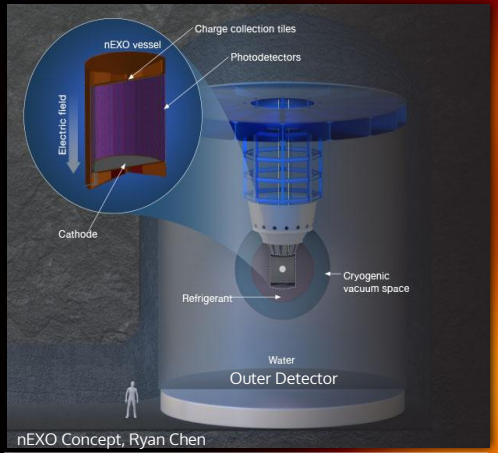
A First Look: Supernova Neutrino Detection with nEXO

Soud Al Kharusi, Daryl Haggard, Thomas Brunner (McGill University)

nEXO is a proposed neutrinoless double beta decay ($0\nu\beta\beta$) search in ^{136}Xe [1]. Low background requirements necessitate a **water-Cherenkov muon veto**, dubbed nEXO's **Outer Detector (OD)**, which may be sensitive to neutrino interactions.

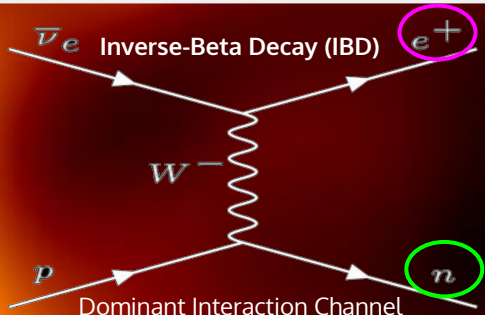


nEXO Concept, Ryan Chen

When the most massive stars end their lives, they explode in a **core-collapse supernova (CCSN)** and emit a neutrino burst lasting ~10 s across all (anti-) neutrino flavours.

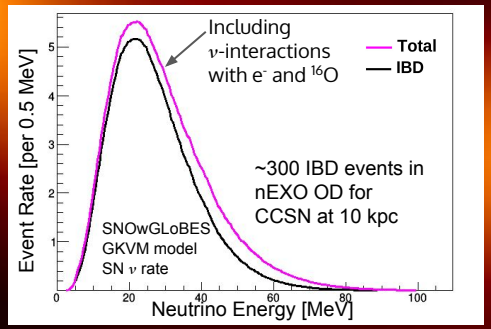
By studying the relative numbers, energies, and arrival times of the various neutrinos we learn about: neutron star and black hole formation, neutrino masses [2], and exotic physics that is difficult to probe in the lab [3].

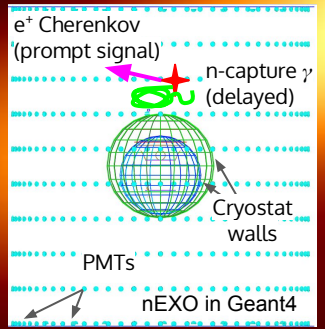
Using canonical supernova neutrino spectra, we calculated event rates in our Outer Detector (1.7 kt water) with SNOwGLoBES [4].

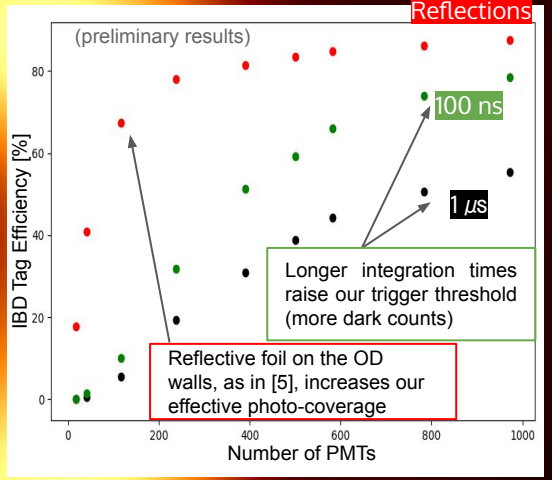


We distributed IBD products in the Outer Detector, and modelled our PMTs in Geant4 Monte Carlo (including quantum efficiency, dark rate, charge collection, and optical effects).

IBD tags require two triggers separated by 10-1000 μs







We are investigating the physics gains of adding dopants to the water (Gd, WbLS) as we develop event localization and background rejection algorithms. We are also evaluating our energy resolution, and scoping out the full supernova reach of nEXO.

References
[1] Albert et al., Phys. Rev. C 97, 065503 (2018)
[2] Scholberg, J. Phys. G: Nucl. Part. Phys. 45 014002 (2018)
[3] Turner, Phys. Rev. Lett. 60, 1797 (1988)
[4] https://github.com/SNOwGLoBES/
[5] Aprile et al., JINST 9 P11006 (2014)

Special thanks to:
L. J. Kaufman (SLAC), R. Tsang (PNNL), T. McElroy (McGill)

Contact: www.physics.mcgill.ca/~soudal
(presented June 2019)

Background image: SN1987A in the Radio (7mm), credit: ICRAR