Inertial Confinement Fusion as a Tool to Study Fundamental Nuclear Science

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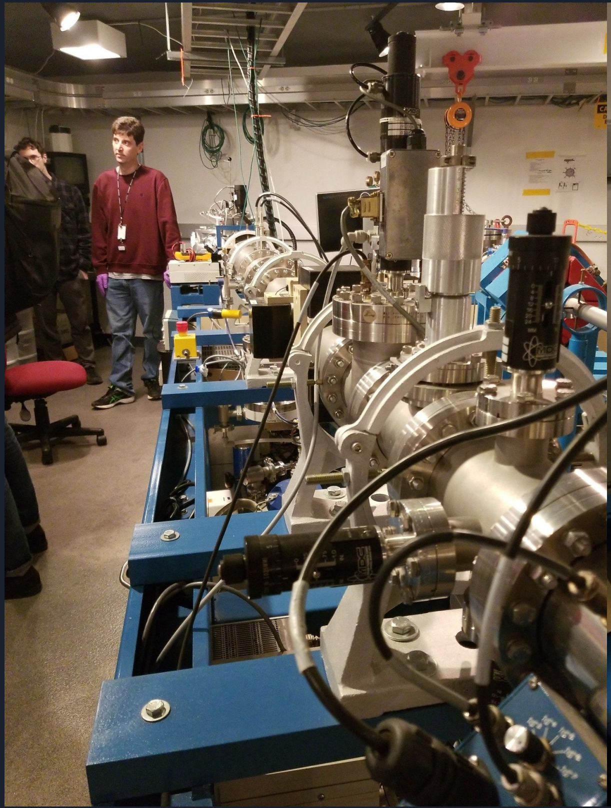
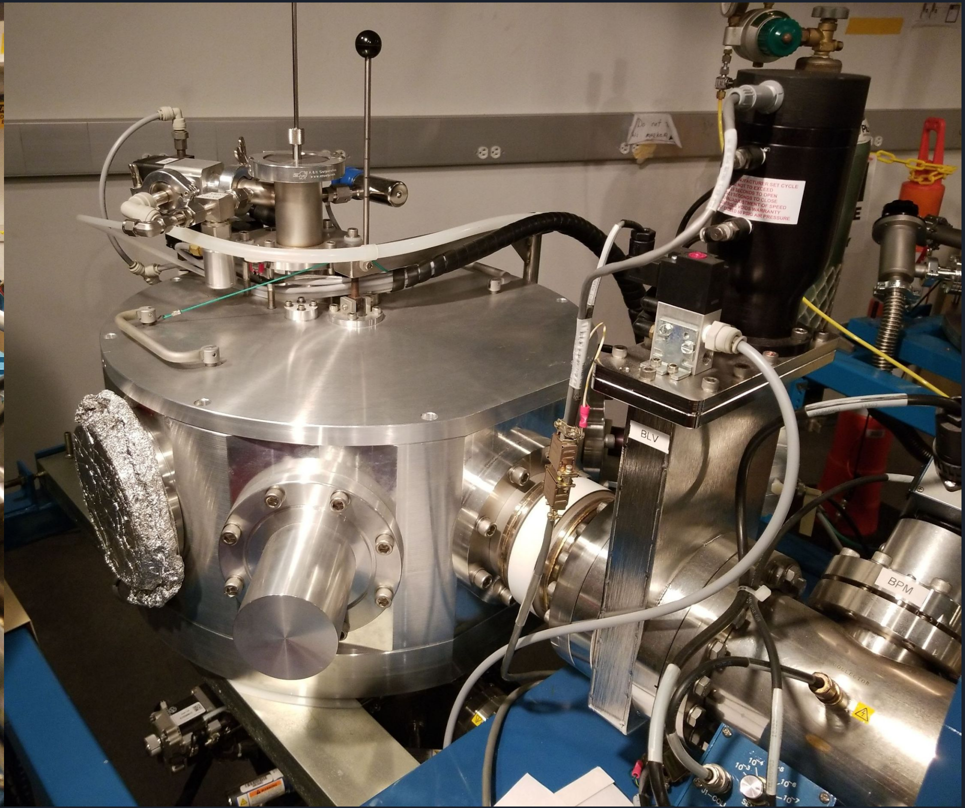
Introduction to Nuclear Science: Cross-Section

$$N = \sigma \frac{N_1 N_2}{A}$$

Introduction to Nuclear Science: Accelerators





Assuming 1 μA beam current, measuring 1,000,000 $^{7}\text{Li}(t,\alpha)^{6}\text{He}$ reactions would take almost 2,800 years

Introduction to Nuclear Science: ICF

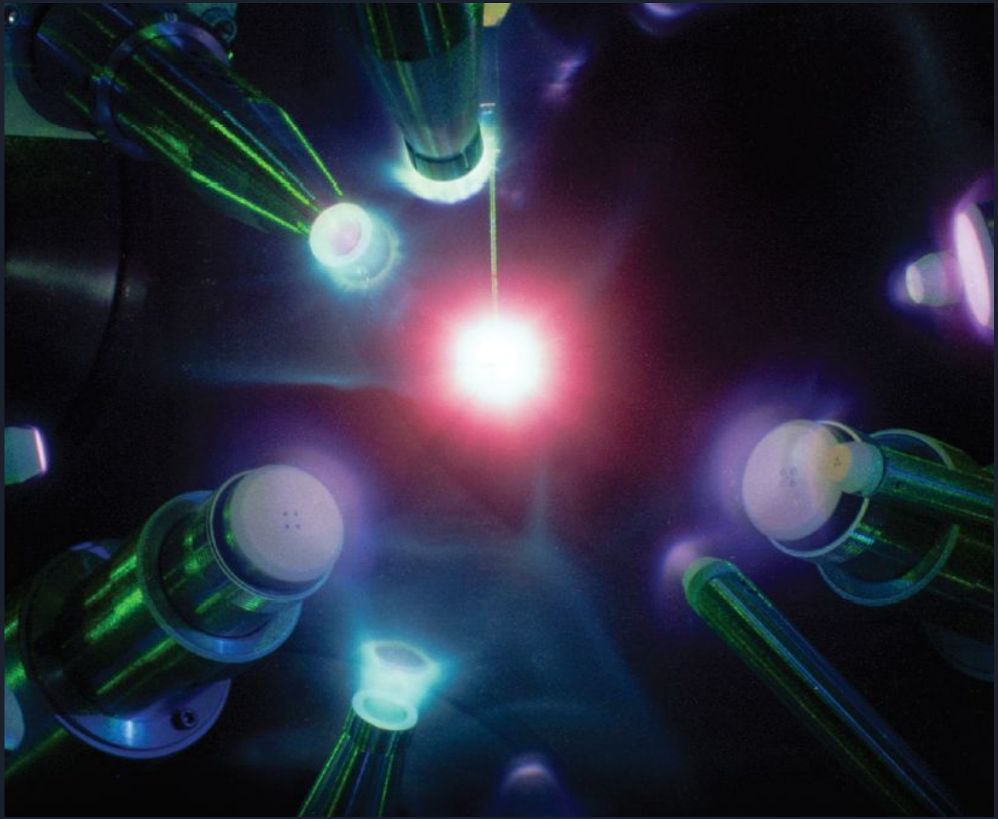
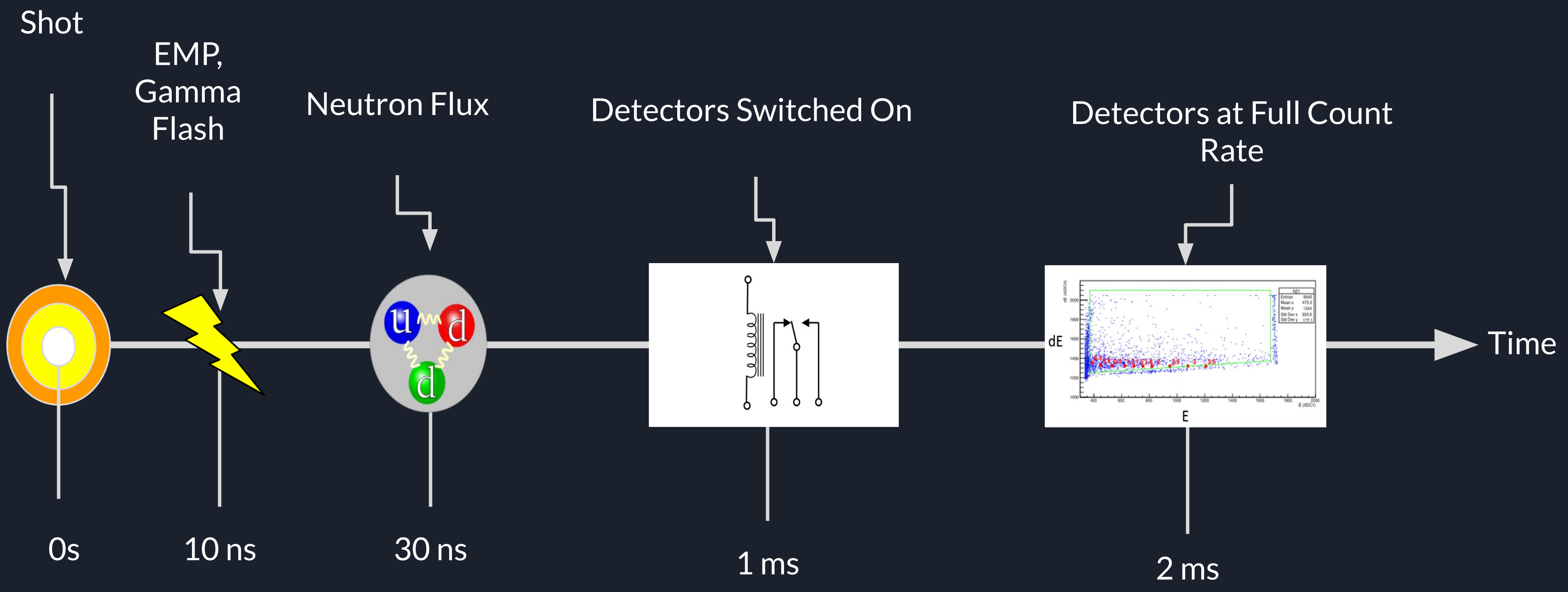
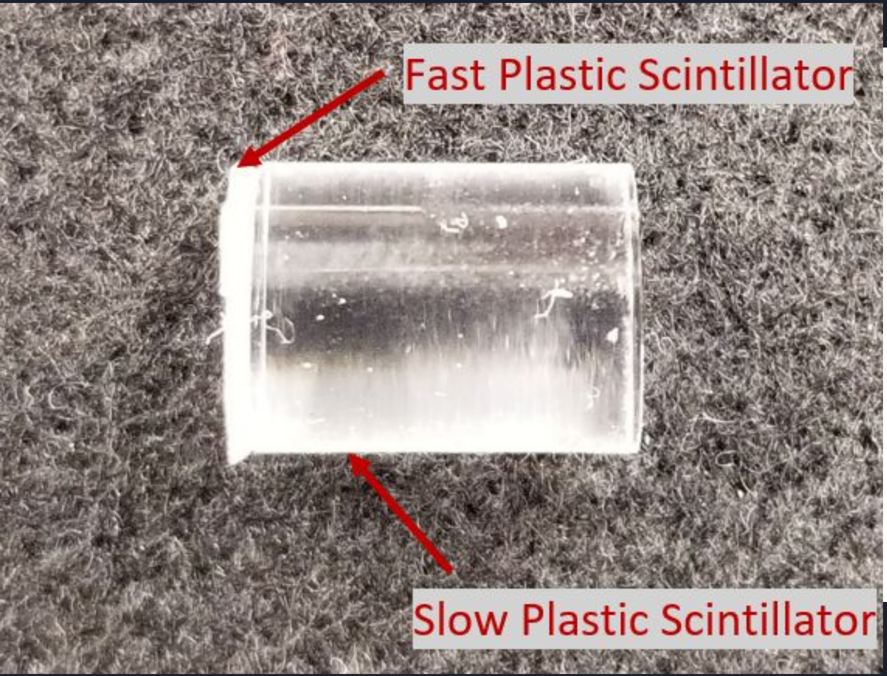


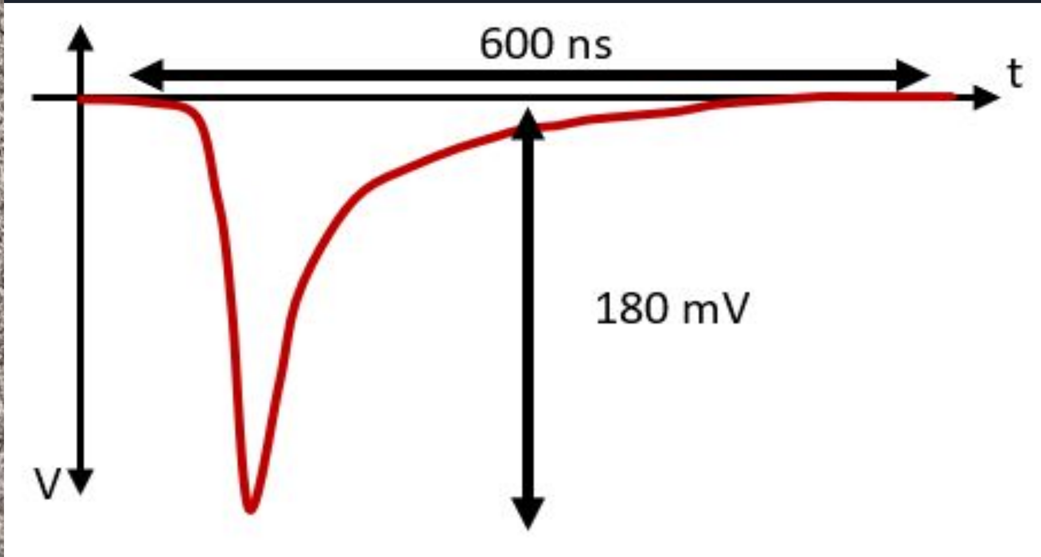
Figure taken from Ref. [1].

The Proposed Methodology: Experiment Timeline

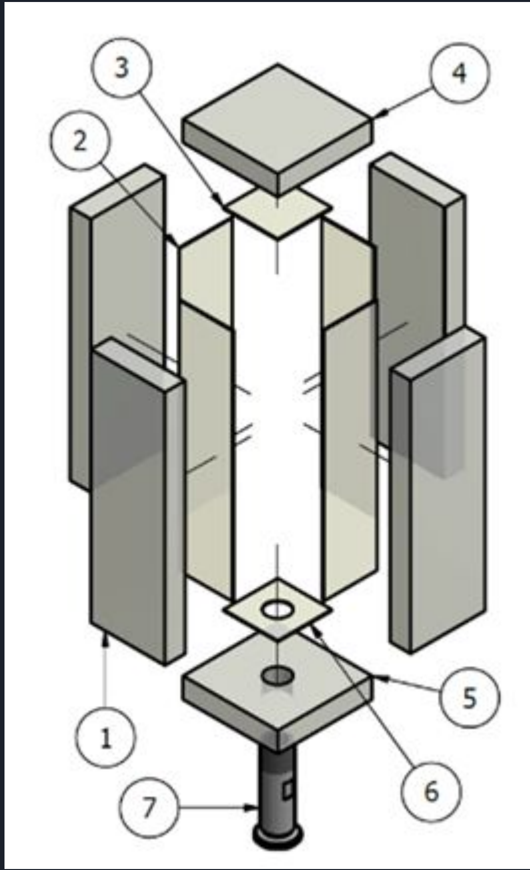


Experiment: Phoswich Detector

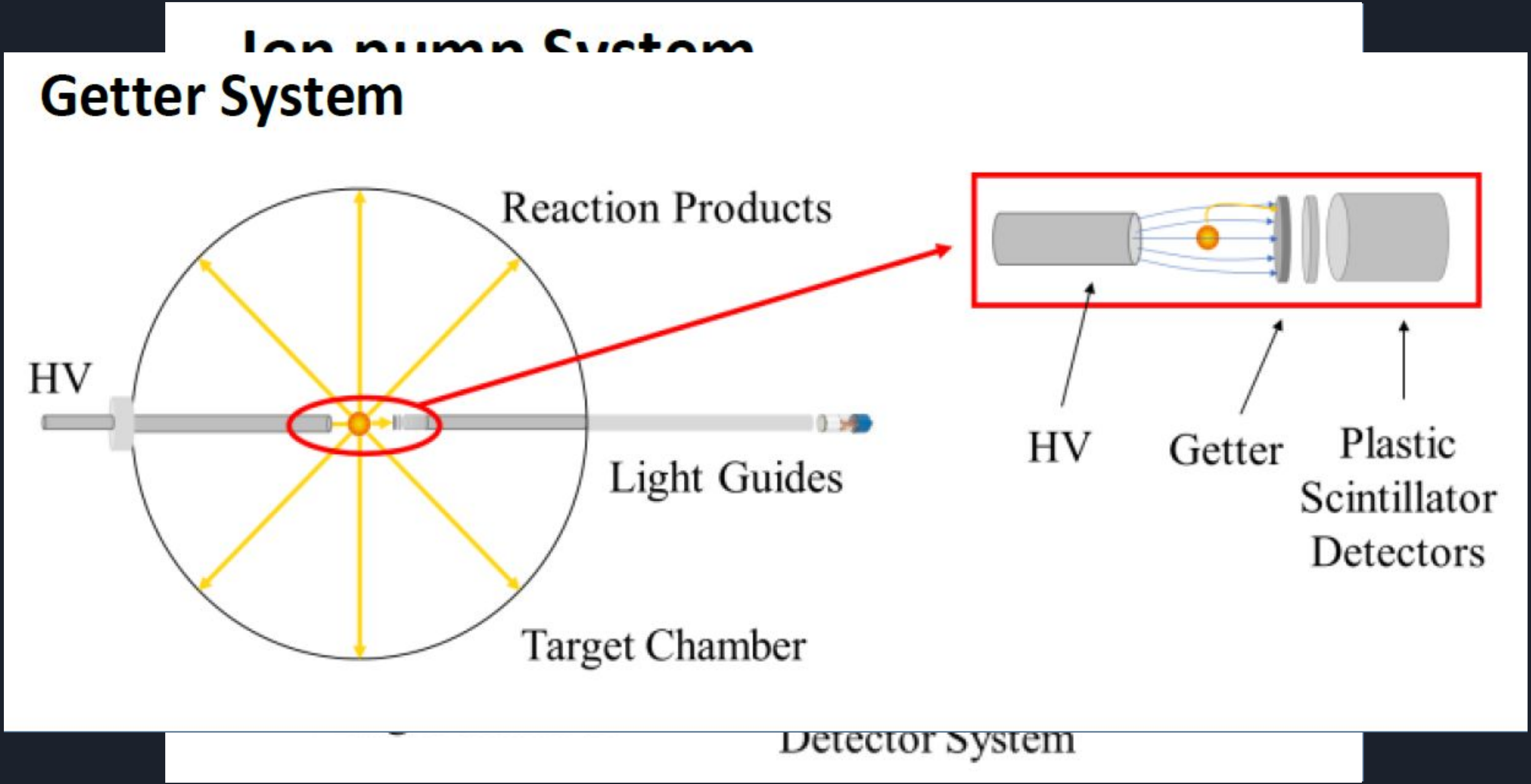




Experiment: 4π Phoswich Detector



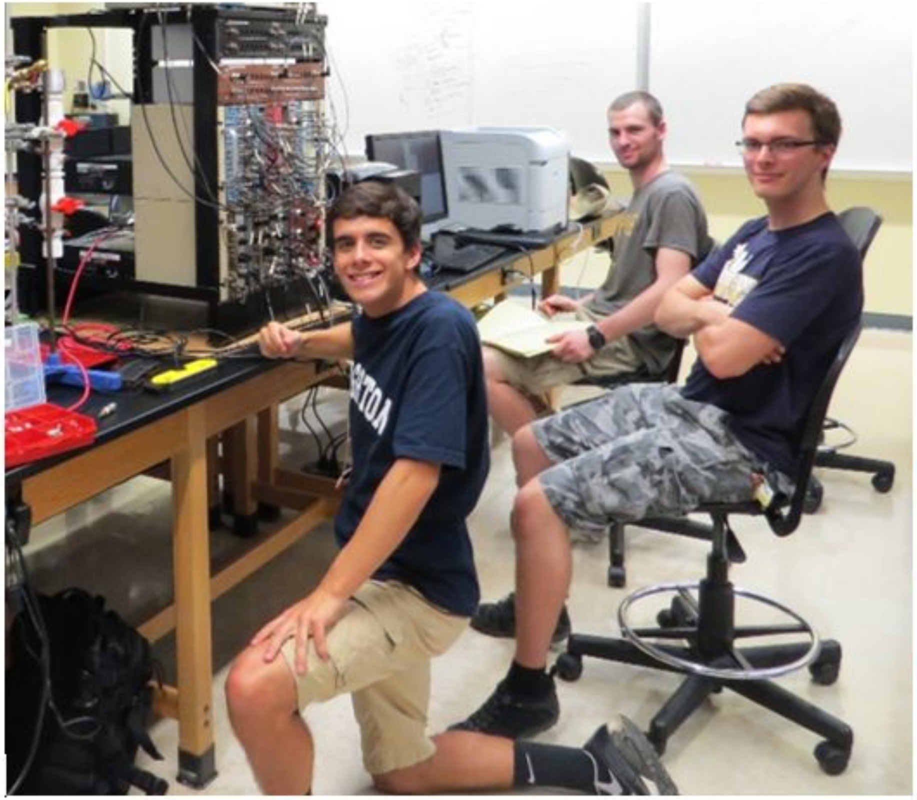
The Proposed Methodology: Collection Methods

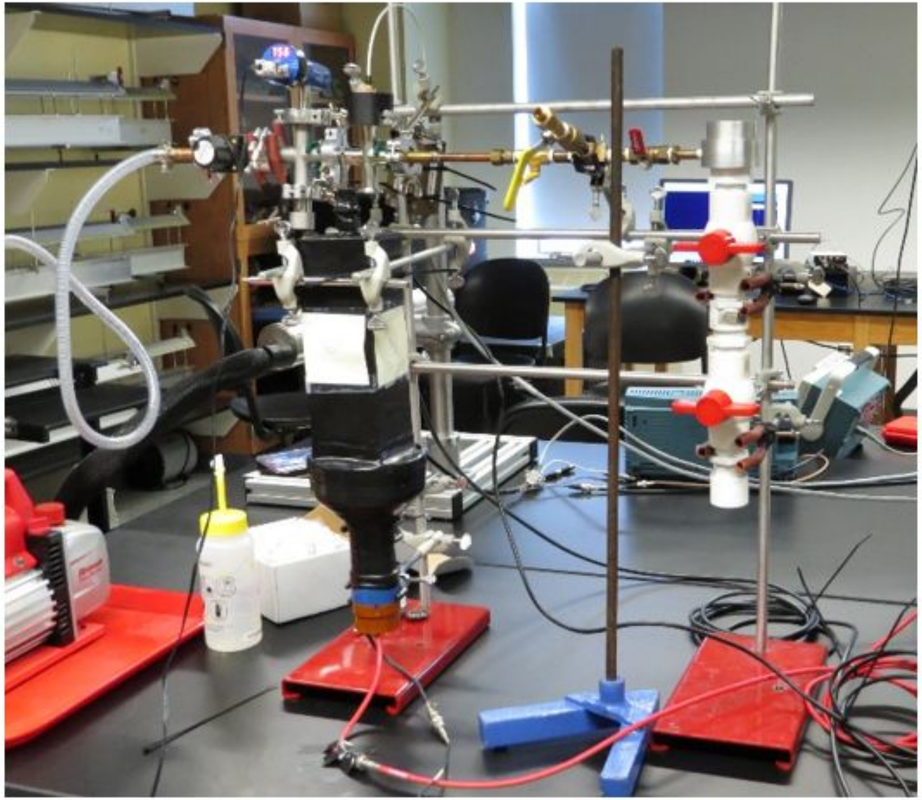


The Proposed Methodology: Possible Isotopes

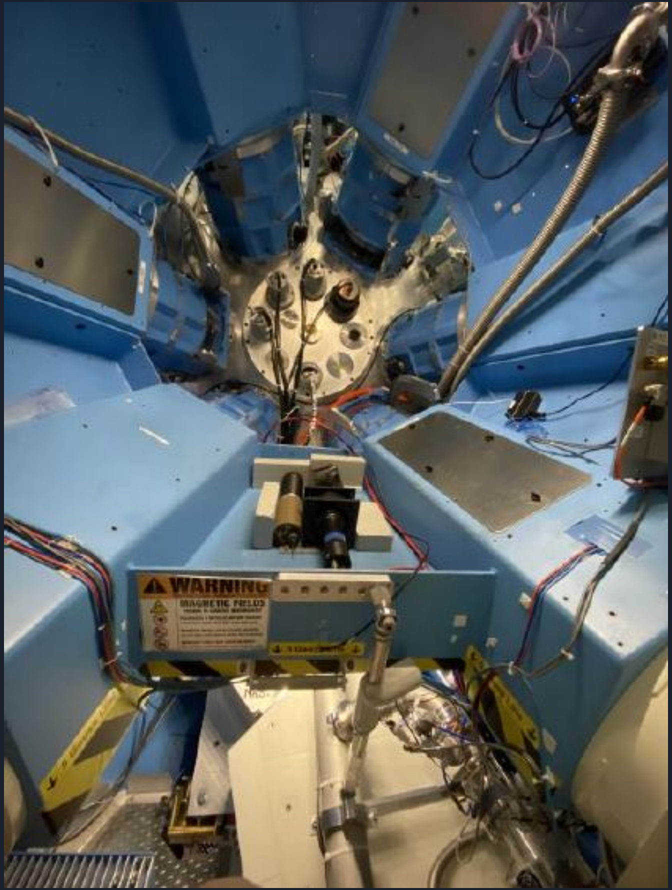
			Shot 39794 (50-50 DT, 11.8 keV)	Shot 77951 (1.5-98.5 DT, 18.3 keV)	
Reaction	Product Half-life	Reactant Abund.	Predicted Yield	Predicted Yield	Notes
^{3}H(t,g)^{6}He	807 ms	^{3}H fill	Branching ratio of ~10^{-7} to ^{3}H(t,2n)^{4}He gives	8 x10^{4}	To ^{6}He g.s. only, excited states decay by 2n
^{6}Li(t,p)^{8}Li	840 ms	7.6%	2-10´10^{5}	4-16 x10^{5}	TALYS + Abramovich et. al.
^{7}Li(t,a)^{6}He	807 ms	92.4%	1-3´10^{5}	1-4 x10^{5}	TALYS + Abramovich et. al. To ^{6}He g.s. only, excited states decay by 2n
^{9}Be(t,a)^{8}Li	840 ms	100%	2.3´10^{4}	8 x10^{4}	TALYS
^{9}Be(t,g)^{12}B	20.2 ms	100%	2.8	3.0	TALYS
^{10}B(t,p)^{12}B	20.2 ms	19.9%	78.3	923	TALYS
^{11}B(d,p)^{12}B	20.2 ms	80.1%	372	1735	TALYS
^{15}N(d,p)^{16}N	7.1 s	0.4%	0.10	2.0	TALYS

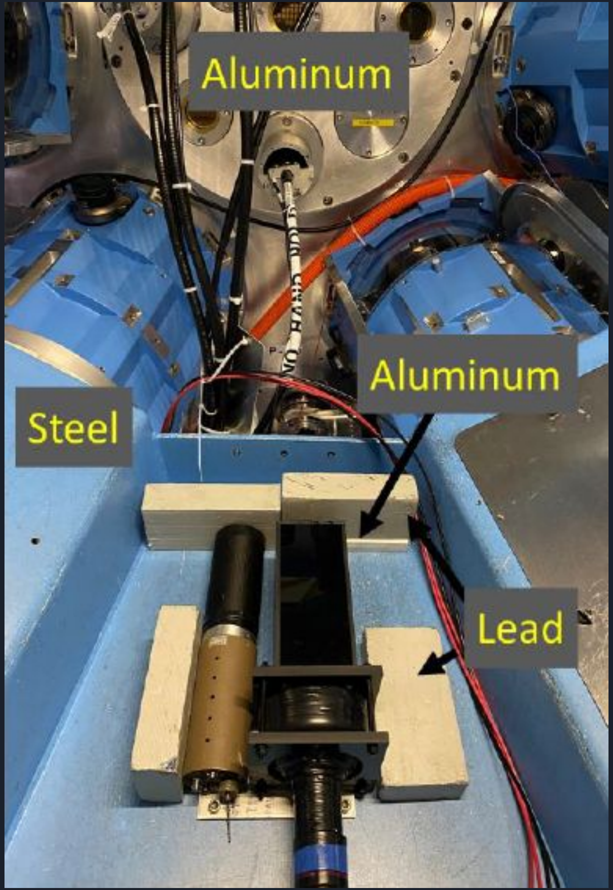
Experiment and Analysis: ^{41}Ar Experiment



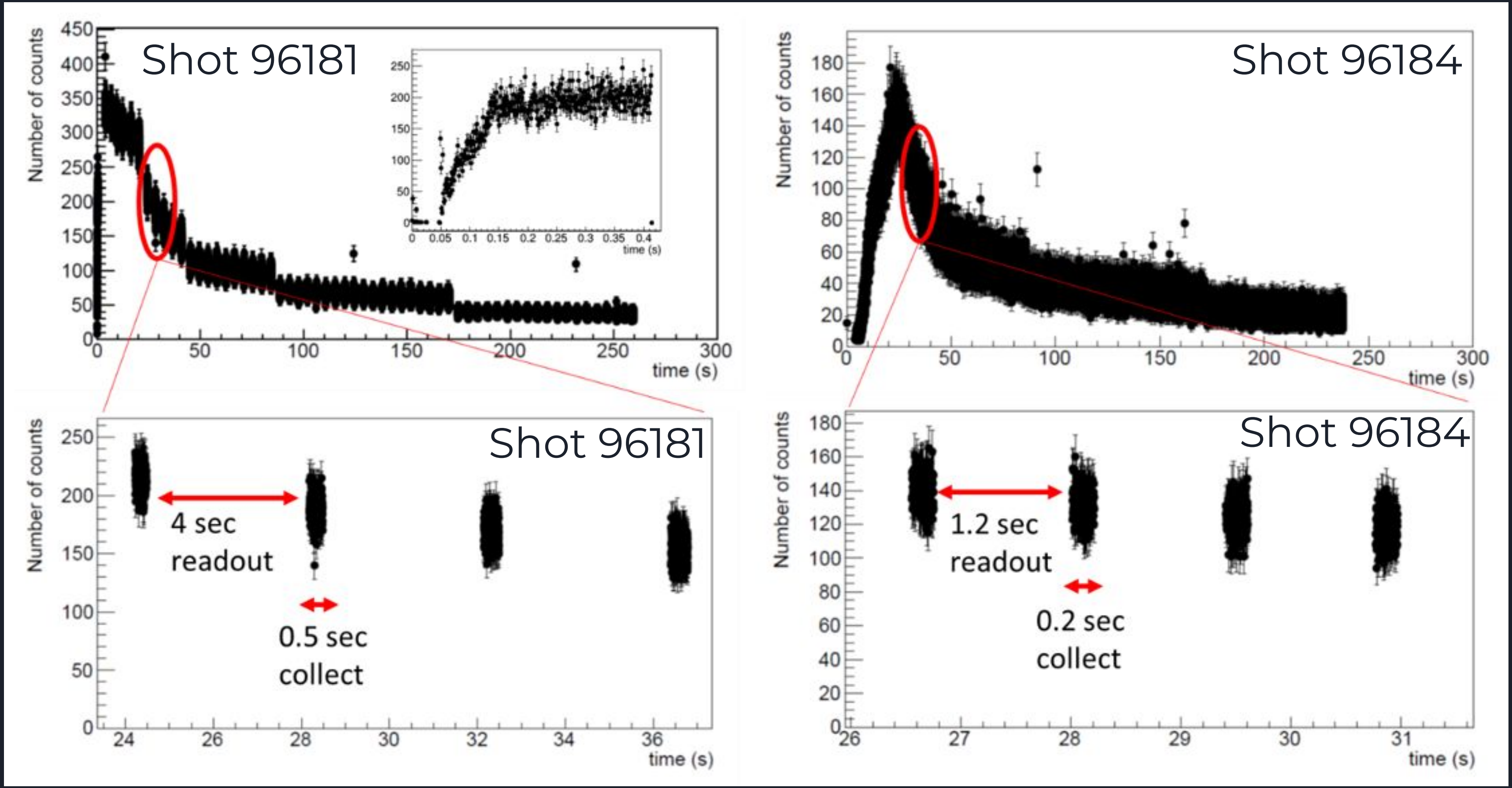


Experiment and Analysis: LLE Ride Along

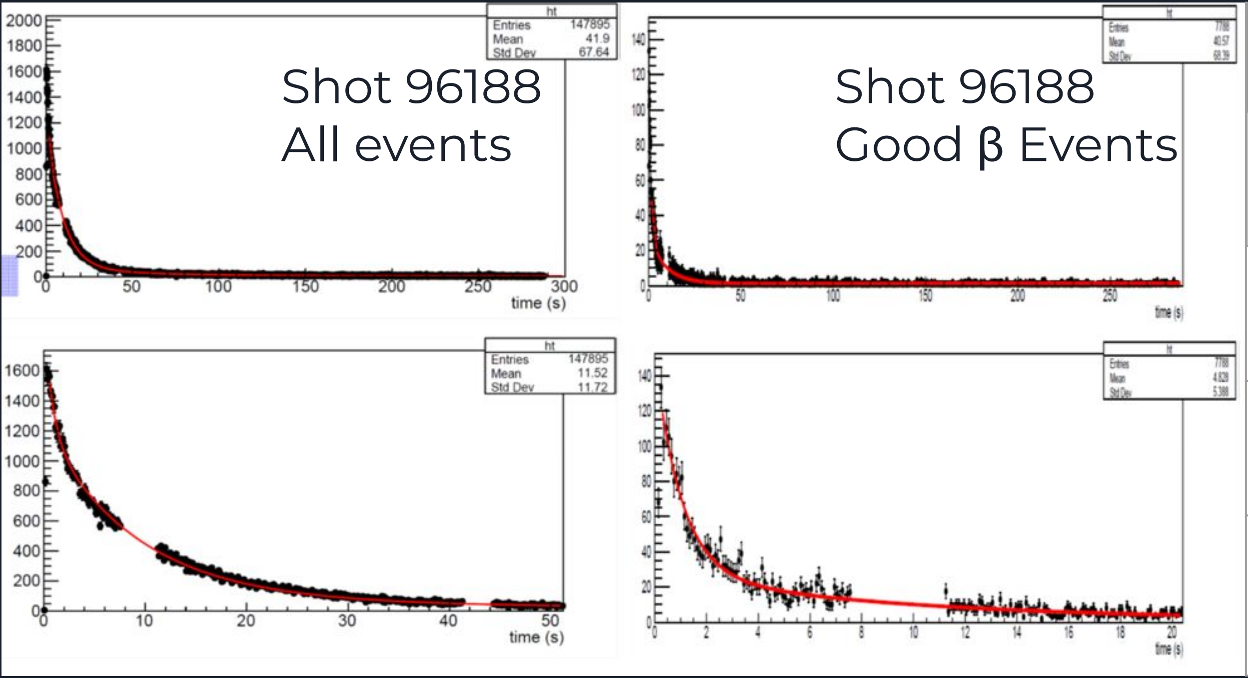




Experiment and Analysis: LLE Ride-Along



Experiment and Analysis: LLE Ride-Along



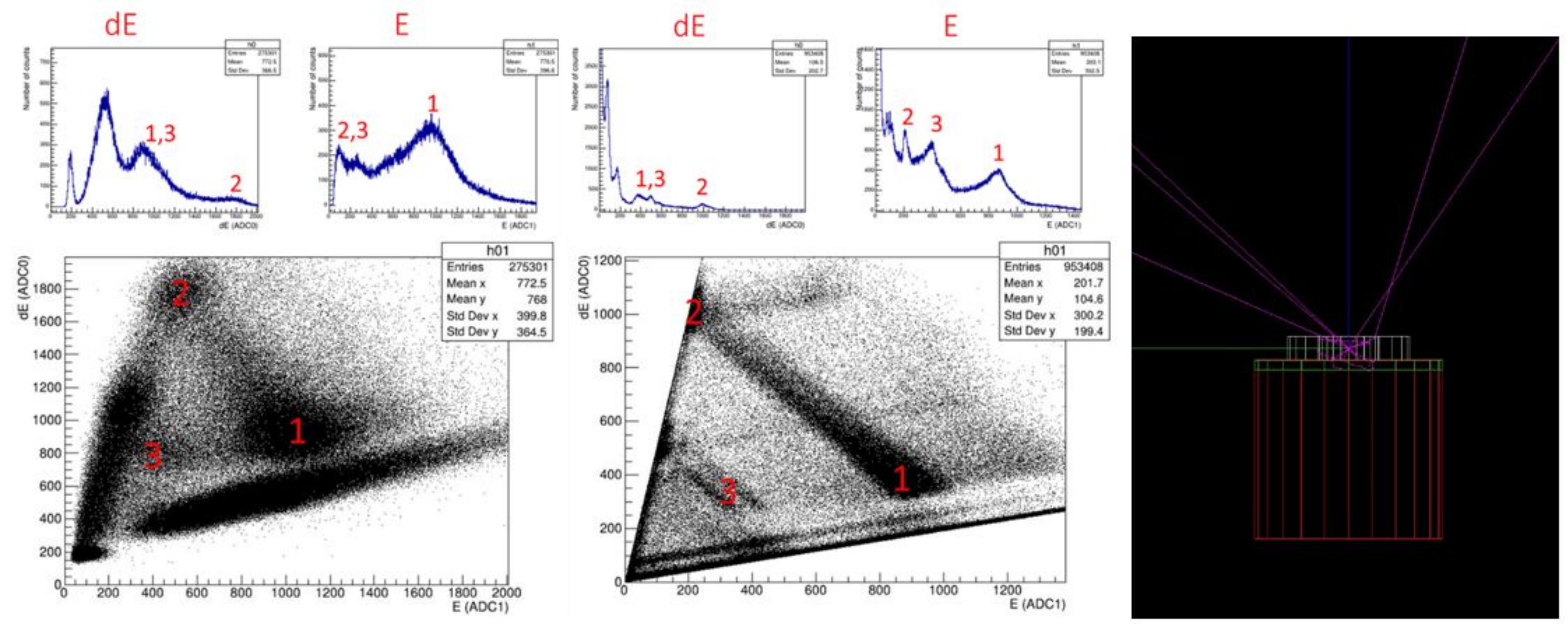
All Counts		Good β	
$T_{1/2}$ (sec)	N	$T_{1/2}$ (sec)	N
0.76	728	0.73	115
7.13 (fixed)	1080	7.13 (fixed)	23
59	40	N/A	N/A

$$F(t) = N_0 e^{-\lambda_0 t} + N_1 e^{-\lambda_1 t} + N_2 e^{-\lambda_2 t} + B$$

Experiment and Analysis: Simulating the Detectors

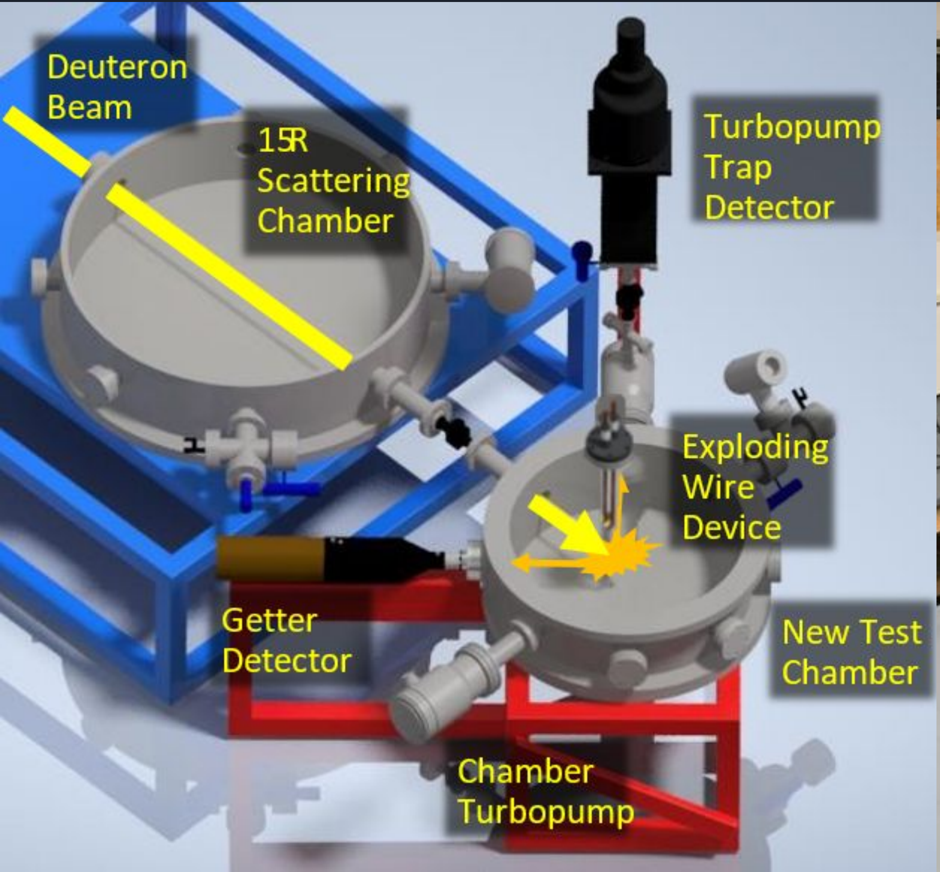
GEANT4 Simulations: Modeling particle interactions with the detectors

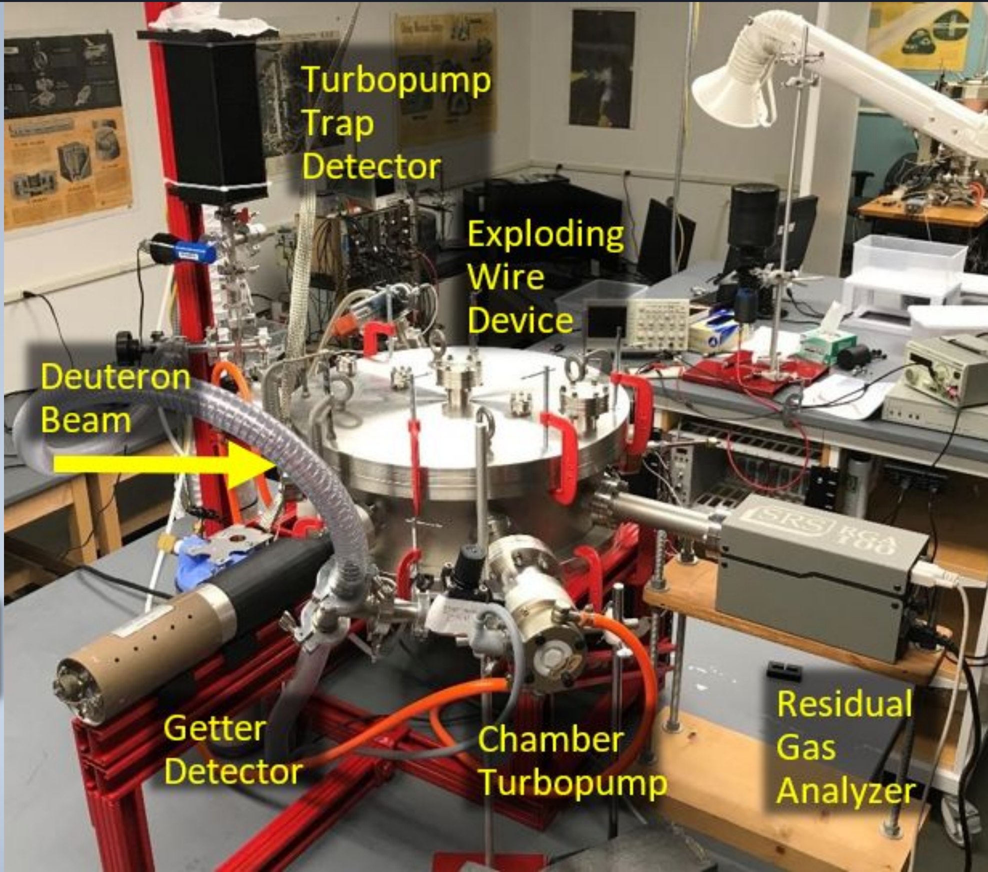
- Absolute Efficiency?
- How do background sources affect the 2-D histograms?



Future Work: Exploding Wire Experiment

What is the collection fraction of each collection method?





References

[1] L. Gresh, R. McCrory, J. Soures, Inertial Confinement Fusion: An Introduction, (Laboratory for Laser Energetics, 2009).