Spherocity analysis using V0M estimator

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ACO meeting

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Outline

- Comparison between methods V0M and reference |eta|<0.3 for spectra, for Mean P_T
- I ll compare what happend when I use Backgroung rejection.
- Correlation pt vs <dN/deta> $_{|eta|<0.3}$
- We compare the V0M-REF ratio for:
  Nch in V0M> <N/deta>$_{|eta|<0.3}$
  Nch in V0M< <dN/deta>$_{|eta|<0.3}$
  Nch in V0M= <dN/deta>$_{|eta|<0.3}$

- Conclusions.

Analysis and run selection

Software: Aliroot:`v5-07-20` Aliphysics:`vAN-20160204`
Event shape classes: (PWGLF/SPECTRA/Spherocity)
Analysis macros: `AddTransverseEventShapeTask.C`
`AliAnaTransverseEventShapeTask.cxx`
`AliAnaTransverseEventShapeTask.h`

LHC15f pass2: (55 mill of evts) (after all ev selection)
MC Pythia6 Perugia 2011 **LHC15g3c3** 50 mill.
MC Pythia8 Monash **LHC15g3a3**: 40 mill,
good runs*:
226500, 226495, 226483, 226476, 226472, 226468, 226466,
226452, 226445, 226444, 226225, 226220, 226170, 226062,
225768, 225766, 225763, 225762, 225757, 225753, 225719,
225717, 225716, 225710, 225709, 225708, 225707, 225705,
225587, 225586, 225579, 225578, 225576, 225322, 225315,
225314, 225313, 225310, 225309, 225307, 225305, 225106,
225052, 225051, 225050, 225043, 225041, 225037, 225035,
225031, 225026

(*) http://twiki.cern.ch/twiki/bin/viewauth/ALICE/PWGLF13TeVanalysis

Event, track and physics selection

Event Selection

Trigger: KINT7 (*Thanks to Gyula*)
Rejection of AliESDEvent::IsIncompleteDAQ (aplied last time)
Vertex selection
SPD Pile-up rejection
Background rejection (aplied last time)
Multivertex Pile-up rejection (new)
low diagonal cut OFO &V0M applied (new)
No PF protection should be applied for LHC15f **

https://twiki.cern.ch/twiki/bin/view/ALICE/PWGPPEvSelRun2pp

**https://twiki.cern.ch/twiki/bin/view/ALICE/AliceHMTFCodeSnippets#Physics_Selection

Physics Selection

- MinNCrossedRowsTPC = 120; *
- MinRatioCrossedRowsOverFindableClustersTPC=0.8;
- MaxFractionSharedTPCCluster = 0.4;
- Maxchi2perTPCcl=4.;
- Max dcaz ITSTPC=2.0;
- SetDCAToVertex2D(kFALSE);
- SetRequireSigmaToVertex(kFALSE);
- RequireTPCRefit(kTRUE);
- RequireITSRefit(kTRUE);
- AcceptKinkDaughters(kFALSE);
- MaxDCAToVertexXYPtDep("0.0182+0.0350/pt^1.01"); *
- SetMaxChi2TPCConstrainedGlobal(36.);

Track selection taken for each analysis:

- So Analysis, Hybrid-track cuts for primary charged particles with $|\eta|<0.3$ and $0.15<p_T<10$ GeV/c.
- $<p_T>$ Analysis, Golden-track cuts with $|\eta|<0.3$ and $0.15<p_T<10$ GeV/c.
- Multiplicity:
  - Reference multiplicity selection with $|\eta|<0.3$
  - V0M percentil selection

Useful tools for Multiplicity estimators

- Used libraries

```
$ALICE_PHYSICS/OADB/COMMON/MULTIPLICITY/AliMultSelectionTask.cxx
$ALICE_PHYSICS/OADB/COMMON/MULTIPLICITY/macros/AddTaskMultSelection.C
```

- Snippets

```
AliMultSelection *MultSelection = (AliMultSelection*) lVEvent->FindListObject("MultSelection");
Float_t lMultiplicityPercentile = MultSelection->GetMultiplicityPercentile("V0M");
```

- More:

https://twiki.cern.ch/twiki/bin/viewauth/ALICE/AliceHMTFEstimators

- AliPPVsMultUtils class from AliPhysics>=vAN-20151019-1 obsolete

Thanks David for help.
and Vytautas for provide the binning

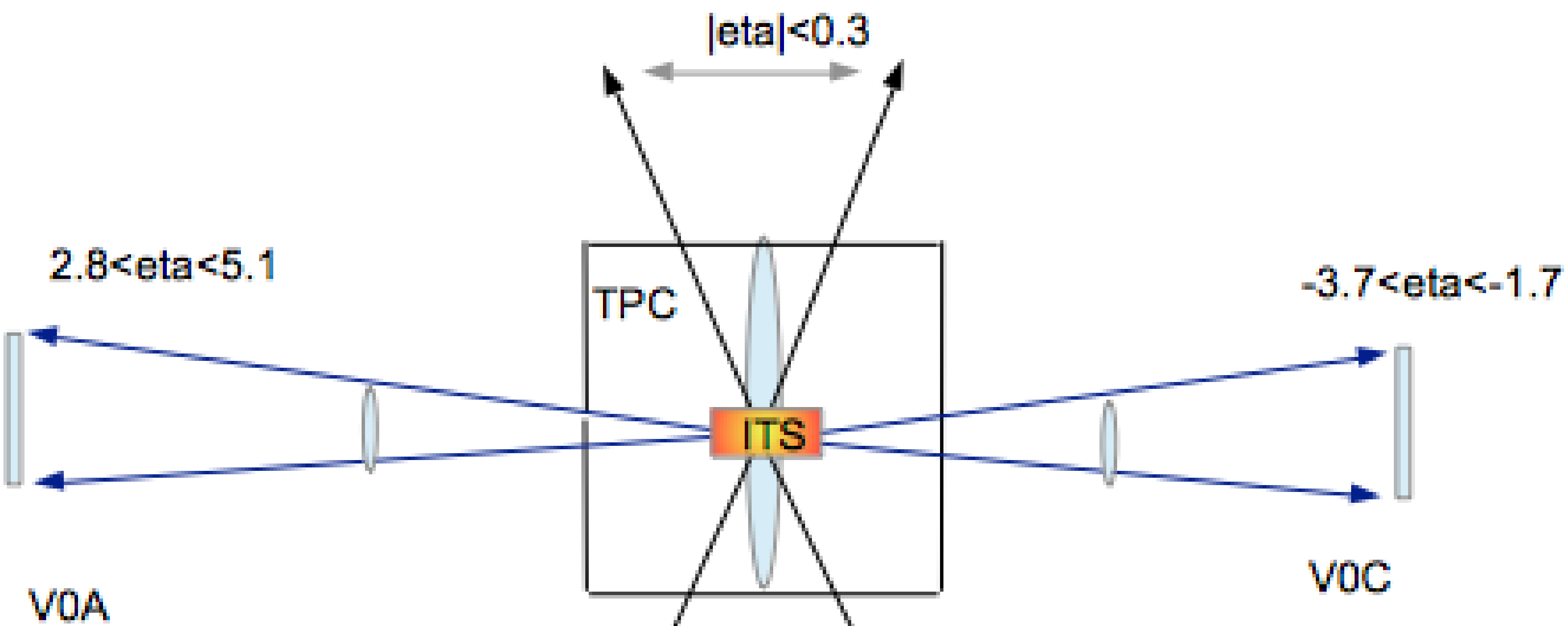
The physical problem

In order to answere Arturo`s question;
Why to do so many technicalities?
Is there any physics motivation?

Where is $\langle p_T \rangle$ high?

In principle we can reach high p_T in |eta|<0.3, but also high Nch.

In V0M we have not high p_T, but also not high Nch.



Precise measurement Is require,
So many technicalities must be taken into account

And why?

Is there any physics or any process such as MPI, CR, flow, wich can explain the behaviour?
And wich observables can help to understand this? Multiplicity? Spherocity?

Events in V0M Multiplicity clases

With BG rejection:

if(fNofITSClusters0+ fNofITSClusters1 > 65+4*fNofTracklets) return;

With MV pileup rejection:

SetMinPlpContribMV=5,
SetMaxPlpChi2MV(5.0),
SetMinWDistMV(15.0), S
SetCheckPlpFromDifferentBCMV=kFALSE.

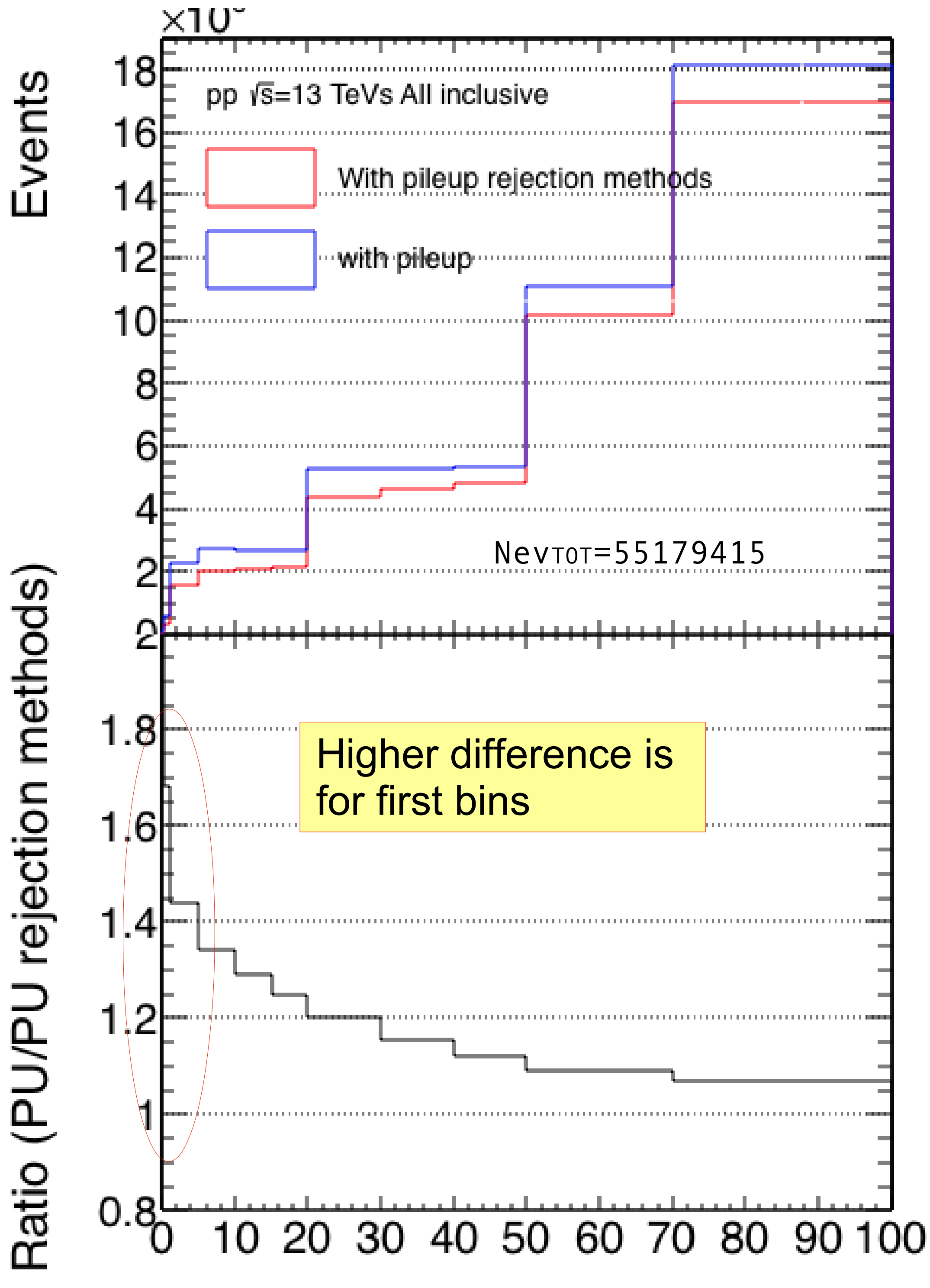
With low diagonal cut SPD & V0M Off-Online FastOR:

onlineSPD >= -20.589 + 0.73664*offlineSPD

&& onlineV0M >= -100.+7.*offlineV0M

Snippets (thanks to Yihye Song)

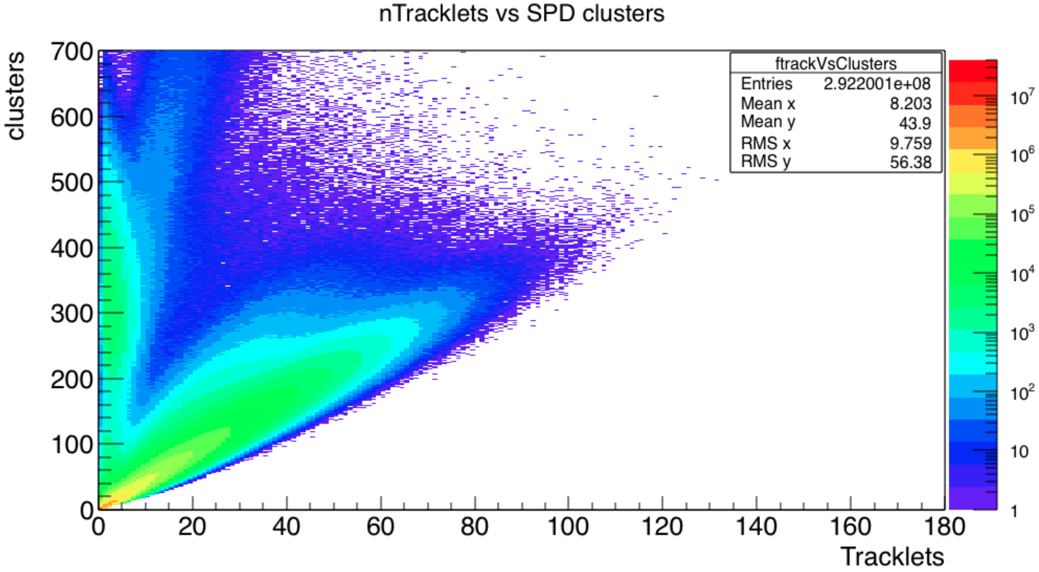
```
AliVVZERO* vzero = fInputEvent->GetVZEROData();
 fMTotV0A = vzero->GetMTotV0A();   fMTotV0C  = vzero->GetMTotV0C();
 fTriggerChargeA = vzero->GetTriggerChargeA();
 fTriggerChargeC = vzero->GetTriggerChargeC();
  onlineV0M     = fTriggerChargeA+fTriggerChargeC;
 offlineV0M    = fMTotV0A+fMTotV0C;
```

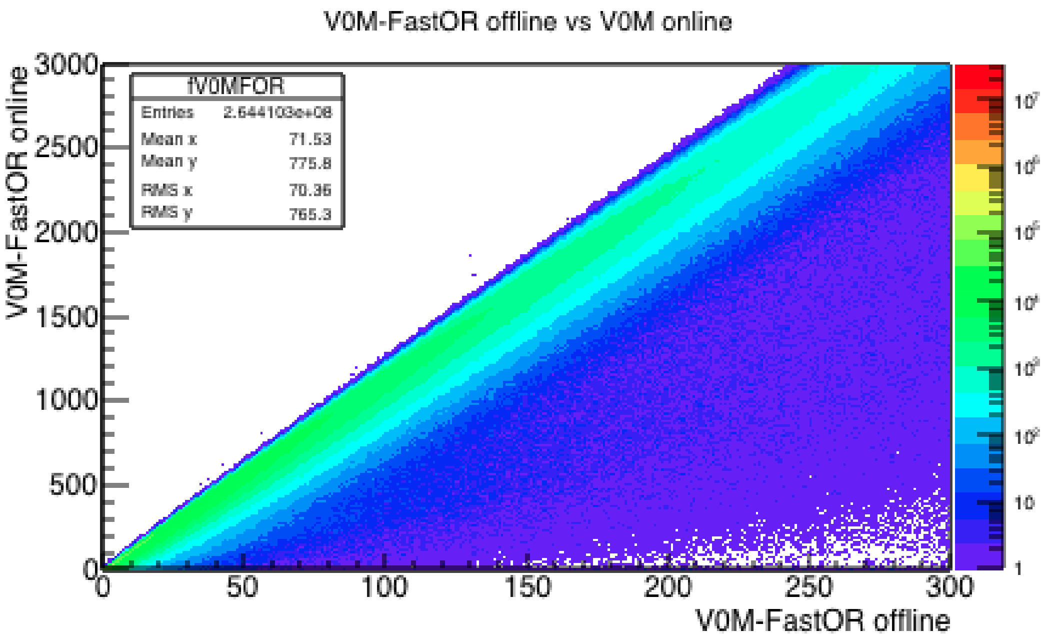


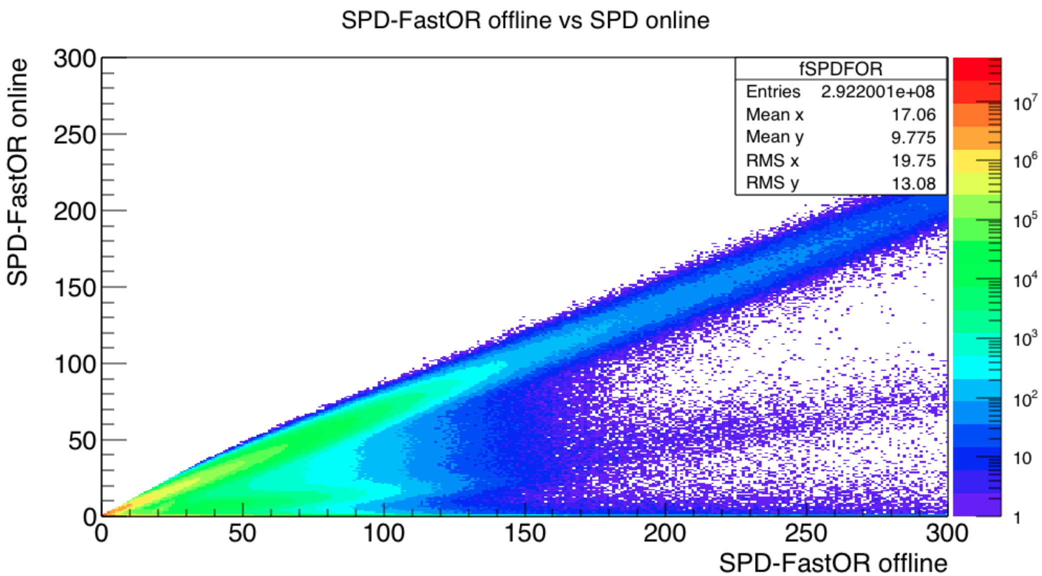
https://twiki.cern.ch/twiki/bin/view/ALICE/AliceHMTFPastFutureProtection

Some control plots to see the cuts applied

With any method of PU rejection

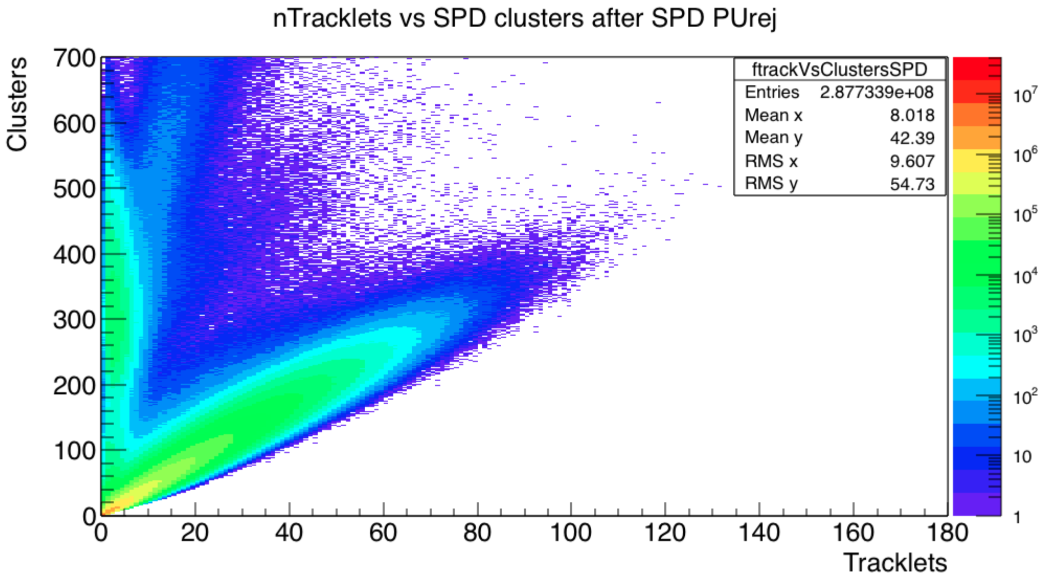




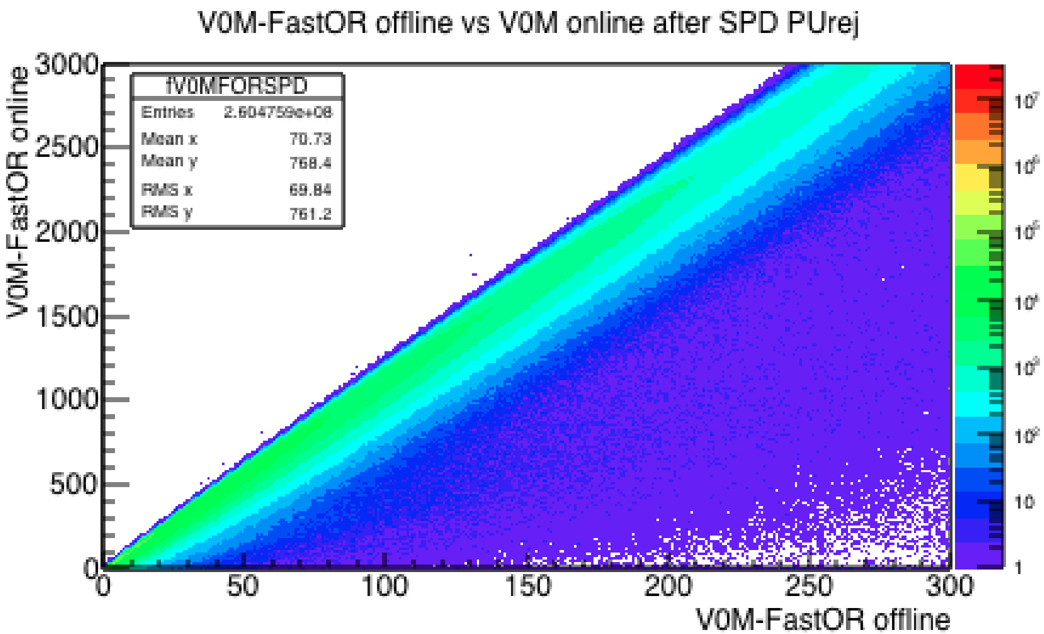


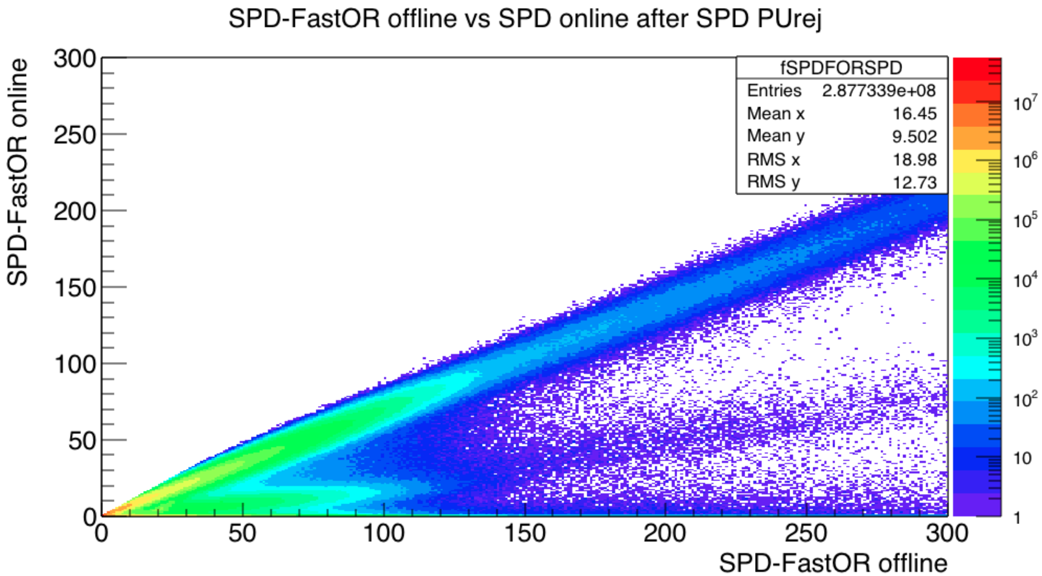
Some control plots to see the cuts applied

With
SPD PU rejection



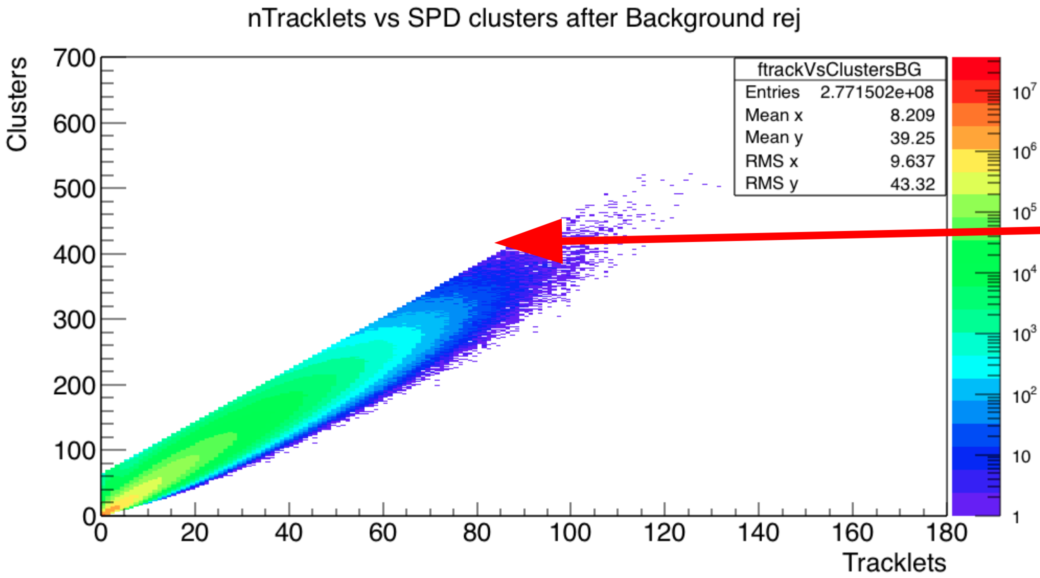
Is SPDPile-up rejection





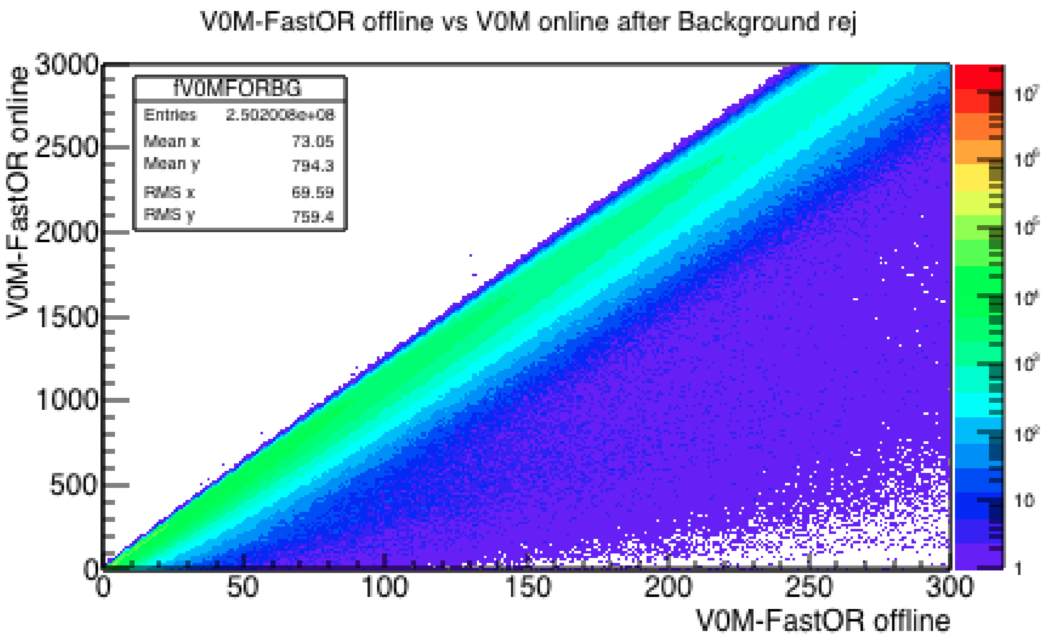
Some control plots to see the cuts applied

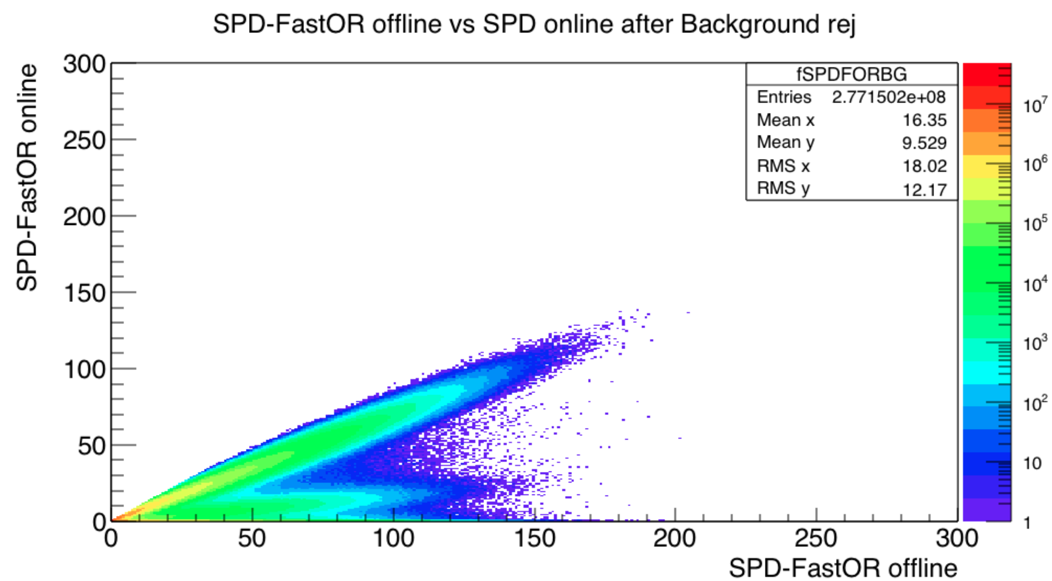
With
Background rejection



Applied the cut on tracklets vs clusters

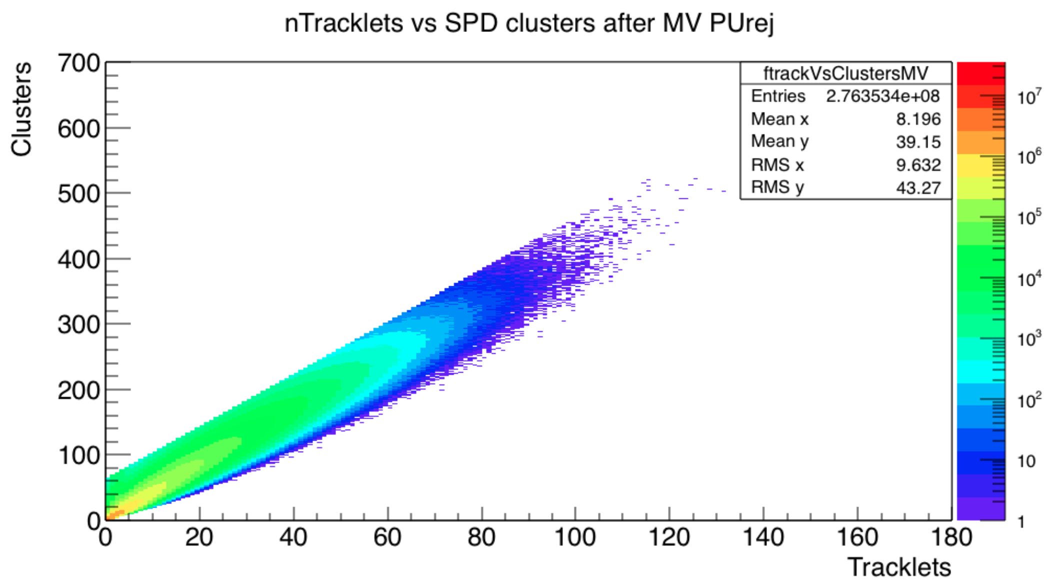
NofITSClusters0+ NofITSClusters1> 65+4*fNofTracklets





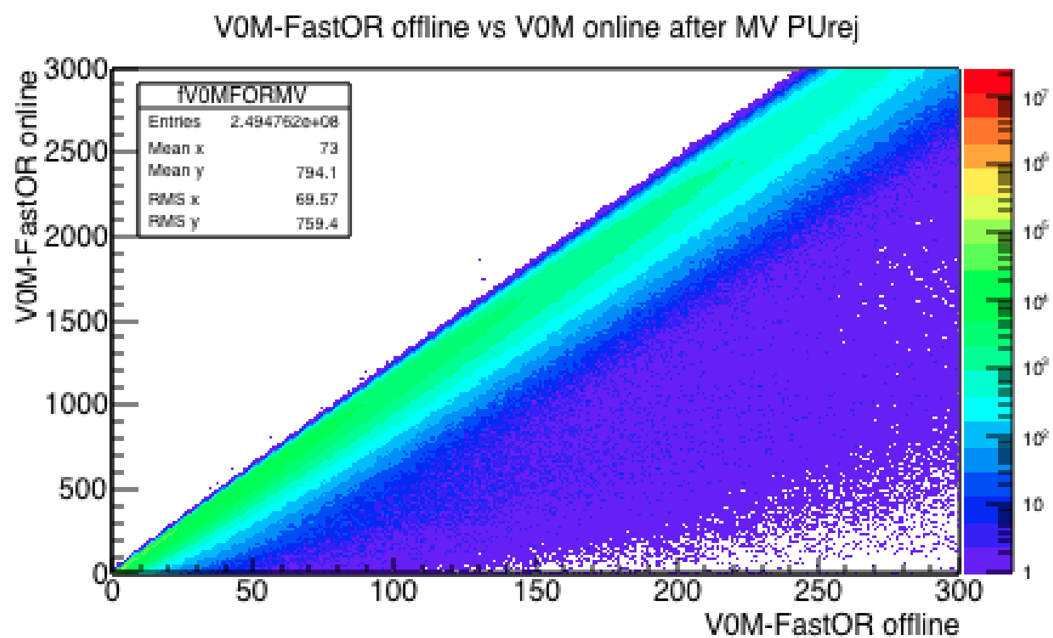
Some control plots to see the cuts applied

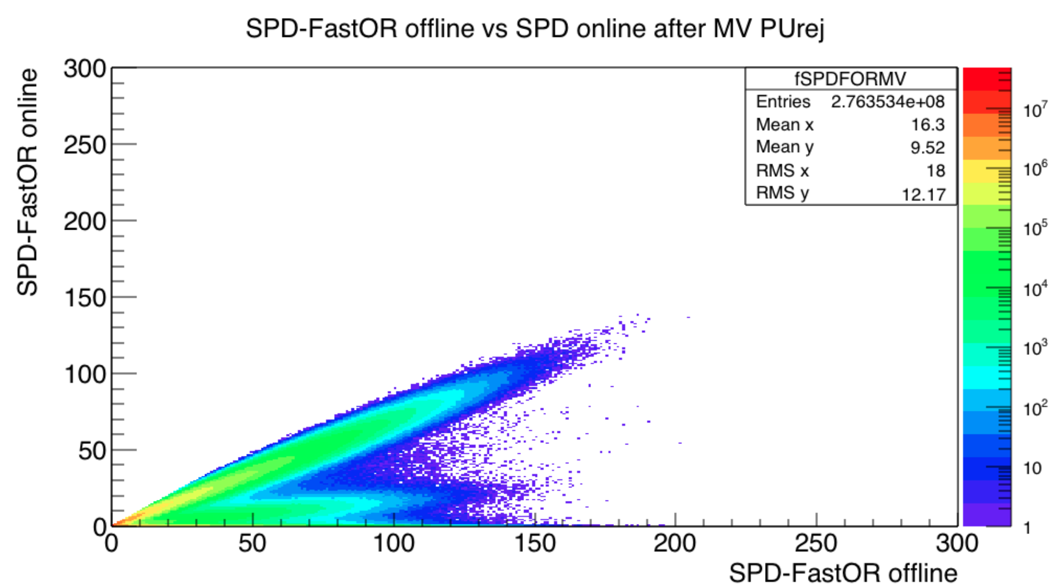
With
MV PU rejection



Using MV parameters:

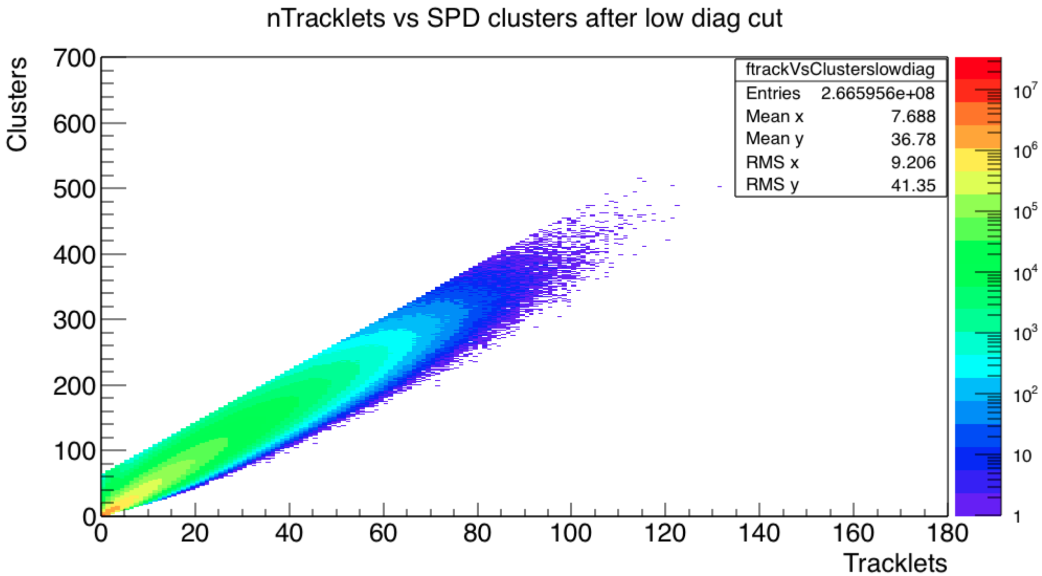
SetMinPlpContribMV=5,
SetMaxPlpChi2MV(5.0),
SetMinWDistMV(15.0), S
SetCheckPlpFromDifferentBCMV=kFALSE.





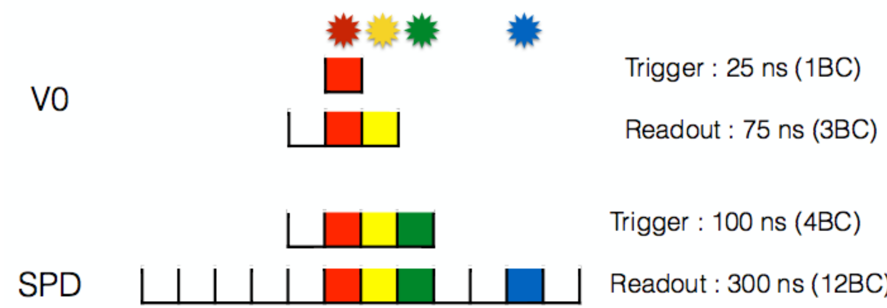
Some control plots to see the cuts applied

With low diagonal cut SPD & V0M Off-Online FastOR:

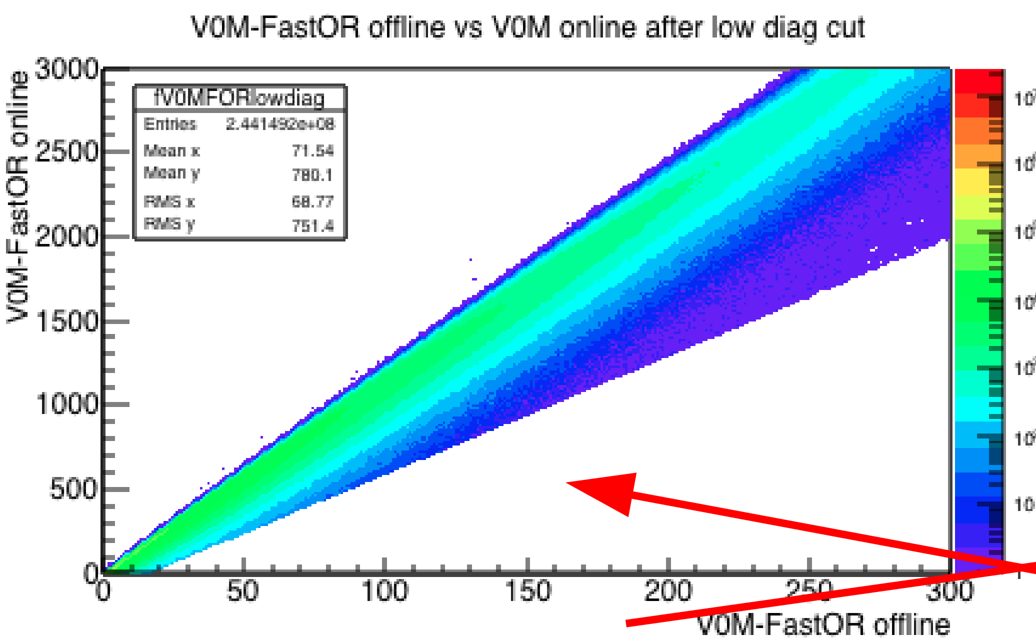


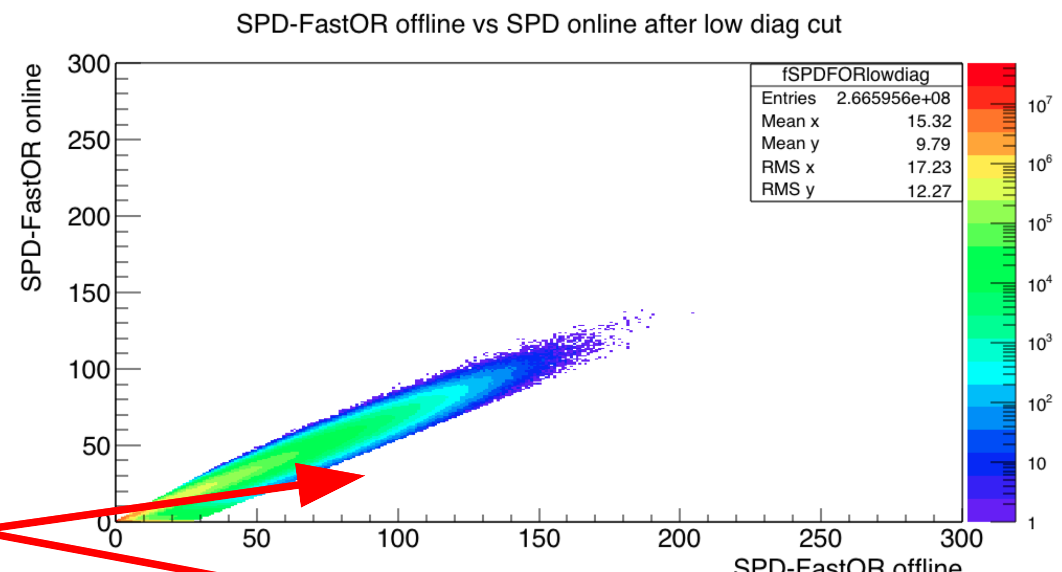
FO , V0M : online vs offline

- In most of the 2015 data taking: trains of **bunches, spaced by 25 or 50 ns**
- Multiple collisions within the readout window of V0 and SPD



- To reject pile-up events, correlations at trigger vs readout can be used

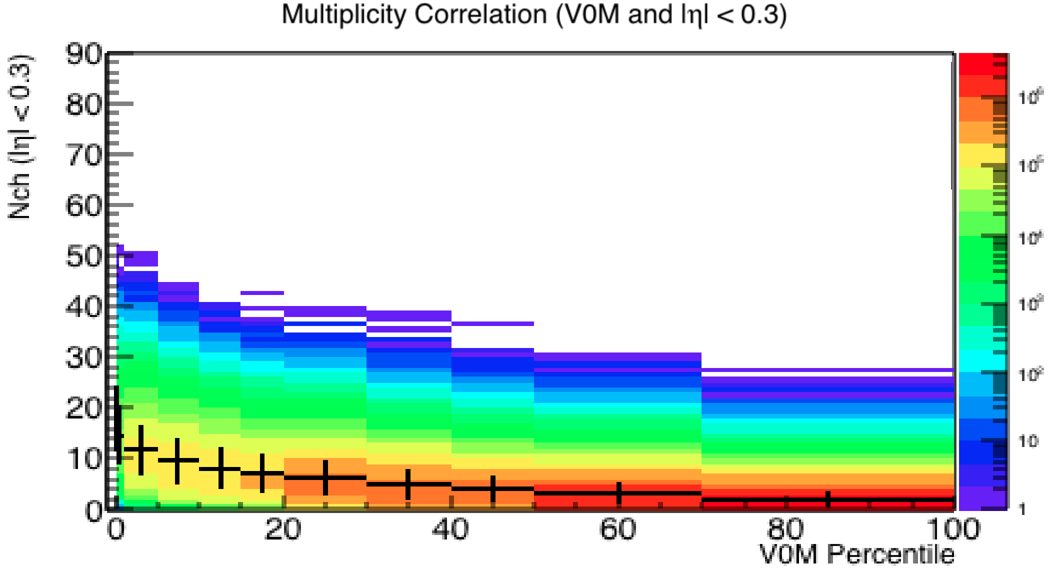




onlineSPD >= -20.589 + 0.73664*offlineSPD && onlineV0M >= -100.+7.*offlineV0M

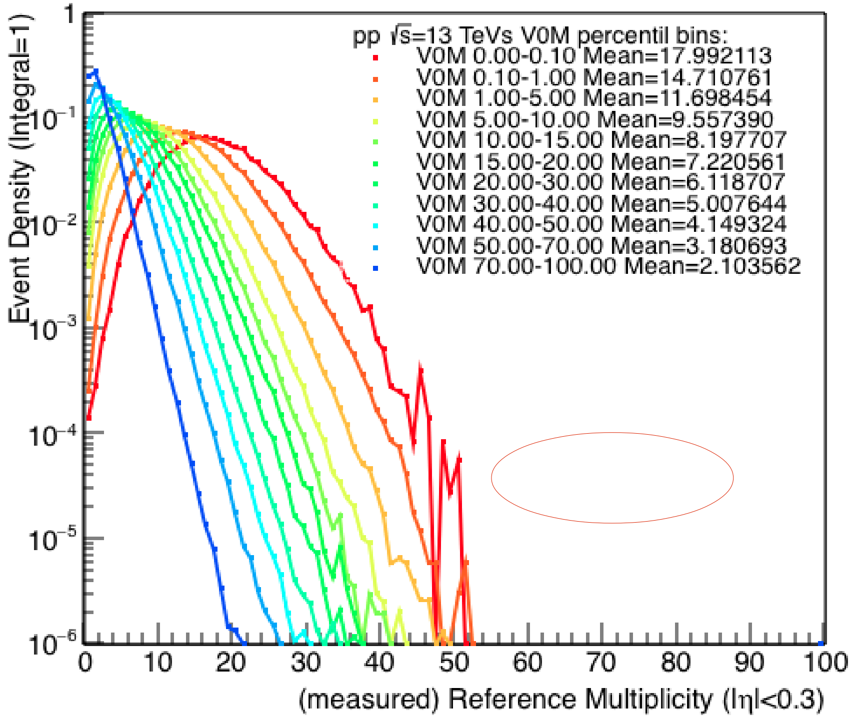
Some usefull plots for V0M Analysis

With All PU rejection cuts



Multiplicity V0M

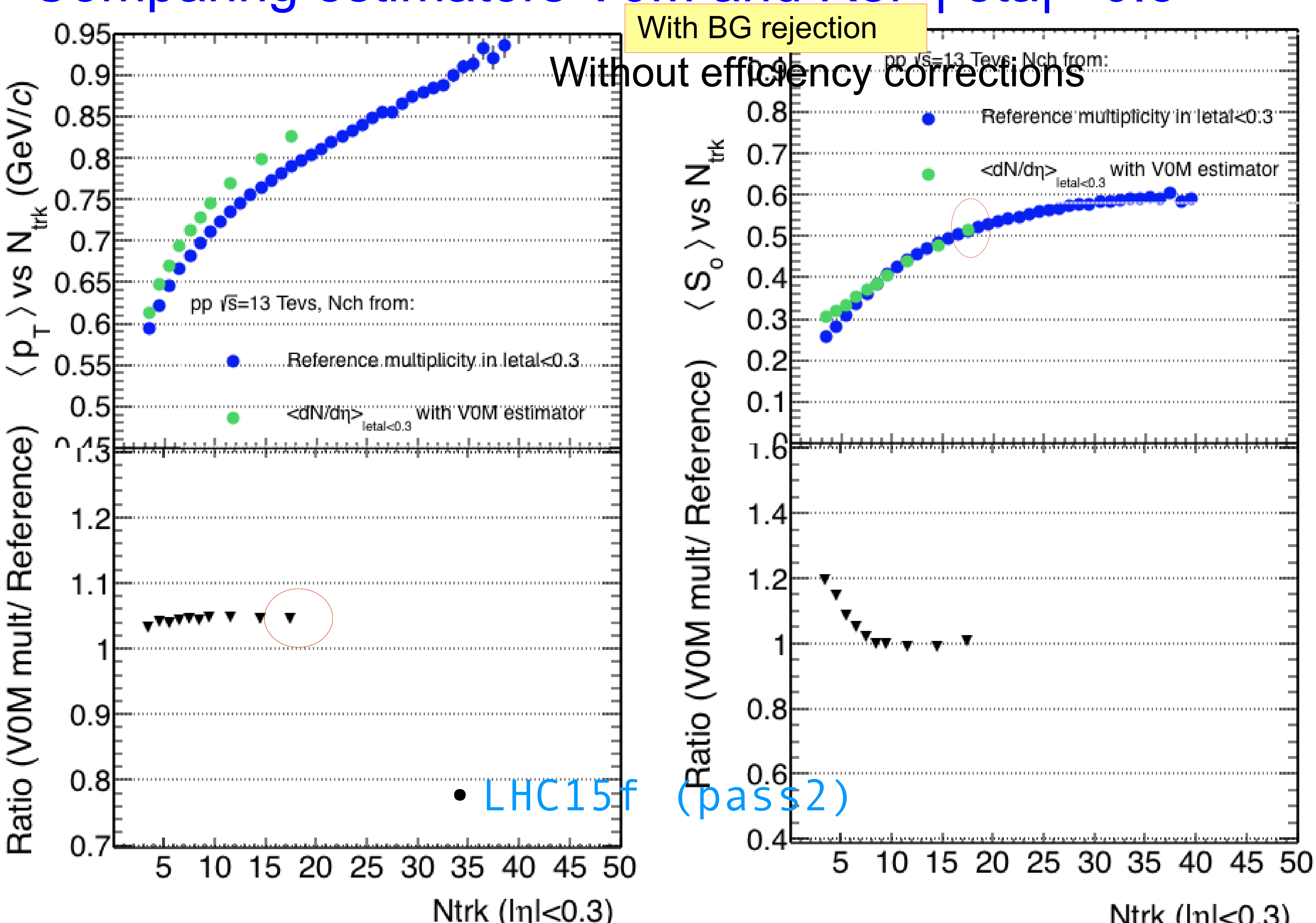
I reproduce the proyections in order to ensure the value of <d*N*/deta>



V0M percentil	<d*N*/deta> |eta|<0.3
0.0-0.1,	17.99
0.1-1,	14.71
1-5,	11.69
5-10,	9.55
10-15,	8.19
15-20,	7.22
20-30,	6.11
30-40,	5.00
40-50,	4.14
50-70,	3.18
70-100	2.10

The number of events where taken from each multiplicity class

Comparing estimators V0M and Ref | eta| <0.3

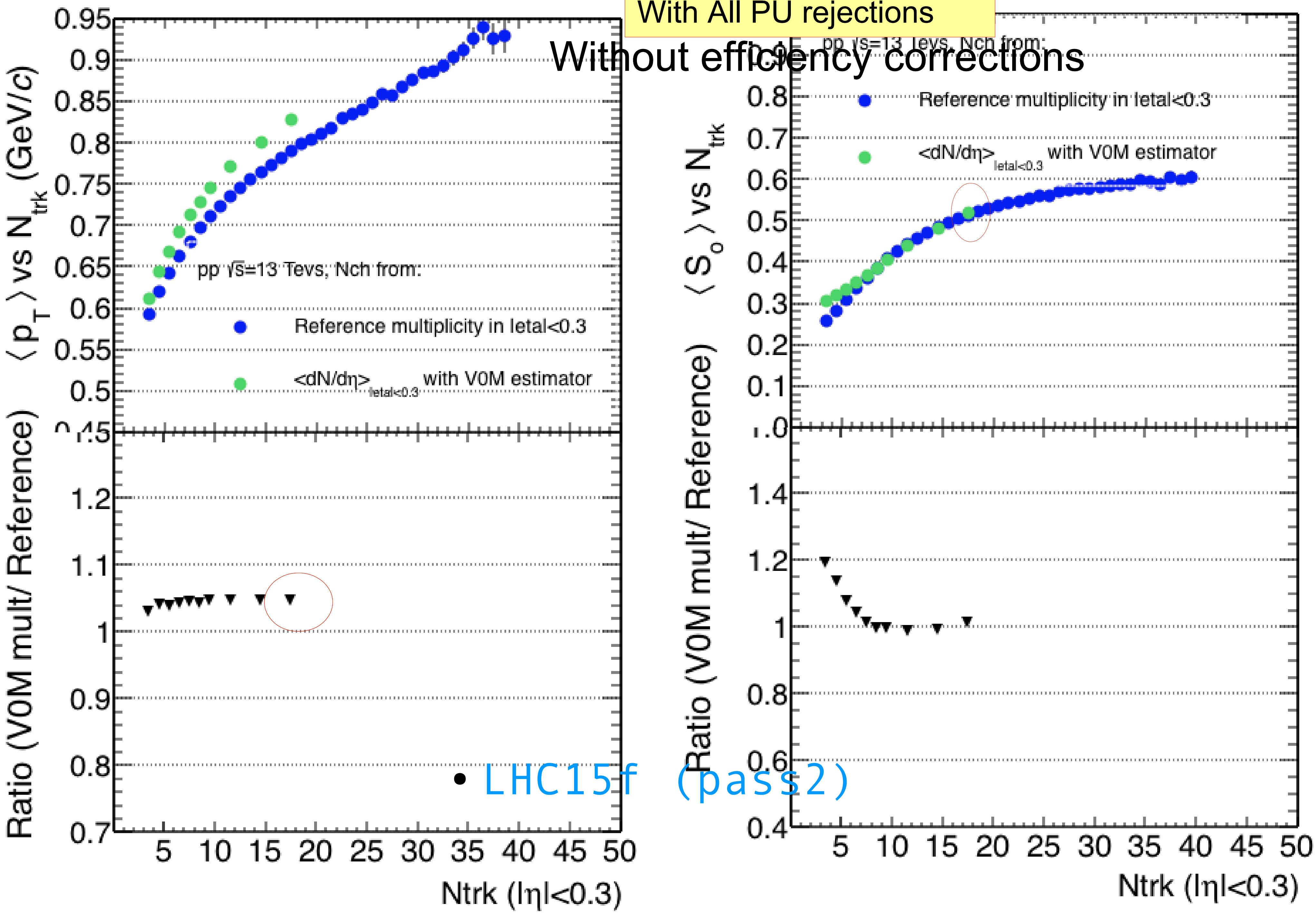


- LHC15f (pass2)

Comparing estimators V0M and Ref |eta| <0.3

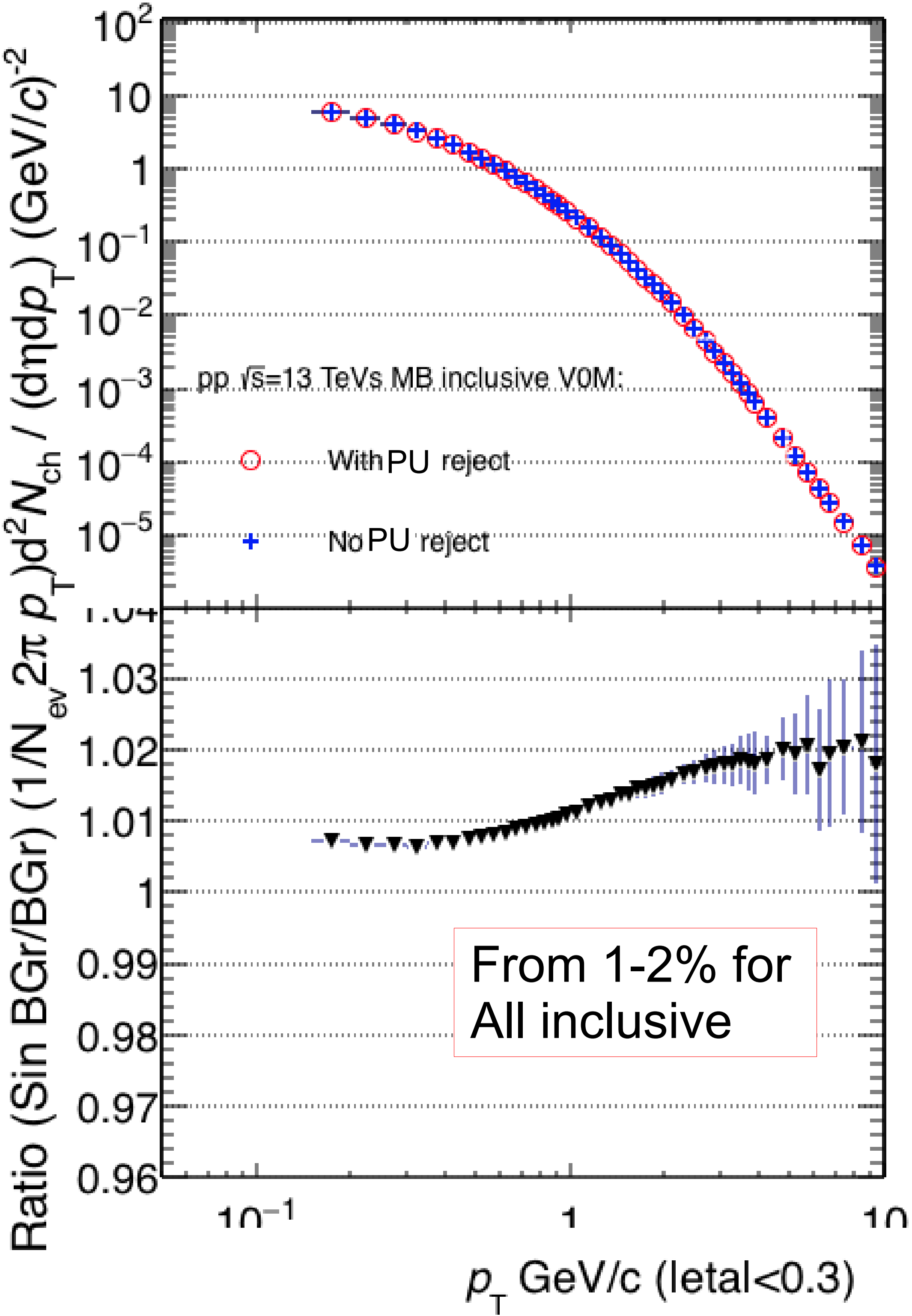
With All PU rejections

Without efficiency corrections



- LHC15f (pass2)

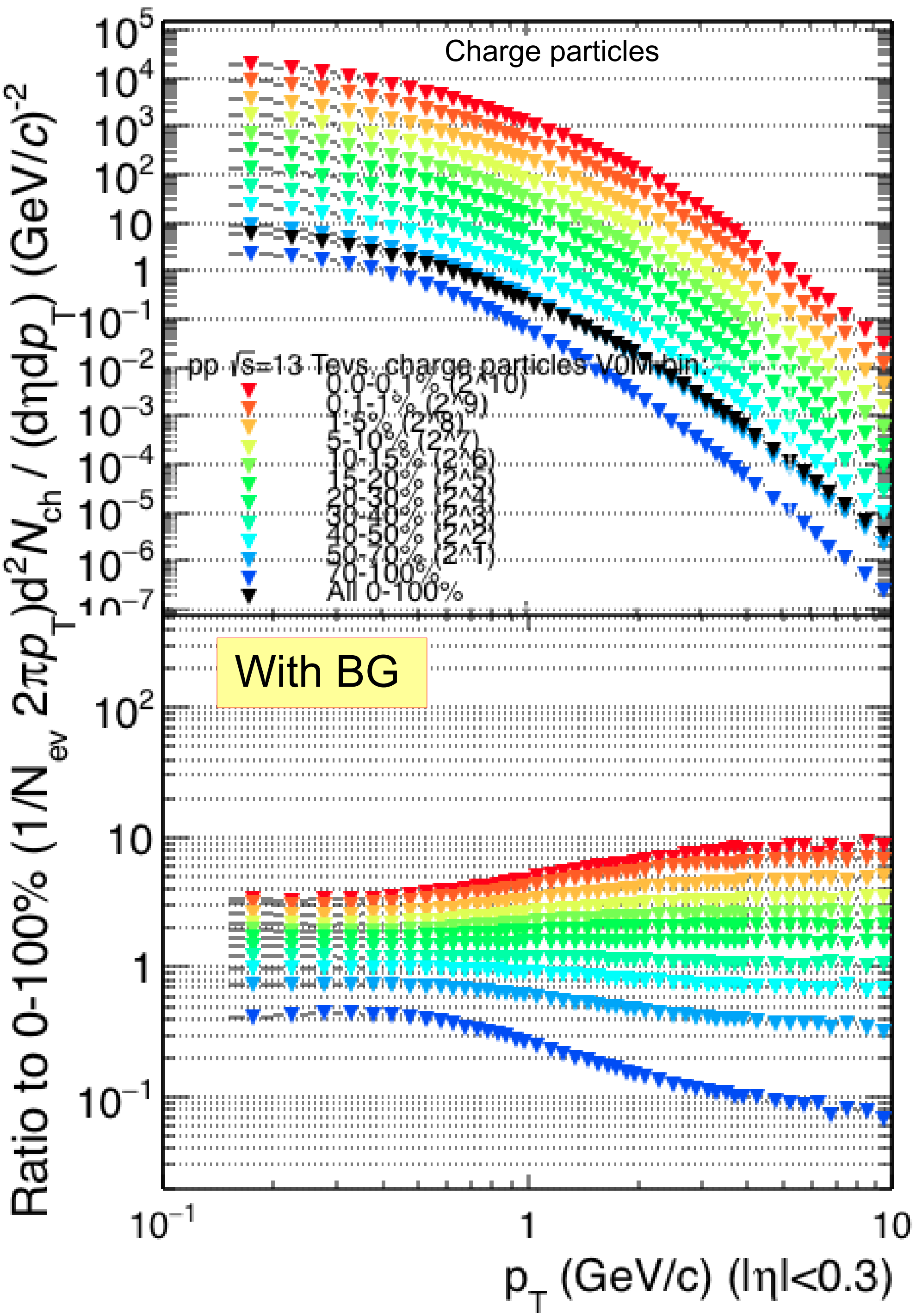
Comparing Yield of All Inclusive (MB V0M) with and without All PU rejection cuts:

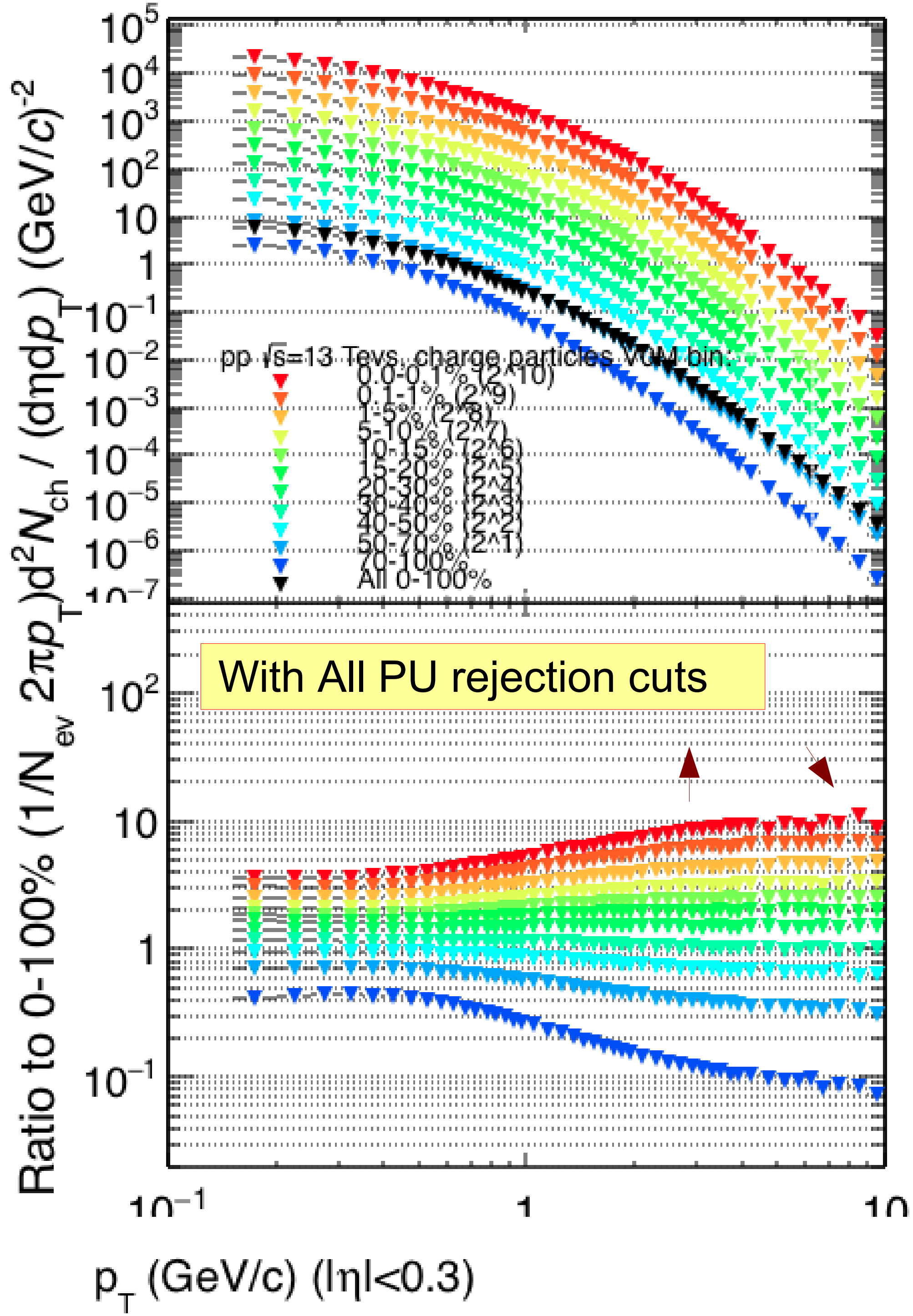


But also the variation will be different for each V0M clases se next slides

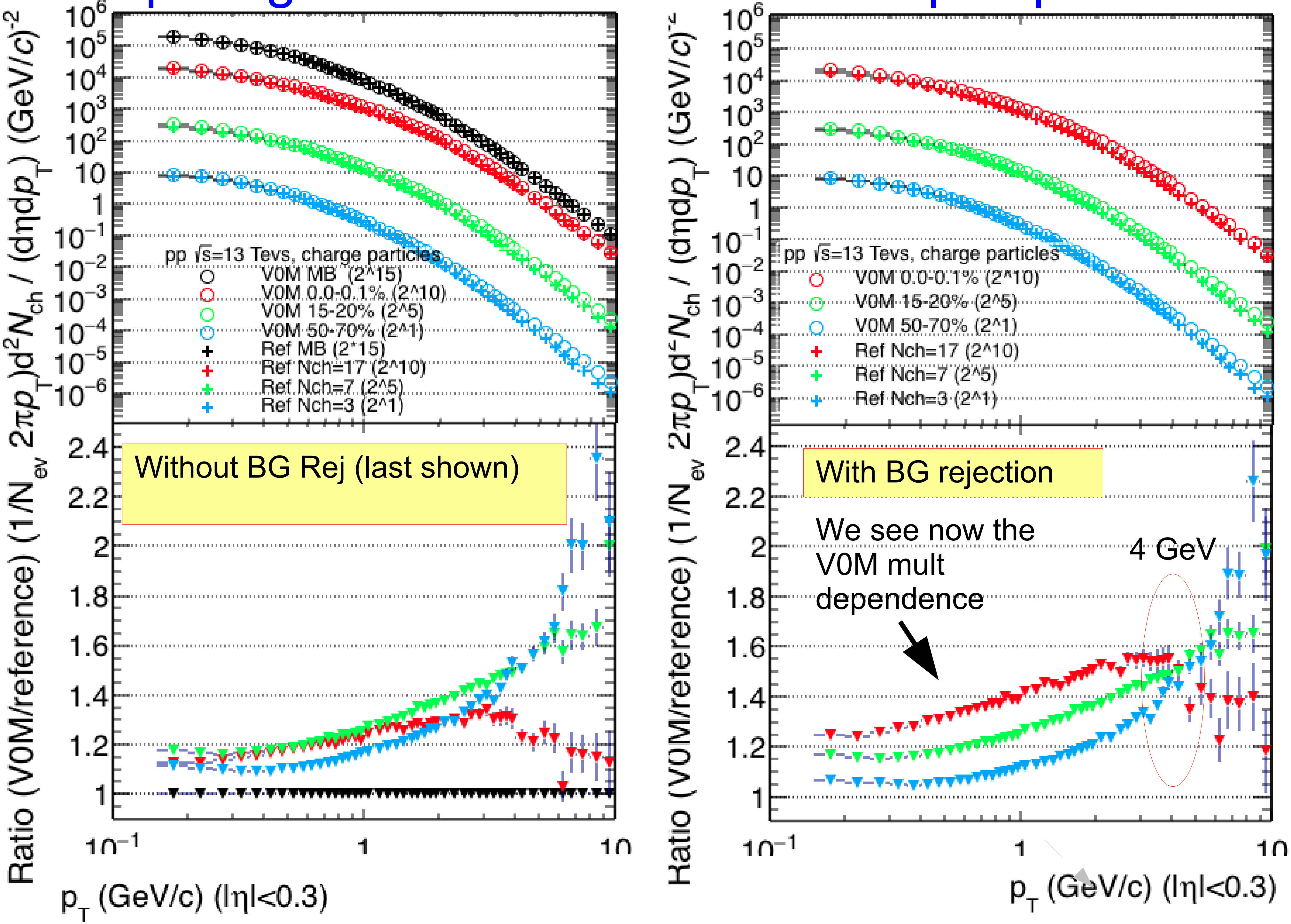
z

Comparing for V0M percentils and N_{ch} for its <d*N*/deta>

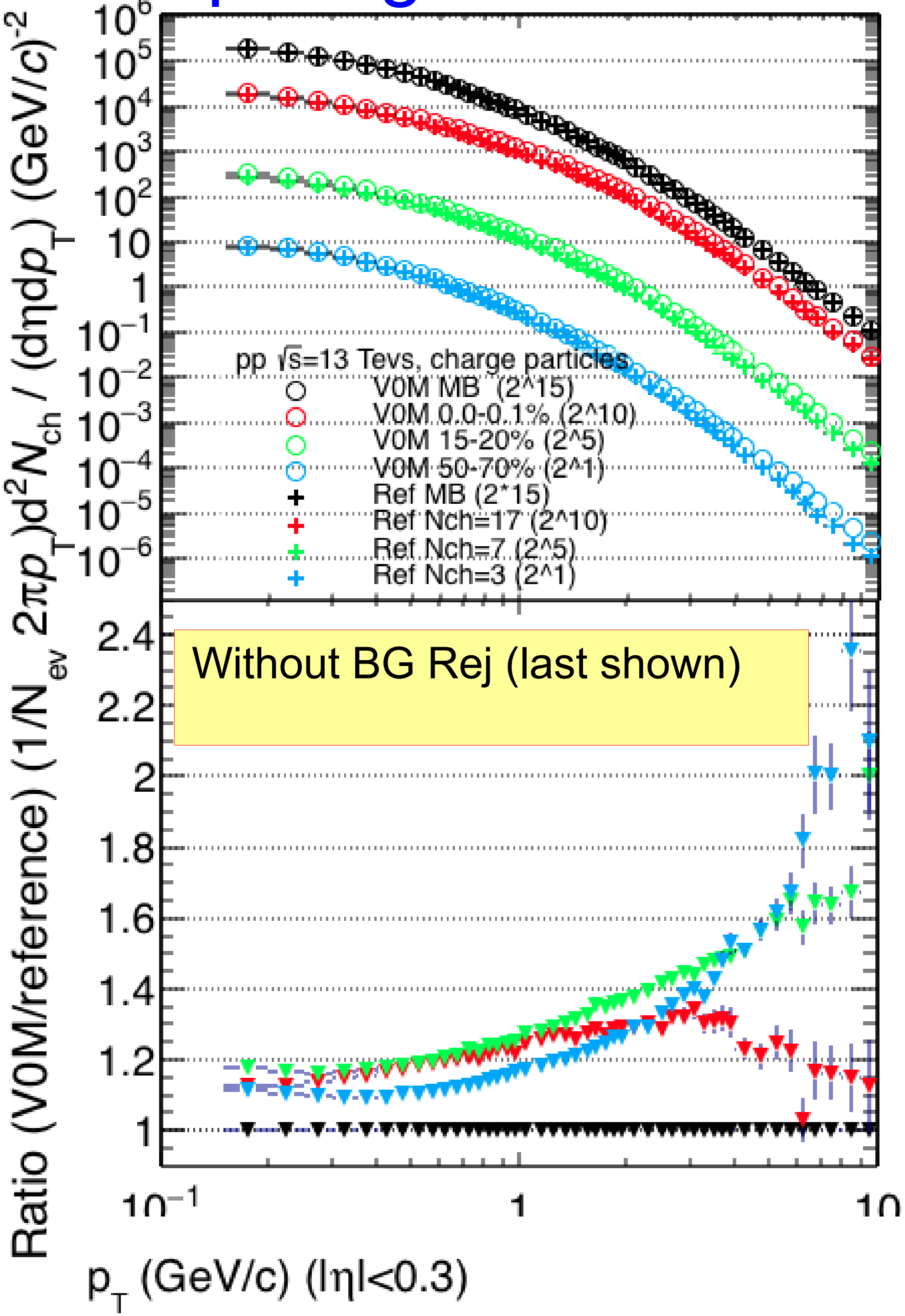


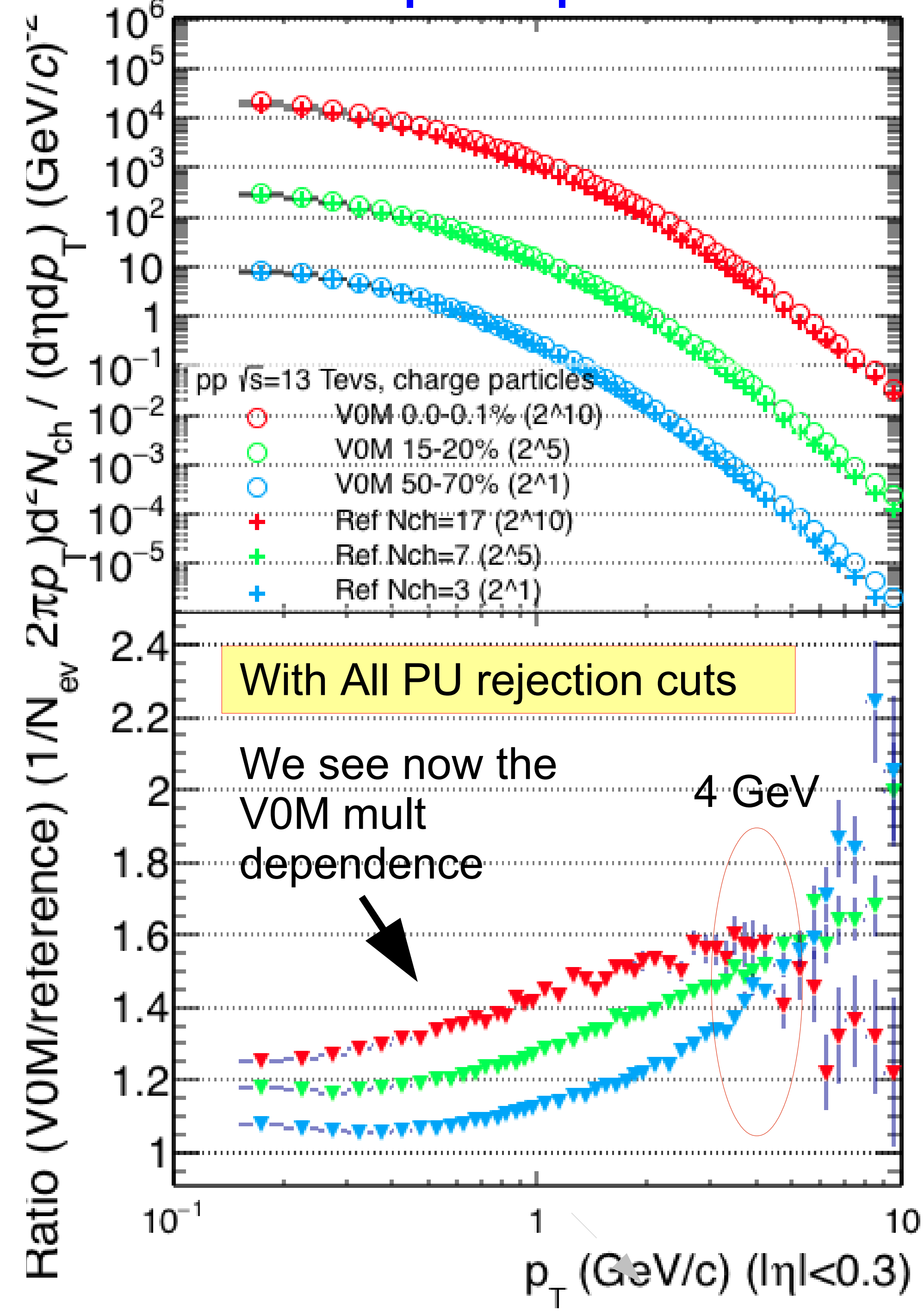


Comparing estimators V0M and Ref | eta| <0.3

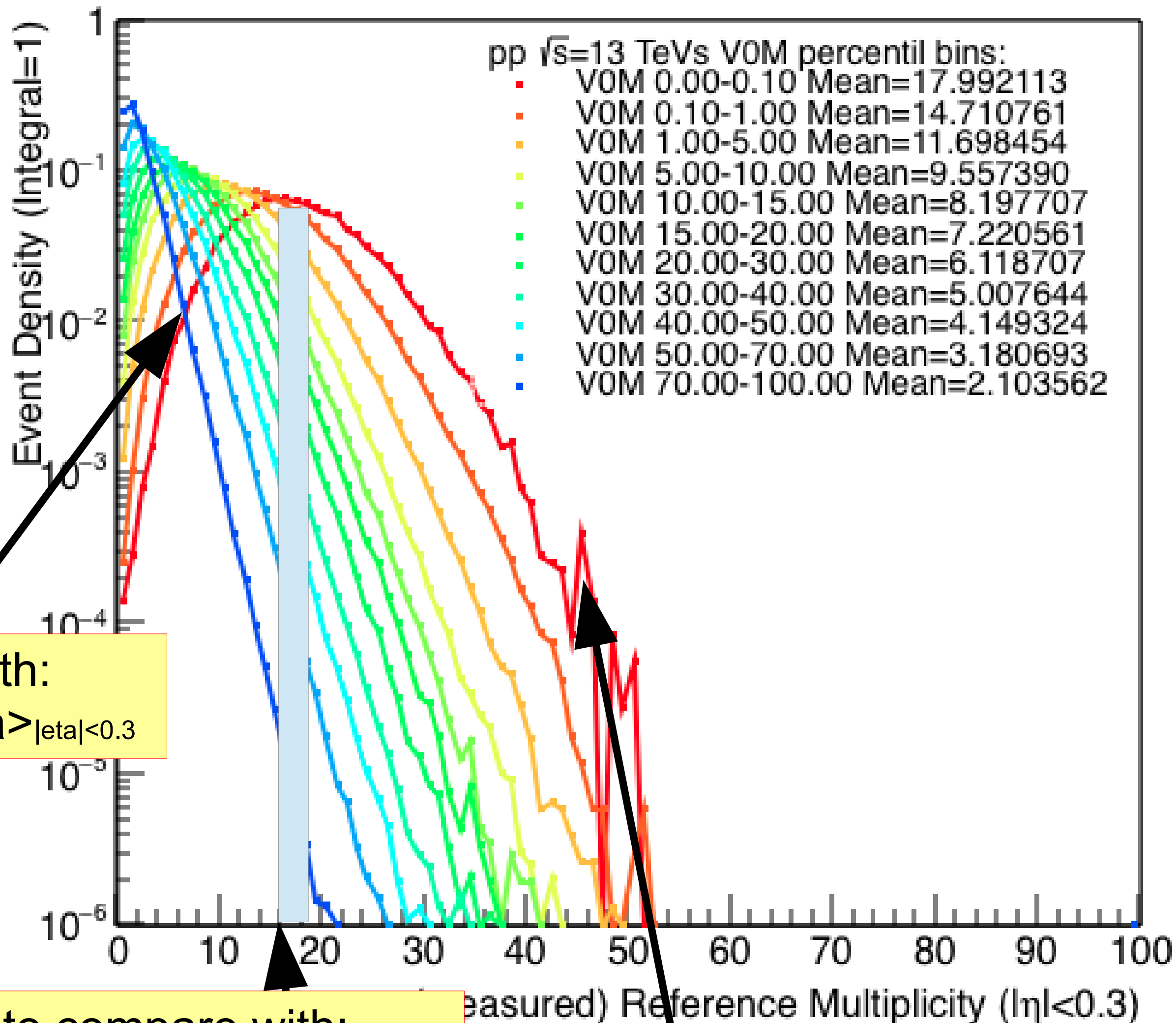


Comparing estimators V0M and Ref | eta| <0.3





Who contributes to the greater fraction for V0M?



Ned to compare with:
$V0M_{Nch} < \langle dN/deta \rangle_{|eta|<0.3}$

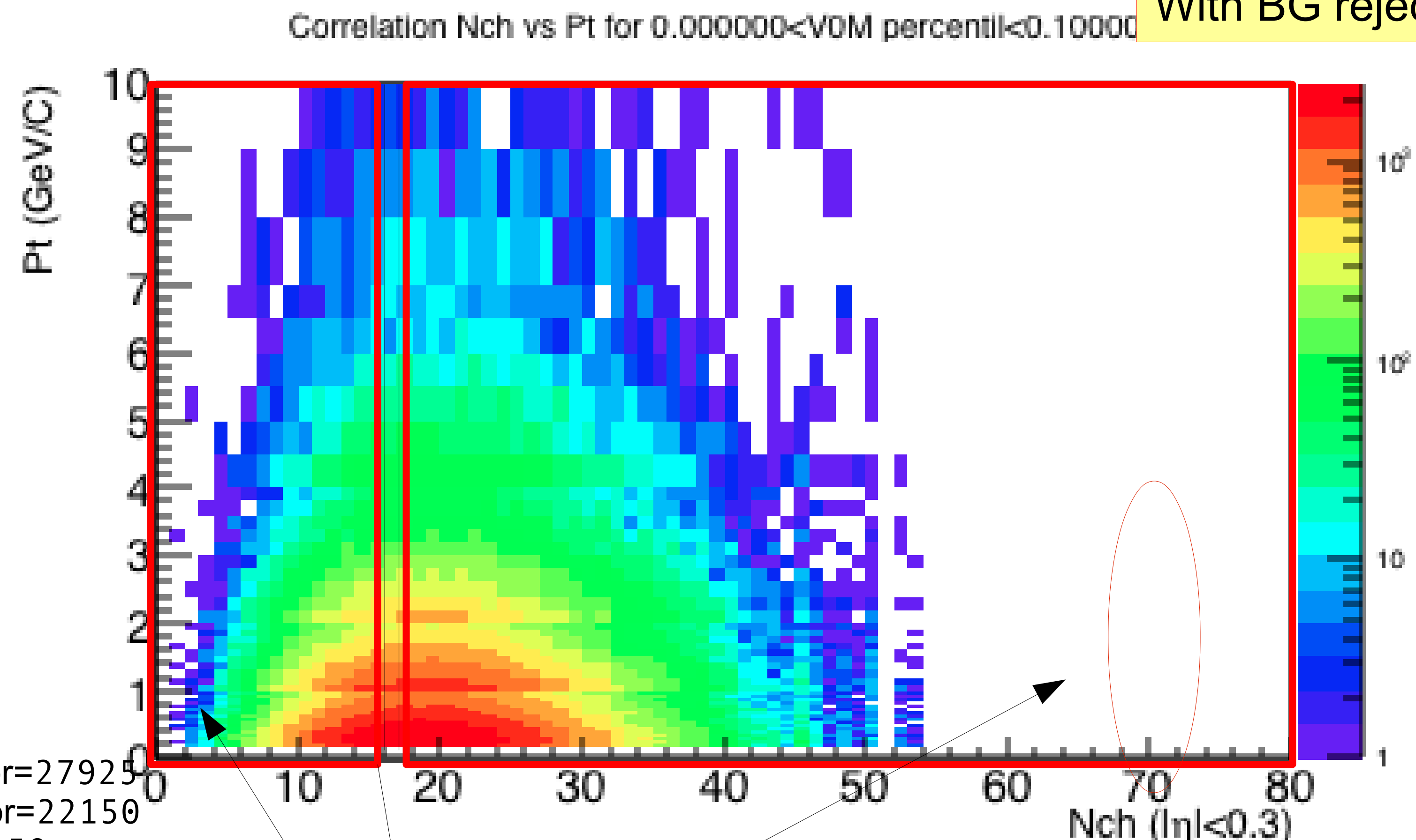
Ned to compare with:
$V0M_{Nch} = \langle dN/deta \rangle_{|eta|<0.3}$

Ned to compare with:
$V0M_{Nch} > \langle dN/deta \rangle_{|eta|<0.3}$

Correlation: P_T vs <dN/deta> $_{|eta|<0.3}$

This was made for all V0M bins

With BG rejection



Nev=53433

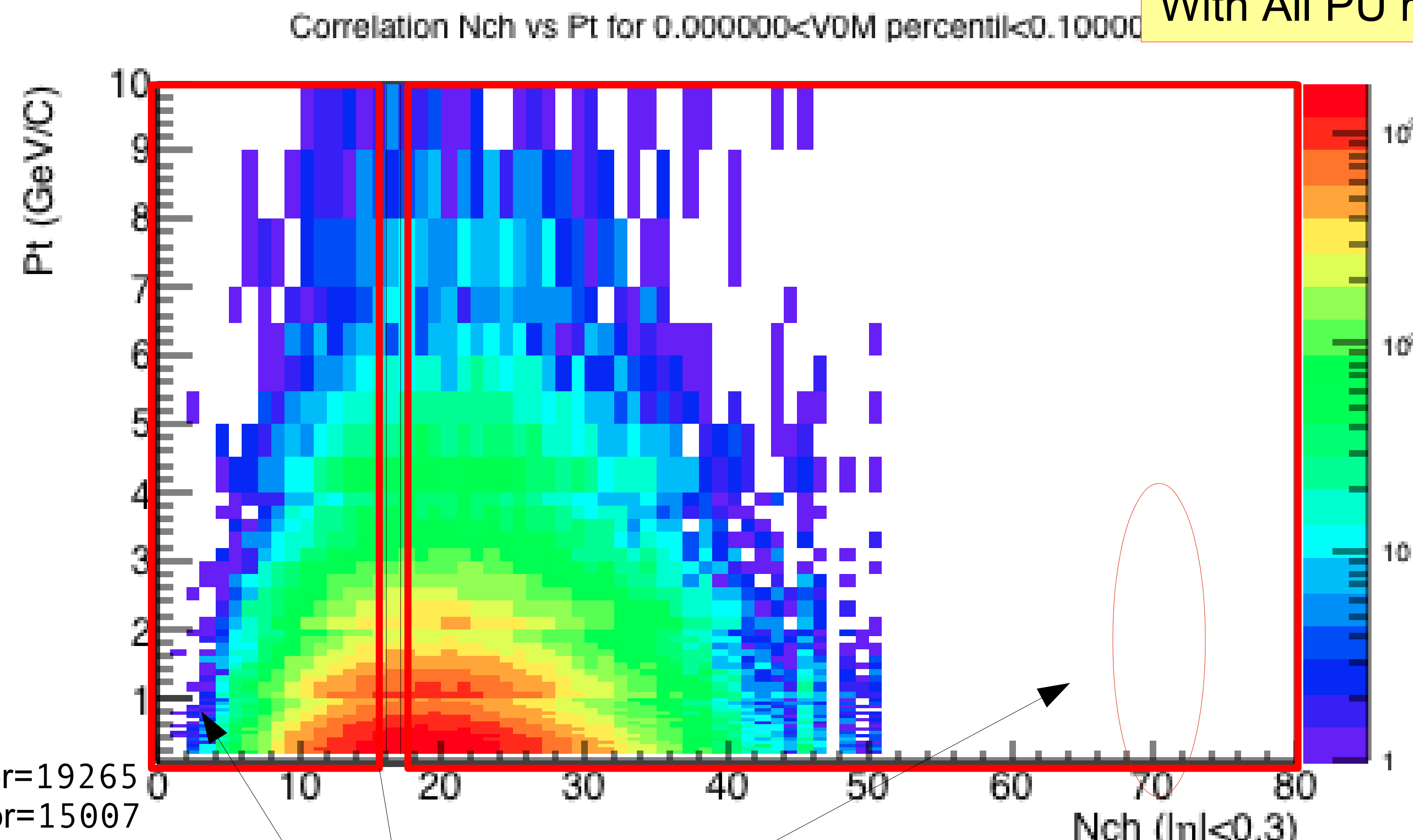
Nev para mayor=27925
Nev para menor=22150
Nev para ig=3358
Suma=53433

In order to get pt distributions for:
Nch in V0M> <dN/deta>$_{|eta|<0.3}$=17
Nch in V0M< <dN/deta>$_{|eta|<0.3}$=17
Nch in V0M= <dN/deta>$_{|eta|<0.3}$ =17

Correlation: P_T vs <dN/deta> |eta|<0.3

This was made for all V0M bins

With All PU rejection cuts



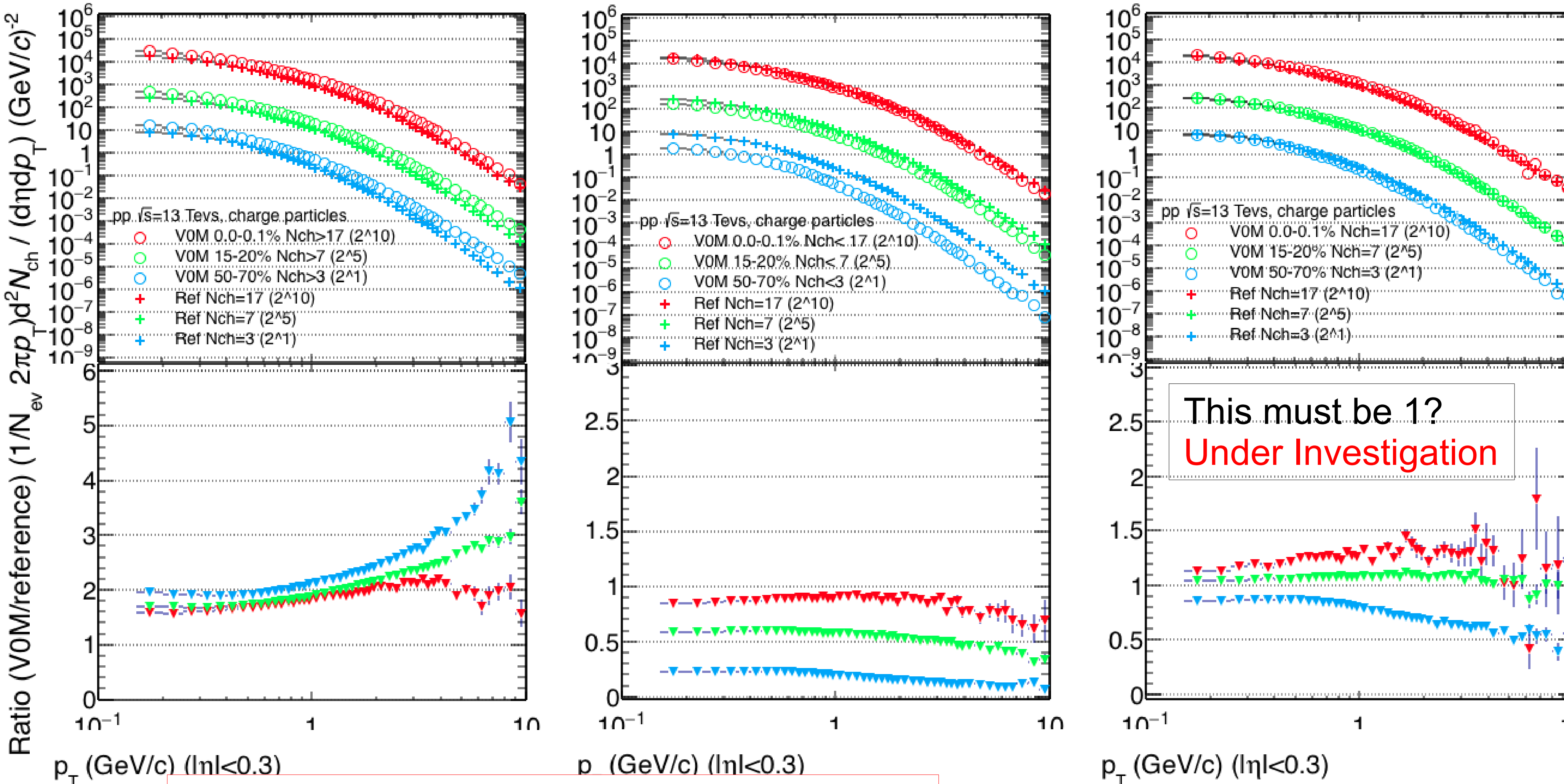
Nev=36600

Nev para mayor=19265
Nev para menor=15007
Nev para ig=2328
Suma=36600

In order to get pt distributions for:
Nch in V0M> <dN/deta>$_{|eta|<0.3}$=17
Nch in V0M< <dN/deta>$_{|eta|<0.3}$=17
Nch in V0M= <dN/deta>$_{|eta|<0.3}$ =17

Comparing with V0M mult for Nch: greater, lower and equal to <dN/deta>

With BG rejection

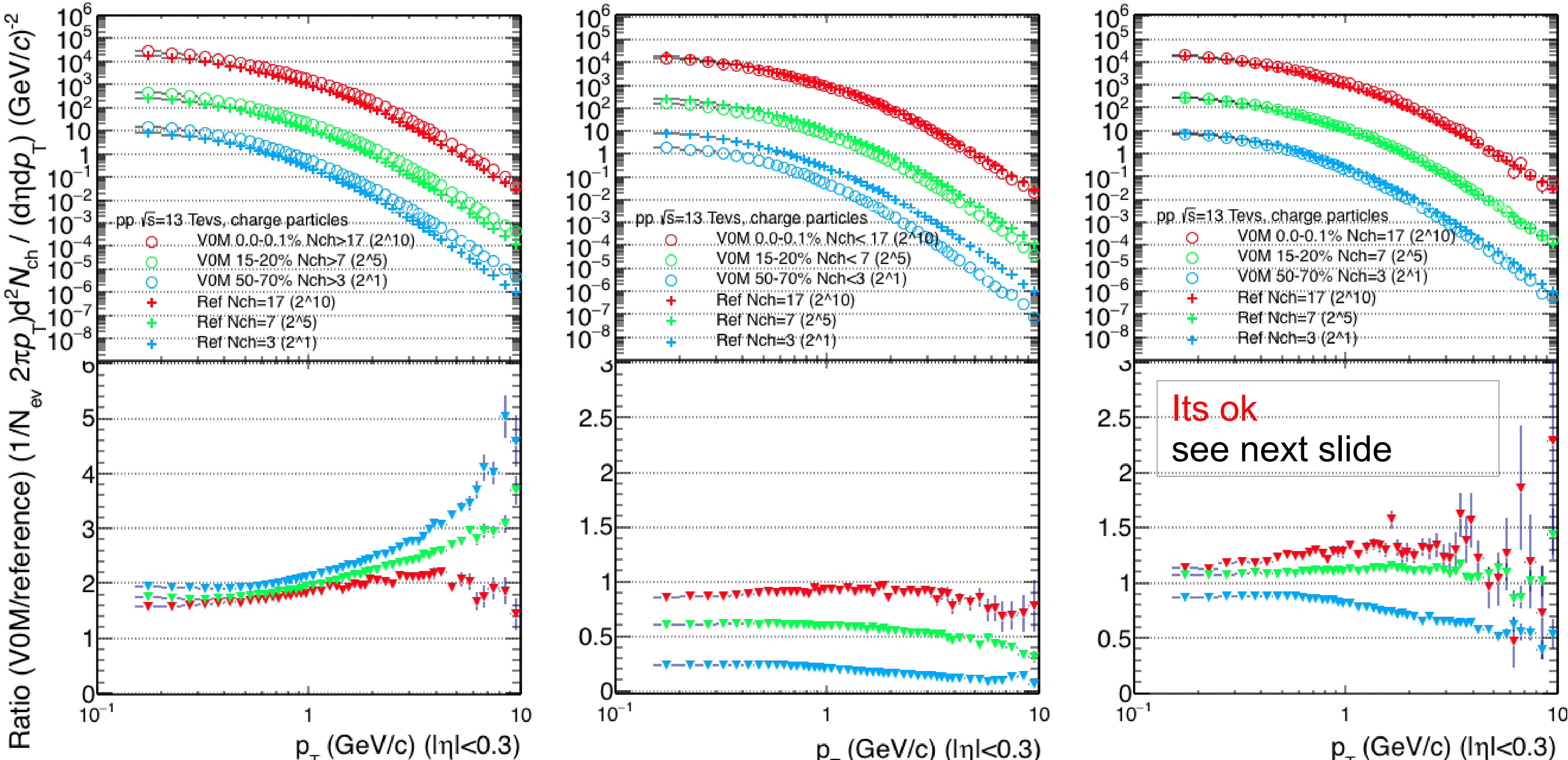


To check the contribution to the ratio,

A crosscheck in number of events has been taken into account

Comparing with V0M mult for Nch: greater, lower and equal to <dN/deta>

With All PU rejection cuts



To check the contribution to the ratio,

A crosscheck in number of events has been taken into account

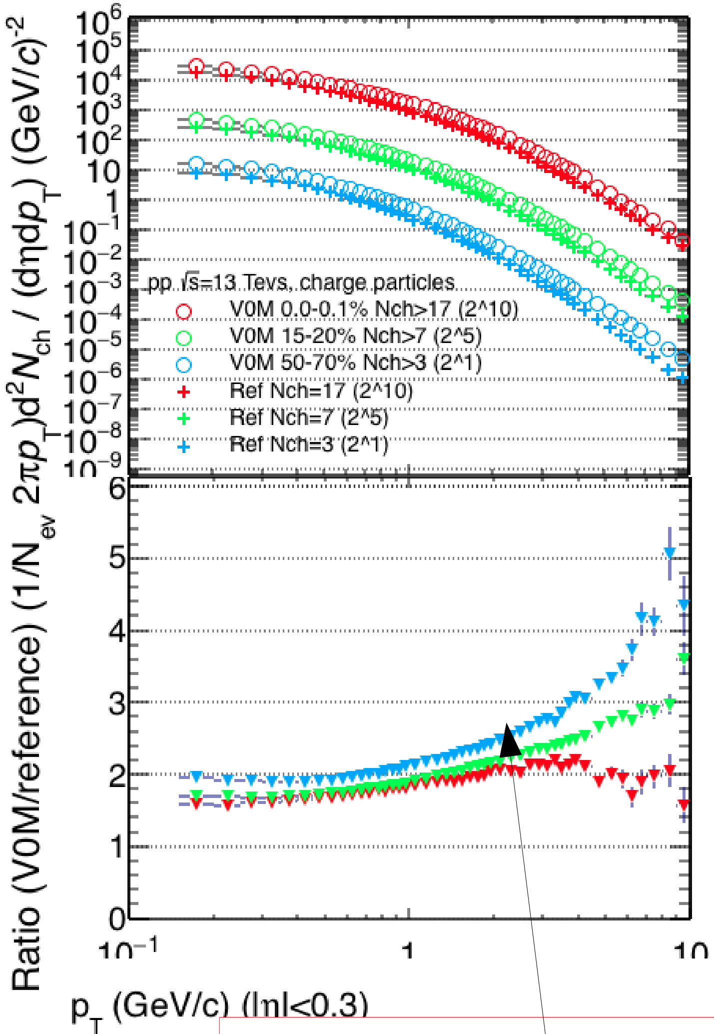
Why V0M mult for Nch equal to <dN/deta> gives ratio different to one:

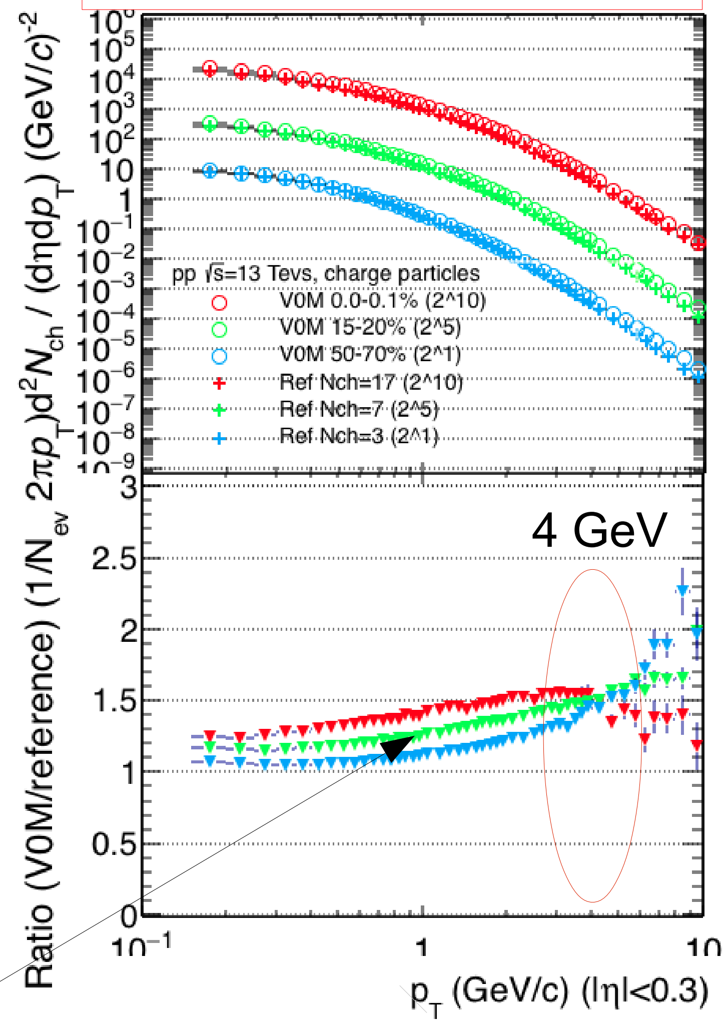
```
No necesariamente el ratio debe ser 1 ej

Caso 1 evento mult 17 pero ratio REF/V0M no es 1.

            N=17                N=17
              .                   .
ent_v0M |     .         ent_ref |     .
        |                       |       .
        |___._> pt              |_____._>pt

                                          REF/v0M     Plot
17 trazas-> ej  9 pt=0.5      9 pt=0.5      1        1_|_.______
                6 pt=1        4 pt =1      4/6=0.66    |   .          Caso linea azul
                5 pt=2        3 pt =2      3/5=0.6     |     .
                0 pt=3        1 pt=3       0           |____.___

17 trazas-> ej  7 pt=0.5      7 pt=0.5     7/7=1       |      .
                5 pt=1        6 pt =1      6/5=1.2     |  .
                2 pt=2        3 pt =2      3/2=1.5   1_|_.______            caso linea roja
                3 pt=3        1 pt=3       1/3=0.33    |______.__

(1/2pipT_i)(1/Nev_ncref)  (dN/detadpTi)=(1/Nev_ncref)  (dN_entv0M)    Ratio=(1/1)(dN_entv0M)/(dN_entref)
(1/2pipT_i)(1/Nev_ncv0m)(dN/detadpTi)=(1/Nev_ncv0m)(dN_entref)
```

Comparing with V0M mult for Nch: greater,

With BG rejection

V0MNch vs REF$_{|eta|<0.3}$



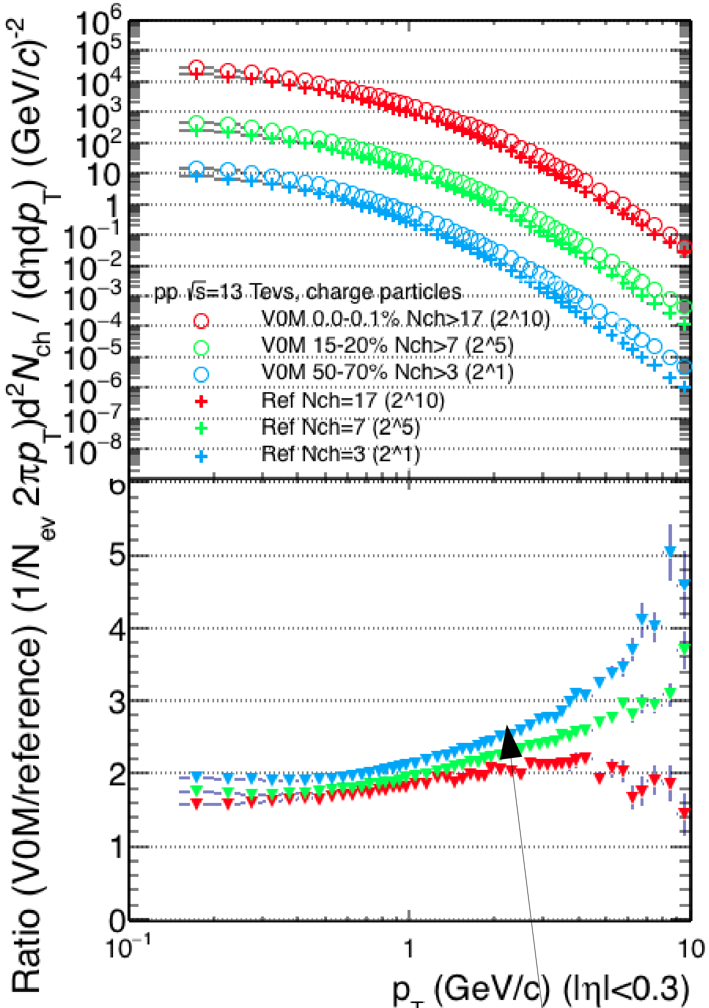


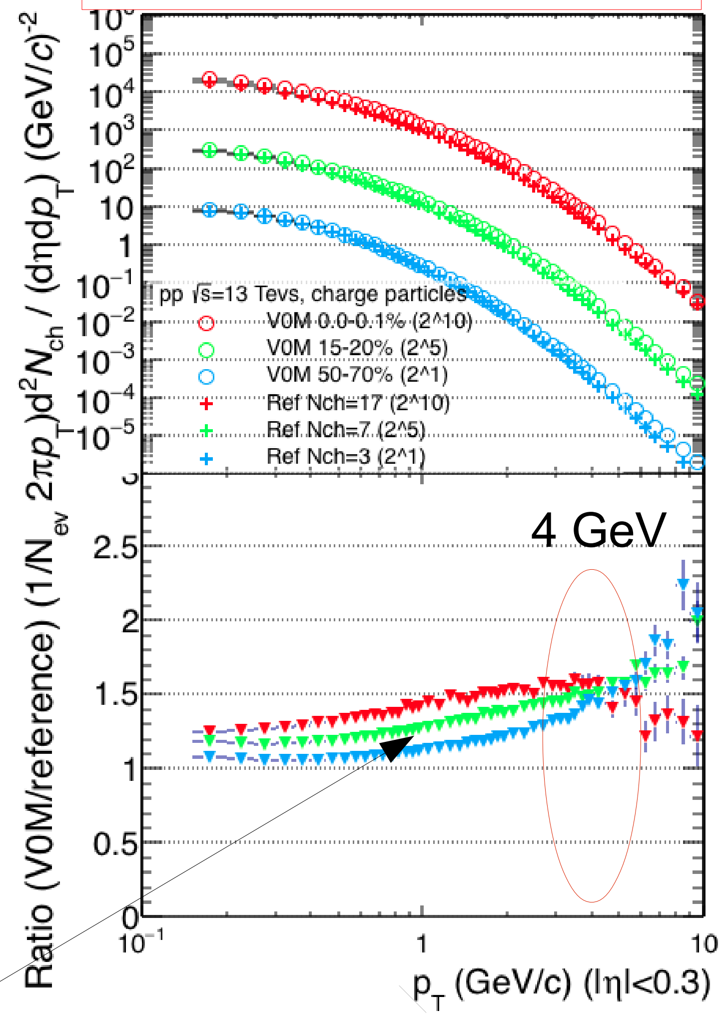
To check the contribution to the ratio, we see the contribution comes from V0MNch > <dN/deta>$_{|eta|<0.3}$

Comparing with V0M mult for Nch: greater,

With BG rejection

V0MNch vs REF|eta|<0.3





To check the contribution to the ratio, we see the contribution comes from V0MNch > <dN/deta>|eta|<0.3

Summary

- Different PU rejection cuts were applied.
- After the analysis, the contribution to have greater spectra for V0M than for Reference seems due to the spectra for wich Nch in V0M is greater than <dN/deta>$_{|eta|<0.3}$
- After all the PU rejection cuts, I see at P_T near 4 GeV the same increase in the ratio V0M to REF for each V0M multiplicity class.

To be done

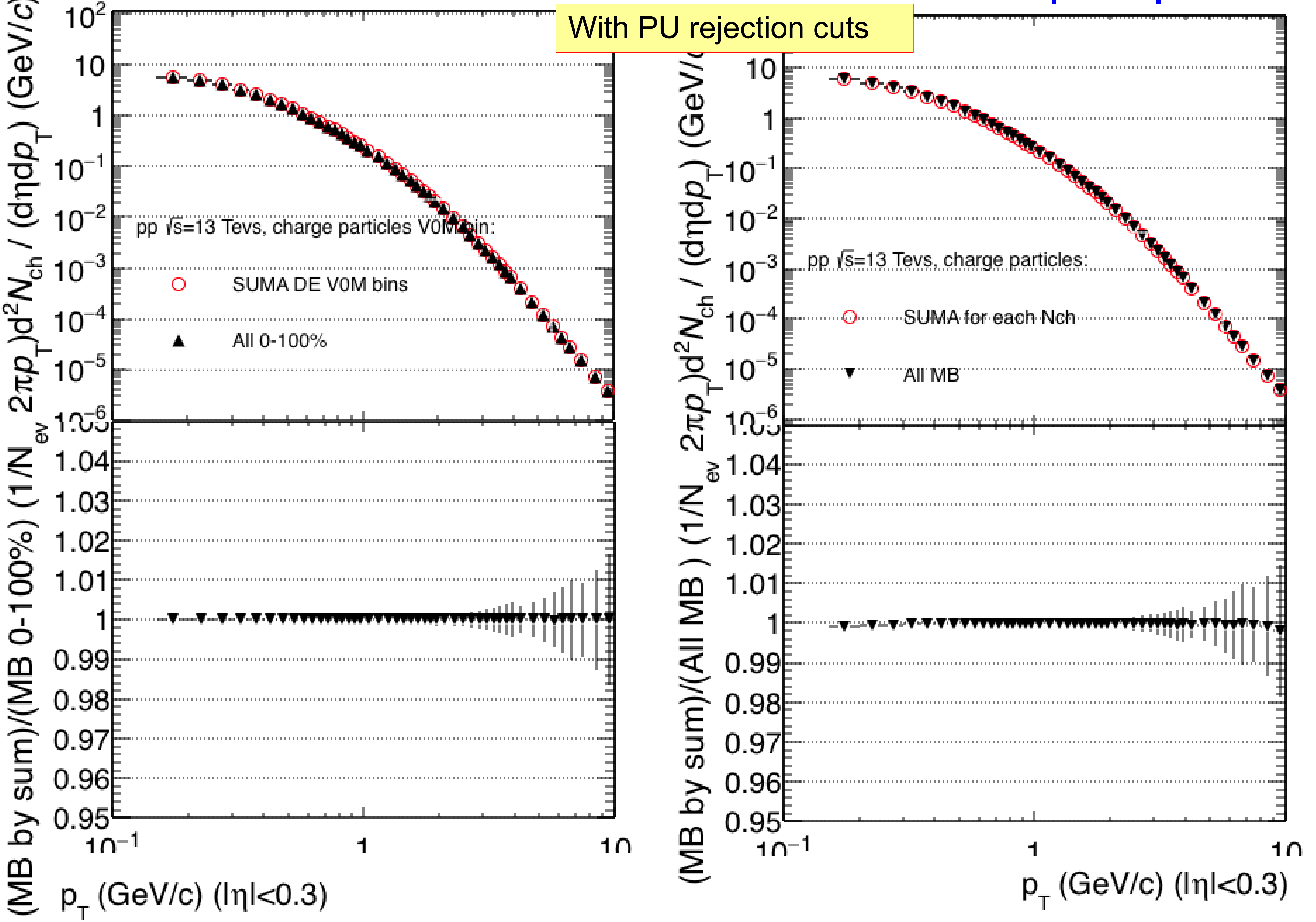
- To see the effect in MC pythia
- Continue with So analysis

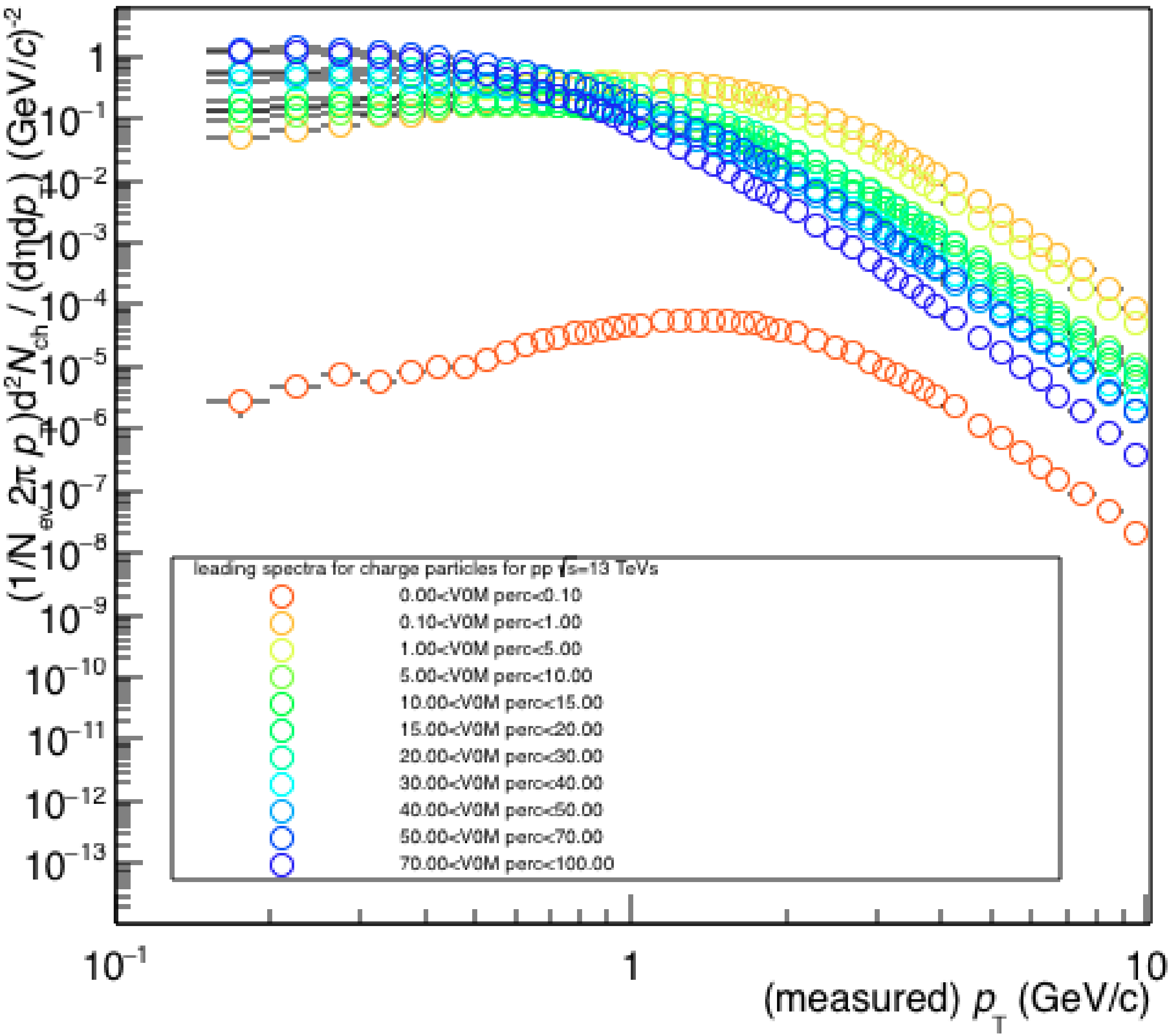
Thank you!.

Back Up

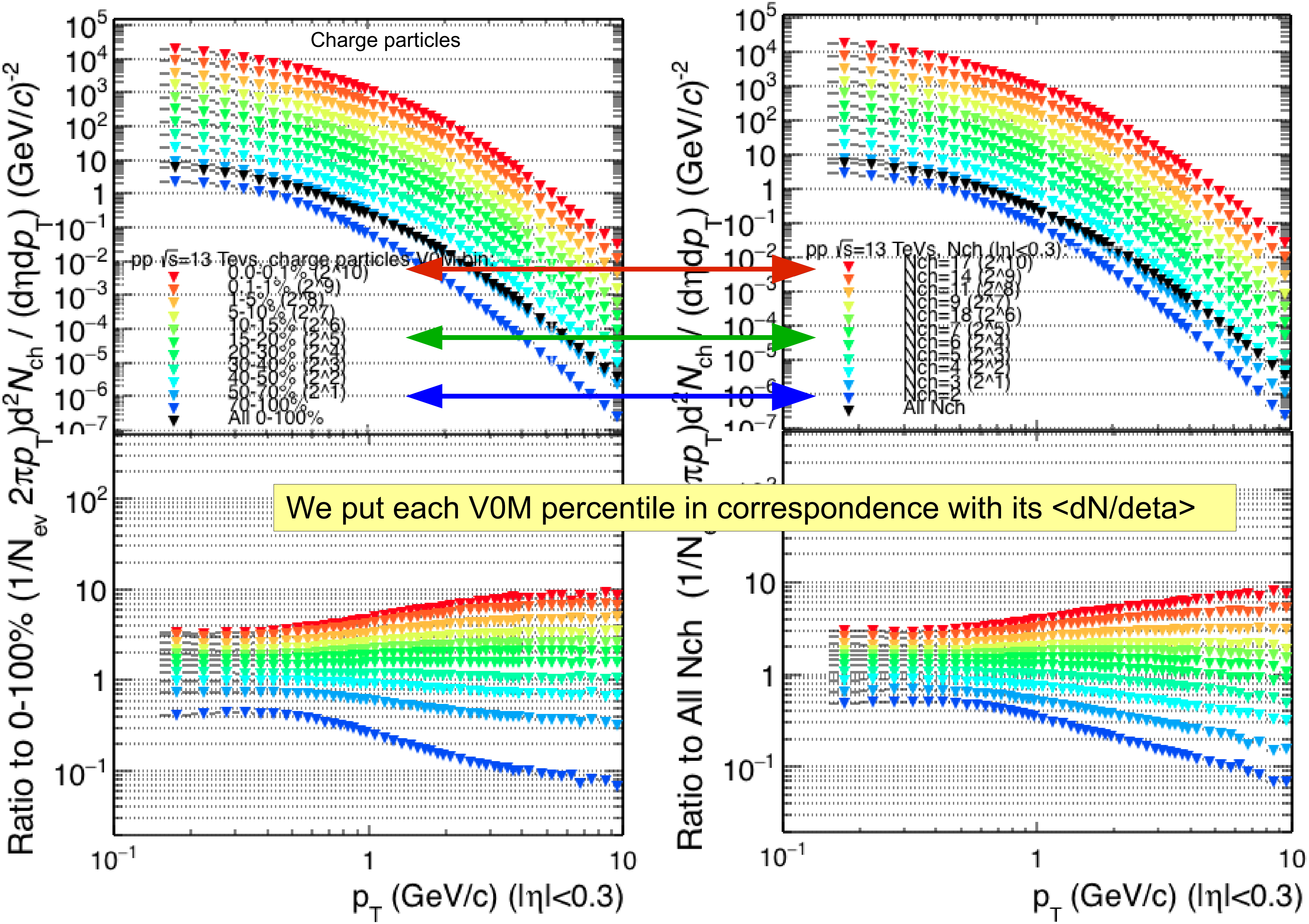
Min Bias cross checks for V0M and Ref |eta| <0.3

With PU rejection cuts



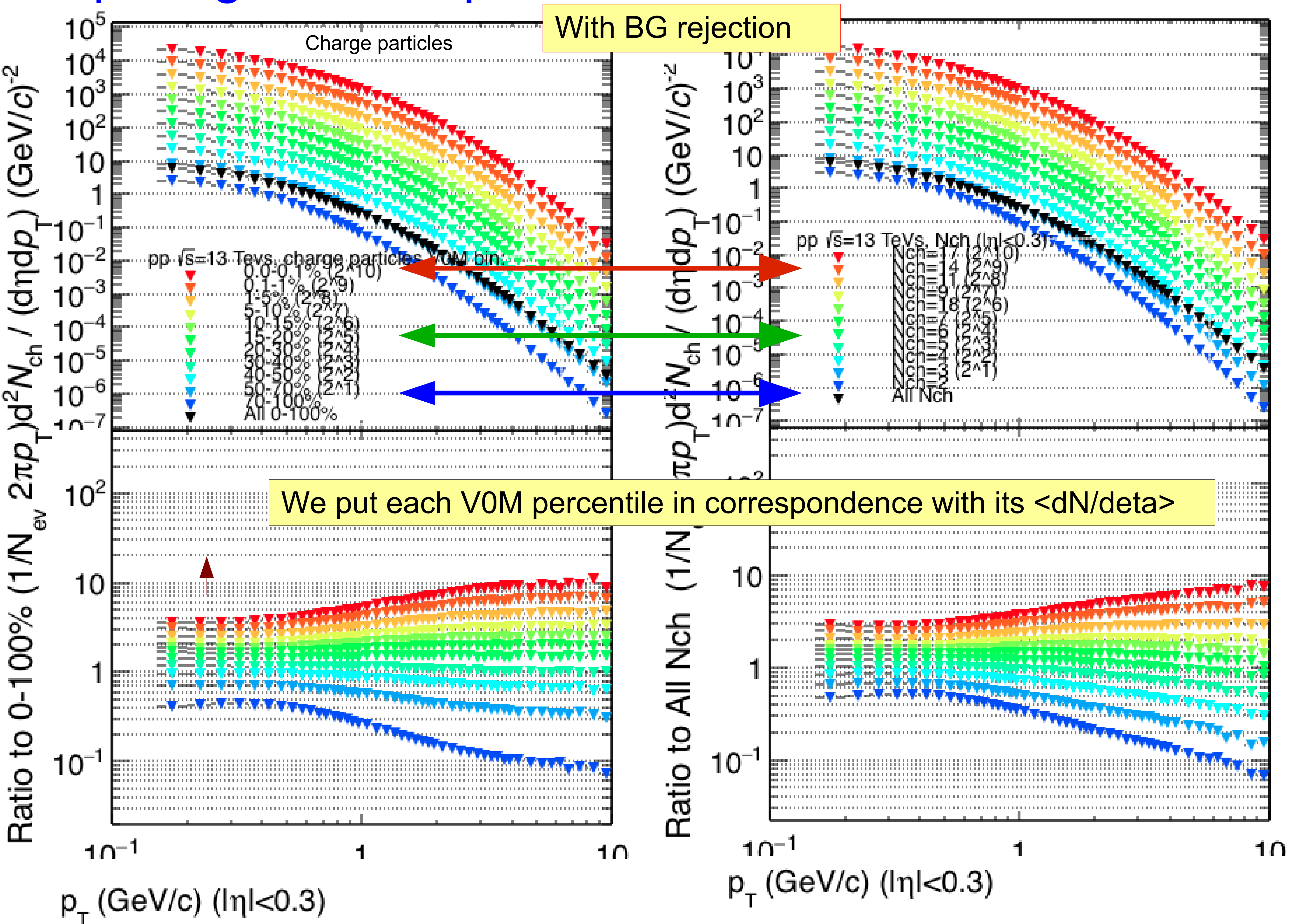

leading spectra for charge particles for pp √s=13 TeVs
0.00<V0M perc<0.10
0.10<V0M perc<1.00
1.00<V0M perc<5.00
5.00<V0M perc<10.00
10.00<V0M perc<15.00
15.00<V0M perc<20.00
20.00<V0M perc<30.00
30.00<V0M perc<40.00
40.00<V0M perc<50.00
50.00<V0M perc<70.00
70.00<V0M perc<100.00
(measured) p_T (GeV/c)
$(1/N_{ev}2\pi p_T)d^2N_{ch}/(d\eta dp_T)$ (GeV/c)$^{-2}$

Comparing for V0M percentils and N_{ch} for its <dN/deta>



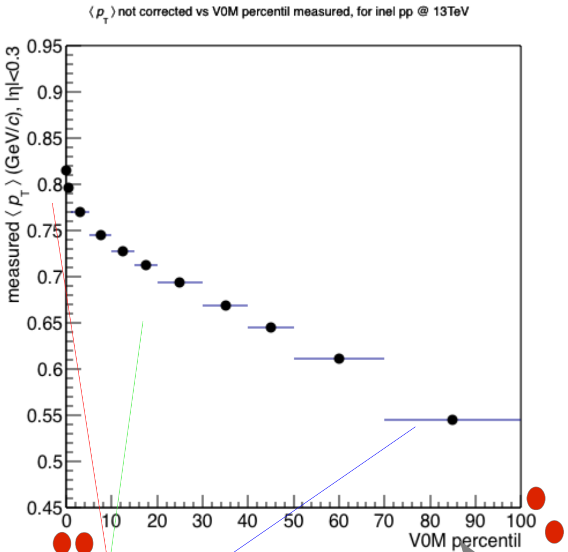
We put each V0M percentile in correspondence with its <dN/deta>

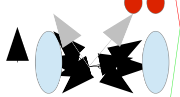
Comparing for V0M percentils and N_{ch} for its <dN/deta>



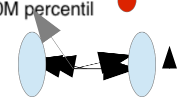
Mean P_T from V0M percentils to $<dN/deta>_{|eta|<0.3}$

Without efficiency corrections

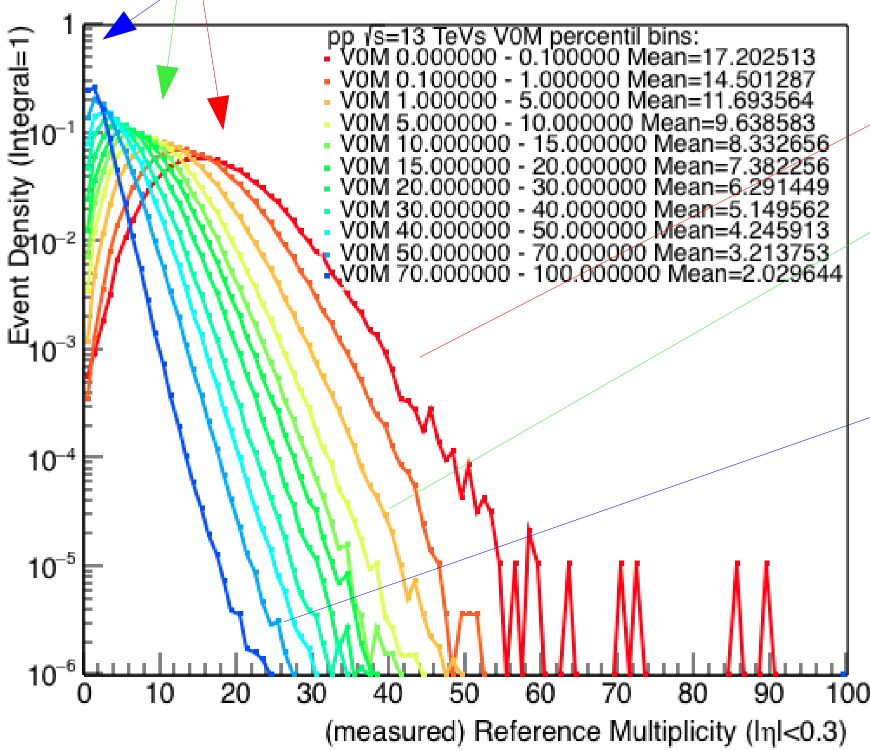


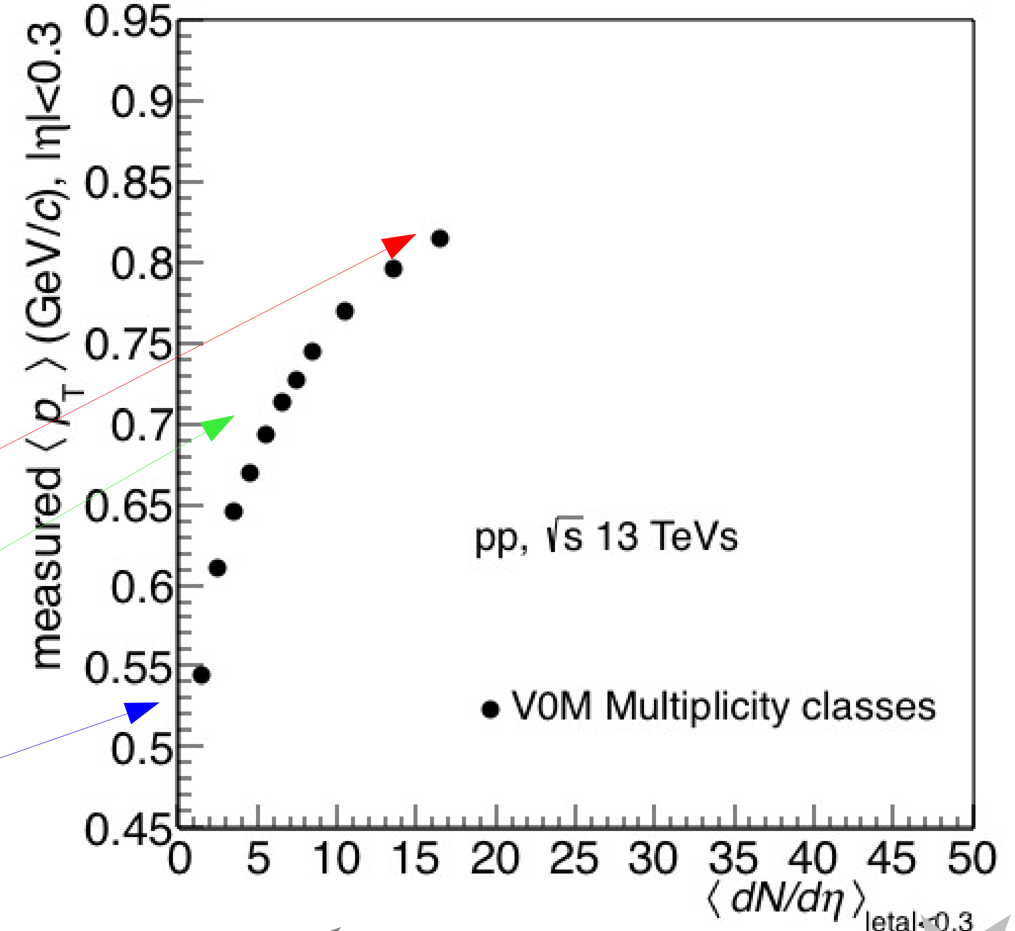


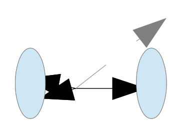
High P_T

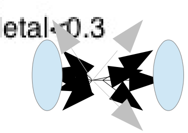


Low P_T



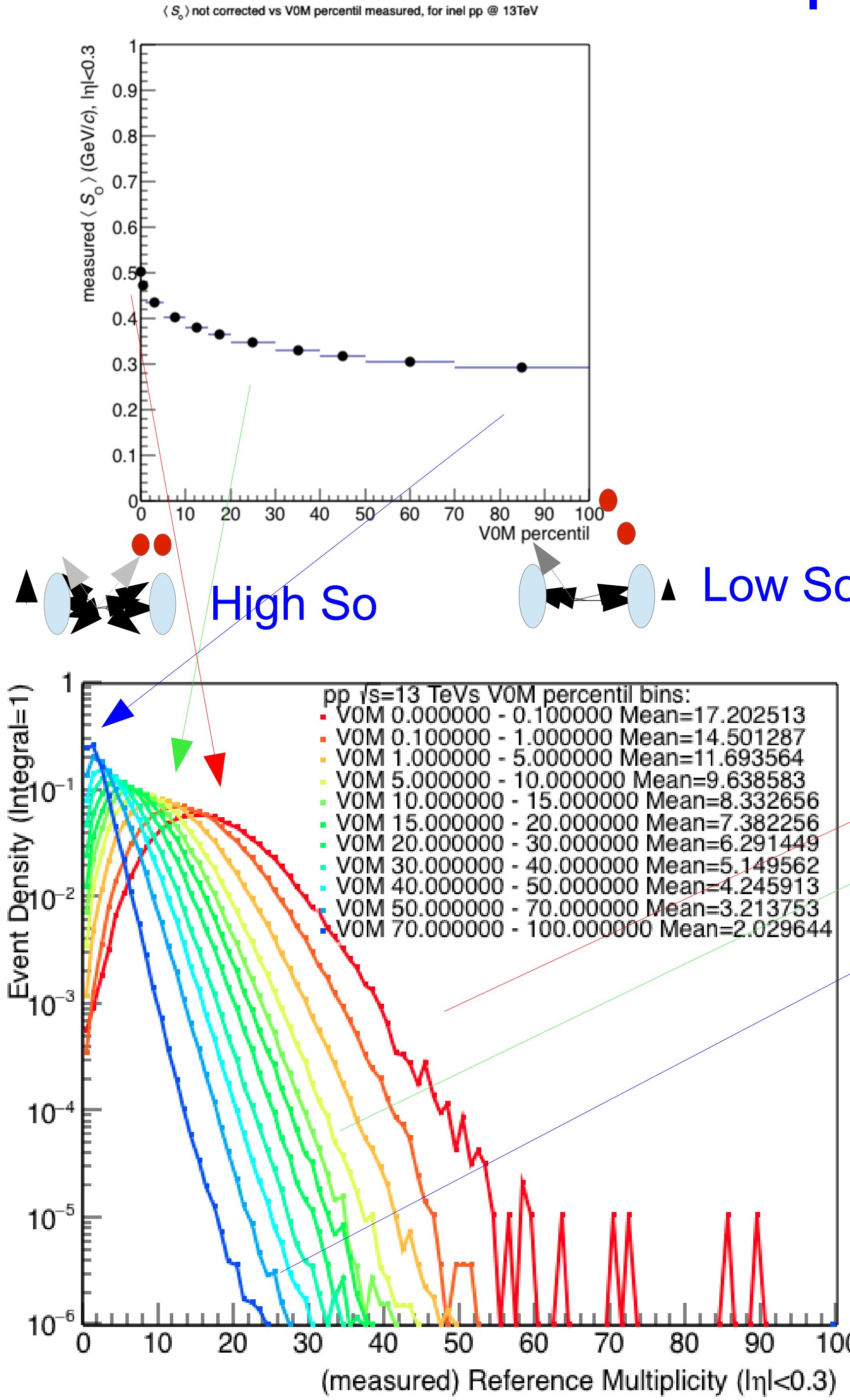


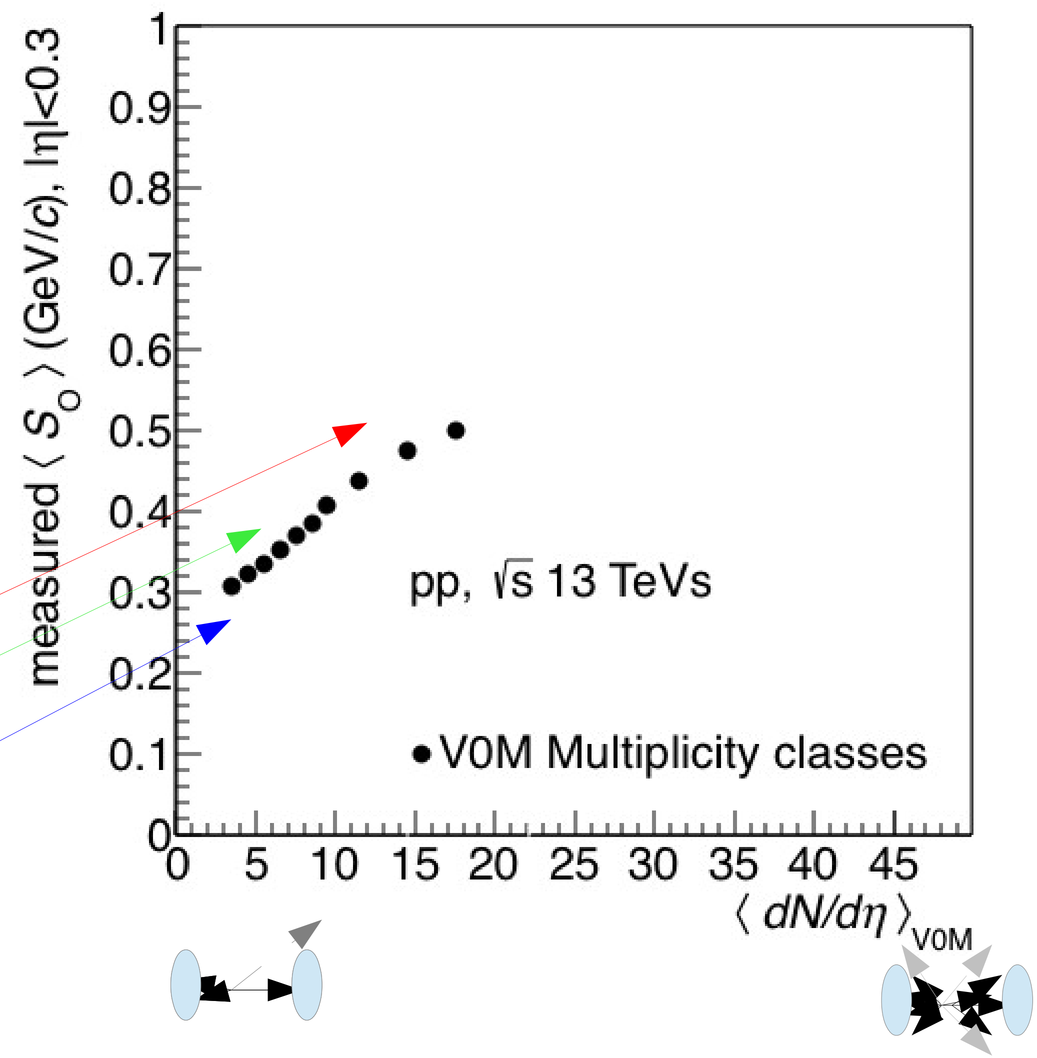




Mean So from V0M percentils to <dN/deta>$_{|eta|<0.3}$

Without efficiency corrections

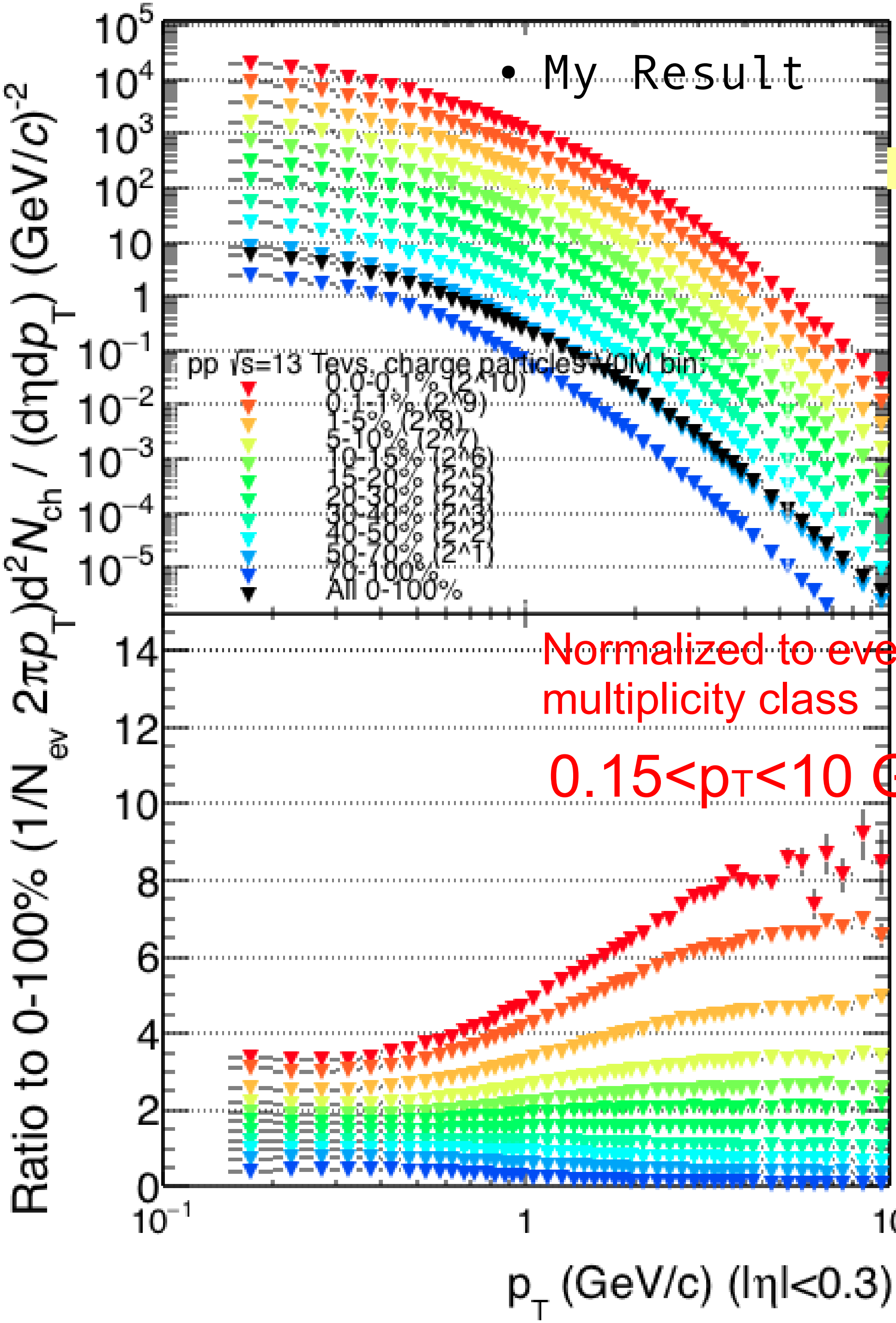




Invariant Yield for V0M percentils

- LHC15f (pass2)

- My Result

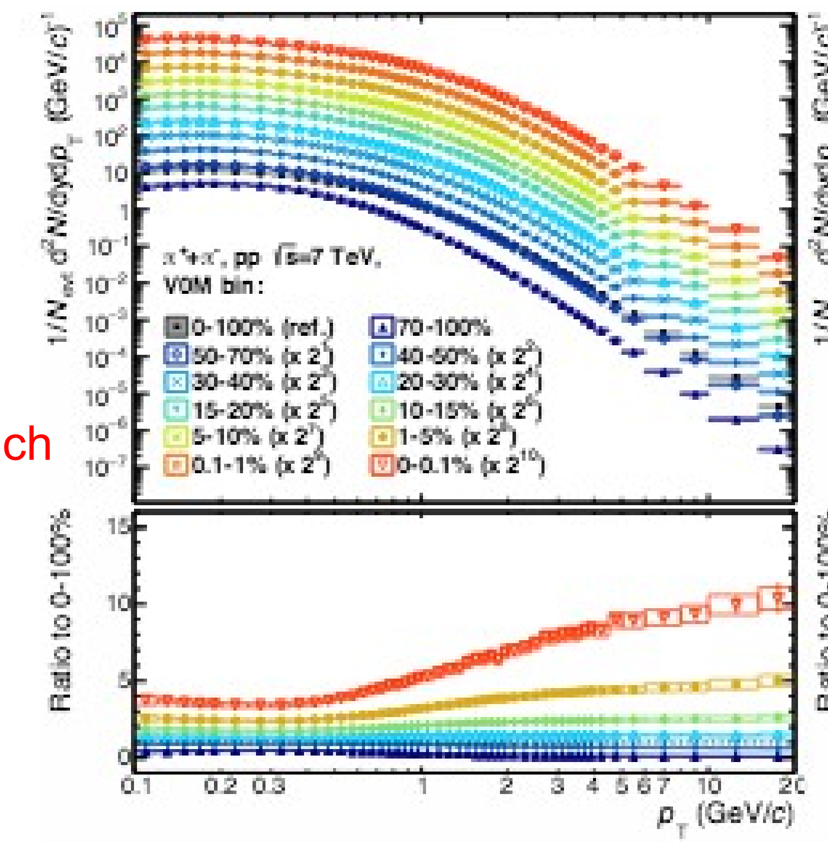


Normalized to events of each multiplicity class

$0.15<p_T<10$ GeV/c

- Vytautas et all Analysis Note

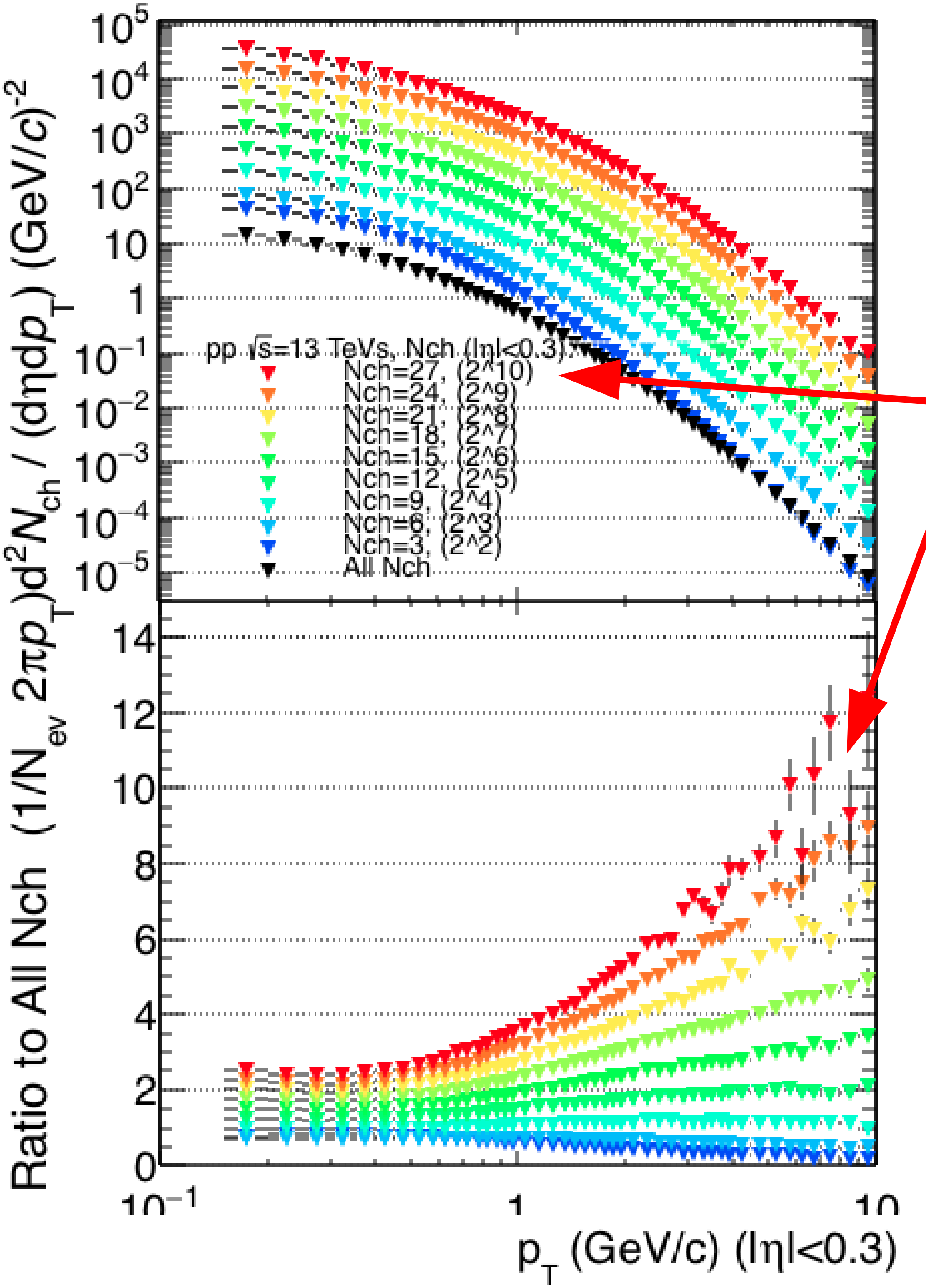
https://aliceinfo.cern.ch/Notes/sites/aliceinfo.cern.ch.Notes/files/notes/analysis/akalweit/2015-Sep-15-analysis_note-A



no $(1/2\pi^* p_T)$ normalization

$0.15<p_T<20$ GeV/c

Invariant Yield for Reference multiplicity estimator

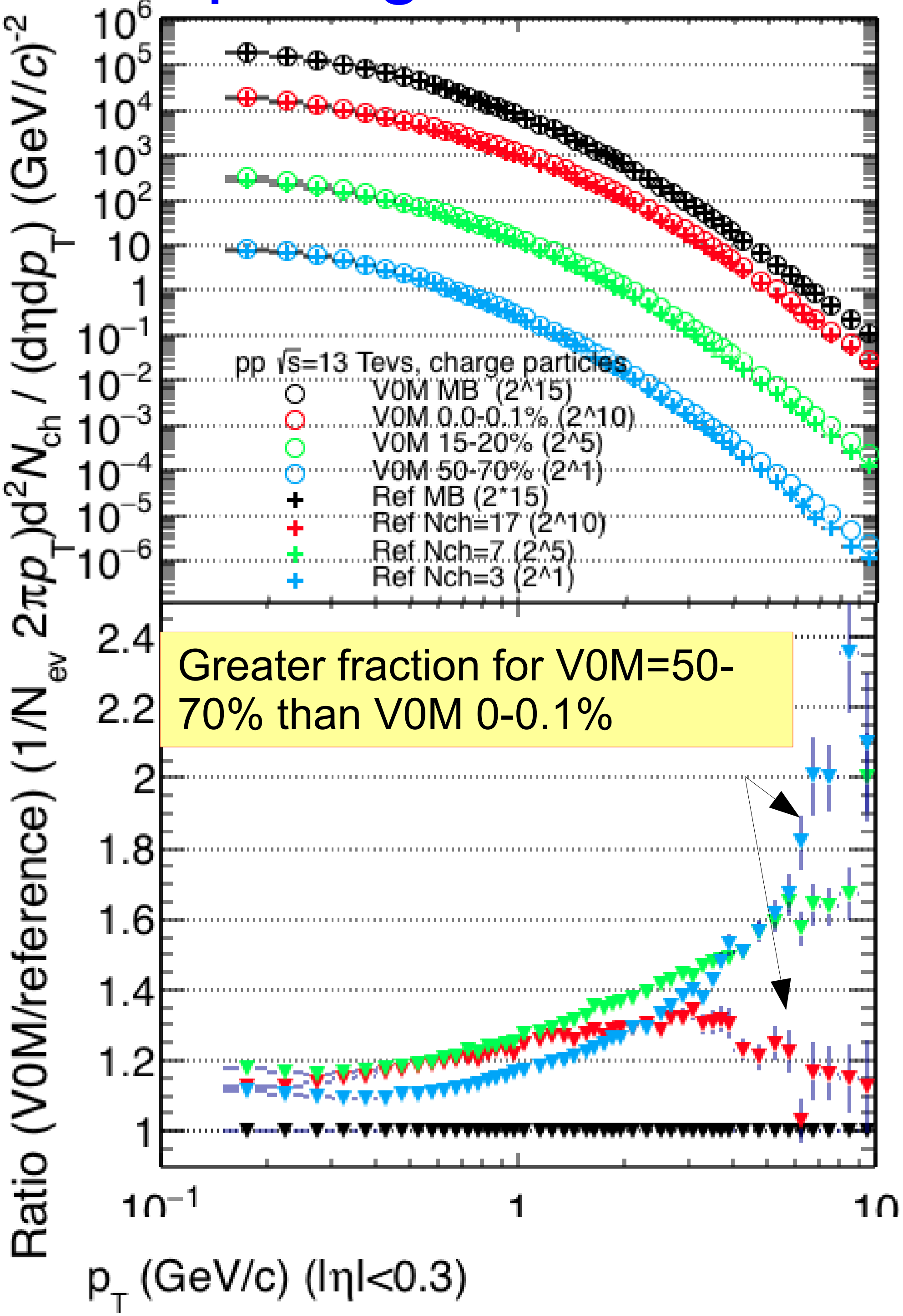


We reach Nch=27

We want to check the spectra behaviour when we take Nch= <dN/deta>$_{|eta|<0.3}$ For each V0M multiplicity class.

See next slide.

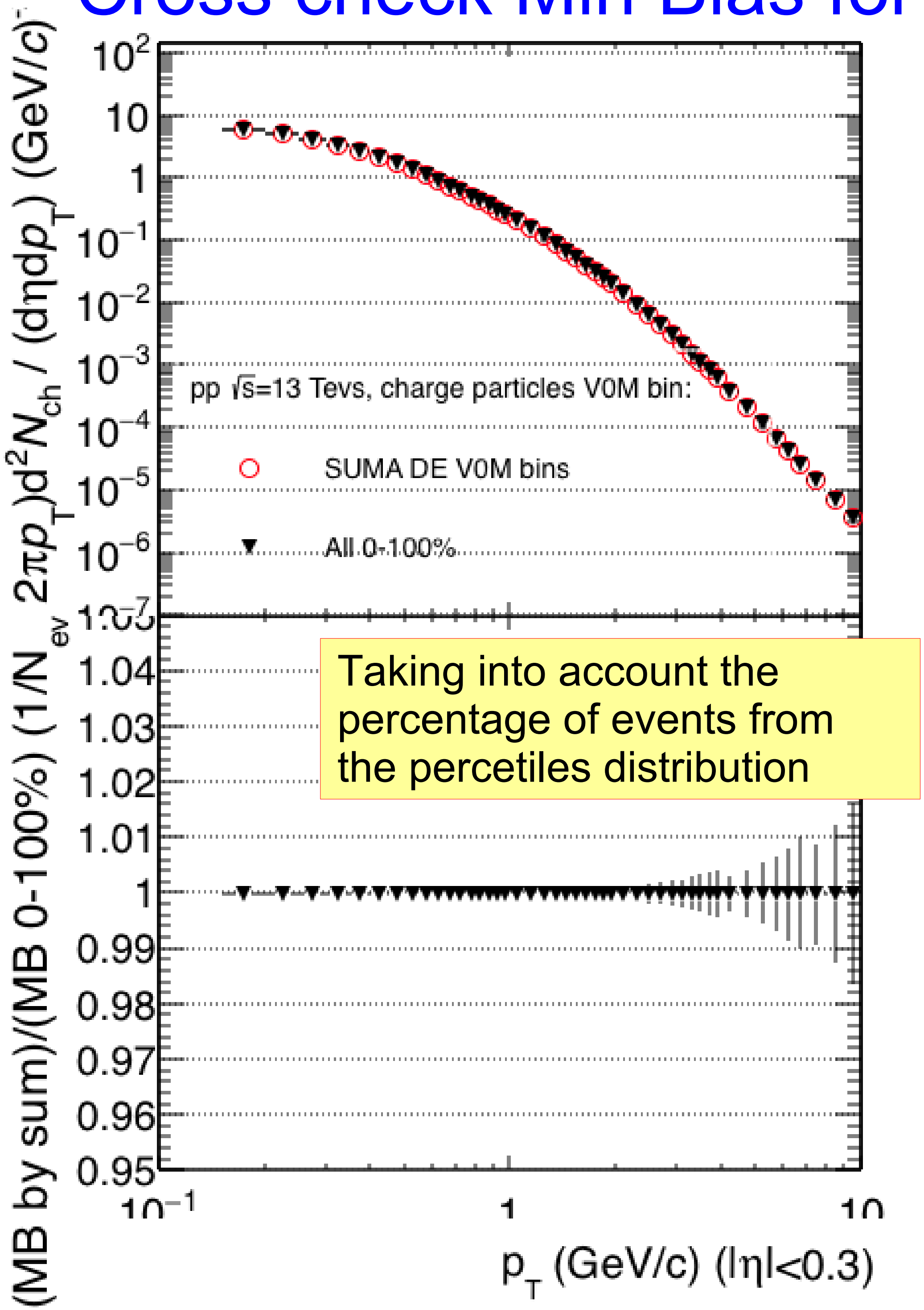
Comparing estimators V0M and Ref | eta| <0.3

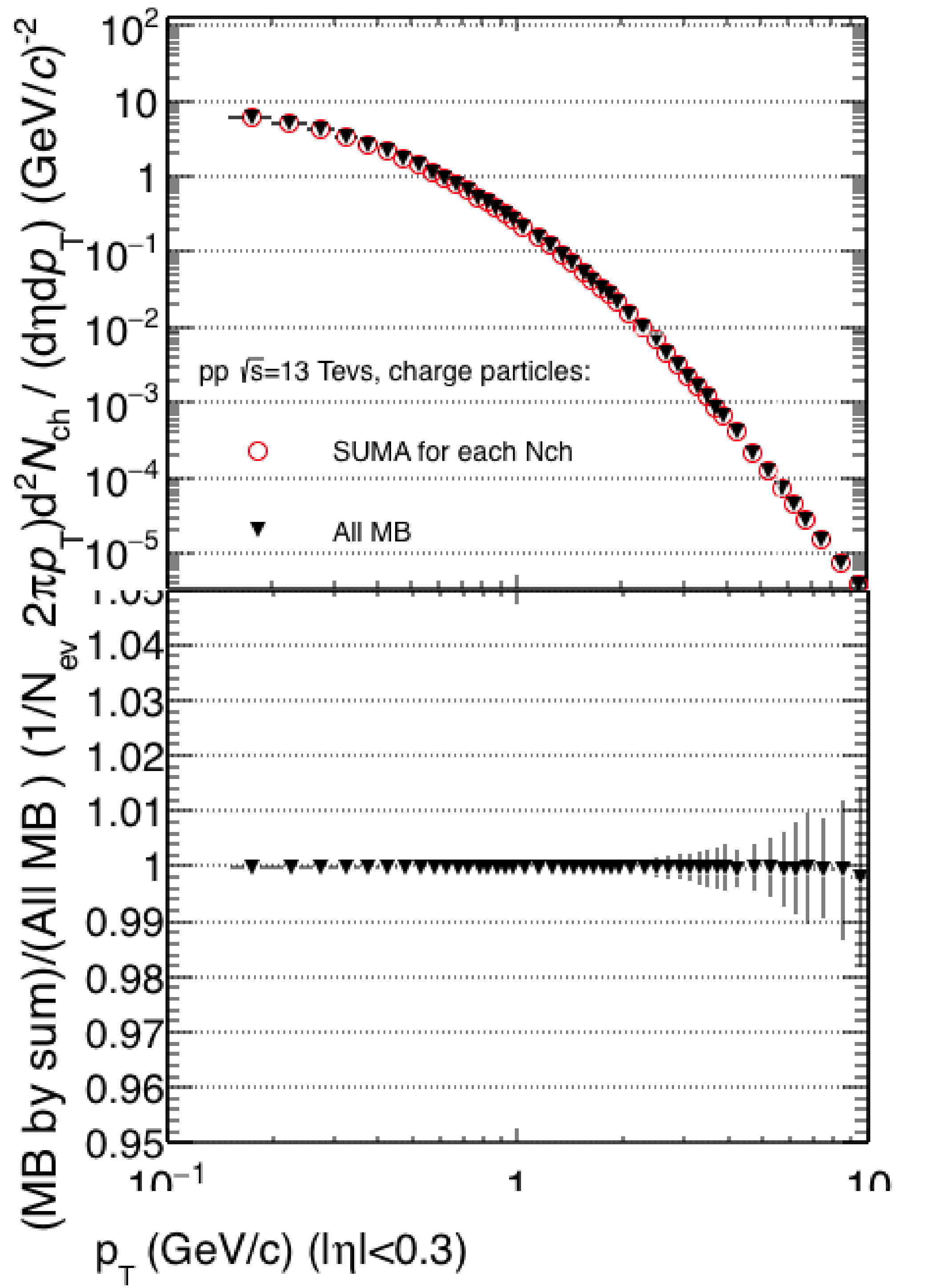


To check the compatibility of my program and the information given by the spectra we make another crosscheck.

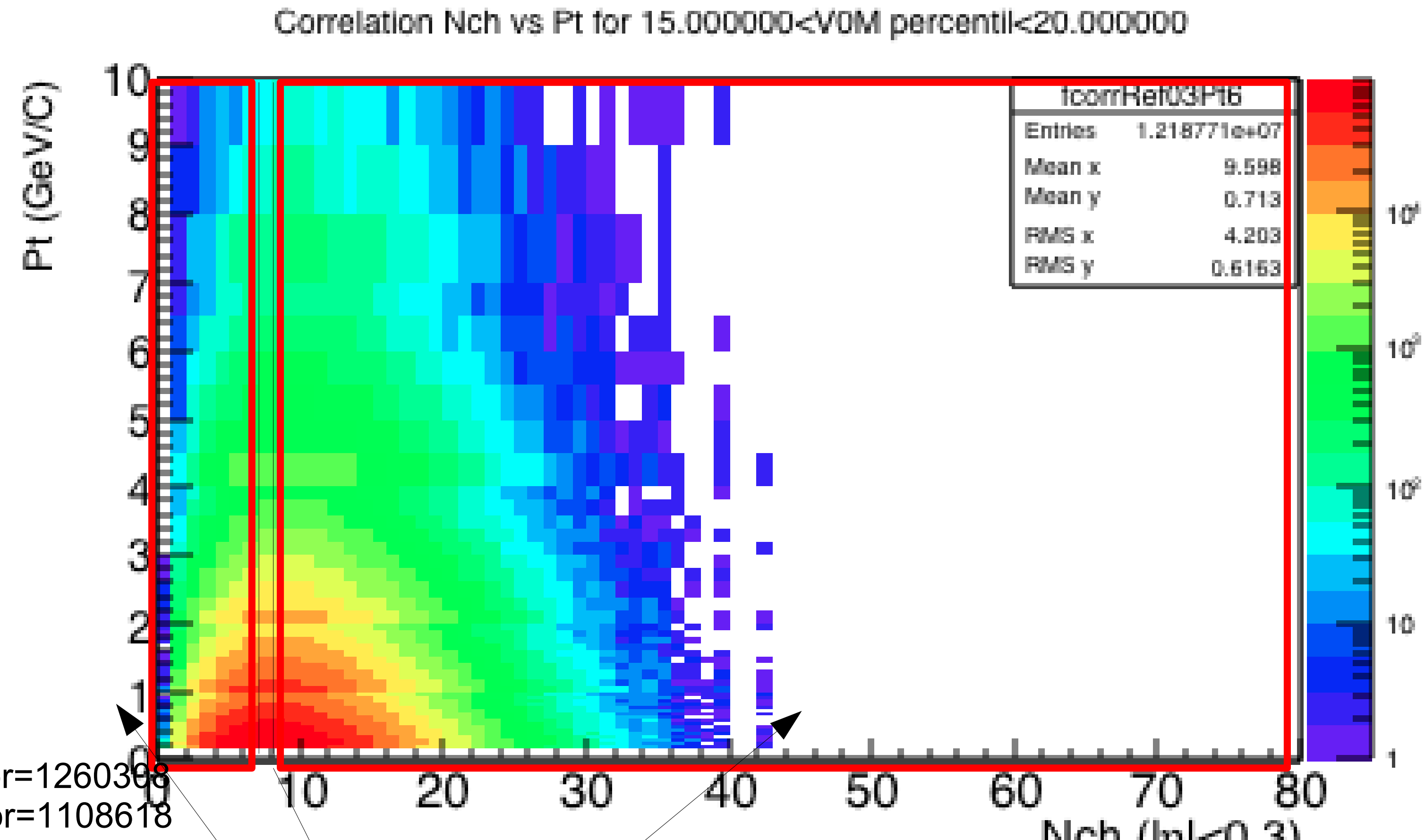
I take the spectra and calculate $<p_T>$

Cross check Min Bias for V0M and Reference





Correlation pt vs <dN/deta> |eta|<0.3

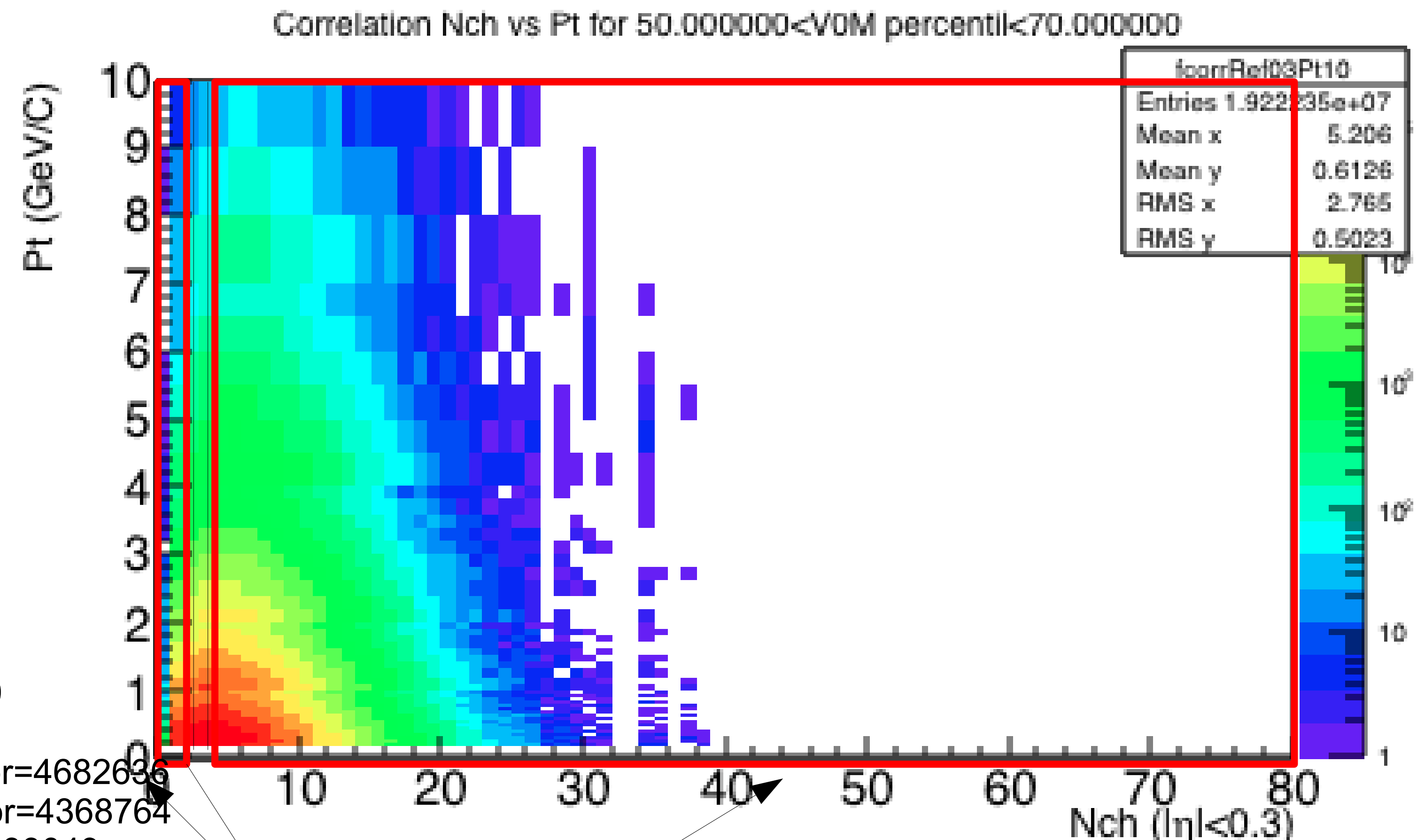


Nev=2648044

Nev para mayor=1260308
Nev para menor=1108618
Nev para ig=279118
Suma=2648044

In order to get pt distributions for:
Nch in V0M> <dN/deta>$_{|eta|<0.3}$=7
Nch in V0M< <dN/deta>$_{|eta|<0.3}$=7
Nch in V0M= <dN/deta>$_{|eta|<0.3}$ =7

Correlation pt vs $\langle dN/deta\rangle_{|eta|<0.3}$



Nev=11084449

Nev para mayor=4682636
Nev para menor=4368764
Nev para ig=2033049
Suma=11084449

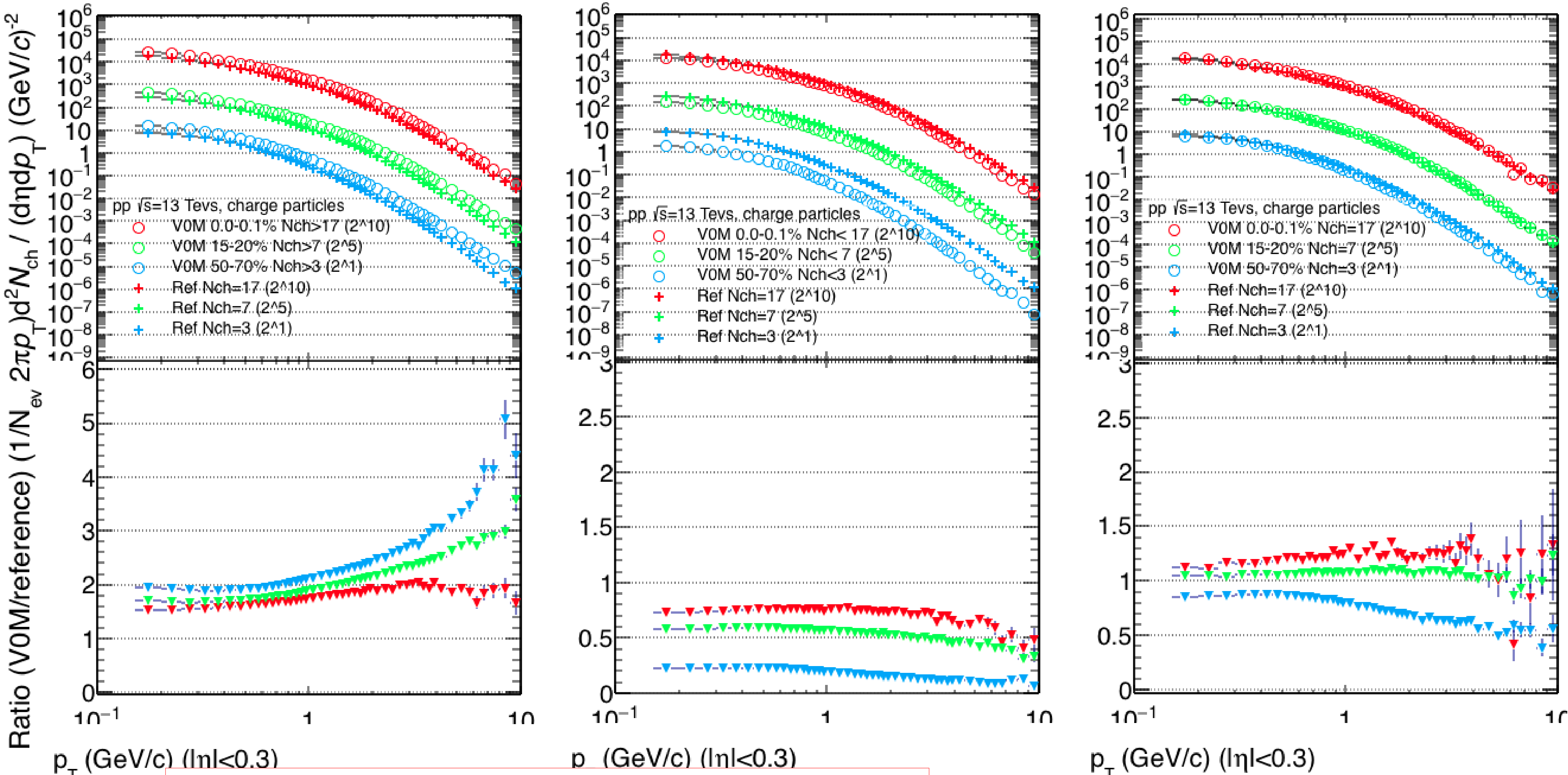
In order to get pt distributions for:

Nch in V0M> $\langle dN/deta\rangle_{|eta|<0.3}=3$

Nch in V0M< $\langle dN/deta\rangle_{|eta|<0.3}=3$

Nch in V0M= $\langle dN/deta\rangle_{|eta|<0.3}=3$

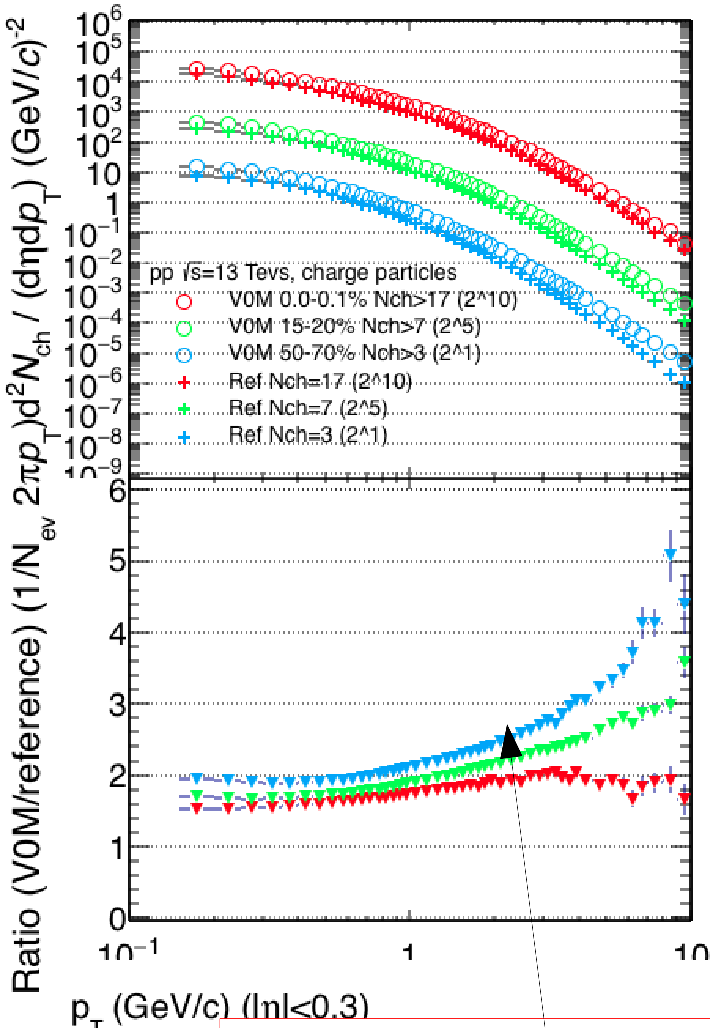
Comparing with V0M mult for Nch: greater, lower and equal to <dN/deta>



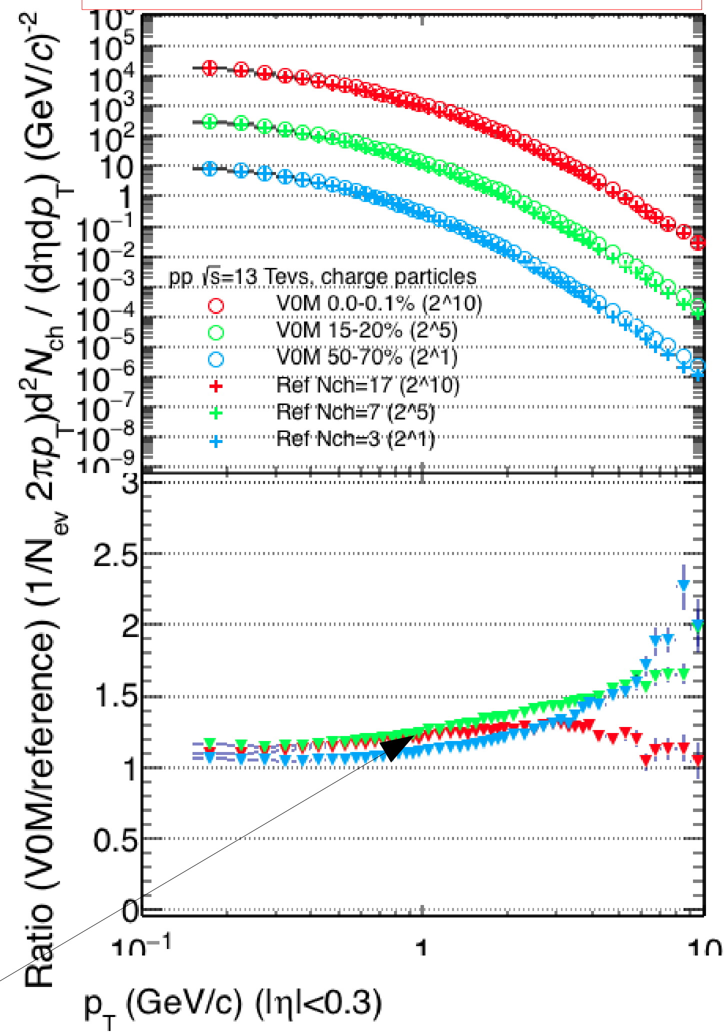
To check the contribution to the ratio,

A crosscheck in number of events has been taken into account

Comparing with V0M mult for Nch: greater,

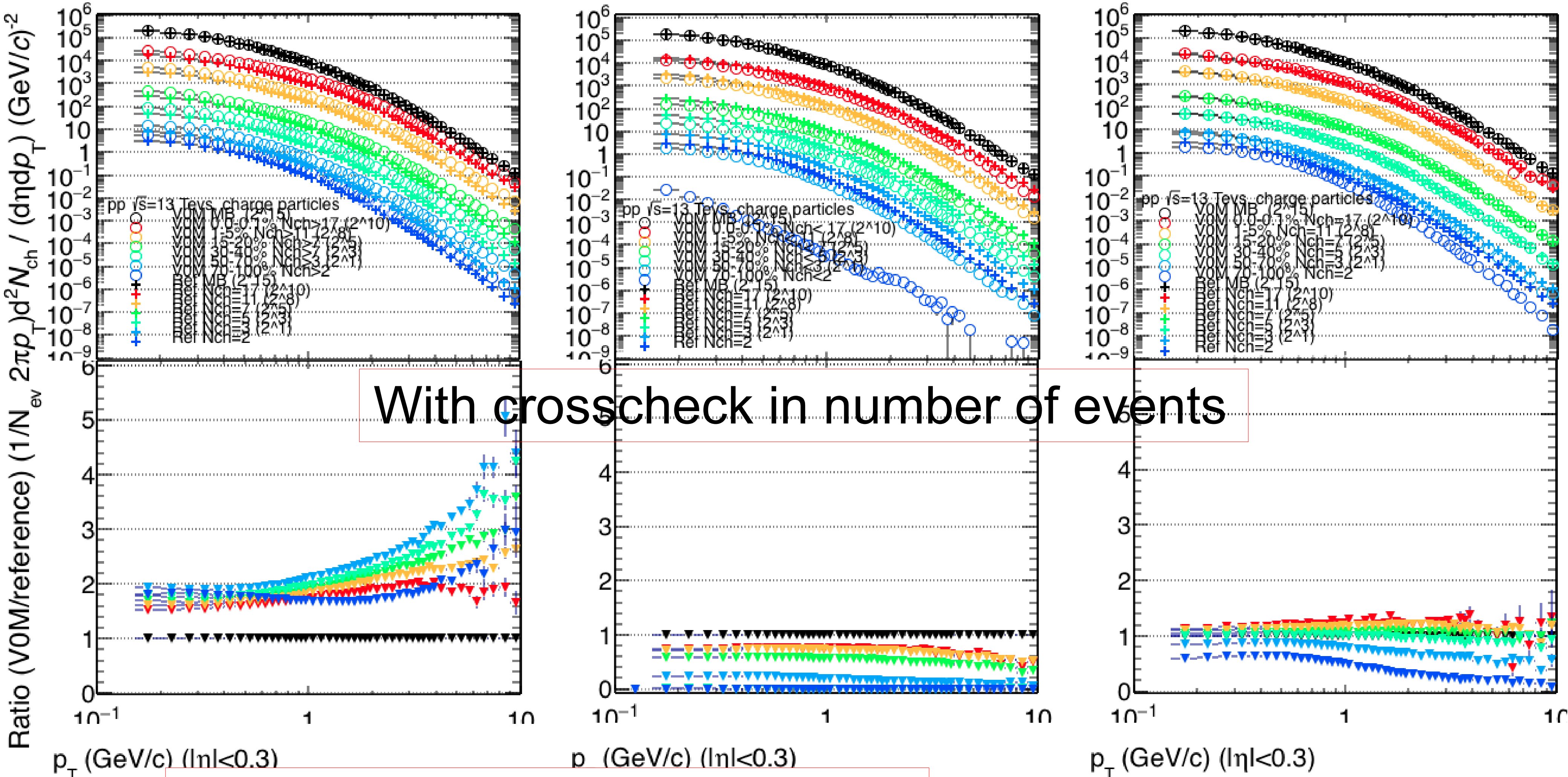


V0MNch vs REF|eta|<0.3



To check the contribution to the ratio, we see the contribution comes from V0MNch > <dN/deta>|eta|<0.3

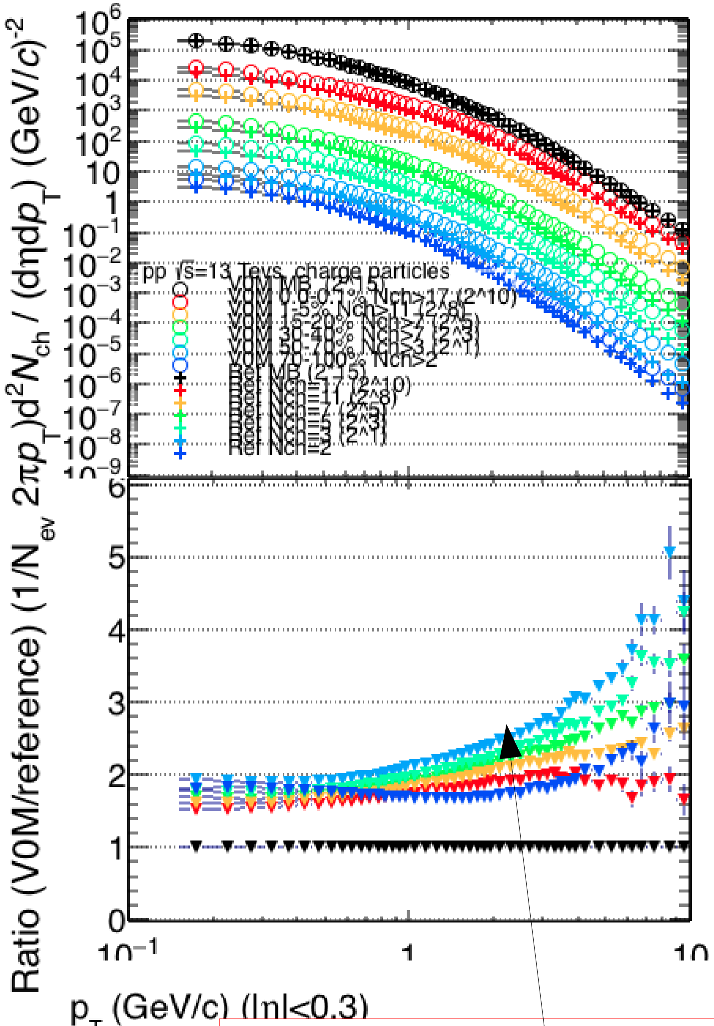
Comparing with V0M mult for Nch: Adding last V0M bin greater, lower and equal to <dN/deta>



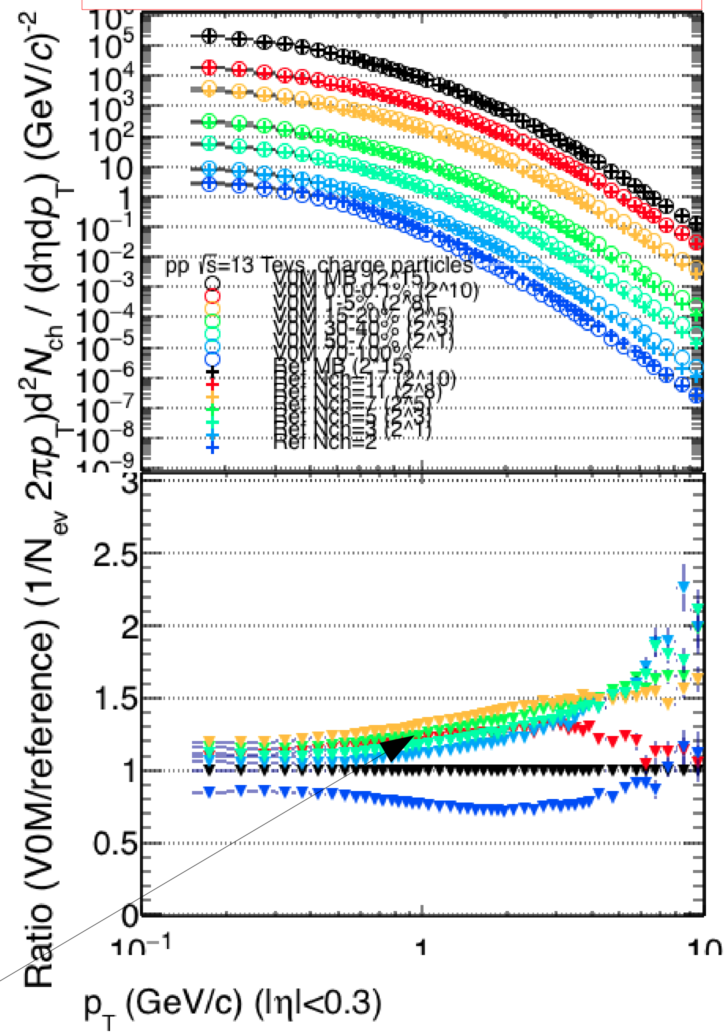
With crosscheck in number of events

To check the contribution to the ratio,

Comparing with V0M mult for Nch: greater,



V0MNch vs REF|eta|<0.3



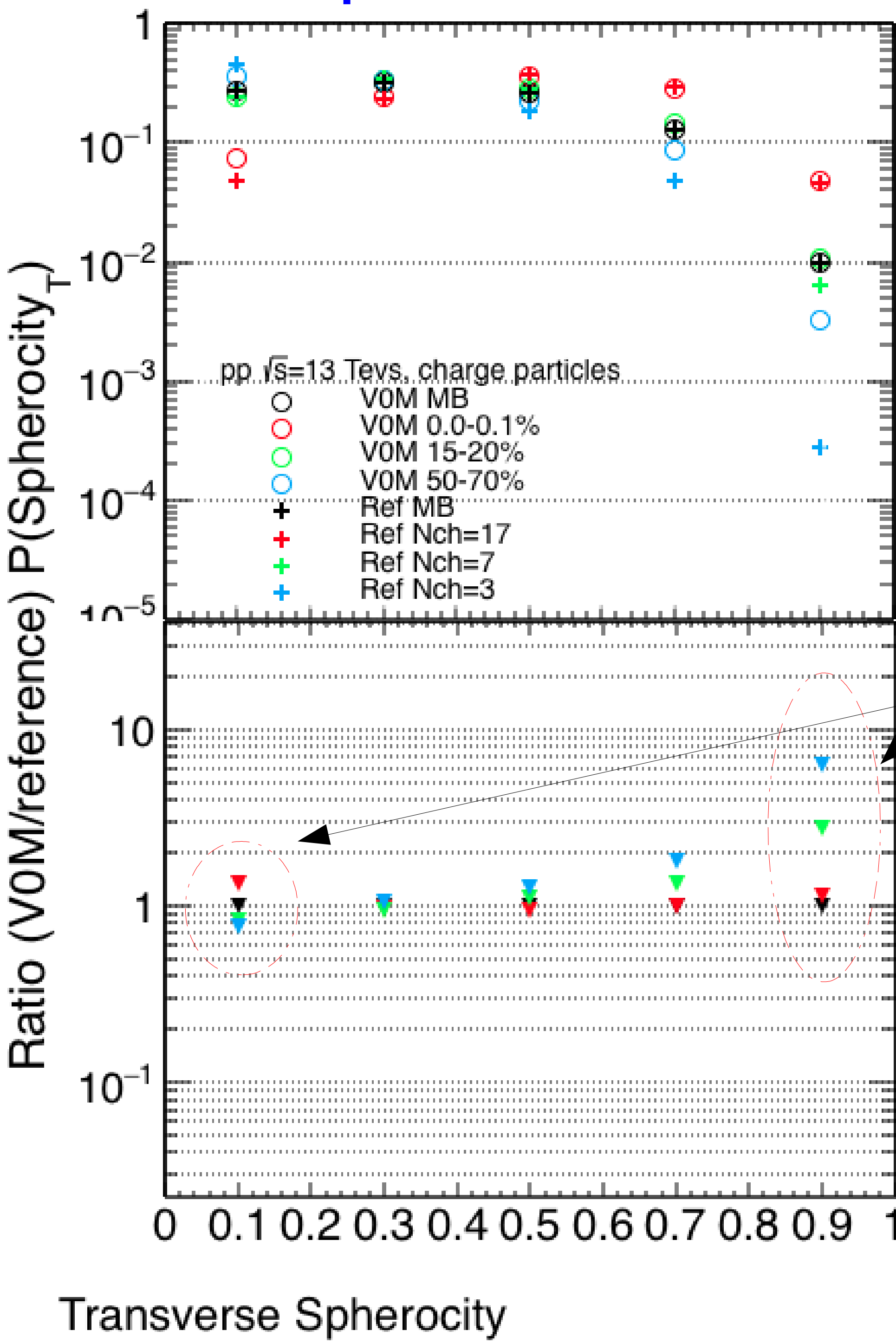
To check the contribution to the ratio, we see the contribution comes from V0MNch > <dN/deta>|eta|<0.3

First Conclusion

The results from V0M percentile and the corresponding to <d*N*/deta>|eta|<0.3 shows consistency in all the Crosschecks we made.

V0M gives greater $\langle p_T \rangle$ for intermediate Multiplicity Than the reference estimator, and start to converge for High N_{ch}.

First Comparison for So with estimators V0M and Ref |eta| <0.3

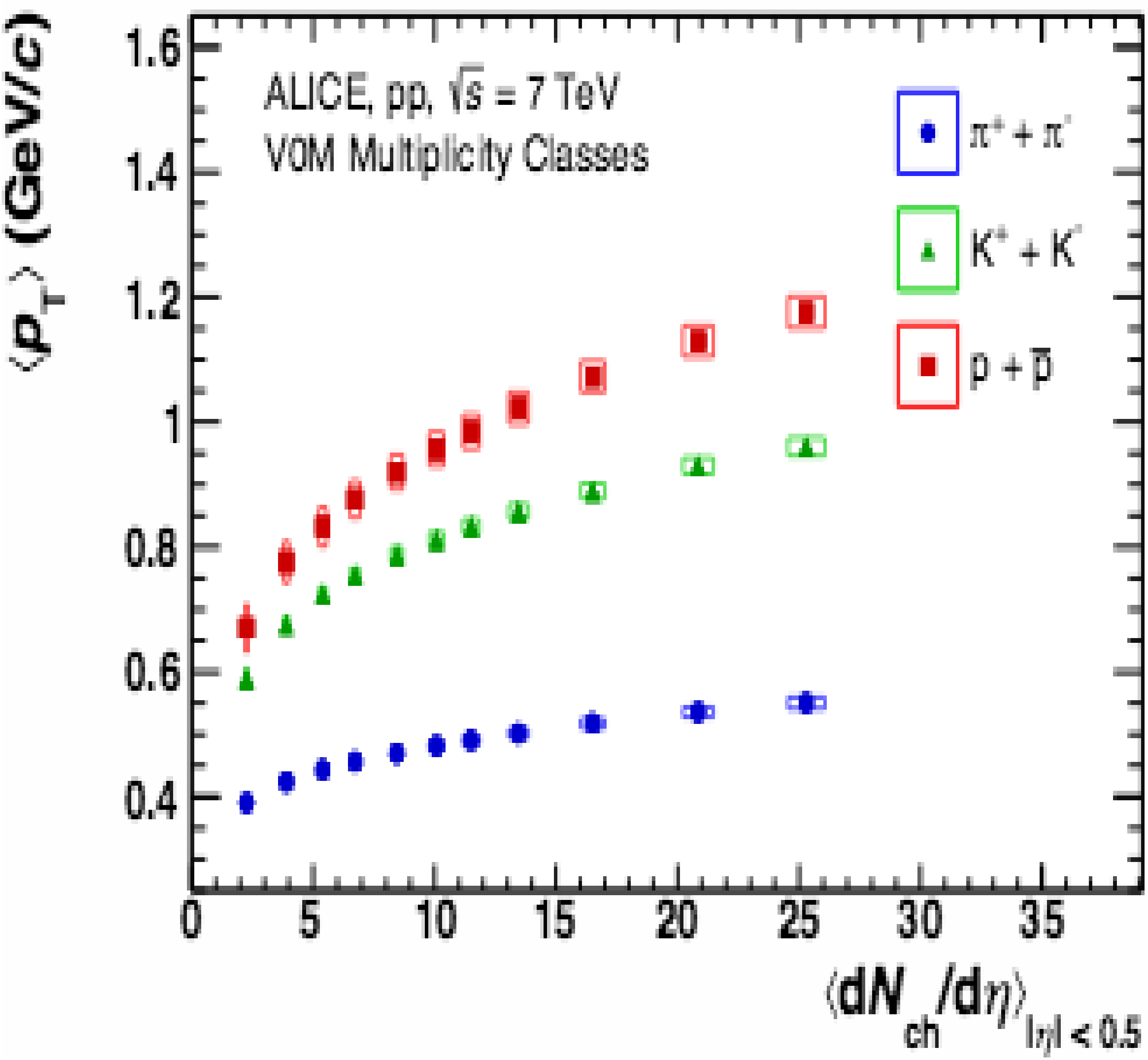


Greater difference for isotropic events specially for low *N*ch

Mean Pt for <dN/deta>

- Vytautas et all Analysis Note

https://aliceinfo.cern.ch/Notes/sites/aliceinfo.cern.ch.Notes/files/notes/analysis/akalweit/2015-Sep-15-analysis_note-AnalysisNote.pdf



Analysis and Event selection

Software: Aliroot:`v5-07-20` Aliphysics:`vAN-20160204`
Event shape classes: (PWGLF/SPECTRA/Spherocity)
Analysis macros:
```
AddTransverseEventShapeTask.C
AliAnaTransverseEventShapeTask.cxx
AliAnaTransverseEventShapeTask.h
```
Runs: 13 TeV

test pass2
LHC15f test pass2: (7.2 mill of evts)
MC Pythia6 Perugia 2011 **LHC15g3c2** 1.8 mill.
MC Pythia8 Monash 2011 **LHC15g3a2**: 2.19 mill,

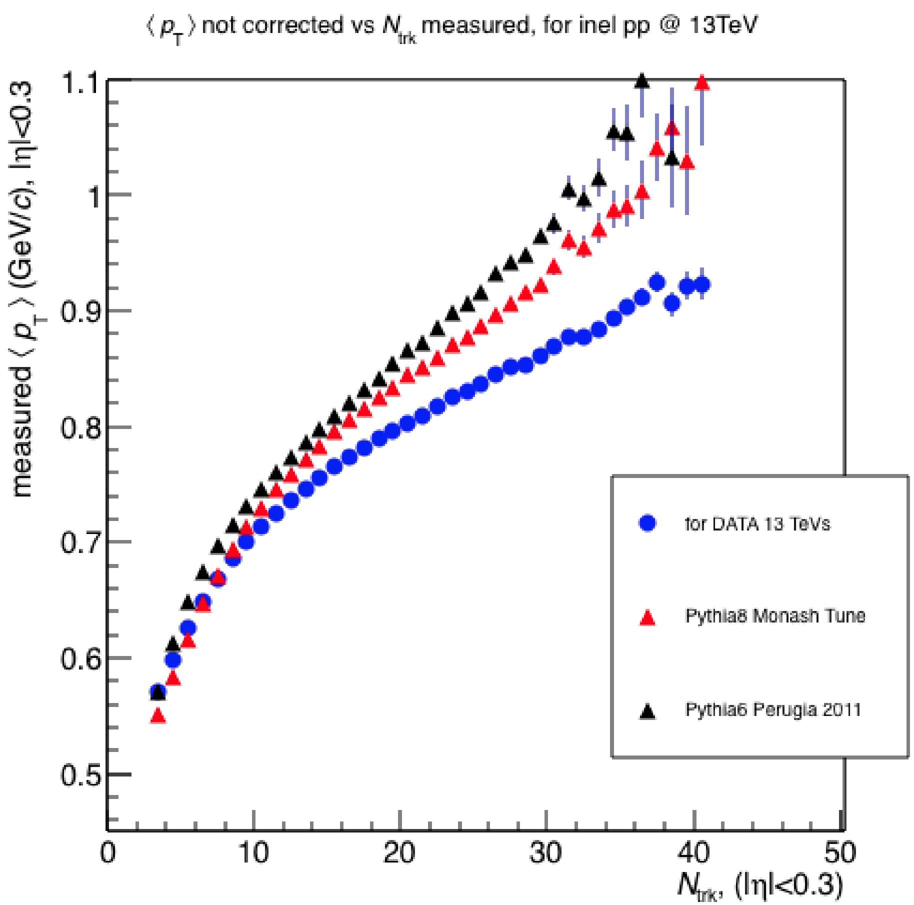
Pass2
LHC15f pass2: (59 mill of evts) good runs
MC Pythia6 Perugia 2011 **LHC15g3c3** 50 mill.
MC Pythia8 Monash 2011 **LHC15g3a3**: 40 mill,

Track selection taken for each analysis:

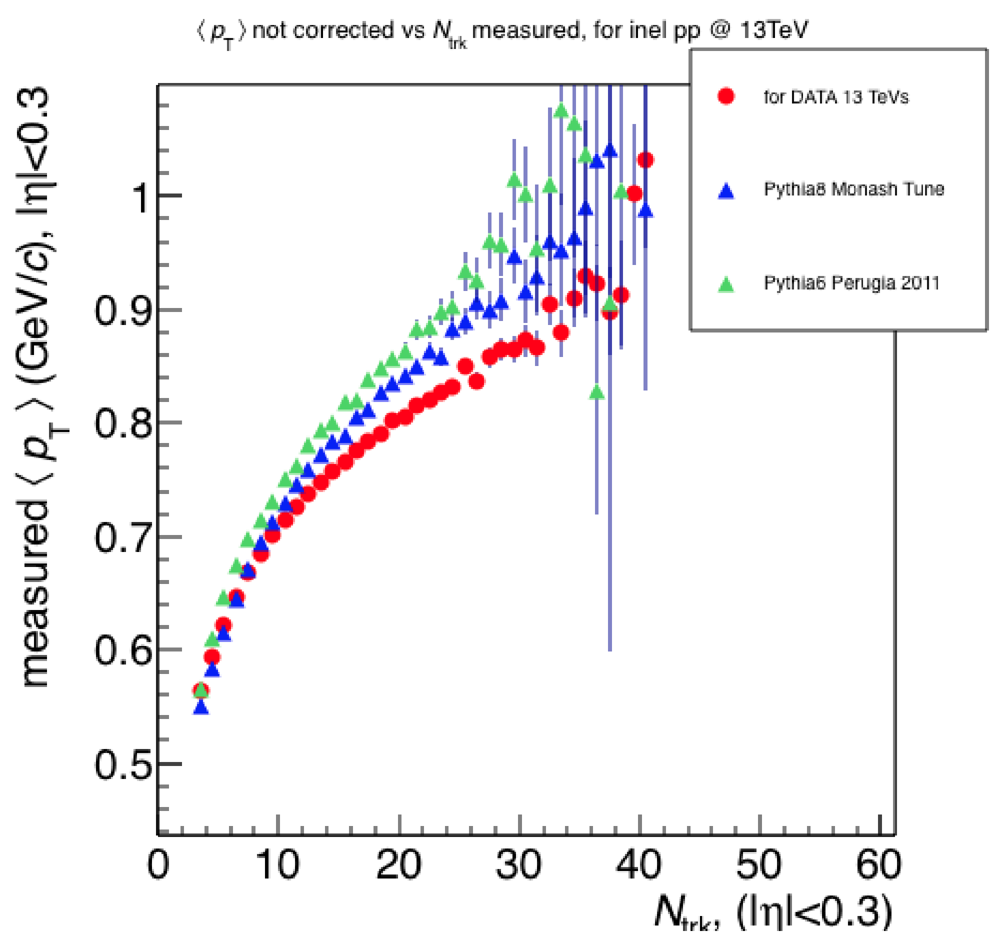
- So Analysis, Hybrid-track cuts for primary charged particles with $|\eta|<0.3$ and $0.15<p_T<10$ GeV/c.
- $<p_T>$ Analysis, Golden-track cuts with $|\eta|<0.3$ and $0.15<p_T<10$ GeV/c.
- Multiplicity, Reference multiplicity selection with $|\eta|<0.3$

Mean Transverse Momentum

Full Pass2



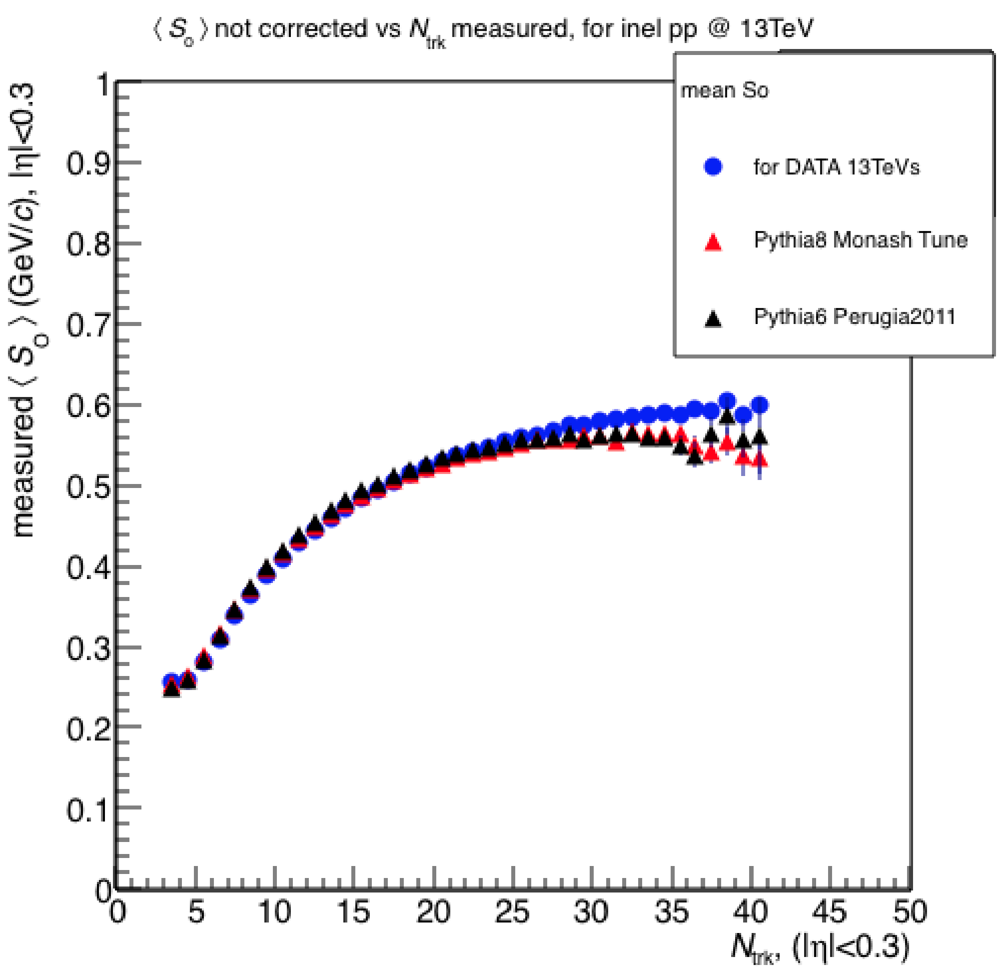
test_pass2

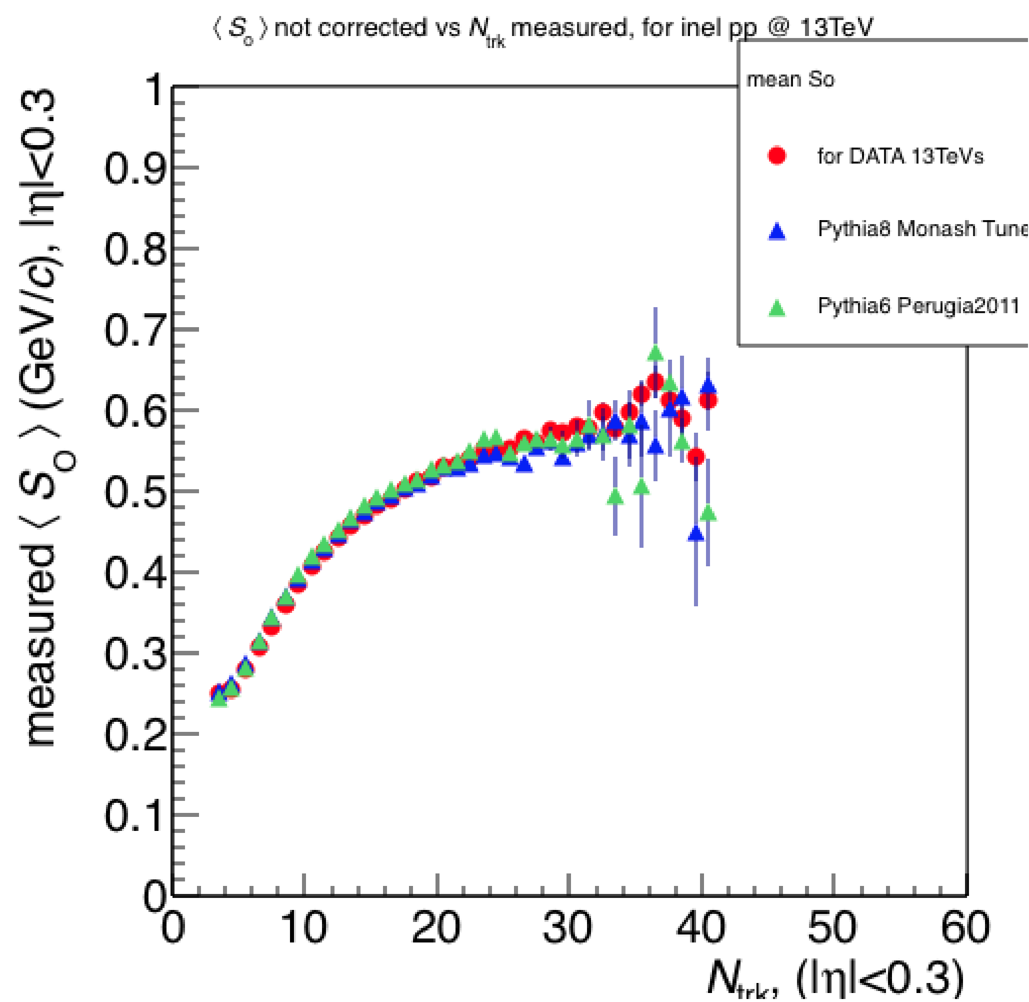


Mean Spherocity

Full Pass2

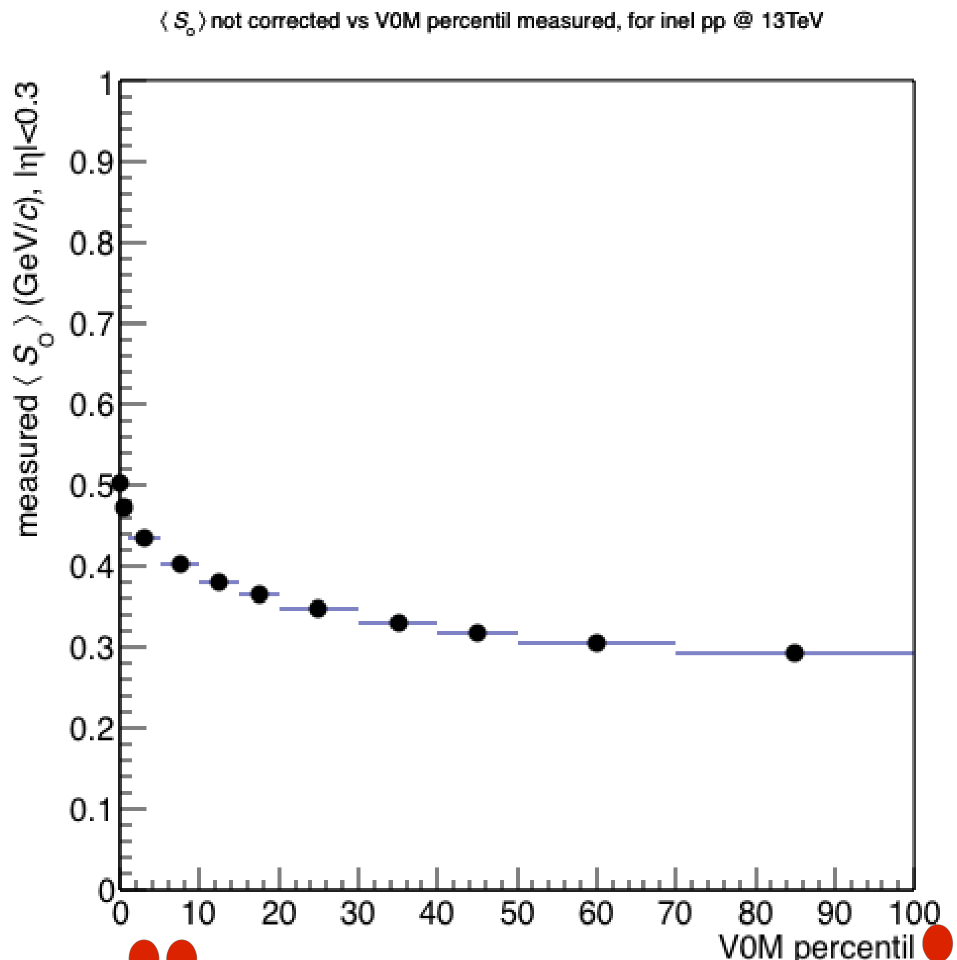
test_pass2

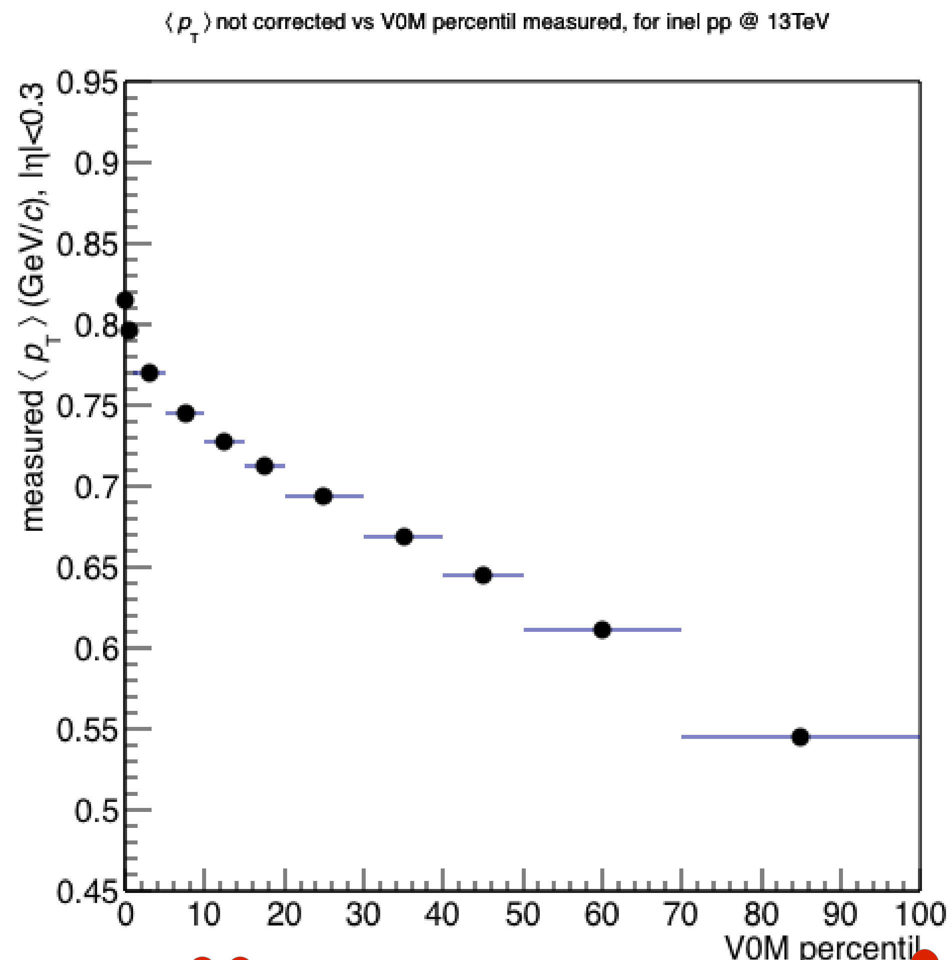


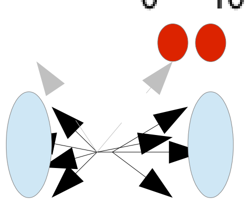


Mean So for V0M percentils

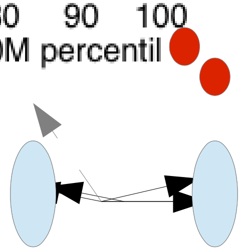
- LHC15f (pass2)



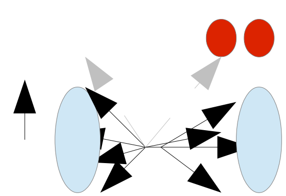




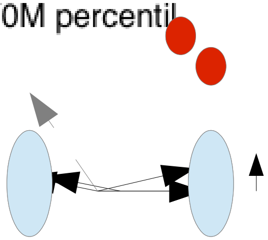
High So



Low So



High pT

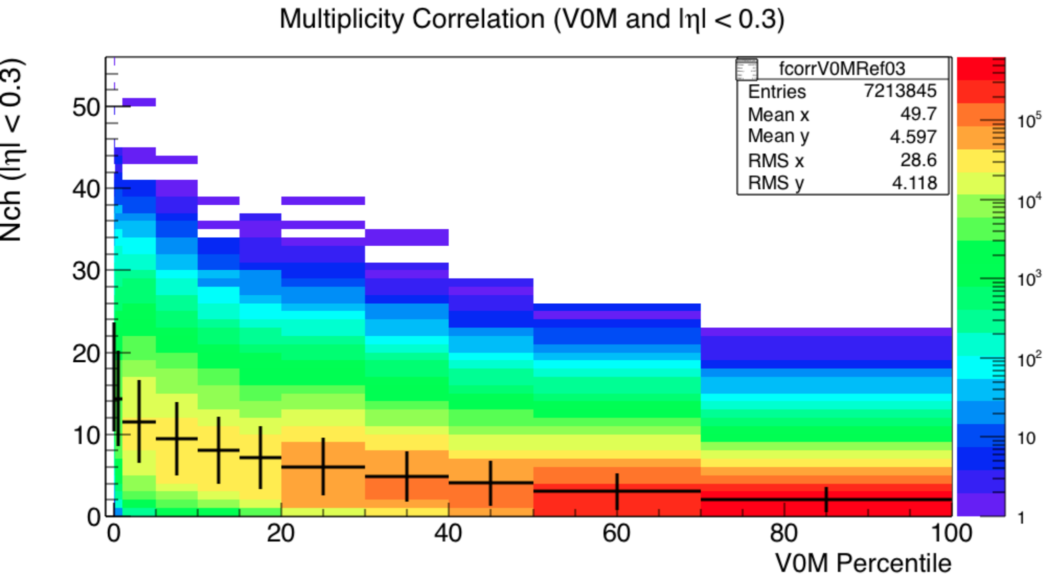


Low pT

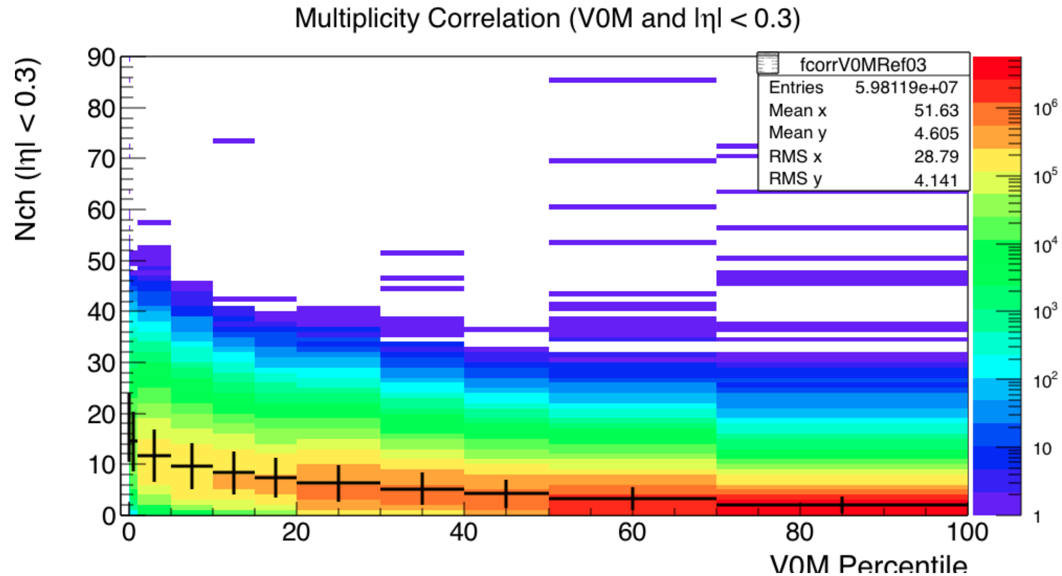

```
V0MbinsDefault={0.0,0.1,1.0,5.0,10.0,15.0,20.0,30.0,40.0,50.0,70.0,100.0};
```

Multiplicity correlation (midrapidity vs V0M percentils)

- LHC15f (test pass2)



- LHC15f (pass2)



Statistics seem not change too much in the mean value

```
V0MbinsDefault={0.0,0.1,1.0,5.0,10.0,15.0,20.0,30.0,40.0,50.0,70.0,100.0};
```

multiplicity in |eta|<0.3	17.20,	14.50,	11.69 ,	9 .63 ,	8 .33,	7.38,	6.29,	5.14,	4 .24,	3.21,	2.02

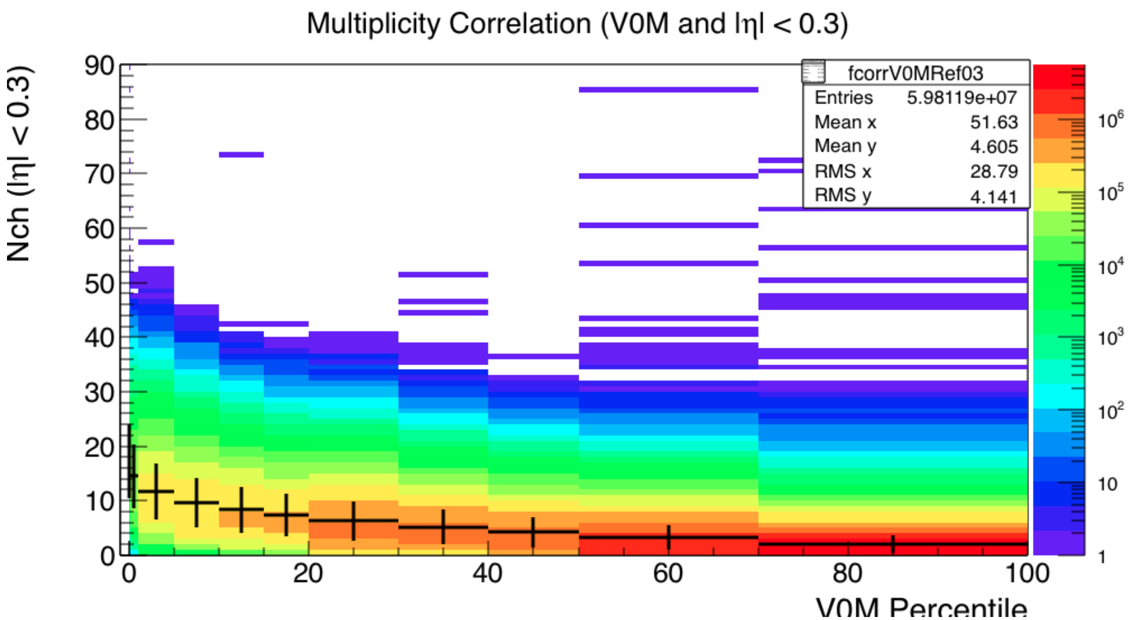
Proposal for the baseline common multiplicity binning scheme

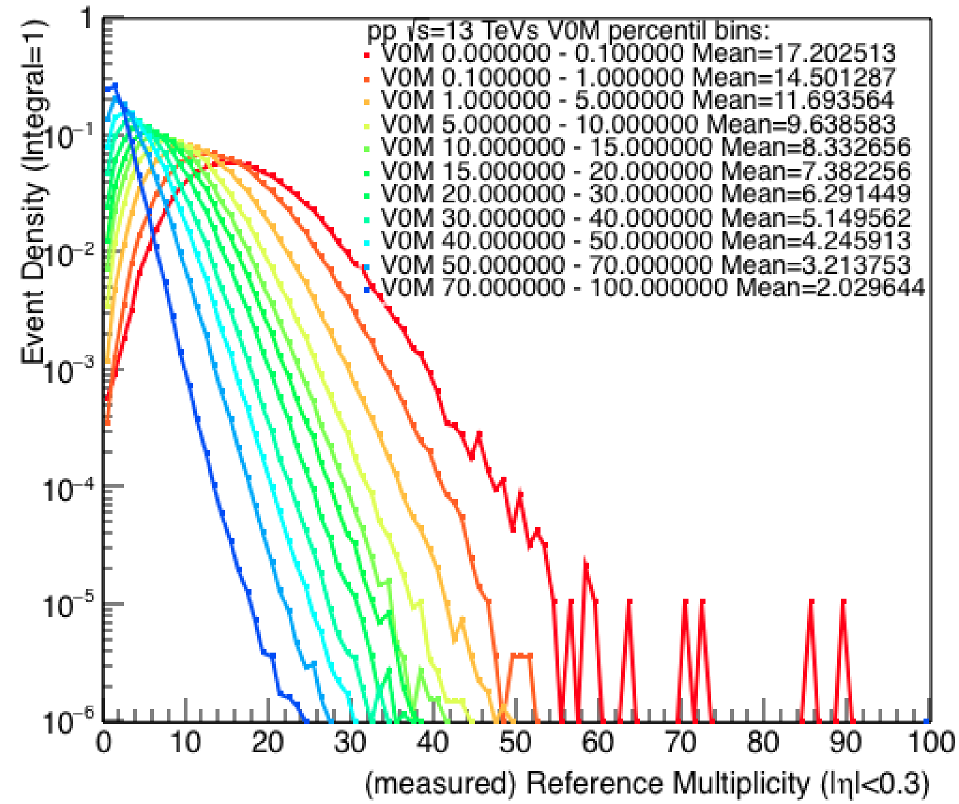
- V0M quantile
- no need to put fraction of cross-section: that's already there by definition.
- [0.00, 0.01] [0.01,0.10] [0.10, 1.0] [1.0, 5.0] [5.0, 10.0] [10.0, 15.0] [15.0, 20.0] [20.0, 30.0] [30.0, 40.0] [40.0, 50.0] [50.0, 70.0] [70.0, 100.0]

class (percentile)	[0.00, 0.01]	[0.01, 0.1]	[0.1, 1.0]	[1.0, 5.0]	[5.0, 10.0]	[10.0, 15.0]	[15.0, 20.0]	[20.0, 30.0]	[30.0, 40.0]	[40.0, 50.0]	[50.0, 70.0]	[70.0, 100.0]
multiplicity in |eta| < 0.5	28.7	24.3	19.9	15.6	12.6	10.7	9.3	7.7	6.1	4.8	3.5	2.3

Multiplicity correlation (midrapidity vs V0M percentils)

- LHC15f (pass2)






```
V0MbinsDefault={0.0,0.1,1.0,5.0,10.0,15.0,20.0,30.0,40.0,50.0,70.0,100.0};
```

multiplicity in |eta|<0.3	17.20,	14.50,	11.69 ,	9 .63 ,	8 .33,	7.38,	6.29,	5.14,	4 .24,	3.21,	2.02

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class (percentile)	[0.00, 0.01]	[0.01, 0.1]	[0.1, 1.0]	[1.0, 5.0]	[5.0, 10.0]	[10.0, 15.0]	[15.0, 20.0]	[20.0, 30.0]	[30.0, 40.0]	[40.0, 50.0]	[50.0, 70.0]	[70.0, 100.0]
multiplicity in |eta| < 0.5	28.7	24.3	19.9	15.6	12.6	10.7	9.3	7.7	6.1	4.8	3.5	2.3

Mean values are less than for |eta|<0.5 Due to small pseudorapidity range

Mean Pt and Mean So for <dN/deta>

- LHC15f (pass2)