^{64}Cu and ^{47}Sc (n,p) Cross-Section Measurements for Medical Radionuclide Production

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31 August 2016

WTTC '16

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Why Should You Care?

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- Emerging medical radionuclides
  - ^{64}Cu ($t_{1/2}$ = 12.7 hr) – 61% β^+ to ^{64}Ni, 39% β^- to ^{64}Zn
  - ^{47}Sc ($t_{1/2}$ = 3.35 d) – β^- to ^{47}Ti, with 159-keV γ

Promising Prospects for ^{44}Sc-/^{47}Sc-Based Theragnostics: Application of ^{47}Sc for Radionuclide Tumor Therapy in Mice

Cristina Müller[1], Maruta Bunka[2,3], Stephanie Haller[1], Ulli Köster[4], Viola Groehn[5], Peter Bernhardt[6,7], Nicholas van der Meulen[2], Andreas Türler[2,3], and Roger Schibli[1,8]

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In Vivo Evaluation of Pretargeted ^{64}Cu for Tumor Imaging and Therapy

Michael R. Lewis, PhD[1]; Mu Wang, MD[1]; Donald B. Axworthy, BS[2]; Louis J. Theodore, PhD[2]; Robert W. Mallet, BS[2]; Alan R. Fritzberg, PhD[2]; Michael J. Welch, PhD[1]; and Carolyn J. Anderson, PhD[1]

[1]Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, Missouri; and [2]NeoRx Corporation, Seattle, Washington

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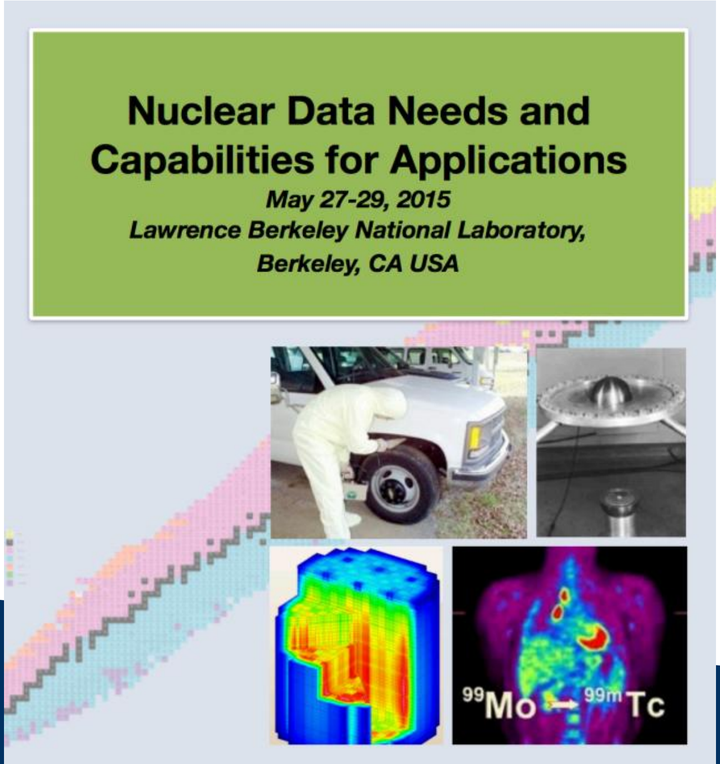
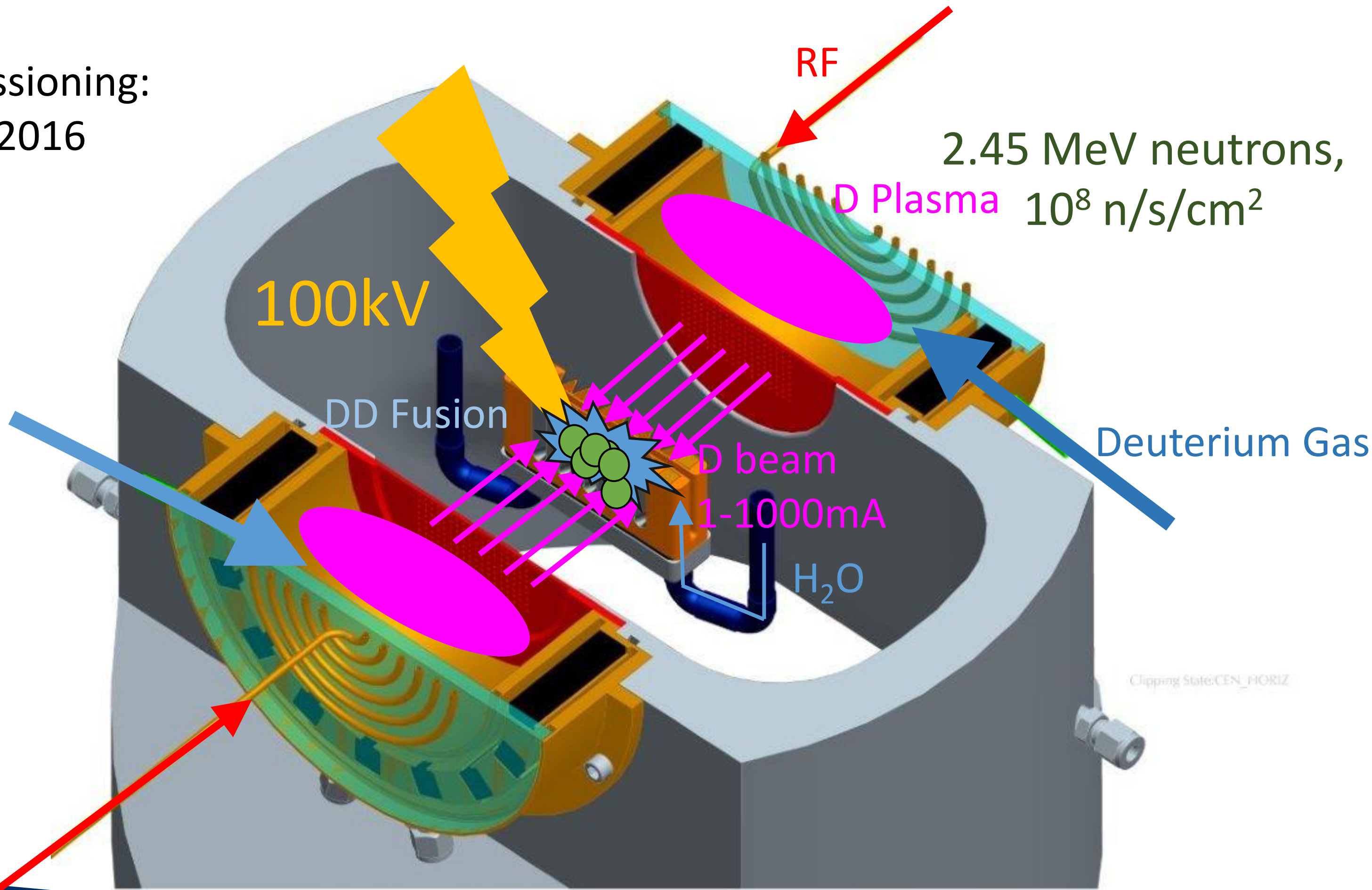
- Nuclear data as fundamental tools

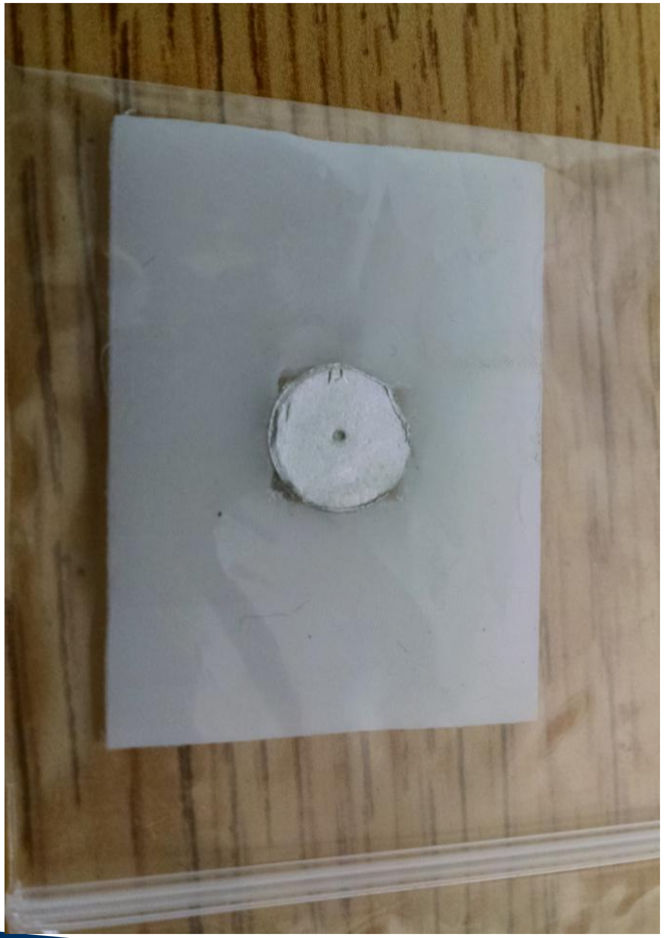


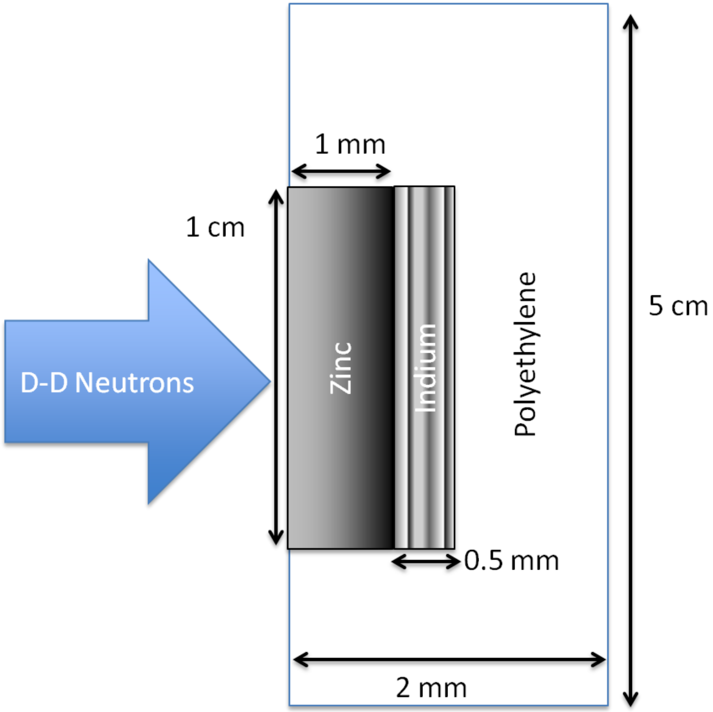
The UC Berkeley High Flux Neutron Generator

Commissioning:
25 July 2016



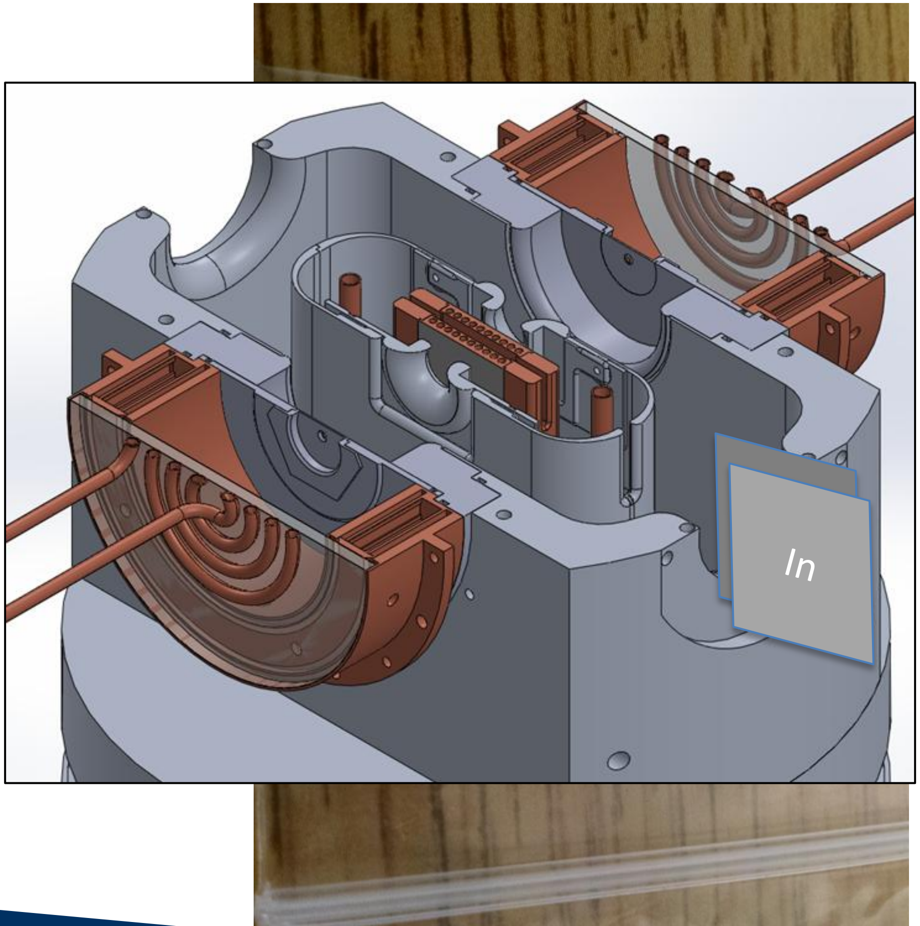
The UC Berkeley High Flux Neutron Generator

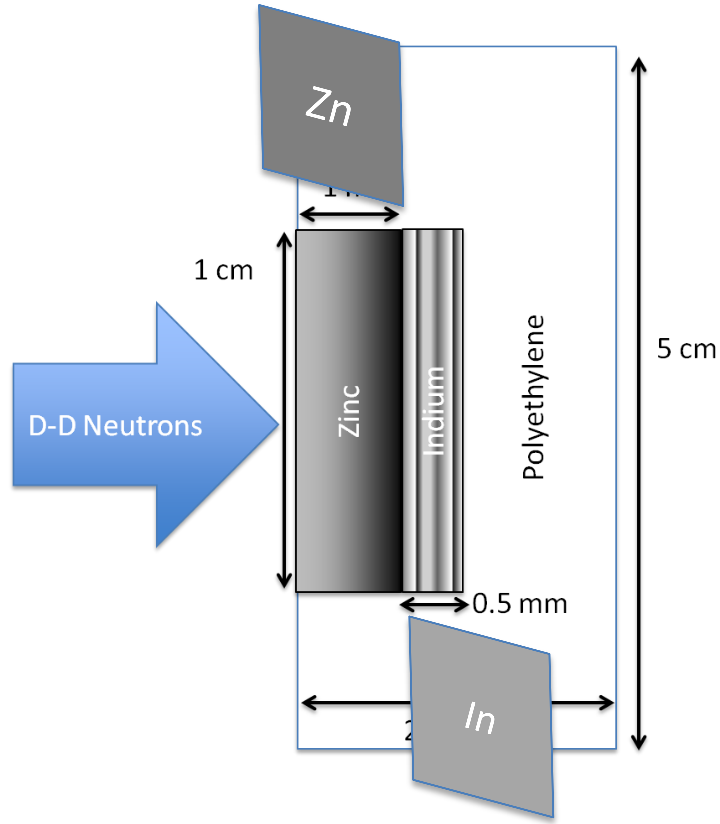




Foils Used	Metal Purity	Abundance (a/o)	Foil Density (mg/cm^2)
^{nat}In	> 99.999%	^{113}In (4.29%), ^{115}In (95.71%)	365.5
^{nat}Zn	> 99.99%	^{64}Zn (49.17%)	714.1
^{nat}Ti	99.999%	^{47}Ti (7.44%)	450.6

The UC Berkeley High Flux Neutron Generator





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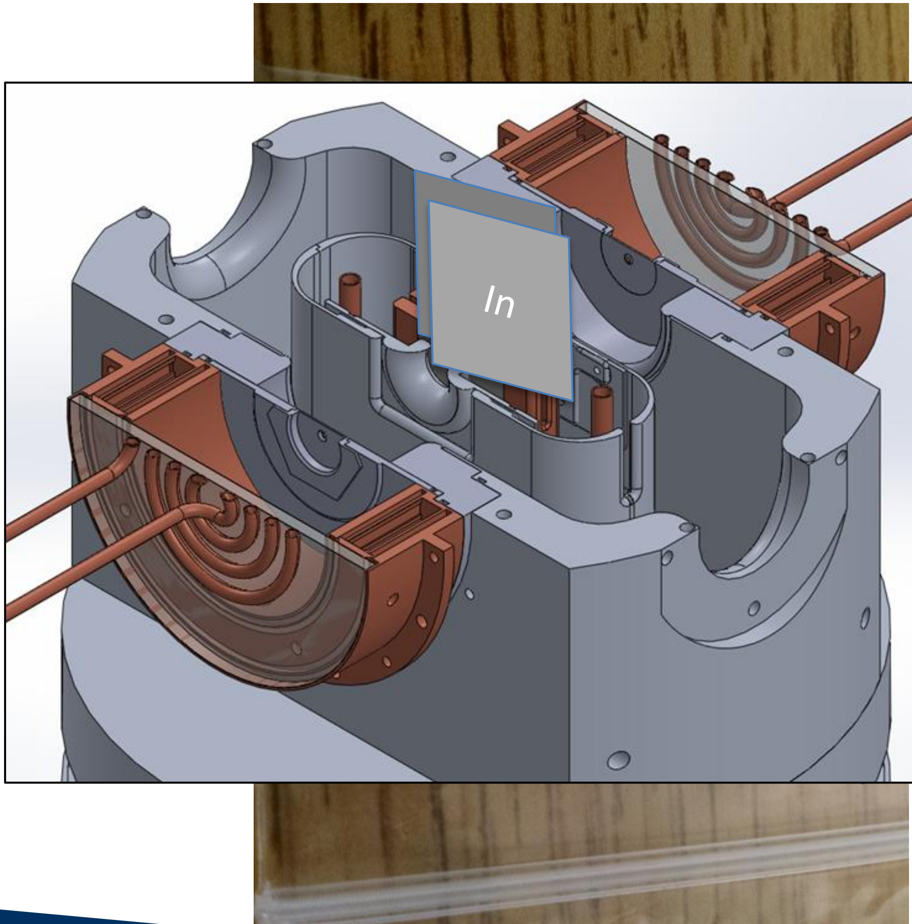
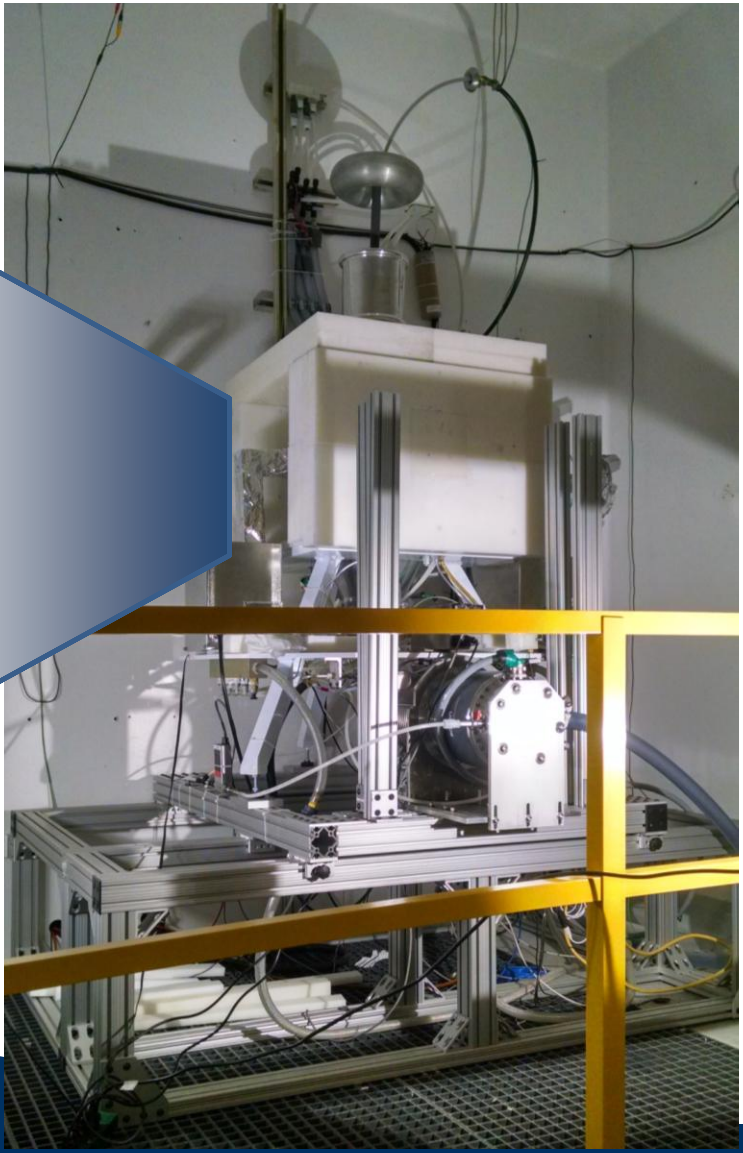


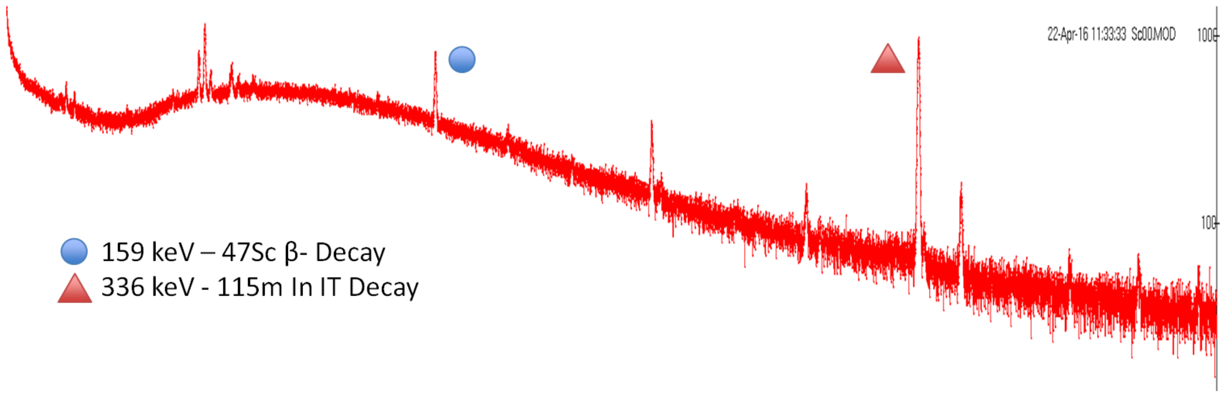


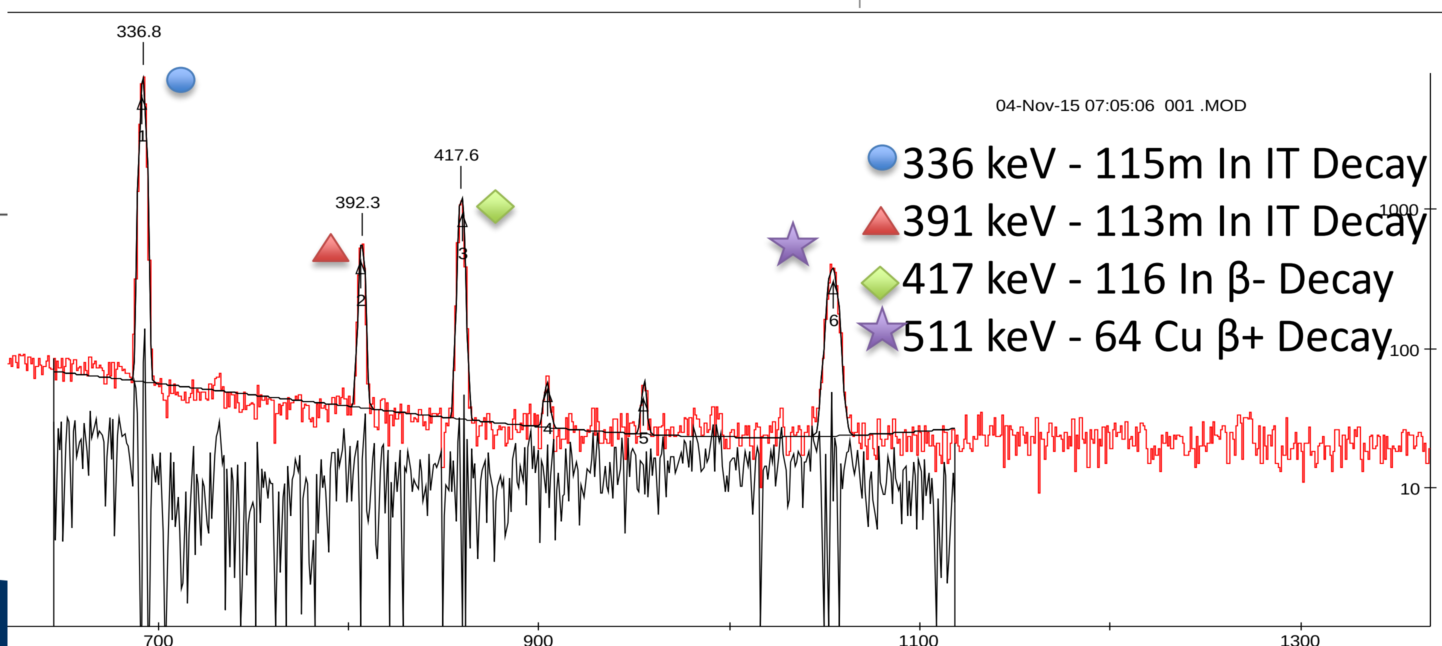
Relative Activation Measurements

Ortec Planar LEPS detector

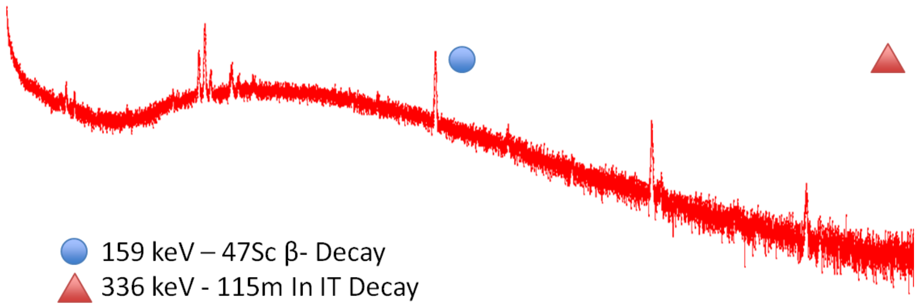
Ortec 80% HPGe detector

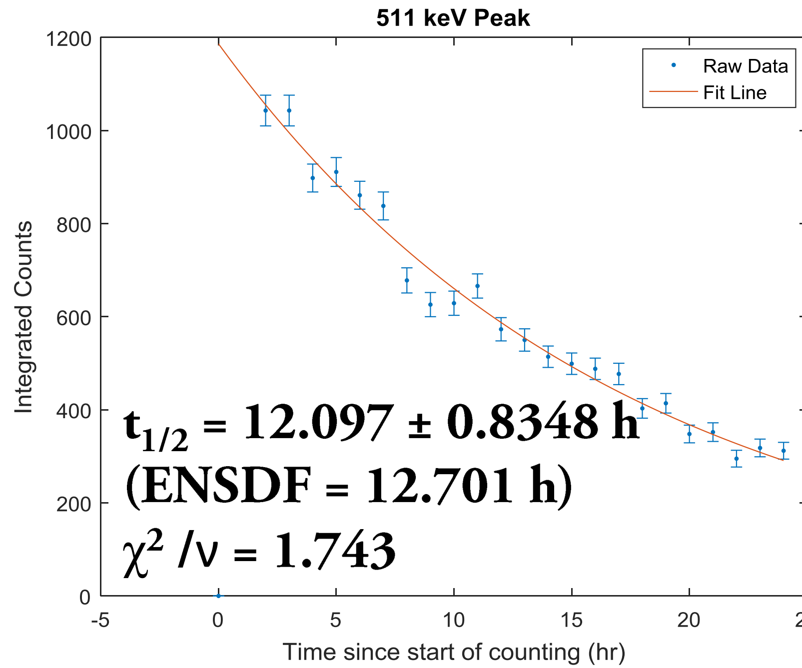
Relative Activation Measurements

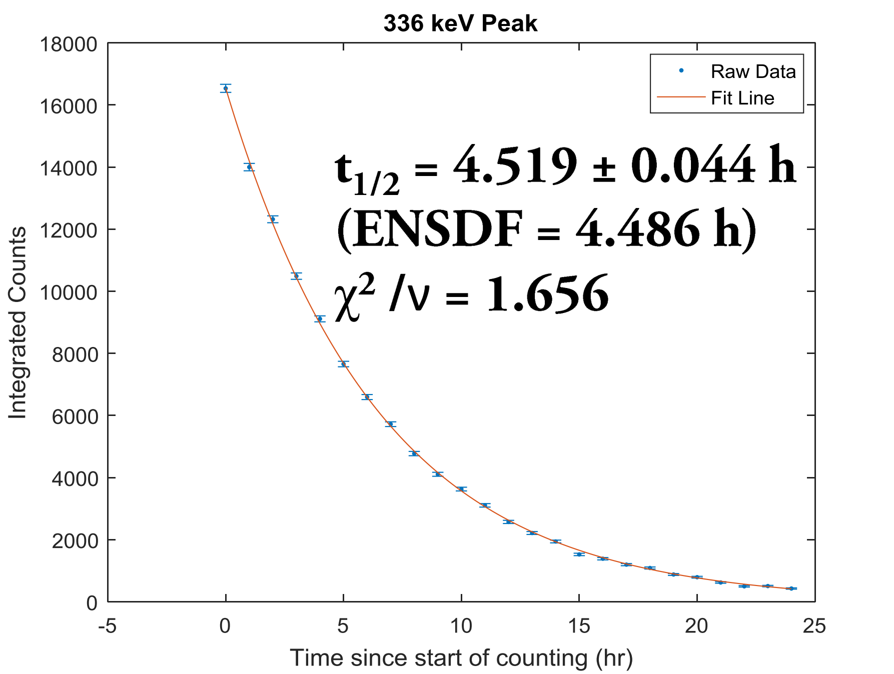


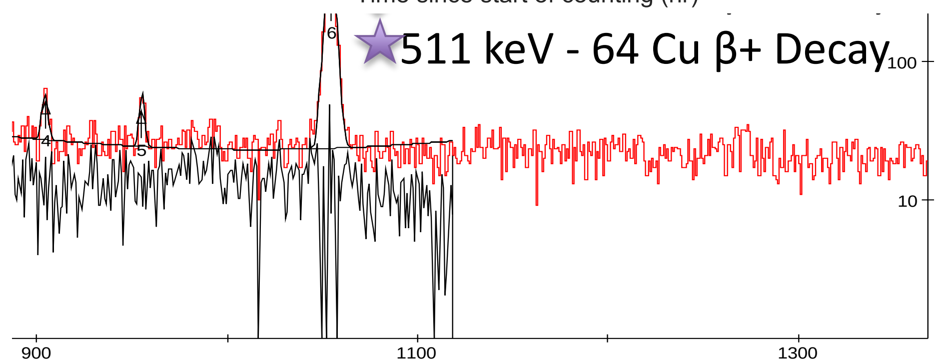


Relative Activation Measurements

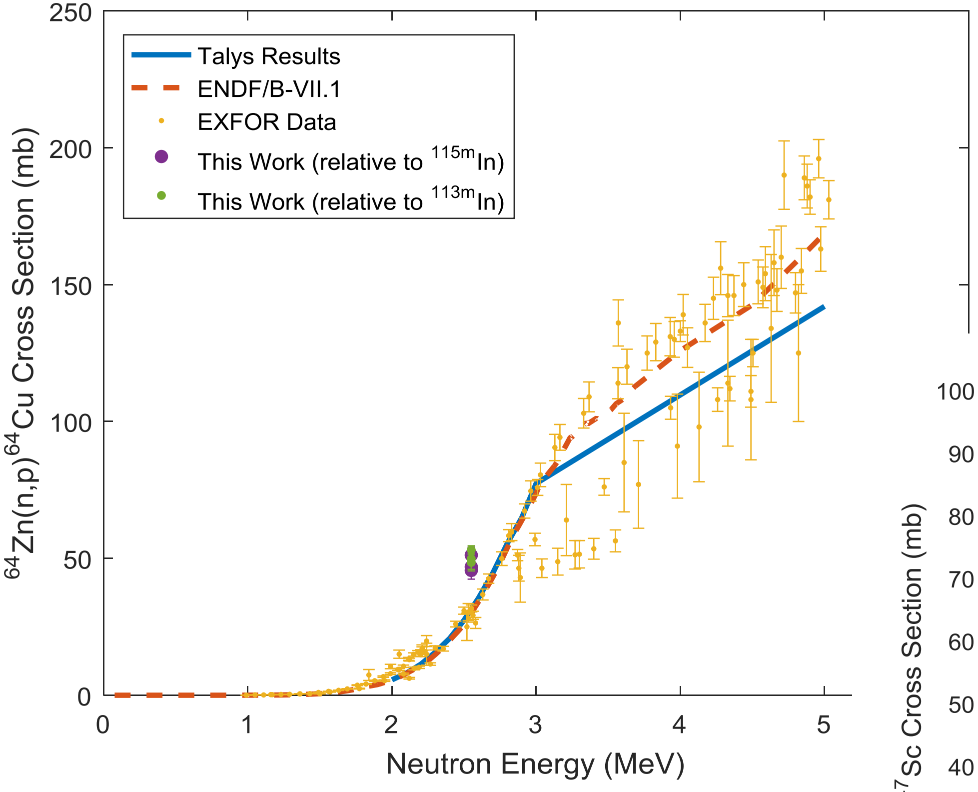


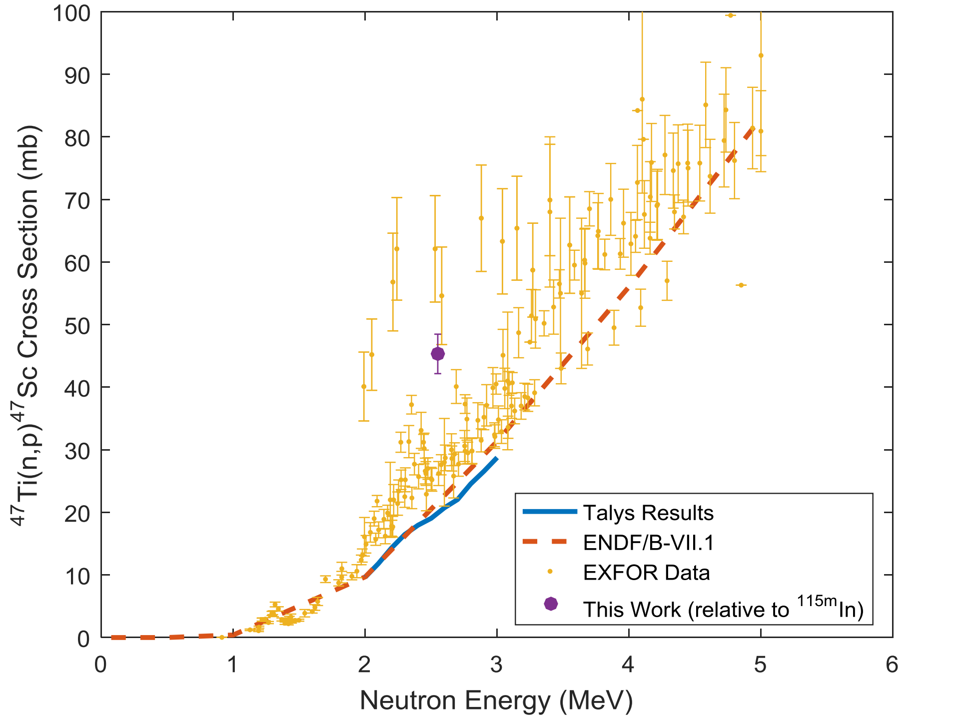




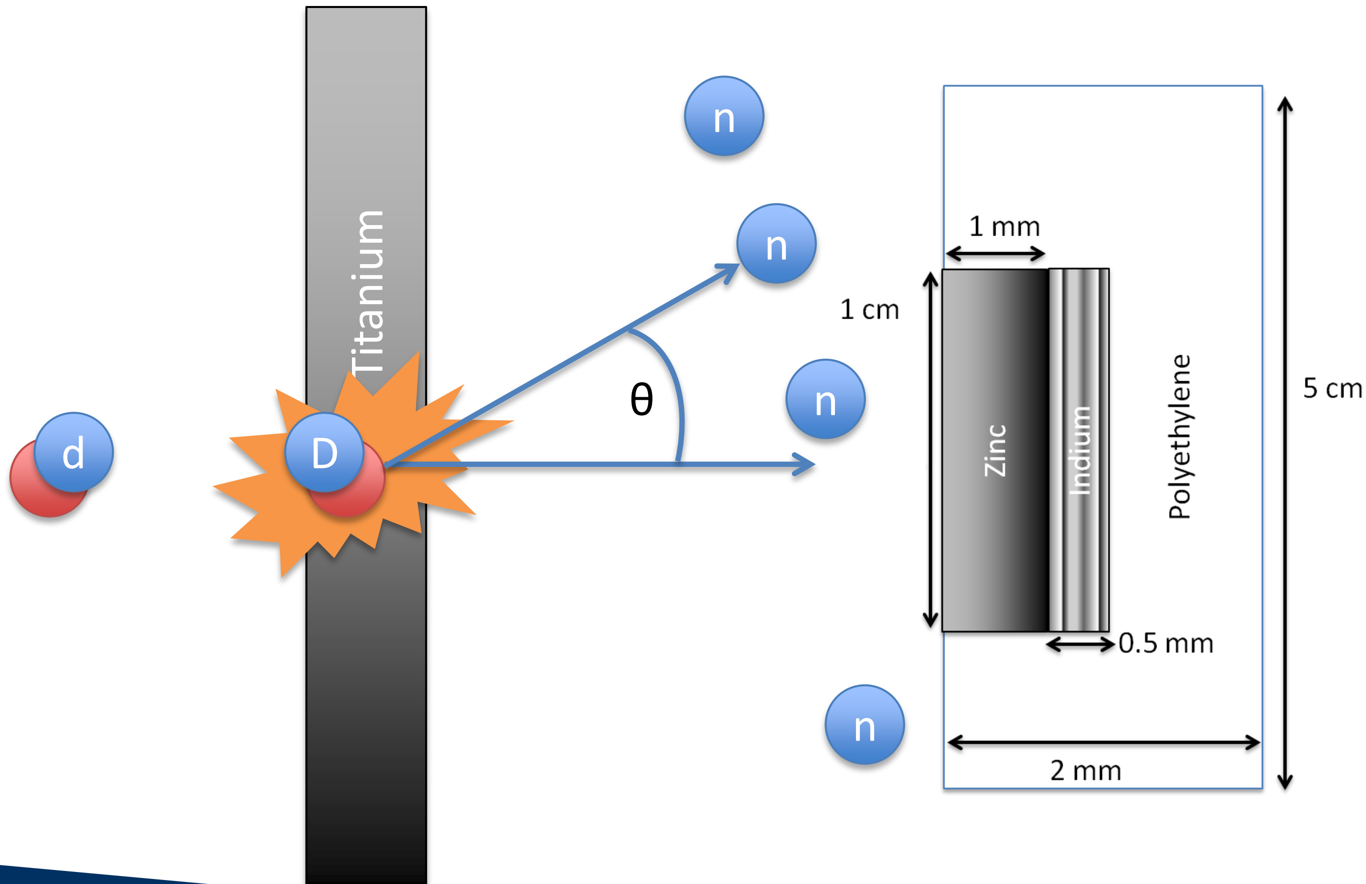


Relative Activation Measurements





Neutron Energy Spread



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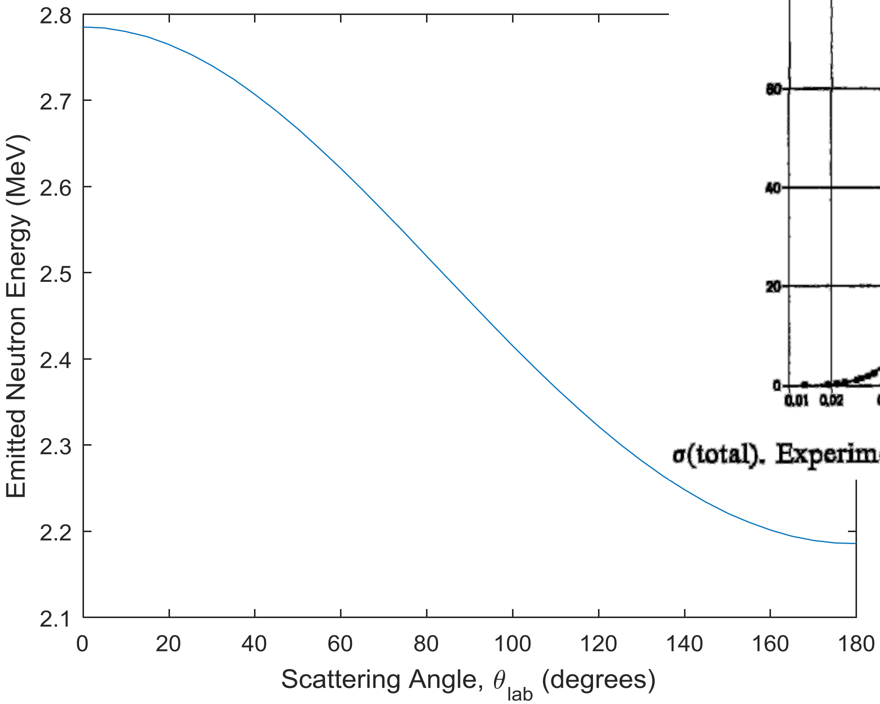
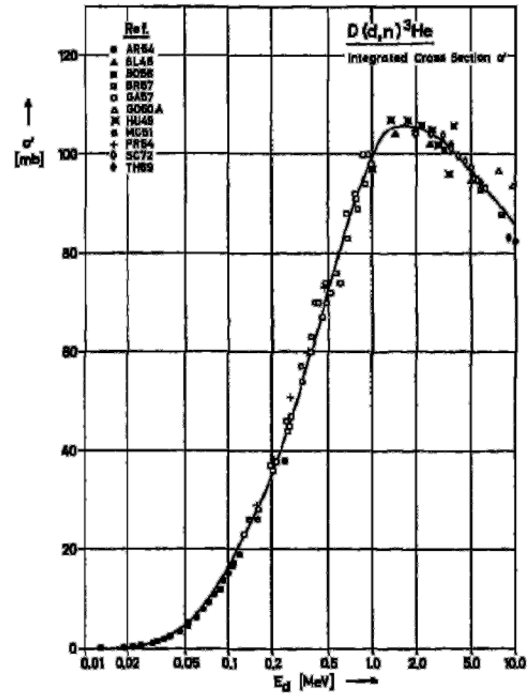
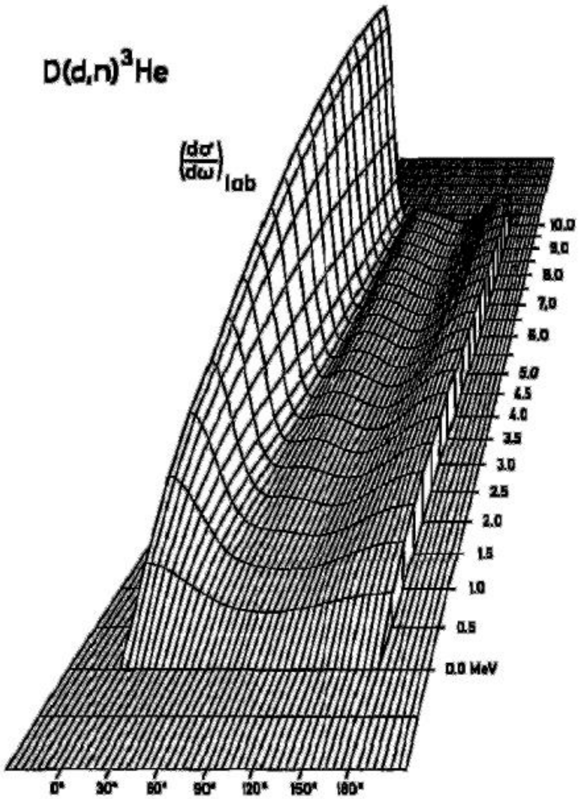




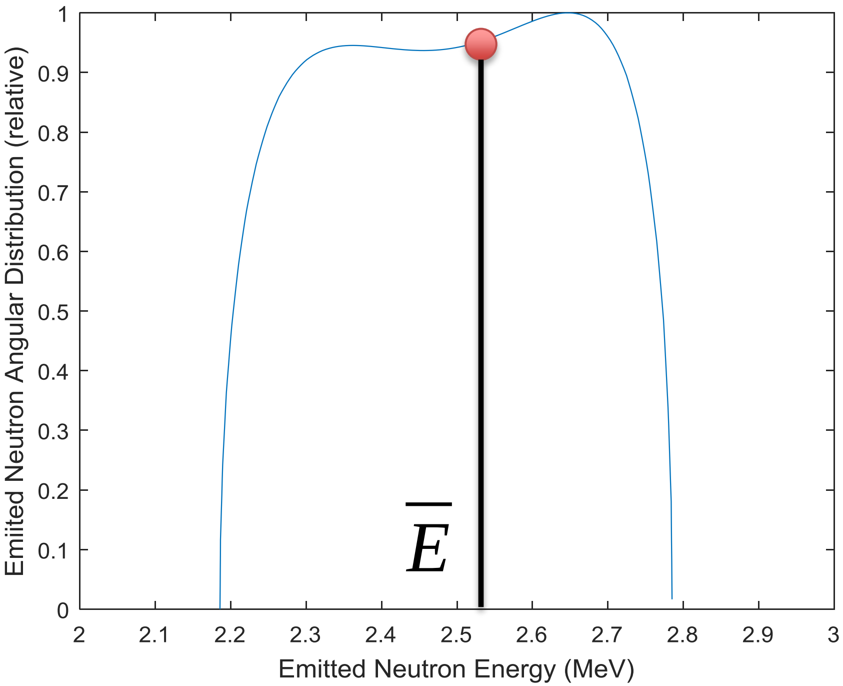
σ(total). Experimental and Recommended Values



$\sigma(\theta, E_p)$. Recommended Values

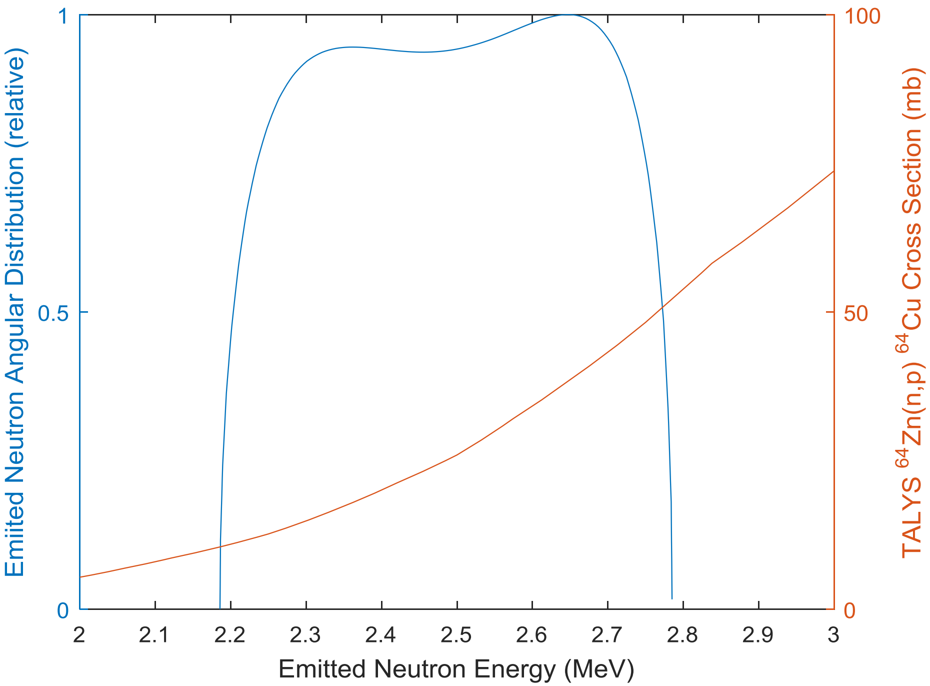
H. Liskien *et al.*, Nucl Data Tables, vol 11, 2973

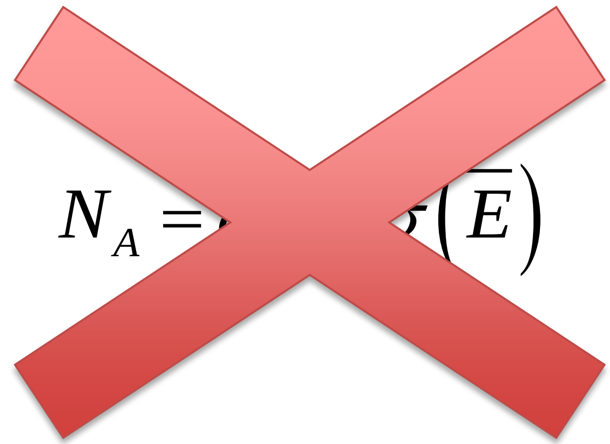
Neutron Energy Spread

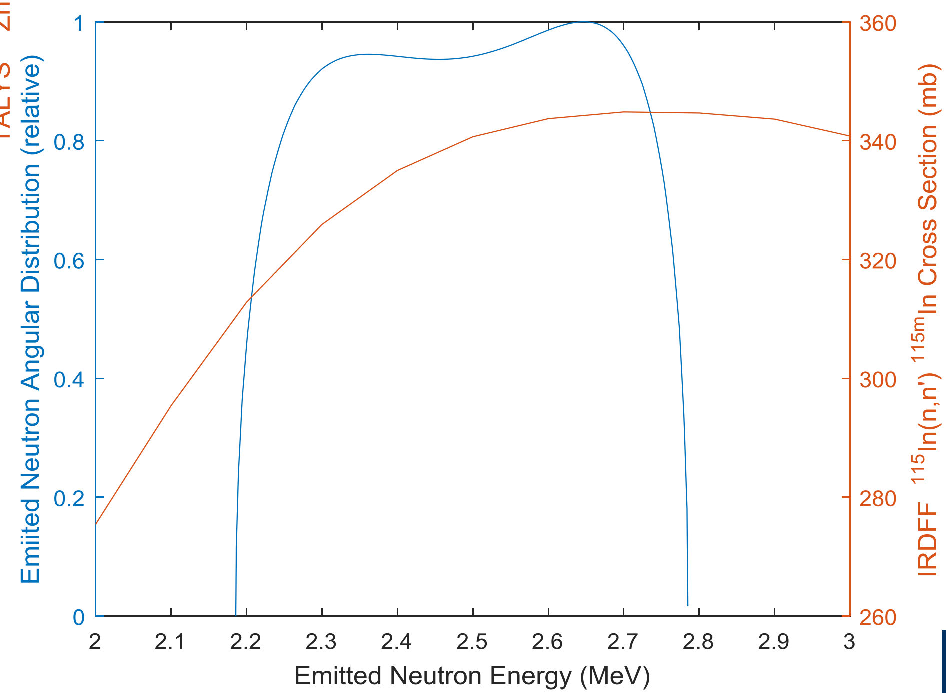


$$N_A = \phi\left(\overline{E}\right)\sigma\left(\overline{E}\right)$$

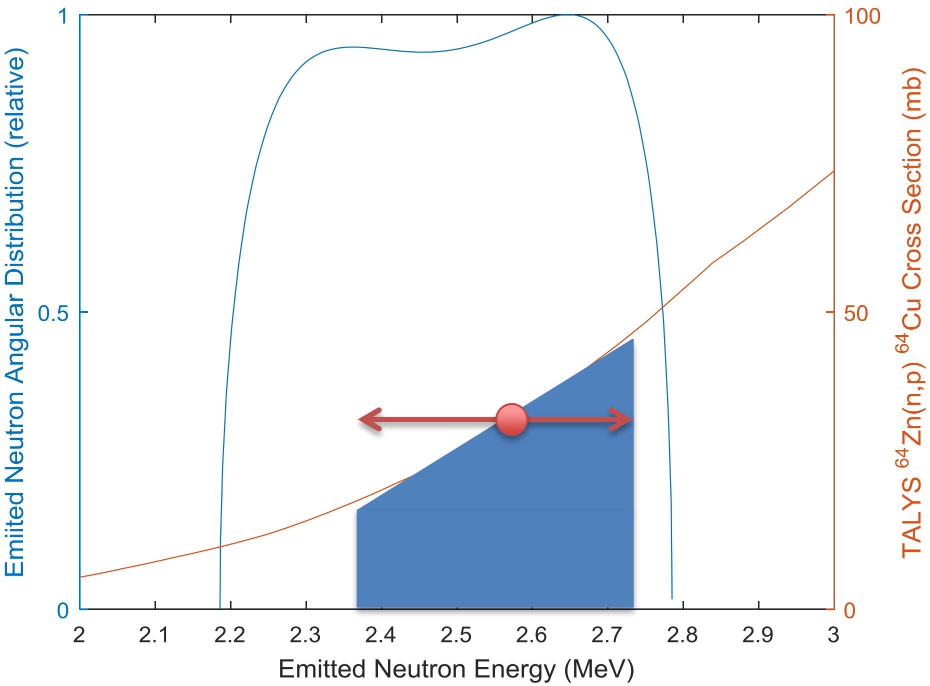
Neutron Energy Spread



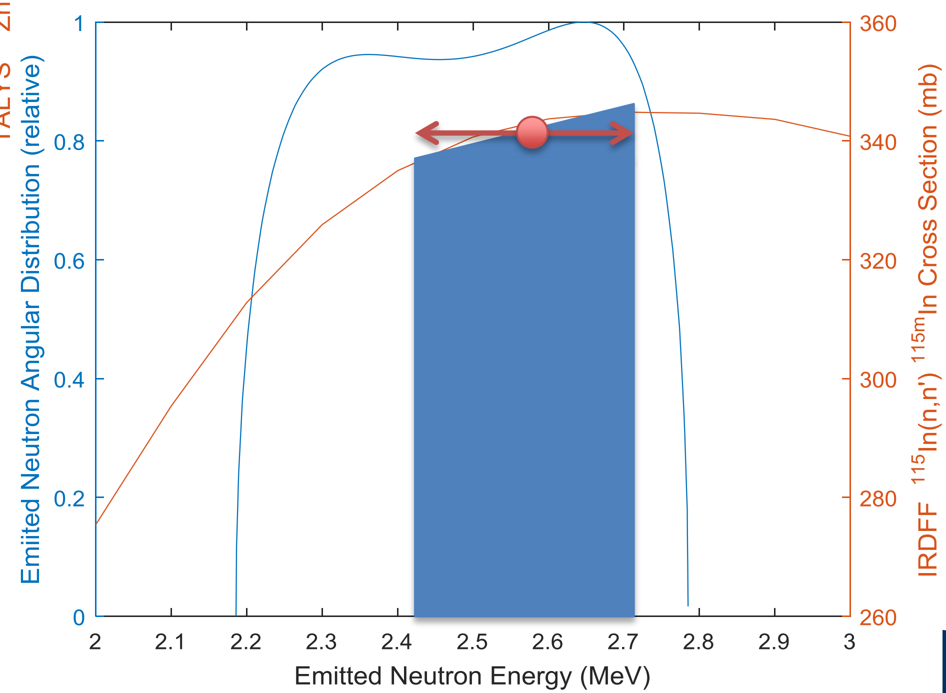




Neutron Energy Spread



$$N_A = \int_{E_0}^{E_f} \frac{d\phi}{dE}\sigma(E)dE$$



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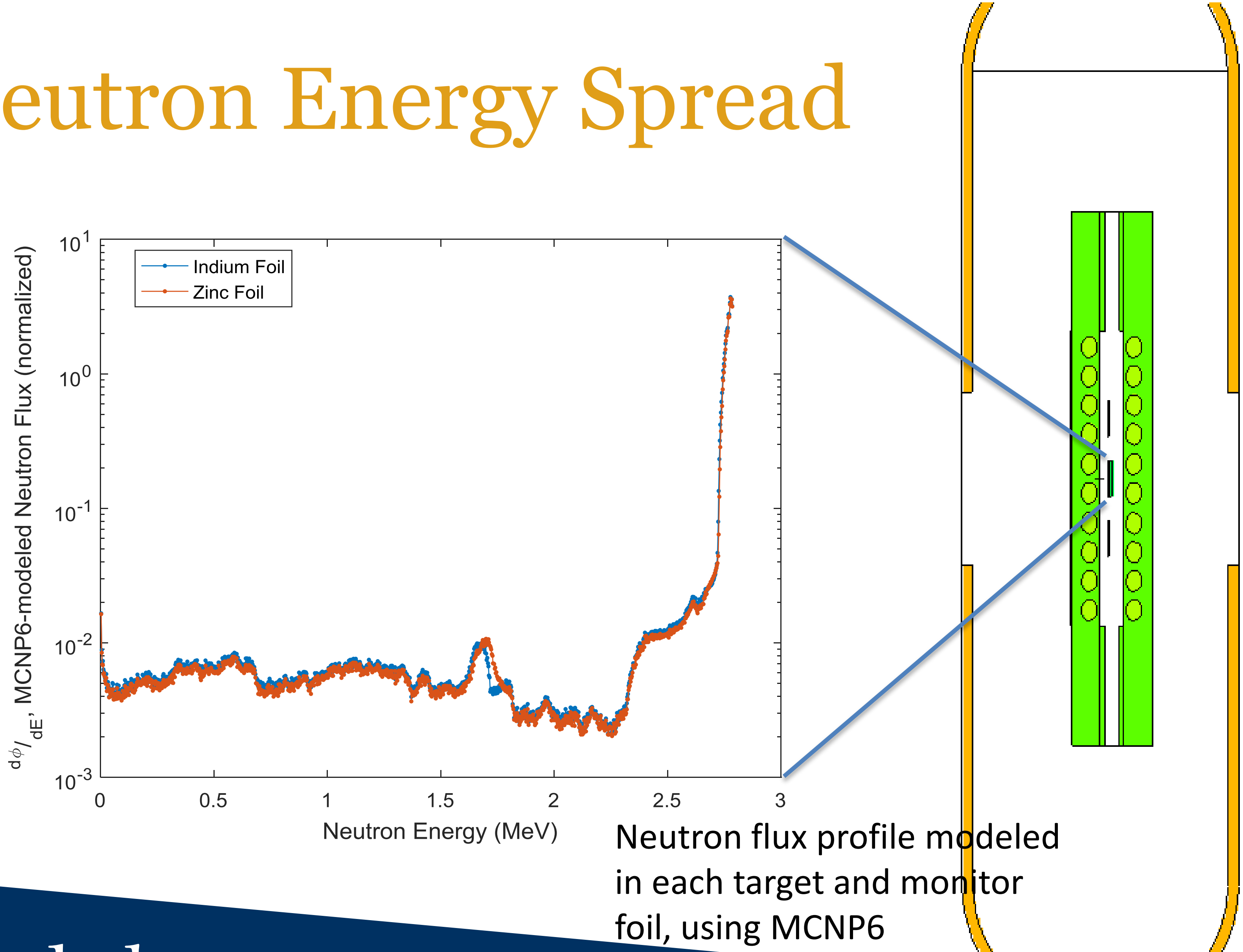
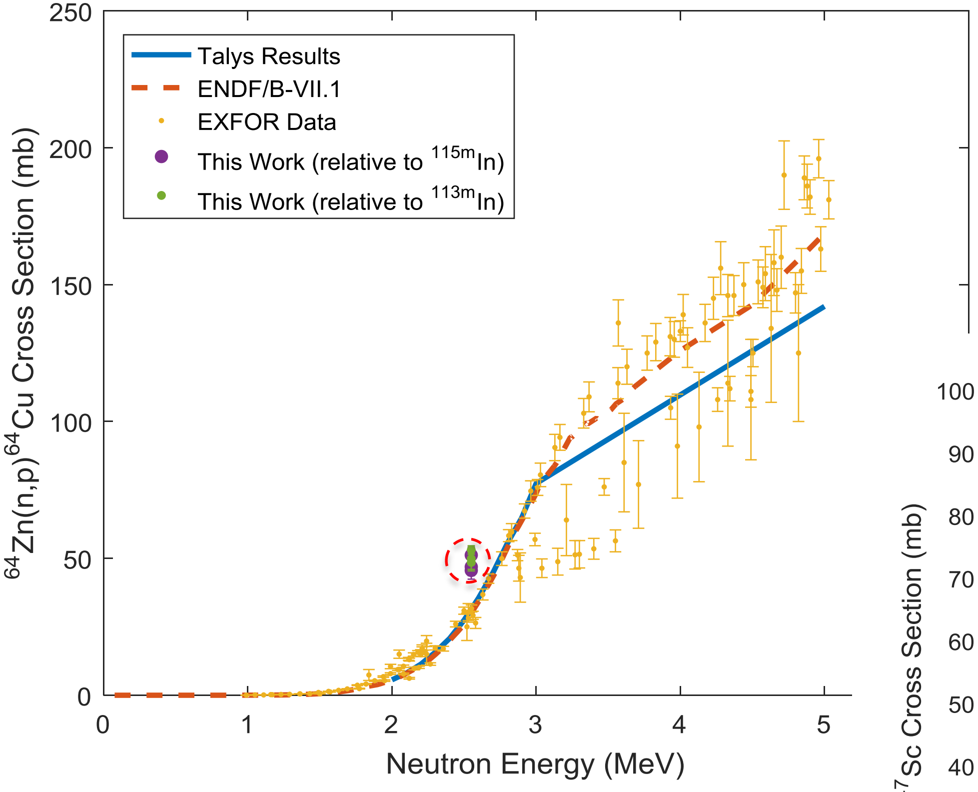
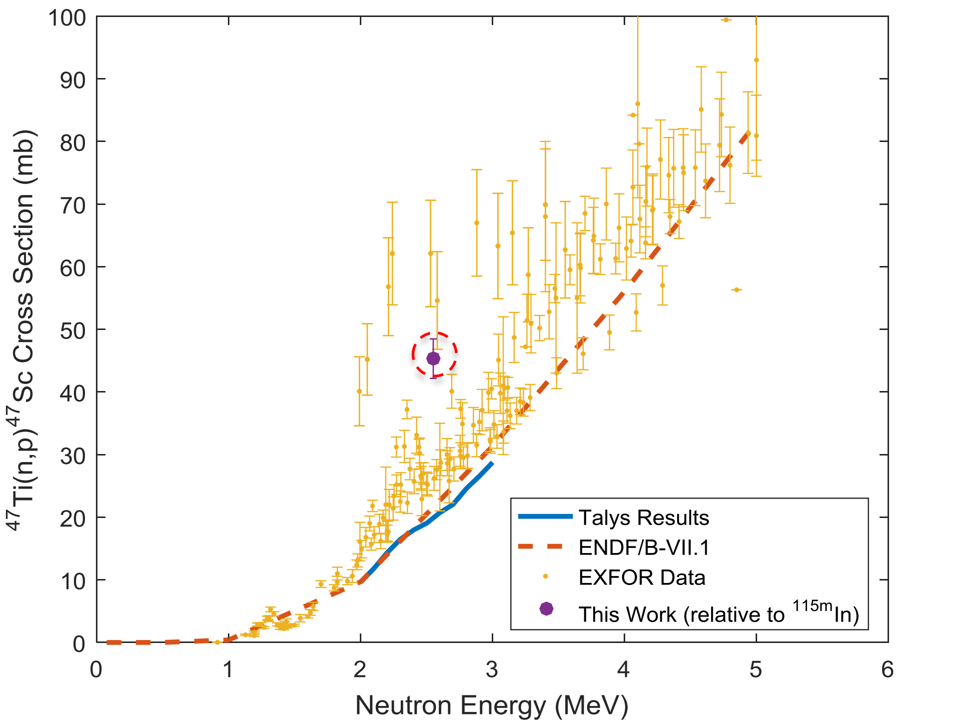


Neutron flux profile modeled in each target and monitor foil, using MCNP6

Neutron Energy Spread



Before…



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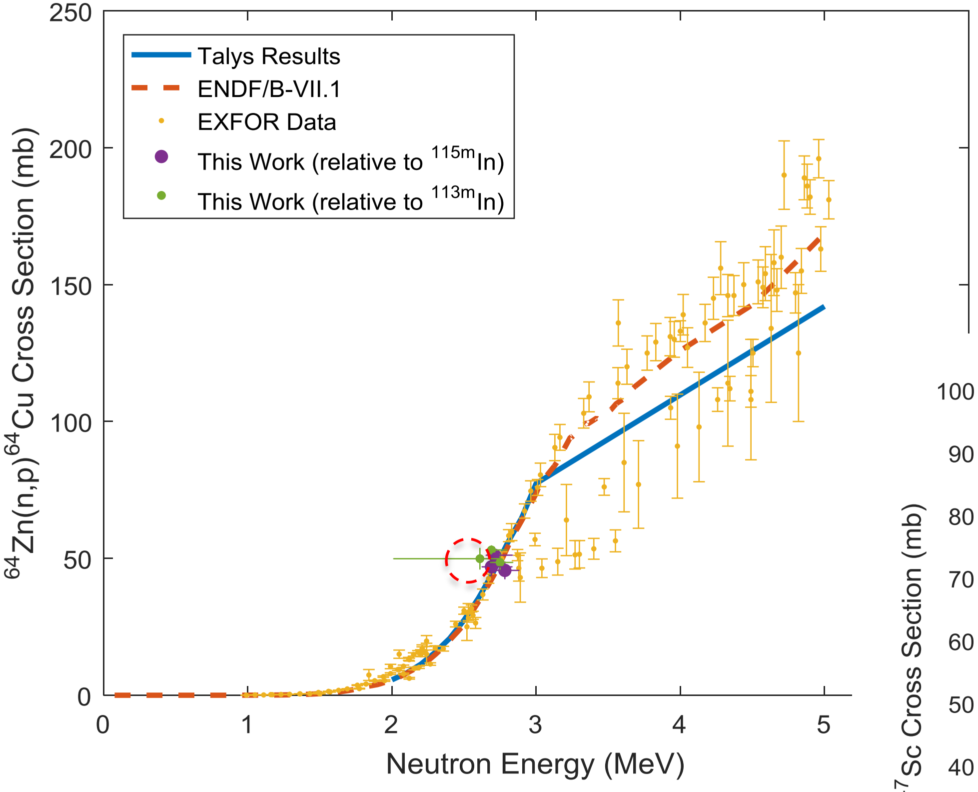
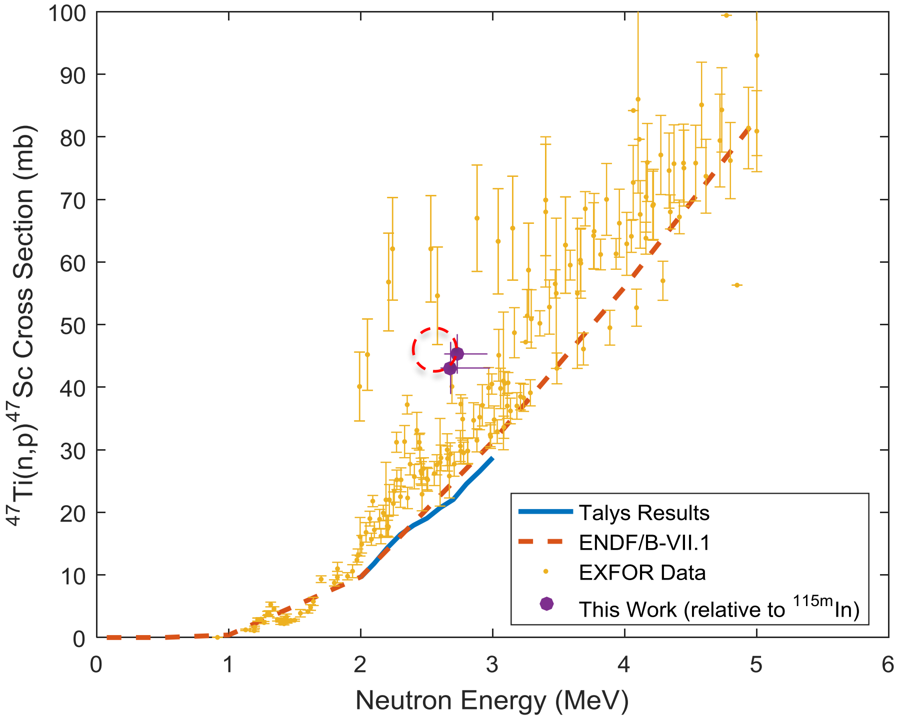
Neutron Energy Spread



After!



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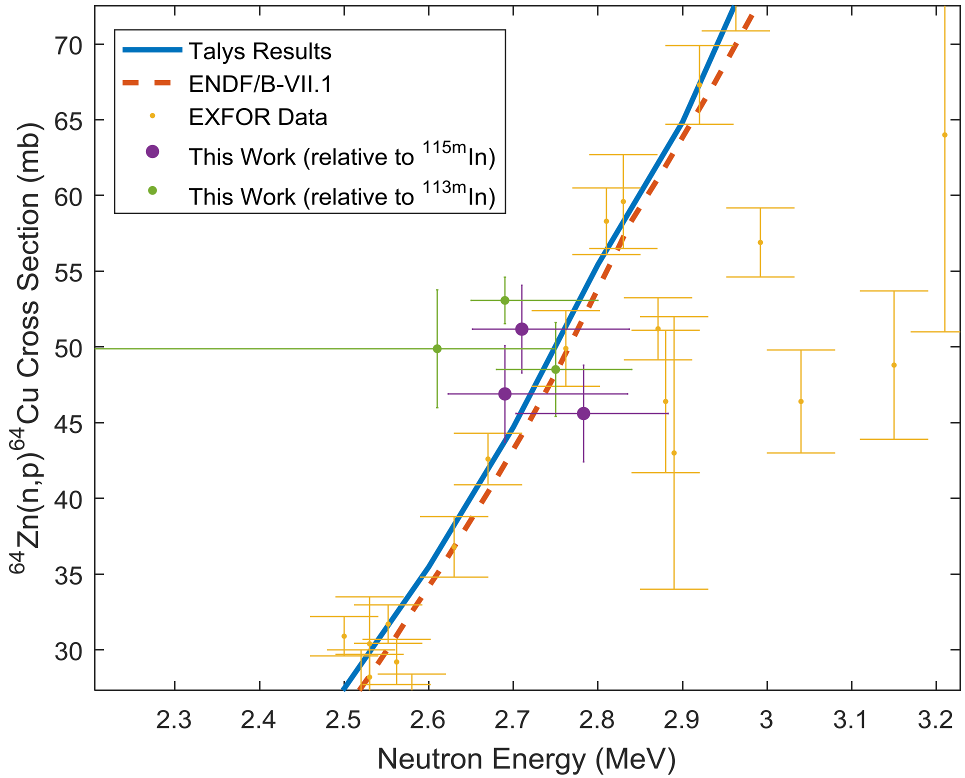
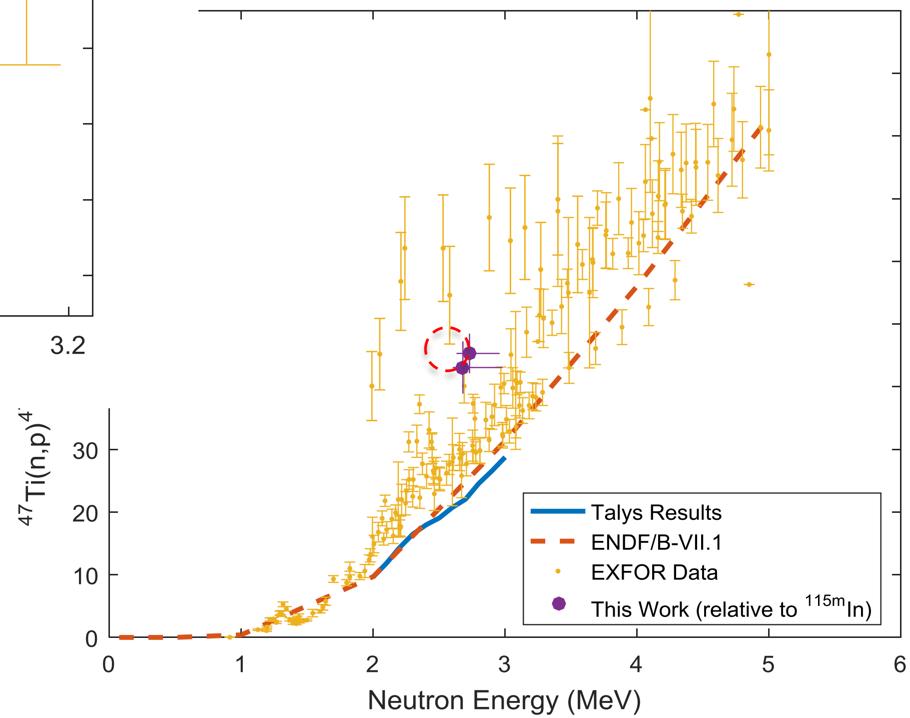
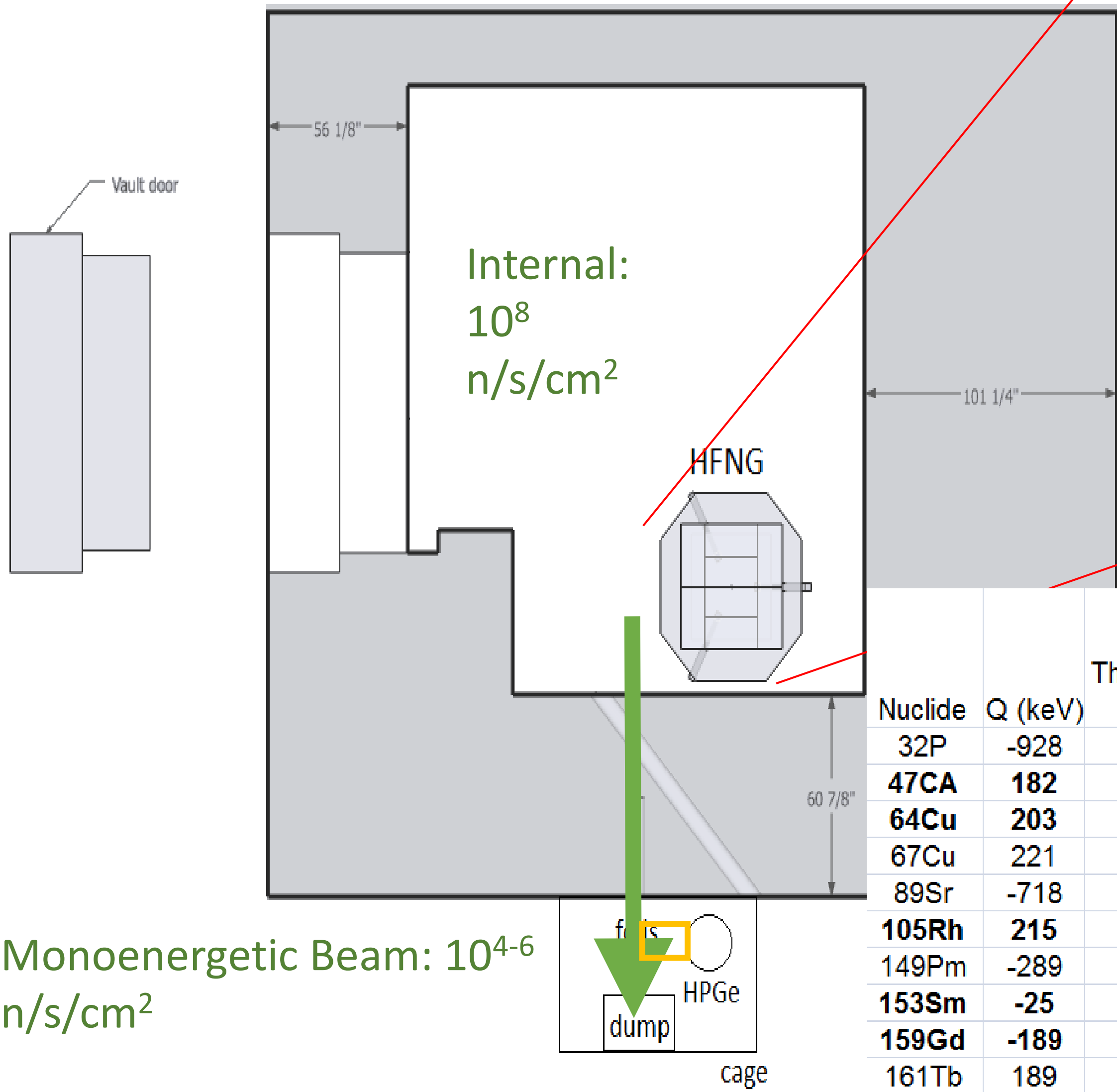


After!



Future Work



Monoenergetic Beam: 10^{4-6} n/s/cm^2

Nuclide	Q (keV)	Threshold (keV)	% abundance	Strongest g-ray branch energy (keV)	# seen in a 0.5% Ge detector	Rate in a 0.5% detector
32P	-928	985	95%	0	0.00E+00	0.00
47CA	**182**	**0**	**7.44%**	**1297.09**	**1.24E+05**	**1.44**
64Cu	**203**	**0**	**49.20%**	**511**	**5.03E+05**	**5.82**
67Cu	221	0	4.04%	184.577	5.45E+04	0.63
89Sr	-718	726	100%	908.96	1.25E+02	0.00
105Rh	**215**	**0**	**22.33%**	**318.9**	**1.27E+05**	**1.47**
149Pm	-289	291	11.24%	285.94	4.47E+03	0.05
153Sm	**-25**	**25**	**52.19%**	**103.18**	**1.36E+05**	**1.58**
159Gd	**-189**	**190**	**100%**	**363.543**	**1.58E+05**	**1.83**
161Tb	189	0	18.89%	75.57	2.66E+04	0.31
166Ho	-1073	1079	33.50%	1379.4	4.39E+03	0.05
169Er	429	0	100%	109.8	1.87E+01	0.00
175Yb	311	0	97.40%	396.3	1.88E+05	2.18
177Lu	281	0	18.60%	208.4	3.77E+04	0.44

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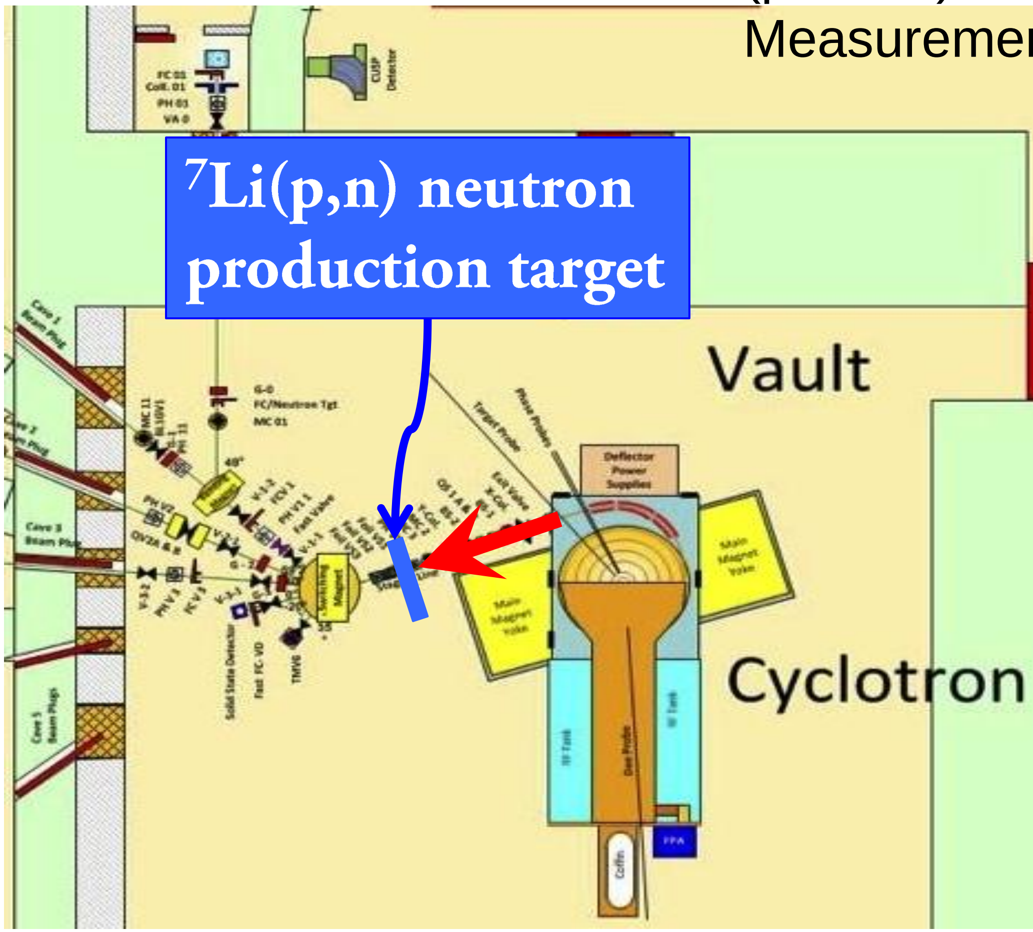
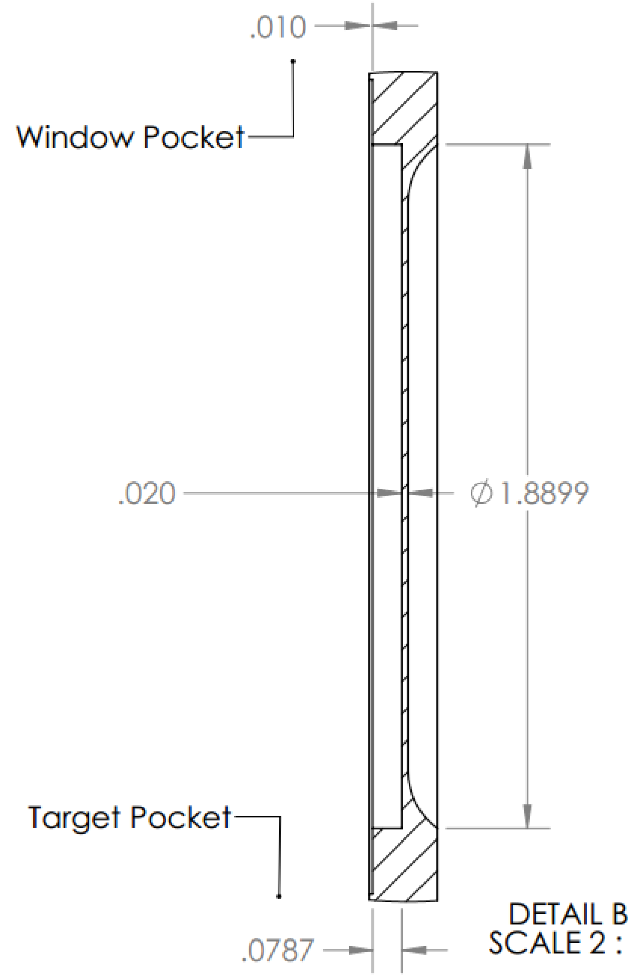
Future Work

(p/d/α, x) and (n,x) Cross Section Measurements at the LBL 88 Inch Cyclotron





Acknowledgements

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