Gauge boson in association with J/Ψ at ATLAS

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Outline

Gauge boson in association with J/Ψ at ATLAS

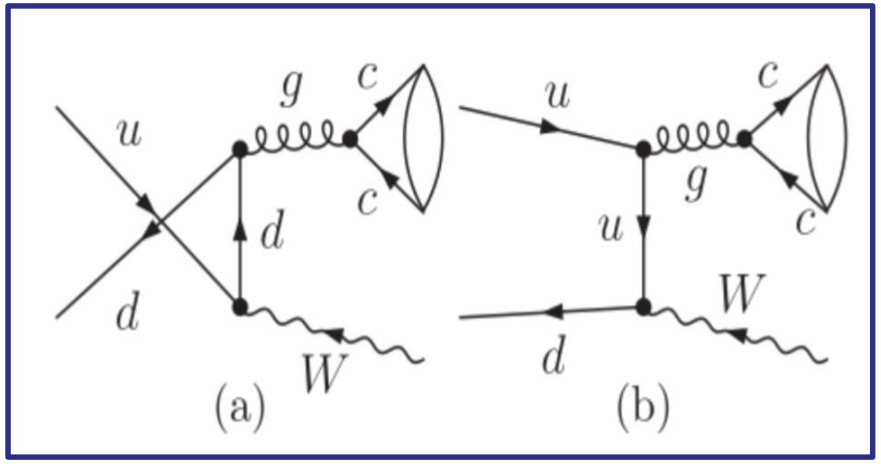
1. W+J/Ψ production (JHEP 04 (2014) 172)

2. Z+J/Ψ production (Eur. Phys. J. C (2015) 75:229)

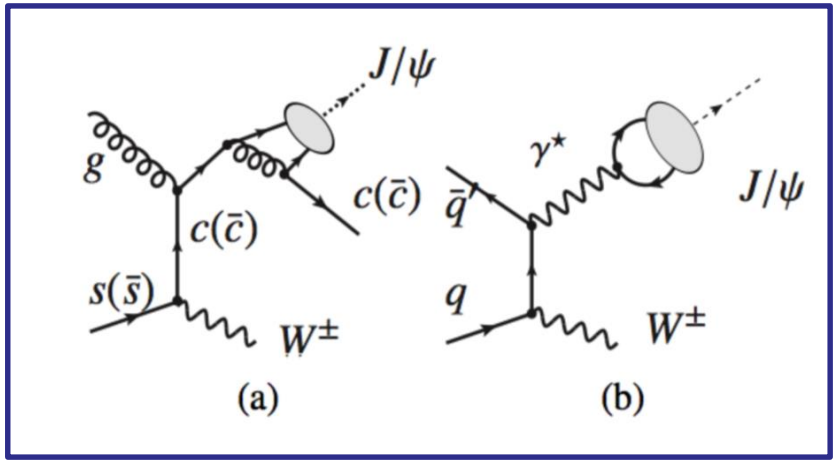
Summary

Motivation

- **Is the CO really dominated?**



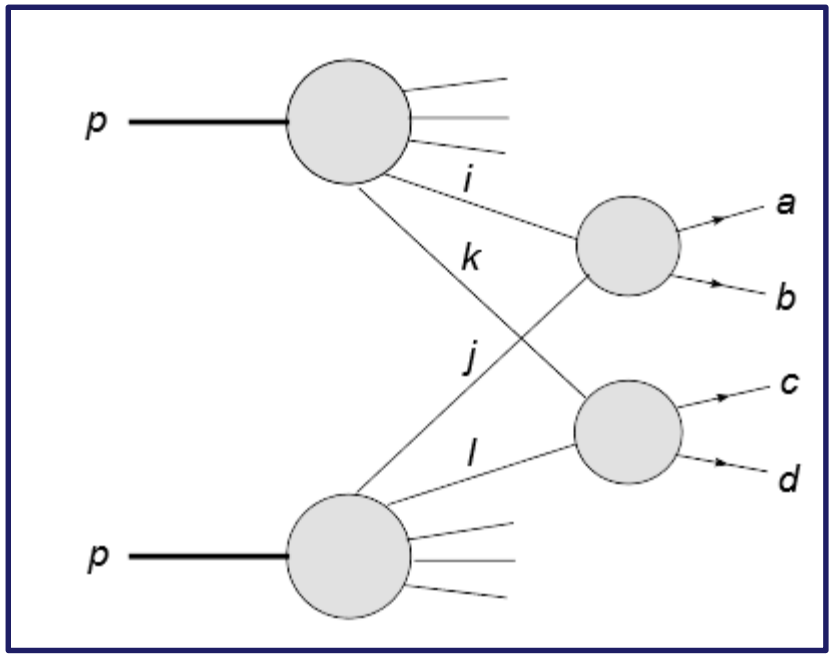
Colour Octet Model



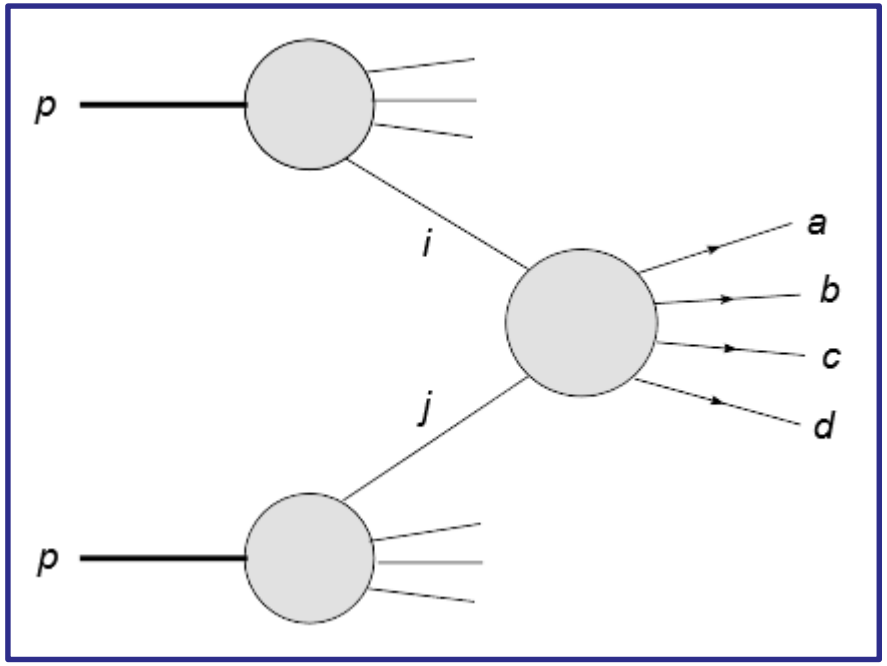
Colour Singlet Model

Motivation

- **SPS or DPS?**



Double Parton Scattering



Single Paton Scattering

General information

W+J/Ψ:
4.5 fb^{-1} at 7 TeV
W→μν, J/Ψ→μμ; three muons + missing transverse energy
Prompt J/Ψ only

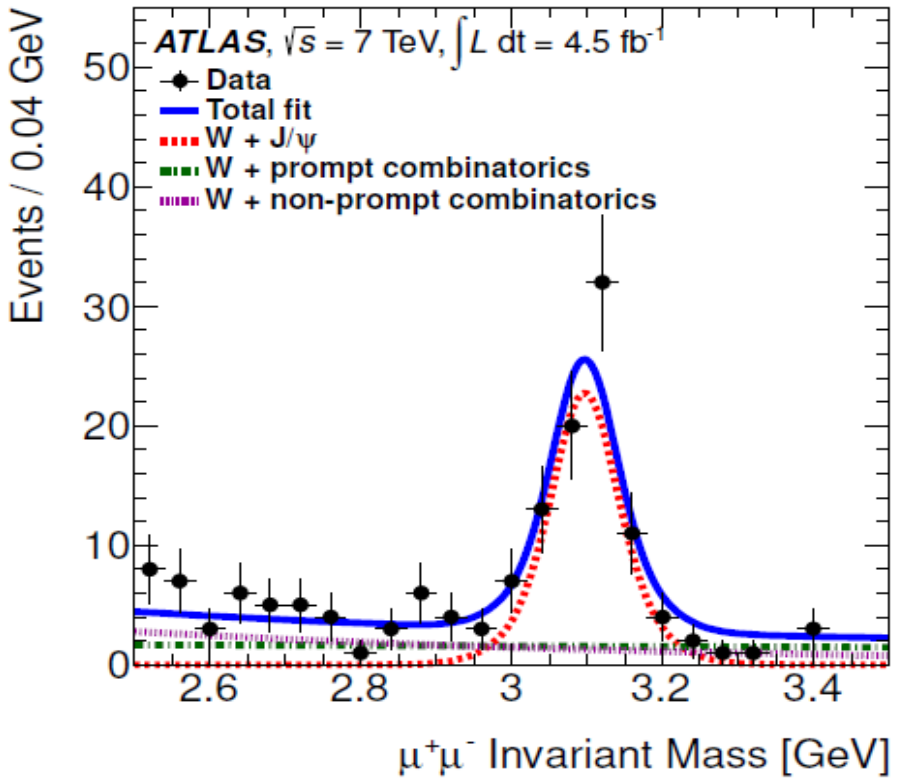
Z+ J/Ψ:
20.3 fb^{-1} at 8 TeV
Z→ee or μμ, J/Ψ→μμ; four leptons
Both prompt and non-prompt J/Ψ

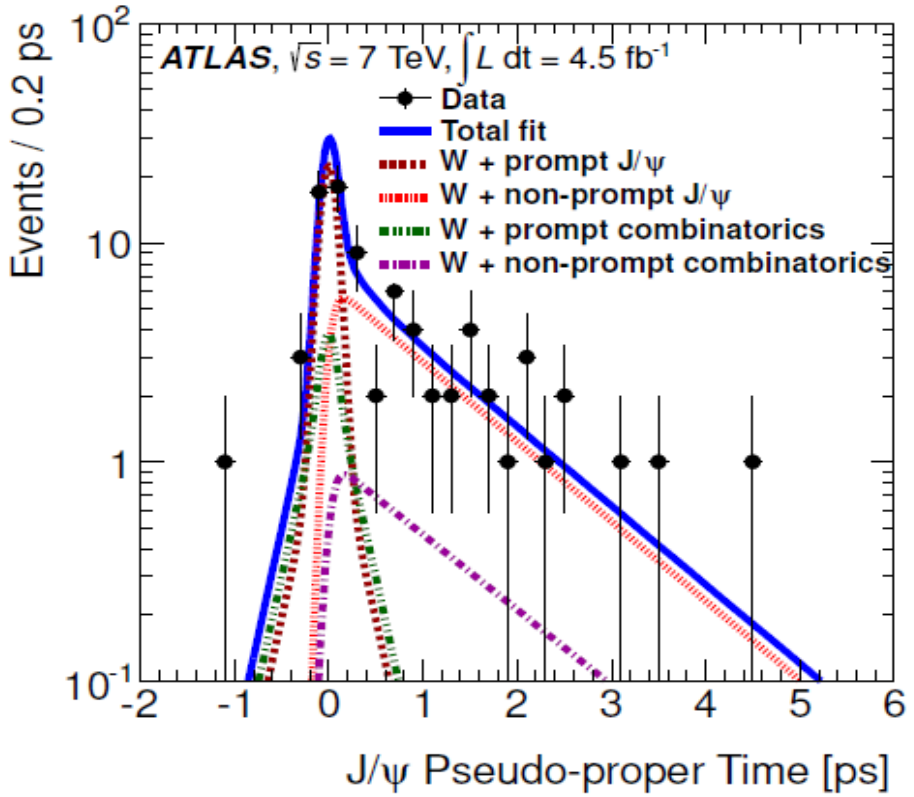
Pseudo-proper time definition: $\tau := \frac{L_{xy} m^{J/\psi}}{p_{\mathrm{T}}^{J/\psi}}$

Methodology: step 1

W+J/Ψ

Select the J/Ψ with two opposite charged muons; separate the prompt and non-prompt by fitting the pseudo-proper time distributions (2D fit: mass and time):



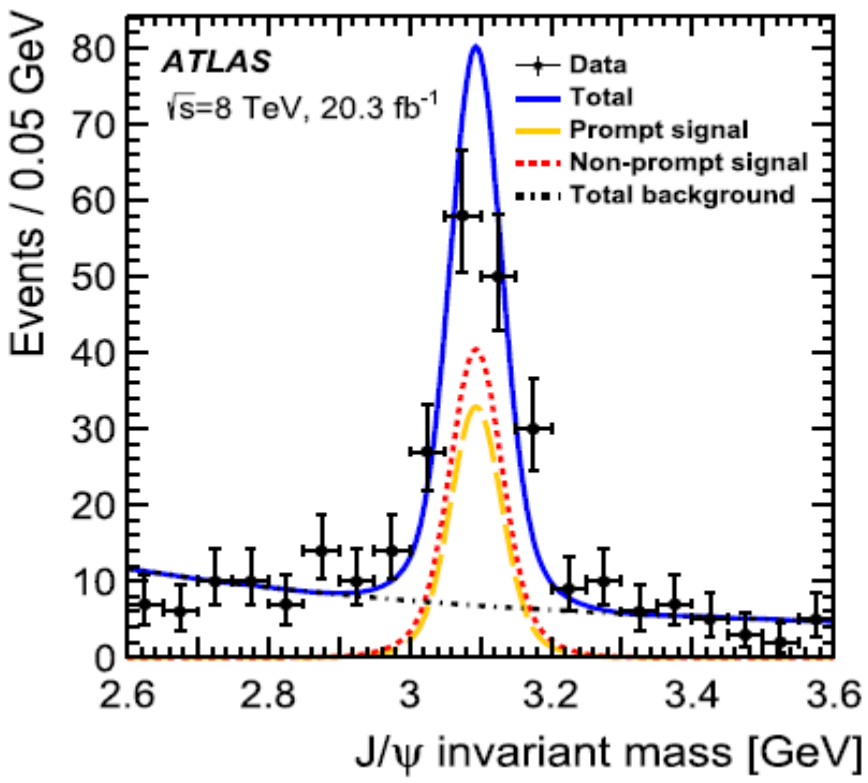


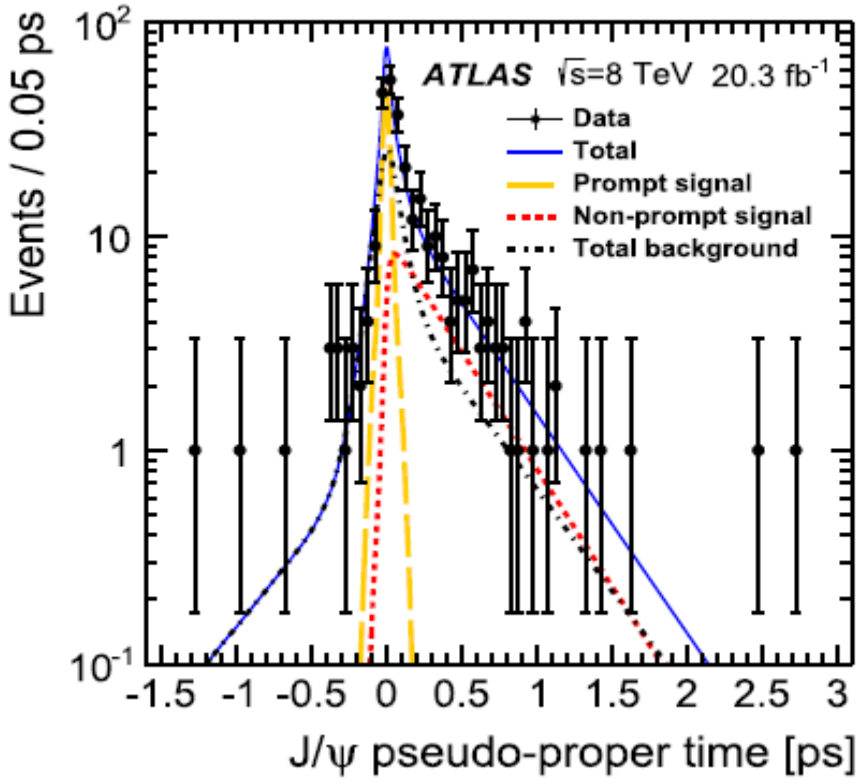
Two rapidity regions of are fitted separately, due to different resolution.
(different multi-scattering status and different magnetic field)

Methodology: step 1

Z+J/Ψ

Select the J/Ψ with two opposite charged muons; separate the prompt and non-prompt by fitting the pseudo-proper time distributions (2D fit: mass and time):



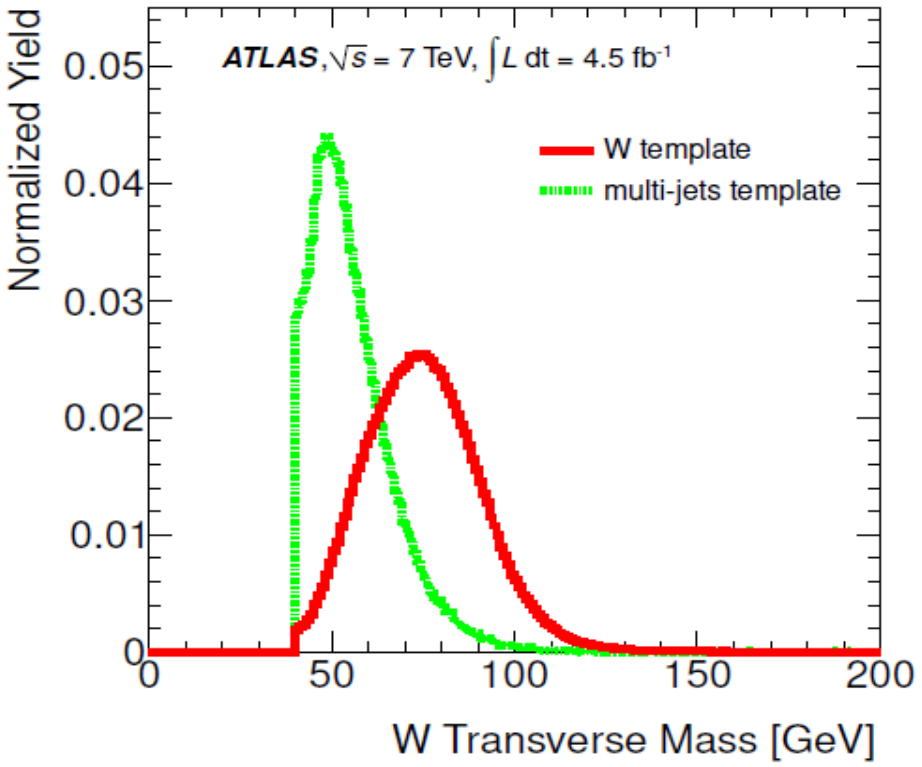


Two rapidity regions of are fitted separately, due to different mass resolution.
(different multi-scattering status and different magnetic field)

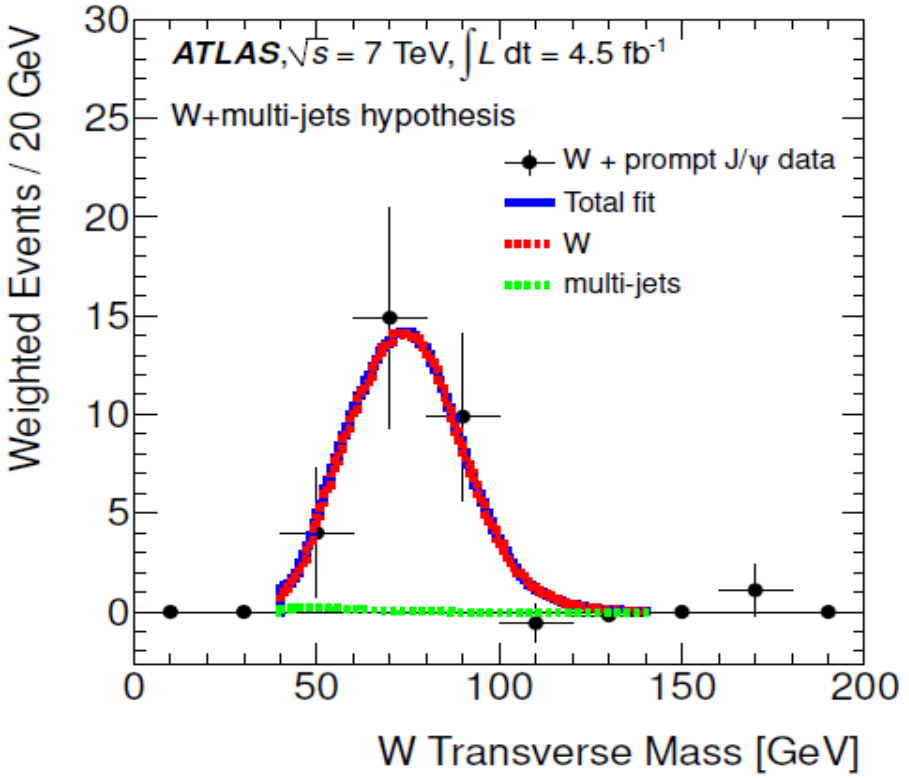
Methodology: step 2

W+J/Ψ

Fit the transverse mass or invariant mass for W or Z (event weight gotten from previous fit is applied):



(a)



(b)

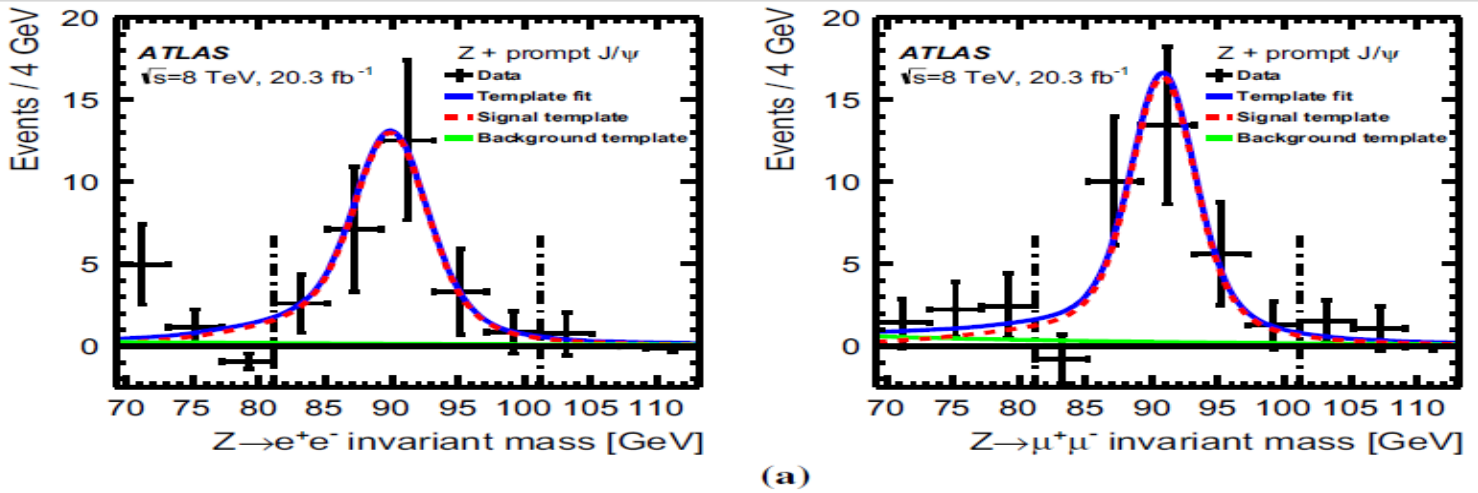
W template is from MC; multi-jet is data driven.

Methodology: step 2

Z+J/Ψ

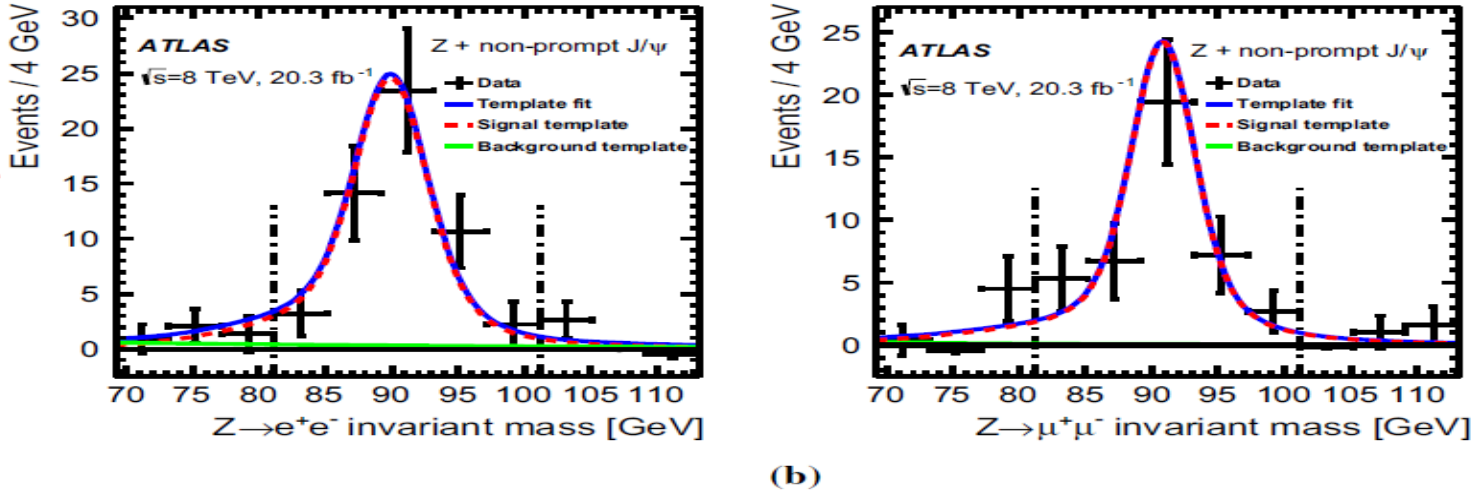
Fit the transverse mass or invariant mass for W or Z (event weight gotten from previous fit is applied):

Prompt Z to ee



Prompt Z to μμ

Non-Prompt Z to ee



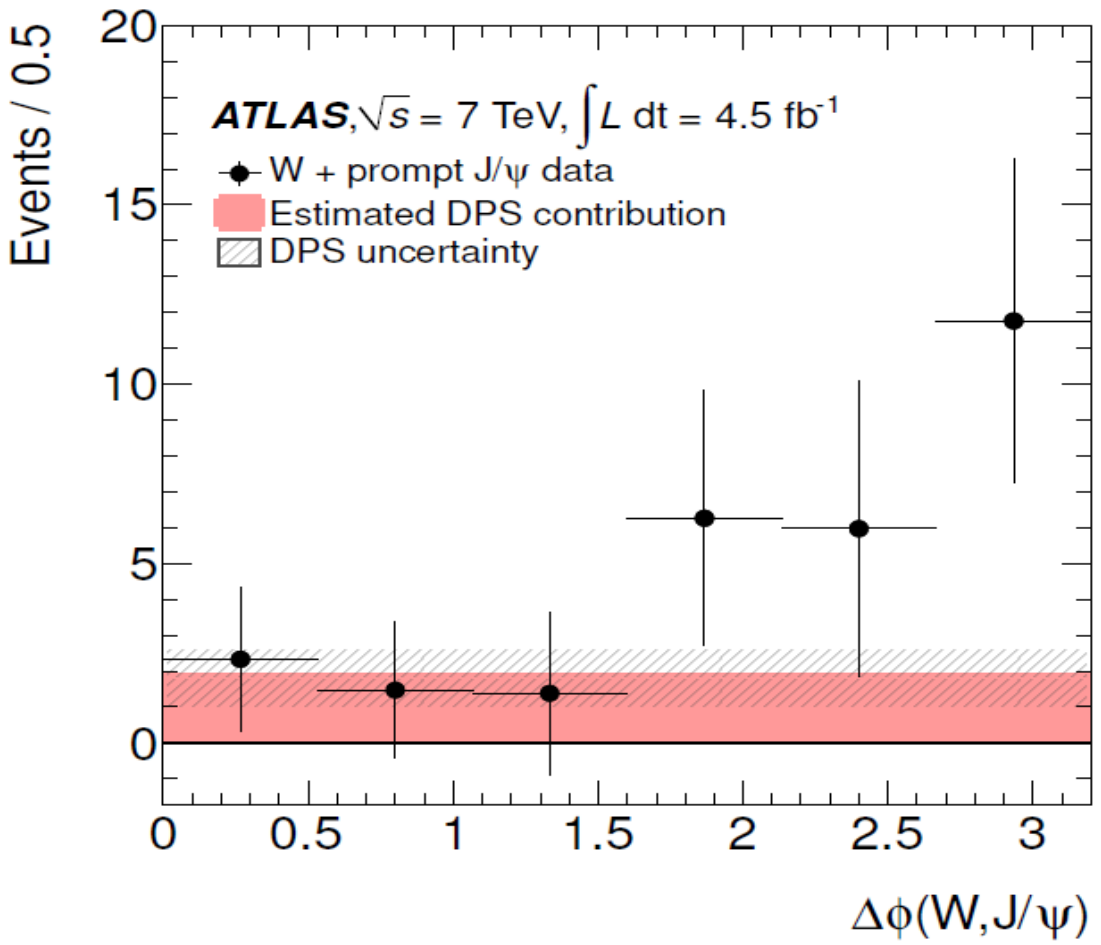
Non-prompt Z to μμ

Signal: Gaussian convolved with a BW. Background: exponential.

Methodology: step 3

W+J/Ψ

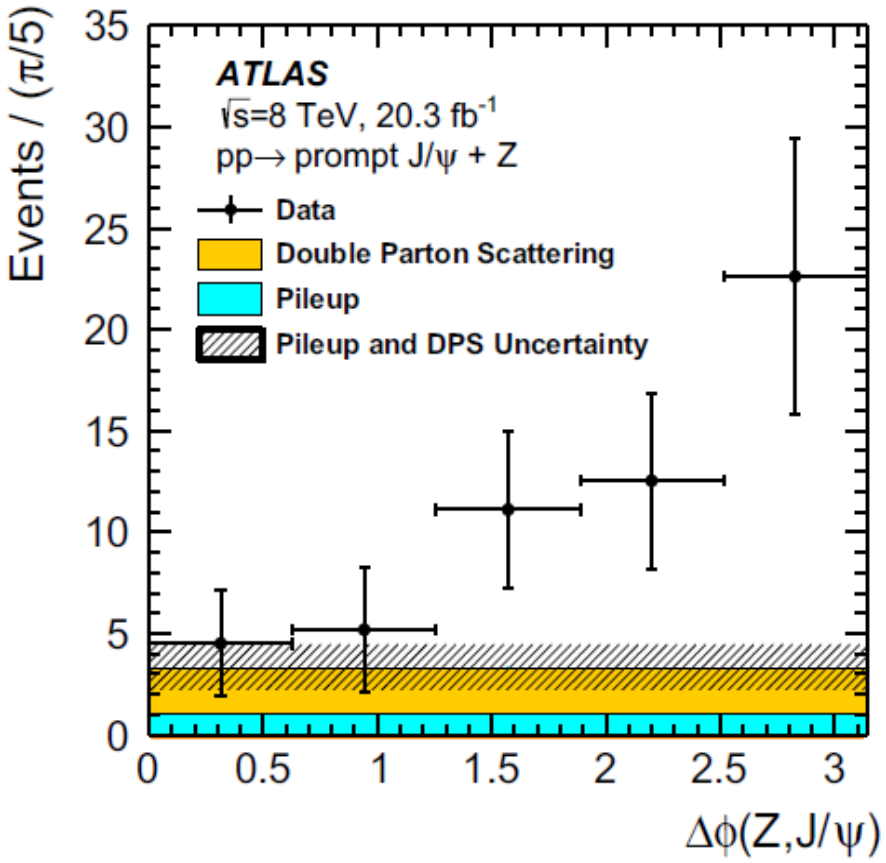
Δϕ (boson, J/Ψ) used to separate SPS and DPS, and the latter has flat distribution:



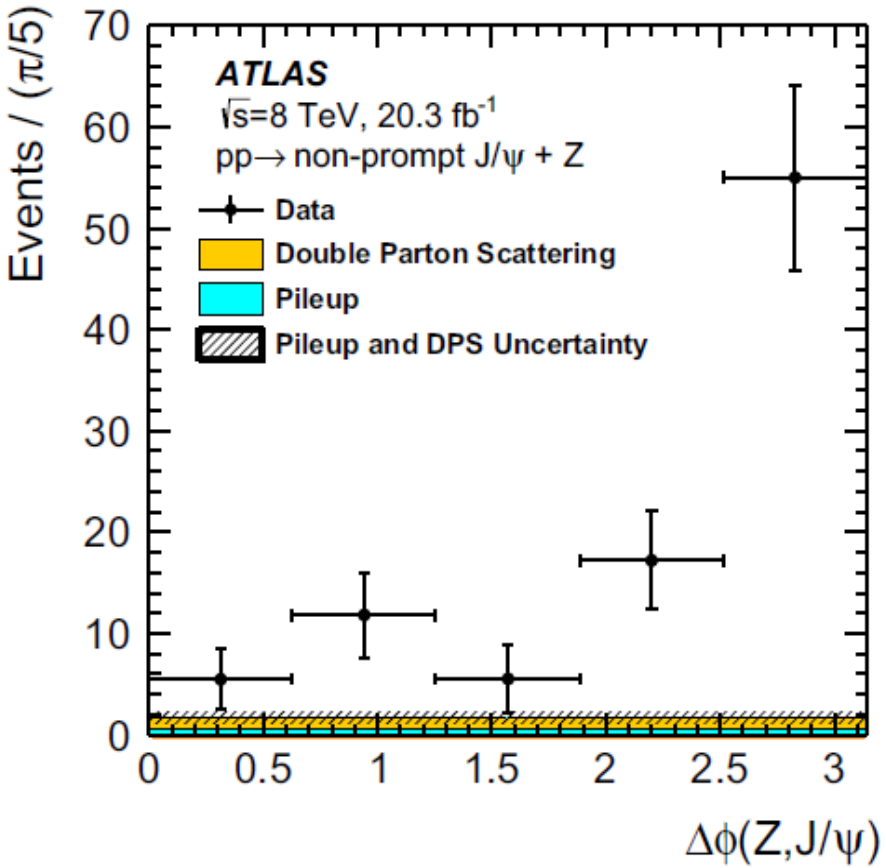
Methodology: step 3

Z+J/Ψ

Δϕ (boson, J/Ψ) used to separate SPS and DPS, and the latter has flat distribution:



Prompt

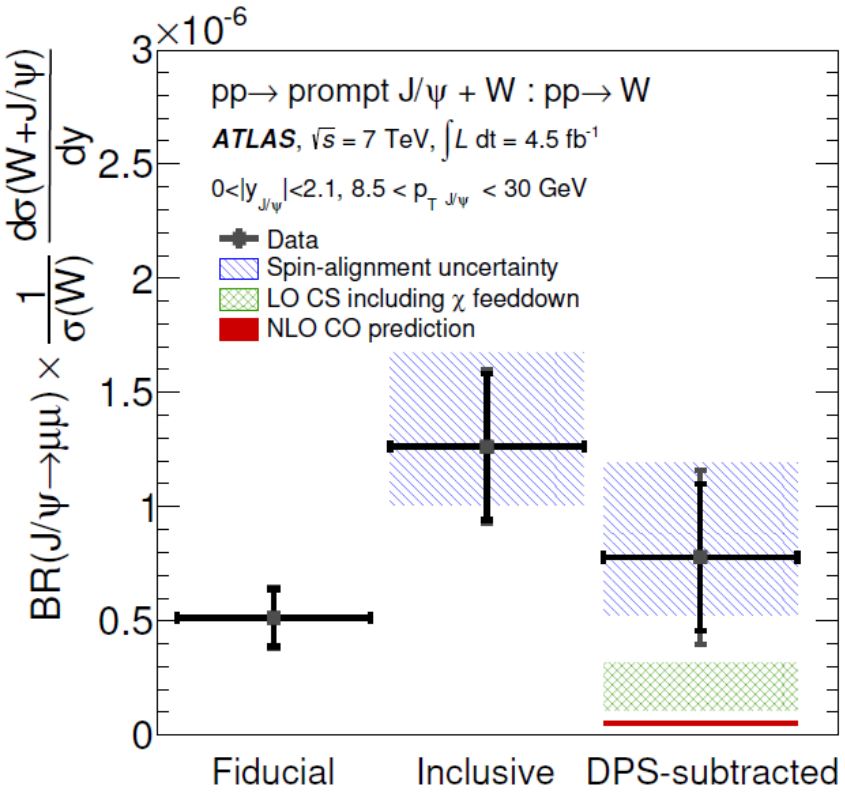


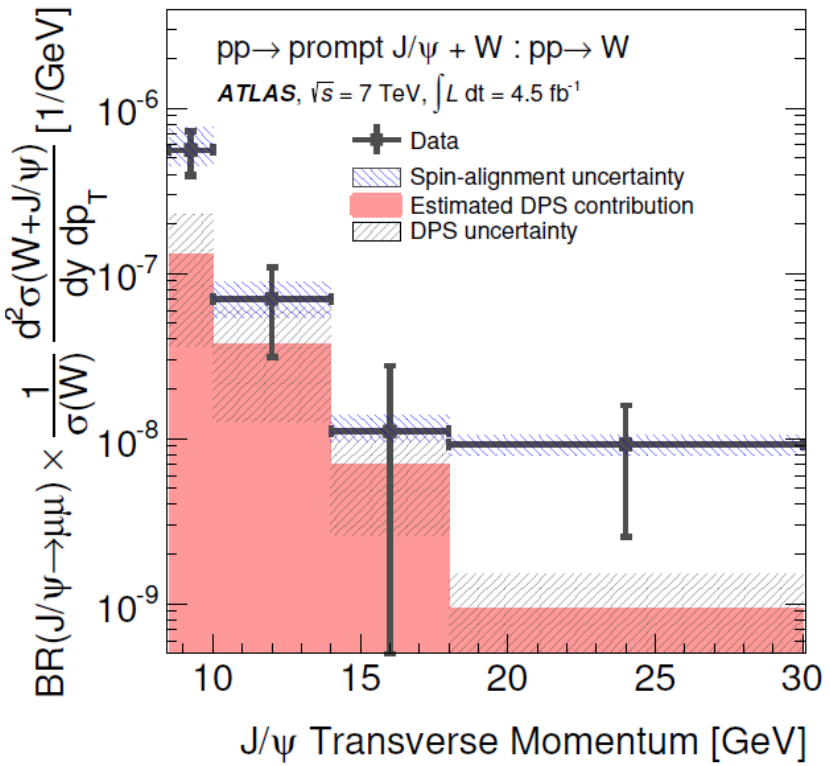
Non-Prompt

W+J/Ψ Results

1. **Observed the process: 5.1 σ**
2. **LO CS is more consistent with data, compared to NLO CO**
3. **SPS is dominant at low J/Ψ transverse momenta.**

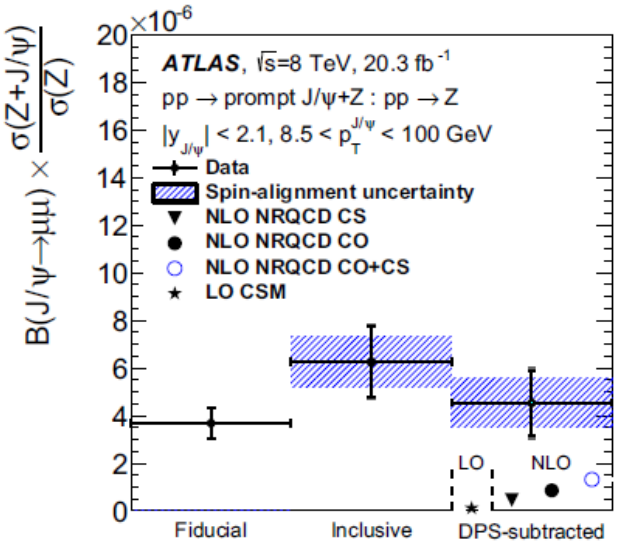
$$R_{J/\psi}^{\mathrm{fid}} = (51 \pm 13 \pm 4) \times 10^{-8}$$
$$R_{J/\psi}^{\mathrm{incl}} = (126 \pm 32 \pm 9^{+41}_{-25}) \times 10^{-8}$$
$$R_{J/\psi}^{\mathrm{DPS\ sub}} = (78 \pm 32 \pm 22^{+41}_{-25}) \times 10^{-8}$$

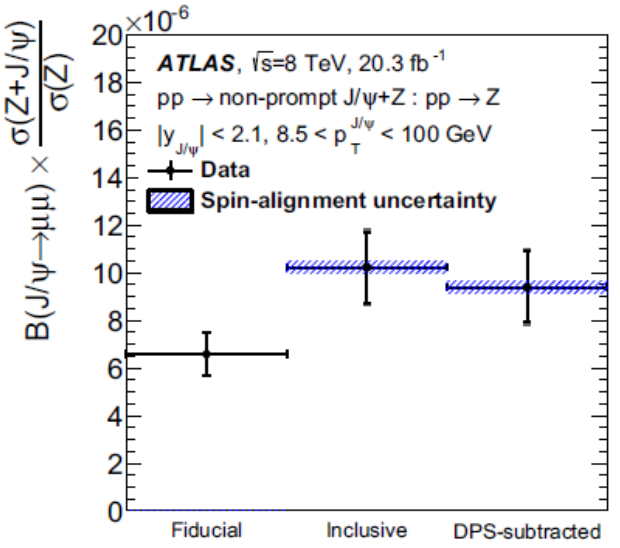




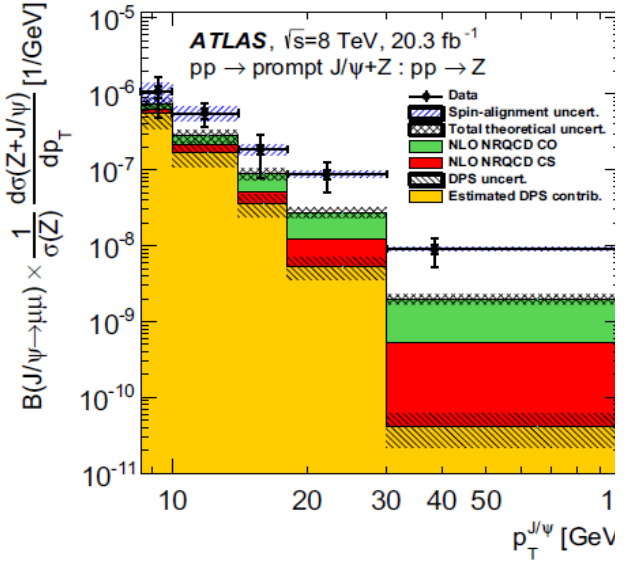
Z+J/Ψ Results

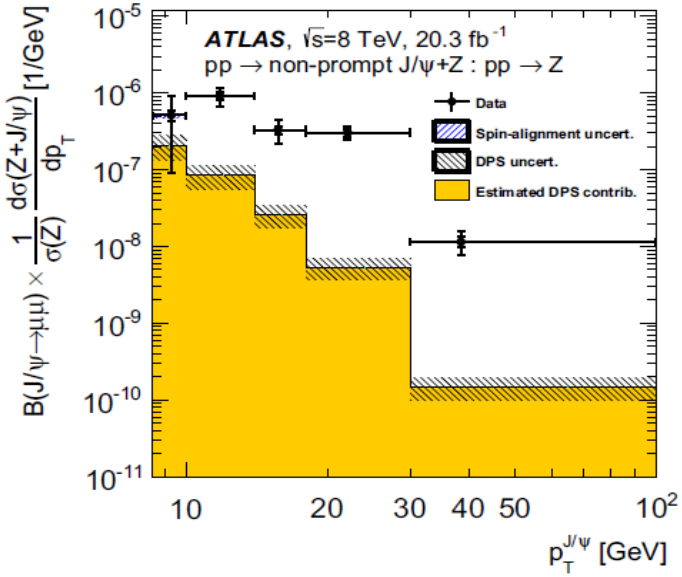
	prompt >5 σ	non-prompt >5 σ
fiducial	${}^{\mathrm{p}}R^{\mathrm{fid}}_{Z+J/\psi} = (36.8 \pm 6.7 \pm 2.5) \times 10^{-7}$	${}^{\mathrm{np}}R^{\mathrm{fid}}_{Z+J/\psi} = (65.8 \pm 9.2 \pm 4.2) \times 10^{-7}$
inclusive	${}^{\mathrm{p}}R^{\mathrm{incl}}_{Z+J/\psi} = (63 \pm 13 \pm 5 \pm 10) \times 10^{-7}$	${}^{\mathrm{np}}R^{\mathrm{incl}}_{Z+J/\psi} = (102 \pm 15 \pm 5 \pm 3) \times 10^{-7}$
DPS subtracted	${}^{\mathrm{p}}R^{\mathrm{DPS\,sub}}_{Z+J/\psi} = (45 \pm 13 \pm 6 \pm 10) \times 10^{-7}$	${}^{\mathrm{np}}R^{\mathrm{DPS\,sub}}_{Z+J/\psi} = (94 \pm 15 \pm 5 \pm 3) \times 10^{-7}$
DPS fraction	${}^{\mathrm{p}}f_{\mathrm{DPS}} = (29 \pm 9)\%$	${}^{\mathrm{np}}f_{\mathrm{DPS}} = (8 \pm 2)\%$





A higher production rate is predicted through colour-octet transitions than through colour-singlet processes, but the expected production rate from the sum of singlet and octet contributions is lower than the data by a factor of 2 to 5;
Momentum dependence is observed.





Summary

1. Both W+J/Ψ and Z+J/Ψ are observed with ATLAS data;
2. In the two processes, DPS is evident;
3. The agreement between data and current calculation is not good.

   Results with larger data sample will come soon.

Thank you very much!