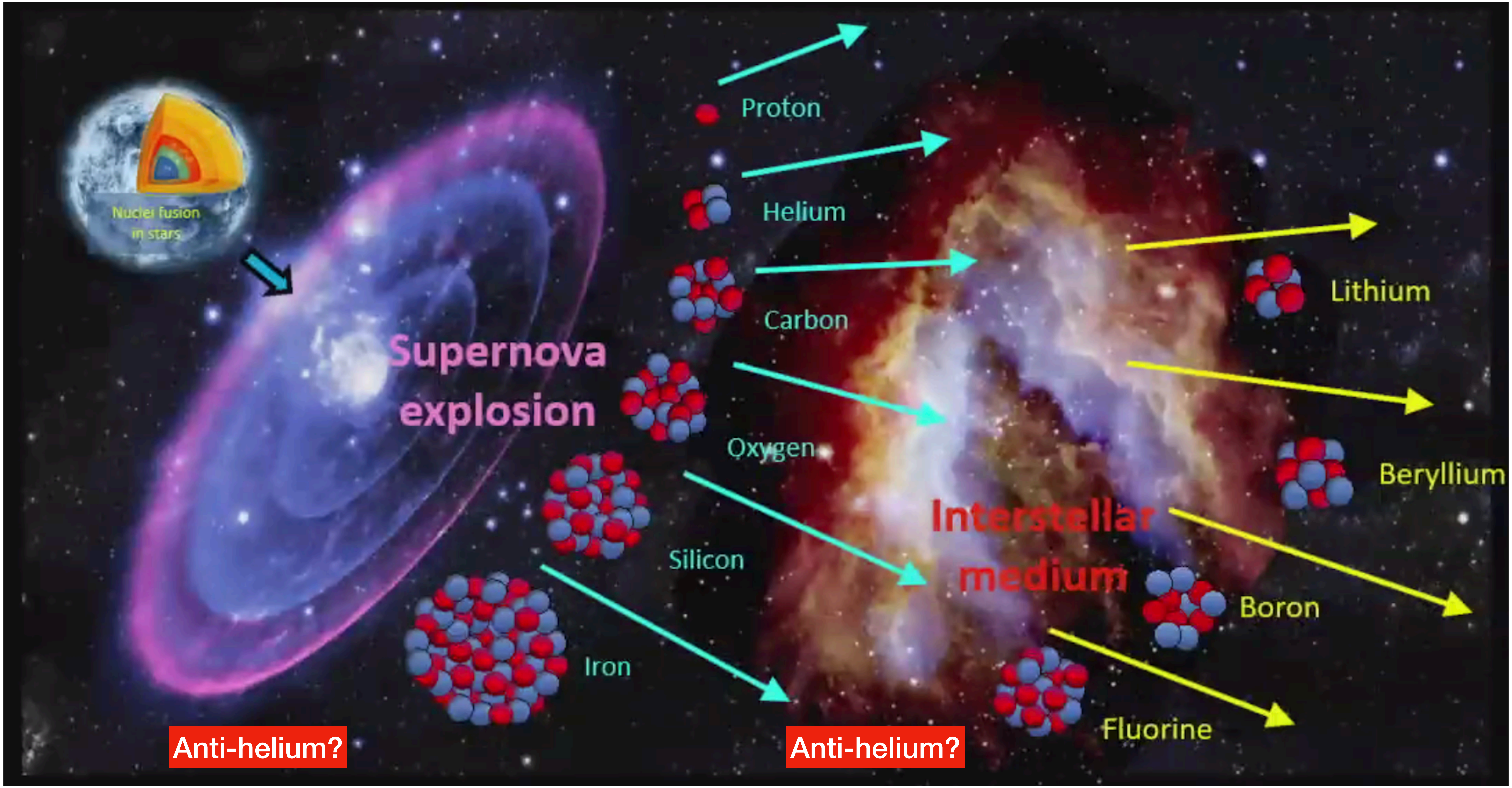
Progress on anti-helium search with ROOT TMVA

AMS Italy Trento
2023-11-30

Jian Tian / Roma 2

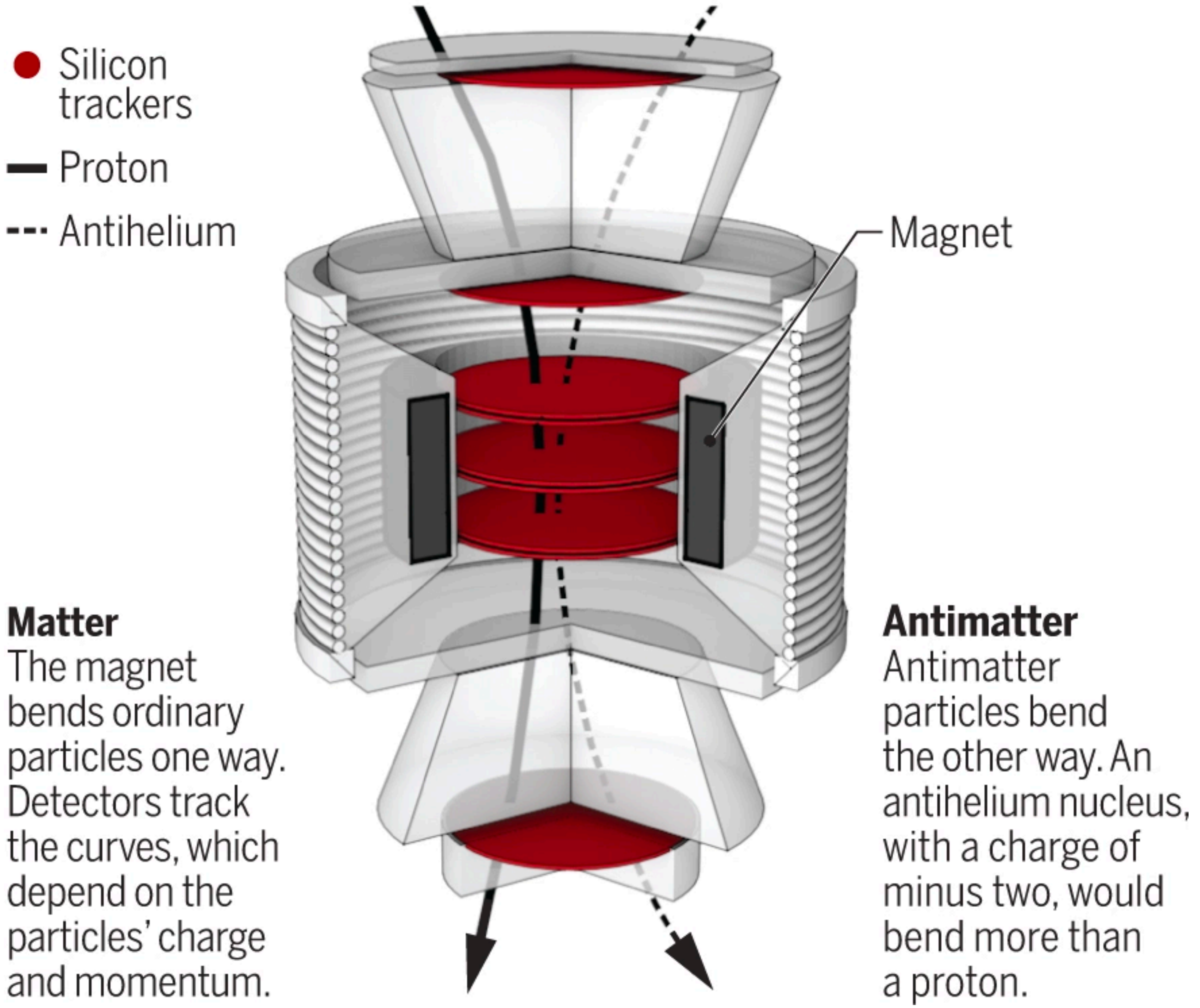
Cosmic rays' production and propagation



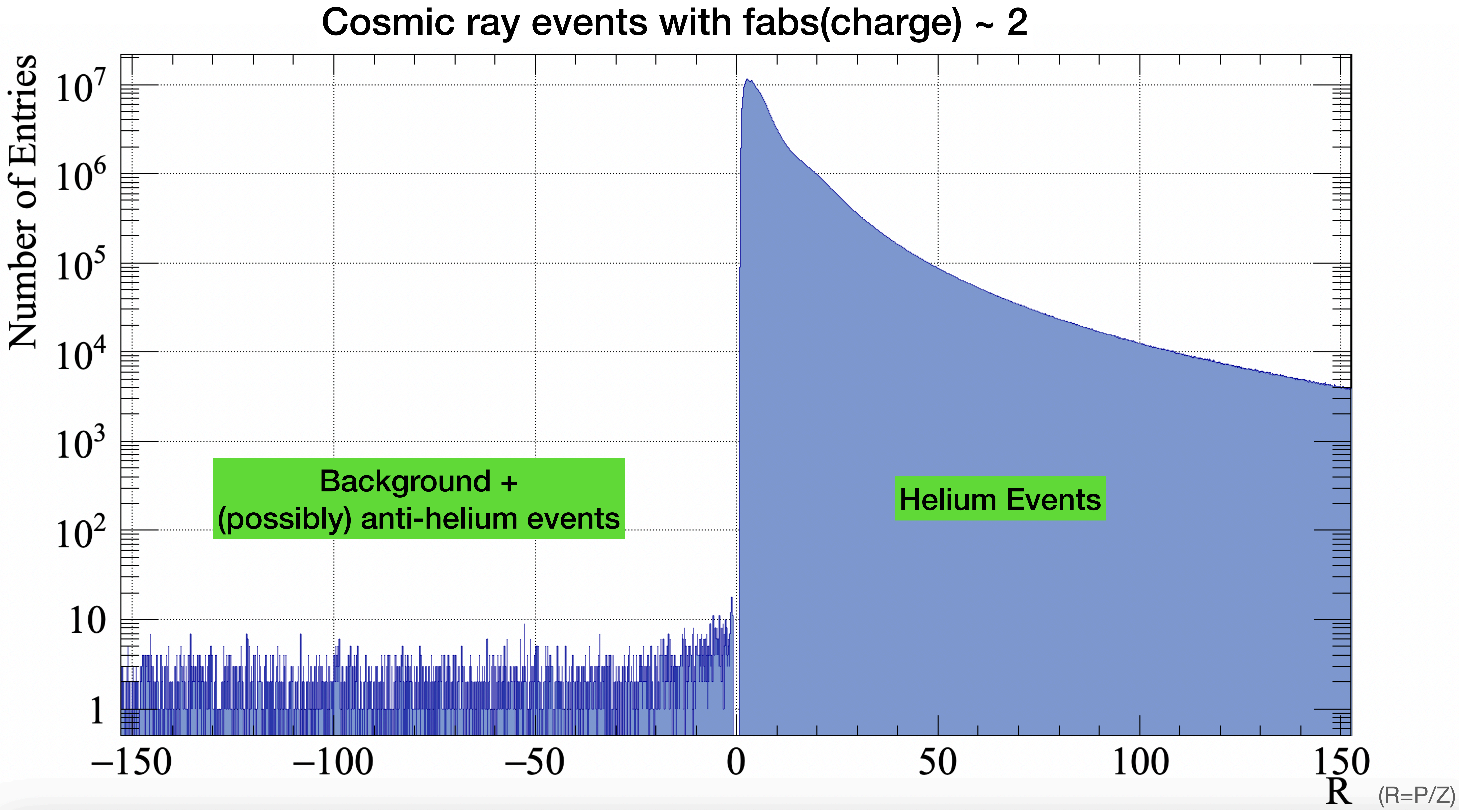
The aim of this analysis is search for anti-helium in cosmic rays

Antimatter particles in cosmic rays are unique messengers for the search of dark matter annihilation signals in the Galaxy, or the presents of large domains of antimatter in the universe.

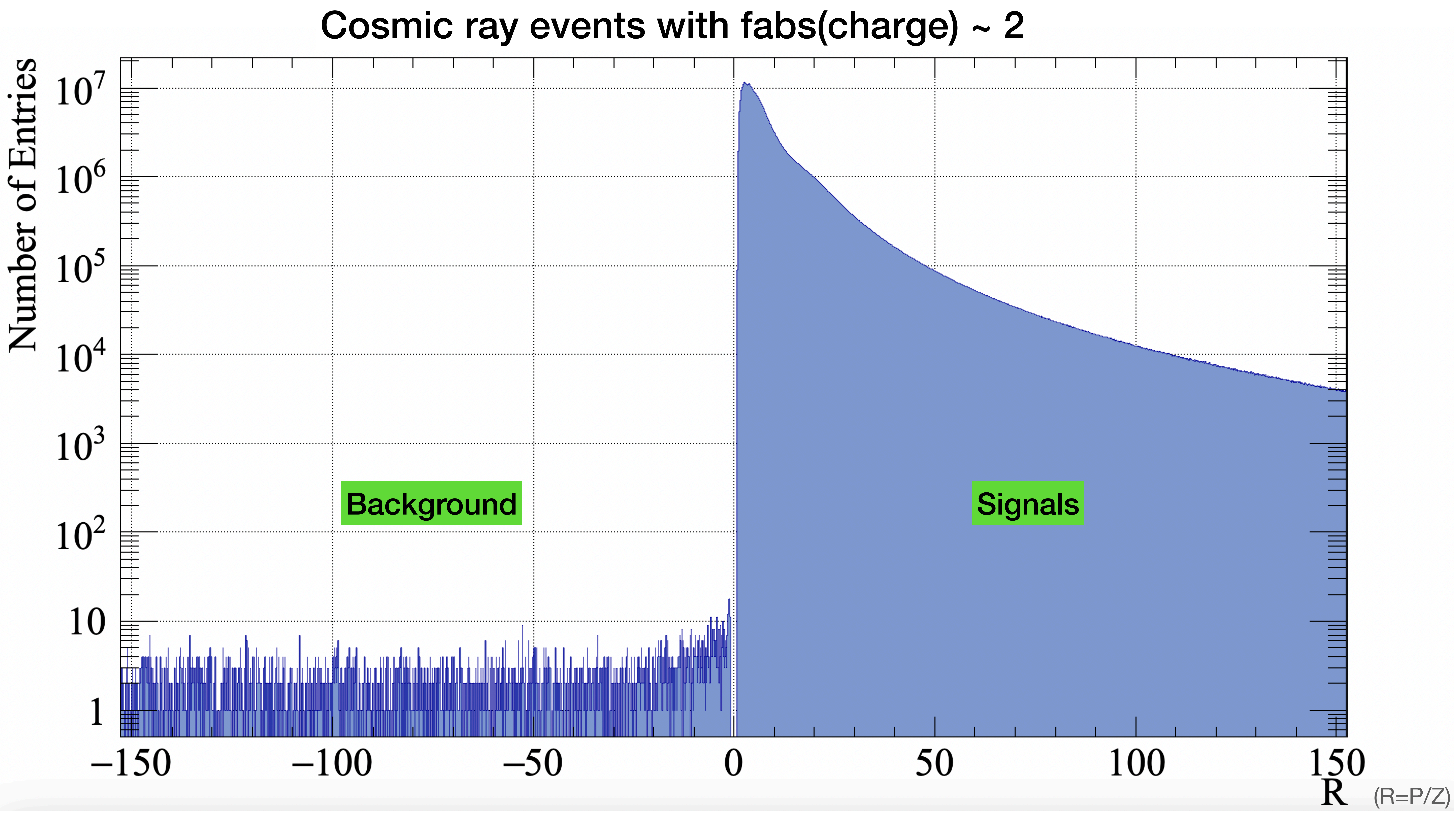
AMS collaboration has publish the results of the positrons, anti-protons. Now we are searching for heavier antimatters in the cosmic rays. Anti-helium is interesting since till now we have no clear evidence that we have anti-helium in cosmic rays.



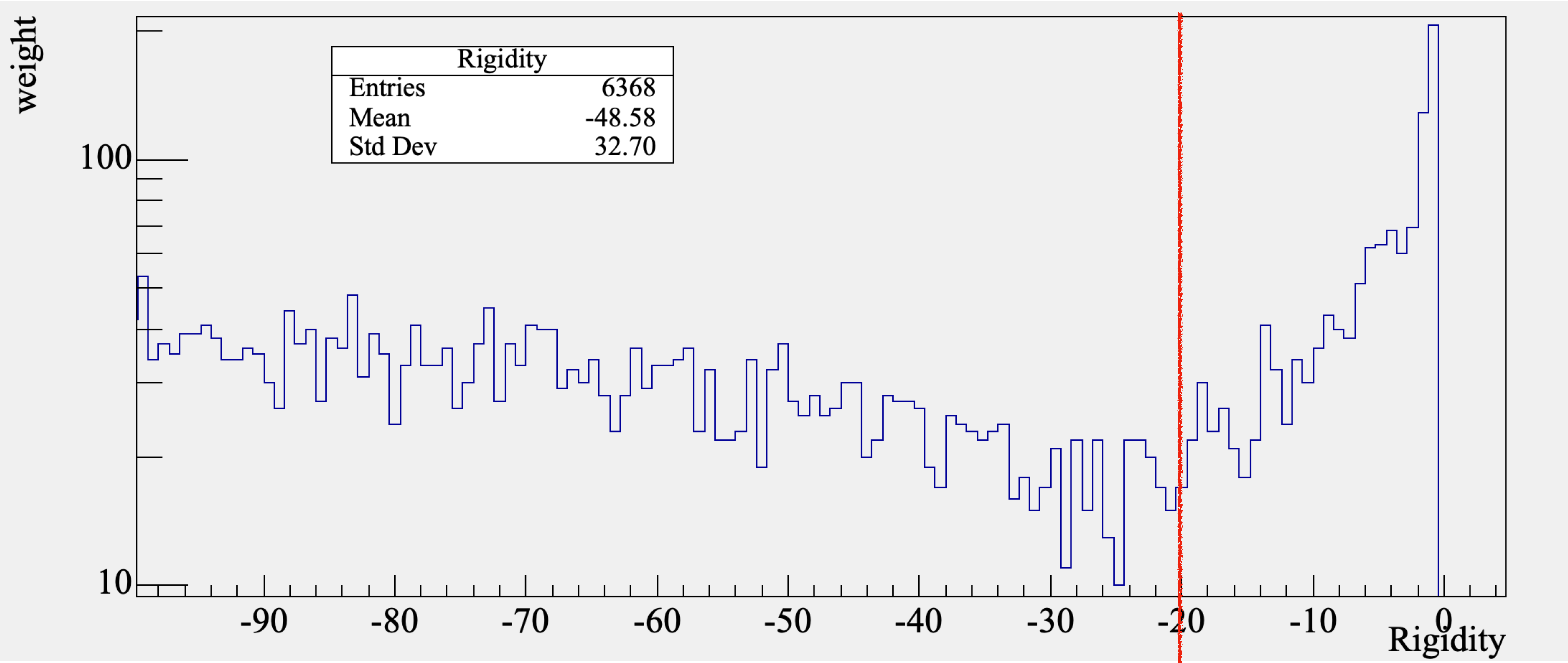
From the propagation theory of the cosmic ray, anti-helium is unlikely to be produced in the cosmic rays, that means, even there are some, should be very small amount. That make the most of the events with charge = -2 reconstructed in AMS are backgrounds.



For most variables of the performance in the detector, Anti-helium should share the similar distribution as helium. So first, we need to find the variables that can be used to discriminate signals from backgrounds, both in Monte Carlo (MC) and the experimental data.



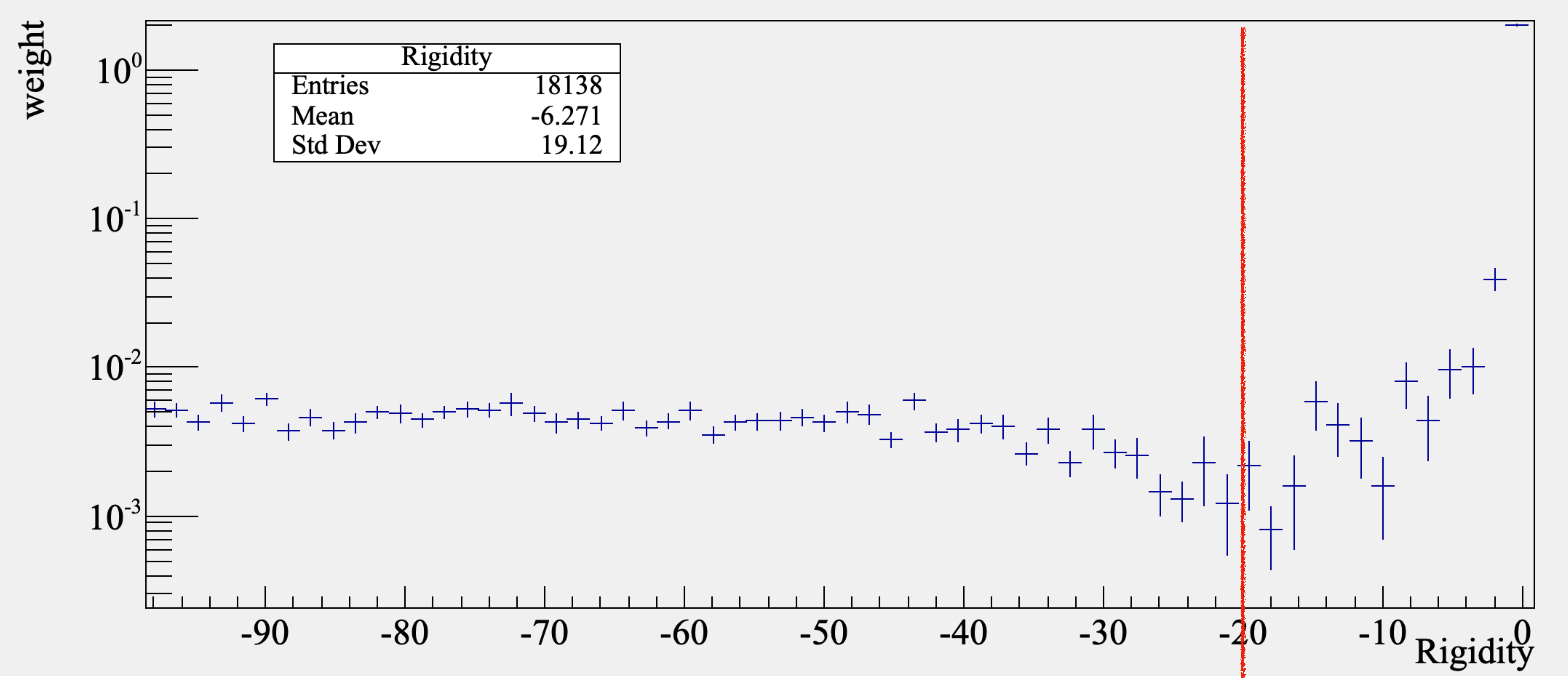
Data



At high energy, the background is mostly from the finite resolution of the detecter, that some helium events are reconstructed with negative charge.

At low energy, the background is mostly from the particle scattering in the detecter. Due to the scattering, some of the helium events are reconstructed with negative charge.

MC

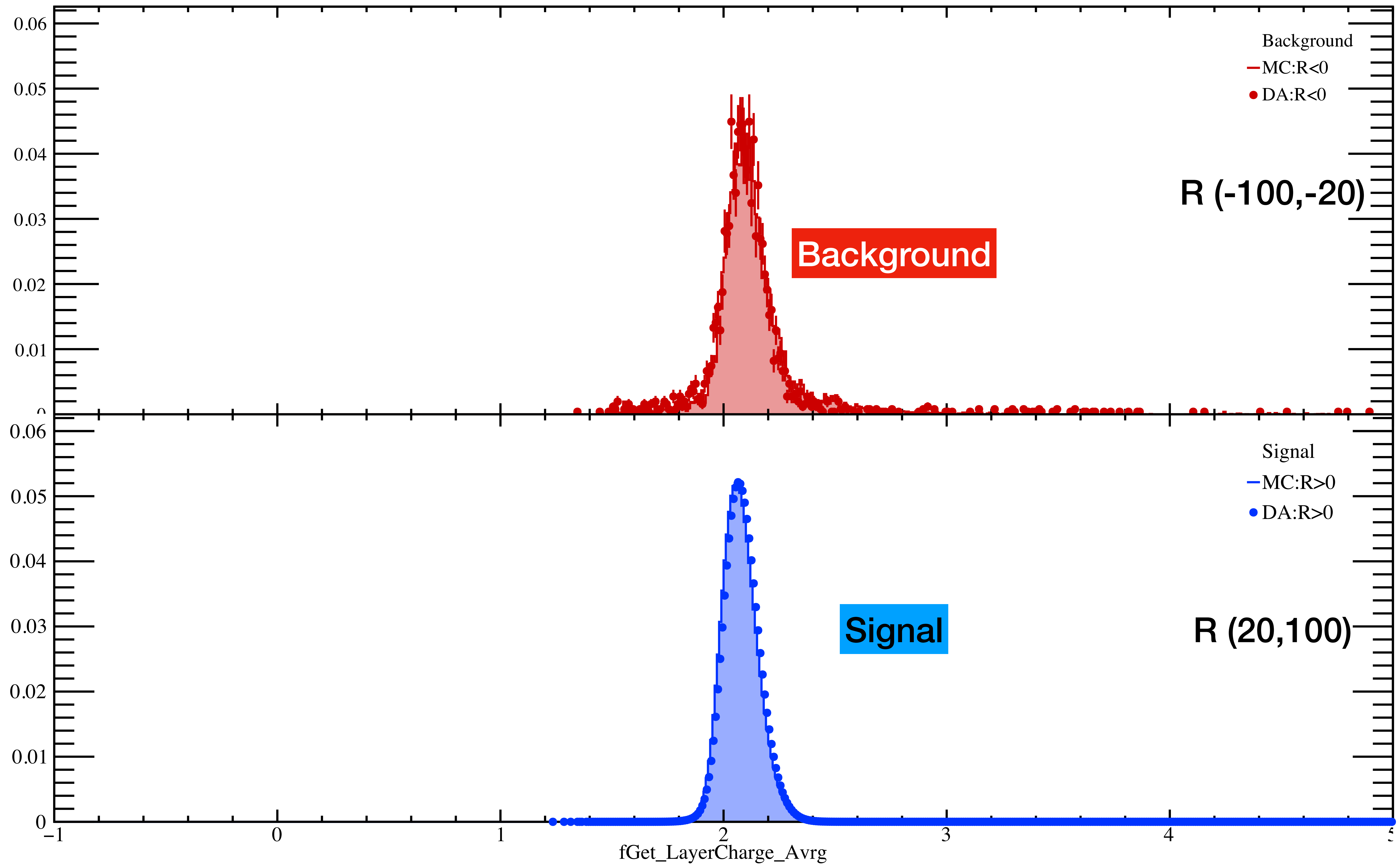


High Rigidity: fabs(R)>=20

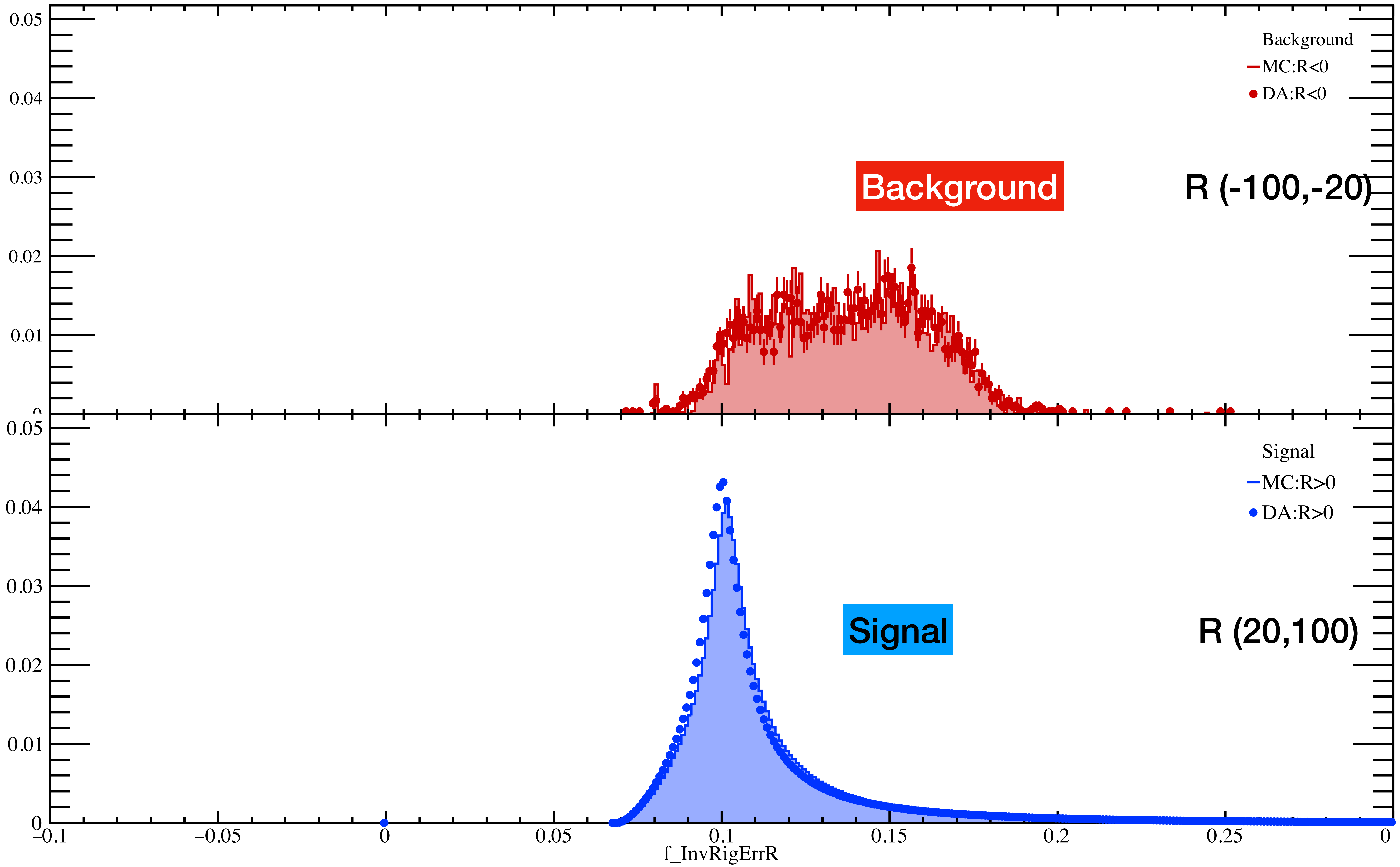
Low Rigidity: fabs(R)<20.

High Rigidity: fabs(R)>=20

looking for variables could discriminate signals from backgrounds.



Average charge of the 7 layers in the inner tracker looking for variables could discriminate signals from backgrounds.



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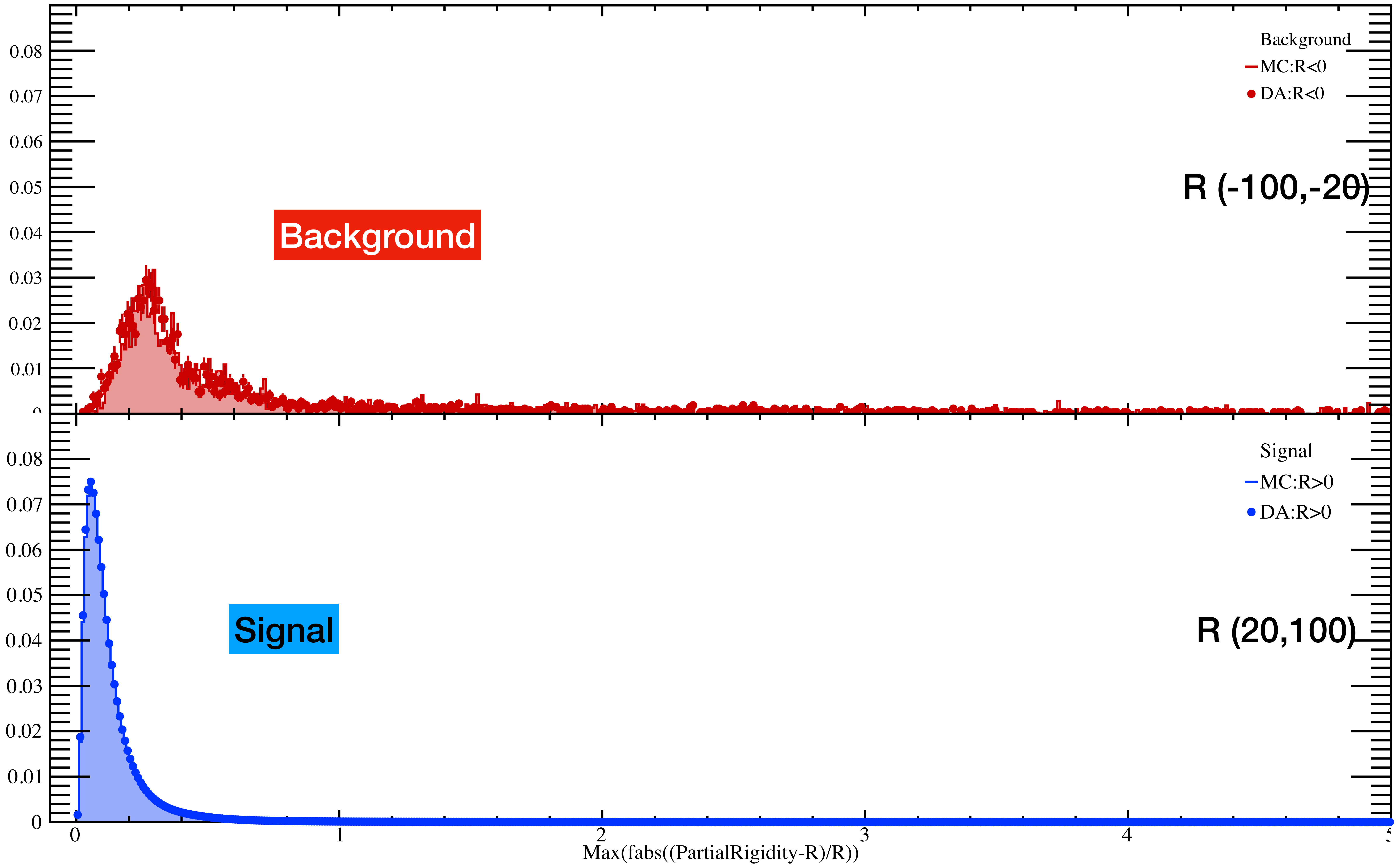

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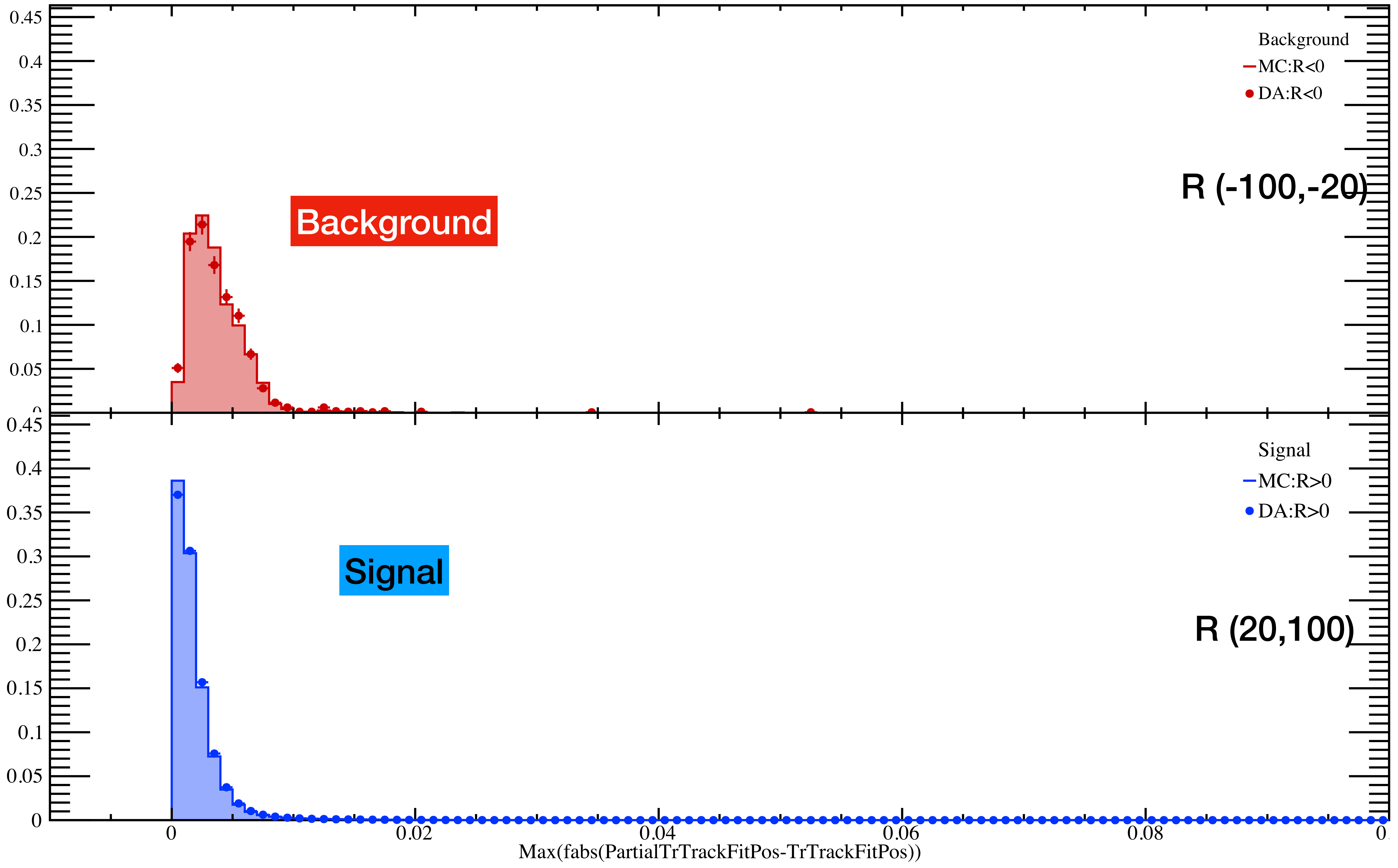

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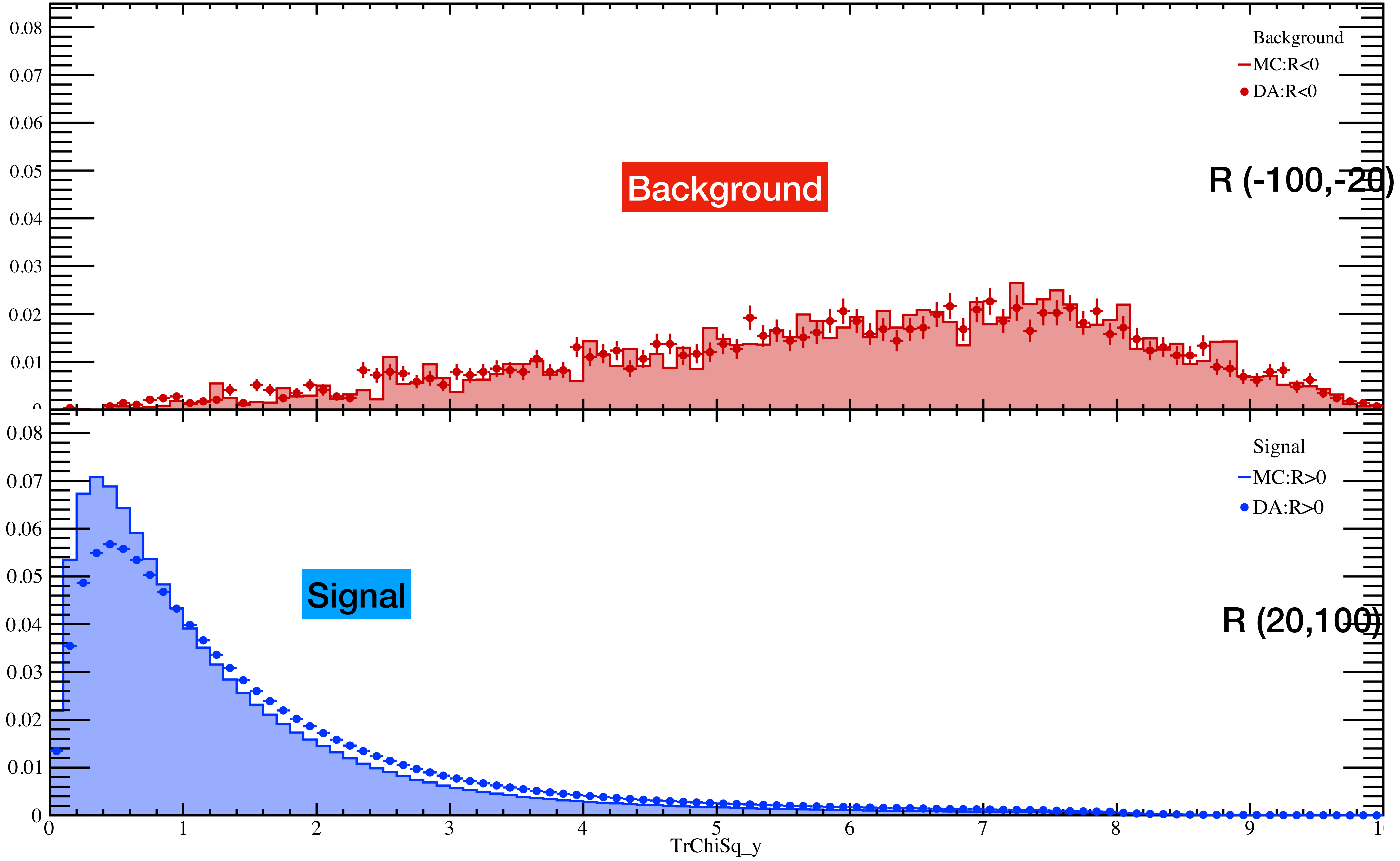

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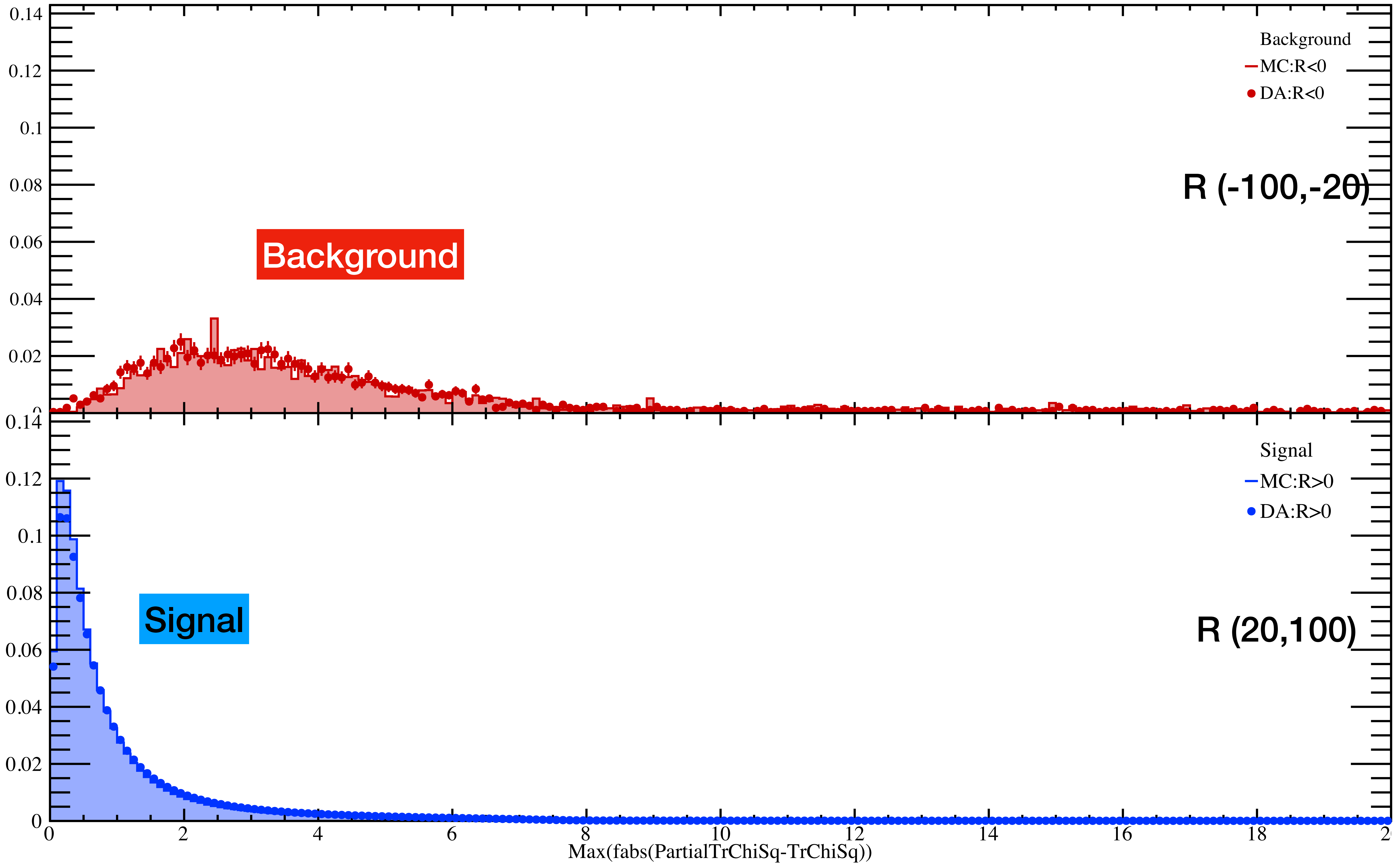

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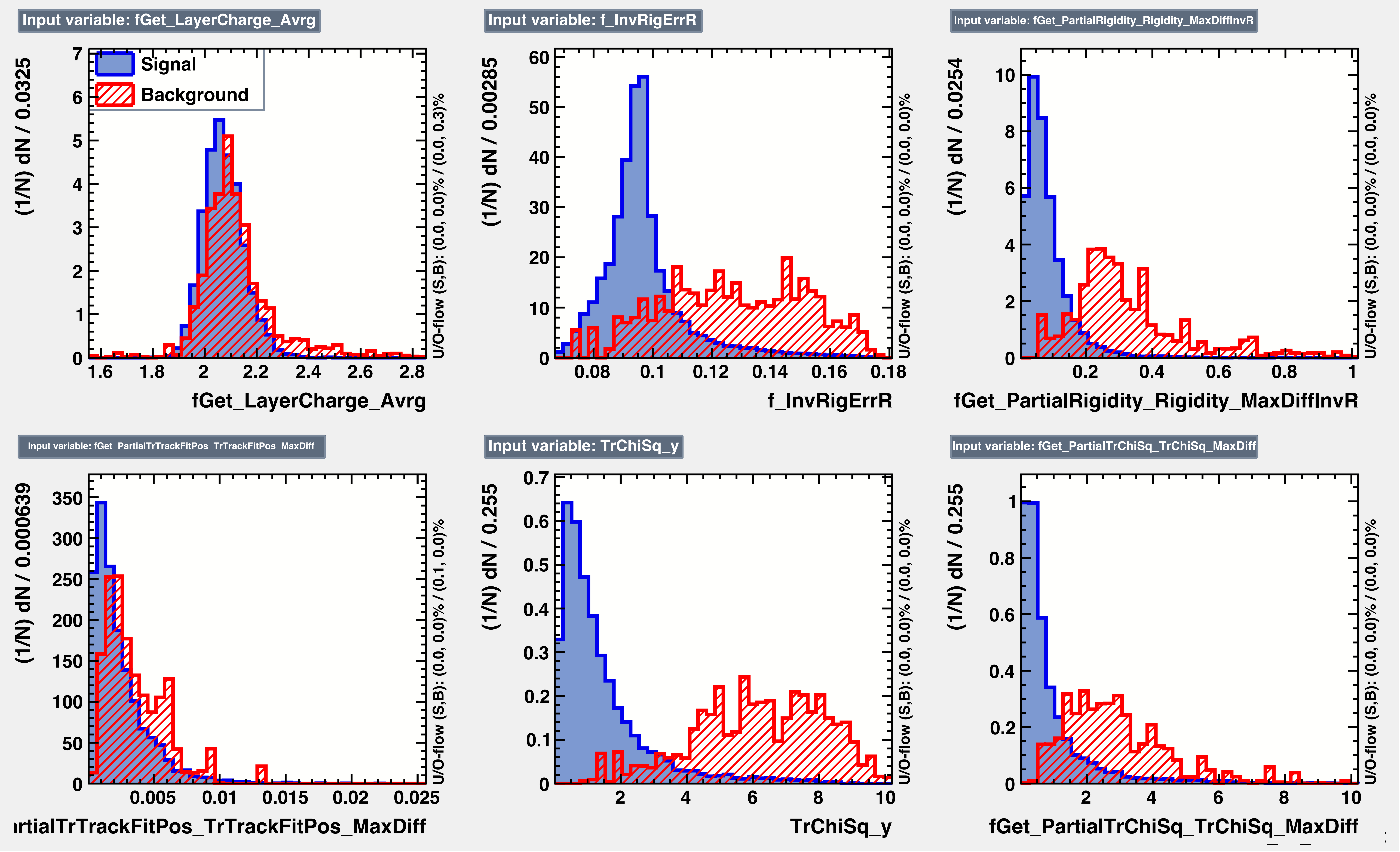
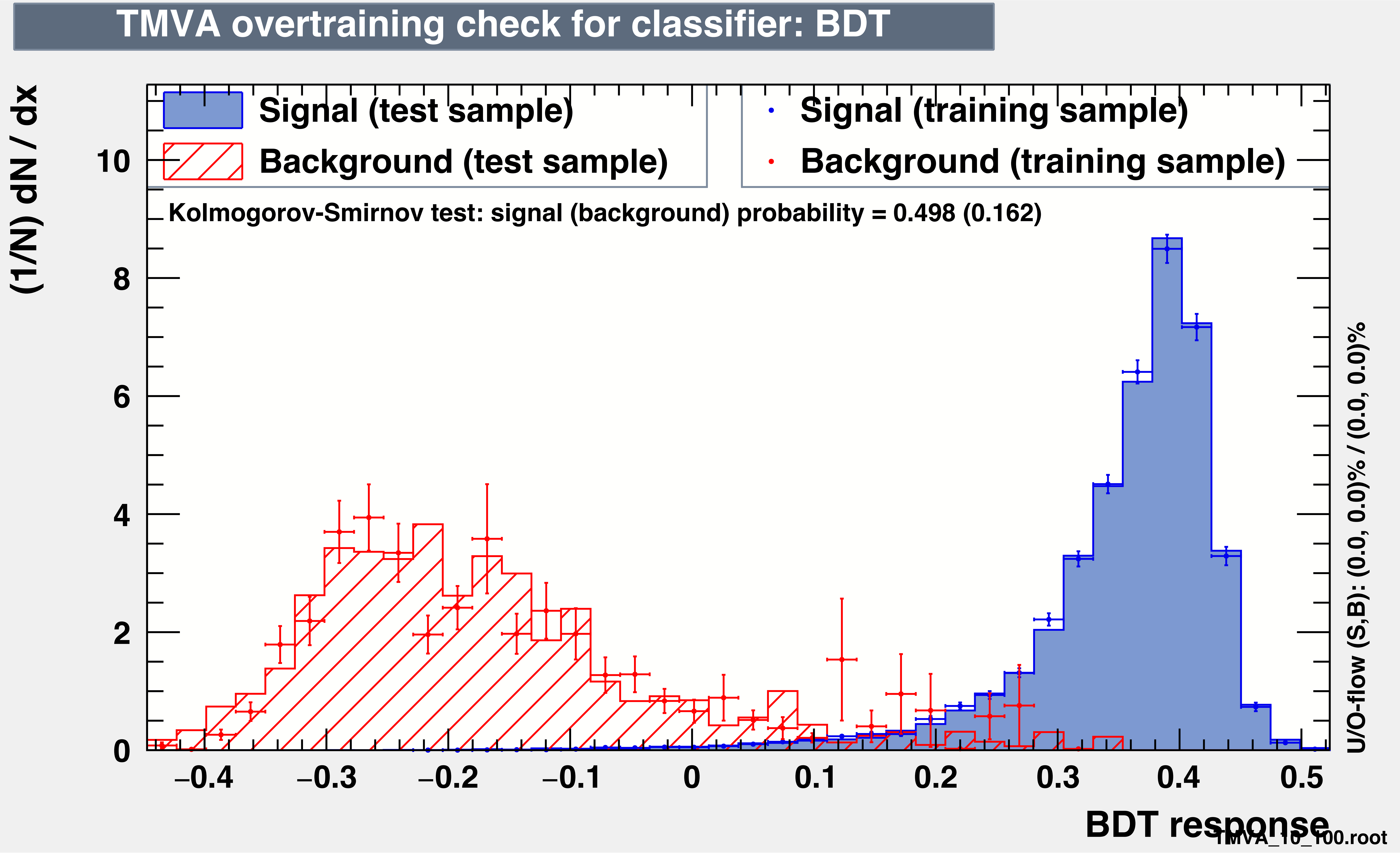


Employ the variables found before, perform machine learning with TMVA integrated in ROOT.
Train the MC data to get the classifier



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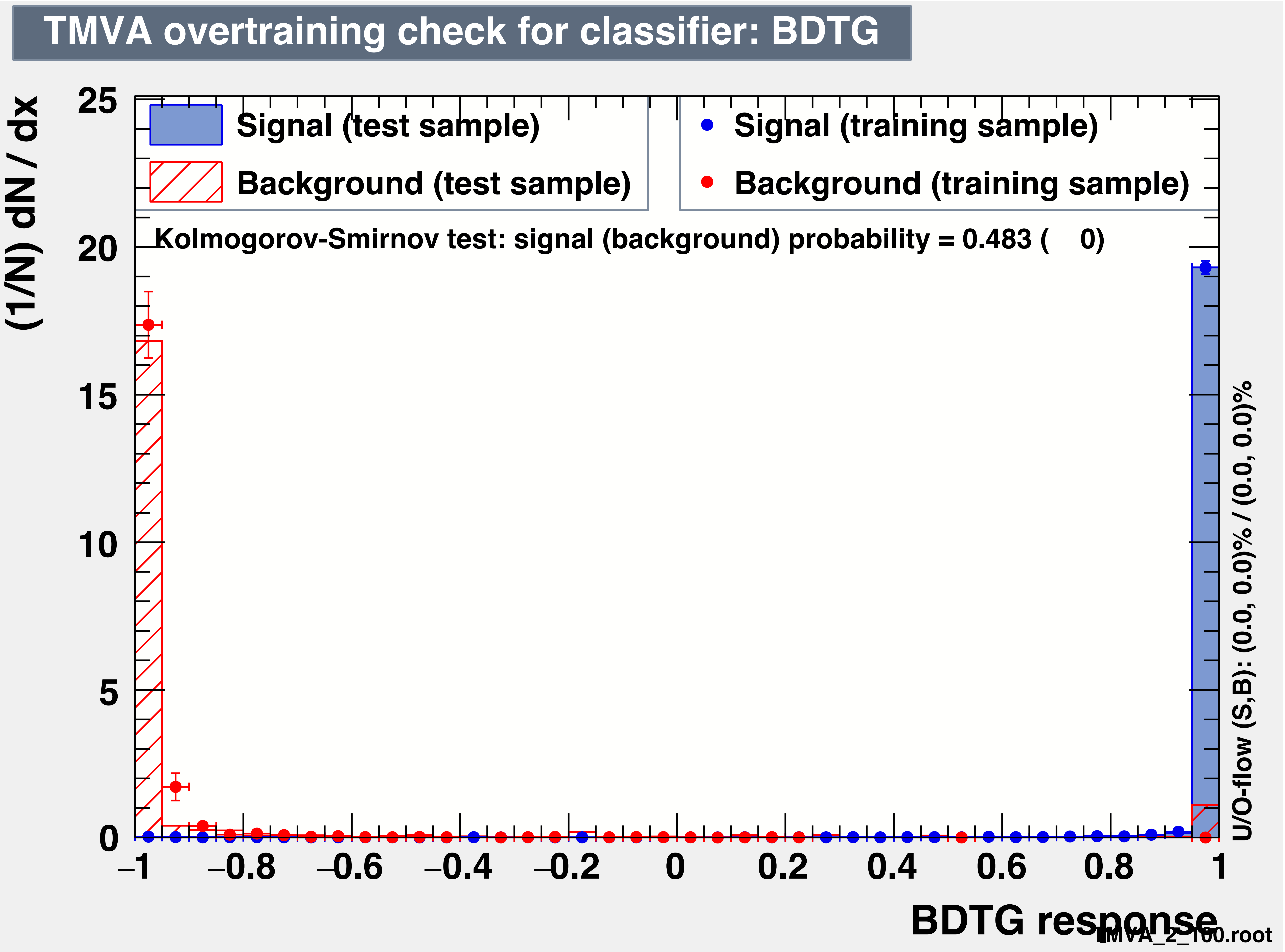

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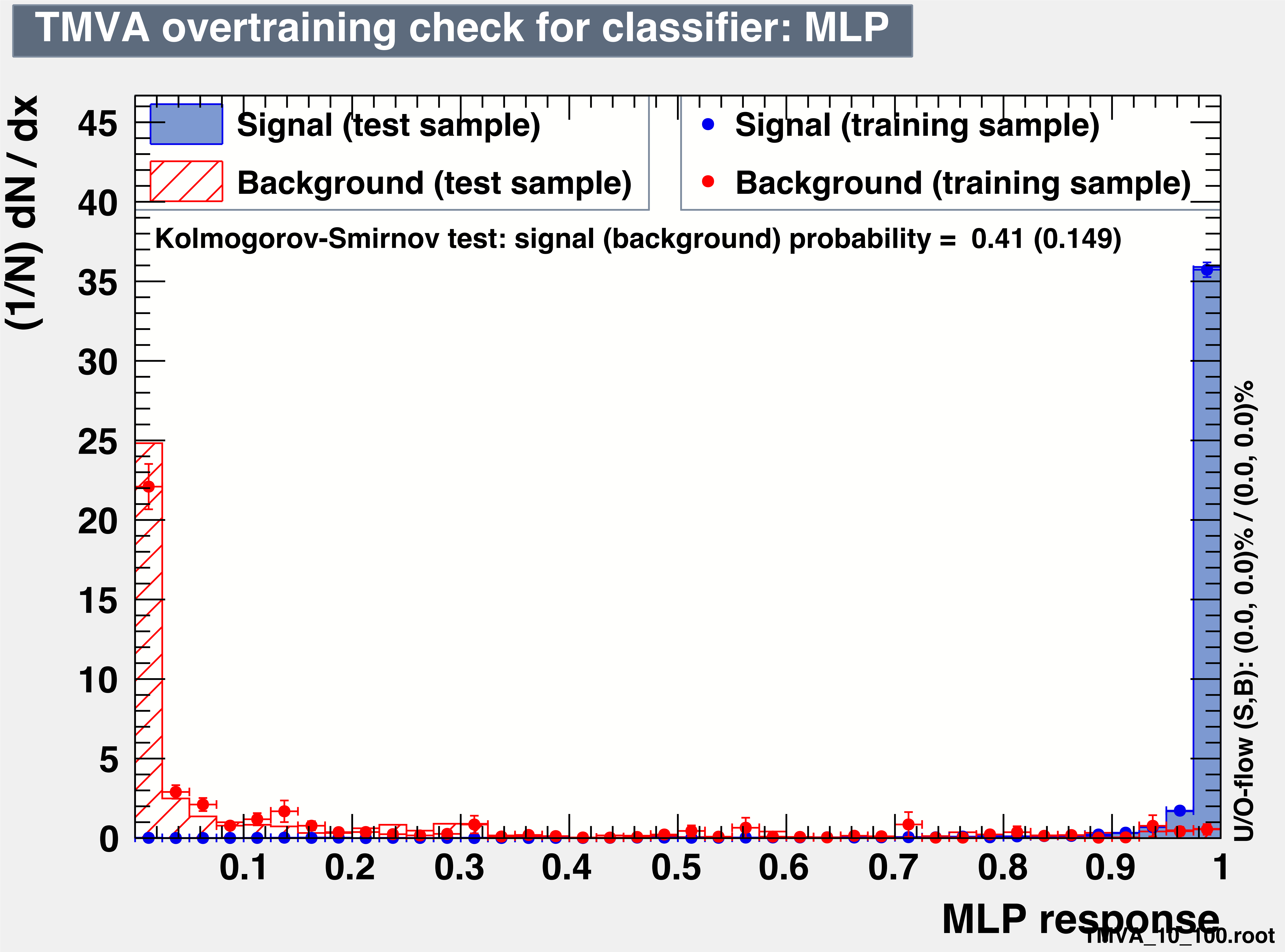

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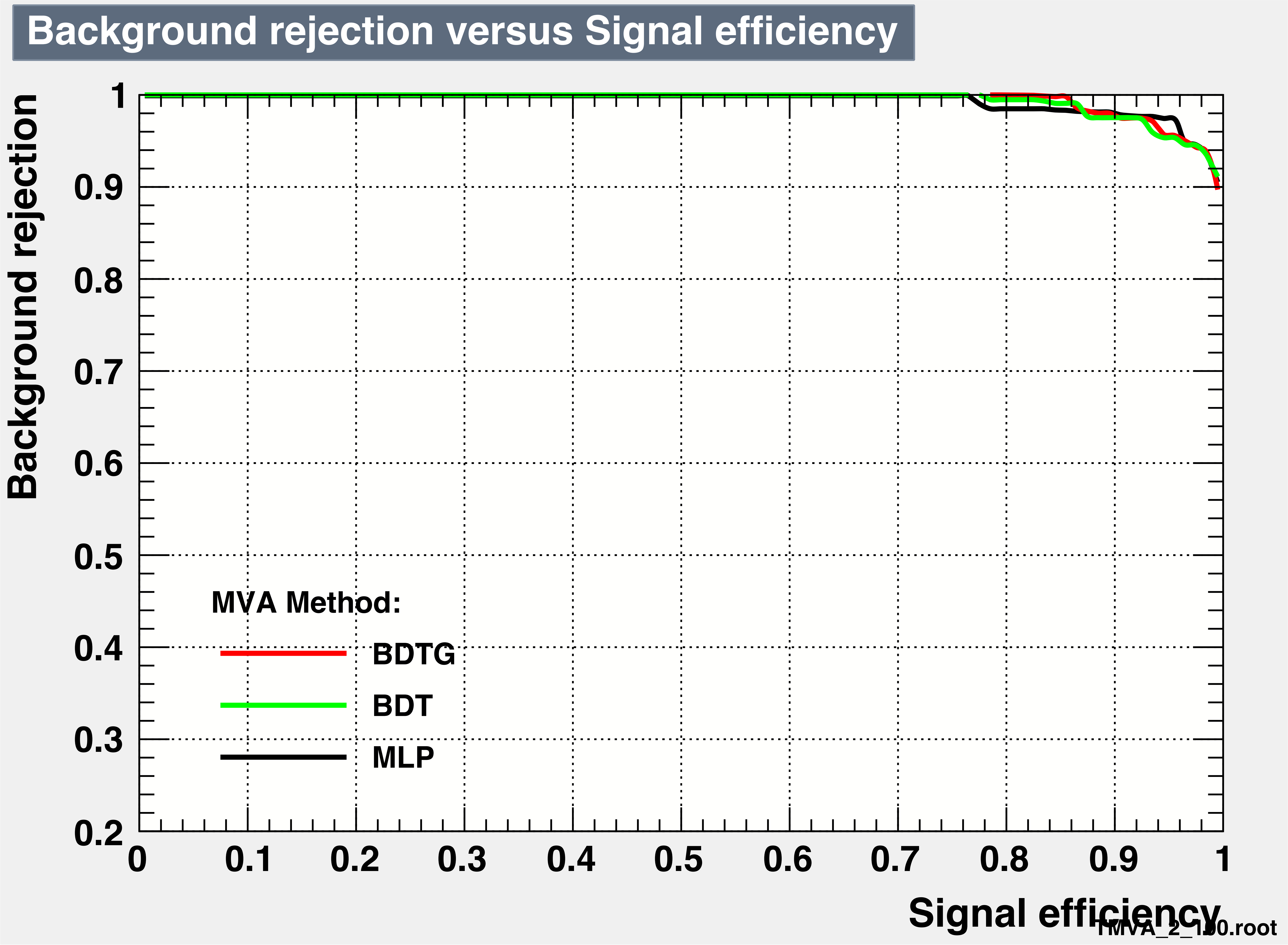
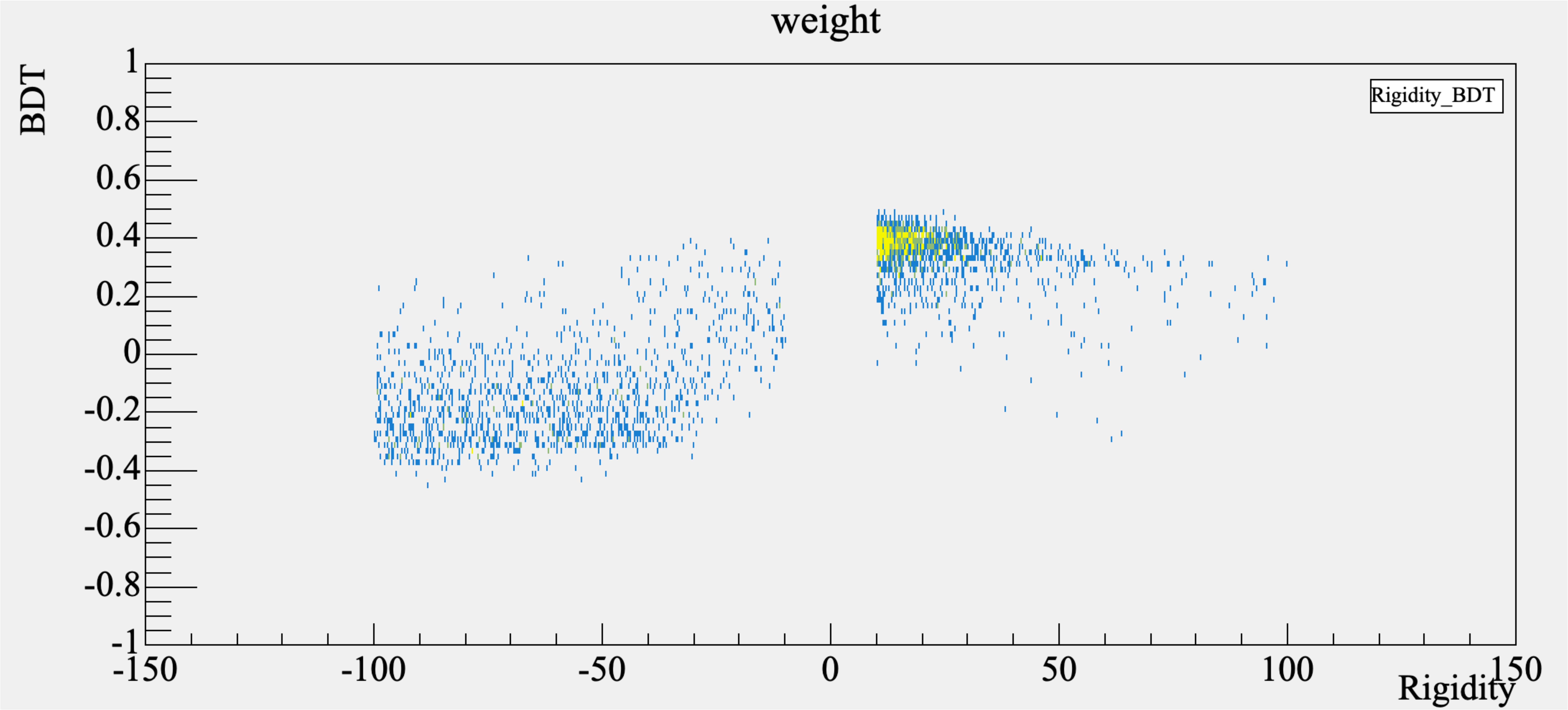
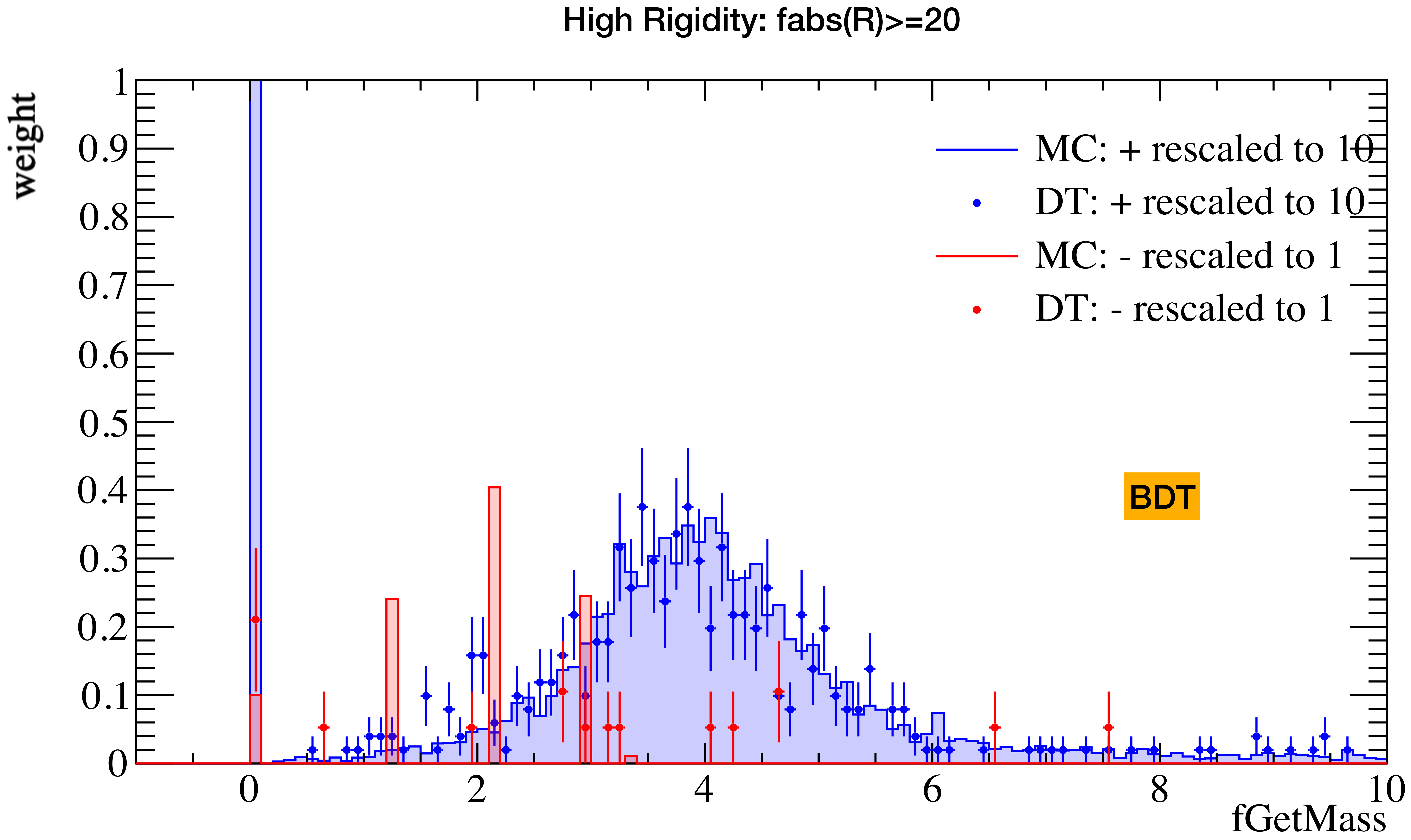


Apply the classifier to data



Apply the classifier to the experimental data



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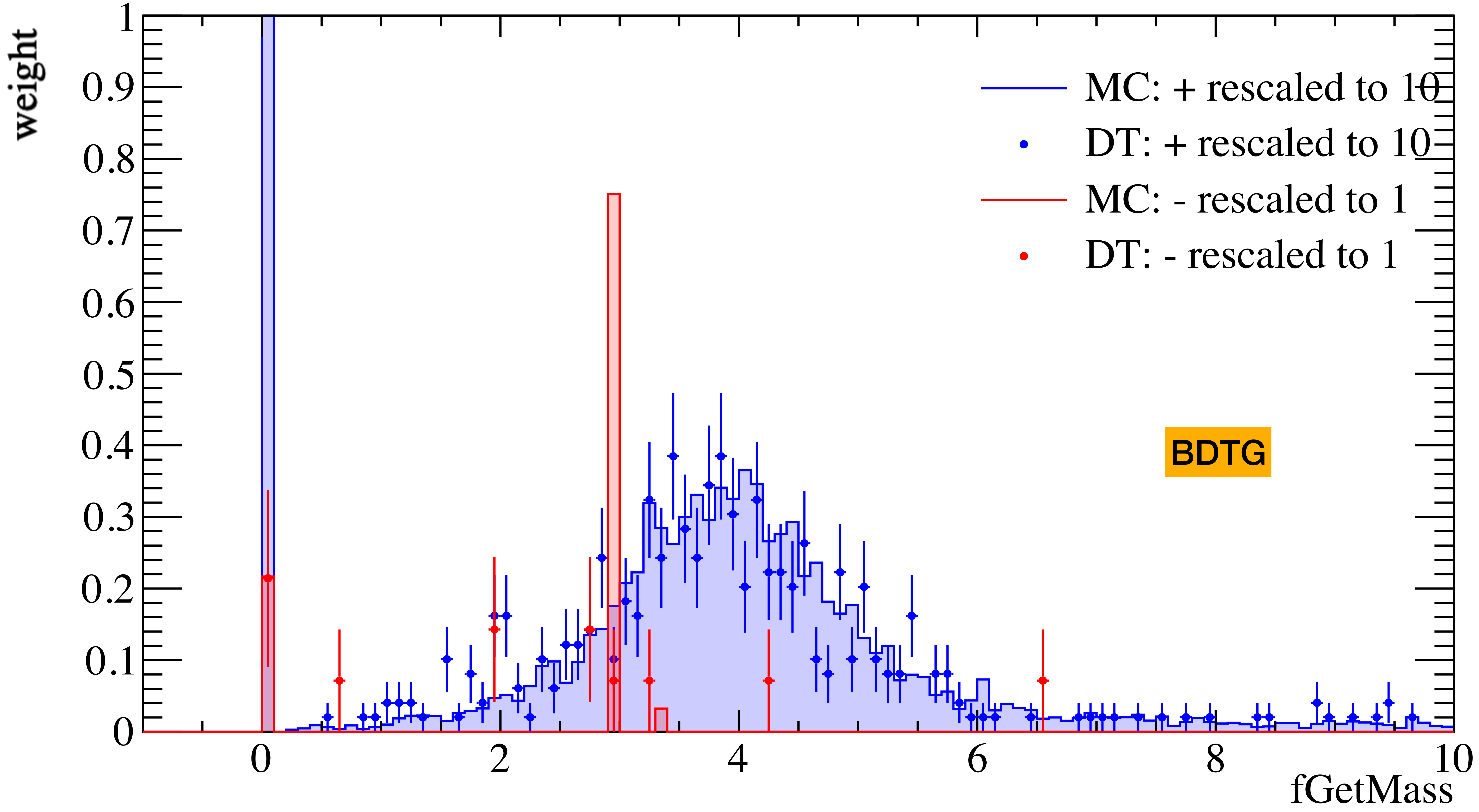

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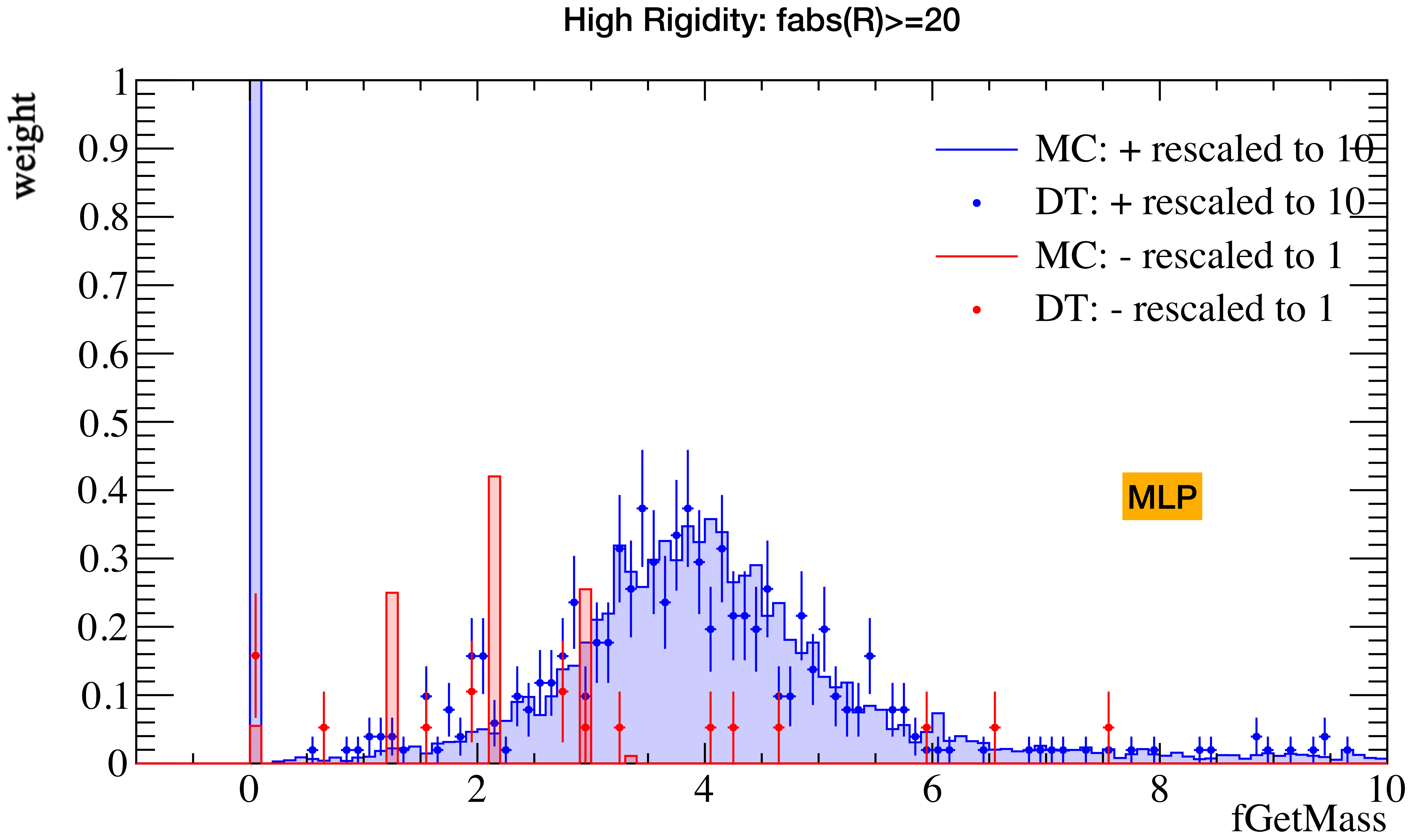

Low Rigidity: fabs(R)<20

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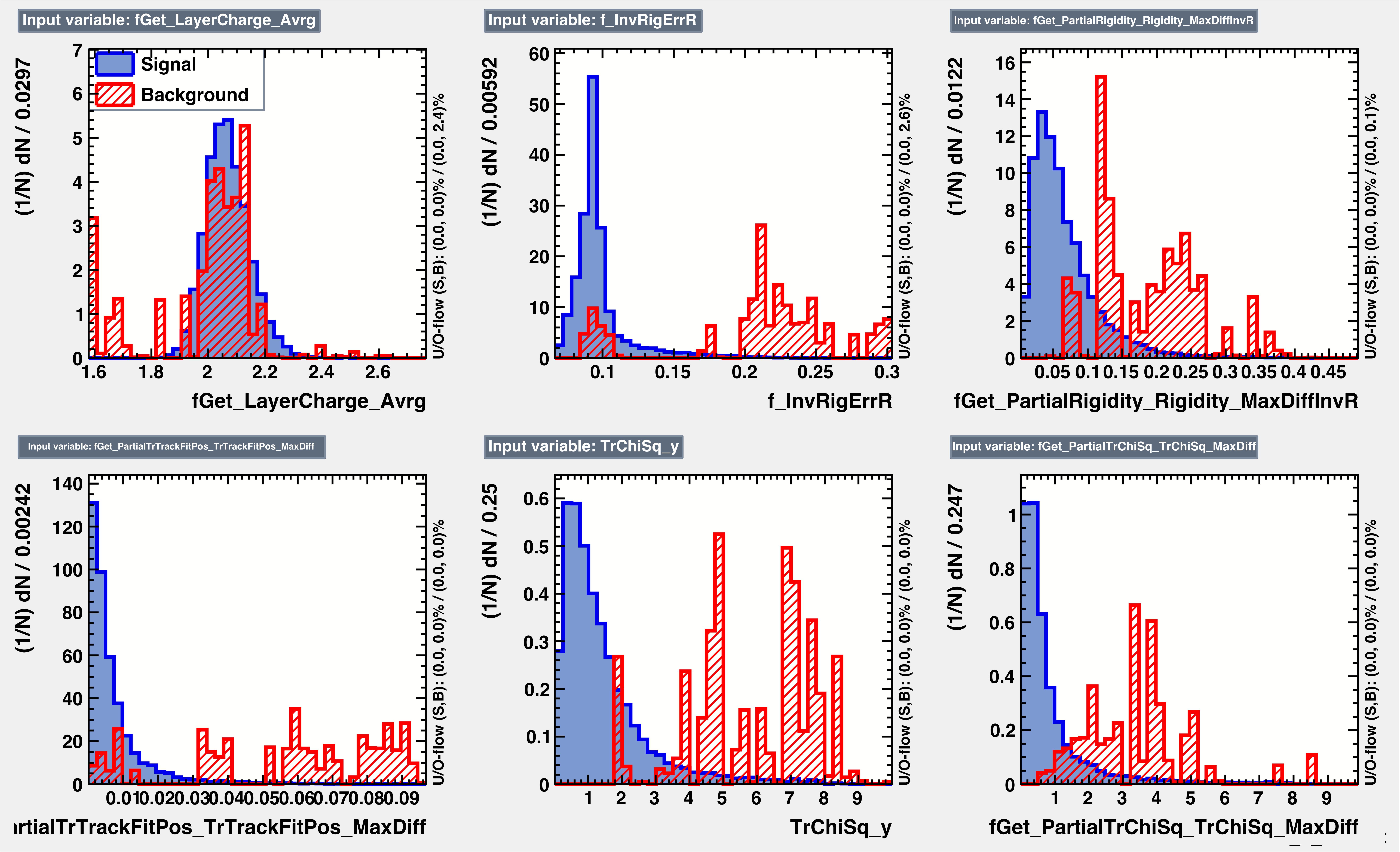

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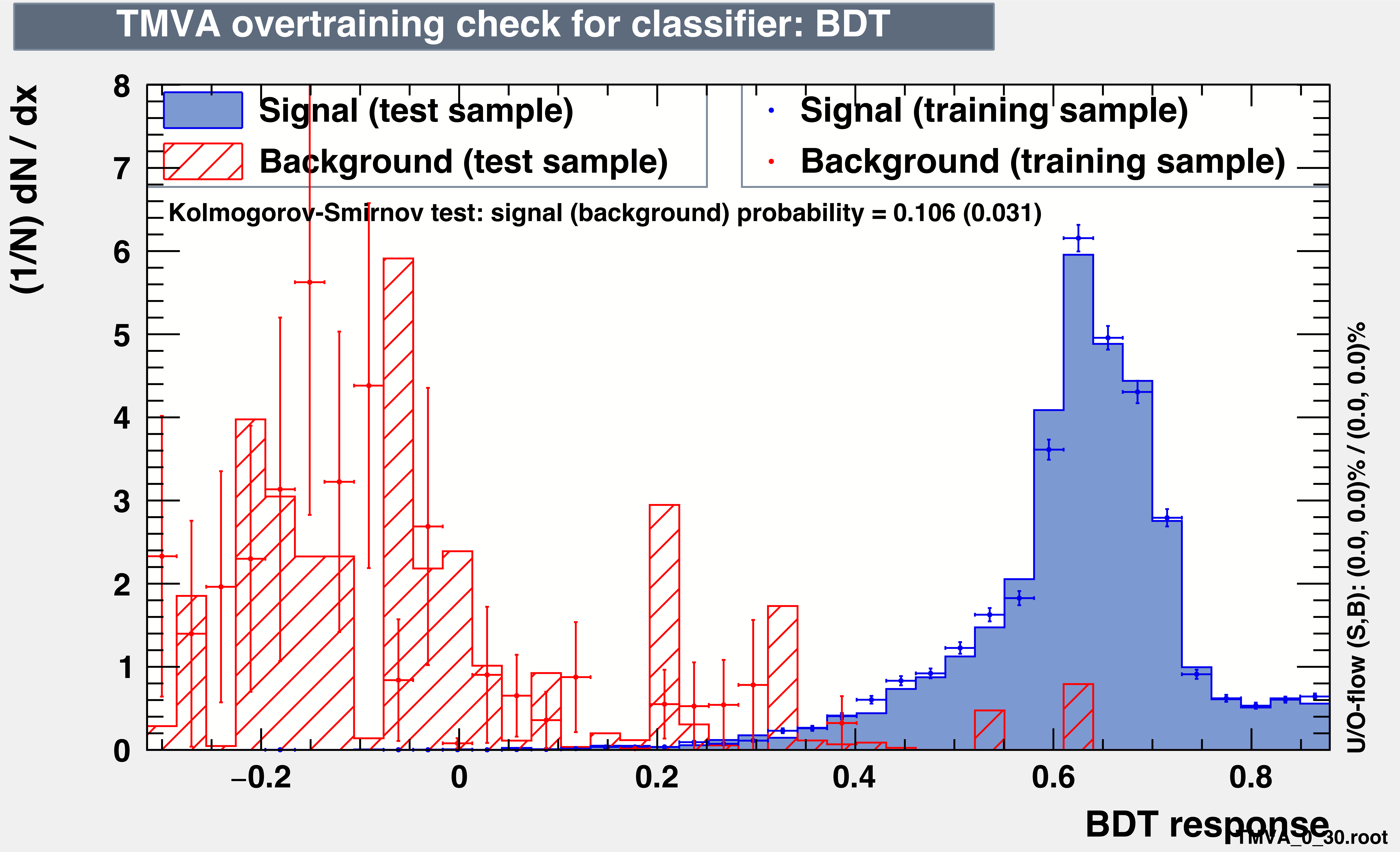

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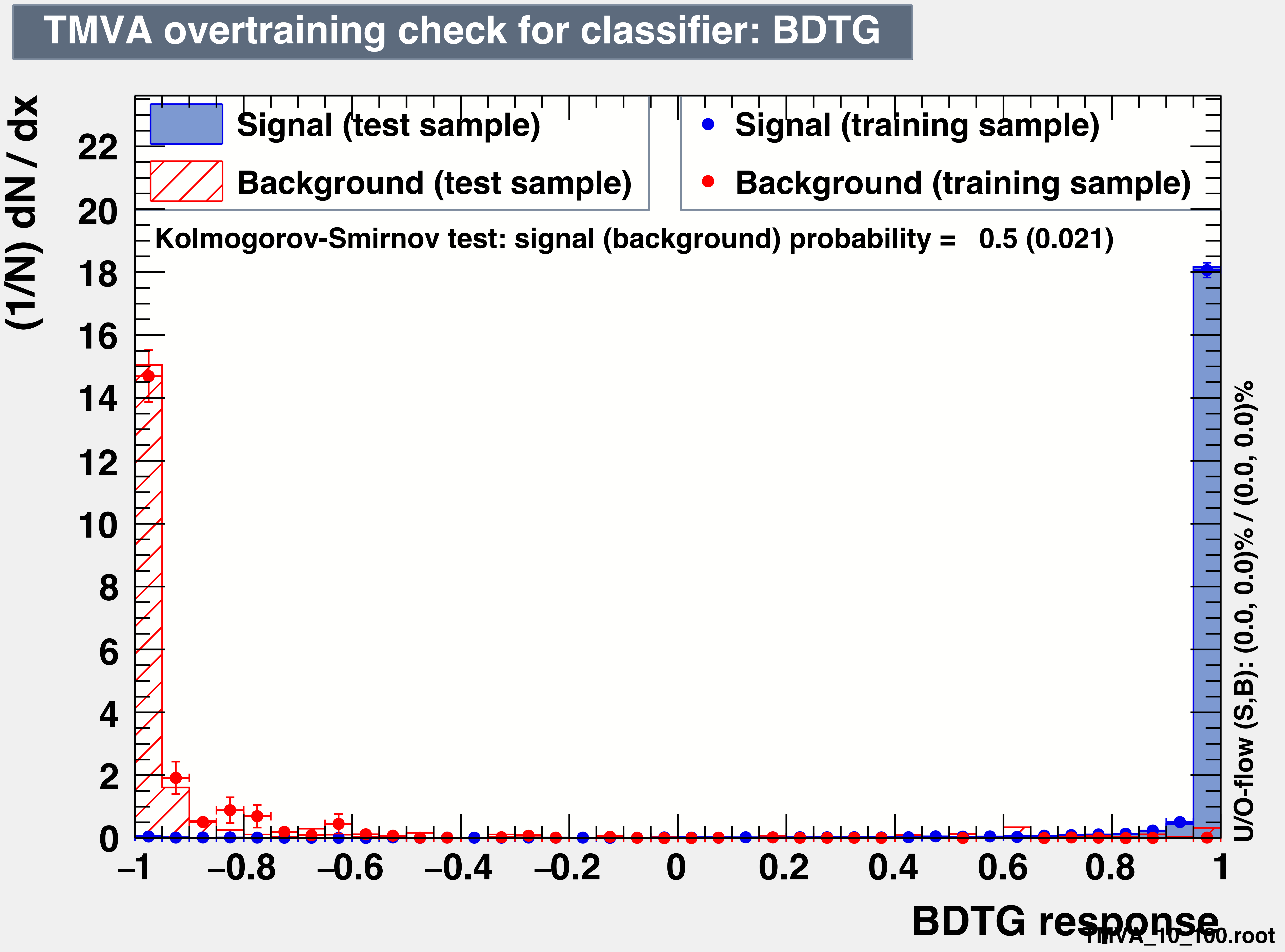

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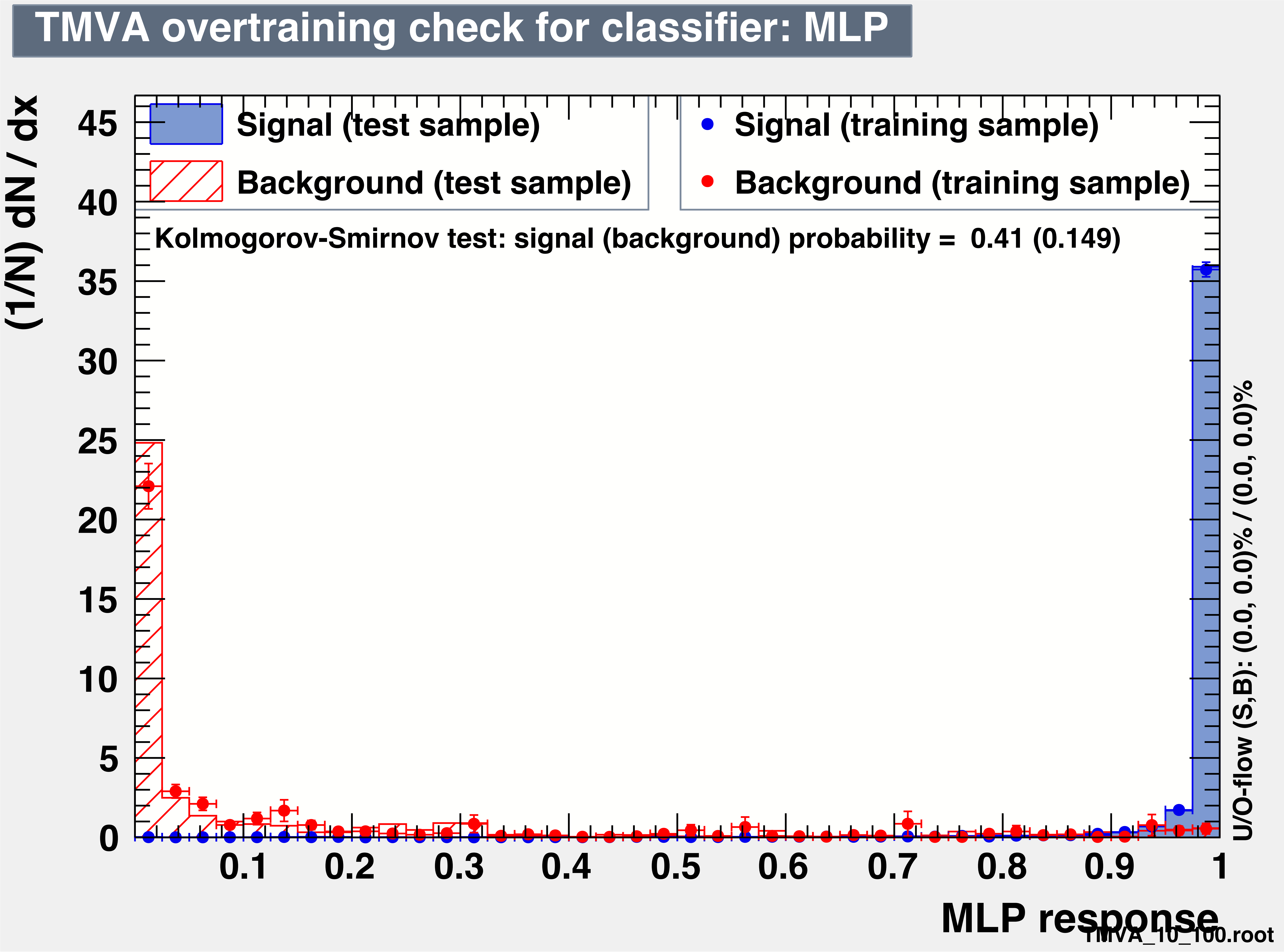

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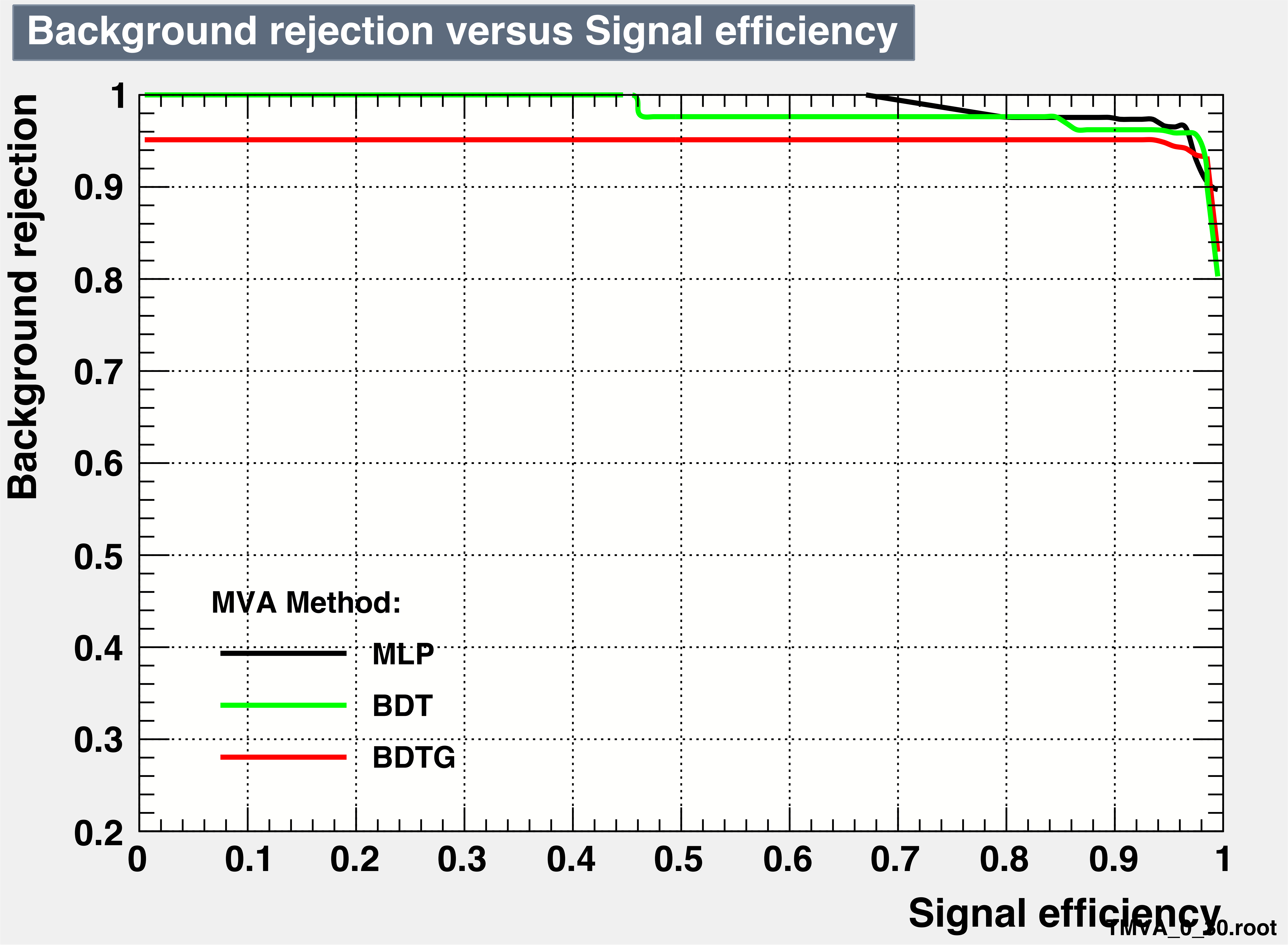
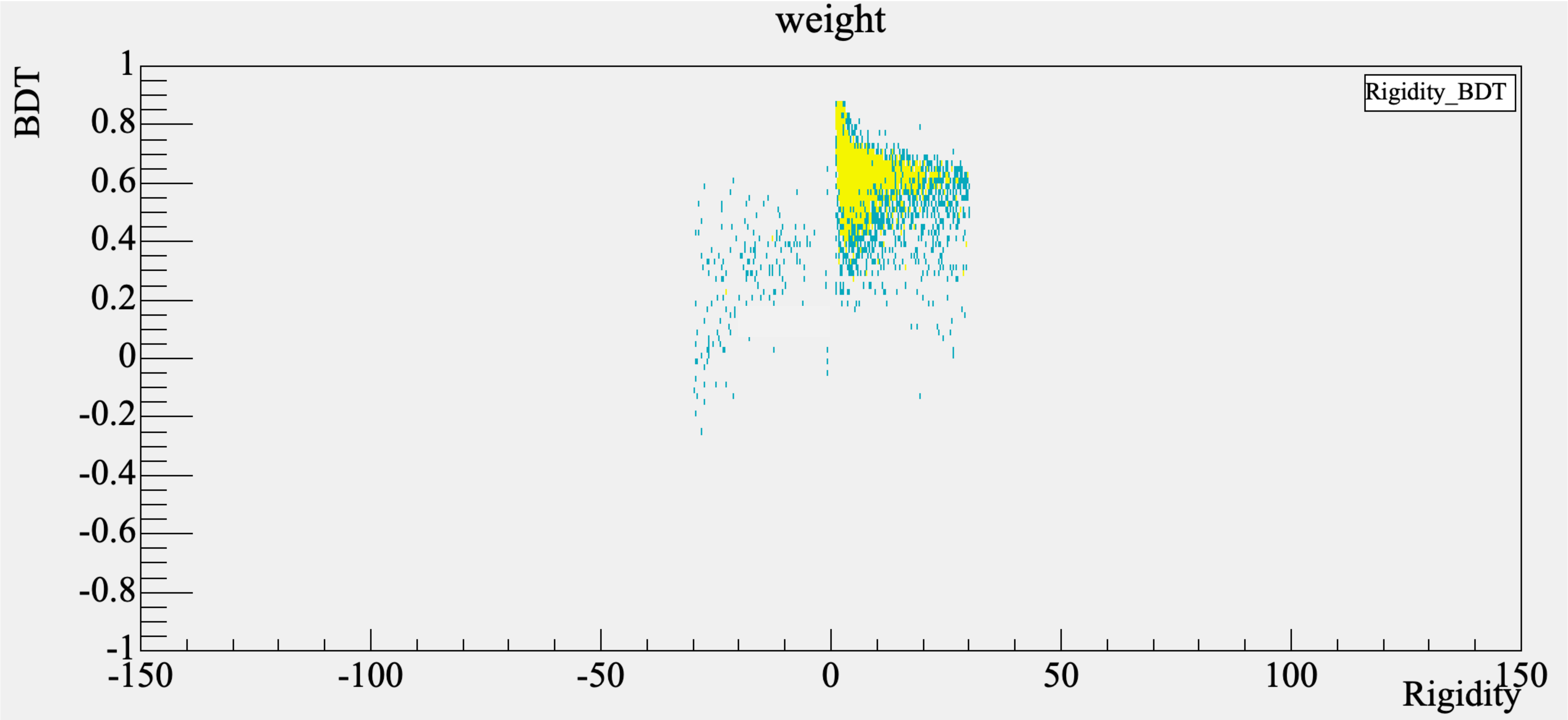


Apply the classifier to data



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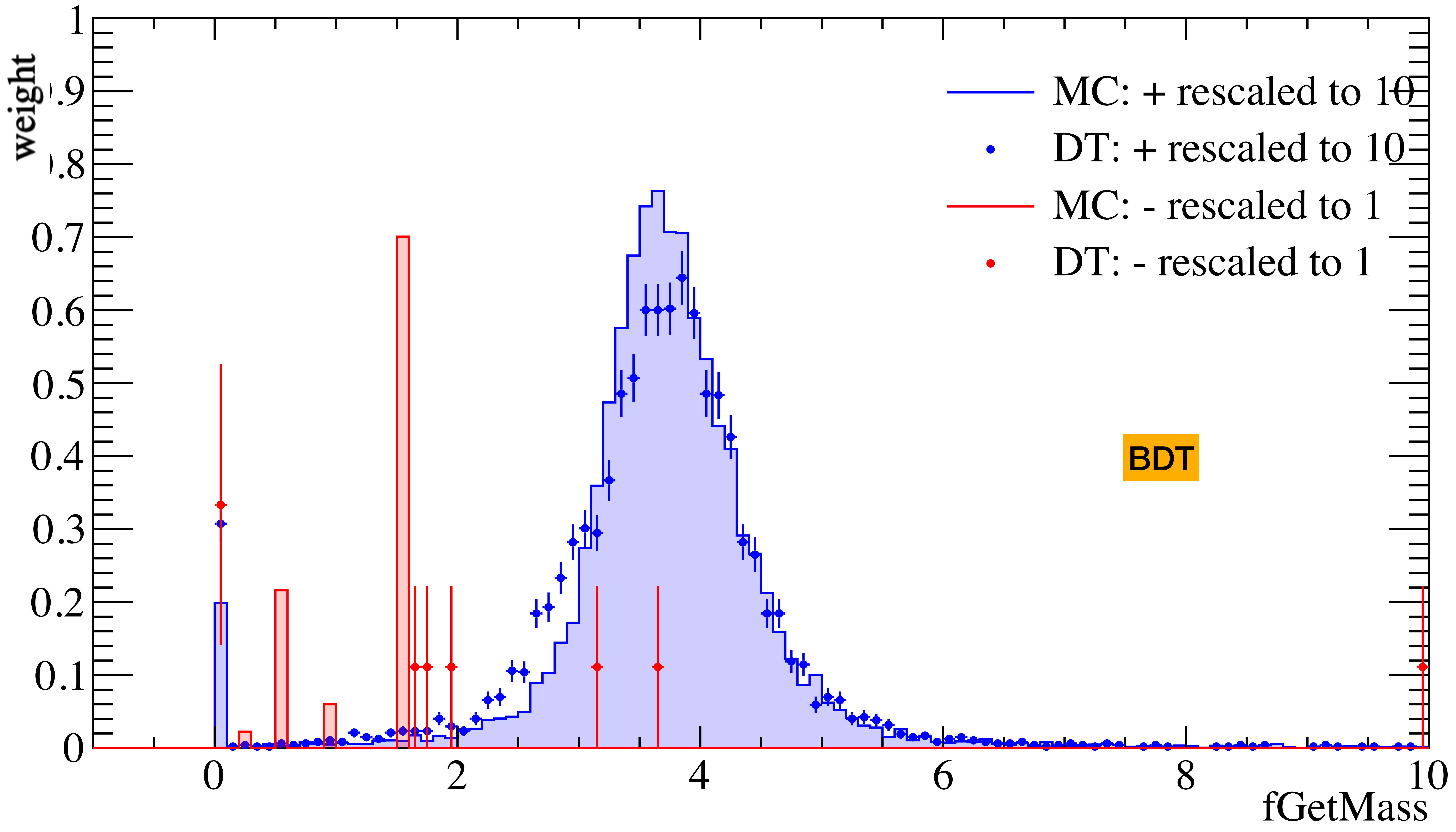

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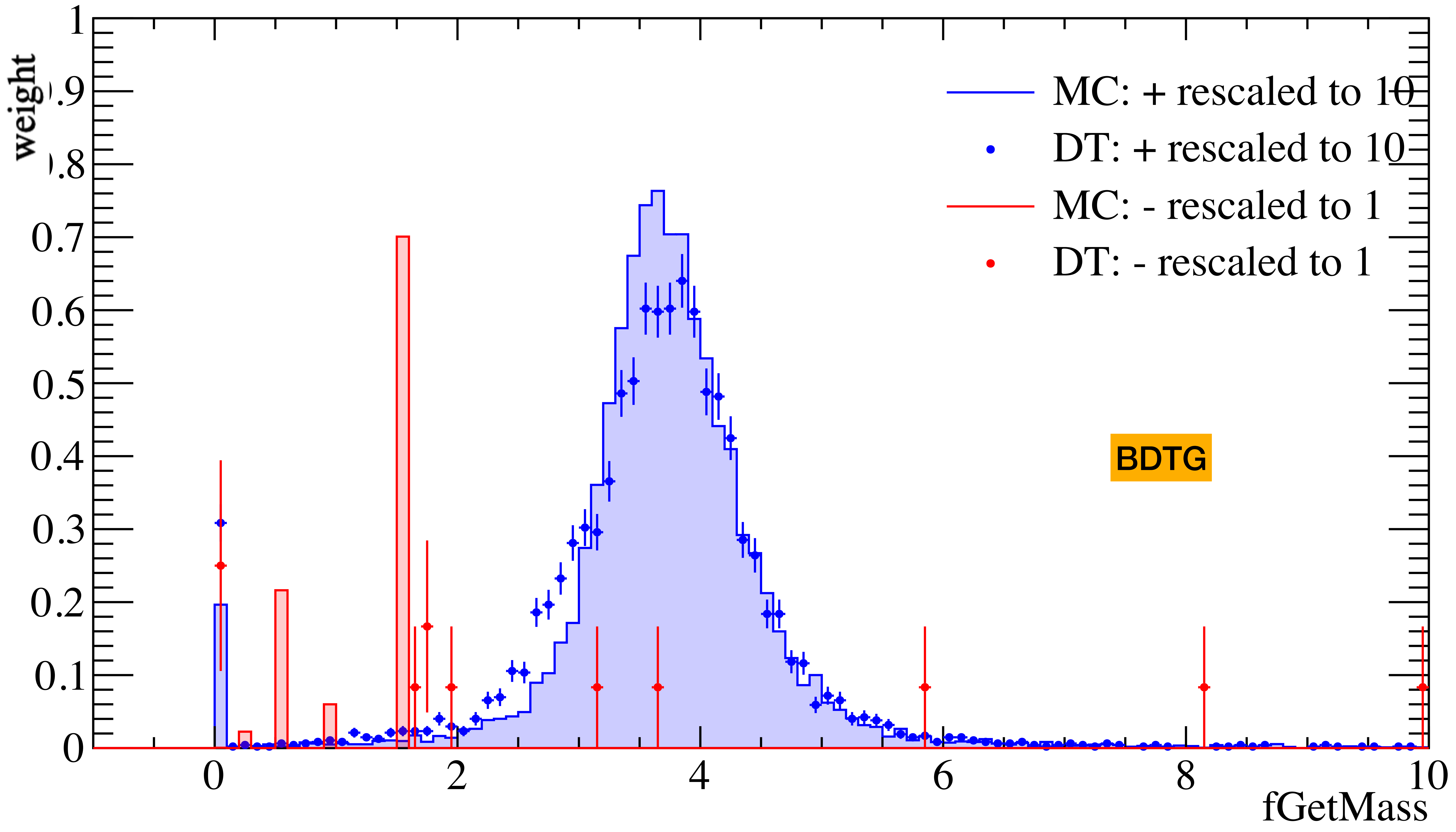

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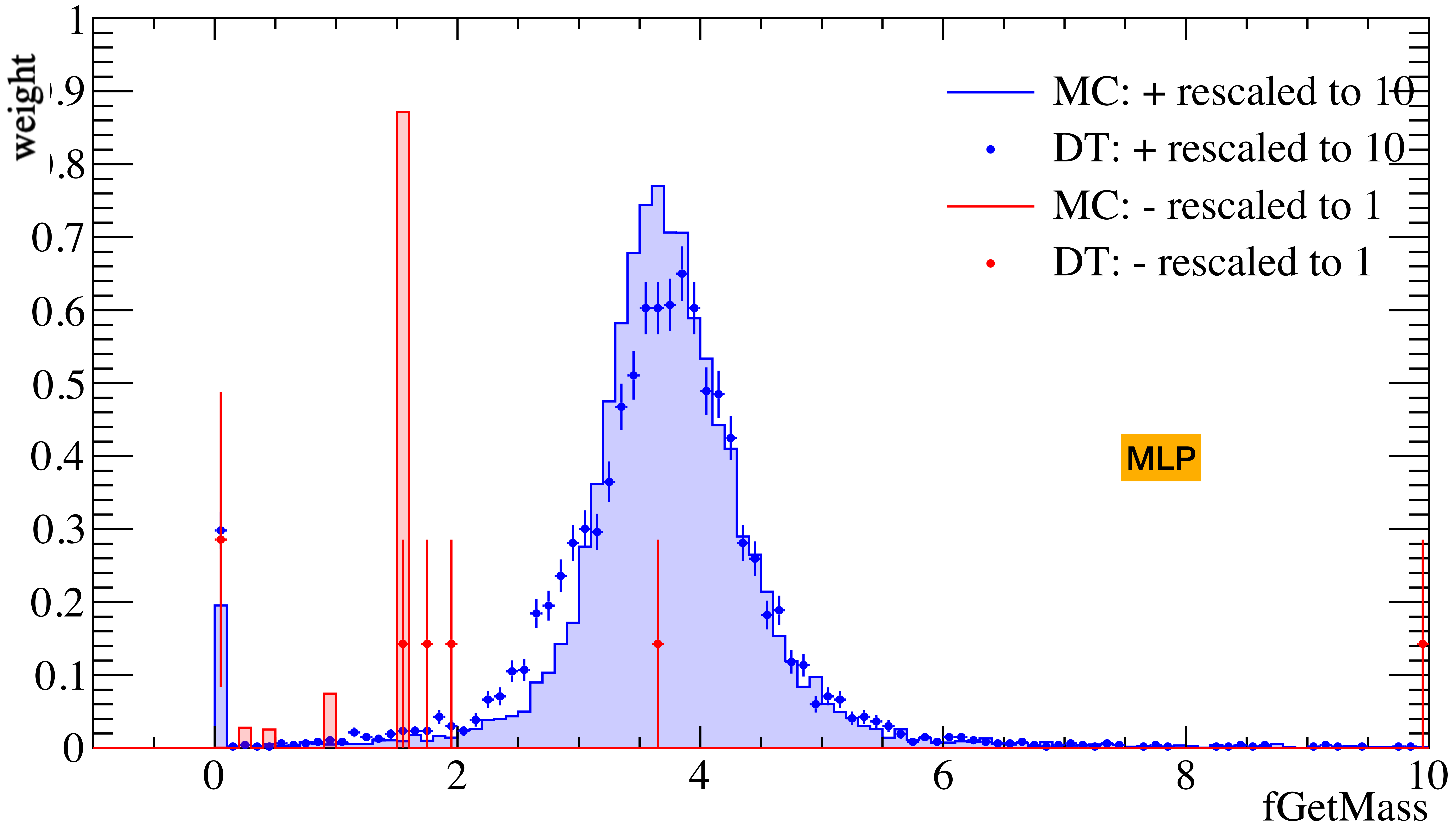

Conclusion:

Three TMVA Classifiers (BDT,BDTG,MLP) are studied in high rigidity and low rigidity region respectively.

NEXT: check the mass measurement.