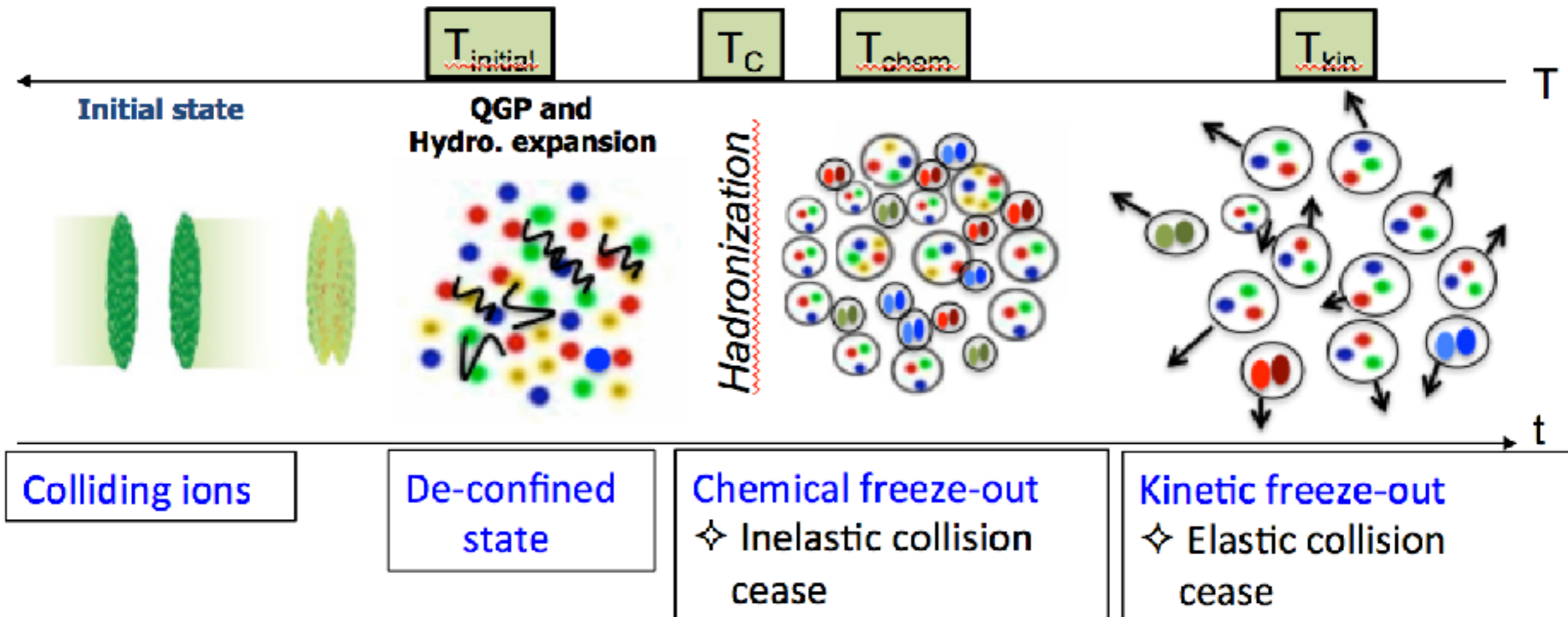


IN-KWON YOO (PUSAN NAT'L UNIV.)

HEAVY ION PHYSICS, STATUS & OUTLOOK

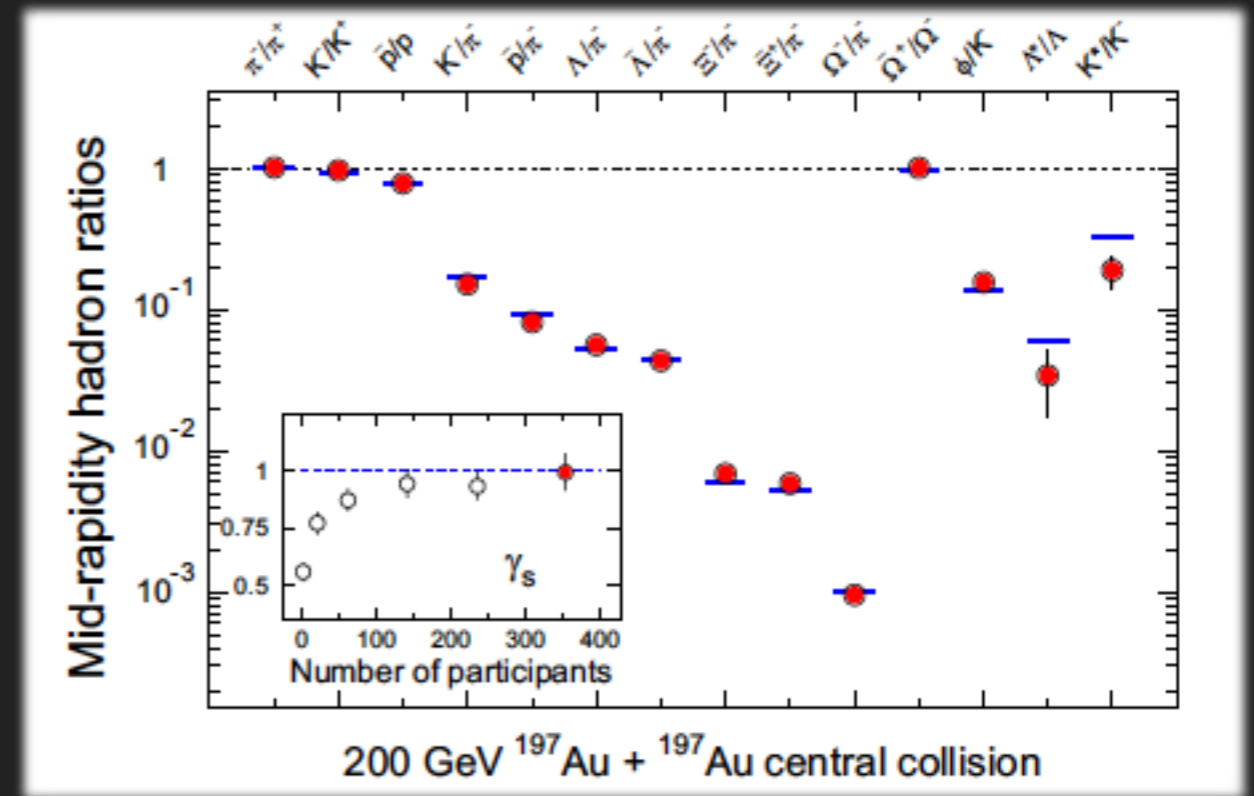
Time Evolution of Heavy-ion Collisions:



- ▶ Variables: E_{CM} , System size (pp, pa, pA, aa, AA)
- ▶ Observables: $d^2N/dp_T dy$, dN/dy , dN/dp_T , $dN/d\varphi$; HBT, E-by-E fluctuation; Lepton vs. Hadrons, LF vs. HF etc.

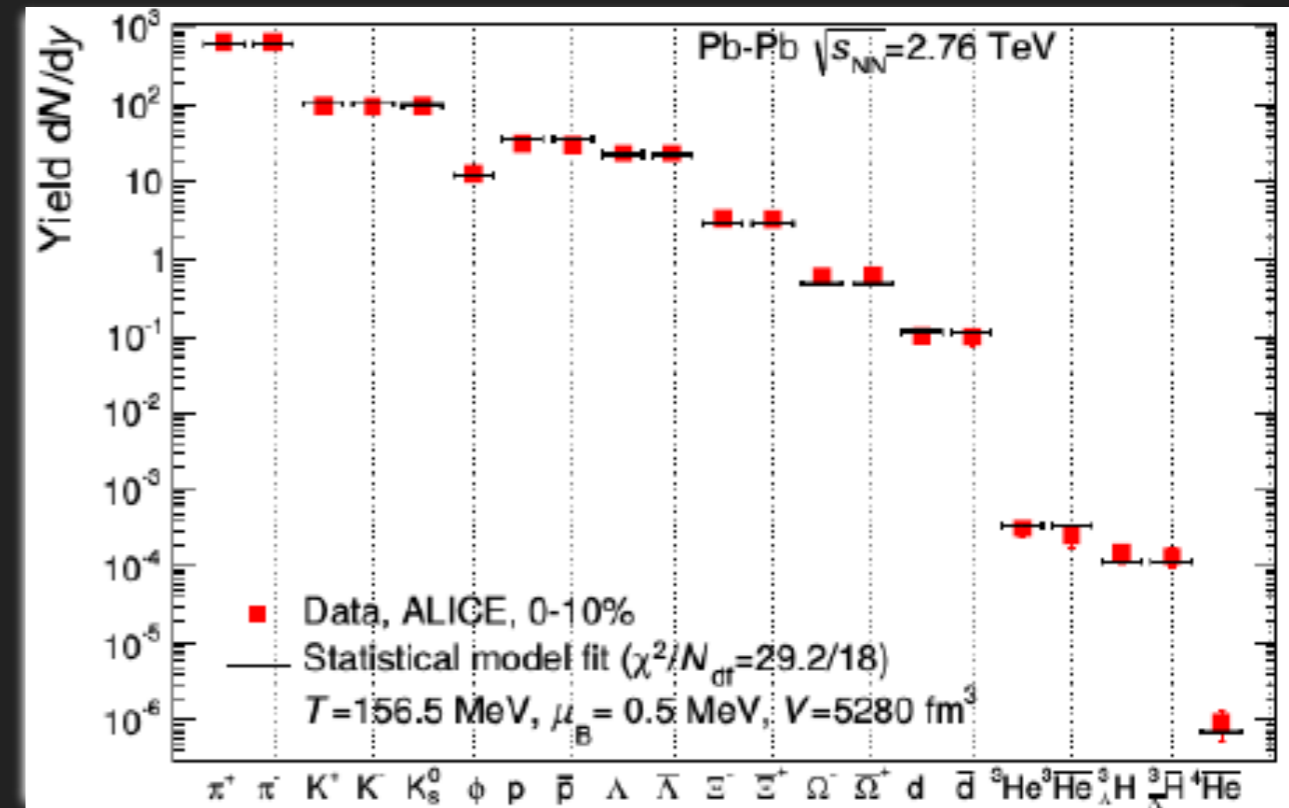
WHERE WE ARE!

- ▶ Statistical Fit
 - ▶ Temperature (T), Chemical potentials (μ_B , μ_S , μ_Q) and volume
- ▶ Assumption
 - ▶ Non-interacting hadrons and resonances
 - ▶ Thermodynamical Equilibrium
 - ▶ Ensembles: Canonical, GC, Strange-Can.



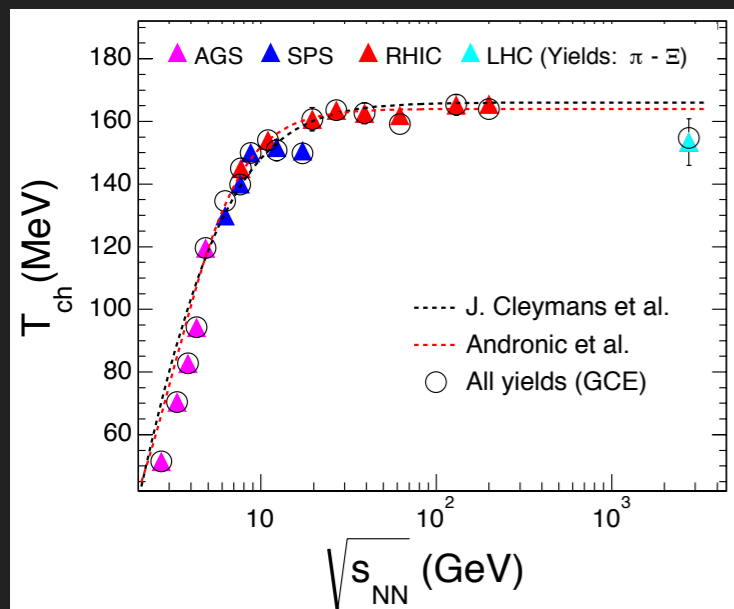
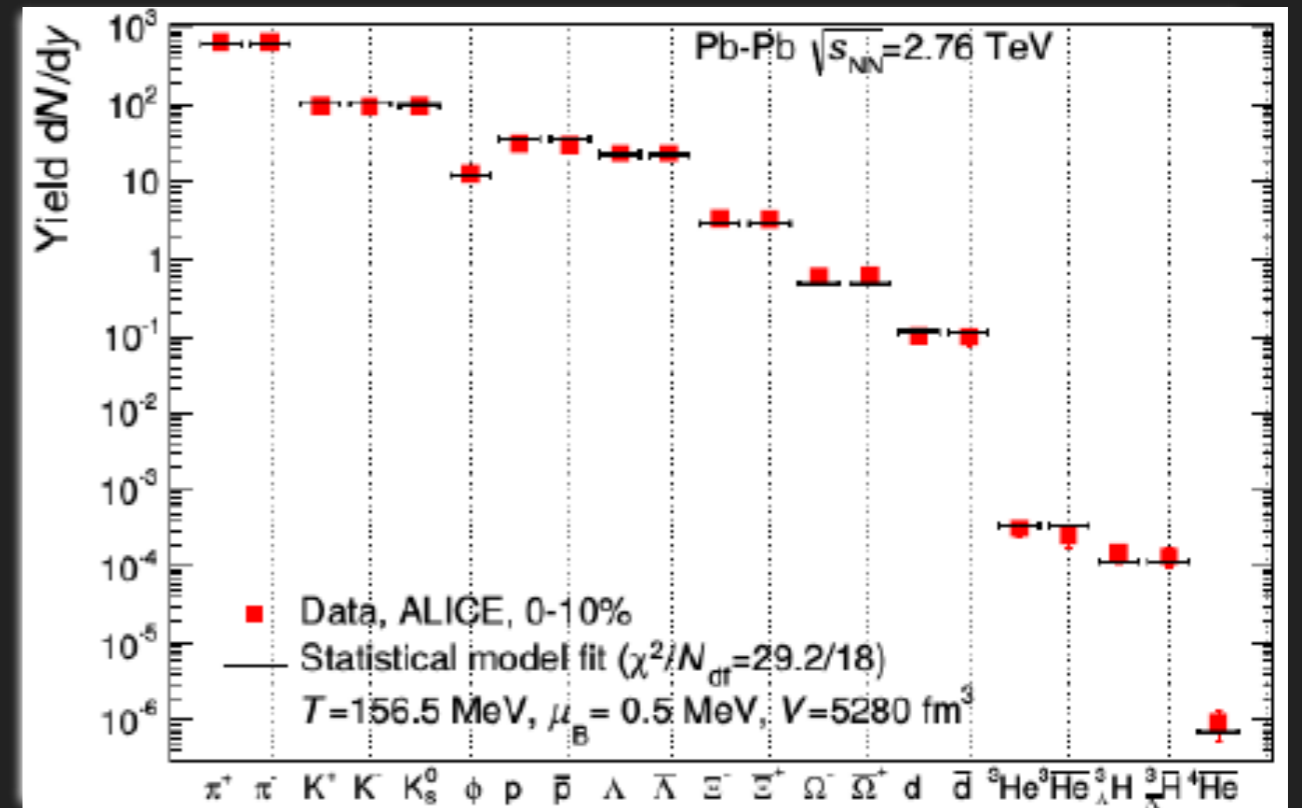
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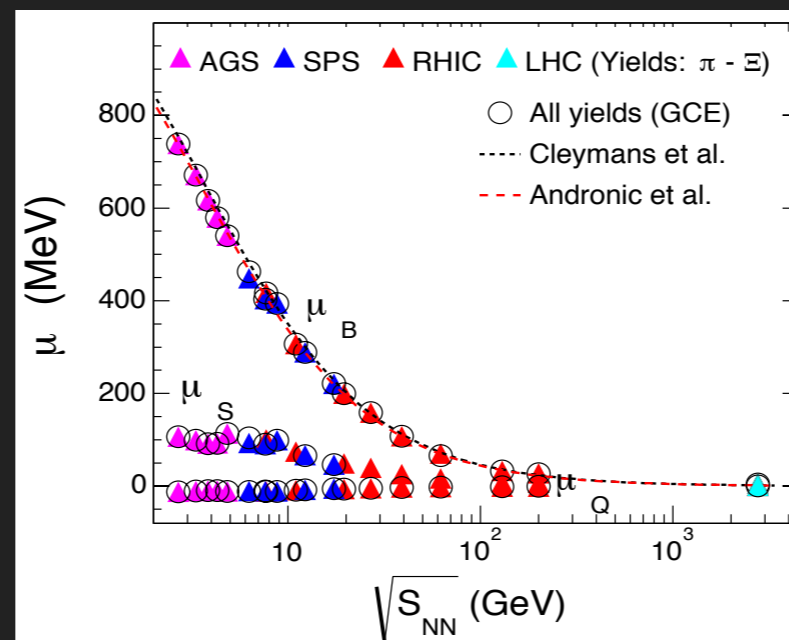
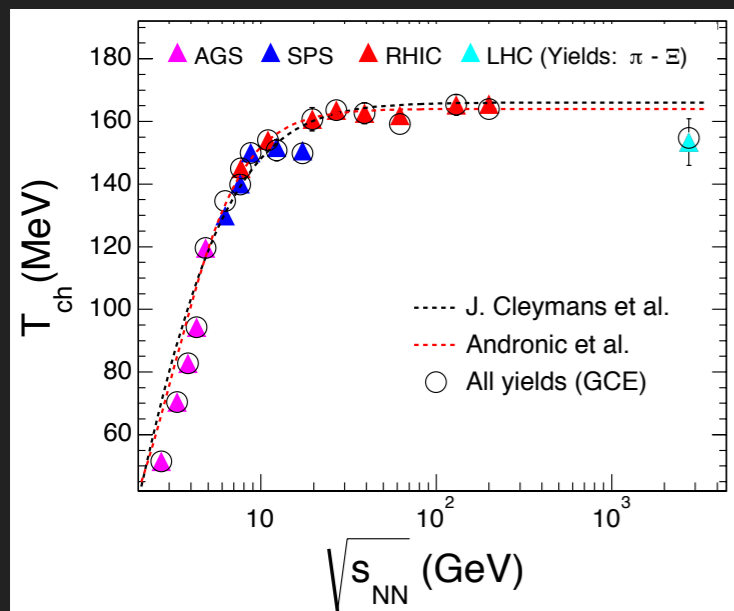
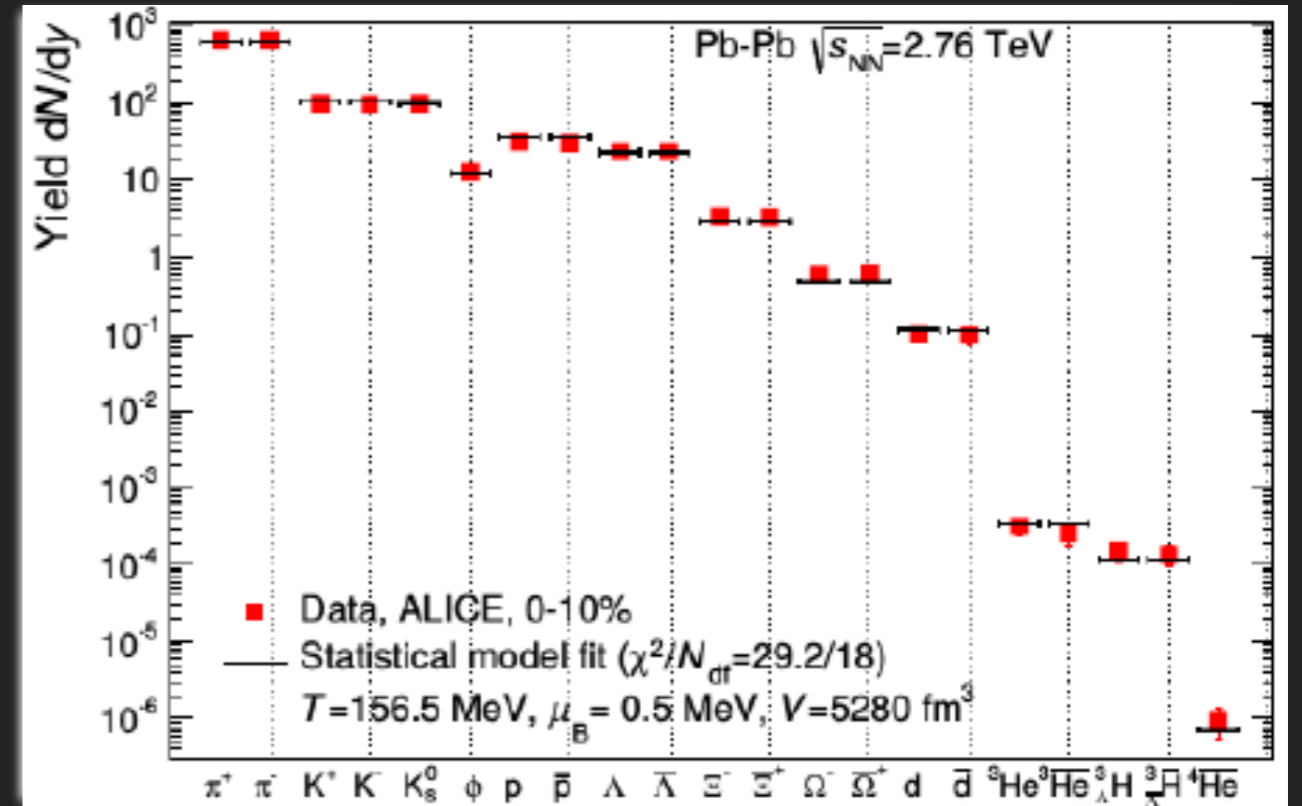
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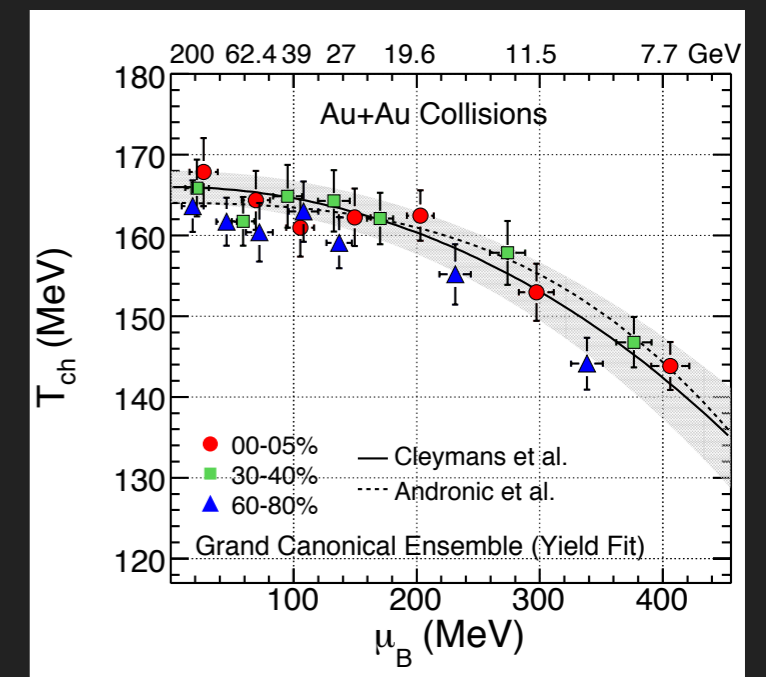
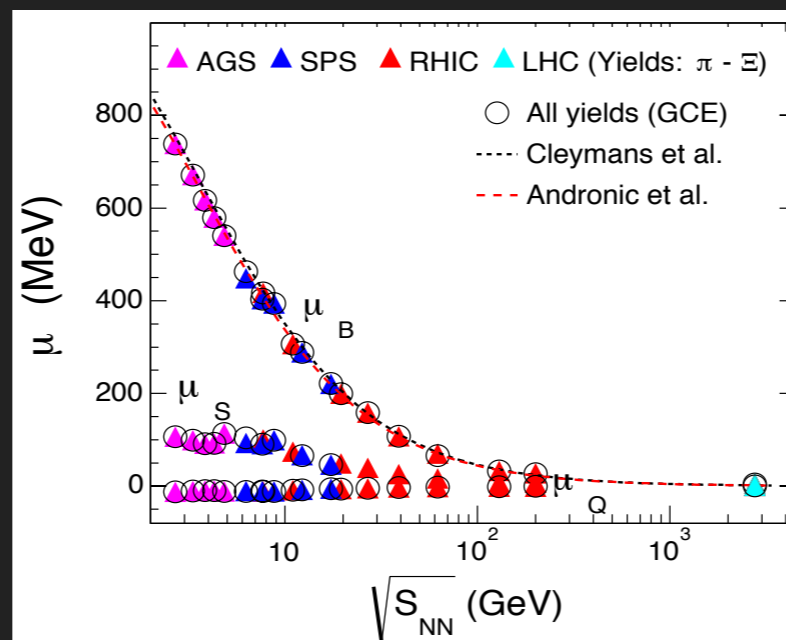
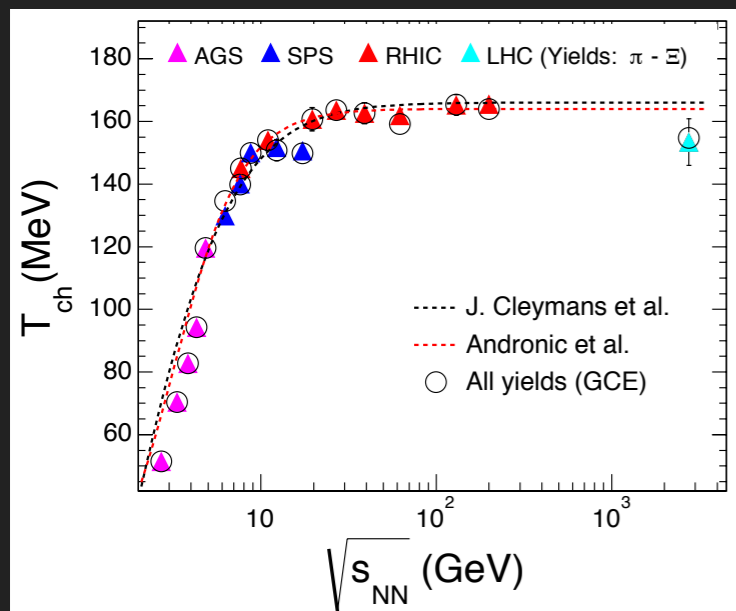
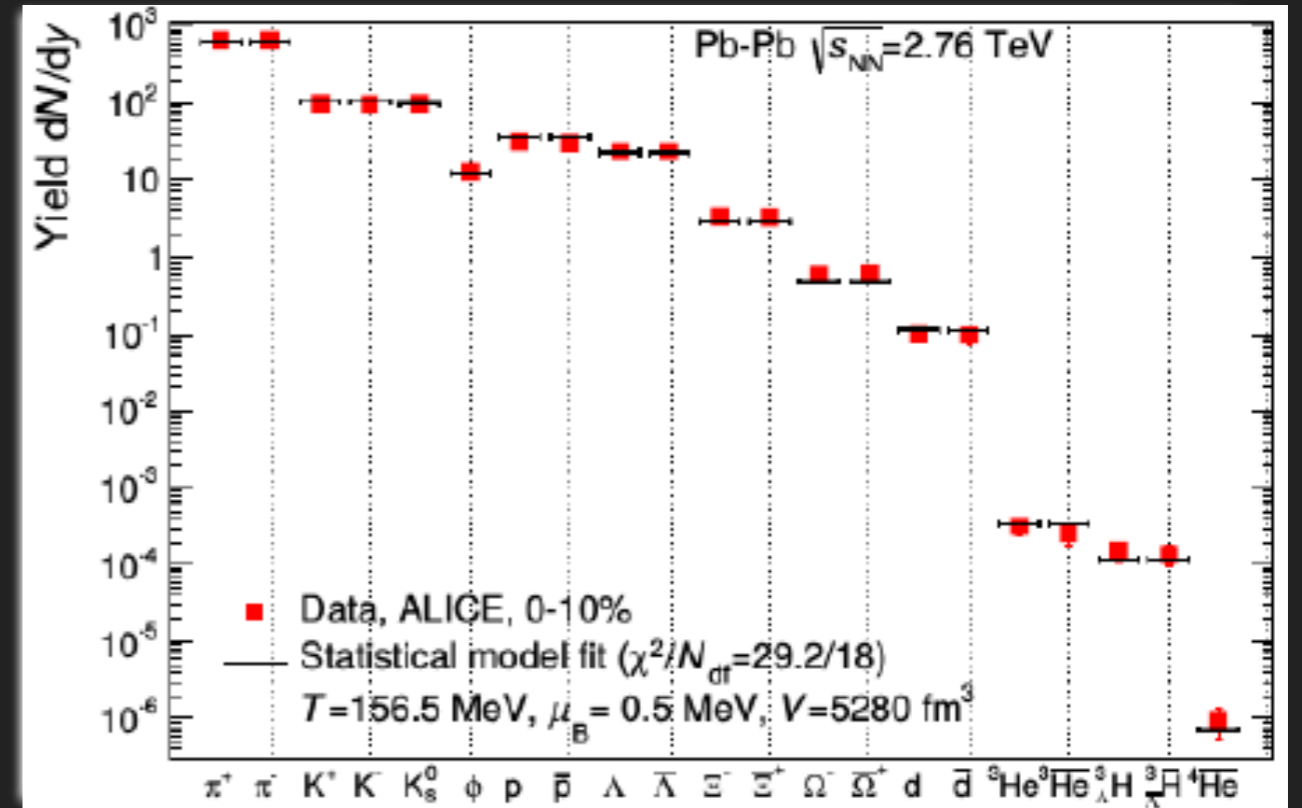
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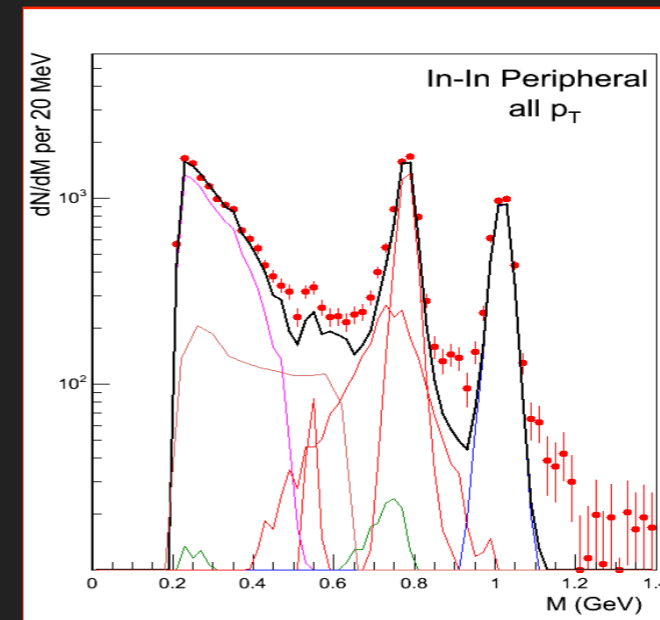


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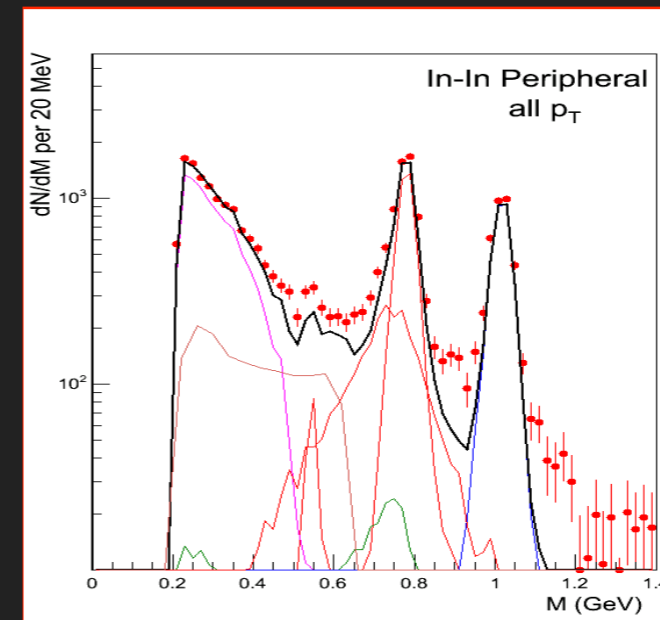


SMOKING GUNS (SPS)



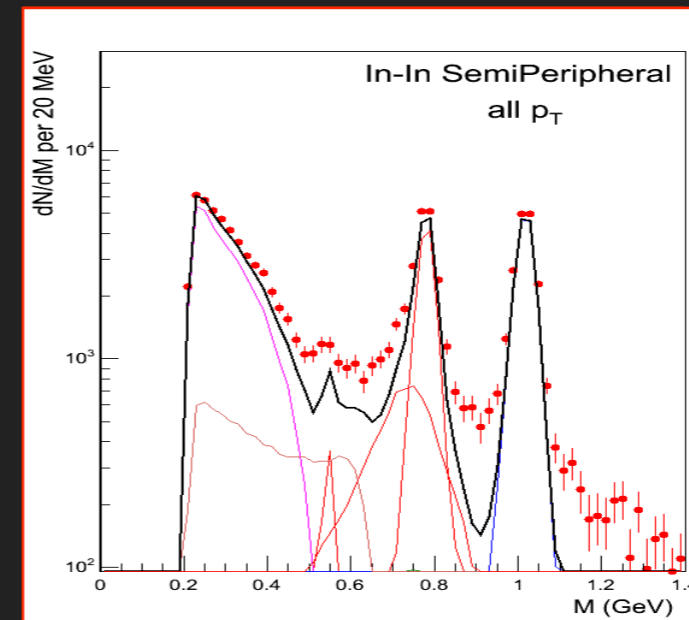
SMOKING GUNS (SPS)

- ▶ Di-lepton Enhancement in IMR



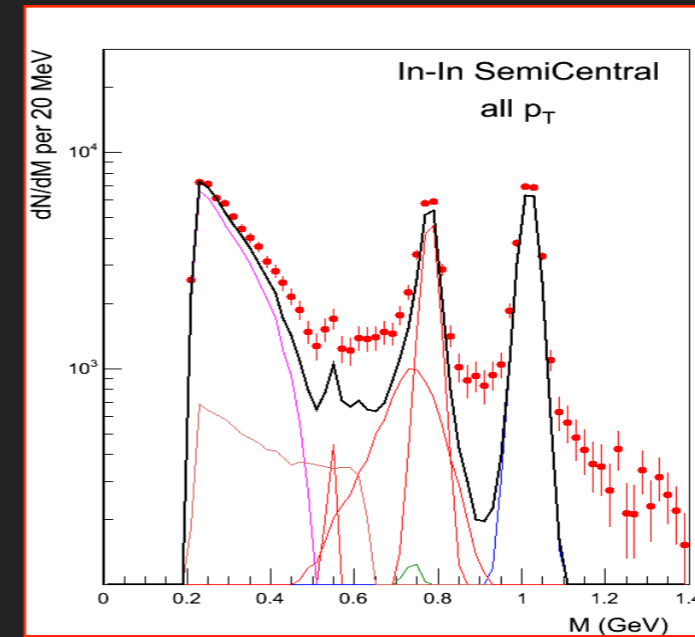
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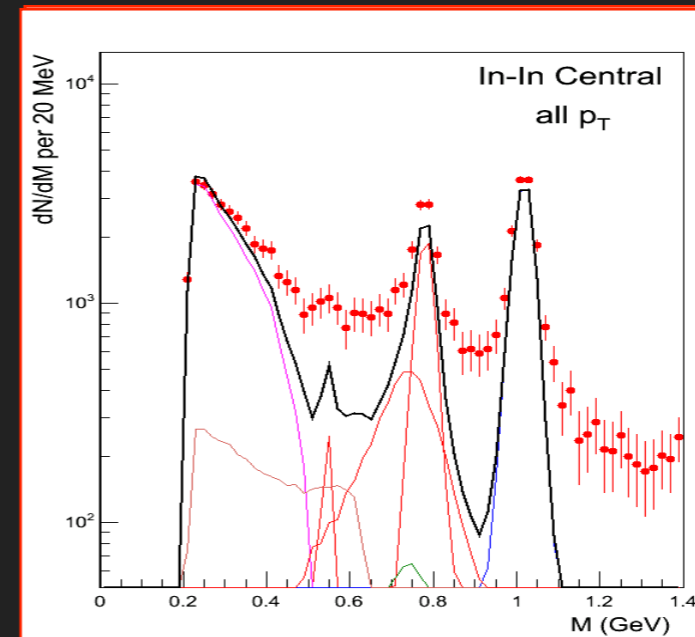
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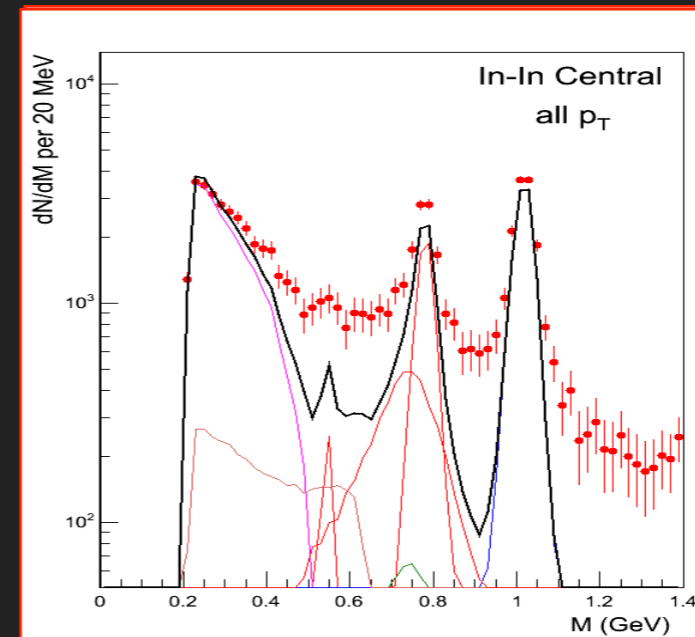
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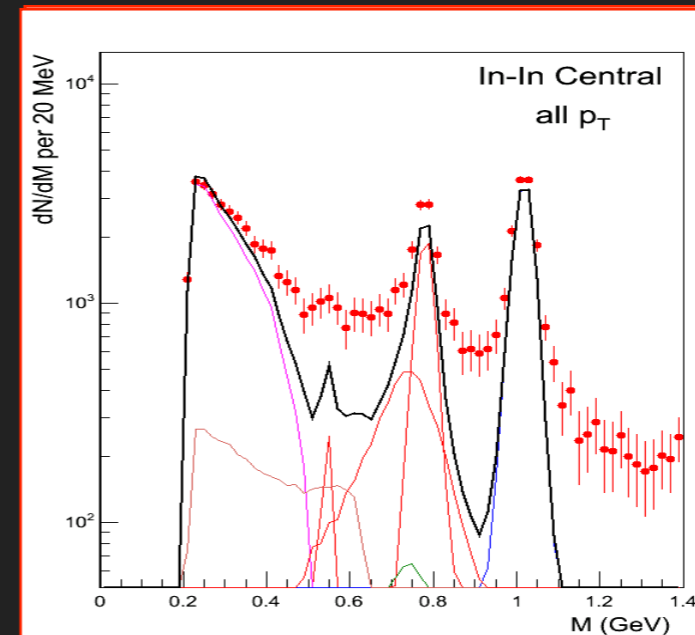
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- ▶ Di-lepton Enhancement in IMR
 - ▶ Mass-shift/broadening of ρ



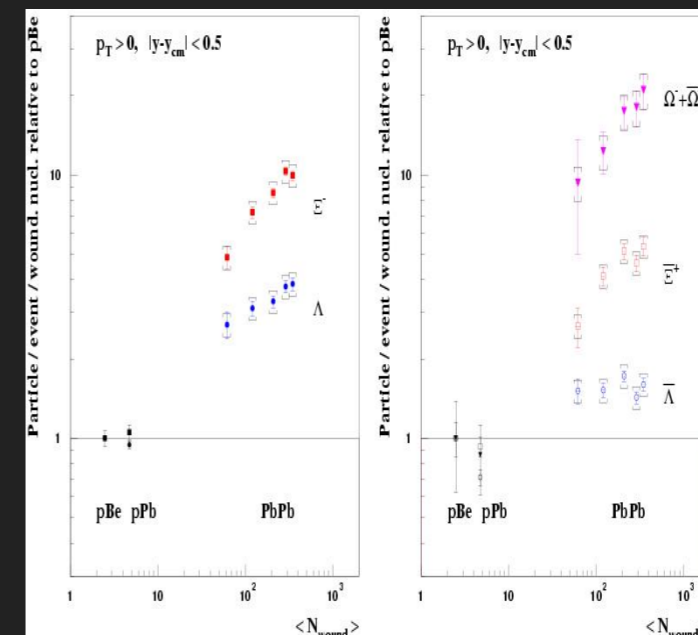
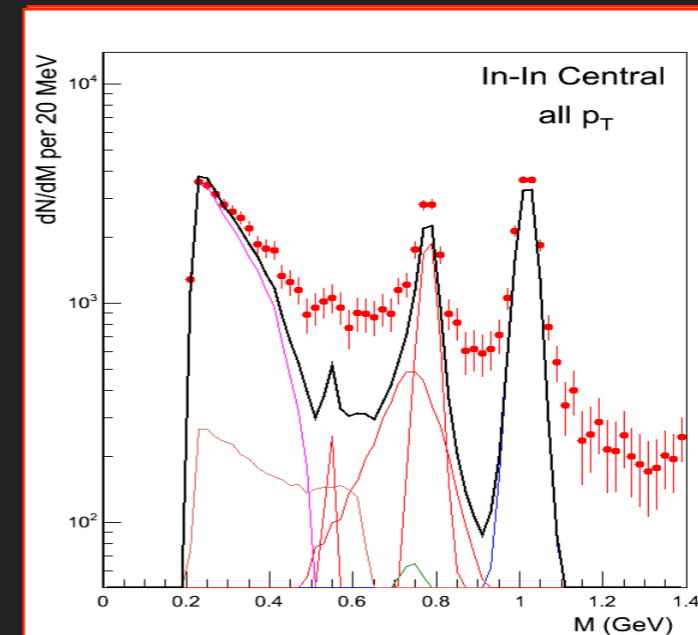
SMOKING GUNS (SPS)

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 - ▶ Mass-shift/broadening of ρ
- ▶ Strangeness Enhancement



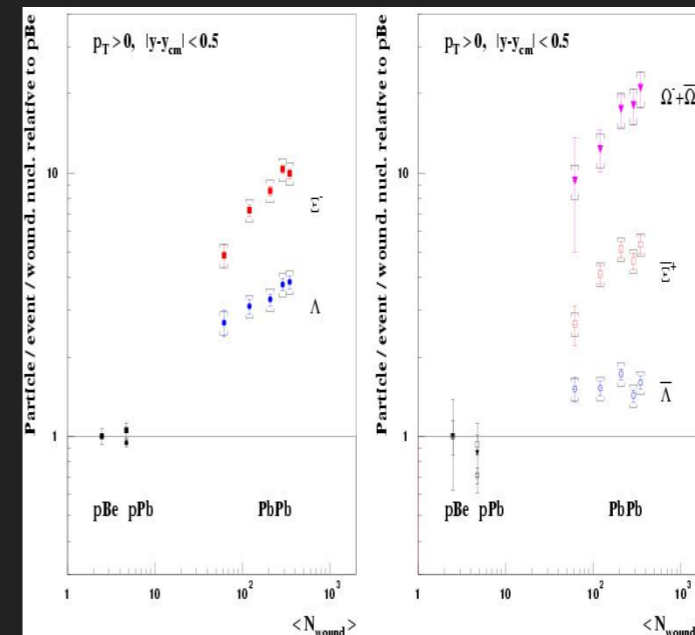
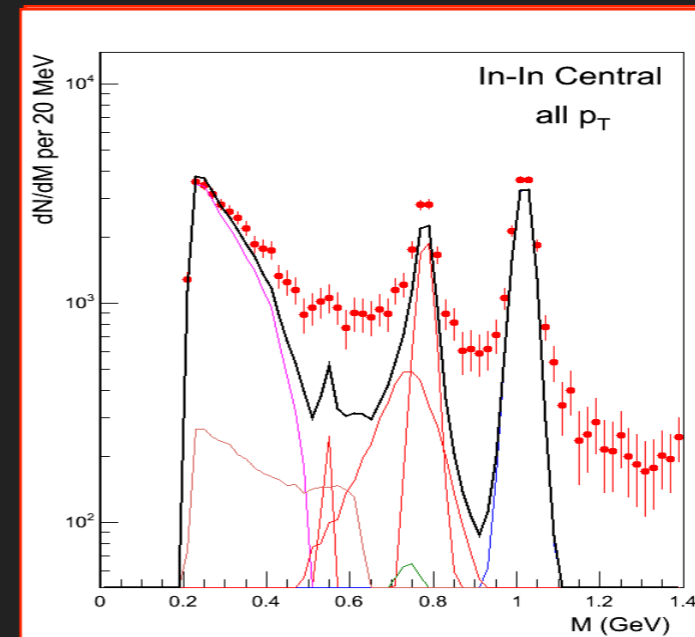
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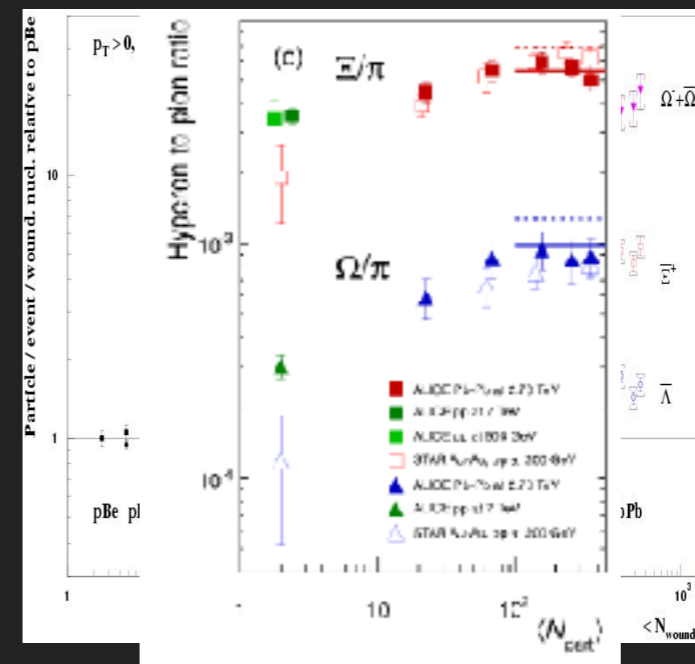
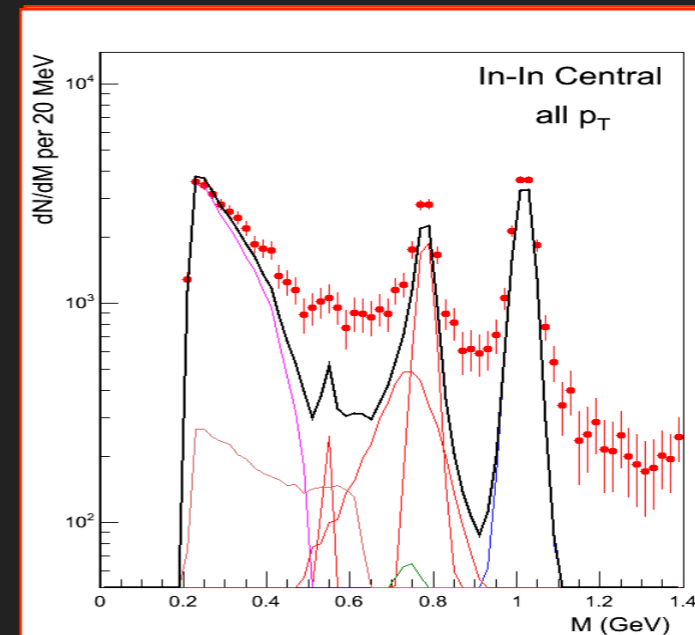
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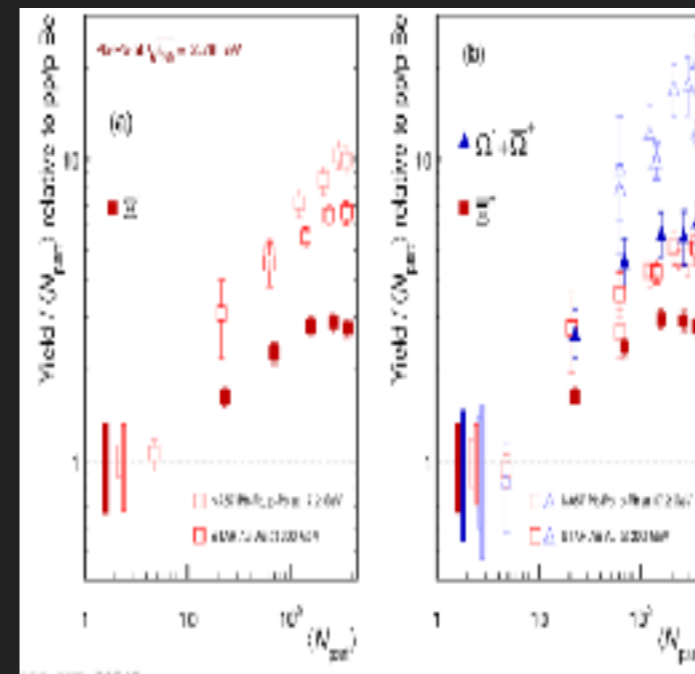
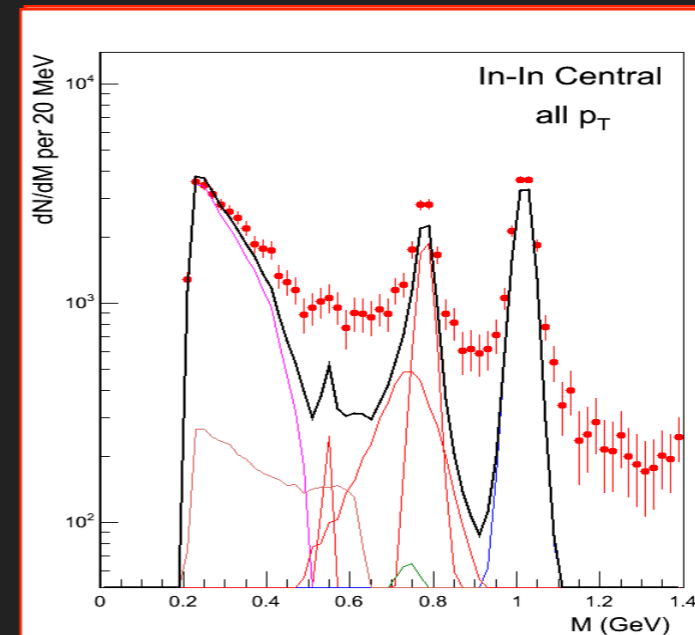
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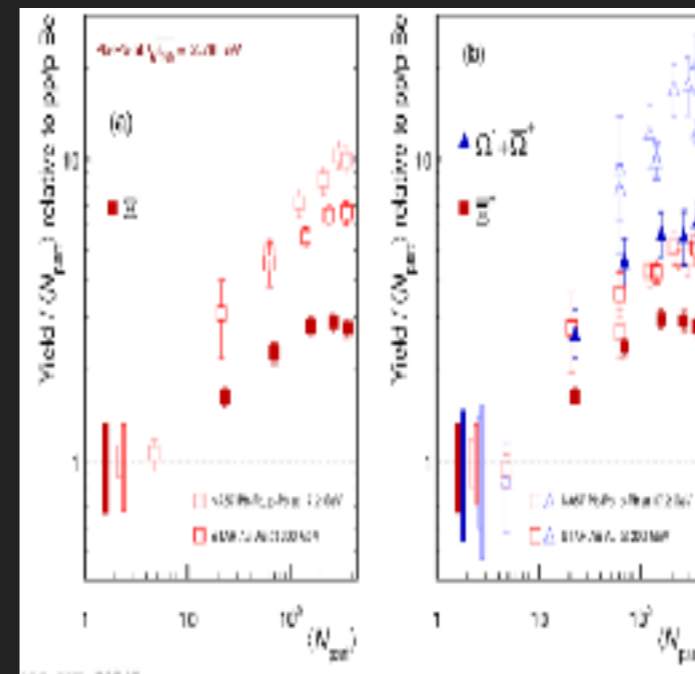
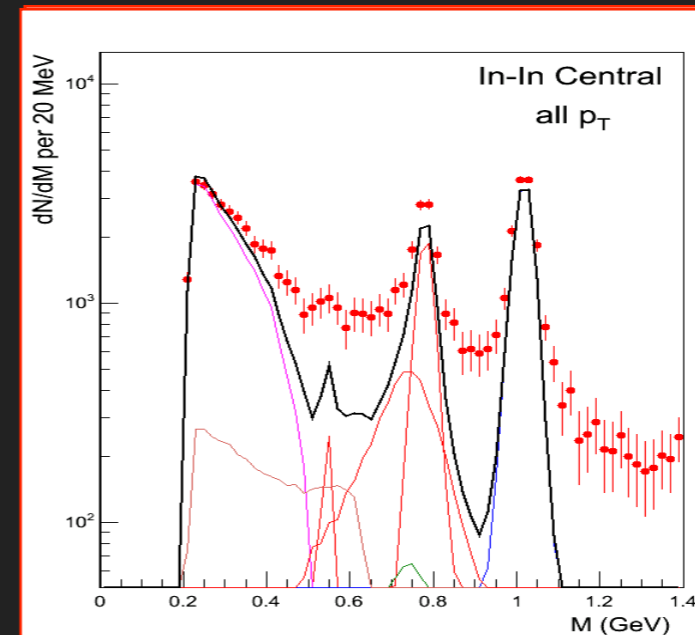
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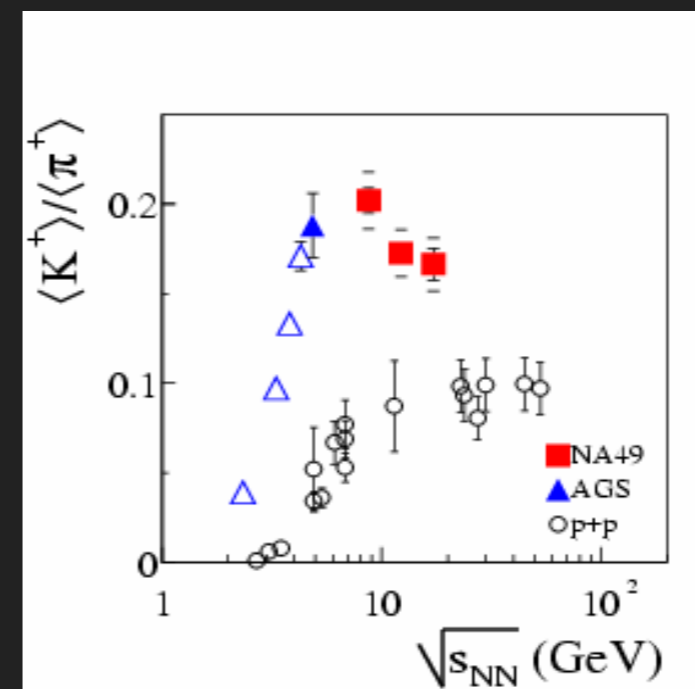
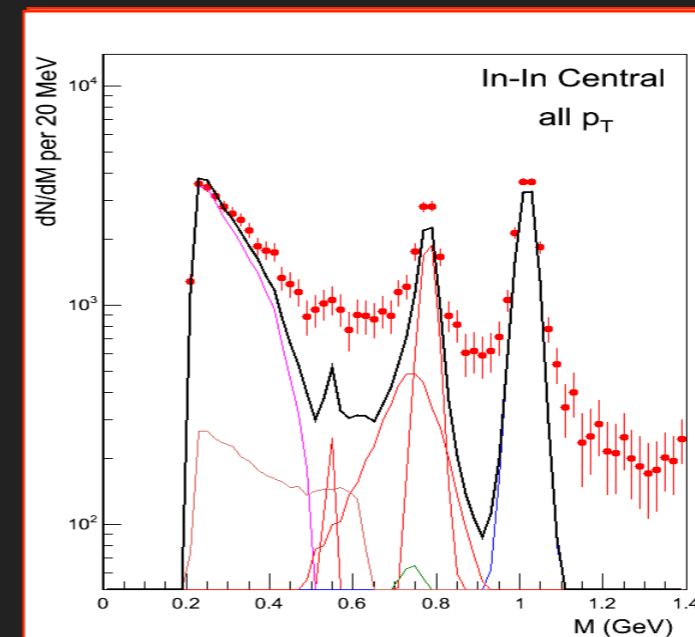
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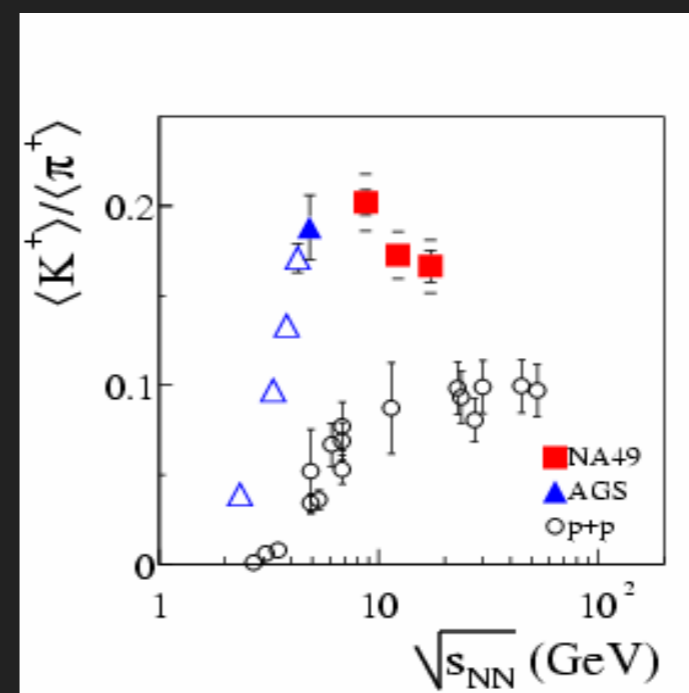
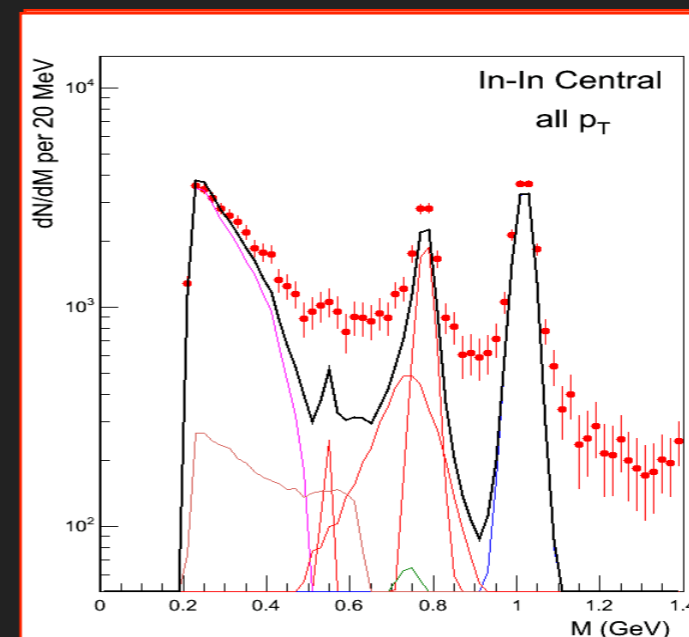
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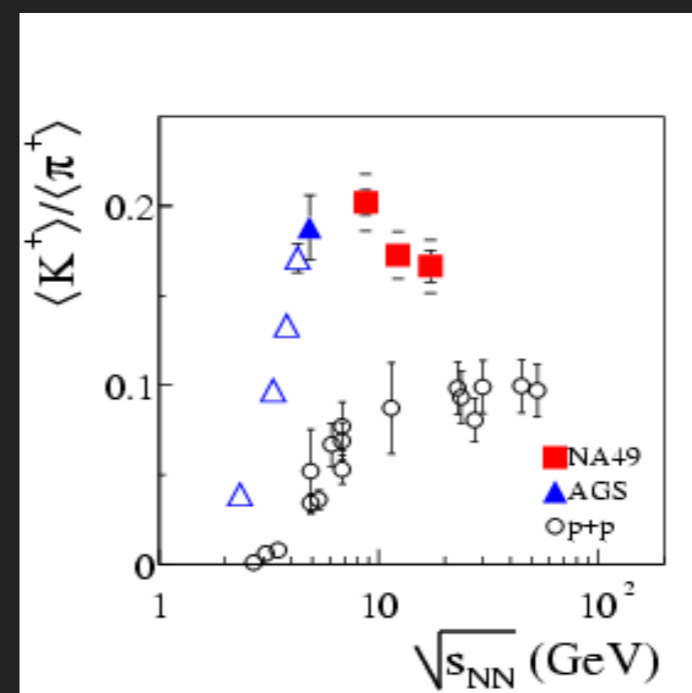
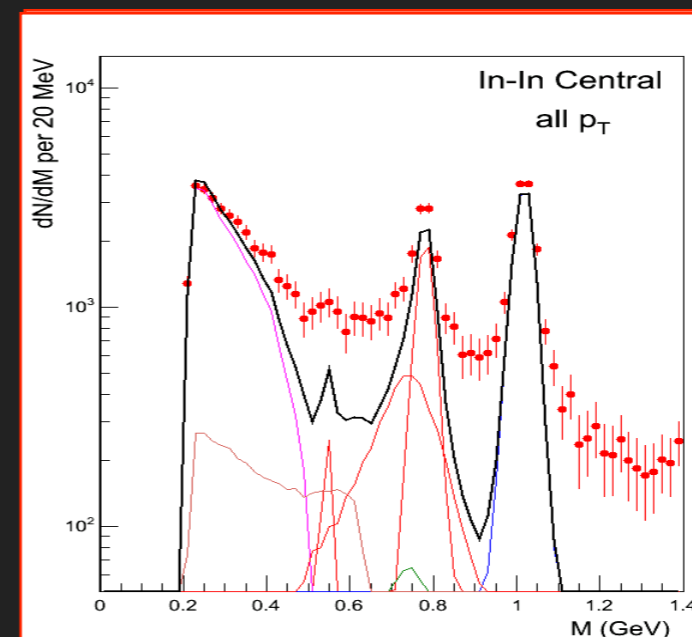
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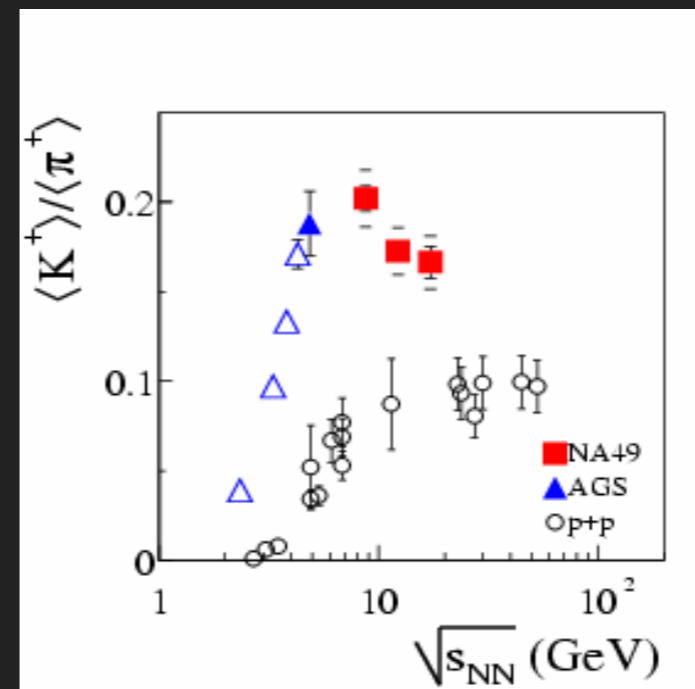
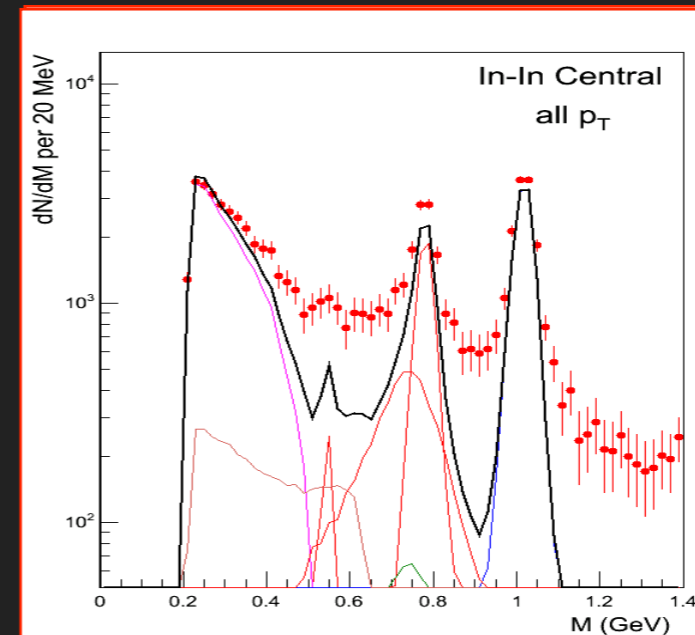
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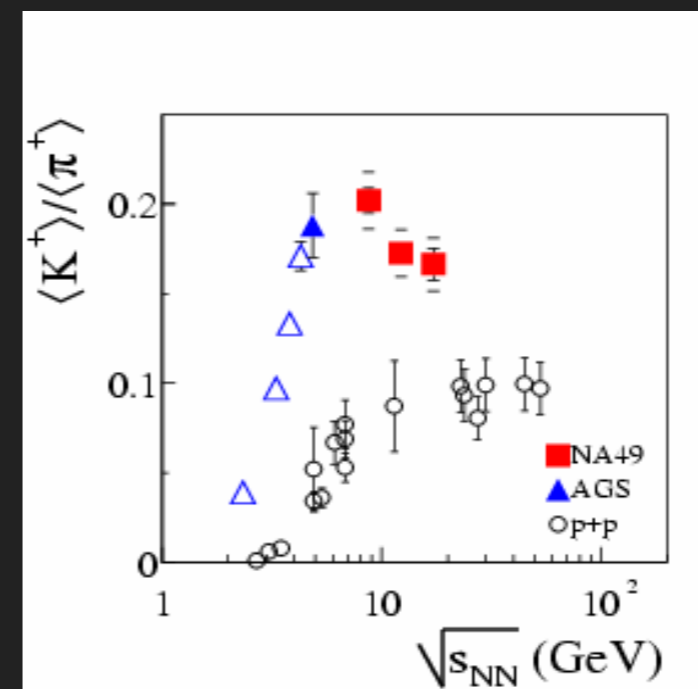
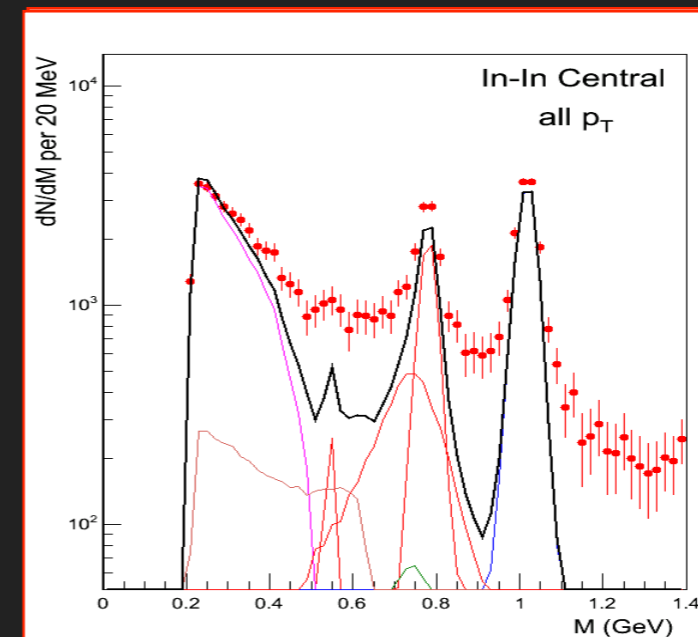
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 - ▶ Debye-screening



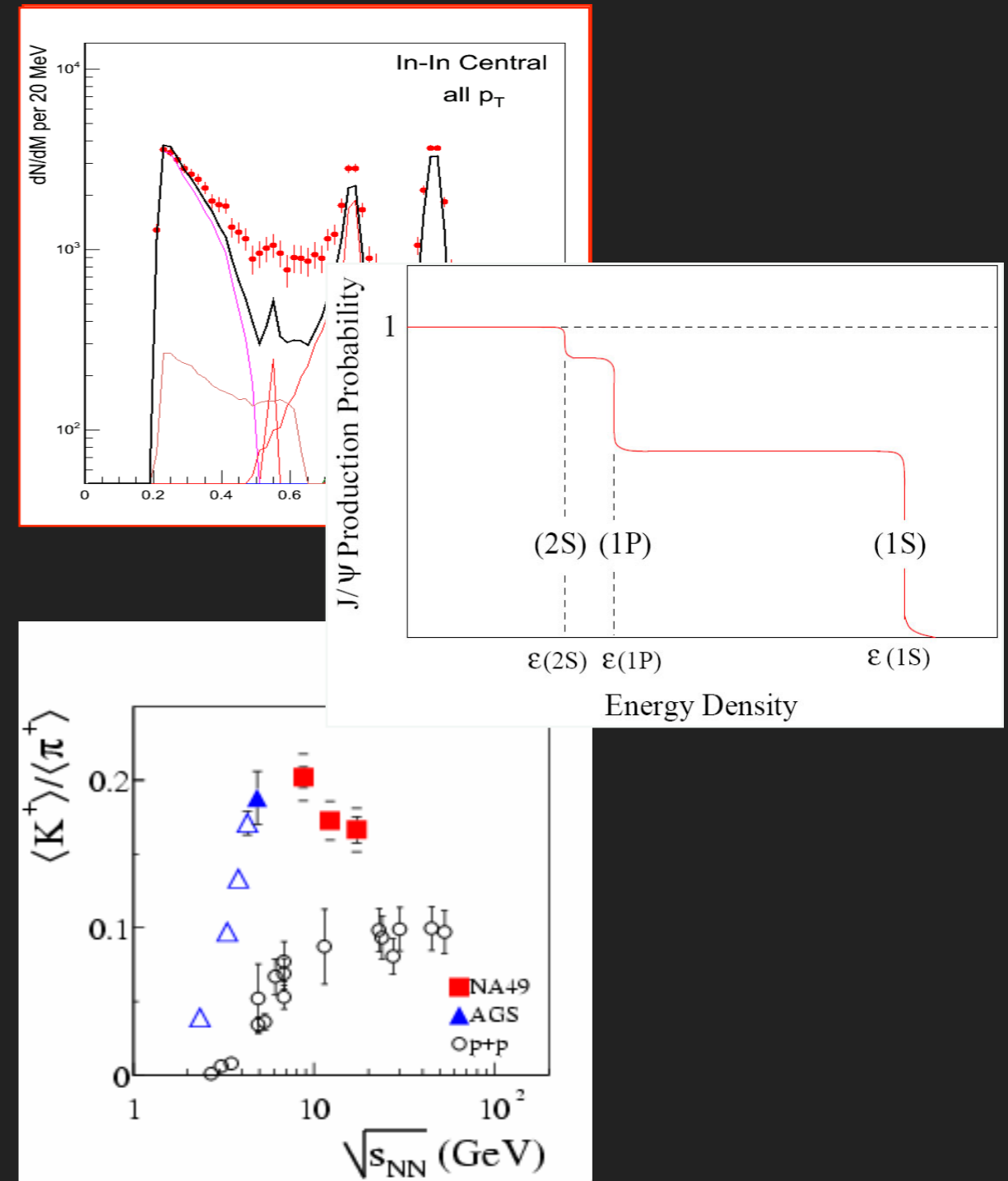
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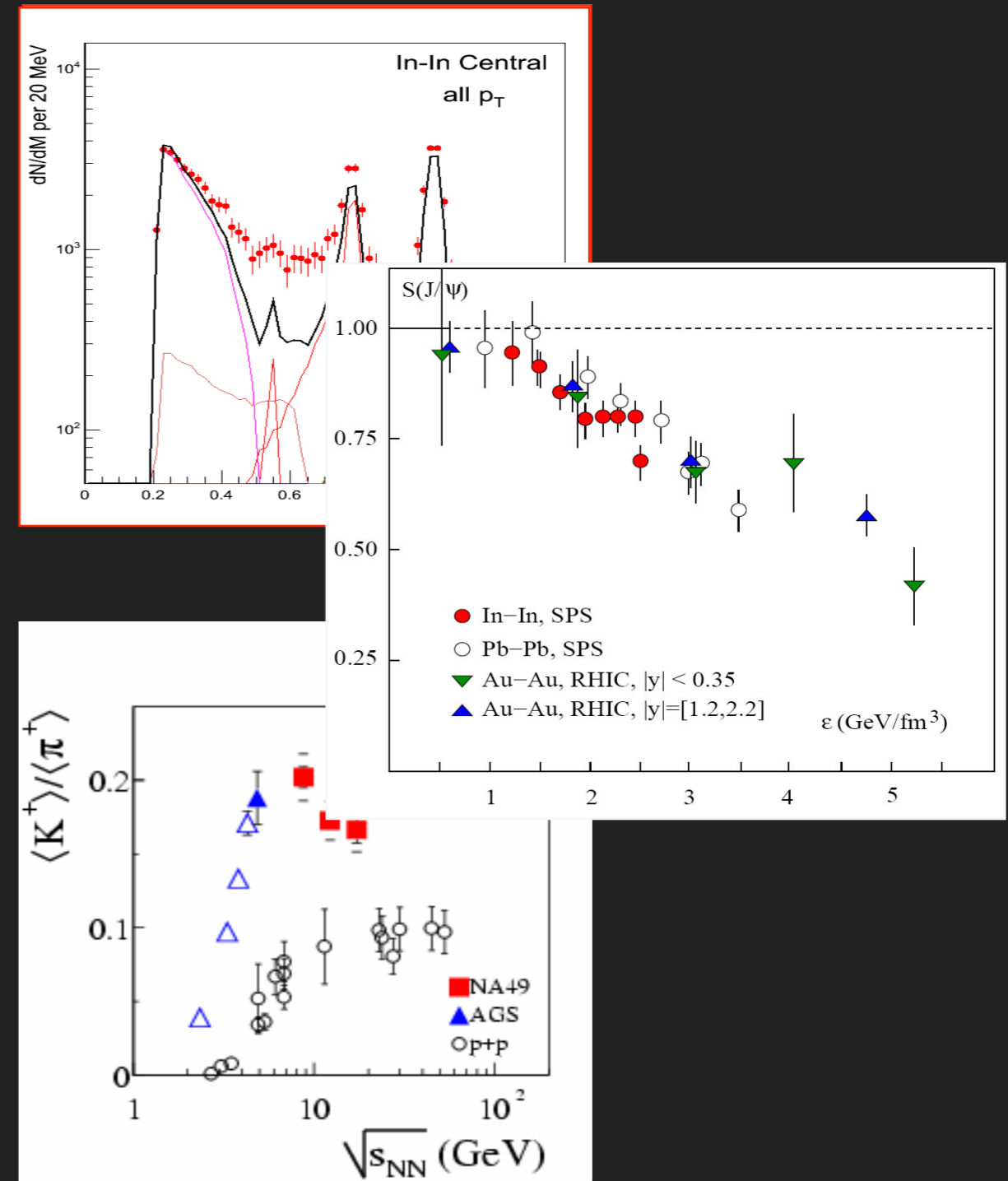
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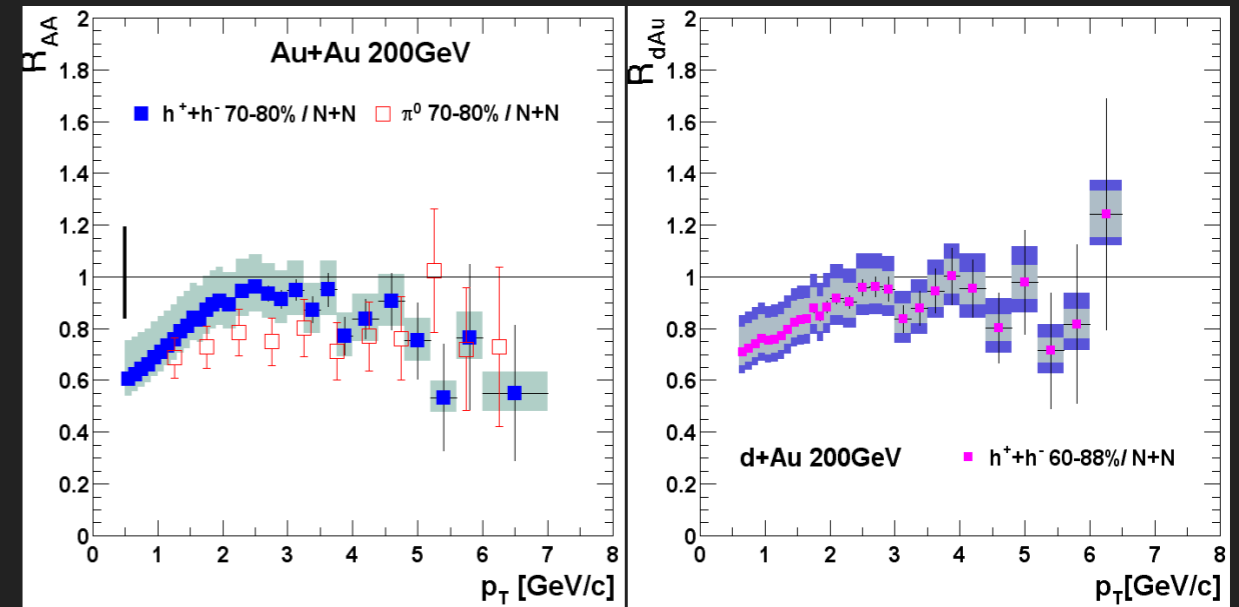


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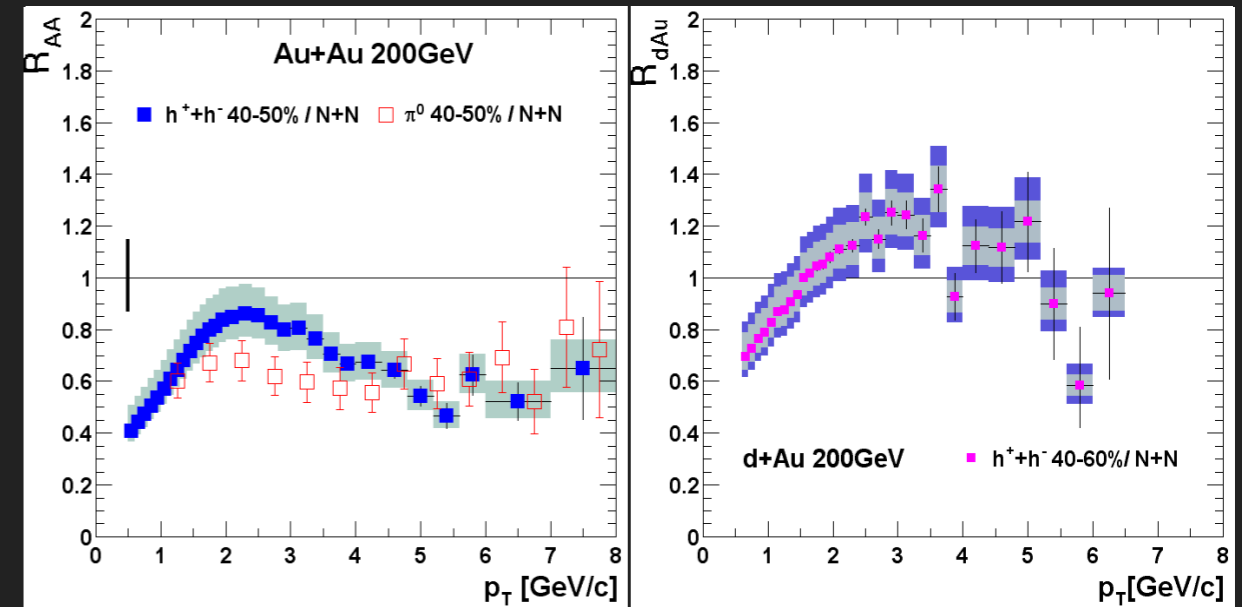
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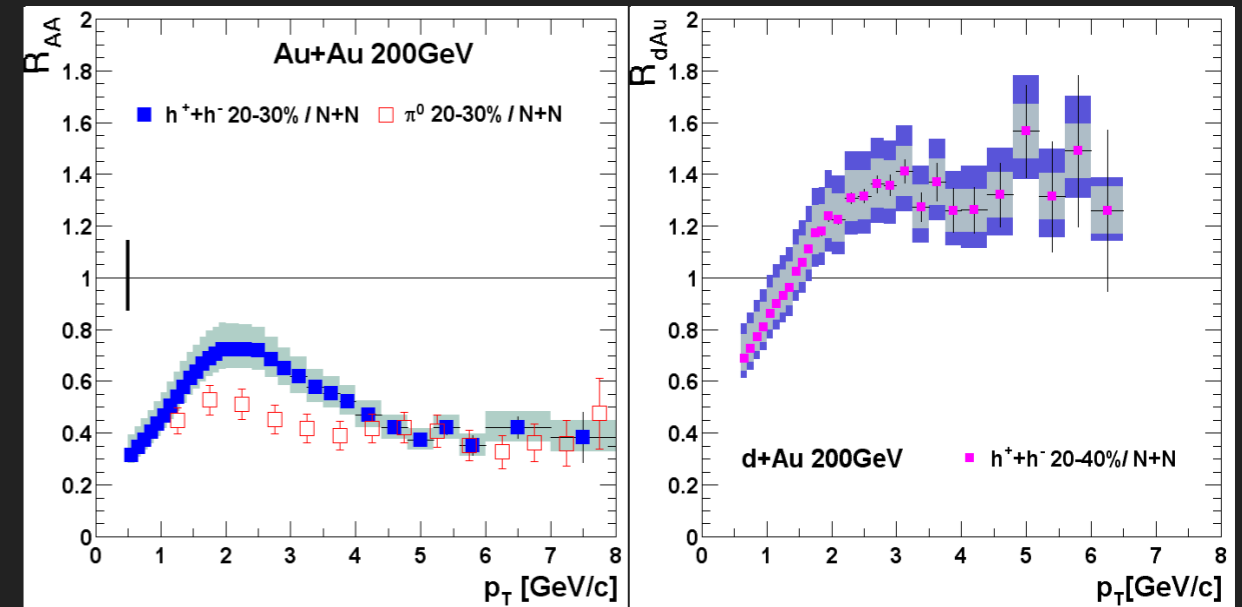
UNEXPECTED PHENOMENON (RHIC)



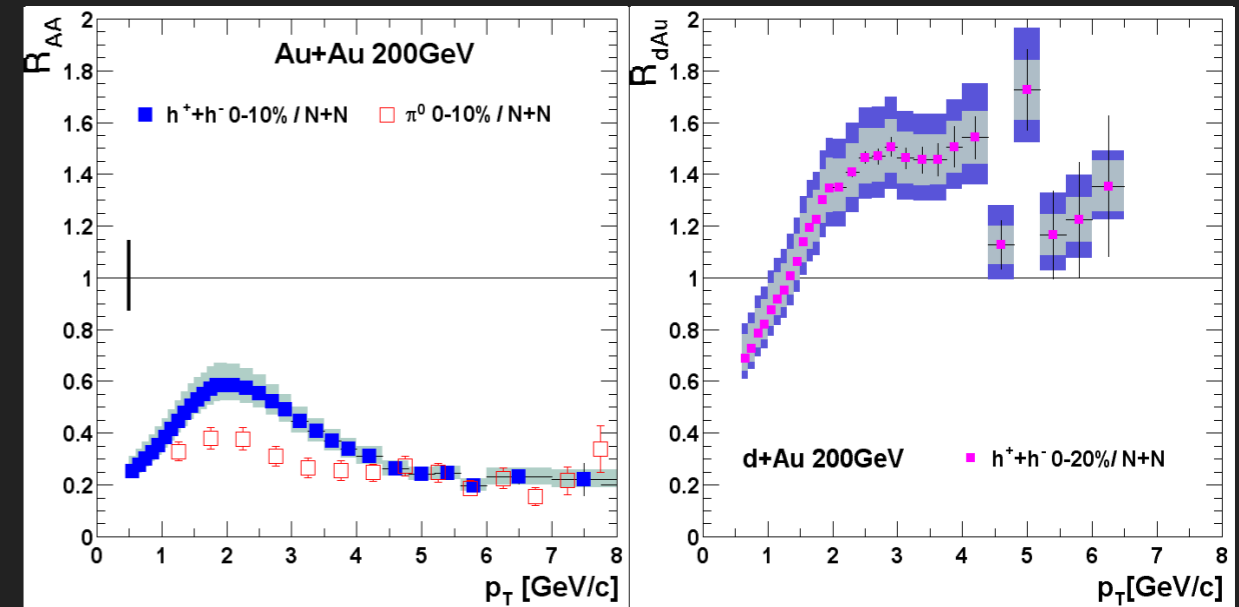
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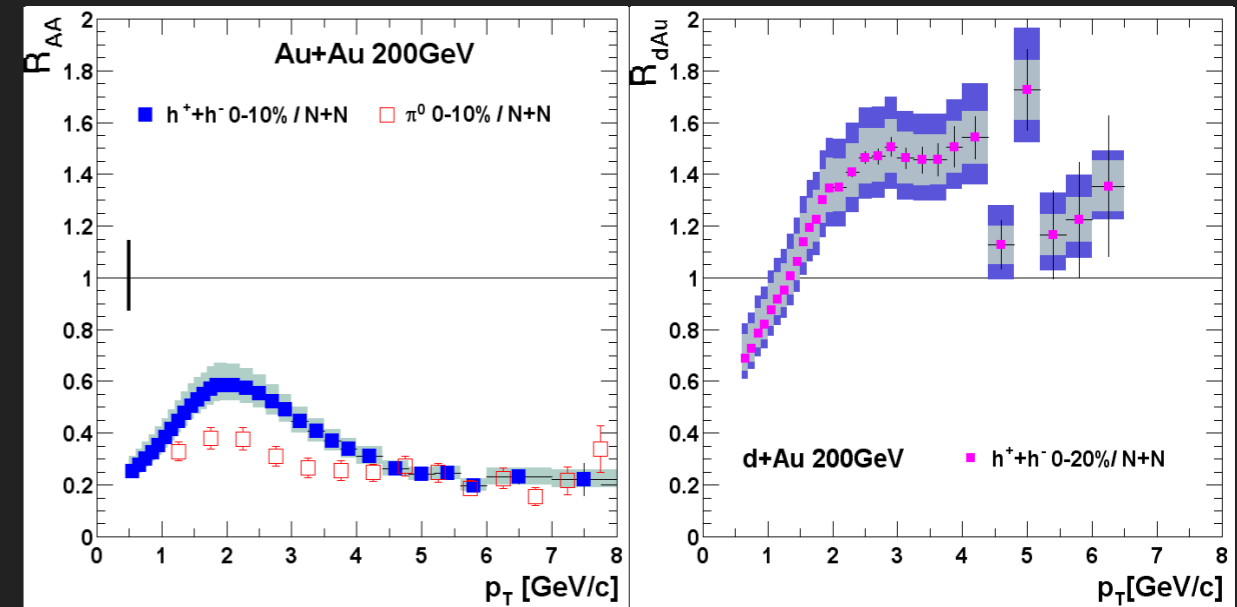


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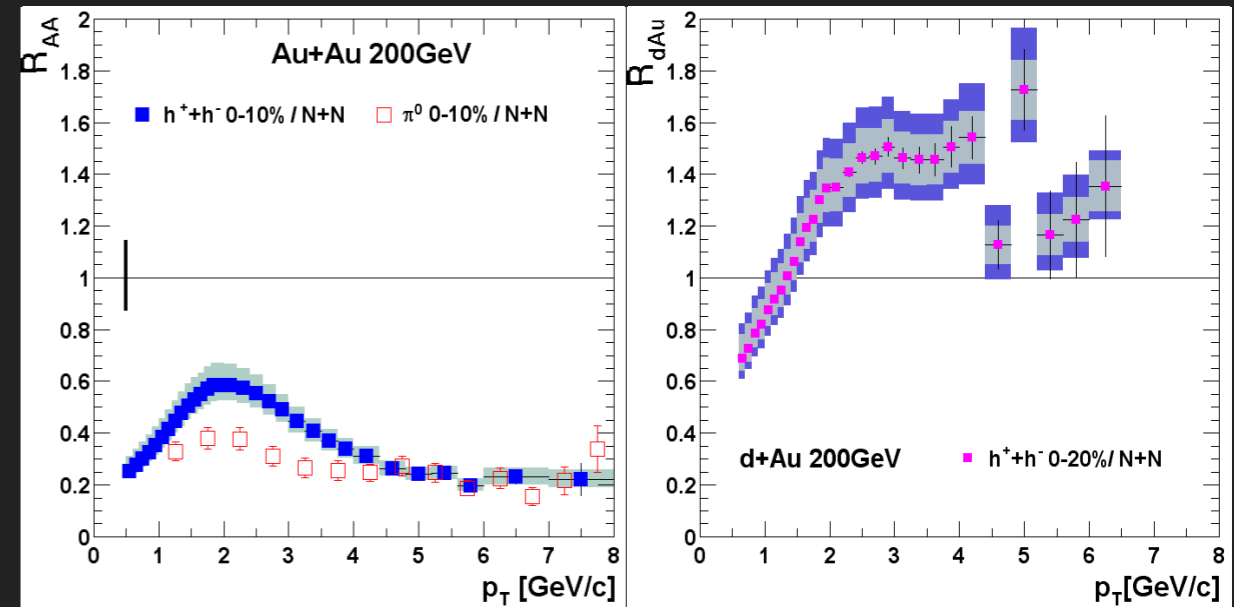
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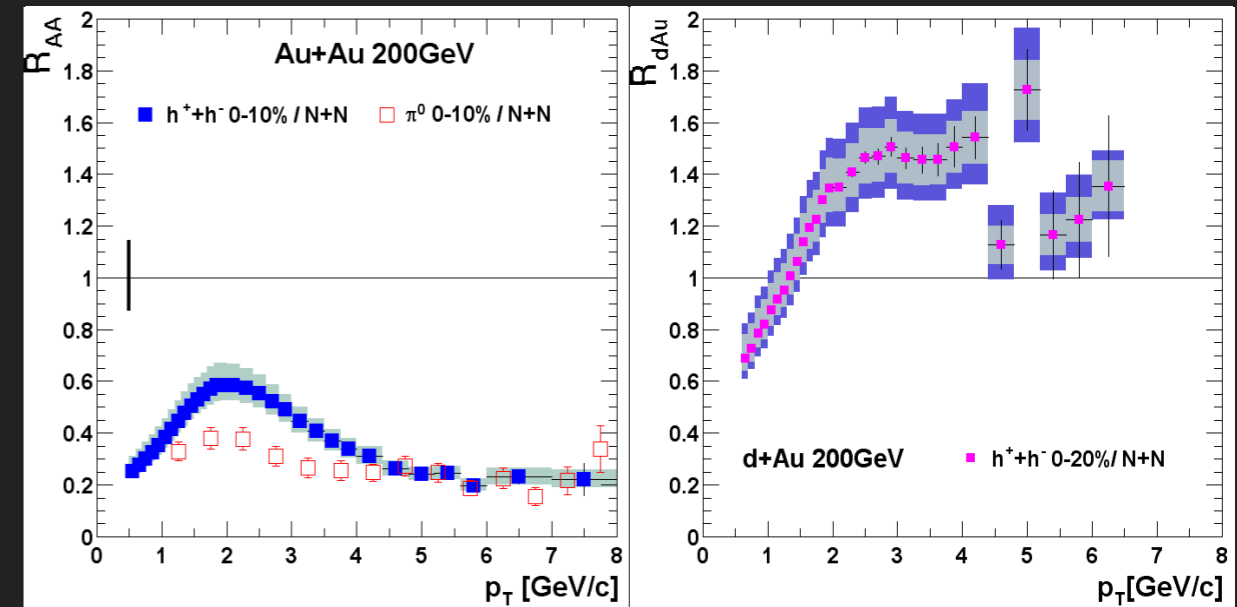
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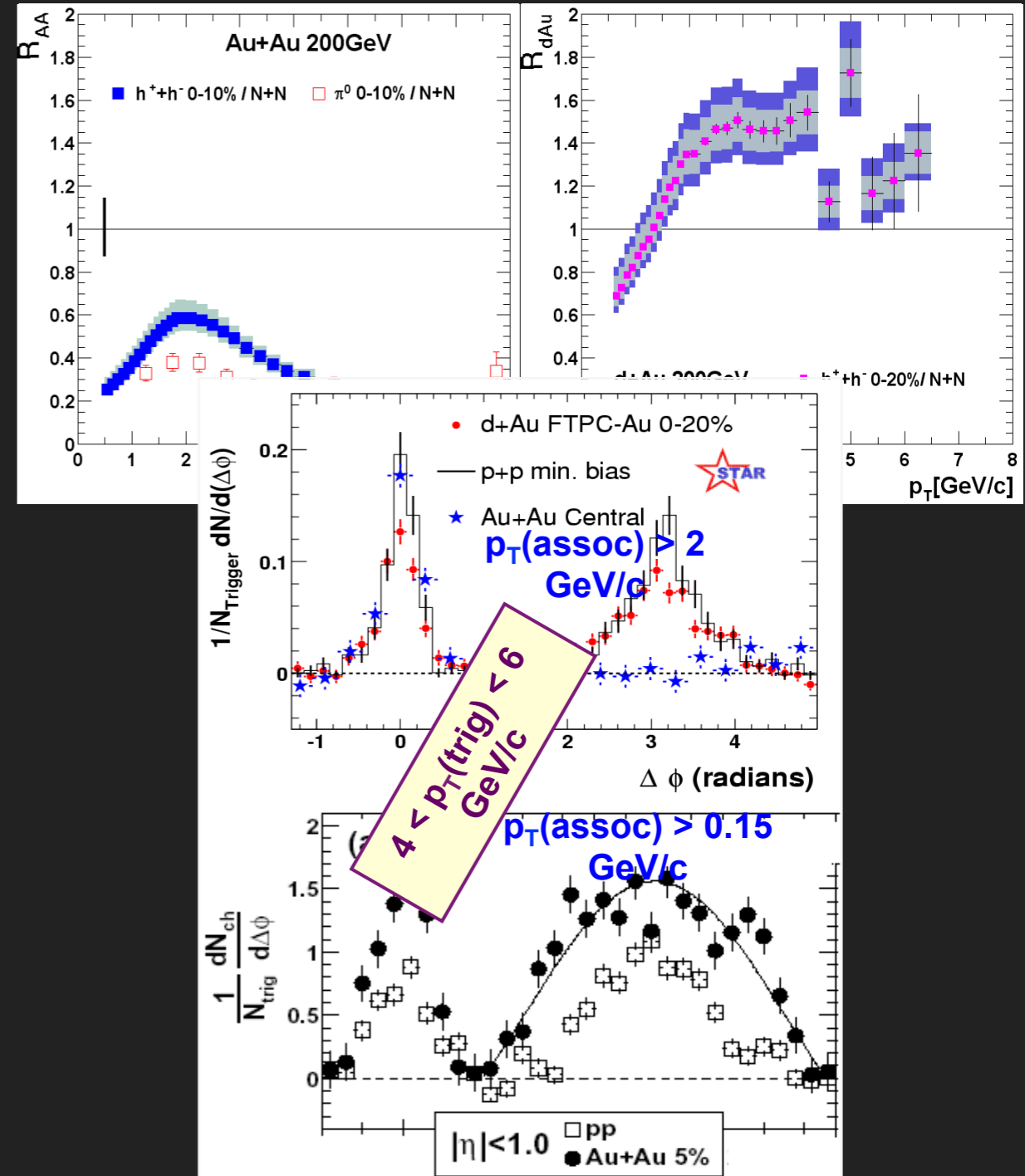
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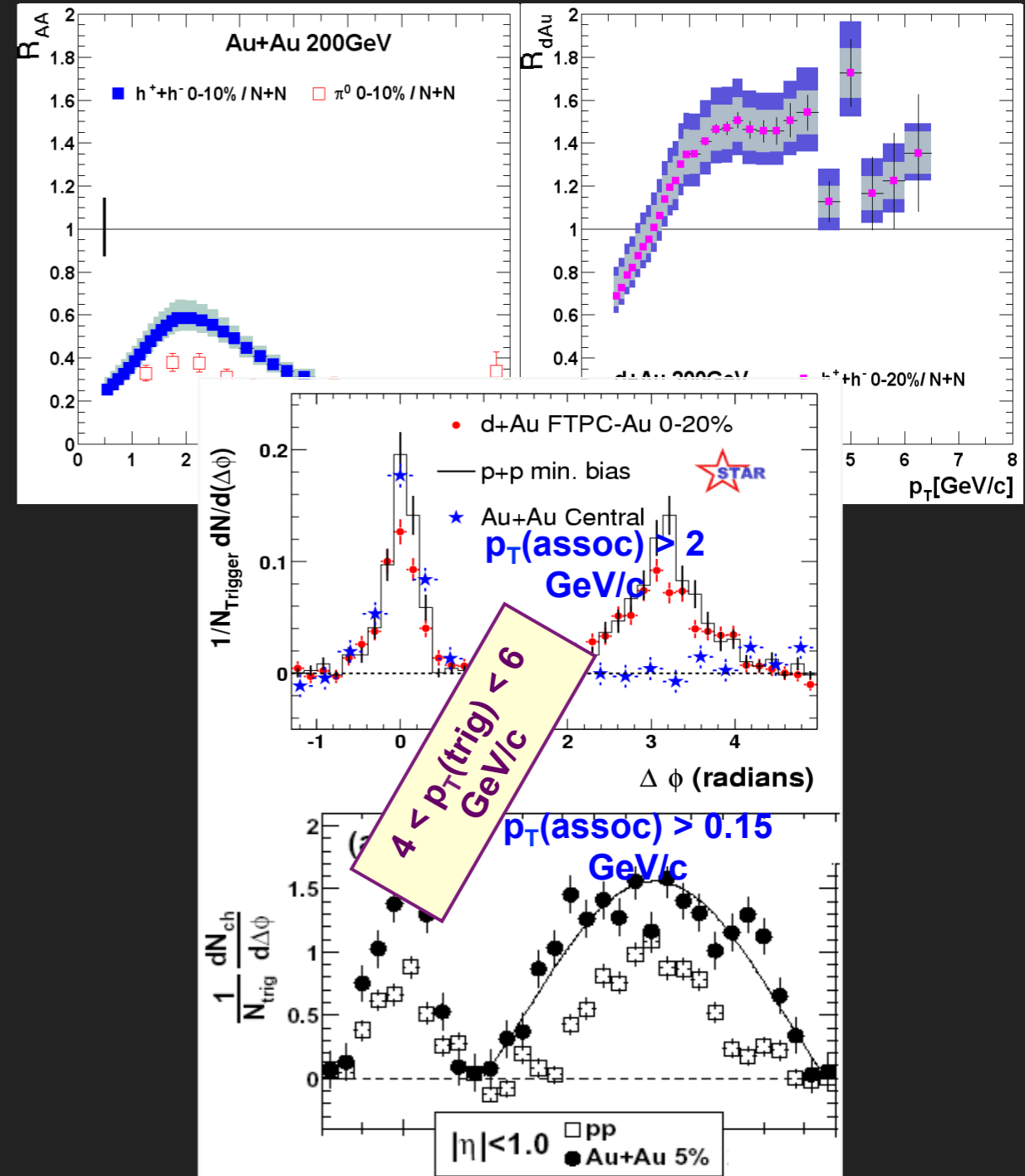
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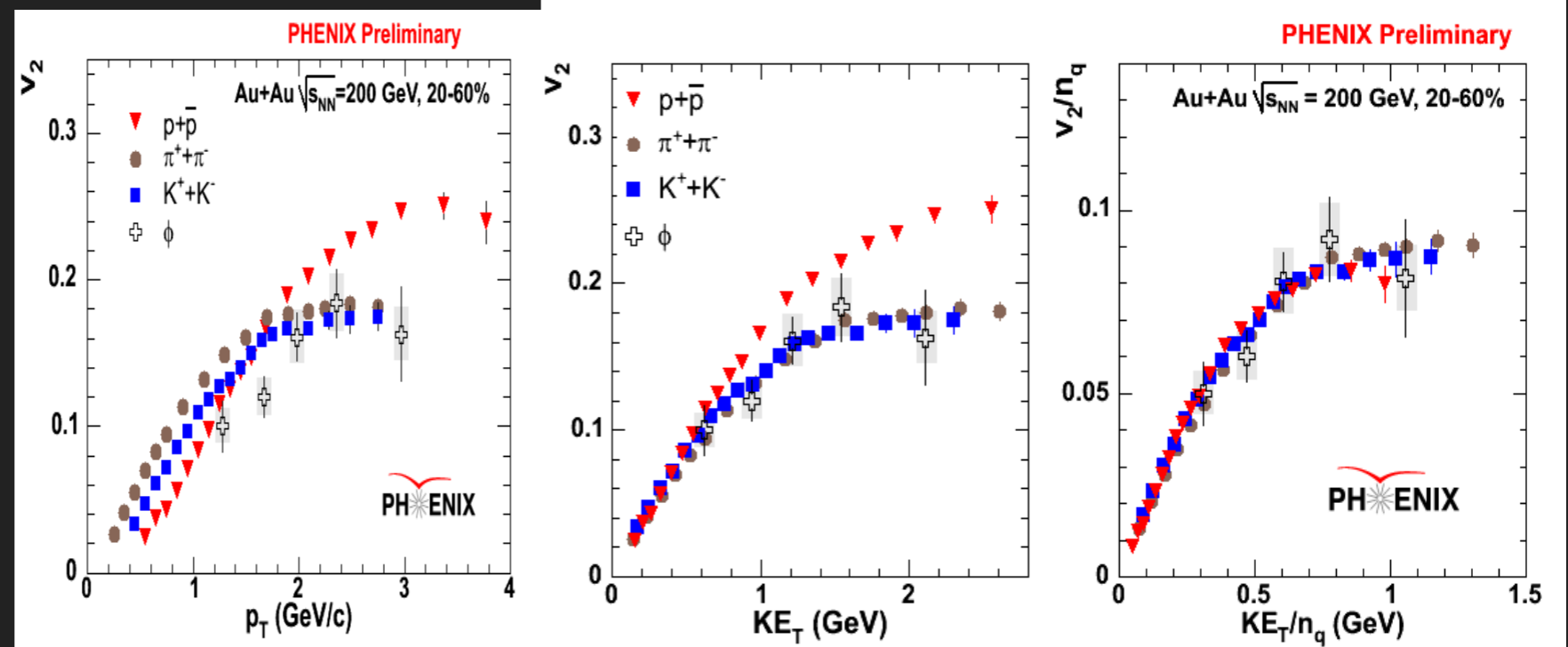
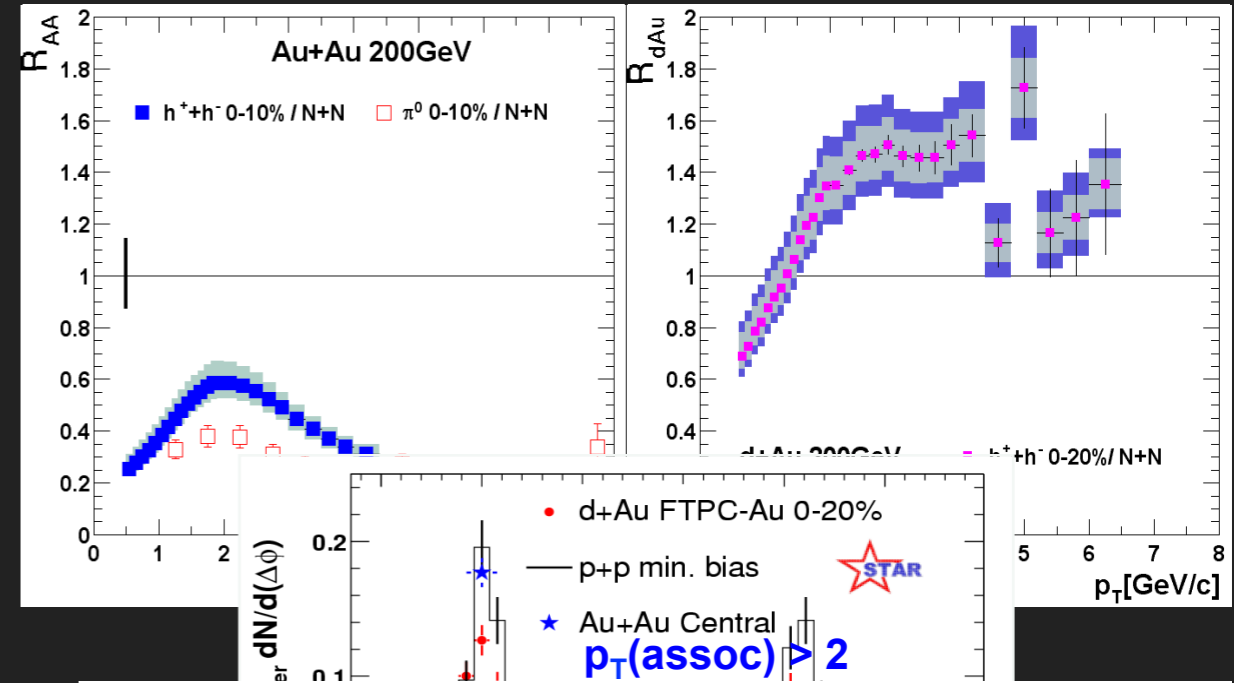
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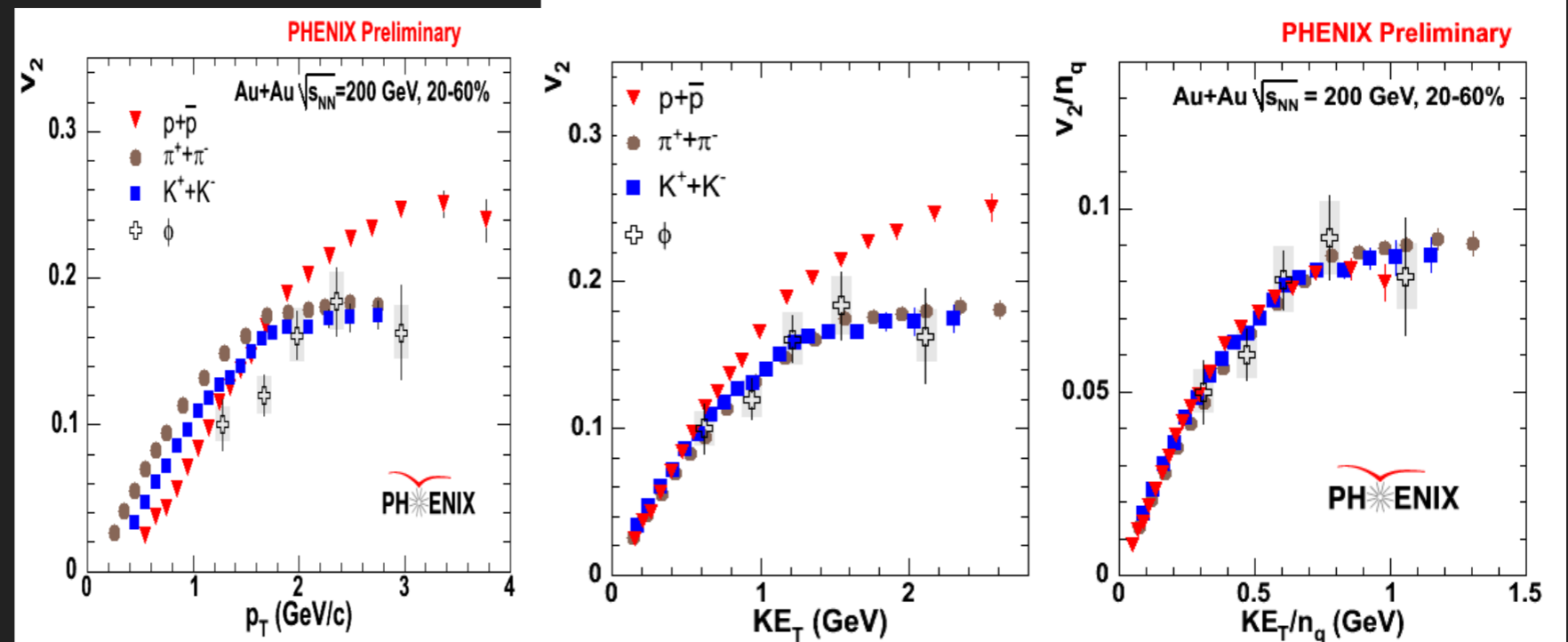
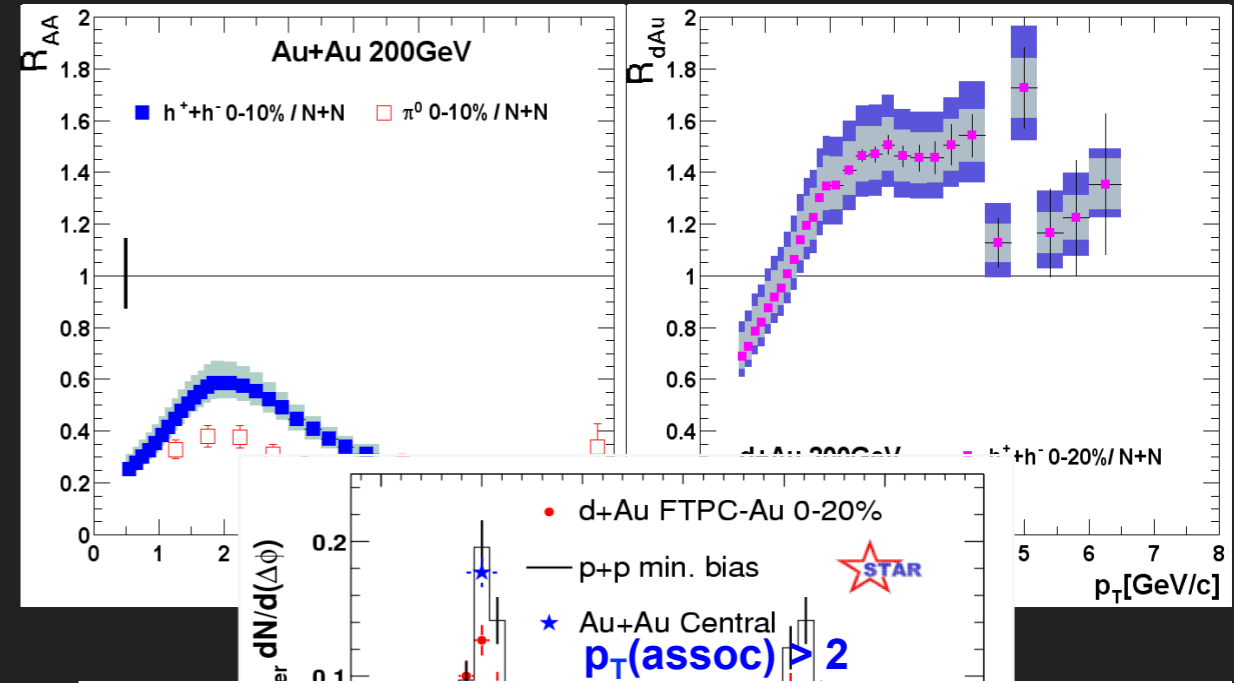
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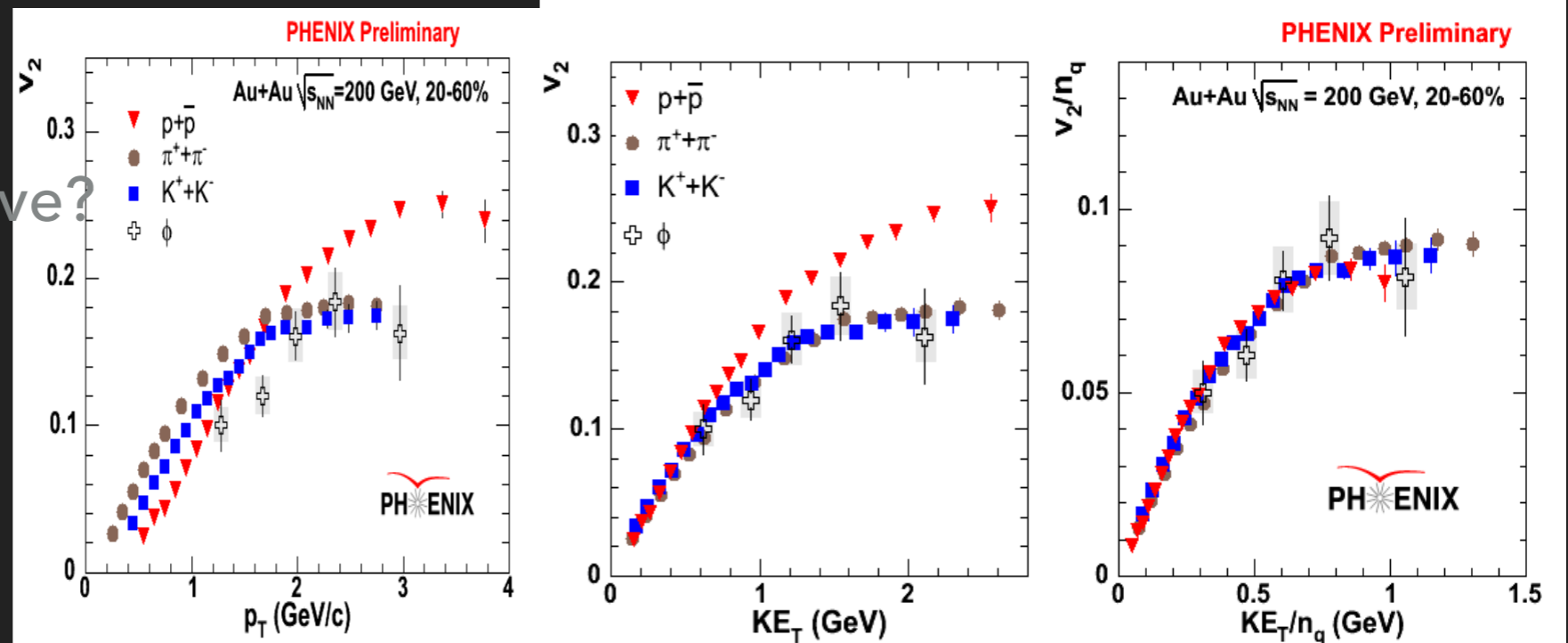
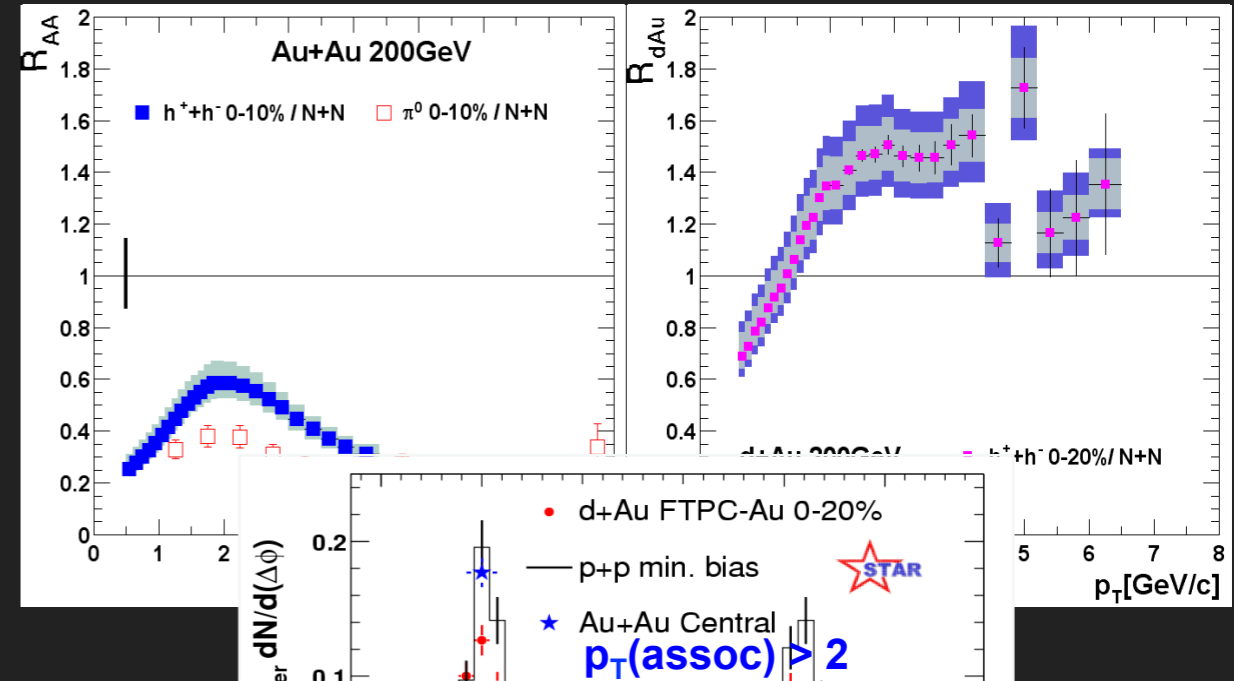
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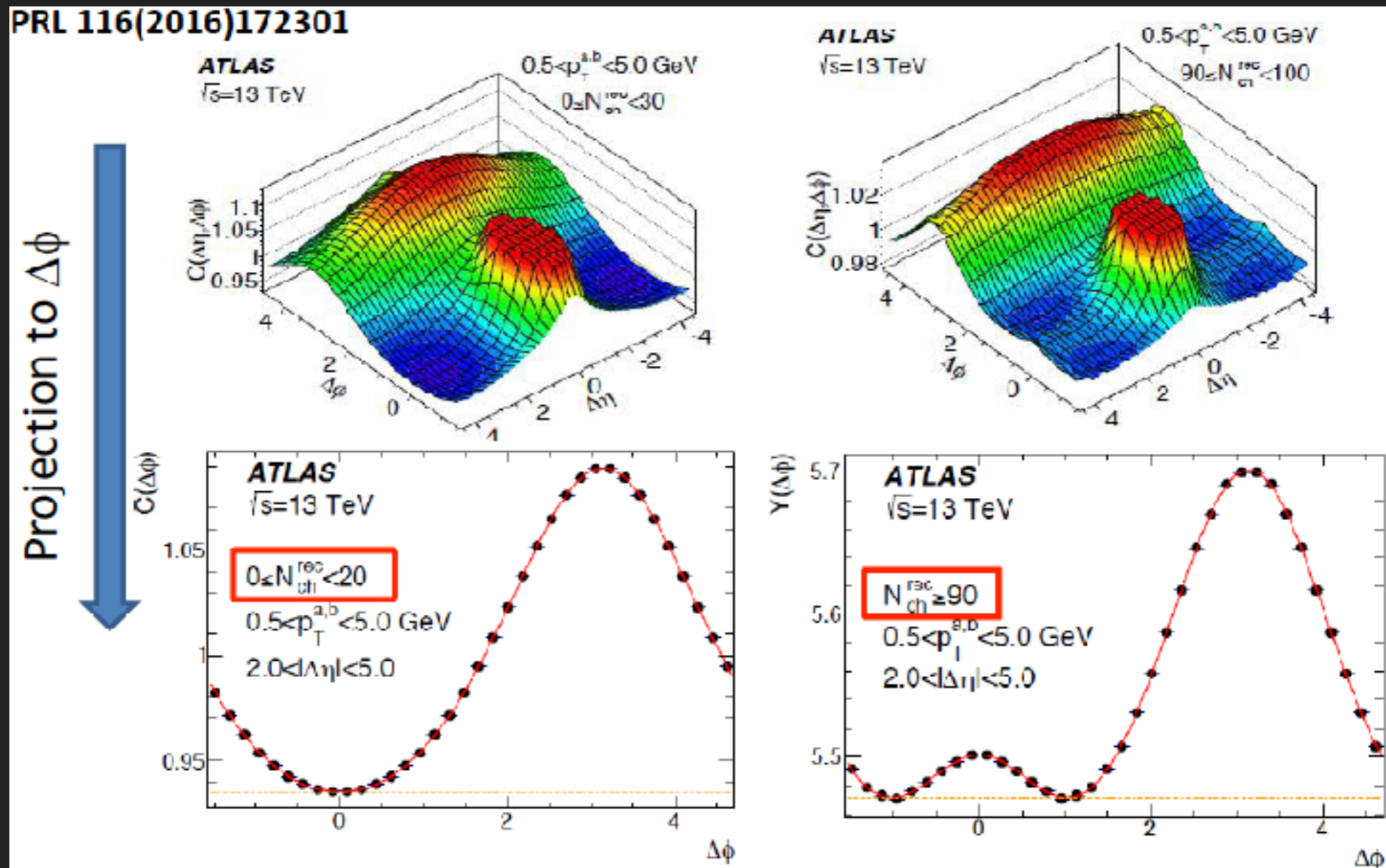


UNEXPECTED PHENOMENON (RHIC)

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 - ▶ Mach-like Shock wave?
 - ▶ Initial condition?
 - ▶ Viscosity: $\eta/s \sim 0$



COLLECTIVITY (EVEN) IN SMALL SYSTEM!



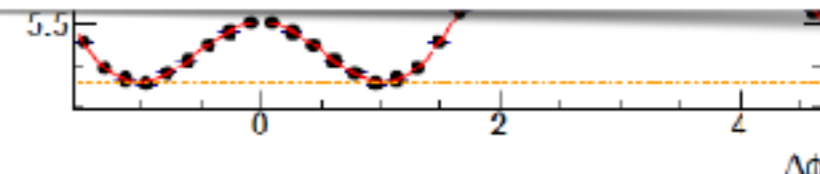
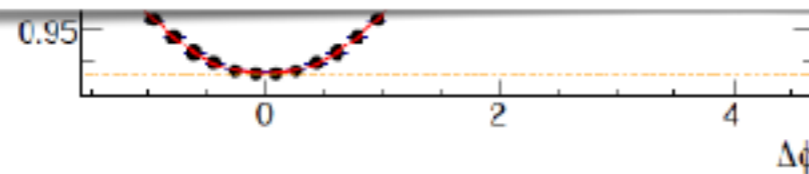
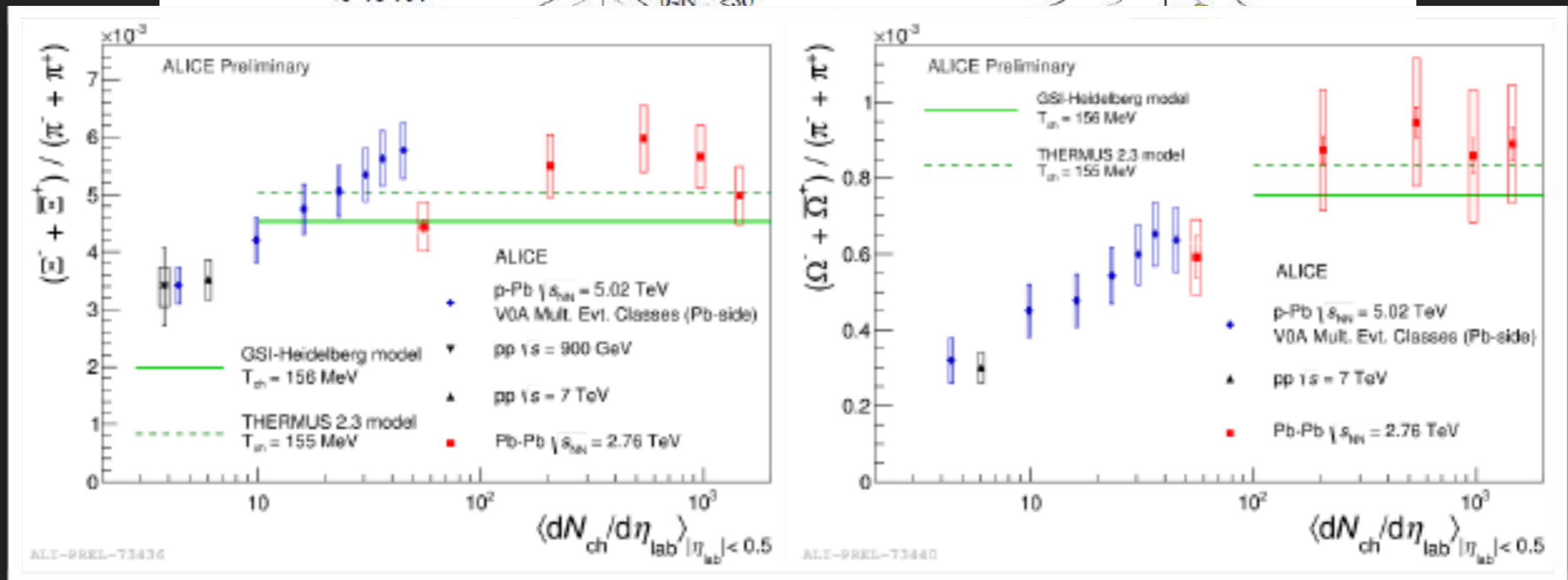
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- ▶ gradual evolution of the system from pp to AA via pA → mini QGP?
- ▶ except high- p_{T} suppression!

COLLECTIVITY (EVEN) IN SMALL SYSTEM!

PRL 116(2016)172301

ATLAS
 $\sqrt{s}=13$ TeV

 $0.5 < p_T^{a,b} < 5.0$ GeV
 $0 < N_{ch}^{100} < 30$
ALIAS
 $\sqrt{s}=13$ TeV

 $0.5 < p_T^{a,b} < 5.0$ GeV
 $90 \leq N_{ch}^{100} < 100$


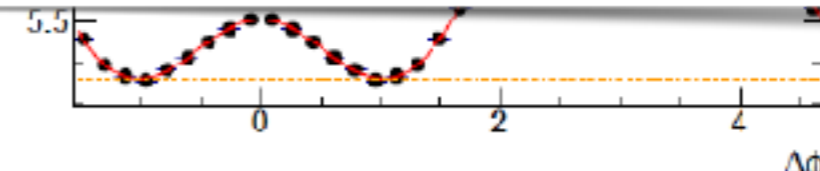
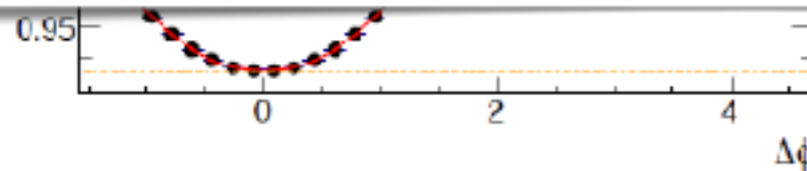
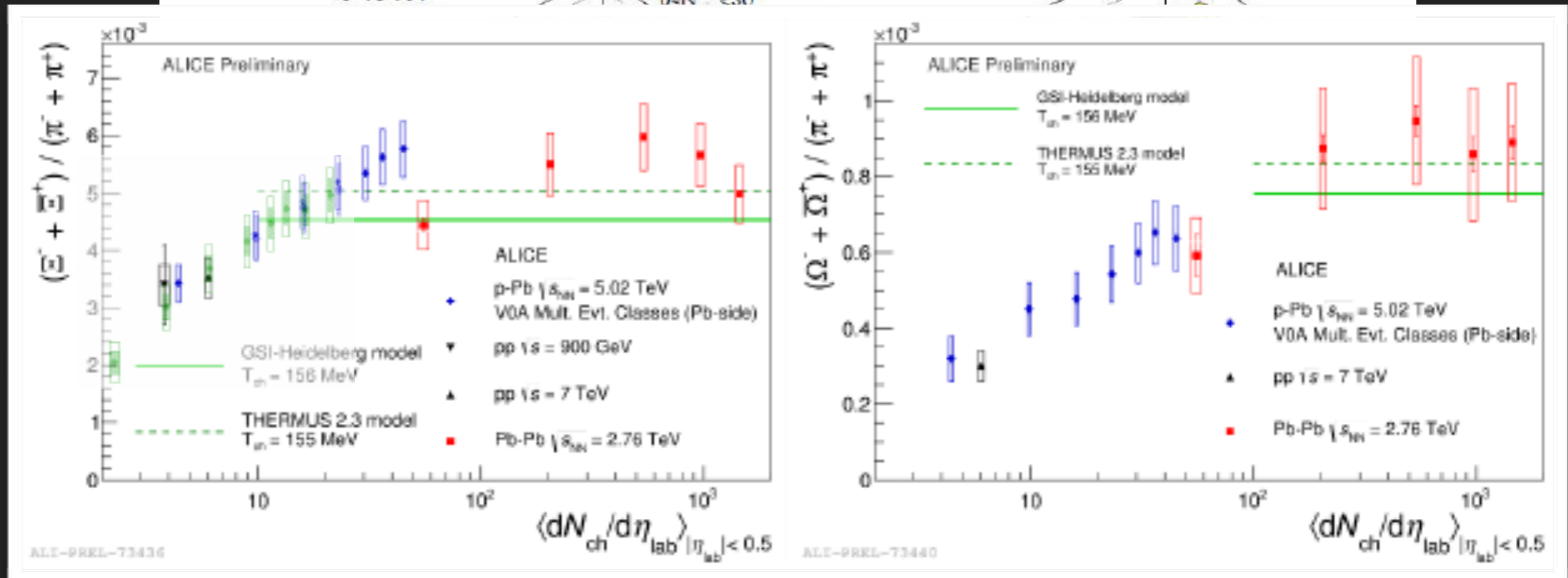
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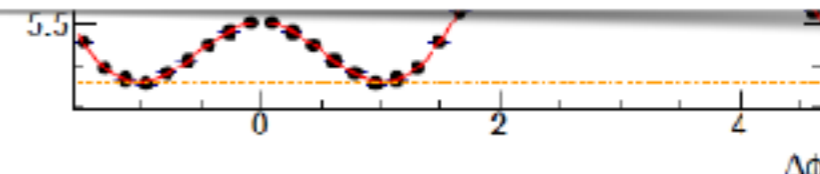
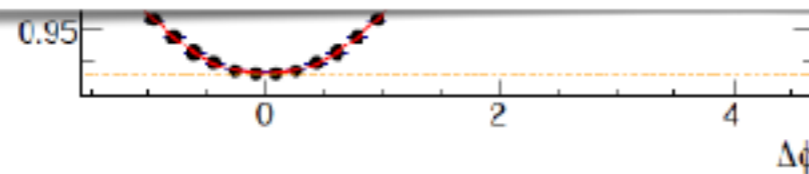
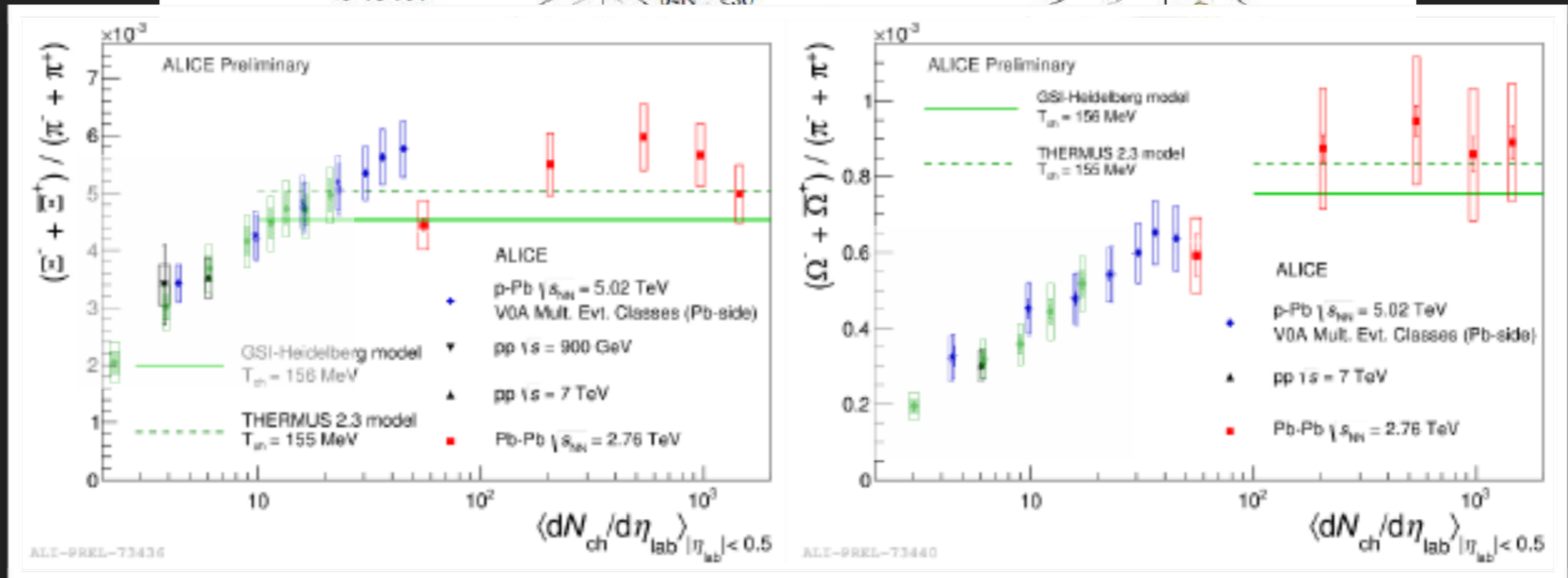
- ▶ high multiplicity events in pp
- ▶ gradual evolution of the system from pp to AA via pA \rightarrow mini QGP?
- ▶ except high- p_T suppression!

COLLECTIVITY (EVEN) IN SMALL SYSTEM!

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ATLAS
 $\sqrt{s}=13$ TeV

 $0.5 < p_T^{a,b} < 5.0$ GeV
 $0 < N_{ch}^{100} < 30$
ALIAS
 $\sqrt{s}=13$ TeV

 $0.5 < p_T^{a,b} < 5.0$ GeV
 $90 \leq N_{ch}^{100} < 100$


- ▶ high multiplicity events in pp
- ▶ gradual evolution of the system from pp to AA via pA \rightarrow mini QGP?
- ▶ except high- p_T suppression!

CROSS-ROADS: HOW TO IDENTIFY IT?

- ▶ Strongly interacting Matter in high T
 - ▶ Heavy Flavor, Higher statistics
 - ▶ Direct photon, Leptons
 - ▶ Nuclear Modification in pp? mini QGP?
 - ▶ sLHC, CCEP etc.
- ▶ 1st order Phase Transition in high μ
 - ▶ New Experiments:
 - ▶ STAR-BESII, CBM (FAIR), (JPARC, NICA)
 - ▶ Rare probe (e.g. charm) but higher statistics
 - ▶ New Theories:
 - ▶ higher moments of mul-distribution
 - ▶ Lattice cal. / Critical Point!
 - ▶ S vs. non-S multi-freeze-out?

