Neutron Backgrounds

Shaun Alsum

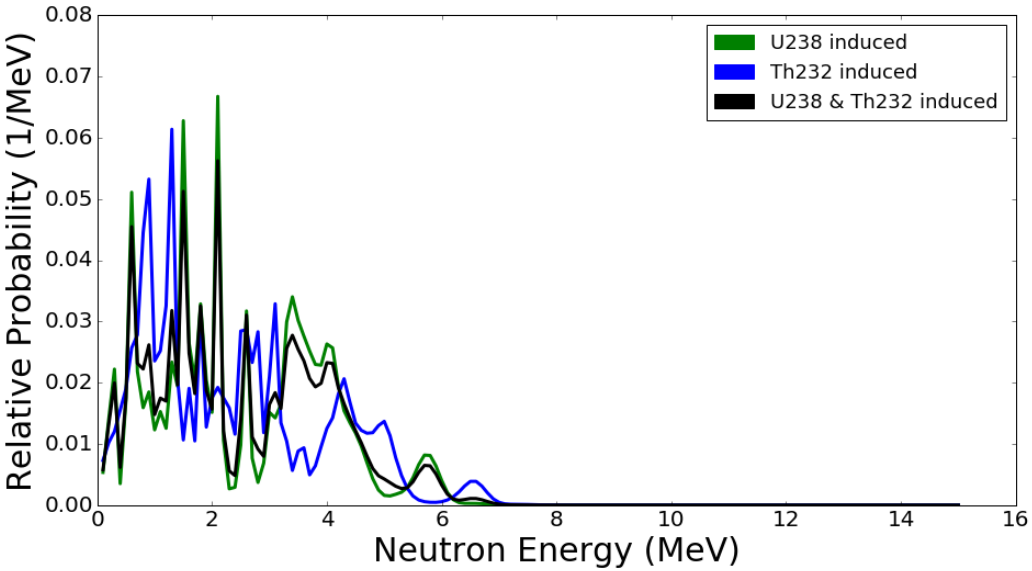
Strategy

- Simulate neutron energy depositions
- Cluster depositions
- Use libNEST to get S1c, S2c
- Determine dimensionality of PDF needed and create it

Considered Backgrounds

- PMTs
  - Neutrons from (alpha, n) from U238 chain alphas
  - Neutrons from (alpha, n) from Th232 chain alphas
  - Neutrons from U235 fission
- PTFE
  - Neutrons from (alpha, n) from Po210 (U238 late) chain alphas

Background Energy Spectra - PMTs

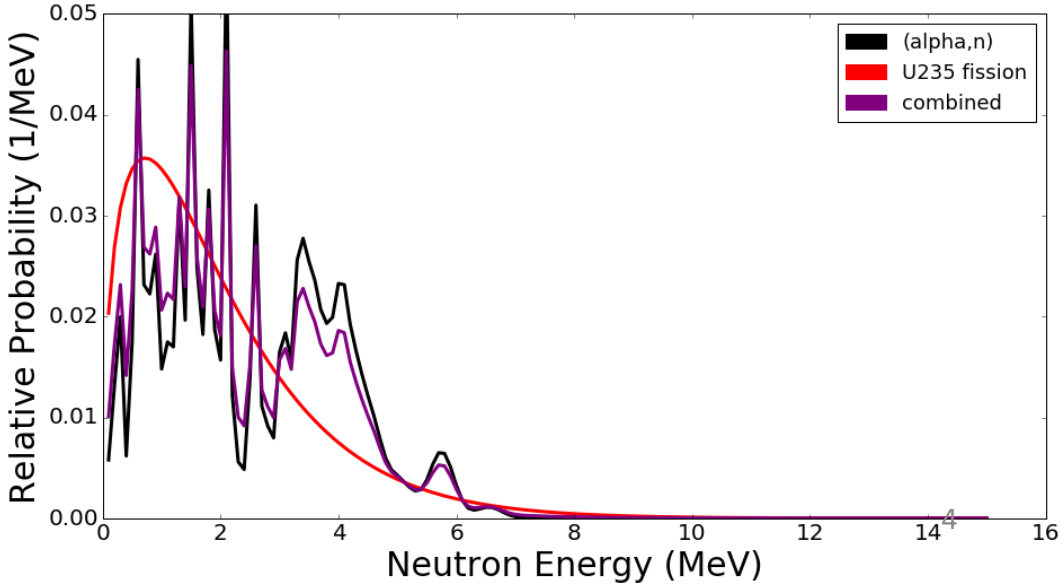


(alpha, n) from neutronyield.usd.edu

With the following concentrations

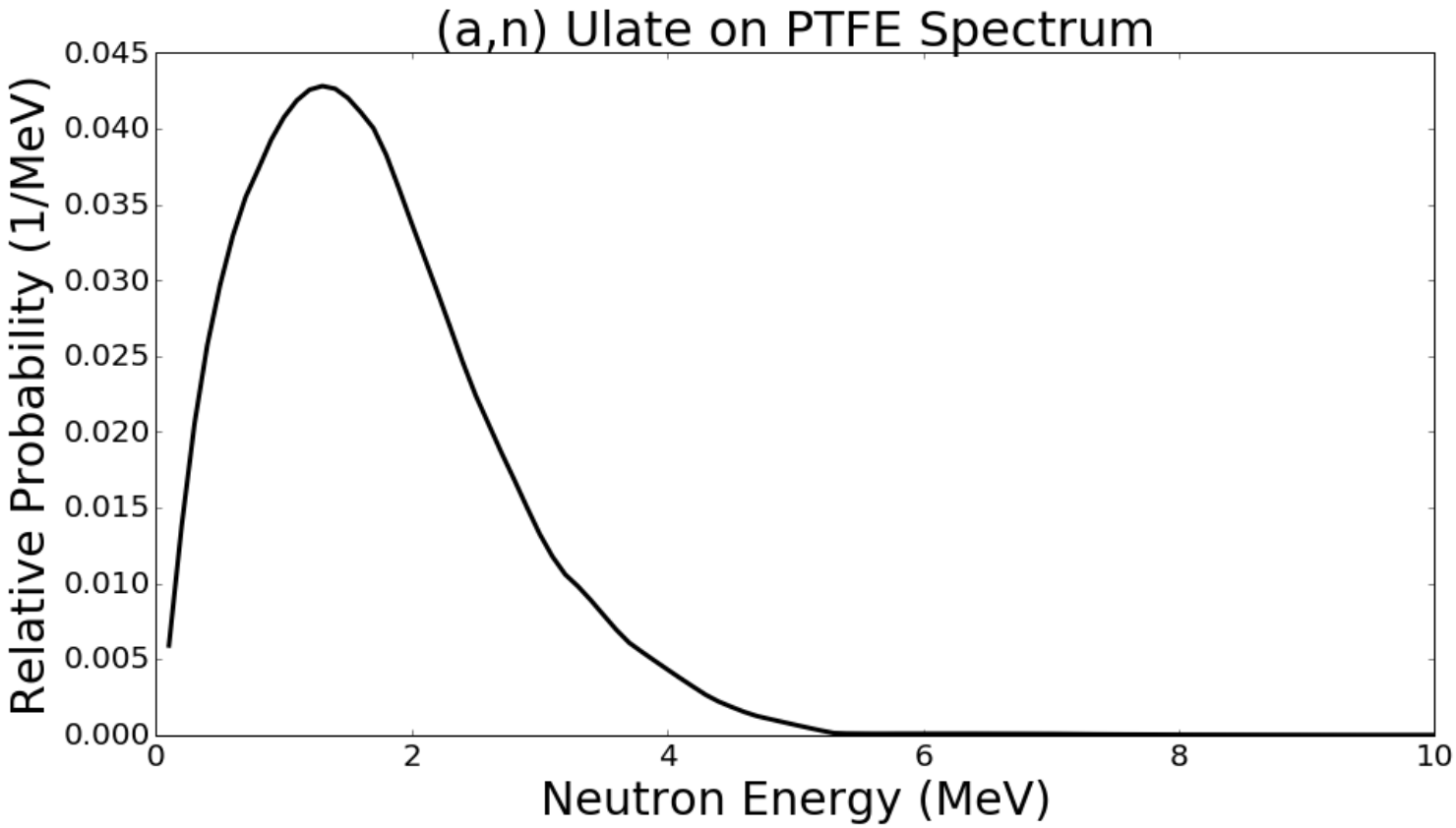
Compound	Mass [g]	(α,n) Yield [n/mBq/yr] ^{238}U	(α,n) Yield [n/mBq/yr] ^{232}Th	(α,n) Neutron Rate [n/PMT/yr] ^{238}U	(α,n) Neutron Rate [n/PMT/yr] ^{232}Th	(α,n) Neutron Rate [n/PMT/yr] Total
B2O3	4	1.17	0.950	2.67E-01	6.13E-02	3.28E-01
Al2O3	15	0.219	0.271	1.86E-01	6.55E-02	2.52E-01
Fe	63	0.0134	0.0426	4.78E-02	4.33E-02	9.11E-02
SiO2	26	0.0272	0.0303	4.02E-02	1.27E-02	5.29E-02
Na2O	1.3	0.329	0.322	2.43E-02	6.76E-03	3.10E-02
Co	13.6	0.0148	0.0524	1.14E-02	1.15E-02	2.29E-02
Li2O	0.22	0.764	0.554	9.54E-03	1.97E-03	1.15E-02
Cr	1.8	0.0502	0.187	5.13E-03	5.42E-03	1.06E-02
Al	0.26	0.402	0.502	5.93E-03	2.11E-03	8.04E-03
Mn	0.4	0.0378	0.100	8.59E-04	6.48E-04	1.51E-03
Ni	41	2.01×10^{-4}	1.45×10^{-3}	4.68E-04	9.62E-04	1.43E-03
Si	0.21	0.0449	0.0522	5.35E-04	1.77E-04	7.12E-04
BaO	0.44	1.22×10^{-3}	1.17×10^{-3}	3.06E-05	8.28E-06	3.88E-05
C	0.008	0.0306	0.0278	1.39E-05	3.59E-06	1.75E-05
S	0.0051	5.01×10^{-3}	7.63×10^{-3}	1.45E-06	6.28E-07	2.08E-06
Zr	0.042	5.34×10^{-6}	9.10×10^{-5}	1.27E-08	6.17E-08	7.44E-08
P	0.0068	5.16×10^{-8}	5.26×10^{-7}	1.99E-11	5.78E-11	7.77E-11
			Sum ((α,n) only)	**0.60**	**0.21**	**0.81**
			Sum ((α,n) + fission)	**0.93**	**0.21**	**1.15**

U238 fission from a parameterization I found in a lecture online…
https://indico.cern.ch/event/145296/contributions/1381141/attachments/136909/194258/lecture24.pdf



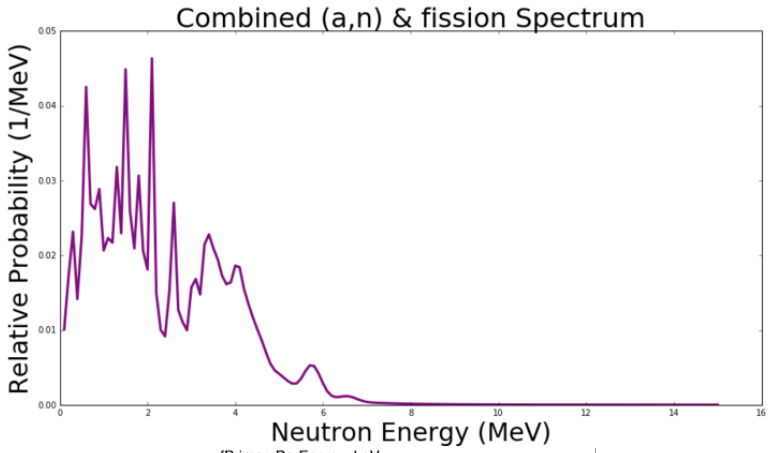
Background Energy Spectra - PTFE

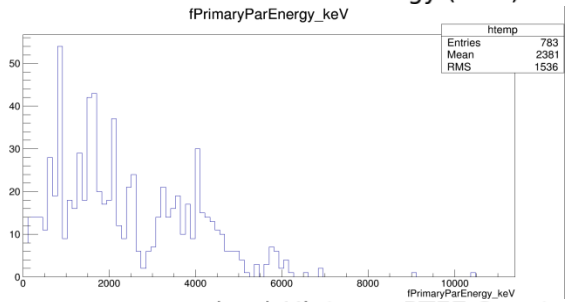
From Paolo…

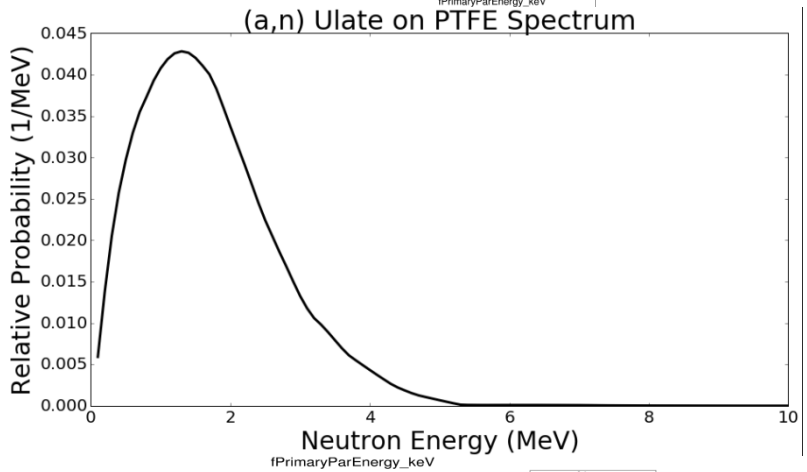


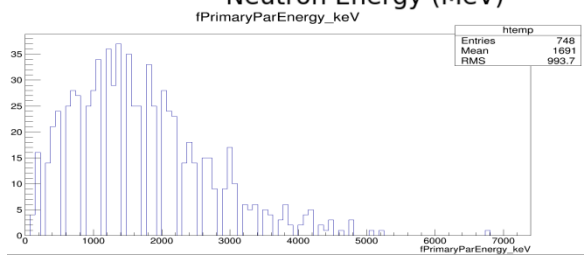
What was actually simulated?

- All components of PMTs, but all neutrons originating in the PMT window.
- All PTFE is the source (specifically, anything with PTFE in the name in LUXSim…)
- Discrete energies normalized to approximate the correct spectrum.









Current status

- 490,000 Energy deposition only sims of PMT backgrounds run (batches of 10,000, one must have failed)
- PTFE ready to run (I think), but haven't actually been run (error in first submission).

Future work

- Clustering
- Further determine what the detector would see for each event (an average of 29 interactions occur in LXe for each neutron, most of which deposit some energy, maybe mostly taken care of with clustering, maybe not)
- libNEST -> S1c, S2c PDFs for each spacetime bin (time bin and z-slice)

The Macros

PMT Macro

```
# I need to do this
/run/initialize
# set how frequently the sims will update it's progress, i.e. every n events
/LUXSim/io/updateFrequency 100
# choose a directory to which to save the output
/LUXSim/io/outputDir .
# choose name of output files
/LUXSim/io/outputName PMT_an_
# geometry?
/LUXSim/detector/select 1_0Detector
# no grids (faster and not doing optics or activity from them)
/LUXSim/detector/gridWires off
# no cryostand
/LUXSim/detector/cryoStand off
# I need to do this as well
/LUXSim/detector/update
# record energy deposits in the volume "LiquidXenon" (i.e., in the active xenon)
/LUXSim/detector/recordLevel LiquidXenon 2

# place source
/LUXSim/source/set PMT_Window SingleParticle_neutron 0.0100862457815 Bq/kg 0.1 MeV
/LUXSim/source/set PMT_Window SingleParticle_neutron 0.0172169043921 Bq/kg 0.2 MeV
/LUXSim/source/set PMT_Window SingleParticle_neutron 0.0231564684468 Bq/kg 0.3 MeV
/LUXSim/source/set PMT_Window SingleParticle_neutron 0.0141594862236 Bq/kg 0.4 MeV
/LUXSim/source/set PMT_Window SingleParticle_neutron 0.0225755162408 Bq/kg 0.5 MeV
/LUXSim/source/set PMT_Window SingleParticle_neutron 0.0425102014676 Bq/kg 0.6 MeV

(more of the same, a LOT more)


# optics off
/LUXSim/physicsList/useOpticalProcesses false
# set number of particles to simulate
/LUXSim/beamOn 10000

# later!
exit
```

PTFE is the exact same, but with PTFE in place of PMT_Window and different numbers.