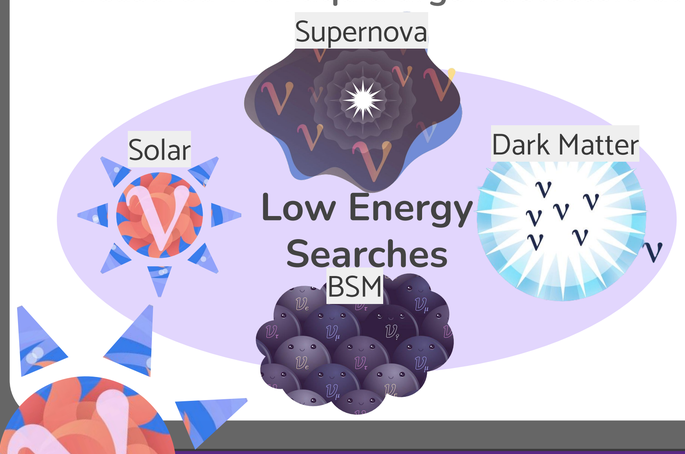
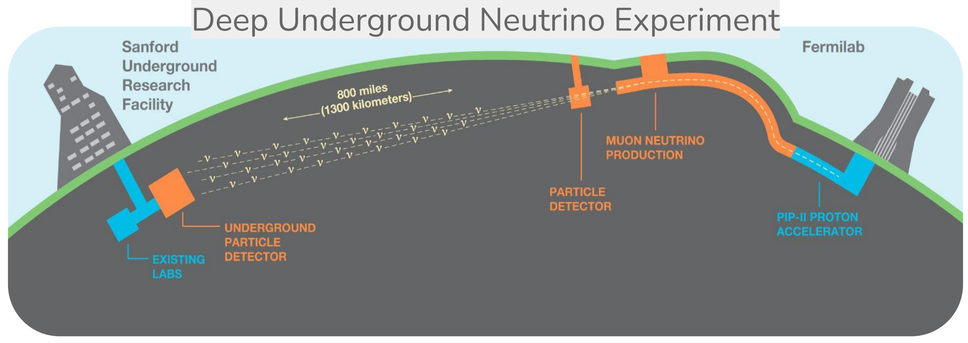
DUNE LOW ENERGY PHYSICS SEARCHES

S. Manthey Corchado for the DUNE collaboration

Deep Underground Neutrino Experiment

DUNE: Long-baseline **neutrino oscillation experiment** with a 1.2 MW beam produced at Fermilab (Illinois, USA), characterised with a **ND complex** and measured with **liquid argon detectors** at SURF (South Dakota, USA), **1.5 km underground**.





DUNE Far Detector (FD) modules [1]:

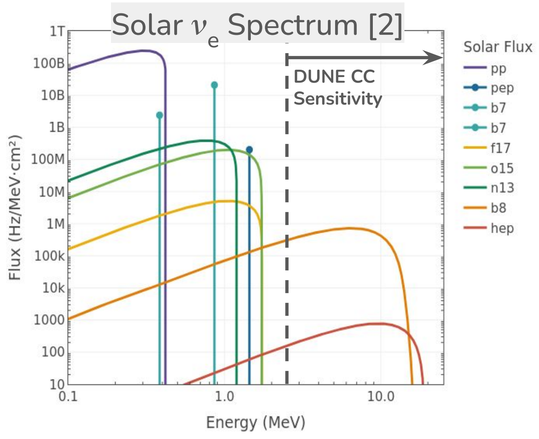
- Excavation ready to host 4 detectors.
- Baseline: 17 kT LAr ~ 66 x 19 x 18 m³.
  → 4th **Module of Opportunity**.

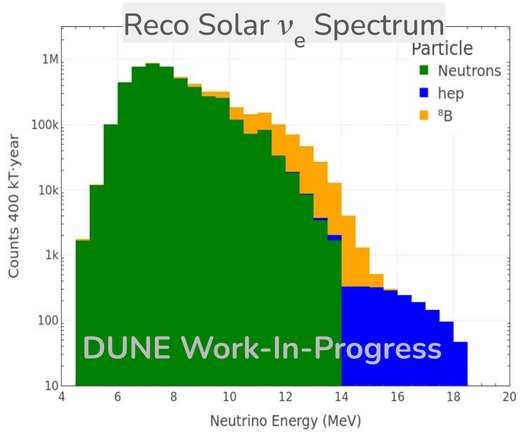
Liquid Argon TPC technology:

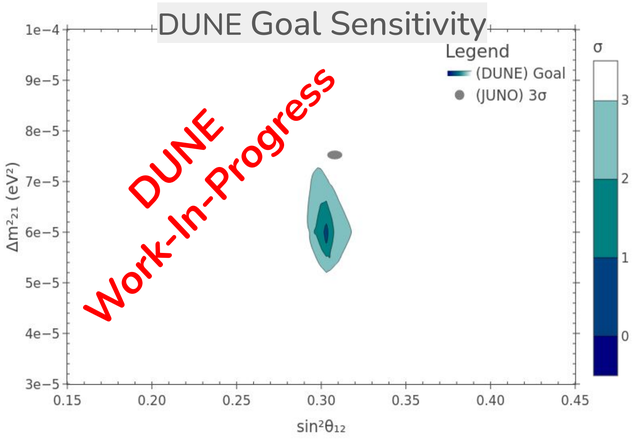
- High density (1.4 g/cm³).
- Ionization (42k e^-/MeV) @ 500 V/cm.
- Scintillation (24k photons/MeV) @128 nm.
- 3D reconstruction & particle ID.

Solar Neutrino Sensitivity

DUNE will be sensitive to solar neutrinos **1.5 - 19 MeV (Q-Value - hep).** Mostly detected via **CC-reaction ^{40}Ar (ν_e, e^-) ^{40}K* interactions.** Per 70 kT · year exposure → **171 k CC ν_e** events. Considering 100% flash-matching background events can be fiducialized.







Solar Neutrino Analysis:

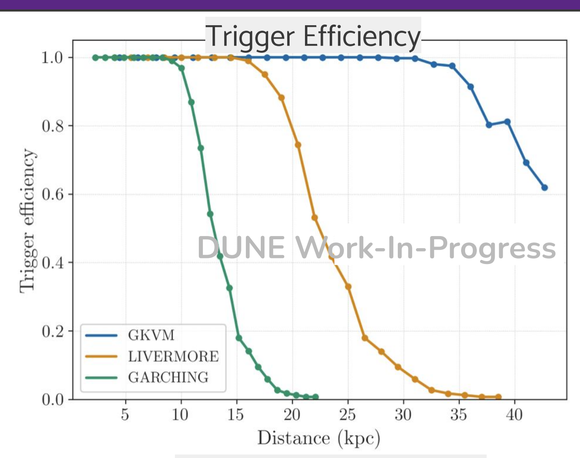
- ~16% energy resolution.
- **Neutron captures on ^{40}Ar/^{36}Ar**, main bkg. due to penetration and topology.
- **S/B 119%** (> 10 MeV).
- Measured day-night asymmetry 4.64% within first year of data.

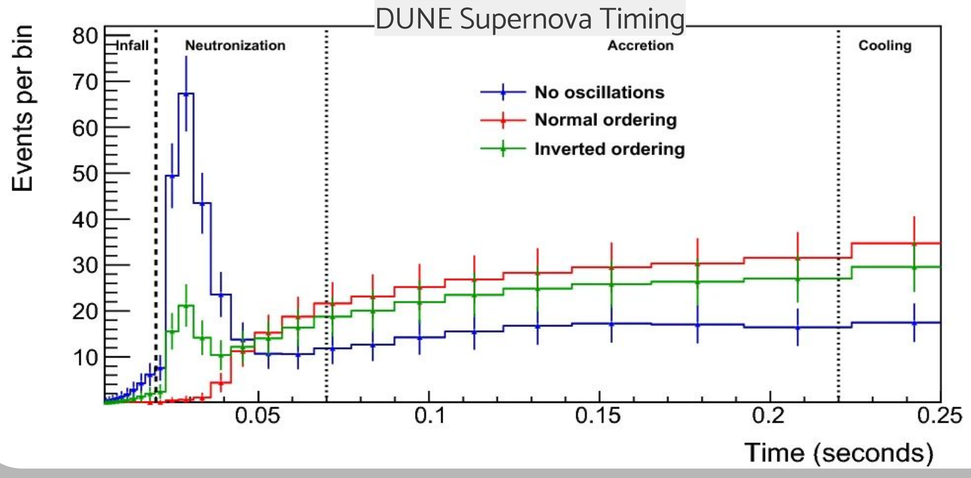
Core-Collapse Supernova: Detection

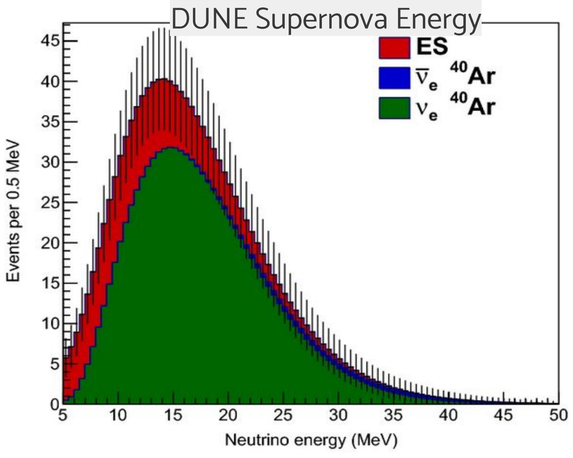
Core-collapse supernovae are a huge source of ν's of all flavors. **Expected 1-3 SN/century** in our Galaxy (10 kpc) [3].

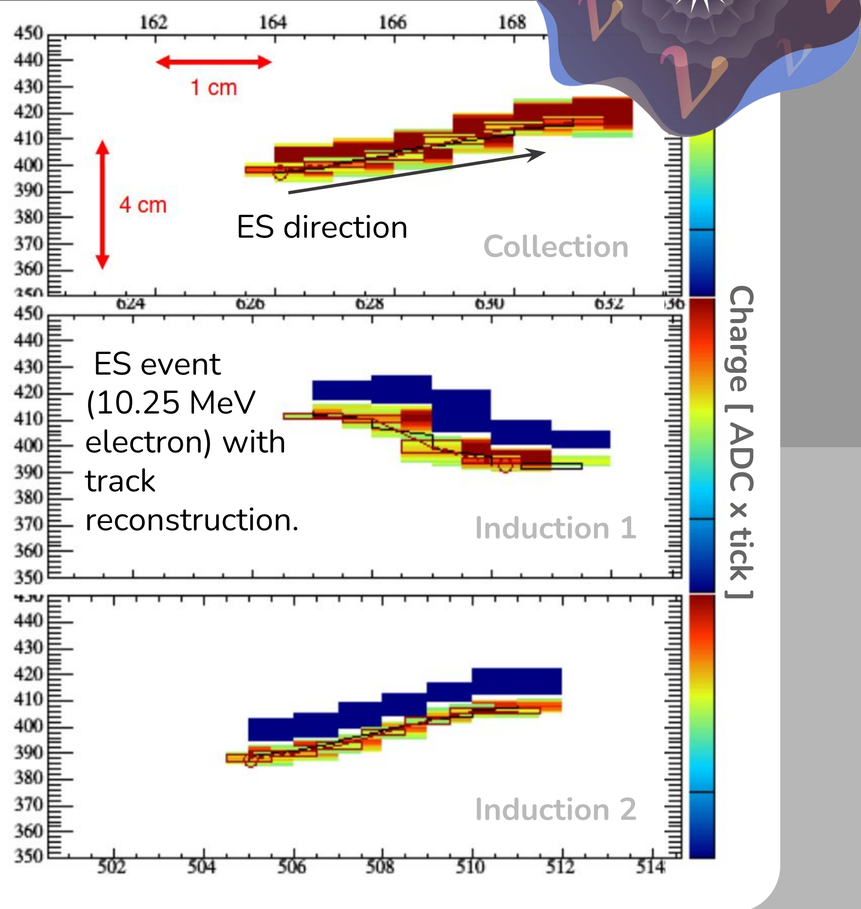
DUNE will participate in **S**uper**N**ova **E**arly **W**arning **S**ystem (**SNEWS**) & provide information about:

- Core-collapse mechanism and model.
- SN evolution in time (evaluate black hole formation).
- Flavor oscillation, absolute mass, etc.





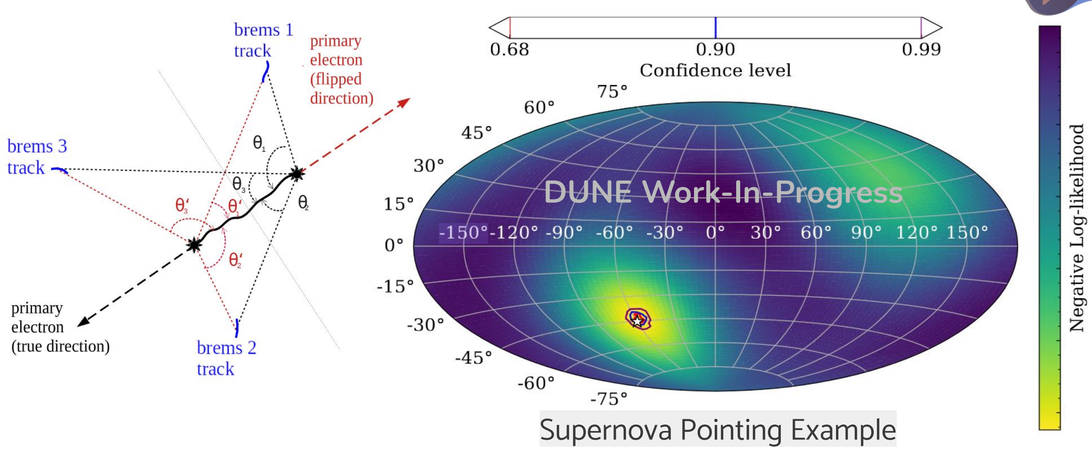




Core-Collapse Supernova: Pointing

Ongoing **pointing efficiency studies estimate 4.3°** resolution assuming 40 kT exposure and 4% CC interaction misidentification [4].

- **Brems-Flipping algorithm:**
  To distinguish forward vs reverse direction improves pointing.



Supernova Pointing Example

References

[1] DUNE Collaboration, Far Detector Technical Design Report, Volume I: Introduction to DUNE, JINST 15 (2020) T08008, arXiv:2002.02967 (2020).

[2] Vinyoles, Núria, et al. A new generation of standard solar models. Astrophys. J. (2017).

[3] Abi, Babak, et al. Supernova neutrino burst detection with the Deep Underground Neutrino Experiment. Eur. Phys. J. C 81(5), 423 (2021).

[4] DUNE Collaboration, Supernova pointing capabilities of DUNE. Publication pending.

Further Studies (Work In Progress)

- ML methods for on-line pointing → multi-messenger observation.
- DSNB (high statistics due to CC channel and huge exposure).
- Constraints on NSI with solar neutrinos.
- Limits on light galactic DM candidates.

Plan de Recuperación, Transformación y Resiliencia

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