# *AMS SIMULATION AND RICH RECONSTRUCTION.*

# *RESULTS FOR PROTONS, HELIUM AND BERYLLIUM.*

Presented by:

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# Outline

This report will overview the status of the RICH reconstruction for certain simulated particle species.

Our goal is to develop the necessary work prior to any detailed analysis: how well the $\beta$ reconstruction is going to perform, what can we expect from badly reconstructed events.

For that purpose we'll be talking about:

- Basic simulation characteristics.
- Minimum requirements for the sample used and quality cuts.
- Some RICH reconstruction general results and further selections.
- Review and next steps.

# What has been simulated?

$5 \cdot 10^5$ generated events on a $324cm \times 324cm$ plane $162cm$ over the central plane of the TRACKER.

- Protons $\longrightarrow$ flat spectrum in momentum: 0-25 GeV/c
- $^4$He $\longrightarrow$ flat spectrum in momentum: 0-50 GeV/c
- $^9$Be $\longrightarrow$ flat spectrum in momentum: 0-200 GeV/c
- $^{10}$Be $\longrightarrow$ flat spectrum in momentum: 0-200 GeV/c

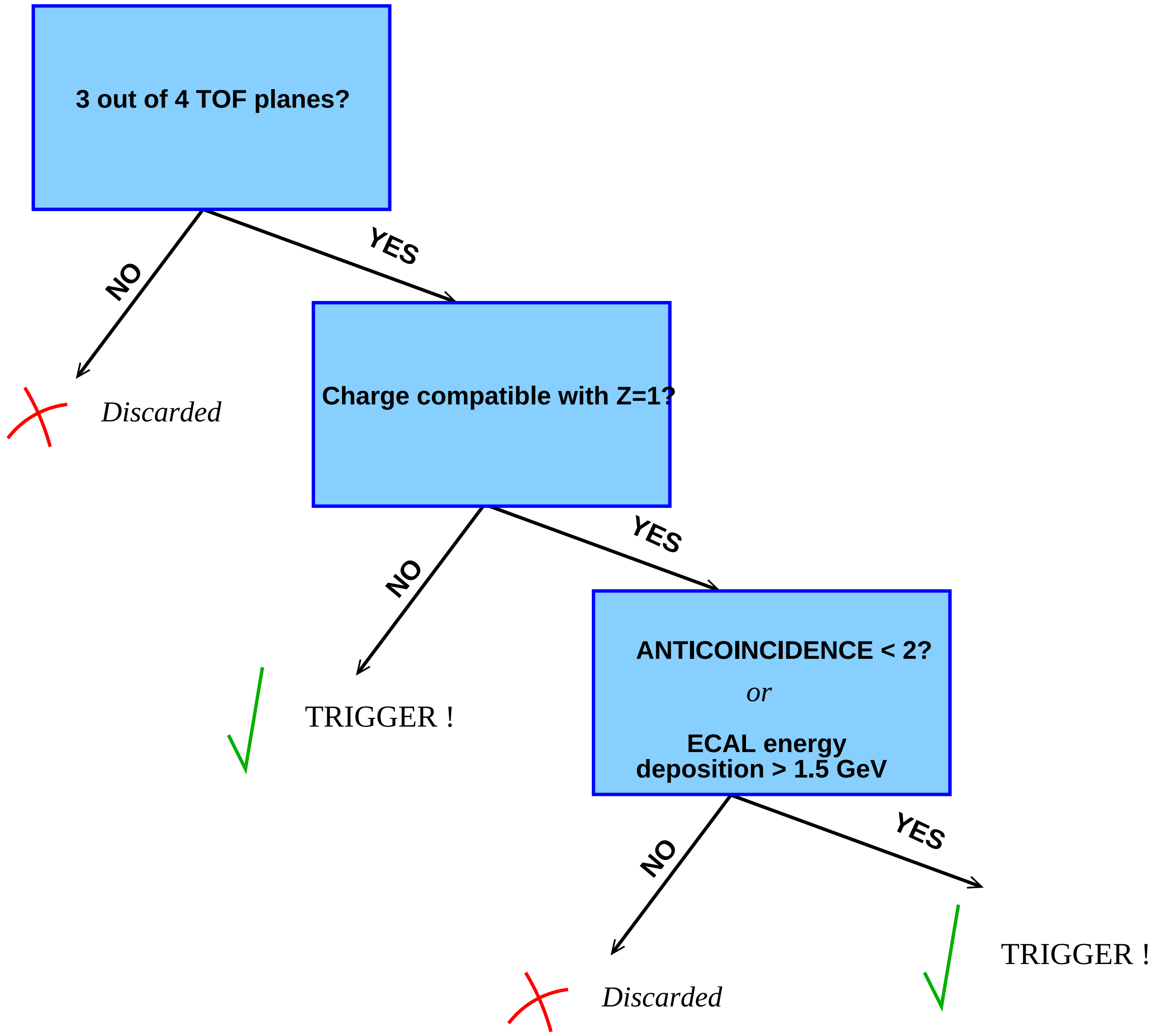
Physical features of the simulated RICH detector.

- 680 PMTs with 37 mm pitch
- 34 mm light guide top dimension
- 3 cm thick radiator
- n=1.05 and clarity=0.0091 $\mu m^4/cm$

# What sample will be used?

First of all, what can be considered as an event?

- An AMS particle has been reconstructed: `npart`=1
- AMS must have triggered on our candidate. This means...




So this is our very basic set...

# What sample will be used?

Now we should consider which sub-sample is to be used for RICH reconstruction analysis purposes. We will call it the **quality** selection.

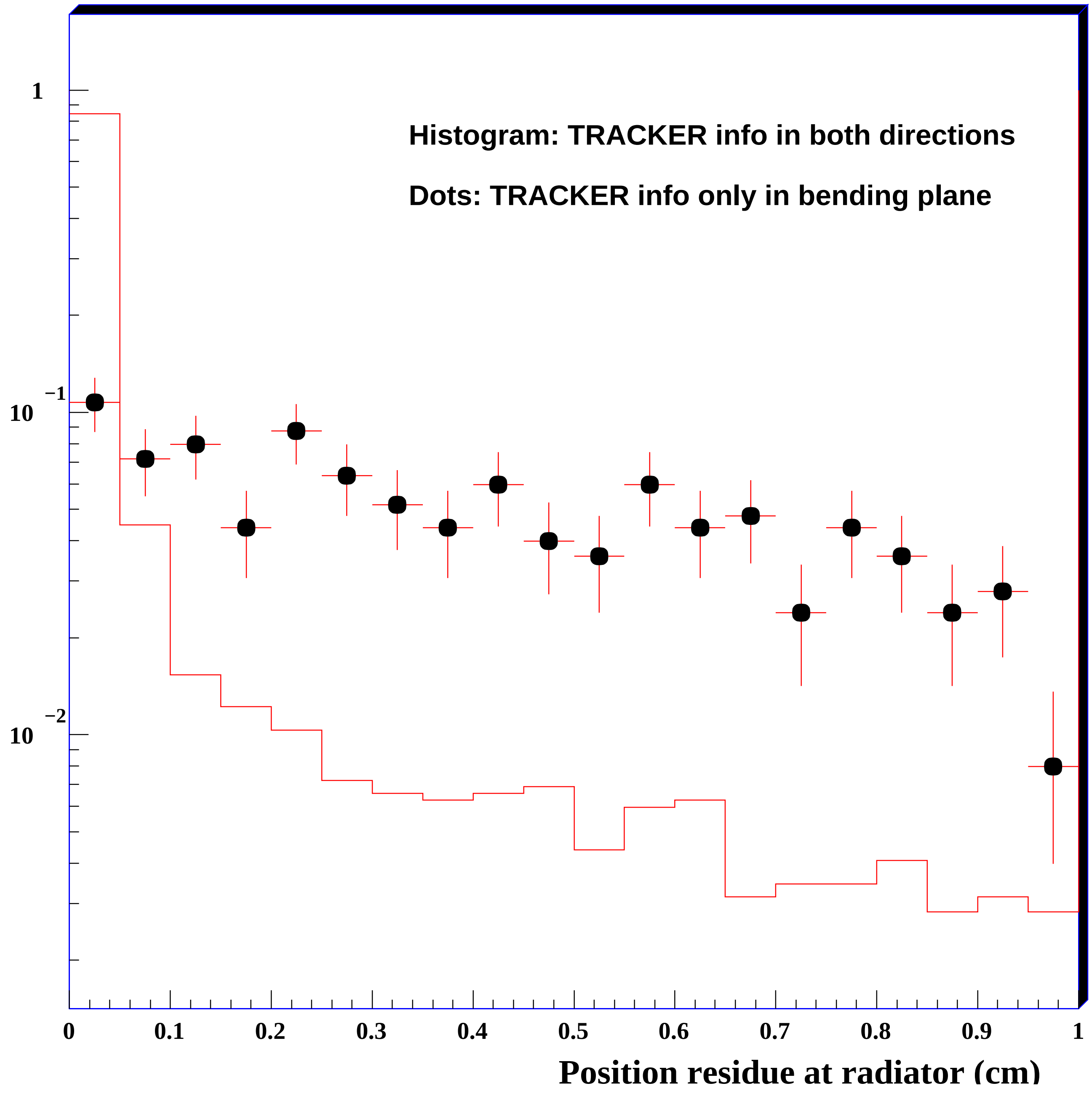
Here are the requirements **for studying a given particle type**:

- Only events with TRACKER info on both directions.
- Rigidity consistency between different TRACKER sections.
- No inconsistent energy depositions at TOF planes from inelastic scattering.
- Simulated charge equal to reconstructed charge.
- Reasonable TOF $\beta$ values.
- Tracker prediction goes through the RICH radiator.

In the following plots, we will justify our selected cuts.

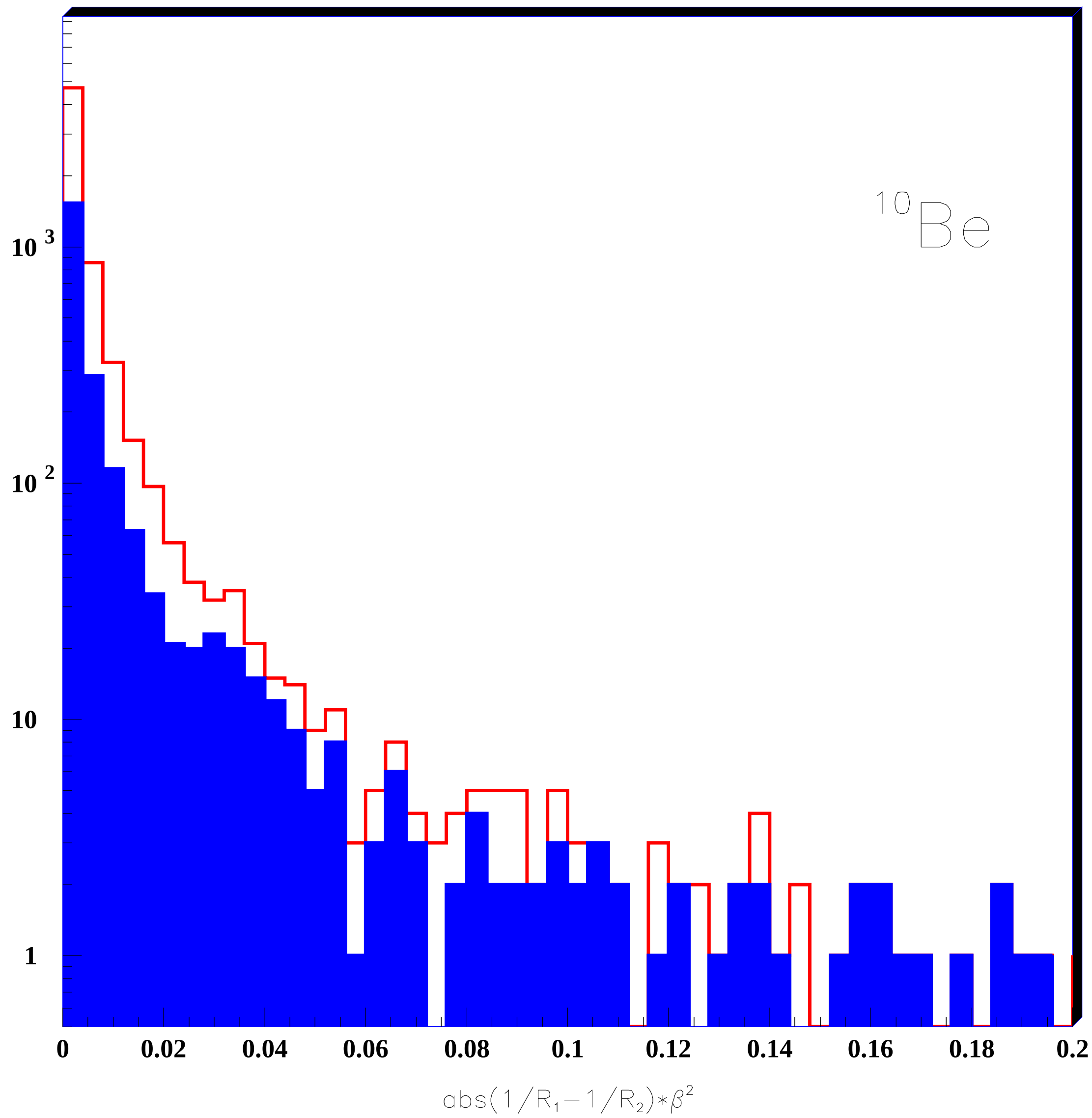
# The quality selection

TRACKER predictions for events reconstructed with only TOF information in the non-bending plane also show a wide position residue at the RICH radiator. This cut affects mainly protons.



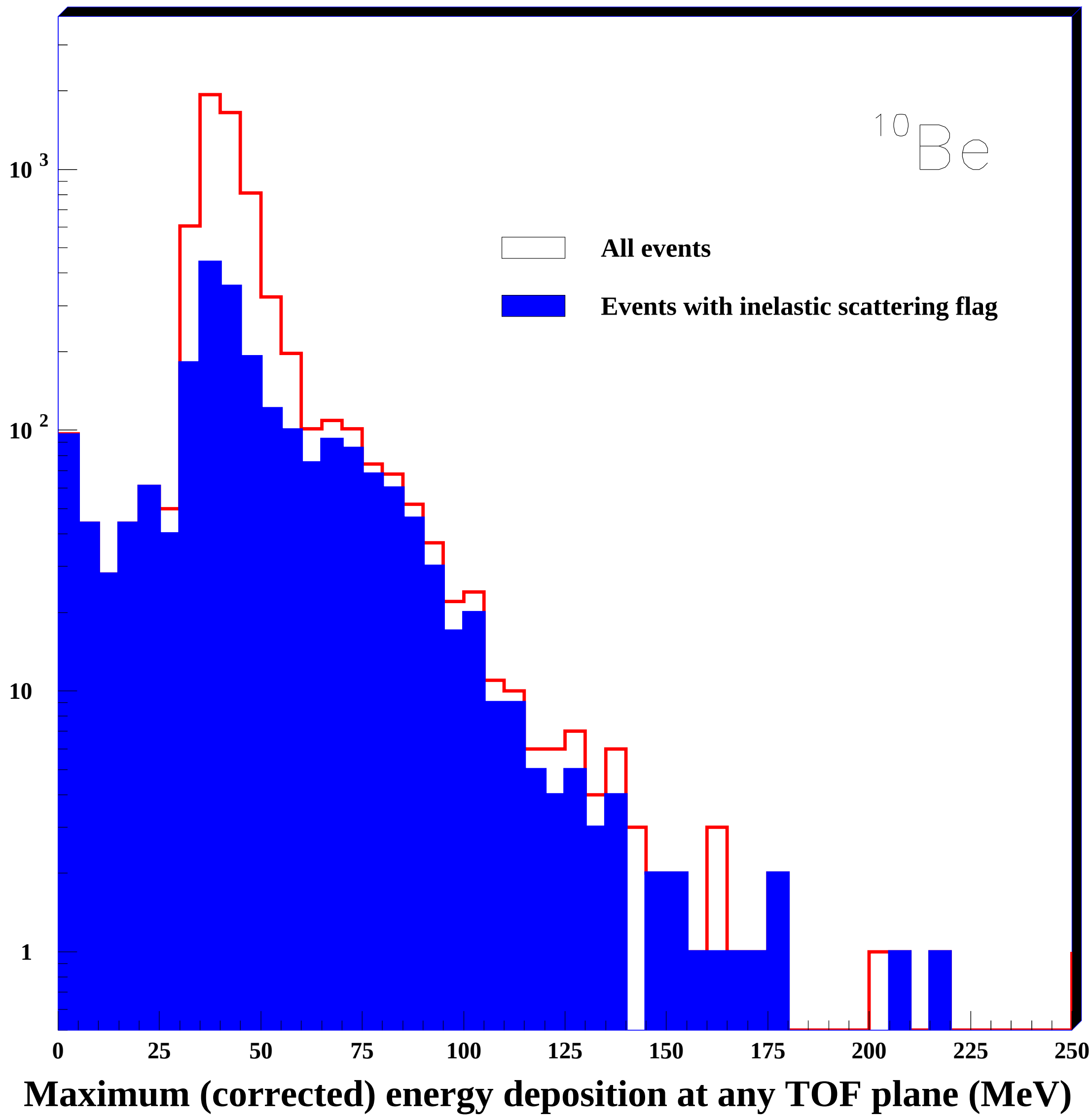
# The quality selection

Half rigidities $R_1$ and $R_2$ are the rigidities measured by the first and last TRACKER sections respectively. Our cut has been chosen to eliminate those events with a high discrepancy in these values, of which a very high fraction have an inelastic scattering flag.



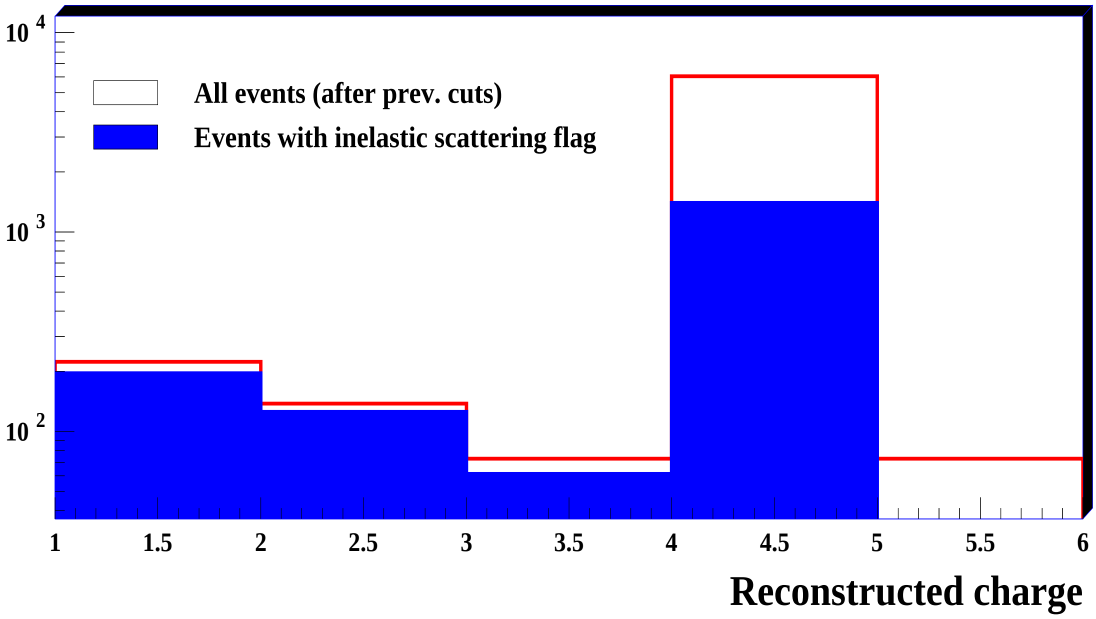
# The quality selection

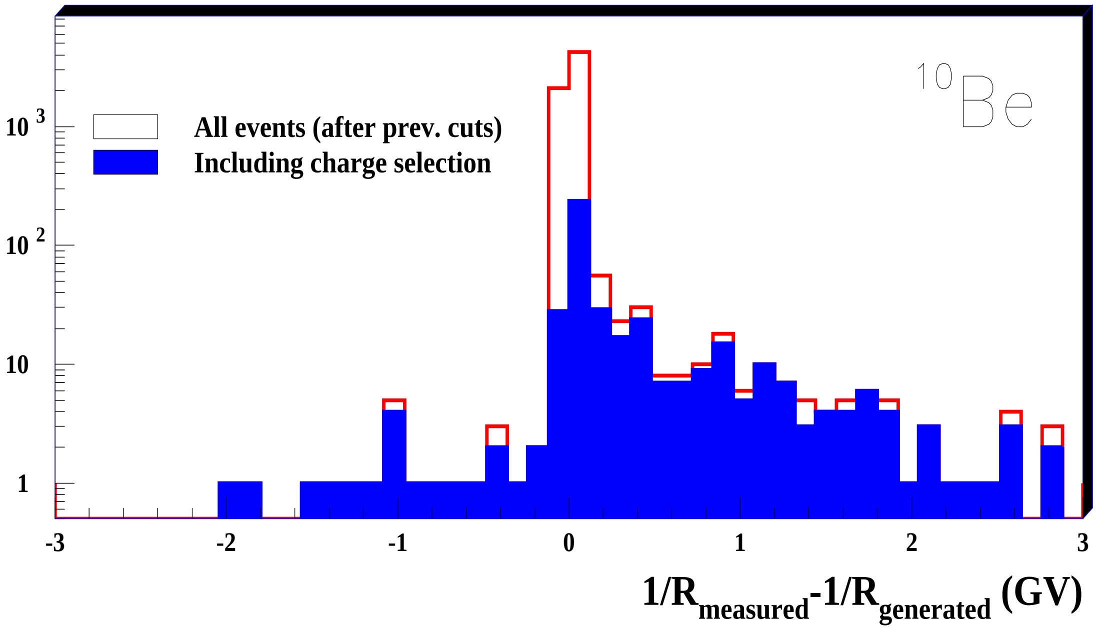
Same for inconsistent energy deposition (MeV) in any TOF plane. In this case we will cut events which show ánomalousénergy depositions at their passing through the TOF planes. We used the variable which measures the highest value for this energy in any plane, corrected for scattering effects at low energies and for the incidence angle (for a high angle, particles will leave more energy).



# The quality selection

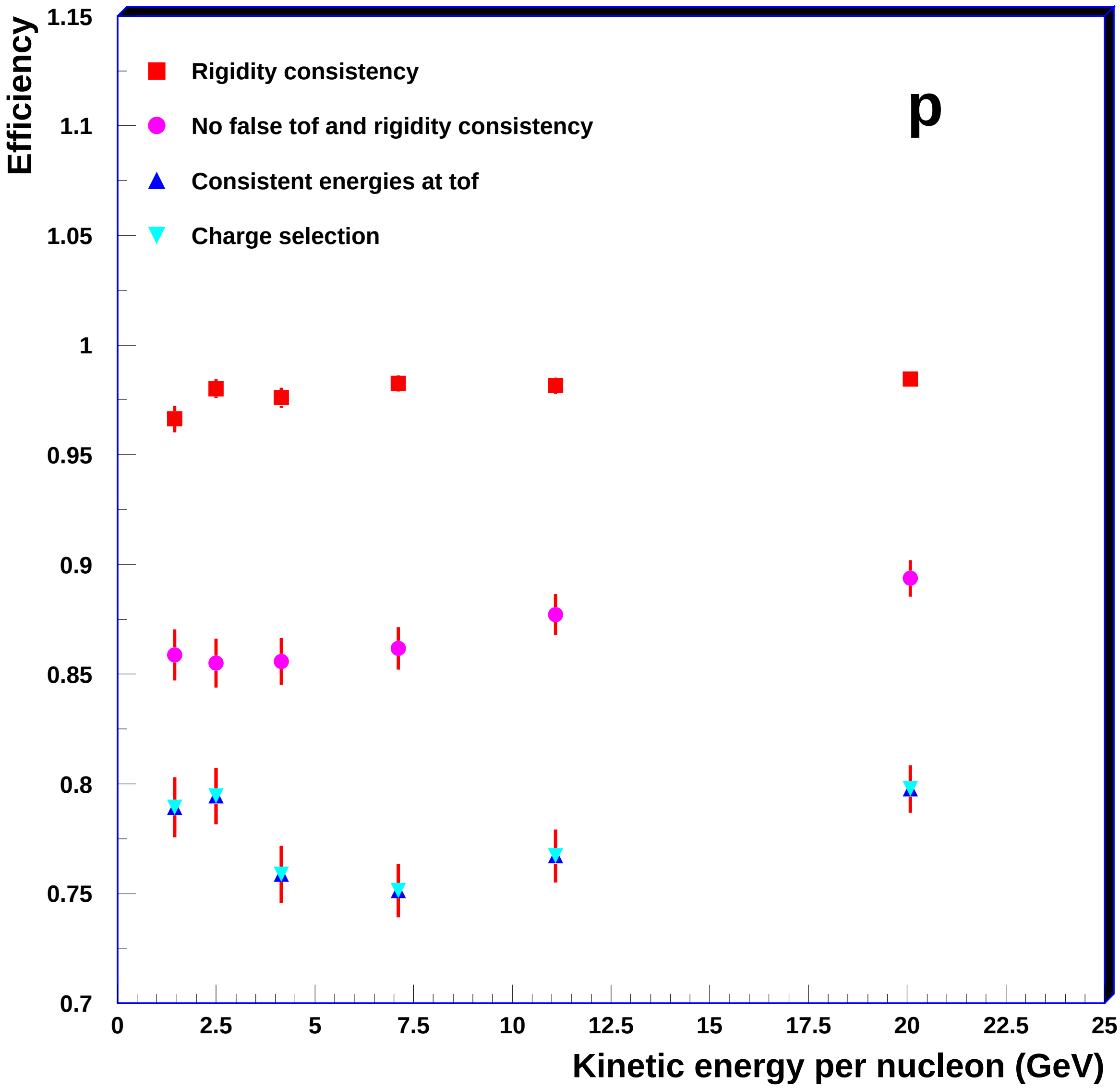
By selecting the charge of the particle we are going to analyze (beryllium), we see that most of the reconstructions with a different value for the charge have the inelastic scattering flag. We also see that these cases are dominant for high values of the residues of the rigidities.



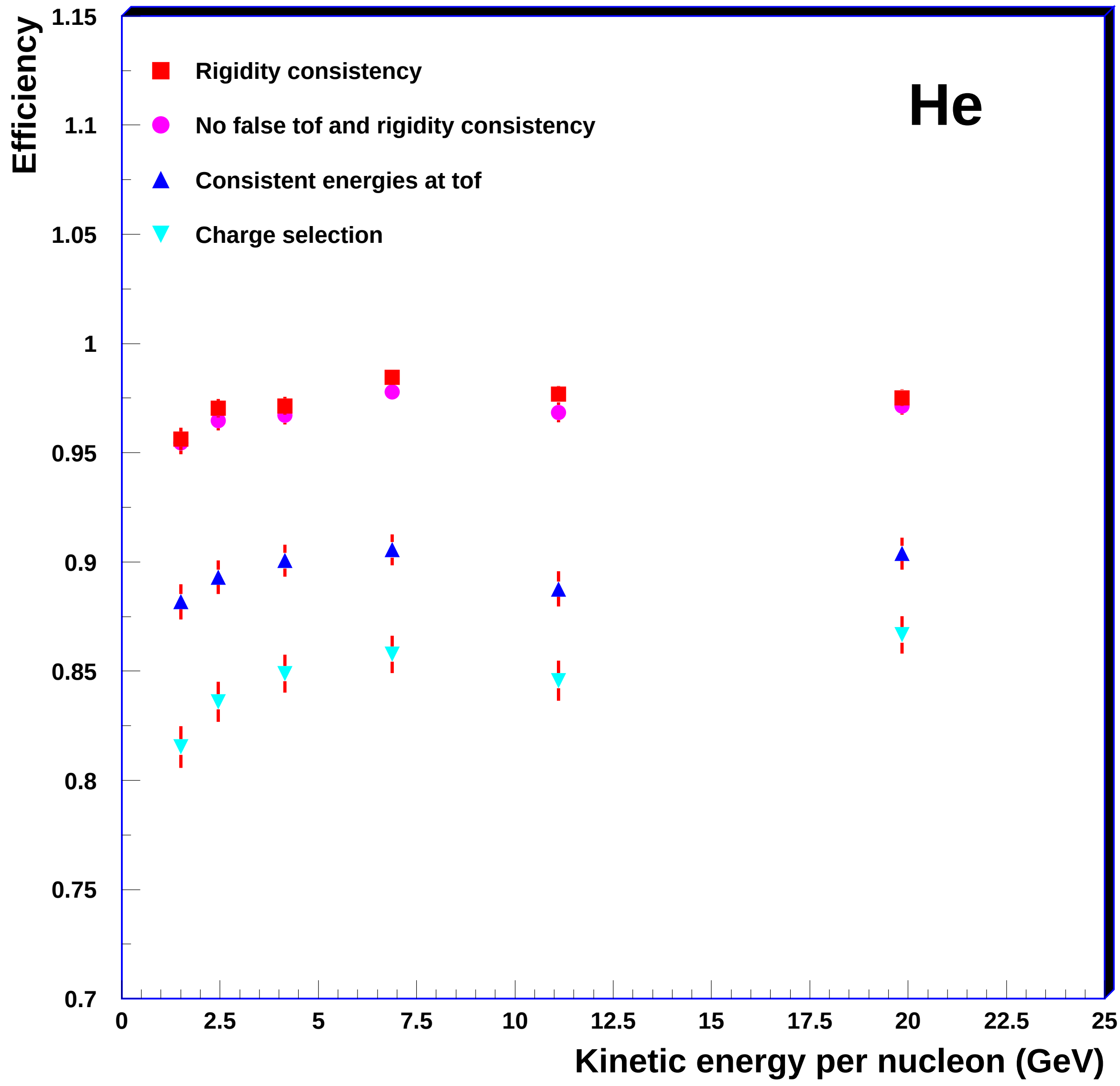
# The quality selection

Efficiency of the quality cuts, starting out from our basic sample (protons):



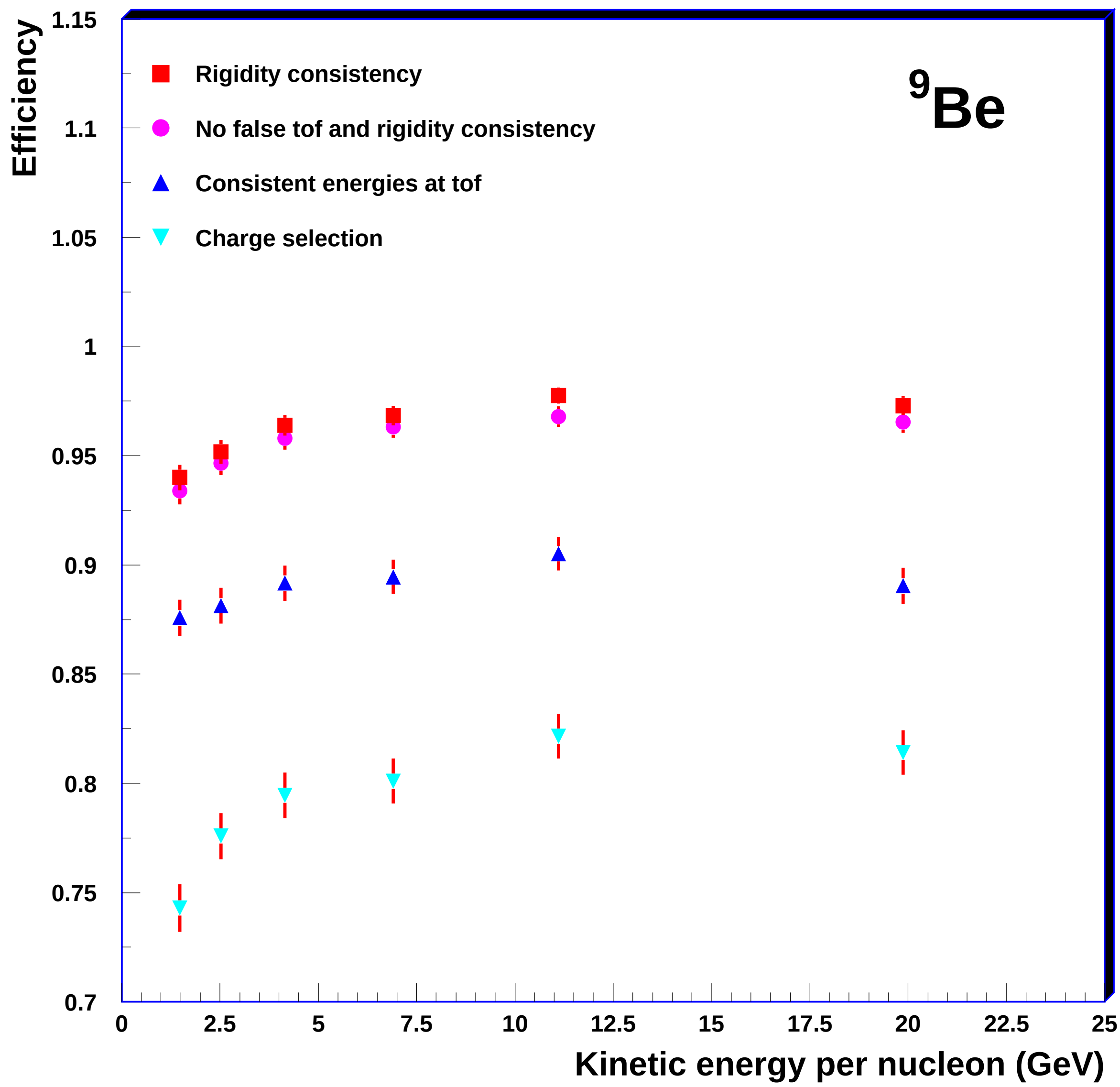
# The quality selection

Efficiency of the quality cuts, starting out from our basic sample (helium):



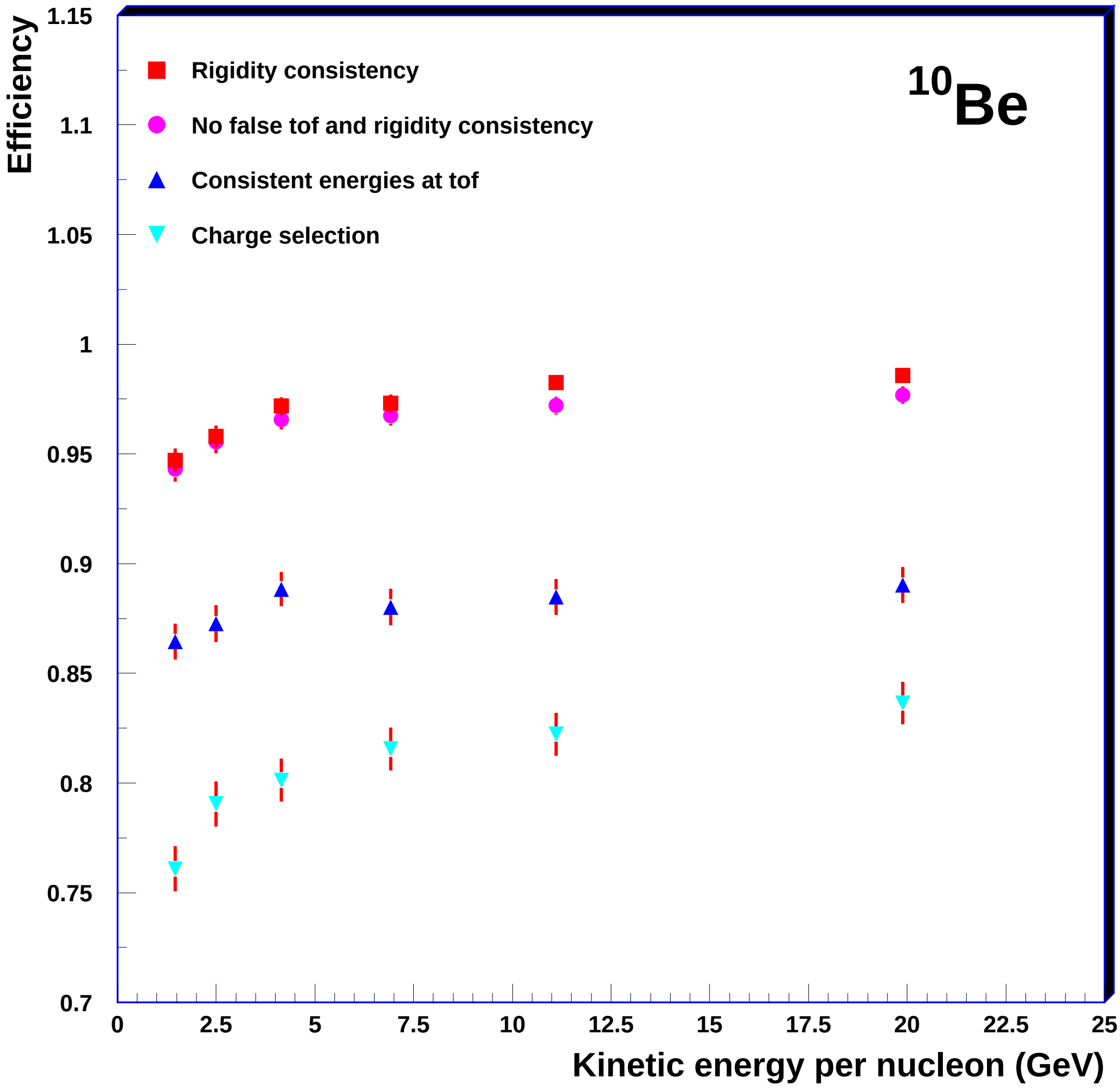
# The quality selection

Efficiency of the quality cuts, starting out from our basic sample (beryllium):



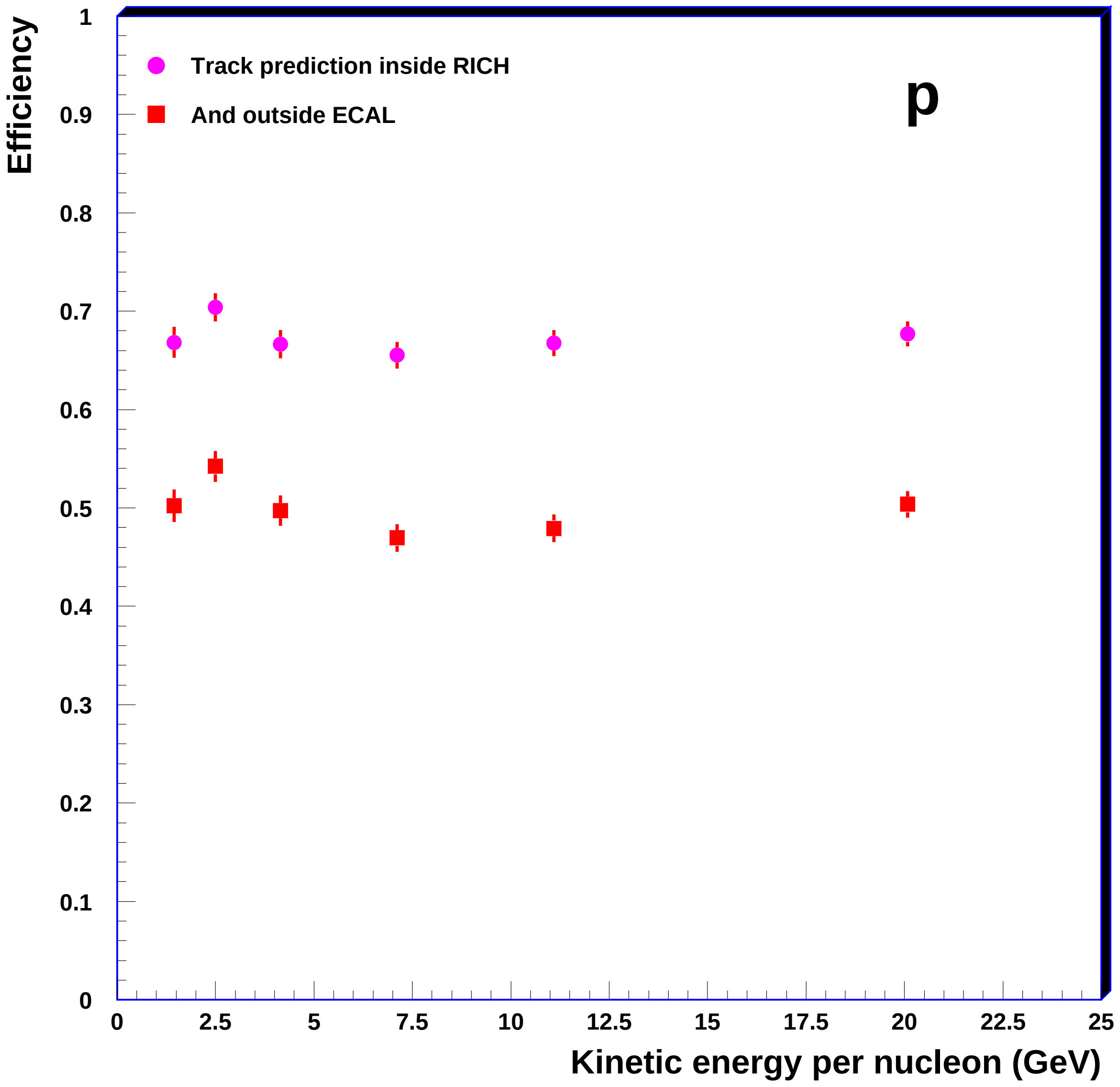
# The quality selection

Efficiency of the quality cuts, starting out from our basic sample (beryllium):



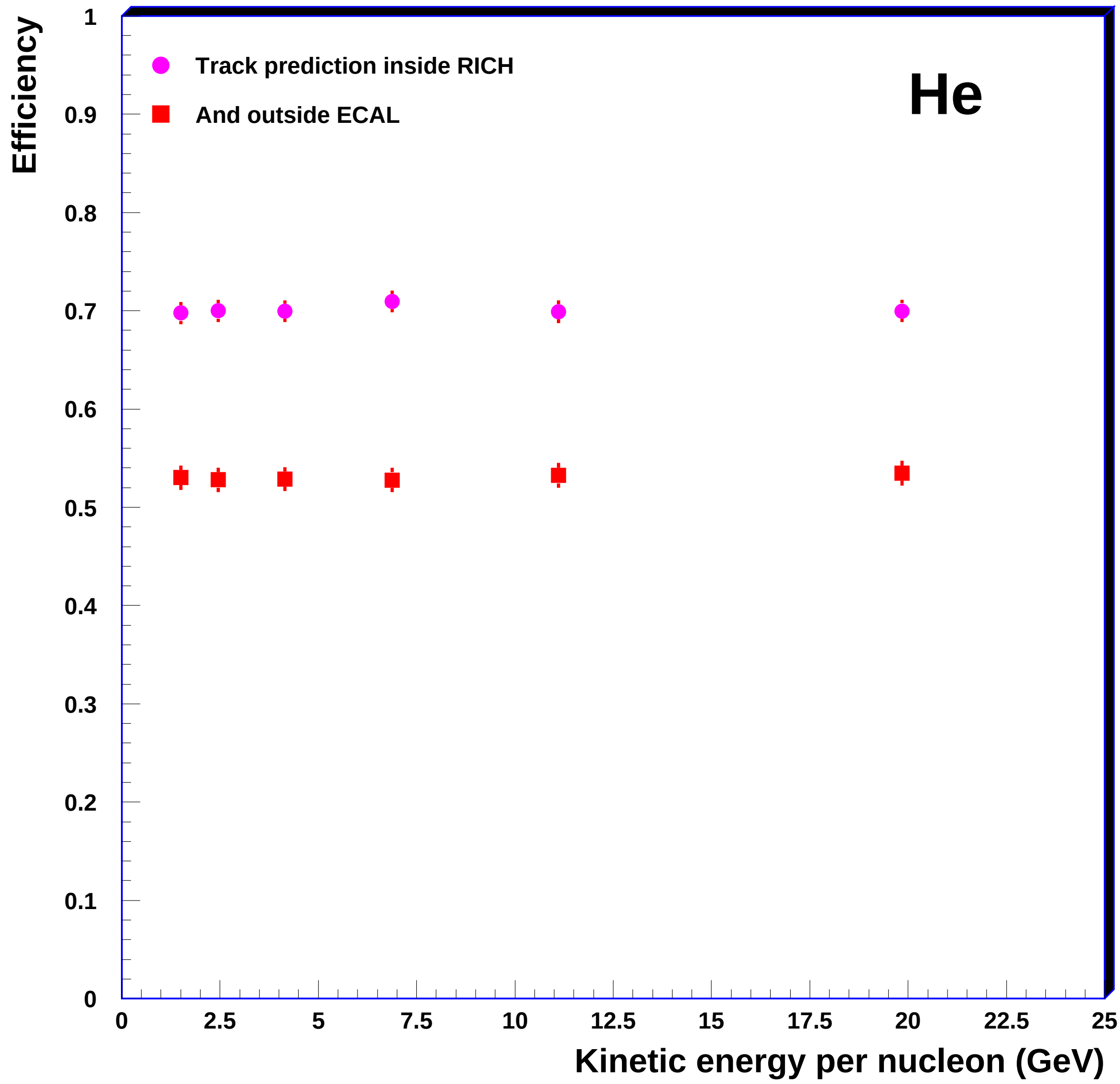
# The quality selection

After the quality cuts, we have been left with $\sim 80\%$ of our basic sample.The sample is reduced further when we require the track to go through the radiator. We are using the minimal sample as $100\%$ once again.

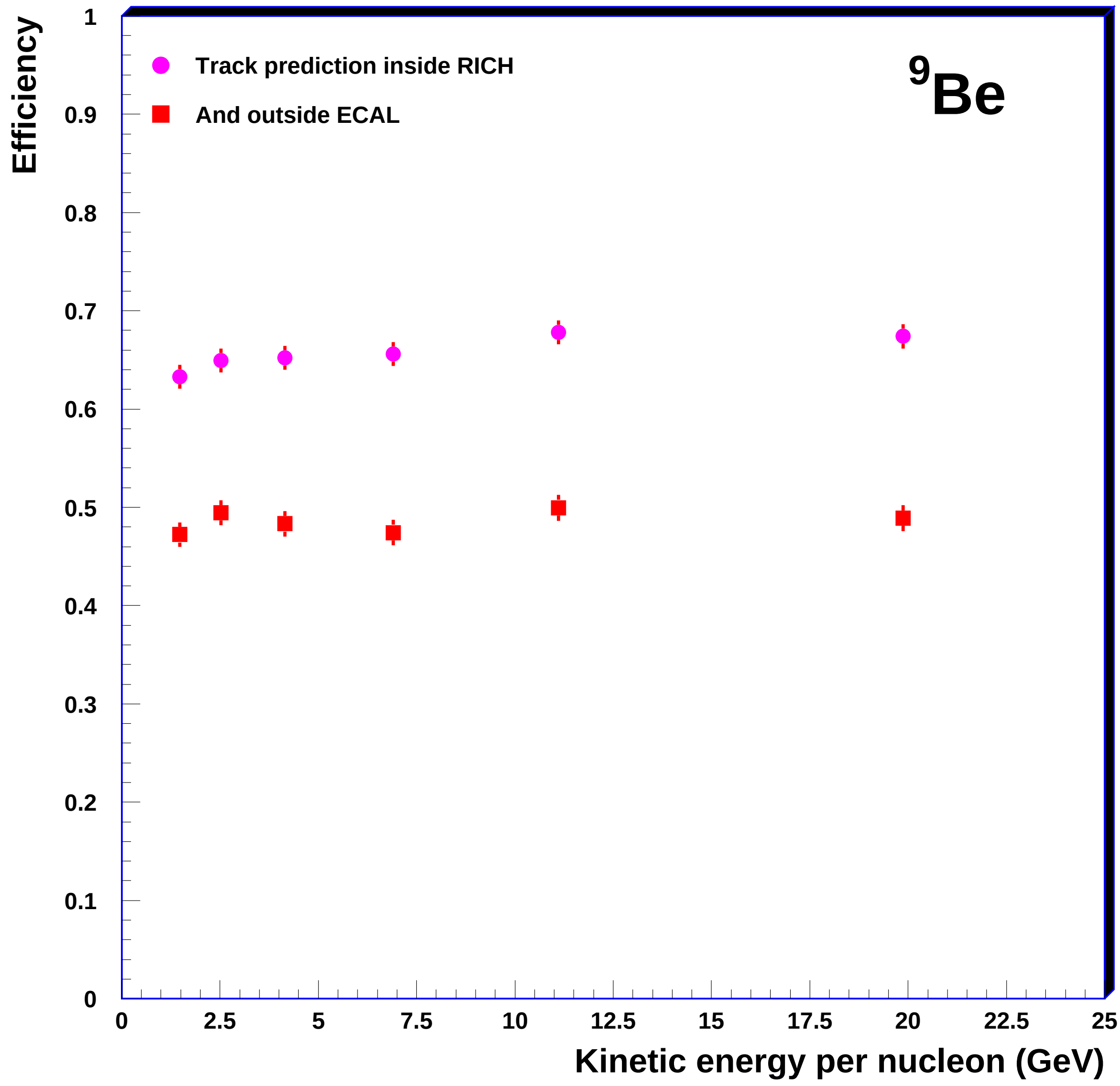


# The quality selection

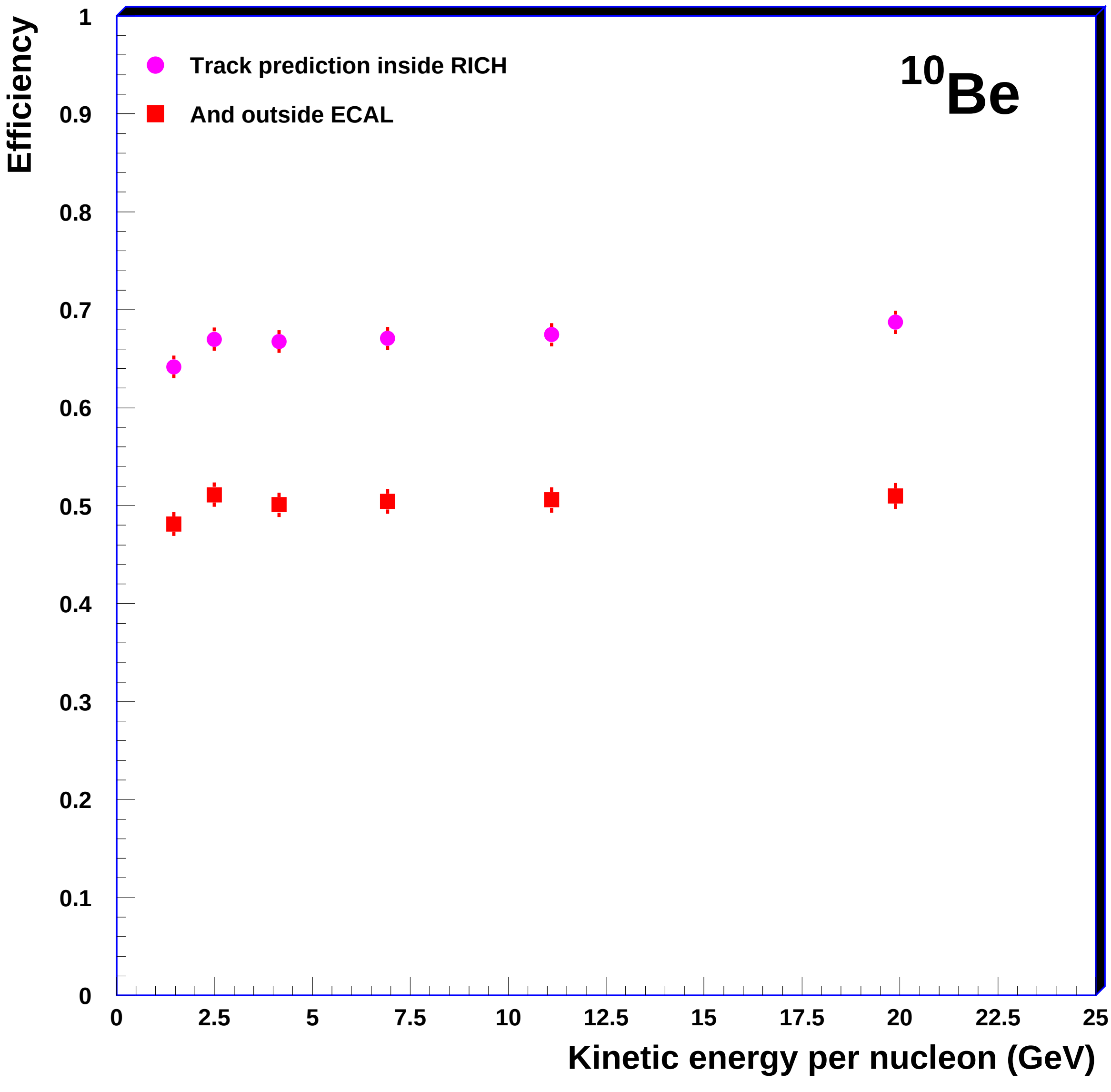
Geometry condition for helium.



Geometry condition for beryllium 9.



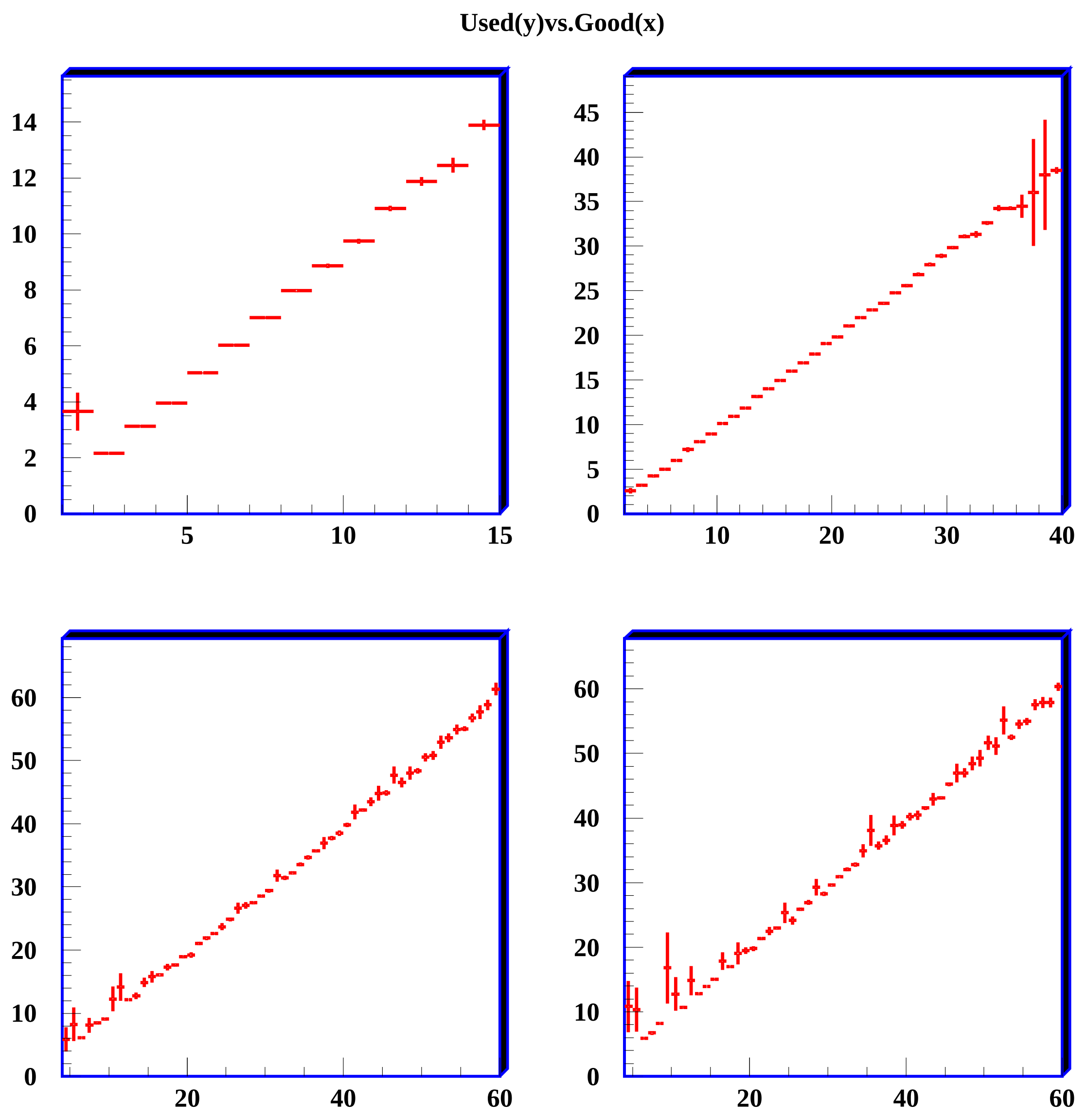
Geometry condition for beryllium 10.



# RICH reconstruction sample

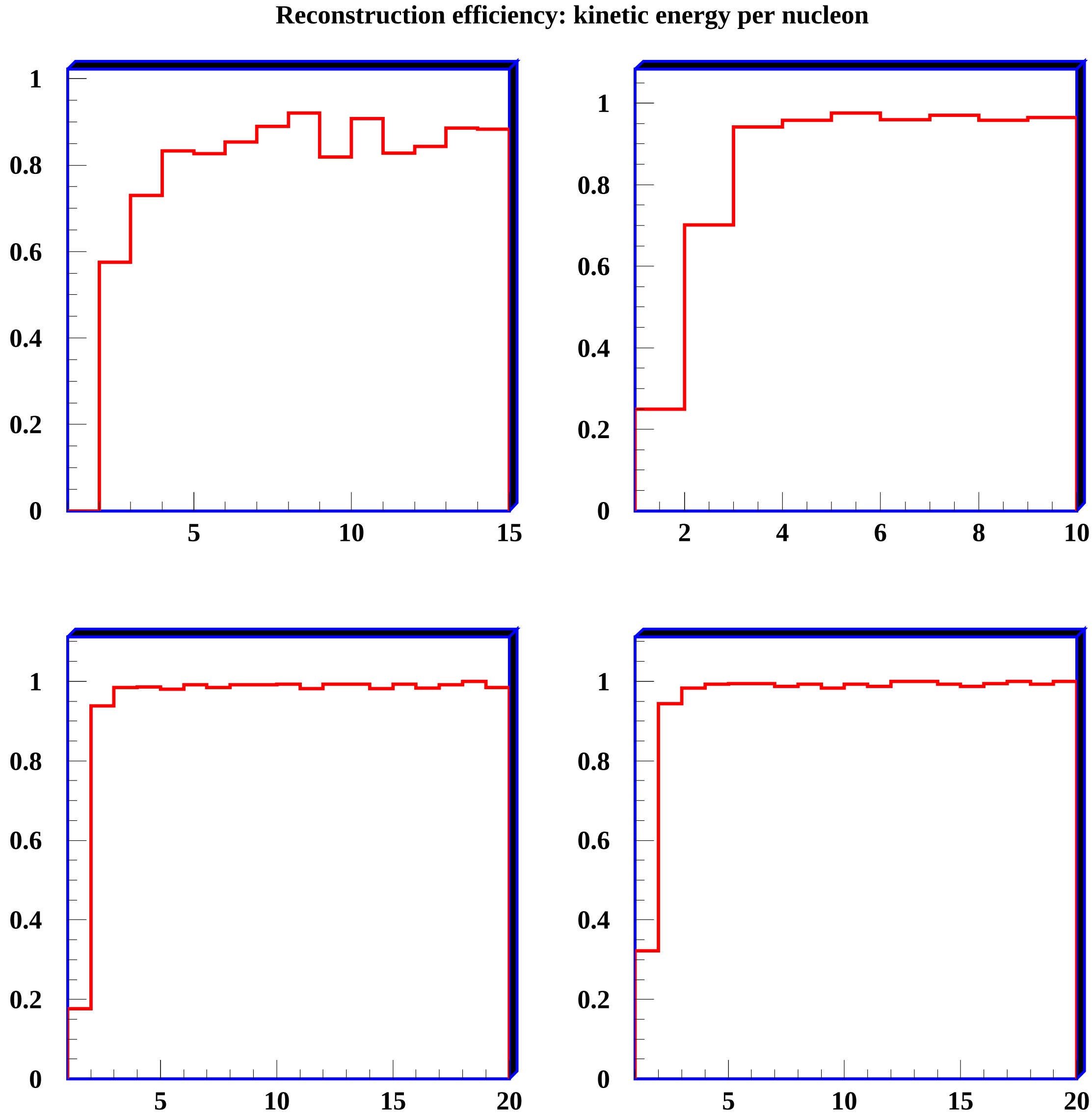
Now we can plot some results for the behavior of the RICH reconstruction, taking the previous selection into account.

We can take a look at **how many hits have been used in an event with a certain amount of good hits**:



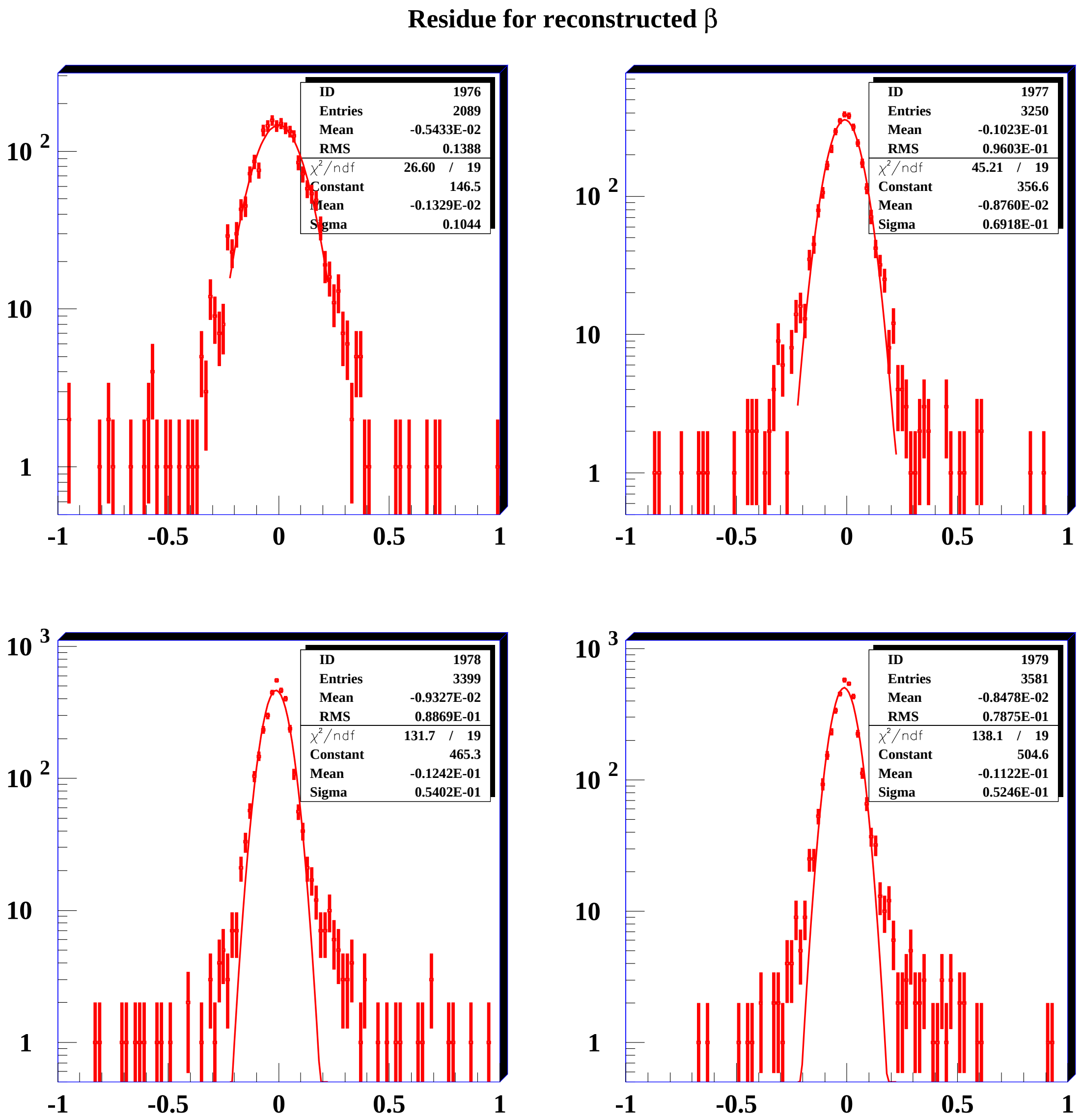
# RICH reconstruction sample

And this is the **reconstruction efficiency** as a function of energy of the incident particle.



# RICH reconstruction sample

Finally, we take a look at what the **residues** look like and have a good estimate of the resolution of $\beta$ for the simulated events.



# RICH reconstruction sample

- However, we still see a small fraction ($\sim 5\%$) of events which show large residues in $\beta$.
- The next step would be taking care of those.

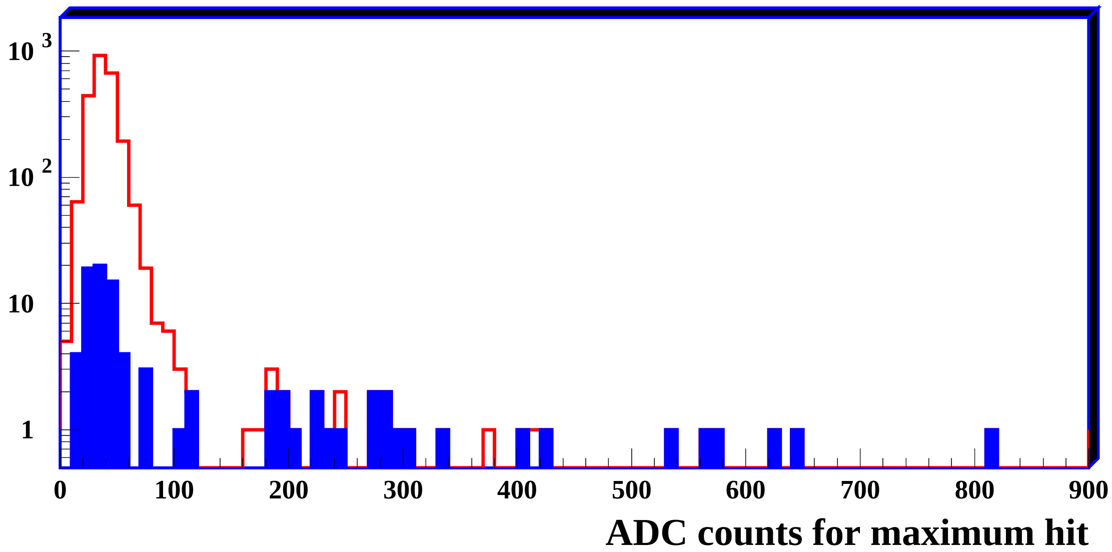
# RICH reconstruction sample

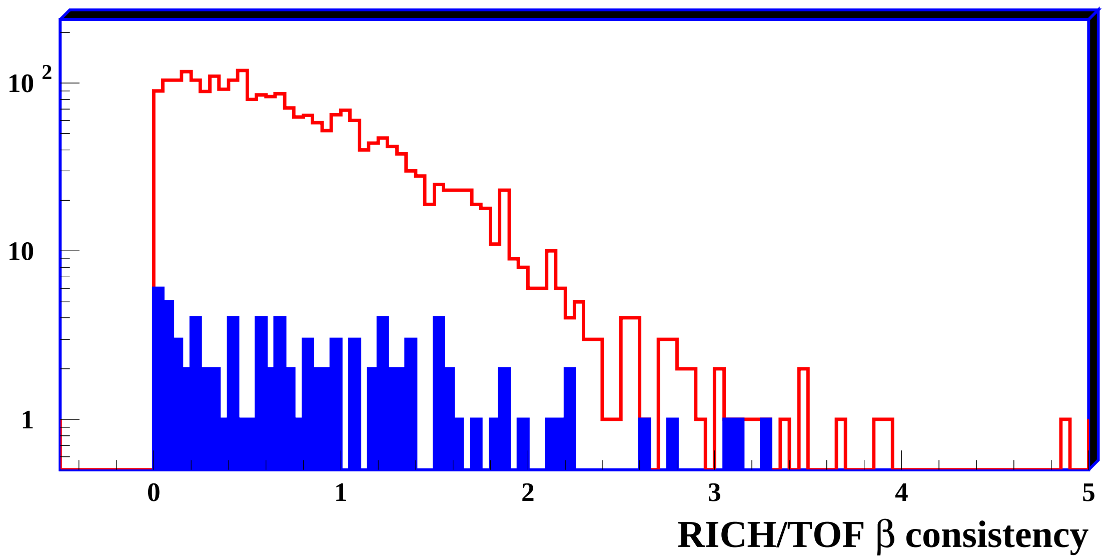
Some of these **tails** are eliminated by requiring:

- A minimum number of hits used by the reconstruction.
- Consistency between RICH and TOF $\beta$ values.
- Not allowing events reconstructed with hits with a high number of ADC counts.
- A small $\chi^2/ndof$ value for the reconstructed ring.

# RICH reconstruction sample

In these plots we see how the tails distribute compared with the overall event distribution:



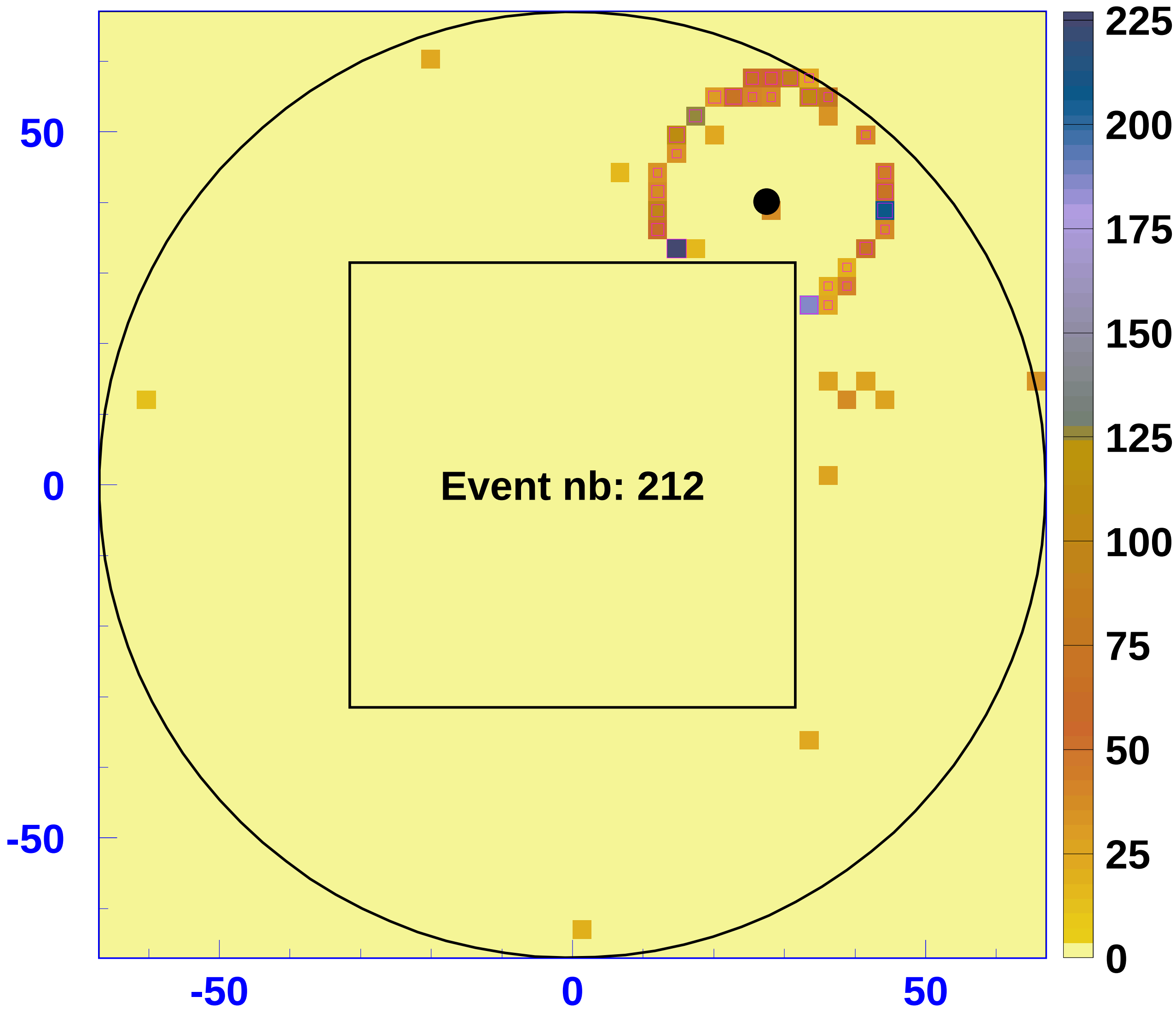



# RICH reconstruction sample

Why do we eliminate events with “hard” used hits?

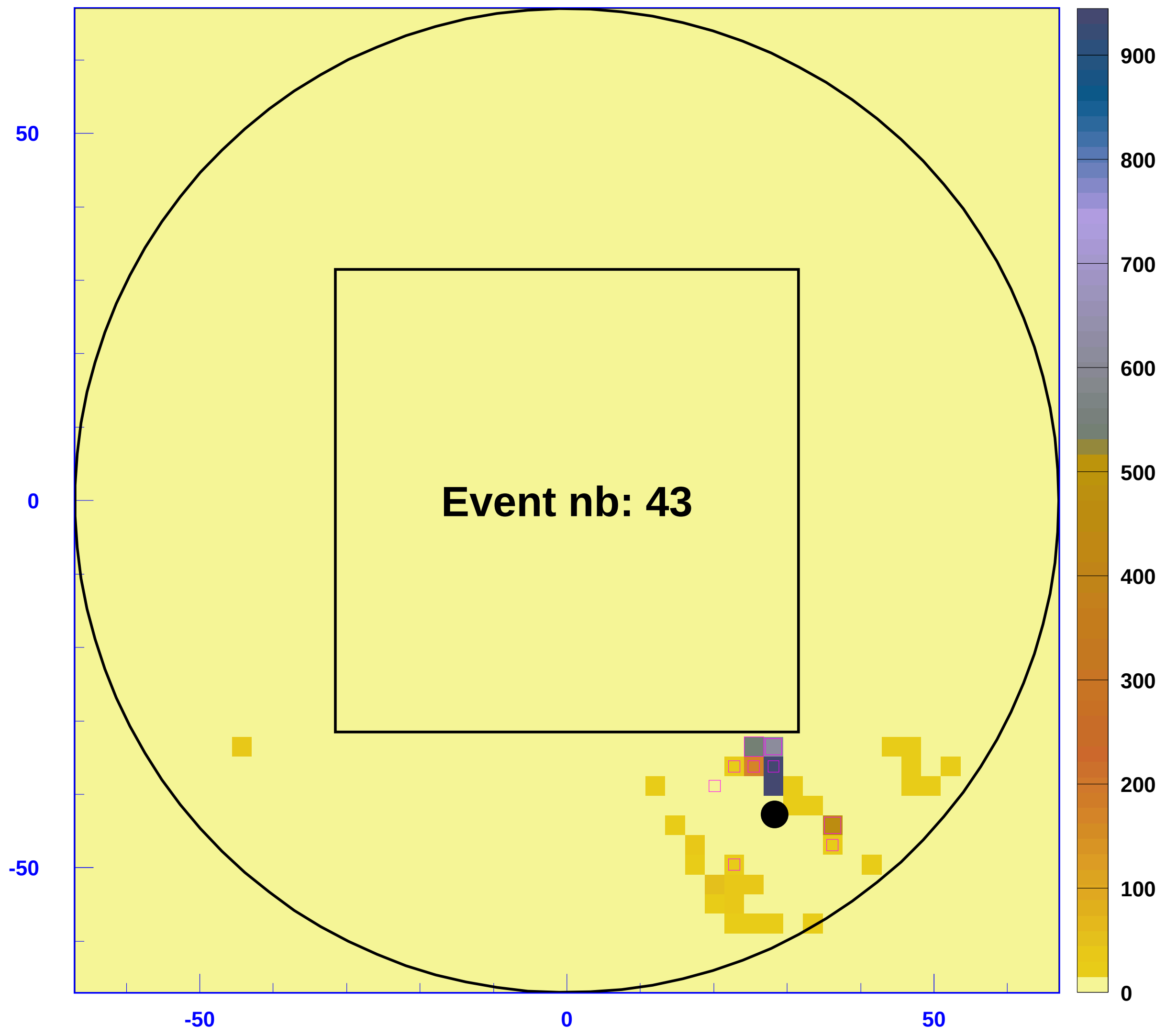
We don’t expect Cherenkov hits with a high number of counts for these particle species. Most probably, the light deposition from a particle going through the detector plane may confuse the reconstruction if the TRACKER prediction (dot) is not correct.

A nicely reconstructed event:



# RICH reconstruction sample

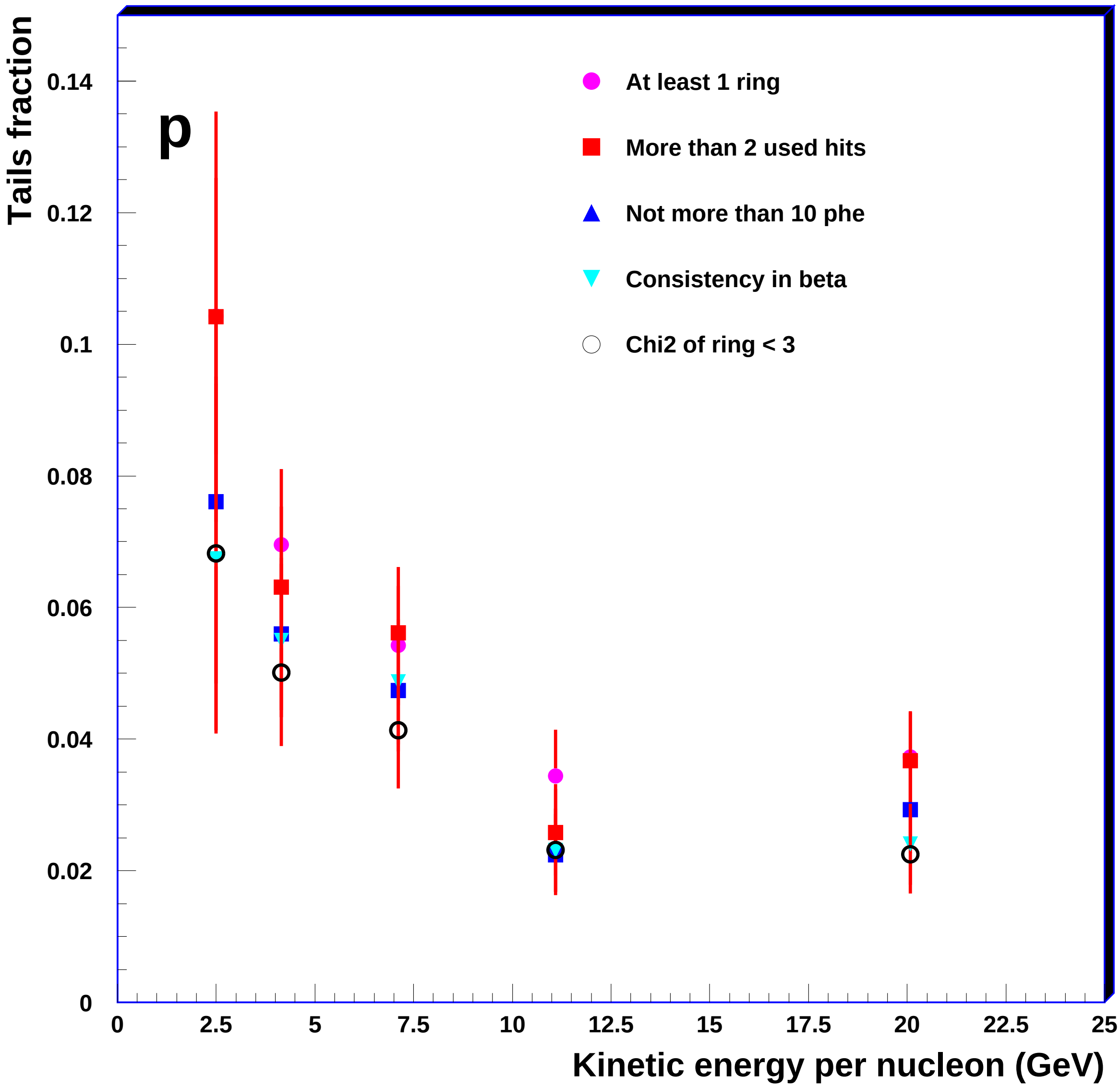
Wrong reconstruction:



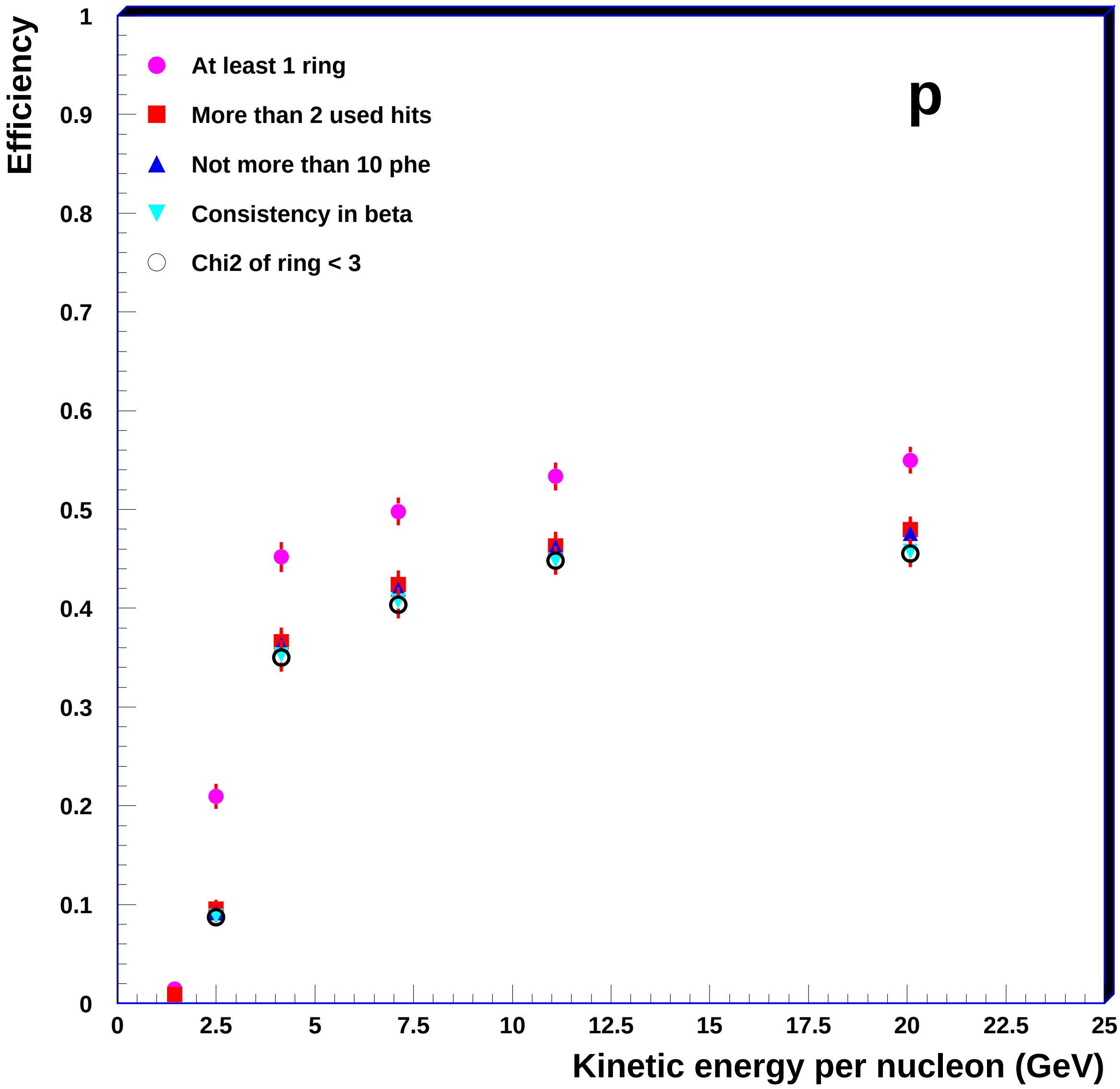
# RICH reconstruction sample

After the selected cuts are made to reduce the tail fraction, we can study how good is this reduction and how efficient it is (we want to lose as few good events as possible).

We can study the case for protons:

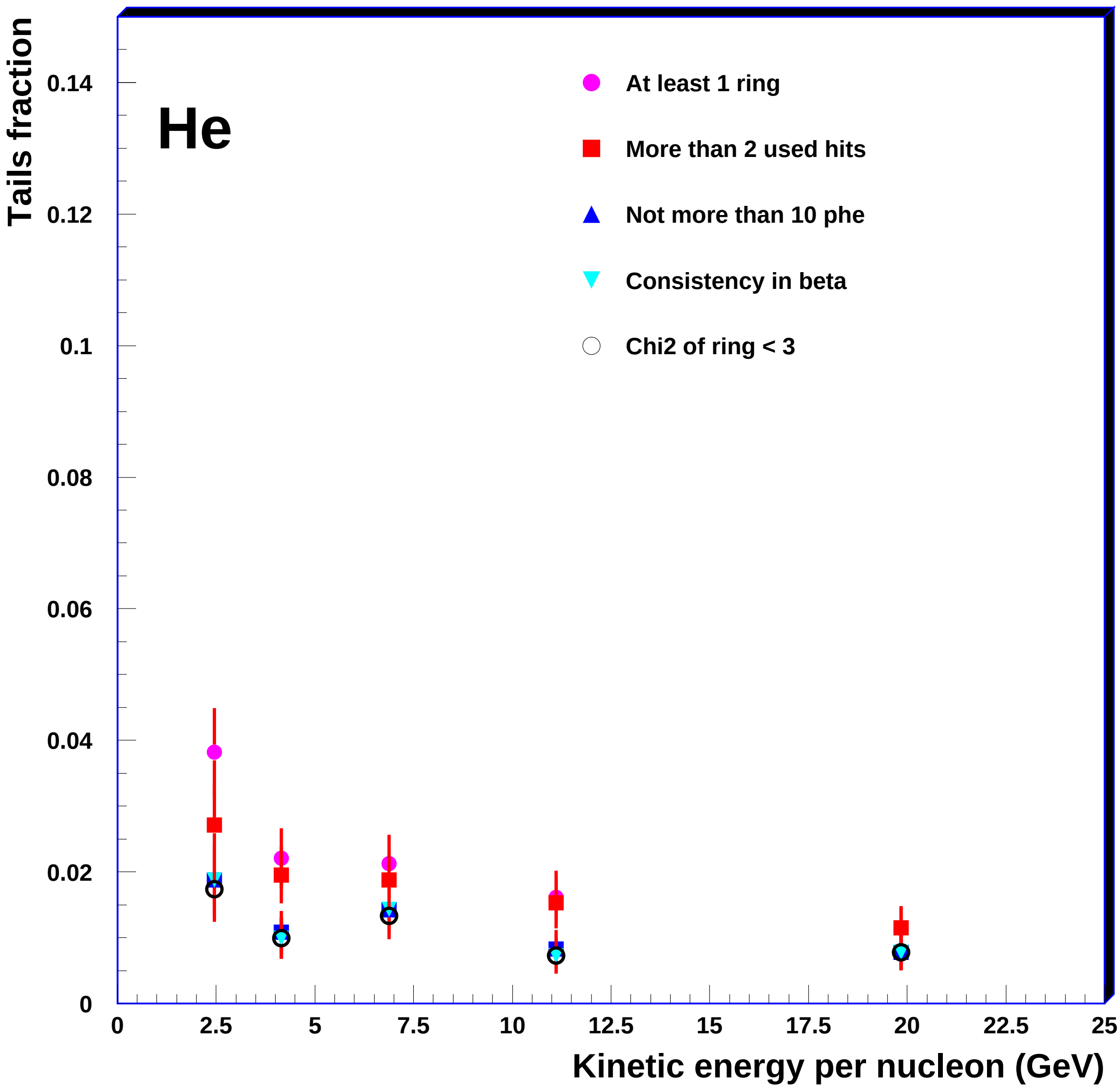


# RICH reconstruction sample

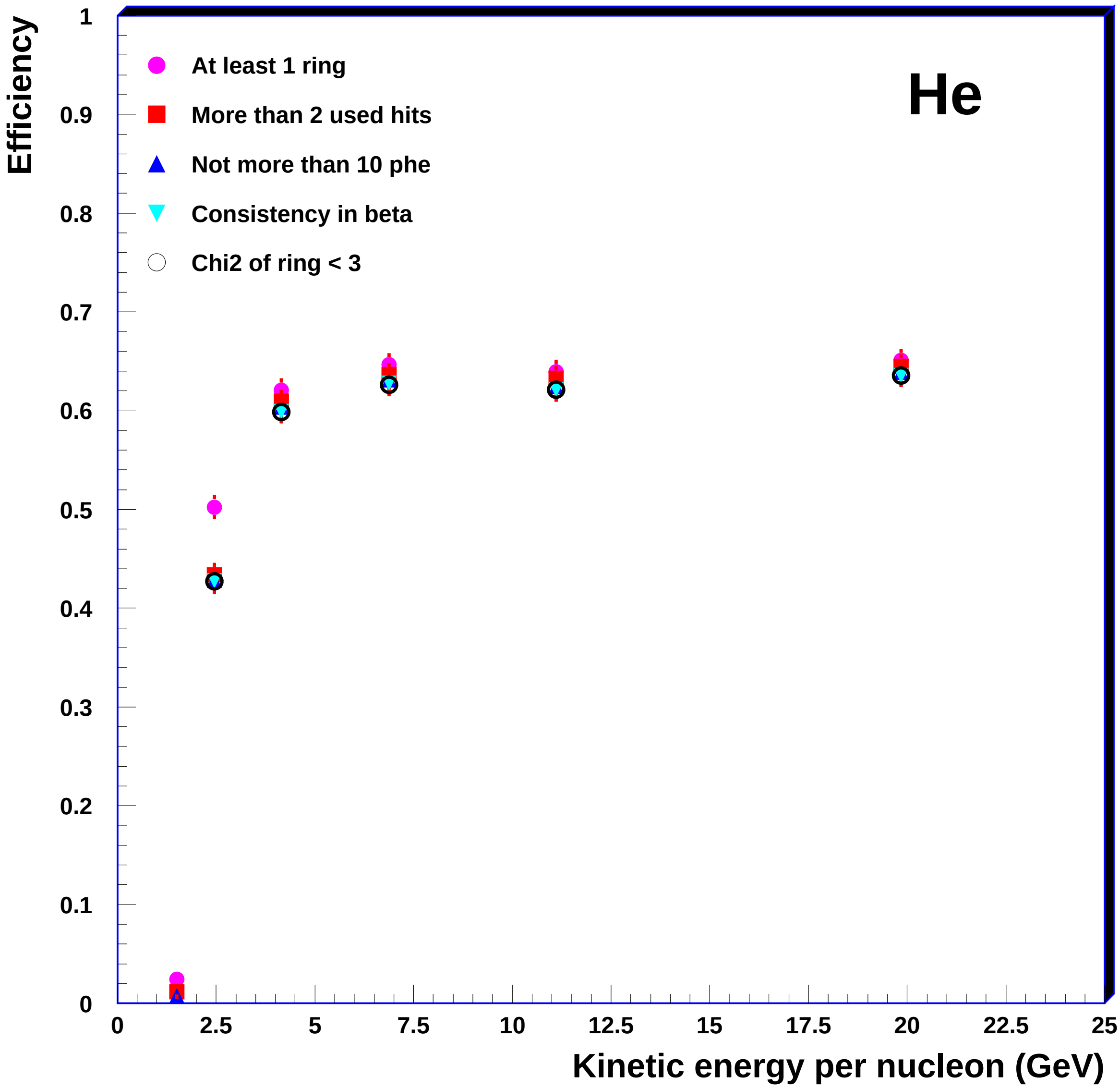


# RICH reconstruction sample

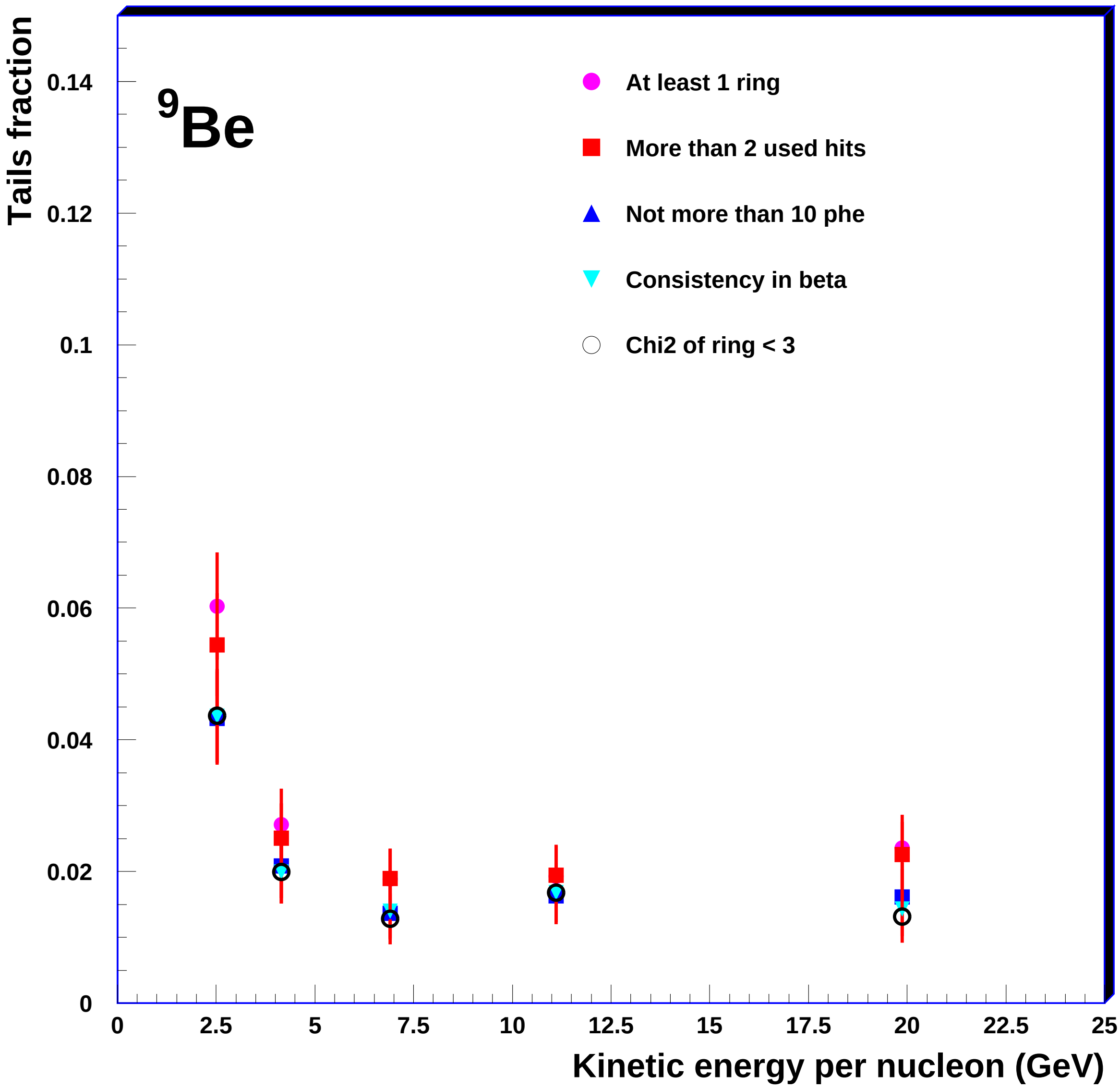
The case for helium:



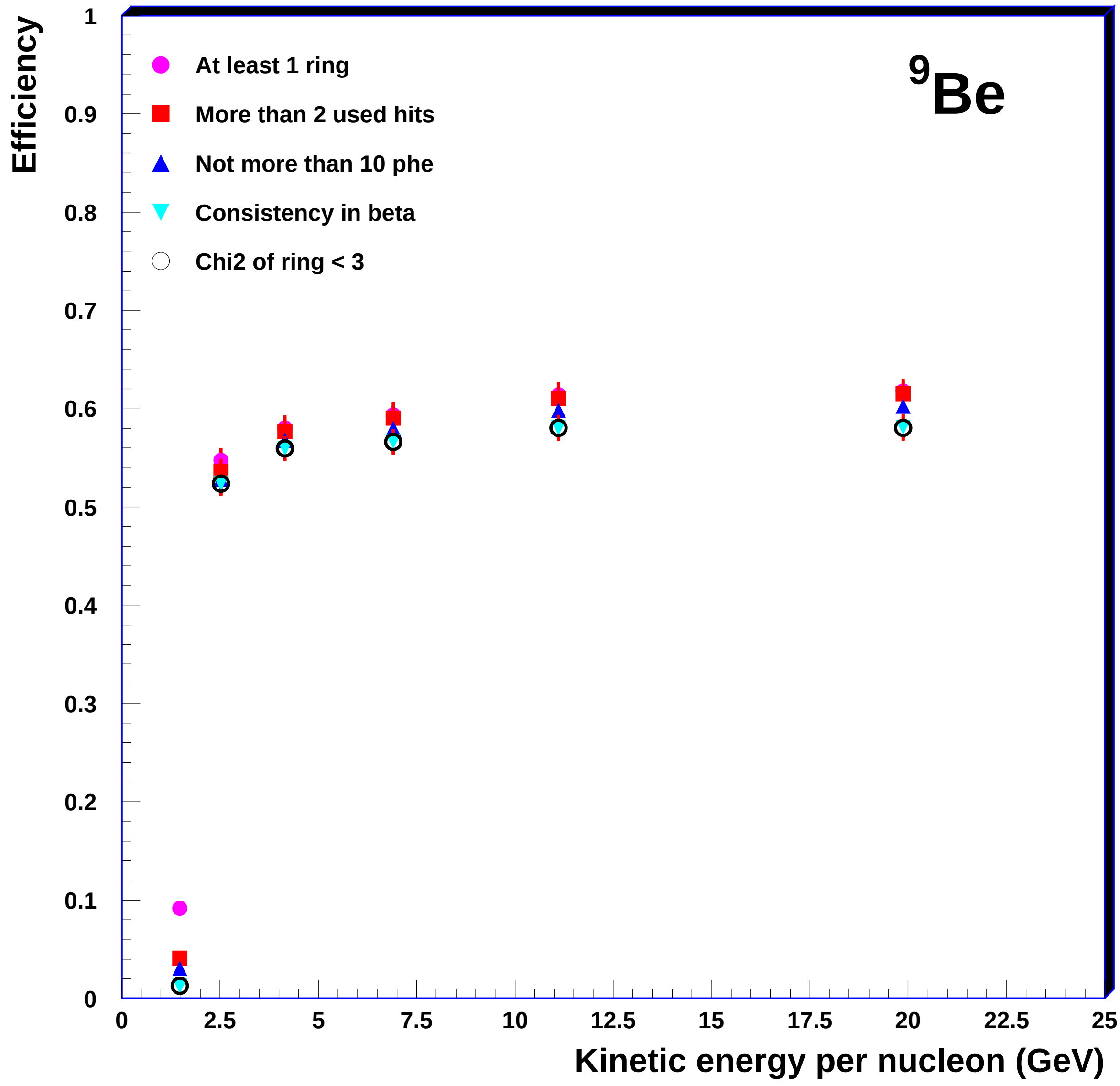
# RICH reconstruction sample



The case for beryllium 9:

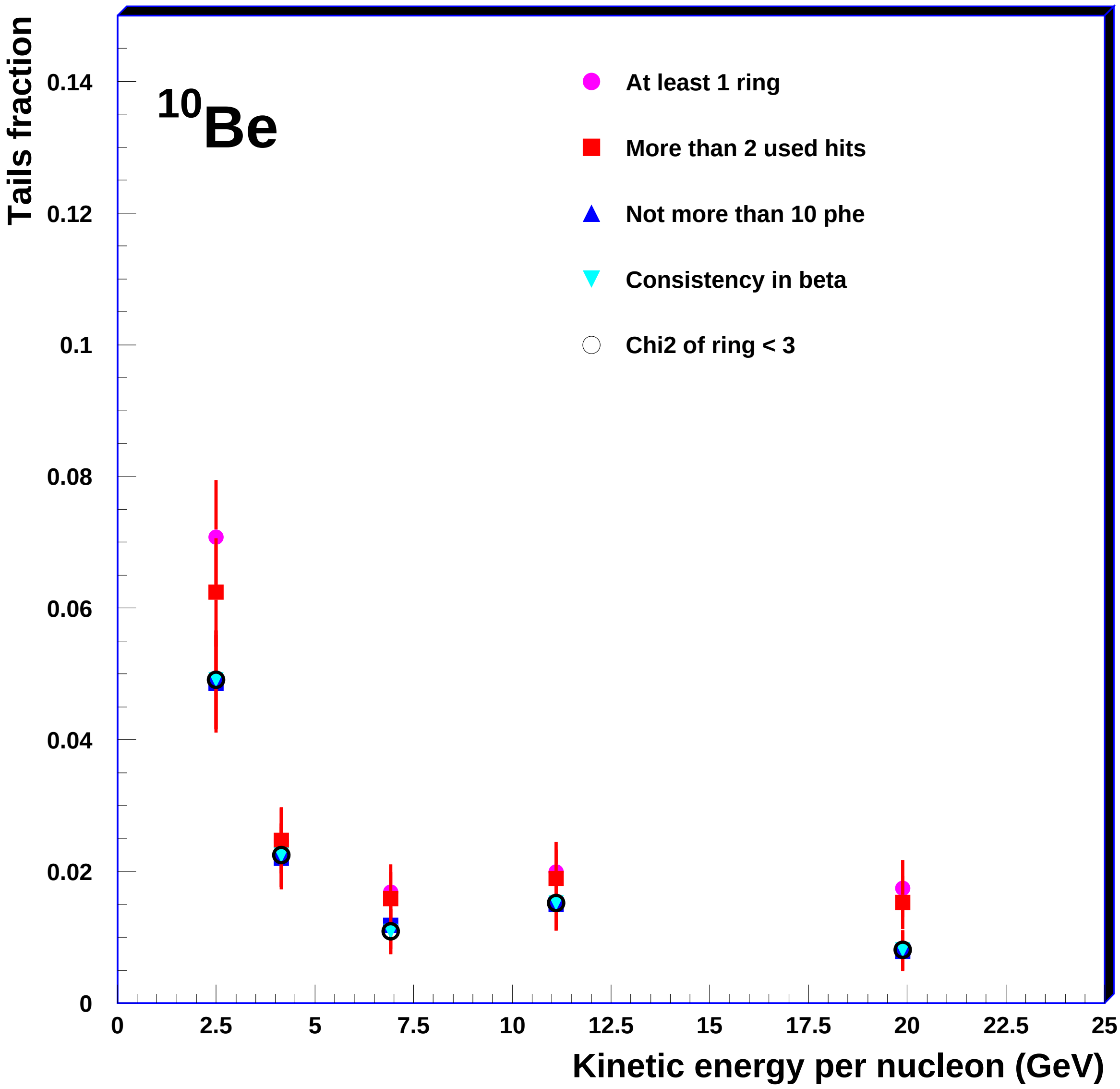


# RICH reconstruction sample

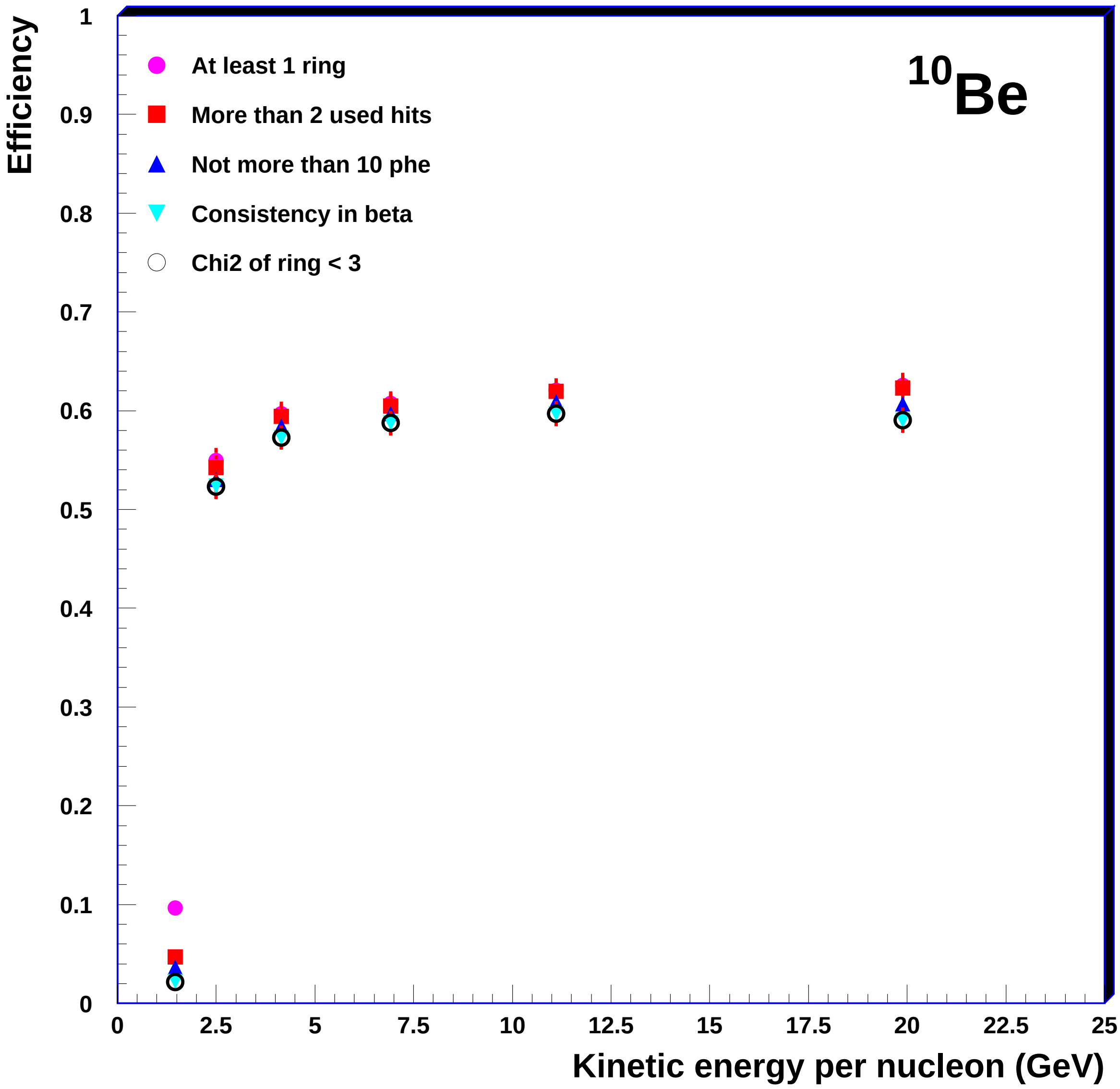


# RICH reconstruction sample

The case for beryllium 10:



# RICH reconstruction sample

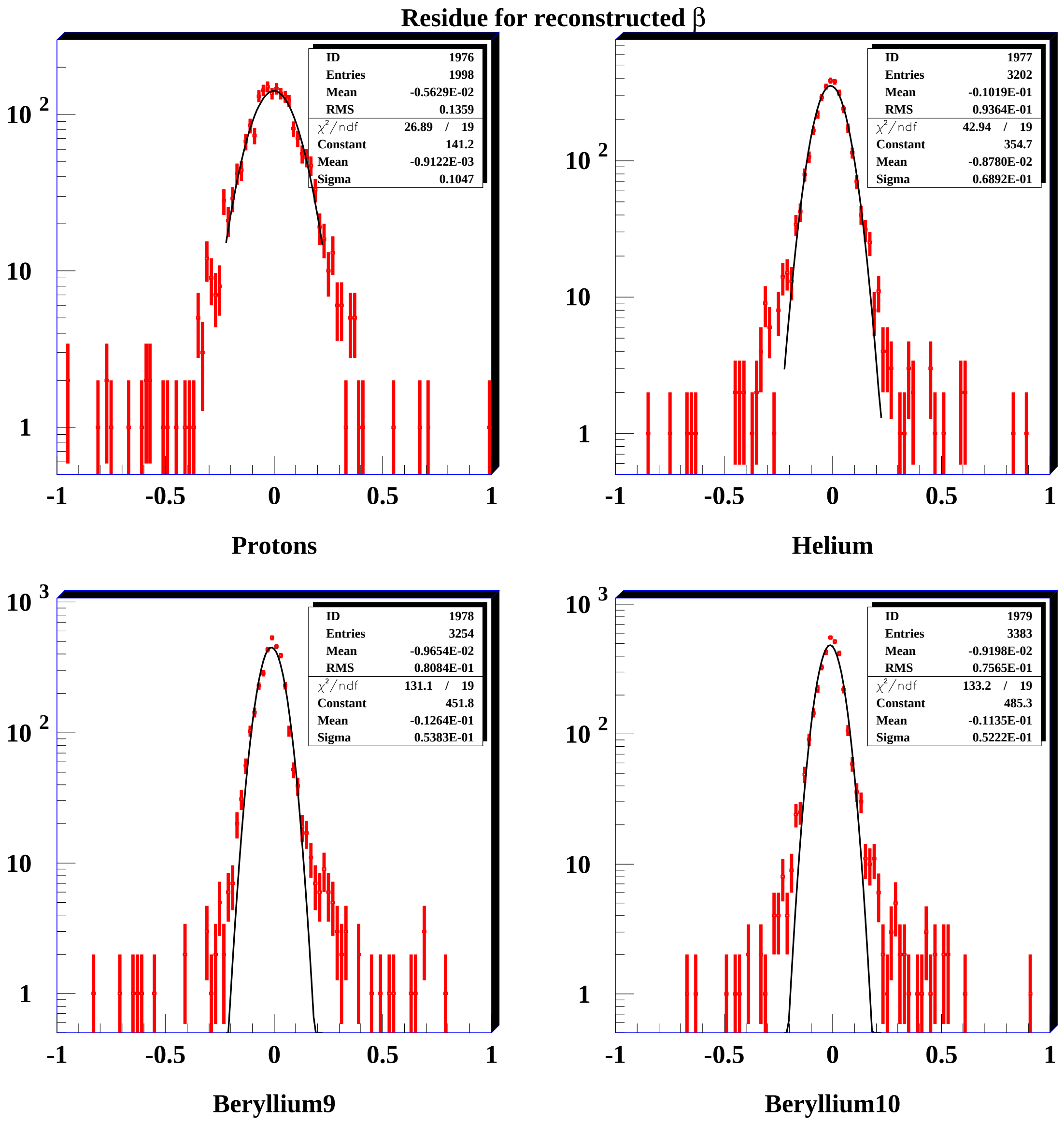


# Summary of the results

- We have simulated proton, helium, ${}^{9}Be$ and ${}^{10}Be$ events to study RICH reconstruction behavior.
- After defining a set of suitable (quality) events, we have obtained a subsample which serves as basis to our study.
- However, we see a small fraction with a large residue for $\beta$. We have chosen a certain number of criteria to eliminate these events, and find that, globally, we reduce the tail fraction from $\sim \mathbf{5\%to} \sim \mathbf{2\%}$. The overall efficiency of the complete set of cuts (quality AND reconstruction cuts) is around $\sim \mathbf{60\%}$ of the original sample of "triggered and reconstructed" events.
- The resulting sample shows a very high reconstruction efficiency for the RICH $\beta$ reconstruction algorithm.
- This particular simulation and cuts yield the following resolutions for the RICH $\beta$:
  - Protons: $0.1\%$
  - Helium: $0.07\%$
  - Beryllium isotopes: $0.05\%$

# Summary of the results

These are the plotted results for the residues after the cuts.



# Prospects and future work

- Understand the origin of tails. How far can we get?
- Optimize present selection cuts (efficiency vs. tail elimination) and look for alternatives. As an example, we may be getting some very useful information on the expected number of hits from the RICH charge reconstruction.