RICH Software Meeting. June 28, 2002

Positron and Antiproton Identification and Background Suppression at RICH energy range in AMS02

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Outline

- Positron Signal

- MC Event samples
- Positron event signature
- Selection cuts
- Results
- Summary

- Antiproton Signal

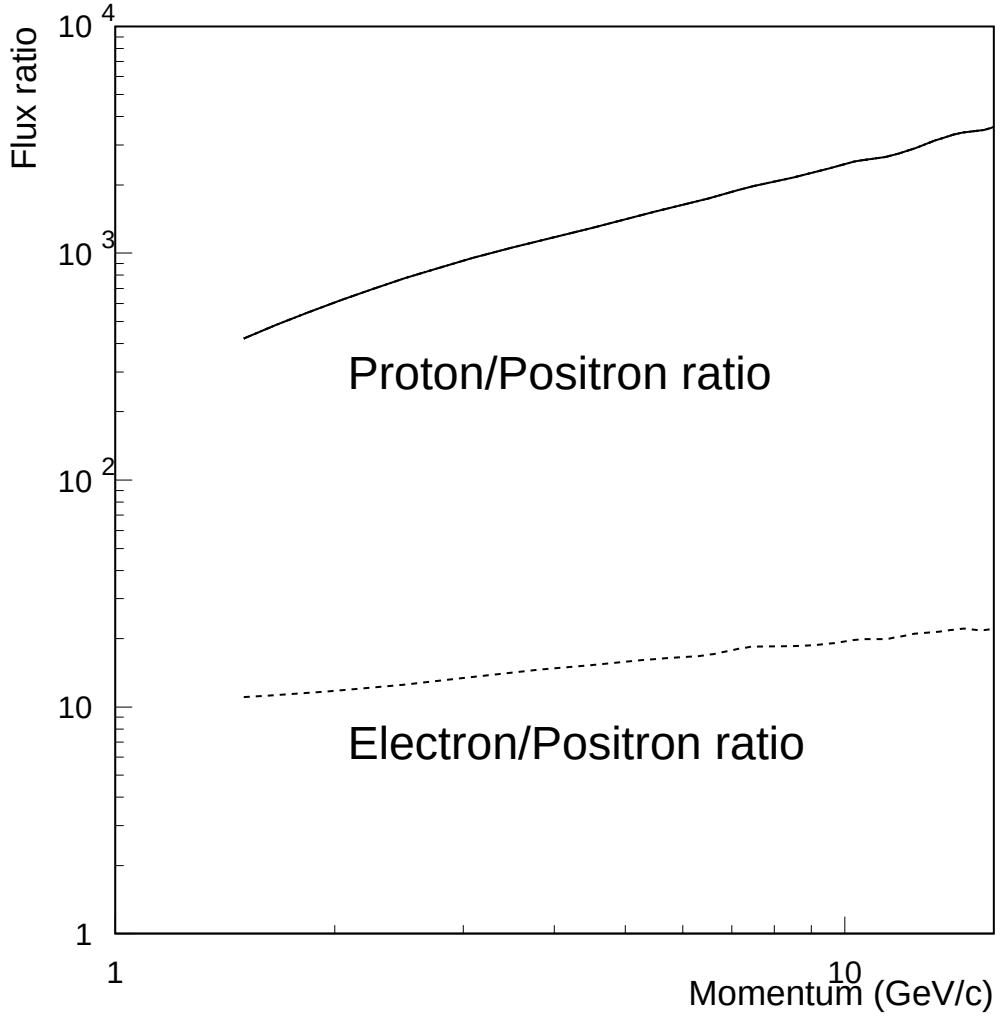
- MC Event samples
- Antiproton event signature
- Selection cuts
- Results
- Summary

Monte Carlo Event Sample

Generated in 47.85 m^2Sr acceptance:

- 7.9×10^6 e^+ continious spectrum 1-20 GeV
- 4.0×10^6 e^+ each 1, 2, 4, 8, 16 GeV
- 6.4×10^6 protons continious spectrum 1-40 GeV
- 6.0×10^6 protons each 1, 2, 4, 8, 16, 32 GeV

The main sources of background

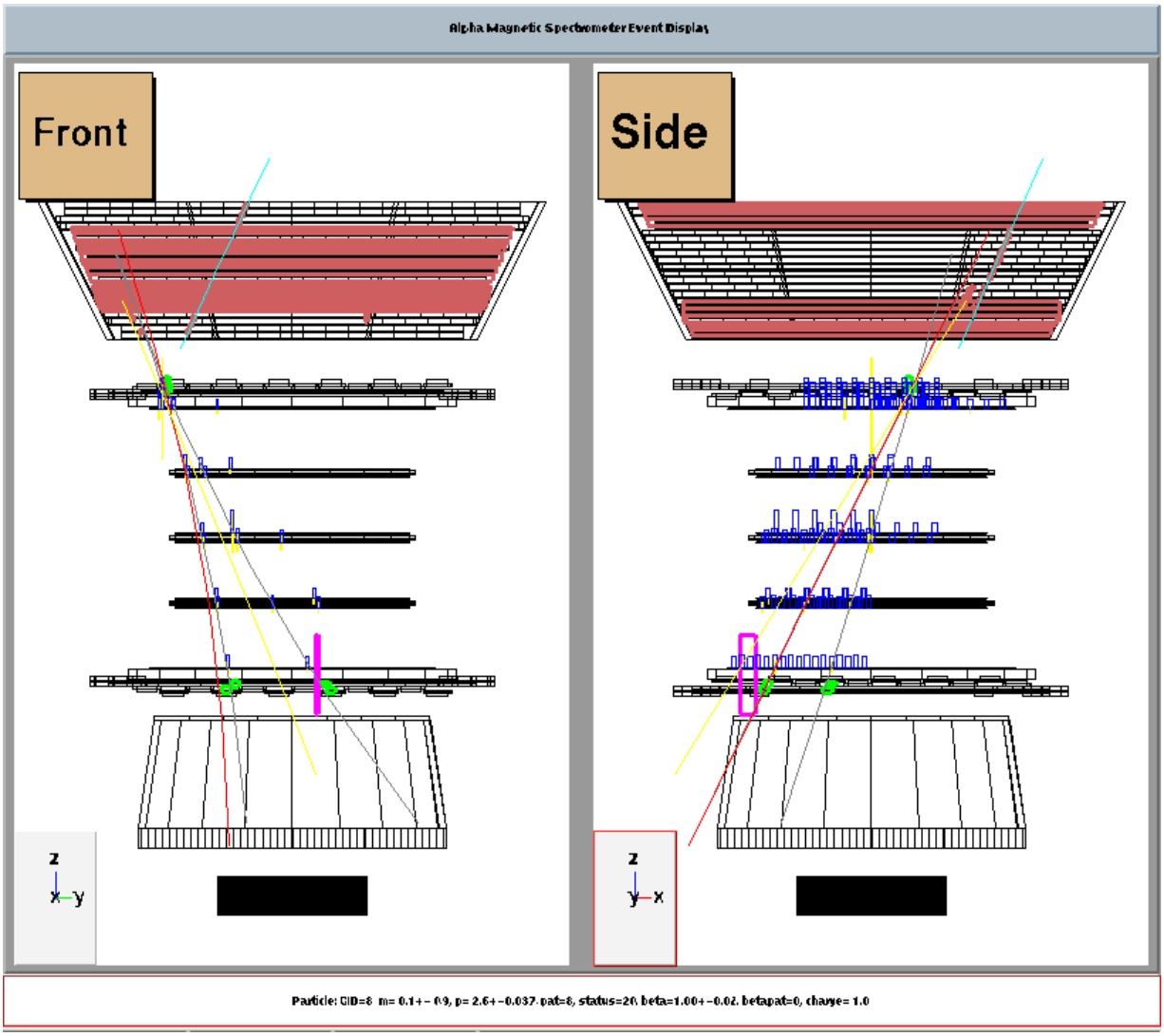


Positron Event Signature

- Positron Signature
  - Measured RICH β compatible with 1.
  - Track with charge +1 in Tracker.
  - TRD dE/dx compatible with electron.
- Proton background signature
  - Hadronic TRD dE/dx.
  - Positive rigidity track in Tracker.
  - RICH β measurement incompatible with 1.
- Electron background signature
  - TRD dE/dx compatible with electron.
  - Track with charge -1 in Tracker.

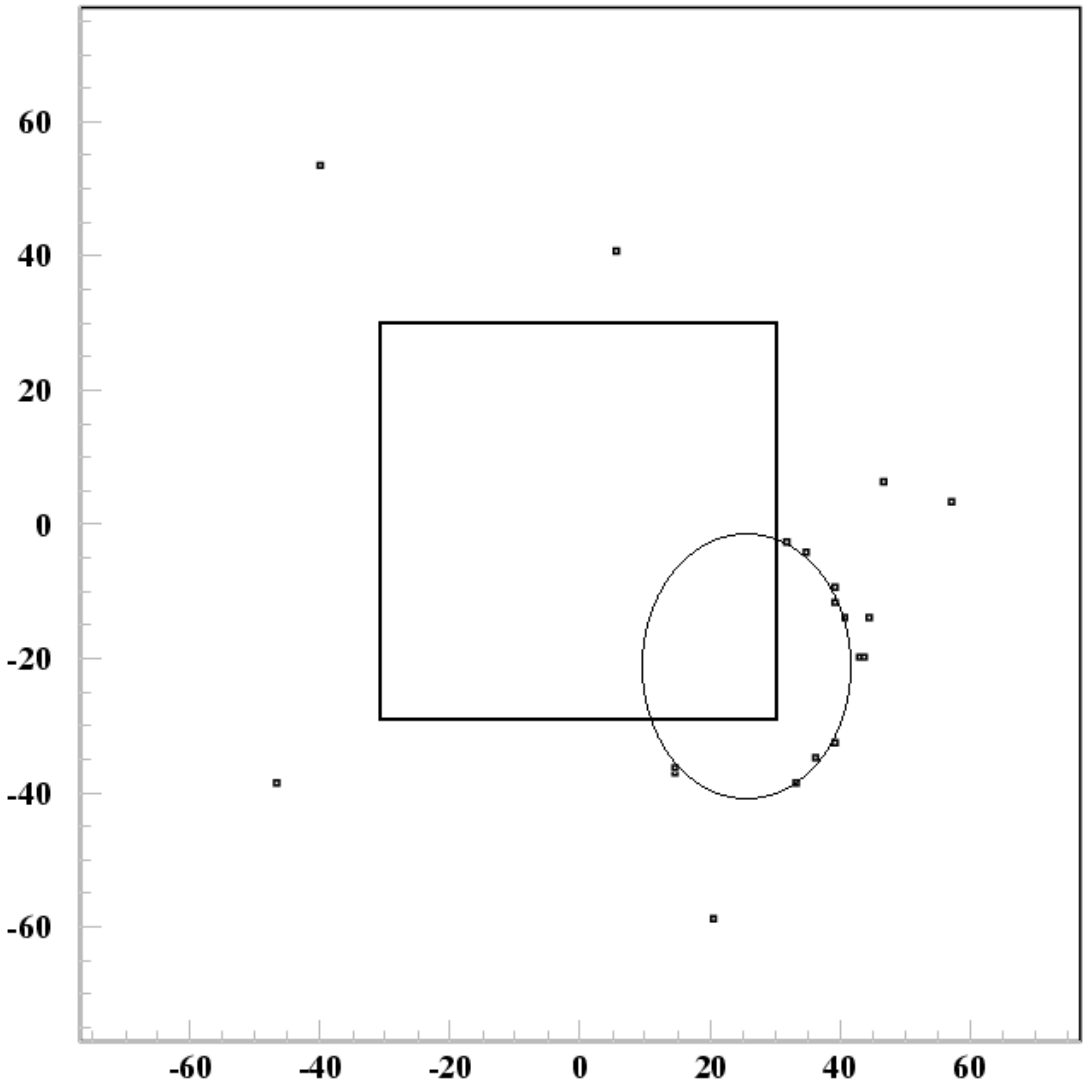
Selection of Positrons

AMS02 event display



Selection of Positrons

RICH event display

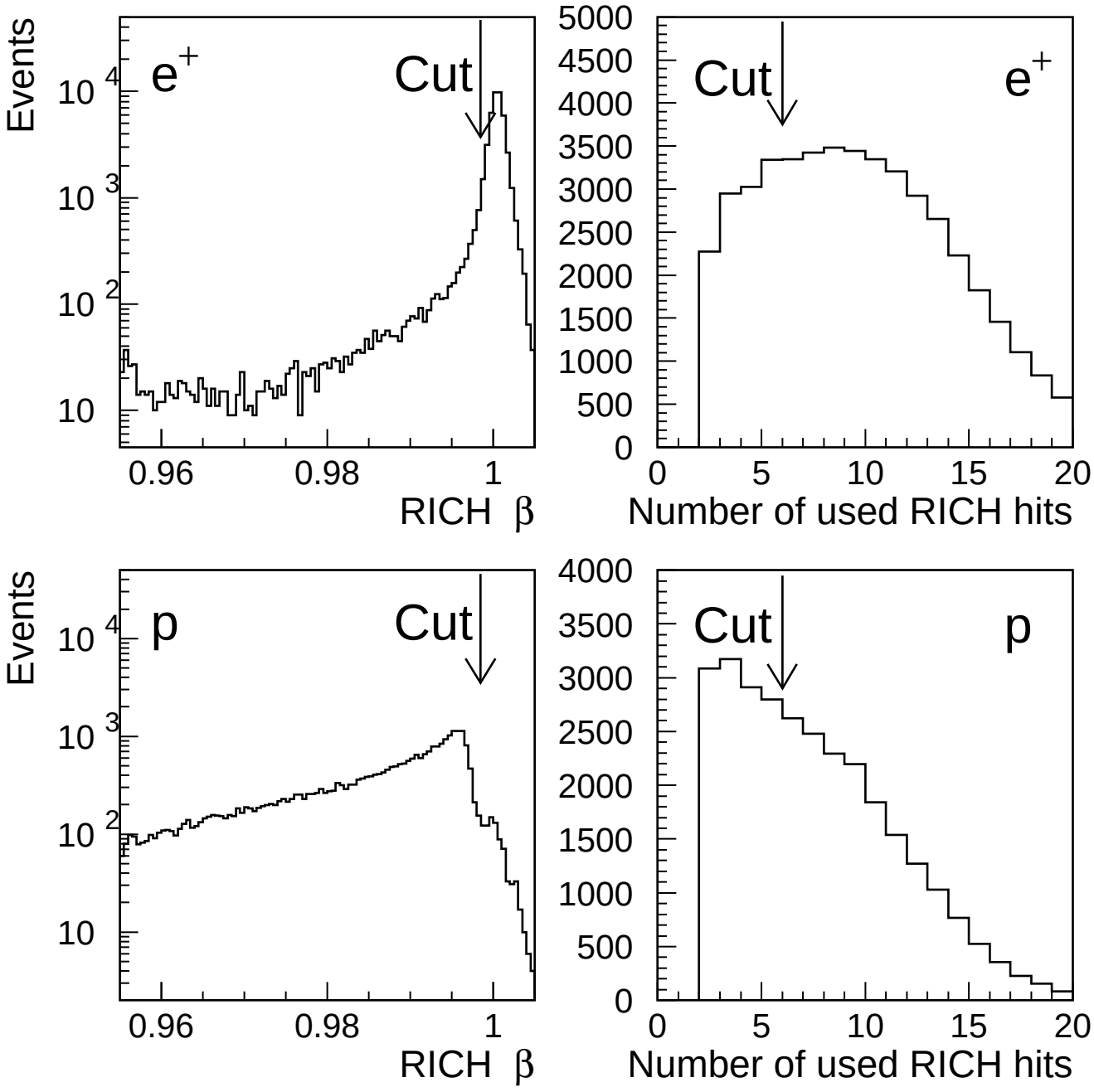


Selection Cuts

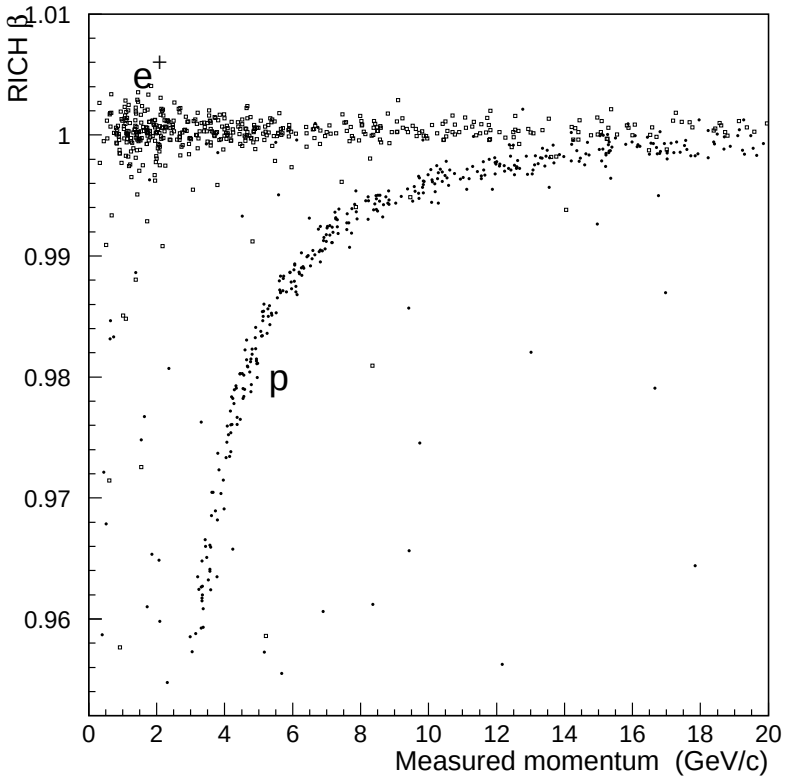
- RICH
  - Measured RICH β >0.9985
  - Number of used hits >6
- Tracker
  - TR reconstructed momentum < 11 GeV/c
  - Number of tracks 0< N_{tr} <3.
  - Number of clusters <23
- TRD, TOF, ANTI
  - Number of TRD clusters with mult.>1, <5.
  - Number of TOF cluster <5
  - Number of ANTI cluster =0 (without ECAL cluster)

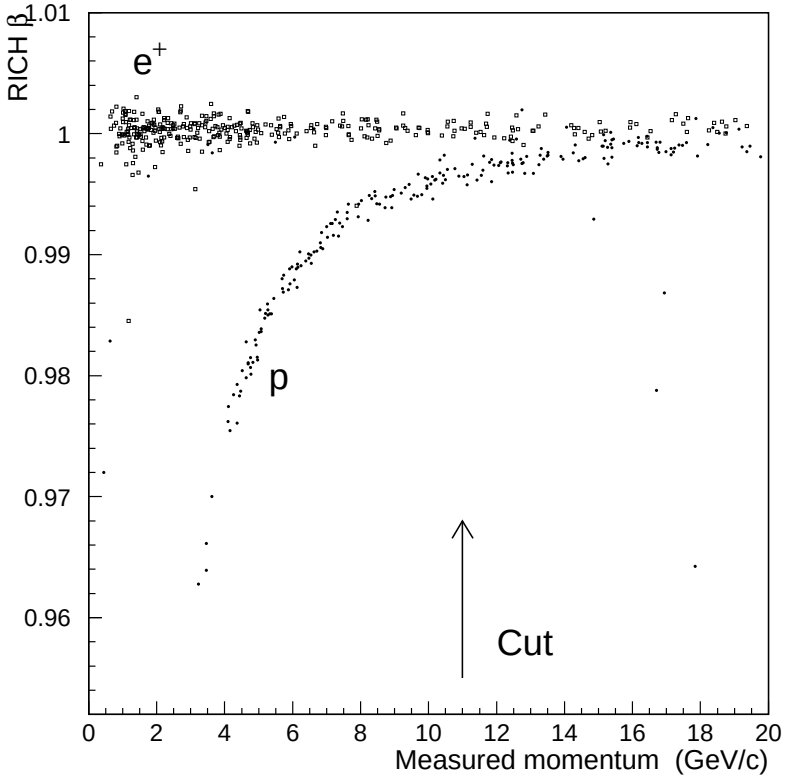
Selection Cuts

RICH $\beta > 0.9985$ Number of used RICH hits > 6



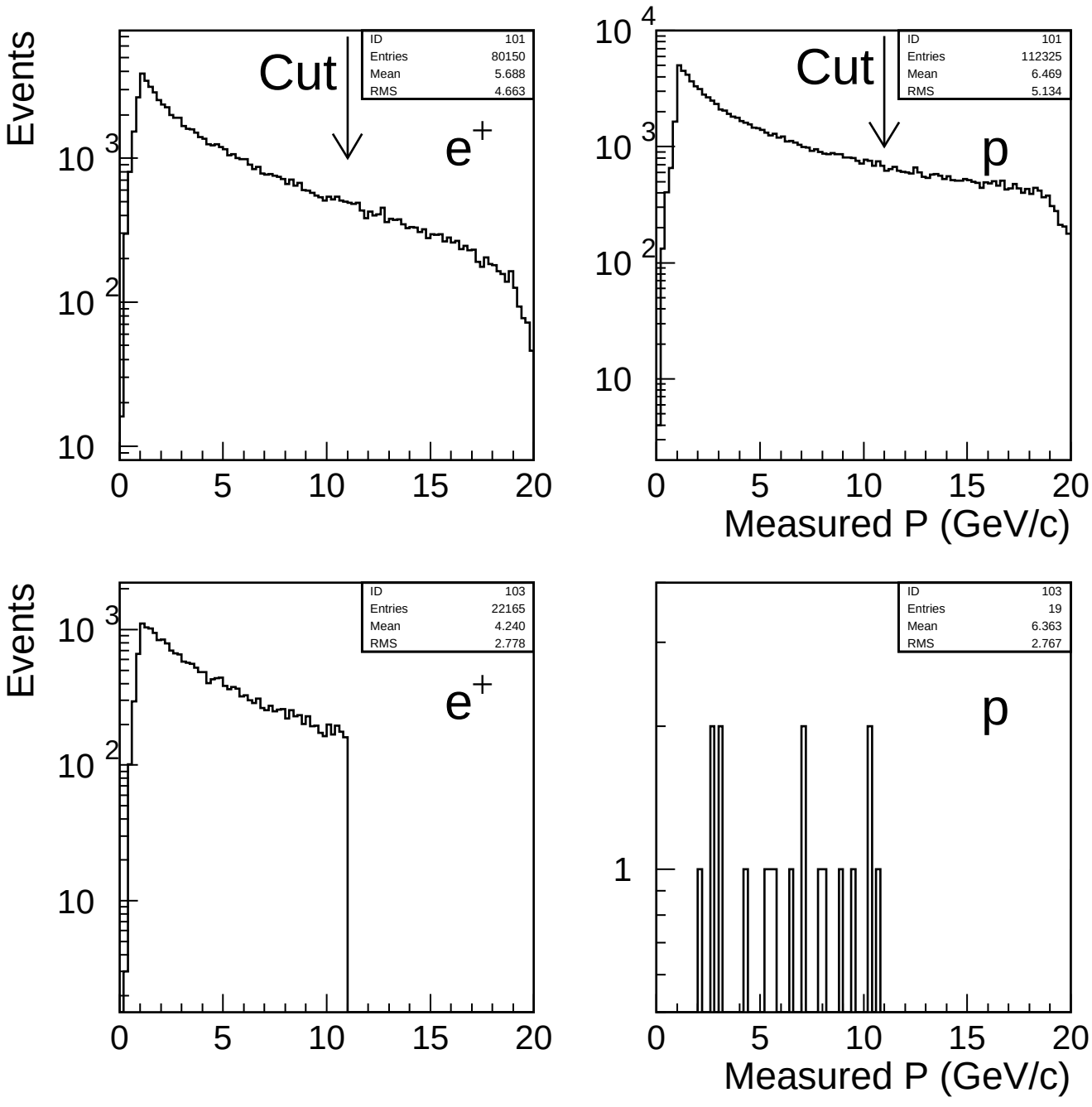
Selection Cuts



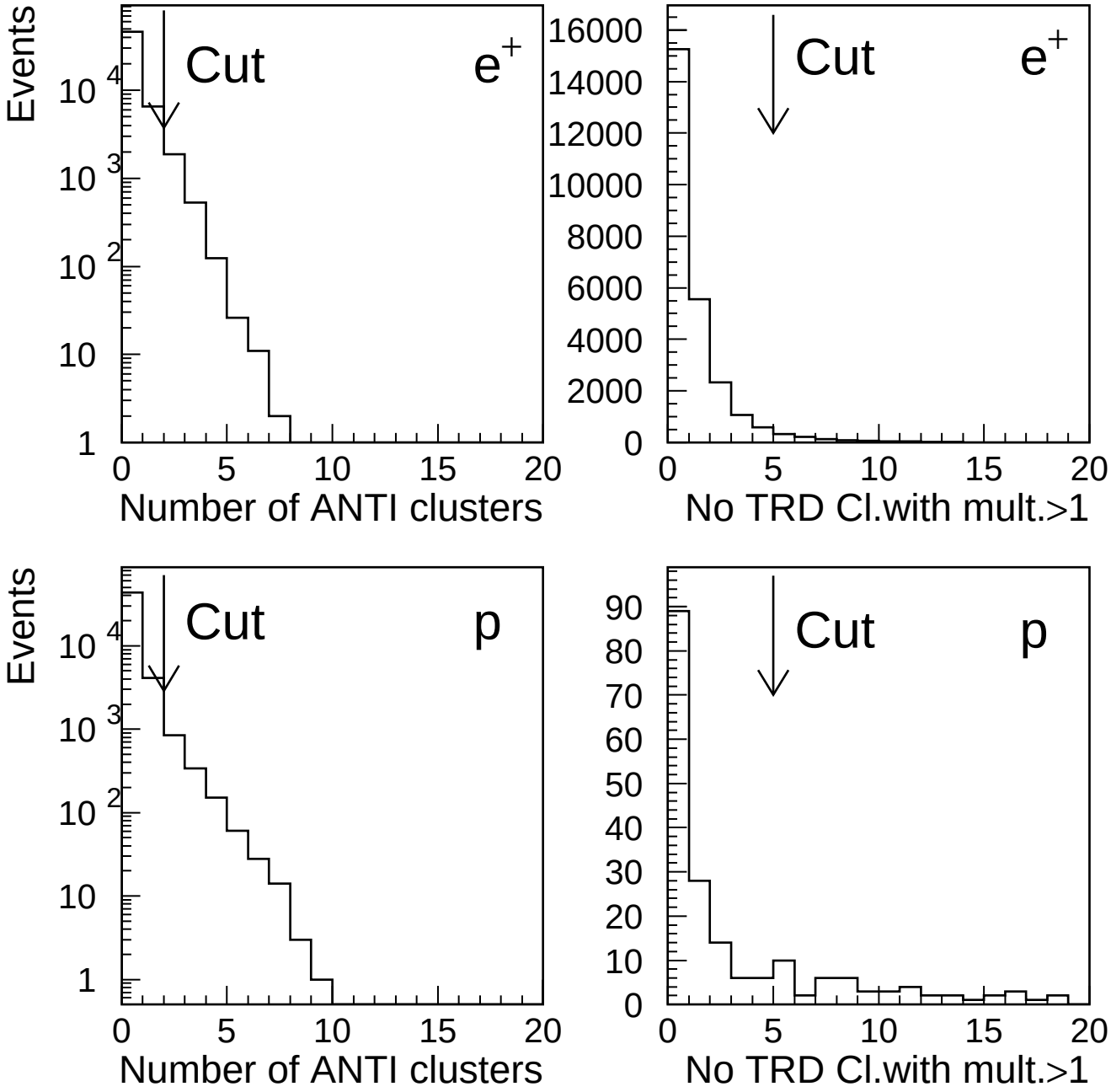


Background Suppression

TR reconstructed momentum < 11 GeV/c

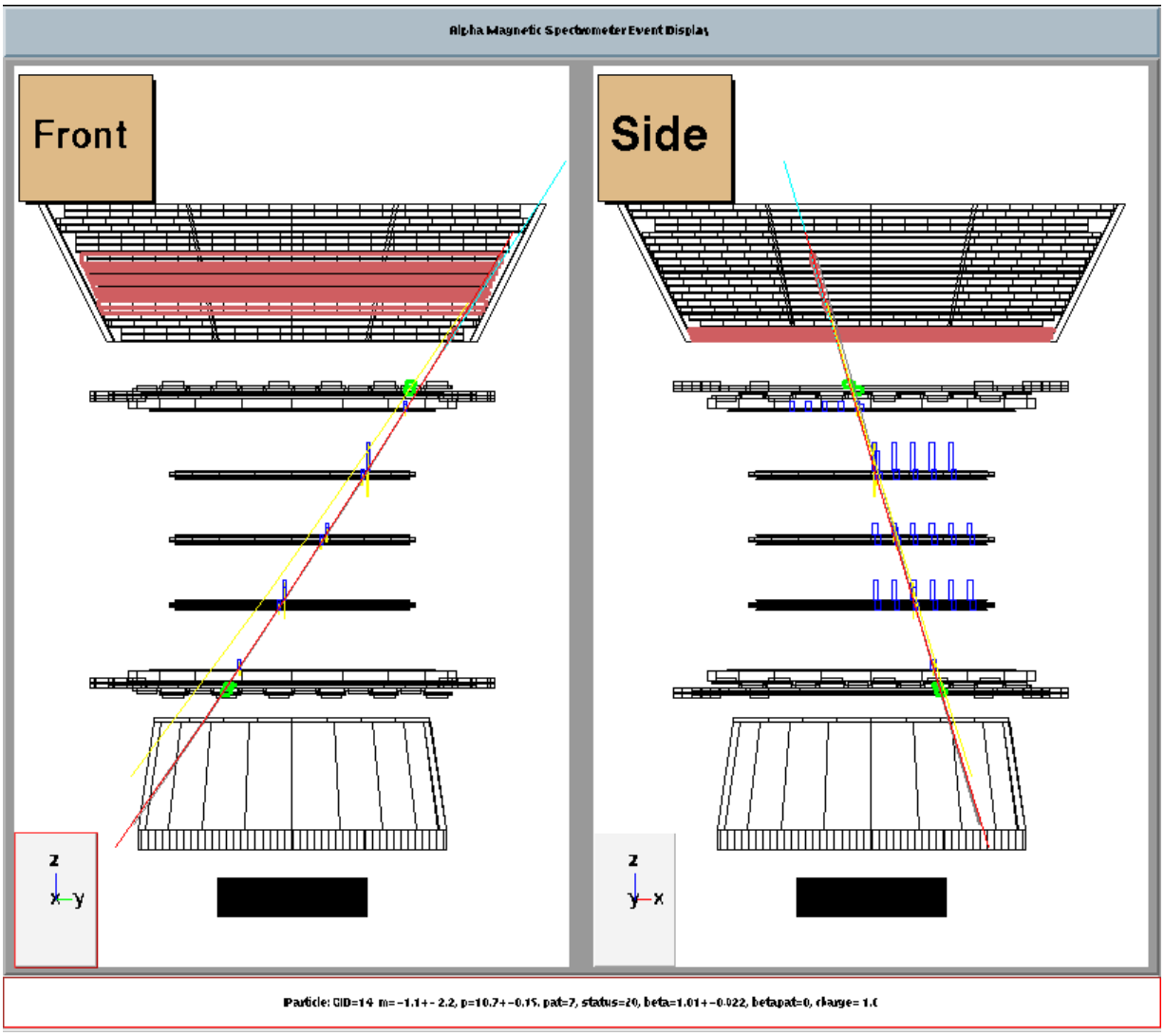


Number of ANTI Counter Clusters < 1 if there is no ECAL Cluster



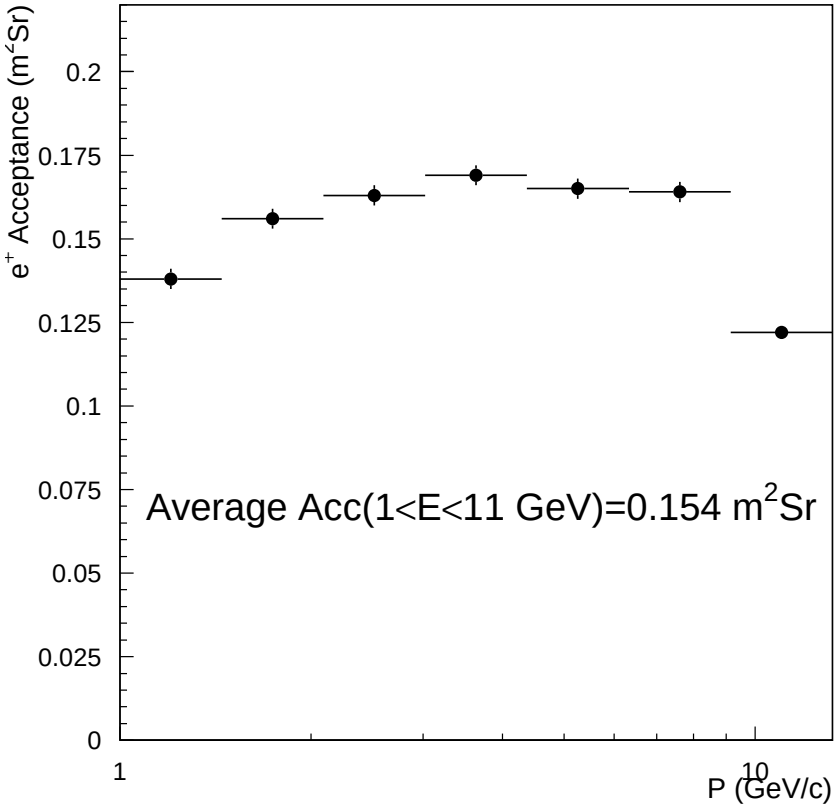
Background Event

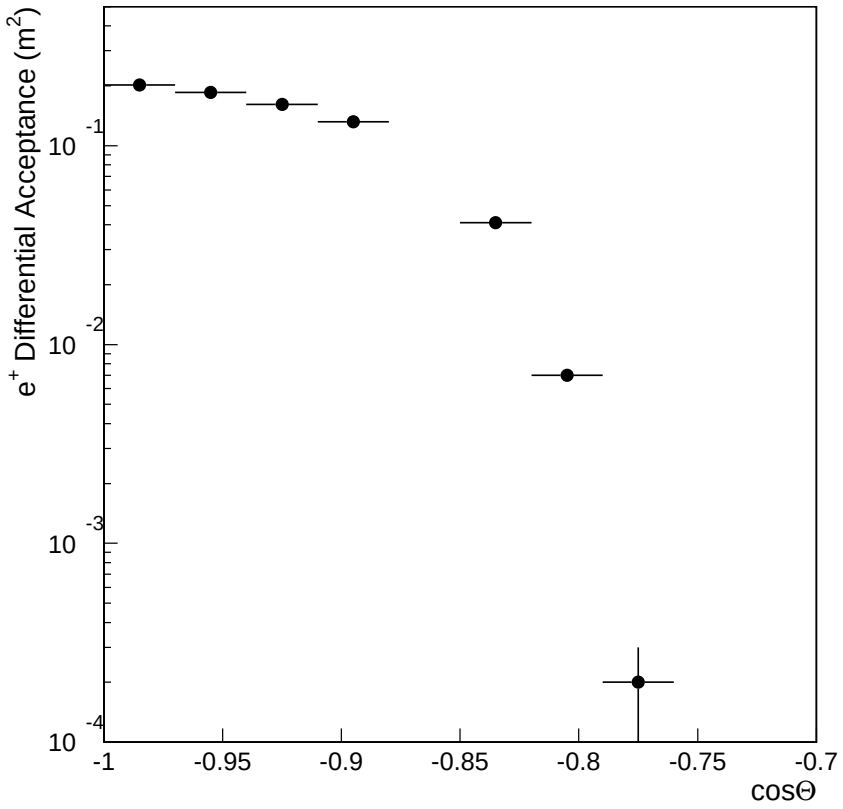
AMS02 event display



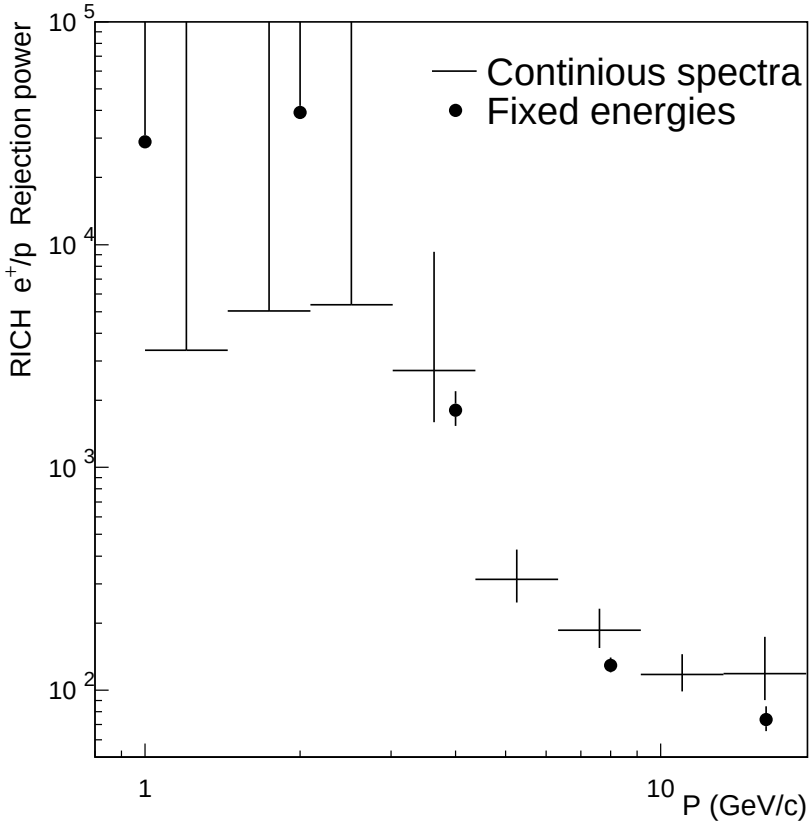
- Run: 140
- Event: 1305354
- Generated momentum: 10.6 GeV/c
- Measured momentum: 10.7 ± 0.15 GeV/c
- RICH Measured β: 1.01 ± 0.0013

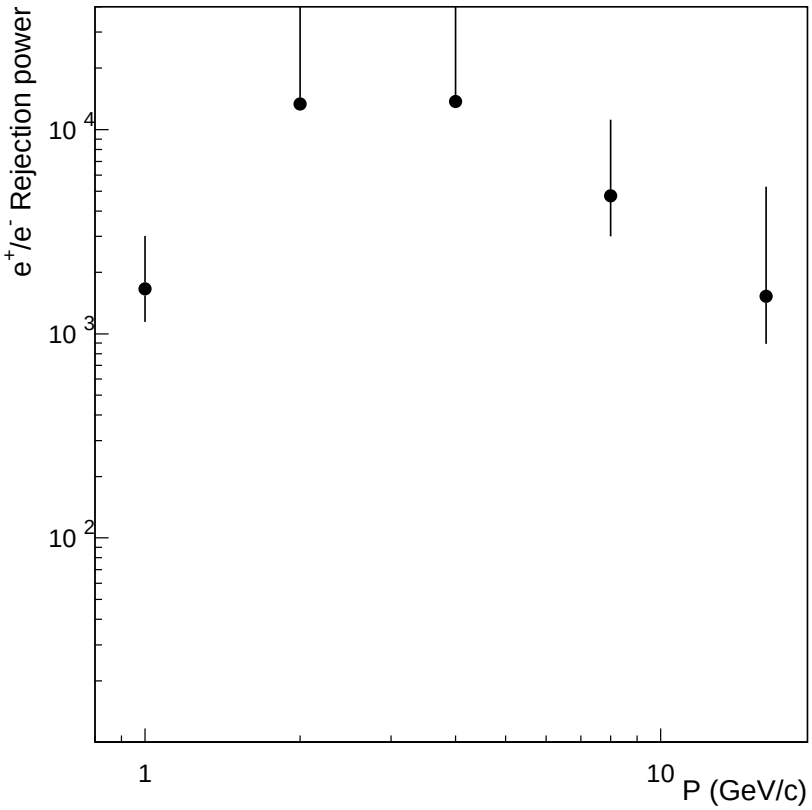
Results

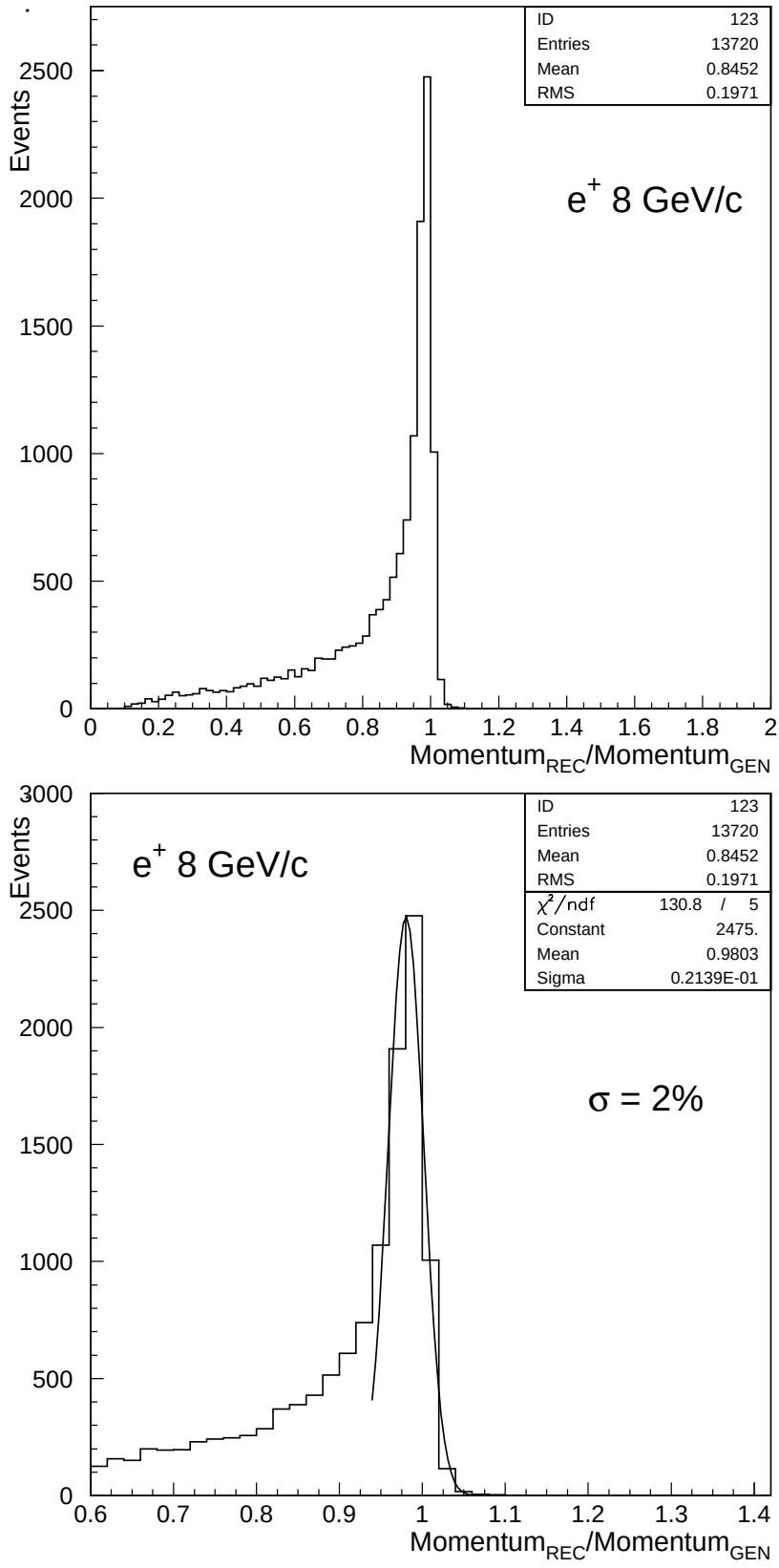

e+ Acceptance (m2Sr)
0.2
0.175
0.15
0.125
0.1
0.075
0.05
0.025
0
Average Acc(1<E<11 GeV)=0.154 m2Sr
1
10
P (GeV/c)

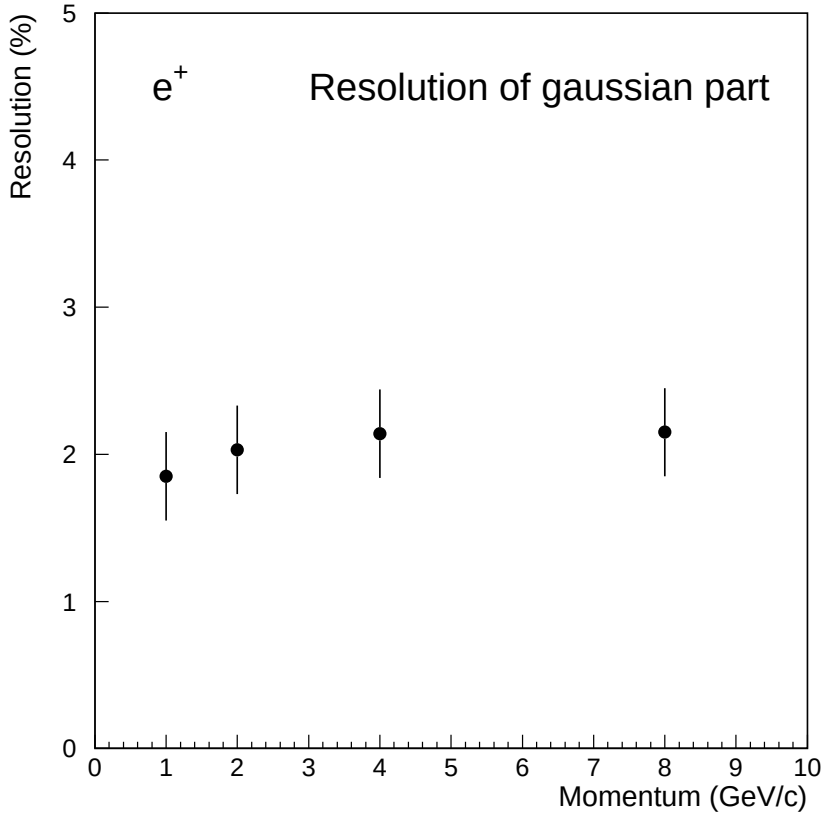

e+ Differential Acceptance (m2)
10-1
10-2
10-3
10-4
-1
-0.95
-0.9
-0.85
-0.8
-0.75
-0.7
cosΘ

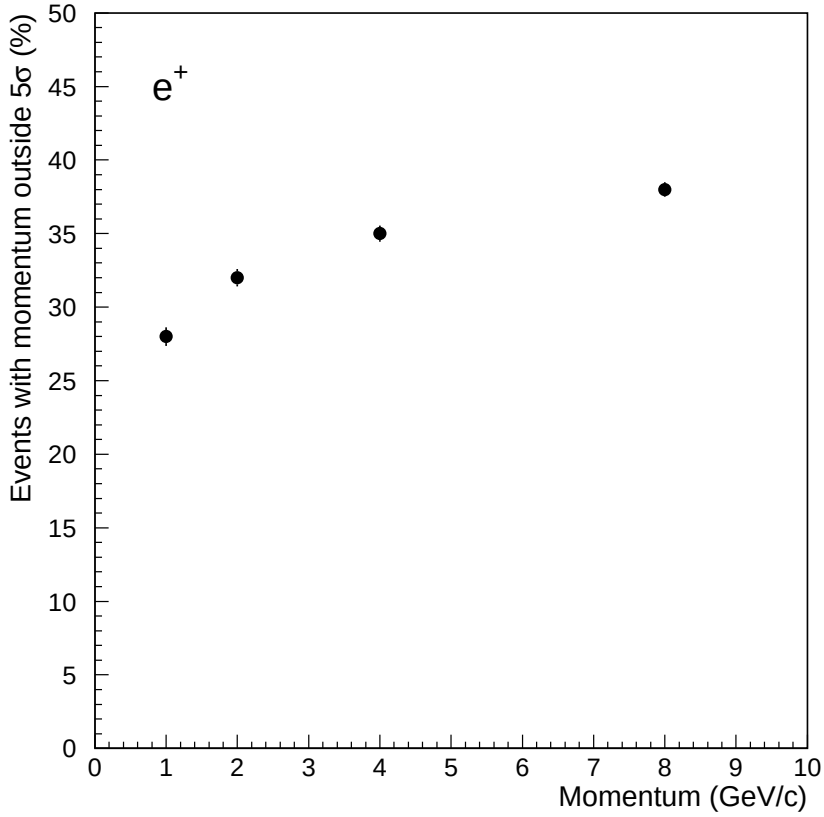
Results


RICH e+/p Rejection power
10 5
10 4
10 3
10 2
Continious spectra
Fixed energies
1
10
P (GeV/c)

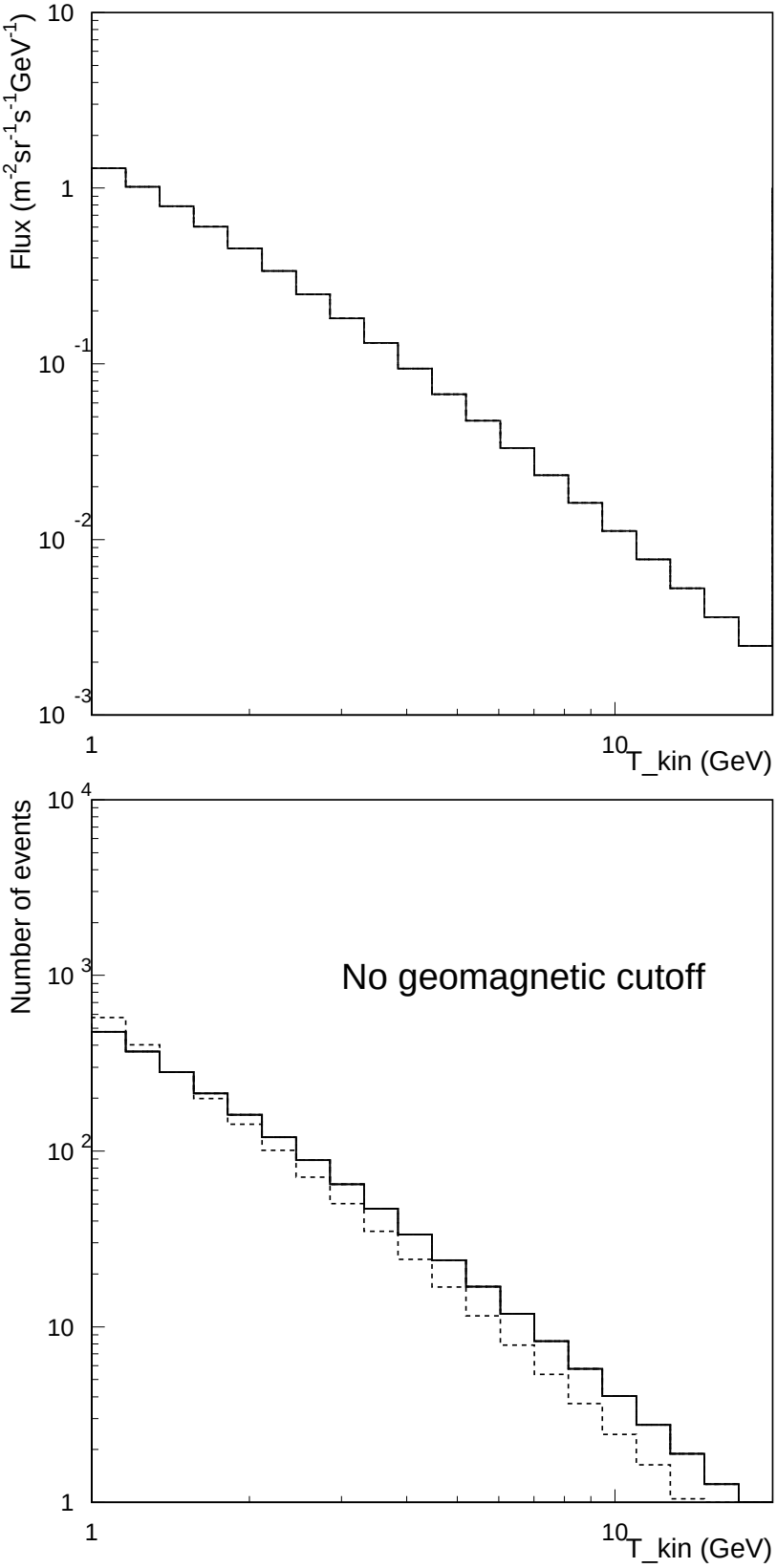

e+/e- Rejection power
10 4
10 3
10 2
1
10
P (GeV/c)


ID 123
Entries 13720
Mean 0.8452
RMS 0.1971
e+ 8 GeV/c
Events
Momentum_REC/Momentum_GEN
ID 123
Entries 13720
Mean 0.8452
RMS 0.1971
χ²/ndf 130.8 / 5
Constant 2475.
Mean 0.9803
Sigma 0.2139E-01
e+ 8 GeV/c
σ = 2%
Events
Momentum_REC/Momentum_GEN


e+
Resolution of gaussian part
Resolution (%)
Momentum (GeV/c)


e+
Events with momentum outside 5σ (%)
Momentum (GeV/c)

Results


Flux (m^{-2}sr^{-1}s^{-1}GeV^{-1})
10
1
10^{-1}
10^{-2}
10^{-3}
1
10
T_kin (GeV)
Number of events
10^{4}
10^{3}
10^{2}
10
1
No geomagnetic cutoff
1
10
T_kin (GeV)

Summary

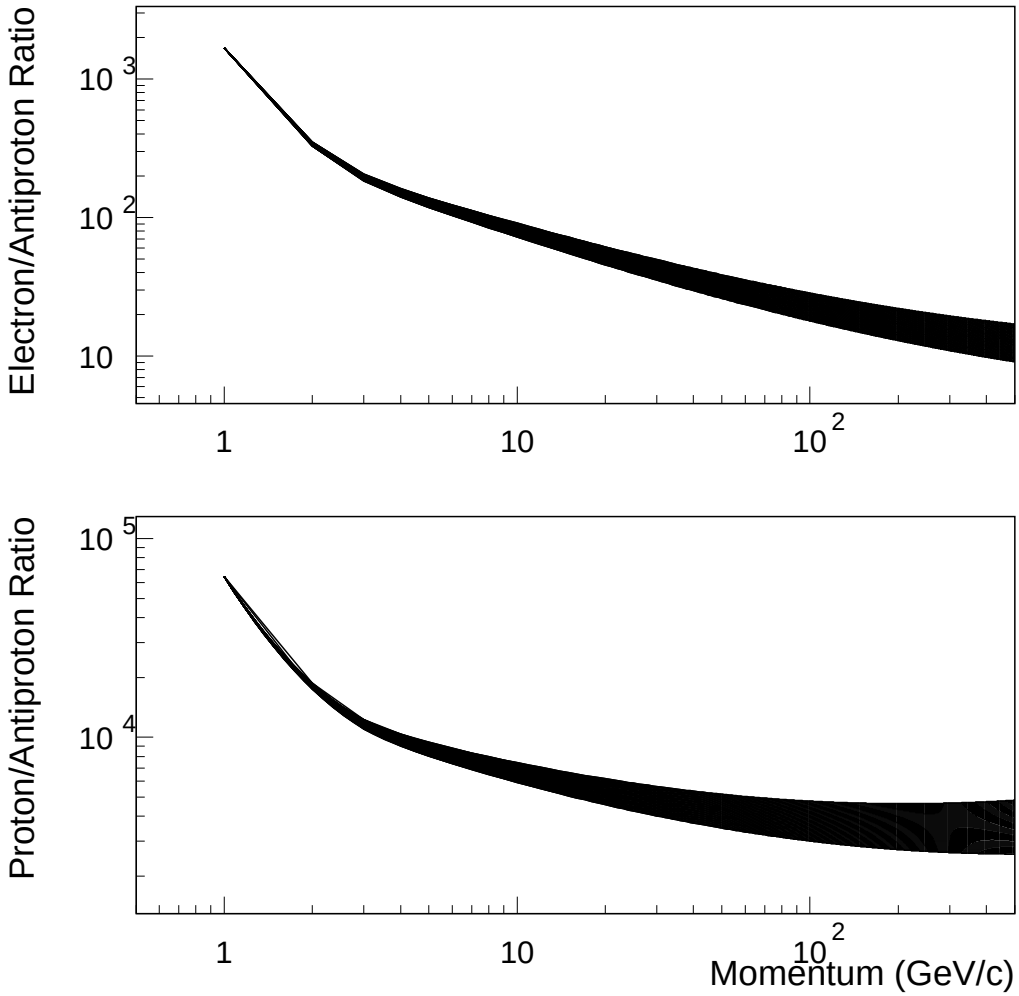
- A Positron identification and background rejection MC study was performed for AMS02 at RICH energy scale.
- The average AMS02 acceptance of 0.154 m^2Sr was obtained when the RICH and TRD information is used in selection.
- The e^+/p rejection factor in excess of 10^3 was achieved without TRD energy cut (TRD multiplicity cut only was used to remove interactions).
- The e^+/e^- background rejection factor is around 10^4.
- A possibility to use Tracker e^+ momentum measurement to estimate its initial energy should be further investigated.

MC Event Sample

Antiproton signal study

- 2.5×10^7 Antiprotons, continious spectrum 1-200 GeV
- 2.8×10^7 Electrons each 1, 2, 4, 8, 16, 32, 64 GeV
- 9.0×10^6 Protons, continious spectrum 1-40 GeV
- 3.5×10^8 Protons each 1, 2, 4, 8, 16, 32, 64 GeV

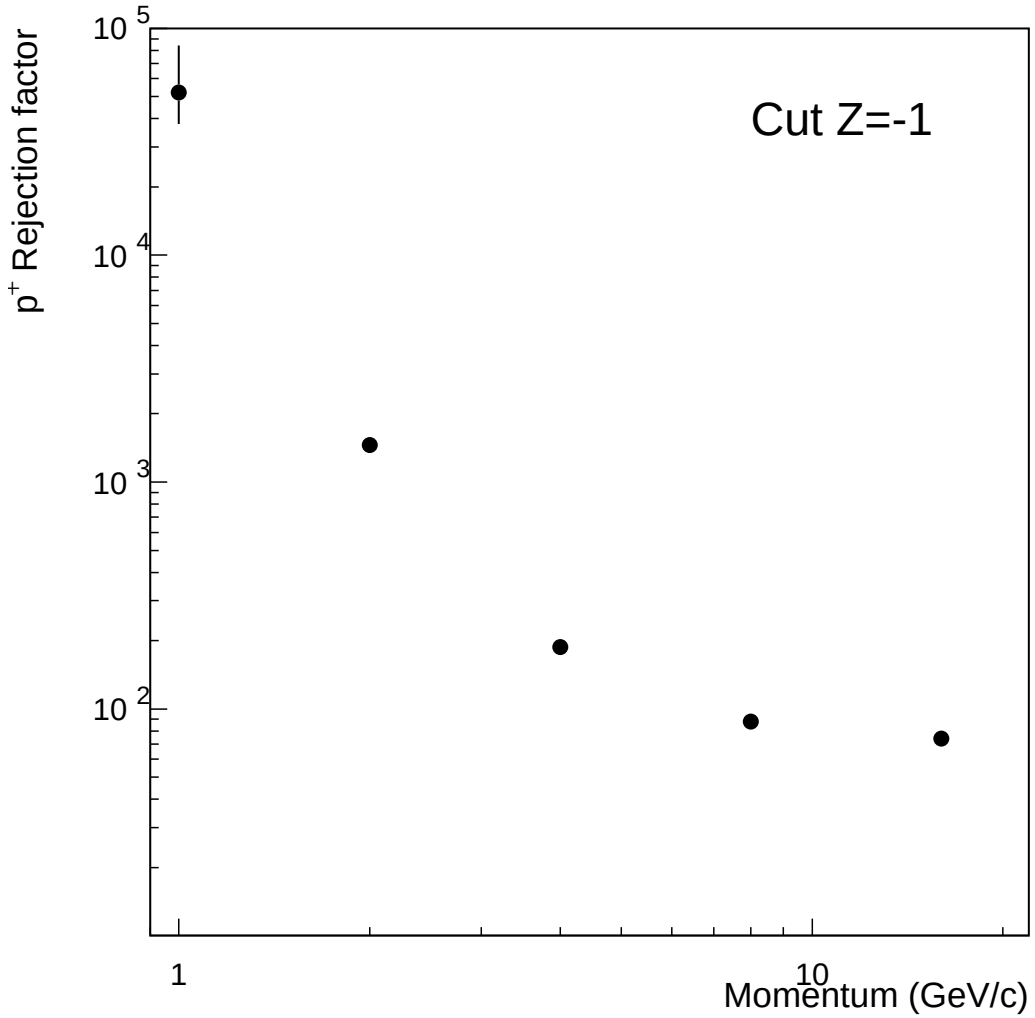
The main sources of background



Positron Event Signature

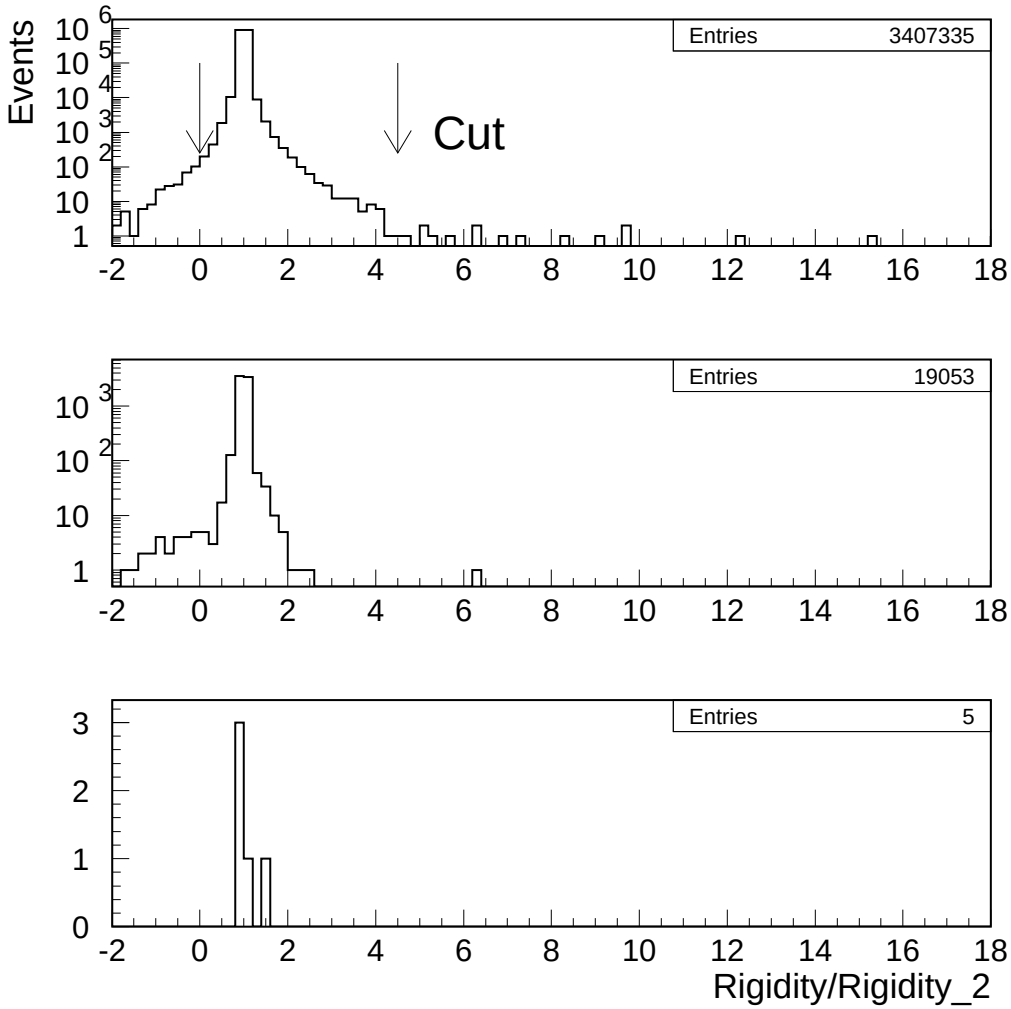
- Antiproton Signature
  - Negative charge sign events Z=-1
  - Mass compatible with a proton
  - TRD dE/dx incompatible with electron.
- Proton background signature
  - Events with wrong rigidity measurement
  - Events with interactions
- Electron background signature
  - Events with low TRD radiation.
  - Events with wrong velocity measurement

Proton backrgound rejection



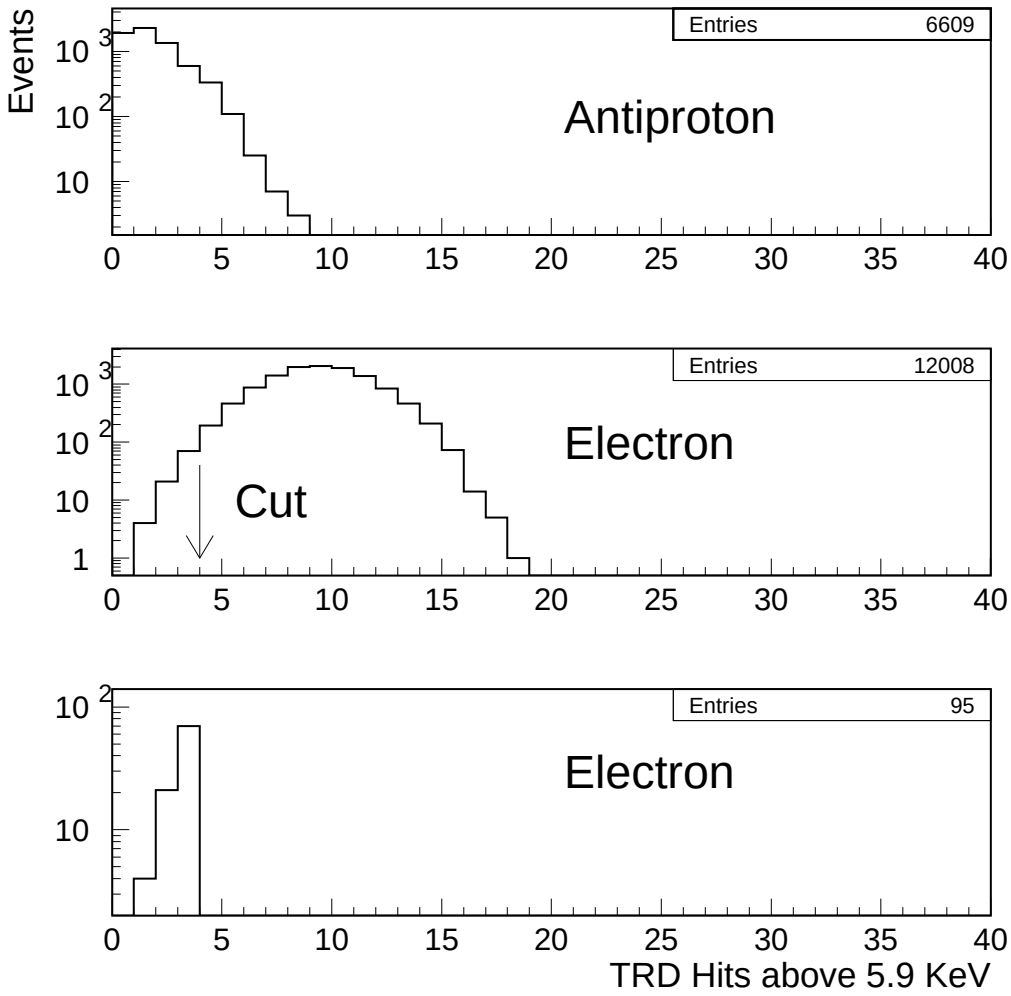
Selection cuts

Proton backrgound rejection



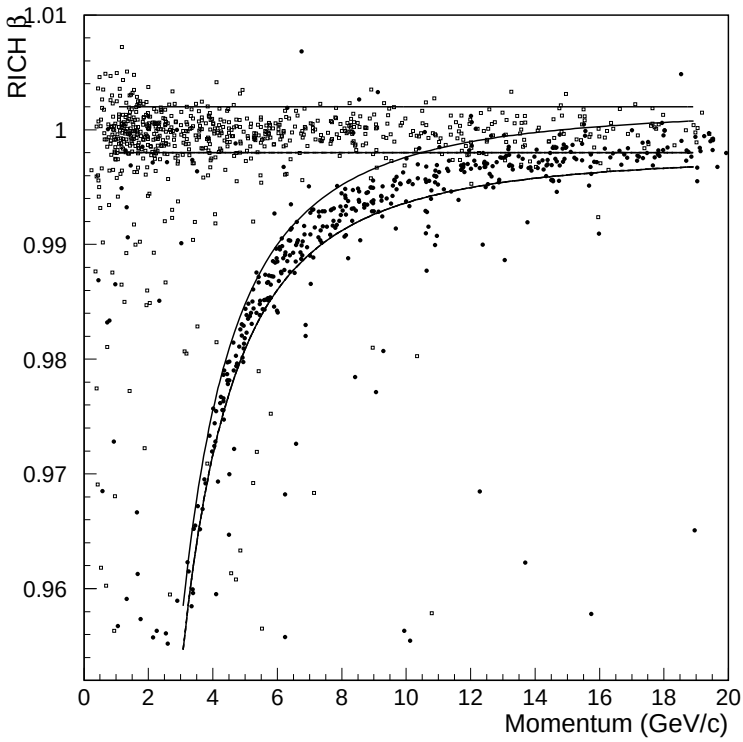
Cut events with interactions and wrong rigidity

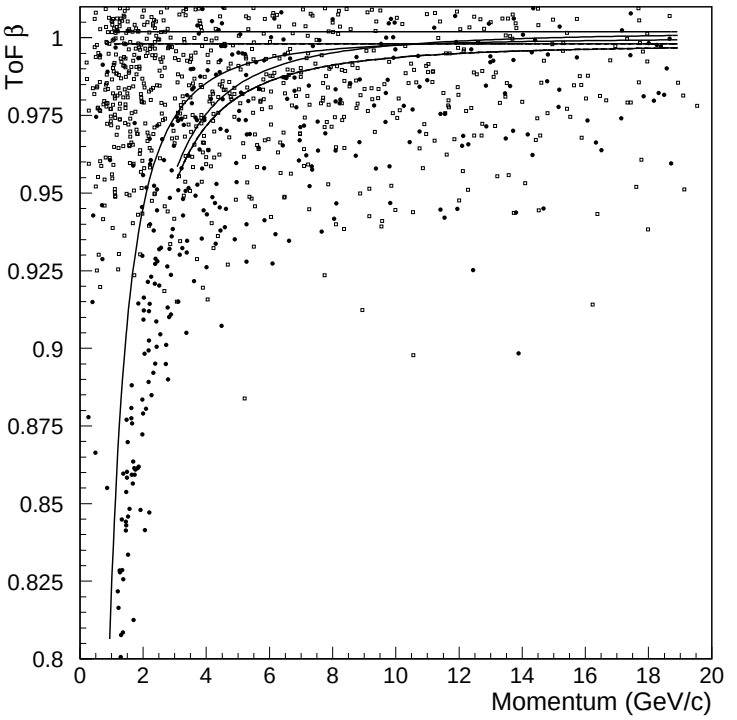
Electron backrgound rejection



Number of TRD Clusters $(E_{dep} > 5.9KeV)$ **<4**

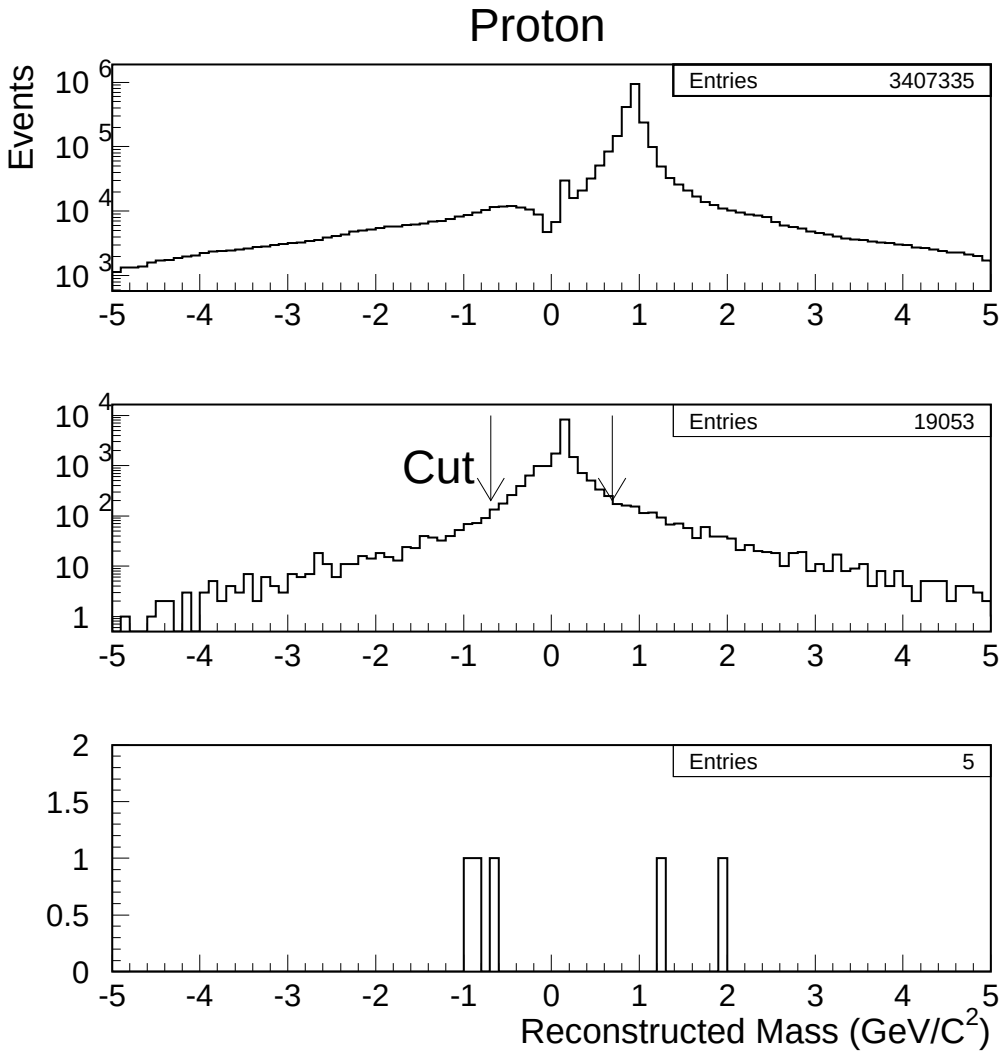
Selection Cuts





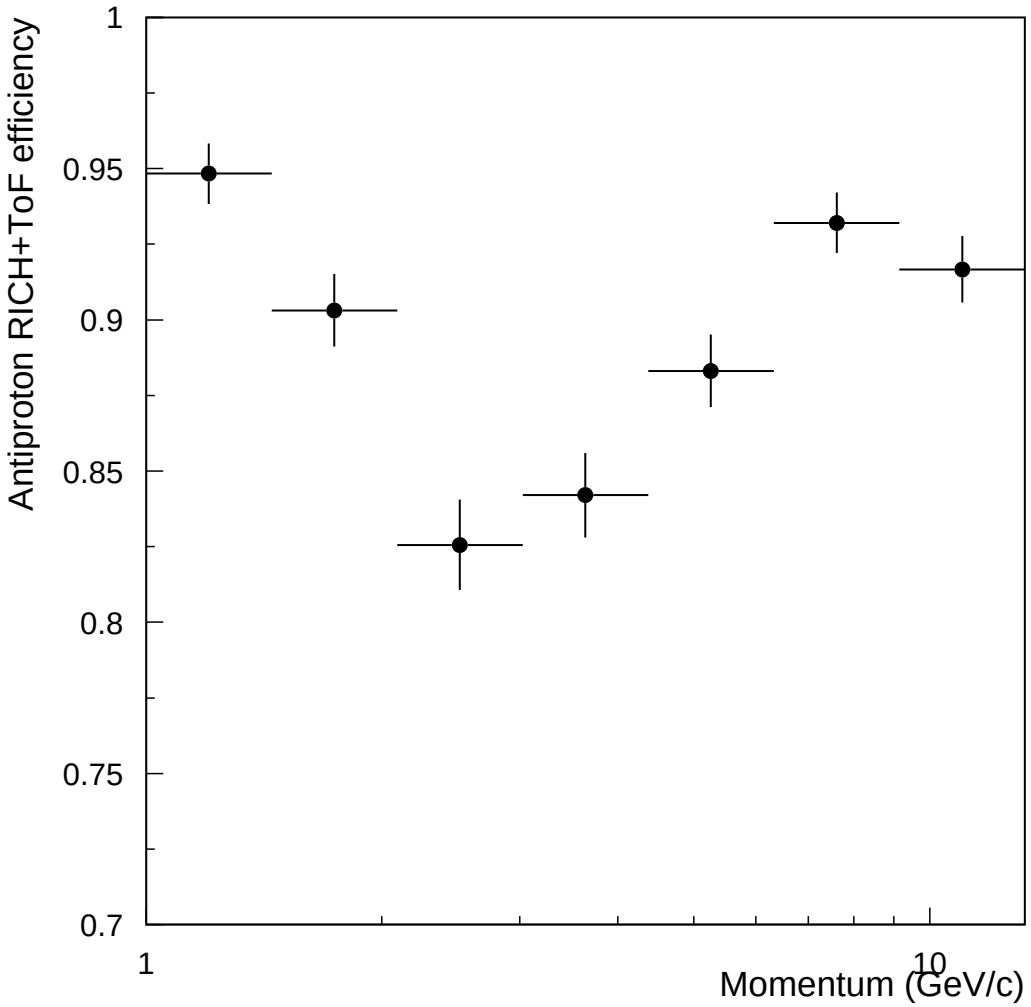
RICH and ToF velocity measurements

Backrgound rejection



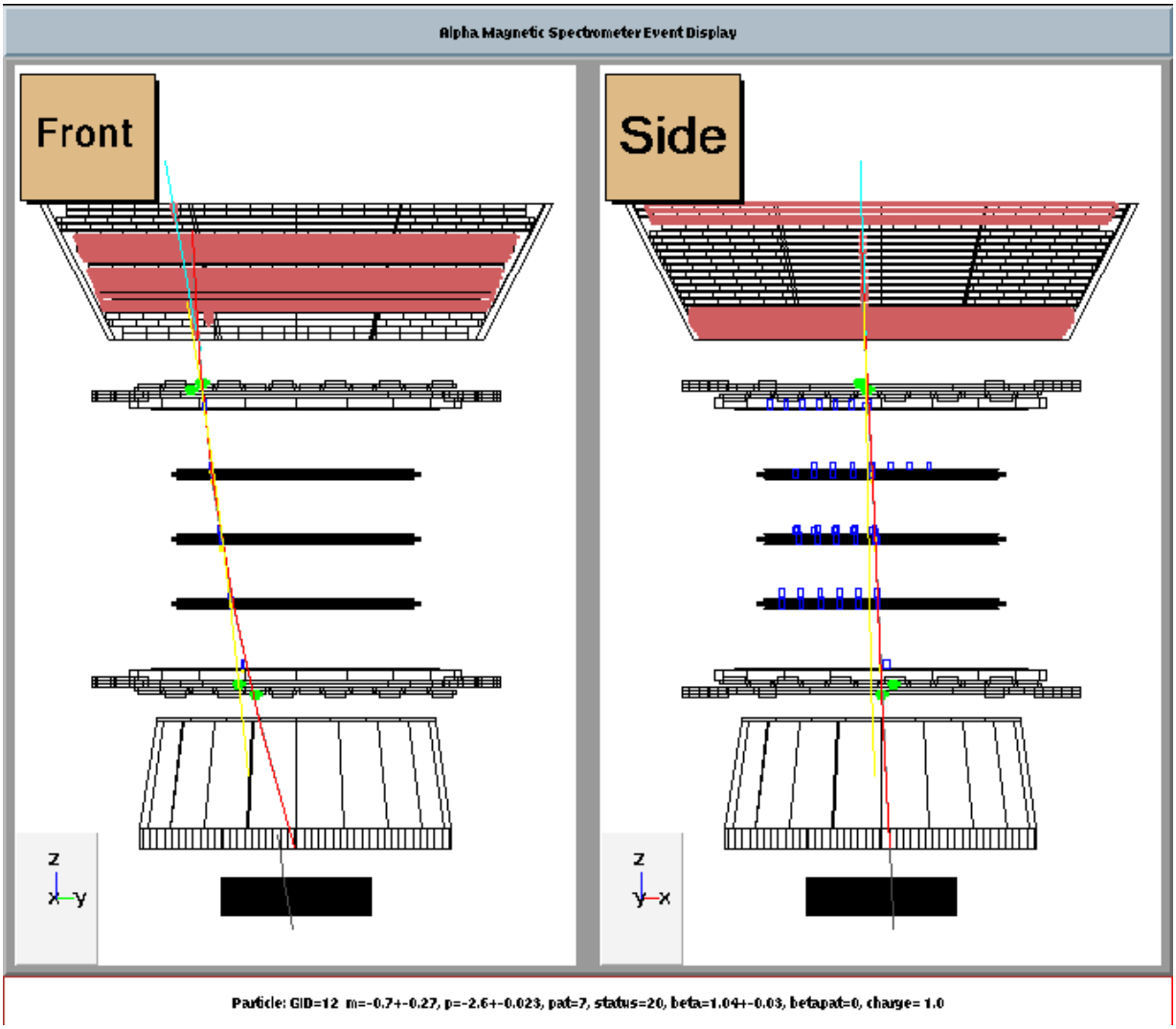
Cut events with Rec.Mass <690 MeV/c^2

Backrgound rejection



Selected Background Event

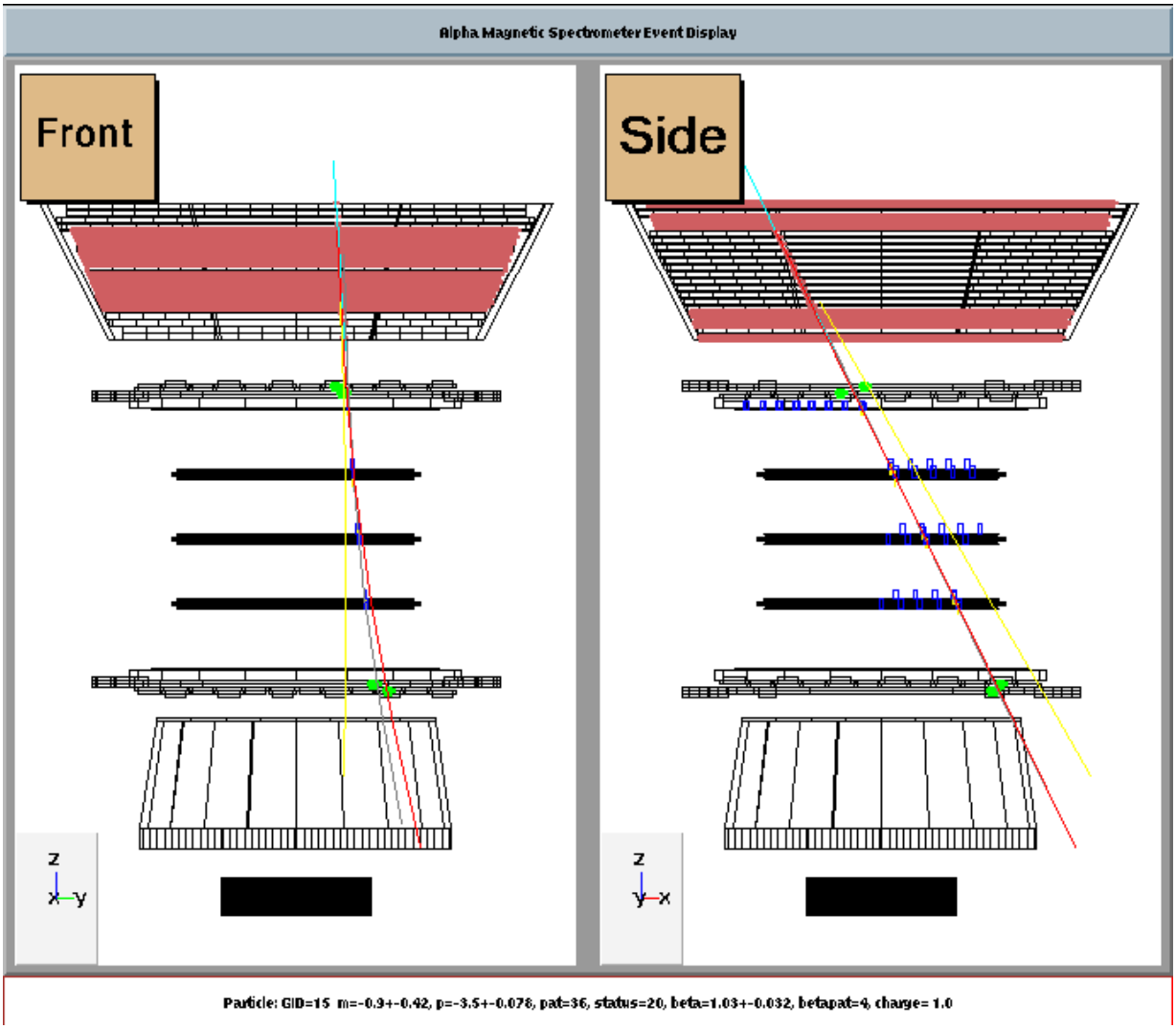
AMS02 event display



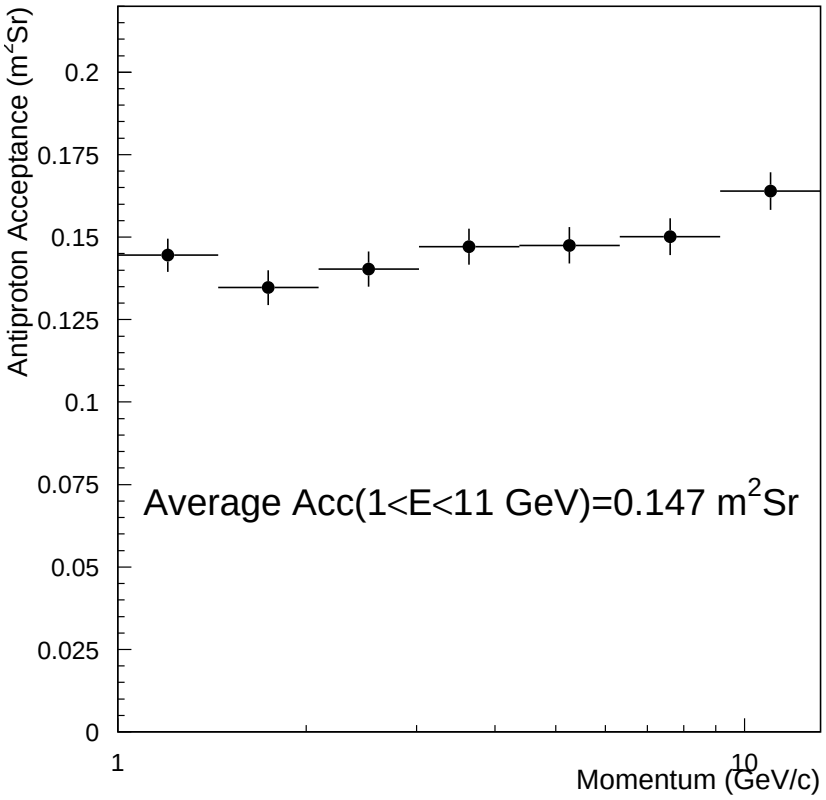
- Run: 114203122
- Event: 32106
- Generated momentum: 8.0 GeV/c
- Measured rigidity: -2.6 ± 0.023 GeV/c
- Reconstructed mass: -0.7 ± 0.27

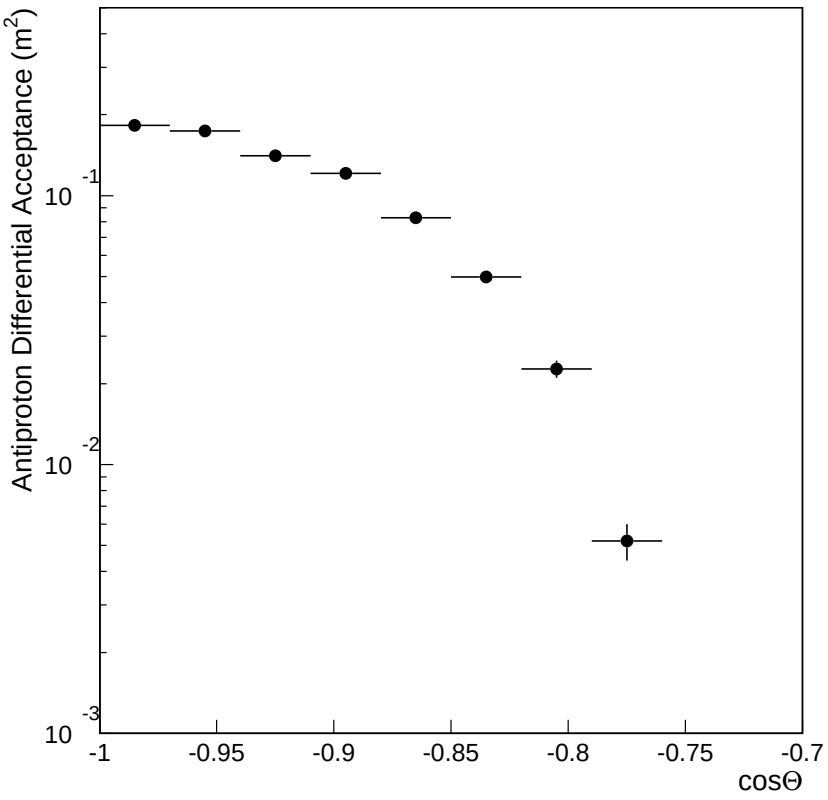
Selected Background Event

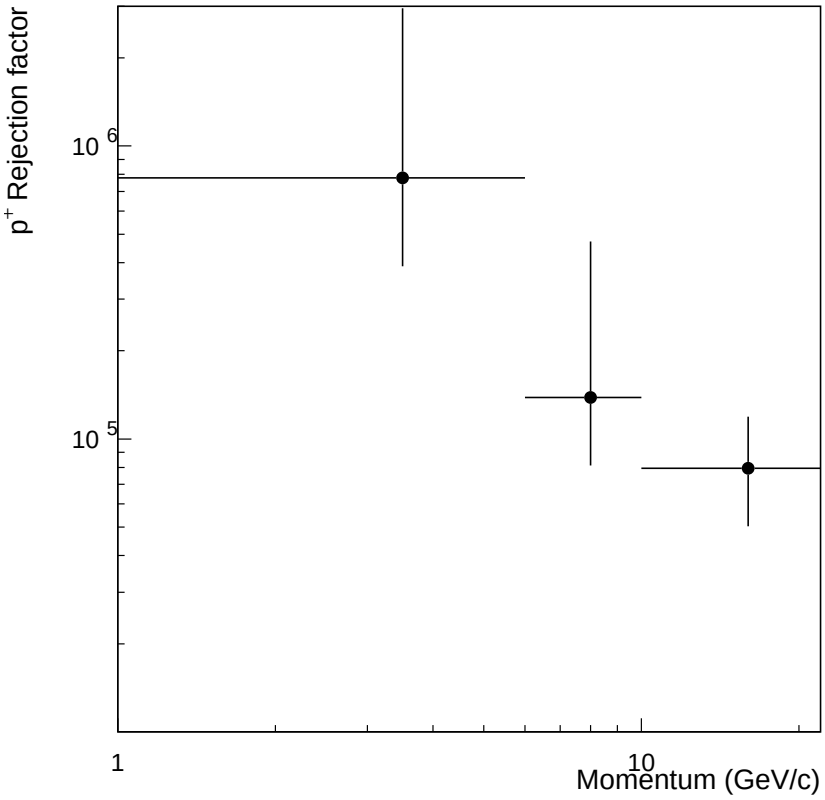
AMS02 event display

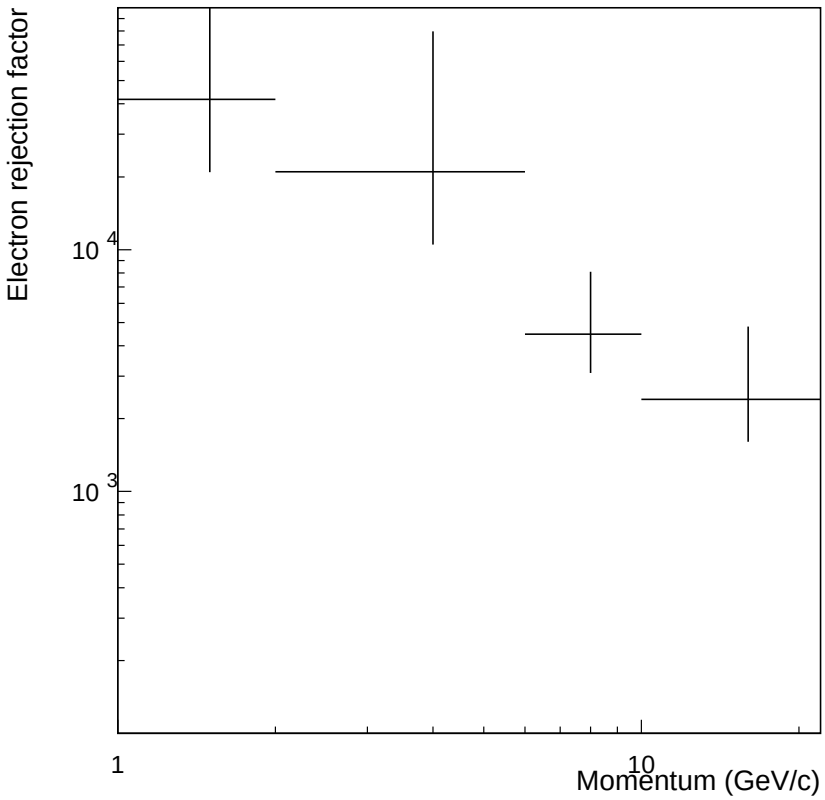


- Run: 114203279
- Event: 94664
- Generated momentum: 8.0 GeV/c
- Measured rigidity: -3.5 ± 0.078 GeV/c
- Reconstructed mass: -0.9 ± 0.042

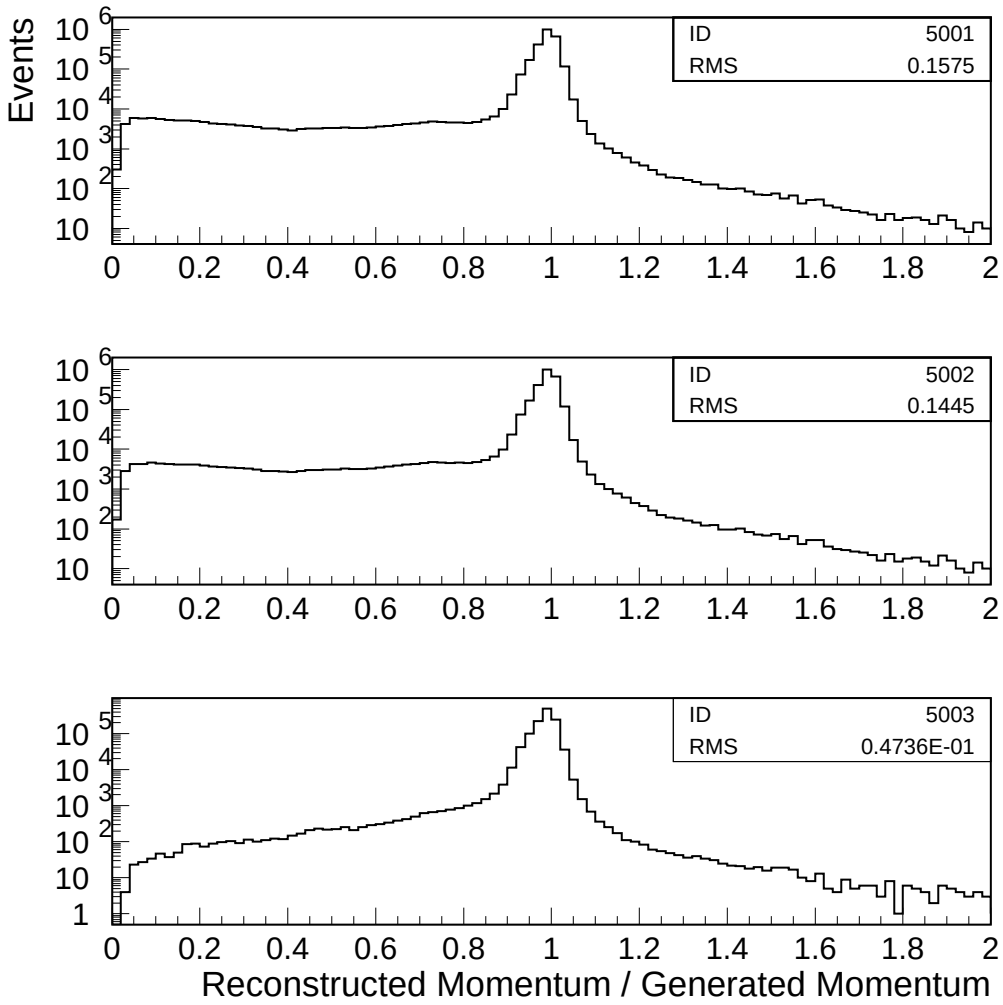

Antiproton Acceptance (m´Sr)
0.2
0.175
0.15
0.125
0.1
0.075
0.05
0.025
0
Average Acc(1<E<11 GeV)=0.147 m²Sr
1
10
Momentum (GeV/c)


Antiproton Differential Acceptance (m²)
10⁻¹
10⁻²
10⁻³
-1
-0.95
-0.9
-0.85
-0.8
-0.75
-0.7
cosΘ


p+ Rejection factor
10 6
10 5
1
10
Momentum (GeV/c)

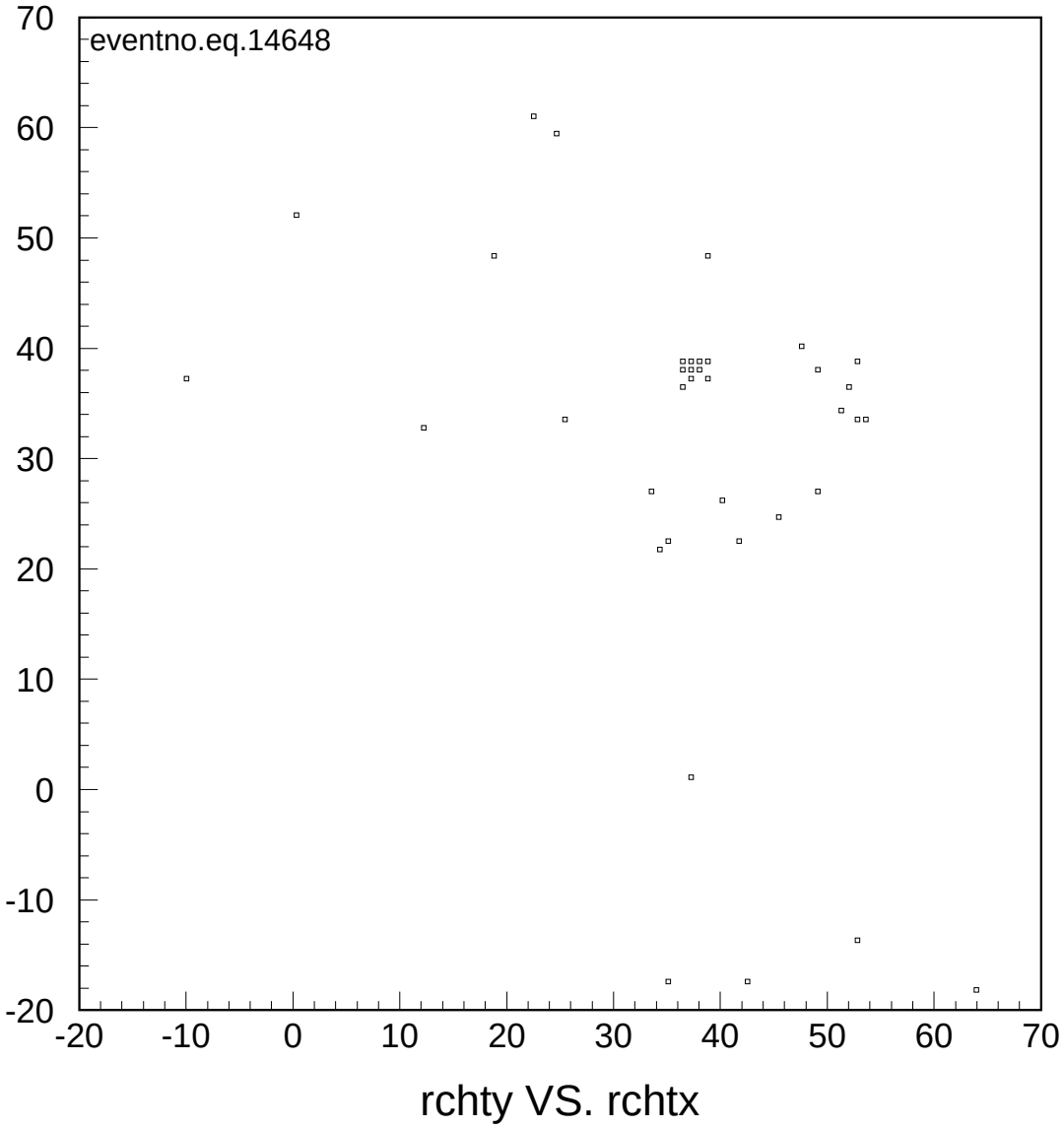

Electron rejection factor
10 4
10 3
1
10
Momentum (GeV/c)

Antiproton momentum reconstruction



Resolution function

Electron event 14648 RICH Hits



"Matrix" event example with RICH used hits >6