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The Measurement of jet-particle v_2 in p-Pb collisions at 5.02 TeV with ALICE at the LHC

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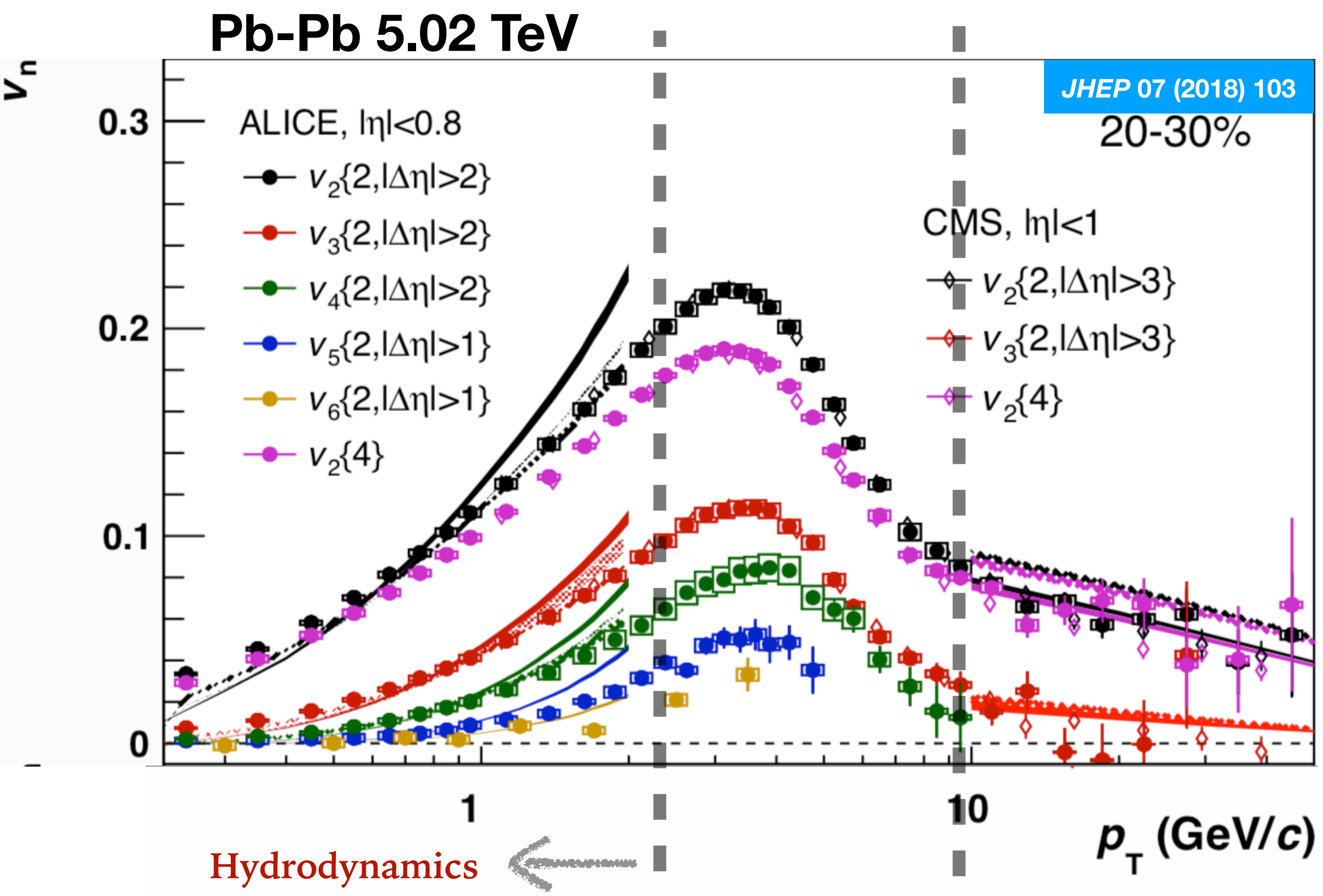
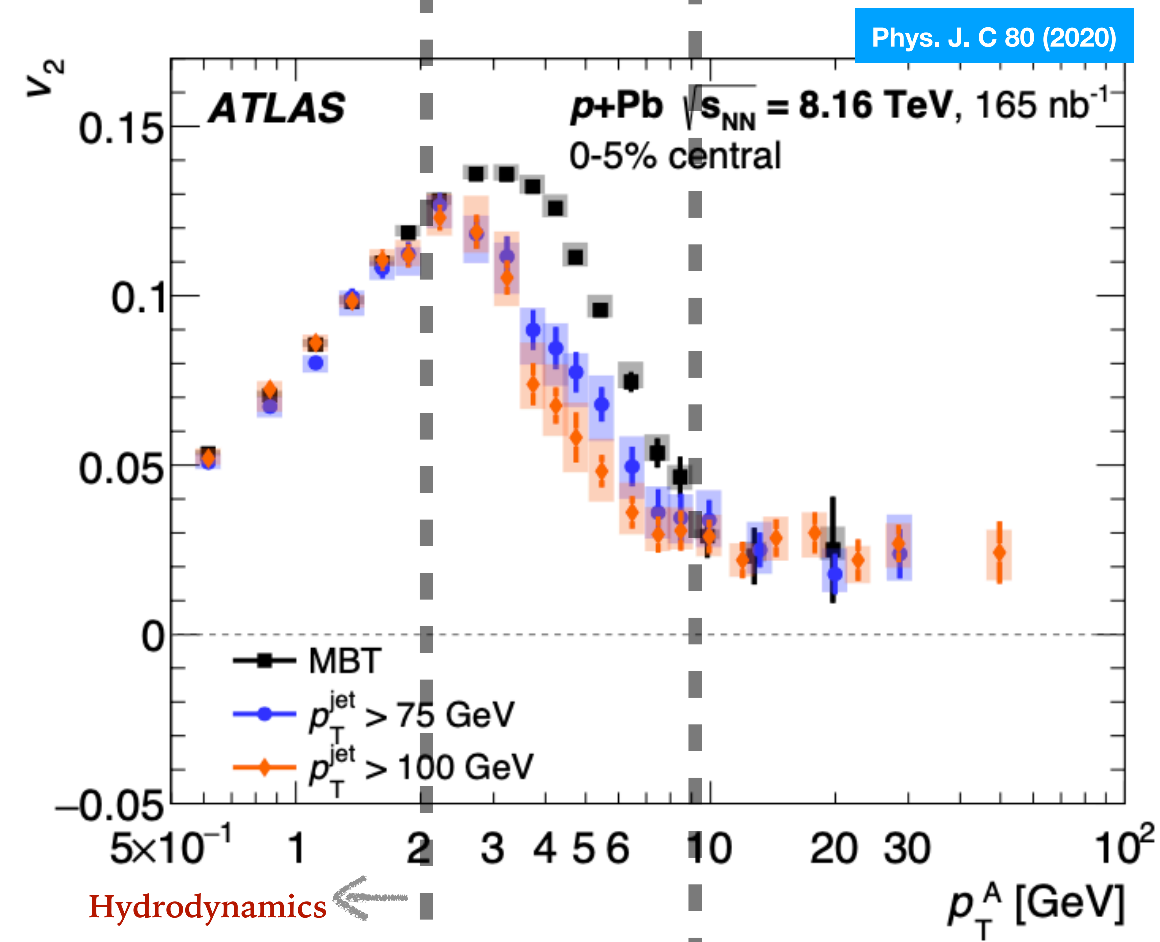
Introduction & Motivation





Parton energy loss

? ? ?

- The azimuthal anisotropy of high-p_T hadrons and associated jets is believed to originate from path-length dependent parton energy loss in the QGP formed in A-A collisions
- However, in small systems, a non-zero v_2 is observed at high p_T, for both minimum bias and jet-triggered events
  - But, no jet quenching effect is observed from the measurement of R_{pPb} and hadron-jet correlations in small systems

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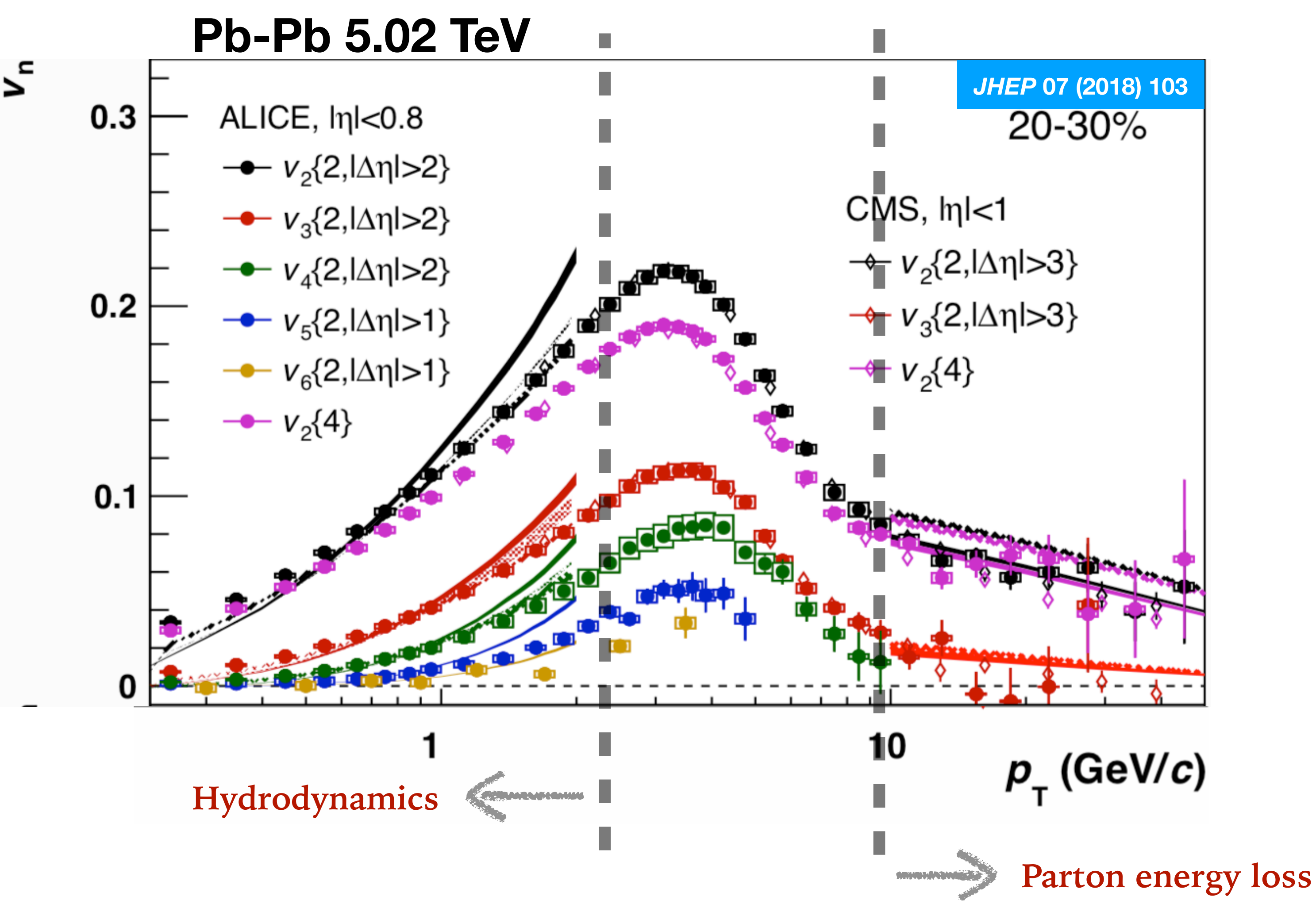

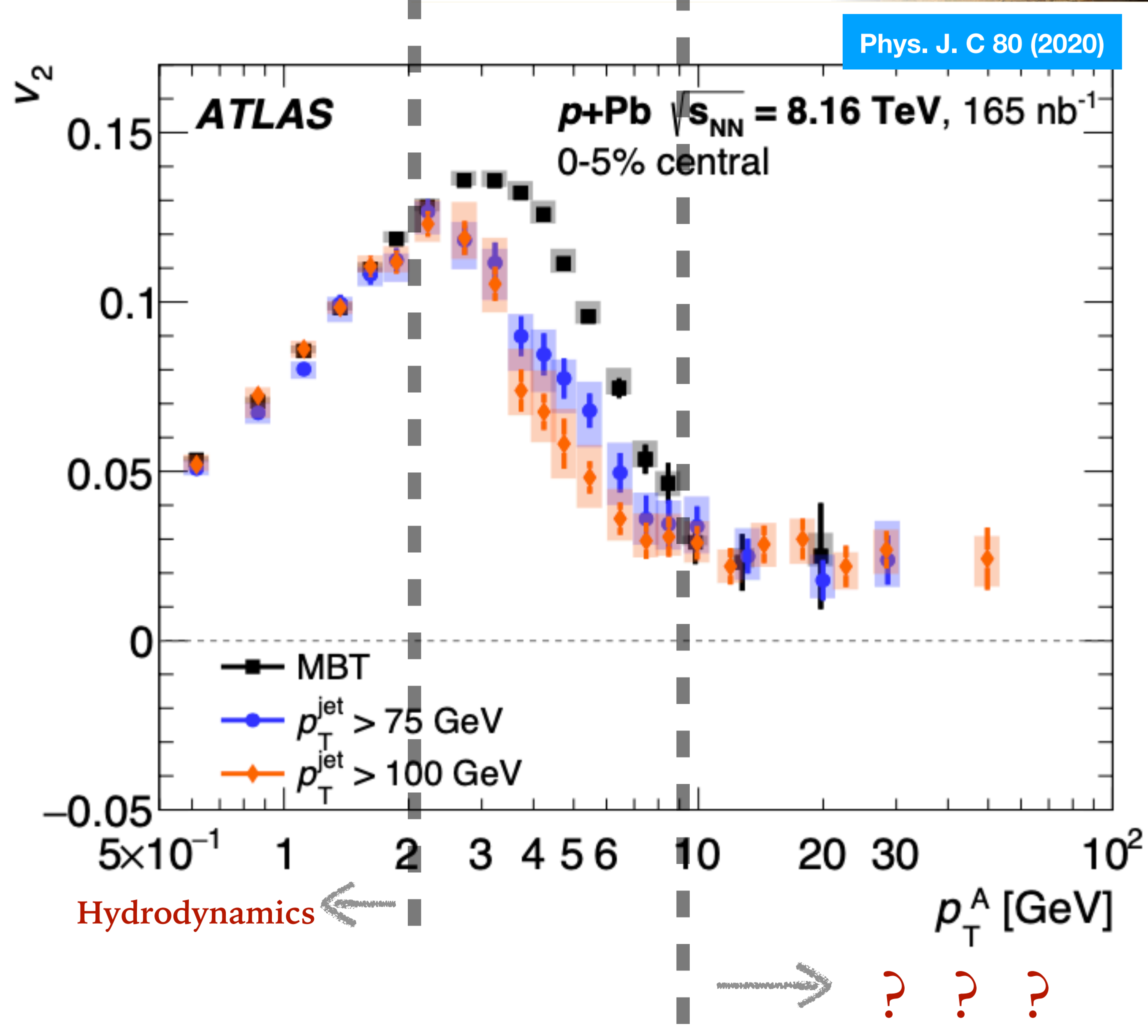

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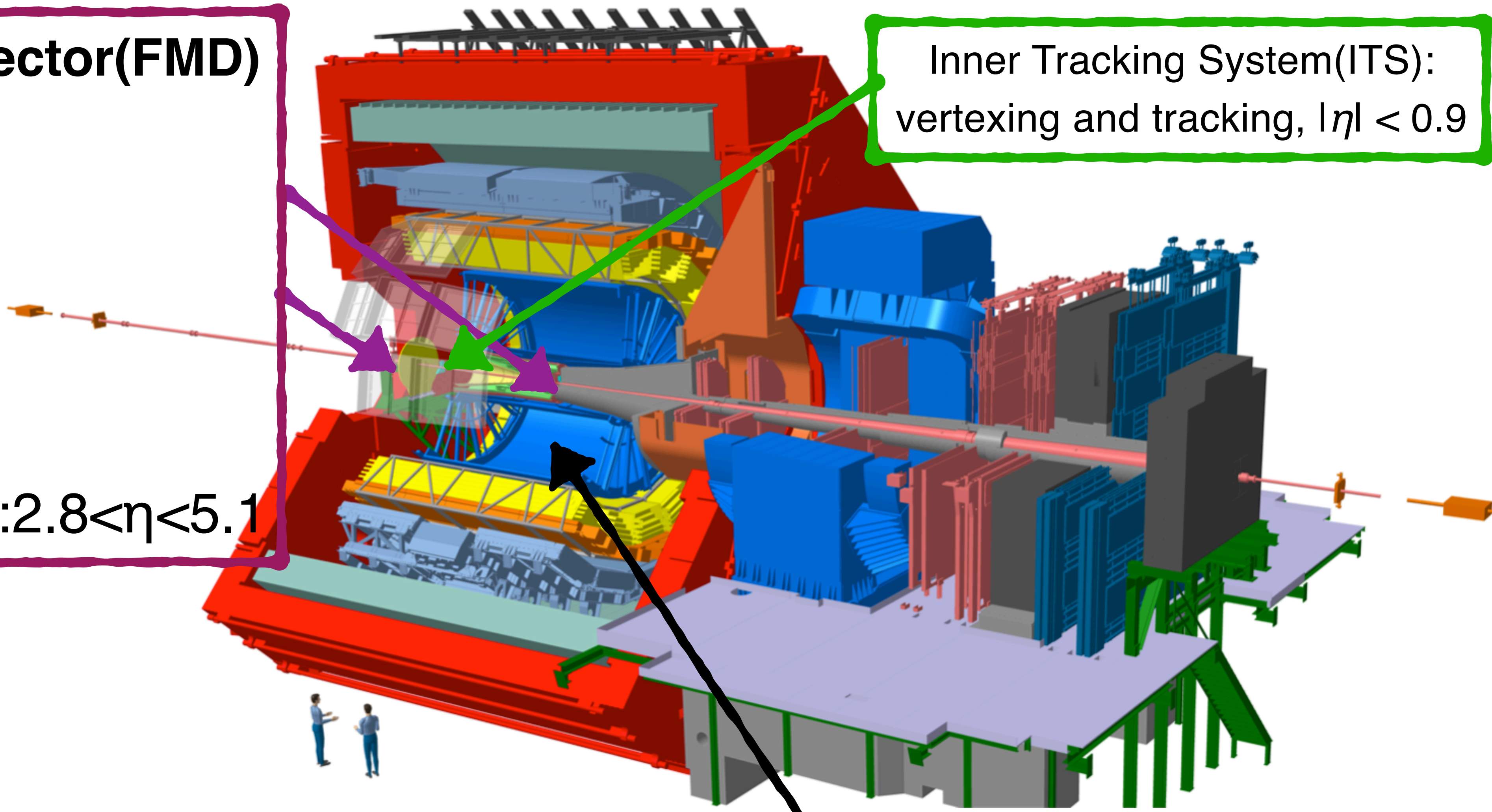
  - But, no jet quenching effect is observed from the measurement of R_{pPb} and hadron-jet correlations in small systems

In this presentation, the v_2 of particles produced in jets is measured at low p_T in order to provide further information on the origin of such collectivity

ALICE Experiment

- **Forward Multiplicity Detector(FMD)**
  - FMD3: $-3.4<\eta<-1.7$
  - FMD1&2: $1.7<\eta<5.1$
- **V0**
  - Trigger and centrality
  - V0C: $-3.7<\eta<-1.7$, V0A: $2.8<\eta<5.1$



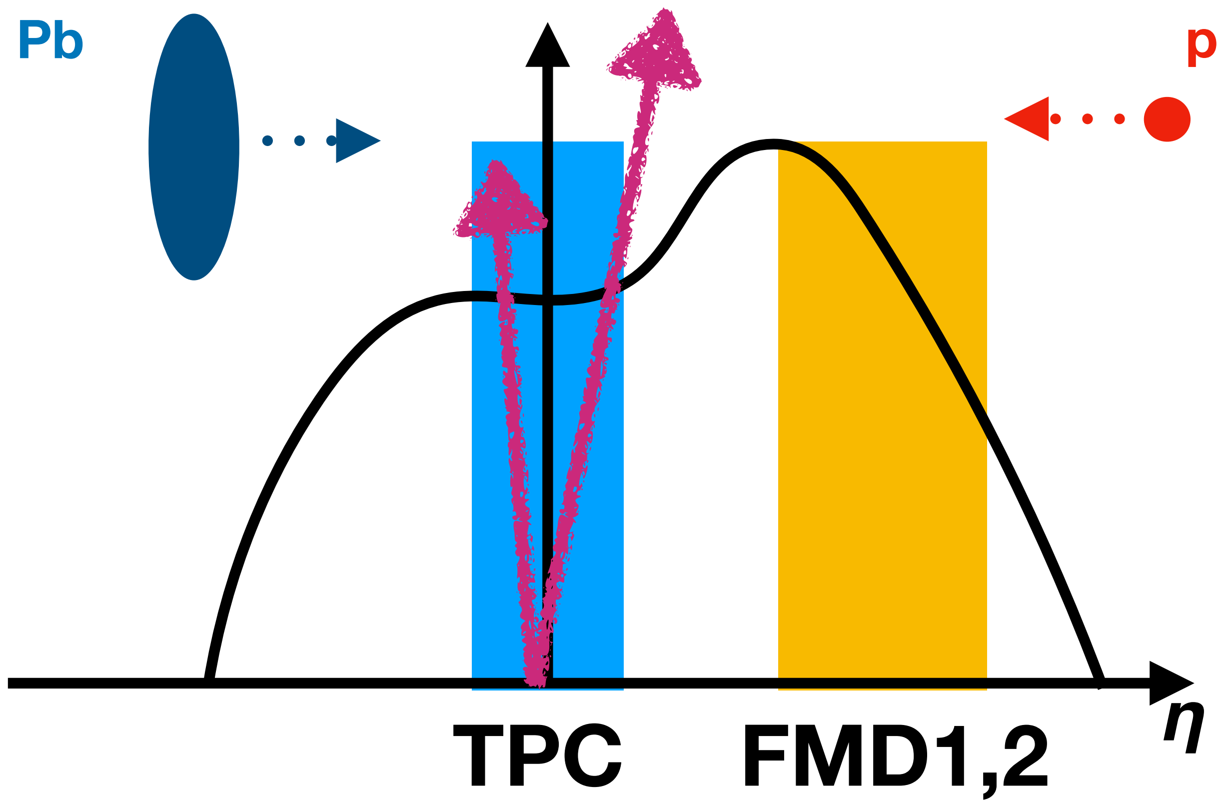
Inner Tracking System(ITS): vertexing and tracking, $|\eta| < 0.9$

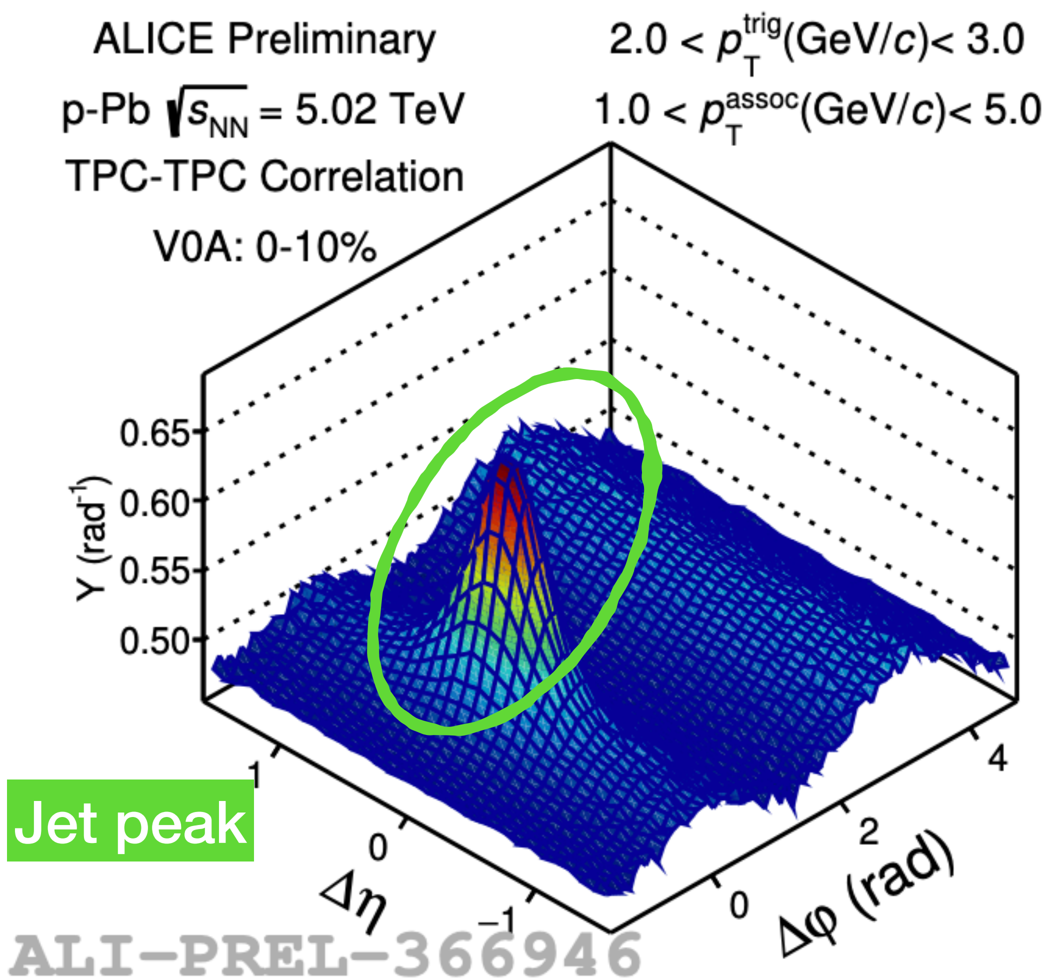
p-Pb 5.02 TeV (2016)
Minimum Bias Triggered
Events ≈ 500M

Time Projection Chamber (TPC)

- Charged Particle Tracking
- $|\eta| < 0.9$

Calculation of Correlation



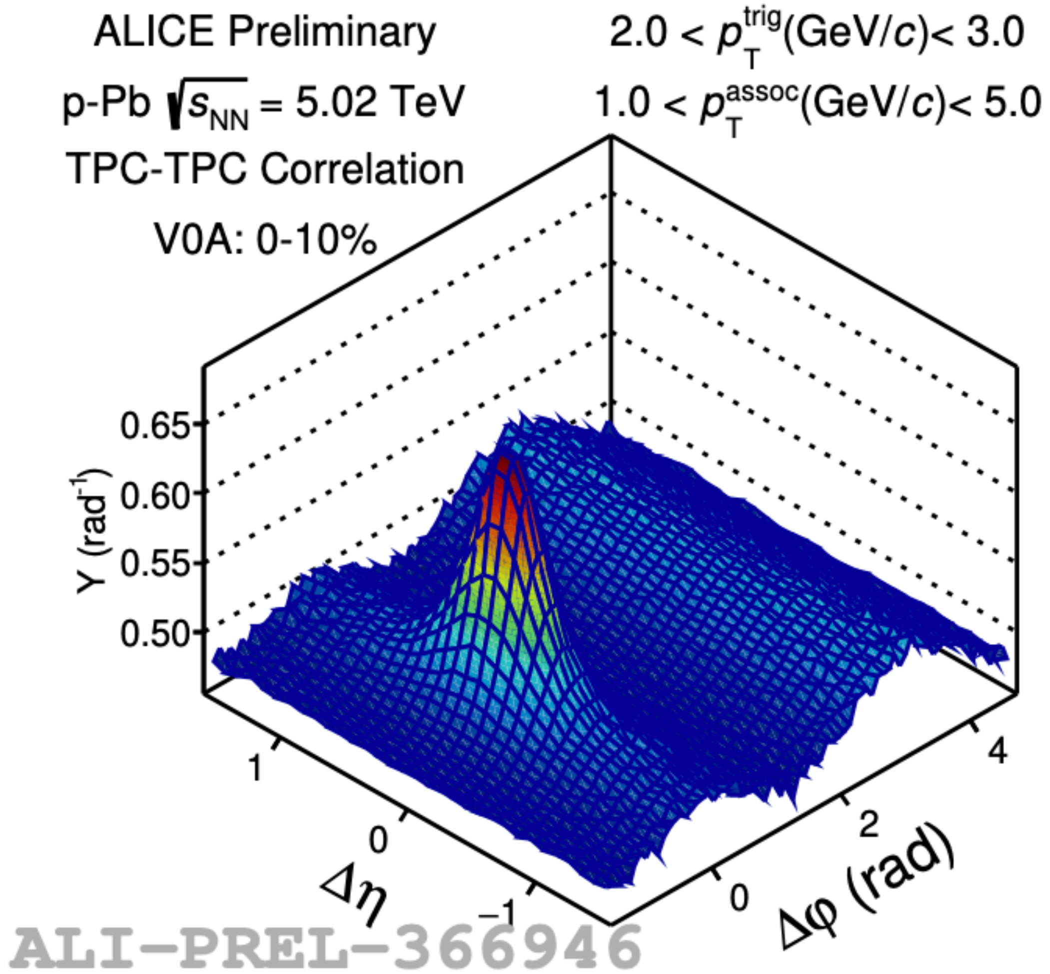


- The same sign charged particles measured in TPC acceptance (-0.8<η<0.8) are chosen as the trigger and associated particles, to construct 2-particle correlation

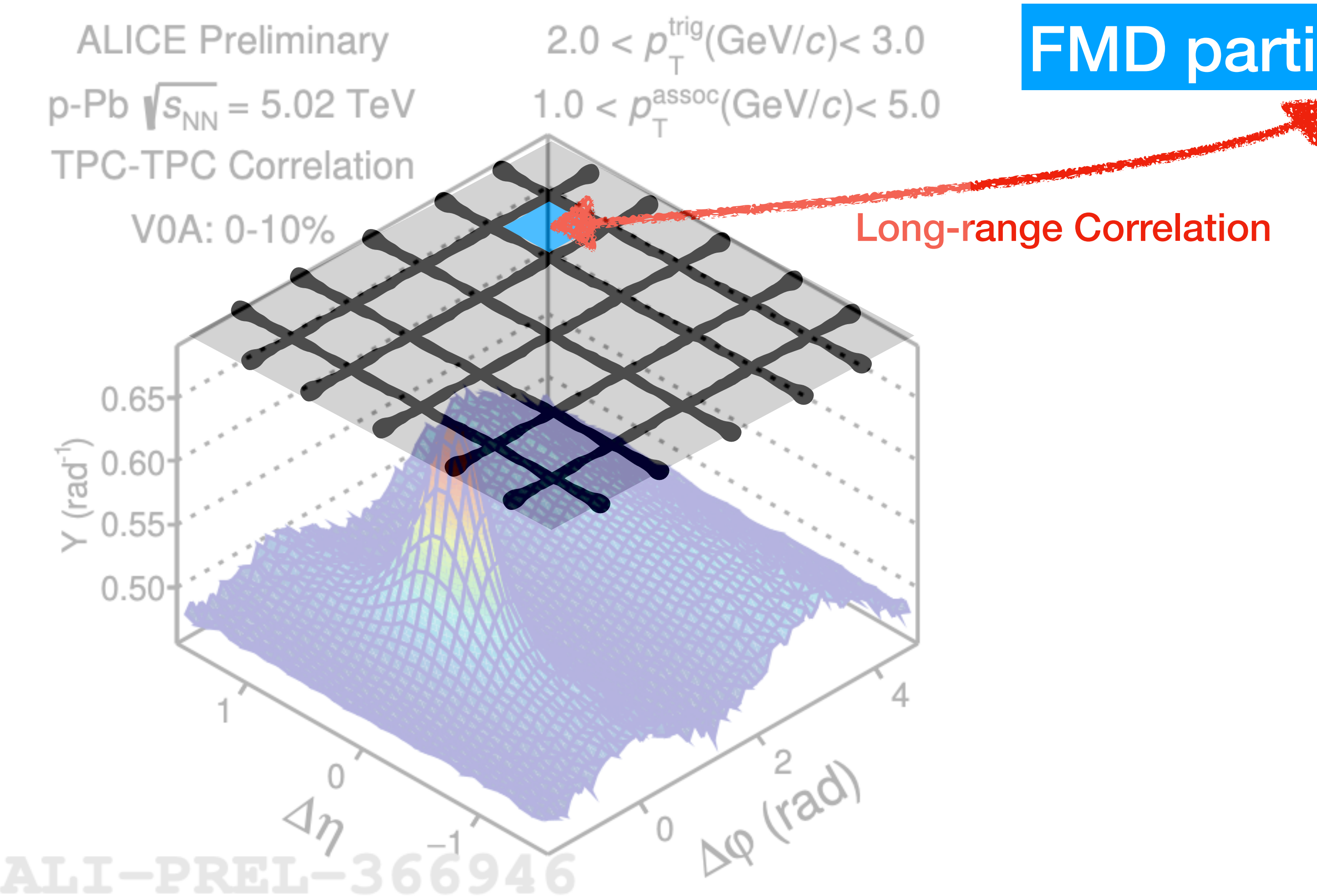
$$Y(\Delta\eta, \Delta\varphi) = \frac{1}{N_{\mathrm{trig}}} \frac{d^2 N_{\mathrm{assoc}}}{d\Delta\eta d\Delta\varphi} = \frac{\mathrm{S}(\Delta\eta,\Delta\varphi)}{\mathrm{B}(\Delta\eta,\Delta\varphi)}$$

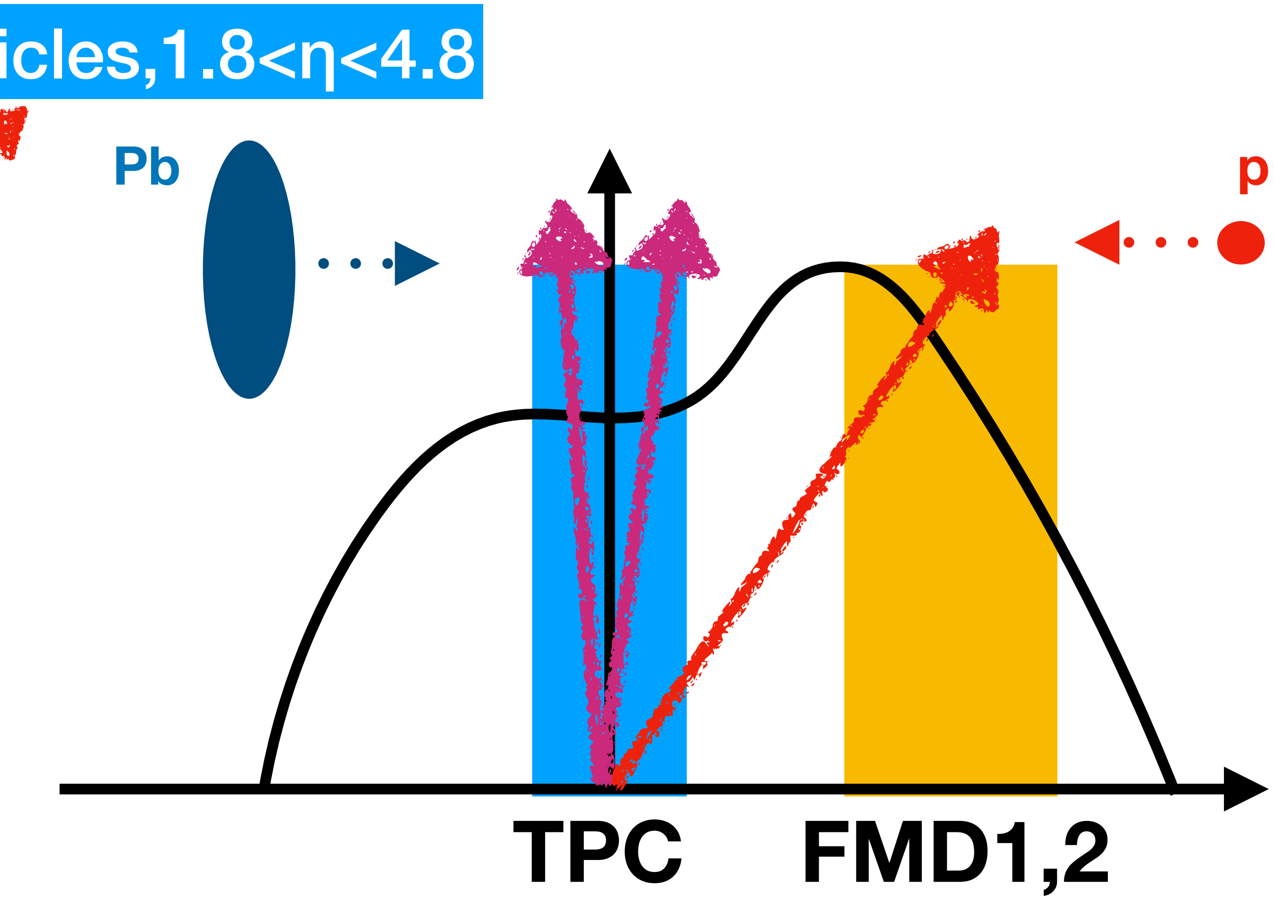
- Near-side jet peak is observed at $(\Delta\eta \sim 0, \Delta\varphi \sim 0)$

Calculation of v_2



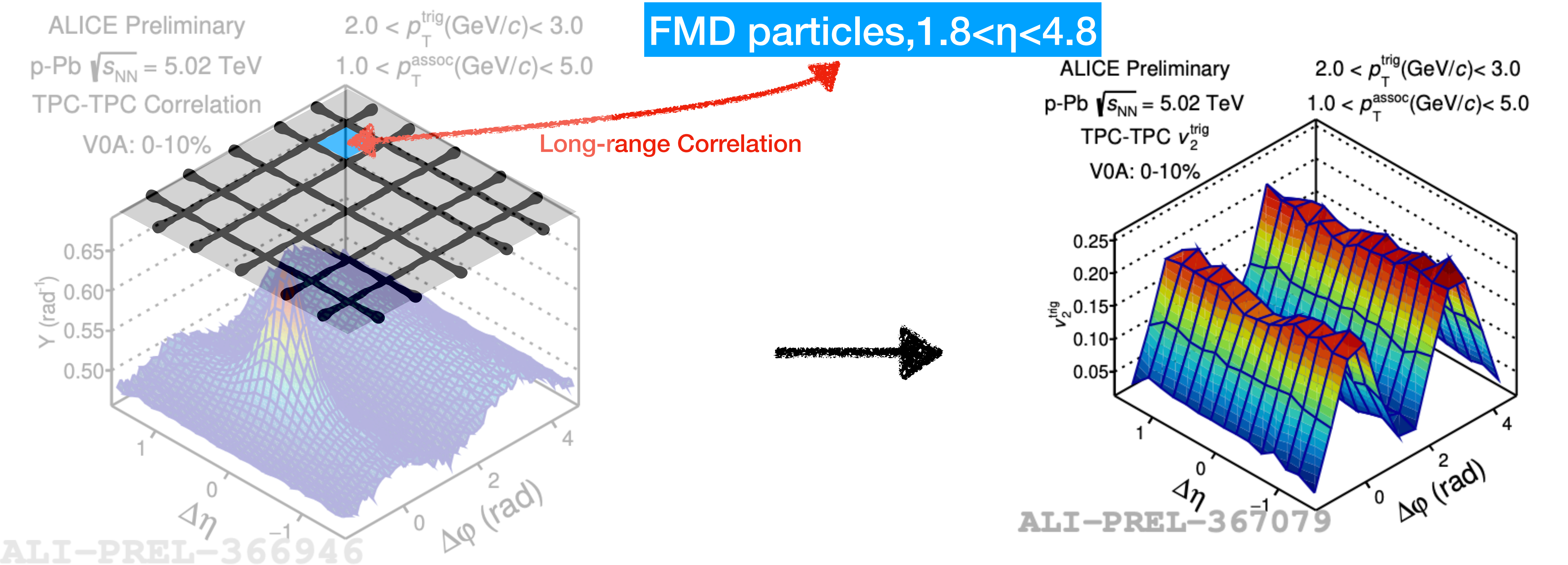
Calculation of v_2





- In each (Δη,Δϕ) region of TPC-TPC pairs, the v_2 of trigger TPC tracks can be obtained with long-range TPC-FMD correlation
  - Non-flow contribution is suppressed by subtraction of low-multiplicity events
  - Factorization: $V_2\{2PC,sub\} = v_2^{\{TPC\}}\, v_2^{\{FMD\}}$

Calculation of v_2



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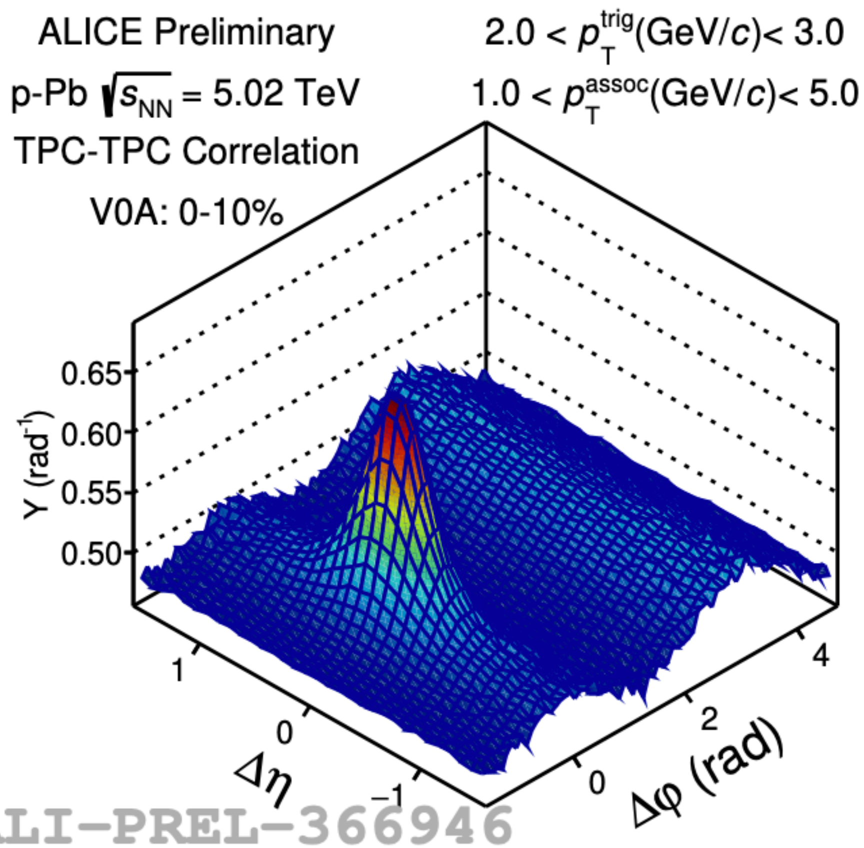
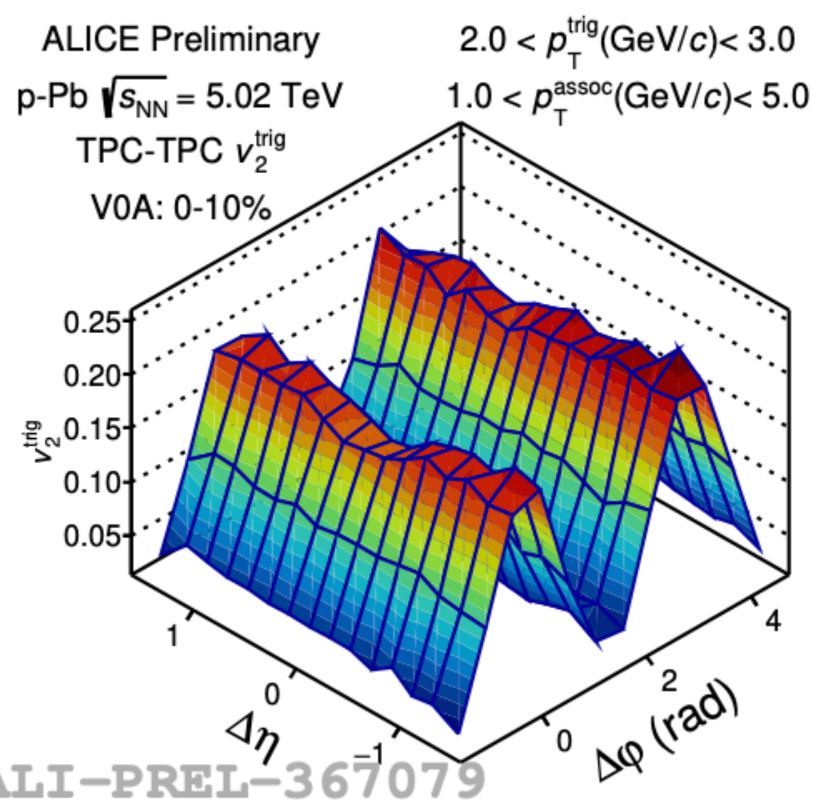
Extraction of Jet v_2

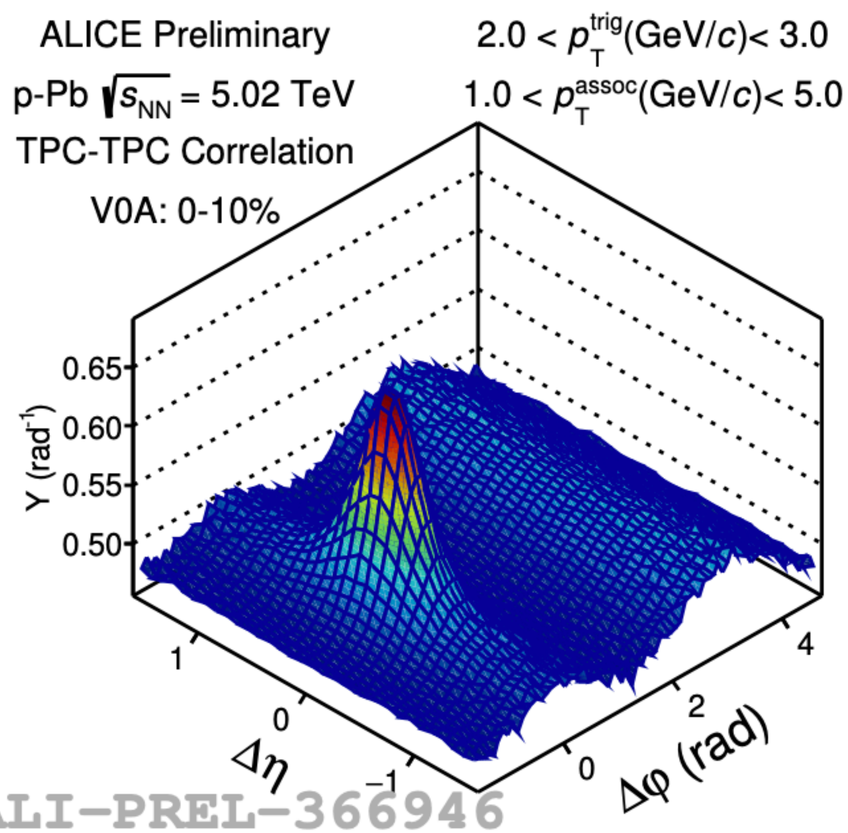


Extract Jet signal and background

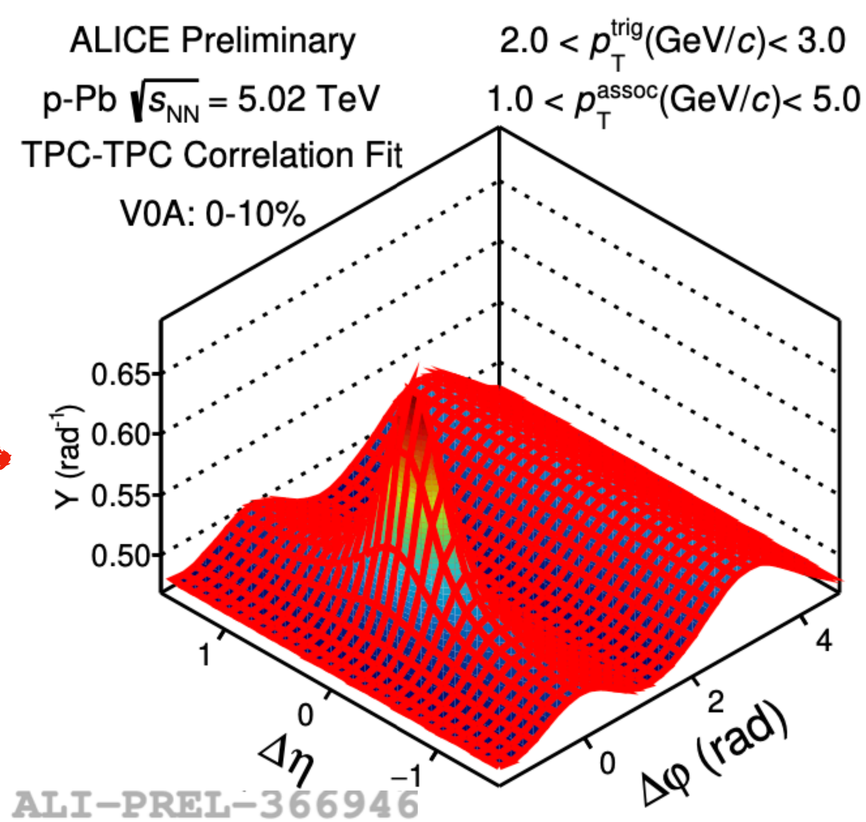


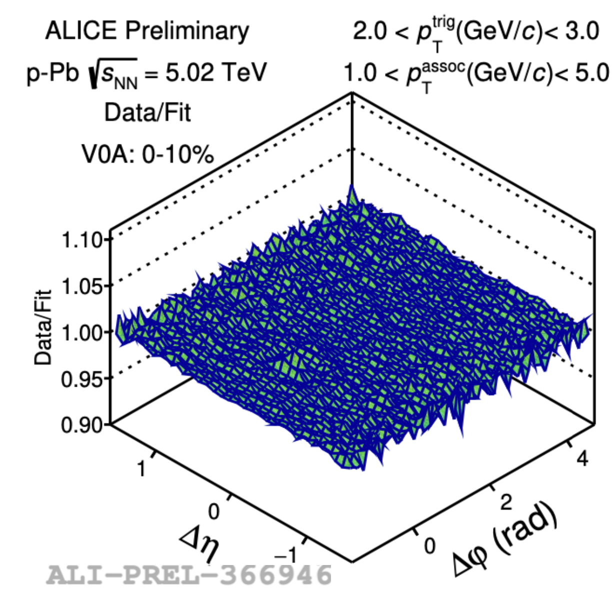
Extract Jet v_2

Extraction of Jet v_2

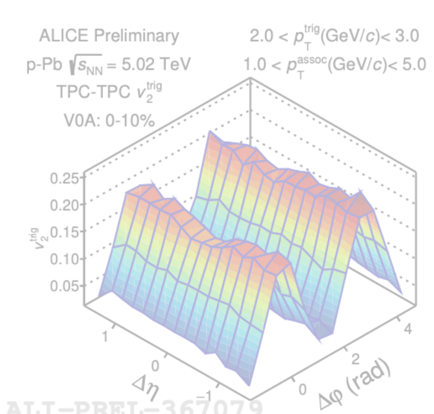


Fit

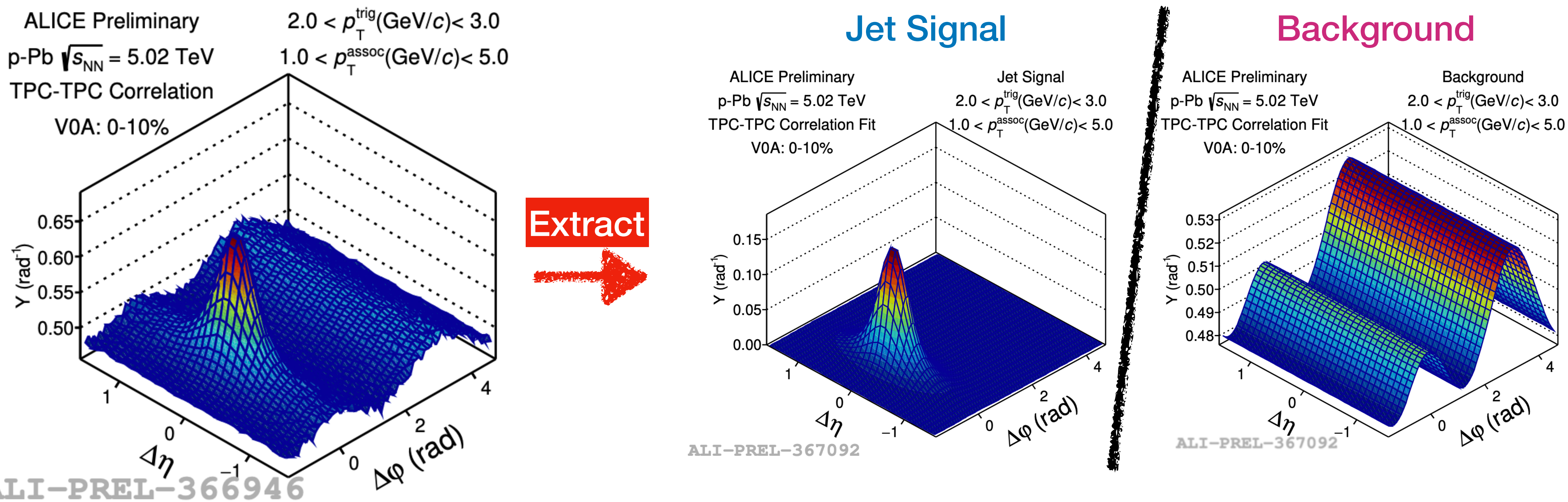




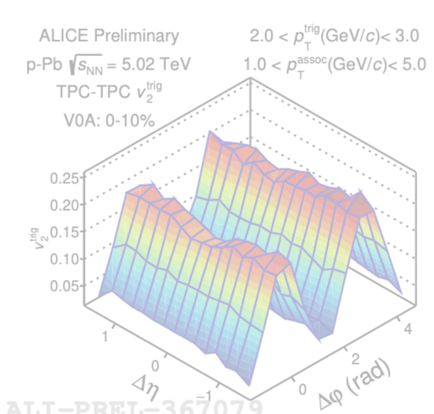
- Double gaussian function is introduced to fit the jet signal, the sum of harmonics is used to fit background



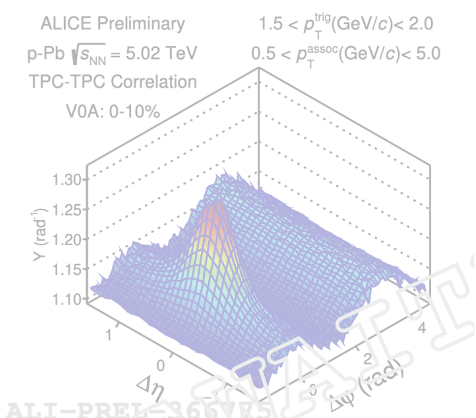
Extraction of Jet v_2



- Double gaussian function is introduced to fit the jet signal, the sum of harmonics is used to fit background
- Jet signal and background are extracted separately, to calculate **S/B**

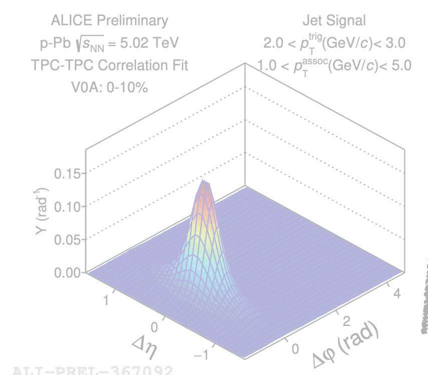


Extraction of Jet v_2

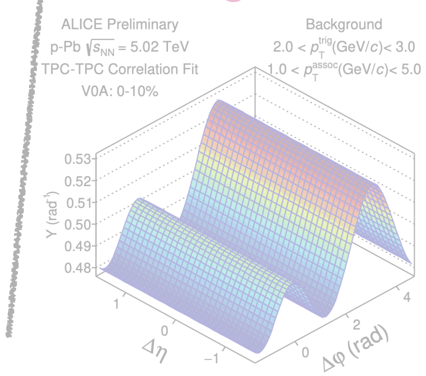


Extract

Jet Signal



Background



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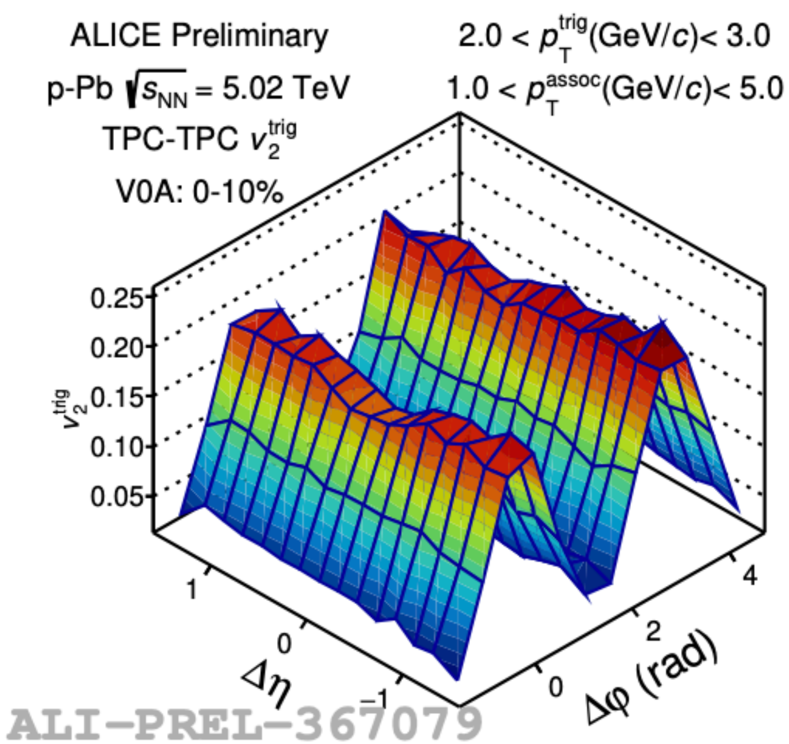
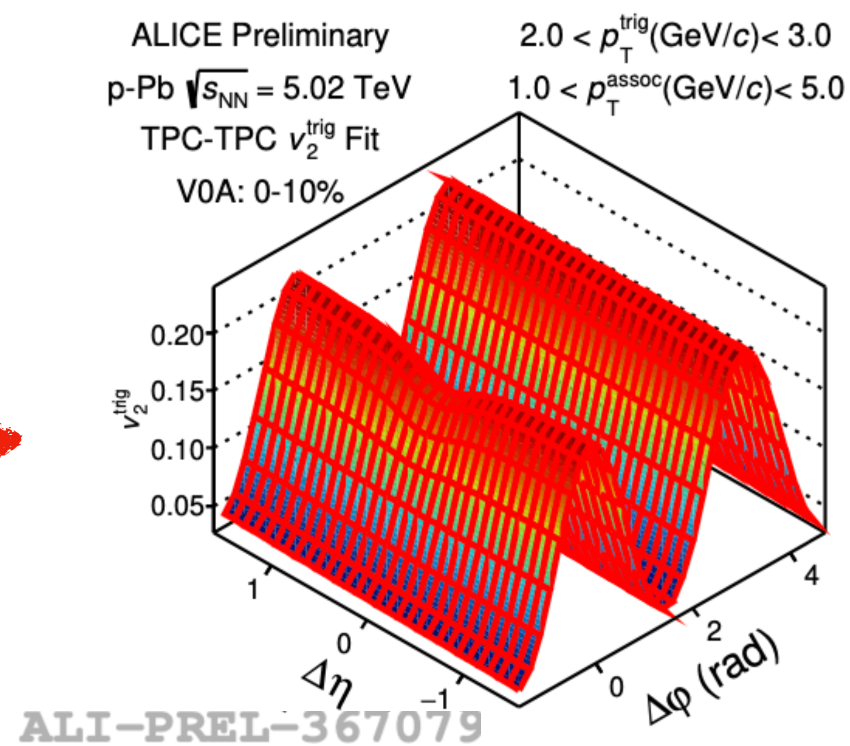
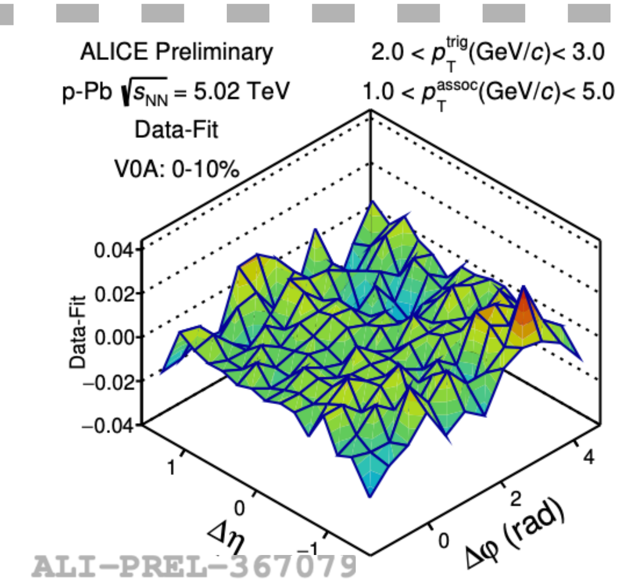


Fit

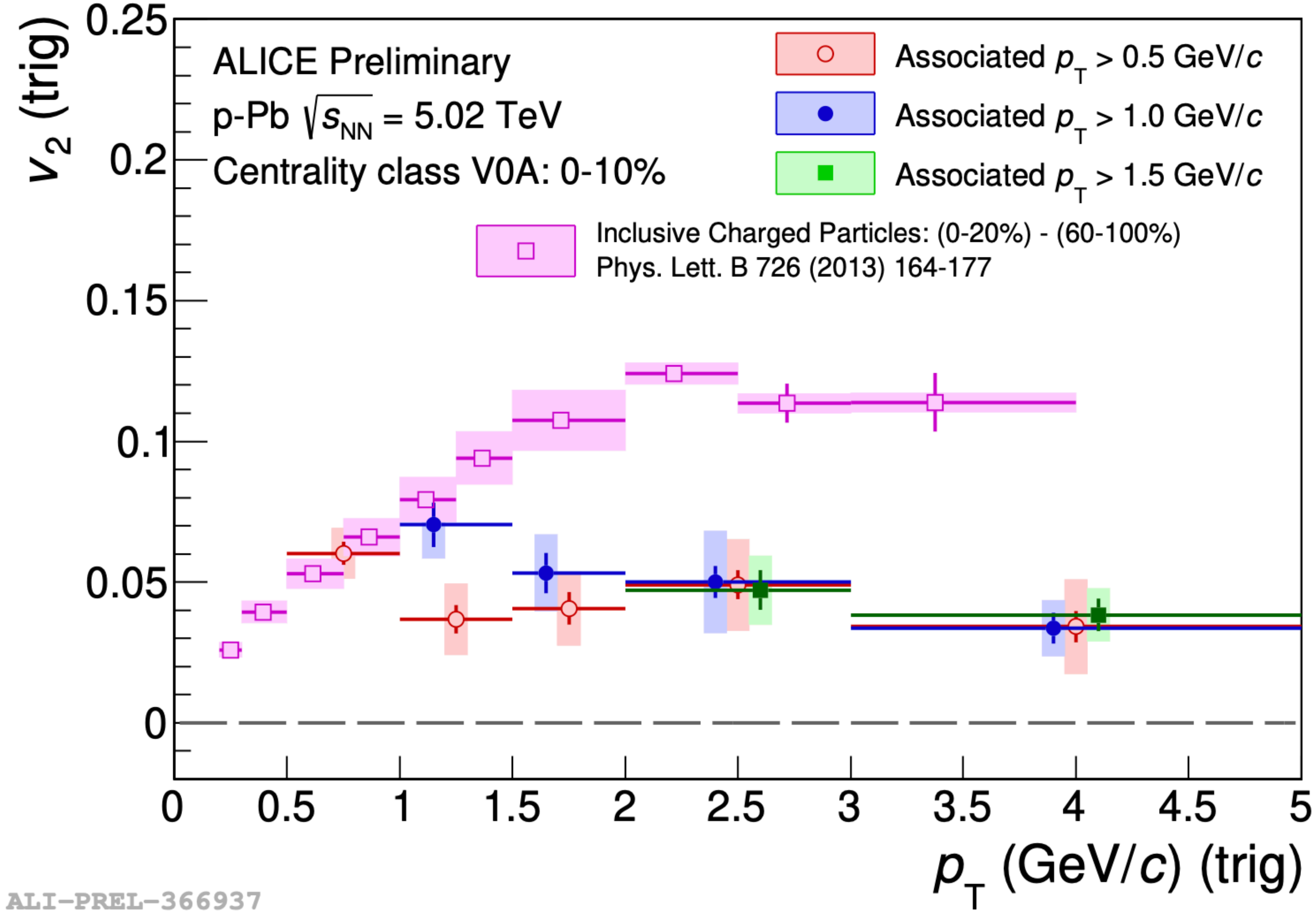


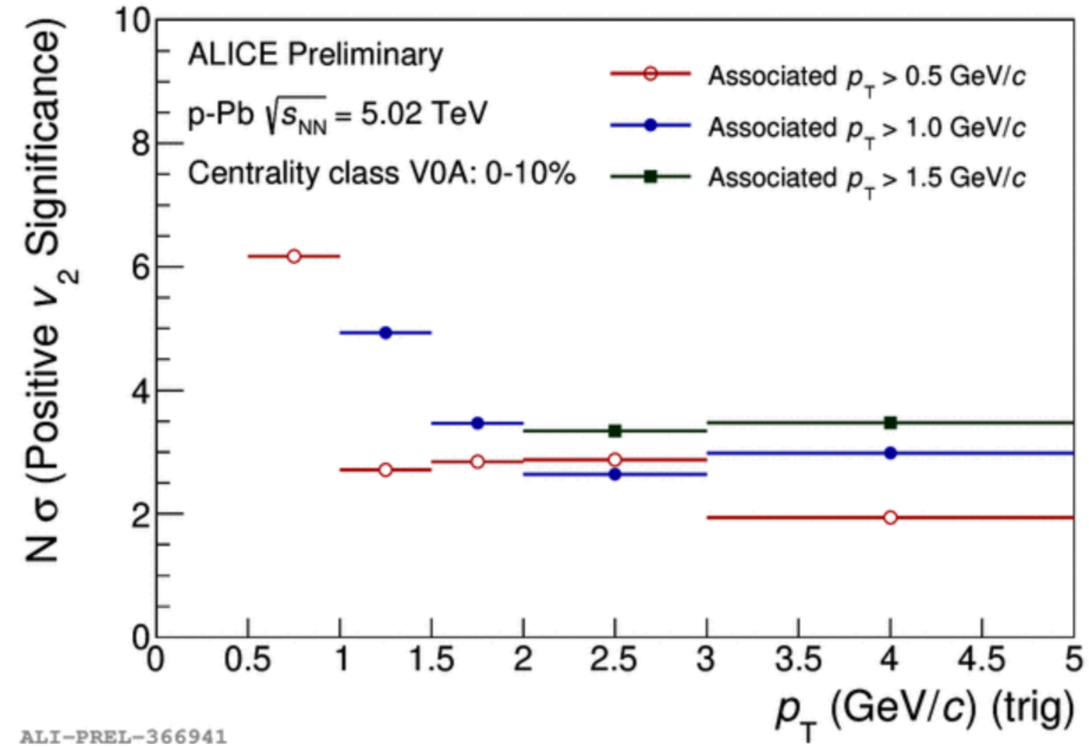


- The **S/B** obtained in TPC-TPC correlation is used as the weight to extract the v_2 of jet particles, in each p_T interval
  - $v_2(\Delta\varphi, \Delta\eta)$ = S/(S+B)* v_2(Jet) + B/(S+B)* v_2(Background)

Sum of 1st->5th harmonics

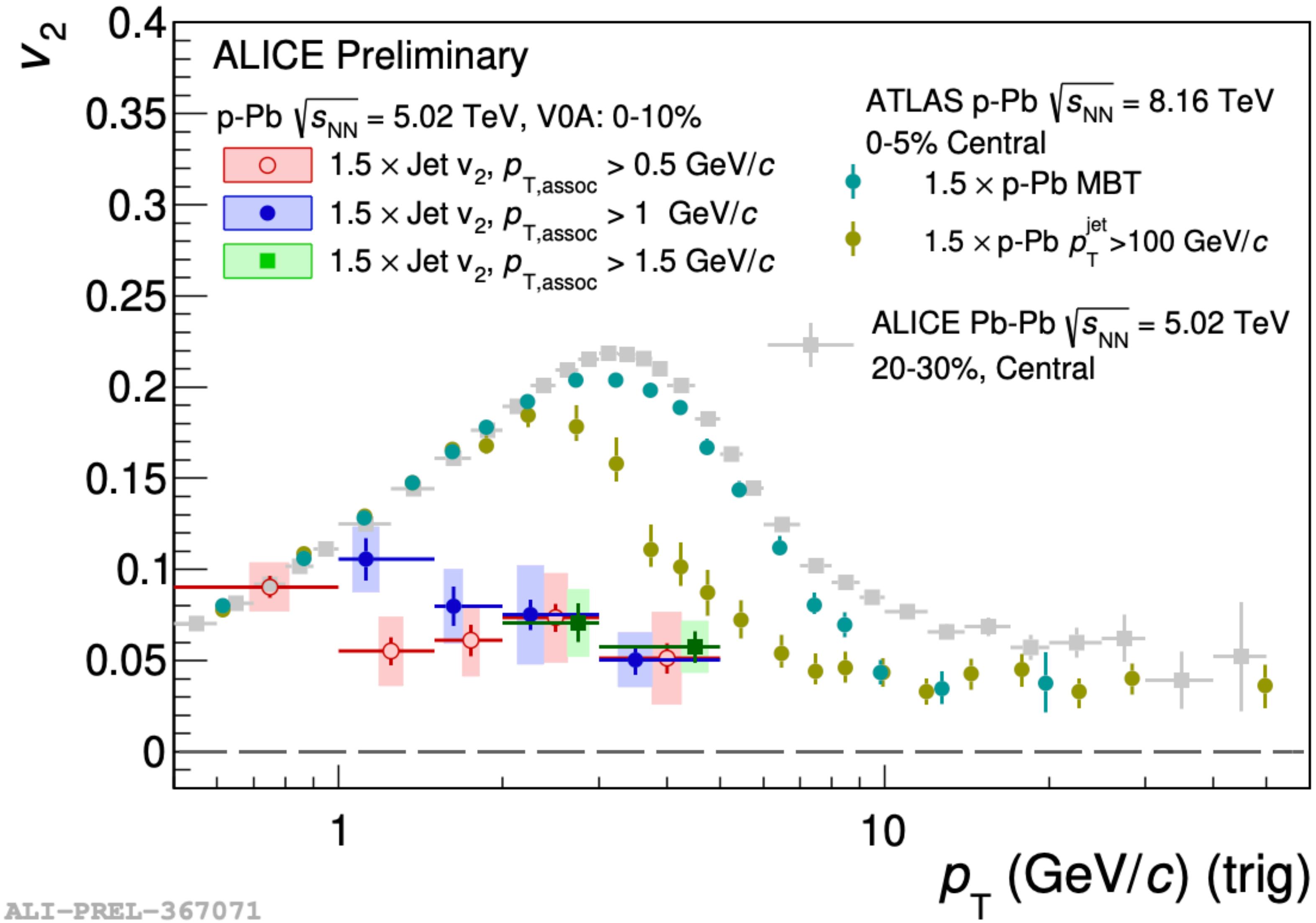
Results





- The positive v_2 of particles in jets is observed in p-Pb collisions
- The jet-particle v_2 is significantly lower than inclusive v_2 of all charged particles
- Consistent v_2 is observed with different associated-particle p_T selection within uncertainties

Results



Factor 1.5[1] is applied in p-Pb v_2 to compare with Pb-Pb results

- Observed v_2 of jet particles in $0.5 < p_T < 5$ GeV/c
- suppressed stronger compared to low and intermediate-p_T v_2 of jet triggered events in p-Pb collisions

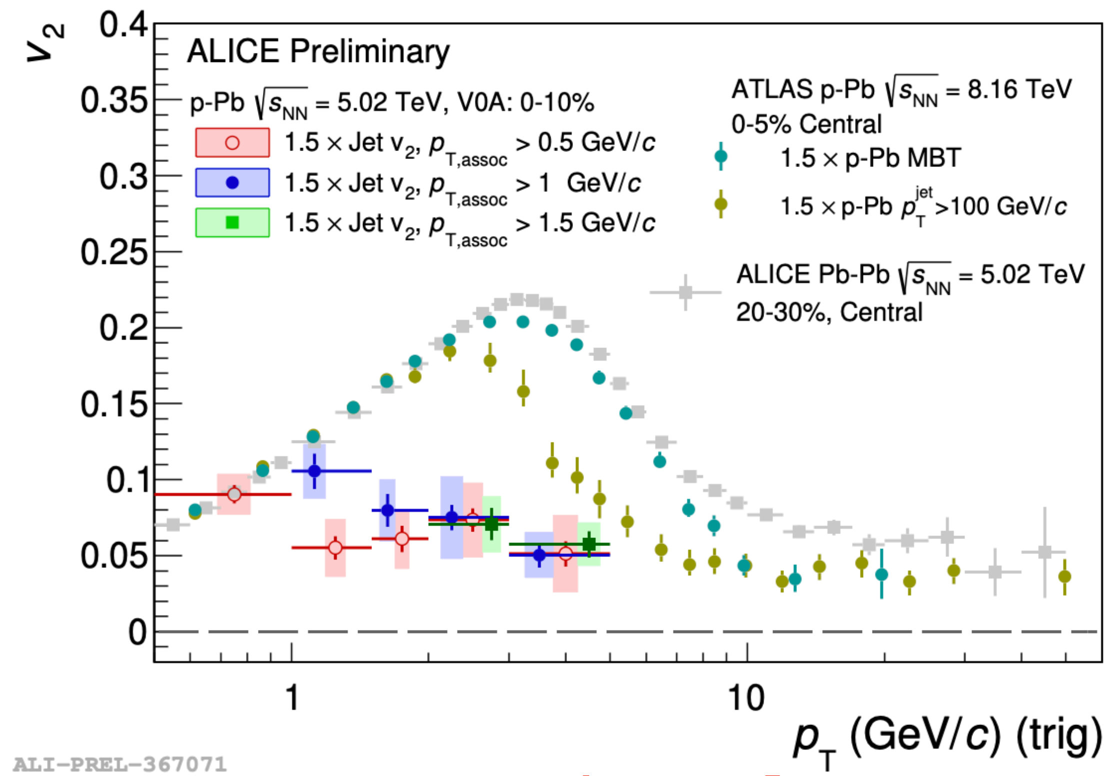
  ===> This measurement has large separating power of v_2 from hard and soft components
- comparable to high-p_T v_2 in p-Pb and Pb-Pb collisions

  ===> Positive v_2 of jet particles observed in p-Pb collisions for the first time

[1] An empirically determined factor from ATLAS paper: Phys. J. C 80 (2020) 73

Summary & Outlook

- First measurement of v_2 of jet particles in p-Pb collisions
- Positive jet-particle v_2 in p-Pb collisions is observed, which is comparable with the high-p_T v_2 measured by ATLAS
- No dependence on associated-track p_T within uncertainties

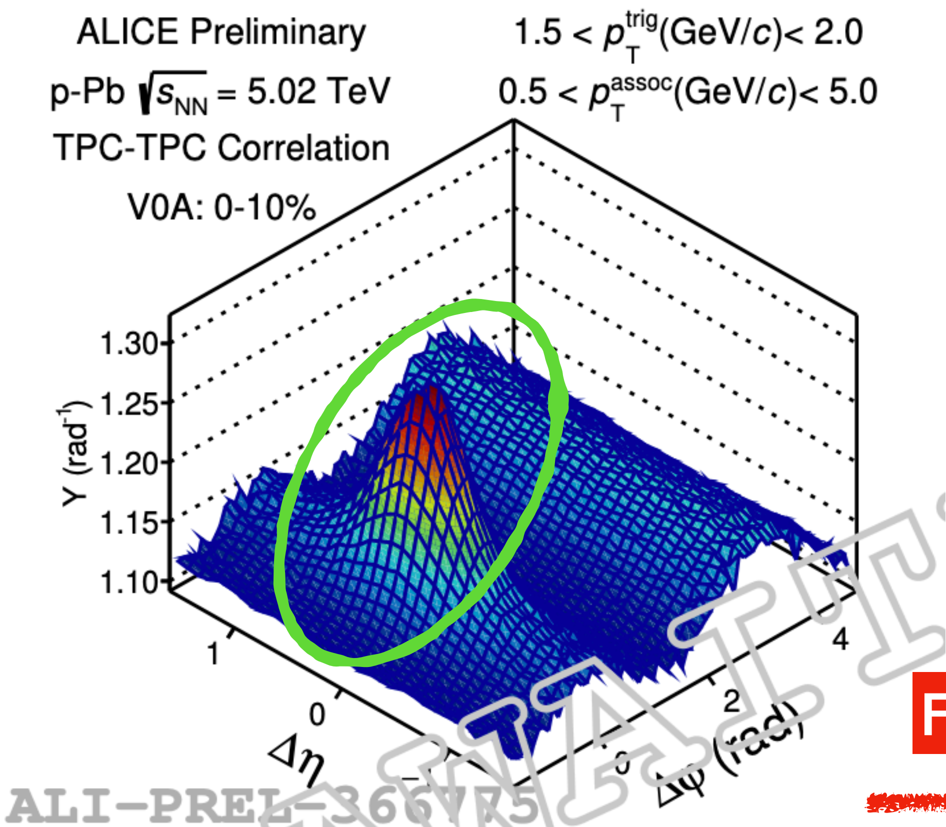


Thank you for your attention!

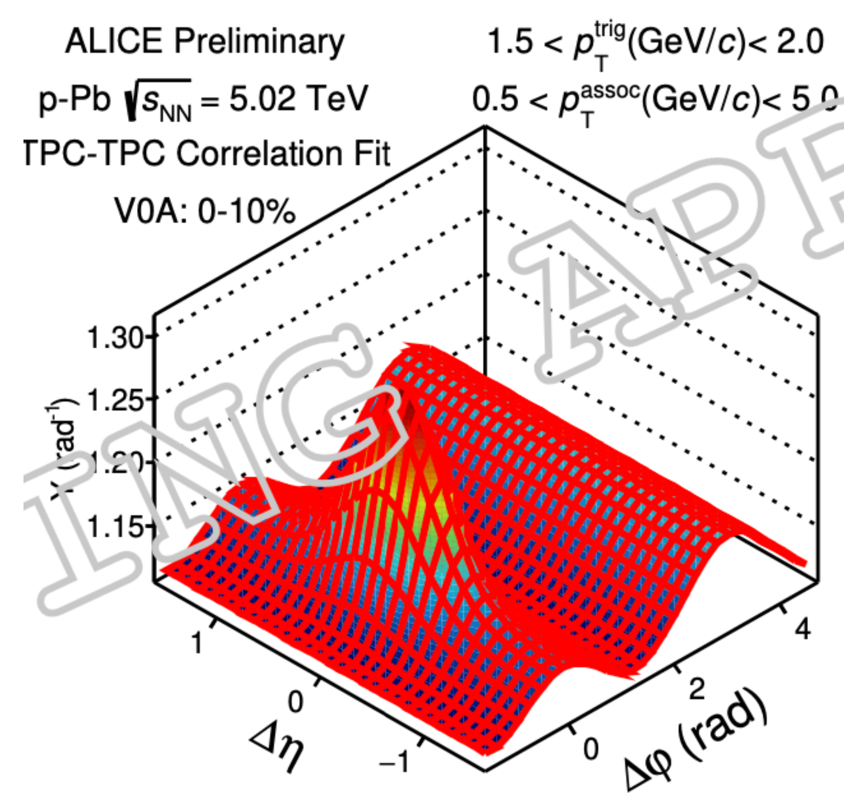
Back up

Calculation of v_2

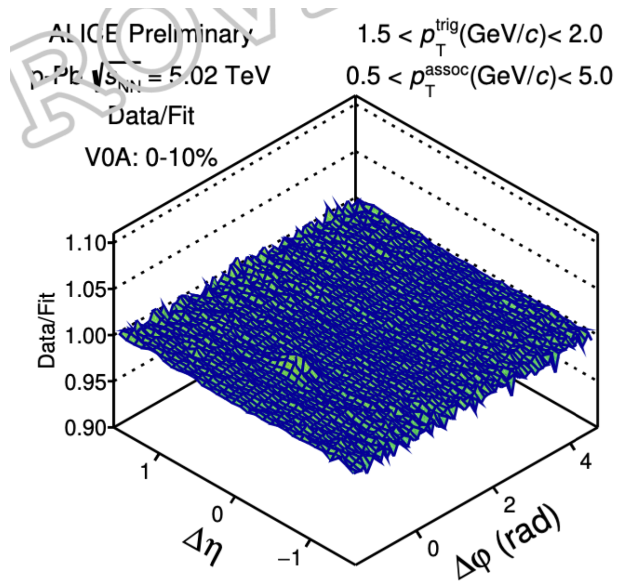
The jet signal is extracted using two Particle Correlation method



Fit



Data/Fit



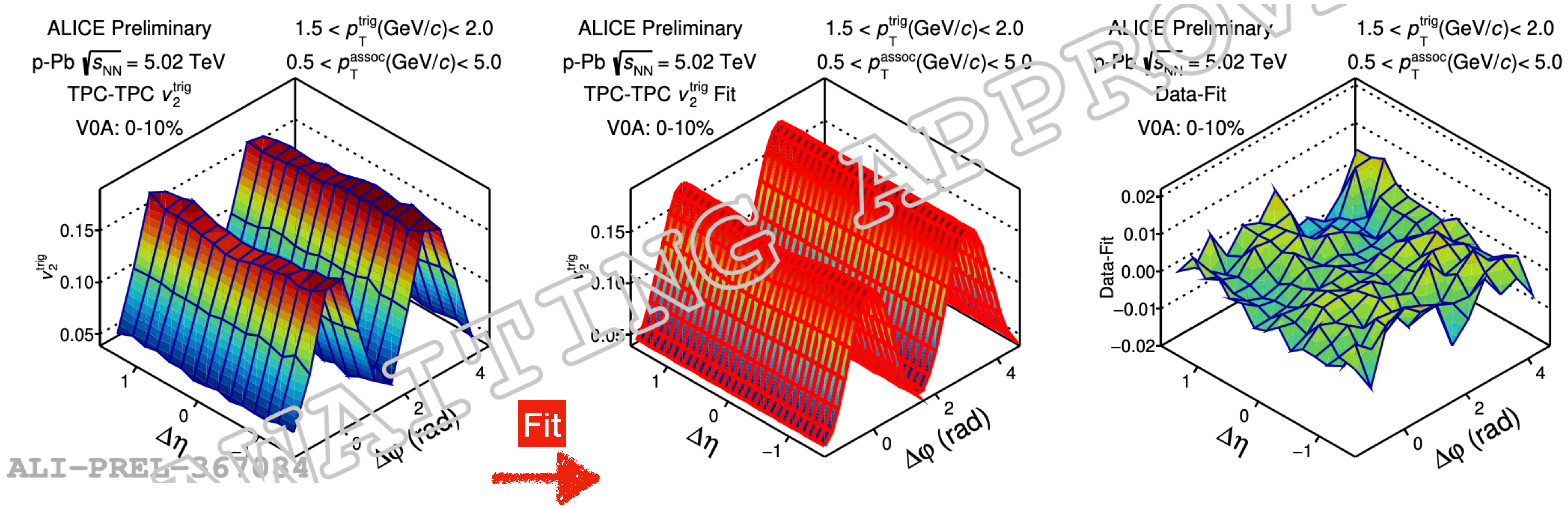
Jet peak

$x = \Delta\varphi, y = \Delta\eta$

$$\frac{1}{2}a_0\left(e^{-\left(\frac{x^2}{2a_1^2}+\frac{y^2}{2a_2^2}\right)}+e^{-\left(\frac{(2\pi-x)^2}{2a_1^2}+\frac{y^2}{2a_2^2}\right)}\right)+\frac{1}{2}a_3\left(e^{-\left(\frac{x^2}{2a_4^2}+\frac{y^2}{2a_5^2}\right)}+e^{-\left(\frac{(2\pi-x)^2}{2a_4^2}+\frac{y^2}{2a_5^2}\right)}\right)+b_0\left(1+b_1(1-\cos x)+2\sum_{n=2}^{5} b_n\cos(nx)\right)$$

- Double gaussian function is introduced to fit the jet signal, the sum of harmonics is used to fit background

Extraction of Jet v_2



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- The S/B obtained in TPC-TPC correlation is used as the weight to extract the v_2 of jet particles, in each p_T intervals

$x = \Delta\varphi, y = \Delta\eta$

$$\boxed{\frac{S}{S+B}}a_0 + \boxed{\frac{B}{S+B}}\left(a_1(1-a_7y) + a_1a_4(1-\cos x) + 2a_1(1+a_7y)(a_2\cos(2x) + a_3\cos(4x) + a_5\cos(5x) + a_6\cos(3x))\right)$$

v_2 of jet particles

v_2 of background