
Thin Diamond Radiator Fabrication for the GlueX Experiment

Brendan Pratt

with

Fridah Mokaya

Richard Jones

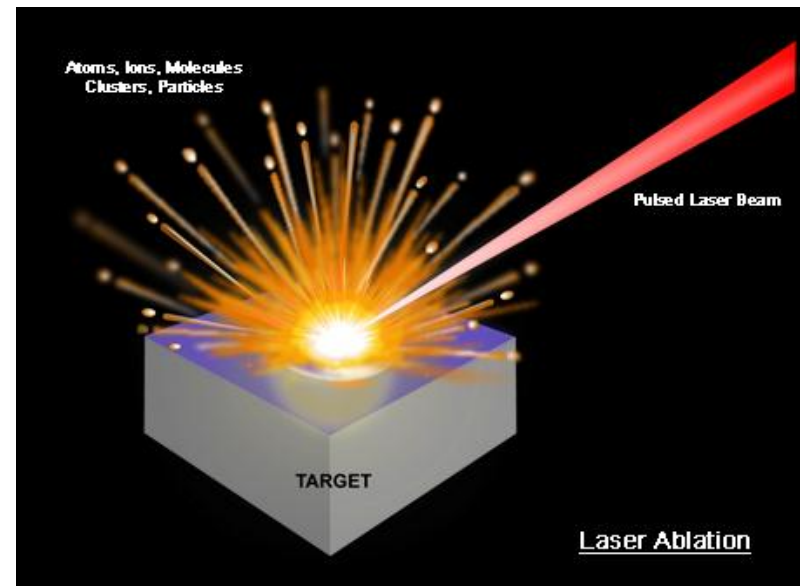
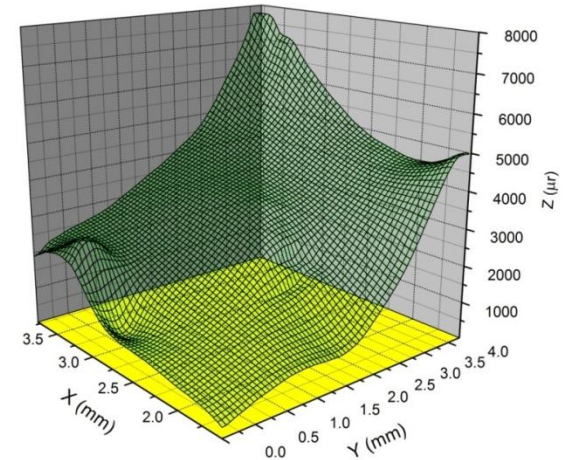
University of Connecticut

Outline

- Overview of GlueX
- UConn Laser Ablation Setup
- Analysis of Radiator Samples

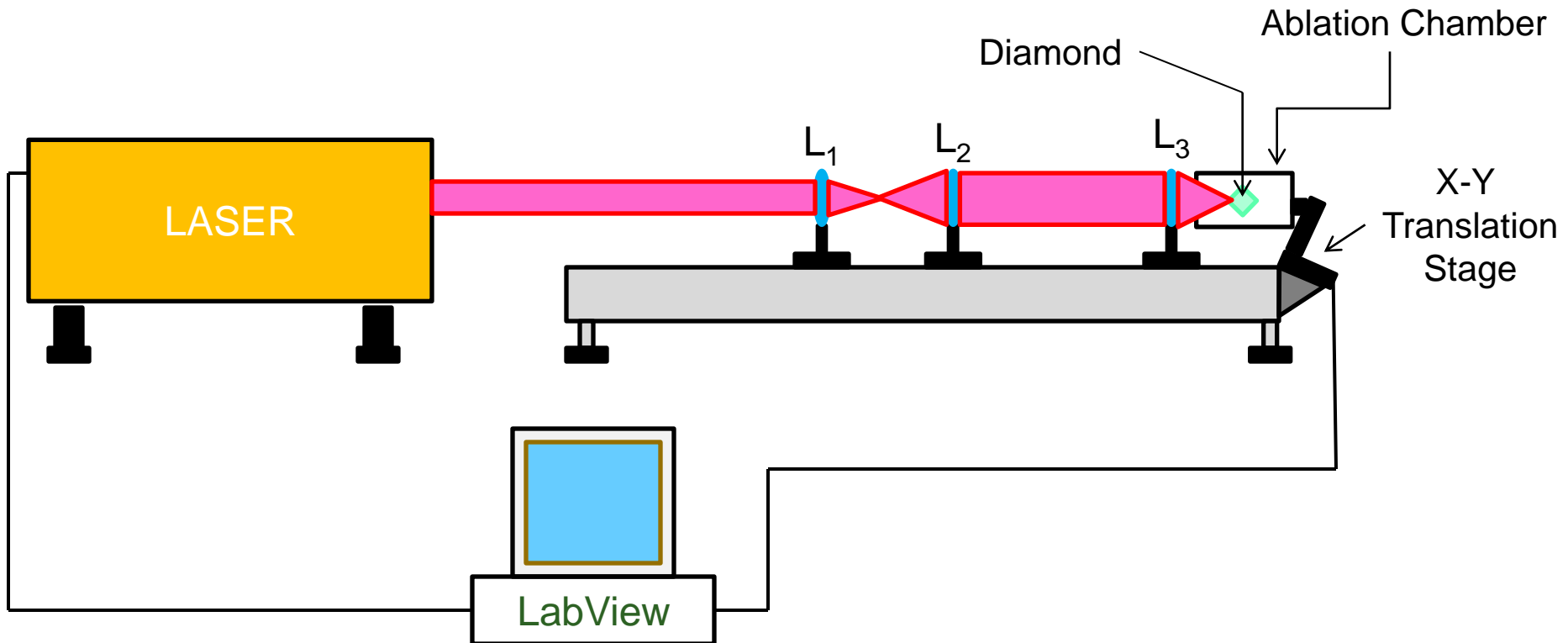
Thin and Flat Diamonds

- Radiators restricted to 20 μm thickness due to multiple scattering
- Must also have well defined crystal structure with whole crystal rocking curves less than 30 μr
- Techniques for thinning diamond exist, but they leave samples stressed and “potato chipped”
- Laser ablation as a viable method for machining while keeping internal crystal structure unchanged



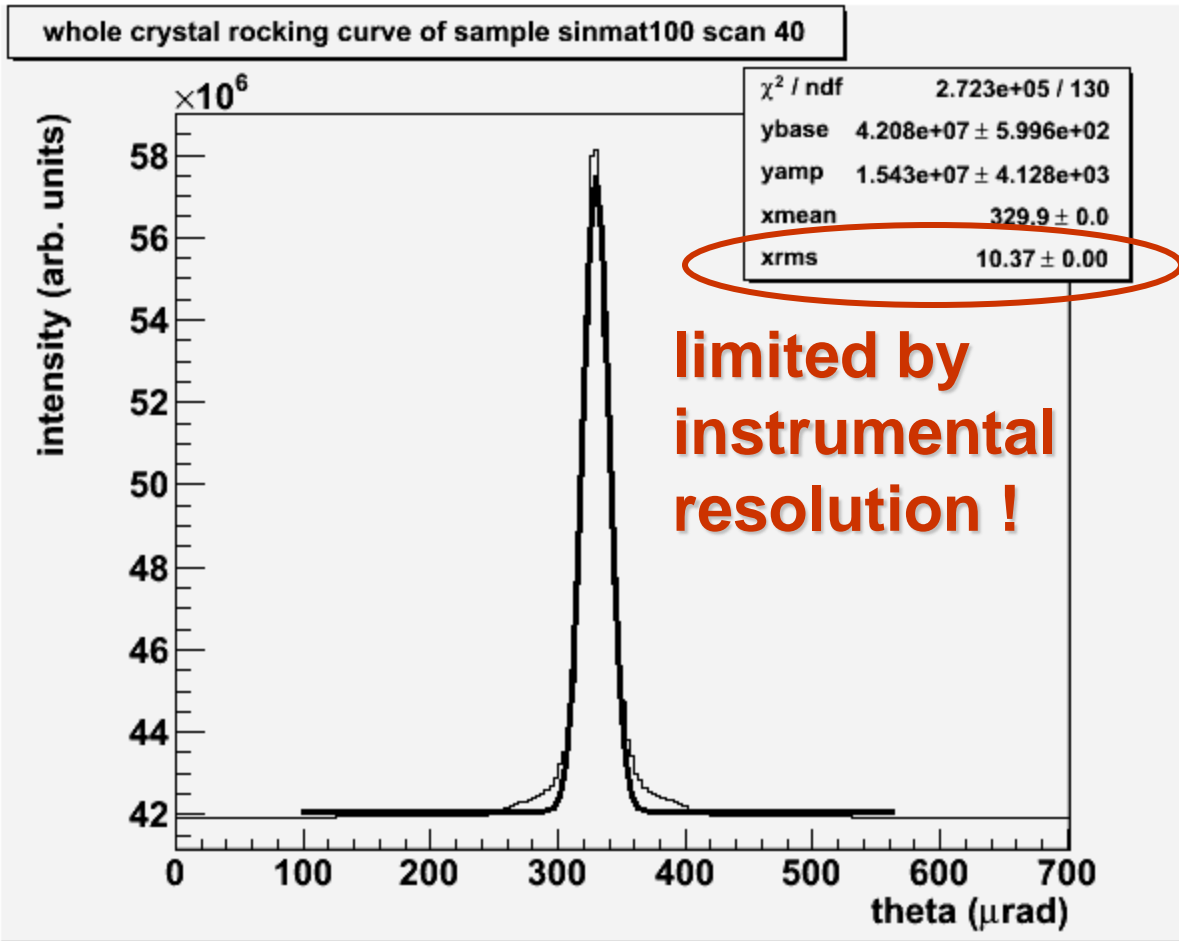
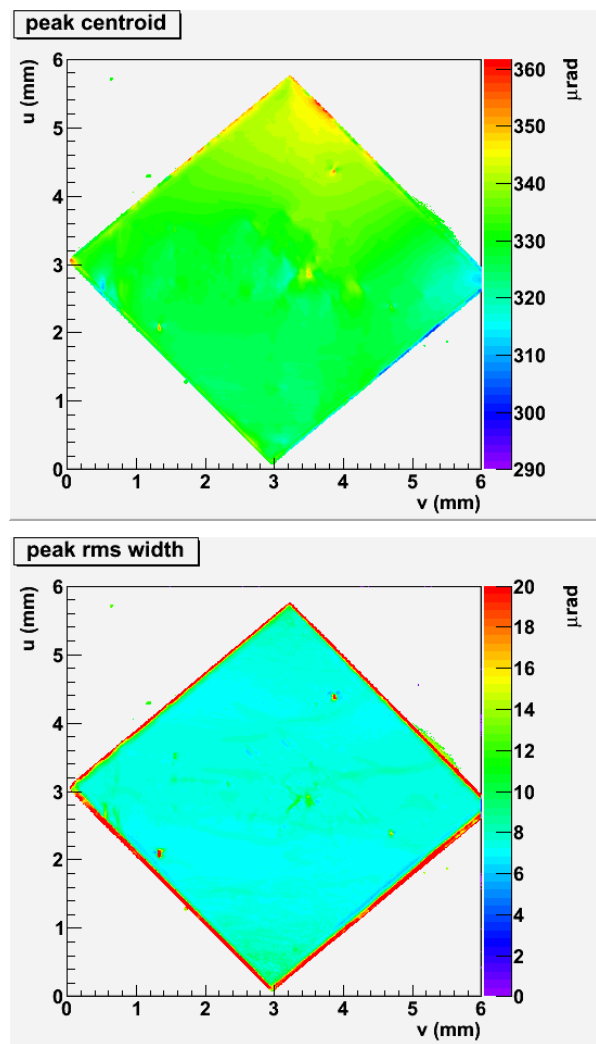
UConn Laser Ablation Facility

- CNC style XY translation and laser pulsing via LabView
- Ablation Chamber optimized to reduce amorphous carbon deposition on windows
- Enhanced optics to reduce spherical aberrations (sub micron beam spot)



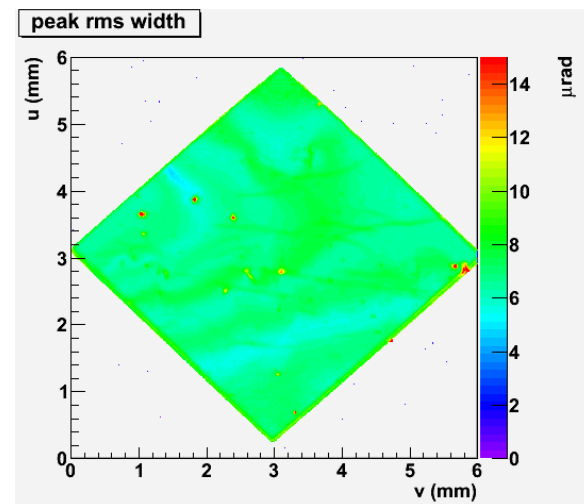
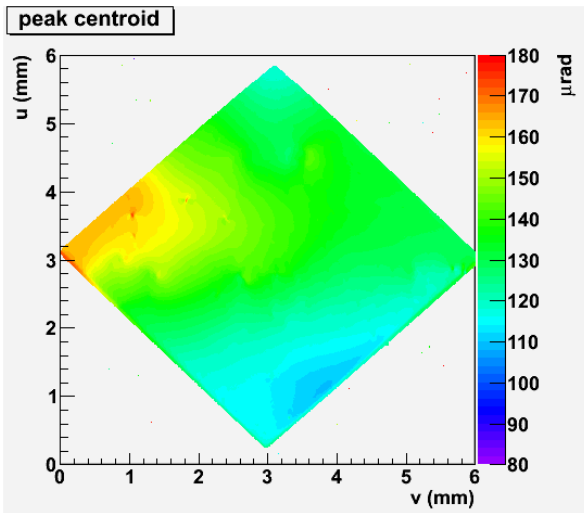
X-ray assessment: S150

surface of S150 was polished with RCMP process

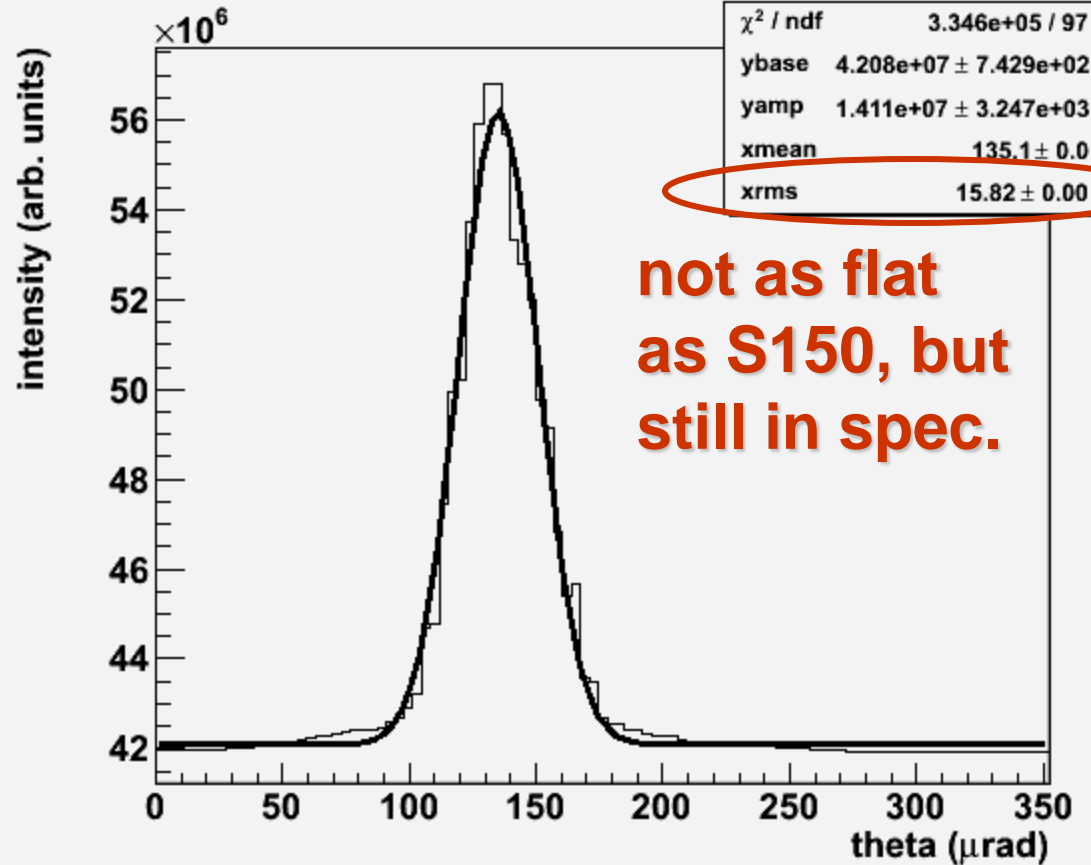


X-ray assessment: S90

surface of S90 was not treated after VPIE process

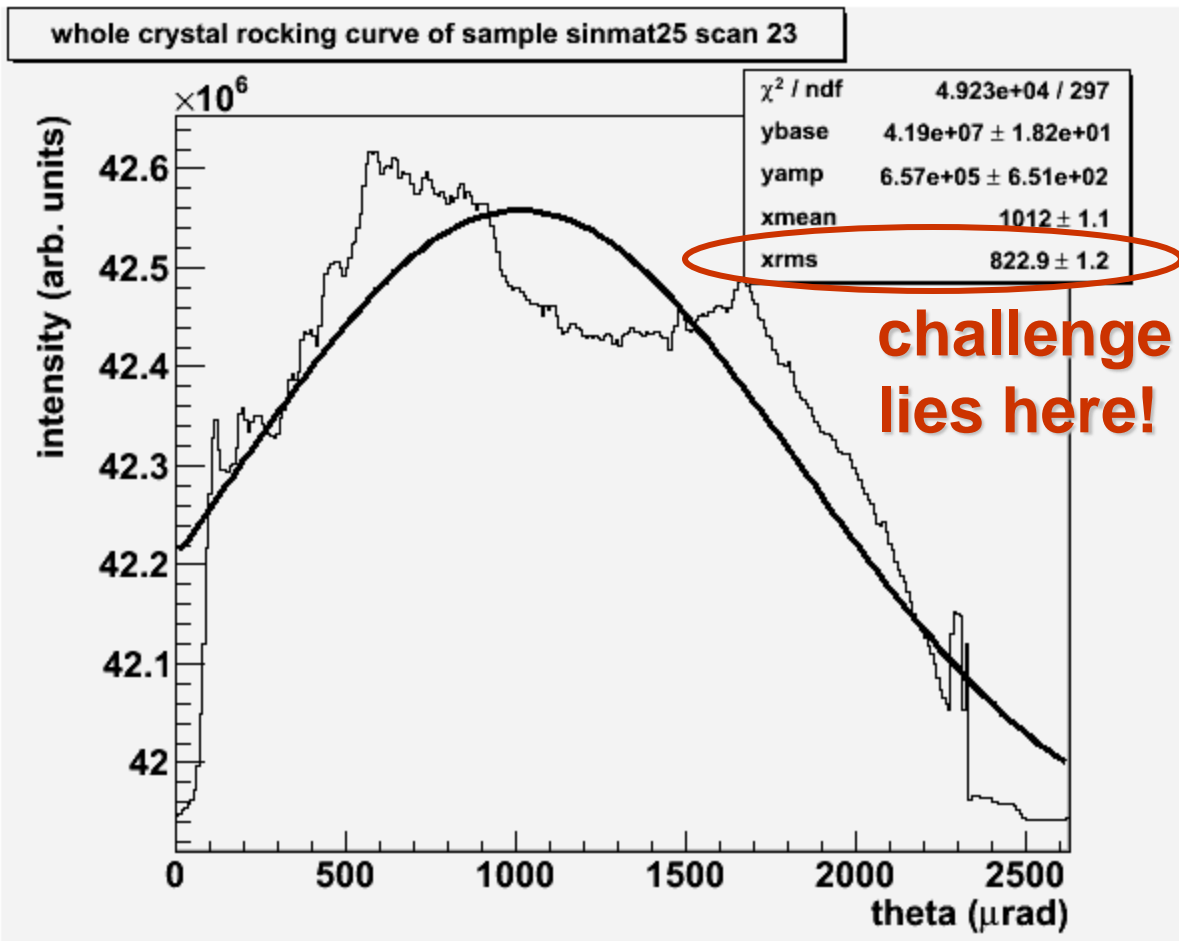
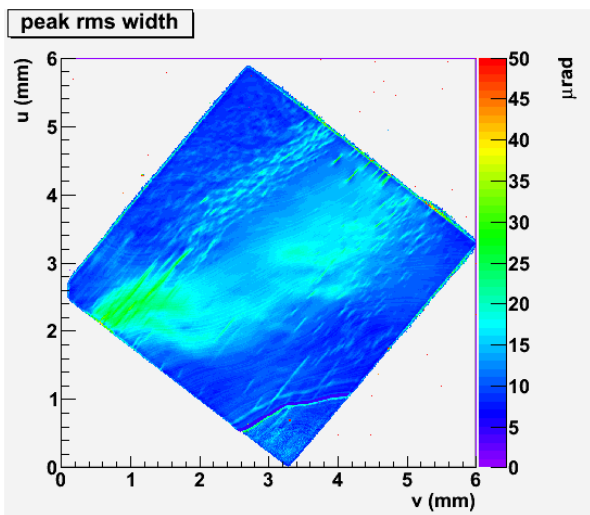
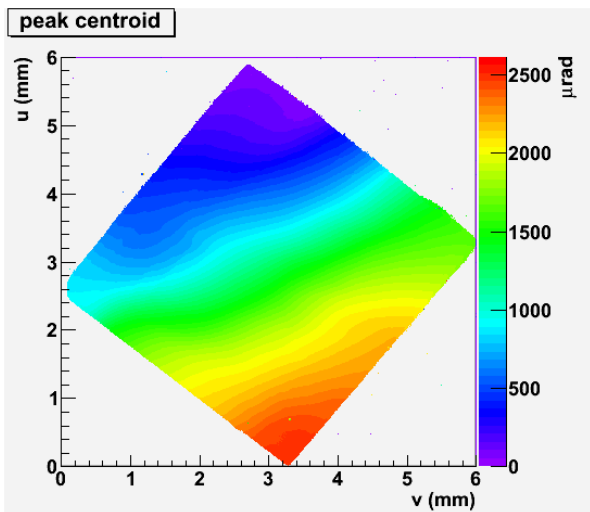


whole crystal rocking curve of sample sinmat50 scan 1



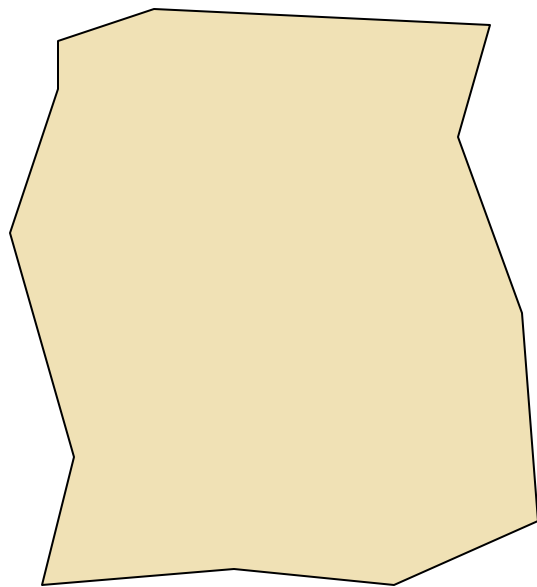
X-ray assessment: S30 – the *real* target

surface of S30 was not treated after VPIE process



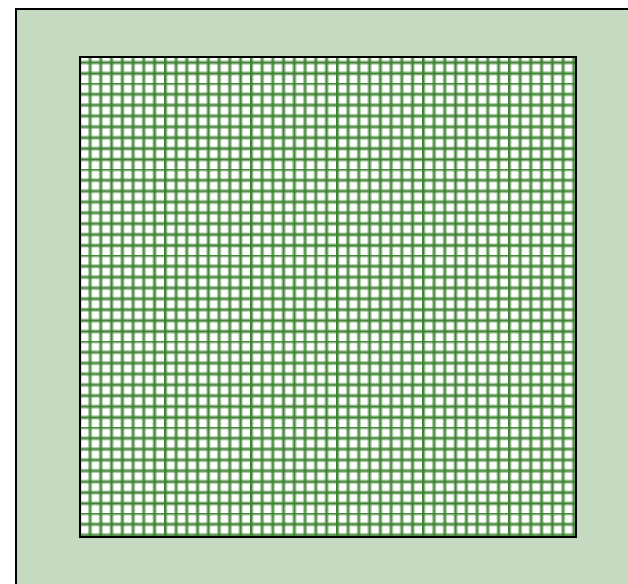
new idea tested in 2012: *add a frame*

diamonds appear to warp severely when thinned to 20 microns



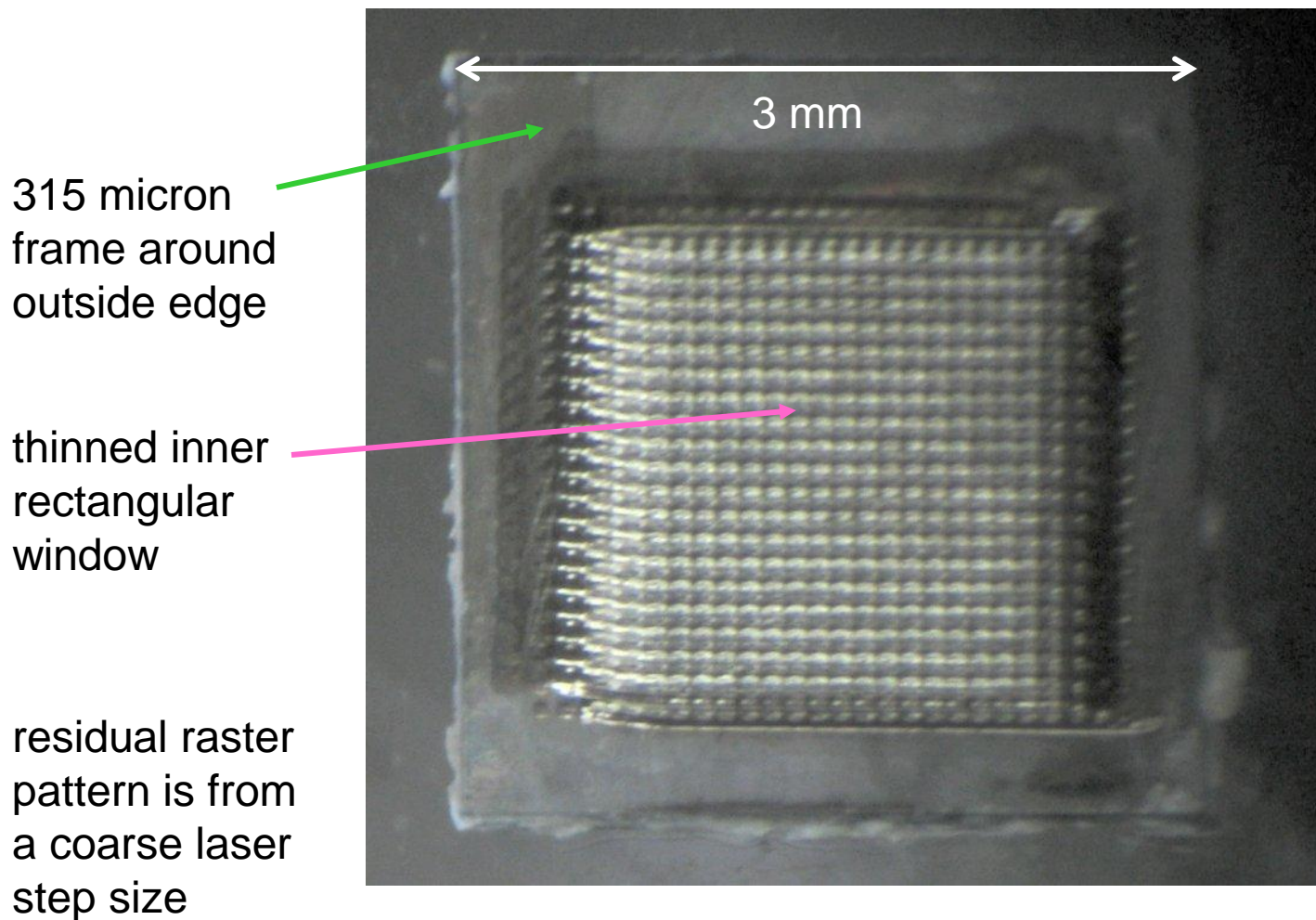
warping is from combination of mounting and internal stresses

try to stiffen the diamond by leaving a thick outer frame around the 20 micron region



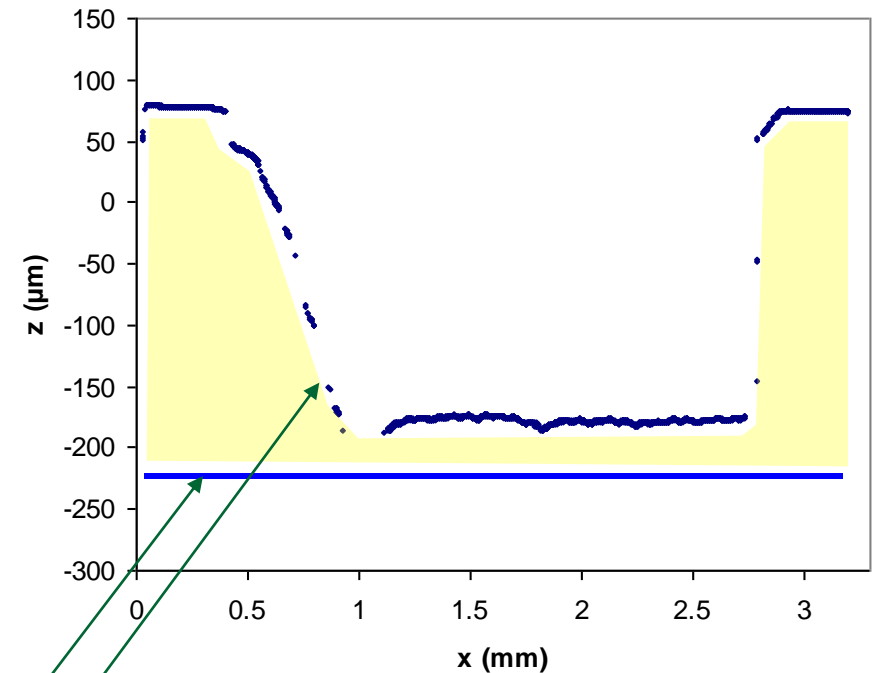
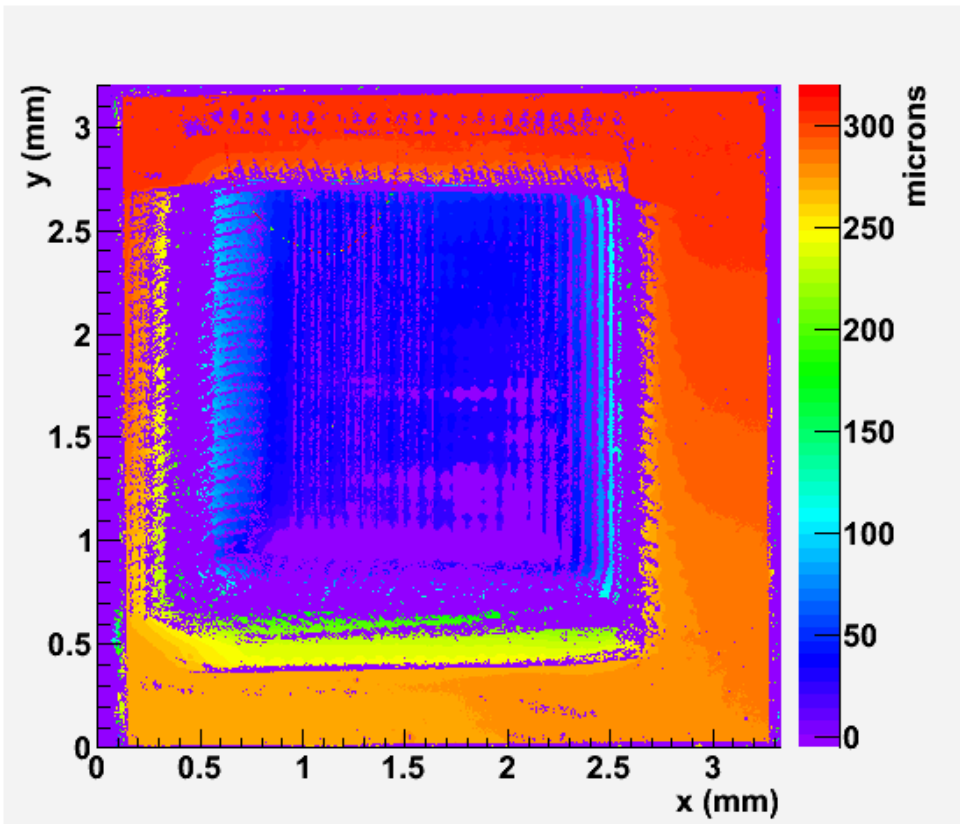
frame around 20 micron is still part of the single crystal, maintains planarity

First “picture frame” sample: U40



3D Zyo Images of U40

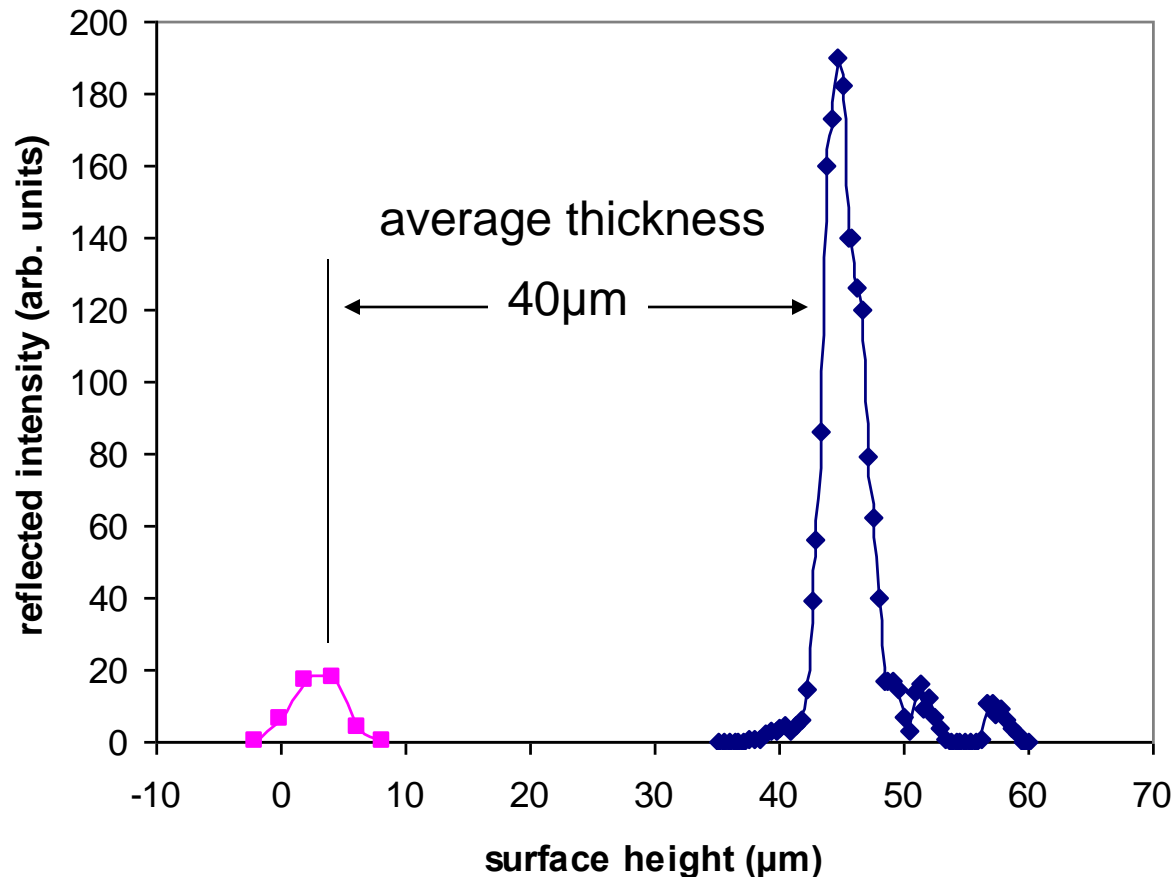
White-light interferometer gives surface and thickness profiles with sub-micron prec.



top surface measurements with Zygo
approximate bottom surface depth,
Zygo measurement on next slide

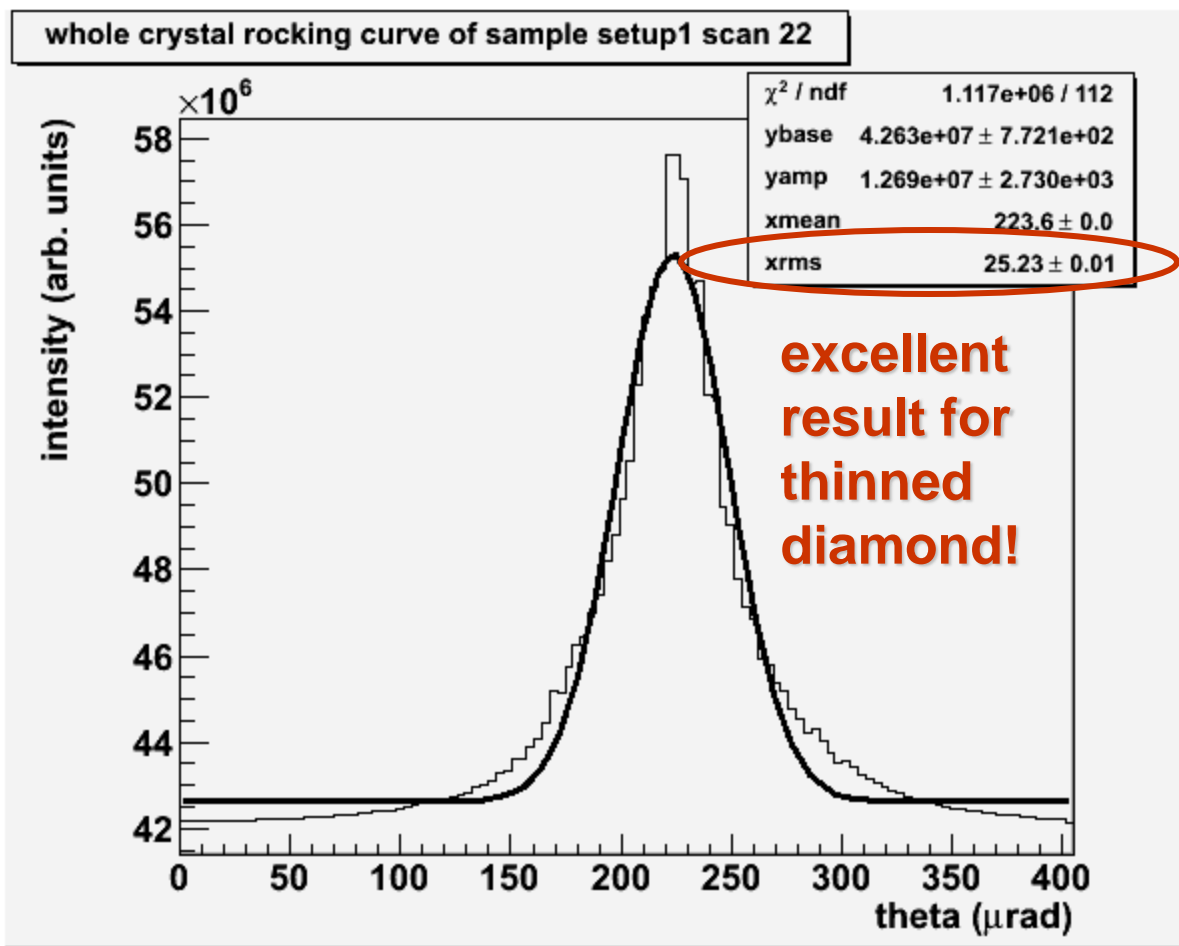
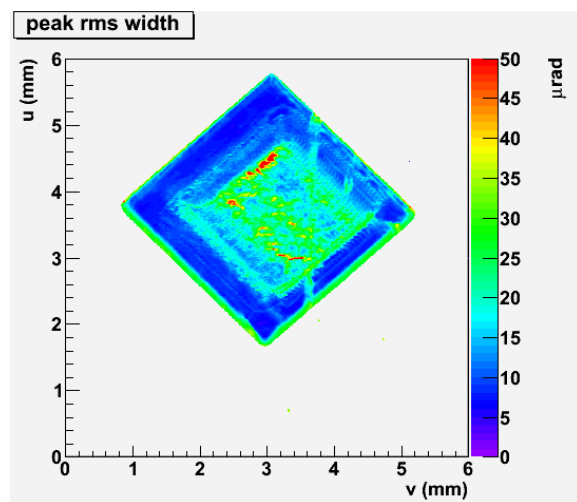
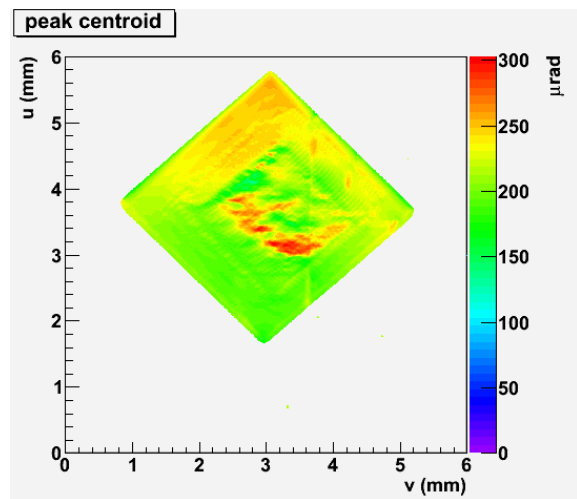
3D Zygo Images of U40

White-light interferometer gives surface and thickness profiles with sub-micron prec.



X-ray rocking curve for U40

surface of U40 was not treated after ablation



Observations on ablated sample

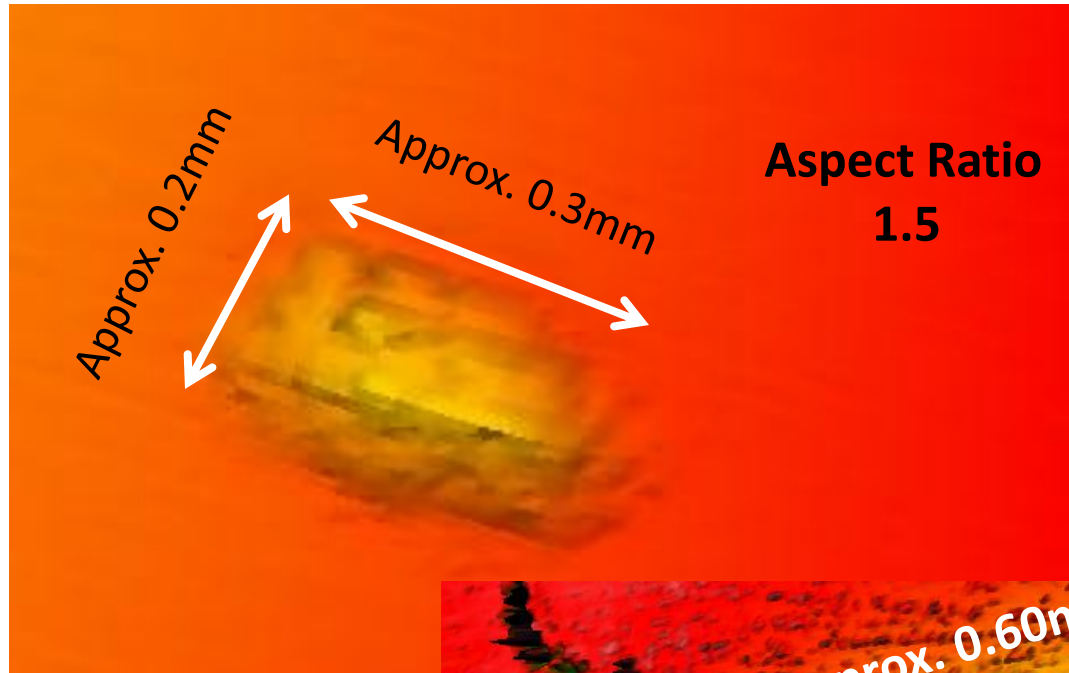
- Central region looks good
- Sharpness of the walls does not degrade with depth
- Pileup of amorphous carbon is not catastrophic
- So far no clouding of the ablation chamber window from residue

- **Excellent flatness of the central region**
- **So far no need for active correction to cutting rate,** but pulse-by-pulse recording of laser power is being collected, can be used to keep the milling rate even more uniform
- Exploring annealing techniques

Questions?

Extra Slides

New vs. Old Spot Profile



Wider spot size in y allows for larger step sizes and faster rasterizing.

