Selection of Helium nuclei using multivariate data analysis in AMS

José Jesus
David Lima
LIP Lisboa, Portugal
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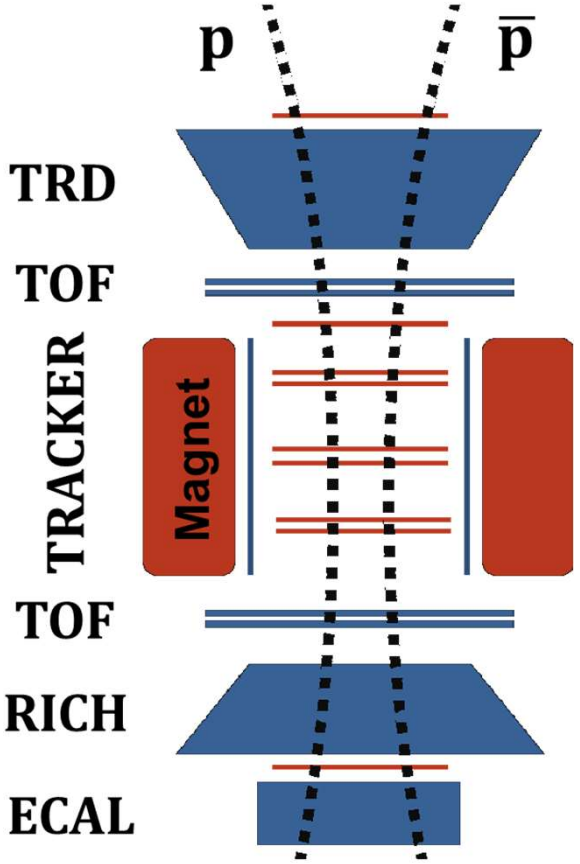
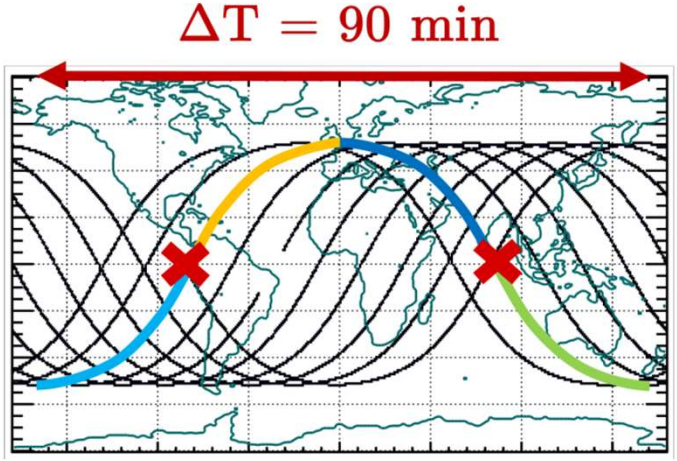
Summer Internships

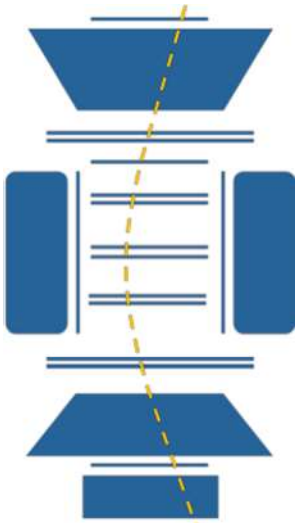
Alpha Magnetic Spectrometer



Data Organization



Each Run is 22 minutes long, 4 per complete orbit of ISS



AMSEventR

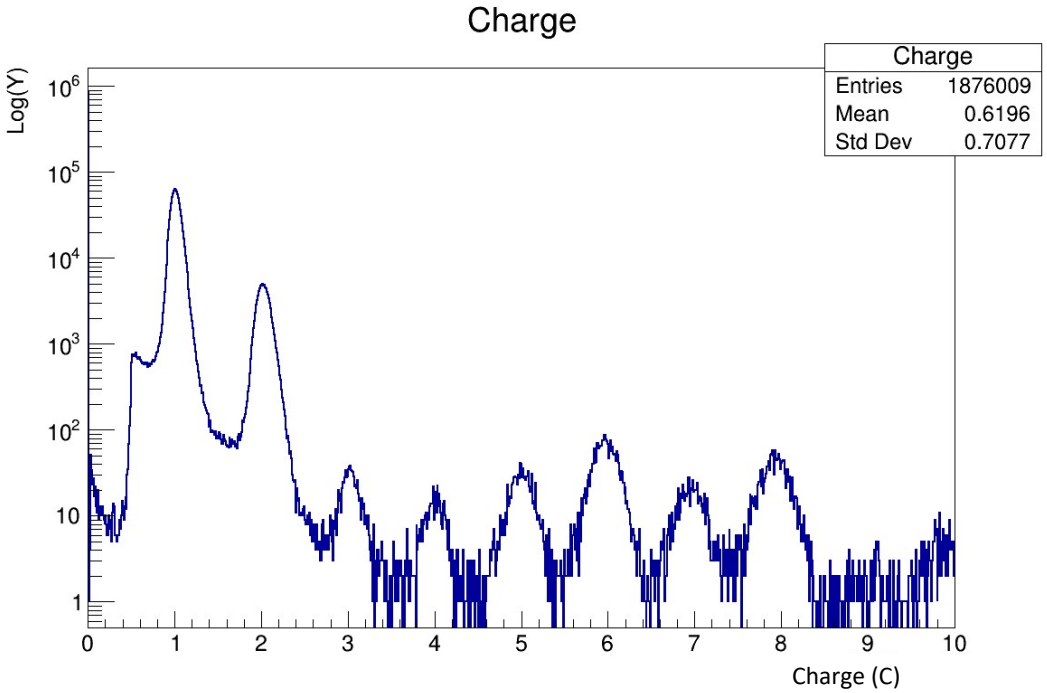
AMSChain (TTree)

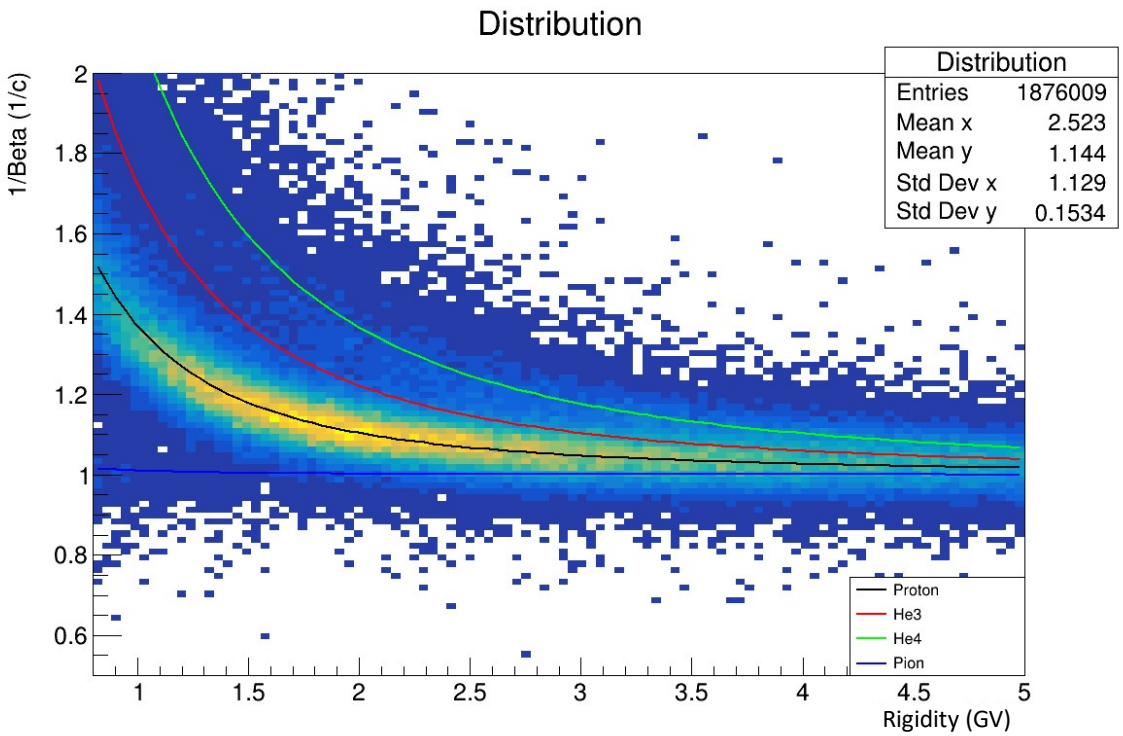
- AMSEventR
- AMSEventR
- AMSEventR
- AMSEventR
-

AMSSetupR

- ISS coordinates
- AMS direction
- Geomagnetic Field
- Exposure time
- Number of events (good, bad, errors)
- SSA
- GPS information
- Only one per Run

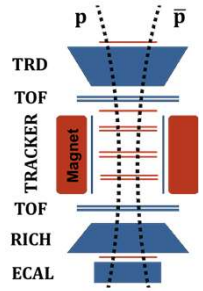
Exploring an event

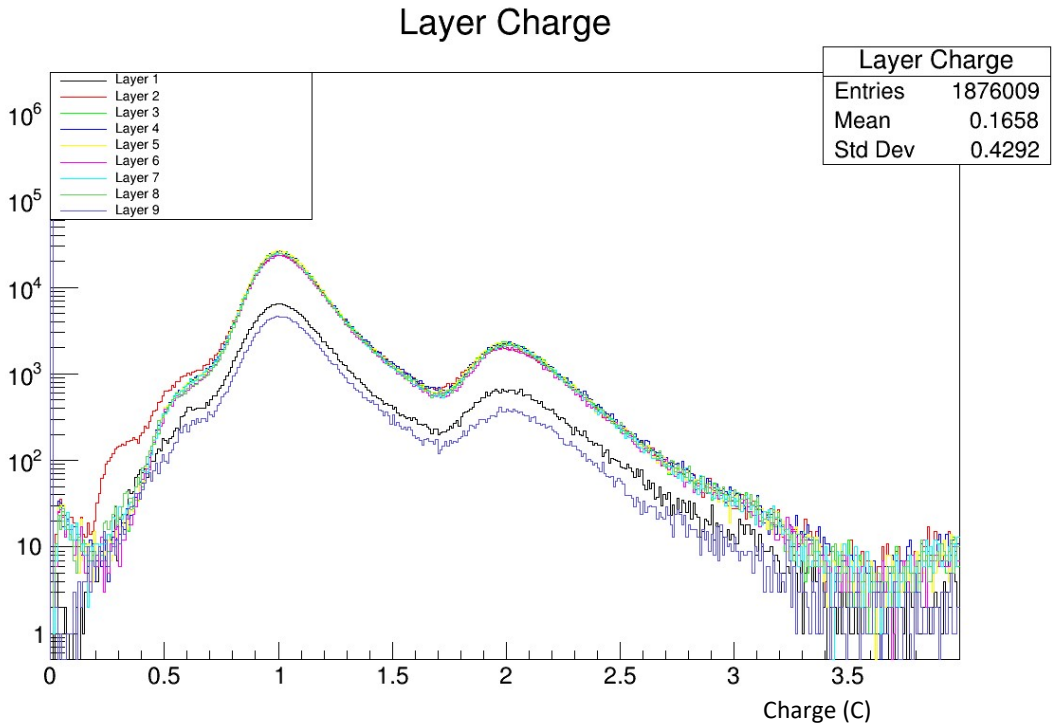


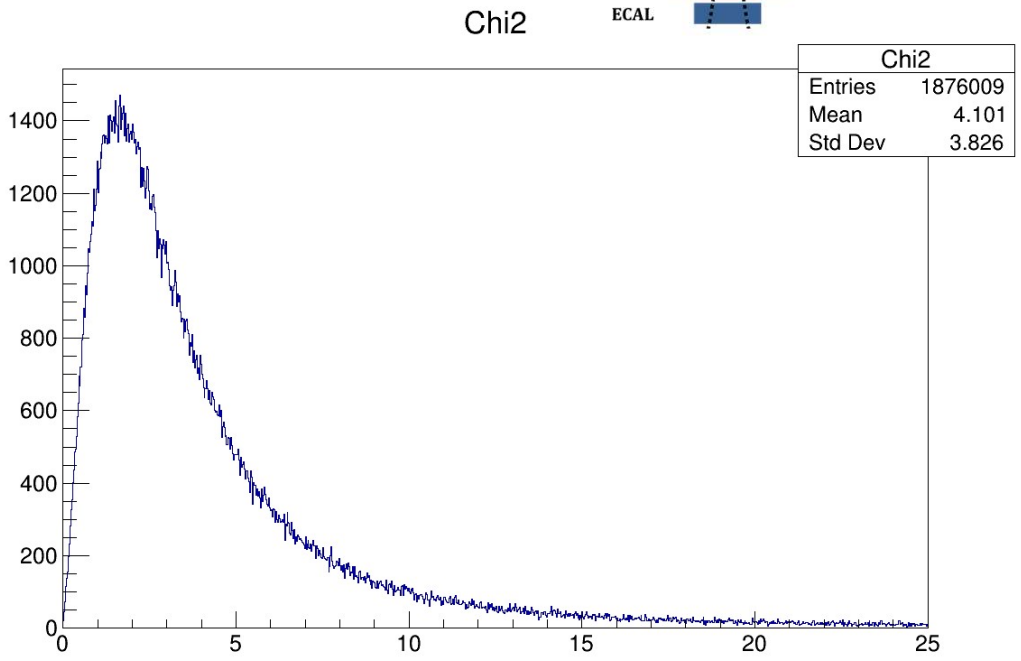


To select and separate the Helium Isotopes it is required a preselection of the Data

Exploring an event







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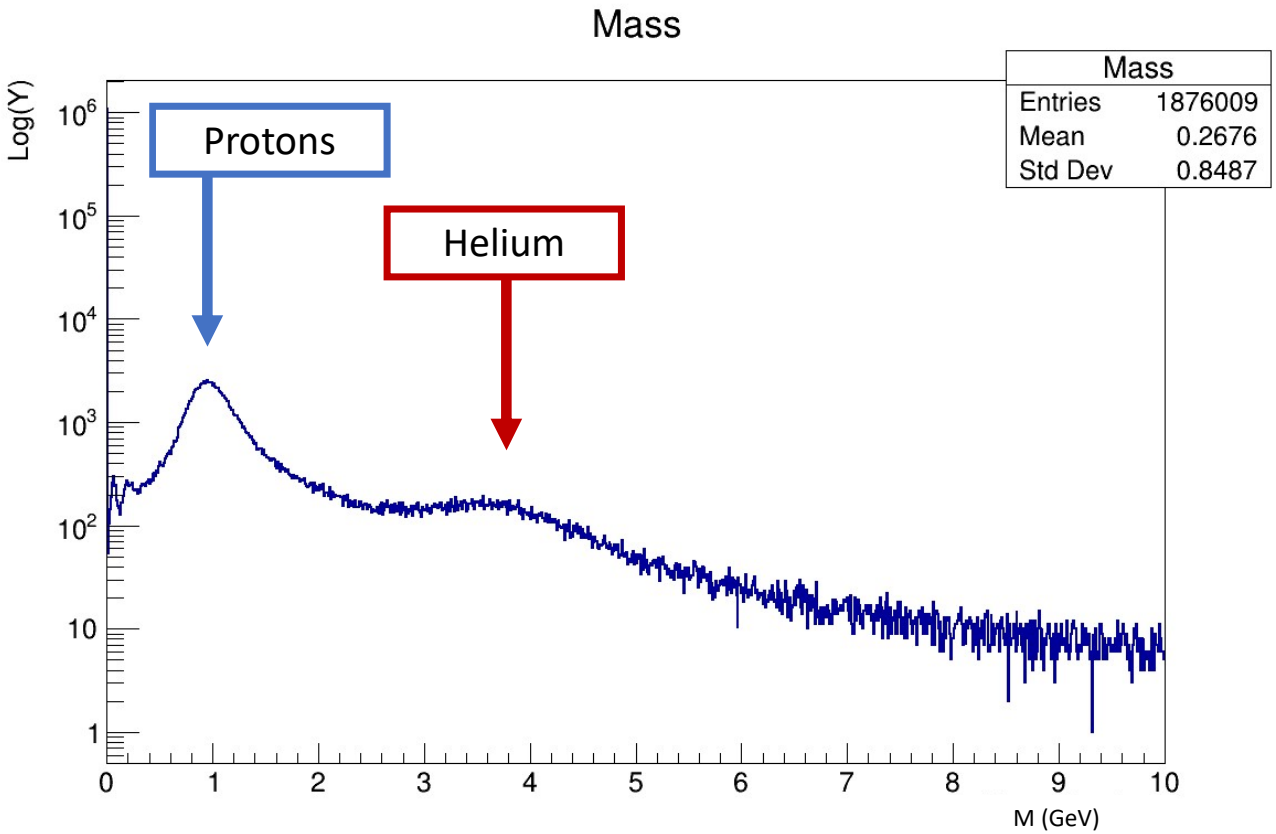
Exploring an event



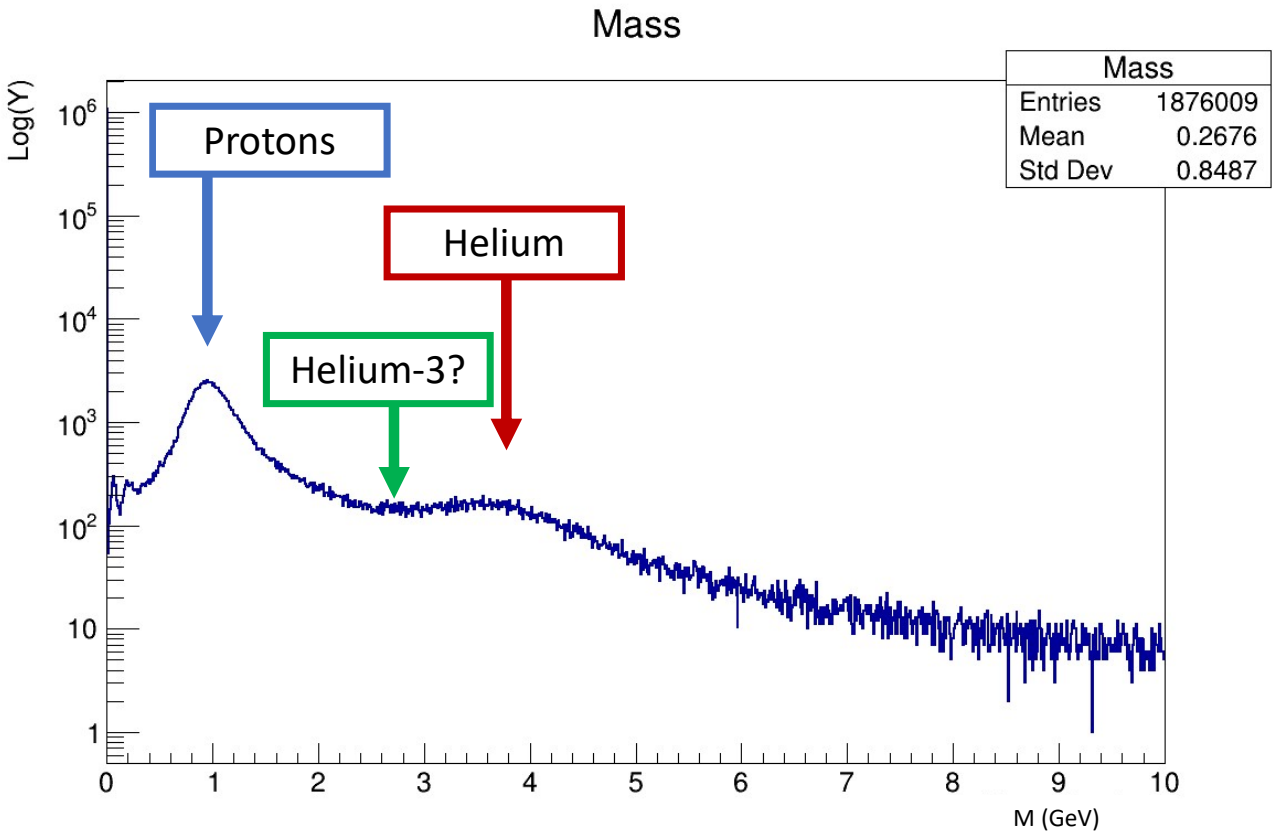
$$m = \sqrt{\left(1/\beta^2 - 1\right)} * R * q$$

Helium-3 mass = 2,814 Gev

Helium-4 mass = 3,752 Gev

To select and separate the Helium Isotopes it is required a preselection of the Data

Exploring an event



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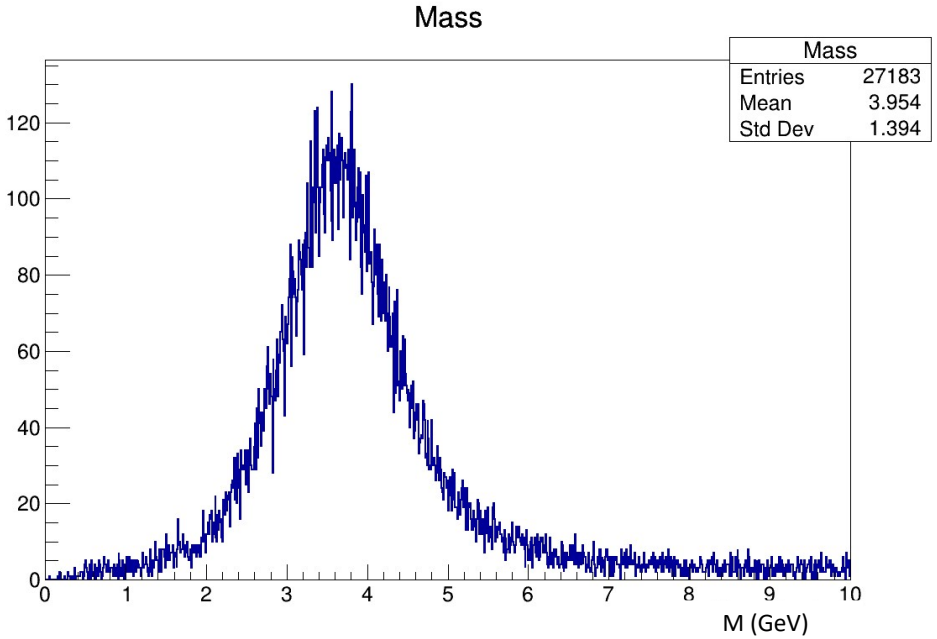
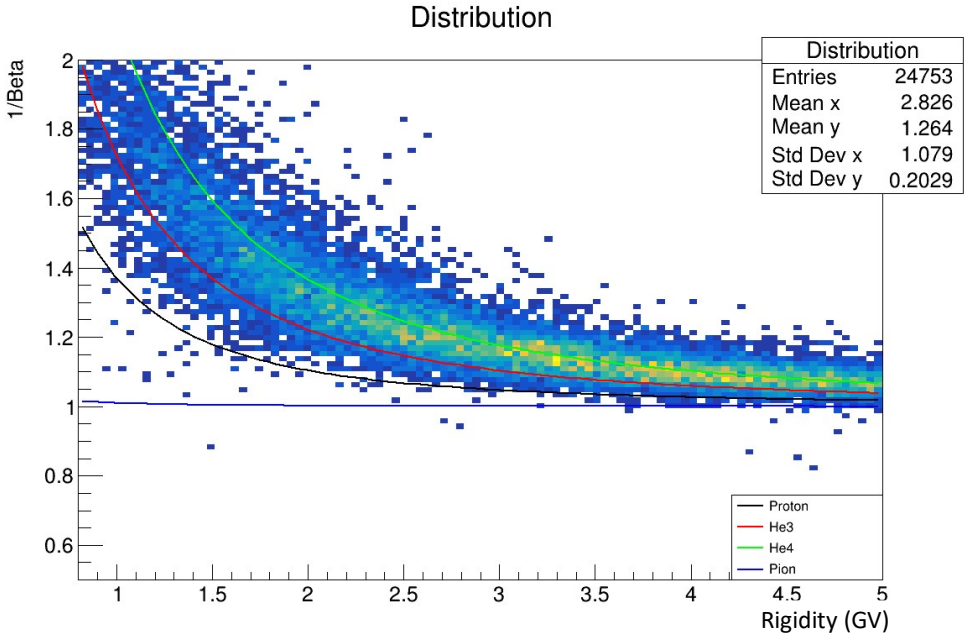
Selection of data



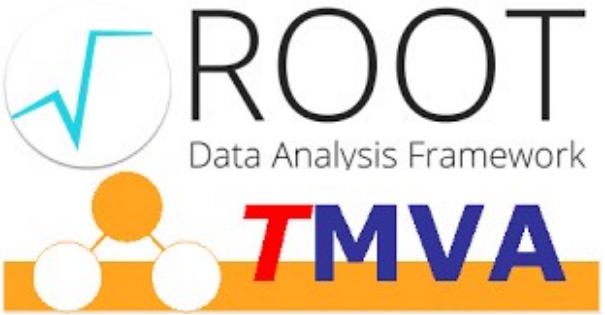


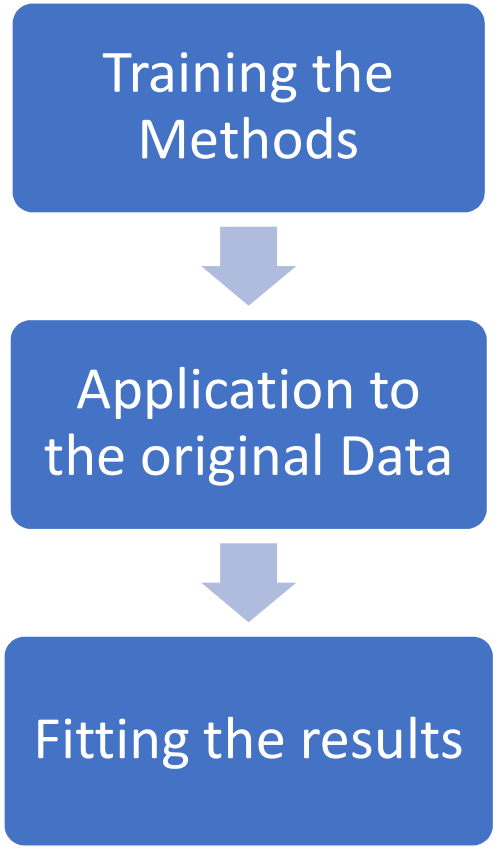
Simple selection of data is not good enough.
More advanced analysis is required

Multivariable Analysis

In order to separate the Isotopes, solutions involving multivariable classification and machine learning are required.

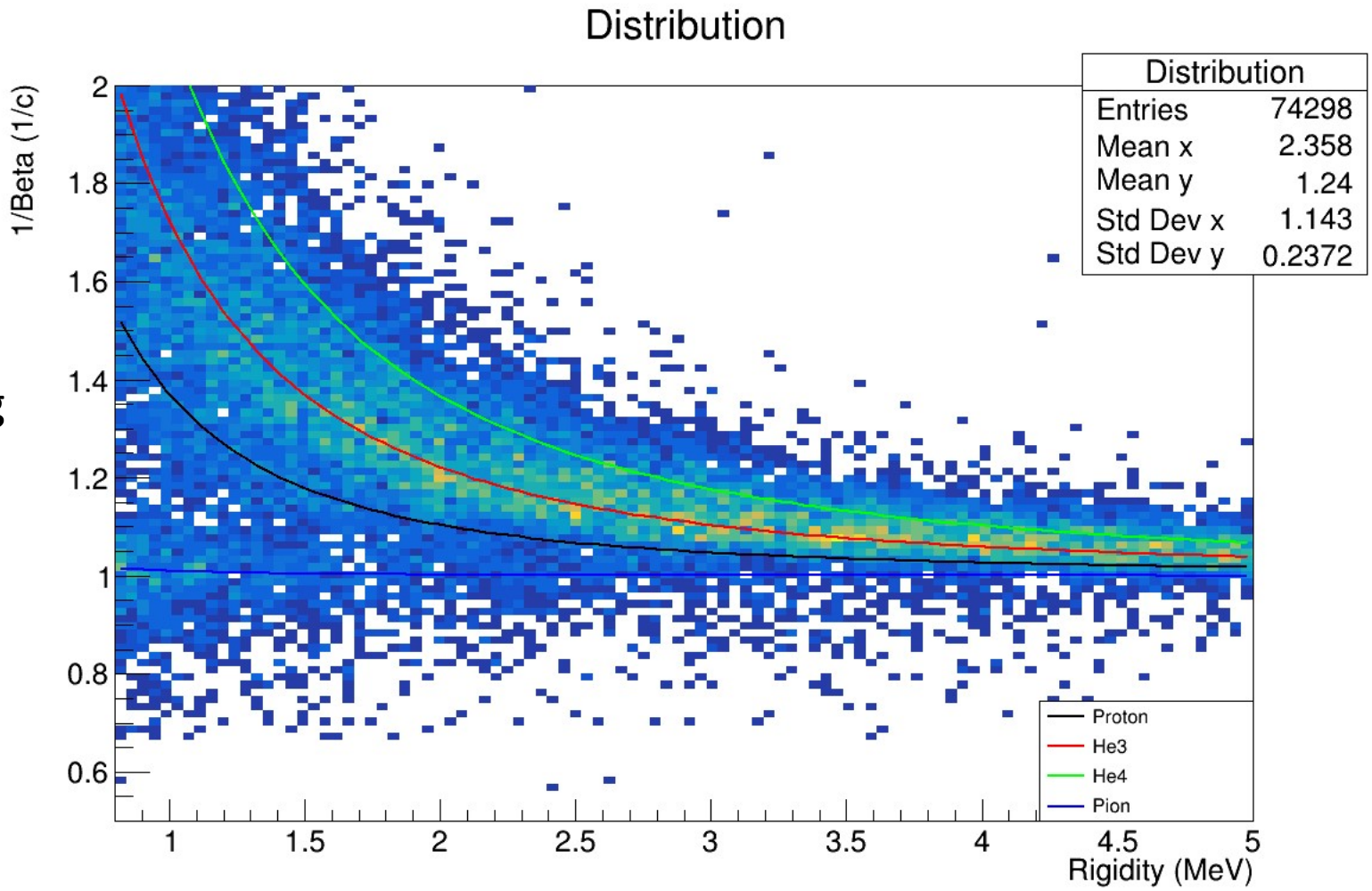
This way, Toolkit for Multivariable Analysis with ROOT (TMVA) was integrated in the project



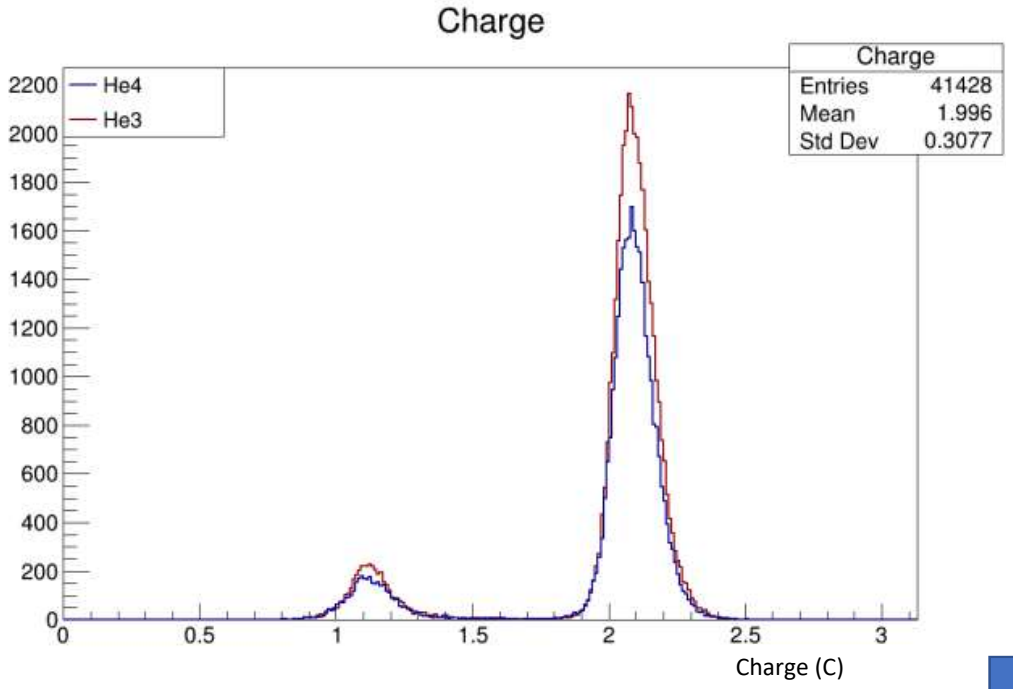


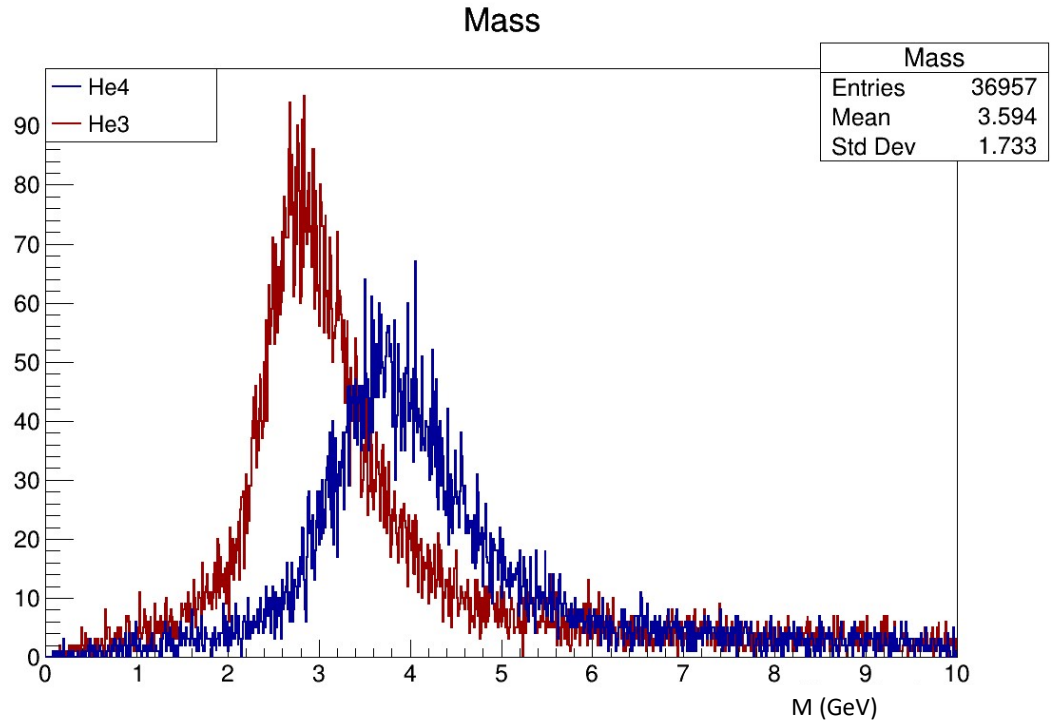
Monte Carlo Data

Events made purely of Helium-3 and Helium-4 Necessary for the training of the TMVA



Monte Carlo Data

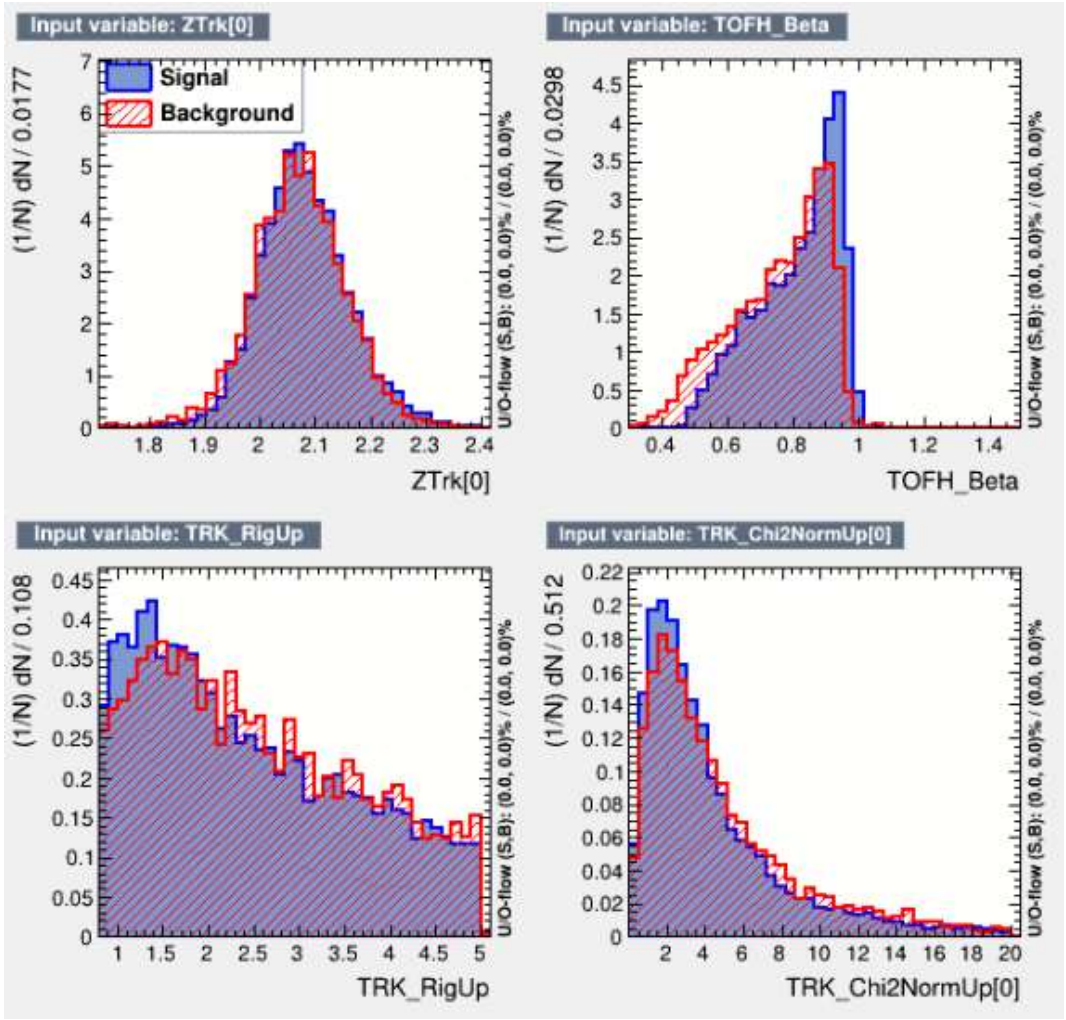




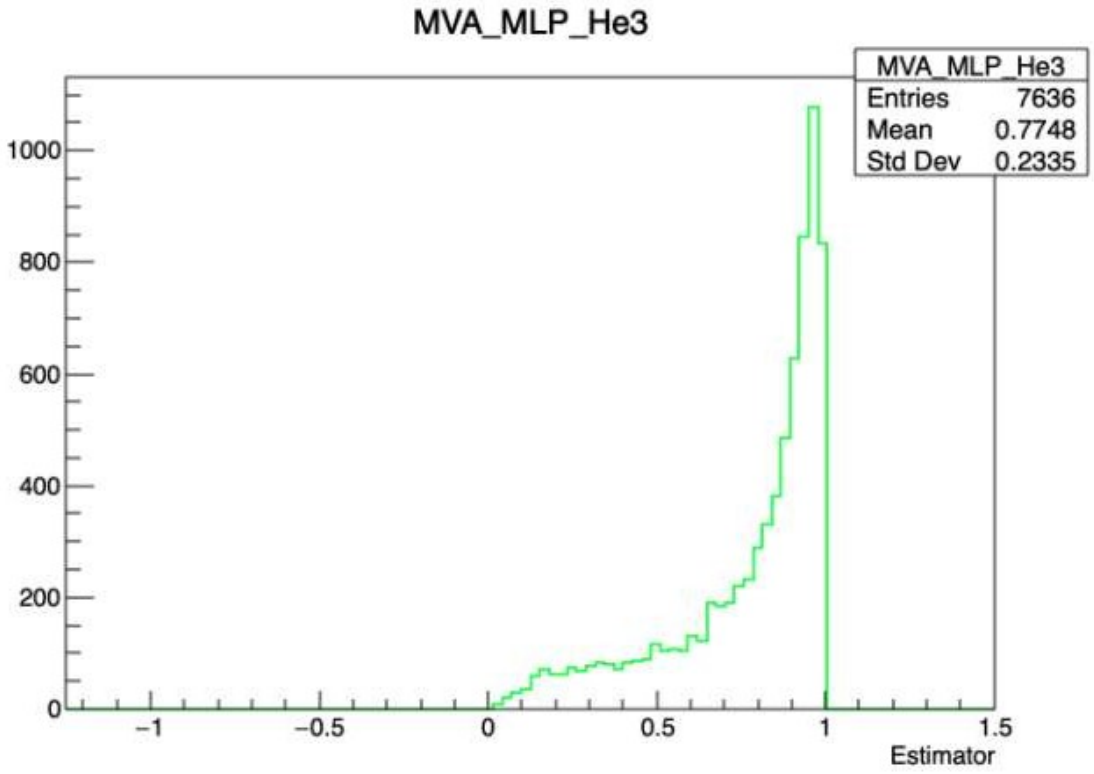
Using the Helium-3 as signal and the Helium-4 as background, it is now possible to train the TMVA methods

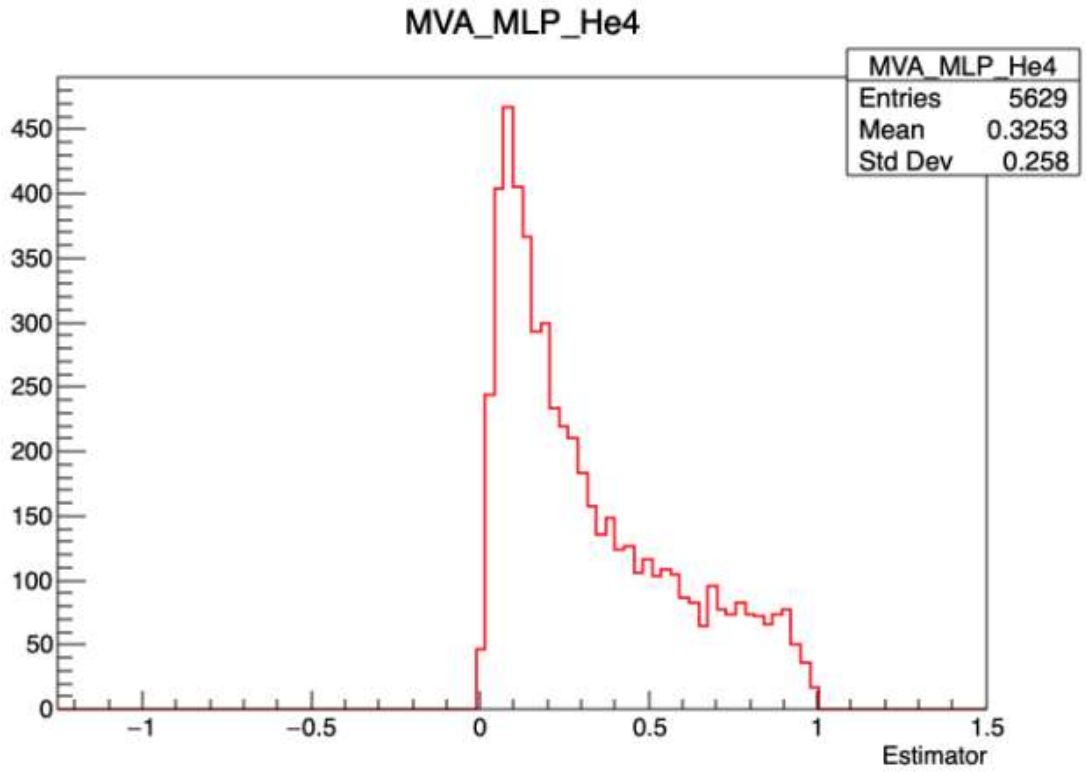
Selecting Variables

Combinations of these variables achieved the best results which shows the machine's capacity of identifying a separation between the isotopes. Contrary to first thoughts, including the calculated mass did not improved the results



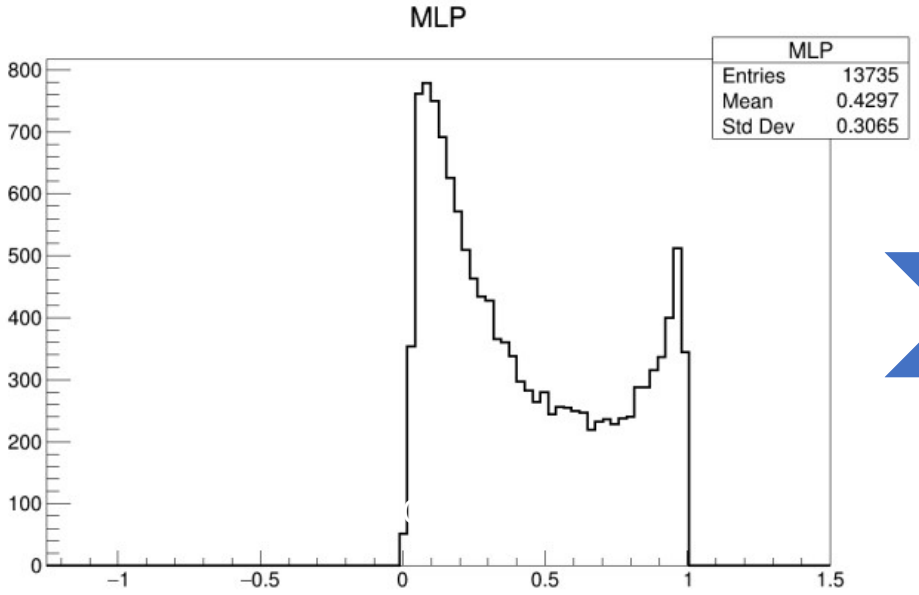
The Results - MLP



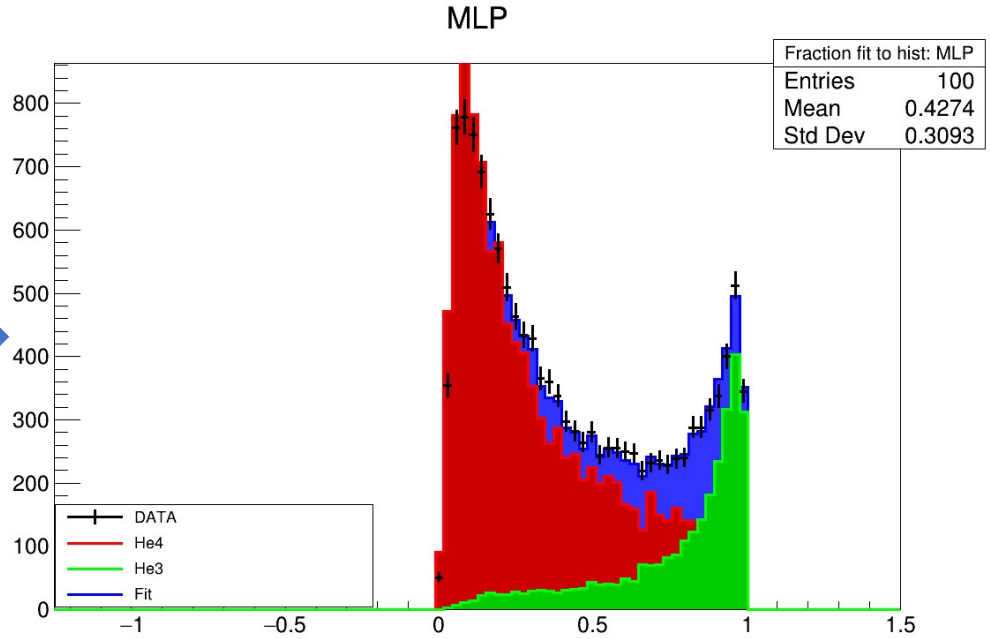


Results obtained after using the classifier over the Monte Carlo Data

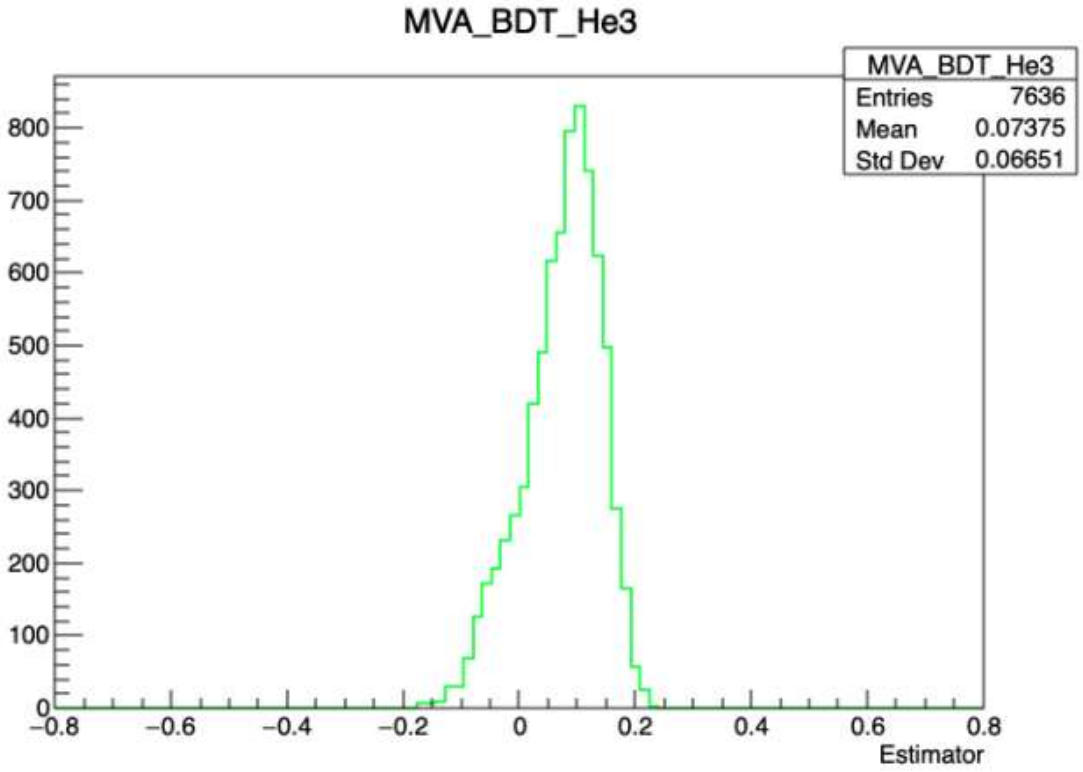
The Results - MLP

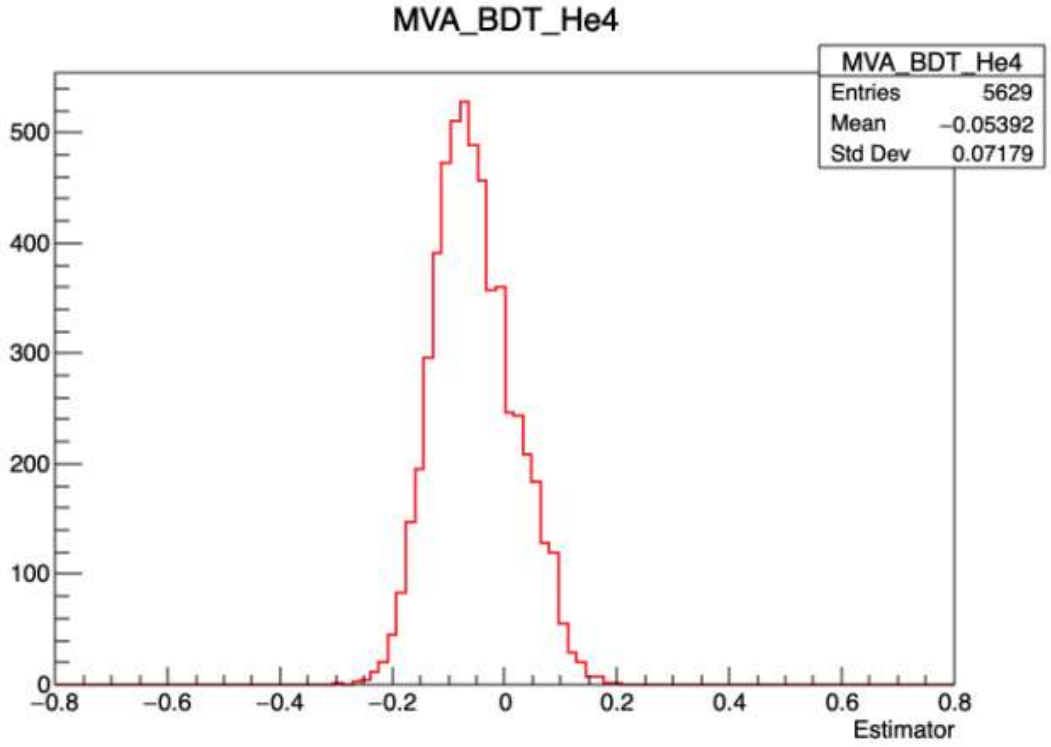


Normalising and Fitting



The Results - BDT





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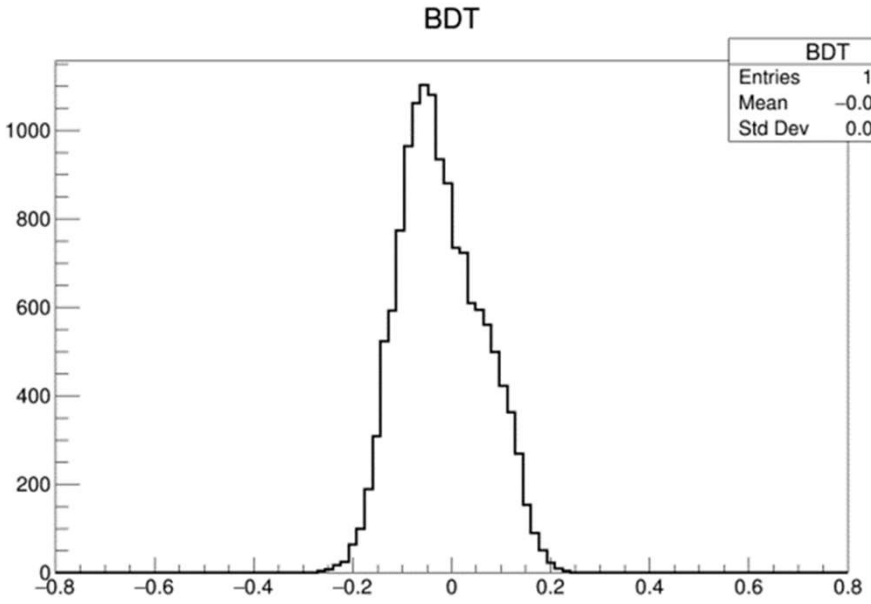
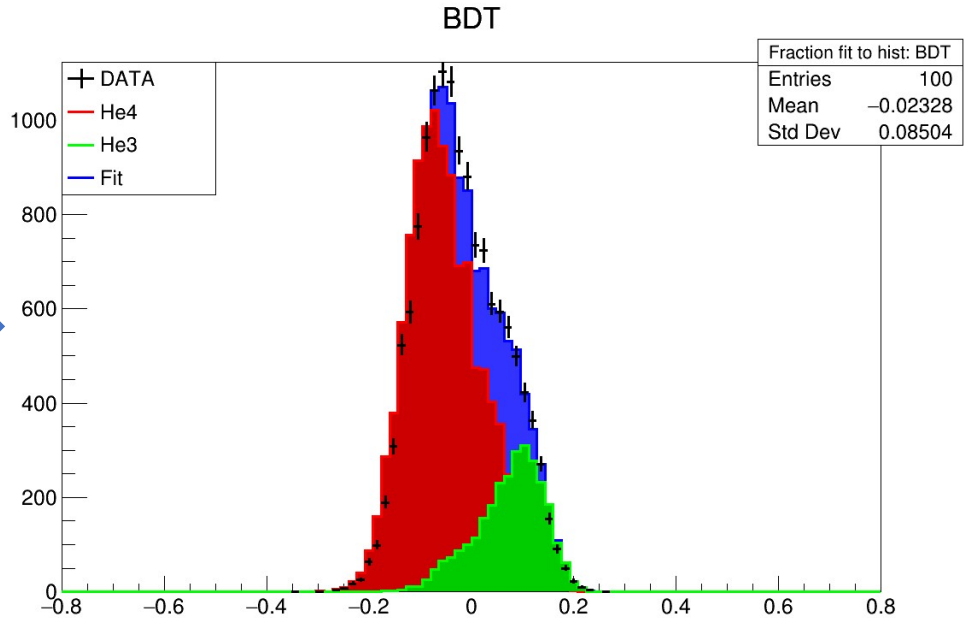


Normalising and Fitting



The Results

BDT	He3 %	He3 error %	He4 %	He4 error %
With charge as a variable	20.80153	0.778479	79.1948	1.44401
Without charge as a variable	16.5464	0.718013	83.4539	1.4834
MLP	He3 %	He3 error %	He4 %	He4 error %
With charge as a variable	21.493	0.781797	78.5071	1.43439
Without charge as a variable	14.7507	0.718052	85.2499	1.51242

The Results – Geomagnetic Cut

BDT	He3 %	He3 error %	He4 %	He4 error %
Without Geomagnetic Cut	16.6088	0.730373	83.3917	1.4883
With Geomagnetic Cut	16.5464	0.718013	83.4539	1.4834
MLP	He3 %	He3 error %	He4 %	He4 error %
Without Geomagnetic Cut	14.8275	0.726253	85.1726	1.51503
With charge as a variable	14.7507	0.718052	85.2499	1.51242

Questions?