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A novel technique for the production of robust actinide targets using Solution Combustion Synthesis (SCS) and electrospraying techniques

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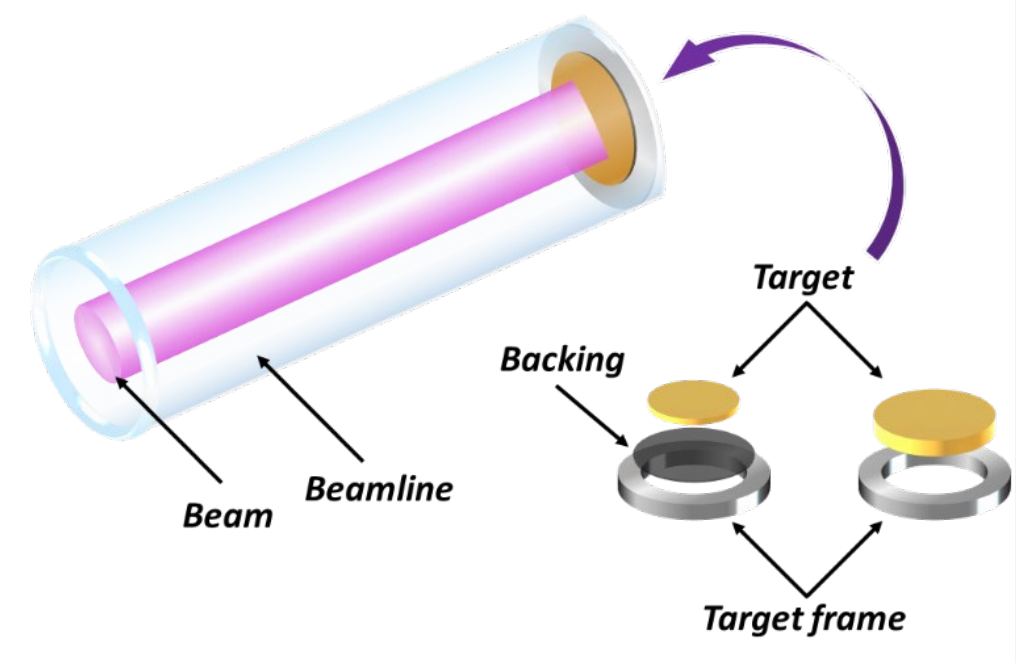
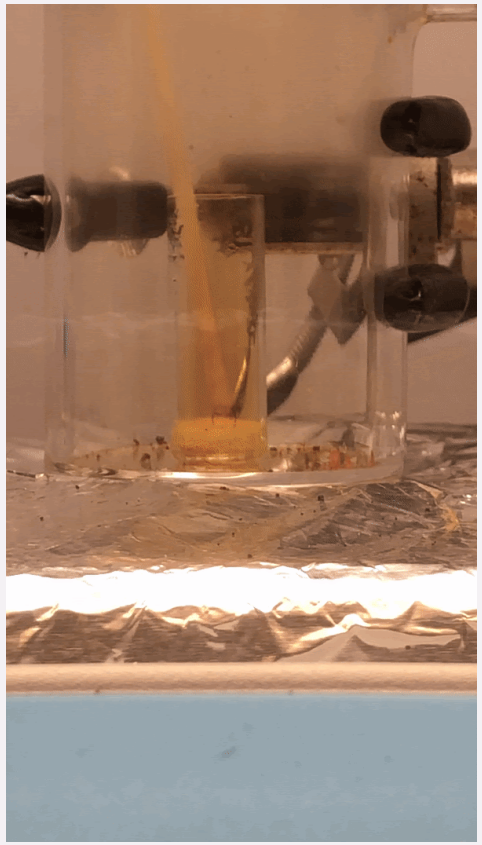
Actinide Targets' Characteristics



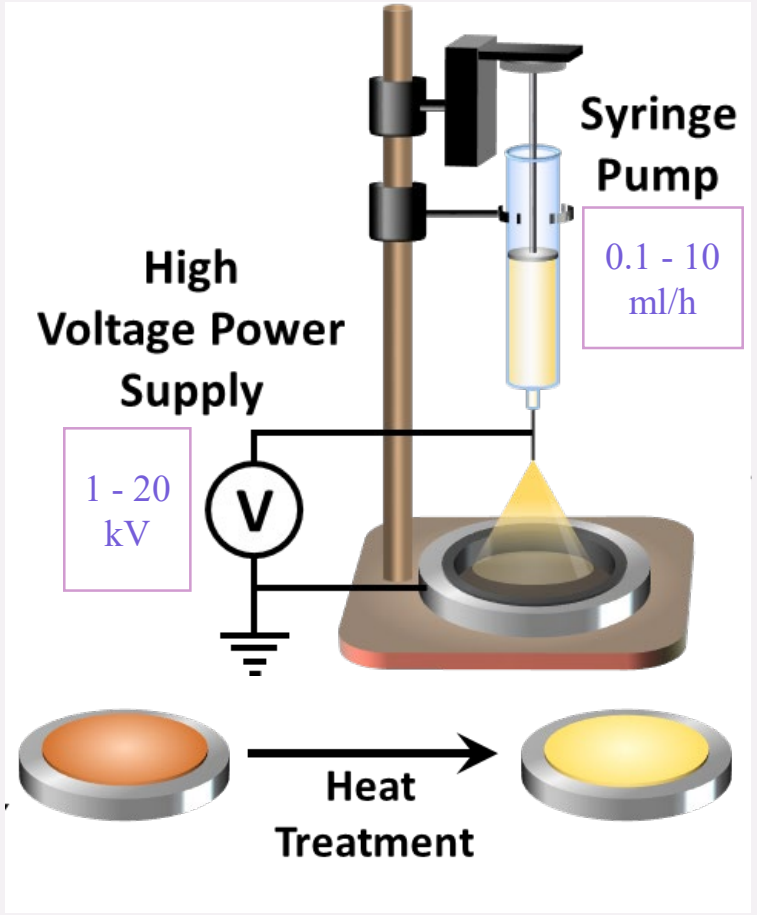
Targets need to be:

- Robust
- Uniform layers
- Self supporting → backing should not interfere with our measurements
  - Carbon
  - Aluminum
  - Polymer (Kapton)
- Thin
- Affordable
  - Radioactive material is rare
  - Expensive
- High Material Collection Efficiency (MCE)

Solution Combustion Synthesis - Electrospraying

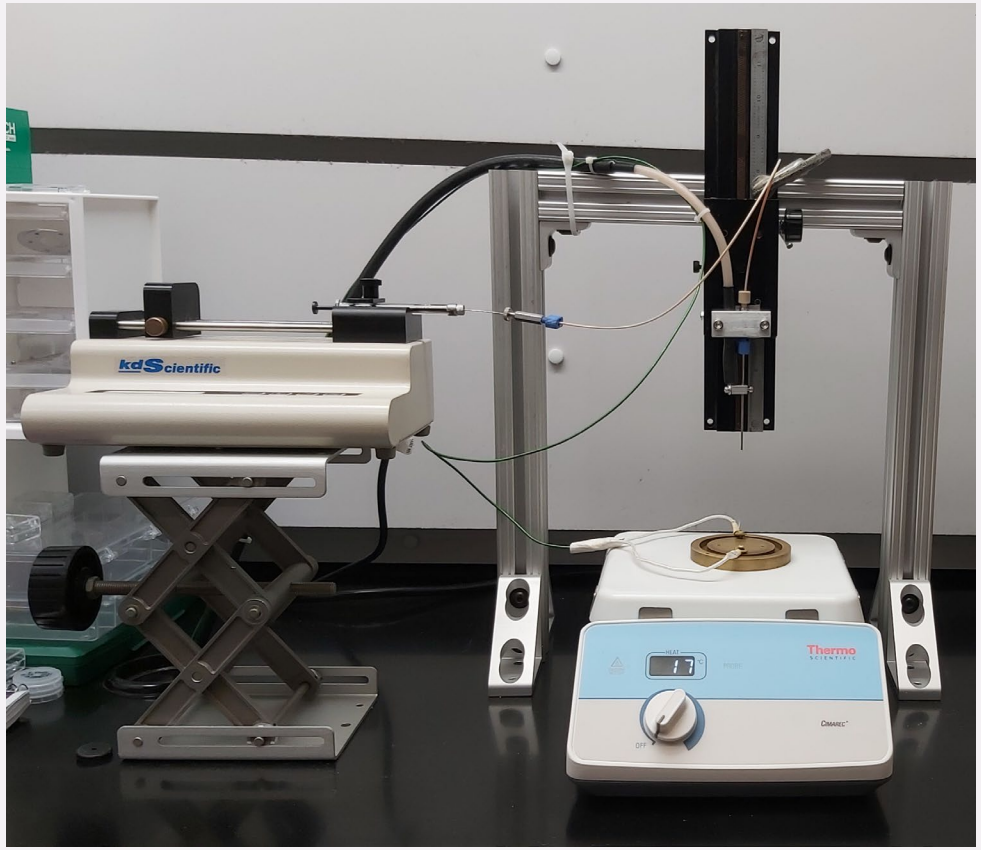


By Jordan M. Roach



- Liquid atomization via electrical forces imposed on the liquid jet flowing from a capillary nozzle.
- Single-step, low-energy, low-cost and flexible production process which is performed at ambient temperatures and atmospheric pressure.

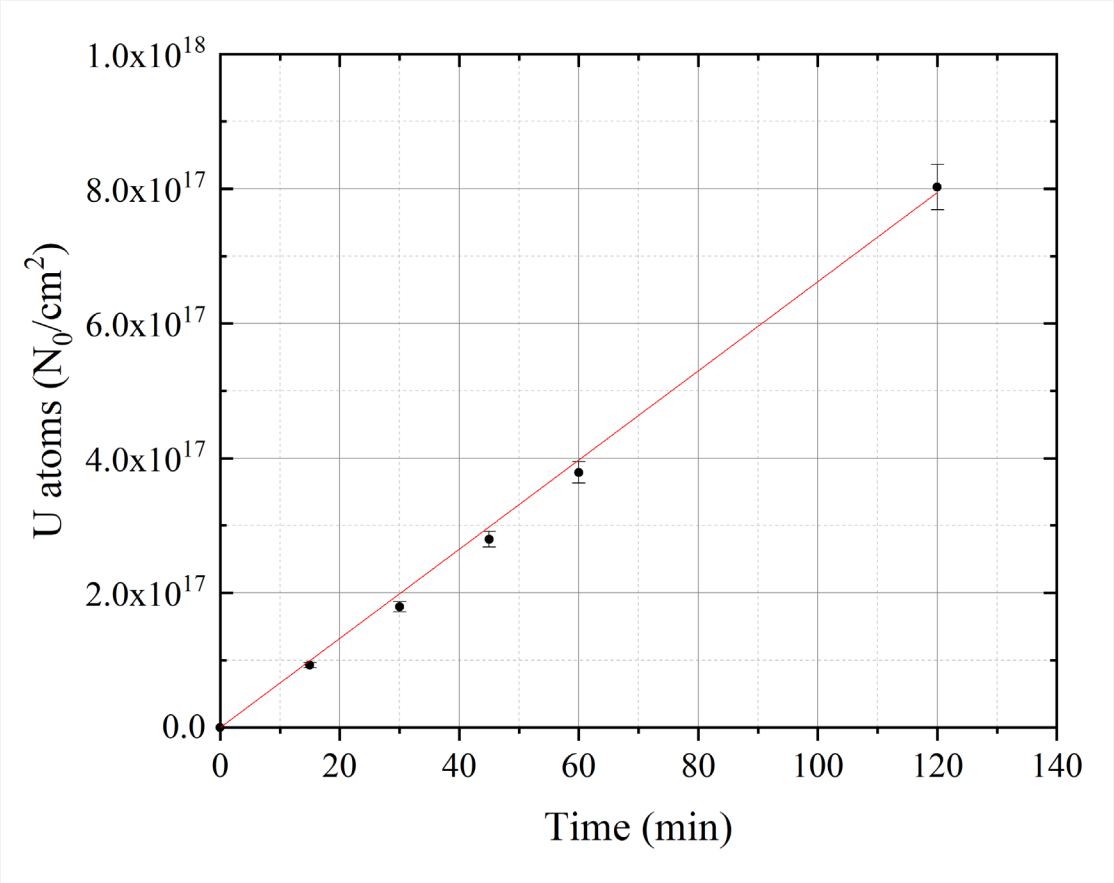
Solution Combustion Synthesis - Electrospraying

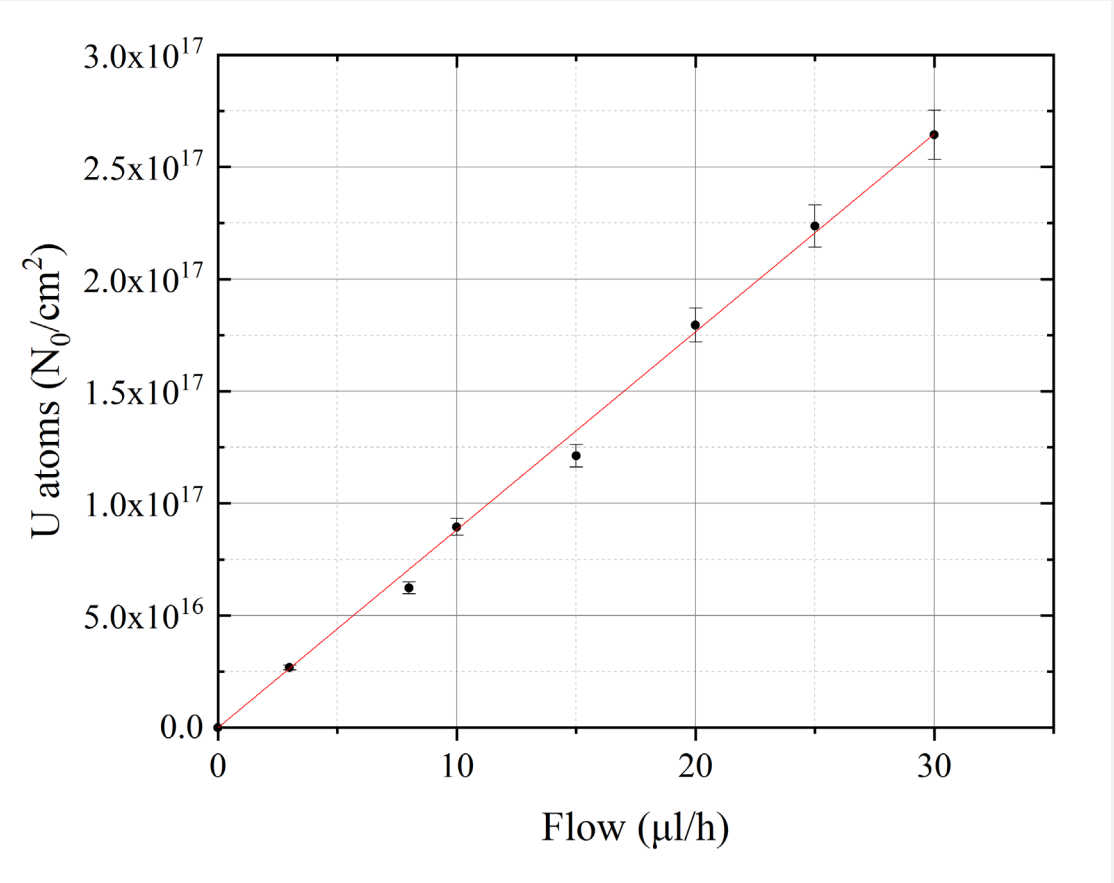


Substrates used in electrospraying:

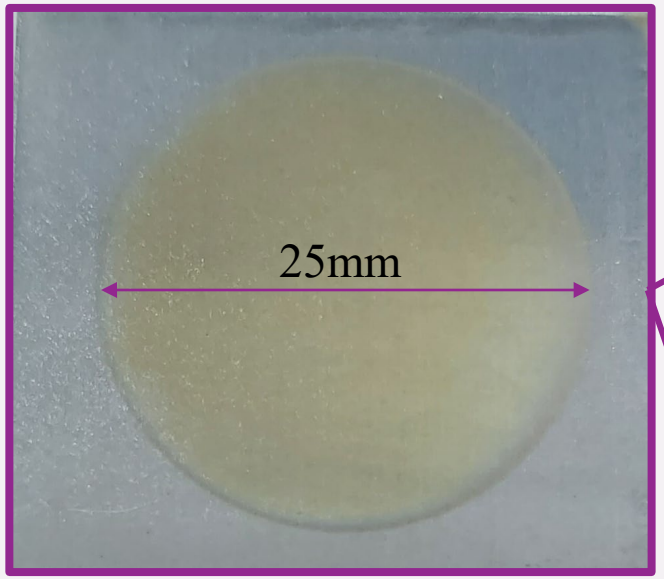
- Puratronic grade Al (99.997%, Alpha Aesar)
- Mirror-finished Al Alloy (6061, with impurities: Cr 0.04 – 0.35%, Cu 0.15 – 0.4%, Fe < 0.7%, Mn < 0.15%, Si 0.4 – 0.8%, Ti < 0.15%, Zn < 0.25%, and Mg 0.8-1.2 wt.%)
- Carbon foils

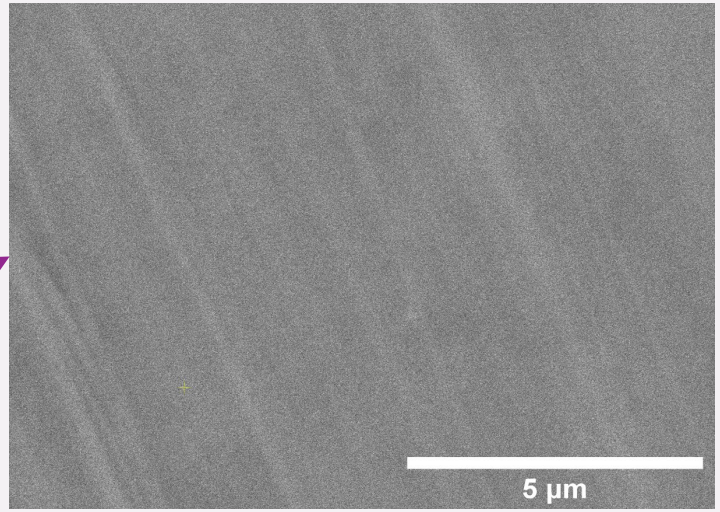
Solution Combustion Synthesis - Electrospraying

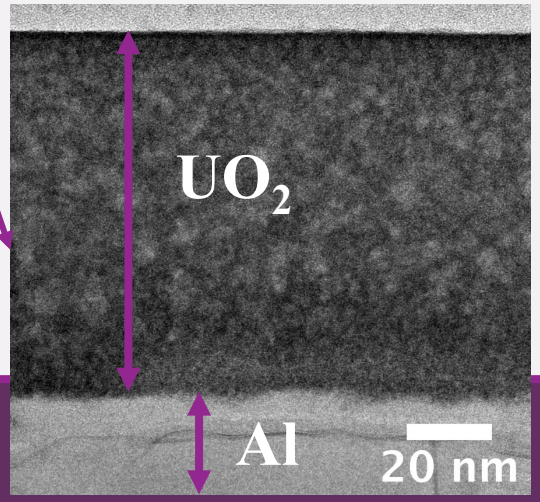


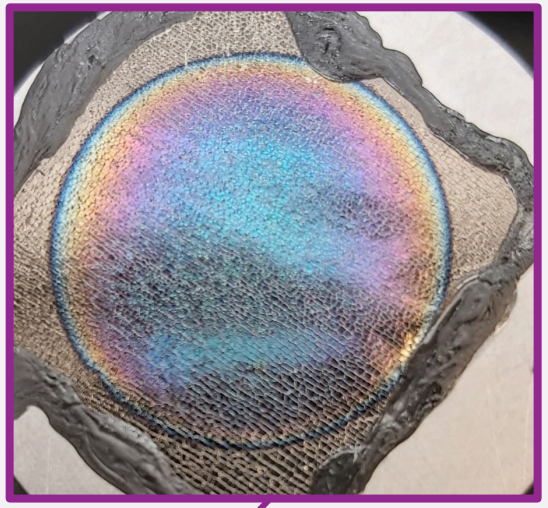


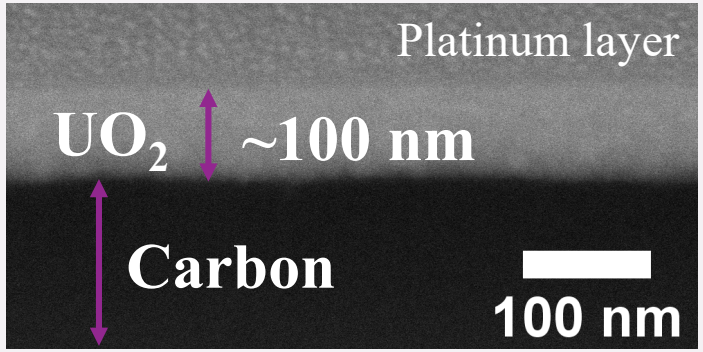
Solution Combustion Synthesis - Targets



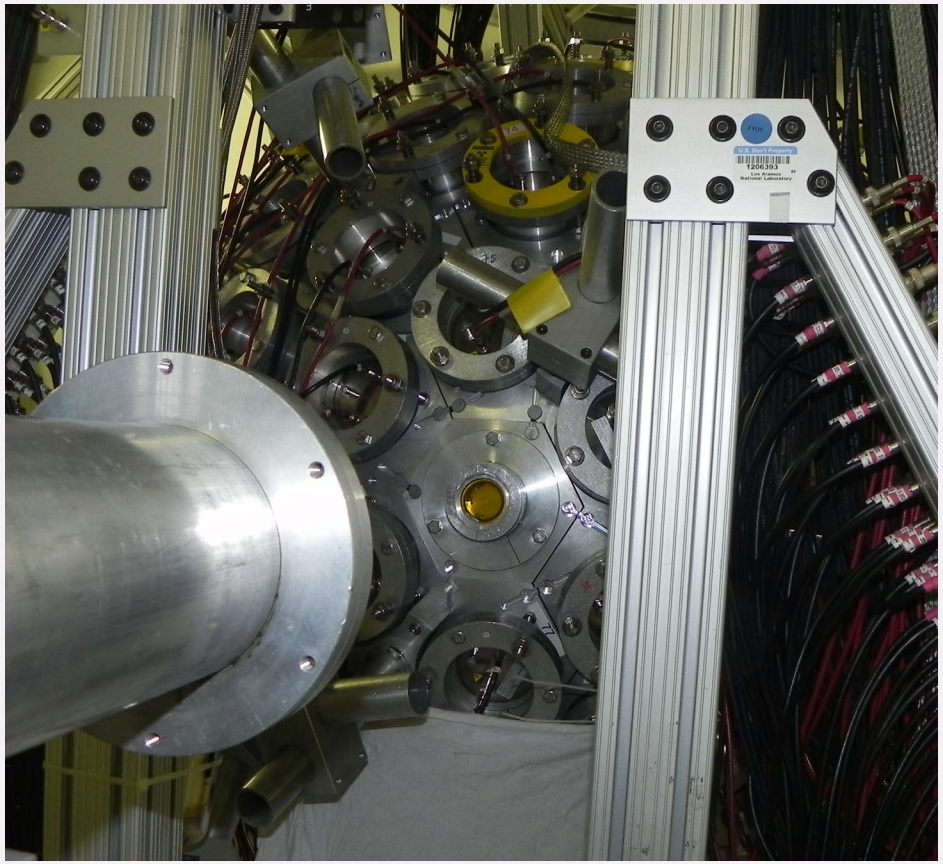




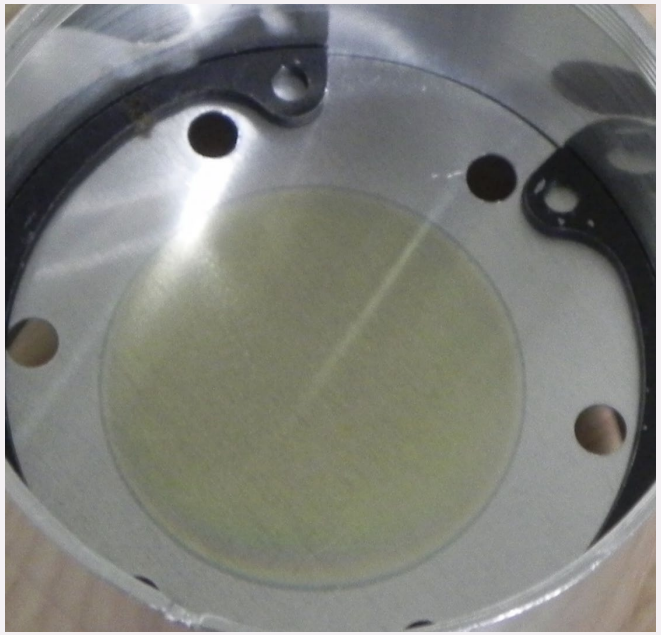




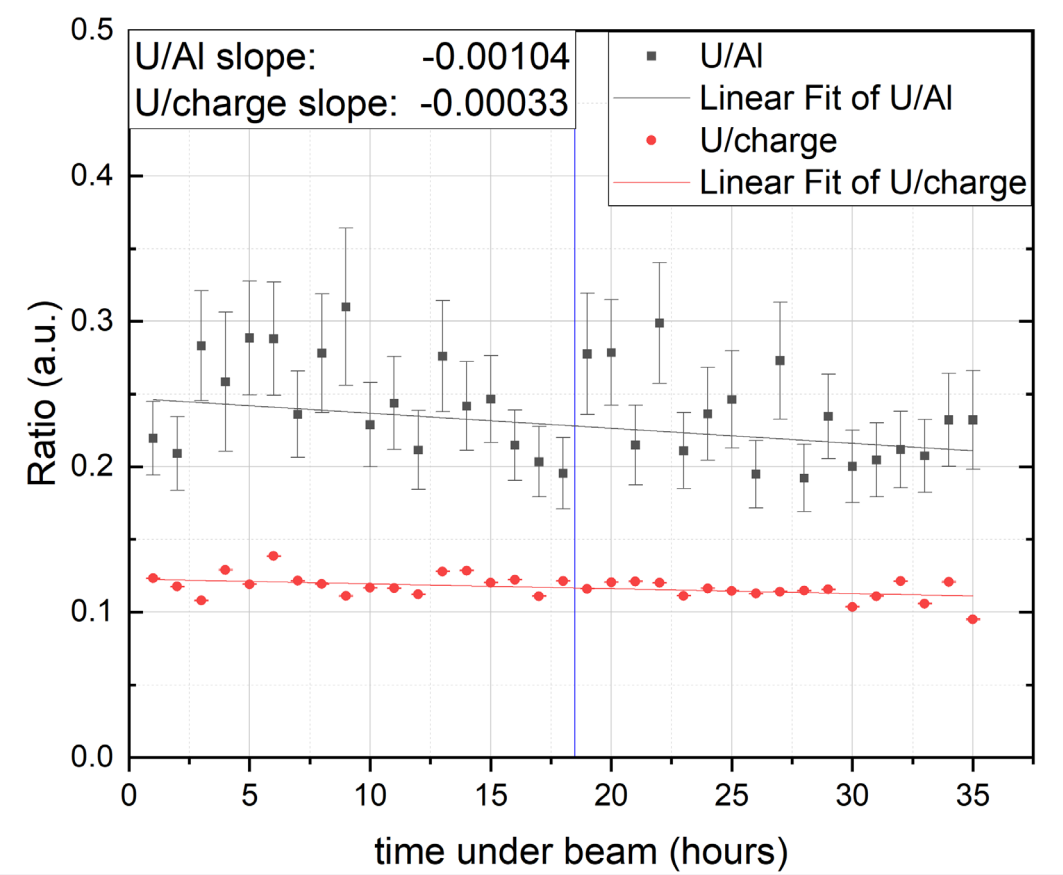
Neutron Irradiation: $^{238}U(n,\gamma)$

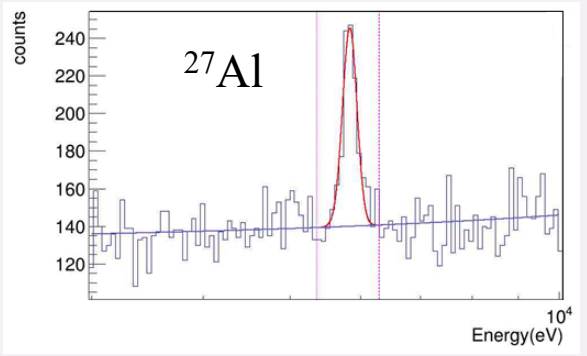


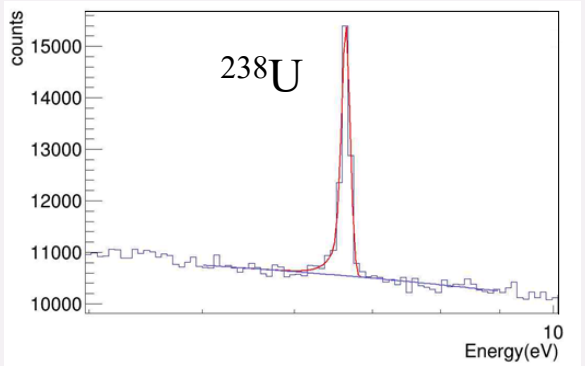
- Test stability and purity of the targets
- Target: 300nm UO_2 on pure Al backing
- Detectors: 160 BaF_2 scintillation detectors at the Detector for Advanced Neutron Capture Experiments (DANCE)

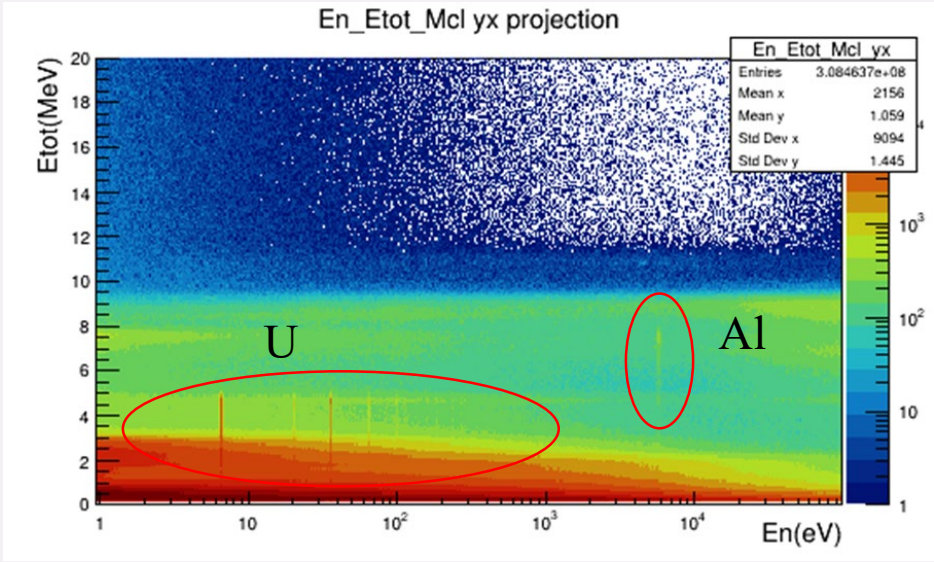


Stability and Purity of the targets

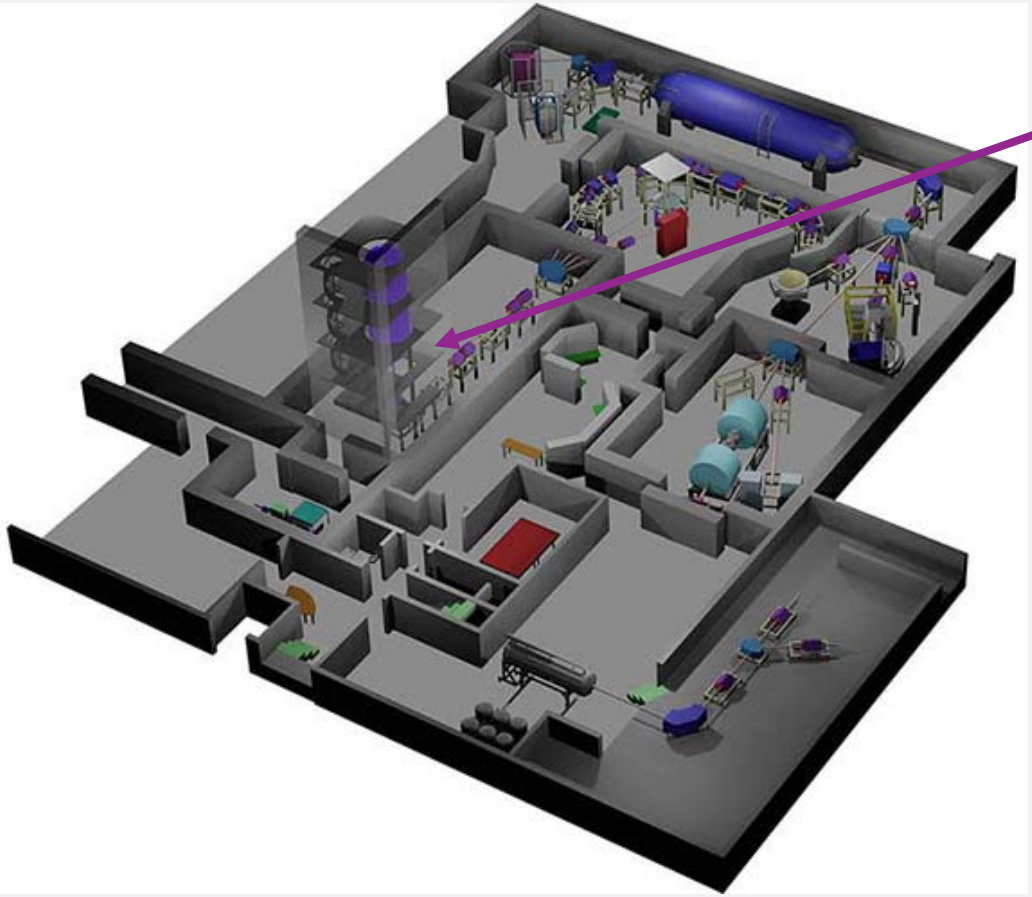








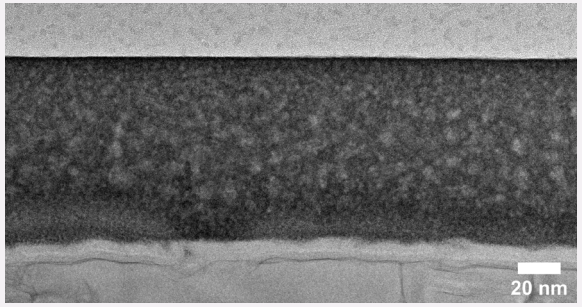
Ion Irradiation: 1.7 MeV Ar^{2+} ions



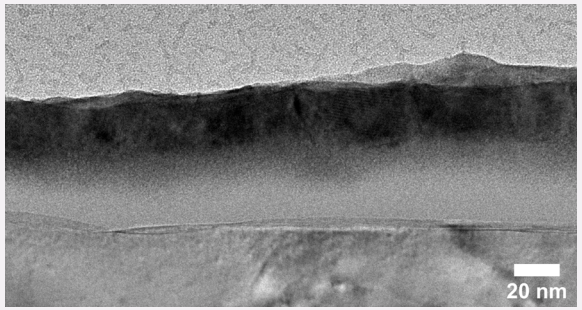
- 5MV single ended (5U) NEC Pelletron accelerator
- Targets: ~ 100 nm UO_2 on Al Alloy backing
- Annealing temperature: 350 °C and 550 °C

Effects of ion irradiation

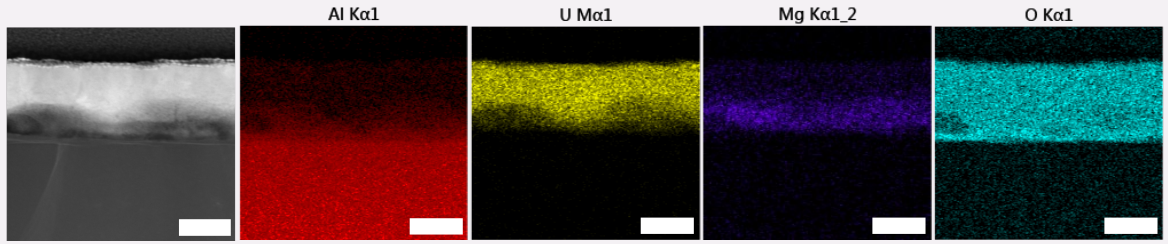
Sample: 350°C annealing temperature



Pristine sample

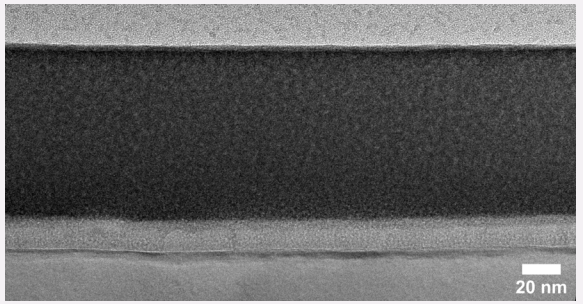


1.29×10^{17} ion/cm^2

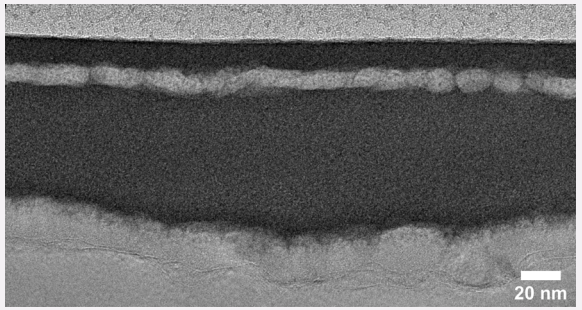


1.29×10^{17} ion/cm^2 Fluence – 50nm scale

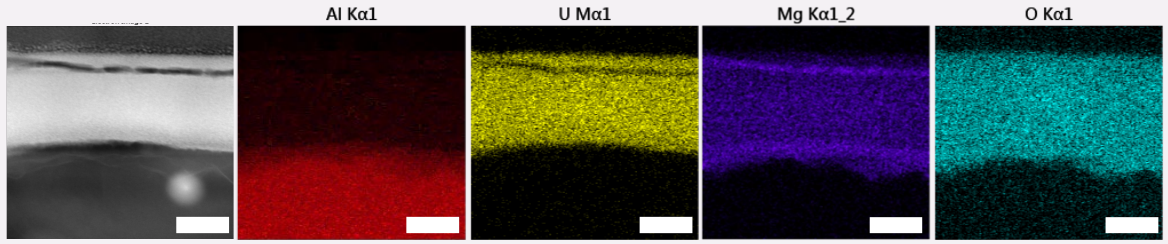
Sample: 550°C annealing temperature



Pristine sample



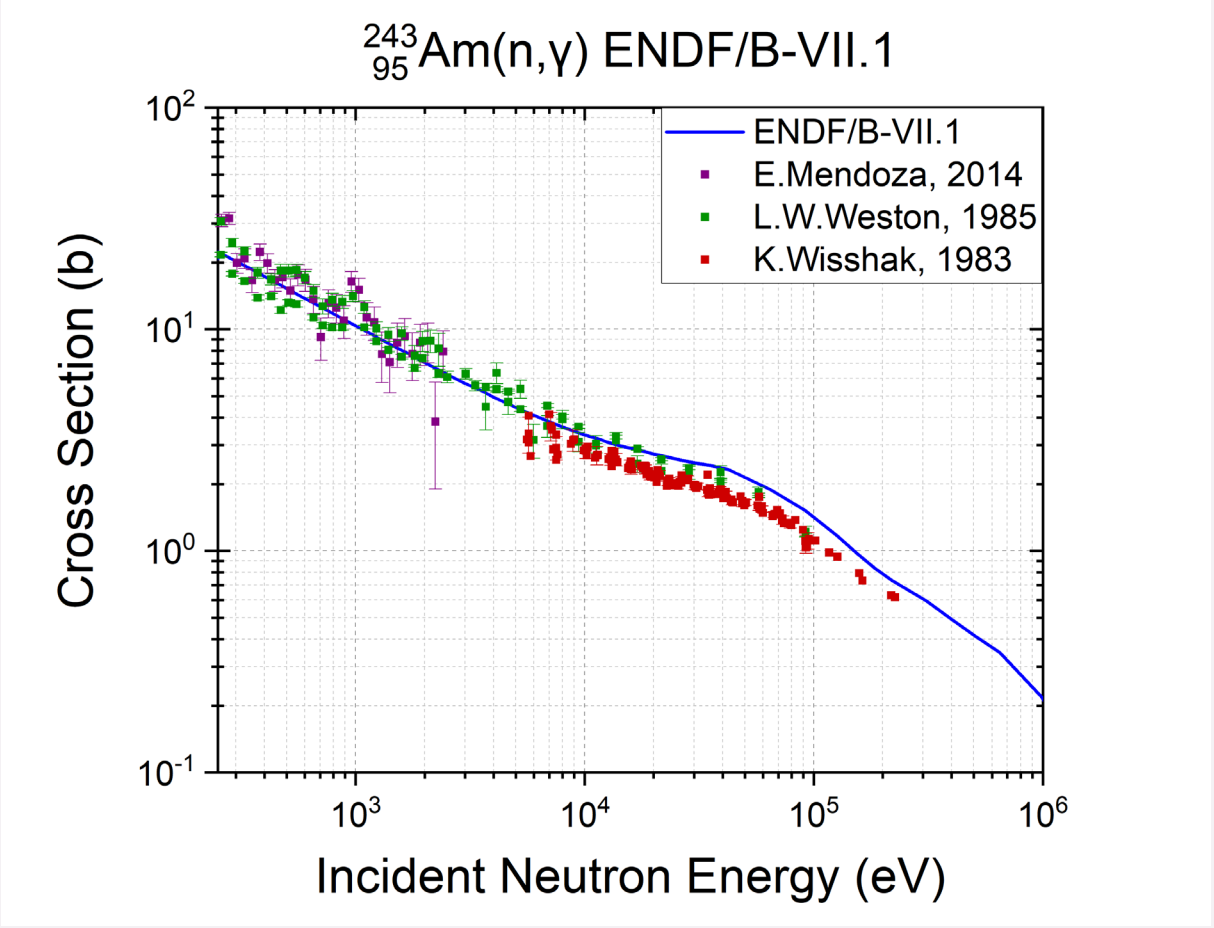
1.26×10^{17} ion/cm^2



1.26×10^{17} ion/cm^2 Fluence – 50nm scale

Future Work - ^{243}Am(n,γ) cross section measurement at DANCE

- Electrosprayed target
  - 8mg of $^{243}AmO_2$ with radius of 1cm on thin (4.5μm) Al substrate and covered with another thin Al foil → 2.55mg/cm^2 → 2.18μm



Conclusions

- Solution combustion synthesis in combination with electrospraying is a novel method we developed to produce actinide targets
  - Small quantities of material needed
  - ~ 100% Material Collection Efficiency
  - Excellent Adhesion
  - Thickness variation of 1 – 3%
  - Ability to tune target thickness (Spraying time, Flow rate)

Conclusions

- The produced targets are stable under neutron beam and have no impurities when a pure Al backing is used.
- Depending on the annealing temperature, Mg can leach into the UO_2 layer when using an Al alloy backing.

- Our work on other actinides, like Am and Th, has already started

16:50–17:10	Novel actinide target making method: Spin-coating assisted combustion synthesis (A. Majumdar, Univ. of Notre Dame, USA)

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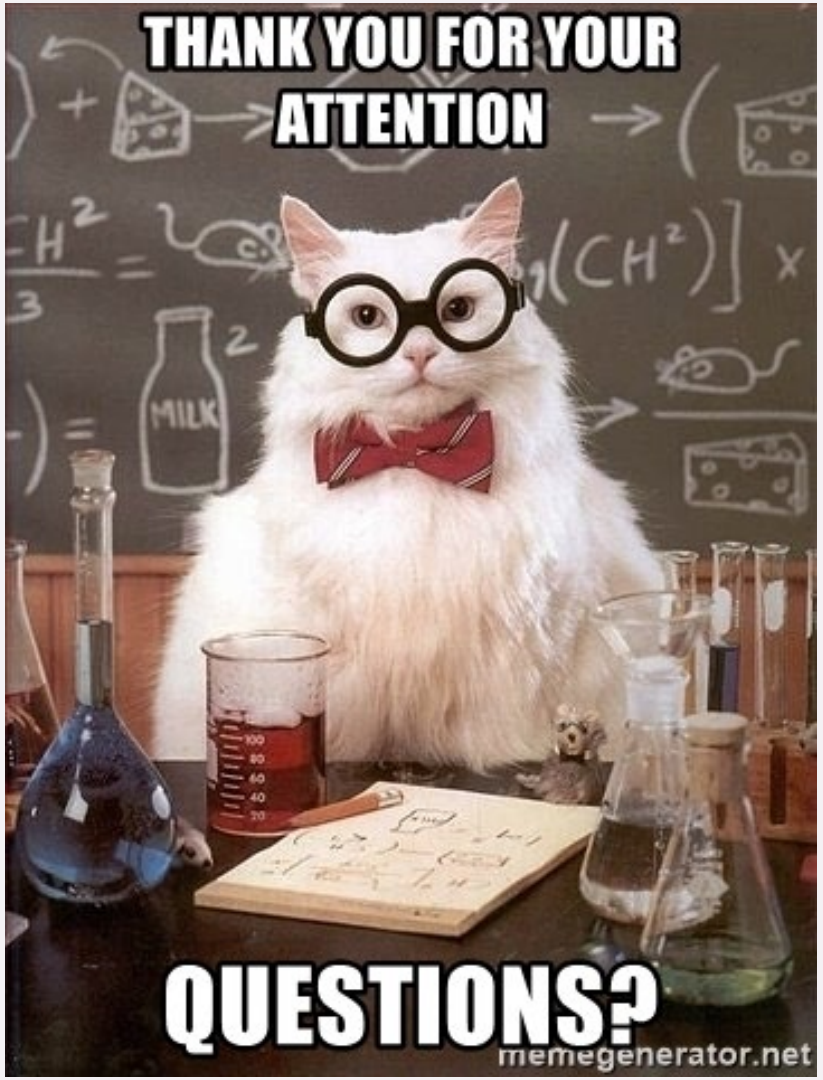
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QUESTIONS?
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