NuSTEC at the Short Baseline Neutrino programme

Andy Furmanski

NuSTEC board meeting

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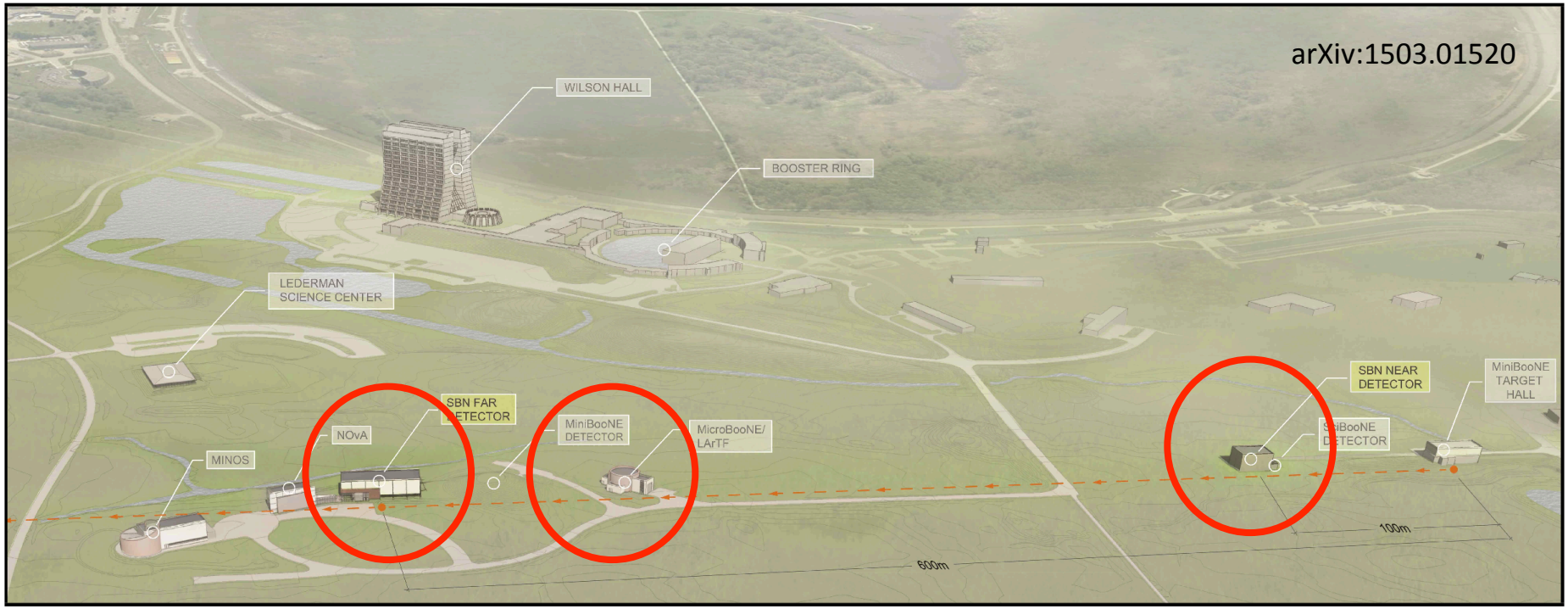
SBN summary

- Three LArTPCs at 100, 450, and 600m (approx) along the BNB beamline
- BNB is a wide band beam with peak at 600MeV

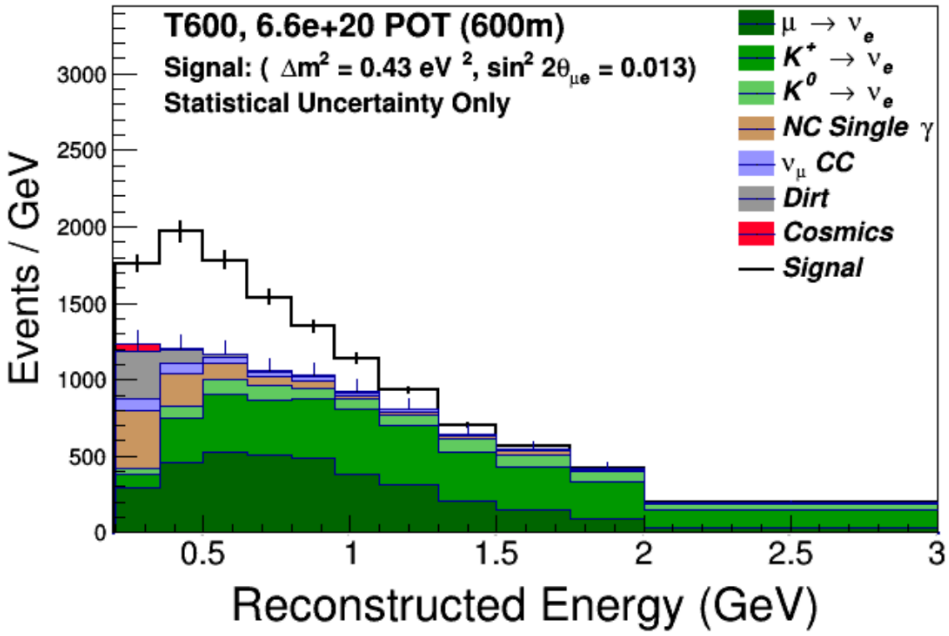


Oscillation searches

- Using near, intermediate, and far detectors, search for ν_μ disappearance and ν_e appearance
- Try to avoid strong model dependence using calorimetric energy reconstruction
  - Of course, this does introduce different model dependencies
  - And new difficulties!

- Potential oscillation signal at ICARUS (far detector)

- Intrinsics and other backgrounds constrained at near detector



Key detector challenges

- Long drift time, and a high cosmic rate (no overburden)
- Photon conversion length is 14cm
  - Worries about merging cosmogenic activity in neutrino reconstruction
- Detector effects such as space charge, lifetime, recombination, diffusion
- Large fraction of muons escape detector – need to use momentum estimation from multiple coulomb scattering
  - Angular dependence to momentum resolution

Low energy protons

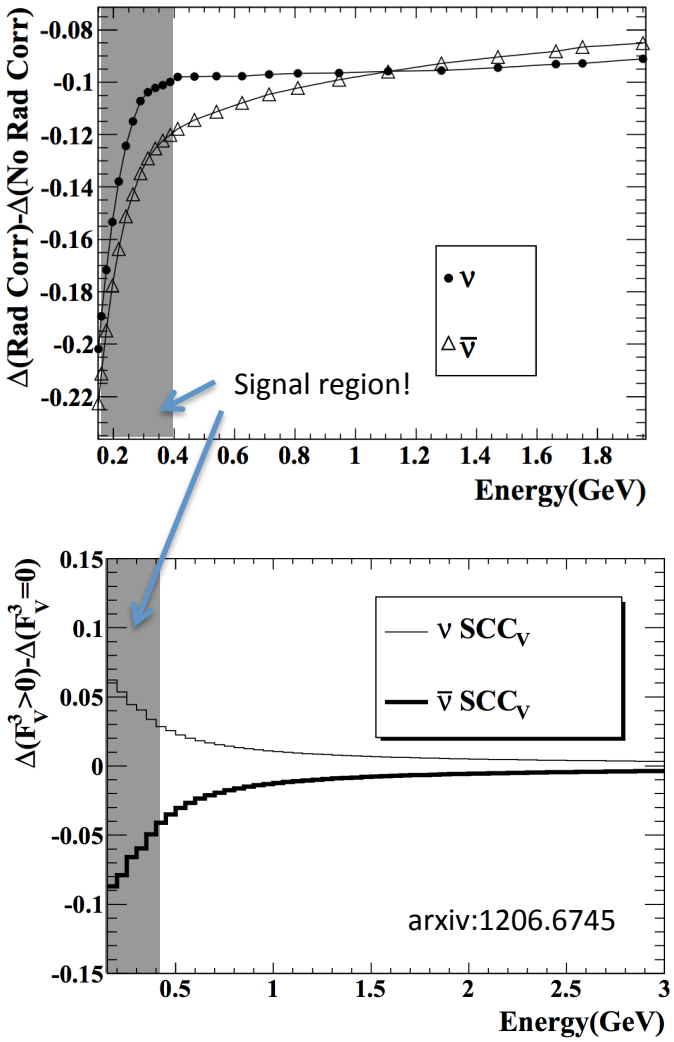
- We are pushing our proton reconstruction threshold down from ~400MeV/c to ~200MeV/c
  - Not just yet, but work has started. MicroBooNE is already highly competitive with MINERvA
- Fairly strong angular-dependent efficiency
- Lost protons (and neutrons) means a model-dependent energy correction
- Theory models that retain the **hadronic degrees of freedom** would be very welcome!

Extrapolation from light nuclei

- Most recent data at these energies is on hydrocarbon targets
- Models **built for carbon extrapolated to argon**
  - Argon is bigger – more FSI etc
  - Different p/n ratio – np/pp correlations?
- Advice on this extrapolation, or models built for argon, would be awesome!

muon-electron differences

- Best sensitivity – joint fit of all ν_μ and ν_e samples at 3 detectors
- Appearance signal expected at low energy (<500MeV)
  - Mass difference leads to different coverage of **energy/ momentum transfer**
  - **Radiative corrections**
  - **mass terms in form factors** (second class currents, pseudoscalar form factor changes)



What we bring to the table - data!!!

- SBND in particular will have huge statistics
- We can provide very precise topological flux-integrated measurements

Inclusive	5,389,168
0 π	3,814,198
0 π + 0p	27,269
0 π + 1p ($>$ 20 MeV)	1,629,252
0 π + 2p ($>$ 20 MeV)	1,150,368
0 π + 3p ($>$ 20 MeV)	413,956
0 π + $>$3p ($>$ 20 MeV)	396,212
1 π^+ + X	942,555
1 π^- + X	38,012
1 π^0 + X	406,555
2 π + X	145,336
$\geqslant$ 3π + X	42,510

- We are going to need help to understand all the data we have!
- What is the most useful thing to measure?
- What is the best way of presenting this?

More detector interactions in one month than historical dataset

Hyperon Production Expectations (CC + NC)
(GENIE Expectations)

	1 Month	1 Year	3 Years
Λ^0 Production	200	2,600	8,000
Σ^+ Production	125	1,500	4,500

Summary

- SBN wants:
  - Models that predict proton spectra
  - Advice on extrapolating from lower mass nuclei
  - Calculations of corrections that impact the ν_μ/ν_e cross section ratio
- In exchange for:
  - Large amounts of high-precision, high-statistics data!