Searching Back to back jets in single phonuclear excitations in Pb+Pb collisions at sqrt(SNN)=5 TeV,pPb at 8Tev with MonteCarlo Simulation(STARLIGHT+DPMJET)

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August 20 2016

Outline

- The Reproduction of the Paper:

  Single and double photonuclear excitations in Pb+Pb collisions at sqrt(SNN)=2.76 TeV at the CERN Large Hadron Collider PhysRevC.83.04190.
- Comparison 5TeV and 2.76 Pb-Pb collisions
- Searching for jets in 5TeV collisions
- Increasing W value
- Studying peaks in deltaphi deltaeta distributions
- What happens with 8TeV collisions?
- Abraham Villatoro Cross check
- To do

- Ultraperipheral Collisions: No geometrical overlap between the colliding nuclei.(Hadronic interaction supressed)

Ions which are accelerated by the
LHC themselves carry an electromagnetic field,
which can be viewed as a source of
photons.

Strong electromagnetic fields with impact parameter larger than the sum of
The nuclear radii lead to large cross sections for
Photonuclear processes.

Reproducing Paper

Single and double photonuclear excitations in Pb+Pb collisions at sqrt(SNN)=2.76 TeV at the CERN Large Hadron Collider

Importance of the study

- Single and Double photon exchange in ultraperipheral Pb+Pb collisions. Since large cross sections are found for particle production around midrapidity, these events are important background to hadronic nuclear interactions at both the trigger and analysis levels
- If the photonuclear events can be clearly separated from the hadronic events, valuable information on the nuclear parton distributions would be provided.(Production cc pair through gamma+gluon fusion).

What is presented in the paper

- Cross section calculation for single and double photon exchange in ultraperipheral Pb+Pb collisions with DPMJET simulation.
- Information about pT, PseudoRapidity,Multiplicity and Photon Energy distributions in this events.

Considerations in the paper

- It is considered particle production in a general photonuclear interaction, $\gamma + A \rightarrow X$ in ultraperipheral collisions between two lead nuclei at the collision energy 2.76 TeV

  The particle production in the photonuclear interactions is modeled using the DPMJET Monte Carlo event generator.

- DPMJET two component dual parton model. It can handle low or intermidate photon virtualities, which is fine for Weizsäcker-Williams method.
- NO considereation of fragmentation of the target nucleus. However, knockout protons from the target remnant are included.

Reproducing the paper

SIMULATION OF EVENTS

- Used STARLIGHT+DPMJET

  VERSION:

  STARLIGHT:trunk

  DPMJET: dpmjet3.0-6

  PYTHIA: pythia6115dpm3v1
- PHOJET: phojet1.12-35c4

Slight.in

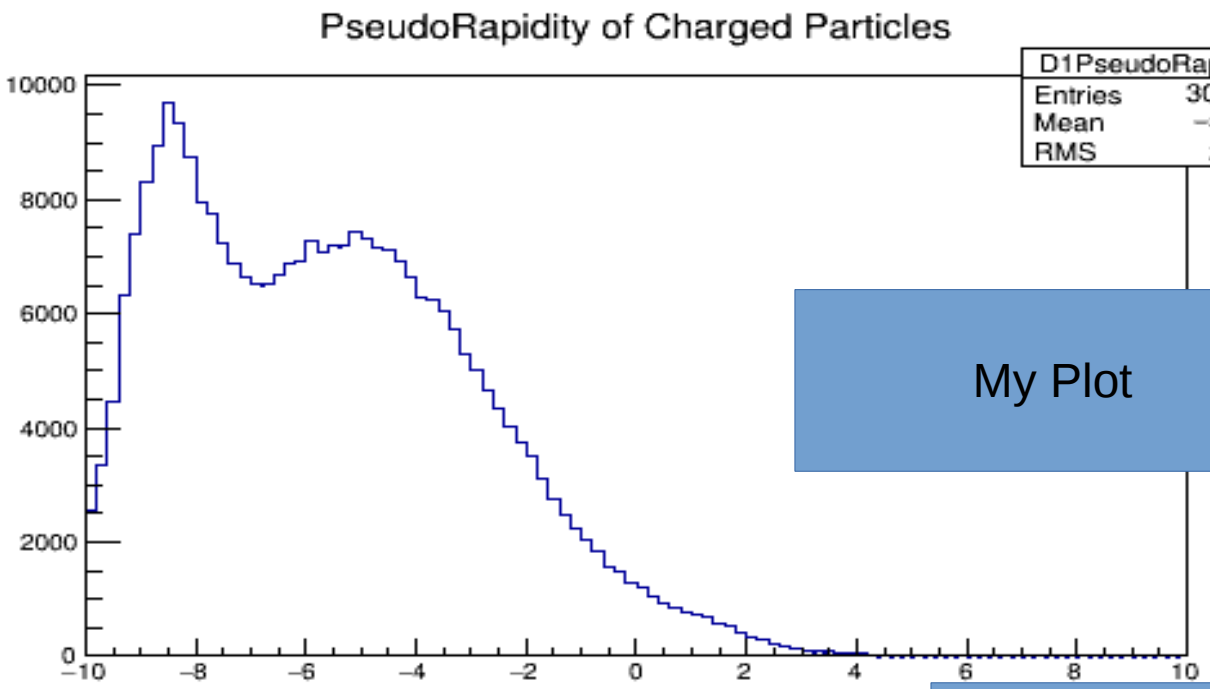
```
BEAM_1_Z = 82    #Z of projectile
BEAM_1_A = 208   #A of projectile
BEAM_2_Z = 82   #Z of target
BEAM_2_A = 208   #A of target
BEAM_1_GAMMA = 927.3 #Gamma of the colliding ions
BEAM_2_GAMMA = 927.3 #Gamma of the colliding ions
W_MAX = 12.0   #Max value of w
W_MIN = 2.0    #Min value of w
W_N_BINS = 40    #Bins i w
RAP_MAX = 8.    #max y
RAP_N_BINS = 80    #Bins i y
CUT_PT = 0 #Cut in pT? 0 = (no, 1 = yes)
PT_MIN = 1.0 #Minimum pT in GeV
PT_MAX = 3.0 #Maximum pT in GeV
CUT_ETA = 0 #Cut in pseudorapidity? (0 = no, 1 = yes)
ETA_MIN = -10 #Minimum pseudorapidity
ETA_MAX = 10 #Maximum pseudorapidity
PROD_MODE = 5     #gg or gP switch (1 = 2-photon, 2 = coherent vector meson (narrow), 3 = coherent vector meson
 (wide),
# 4 = incoherent vector meson, 5 = A+A DPMJet single, 6 = A+A DPMJet double, 7 = p+A DPMJet single, 8 = p+A Pythia
single )
N_EVENTS = 10000   #Number of events
PROD_PID = 443013   #Channel of interest (not relevant for photonuclear processes)
RND_SEED = 34533 #Random number seed
BREAKUP_MODE = 5     #Controls the nuclear breakup
INTERFERENCE = 0     #Interference (0 = off, 1 = on)
IF_STRENGTH = 1.    #% of intefernce (0.0 - 0.1)
INT_PT_MAX = 0.24  #Maximum pt considered, when interference is turned on
INT_PT_N_BINS =120   #Number of pt bins when interference is turned on
COHERENT = 1     #Coherent=1,Incoherent=0
INCO_FACTOR = 1.    #percentage of incoherence

# Photonuclear specific options, energies in Lab frame. These values should be within the range of the
# values specified in the DPMJet input file (when DPMJet is used)
MIN_GAMMA_ENERGY = 6.0
MAX_GAMMA_ENERGY = 600000.0
```

```
**********************************************************************
* Example for a DTUNUC input file.
* Uncomment the input-cards according to your requirements.
*
* Format: A10,6E10.0,A8
*       (except for the section enclosed by "PHOINPUT" and "ENDINPUT"
*        which is format-free)
*        lines starting with "*" are comment lines
**********************************************************************
*
* projectile / target / Energy
* -------------------
*      1       2       3       4       5       6       7
*23456789012345678901234567890123456789012345678901234567890123456789012345678
PROJPAR         0.0                                     PHOTON
TARPAR        208.0      82.0
ENERGY          6.0  600000.0
*ENERGY        100.0
* Initialize the random number generator
RNDMINIT       55.0     101.0      15.0      73.0
*
*
* PHOJET-specific input
* ---------------------
* The following lines control the event-generation with PHOJET for
* individual photon/nucleon-nucleon collisions.
* For details see the PHOJET-manual available at
*       http://lepton.bartol.udel.edu/~eng/phojet.html
* Any options explained in the PHOJET-manual can be used in between
* the "PHOINPUT" and "ENDINPUT" cards.
PHOINPUT
PROCESS          1 0 1 1 1 1 1 1
ENDINPUT
*
* Output
* ------
*   some default output (particle multiplicities etc.)
HISTOGRAM      101.0     102.0
* Start of event generation
* -------------------------
*START         5000.0       0.0
START         100.0       0.0
STOP
*  +    1    +    2    +    3    +    4    +    5    +    6    +    7
```

my.input

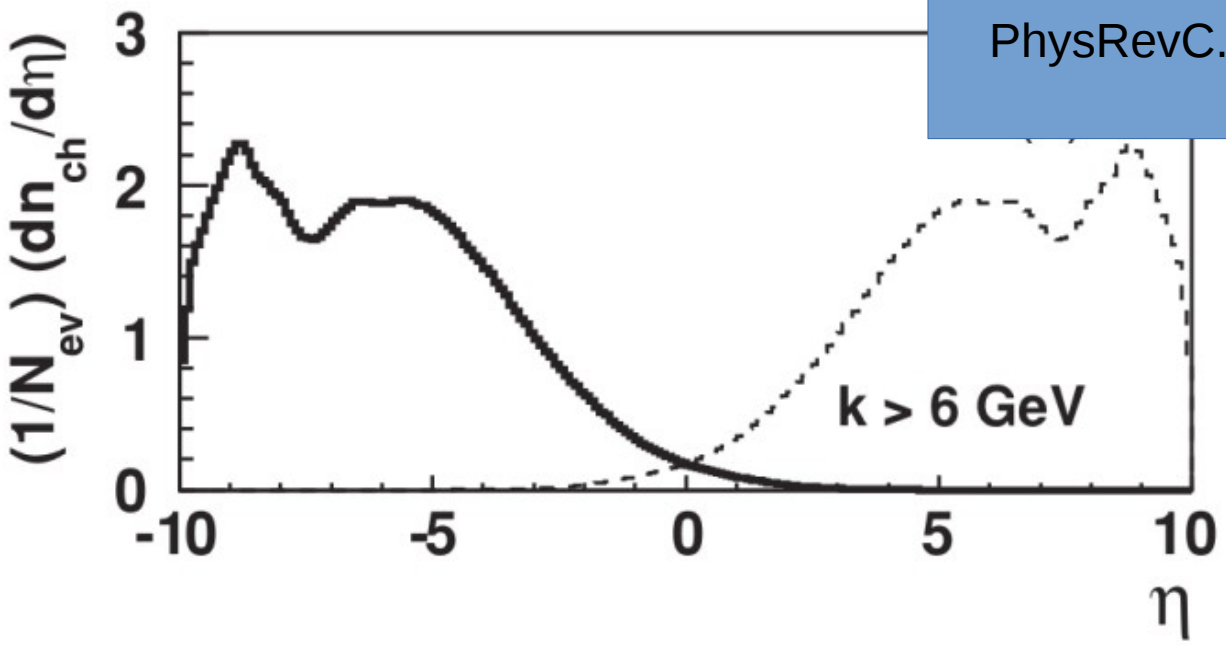
k_min>6GeV

The particle production become
More centered around
Midpseudorapidity with increasin
Photon energy.

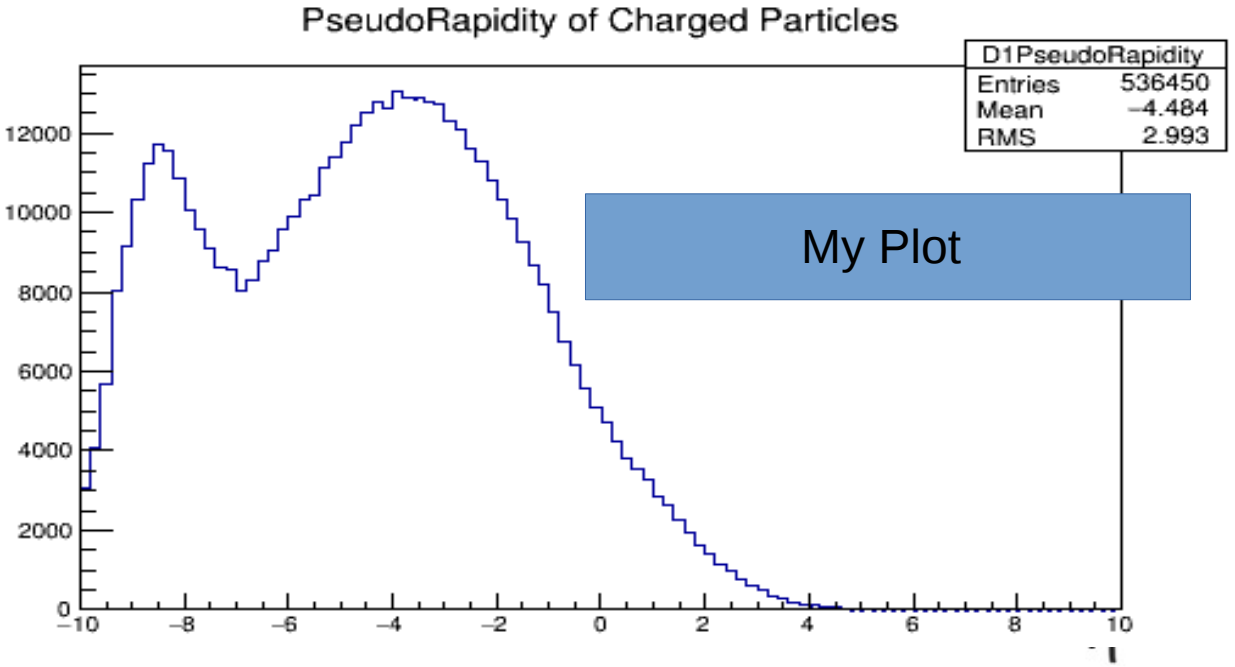


My Plot

PhysRevC.83041901

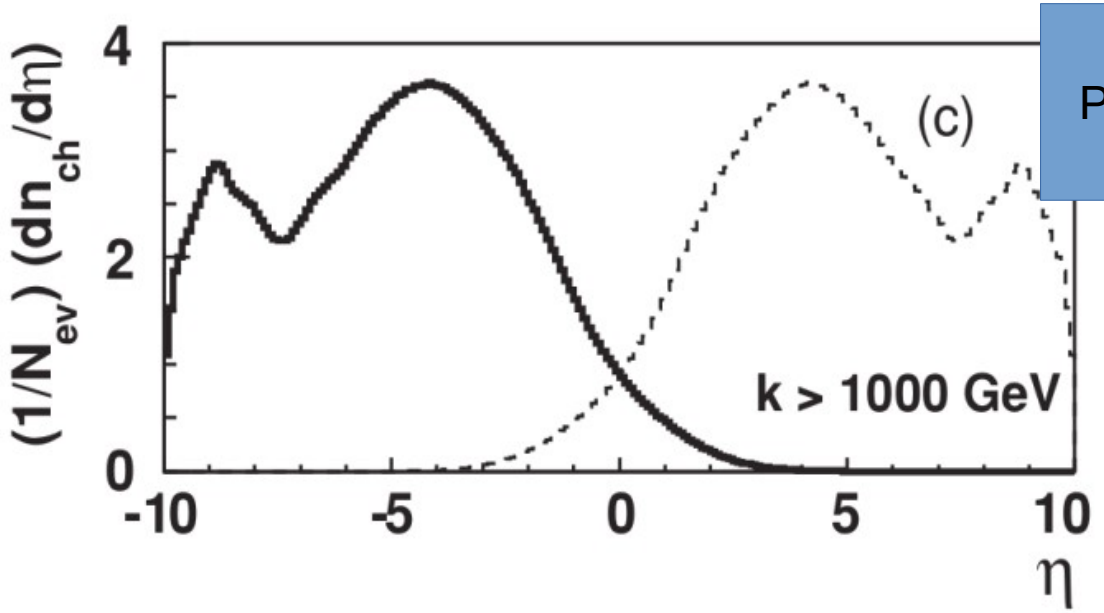


k_min>1000 GeV



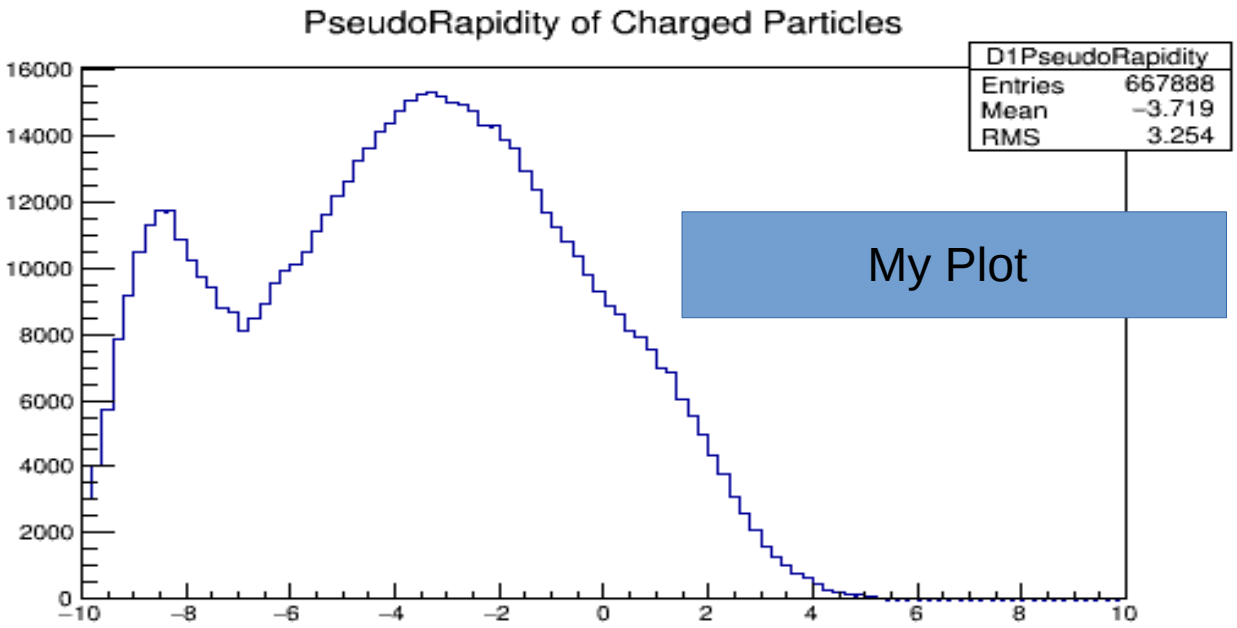
My Plot

The particle production become More centered around Midpseudorapidity with increasing Photon energy.



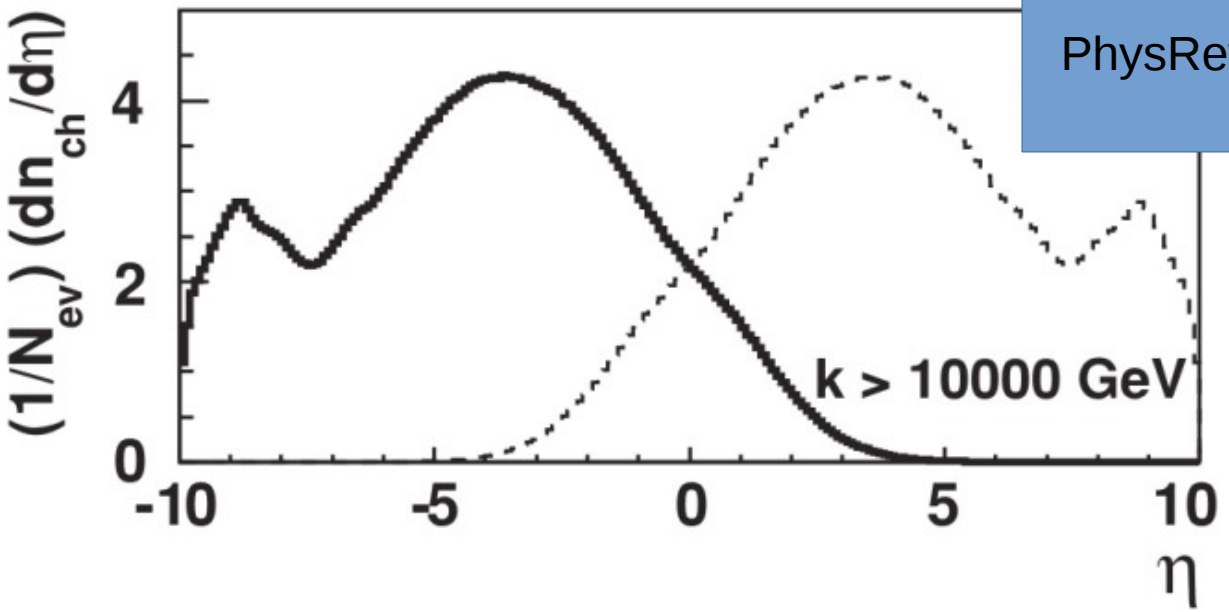
PhysRevC.83041901

k_min>10,000 GeV



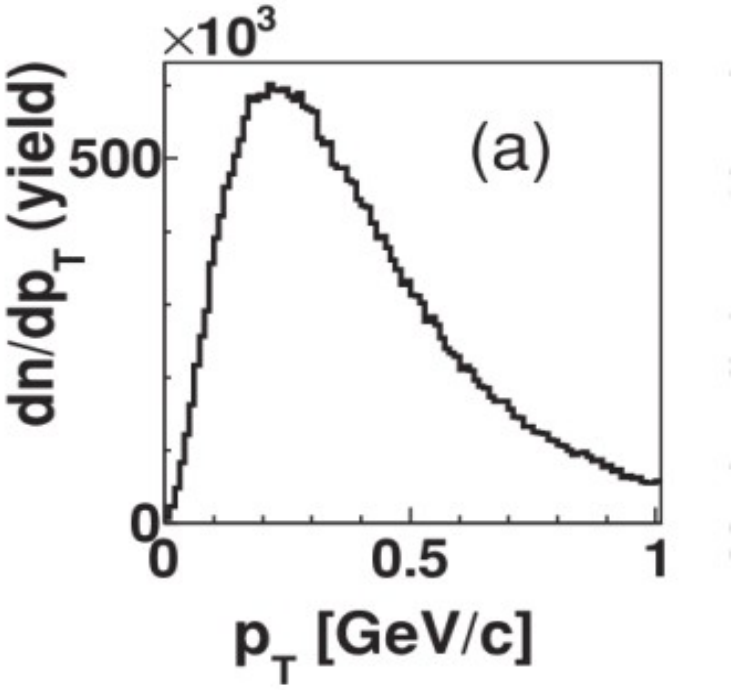
My Plot

The particle production become More centered around Midpseudorapidity with increasing Photon energy.

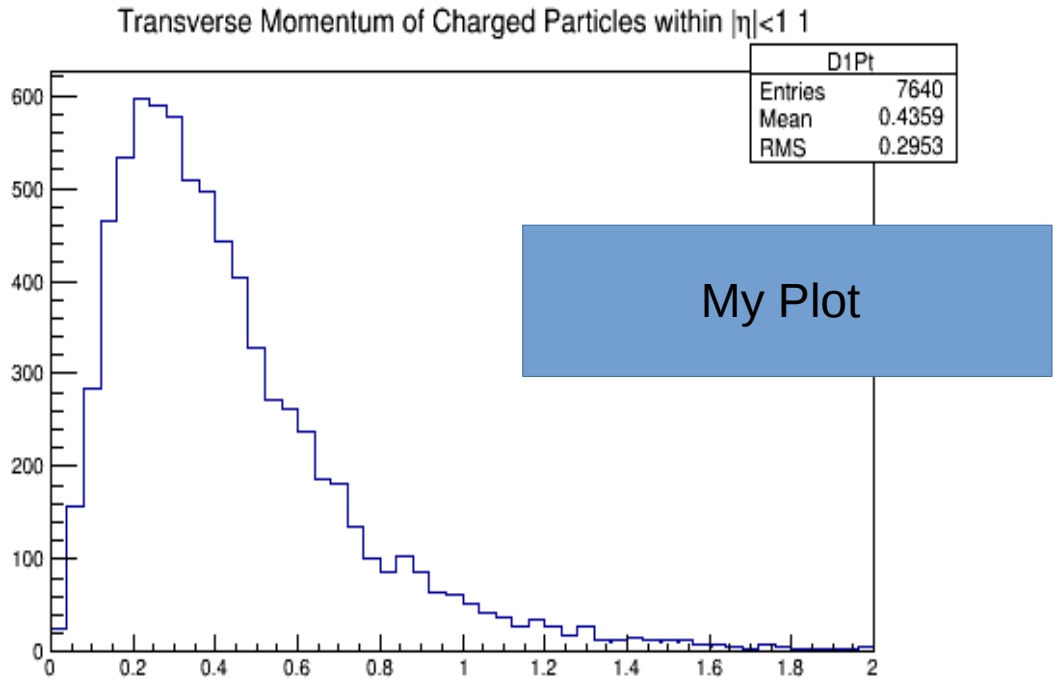


PhysRevC.83041901

k_min>6 GeV

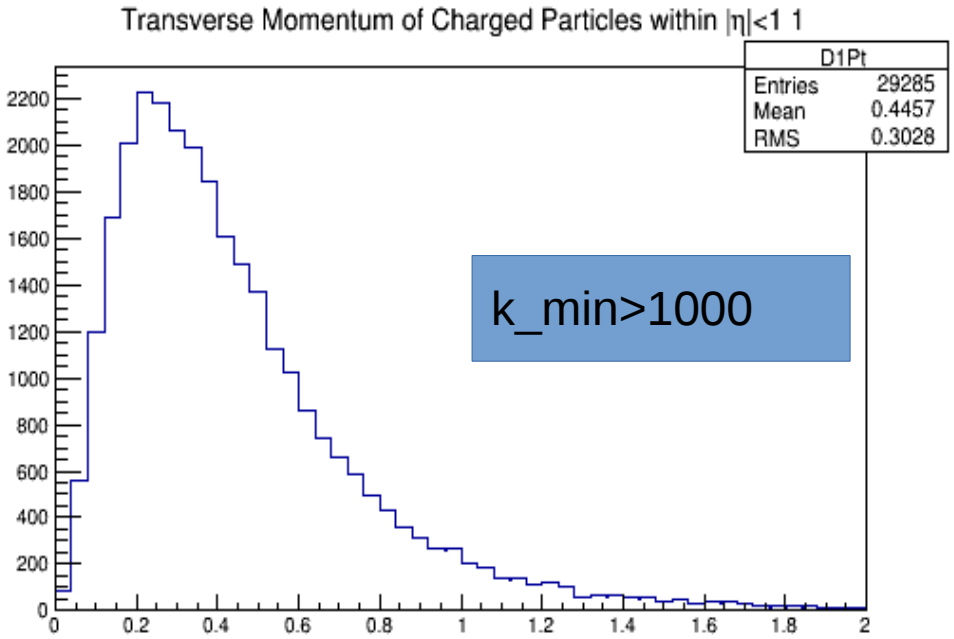


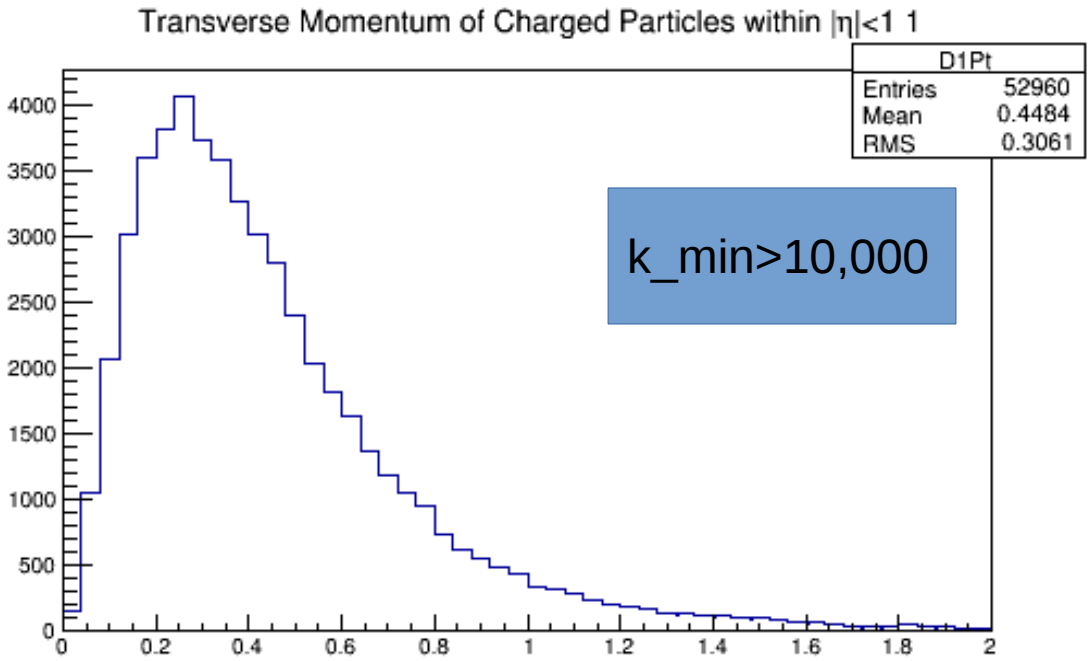
PhysRevC.83041901



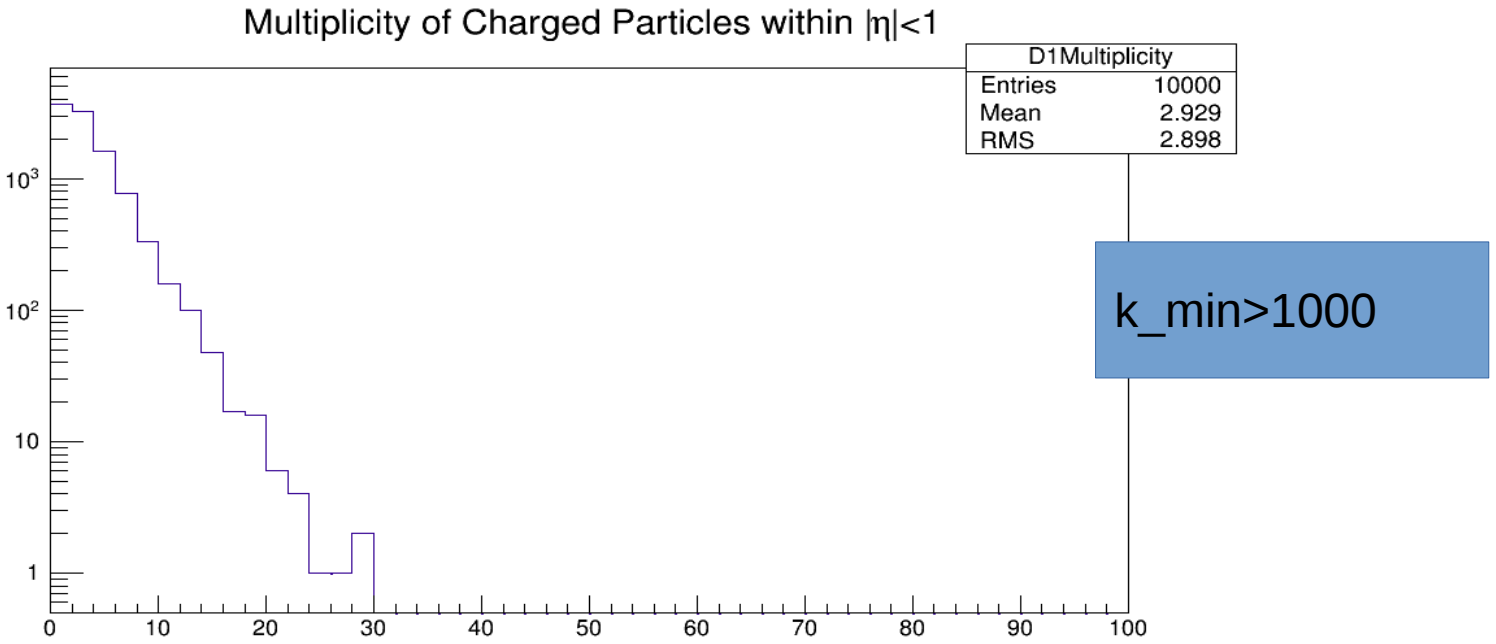
My Plot

The pT distribution is essentially
the same for all samples with a mean transverse momentum of p T ≈ 450 MeV/c

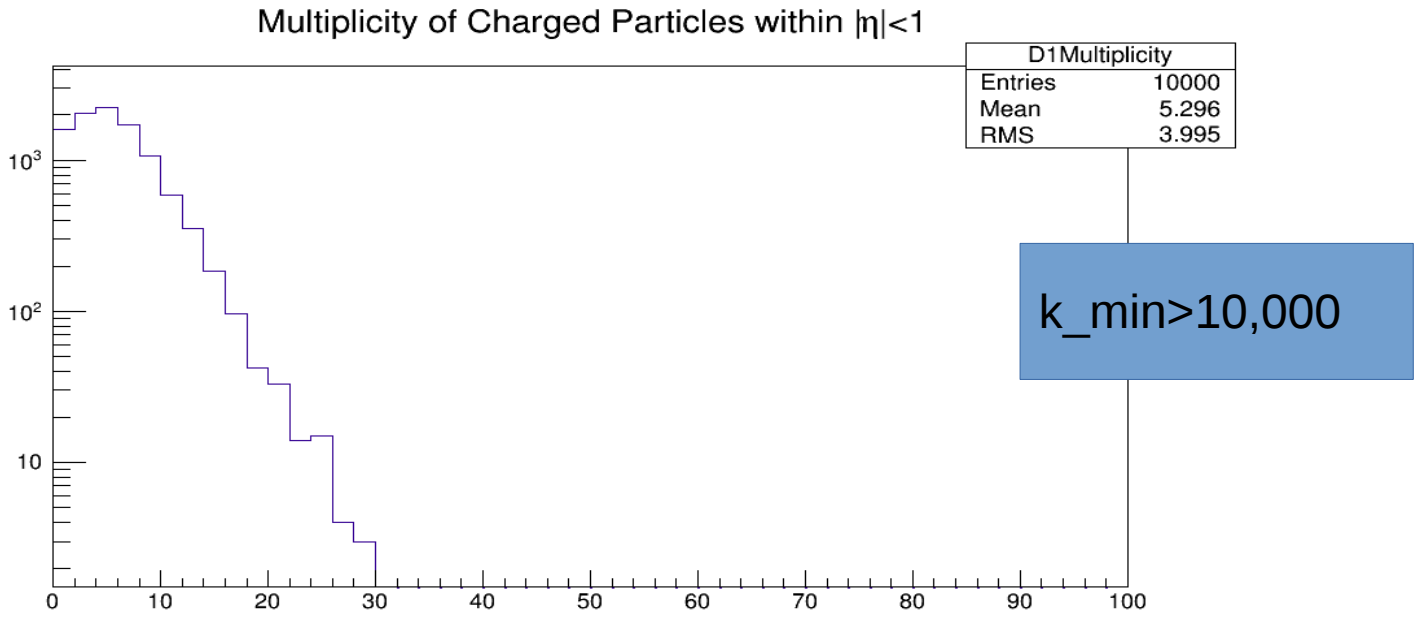




The pT distribution is essentially
the same for all samples with a mean transverse
momentum of p T ≈ 450 MeV/c



k_min>1000



k_min>10,000

Probability of having larger multiplicities around midpseudorapidity Is also high.

Cross Section

k_min [GeV]	All sigma(b)
6	23.62
1000	4.64
10000	0.81

My calculation Result

$k_{\min}$ (GeV)	Sir All
6	24.2
1000	4.9
10 000	0.90

PhysRevC.83041901

The cross section for a photonuclear interaction with photons from a single beam is then given by

$$\sigma_{A+A\to A+X} = \int_{k_{\min}}^{\infty} \frac{dn}{dk}\sigma_{\gamma A}(k)\,dk. \qquad (3)$$

$$\int_a^b f(x)\,dx \approx (b-a)\left[\frac{f(a)+f(b)}{2}\right]$$

Trapezoidal Rule

Important conclusions

- For particle production around midrapidity, photons with low energy do not contribute.The Photon Energy distribution goes to zero around k ≈ 150 GeV, and photons with energy lower than this do thus not contribute to the particle production within the two most central units of pseudorapidity.

- The single excitations, are characterized by a strong asymmetry around mid-rapidities event by event. They can thus be **rejected** by requiring the presence of particles on either side of midrapidity.

Intersted in 5 TeV collisions with single photon excitation

- We compare the features of 2.76 TeV collisions with the 5TeV ultraperipheral collisions
- We want to know about the cross section, the pT distributions, multiplicity, pseudorapidity.

Cross Section

k_min [GeV]	5 TeV All sigma(b)	(2.76TeV)All sigma(b)
6	27.66	23.62
1000	6.41	4.64
10000	1.58	0.81

My calculation Result

$k_{\min}$ (GeV)	All
6	24.2
1000	4.9
10 000	0.90

(2.76TeV)PhysRevC.83041901

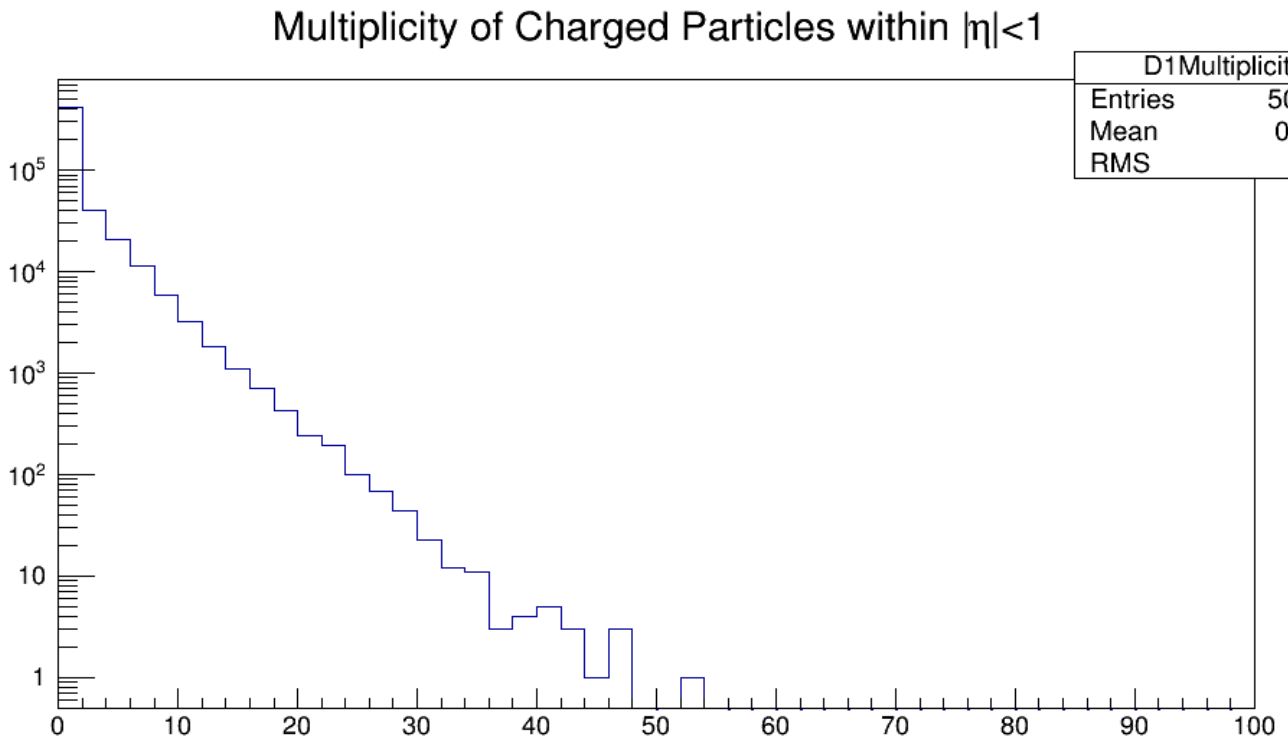
The cross section for a photonuclear interaction with photons from a single beam is then given by

$$\sigma_{A+A\to A+X} = \int_{k_{\min}}^{\infty} \frac{dn}{dk}\sigma_{\gamma A}(k)\,dk. \qquad (3)$$

$$\int_a^b f(x)\,dx \approx (b-a)\left[\frac{f(a)+f(b)}{2}\right]$$

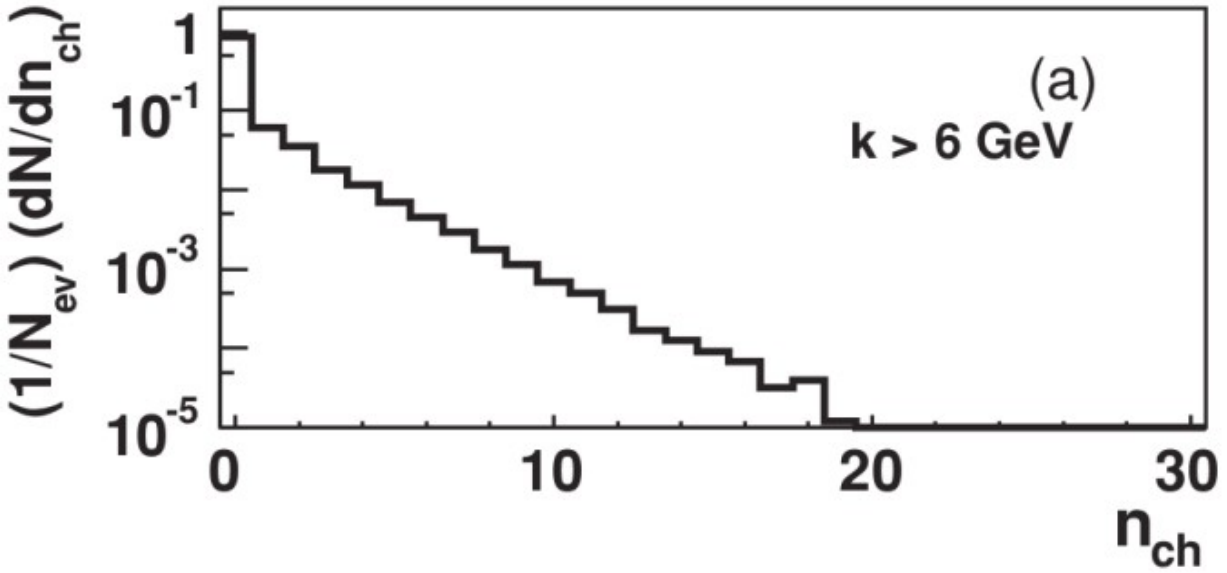
Trapezoidal Rule

- Comparisons with Energy Photon kmin>6GeV between 2.76TeV and 5 TeV

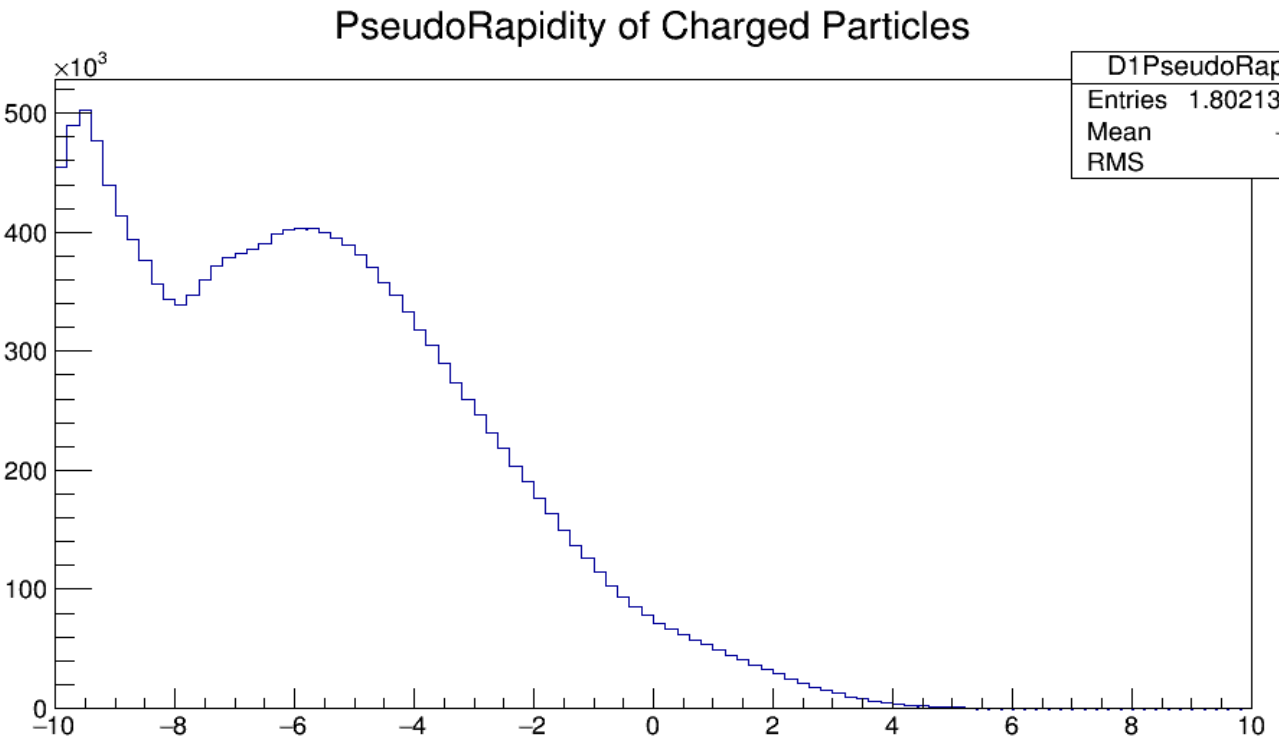


5TeV

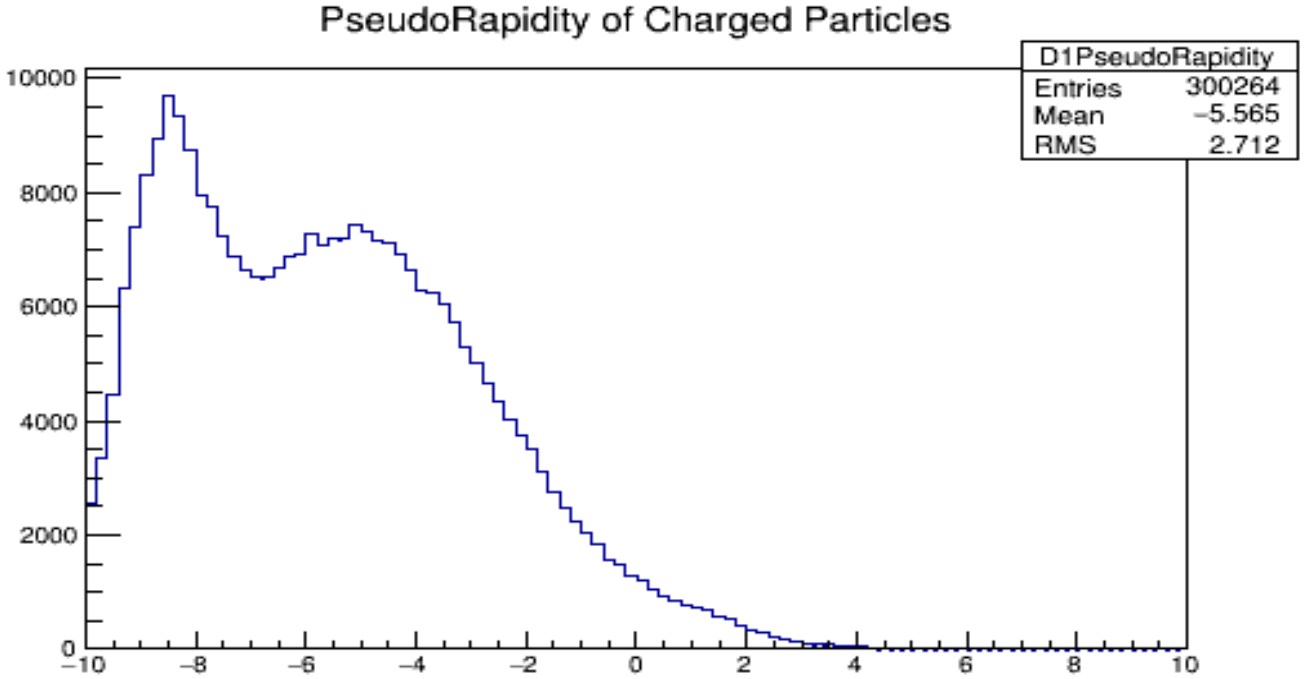
2.76TeV



- Comparisons with Energy Photon kmin>6GeV

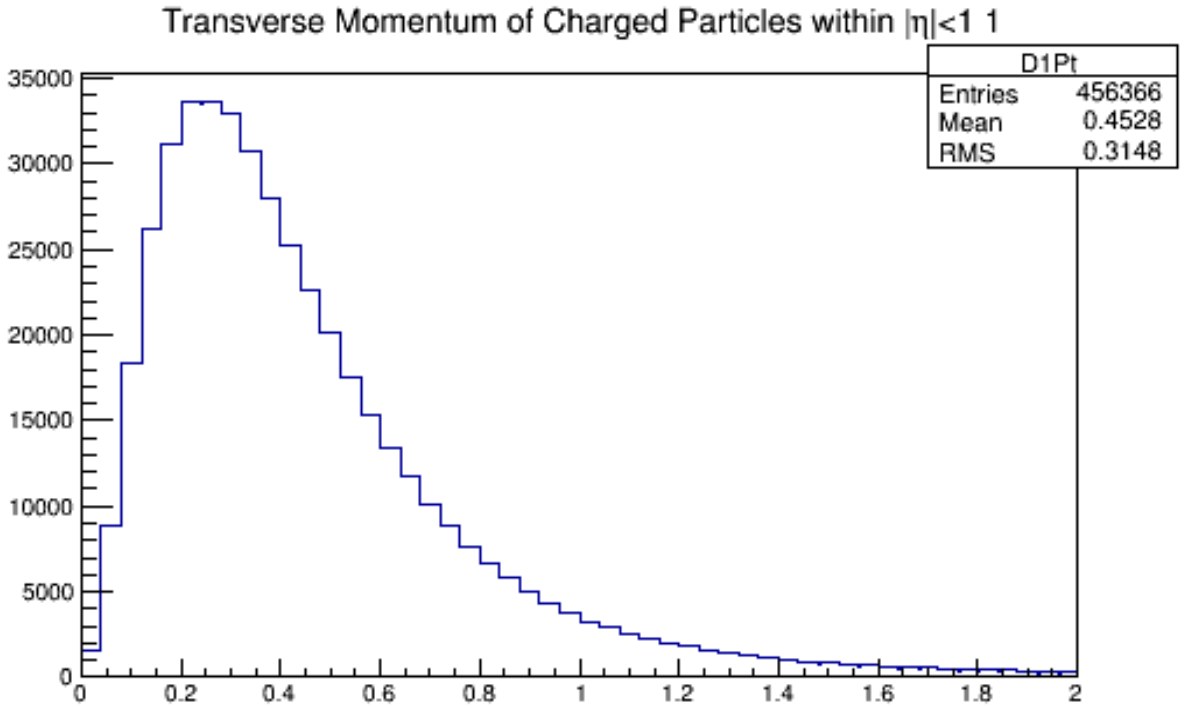


5TeV

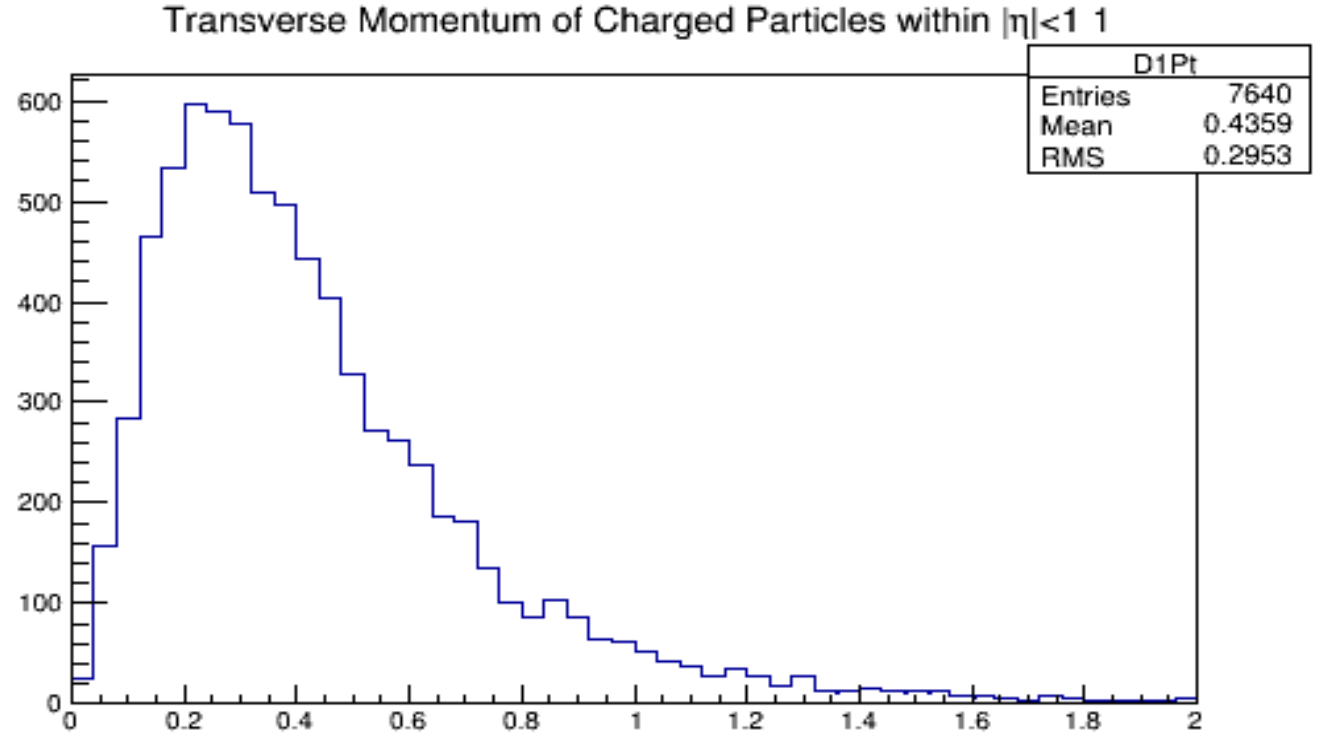


2.76TeV

- Comparisons with Energy Photon kmin>6GeV



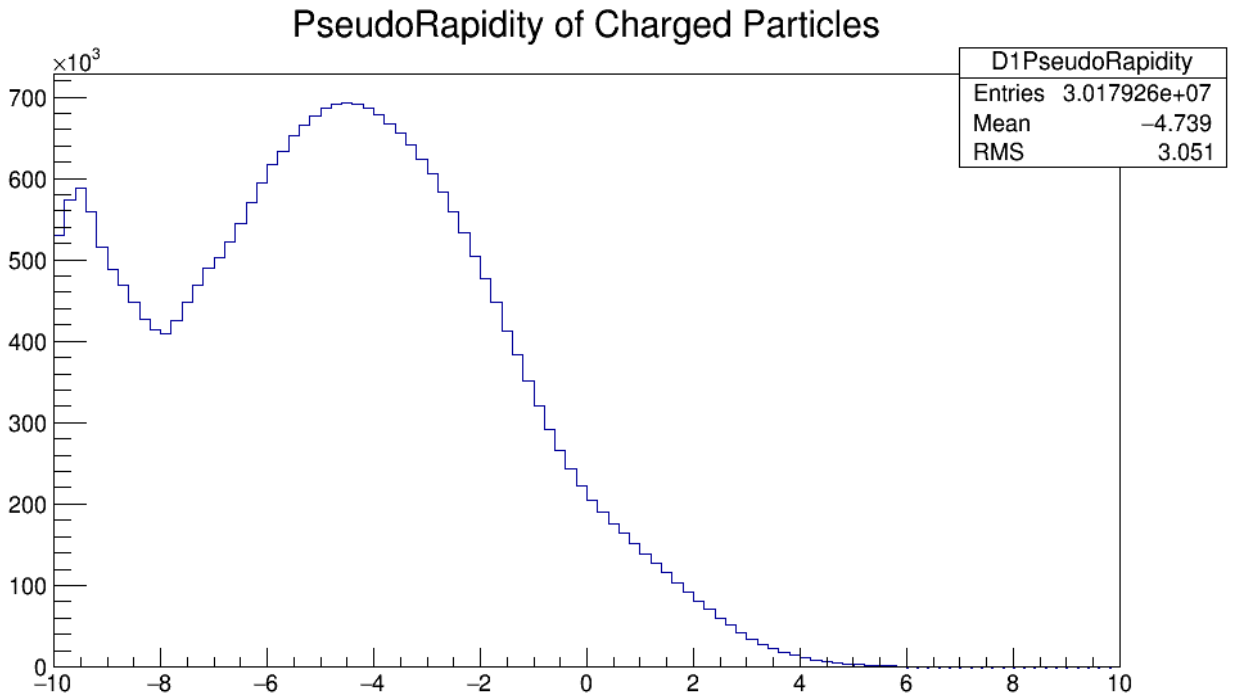
5TeV



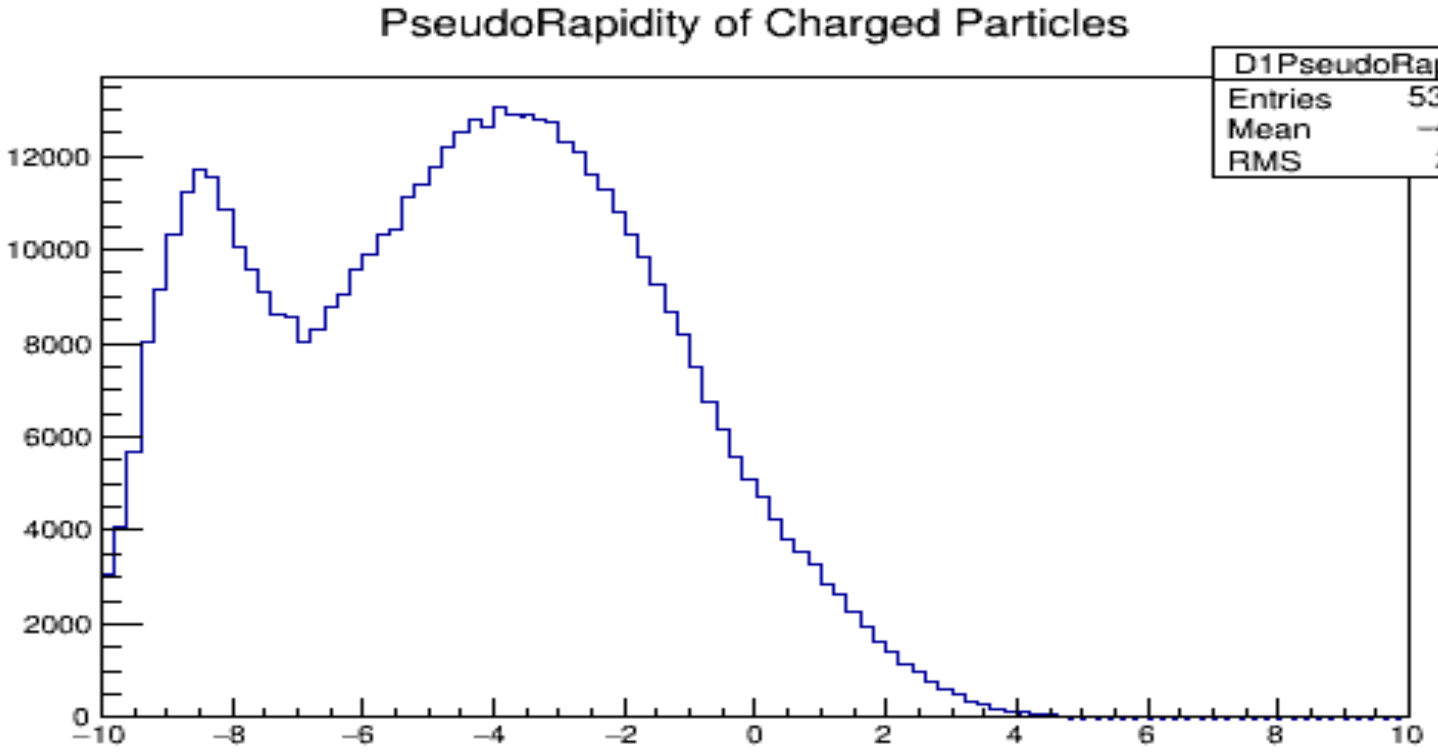
2.76TeV

- Comparisons with Energy Photon kmin>6GeV

- Comparisons with Energy Photon kmin>1000GeV between 2.76TeV and 5 TeV

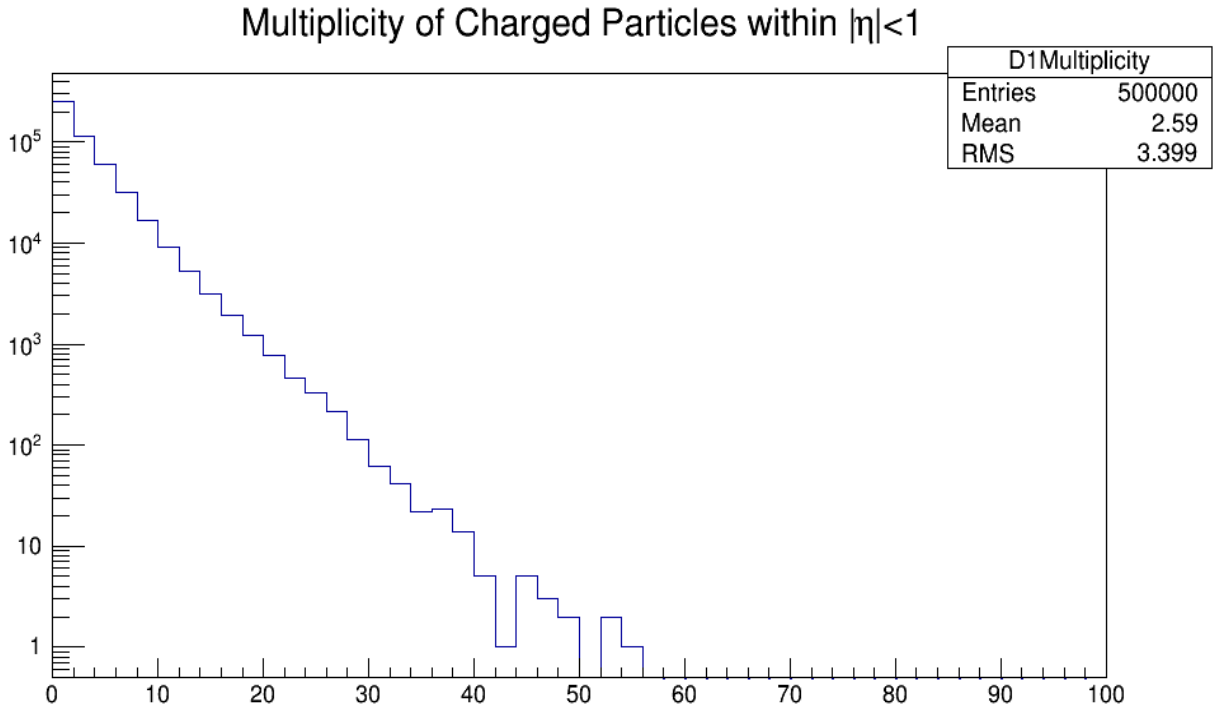


5TeV

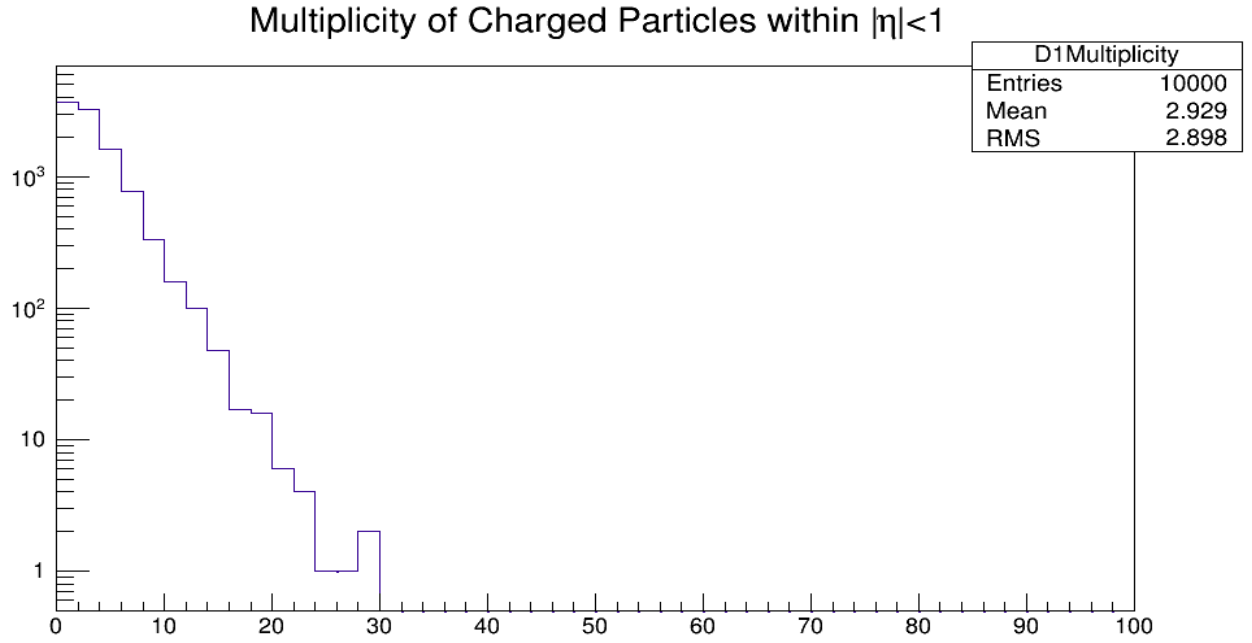


2.76TeV

- Comparisons with Energy Photon kmin>1000GeV

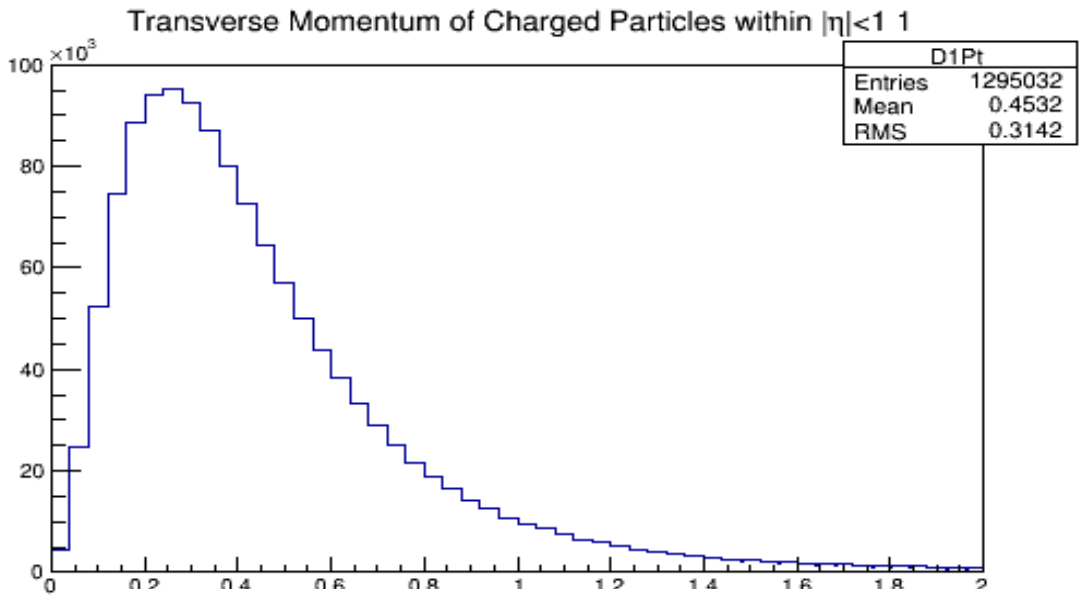


5TeV

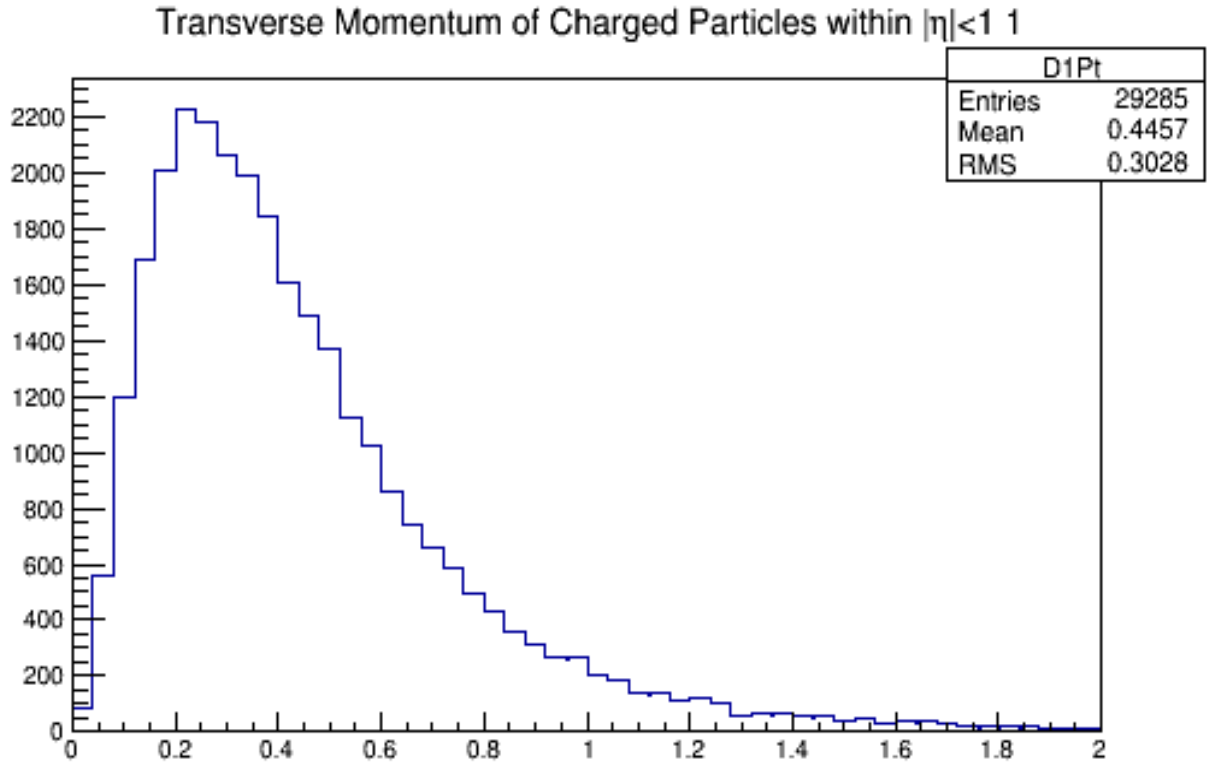


2.76TeV

- Comparisons with Energy Photon kmin>1000GeV



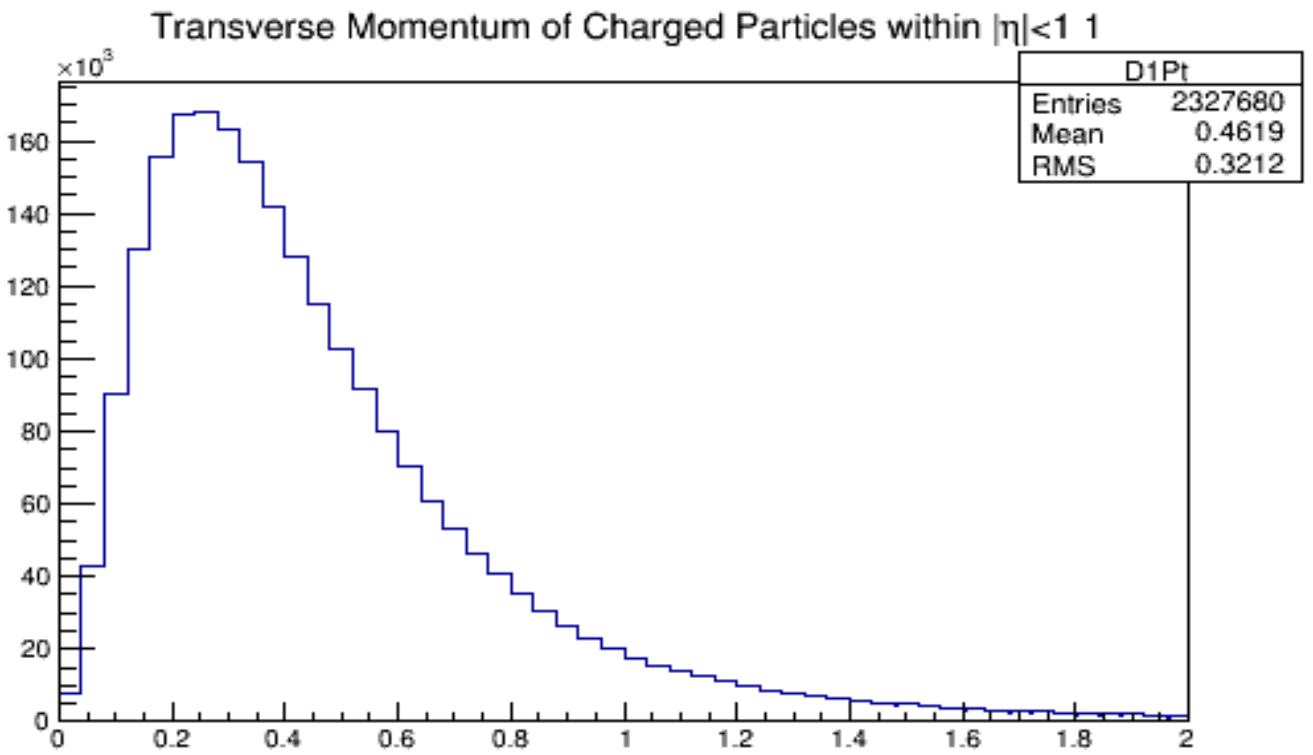
5TeV



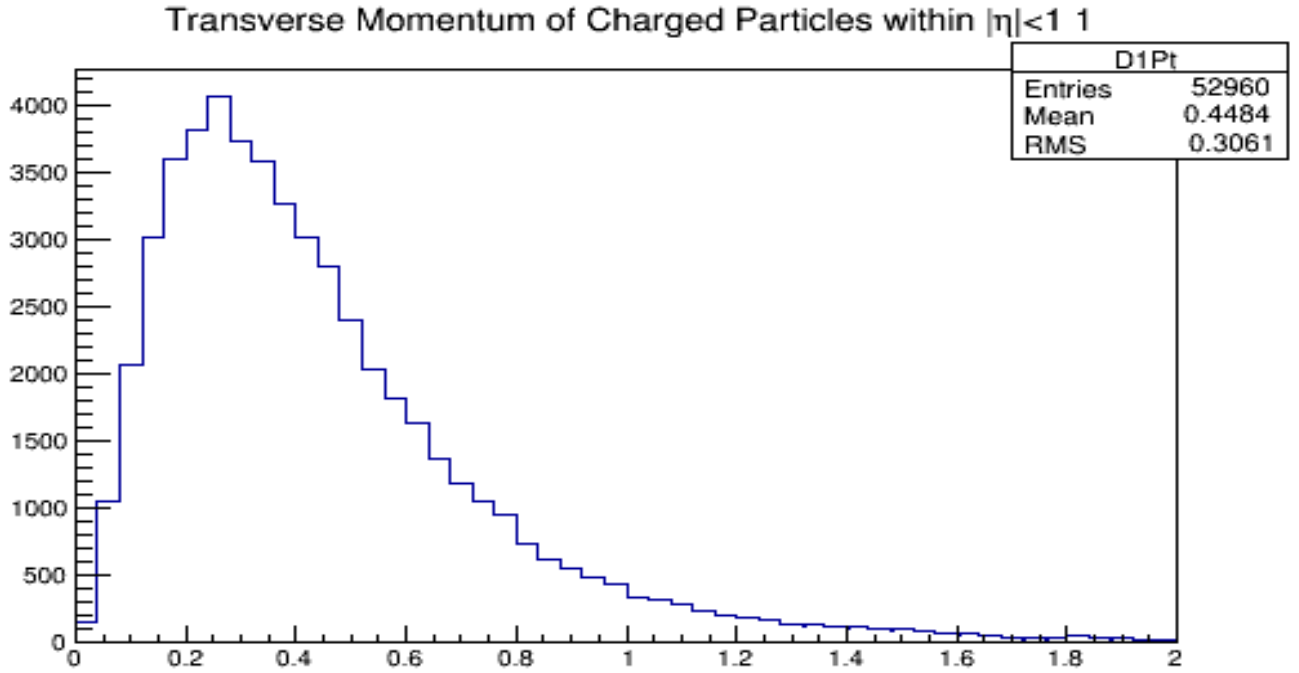
2.76TeV

- Comparisons with Energy Photon kmin>1000GeV

- Comparisons with Energy Photon kmin>10,000GeV between 2.76TeV and 5 TeV

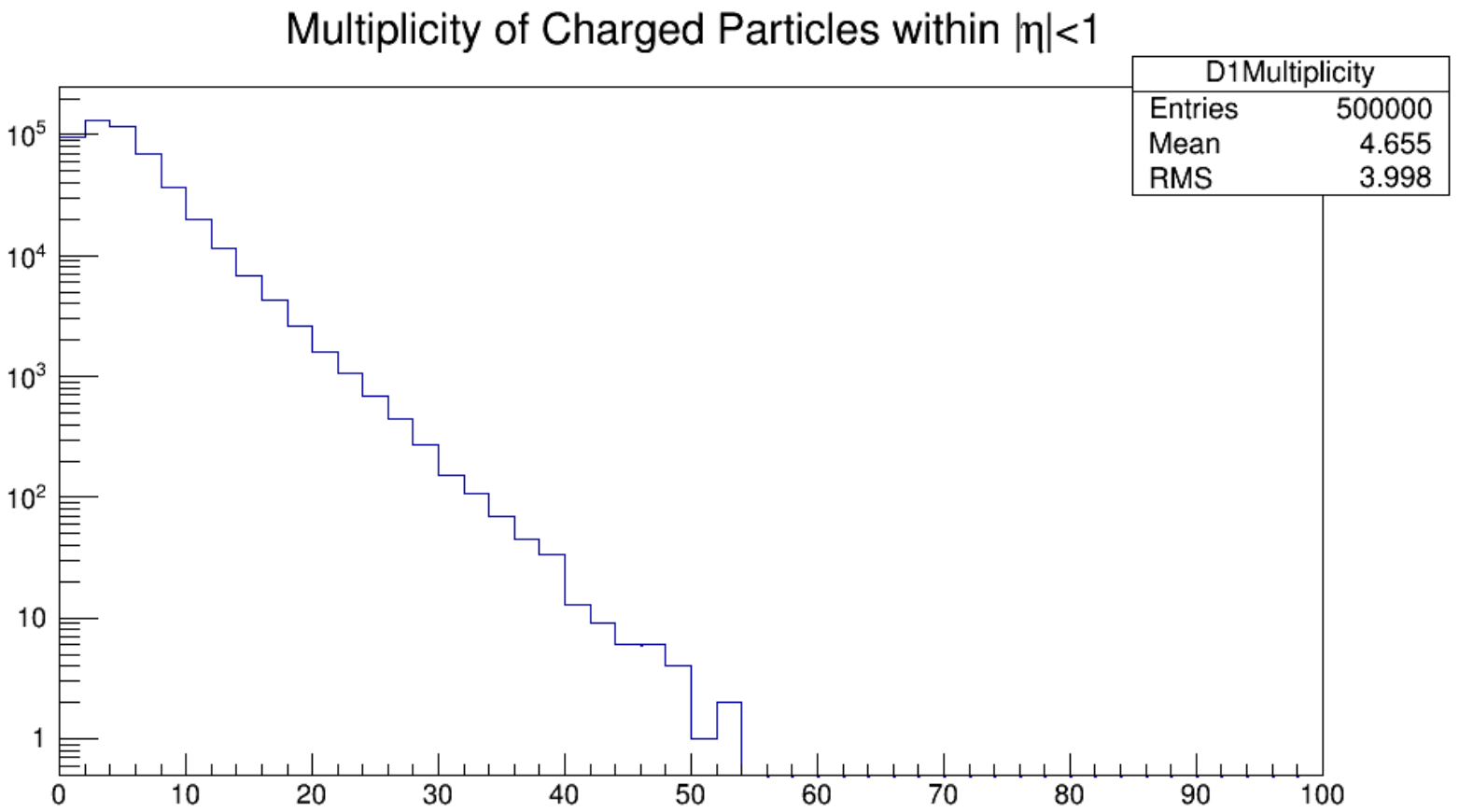


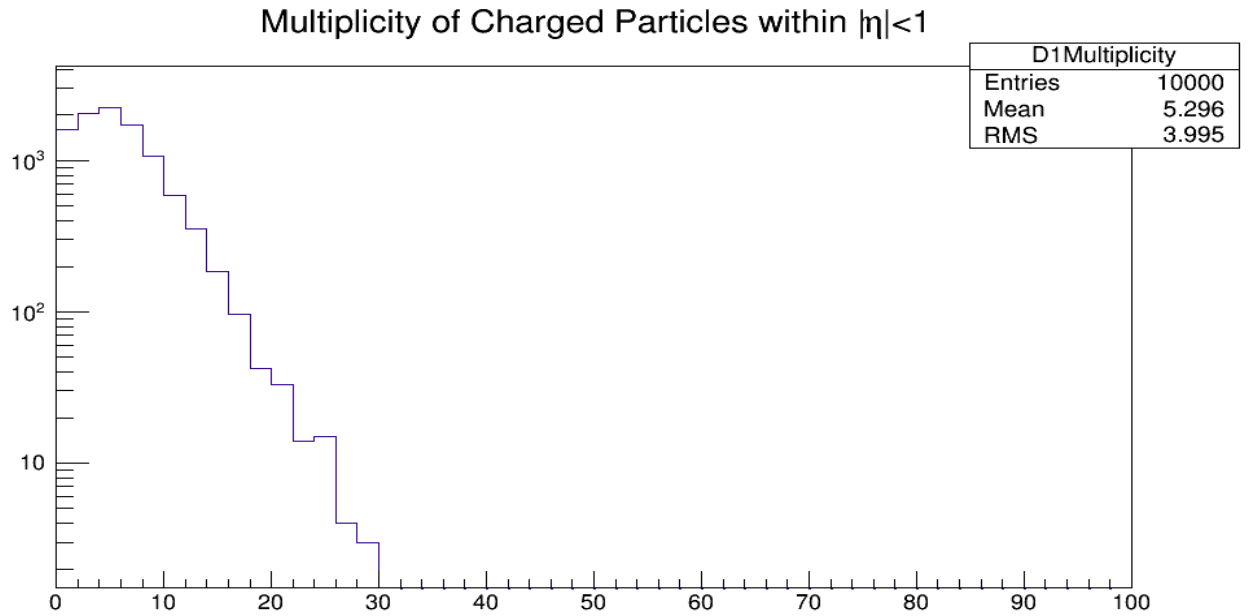
5TeV



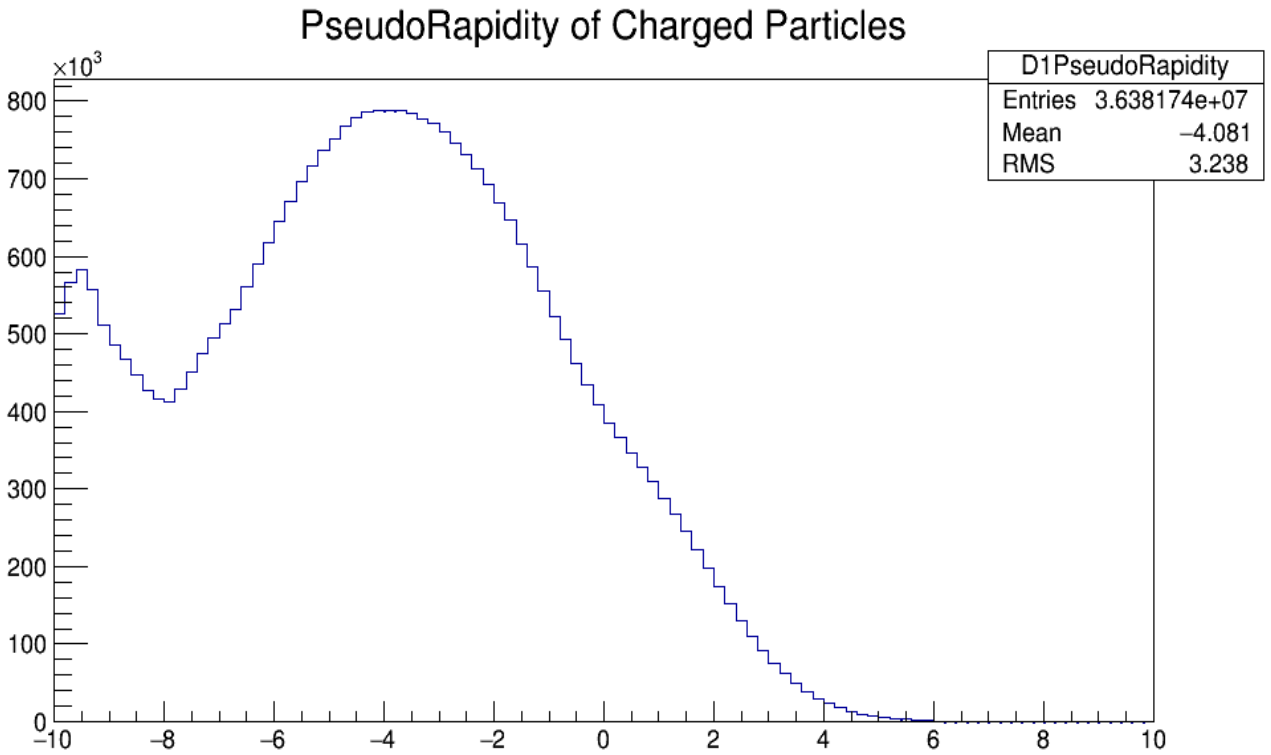
2.76 TeV

- Comparisons with Energy Photon kmin>10,000GeV

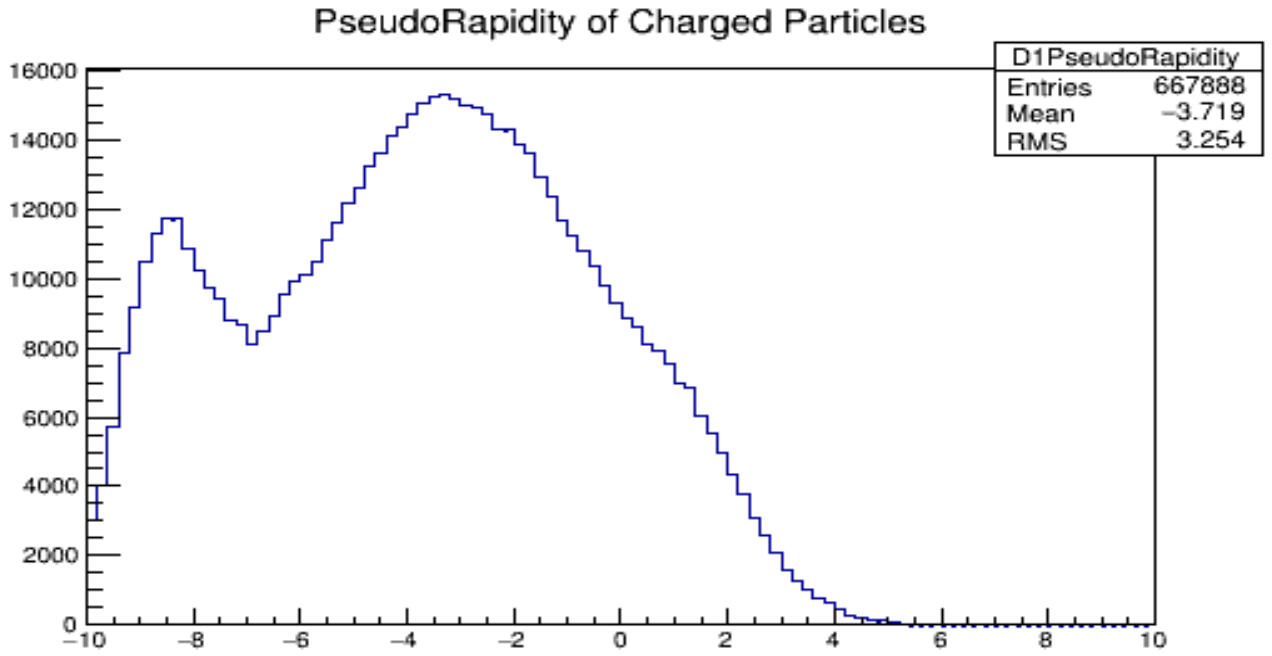




- Comparisons with Energy Photon kmin>10,000GeV



5TeV



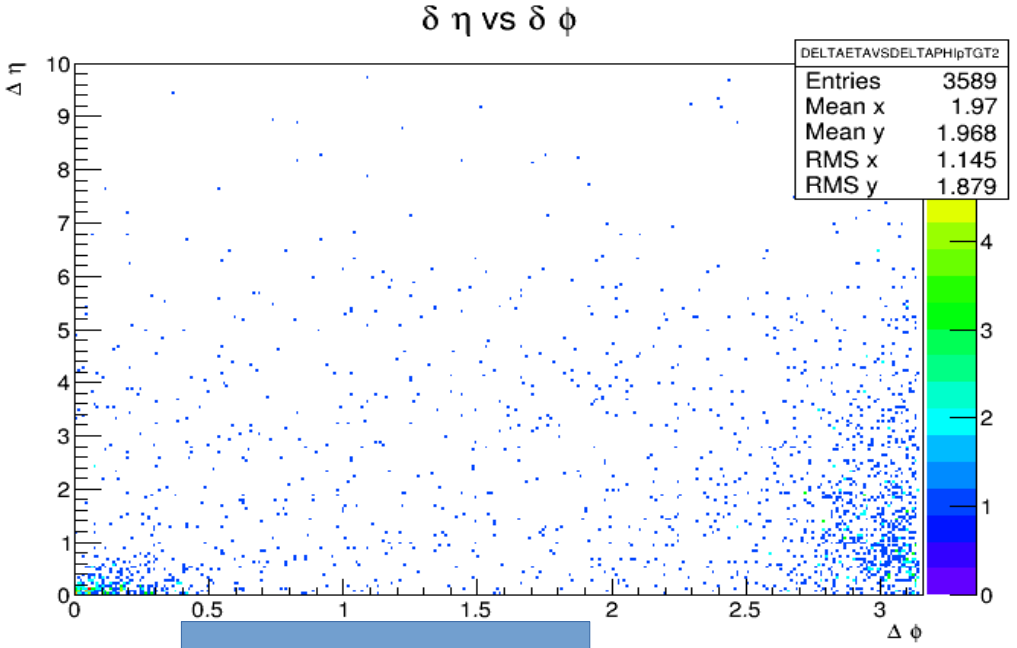
2.76TeV

- Comparisons with Energy Photon kmin>10,000GeV

Searching for Jets

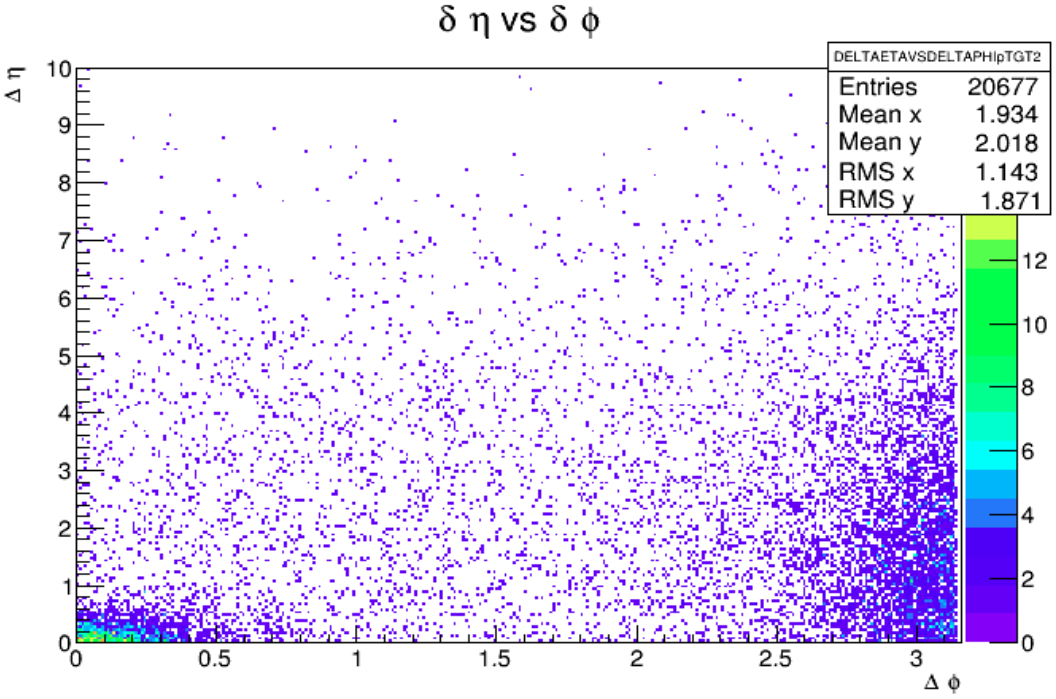
- Can be used for trigger.
- No published before about jets in ultraperipheral collisions.
- Good opportunity to learn about their features.

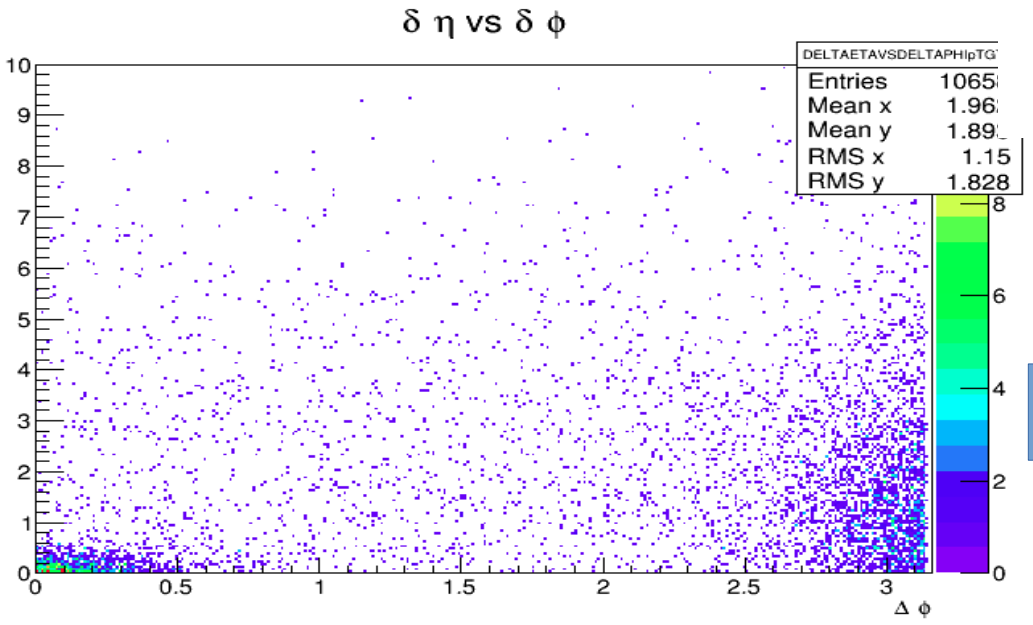
Back to back events in 5TeV?



kmin>6GeV

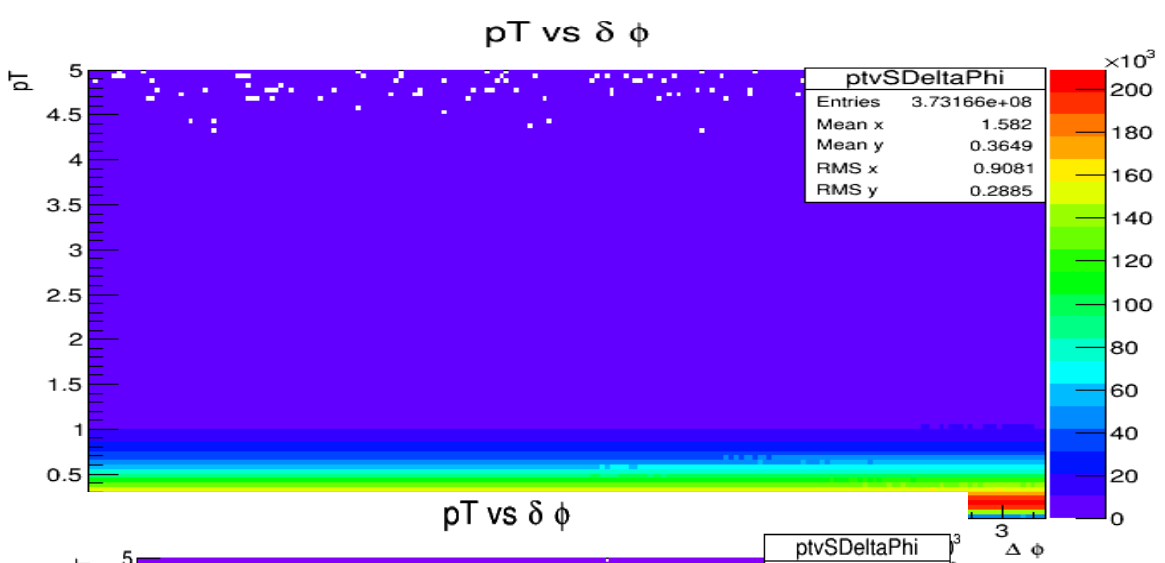
Kmin>10,000GeV



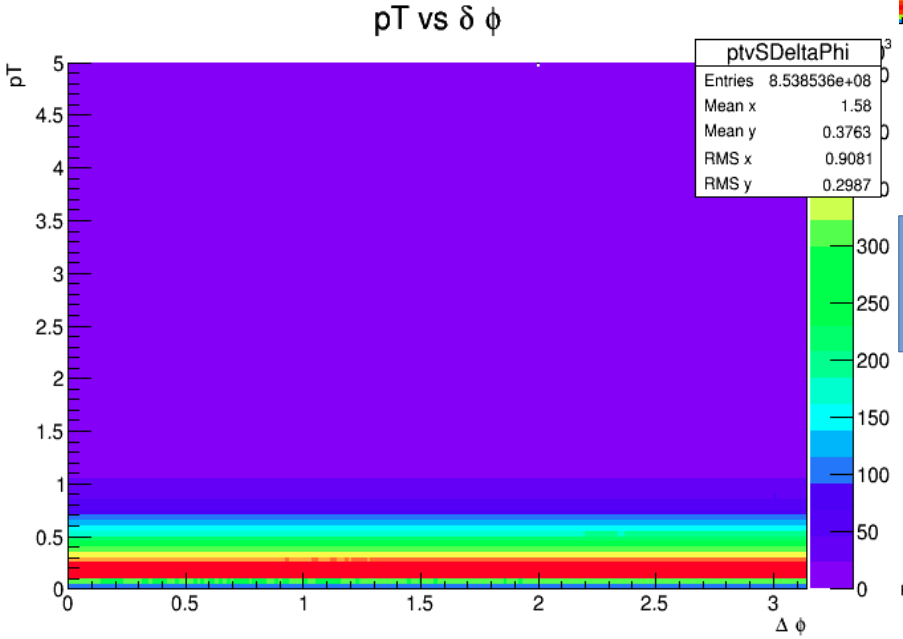


kmin>1000GeV

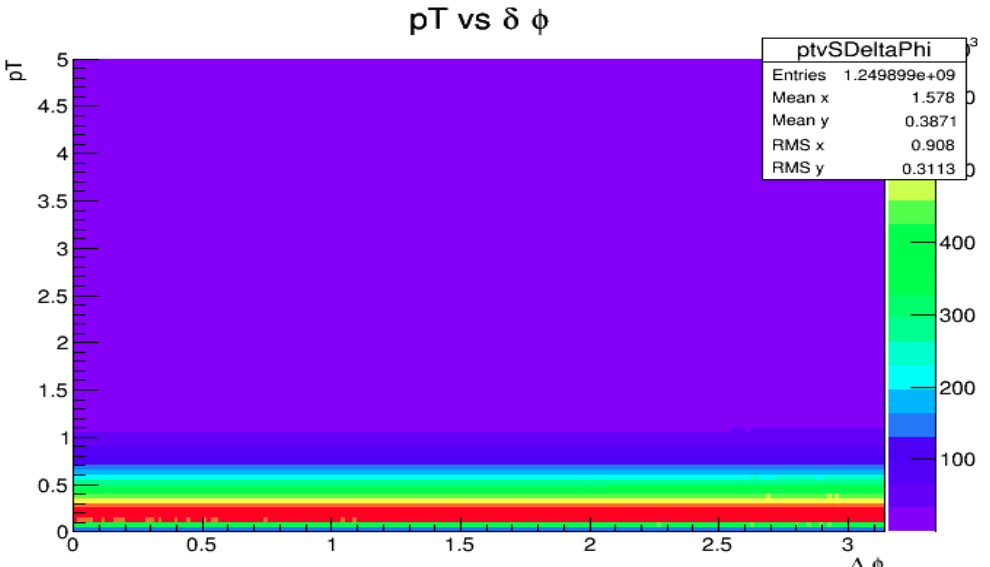
(Following Joakym suggestion)Cut in pT>2.0



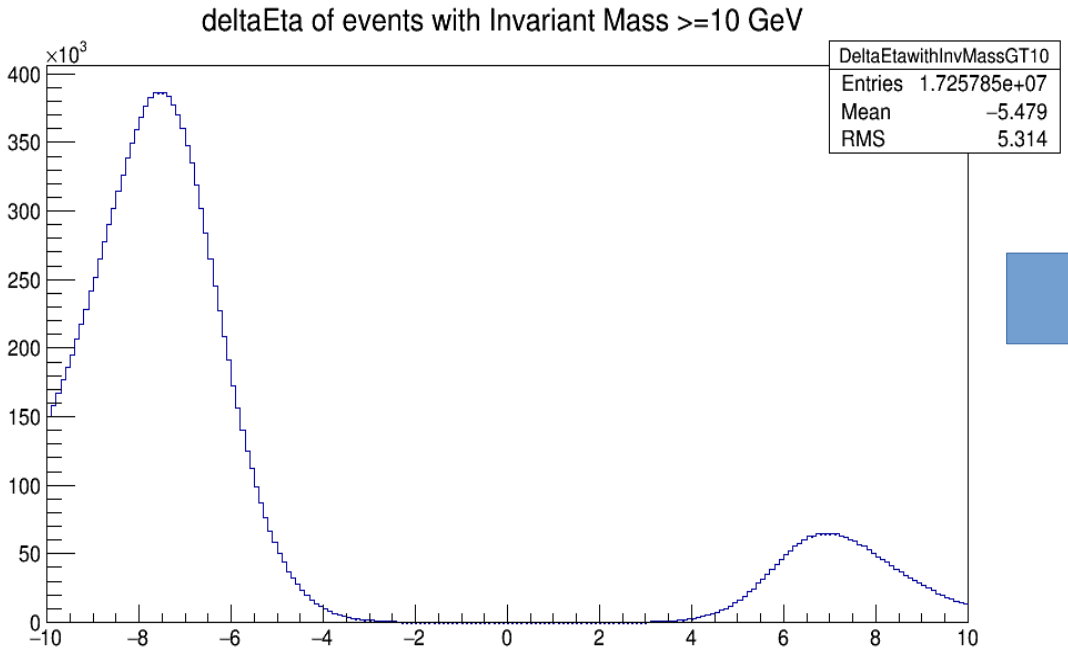
kmin>6



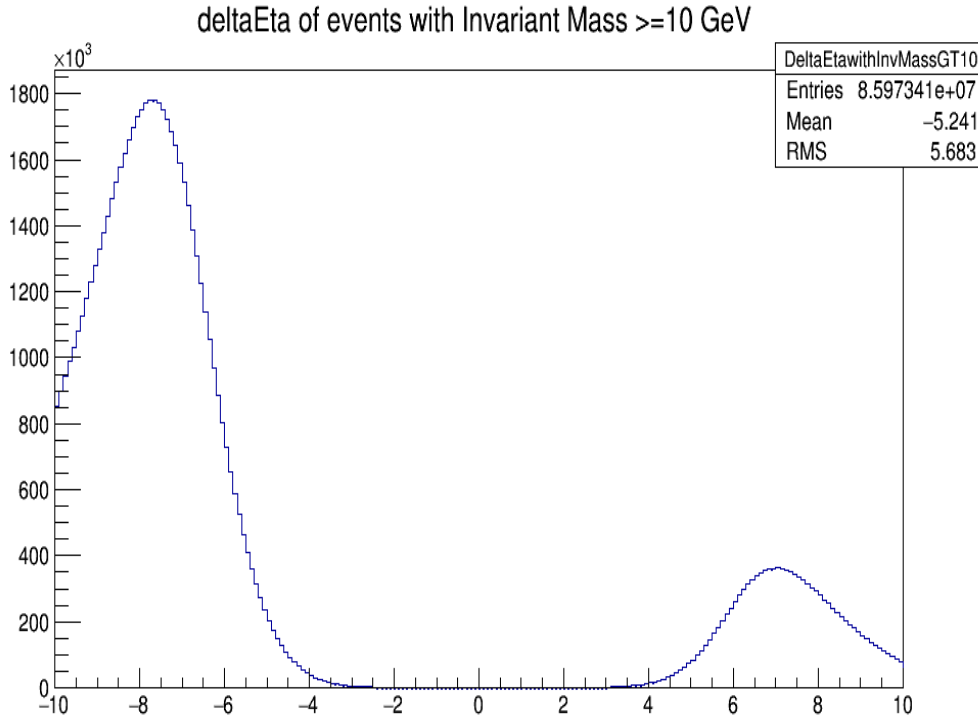
kmin>1000



Kmin>10,000



Kmin>6



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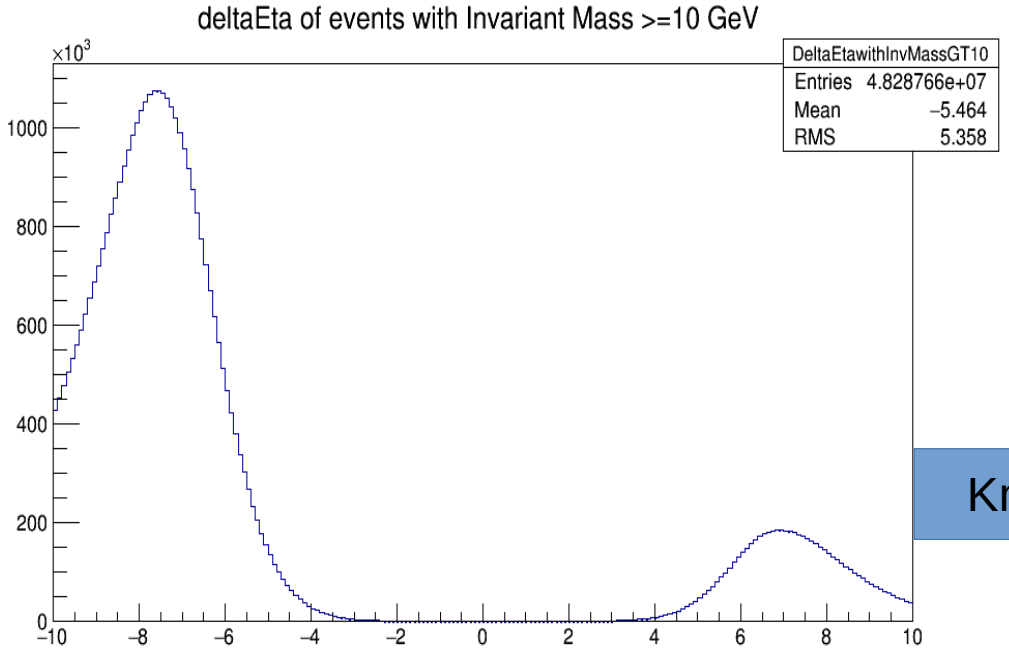
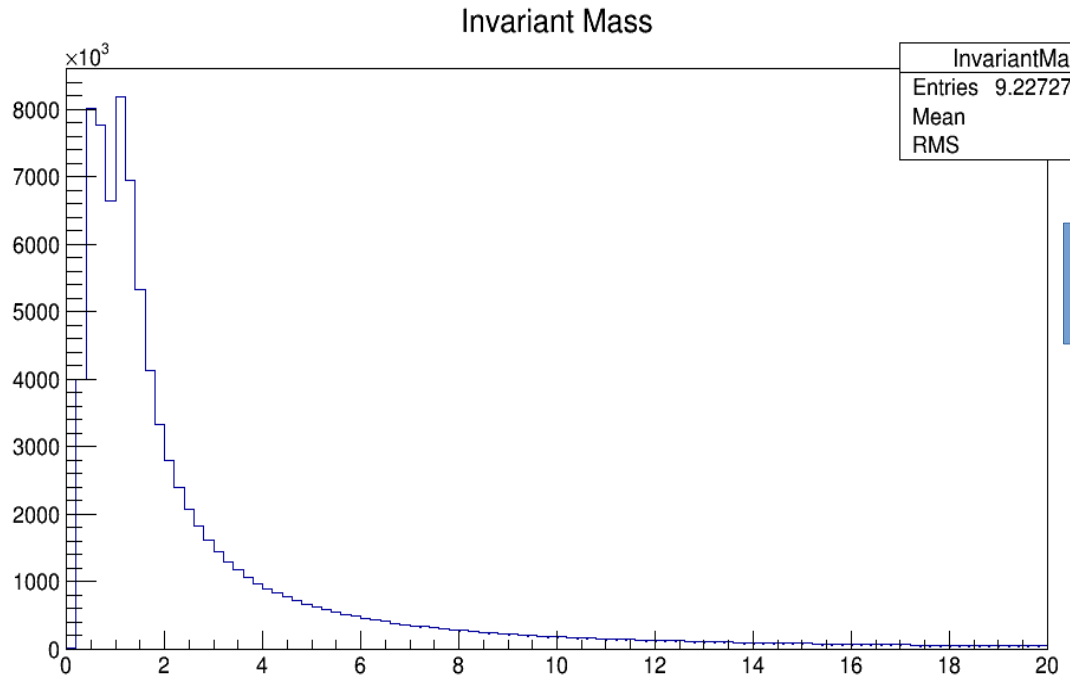
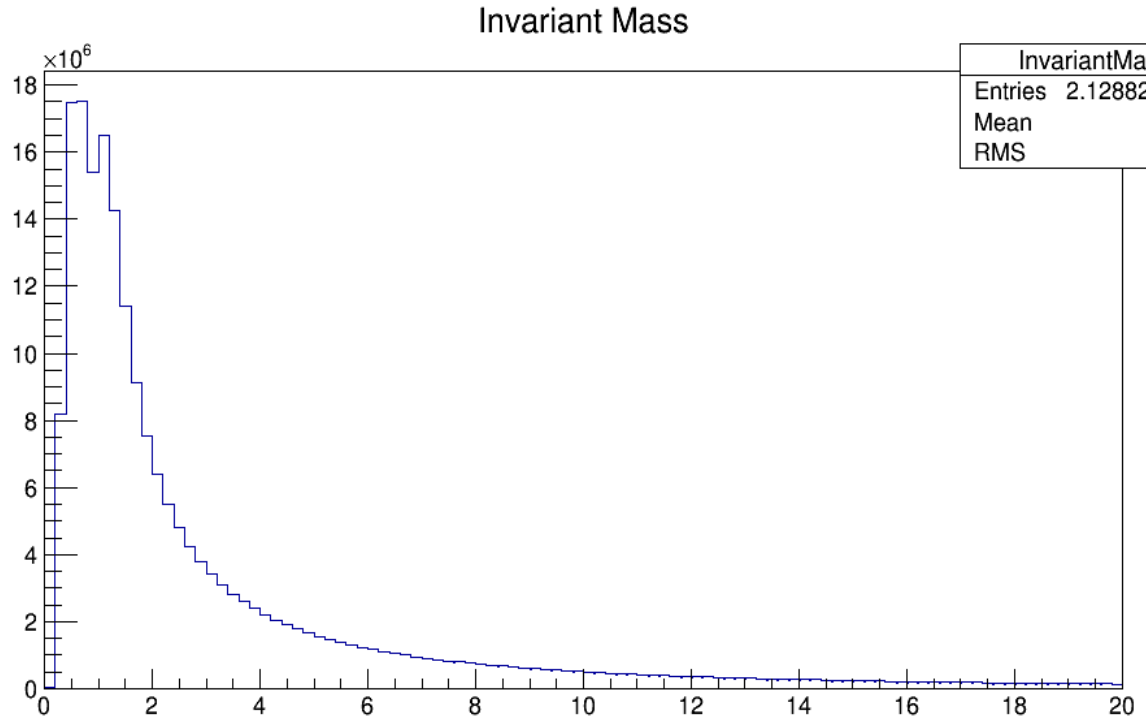


Kmin>1,000



kmin>6GeV

RhoZero Mass=0.7 GeV

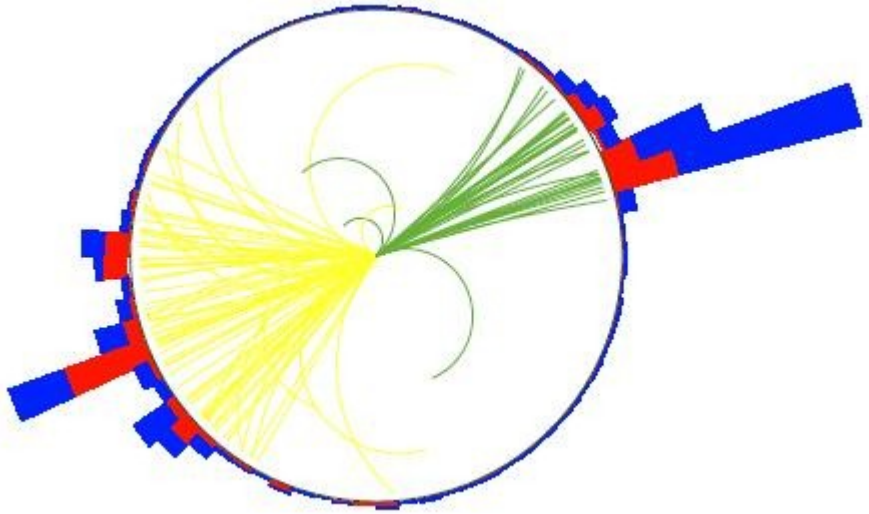


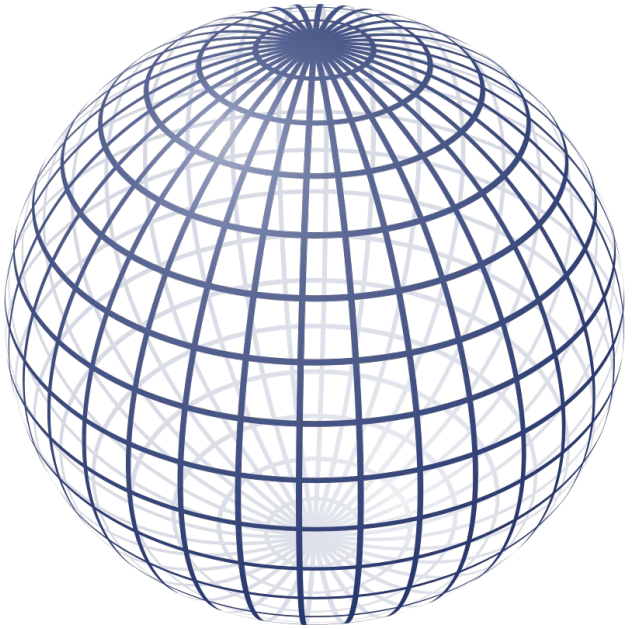
kmin>1000GeV

SPHEROCITY and SPHERICITY

- Physical variables that give information about the isotropy of the system.
- Value range 0< spherocity<1.0
- Value range 0<sphericity<1.0
- Values close to zero are jets
- Zero value of sphericity is a

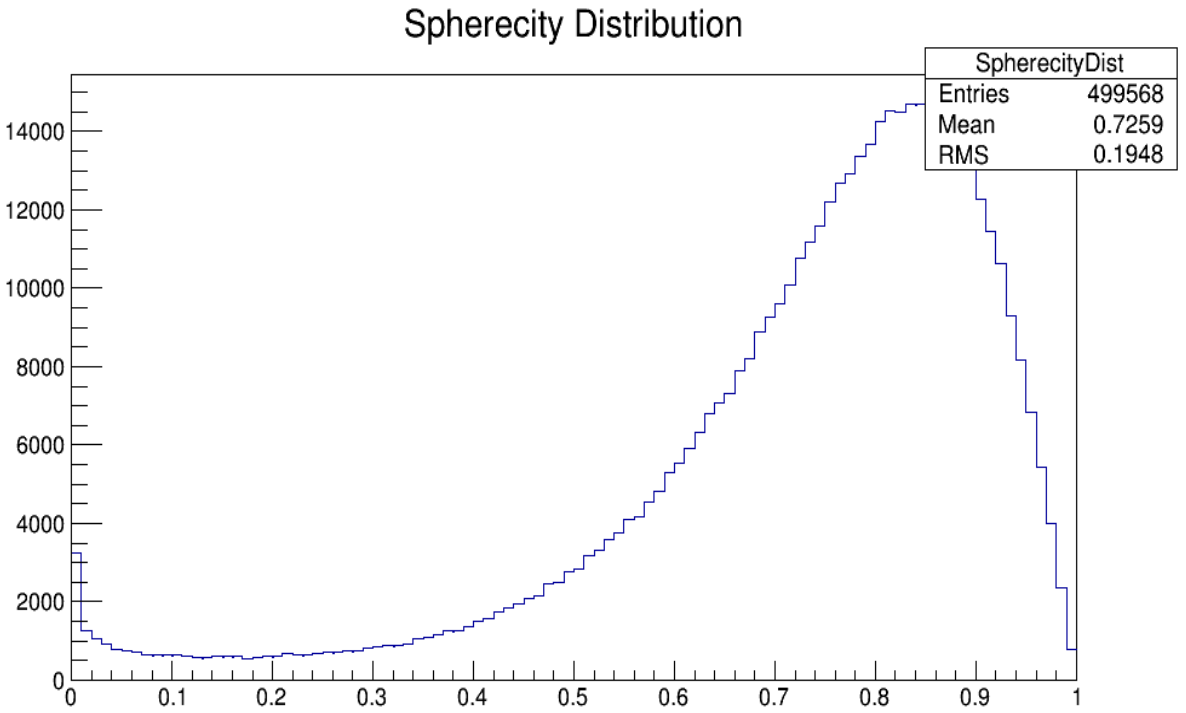
  back to back jet event

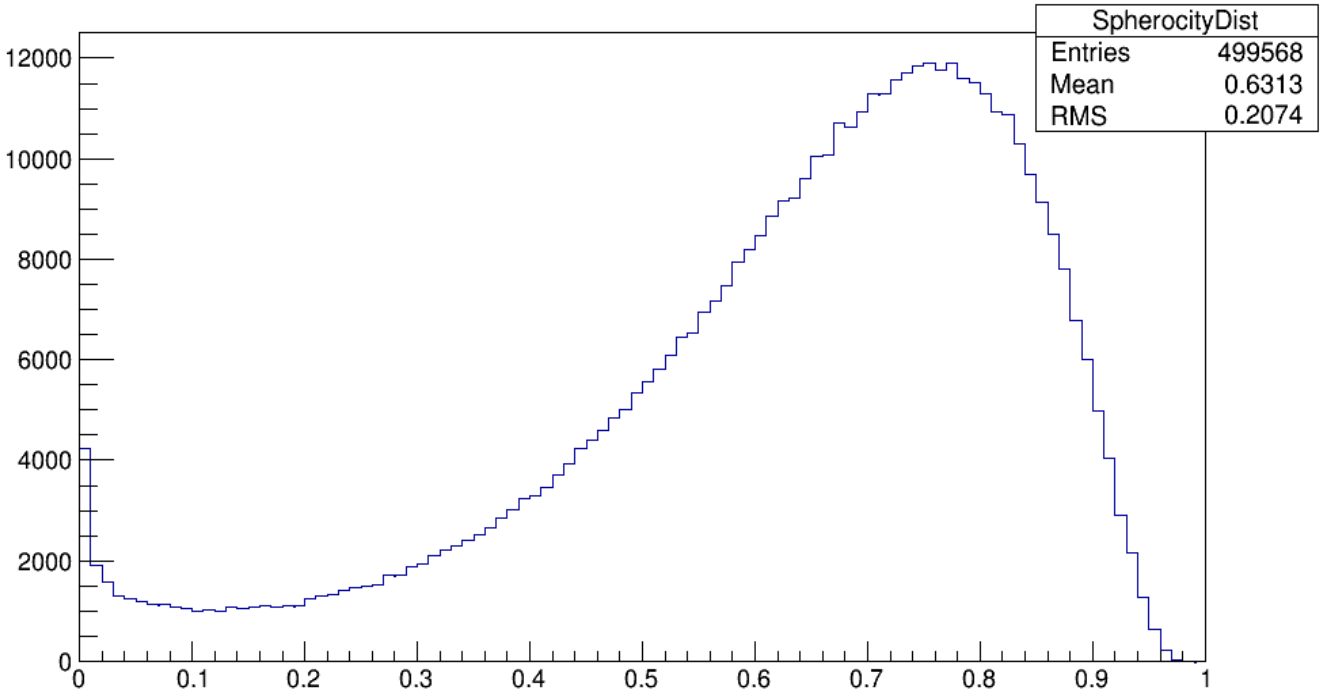




Spherocity=1

Pb+Pb Simulation with kmin>1,000 GeV AT 5TeV

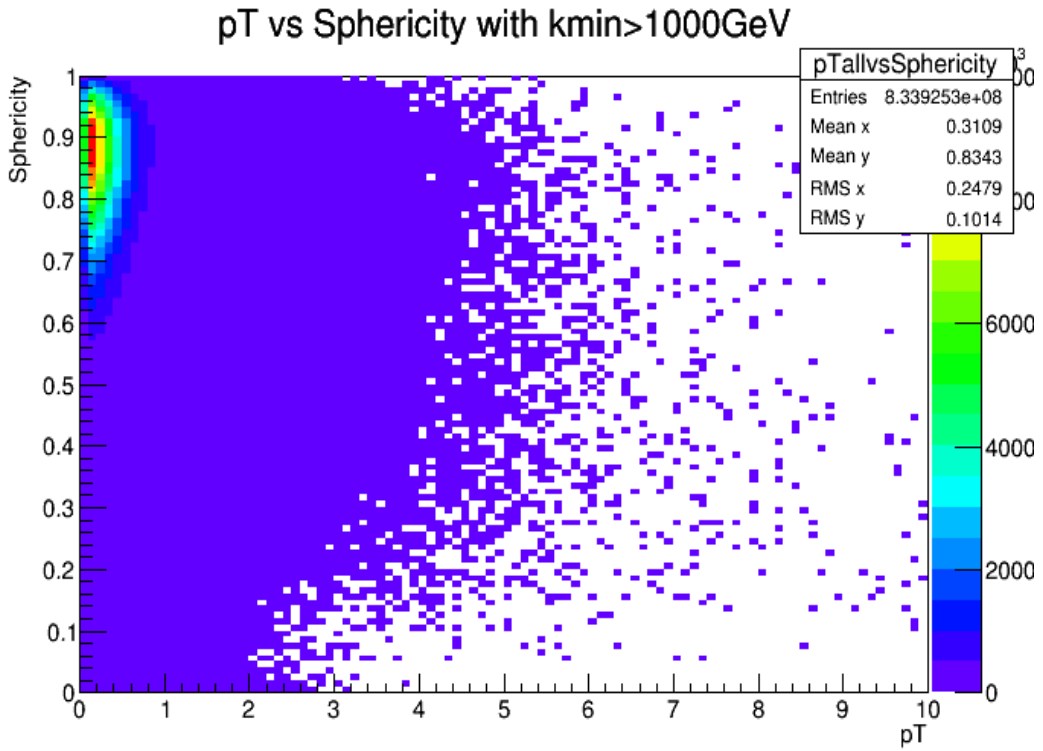


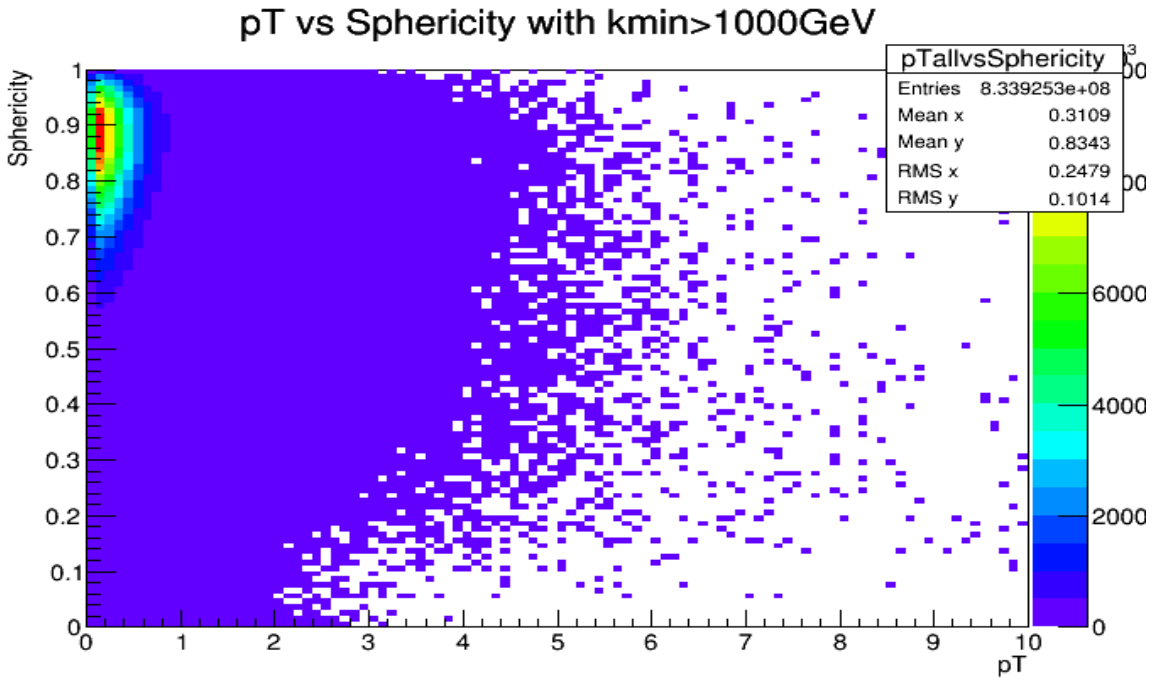


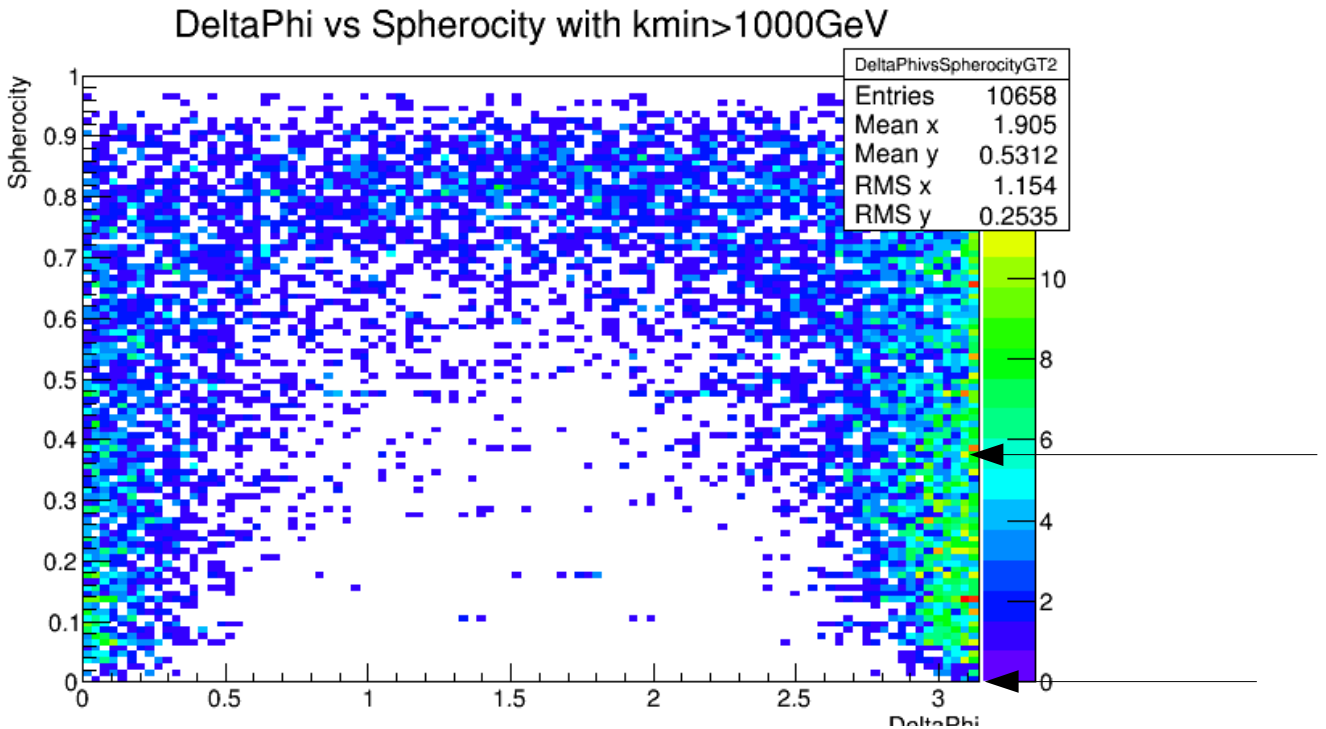
Peak in Zero.
Jet back
To back Events

Jet Region

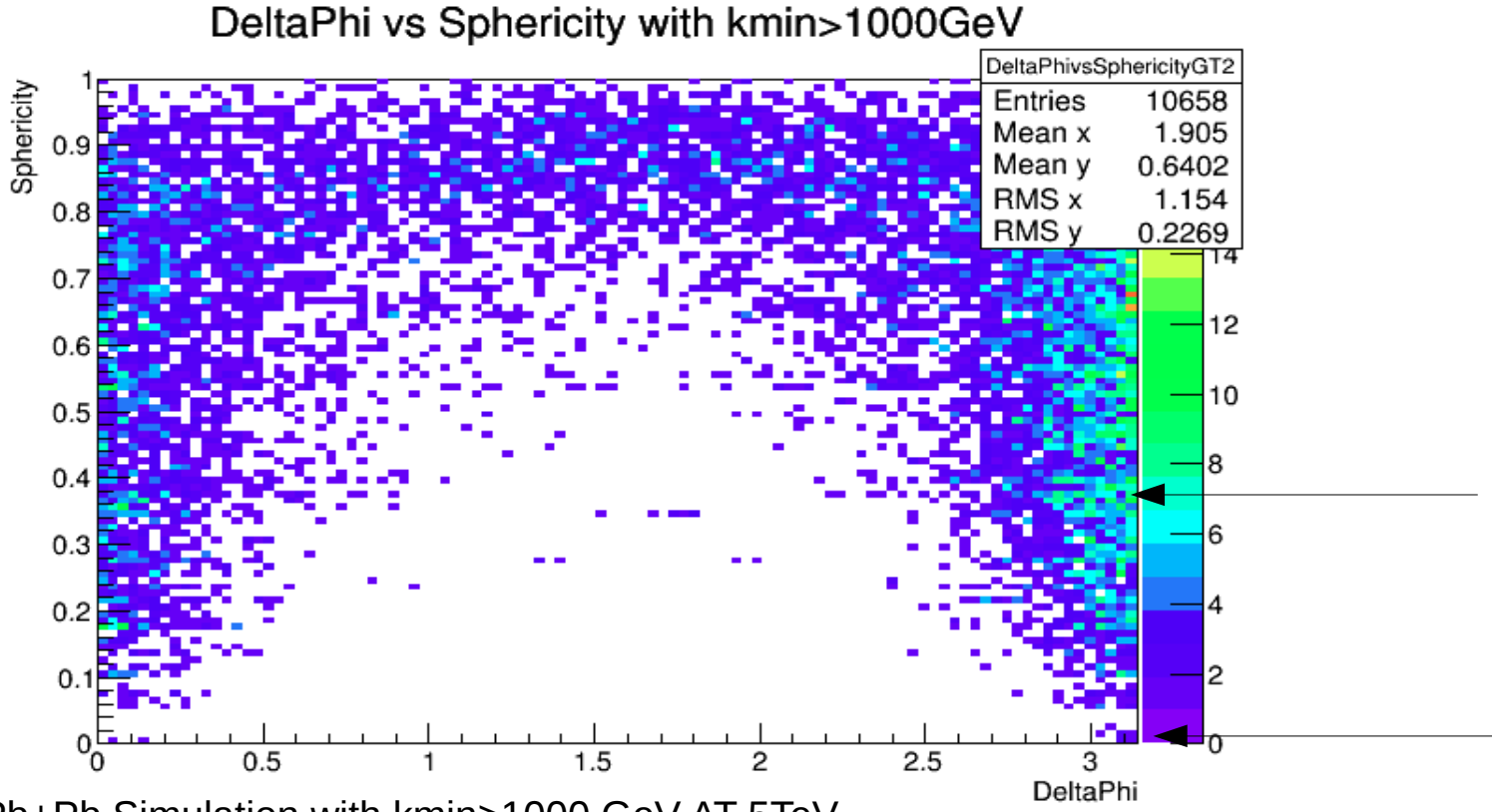
Pb+Pb Simulation with kmin>1000 GeV AT 5TeV





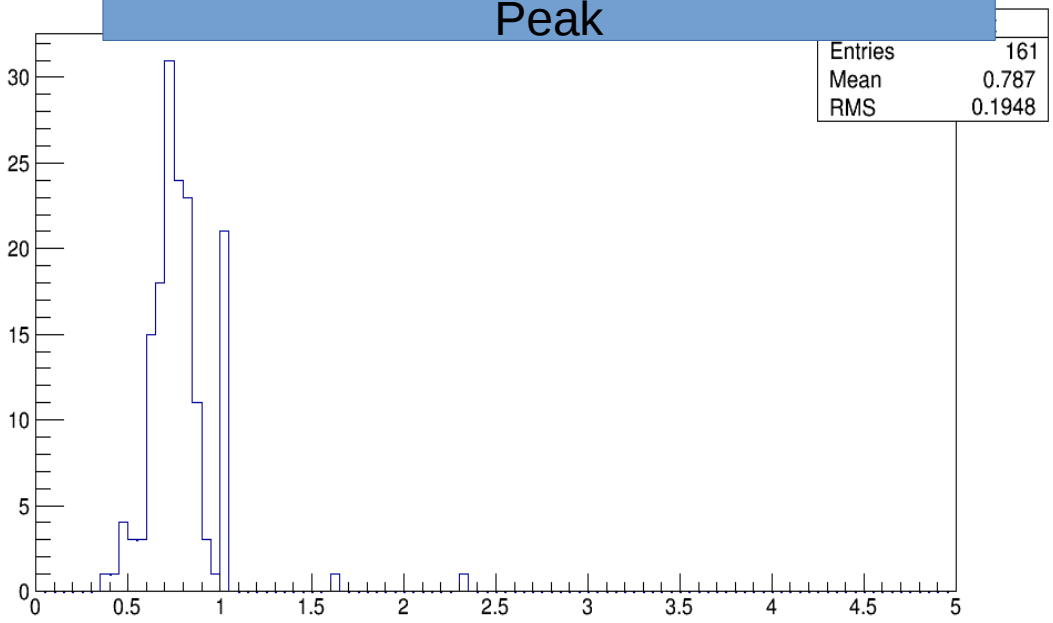


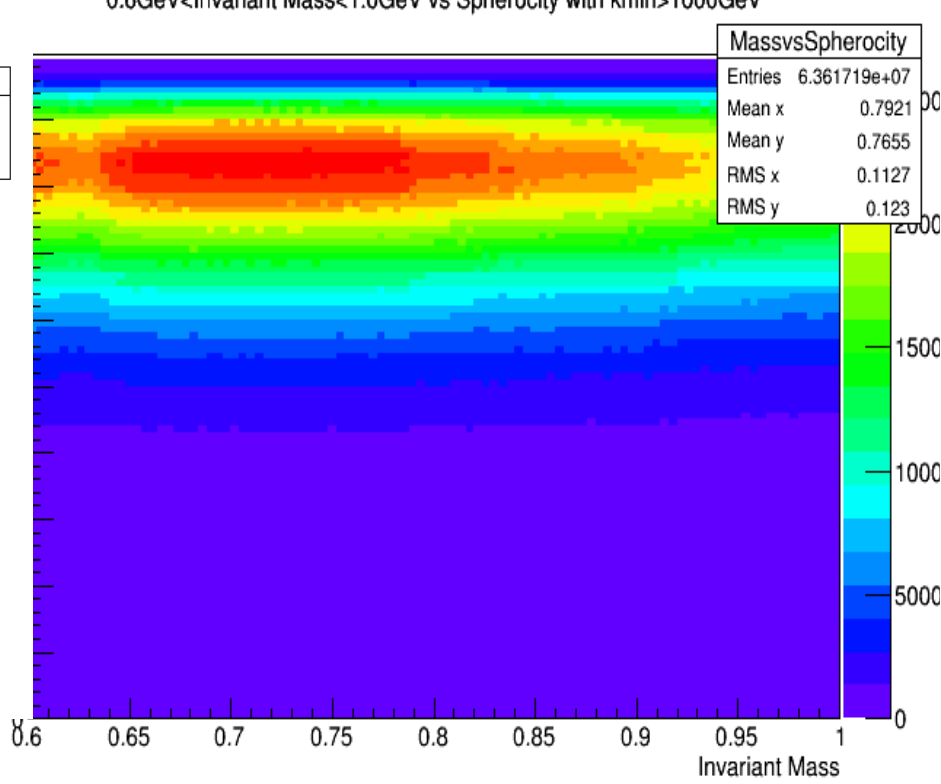
(Following Joakym suggestion)Cut in pT>2.0

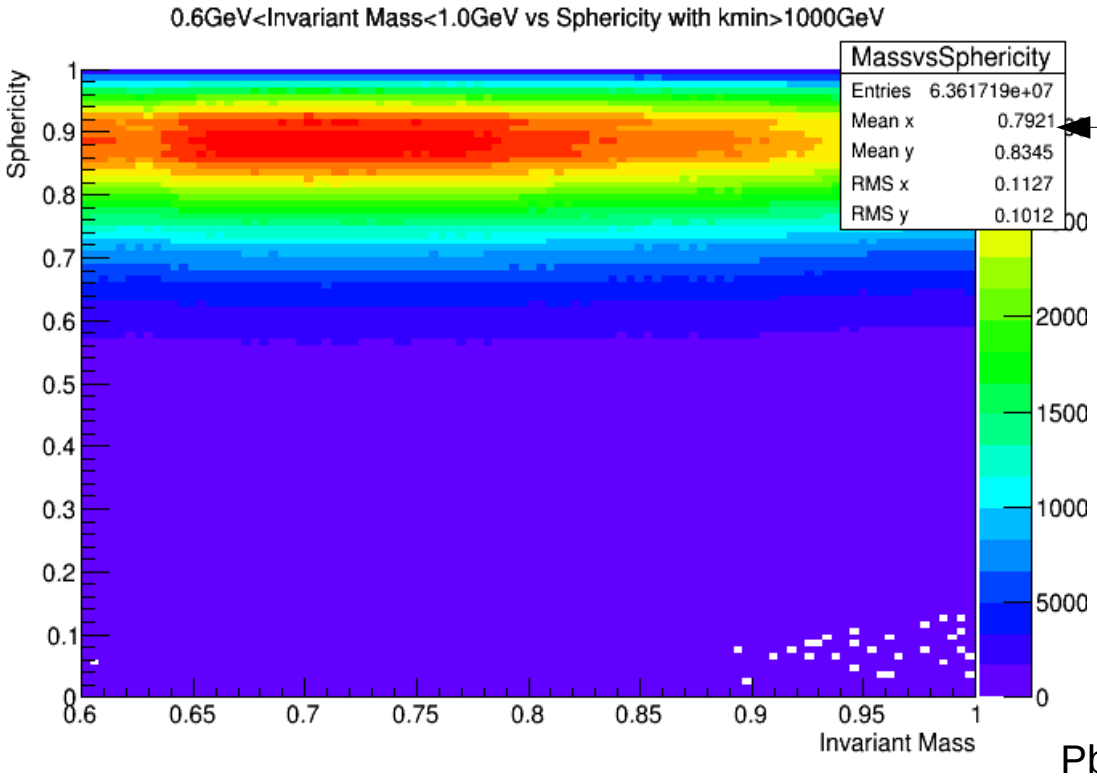


Pb+Pb Simulation with kmin>1000 GeV AT 5TeV

Invariant Mass Around the Rho Zero Peak



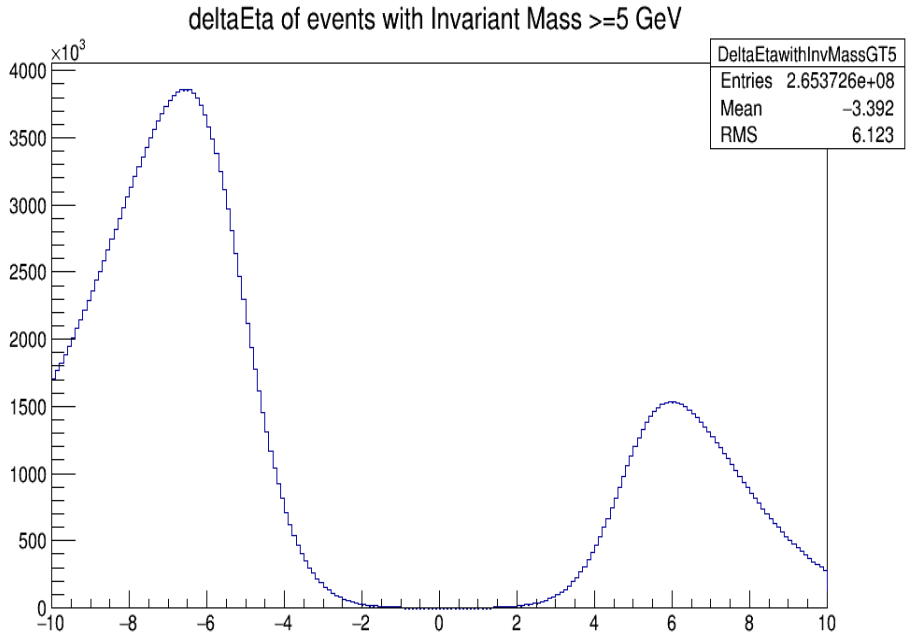




RhoZero Mass=0.7 GeV

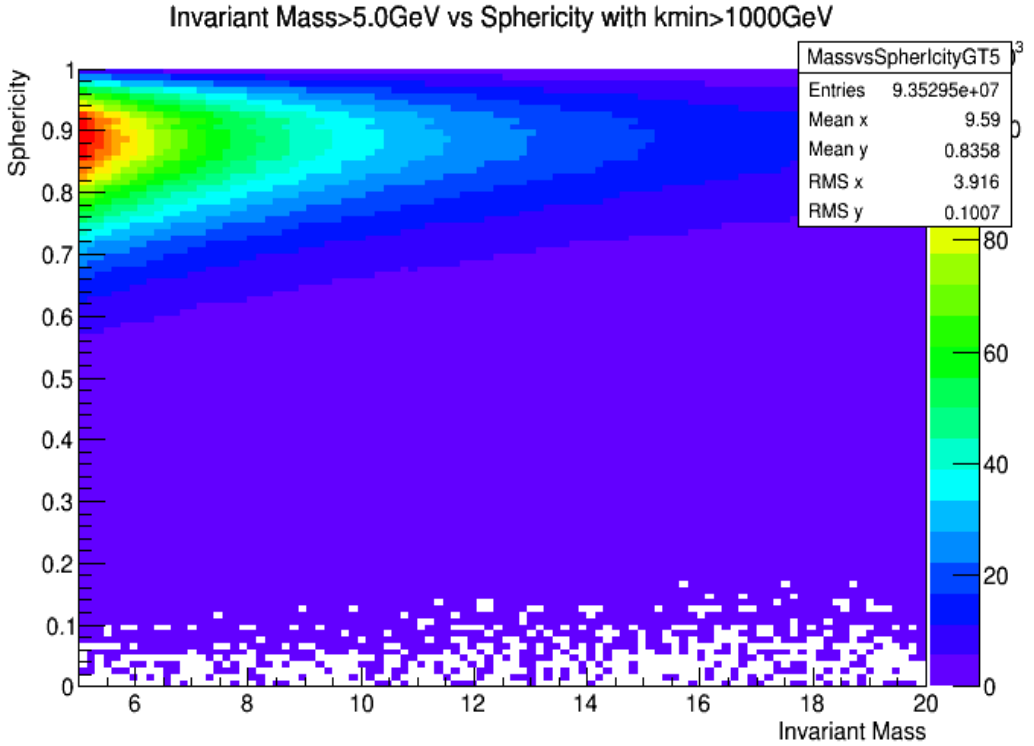
Taking only Invariant Masses around the Rho Zero peak.

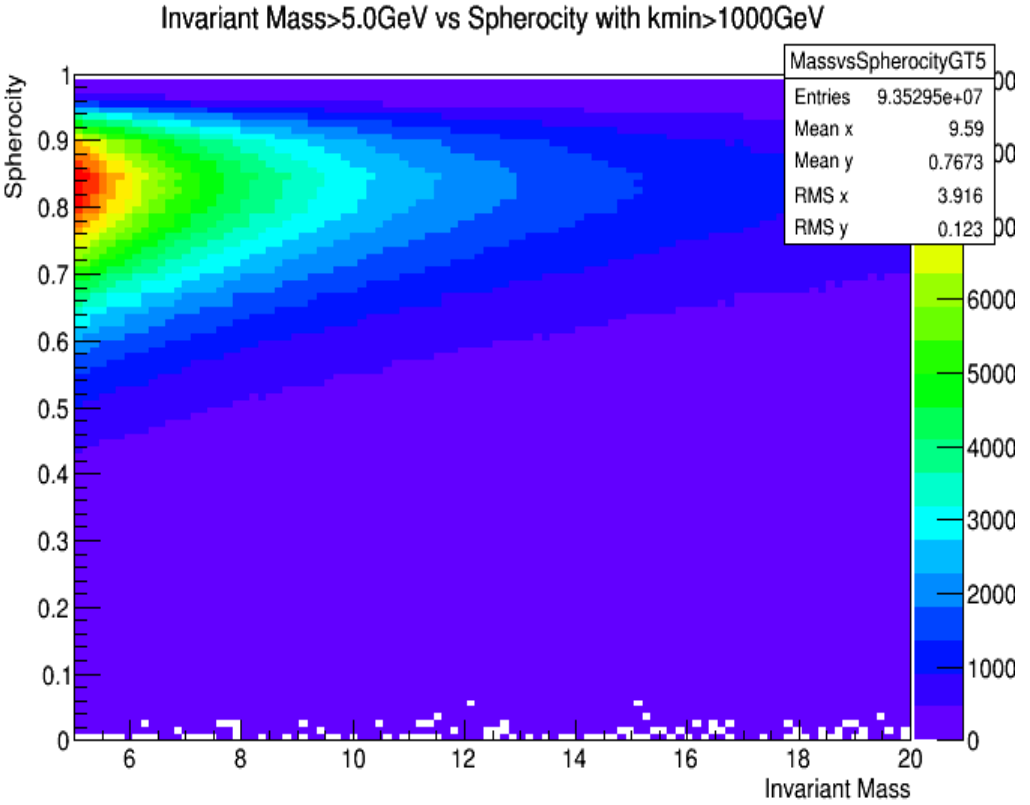
Pb+Pb Simulation with kmin>1000 GeV AT 5TeV



What happens
With those events
With InvMass>5.0 GeV?

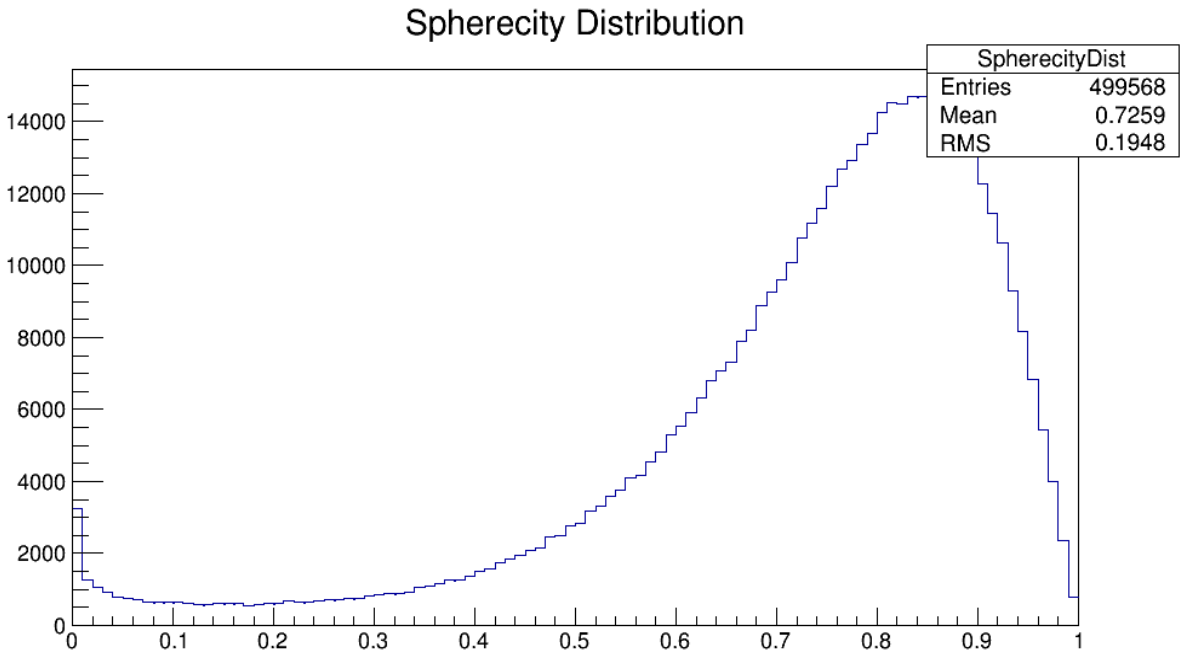
Not in the spherocity and
Sphericity jet Region

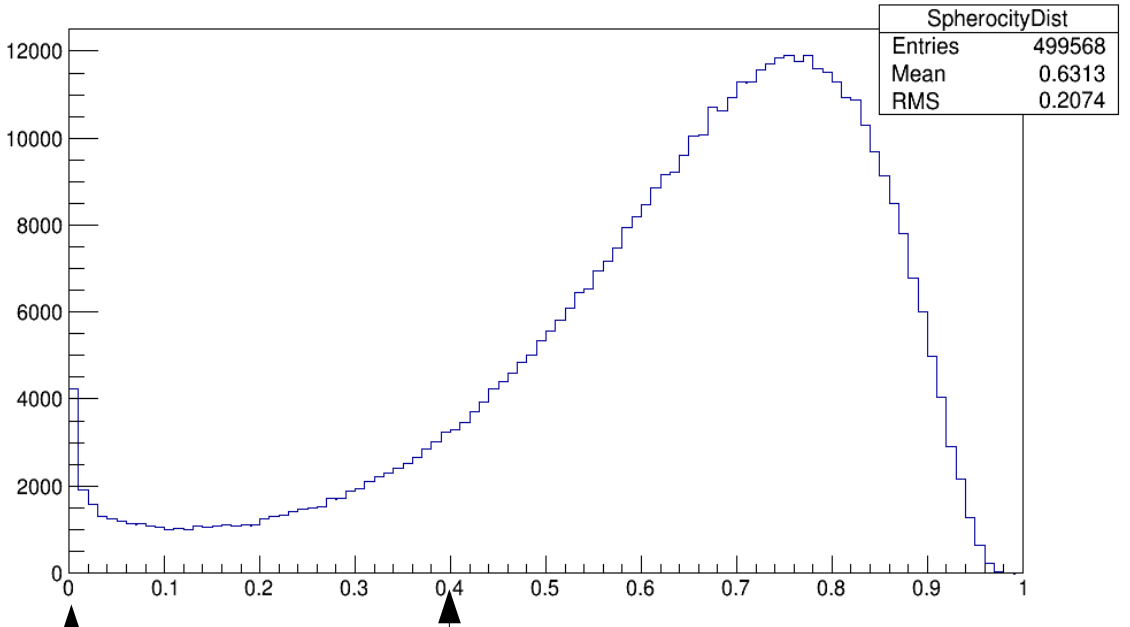




Pb+Pb Simulation with kmin>1000 GeV AT 5TeV

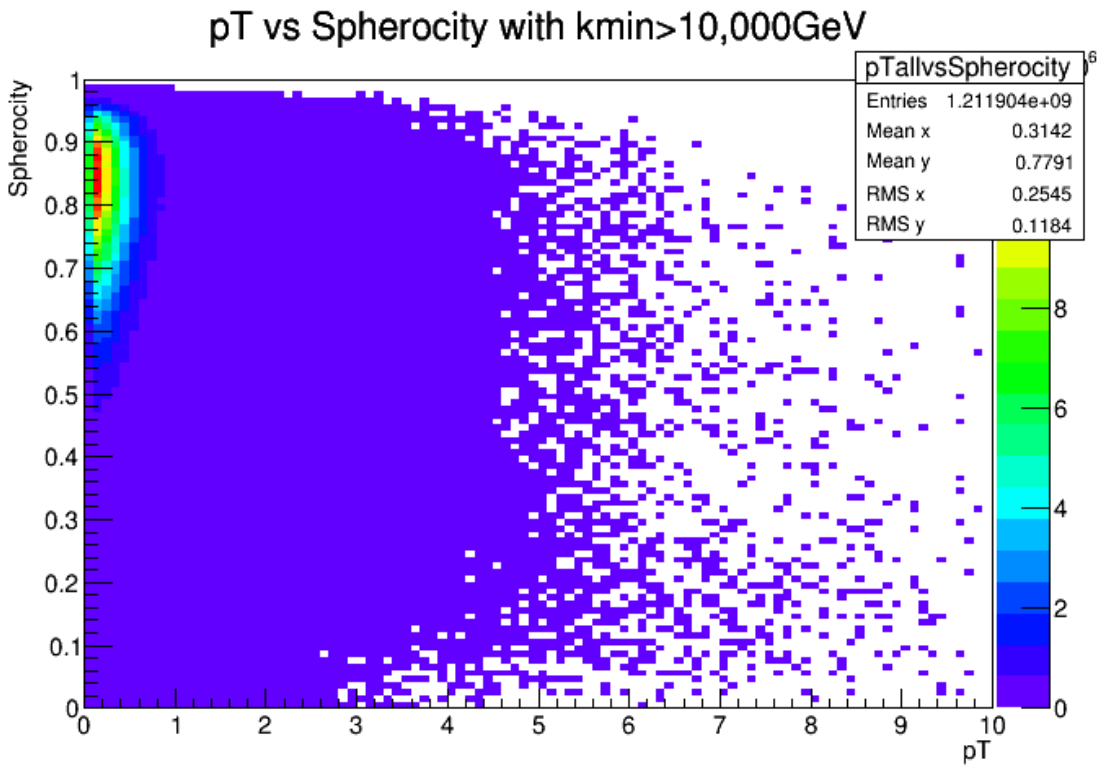
Pb+Pb Simulation with kmin>10,000 GeV AT 5TeV

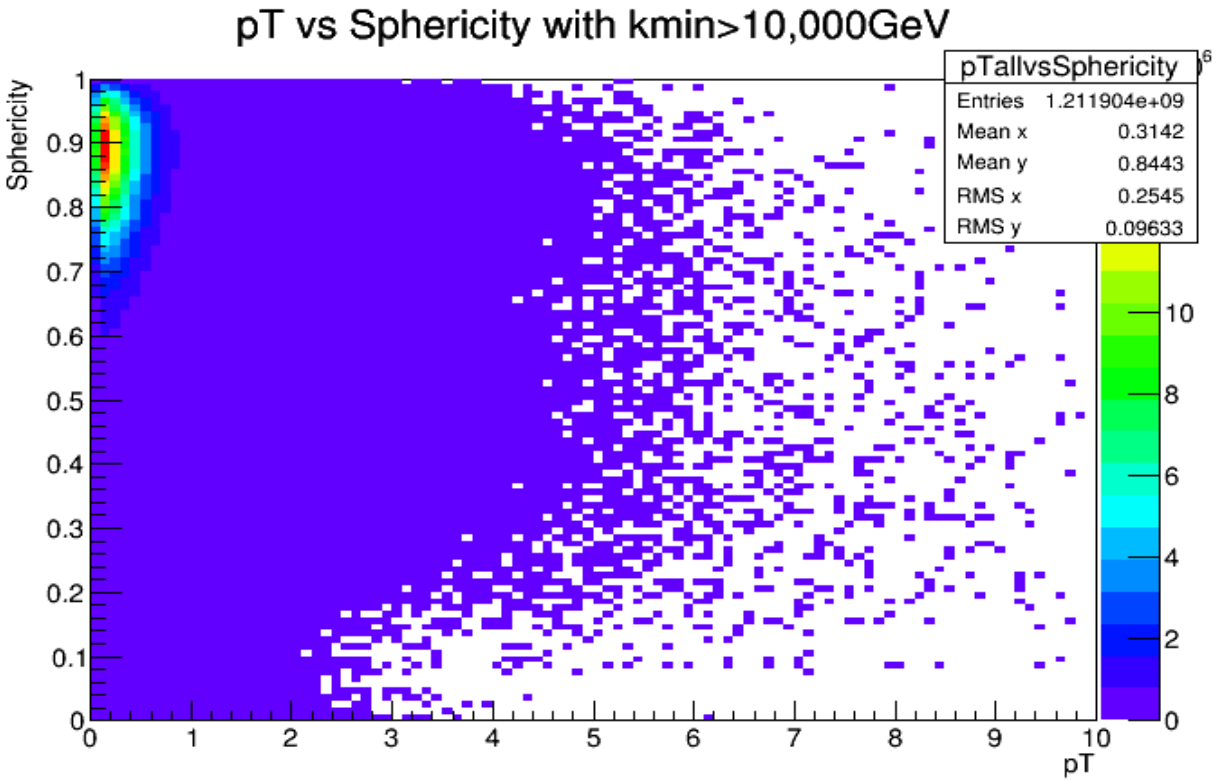


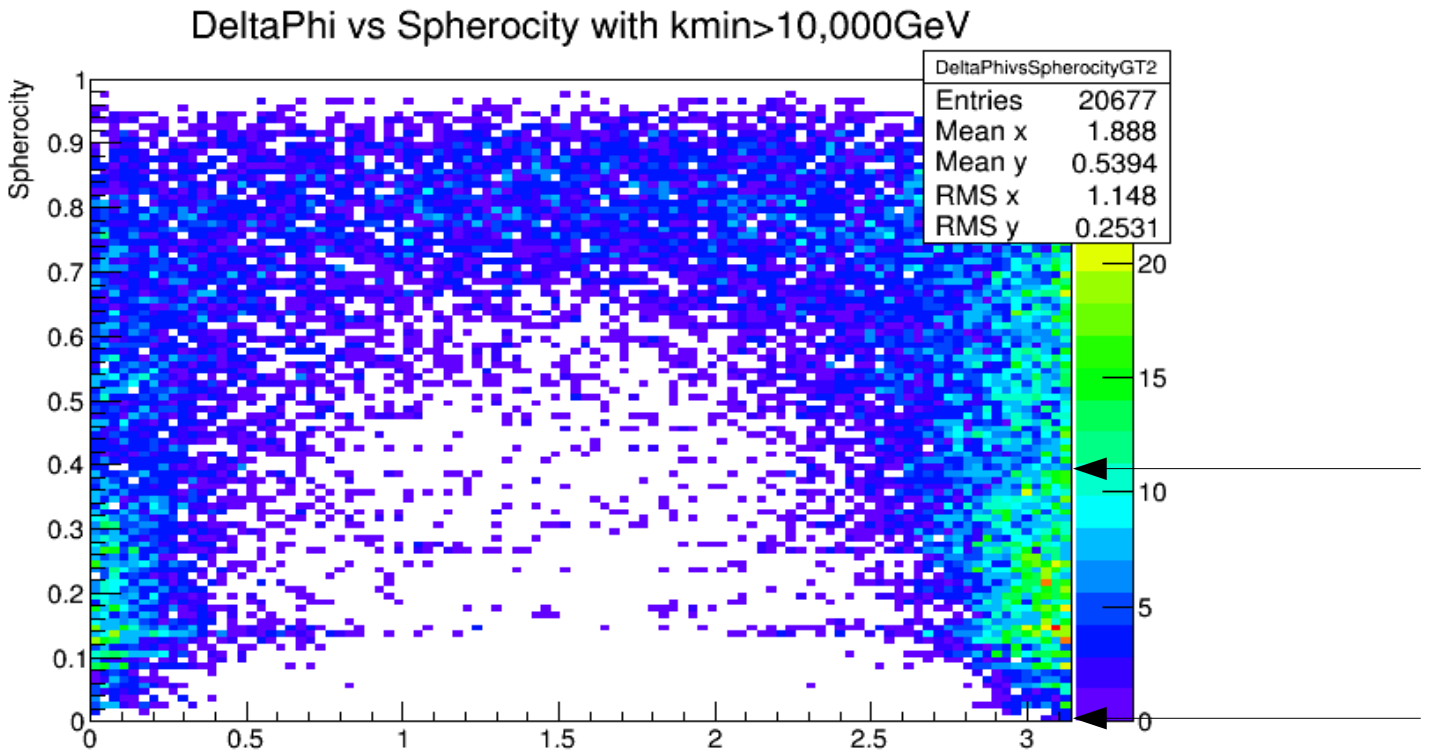


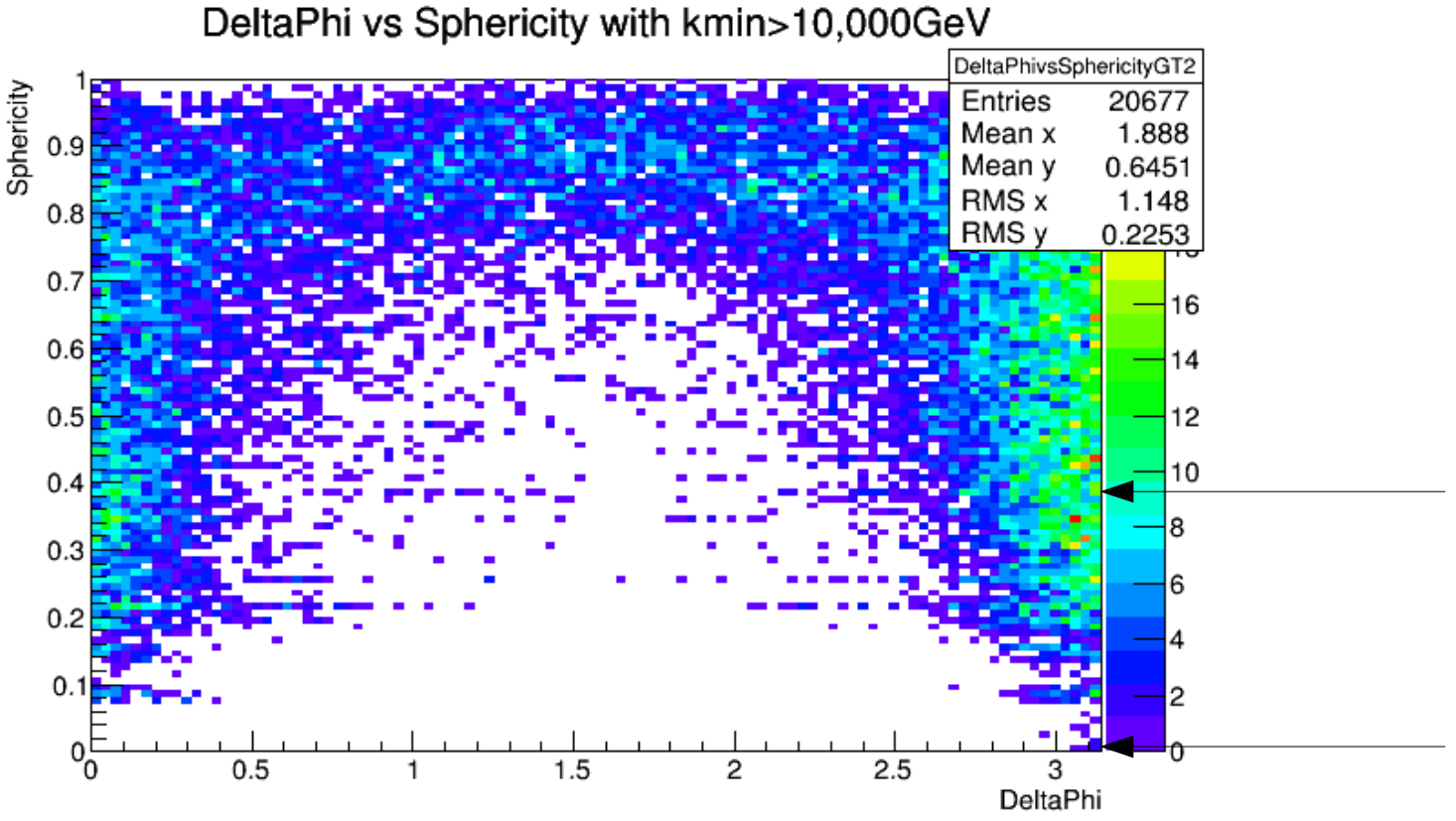
Peak in Zero.
Jet back
To back Events

Jet Region

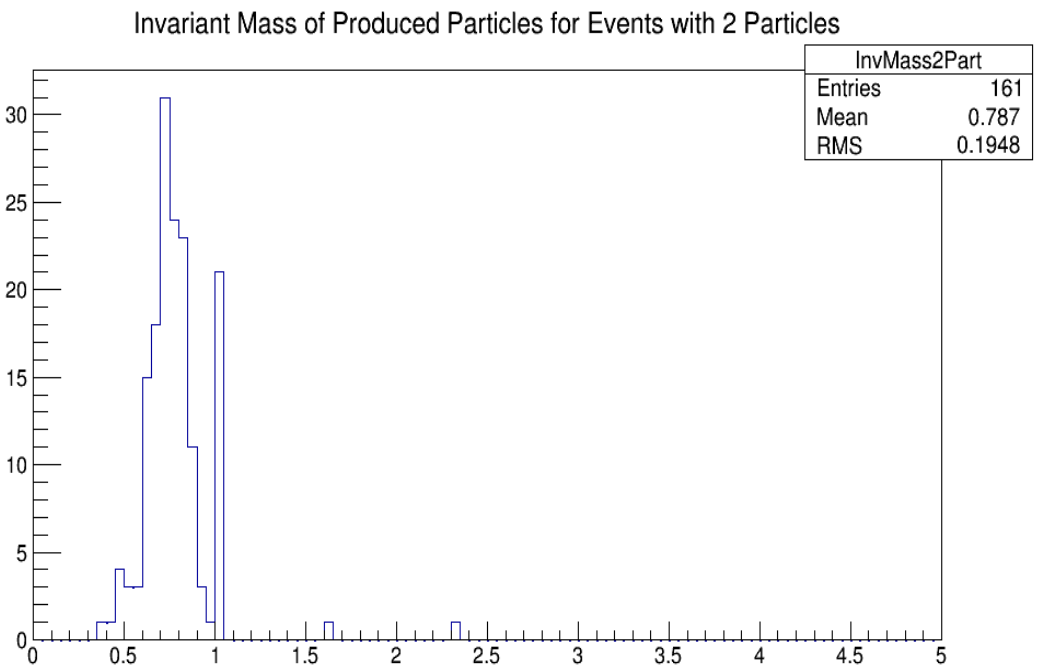

pT vs Spherocity with kmin>10,000GeV
pTallvsSpherocity
Entries 1.211904e+09
Mean x 0.3142
Mean y 0.7791
RMS x 0.2545
RMS y 0.1184
Spherocity
pT

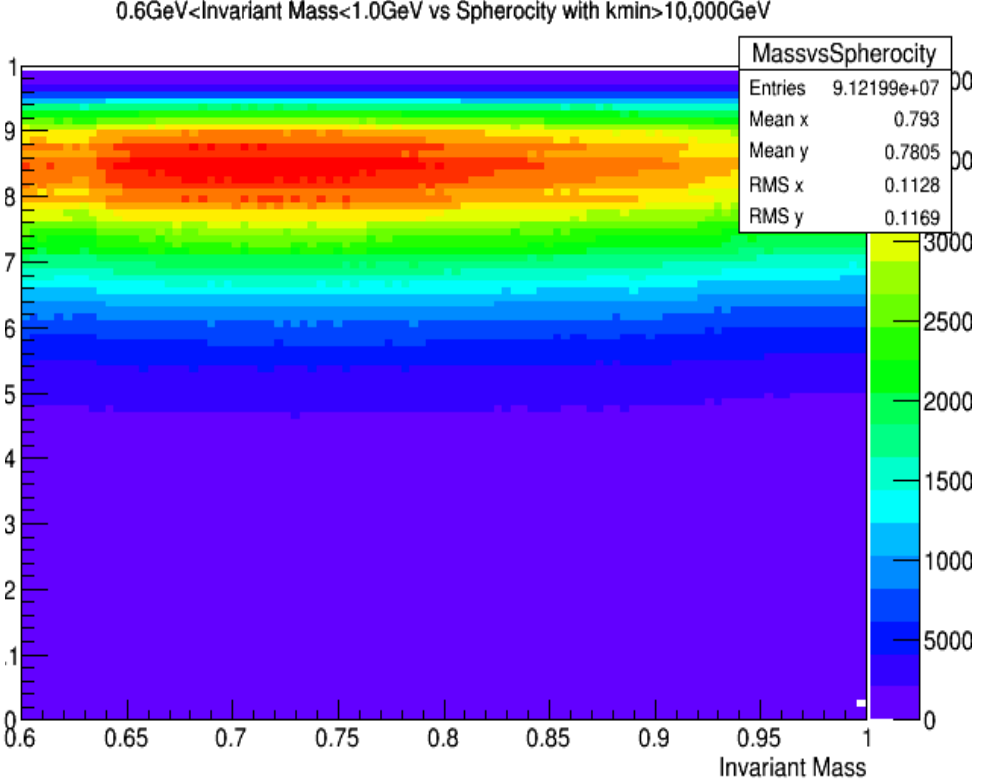

pT vs Sphericity with kmin>10,000GeV
pTallvsSphericity
Entries 1.211904e+09
Mean x 0.3142
Mean y 0.8443
RMS x 0.2545
RMS y 0.09633
Sphericity
pT

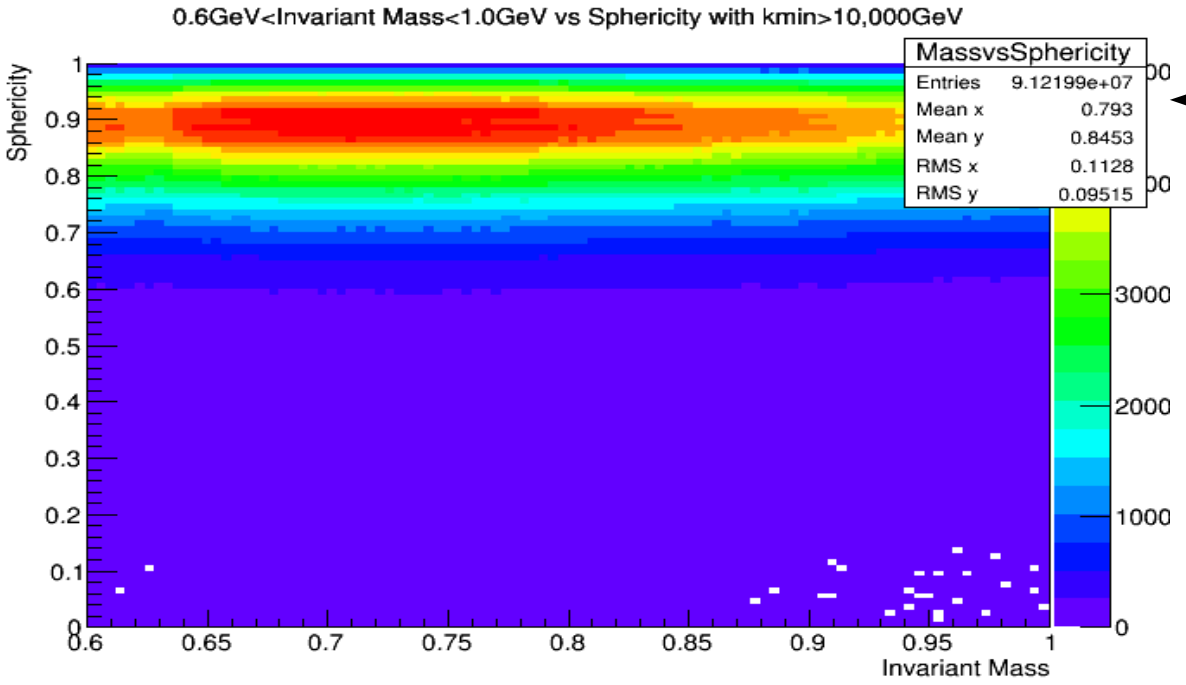




(Following Joakym suggestion)Cut in pT>2.0

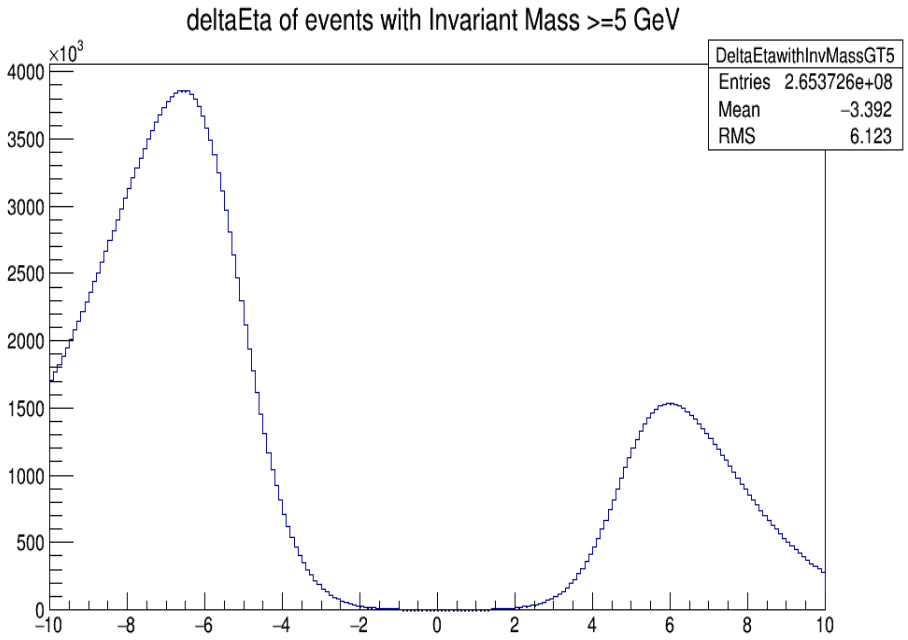


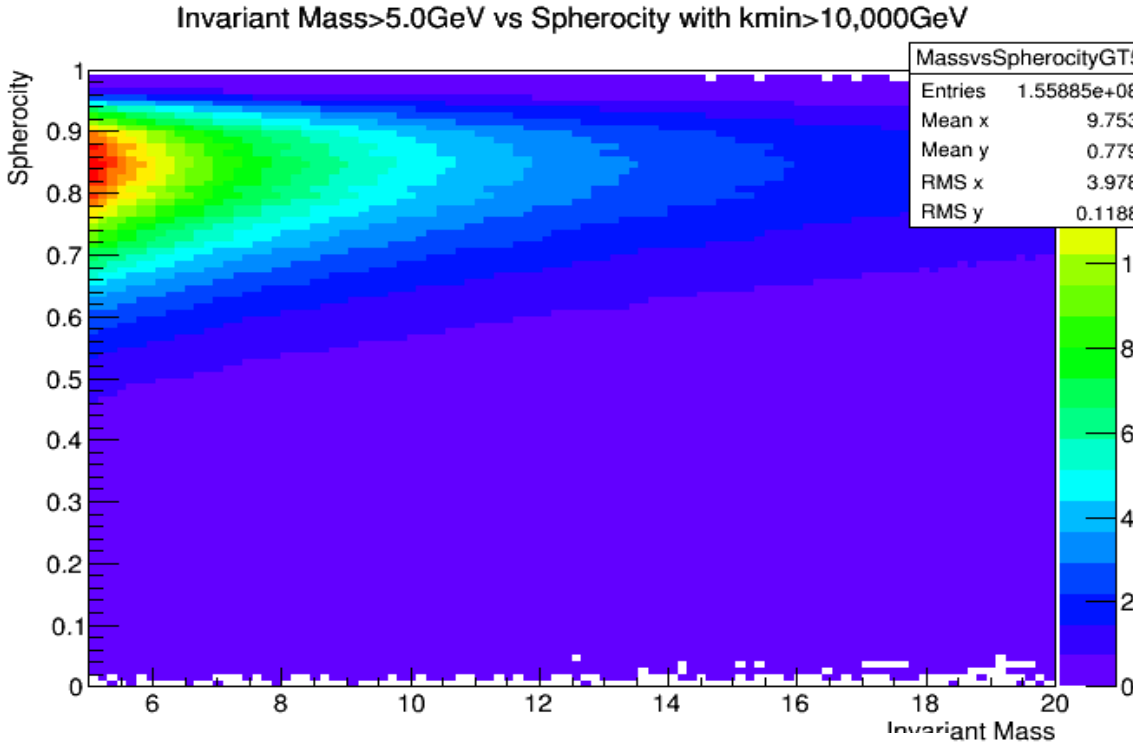


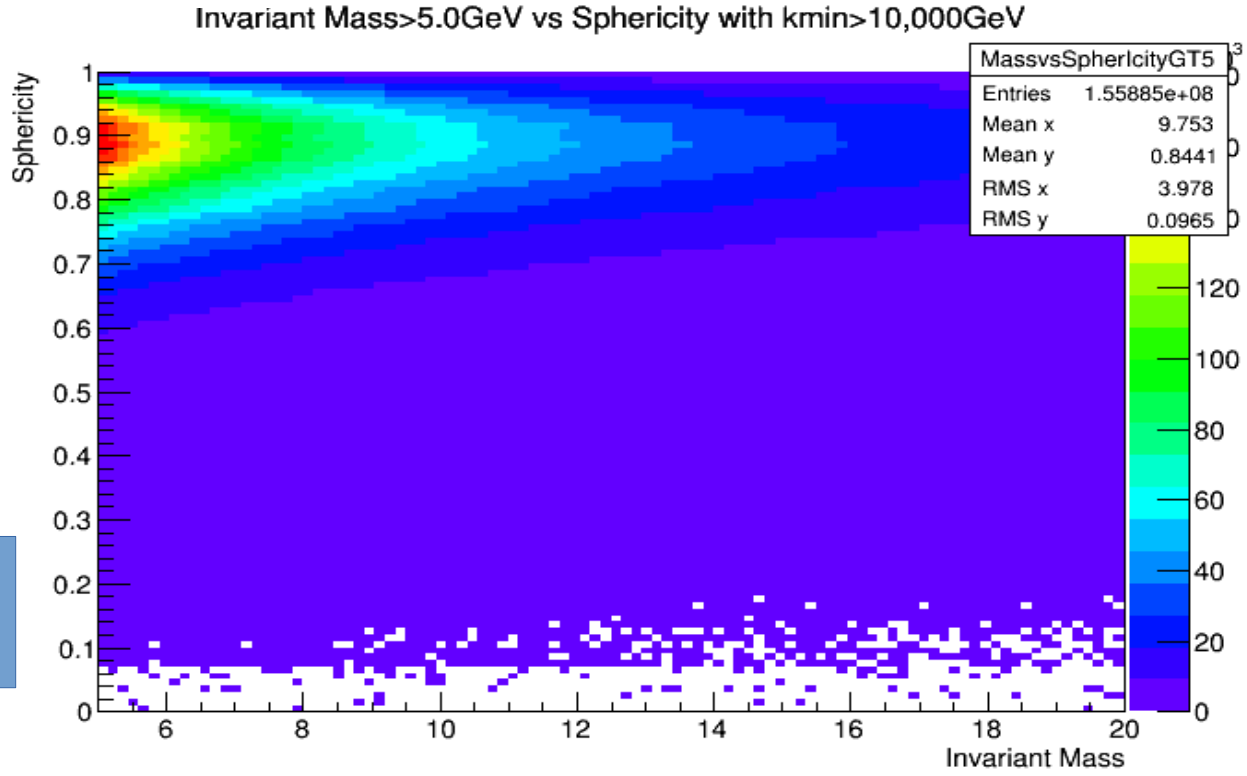


RhoZero Mass=0.7 GeV

Taking only Invariant Masses around the Rho Zero peak.







What happens
With those events
With InvMass>5.0 GeV?

Not in the spherocity and
Sphericity jet Region

- INCREASING W VALUE (Value of the gamma-gamma center of mass energy)

- We make a new MonteCarlo Generation with gretaer W energy. We want to produce events with more energy which could lead to the production of jets. Also we want to produce heavier particles.

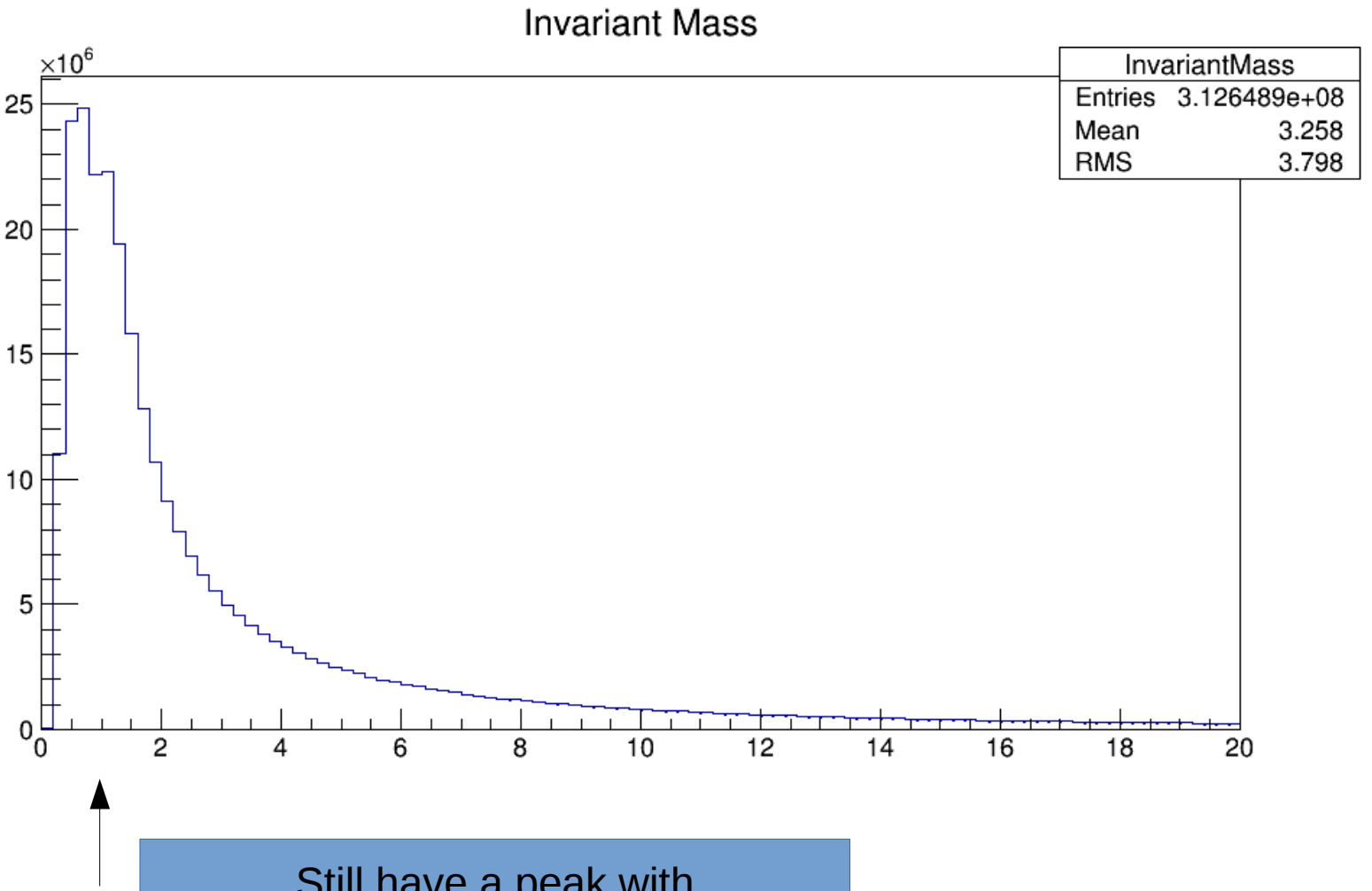
base file name ..... 'slight'
beam 1 atomic number 1
beam 1 atomic mass number 1
beam 2 atomic number 82
beam 2 atomic mass number 208
Lorentz gamma of beams in CM frame 4269.53
mass W of produced hadronic system ..... 2 < W < 12 GeV/c^2
# of W bins 40
maximum absolute value for rapidity 8
# of rapidity bins 80
cut in pT..... no
cut in eta..... no
production mode 5
number of events to generate 500000
seed for random generator 34533
breakup mode for beam particles 5
interference enabled ..... no
coherent scattering off nucleus ..... yes

##
Initialising Starlight version: trunk...
##

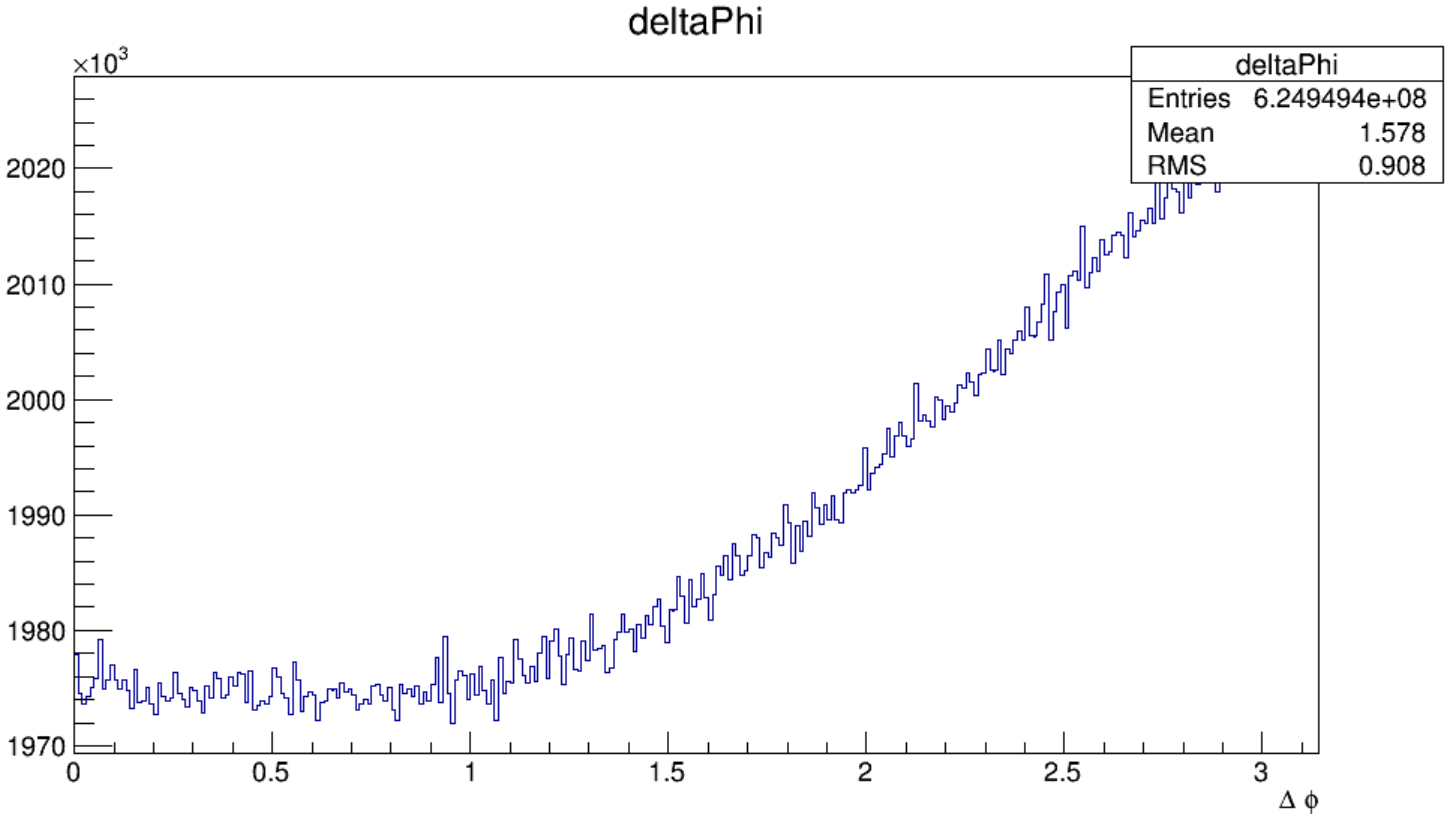
```
BEAM_1_Z = 82    #Z of projectile
BEAM_1_A = 208   #A of projectile
BEAM_2_Z = 82   #Z of target
BEAM_2_A = 208   #A of target
BEAM_1_GAMMA =2731 #Gamma of the colliding ions
BEAM_2_GAMMA = 2731 #Gamma of the colliding ions
W_MAX = 600.0   #Max value of w
W_MIN = 300.0    #Min value of w
W_N_BINS = 40    #Bins i w
RAP_MAX = 8.    #max y
RAP_N_BINS = 80    #Bins i y
CUT_PT = 0 #Cut in pT? 0 = (no, 1 = yes)
PT_MIN = 1.0 #Minimum pT in GeV
PT_MAX = 3.0 #Maximum pT in GeV
CUT_ETA = 0 #Cut in pseudorapidity? (0 = no, 1 = yes)
ETA_MIN = -10 #Minimum pseudorapidity
ETA_MAX = 10 #Maximum pseudorapidity
PROD_MODE = 5     #gg or gP switch (1 = 2-photon, 2 = coherent vector meson (narrow), 3 = coherent vector meso
# 4 = incoherent vector meson, 5 = A+A DPMJet single, 6 = A+A DPMJet double, 7 = p+A DPMJet single, 8 = p+A Py
single )
N_EVENTS = 500000   #Number of events
PROD_PID = 443013   #Channel of interest (not relevant for photonuclear processes)
RND_SEED = 34533 #Random number seed
BREAKUP_MODE = 5     #Controls the nuclear breakup
INTERFERENCE = 0     #Interference (0 = off, 1 = on)
IF_STRENGTH = 1.    #% of intefernce (0.0 - 0.1)
INT_PT_MAX = 0.24  #Maximum pt considered, when interference is turned on
INT_PT_N_BINS =120   #Number of pt bins when interference is turned on
COHERENT = 1     #Coherent=1,Incoherent=0
INCO_FACTOR = 1.    #percentage of incoherence

# Photonuclear specific options, energies in Lab frame. These values should be within the range of the
# values specified in the DPMJet input file (when DPMJet is used)
MIN_GAMMA_ENERGY = 10000.0
MAX_GAMMA_ENERGY = 600000.0
```

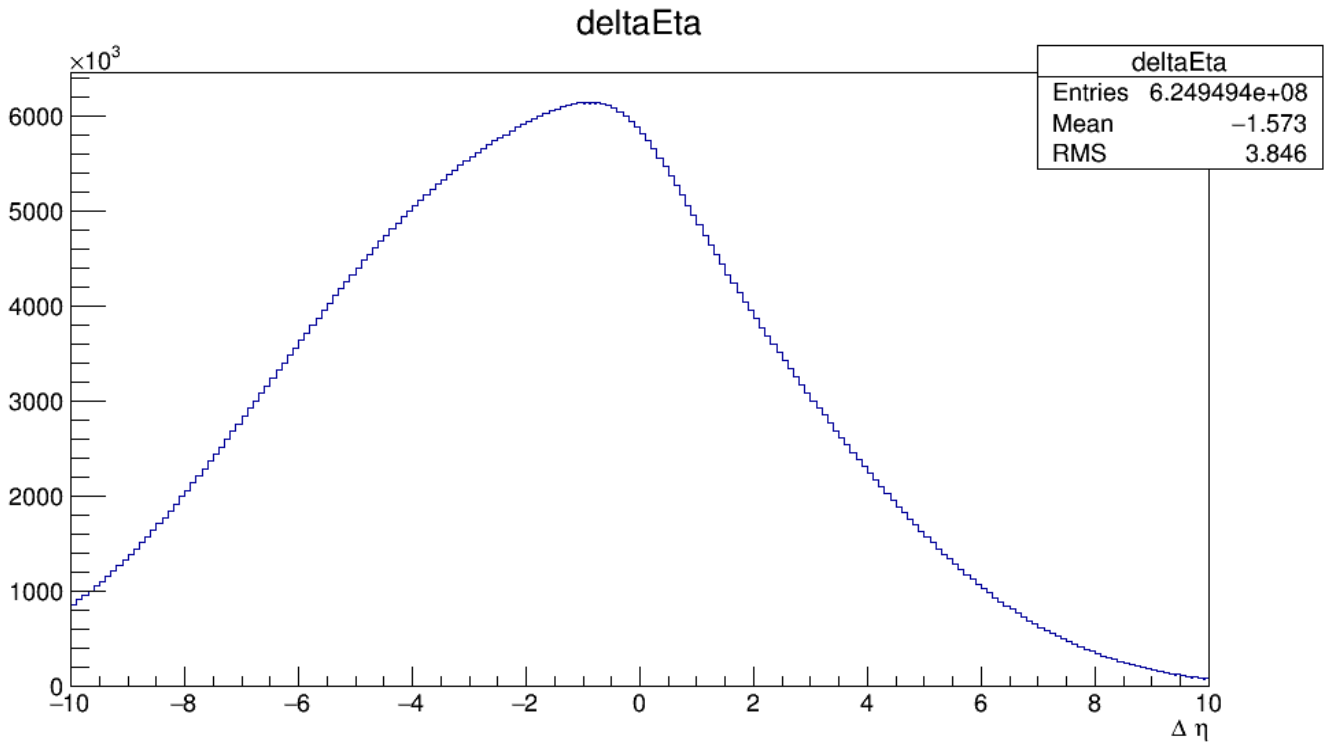
New Distributions with the MonteCarlo Generation

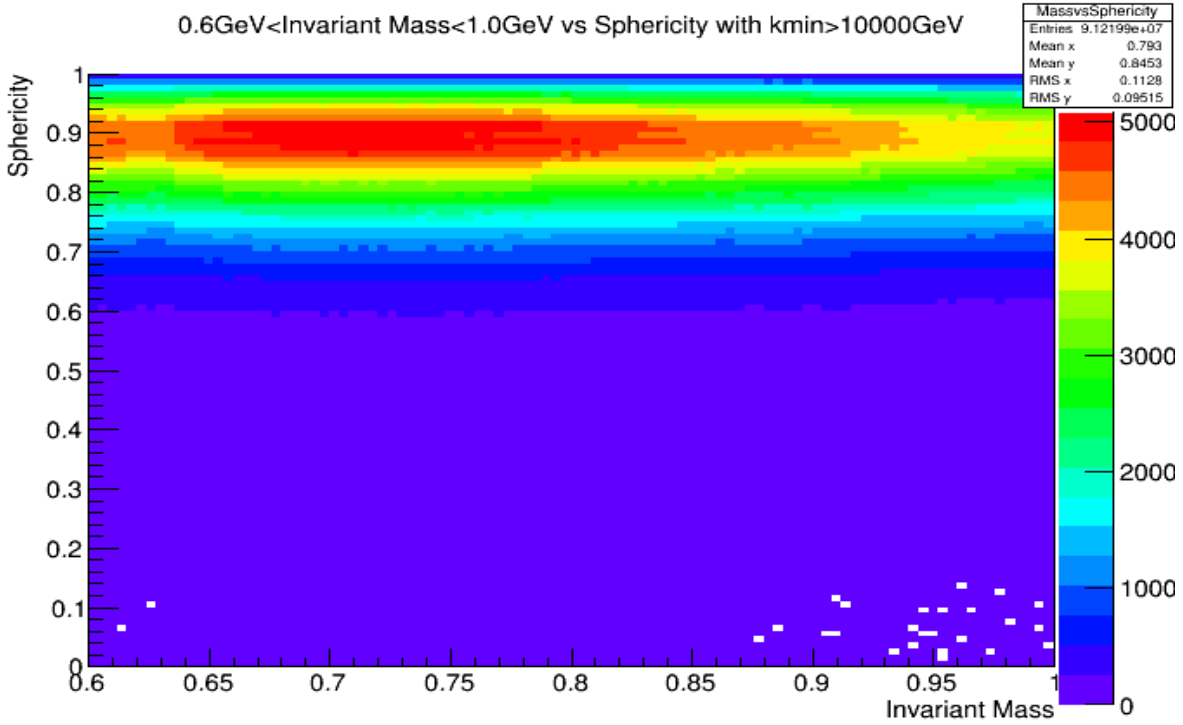


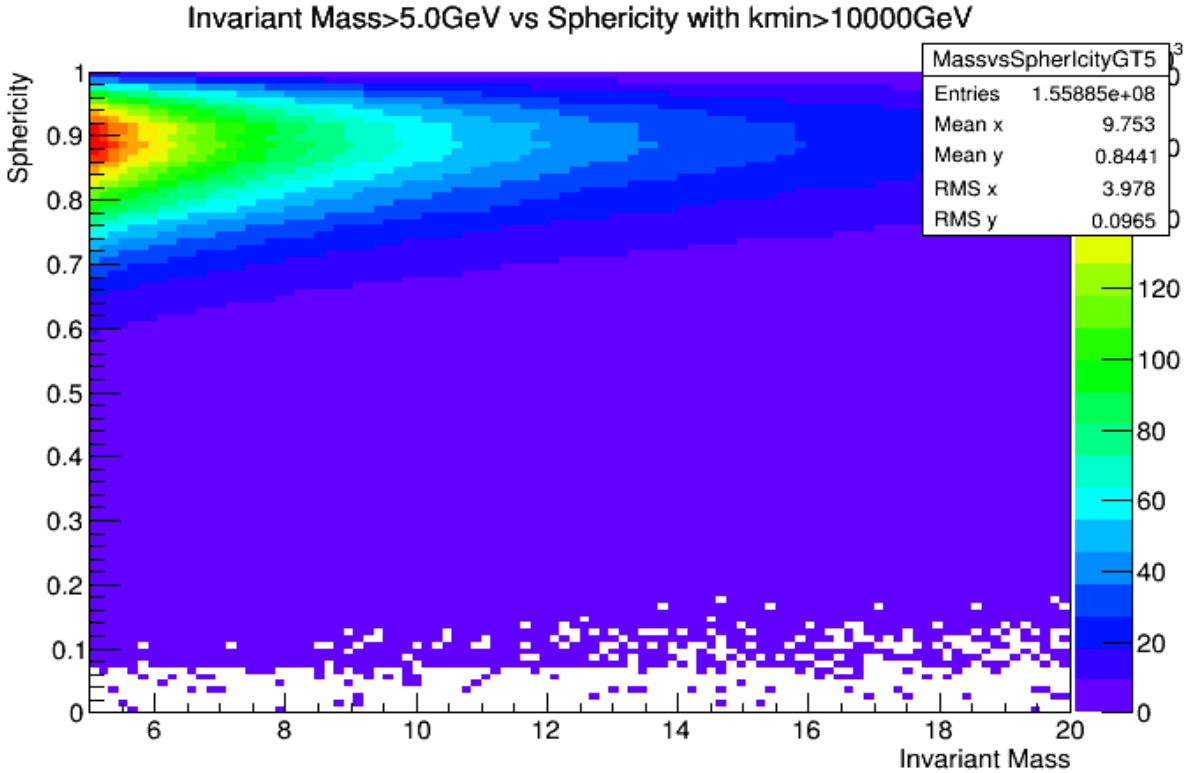
Still have a peak with
Low mass (0,7), Rho Zero mass

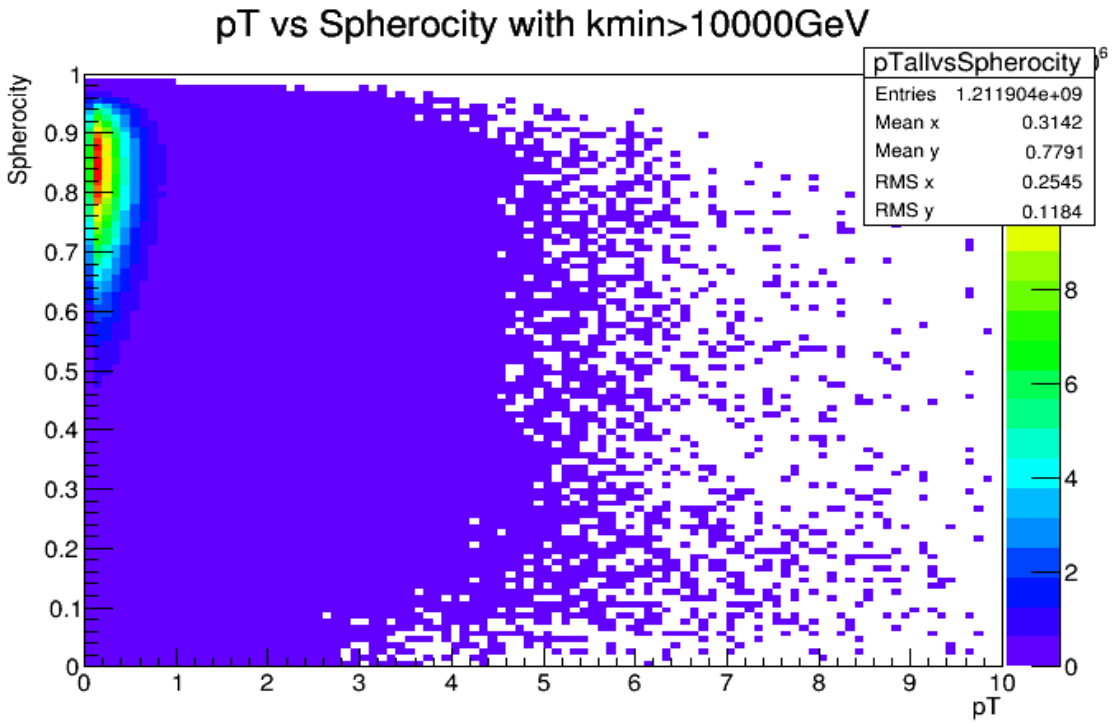


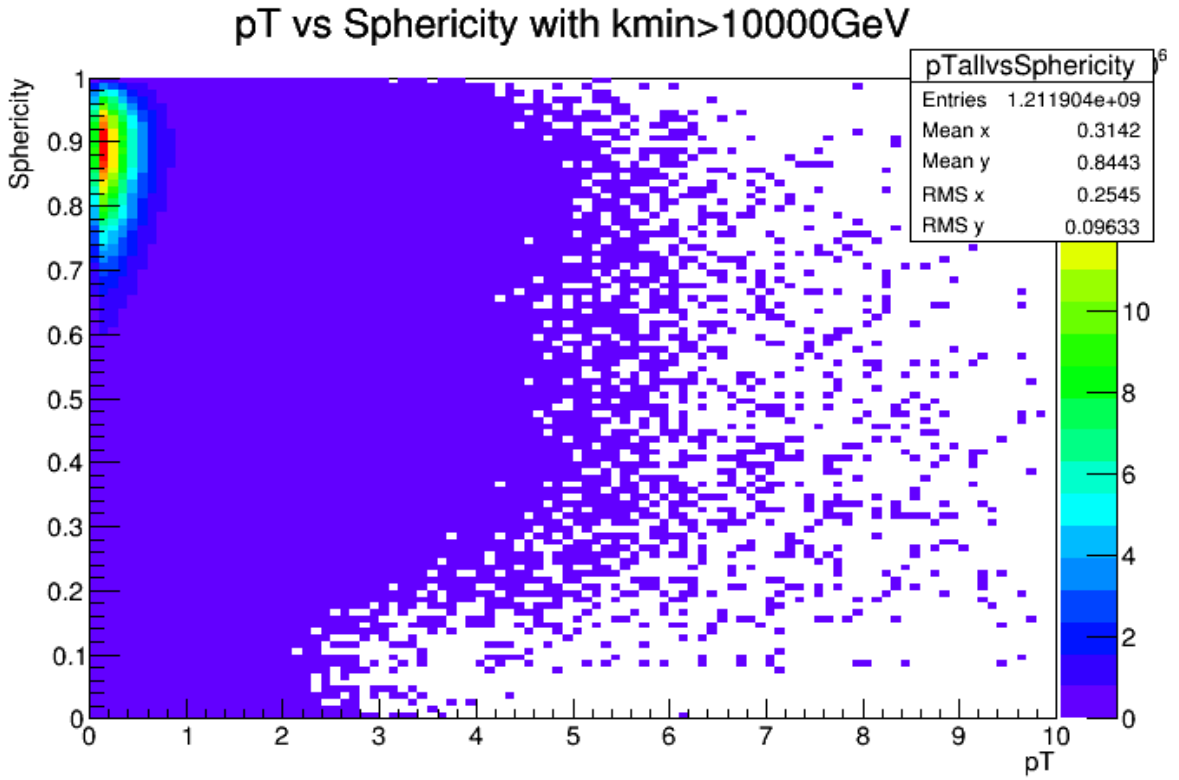
All Events,
(No Cuts)



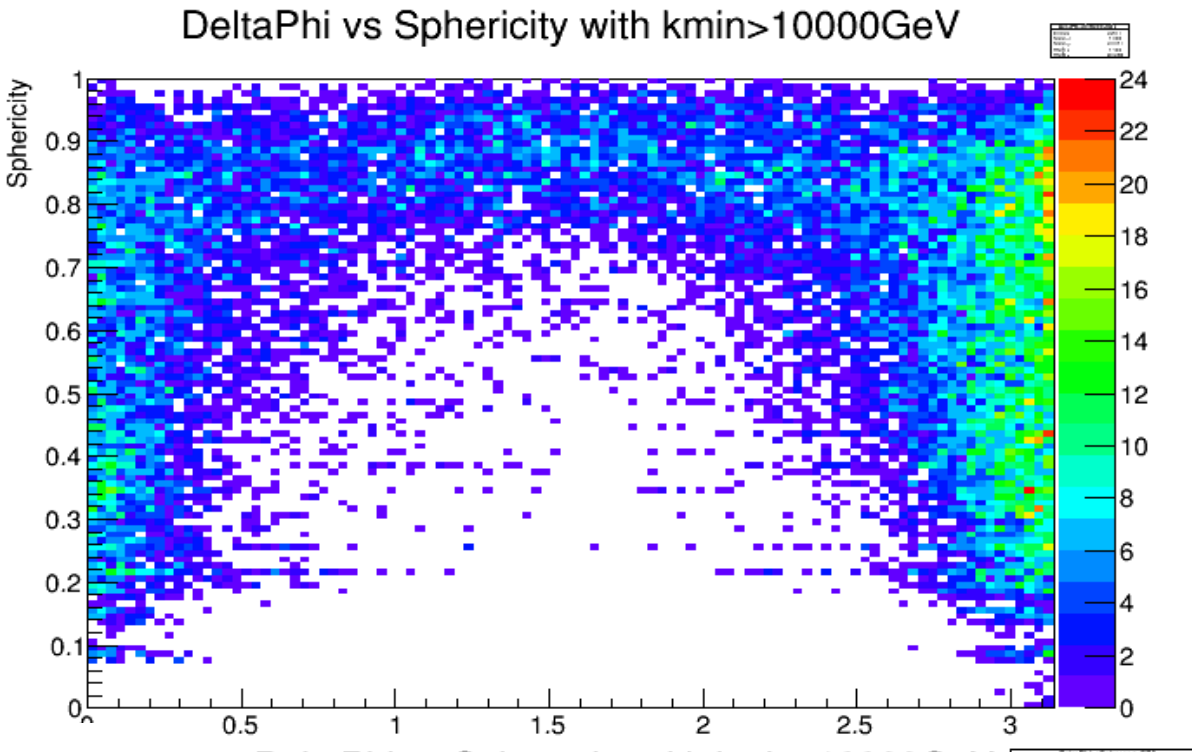

0.6GeV<Invariant Mass<1.0GeV vs Sphericity with kmin>10000GeV
MassvsSphericity
Entries 9.12199e+07
Mean x 0.793
Mean y 0.8453
RMS x 0.1128
RMS y 0.09515
Sphericity
Invariant Mass
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
5000
4000
3000
2000
1000
0

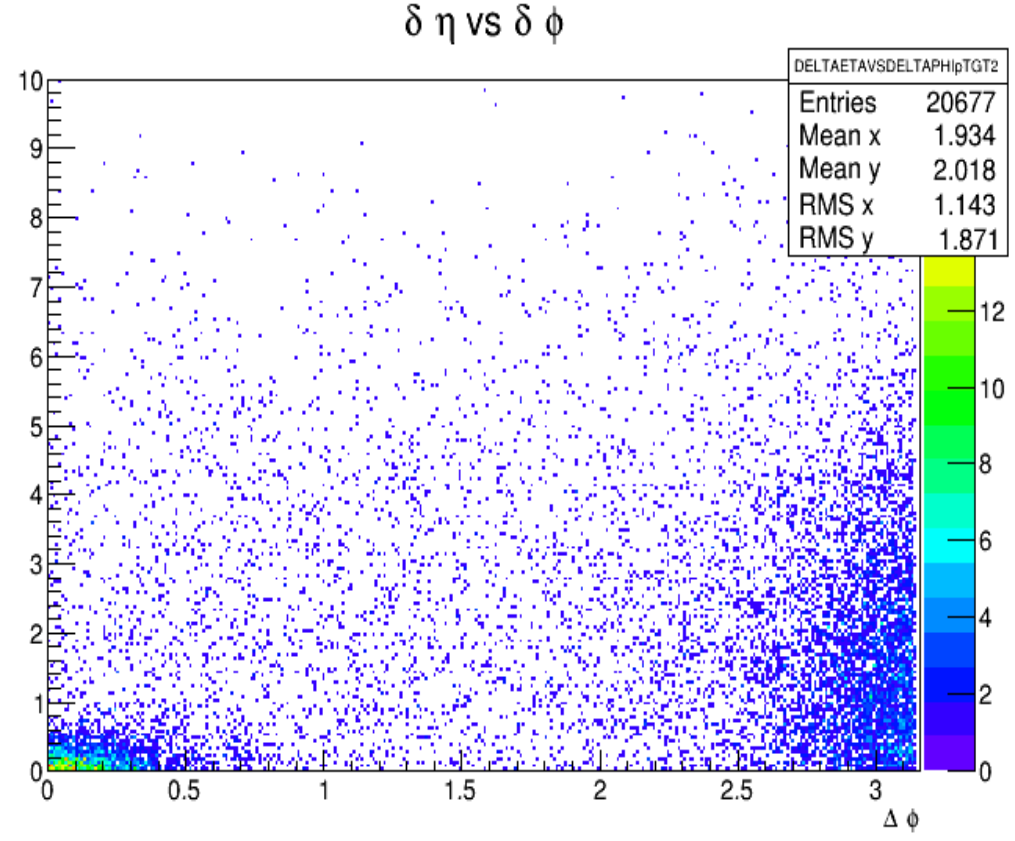

Invariant Mass>5.0GeV vs Sphericity with kmin>10000GeV
MassvsSpherIcityGT5
Entries 1.55885e+08
Mean x 9.753
Mean y 0.8441
RMS x 3.978
RMS y 0.0965
Sphericity
Invariant Mass
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
6
8
10
12
14
16
18
20
120
100
80
60
40
20
0

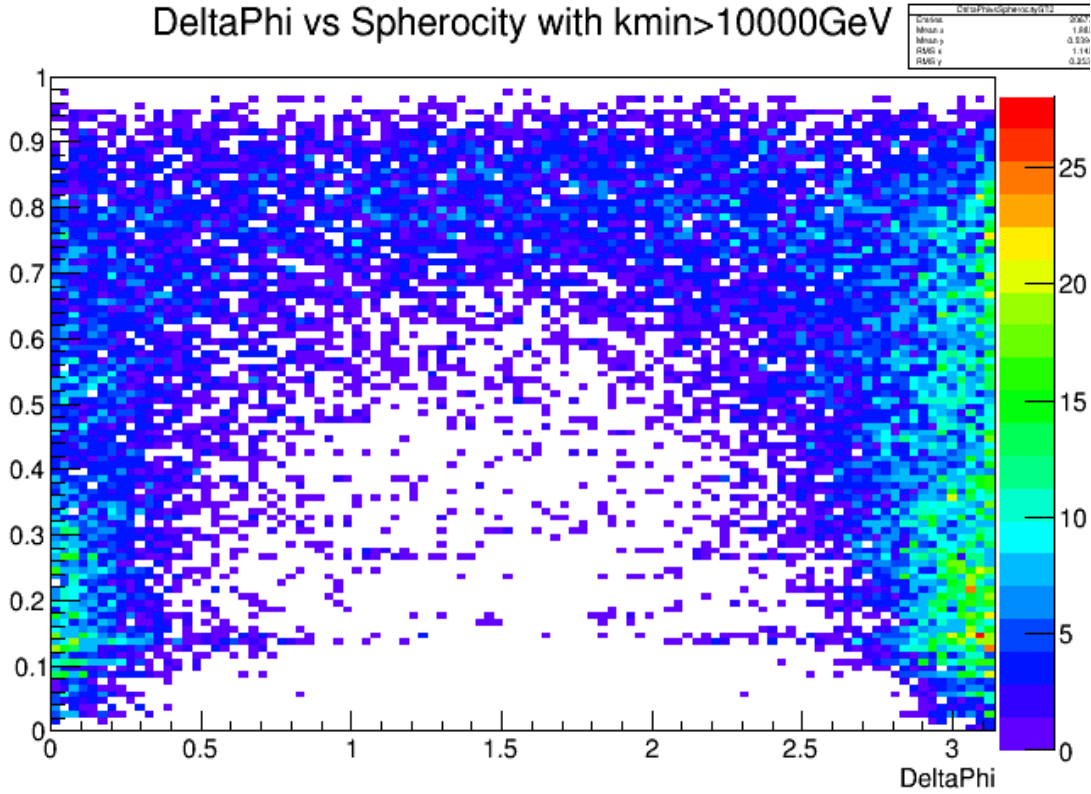

pT vs Spherocity with kmin>10000GeV
pTallvsSpherocity
Entries 1.211904e+09
Mean x 0.3142
Mean y 0.7791
RMS x 0.2545
RMS y 0.1184
Spherocity
pT

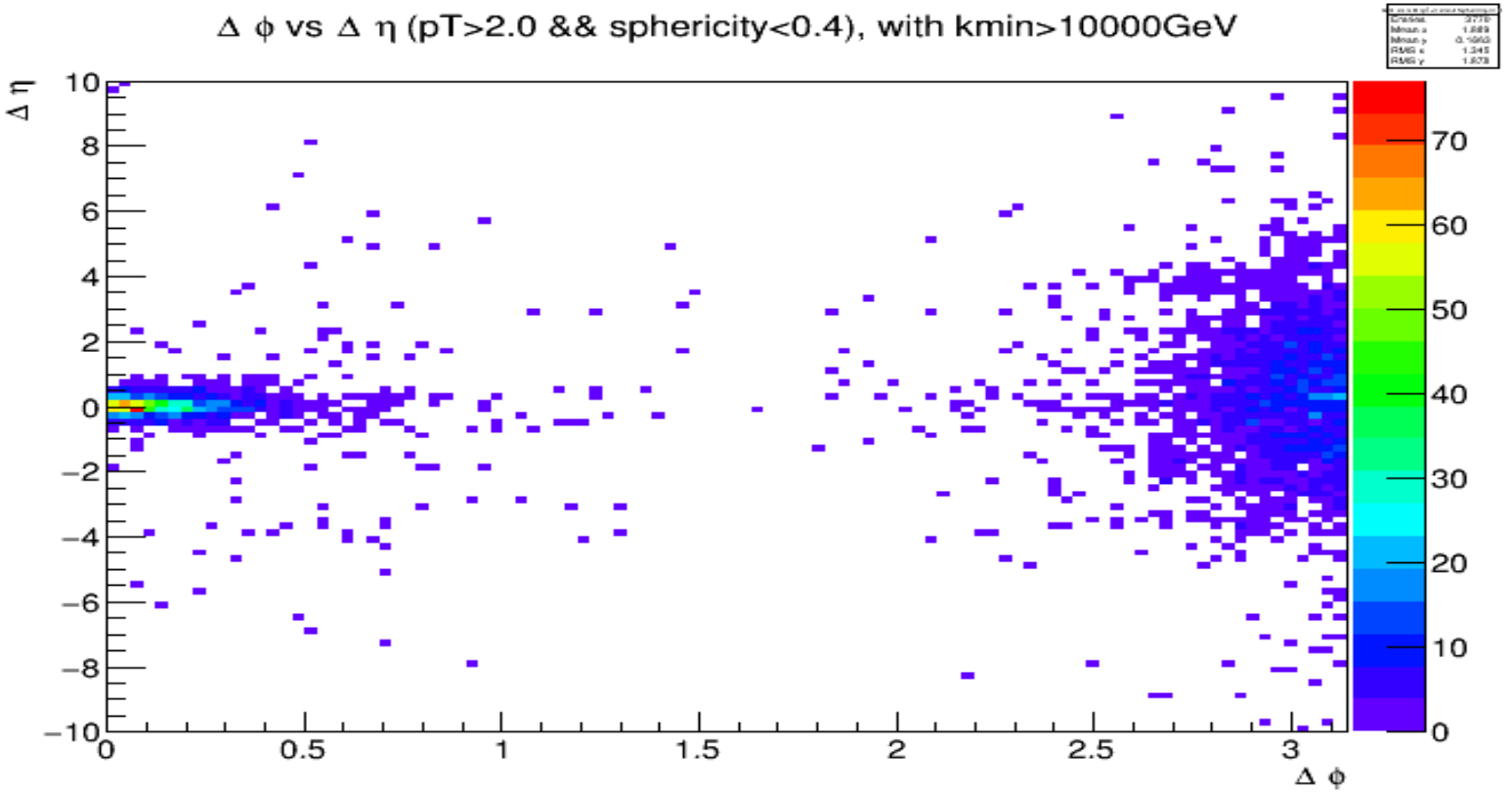

pT vs Sphericity with kmin>10000GeV
pTallvsSphericity
Entries 1.211904e+09
Mean x 0.3142
Mean y 0.8443
RMS x 0.2545
RMS y 0.09633
Sphericity
pT

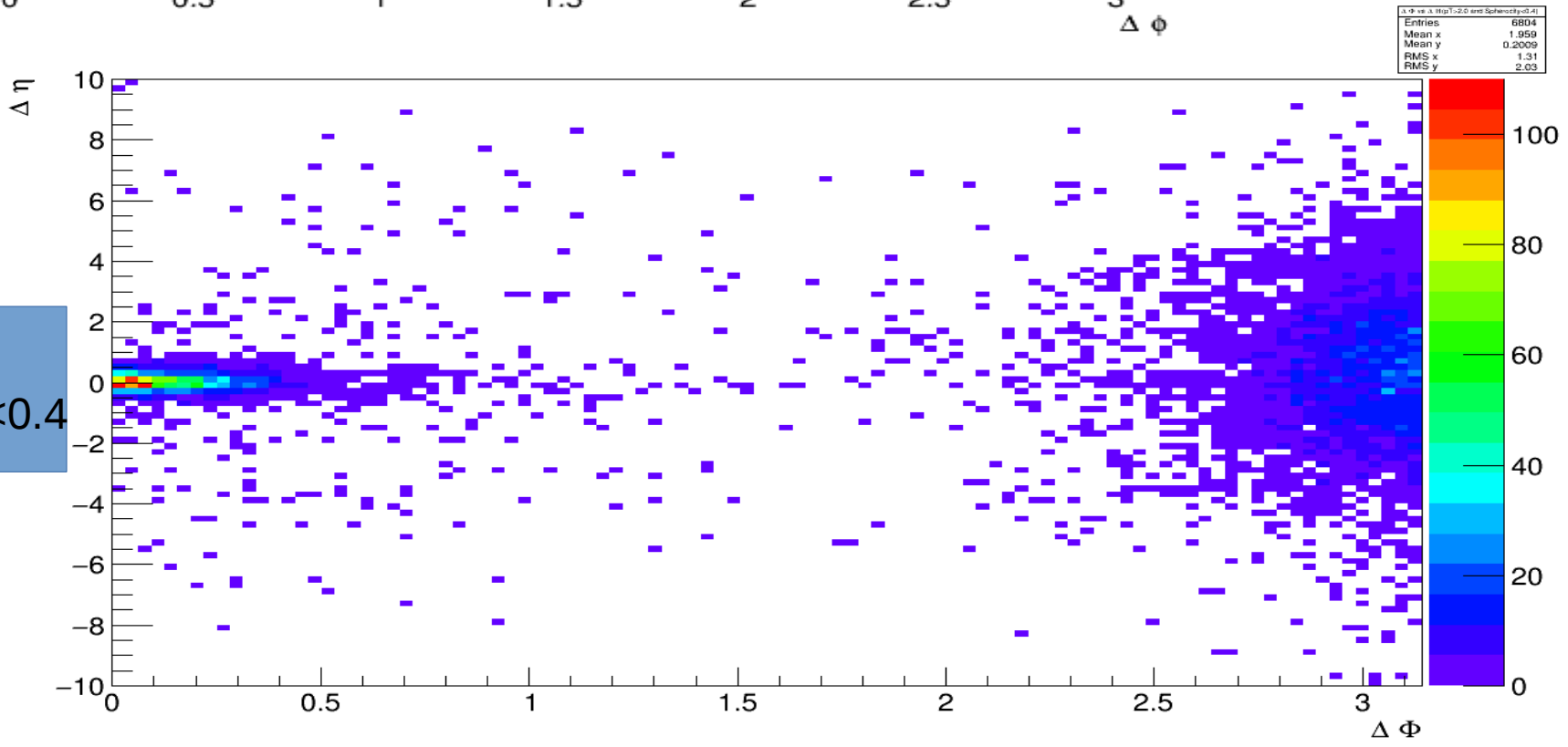
CUT with Pt>2.0





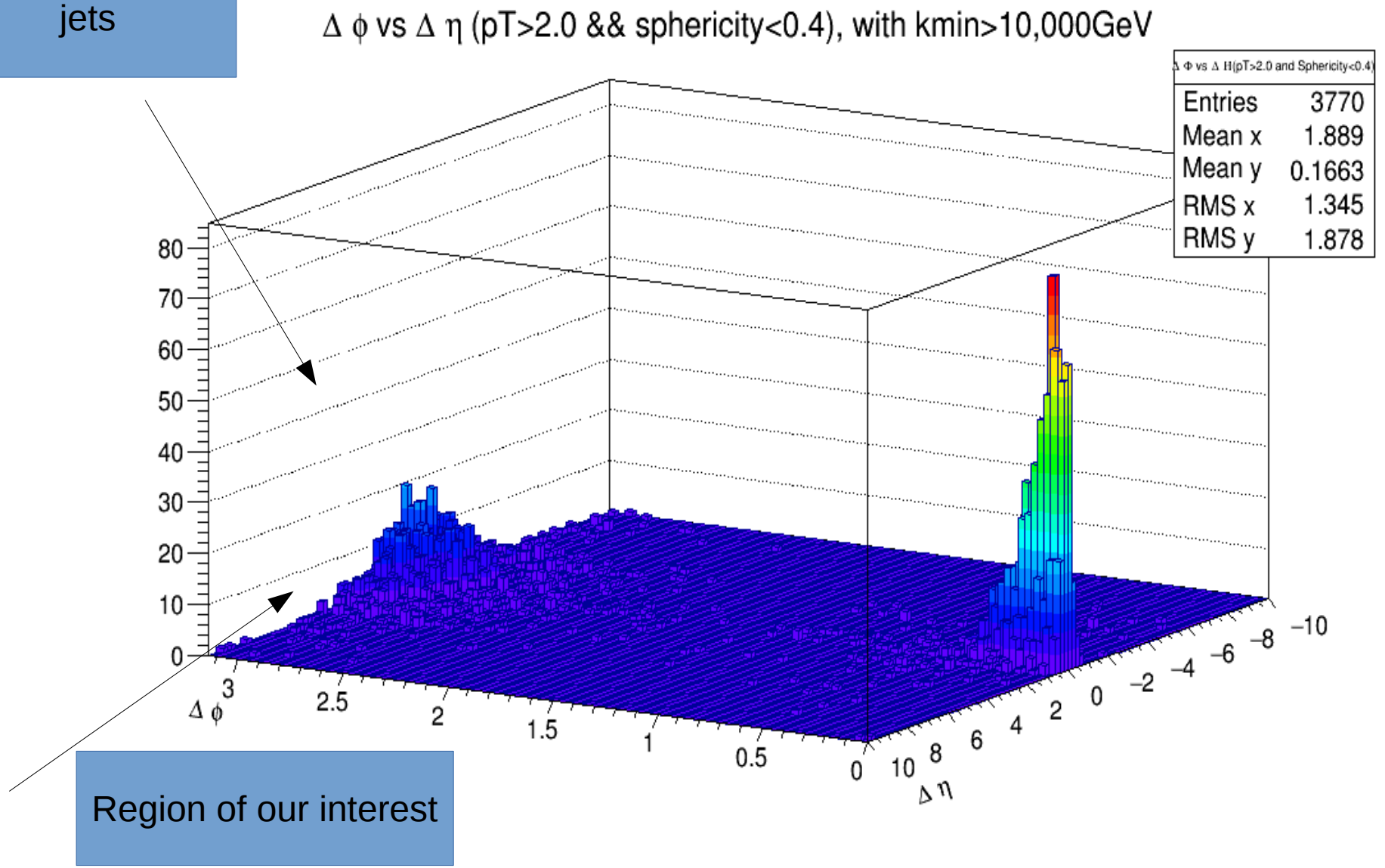






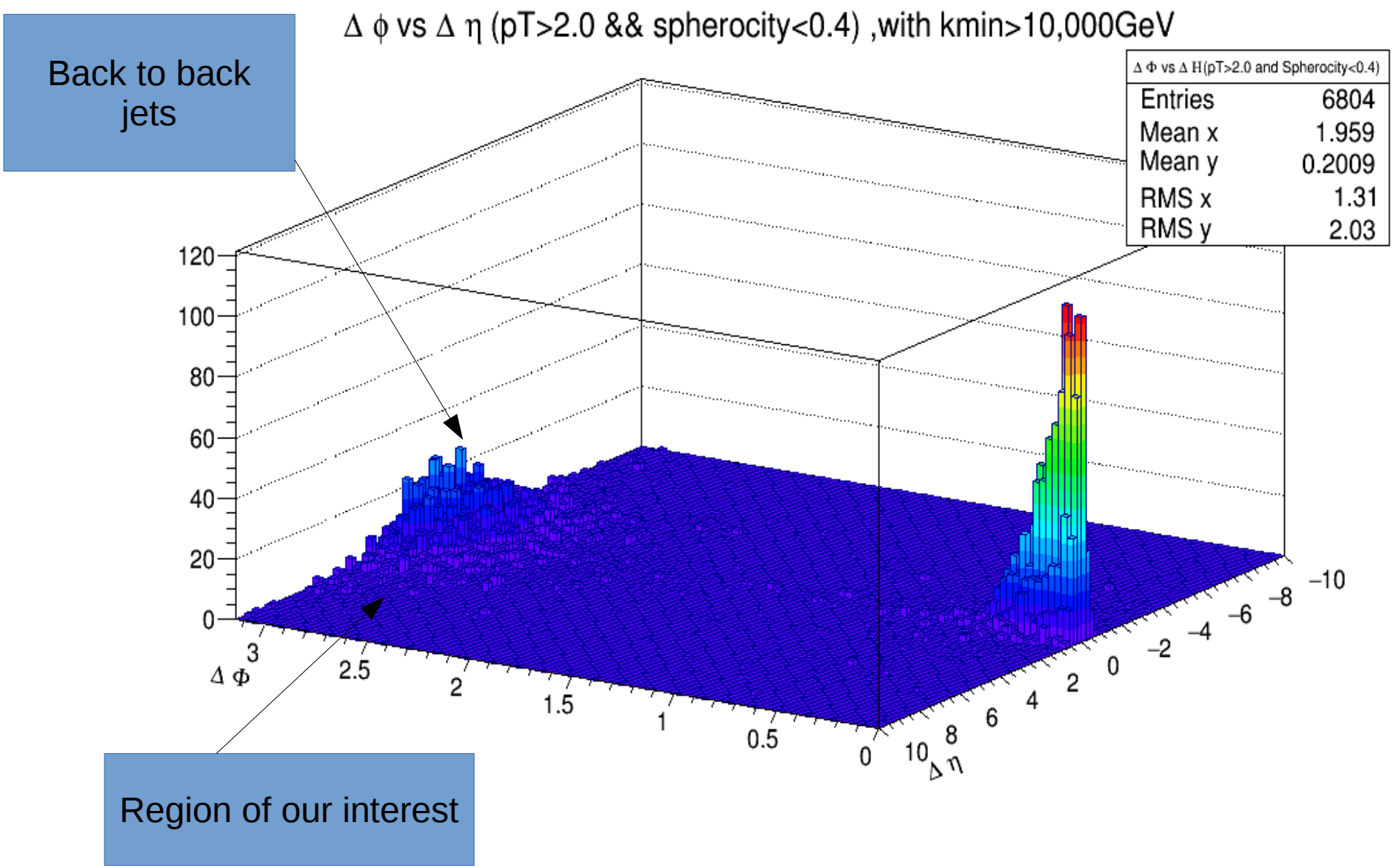
pT>2.0
Spherocity<0.4

Back to back jets



Region of our interest

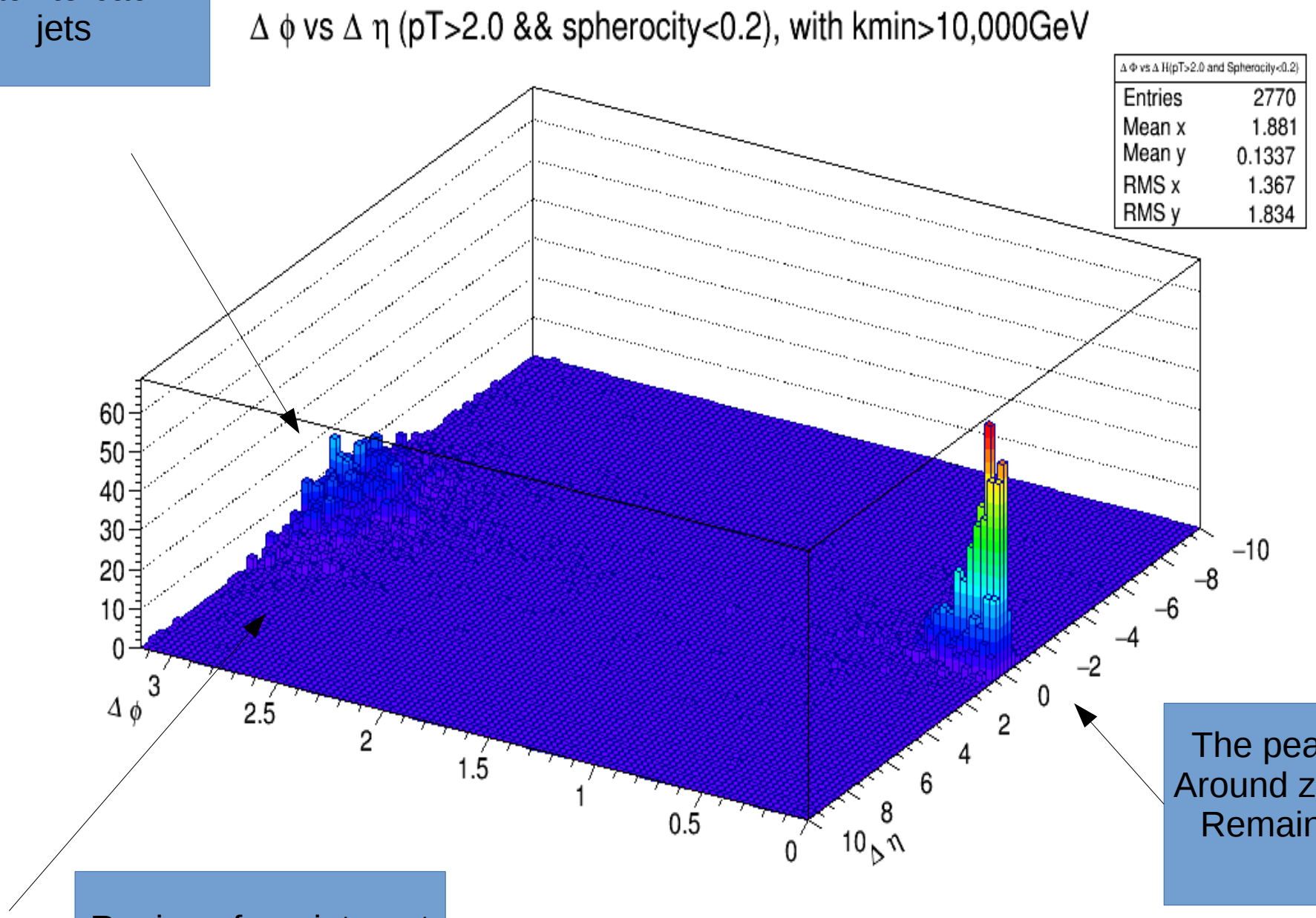
Back to back jets



Region of our interest

What happens if the we make spherocity more restrective?

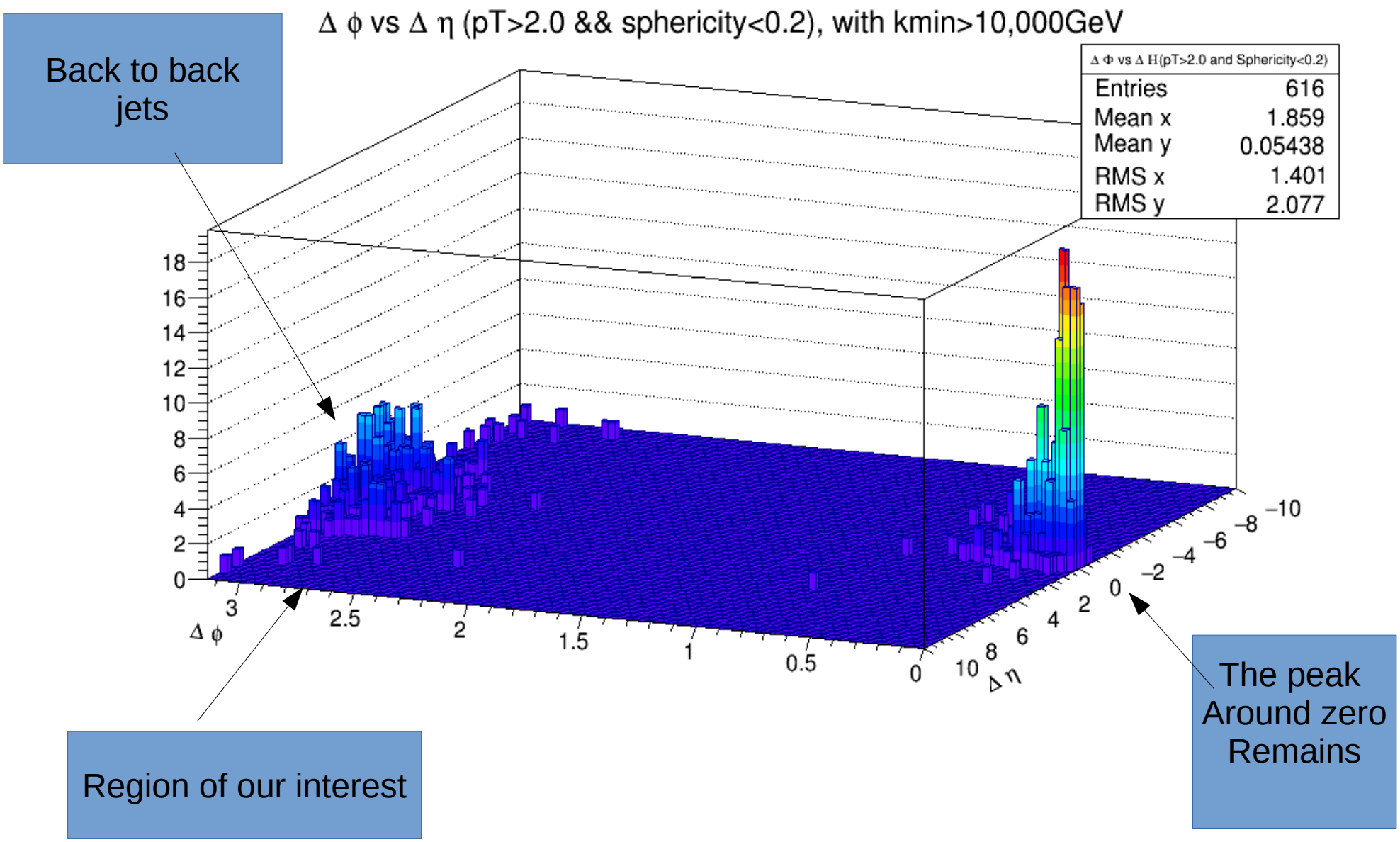
Back to back jets



Region of our interest

The peak Around zero Remains

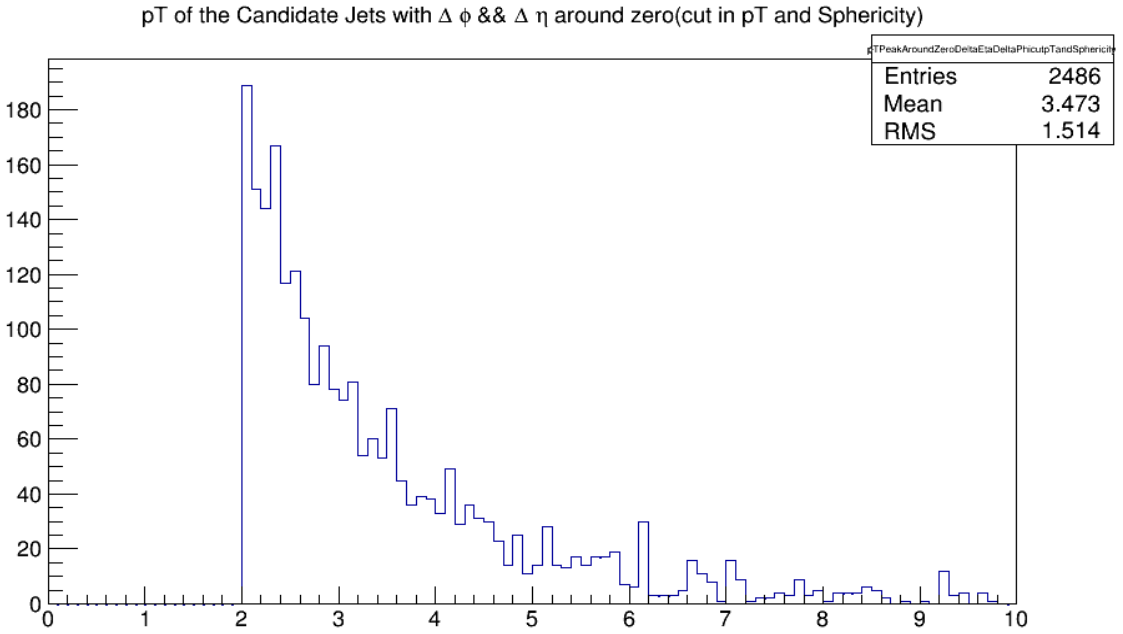
What happens if the we make sphericity more restrective?



Studying both peaks

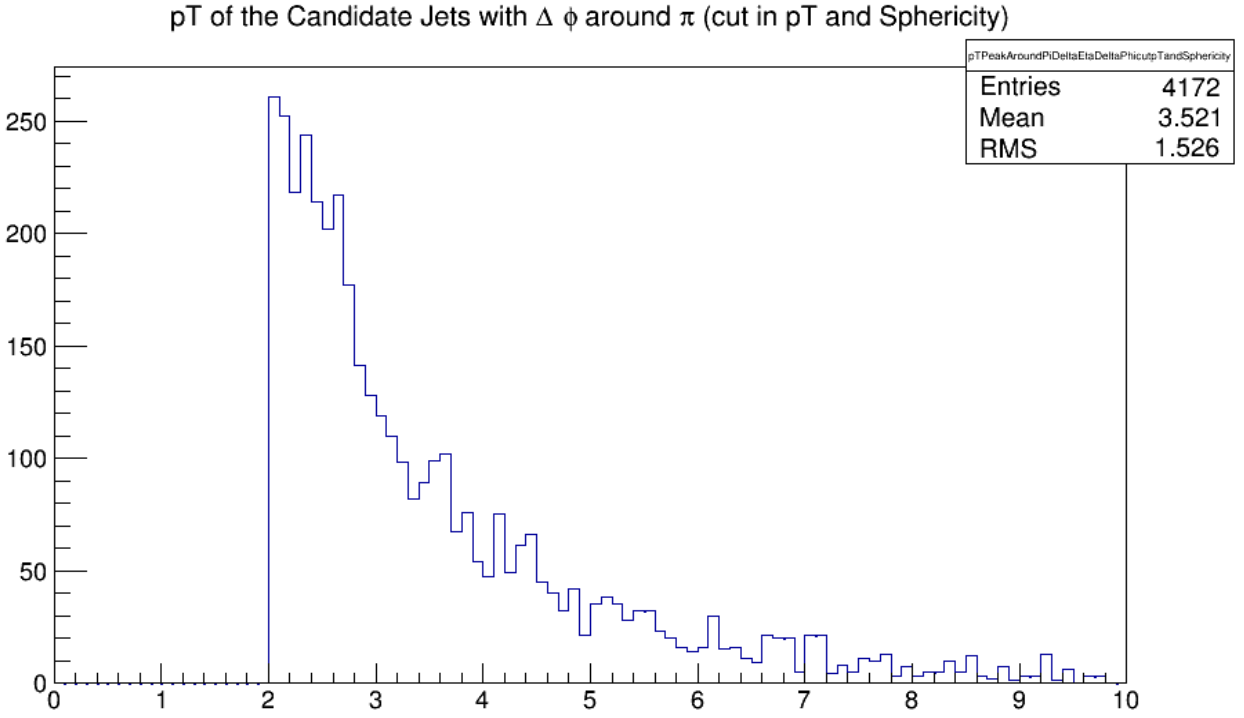
- The peak around 3.1416 in deltaphi are back to back events (of our interest).
- We study which are the properties of both peaks to make the cut that can clean the signal.

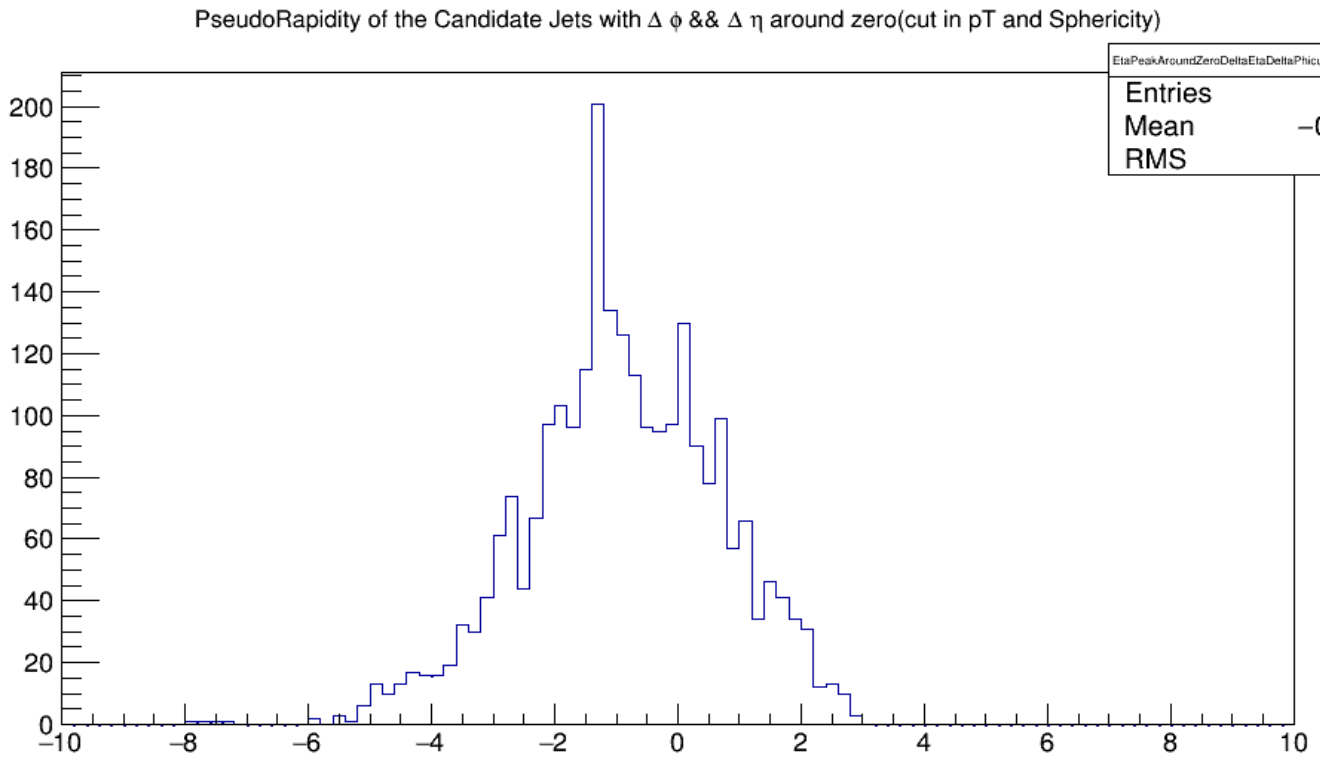
Comparing information of the jets in the DeltaPhi region around Pi and the DeltaPhi region around Zero



Around Pi cut:
DeltaPHI>2.5
-4.0<DeltaEta<4.0

Around Zero cut:
DeltaPhi<0.5
-0.6<DeltaEta<0.6

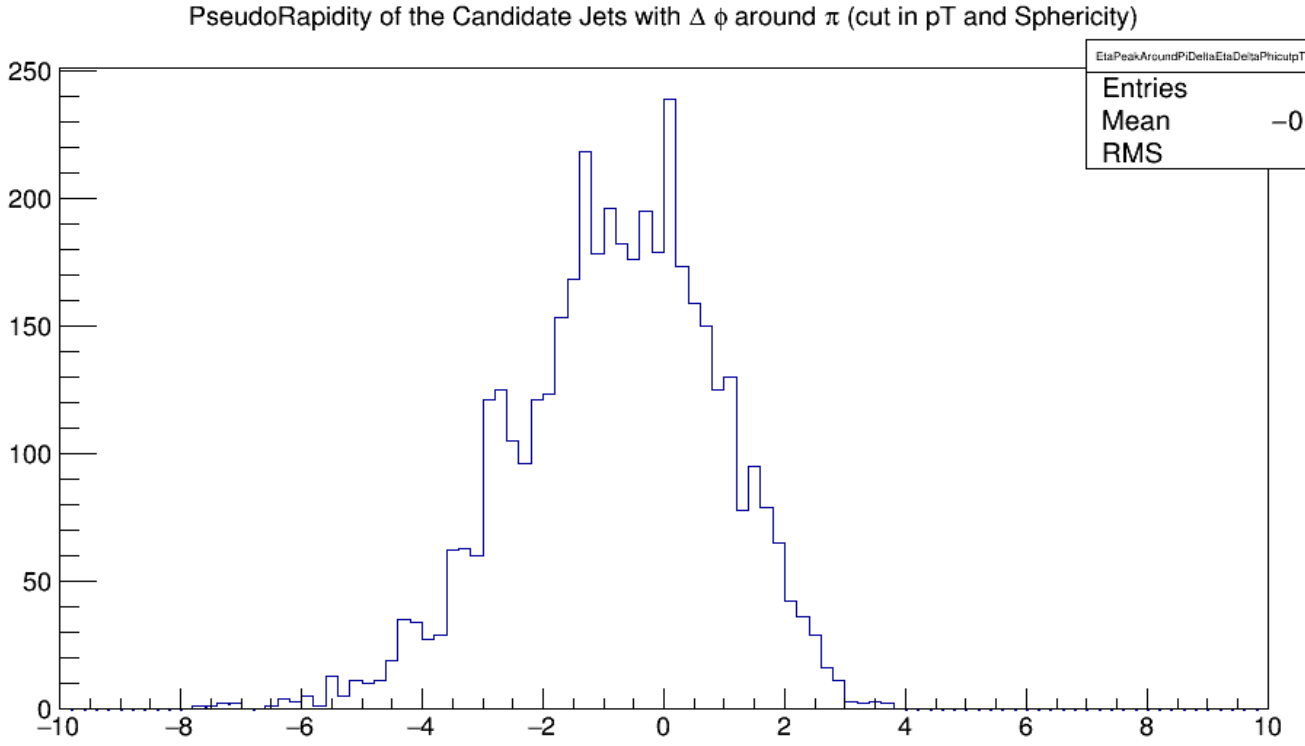


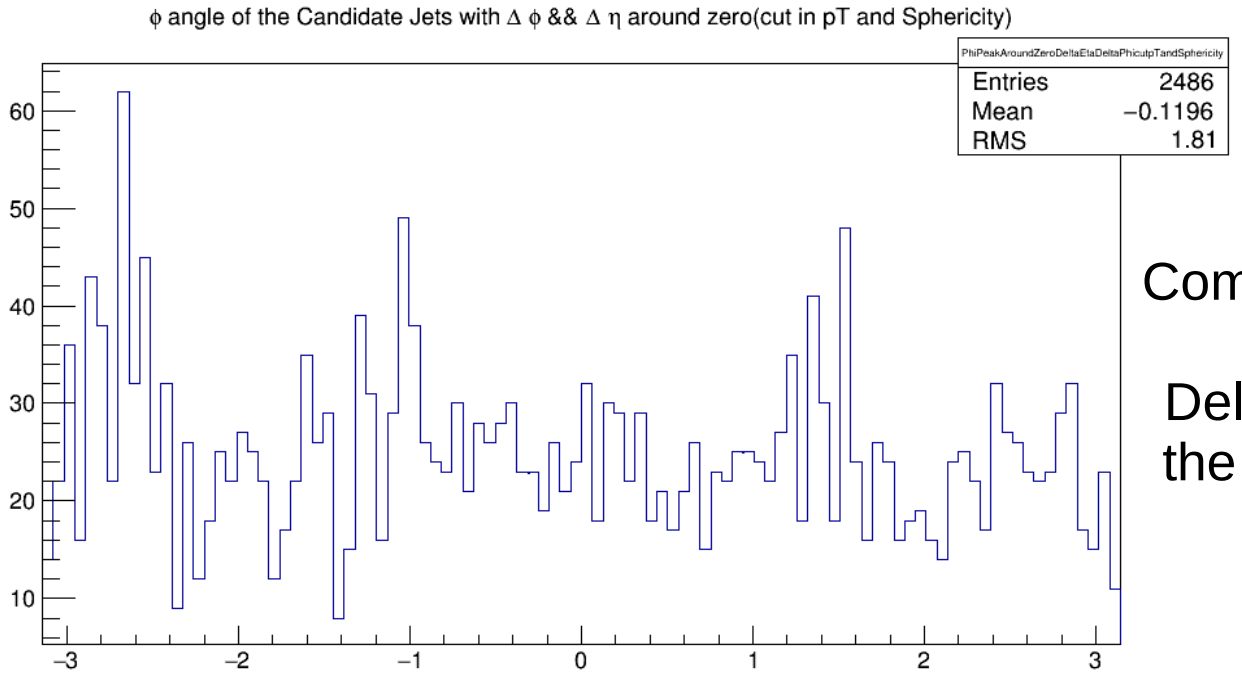


Comparing information of the jets in the DeltaPhi region around Pi and the DeltaPhi region around Zero

Around Pi cut:
DeltaPHI>2.5
-4.0<DeltaEta<4.0

Around Zero cut:
DeltaPhi<0.5
-0.6<DeltaEta<0.6

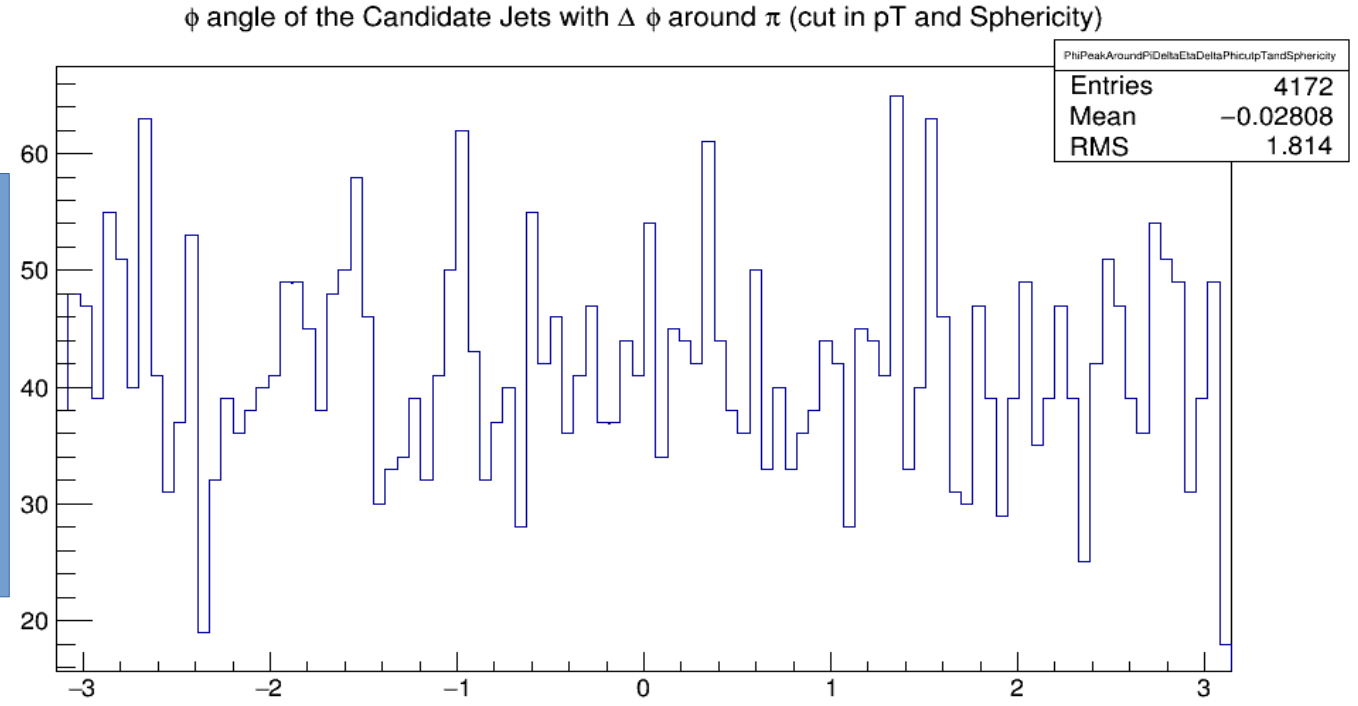


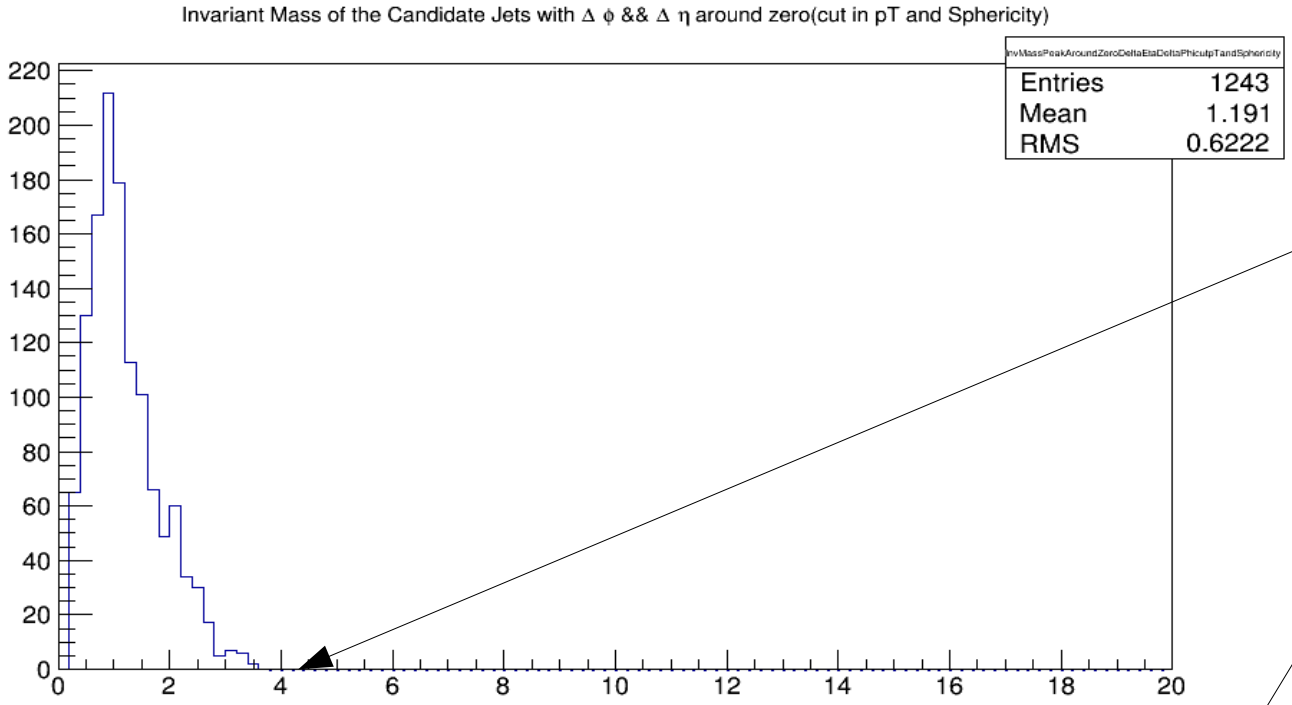


Comparing information of the jets in the DeltaPhi region around Pi and the DeltaPhi region around Zero

Around Pi cut:
DeltaPHI>2.5
-4.0<DeltaEta<4.0

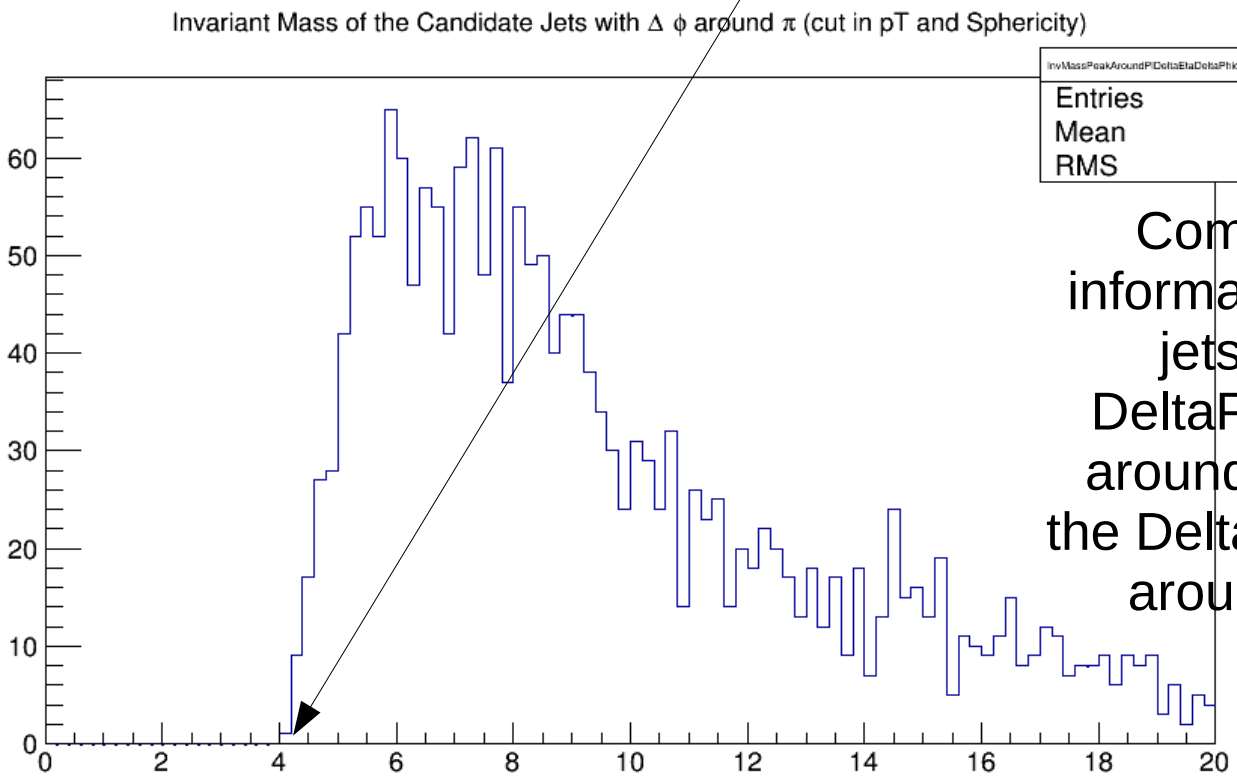
Around Zero cut:
DeltaPhi<0.5
-0.6<DeltaEta<0.6





Difference in the Invariant Mass distributions for those events Around Pi and Zero events.

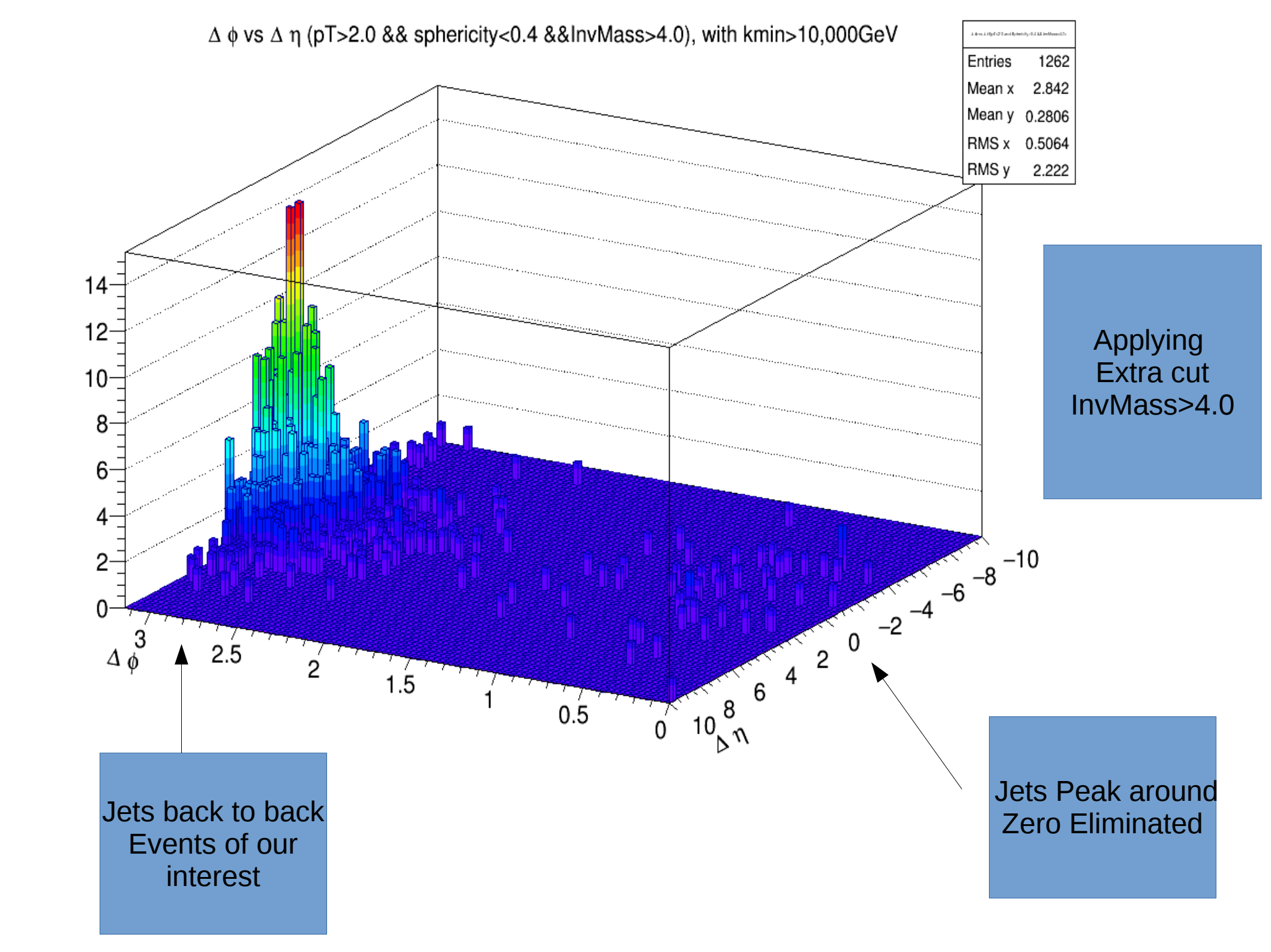
A cut in the Invariant Mass Greater than 4 GeV Should leave only the Events around Pi in DeltaPhi

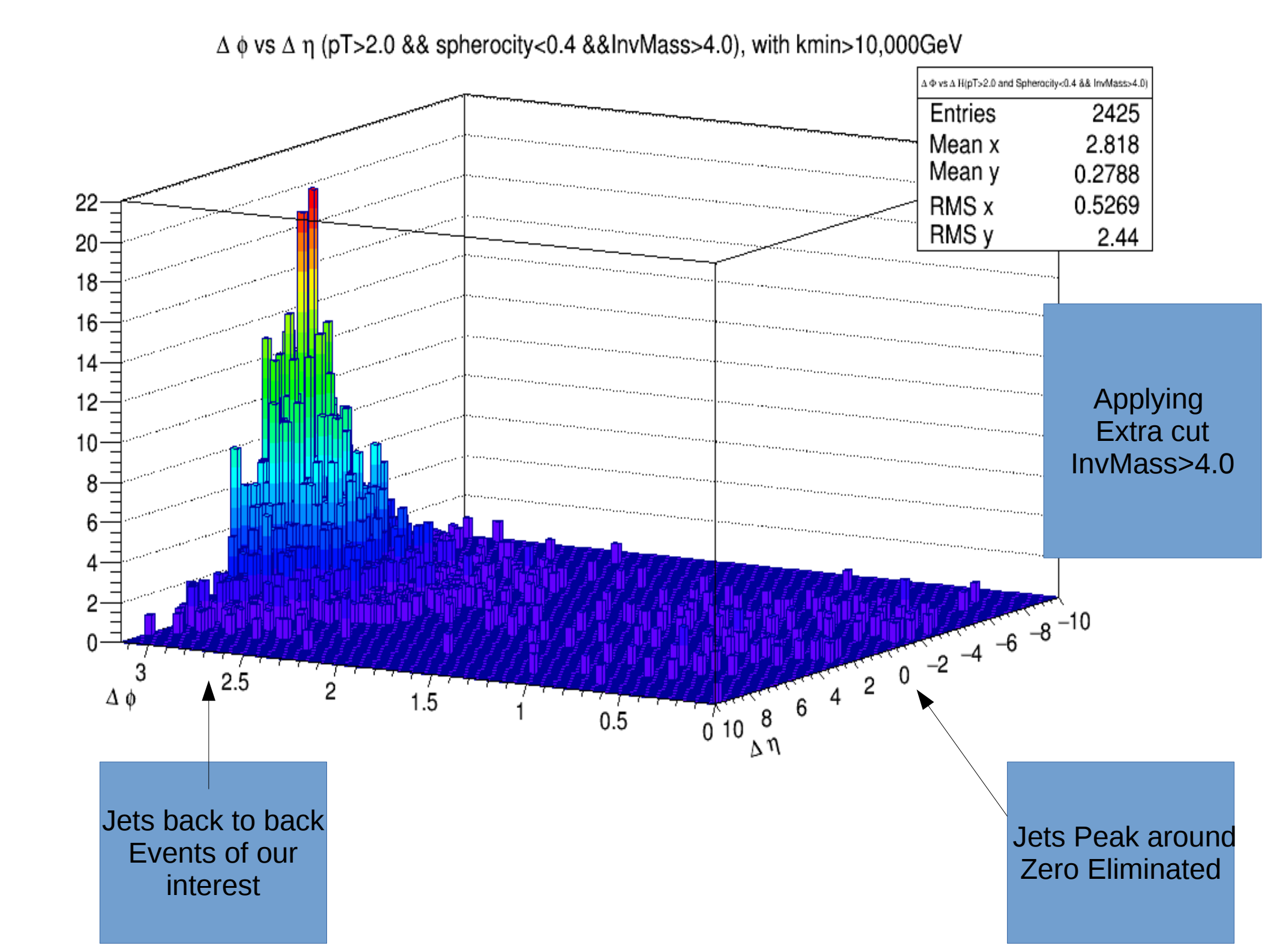


Around Pi cut:
DeltaPHI>2.5
-4.0<DeltaEta<4.0

Around Zero cut:
DeltaPhi<0.5
-0.6<DeltaEta<0.6

Comparing information of the jets in the DeltaPhi region around Pi and the DeltaPhi region around Zero


Δ ϕ vs Δ η (pT>2.0 && sphericity<0.4 &&InvMass>4.0), with kmin>10,000GeV
Entries 1262
Mean x 2.842
Mean y 0.2806
RMS x 0.5064
RMS y 2.222
Applying Extra cut InvMass>4.0
Jets back to back Events of our interest
Jets Peak around Zero Eliminated
Δ ϕ
Δ η


Δ ϕ vs Δ η (pT>2.0 && spherocity<0.4 &&InvMass>4.0), with kmin>10,000GeV
Δ Φ vs Δ η(pT>2.0 and Spherocity<0.4 && InvMass>4.0)
Entries 2425
Mean x 2.818
Mean y 0.2788
RMS x 0.5269
RMS y 2.44
Applying Extra cut InvMass>4.0
Jets back to back Events of our interest
Jets Peak around Zero Eliminated
Δ ϕ
Δ η

- What happens with 8TeV pPb ultraperipheral collisions?

New Simulation of Events with pPb

```
BEAM_1_Z = 1    #Z of projectile
BEAM_1_A = 1   #A of projectile
BEAM_2_Z = 82   #Z of target
BEAM_2_A = 208   #A of target
BEAM_1_GAMMA =6800 #Gamma of the colliding ions
BEAM_2_GAMMA = 2680.72 #Gamma of the colliding ions
W_MAX = 12.0   #Max value of w
W_MIN = 2.0    #Min value of w
W_N_BINS = 40    #Bins i w
RAP_MAX = 8.    #max y
RAP_N_BINS = 80    #Bins i y
CUT_PT = 0 #Cut in pT? 0 = (no, 1 = yes)
PT_MIN = 1.0 #Minimum pT in GeV
PT_MAX = 3.0 #Maximum pT in GeV
CUT_ETA = 0 #Cut in pseudorapidity? (0 = no, 1 = yes)
ETA_MIN = -10 #Minimum pseudorapidity
ETA_MAX = 10 #Maximum pseudorapidity
PROD_MODE = 5     #gg or gP switch (1 = 2-photon, 2 = coherent vector meson (narrow), 3 = coherent vector meson (wide),
# 4 = incoherent vector meson, 5 = A+A DPMJet single, 6 = A+A DPMJet double, 7 = p+A DPMJet single, 8 = p+A Pythia single )
N_EVENTS = 500000   #Number of events
PROD_PID = 443013   #Channel of interest (not relevant for photonuclear processes)
RND_SEED = 34533 #Random number seed
BREAKUP_MODE = 5     #Controls the nuclear breakup
INTERFERENCE = 0     #Interference (0 = off, 1 = on)
IF_STRENGTH = 1.    #% of intefernce (0.0 - 0.1)
INT_PT_MAX = 0.24  #Maximum pt considered, when interference is turned on
INT_PT_N_BINS =120   #Number of pt bins when interference is turned on
COHERENT = 1     #Coherent=1,Incoherent=0
INCO_FACTOR = 1.    #percentage of incoherence

# Photonuclear specific options, energies in Lab frame. These values should be within the range of the
# values specified in the DPMJet input file (when DPMJet is used)
MIN_GAMMA_ENERGY = 1000.0
MAX_GAMMA_ENERGY = 600000.0
```

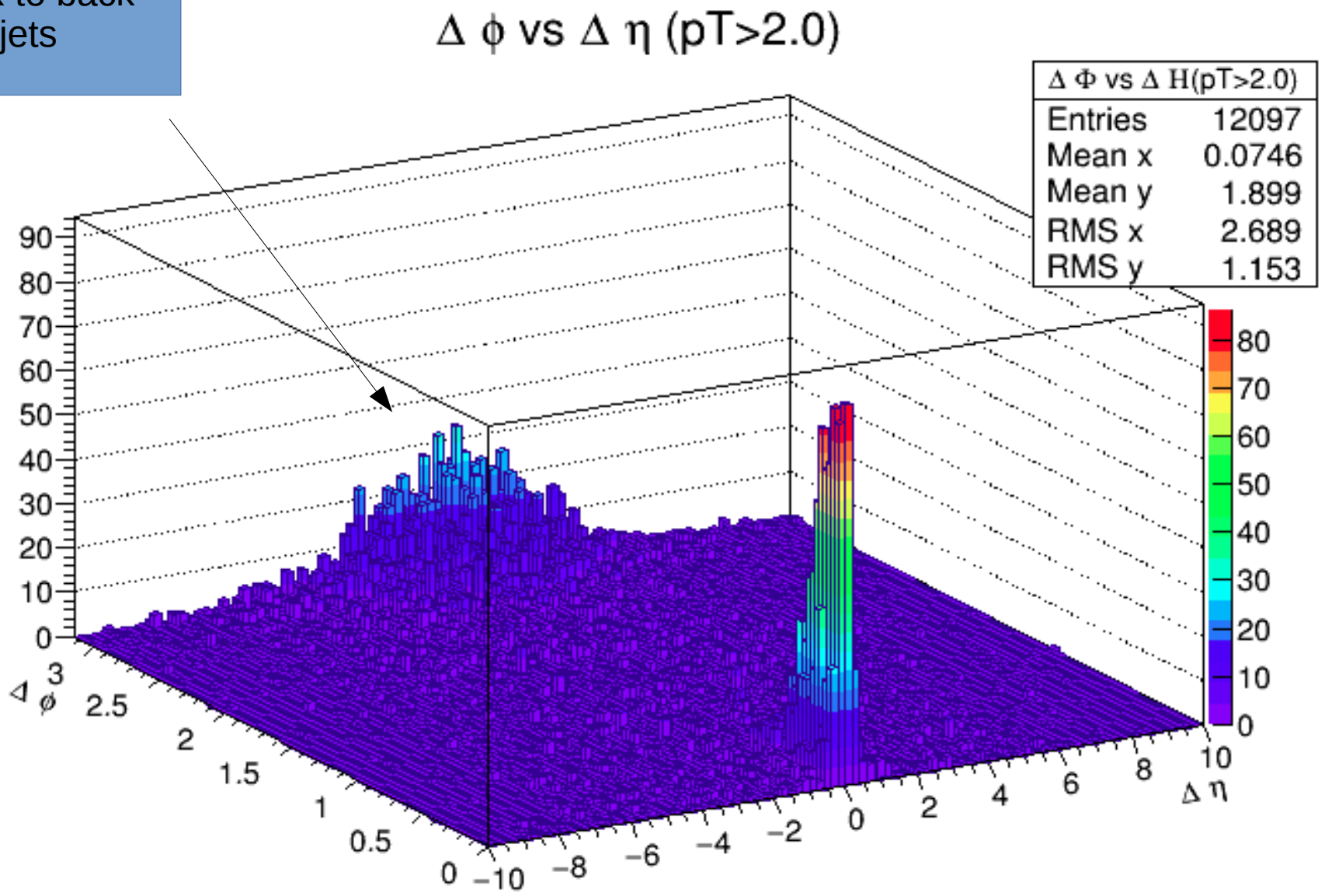
```
**********************************************************************
* Example for a DTUNUC input file.
* Uncomment the input-cards according to your requirements.
*
* Format: A10,6E10.0,A8
*       (except for the section enclosed by "PHOINPUT" and "ENDINPUT"
*        which is format-free)
*        lines starting with "*" are comment lines
**********************************************************************
*
* projectile / target / Energy
* -------------------
*       1       2       3       4       5       6       7
*234567890123456789012345678901234567890123456789012345678901234567890123456789012345678
PROJPAR         0.0                                     PHOTON
TARPAR        208.0     82.0
ENERGY         1000.0  600000.0
*ENERGY        100.0
* Initialize the random number generator
RNDMINIT       55.0     101.0      15.0      73.0
*
*
* PHOJET-specific input
* --------------------
* The following lines control the event-generation with PHOJET for
* individual photon/nucleon-nucleon collisions.
* For details see the PHOJET-manual available at
*       http://lepton.bartol.udel.edu/~eng/phojet.html
* Any options explained in the PHOJET-manual can be used in between
* the "PHOINPUT" and "ENDINPUT" cards.
PHOINPUT
PROCESS          1 0 1 1 1 1 1 1
ENDINPUT
*Output
* ------
*   some default output (particle multiplicities etc.)
HISTOGRAM      101.0     102.0
* Start of event generation
* -------------------------
*START         5000.0       0.0
START         100.0       0.0
STOP
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7...
```

my.input

Last time
Simulation

Changing parameters
To kmin 10,000,
And one simulation
With
Kmin 200,000
To kmax 6,000,000

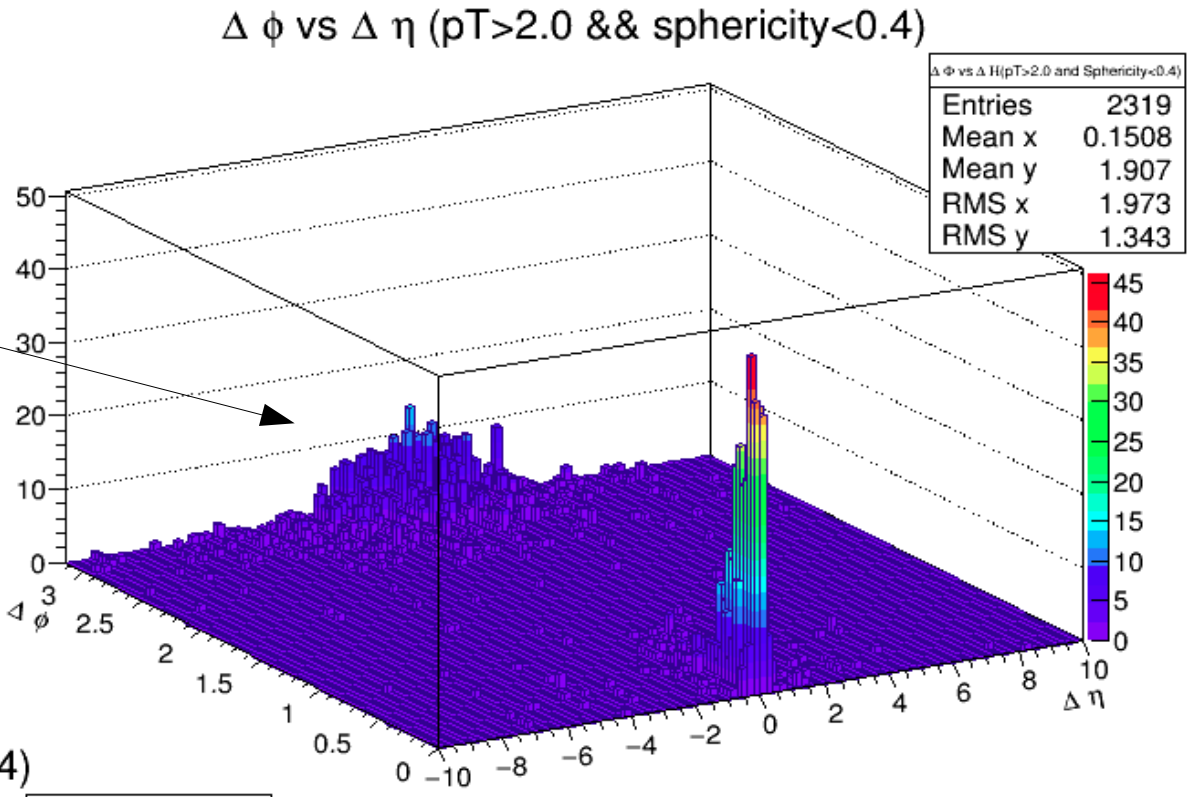
Back to back jets

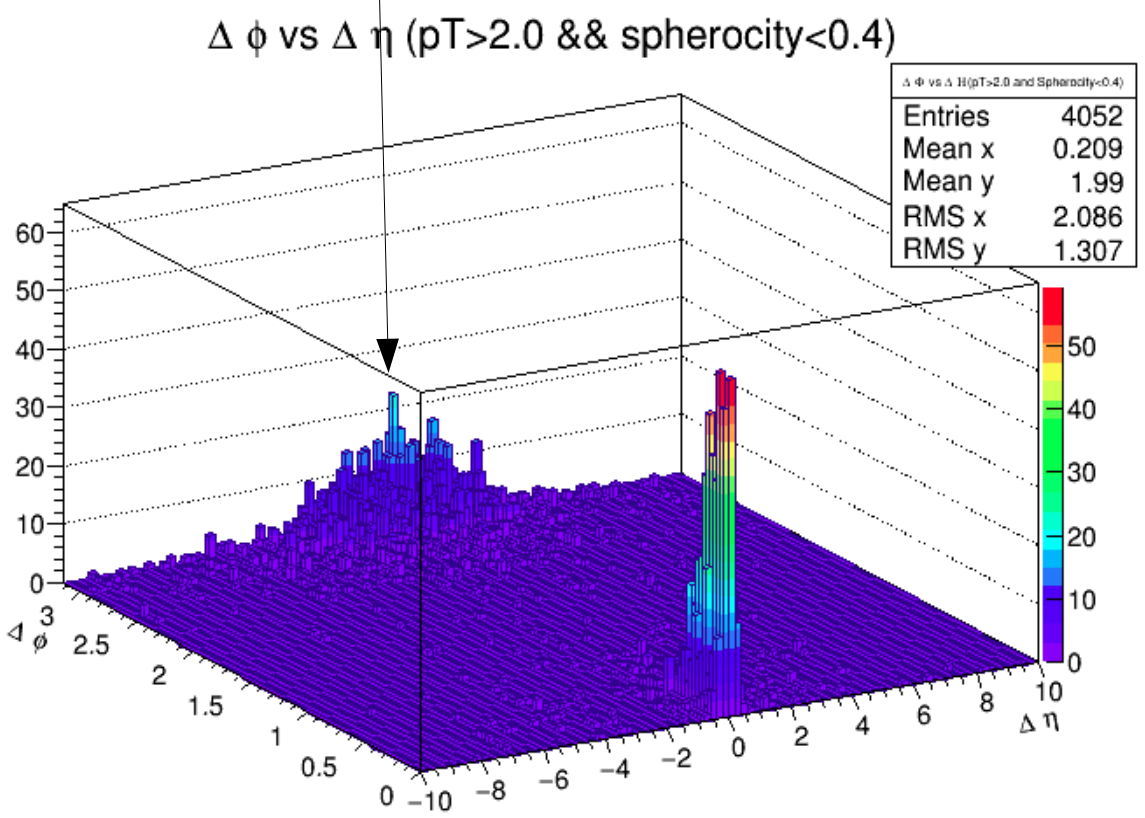


Adding cut in sphericity

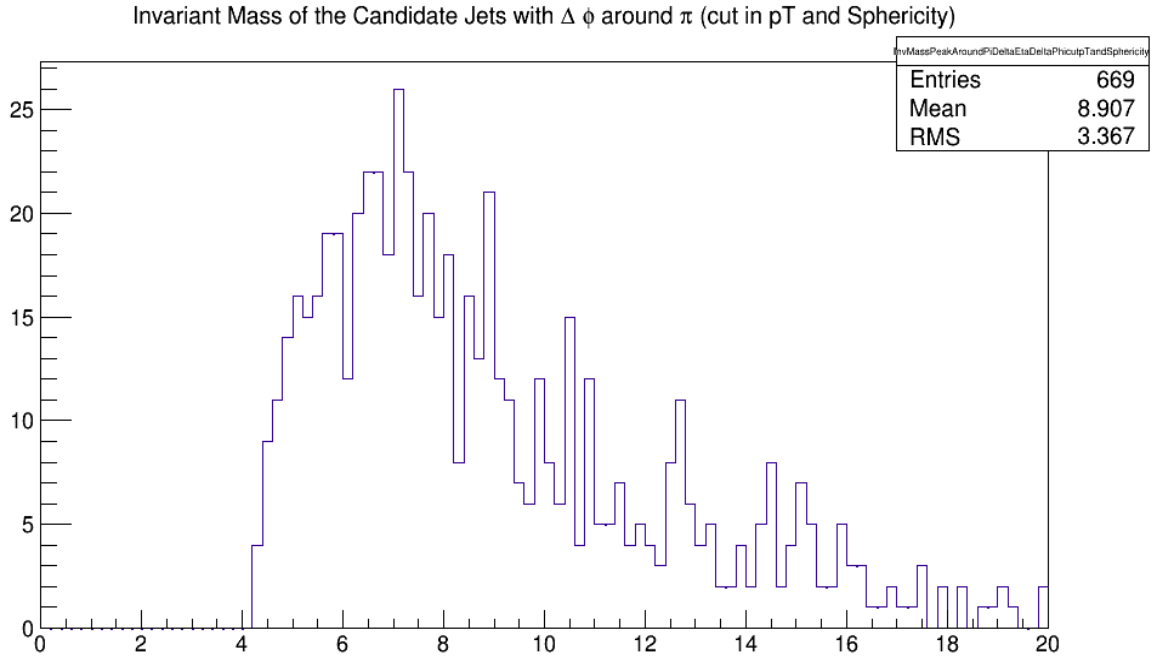
Adding cut in spherocity

Back to Back events



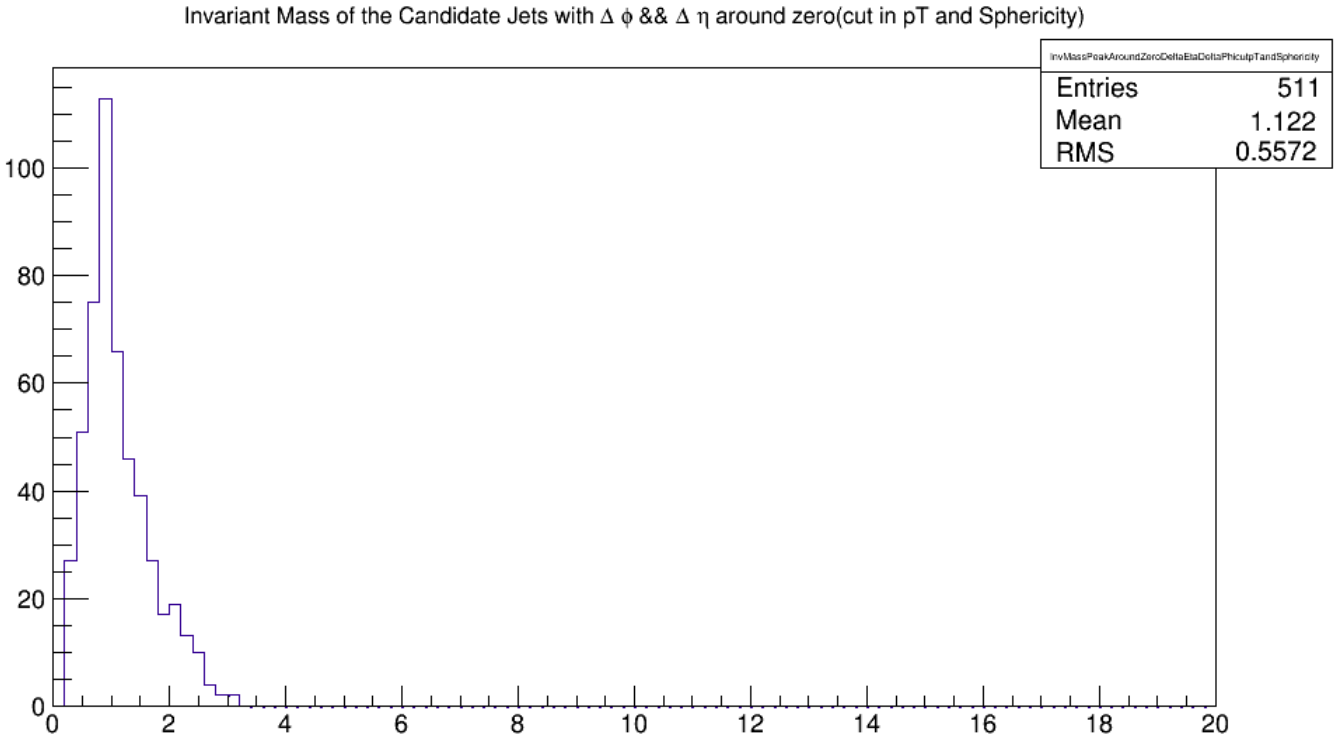


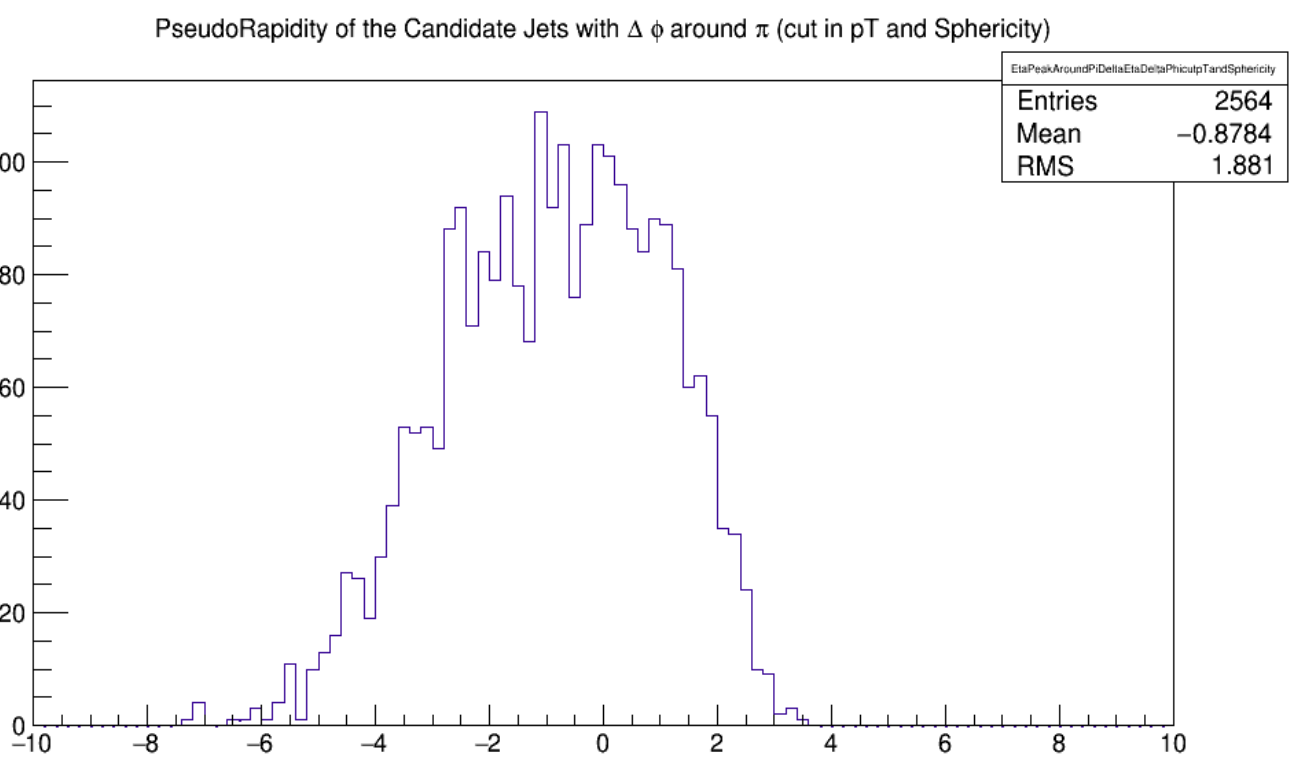
Information about both peaks



Around Pi cut:
DeltaPHI>2.5
-4.0<DeltaEta<4.0

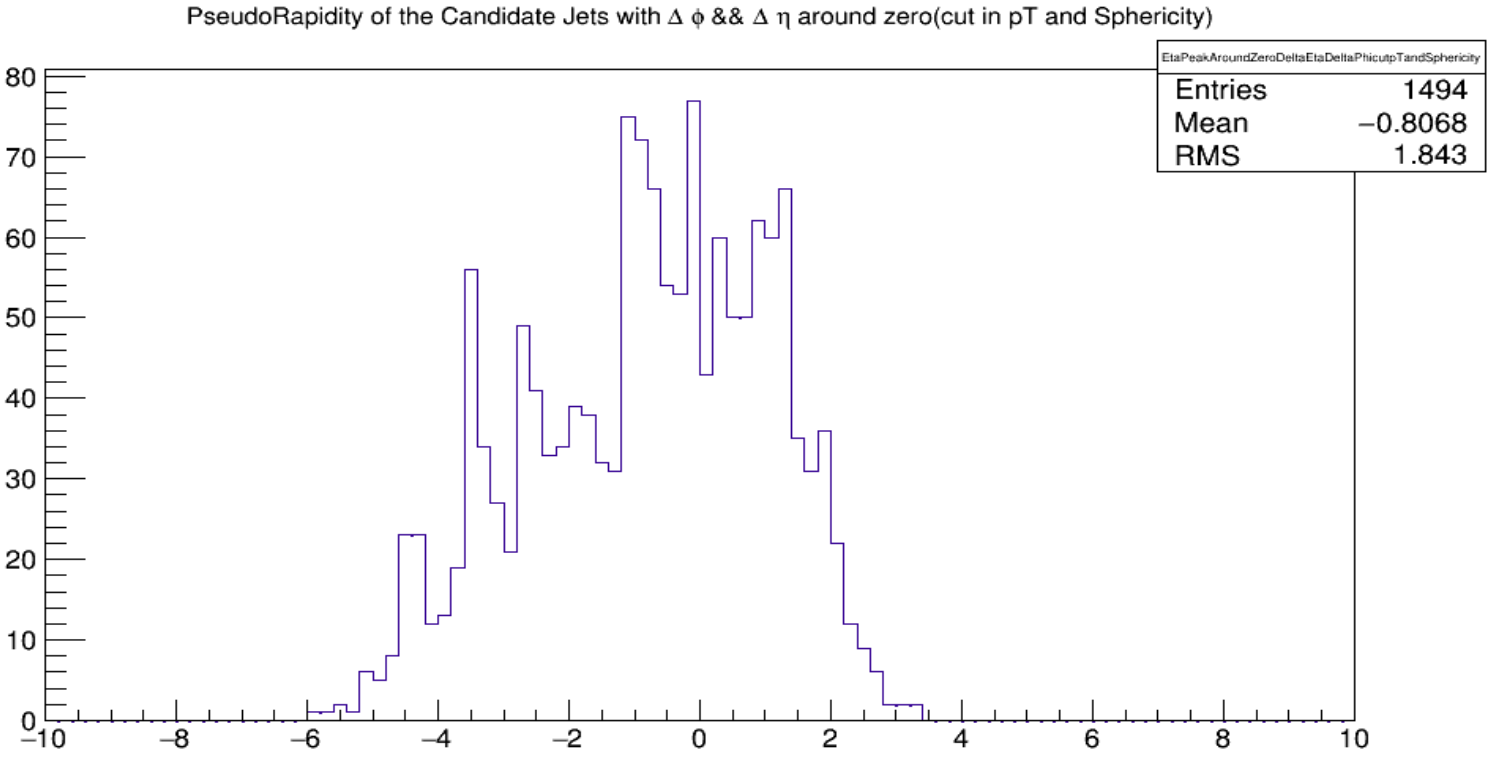
Around Zero cut:
DeltaPhi<0.5
-0.6<DeltaEta<0.6

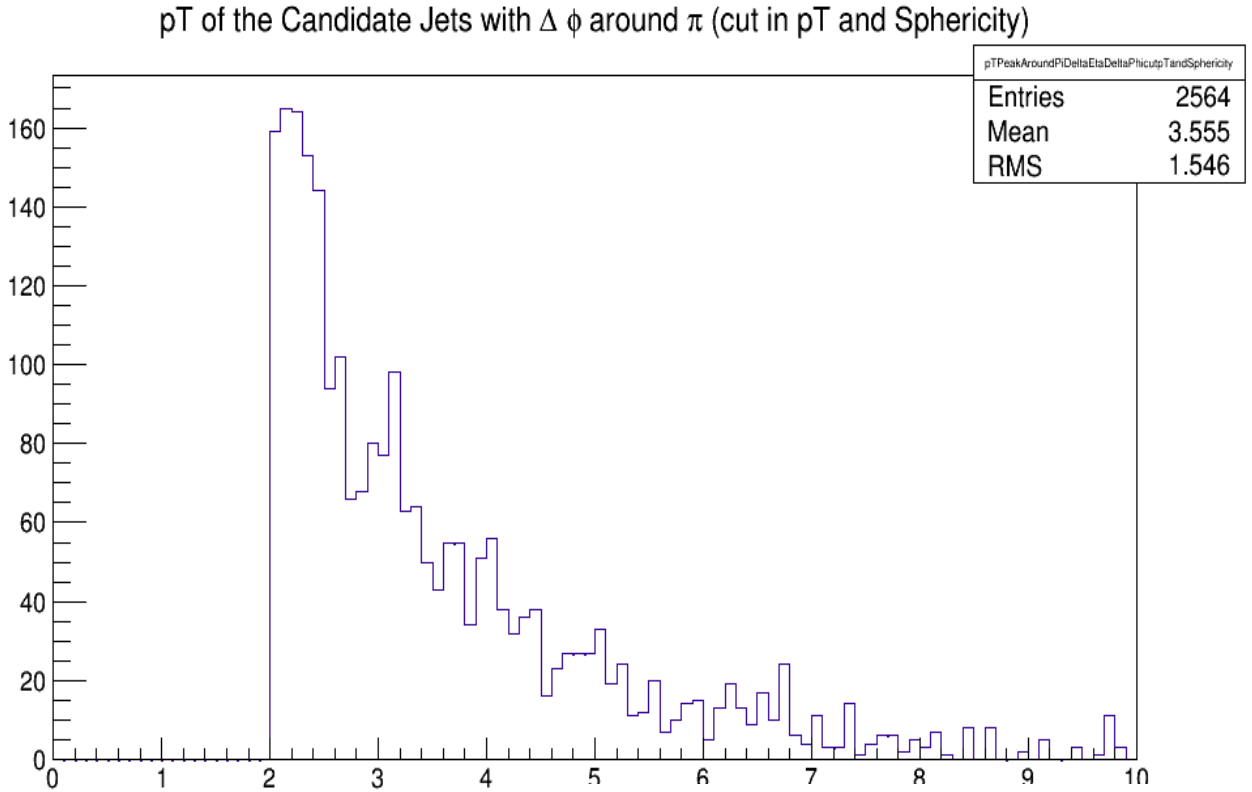




Around Pi cut:
DeltaPHI>2.5
-4.0<DeltaEta<4.0

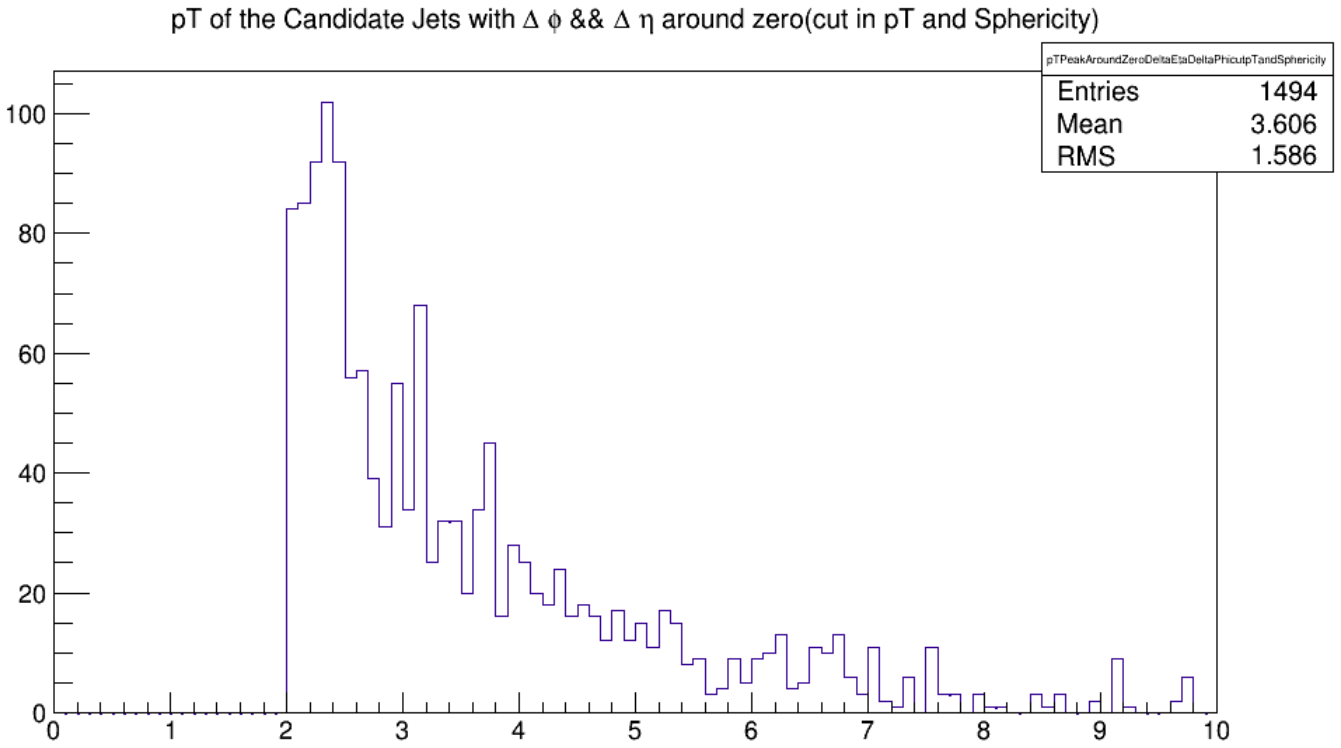
Around Zero cut:
DeltaPhi<0.5
-0.6<DeltaEta<0.6

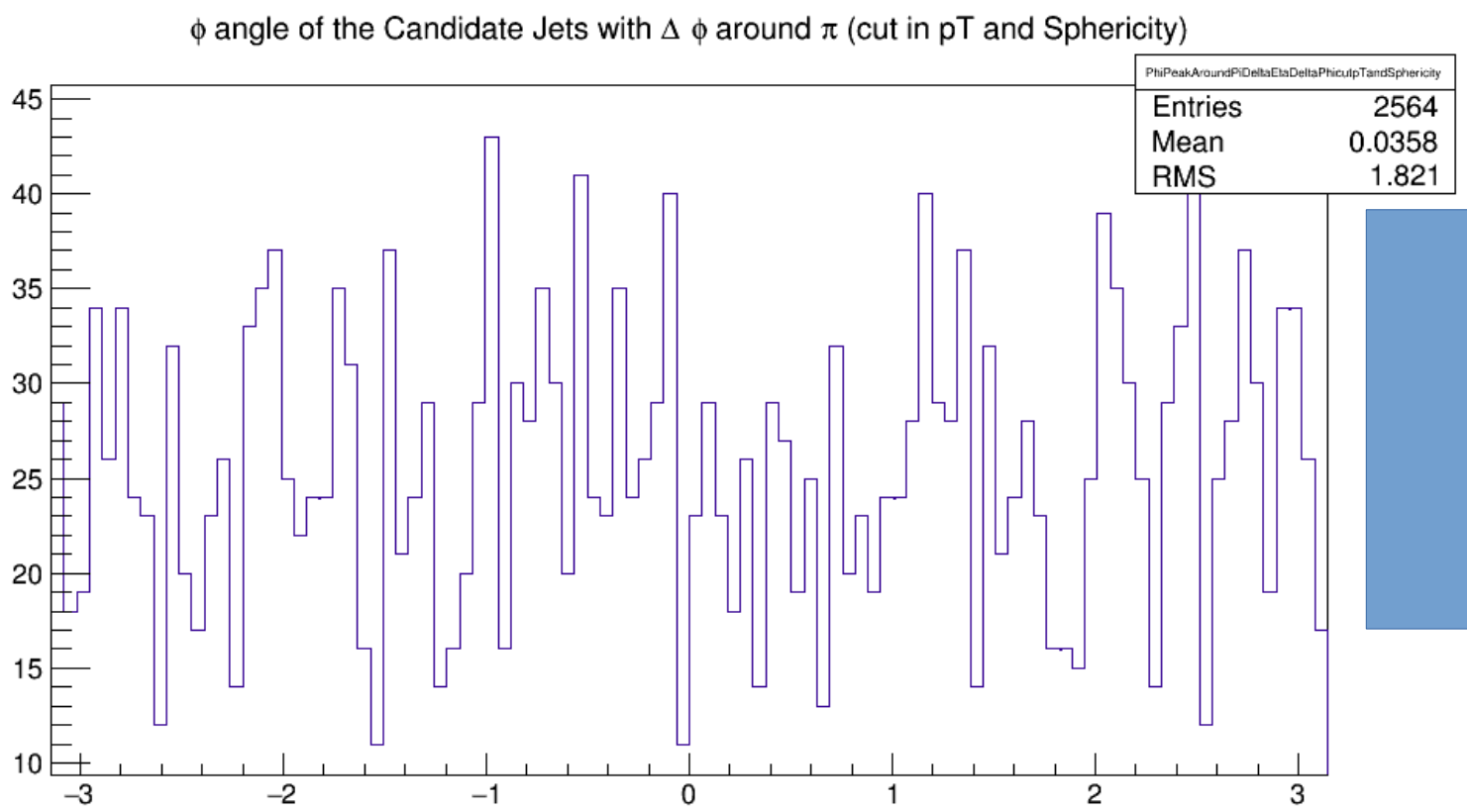




Around Pi cut:
DeltaPHI>2.5
-4.0<DeltaEta<4.0

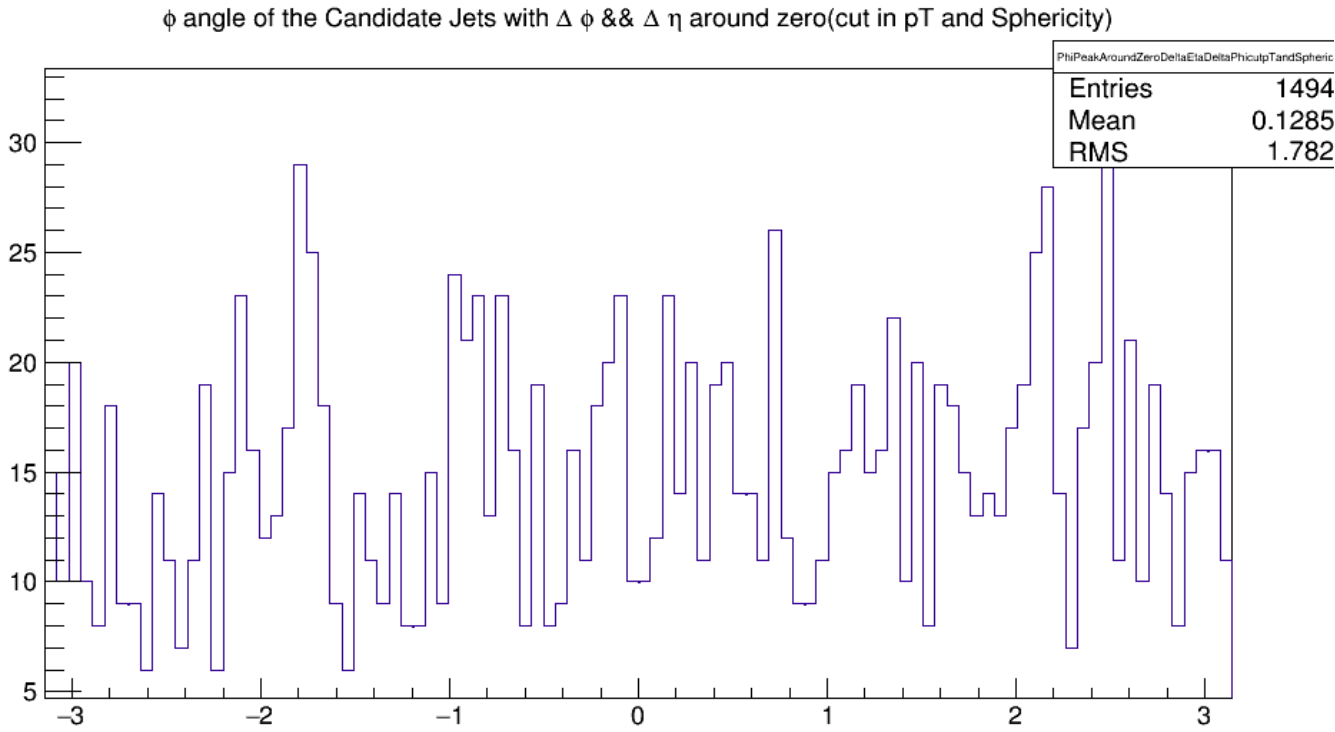
Around Zero cut:
DeltaPhi<0.5
-0.6<DeltaEta<0.6

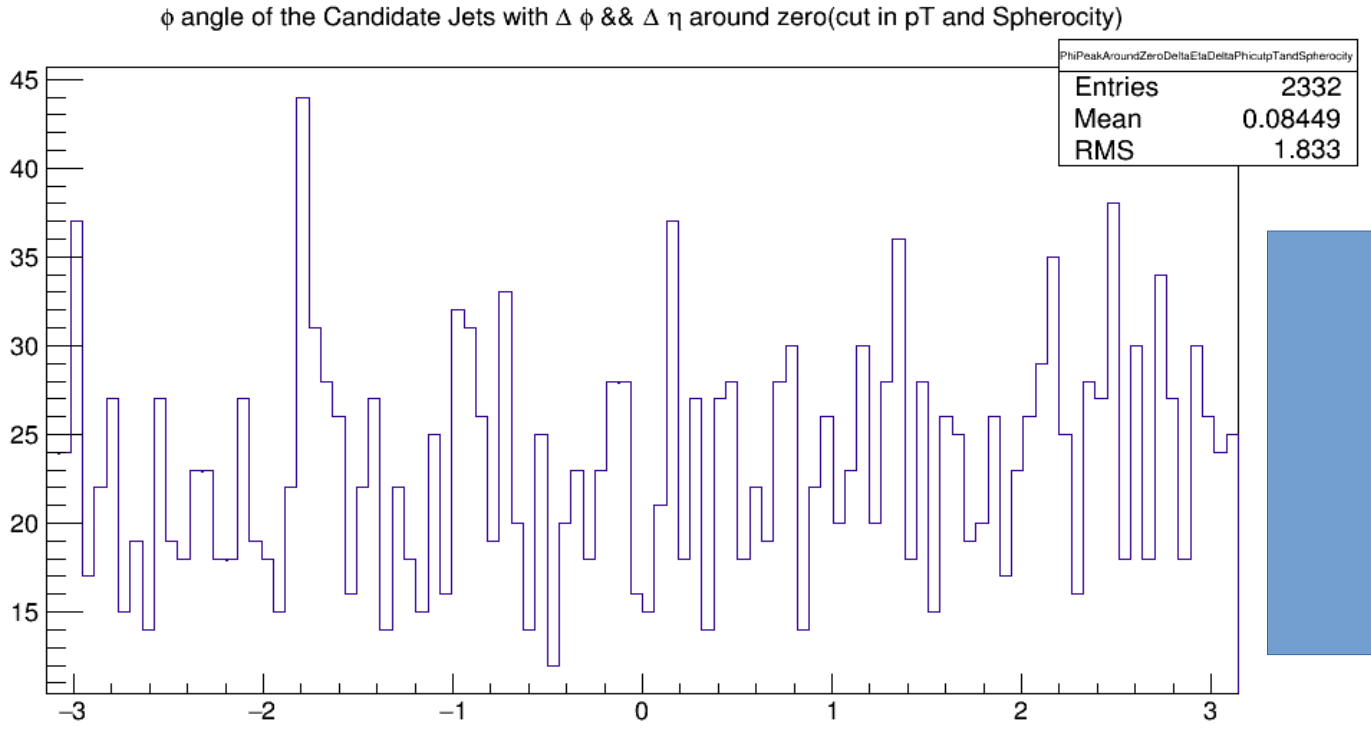




Around Pi cut:
DeltaPHI>2.5
-4.0<DeltaEta<4.0

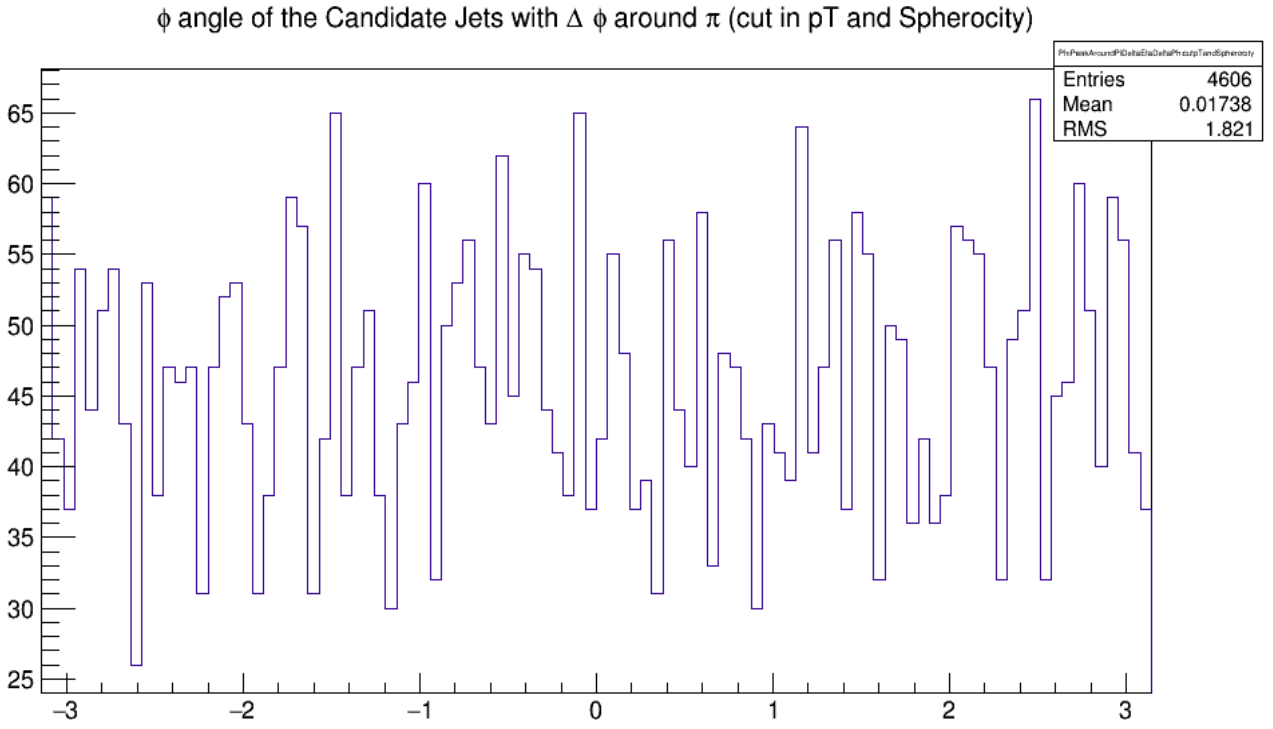
Around Zero cut:
DeltaPhi<0.5
-0.6<DeltaEta<0.6



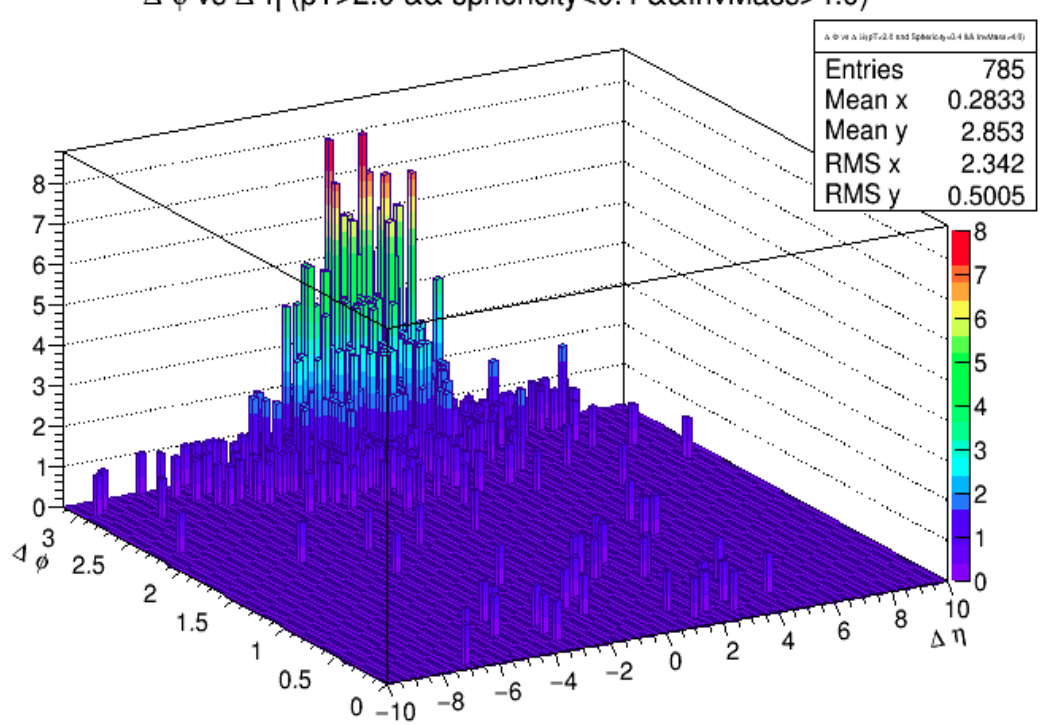


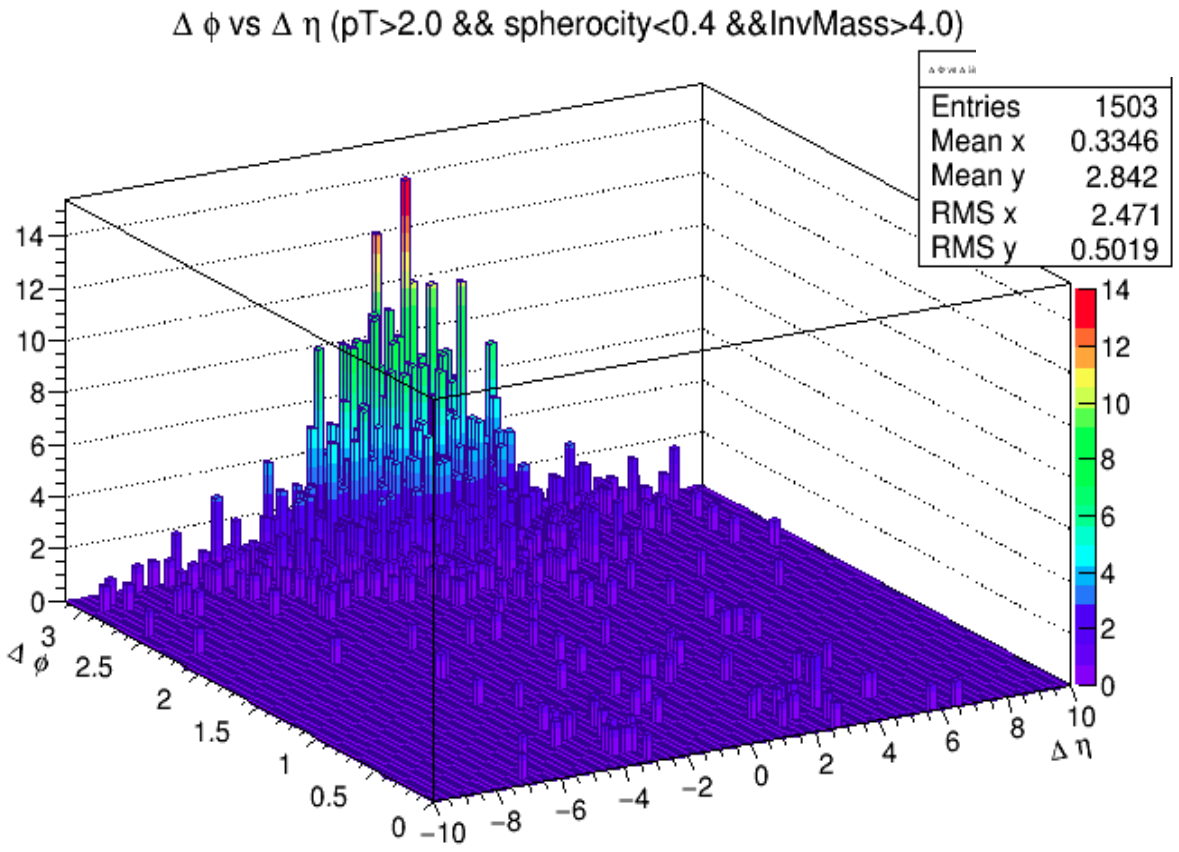
Around Pi cut:
DeltaPHI>2.5
-4.0<DeltaEta<4.0

Around Zero cut:
DeltaPhi<0.5
-0.6<DeltaEta<0.6



Adding cut of Invariant Mass>4.0





New Simulation of Events with pPb

Slight.in

```
BEAM_1_Z = 1    #Z of projectile
BEAM_1_A = 1    #A of projectile
BEAM_2_Z = 82   #Z of target
BEAM_2_A = 208   #A of target
BEAM_1_GAMMA =6800 #Gamma of the colliding ions
BEAM_2_GAMMA = 2680.72 #Gamma of the colliding ions
W_MAX = 12.0   #Max value of w
W_MIN = 2.0    #Min value of w
W_N_BINS = 40    #Bins i w
RAP_MAX = 8.    #max y
RAP_N_BINS = 80    #Bins i y
CUT_PT = 0 #Cut in pT? 0 = (no, 1 = yes)
PT_MIN = 1.0 #Minimum pT in GeV
PT_MAX = 3.0 #Maximum pT in GeV
CUT_ETA = 0 #Cut in pseudorapidity? (0 = no, 1 = yes)
ETA_MIN = -10 #Minimum pseudorapidity
ETA_MAX = 10 #Maximum pseudorapidity
PROD_MODE = 5     #gg or gP switch (1 = 2-photon, 2 = coherent vector meson (narrow), 3 = coherent vector meson (wide),
# 4 = incoherent vector meson, 5 = A+A DPMJet single, 6 = A+A DPMJet double, 7 = p+A DPMJet single, 8 = p+A Pythia single )
N_EVENTS = 500000   #Number of events
PROD_PID = 443013   #Channel of interest (not relevant for photonuclear processes)
RND_SEED = 34533 #Random number seed
BREAKUP_MODE = 5     #Controls the nuclear breakup
INTERFERENCE = 0     #Interference (0 = off, 1 = on)
IF_STRENGTH = 1.    #% of intefernce (0.0 - 0.1)
INT_PT_MAX = 0.24  #Maximum pt considered, when interference is turned on
INT_PT_N_BINS =120   #Number of pt bins when interference is turned on
COHERENT = 1     #Coherent=1,Incoherent=0
INCO_FACTOR = 1.    #percentage of incoherence

# Photonuclear specific options, energies in Lab frame. These values should be within the range of the
# values specified in the DPMJet input file (when DPMJet is used)
MIN_GAMMA_ENERGY = 1000.0
MAX_GAMMA_ENERGY = 600000.0
```

Last time Simulation

New Simulations, changing Wmin And Wmax (300-600)

Last time Simulation

Changing parameters To kmin 10,000, And one simulation With Kmin 200,000 To kmax 6,000,000

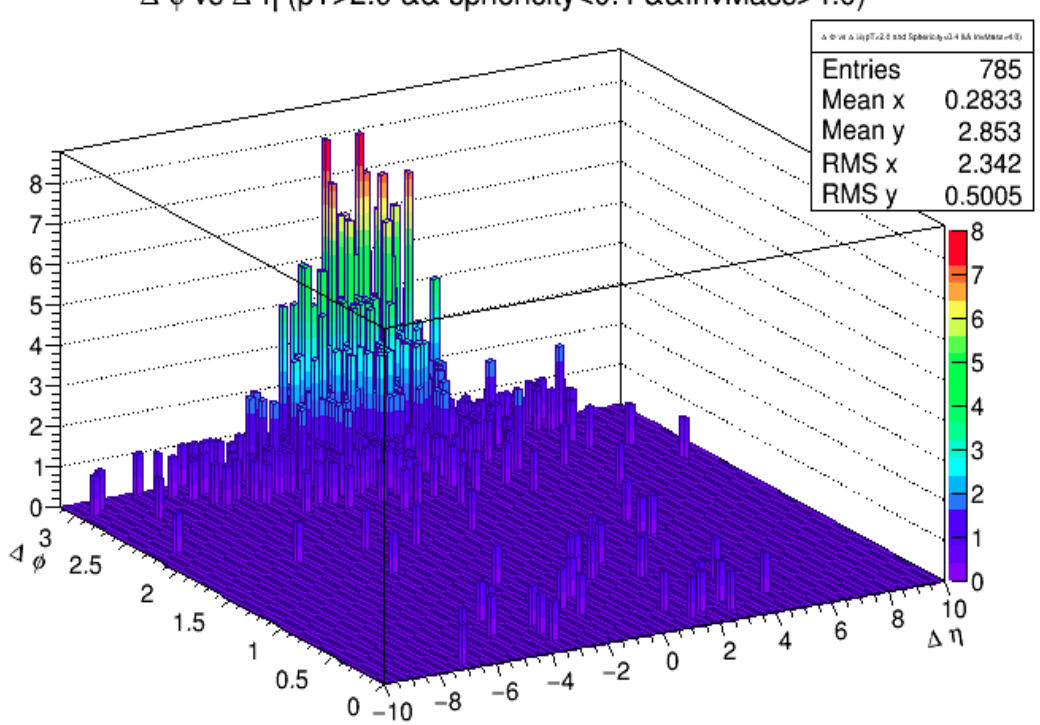
```
**********************************************************************
* Example for a DTUNUC input file.
* Uncomment the input-cards according to your requirements.
*
* Format: A10,6E10.0,A8
*       (except for the section enclosed by "PHOINPUT" and "ENDINPUT"
*        which is format-free)
*        lines starting with "*" are comment lines
**********************************************************************
*
* projectile / target / Energy
* -------------------
*       1       2       3       4       5       6       7
*234567890123456789012345678901234567890123456789012345678901234567890123456789012345678
PROJPAR         0.0                                     PHOTON
TARPAR        208.0     82.0
ENERGY         1000.0  600000.0
*ENERGY        100.0
* Initialize the random number generator
RNDMINIT       55.0     101.0      15.0      73.0
*
*
* PHOJET-specific input
* --------------------
* The following lines control the event-generation with PHOJET for
* individual photon/nucleon-nucleon collisions.
* For details see the PHOJET-manual available at
*       http://lepton.bartol.udel.edu/~eng/phojet.html
* Any options explained in the PHOJET-manual can be used in between
* the "PHOINPUT" and "ENDINPUT" cards.
PHOINPUT
PROCESS          1 0 1 1 1 1 1 1
ENDINPUT
*Output
* ------
*   some default output (particle multiplicities etc.)
HISTOGRAM      101.0     102.0
* Start of event generation
* -------------------------
*START         5000.0       0.0
START         100.0       0.0
STOP
*...+....1....+....2....+....3....+....4....+....5....+....6....+....7...
```

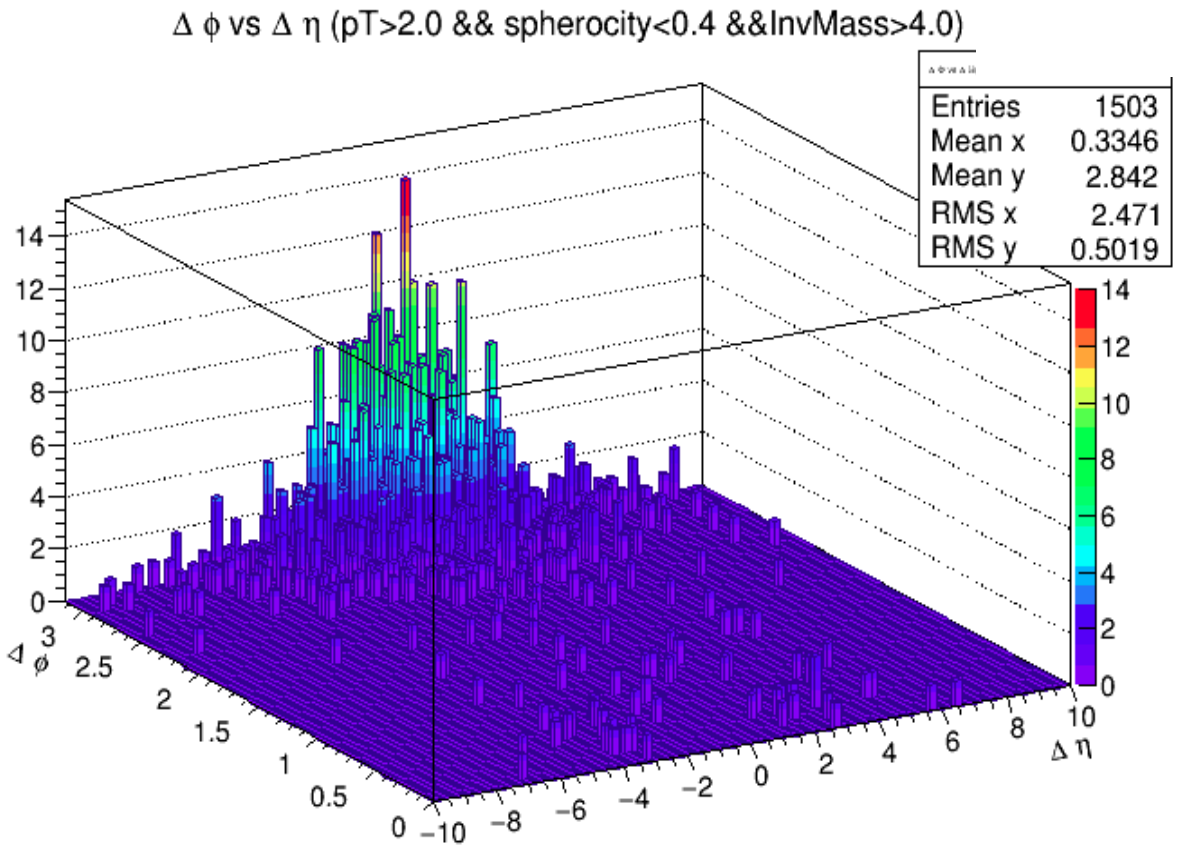
my.input

Last time
Simulation

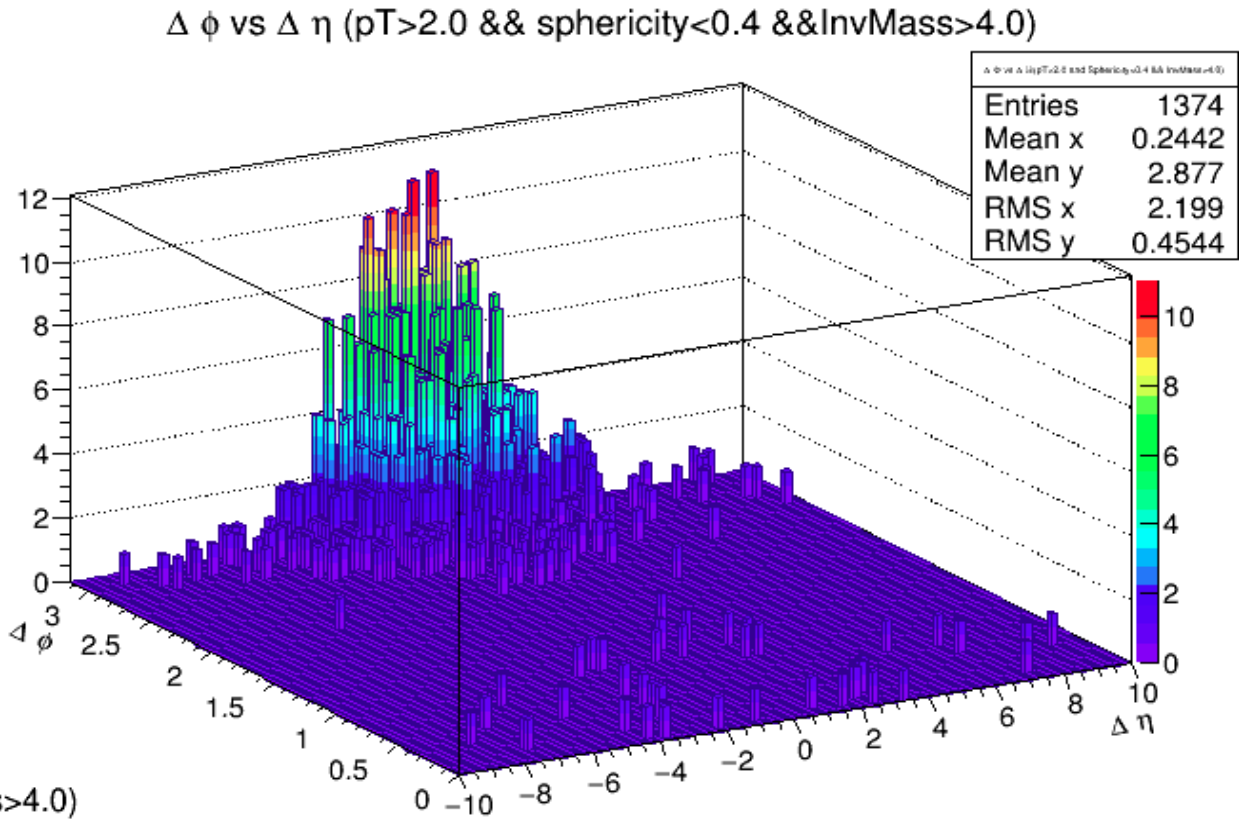
Changing parameters
To kmin 10,000,
And one simulation
With
Kmin 200,000
To kmax 6,000,000

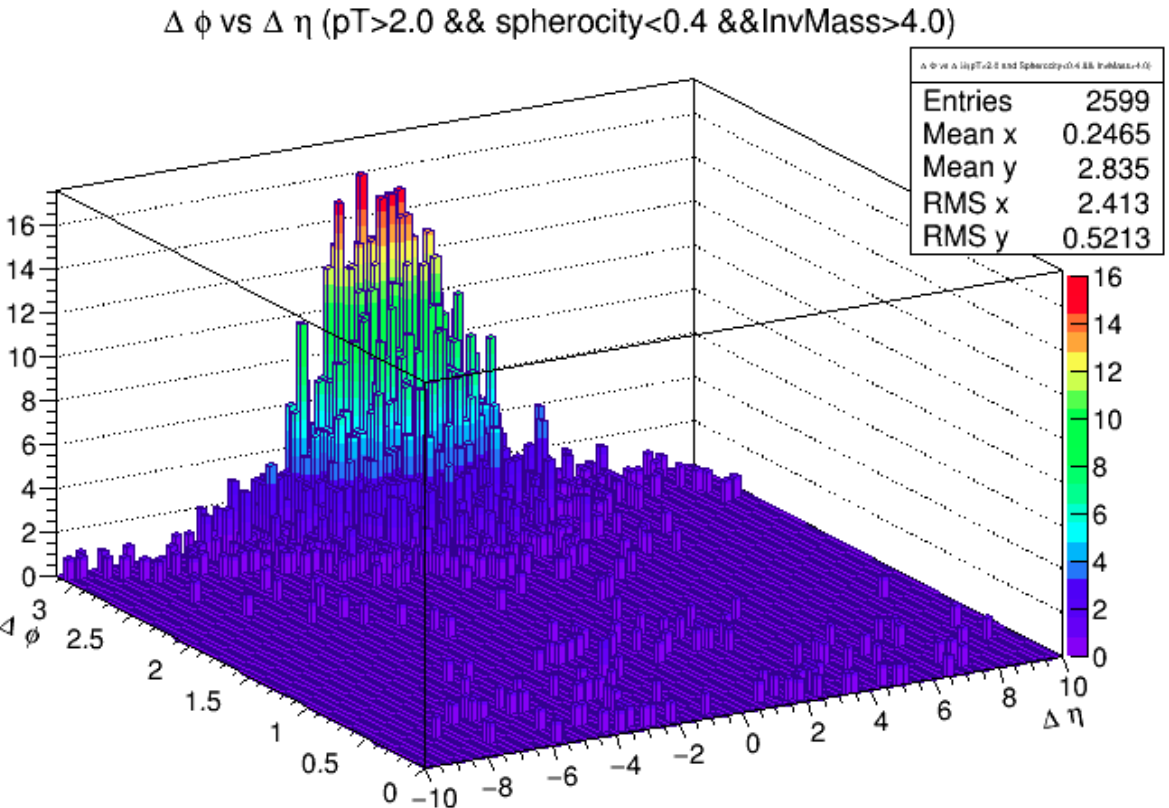
Back to back events
With pPb,kmin 1000GeV
Wmin 12, Wmax 20



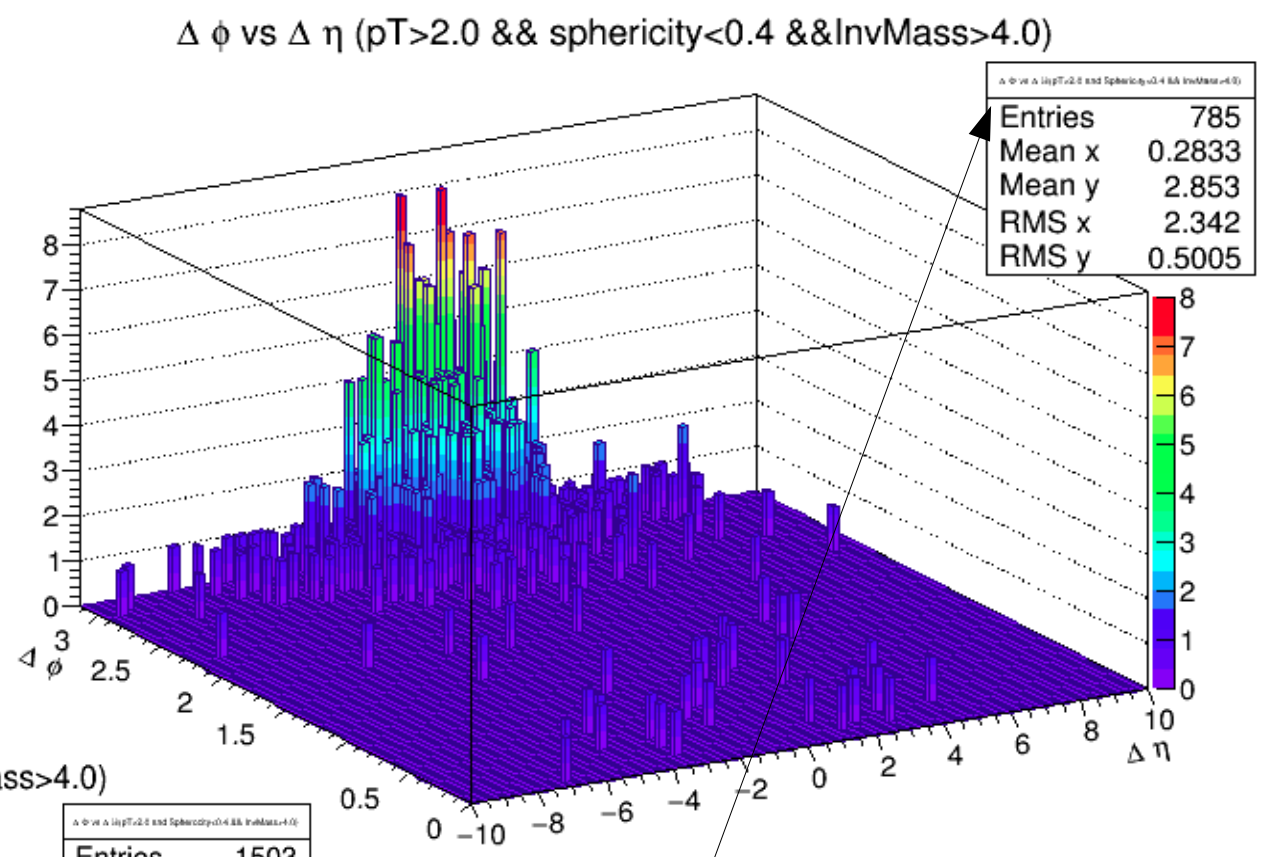


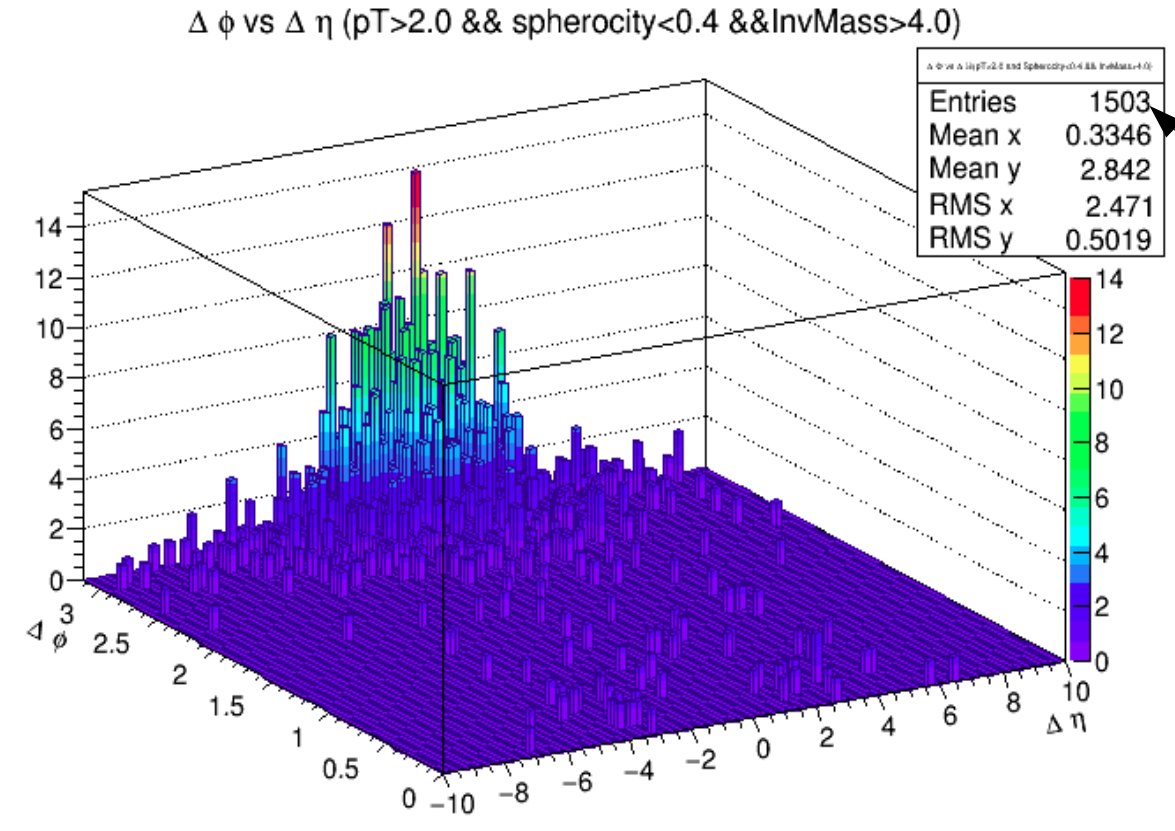
Back to back events
With pPb,kmin 10,000GeV
Wmin 12, Wmax 20





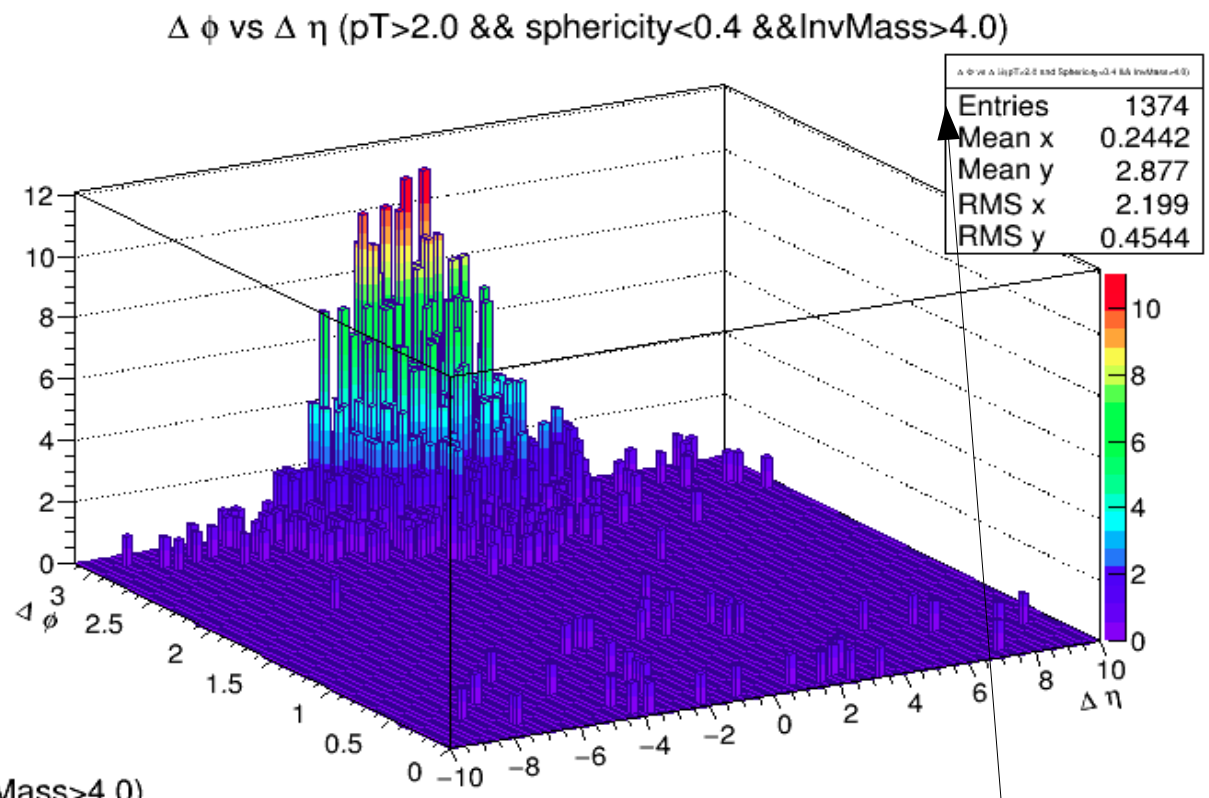
Back to back events
With pPb,kmin 1000GeV
Wmin 300, Wmax 600

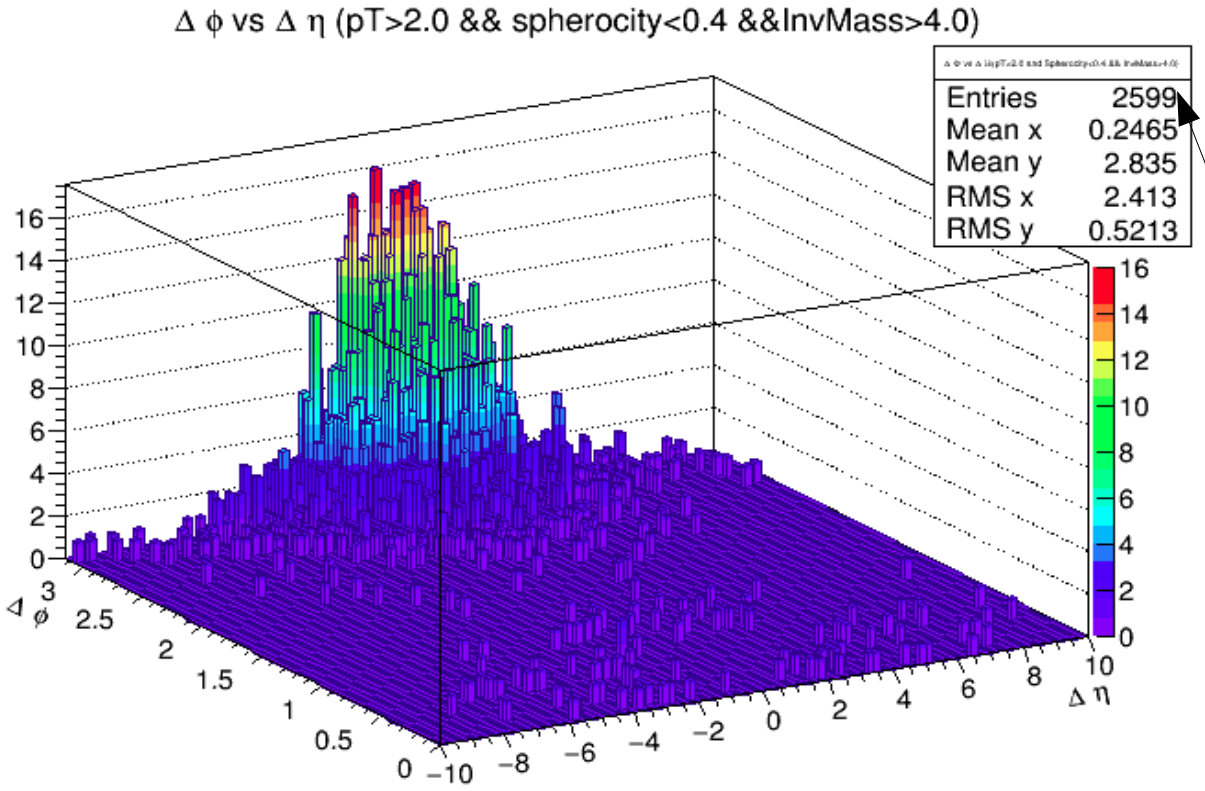




Same number of entries as
Back to back events
With pPb,kmin 1000GeV
Wmin 12, Wmax 20

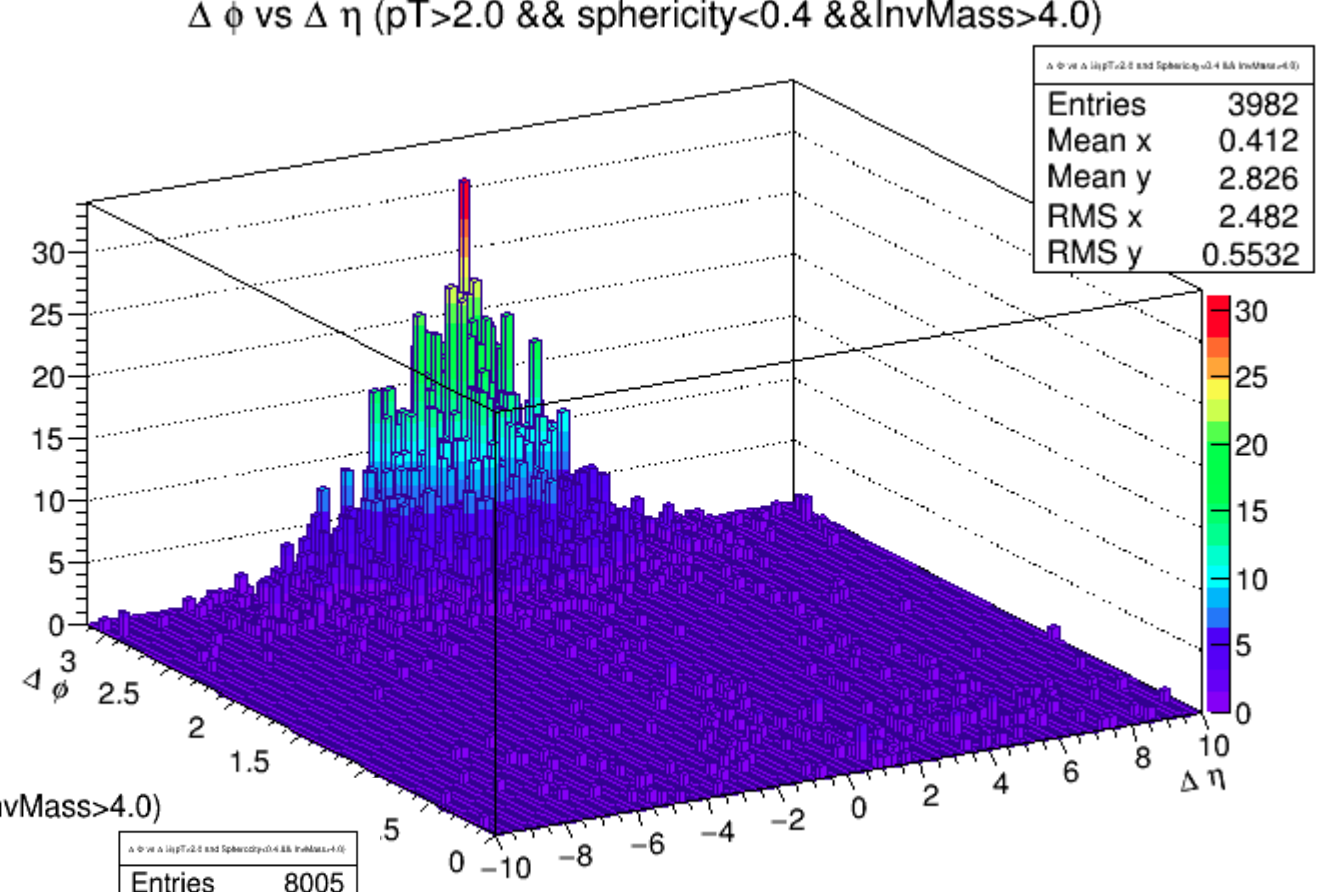
Back to back events
With pPb,kmin 10,000GeV
Wmin 300, Wmax 600

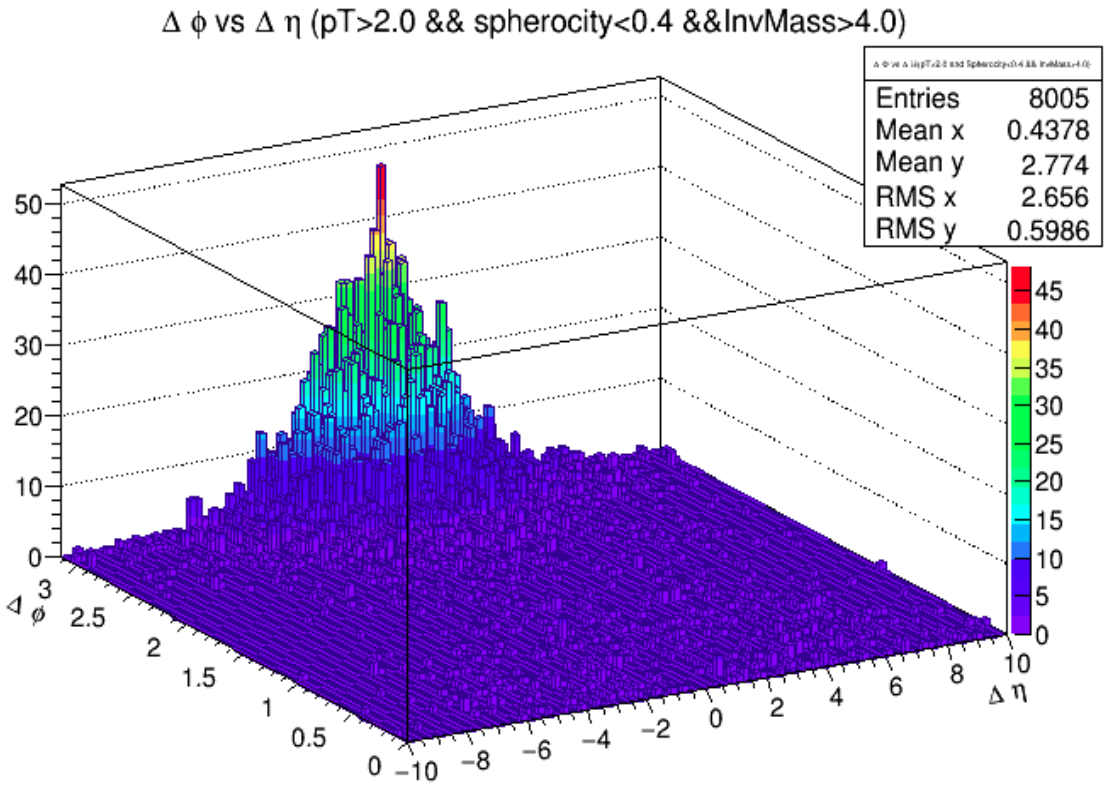




Same number of entries as
Back to back events
With pPb,kmin 10,000GeV
Wmin 12, Wmax 20

Back to back events
With pPb,kmin
200,000GeV
Kmax 6,000,000
Wmin 2, Wmax 12





Number of Back to back events

----------	P-Pb ultraperipheral collisions at 8TeV	
----------	No. of entries back to back events cut spherocity	No. of entries back to back events cut sphericity
1000<k<600,000 2<W<12	1503	785
1000<k<600,000 300<W<600	1503	785
10,000<k<600,000 2<W<12	2599	1374
10,000<k<600,000 300<W<600	2599	1374
200,000<k<6,000,000 2<W<12	8005	3982

No dependency in W?

CROSS CHECK FOR ABRAHAM VILLATORO TELLO

RunNumber	S7	S6	S5	S4	S3	S2	S1	S0
255711	-0.25265	-0.669552	-0.306344	-0.915519	-0.328205	-2.11601	-0.715729	1141.32
255720	-0.350356	-0.874323	-0.344514	-0.797982	-0.32004	-2.33412	1109.55	-0.292634
255715	-0.439267	-1.01197	-0.407564	-0.86978	-0.327875	1328.4	-0.723739	-0.257923
255722	-0.482517	-1.06284	-0.445345	-0.816625	1425.77	-1.94999	-0.560429	-0.111204
255718	-0.409306	-0.986476	-0.293985	1282.14	-0.373963	-2.34115	-0.683716	-0.337101
255723	-0.147205	-0.63427	1232.51	-0.694578	-0.344724	-1.96876	-0.612043	-0.276521
255736	-0.169598	-0.500408	-0.250571	-0.56856	-0.242748	-1.46611	-0.515763	1205.99
255744	-0.304046	-0.698352	-0.298984	-0.574692	-0.238583	-1.86046	1176.78	-0.281038
255738	-0.296719	-0.717581	-0.289783	-0.608822	-0.268368	1043.57	-0.553824	-0.0409297
255745	-0.30964	-0.73126	-0.318211	-0.672555	1091.19	-1.87691	-0.473213	-0.0806735
255741	-0.270288	-0.60531	-0.13928	1204.93	-0.317434	-1.69189	-0.502954	-0.179533
255746	-0.225468	-0.663358	1014.2	-0.43493	-0.293514	-1.8155	-0.524446	-0.231196
255742	-0.254426	1240.05	-0.23169	-0.538478	-0.258174	-1.70251	-0.500791	-0.211552
255747	1436.84	-0.35047	-0.0770125	-0.518962	-0.283521	-1.77794	-0.438496	-0.163393

Proof with ADC. There should be practically the same Charge signal in the other chanels which the signal was not given

To do

- Simulation with 100<W<400, 300<W<400 to check the no dependecy in jet reproduction
- Waiting for more instructions from Dr. Daniel Tapia
- Make the Plateau curves of the ACO-PMTs with Abraham

THANK YOU FOR YOUR ATTENTION!

ANY QUESTIONS?