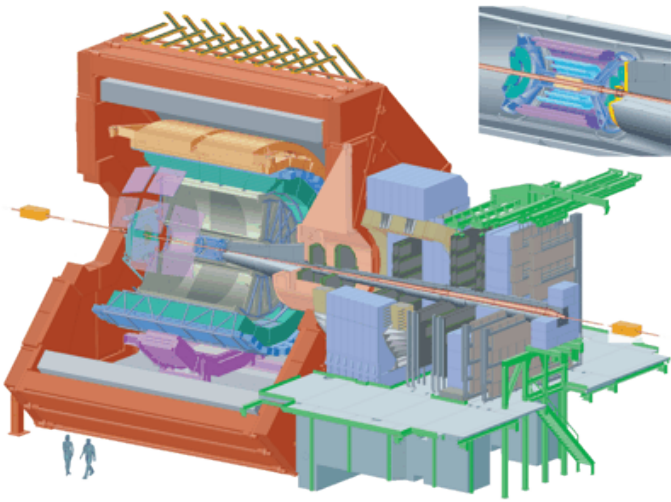
Forward–Mid rapidity correlation using TPC and V0 in ALICE p-Pb collisions at $\sqrt{S_{NN}}$ = 5.02 TeV

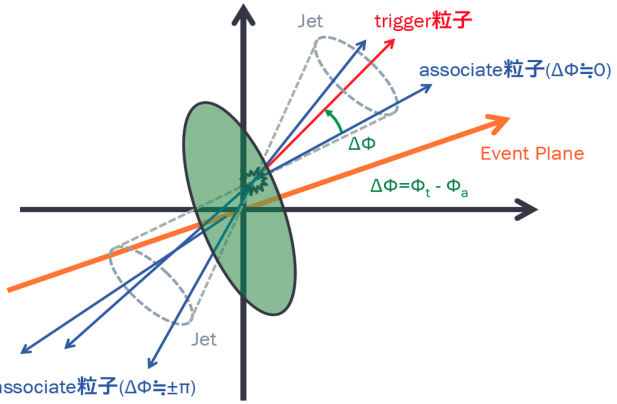
- Introduction
- Analysis method
- Result
  - ✓ *Correlation function*
  - ✓ *Fitting parameter*
  - ✓ v_n *TPC&V0*
- Summary & Outlook

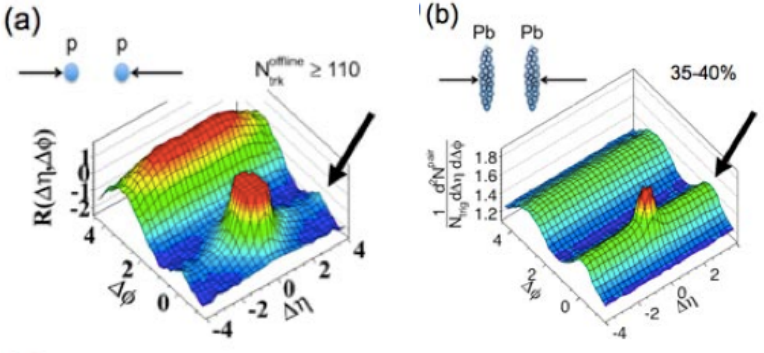
Kazuki Oshima



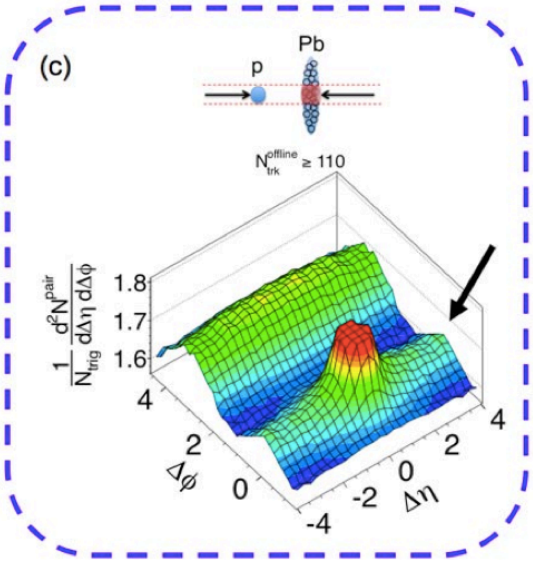
Introduction

- 2-particle correlation study.





- Ridge structure in heavy ion collision.
  - ✓ Enhancement C(Δϕ,Δη) at $|\Delta\phi| \sim 0$.
  - ✓ Not observed in MC.
  - ✓ Comes from early stage of collision.



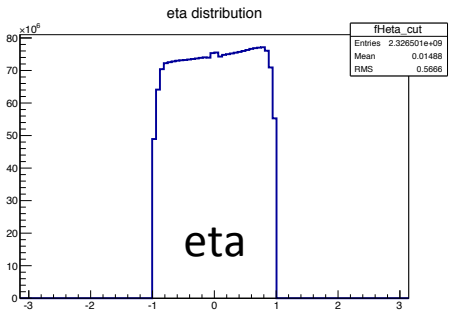
CMS arXiv:1210.5482v3

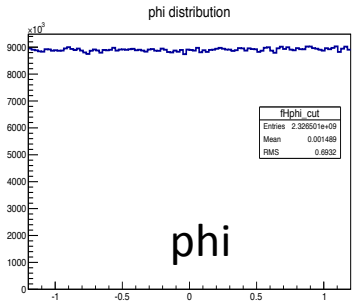
- p-A asymmetrical system
  - ✓ Expect there is different correlation between forward and backward.

Detectors

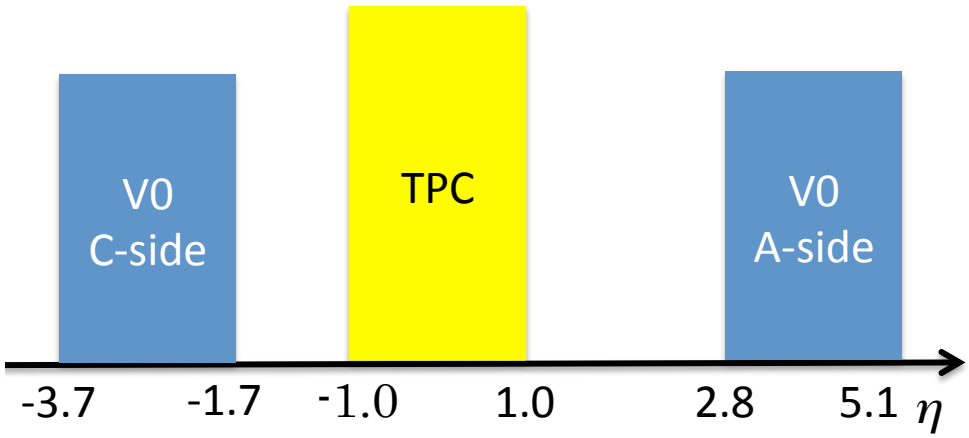
TPC

- ✓ tracking charged particle
- ✓ TPC track selection.
  - $|\eta| < 1.0$
  - tracking by TPC only





eta acceptance



TPC:TPC $|\Delta\eta_{max}| = 2.0$

V0C:TPC $|\Delta\eta_{max}| = 4.7$
V0A:TPC $|\Delta\eta_{max}| = 6.1$
V0C:V0A $|\Delta\eta_{max}| = 8.8$

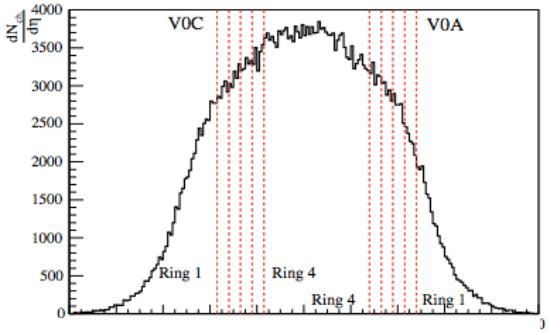
V0

- ✓ Define event class.
- ✓ TPC - V0 correlation
- ✓ V0C - V0A correlation

we can calculate correlation with larger eta gap!

V0-TPC correlation

- **V0 η acceptance**
  - ✓ C (p going) side : $-3.7 < \eta < -1.7$
  - ✓ A (Pb going) side: $2.8 < \eta < 5.1$



- **Definition of track(ϕ,η)**
  - ✓ item1 : center of each V0 segment's angle. inclusive p_T

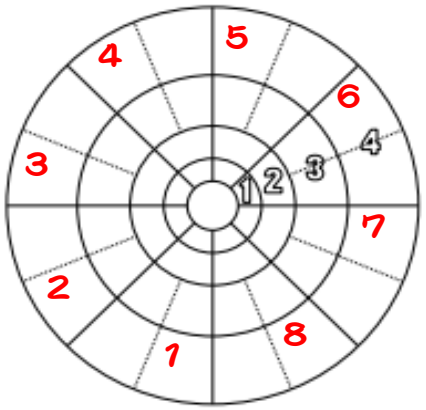
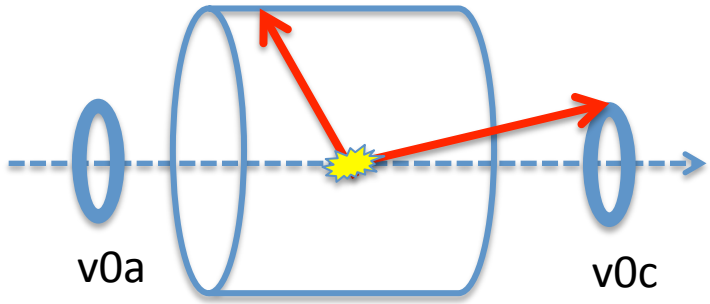


Table 3.1: V0A and V0C arrays. Pseudo-rapidity and angular acceptances (deg.) of the rings.

Ring	V0A		V0C	
	η_{max}/η_{min}	$\theta_{min}/\theta_{max}$	η_{min}/η_{max}	$\theta_{max}/\theta_{min}$
1	5.1 / 4.5	0.7 / 1.3	−3.7 / −3.2	177.0 / 175.3
2	4.5 / 3.9	1.3 / 2.3	−3.2 / −2.7	175.3 / 172.4
3	3.9 / 3.4	2.3 / 3.8	−2.7 / −2.2	172.4 / 167.5
4	3.4 / 2.8	3.8 / 6.9	−2.2 / −1.7	167.5 / 159.8

  - ✓ item2: TPC charged 0.5~4.0 GeV



analysis flow

Define $\Delta\phi$, $\Delta\eta$

$$\Delta\phi = \phi_{TPC} - \phi_{V0}(seg) \quad \Delta\eta = \eta_{TPC} - \eta_{V0}(ring)$$

Correlation function

✓ weighting factor(W_{V0}) ··· charged multiplicity in each v0 segment.

$$C(\Delta\phi, \Delta\eta) = \frac{N_{pair}^{mix}}{N_{pair}^{real}} \frac{A_{real}}{A_{mix}} \qquad A = \sum N_{TPC} W_{V0}(\Delta\phi, \Delta\eta)$$

$$dA = <W_{V0}> \sqrt{A / <W_{V0}>}$$

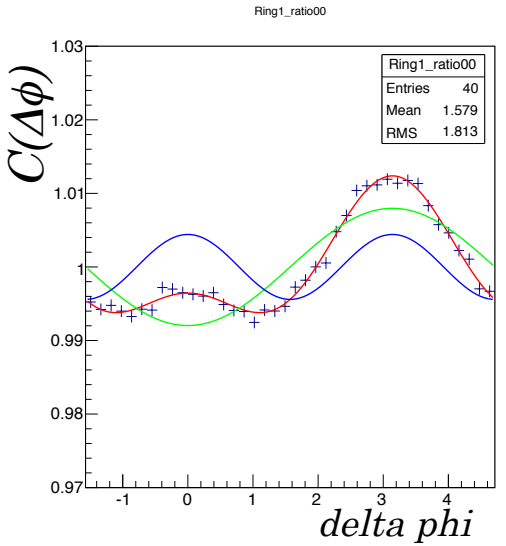
Fit by 2nd Fourier series

$$f(x) = C_0[1 + 2\{C_1 \cos(x) + C_2 \cos(2x)\}]$$

consider C_n as the product of v_n^{item1} and v_n^{item2}

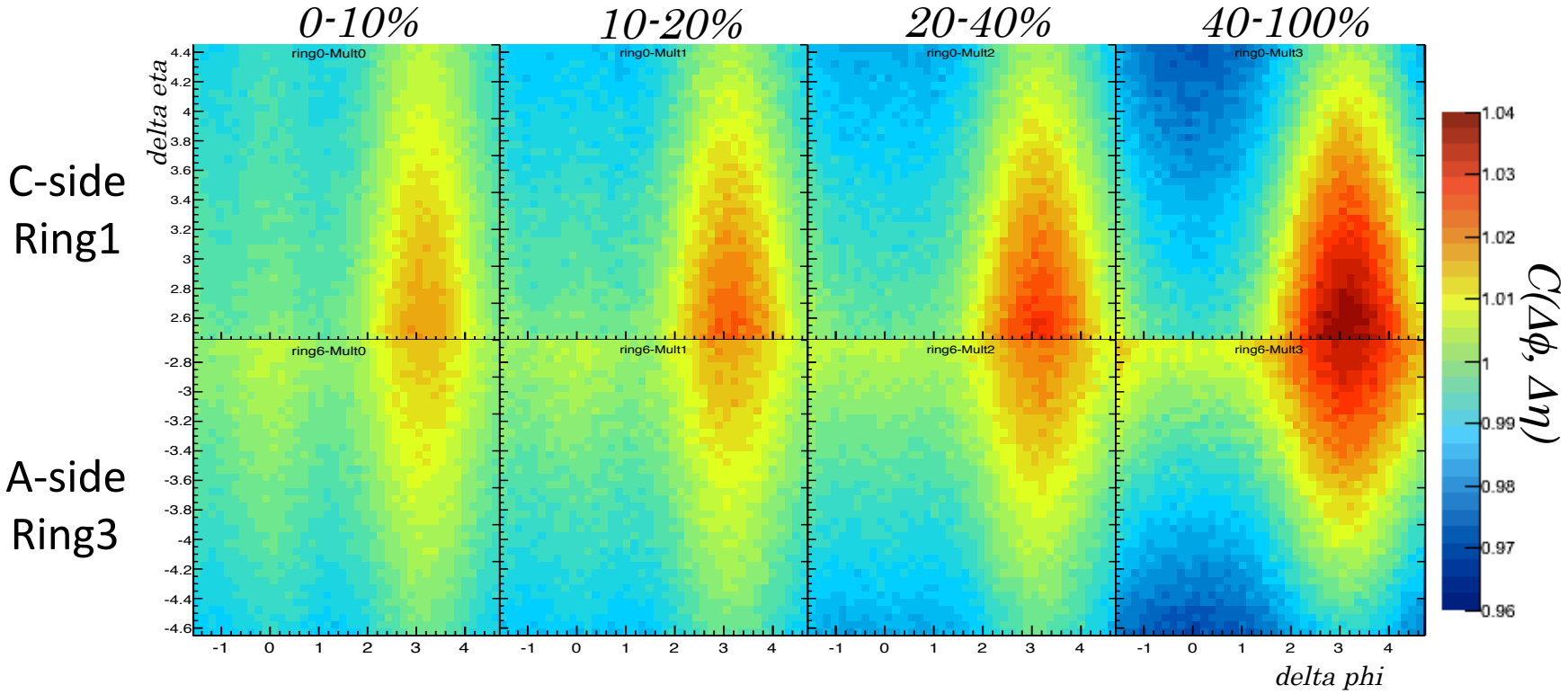
Event Class: 0-10%, 10-20%, 20-40%, 40-100%

high multiplicity ⟺ low multiplicity



Comparison C-side with A-side

- **Compare two ring, they have similar $|\eta|$**
  - ✓ C(p going) side Ring 1 ： $3.4 < \eta < 3.9$
  - ✓ A(Pb going) side Ring 3: $-3.7 < \eta < -3.2$



- ✓ v1-like effect in C-side is stronger than A-side
- ✓ v2-like effect in A-side is stronger than C-side

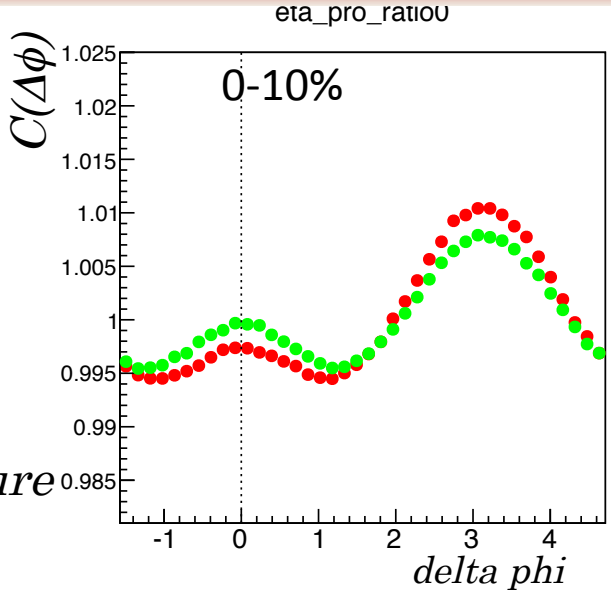
dphi slice

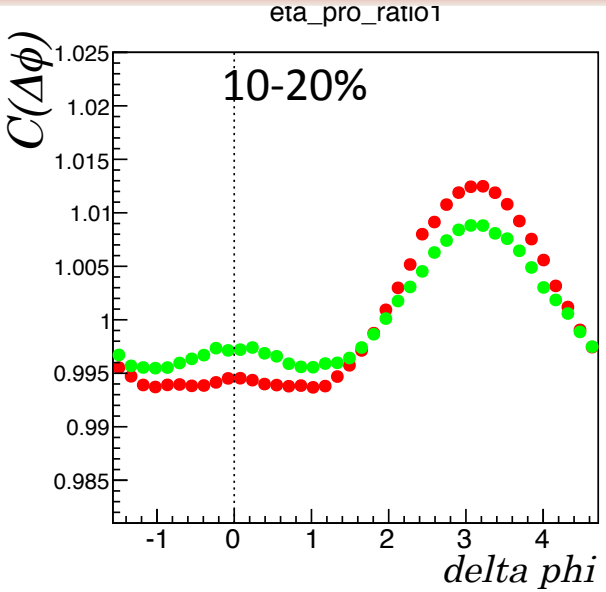
Slice
$3.6 < |\Delta\eta| < 4.4$

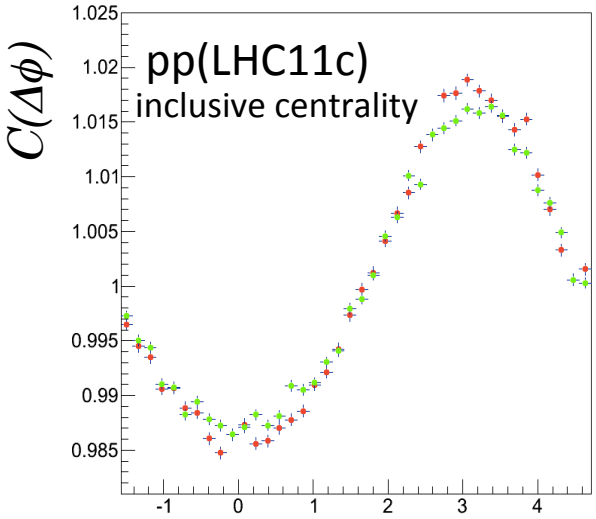
- C(p going) side
- A(Pb going) side

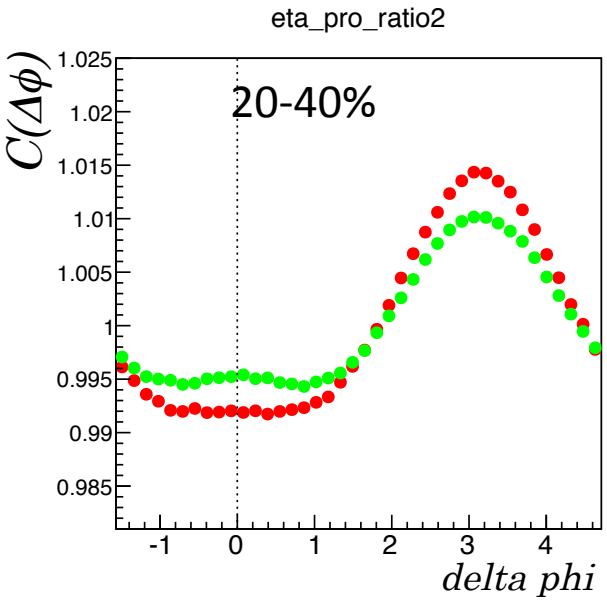
There are ridge like structure

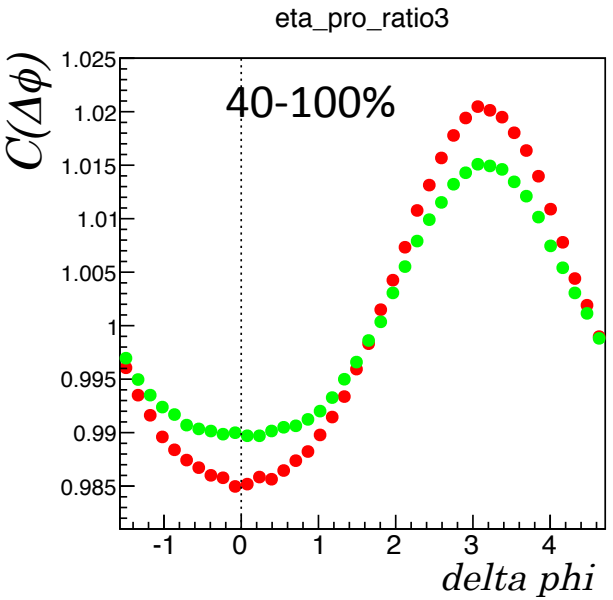
Near side peak has multiplicity dependence.









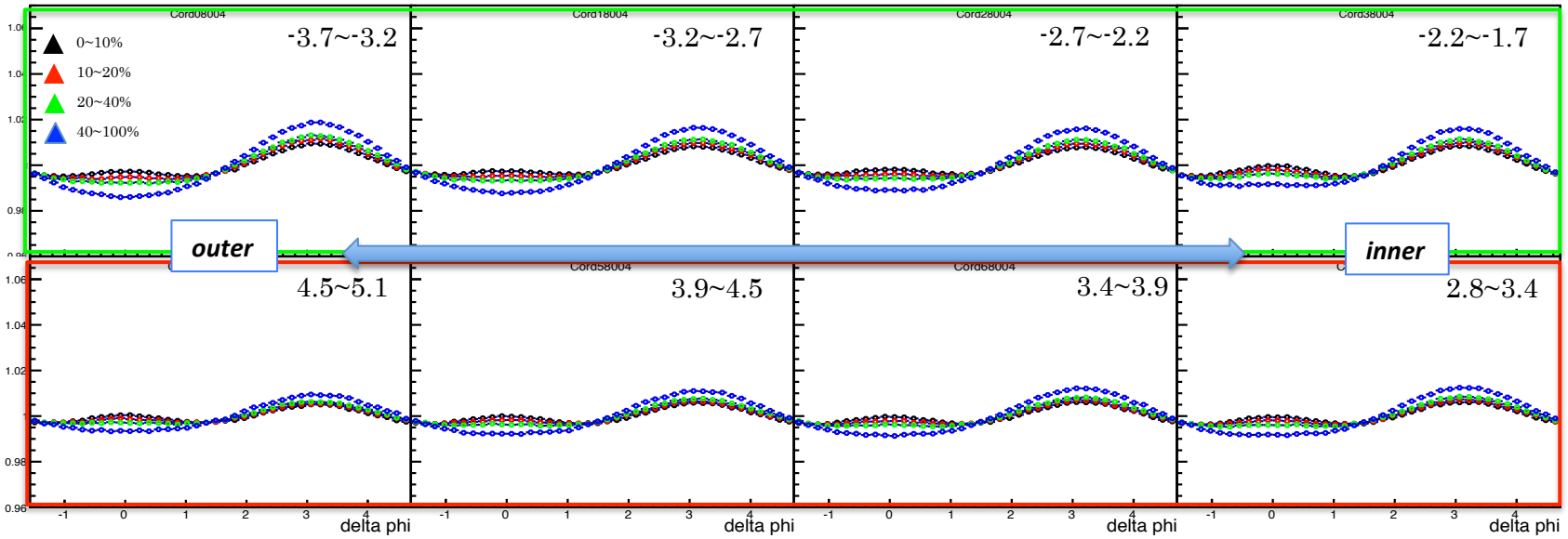


$C(\Delta\phi)$ shape

0.5~1.0GeV

C-side

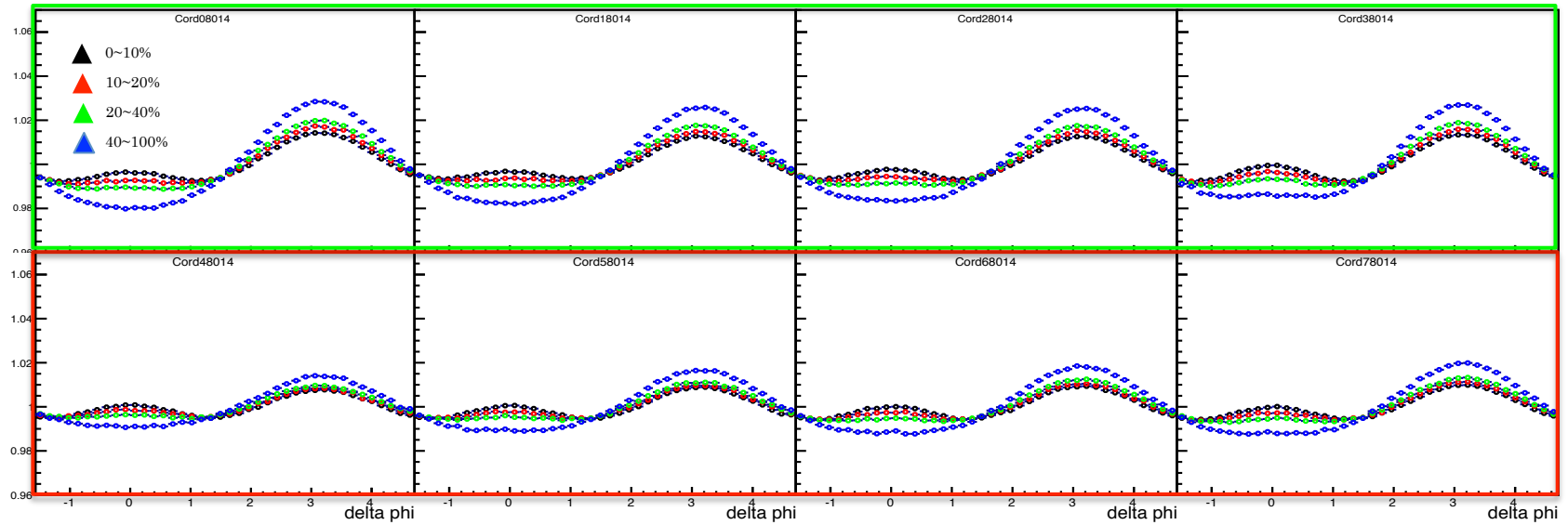
A-side



1.0~2.0GeV

C-side

A-side

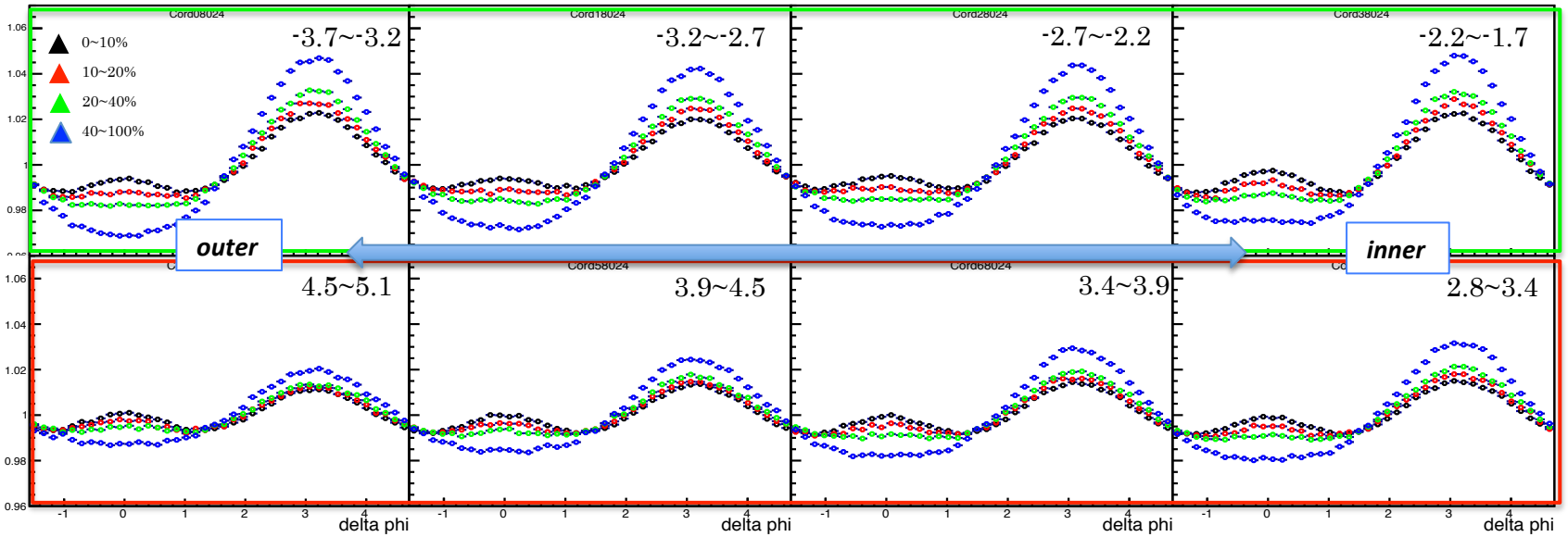


$C(\Delta\phi)$ shape

0.5~1.0GeV

C-side

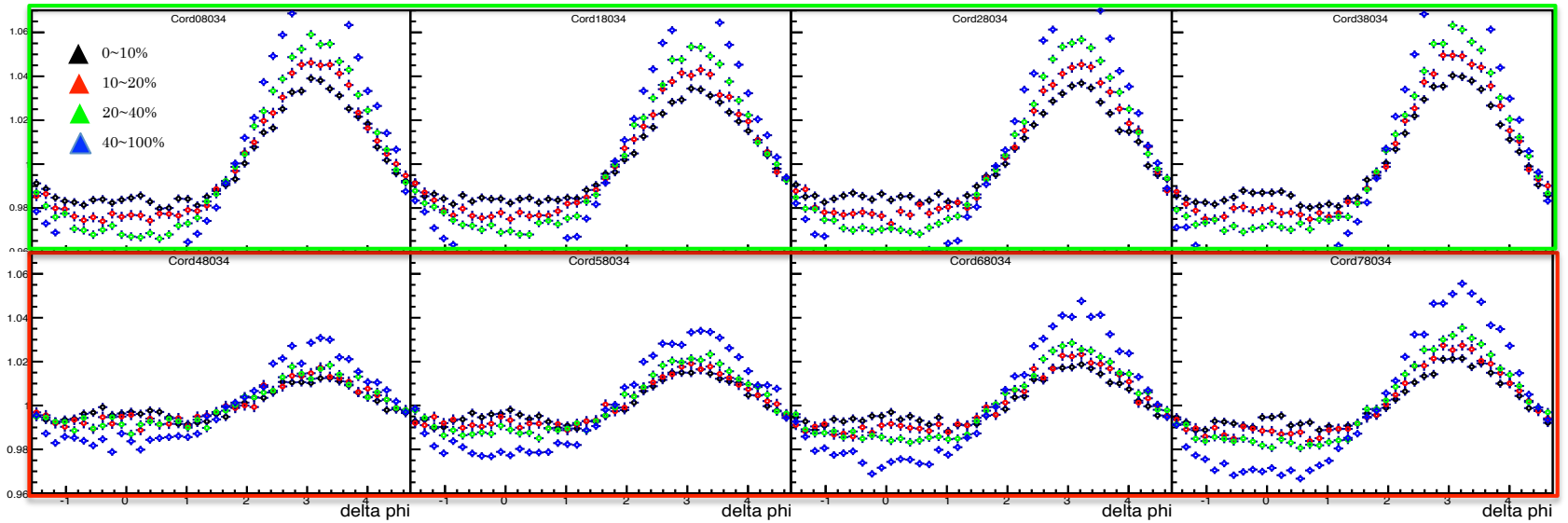
A-side



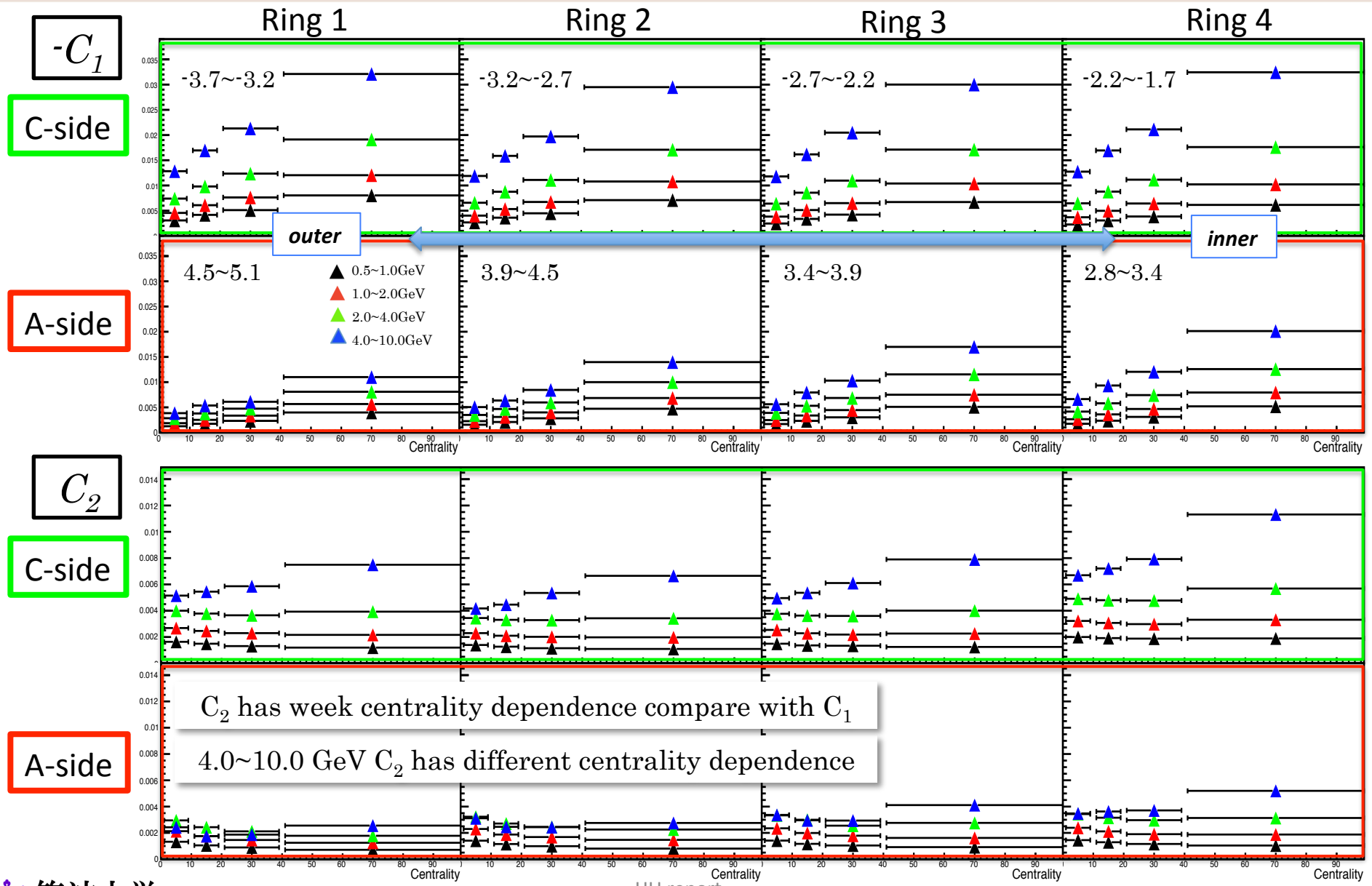
1.0~2.0GeV

C-side

A-side



Centrality dependence



V0 C-side – A-side correlation

- Define Δϕ, Δη

$$\Delta\phi = \phi^{V0A}(seg) - \phi^{V0C}(seg) \quad \Delta\phi = \eta^{V0A}(ring) - \eta^{V0C}(ring)$$

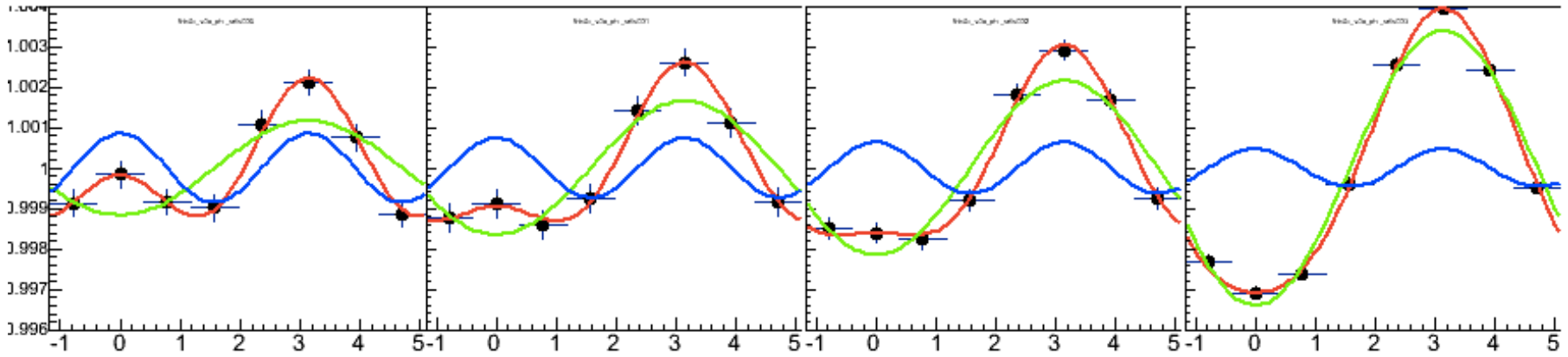
- Correlation function
  - ✓ weighting factor(W_{V0})・・・charged multiplicity in each v0 segment.

$$C(\Delta\phi, \Delta\eta) = \frac{N^{mix}_{pair}}{N^{real}_{pair}} \frac{A_{real}}{A_{mix}} \qquad A = \sum W_{V0A} W_{V0C}(\Delta\phi, \Delta\eta)$$

$$dA = <W_{V0C}><W_{V0A}> \sqrt{A/ <W_{V0C}><W_{V0A}>}$$

- Correlation A-side ring 4 and C-side 4: |Δη|=8.1

0-10% *10-20%* *20-40%* *40-100%*



summary & outlook

- It seems that there are ridge like structure in large Δη region with clearly centrality dependence.
- Strong v2-like effect in central, strong v1-like effect in peripheral.
- There are the different correlation between p-going side and Pb-going side.
- Strong v1-like effect in the p-going side.
- Strong v2-like effect in the Pb-going side.

outlook

Quantitative analysis of extracted Fourier parameters is on going in order to understand the observed ”ridge-like" experimental data with jet-like and/or flow-like features.

Backup

Productions

- Data set
  - LHC13b pass3 AODs

    195344, 195346, 195351, 195389, 195390, 195391, 195478, 195479, 195480, 195481, 195482, 195483.

  - LHC13c pass2 AODs

    195529, 195532, 195566, 195567, 195568, 195592, 195593, 195596, 195633, 195635, 195644, 195673, 195675, 195677.

- MC data DPM(dual parton model generator)
  - MC:LHC13b2・・・p-A, DPMJET anchored to LHC13b

    195344, 195346, 195351, 195389, 195390, 195391, 195478, 195479, 195480, 195481, 195482, 195483.

  - MC:LHC13b2_fix_1 and LHC13b2_efix_p1

    ・・・p-A, DPMJET anchored to LHC13b,c

    195344, 195346, 195351, 195389, 195390, 195391, 195478, 195479, 195480, 195481, 195482, 195483, 195529, 195531, 195566, 195567, 195568, 195592, 195593, 195596, 195633, 195635, 195644, 195673, 195675, 195677.

Event Selection

- **LHC13b pass3 AODs**
  - ✓ run number:195344,195346,195351,195390,195391,195478,195479, 195480,195381,195482,195483
- **LHC13c pass2 AODs**
  - ✓ run number:195529, 195532, 195566, 195567, 195568, 195592, 195593, 195596, 195633, 195635, 195644, 195673, 195675, 195677
- **Event Selection :**
  - ✓ minimum bias kINT7: requiring a signal in both V0-A and V0-C.
  - ✓ -8 cm < Zvertex < +8 cm

  after all event selection, I used 80 million events…
- **Event mixing class**
  - ✓ divide to 10 classes about zvertex.
  - ✓ divide to 10 classes about multiplicity.

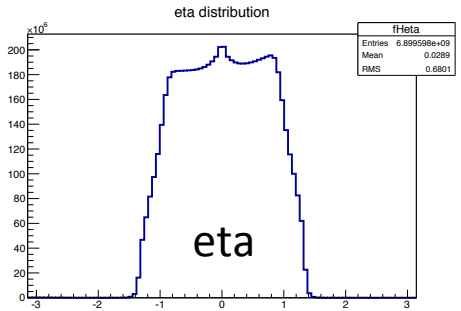
  multiplicity is decided by sum of v0 multiplicity about both side

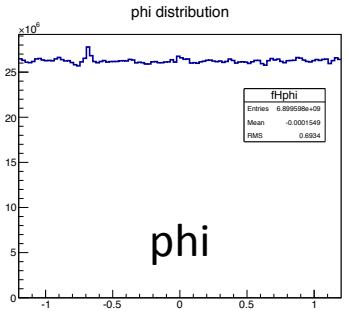
Track selection

- AliAODFilterBit(7): tracked by TPC only
  - ✓ Min-NClusterTPC > 70,
  - ✓ MaxChi2PerClusterTPC > 4,
  - ✓ AcceptKinkDaughters = kFALSE,
  - ✓ MaxDCAZ < 3.2 cm, MaxDCAXY < 2.4 cm
  - ✓ DCAtoVertex2D = kTRUE

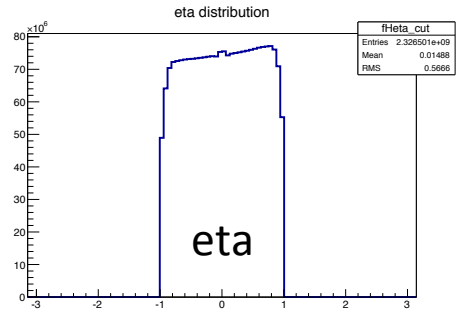
- Another cut
  - ✓ $|\eta|<1.0$
  - ✓ $0.5 < p_T < 4.0$

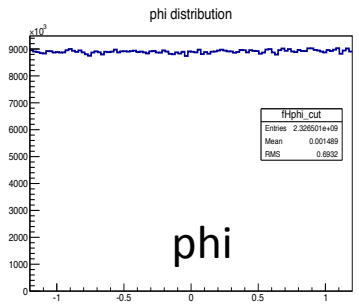
before



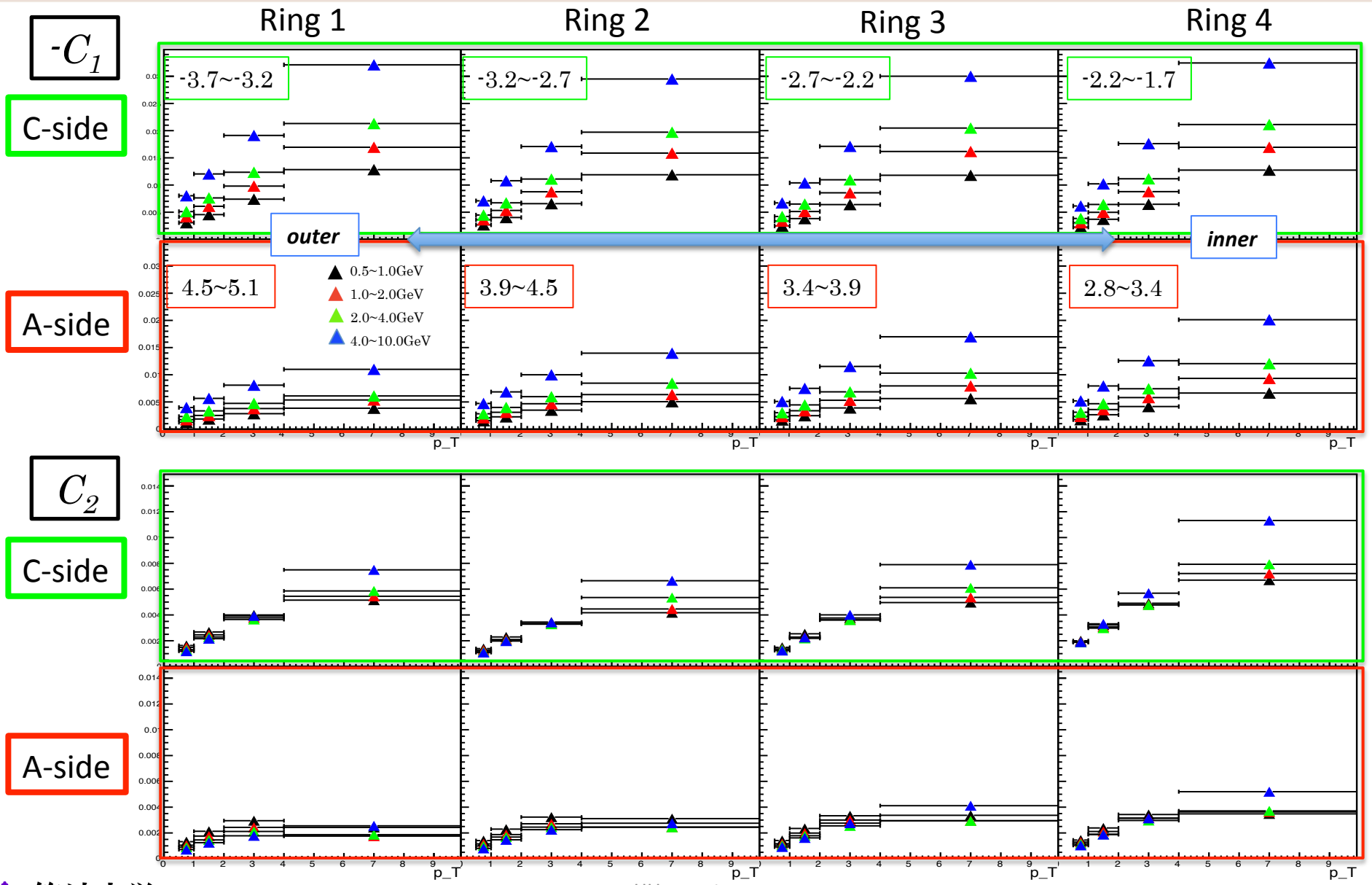


after





Pt dependence



The shape $C(\Delta\phi)$ V0C – V0A