Quarkonium production at the LHC: QCD corrections and new observables

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IPN Orsay – Paris-Sud 11

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Outline

Context:

1. The CSM predictions account correctly for the yield
2. Difficulties in describing mid- and high-P_T data ?
3. Colour Octet Dominance is challenged at low/mid P_T in pp
4. QCD corrections and polarisation

New Observables:

5. $\mathcal{Q} + Q$
6. $\mathcal{Q} + \gamma$

Part I

Context

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JPL, PoS(ICHEP 2010), 206 (2010)

→ The yield vs. $\sqrt{s}$ (here only LO curves)

- Unfortunately, very large th. uncertainties: masses, scales (μ_R, μ_F), gluon PDFs at low x and Q^2, ...
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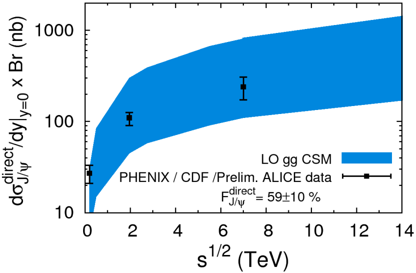

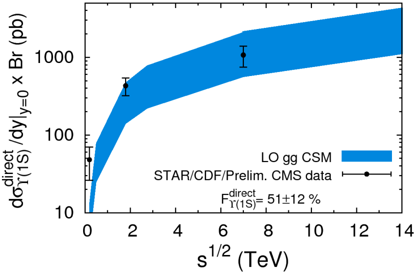

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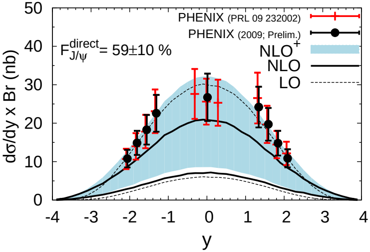

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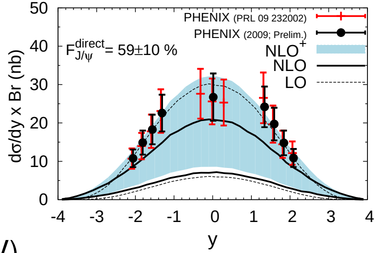

→ LHC ($\sqrt{s} = 7$ TeV)

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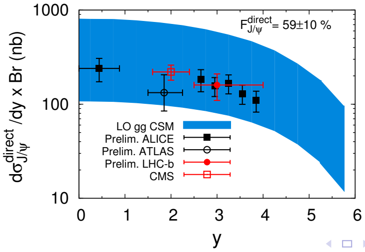

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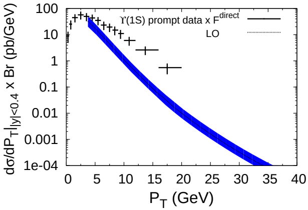

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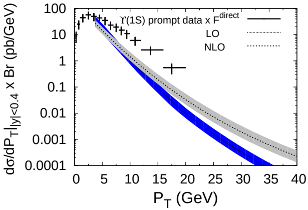

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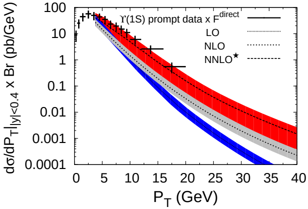

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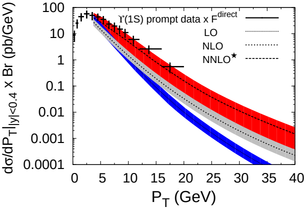

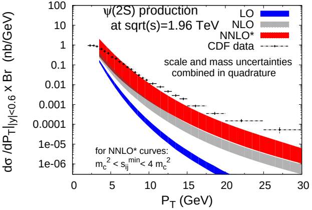

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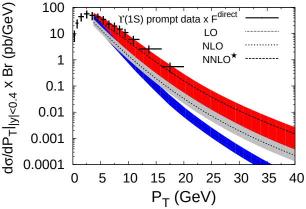

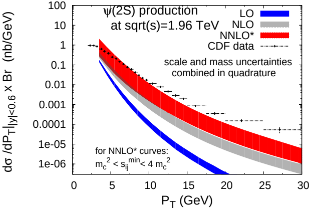

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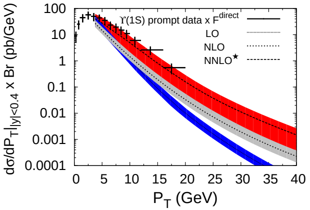

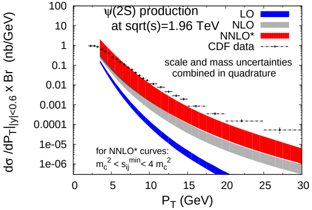

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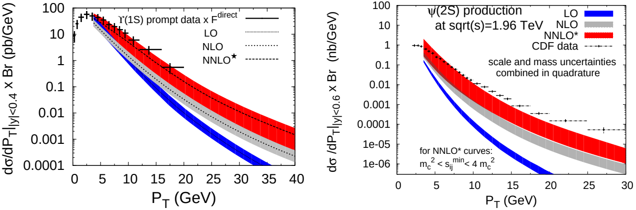

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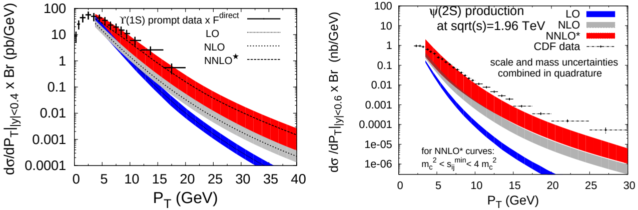

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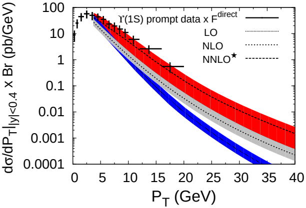

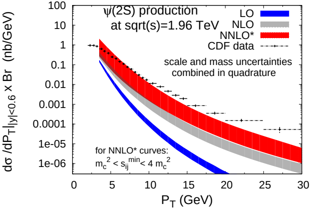

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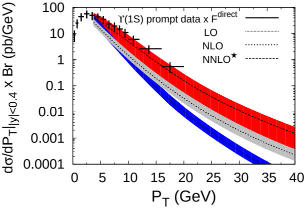

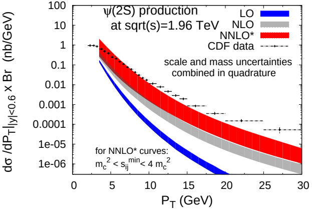

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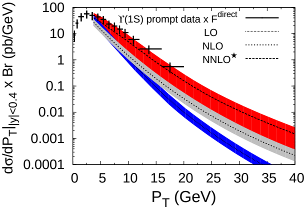

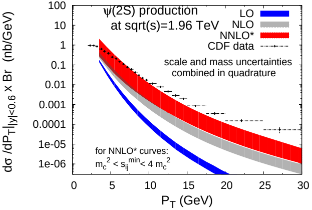

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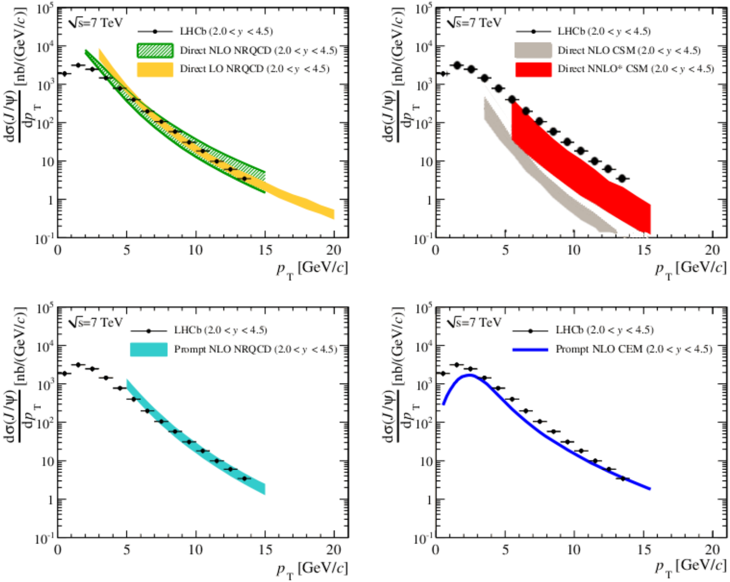
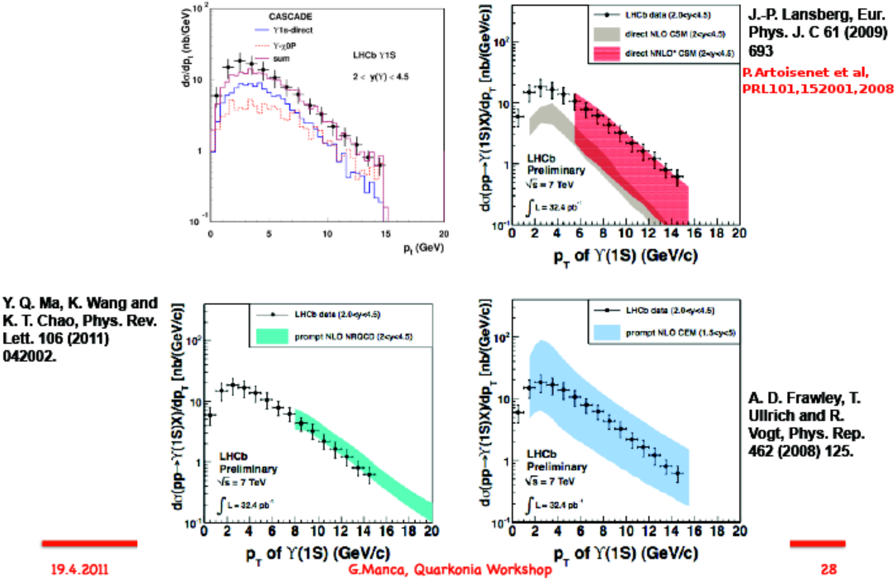
e^+e^- constraints on ${}^1S_0^{[8]}$ & ${}^3P_J^{[8]}$	k_T fact. $\leftrightarrow$ NNLO Collinear fact. ?

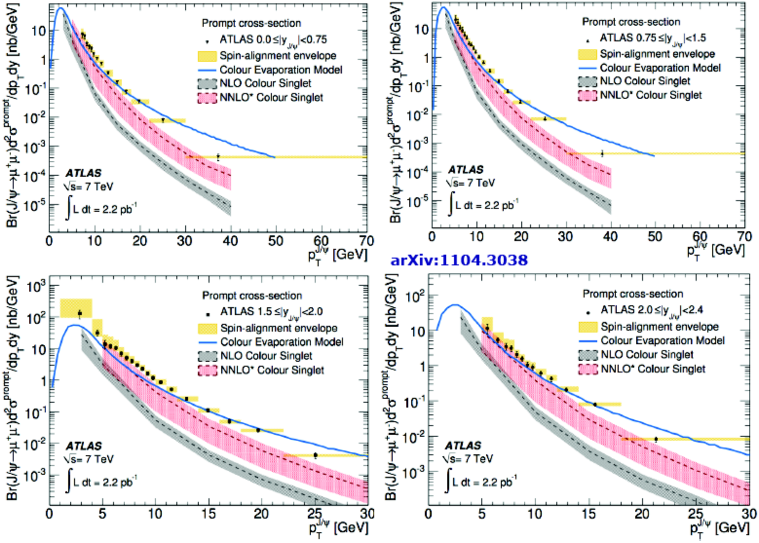
Models vs. LHCb data for the J/ψ (Courtesy of J.He & P. Robbe)



Models vs. LHCb data for the Υ (borrowed from G. Manca, April'11)



Models vs. ATLAS data for the J/ψ (borrowed from D. Price, April'11)



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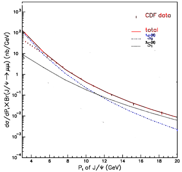

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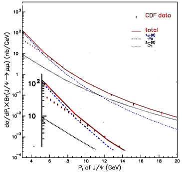

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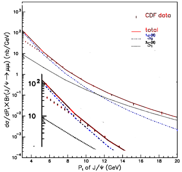

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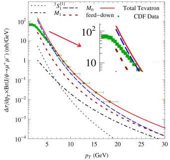

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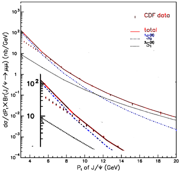

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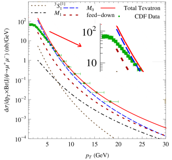

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  - ISR resummations would smear the divergence at $P_T \to 0$ out

    Would this further enhance the CO yield at low P_T ?

Υ & ψ polarisation within CSM and COM

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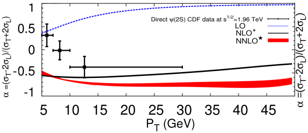

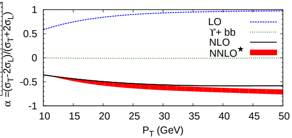

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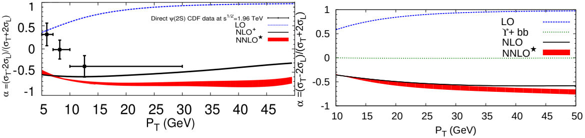

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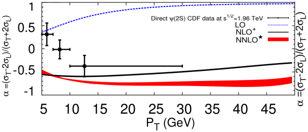

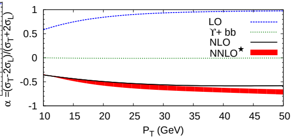

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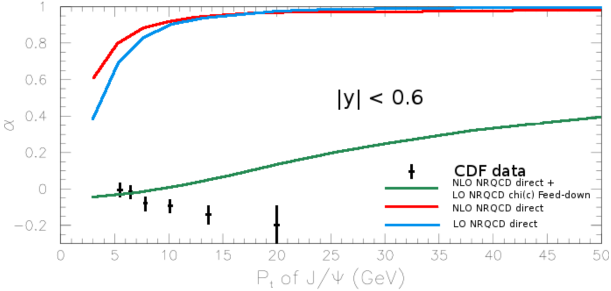

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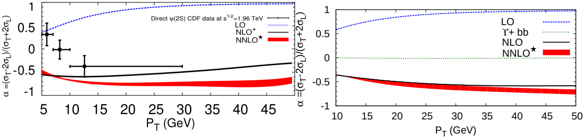

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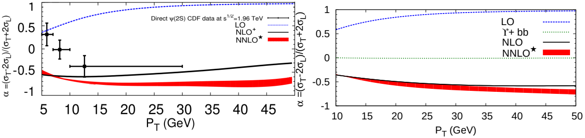

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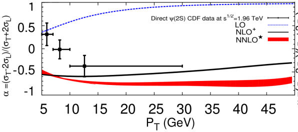

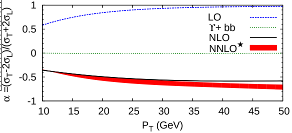

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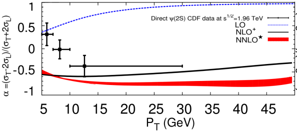

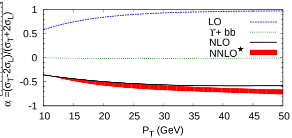

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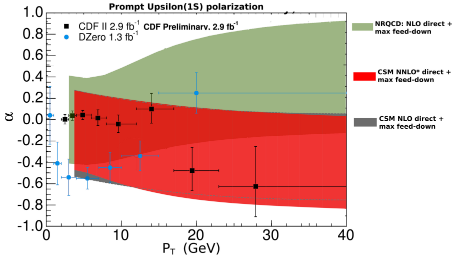

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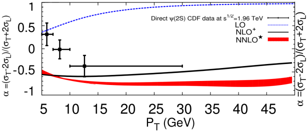

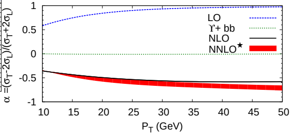

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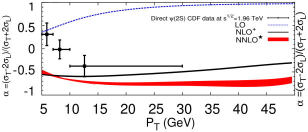

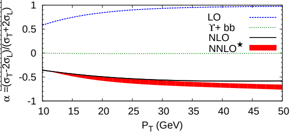

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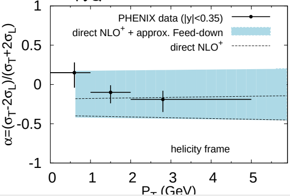

Part II

what we expect from the LHC:

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what we expect from the LHC: new measurements

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S. J. Brodsky and JPL, PRD 81 051502 (R), 2010

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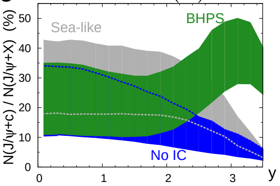

plot for RHIC kinematics

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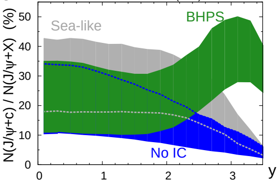

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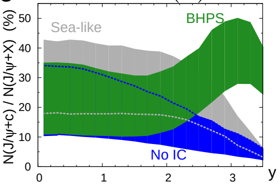

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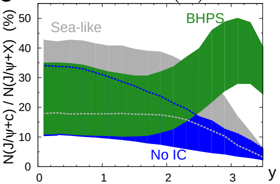

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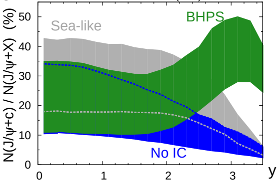

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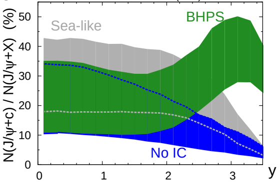

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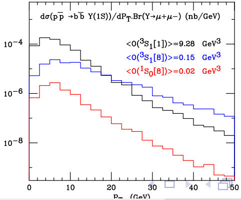

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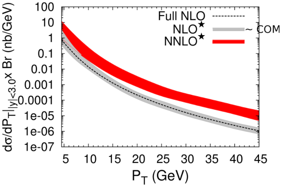

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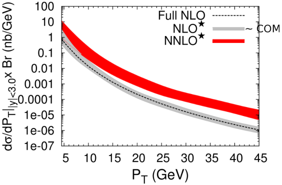

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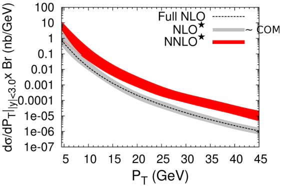

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- Possible: see $(c, b) - jet + \gamma$ studies by D0 up to $P_T^\gamma \simeq 150$ GeV !

D0, PRL102 (2009) 192002.

Part III

Conclusions and Outlooks

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- The time has come for another look with **new observables**
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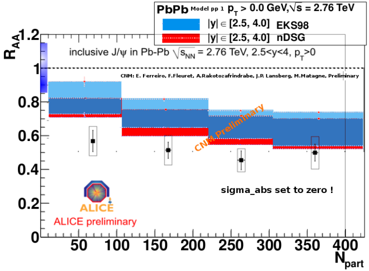
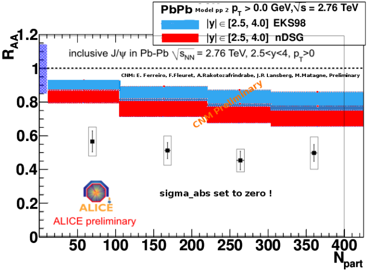
- Let us apply the lessons learnt in *pp* ($gg \to \psi g$) to compute CNM in PbPb:





Without P_T cut and forward (ALICE acceptance)

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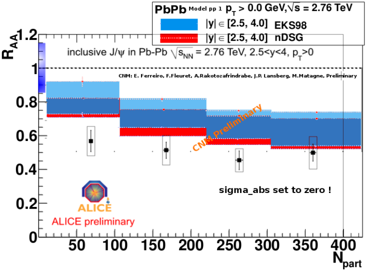

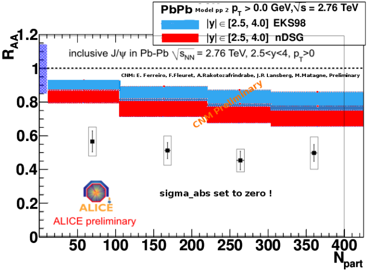

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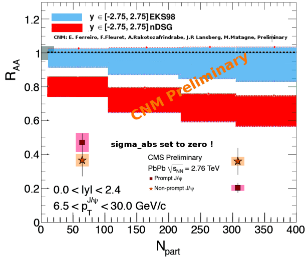

With $P_T > 6.5$ GeV cut and mostly central (CMS/ATLAS acceptance)

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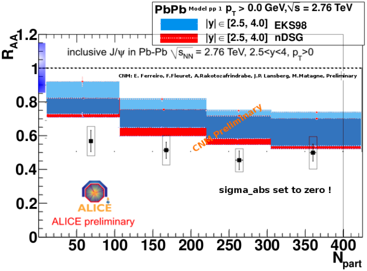

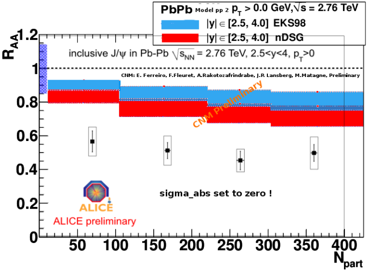

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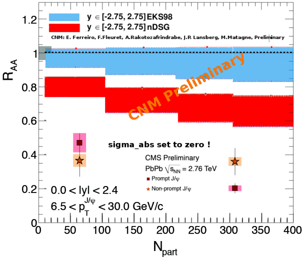

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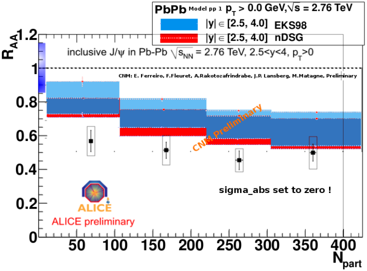

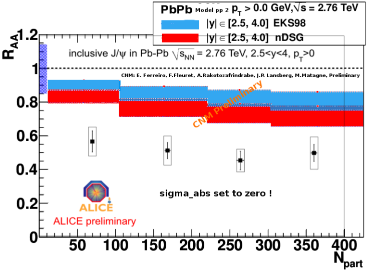

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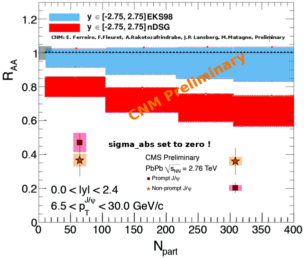

With $P_T > 6.5$ GeV cut and mostly central (CMS/ATLAS acceptance)

- Non trivial effect of the P_T cut. $\sigma_{abs}^{effective} = 0$mb ?
- Need for a better understanding of shadowing (at small and not so small x)

Part IV

Backup

Describing the mid- and high-P_T's: QCD corrections

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J.Campbell, F. Maltoni, F. Tramontano, Phys.Rev.Lett. 98:252002,2007
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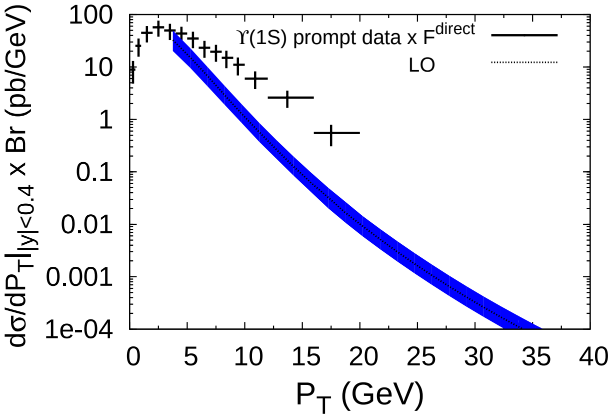

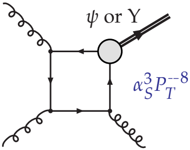

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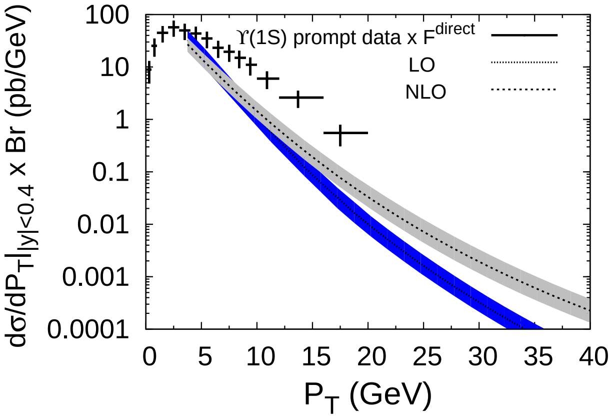

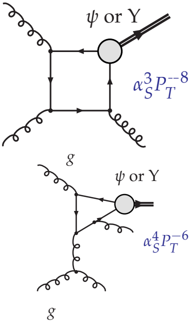

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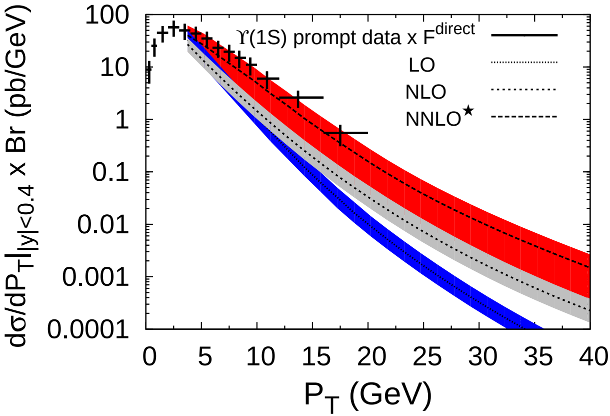

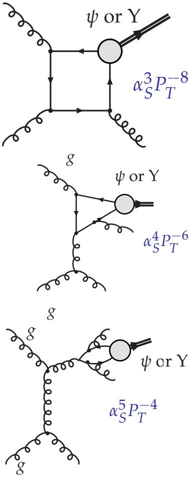

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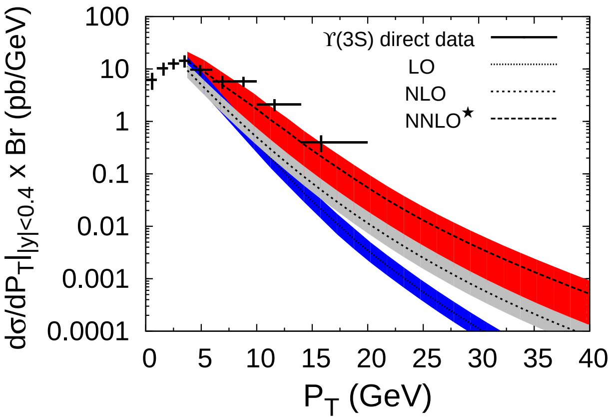

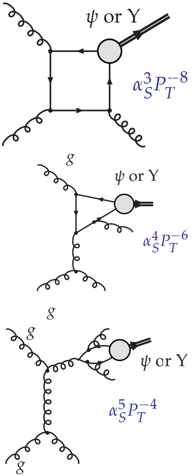

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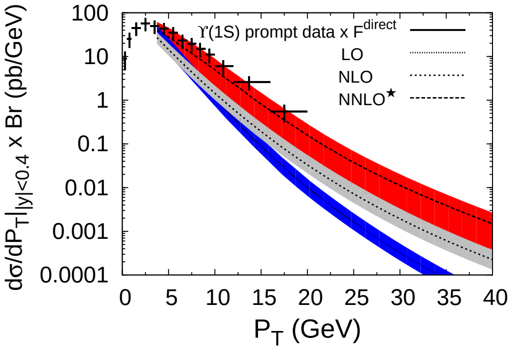
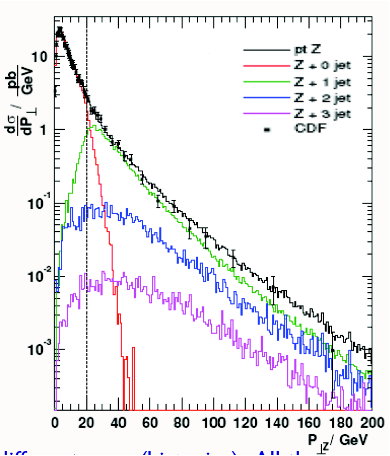
Analogy with the P_T spectrum for the Z^0 boson





New observables

→ $J/\psi+$ hadron azimuthal correlations **STAR Collab., Phys.Rev.C80:041902 (R),2009.**

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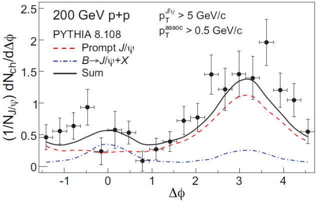

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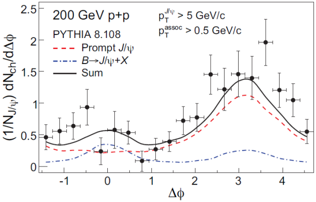

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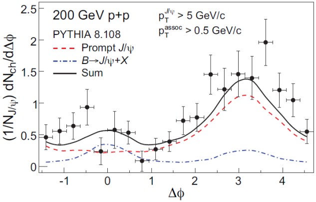

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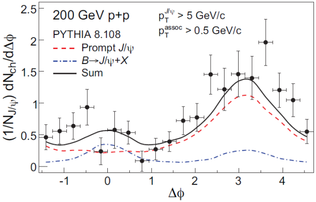

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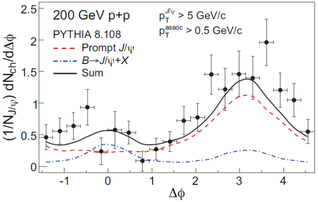

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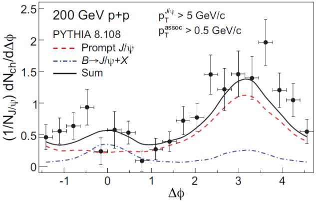

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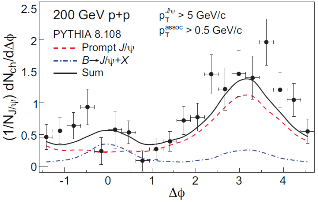

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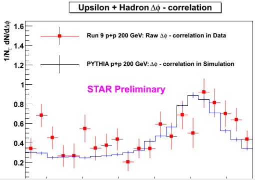
Talk by M. Cervantes (STAR) at WWND 2011



Gluon shadowing at different scales for Pb ions