SNB/LE WG TDR assessment

Kate/Alex/Inés

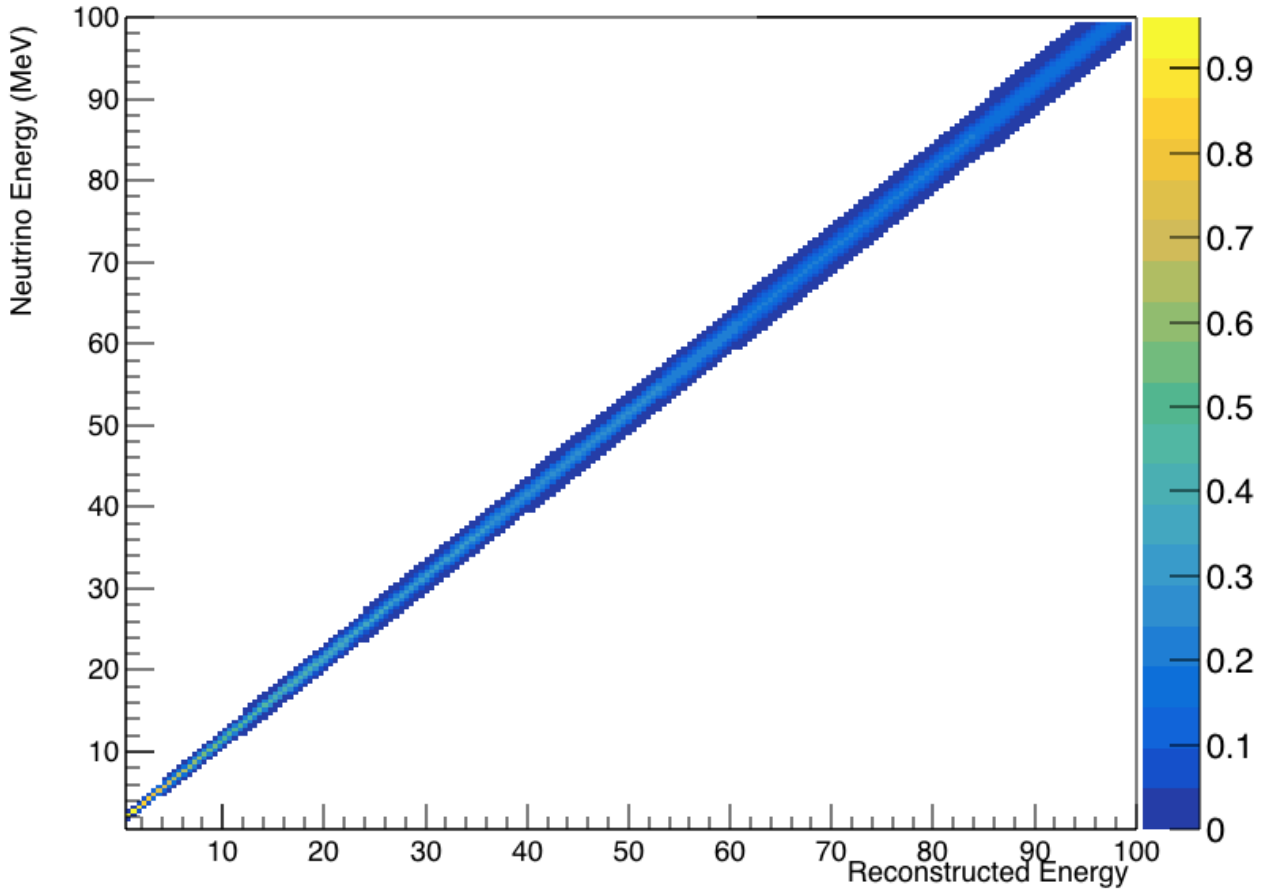
CDR assumptions

- Event rates for a core-collapse SN at 10 kpc

Channel	Events "Livermore" model	Events "GKVM" model
$\nu_e + {}^{40}\mathrm{Ar} \rightarrow e^- + {}^{40}\mathrm{K}^*$	2720	3350
$\overline{\nu}_e + {}^{40}\mathrm{Ar} \rightarrow e^+ + {}^{40}\mathrm{Cl}^*$	230	160
$\nu_x + e^- \rightarrow \nu_x + e^-$	350	260
Total	3300	3770

  - Detection threshold: 5 MeV
  - 100% visible energy reconstruction
  - 100% trigger efficiency
  - ICARUS energy resolution: 11%/√E(MeV) + 2%
  - Perfect identification of ν_e:$\overline{\nu}_e$:ν_x flavors
  - Uncertainties in the cross-sections not included

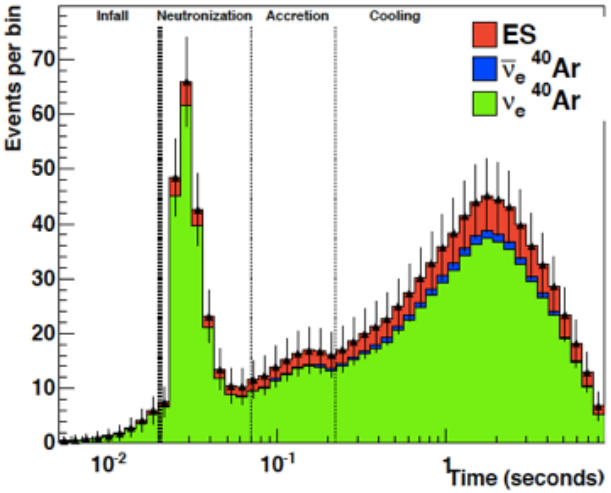
Smearing matrix currently used in SNOwGLoBES

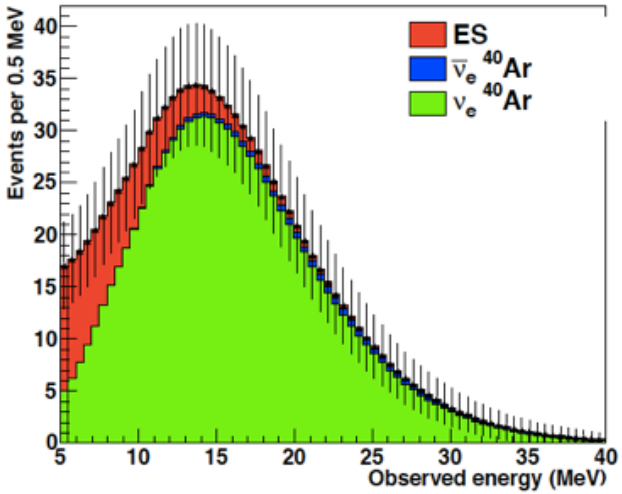


Current default in SNOwGLoBES, assumes
all final-state energy recovered, which is likely much too optimistic

reco energy = true ν energy – 1.5 MeV, convolved with
Icarus resolution

CDR assumptions





- Time profile
  - Good timing resolution: ~10 ms or better
- Backgrounds (^{39}Ar, cosmogenics, radiologicals, …)
  - Assuming perfect rejection of background events
- We aim to have more realistic assumptions by 2019 (incrementally improving...)

FD Task Force final report for March 2017

- By March 2017, we hope to have revised CDR studies based on new SNOwGLoBES smearing matrix made from MARLEY-simmed samples
- This will conservatively take into account loss of energy resolution from un-tracked final-state particles from CC ν_e
- We will try to include other channels (at least ES)

Status of the work

- SN Hack Days organization to train people and cover critical tasks (1st hack-days July 2016, 2nd hack-days Jan 2017)
- Developing reconstruction tools for low energy events (not available in LArSoft)
- Developing realistic simulation of SN neutrino events (including time profile) and integration within LArSoft (MARLEY, elastic scattering and other channels pending)
- Developing gamma tagging algorithms
- Study of the ^{39}Ar background in the low energy reconstruction
- Study of the capabilities of the photon detection system to trigger and reconstruct SN neutrino events
- …

Hack Days II

Jan 9-11, 2017 at Fermilab

Name	Institution	Task
Kate Scholberg	Duke	New more realistic smearing file for SNOwGLoBES
Erin Conley	Duke	Brems vs deexcitations
AJ Roeth	Duke/U. of Oklahoma	10 MeV NC channel
Kirk Bays	Caltech	DSNB
Steven Gardiner	UC Davis	MARLEY time sampling
Michael Baird	Sussex	DAQ sim and triggering
Jingbo Wang	UC Davis	Angular distributions
Jason Stock	SDSMT	
Chris Backhouse	Caltech	Photon matching/energy resolution/SN reco
Ivan Lepetic	IIT	LArIAT/ArgoNEUT gammas

Closeout slides at docdb 2082

Hack Days Progress

- LArSoft backtracker bug fix (Stock, Gardiner)
- MARLEY-based smearing matrix progress (aim to finish by collab meeting) (Scholberg)
- Photon attenuation correction study progress (Backhouse)
- Progress on gamma/brem tagging (Roeth, Conley)
- Progress on DAQ-sim time-profile simulator/Ar-39 rate handling (Baird)
- Calibration study w/ LArIAT data (Lepetic)
- DSNB project launched (Bays)
- Training: some new people launched (Lepetic, Wang)

Identification of risks and direction changes

- If the reconstruction performance is not as good as indicated in the CDR (which will likely be the case)
  - Need to understand effect on physics
- If we are not able to demonstrate the reconstruction performance
  - Develop new algorithms
- If the photon-triggering system is not efficient enough
  - Define requirements (goals?) for photon detectors; we may need a new design
- If the detector design does not fulfill our requirements...

Effort allocation and priorities

Approximate priority order

1. Low energy reconstruction of electrons and photons
2. Full simulation of realistic CC events
3. Trigger and DAQ of SN events
4. Simulation of other detection channels (NC, elastic)
5. Comparison between single and dual phase technologies
6. Impact of backgrounds in the detection threshold and energy resolution
7. Directionality
8. Solar neutrinos & DSNB estimations

- Need to involve more people interested in the subject into the work
  - This is happening– new people are getting involved, but still more are welcome
- Take advantage of the SN work done in other neutrino experiments by people also signing DUNE
  - Also happening, but more cross-pollination welcome

TDR goalposts

- Demonstration of SNB detection with full MC simulation and reconstruction for different detection channels and different theoretical models
  - Including realistic energy threshold, energy resolution, time resolution, trigger efficiency and reconstruction efficiency
  - Include CC, NC, ES channels
- Impact of expected background
- SN trigger scheme (in coordination with DAQ)
- Remark the advantages of LAr detectors compared to WC or LS