Cuts on momentum reconstruction for antideuteron analysis

M.Sapinski November 30, 2005

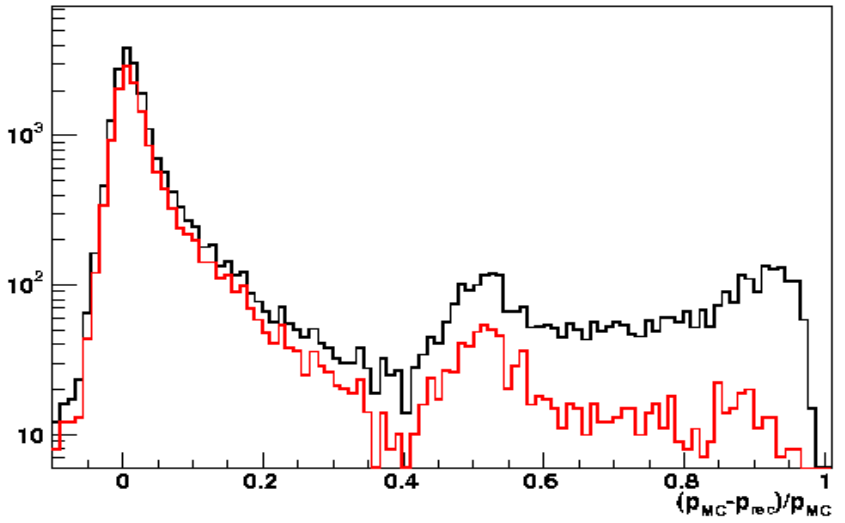
Goals

- Optimize momentum reconstruction,
  ie. $(p_{MC} - p_{rec})/p_{MC}$
- Assure good reconstruction of the sign of charge
- Reject events which have complicated topology due to scattering
- Reject events with scattering which can spoil measurement in the downstream detectors (TOF, RICH, ECAL)
- Reject events with mathematically wrong reconstruction (χ^2)
- Reject background events

Preselection

- Zero clusters in Anticoincidence Counters
- One AMS-Particle
- with beta mesurement
- with track measurement in TRK and TRD
- with |Z|=1

Already preselection removes lot of events with wrongly reconstructed momentum

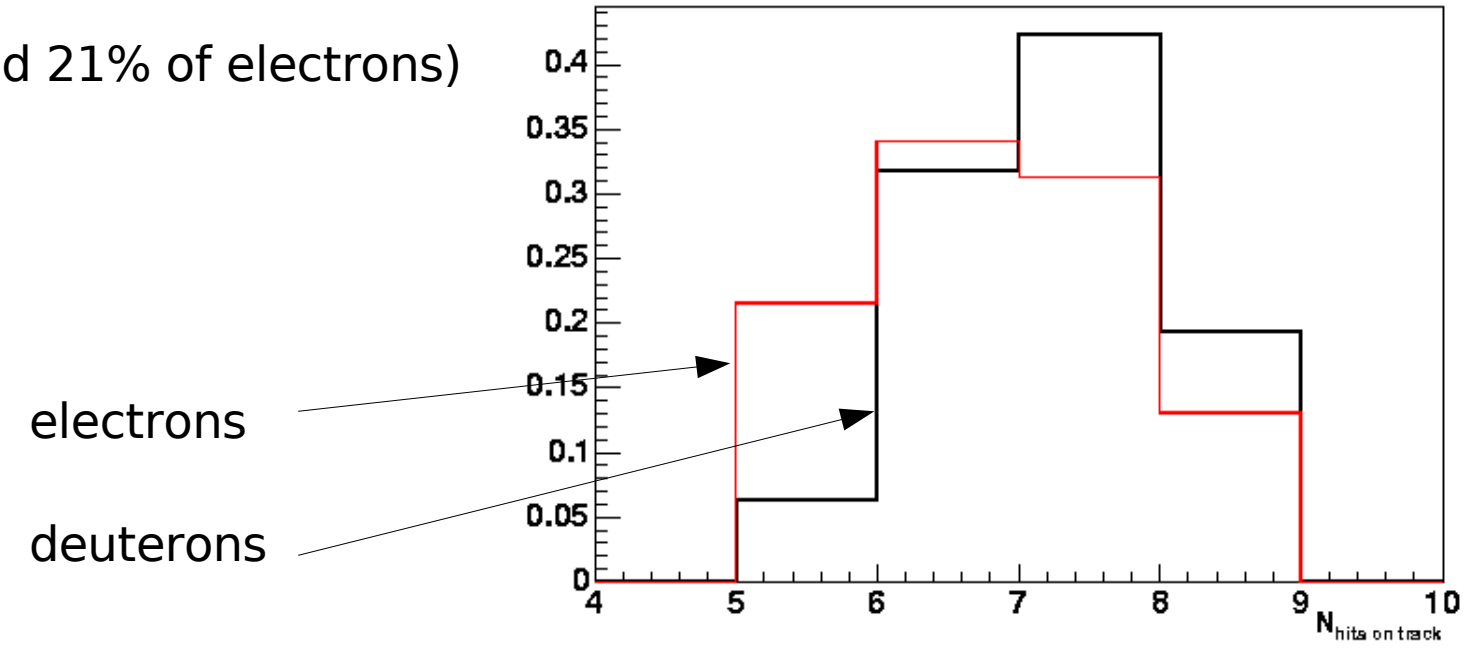


Cut on number of hits used in track

- Nhits>5
- It does not improve momentum resolution
- But helps to reject electrons and antiprotons paying low price in efficiency

- 5 hits: 6.6% (and 21% of electrons)
- 6 hits: 32.8%
- 7 hits: 40.2 %
- 8 hits: 20.4 %

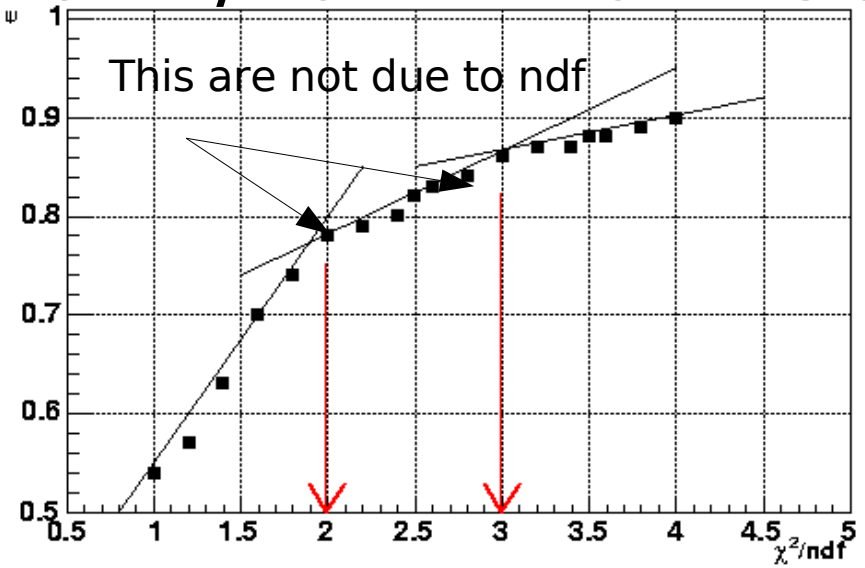
ε=93.4%

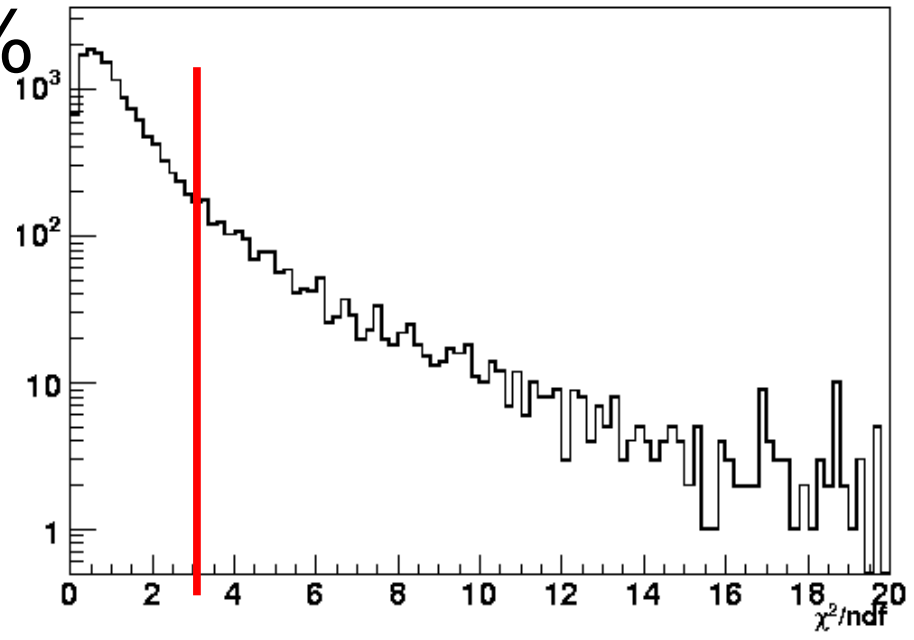


chi2 cut

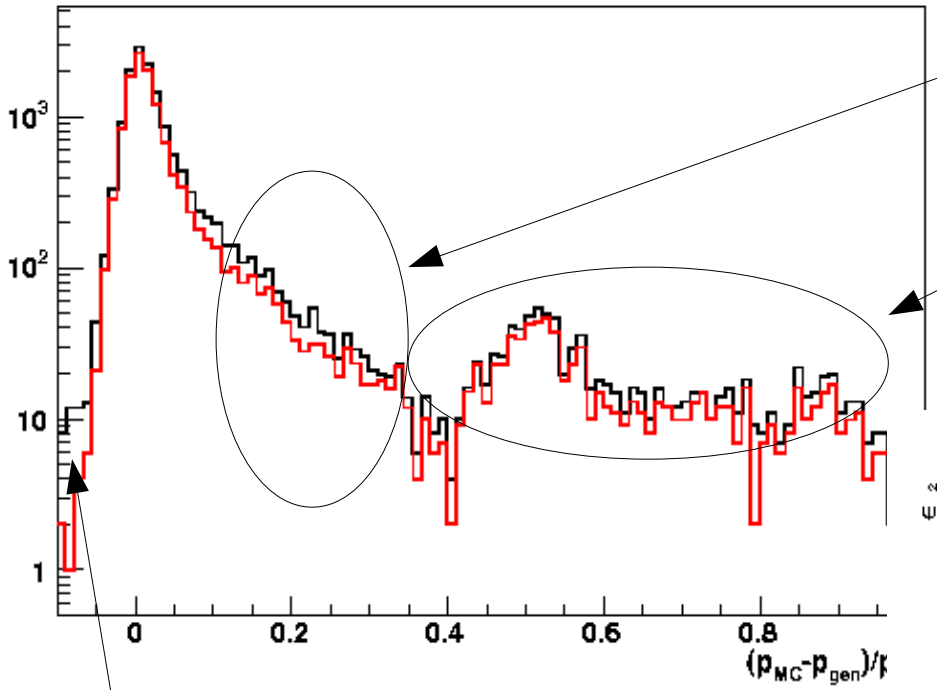
- chi2/ndf < 2.0: 78%
- chi2/ndf < 2.5: 82%
- chi2/ndf < 3.0: 86%
- chi2/ndf < 3.5: 88%
- chi2/ndf < 4.0: 90%

Good value because efficiency grows slower after chi2/ndf = 3





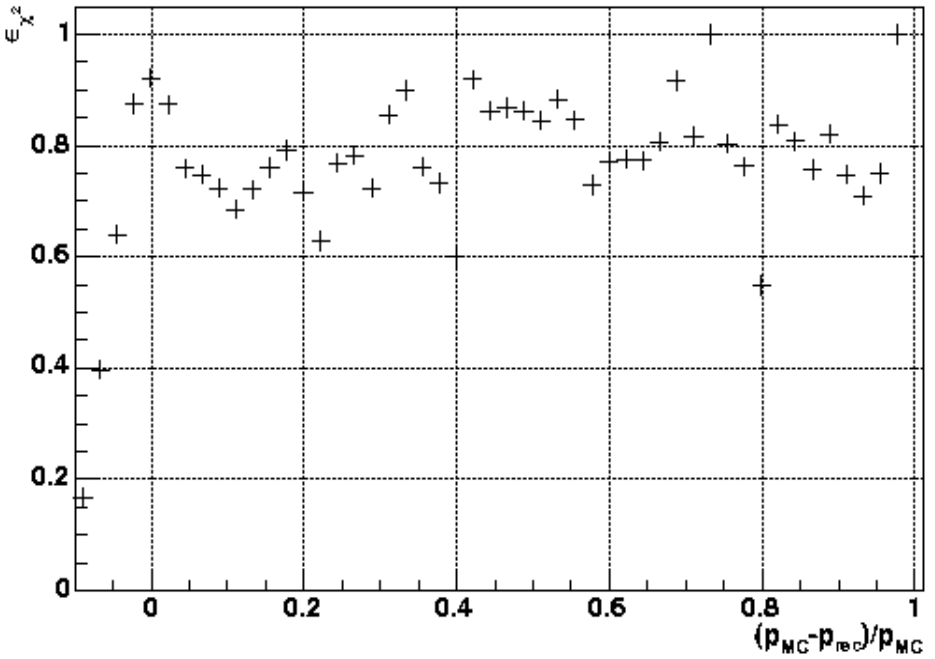
chi2 cut



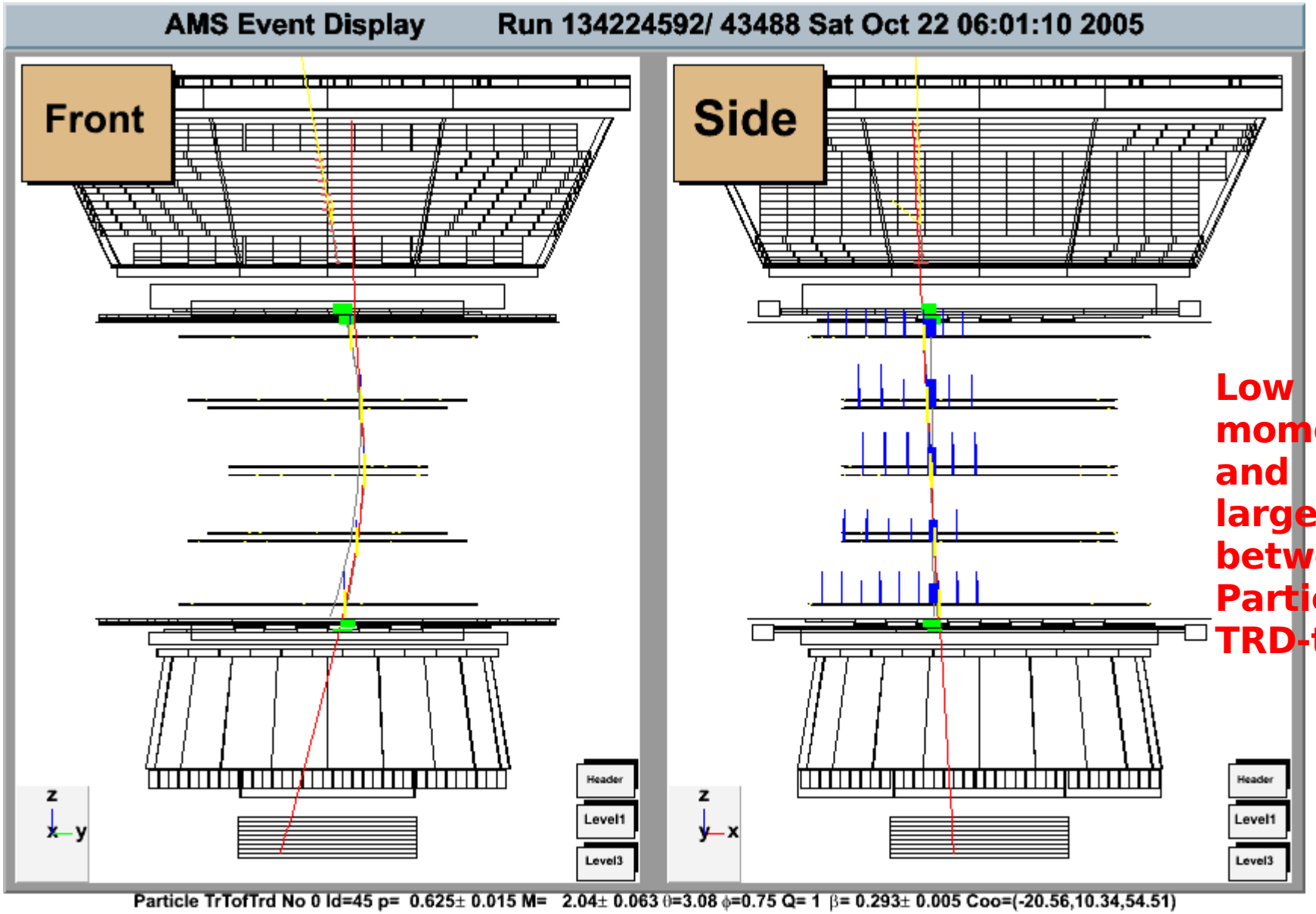
What events are here? Zone 1

What events are here? Zone 2

Wrongly reconstructed sign of charge – helps to reject proton background

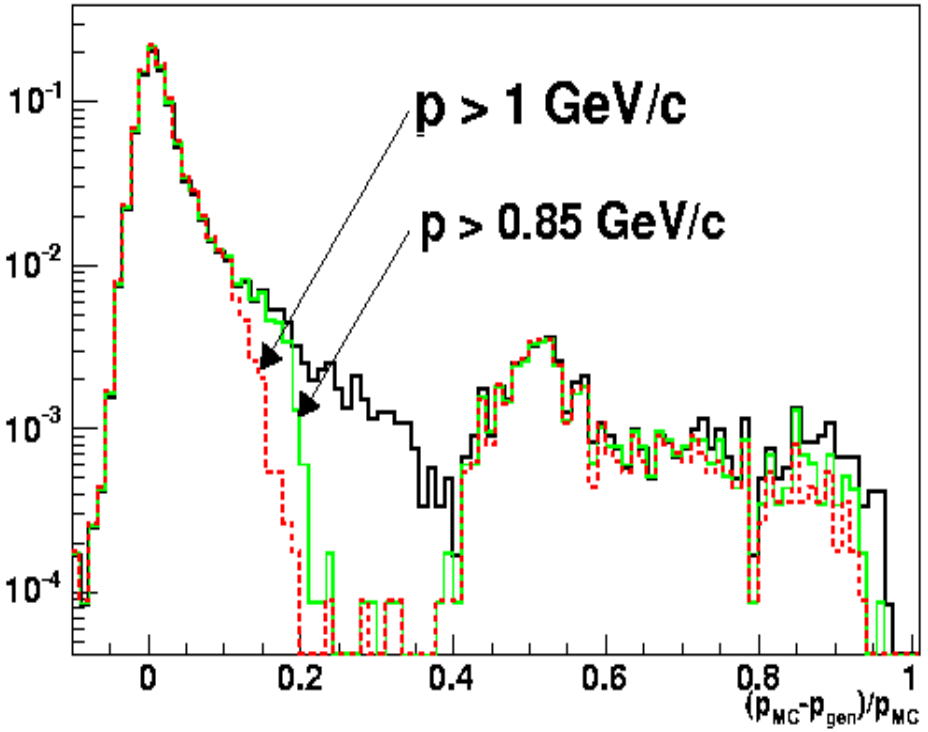


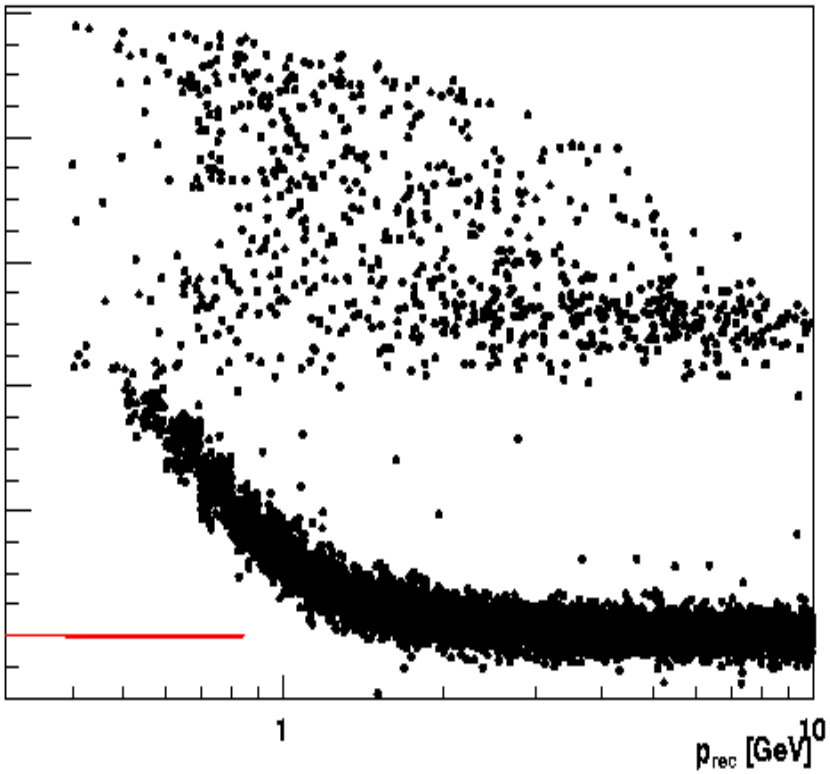
Zone 1 example



Low momentum and large distance between Particle and TRD-track

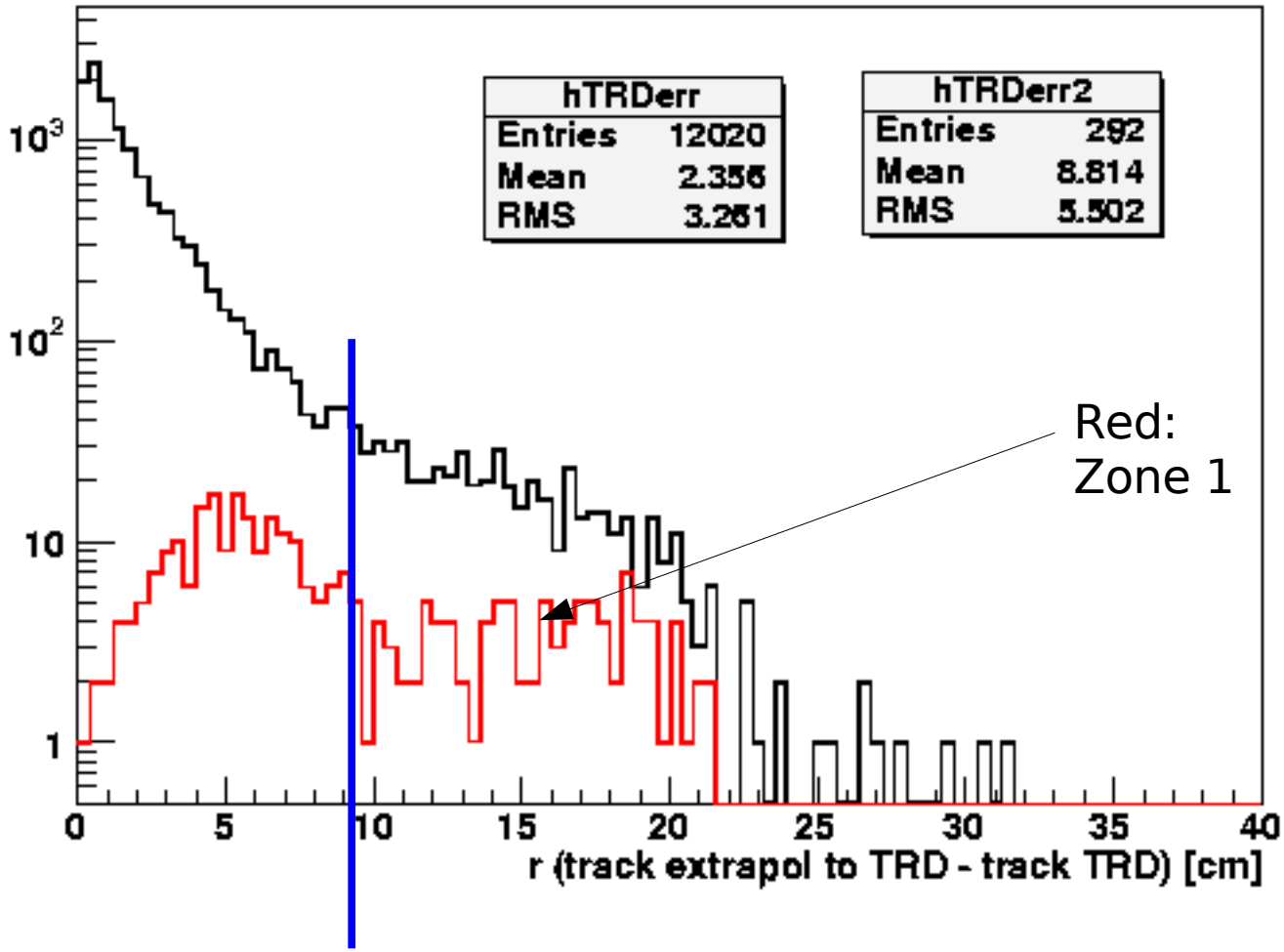
Proof that the events in Zone 1 have low momentum





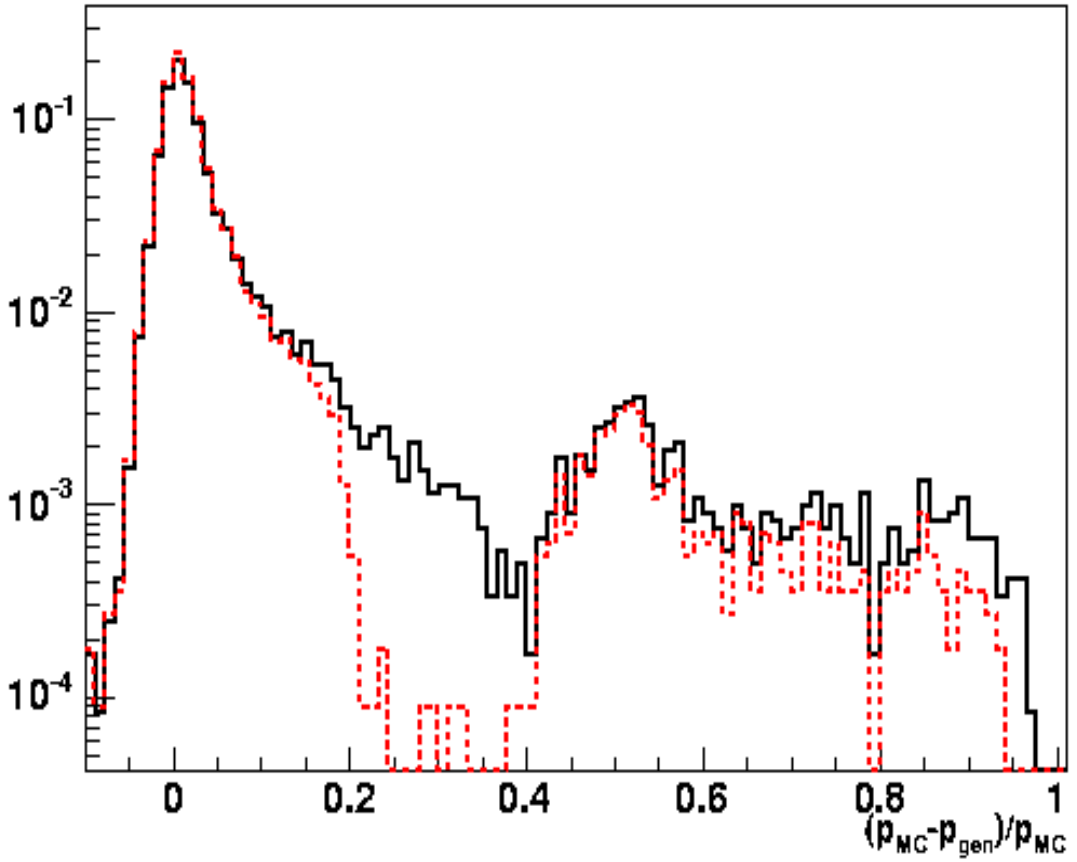
But we would like to avoid cutting on momentum as DM signal is for low momentum – signal is around 1 GeV/c. The LVL1 efficiency however drops below 0.85 GeV/c. We cut out events with p<0.85 GeV/c Later we recalibrate events with 0.85<p<2 GeV in order to correct them for multiple scattering.

Distance between TRD track and extrapolation of Particle track



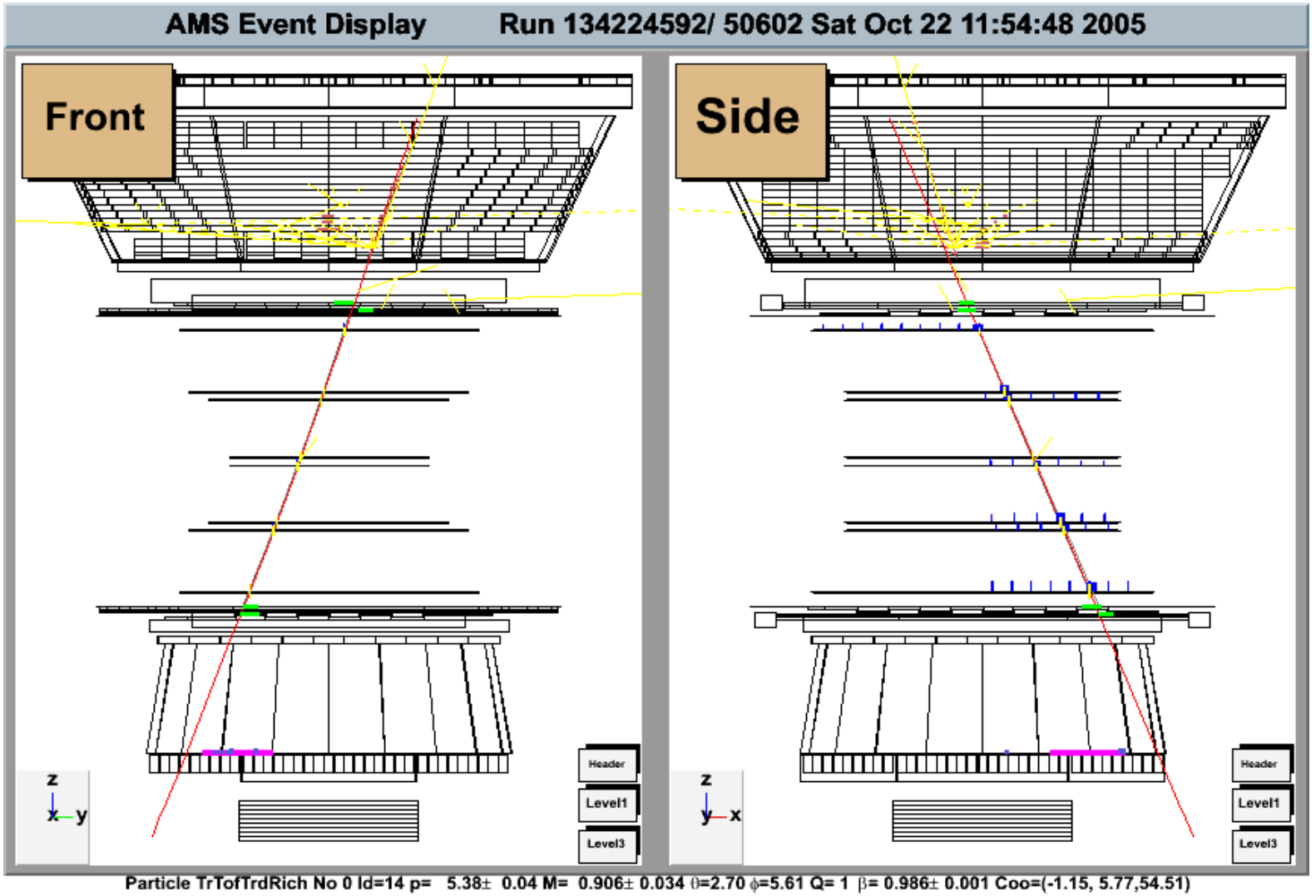
Proposed cut: 9cm

Effect of the cut



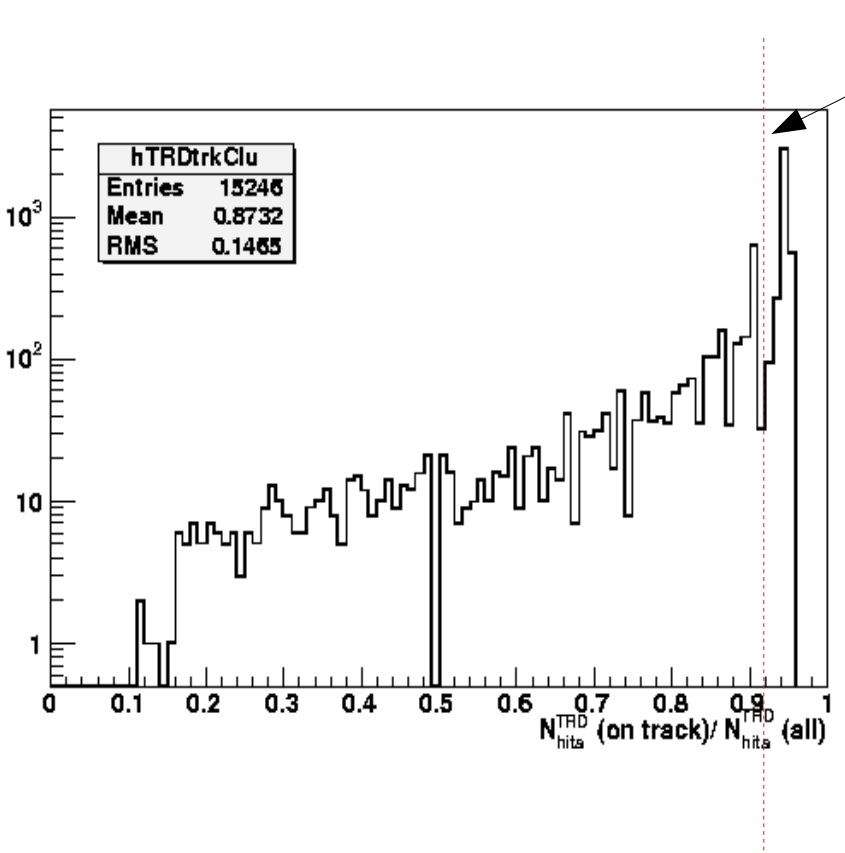
effic=0.928

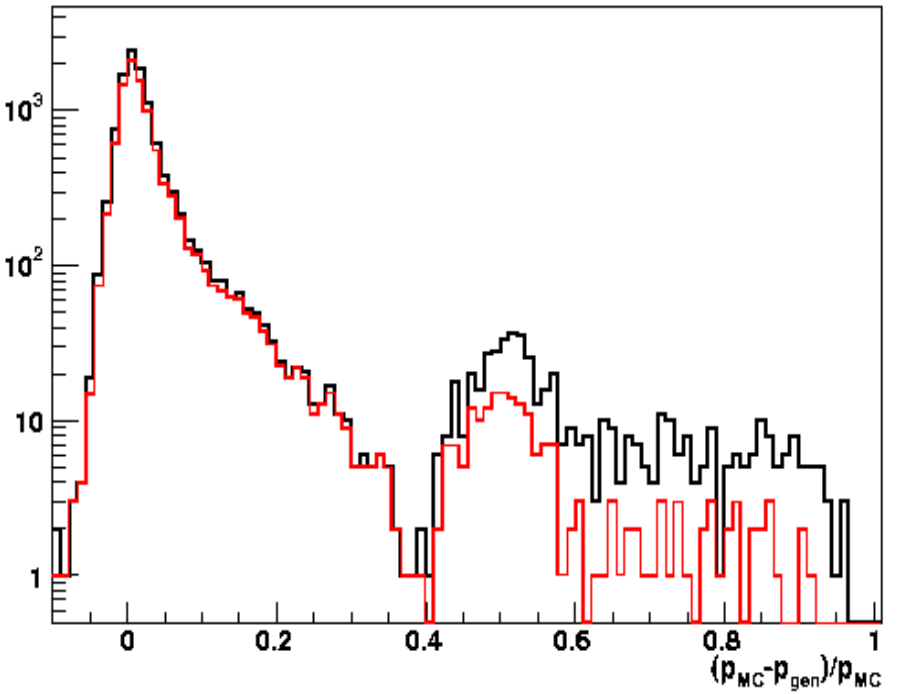
Zone 2 example



Usually lot of activity in TRD and the first TOF, the "voted" particle is often proton instead of deuteron

Cut on activity in TRD



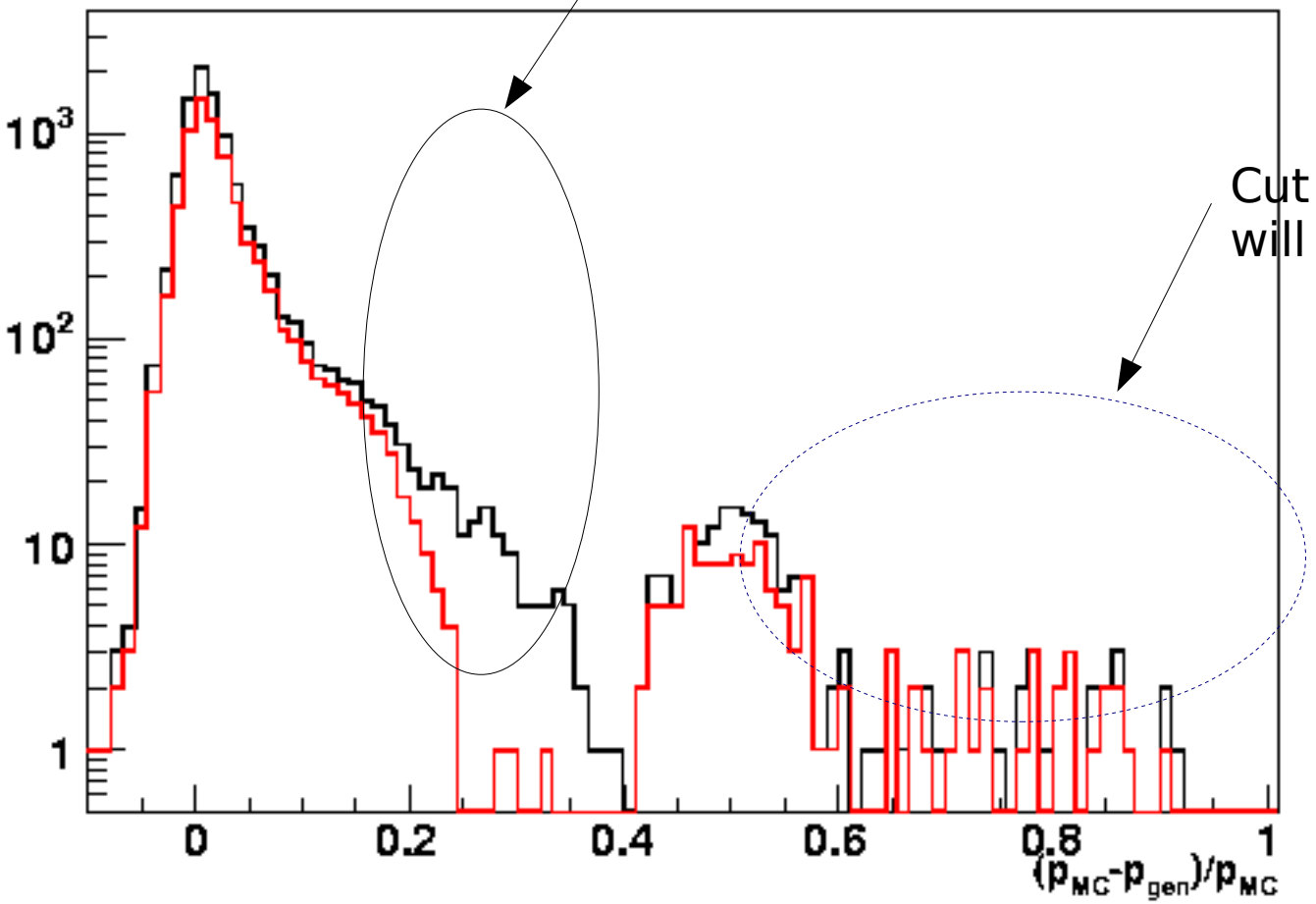


efficiency=0.864

Cut on activity in TOF?

1. exactly 4 clusters from 4 different layers used for beta reconstruction

We accept that keeping in mind that low momentum deuterons tend to have underestimated momentum

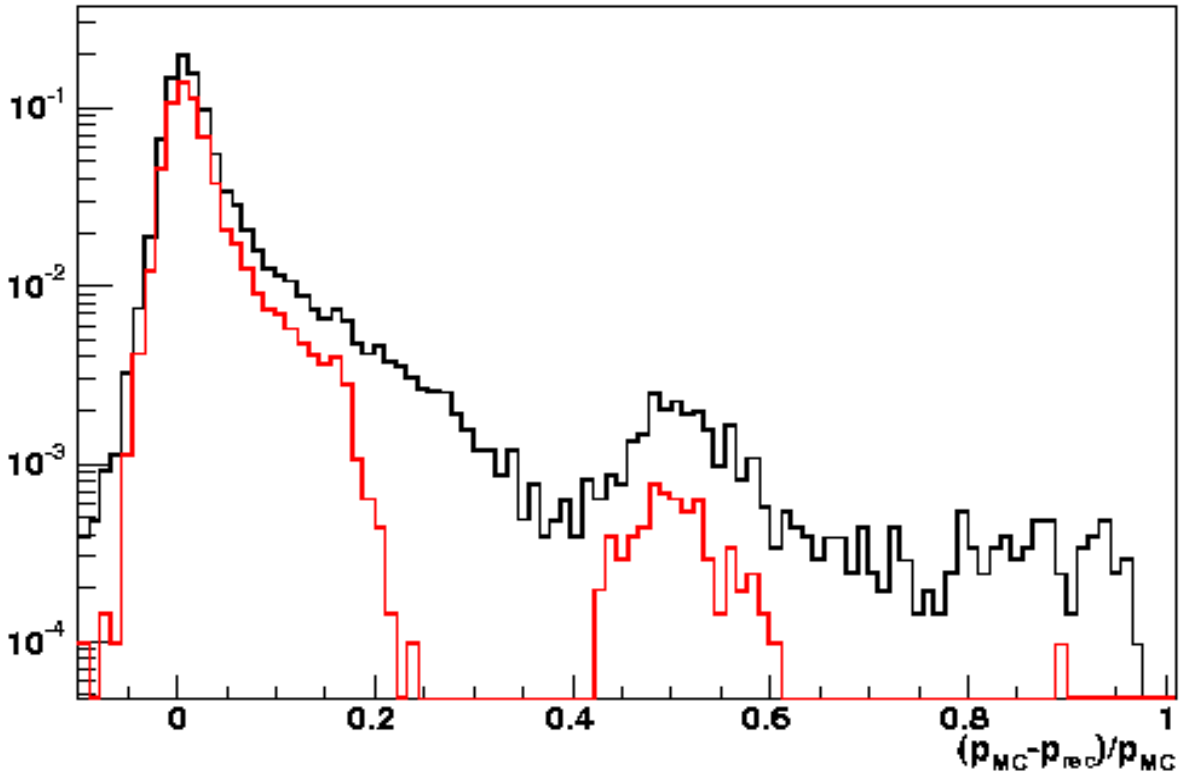


Cut on betamax will help here

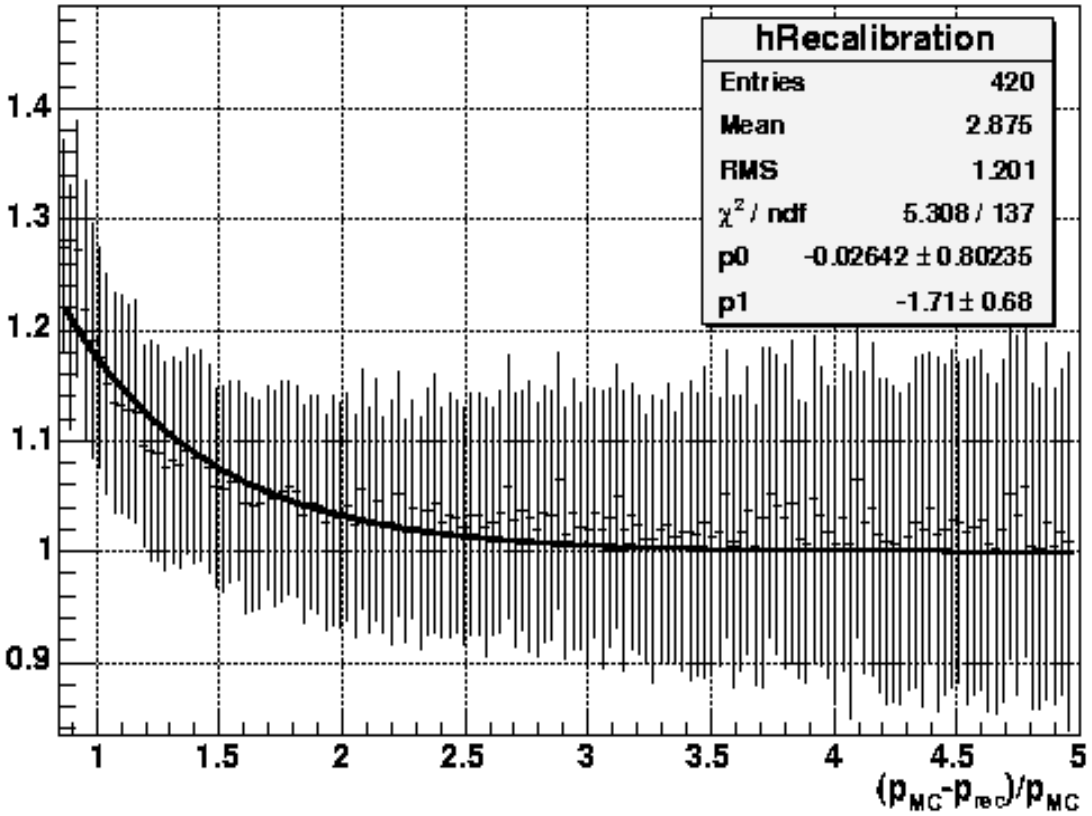
Shall we use this cut? See Valentina's presentation

All cuts on momentum together

effic=0.640

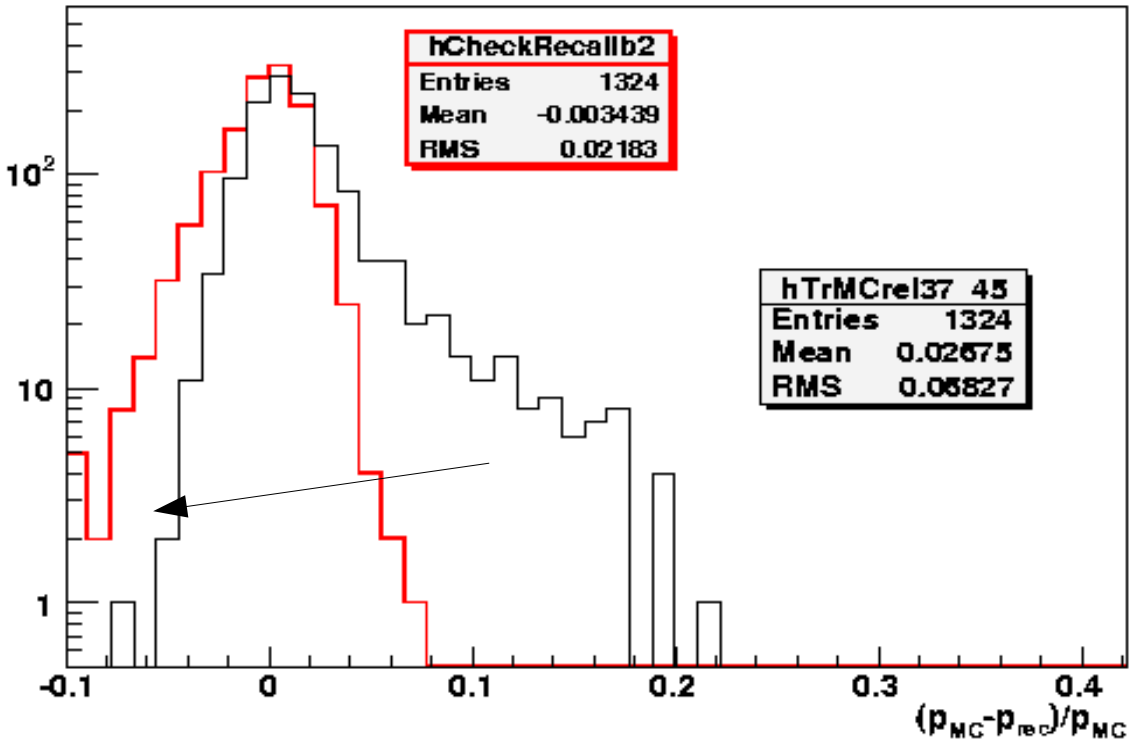


Momentum recalibration



f(x)=1+exp(p0+p1*x), where $X=(p_{MC}-p_{rec})/p_{MC}$

Momentum recalibration



We overcalibrate, mass distribution affected

→ More work on that

→ A correction on beta should also be applied?

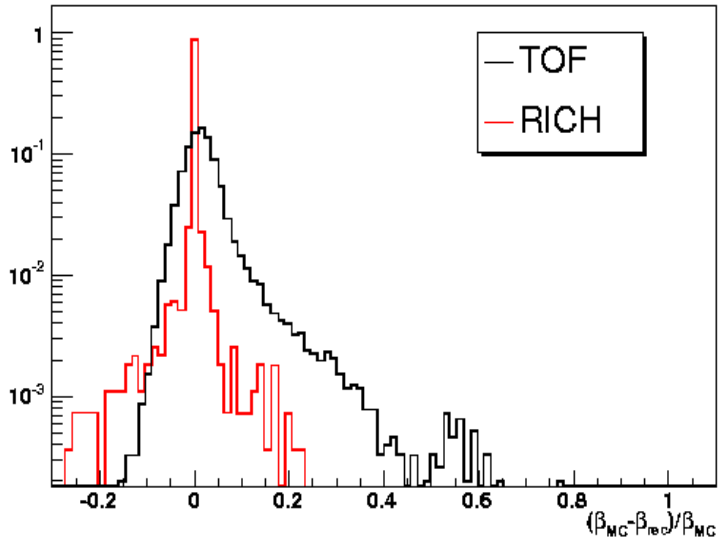
Beta measurement

2 possibilities: RICH and TOF
if RICH is accessible and passes cuts, we take RICH
otherwise we take TOF

optimization cuts:
TOF – see Valentina's presentation
RICH – cuts suggested by Carlos Delgado

26% of events have a RICH Ring

After preselection



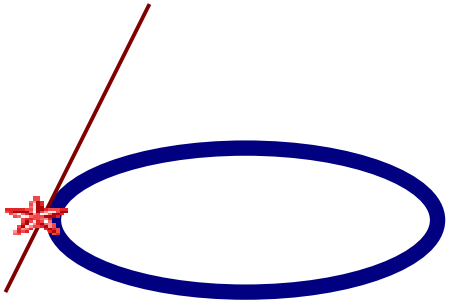
A comparison of beta reconstruction if TOF and in RICH:
TOF has large tail with under-estimated beta while for RICH we must deal with overestimated beta

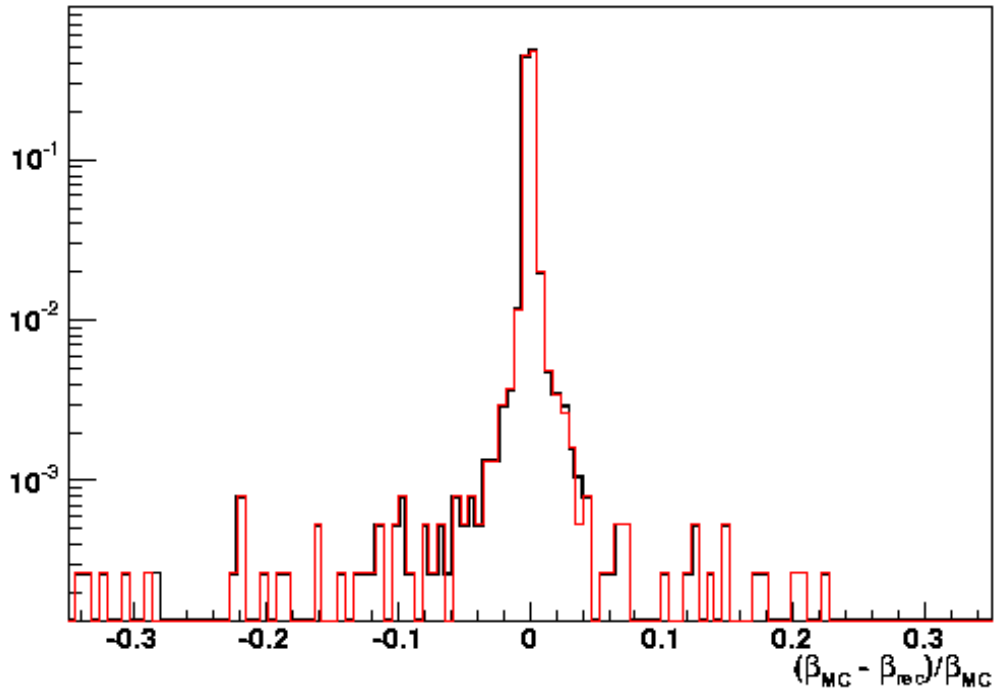
Cuts on quality of Rings are suggested by Carlos Delgado

Optimization on RICH beta

cuts proposed by Carlos Delgado

1. reject ring with an overlapping particle



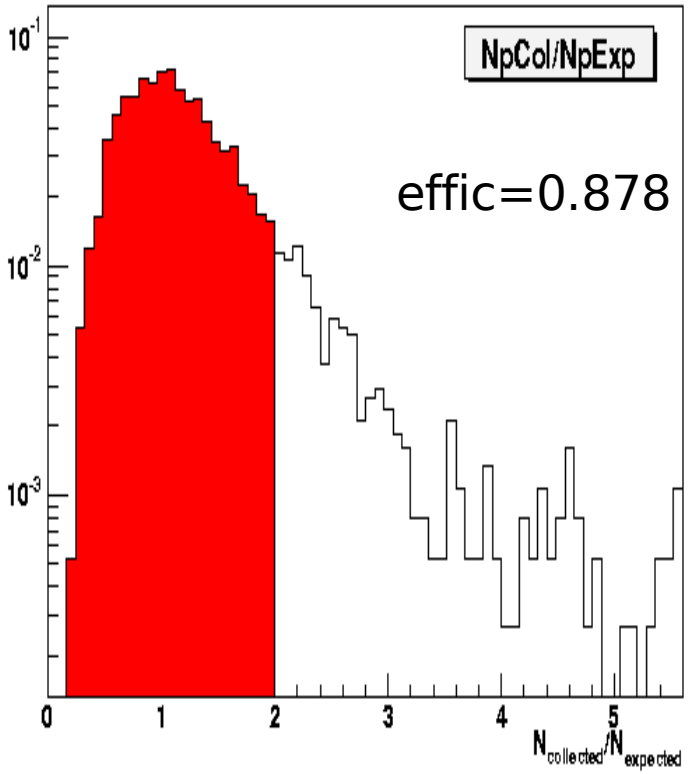


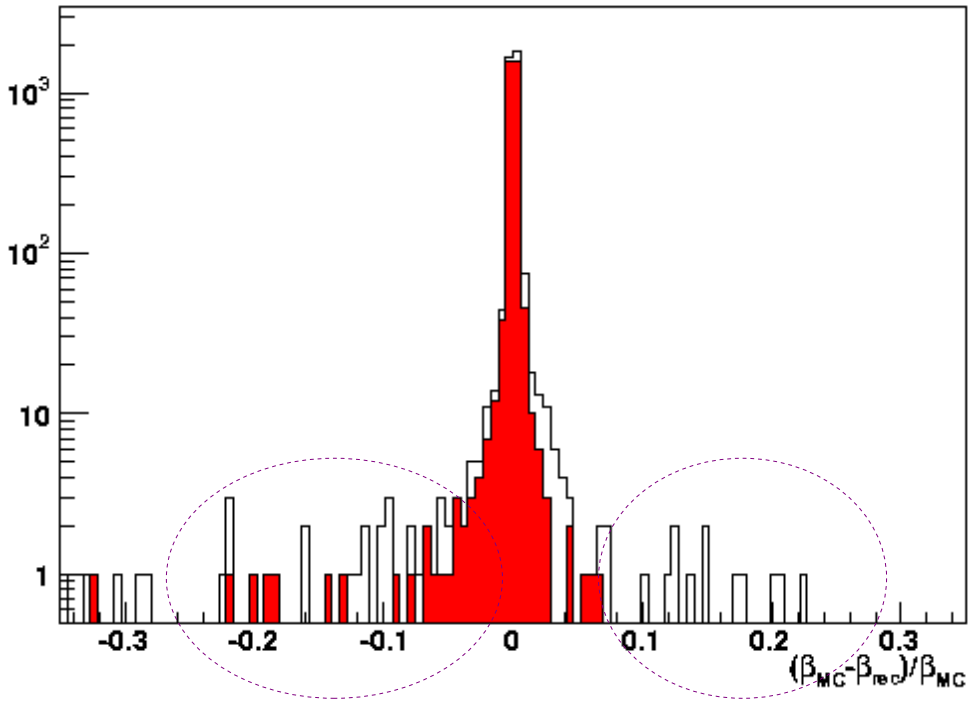
Efficiency
almost 100%

Optimization on RICH beta

2. accepting Z=1 particles => Number of collected photoelectrons to number of expected ones for Z=1 particle < 2 (originally proposed 1.5, what gives efficiency 0.73).

Maybe this cut should be released because we are not afraid of anti-nucleai background. It seems that particles with Ncol/Nexp>2 are “normal”

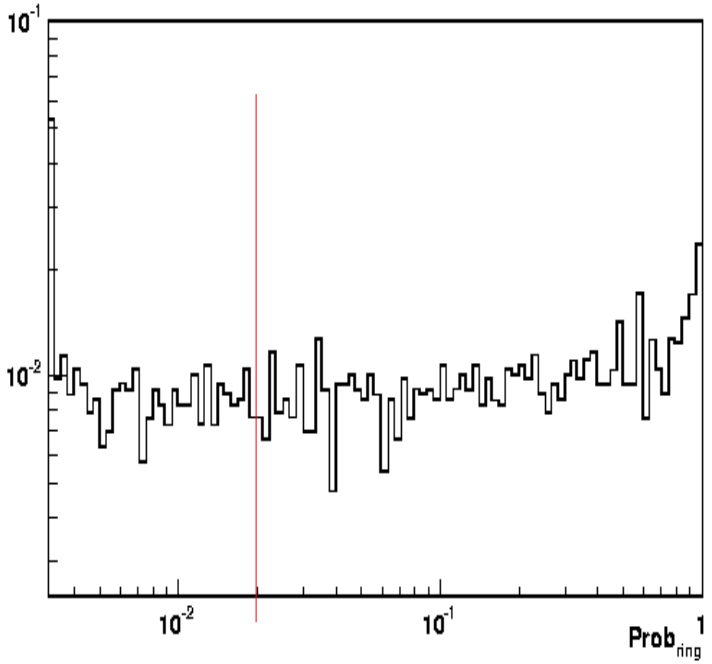


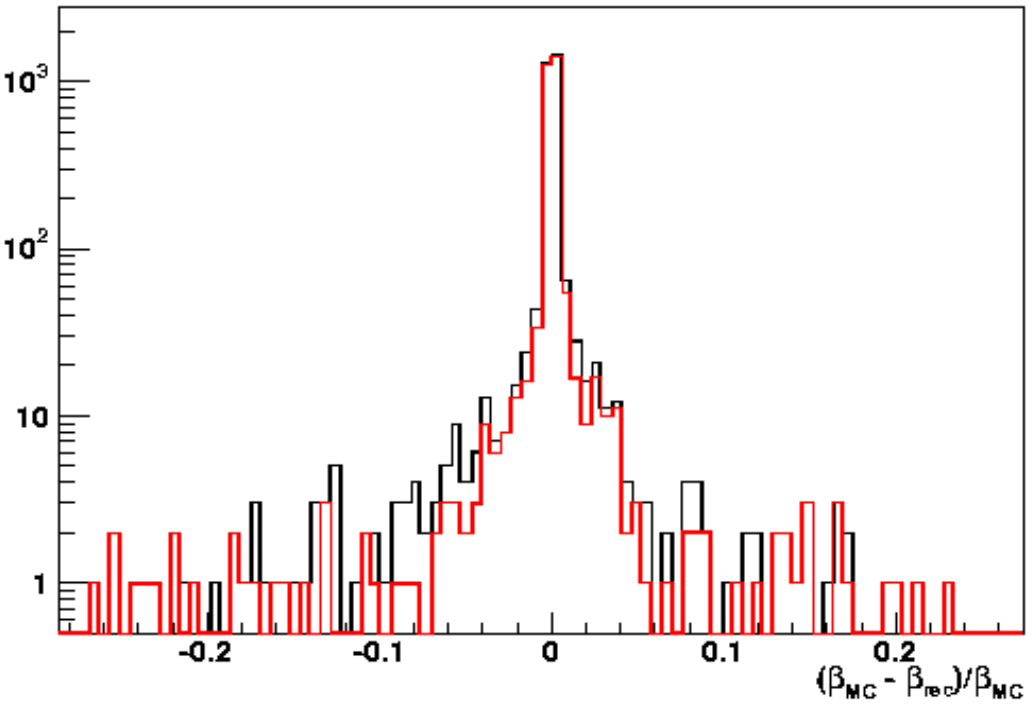


Good in tail cutting

Optimization on RICH beta

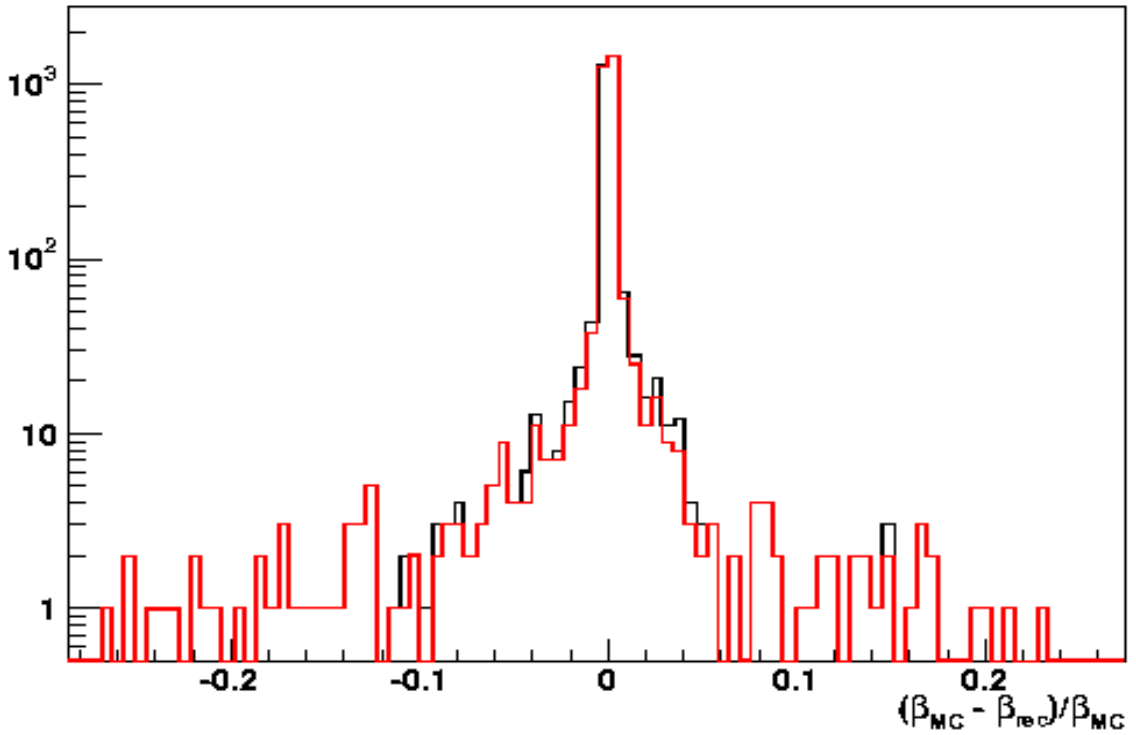
3. good shape of the ring, Carlos proposed cut: $3 \bullet 10^{-2}$, efficiency: 0.934





Optimization on RICH beta

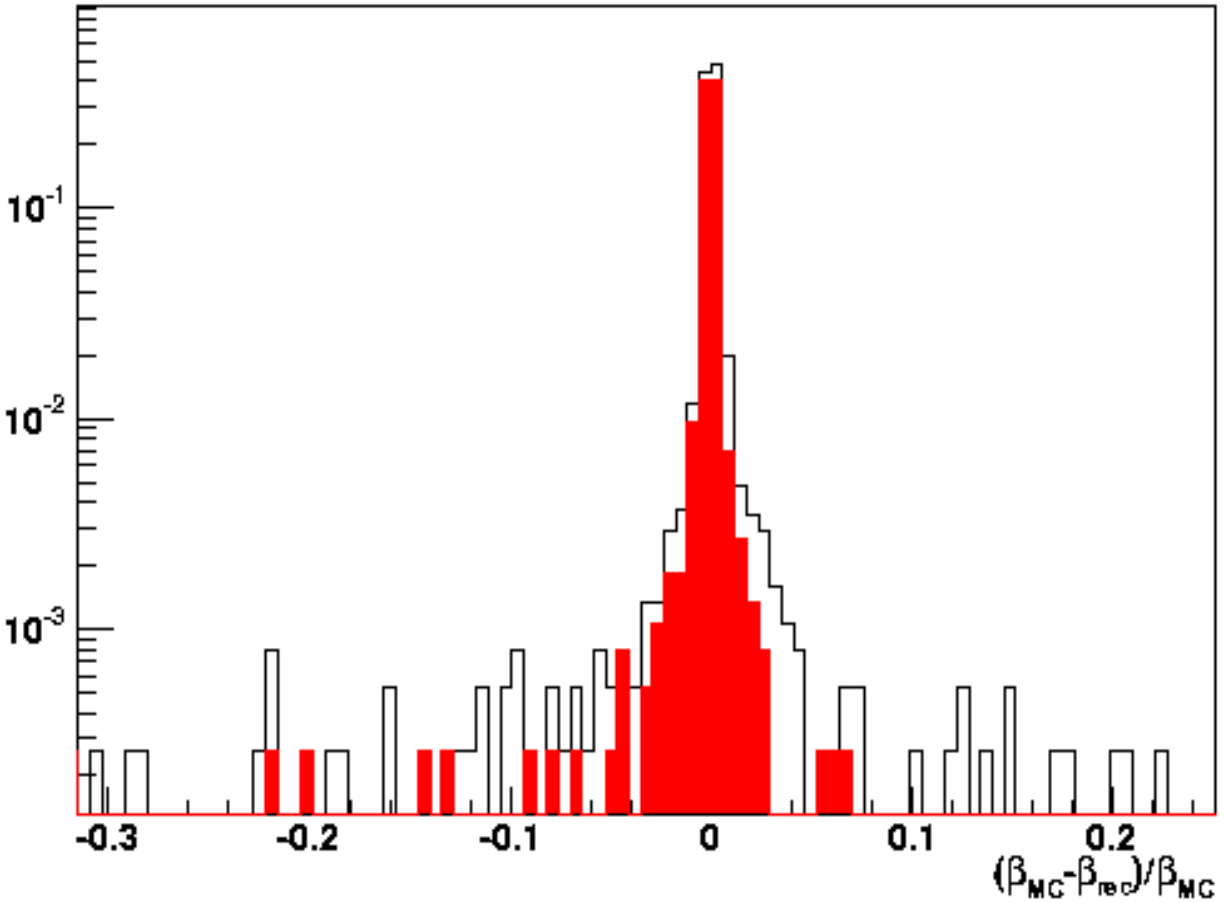
4. single particle crossing the plane of PMTs in RICH



efficiency=0.999

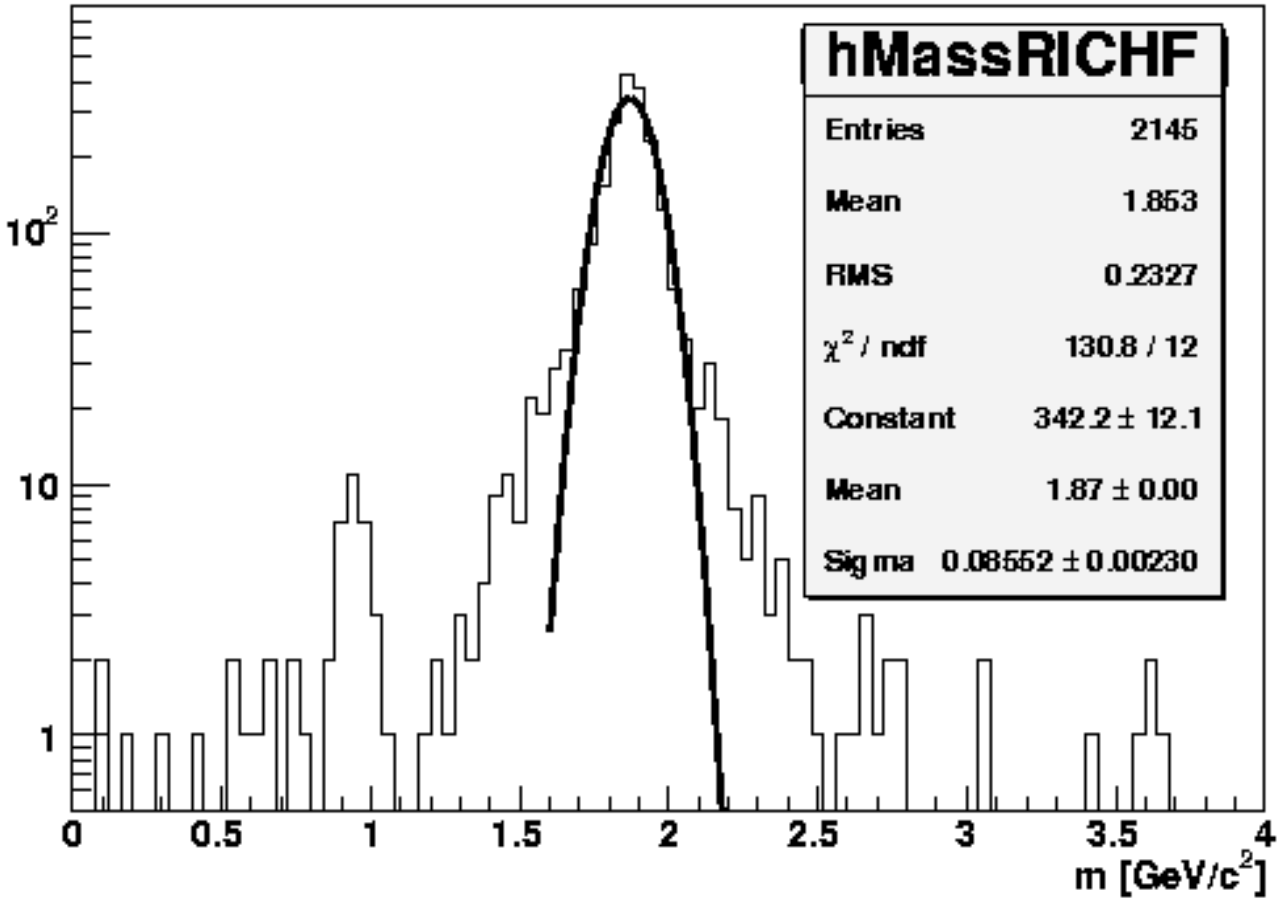
Optimization on RICH beta

All cuts on RICH together



efficiency=0.841

RICH mass


hMassRICHF
Entries 2145
Mean 1.853
RMS 0.2327
χ² / ndf 130.8 / 12
Constant 342.2 ± 12.1
Mean 1.87 ± 0.00
Sigma 0.08552 ± 0.00230
10²
10
1
0
0.5
1
1.5
2
2.5
3
3.5
4
m [GeV/c²]

Conclusions

1. we need a scooter or two to move between labs

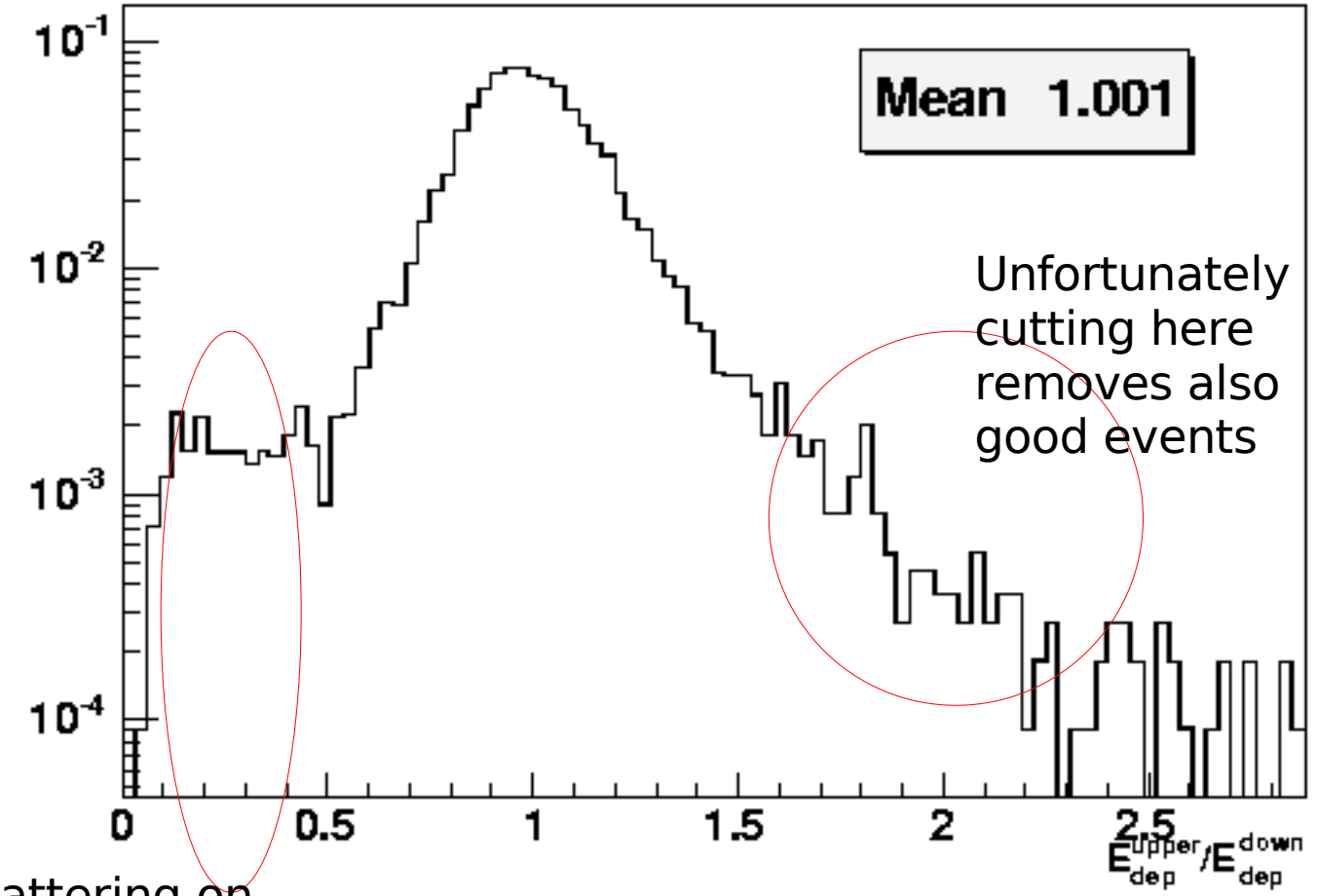
2. optimized cuts for momentum reconstruction and RICH velocity reconstruction in RICH are determined.

3. for deuterons efficiency of cuts in RICH is about 84% (multiply by 26% of events with ring) and cuts for momentum 64%

To Do

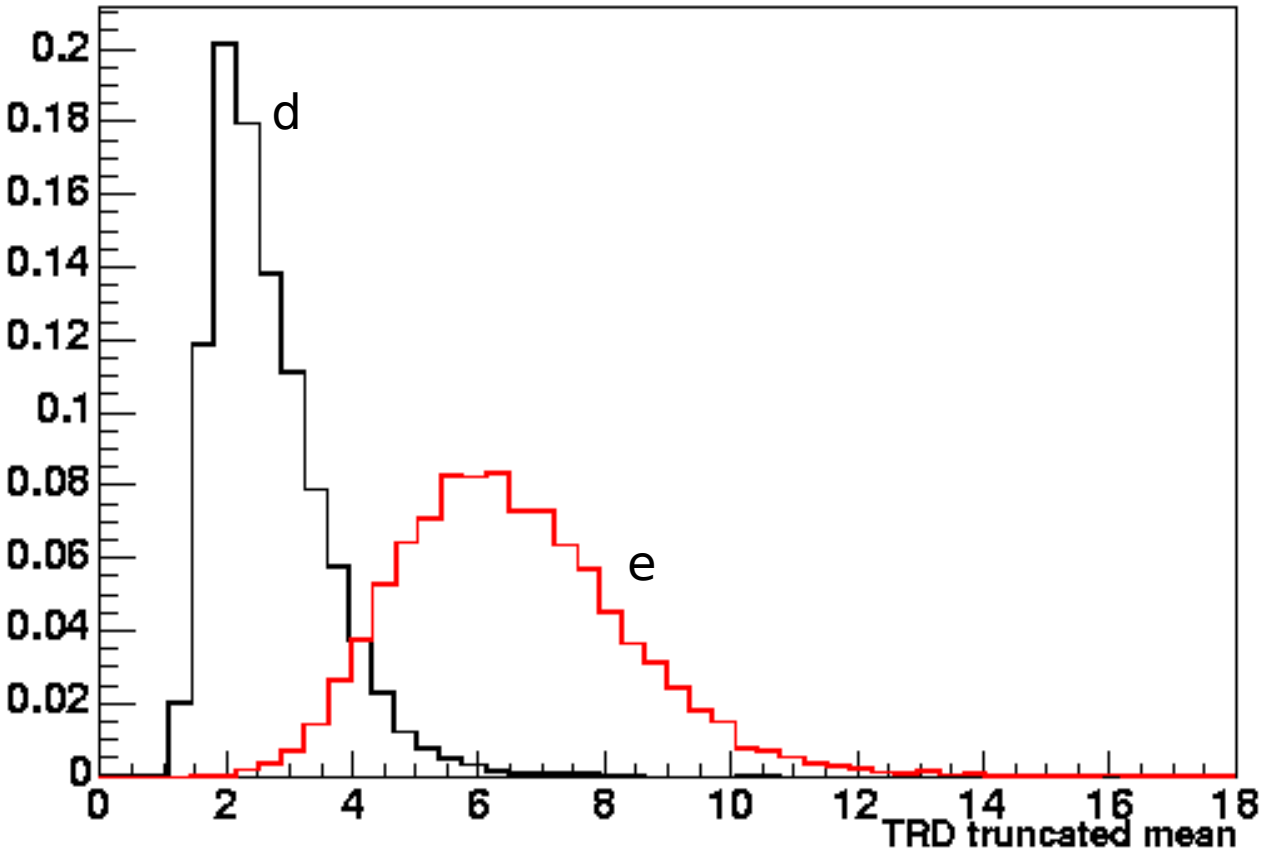
1. finalize algorithm with TOF-cuts optimization from Valentina
2. use electron-rejection cuts based on TRD
3. obtain the final numbers: efficiencies for signal and background, acceptance and number of expected events

Upper/Down TOF energy deposits

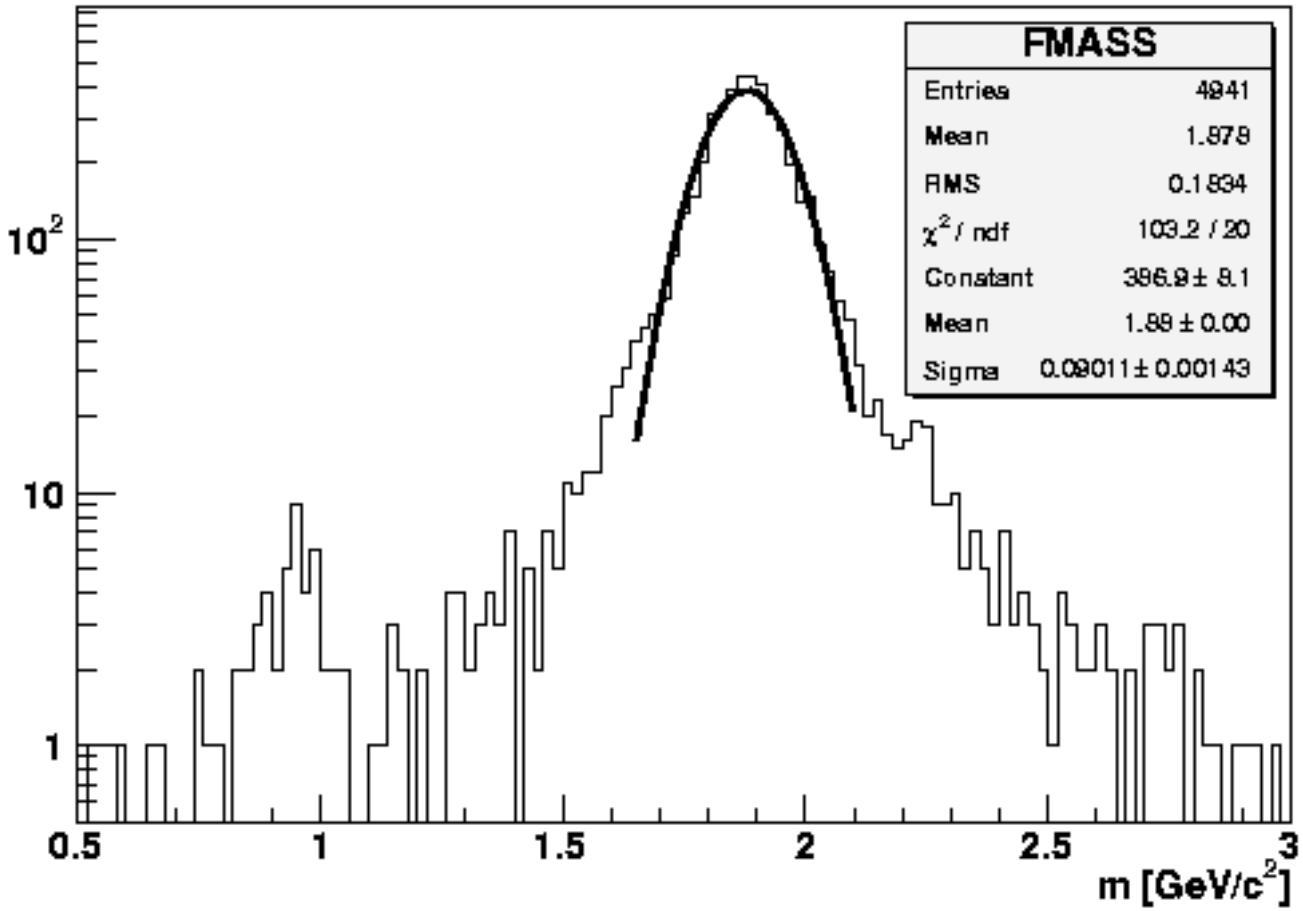


Scattering on down TOF – before entering RICH

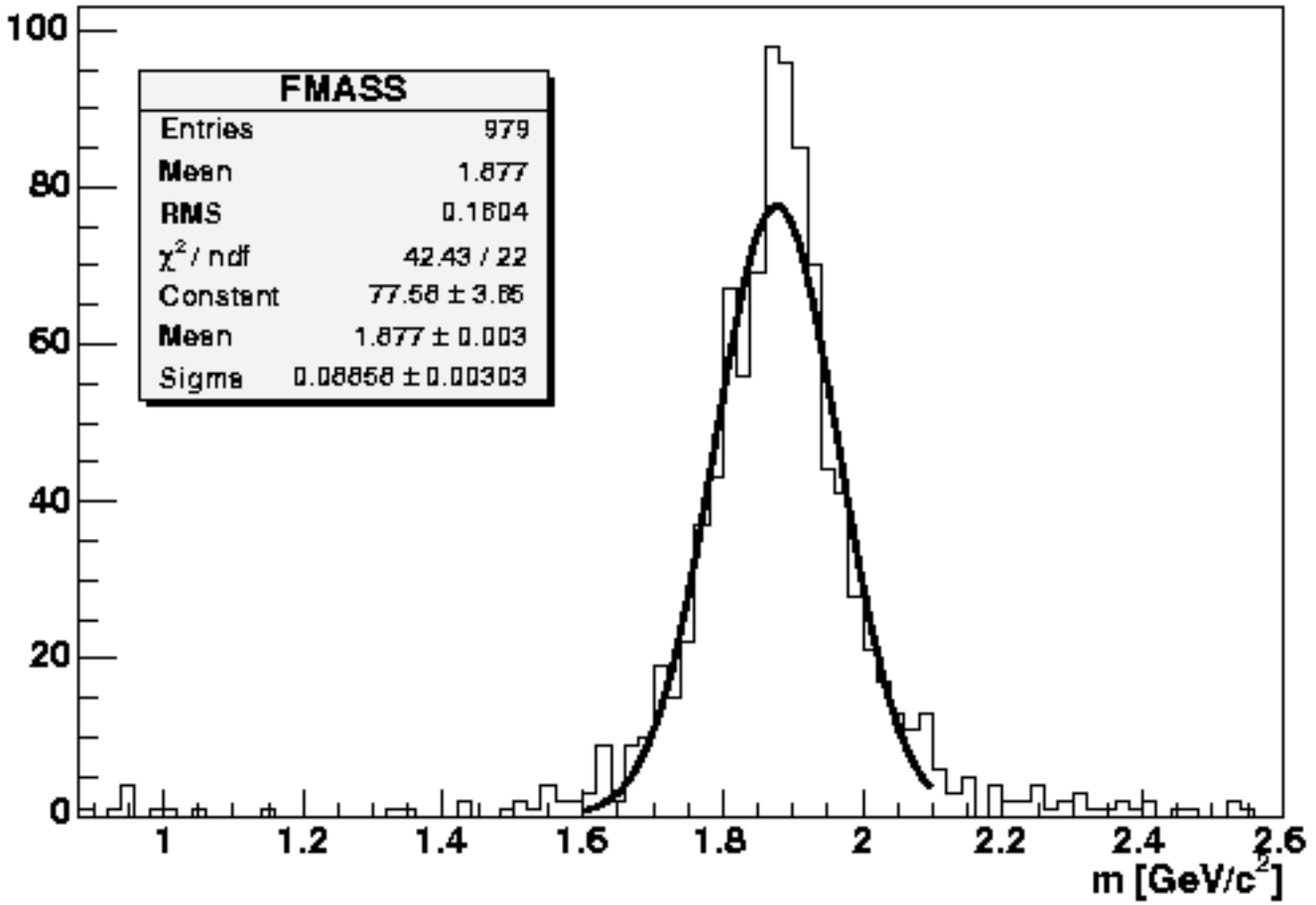
Truncated mean



Mass distribution after cuts on momentum and beta



Mass dist


FMASS
Entries 979
Mean 1.877
RMS 0.1604
χ² / ndf 42.43 / 22
Constant 77.58 ± 3.85
Mean 1.877 ± 0.003
Sigma 0.08858 ± 0.00303
100
80
60
40
20
0
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
m [GeV/c²]

Optimization of cuts on background rejection