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

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20th of RHIC
RHIC & AGS Annual Users' Meeting 2020
This meeting will be held as an interactive virtual event October 22–23, 2020

STAR

Step-I: Mock data challenge — Test data structure (27 GeV files)
Step-II: Isobar-Mixed Analysis — QA, physics & code freezing (One run is Ru+Zr)
Step-III: Isobar-Blind Analysis — Run-by-run QA, full analysis (One run is Ru/Zr)
Step-IV: Isobar-Unblind Analysis — Full analysis (Ru and Zr separated)

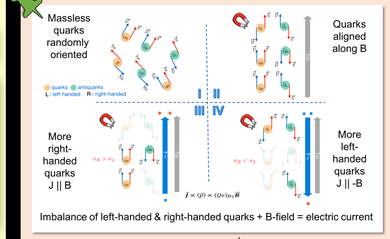
<100 Runs	A fraction of Events	Mixed-Analysis
1	Freeze Event Level Cuts	
2	Freeze Track Level Cuts	
3	Freeze Analysis Method	
4	Freeze Procedure for QA	
5	Freeze Analysis Code	

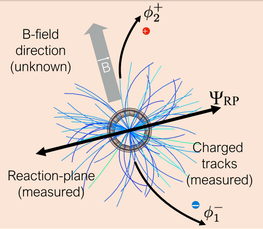
~2k Runs	A fraction of Events	Blind-Analysis
1	Do Run-by-Run QA	
2	Freeze Run-by-run Cuts	

~2k Runs	All events	Prior-to-Unblinding
1	Fix Acceptance Correction Factor	
2	Estimate all Observables	
3	Statistical Uncertainty	
4	Systematic Uncertainty	

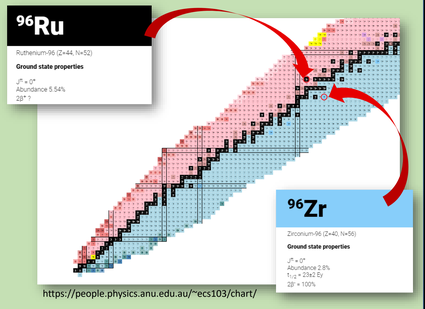
~2k Runs	All events	Unblinding
1	Re-group the run Ids	
2	Ratios, confidence limit	

1 The Chiral Magnetic Effect (CME)



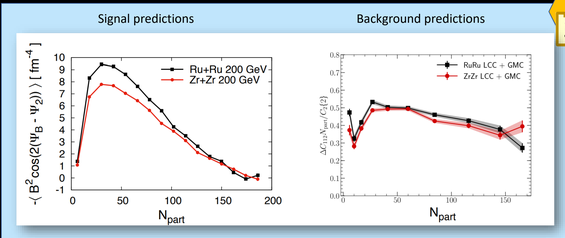


2 Isobaric Nuclei



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.

3 Model Predictions



Model calculations predict larger (~10-18%) vacuum B-field in Ru+Ru than Zr+Zr and about similar (within 4%) backgrounds in terms of $\Delta\gamma_{112}/v_2$ in the two systems[5,6]

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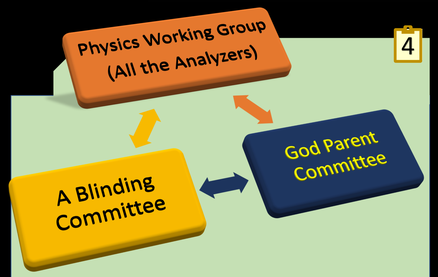
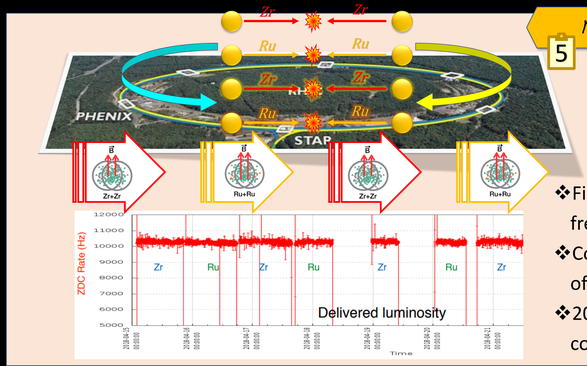


- PWG: Analyzers, blinded with the run information until the last step.
- ABC: Response to the blind procedure.
- GPC: Response to the paper and the analyze procedures.

5 Minimize the Systematics



Similar run conditions for both species

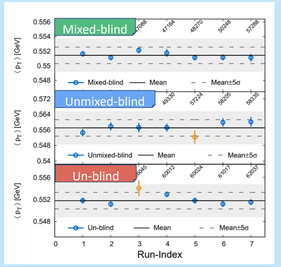
- Fill-by-fill switching, alternated frequently.
- Collect data during 30-minute "runs" of the data acquisition system.
- 20 hour fills to maintain nearly constant collision rates.

6 STEP-I. Mock Data Challenge

Mock data challenge — Test data structure (27 GeV files)

Using the 27 GeV data taken in the same year.

"Blinded" samples of Au+Au 27 GeV data were provided to analysts, utilizing the same techniques intended for blinding the isobar data.



Note that in this figure, the different samples did not contain identical sets of events

7 STEP-II. Isobar-Mixed Analysis

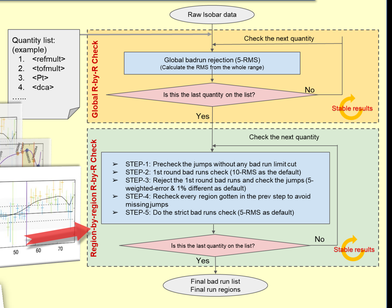
Isobar-Mixed Analysis — QA, physics & code freezing (One run is Ru+Zr)

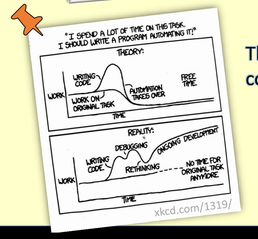
Analysts are provided with a mixed sample of data by mixing events from two species.

In this step all criteria for the event level selections, track level selections, the analysis methods, the Run-by Run QA, algorithm & procedures and in the end, all the analysis codes must be frozen.

How do we find the stable run period before we see the data?

An automated Run-by-Run QA Algorithm!

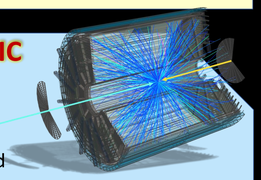




Then we freeze all the code for this analysis!

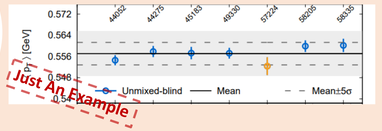
The solenoidal tracker at RHIC

This measurements are carried out using various subsystems of the STAR detector, including the Time Projection Chamber (TPC), the Event Plane Detector (EPD) and the Zero Degree calorimeters (ZDC).



8 Step-III. Isobar-Blind Analysis

Isobar-Blind Analysis — Run-by-run QA, full analysis (One run is Ru/Zr)



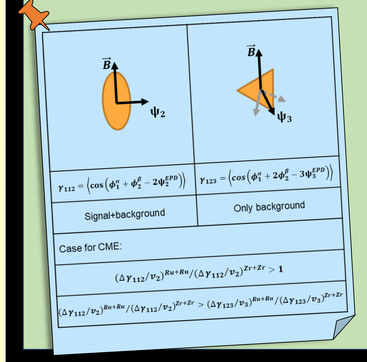
- One run is either Ru+Ru or Zr+Zr but unknown to analysts
- Outlier runs due to bad detector conditions are removed by frozen automated algorithm.
- Also, do analysis of physics observables with frozen codes

9 STEP-IV. Isobar-Unblind Analysis

Isobar-Unblind Analysis — Full analysis (Ru and Zr separated)

In the last step, the analysts get the species information for each run and obtain final observables and directly publish.

Many different methods and observables will be measured in this study, and meanwhile with track information from the different detectors, such as TPC, EPD, ZDC …



For example, the mixed harmonics of charge separation.
Using the $\Delta\gamma/v$ w.r.t different harmonics, the intensity of the signal from the different isobar collisions can be compared.

References:

1. *STAR collaboration, arXiv:1911.00596*
2. *S. A. Voloshin, Phys. Rev. C 70, 057901 (2004)*
3. *S. A. Voloshin, Phys. Rev. Lett. 105, 172301 (2010)*
4. *P. Tribedy for the STAR Collaboration, J. Phys. Conf. Ser. 1602, 1, 012002 (2020)*
5. *S. Chatterjee, P. Tribedy, Phys. Rev. C (R) 92, 011902 (2015)*
6. *B. Schenke, C. Shen, P. Tribedy, Phys. Rev. C 99, 044908 (2019)*

20th of RHIC
Supported in part by U.S. DEPARTMENT OF ENERGY
BROOKHAVEN NATIONAL LABORATORY
FUDAN UNIVERSITY 1905 復旦大學