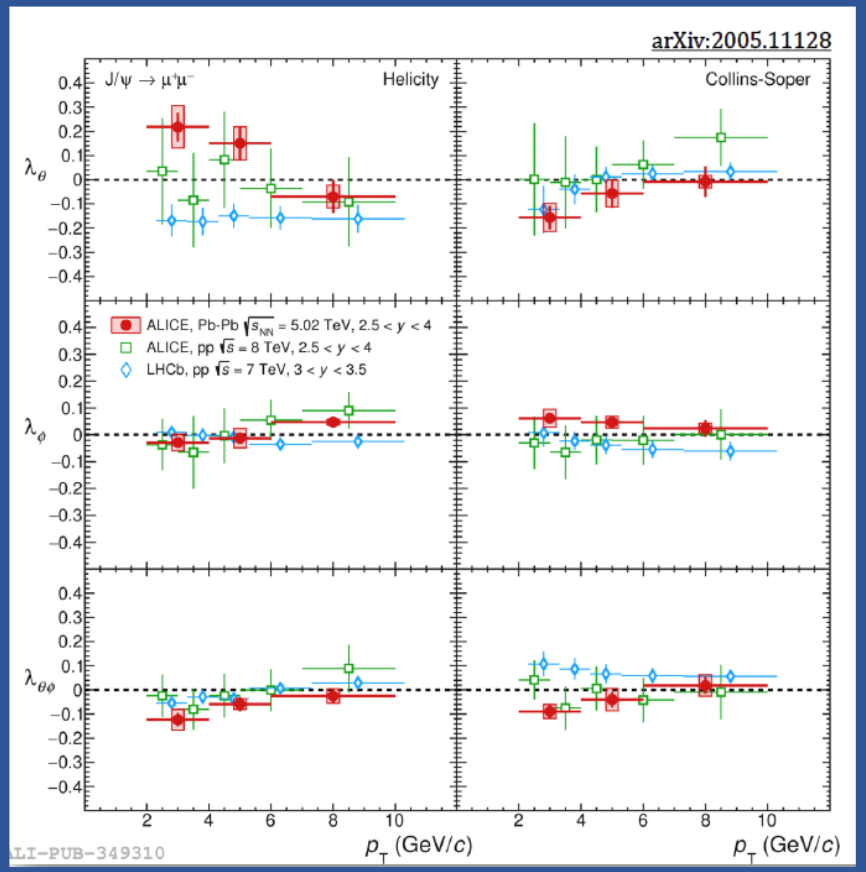
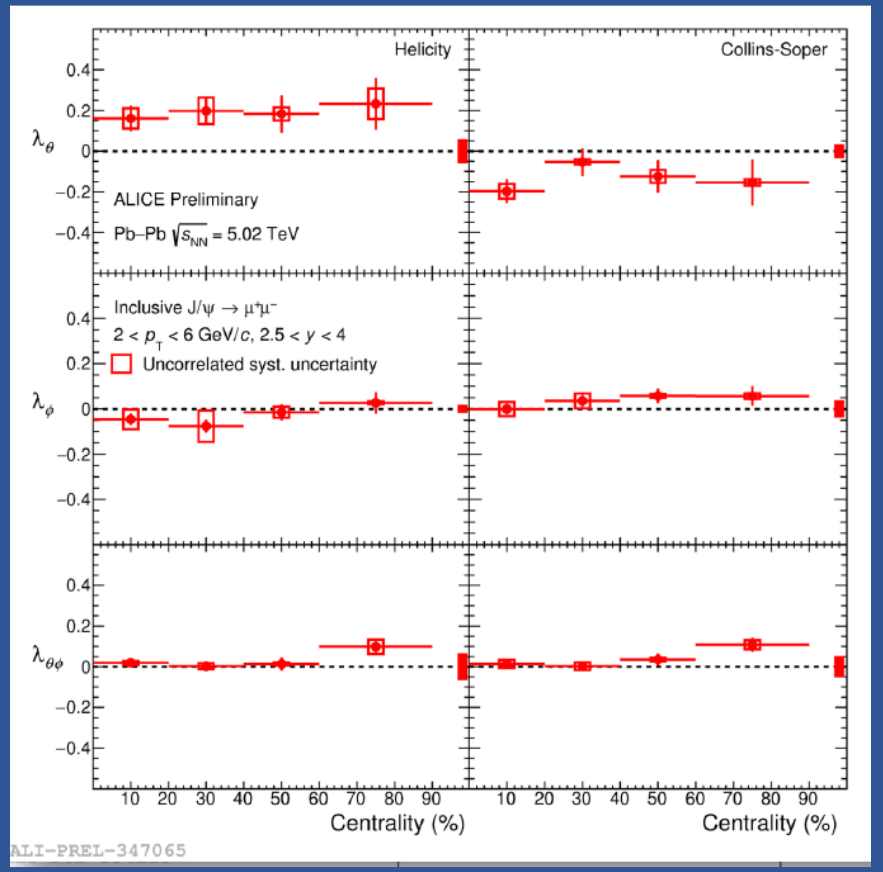
# Quarkonium polarization in AA – where do we go ?

- Little (not) explored up to now, neither on theory nor on experiment side
- First results discussed at this meeting (L. Micheletti)




+ forthcoming results on event-plane dependence

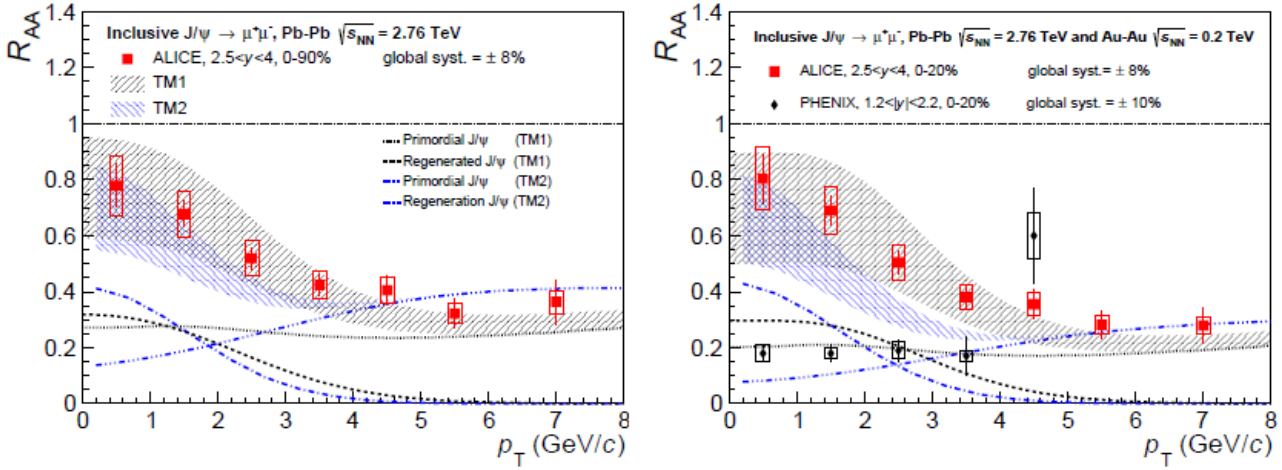
Small but significant deviation from $\lambda_\theta = 0$

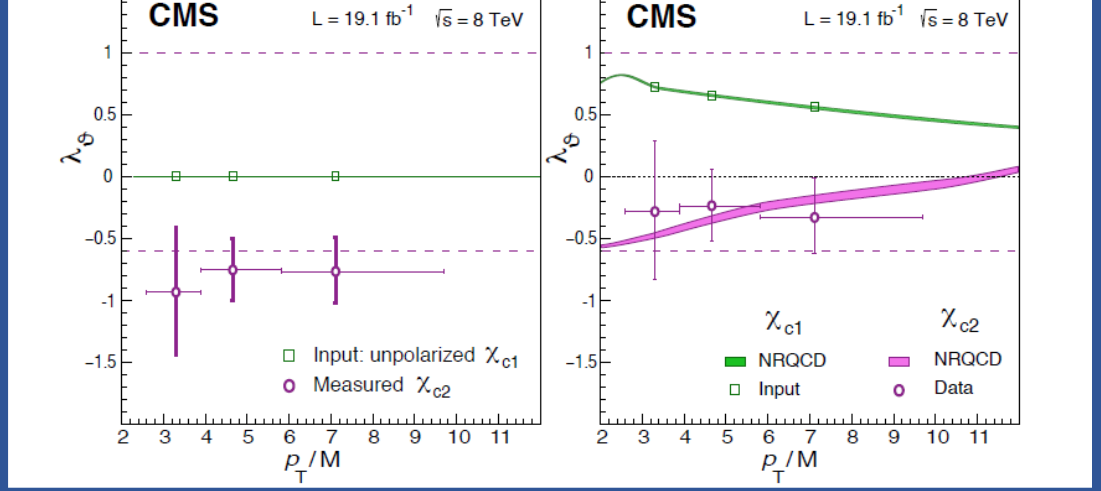
$p_T$ dependence

Centrality dependence ($2<p_T<6$ GeV/c)

# Charmonium: from pp to AA

1) One can consider effects related to the modification of charmonium yields in QGP wrt pp




- Recombination
  Strong effect at low $p_T$ (>50% regeneration)
  → Leads to non-polarized J/ψ ?

- Sequential melting
  J/ψ from $\chi_C$ are suppressed
  → Might lead to a modification of the net J/ψ polarization wrt pp
  → But need a measurement of *absolute* $\chi_C$ polarization in pp

Non-trivial to connect small difference observed in Pb-Pb wrt pp to the extra-effects present in J/ψ production/suppression/regeneration in Pb-Pb

# Effects of B-field ?

2) One can consider effects related to the change of orientation of the J/$\psi$ spin in QGP

- The magnetic field "lives" in the c.m.s. frame of heavy ion collisions, and is perpendicular to the event plane. In any other frame, there is an additional electric field which complicates the analysis

- Magnetic field cannot create a difference between $J_z = +1$ and $J_z = -1$ states, only the difference between $J_z = \pm 1$ and $J_z = 0$ states

- One may expect the enhancement of population of $J_z = +1$ and $J_z = -1$ states relative to $J_z = 0$ when the z axis is parallel to the magnetic field

- The most straightforward case is J/$\psi$ at rapidity y=0, and zero $p_T$, in which case the J/$\psi$ is at rest in the frame where the background field is purely magnetic. At finite momenta complications arise

From discussions with Dima

→ Theory calculations badly needed in view of a quantitative phenomenology!

# Quarkonium polarization in AA – where do we go ?

- Run 3 LHC → L ~ 10 $nb^{-1}$ (factor >10 wrt ALICE run 2)
- Could aim at a measurement for
  - $\Upsilon$(1S) → likely, feasibility already shown in run 2
  - $\psi$(2S) → tougher, due to background
- If there are effects related to the B-field, may a different quarkonium formation time lead to different effects for the various states ?
- Can it be interesting to push the measurement to low(er) $p_T$ ?
- May be interesting for AA → recombination dominates
  - → Needs low trigger thresholds, to be negotiated with the experiment, to avoid complications related to efficiencies
- Discussions a LHC on the exploration of other collision systems (O-O): how B-field strength depends on system size ?