A first look into anti-Helium analysis

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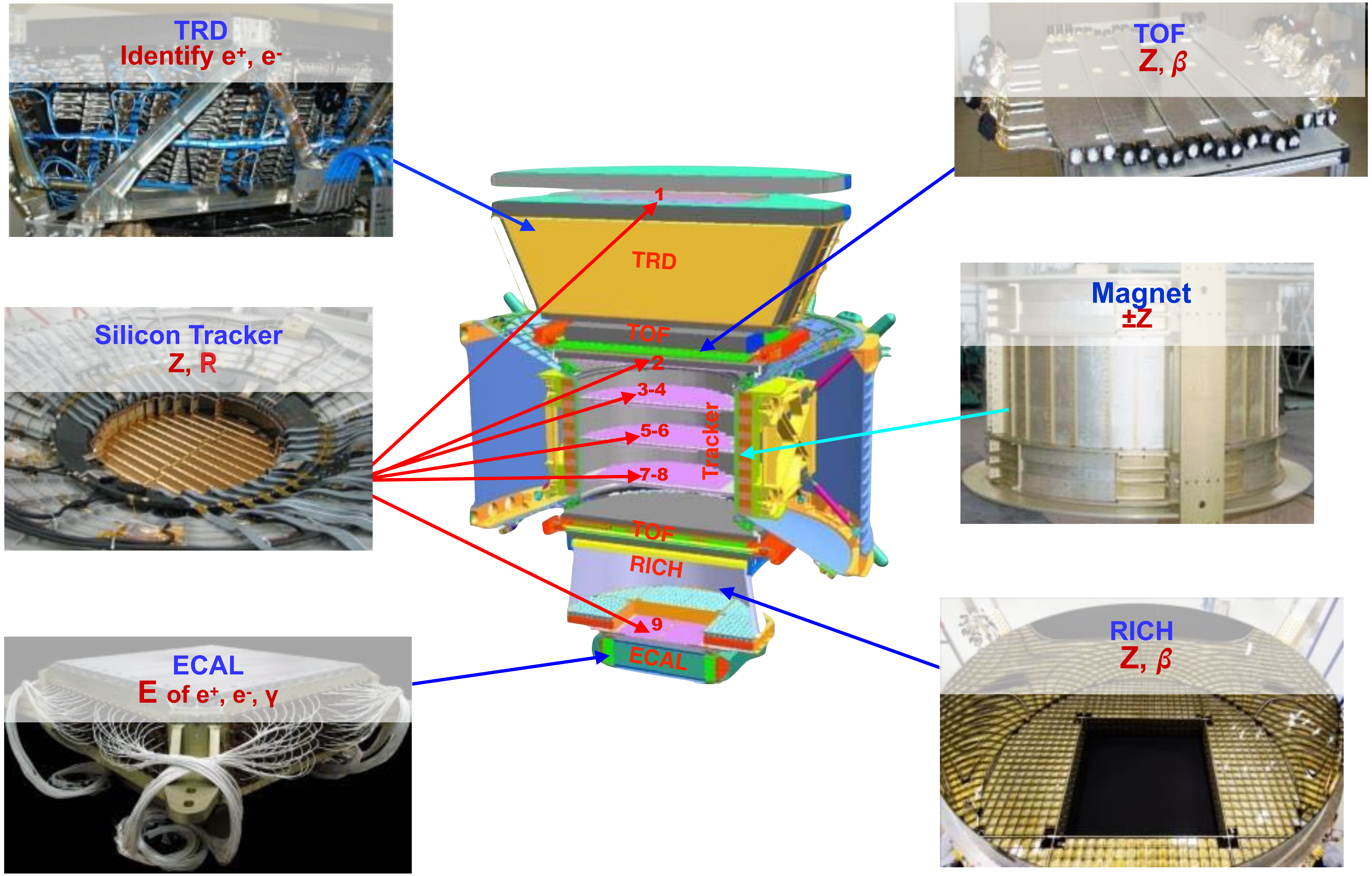
AMS SUBDETECTORS

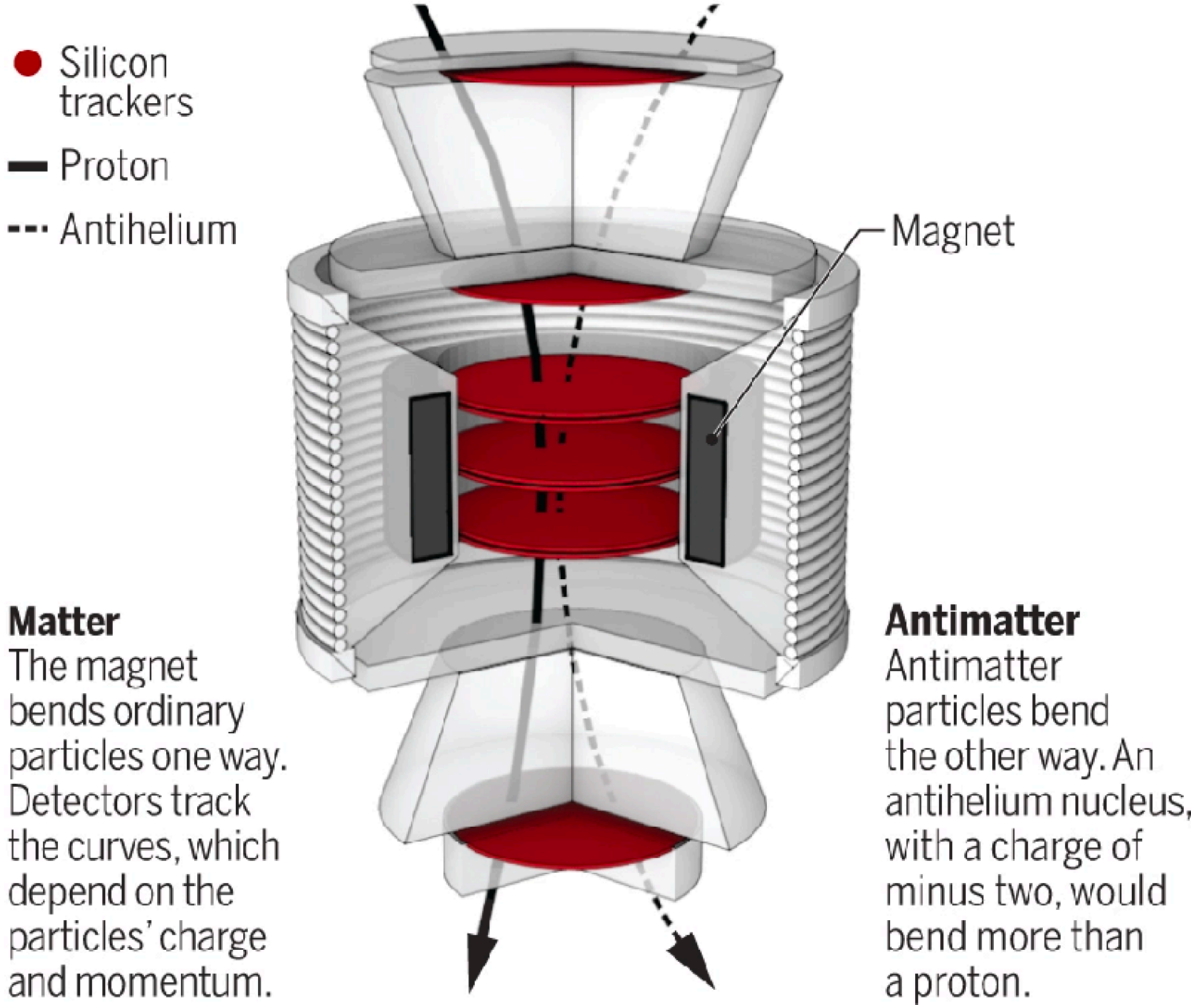
Particles and nuclei are defined by their charge (**Z**) and energy (**E ~ P**) or rigidity **R=P/Z**

Both quantities are measured redundantly and independently by AMS sub-detectors: Tracker, TOF, TRD, ECAL, RICH



Antimatter particles in cosmic rays are unique messengers for the search of dark matter annihilation signals in the Galaxy or the presents of large domains of antimatter in the universe.

AMS collaboration has publish the results of the positrons, anti-Protons. Now we need to search for heavier antimatters in the cosmic rays with AMS. Antihelium is a very interesting topic since till now we have no clear evidence that we have antihelium in cosmic rays.



- Ntuple:
  /storage/gpfs_ams/ams/groups/AMS-Italy/ntuples/v1.0.0/ISS.B1236/pass8

  from 1305853512.root to 1635855691.root

  20 May 2011 —> 2 Nov 2021

- Rigidity: GBL

Selections:

Trigger:

HasPhysicsTrigger;

RTI Selections;

Inner Tracker:

Charge on each layer (charge - 0.3f, charge + 0.5f);

ChargeRMS/InnerCharge < 0.12

Hits on Y side = 7;

Hits ChiSquare < 10;

Fiducial volume in inner tracker;

TOF:

Beta>0.3;

Good hits on Upper TOF: GoodPathlength(0b0011);

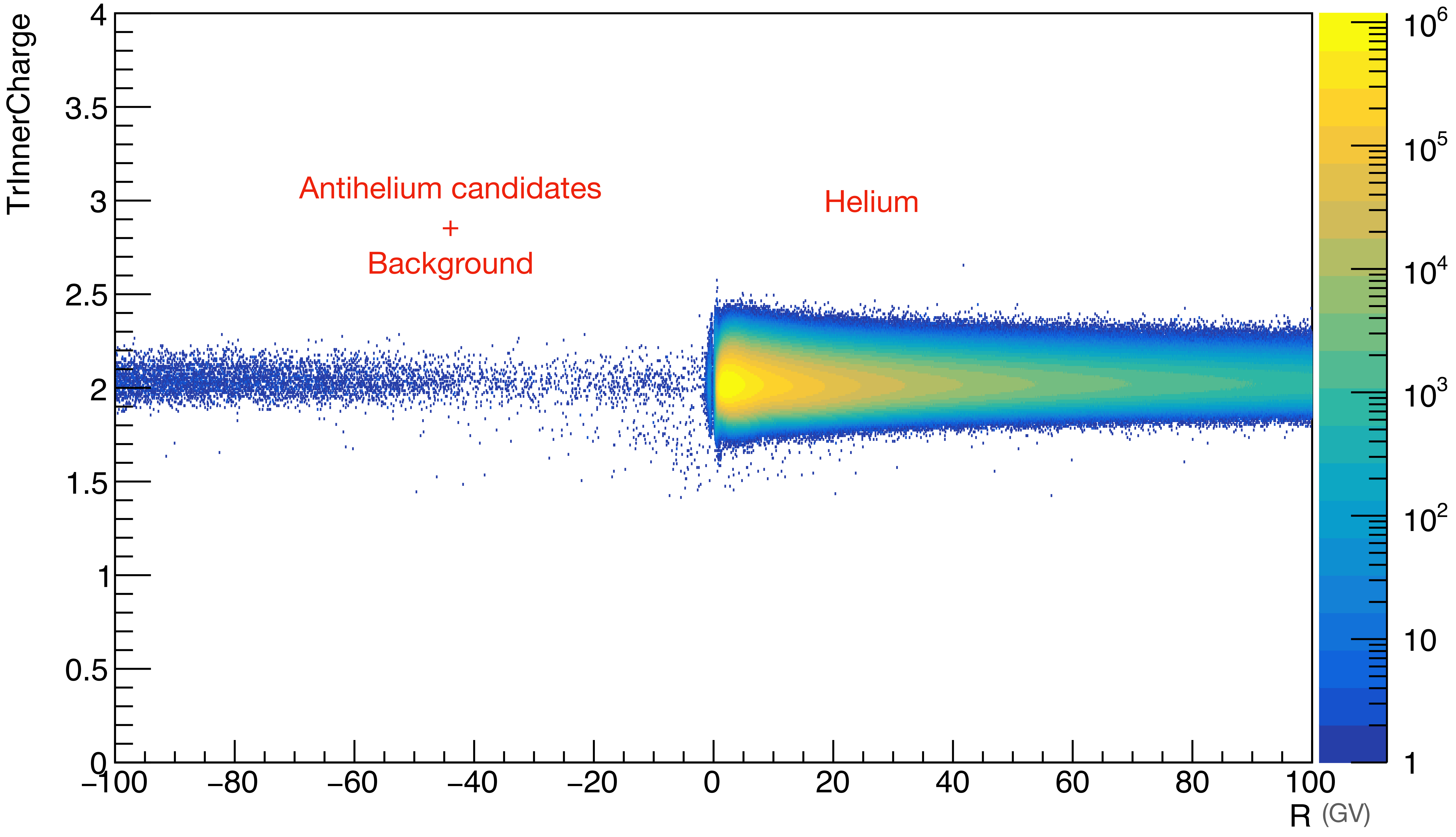
Charge in Upper TOF (charge - 0.5f, charge + 0.75f);

Charge in Lower TOF (charge - 0.5f, charge + 0.75f);

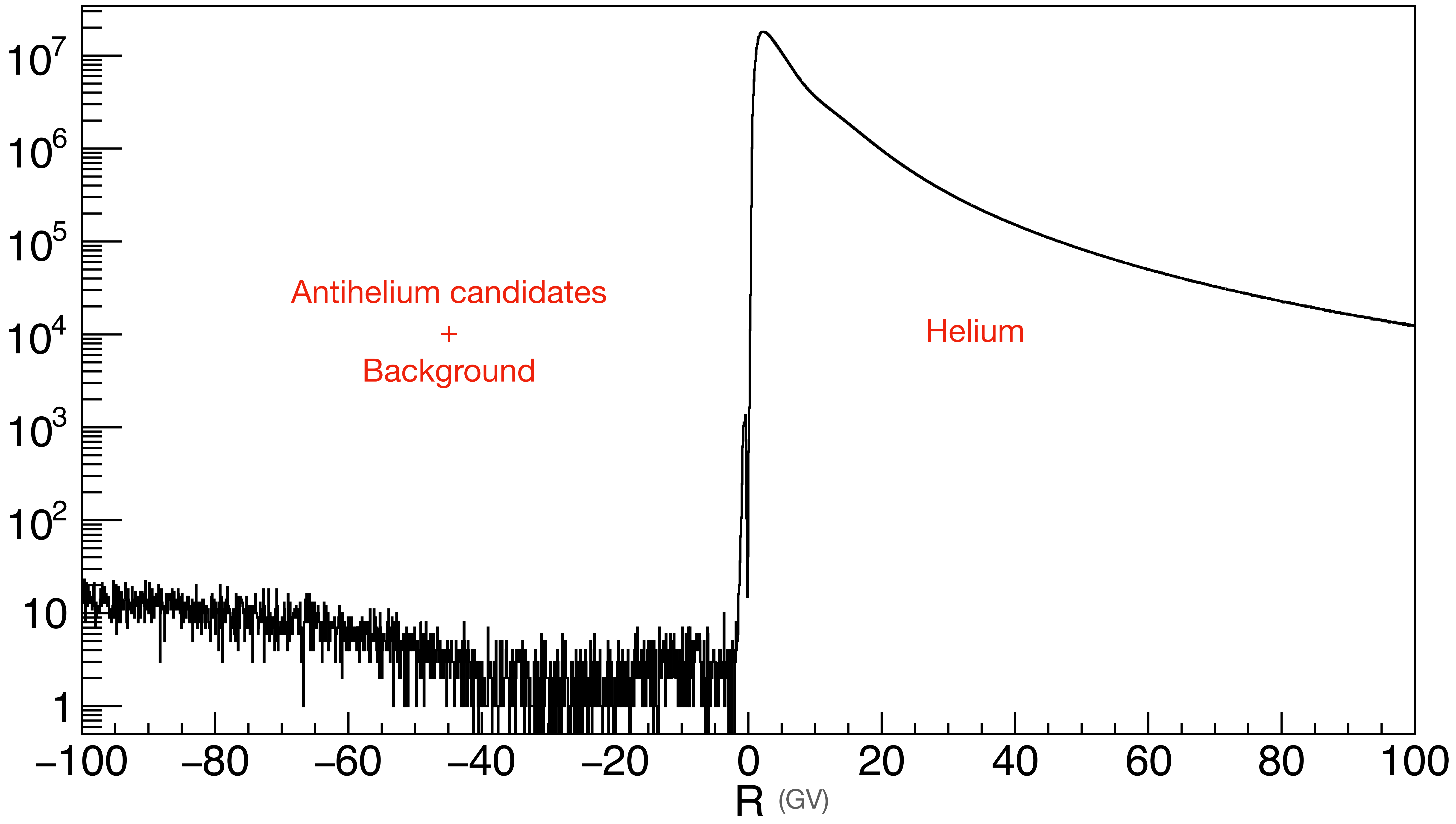
TofPlus.Chi2Coo < 5.0f

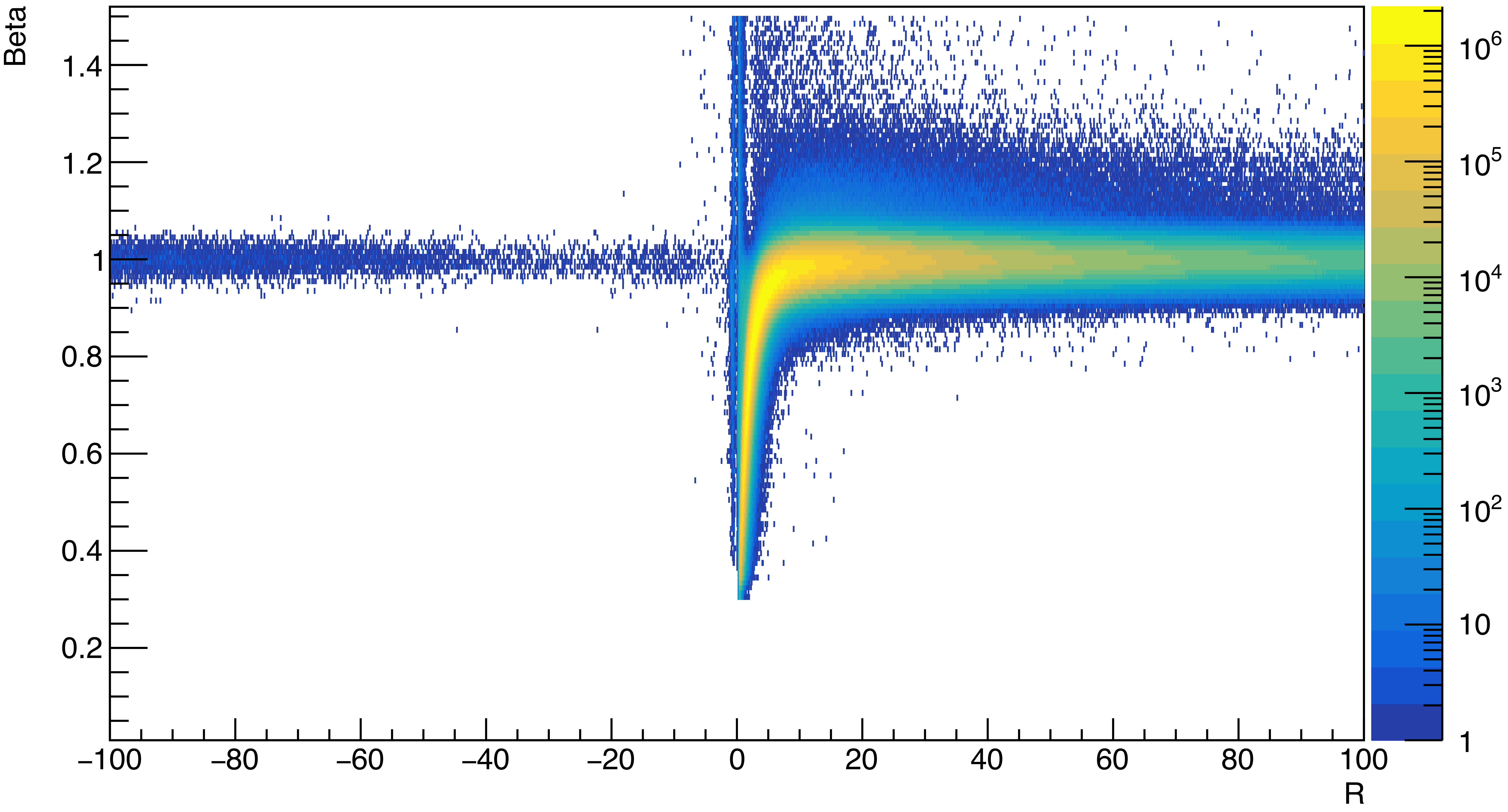
TofPlus.Chi2Time < 10.0f

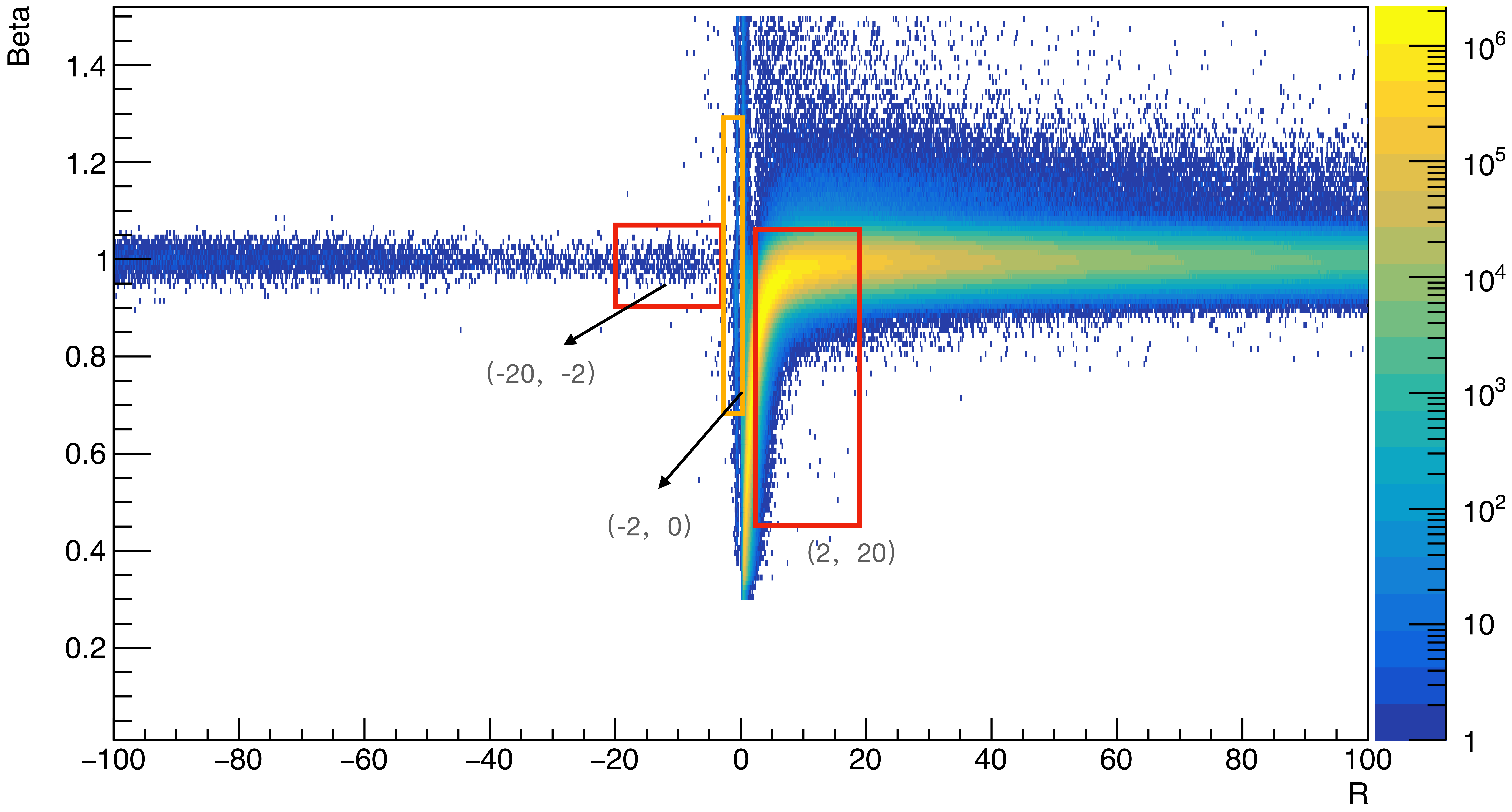
From the propagation theory of the cosmic ray, antihelium is unlikely to be produced in the cosmic rays, that means, even there are some, should be very small amount. That makes the search for antihelium much more difficult.



The background is mostly from the particle scattering in the detecter. Due to the scattering, some of the helium events are reconstructed with negative charge.
In this analysis, the most challenge job is to characterise the background and find discriminating variables.




Beta
1.4
1.2
1
0.8
0.6
0.4
0.2
−100
−80
−60
−40
−20
0
20
40
60
80
100
R
10^6
10^5
10^4
10^3
10^2
10
1

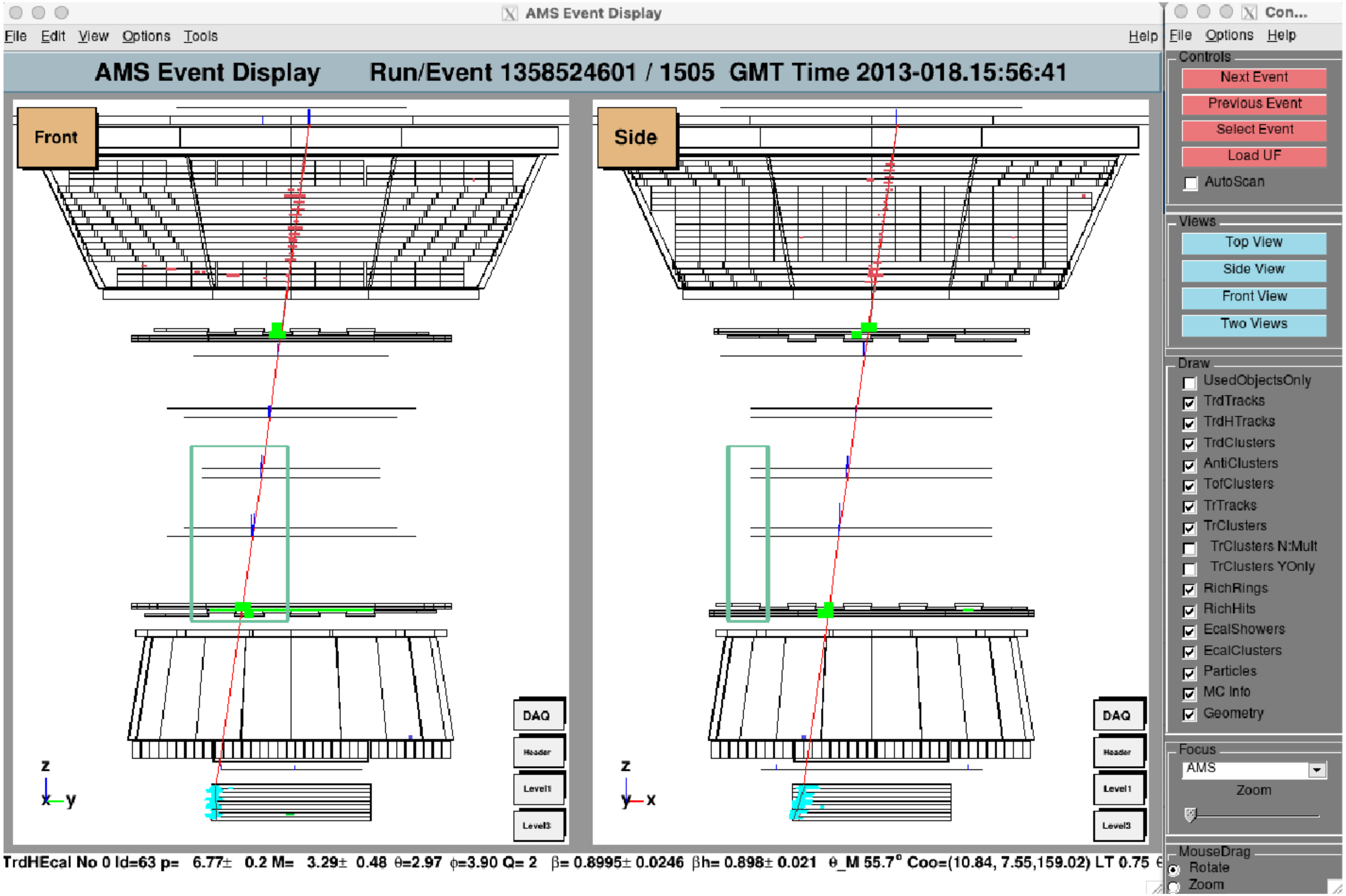


Beta
1.4
1.2
1
0.8
0.6
0.4
0.2
−100
−80
−60
−40
−20
0
20
40
60
80
100
R
(-20, -2)
(-2, 0)
(2, 20)
10^6
10^5
10^4
10^3
10^2
10
1

Event display in AMS detector:

Rigidity: 2 GV —> 20 GV

Helium events


AMS Event Display
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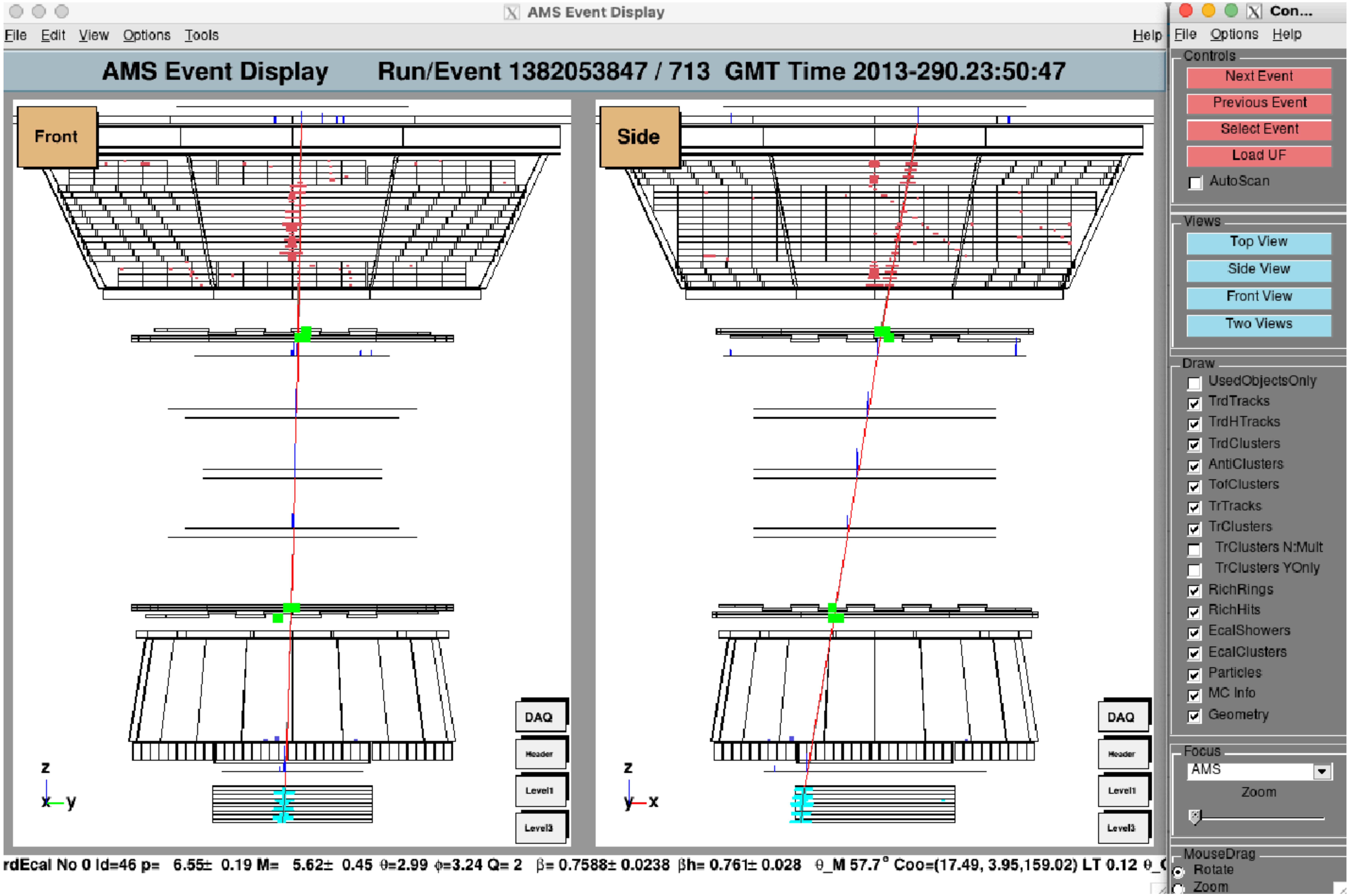
Help
AMS Event Display Run/Event 1358524601 / 1505 GMT Time 2013-018.15:56:41
Front
Side
DAQ
Header
Level1
Level3
z
x y
z
y x
TrdHEcal No 0 Id=63 p= 6.77± 0.2 M= 3.29± 0.48 θ=2.97 ϕ=3.90 Q= 2 β= 0.8995± 0.0246 βh= 0.898± 0.021 θ_M 55.7° Coo=(10.84, 7.55,159.02) LT 0.75
Con...
File Options Help
Controls
Next Event
Previous Event
Select Event
Load UF
AutoScan
Views
Top View
Side View
Front View
Two Views
Draw
UsedObjectsOnly
TrdTracks
TrdHTracks
TrdClusters
AntiClusters
TofClusters
TrTracks
TrClusters
TrClusters N:Mult
TrClusters YOnly
RichRings
RichHits
EcalShowers
EcalClusters
Particles
MC Info
Geometry
Focus
AMS
Zoom
MouseDrag
Rotate
Zoom


AMS Event Display
File Edit View Options Tools Help
AMS Event Display Run/Event 1382053847 / 713 GMT Time 2013-290.23:50:47
Front
Side
DAQ
Header
Level1
Level3
z
x y
z
y x
rdEcal No 0 Id=46 p= 6.55± 0.19 M= 5.62± 0.45 θ=2.99 φ=3.24 Q= 2 β= 0.7588± 0.0238 βh= 0.761± 0.028 θ_M 57.7° Coo=(17.49, 3.95,159.02) LT 0.12
Con...
File Options Help
Controls
Next Event
Previous Event
Select Event
Load UF
AutoScan
Views
Top View
Side View
Front View
Two Views
Draw
UsedObjectsOnly
TrdTracks
TrdHTracks
TrdClusters
AntiClusters
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TrTracks
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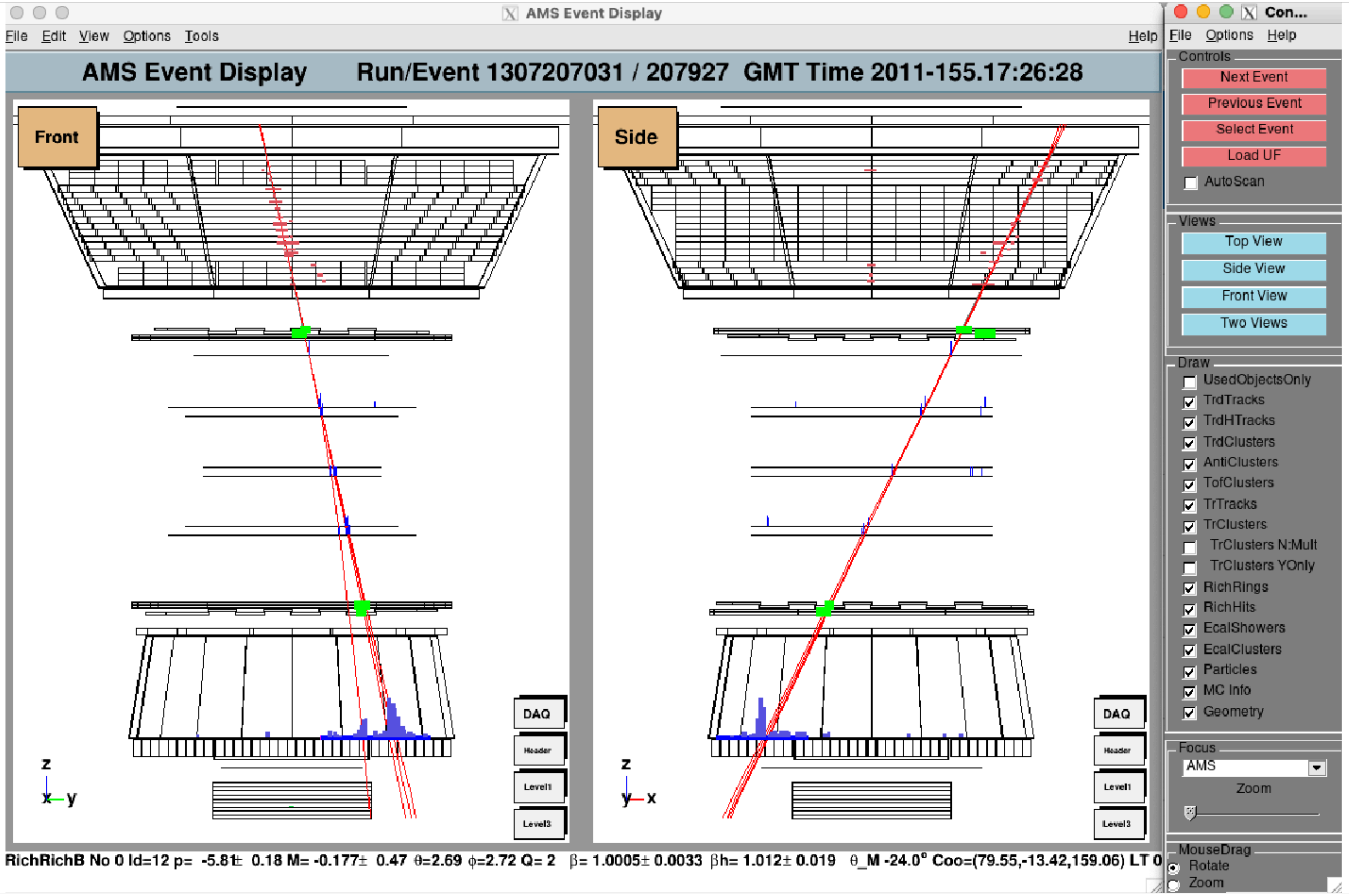
Rotate
Zoom

Event display in AMS detector:

Rigidity: -20 GV —> -2 GV

antihelium candidates or background


AMS Event Display
File Edit View Options Tools Help
AMS Event Display Run/Event 1307207031 / 207927 GMT Time 2011-155.17:26:28
Front
Side
DAQ
Header
Level1
Level3
Con...
File Options Help
Controls
Next Event
Previous Event
Select Event
Load UF
AutoScan
Views
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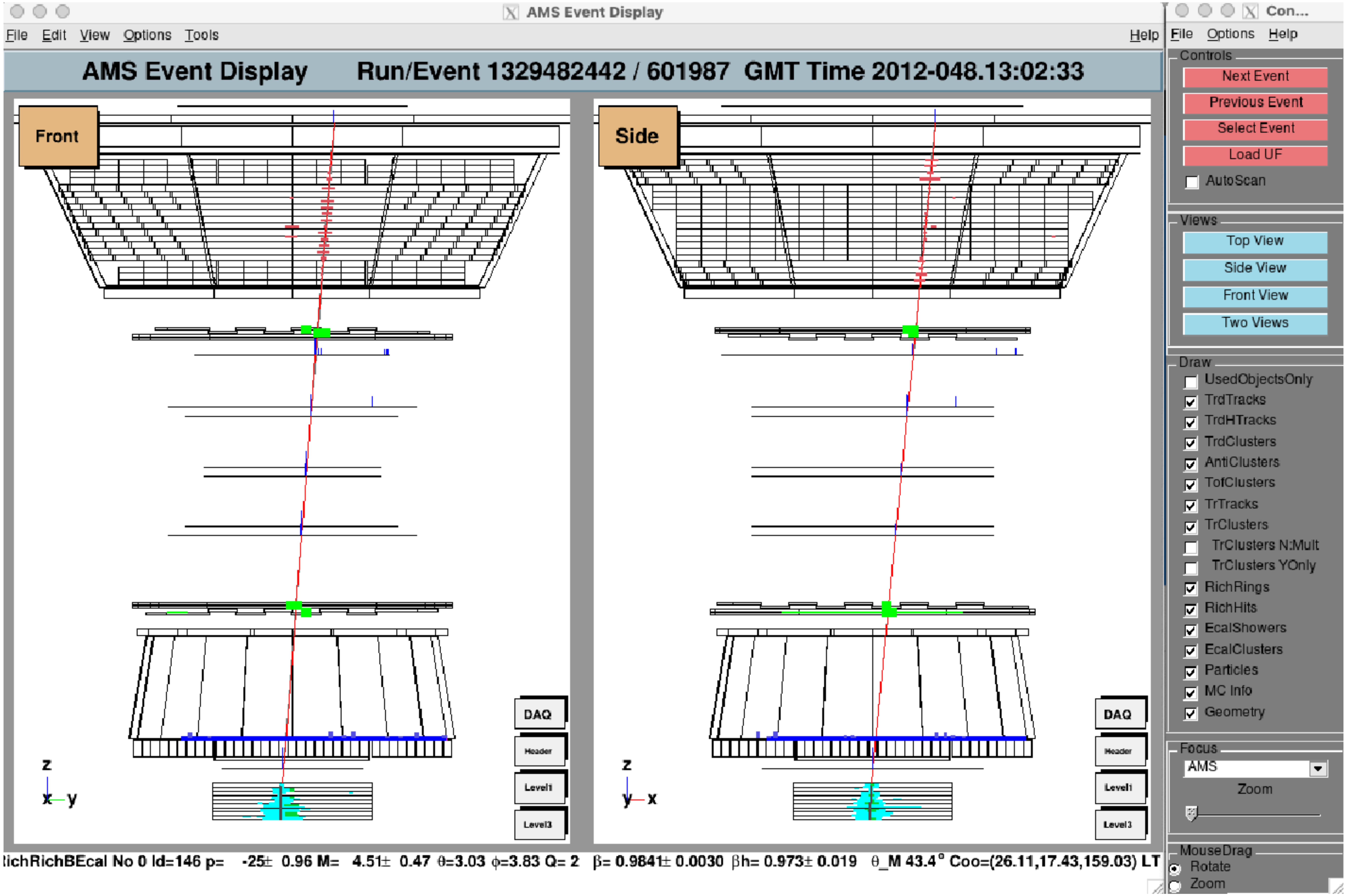
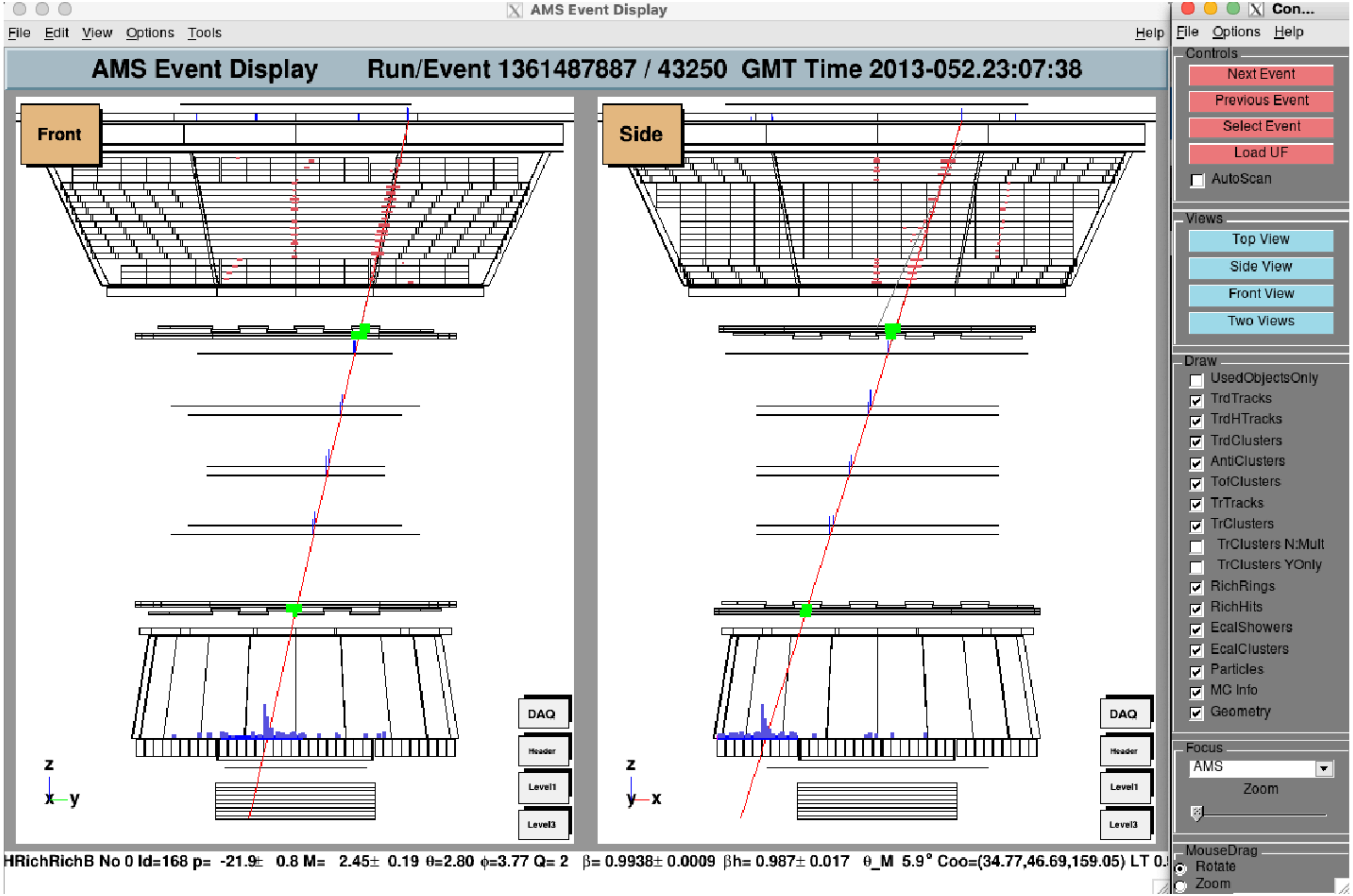
Front View
Two Views
Draw
UsedObjectsOnly
TrdTracks
TrdHTracks
TrdClusters
AntiClusters
TofClusters
TrTracks
TrClusters
TrClusters N:Mult
TrClusters YOnly
RichRings
RichHits
EcalShowers
EcalClusters
Particles
MC Info
Geometry
Focus
AMS
Zoom
MouseDrag
Rotate
Zoom
RichRichB No 0 Id=12 p= -5.81± 0.18 M= -0.177± 0.47 θ=2.69 φ=2.72 Q= 2 β= 1.0005± 0.0033 βh= 1.012± 0.019 θ_M -24.0° Coo=(79.55,-13.42,159.06) LT 0


AMS Event Display
File Edit View Options Tools Help
AMS Event Display Run/Event 1329482442 / 601987 GMT Time 2012-048.13:02:33
Front
Side
DAQ
Header
Level1
Level3
z
x y
z
y x
ichRichBEcal No 0 Id=146 p= -25± 0.96 M= 4.51± 0.47 θ=3.03 φ=3.83 Q= 2 β= 0.9841± 0.0030 βh= 0.973± 0.019 θ_M 43.4° Coo=(26.11,17.43,159.03) LT
Con...
File Options Help
Controls
Next Event
Previous Event
Select Event
Load UF
AutoScan
Views
Top View
Side View
Front View
Two Views
Draw
UsedObjectsOnly
TrdTracks
TrdHTracks
TrdClusters
AntiClusters
TofClusters
TrTracks
TrClusters
TrClusters N:Mult
TrClusters YOnly
RichRings
RichHits
EcalShowers
EcalClusters
Particles
MC Info
Geometry
Focus
AMS
Zoom
MouseDrag
Rotate
Zoom



AMS Event Display
File Edit View Options Tools Help
AMS Event Display Run/Event 1361487887 / 43250 GMT Time 2013-052.23:07:38
Front
Side
DAQ
Header
Level1
Level3
HRichRichB No 0 Id=168 p= -21.9± 0.8 M= 2.45± 0.19 θ=2.80 ϕ=3.77 Q= 2 β= 0.9938± 0.0009 βh= 0.987± 0.017 θ_M 5.9° Coo=(34.77,46.69,159.05) LT 0.
Con...
File Options Help
Controls
Next Event
Previous Event
Select Event
Load UF
AutoScan
Views
Top View
Side View
Front View
Two Views
Draw
UsedObjectsOnly
TrdTracks
TrdHTracks
TrdClusters
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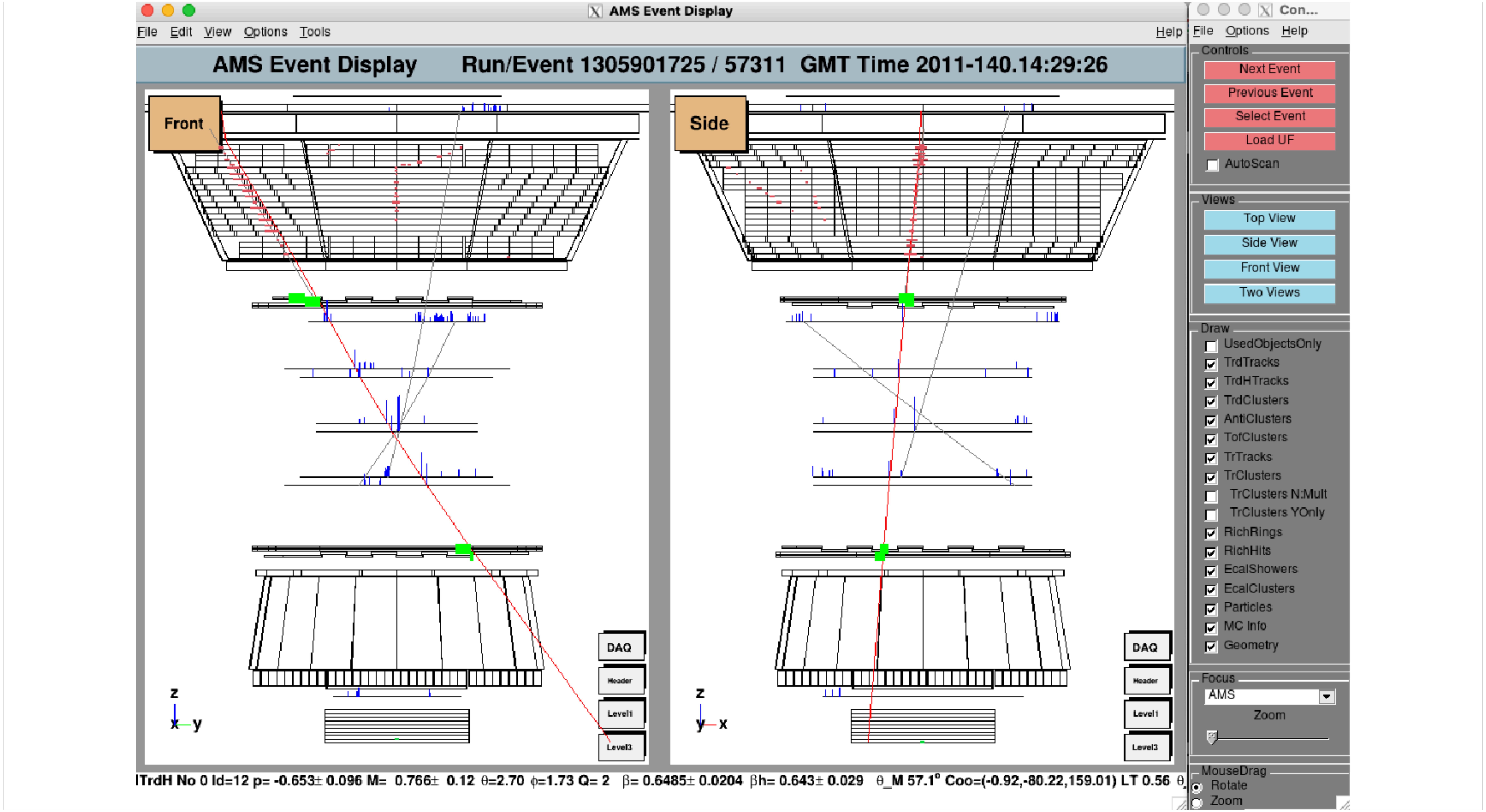
TrTracks
TrClusters
TrClusters N:Mult
TrClusters YOnly
RichRings
RichHits
EcalShowers
EcalClusters
Particles
MC Info
Geometry
Focus
AMS
Zoom
MouseDrag
Rotate
Zoom

Event display in AMS detector:

Rigidity: -2 GV —> 0 GV

background


AMS Event Display
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Help
AMS Event Display Run/Event 1305901725 / 57311 GMT Time 2011-140.14:29:26
Front
Side
DAQ
Header
Level1
Level3
z
x y
z
y x
ITrdH No 0 Id=12 p= -0.653± 0.096 M= 0.766± 0.12 θ=2.70 φ=1.73 Q= 2 β= 0.6485± 0.0204 βh= 0.643± 0.029 θ_M 57.1° Coo=(-0.92,-80.22,159.01) LT 0.56
Con...
File Options Help
Controls
Next Event
Previous Event
Select Event
Load UF
AutoScan
Views
Top View
Side View
Front View
Two Views
Draw
UsedObjectsOnly
TrdTracks
TrdHTracks
TrdClusters
AntiClusters
TofClusters
TrTracks
TrClusters
TrClusters N:Mult
TrClusters YOnly
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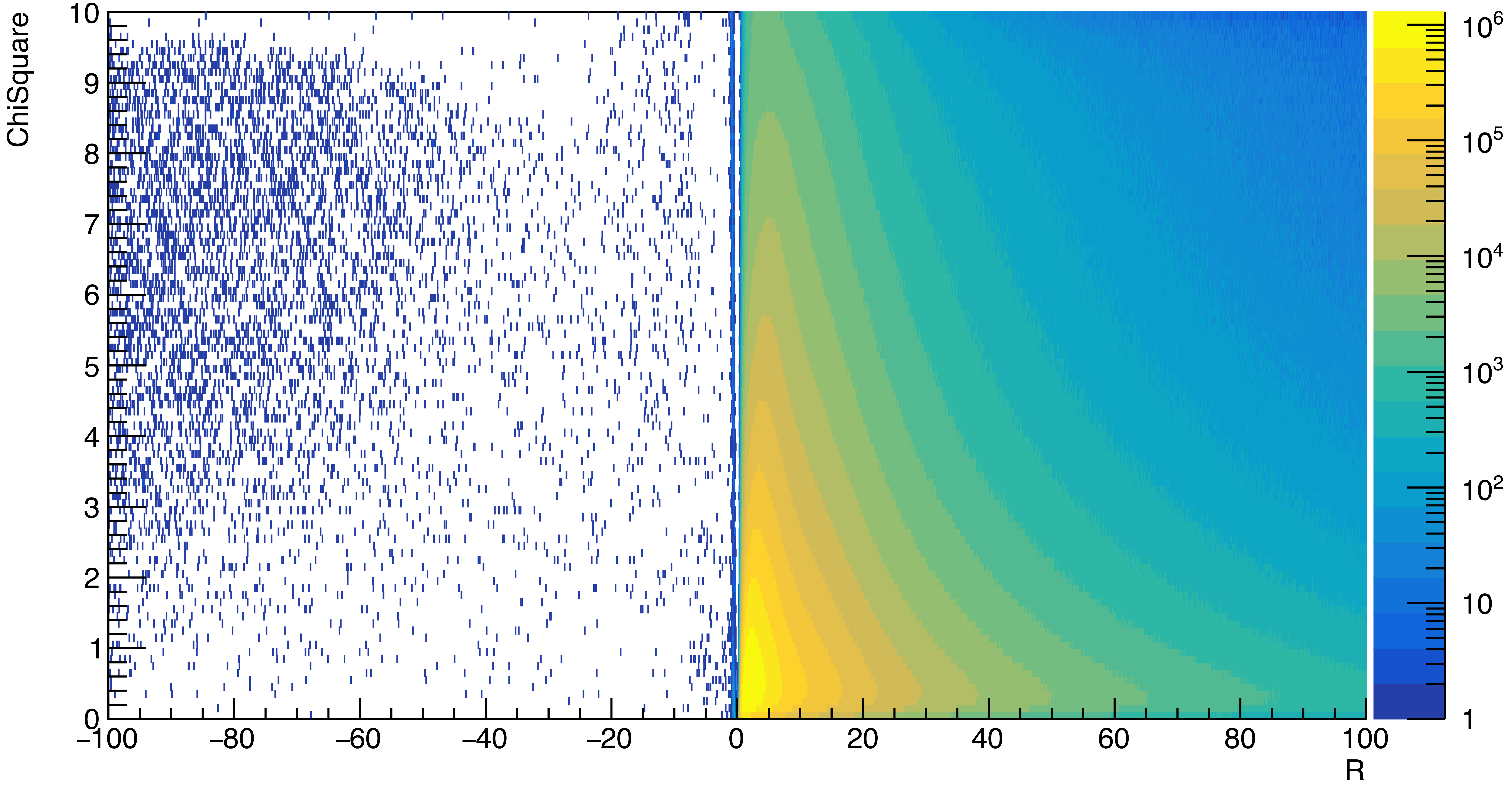
For example, we are examining several variables that are closely related to the equality and properties of the trajectory reconstructed in the inner tracker of the AMS.
These variables are defined from the very beginning to be as sensitive as possible to particle scattering and resolution effects in the inner tracker.



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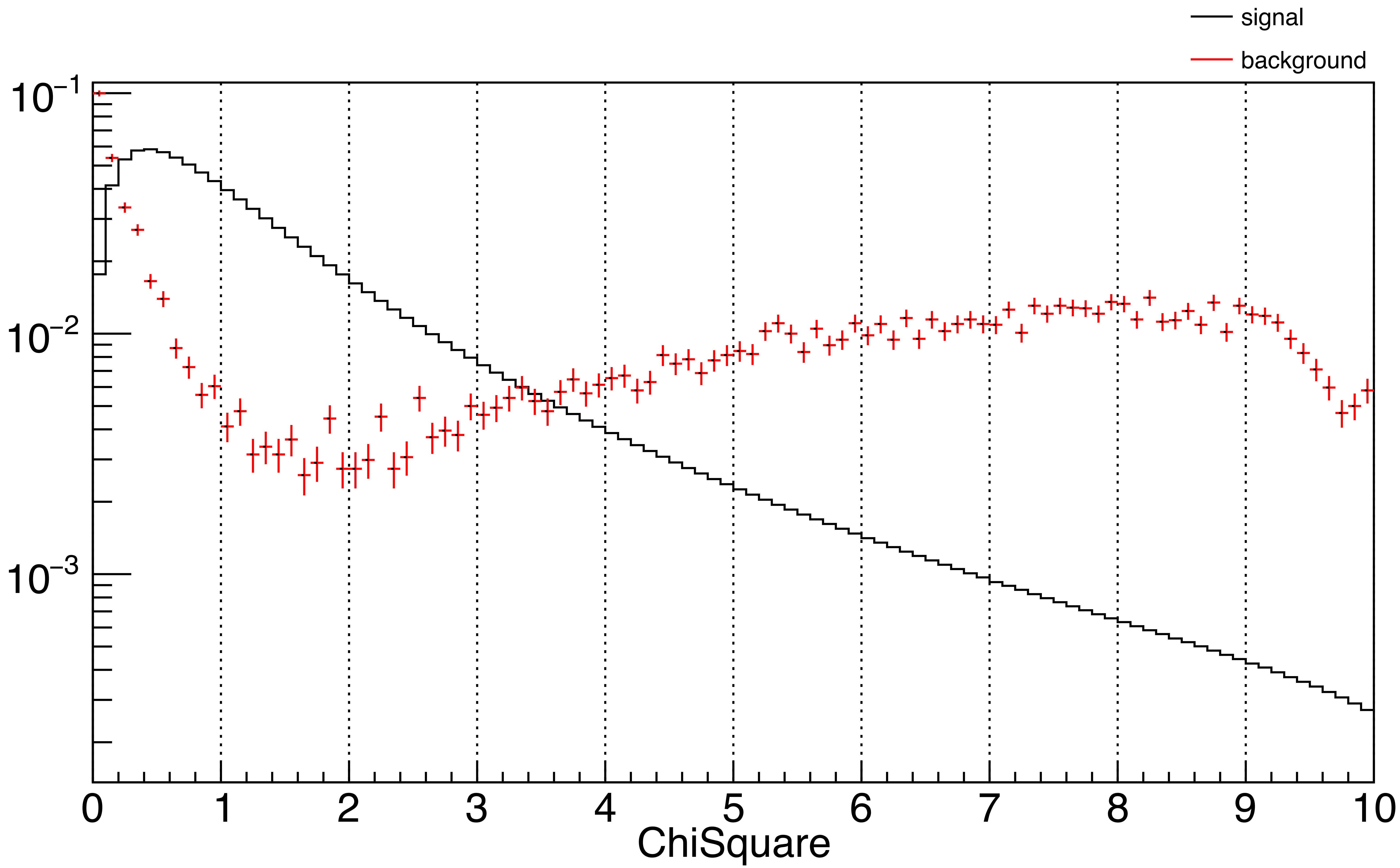
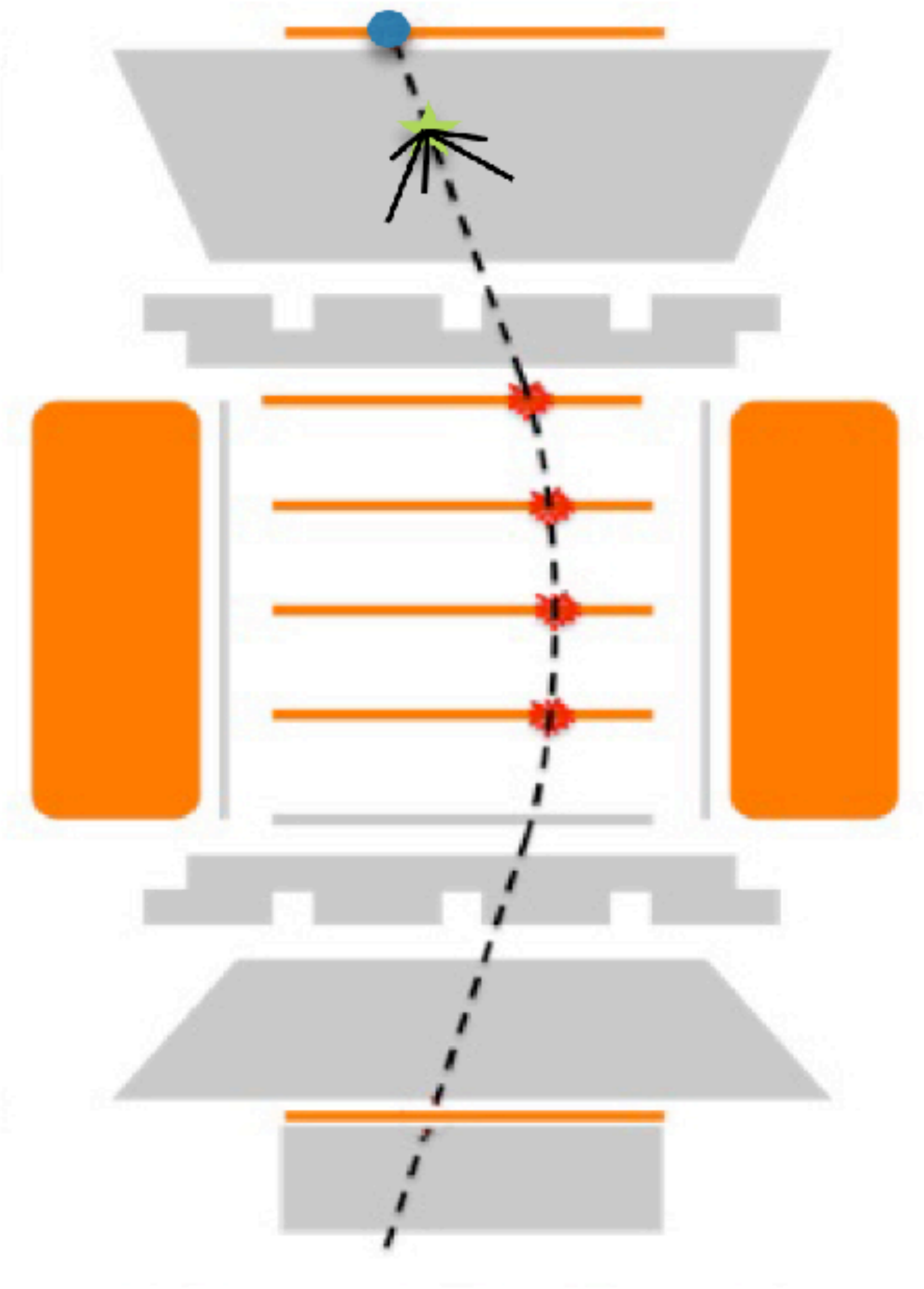


SameSignPatialRNum

PartialRigidity: Rigidity obtained from a fit where the hit on a given layer 'i' is not considered. We have 7 PartialRigidity in total, considering 7 layers of the inner tracker.

SameSignPatialRNum: the total count of the case that PartialRigidity have the same sign as the general reconstructed rigidity.



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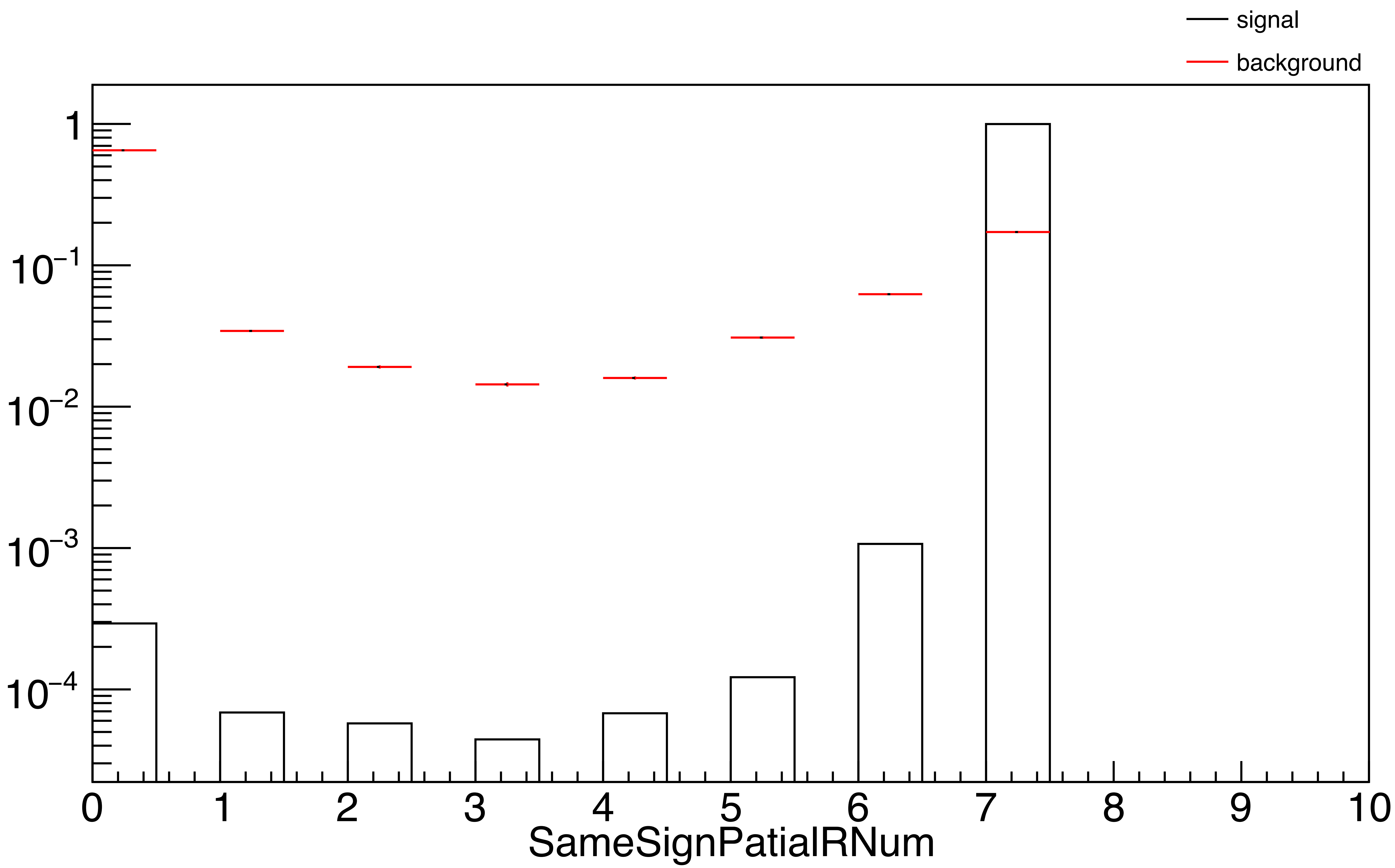

Conclusion:
We have found some variables that for signal and background behave different, which means they are sensitive to the particle scattering and resolution effects. we can use them to clean the background.

In Progress:
We need to understand the background more and develop more discriminating variables for generating a powerful estimator that can help to eliminate the background.