Complex Target Manufacturing Efforts at the Laboratory for Laser Energetics*

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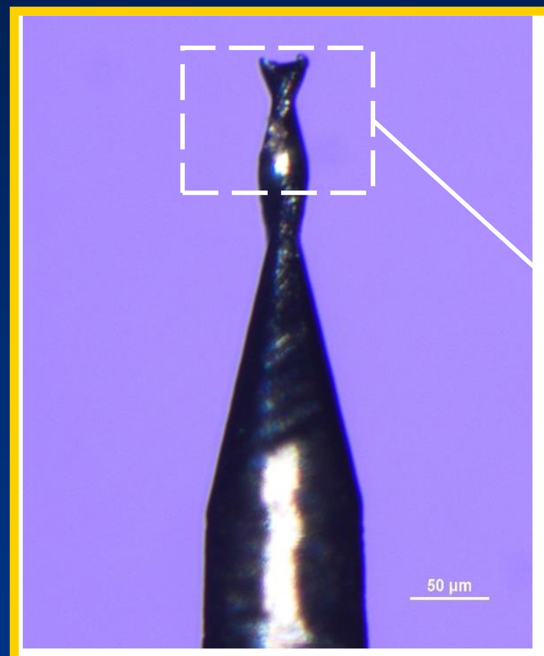
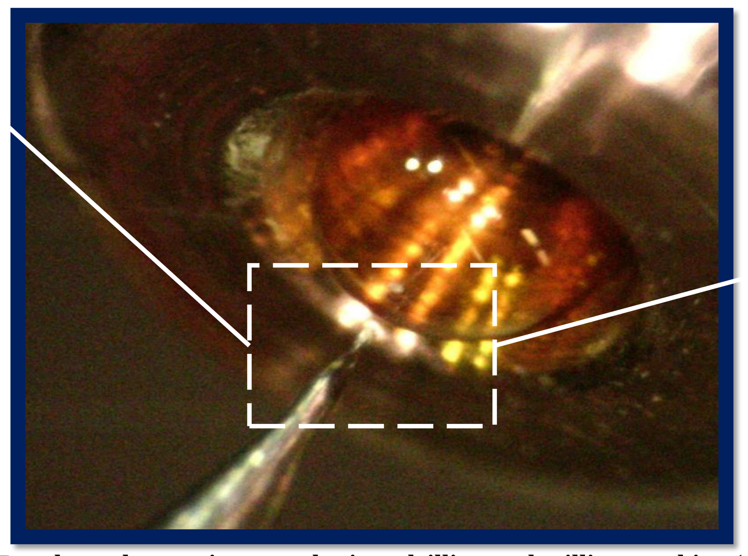
S. KARIM, M. J. BONINO, R. C. SHAH, R. F. EARLEY, T. CRACIUM, K. J. LINTZ, AND D. R. HARDING

Capsule Machining

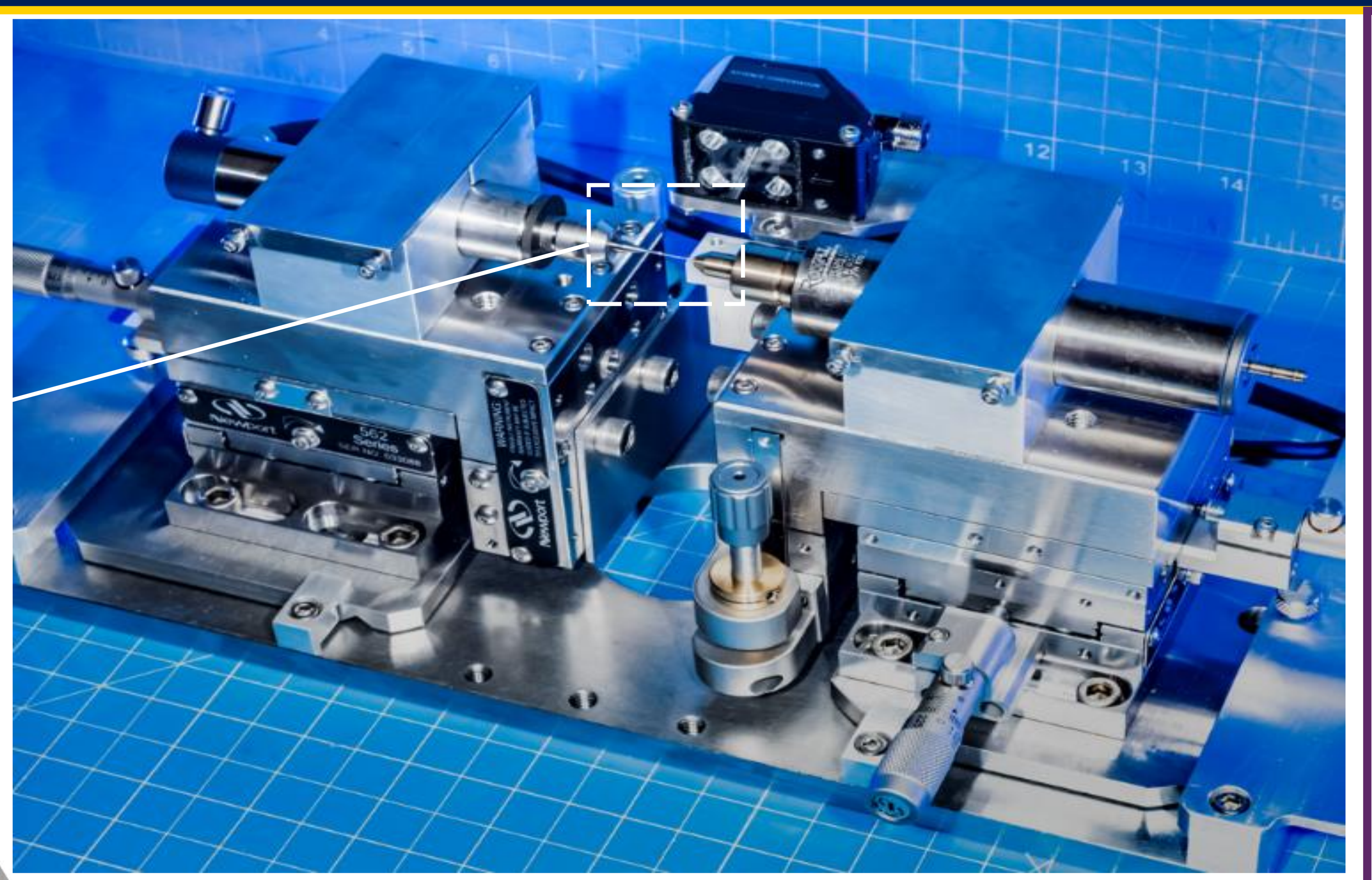


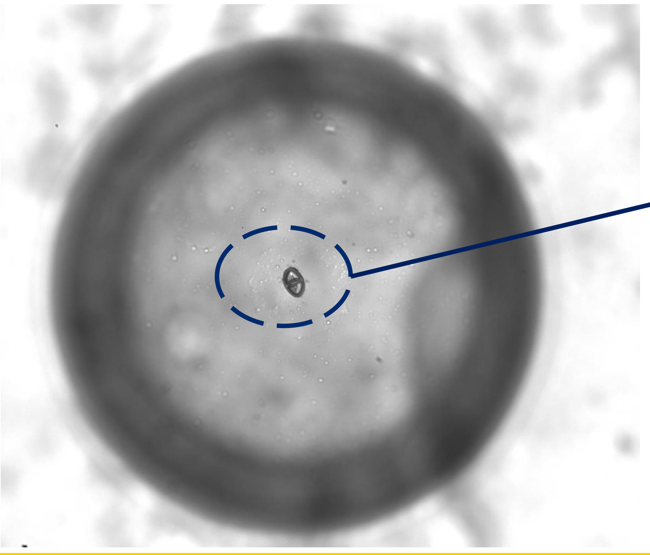
A close-up view of the tool used to machine divots into the capsule surface. The tool is characterized as two-fluted, CNC ground solid carbide with a 25-μm tip width.

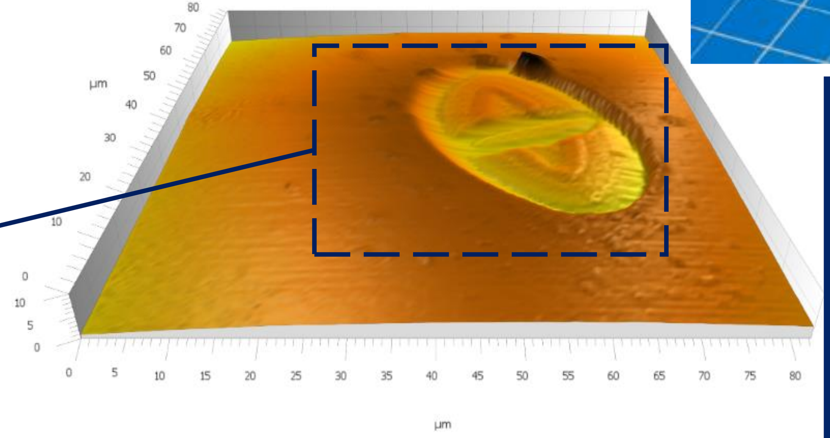
Tool in close contact with the capsule (amber sphere), held in a burnished brass vacuum chuck.



Benchtop three-axis manual micro drilling and milling machine (14-in. long × 4-in. tall by 6-in. deep) is a precision tool used for machining a divot in the surface of a 20-μm wall thickness, 870-μm-diam fusion capsule. The system uses direct laser TOF sensor to control the tools depth to 1-μm.



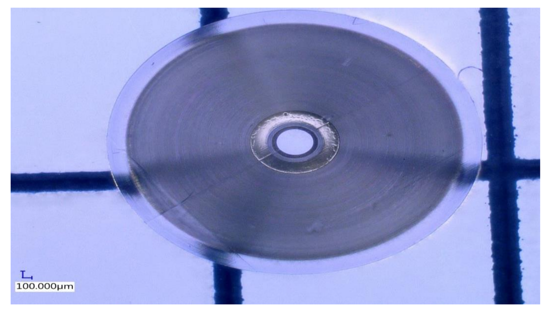


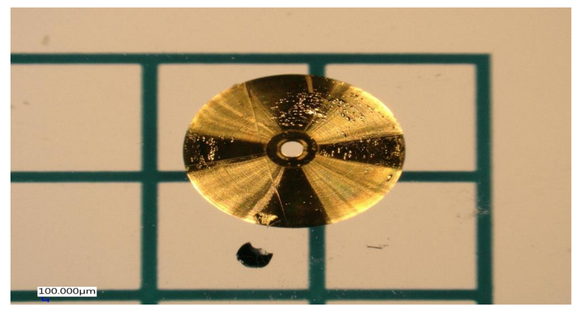


AFM image of the tool profile into the GDP shell surface (3-μm deep × 61-μm major length). The elliptical shape indicates the capsule was vibrating during machining (as viewed during the operation).

Cleaning/Coating

Cleaning capsules post-machining utilized a simple process of rinsing with 2-propanol in a 60-ml syringe, 0.2-μm PTFE filter.

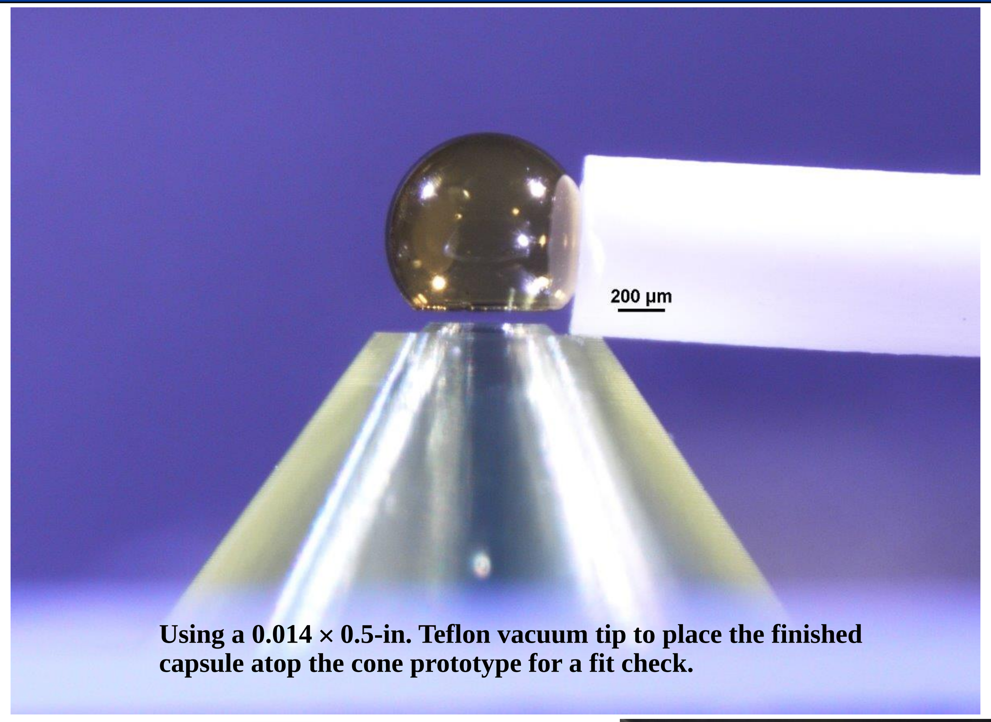




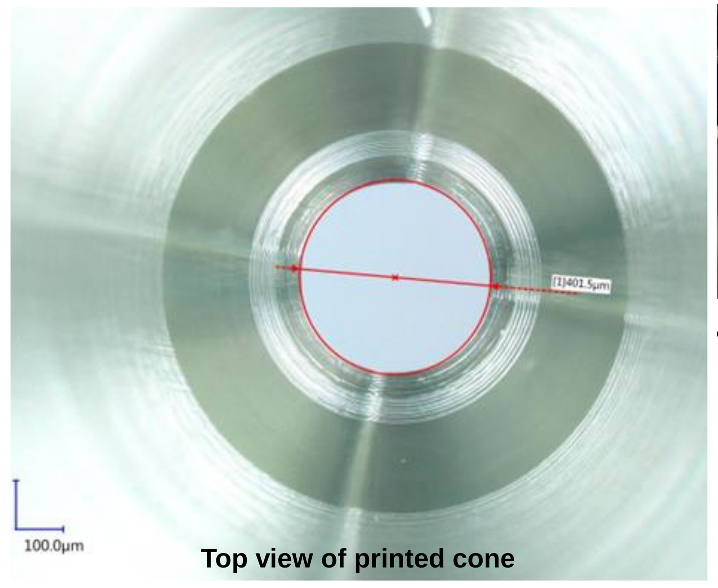
Pre- and post-coating of cones. Coating was 1.5 μm of gold.

The sputter coater is one of a few options we have for coatings. The sputter coater was designed in-house at LLE; its setup allows us to apply thicker coatings of materials using less material within the spec parameters.

Assembly



Using a 0.014 × 0.5-in. Teflon vacuum tip to place the finished capsule atop the cone prototype for a fit check.

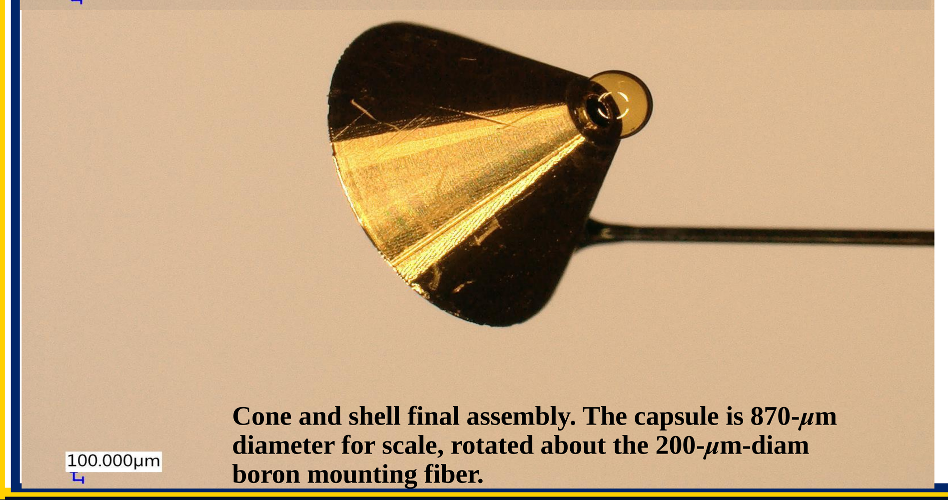


Top view of printed cone

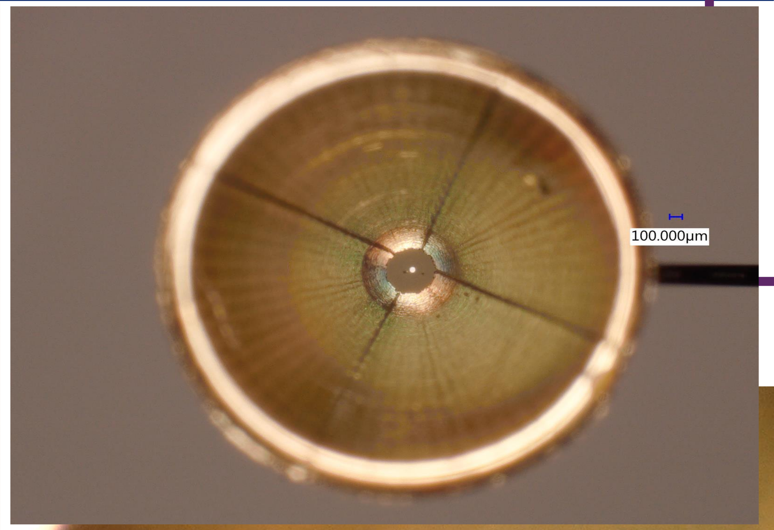
The capsule is spot-mounted to the gold-coated cone around the laser-machined hole using a rotary stage and stereomicroscope.

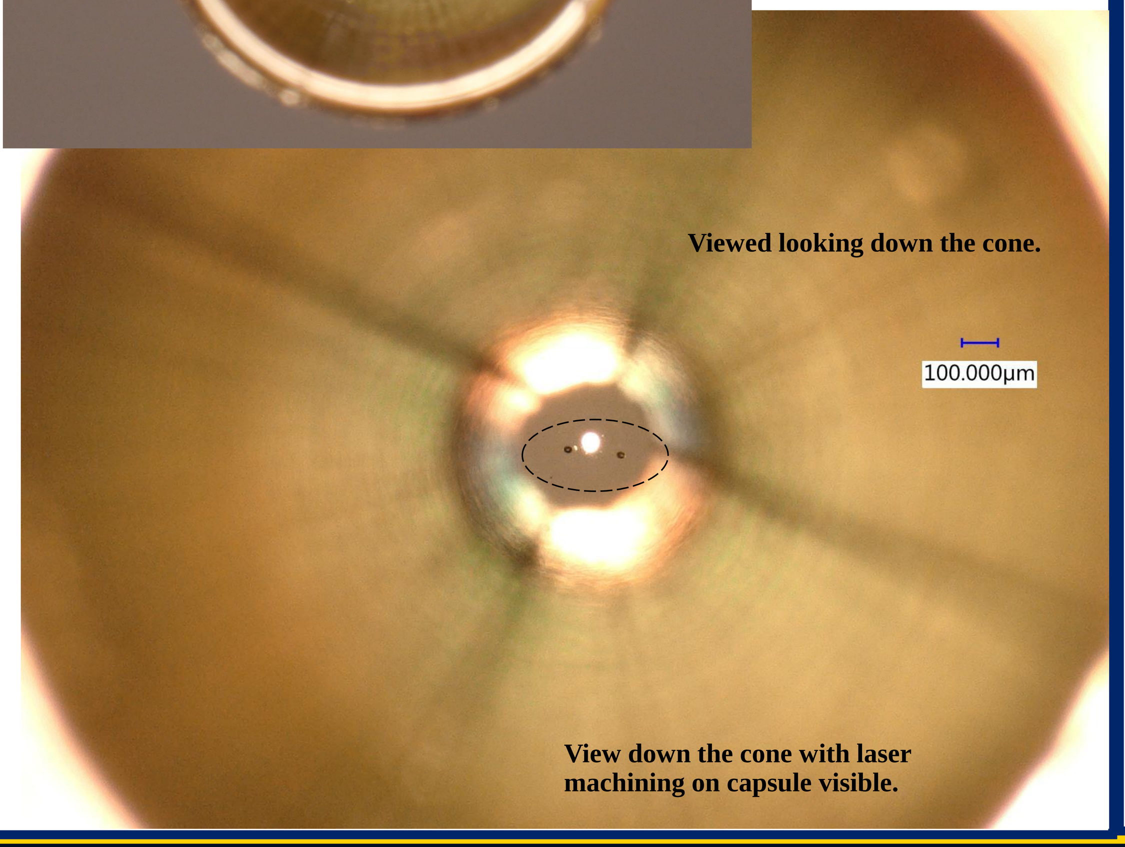
Final Assembly

Cone and shell final assembly, edge-on view.



Cone and shell final assembly. The capsule is 870-μm diameter for scale, rotated about the 200-μm-diam boron mounting fiber.

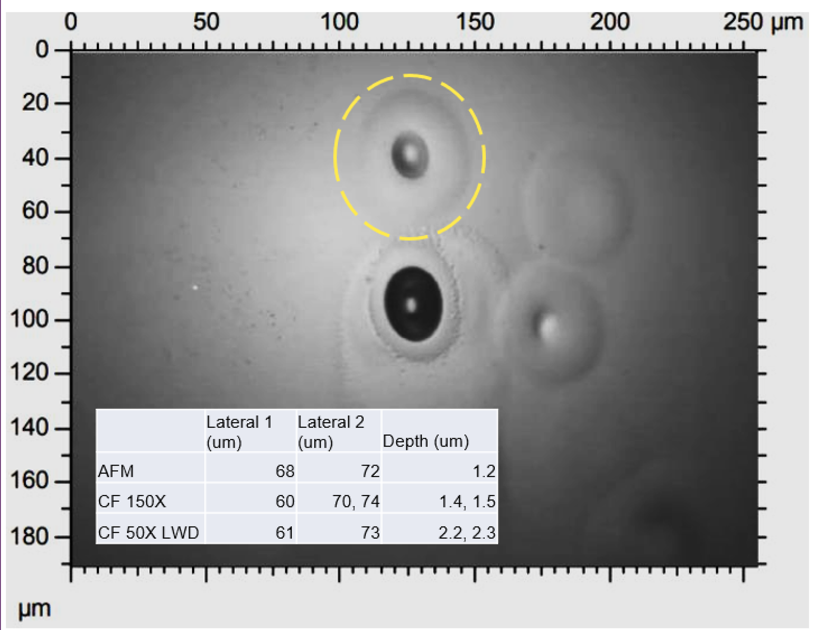




Viewed looking down the cone.

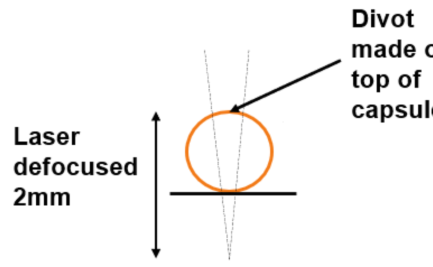
View down the cone with laser machining on capsule visible.

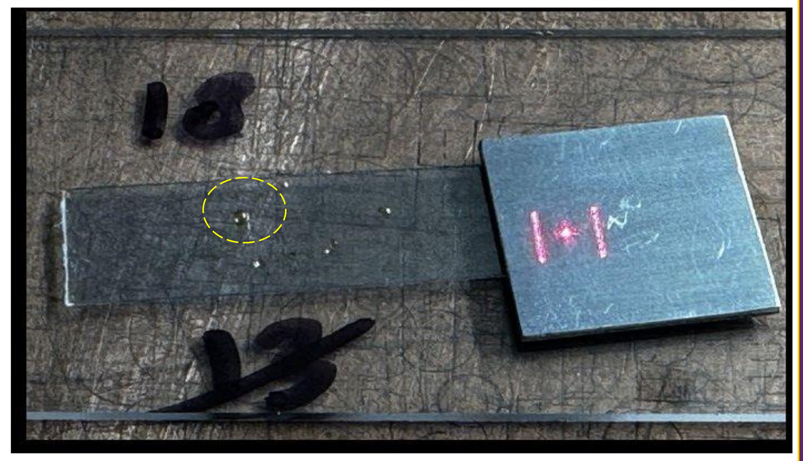
Laser Machining/Metrology



	Lateral 1 (um)	Lateral 2 (um)	Depth (um)
AFM	68	72	1.2
CF 150X	60	70, 74	1.4, 1.5
CF 50X LWD	61	73	2.2, 2.3

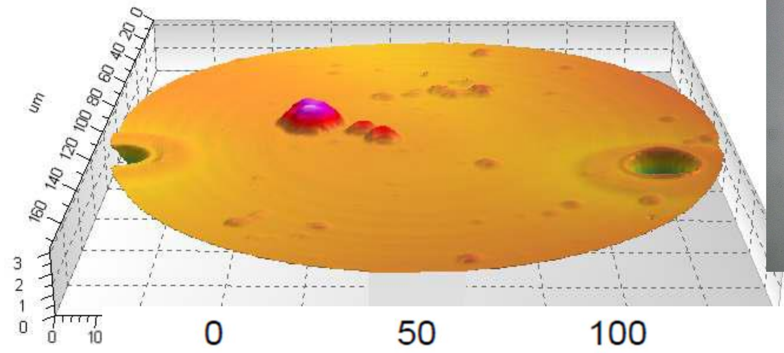
- The circled feature was measured with confocal (50x, 150x mag) and AFM. Depth values agree between AFM and 150X mag.
- Lateral dimensions are more uncertain; hard to determine ‘edge’ of spot (+/-2um)
- UV laser conditions: 355nm wavelength, laser power 0.3%, scan speed 2mm/s, 60kHz rep rate, 2mm defocus

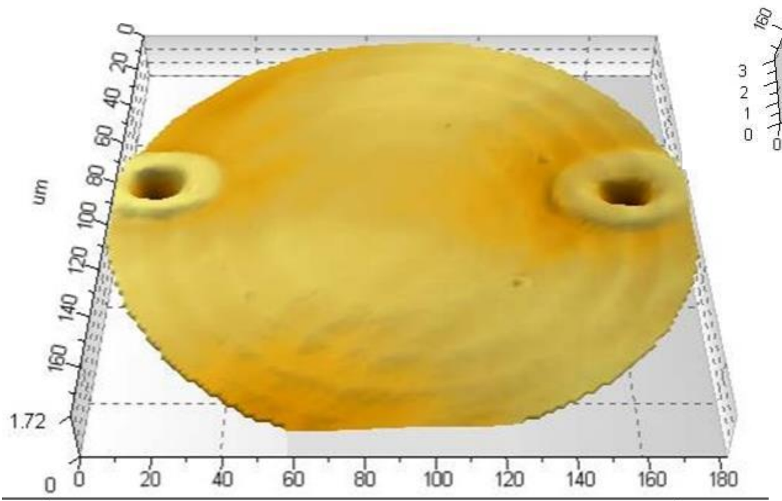


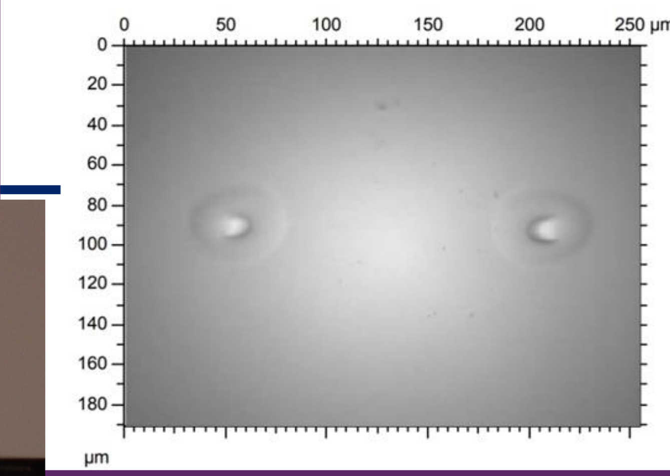


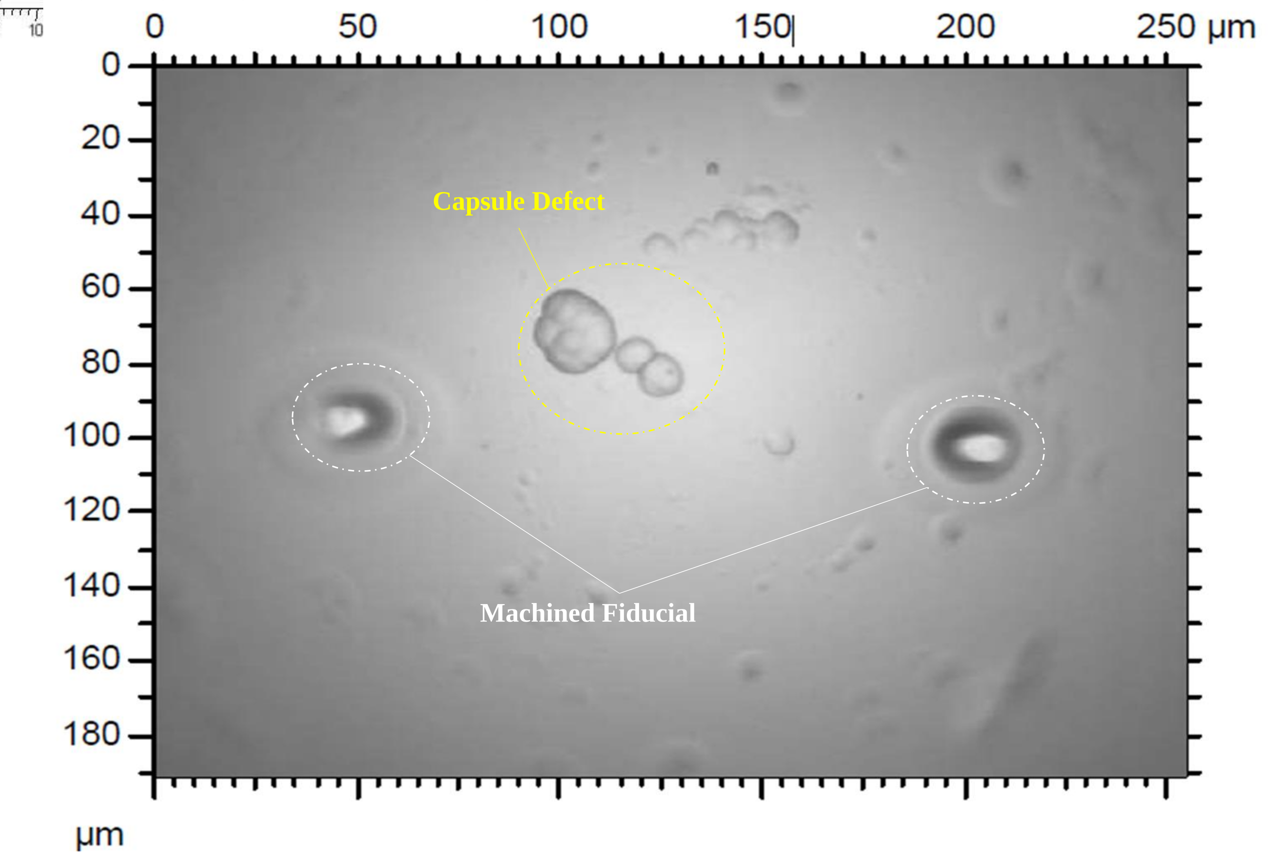
A square piece of shim stock (right) with thickness matched to the capsule diameter (left, 870 μm, circled in yellow) provides best focus for laser machining. Best focus is determined by the central spot equidistant from the neighboring lines.

The AFM was used to characterize the surface of the capsules with defects and laser-machined fiducials for depths and heights. Divots are 0.7um deep measured by CF 150X obj 0.95 NA. No debris is seen between divots (no recast)









Results

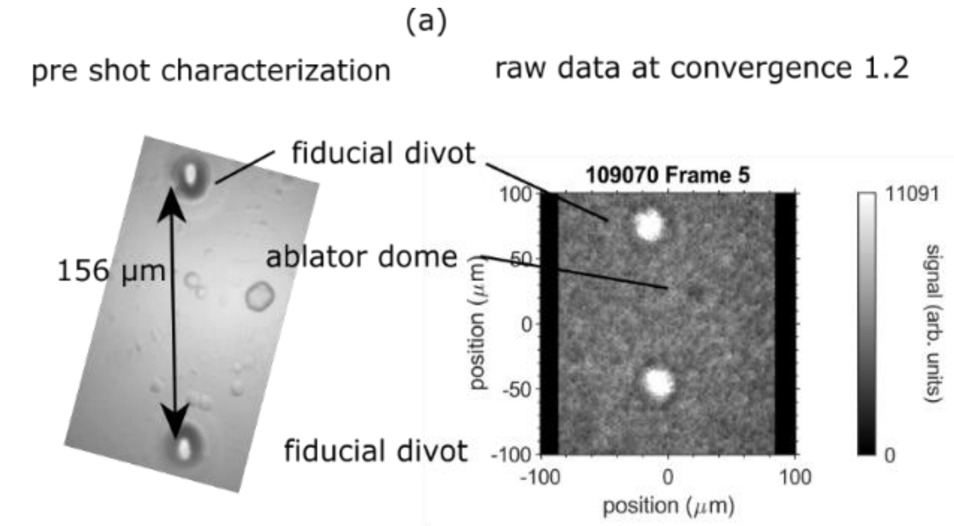


Figure 1(a) Left image shows pre shot characterization of target and laser drilled fiducial divots. Right image shows radiograph at convergence ratio of the spherical target of 1.2.

Calculations, as well as questions about understanding cryogenic performance, motivated consideration of target features as a source of hydrodynamic instability. Recent experiments (Exp. PI R. Shah) suggest that hot electrons generated by the two-plasmon-decay instability will impact the growth thus indicating the need for careful matching of intensity and pulse shape. The experiment was enabled by novel spherical targets built and characterized in the LLE Target Fabrication group (M. Bonino, S. Karim and others), which used fiducials to locate the target defects and determine distance travelled during the implosion [Fig. 1(a)]. Upcoming experiments will test this explanation by varying the intensity (and pulse shape), thus modifying the hot electron production.

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