Short communication: Sivers asymmetry of the J/ψ in COMPASS 2010 proton data

Jan Matoušek

TMDe2015, Trieste, Italy

Process of interest

Goal:

Sivers asymmetry in J/ψ production in scattering of μ off transversely polarized p

$$\mu^+ + p^\uparrow \to \mu^+ + J/\psi + X$$

- J/ψ identified from decay to muons... $2\mu^+ + 1\mu^- + X$ in the final state.
- Rare process... impossible to do fine binning.
- Just 2 bins in $z \overset{\text{lab}}{=} \frac{E_{J/\psi}}{E-E'}$ to distinguish inclusive and exclusive production.

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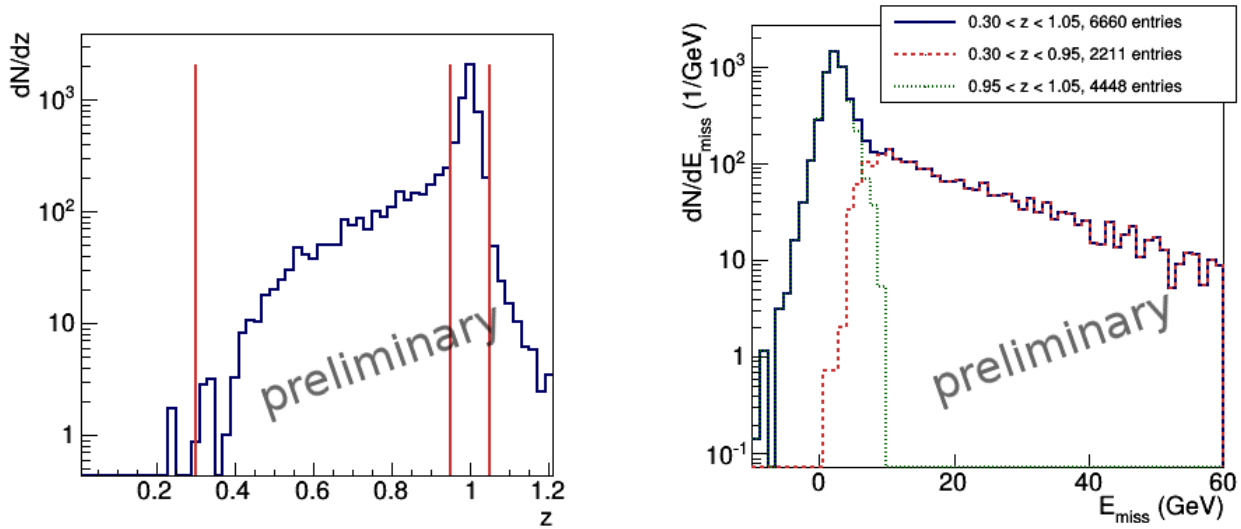

Left: The variable z with indicated boundaries of the two bins.
Right: The missing energy $E_{\text{miss}} \overset{\text{lab}}{=} E - E' - E_{J/\psi} + \frac{t}{2M_p}$.

Motivation

R. M. Godbole *et al.*: PRD 85, 094013 (2012) and PRD 88, 014029 (2013)[1]:

- Color evaporation model:
  - The LO subprocess: $\gamma + g \to c + \bar{c}$.
  - formation of J/ψ—soft process, statistic treatment of color states.
- J/ψ production could give access to **gluon Sivers function**.
- Under a lot of assumptions estimate of the asymmetry for approx. COMPASS case[2] between 0.03 and 0.18.

[1] `http://arxiv.org/abs/1201.1066`, `http://arxiv.org/abs/1304.2584`

[2] $\sqrt{s} = 17.33$ GeV, p_T integrated from 0 to 1 GeV.

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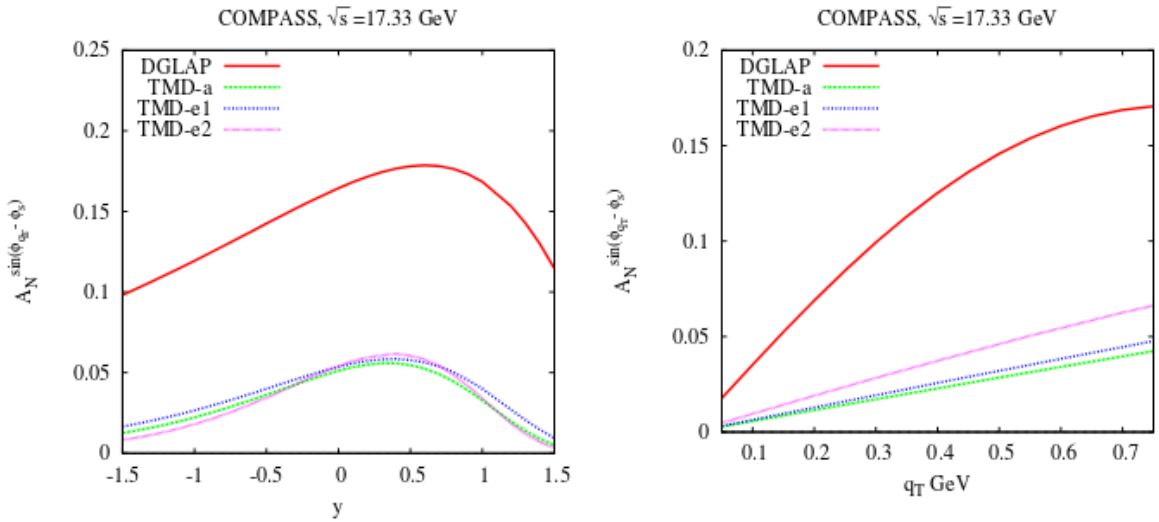

Fig. 3 COMPASS energy ($\sqrt{s} = 17.33$ GeV), Asymmetry as a function of y (left panel) and q_T (right panel). The integration ranges are $(0 \leq q_T \leq 1)$ GeV and $(-1.5 \leq y \leq 1.5)$ [6].

(William Weizsaker approximation, $k_\perp$ dependance in gaussian form, x-dependent normalization of the d quark are used; `http://arxiv.org/abs/1411.3893`)

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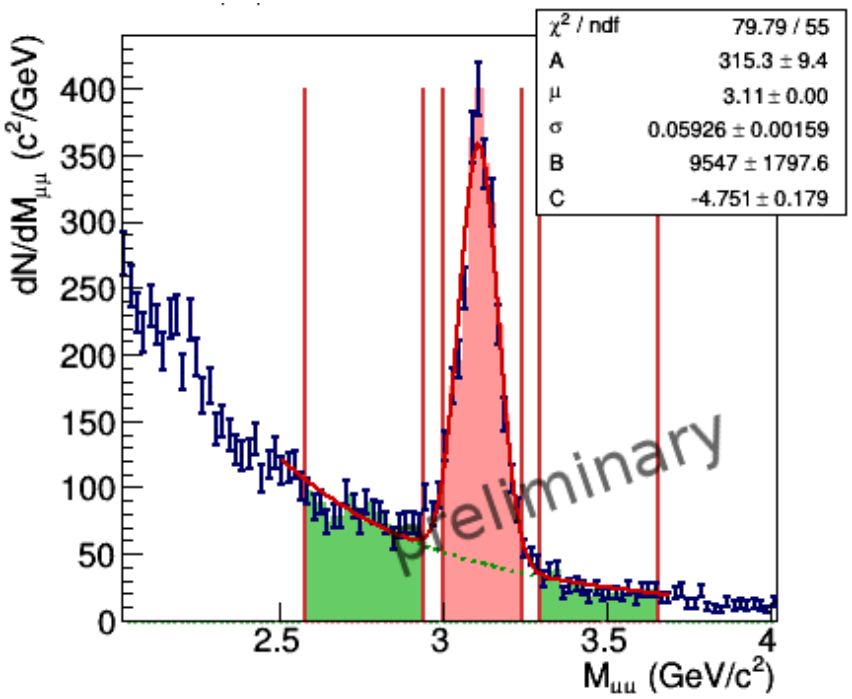
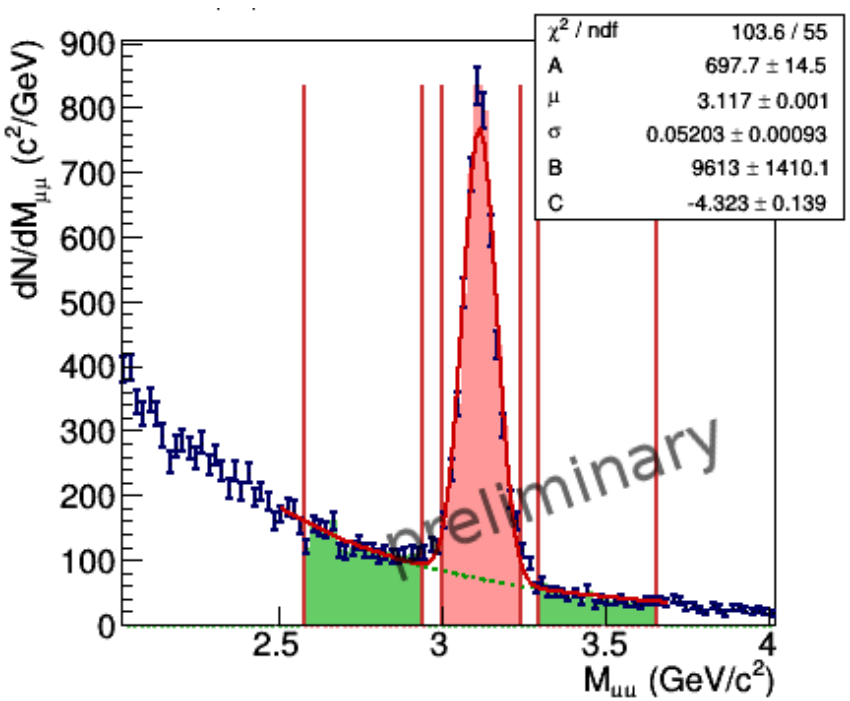
J/ψ selection by invariant mass





Dimuon invariant mass in the 2 z-bins.

- Signal band (in red): 8 026 events in total.
- 2 side-bands (in green) for background asymmetry measurement.
- The red fit is the normal distribution plus exponential background.

$$A\,N\left(M_{\mu\mu},\mu,\sigma\right)+B\,M_{\mu\mu}^{C}$$

- From the fit: 6 600 J/ψ events in total (2 211 inclusive, 4 448 exclusive).

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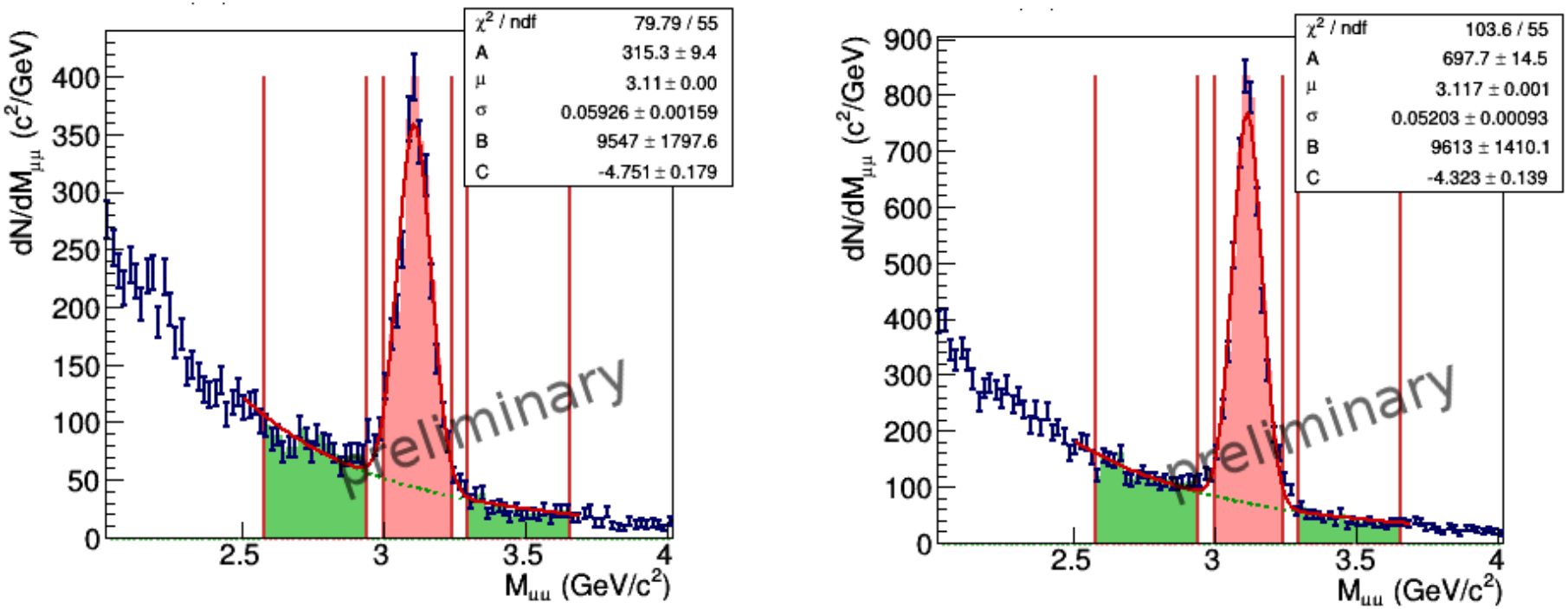

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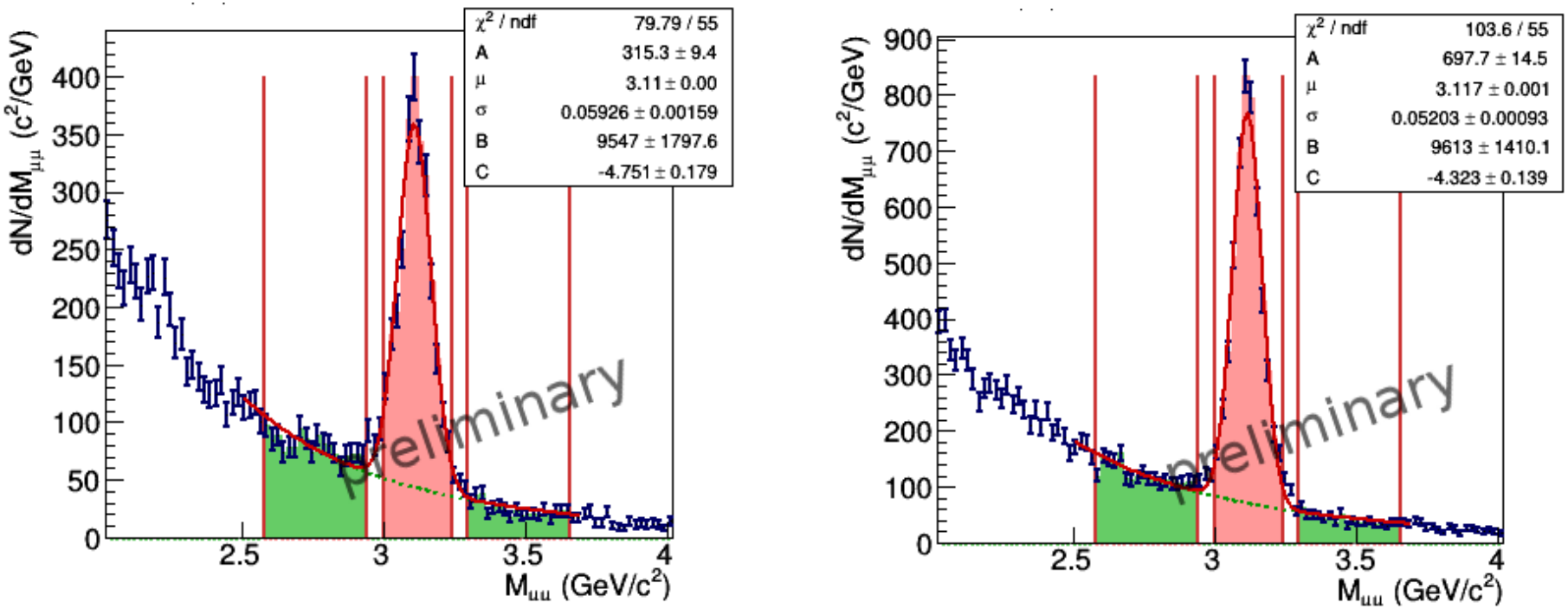

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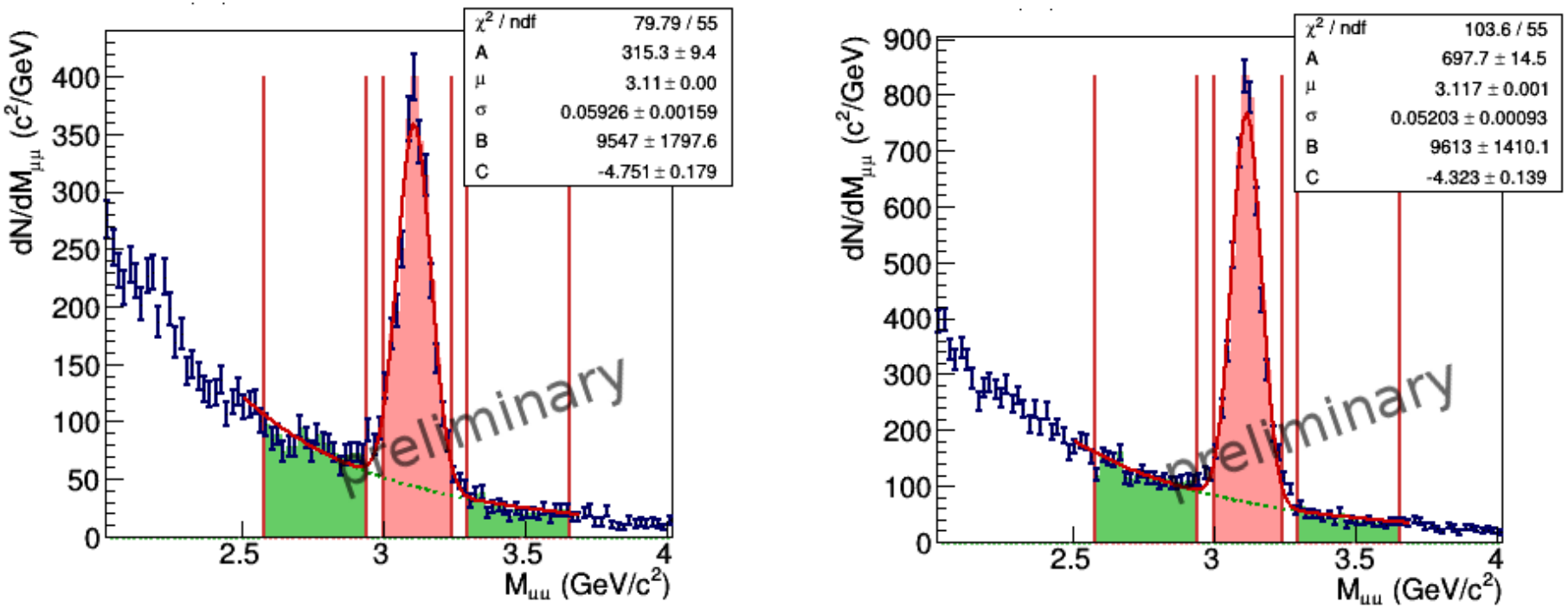

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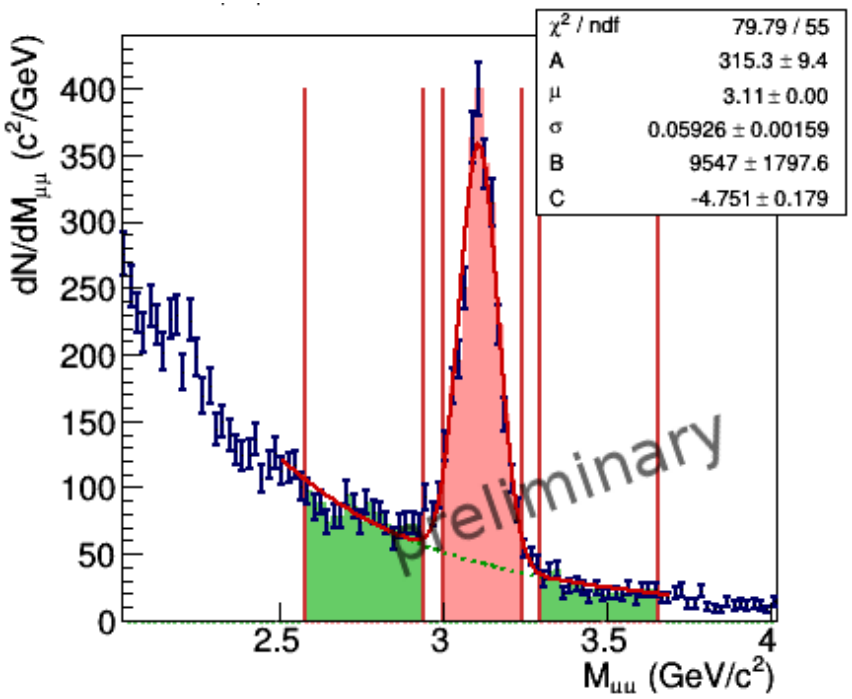

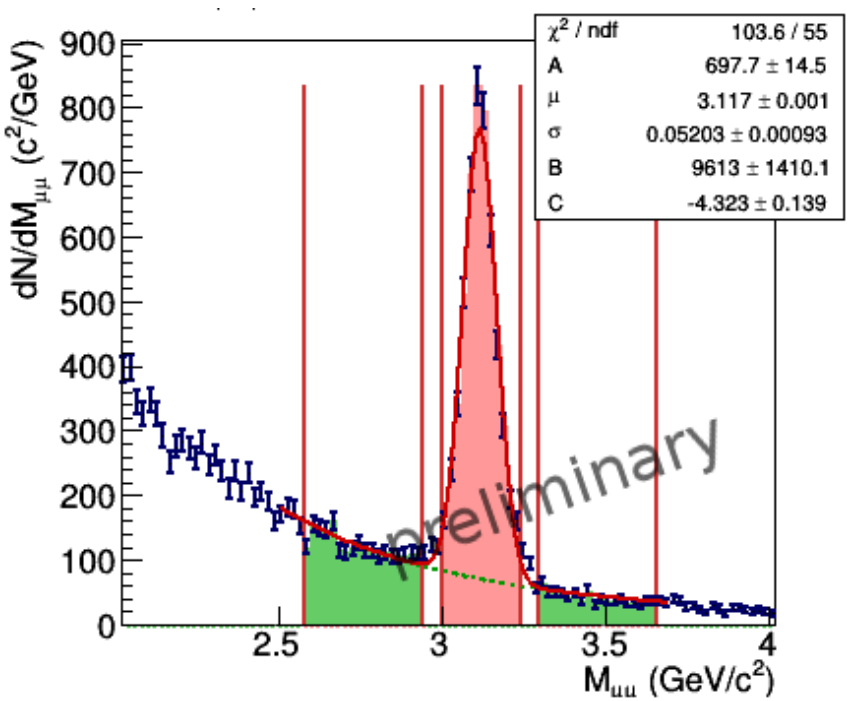

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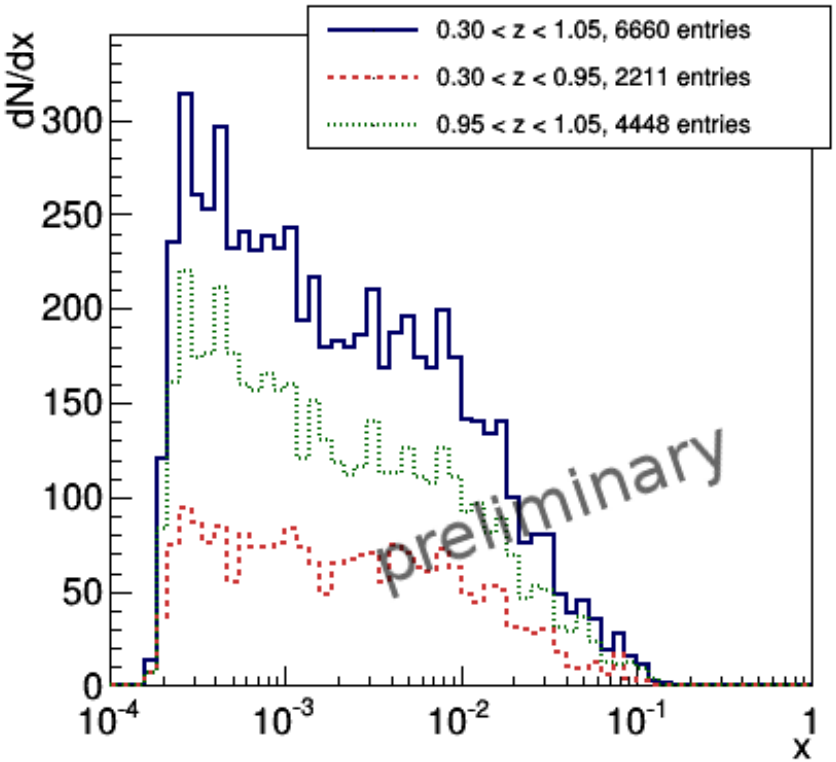

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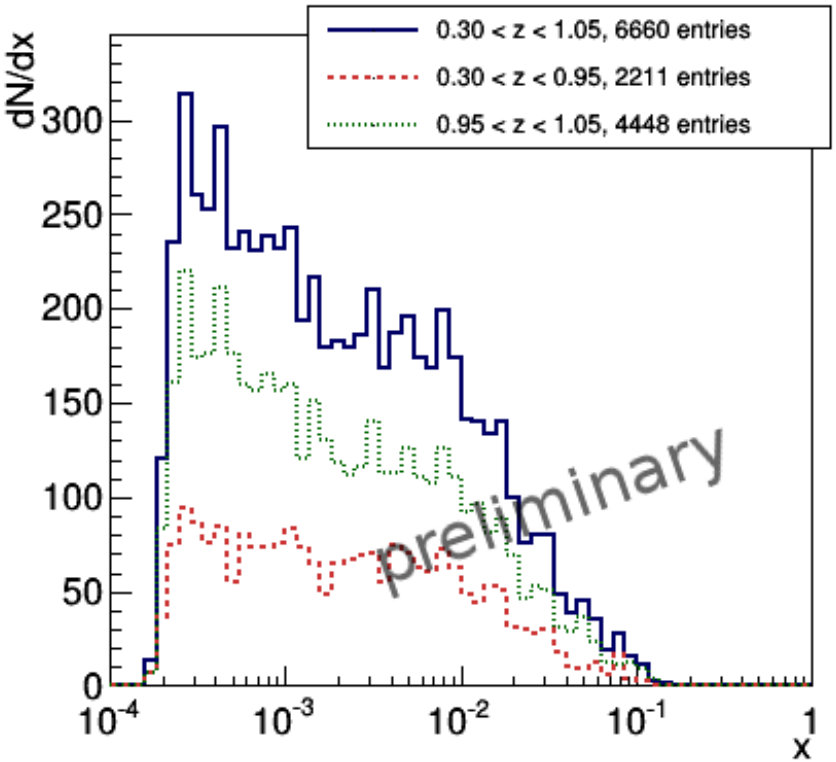

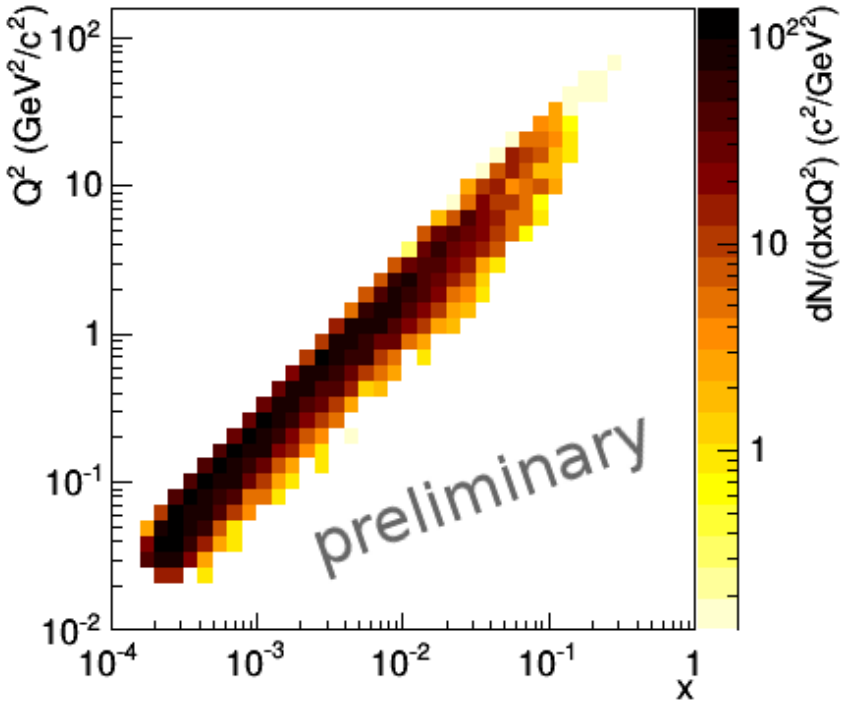

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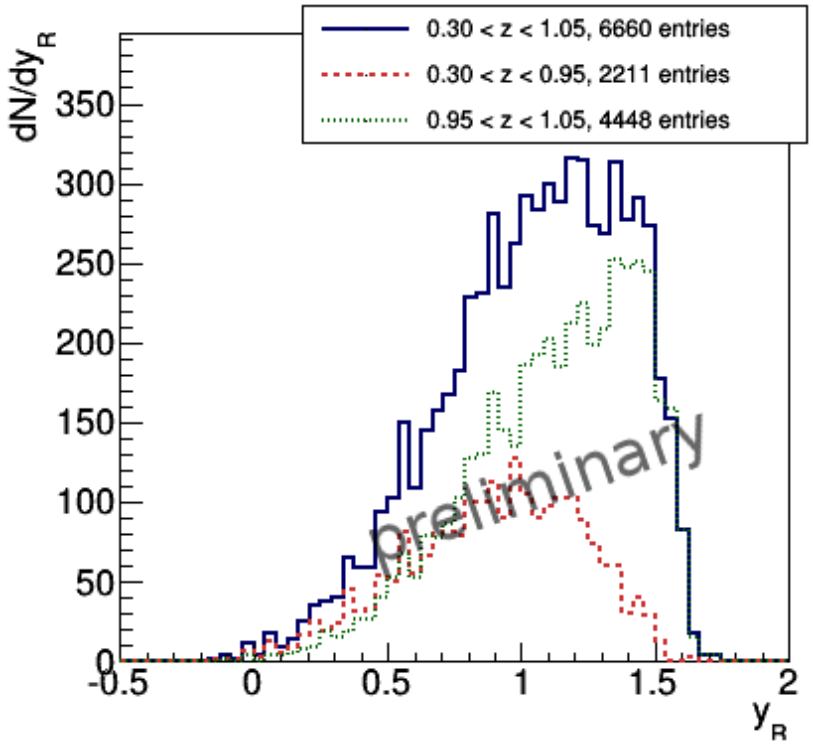
J/ψ rapidity and x-gluon



Left: The rapidity of the J/ψ in μp CMS Right: x-gluon (from the rapidity).

- Formula from R. M. Godbole *et al.*: PRD 85, 094013 (2012): $x_g = \frac{M_{J/\psi}}{\sqrt{s}} e^{y_R}$.
- x_g rather high to our taste...

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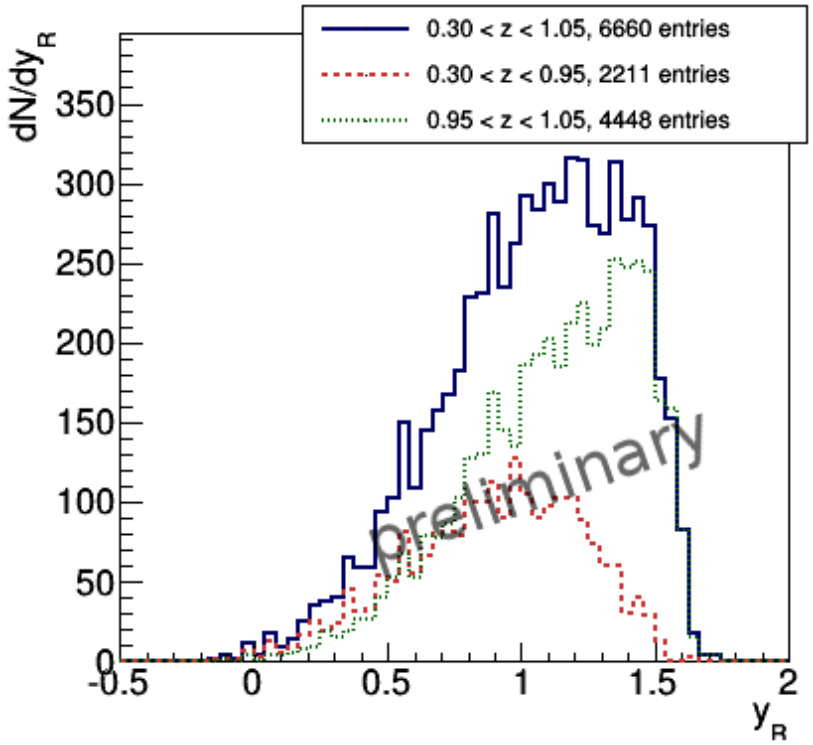

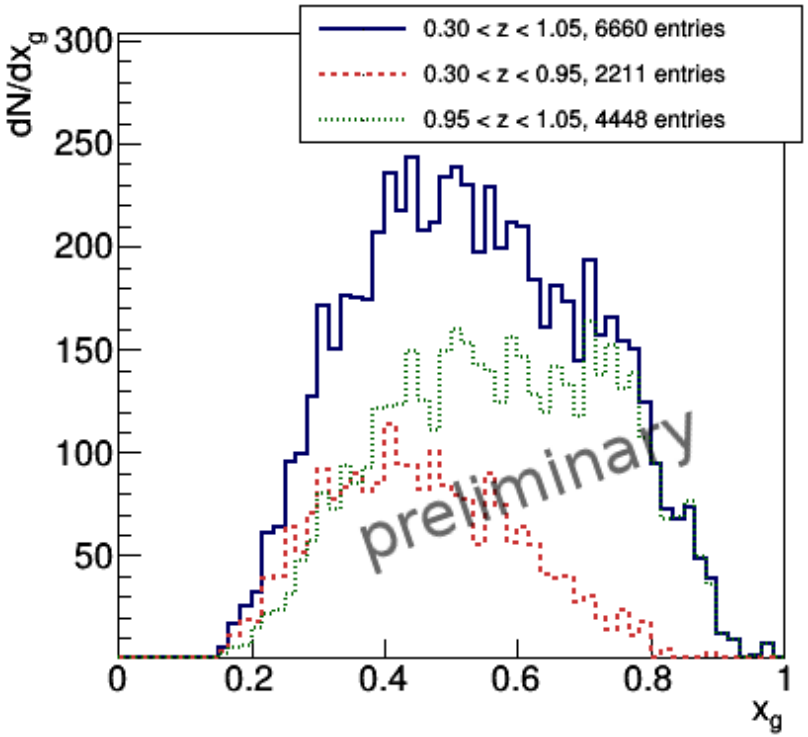

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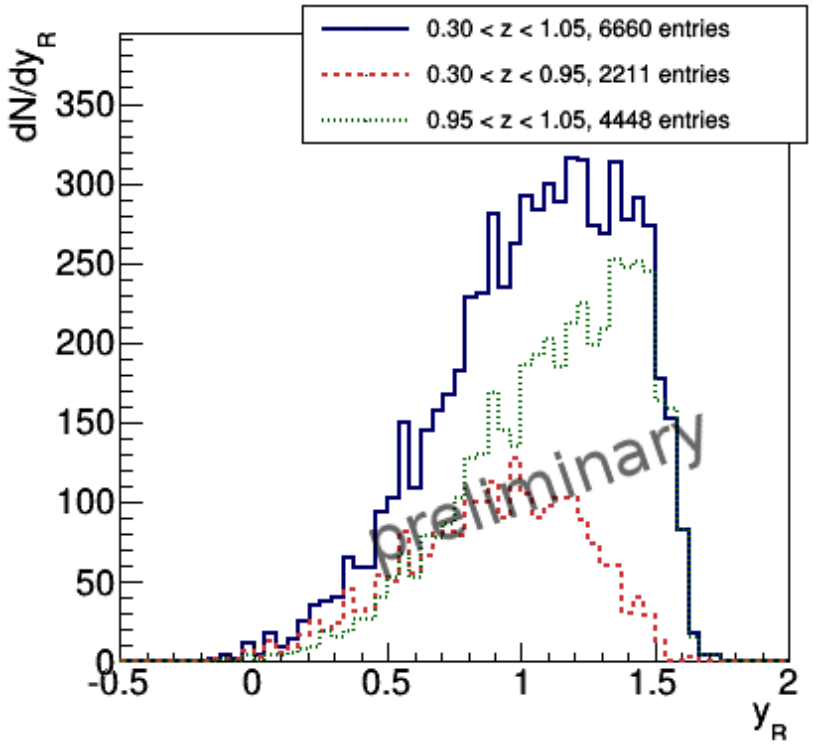

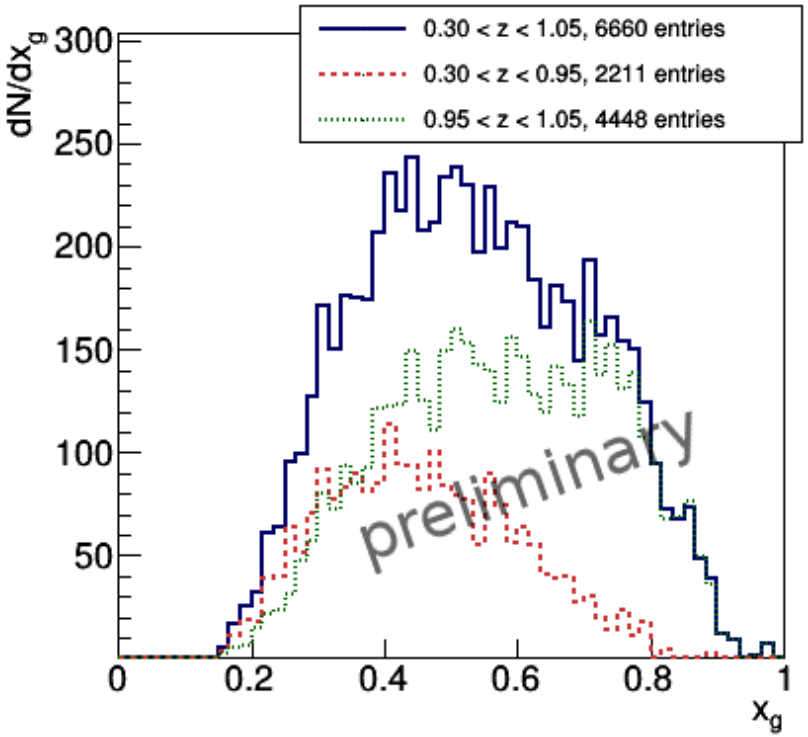

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Conclusion

- The process of interest is rare (2 211 inclusive, 4 448 exclusive J/ψ from 2010).
- The relative uncertainty is too large to give a hint for the theory.
- A_{Siv} found compatible with 0 (details in Dubna on DSPIN-2015).
- Room for possible improvement:
  - "New production"... max. 10% events more.
  - All COMPASS transverse data (p + d)... better, but still not an order of magnitude in the error...

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