Los Alamos
NATIONAL LABORATORY

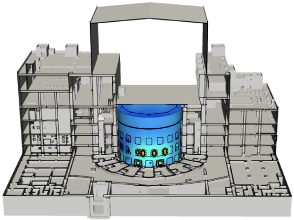
A New (n,xn) Measurement Capability at LANSCE

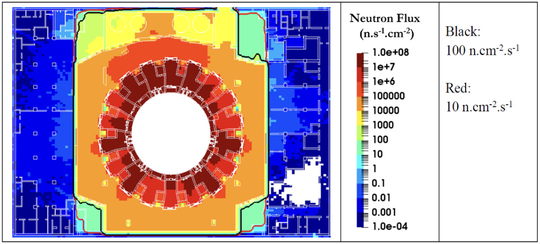
Funded by DOE SC Early Career Research Program

Keegan J. Kelly

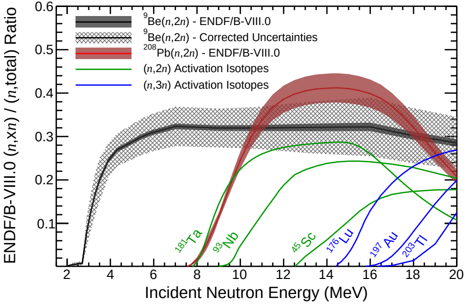
2025 Workshop for Applied Nuclear Data Activities

Fusion Reactors Rely on $(n,2n)$ and $(n,3n)$ Rxns





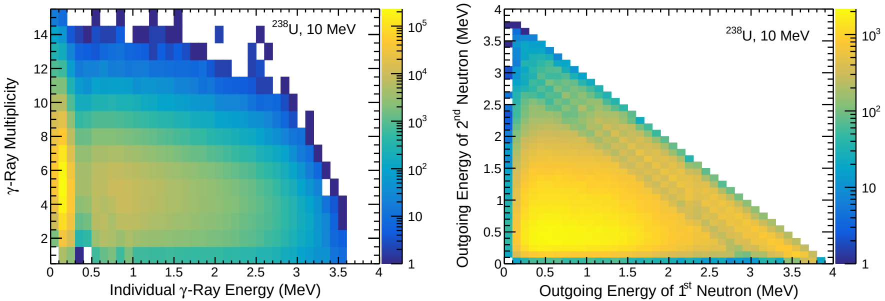
ITER_D_3FM52L - Radiation environment for equipment during operations by R Juarez



- n breeding essential for t production via ^{6}Li(n,t), to drive d-t
  - ^{9}Be$(n,2n)$ and ^{208}Pb$(n,2n)$
- Activation-based flux measurements motivate a suite of $(n,2n)$ measurements

Traditionally: γ-rays, Activation, or n Counting

Calculated with CoH_3 - T. Kawano, Springer Proceedings in Physics 254 (2021) 27



→ Traditional methods do not measure emitted n information

→ Detection of both $(n,2n)$ neutrons captures 100% of strength.

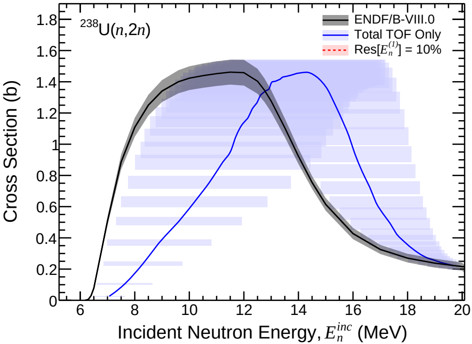
Continuous white-source neutron measurements are ideal, but neutron TOF degeneracies are problematic

Degeneracies of White Sources can be Solved

Neutron energies for $(n,2n)$ for $(n,3n)$ reactions at white sources are degenerate

$$T_n^{(1)} = t_n^{inc} + t_n^{(1)} = \text{First TOF}$$
$$T_n^{(2)} = t_n^{inc} + t_n^{(2)} = \text{Second TOF}$$

BUT, measuring one neutron energy breaks the degeneracy!



$$t_n^{(1)} = \left(\frac{l_{out}}{c}\right)\left[1-\left(1+\frac{E_n^{(1)}}{m_n c^2}\right)^{-2}\right]^{-1/2} \Rightarrow t_n^{inc} = T_n^{(1)} - t_n^{(1)} \Rightarrow E_n^{inc}, E_n^{(2)}$$

LANSCE can provide continuous $(n,2n)$ and $(n,3n)$ measurements with emitted neutron energy and angular information

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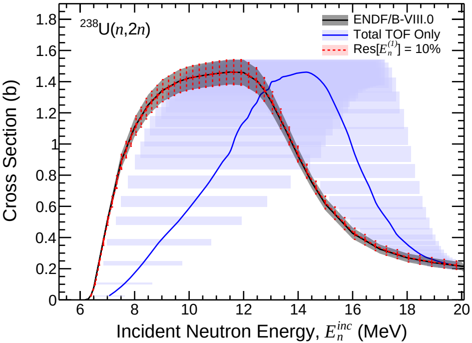

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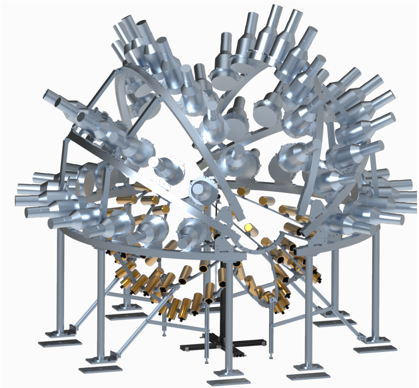
Accomplished with CLYC-7 E_n Data and CoGNAC

- Upgrade CoGNAC to include a series of high-volume CLYC-7 scintillators
- ^{35}Cl(n,p) measures $E_n^{(1)}$ directly
- EJ-309 and CLYC-6 detectors provide $T_n^{(2)}$ measurement to low energy



Applicable to 20+ (n,$2n$) and (n,$3n$) measurements for DOE SC NP FES, and could lead to a decade+ campaign for OES / SAT and PAT

→Opens possibilities for correlated (n,$2n$), (n,n), and (n,n') measurements

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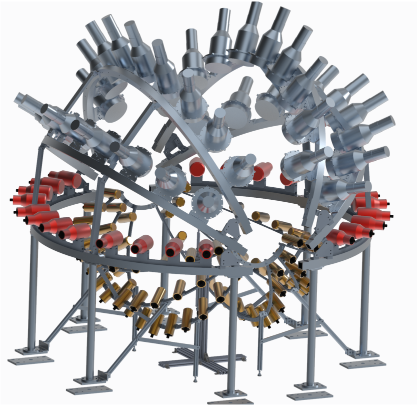

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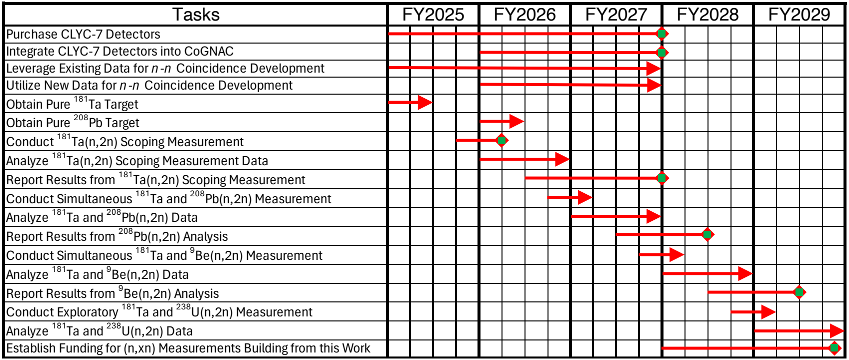
Project Tasks in Progress So Far



- CLYC-7 purchases placed; ^{181}Ta & ^{208}Pb target purchase in progress
- ^{9}Be CoGNAC data being investigated for $(n,2n)$
- n-n coincidence development in progress with existing data
- Experiment on ^{181}Ta$(n,2n)$ planned for 2025 LANSCE run cycle
- Engineering of CLYC-7 integration in CoGNAC in progress

THANK YOU!

Direct questions to kkelly@lanl.gov