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Fabrication of Planar Laser Targets with Sub-Micrometer Thickness Uniformity

M. Bono, C. Castro, L. Griffith, R. Hibbard, J. Kass, J. Satcher

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Fabrication of Planar Laser Targets with Sub-Micrometer Thickness Uniformity

The Cu EOS Targets

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Matthew Bono, Carlos Castro, Lee Griffith, Robin Hibbard,
Jeff Kass, Joe Satcher

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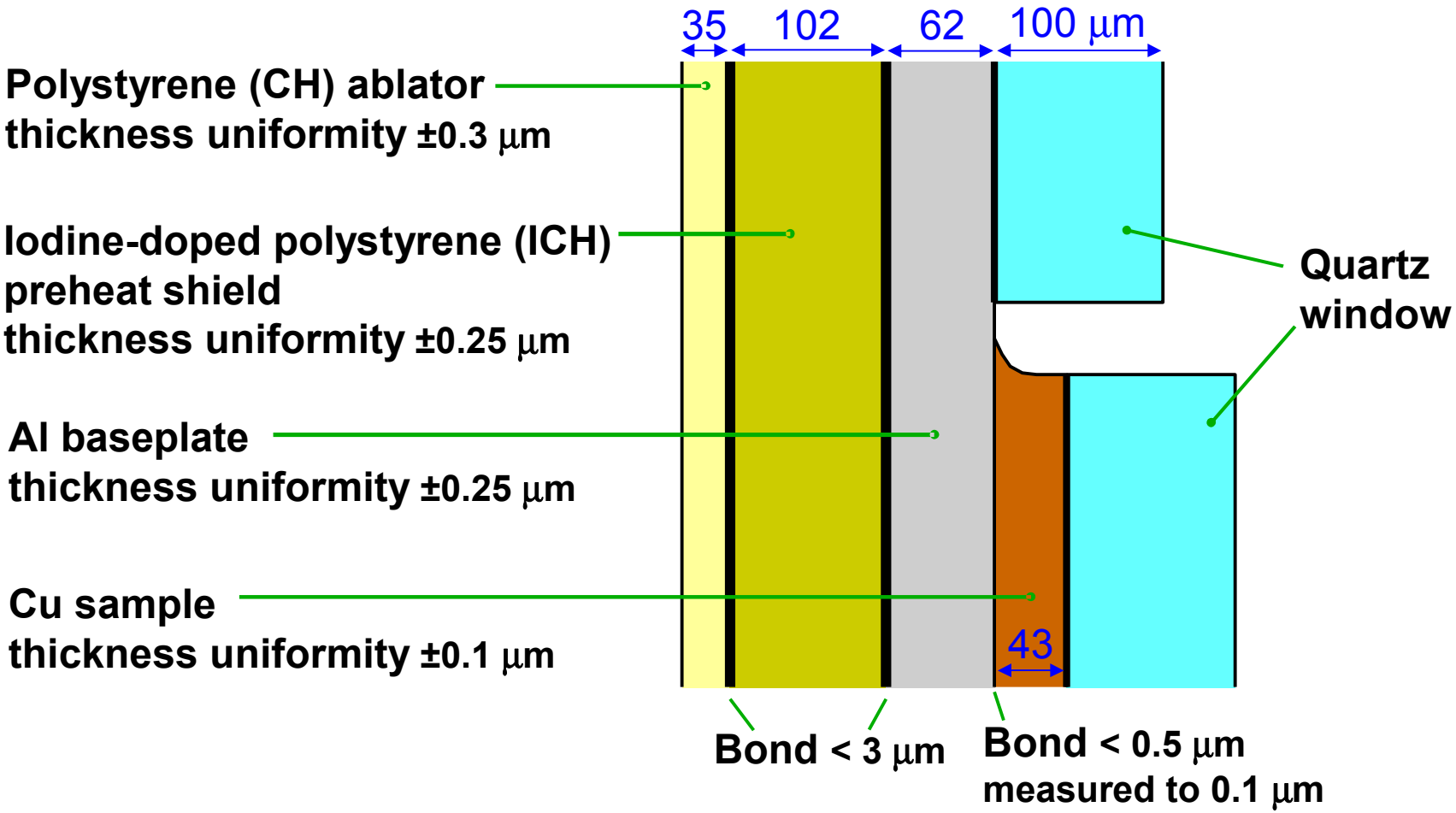
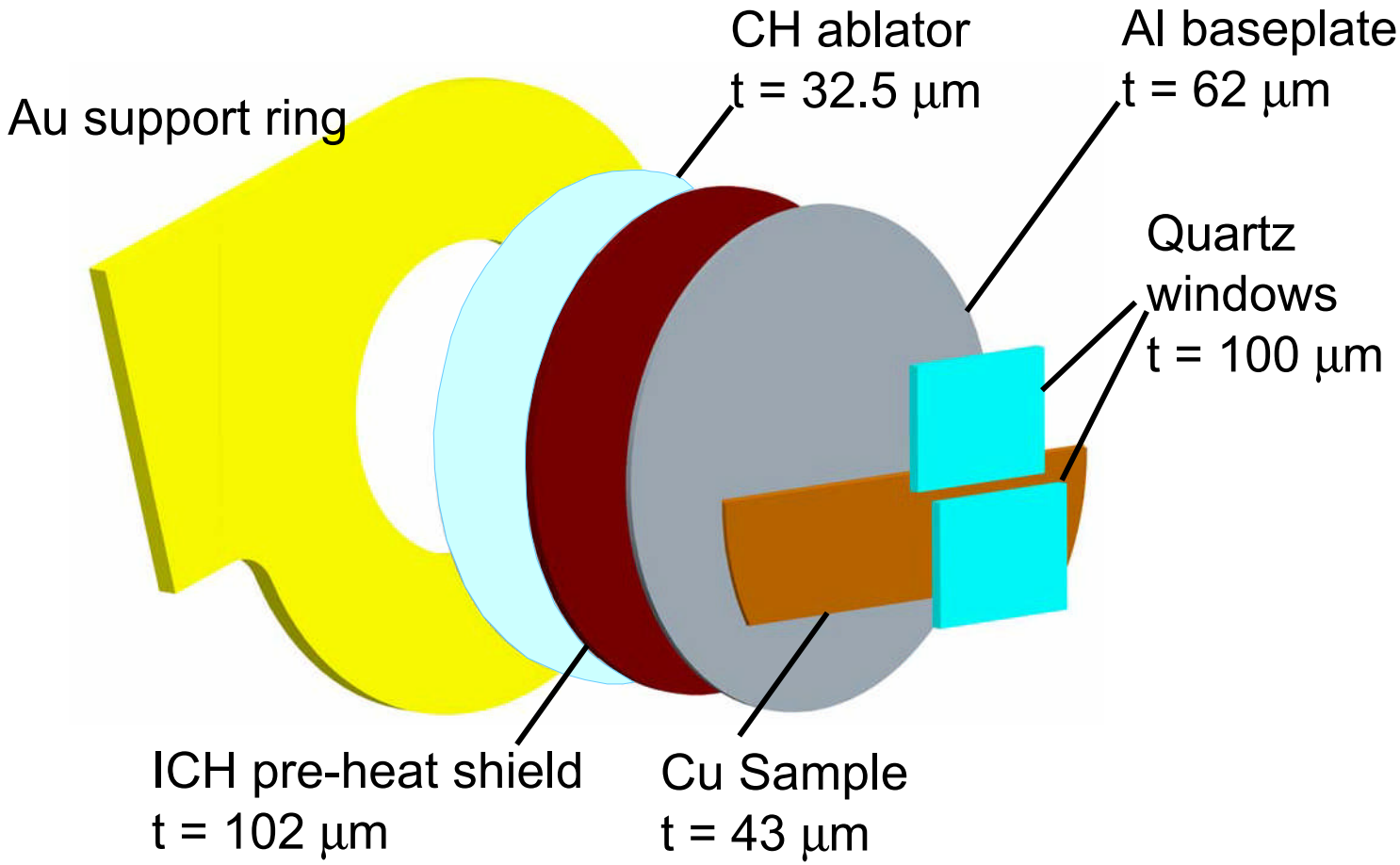
Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, CA 94551

The selection of target specifications requires close collaboration between Target Fab and Physics



To make the targets manufacturable, the specifications were re-examined and revised several times.

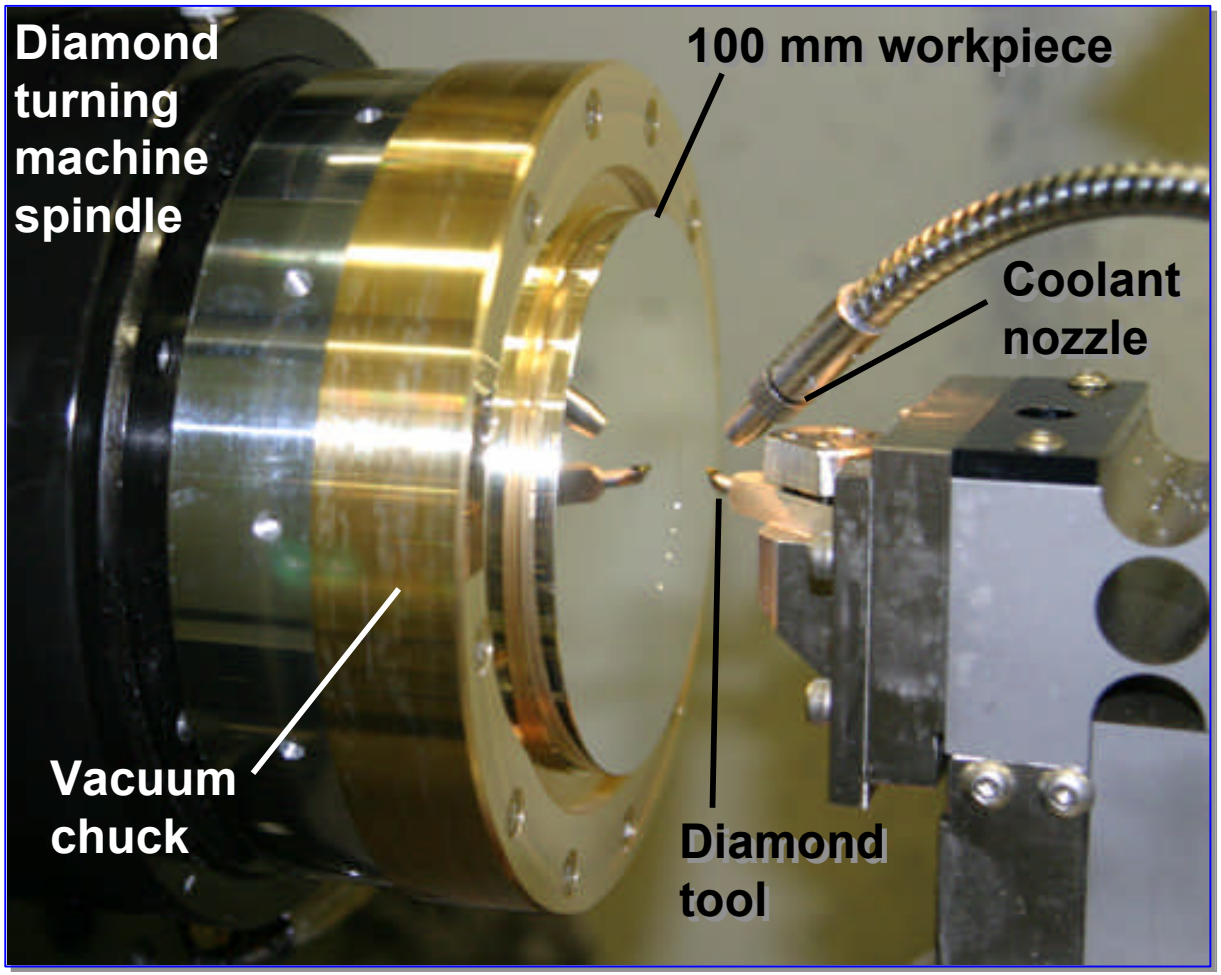
The target specifications necessitate a very precise manufacturing strategy



The required level of precision is approximately 10× that of most laser targets

The specified thickness uniformities of the components require high-precision fixturing methods

A batch of targets is built on a 6 mm thick 100 mm diameter Al disk. Both sides of the disk are diamond turned so that the faces are parallel to 0.1-0.2 μm.



To meet the specifications for the baseplate-sample joint, the Cu sample is deposited onto the Al baseplate

The requirements for the Cu-Al interface are very demanding.

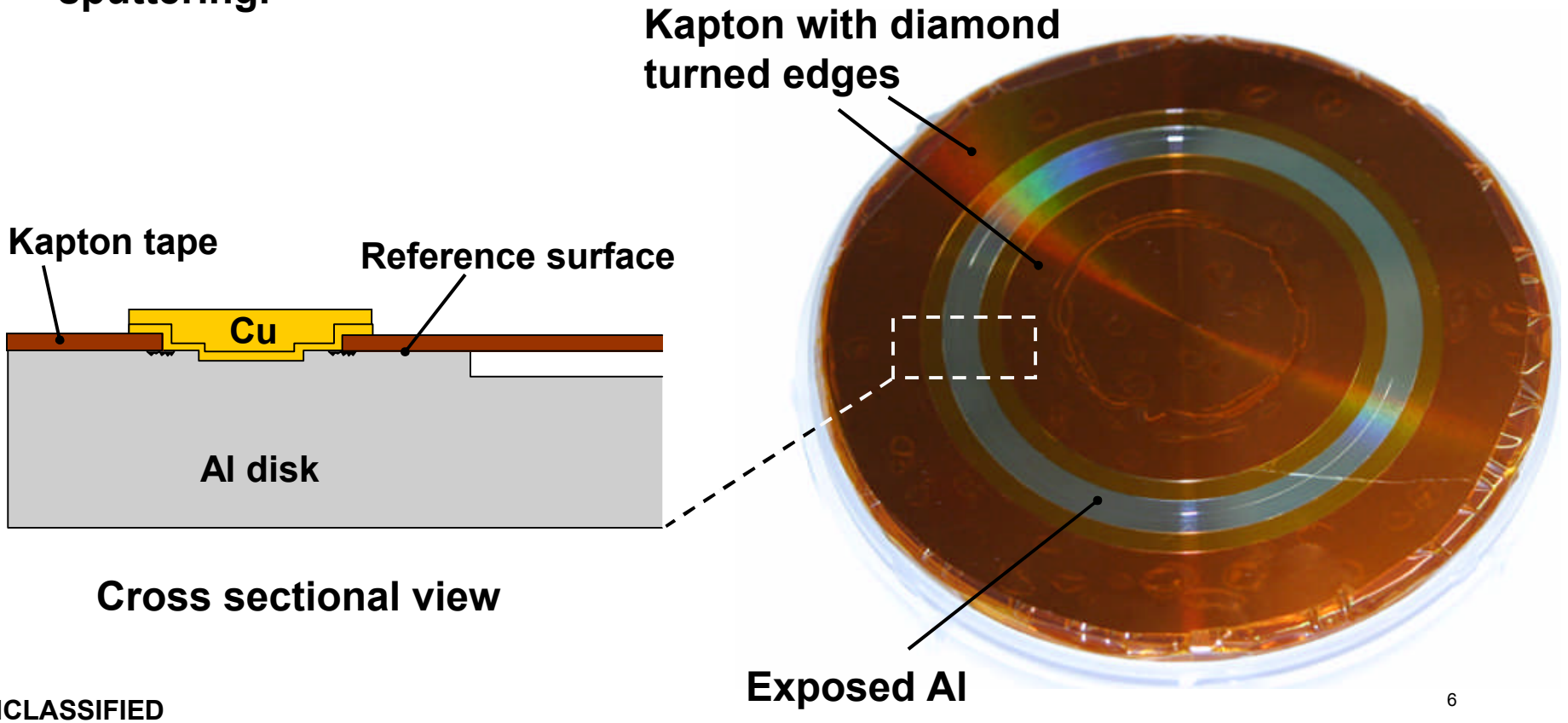
- **Cu-Al interface must be < 0.1 μm**
- **Outside the 25 μm region on either side of the edge of the Cu, all flaws must be < 0.1 μm**
- **Al disk must not be warped, scratched, pitted, or otherwise damaged**
- **Cu must have adequate adhesion for diamond turning**
- **Cu must be placed on Al disk in a band with radial tolerance of ±10 μm**

A great deal of research has gone into identifying an acceptable method of depositing Cu onto the Al disk.

The masking process is designed to accommodate flaws created in the electroplating process

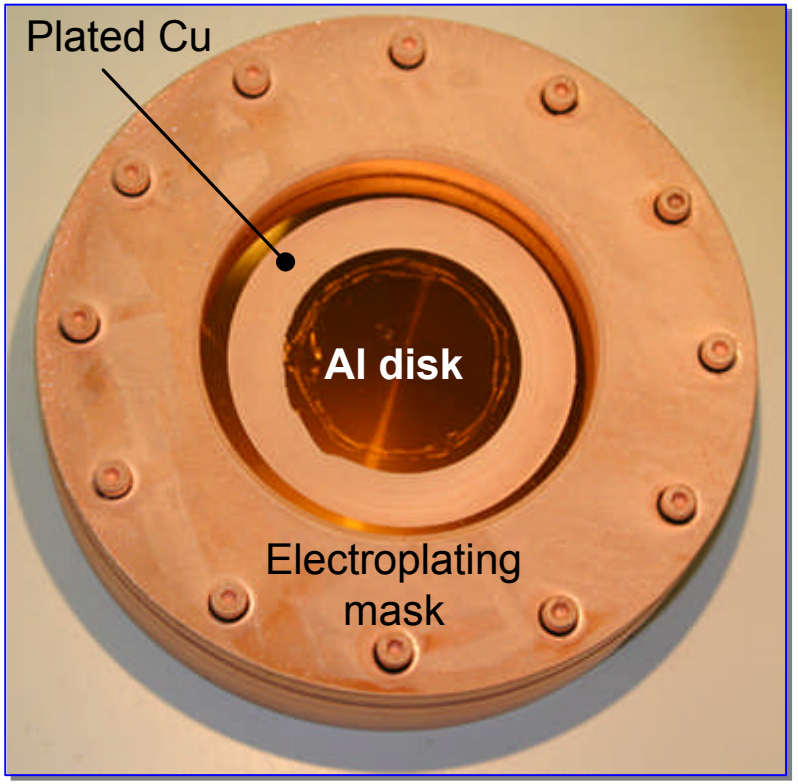
The selected deposition process sputters 3-5 μm of Cu onto the Al and then electroplates additional Cu.

The 100 mm Al disk is masked with precisely placed Kapton tape prior to sputtering.



After sputtering 3-5 μm of Cu, additional Cu is electroplated onto the sputtered Cu

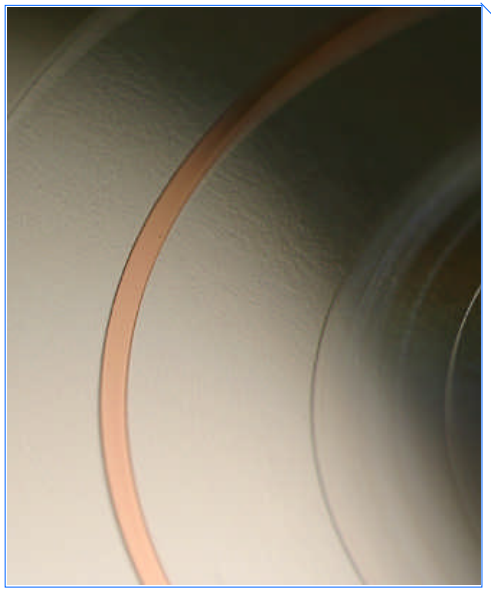
Disk masked with Kapton tape after sputtering 3-5 μm of Cu

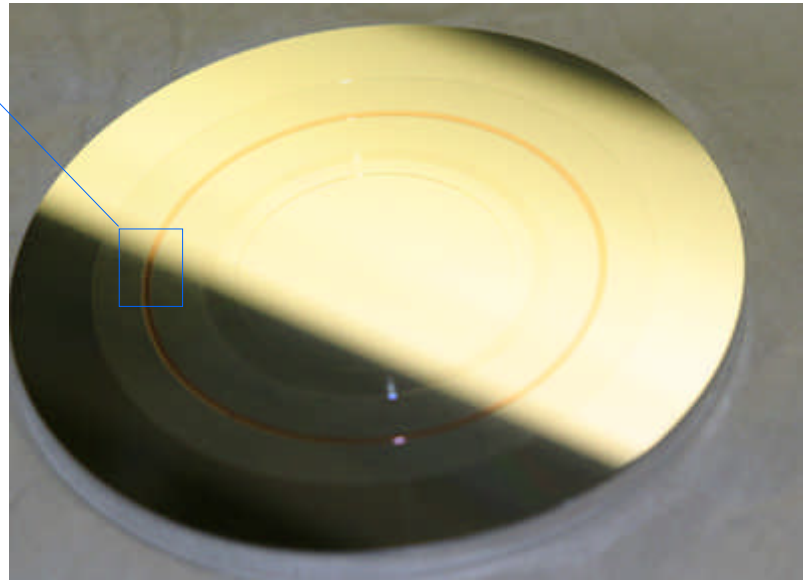


Disk in the hardmask that is used to electroplate additional Cu

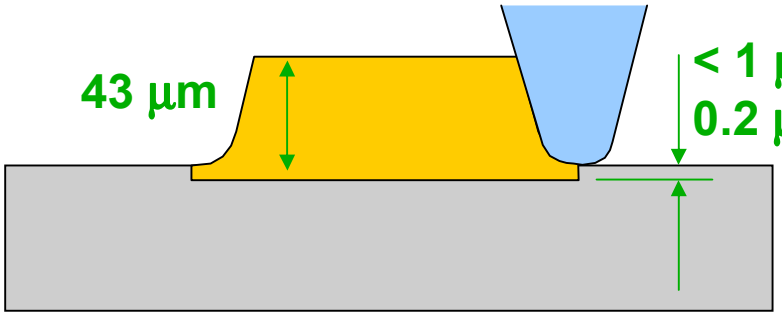
The deposited Cu is diamond turned to a thickness of 43 μm

A band of Cu of thickness 43 μm and width 1 mm is left on the surface of the Al.





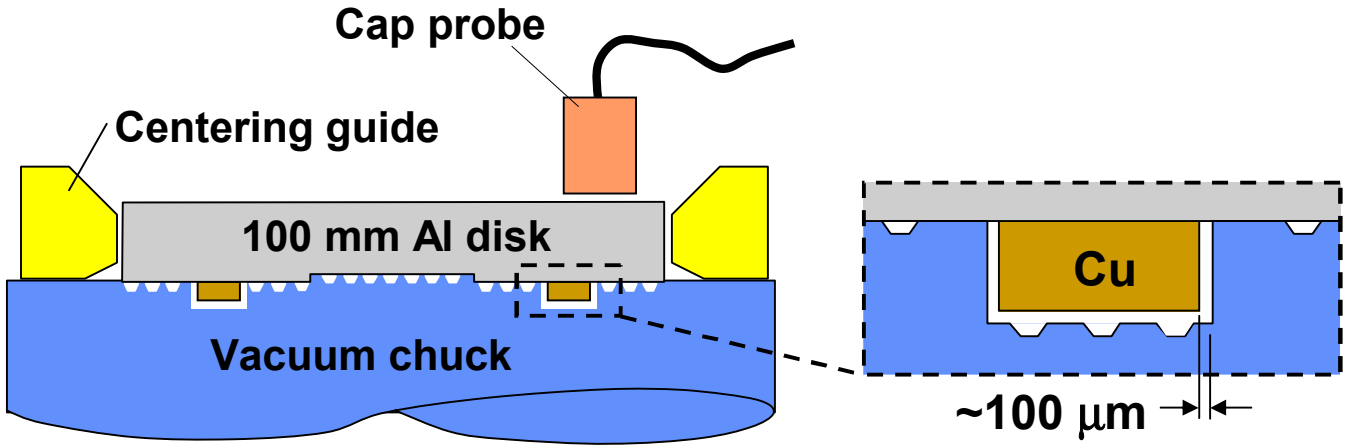
Machining may leave a 1 μm step in the Al, but it must be known to within 0.2 μm



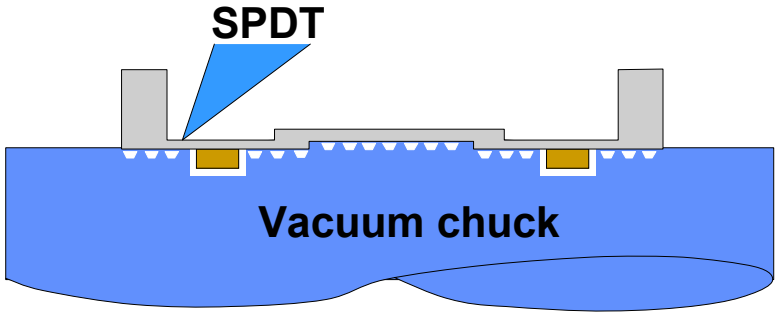
The Cu is then carefully measured in several locations with an LVDT mounted on the machine tool.

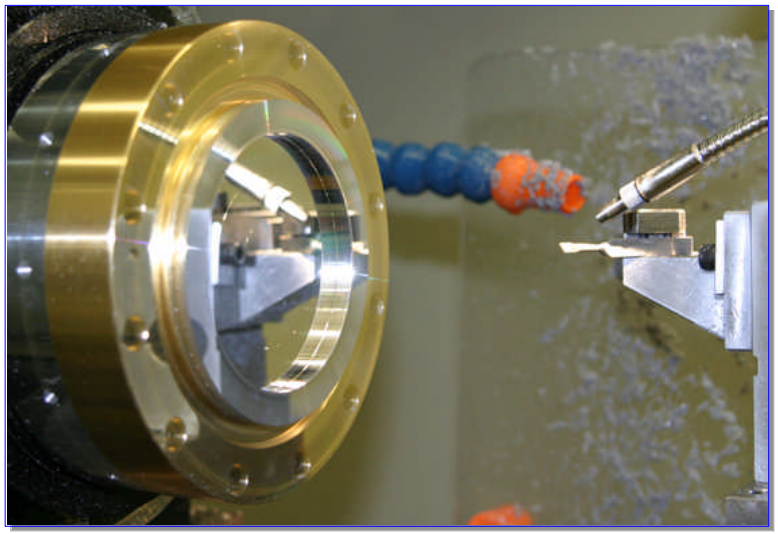
The Cu-side of the disk is placed against another precision narrow-land vacuum chuck

Centering guides allow the ring of Cu to fit precisely into a groove in the chuck.



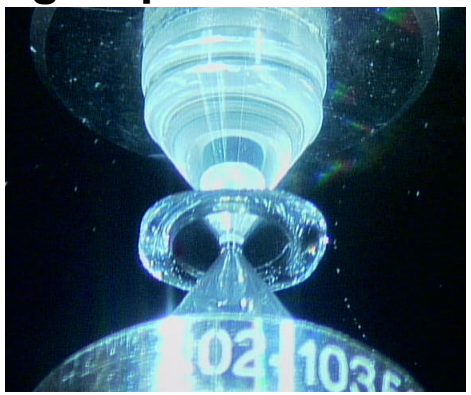
The Al disk is machined to a thickness of 62 μm to form the baseplate.

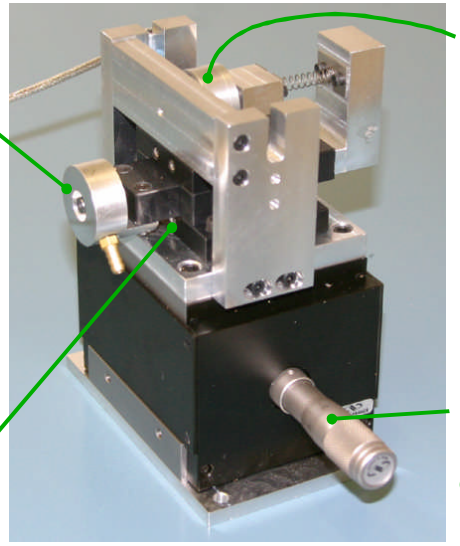




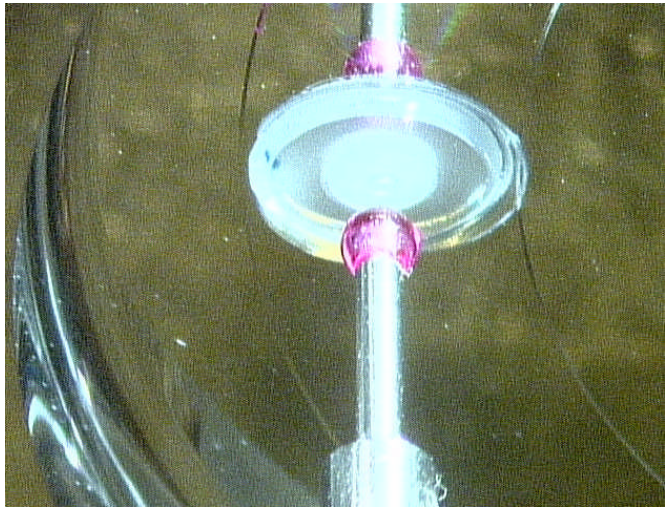
Pads of iodine-doped polystyrene are bonded and machined to form the pre-heat shields

Precise pads of iodine-doped polystyrene (ICH) are bonded to the Al using a special assembly station.





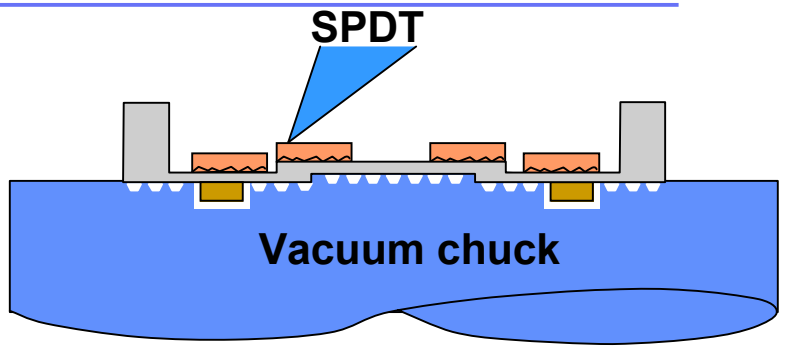
An LVDT measures the thickness of the adhesive in 4 spots.

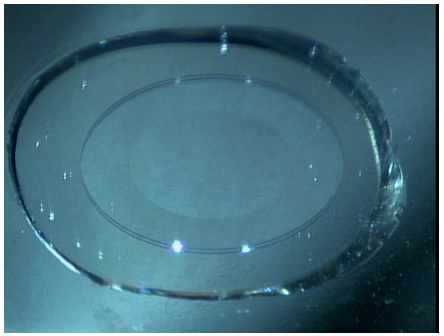


After finishing the pre-heat shields, pads of polystyrene are bonded and machined to form the ablators

The pads of iodine-doped polystyrene are diamond turned to the required thickness to complete the pre-heat shields.

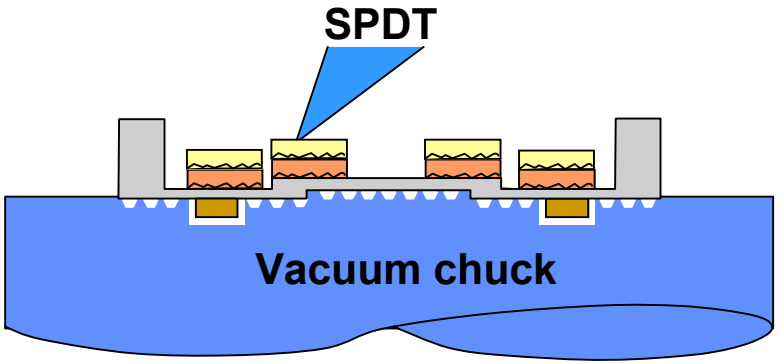
The pre-heat shields are then measured again with the LVDT in 4 spots.





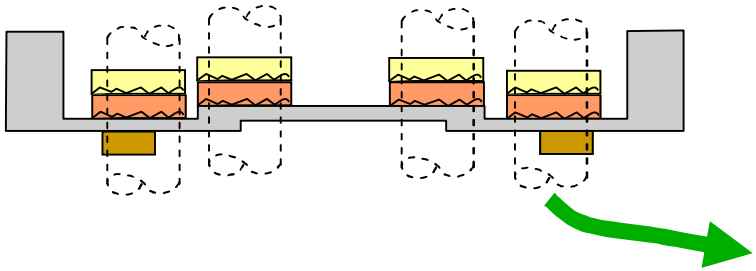
Diamond turned pad

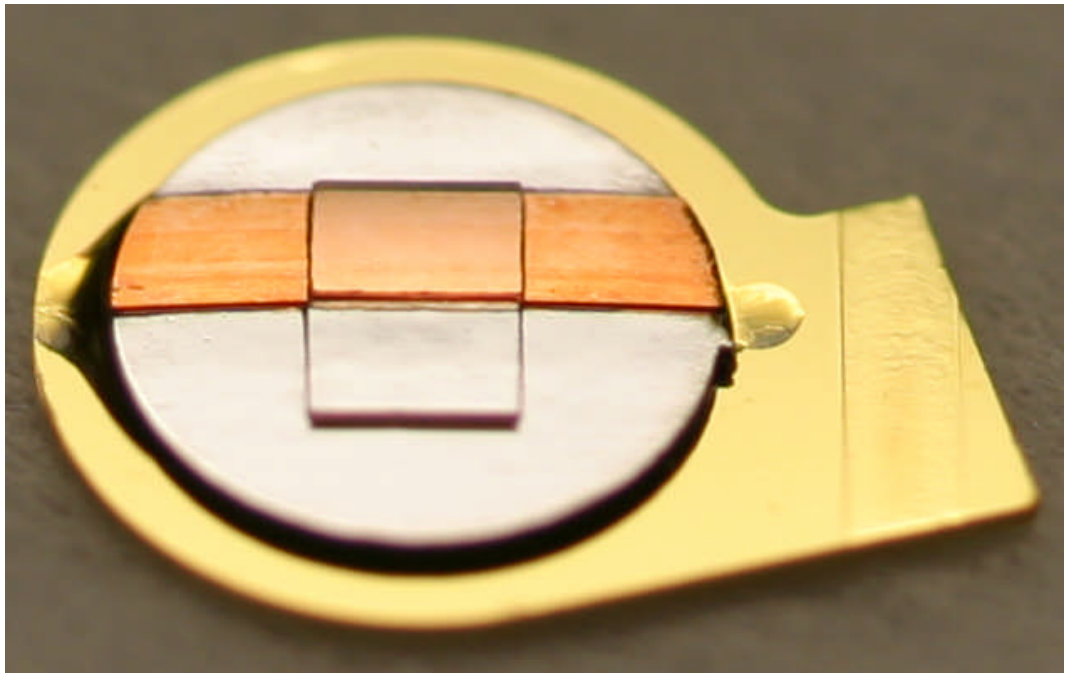
To form the ablators, the process of bonding, measuring, machining, and measuring is repeated with pads of polystyrene (CH).



Targets are laser cut from the 100 mm disk and bonded to windows and support rings

The “ablator – preheat shield – baseplate – sample” subassemblies are laser cut from the 100 mm disk





Summary - close collaboration between Target Fab and physicists is crucial to designing manufacturable targets

- Metrology is almost as labor-intensive as the fabrication process.
- The required level of precision is approximately 10× that of most laser targets. Extreme care must be taken at each step of the process.
- Appropriate fixturing of the workpiece is critical to achieving the manufacturing and metrology tolerances.
- The seating of the workpiece against the vacuum chucks must be verified at each step.
- A great deal of research has gone into identifying an acceptable method of depositing Cu onto the Al disk. Sputter-seeded electroplating was identified as an acceptable method of depositing the Cu.
- Batch processing allows several targets to be produced from each 100 mm disk.