Implementation RHIC analyses in Rivet

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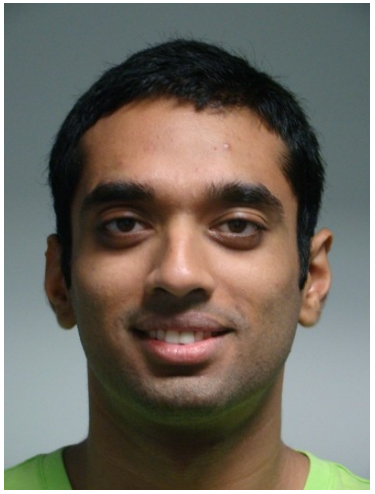

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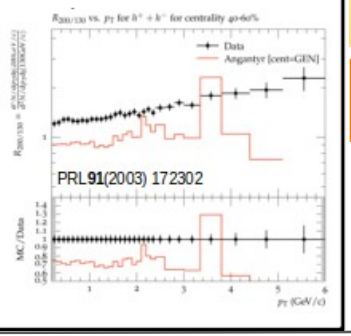
University of Tennessee, Knoxville

Challenges

HepMC

HEPData → Rivet

Comparison to data



1. Data not in HEPData

Labor

Technical

Political

5. Not all generators 100% Rivet-compatible

2. Need to write code

3. Need “primary particle” definition

4. Need validation

Technical – Mostly non-issues

- Measurement reported vs N_{part} or N_{coll}
  - Use centrality on the x-axis instead
  - Multiple options for centrality determination
  - Can “undo” Glauber model scaling of R_{AA} as well
- Rivet (mostly) requires bins on x-axis
  - Have to be reconstructed
  - Can be done when formatting HEPData

1. Labor – HEPData – Status

STAR

- Required for new publications since early 2020
- 190/284 (67%) papers*
- Option for shifts in 2020

PHENIX

- Required for new publications since August 2020
- 47/223 (21%) papers*

RHIC
248/781
32%

PHOBOS

- 2/152 (1%) papers*
- No process for uploads
- Spokesperson: Wit Busza

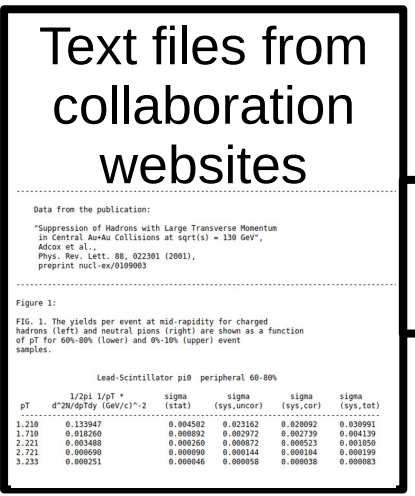
BRAHMS

- 9/122 (7%) papers*
- In progress

*As of April 4, 2021. Denominator from InspireHep.net requiring published papers

1. Labor – HEPData – Semi-automated

Text files from collaboration websites



Data from the publication:

"Suppression of Hadrons with Large Transverse Momentum in Central Au+Au Collisions at sqrt(s) = 130 GeV", Adcox et al., Phys. Rev. Lett. 88, 022301 (2001), preprint nucl-ex/0109003

Figure 1:

FIG. 1. The yields per event at mid-rapidity for charged hadrons (left) and neutral pions (right) are shown as a function of pT for 60%-80% (lower) and 0%-10% (upper) event samples.

Lead-Scintillator pi0 peripheral 60-80%

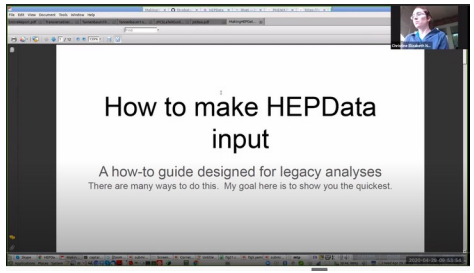
pT	1/2pi 1/pT * d^2N/dpTdy (GeV/c)^-2	sigma (stat)	sigma (sys,uncor)	sigma (sys,cor)	sigma (sys,tot)
1.210	0.133947	0.004502	0.023162	0.020092	0.030991
1.710	0.018260	0.000892	0.002972	0.002739	0.004139
2.221	0.003488	0.000260	0.000872	0.000523	0.001050
2.721	0.000690	0.000090	0.000144	0.000104	0.000199
3.233	0.000251	0.000046	0.000058	0.000038	0.000083

- Inconsistent format
- Sometimes messy, unclear

Moderate manipulation

- Requires human input

YAML_Maker

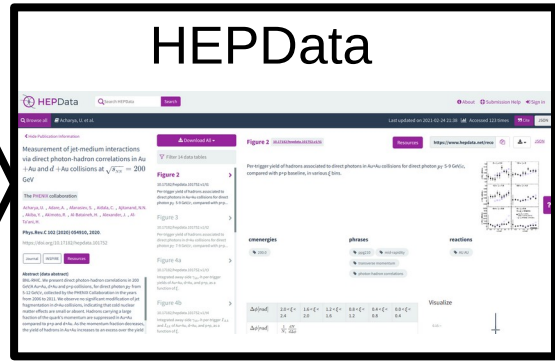


- Easy to install & used
- On github
- 13 minute Tutorial
- Or try https://gitlab.com/cholmcc/hepdata

Moderate formatting

- Needs header file, proof-reading

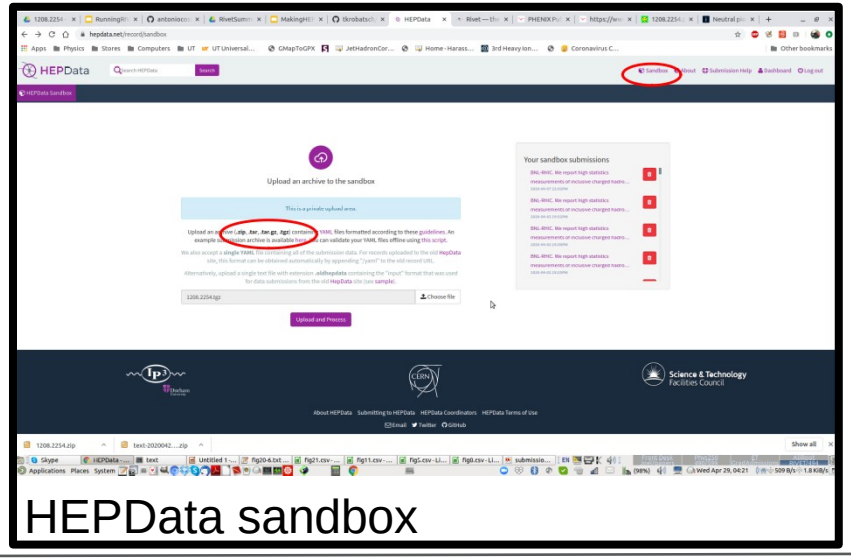
HEPData



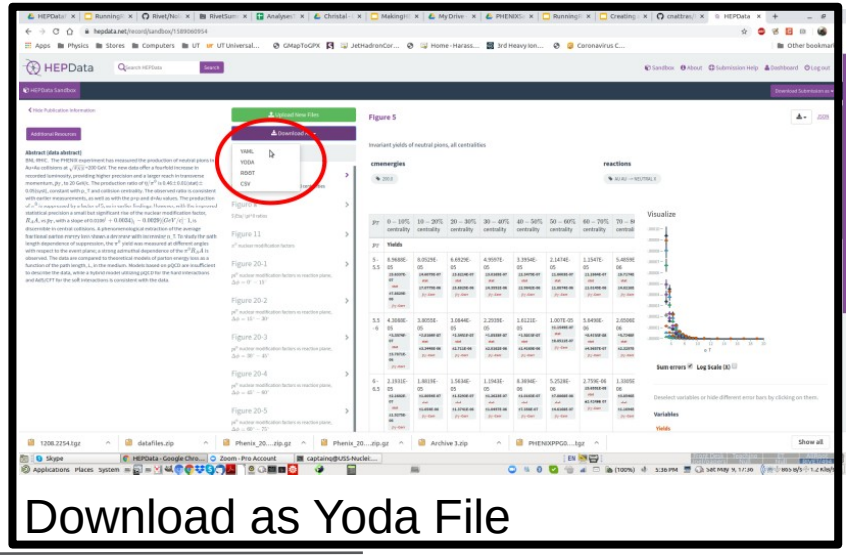
- Some additional requirements for experimental approval, rivet compatibility
- 2-20 hours/paper

1. Labor – HEPData – What you can do

- If you need data from a paper for Rivet
  - Format for HEPData
  - Use the HEPData sandbox to get Yoda file
  - Contact experiment to get it submitted to HEPData
    STAR: Frank Geurts (geurts@rice.edu)
    PHENIX: Maxim Potekhin (potekhin@bnl.gov)
    BRAHMS: Christian Holmes Christiansen (cholm@nbi.dk)
  - Feel free to contact me for help! Christine.nattrass@utk.edu



HEPData sandbox



Download as Yoda File

2. Labor – The dilemma

Few heavy ion analyses in Rivet

Theorists don't use Rivet

http://iterated-reality.com/en/2015/03/17/the-chicken-or-the-egg-causality-dilemma-solved-by-unity-consciousness/

2. Labor – The solutions

Undergraduates!*

Left to right: Ricardo Santos (Berea), James Neuhaus, Jerrica Wilson, Mariah McCreary, Christine Nattrass, Austin Schmier (UTK)

*And one beginning graduate student with no programming experience

2. Labor – The solutions

Course-based undergraduate research experience

Ask me if you want more info!

CBE—Life Sciences Education, Vol. 15, No. 2 | Articles

Free Ac

Early Engagement in Course-Based Research Increases Graduation Rates and Completion of Science, Engineering, and Mathematics Degrees

Stacia E. Rodenbusch, Paul R. Hernandez, Sarah L. Simmons, and Erin L. Dolan

Jennifer Knight, Monitoring Editor:

Published Online: 13 Oct 2017 | https://doi.org/10.1187/cbe.16-03-0117

Sections View Article Tools Sha

Abstract

National efforts to transform undergraduate biology education call for research experiences to be an integral component learning for all students. Course-based undergraduate research experiences, or CUREs, have been championed for engagi students in research at a scale that is not possible through apprenticeships in faculty research laboratories. Yet there are few if any studies that examine the long-term effects of participating in CUREs on desired student outcomes, such as graduating from college and completing a science, technology, engineering, and mathematics (STEM) major. One CURE program, the Freshman Research Initiative (FRI), has engaged thousands of first-year undergraduates over the past decade. Using propensity score–matching to control for student-level differences, we tested the effect of participating in FRI on students' probability of graduating with a STEM degree, probability of graduating within 6 yr, and grade point average (GPA) at graduation. Students who completed all three semesters of FRI were significantly more likely than their non-FRI peers to earn a STEM degree and graduate within 6 yr. FRI had no significant effect on students' GPAs at graduation. The effects were similar for diverse students. These results provide the most robust and best-controlled evidence to date to support calls for early involvement of undergraduates in research.

Phys 494 – Course-based Undergraduate Research Experience in Relativistic Heavy Ion Physics

Instructor:
Dr. Christine Nattrass
Office: SERF 609
Phone: 974-6211
Email: christine.nattrass@utk.edu
Office hours: TBA

Teaching assistant: N/A

Class time & Location: TR 12:40-1:55 SERF 210

Course Description:
This course will incorporate undergraduates into a research project in high energy nuclear physics in a course setting. Each student will be responsible for implementing a heavy ion analysis in the program RIVET so that it can be used by the JETSCAPE collaboration to make comparisons between Monte Carlo models and data. Each student's project will be incorporated into a public software repository so that it is available to the field and, if possible, it will be validated by the relevant experiment and incorporated into the official RIVET software.

4 semesters
17 students
8 women
4 minorities
3 non-traditional

All Rivet students
26 students
12 women
8 minorities
4 non-traditional

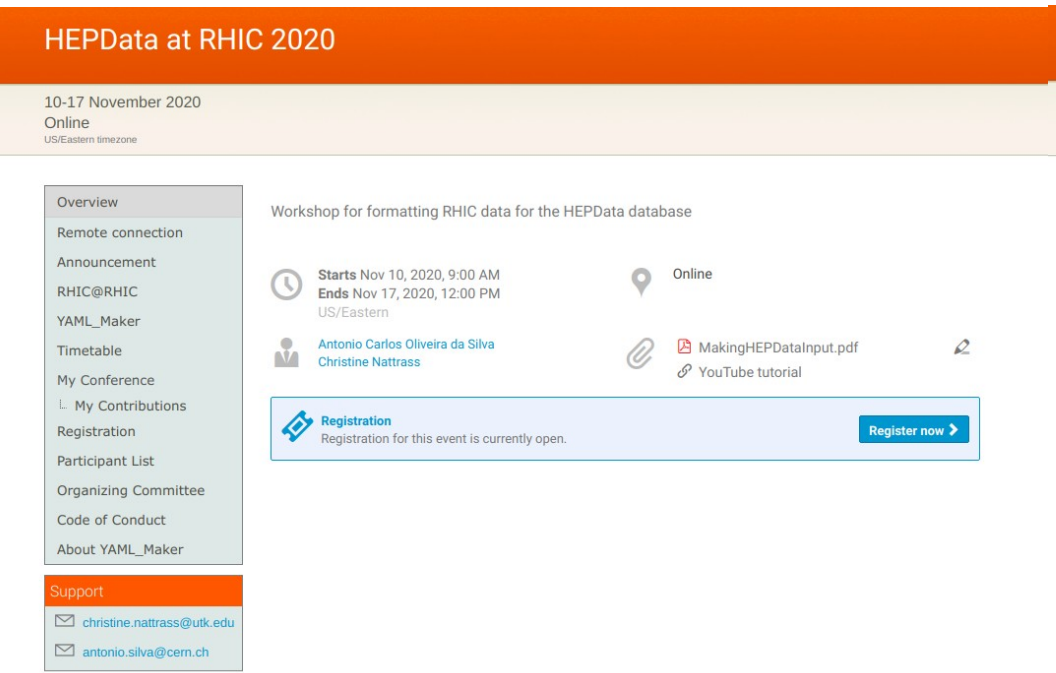
2. Labor – The solutions

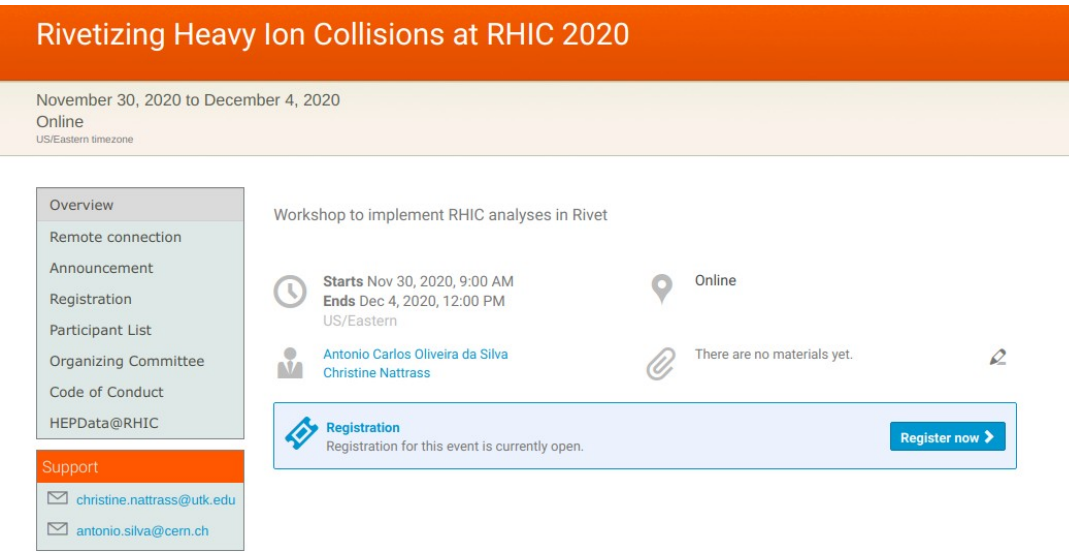
2. Labor – The solutions

Targeted workshops

https://indico.bnl.gov/event/8843/

https://indico.bnl.gov/event/8840





2. Labor – Rivet – Efforts in STAR

- Developing PYTHIA 8 tune for pp with Rivet, Professor
  - About 6 analyses to be released soon
  - pp collisions only
- Heavy ion analyses in development, need validation (see #4)

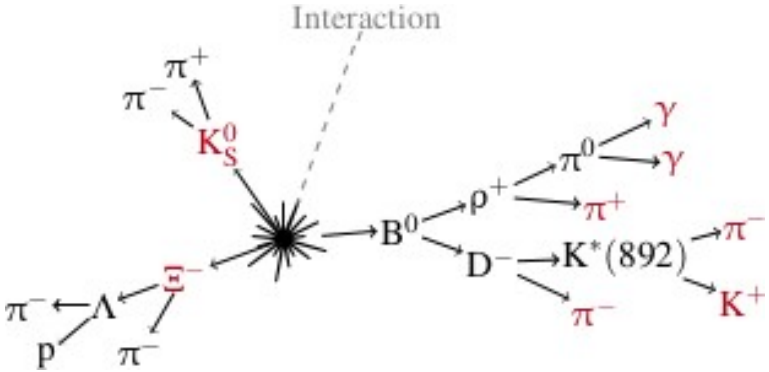
https://professor.hepforge.org/

2. Labor – Resources

- Output - github
  - Unvalidated, work in progress
  - About 45 analyses, mostly R_{AA} & dihadron correlations
  - May have issues with some models (see #5)
  - May need primary particle, centrality definition approval (see #3)
- Course-based undergraduate research experience
  - Designed for ~135 hours of effort by undergraduate students with one intro computing class and no previous Linux experience
  - Flipped pedagogy → extensive out-of-class activities, interactive class sessions
  - Possible alternative for diploma students?
  - Syllabus
  - Schedule with links to resources
  - Tutorial slides Part 1 UTK-specific Part 2 Universal
- Workshop
  - Slides
  - Recordings

Contact me!

3. Technical/Political – Primary Particles



Experimental definition:
Looks like it comes from the interaction vertex, cτ> 1 cm
Slight variations by experiment

Technical: Definition for each experiment

Technical: Needs particle decays in MC

Political: Needs experiment approval

Specie	Width Γ (GeV)	Mean proper lifetime τ (ps)	(cm/c)
p^+	0	∞	∞
γ	0	∞	∞
K^0	0	∞	∞
e^-	0	∞	∞
n	7.478×10^{-28}	$8.861 \times 10^{+14}$	$2.656 \times 10^{+13}$
μ^-	2.996×10^{-19}	$2.212 \times 10^{+06}$	$6.63 \times 10^{+04}$
K^0_L	1.287×10^{-17}	$5.148 \times 10^{+04}$	1543
π^+	2.528×10^{-17}	$2.621 \times 10^{+04}$	785.7
K^+	5.317×10^{-17}	$1.246 \times 10^{+04}$	373.6
Ξ^0	2.27×10^{-15}	291.9	8.751
Λ	2.501×10^{-15}	264.9	7.943
Ξ^-	4.02×10^{-15}	164.8	4.941
Σ^-	4.45×10^{-15}	148.9	4.464
K^0_S	7.351×10^{-15}	90.14	2.702
Ω^-	8.071×10^{-15}	82.1	2.461
Σ^+	8.209×10^{-15}	80.72	2.42

Theoretical definition

in Rivet projection - ALICE public note
Christian Holmes Christiansen (cholm@nbi.dk)

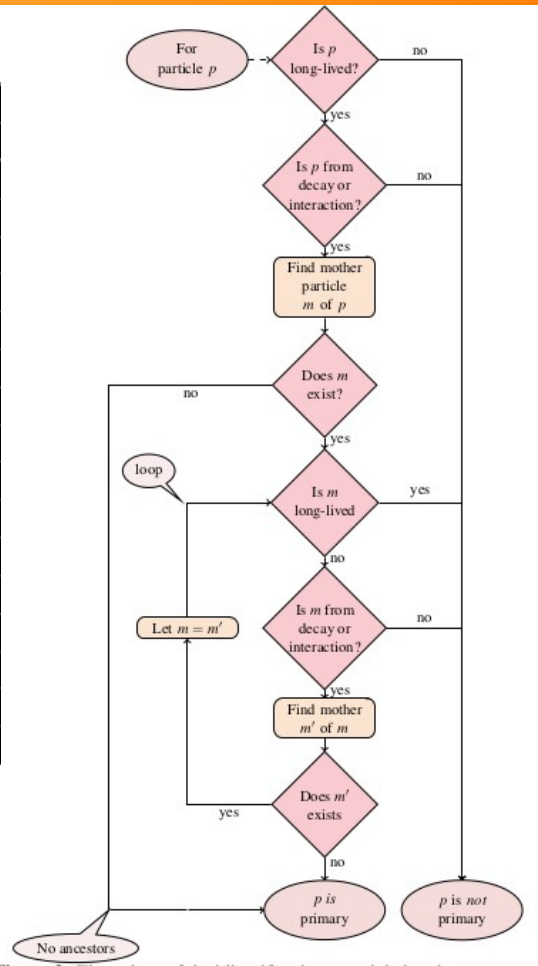


Figure 2: Flow chart of deciding if a given particle is primary or not.

4. Political – Analysis validation

- ALICE procedure:
  - Compare to sufficiently large MC sample
    - New analysis – w/ paper approval
    - Already published analysis – reproduce MC comparisons from published paper. Analogous to paper approval

How large is large enough?

What if there aren't any? Or it's hard to reproduce?

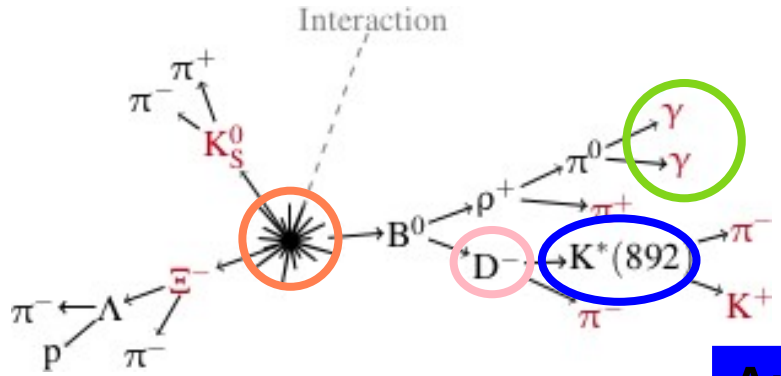
What about analyses produced outside the collaboration?

What about ambiguities in the analysis?

5. Technical – Rivet compatibility of MC

Does selection of beam particles work? Some methods depend on beam particle being in the HEPMC output.

No spin-aware MC

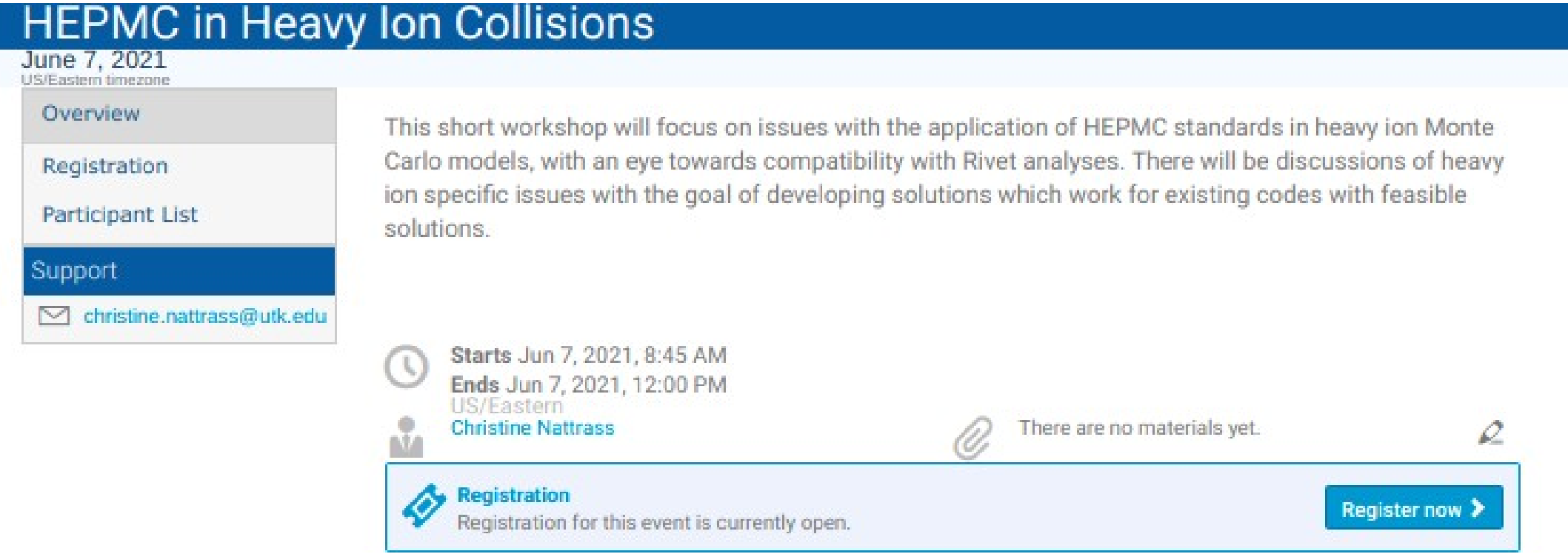


Are particles decayed?

Do projections (e.g. PromptParticles) work with MC output? Some depend on record of parentage.

Are unstable particles kept in the output? Is their parentage recorded? Are daughters kept too?

5. Technical – Rivet compatibility of MC



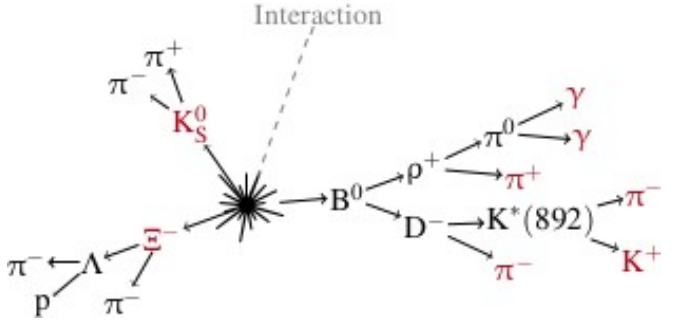
3 hour workshop to discuss HEPMC output of heavy ion models

Summary

1. Data getting into HEPData

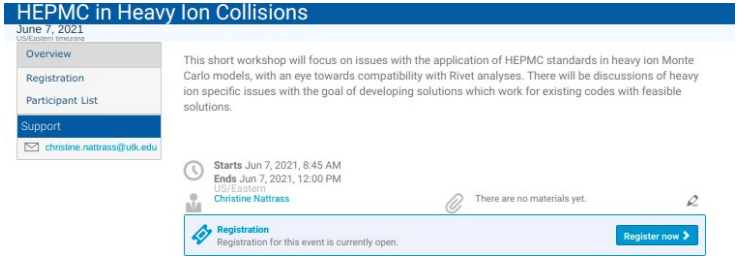
2. Build your own undergraduate army

3. Primary particle definition



4. Validation Procedure

5. HEPMC output may have some issues



https://indico.bnl.gov/event/10966/