RIVET / RIVET-HI

James Neuhaus

NSF

THE UNIVERSITY OF
TENNESSEE
KNOXVILLE

JETSCAPE

RIVET

- **R**obust **I**ndependent **V**alidation of **E**xperiment and **T**heory

THE UNIVERSITY OF
TENNESSEE
KNOXVILLE
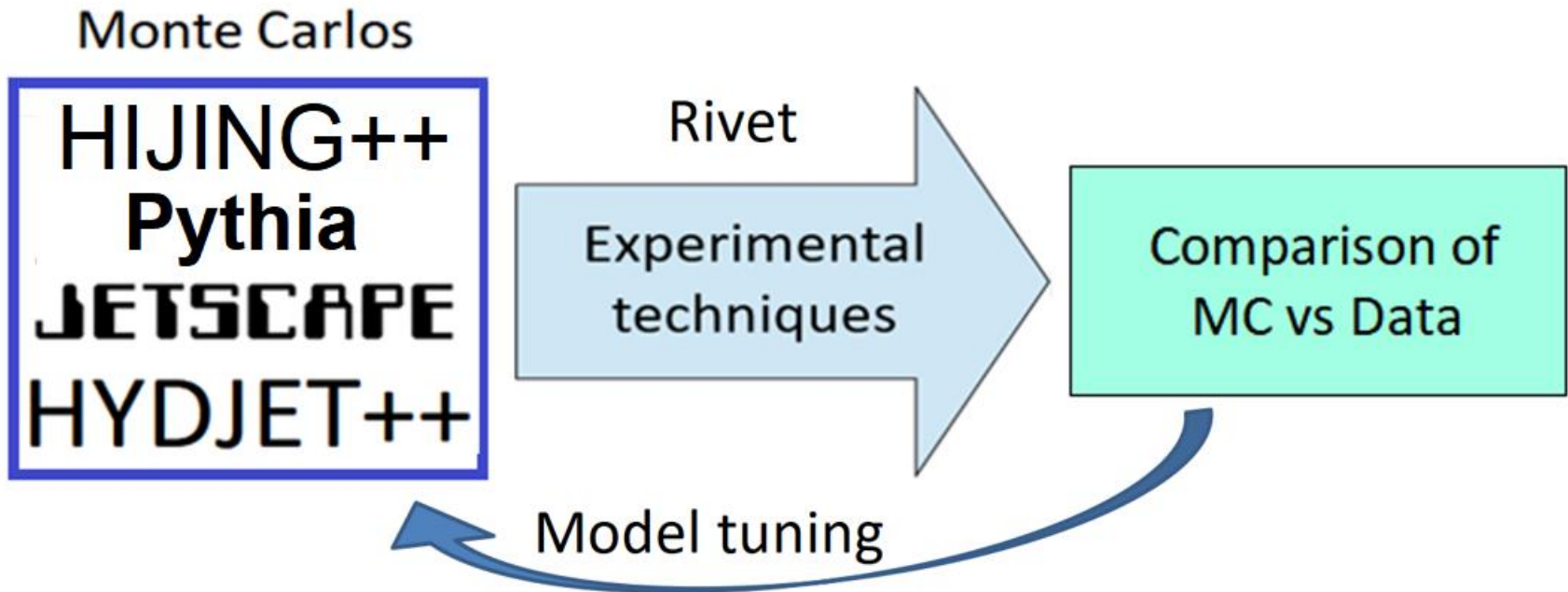
RIVET

- C++ based package

- Researchers generate code for specific analyses based on published papers

- End users run MC output through analyses

- Compare MC against experimental data

Generating an Analysis

- Plugin with three subroutines

  - *init()* : Register objects which will be used

  - *analyze()* : calculate desired observables for single MC event output

  - *finalize()* : prepare histogram data

RIVET Projections

- RIVET uses "Projection" objects
- Reduced duplication of effort between analyses
- Includes staples such as:
  - **ChargedFinalState** – Charged particles, Kinematic Cuts can be applied
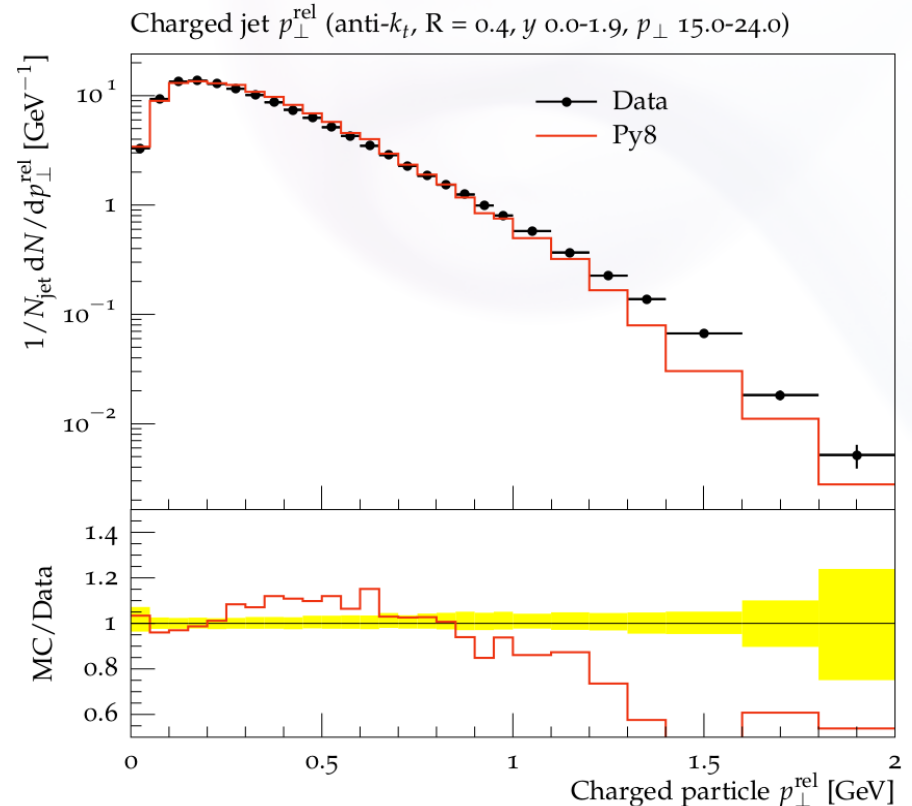 - **FastJets** – FastJet wrapper

Using RIVET

- Can run one or multiple analyses over multiple MC output files (.hepmc) or pipe in output from a simultaneously running MC

- RIVET is single threaded, most (all?) analyses written so "finalize" hinders merging of parallel run RIVET instances

RIVET Output

- Output visualized through provided scripts and YODA package

- Directly compares MC vs published data

Example Rivet Plot

Charged jet $p_\perp^{\mathrm{rel}}$ (anti-k_t, R = 0.4, y 0.0-1.9, $p_\perp$ 15.0-24.0)

Data
Py8

$1/N_{\mathrm{jet}}\, dN/dp_\perp^{\mathrm{rel}}$ [GeV^{-1}]

MC/Data

Charged particle $p_\perp^{\mathrm{rel}}$ [GeV]

THE UNIVERSITY OF TENNESSEE KNOXVILLE

RIVET-HI

- RIVET lacks Heavy Ion functionality
- ALICE spun off RIVET-HI
  - Added centrality, 3 analyses
- UT-Fork created Spring 2018
  - Primarily developed over 10 week REU
  - 4 Undergraduates, 1 new Graduate student
    - Dr. Redmer Bertens
  - https://github.com/cnattras/rivet-hi

Centrality Handling

- Credit: ALICE collaboration

- Each analysis selects a number of events to calibrate centrality binning
  - Multiplicity or Impact parameter based
  - Calibration events are not used for calculating any other observables

UT-Fork

- Added new projections:

  - Nth order event plane calculator using Q vectors

  - Event Plane Resolution Calculation

  - Fourier-Fit v_n Calculator

  - Detector Pixel mapping (allows tower Jets)

Background Handling

- Methods incorporated for reconstructed jets:
  - STAR/ALICE method [1]
  - ATLAS method [2]
  - CMS Noise/Pedestal [3]
  - CMS η reflection [4]

[1] Eur. Phys. J. C (2011) 71: 1539   [3] Eur. Phys. J. C 50 (2007) 117
[2] Phys. Lett. B 719, 220 (2013)   [4] Phys. Rev. C 90, 024908 (2014)

THE UNIVERSITY OF TENNESSEE KNOXVILLE

New HI Analyses

- 2x ALICE Jet Spectra [1] [2]
- CMS Inclusive Jet Cross Section [3]
- ATLAS R_{AA} [4]
- CMS Fragmentation Functions [5]
- ATLAS, ALICE Jet v_2 [6] [7]

[1] JHEP 30 (2014) 013
[2] Phys. Lett. B 746 (2015) 1
[3] Phys. Rev. C 96 (2017) 015202
[4] Phys. Rev. Lett. 114 (2015) 072302
[5] Phys. Rev. C 90 (2014) 024908
[6] Phys.Lett. B 753 (2016) 511-525
[7] Phys. Rev. Lett.111 152301 (2013)

THE UNIVERSITY OF TENNESSEE KNOXVILLE

Summary

- RIVET melds theory and experiment

- RIVET-HI handles centrality and UT fork provides heavy ion-specific tools

- Great way to get undergraduates experience in Relativistic HI Physics

Questions?

Special Thanks to:

- Dr. Christine Nattrass
- Dr. Soren Sorensen
- Dr. Redmer Bertens

UTK RIVET-HI working group:

- Mariah McCreary
- Ricardo Santos
- Austin Schmier
- Jerrica Wilson

- "Weeks of programming can save you hours of planning." – Source Unknown

THE UNIVERSITY OF TENNESSEE KNOXVILLE