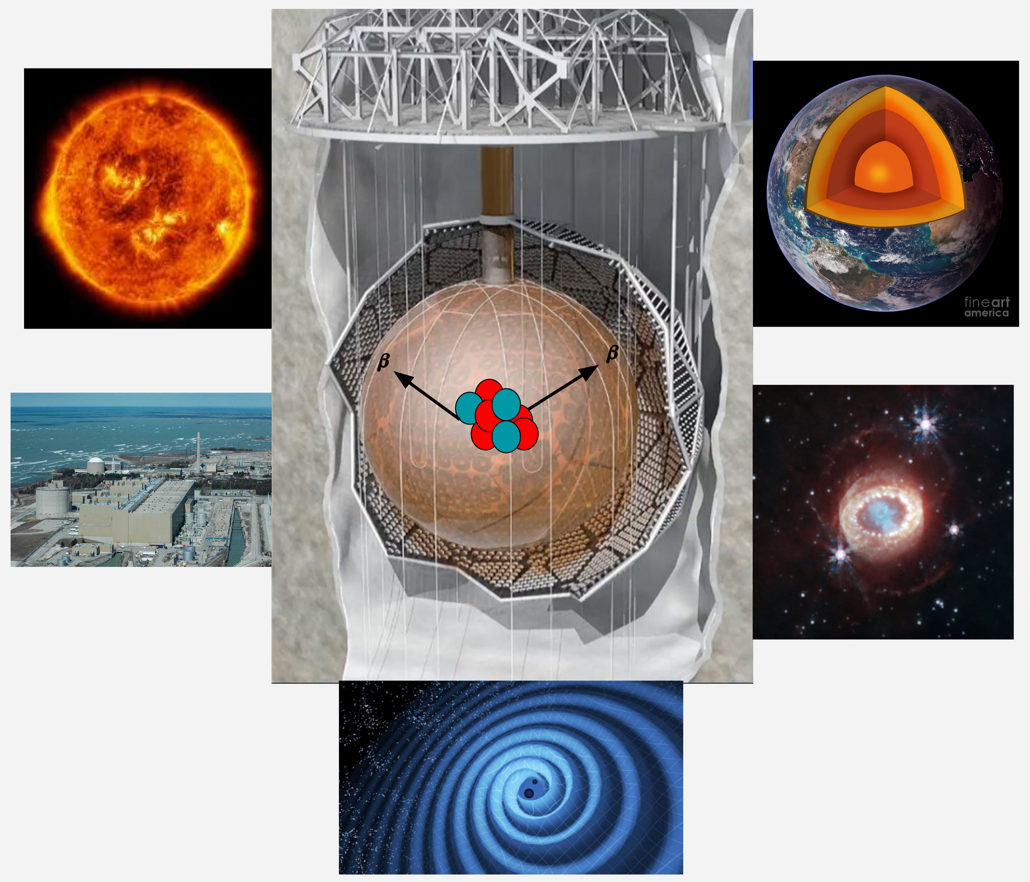
A Search for MeV-Scale Neutrinos Coincident with O4 Gravitational Wave Events in SNO+

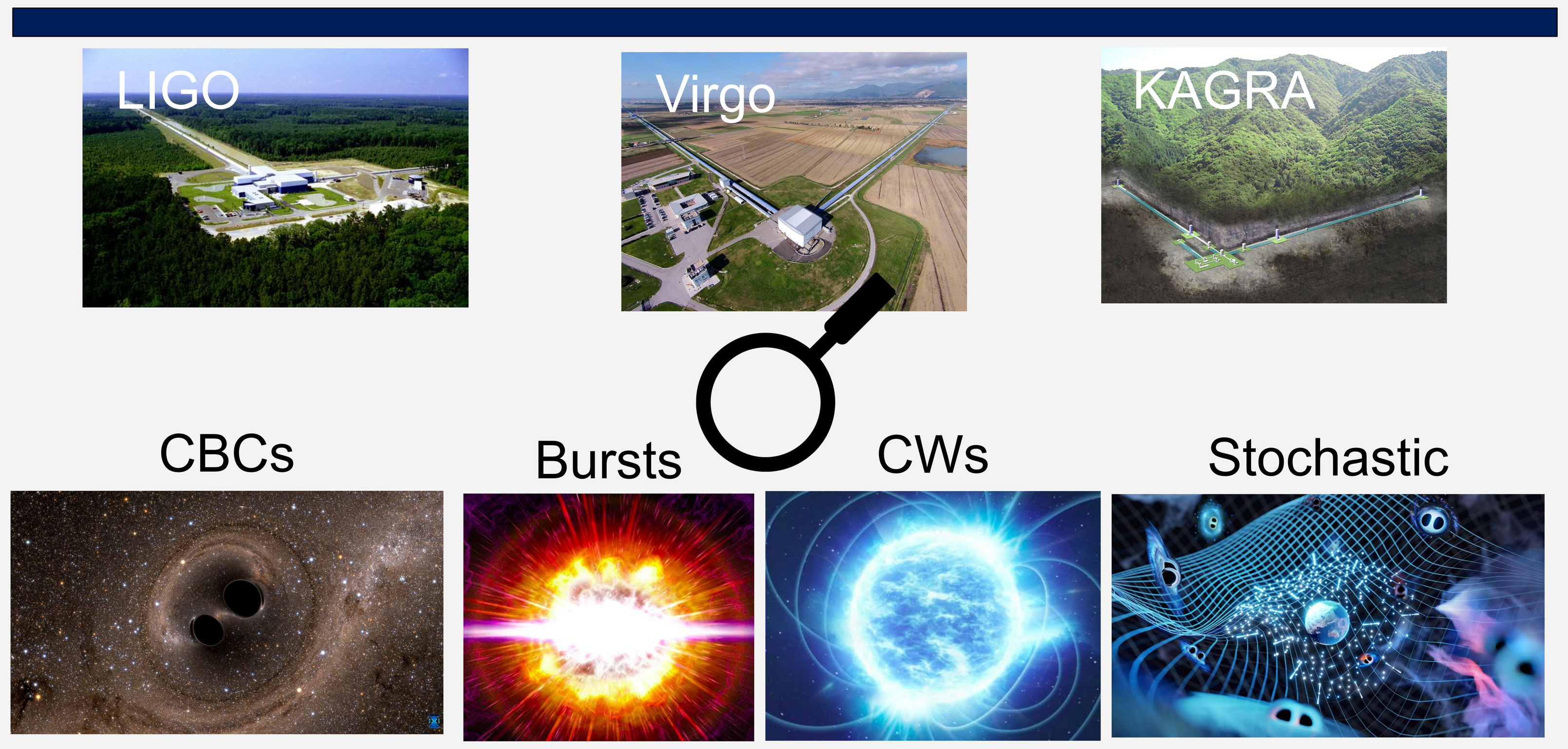
Amanda Bacon
on behalf of the SNO+ collaboration

The SNO+ Experiment

- SNO+ is a 780 tonne liquid scintillator experiment located 2 km underground in Ontario, Canada. Its primary physics goal is the search for neutrinoless double beta decay.



Gravitational Waves (GWs)



- CBCs may emit MeV neutrinos through accretion disks, relativistic outflows, or remnant neutron star activity.
- A coincident neutrino signal would provide complementary information about GW sources.

Previous Results

- Existing GW neutrino searches have established fluence limits between 10^{7} and 10^{12} cm^{-2} depending on neutrino energy. SNO+ extends these searches using a large target in a deep location.

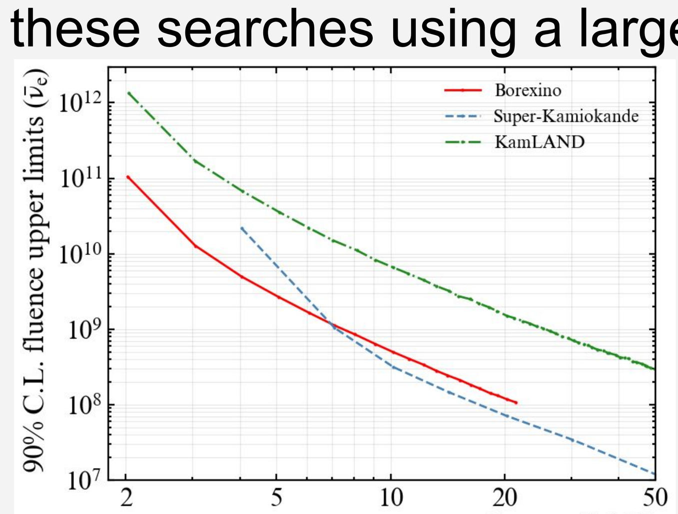
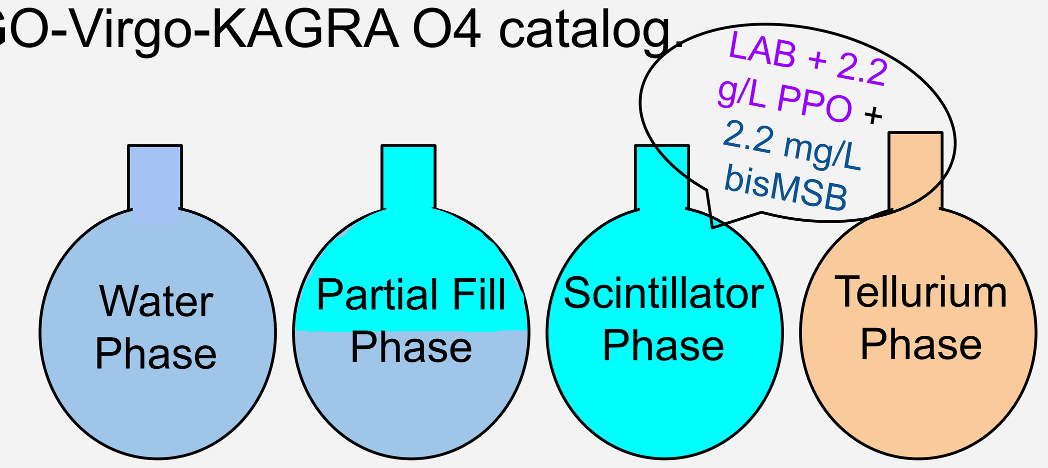
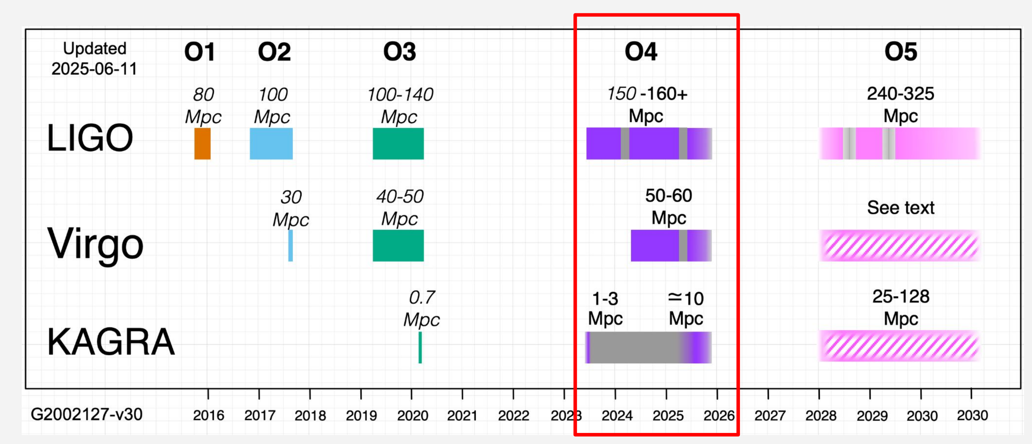


Fig. 1: Plot of Borexino (2023), Kamland (2020), and Super-Kamiokande (2021) 90% confidence level fluence upper limits for the inverse beta decay (IBD) interaction.

SNO+ Search

- This search uses SNO+ scintillator phase data collected during the LIGO-Virgo-KAGRA O4 catalog.





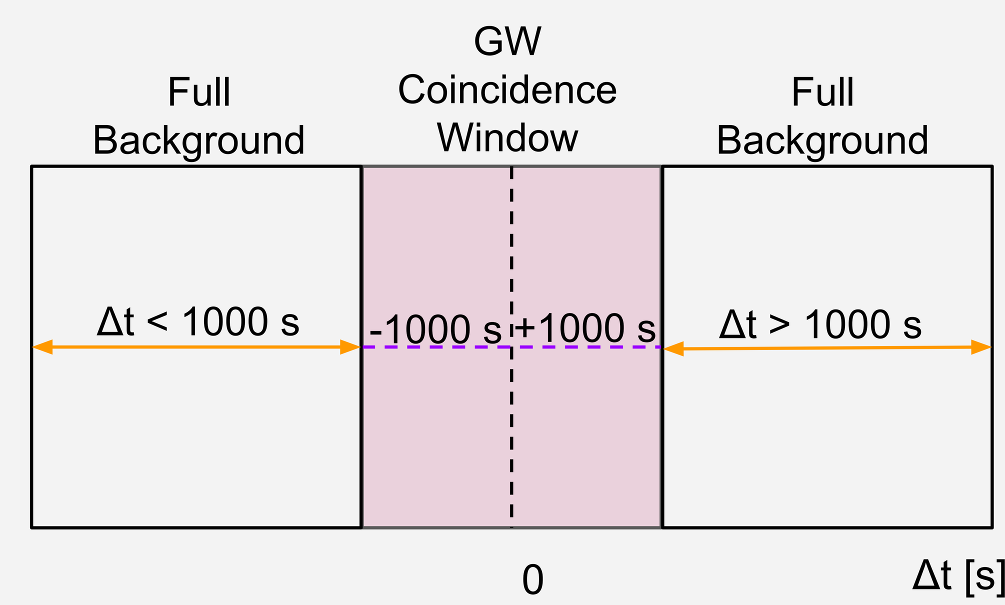
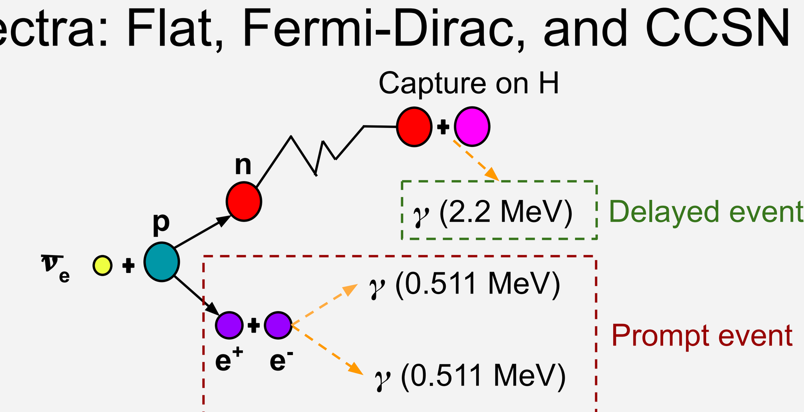


Fig. 2: Diagram of neutrino coincidence (±1000 s), background sideband, and full background windows.

Results

- 126 O4 GW coincidence windows analyzed.
- No IBD candidates observed.
- 90% C.L. fluence limits established. Limits improve upon Borexino in the 2-5 MeV range
- Emission Spectra: Flat, Fermi-Dirac, and CCSN



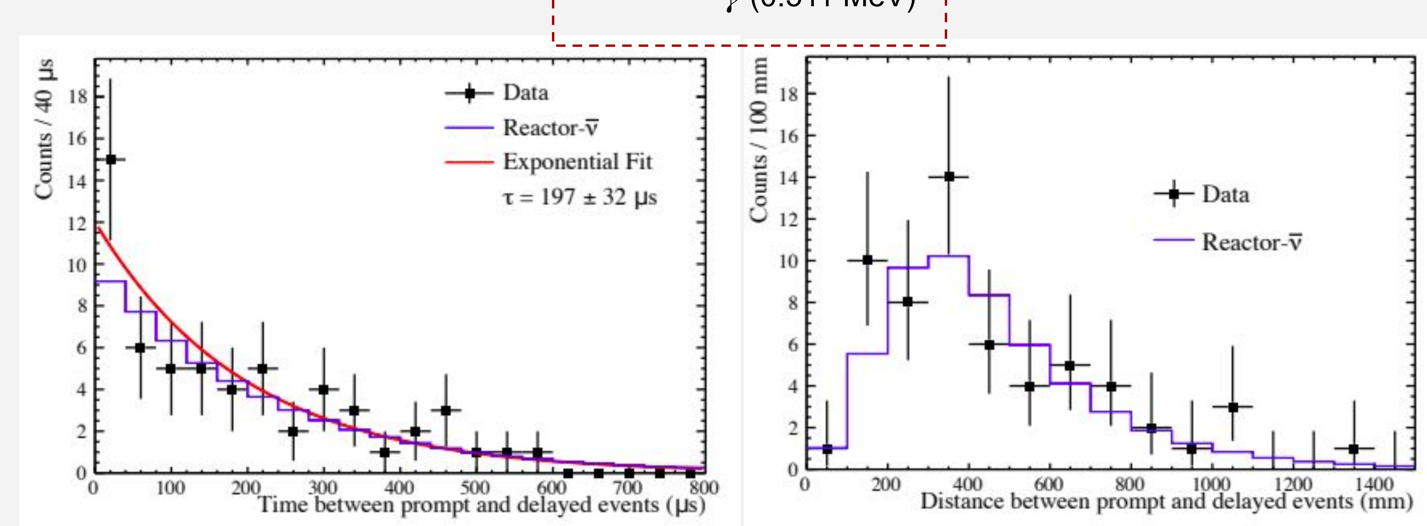


Fig. 3 & 4: Distance and time between prompt and delayed events (Δt and Δr) for both data and reactor IBD simulation. The exponential fit (red) results in a neutron capture time constant of (197 ± 32) μs.

Results (Cont.)

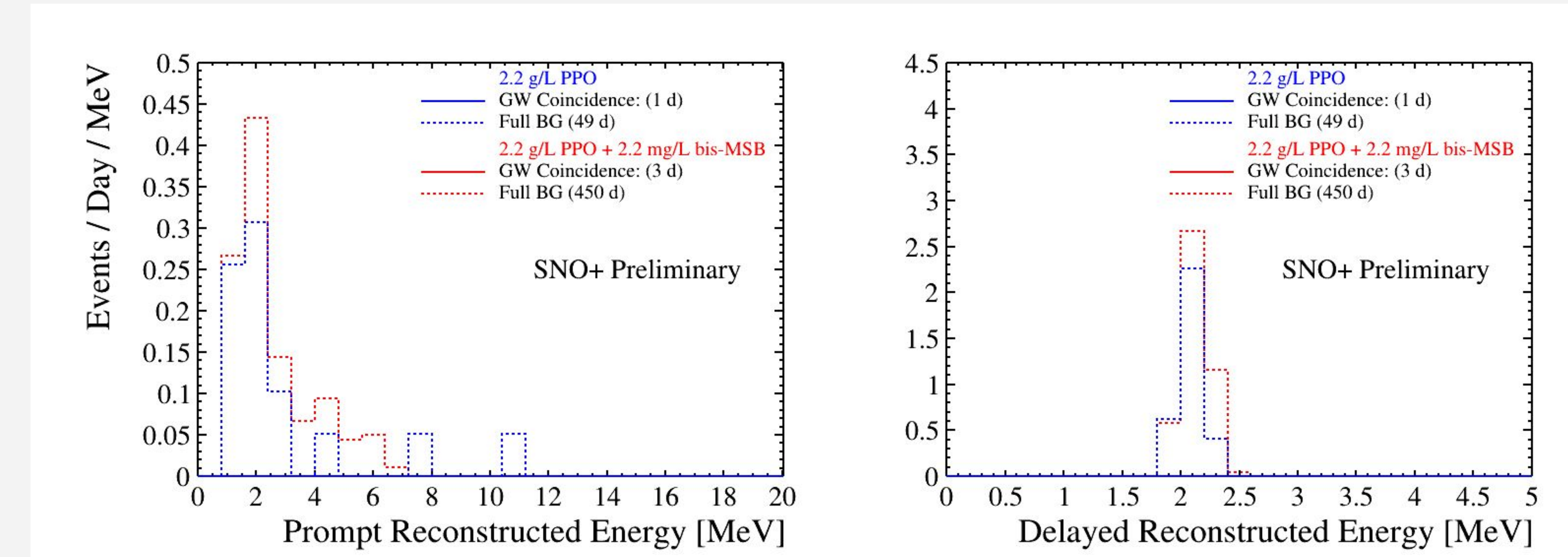


Fig. 5 & 6: No IBD candidates were tagged in the coincidence windows. Candidates tagged in the background windows are consistent with reactor and solar analyses.

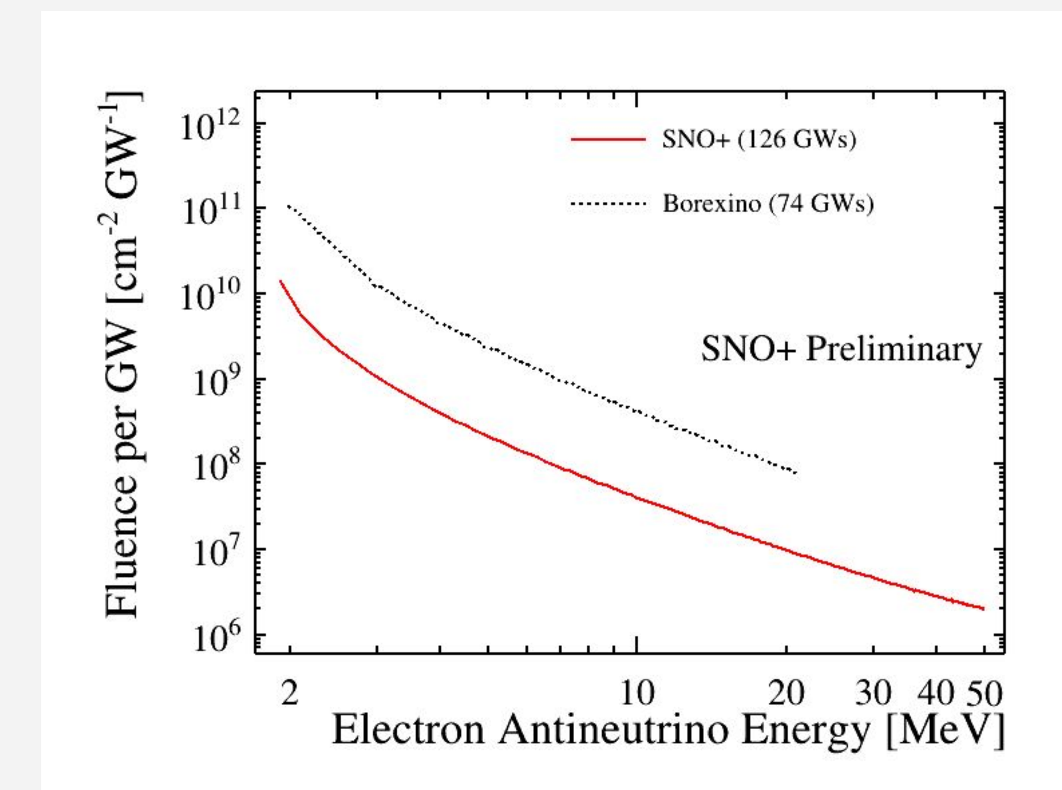


Fig. 7: SNO+ 90% confidence level fluence upper limit insensitive to merger type compared to Borexino (2023).

Conclusions

- No significant excess of IBD candidates observed.
- SNO+ sets the most stringent GW-neutrino fluence limits in the 2-5 MeV energy range.
- Future work: neutrino-proton ES channel

Acknowledgements

This material is based upon work supported by the U.S. Department of Energy, Office of Nuclear Physics under Award Number DE-FG02-88ER40479.