Supported in part by:

Probing the system-size dependence of parton energy loss in heavy-ion collisions with the STAR detector

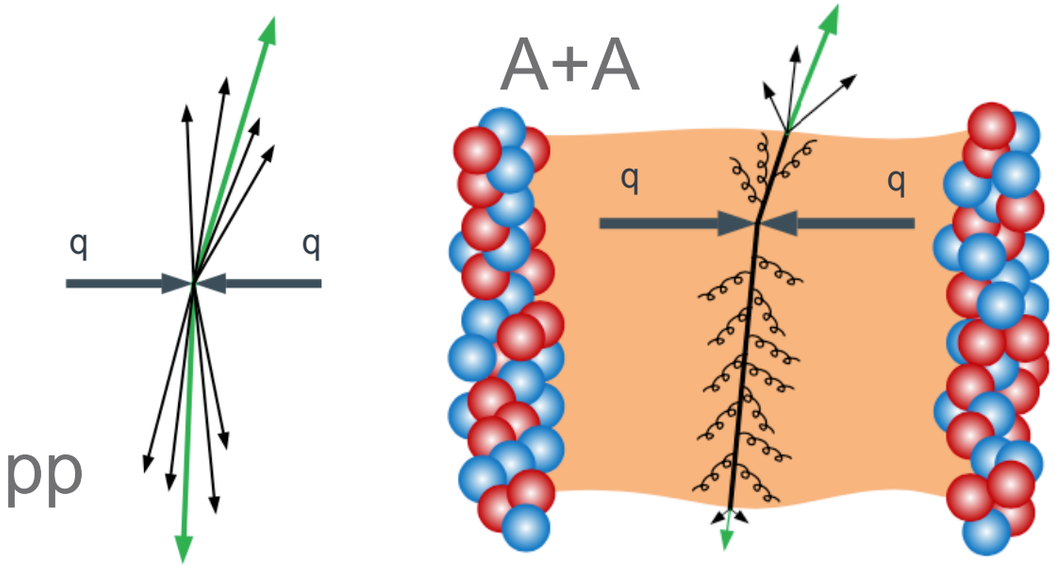
DNP2020

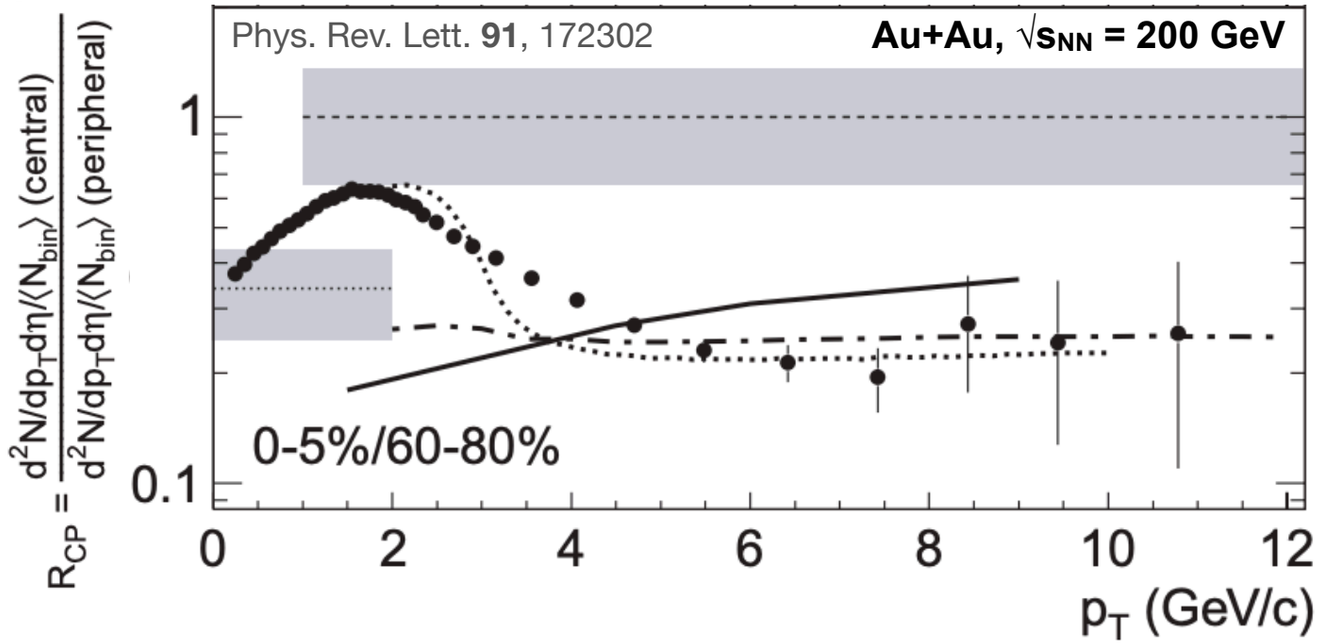
Fall Meeting of the Division of Nuclear Physics
of the American Physical Society
Oct. 29 – Nov. 1, 2020 *Now Virtual Meeting!*
~~Hyatt Regency Hotel, New Orleans, LA~~

Audrey Francisco (Yale University)
for the STAR Collaboration

Motivations for intermediate systems

- High-p_T hadrons are created during hard processes at early stages of the collision
- Suppression is observed in central heavy-ion collisions
- Interpreted as partonic energy loss through the formed QGP





- Energy loss depends on:
  - partonic flavor
  - path length in medium
  - energy density of the medium

How does energy loss depend on the system properties?

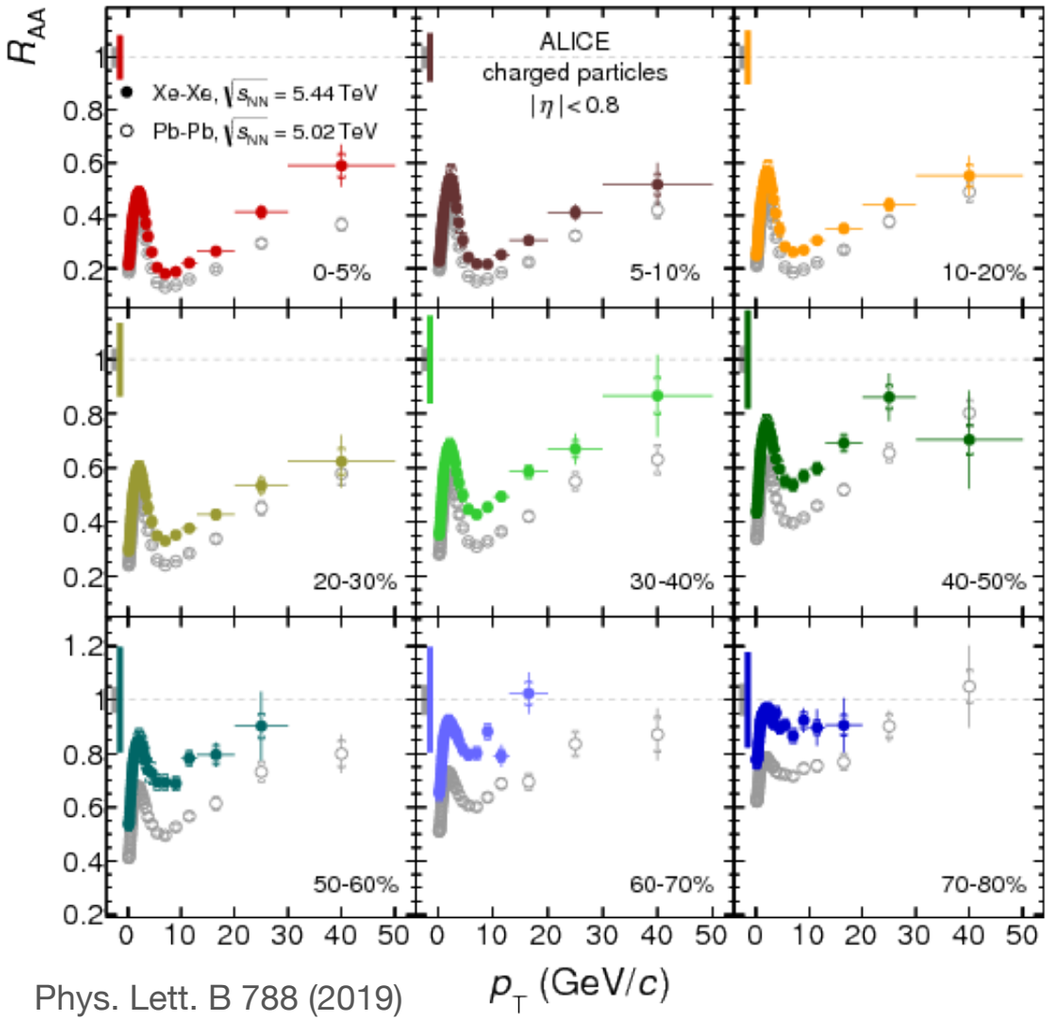
- Effect of varying the collision energy?
- Effect of varying the system size?

Motivations for intermediate systems

- Study of different collision energies: compare results from RHIC and the LHC + Beam Energy Scan at RHIC

- Study of different system sizes: vary the centrality or compare different (heavy-ion) collision systems

  →more statistics, overlap regions, nuclei properties, etc…



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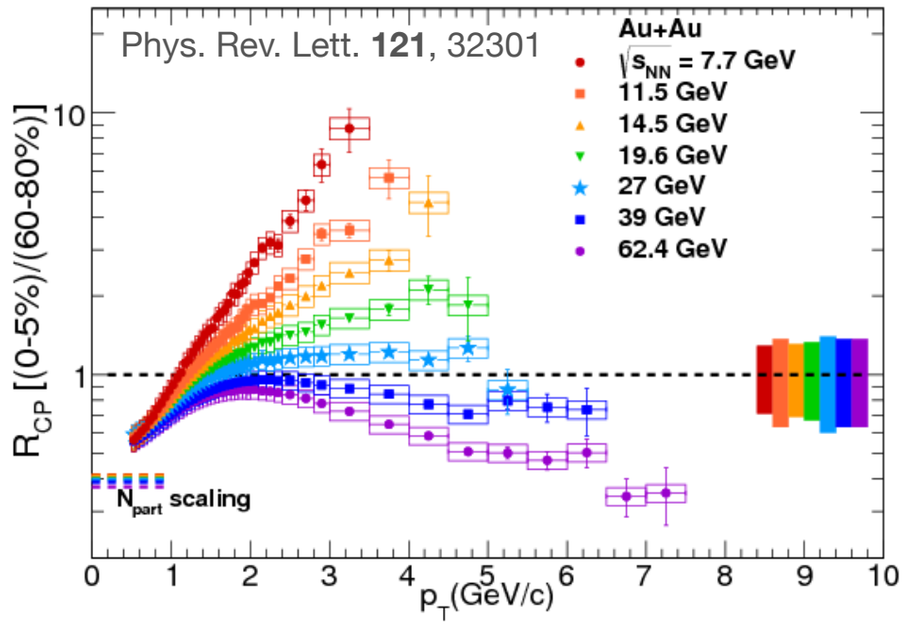
BES for Au+Au collisions



At the LHC:

Xe+Xe collisions at 5.44 TeV

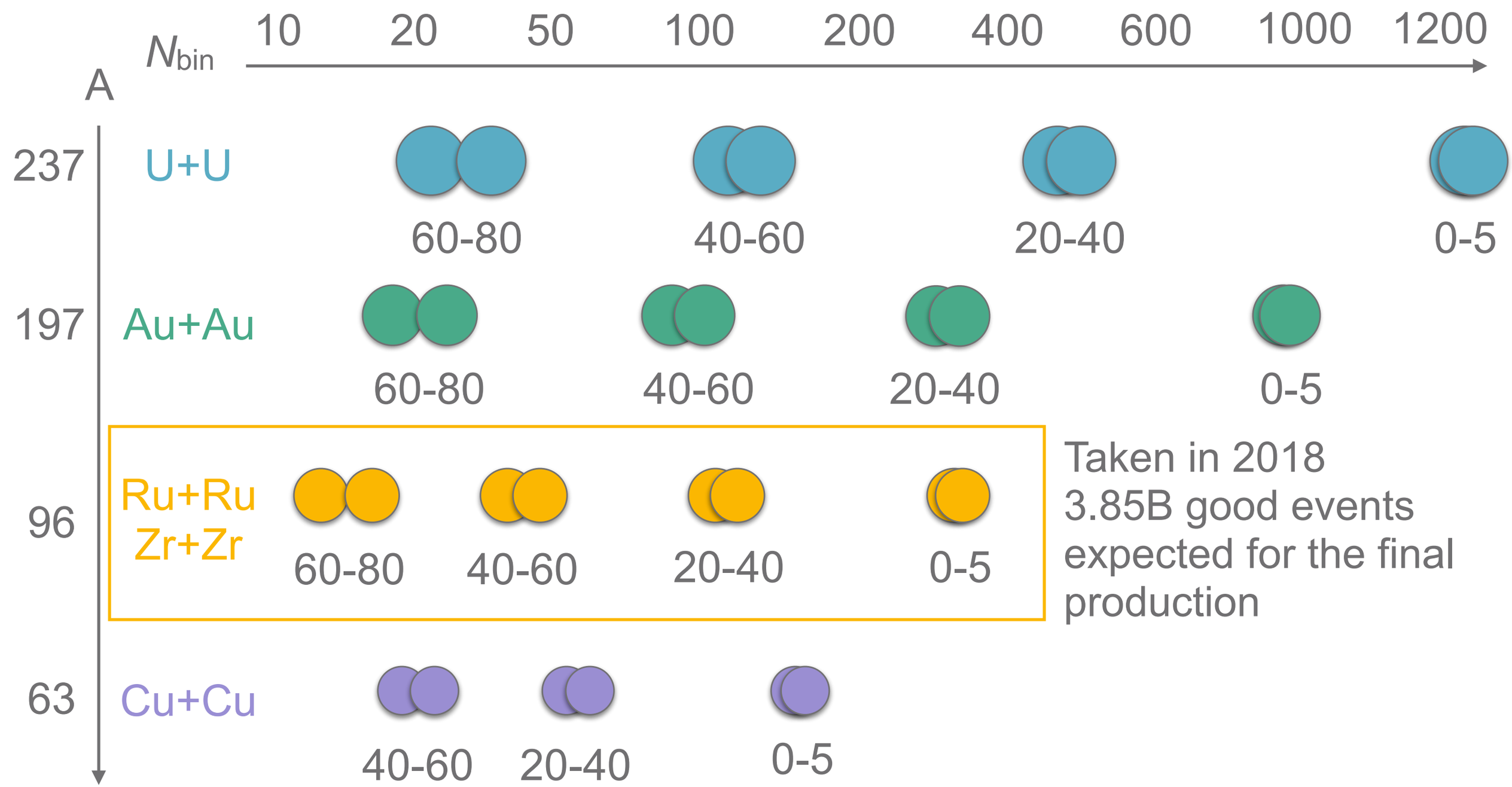
vs Pb+Pb collisions at 5.02 TeV

At RHIC:

several systems at 200 GeV

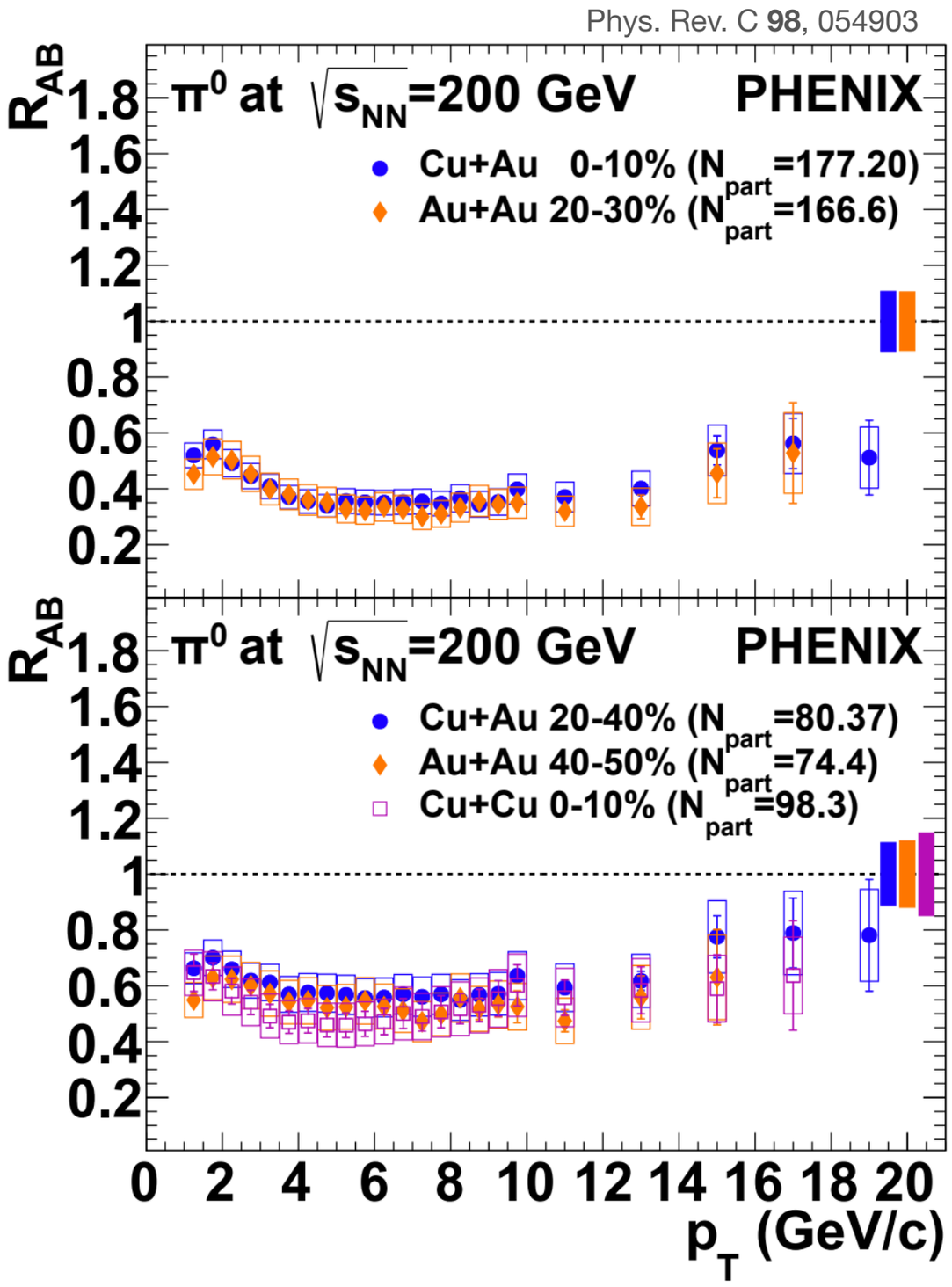
Au+Au	Cu+Au
U+U	Zr+Zr
Cu+Cu	Ru+Ru

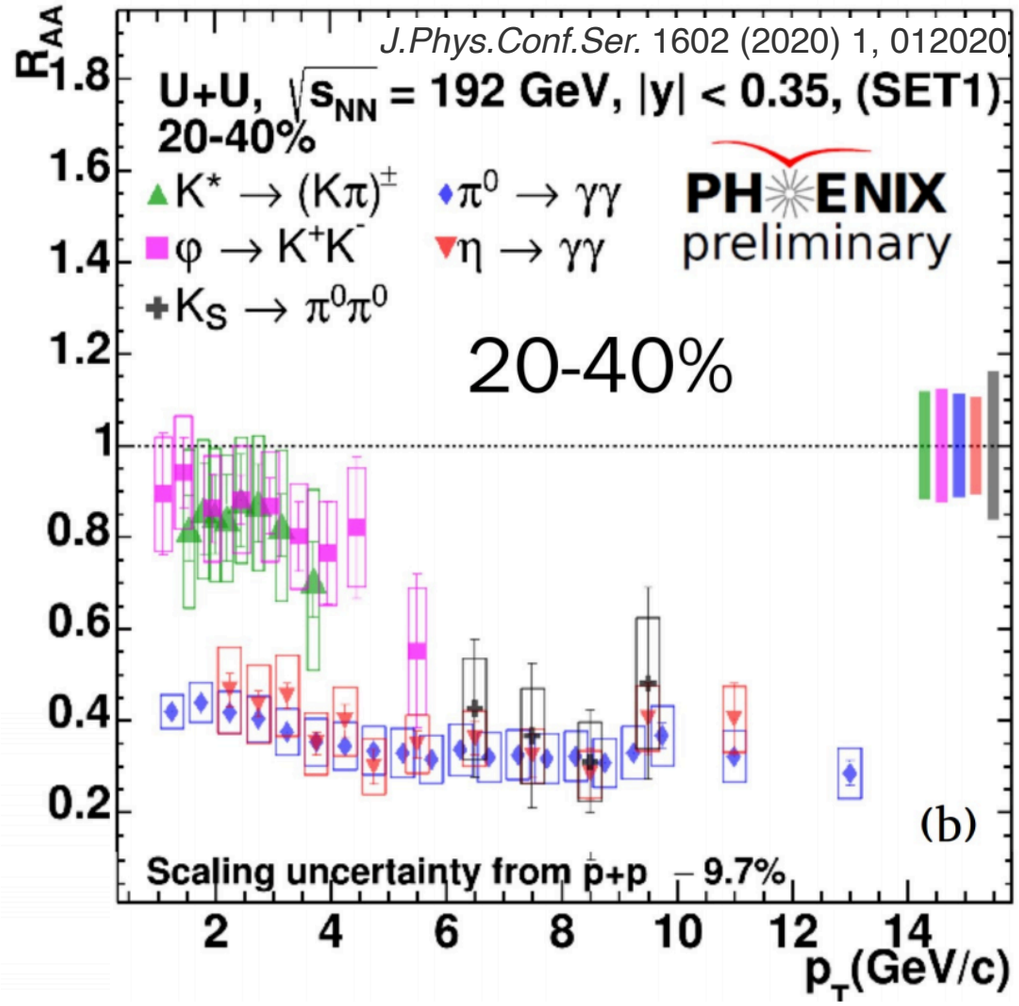
Number of binary collisions for different systems at RHIC



Taken in 2018
3.85B good events expected for the final production

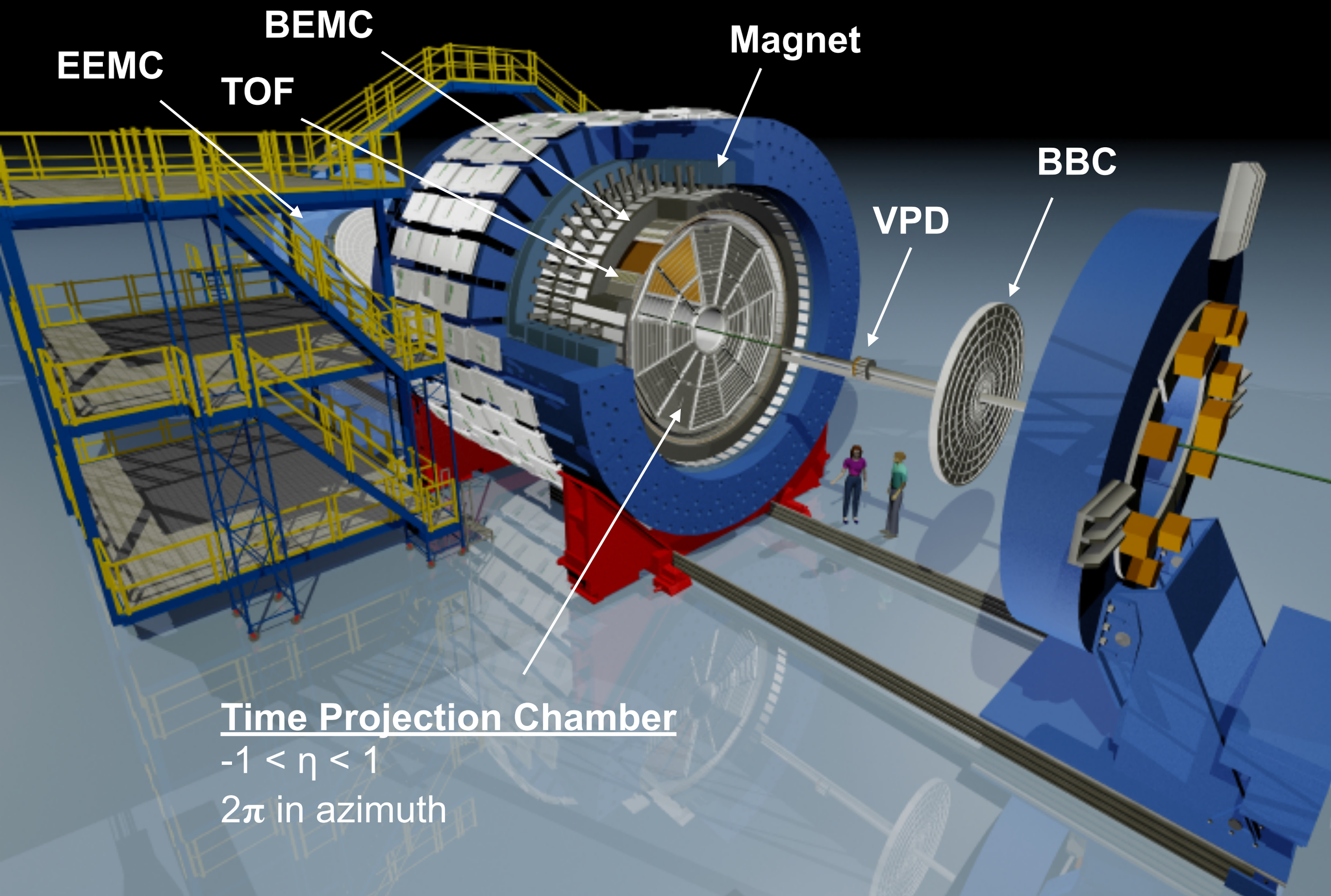
Previous results from RHIC



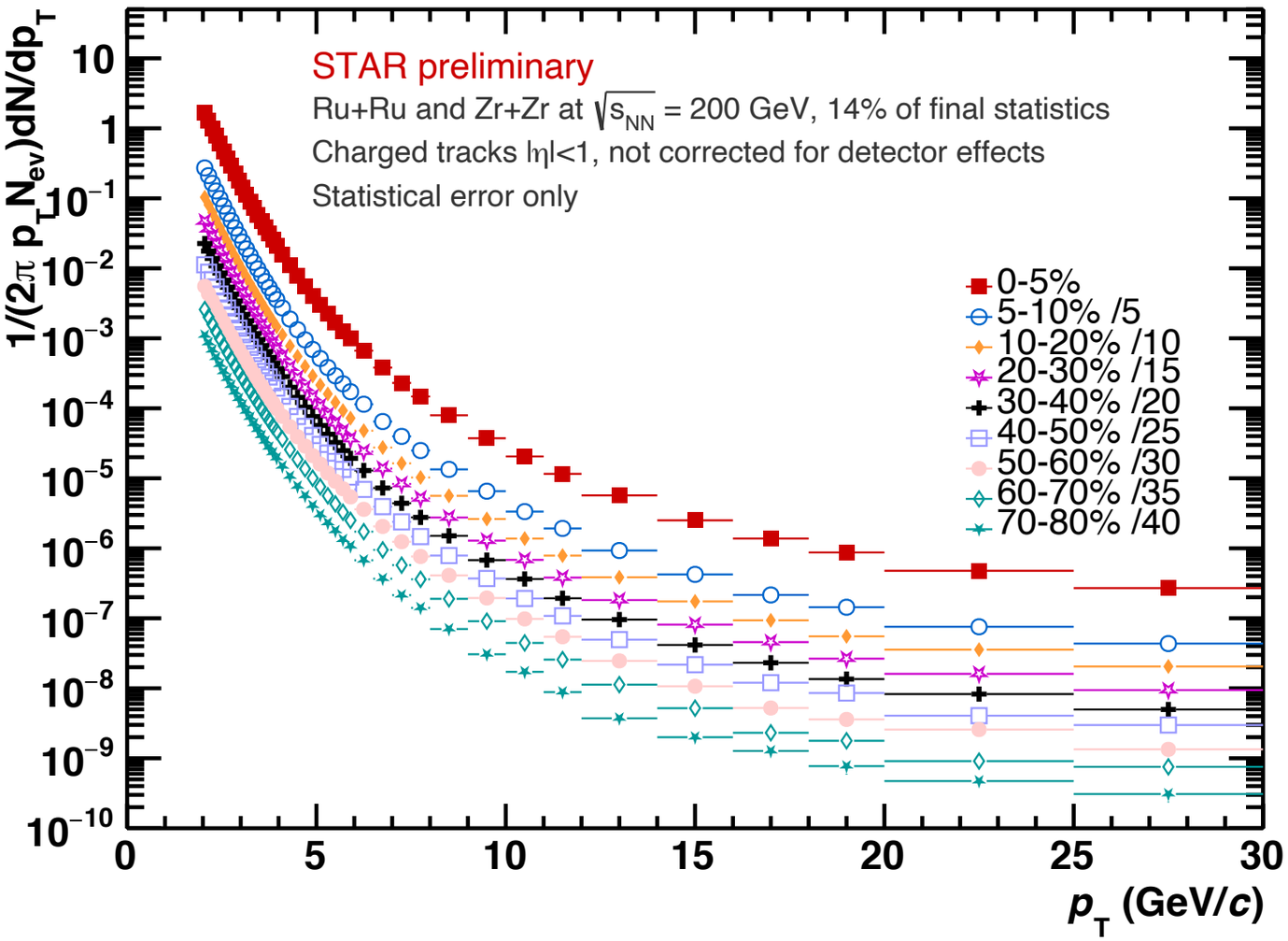


R_{AA} results show a similar suppression for π^0 across Cu+Au, Au+Au, Cu+Cu and U+U systems for similar numbers of participants

The Solenoid Tracker At RHIC



Charged particle spectra



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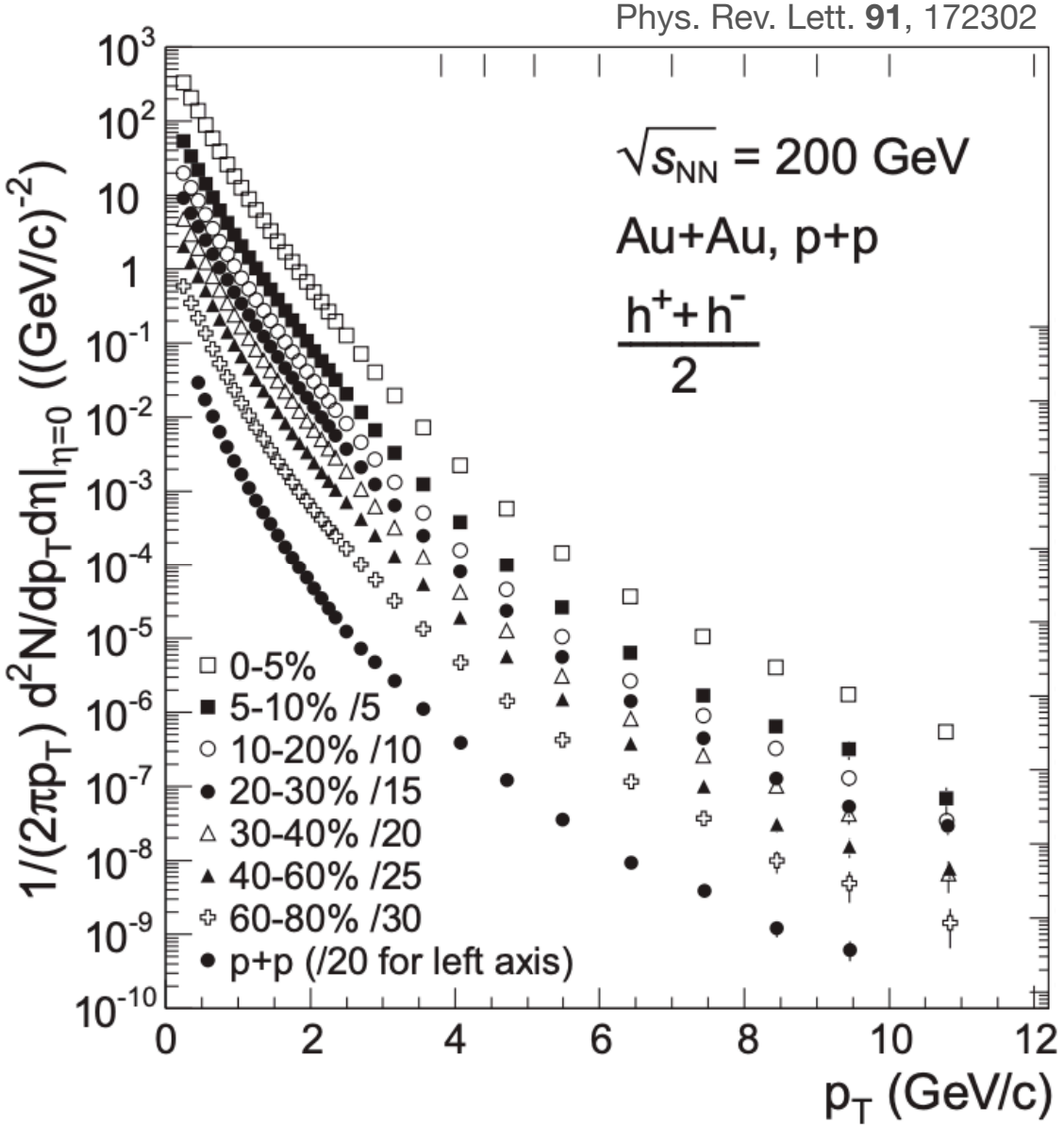
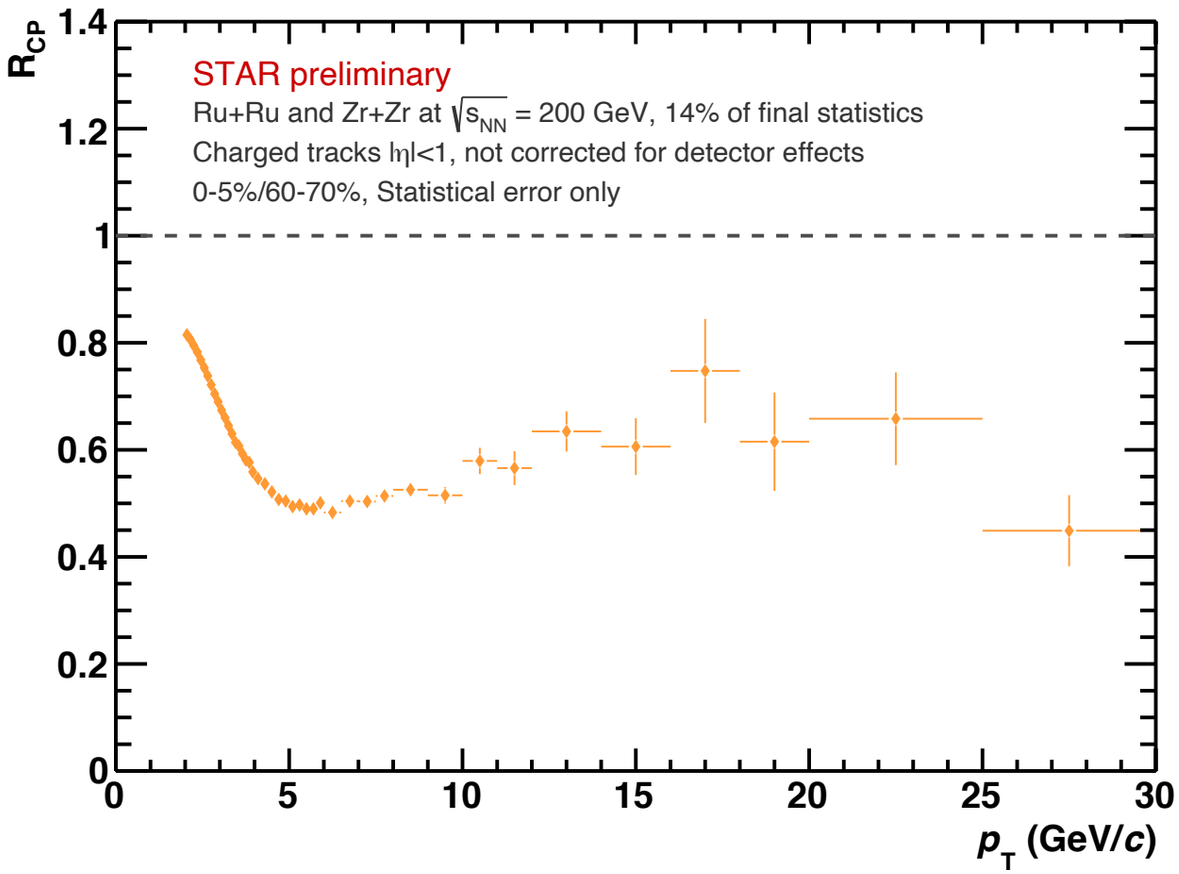


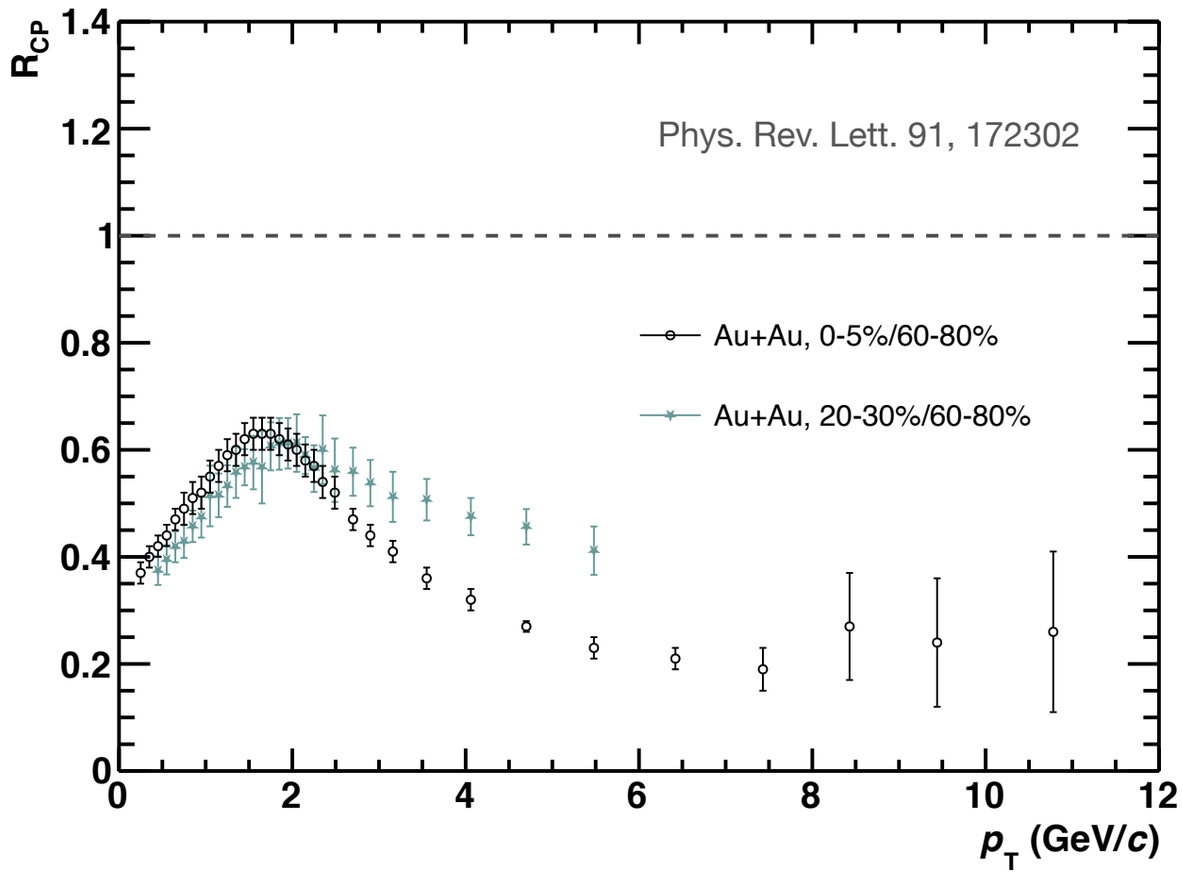
Ru+Ru/Zr+Zr results are not corrected for detector effects

Extended p_T reach for Ru+Ru/Zr+Zr

Nuclear modification factor R_{CP}

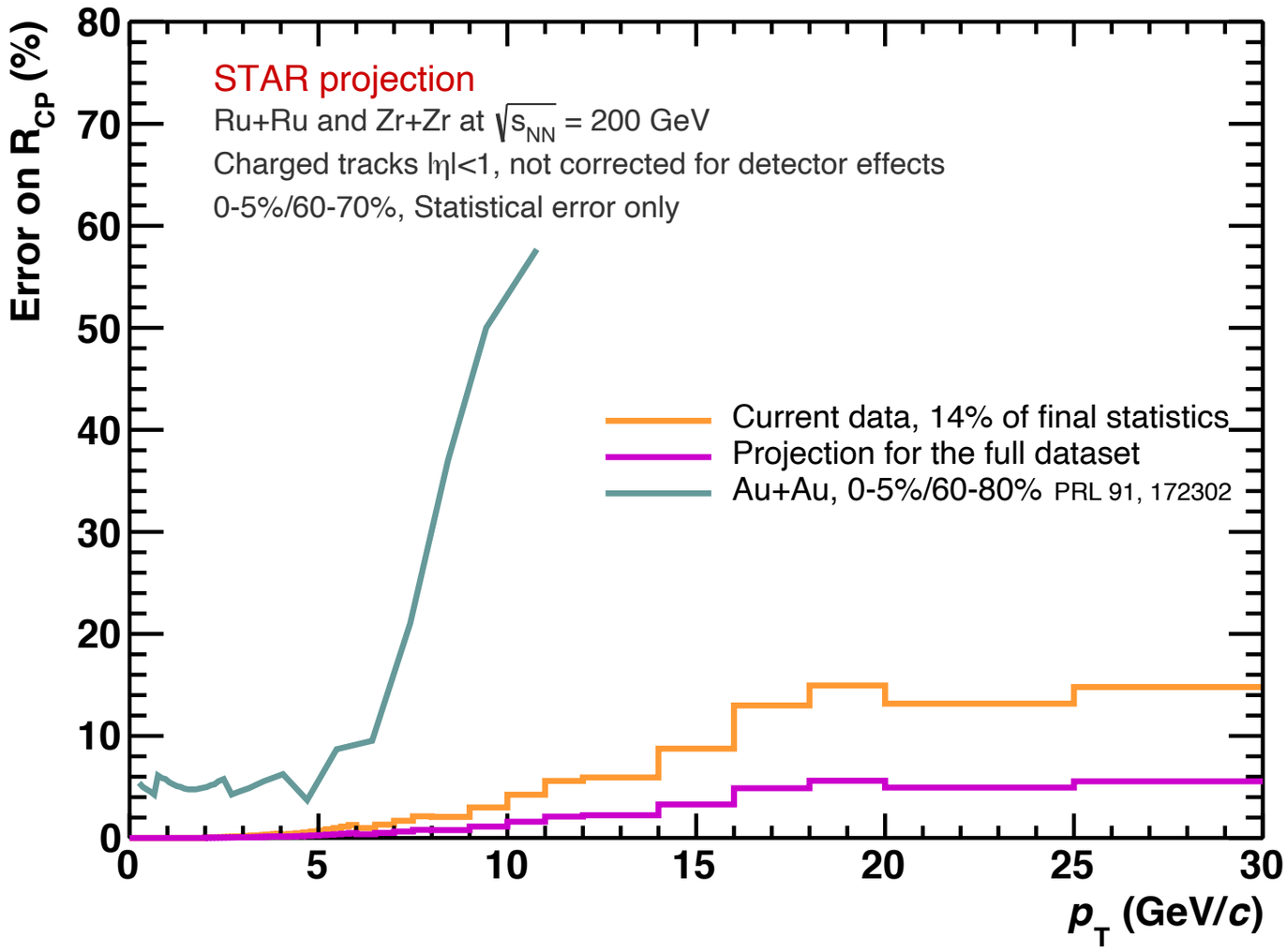
$$R_{\mathrm{CP}} = \frac{N_{\mathrm{bin,Peri}}}{N_{\mathrm{bin,Cent}}} \times \frac{\left(\frac{d^2N}{\langle N_{\mathrm{ev}}\rangle dp_{\mathrm{T}}d\eta}\right)_{\mathrm{Cent}}}{\left(\frac{d^2N}{\langle N_{\mathrm{ev}}\rangle dp_{\mathrm{T}}d\eta}\right)_{\mathrm{Peri}}} = \frac{\text{Central}}{\text{Peripheral}}$$





- Ratio of 0-5% to 60-70%, not corrected for detector efficiency (will enhance the final R_{CP} by a few %)
- Clear suppression is observed at all p_T, corrected data are required for comparing to Au+Au collisions
- Comparison to Au-Au:
  similar N_{part} regions : 0-5%(165.7) vs 20-30%(167.6), 60-70%(16.7) vs 60-80%(20.9)

Improved measurement precision



- Dramatically reduced statistical errors at high p_T
- Finer centrality bins (peripheral is 10% wide)
- Significantly extended p_T range up to 30 GeV/c
- Au+Au contains statistical + systematic uncertainties

- Very promising with the full dataset!
- Prospects for new differential measurements (event-plane, rapidity, etc…)

Conclusions

- New dataset with intermediate number of nucleons: Ru+Ru and Zr+Zr
- No difference is expected between both datasets but will check
- New opportunity to investigate partonic energy loss and its dependence on the system-size and the initial energy density by comparing to Au+Au collisions

Future prospects

- Substantial statistics for Ru+Ru and Zr+Zr will allow:
  - a finer centrality and p_T binning + increase the p_T reach to 30 GeV/c
  - new differential measurements
- Run O+O at RHIC… and the LHC?

Thank you for your attention!

Back-up

Dataset status

<100 runs
A fraction of events
Mixed dataset

2K runs
A fraction of events
Blinded dataset

→ Data with partial statistics
Blinded but not mixed
(1 run = 1 coll. system)

2K runs
All events
Unblinded dataset

Estimated final dataset statistics:
1.85B + 2B

LHC Xe-Xe results

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