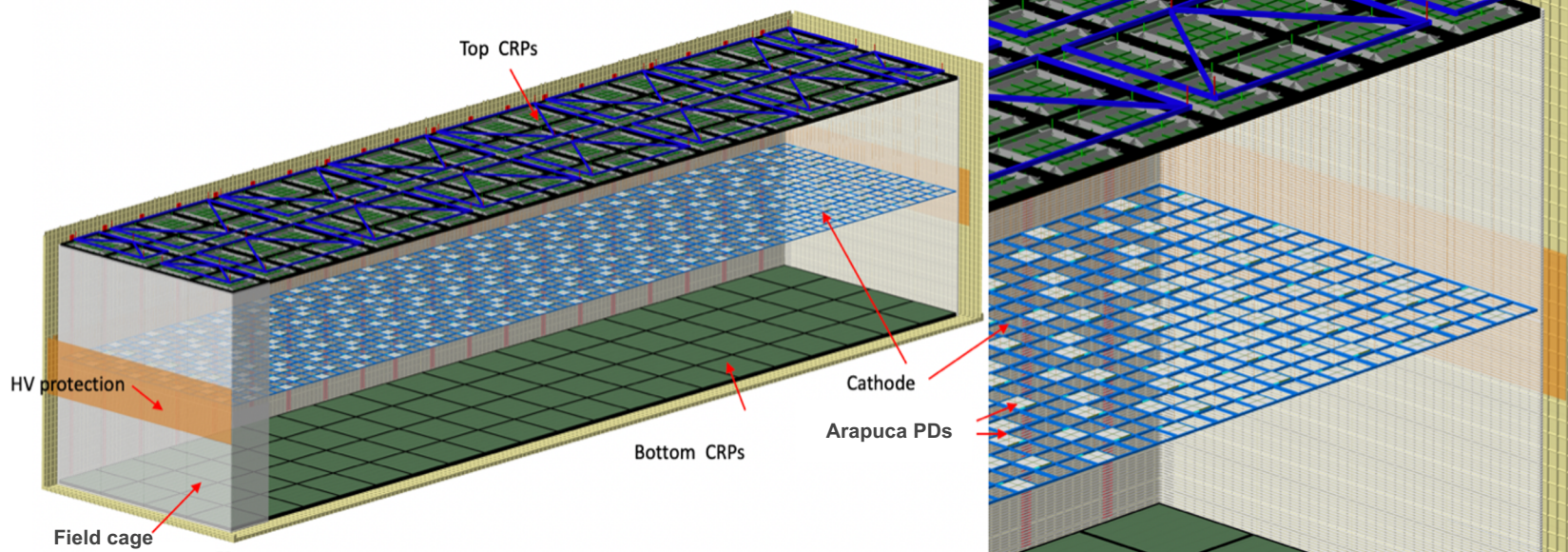


VD Physics with Reference Photon System



Kate Scholberg
(Duke University)
10 May 2021

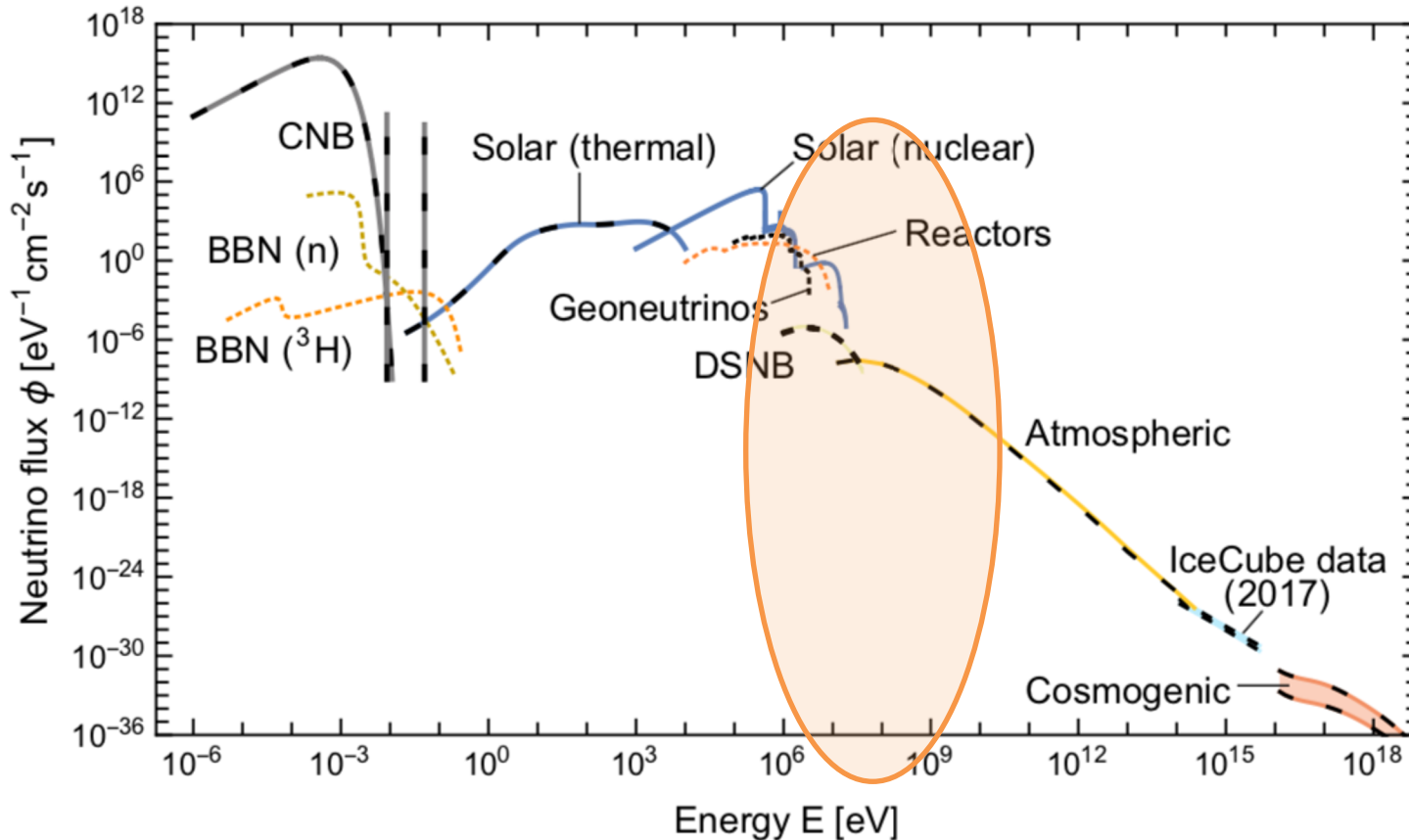
DUNE Physics Signals

Grand Unified Neutrino Spectrum at Earth

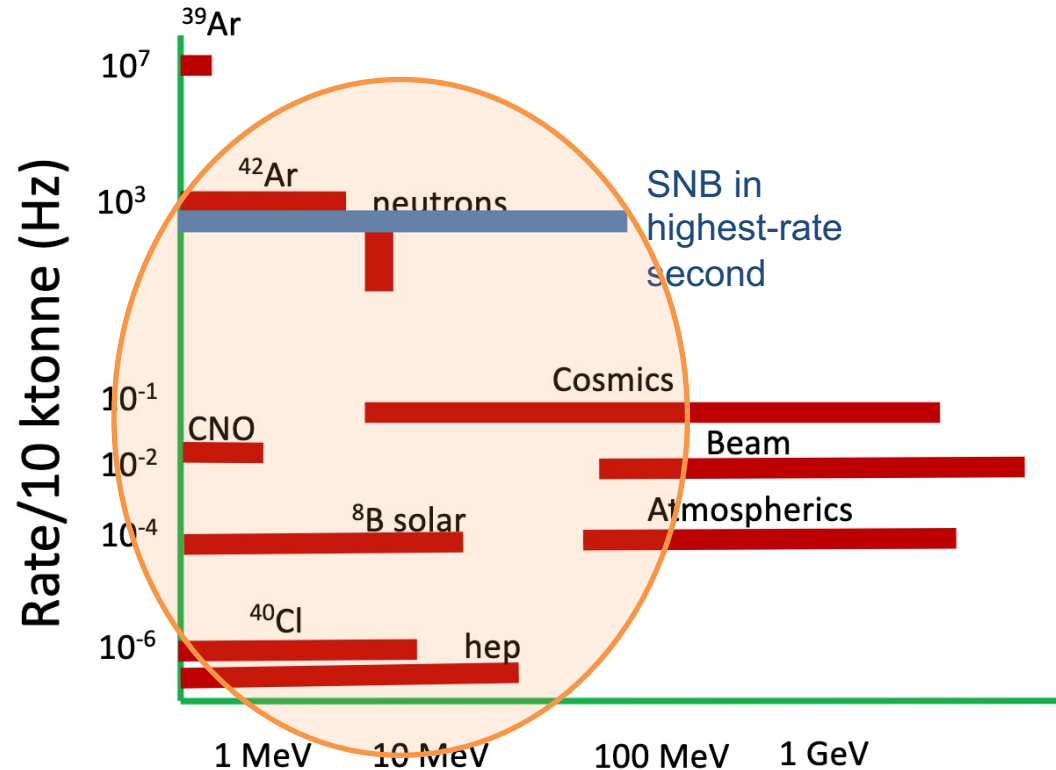
Edoardo Vitagliano, Irene Tamborra, Georg Raffelt. Oct 25, 2019. 54 pp.

MPP-2019-205

e-Print: [arXiv:1910.11878](https://arxiv.org/abs/1910.11878) [astro-ph.HE] | [PDF](#)

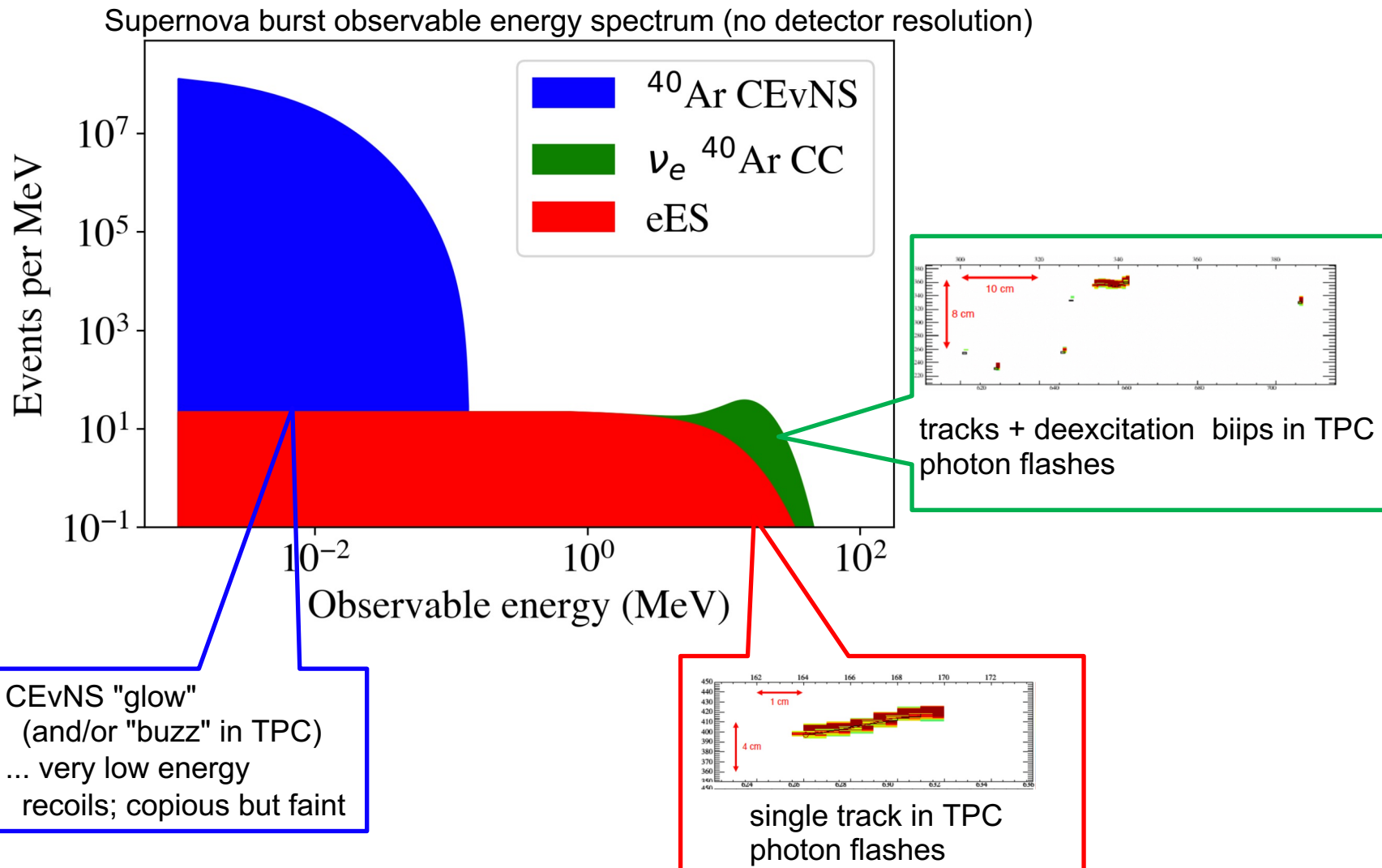


DUNE Physics Signals



Will comment here mostly on low-energy physics enabled by photon detection, with emphasis on supernova burst physics (others have similar issues)

Low-Energy Physics Signals in DUNE

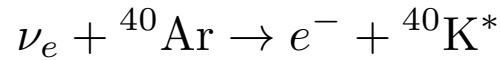


Photons Matter for Low-Energy Signals

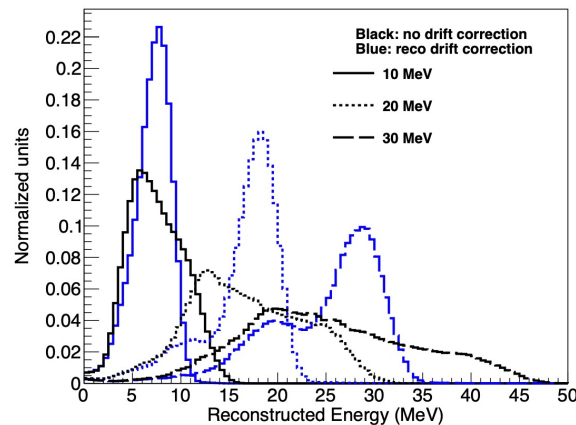
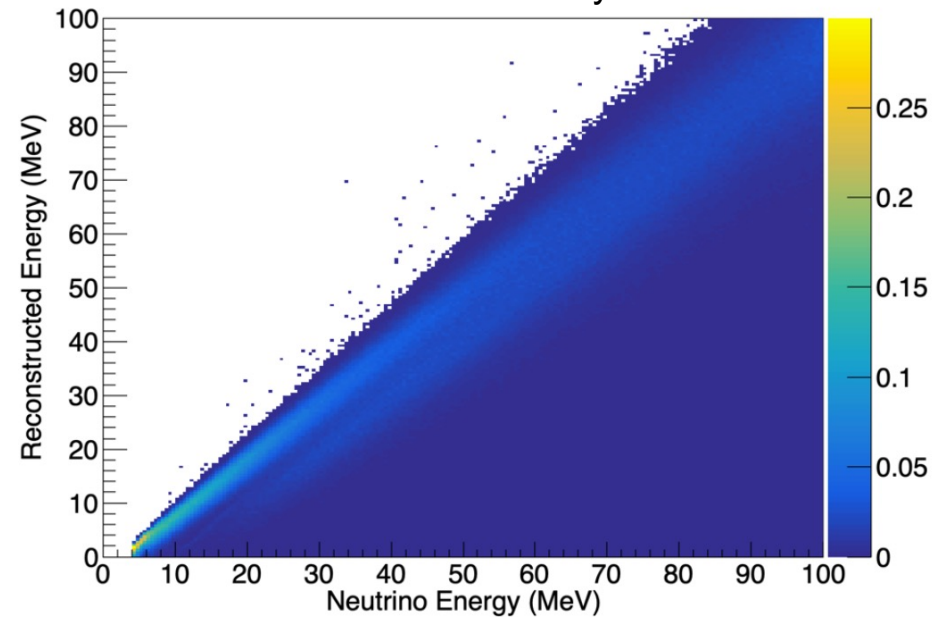
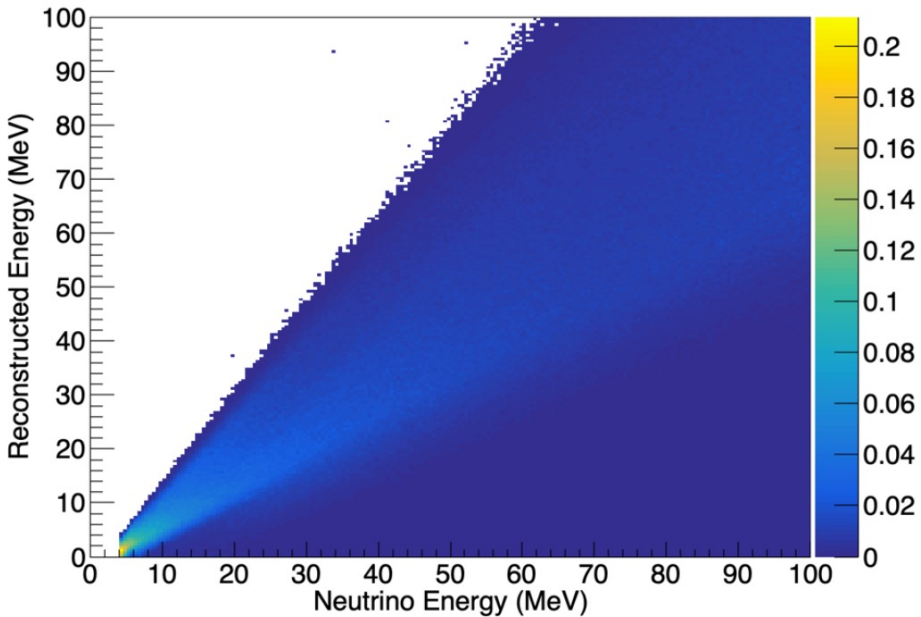
- Energy resolution:
 - drift-time correction for TPC
 - photon calorimetry
- Absolute event timing
- Position resolution (bg rejection, reconstruction)
- Enhanced triggering, event selection, channel tagging

Will look at some examples of
detector parameter impact on physics

Energy resolution: drift time correction

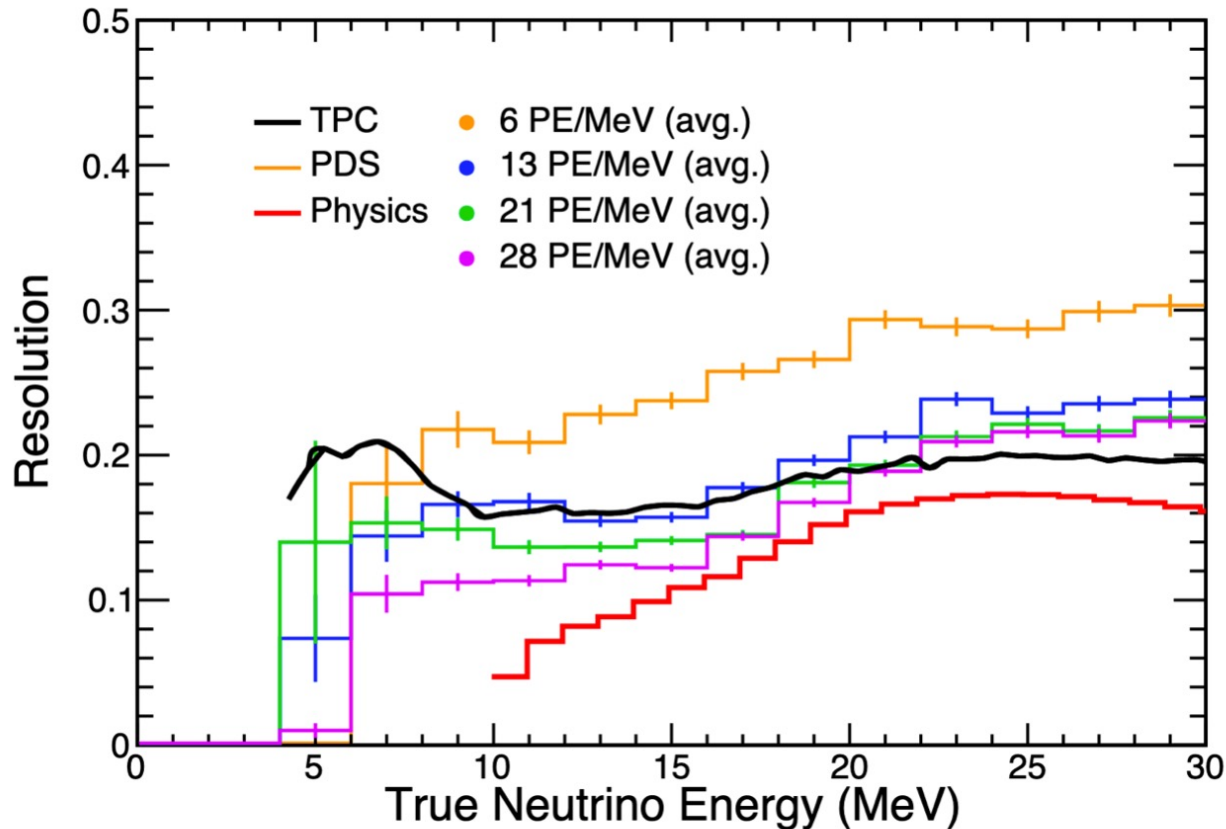


SP study



[Note: limited by final-state product distribution...
"physics" resolution]

Energy resolution: TPC and photons

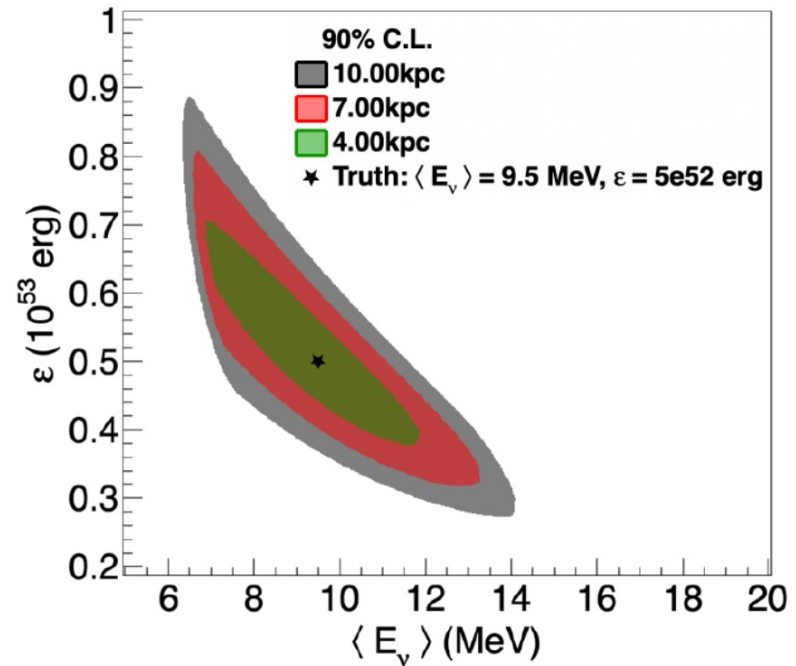
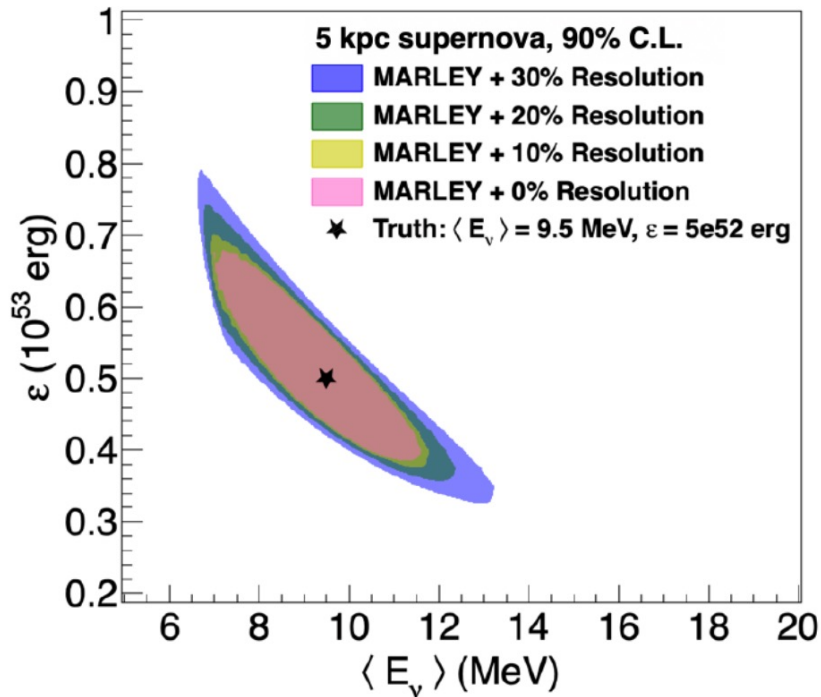


More photons will help, both with photon calorimetry,
 and with improved drift correction... approach "physics" resolution
 Combination of TPC+PDS also helps

Effect of energy resolution on SNB physics

Fit to spectral parameters

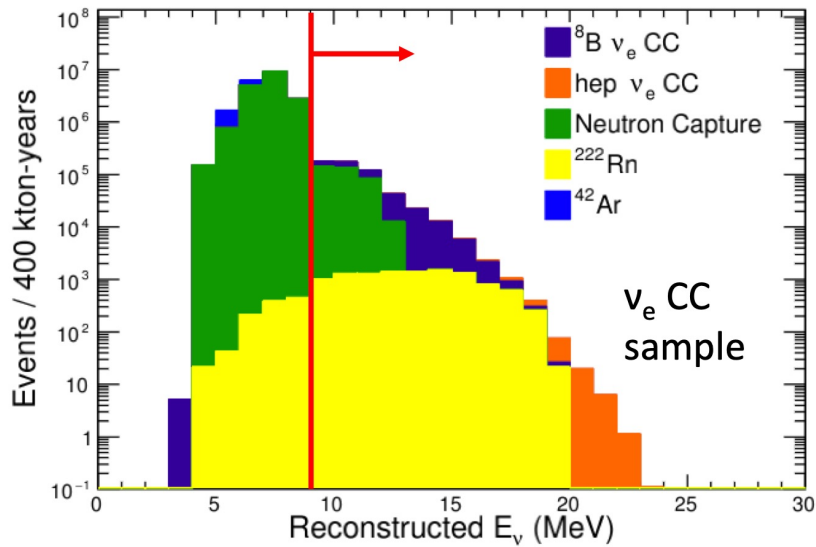
$$\phi(E_\nu) = \mathcal{N} \left(\frac{E_\nu}{\langle E_\nu \rangle} \right)^\alpha \exp \left[-(\alpha + 1) \frac{E_\nu}{\langle E_\nu \rangle} \right]$$



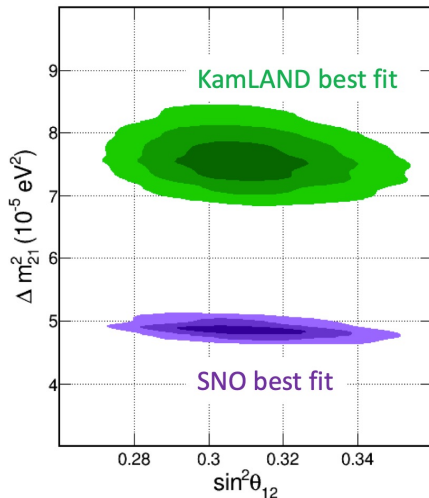
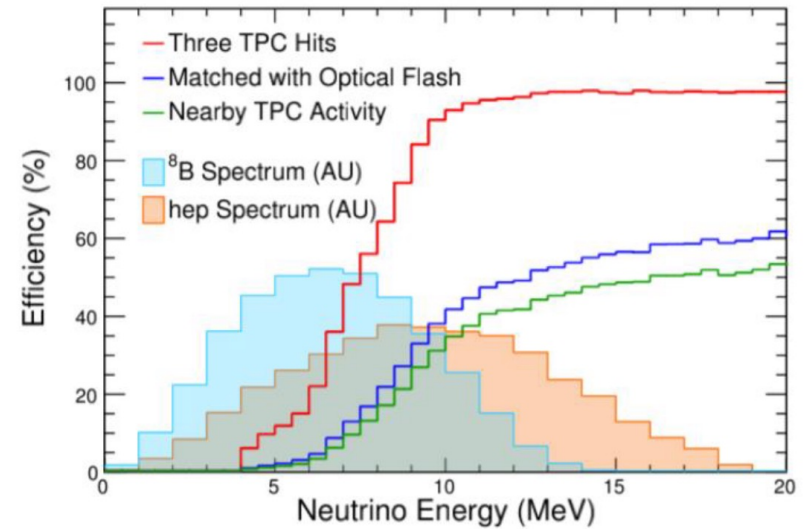
Better energy resolution improves understanding of supernova energy spectrum (+ more energy-dependent events: flavor transitions, SASI, ...)

And improved stats help too !
(fiducial volume)

Solar Neutrinos in DUNE



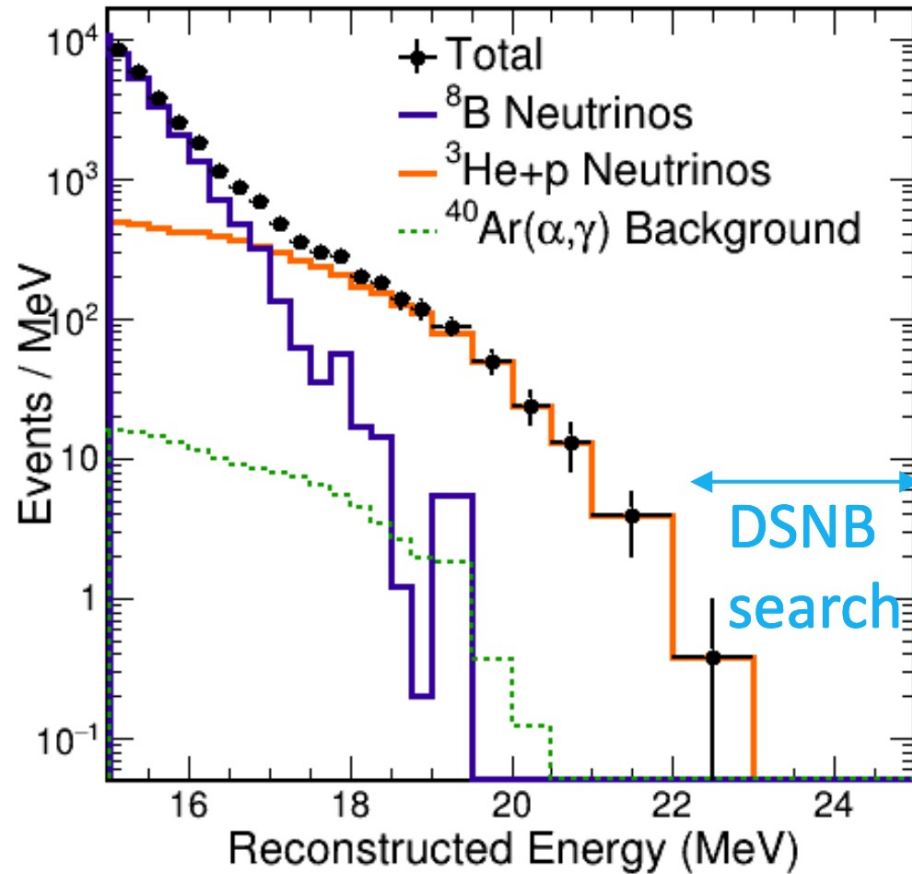
D. Pershey



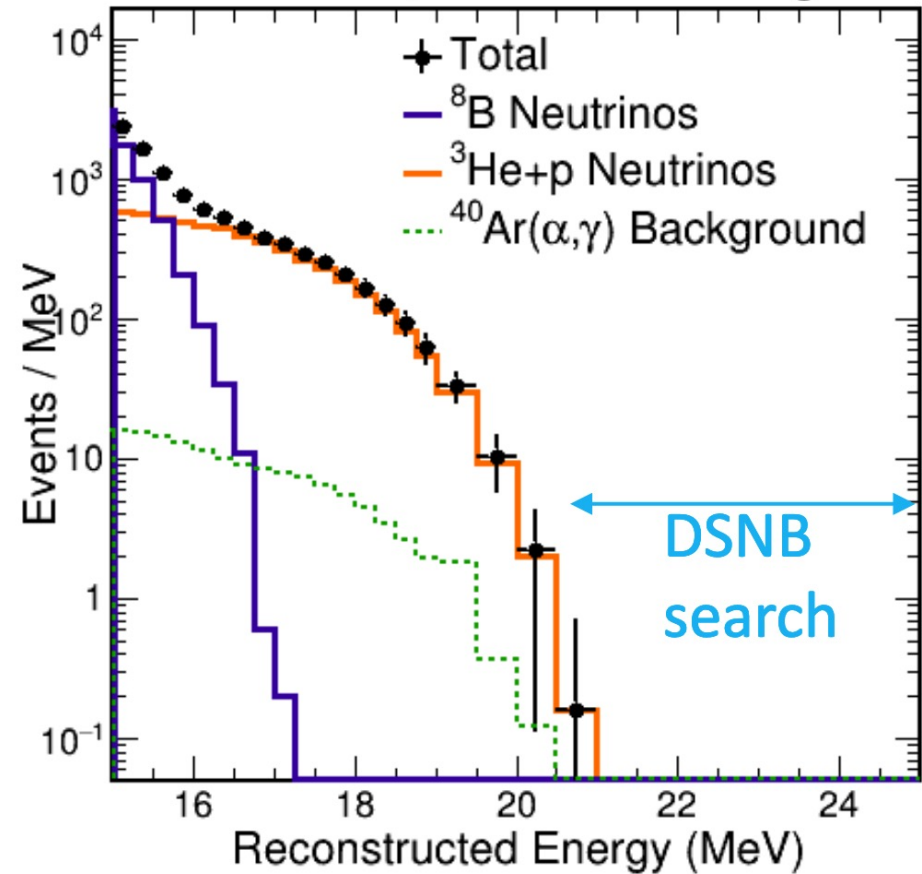
Energy resolution improves event selection, and also oscillation fit

Higher End of the Low-Energy Signal

Nominal LArSoft



LArSoft, 50% smearing



D. Pershey

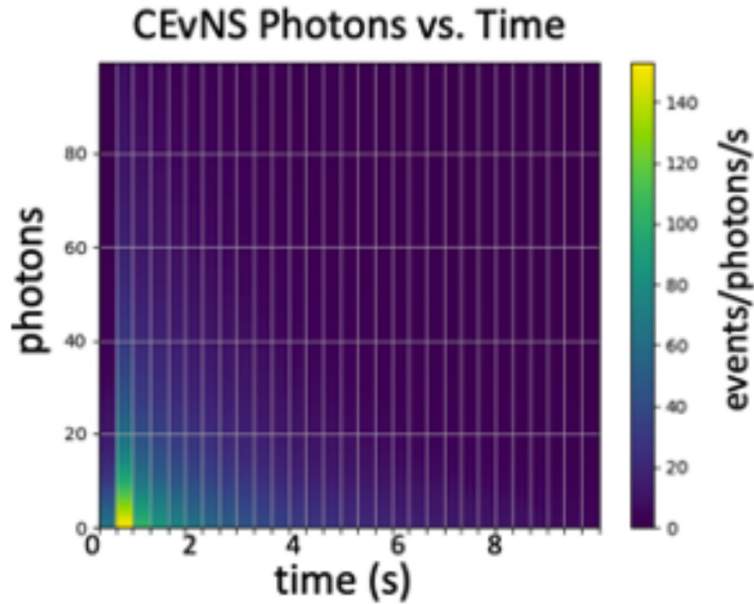
Energy resolution improves DSNB search

- Extra photons available with the VD design
are **very appealing for low-energy physics**
- Improved energy resolution improves SNB, solar, DSNB
- Expect additional improvements
for event selection & reco, position, timing
- Work underway to evaluate impact on physics in detail

BACKUP

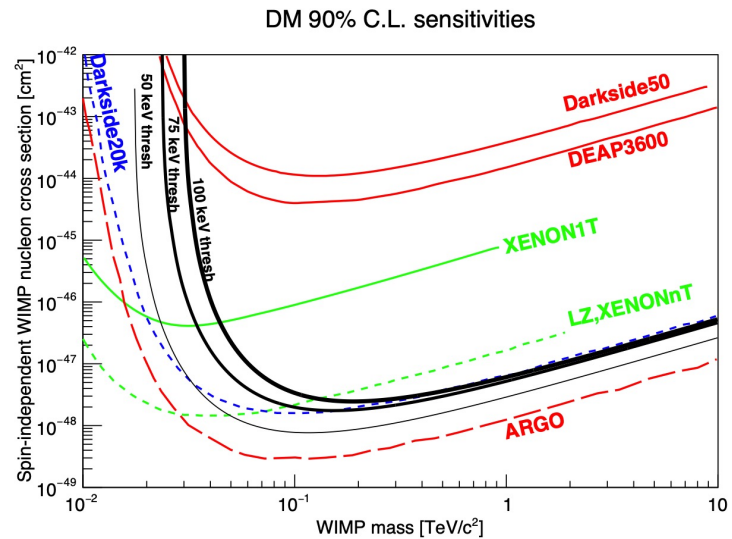
"Aspirational" ideas...

"CEvNS glow" within SNB burst



A. Major

WIMP dark matter search
Church et al. arXiv:2005.04824
Pulse shape discrimination?



(these are a reach... bg is the issue, need underground argon... but more photons will help)

Final State Distribution for ν_e CC (MARLEY)

