Data-driven particle composition correction of tracking effciency for charged particles with ALICE

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Motivation

The ALICE experiment at the LHC is designed to study the properties of the Quark-Gluon-Plasma (QGP) based on high energy pp, p-Pb and Pb-Pb collisions. Certain properties of these collisions e.g. the mean energy density can be studied by measuring the production of charged hadrons. In ALICE, charged hadrons are measured with the Time Projection Chamber (TPC) and the Inner Tracking System (ITS). The measurement is corrected for the tracking efficiency of the detector.

In this work, tracking efficiencies are calculated based on two simulation stages: The Monte Carlo generator PYTHIA or HIJING for the particle production (primary event generation) and GEANT to simulate the detector response and the interaction with the detector material.

As particle abundances in the Monte Carlo simulations differ from the measured yields of identified particles, the particle composition of the tracking efficiency for inclusive charged particles has to be tuned. In particular, the influence of the charged Σ-Hyperon, as the lightest charged hyperon, needs to be addressed as the production yields of hyperons are typically not well reproduced by MC event generators [1].

ALICE Detector

Main detectors used in this work:

Time Projection Chamber (TPC)
• main tracking detector
• particle identification via dE/dx

Inner Tracking System (ITS)
• vertex reconstruction
• pile-up rejection
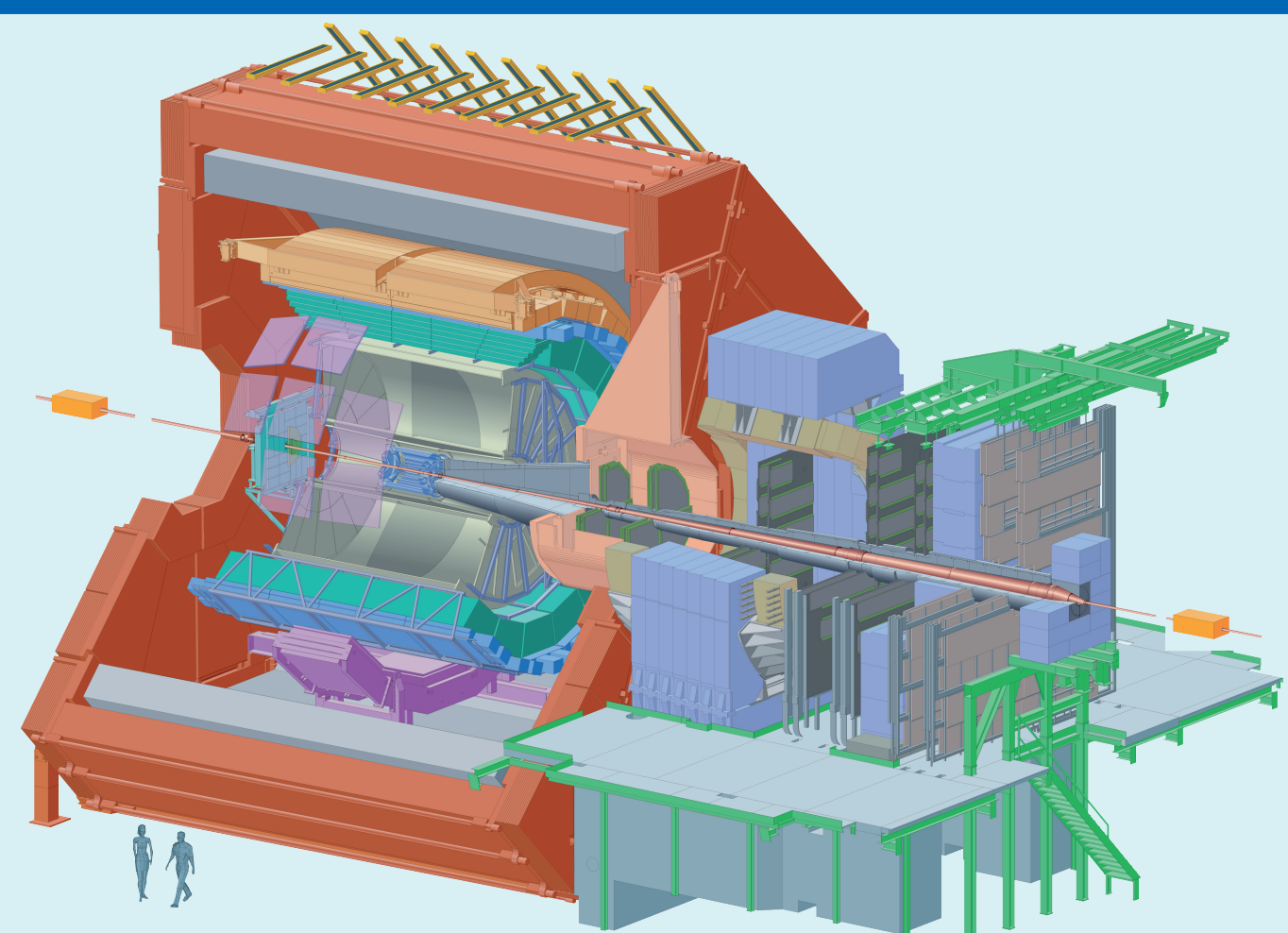
Data and Monte Carlo

Data:

• identified particle measurements used as input for the determination of proper corrections for the inclusive charged particle analysis
• pp collisions at $\sqrt{s}$ = 7 TeV [2]
• Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV [3]
• identified particles:
  • $\pi^+ + \pi^-$
  • $K^+ + K^-$
  • $p + \bar{p}$
• measurement of Λ-baryons [4] are used to approximate the spectra of charged Σ-baryons

Monte Carlo:

• pp $\sqrt{s}$ = 5.02 TeV:
  • PYTHIA 8 tune Monash 2013
• Pb-Pb $\sqrt{s_{NN}}$ = 5.02 TeV:
  • HIJING event generator

• particle species: $\pi^+ + \pi^-$, $p + \bar{p}$, $K^+ + K^-$, Σ^+, Σ^-; all others: *rest* (e, μ, Ξ, Ω)
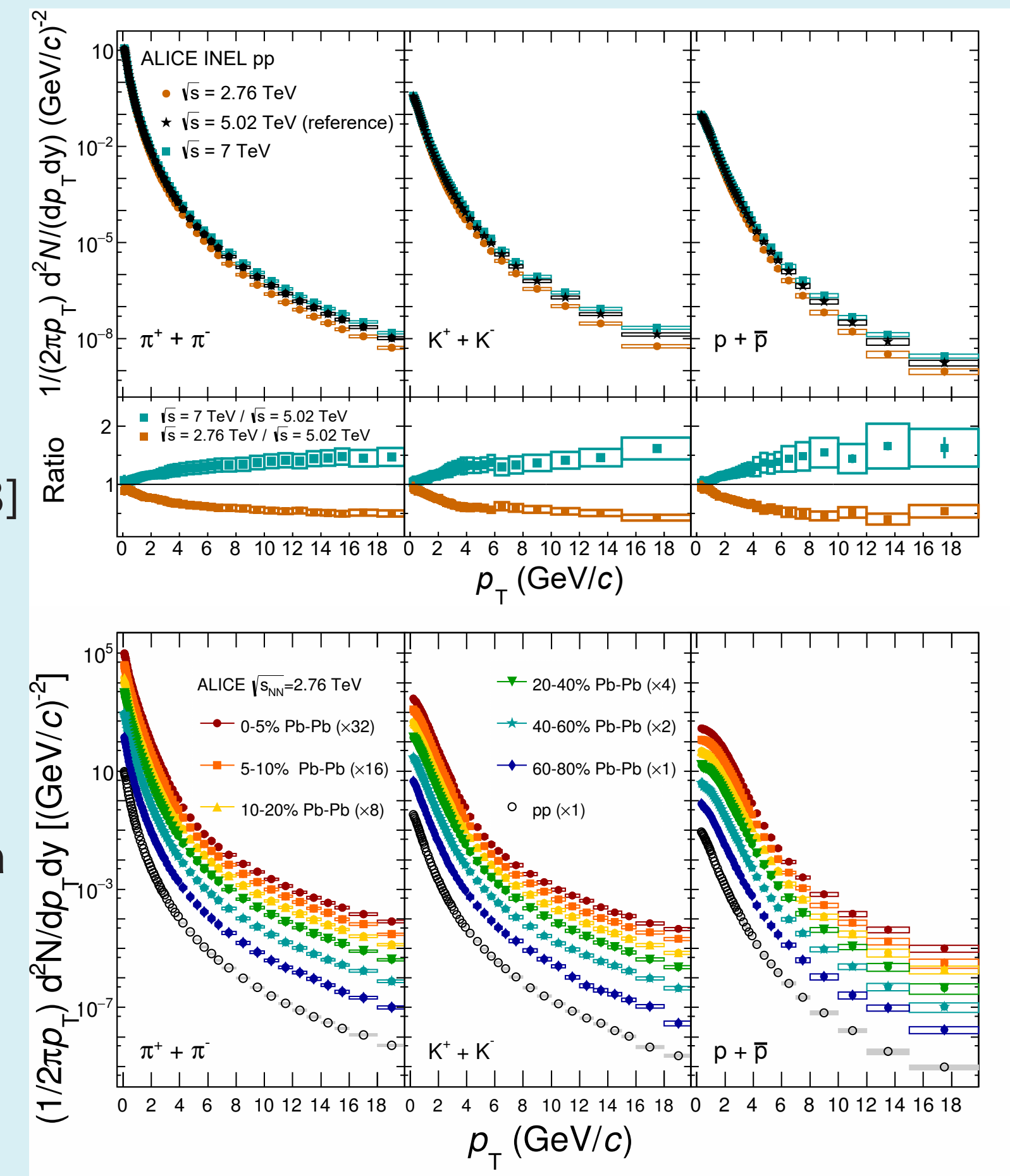

Tracking Efficiencies

Construction of tracking efficiency for inclusive charged particles

• for each particle species: tracking efficiency weighted with expected relative abundance in data
  → improved tracking efficiency of inclusive charged particles by using a reweighted average of tracking efficiencies
 → reduced systematic uncertainty by factor 4

• The influence of charged Σ-Baryons is studied by including it in the *rest*
  → separating charged Σ-baryons from *rest* crucial for reweighted tracking efficiency for inclusive charged particles
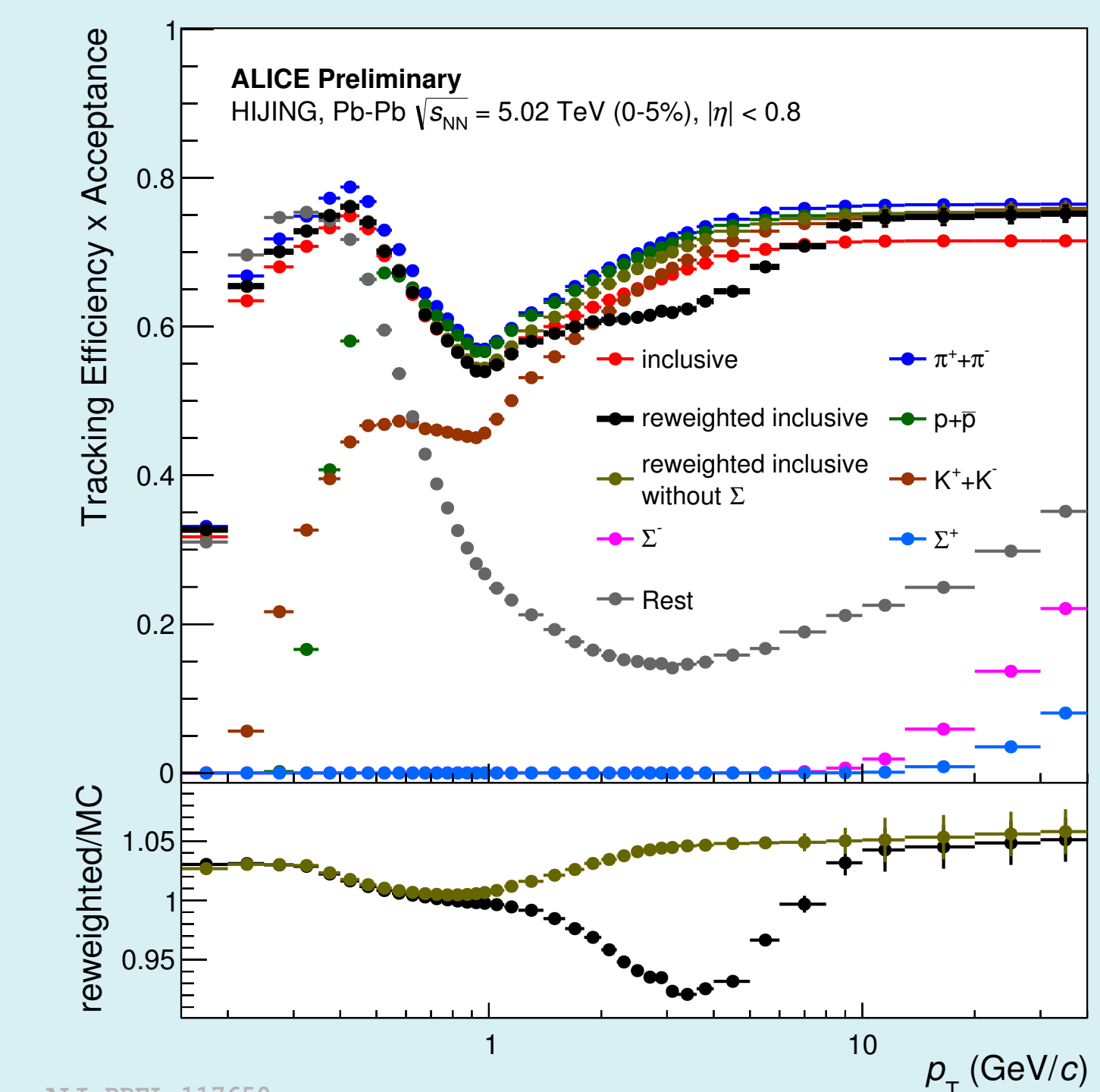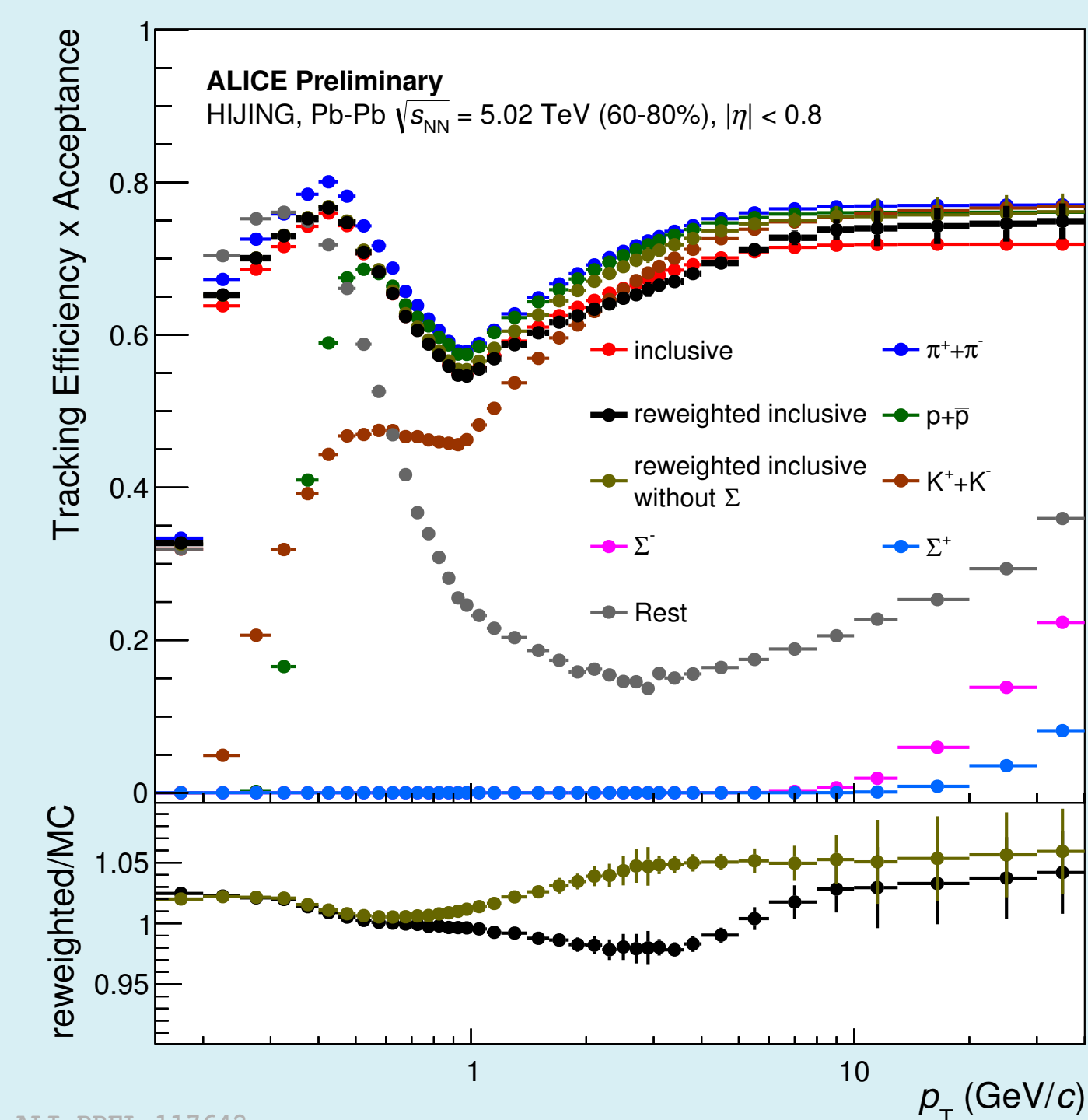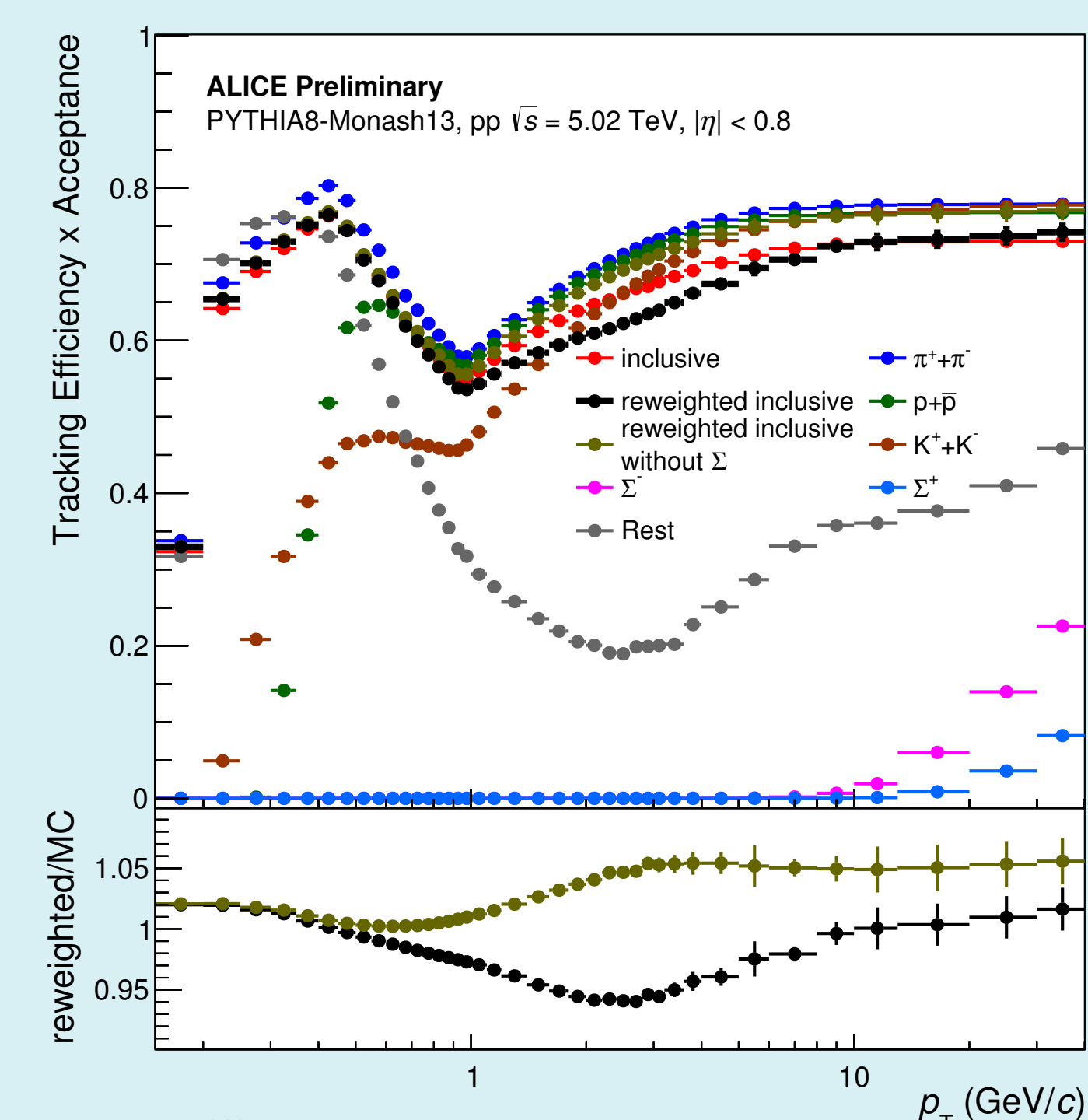
Relative Abundances

• for each particle species, we determine the ratio to all charged particles from data
• measured ratios corrected for remaining particle species (denoted *rest* in the figures)
• largest difference between data and MC observed in charged Σ-baryons
• central Pb-Pb: difference between data and MC also related to radial flow

Assumption: relative abundances do not change as function of center of mass energy at LHC energies
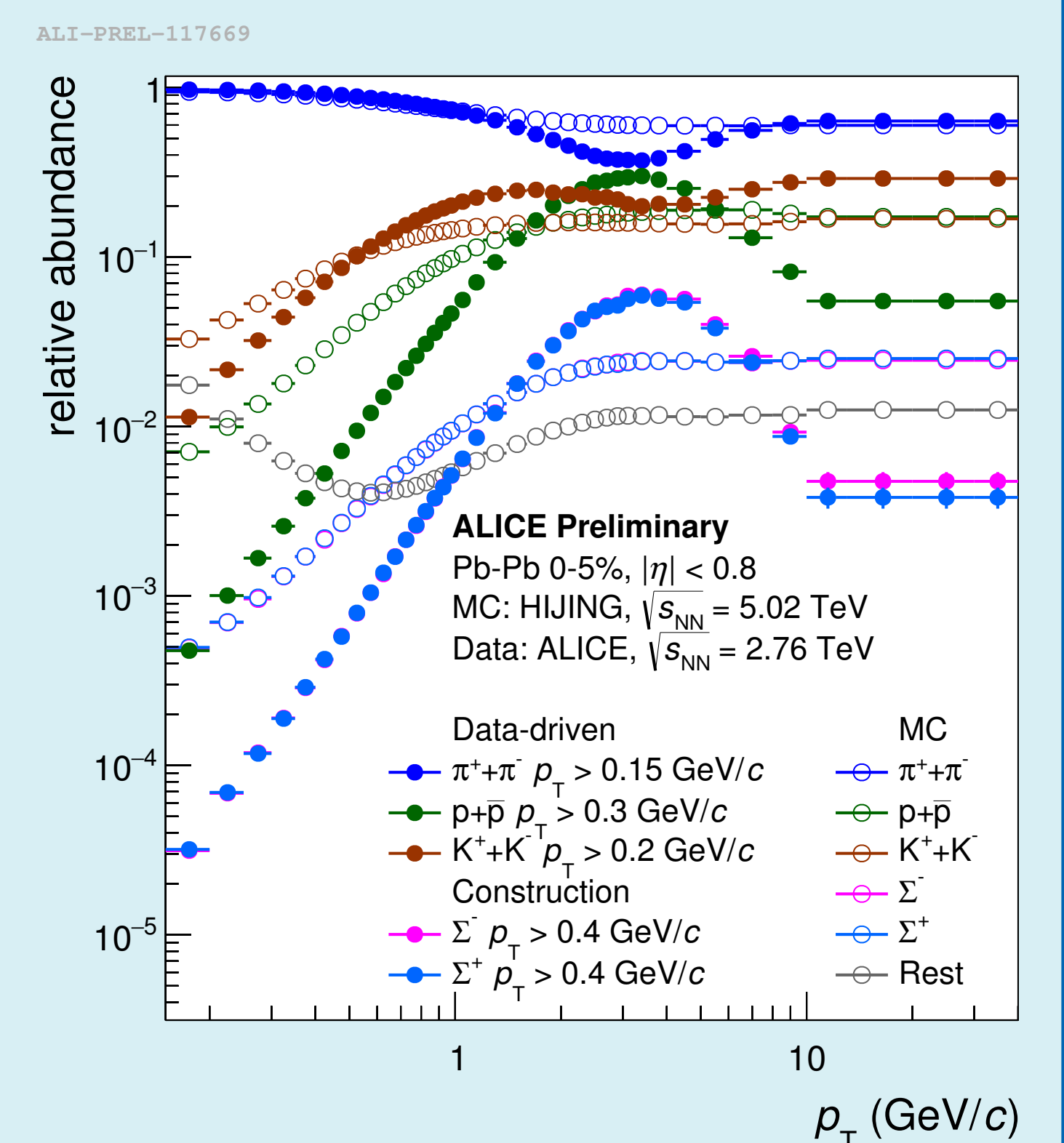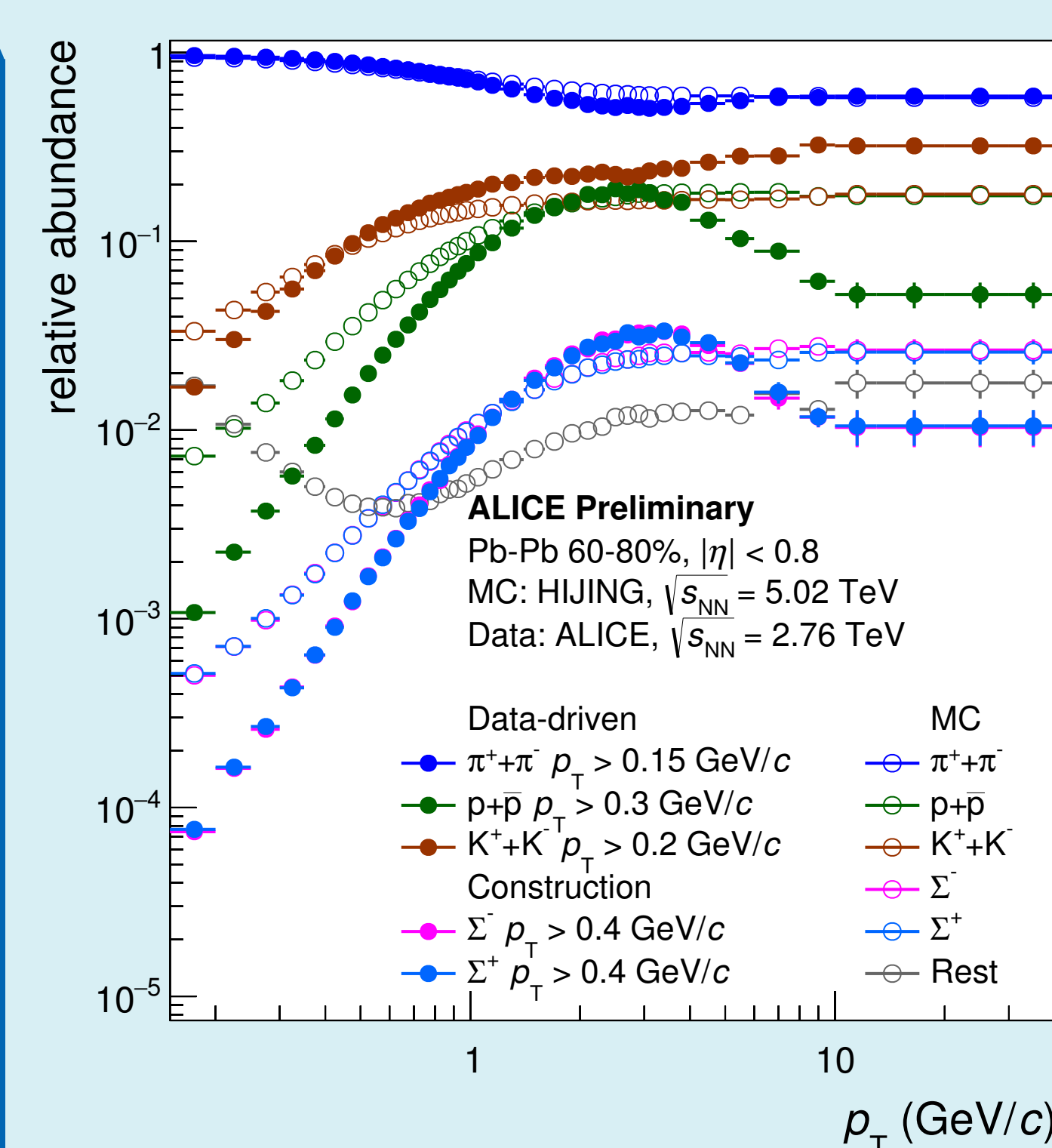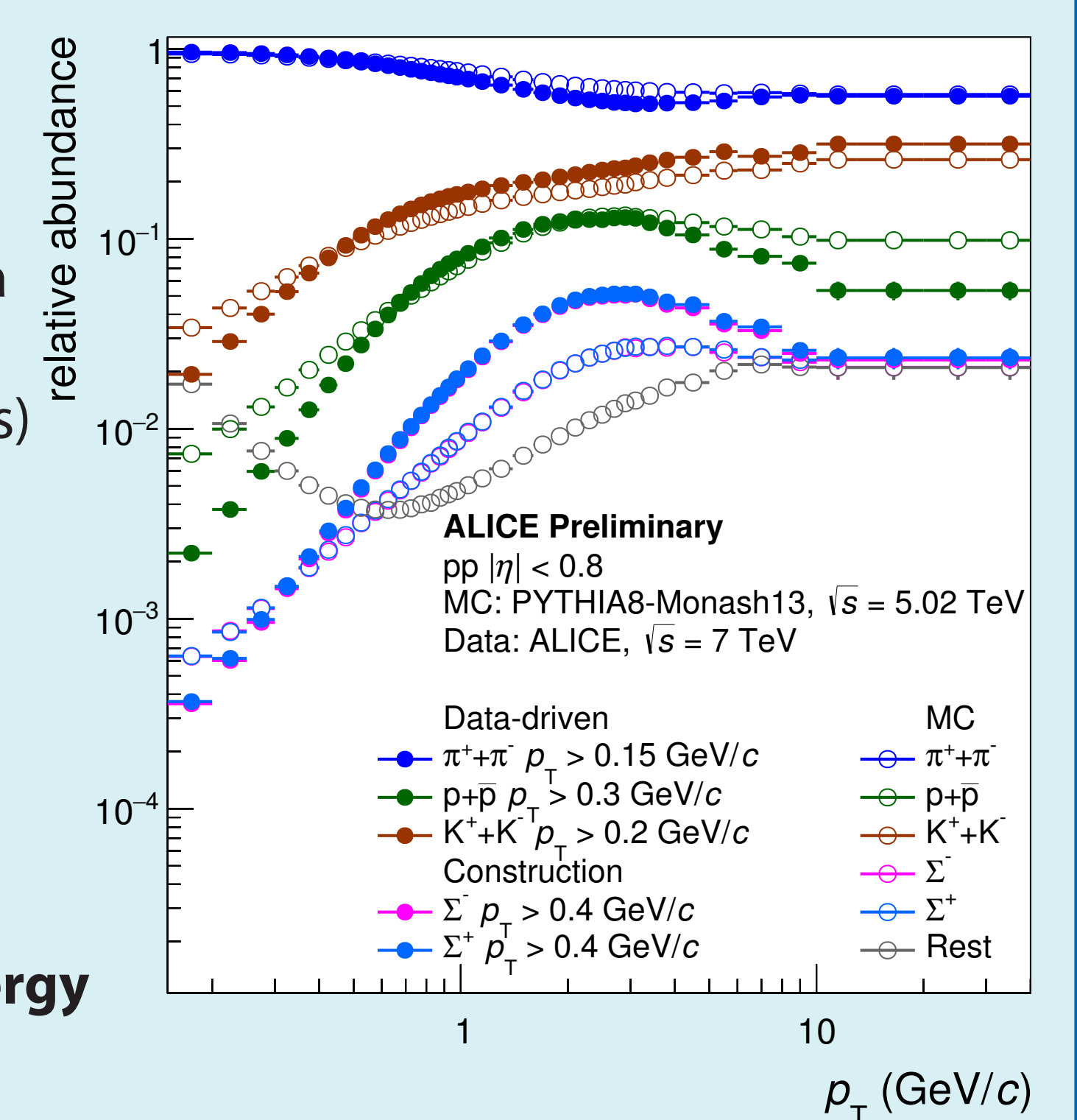
References

[1] ALICE Collaboration, *Production of $\Sigma(1385)^{\pm}$ and $\Xi(1530)^0$ in proton-proton collisions at $\sqrt{s}$ = 7 TeV*, Eur. Phys. J. C 75 (2015) 1

[2] ALICE Collaboration, *Measurement of pion, kaon and proton production in proton-proton collisions at $\sqrt{s}$ = 7 TeV*, EPJC 75 (2015) 226

[3] ALICE Collaboration, *Production of charged pions, kaons and protons at large transverse momenta in pp and Pb–Pb collisions $\sqrt{s_{NN}}$ = 2.76 TeV*, PLB 736 (2014) 196-207

[4] ALICE Collaboration, *K_0^S and Λ production in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV*, Phys. Rev. Lett. 111 (2013) 222301

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