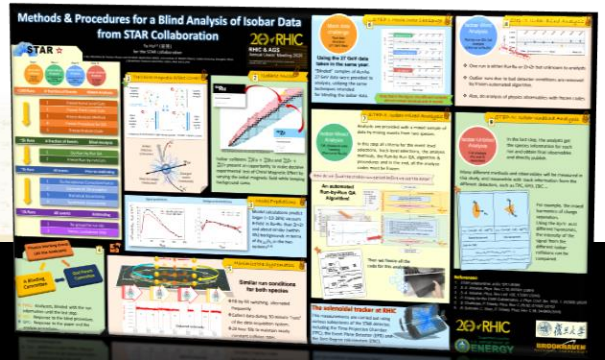
Flash Talk on:

Methods & Procedures for a Blind Analysis of Isobar Data from STAR Collaboration



1.Fudan University
2.Brookhaven National Laboratory

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for the STAR collaboration

2020.10.23

Link to my poster video: https://drive.google.com/file/d/1gdg7Yx0WLzeLie8Nf_2COaWhD7KgEvzm/view?usp=sharing

Supported in part by U.S. DEPARTMENT OF ENERGY

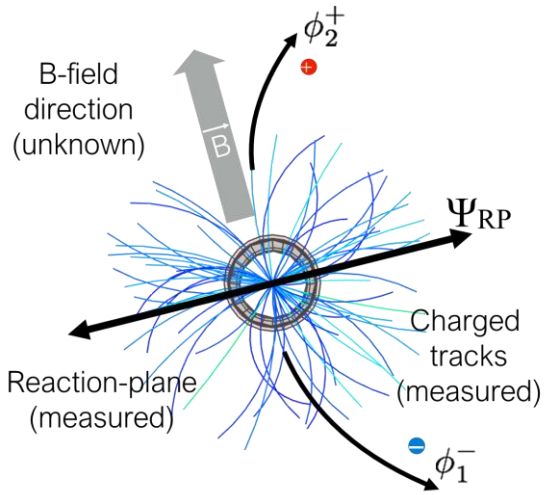
Decisive Experimental Test of Chiral Magnetic Effect (CME)

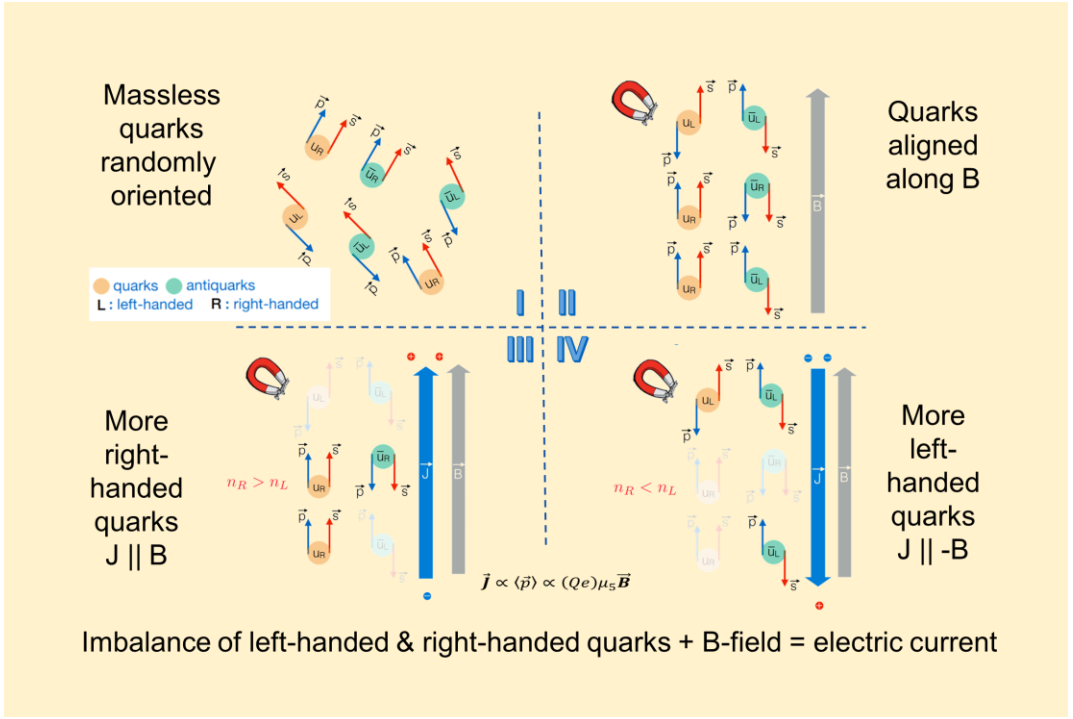
A decisive experimental test of the Chiral Magnetic Effect (CME) will lead to three major discoveries in heavy ion collisions:

1. Formation of deconfined medium where chiral symmetry of Quantum Chromodynamics is restored

2. Creation of strongest known electromagnetic field in nature

3. Strong local Parity Violation



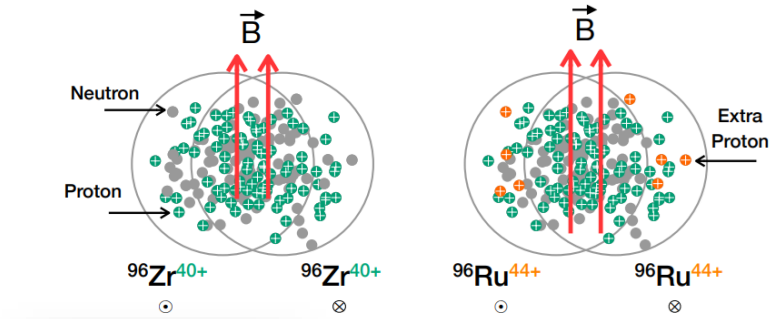


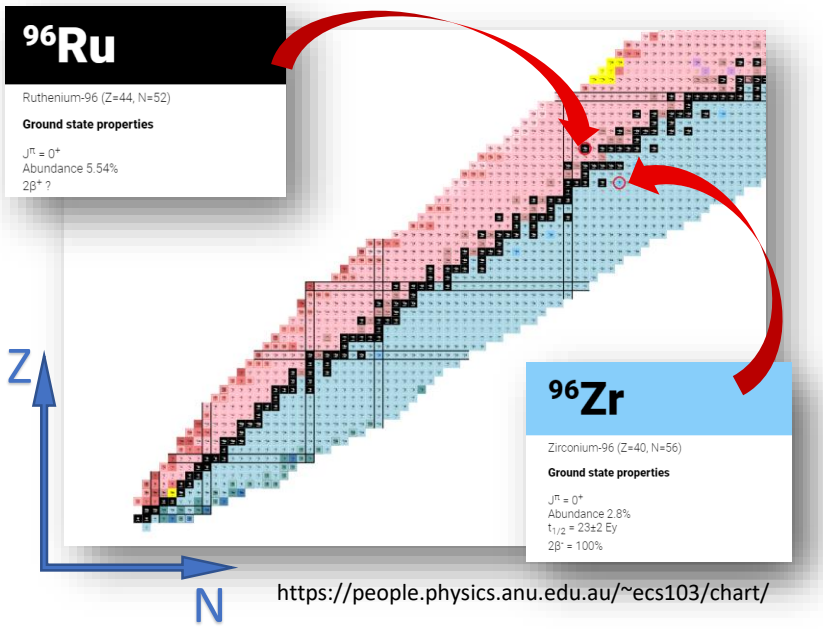
D.E. Kharzeev, Phys.Lett. B 633 260–264 (2006)

S. A. Voloshin, Phys. Rev. C 70, 057901 (2004)

D. E. Kharzeev, J. Liao, S. A. Voloshin, G. Wang, Prog. Part. Nucl. Phys. 88, 1-28 (2016)

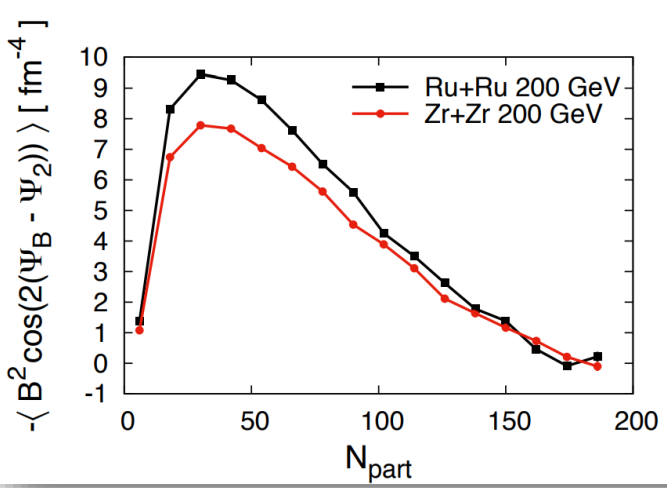
Why isobar? & Theory Predictions



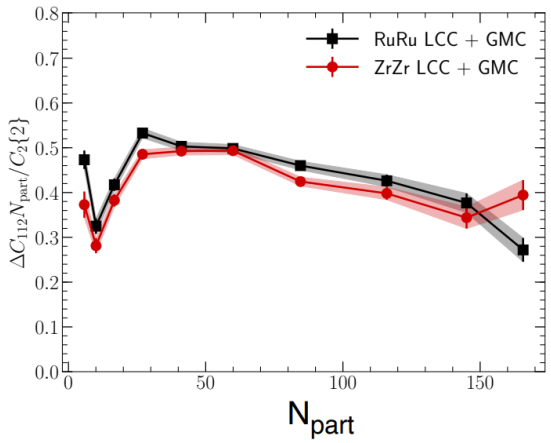


https://people.physics.anu.edu.au/~ecs103/chart/

Signal predictions



Background predictions



S. Chatterjee, P. Tribedy, Phys. Rev. C (R) 92, 011902 (2015)
B. Schenke, C. Shen, P. Tribedy, Phys. Rev. C 99, 044908 (2019)

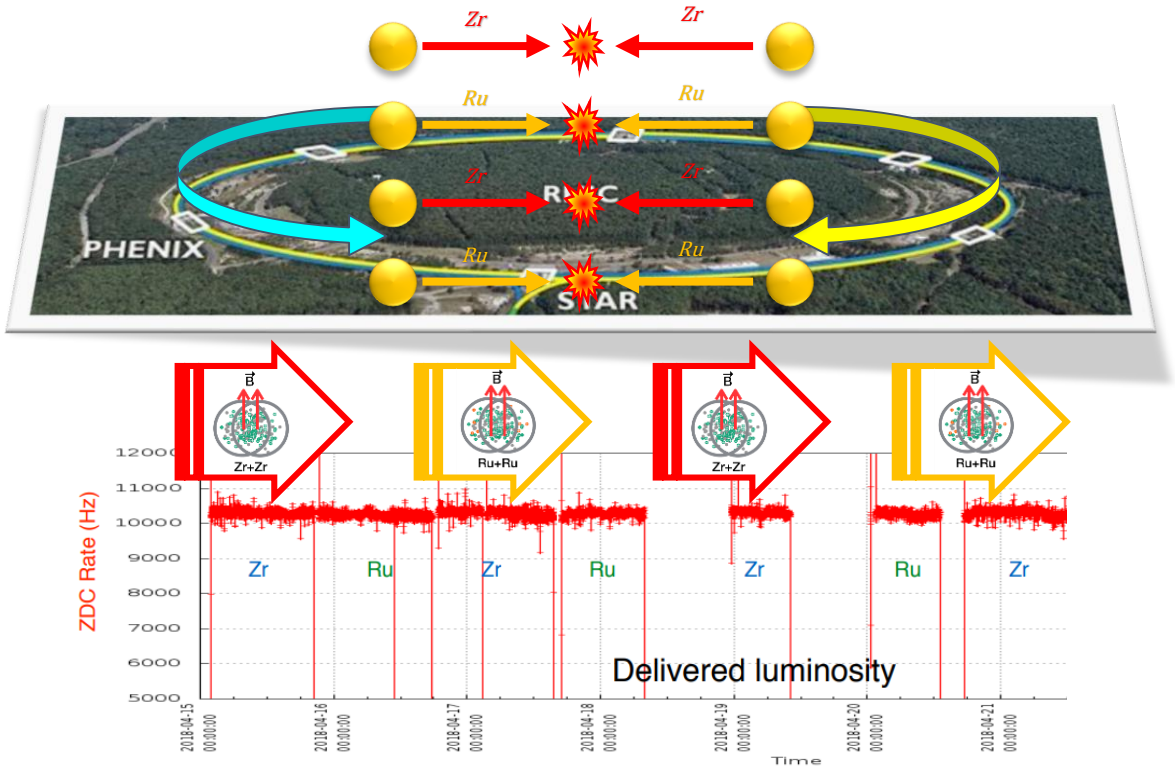
Model calculations predict:

- Vacuum B-field: ~10-18% difference
- Backgrounds: within 4% (for $\Delta\gamma_{112}/v_2$)

Isobar collisions $^{96}_{44}Ru + ^{96}_{44}Ru$ and $^{96}_{40}Zr + ^{96}_{40}Zr$ present an opportunity to make decisive experimental test of Chiral Magnetic Effect by varying the initial magnetic field while keeping background same.

S. A. Voloshin, Phys. Rev. Lett. 105, 172301 (2010)

Preparation & Data collection



- Fill-by-fill switching, alternated frequently.
- Collect data during 30-minute “runs” of the data acquisition system.
- 20 hour fills to maintain nearly constant collision rates.

Minimize the Systematics:

Similar run conditions for both species

Eliminate Pre-determined bias:

Perform blind analysis of data

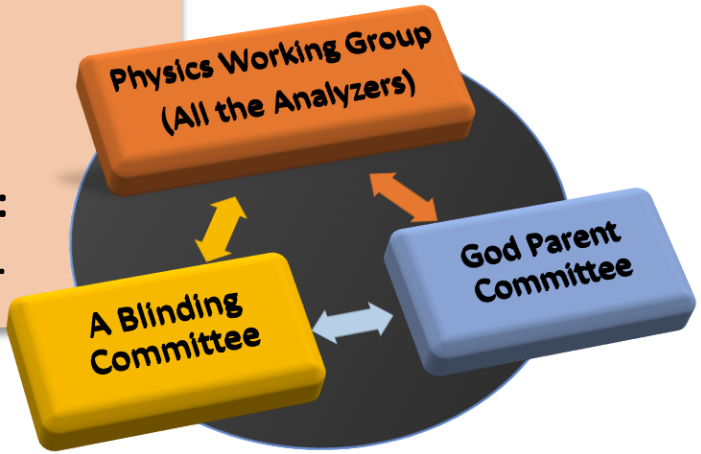
Blind analyses (5 groups):

- $\Delta\gamma, \Delta\delta \; and \; \kappa$
- $\Delta\gamma, \Delta\delta, \Delta\gamma(\Delta\eta)$
- $\Delta\gamma \; in \; \mathrm{PP/SP}$, $\Delta\gamma(M_{inv})$
- $\Delta\gamma \; in \; \mathrm{PP/SP}$
- $R(\Delta S)$ Correlator.

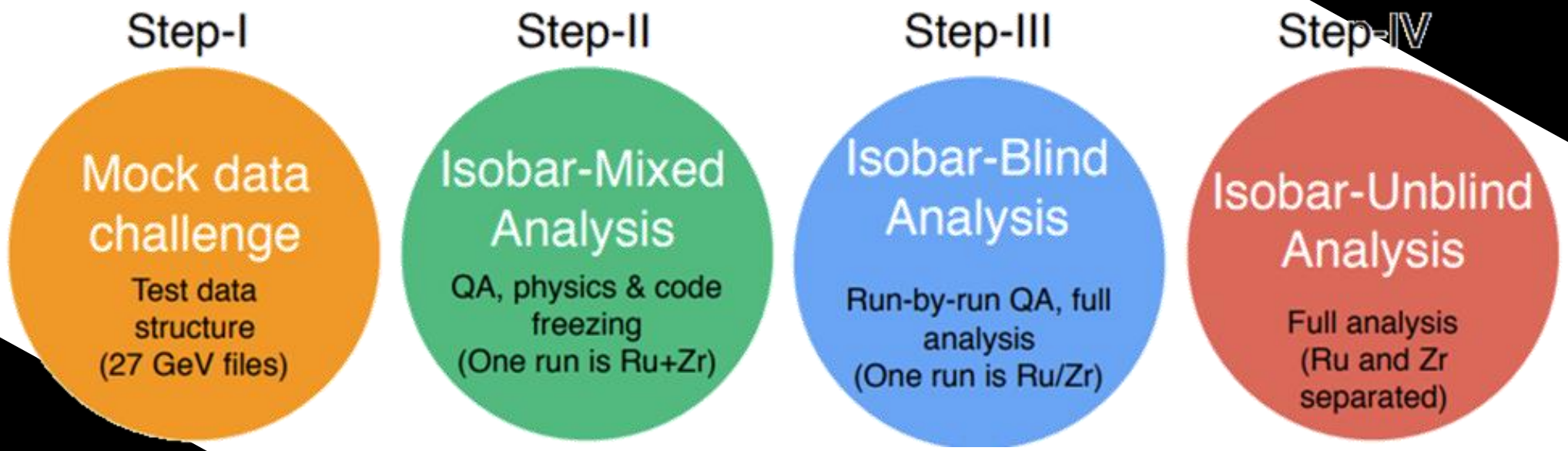
No-Blind analysis (1 group):

- Signed Balance Function.

A large, collective effort



P. Tribedy for the STAR Collaboration, J. Phys. Conf. Ser. 1602, 1, 012002 (2020)



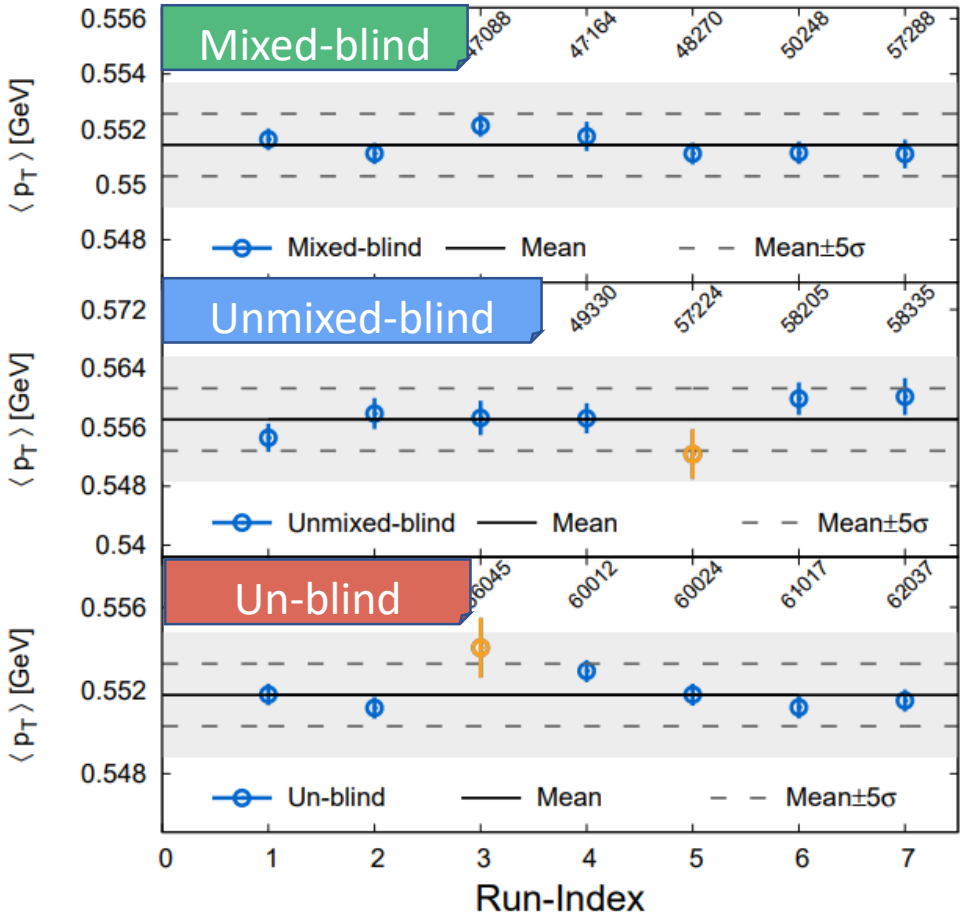
P. Tribedy for the STAR Collaboration, J. Phys. Conf. Ser. 1602, 1, 012002 (2020)

STEP-I

Mock data challenge

Test data structure (27 GeV files)

- Using the 27 GeV data taken in the same year.



STEP-II

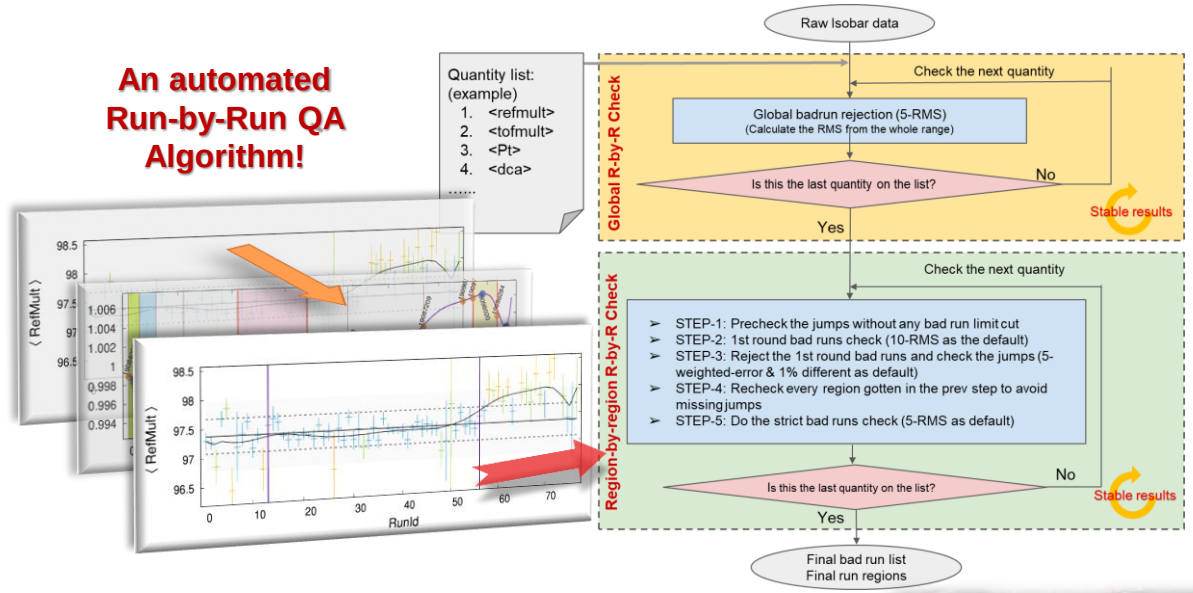
Isobar-Mixed Analysis

QA, physics & code freezing (One run is Ru+Zr)

- One "run" is mixed with Ru&Zr events.
- Freeze the cuts, methods & codes.

How do we define the stable run period before we have the data?

An automated Run-by-Run QA Algorithm!



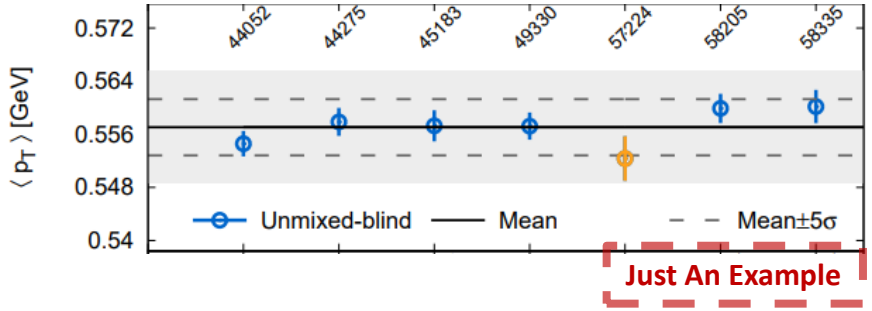
Then we freeze all the code for this analysis!

Isobar-Blind Analysis

Run-by-run QA, full analysis (One run is Ru/Zr)

STEP-III

- One “run” is either Ru or Zr, but the species are still unknown



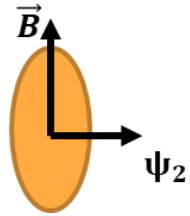
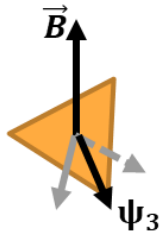
- Outlier runs due to bad detector conditions are removed by frozen automated algorithm.
- Also, do analysis of physics observables with frozen codes.

Isobar-Unblind Analysis

Full analysis (Ru and Zr separated)

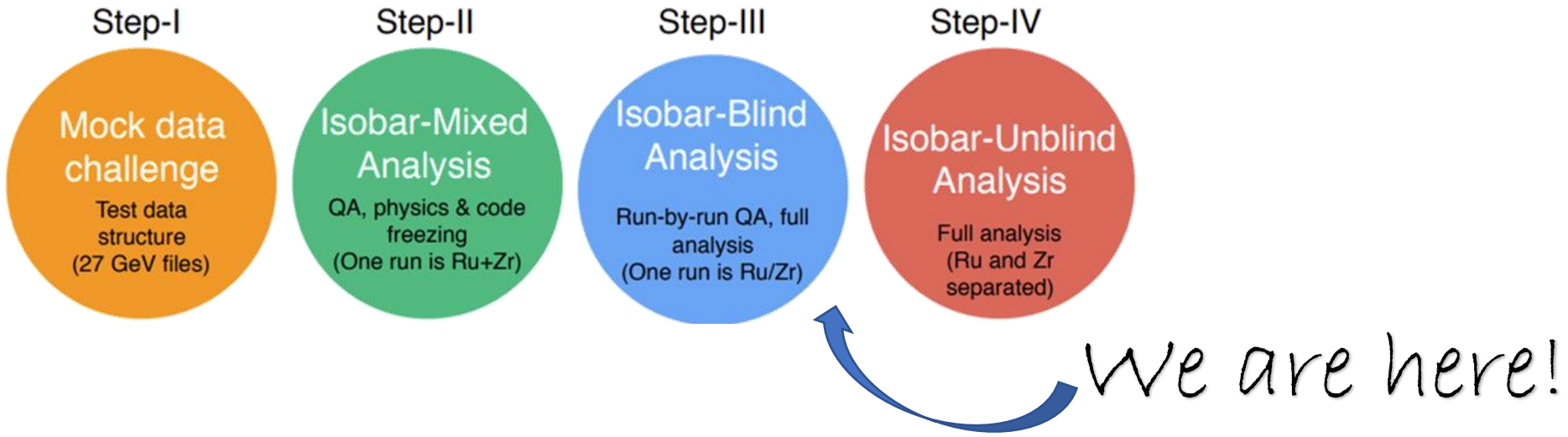
STEP-IV

- Ideally, no additional analysis work is required for the publication.
- Many different methods and observables will be measured.

	
$\gamma_{112} = \left\langle \cos\left(\phi_1^\alpha + \phi_2^\beta - 2\psi_2^{EPD}\right)\right\rangle$	$\gamma_{123} = \left\langle \cos\left(\phi_1^\alpha + 2\phi_2^\beta - 3\psi_3^{EPD}\right)\right\rangle$
Signal+background	Only background
Case for CME:	
$(\Delta\gamma_{112}/v_2)^{Ru+Ru}/(\Delta\gamma_{112}/v_2)^{Zr+Zr} > 1$	
$(\Delta\gamma_{112}/v_2)^{Ru+Ru}/(\Delta\gamma_{112}/v_2)^{Zr+Zr} > (\Delta\gamma_{123}/v_3)^{Ru+Ru}/(\Delta\gamma_{123}/v_3)^{Zr+Zr}$	

Cartoon: P. Tribedy for the STAR Collaboration, J. Phys. Conf. Ser. 1602, 1, 012002 (2020)

Isobar bind analysis is ongoing by STAR



Thank you for your attention!

Supported in part by U.S. DEPARTMENT OF ENERGY