Rivet for HICs

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What is the concept of Rivet for HICs ?

Rivet home page:
"The Rivet toolkit (Robust Independent Validation of Experiment and Theory) is a system for validation of Monte Carlo event generators. It provides a large (and ever growing) set of experimental analyses useful for MC generator development, validation, and tuning, as well as a convenient infrastructure for adding your own analyses. "

What should be a goal of Rivet for HICs (?!): *(Personal view!)*

❑ **a tool which helps to perform a comparison of theoretical results with exp. data – make such analysis simple and robust**
(however, it should NOT be obligatory)

❑ **collect / keep the exp. data including analysis to calculate observables**
(e.g. application of exp. cuts, acceptances etc.)

PHSD experience with Rivet

❑ **Rivet input format HepMC2** is NOT well suited for the HIC event generators (using OSCAR format)

It reciures a lot of ,extra' information which is NOT needed for comparison of theory to the HIC exp. data

❑ **Convertor has been developed :**

 the PHSD output "phsd.dat" (event-by-event output in OSCAR format) to the **HepMC2 format**

- **written by Viktar Kireyeu** (cf. presentation by Viktar, thanks to Christian Bierlich for the help)

➔ **Application of Convertor made possible to use Rivet for the PHSD output for pp and A+A data (see examples)**

Elementary reactions p+p at LHC

ALICE_2015_I1357424

V. Kireyeu et al., Eur.Phys.J.A 56 (2020) 223
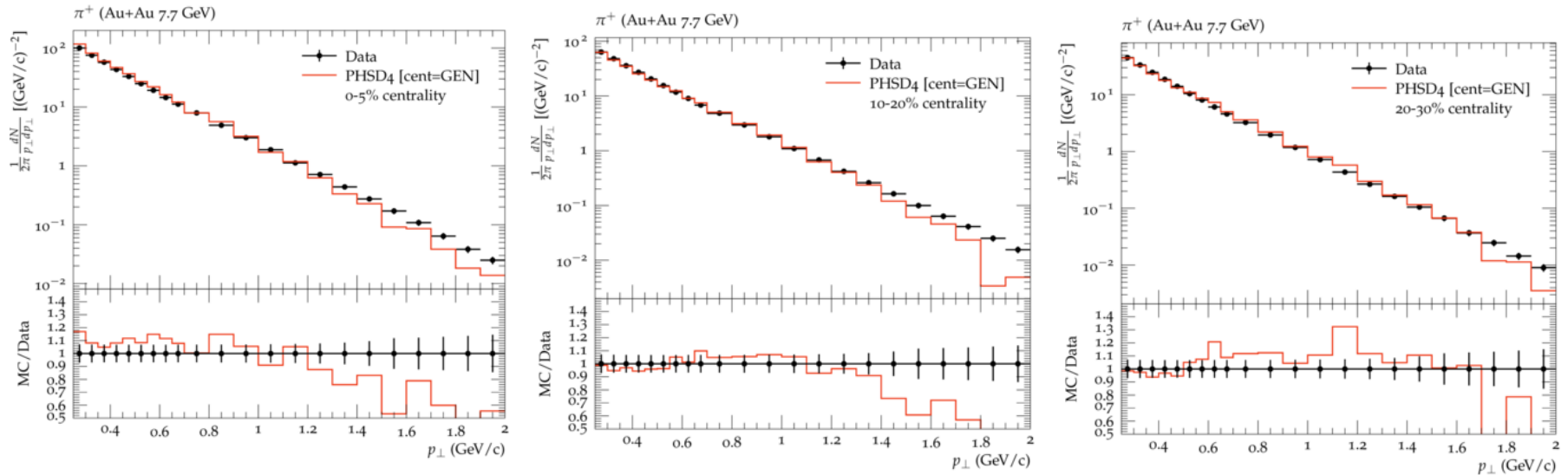**PHSD analysis by Ilia Grishmanovskii**
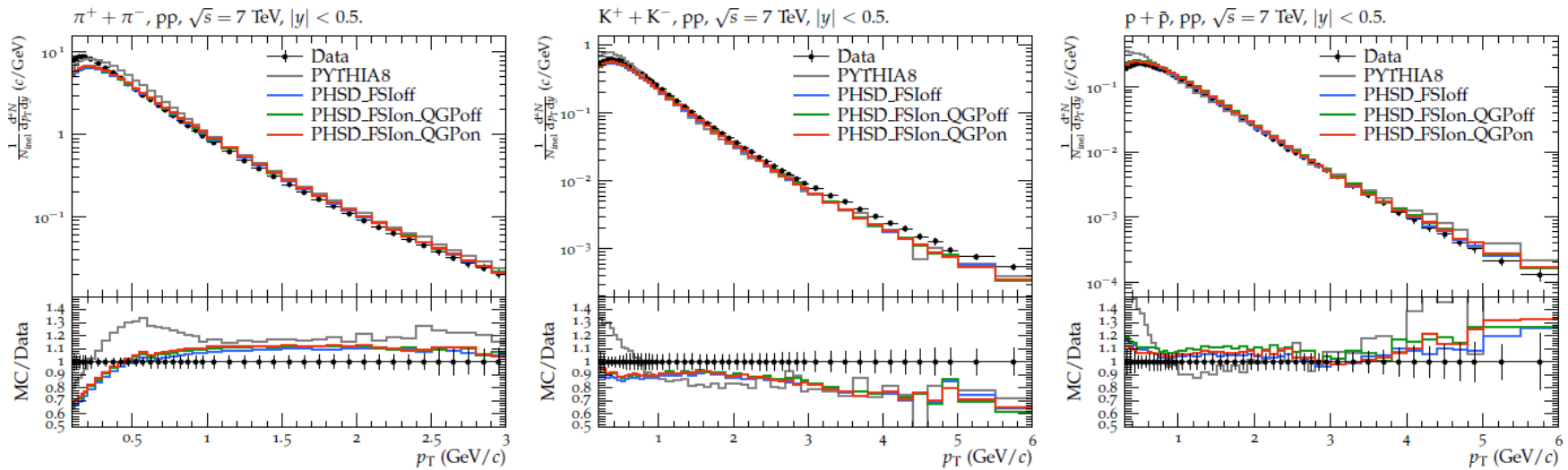
■ **Example of the application of the Rivet to PHSD output (after Convertor)**
and comparison to ALICE experimental data on p+p

Rivet for HICs: PHSD vs. STAR

STAR_2017_I1510593

PHSD analysis from Viktar Kireyeu, March 2021

- **Example of the application of the Rivet to the PHSD output (after Convertor) and comparison to STAR experimental data on Au+Au at $s^{1/2}$=7.7 GeV**

What should be a concept of Rivet for HICs ?

Questions to clarify:

❑ **Input for Rivet** is based on **HepMC format** which requires a lot of information which **CAN NOT be measured** in experiments **directly**:

E.g.: the number of hard scatterings, the number of projectile participants, the number of target participants, the number of nucleon-nucleon collisions, the number of spectator neutrons, and the number of spectator protons, …

❑ **Rivet has to treat the theoretical input in the same way as experimental data ➔**

Input: **only particle ID's in 4-momenta on event-by-event basis!**

➔ **All other unmeasured quantities** (number of participants, spectators etc.) have to be RECONSTRUCTED (if needed!) from theory output in the same way as it is done with exp. data!

➔ **real improvement** of comparison of theory and experiments!

❑ **Standard convertor** from transport model output (OSCAR) to Rivet input for HICs has to be available or Rivet input has to be updated

Rivet for HICs : open questions

Questions to clarify:

❑ **Special attention:**
- definition of centrality,
- reconstruction reaction plane for v_n observables
- reconstruction of resonances
- excitation functions of some observables

❑ **How to deal with observables calculated via a "perturbative treatment" (weighted method) in transport models**
→ **Dileptons and photons (shining method)?**
Such input can not be provided on e-by-e basis!

❑ **What about theoretical models which can NOT present output on e-by-e basis, e.g. they deal with limited phase space or doing analytical calculations of some observables?**

E.g.: Langevin models for charm, calculations with hydro (without particlization); the way to simulate centrality or cover different rapidity ranges (e.g. 2D+1 hydro)

Rivet for HICs : open questions

Questions to clarify:

❑ **How to validate that analysis is correctly imlemented in Rivet ?!**

   The way: take exp. events → Rivet → reproduce measured observables!

Who and how will perform such control of Rivet?

❑ **Rivet is an open source code (it can be changed by users).
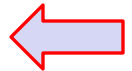How to control the quality of the presented comparison? Should user modifications be absorbed by Rivet?!**

❑ **How to deal with the copyright problem?**
(Results analysed with Rivet → authorization?)

❑ **How fast the preliminary exp. data will be available in Rivet?
How theory can make predictions?**
Presently: „Reference data connection to HepData, avoid hard-coding"

**Expectation:
Rivet – could be a great tool to help in theoretical analysis for HICs!**