Glow Discharge Spectroscopy For Nuclear Material Analysis

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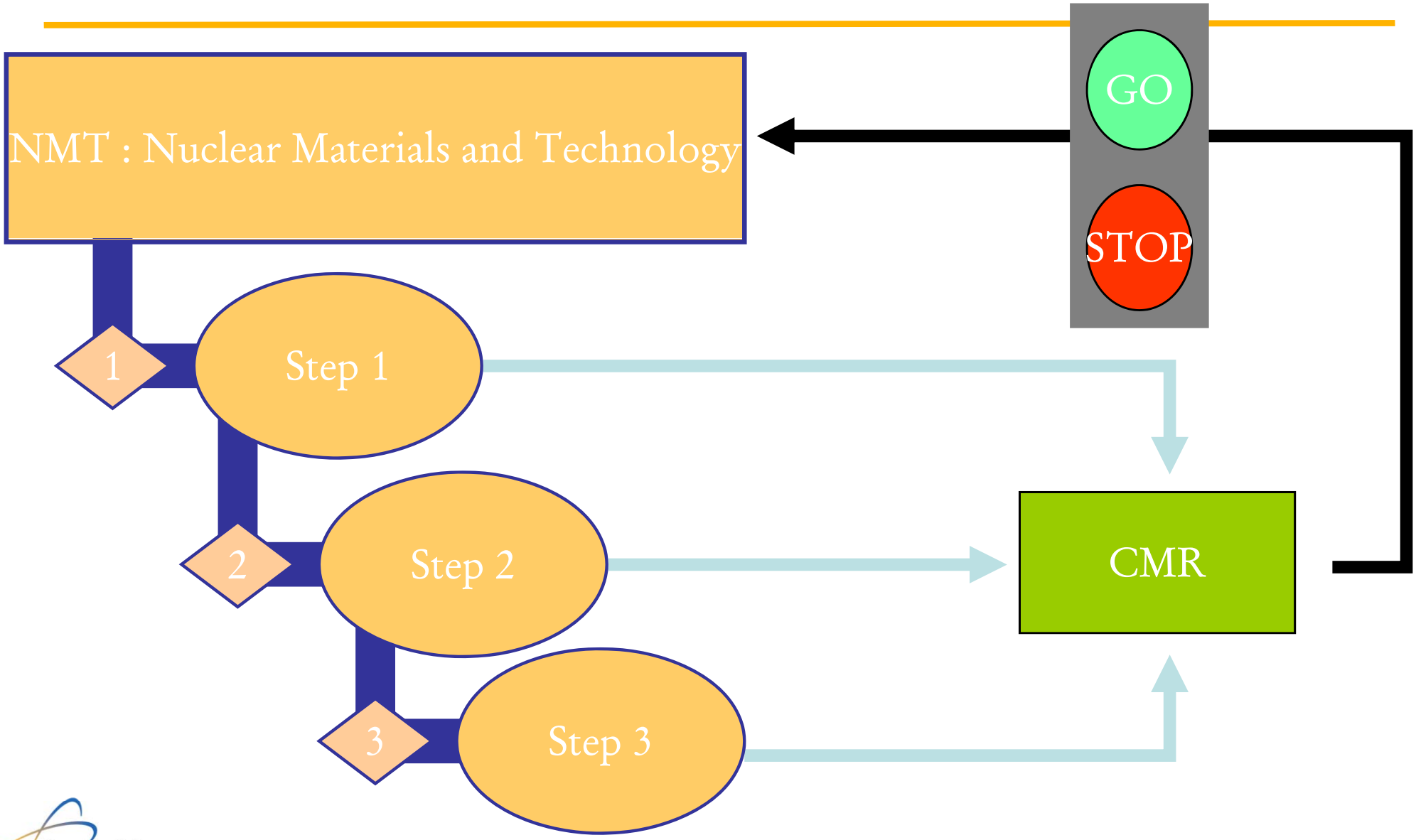
Overview

- Nuclear material analysis at LANL
- Glow Discharge for nuclear material analysis
  - Optical emission experiments
  - Mass spectrometry experiments
- Future directions

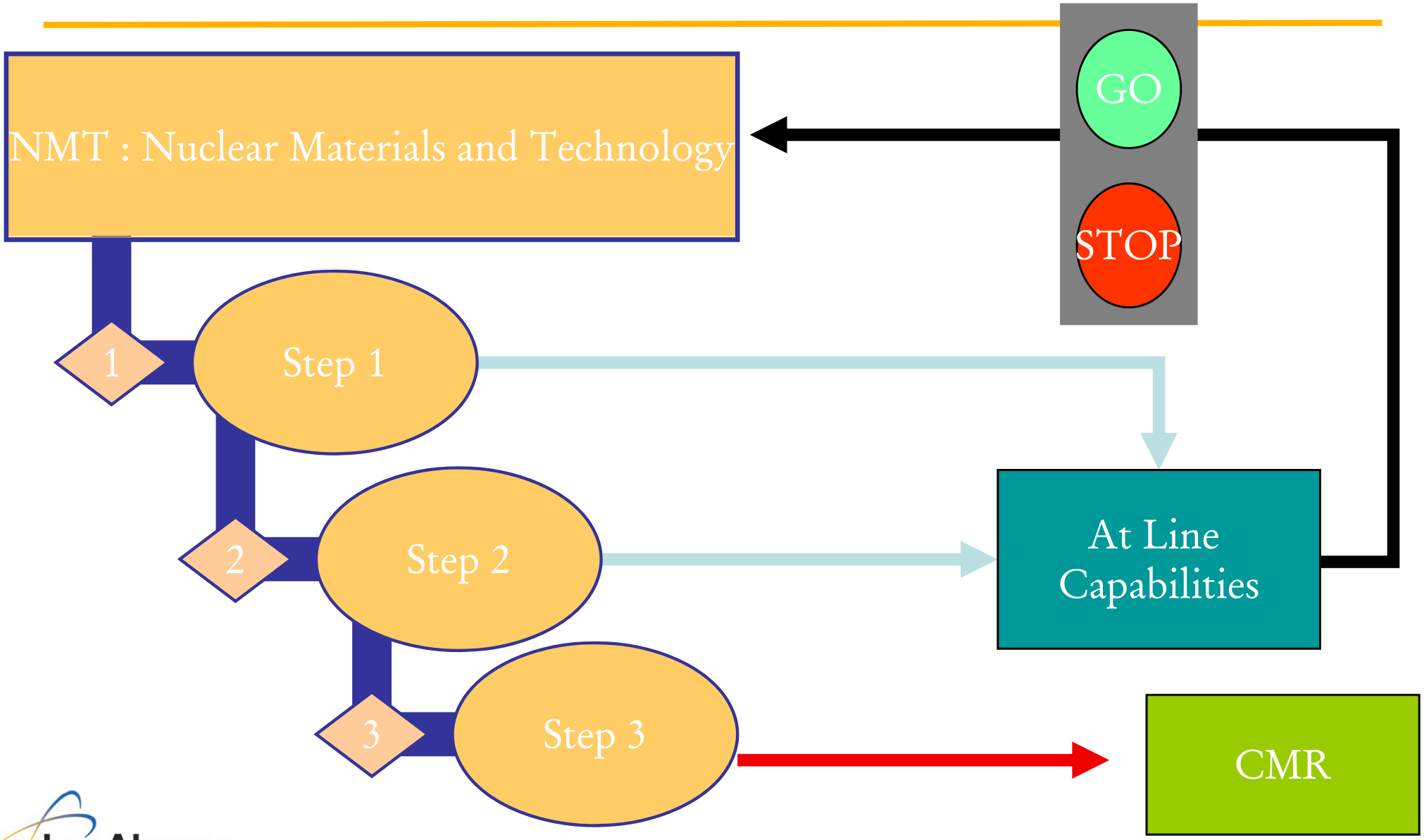
Overall Project Outline

- Determine areas of need for process analytical chemistry
  - Nuclear material production
- Propose technologies to address the need
  - At Line Glow Discharge
- Feasibility of possibly technologies
  - Glow Discharge Figures of Merit
- Implement technology to address need
  - Compact Glow Discharge Mass Spectrometry

LANL Nuclear Material Production



LANL Nuclear Material Production

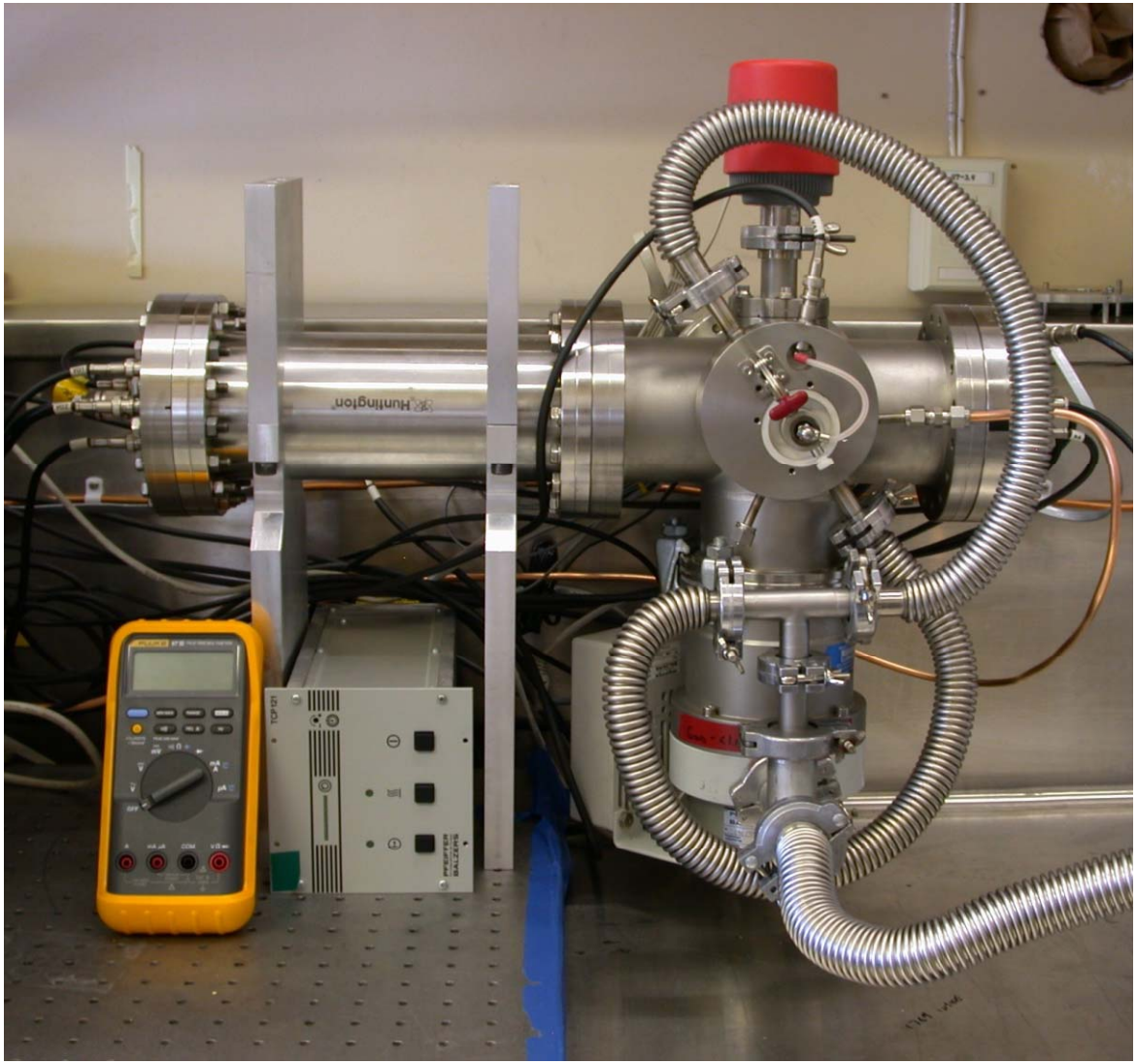


Project Goals - Feasibility

- Determine utility of GD-MS as process monitor for nuclear material production
- 1. Applicability of GD to nuclear materials
  - Q1: What are the sputtering characteristics?
  - Q2: Are any components volatile under GD sputtering
- 2. Long term precision and accuracy of MS
  - Q1: Does instrument give same answer over time?

GD-MS Summary

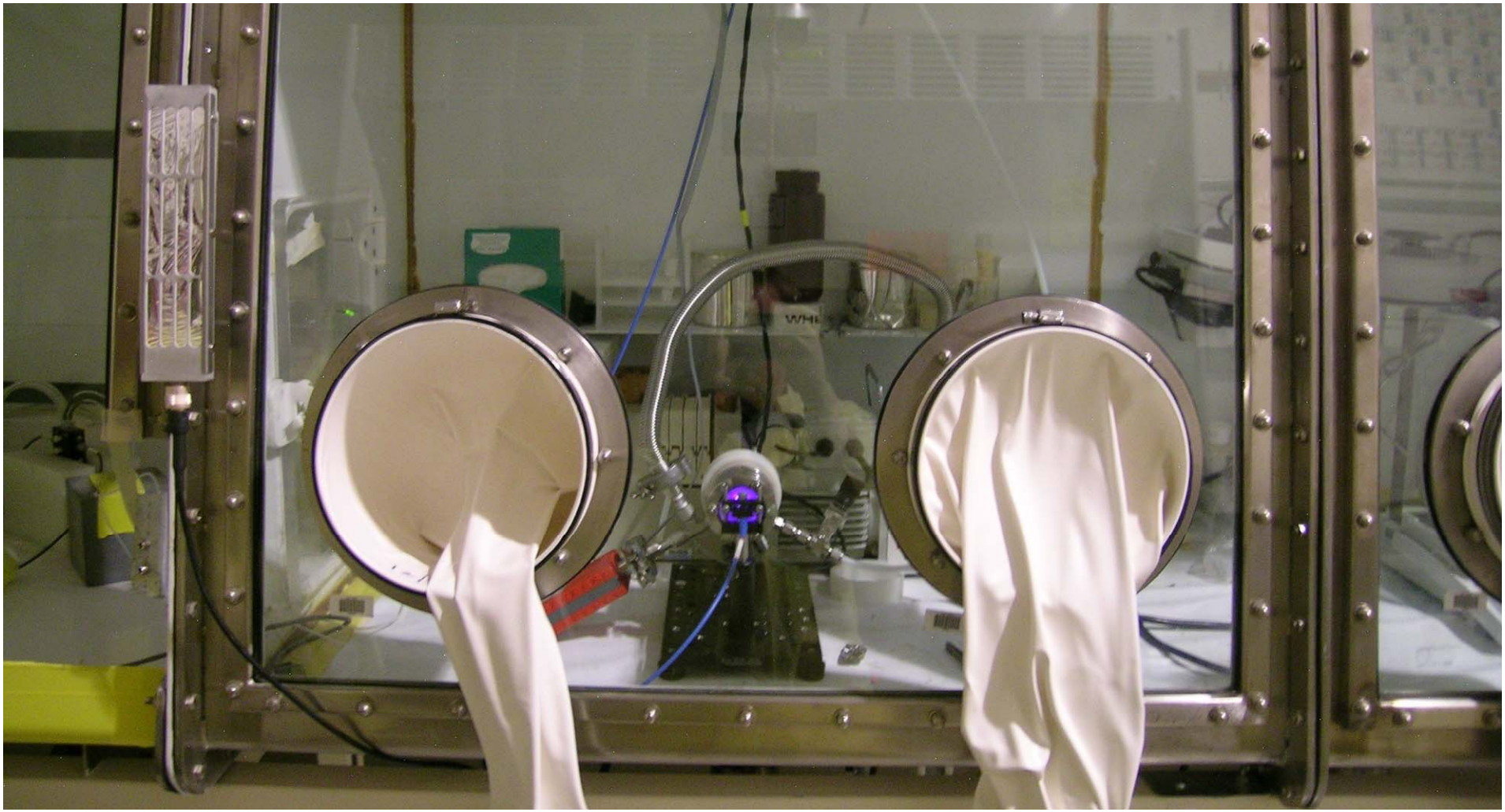
- Compact In-house constructed TOF-MS
- Experiments with NIST SRM
- No analysis of nuclear materials



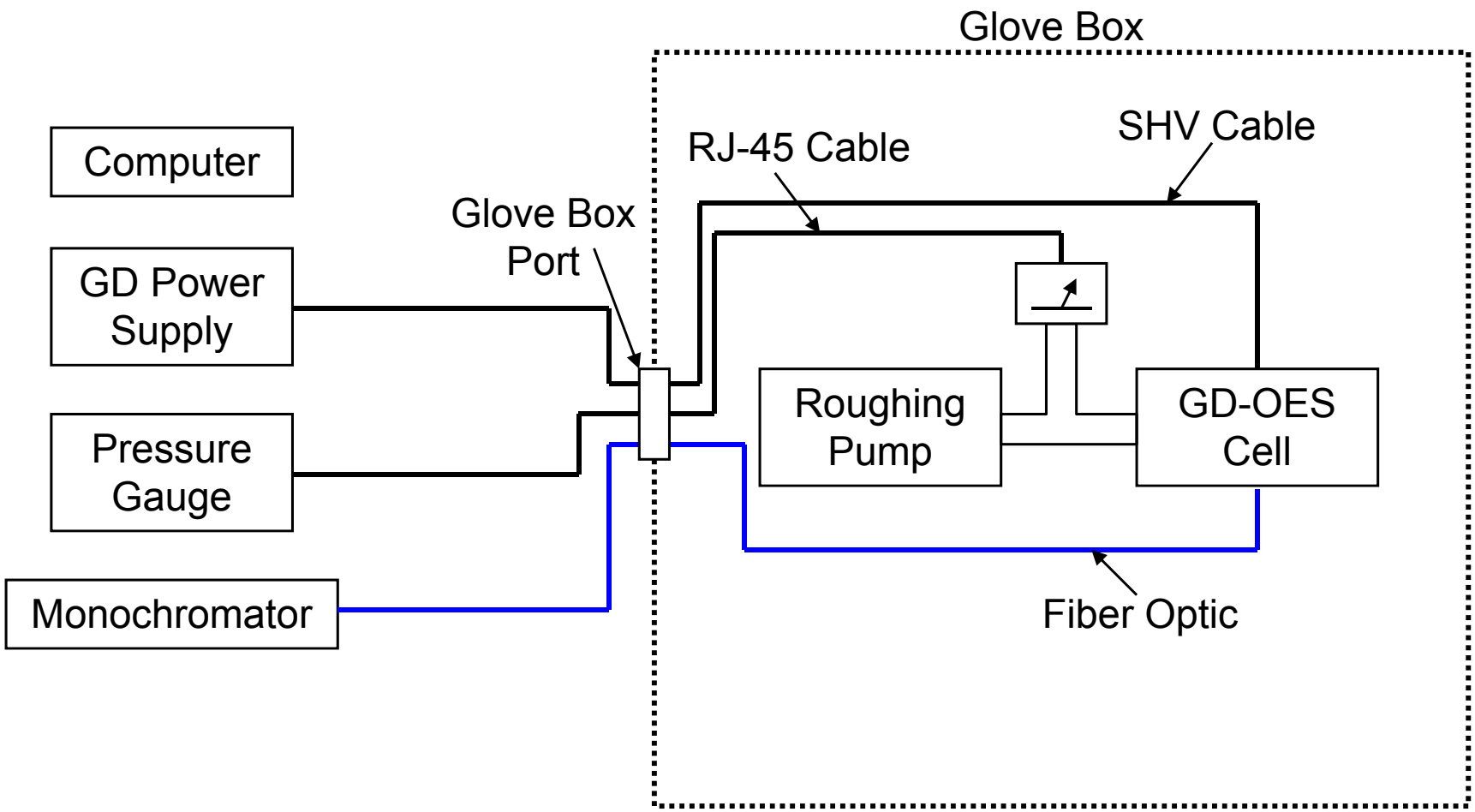
GD-MS Summary

- Long term precision (6 months):
  - >0.1% wt: Less than 10% RSD
  - <0.1% wt: Less than 20% RSD
- Long term accuracy:
  - >0.1% wt: Less than 0.5% error
  - <0.1% wt: Typically less than 5% error
- Sensitivity:
  - Bulk to <100 ppm
- Mass range:
  - 10 – 300 amu

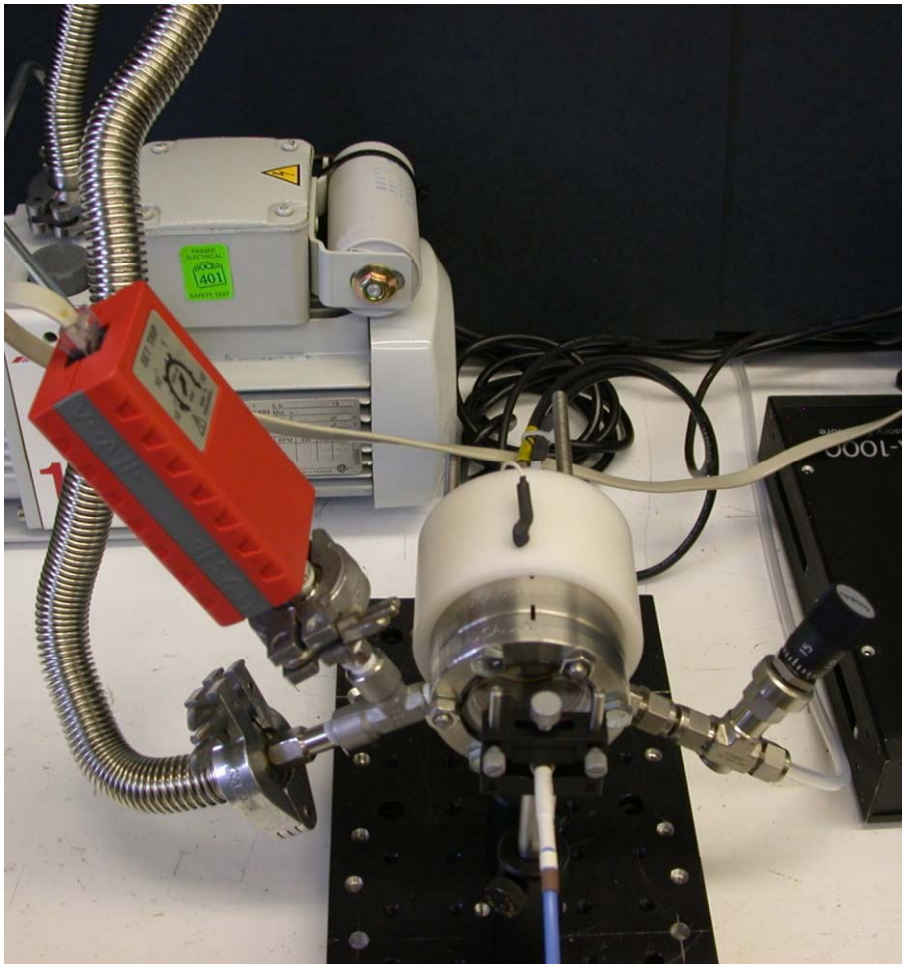
GD-OES Experiments

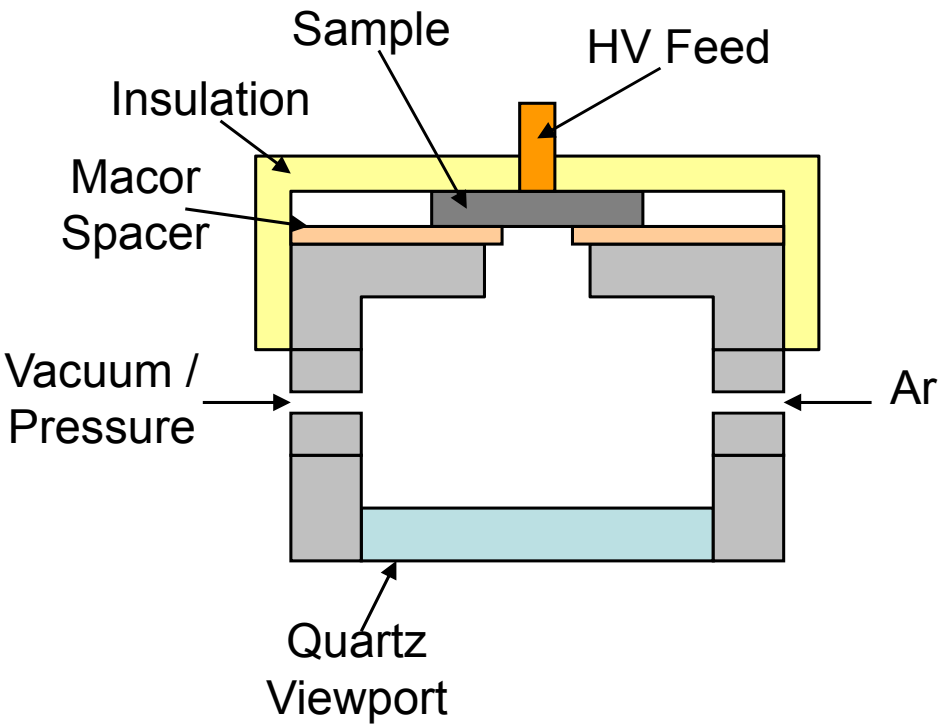


GD-OES Experimental Setup

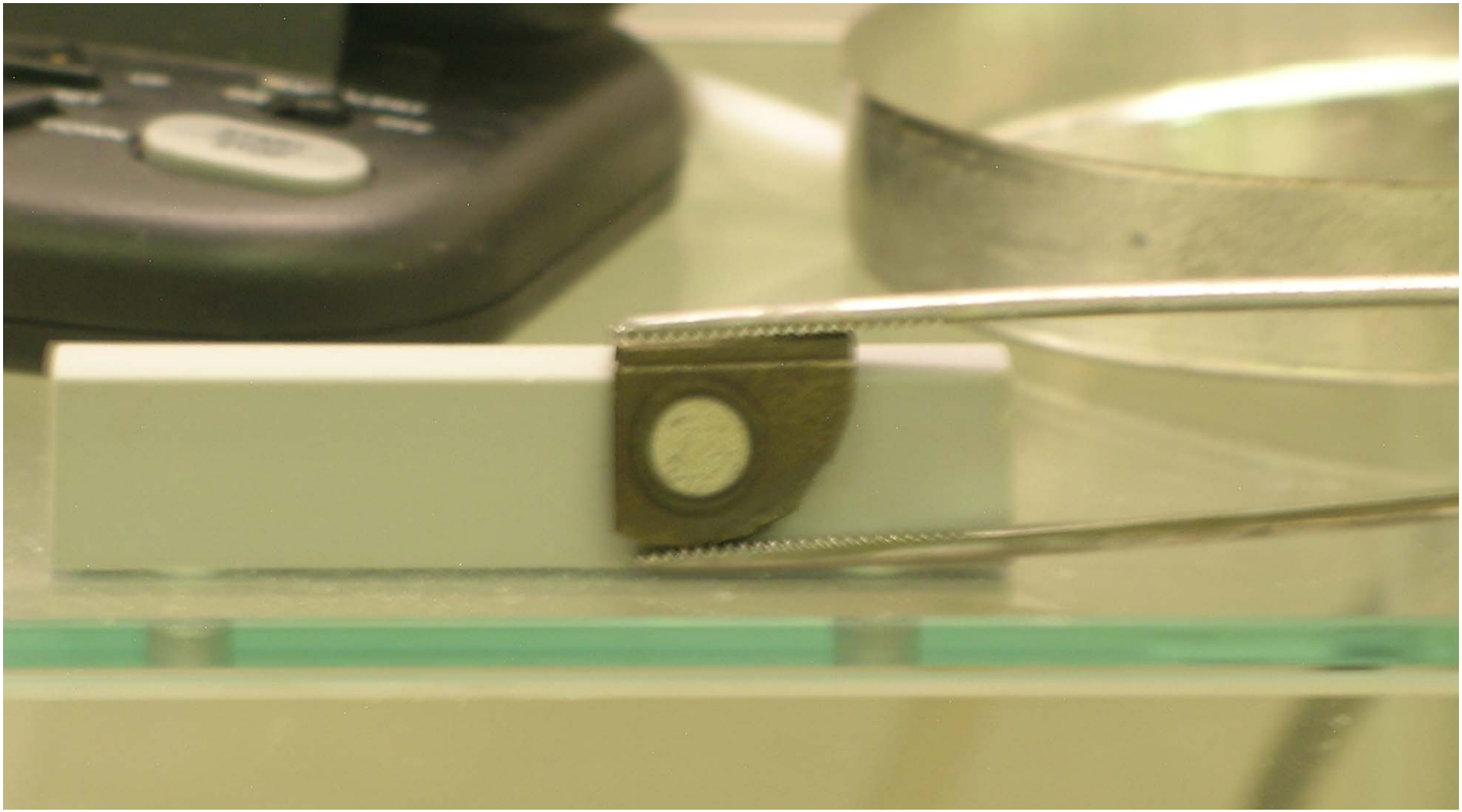


GD-OES Emission Cell

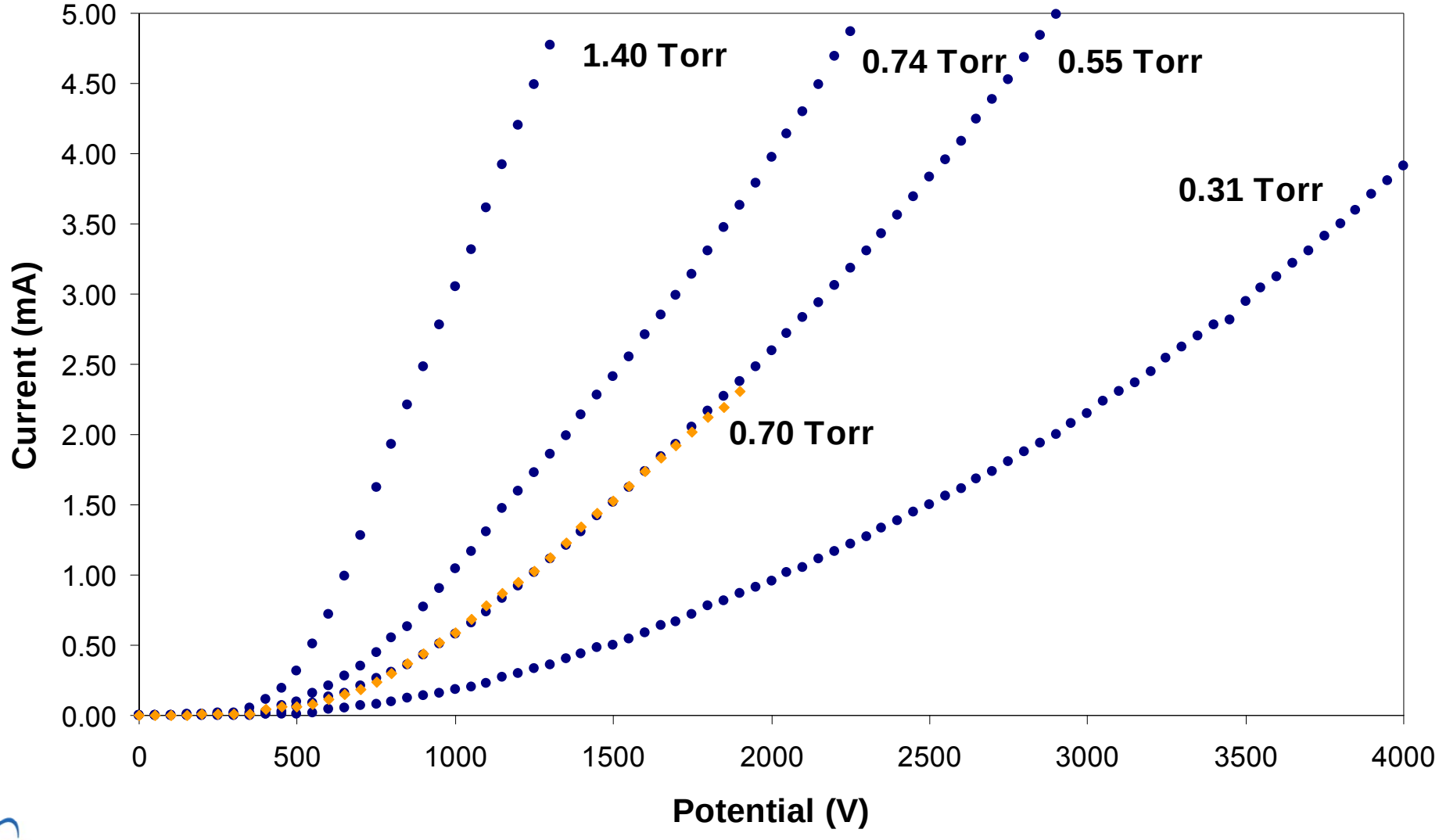




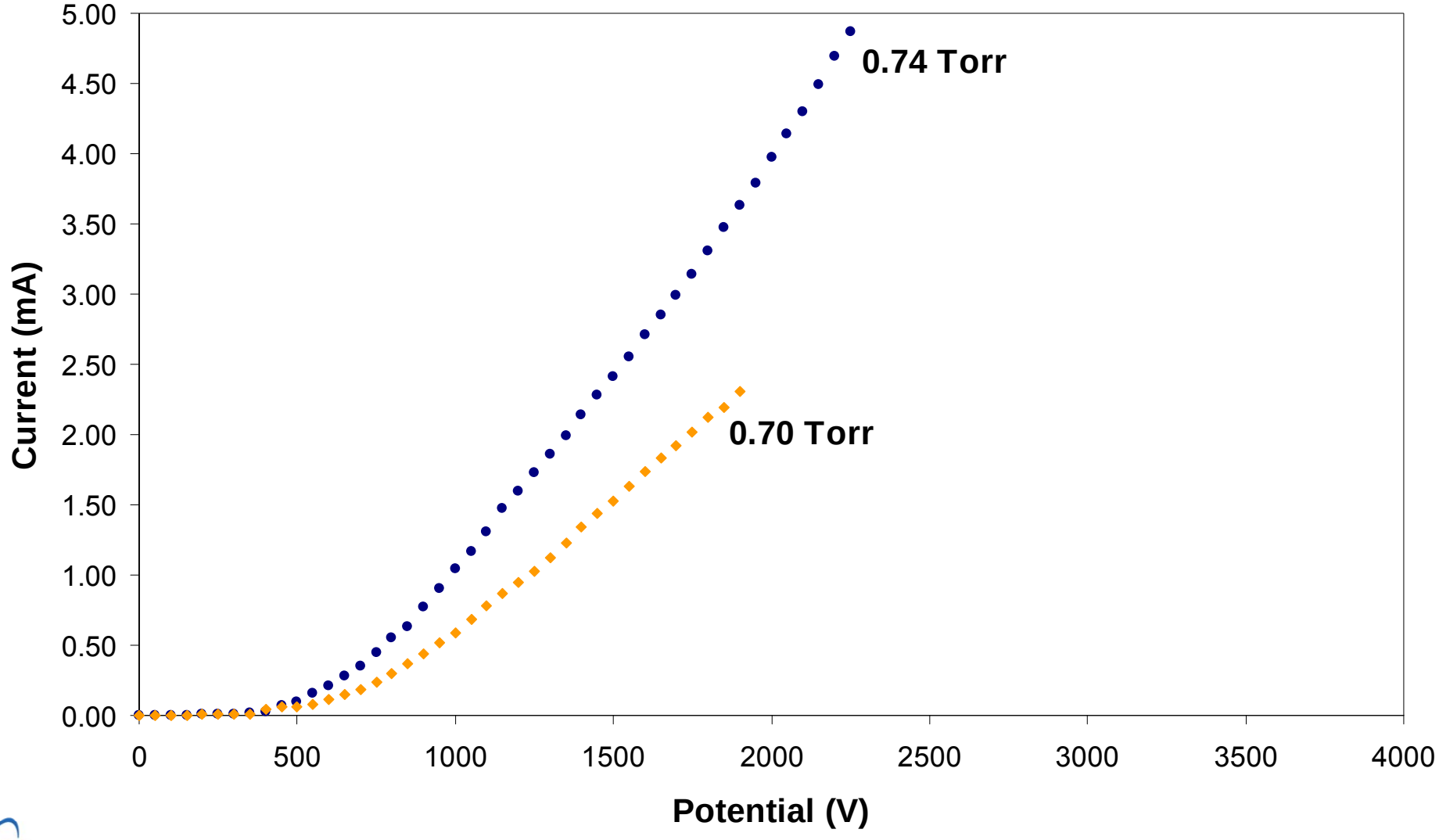
Analyzed Nuclear Material - Plutonium



Plutonium GD Current – Voltage Curves



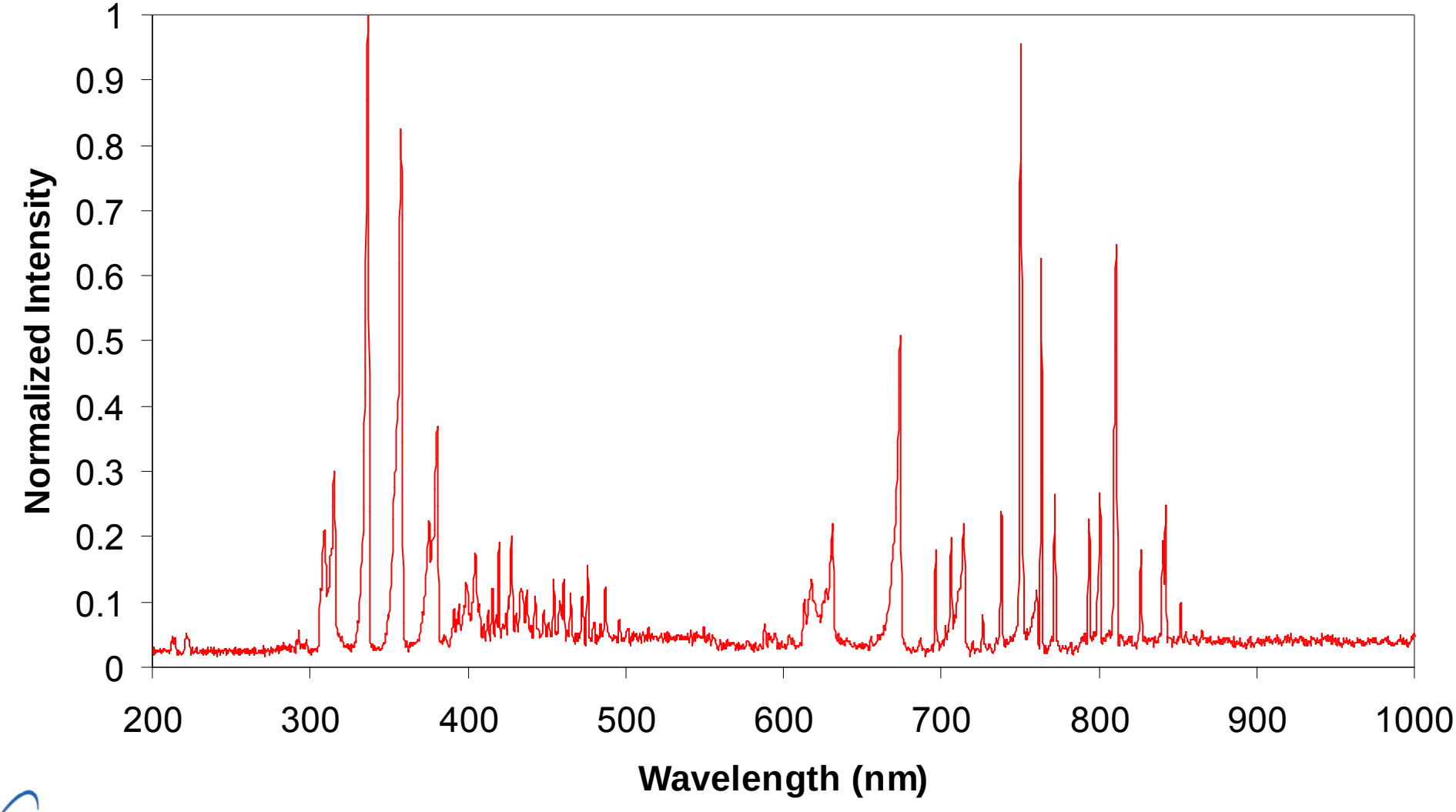
Plutonium GD Current – Voltage Curves



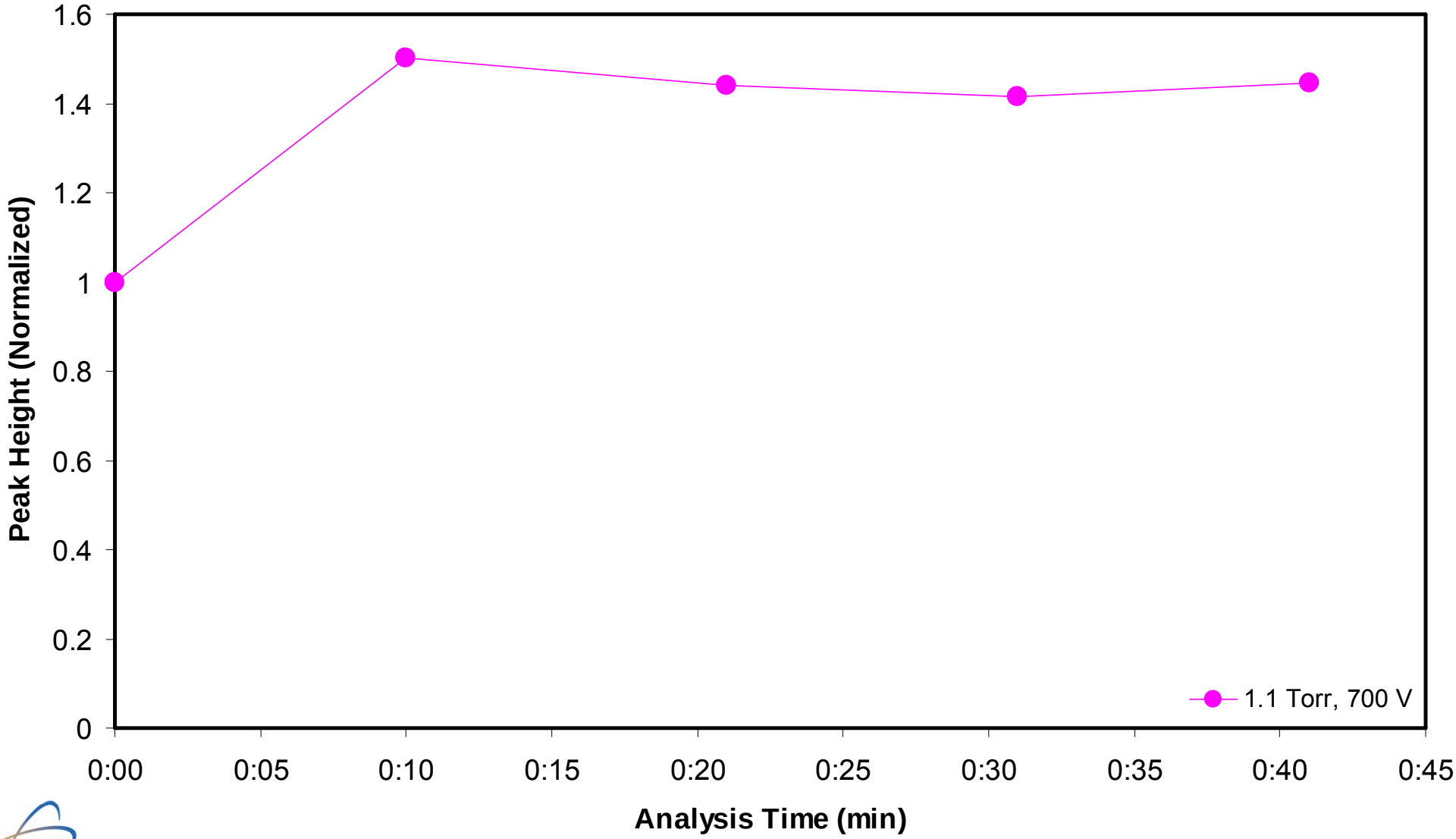
Sputtering Summary

- Sputtering rate: 0.6 μg/min
  - Not corrected for added mass
- Plasma onset at lower potentials
- Stable plasma regardless of surface oxidation

Plutonium GD-OES Spectrum



Gallium Emission (639.7 nm)



Future Directions

- Install GD-MS in foundry facility
- Determine long term precision and accuracy with nuclear materials

Acknowledgments

- Robert Putnam – NMT
- Laura Kelly – Interim Capacity
- Michael Drake
- Judy Eglin