Ongoing Work at UConn on diamonds and replacement fibers

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University of Connecticut
GlueX Collaboration Meeting May 2016

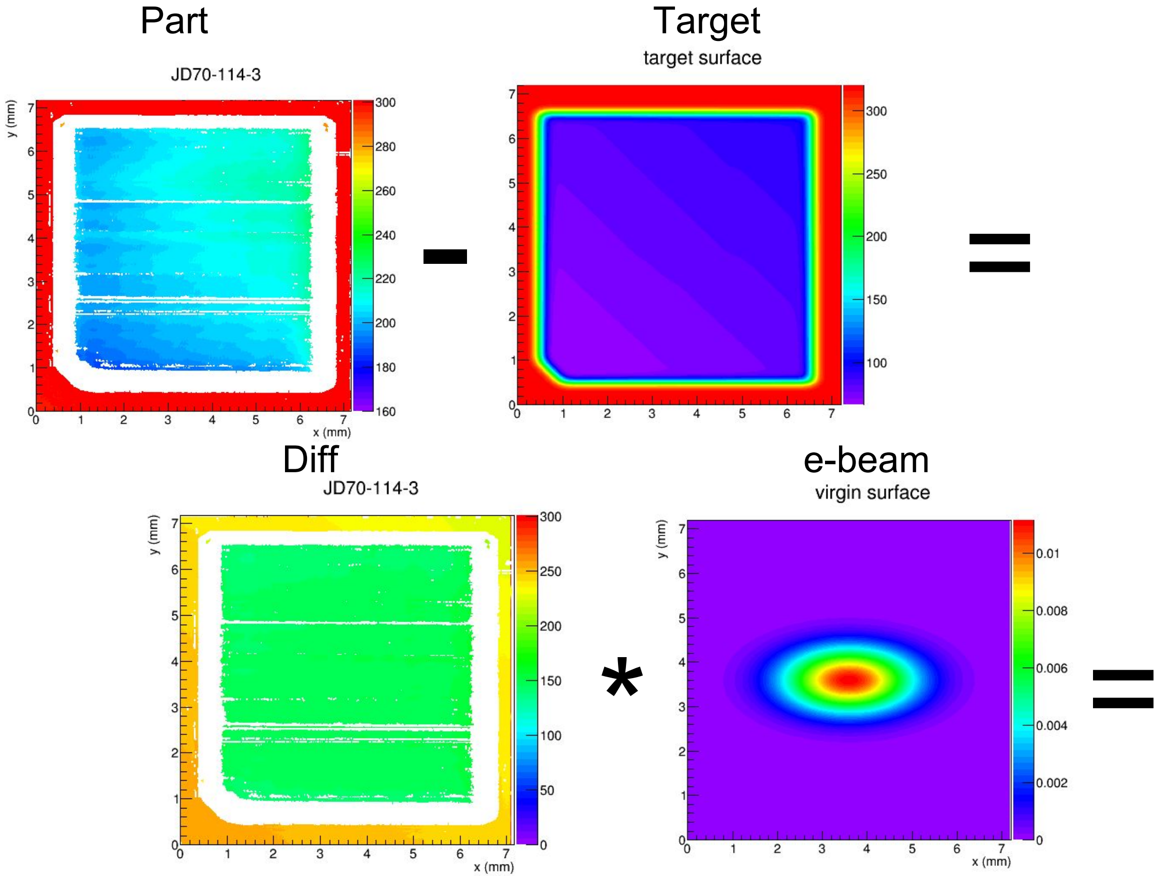
OUTLINE

- **CHESS results**
- **Laser status and ablation upgrades**
- **Ongoing work**

Measuring thickness:

electron beam

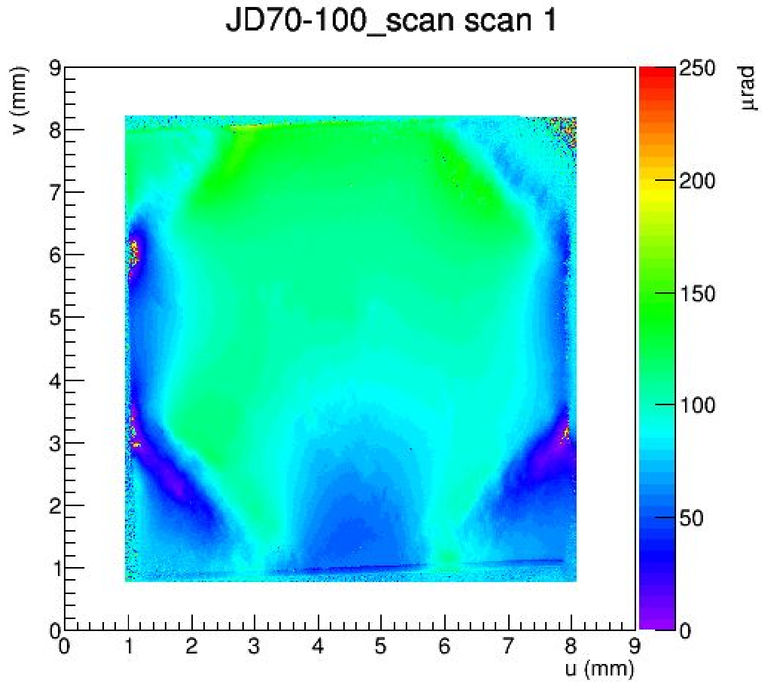
σ_x : 1e-3m
σ_y:0.5e-3m
Normalized
Shows diamond thickness seen by the electron beam

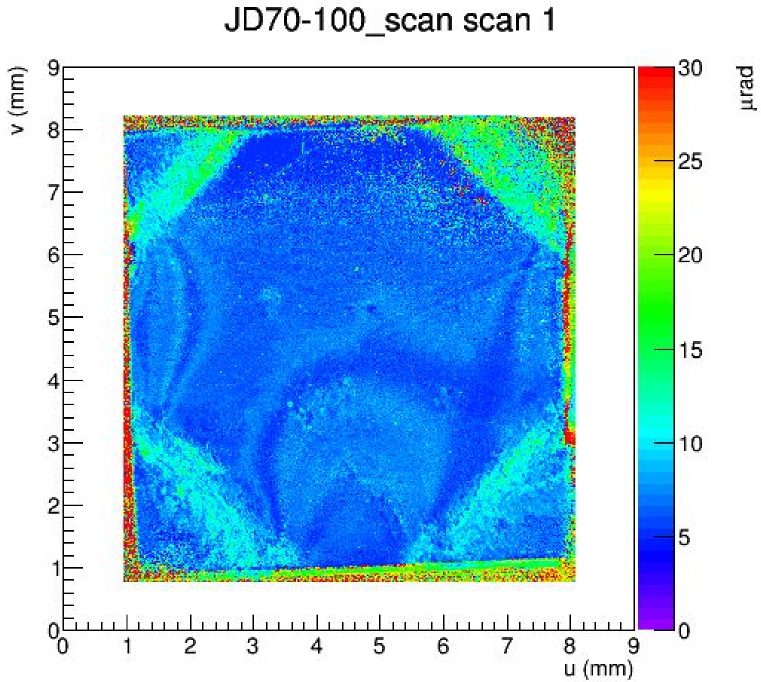


thickness

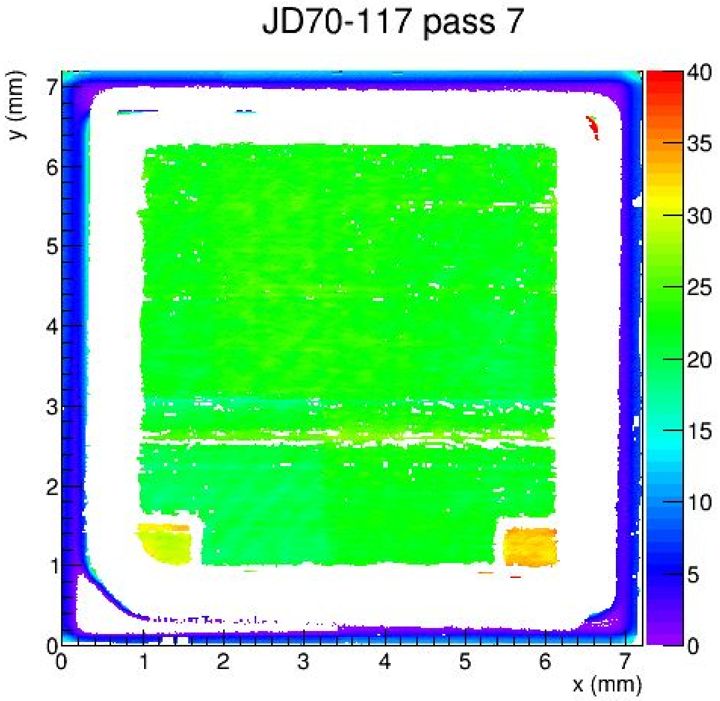
JD70-100: CHESS data

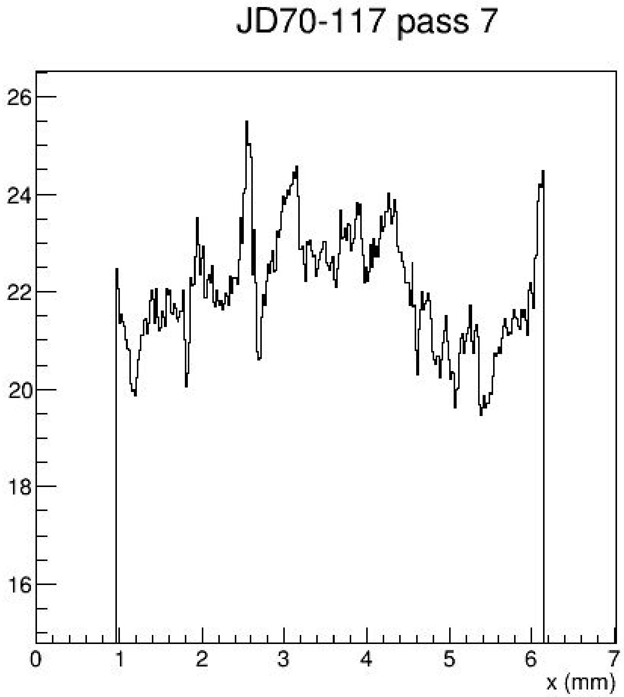
w.c.r.c. $\sigma = 16.3 \mp 0.1 \mu r$





JD70-117: 21.6 ± 0.5μm

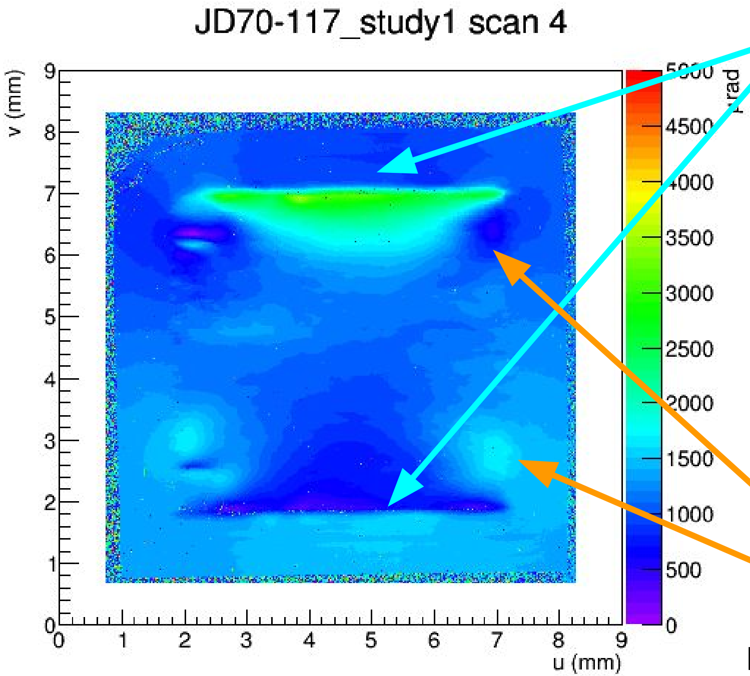


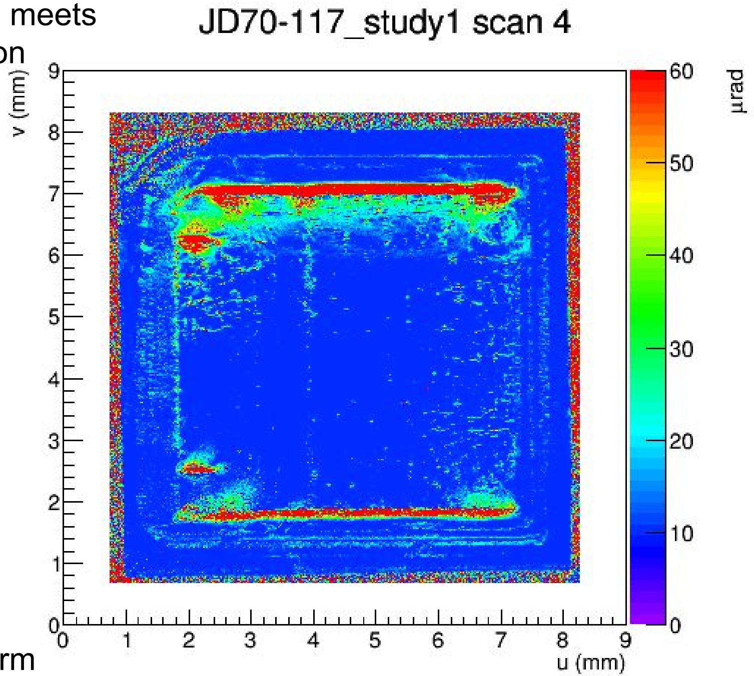


JD70-117: CHESS data

w.c.r.c. σ = 320.4 ∓ 0.1μr

Highest stress point where frame meets thinned region

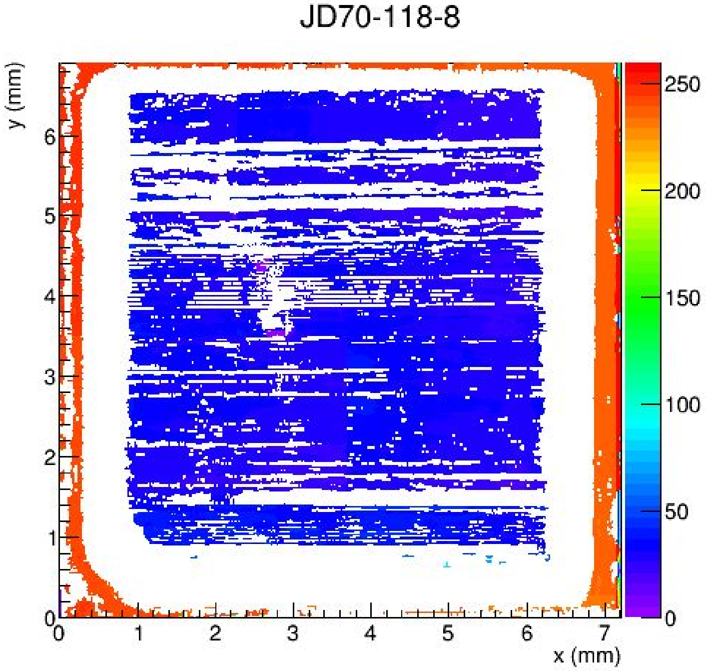


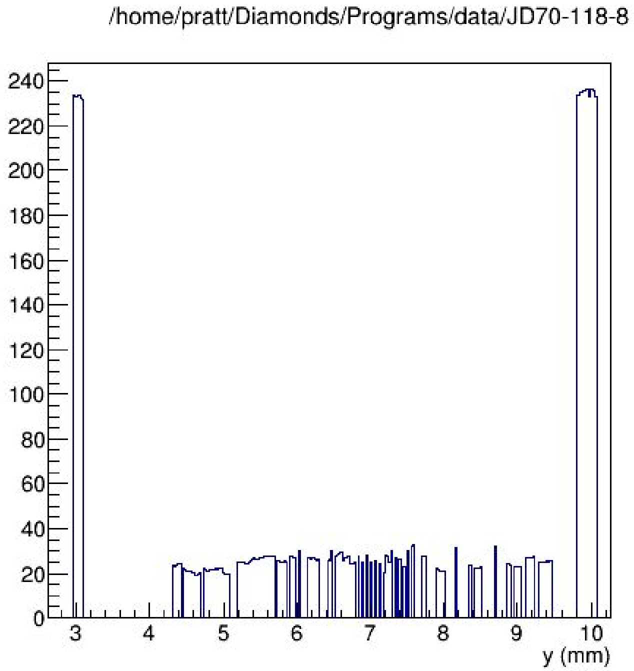


Relief pockets form

Peak centroid

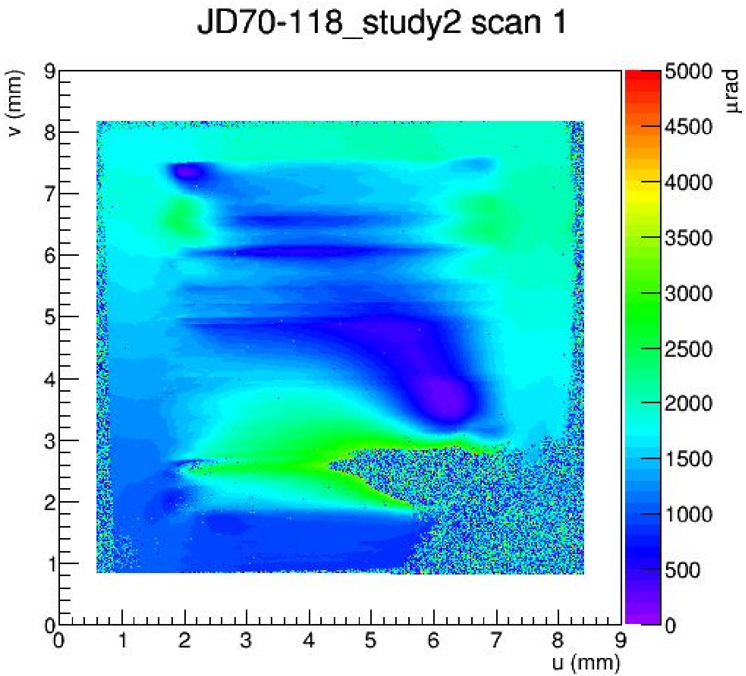
JD70-118: 31.1 ± 0.5μm

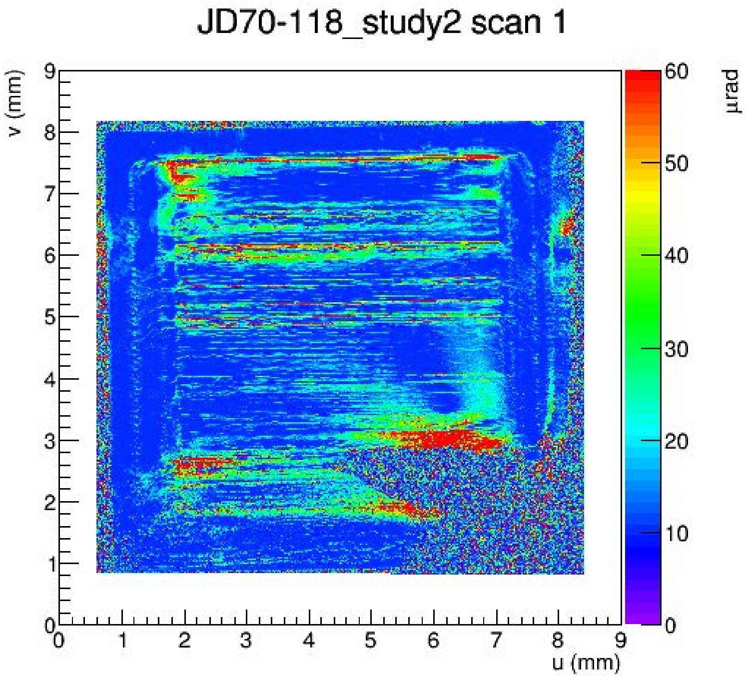




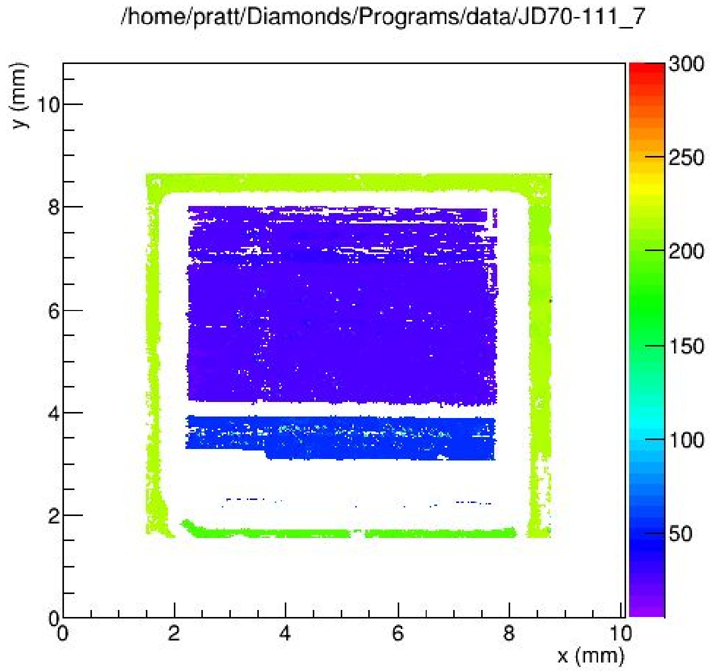
JD70-118: CHESS data

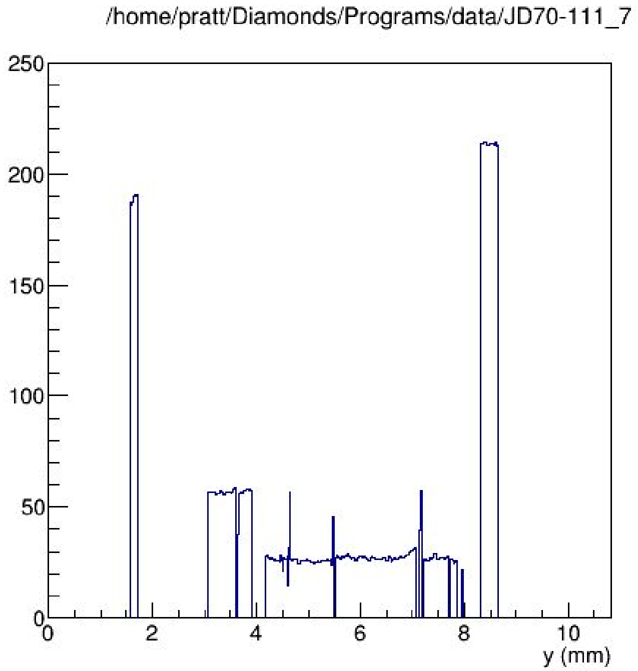
w.c.r.c. $\sigma = 537.9 \mp 0.1 \mu r$





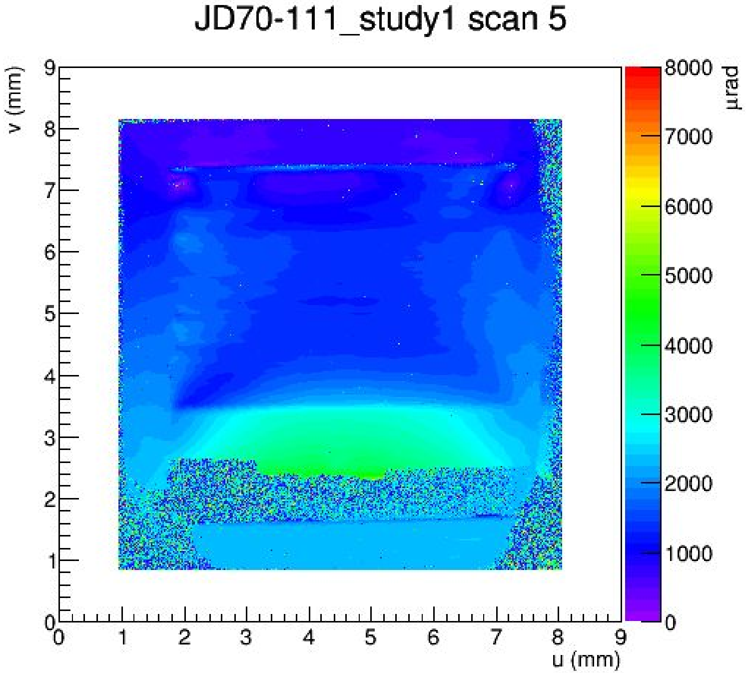
JD70-111: 26.4 ± 0.4μm

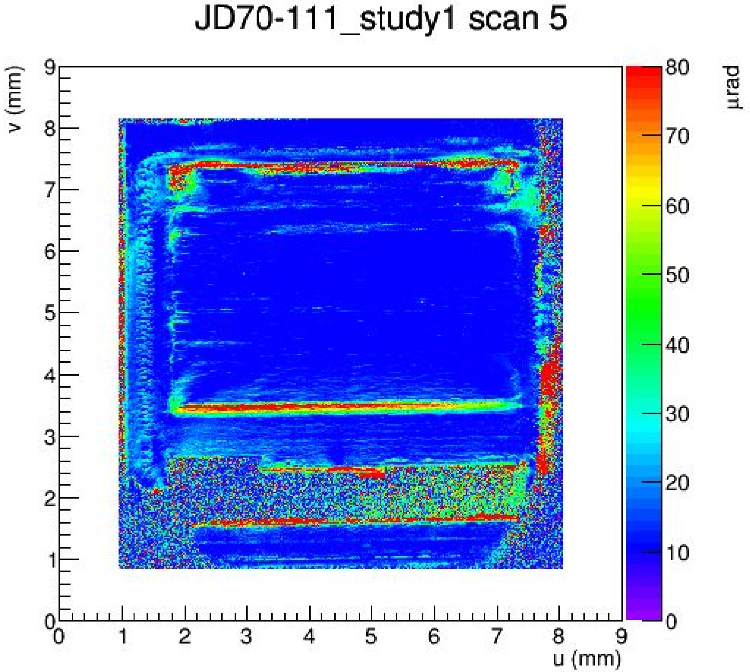




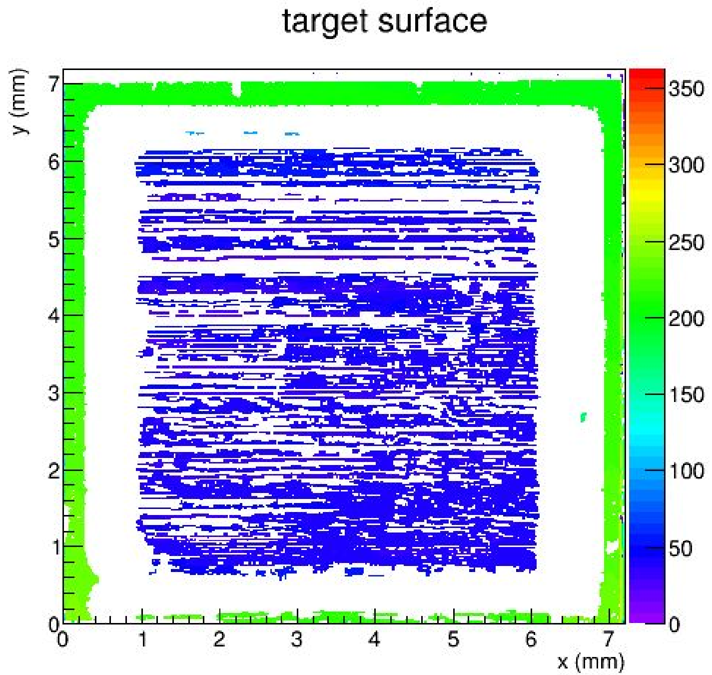
JD70-111: CHESS data

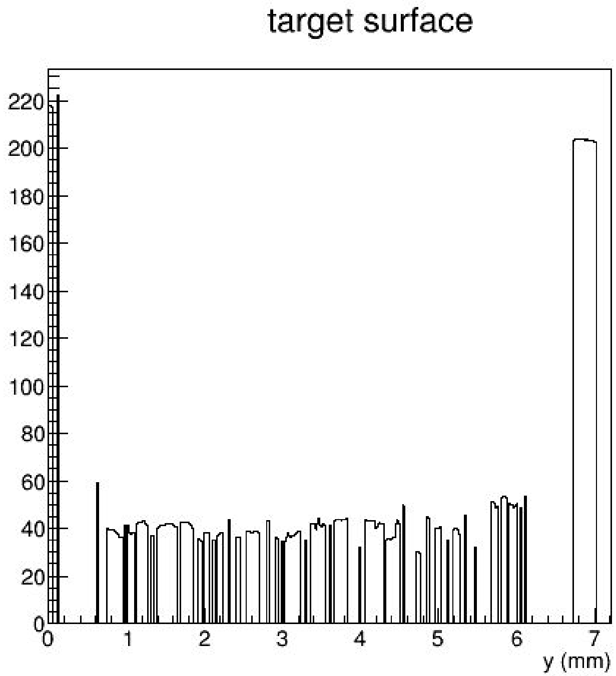
w.c.r.c. σ = 493.8 ∓ 0.1μr





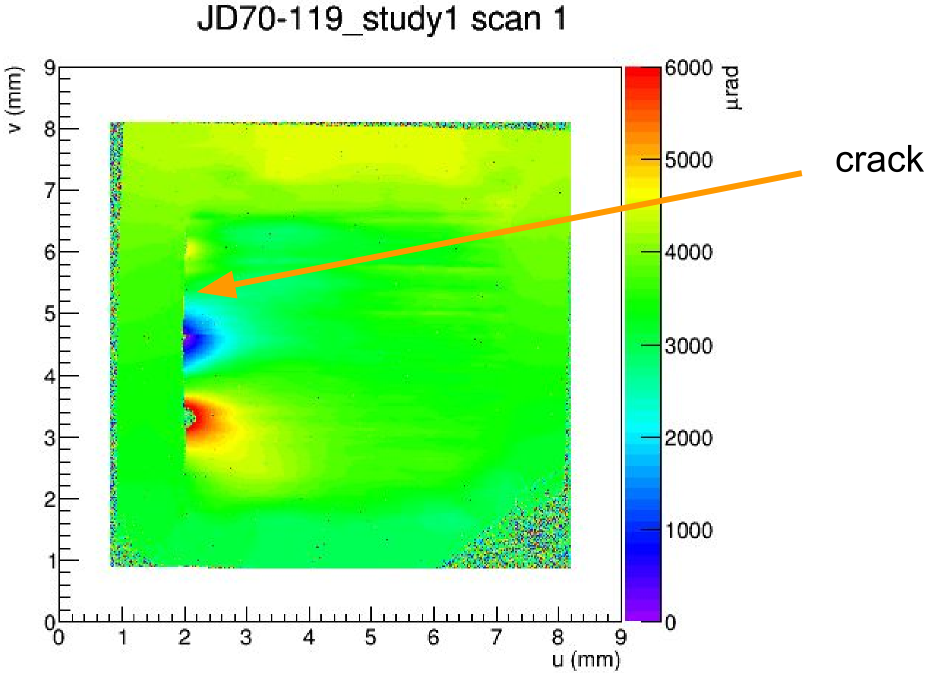
JD70-119:40.1 ± 0.3μm

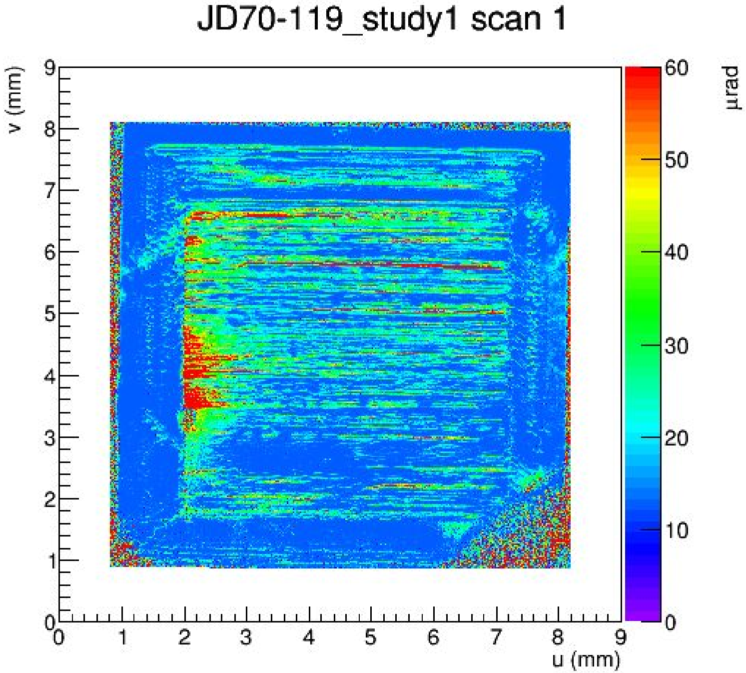




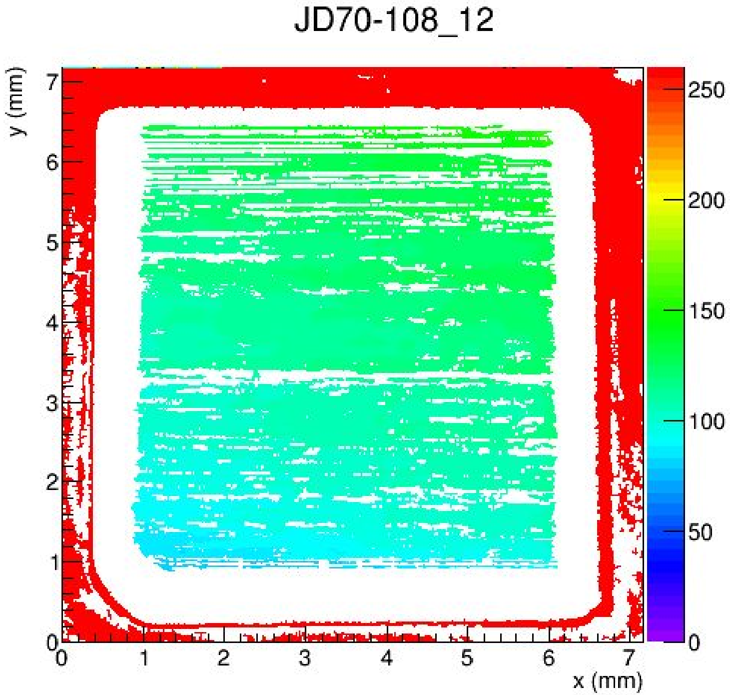
JD70-119:CHESS data

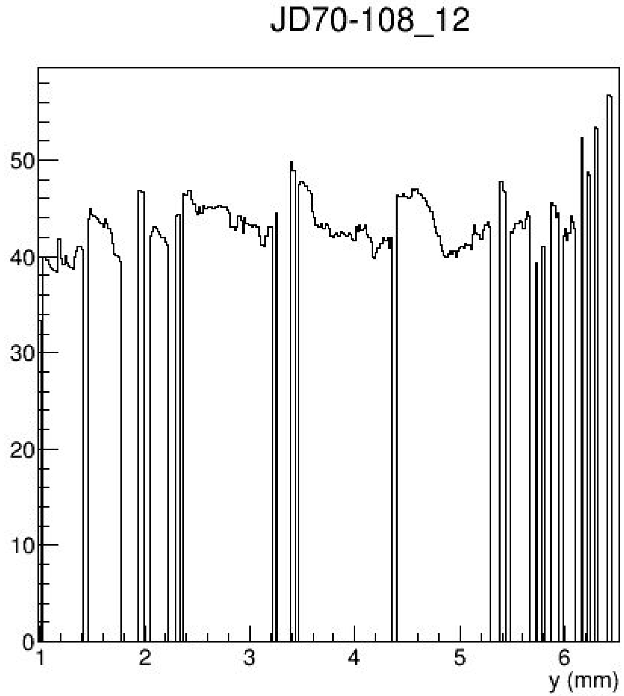
w.c.r.c. $\sigma = 390.5 \mp 0.1\mu r$



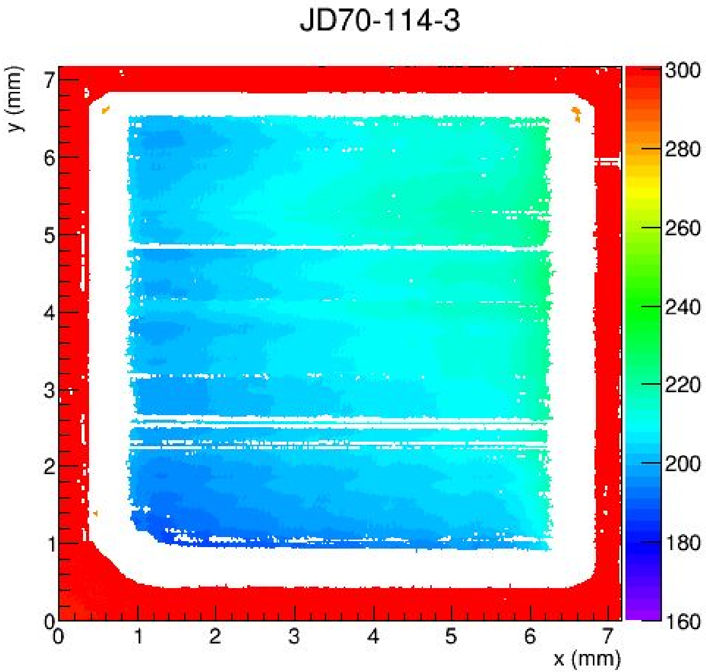


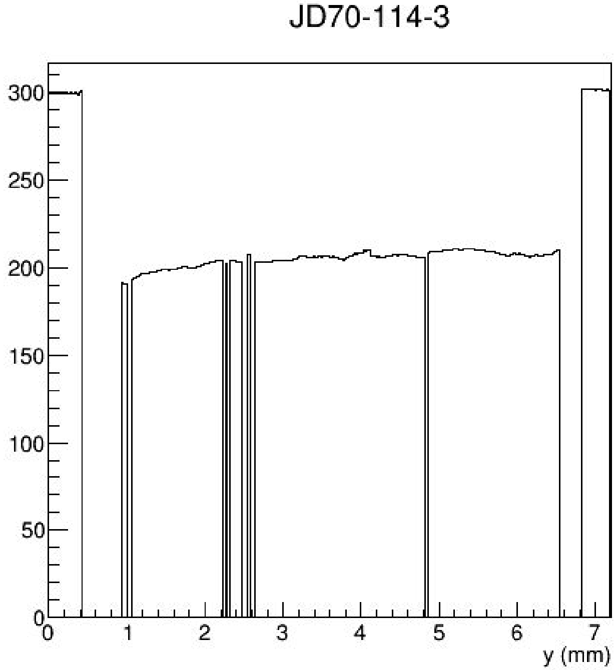
JD70-108: Sent to D.D.K. for etching





JD70-114: Will be machined from both sides





Laser Status: skeptically optimistic

- Laser had short on 4kV line in laser
  - Replaced damaged electrical and mechanical components
- ILC energy feedback reporting inconsistent energy values
  - Replaced burned out op-amp and capacitors on energy monitor circuit board
- Purchased “new” Lambda Physik EMG 102 excimer laser
  - Now have spare parts (some of which have already been needed and installed)
- Now running with highest energies ever seen!

What we’re working on now

- Surface variation along X axis is low (<1μm r.m.s.), but along Y axis it increases as the diamond is machined. Possible reasons include:
    - Chamber pressure changing over time (Cutting rate is largely affected by chamber pressure).
    - Unknown offset in Y axis from 45° tilt of diamond
    - Cut depth vs. laser energy calibration is introducing noise
- Installed mass-flo controller on roughing pump to reduce change in chamber pressure experienced over the 5+ hours of ablation. Can now control pressure within 1 mtorr
- Calibrating walk in Y axis as a function of cut depth
- Will check cut depth vs. laser energy calibration

Connection with BNL group for RIE

Oxford-F plasma system. Used to remove dead carbon from ablated diamond making use of the different bond strength between diamond and the dead carbon.

. Controls include:

- RF power (controls ion kinetic energy), ICP (plasma density)
- chamber temperature (ion kinetic energy an reaction rate)
- pressure (possibility of ions/atoms collide wi other)
- gas mixture (isotropic etching or anisotropic etching).

Summary:

- First round of 7mm radiators produced
- CHESS data shows broad rocking curves of ablated samples throughout entire crystal including frame...not expected
- Currently exploring 3 separate techniques for reducing strain
    - D.D.K. etching JD70-108 from 40μm→20μm
    - UConn machining JD70-114 from both sides
    - UConn sending machined sample to BNL for RIE post processing
- Laser is now running well, producing highest energies to date.

Acknowledgements

- This work is based upon research conducted at the Cornell High Energy Synchrotron Source (CHESS) which is supported by the National Science Foundation and the National Institutes of Health/National Institute of General Medical Sciences under NSF award DMR-1332208

Replacement Fiber Bundle Update

James M^c Intyre

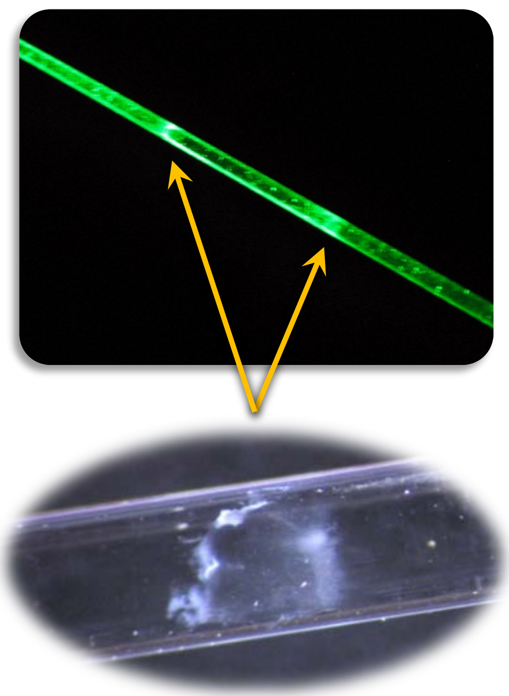
GlueX Collaboration Meeting, May 9, 2016

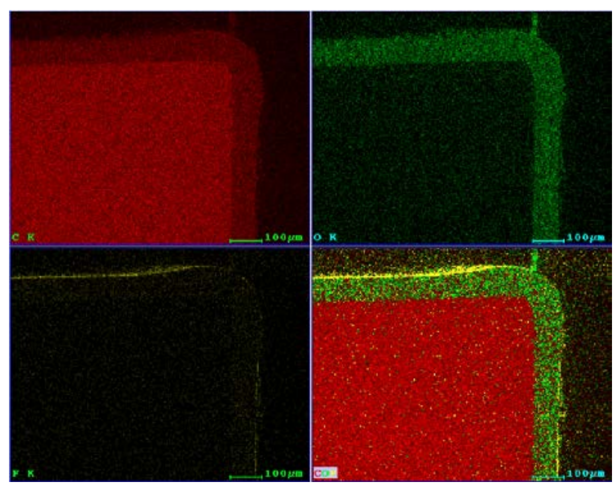
Outline

- Modifications to production setup
- Light yield testing
- Fused joint testing (destructive and non-destructive testing)
- Current status

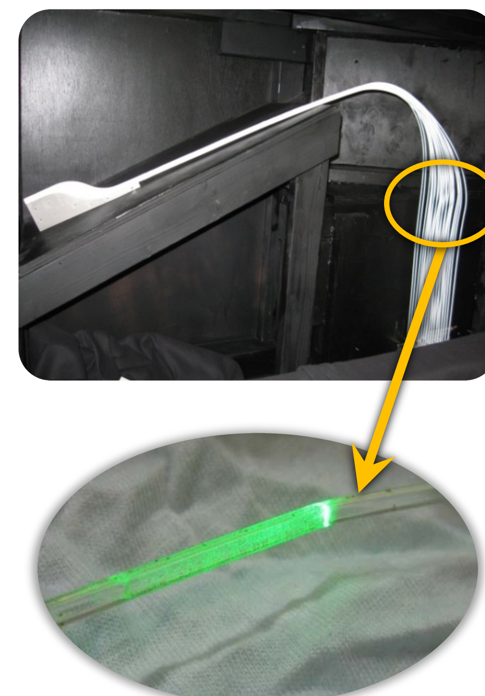
Past Problems

Hard-Water Deposits





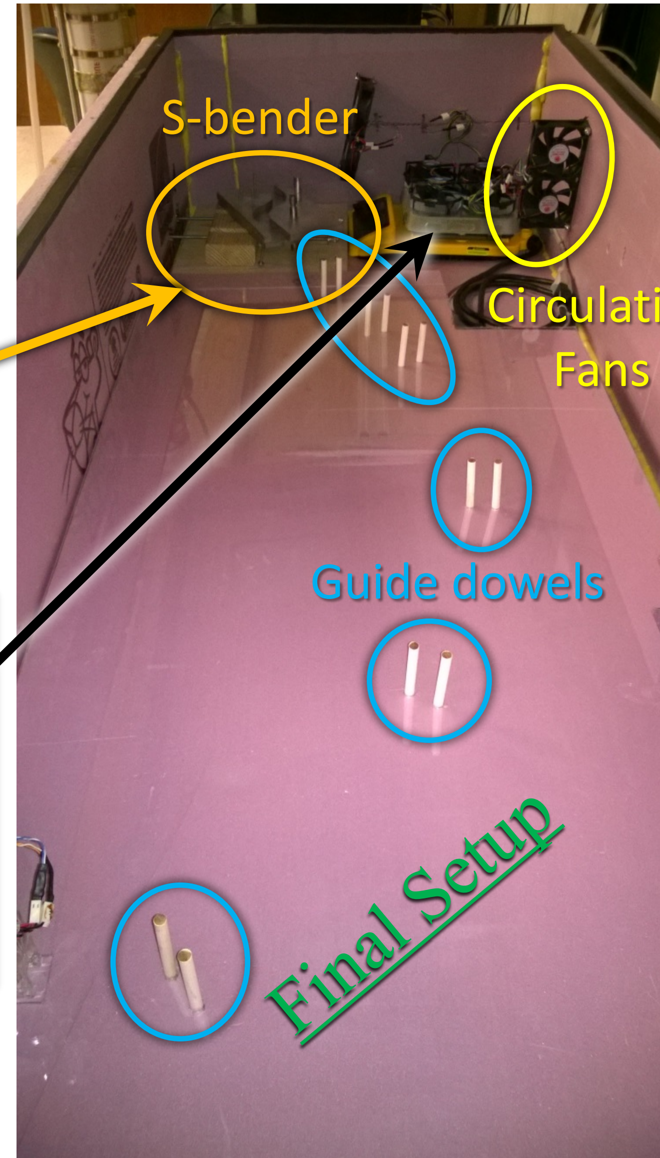
Kinks in Fiber

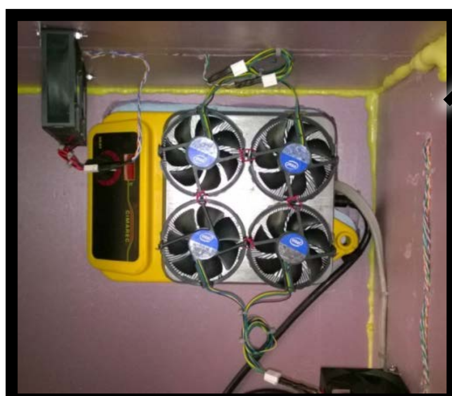


Replacement Fiber Bundle Status

No more fiber straightening or hot water bending

Hot-Air Bending Box

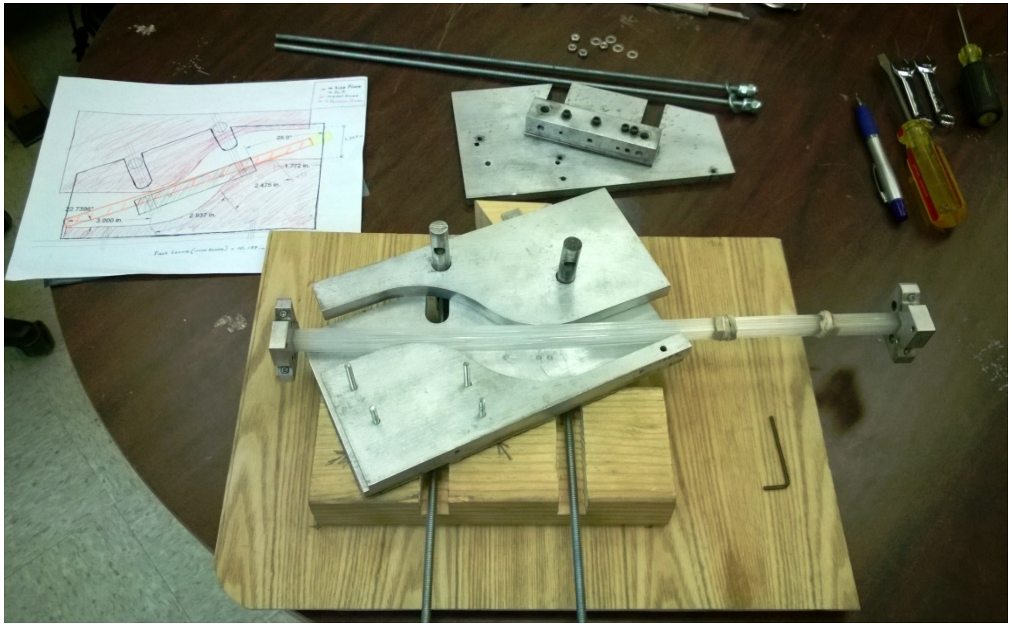




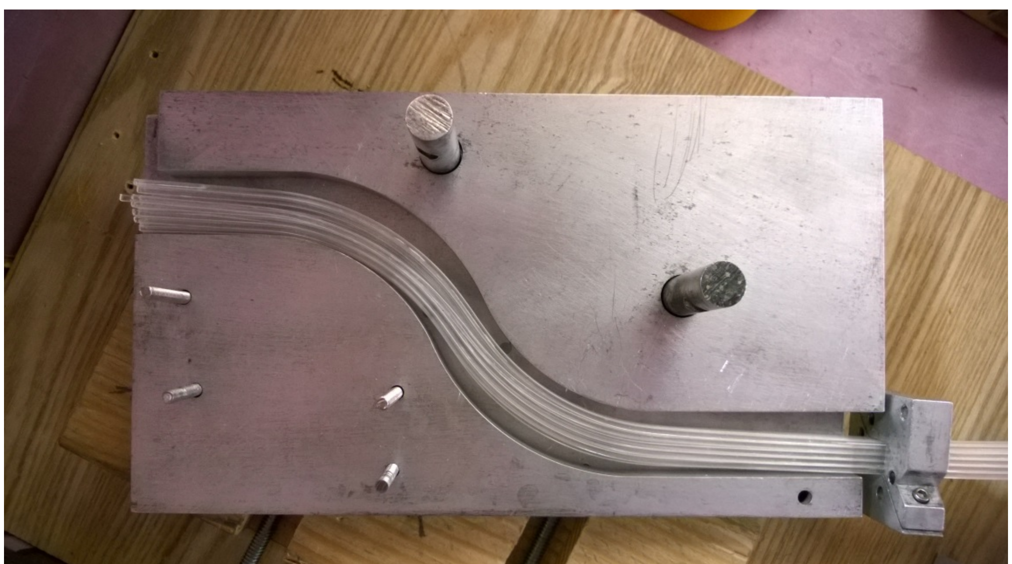
Hot plate with thermally bonded heat sinks/fans

Replacement Fiber Bundle Update

Before



After

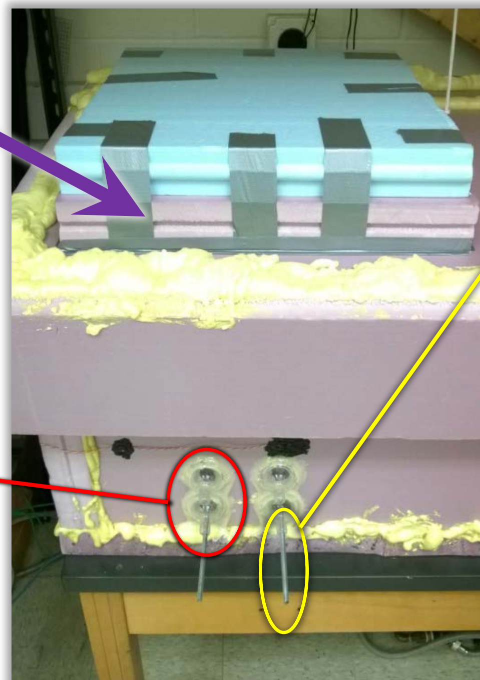


Inside Sealed Box

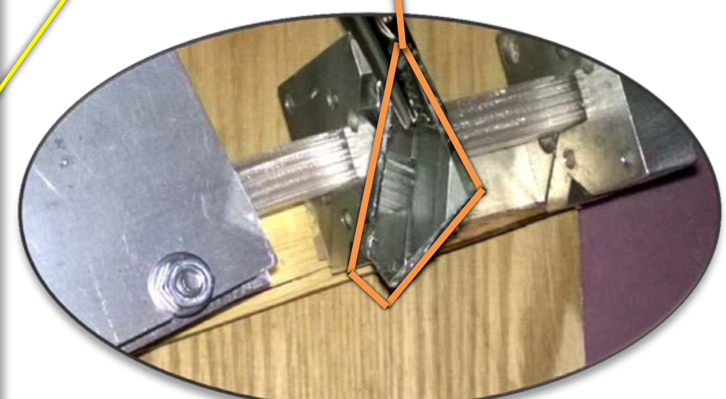
Outside Box

Replacement Fiber Bundle Update

Allows us to bend without opening the box

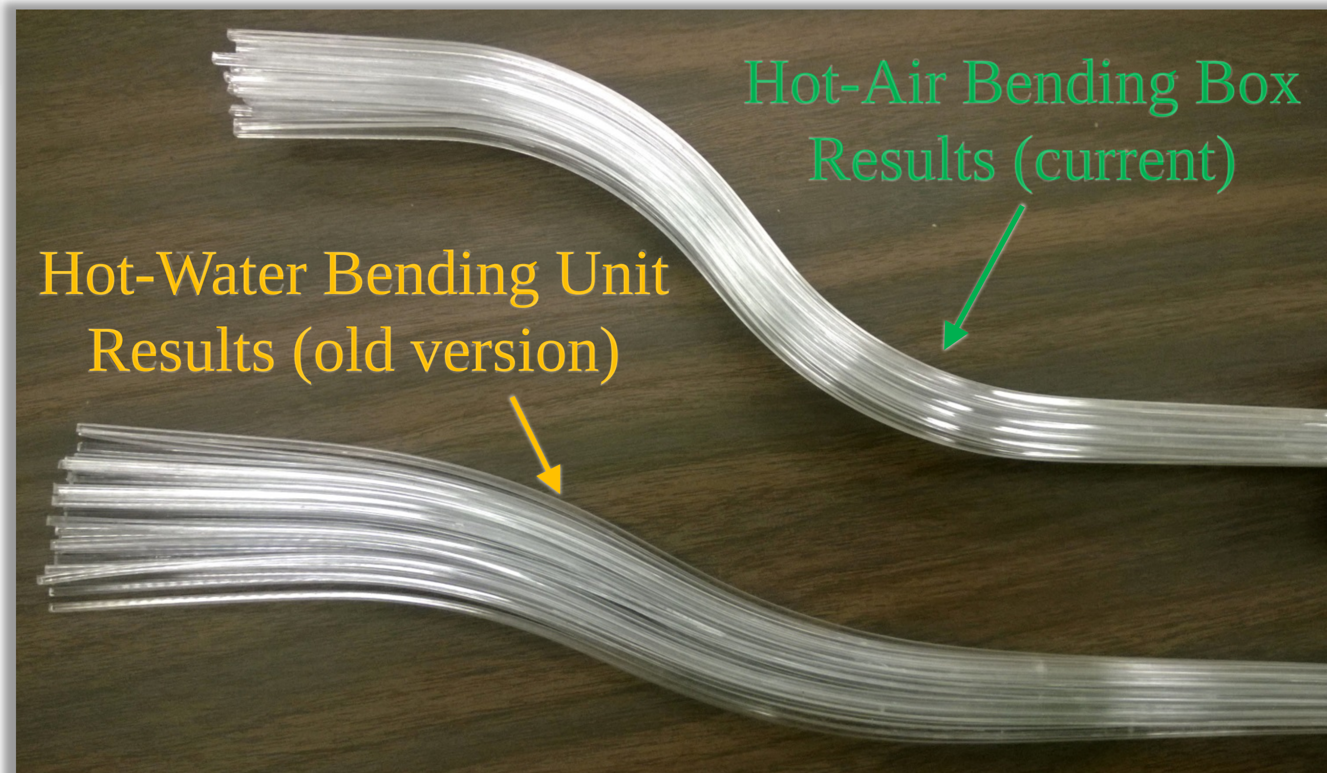


Air Seal



Mirror

Replacement Fiber Bundle Update

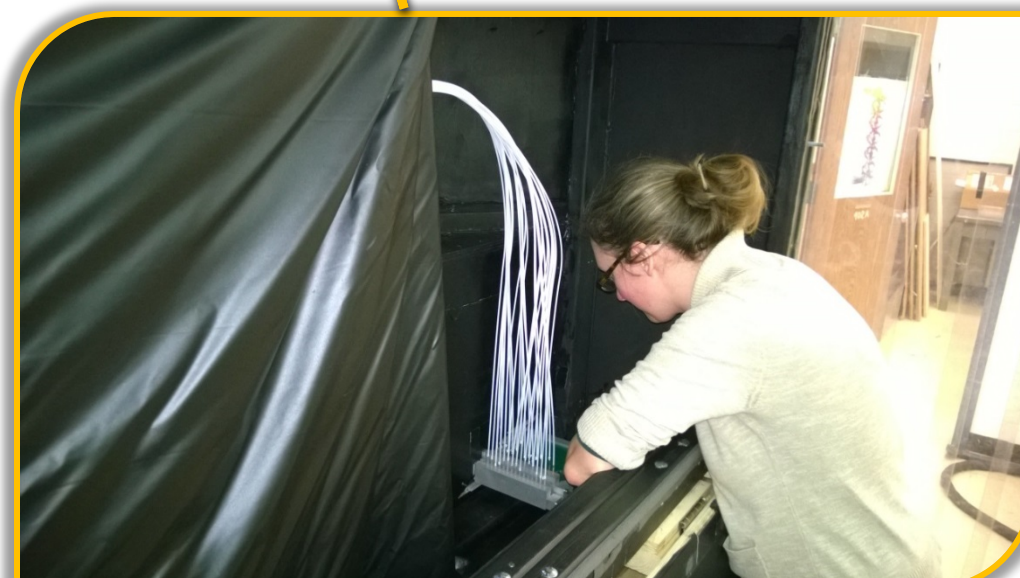


<u>Hot-Air Bending Box</u>

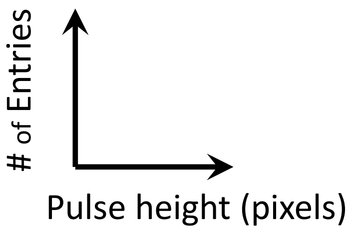
- Maintains constant temperature (+/- 2°F)
- Finer adjustments of the S-bend allowed
- No thermal shock while bending
- No hard-water stains
- 1-person operation
- Overall easier to use

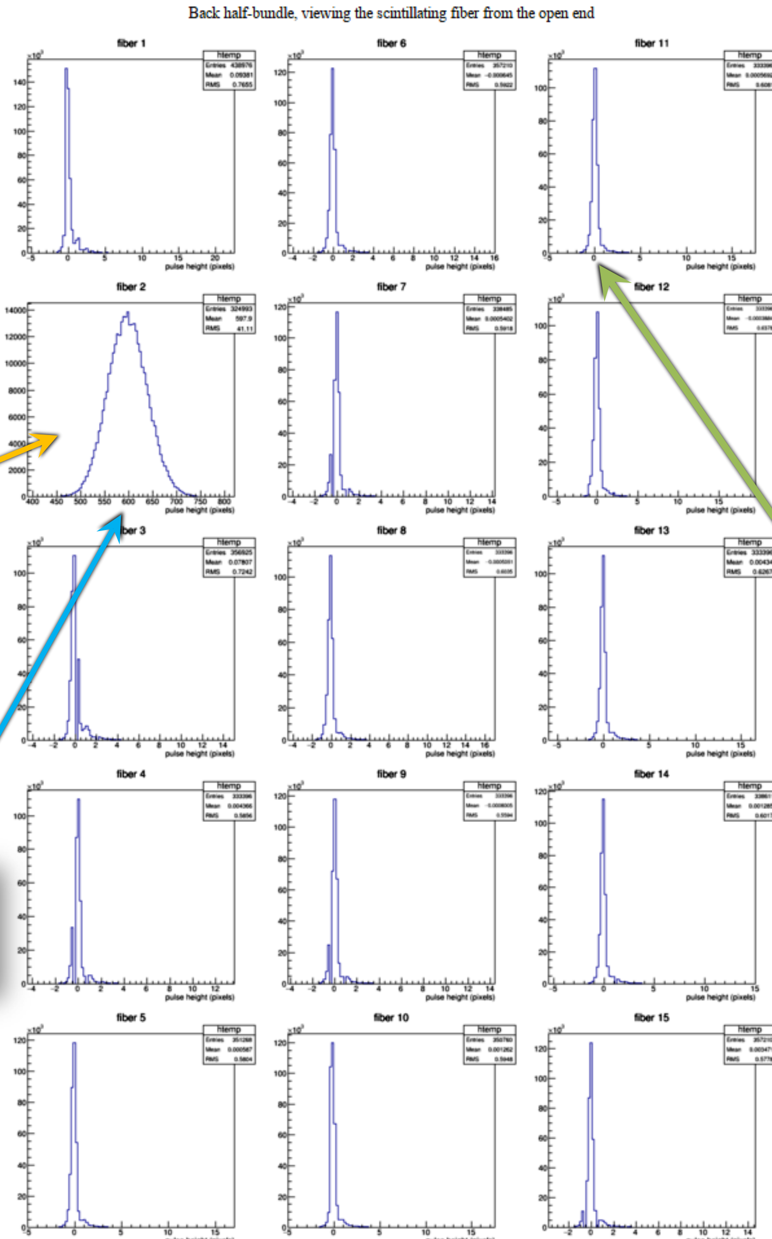
Replacement Fiber Bundle Update

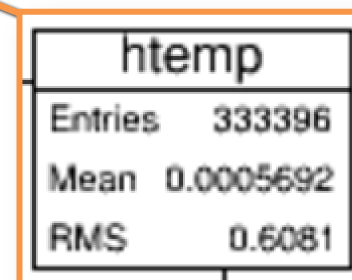
Each fiber is color-coded and tracked during production and testing

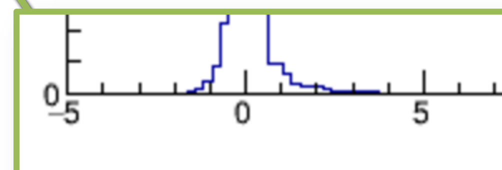


Replacement Fiber Bundle Update

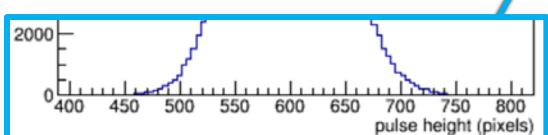








Only SiPM populated with a fiber



Note:

- *No cross-talk observed*
- *No light leaks in darkbox*

Fused vs. Unfused

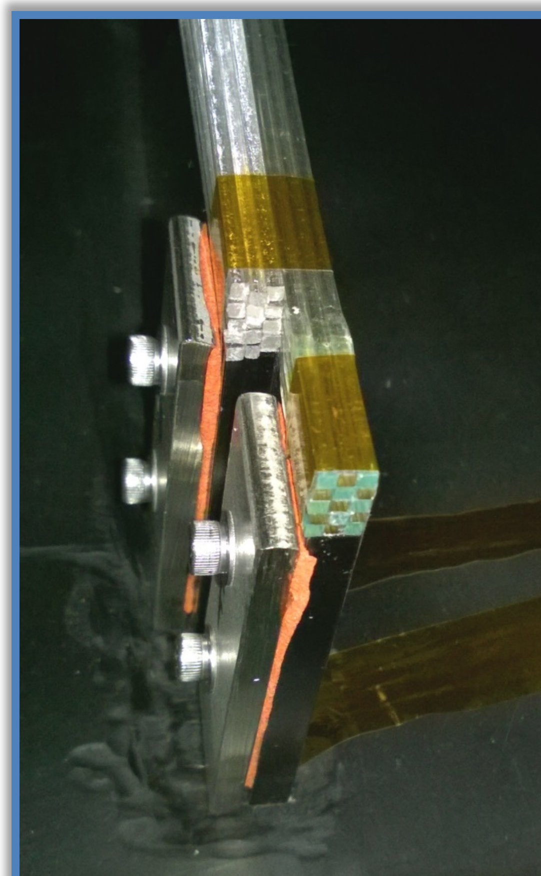
Testing:
- 8 fused, unbent fibers with both ends highly polished
- 7 unfused, unbent light-guides only with both ends highly polished

Results:

Fused
- Avg. Pulse Height (pixels) = 441

Unfused
- Avg. Pulse Height (pixels) = 471

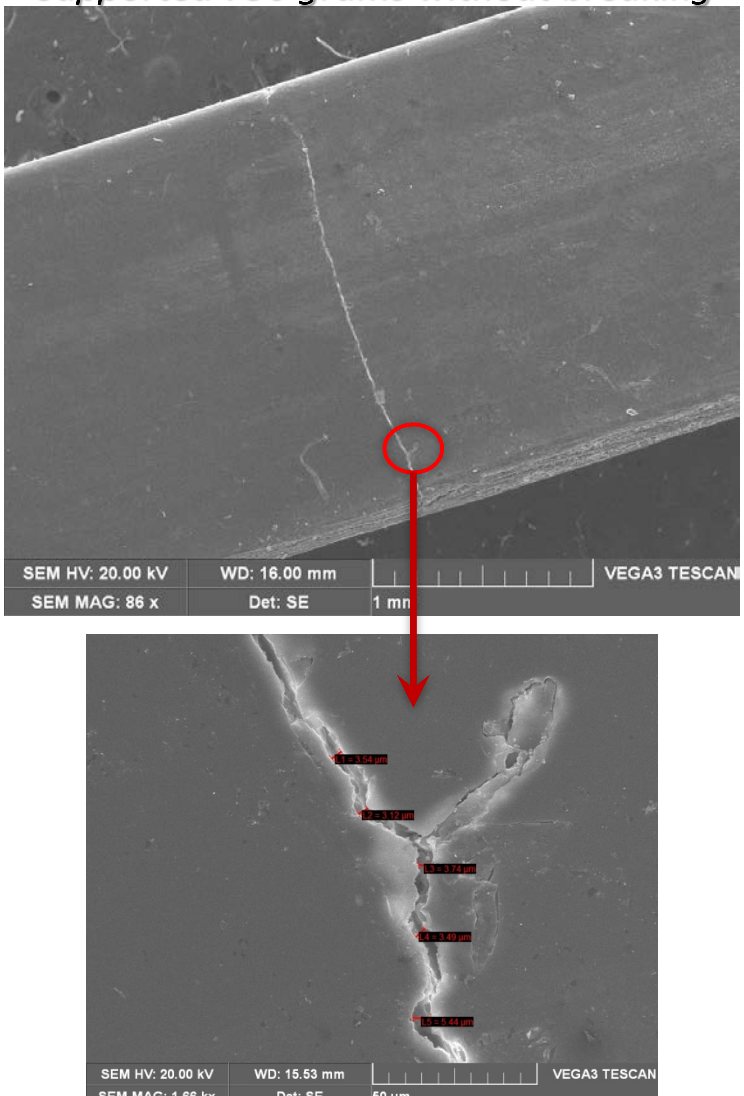
Light Loss
~ 6.4 %



Replacement Fiber Bundle Update

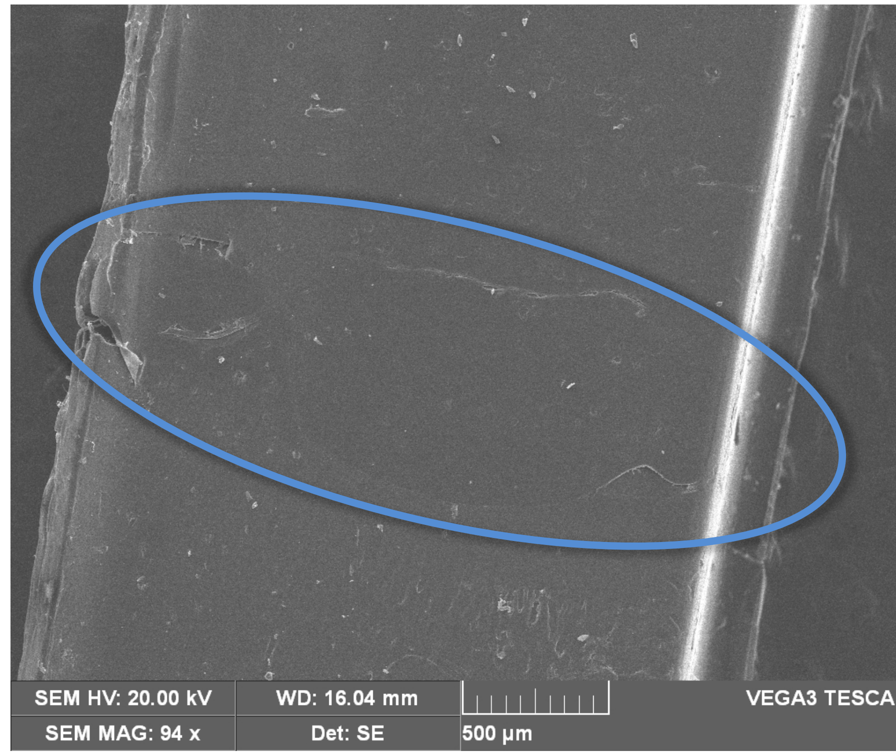
Within Spec. Fused Joint

- *Slight cladding gap*
- *Supported 750 grams without breaking*

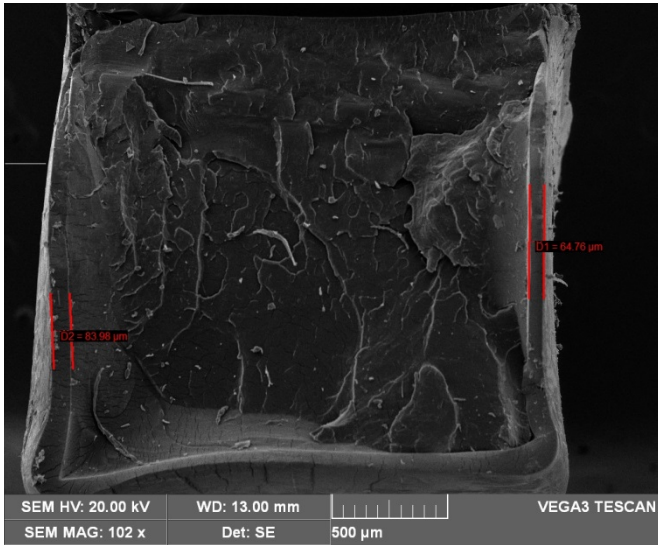


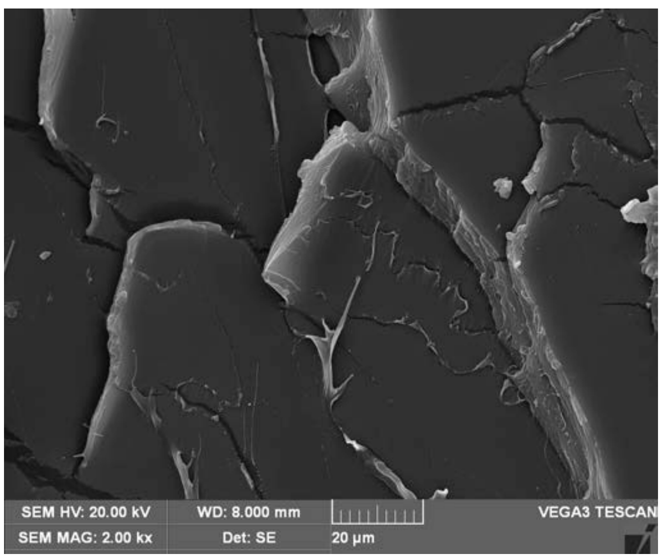
Oversized Fused Joint

- *No cladding gap*
- *Supported 900 grams without breaking*



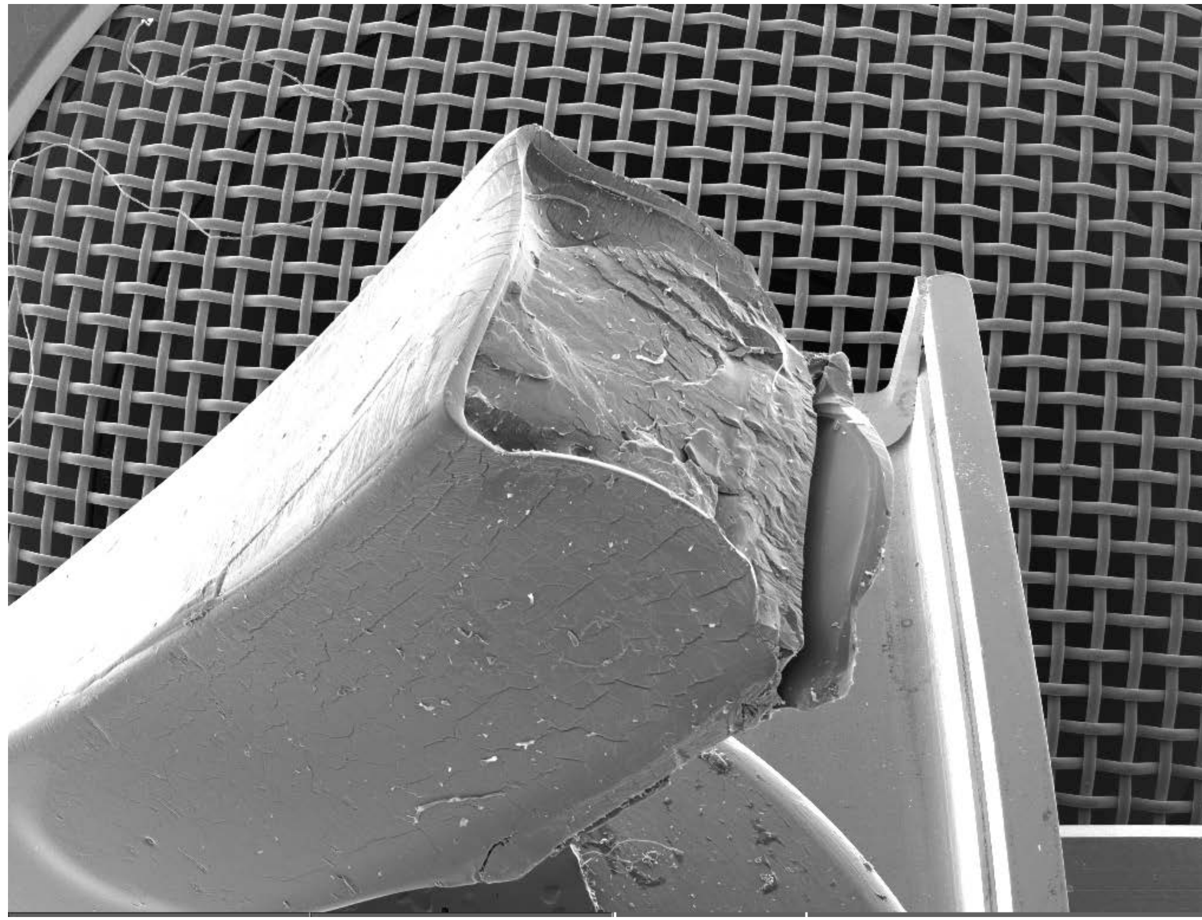
Replacement Fiber Bundle Update



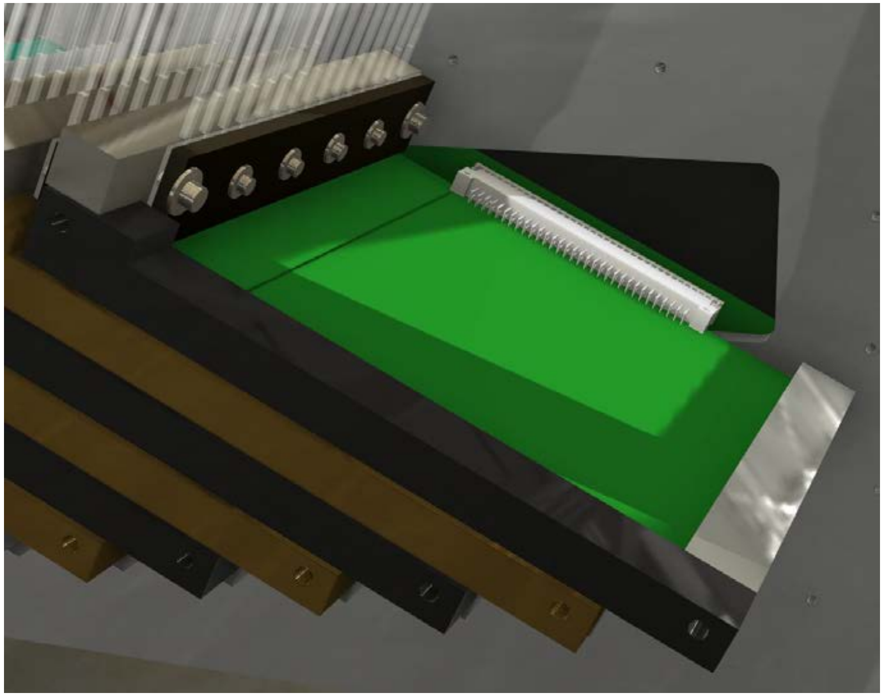


Broken Fused Joint (SciFi / Light guide)

- *Fused joint placed at center of a gap spanning 1 $^{3}/_{16}$ inches*
- *Supported a 750 gram weight without breaking*



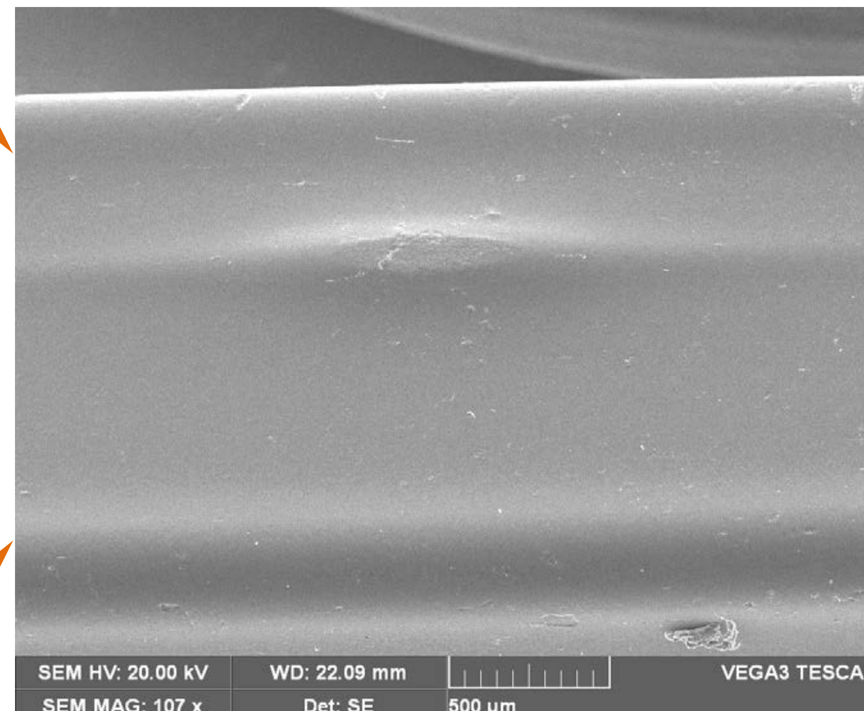
Replacement Fiber Bundle Update



Manufacturing Defects

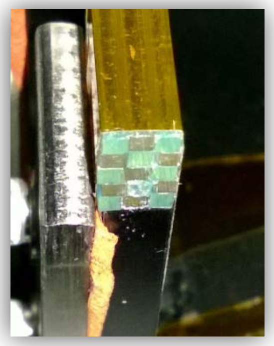
- *Random locations*
- *Can making insertion into chimney impossible*

Fiber width
(2 mm)



Current Status

- 4 Fiber bundles
  - Fused, polished, & light yield tested
  - Meets all JLab contract specifications
  - Ready for bending (awaiting summer student workers to start)
- 5 Fiber bundles
  - Fused, polished, some light yield tested
  - Do not meet JLab specs for fused joint cross-sectional dimensions
    - > 2.05 mm avg. cross-section
    - Most can be sanded into spec.
      - A student researcher is investigating the effect of sanding on light yield
- Oversized fused joint
  - Mounting straps put too much stress on joint when bundling 30 oversized fibers
  - Mixing a fiber bundle with in-spec. & oversized fibers ***will work***



Current Status

- SciFi
  - ~ 52 meters unused
  - Enough to produce at least 50 more bundles

- Light-guide fiber
  - ~ 530 meters unused
  - Enough to produce 10 more bundles

- Looking into using *round* light-guides fused to square SciFi
  - Little to no modifications should be required

Questions?