Experience with RIVET from a user/”analyser”
(event generator user point-of-view)

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HF-QGP : theory meets experiments about RIVET (April 8th 2021)

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First steps with RIVET

1. First contact with RIVET during a hand-on session given by C. Bierlich at ***COST Workshop on Interplay of hard and soft QCD probes for collectivity in HIC*** (Lund, Feb. 2019)

⇒ using a virtual machine to run an analysis on a provided *.hepmc* file

2. Master student at that time, I used this fresh knowledge to install RIVET in Subatech's network and started to use it, in order to handle it well

There started a lot (too much ? ☺) of exchanges with C. Bierlich and P. Karczmarczyk...

RIVET as an analyser

Write an analysis for RIVET

What's better, to learn how to handle RIVET, than to write a new analysis ?

As a preparation for my PhD, and to help M. Stefaniak in her own PhD work, we started to write analyses (in collaboration with G. Pokropska) for :

Bulk Properties of the Medium Produced in Relativistic Heavy-Ion Collisions from the BES Program
(STAR_2017_I1510593)

$\sqrt{s_{NN}} = [7.7, 11.5, 19.6, 27, 39]$ GeV/A

QGP formation depending on energy, by extraction of T_{ch} and μ_B at chemical freeze-out with statistical thermal model of particle production

Submitted and implemented in RIVET ☑

Elliptic flow of identified hadrons in Au+Au collisions at $\sqrt{s_{NN}} =$ 7.7-62.4 GeV

$\sqrt{s_{NN}} = [7.7, 11.5, 19.6, 27, 39, 62.4]$ GeV/A

QGP formation depending on energy, by study of elliptic flow (v_2), in comparison with results from $\sqrt{s_{NN}}$ =200 GeV collisions

Unachieved ☒
(now need to consider recent updates on event plane analyses)

RIVET as an analyser

Get the experimental data

To do such, we need experimental data in *.yoda* format, usually available in HepData.

However, the paper was not referenced at that time on HepData
$\rightarrow$ we created it directly with data from STAR website

```
Figure 12:
=======
Au+Au 7.7 GeV
------------------------
pTlow [GeV/c] pThigh[GeV/c]   d^2N/(2pi*pt*dpt*dy)[(GeV/c)^-2]   error(stat.)    error(sys.)
pi-  0-5%
0.25     0.30    114.898        0.21538         7.89015
0.30     0.35    83.9507        0.17051         5.61535
0.35     0.40    62.4481        0.13799         4.10800
0.40     0.45    46.3708        0.11247         3.01883
0.45     0.50    34.7823        0.09267         2.24990
0.50     0.55    26.3221        0.07704         1.69598
0.55     0.60    19.7093        0.06396         1.26704
0.60     0.65    15.0548        0.05379         0.96702
0.65     0.70    11.2735        0.04492         0.73605
0.70     0.75    8.7656         0.03832         0.56201
0.40     0.50    40.5278        0.09157         2.62896
0.50     0.60    22.9845        0.06263         1.47893
0.60     0.70    13.3825        0.04416         0.85857
0.70     0.80    8.0326         0.03214         0.51490
0.80     0.90    4.8609         0.02371         0.31167
0.90     1.00    2.9687         0.01761         0.19063
1.00     1.10    1.8153         0.01307         0.11705
1.10     1.20    1.1242         0.00978         0.07324
1.20     1.30    0.6839         0.00729         0.04569
1.30     1.40    0.4270         0.00555         0.03024
1.40     1.50    0.2707         0.00427         0.02168
1.50     1.60    0.1693         0.00326         0.01688
1.60     1.70    0.0995         0.00241         0.00992
1.70     1.80    0.0560         0.00174         0.00560
1.80     1.90    0.0368         0.00139         0.00369
1.90     2.00    0.0238         0.00112         0.00240
------------------------
```

```
BEGIN YODA_SCATTER2D_V2 /REF/STAR_2017_PRC96_044904/d12-x01-y01
Variations: [""]
IsRef: 1
Path: /REF/STAR_2017_PRC96_044904/d12-x01-y01
Title: ~
Type: Scatter2D
---
# xval   xerr-   xerr+   yval    yerr-   yerr+
2.750000e-01    2.500000e-02    2.500000e-02    1.148980e+02    8.105530e+00    8.105530e+00
3.250000e-01    2.500000e-02    2.500000e-02    8.395070e+01    5.785860e+00    5.785860e+00
3.750000e-01    2.500000e-02    2.500000e-02    6.244810e+01    4.245990e+00    4.245990e+00
4.250000e-01    2.500000e-02    2.500000e-02    4.637080e+01    3.131300e+00    3.131300e+00
4.750000e-01    2.500000e-02    2.500000e-02    3.478230e+01    2.342570e+00    2.342570e+00
5.250000e-01    2.500000e-02    2.500000e-02    2.632210e+01    1.773020e+00    1.773020e+00
5.750000e-01    2.500000e-02    2.500000e-02    1.970930e+01    1.331000e+00    1.331000e+00
6.250000e-01    2.500000e-02    2.500000e-02    1.505480e+01    1.020810e+00    1.020810e+00
6.750000e-01    2.500000e-02    2.500000e-02    1.127350e+01    7.809700e-01    7.809700e-01
7.500000e-01    5.000000e-02    5.000000e-02    8.032600e+00    5.470400e-01    5.470400e-01
8.500000e-01    5.000000e-02    5.000000e-02    4.860900e+00    3.353800e-01    3.353800e-01
9.500000e-01    5.000000e-02    5.000000e-02    2.968700e+00    2.082400e-01    2.082400e-01
1.050000e+00    5.000000e-02    5.000000e-02    1.815300e+00    1.301200e-01    1.301200e-01
1.150000e+00    5.000000e-02    5.000000e-02    1.124200e+00    8.302000e-02    8.302000e-02
1.250000e+00    5.000000e-02    5.000000e-02    6.839000e-01    5.298000e-02    5.298000e-02
1.350000e+00    5.000000e-02    5.000000e-02    4.270000e-01    3.579000e-02    3.579000e-02
1.450000e+00    5.000000e-02    5.000000e-02    2.707000e-01    2.595000e-02    2.595000e-02
1.550000e+00    5.000000e-02    5.000000e-02    1.693000e-01    2.014000e-02    2.014000e-02
1.650000e+00    5.000000e-02    5.000000e-02    9.950000e-02    1.233000e-02    1.233000e-02
1.750000e+00    5.000000e-02    5.000000e-02    5.600000e-02    7.340000e-03    7.340000e-03
1.850000e+00    5.000000e-02    5.000000e-02    3.680000e-02    5.080000e-03    5.080000e-03
1.950000e+00    5.000000e-02    5.000000e-02    2.380000e-02    3.520000e-03    3.520000e-03
END YODA_SCATTER2D_V2
```

"PROBLEM" NOW : the datasets has been implemented in HepData since, but in a different way (author didn't know the existence of the corresponding RIVET analysis ?)

$\rightarrow$ we need to re-write the *.yoda* file originally submitted to RIVET, in order to match the plots numbering, for automatic synchronisation with HepData

RIVET as a user

Benefits to use RIVET for an event generator user

Now doing a PhD with EPOS, I constantly need to compare my simulation results to experimental data.

Until now (and still today) had to reproduce the analysis by ourselves, sometimes spending a lot of time to understand properly :

- kinematic cuts
- centrality determination
- corrections
- ...

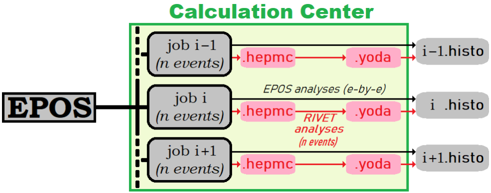
$\Rightarrow$ **RIVET is a very good for this !**

Don't have to "think about" the analysis details anymore *(but read it anyway obviously)*
\+ **easy to handle** (a lot of documentation + helpful reactive developers)

Our first effort was to ”adapt” EPOS to RIVET, i.e. produce HepMC files
(work done with the help of M. Stefaniak).

Then, already having our ”local” analysis tool *(cf. K. Werner’s talk)*

→ we included RIVET in our framework



Probably a better way to do it, but :

- we don’t want to save **heavy .hepmc files** (cf. V. Kireyev’s talk)
- analysis we already use are **not all available yet in RIVET**
  ⇒ **Main concern for HIC :** ALICE started (a bit slowly) to play the game
  STAR is almost absent

(+ we want to keep our system anyway, for internal checking at least)

Summary

DISCLAIMER : I just point out some issues/difficulties, and I do not blame anyone for them

- RIVET is easy to use (even without a lot of knowledge in C++)
- developers are very helpful and reactive
- very useful for phenomenology people like us, but also for any user of event generators

- installation not always trivial (1st time OK, then impossible)
- HepMC format is quite heavy
- still a lack of efforts from experiments in the HIC field

"you can't use Monte Carlo simulations for everything"

Thank you !