Supernova Burst Event Generator Work

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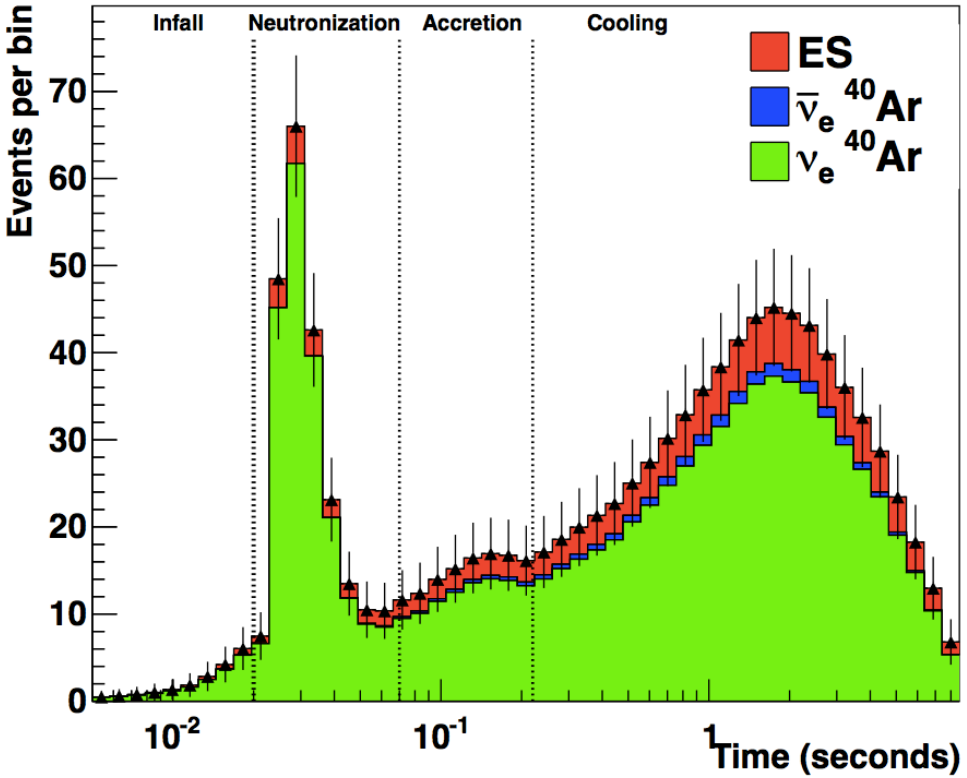
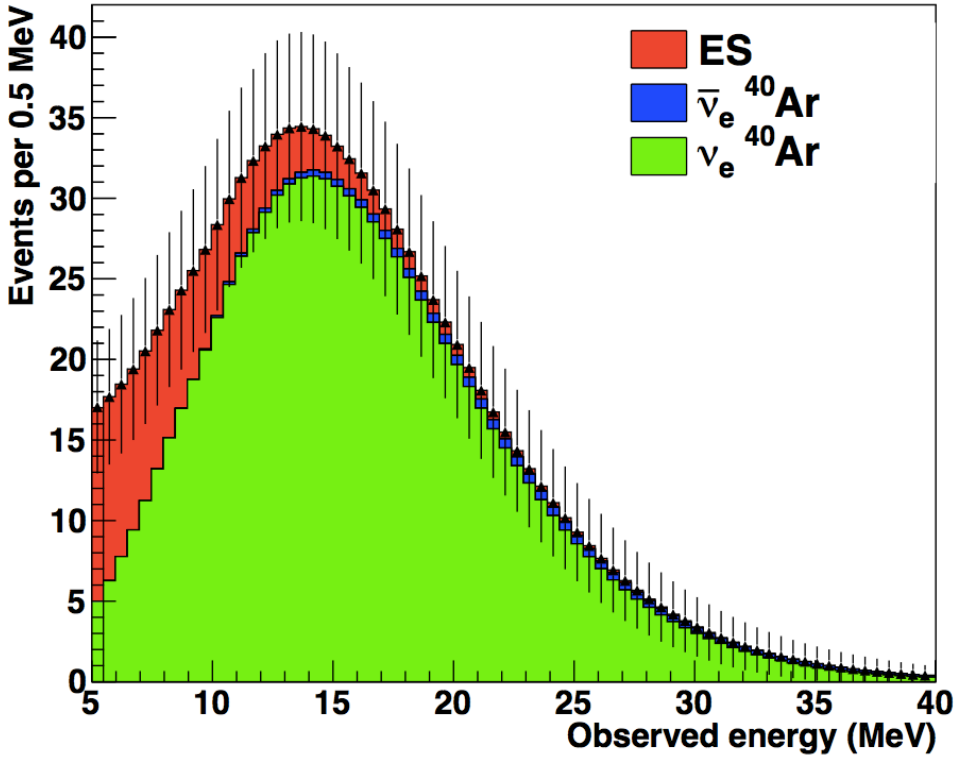
SNB meeting
October 13, 2015

Want to generate SN burst signals in DUNE for

- DAQ/triggering studies
- Reconstruction studies
- Physics studies

From SNOwGLoBES: a folding calculation, not a sim





Would like realistic time and energy profile for all channels (+ NC, not shown here) w/ **detailed final state simulation**

What's been done so far:

simple event generator modeling ν_eCC w/ deexcitation γ's by **AJ Roeth**

Old docdb: 7088, 7815, 7757, **8074, 8225**

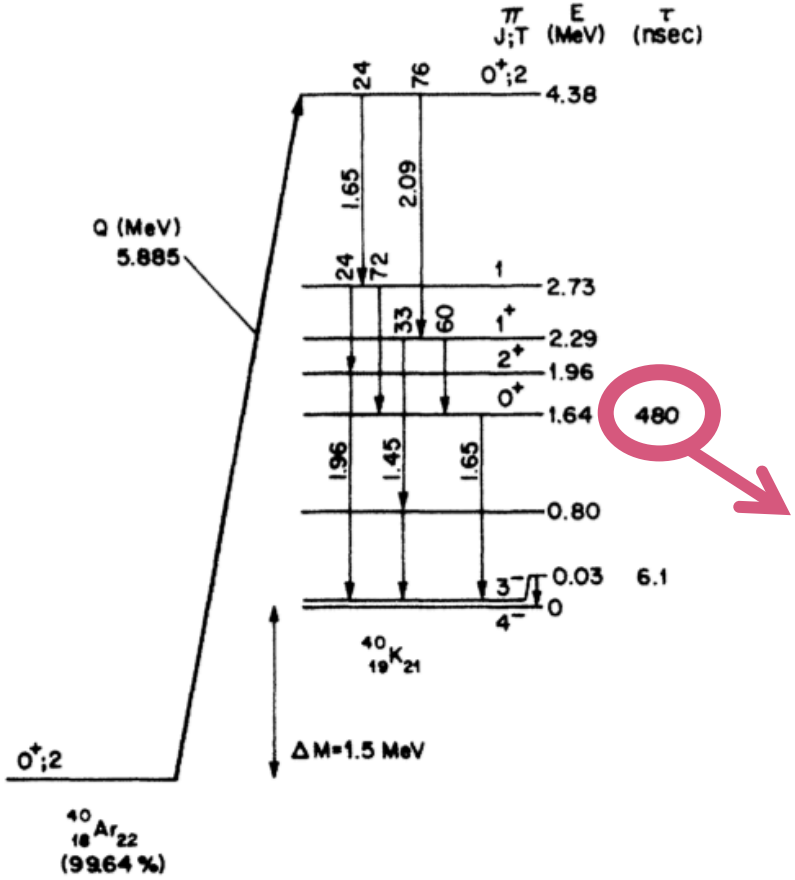
(+ work on MARLEY by Davis group: see September collab meeting slides)

Raghavan deexcitation model

PHYSICAL REVIEW D VOLUME 34, NUMBER 7 1 OCTOBER 1986

Inverse β^- decay of ^{40}Ar: A new approach for observing MeV neutrinos from laboratory and astrophysical sources

R. S. Raghavan
AT&T Bell Laboratories, Murray Hill, New Jersey 07974
(Received 21 April 1986)



Superallowed transition dominates and leads to:

- Electron $E_e = E_\nu - 5.885$ MeV

- Characteristic cascade of γ's adding to 4.38 MeV

One intermediate state is metastable, 480 ns lifetime

Modest e^- anisotropy wrt SN direction ~ $1+(v/c)\cos\theta$

But this isn't the whole story…

Event generator for ν_eCC w/ deexcitation γ's based on ^{40}Ti measurements (AJ Roeth)

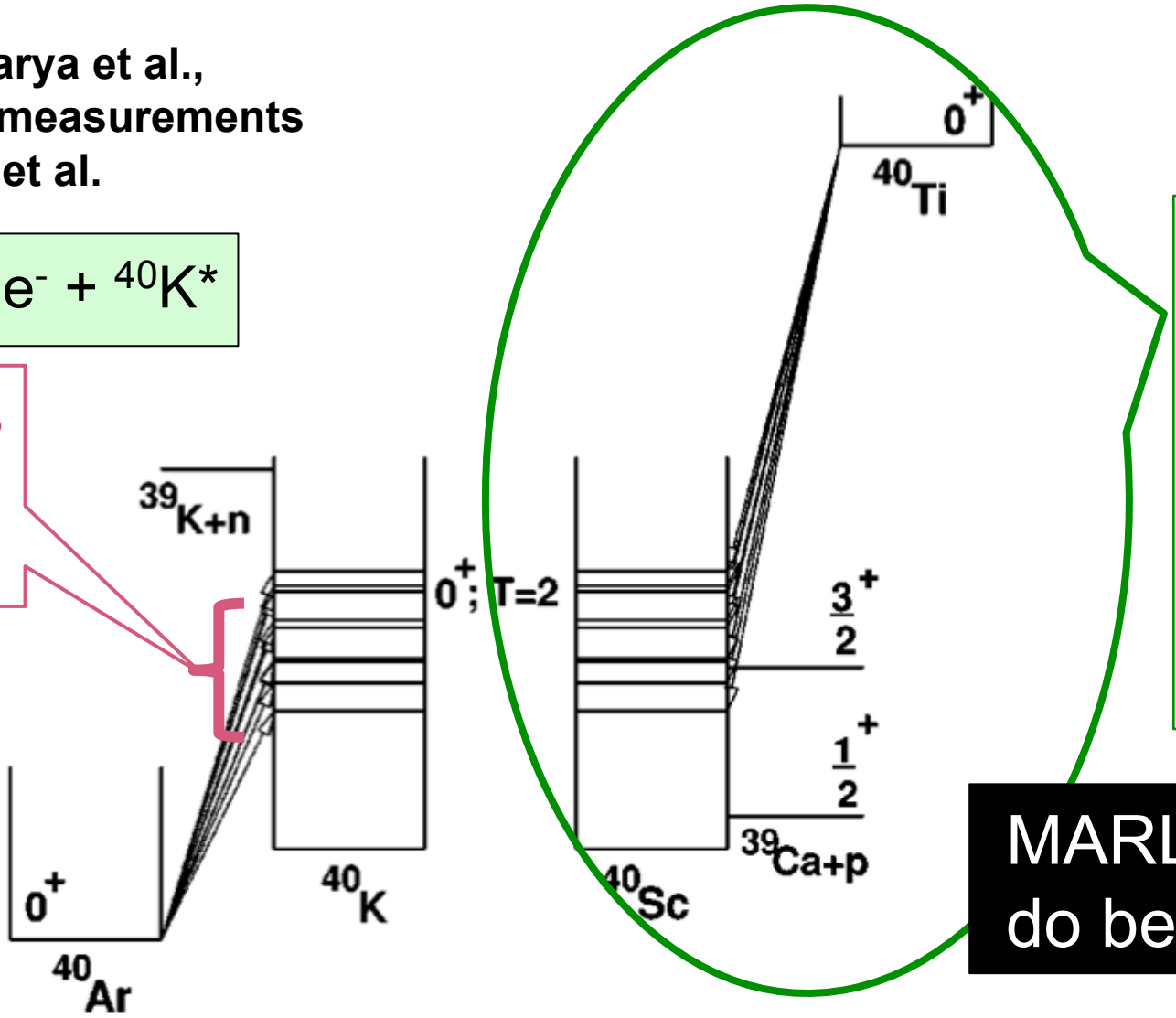
PHYSICAL REVIEW C VOLUME 58, NUMBER 6 DECEMBER 1998

Neutrino absorption efficiency of an ^{40}Ar detector from the β decay of ^{40}Ti

M. Bhattacharya et al., and newer measurements by Trinder et al.

$$\nu_e + {}^{40}\mathrm{Ar} \rightarrow e^- + {}^{40}\mathrm{K}^*$$

these states can be populated

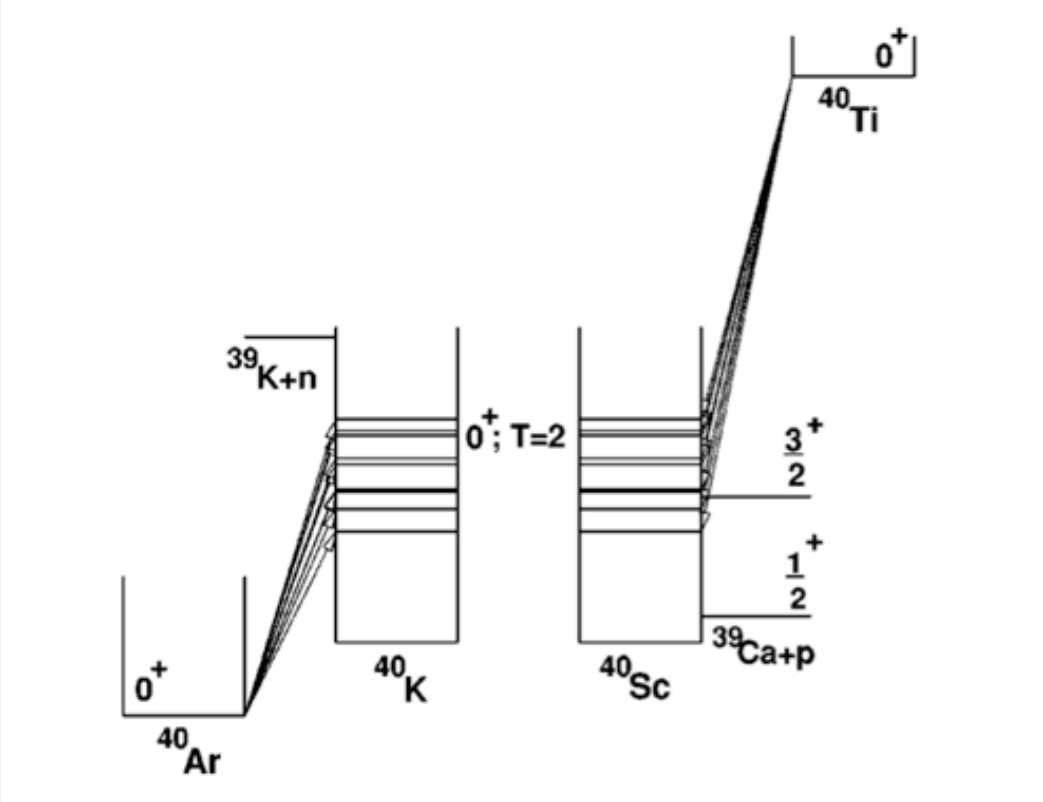


measure relative strengths with βdk of ^{40}Ti to mirror nucleus

MARLEY will do better!

AJ Roeth, docdb 8074

- Starting levels ranged from 2.281 to 6.006 MeV, based on Sc-40, selected based on cross sections
- 73 levels, branching ratios calculated using gamma ray intensity
- Wi = Eν − (Ei + 1.5), 1.5 MeV of neutrino energy converts Ar-40 into K-40, some of the neutrino's energy excites the K-40, left over energy makes the electron

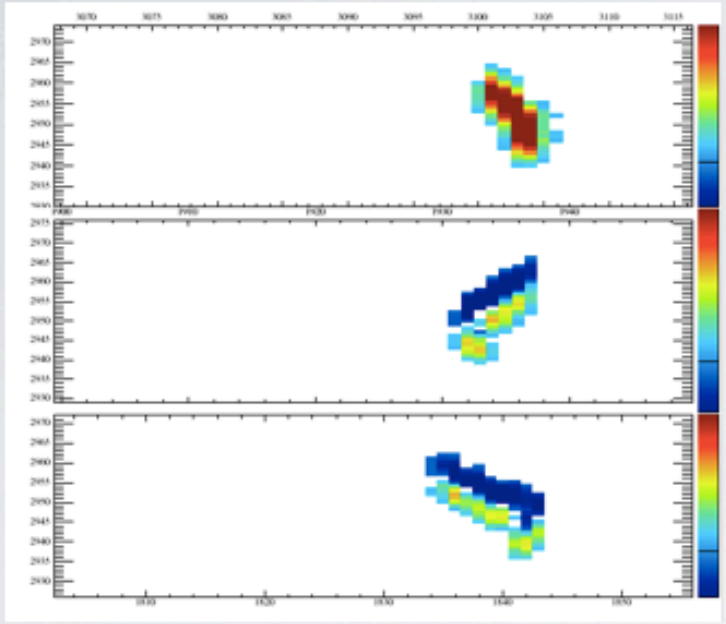


$$\sigma(E_\nu) = \frac{G_F^2 \cos^2(\theta_{ud})}{\pi \hbar^4 c^3} \sum_i \rho_i W_i F(Z, W_i)[B_i(GT) + B_i(F)]$$

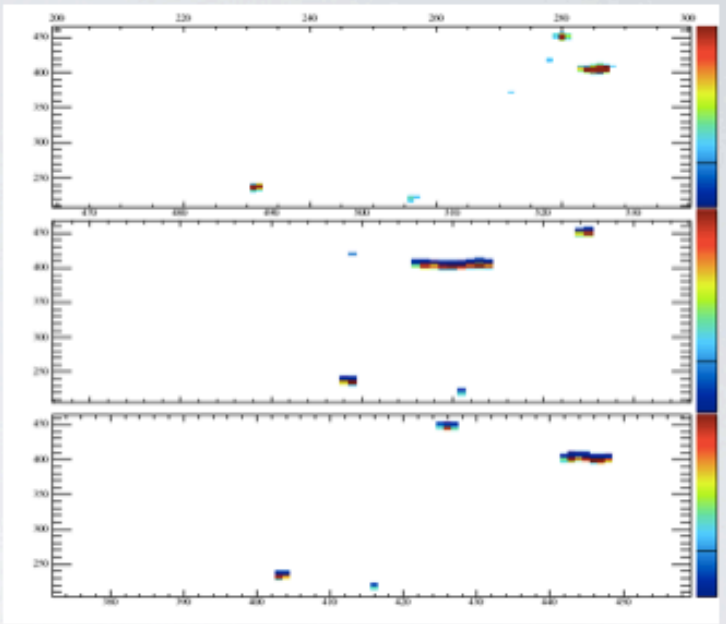
$$F(Z, W) = [A + B/(W - 1)]^{1/2}$$

EVENT DISPLAYS

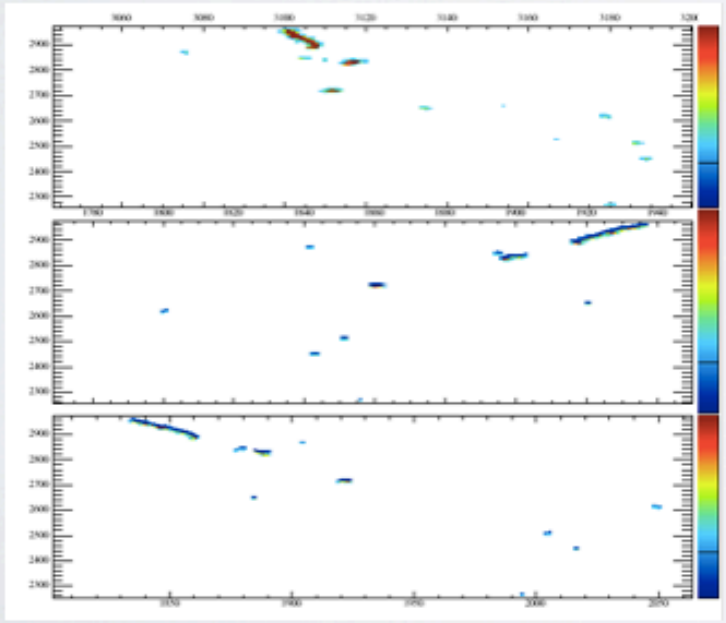
AJ Roeth, docdb 8074



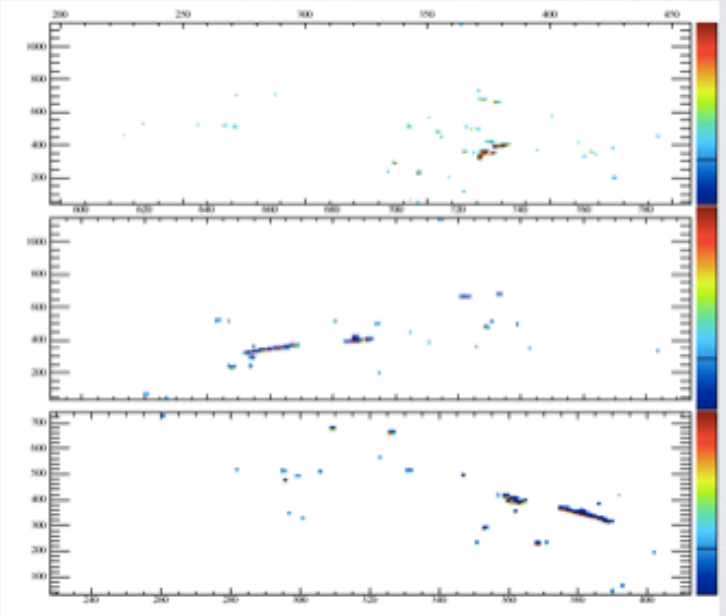
12 Mev, no gamma decay



12 MeV, with gamma decay



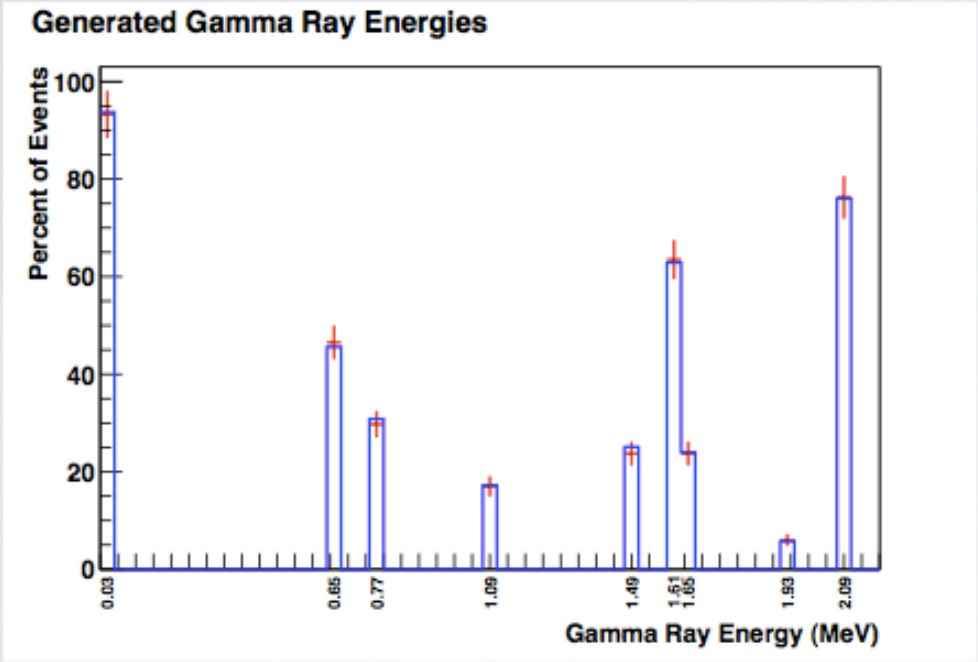
50 MeV, no gamma decay



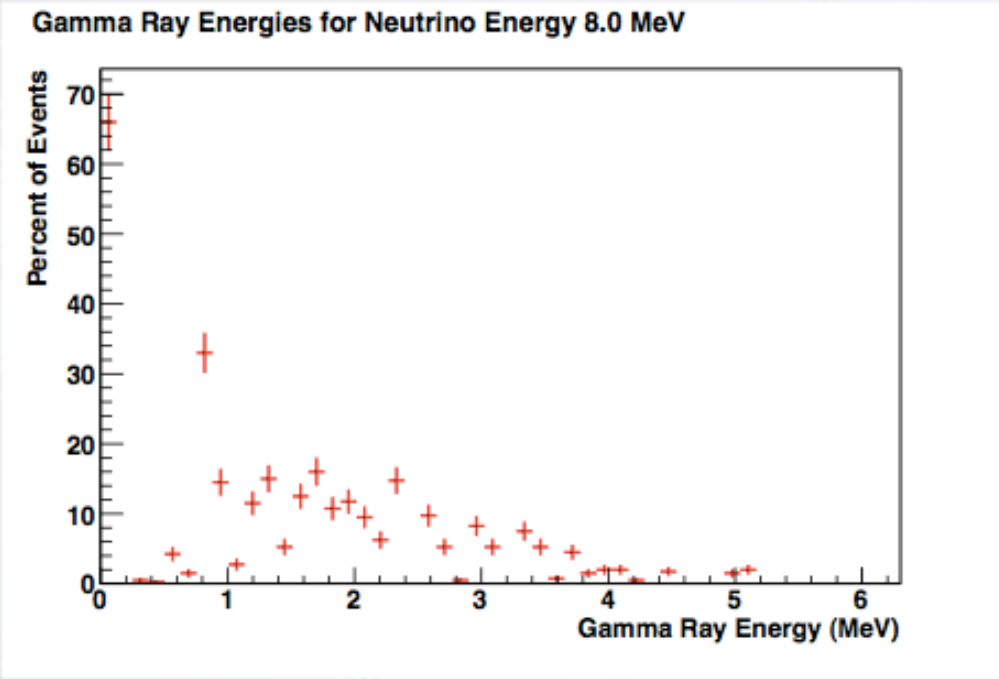
50 MeV, with gamma decay

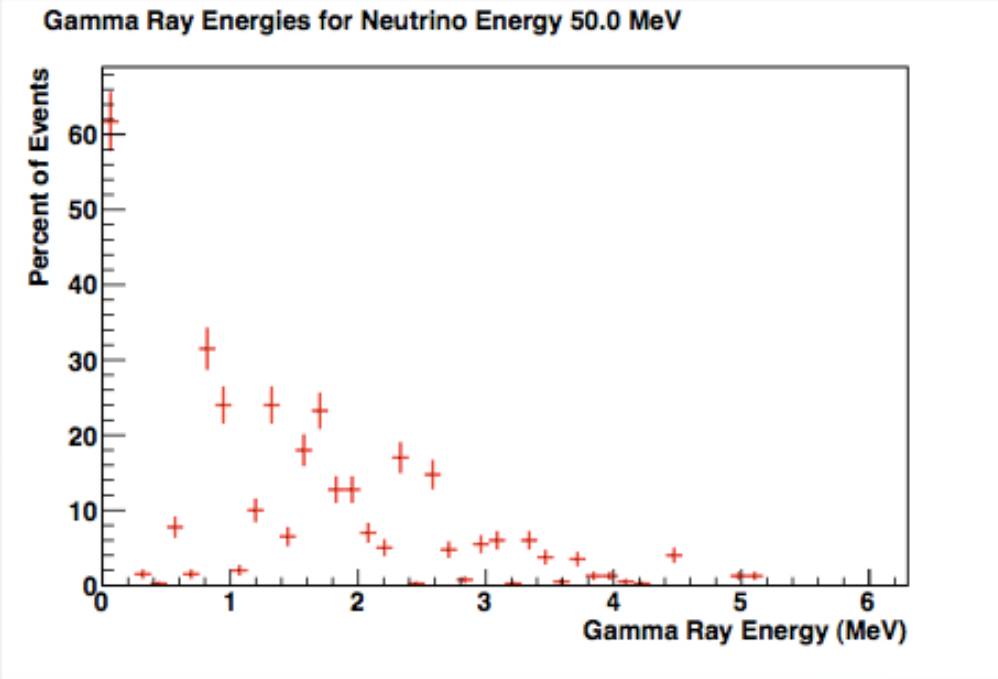
Note brems @ high energy

AJ Roeth, docdb 8074



- Left- Raghavan version
- Blue = Calculated gamma ray energy distribution
- Red = Gamma ray energy distribution generated by event generator
- Method for calculating branching ratios works
- Below- Measurement-based version distributions





Status and to-do

- Event generator for ν_eCC w/deex γ
  exists as standalone Root code
- Generates LArSoft-readable kinematics files
- Need to select from energy/time distributions
  (SNOwGLoBES)
- Isotropic, no directionality yet
- ~few week timescale: integrate into LArSoft
- Should be useful for many studies in short term
  e.g. DAQ/triggering studies don't require precision modeling
- Next improvements: directionality, ES, NC, nuebar
- Will be superseded by MARLEY modeling