XAPPER Progress on the First Wall Battle Plan

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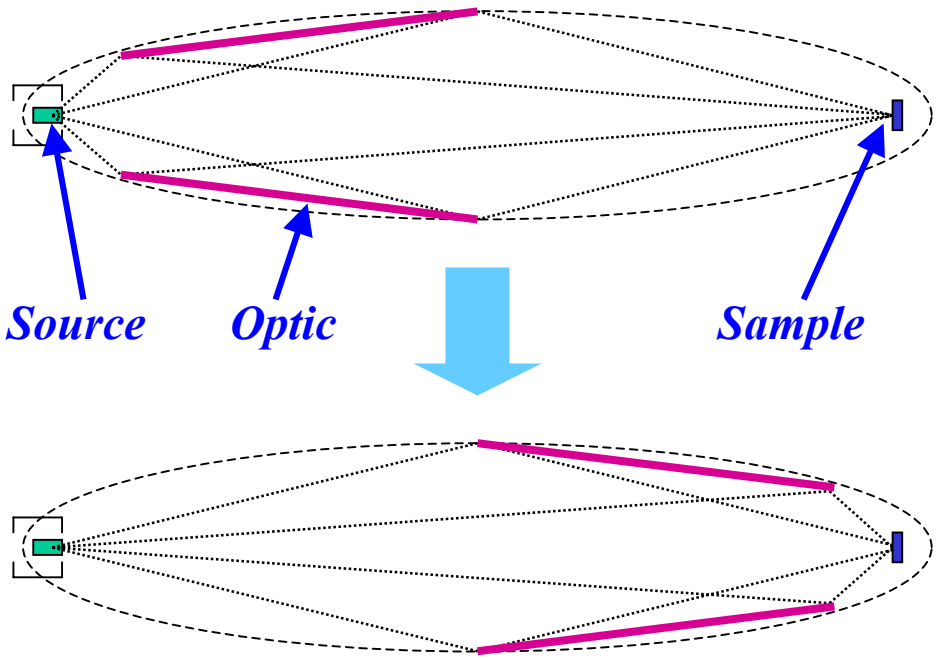
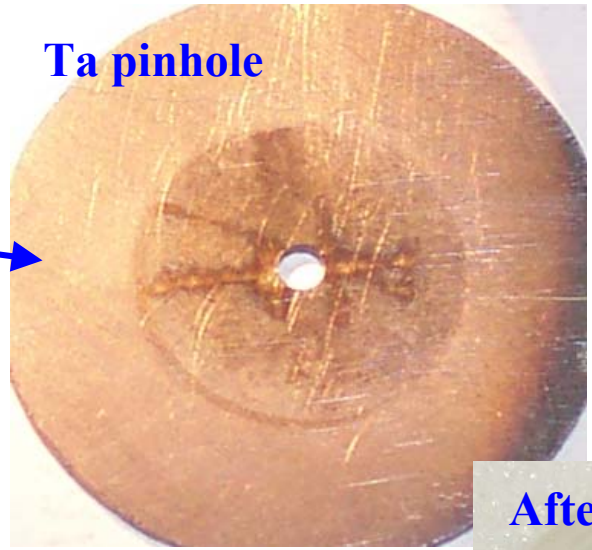
XAPPER is up and running again

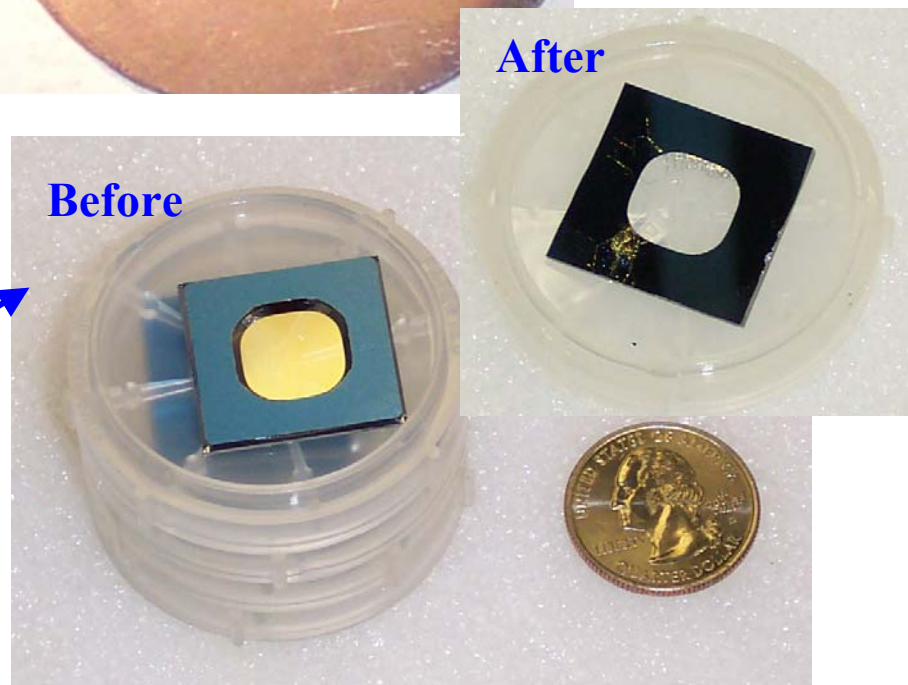
- Machine came back up June 12
- ~10^6 pulses in past month
- Completed numerous photodiode, filtering, calorimeter, and exposure runs
- Analyzed and opted to reverse the optic:
  - Only collect ~¼ as much light
  - Demagnify vs. magnify the image
  - Less sensitive to optical imperfections, which are what is causing our problem



XAPPER is up and running again, (Cont'd.)

- In the reversed configuration, we do seem to have a higher fluence:
  - Observe scaring on tantalum pinholes
  - Observe smaller damage spot on exposed samples
- With a (considerably?) higher fluence we are having trouble measuring it:
  - Photodiode is clearly saturated
  - Destroyed Si_3N_4 filter quite easily
  - Ordered set of polyimide filters (10, 100, 1000×) from Luxel



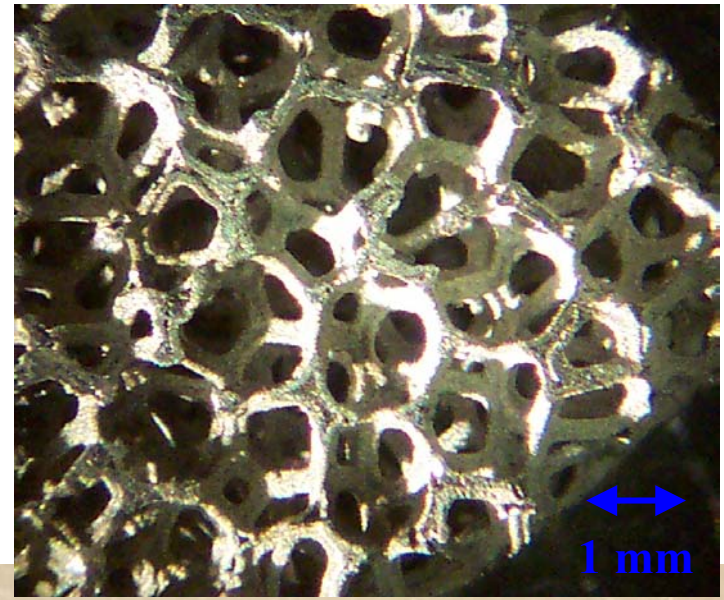


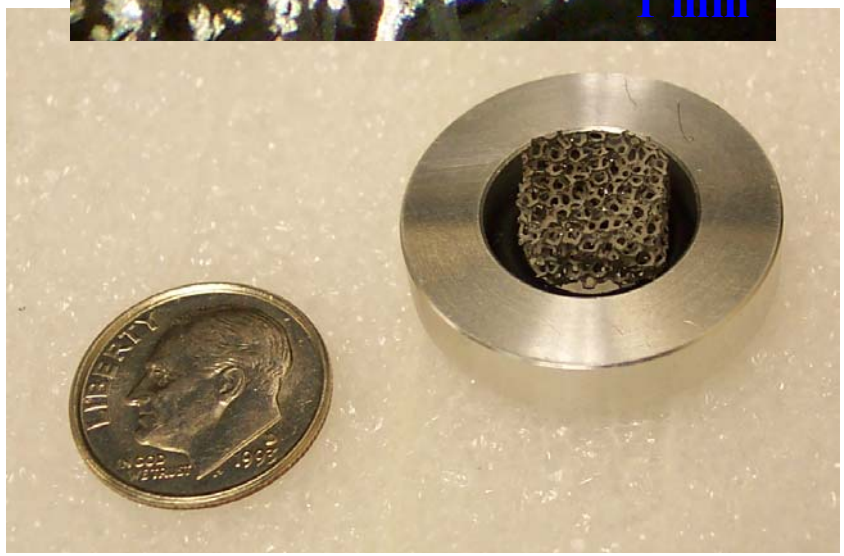
What fluence do we have?

- At the moment, we can only bracket the fluence:
  - Ray tracing calculations predict fluence increase of 3-6× (from 0.18 J/cm^2 in the original configuration)
  - Damage to Ta pinholes didn't occur with optic in original configuration, and thus, we have $\phi > 0.18$ J/cm^2
  - Transient heat transfer calculations suggest tungsten will melt at ~1 J/cm^2, so we must be lower than that
- Evidence suggests we are in the 0.5-0.9 J/cm^2 range
- Plans:
  - Filtering, if they can survive even the unfocused beam
  - Use a variety of target materials to empirically determine fluence

Tungsten foam exposures

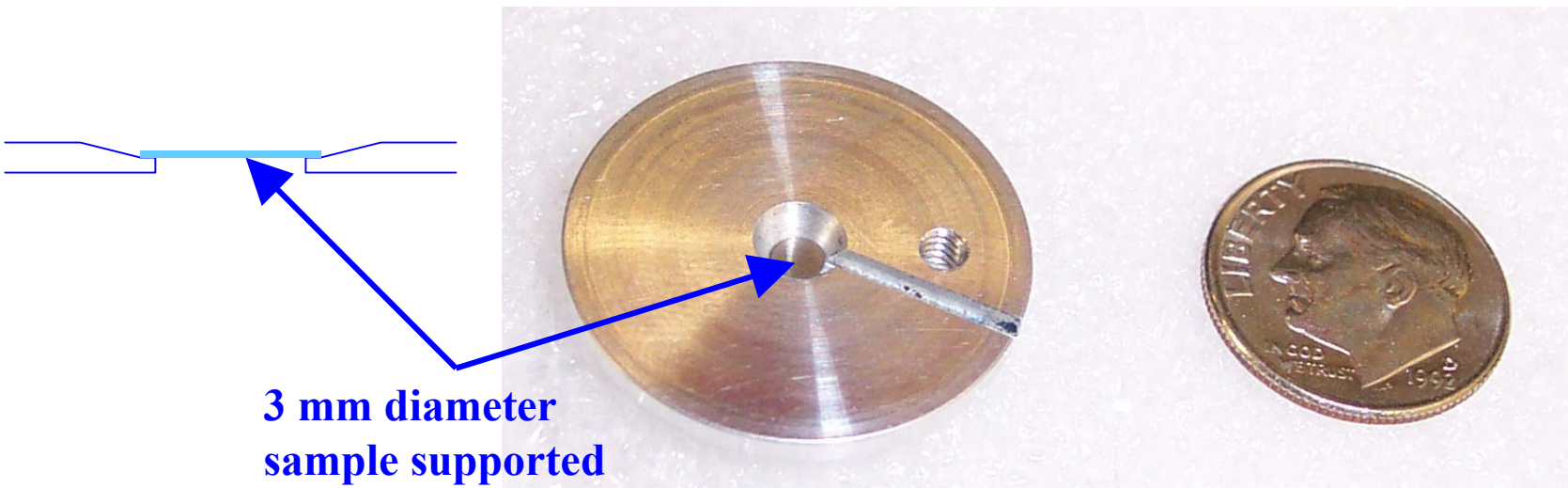
- Tungsten foam samples provided by Ultramet thanks to Shahram Sharafat:
  - 11% dense
  - 45 pores per inch
  - Nominally 1 × 1 × 0.5 cm
- Baked out according to Snead guidance
- Samples hit with maximum fluence (see previous page) for 20,000 pulses at 10 Hz; started at room temperature
- Unable to perform any type of surface analysis; only optical microscopy
- No noticeable change to the material
- Same result for Re (10,000 pulses)
- Ideas for other analyses?





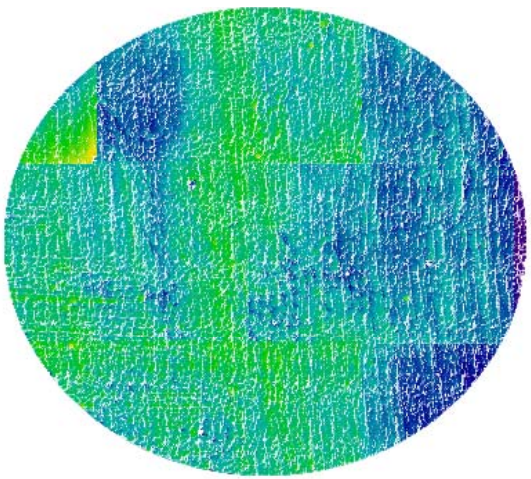
Powder met. tungsten exposures

- Powder met. tungsten samples provided by Lance Snead:
  - 99.95% purity
  - 3 mm diameter samples; 100 μm thick
- Acetone/ethanol ultrasonic baths & baked out according to Snead guidance
- Samples hit with maximum fluence (see slide #4) at 10 Hz; started at room temperature

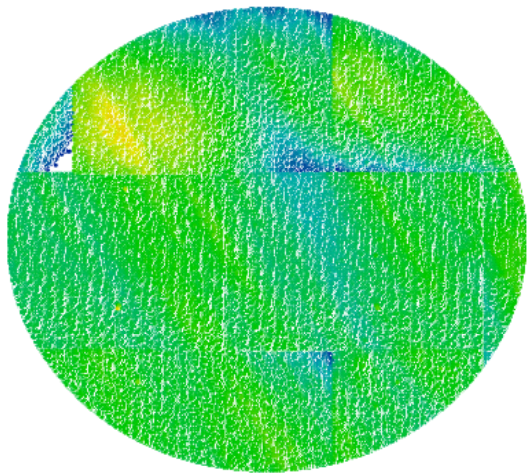


Powder met. tungsten exposures, (Cont'd.)

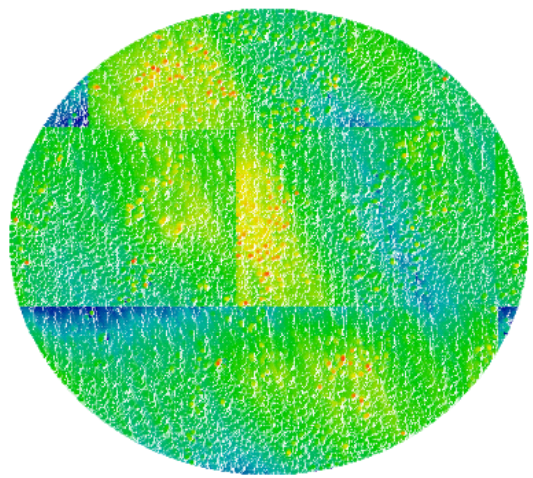
- Three separate samples: control (0 pulses), 10K pulses, 79.5K pulses
- White-light interferometer used post-irradiation
- Contour plots show innermost 1.5 mm of each sample (edges appear to show effects of punching disks)



Control (unirradiated)



10,000 pulses



79,500 pulses

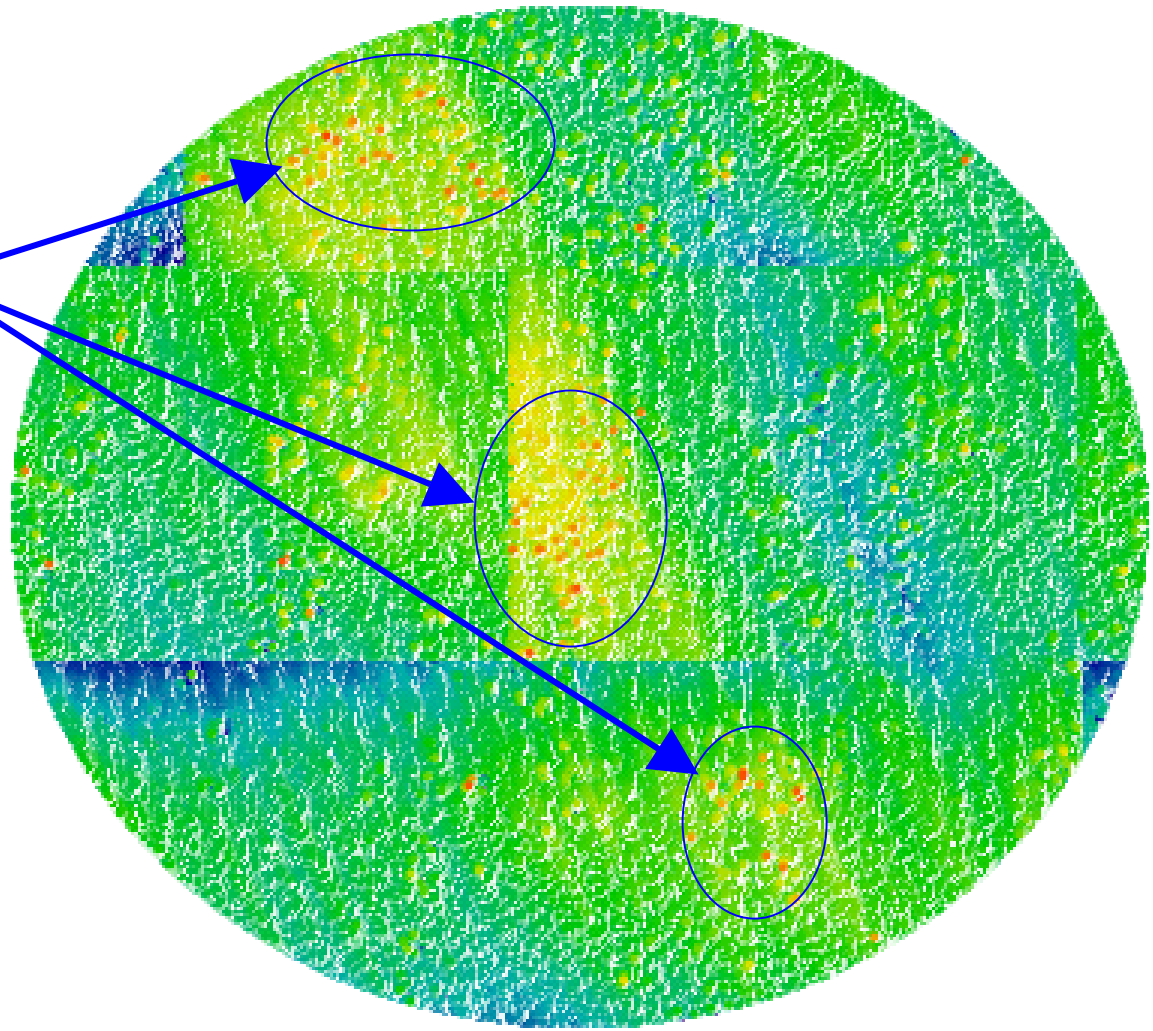
Powder met. tungsten exposures, (Cont'd.)

Spikes (10-20 μm diameter, 0.3-0.4 μm high)

Don't appear on control or 10K samples

Are these real?

Were they caused by x-rays?



79,500 pulses

Plans for next round

- Larger samples – Lance?
- Procedure:
  - Ultrasonic baths
  - Mount samples to sturdy (Ta?) disks
  - Bake out samples
  - White-light interferometer for baseline
  - Bake out again?
  - X-ray exposures: 0, 10K, 100K pulses @ 10 Hz & max. fluence
  - White-light interferometer; subtract off baseline
  - Consider Tina Tanaka's ion cross-section imaging technique?
- Comments and/or suggestions?

Additional plans

- Accurate fluence measurements:
  - Filtering
  - Fast photodiode backup
  - Calorimeter confirmation
- Get to even higher fluence with new condensing optic
- Implementation of UCSD's thermometer – parts now being ordered
- Sample heating under investigation