T. NUNES - UNIVERSIDADE FEDERAL DE SANTA CATARINA (UFSC)

IN COLLABORATION WITH D.D. CHINELLATO, G. DENICOL, M. HIPPERT, M. LUZUM, J. NORONHA, W. SERENONE, AND J. TAKAHASHI (THE EXTREME COLLABORATION)
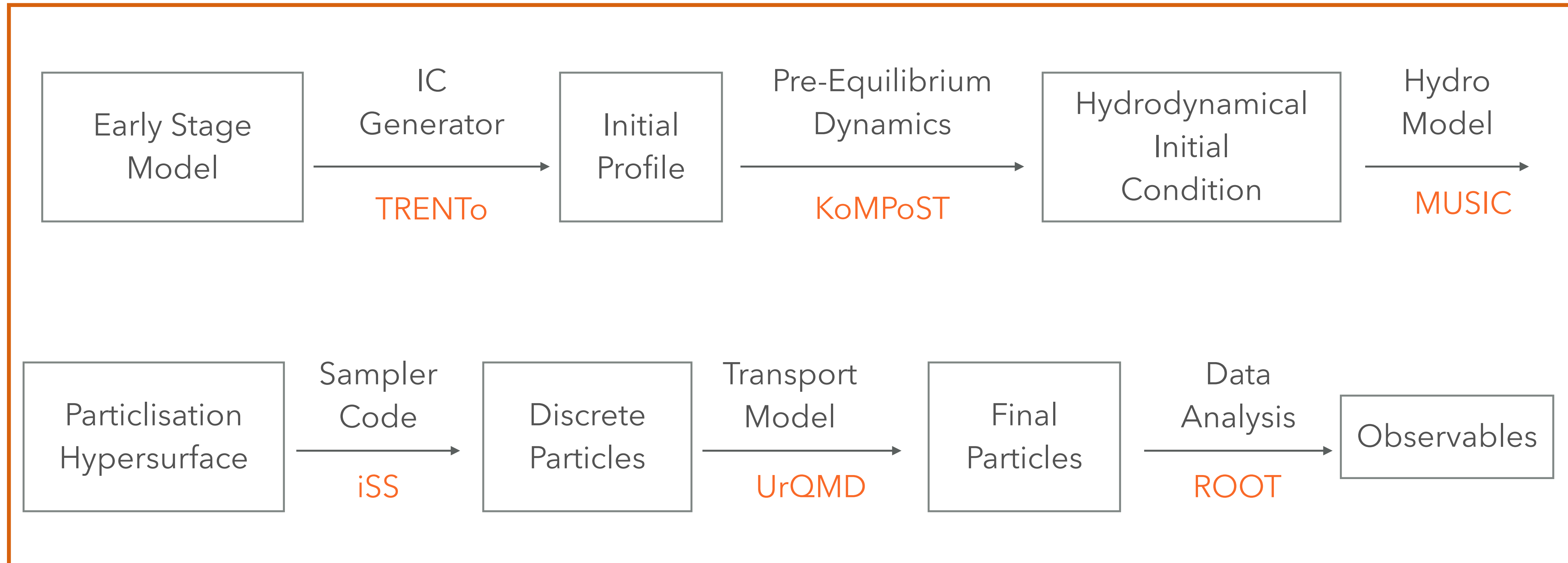
PRE-HYDRODYNAMIC EVOLUTION AND ITS SIGNATURES IN FINAL-STATE HEAVY-ION OBSERVABLES

HOW DO WE SIMULATE HEAVY ION COLLISIONS?


Several pieces, that must be connected in a a consistent way.

EFFECTS OF PRE-EQUILIBRIUM DYNAMICS

▸ How do different pre-equilibrium scenarios affect final state observables?

▸ We investigate three different scenarios:

    A. No pre-equilibrium dynamics (TRENTo → MUSIC → iSS → UrQMD)

    B. Free Streaming (TRENTo → Free Streaming → MUSIC → iSS → UrQMD)

    C. KoMPoST EKT (TRENTo → EKT → MUSIC→ iSS → UrQMD)

▸ Goal is not to obtain optimal chain parameters for data fitting, but to investigate effects of different scenarios on final state observables.

MULTIPLICITIES

▸ The three scenarios were simulated with the same set of TRENTo initial profiles;

▸ Overall normalisation chosen to yield similar final state charged particle multiplicity at mid-rapidity for the three scenarios, and to match ALICE data for central events.
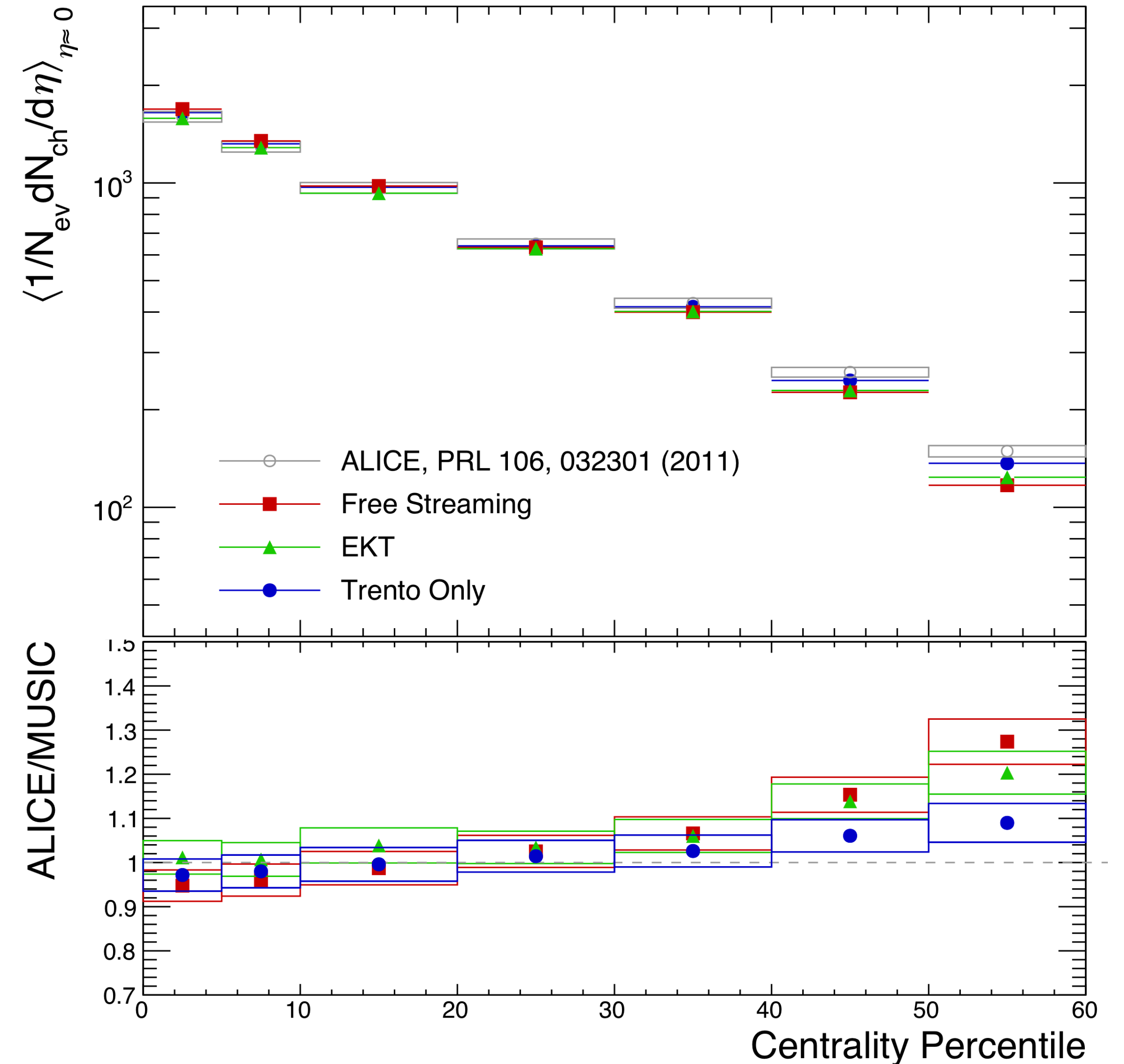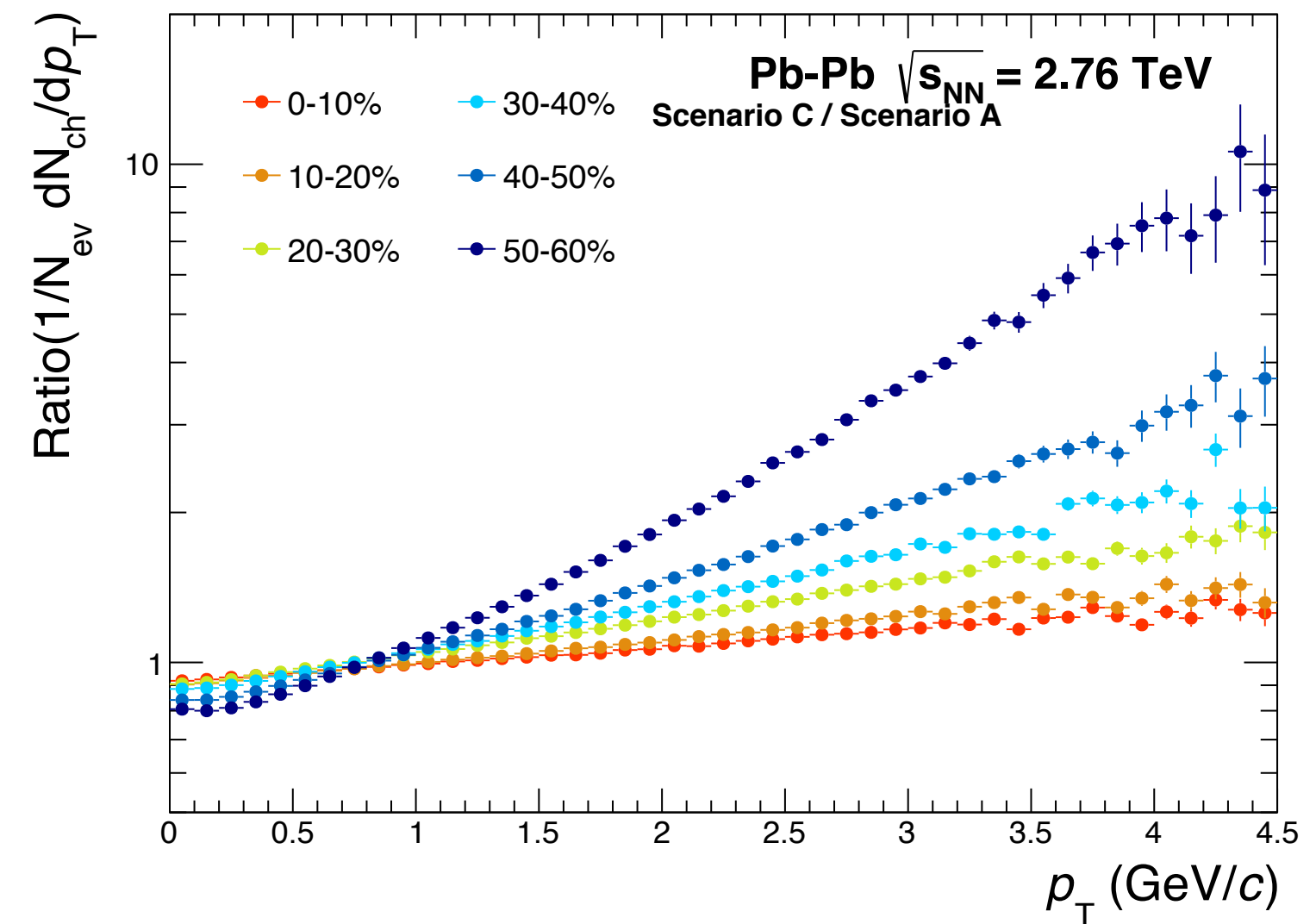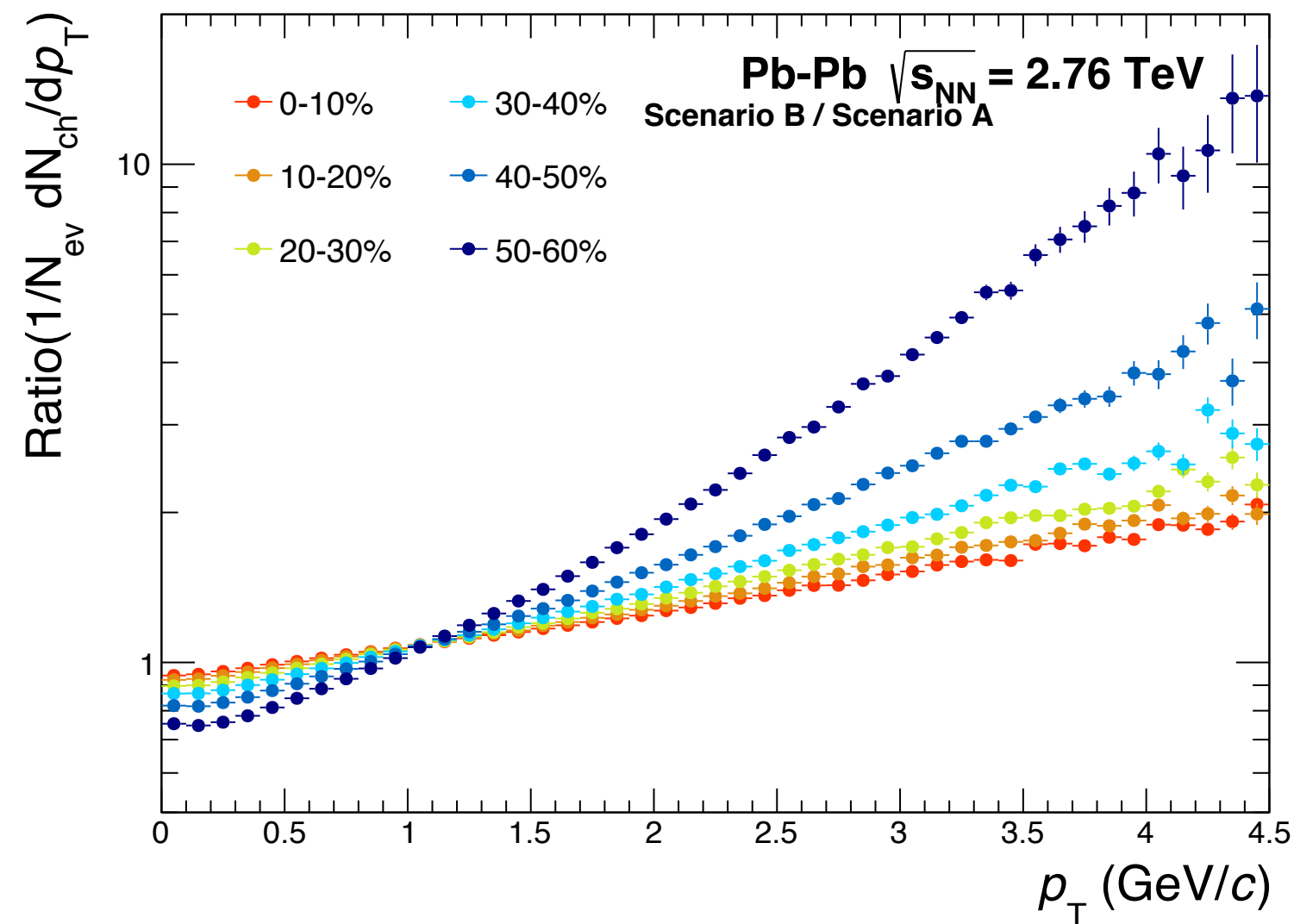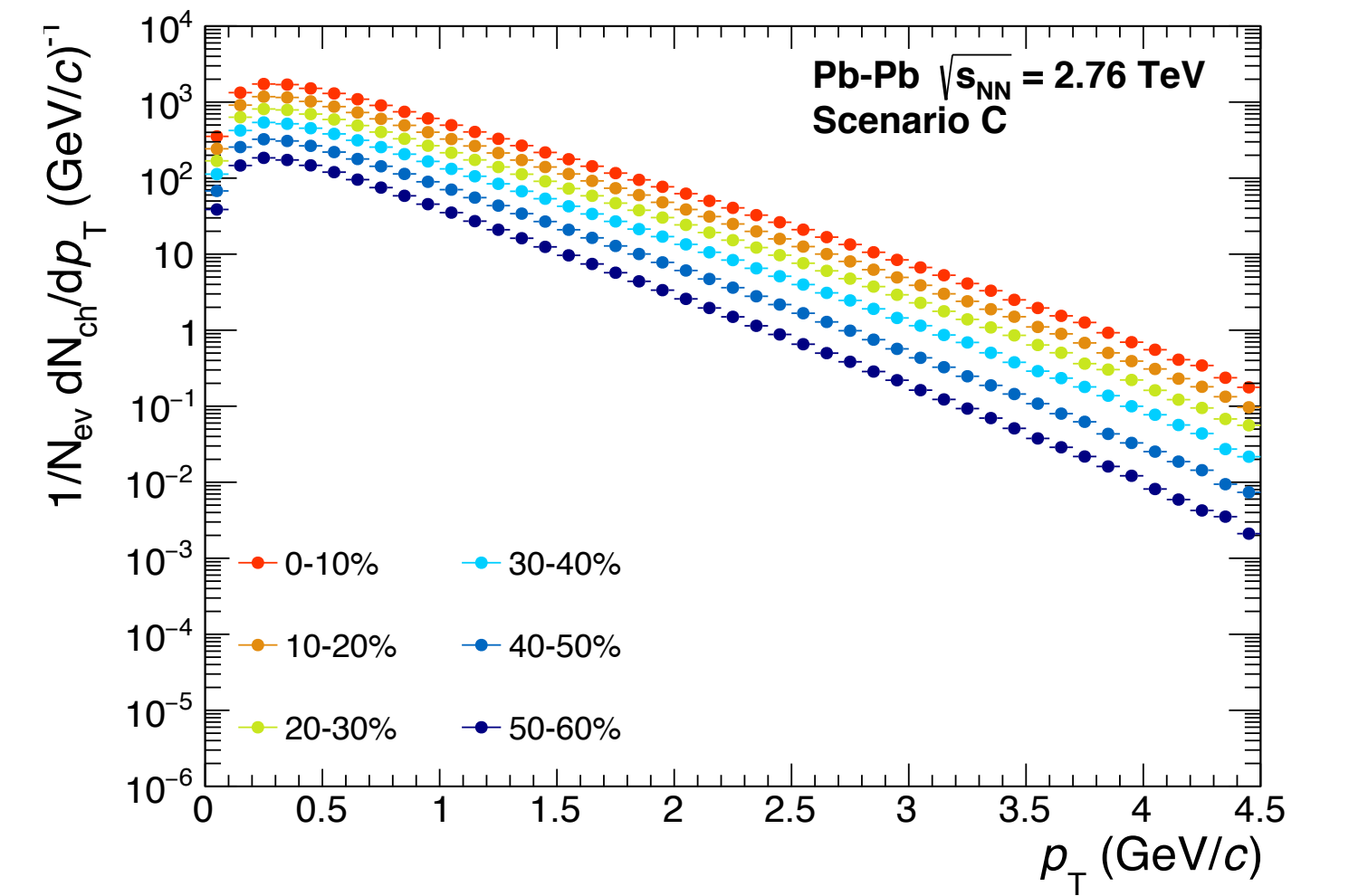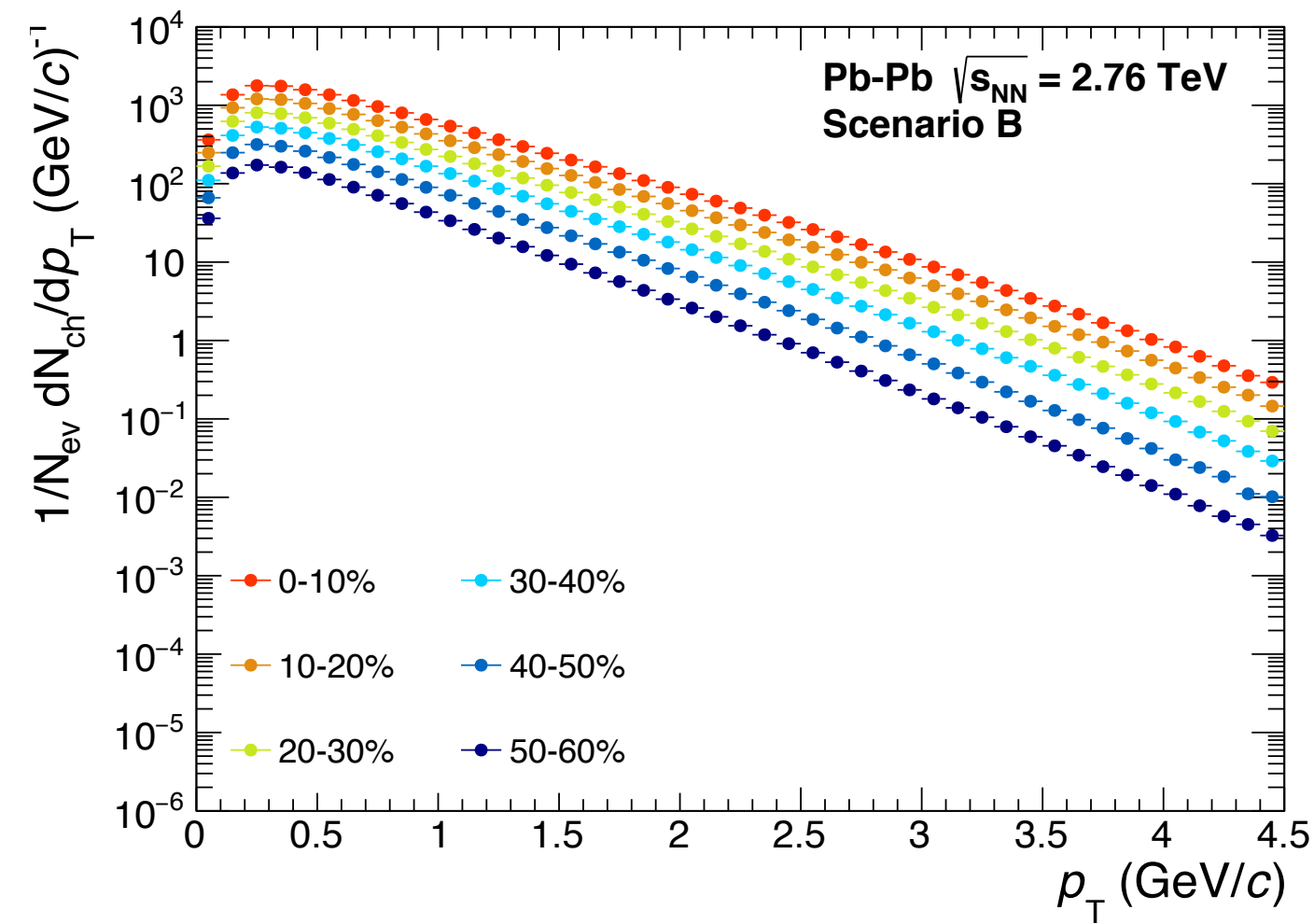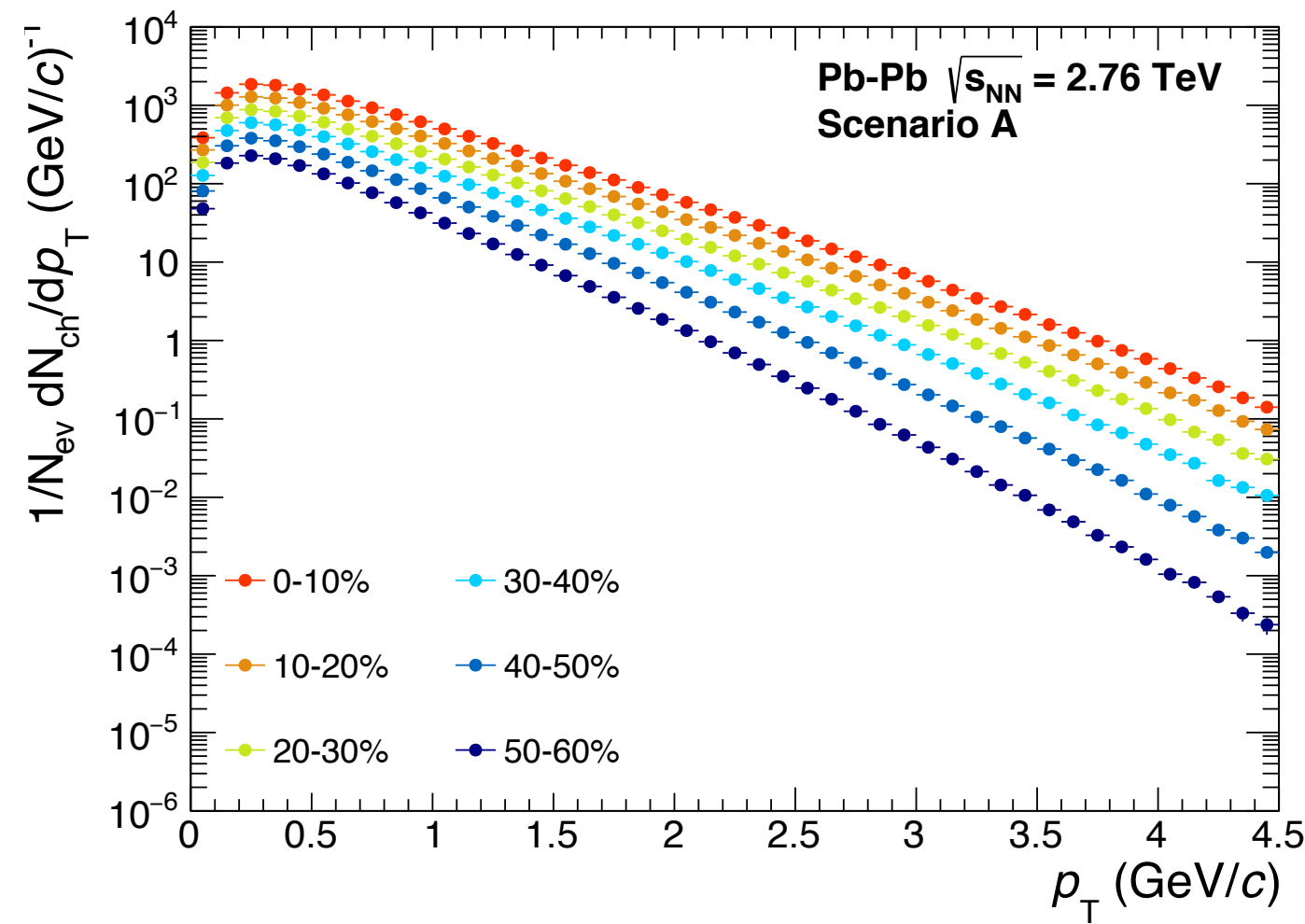
FLOW COEFFICIENTS

▸ An increase in integrated flow coefficients is observed in scenarios with pre-equilibrium dynamics;

▸ The effect is mild, however, on differential flow;

▸ What is happening with the particle spectra?
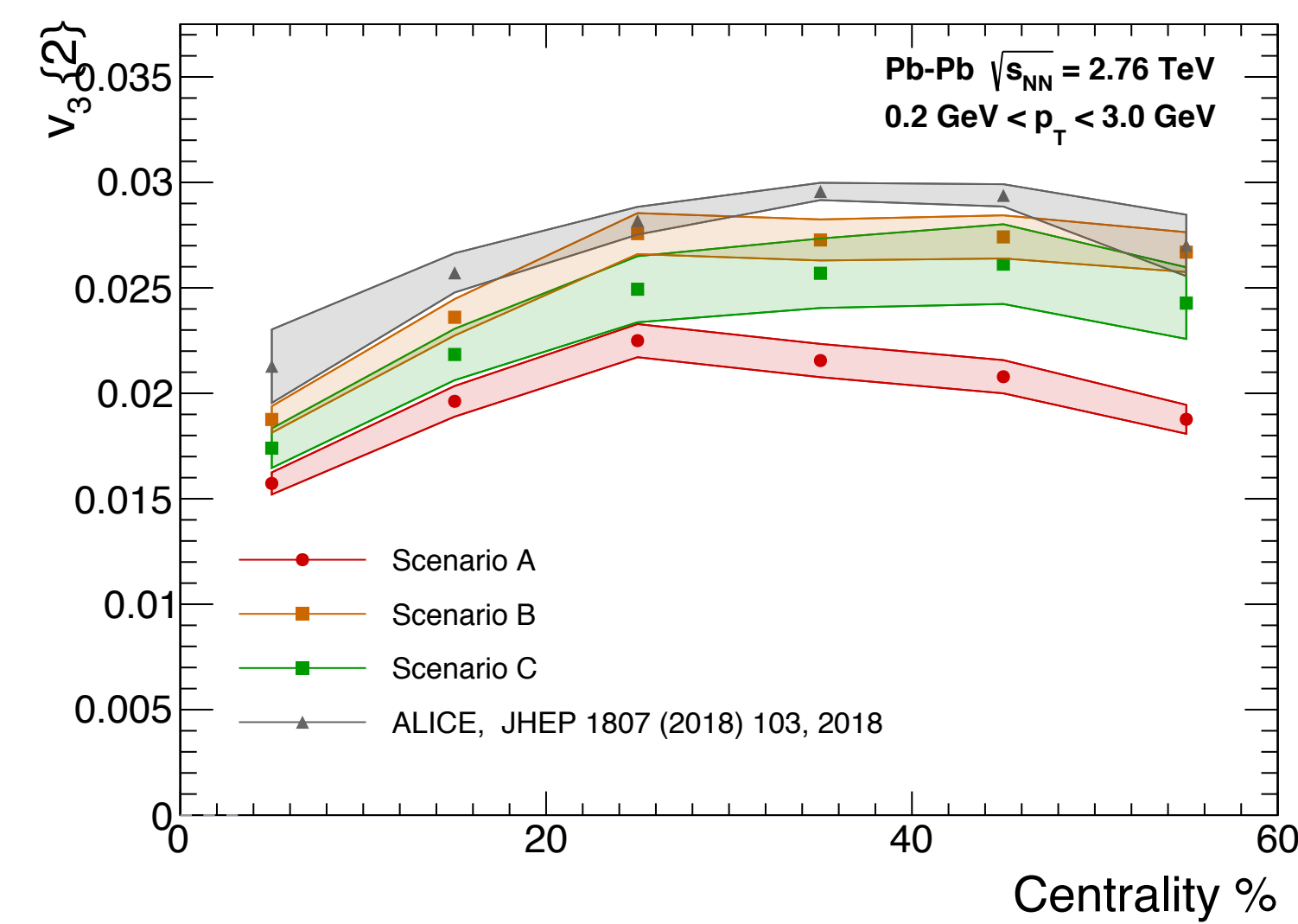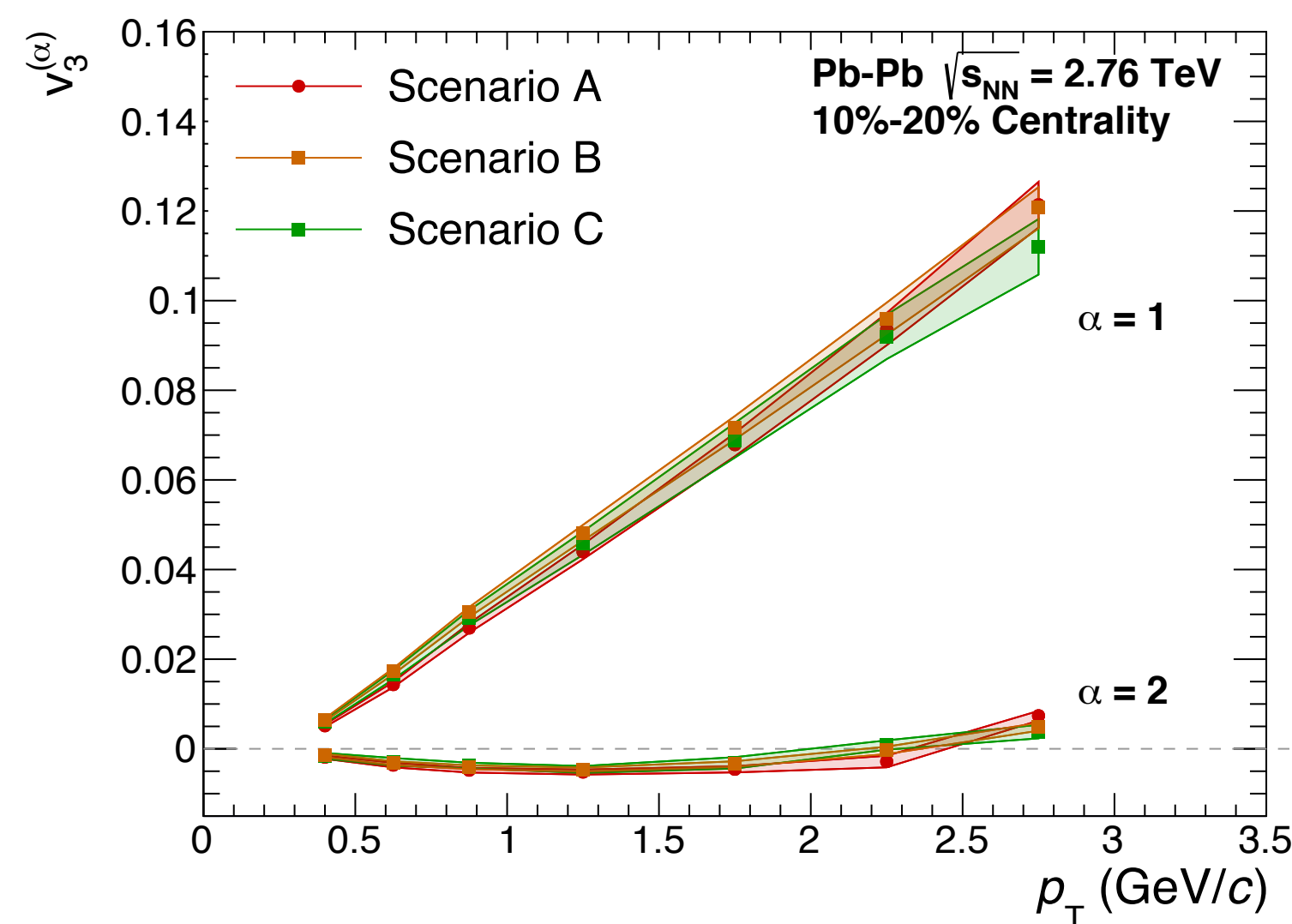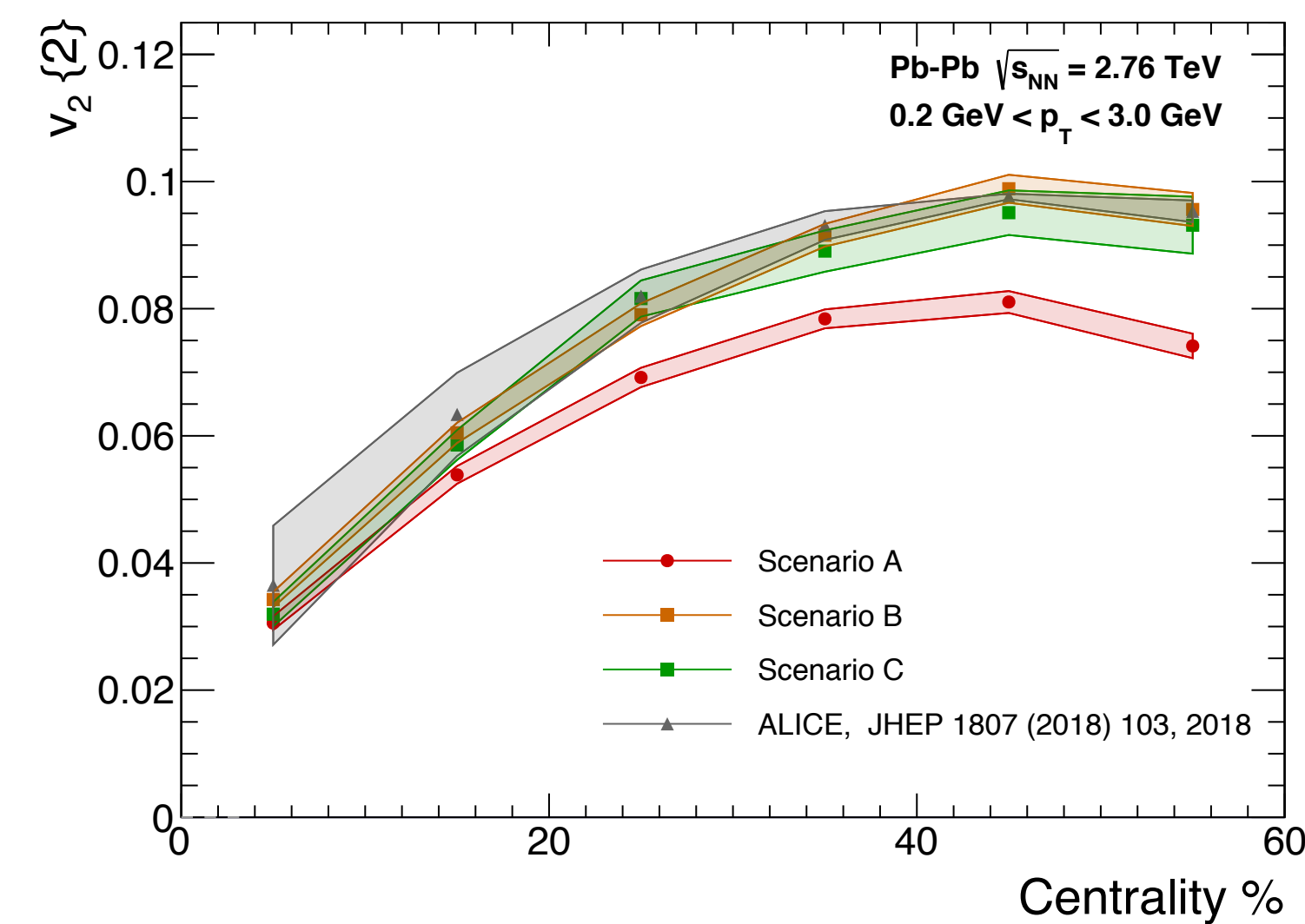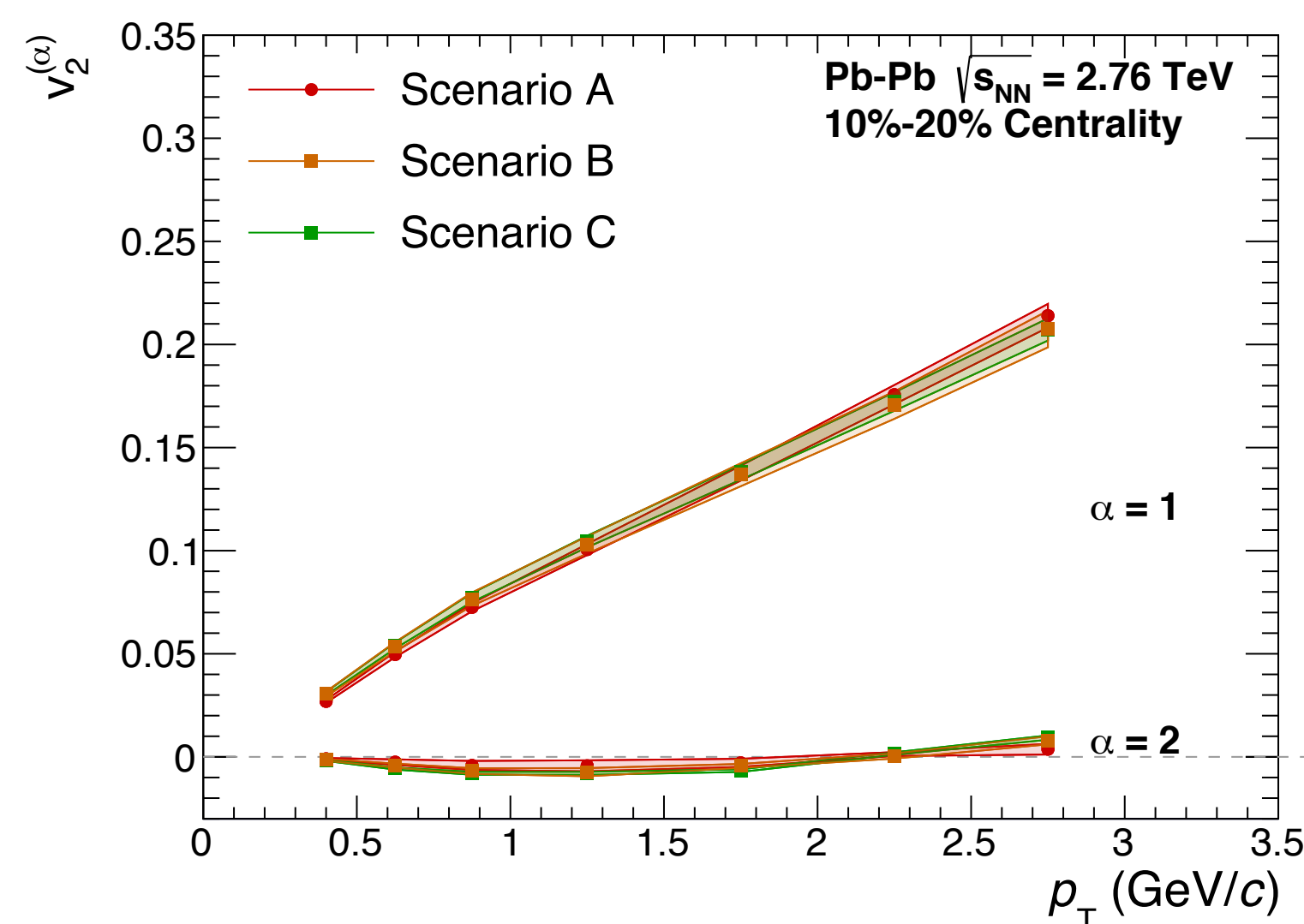
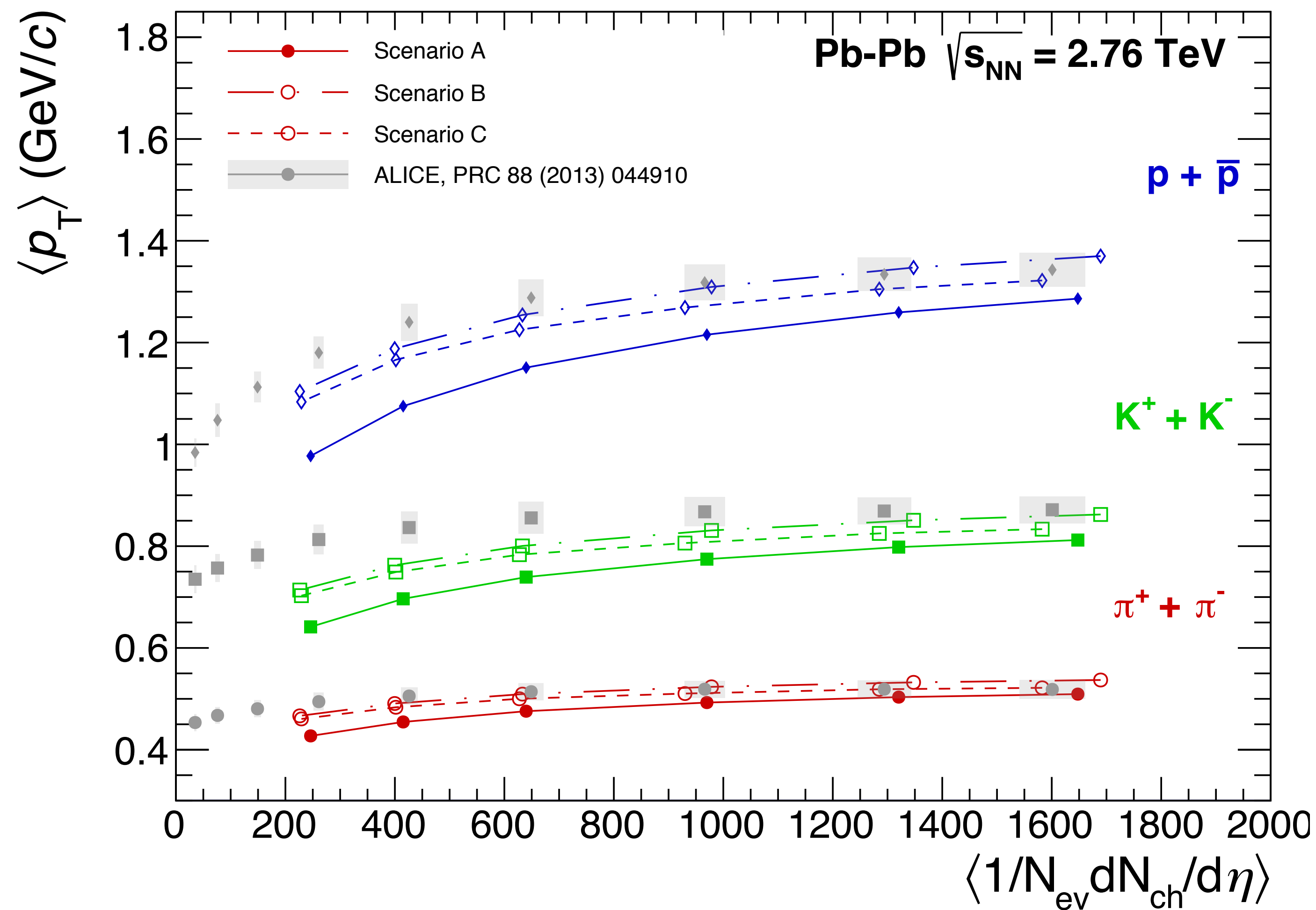# PARTICLE SPECTRA

MEAN-P_T

▶ mean-p_T is increased when either an EKT or free streaming phase is included in the hybrid model;

▶ Where is this extra momentum coming from? May it be due to some common feature?

BULK

- ▸ Both scenarios model conformal systems with massless particles;

- ▸ This implies $T^\mu{}_\mu = 0$, $\Pi = 0$ and $p_{kinetic} = e/3$;

- ▸ At kinetic to hydro matching, QCD is not conformal $\Rightarrow$ artificial discontinuity in bulk pressure: $\Pi + p(e) = e/3$

- ▸ $\Pi/p(e) \approx \mathcal{O}(1)$ around T_{switch}

- ▸ Is this extra bulk pressure responsible for the added mean-p_T?
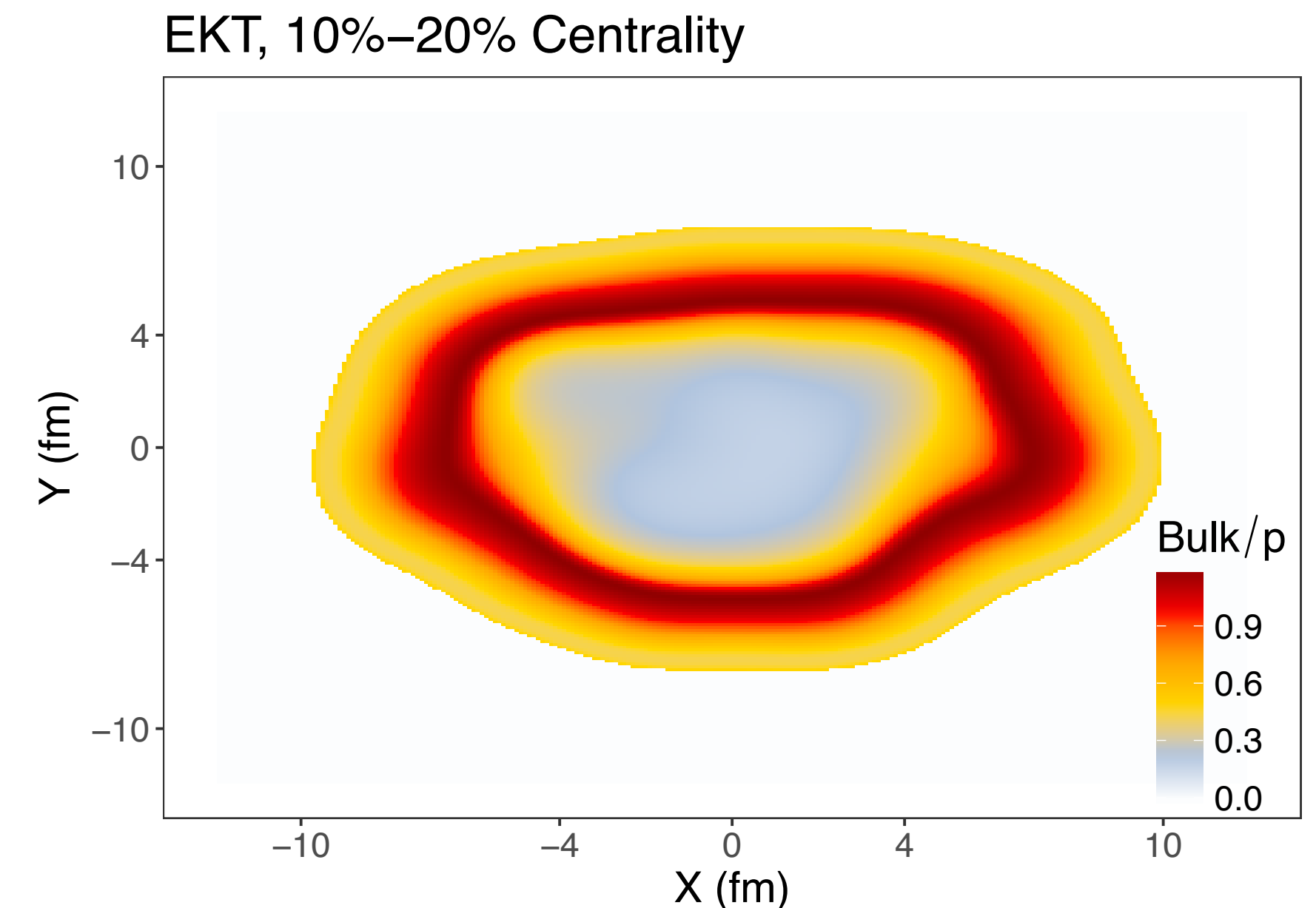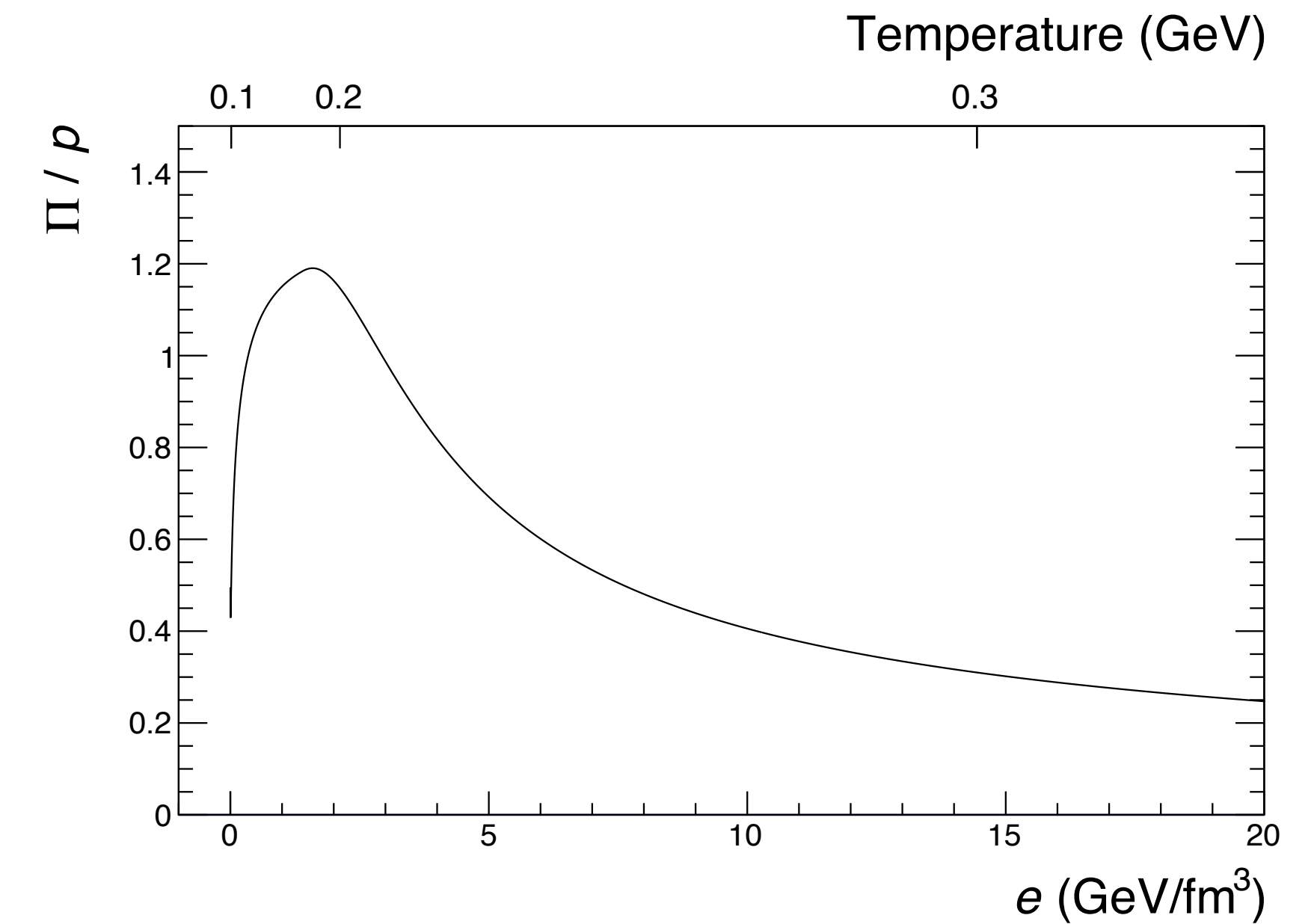
EKT, 10%–20% Centrality

REMOVING THE INITIAL BULK

▸ Additional set of simulations, with initial bulk for hydro set to zero;

▸ A significant portion of the increase in mean-p_T seems to be related to the artificially large bulk at switch time

▸ This increase will also be reflected in final state observables that are integrated over the p_T spectrum;
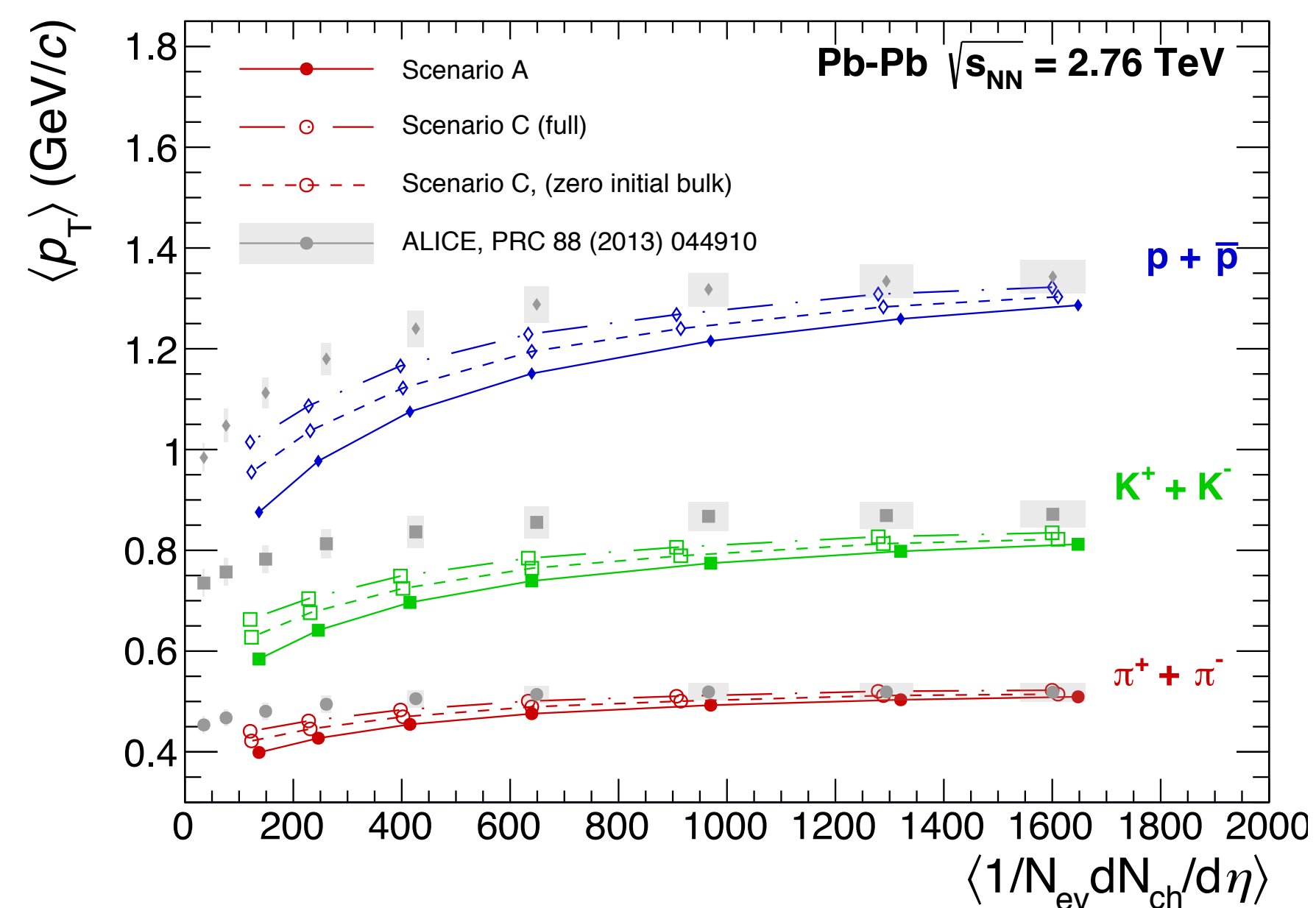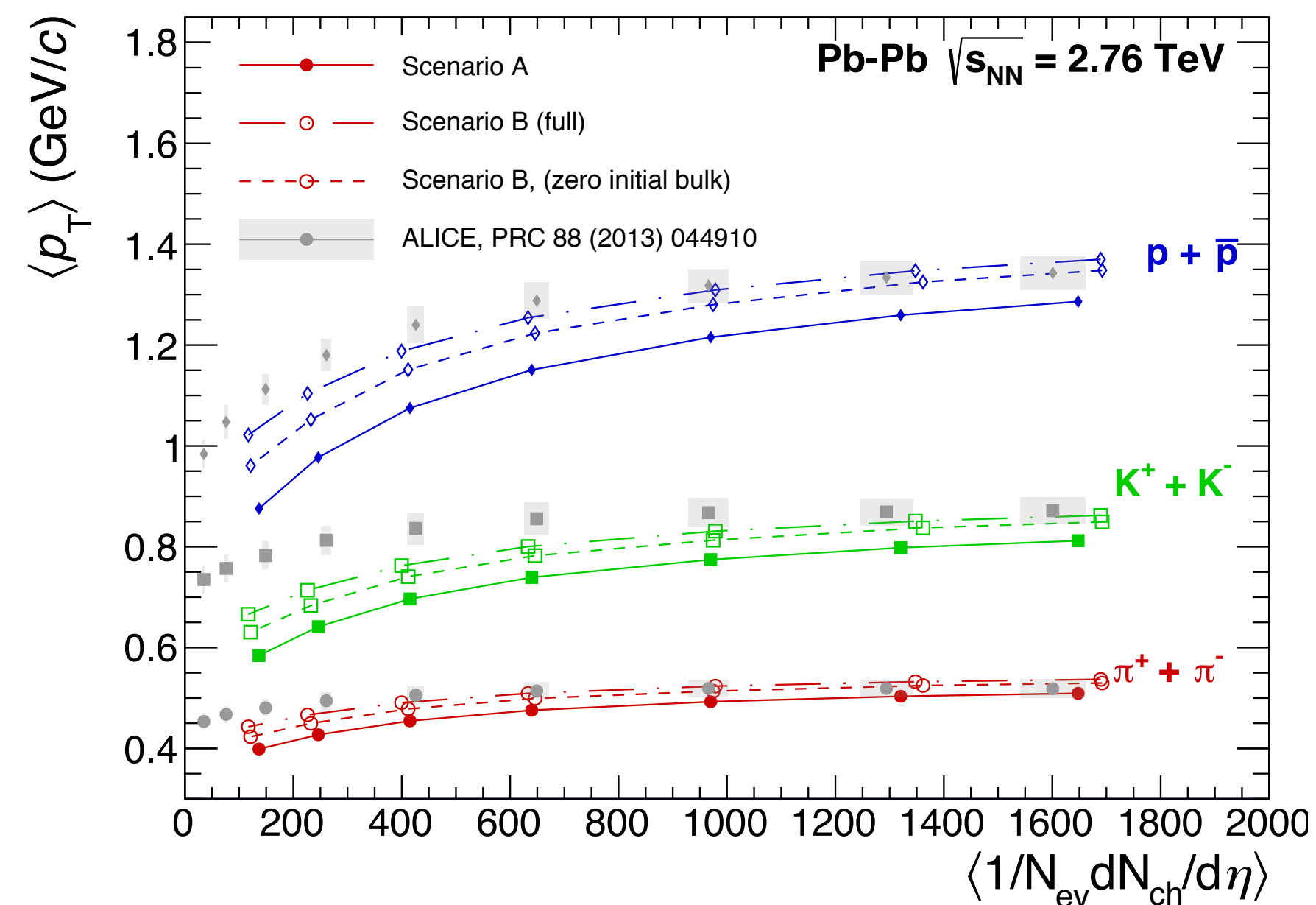
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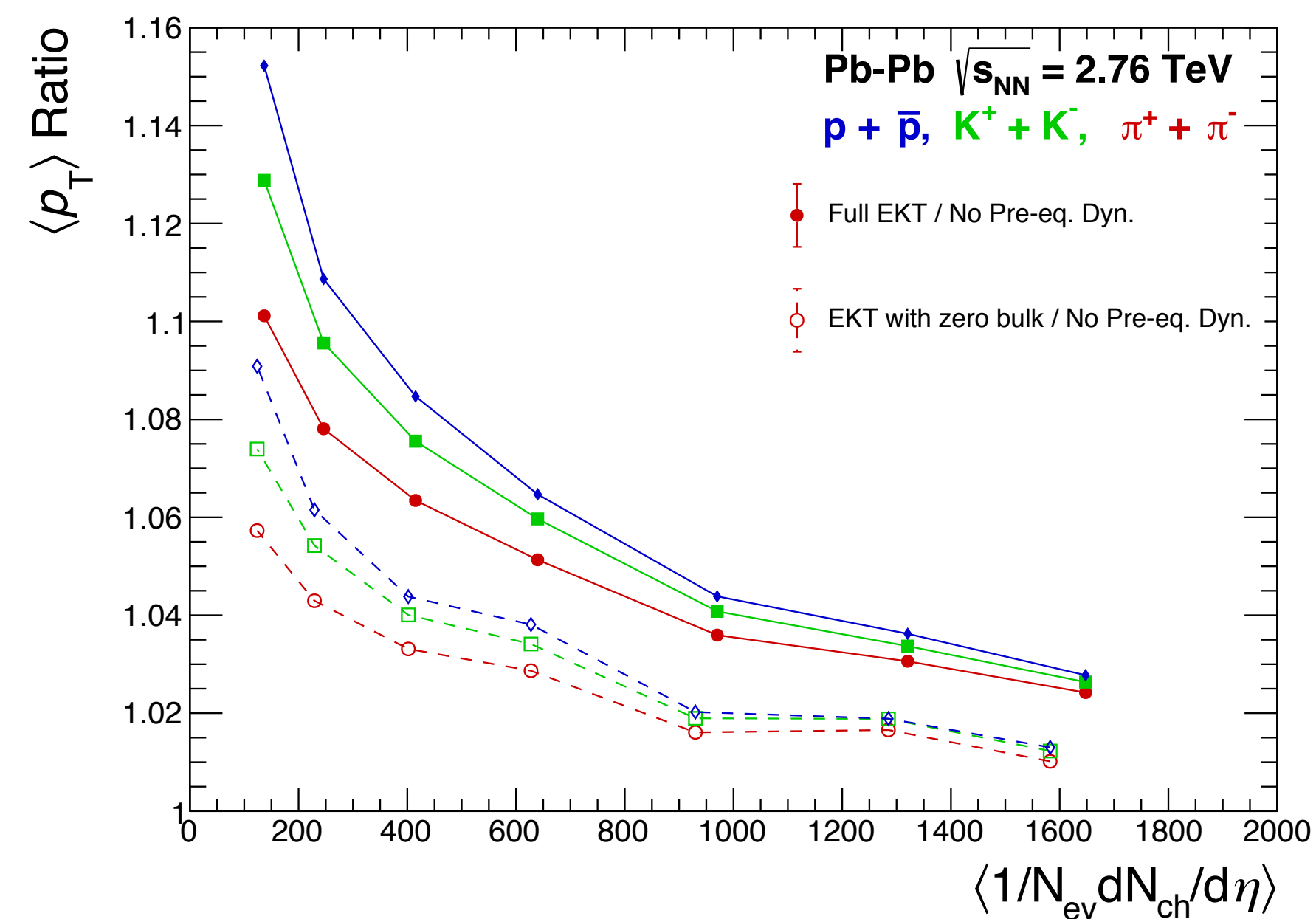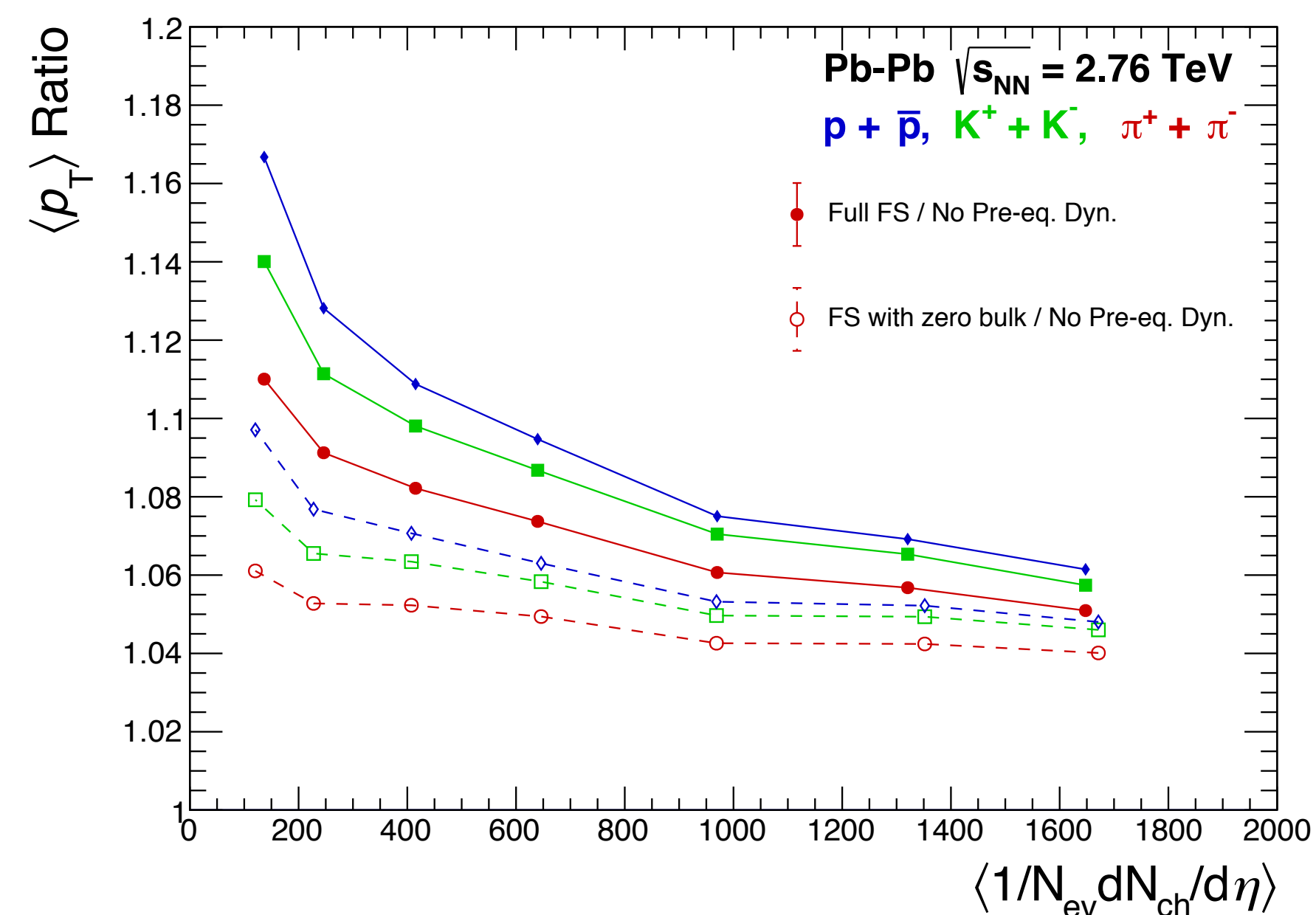
CONCLUSIONS AND OUTLOOK

▸ We have studied how the inclusion of a pre-equilibrium dynamics stage in hybrid models of heavy-ion collisions affect usual final state observables;

▸ Differential flow observables seem largely insensitive to this phase;

▸ Other observables, such as the p_T spectrum, are sensitive;

▸ However, a potentially large fraction of the effects may be an artifact related to the underlying assumption of conformal invariance;

▸ These effects should be kept in mind when comparing calculations based on the conformal assumption to experimental data;

▸ Ultimately, we will need to relax this assumption when building models of pre-equilibrium dynamics.