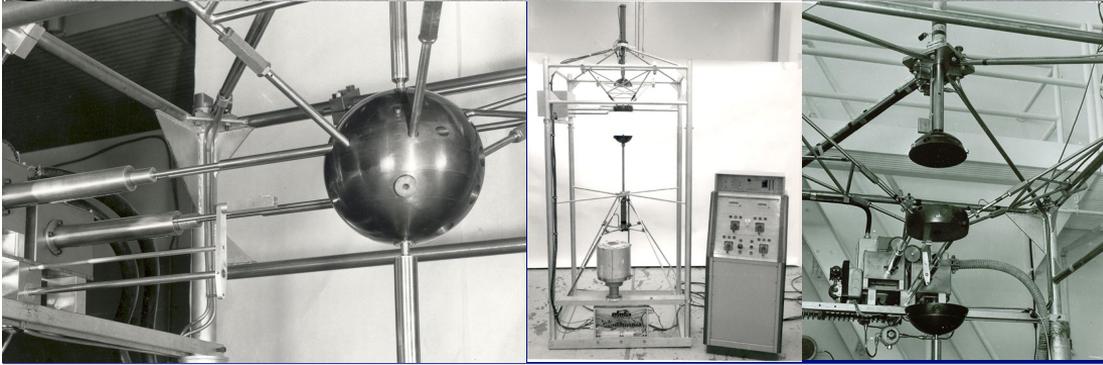Delivering science and technology
to protect our nation
and promote world stability

2023 NCSP Technical Program Review – Lessons Learned in Experiment Design and Execution

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NEN-2

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Overview

- Operational NCERC lessons learned from experiments and activities in 2022
  - Focus on experiment design and execution
- Experiments:
  - TEX-Hf (IER 532)
  - PFUNS (IER 153)
  - Flat-Top Benchmark Physical Measurements (IER 423)
- Lessons learned often apply generically
- Lessons often already known, but demonstrate importance for future work

TEX-Hf (IER 532)

- Measurement difficulties when using height gauge
- Source placement for 1/M

TEX-Hf Critical Measurement

TEX-Hf: Height Gauge Measurement Difficulties


TEX-Hf Height Gauge Measurement

- Not much room to securely place the base of the height gauge for the height measurements on the bottom stack
  - Holding down height gauge by hand or with clamps?
  - Avoid restacking on a cart/table due to reproducibility
- Solutions:
  - Collar around the base of the bottom to allow for additional space for the height gauge
    - Flatness issues
    - Can't forget to remove the collar, as it will interfere with operations
  - Do not use height gauge, use a Coordinate Measurement Machine (CMM) instead
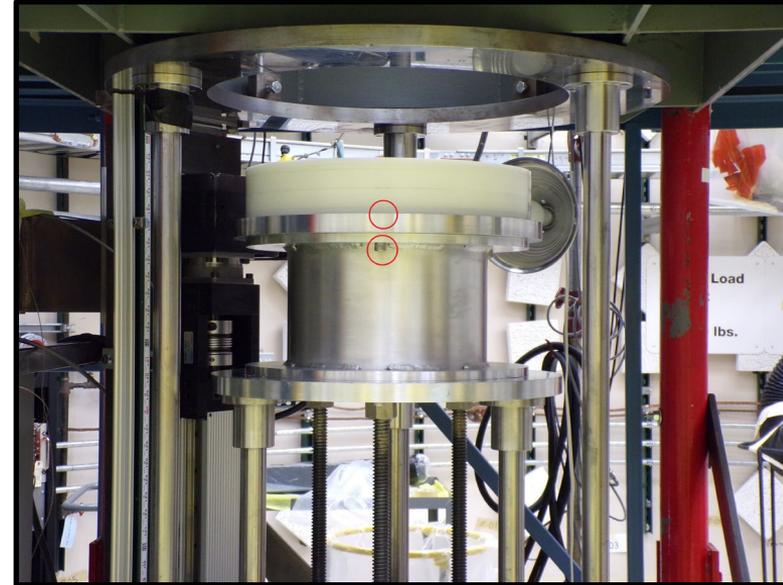
TEX-Hf: 1/M Source Placement

- TEX-U/TEX-Hf bottom HDPE reflector includes location for neutron source
  - Source removed for final benchmark measurement
  - Removal entails unstacking the bottom, removing the source, then restacking the bottom
  - ~30-60 minute operation
- Can the source be placed outside of the HDPE and still get good 1/M data?
- Outside source locations were attempted early in the TEX-Hf experimental cycle
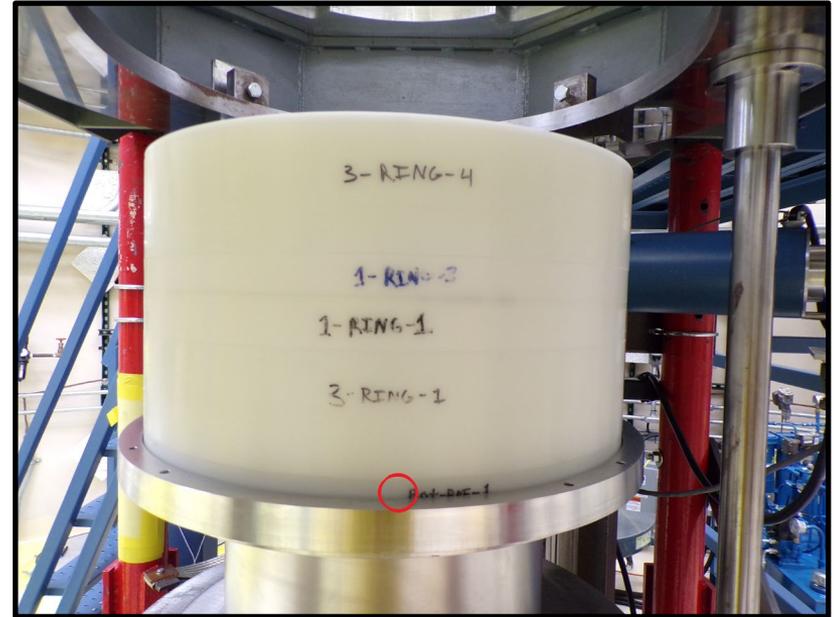
**TEX-Hf Lower Core on Comet Platen
Source Location Shown in RED**

TEX-Hf: 1/M Source Placement

- Outside source placed on the outside of the system, opposite to the start-up neutron detectors

- 1/M results were very non-conservative

- Experimental team did not feel comfortable continuing with the non-conservative 1/M and moved source back to inside of the bottom HDPE reflector

TEX-Hf Lower Core on Comet Platen
Outside Source Locations in RED
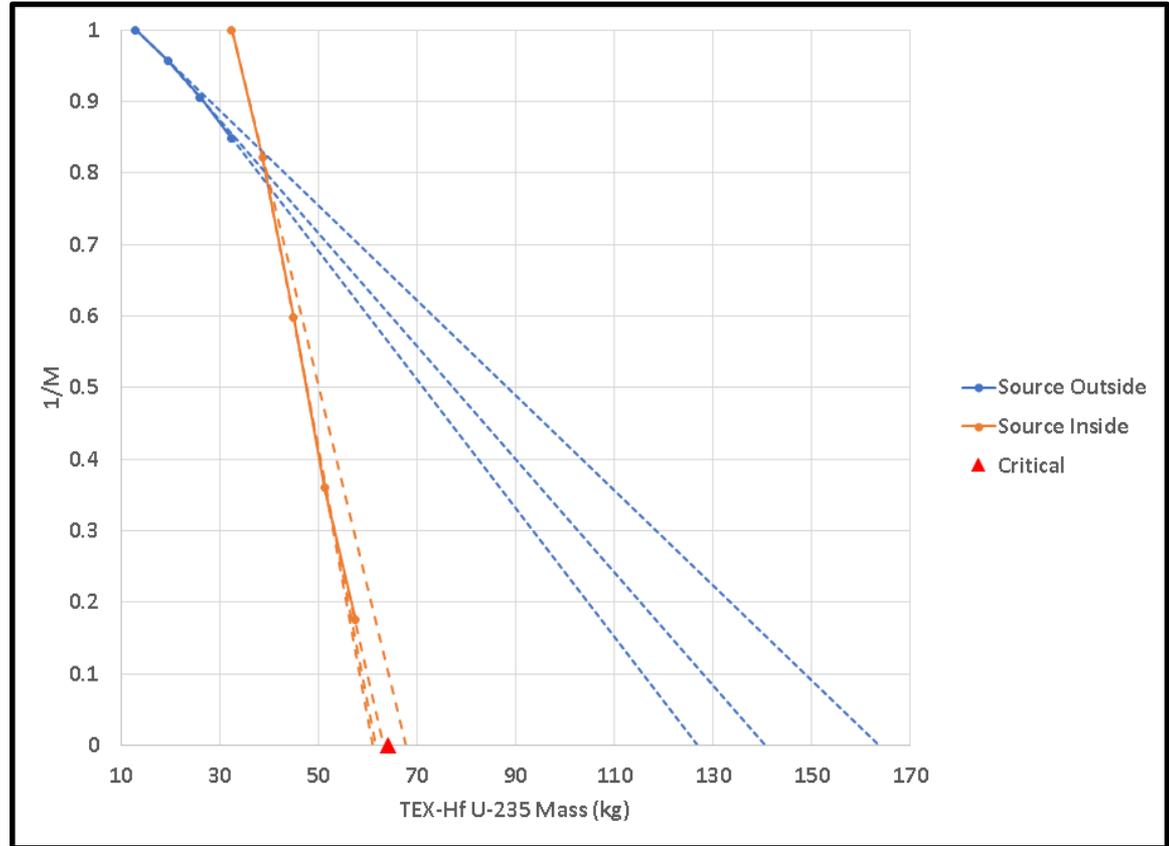**Start-up Neutron Detectors in the back**

TEX-Hf: 1/M Source Placement

1/M Source Outside

Mass (kg)	Predicted Critical (kg)	1/2 Rule (kg)	3/4 Rule (kg)
12.9	-	-	-
19.4	163.6	91.5	122.7
25.9	140.5	83.2	105.4
32.3	126.7	79.5	95.0

1/M Source Inside

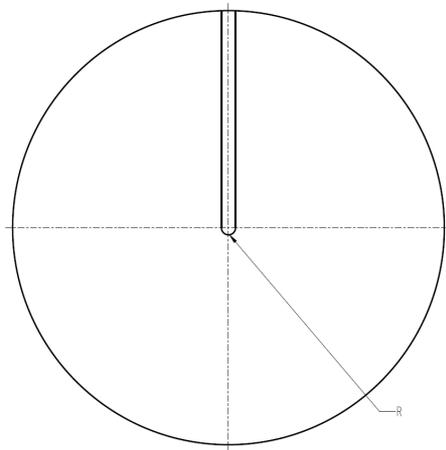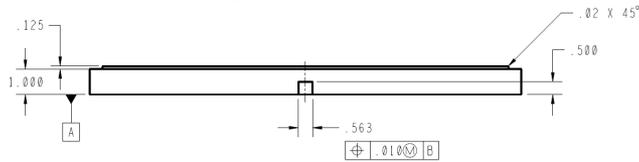| Mass (kg)	Predicted Critical (kg)	1/2 Rule (kg)	3/4 Rule (kg)
32.3	-	-	-
38.6	67.6	53.1	50.7
44.8	61.6	53.2	46.2
51.1	60.8	56.0	45.6
57.4	63.2	60.3	47.4

Critical Mass: ~64 kg

1/M Plot

TEX-Hf: 1/M Source Placement

- After TEX-Hf complete, discussed a redesign of the bottom HDPE moderator (and surrounding Al structure) to include a removeable source
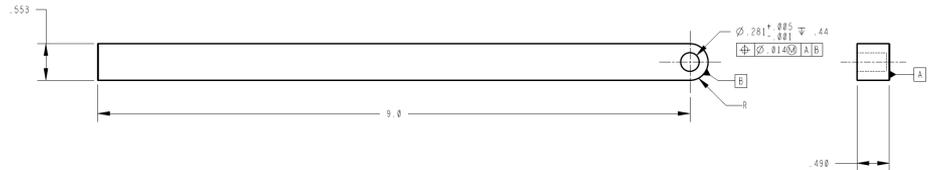
PFUNS (IER 153)

- Planned PFUNS irradiation involved highest dose rates from a Planet experiment

- Locations of some equipment necessary to Planet operations inadequate for this high powered irradiation
  - Power supplies and motor controller located in JB next to Planet

- Irradiation could not be performed without moving this equipment
  - Relocated to JBs outside of experimental area, behind shielding wall
  - Similar to Comet/Godiva IV building

- Modifications improve Planet and machine capability, more robust capability
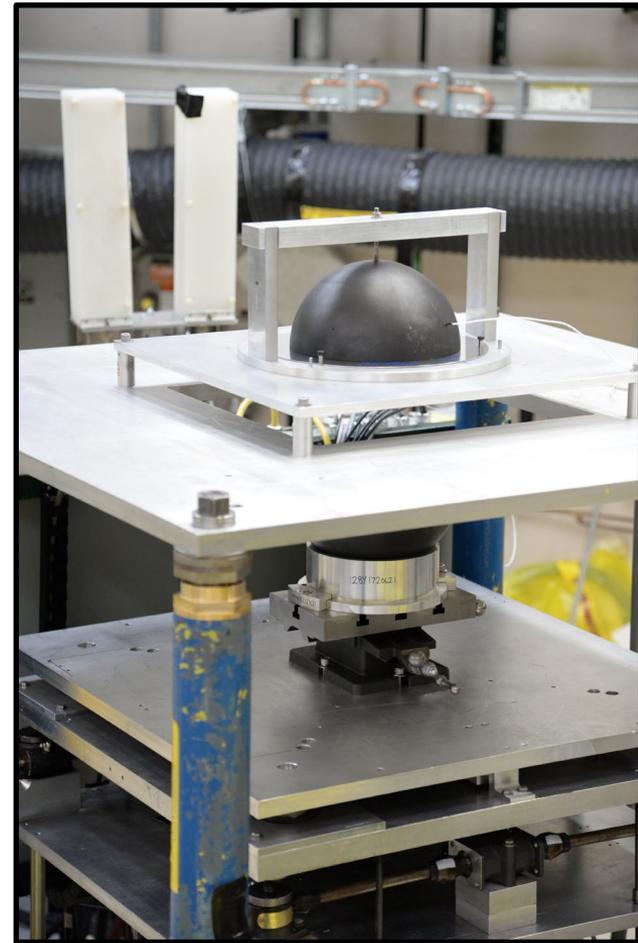

PFUNS Experiment on Planet

PFUNS (IER 153)

- Irradiation dosimetry studies useful for future high radiation area work

- Continuity between CED stages
  - ~ 5 year gap between CED-2 to CED-3
    - Primarily due to safety basis delays (unattended counting)
  - Lost knowledge due to personnel turnover (retirements, job transfers, lost knowledge)

- Good reminders on planning and organization:
  - Engage engineering design personnel early, who will engage cognizant systems engineers
  - Engage HPs 2+ months in advance if new RWPs are required
  - Incorporate 1/M approach early in design
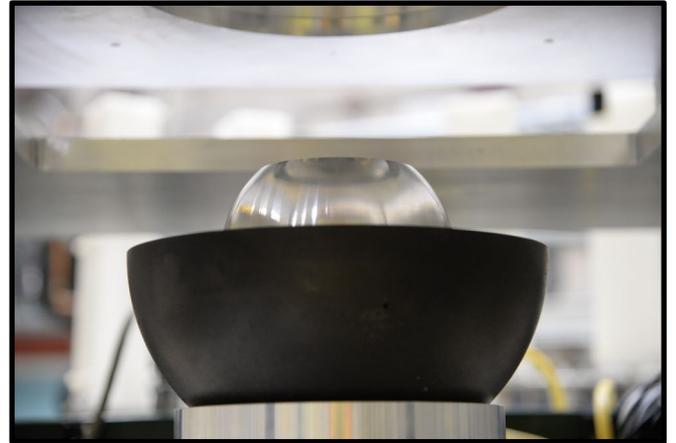
PFUNS Lower Portion on Planet Platen

Flat-Top Benchmark Measurements (IER 423)

- During the Time of COVID:
  - Ensure that at least two people on the team are very familiar with the planned work and instruments

- Measurement Specific Lessons Learned:
  - Coordinate Measuring Machine (CMM)
  - Pycnometer

Flat-Top Benchmark Measurement Team

Flat-Top Benchmark Measurements

- Coordinate Measuring Machine (CMM):
  - Points needed to construct shapes
    - Additional points give better results
    - Three points for sphere minimum
    - Some shapes split into multiple
      - Cylinder: two planes and a circle
  - Proper positioning for CMM base when taking measurement
    - Just because the arm can move to a location does not mean that the arm can collect data in that location.
  - CMM placement: On a stable surface
    - Flat-Top table is very stable
    - Cart/table is not
    - Machining table ideal

LANL Qualified Machinist performing CMM measurements on Flat-Top stationary reflector

Flat-Top Benchmark Measurements

- Pycnometer
  - DAF and steady-state temperature
    - Need temperature equilibrium between sample holder and sample
    - Few degrees difference results in large uncertainty for volume/density
  - Sample preparation: Dry cleaning methods only
    - Wet methods can introduce additional liquids and disrupt volume measurement
    - Wet methods are the "go-to" cleaning method for radcon

NCERC Personnel performing pycnometer measurements on Flat-Top parts

Acknowledgements