Updated NC Delta Radiative Single Photon LEE Analysis From MicroBooNE

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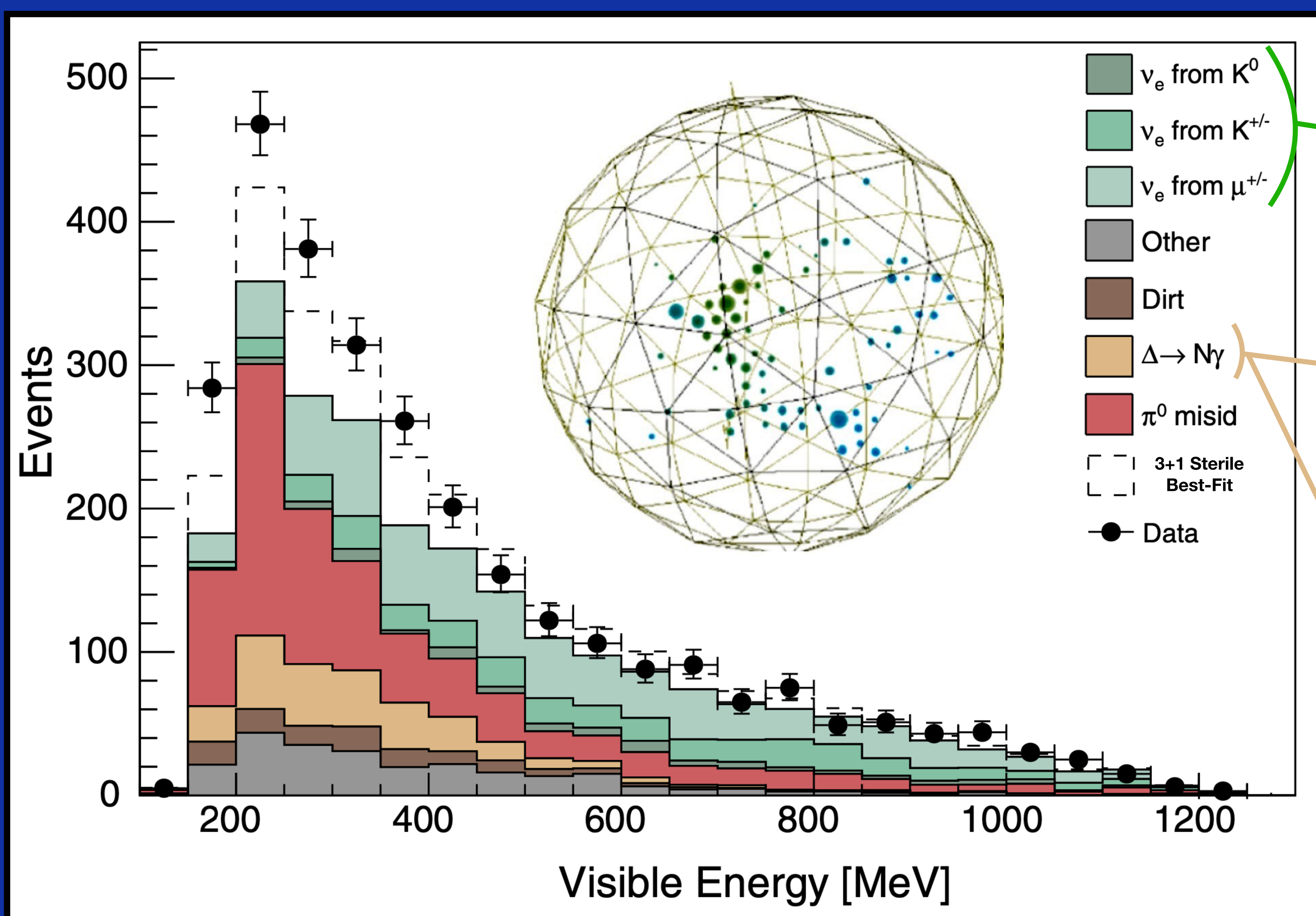
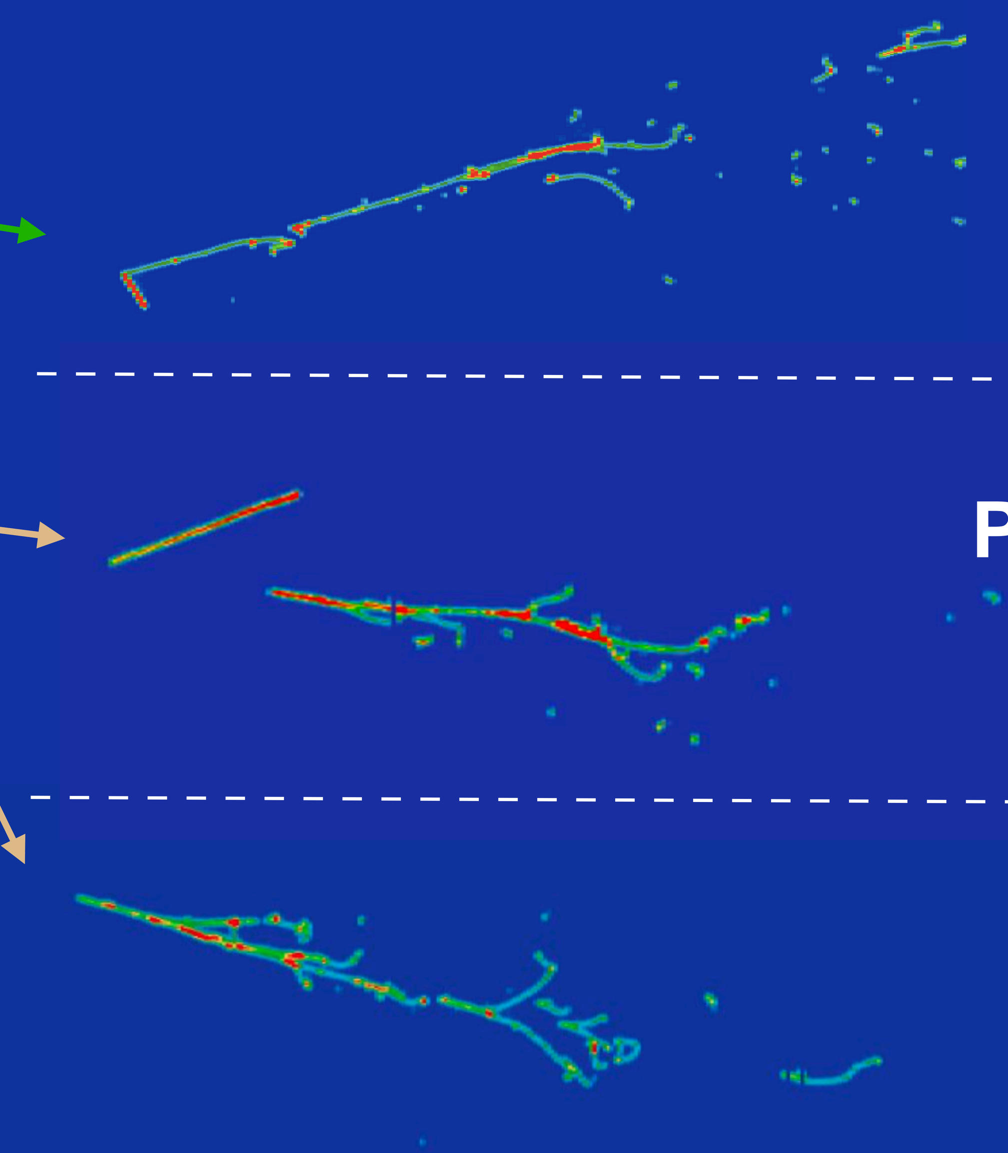
MiniBooNE Saw A Big Excess! [1]



What Was It?

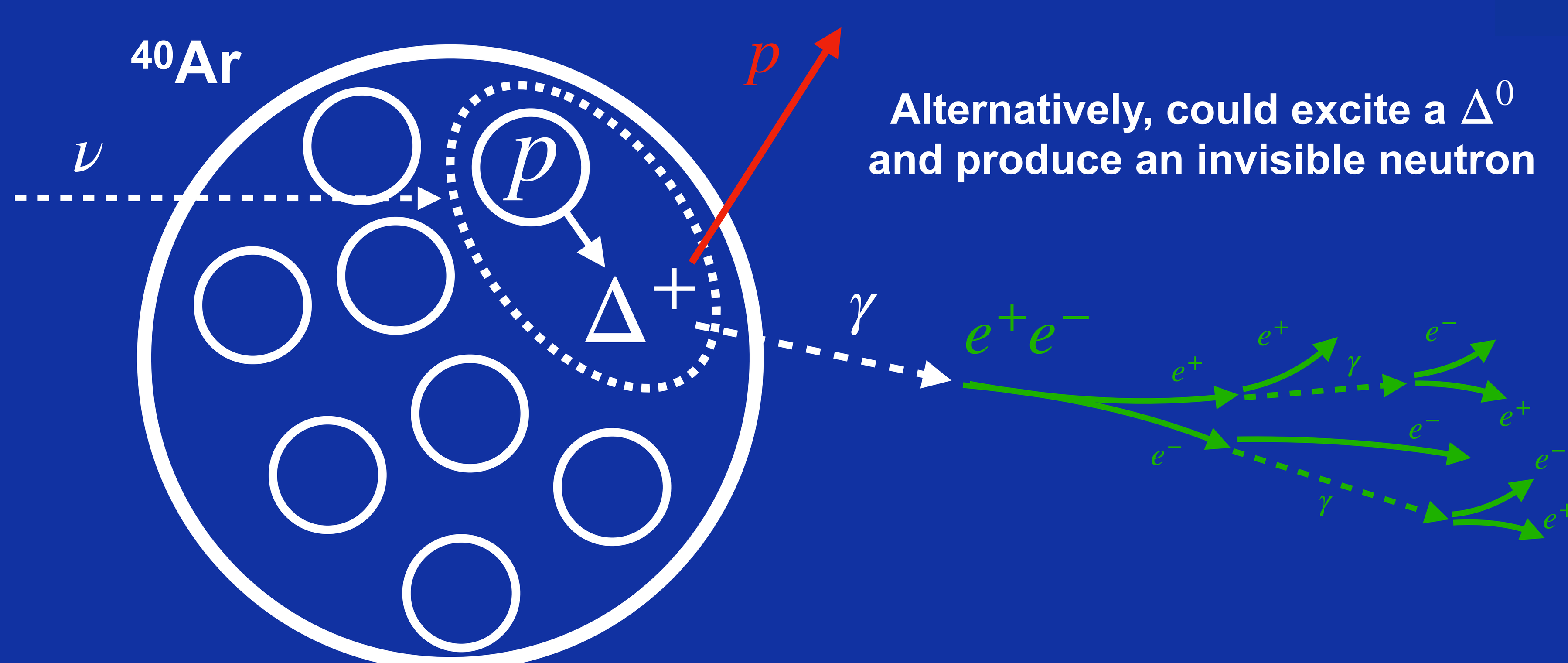


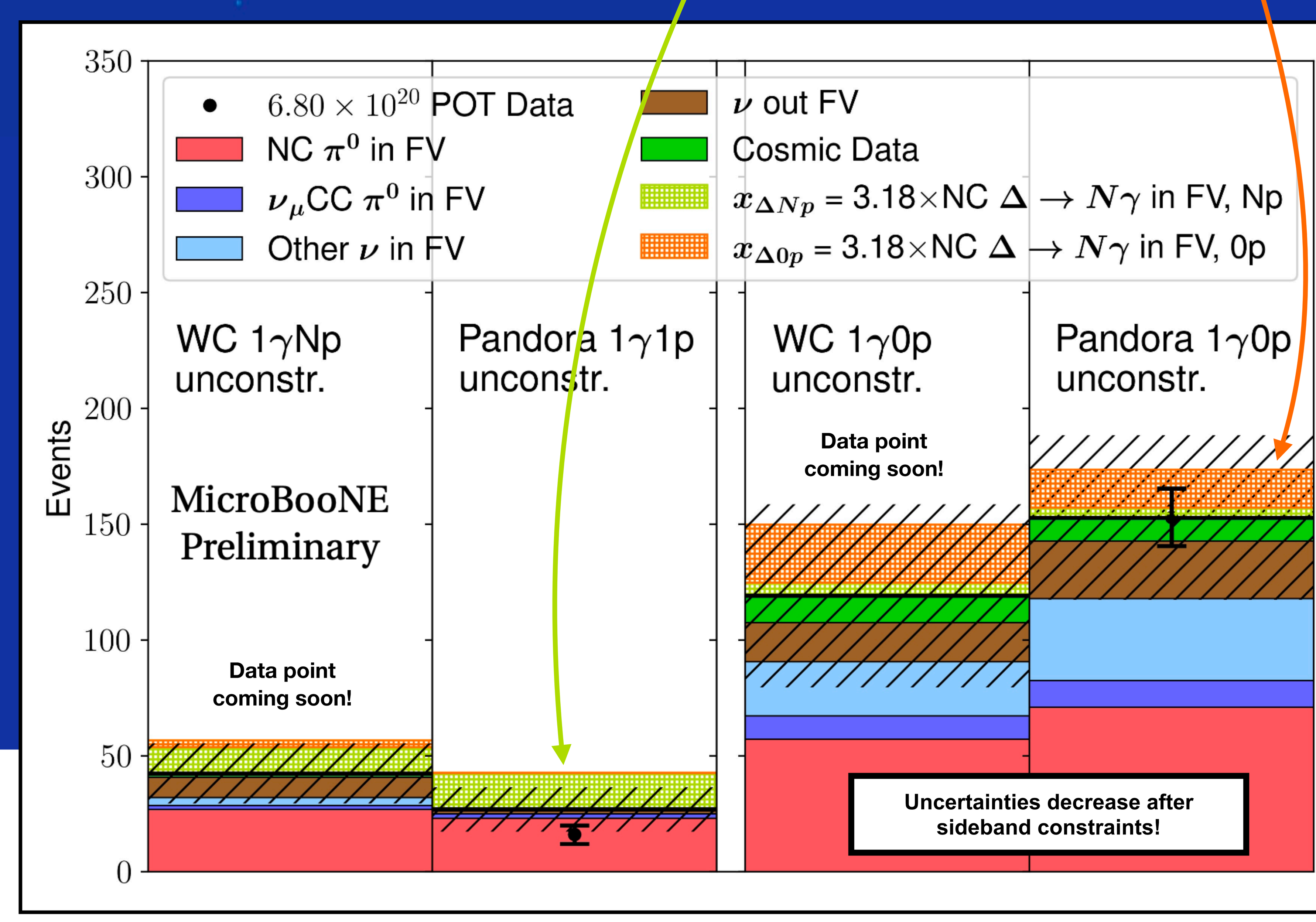
Probably not ν_eCC [2]

Probably not NC $\Delta \to N\gamma$

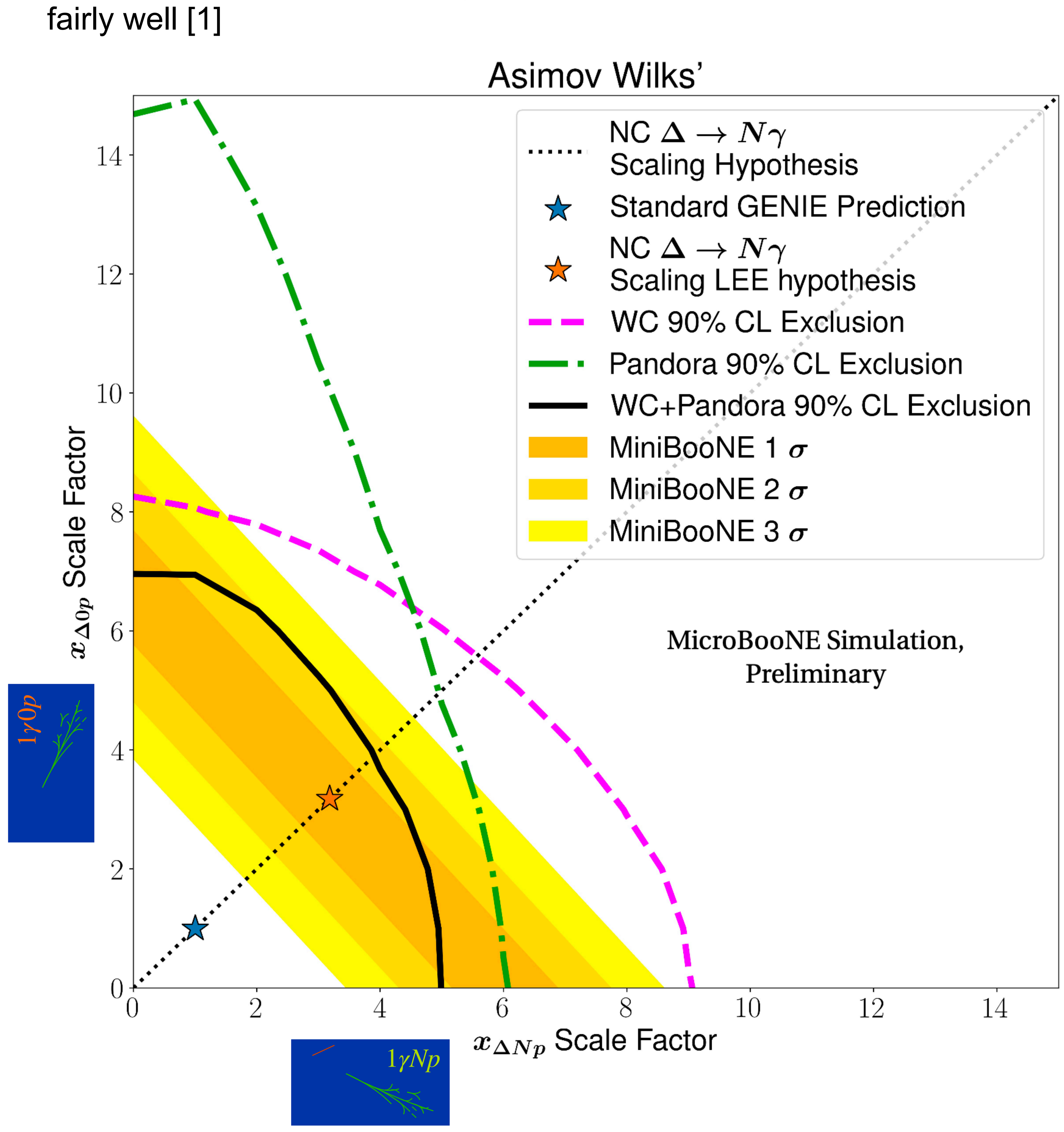
$1\gamma1p$ [3]

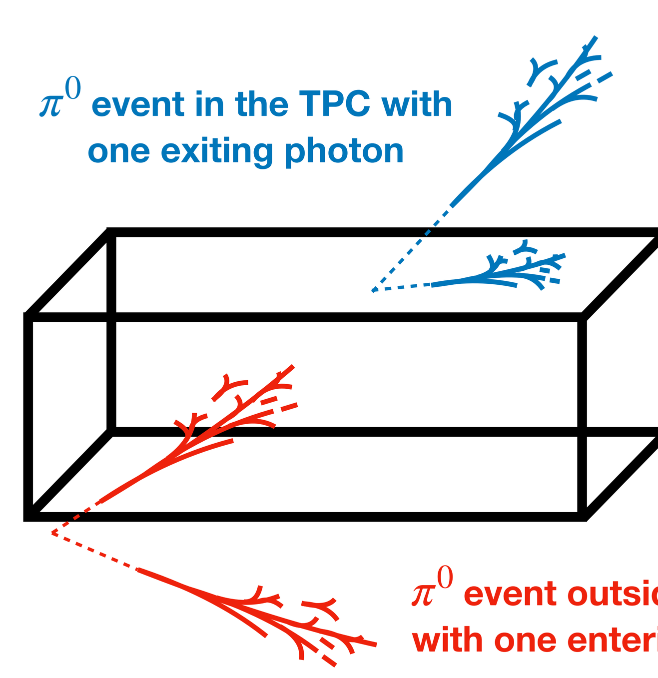
Could it be $1\gamma0p$?



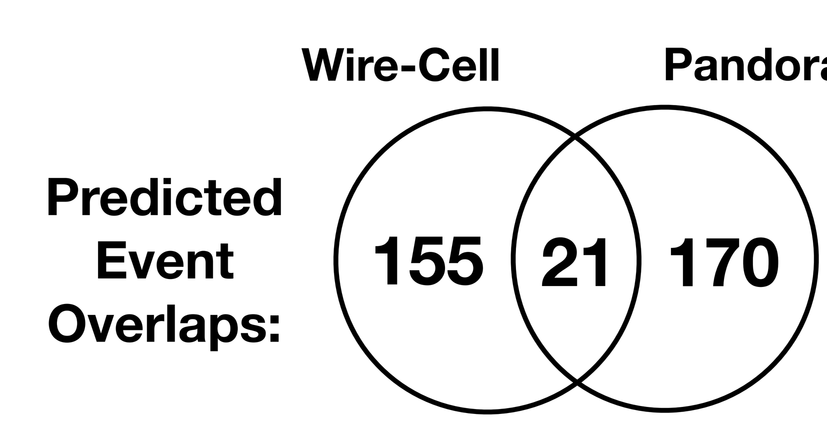


- MicroBooNE can see low energy hadronic activity and dE/dx information, letting us distinguish between electron and photon topologies
- We target NC $\Delta \to N\gamma$ events, the only significant expected source of single photons
- This process has never been observed, and the MiniBooNE Collaboration concluded that a 3.18x scaling of these events could explain the LEE fairly well [1]





- The photon topology is very difficult in MicroBooNE, with large backgrounds of $\pi^0 \to \gamma + \gamma$ backgrounds where one photon is not reconstructed
  - Particularly true for $1\gamma0p$, when we do not know the neutrino interaction vertex location



- Previously, we measured an NC $\Delta \to N\gamma$ rate consistent with the nominal prediction, mostly using the $1\gamma1p$ channel [3]
- This analysis adds new selections using Wire-Cell 3D reconstruction
  - Small overlap with prior Pandora reconstructed selections, which means we almost double our data statistics
  - Significantly increased performance for $1\gamma0p$ events:
    - efficiency: 5.6% → 8.8%
    - purity: 4.4% → 8.8%
- We expand to a 2D LEE hypothesis, considering different scaling rates of NC $\Delta \to N\gamma$ with and without protons, $x_{\Delta Np}$ and $x_{\Delta 0p}$
- The MiniBooNE LEE becomes a diagonal band, showing the phase space that leads to a total NC $\Delta \to N\gamma$ rate consistent with the excess
- The addition of Wire-Cell channels leads to a significant improvement in $1\gamma0p$ sensitivity!

Supporting MicroBooNE Public Note: https://microboone.fnal.gov/wp-content/uploads/2024/06/MICROBOONE-NOTE-1126-PUB.pdf
[1] Phys. Rev. D 103, 052002 (2021)
[2] Phys. Rev. Lett. 128, 241801 (2022)
[3] Phys. Rev. Lett. 128:111801 (2022)

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