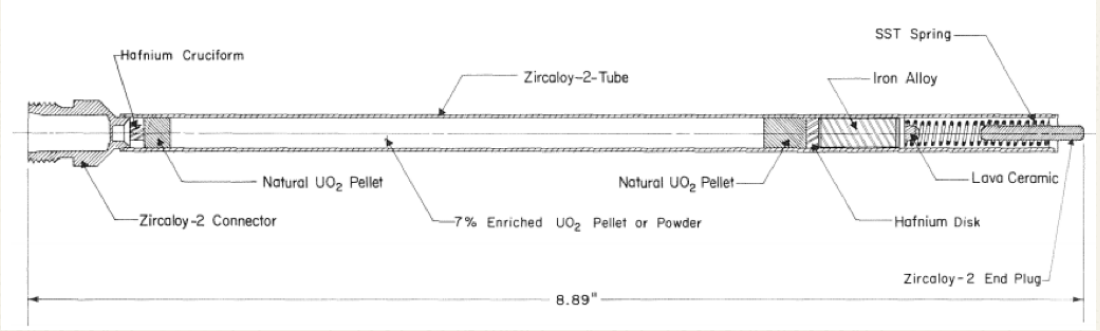
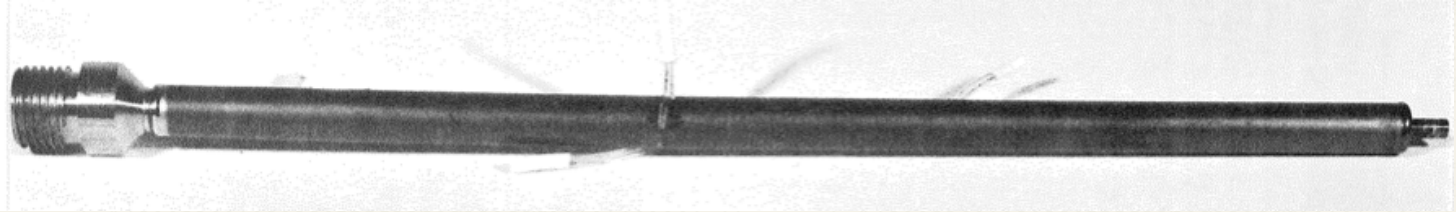
Detecting Damaged Reactor Components

Design Review

SPERT Tests


Hafnium Cruciform
Zircaloy-2-Tube
SST Spring
Iron Alloy
Natural UO_2 Pellet
Natural UO_2 Pellet
Lava Ceramic
Zircaloy-2 Connector
7% Enriched UO_2 Pellet or Powder
Hafnium Disk
Zircaloy-2 End Plug
8.89"



SPERT Tests

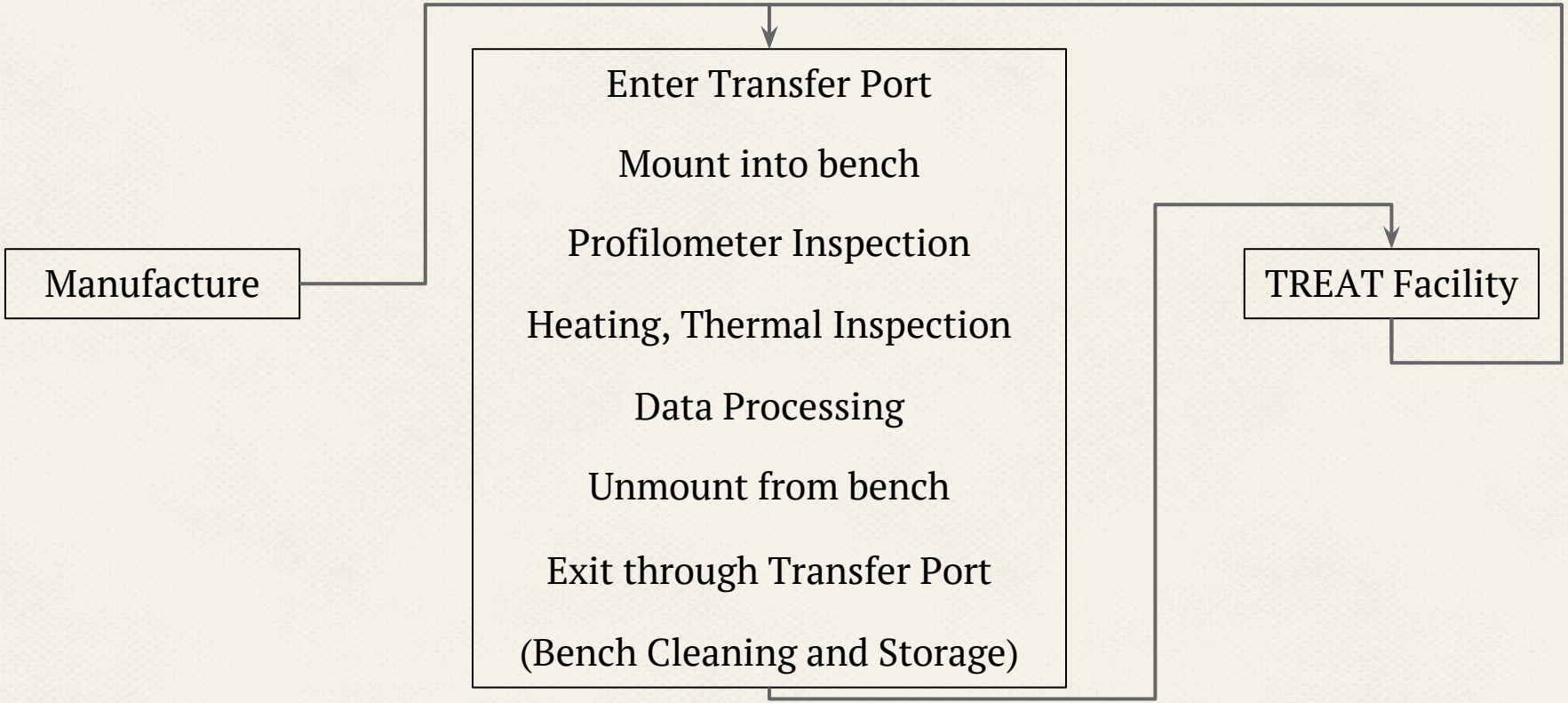
Lessons Learned

- Rod geometry
- Post-testing condition
- Types of failure

Project Definition

Deliver a test apparatus to be used for geometric and thermometric inspection of fuel rod test specimens. Rods will be analyzed both pre- and post-irradiation to measure ovality and to identify the location and geometry of cracks and end cap or weld faults.

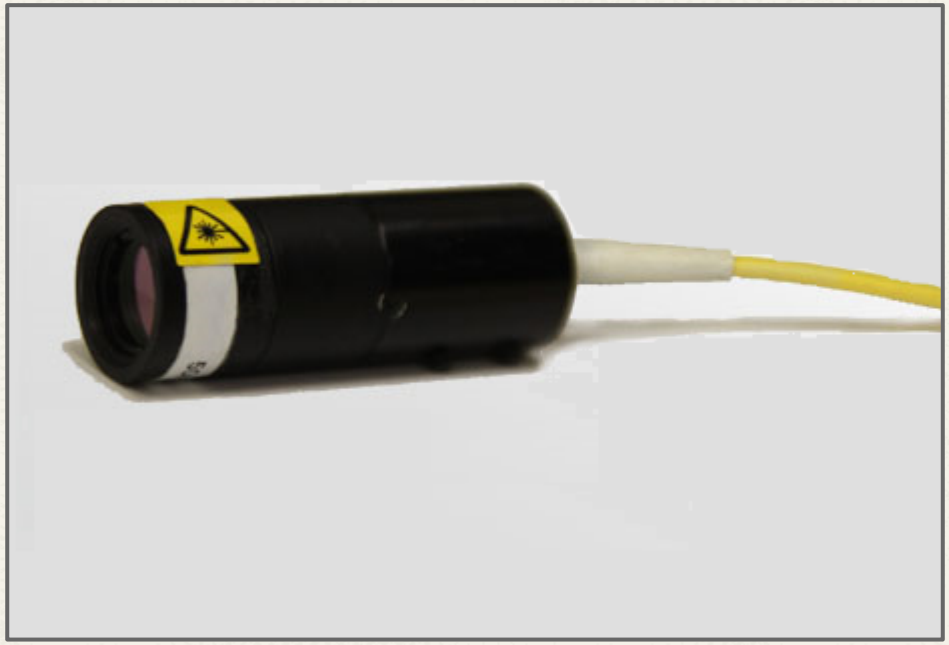
Test Specimen Life Cycle



Profilometer Options

Nanovea Jr25

Profilometer Options



Novacam

Profilometer Options

LuphoSpin

Profilometer Comparison

	Resolution	Software	Price
Novacam	1 μm	MATLAB ready	$40k
Nanovea	0.9 μm (xy) 1 nm (z)	CSV format, MATLAB compatible	$55k
Taylor-Hobson	10 μm (xy) 0.1 nm (z)	ASCII, binary	unknown

Thermal Testing

Results

- Saturation issues

  Need shielding from heat source

- New methods of heating required

  More transient control

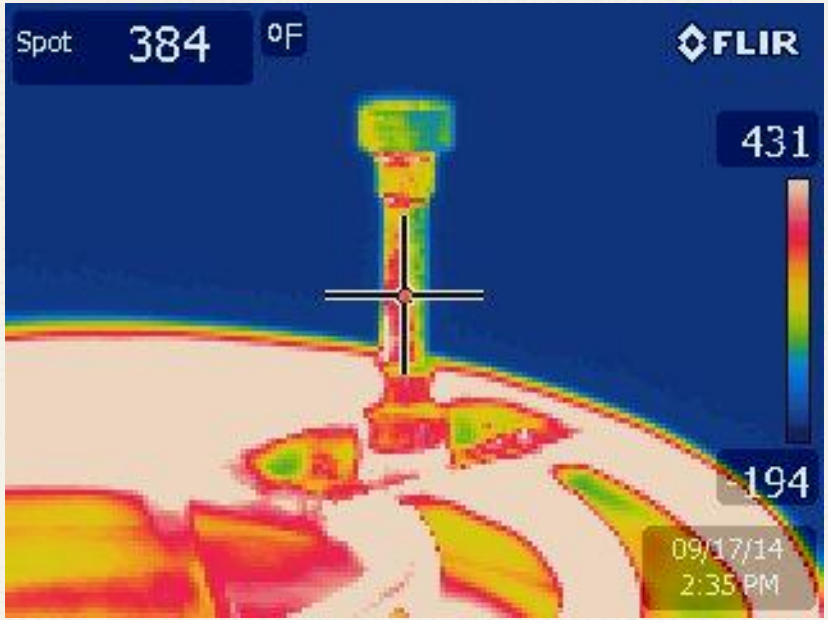


Figure 1; Heating of a “pull” specimen

Thermal Testing

Results

- Internal geometry identified

  Block to empty space transition discernible

- New heating methods required

  Simply adding thermal mass doesn't solve transient issues

- High temperatures/ high saturation

  Thermal pulse should be minimal

- Internal defects

  Camera resolution is a limiting factor

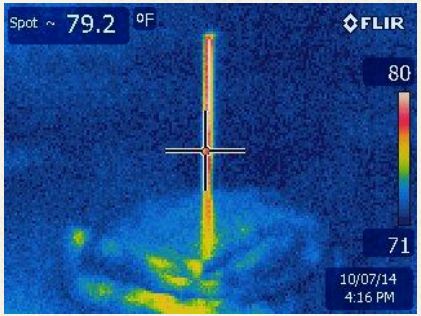


Figure 1; Initial heating

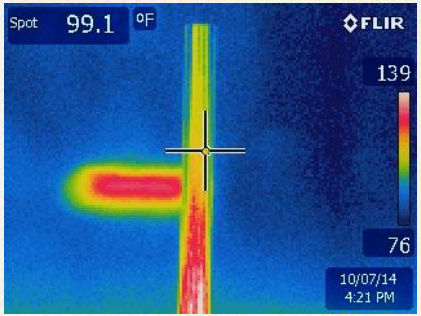


Figure 2; transient heating

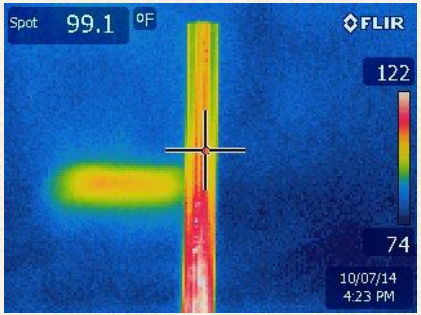


Figure 3; Steady-state

Thermal Testing

Results

- Microcontroller

  Allows for fine tuned pulse manipulation

- New collet design required

  Lower thermal mass necessary for pulse resolution

- Future Experiments

  For now the cartridge heater/Arduino combination seems perfect, need to test other collet materials and designs.

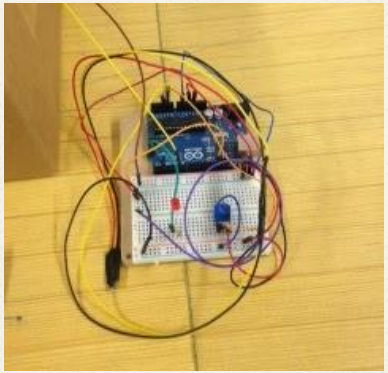


Figure 1: Arduino microcontroller

Figure 2: New heater setup

Figure 3: FLIR camera apparatus

Preliminary Budget

	Budget	Encumbered
Travel	$1,000.00	$0.00
Graduate Mentor Support and Fringe Cost	$2,800.00	$2,800.00
ME Shop / Capstone Program Support	$1,000.00	$1,000.00
Purchased Material	$4,700.00	$168.40
University Overhead	$500.00	$500.00
Totals	**$10,000.00**	**$5,531.60**

Plans through Dec. 19

1. Thermal Imaging
    a. Test composite collet design
    b. Darkroom testing
    c. Establish file import procedure in MATLAB
2. Profilometer
    a. Manufacture endcaps
    b. Weld endcaps to tubing
    c. Apply EDM defects to specimen
    d. Send specimen to profilometer companies
    e. Receive profilometry sample and process video

Second Semester Deliverables

February - *Design Review* - Specimen mounting procedure

Solid model of test bench

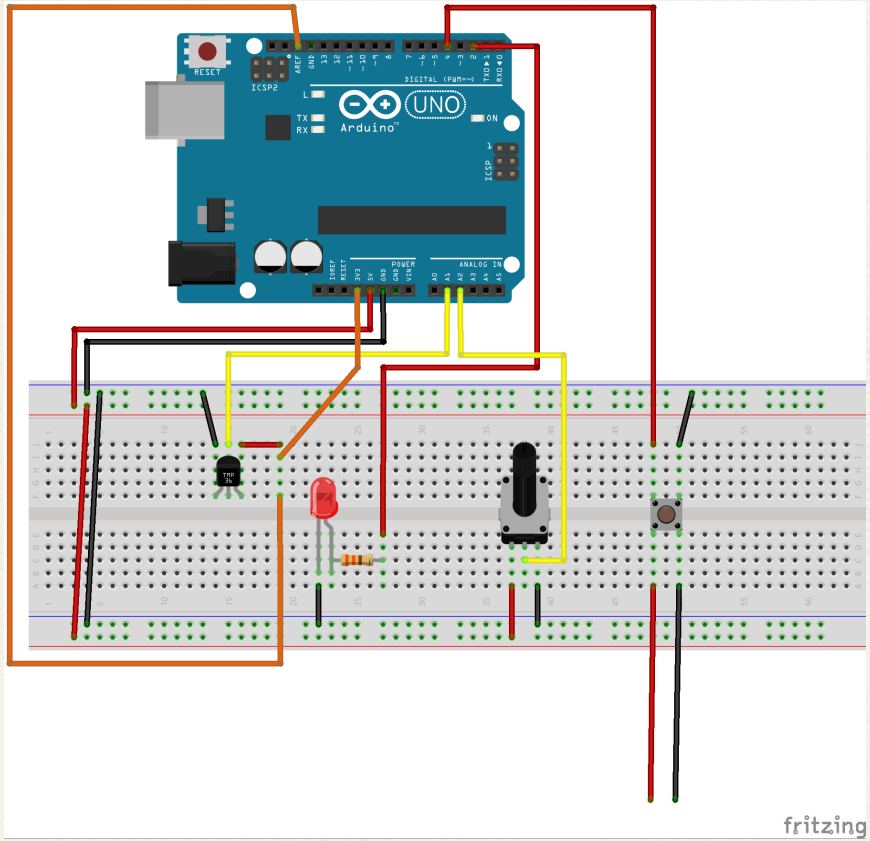
March - *Snapshot Day* - Software package

May - *Engineering Expo* - Test bench

Points of Discussion

1. Effects of thermal camera resolution on results
2. Reasonable timeline for receiving profilometer
3. Ideal use case of software package

Arduino Circuit



Testing Setup