MeV Scale Physics in MicroBooNE

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MeV signatures in ν Interactions

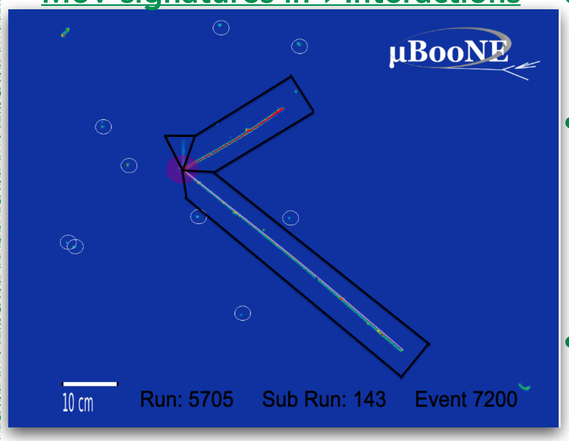


Fig1. Signal highlighted in white circles, neutrino correlated retained in conical cylinder

- MeV photons produced by gamma nuclear de-excitations and neutron scatters.
- MicroBooNE a surface detector ➔ large cosmogenic background at low energy such as delta rays, bremsstrahlung photons etc.
- Uncorrelated backgrounds include cosmogenic neutrons

- 3-D reconstruction is achieved by plane matching in time.
- Energy reconstruction† is done utilizing gain calibration factors (ADC ➔ Q), a recombination factor & NIST ESTAR range table (Q ➔ MeV).
- Improved reconstruction by lowering threshold to see as much of low energy activity as possible

Lowest neutrino LArTPC energy thresholds

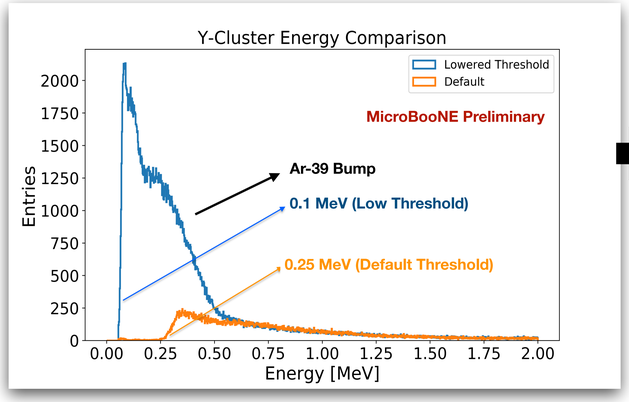


Fig2. Lowering Energy Thresholds in data

Measurement of Uncorrelated Backgrounds in data

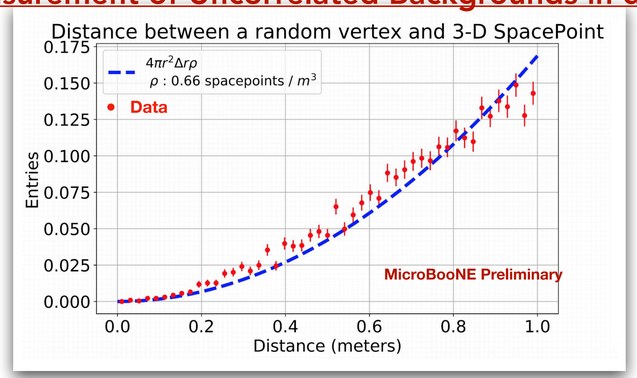


Fig3. Uncorrelated backgrounds such as cosmogenic neutron activity and Ar spallation products are uniformly spread throughout the detector

Supernova Neutrino Reconstruction in LArTPC

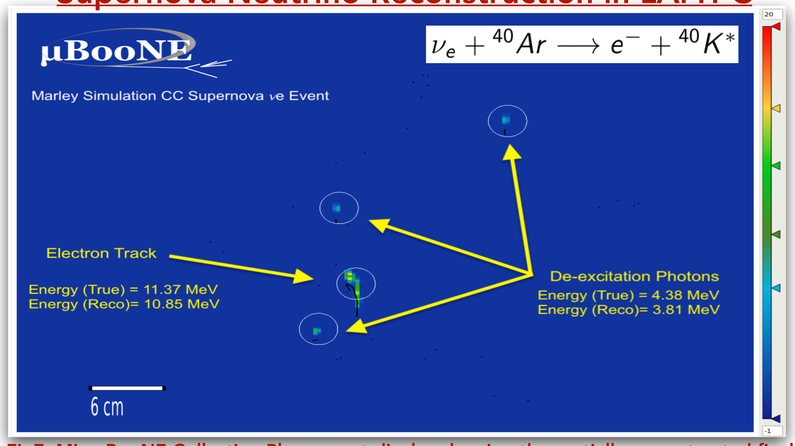


Fig7. MicroBooNE Collection Plane event display showing the partially reconstructed final state particles corresponding to a MARLEY simulated Supernova Neutrino Event

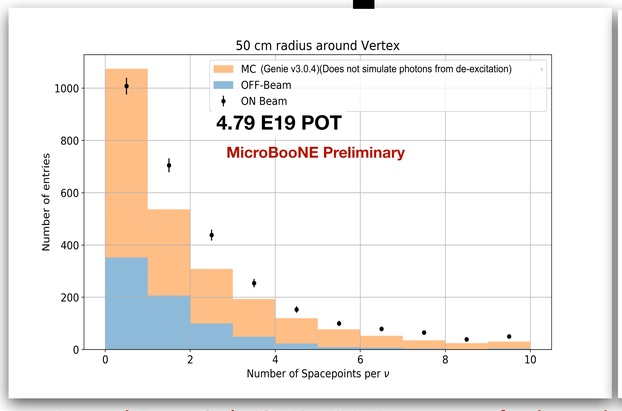
Summary and Conclusions

- Improved reconstruction to detect activity as low as 100 keV
- Measured background activity (cosmogenic neutron scatter, Ar spallation) that is not correlated to cosmogenic track activity such as delta, bremsstrahlung radiation.
- Observe a greater average number of reconstructed spacepoints in data, likely due to nuclear de-excitations. First reported by ArgoNeuT† . Future analysis ongoing.
- An excess of low energy hot spot regions in data, attributed to the G10 material has been found using this reconstruction.
- This has implications for DUNE which utilizes a large quantity of G10 in insulating panels, hanger plates, bushings and printed circuit boards (PCB).
- MeV Scale Reconstruction has also been successful in partial reconstruction of simulated Supernova and MuDAR neutrino events in MicroBooNE.

G-10 'Hot-Spots' in MicroBooNE data

Fig4. 2-D spacepoint distribution within MicroBooNE highlighting Hot Spot regions

Neutrino Results



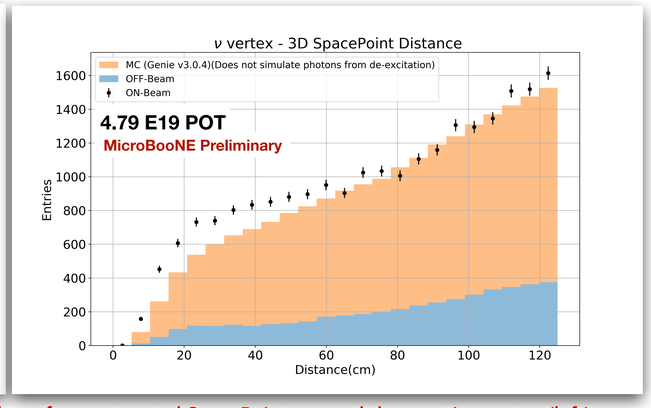


Fig6. Data and Monte Carlo (GENIE v3.0.4) comparison for the number of reconstructed SpacePoints around the neutrino vertex (left) and 3D distance between neutrino vertex and 3-D SpacePoints (right). Greater number of spacepoints in ON-Beam data could have contributions from un-modeled nuclear de-excitation gammas and modeled neutron scatters.

- Multiplicity of reconstructed spacepoints in ON-Beam data, Monte Carlo Simulation and OFF-Beam data is 1.95,1.81 and 1.11, respectively as seen in the plot on the left
- Greater average number of reconstructed spacepoints in ON-Beam Data over Monte Carlo Simulations attributed to de-excitation photons
- More reconstructed spacepoints close to the neutrino vertex also attributed to de-excitation photons.

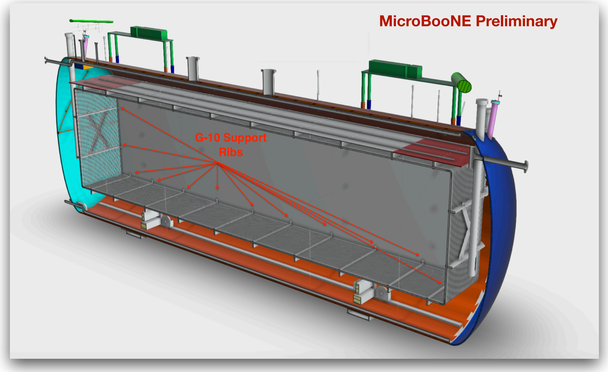


Fig5. The hot spot regions in the above plot are spatially coincident with the G10-structures that act as support for the field cage.

- The activity associated with G-10 support ribs has been found to be stable over time.
- Preliminary characterization of energy spectrum
- Origin (activation / radiological) under investigation.

† R. Acciarri *et al.* (ArgoNeuT Collaboration) Phys. Rev. D 99, 012002 – Published 7 January 20