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Introduction

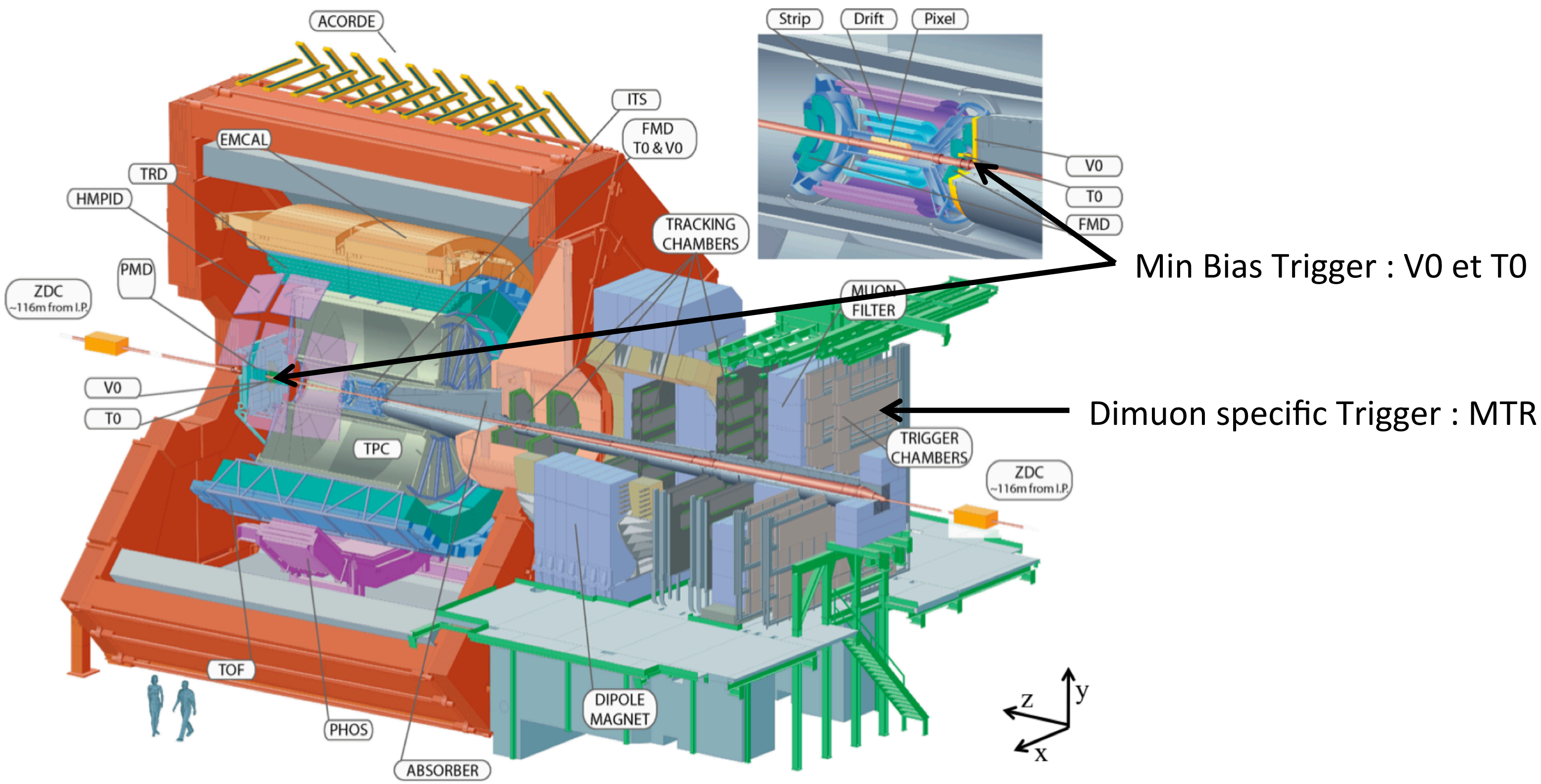
- Official analysis on Arxiv since September 28th 2015.
  (link : http://arxiv.org/abs/1509.08258)

- Presents results vs p_T and rapidity for J/Ψ, Ψ(2S), Υ(1S), Υ(2S), and Υ(3S) in pp at 8TeV

- Non official analysis :
  - Cross-check
  - Learn about analysis tools and methods

Introduction

- √s = 8 TeV in 2012
- Two periods: LHC12h & LHC12i



Introduction

- Calculation of the cross section :

$$\frac{d^2\sigma}{dp_T dy} = \frac{N_{J/\Psi}}{A.\varepsilon \times Lum \times BR \times \Delta p_T \times \Delta y}$$

- $N_{J/\Psi}$ calculated by fitting an invariant mass spectrum
- A.ε = Acceptance-Efficiency of the detector, trigger and analysis
- Lum= Integrated Luminosity
- BR = Branching ratio

Trigger Selection

- QA Selection : 225 runs in LHC12h & 45 runs in LHC12i

	LHC12 h	LHC12i	**Total**
CMUL8 (MTR & T0)	111 runs	28 runs	**139 runs**
CMUL7(MTR & V0)	114 runs	17 runs	**131 runs**
C0MUL (MTR)	152 runs	45 runs	**197 runs**

- A fraction of unlike-sign events are actually detected by like-sign trigger only
  -> use of both unlike (MUL) and like sign (MLL) trigger classes

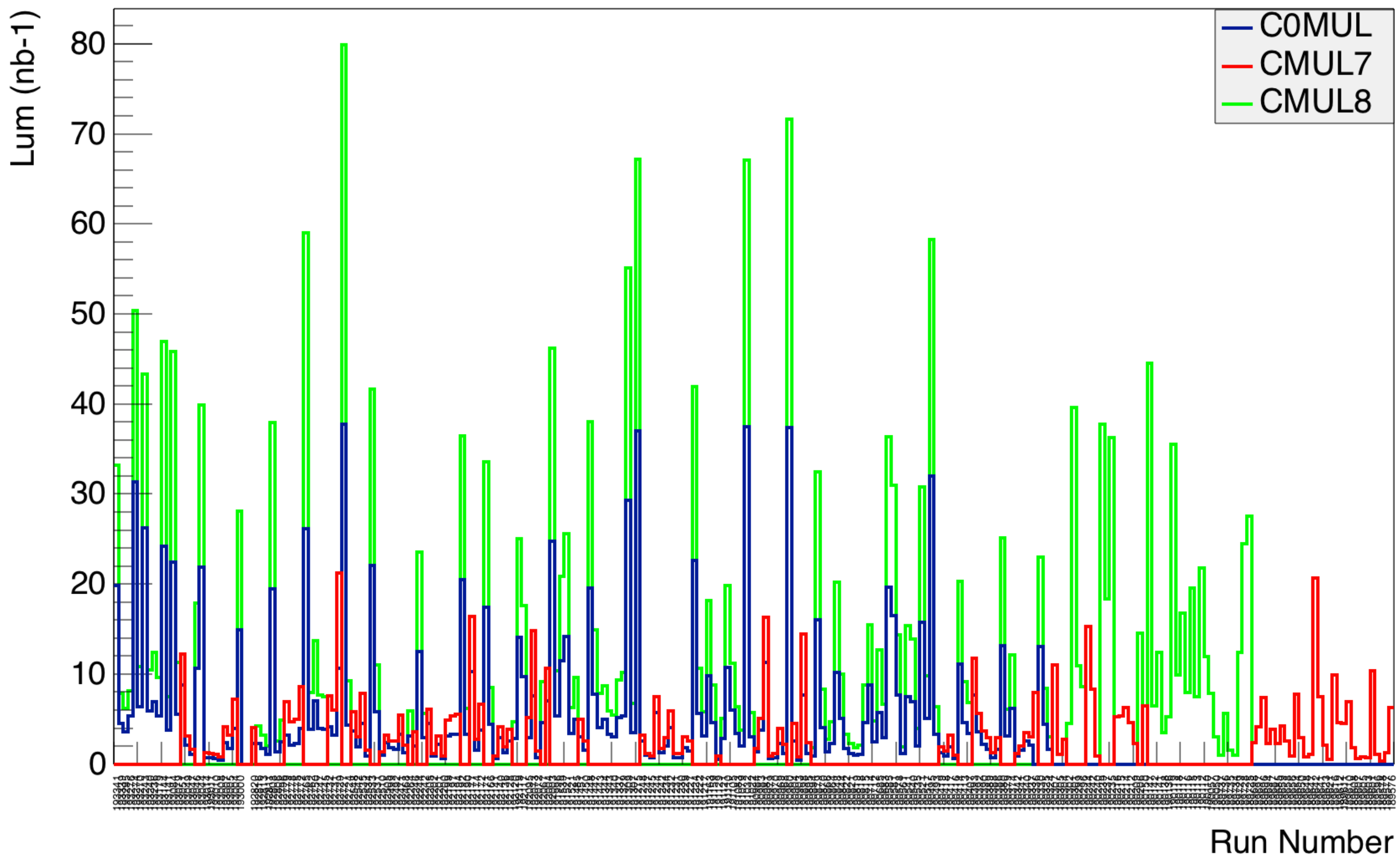
- V0 dataset : (CMUL7-S||CMLL7-S)
- T0 dataset : (CMUL8-S||CMLL8-S||CMUL7-S||CMLL7-S)&&T0
- C0MUL dataset : C0MUL-SC

LUMINOSITY

Luminosity

- Luminosity : $Lum = \frac{N_{CINT7,8}}{\sigma_{CINT7,8}}$ (CINT 7,8 = V0 or T0 only)
- With $N^{eq}_{CINT7,8} = \frac{N_{CMUL7,8}}{R_{CMUL7,8}}$
- And $R_{CMUL} = \frac{Scal_{CMUL7,8}}{Scal_{CINT7,8} \times Purity \times Pile-up}$
- Purity = selection of beam beam collisions
- Pile-up correction = multiple events non detected ≈1

Luminosity



Luminosity

	Victor Analysis	Values from Note
CMUL8	2414.6 nb^{-1}	2416.2 nb^{-1}
CMUL7	572.98* nb^{-1}	581.34 nb^{-1}
C0MUL	1267.0* nb^{-1}	1277.2 nb^{-1}

* 2 runs where the Scalar information is missing

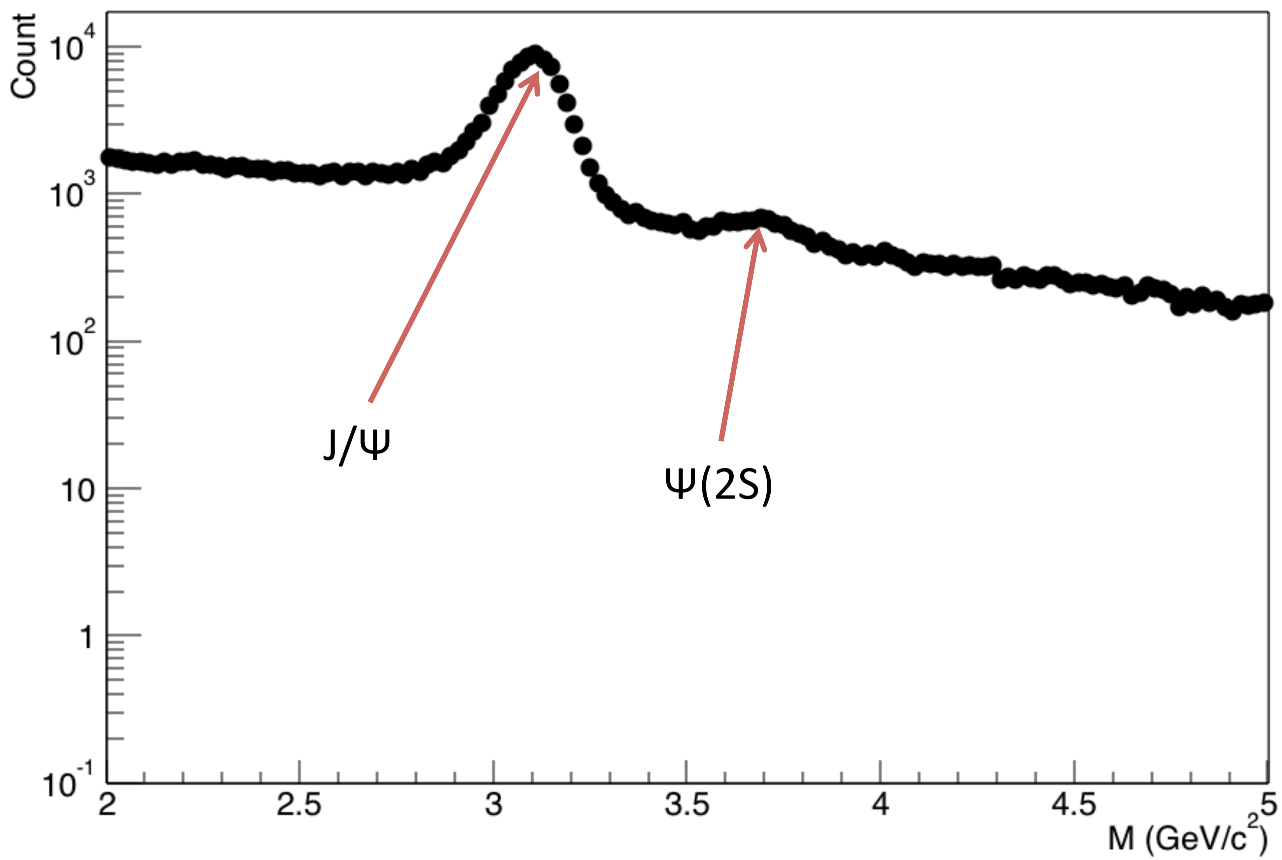
- Systematics :
  - Cross section from vdM scan
  - Luminosity T0 vs V0

SIGNAL EXTRACTION

Track and Pair Selection

- Pseudo-rapidity of each muon: $-4.0 < \eta < -2.5$
- $17.6 < R_{abs} < 89.5$ cm
- $pDCA < 6x\sigma_{pDCA}$
- Track of opposite signs
- Rapidity of dimuon pair : $2.5 < y < 4.0$

Invariant Mass Spectrum



Signal Function

- Fit Function : Extended Crystall Ball Function (CB2)

$$f(x;\mu;\sigma;\alpha_L;n_L;\alpha_R;n_R) = N \times \begin{cases} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right) & \text{for} \quad \alpha_R > \frac{x-\mu}{\sigma} > -\alpha_L \\ A_L \times \left(B_L - \frac{x-\mu}{\sigma}\right)^{-n_L} & \text{for} \quad \frac{x-\mu}{\sigma} \le -\alpha_L \\ A_R \times \left(B_R + \frac{x-\mu}{\sigma}\right)^{-n_R} & \text{for} \quad \frac{x-\mu}{\sigma} \ge \alpha_R \end{cases}$$

- With $A_{L,R} = \left(\frac{n_{L,R}}{|\alpha_{L,R}|}\right)^{n_{L,R}} \times \exp\left(-\frac{|\alpha_{L,R}|^2}{2}\right)$

$$B_{L,R} = \frac{n_{L,R}}{|\alpha_{L,R}|} - |\alpha_{L,R}|$$

- Tails parameters fixed to MC
- Other possibility : NA60 function

Background Functions

- Background : Variable Width Gaussian (VWG)

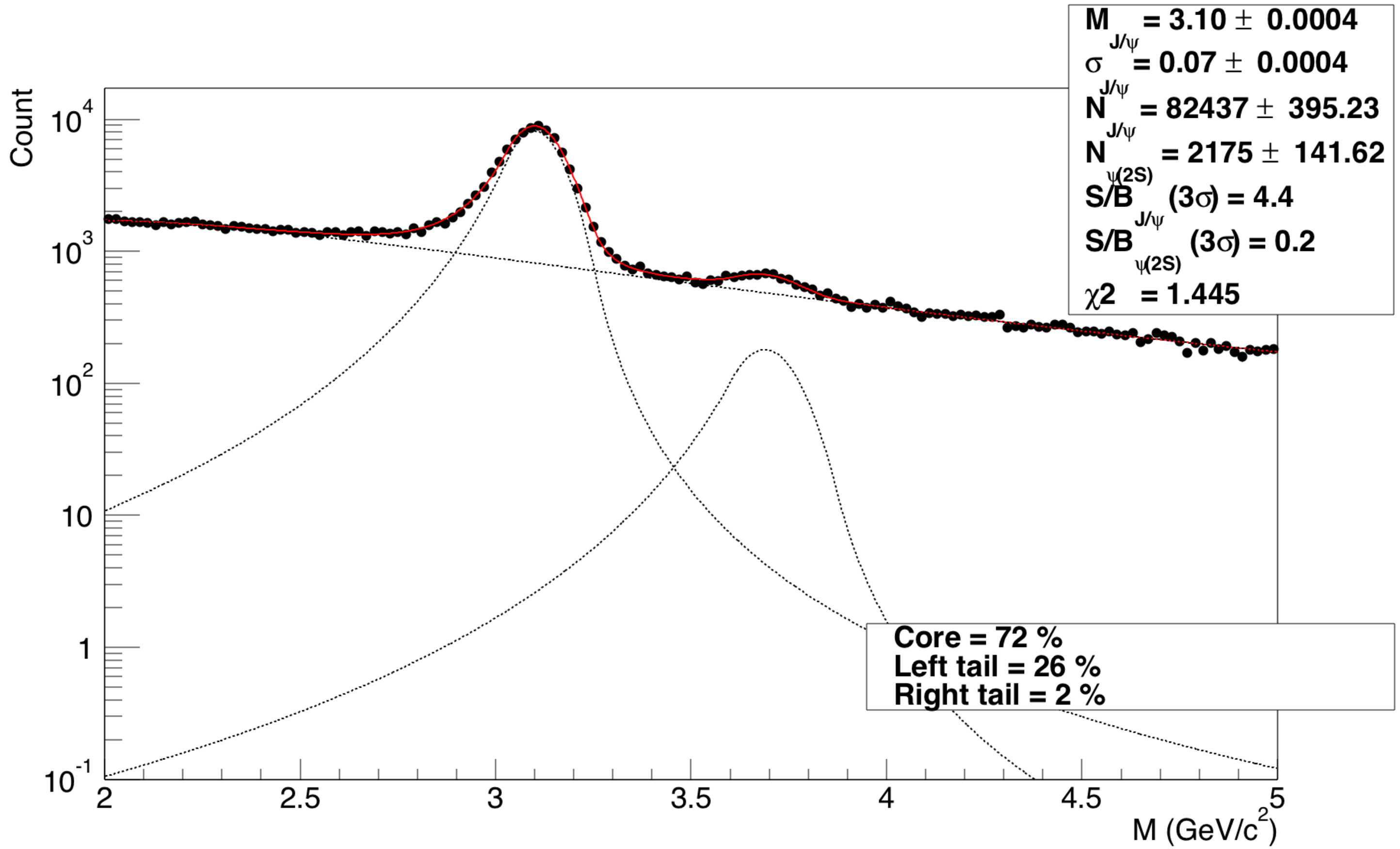
$$f(x) = N \times \exp\left(-\frac{(x-\alpha)^2}{2\sigma^2}\right)$$

$$\sigma = \beta + \gamma \frac{(x-\alpha)}{\alpha}$$

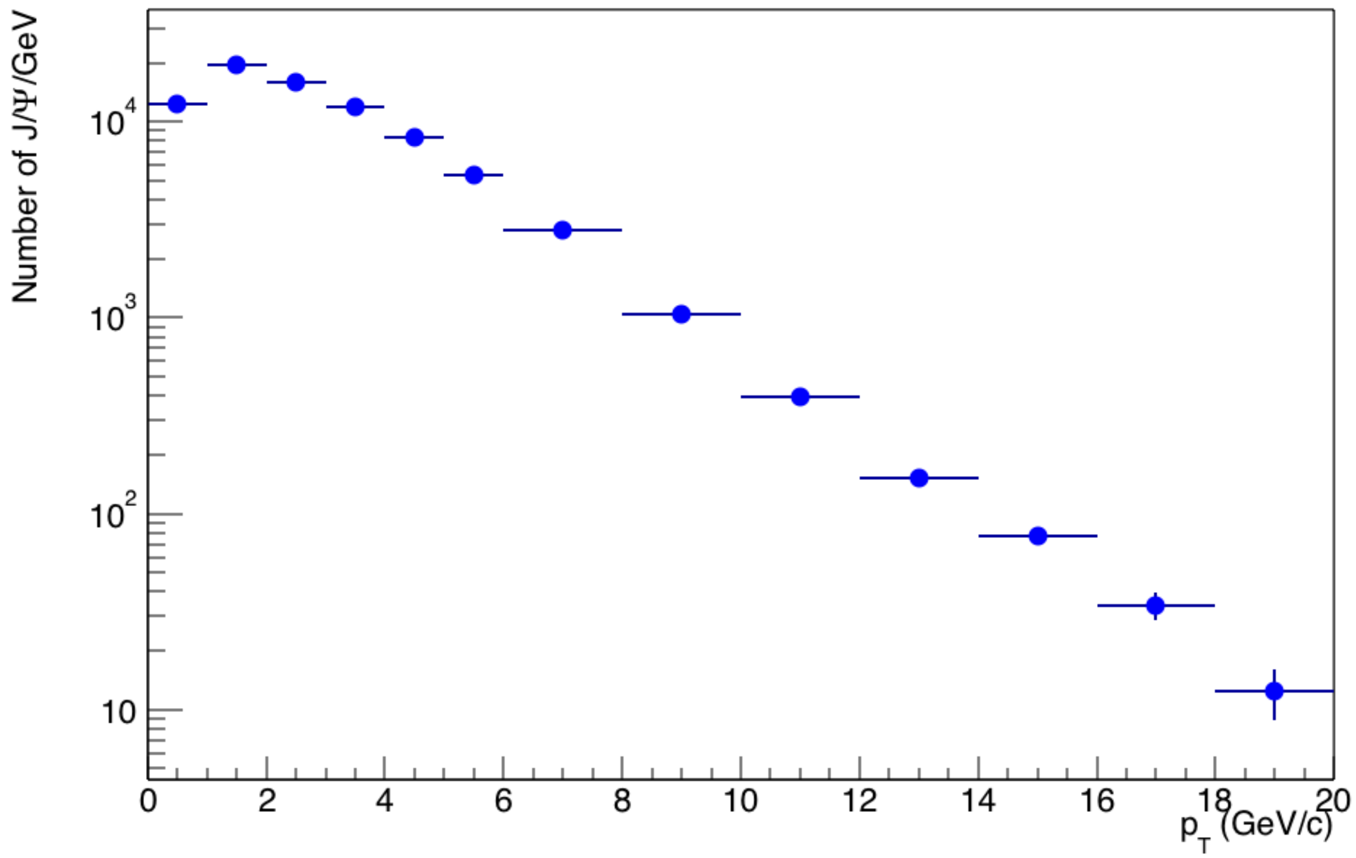
- Other possibilities : 2nd order polynomial times exponential

Number of J/Ψ

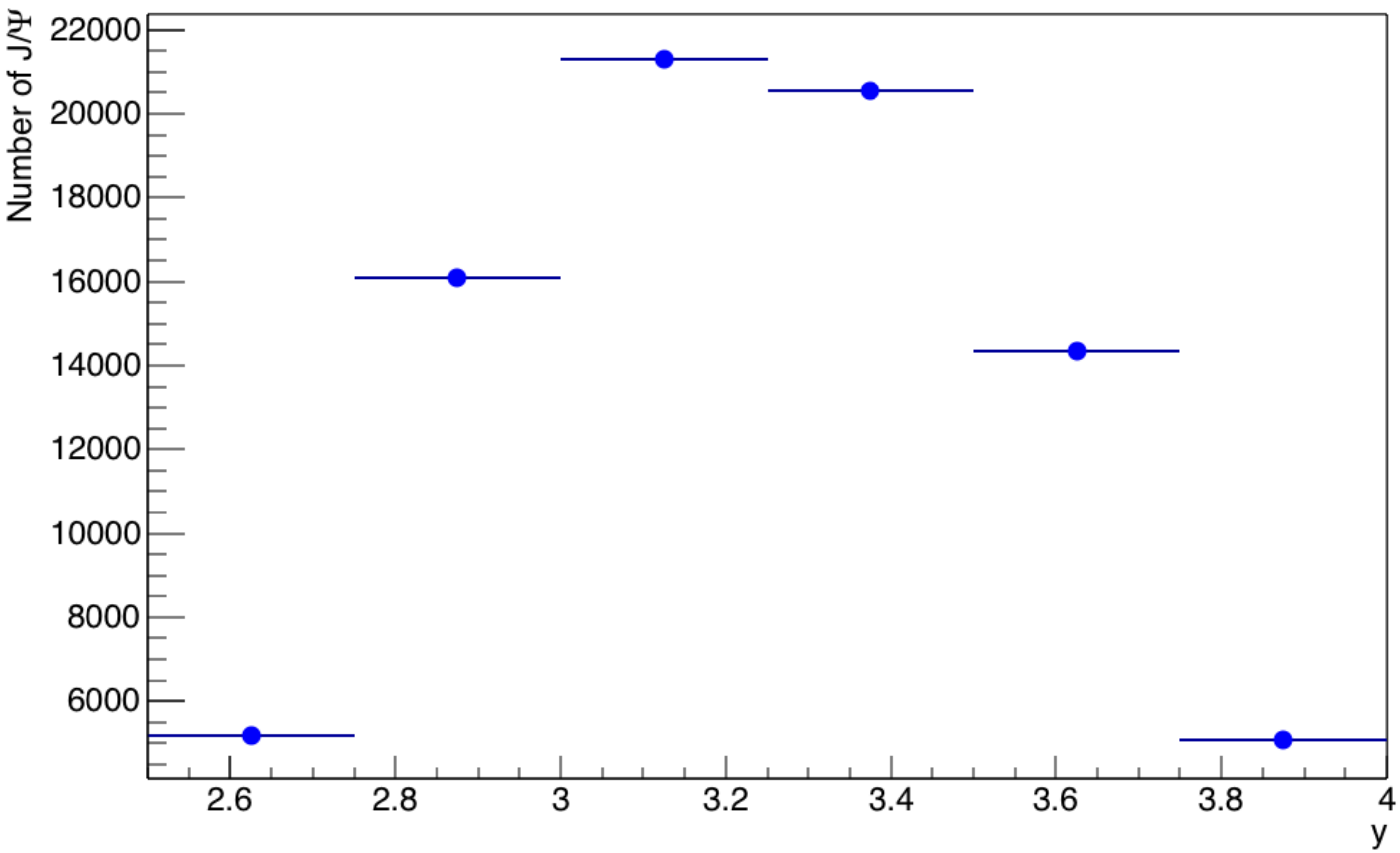
- Example of fit : CB2 and VWG for C0MUL trigger



Number of J/Ψ



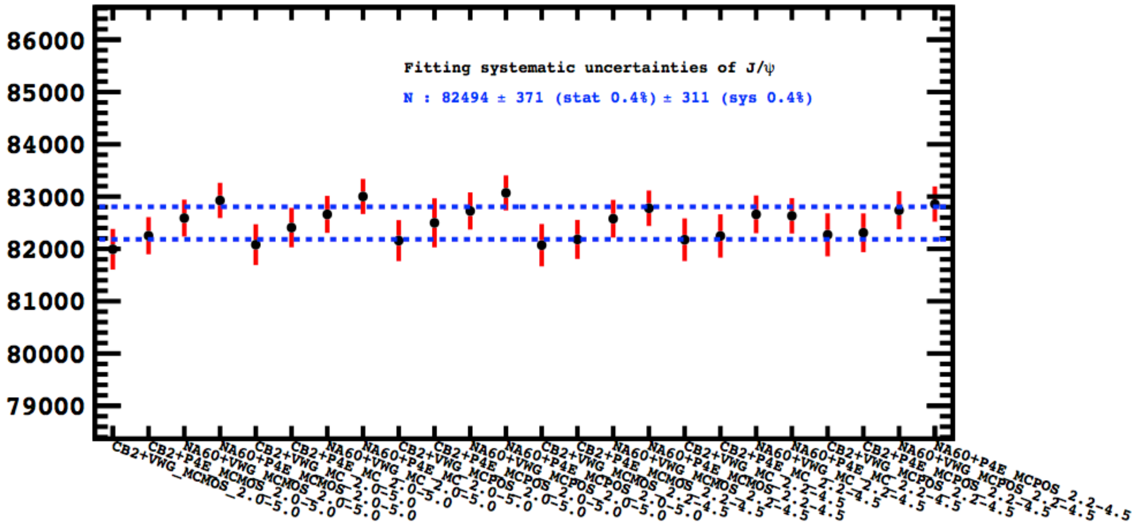
Number of J/Ψ



Number of J/Ψ
22000
20000
18000
16000
14000
12000
10000
8000
6000
2.6
2.8
3
3.2
3.4
3.6
3.8
4
y

Systematics

- Signal function
- Background function
- Fitting range
- Tails parameters



J/Psi systematics for C0MUL dataset (from analysis note)

ACCEPTANCE EFFICIENCY

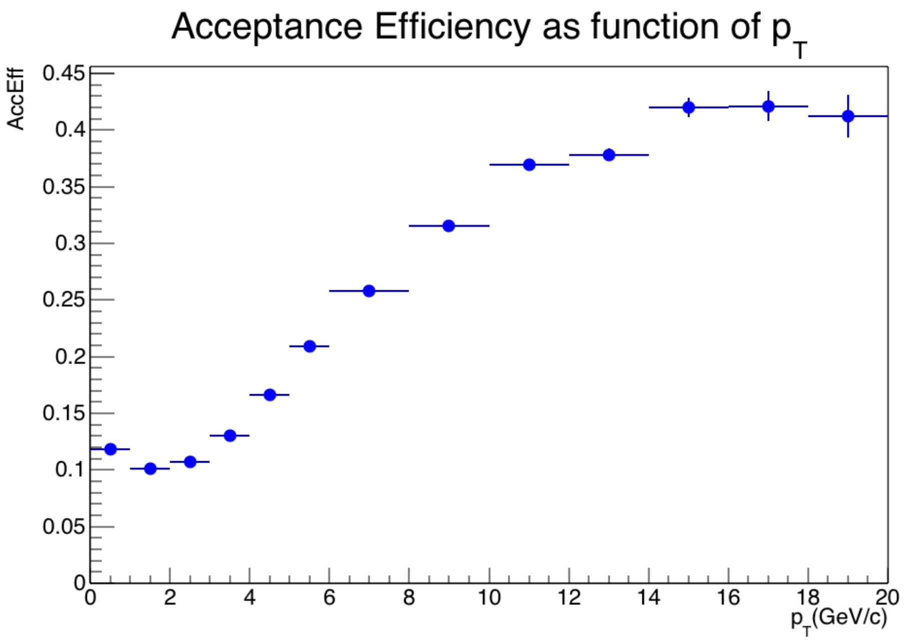
Acceptance-Efficiency

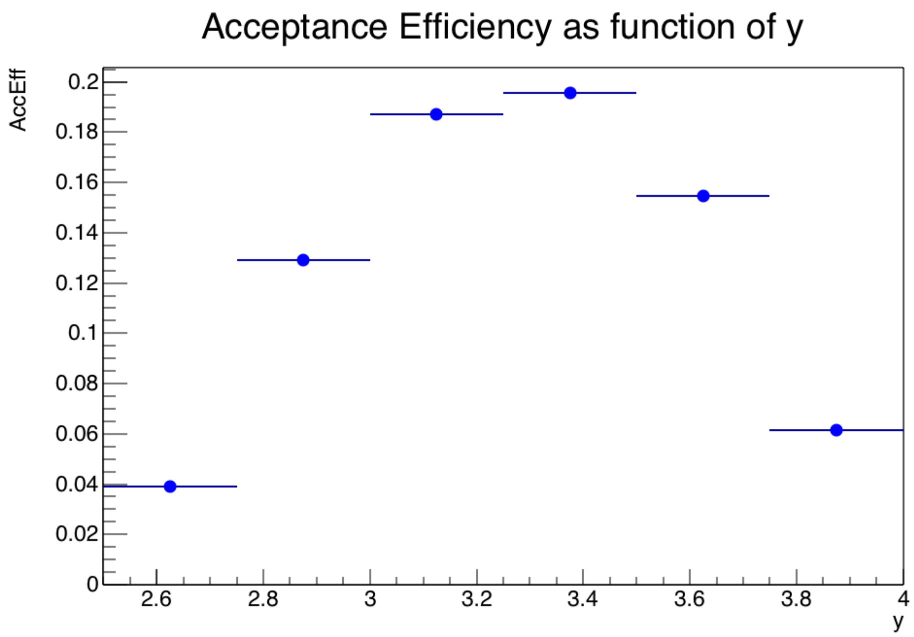
- Based on Monte-Carlo simulations

$$A.\varepsilon = \frac{N_{J/\Psi}^{RECONSTRUCTED}}{N_{J/\Psi}^{SIMULATED}}$$

- $N_{J/\psi}^{reco}$ count :
  - Fit on the simulation
  - $2.5 < y < 4.0$ & $0 < p_T < 20$
  - η, R_{abs}, pDCA

Acceptance-Efficiency





Acceptance-Efficiency

- Systematics :
  - Input p_T and y distribution
  - Tracking uncertainties:
    - Efficiency
    - Dead Area
  - Trigger efficiency
  - Matching uncertainties
- Systematics for A.ε calculated with same procedures as for 7TeV.

EFFICIENCY OF THE MIN-BIAS TRIGGERS

Efficiency of the Min-Bias Triggers

- Efficiency of the V0 trigger :

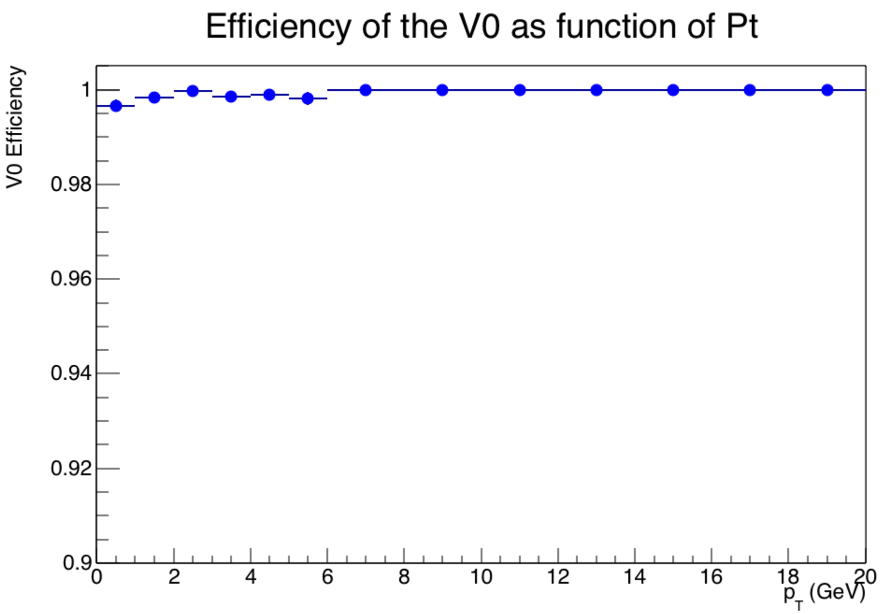
$$\frac{N_{J/\Psi}^{C0MUL\&V0}}{N_{J/\Psi}^{C0MUL}} = \varepsilon_{V0}$$

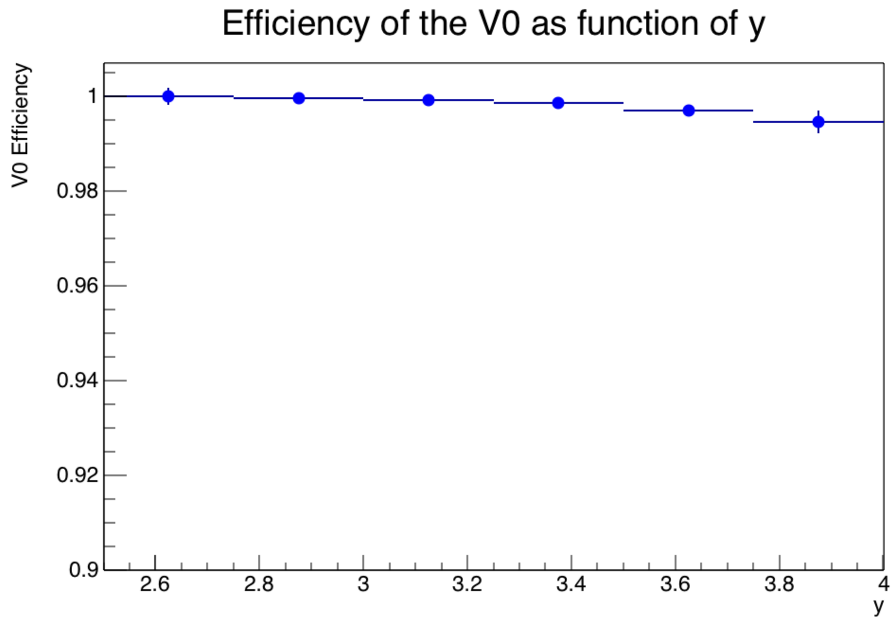
- Efficiency of the T0 trigger :

$$\frac{N_{J/\Psi}^{C0MUL\&T0}}{N_{J/\Psi}^{C0MUL}} = \varepsilon_{T0}$$

Efficiency of the Min-Bias Triggers

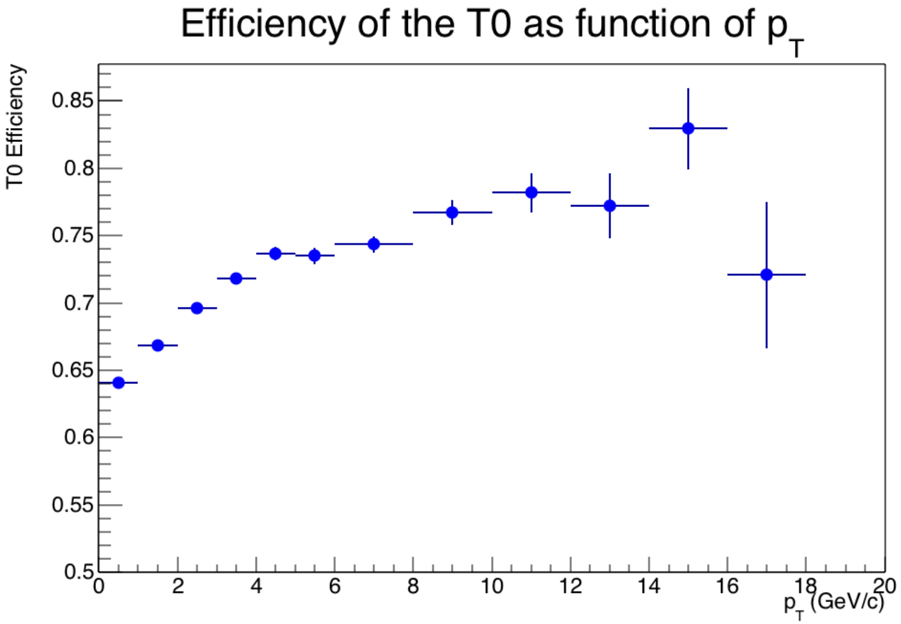
- V0 Trigger

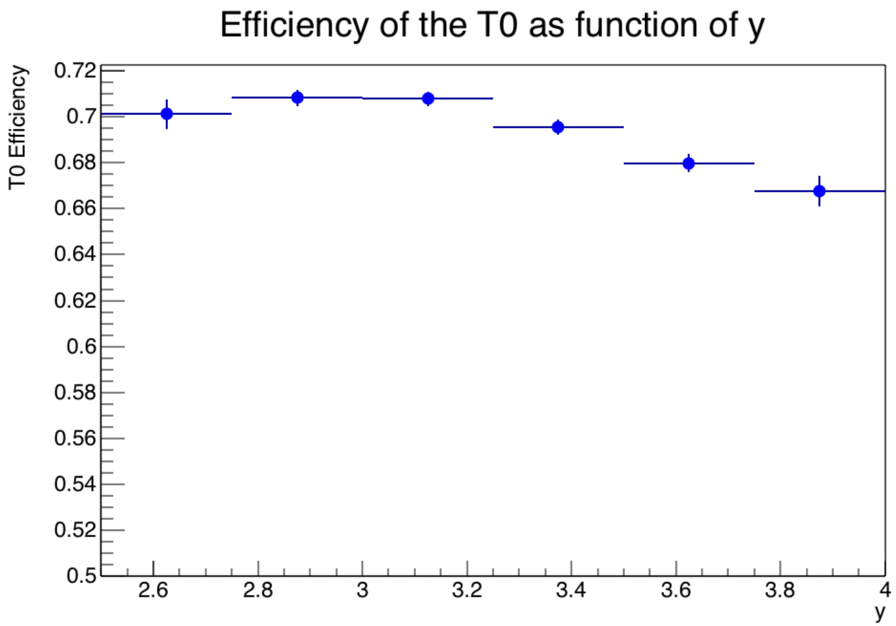




Efficiency of the Min-Bias Triggers

- T0 Trigger





Efficiency of the Min-Bias Triggers

- For V0, efficiency ≈ 1, but low Luminosity
- For T0, high Luminosity, but efficiency function of p_T and y not well understood
- Therefore, use of the C0MUL trigger

TRACK SIGN UNCERTAINTIES

Track Sign Uncertainties

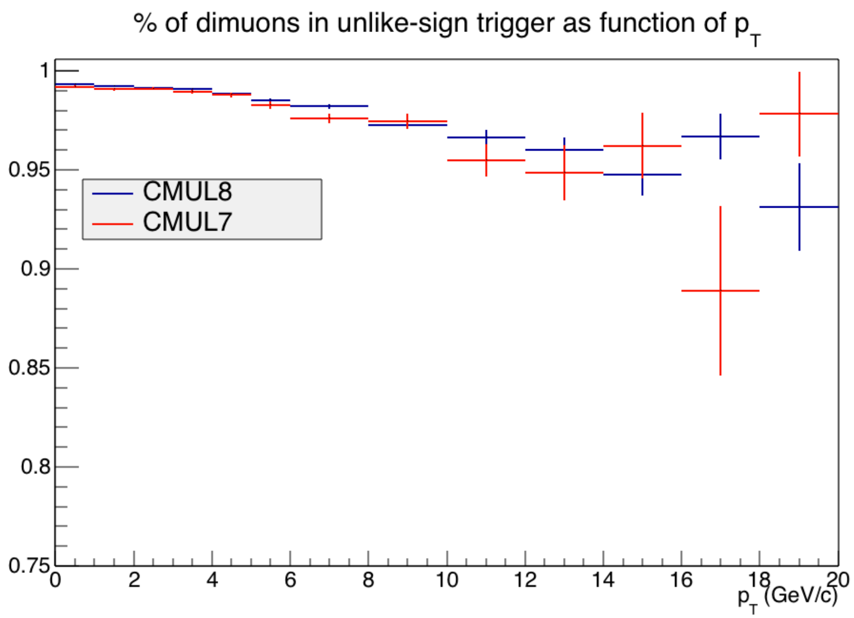
- Unlike signs in MLL
- C0MLL does not exist

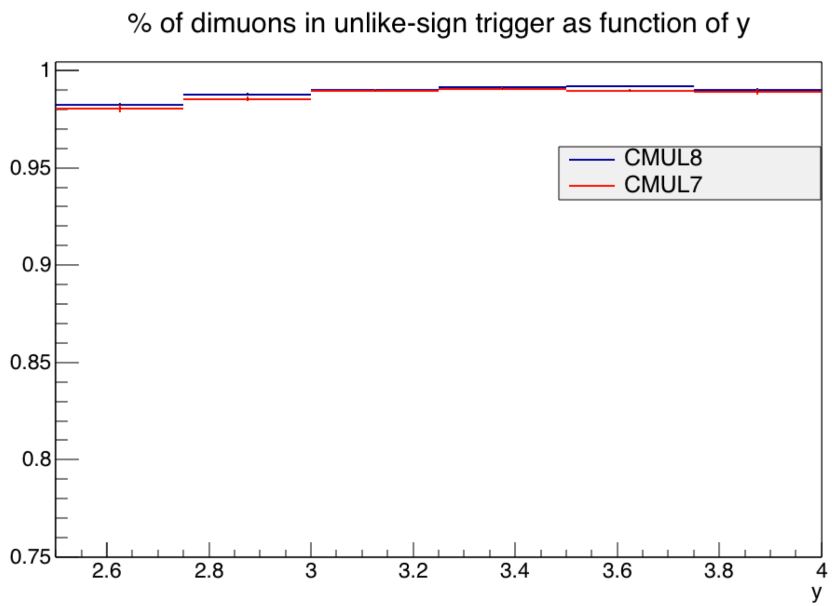
- We estimate correction thanks to T0 et V0 :

$$\varepsilon_{MLL} = \frac{N_{J/\Psi}(CMUL7,8)}{N_{J/\Psi}(CMUL7,8 \,||\, CMLL7,8)}$$

- For CMUL8, ε_{MLL} = 0.9900 ± 0.0002
  For CMUL7, ε_{MLL} = 0.9887 ± 0.0004

Track Sign Uncertainties





CROSS SECTION

Cross Section

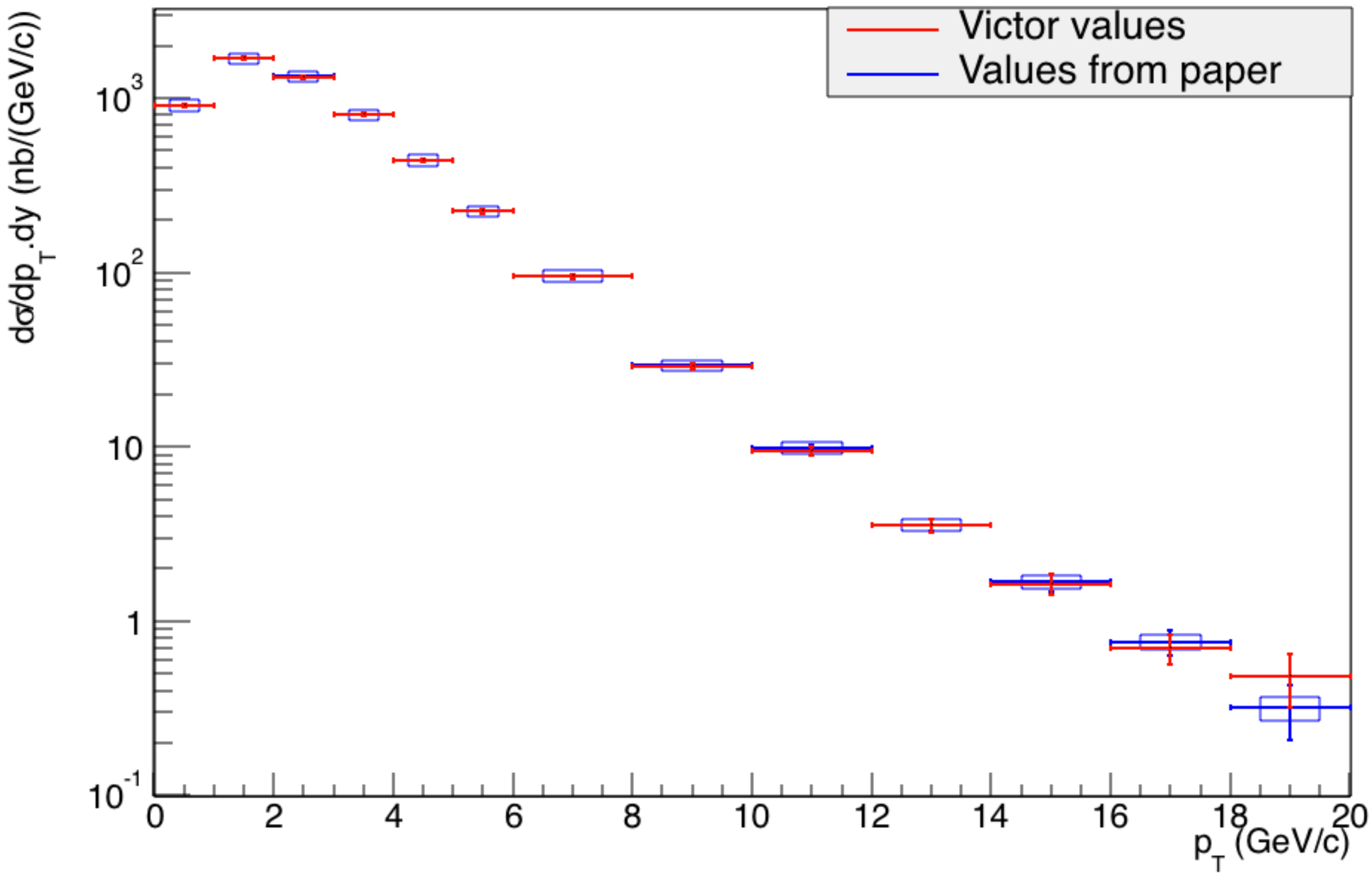
- The cross section of the J/Psi is given by :

$$\frac{d^2\sigma}{dp_T dy} = \frac{N_{J/\Psi}}{A.\varepsilon \times Lum \times BR \times \Delta p_T \times \Delta y}$$

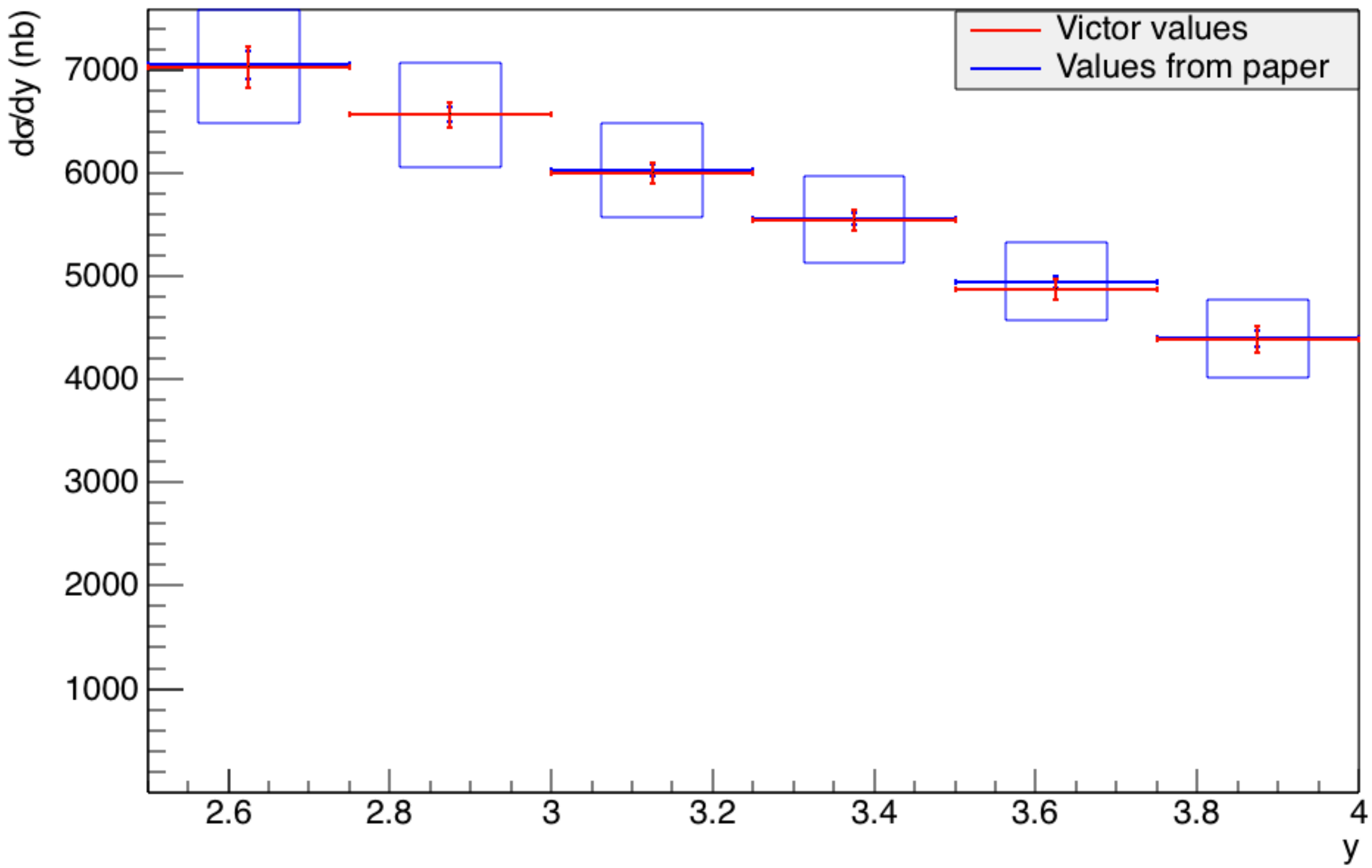
- With BR = 0.05961 ± 0.00033 (Particle Data Group Booklet)

- Integrated in p_T and y, we have σ = 8.59 ± 0.04 μb
  In the paper σ = 8.63 ± 0.04(stat) ± 0.79(syst) μb

Cross Section



Cross Section

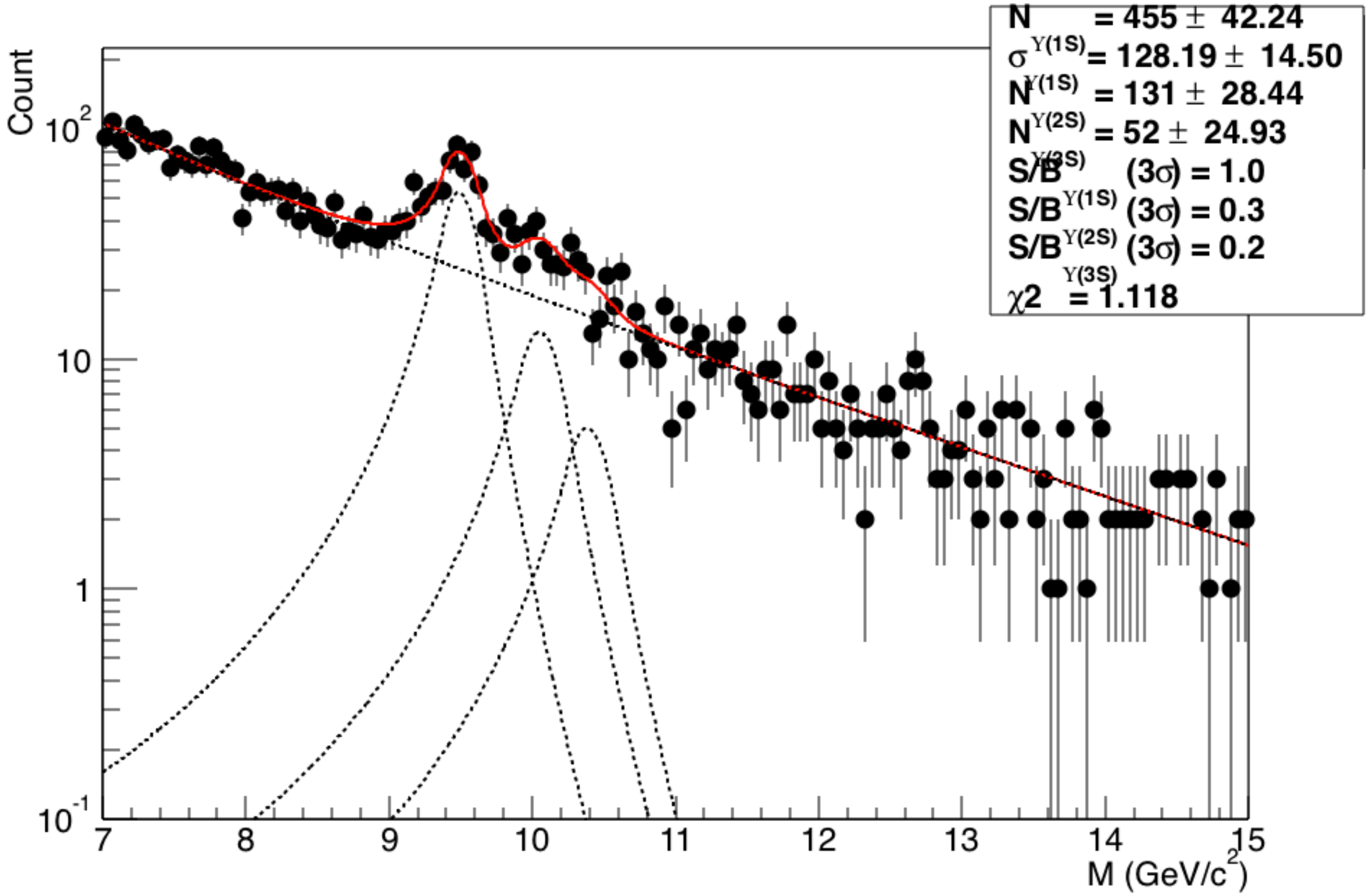


Conclusion

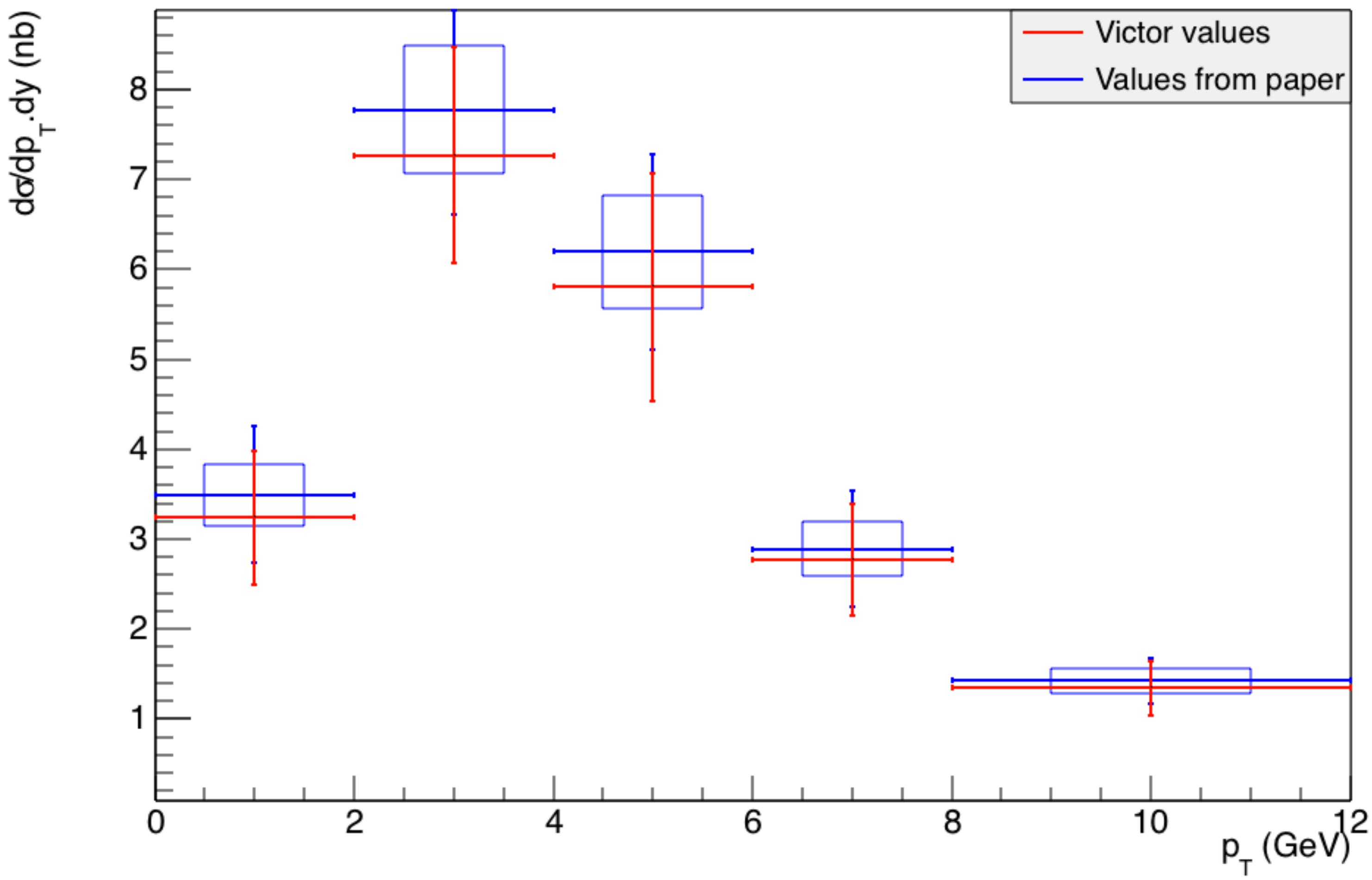
- Results in agreement
- Independent cross-check completed
- Next : pp $\sqrt{s}$ = 13 TeV and Pb-Pb at $\sqrt{s_{NN}}$ = 5 TeV analysis.

UPSILON 1S

Signal Upsilon



Cross Section



THANK YOU FOR YOUR ATTENTION!

Questions?

Back-up Purity

- Purity calculated by looking at the time when the particle hits the detector on the left and the right
- $8 < t_{V0A} + t_{V0C} < 22$ & $0 < t_{V0A} - t_{V0C} < 14$ ns