Project Goals

Build and commission a rugged and **portable ultraviolet (213 nm) laser ablation micro-sampling device** to enable in situ sample removal from cultural heritage objects and natural history specimens comprising transparent and translucent materials prone to brittle fracture. The ablated material is deposited onto pre-cleaned filters, which are later processed for elemental and isotope analysis using ICP-MS and/or TIMS. Equip 2nd generation design with gate-delayed spectrometer to allow **tandem Laser Induced Breakdown Spectroscopy (LIBS) and laser ablation**. The portable sampling tool will be used in Yale's museums and collections, by Yale researchers for field work, and will serve as a model for use by other cultural heritage institutions.

Resources Needed

- Advanced Prototyping Center, Machine Shop, Electronics Shop
- Yale Metal Geochemistry Center & Cleanroom (G&G/E&PS)
- Expertise: optics & pulsed lasers; ICP-MS & TIMS; cleanroom; sample digestion & preparation; LIBS; engineering; data science
- Training: laser safety, clean room use, instrumentation use, museum object handling, optical spectroscopy
- Personnel: research scientists @ Cores, machine shop, engineers, postdocs
- Management: budget/expense tracking, postdoc recruitment & supervision





PI/Group

Anikó Bezur, <u>Technical Studies Lab</u>, <u>Institute for the Preservation of Cultural Heritage</u>

Link/Reference: Based on visible 532 nm laser ablation device.

Current Approach

Prototype 1

- Ablation chamber: Advanced Prototyping Center
- Laser support: Gibbs Machine Shop
- Filter cleaning, sample digestion, elemental and isotope analysis: Yale Metal Geochemistry Center & Cleanroom

How might a new instrumentation development center help?

What research would be enabled by an instrumentation development center?

- A portable UV laser ablation micro-sampling device will enable trace element and isotope analysis of a whole class of cultural heritage objects that has been off-limits to any analysis other completely non-destructive approaches, such as x-ray fluorescence and Raman spectroscopies. This opens the door to addressing questions about materials sources, material processing technologies, and degradation mechanisms. Whole or reassembled objects made of brittle and transparent/translucent materials are rarely sampled, because mechanical sample cause micro-cracks that lead failure. A portable ultraviolet laser ablation device will permit safe and virtually unnoticeable sampling that can be conducted in the object's collection environment, further reducing risk from transportation.
- The addition of LIBS capacity to the sampling device will allow instant elemental analysis capacity and results that will complement later sample workup with ICP-MS and TIMS.

What difference can it make to your research and the training of personnel?

- It can lower the activation barrier for the customization of existing instrumentation or the creation of new solutions for cultural heritage objects and environments.
- Provide integrated and more efficient onboarding of students, postdocs, and research staff with respect to resources at Yale.
- Serve as a networking point and a springboard for professional development through training, courses, seminars, and events.