Supernova Neutrino Sensitivity of the COSINUS Experiment

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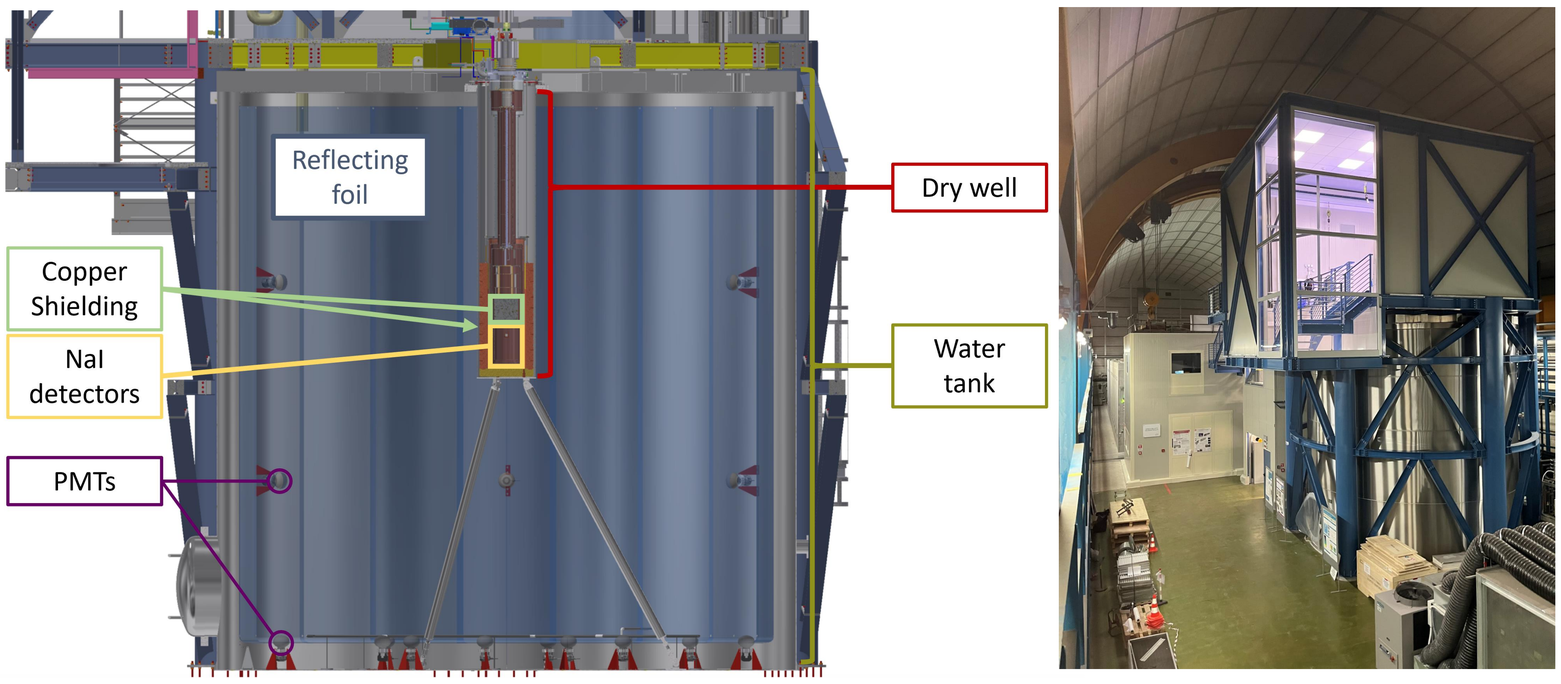
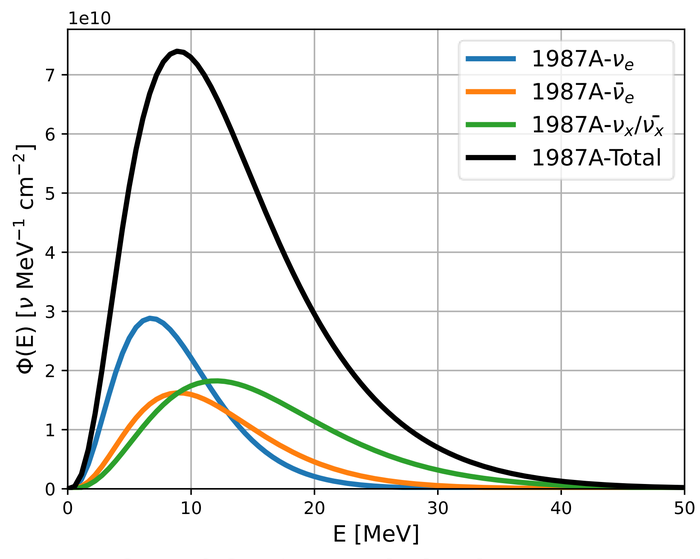
COSINUS Facility

- Direct search for dark matter using cryogenic sodium iodide (NaI) calorimeters
  - Distinguish nuclear recoils from electromagnetic interactions by measuring heat and light
  - First data taking is planned late 2024/early 2025
- Located in Laboratori Nazionali del Gran Sasso (LNGS)
- 7 m diameter by 7 m tall Cherenkov muon veto with 30 PMTs and 230 tonnes of water

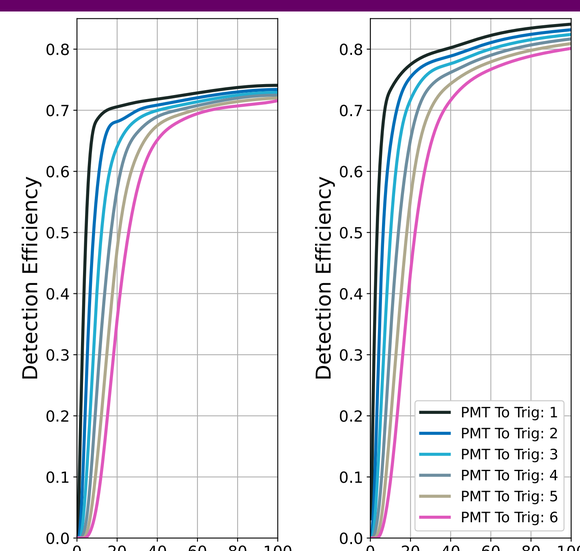


Input Parameters

- Use two fluence models for supernova neutrinos
  - Quasi-thermal model fit to SN1987A events[a]
  - 27 Solar mass simulation[b]
- Use GEANT4 to calculate detector efficiency of muon veto[c]



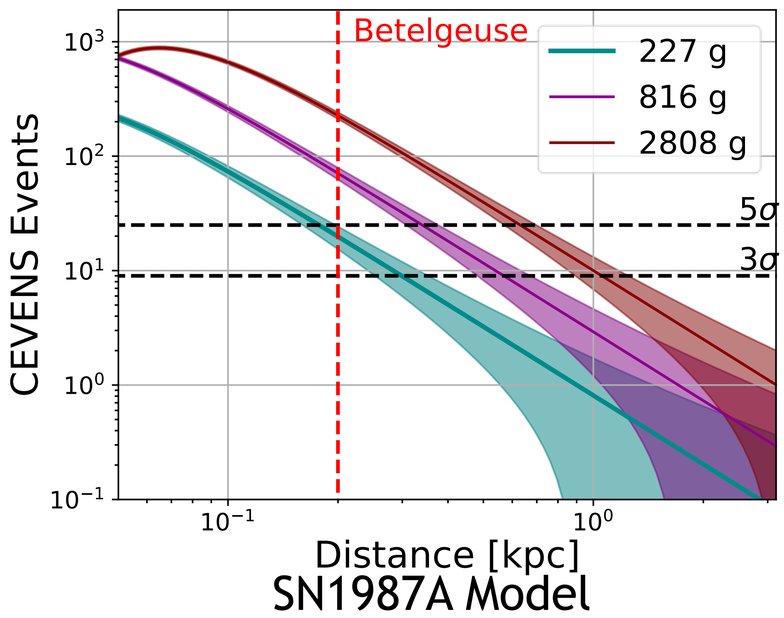
SN1987A Model Fluence



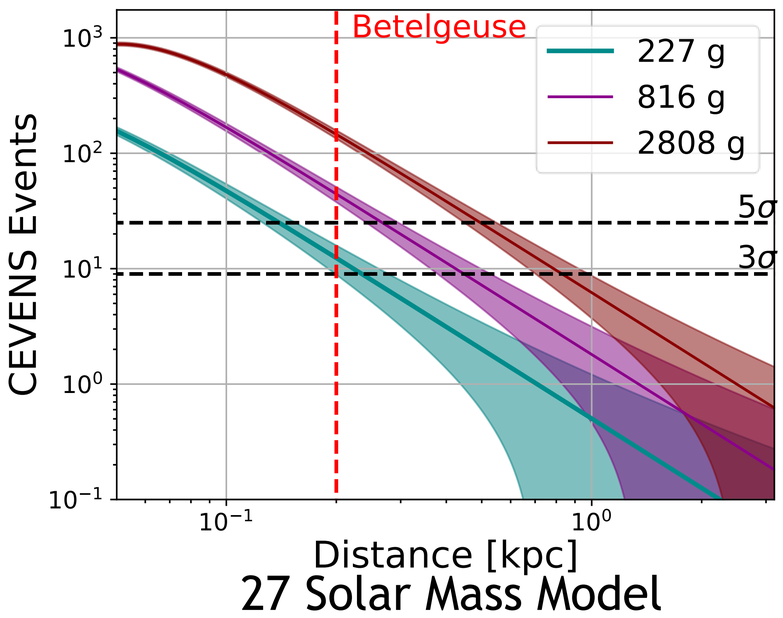
Muon Veto Efficiency

NaI Calorimeter Sensitivity

- NaI is sensitive to CEvNS which is flavor independent
  - Number of CEvNS events shown in figures to the right
- Charged current interaction on ^{127}I from a supernova at 200 pc produces 1 event
- Calorimeters are sensitive up to 1.06 kpc away



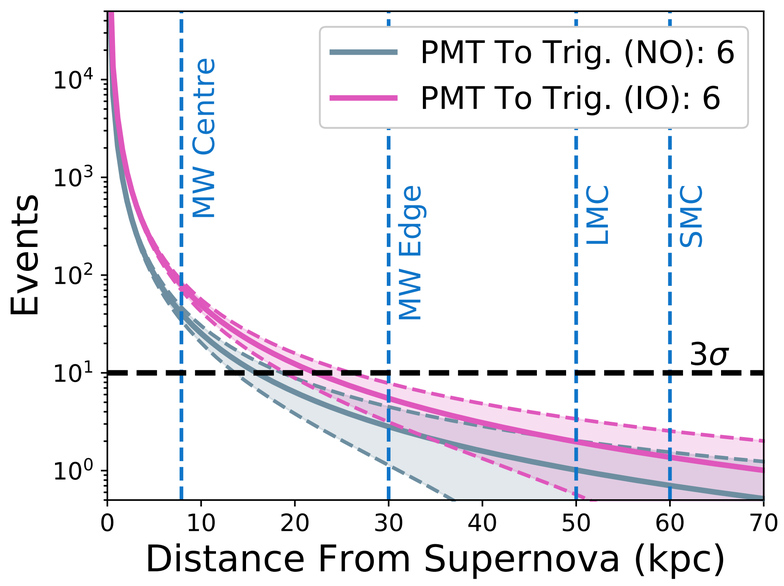
SN1987A Model



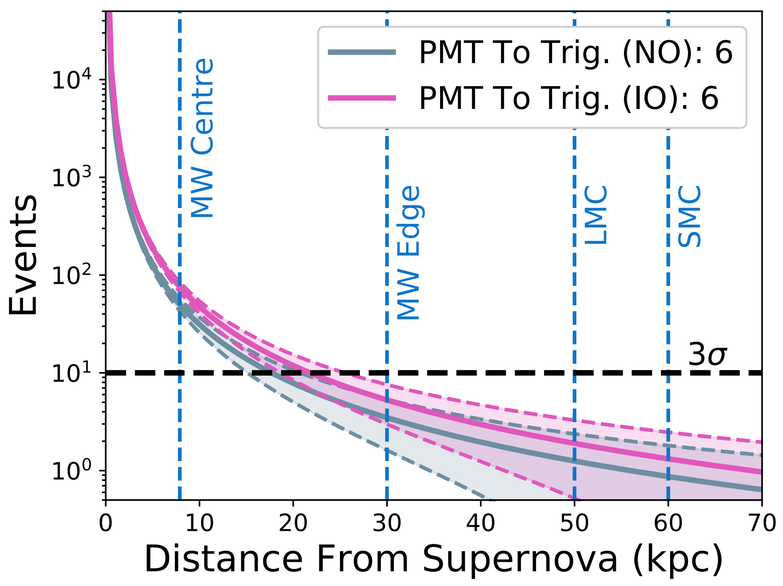
27 Solar Mass Model

Muon Veto Sensitivity

- Several neutrino processes in water were calculated[e]
  - 85% of events are from inverse beta decay
  - These calculations include oscillations in vacuum to and from electron neutrinos[f]
- Water tank is sensitive to 16 kpc assuming normal ordering and 1987A fluence



SN1987A Model



27 Solar Mass Model

[a]Odysse Halim *et al* JCAP11 021 (2021)
[b]Irene Tamborra, *et al* Phys. Rev. Lett. 111 121104 (2014)
[c]Angloher, G et al. *Eur. Phys. J. C* **84**, 551 (2024).
[d] Daniel Z. Freedman Phys. Rev. D 9, 1389 (1974)
[e]K Scholberg et al. Snowglobes. software package. https://webhome.phy.duke.edu/~schol/snowglobes/.
[f]A. S. Dighe and A.Y. SmirnovPhys. Rev. D 62, 033007 (2000)