Argonne NATIONAL LABORATORY

IPNS MODERATOR SYSTEM OVERVIEW

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Outline

- Introduction
- IPNS Moderator History
- Configuration, Construction and Inner Reflector Assembly
- Installation
- Operation
- Cooling system
- Methane Systems
- Operational Issues

What Does A Moderator Do?

- Converts high energy neutrons to low energy neutrons with an energy spectrum and pulse characteristics suitable for scattering science
- How?
  - Neutrons exchange energy in collisions with nuclei of an appropriate material
- Desired Characteristics
  - Low loss by leakage
  - Low loss by capture
  - Chemical stability
- Hydrogen is best element

Moderators at Spallation Neutron Sources

SOURCE	MODERATORS
IPNS	CH_4 (s) - 28 K CH_4 (ℓ) - 100 K
KENS	CH_4 (s) - 27K H_20 (ℓ) – room temperature
LANSCE	H_20 (ℓ) - 283 K H_2 (ℓ) - 20 K
ISIS	H_20 (ℓ) - 316 K CH_4 (ℓ) - 100 K H_2 (ℓ) - 20 K
SINQ	D_20 (ℓ) – temperature ? D_2 (ℓ) - 25 K

History of Moderator Materials at IPNS

- C, H, F Ambient HDPE
- C, H, F Liquid Methane/Be reflector
- C - LN2 cooled HDPE / H, F - Ambient HDPE
- C - LHe cooled HDPE / H, F - Ambient HDPE
- C - Solid Methane / H, F - Ambient HDPE
- C - Solid Methane / H, F - Liquid Methane
- C - Liquid Hydrogen / H, F - Liquid Methane (enriched target)
- C, H Solid Methane / F Liquid Methane

IPNS Moderators

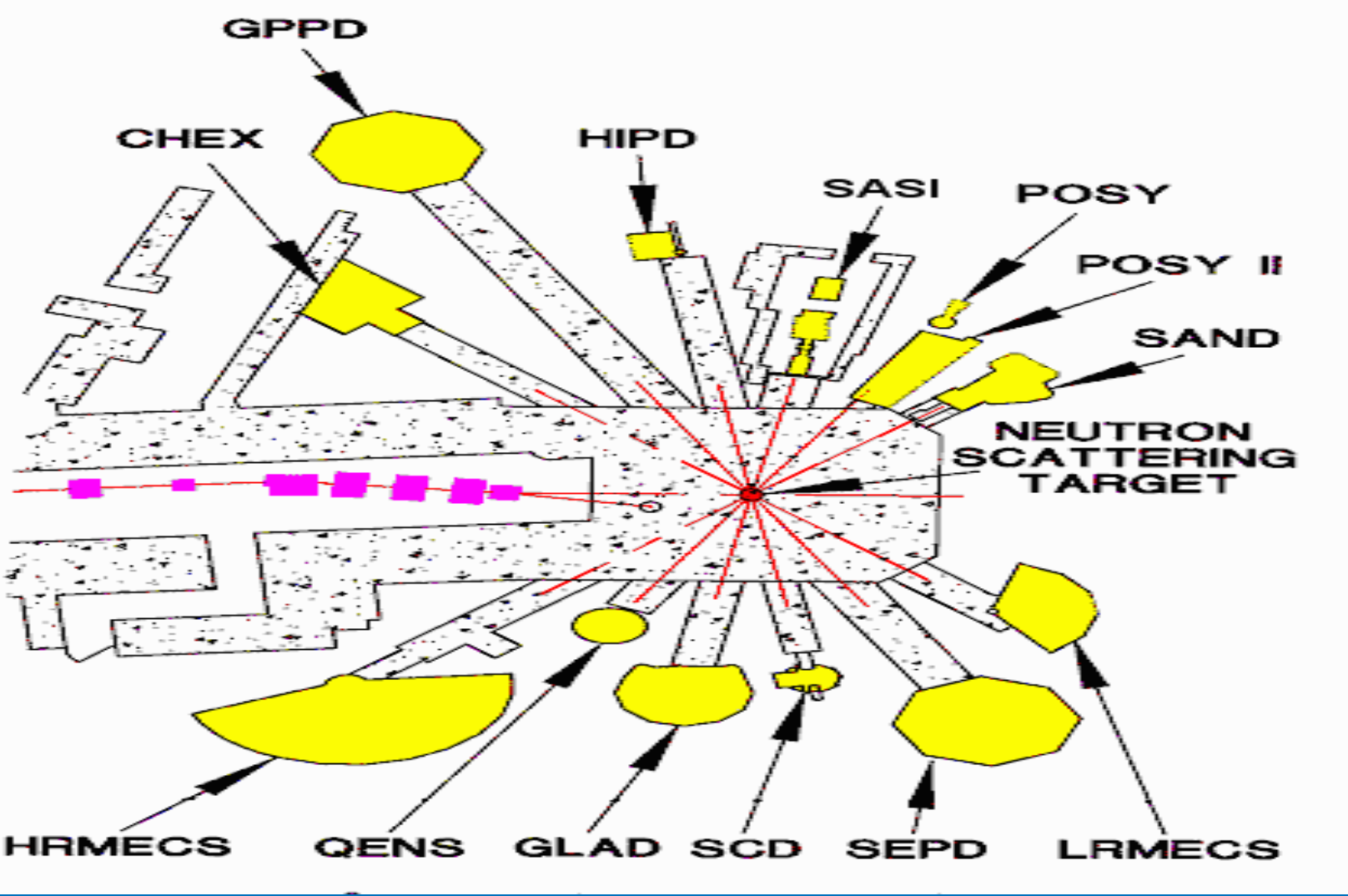
- **2 Solid Methane,** 28 K
  - **“C” Moderator** – 10x10x7.6 cm^3 coupled, re-entrant geometry, unpoisoned
    - *SASI*
    - *POSY I, II*
    - *SAND*
  - **“H” Moderator** – 10x10x4.5 cm^3 Cd decoupled, Gd poisoned
    - *HRMECS*
    - *QENS*
    - *GLAD*
- **1 Liquid Methane “F”** 100K – 10x10x5 cm^3 Cd decoupled, Gd poisoned
  - SCD, SEPD, LRMECS, HIPD, GPPD, CHEX

Methane as a Moderator

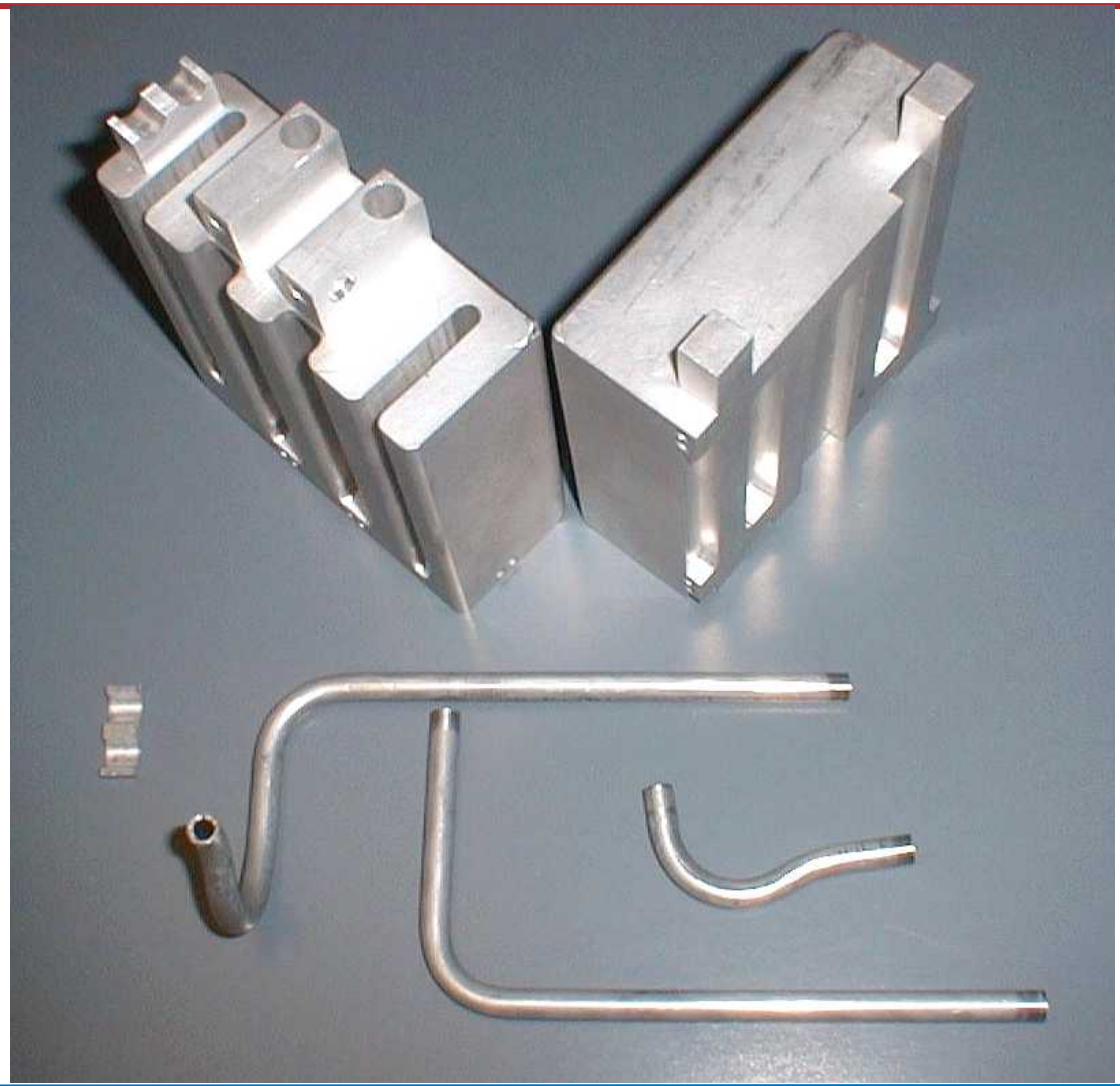
High efficiency

- High H atom density, ~1.8X LH_2
- Inter- and Intra-molecular rotational and vibrational energy exchange modes in good range
- Neutron temperature very near methane temperature
- ~3.5X cold neutron flux as LH_2

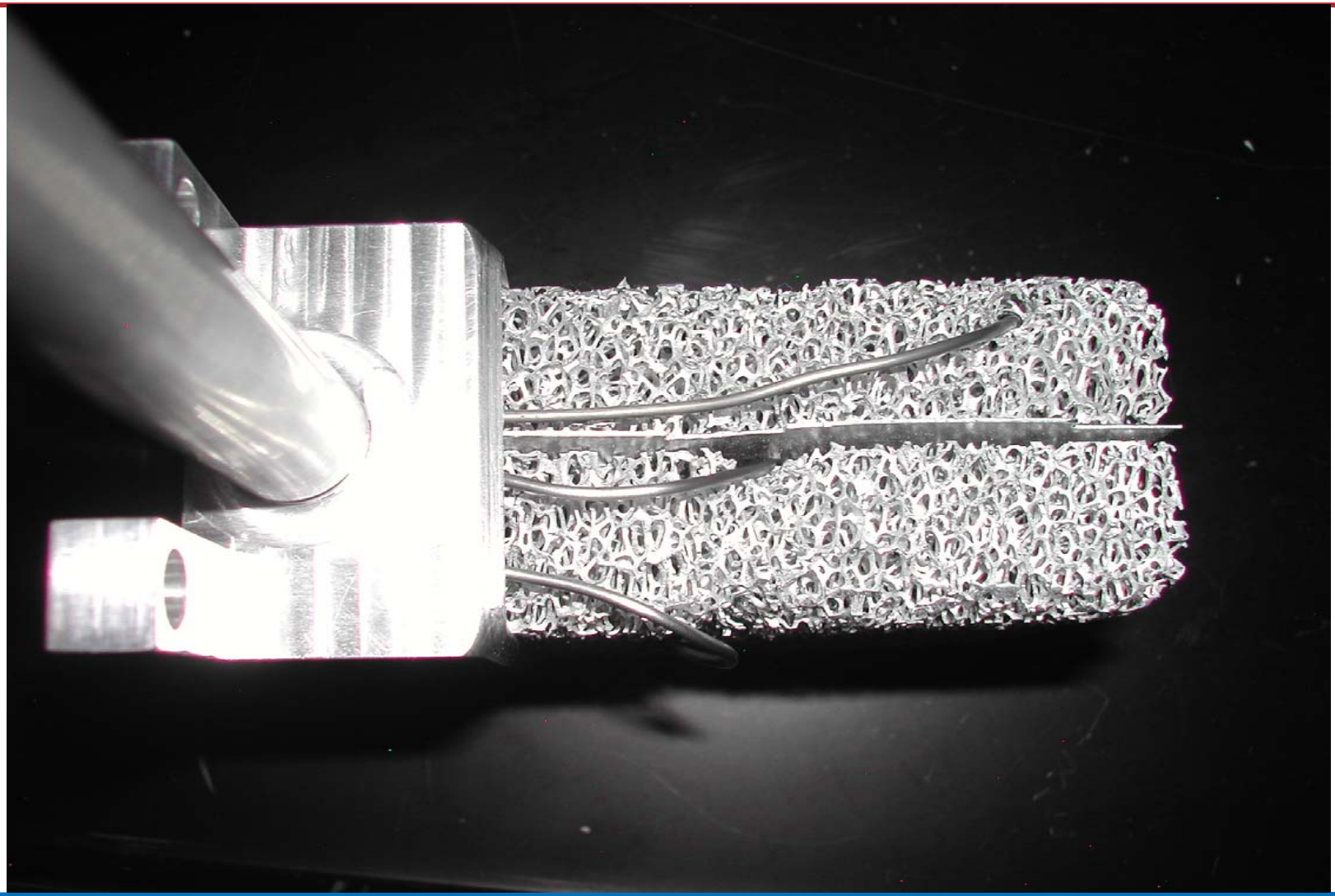
IPNS Experimental Hall



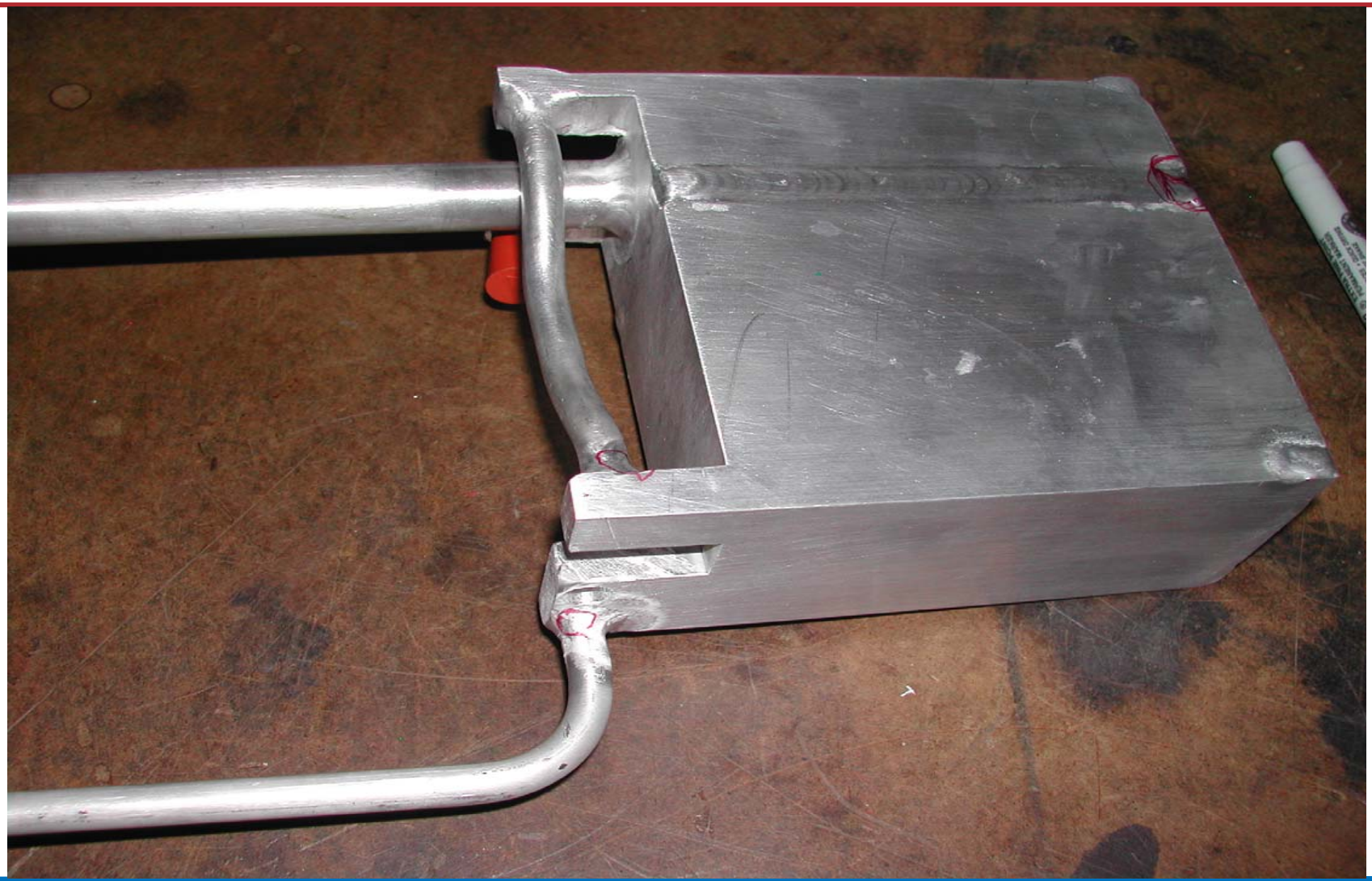
Vertical Groove C Moderator Parts



H Moderator Interior

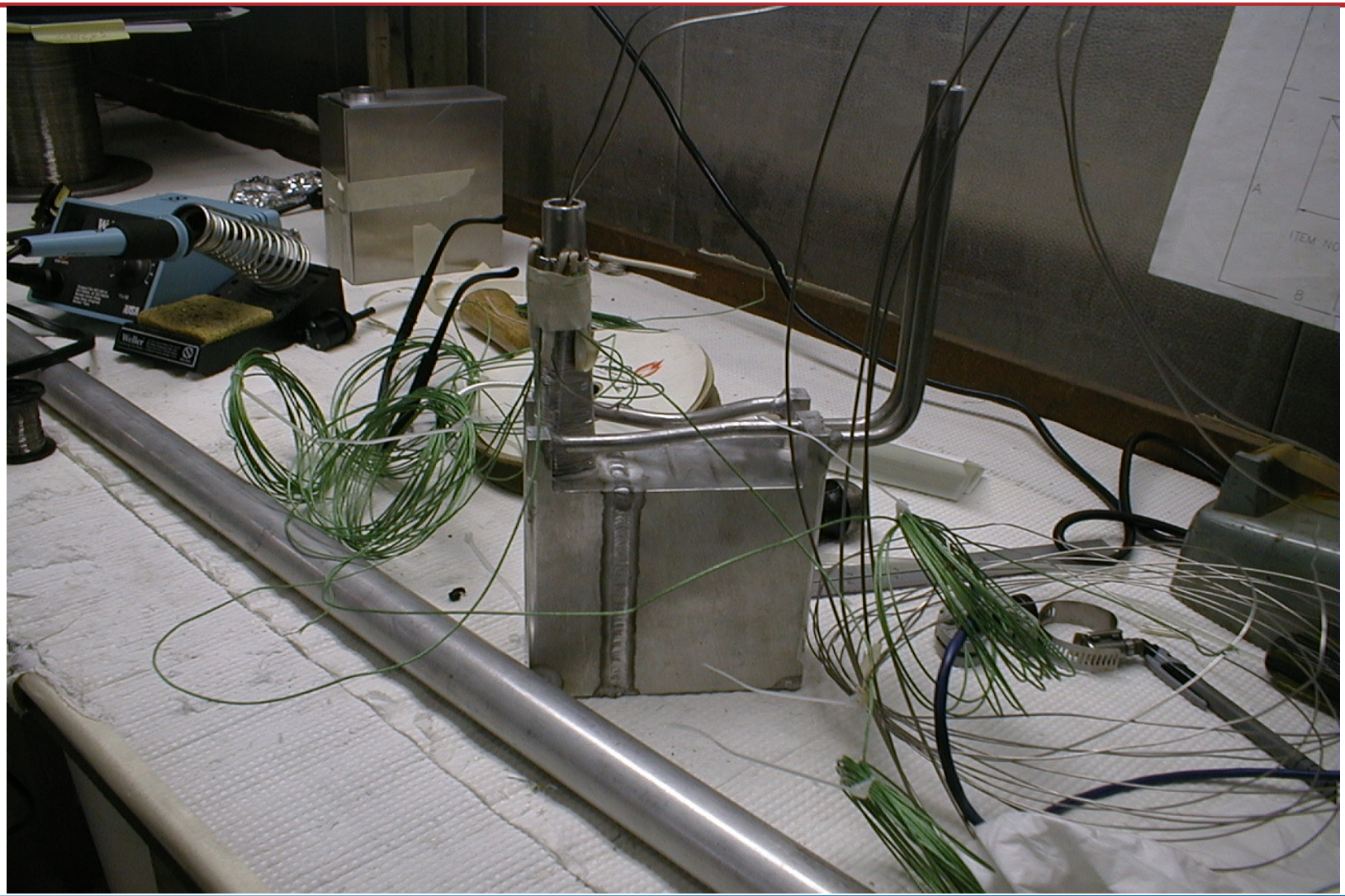


H Moderator Exterior



Vertical Groove C Moderator

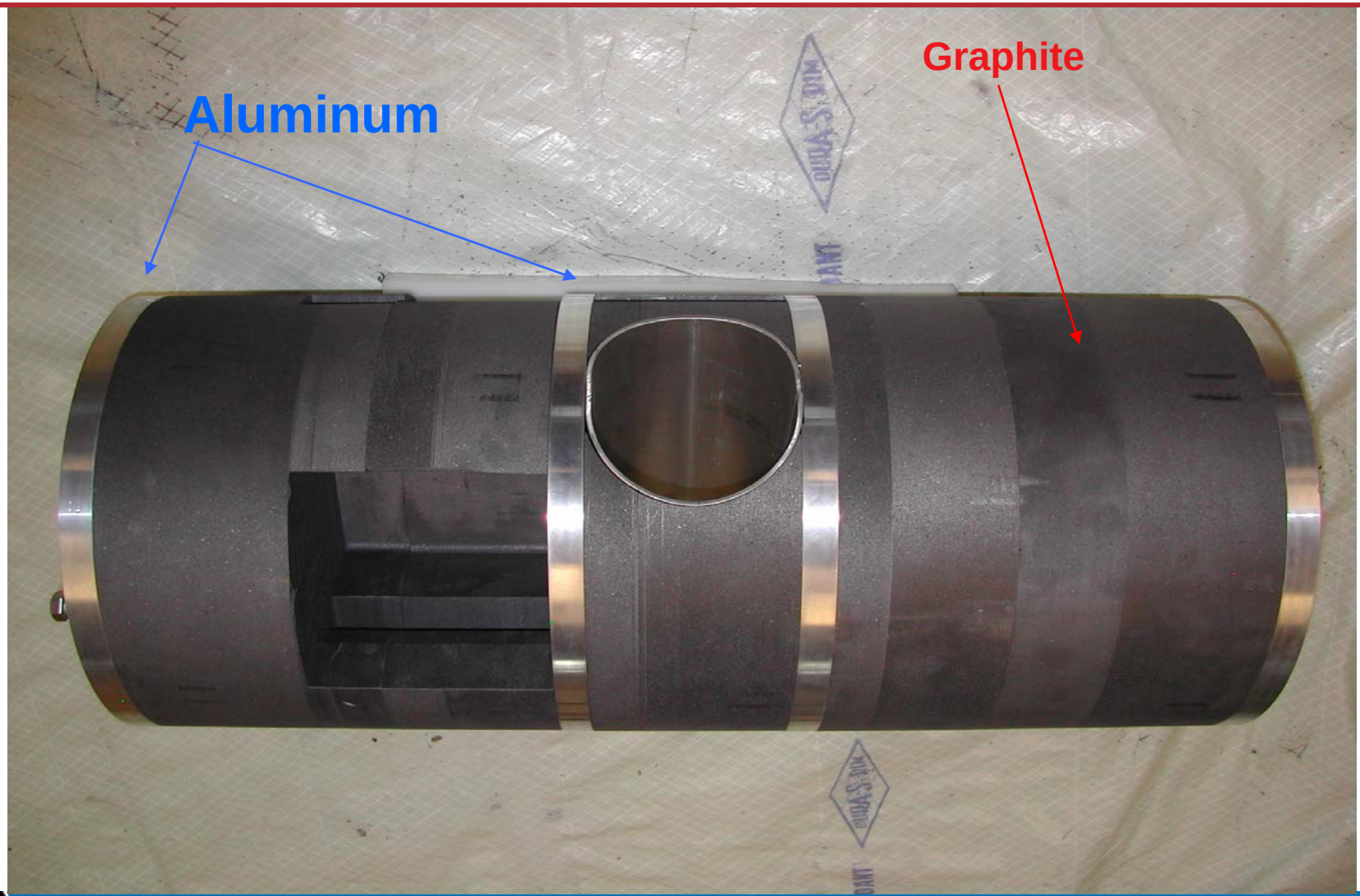
H Moderator



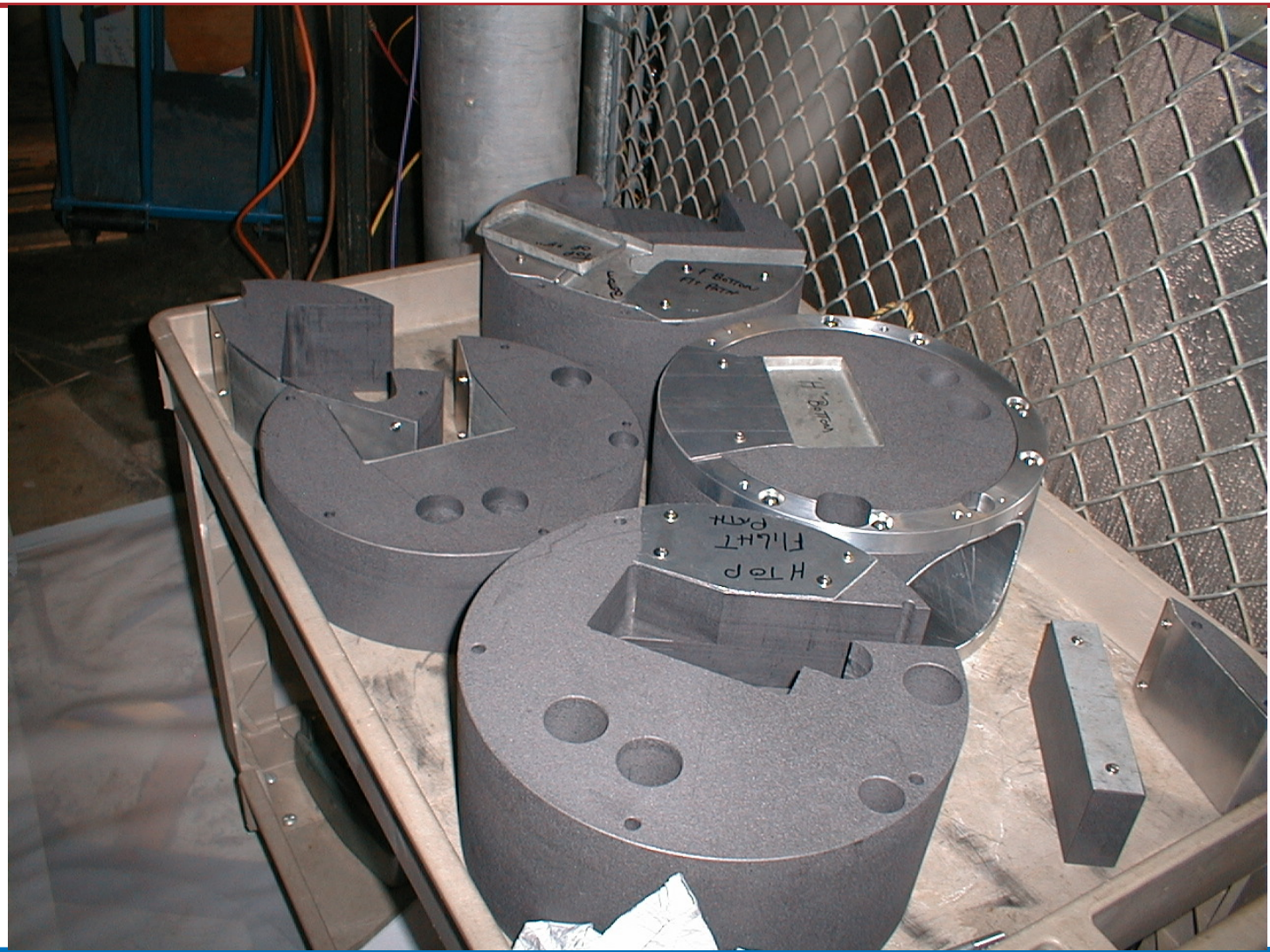
C Moderator

Moderator/Reflector Assembly

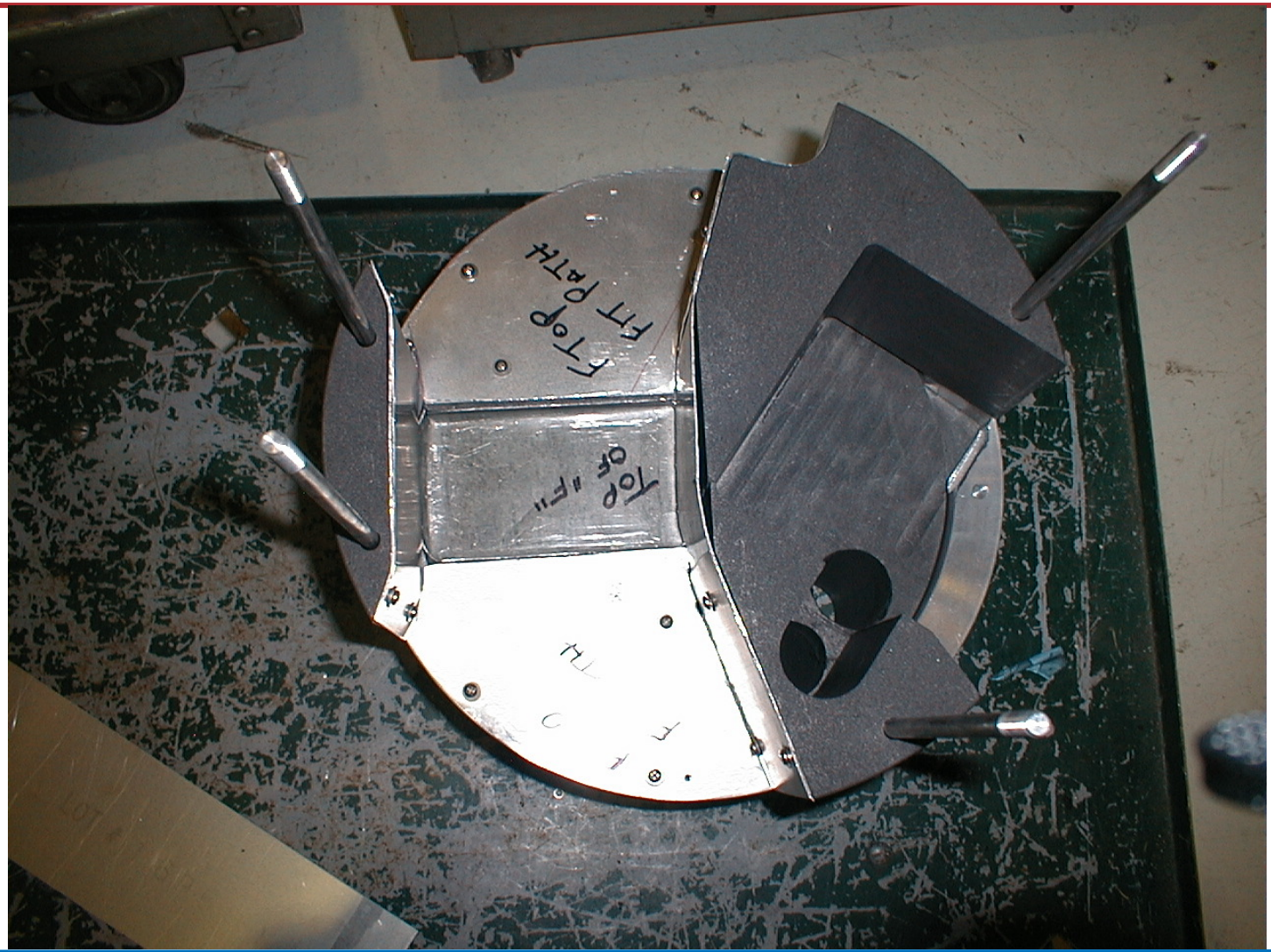
Inner Reflector Assembly



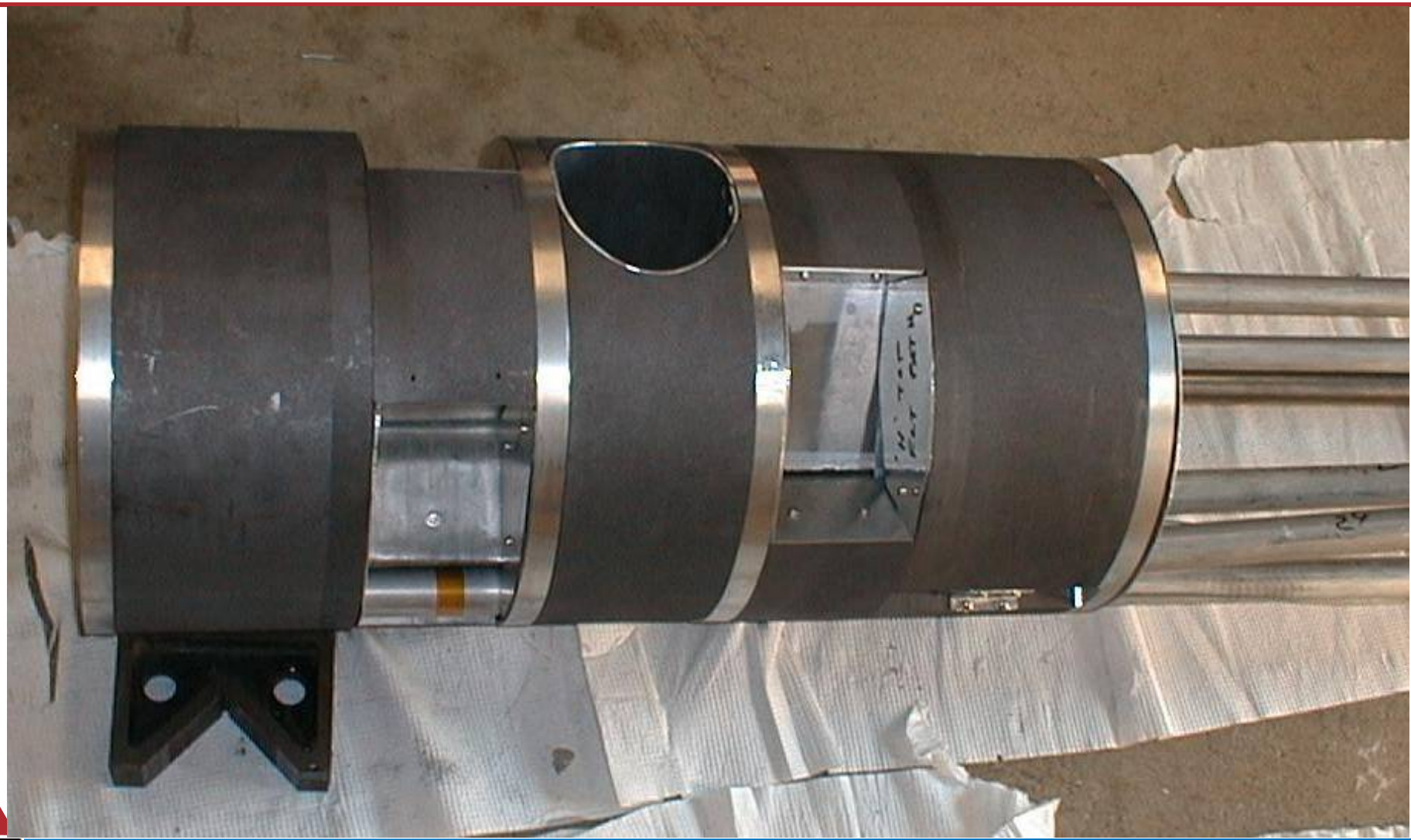
Parts Is Parts (Inner Reflector)



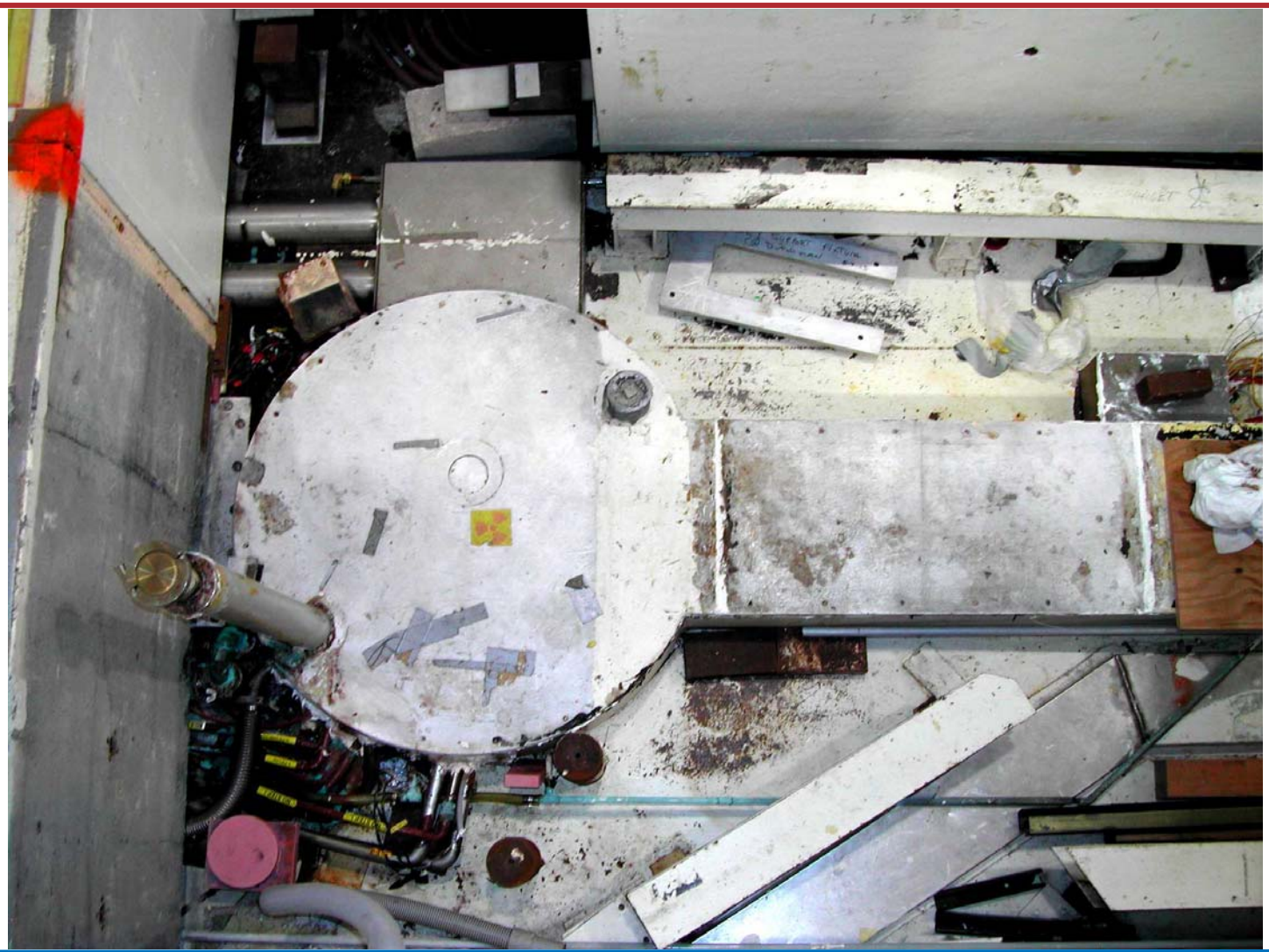
F Moderator Flight Path



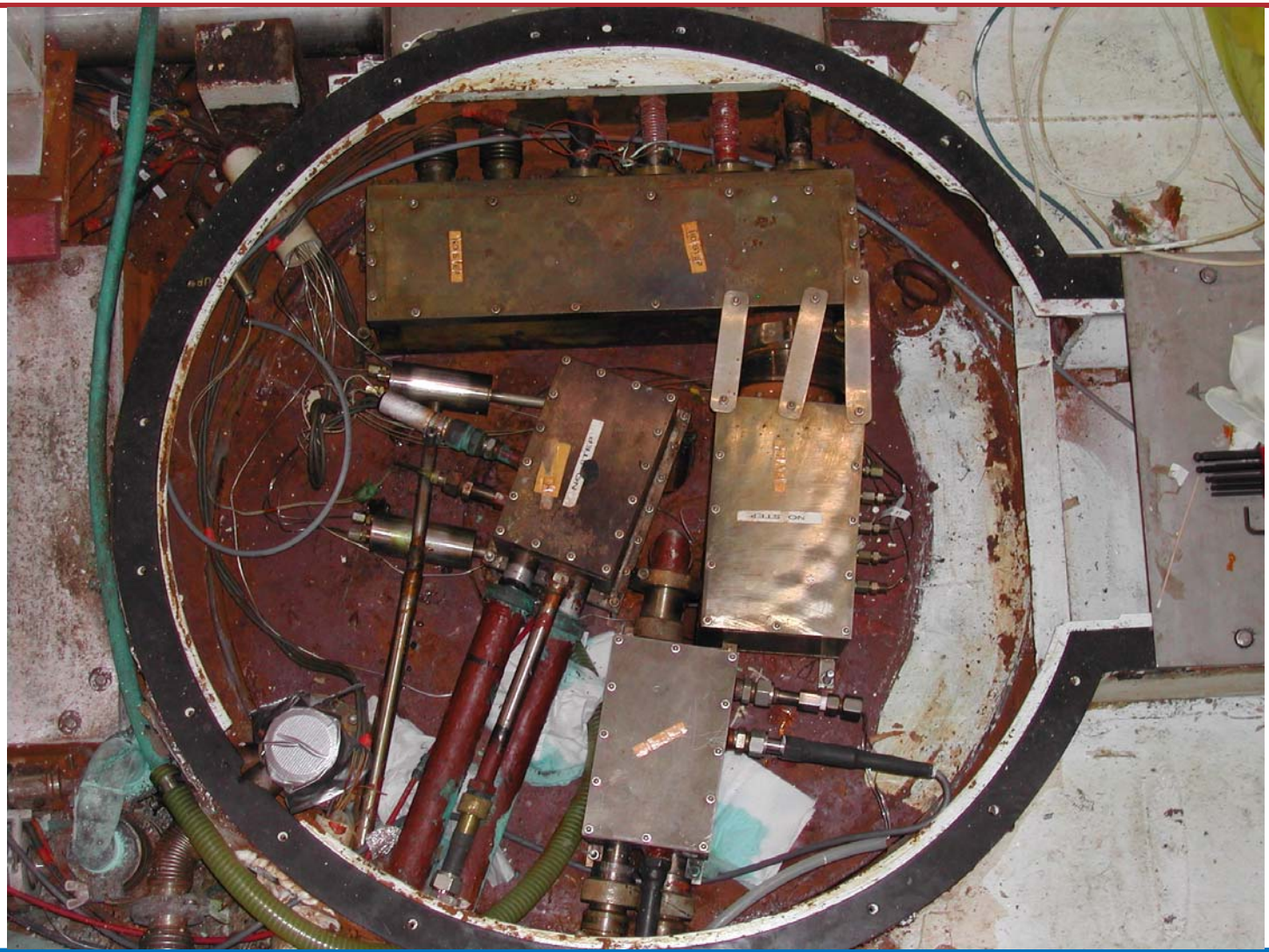
Moderator/Reflector Assembly



Banjo Area



Vacuum Connection Boxes Inside Banjo

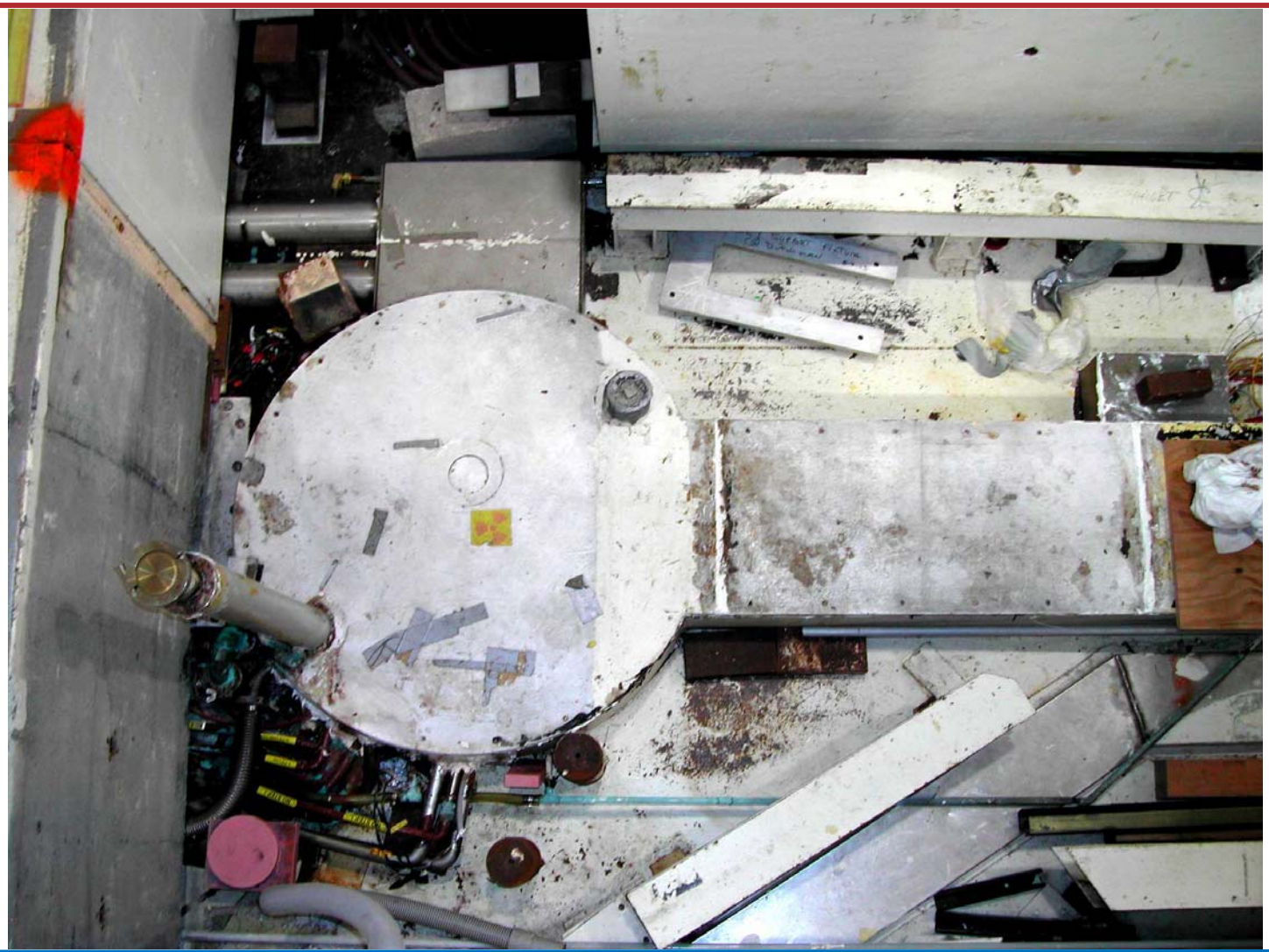


Reflector Removal

Reflector Installation

Inside Banjo

Banjo Area

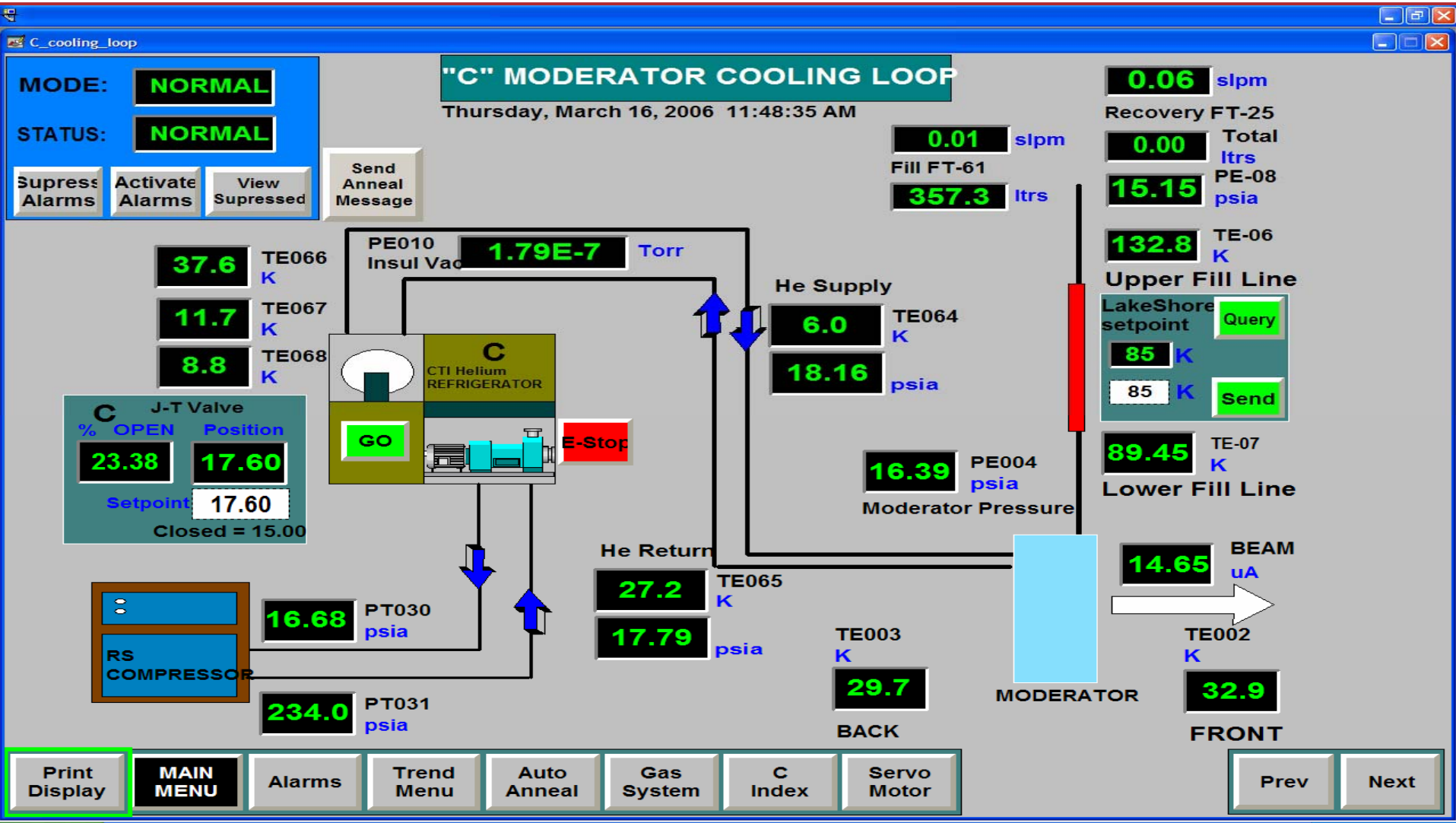


Run Cycle Operation

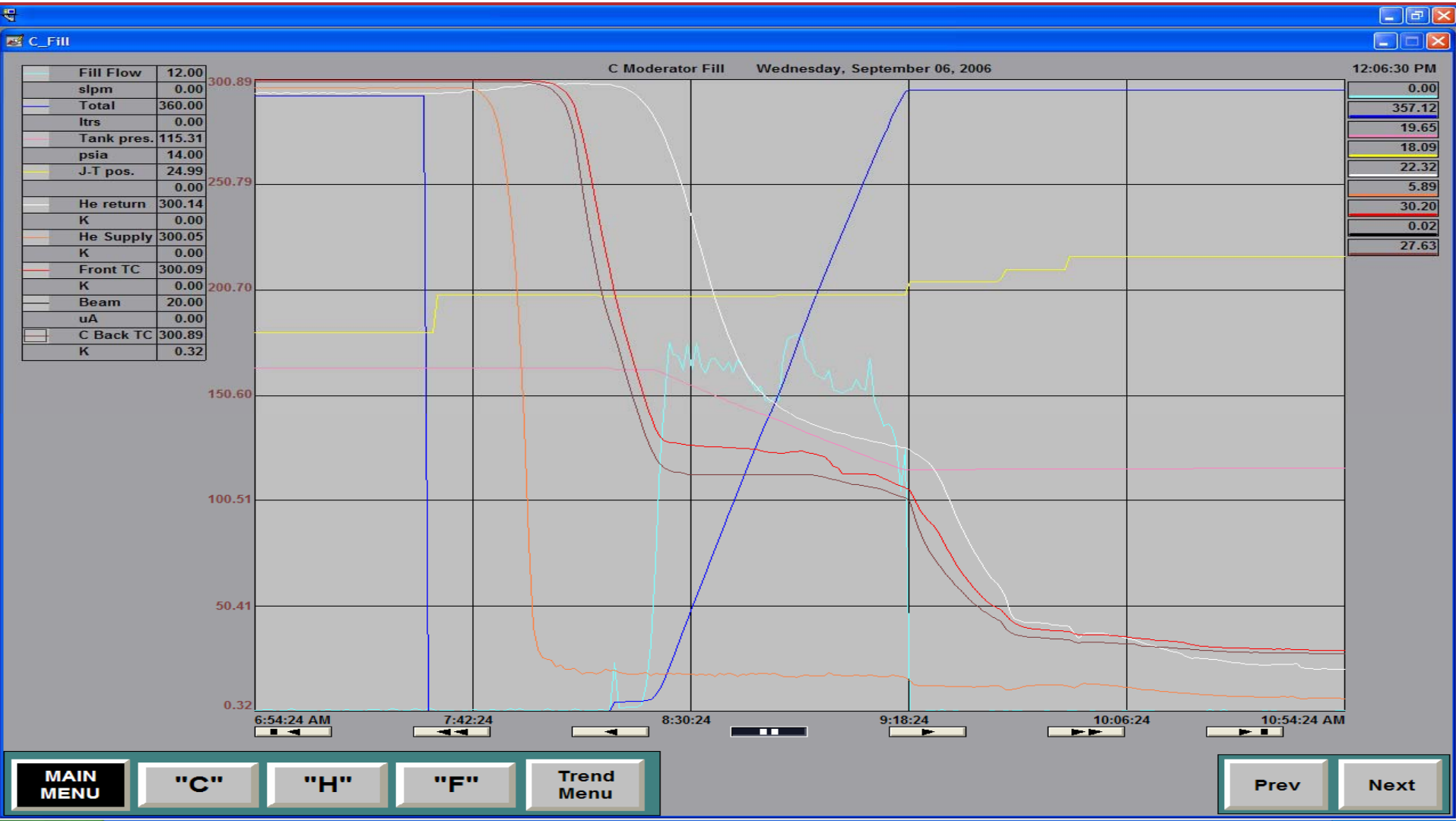
- Liquid Methane
  - Fill system with methane (gas)
  - Circulate and cool
  - Condense and circulate
  - Replace methane periodically

- Solid Methane
  - Start and cool down refrigerators
  - Cool moderator
  - Fill with methane (condensing gas)
  - Cool to operating temperature
  - Anneal every 2-3 days
  - Replace methane periodically

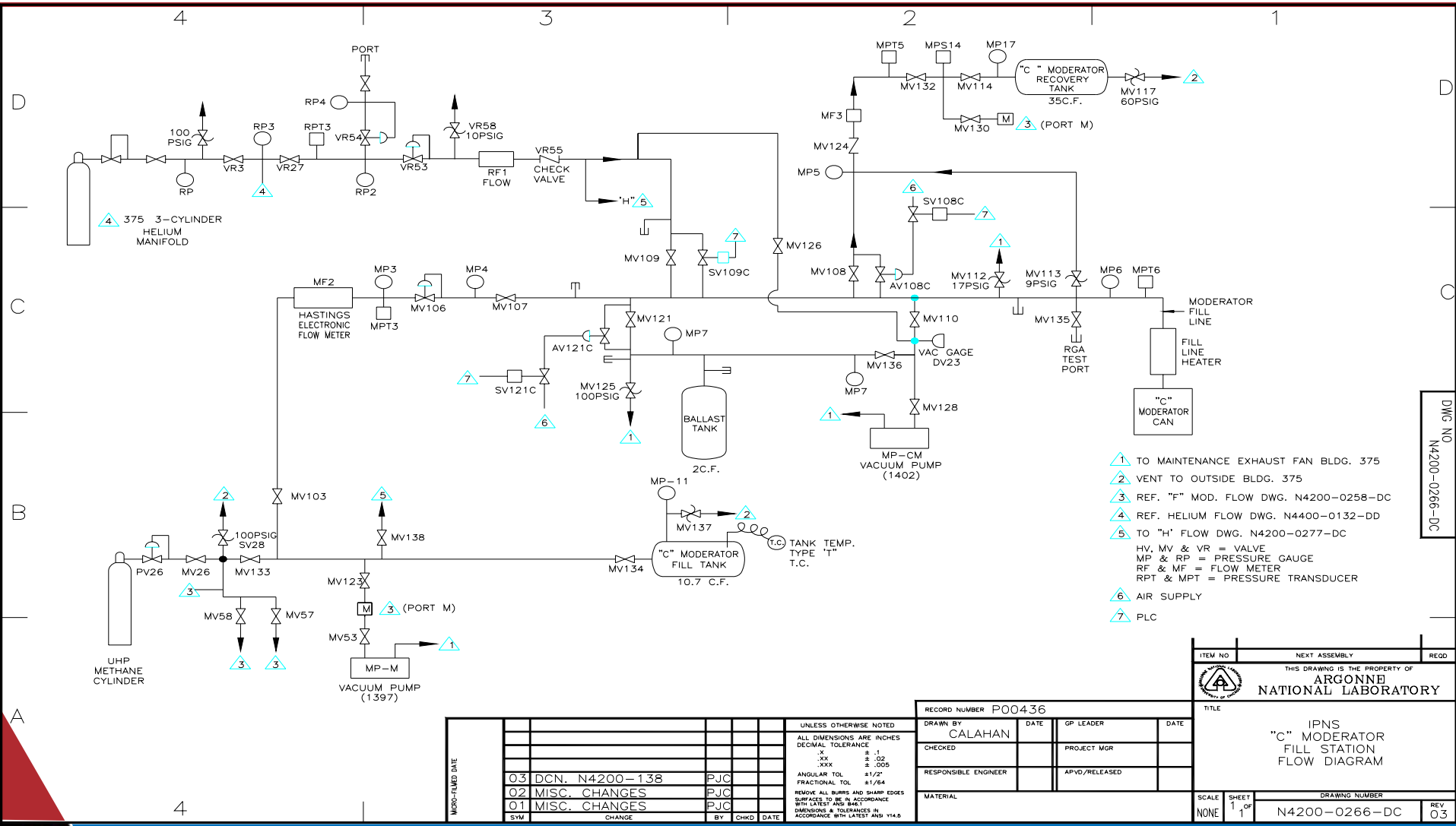
C Moderator Cooling Loop Display



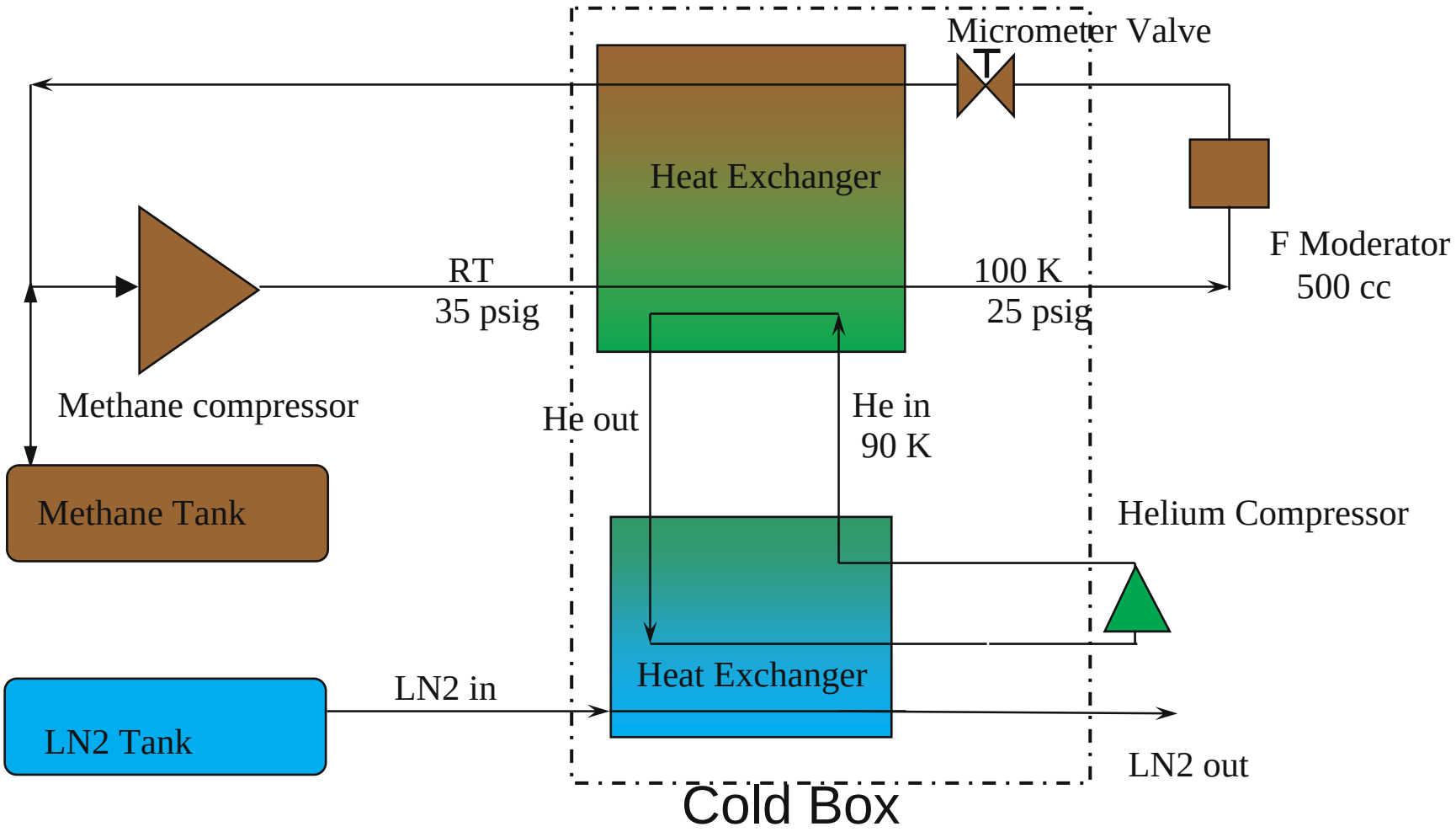
Typical Moderator Cool Down



C Methane P&ID



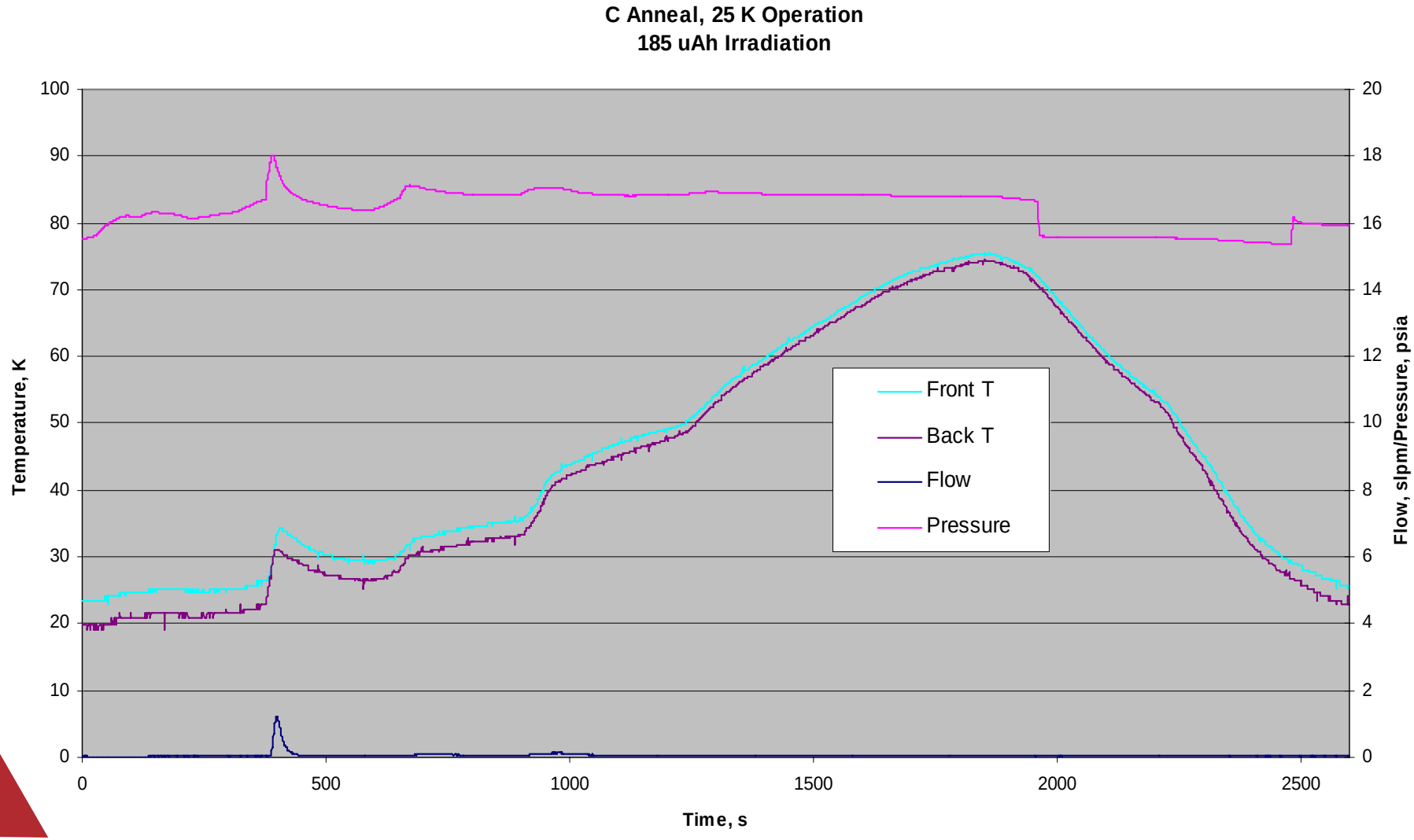
Liquid Methane System (simplified)



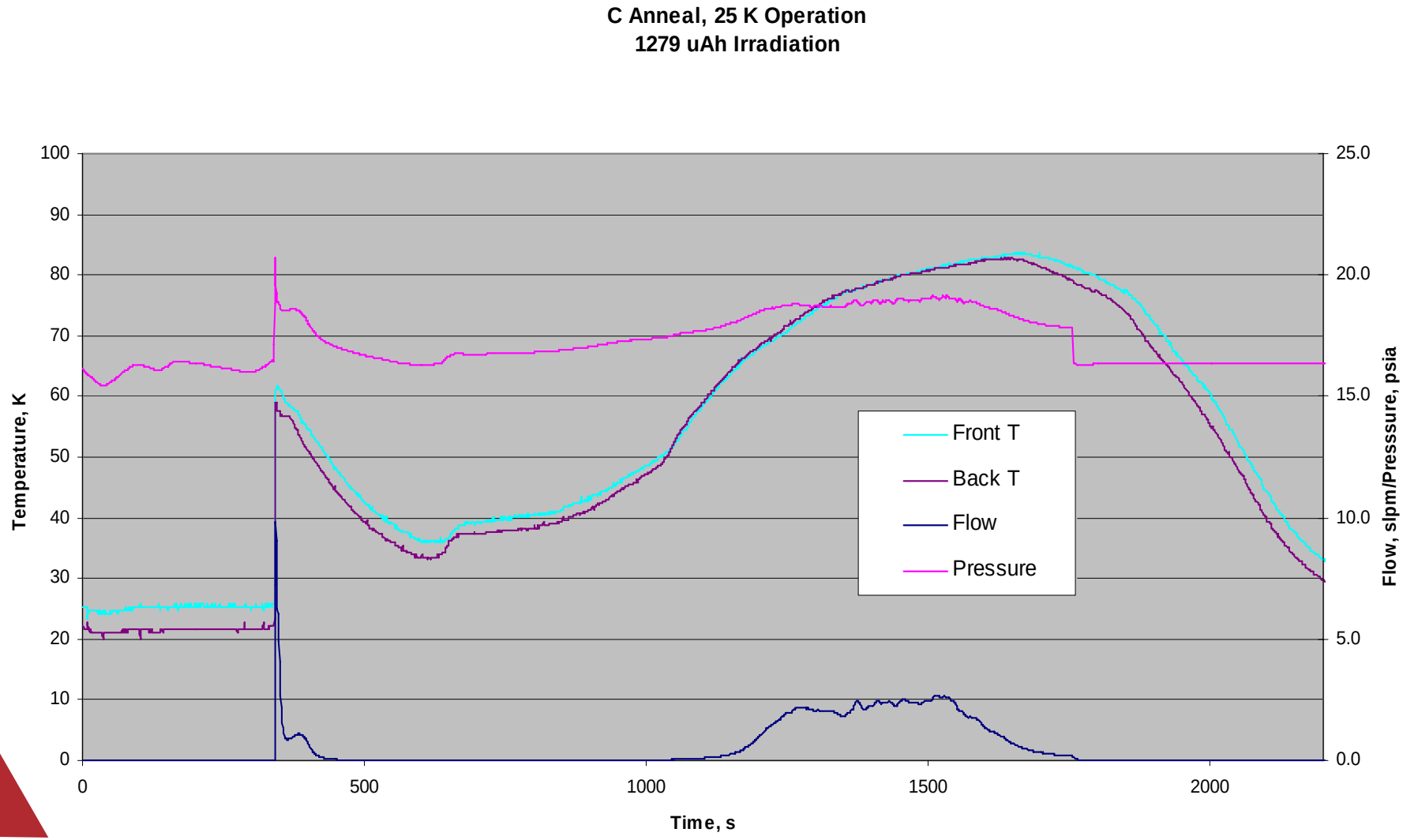
Operation Issues Of Methane Moderators

- Radiation damage products - $CH_3^{\cdot}$ $H^{\cdot}$
  - Liquid
    - *Polymerization*
    - *Hydrogen formation*
  - Solid
    - *Stored Energy*
    - *Hydrogen Formation*
    - *Polymerization*

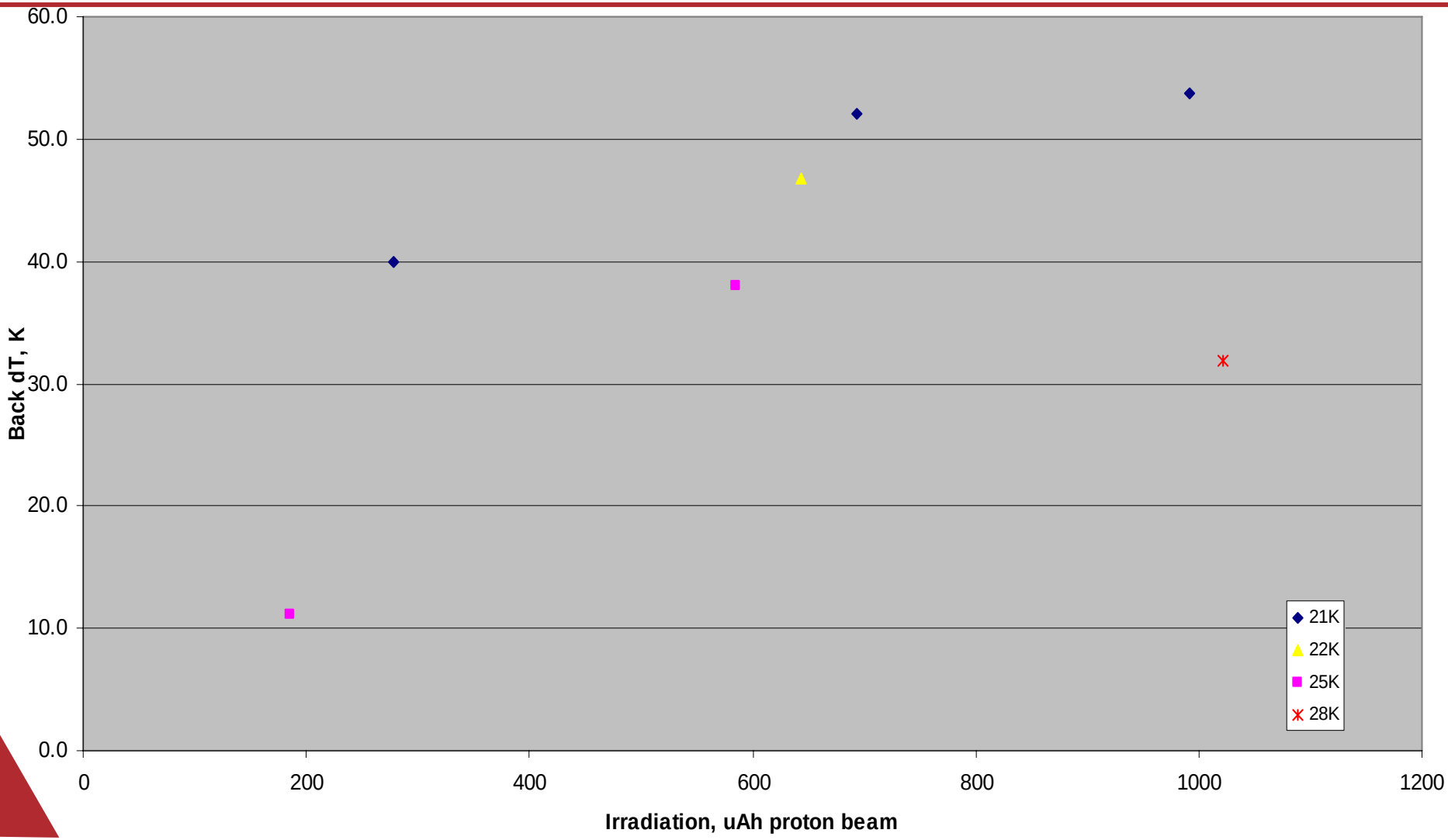
Anneal Temperature Response



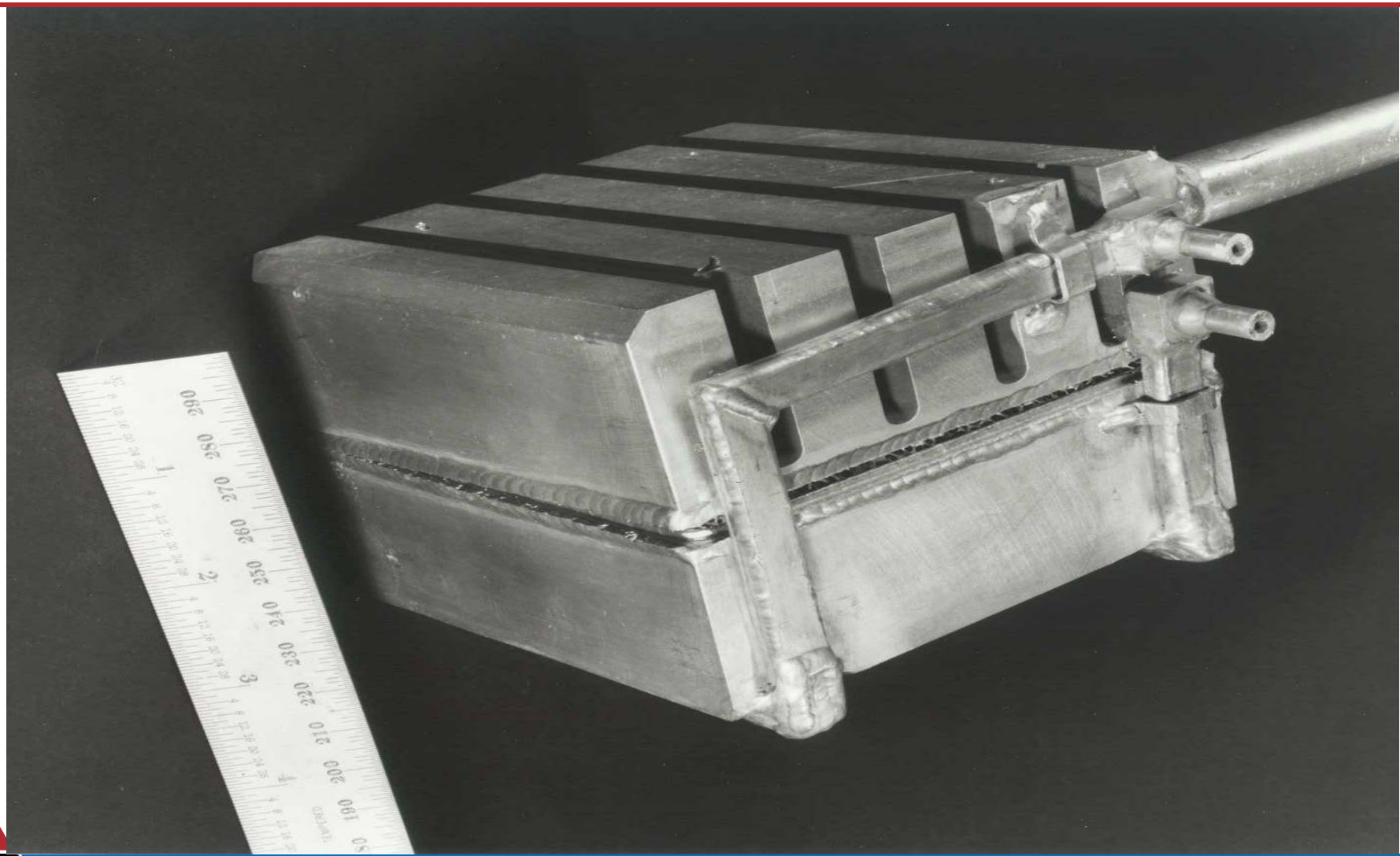
Anneal Temperature Response



C Moderator Anneal Energy Release



Burst C Moderator



Acknowledgements

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