Nucleus-nucleus collisions:
Summary of the round table

Émilien Chapon

Pol Gossiaux (round table)

Ivan Vitev, Antoine Lardeux,
Manuel Calderón de la Barca Sánchez, Jana Crkovska (talks)

Quarkonia as Tools 2019

Aussois, France

Talks in the morning

Quarkonium dynamics and energy loss	*Dr Ivan Vitev*	*Centre Paul Langevin*	08:30 - 09:10
Charmonia in AA	*Dr Antoine Lardeux*	*Centre Paul Langevin*	09:10 - 09:50
Coffee break		*Centre Paul Langevin*	10:00 - 10:30
Bottomonia in AA	*Manuel Calderon De La Barca Sanchez*	*Centre Paul Langevin*	10:30 - 11:10
Quarkonia in small systems	*Jana Crkovska*	*Centre Paul Langevin*	11:10 - 11:50

Many thanks to the speakers for the review talks!!

Topics discussed at the round table (Pol Gossiaux)

Topic I: Charmonia as a hard probe of QGP ?

Topic II: the "standard" (and not so standard) factorization for AA

Topic III: (the unbearable flatness of) $R_{AA}(N_{part})$

Topic IV: the flows... and possible benefits from higher states

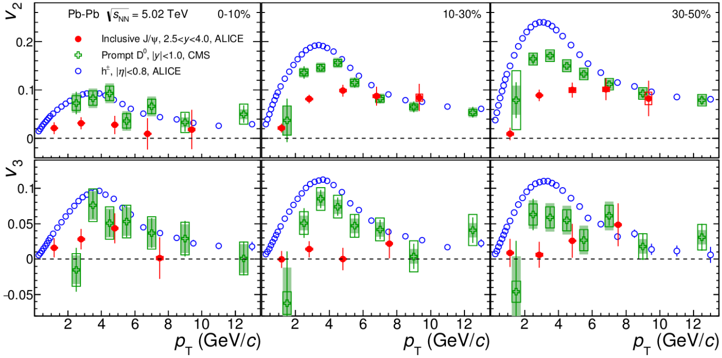
Topic V: HQ interaction in the medium and with the medium

Topic VI: Quarkonia at intermediate and high pT

Topic VII: Quarkonia and HF in small systems

Thanks a lot Pol for the preparation and steering the discussion!

Elliptic flow v_2



- ordering at low p_T
- universality at high p_T

Elliptic flow v_2

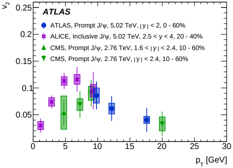
Why wouldn't J/ψ v_2 be described similarly to light hadrons? (J-P Lansberg + J-Y Ollitrault)

Remember, at least 2 mechanisms for v_2:

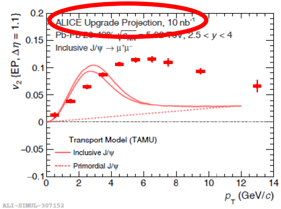
- energy loss at high p_T (path length dependence)
- bulk flow (i.e. interactions with the bulk) at low p_T (pressure anisotropies)

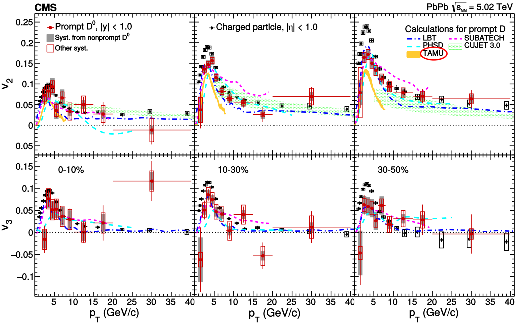
- Discussion about correlated pairs... how much they contribute (not much? $\sim$ dipole $\rightarrow$ small xsec)
- Statistical hadronisation model ruled out by v_2?

high p_T v_2



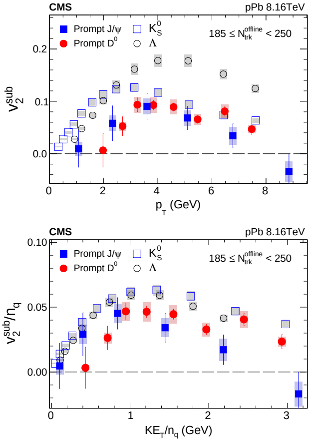
- High p_T v_2: connection with jet fragmentation? Transport models lack $g \to J/\psi$ fragmentation: not expected to work at high p_T





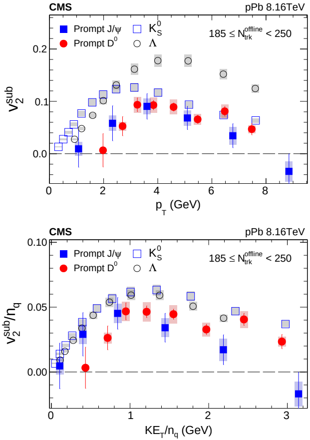
v_2: pA, y

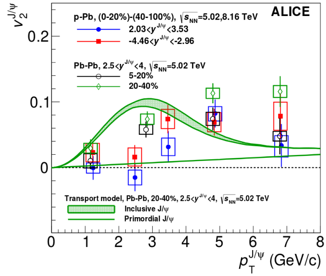
- v_2, v_3 vs KE_T/n_q?



v_2: pA, y

- v_2, v_3 vs KE_T/n_q?
- v_n vs y? little dependence in AA. In pA: higher at backward?? comovers vs QGP??





Time vs quantum effects in models

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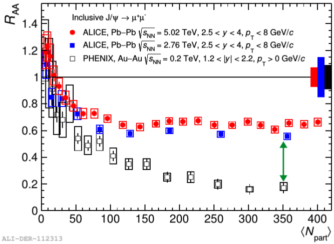
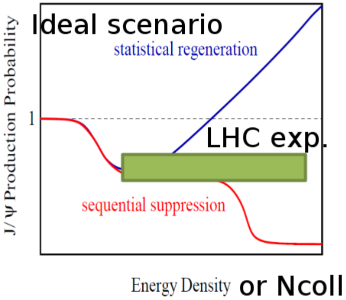
- It is important for models to include correlations between states: move away from diagonal approximation
- One idea: instead of LDMEs, work with $Q\bar{Q} + (\mathrm{bkg}) \to \mathcal{Q}$

Flatness of the R_{AA} at the LHC as a function of centrality





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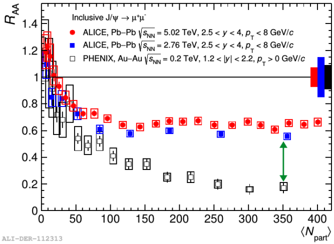
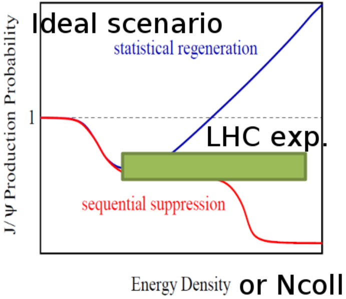
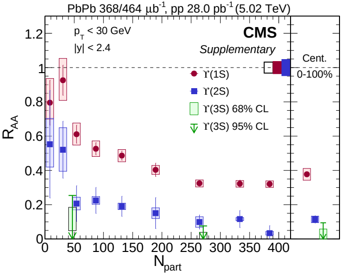
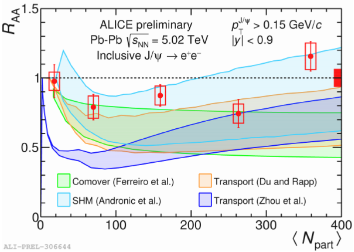




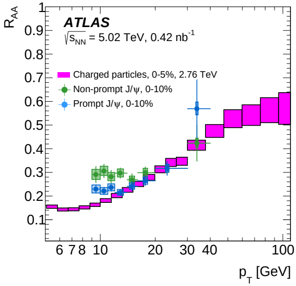


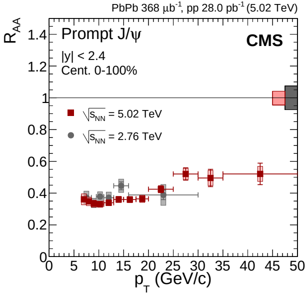


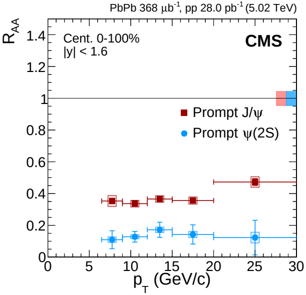
Flatness of the R_{AA} at the LHC as a function of centrality

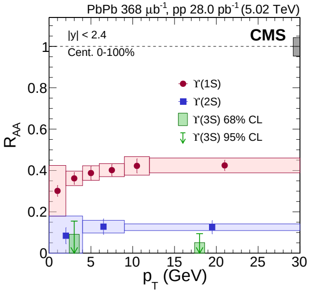
- Very flat R_{AA}! Maybe even more puzzling: flat BOTH at 2.76 and 5.02 TeV. Magic compensation?
- Low energy (between RHIC and top LHC) to check? < 1 TeV
- Remember however: upsilons are not flat at all
- J/ψ at midrapidity: small increase towards central? need more precise data
- Not much enthousiasm for other A than Pb...
- ψ(2S)? precise (but not reliable?) predictions from SHM. LHC data currently lack precision, no data from RHIC

High p_T


ATLAS
√sNN = 5.02 TeV, 0.42 nb-1
Charged particles, 0-5%, 2.76 TeV
Non-prompt J/ψ, 0-10%
Prompt J/ψ, 0-10%
RAA
pT [GeV]


PbPb 368 μb-1, pp 28.0 pb-1 (5.02 TeV)
Prompt J/ψ
CMS
|y| < 2.4
Cent. 0-100%
√sNN = 5.02 TeV
√sNN = 2.76 TeV
RAA
pT (GeV/c)


PbPb 368 μb-1, pp 28.0 pb-1 (5.02 TeV)
Cent. 0-100%
|y| < 1.6
CMS
Prompt J/ψ
Prompt ψ(2S)
RAA
pT (GeV/c)


PbPb 368 μb-1, pp 28.0 pb-1 (5.02 TeV)
|y| < 2.4
Cent. 0-100%
CMS
Υ(1S)
Υ(2S)
Υ(3S) 68% CL
Υ(3S) 95% CL
RAA
pT (GeV)

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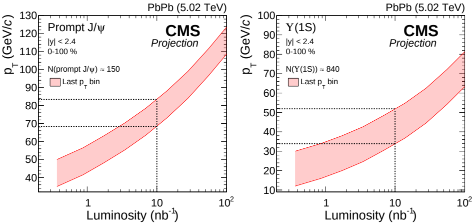
- Is the ATLAS/CMS high p_T prompt J/ψ trend real? to be followed up. Not seen in ψ(2S)?? (though lower p_T – also, remember J/ψ vs ψ(2S) in pPb...)



Energy loss

- Coherent energy loss: along the beam axis, not transverse. How do $c\bar{c}$ survive interactions (how are quantum numbers not changed?)
- Polarisation in pA/AA? Difficulty: it is ~ 0 in pp... SHM predicts 0 polarisation in AA
- Drell-Yan as reference: energy loss on partons ($\rightarrow$ onia), not on γ^*
- Energy loss in a nutshell:
  - $\epsilon = \Delta p_T / p_T$
  - $\sigma \propto p_T^{-n}$
  - energy loss $\rightarrow$ shift spectrum to the left $\rightarrow$ suppression (R_{AA})
- Should be the same for J/ψ and ψ(2S) (same n for the p_T spectrum)
- Note: avoid calling everything "energy loss"... generates confusion

My (biased) take-home messages

- For maximum model descrimination / parameter inference:
  - Push experimental precision, publish covariance matrices, etc. make quantitative statements
  - Push to high p_T
  - v_2 especially challenging for models, also p_T dependence of R_{AA}
- Complex models, many parameters (production, CNM, medium properties, medium-onia interactions...): identify "cleaner" observables / corners of phase space
- Relation between high p_T and jet fragmentation?