

# Pathway to $\pi^0 \nu_n$ Measurements

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UNIVERSITY OF  
**ILLINOIS**  
URBANA-CHAMPAIGN



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# Discussion at Bulk TG

- Goal: Measure  $\pi^0 v_n$  via scalar product method
- Needs:
  - Good run list for calibrated EMCal and MBD data
  - Event plane and centrality production/modules
- What we have:
  - $\pi^0$  reconstruction code
  - EMCal QA code
- Anticipated Systematics
  - Event plane resolution
  - $\pi^0$  reconstruction
- Intended data sample: All of Run 23

# Personpower

- Postdoc:
  - Anthony – supervisory
- Graduate Students
  - Apurva Narde – EMCAL/ $\pi^0$  analysis
  - Grace Garmire – MBD/Event plane analysis
  - Justin Bennett – EMCAL calibrations
- Undergraduates
  - Abraham Holtermann – EMCAL analysis and QA
  - Max Erbach – MBD Analysis and QA
- More opportunities bound to arise as we delve into the analysis!

# Doing a Physics Analysis

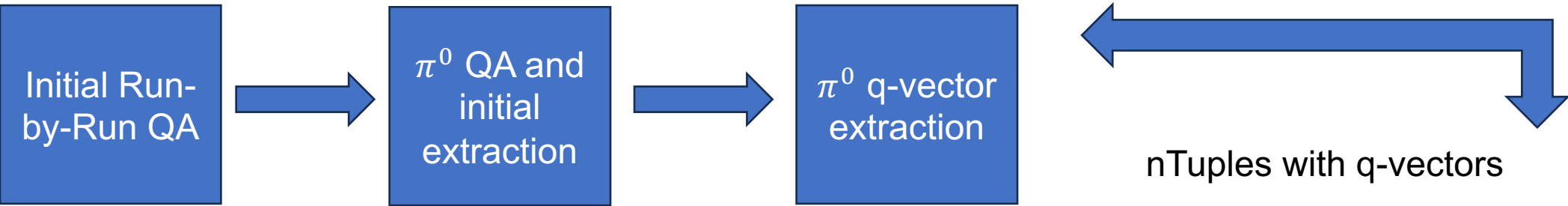
- Firstly one always starts with QA
  - Hot tower/PMT removal
  - Bad cluster removal
  - NB some of this will be done by the Calo Calibrations team, but our aim is to provide a *baseline* data set, which users are free to (reasonably) refine based on their analysis needs.
- Extraction of “objects of interest”
  - $\pi^0$ 's and event planes
  - $q_{\pi^0}$  and  $Q_{EP}$
- Extraction of Signal
  - $v_n\{SP\}$
- Corrections
- Systematics

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Note that each of these stages is iterative and should be reported to the TG when a major milestone is reached

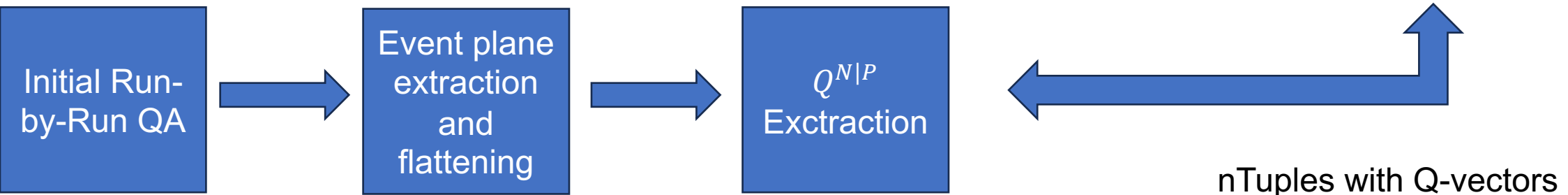
# (Very Basic) Analysis Roadmap



EMCal

$$v_n\{SP\} = \frac{\langle |q_{n,j}| |Q_n^{N|P}| \cos\left(n\left(\phi_j - \Psi_n^{N|P}\right)\right) \rangle}{\sqrt{\langle |Q_n^N| |Q_n^P| \cos\left(n\left(\Psi_n^N - \Psi_n^P\right)\right) \rangle}}$$

MBD

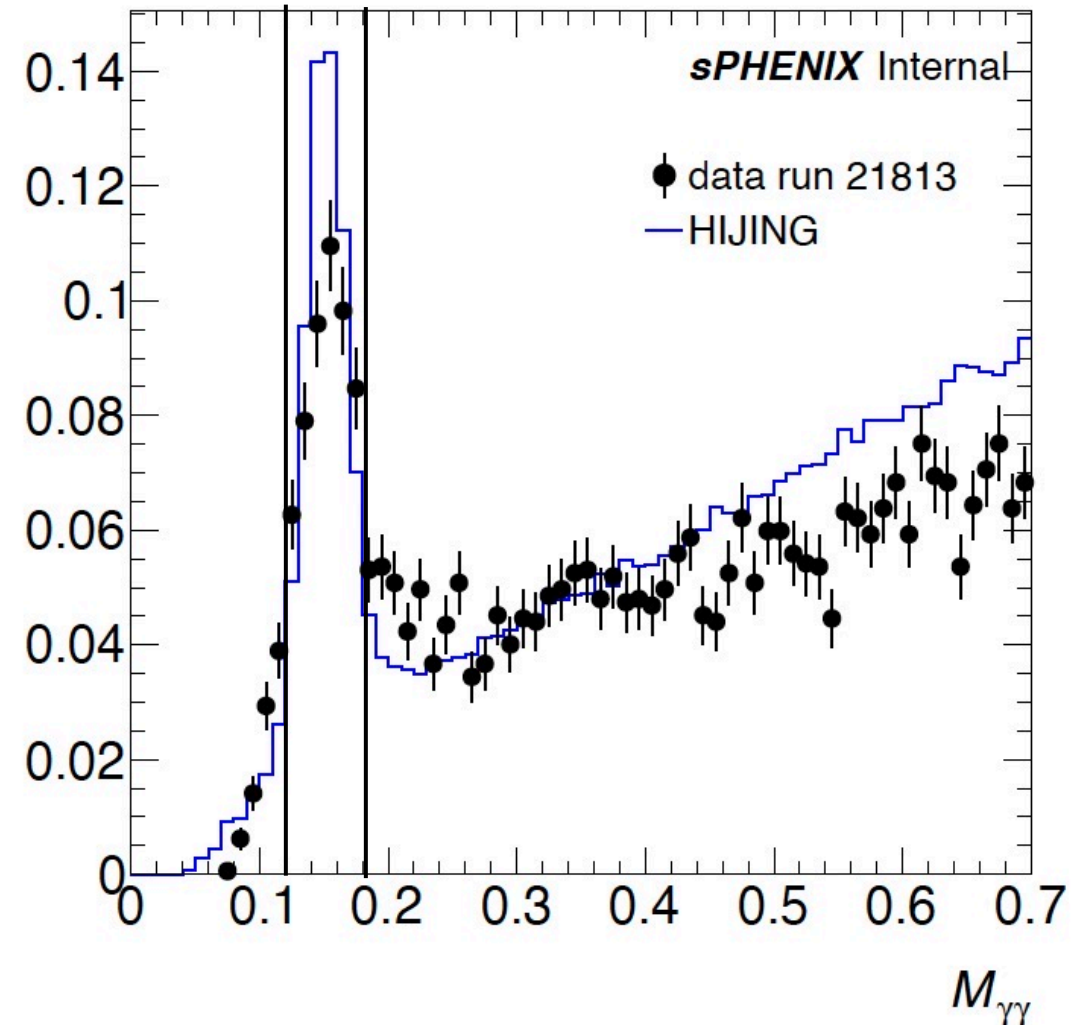


# Event Mixing and Efficiency Corrections

- Correlation signals can arise from non-physical source
  - E.g. Solely because particles saw the same detector
- To remedy this, one can take  $\pi^0$  q-vectors from one event and compute the scalar product with Q-vectors from another
- In my analysis, this was a correction to the overall correlation shape (i.e. it integrated to 1)
- Unless the efficiency has some phi dependency to it, I'm not sure it's necessary and/or the event mixing will handle it

# $\pi^0$ Systematics

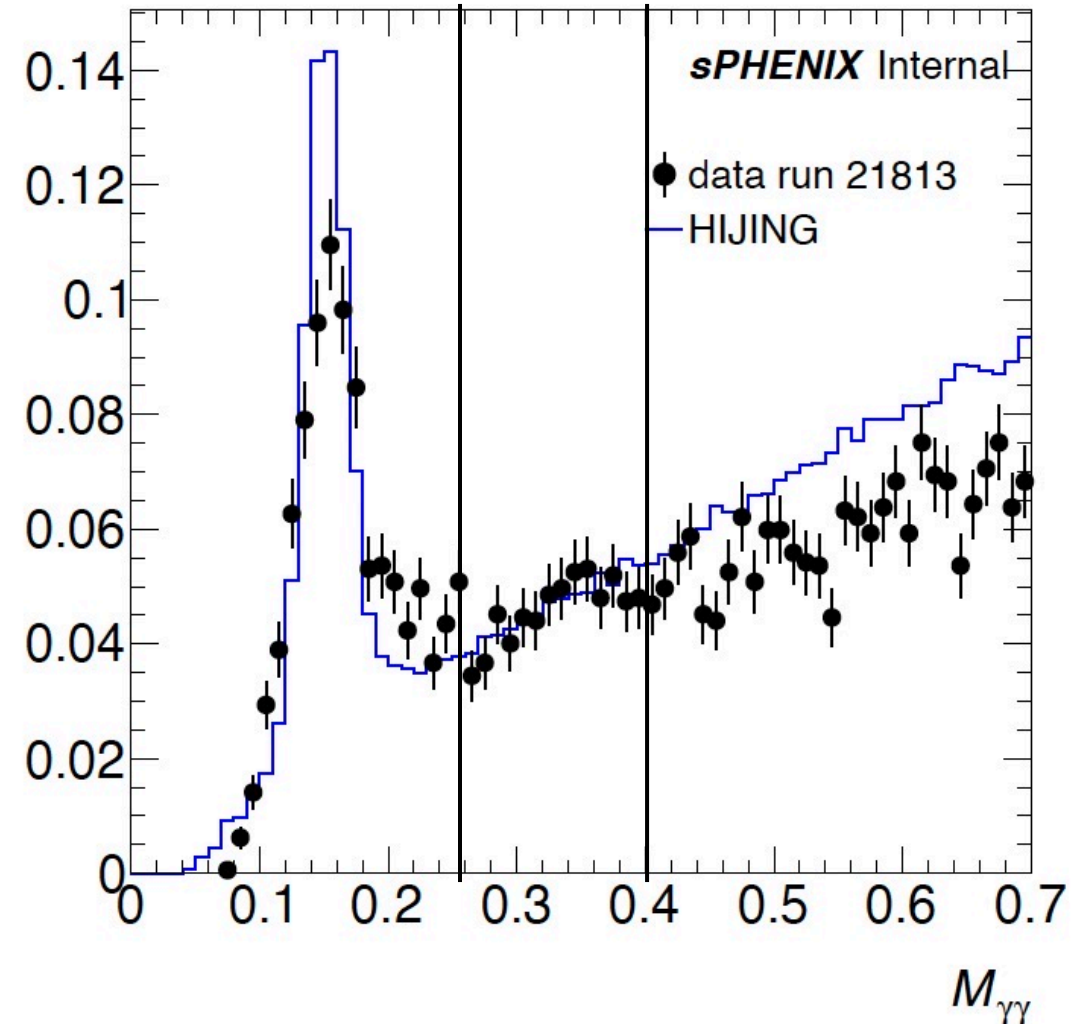
- $\pi^0$  combinatoric background
- Nominally, we accept  $\pi^0$ 's with a mass between some range (TBD)
- However not all  $\pi^0$ 's in this range are real  $\pi^0$ 's





# $\pi^0$ Systematics

- Nominally, we accept  $\pi^0$ 's with a mass between some range (TBD)
- However not all  $\pi^0$ 's in this range are real  $\pi^0$ 's
- Therefore you need to estimate the contributions from fake  $\pi^0$ 's to the  $v_n$
- This involves doing a sideband analysis in an area you know is essentially all “fakes”



# Event Plane Systematics

- Interesting since you're already dividing by a  $\Psi_n^N - \Psi_n^P$  term, unsure how this propagates to actual systematic uncertainties simultaneously

# Summary

- Woot woot! Physics time!
- Pre-QM23 dataset is a great place to start refining tools and code:
  - [https://wiki.sphenix.bnl.gov/index.php/Calorimeter\\_Data](https://wiki.sphenix.bnl.gov/index.php/Calorimeter_Data)
- **Do not look at uncalibrated DST's unless you need to or you're assigned to**
- Make yourself a spot in the... Bulk TG area? Probably actually use the Jet TG space, it's where our work will eventually culminate
  - /direct/sphenix+tg+tg01
- My advice would be to take advantage of the large disk space to keep everything as nTuples/Trees

# Yes, you can start right now

- Right? Have suite of QA tools for EMCAL already, those should be deployed on the Pre-QM dataset to hone down observables of interest
- MBD QA in development?