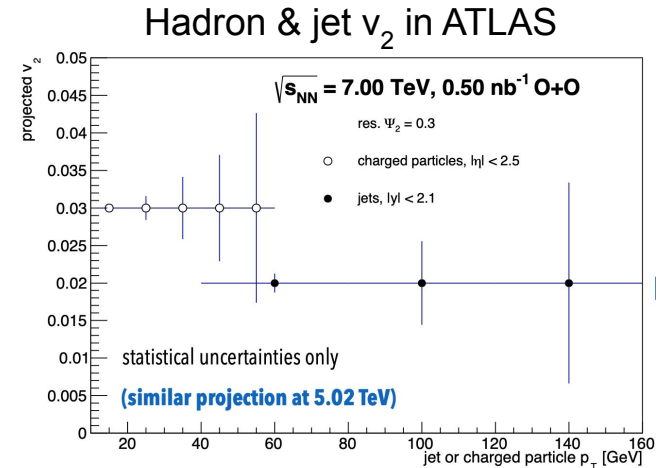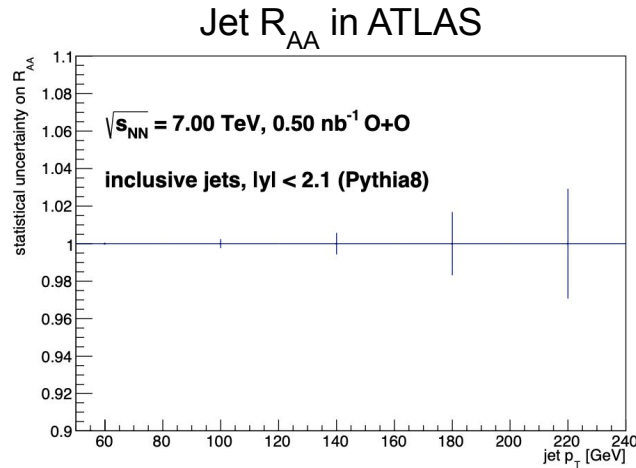# Experimental **opportunities** with O-O and p-O collisions

- Searching for jet quenching in a small system
  - Inclusive hadron R_{AA}, LF/HF/jet R_{AA}
  - Photon/Z-tagged jet and hadron spectra
  - Semi-inclusive h-jet recoil

Hadron R_{AA} in ALICE

Jet R_{AA} in ATLAS

Hadron & jet v_2 in ATLAS

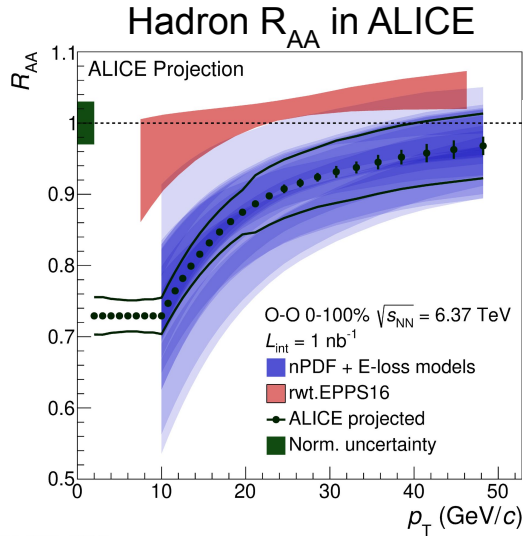Alice Ohlson , Guilherme Milhano, Yen-Jie Lee

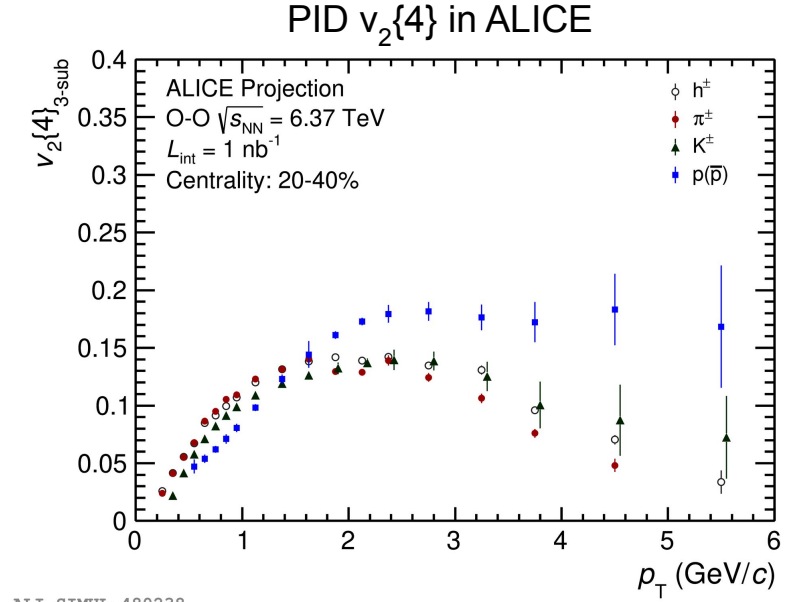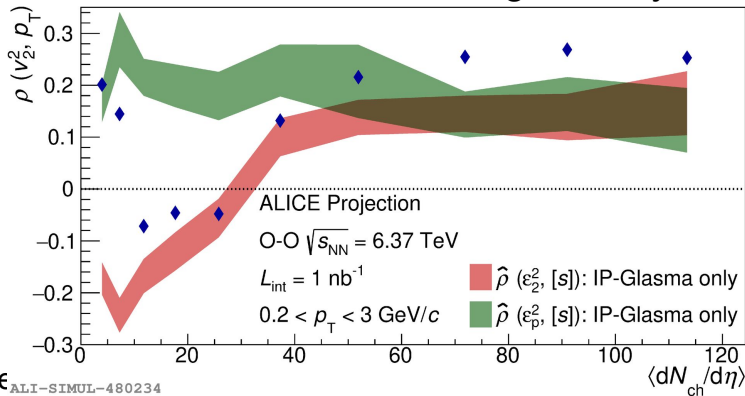# Experimental **opportunities** with O-O and p-O collisions

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- Collective effects in *light*-ion collisions
  - Unidentified and identified-hadron v_n
  - Higher-order correlations of v_n coefficients
  - $<p_T>$-v_n correlations → separate initial-state momentum correlations and geometry

PID $v_2\{4\}$ in ALICE

ALI-SIMUL-480238

ALI-SIMUL-480234

$$\hat{\rho}(v_2^2, [p_T]) = \frac{\langle \hat{\delta} v_2^2 \hat{\delta}_{[p_T]} \rangle}{\sqrt{\langle (\hat{\delta} v_2^2)^2 \rangle \langle (\hat{\delta}_{[p_T]})^2 \rangle}}$$

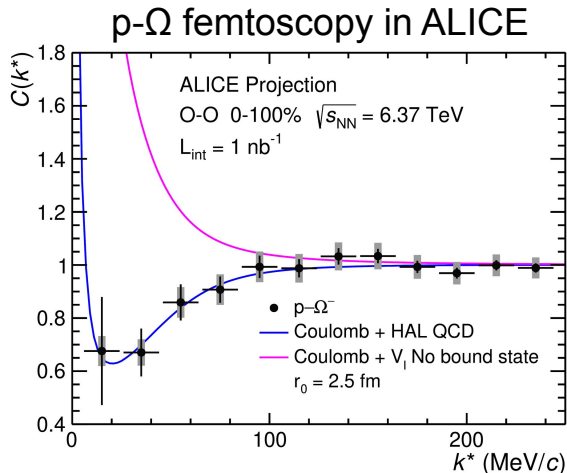# Experimental **opportunities** with O-O and p-O collisions

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  - Higher-order correlations of v_n coefficients
  - $<p_T>$-v_n correlations → separate initial-state momentum correlations and geometry
- Strangeness enhancement vs N_{part}
- Quarkonia suppression/melting
- Hadron-hadron interactions, search for bound states
- Photoproduction in ultraperipheral collisions
- γγ, γp, γO collisions
- nPDFs with electroweak bosons, dijet, D mesons

p-Ω femtoscopy in ALICE

ALICE Projection
O-O 0-100% $\sqrt{s_{NN}}$ = 6.37 TeV
L_{int} = 1 nb^{-1}

- p–Ω$^-$
— Coulomb + HAL QCD
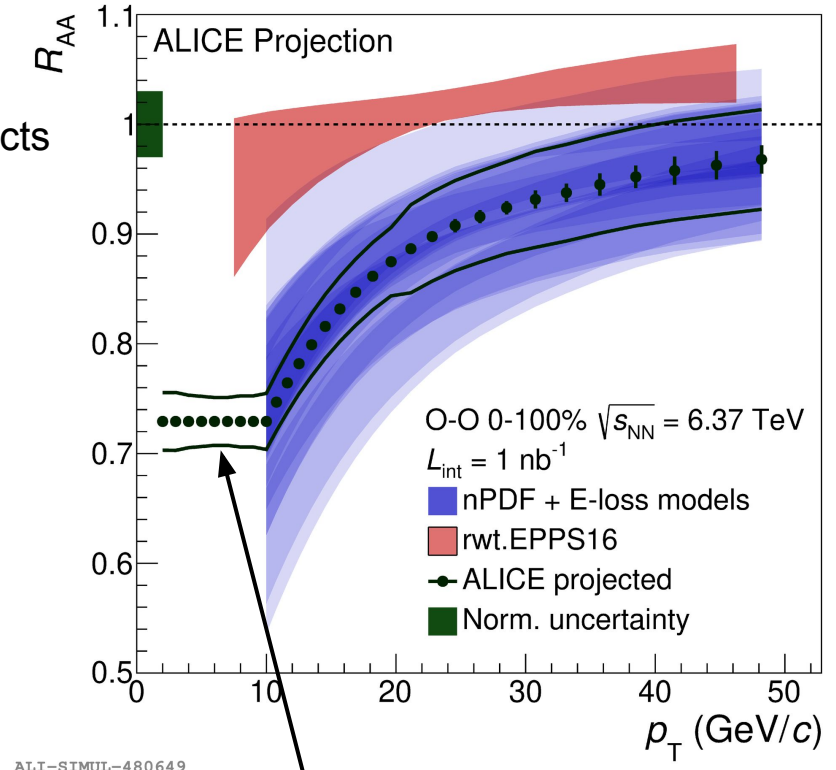— Coulomb + V_I No bound state
r_0 = 2.5 fm

ALI-SIMUL-481172

- Double-differential (p_T, η) identified hadron cross-sections
  - Important input for astrophysical calculations! e.g. air-shower simulations

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Experimental **challenges** with O-O and p-O collisions

1) Experimental
   - Statistical uncertainties
   - Systematic uncertainties due to detector effects
   - Selection bias in centrality selection
2) Theoretical uncertainties
   - nPDF uncertainties
   - Uncertainties on Glauber model calculations
   - Interpolation/extrapolation
3) LHC performance
   - Length of the run / luminosity delivered
   - pp reference run (and at what energy?)
   - Pileup
   - Quality of the beam, e.g. transmutations

ALICE Projection

R_{AA}

O-O 0-100% $\sqrt{s_{NN}}$ = 6.37 TeV
L_{int} = 1 nb^{-1}
- nPDF + E-loss models
- rwt.EPPS16
- ALICE projected
- Norm. uncertainty

p_T (GeV/c)

ALI-SIMUL-480649

Includes uncertainties from the interpolation of the pp reference

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Do we need a pp reference?

- Do we need/want a pp reference run? At what energy? How much statistics?
- What observables can be measured without a pp reference?
  - Flow coefficients/correlations, h-jet recoil, h-h interactions, strangeness enhancement,...
- What observables cannot be explored without a same-energy pp reference?
  - RAA (for light flavor, heavy flavor, and jets)
  - nPDF: need pp reference for p-O run
- If O-O and p-O are at different c.o.m. energies, do we want pp reference runs for one or the other or both?
  - Looks like a pp ref at the p-O energy will be difficult. Would p-O and O-p help? (N.B. O-p not currently requested)

- Suggestion for after the workshop: an exclusion plot for the possibility of observing jet quenching based on R_{AA}, with and without a pp reference

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Can we interpolate the reference?

- ALICE estimation for uncertainty due to interpolation is 2-3%
- But we have seen before that interpolations can be dangerous!
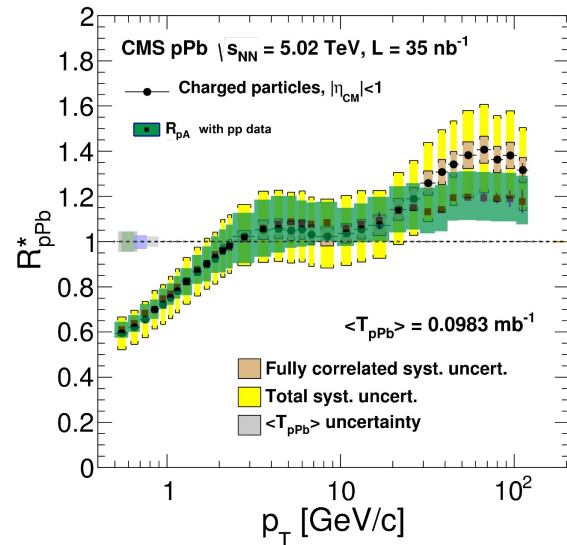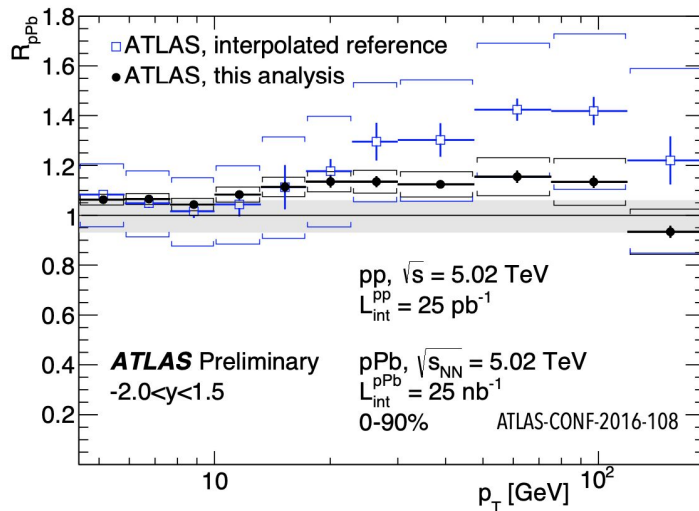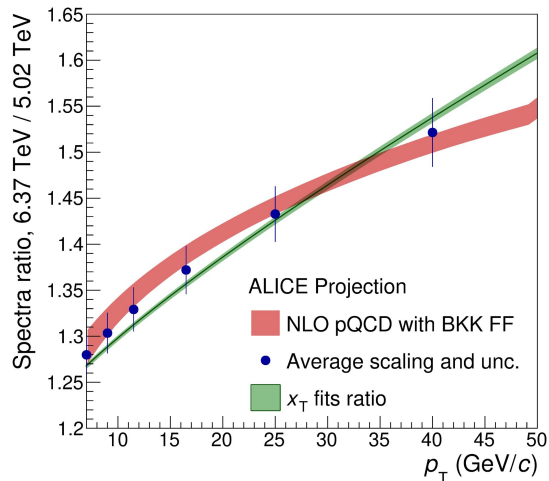
- N.B. If we run O-O at 7 TeV, then a pp reference from Run 1 exists, but due to hardware and software changes there would probably be little/no cancelation of uncertainties, and it's not clear all relevant observables were measured in Run 1.

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Further questions for discussion...

- What energies do we want for p-O and O-O?
    - As high as possible for hard probes?
    - Same as Pb-Pb for comparisons?
- What integrated luminosity do we want/need for p-O and O-O?
    - Projections shown here assume L_{int} = 1 or 0.5 nb^{-1}, $\sqrt{s_{NN}}$ = 6.37 or 7 TeV for O-O
    - LHCb requests 2 nb^{-1} for p-O

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