^{233}U PPAC design and fabrication

2025 NCSP Technical Program Review

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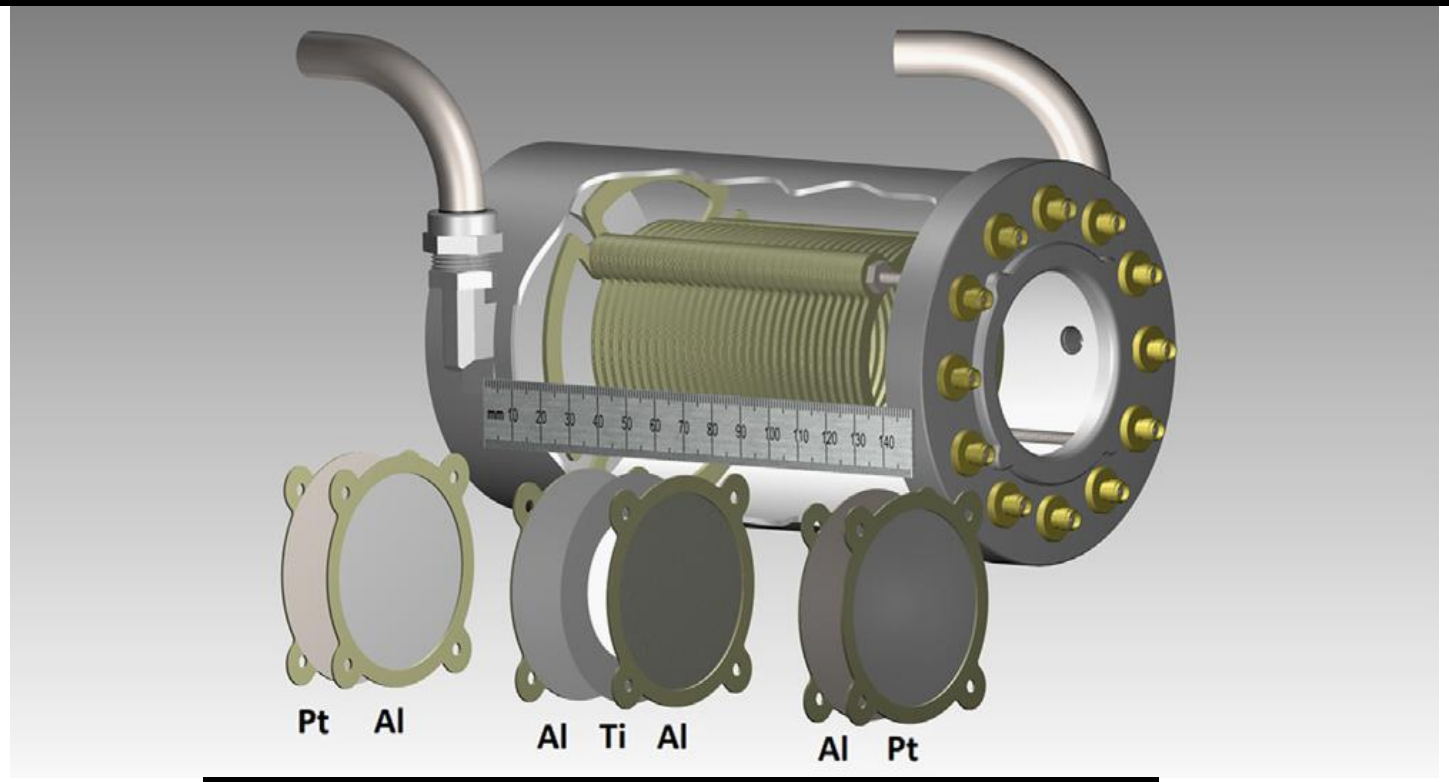
The role of PPAC in prompt fission neutron spectrum measurement

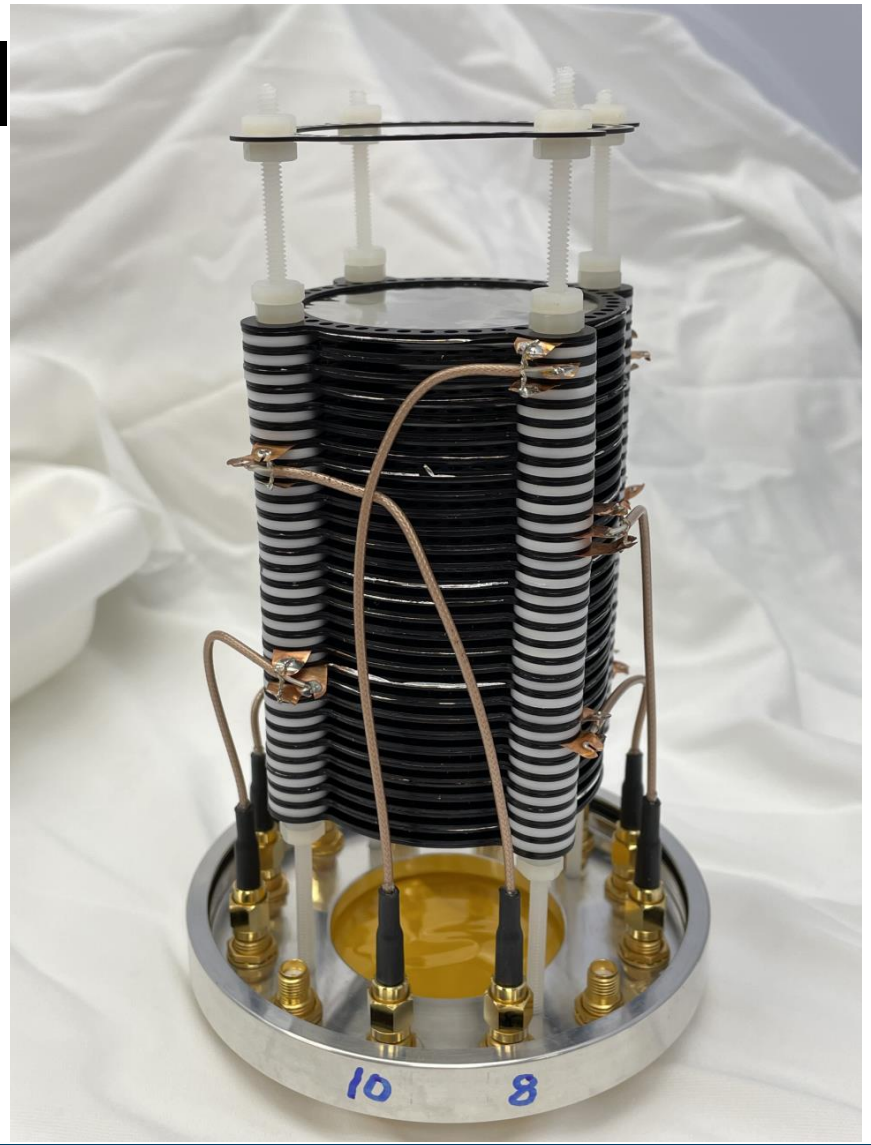
- The prompt fission neutron spectra (PFNS) for major actinides have been successfully measured at LANSCE/WNR facility using two neutron detection arrays, developed by LANL, and a fission PPAC (parallel-plate avalanche counter), developed by LLNL. (Chi-Nu project)
- A double Time-of-Flight technique was used to measure the incoming neutron energy, the timing between proton beam pulse and the trigger of PPAC, and the outgoing neutron energy (PFNS), the timing between the trigger of neutron detector and the trigger of PPAC.
- Under NCSP, the current focus is on the PFNS of ^{233}U after the results of ^{240}Pu was published in FY24.
  - Design and fabrication of a 233U fission PPAC is the topic of this presentation.

PPAC compact design with 10 target foils

C.Y. Wu, R.A. Henderson, R.C. Haight *et al*., NIMA 794, 76 (2015)



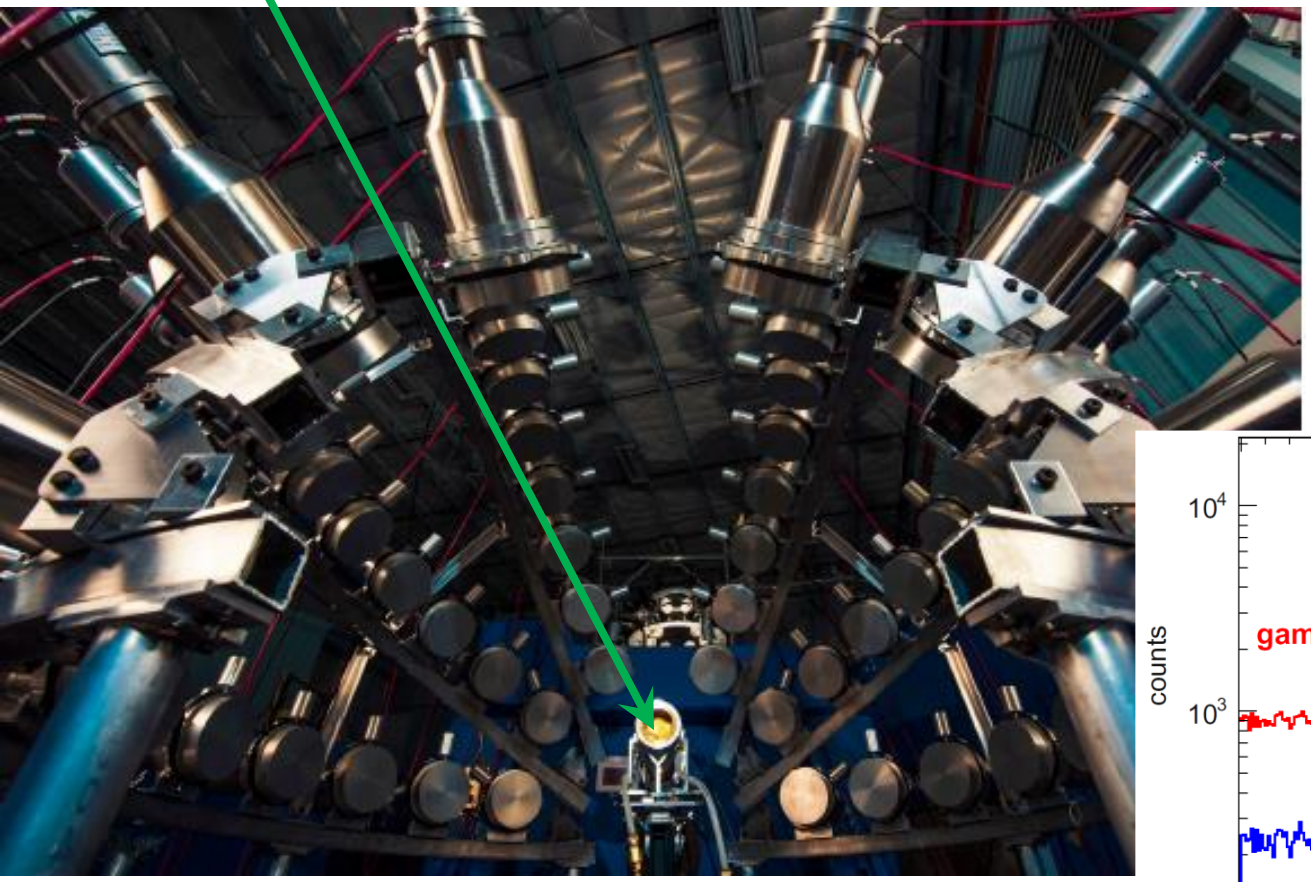
Total foil thickness is less than 200 μm



A unique design with a minimum mass principle

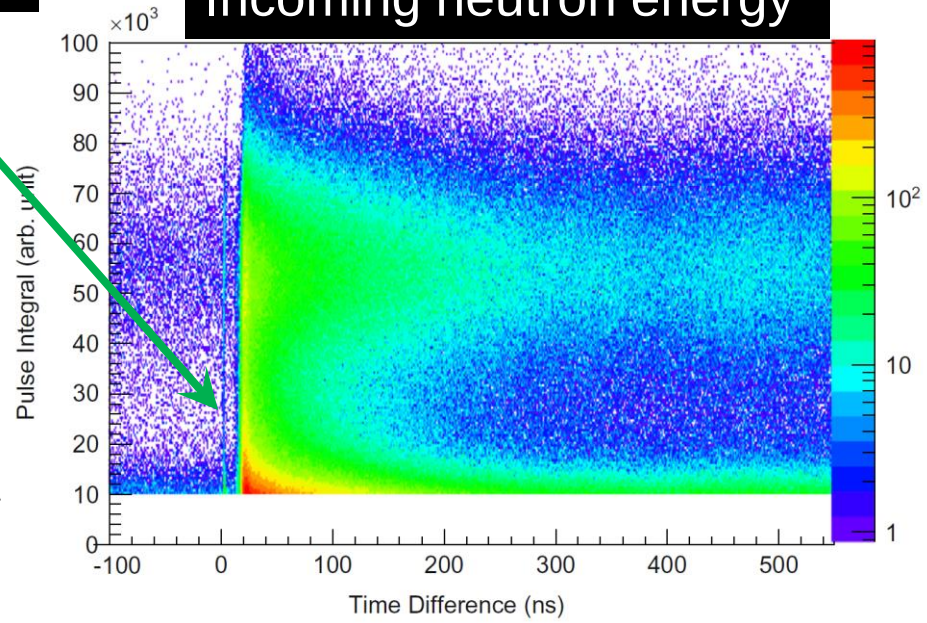
PPAC with an array of 54 liquid scintillators

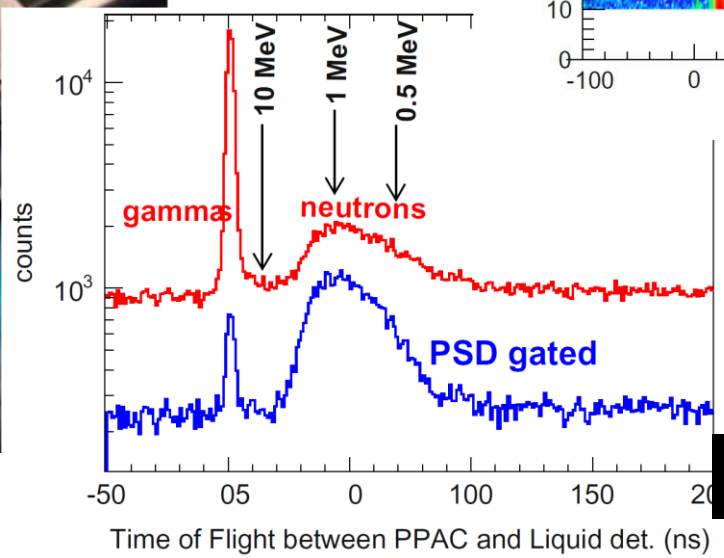
PPAC



Photofission

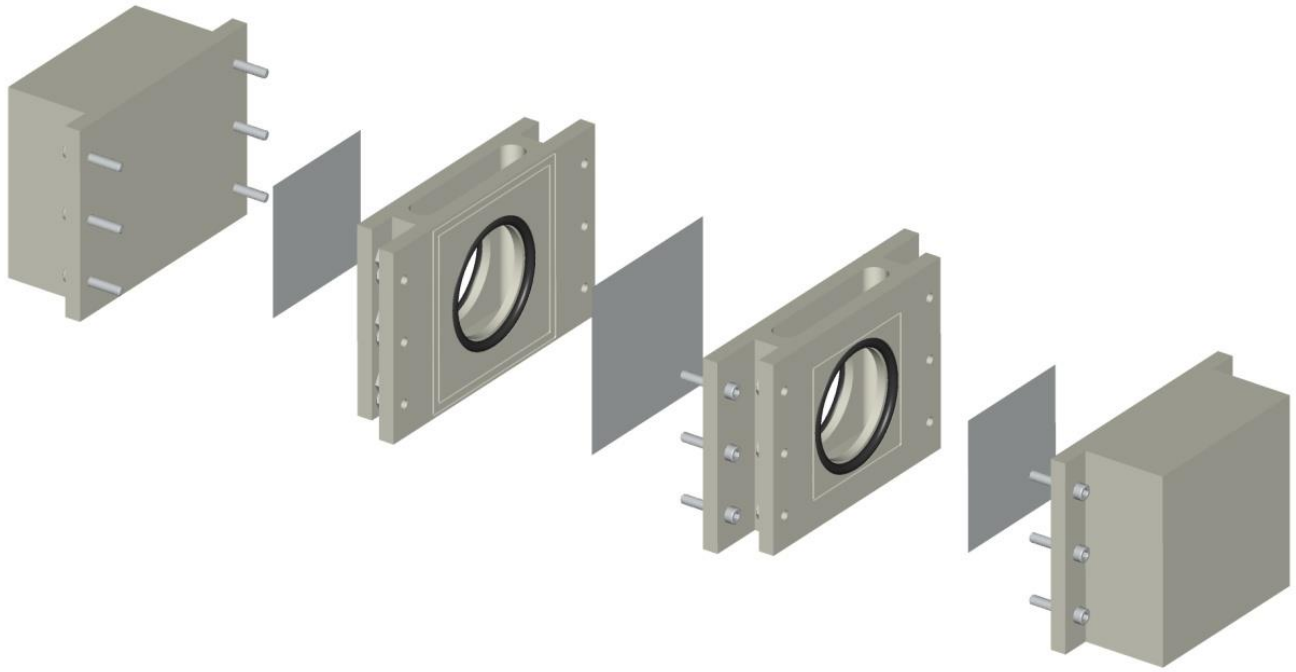
Incoming neutron energy



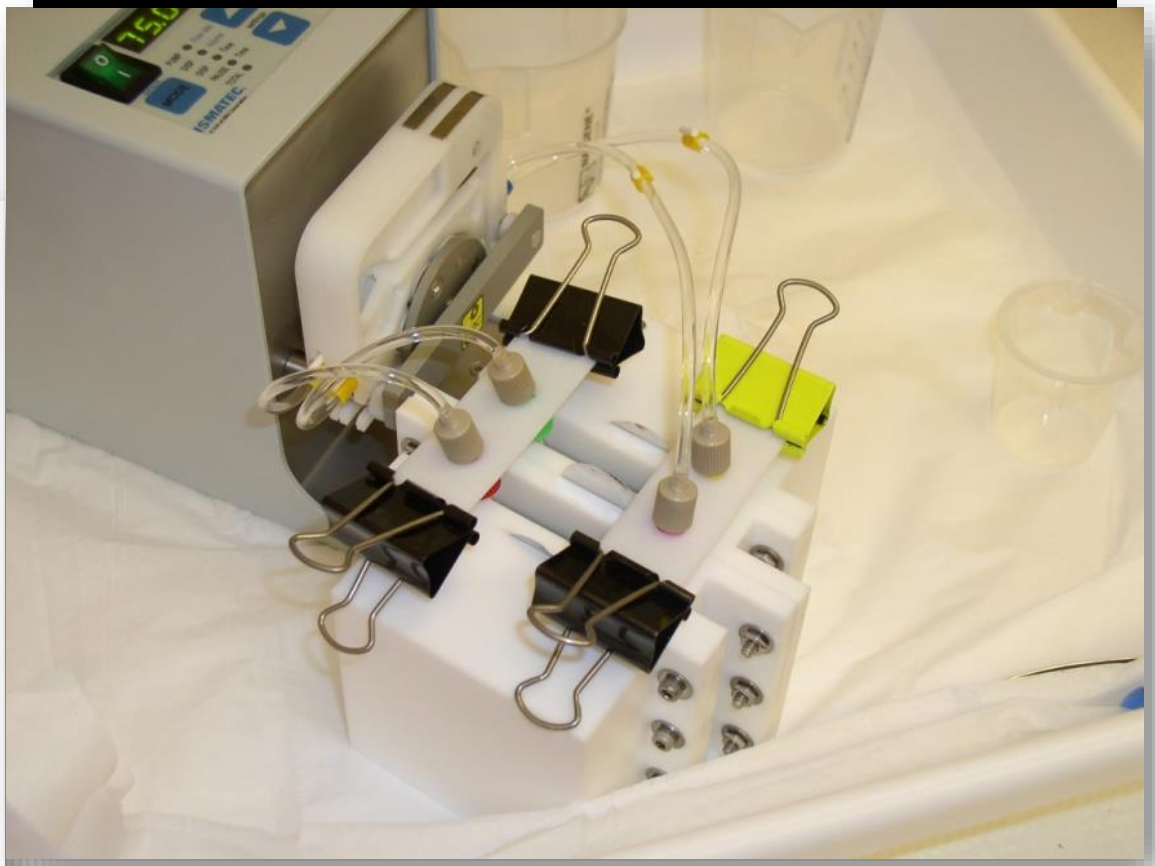


Outgoing neutron energy

Target fabrication

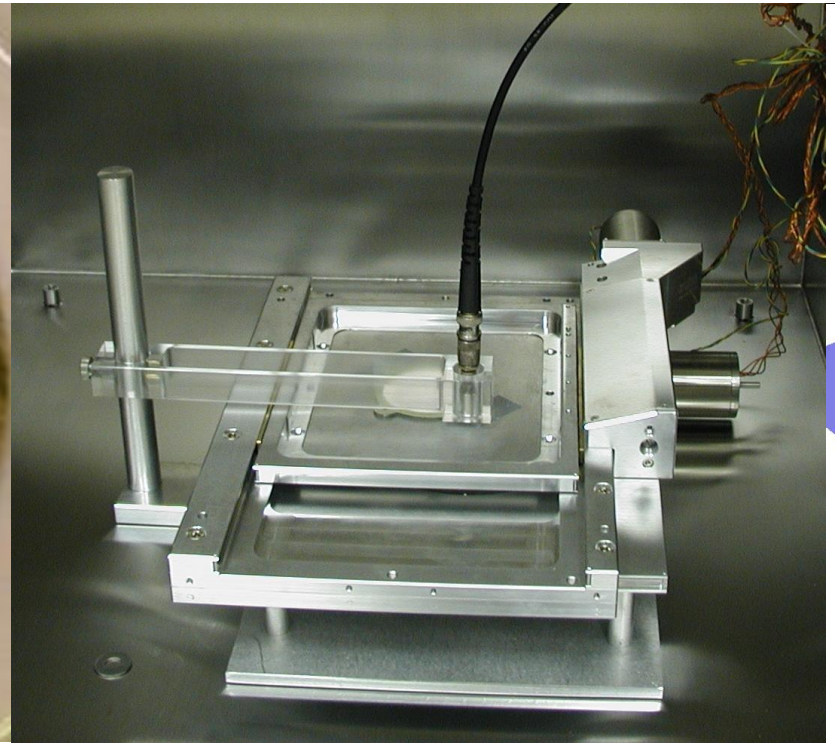


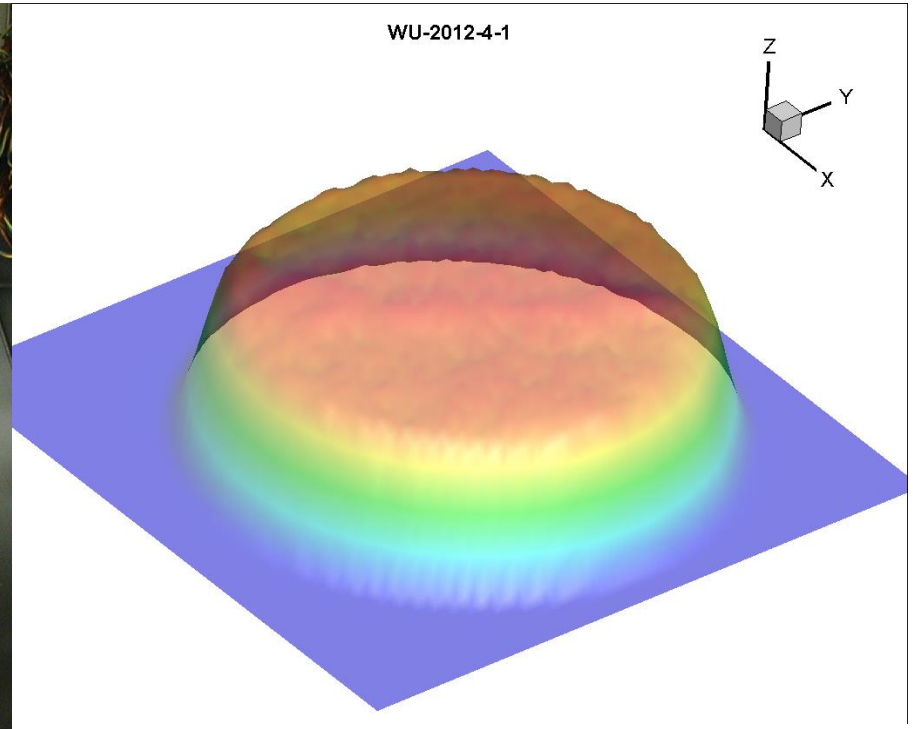
R.A. Henderson *et al.*, NIMA 655, 66 (2011)



- Double-sided plating cell
- Plated from IPA at constant current – 3 mA/cm^2 of target area

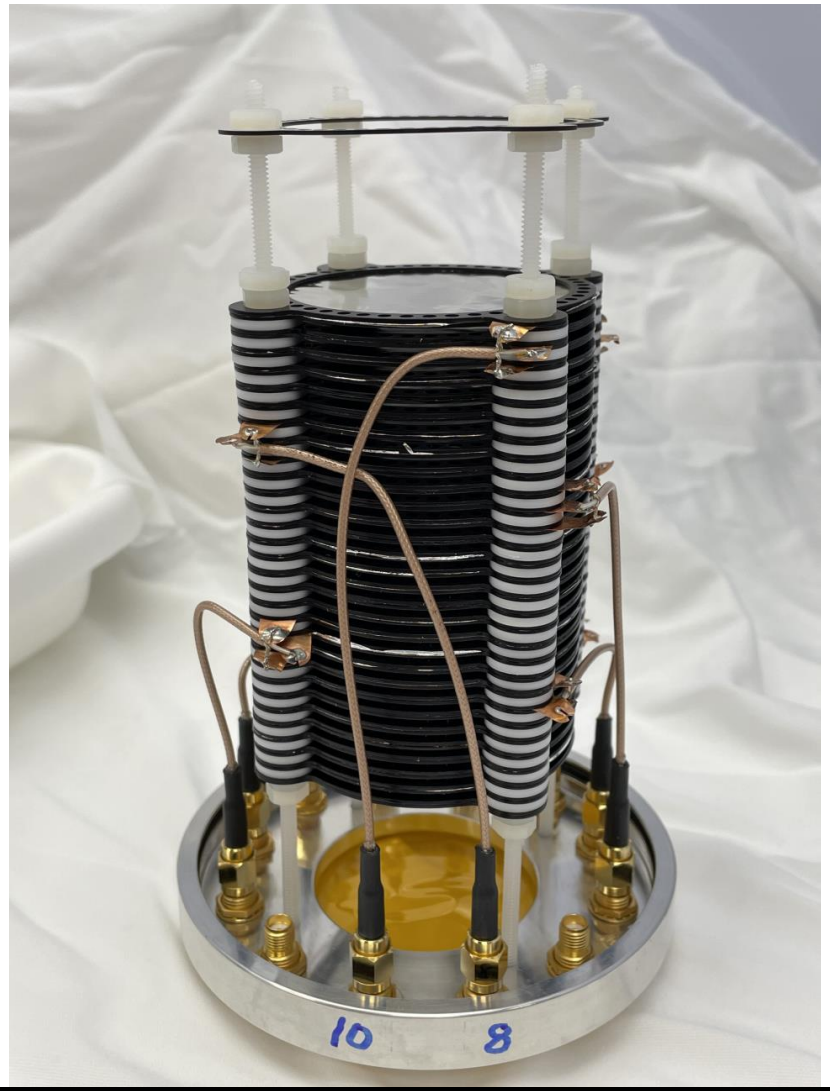
Target characterization





- Double-sided deposition with a total mass about 10 mg
- Mass determined by γ-spectroscopy
- Uniformity – std dev < 4% over the entire area of 4 cm diameter – determined by Target Record Player

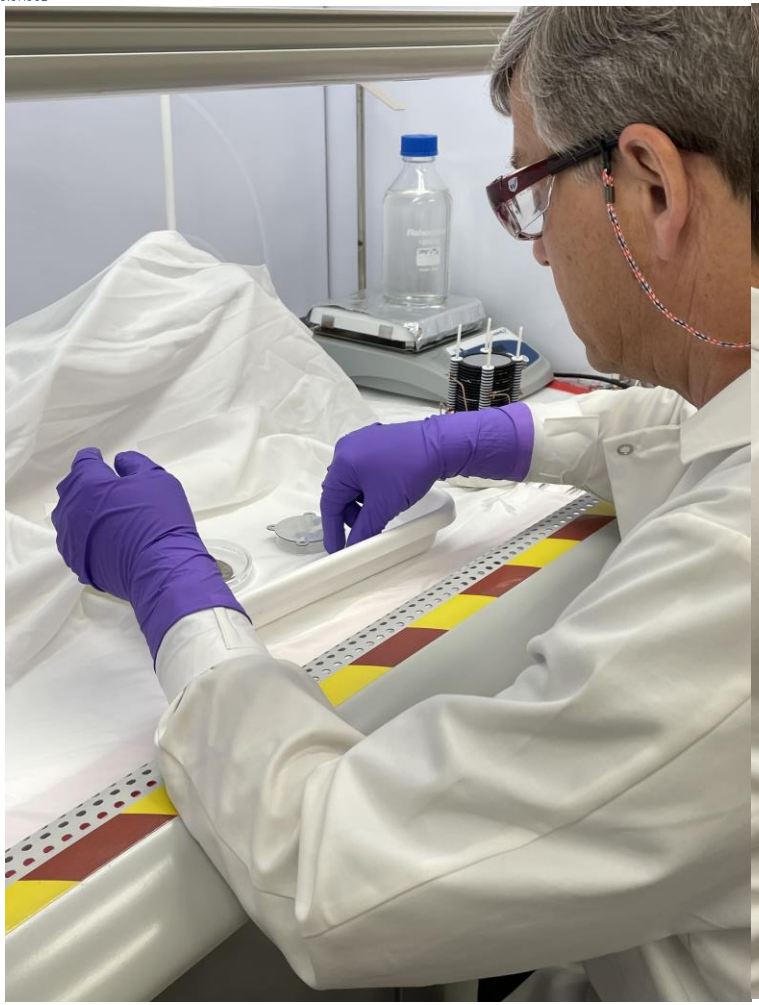
^{233}U PPAC

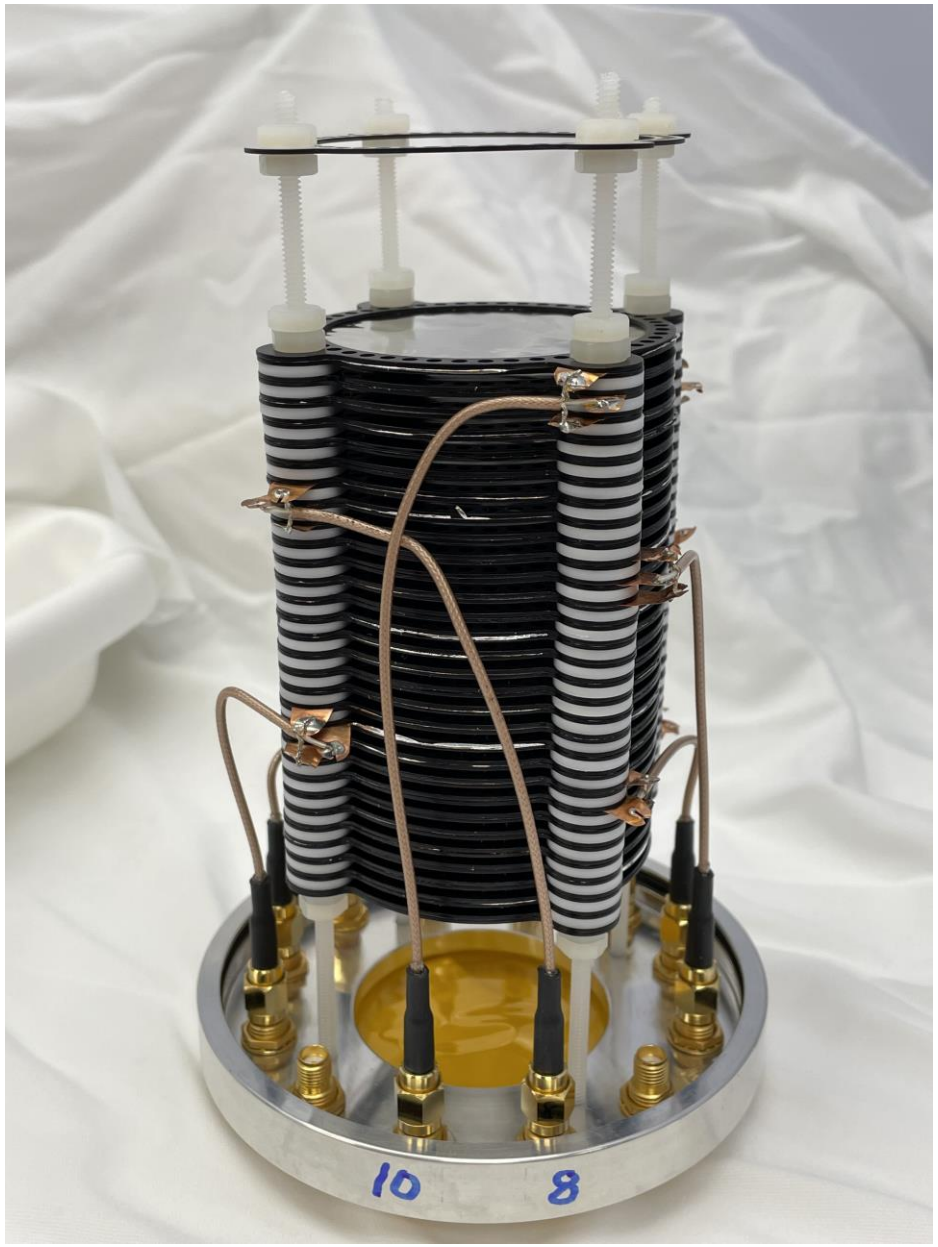


ID	Mass (mg)	σ (%)	Remark
1	7.61	1.0	
2	6.83	1.1	
3	10.37	0.7	
4	9.58	0.7	
5	10.01	0.8	
6	8.53	0.8	
7	9.29	0.7	
8	8.90	0.8	
9	9.21	0.7	
10	8.85	0.8	

A total of 10 double-sided targets were fabricated with a total mass of 89.18 mg

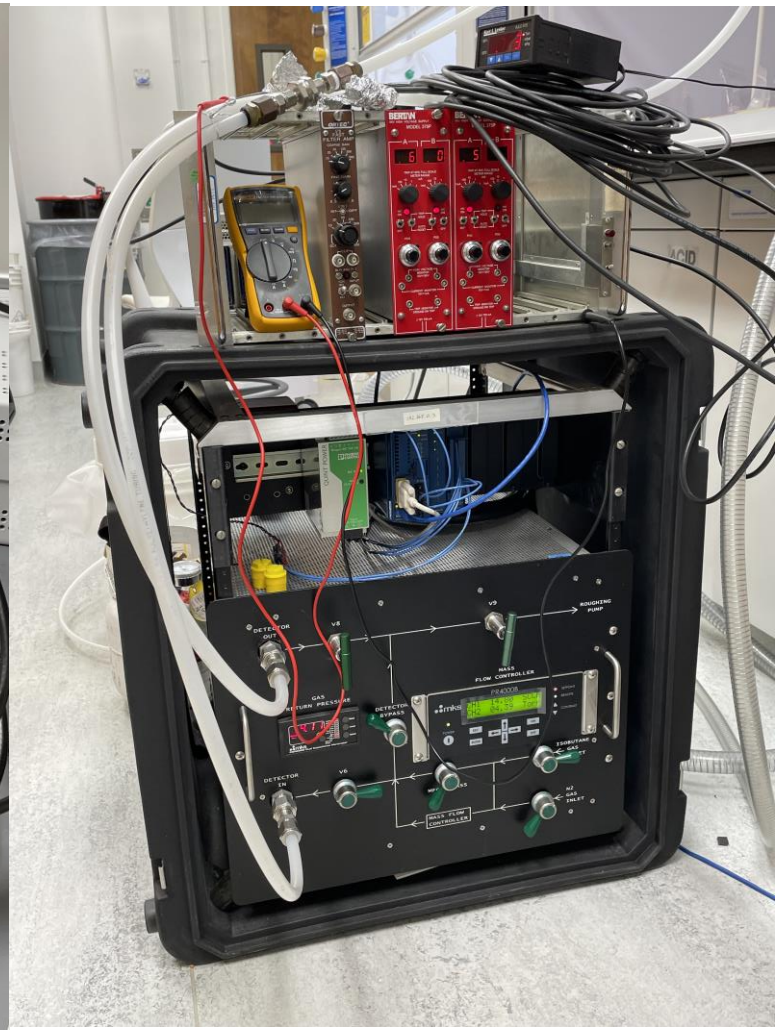
Assembling



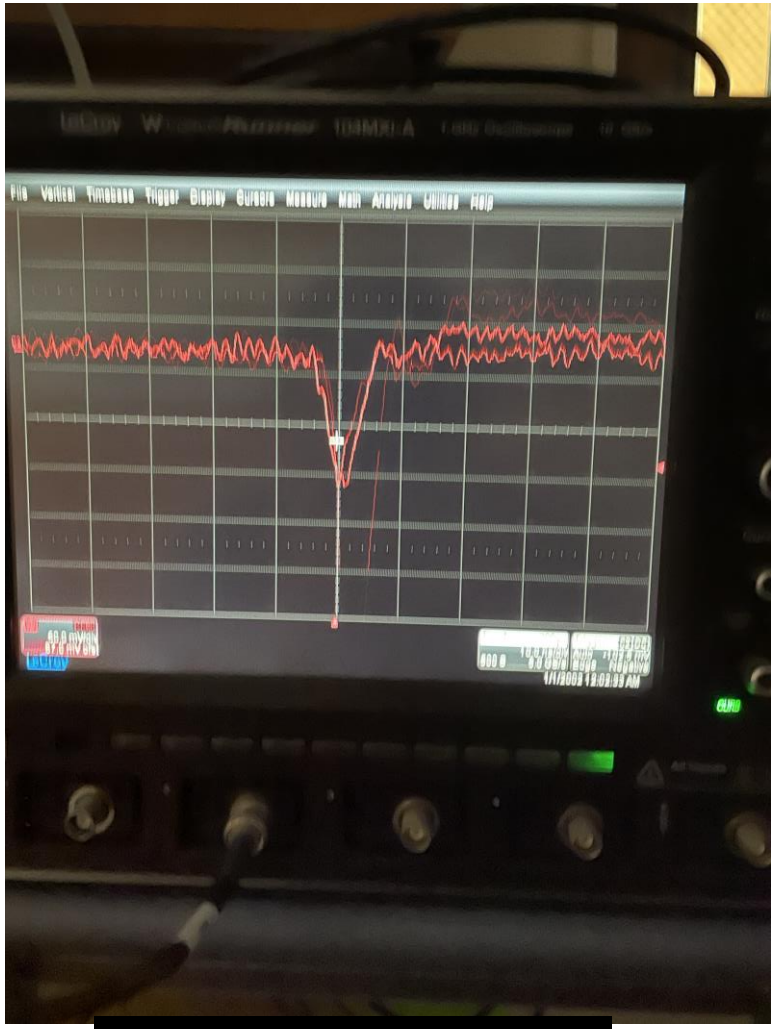


Roger worked on the assembling of PPAC in his laboratory

Testing



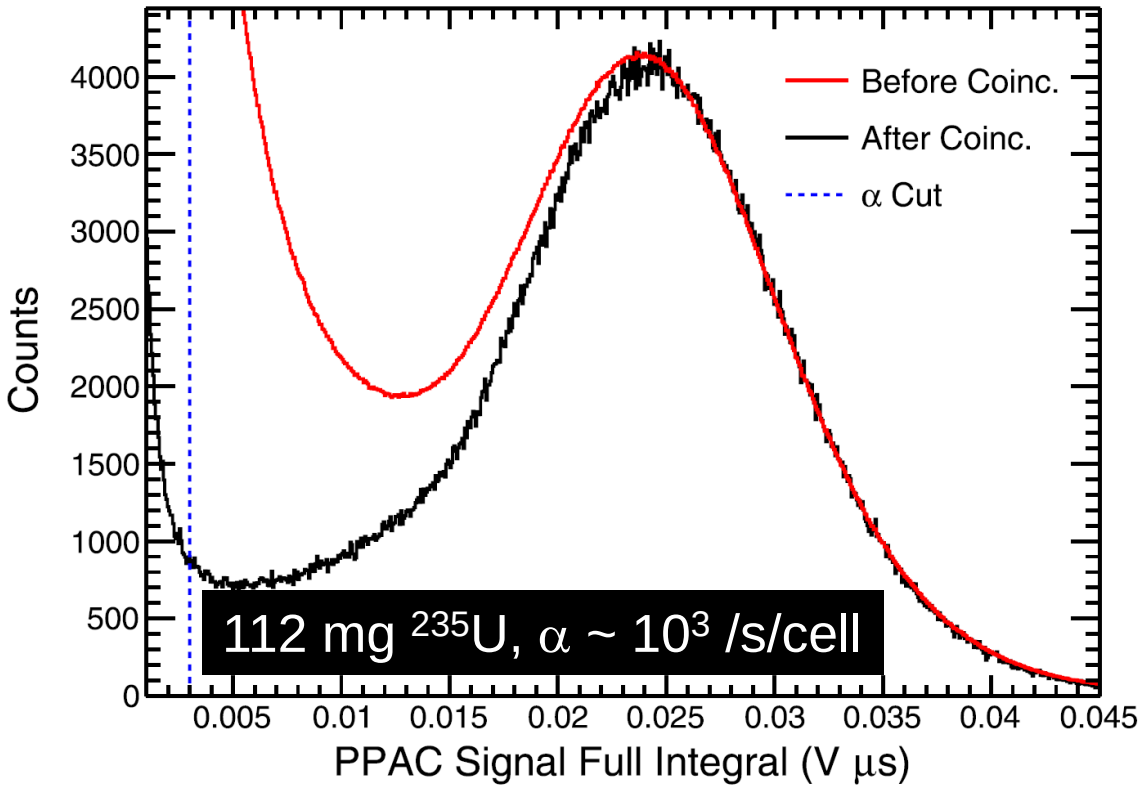
PPAC with 10 channels coupled to amplifiers and isobutane flow controlled by a gas handling system

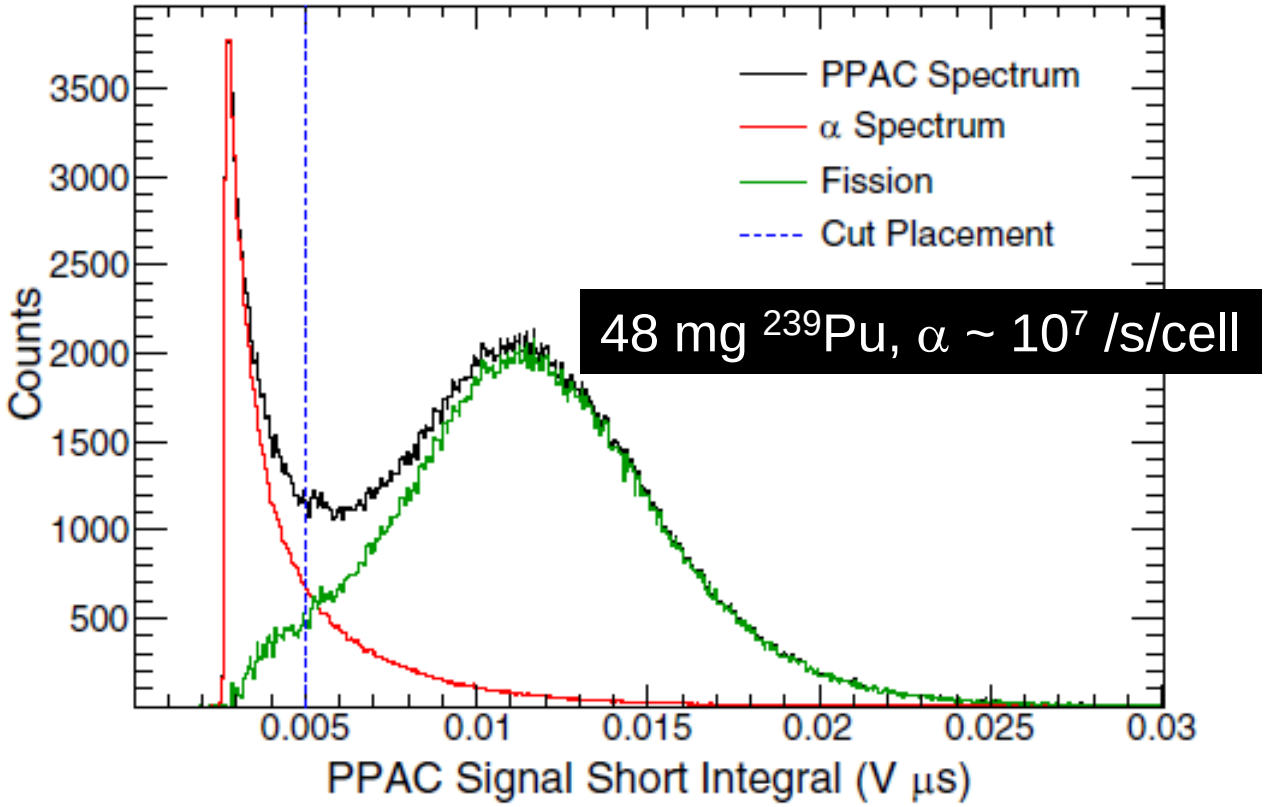


α pulse from PPAC

What to expect the performance of ^{223}U PPAC

89 mg ^{233}U, α ~ 3 millions /s/cell





K.J. Kelly *et al*., PRC 105, 044615 (2022)

K.J. Kelly *et al*., PRC 102, 034615 (2020)

Summary

- ^{233}U fission PPAC with a total mass of 89 mg over 10 target foils has been assembled and tested successfully at LLNL. The initial indication shows no significant leak current under a bias of 375 V. It means that a similar performance is expected as that of ^{235}U PPAC with a decent separation between α and fission fragments.

Thank you