IFE Materials Response

Z Machine Materials Studies

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

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Outline

- Z machine
- Debris Issues
- Multipurpose radiation box (MPR)
- Methods of analysis
- Samples exposed and analyzed
  - W
  - Poco graphite
  - LiF
  - Honeycomb collimator
- Future Work

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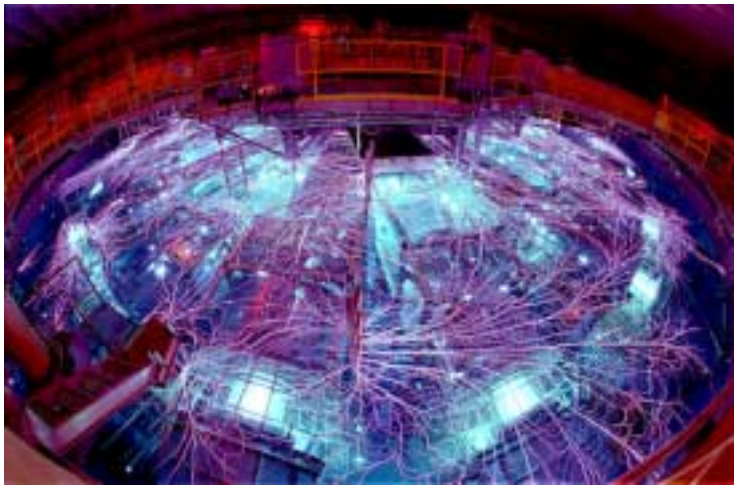
Z Machine



- Capabilities
  - 65 J/cm^2 of X rays in 20 ns (in present location)
  - Black body Temp. ~(200 eV)
- Availability
  - 1 shot per day
  - Piggy back mode
- Limitations
  - Only on shots when allowed
  - Depends on space available
  - Z machine needs to be in right configuration
  - Debris from target area must be mitigated

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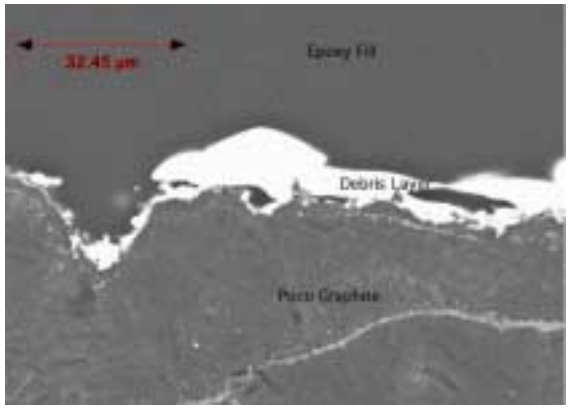
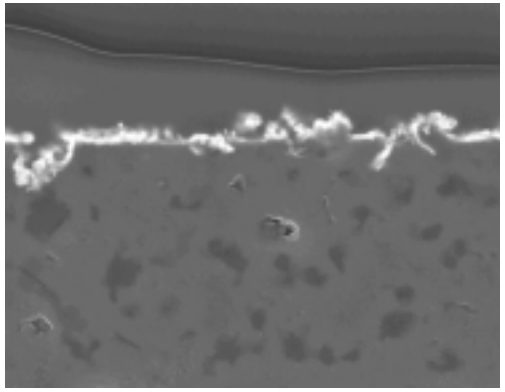
Debris Issues

- **Z machine generates many X rays, but also debris from molten target material**
- **Fast valves may be an option, but only on occasional shots**
- **The MPRS box has significantly reduced the debris, but cannot eliminate it.**



No collimation-20 µm debris



With collimation-1 µm

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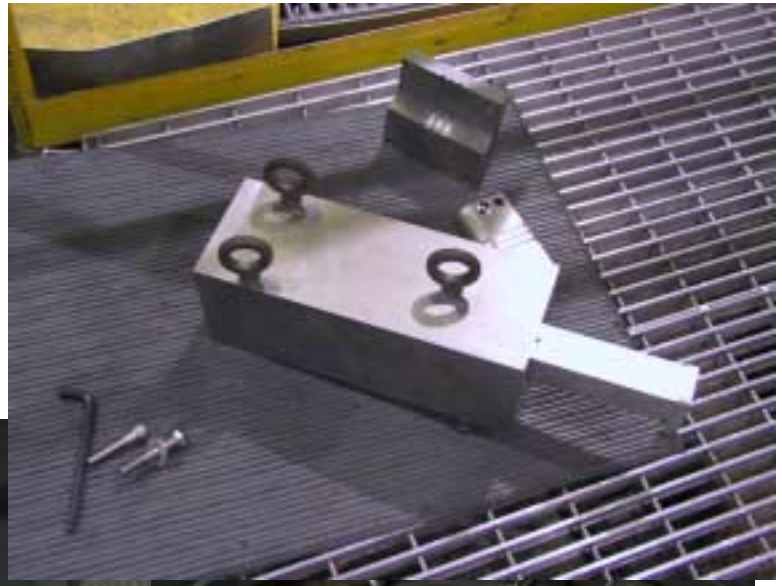
Multipurpose Radiation Box (MPR)

- Stainless steel box
- Inner slide with filter and additional apertures
- Collimation



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Methods of analysis

- Surface Profiling
  - Mechanical-Dektak
  - Optical-WYKO
- Scanning Electron Microscopy
  - Flat and cross sectioned samples
  - Measure debris depth of cross section samples
  - Elemental analysis
- Time-of-Flight Mass Spectroscopy
  - Depth profiling of debris

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Proposed and tested samples on Z

Material	Fluence	Application
Graphite (Poco)	7 J/cm^2	Dry wall
Tungsten	~ 7 J/cm^2	Dry wall
LiF	42 J/cm^2	Wetted wall surrogate
Carbon velvet	~ 42 J/cm^2	Dry wall
Silicon Carbide		Dry wall
Carbon Composite		Dry Wall
Silicon wafer		Reference material
Aluminum		Reference material
FLiBe		Wetted wall

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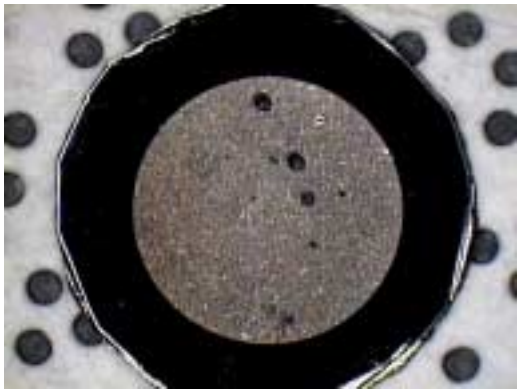
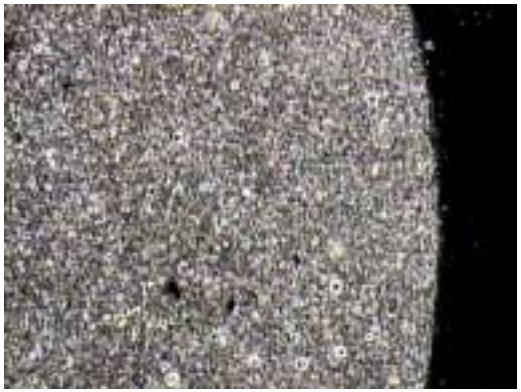
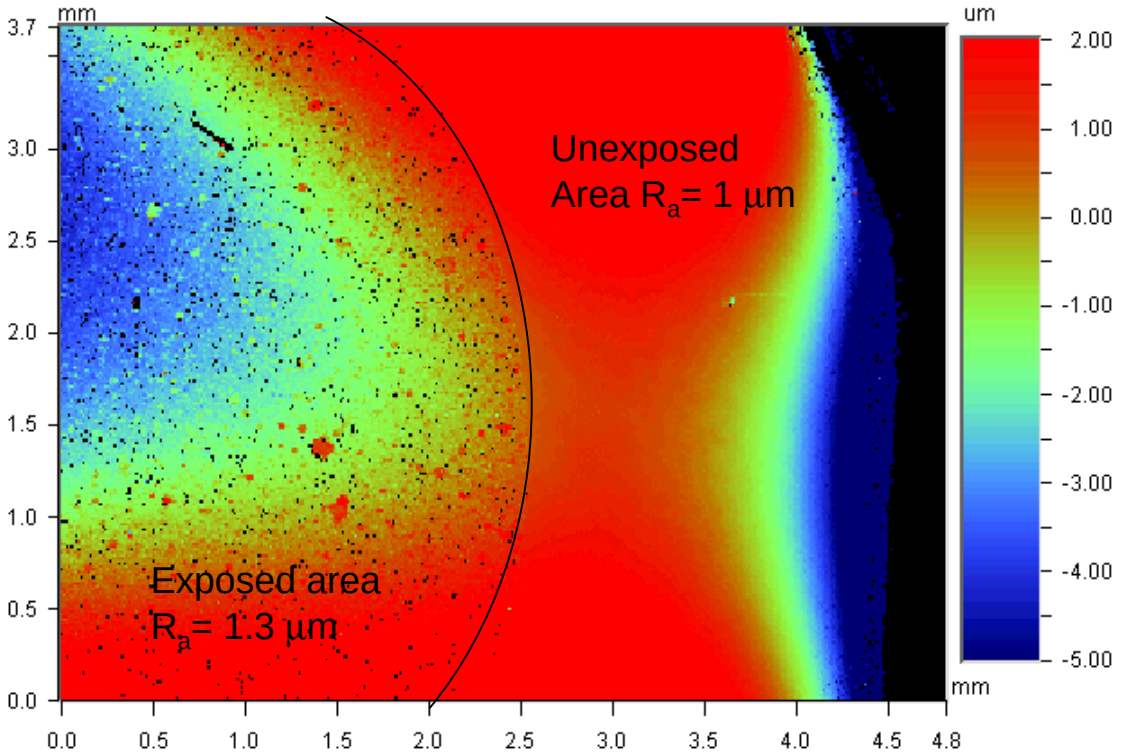
Tungsten







W sample shows pitting, but the surface level is approximately level. Filtered sample.

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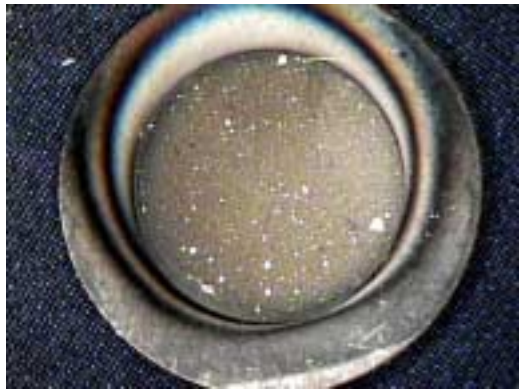
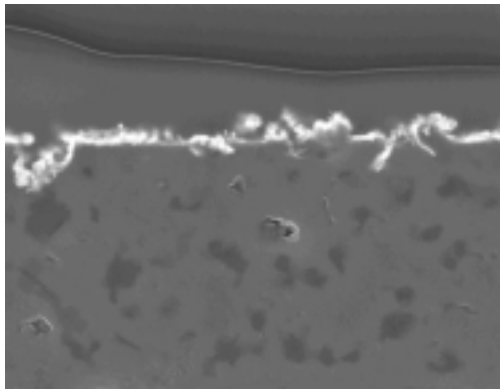
Poco Graphite

- **Poco graphite, polished**
  - **Exposed in MPR box**
  - **2 micron Kimfol + 100Å Al Filter**
- **Debris layer consists of Fe, Ni, Cu, Al**
- **No significant level change from ablation, instead 1-2 μm pits developed**





SEM shows 1 μm debris

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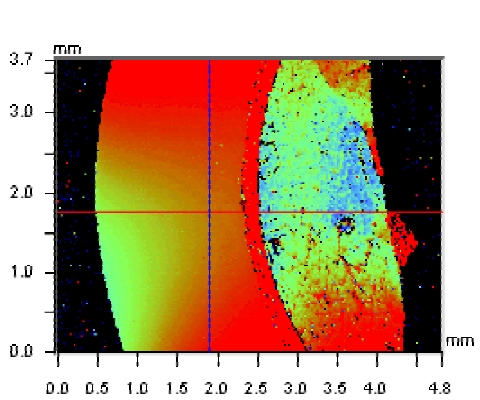
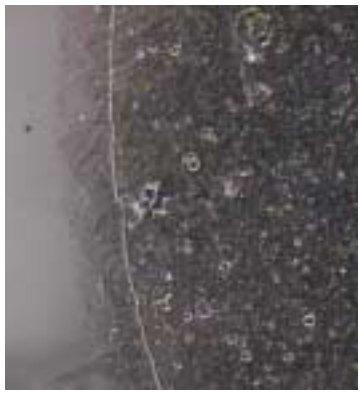
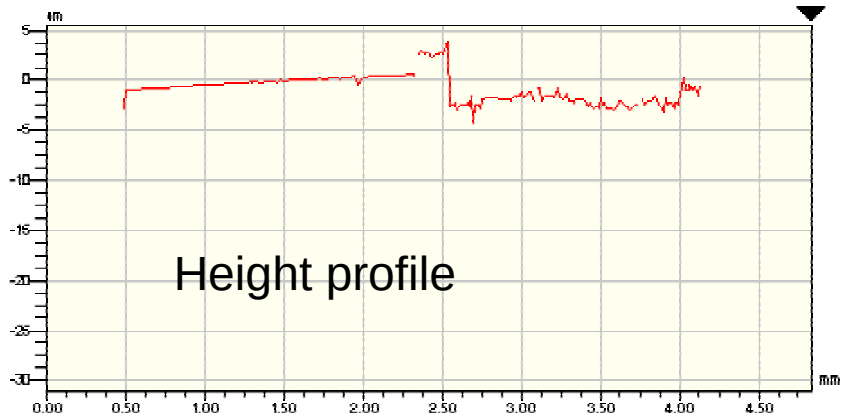
Lithium Fluoride as a FLiBe substitute







- LiF vacuum windows
  - Exposed in MPR box
  - No filters, only collimation
- Measured 3 micron step between original level and exposed region
- Flat ridge of LiF formed around edge of exposed region

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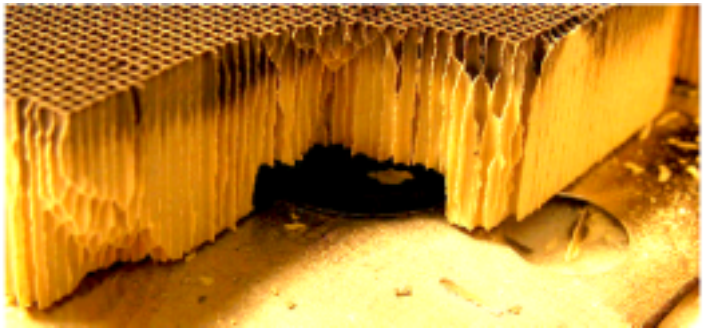
Carbon velvet and honeycomb collimator

- Honeycomb collimator of Celcor
  - 1mm openings, 25 mm long
  - Aspect ratio similar to MPR box
- Material tested both collimated and open exposures on Z
  - 2 densities of carbon velvet
  - Carbon mirror
  - Epoxy coated Al
- Results
  - Much more velvet left on sample behind collimator
  - Little debris behind collimator
  - honeycomb pattern on all samples behind collimator



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Future Work

- Adjust flux levels to determine threshold levels
- Test more materials
- How best to analyze carbon velvet and carbon composite materials?
- Fielding molten samples
- Start up web site

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