribution and get p_T dependent systematic uncertainty on acceptance. High pt bins as in preblessing.
- Added systematic uncertainty on $p_T(J/\psi) < 3$ GeV/c acceptance from SVXII material accounting.
- "Final" calculations of total p_T dependent systematic uncertainties

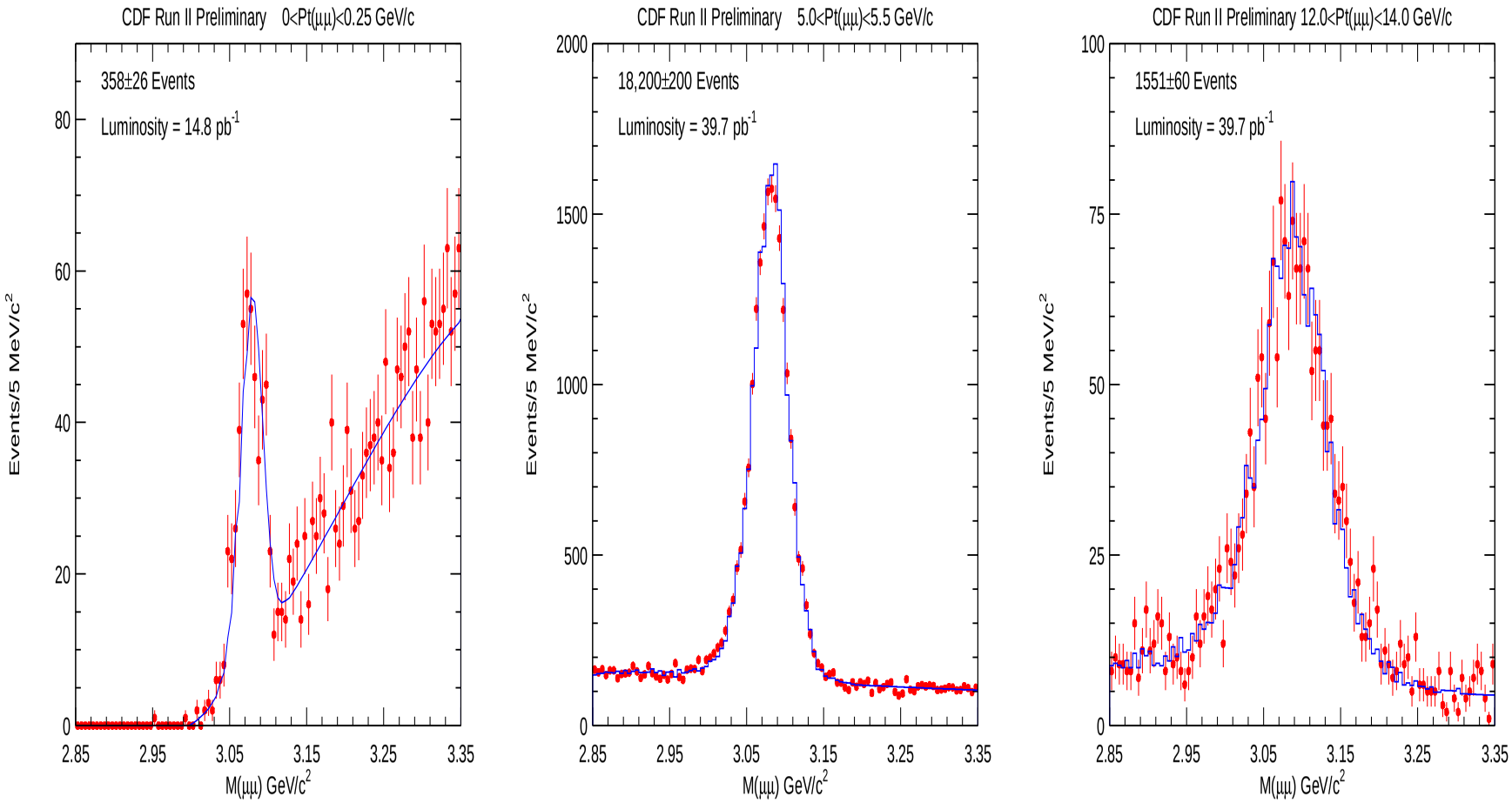
J/ψ yield and p_T - BLESS





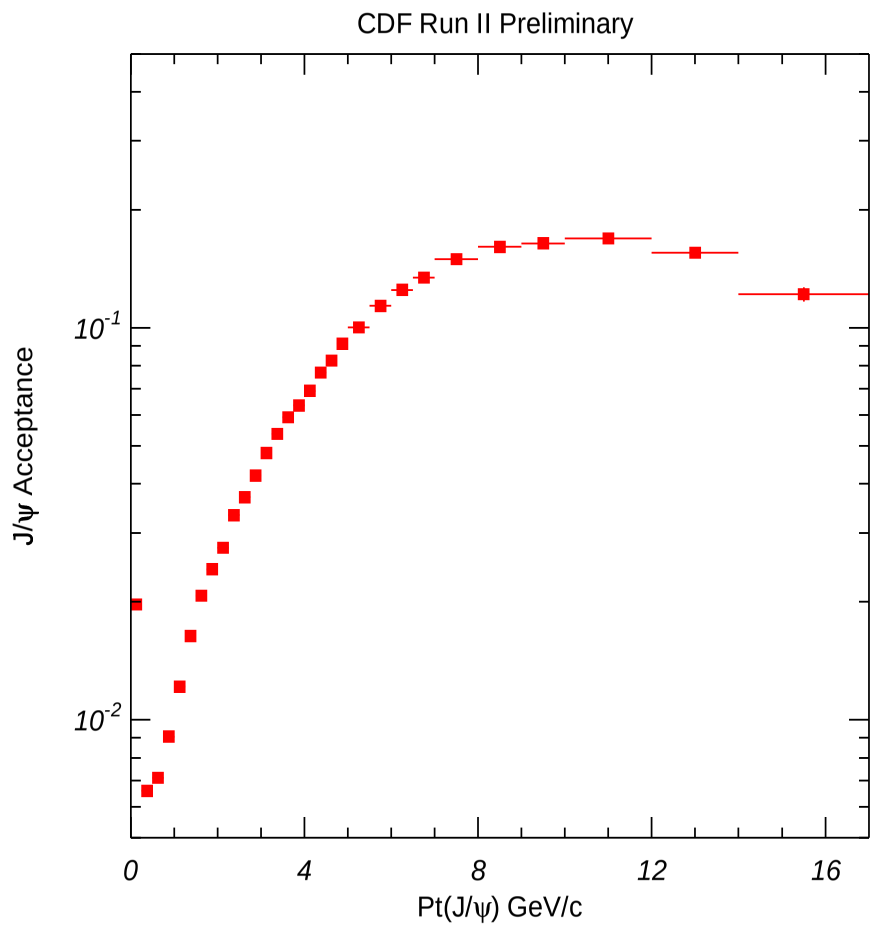
J/ψ Mass fits - BLESS

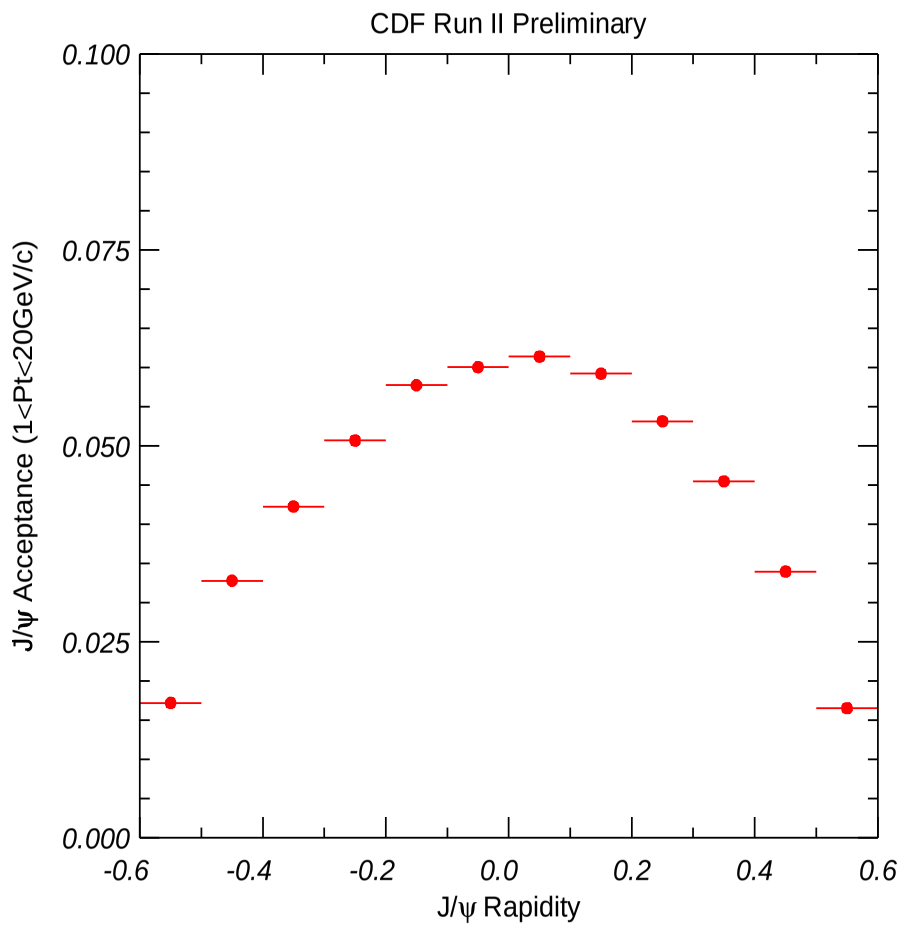
In each momentum bin, use CotSim mass shape + Chebyshev polynomial.



$0 < p_T(J/\psi) < 0.25 GeV/c$ $\quad$ $5.0 < p_T(J/\psi) < 5.5 GeV/c$ $\quad$ $10.0 < p_T(J/\psi) < 12.0 GeV/c$

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

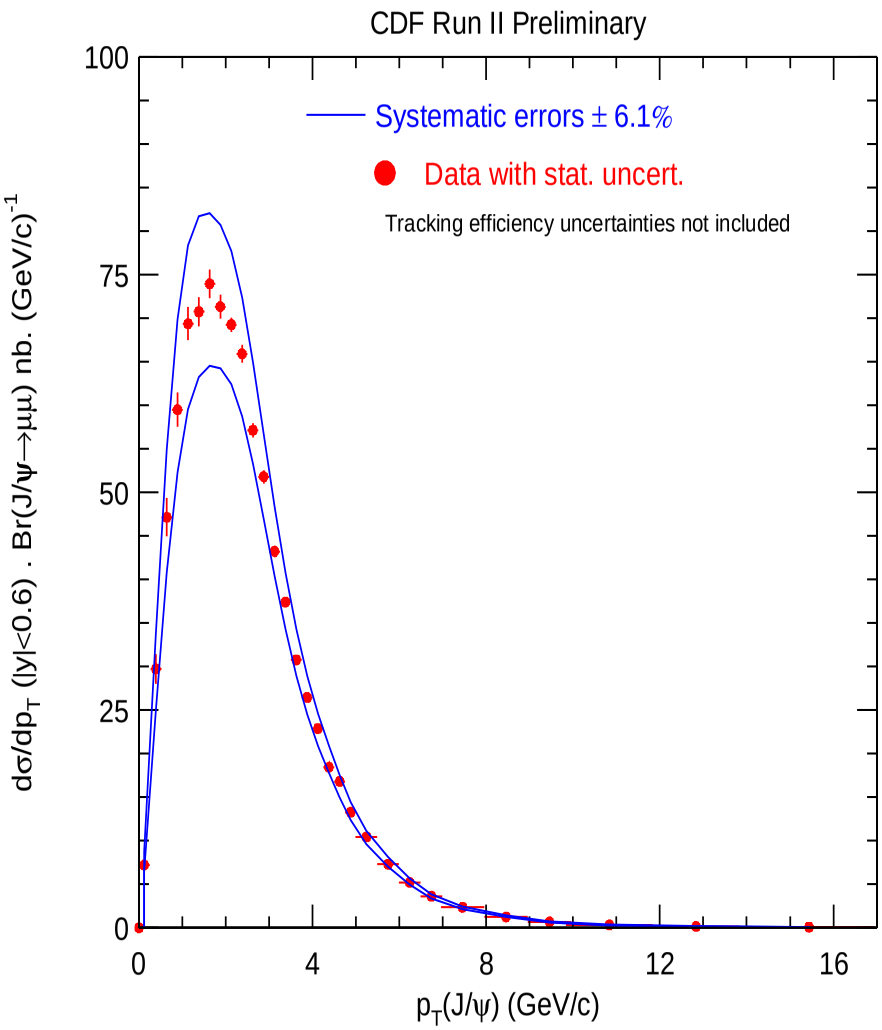


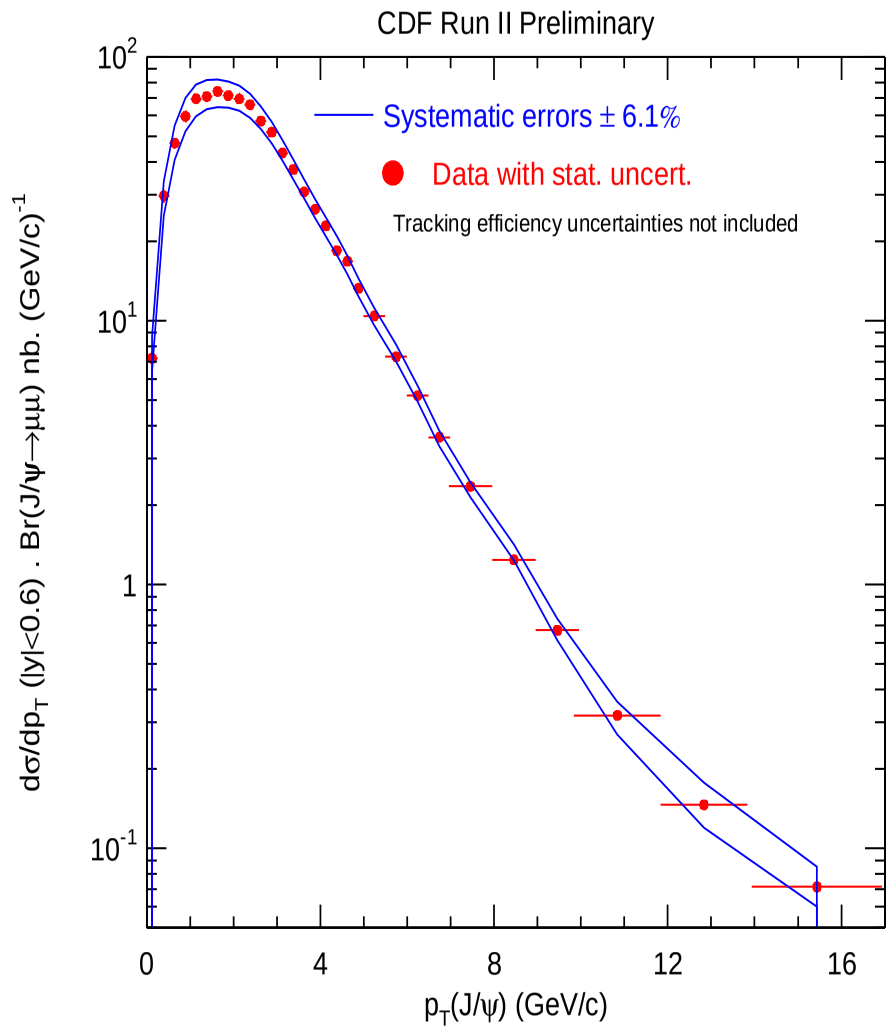


Systematic uncertainties

Source	Systematic uncertainty
J/ψ Polarization	$\pm 4 - 10\%$ (p_T dependent)
J/ψ Spectrum	$\pm 3 - 15\%$ (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)
Luminosity	$\pm 5.8\%$
CMU Simulation	$\pm 1.4\%$
Data quality (bad runs)	$\pm 1.0\%$
Reconstruction eff.	$\pm 0.9\%$
Momentum resolution	$\pm 0.5\%$
Total	$\pm 6.1\% \oplus \epsilon(p_T^{J/\psi})$

Differential Cross-section - BLESS





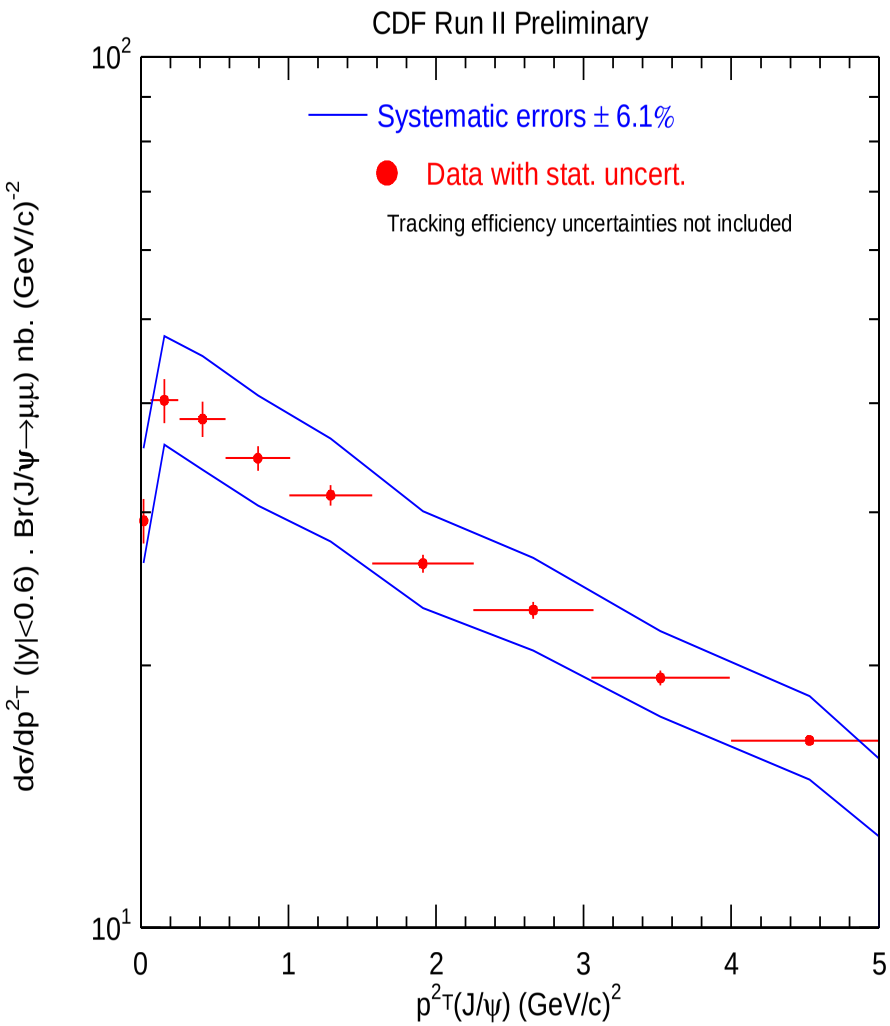
Differential Cross-section Numbers - BLESS

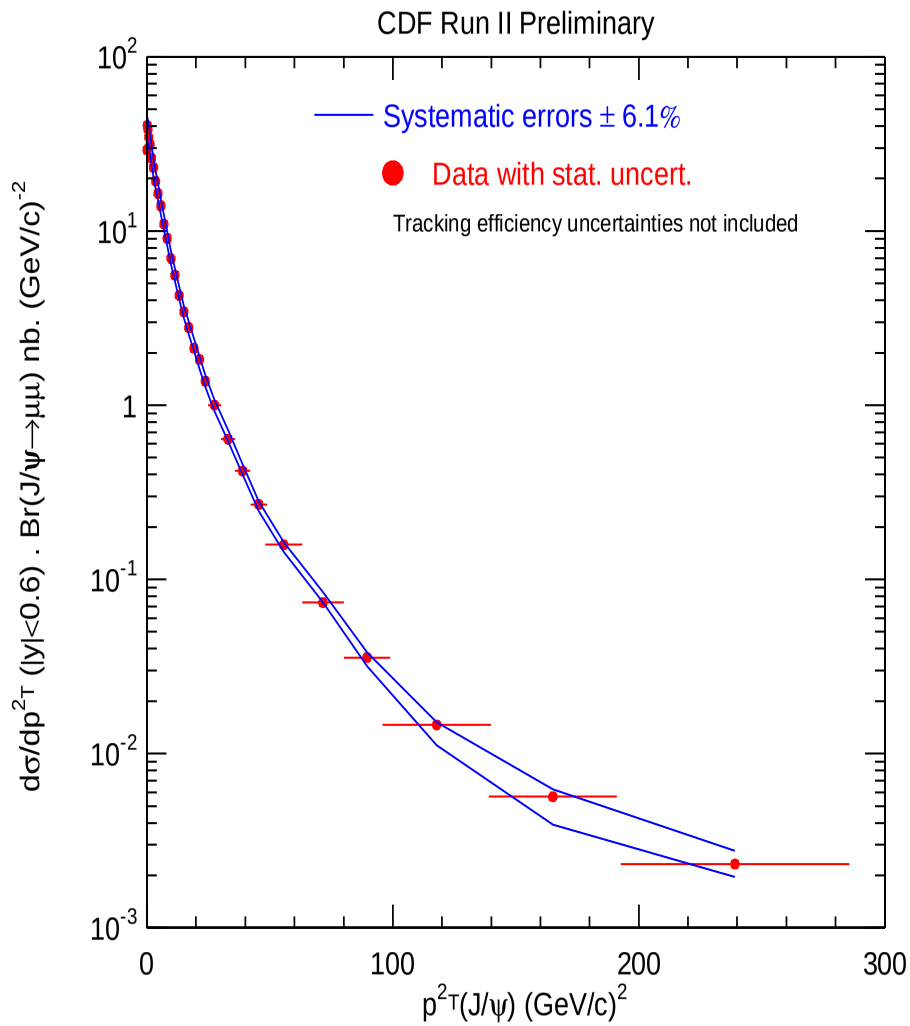
$p_T(J/\psi)$ (GeV/c)	Mean p_T (GeV/c)	$\frac{d\sigma}{dp_T} \cdot \mathcal{B}(J/\psi \to \mu\mu)$ nb .(GeV/c)$^{-1}$
0.0 – 0.25	0.129111	$7.20 \pm 0.4(stat)^{+1.54}_{-0.76}(syst)$
0.25 – 0.5	0.390865	$29.7 \pm 1.7(stat)^{+5.47}_{-3.29}(syst)$
0.5 – 0.75	0.641480	$47.1 \pm 2.2(stat)^{+8.54}_{-5.9}(syst)$
0.75 – 1.0	0.886447	$59.5 \pm 1.9(stat)^{+10.7}_{-7.0}(syst)$
1.0 – 1.25	1.13306	$69.4 \pm 1.9(stat)^{+11.2}_{-7.9}(syst)$
1.25 – 1.5	1.38021	$70.7 \pm 1.6(stat)^{+10.5}_{-7.8}(syst)$
1.5 – 1.75	1.62733	$73.9 \pm 1.6(stat)^{+10.9}_{-7.5}(syst)$
1.75 – 2.0	1.87480	$71.3 \pm 1.3(stat)^{+9.4}_{-6.9}(syst)$
2.0 – 2.25	2.12714	$69.2 \pm 0.8(stat)^{+8.6}_{-6.8}(syst)$
2.25 – 2.5	2.37480	$65.9 \pm 0.9(stat)^{+7.8}_{-5.8}(syst)$
2.5 – 2.75	2.62398	$57.1 \pm 0.8(stat)^{+6.4}_{-4.9}(syst)$
2.75 – 3.0	2.87395	$51.8 \pm 0.7(stat)^{+5.4}_{-4.3}(syst)$
3.0 – 3.25	3.12278	$43.2 \pm 0.6(stat)^{+4.4}_{-3.4}(syst)$
3.25 – 3.5	3.37541	$37.4 \pm 0.5(stat)^{+3.7}_{-2.9}(syst)$
3.5 – 3.75	3.62432	$30.8 \pm 0.4(stat)^{+2.9}_{-2.3}(syst)$
3.75 – 4.0	3.87414	$26.4 \pm 0.4(stat)^{+2.4}_{-1.9}(syst)$
4.0 – 4.25	4.12297	$22.9 \pm 0.4(stat)^{+2.1}_{-1.7}(syst)$
4.25 – 4.5	4.37527	$18.4 \pm 0.3(stat)^{+1.6}_{-1.3}(syst)$
4.5 – 4.75	4.62188	$16.8 \pm 0.3(stat)^{+1.5}_{-1.2}(syst)$
4.75 – 5.0	4.87528	$13.3 \pm 0.2(stat)^{+1.1}_{-0.9}(syst)$

$p_T(J/\psi)$ (GeV/c)	Mean p_T (GeV/c)	$\frac{d\sigma}{dp_T} \cdot \mathcal{B}(J/\psi \to \mu\mu)$ nb .(GeV/c)$^{-1}$
5.0 – 5.5	5.24096	$10.4 \pm 0.14(stat)^{+0.9}_{-0.70}(syst)$
5.5 – 6.0	5.73903	$7.30 \pm 0.12(stat)^{+0.57}_{-0.48}(syst)$
6.0 – 6.5	6.23668	$5.20 \pm 0.08(stat)^{+0.39}_{-0.32}(syst)$
6.5 – 7.0	6.73948	$3.61 \pm 0.06(stat)^{+0.26}_{-0.22}(syst)$
7.0 – 8.0	7.45242	$2.35 \pm 0.03(stat)^{+0.16}_{-0.14}(syst)$
8.0 – 9.0	8.45618	$1.24 \pm 0.02(stat)^{+0.08}_{-0.07}(syst)$
9.0 – 10.0	9.45614	$0.671 \pm 0.017(stat)^{+0.076}_{-0.073}(syst)$
10.0 – 12.0	10.8359	$0.319 \pm 0.008(stat)^{+0.051}_{-0.050}(syst)$
12.0 – 14.0	12.8433	$0.146 \pm 0.006(stat)^{+0.023}_{-0.023}(syst)$
14.0 – 17.0	15.446	$0.071 \pm 0.004(stat)^{+0.014}_{-0.011}(syst)$
17 – 20.0	18.5026	< 0.07

The systematic uncertainties shown are the p_T dependent systematic uncertainties only. The non p_T dependent systematic uncertainty is $\pm 6.1\%$.

$d\sigma/dp_T^2$ - BLESS





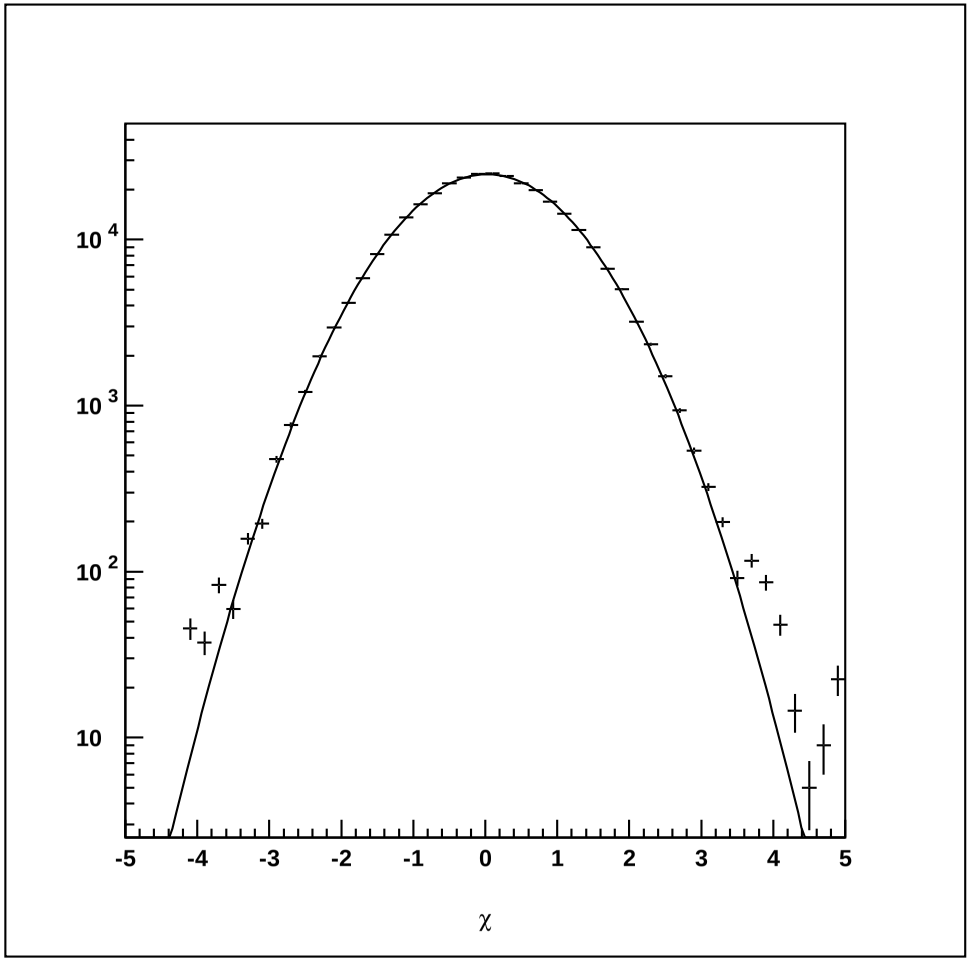
Total Integrated X-section - BLESS

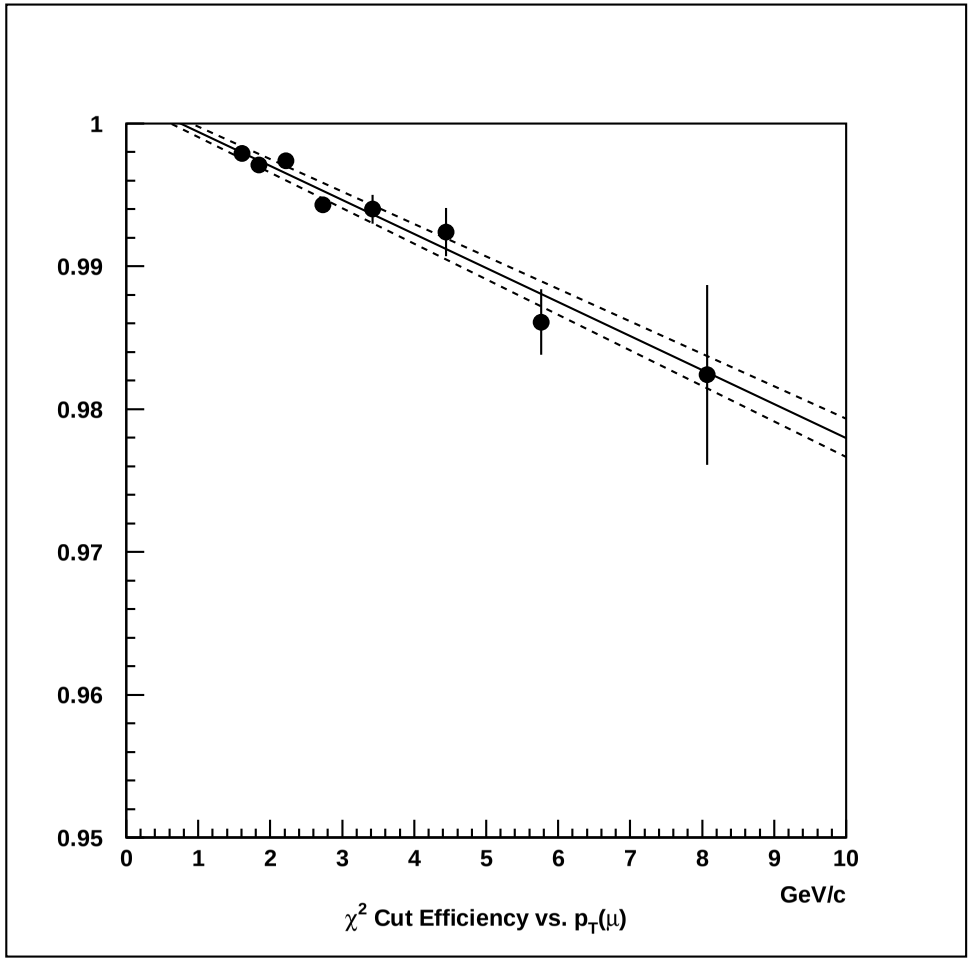
BLESS: TOTAL integrated inclusive J/ψ cross section :

$$\sigma(p\overline{p} \to J/\psi X, \mid y(J/\psi) \mid < 0.6) \cdot Br(J/\psi \to \mu\mu) = 239.2 \pm 1.5(stat)^{+30.6 \oplus 14.6}_{-23.1 \oplus 14.6}(syst)$$

Track stub match - $\chi^2(\Delta r\phi)$

$$\epsilon_{\chi^2} = (1.0018 \pm 0.0003) - (0.0024 \pm 0.0001)p_T$$





BLESS: CDFNOTE 6114