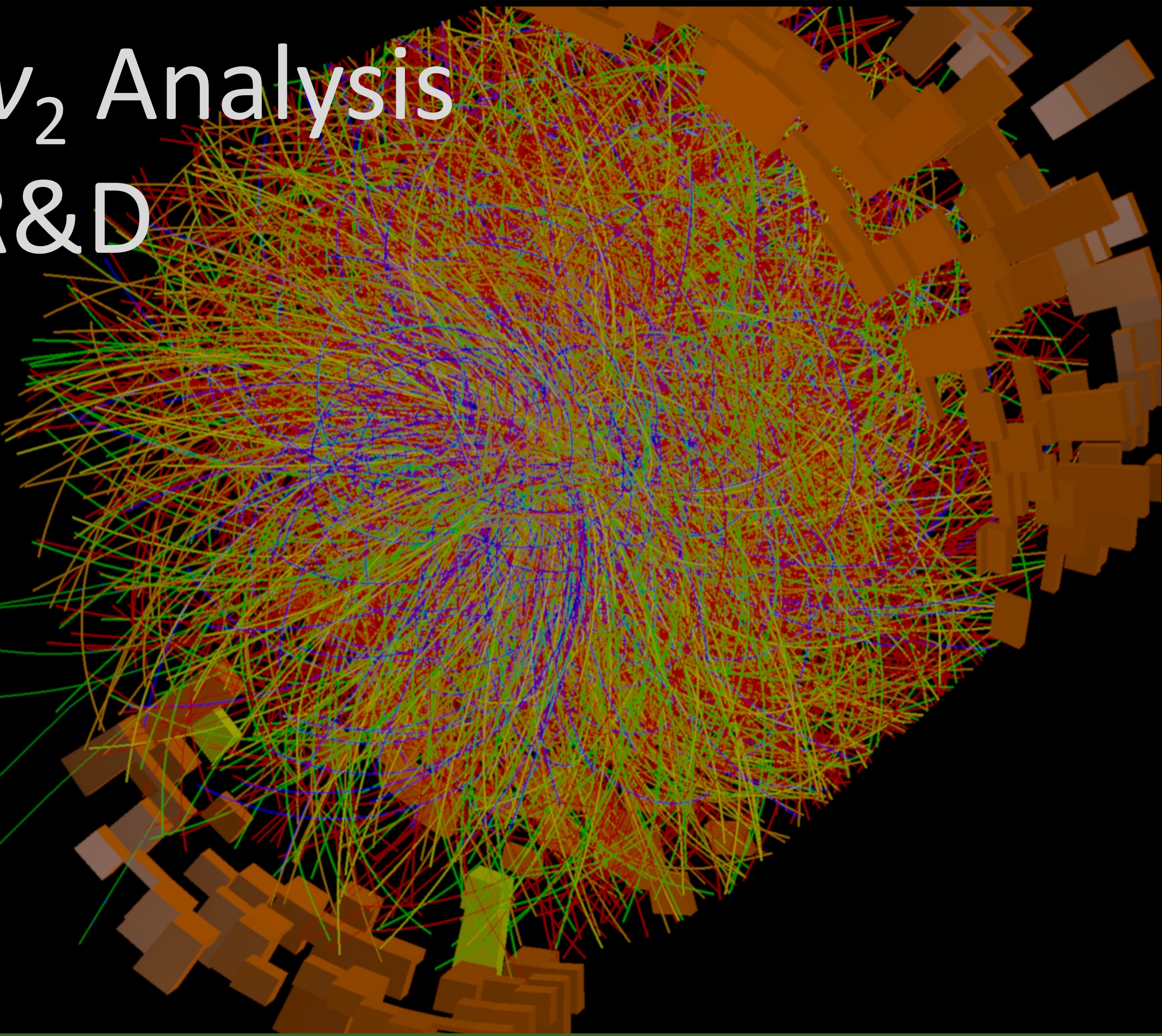
Inclusive Jet R_{AA} and v_2 Analysis and FoCal detector R&D



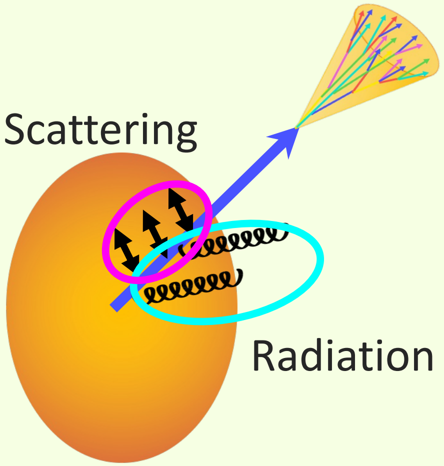
University Grenoble Alpes

University of Tsukuba

RIKEN (JRA)

Takuya Kumaoka

Jet v2 measurement enable to measure the jet suppression effect according into QGP matter shape



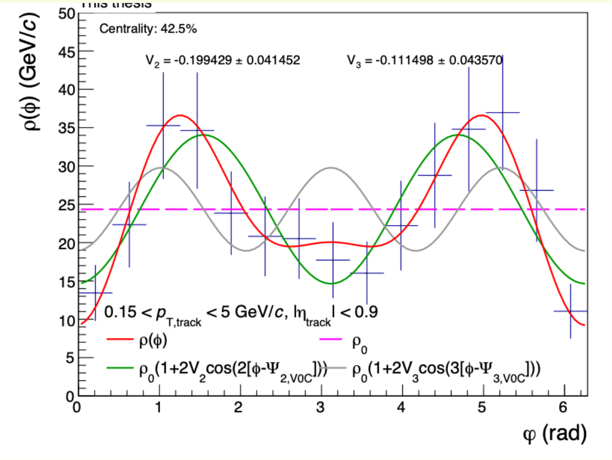
$$v_2^{\mathrm{jet}} = \frac{1}{\mathrm{Res}\left\{\psi_2^{meas}\right\}} \frac{\pi}{4} \frac{N_{in} - N_{out}}{N_{in} + N_{out}}$$

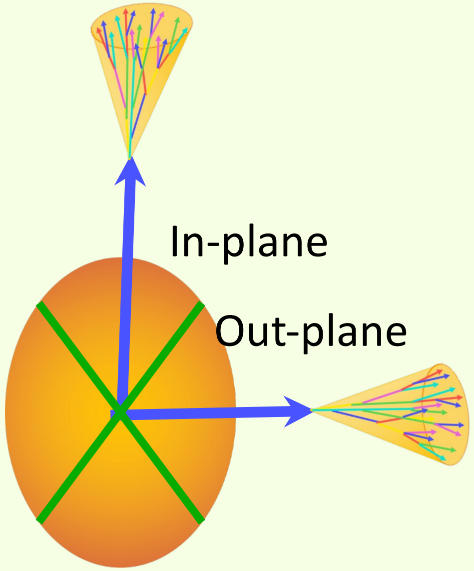
$N_{in},\ N_{out}$: Jet yield at in-plane and at out-of-plane

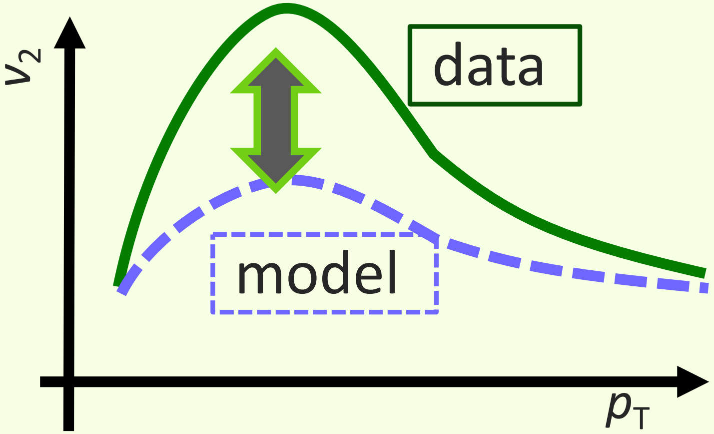
$\mathrm{Res}\left\{\psi_2^{meas}\right\}$: Event plane resolution

Radiation / Scattering dominant?

→ L^2 or L







It enables to two kinds of approach for measuring pass length dependency of jet suppression

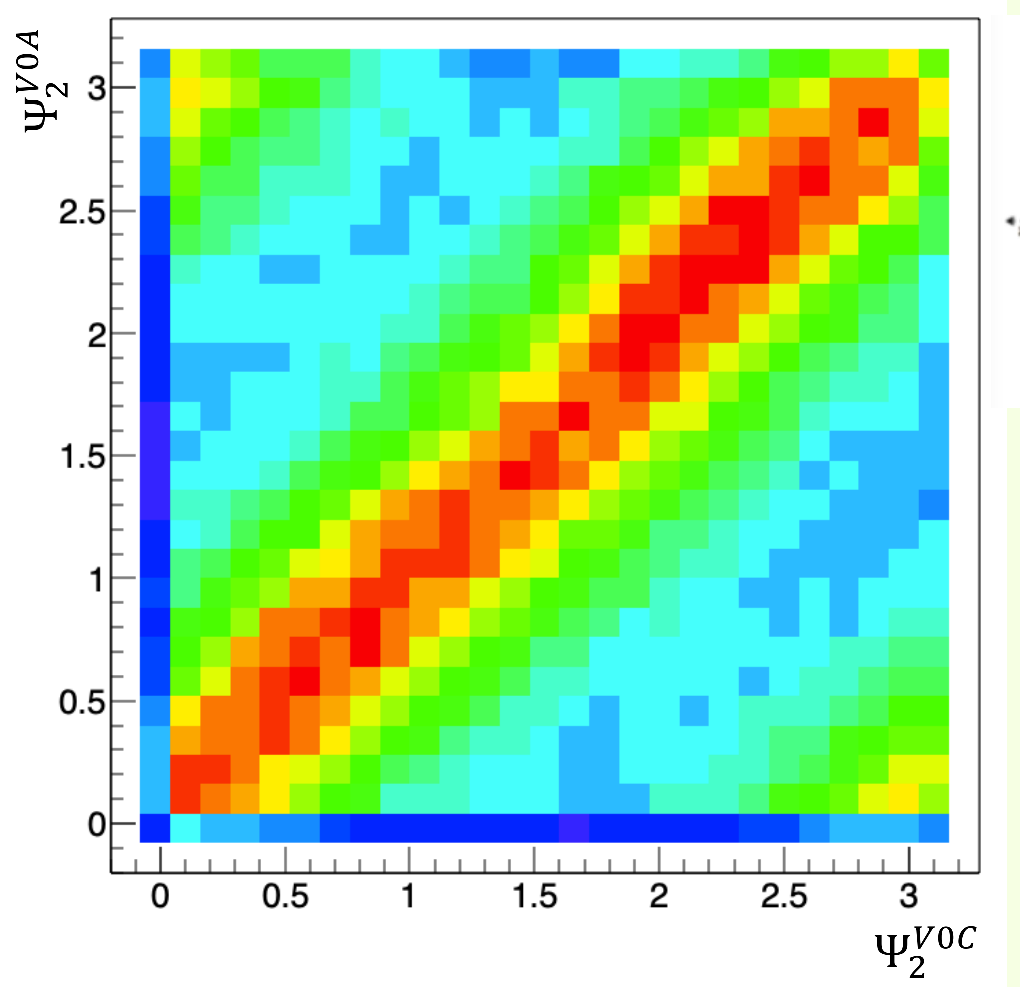
Event Plane calibration problem

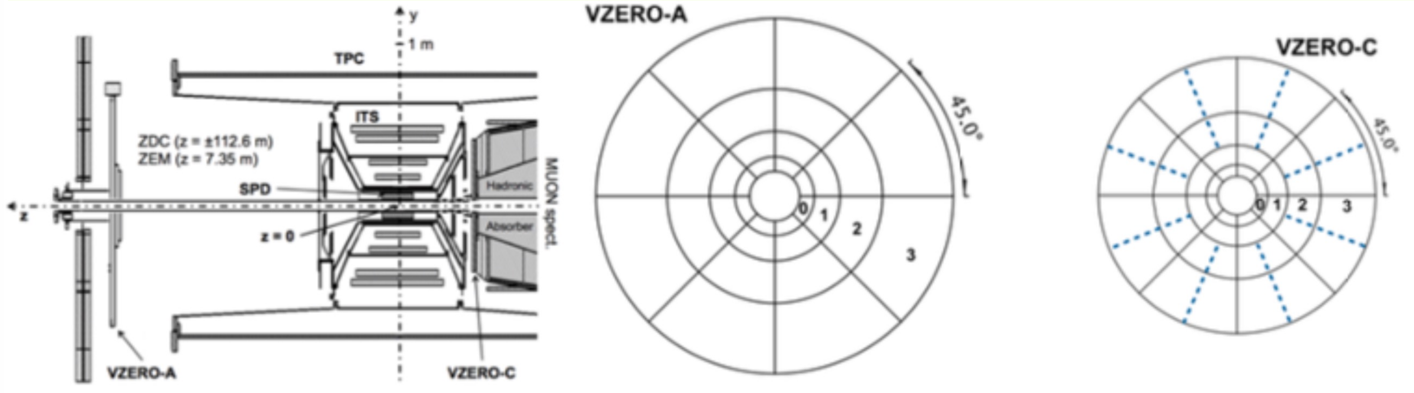
In last meeding, I reported my task success only 10% on the train.
→ The problem happened also on the grid.
→ It seems came from the memory leak of reading the EP calibration reference root file.
→ I could solve this problem and I confirmed it fully works well on the train.
→ However, another problem happens on the train. And this problem is very wired. (I sent mail to experts (taskforce and JE group, but I could not get any response.))
→ Now I am trying to specify the reason.

But I could get the results of full statistic of one run using grid.
I will show the results after slides.

Colliration of estimated event plane anlgle between V0C and V0A

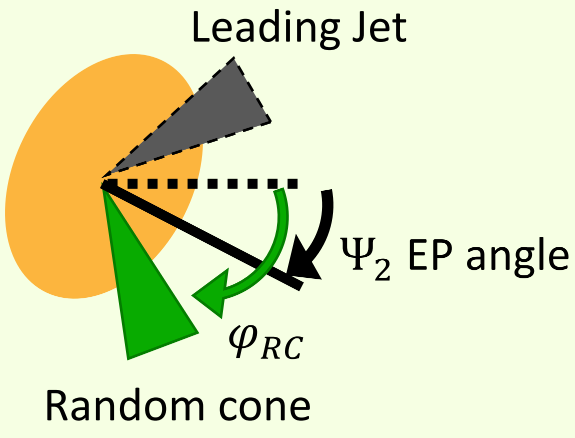
One Run (LHC18q 296623) : 1,400,000 Events





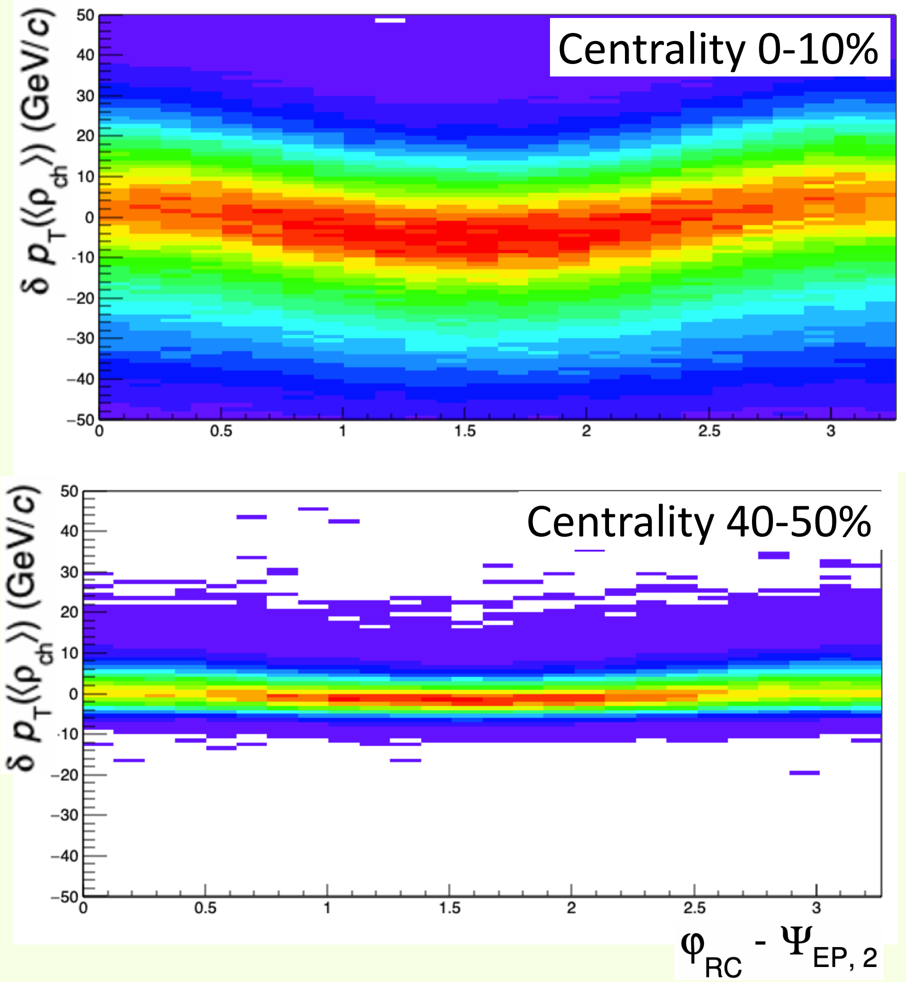
The corrilation seems correct.

The background δpT distribution

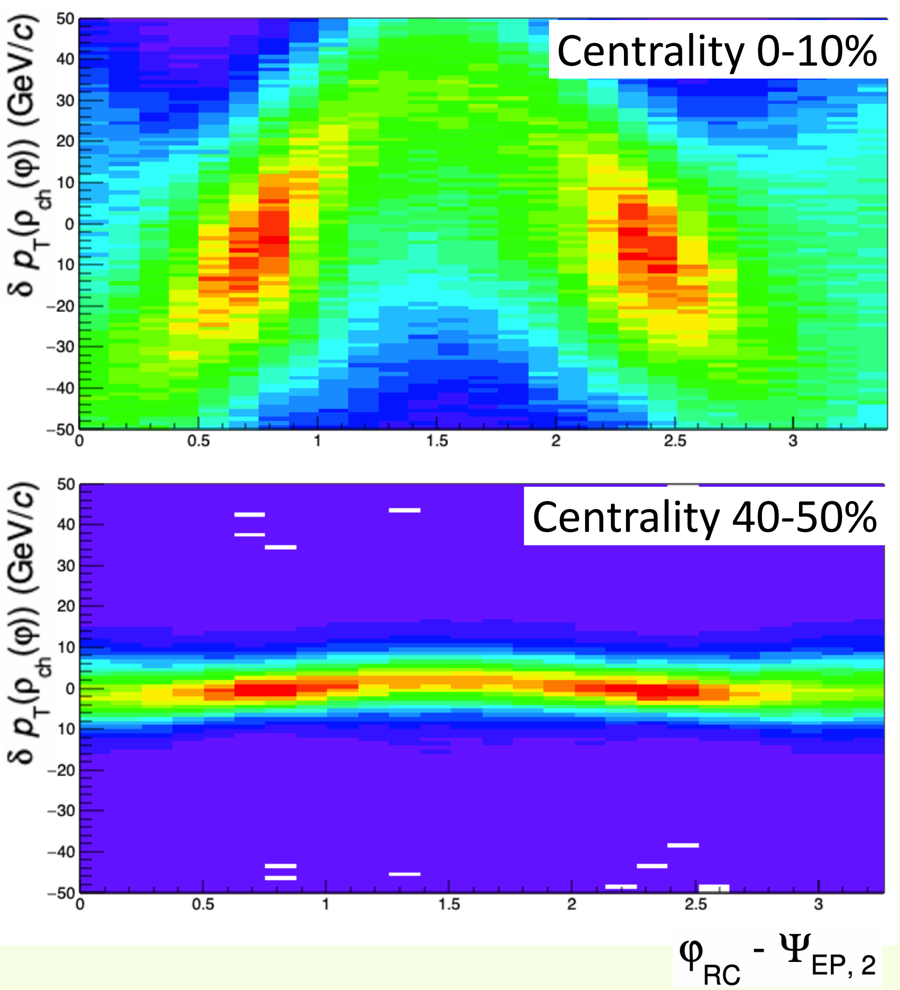


$$\delta p_{\mathrm{T}} = \sum p_{\mathrm{T}}^{\mathrm{tracks}} - \rho \pi R^2$$

Global Rho



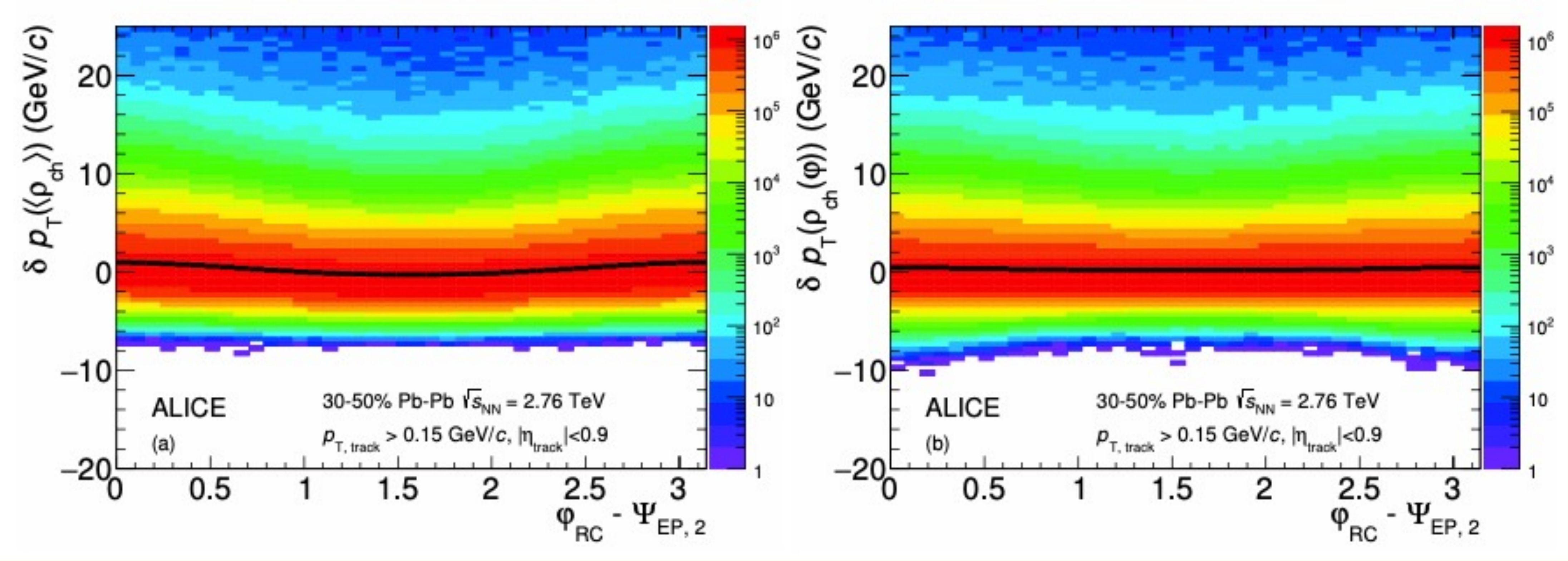
Local Rho



Local Rho Results seems wirerd. I need to check the calculation. I use same code of Run1, so I need to check the background fitting and fLocalRho works.

Ideal results of δp_{T} distribution for azimuthal angle

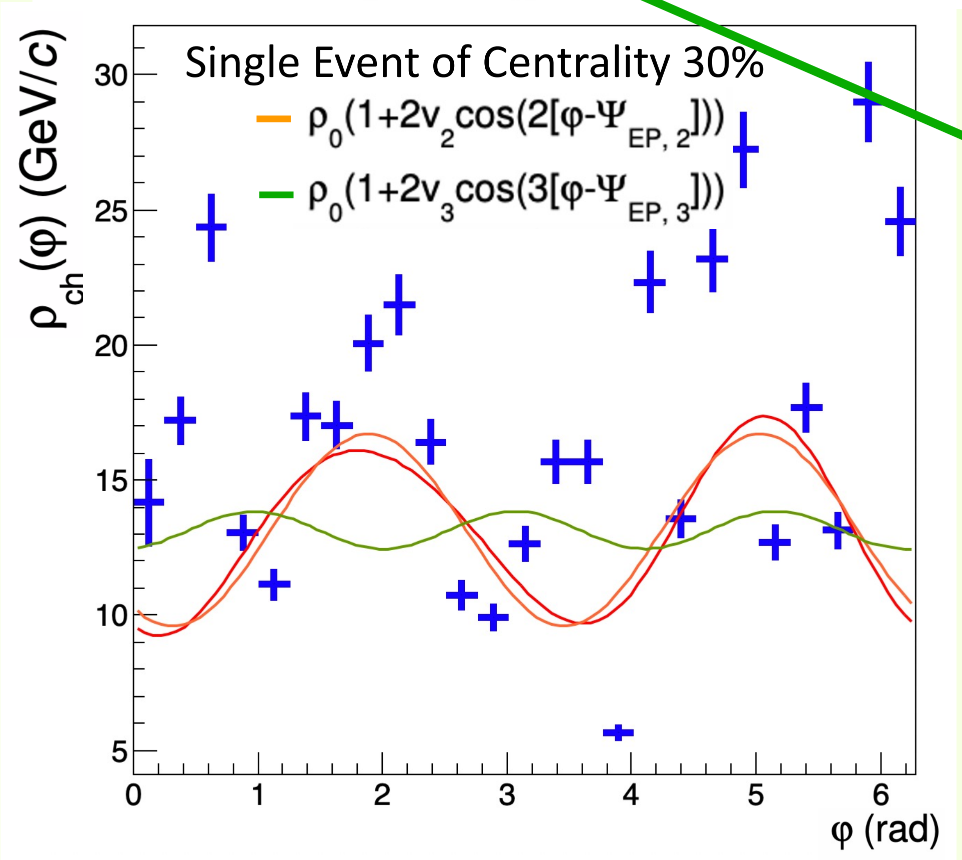
Run1 (Redmer's analysis)



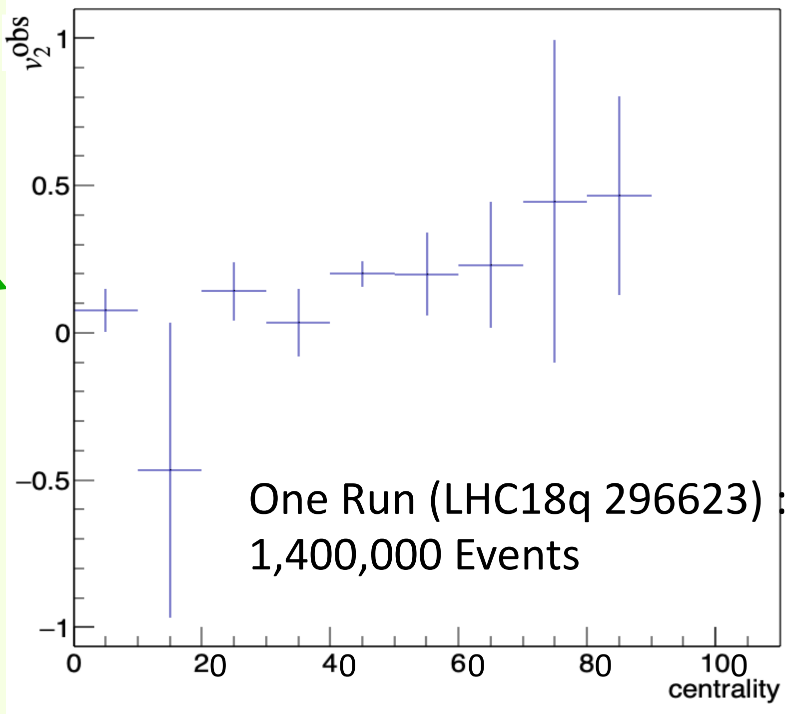
The figures show the way to estimate local rho modifies the azimuthal angle dependency.

Soft Particle Background and its v2

$$\rho(\varphi) = \rho_0 \times \left(1 + 2\left\{v_2^{\mathrm{obs}} \cos(2[\varphi - \Psi_{\mathrm{EP},2}]) + v_3^{\mathrm{obs}} \cos(3[\varphi - \Psi_{\mathrm{EP},3}])\right\}\right)$$



Fitting value

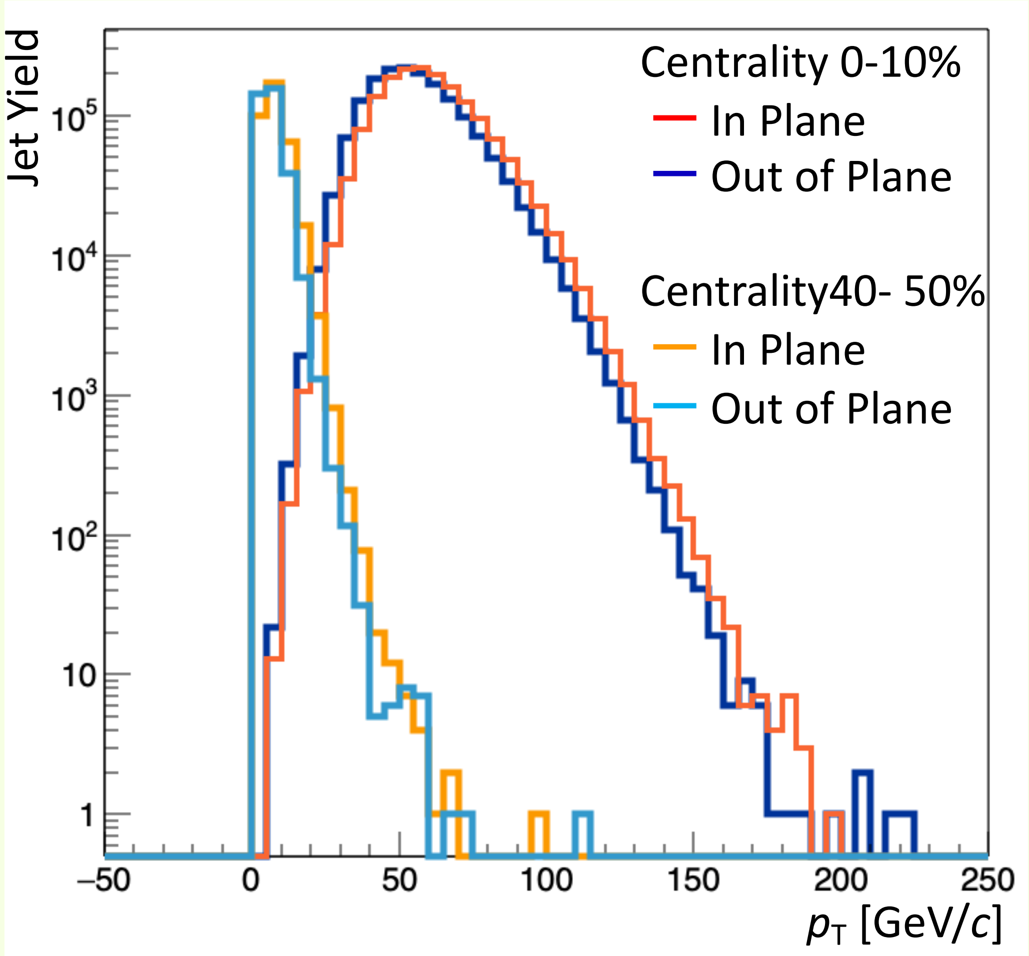


The increasing tendency on centrality is reasonable.
However, the small statistic of centrality 10-20% seems strange
→ I am searching for the reason.

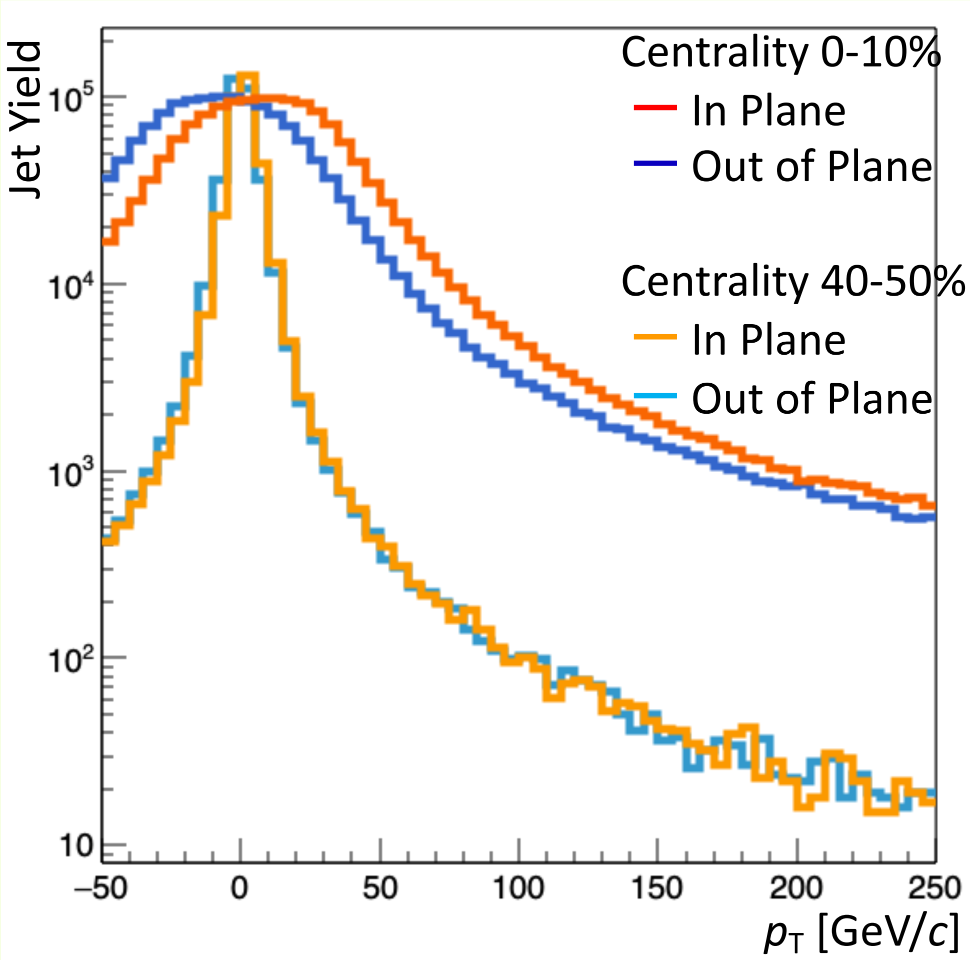
Raw Jet Spectrum

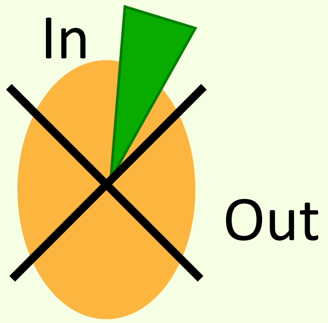
One Run (LHC18q 296623) : 1,400,000 Events

Raw jet pT distribution: p_{T}^{raw}



Corrected Raw jet pT distribution (w/o unfolding): $p_{\mathrm{T}}^{raw} - \rho(\phi)A$





$\rho(\phi)$ are calculated using the previous slid. So the results are suspecious.

Calculation of EP resolution

The product of the resolution of two sub-events can be written as a correlation of the two event planes [40, 42]:

$$\begin{aligned}\langle\cos(n[\Psi^{\mathrm{a}}_{\mathrm{EP},n}-\Psi^{\mathrm{b}}_{\mathrm{EP},n}])\rangle &= \langle\cos(n[\Psi^{\mathrm{a}}_{\mathrm{EP},n}-\Psi_n])\rangle\langle\cos(n[\Psi^{\mathrm{b}}_{\mathrm{EP},n}-\Psi_n])\rangle \\ &= \mathscr{R}^a_n\mathscr{R}^b_n. \end{aligned} \tag{3.3.13}$$

This correlation is available experimentally. Extending this to include sub-event c,

$$\begin{aligned}\langle\cos(n[\Psi^{\mathrm{a}}_{\mathrm{EP},n}-\Psi^{\mathrm{c}}_{\mathrm{EP},n}])\rangle &= \langle\cos(n[\Psi^{\mathrm{a}}_{\mathrm{EP},n}-\Psi_n])\rangle\langle\cos(n[\Psi^{\mathrm{c}}_{\mathrm{EP},n}-\Psi_n])\rangle \\ &= \mathscr{R}^a_n\mathscr{R}^c_n, \end{aligned} \tag{3.3.14}$$

$$\begin{aligned}\langle\cos(n[\Psi^{\mathrm{b}}_{\mathrm{EP},n}-\Psi^{\mathrm{c}}_{\mathrm{EP},n}])\rangle &= \langle\cos(n[\Psi^{\mathrm{b}}_{\mathrm{EP},n}-\Psi_n])\rangle\langle\cos(n[\Psi^{\mathrm{c}}_{\mathrm{EP},n}-\Psi_n])\rangle \\ &= \mathscr{R}^b_n\mathscr{R}^c_n. \end{aligned} \tag{3.3.15}$$

The resolutions for window a can now be derived from 3.3.13, 3.3.14 and 3.3.15:

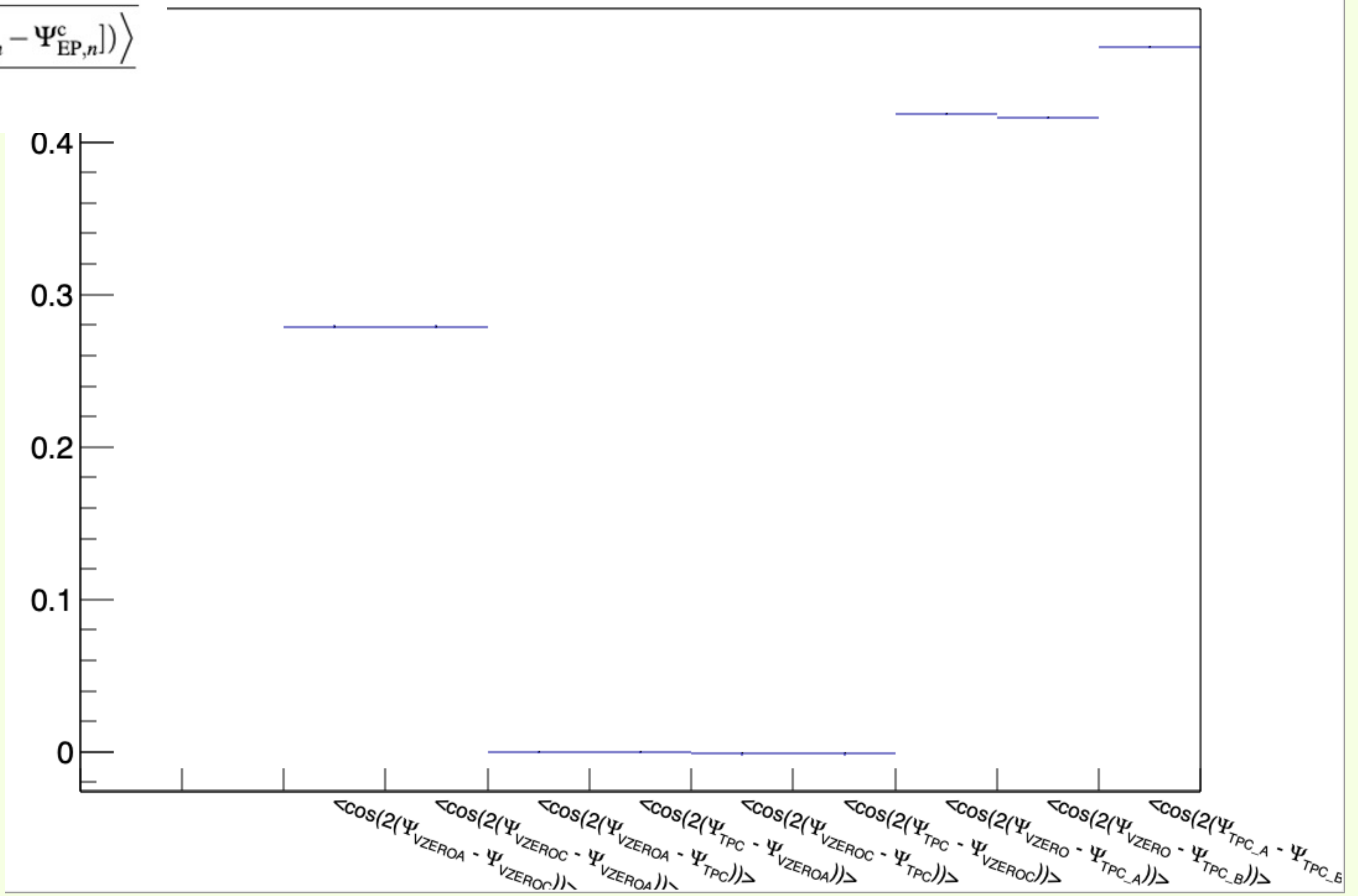
$$\mathscr{R}^a_n = \langle\cos(n[\Psi^{\mathrm{a}}_{\mathrm{EP},n}-\Psi_n])\rangle = \sqrt{\frac{\left\langle\cos(n[\Psi^{\mathrm{a}}_{\mathrm{EP},n}-\Psi^{\mathrm{b}}_{\mathrm{EP},n}])\right\rangle\left\langle\cos(n[\Psi^{\mathrm{a}}_{\mathrm{EP},n}-\Psi^{\mathrm{c}}_{\mathrm{EP},n}])\right\rangle}{\left\langle\cos(n[\Psi^{\mathrm{b}}_{\mathrm{EP},n}-\Psi^{\mathrm{c}}_{\mathrm{EP},n}])\right\rangle}} \tag{3.3.16}$$

The information for event plane resolution

$$\mathcal{R}_n^a = \left\langle \cos(n[\Psi_{\mathrm{EP},n}^{\mathrm{a}} - \Psi_n]) \right\rangle = \sqrt{\frac{\left\langle \cos(n[\Psi_{\mathrm{EP},n}^{\mathrm{a}} - \Psi_{\mathrm{EP},n}^{\mathrm{b}}]) \right\rangle \left\langle \cos(n[\Psi_{\mathrm{EP},n}^{\mathrm{a}} - \Psi_{\mathrm{EP},n}^{\mathrm{c}}]) \right\rangle}{\left\langle \cos(n[\Psi_{\mathrm{EP},n}^{\mathrm{b}} - \Psi_{\mathrm{EP},n}^{\mathrm{c}}]) \right\rangle}}$$

I need to calculate the resolution from the value on this figure.
But I still do not.

We can distinguish which detector, V0C, V0A, and V0 merge, is the best to use EP estimation by estimating of each detector resolutio.



Next Step

1. Raw Jet Results
    1.1 Fix the train problem and get full statistic of LHC18qr.
    1.2 Check the results.
2. Embedding
    2.1 Estimate jet pT resolution and pT shift.
    2.2 Get the response matrix for out of plane and in plane.
3. Estimate systematic uncertainty
4. Compare models

Backup Slides

EP calibration codes

1. Run1 Redmer used

→ It was common framework for all analysis group.

→ Firstly, I tried to use it but it does not work. And Rhian (CF combiner) told me it was not used in Run2.

Then now I have two choice.

2. JE group way (JEHandler: Micheal Oliver and Caitie Beattie using)

- The gain calibration way does not take account of collision point (z) dependency.
- V0 merge Q2 does not recentering
- V0 merge Q2 does not take the weight of V0C and V0A into account.

$$\mathbf{Q}_{n,\mathrm{V0}} = \chi^2_{n,\mathrm{V0A}}\mathbf{Q}_{n,\mathrm{V0A}} + \chi^2_{n,\mathrm{V0C}}\mathbf{Q}_{n,\mathrm{V0C}}$$

- It had memory leak and the order 3 calculation was not implemented correctly

→ I solved it

3. Rhian's way

- Mostly same of Run1 calculation.

Event Plane Calibration

I was making the code for event plane calibration.
→ I needed to do by my self because there is nothing to calibrate V0 merge and TPC based on previous study.

- V0 merge calibration

$$\mathbf{Q}_{n,\mathrm{V0}} = \chi^2_{n,\mathrm{V0A}}\mathbf{Q}_{n,\mathrm{V0A}} + \chi^2_{n,\mathrm{V0C}}\mathbf{Q}_{n,\mathrm{V0C}}$$

  χn (weights): approximately proportional to the event plane resolution in each detector

- Collision point dependency

However, other people using event plane use other way.
-> So eventually I follow the other people.
-> And I modified my code to apply the calibration way.