Update on Neutron Calibration Source

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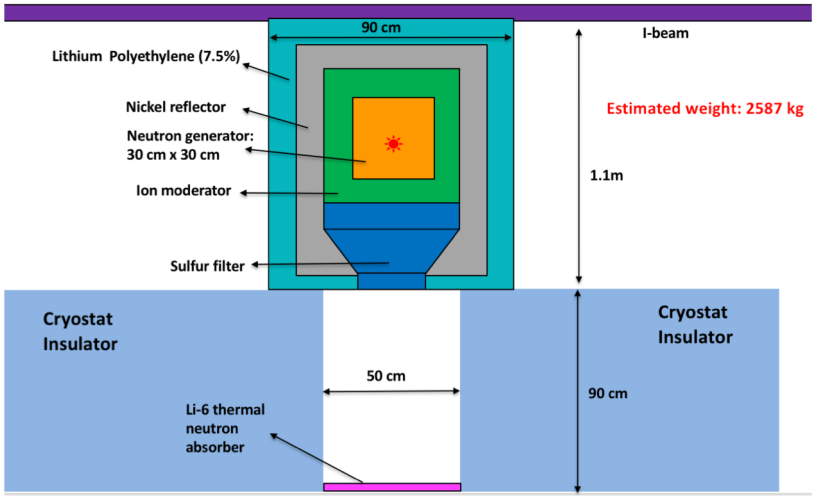
DUNE
DEEP UNDERGROUND
NEUTRINO EXPERIMENT

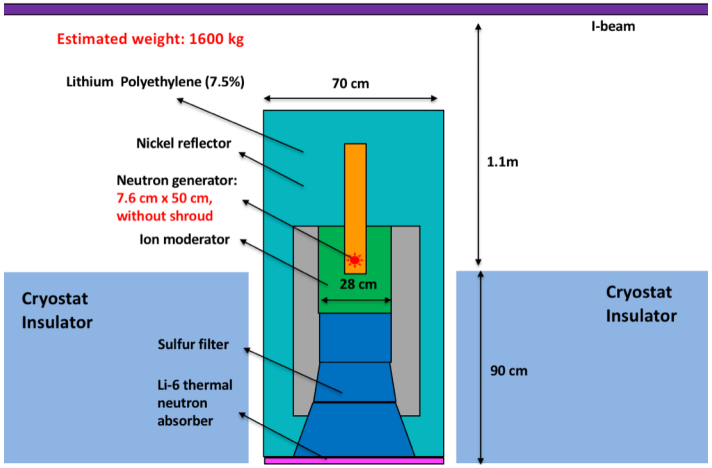
Current Status

- Three design of configurations
- Optimization and shielding studies done for Design#1
- Design#2 is similar to Design#1 except that the source is in a manhole
- Design#3 has to compromise with the feedthrough size (25 cm)
- Design#3 needs extra shielding for gammas

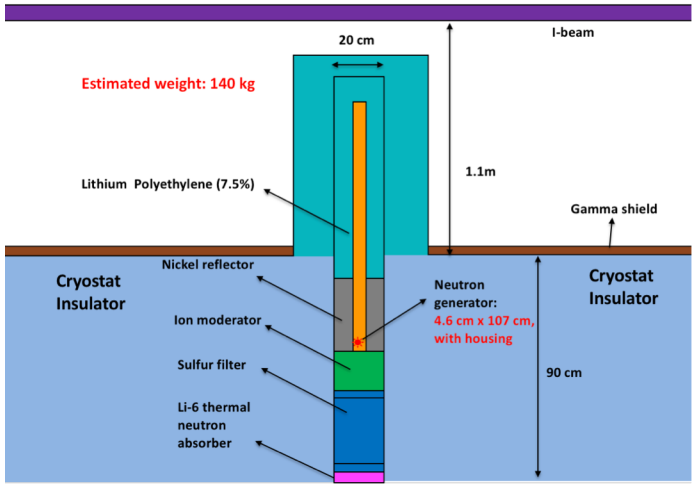
Design#1



Design#2

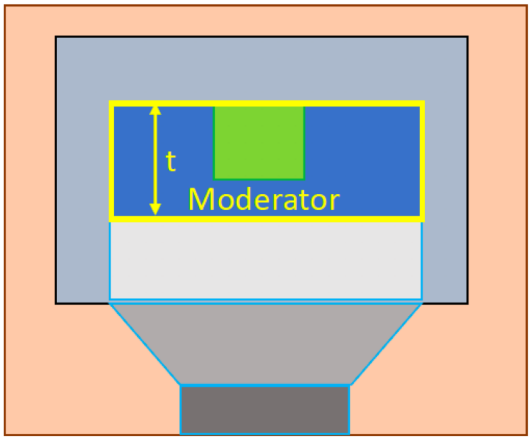


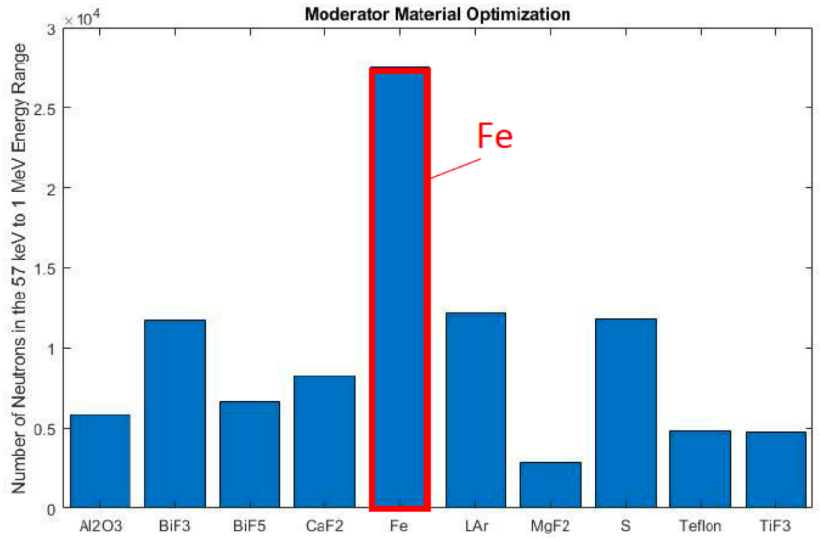
Design#3

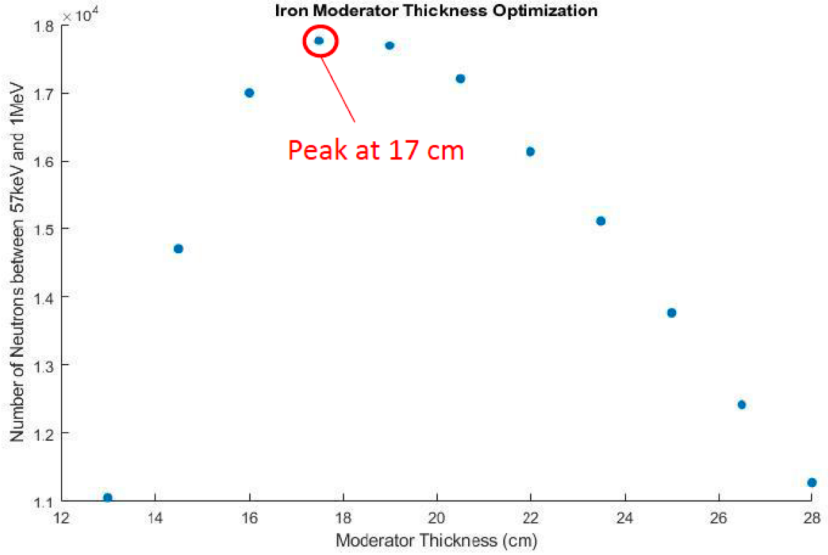


Optimization: Moderator study

- Materia must have high elastic scattering and low absorption for neutrons
- Fe is chosen as the most efficient moderator to degrade the neutron energy from 2.5 MeV to less than 1 MeV
- Best Fe thickness is 17 cm







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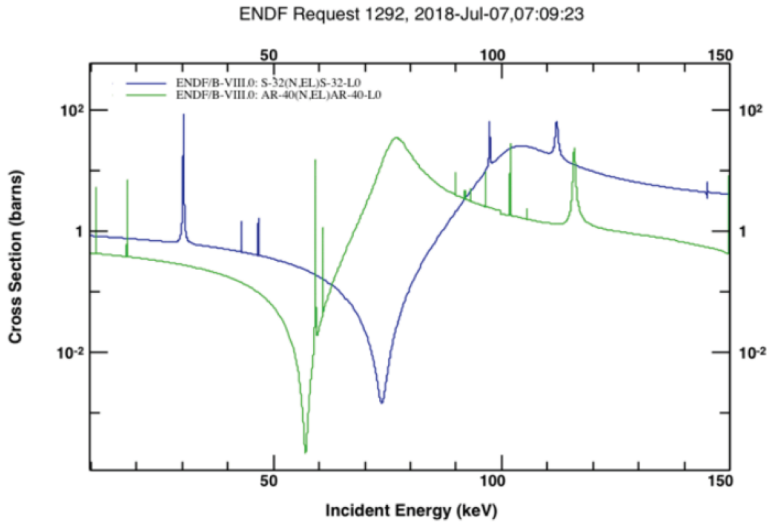
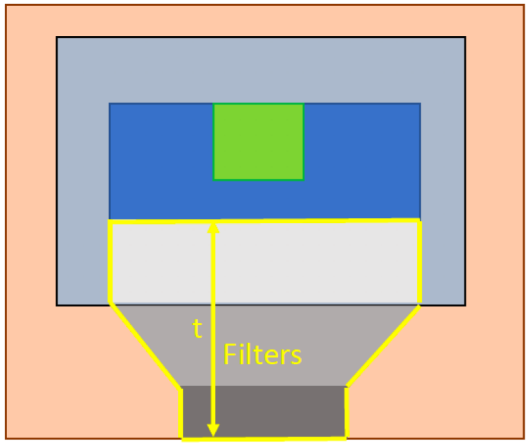
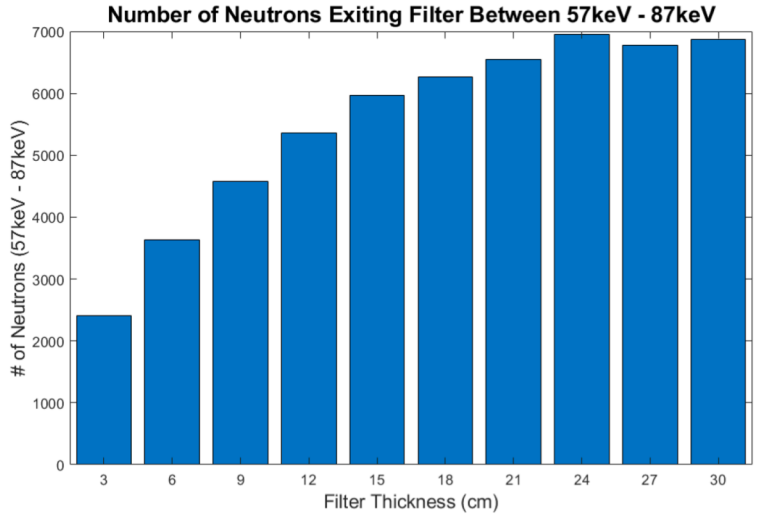
Optimization: Filter study

- Liquid argon itself is the best filter but the need for a cryostat brings complication
- Sulfur is a good filter due to its n 73 keV anti-resonance for neutron elastic scattering
- Thickness of Sulfur filter was studied







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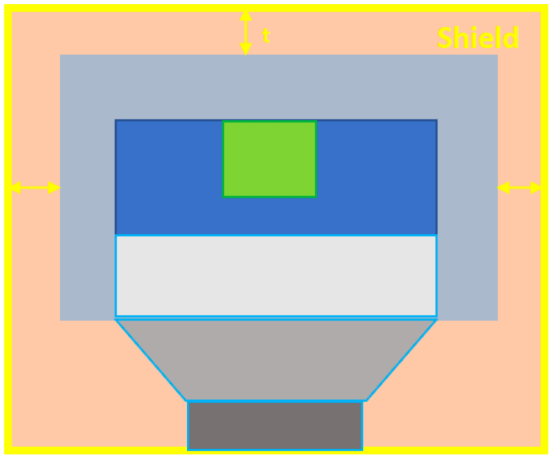
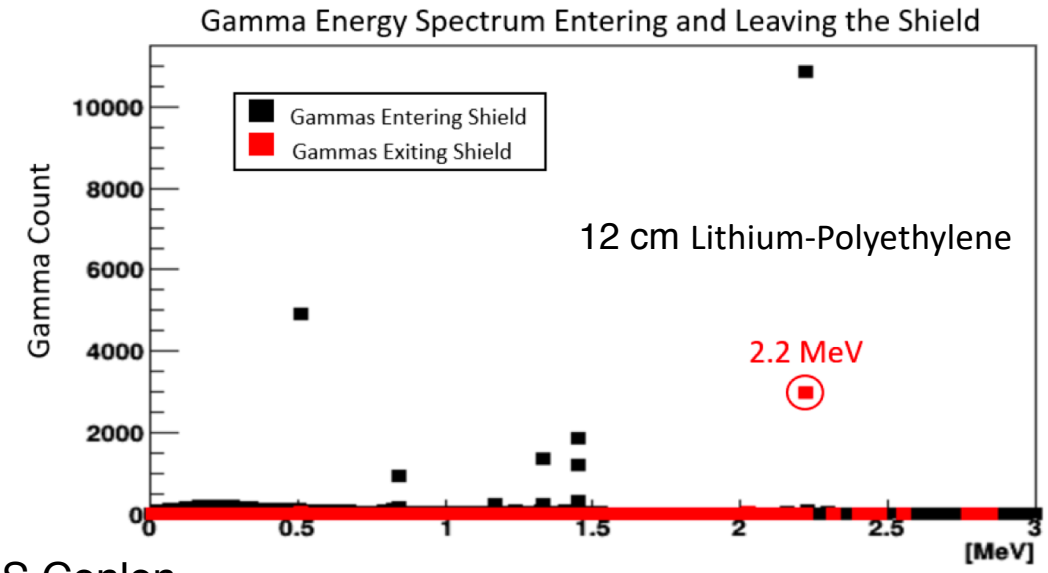
Optimization: Shielding study

- Lithium-Polyethylene is used as the shielding material
- Shield is to block both neutrons and gammas from neutron capture
- 2.2 MeV gamma peak is from neutron capture on hydrogen
- Shield can effectively block the lower energy gammas peaks but is only able to degrade 2.2 MeV gammas
- The dose of radiation form 2.2 MeV gammas is 1.8×10^{-7} mrem per pulse (10^6 neutrons) for a person standing 1 meter away from the source





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What is missing for TDR?

- Both the “man-hole” and the “feedthrough” designs studied in simulation. Need to choose one for TDR
- Neutron/gamma shielding study needed for the “feedthrough” design
- Neutron capture simulation in LArSoft needed to understand the reconstruction capability of LArTPC
- Better understand the cross-section and correlated gamma cascades from neutron capture on argon
- Neutron energy moderator/filter test at Berkeley
- Measurement of anti-resonance cross-section (after TDR)

Argon Capture Experiment at DANCE (ACED)

Measurement of the neutron capture cross-section on ^{40}Ar

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Boston University, Department of Physics, Boston, MA 02215, U.S.A.

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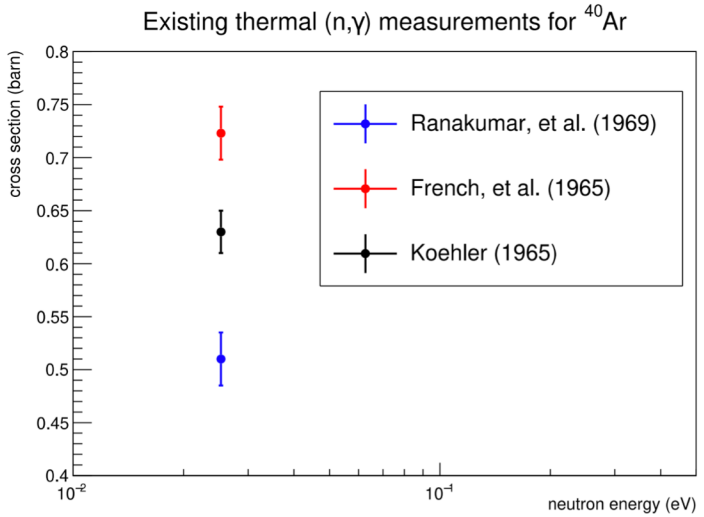
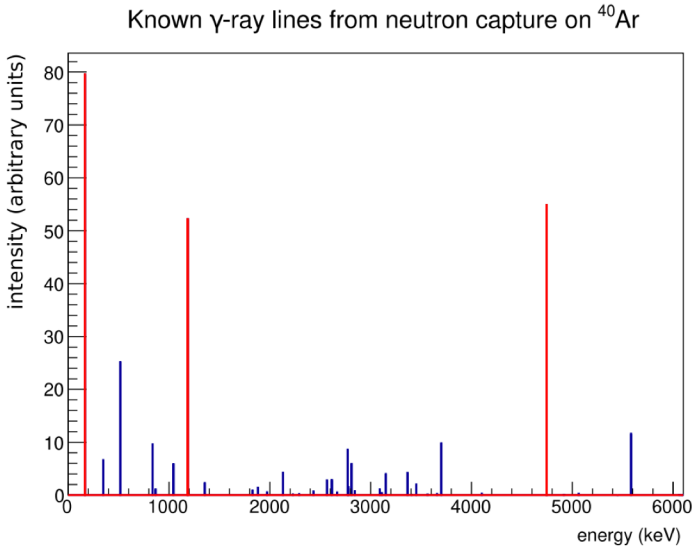
(ACED Collaboration)
(Dated: September 10, 2018)

- Cross-section for thermal neutron capture was poorly measured
- All existing measurements used activation method
- There was no event-by-event measurement of the correlated gamma cascade
- ACED measurement will address all these issues

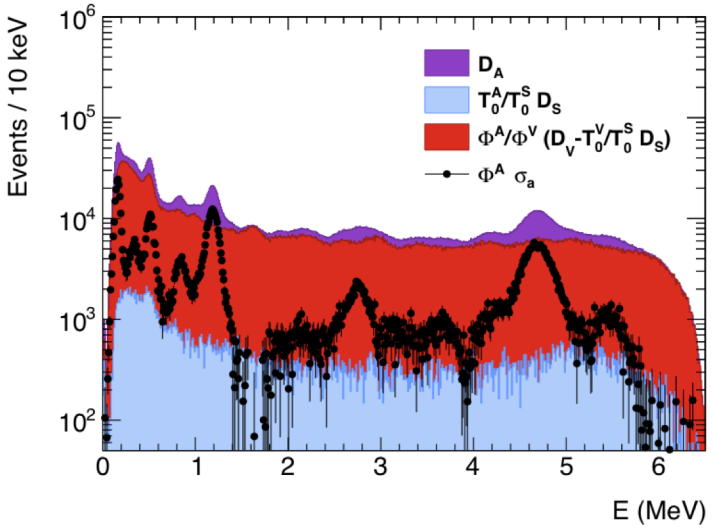


Argon Capture Experiment at DANCE (ACED)

- Some gamma lines have been measured, but full event-by-event cascade data are unavailable
- Three know gammas (167 keV, 1.2 MeV, 4.7 MeV)
- Roughly 51% of all captures will produce those 3 gammas
- After background subtraction, a single peaks corresponding to argon capture events becomes visible
- We are working very hard on the data analysis now!



ACED result:
Background subtraction to obtain the 40-Ar gamma cascade spectrum



Conclusion

- Feasibility study has been done
- Need to study the shielding for different designs
- LArSoft simulation is need for understanding the neutron capture reconstruction
- ACED analysis/paper is close to being finalized