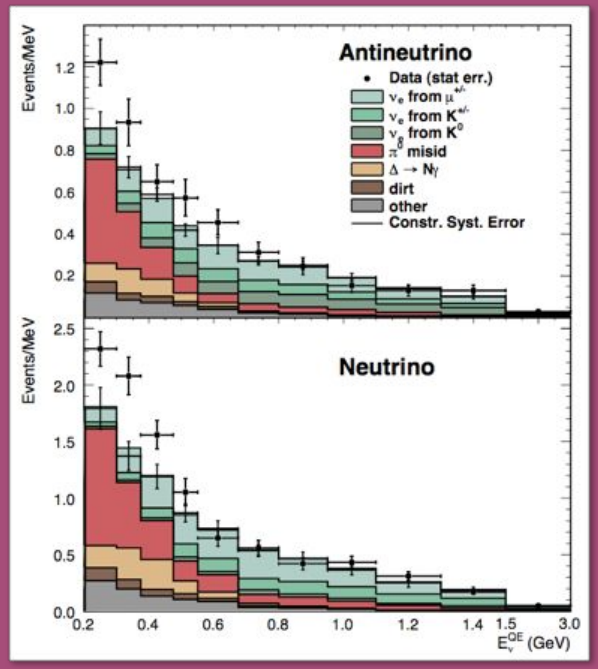
The LEE



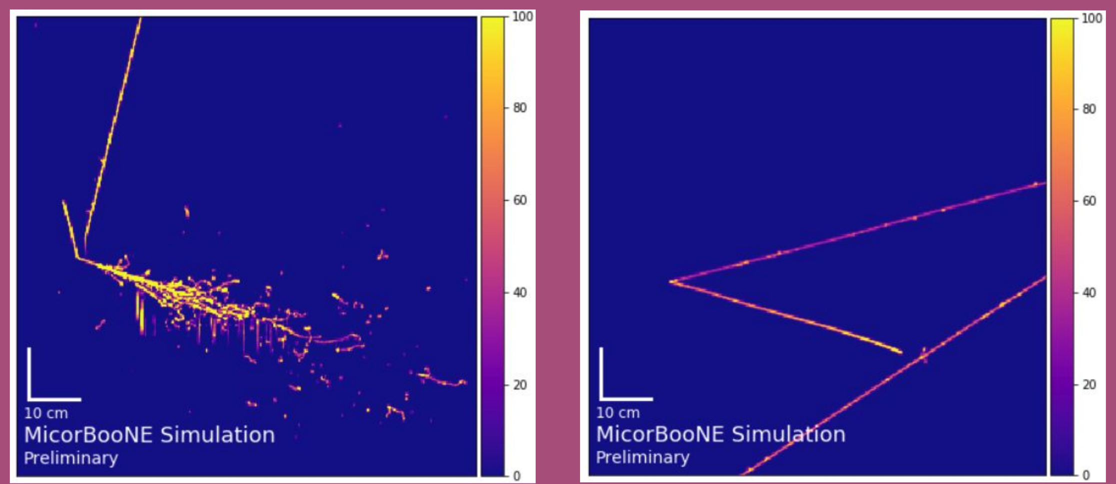
[1]

or **Low Energy Excess** is an anomalous excess of electron neutrinos and antineutrinos measured by the MiniBooNE collaboration on the Fermilab Booster Neutrino Beamline (BNB).[1]

MicroBooNE is a direct response to this anomaly.

When a neutrino event interacts with an argon atom inside the detector, the released final-state particles will travel through the detector, ionizing electrons along the way.

An electric field carries these electrons to an array of wire planes, showing us the paths taken by charged particles as images on three planes.



[2]

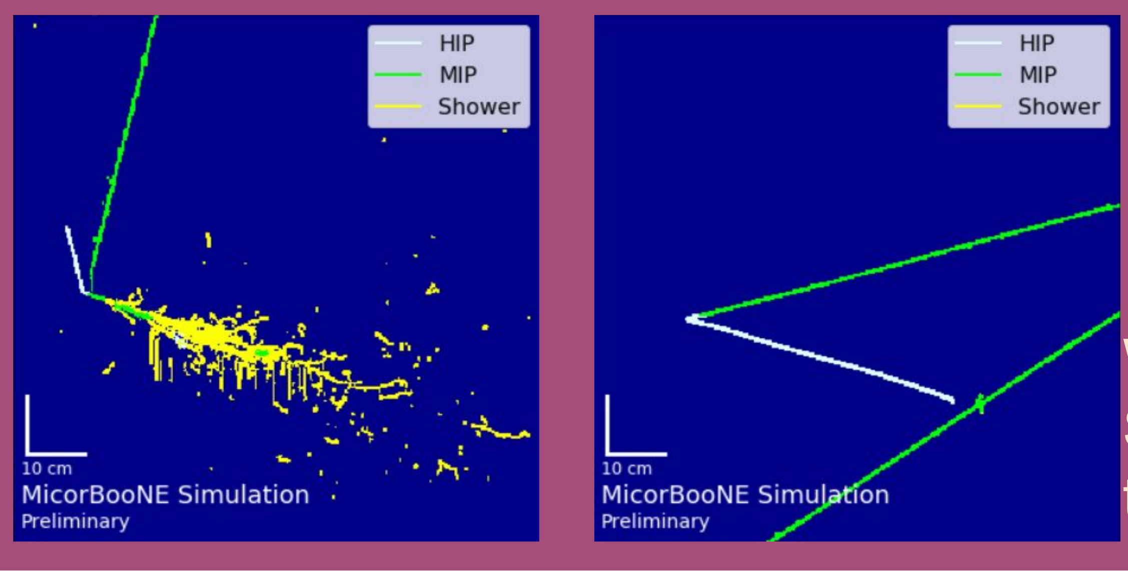
What the detector sees.

SSNets

are Semantic Segmentation Networks.

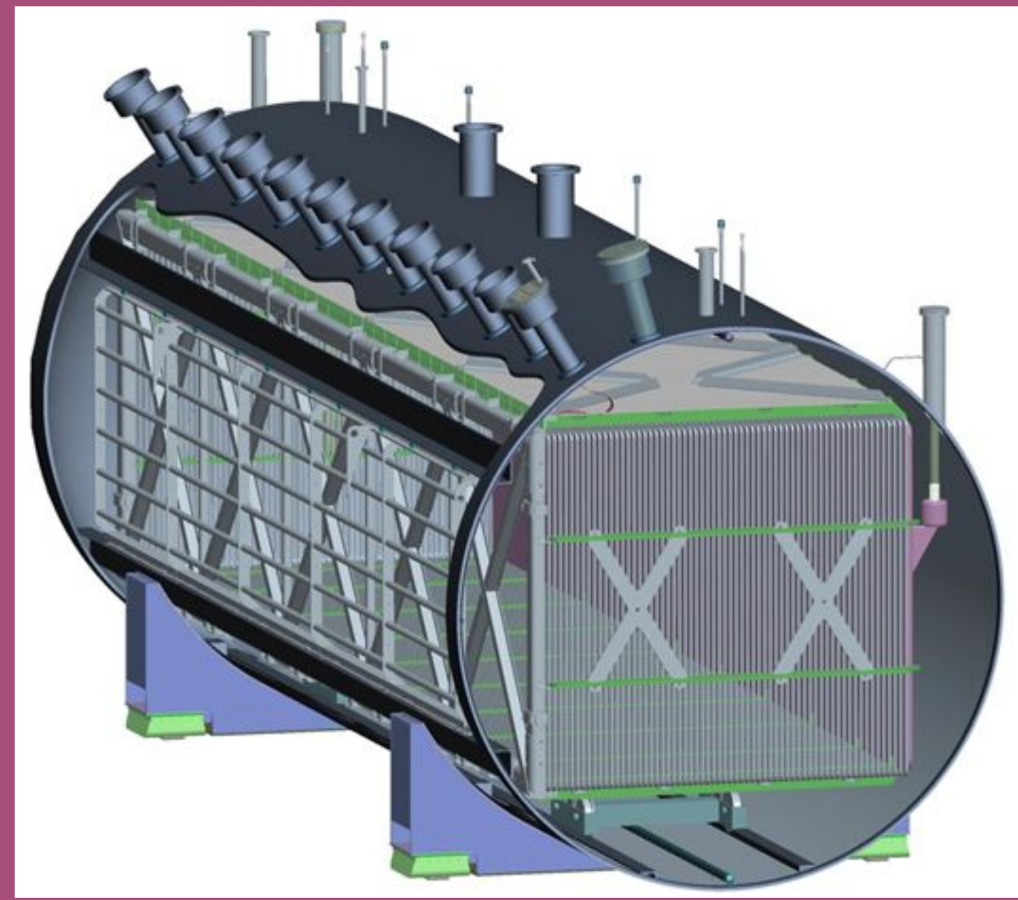
SSnets are trained on simulated images using deep learning technology to recognize patterns within each signature and perform visual identification of those signatures.

Our SSN tags each pixel in an image as **track-like** or **shower-like.**



[2]

What SSNet tells us.



The µBooNE Detector

is an 87 ton active volume Liquid Argon Time Projection Chamber (LArTPC) detector, located on the same beamline as MiniBooNE.

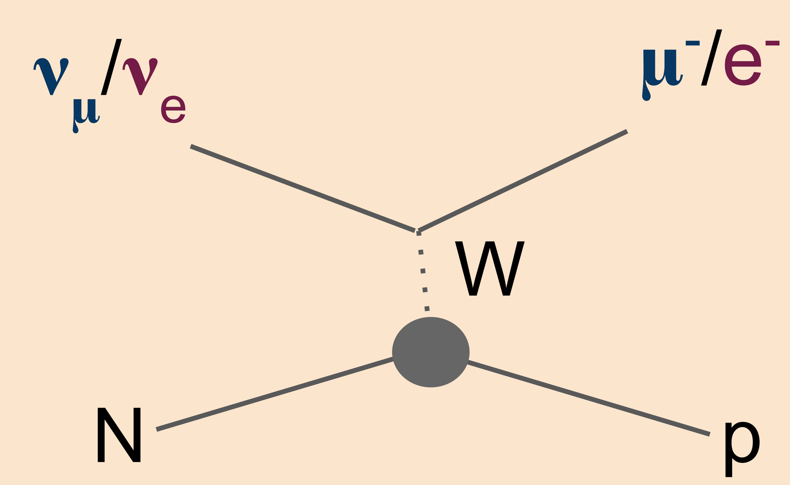
MicroBooNE will more finely resolve its predecessor's mysterious low energy excess.

But why ν_μ's? Wasn't the excess in ν_e's?

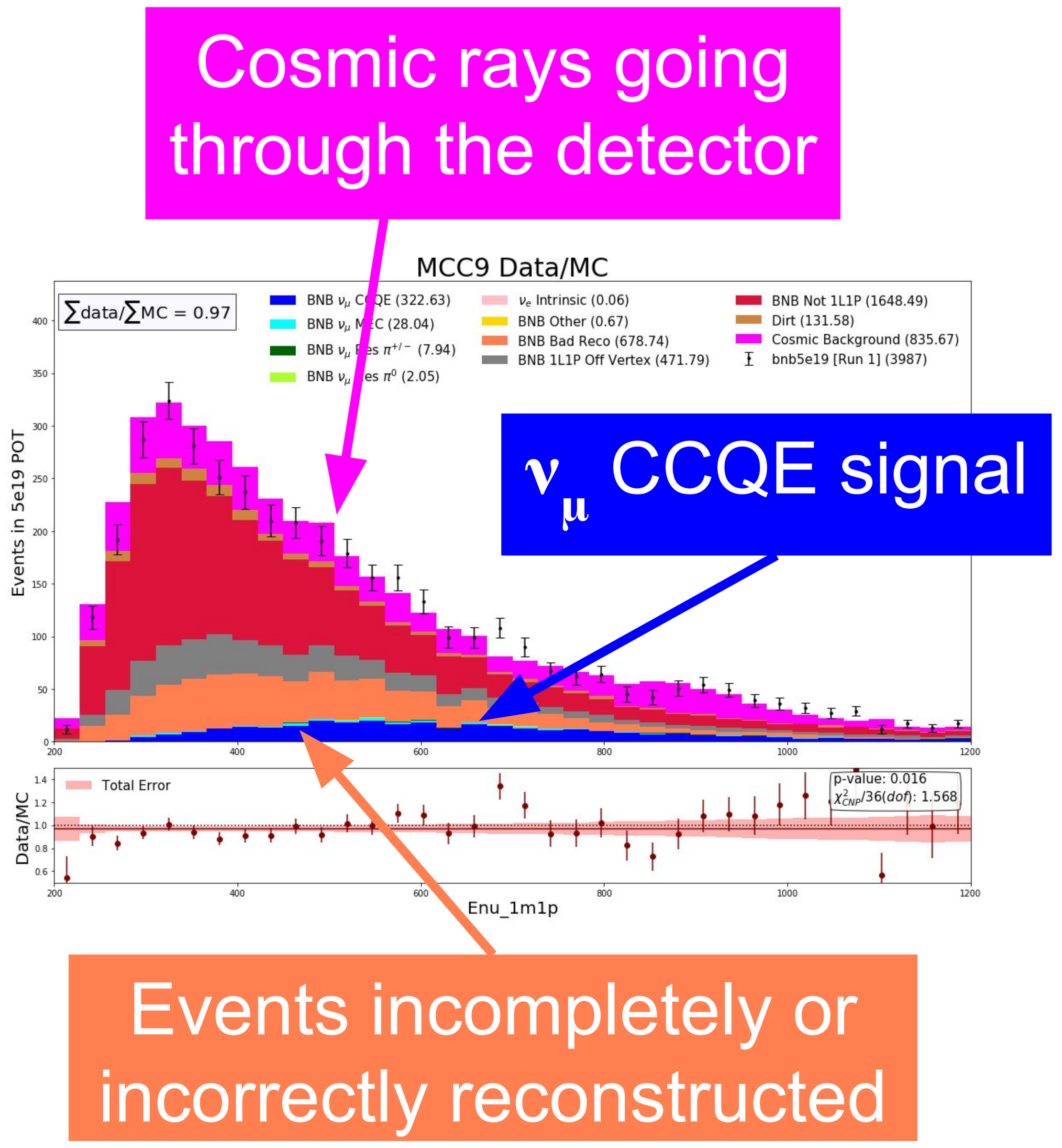
Yes! But since our beam comprises ~1% ν_e's , a high-purity, high efficiency measurement of ν_μ majority can provide **a powerful statistical constraint** on anything we want to say about the LEE.

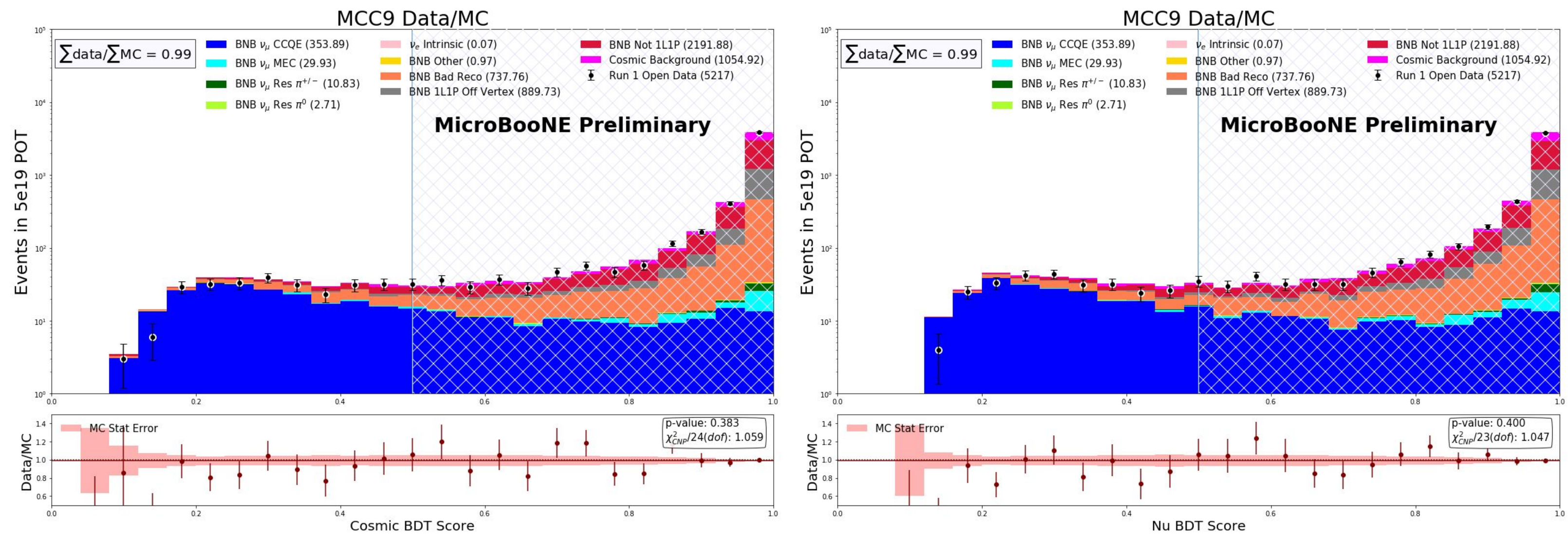
Our analysis is honed to pick out events with one muon and one proton in the final state, reflected best by a ν_μ charged-current, quasi-elastic (CCQE) interaction.

CCQE interactions for both electron and muon neutrinos are highly correlated, sharing the same **flux parentage** and **cross section**.



Our main backgrounds are:

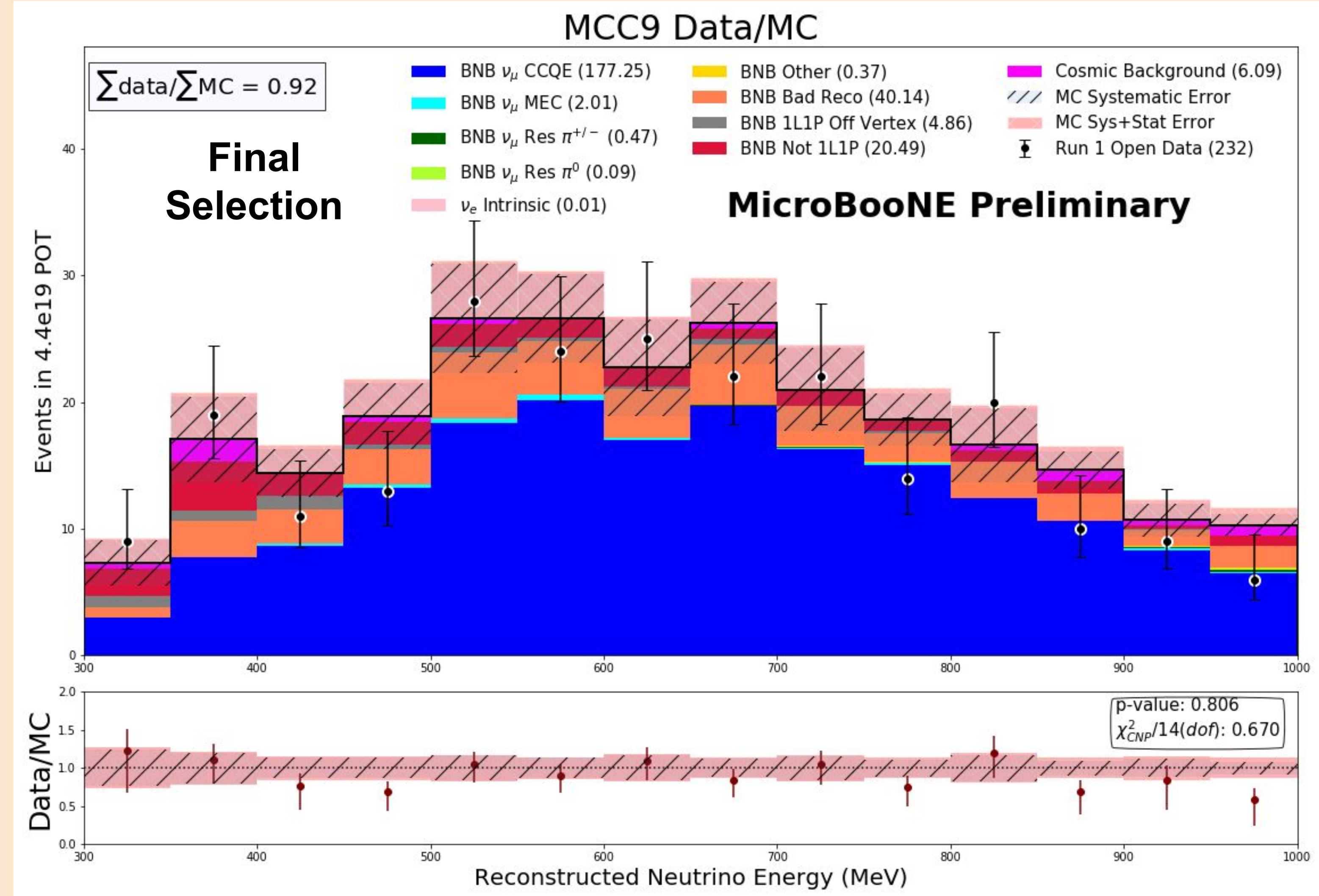




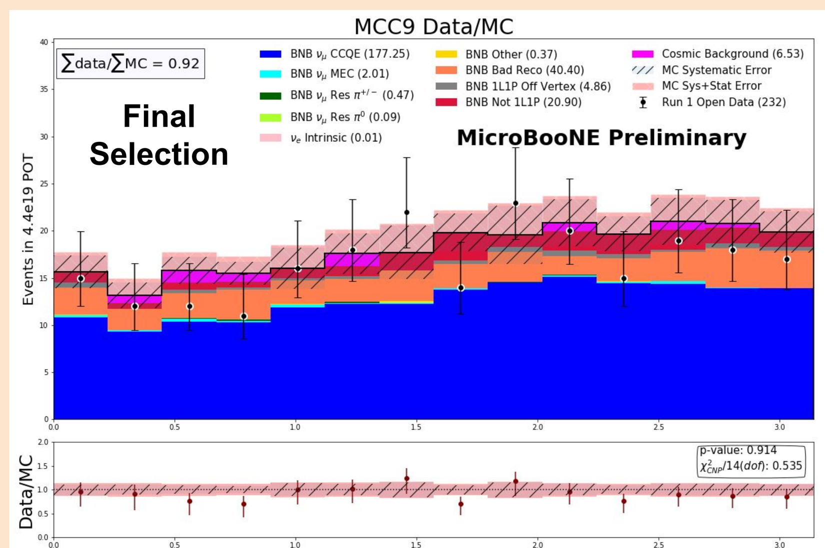
A boosted decision tree (BDT) is trained by looking at a big list of variables for a test sample of our **signal** and one from each background.

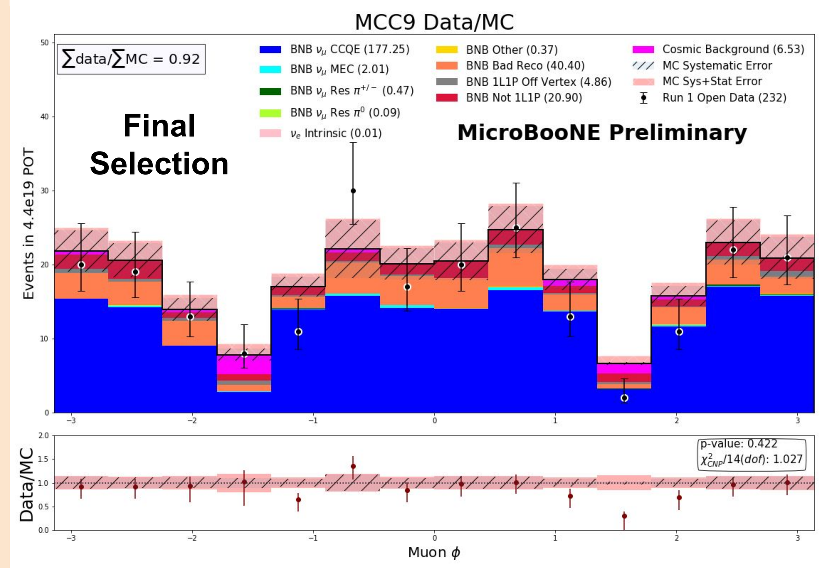
The BDT can then predict how signal-like or background-like any given event is.

Our final selection is made by placing cuts on these BDT predictions.



After selection, and accounting for flux, cross section, and detector systematic effects, we eliminate all but 2% of our major backgrounds. In our full data sample of 10.1e20 POT, we predict to see over 4k ν_μ events!





MicroBooNE can select a 70% **pure** sample of our ν_μ CCQE signal with:

- High statistics
- 2% cosmic background
- High agreement of data to predicted events

In the coming months, this will be combined with a selection of ν_e CCQE events to constrain our measurement of the LEE.

Selection Of Muon Neutrinos for the MicroBooNE Deep-Learning-based Low Energy Excess Search

For more details, see MicroBooNE Public Note 1086!

Davio Cianci on behalf of the MicroBooNE Collaboration

Nevis Labs, Columbia University

Refs 1: *Phys. Rev. Lett. 110, 161801 (2013)*
2: *MicroBooNE Public Note 1091*