SEARCHING FOR ANTIDEUTERONS

STATUS OF THE DBAR ANALYSIS STARTING IN BOLOGNA

D’Angelo Francesco – University of Bologna – Francesco.dangelo13@unibo.it

To search for antideuterons in the AMS-02 data are needed:

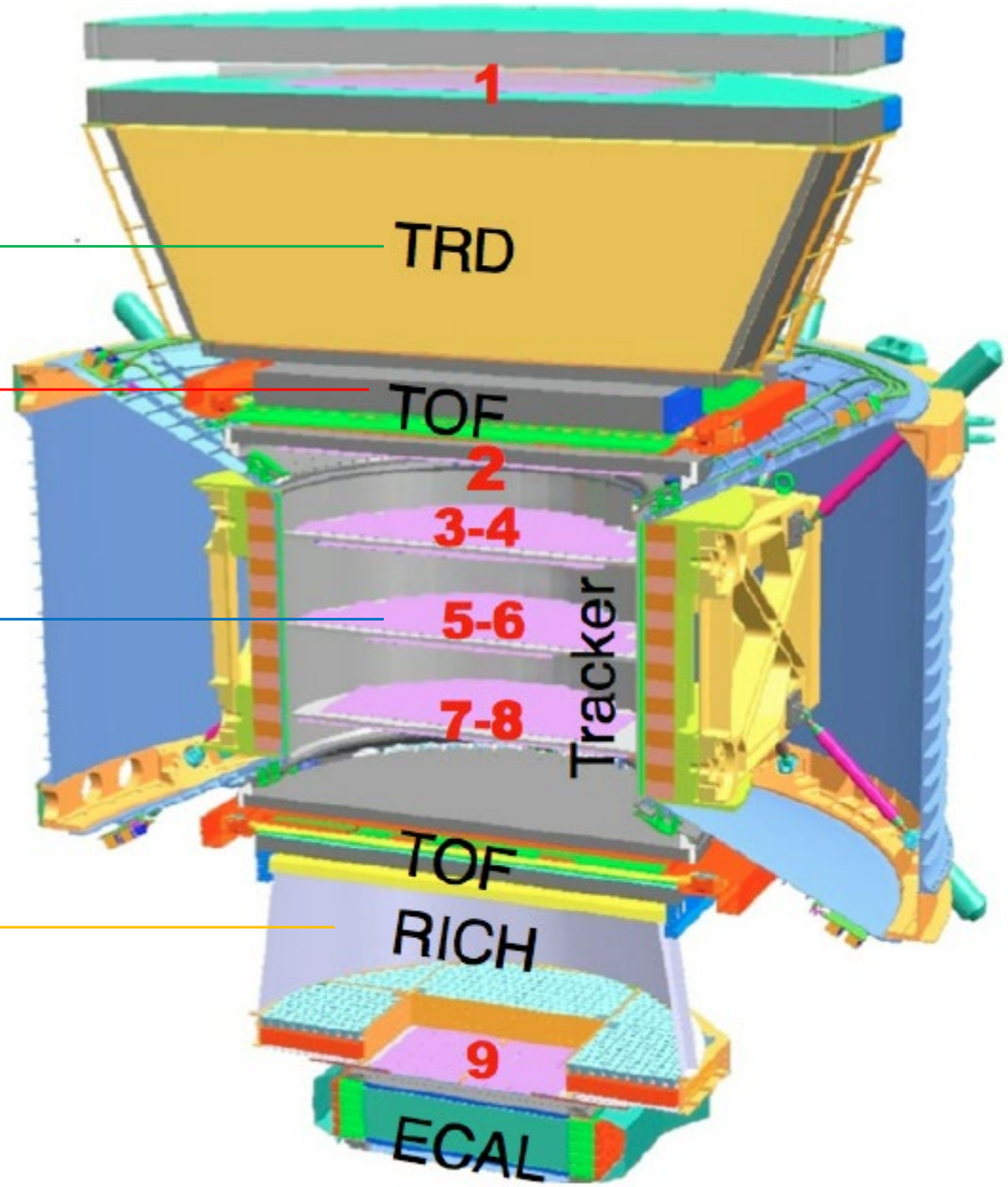
TRD to identify particle produced in the interaction with the detector

TOF for the beta and charge reconstruction reconstruction

Inner Tracker (IT) for the rigidity and charge reconstruction

RICH NaF & RICH aerogel for the beta reconstruction

These analysis range has not been considered yet



MASS SAMPLE DEFINITION

12 samples in mass in the TOF analysis range have been defined using:

- β -> betaH (TOF)
- Rigidity -> GBL (InnerTracker)
- Charge -> InnerTracker
- 0.3 < β < 0.8

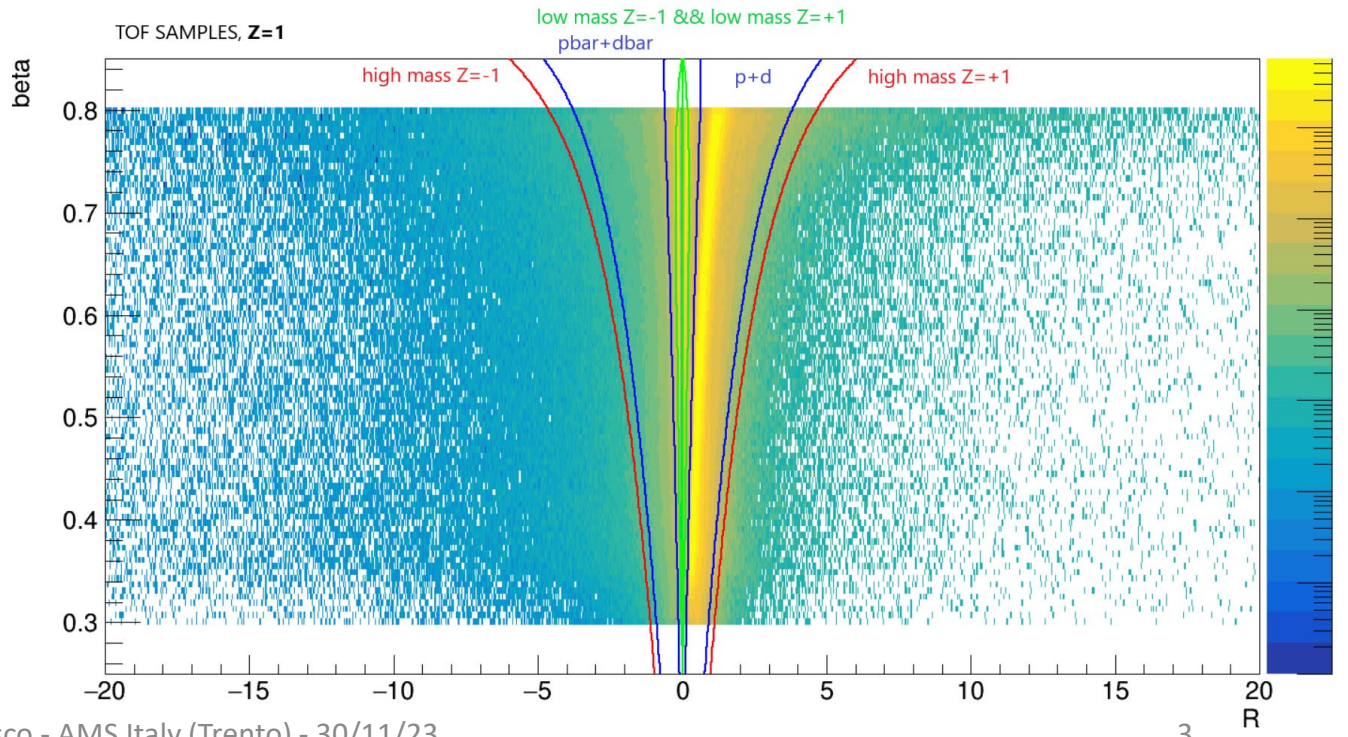
MASS SAMPLES have been used to discriminate between "bad (too high or too low mass)" and "good (correct mass)" events:

$$\frac{\sigma_m}{m} = \frac{\Delta R}{R} \oplus \frac{1}{(1-\beta^2)}\frac{\Delta\beta}{\beta}$$

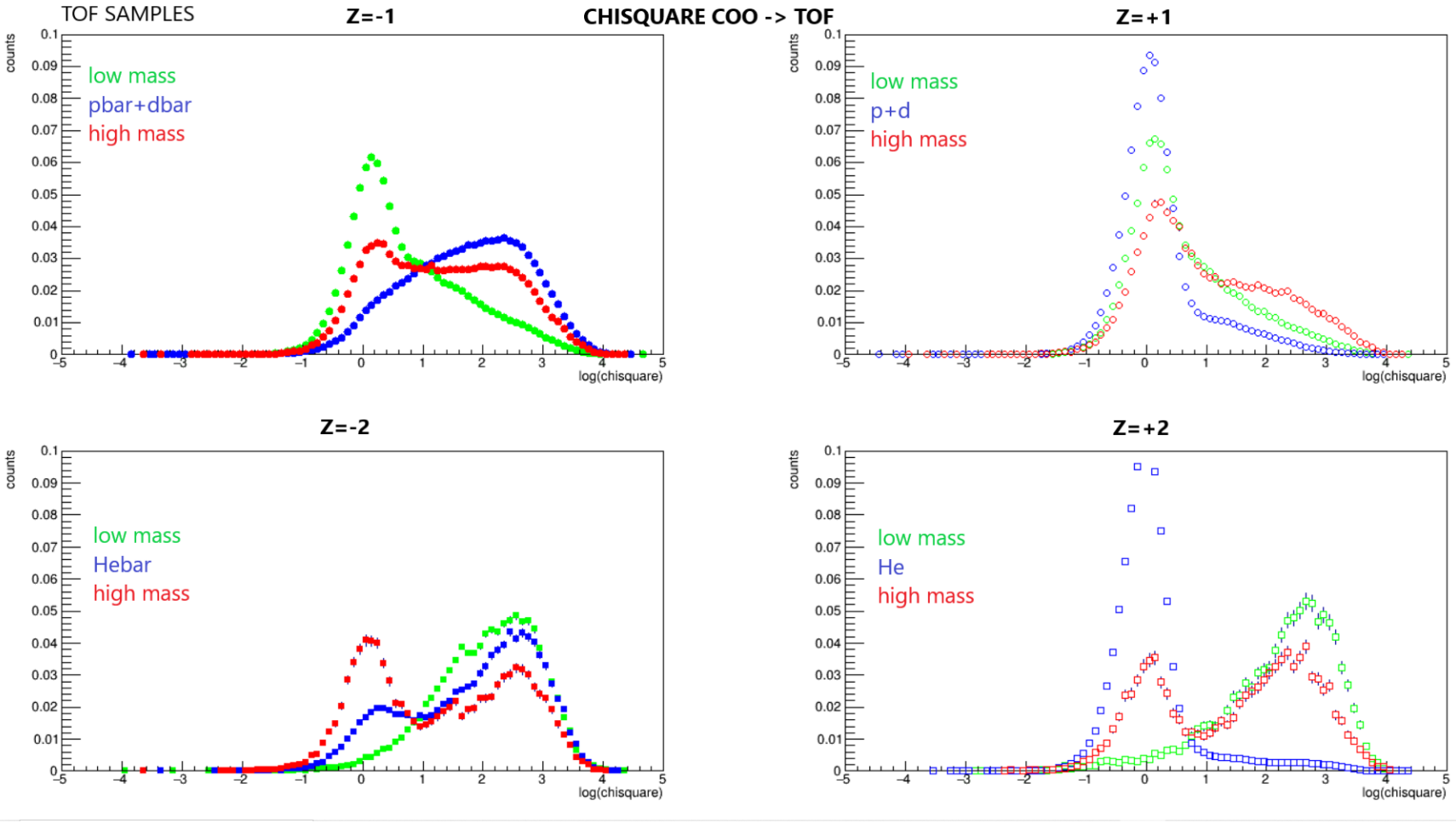
Assuming: $\frac{\Delta R}{R} \cong 0.1$ for R < 100 GeV

$\Delta\beta \cong 0.04$ at β = 1 and Z=1

	POSITIVES
Z = 1	Low mass Z=+1: m < mp $(1 - 5\sigma_m)$ p+d: mp $(1 - 3\sigma_m)$ < m < md$(1 + 3\sigma_m)$ High mass Z=+1: m > md $(1 + 5\sigma_m)$
Z = 2	Low mass Z=+2: m < m3he $(1 - 5\sigma_m)$ He: m3he $(1 - 3\sigma_m)$ < m < m4he $(1 + 3\sigma_m)$ High mass Z=+2: m > m4he $(1 + 5\sigma_m)$
	NEGATIVES
Z=-1	Low mass Z=-1: m < mp $(1 - 5\sigma_m)$ pbar+dbar: mp $(1 - 3\sigma_m)$ < m < md $(1 + 3\sigma_m)$ High mass Z=-1: m > md $(1 + 5\sigma_m)$
Z=-2	Low mass Z=-2: m < m3he $(1 - 5\sigma_m)$ Hebar: m3he $(1 - 3\sigma_m)$ < m < m4he $(1 + 3\sigma_m)$ High mass Z=-2: m > m4he $(1 + 5\sigma_m)$



STANDARD SELECTION DEFINITION



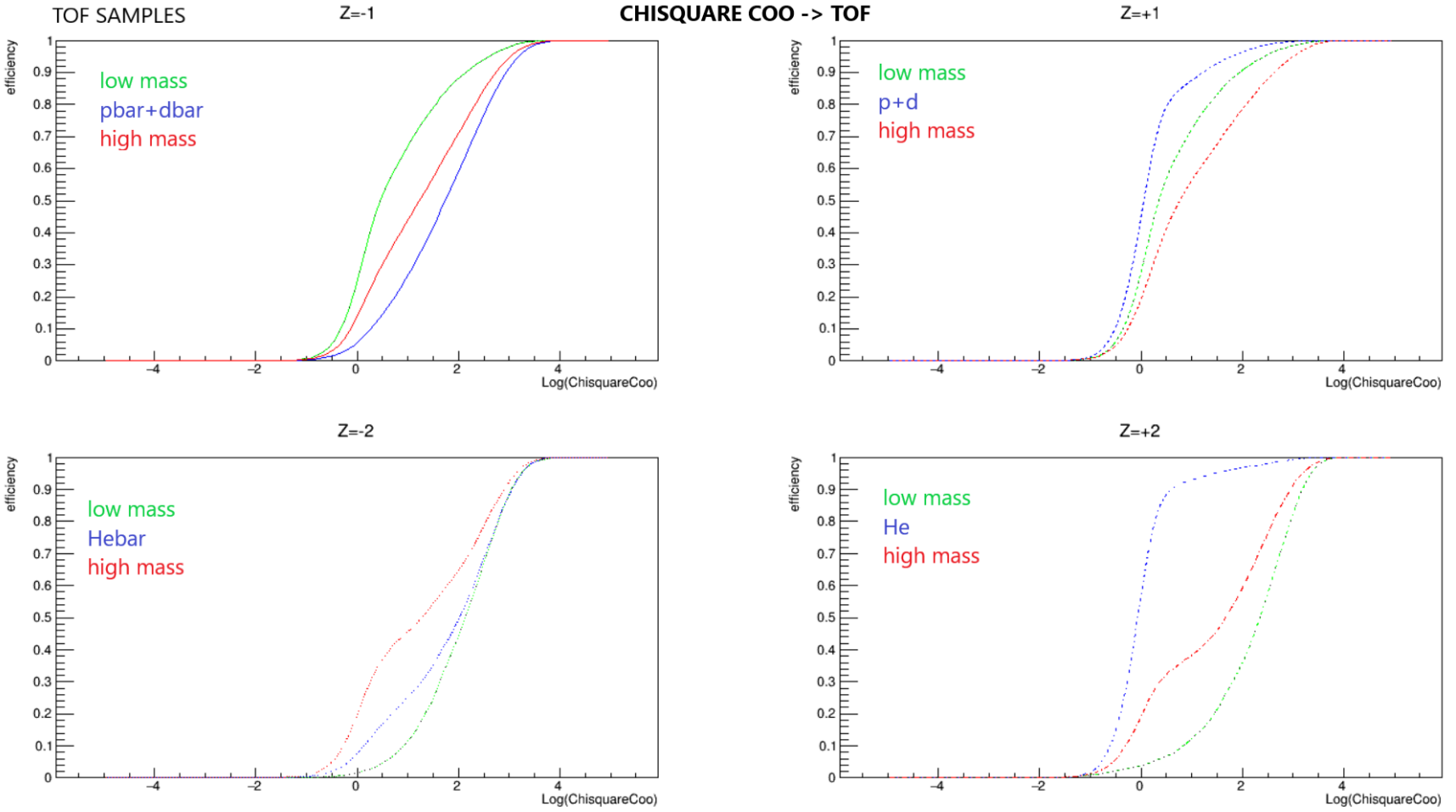
To define a standard selection:

1. some variable distributions **(assumed independent)** have been looked for the different mass samples, identifying the ones with a high discrimination power

2. Using the interested variable as a cut variable, the efficiencies and the rejections have been calculated as a function of the cut value

3. The cut value has been chosen as the value that maximize the rejection of a bad sample (composed by high mass negative events) times the efficiency of a good sample (protons for Z=1 and helium for Z=2)

STANDARD SELECTION DEFINITION



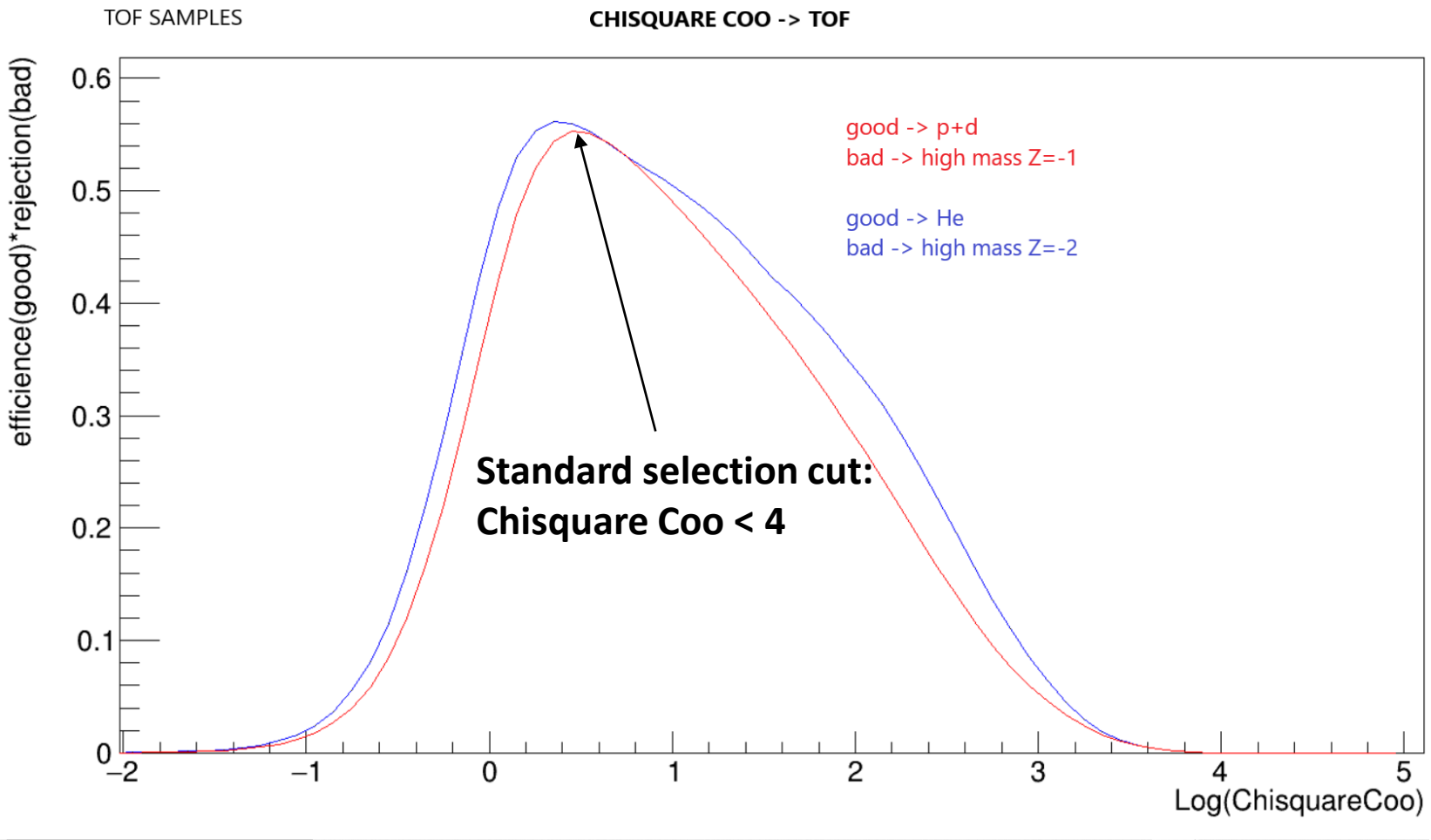
To define a standard selection:

1. some variable distributions (**assumed independent**) have been looked for the different mass samples, identifying the ones with a high discrimination power

2. Using the interested variable as a cut variable, the efficiencies and the rejections have been calculated as a function of the cut value

3. The cut value has been chosen as the value that maximize the rejection of a bad sample (composed by high mass negative events) times the efficiency of a good sample (protons for Z=1 and helium for Z=2)

STANDARD SELECTION DEFINITION



To define a standard selection:

1. some variable distributions (**assumed independent**) have been looked for the different mass samples, identifying the ones with a high discrimination power

2. Using the interested variable as a cut variable, the efficiencies and the rejections have been calculated as a function of the cut value

3. The cut value has been chosen as the value that maximize the rejection of a bad sample (composed by high mass negative events) times the efficiency of a good sample (protons for Z=1 and helium for Z=2)

STANDARD SELECTION DEFINITION

Repeating the procedure for many variables a standard selection has been defined:

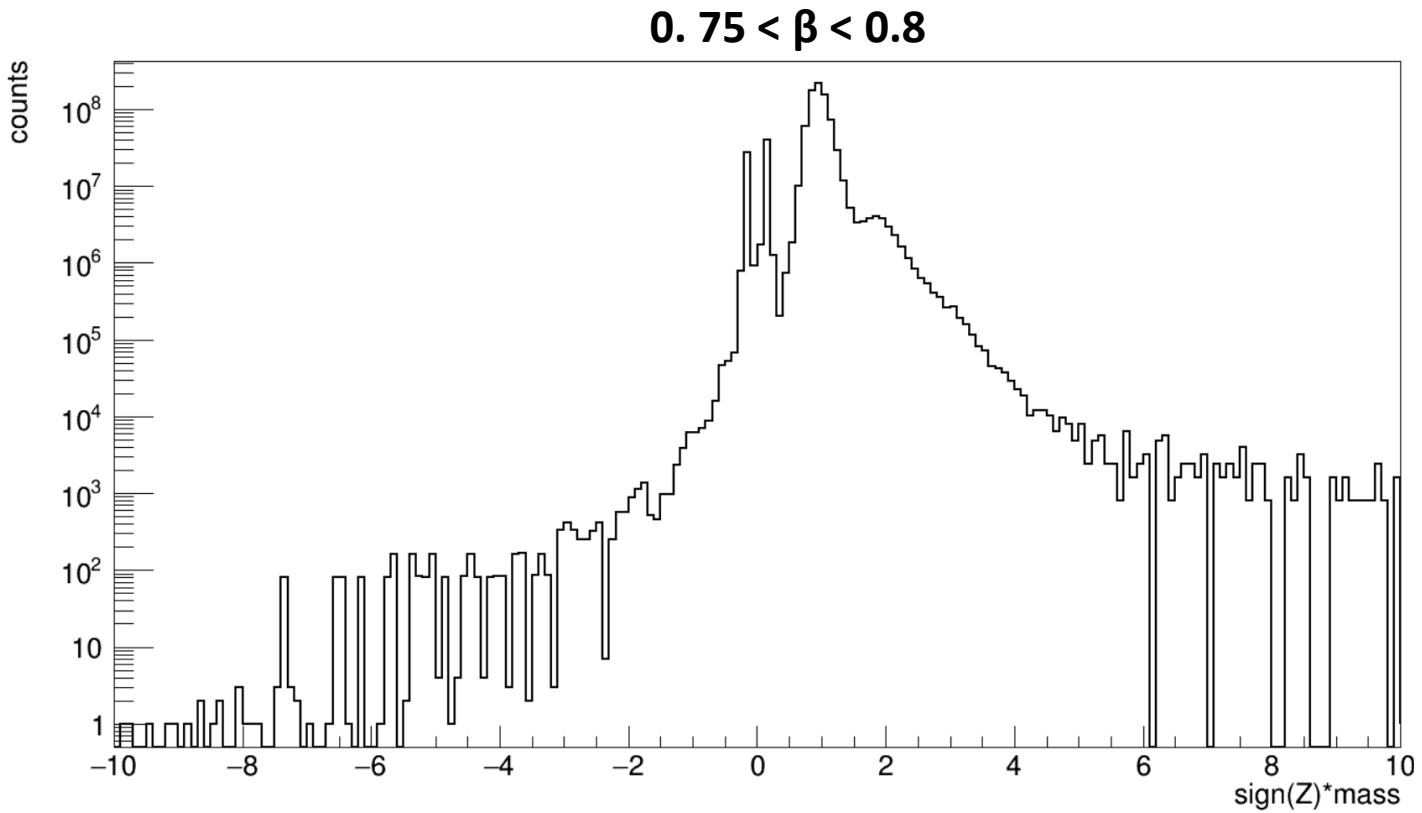
TOF:

- Nhits TOF = 4
- $\chi^2_{Coo} < 4$
- $\frac{|Z_{utof} - Z_{ltof}|}{Z_{utof}} < 0.2$

Inner Tracker (L2 to L8):

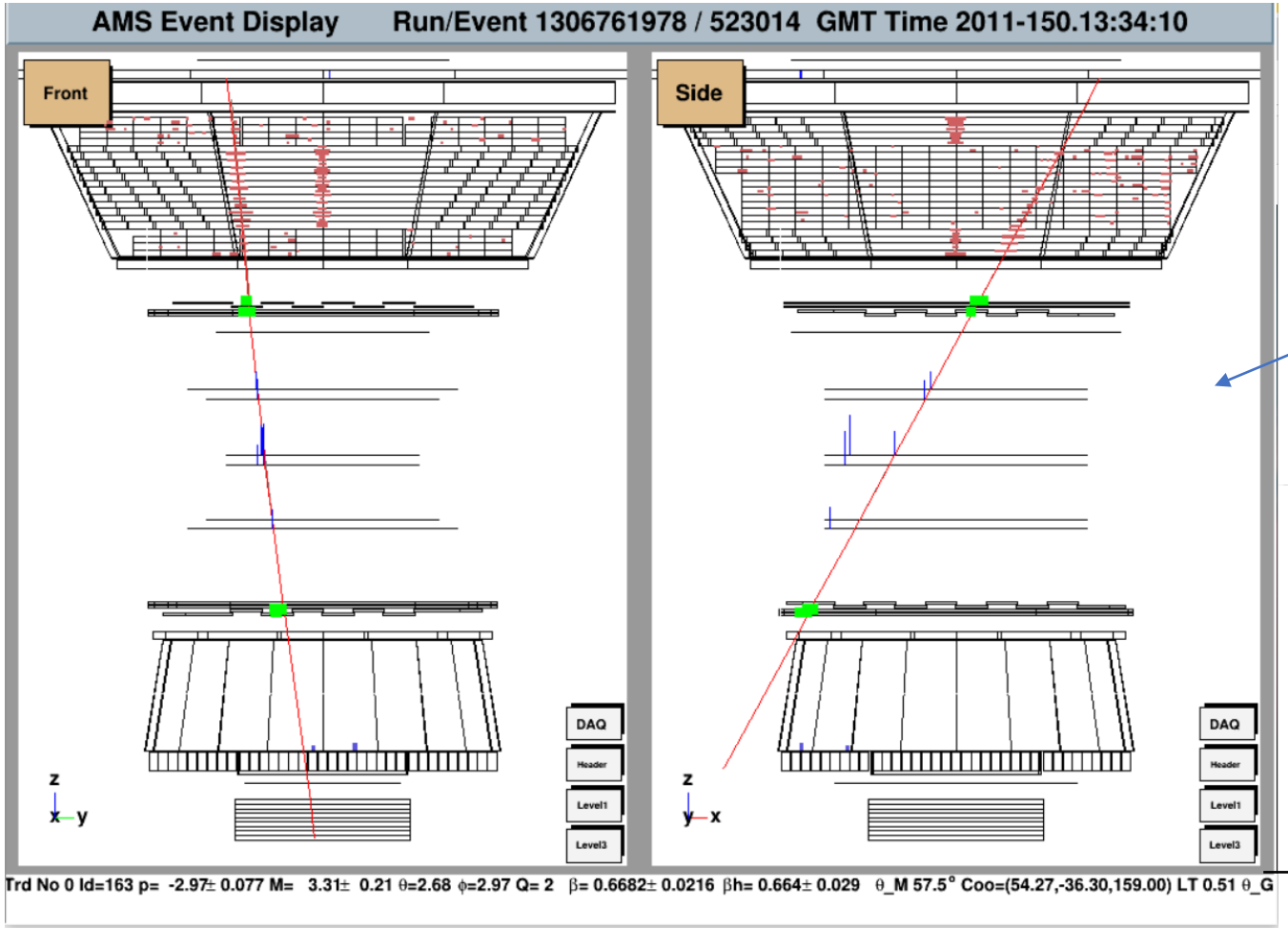
- PATTERN Y L2 & (L3 || L4) & (L5 || L6) & (L7 || L8)
- $\chi^2_Y < 10$
- $\frac{\sigma_Z}{Z} < 0.1$

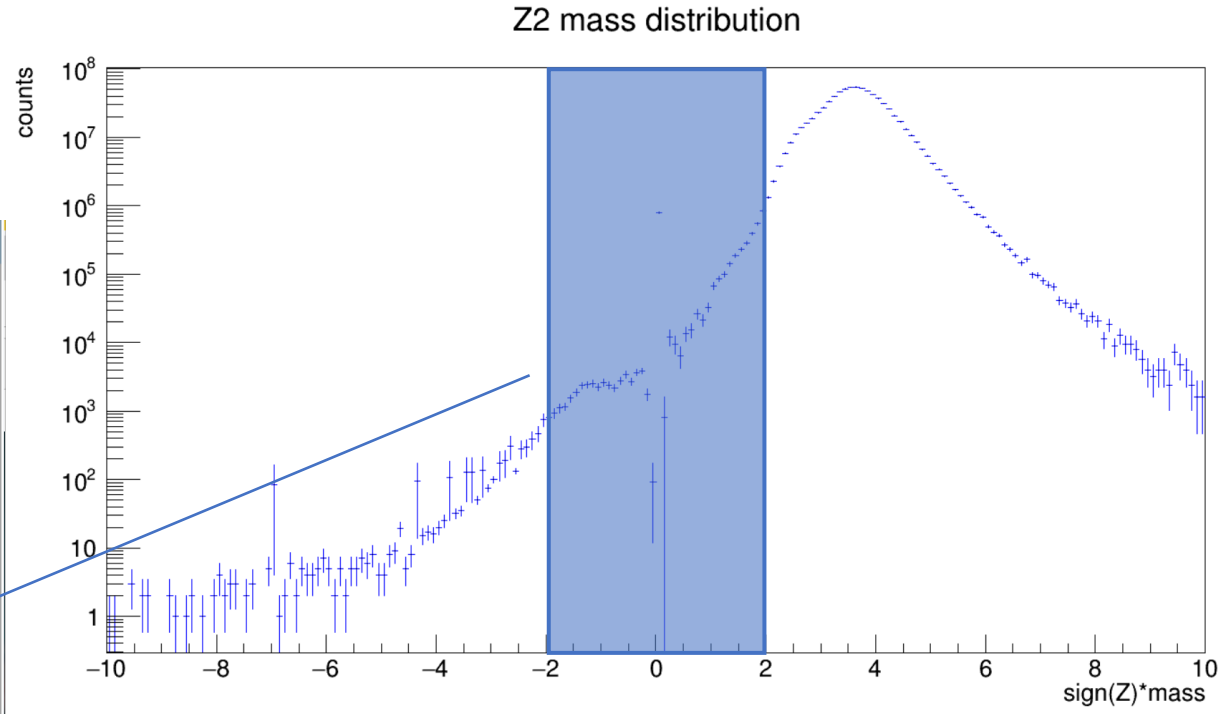
- Physics trigger ON



BACKGROUNDS EVENTDISPLAY

Some background events have been identified using the overall mass distribution: these events pass the standard selection and additional variables need to be used to remove them.





EXAMPLE (After the standard selection):

Mass 1.62921
Rigidity -0.722474
ITCharge Z=2
Pattern Y IT: 1 10 11 11

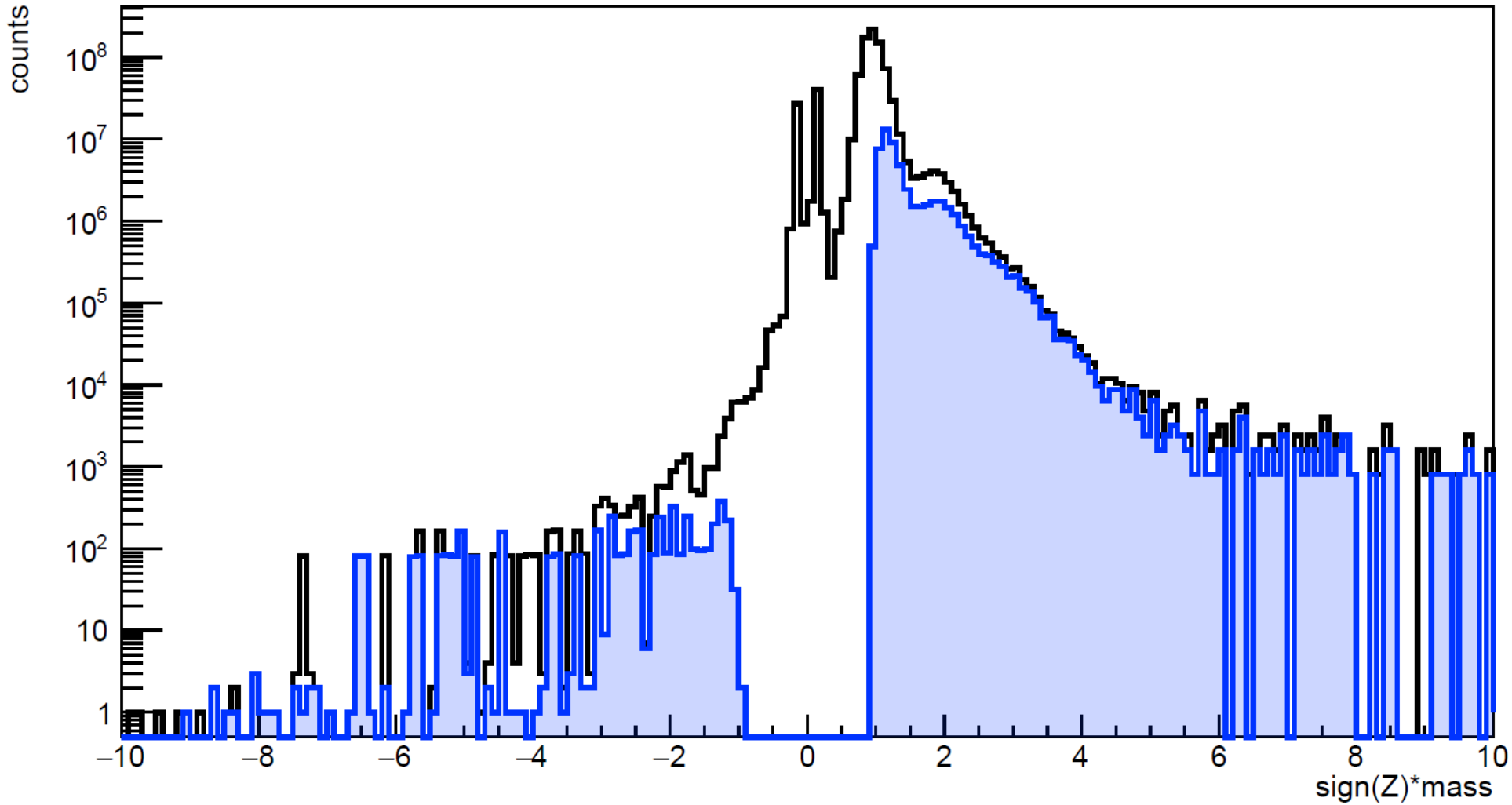
Studying a tight selection to remove the remaining background events, using the eventdisplay is ongoing

RTI RIGIDITY CUTOFF

The RTI rigidity cutoff on the data has been applied:

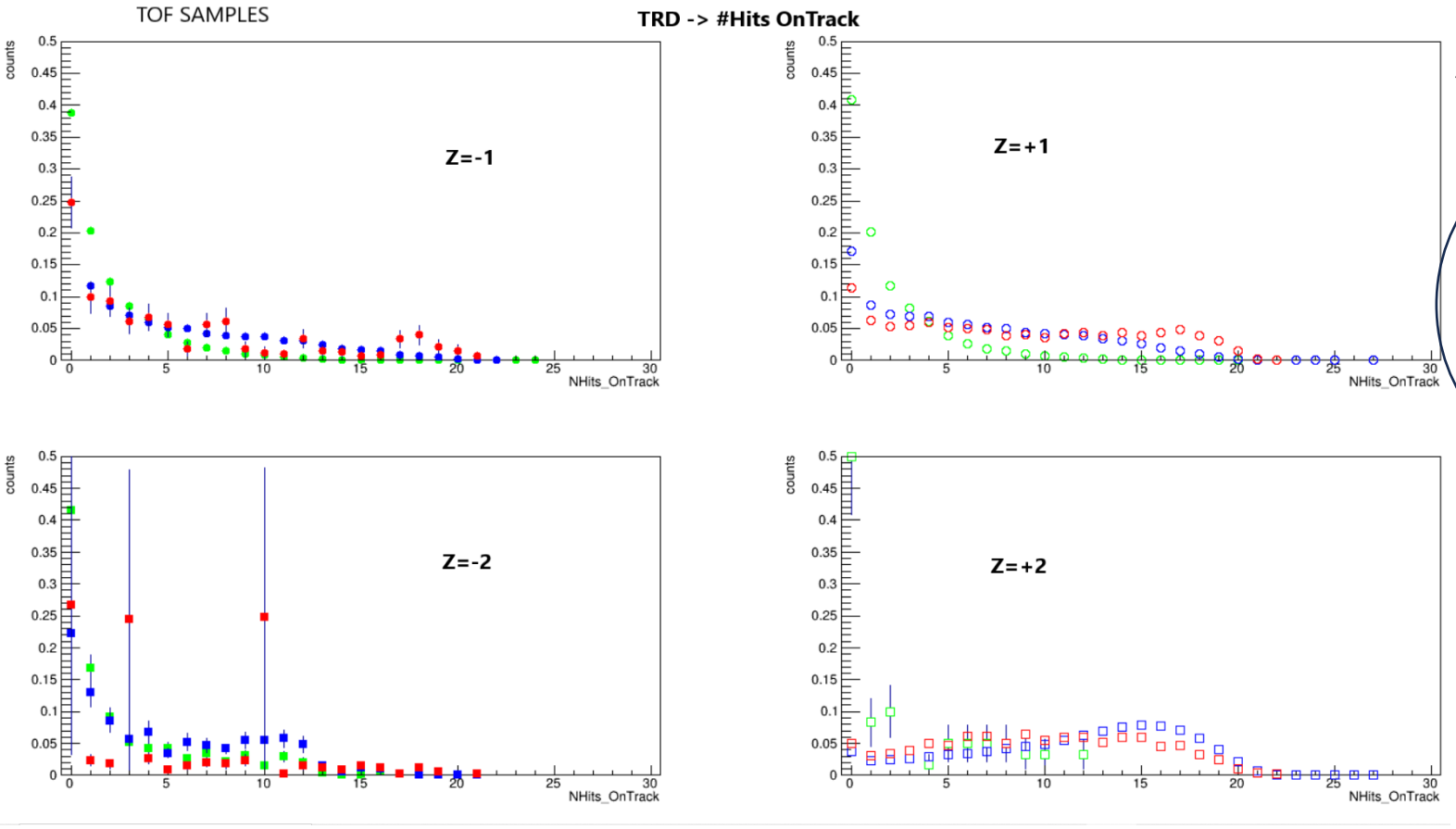
$$R_{rec} > 1.2R_{cutoff}$$

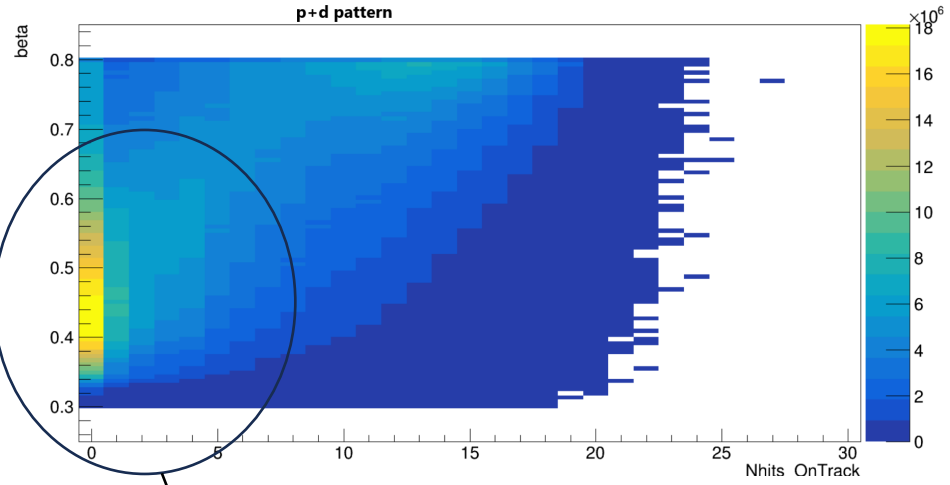
0. 75 < β < 0.8



TRD RECONSTRUCTION PROBLEM

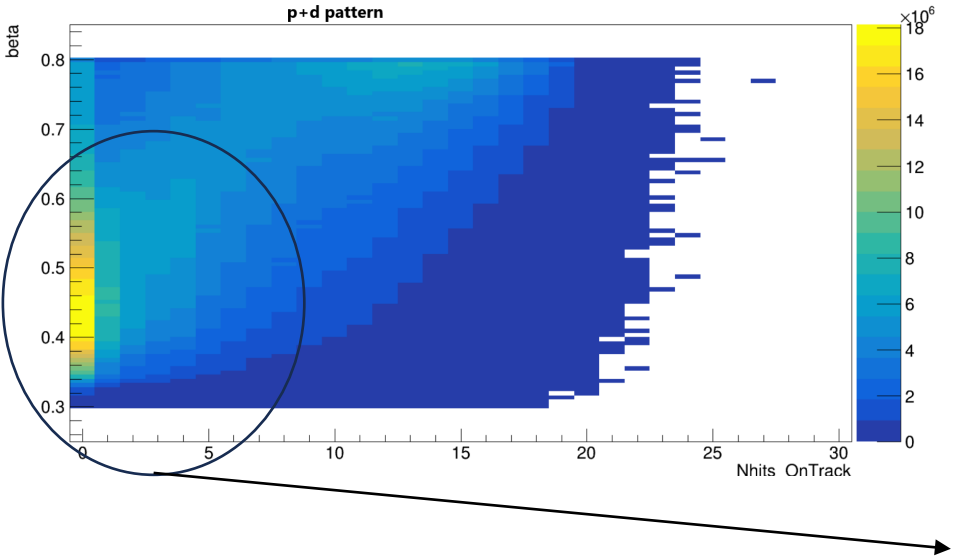
(further details tomorrow in the NAIA meeting)





Analyzing the TRD distributions an inefficiency in the TRD, especially for low reconstructed beta, has been noticed

TRD RECONSTRUCTION PROBLEM

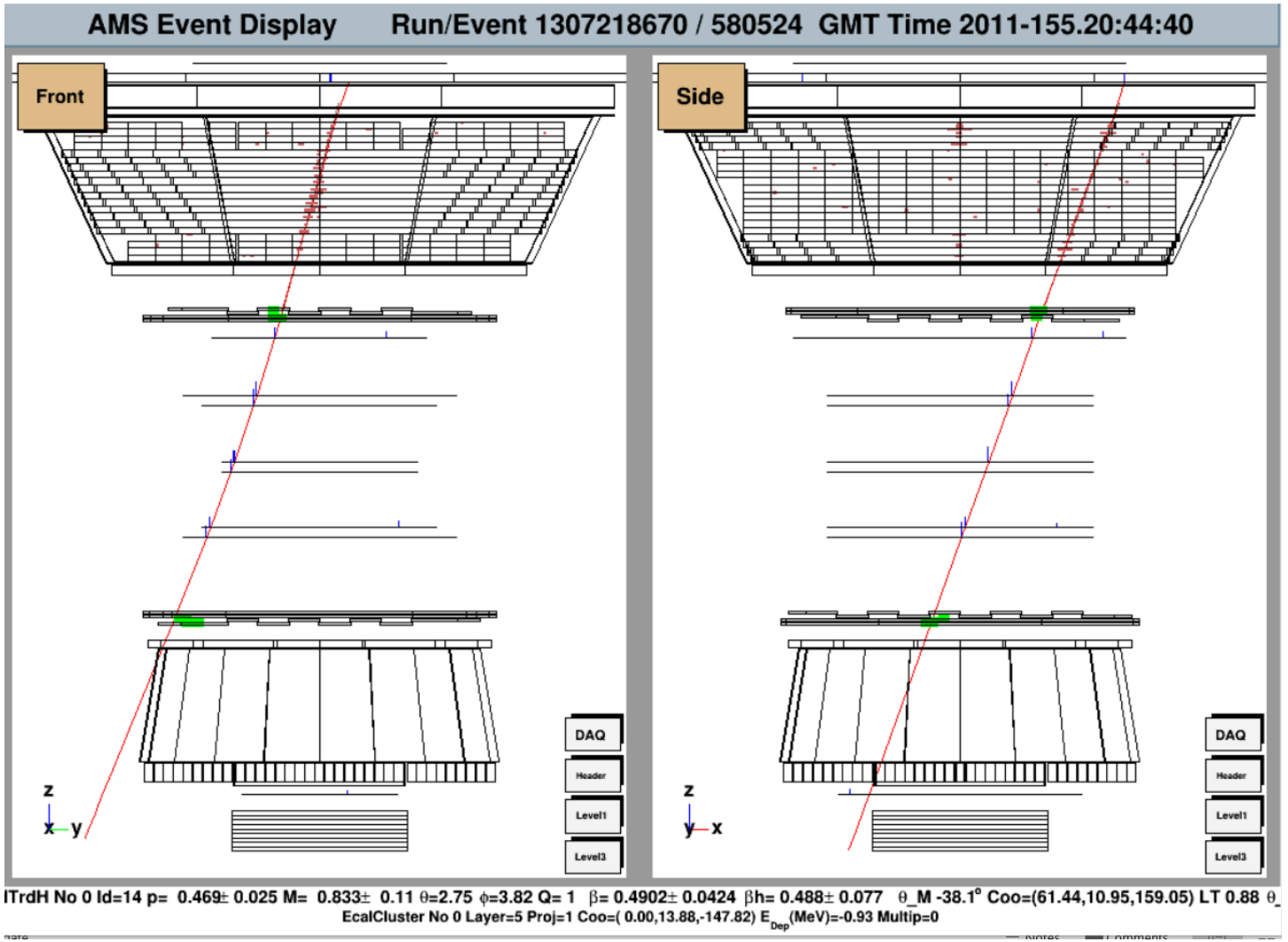


Some incriminated events have been looked in the eventdisplay to better understand the reason of the inefficiency.

Two reasons:

A. The reconstructed track is deflected at low beta and doesn't match the TRD

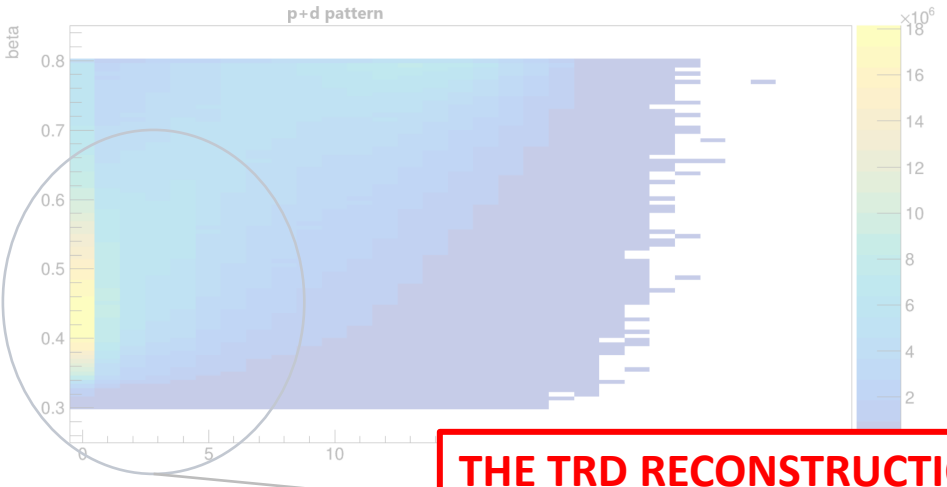
B. The reconstruction is selecting the wrong TRD track

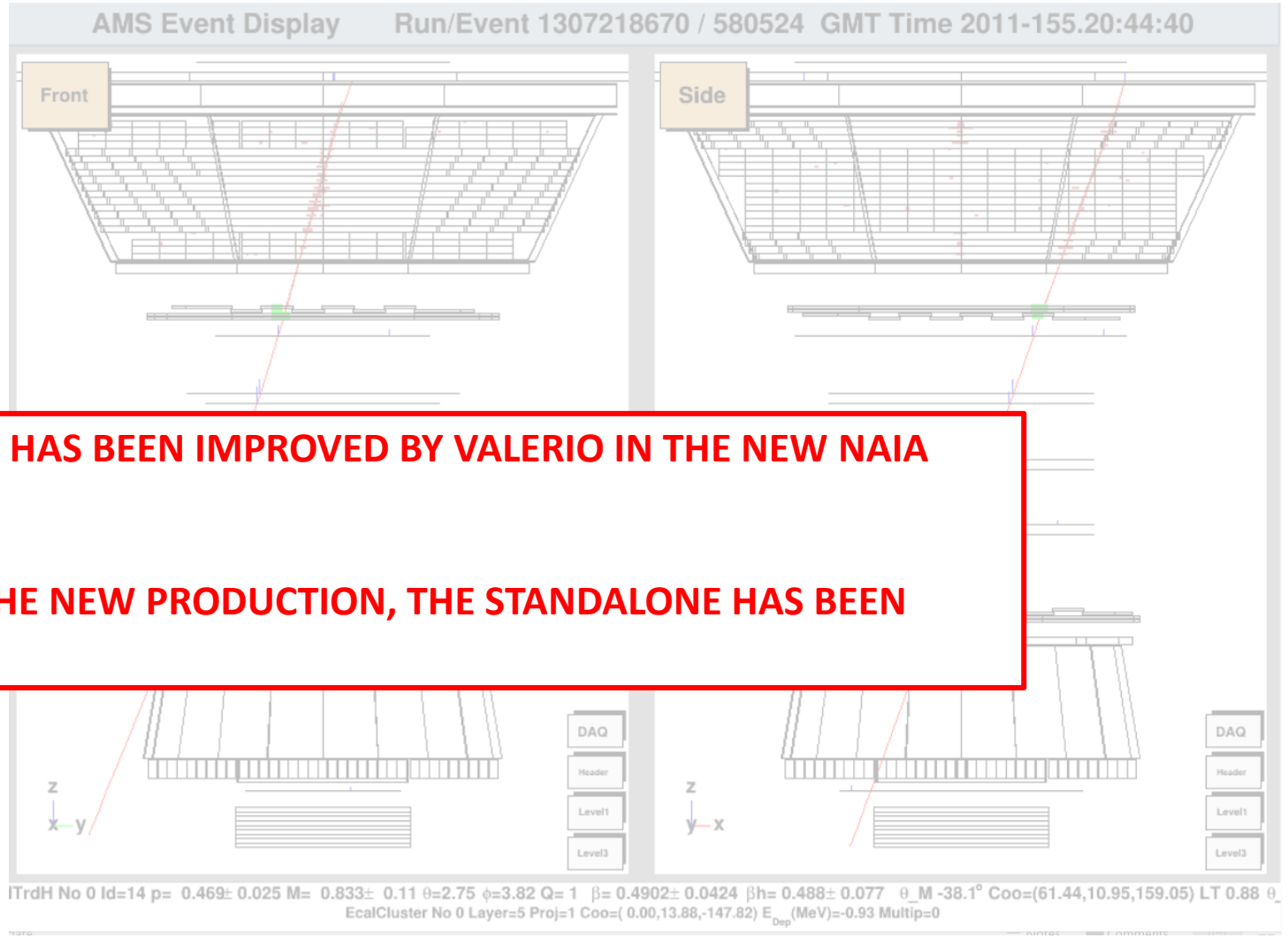


TRD ON TRACK STANDALONE = 20 : there is a good track in the TRD

TRD ON TRACK = 4 : that track is not reconstructed starting from the tracker

TRD RECONSTRUCTION PROBLEM





THE TRD RECONSTRUCTION HAS BEEN IMPROVED BY VALERIO IN THE NEW NAIA VERSION (1.1.0).

HOWEVER, WAITING FOR THE NEW PRODUCTION, THE STANDALONE HAS BEEN USED IN THE MAINTIME

We have looked i
some incriminate
understand the re
inefficiency.

Two reasons:

A. The IT track is deflected at low beta and doesn't match the TRD
B. We are selecting the wrong TRD track in the reconstruction

TRD ON TRACK STANDALONE = 20 : there is a good track in the TRD

TRD ON TRACK = 4 : that track is not reconstructed starting from the IT

MONTECARLO SAMPLES

In the analysis the MonteCarlo is needed for two reasons:

1. calculate the acceptance of the detector, using a certain selection;

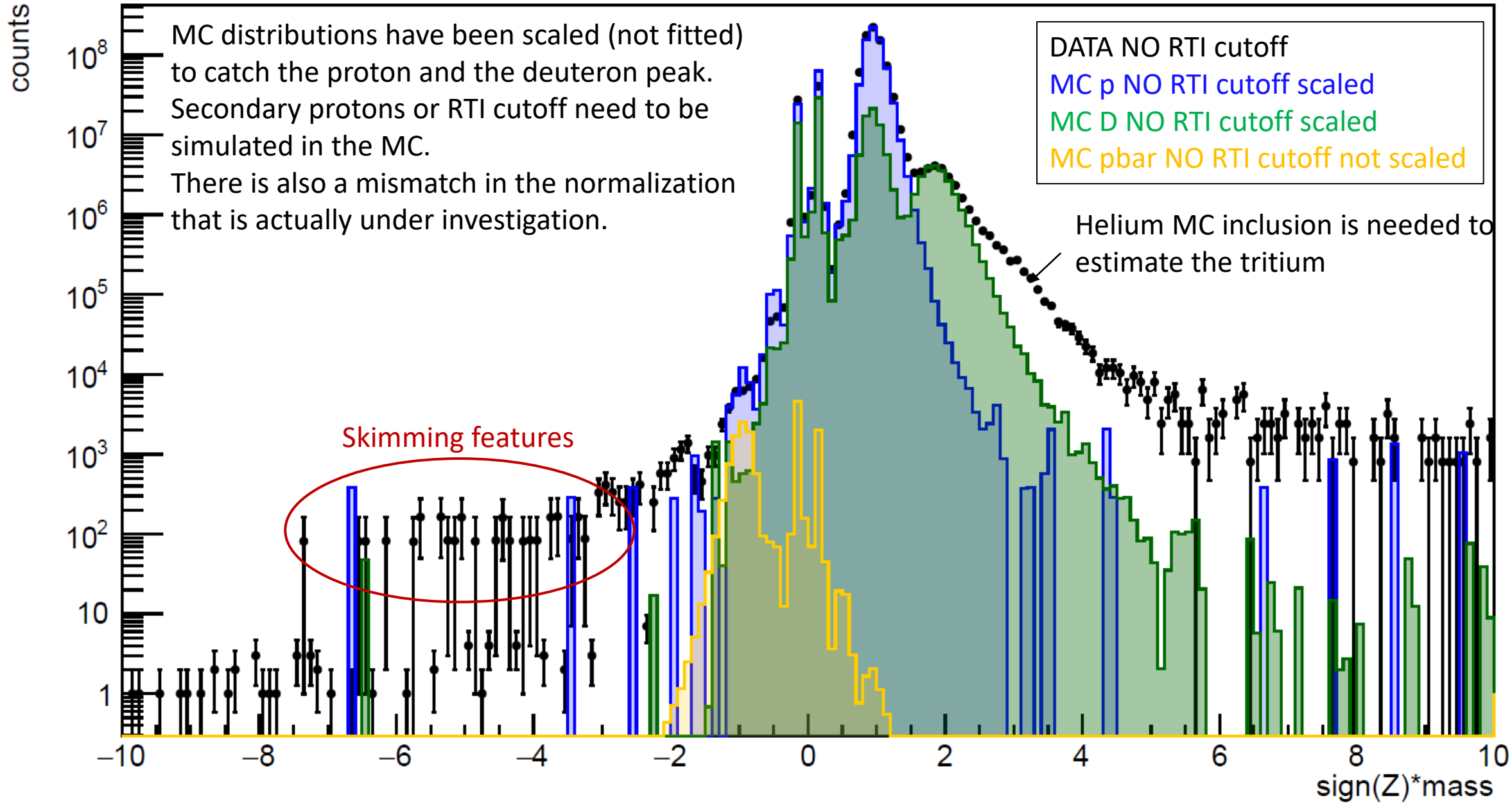
2. create the mass templates for protons, deuterons, antiprotons and antideuterons that can be used to fit the data.

For the protons the ntuples in the following path has been used:
/storage/gpfs_ams/ams/groups/AMS-Italy/ntuples/v1.0.0/Pr.B1236/pr.pl1.05100.6_02
The ntuples have been scaled according to Physics Reports 894 (2021)

For the deuterons the ntuples in the following path has been used:
/storage/gpfs_ams/ams/groups/AMS-Italy/ntuples/v1.0.0/D.B1236/d.pl1.05200/
The ntuples have been scaled according to proton flux Physics Reports 894 (2021) and the d/p ratio in the deuteron draft.

For the antiprotons the ntuples the proton ntuples has been used, recostructing the rigidity with the opposite sign.
The ntuples have been scaled according to proton flux and $\frac{\bar{p}}{p}$ ratio both in the Physics Reports 894 (2021).

0. 75 < β < 0.8


counts
MC distributions have been scaled (not fitted) to catch the proton and the deuteron peak.
Secondary protons or RTI cutoff need to be simulated in the MC.
There is also a mismatch in the normalization that is actually under investigation.
DATA NO RTI cutoff
MC p NO RTI cutoff scaled
MC D NO RTI cutoff scaled
MC pbar NO RTI cutoff not scaled
Helium MC inclusion is needed to estimate the tritium
Skimming features
sign(Z)*mass

CONCLUSIONS

- A standard selection and the RTI cutoff on the data have been applied
- The TRD variables have been investigated to be added in the standard selection: a problem arose in the TRD reconstruction. These variables have not been included in the selection, waiting for the new NAIA production.
- The backgrounds survived to the selection have been investigated using the event display and we are trying to find a tight selection to suppress them.
- The MonteCarlo distributions of protons, deuterons and antiprotons (switched MC protons) have been used to try to reproduce the data, but there is a strong mismatch with respect them. Investigation is ongoing.

BACKUP

MONTECARLO DISTRIBUTIONS

We started to use the MonteCarlo for the protons, trying to quantify the negative particles produced by the interaction between the incoming protons and the detector, and the efficiencies of the selections applied.

The ntuples in the directory /storage/gpfs_ams/ams/groups/AMS-Italy/ntuples/v1.0.0/Pr.B1236/pr.pl1.05100.6_02 have been used.

The MonteCarlo has been weighted to be comparable with the counts obtained processing the data. The flux is defined as:

$$\Phi(\mathrm{R}) = \frac{\#_{counts}(R)}{dt\ dS\ d\Omega\ dR}$$

so it's possible to find the number of the counts for every rigidity bin in this way:

$$\#_{counts}(R) = \Phi(\mathrm{R})\ \mathrm{t(R)}\ \pi\ l^2\ \Delta(R)$$

$\Delta(R)$ → Bin width

$\Phi(\mathrm{R})$ → Flux taken from Physics Reports 894 (2021)

$\mathrm{t(R)}$ → Exposure time calculated using the RTI cutoff info

$\pi\ l^2$ → Generation acceptance: the MC uses a 3.9x3.9 mq generation surface on top of the instrument.

The number of generated events in the MC for every rigidity bin is:

$$\#_{counts\_MC}(R) = \frac{\#generated}{\log(R_{max,gen}) - \log(R_{min,gen})}\ \Delta(logR)$$

$\frac{\#generated}{\log(R_{max,gen}) - \log(R_{min,gen})}$ → MC generation factor

Each event has been weighted using the following:

$$w(R) = \frac{\#_{counts}(R)}{\#_{counts\_MC}(R)}$$

MONTECARLO DISTRIBUTIONS (2)

We are using also the deuteron Montecarlo in the following path:

/storage/gpfs_ams/ams/groups/AMS-Italy/ntuples/v1.0.0/D.B1236/d.pl1.05200/.

We calculated the flux as:

$$\Phi_D(\mathrm{R}) = \Phi_p(R)\frac{D}{p}(R)$$

Ratio interpolated from the deuteron draft and kept fixed outside the boundaries

Flux taken from
Physics Reports 894 (2021)

We are using the proton Montecarlo, switching the rigidity sign, in the following path:

/storage/gpfs_ams/ams/groups/AMS-Italy/ntuples/v1.0.0/Pr.B1236/pr.pl1.05100.6_02 .

We calculated the flux as:

$$\Phi_{\bar{p}}(\mathrm{R}) = \Phi_p(R)\frac{\bar{p}}{p}(R)$$

Ratio interpolated from the Physics Reports 894 (2021) and kept fixed outside the boundaries

We applied the RTI cutoff in the data (with the 1.2 safety factor) and we simulated it in the MonteCarlo