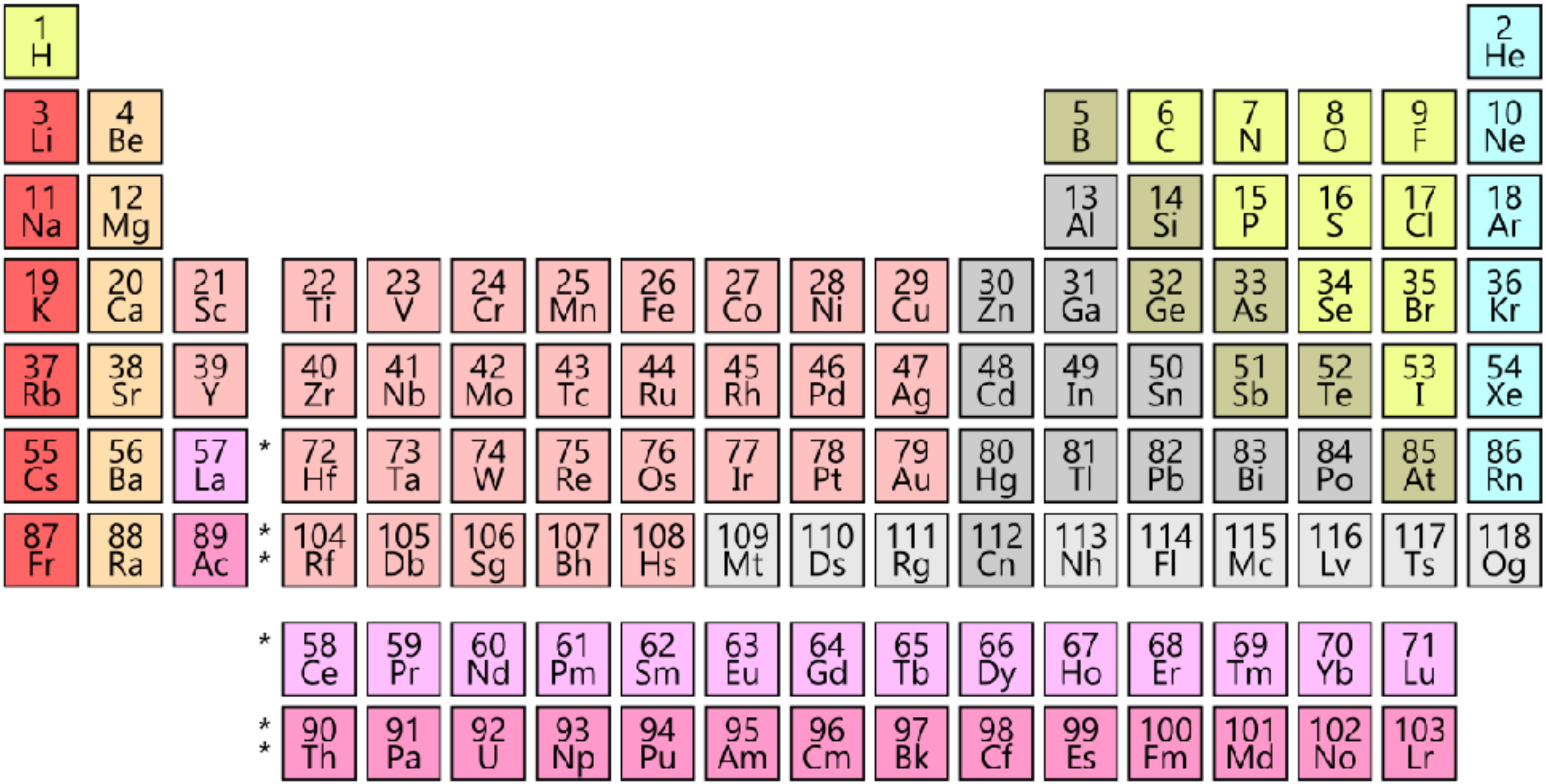

Light Ions for Jet Probes

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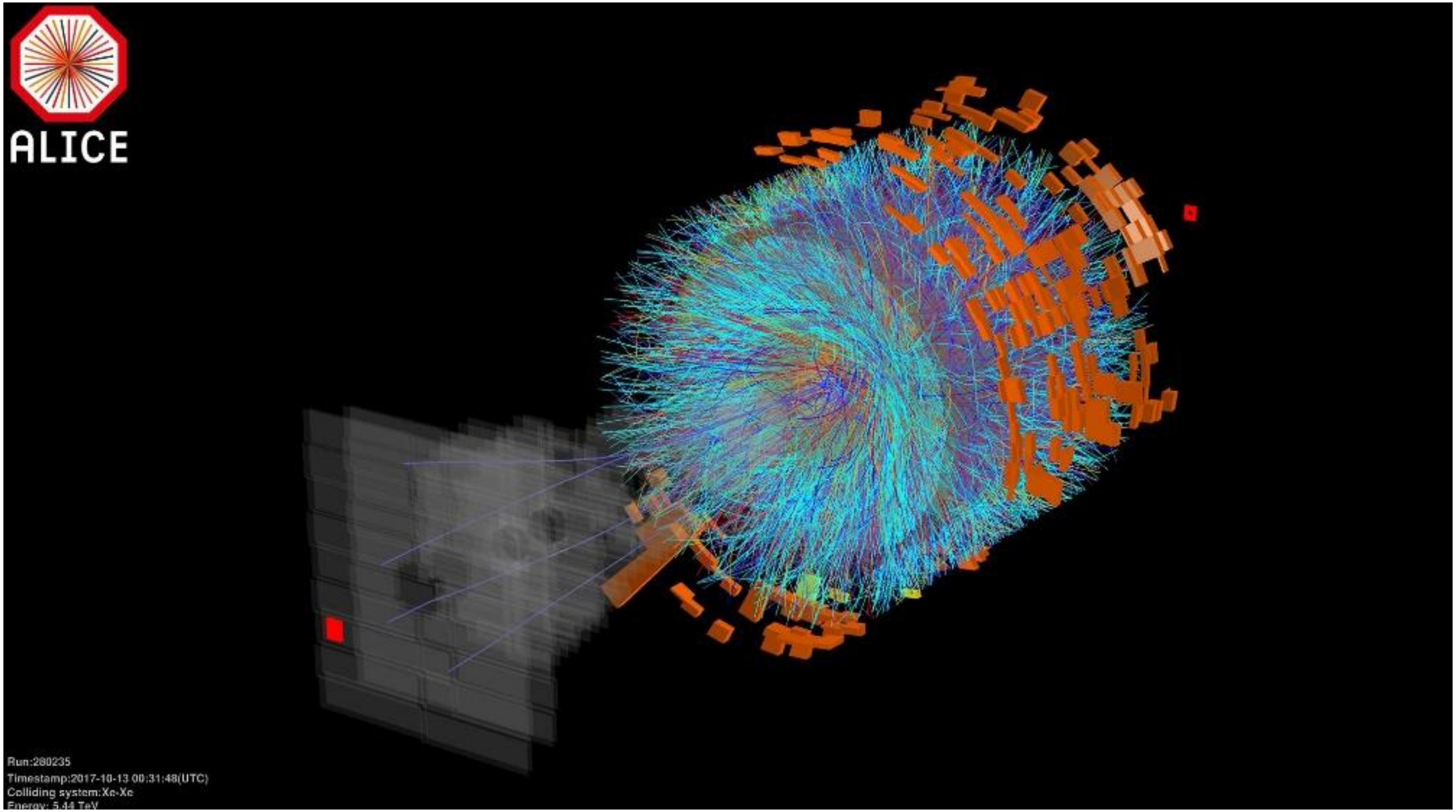
June 19, 2018

ILLINOIS

outline

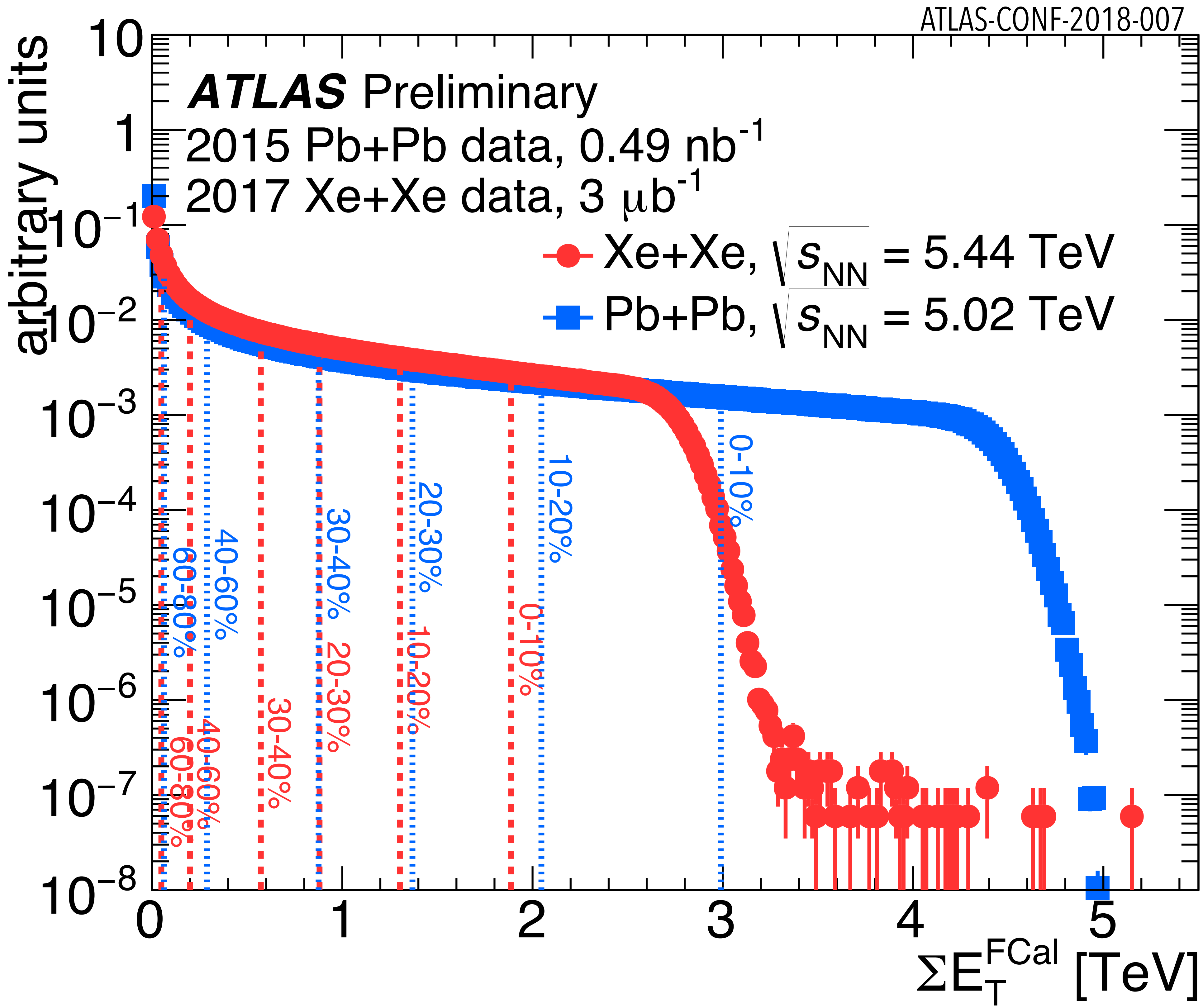
- what did we learn about jets from XeXe collisions so far?
- arguments in favor of high luminosity light ion running
  - increased rates for hard probes
  - understanding the onset of jet quenching
  - decreased systematics from the UE
- questions
  - which ion(s)?
  - how much running is needed?

using the XeXe data



- new XeXe (max Npart ~280) provided a first look at lighter species at the LHC

central XeXe still pretty central



smaller systems → smaller quenching

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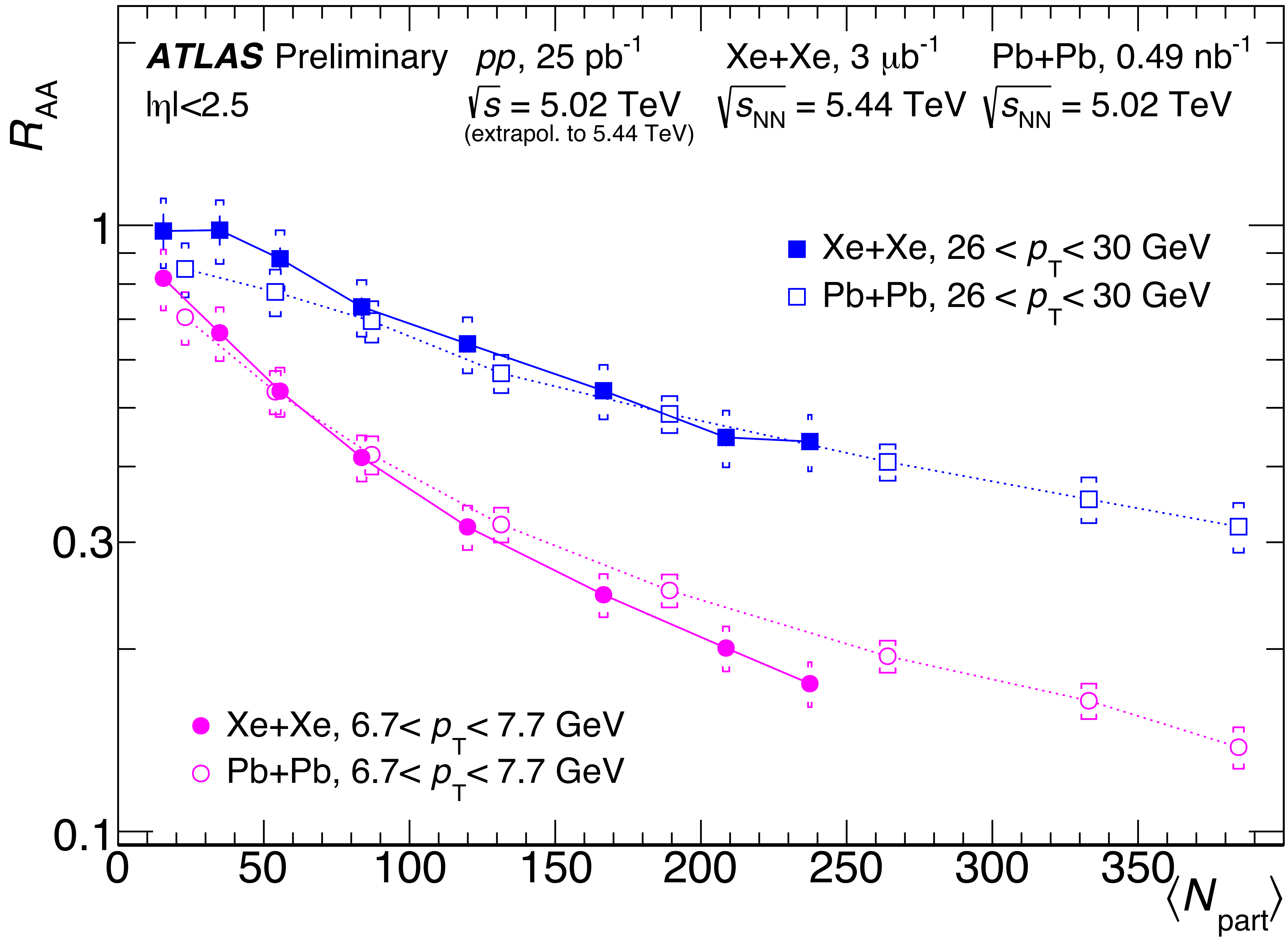

R_{AA} comparisons with system size selection

charged particles

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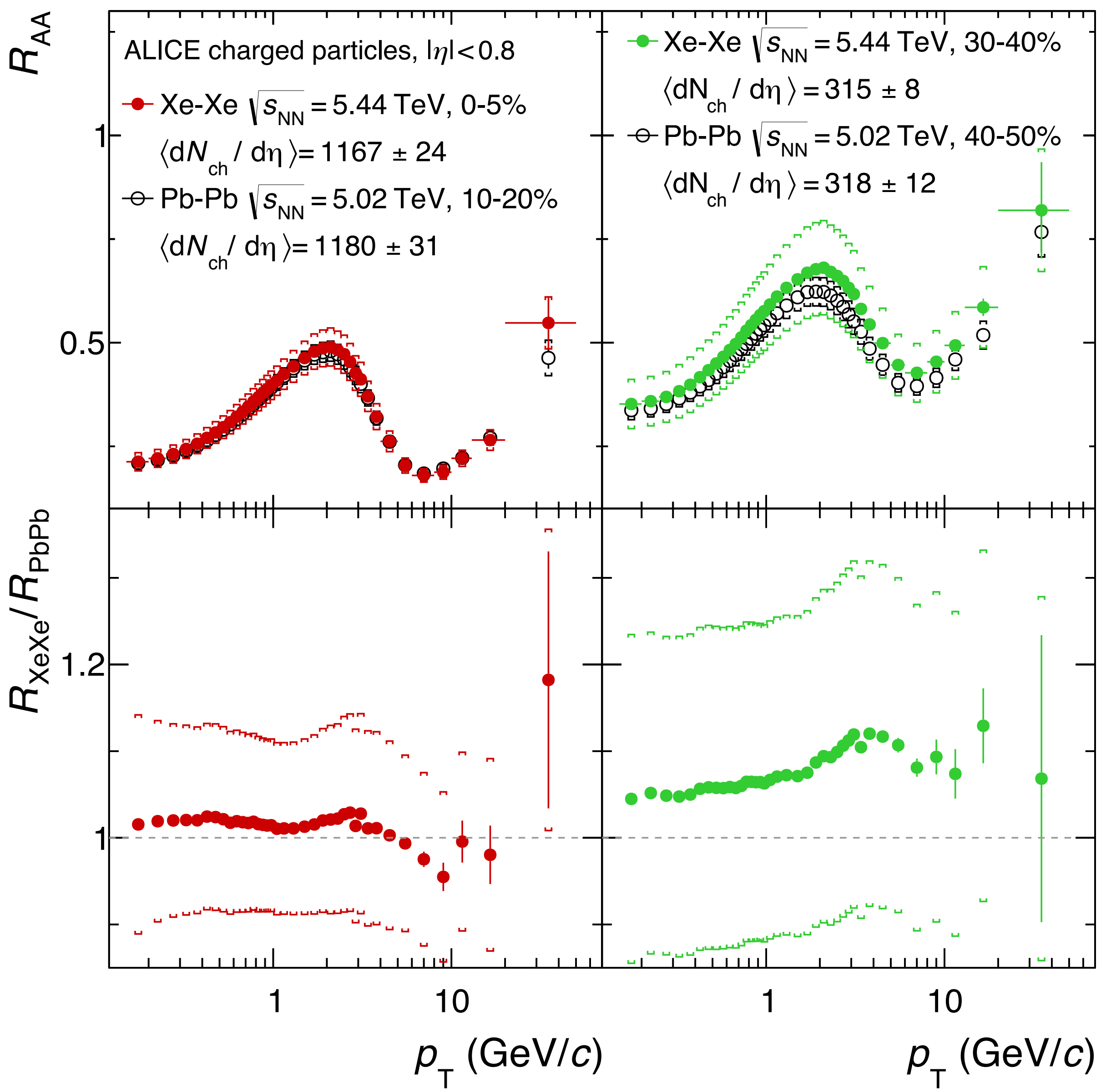

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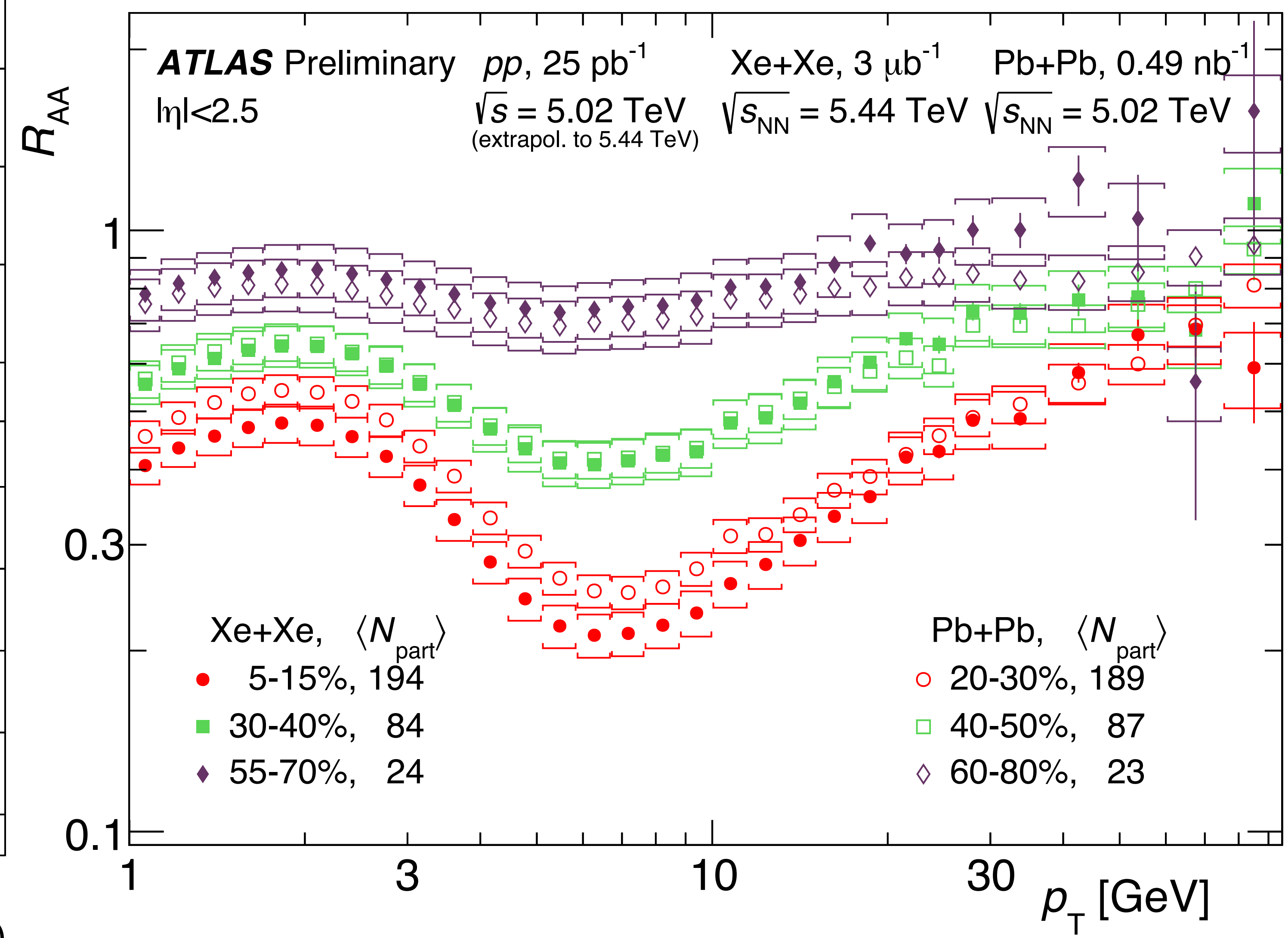
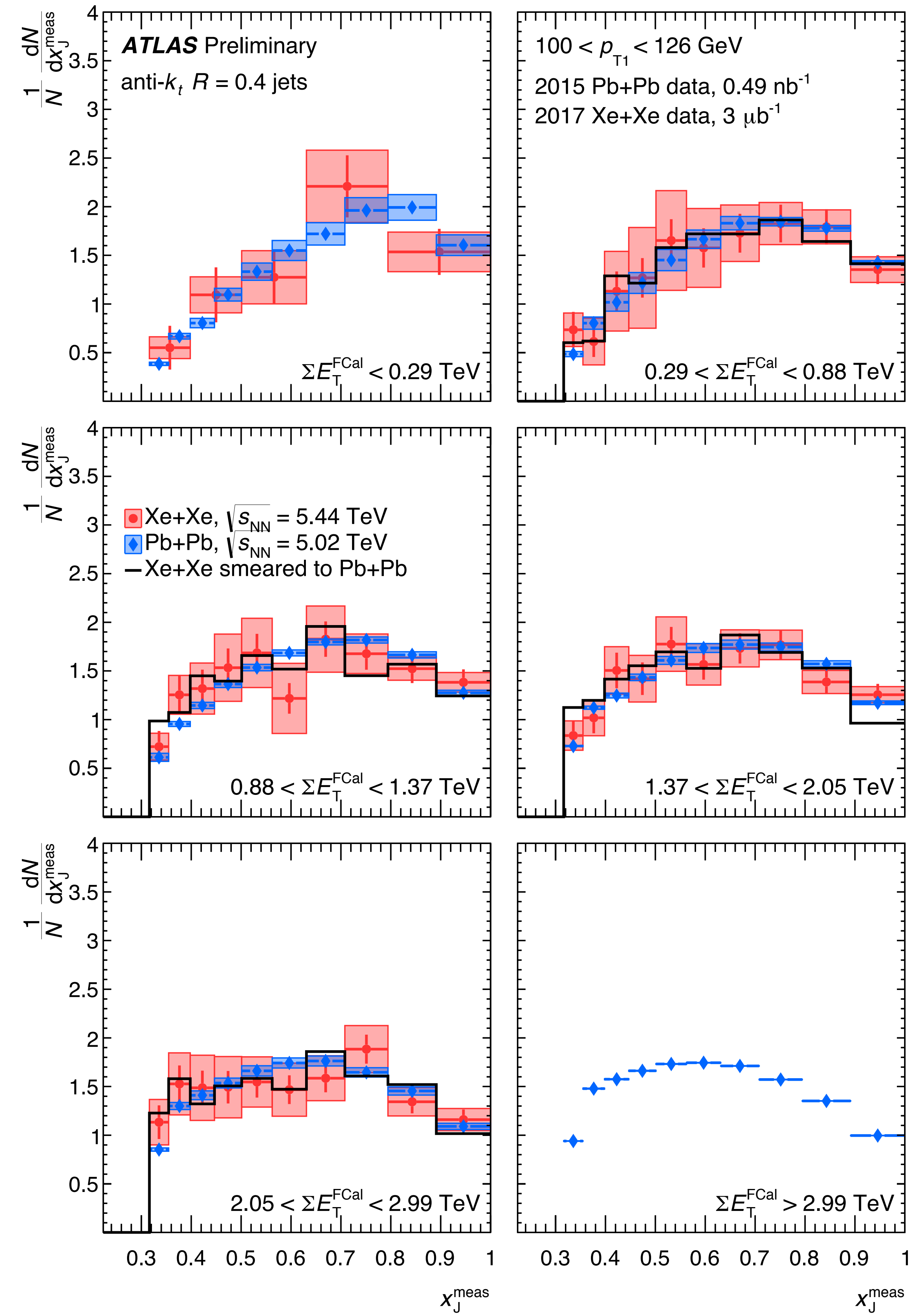


R_{AA} comparable for systems with the similar $dN_{ch}/d\eta$ or N_{part}

dijet asymmetry in XeXe

ATLAS-CONF-2018-007

- XeXe and PbPb have consistent xJ distributions when selected on the same forward ET
  - no unfolding done here—additional smearing applied to XeXe to match the UE fluctuations of the PbPb
  - with current (large) uncertainties comparing as a function of centrality works as well
    - would have been very interesting to see if a very small system (OO) would have discriminated between centrality and forward E_T



why lighter ions?

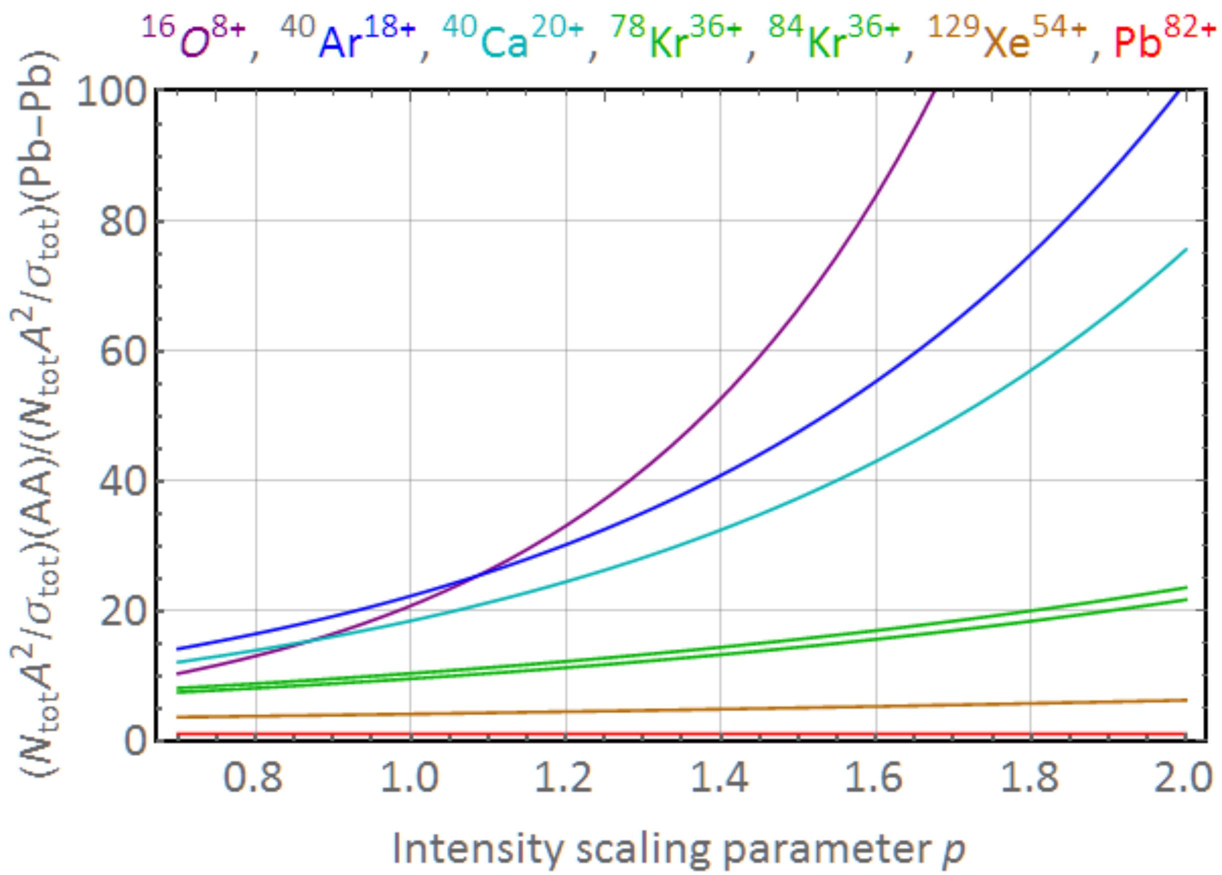
gain in nucleon-nucleon luminosity as a function of A

Gains in ULTIMATE integrated nucleon-nucleon luminosity PER FILL wrt Pb-Pb

This would be on the assumption that a fill would be kept forever until one beam was exhausted (and other loss mechanisms are neglected). Real gain/fill will be less.

In reality, one also gains from longer luminosity lifetime and less time spent refilling the machine.

We will try to quantify this better in future.



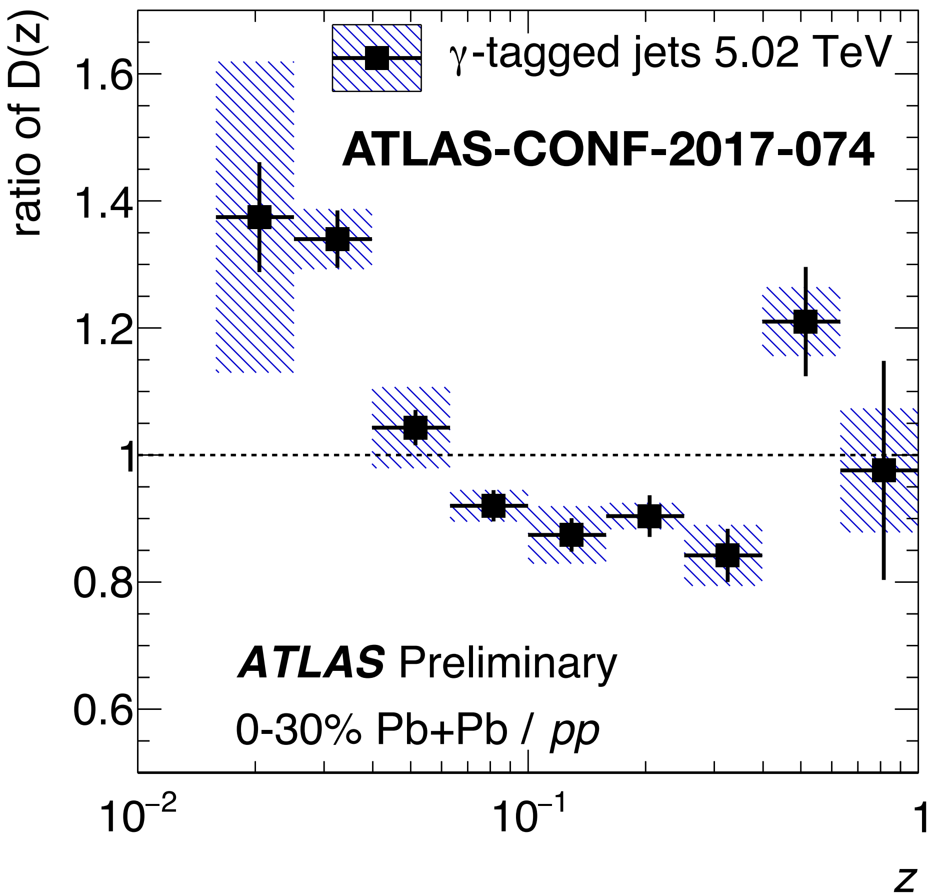
J.M. Jowett, HI-HE-LHC Physics Workshop, 18/6/2018 13

the smaller the system, the greater the increase in the number of jets

ArAr 20-50x more NN luminosity than PbPb

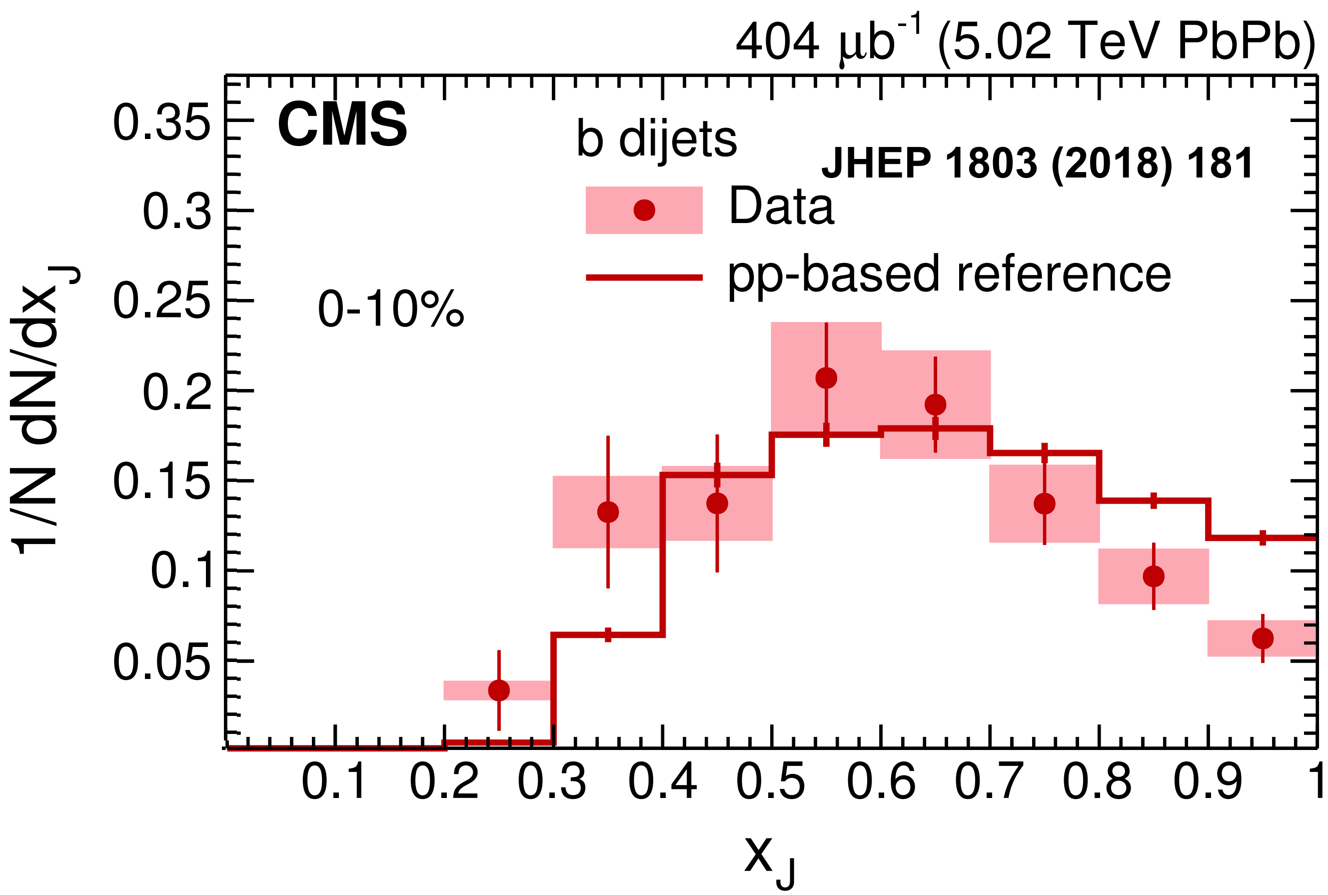
impact of limited statistics

fragmentation functions of jets opposite photons



photon p_T: 79.6-125 GeV
jet p_T: 63.1-144 GeV

asymmetry of b-jets



jet $p_{T,1}$: > 100 GeV
jet $p_{T,2}$: > 40 GeV

non-inclusive jet observables—statistics limitations preclude looking at p_T / centrality dependence and comparison to corresponding inclusive jet observables

impact of limited statistics

fragmentation functions of jets opposite photons

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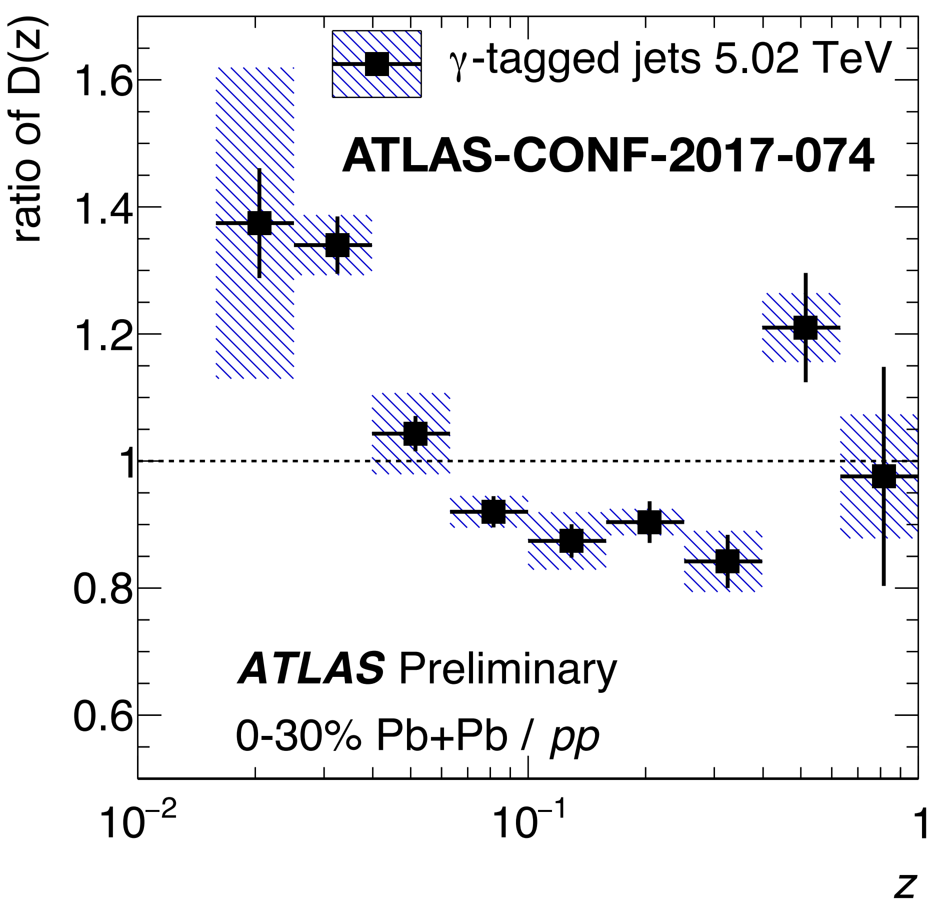
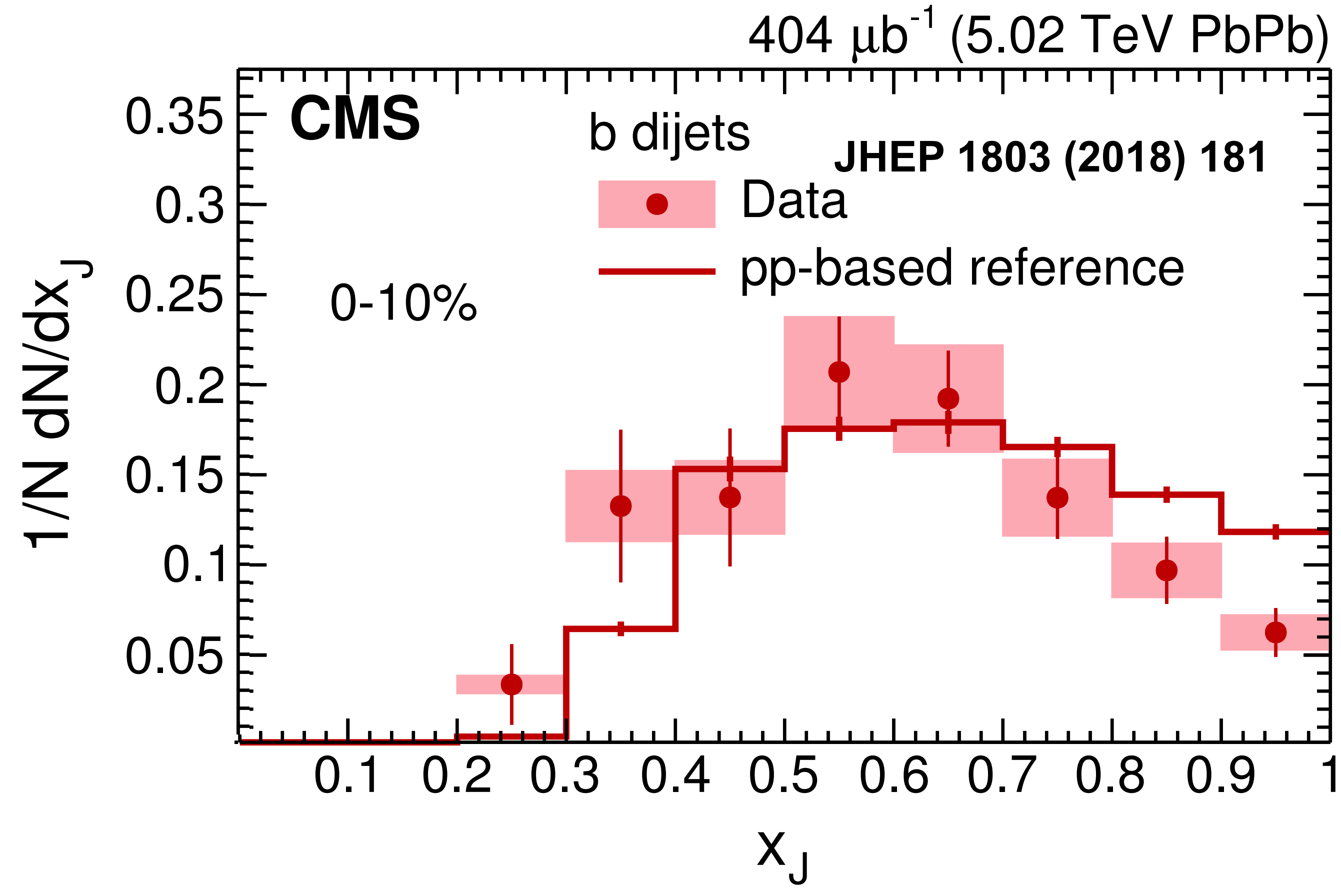


photon p_T: 79.6-125 GeV
jet p_T: 63.1-144 GeV

asymmetry of b-jets



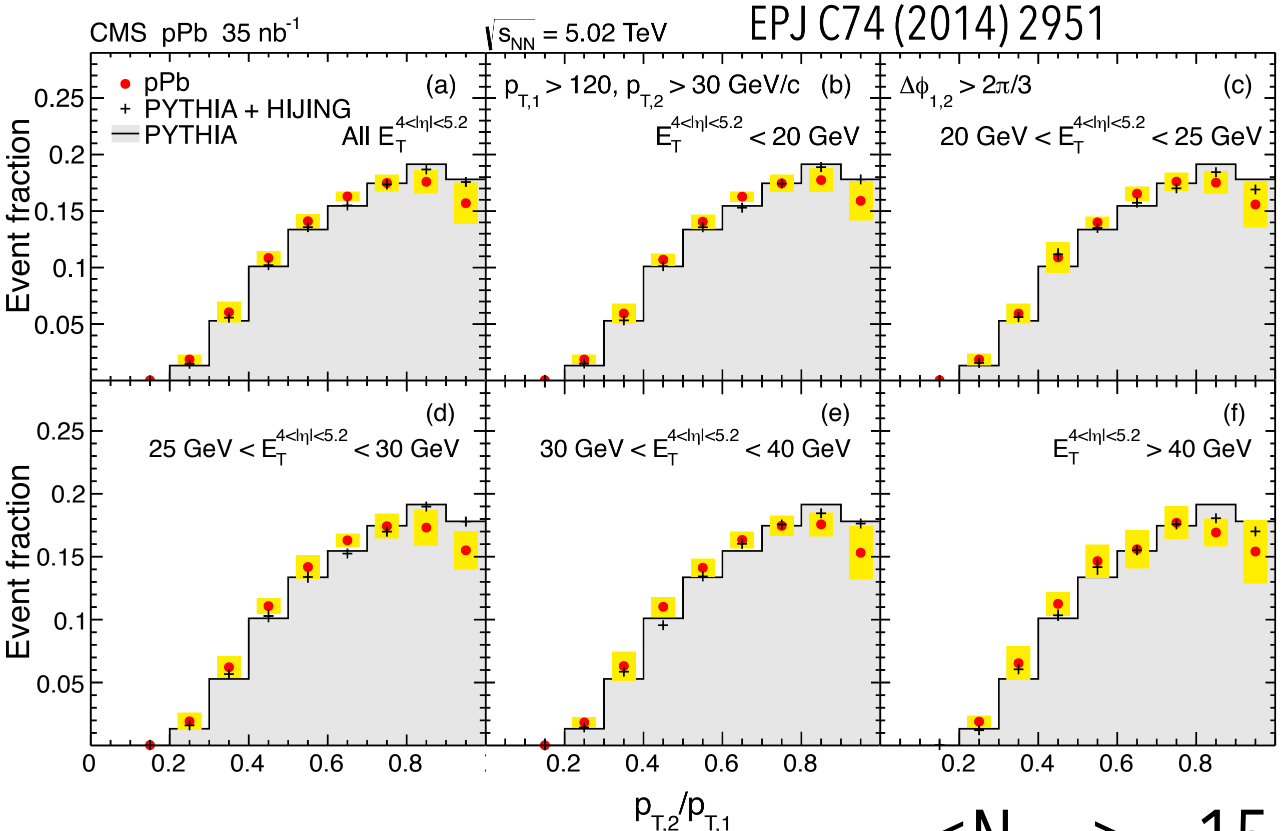
jet $p_{T,1}$: > 100 GeV
jet $p_{T,2}$: > 40 GeV

- the planned 10 nb^{-1} of PbPb will improve the statistics of all observables
- however, new observables can be exploited with larger luminosity gains
  - b-tagged substructure (1801.00008), top (PRL 120 232301), …

where is the onset of jet quenching?

understanding the onset of jet quenching is one of the most important outstanding questions

EPJ C74 (2014) 2951

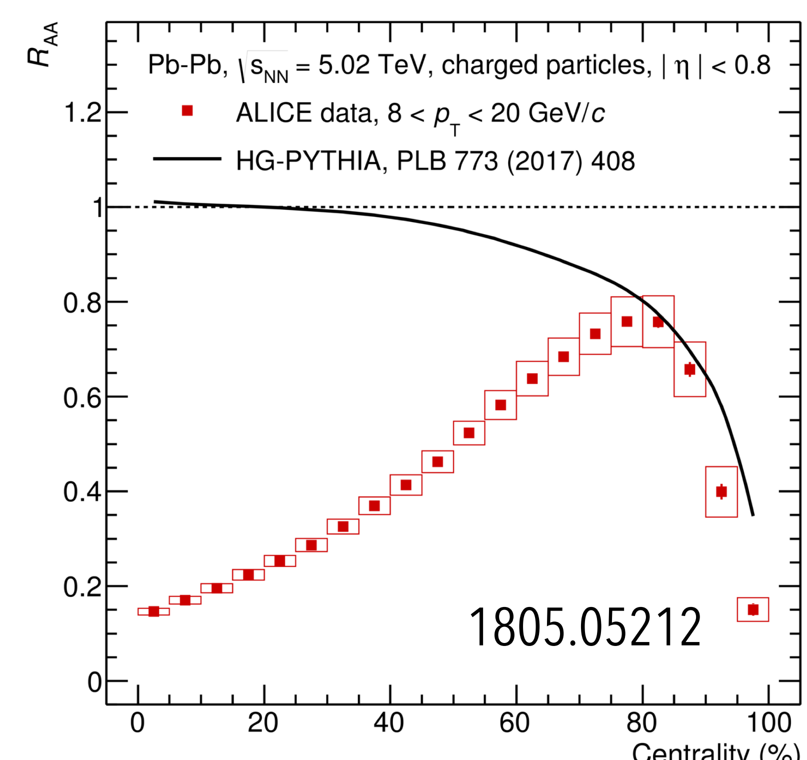


$\langle N_{part} \rangle \sim 15$

no evidence seen for jet quenching in pPb collisions from ALICE, ATLAS or CMS

looking for jet quenching in peripheral PbPb collisions complicated by large TAA uncertainties and selection biases (ALICE QM18)

light ions (both Ar & O) have small N_{part} in central collisions providing excellent systems to study the onset of jet quenching

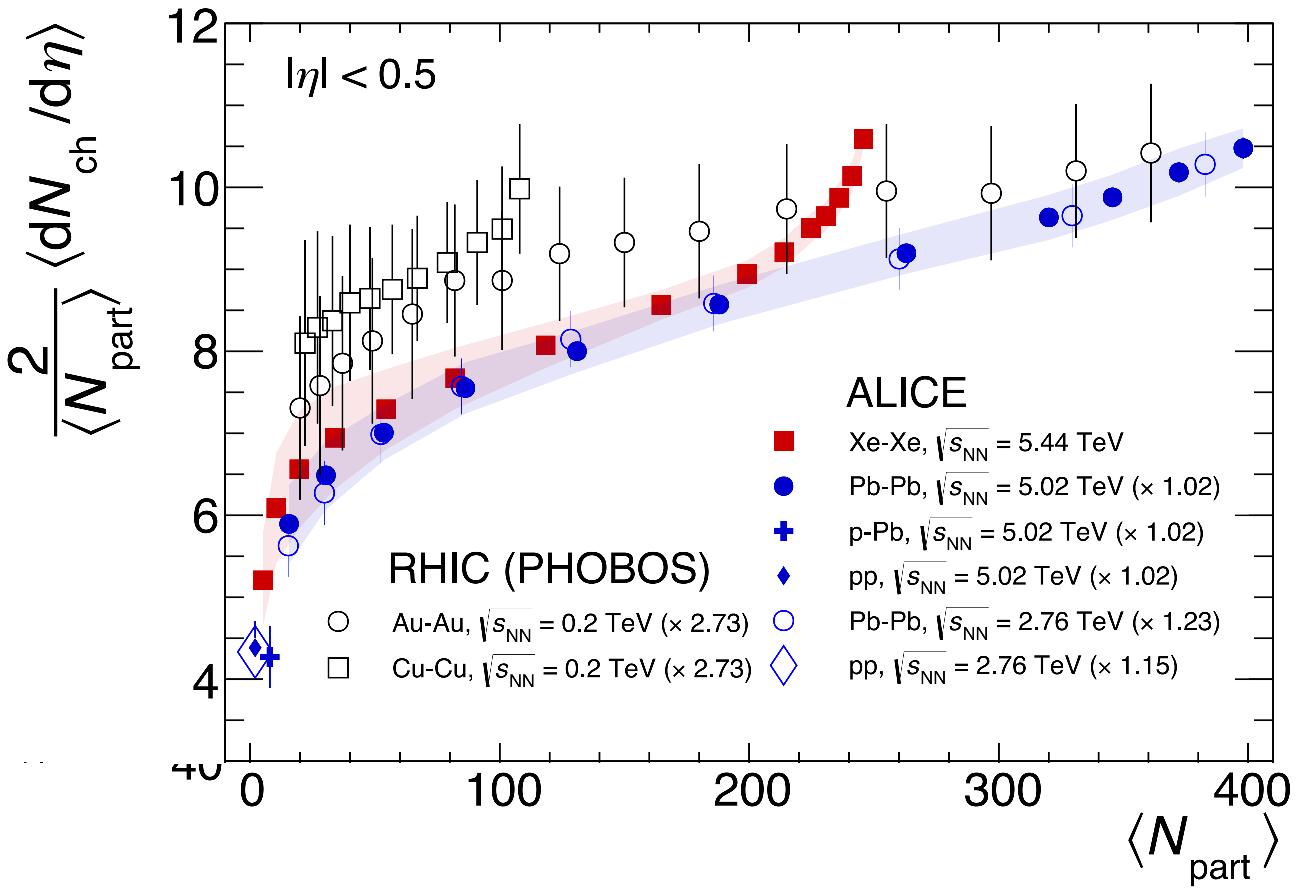


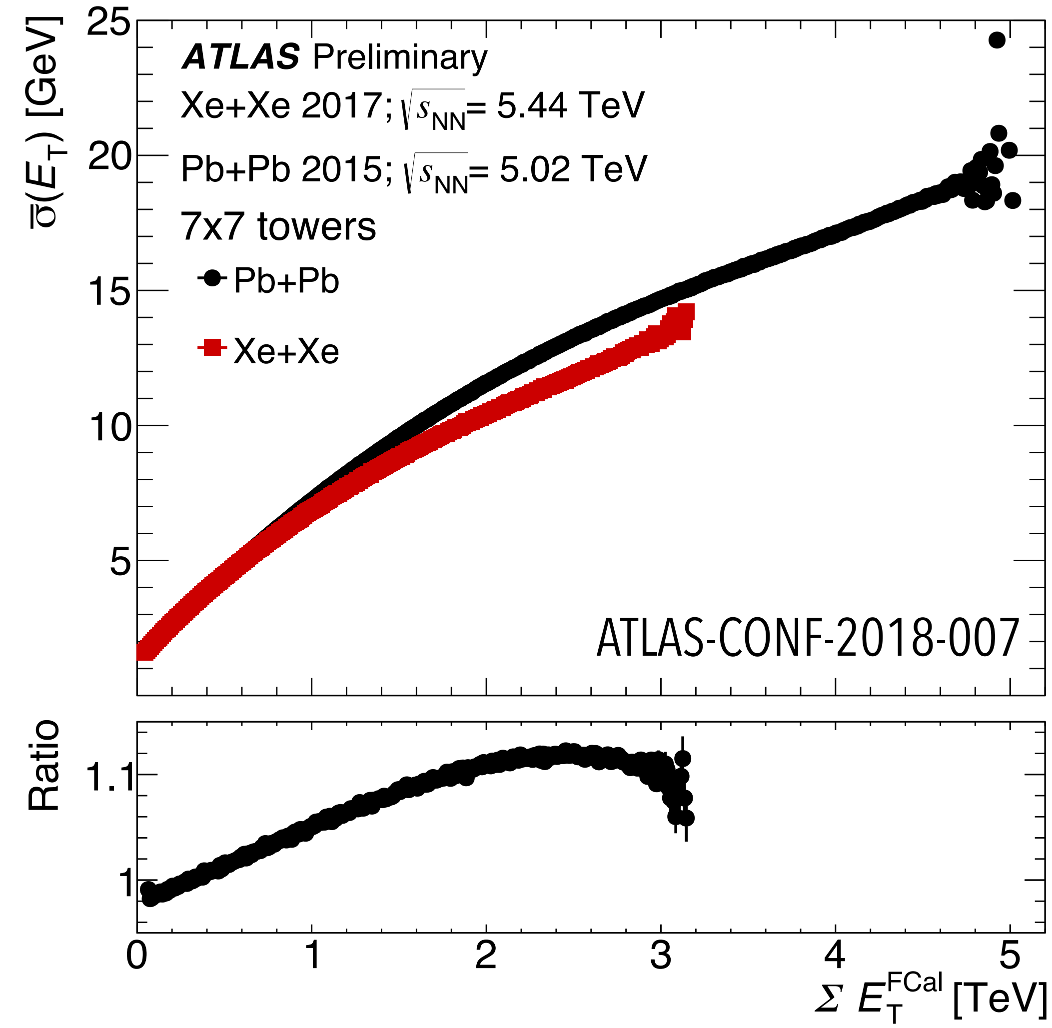
1805.05212

measurement of the UE & fluctuations in XeXe & PbPb

mean UE fluctuations over the size of an R = 0.4 jet

1805.04432





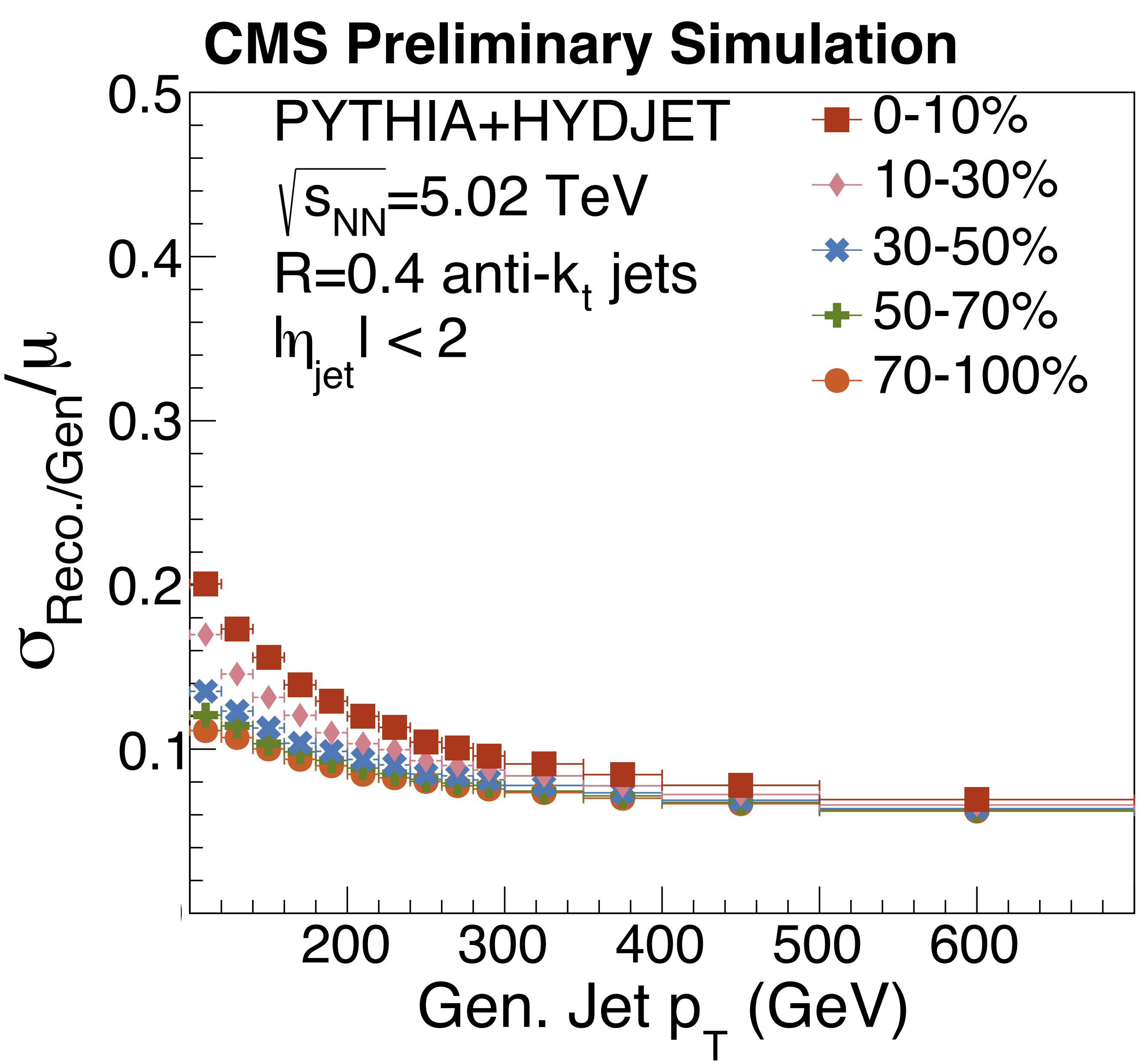
UE in central collisions ~2x smaller in central XeXe than in PbPb

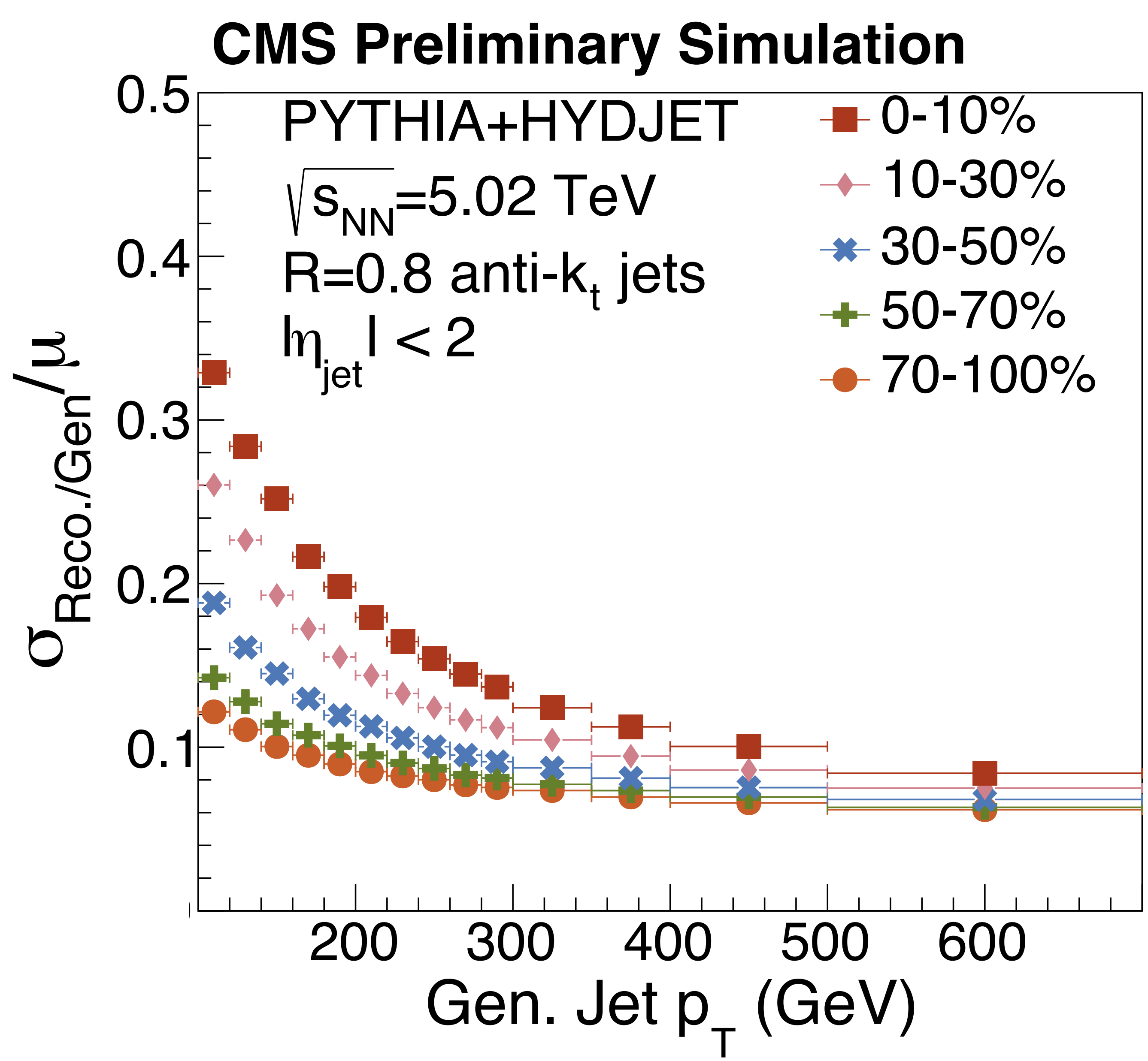
at the same forward energy XeXe has up to ~10% smaller UE fluctuations than PbPb

effects of the UE and its fluctuations decrease with system size– improving precision of measurements

JER for large R jets in PbPb

example: light ions would improve the feasibility of large R jets in central collisions





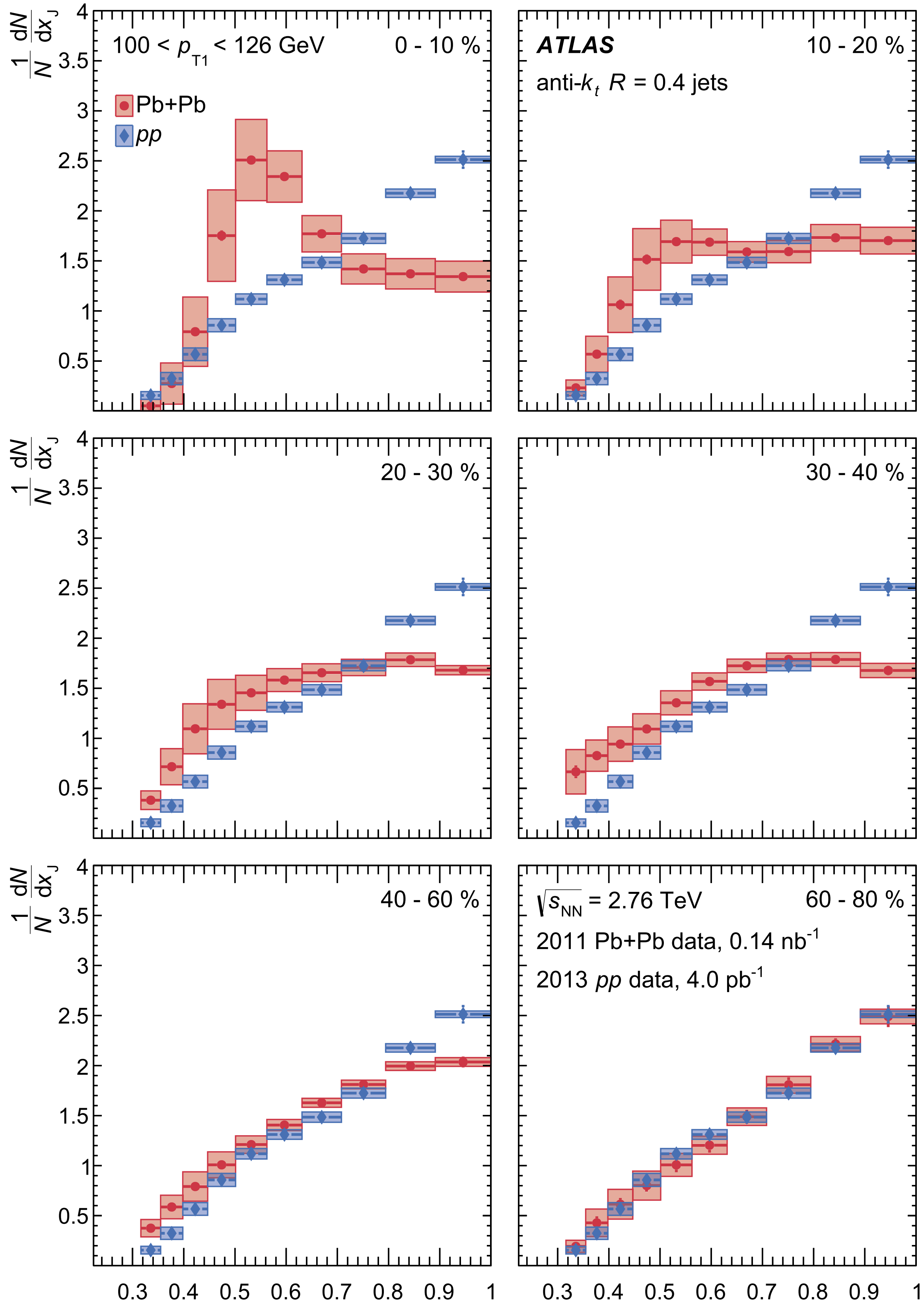
which ions and how much running?

- ions:
  - trade off between luminosity increases and medium effects
    - we have seen the Xe+Xe collisions have significant quenching
  - for onset of quenching probably want very light ions; O+O, Ar+Ar
- how much luminosity:
  - if we were sure that we could see all the Pb+Pb effects with light ions there would be no reason to go back to Pb+Pb
  - strawman proposal: a sample of Ar+Ar early in Run 3 which has ~ the same number of jets as 2015 Pb+Pb data
    - greatly improve understanding of quenching in small systems
    - understand the balance between luminosity and medium effects for future planning

summary

- XeXe data shows significant jet quenching based on first results
- arguments in favor of high luminosity light ion running
  - increased rates for hard probes
  - understanding the onset of jet quenching
  - decreased systematics from the UE
- light ions are promising looking toward Run3 & 4
  - it would be very useful to have a large sample of Ar+Ar collisions to
    - study the onset of quenching
    - understand the balance between luminosity and medium effects for future planning

backup



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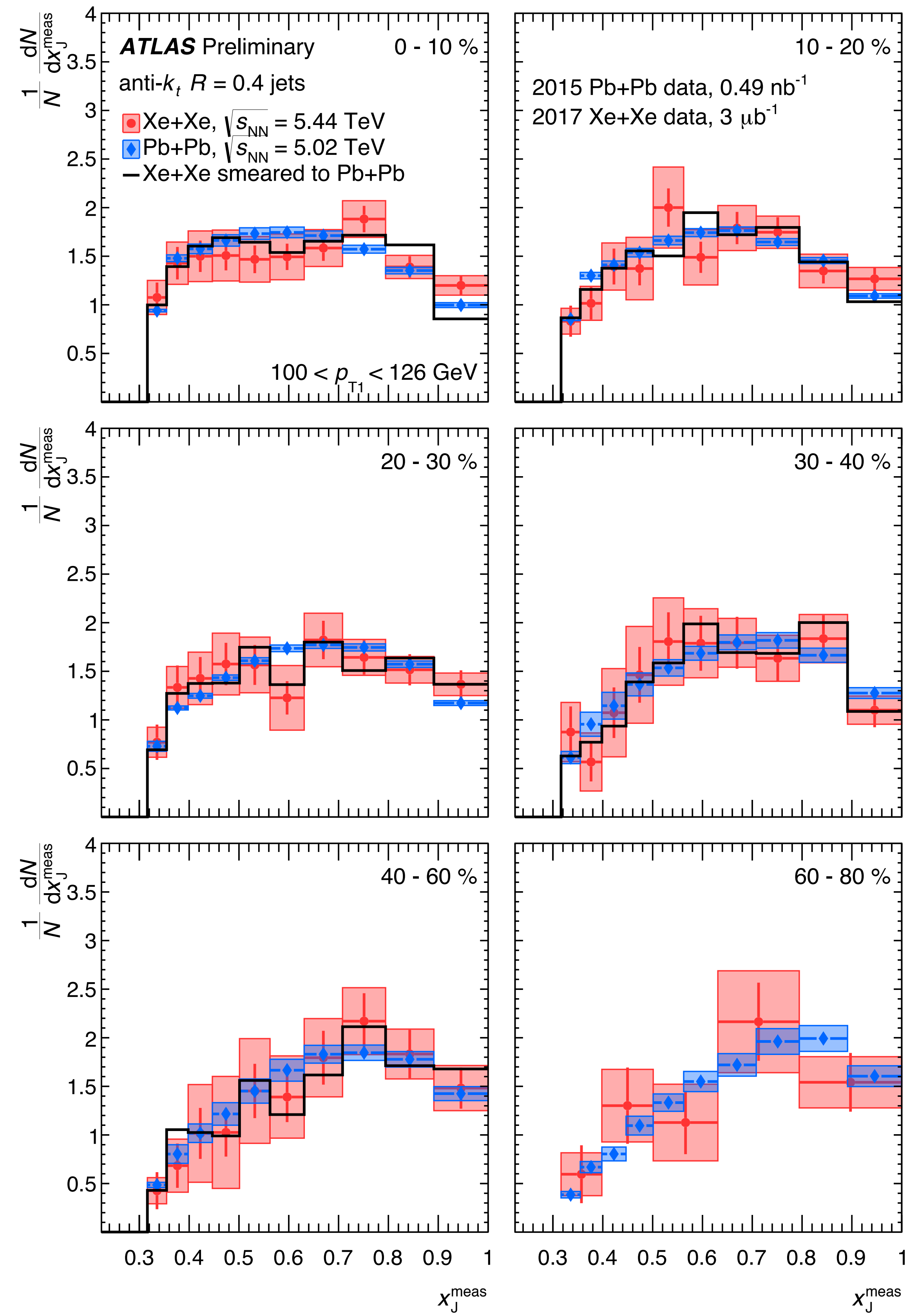

jet fragmentation & medium response