

Problem Statement

Current inspection of nuclear fuel cells requires the use of cumbersome hot cells. INL is investigating an alternative process for inspecting these fuel cells that can be located closer to reactor sites and does not require a dedicated building for operation. Our task is to develop segments of this process that will perform non-destructive profilometric and visual inspection of irradiated test specimens. The processes must be fast and easily serviceable while maintaining a high level of fidelity and flexibility.

Commented [11]: Irradiated nuclear fuel elements

Client Interview Notes

INL Background

- i. Part of nuclear power complex
- ii. Design and develop entire reactors
- iii. Building and testing new nuclear fuels

MEITNER

▪ **Overview**

- i. Analysis of how the fuel performs
- ii. Profilometry – analysis along full length of rod
- iii. Post irradiation analysis
- iv. Reduce the cost of implementing new Post Irradiation Examination (PIE) procedures
- v. New platform negates the use of the main hot cell or Hot Fuel Examination Facility (HFEF)
- vi. Fuel rods will be placed in an a cask that transports fuel rod to MEITNER

Commented [12]: Provide non-destructive dimensional inspection of the fuel element

Commented [13]: The MEITNER platform will reduce the time and cost of implementing new PIE techniques and capabilities.

Commented [14]: I wouldn't say that MEITNER negates the HFEF main cell, as we will not be performing destructive analysis. MEITNER enables non-destructive PIE outside the HFEF main cell.

▪ **Project information**

- vii. 8 inches of lead shielding will have through holes that allow the instruments to view the fuel rod
- viii. The device can be installed anywhere
- ix. MEITNER is one instrument module?
- x. The fuel rods will be transported in casks that will the sit on top of the cylinders as the fuel rod is lowered into modules
- xi. Fuel rods will be capable of spinning and moving vertically
- xii. Fuel rod flaws include; corrosion, cracks, bulges, bowing, indents
- xiii. 3D modeling should be done in Autodesk or Pro E software

Commented [15]: Anywhere that can handle a cask and has a floor pit.

Commented [16]: MEITNER is a platform that allows modular implementation of instrumentation for non-destructive evaluation of highly-radioactive objects. Individual instruments are installed into space within MEITNER platform.

Commented [17]: It may not be a cylinder in the end. You could say that the cask sits on top of MEITNER and the fuel element is lowered into the central cavity for evaluation.

▪ **Specifications**

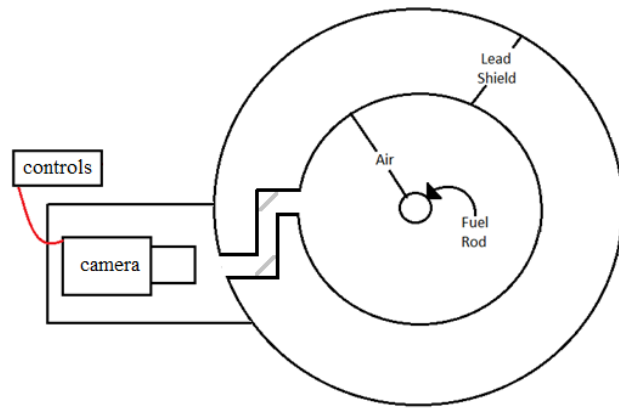
- i. Visual and profilometry inspection of test specimen fits in modular platform
- ii. High degree of accuracy to < 10 microns

Commented [18]: Remote rotational and axial positioning.

- iii. Withstand 1200 rads/hr
- iv. 20-100x zoom
- v. Remote operation
- vi. Easily serviceable/removable
- vii. Post irradiation inspection done quickly
- **Additional notes**
 - i. INL trip dates are still to be determined
 - ii. Budget will emailed soon and has some flexibility

▪ **Additional Client Questions**

1. What size of a hole could be made in the lead shielding?
2. Will additional shielding be needed around opening in the lead shield?
3. Off the shelf profilometers are available. Are these appropriate for the task at hand or should a system be constructed from parts?



Commented [I9]: This is A measured dose rate from a particular specimen. This will vary widely between specimens.

Commented [I10]: These tests take some time to do well. By the time the fuel is transported and mounted to MEITNER, the process is already very time-consuming. If it takes an hour to inspect the fuel element properly and get quality data, that's fine. I wouldn't suggest pushing to reduce inspection time at the expense of data quality in this case. We can discuss this further if you like.

Commented [I11]: Almost whatever size is required, but the shielding would have to be designed to provide adequate shielding. Typical through-hole sizes range from 1" to 4" or even larger.

Commented [I12]: Yes, additional shielding will be required around the through-hole.

Commented [I13]: We would be interested in how well off-the-shelf equipment performs in addition to other custom systems the team may develop.

Commented [I14]: The through-hole will have to be meandering to provide a tortuous path such that there is no direct line of sight through the radiation shielding. The drawing has been edited to depict such a through-hole with mirrors at the bends to allow visual inspection.

Figure 1 The figure depicted above shows team MEITNER's understanding of the layout of the project from a birds eye view. We wanted to check bases and make sure our interpretation is correct.