



UNIVERSITY OF
LIVERPOOL



SBN(D) @ Oliver Lodge

Marco Roda

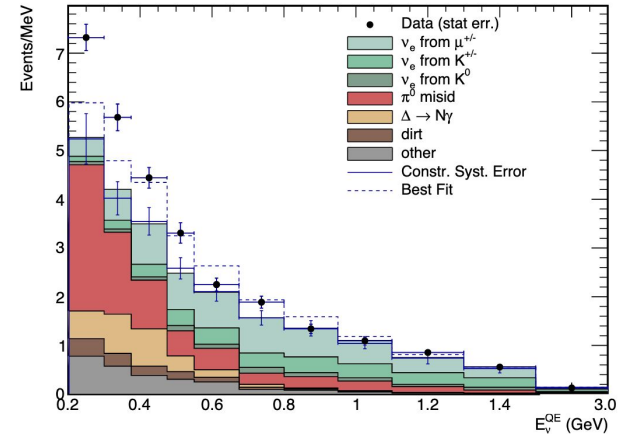
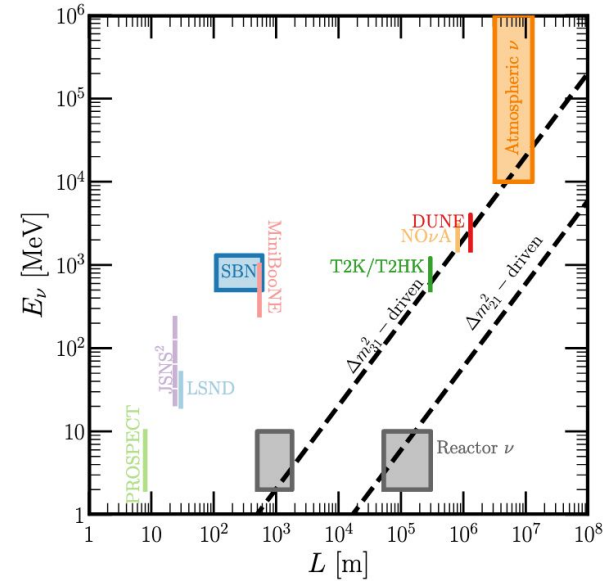
Liverpool HEP Meeting
18 May 2023

Overview

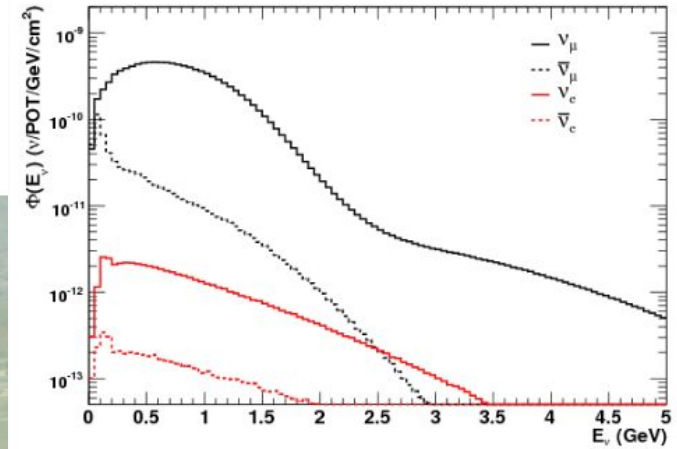
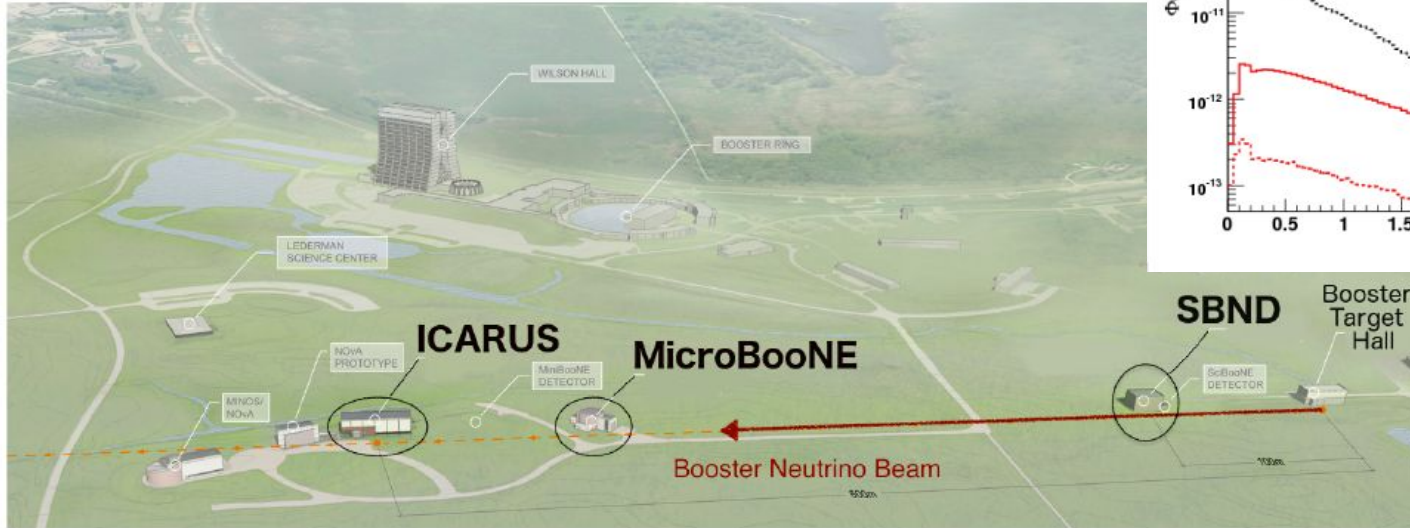
- Recap of physics goals
- SBN status
- Liverpool team
- Recent activities
- Summary

Physics goals

- Observations that cannot be explained using the standard 3 flavour oscillation paradigm
 - LSND anomaly
 - 50 MeV anti- ν_e appearance (3.8σ)
 - MiniBooNE
 - 1 GeV ν_e and anti- ν_e appearance (4.7σ)
 - Reactor anomaly
 - O(MeV) anti- ν_e disappearance (3.0σ)
- These signals could be interpreted as an oscillation signal
 - with a high Δm^2
- Other SM physics
 - Neutrino interaction studies
 - 7.5M-12M ν_{μ} CC interactions in nominal $10\text{-}16 \cdot 10^{20}$ POT run



SBND within SBN



Detector	Baseline (m)	Active LAr mass (tonnes)
SBND	110	112
MicroBooNE	470	87
ICARUS	600	476

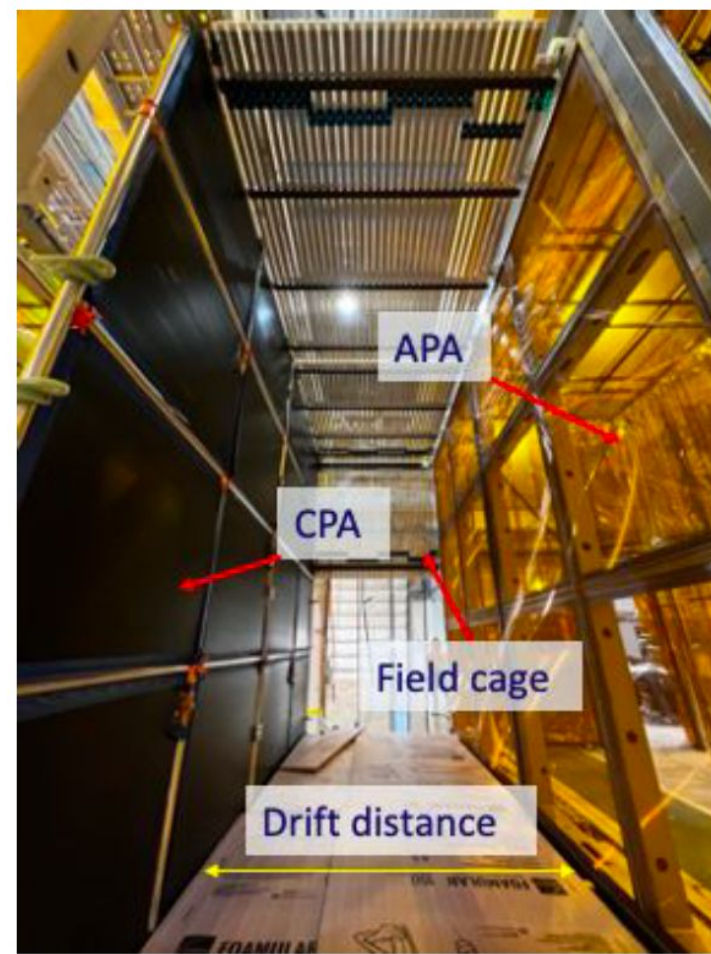
- ICARUS is already taking data, since Oct 2021
- SBND should start cooling down this summer
 - Hopefully first commissioning data before the end of the year

BSM physics

Model	U. Signature	LSND	MB	Reactors	Cosmology	Issues	Score
3+1	Oscillations					Appearance-disappearance tension.	6
(3+1) + inv- ν decay	Damped oscillations					Large couplings. UV model?	4
(3+1) + NSI	Modified matter effects					Large NSI couplings. DeepCore tension.	11
Anomalous matter	Resonant appearance				unknown	Tension with T2K if resonance in E.	9
Large extra dim	Osc with related freqs.				unknown	Same issues as 3+1 or worse.	12
LNV in μ decays	$\mu^+ \rightarrow \text{anti-}\nu_e$					Michel params in tension w/ TRIUMF.	8
Lorentz violation	Sidereal time variation				unknown	HE IceCube tension.	10
Dark neutrinos	Upscattering to $N \rightarrow \nu e^+e^-$					MINERvA/CHARM-II/ND280 tension?	2
Dipole portal	Upscattering to $N \rightarrow \nu \gamma$					MINERvA/CHARM-II/ND280 tension?	3
(3+1) + vis- ν decay	DIF of $\nu_s \rightarrow \nu_e$					Tension with solar antineutrinos.	5
(3+1) + vis decay	DIF of $N \rightarrow \nu \gamma$					Timing at MB.	7
Dark sectors: dark matter	Upscattering to $\chi' \rightarrow \chi e^+e^-$					MINERvA/CHARM-II/ND280 tension?	5
Dark sectors: (pseudo)-scalar	Forward scattering to γ					MINERvA/CHARM-II/ND280 tension?	1

Detector status - last year this time

- Completed TCP
 - But it was on a different site
 - It had to be moved!



Detector status - the move



Detector status - the move



Past 9 o' clock ...

... It was a cold frosty morning

Detector status - the move

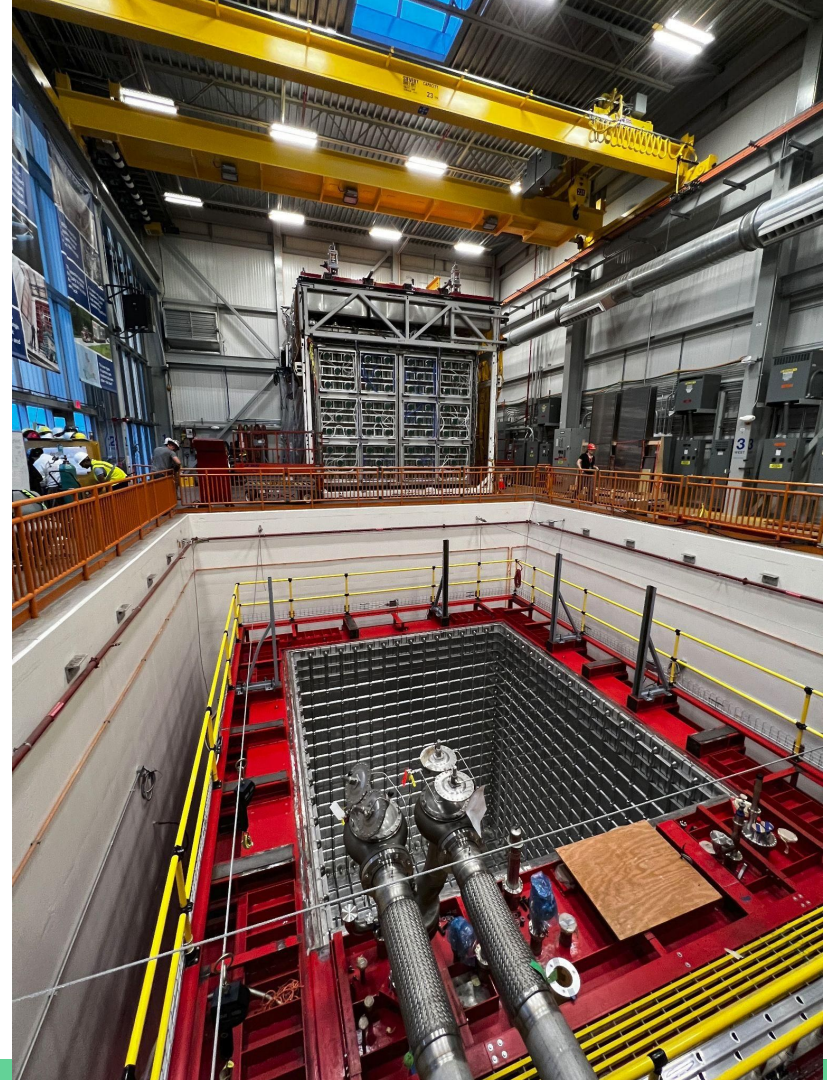
- moved by 3 miles
- Route preparations
 - trees were cut
 - power lines lifted
 - roads were smoothed
- acceleration, tilt and roll data was monitored
 - no cause for concern
 - Detector didn't slip at all



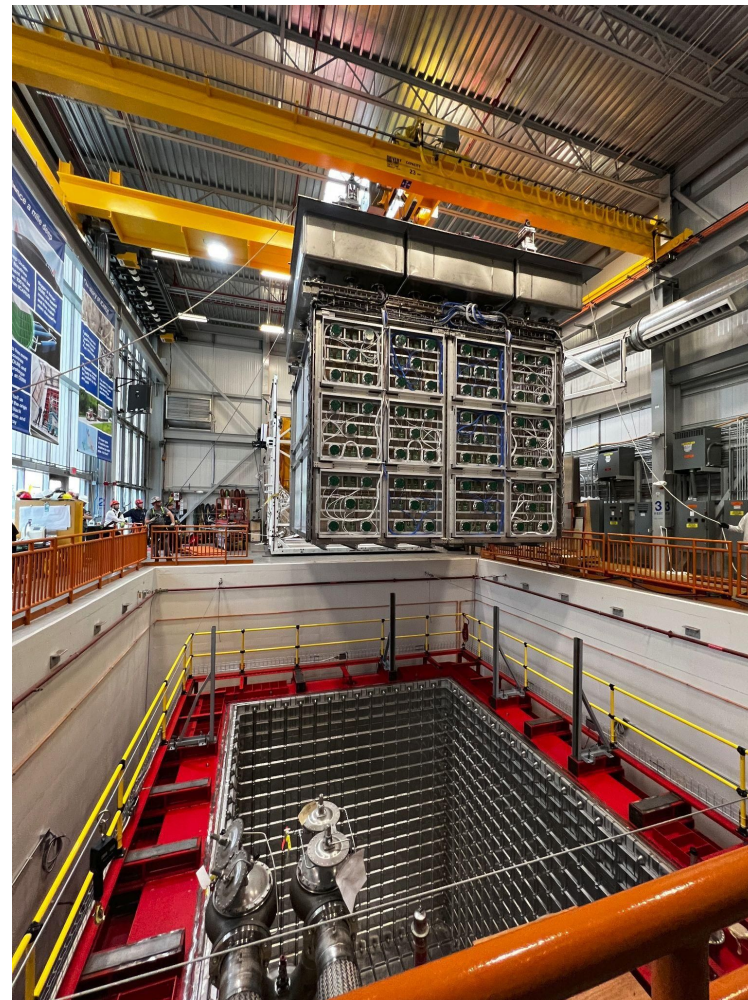
Detector status - the move



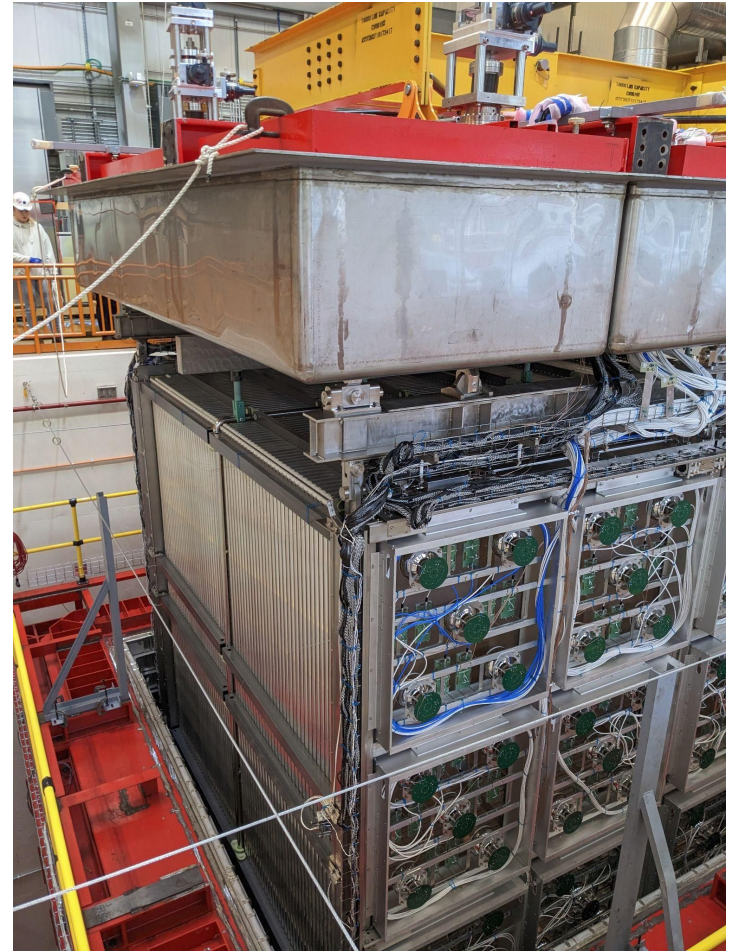
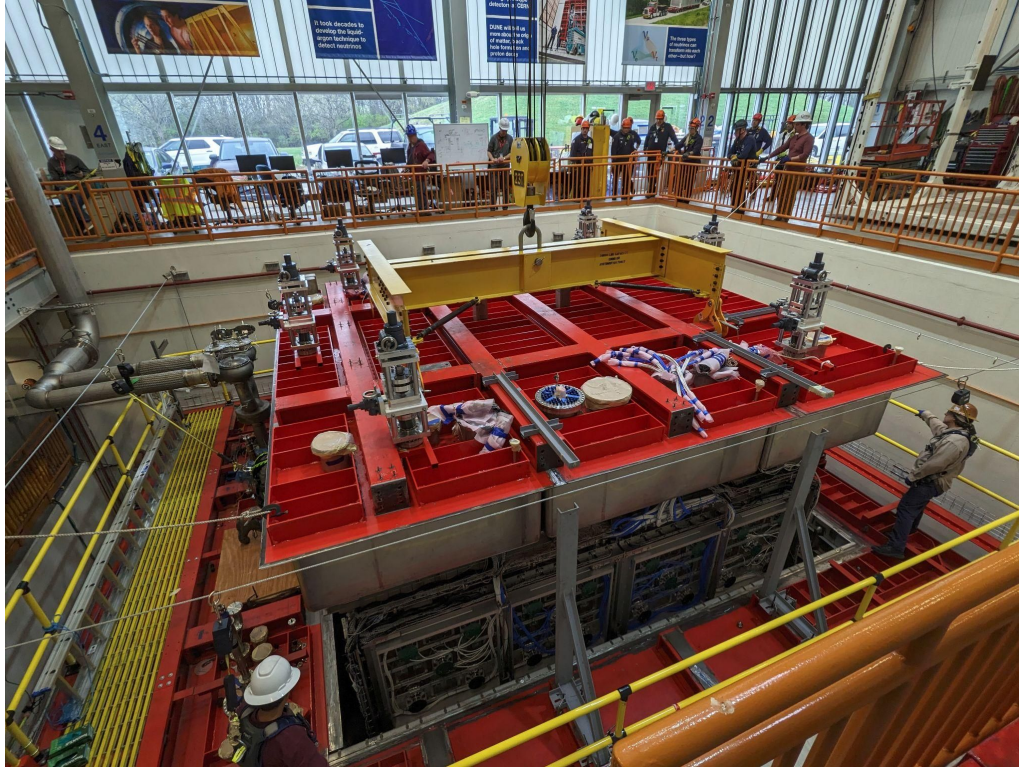
detector status - the rigging



detector status - the rigging



detector status - the rigging



detector status - It's in!



Liverpool team

- Academics
 - Costas Andreopoulos (40% FTE)
 - Liverpool SBND and SBN IB (2020-)
 - SBND Executive Committee (2020-)
 - SBND Physics co-Coordinator (2017-)
 - SBN Oscillation and Systematics WG co-Coordinator (2018-)
 - SBND Speakers committee chair (2019-2022)
 - Kostas Mavrokoridis (<5%) - SBND TPC L2 manager (2015-2019)
 - Christos Touramanis (<5%)
- Research staff:
 - Marco Roda (10%)
 - SBND Simulation and Calibration WG co-Coordinator (2022-)
 - SBN Generators WG co-Coordinator (2018-)
 - David Payne (<5%)
 - SBND Cathode Plane Assembly (CPA) L3 manager (2015-)
 - Soon to move to Fermilab
 - successful URA fellowship to partially cover the expenses
 - First CRT commissioning, then as operation coordinator
- PhD Students:
 - Beth Slater (Yr 2)
 - Thomas Ham - submitted, viva on 25th May

Liverpool contributions

- Cathode plane built in Liverpool
- Students spent time in LTA, contributing to a number of hardware projects
- Key contributions towards physics oscillation and BSM physics
 - For example in the generator working group we just redefined the baseline model for our oscillations
 - It's going to be used not only by SBND and ICARUS
 - But also by DUNE

Summary

- SBND is almost ready to go
 - We were delayed by pandemic, problem with cranes, etc but it seems we are getting there
 - Data will start piling up data quickly
 - Unprecedented statistics for neutrino physics
 - Physics analyses will be possible with just a month of data
- SBN(D) has a very interesting physics programme
 - Sterile Neutrino oscillations
 - Neutrino cross section
 - BSM
- Liverpool made important hardware + physics contributions in past 5+ years
 - as we approach the physics exploitation phase, Liverpool effort is subcritical
 - 0.6 FTE spent amongst 5 academics and research staff
 - 1 active PhD student (from 5 a bit over a year ago)
 - We have an opening position for a PostDoc
 - Main goal to work on the first analyses

Backup
