

Rare Neutrino Interaction and π^0 Production Cross Sections with MicroBooNE

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The University of Manchester

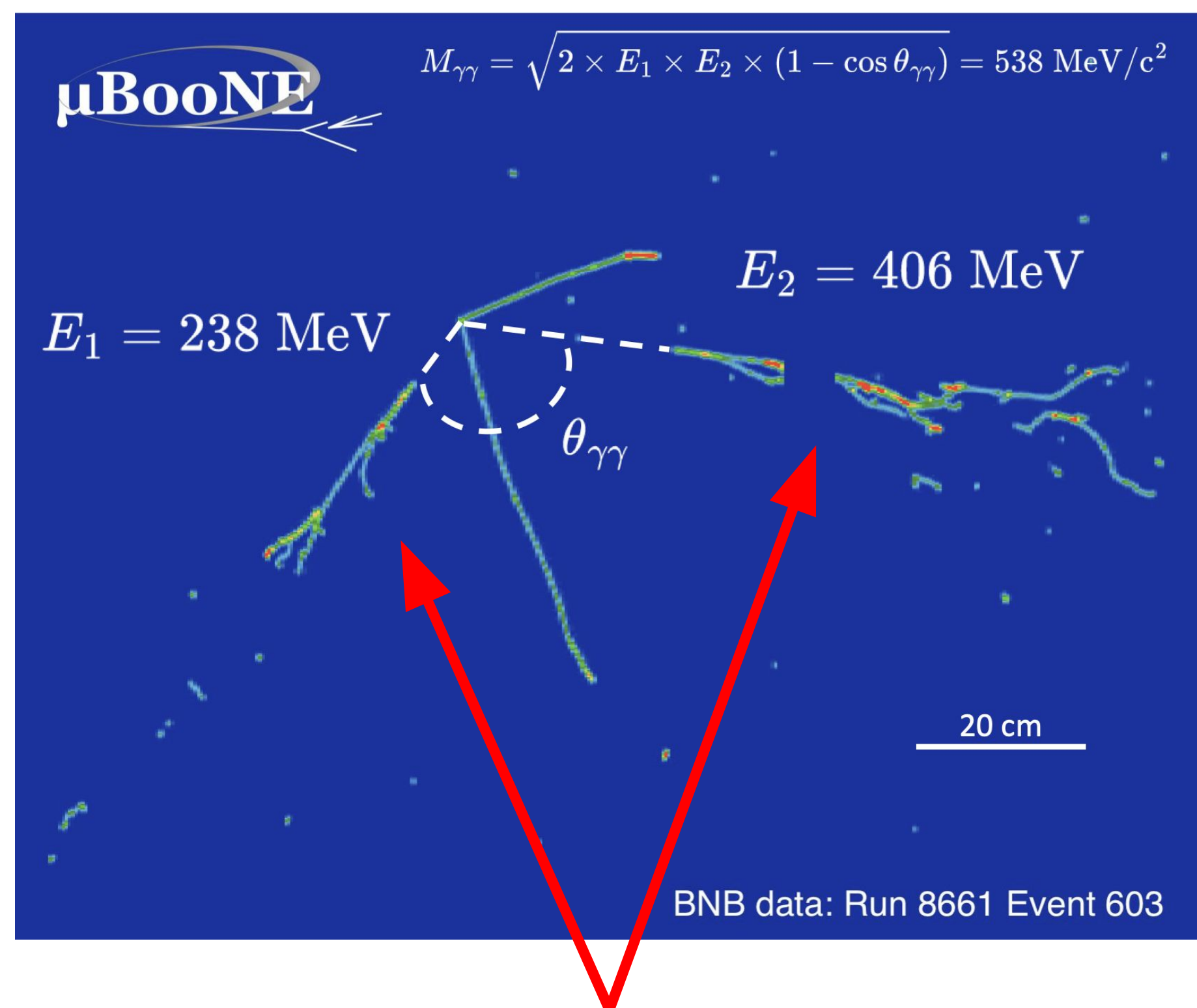
η Mesons

Search for interactions of the type:

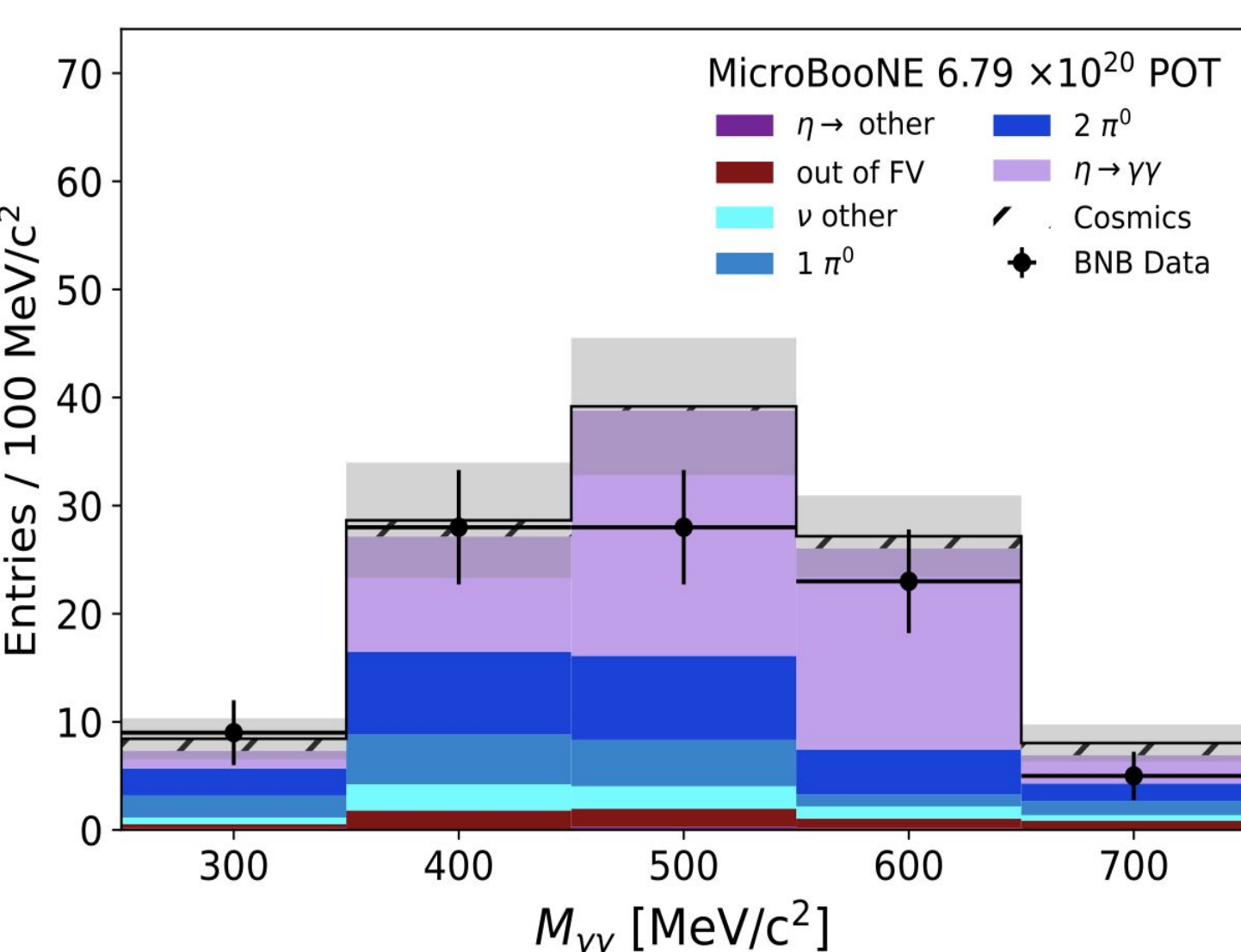
$$\nu + \text{Ar} \rightarrow \eta + 0\pi^0 + X$$

X denotes any other final state hadrons or leptons.

These interactions are a **background to proton decay** measurements [1] and a valuable **probe of resonances** above the Δ (1232).



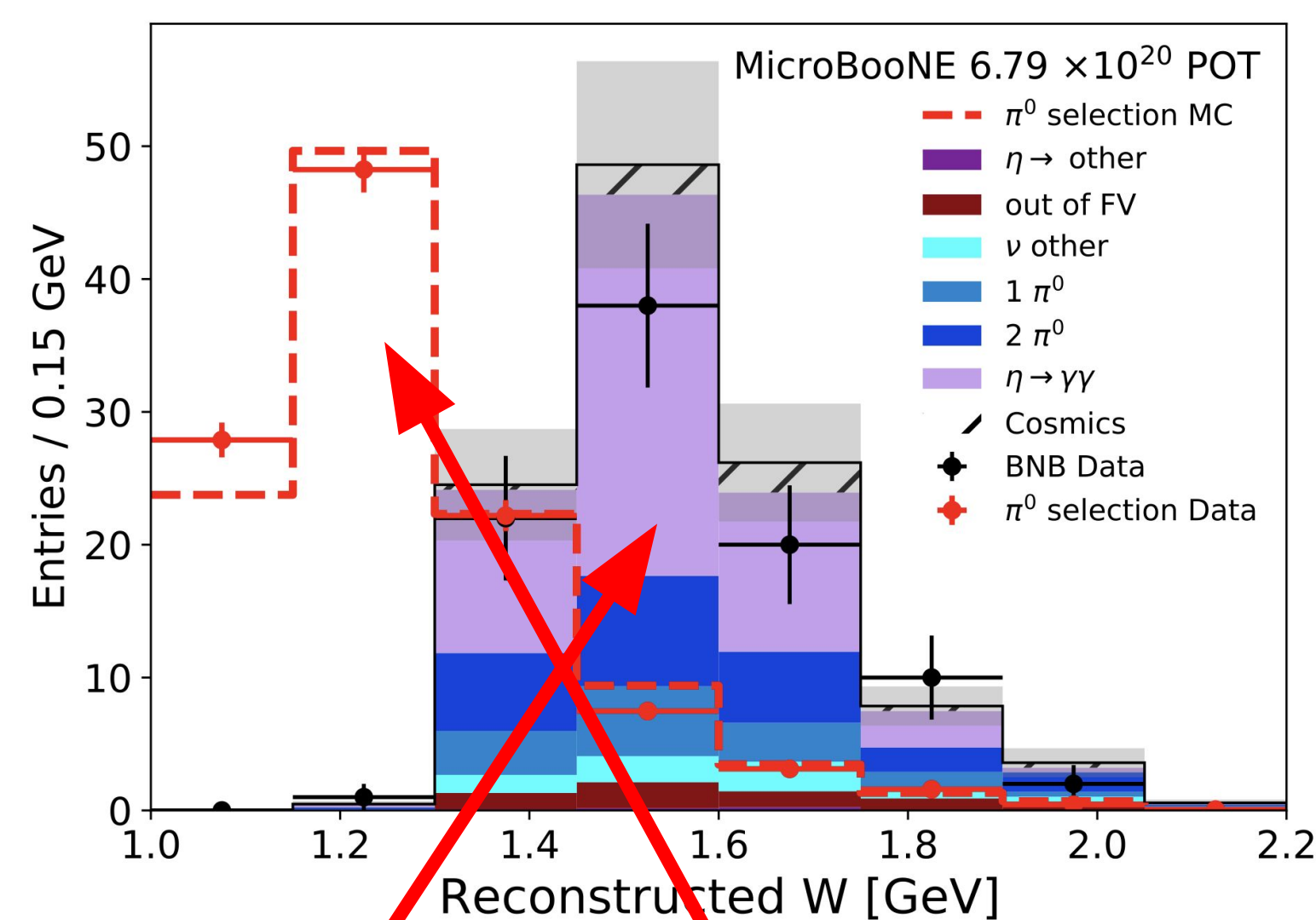
Select by identifying two showers with calorimetry consistent with two photons with large combined invariant mass.



$\gamma\gamma$ invariant mass peak shape consistent with prediction.

Extracted cross section:

$$3.22 \pm 1.20 \times 10^{-41} \text{ cm}^2/\text{nucleon}$$



Hadronic invariant mass from η selection versus π^0 selection. Separate $\Delta(1232)$ and $N(1530)$ peaks - see resonance structure.

See [Phys. Rev. Lett. 132 \(2024\) 15 151801](#) for more information!

Pion Production

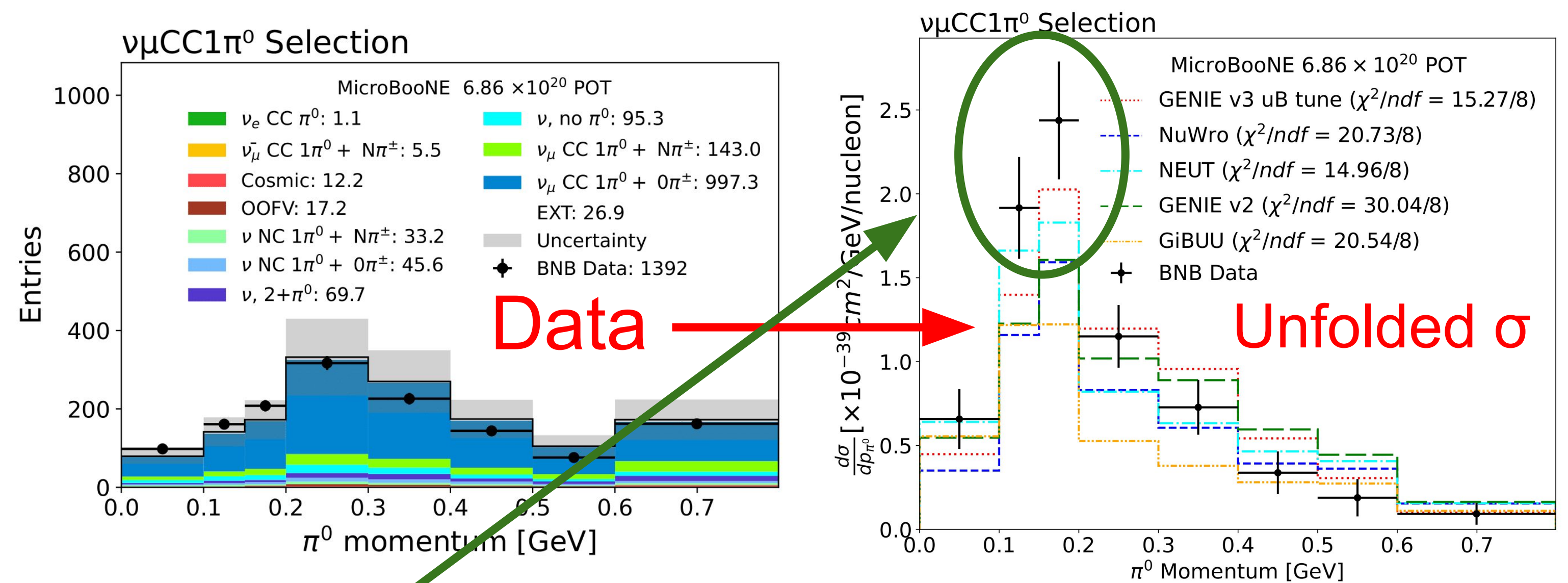
Search for interactions of the type:

$$\nu_\mu + \text{Ar} \rightarrow \mu^- + \pi^0 + X$$

$$\nu_l + \text{Ar} \rightarrow \nu_l + \pi^0 + X$$

Among the dominant sources of background in ν_e measurements, searches for BSM particles in neutrino detectors. Tool for studying resonance region.

Measure differential cross section as function of several variables. Obtain cross section through Wiener-SVD method [3], compare with generators.



Overprediction in NC channels and underprediction in CC channel.

See [arXiv:2404.09949](#) and [arXiv:2404.10948](#).

Λ Baryons

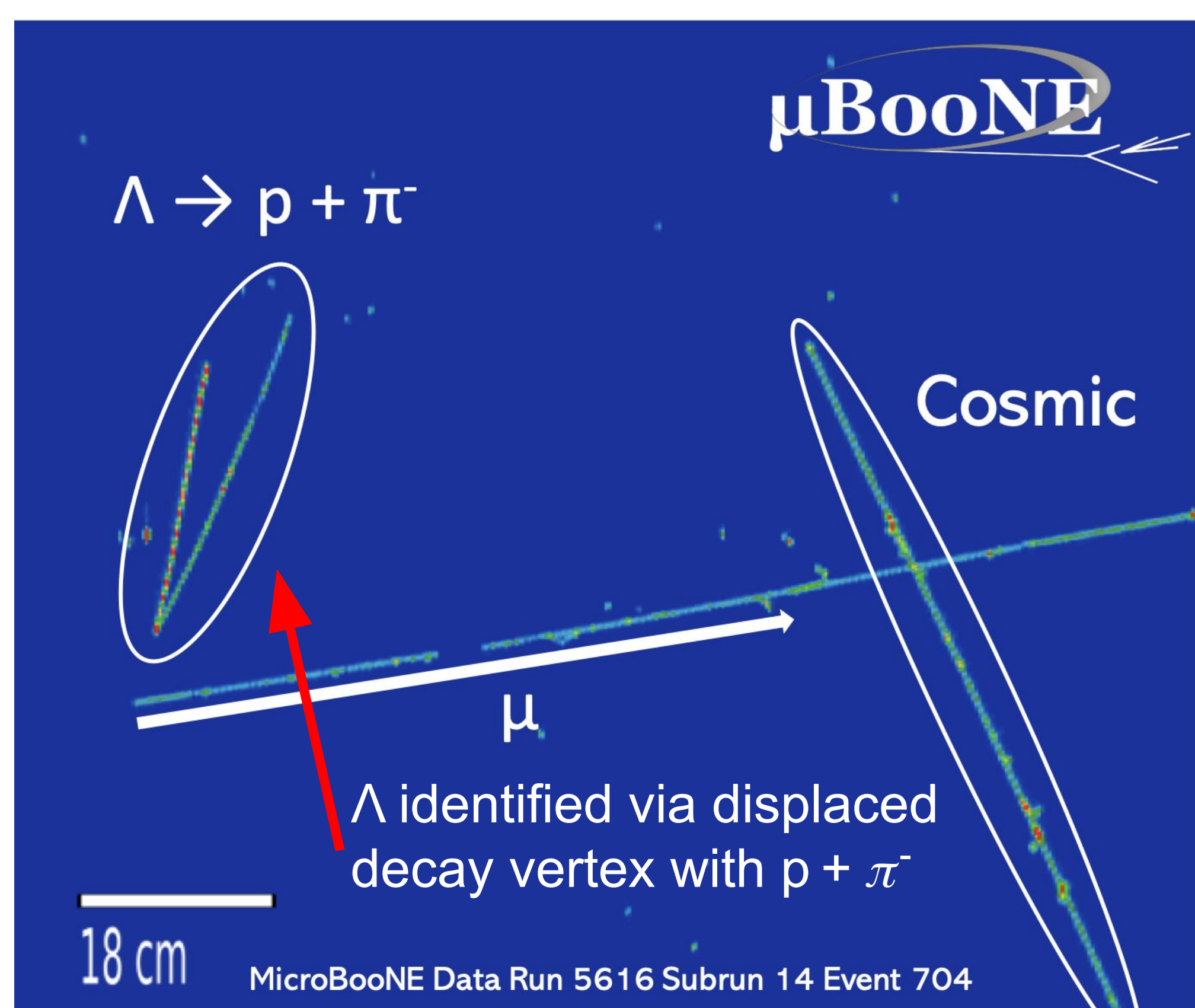
Search for interactions of the type:

$$\bar{\nu}_\mu + \text{Ar} \rightarrow \mu^+ + \Lambda + 0K + X$$

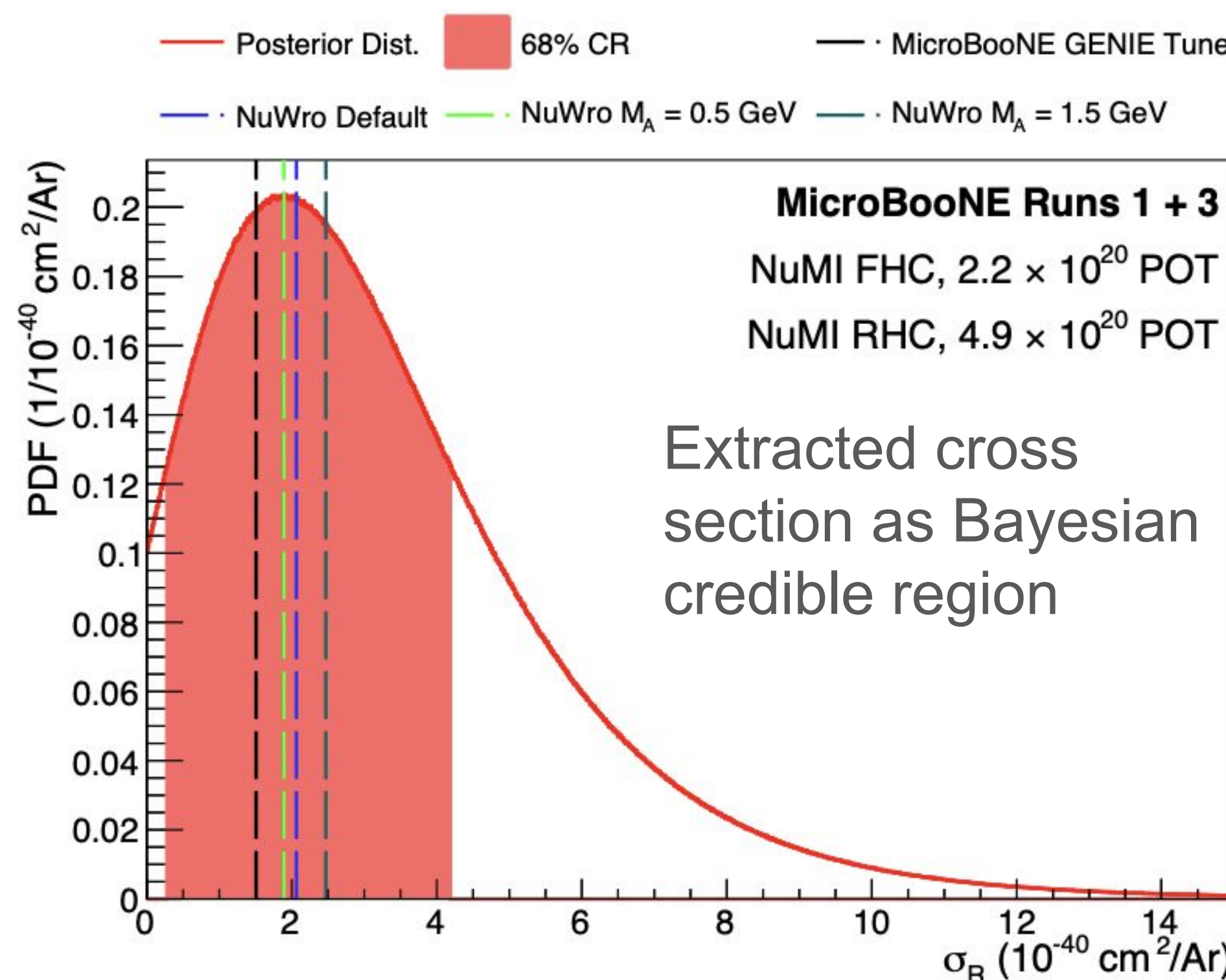
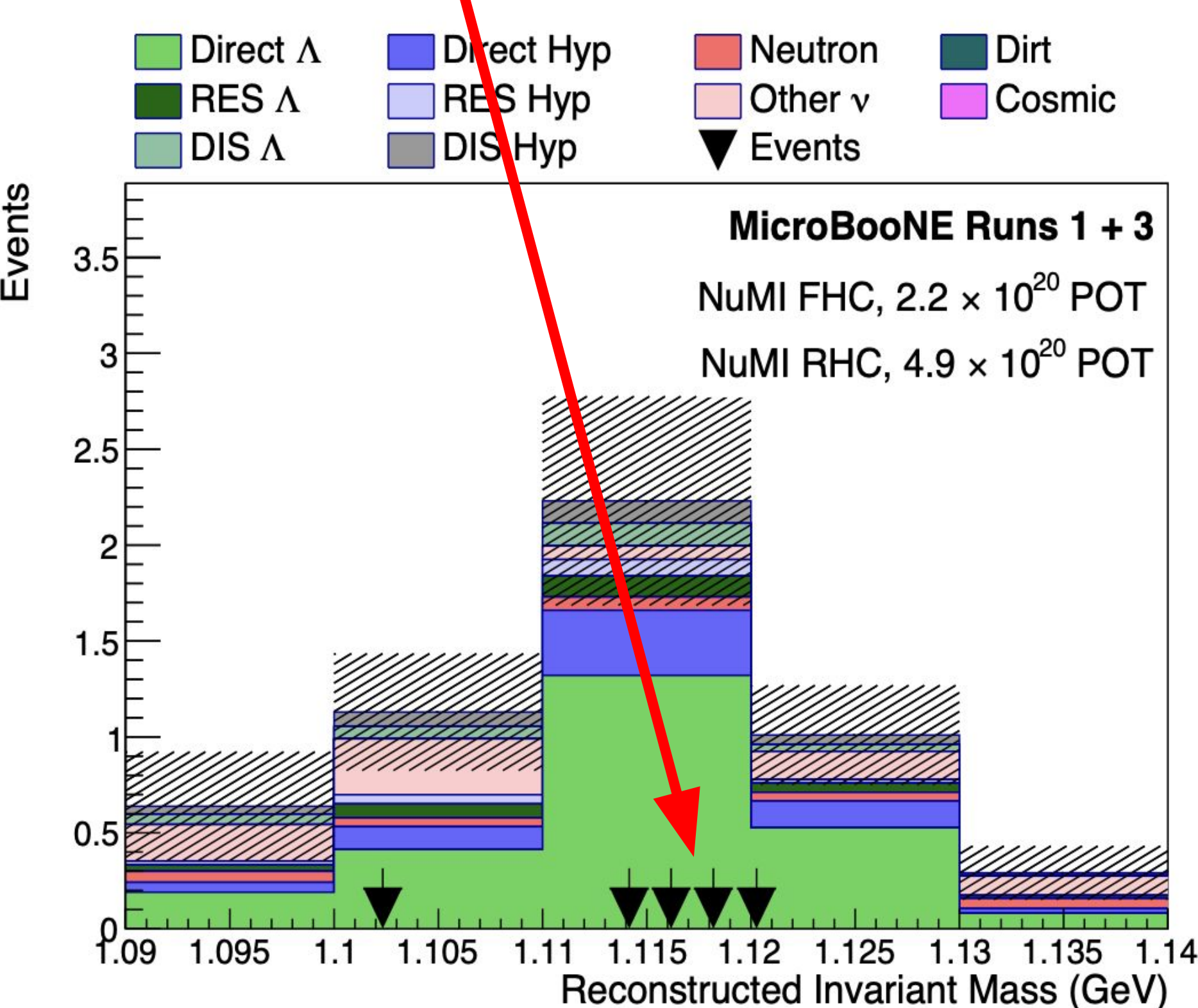
Hyperon production is one of the **least understood neutrino interactions**.

Measurements of Λ and Σ production channels can **disentangle final state interactions from other effects** [2].

Simulation predicts 34 candidates prior to selection against $\sim 10^6$ background events. Selection reduces background to O(1) event. After selection, find 5 Λ candidates in data.

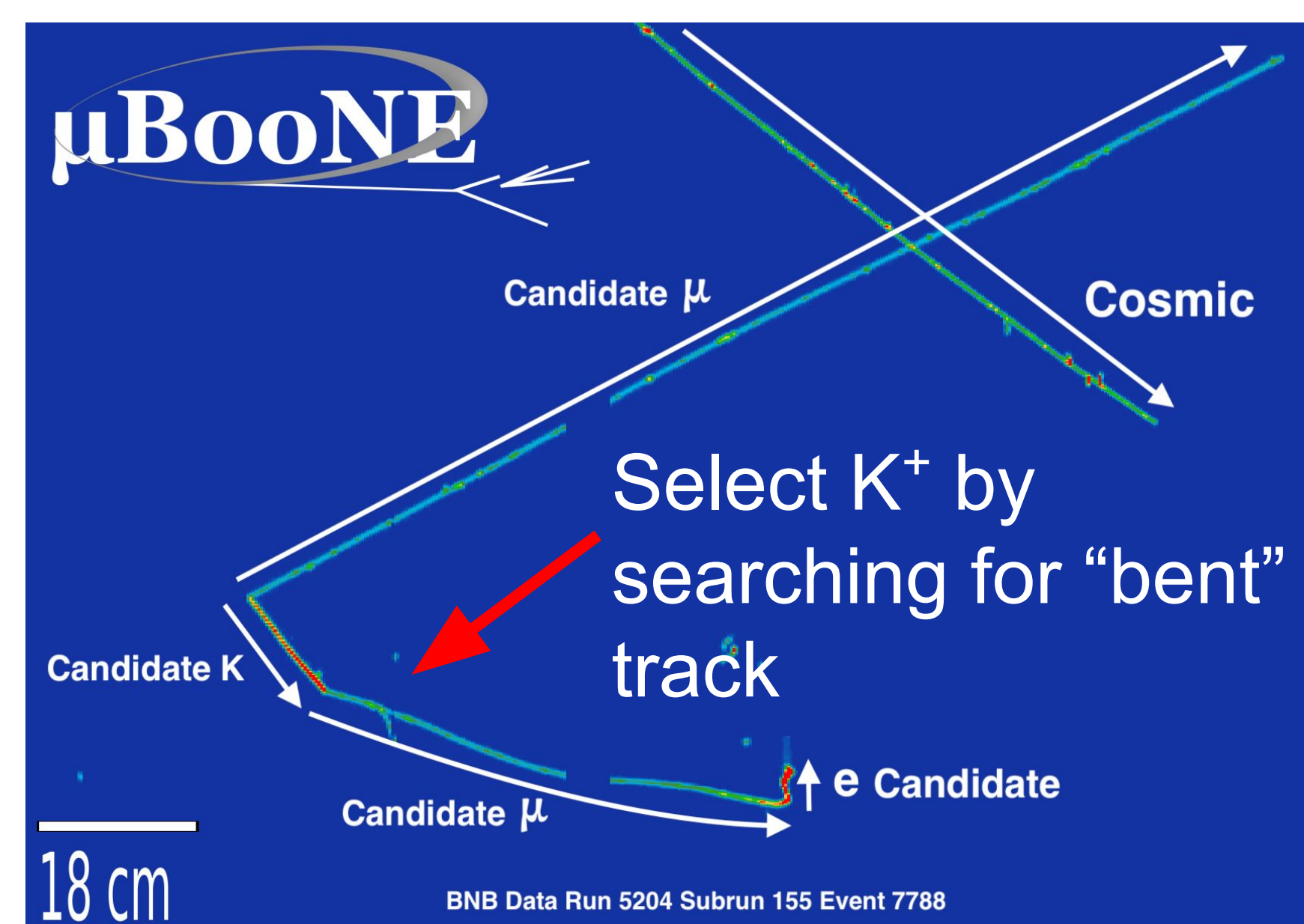


See [Phys. Rev. Lett. 130 \(2023\) 23 231802](#).

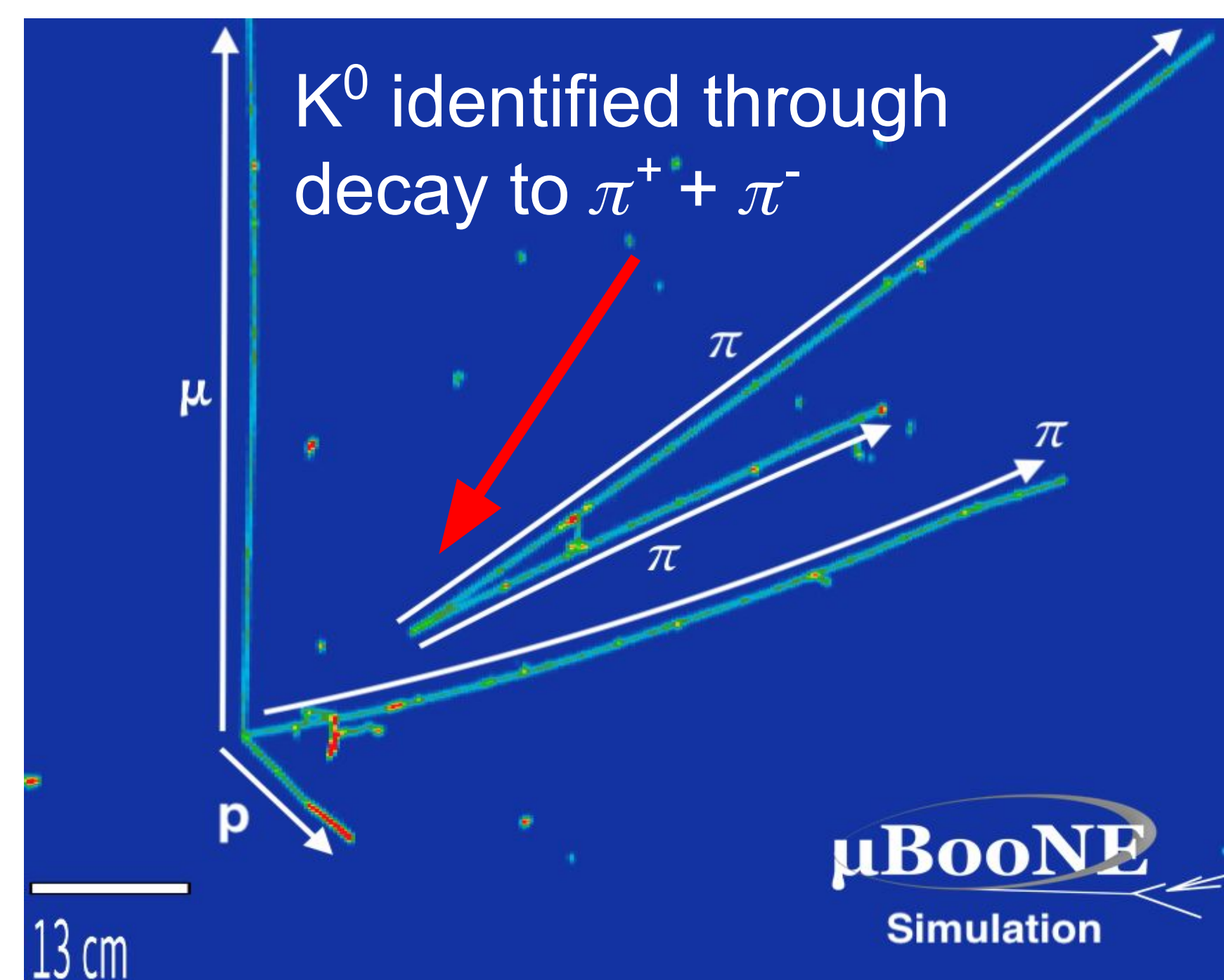


In Development

K^+ Production: $\nu_\mu + \text{Ar} \rightarrow \mu^- + K^+ + X$



K^0 -Short Production: $\nu_\mu + \text{Ar} \rightarrow \mu + K_S^0 + X$



Both dangerous sources of background in proton decay measurements.

[1] [arXiv:1705.07221](#).
[2] [Phys. Rev. C 104 \(2021\) 035502](#).
[3] [JINST. 12, P10002 \(2017\)](#).