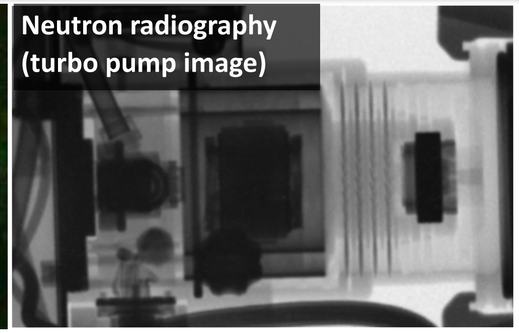
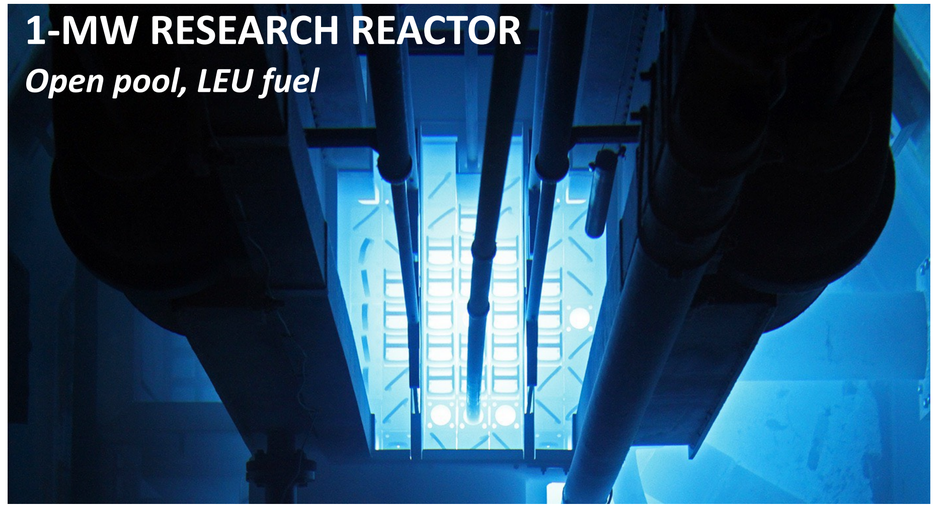
UMass Lowell Radiation Laboratory: Facility, Detectors, & upgrades



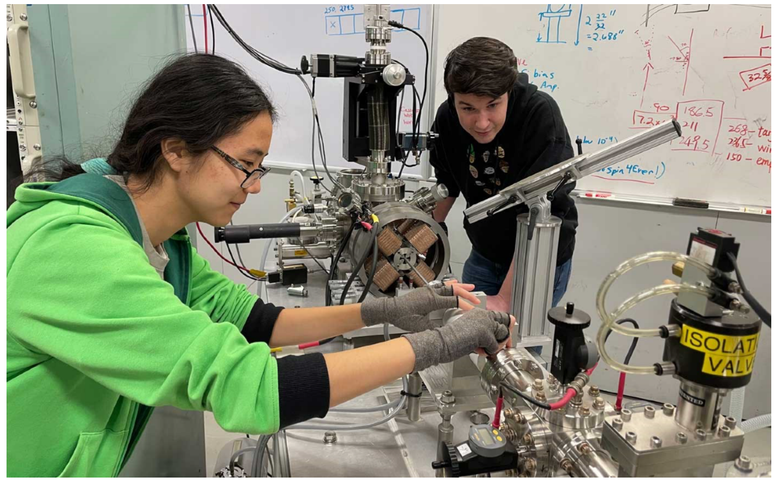


CAPABILITIES

in-core sample(~10^{13} n/cm^2/s)
graphite thermal column (~10^6 n/cm^2/s)
digital neutron radiography
hot cell with remote manipulators

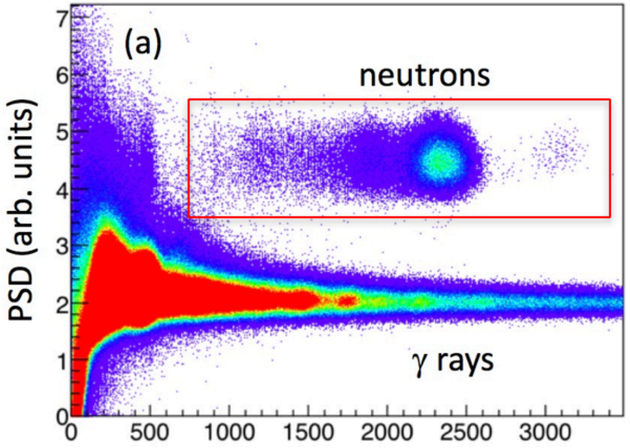
CAPABILITIES

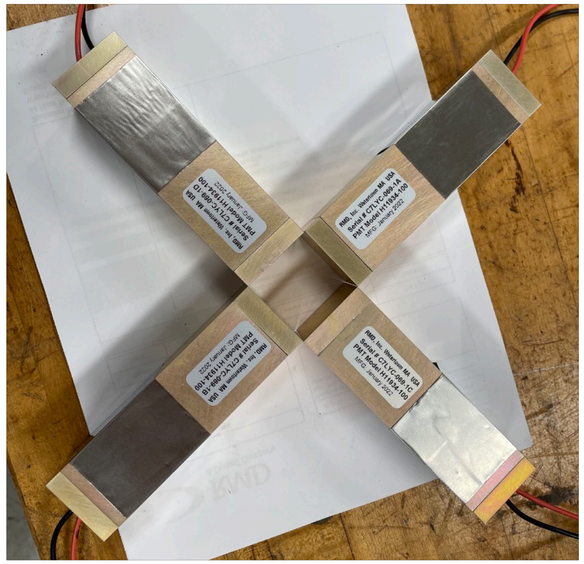
- *p*, *d*, He, … ions
- Up to 50-μA DC beam
- ***Sub-ns pulsing***
- Mono-energetic pulsed neutrons via ^{7}Li(*p*,*n*) reaction
- Fast-neutron beamline (goniometer, neutron scattering, ToF)
- Ion microprobe
- General purpose scattering chamber

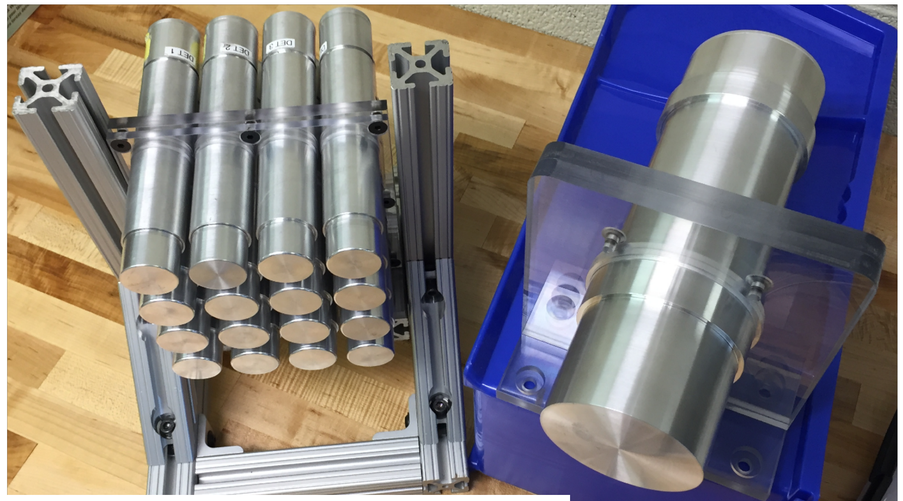


C⁷LYC Detector development measurements at UML

EX: C⁷LYC detector characterization

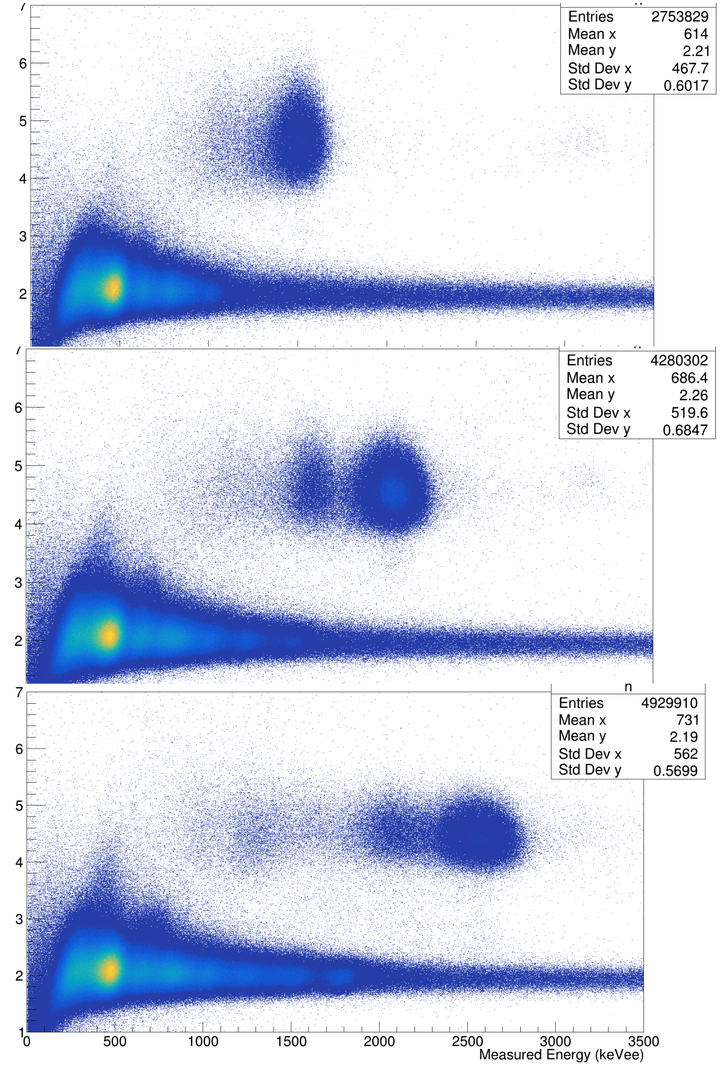






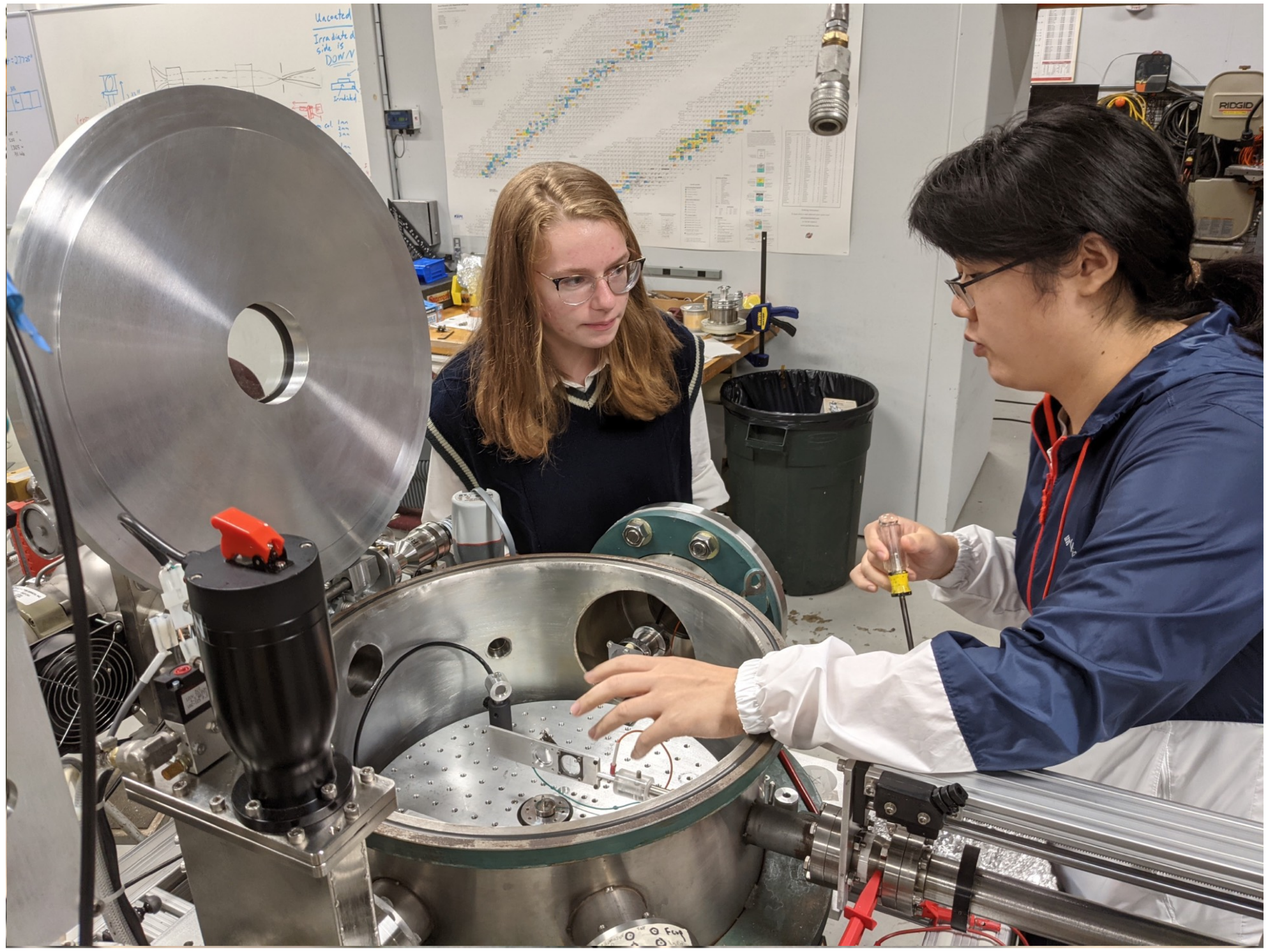
⁷Li enriched C⁷LYC detectors

- Fast-neutron spectroscopy response.
- Characterization at UML Accelerator Facility.
- **Future measurements exploring recently obtained 1”x1”x3” rectangular detectors.**



Implanted targets and ion-beam analysis

<u>Faculty:</u> Peter Bender



- **Lifetime measurements of excited states** using well-characterized implanted targets.
- Deuteron beams (~2 μA) are energy degraded and implanted in a target foil.
- Elastic Recoil Detection Analysis (ERDA) using ^{4}He beams to characterize the depth and number of implanted ^{2}H.

<u>Future projects</u>:

- Develop low-energy ion source for ion-implantation applications.
- Develop general ion-beam analysis techniques at UML.

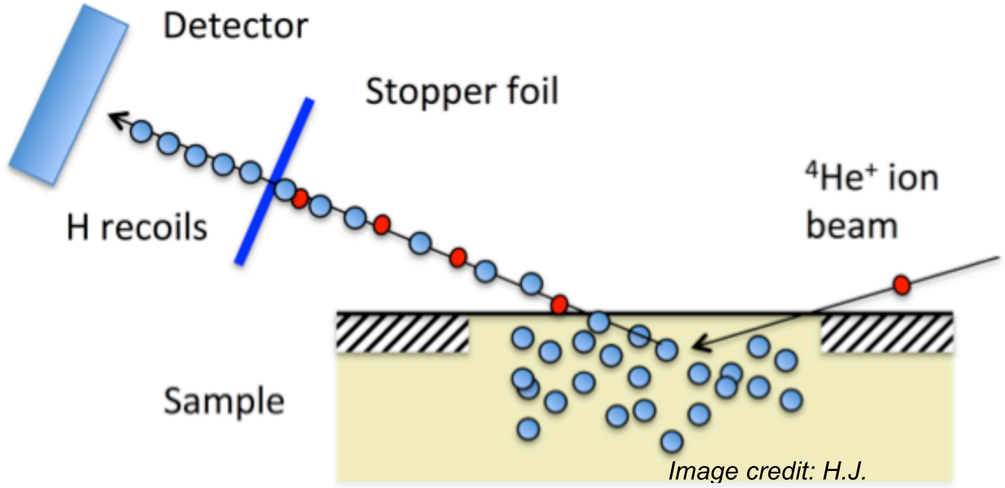
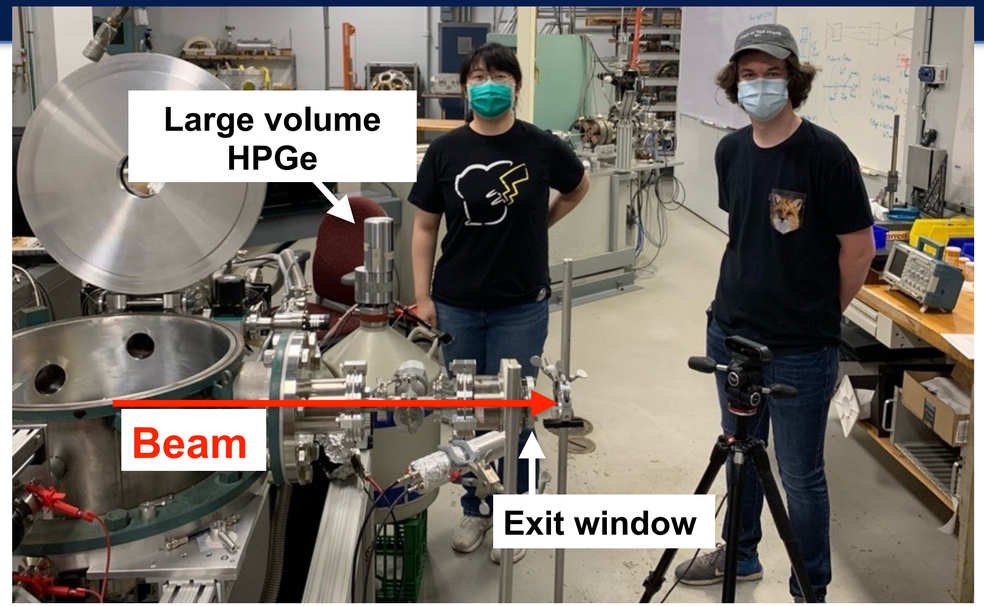
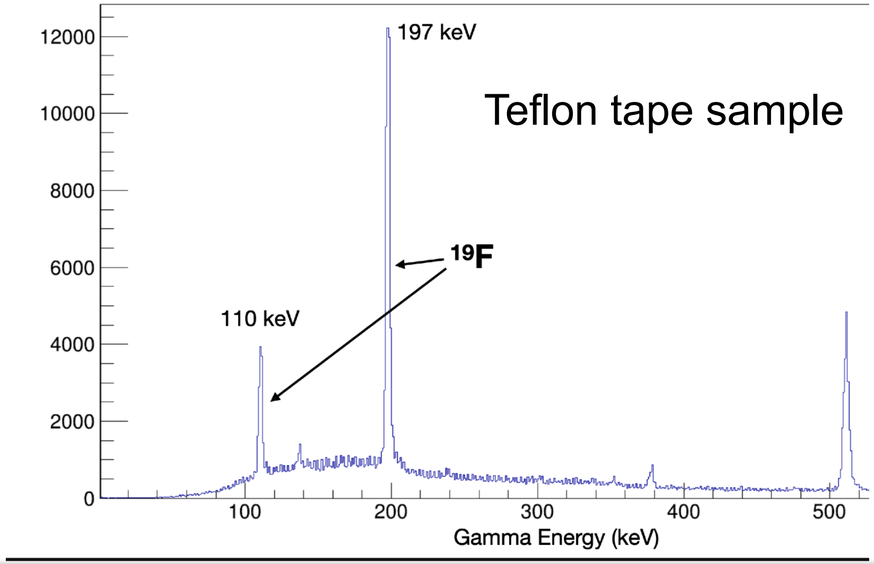


Image credit: H.J.

External-beam development and end station

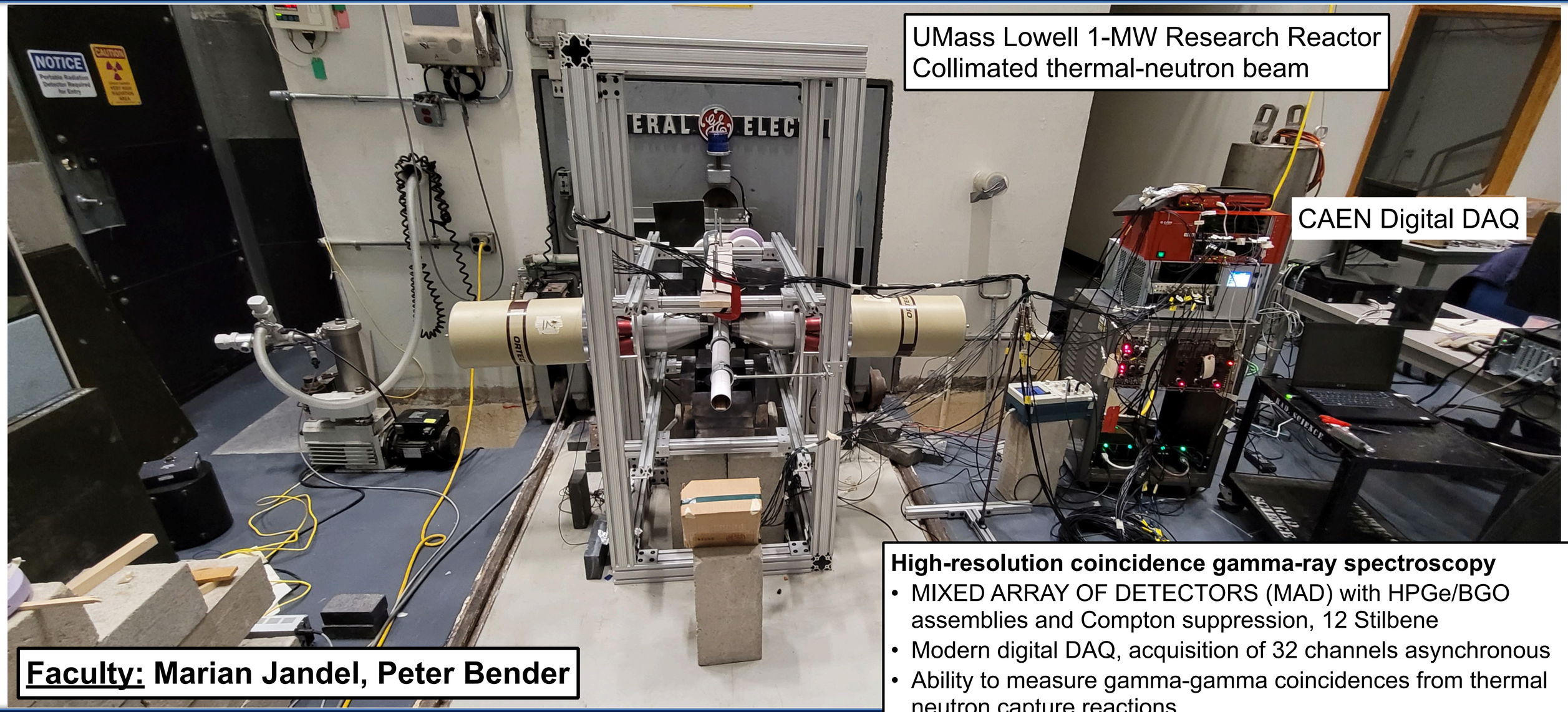




- Ion-beam analysis and high-throughput irradiations of in-air samples.
- Significant interest in external irradiation capability.
- Initial test using PIGE for identifying and quantifying ^{19}F from PFAS [1].
- **Future development** of a fully instrumented end-station for ion-beam analysis, including PIGE, PIXE, and sample irradiation.

[1] L. Schultes, G.D Peaslee et al., Environ. Sci. Technol. Lett. 2019, 6, 2, 73–78

New capabilities for measurements of capture gamma rays

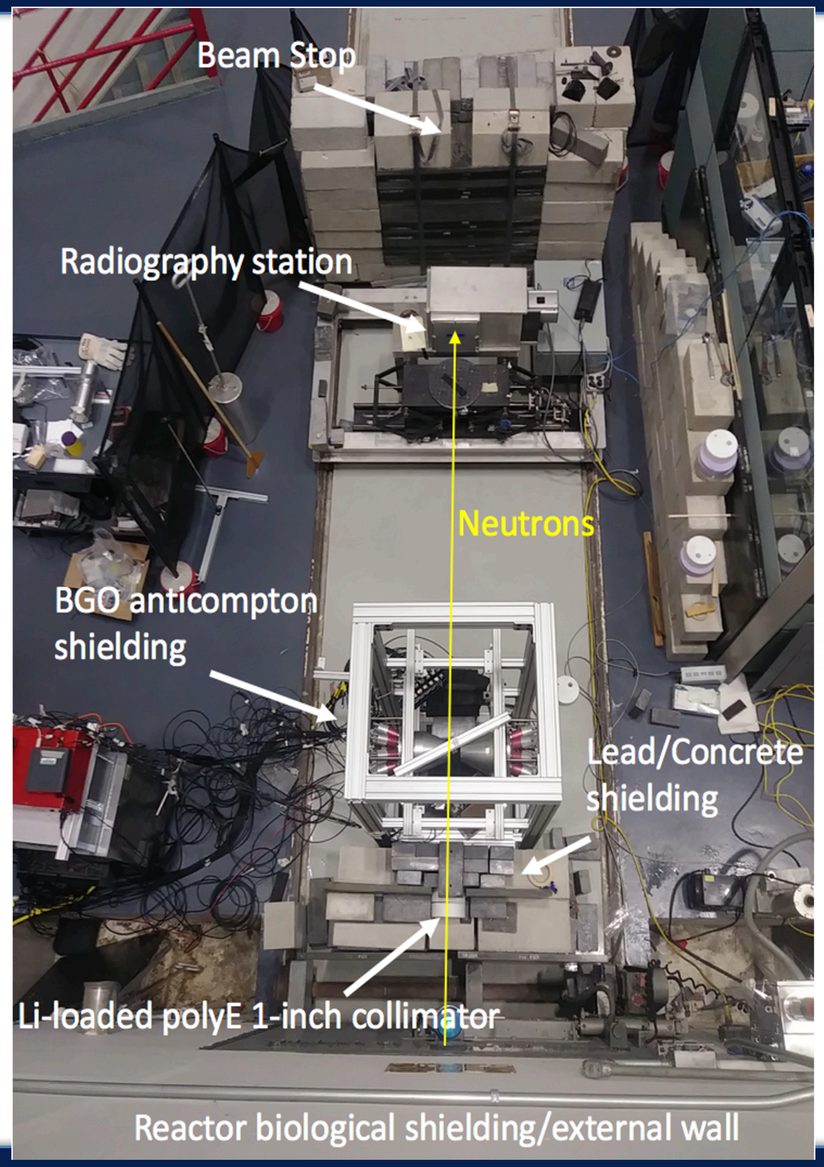


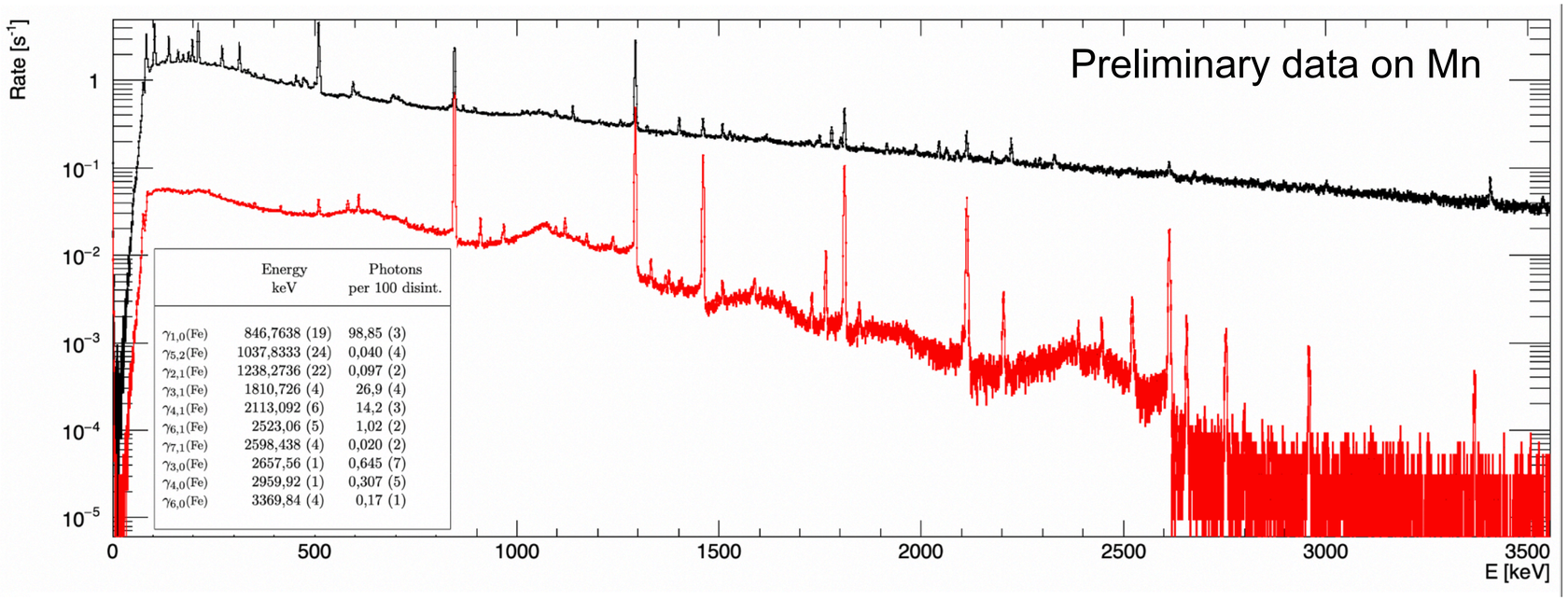
Faculty: **Marian Jandel, Peter Bender**

High-resolution coincidence gamma-ray spectroscopy

- MIXED ARRAY OF DETECTORS (MAD) with HPGe/BGO assemblies and Compton suppression, 12 Stilbene
- Modern digital DAQ, acquisition of 32 channels asynchronous
- Ability to measure gamma-gamma coincidences from thermal neutron capture reactions.

New capabilities for measurements of capture gamma rays





- Accurate gamma intensity determination: activation/decay and witness sample analysis
- Compton suppressed spectrum of gamma rays obtained during the 2-hour long irradiation of the ^{55}Mn foil (black) and after the irradiation (red) at UMLRR in January 2021.

E [keV]	I[%] EGAF	I[%] ENSDF	I[%] UML
212	15.9	10.6	**11.9**
271.2	7.04	5.7	**5.9**
314.4	10.9	9.4	**8.5**
1401	3.5*	0.88	**3.4**
1705	1.39	1.39	**<0.5**
1747	3.31	3.31	**1.77**
1915	2.0	2.5	**1.35**

Summary

- Our infrastructure includes a **5.5-MV Accelerator** and **1-MW Reactor,** offering unique opportunities.
- The UMass Lowell Radiation Laboratory is an excellent environment for **training students** and supporting the goals of the nuclear physics community.
- Development of **ion-beam analysis** capabilities.
- New capabilities for measurement of **capture gamma-rays**.
- Our university-based laboratory supports our basic science program and enables a variety of interdisciplinary research within the university as well as a resource for industry.