# Implementation of heavy ion analyses in Rivet

Antonio Da Silva

Christine Nattrass, Antonio Da Silva
University of Tennessee, Knoxville

# The Lisbon Accord

- Lisbon Accord proposed that heavy ion experiments adopt Rivet in July 2014
- Fully heavy ion capable with June 2019 release of Rivet 3.0

https://www.aworldtotravel.com/things-lisbon-is-famous-for/

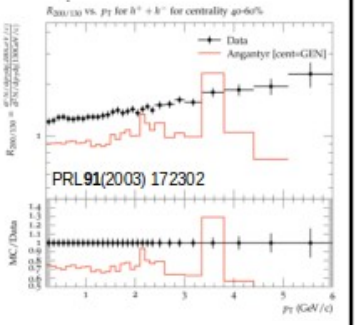
# What is Rivet?

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


HepMC

HEPData → Rivet

Comparison to data



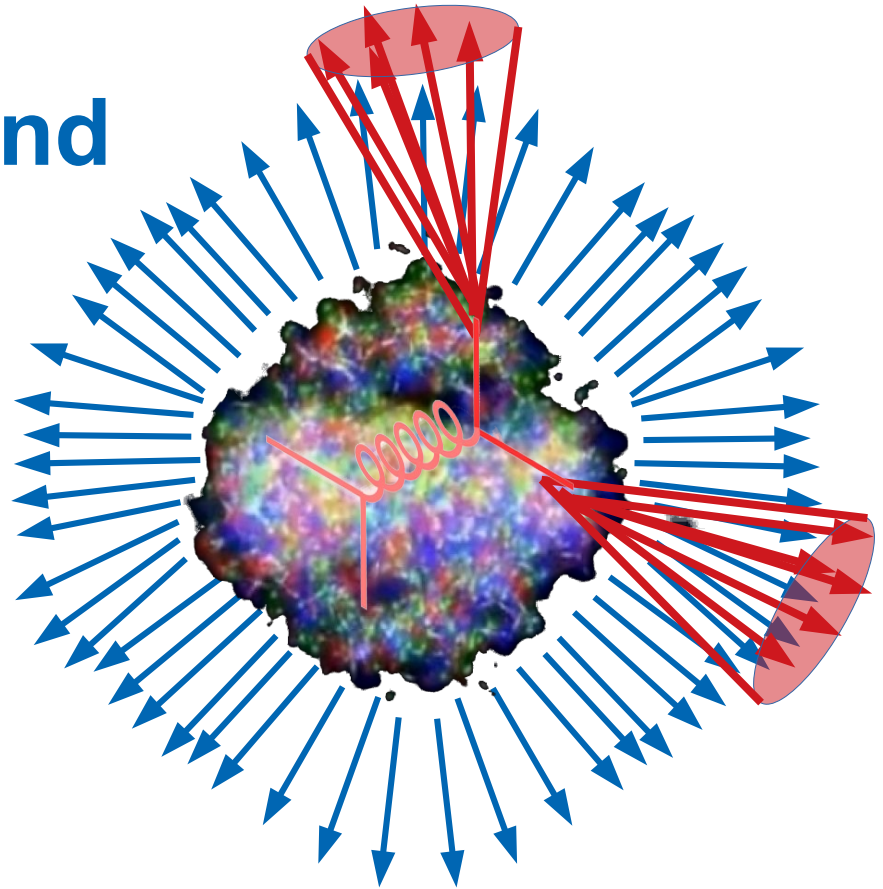
# Why use Rivet?

- Facilitates comparisons between Monte Carlos and data
- It’s not that hard
- It preserves analysis details
- You can treat Monte Carlo like data

# Signal vs Background:

## The standard paradigm

**Background**

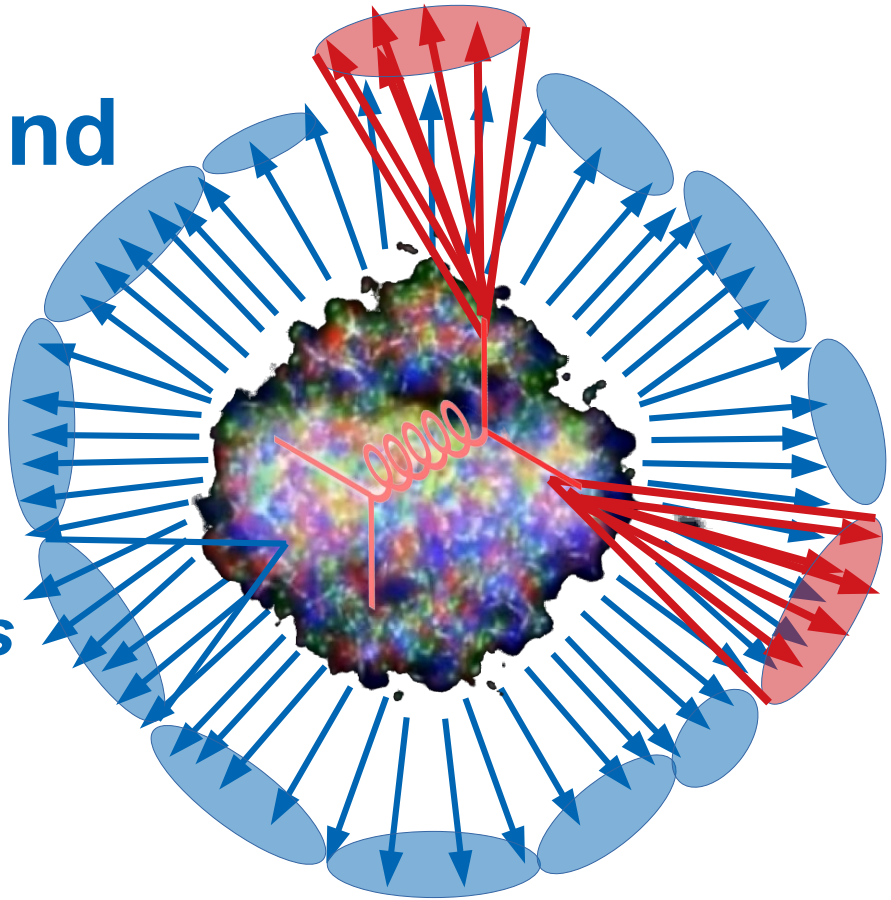


**Signal**

# Signal vs Background:

## The standard paradigm

**Background**



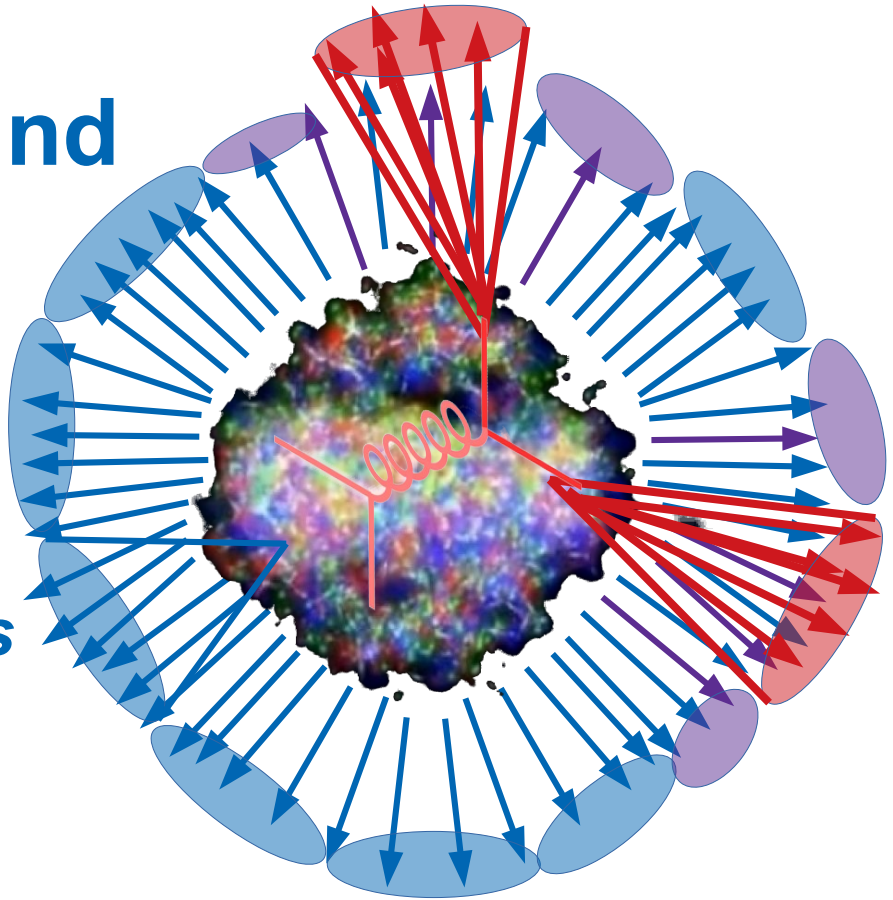
***Combinatorial jets***

**Signal**

# Signal vs Background:

## The standard paradigm

**Background**



***Combinatorial jets***

**Signal**

***Some gray areas**

**Snowmass Accord:** Apply the same algorithm to data and your model. Then the measurement and the calculation are the same.

**Rivet:** Apply the same algorithm to data and your model. Then the measurement and the calculation are the same.

# Analysis steps – **Data**

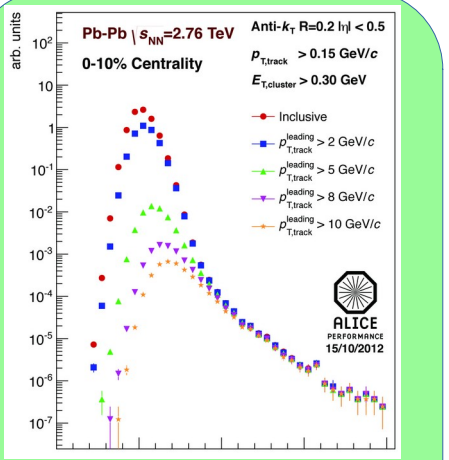
Tracks

Clusters

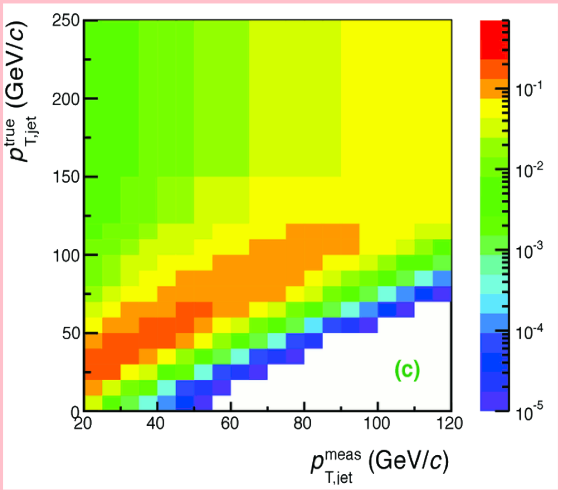
Jet finding algorithm

Jet candidates

Background subtraction

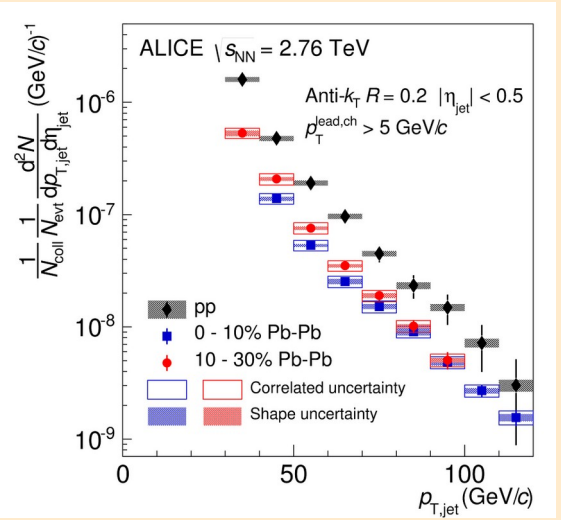



Jet spectrum smeared by energy resolution, background fluctuations




**Unfolding** – corrects for single track reco ε, E resolution, background fluctuations

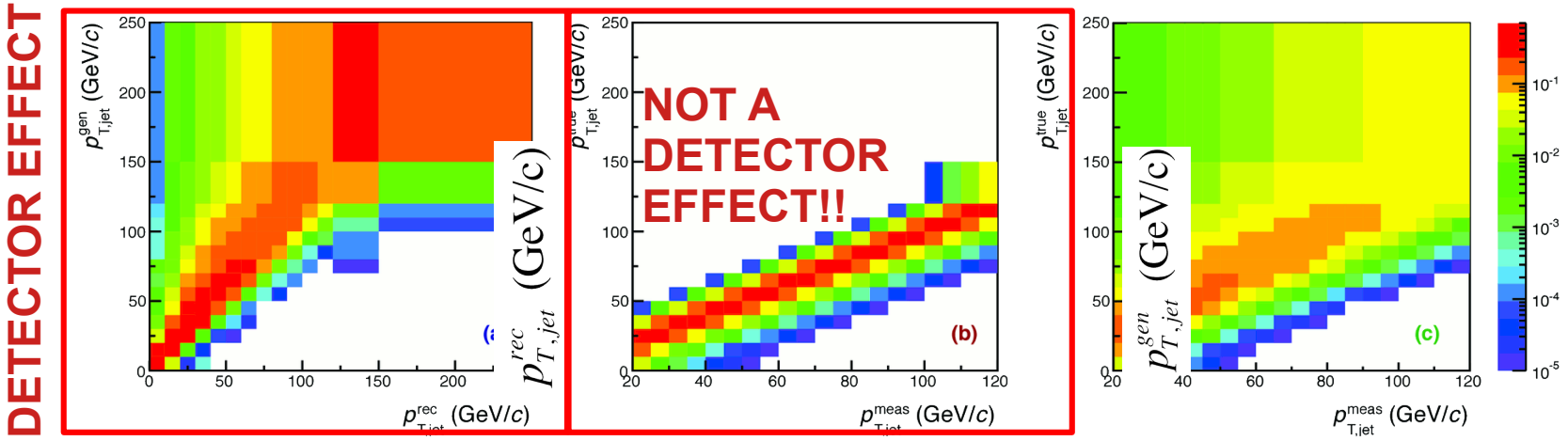
Phys. Lett. B 722 (2013) 262-272




Corrected spectra

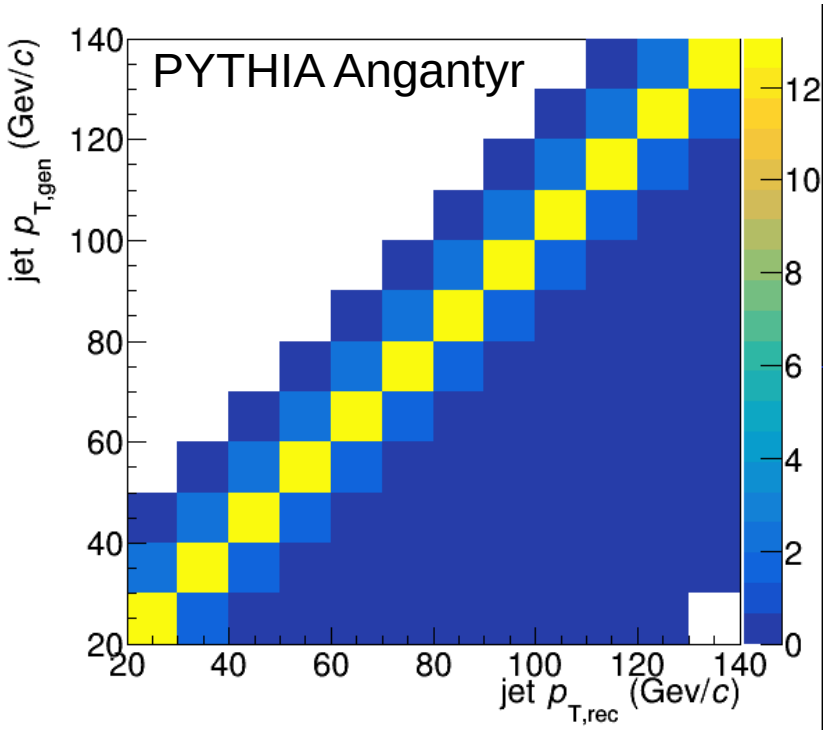
# Jets in ALICE: Response Matrix Construction

**RMdet X RMbkg = RM**




**$RM_{bkg}$ and $RM_{det}$ are approximately factorizable**

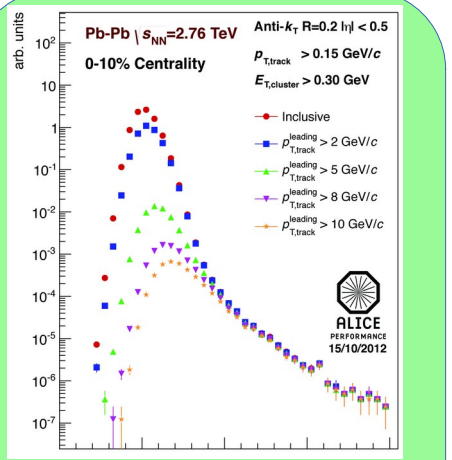
# Energy is smeared in Monte Carlo!



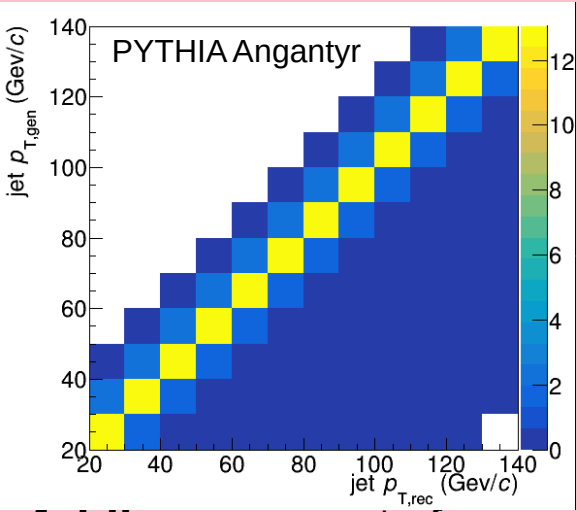

See W. Witt, HP2020, A. Da Silva RHIC/AGS AUM 2020

# Analysis steps – **Monte Carlo**

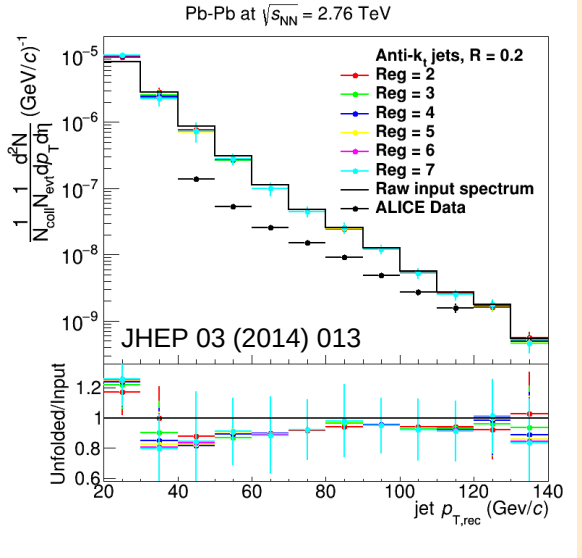
**Particles** → Jet finding algorithm → Jet candidates → Background subtraction




Jet spectrum smeared by energy resolution, background fluctuations




**Unfolding** – corrects for ***background fluctuations***



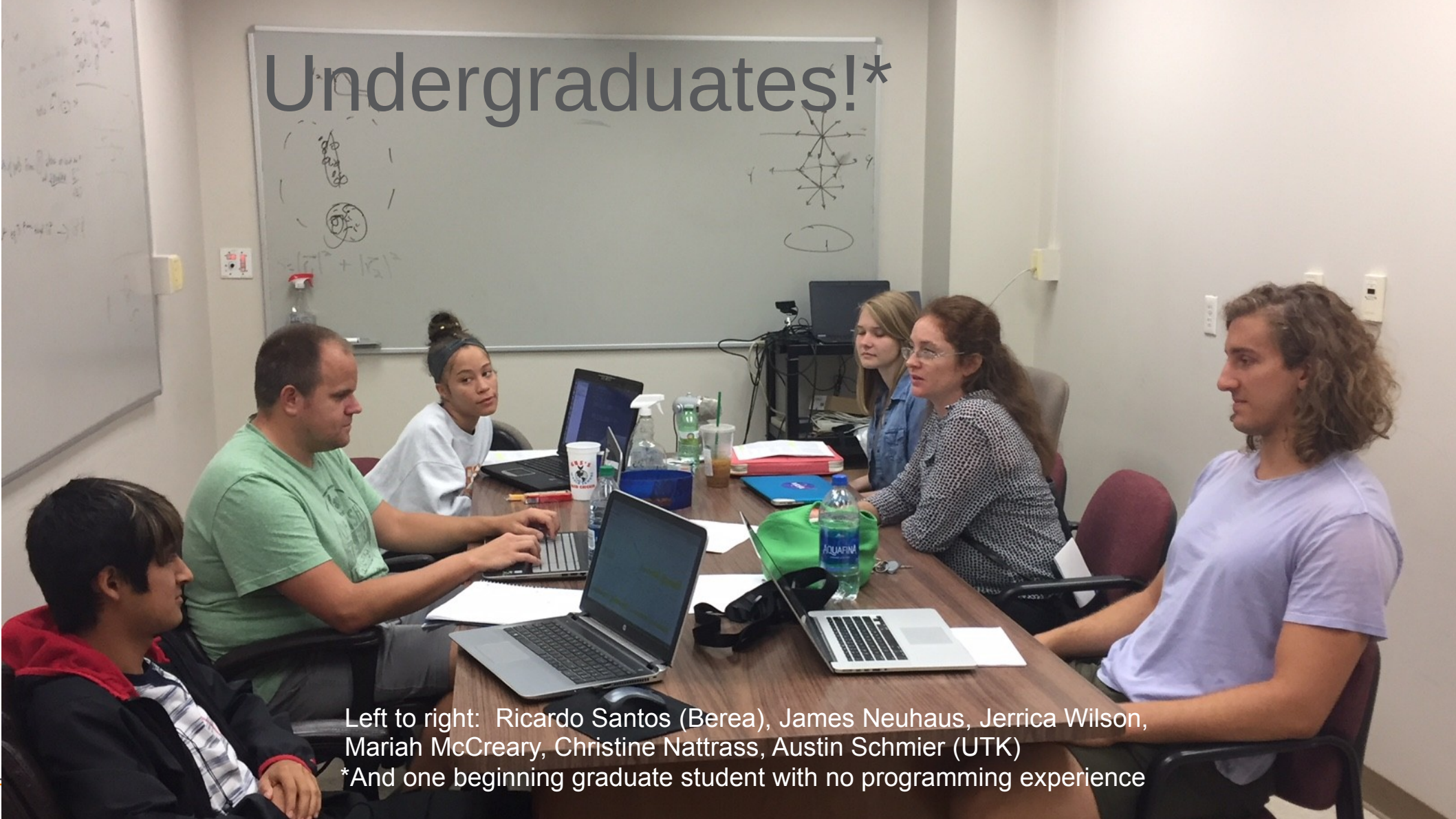

Corrected spectra

# 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/

# 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

# 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 f if any studies that examine the long-term effects of participating in CUREs on desired student outcomes, such as graduatir 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.

**3 semesters**
15 students
8 women
3 minorities
3 non-traditional

**All Rivet students**
22 students
11 women
7 minorities
4 non-traditional

# Learn Rivet yourself!

## Or send your students & postdocs!

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

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