Neutron update and transition to 1x2x6

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Updated PU-Foam Composition

- **Measured definition of PU foam composition**
  - Atomic composition: $C_{54}H_{60}O_{15}N_4$, density 0.09 g/cc
  - Estimated capture rate reduction:
    - 75cm * 0.09 g/cc = 6.75 g cm^{-2}
    - It is known that 10cm of CH2 (9.2 g cm^{-2}) attenuates neutrons by factor 10-20
    - Accounting for thickness and hydrogen content we can expect attenuation of 3-5 (ish)

- **Capture rate results**
  - Capture rate before insulation applied in geometry: 116.37 Hz
  - Capture rate after insulation applied in geometry: 19.75 Hz
  - Attenuation factor: 5.9
  - This is higher than the estimated range, however the estimation doesn't take into account the attenuation from the C, N, O

Updates in GEANT4

- **Pre larsoft v08_62_00 (before August 2020)**
  - GEANT4 v4_10_3_p03b was being used
  - Nuclear data library: G4NDL4.5
  - Neutron cross sections below 20 MeV come from ENDF/B-VII.1

- **Post larsoft v08_62_00 (after August 2020)**
  - GEANT4 v4_10_6_p01 is now being used
  - Nuclear data library updates to G4NDL4.6
  - Neutron cross sections below 20 MeV come from JEFF-3.3

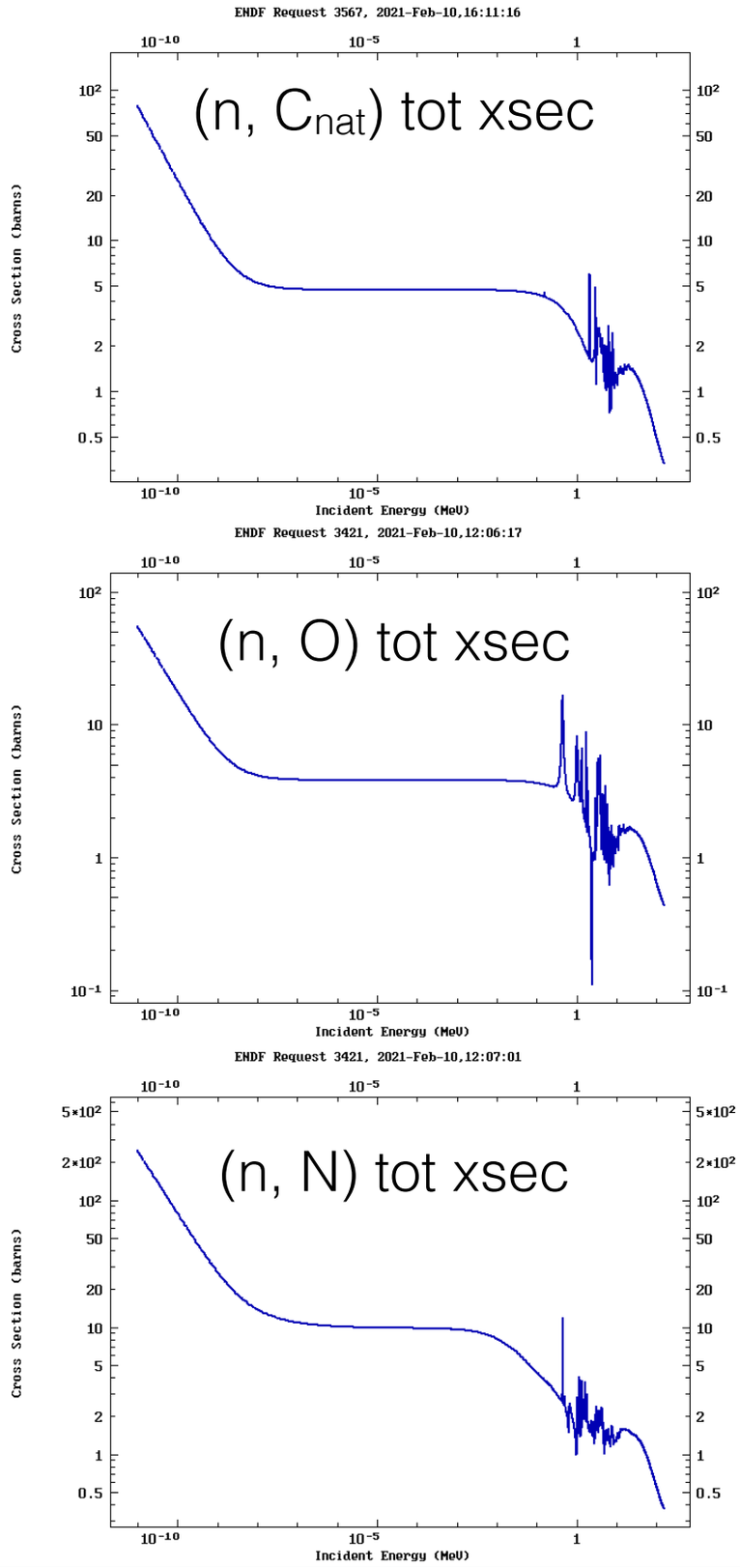
- **Packages I've used**
  - For the task force review (work done from May - July) larsoft v08_43_00, pre GEANT4 update
  - More recently updated to larsoft v09_08_00 (live since October 2020)

Cross section comparisons

- **Carbon, oxygen and nitrogen cross sections**
  - All elements have resonances at ~1 MeV
  - These will contribute to neutron attenuation
  - Small peak at 0.1 MeV in carbon cross section coming from the similar peak in the C-13 cross section

- **Overview**
  - There are no earth shattering changes between the different libraries
  - It is very unclear why results have varied as they have

JEFF-3.3



Neutron capture rate by main sources

- **Source by source breakdown**
  - Dominant source: Shotcrete
  - Next leading source: Cavern rock
  - Total capture rate: 3 Hz

	Rock	Concrete	Shotcrete	I-Beams	Warm Skin	Cold Steel	Total
Capture Rate [Hz]	1.04	1.13E-01	1.35	2.13E-01	8.53E-02	2.03E-01	3.00

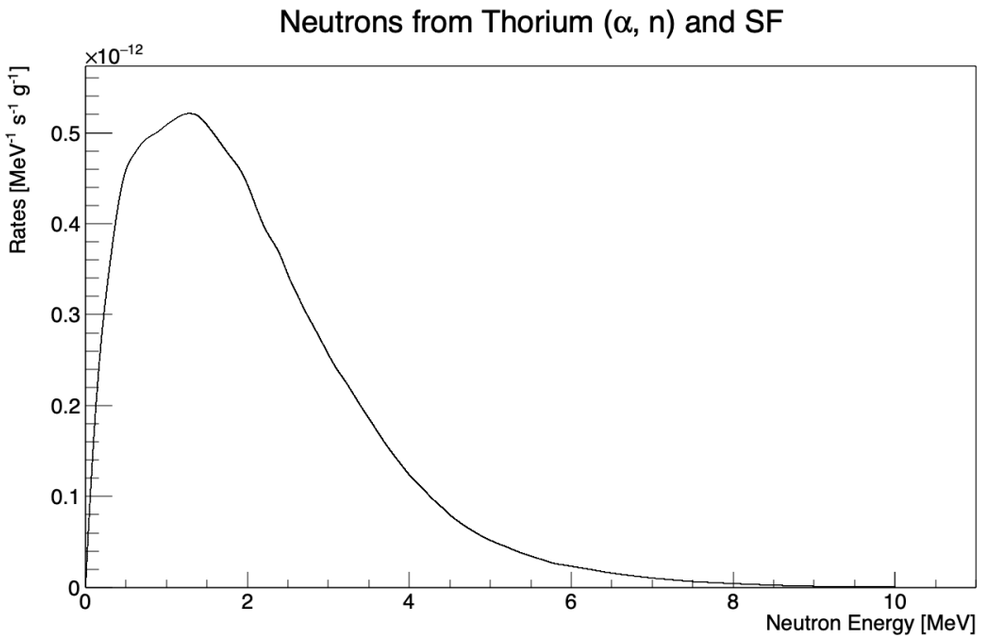
Scaling results to 1x2x6 workspace geometry

- **Spectra for 1x2x6 sims**
  - For each neutron:
    - Measure the energy of the particle IF is crosses into the LAr
    - Populate a TH1D with these energy values
    - Fit, as best as possible, a curve to the histogram
    - Produce relevant 10,000 point TGraph as input for new 1x2x6 sim
  - All spectra now in:
    /dune/app/users/aborkum/v09_08_00_prof_e19_py2/localProducts_larsoft_v09_08_00_e19_prof/dunetpc/v09_09_01/gdml/Radionuclides

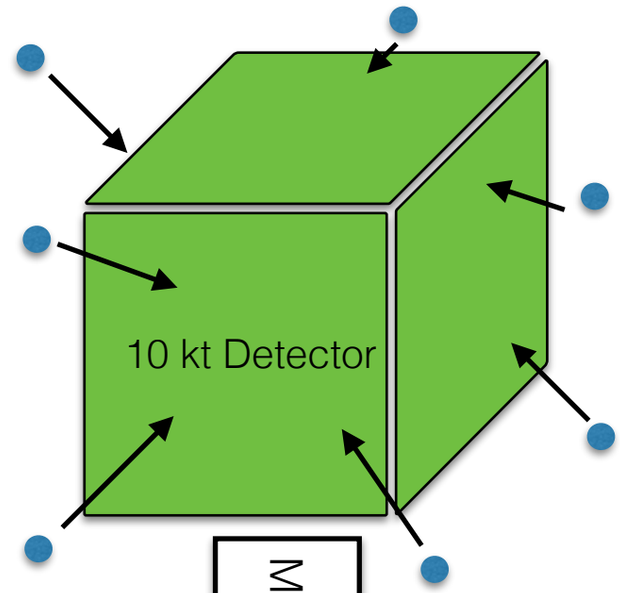
- **Scaling fluxes for 1x2x6 sim**
  - For each source stand alone sims of 100,000 events were run
  - Capture rate recorded for each
  - Flux value tuned to get capture rate to match that seen in full geometry

- **Verifying the results**
  - All 18 sources run simultaneously using new radiological model fhicl
  - Total capture rate recorded to be 2.8 Hz (close enough?)

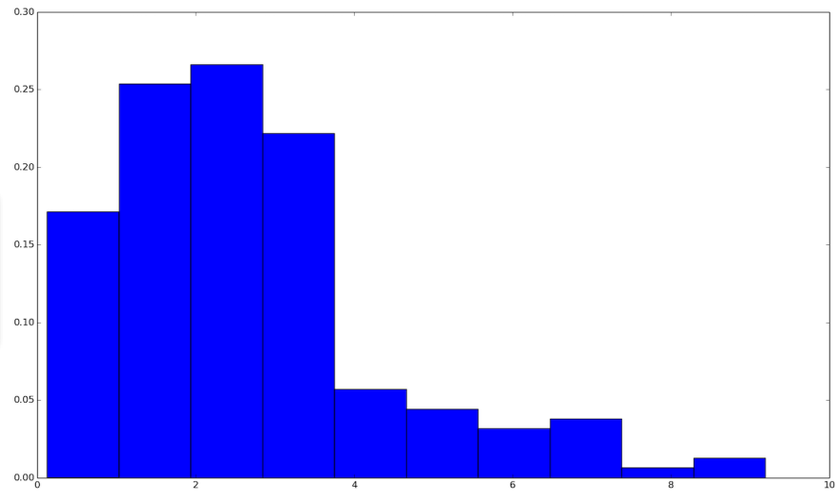
Scaling results to 1x2x6 workspace geometry



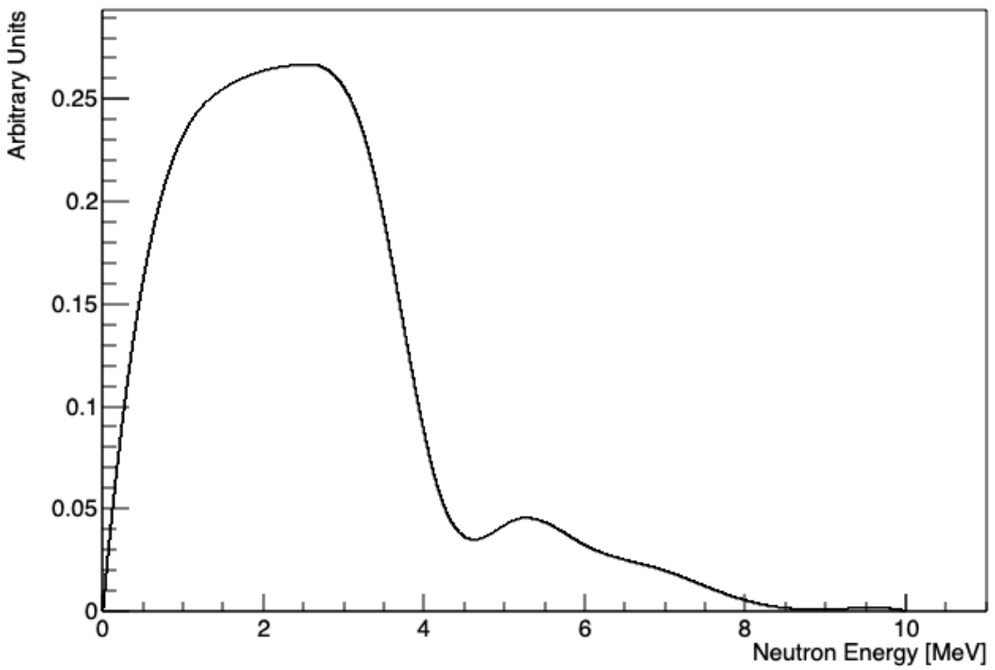
Run Simulation



Measure energies



LArSoft Input



Conclusion and future work

- **Capture rate**
  - All main sources analysed
  - Combined neutron capture rate of 3 Hz

- **Workspace simulation**
  - Scaling of sources now complete
  - Ready to be applied to new radiological model
  - I'm trying to run jobs to see how this impacts the Marley + background results
  - As soon as they stop getting held up will investigate clustering/triggering/SNB efficiencies