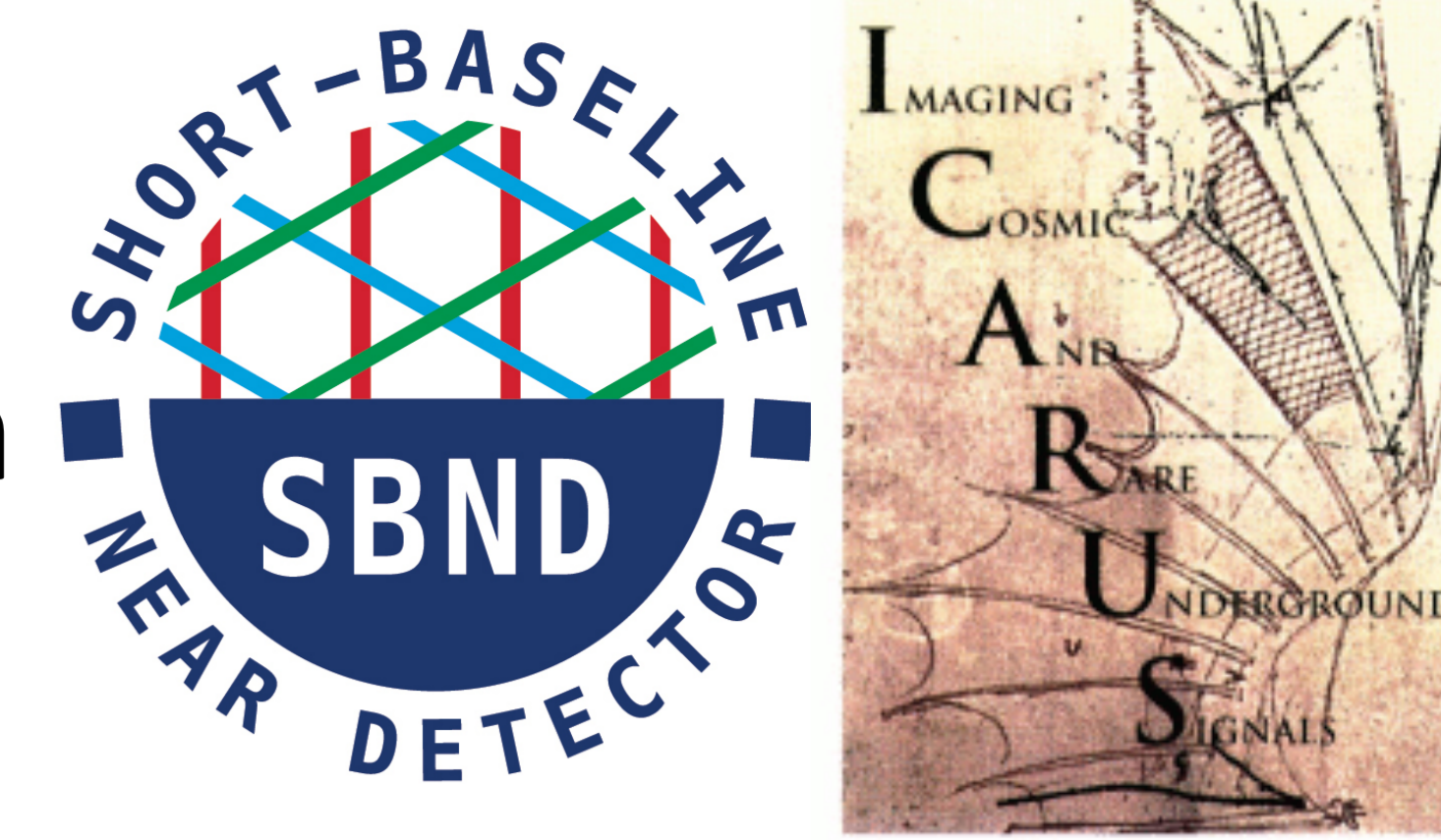# Sensitivity to eV scale sterile neutrino oscillations at SBN

Jacob Larkin (Brookhaven National Lab & Stony Brook University) for the SBN collaboration

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3+1 Oscillation Model

$$U = \begin{pmatrix} U_{e1} & U_{e2} & U_{e3} & U_{e4} \\ U_{\mu 1} & U_{\mu 2} & U_{\mu 3} & U_{\mu 4} \\ U_{\tau 1} & U_{\tau 2} & U_{\tau 3} & U_{\tau 4} \\ U_{s1} & U_{s2} & U_{s3} & U_{s4} \end{pmatrix}$$

$$P_{\alpha \to \beta} = \left| \delta_{\alpha \beta} - \sin^2 2\theta_{\alpha \beta} \sin^2 \left(\frac{\Delta m_{41}^2 L}{4E} \right) \right|$$
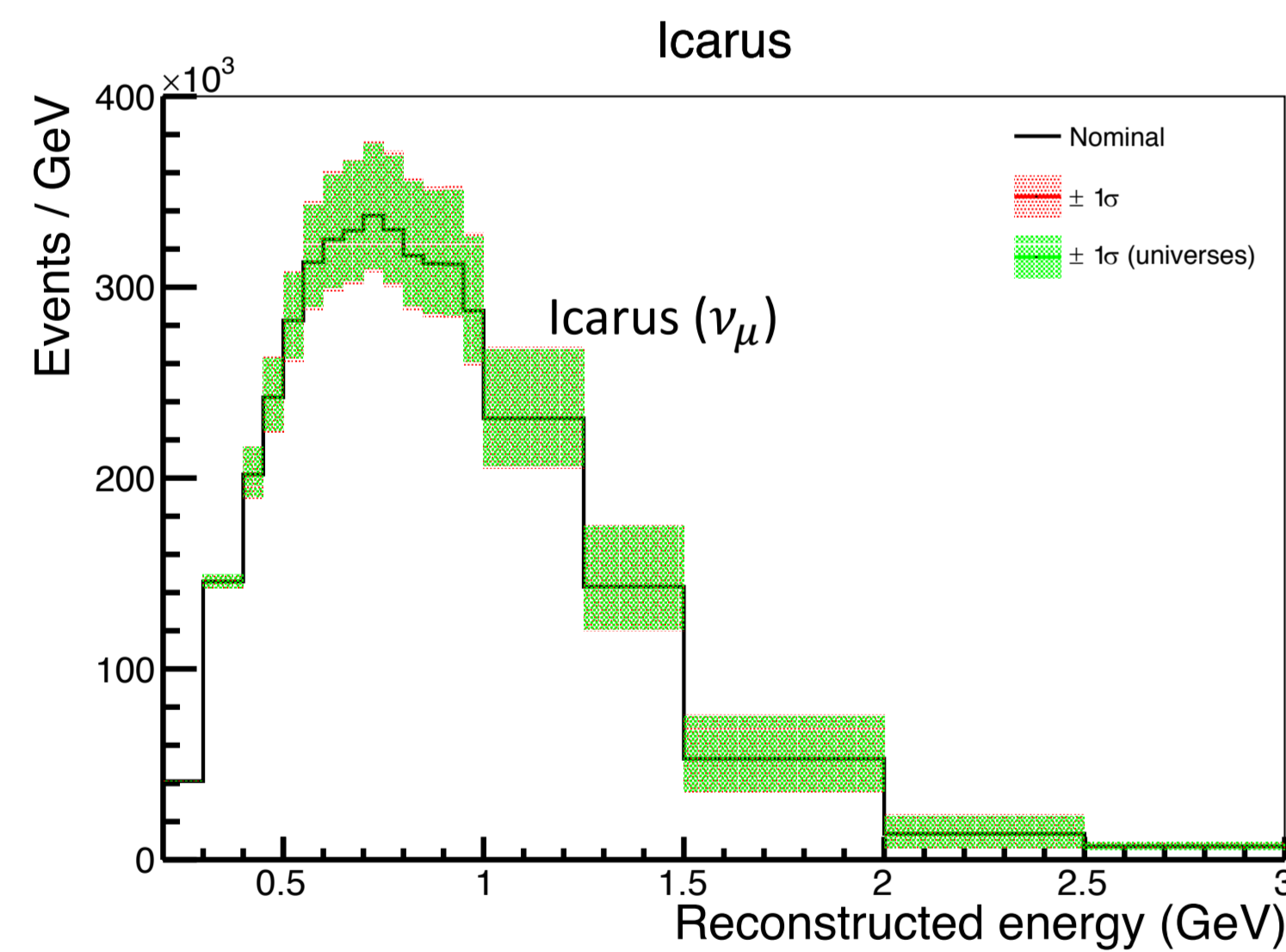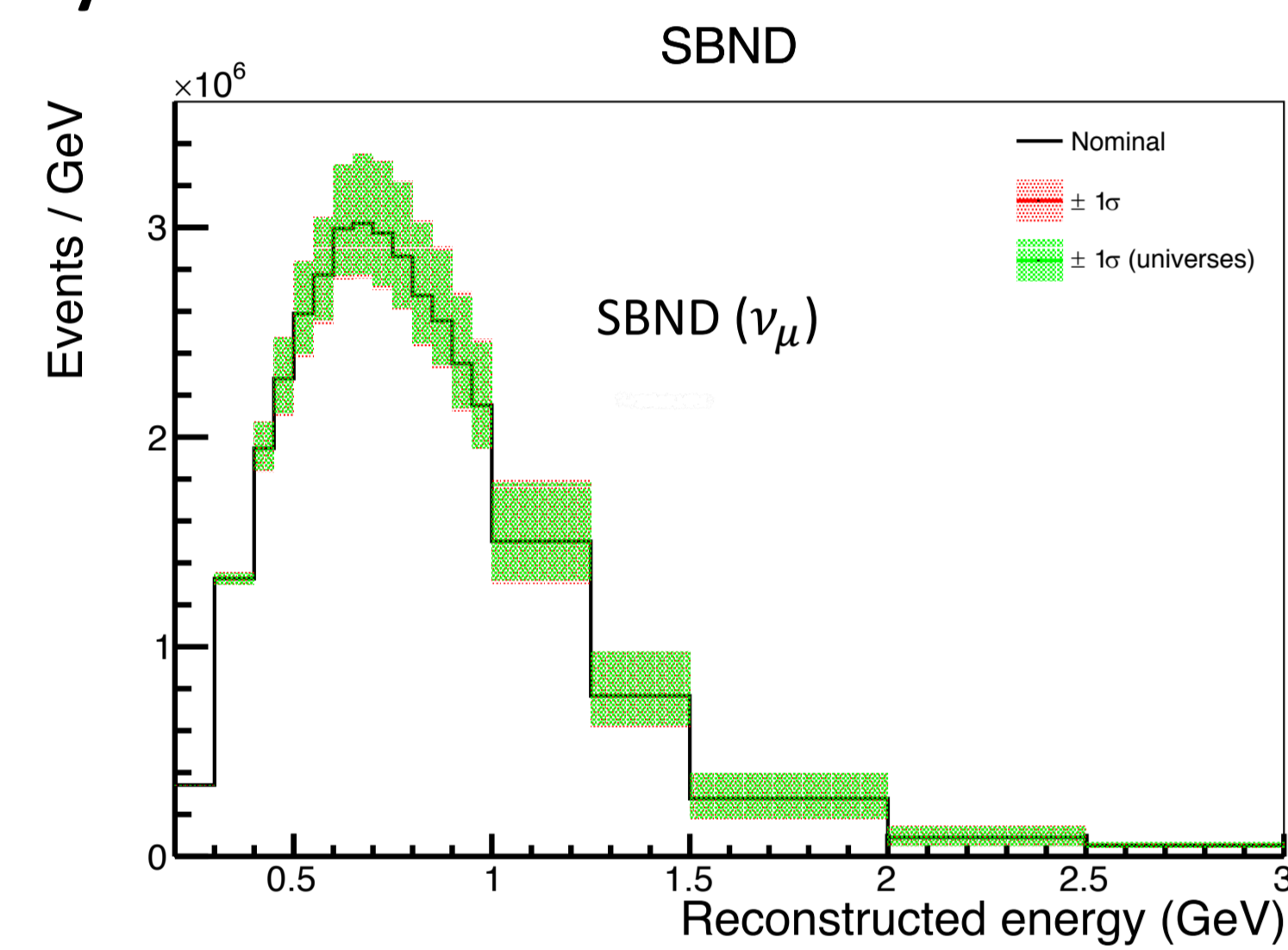
$$\sin^2 2\theta_{\mu e} = 4|U_{\mu 4}|^2 |U_{e4}|^2$$

$$\sin^2 2\theta_{\mu \mu} = 4|U_{\mu 4}|^2 \left(1 - |U_{\mu 4}|^2 \right)$$

CAFAna

- Developed originally for NOvA, and used in DUNE LBL analysis
- Analysis and fitting framework facilitates exploration of sensitivity and impact of systematics
- Using binned Poisson distributed data (M = expected, D = observed, $P(\theta)$ = penalty term):

$$\chi^2 = 2 \sum_i^{N_{bins}} \left[M_i(\theta) - D_i + D_i \log \left(\frac{D_i}{M_i(\theta)} \right) \right] + P(\theta)$$

Systematics

SBND

SBND (ν_μ)

Icarus

Icarus (ν_μ)

- Red: 68% error band from CAFAna systematic parameterization
- Green: 68% error band from 1000 generated universes
- CAFAna covers variations in the universes well
- Preliminary estimate of flux and interaction systematics included
- Detector effects not yet included

Muon Neutrino Disappearance
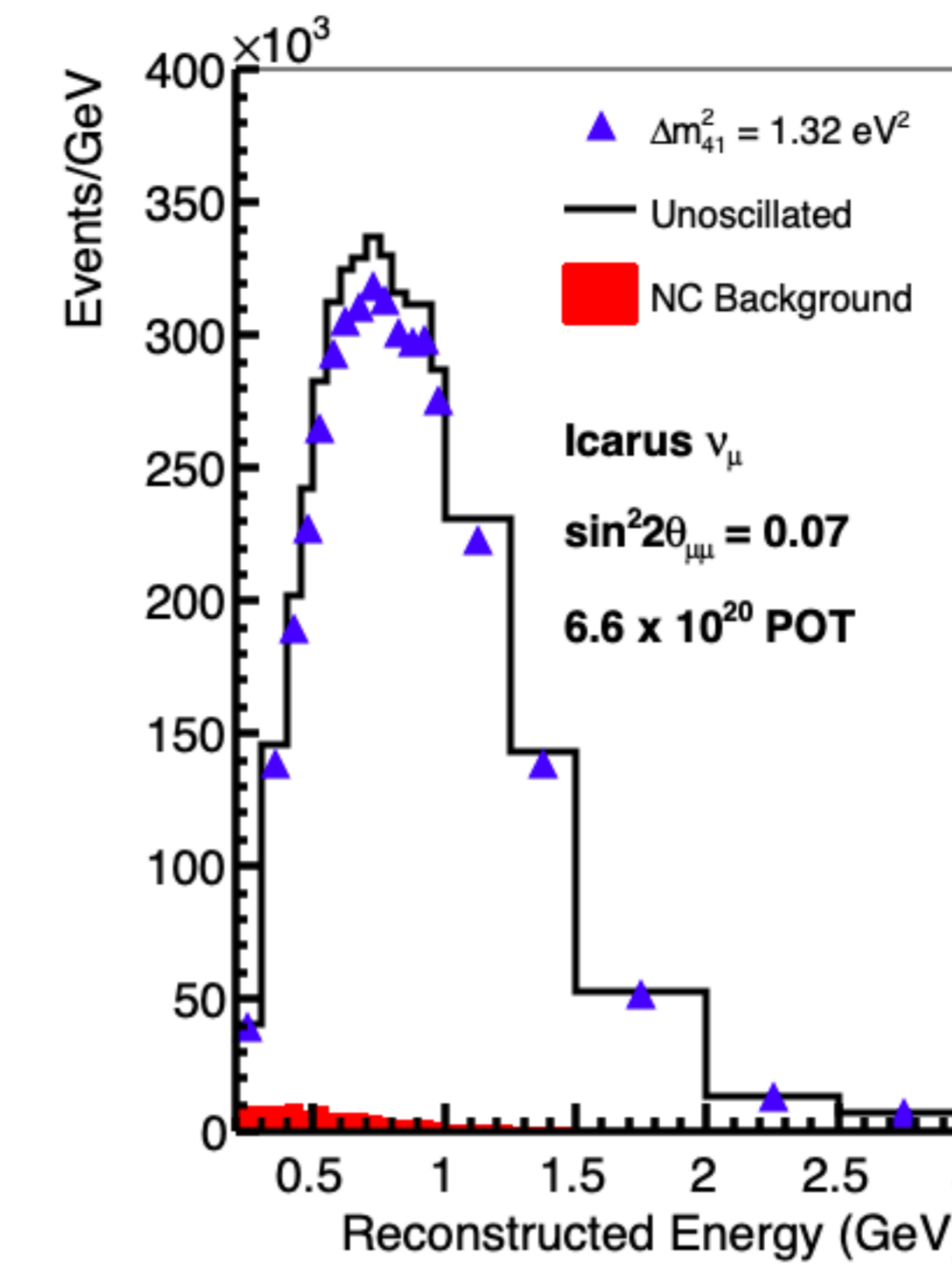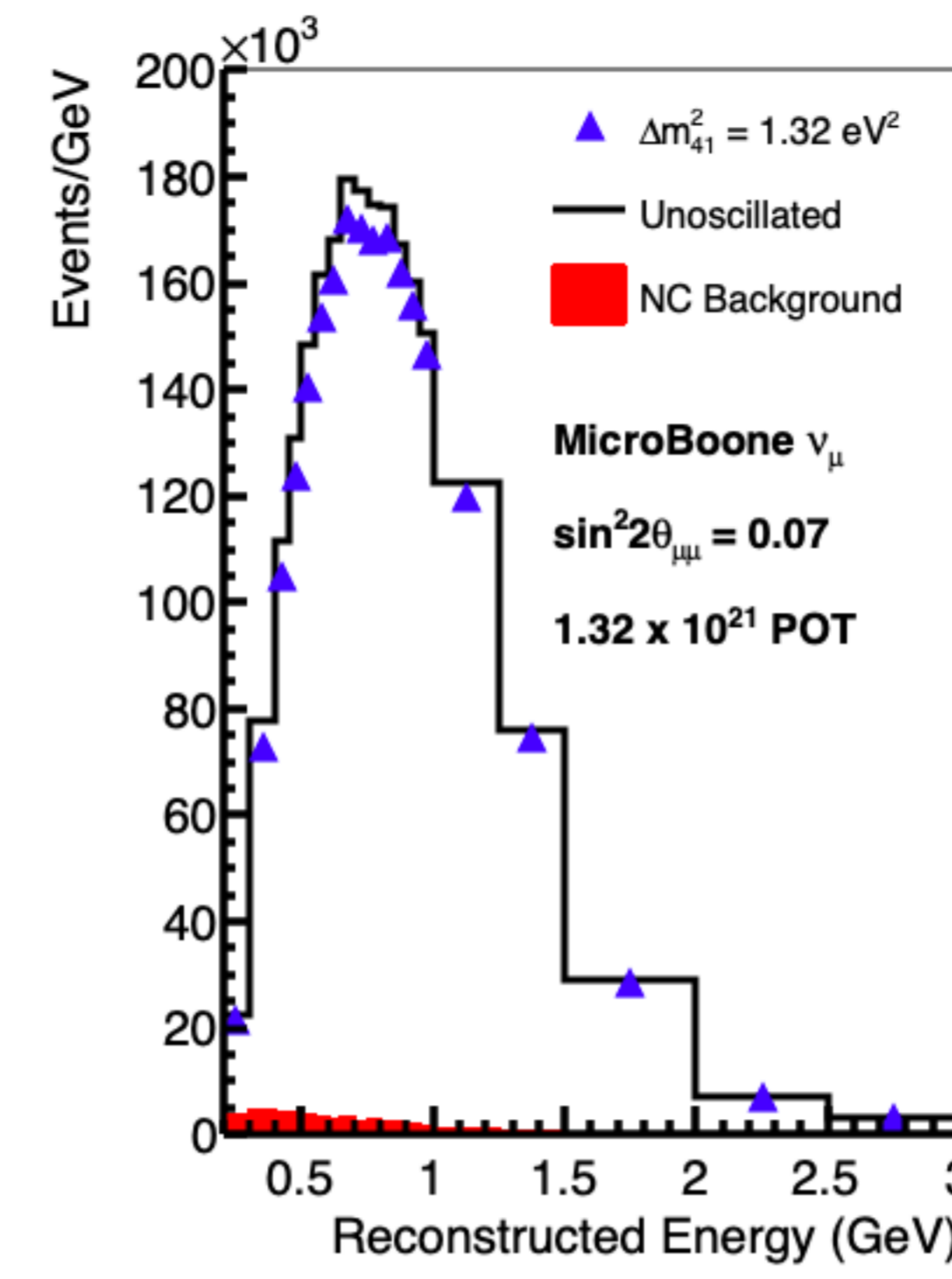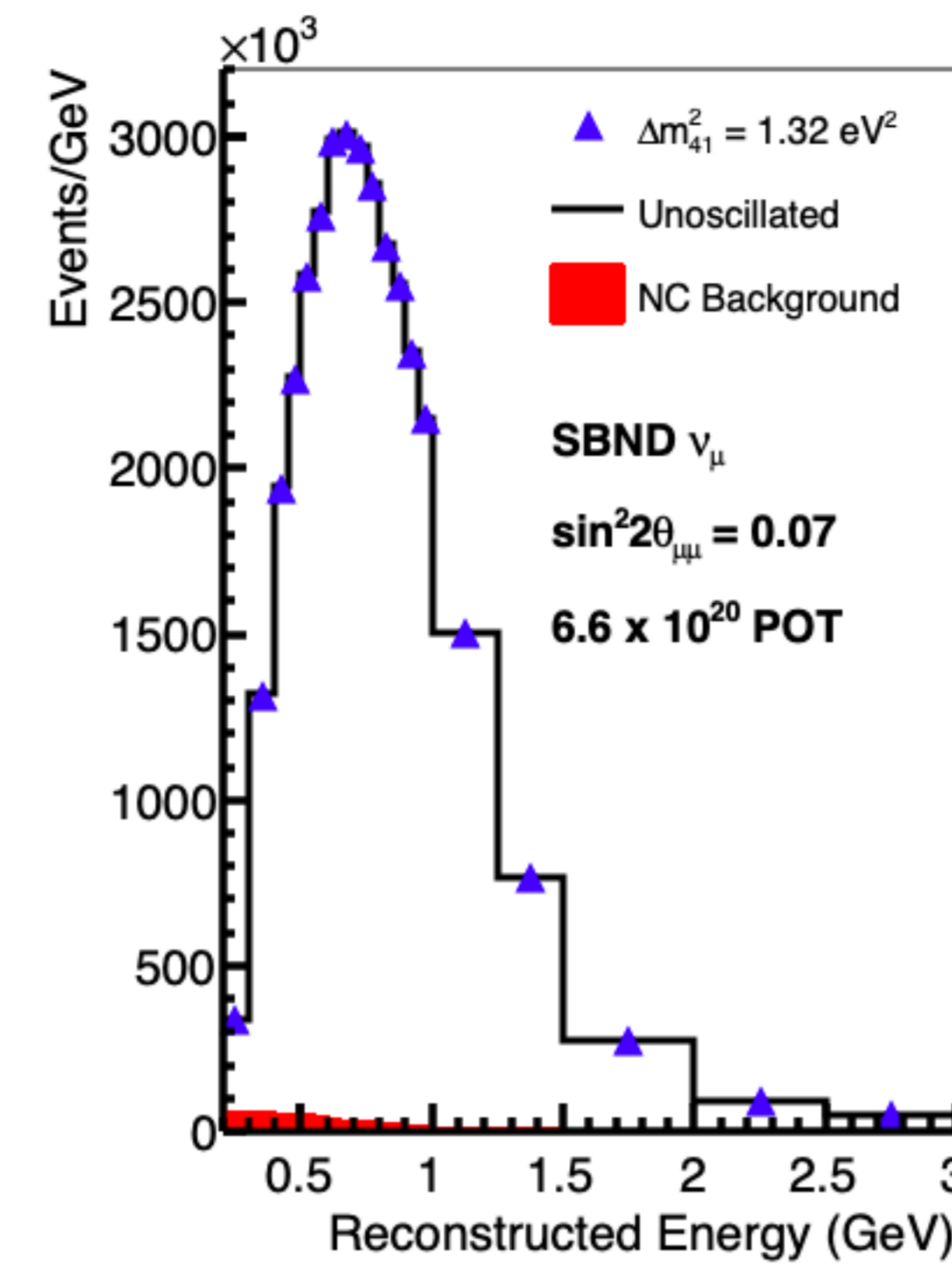
- Oscillated spectra (blue triangles) show disappearance signal when compared to unoscillated spectra (solid line)
- Bottom plots show oscillated over unoscillated ratio in each bin, also showing disappearance near the peak of the MicroBooNE and Icarus spectra

Electron Neutrino Appearance
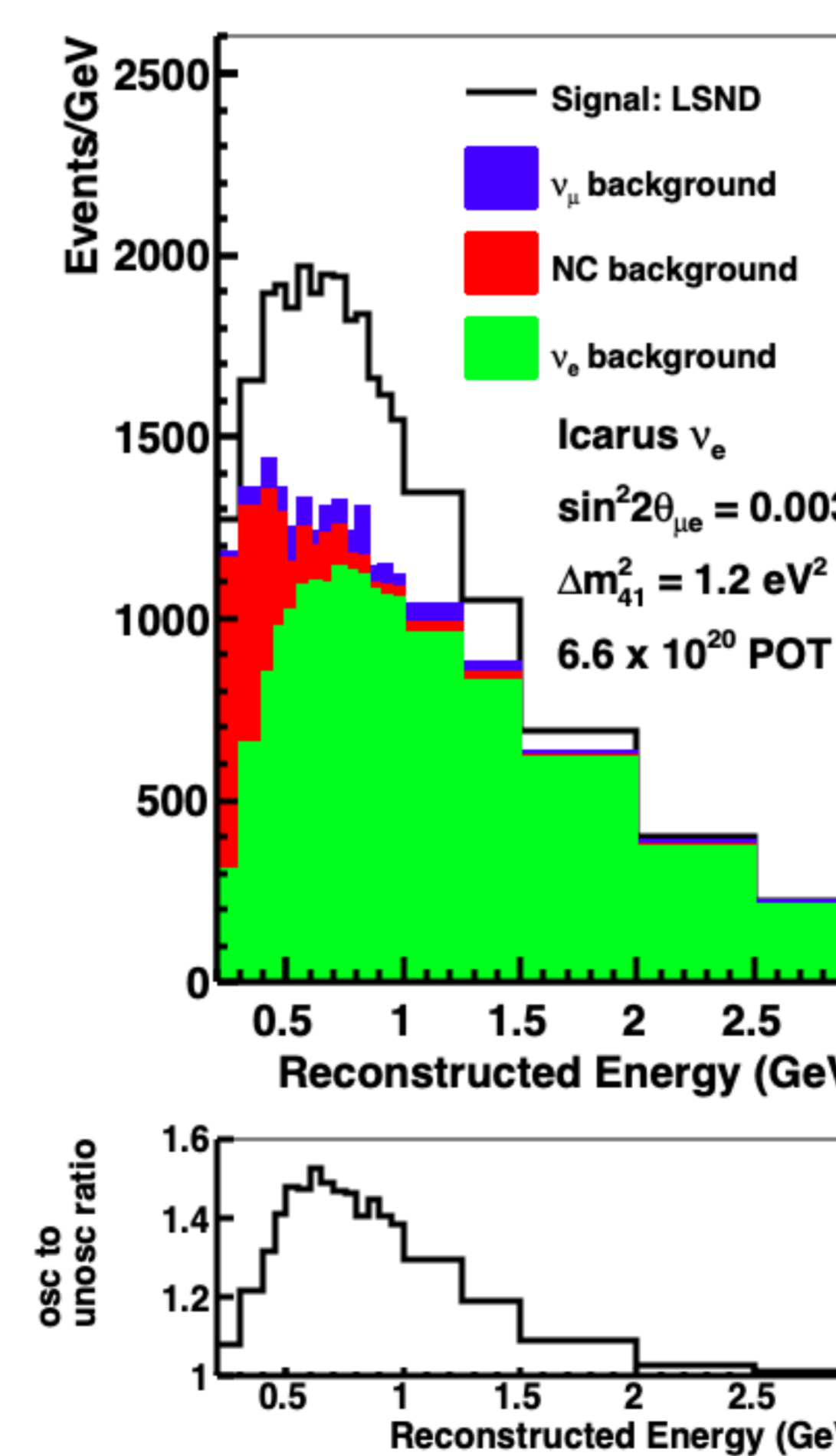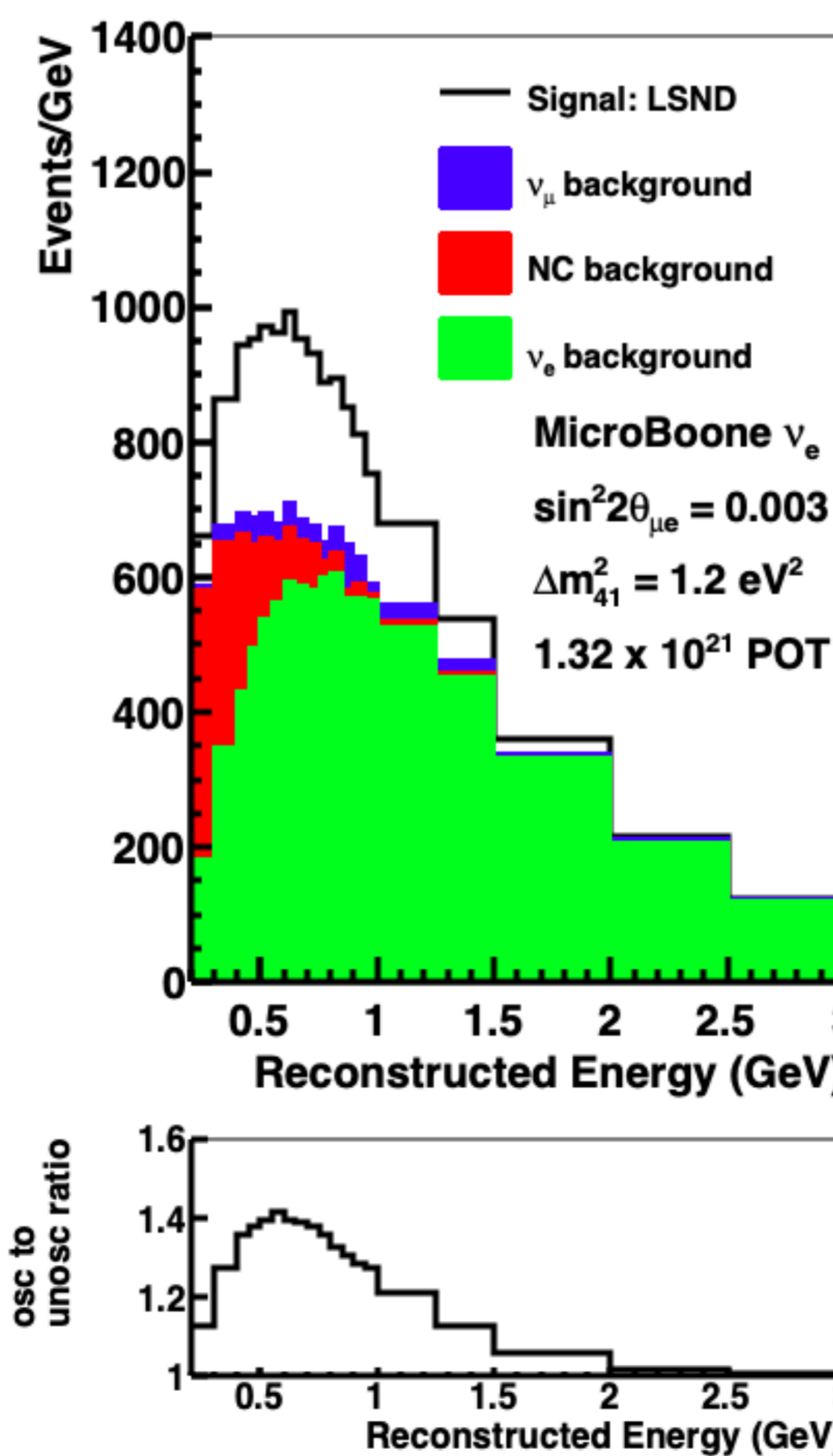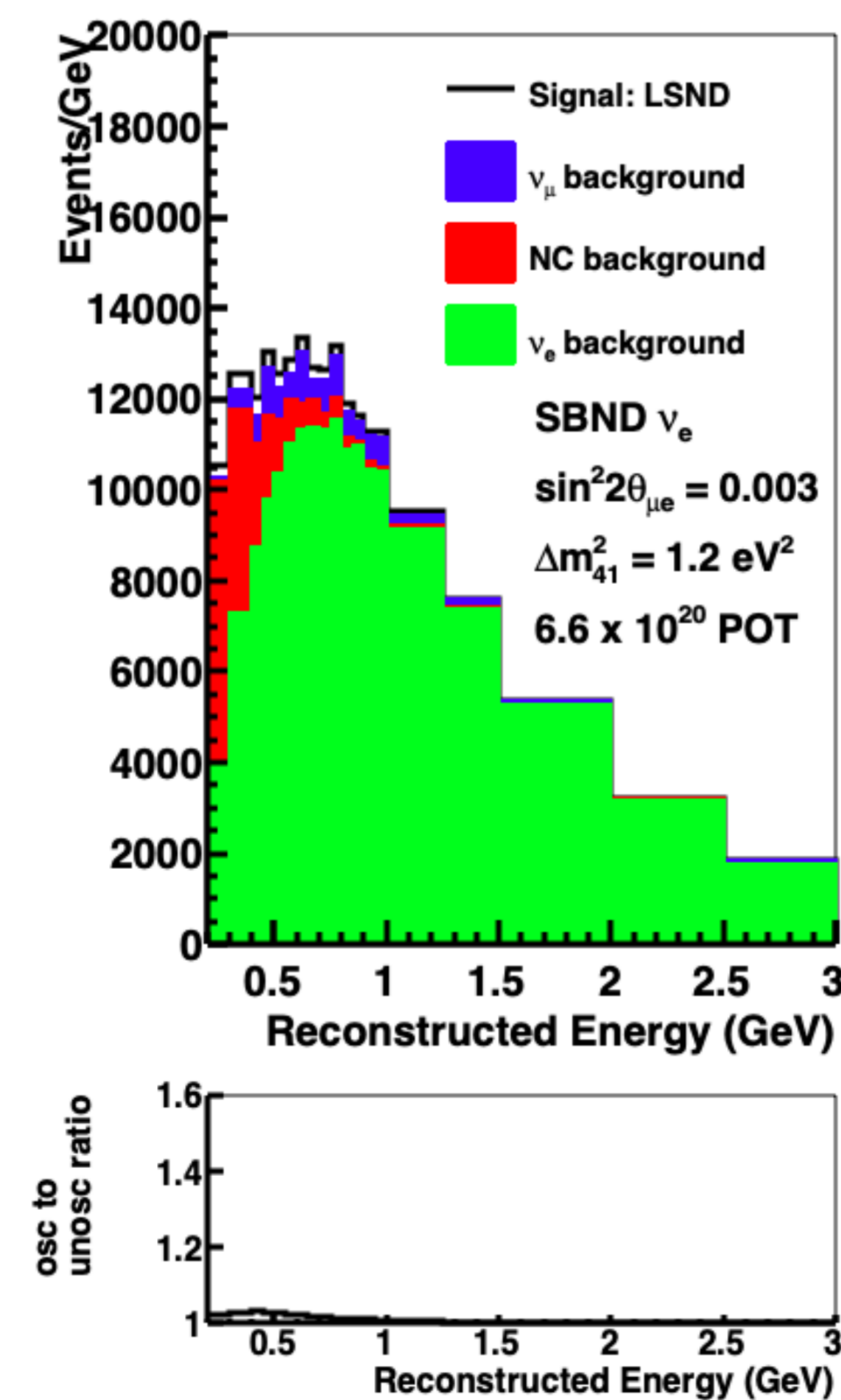
- Oscillated spectra (black line) show appearance signal when compared to background
- Bottom plots show oscillated over unoscillated ratio in each bin, also showing appearance near the peak of the MicroBooNE and Icarus spectra

Sensitivities

- Multi-detector experiment reduces impact of systematic uncertainty
- The oscillation sensitivities shown here, employ the same systematic error assignments used in the SBN proposal [arXiv:1503.01520] with known caveats. Work is currently in progress to improve the SBN oscillation sensitivity calculations by a) migrating to a better-motivated interaction model and modern uncertainty assignments from GENIE 3, b)incorporating a first evaluation of uncertainties in the detector response, and c)evaluating model dependencies and biases in the extrapolation from SBND to ICARUS (a-c not included here).

ν_μ Disappearance 90% Exclusion
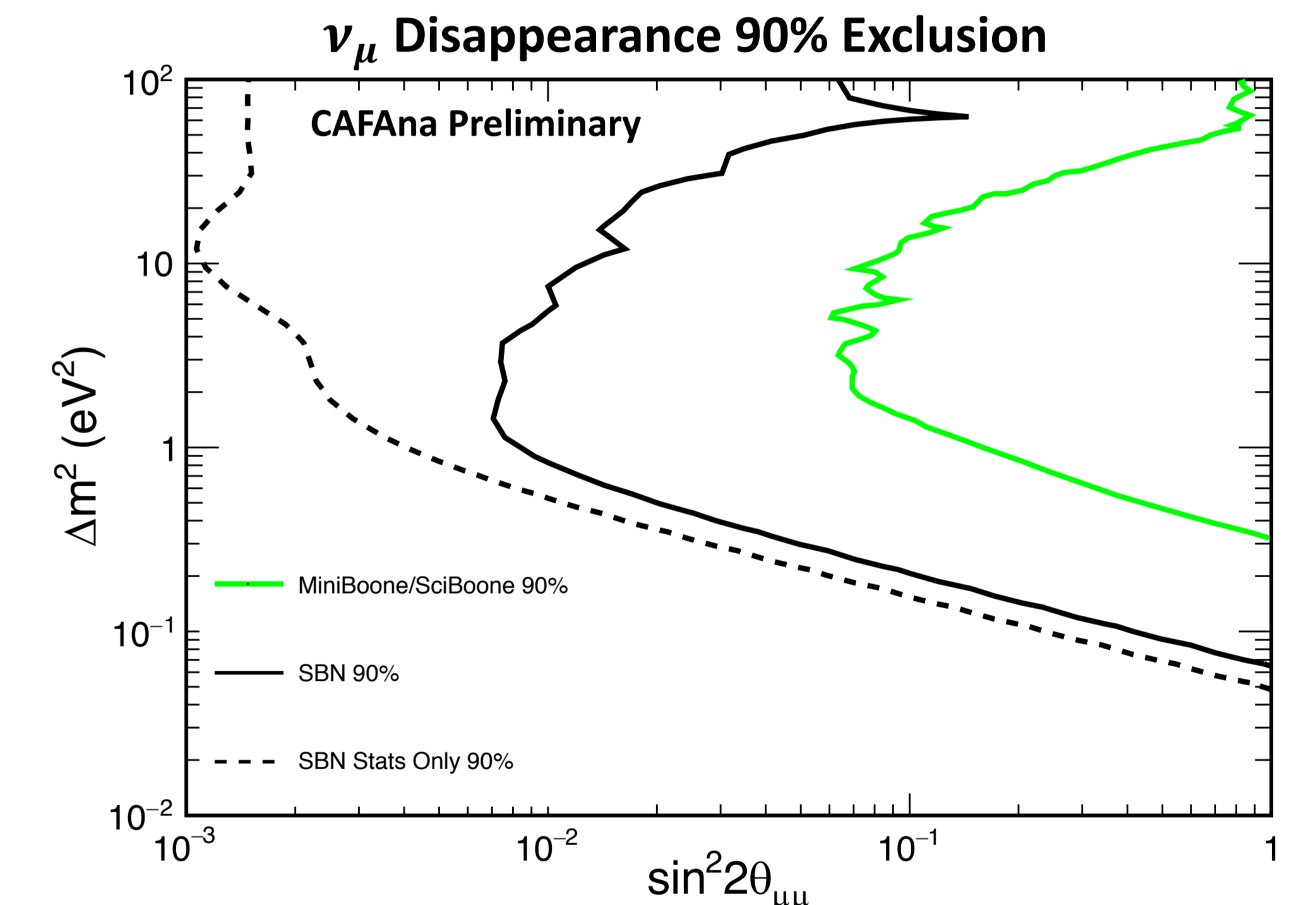
- Significant increase in sensitivity over MiniBooNE/SciBooNE (green contour) [arXiv:1106.5685]

ν_e Appearance 90% Exclusion
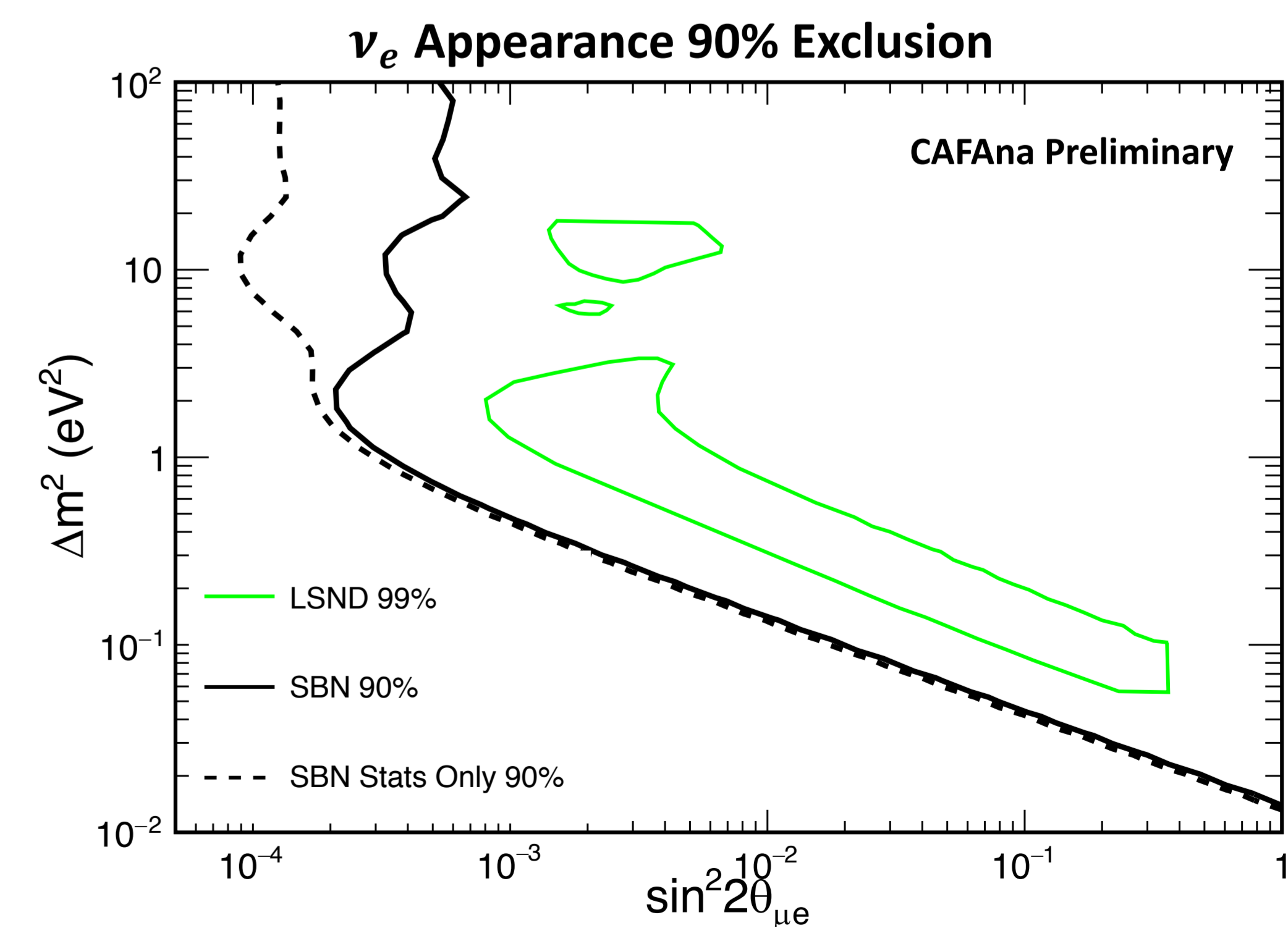
- 3 detector sensitivity (black) covers the entire 99% allowed region from LSND (green) [arXiv:1803.10661v1]