

Sapphire Fused Silica and EP30-2

Removing prisms from ITM09

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11-5-14
LIGO-T1400711-v1

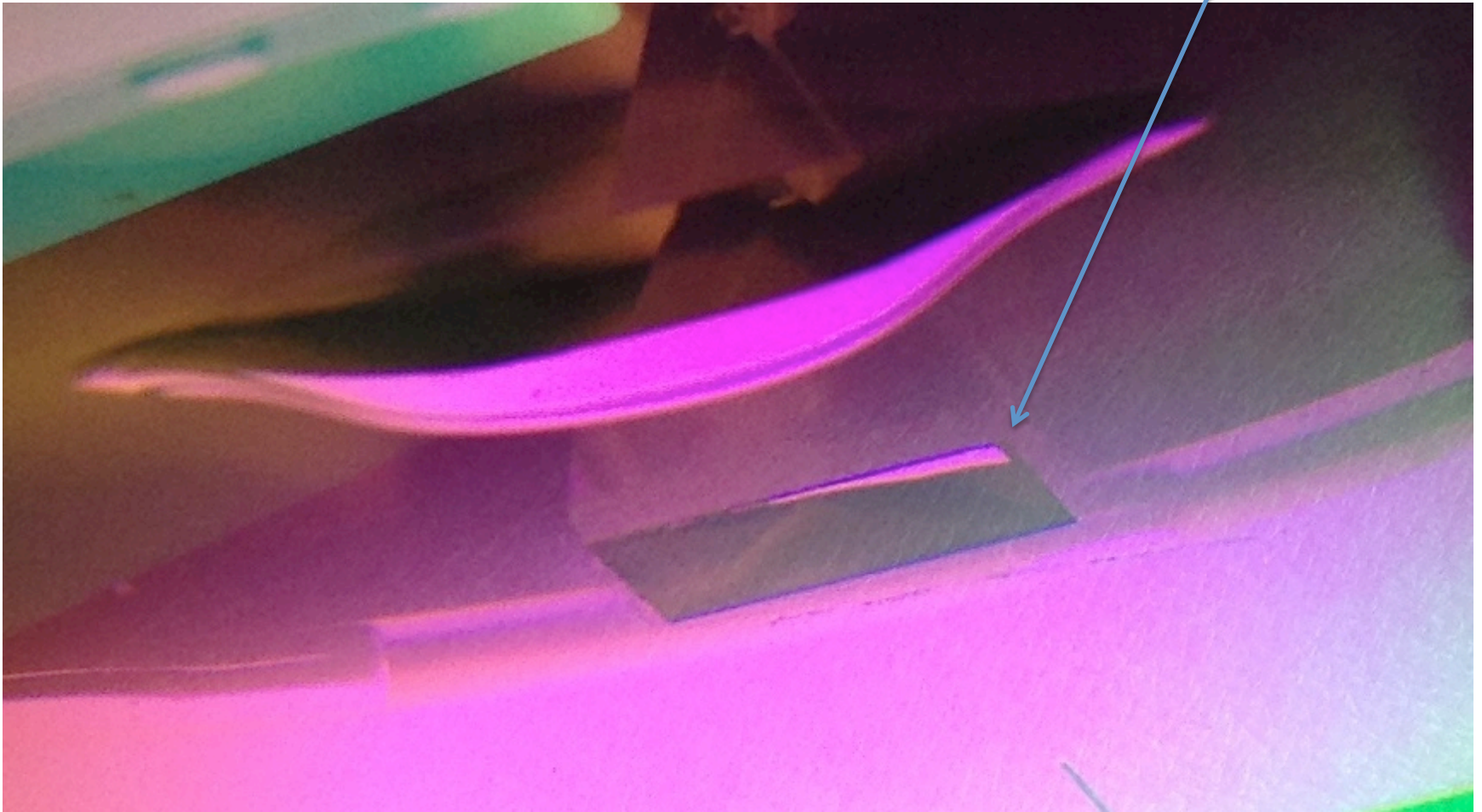
Chemical removal

- Prisms on ITM09 were soaked in methylene chloride.
- An early attempt at spreading the prisms during soaking did result in a slight bond lift for one prism, but also in the breakage of the Test Mass. See T1400562
- Additionally the remaining prism was soaked for two months without change.

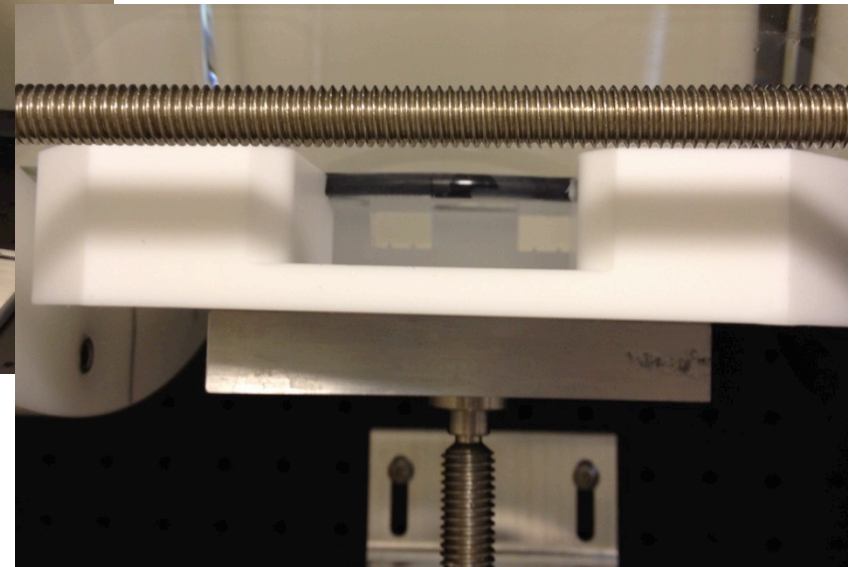
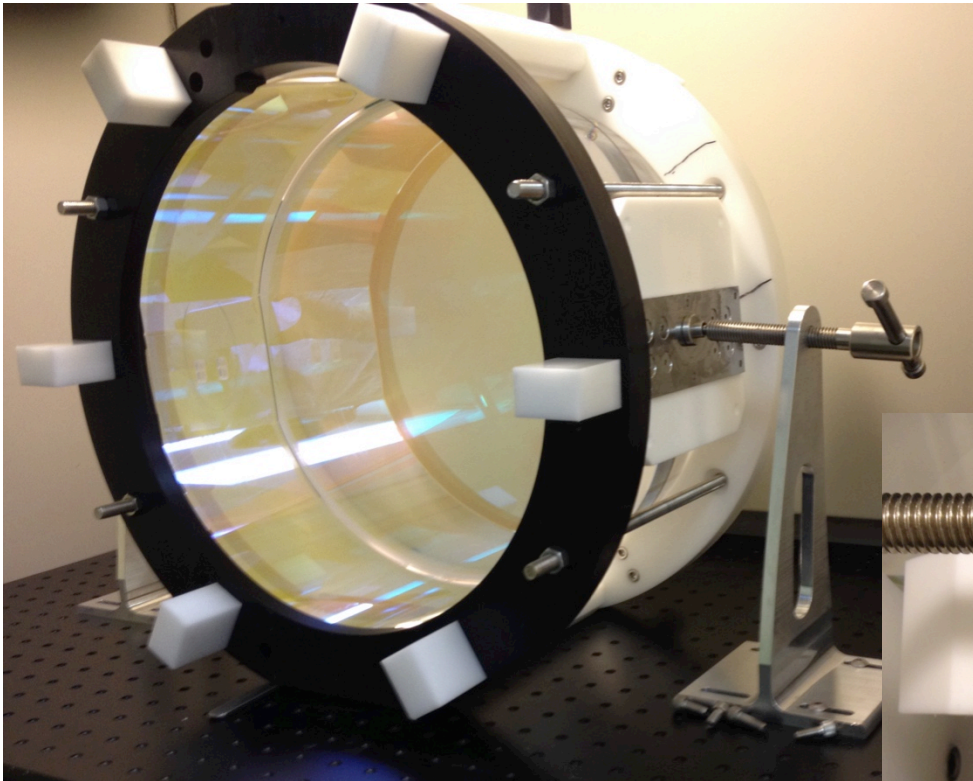
View from below, soak and spread



Slight lift visible on second prism edge
after spreading/breaking



Soak both sides at once



Heat removal – Test Plate

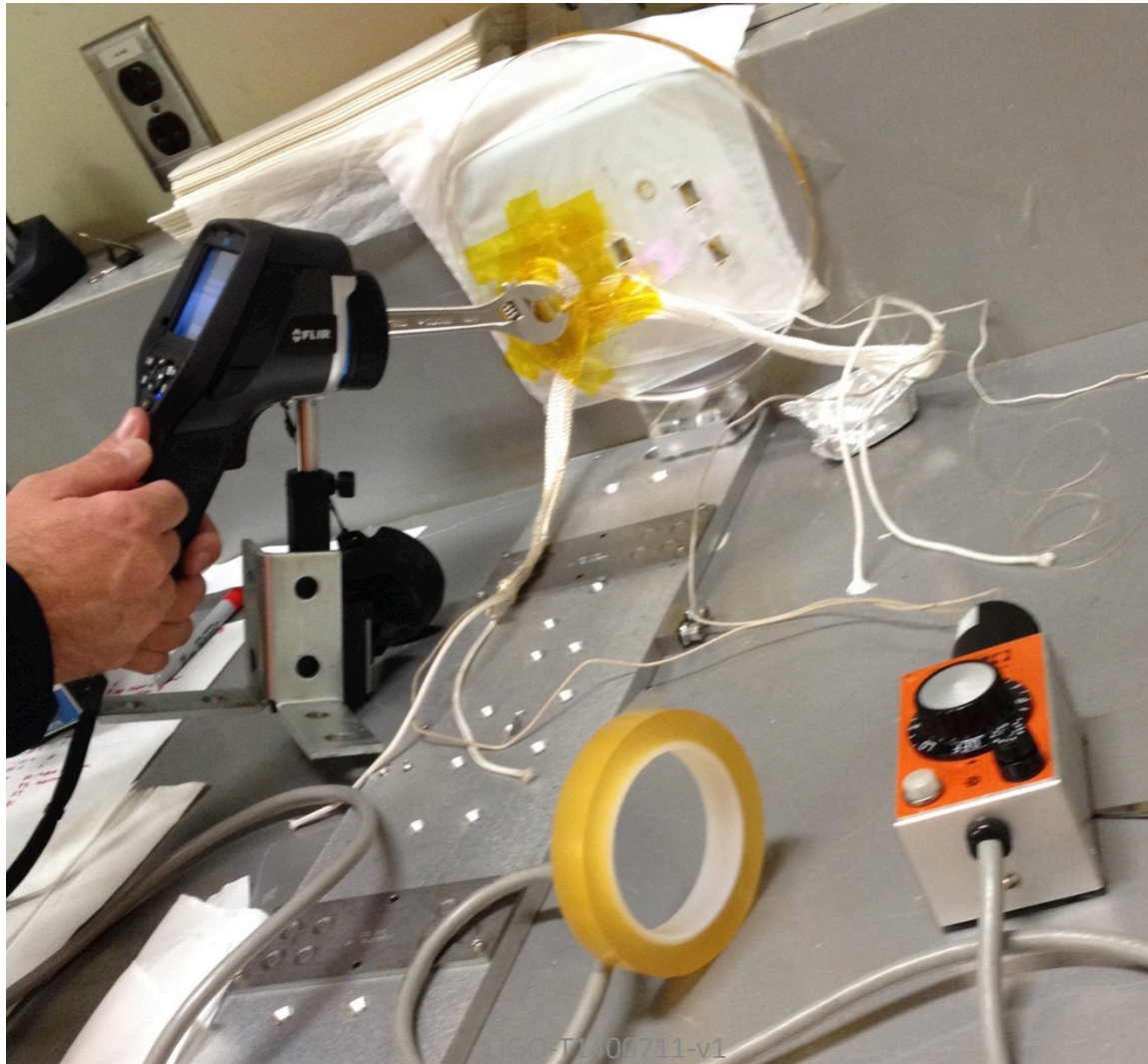
- 5 sapphire prisms were glued to an AR coated fused silica test plate.
- Bonds were 7-12 days old, made according to LIGO-T1300322-v6 with no spacers
- 34 C° cure occurred well after ~44 hours of room temperature cure.
- 450 gram weight was used, suspended at the end of a 6” Crescent wrench. Presence of weight is necessary for de-bonding.
- FLIR was positioned 13” from plate – detection point was aimed at prism apex – front/center.
- Heating rate is highly dependent on insulation

First prism removed with heat gun Not easy to control



Test Plate

Four prisms removed with heat tape



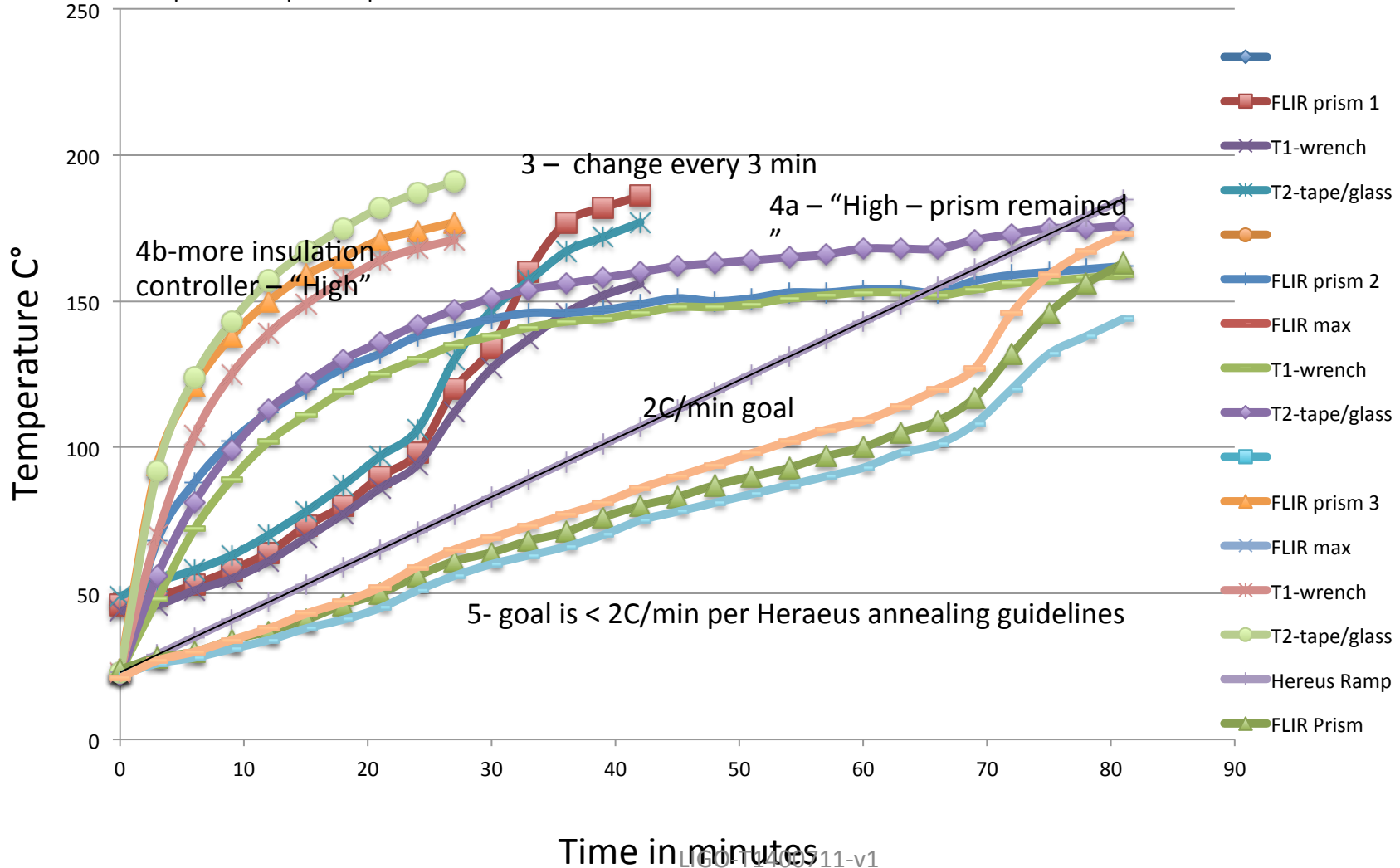
Test plate Thermal Profile

Group order:

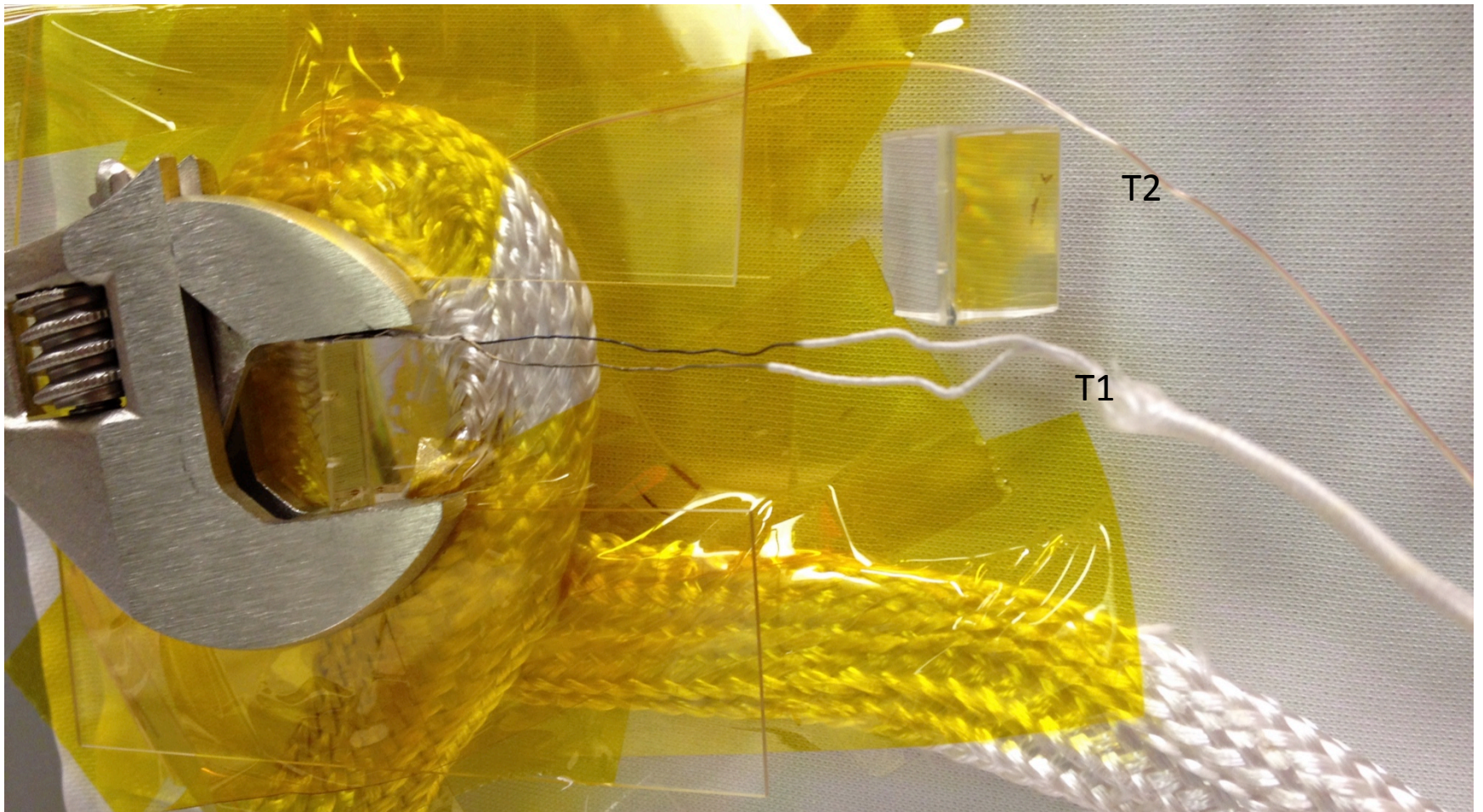
Highest Temp: T2-plate at prism base

FLIR-on prism apex

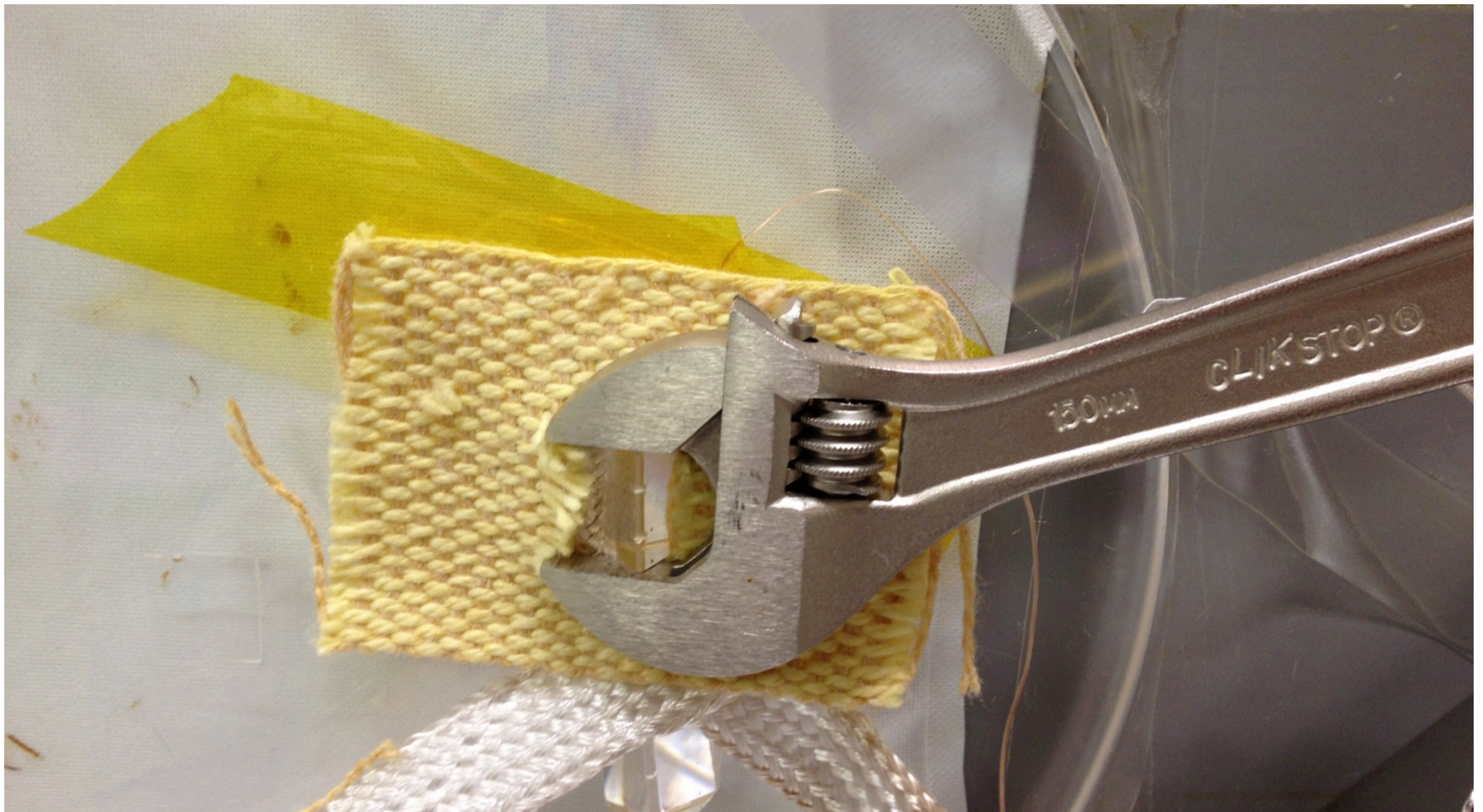
Lowest Temp: T1-clamped on prism flat with wrench



Insulation configuration used in Test plate prism 2, 3 and 4a removal

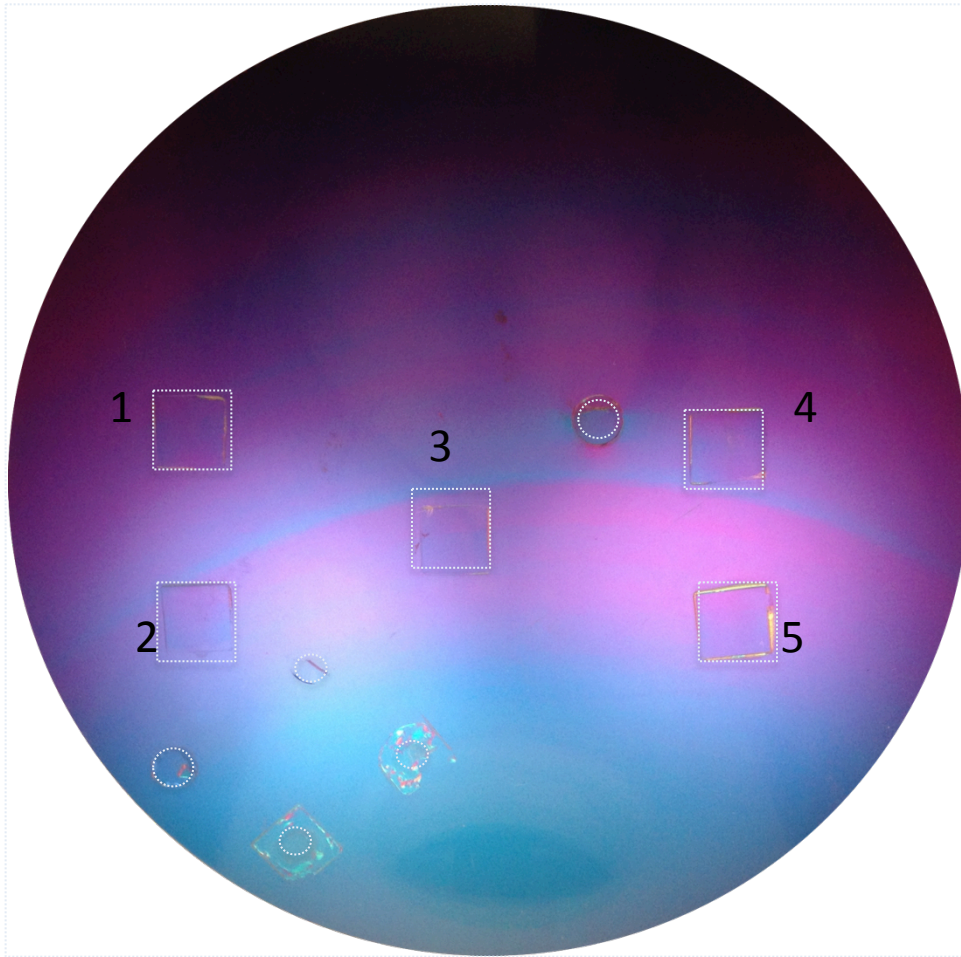


Final Insulation configuration Used in Test Plate prism 4b and 5 removal



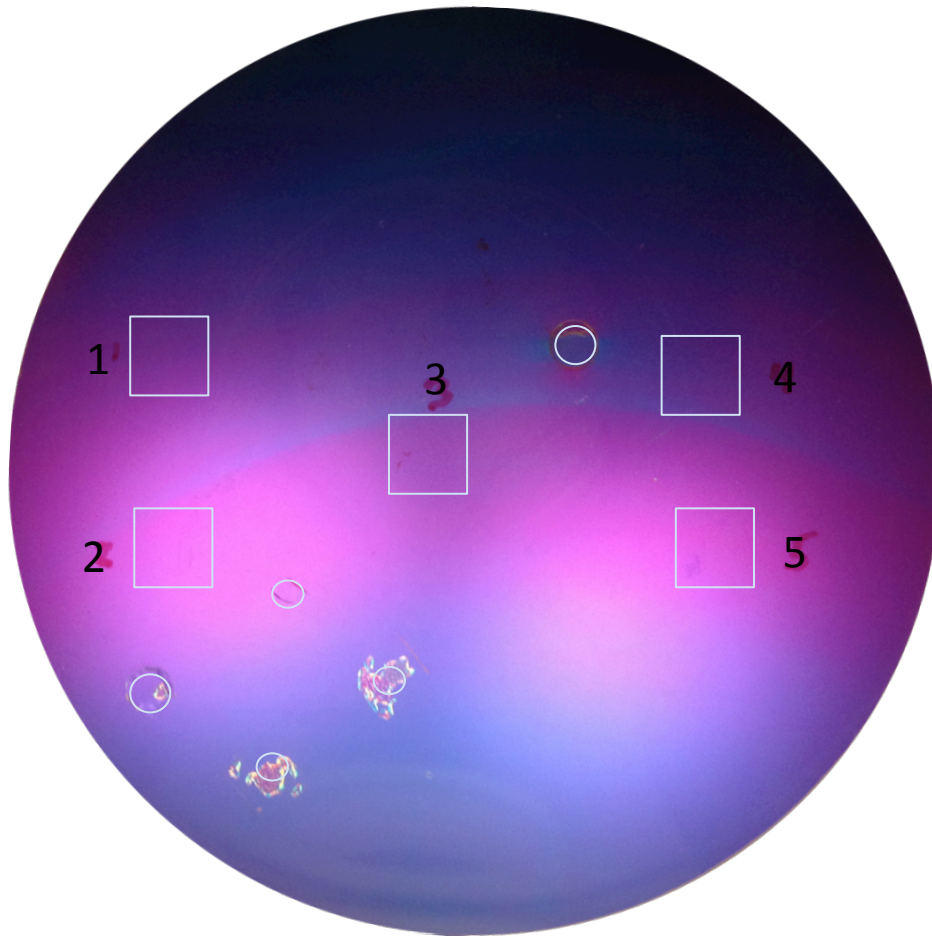
Test Plate After 5 Prism removal

Polariscope shows no stress near prism footprint



- 1 – Heat Gun
- 2 – 3 cycles per $\frac{1}{2}$ tic
- 3 – 3 minutes per tic
- 4 a – Set to High at outset glue did not release
- 4 b – same as 4a but added kevlar insulation
- 5 – try 2C/min ramp

Test Plate After most glue removal



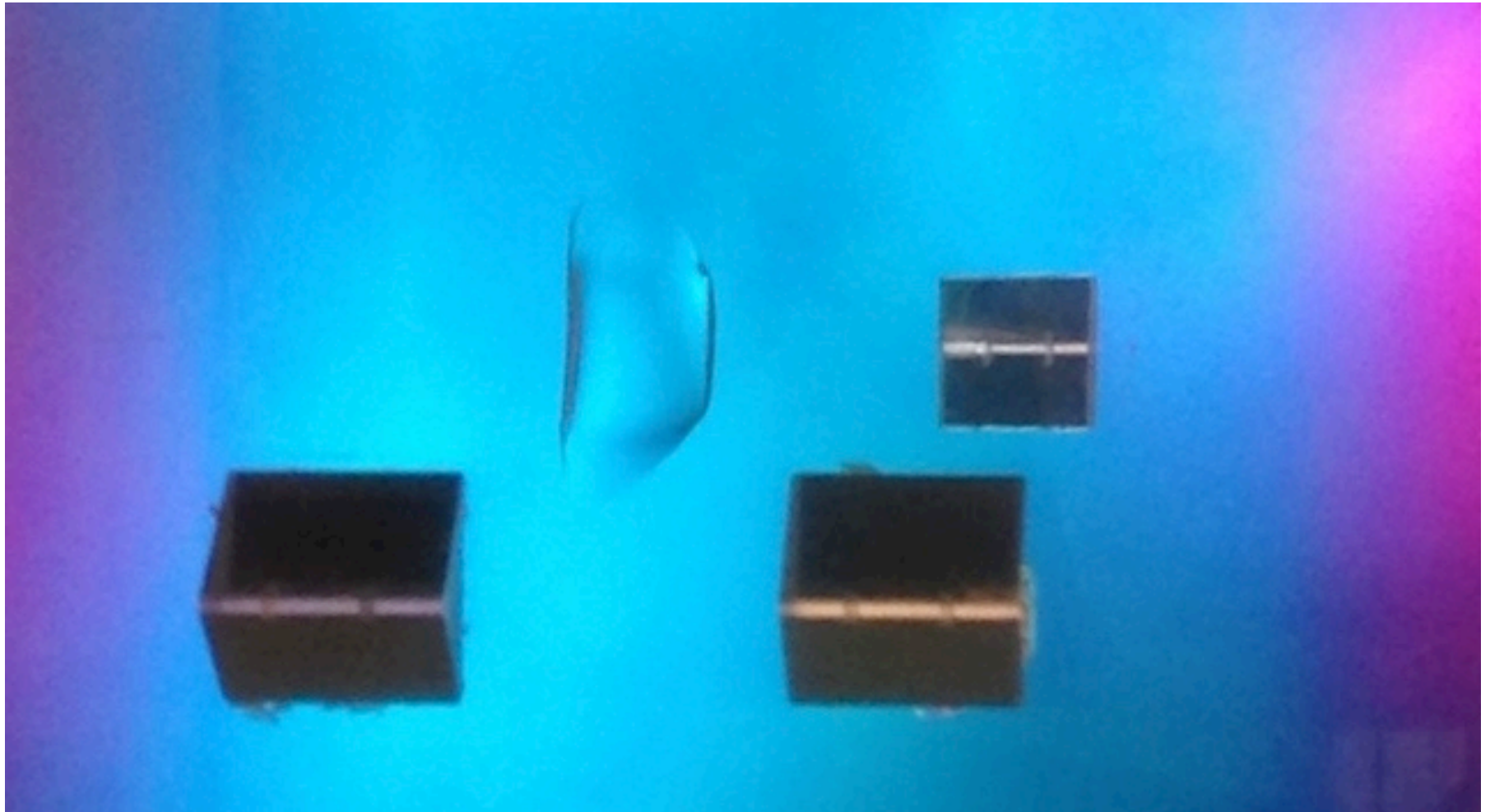
- 1 – Heat Gun
- 2 – 3 cycles per $\frac{1}{2}$ tic
- 3 – 3 minutes per tic
- 4 a – Set to High at outset
- 4 b – same/kevlar insulation
- 5 – try 2C/min ramp

Test plate Glue removal

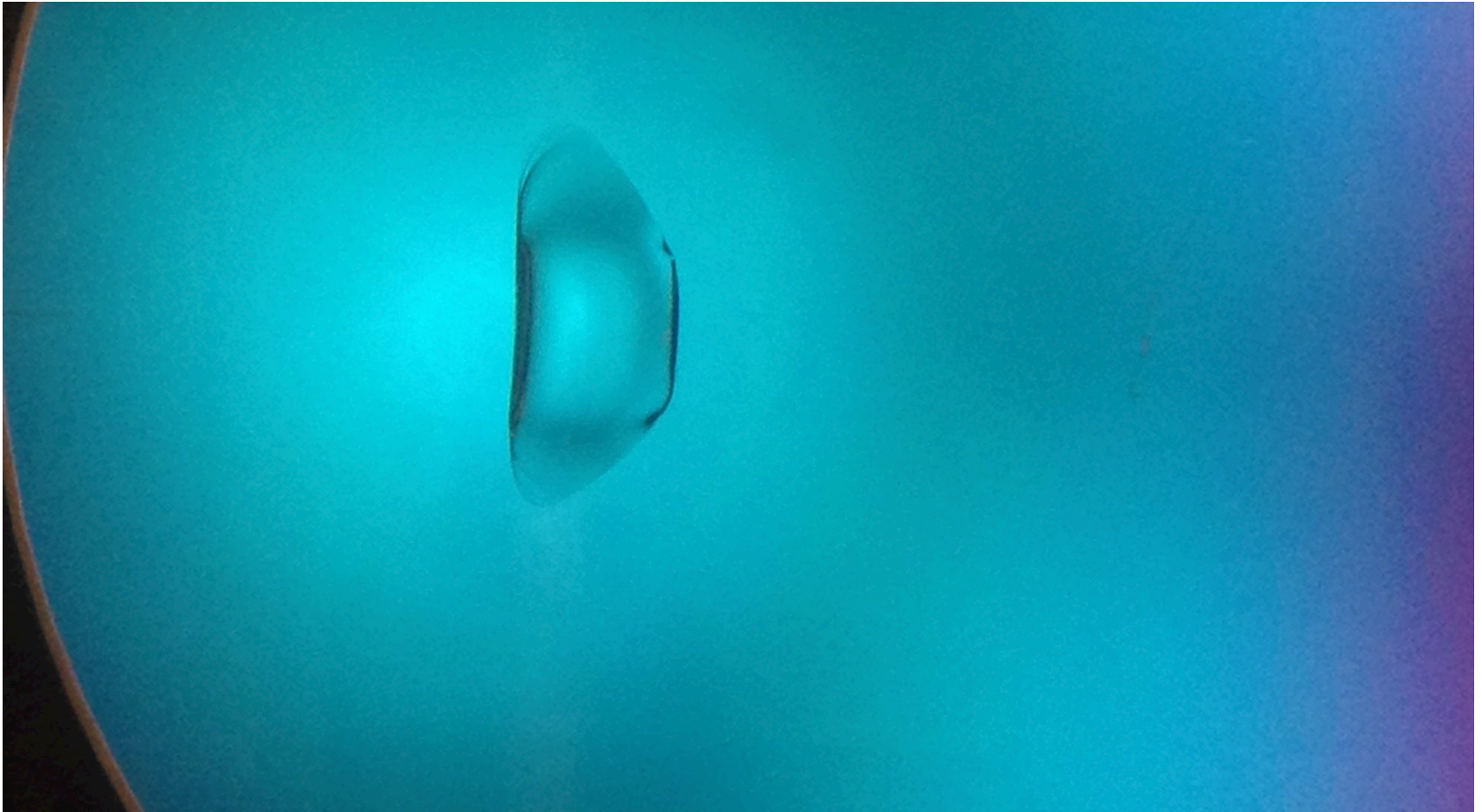
- Most Glue remained on the silica plate
- The plate was soaked in methylene chloride, however the glue could not be rubbed off with a cotton q-tip.
- Eventually, a razor blade was used after soak.
- A faint discoloration of the AR coating on the silica plate can still be seen in the prism footprint.
- The microscope slide used to proof the glue was soaked in Methylene chloride, exposed for several days – that glue would still not scrub off with a q-tip.

ITM09 Prism removal

Polariscope image of all prisms viewed through both flats, showing no measurable stress



Same view after prism removal

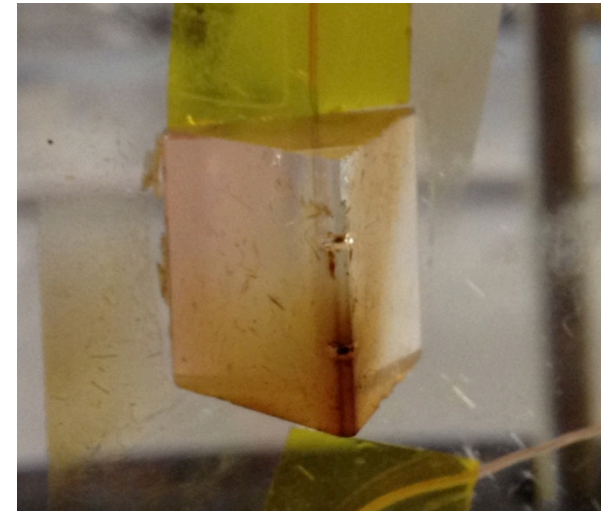


Higher Temperature and more force to de-bond prisms from ITM09

- A ramp rate of $< 2\text{ C}^\circ/\text{minute}$ was used per Heraeus annealing instructions
 - * measured at the prism base as shown in this photograph
 - * Accomplished by increasing the controller by $\sim 1/4$ every 3 minutes
- The ITM09 prisms released at:
 - $\sim 240\text{ C}^\circ$ - measured with a type k thermocouple attached as shown
 - 1.6 kg suspended at the end of a 6' wrench as seen in the test plate photos
- Compare to 150 C° - 190 C° and 450 g for the test plate.
- Great care was taken to ensure the weighted wrench did not impact the Test Mass

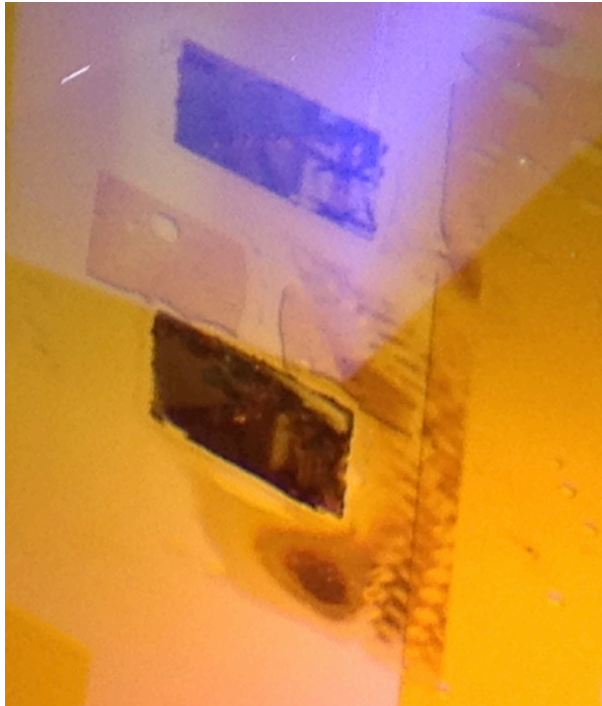


LIGO-T1400711-v1

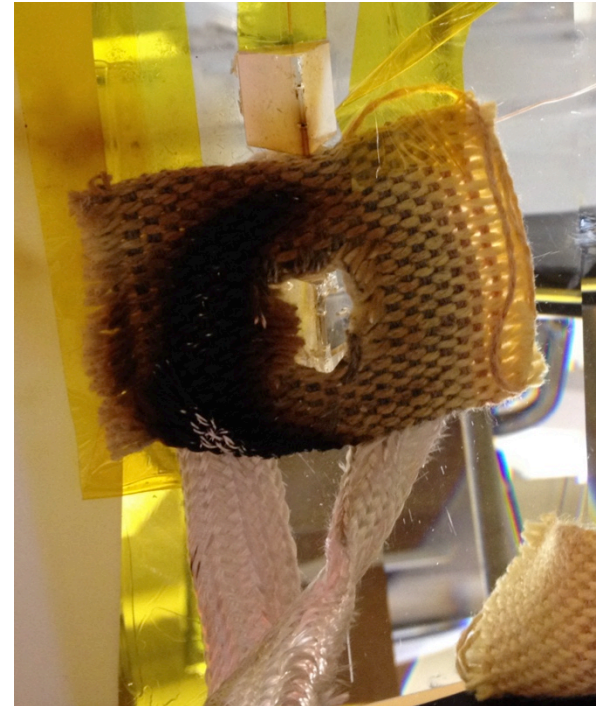


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Test Mass required additional insulation to reach de-bonding temperatures Kevlar burnt and left a residue



The kevlar insulation burnt, leaving a residue. This residue was removed, along with the EP30 by scraping with a razor blade after soaking in Methelyne Chloride.



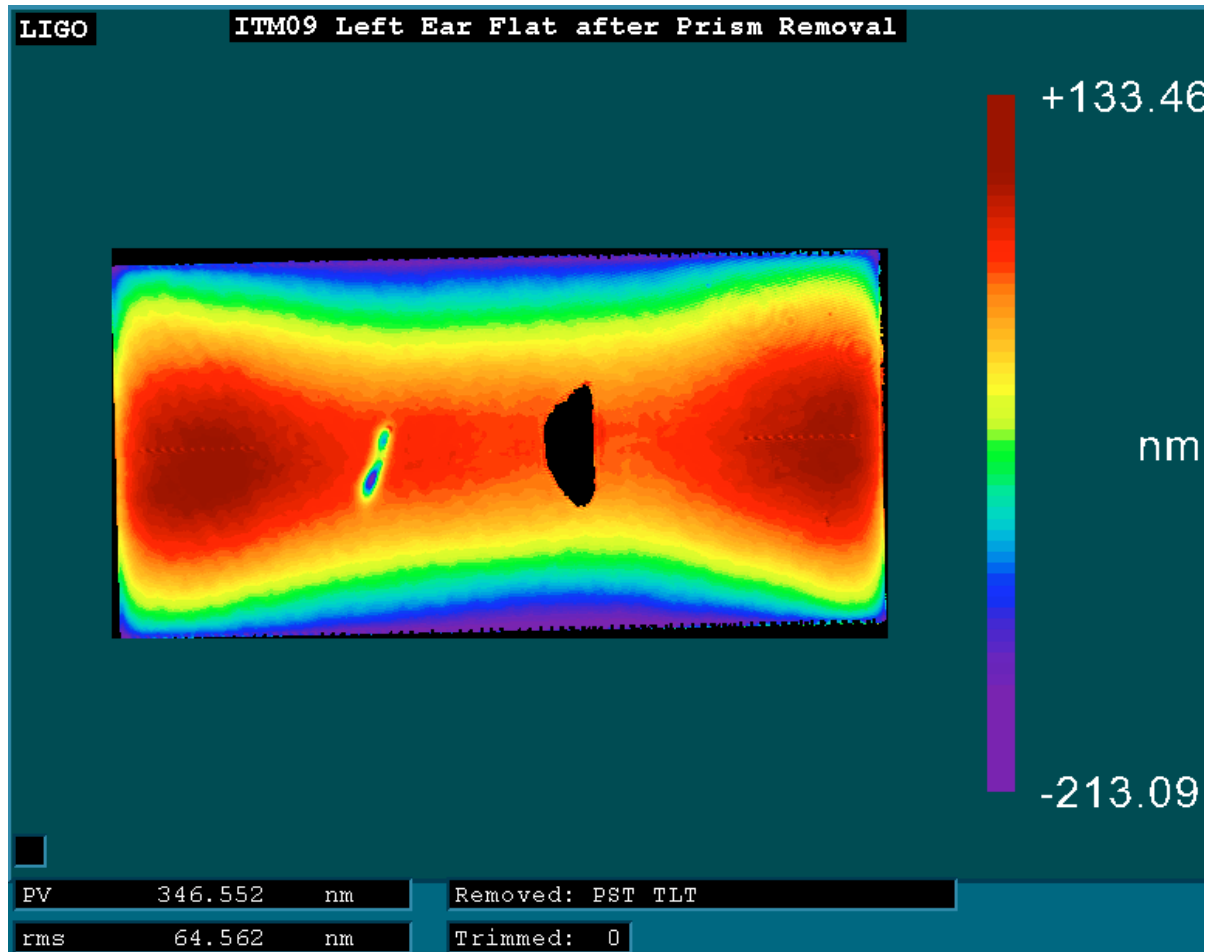
- * Kapton tape was quite resistant to high temperatures It was used successfully to protect the ear-bond zone: beginning at 16mm below center.
- * A layer of microscope slides and foil between the heater tape and the first kevlar insulation kept the insulation from burning on subsequent prisms

Test Mass Glue removal

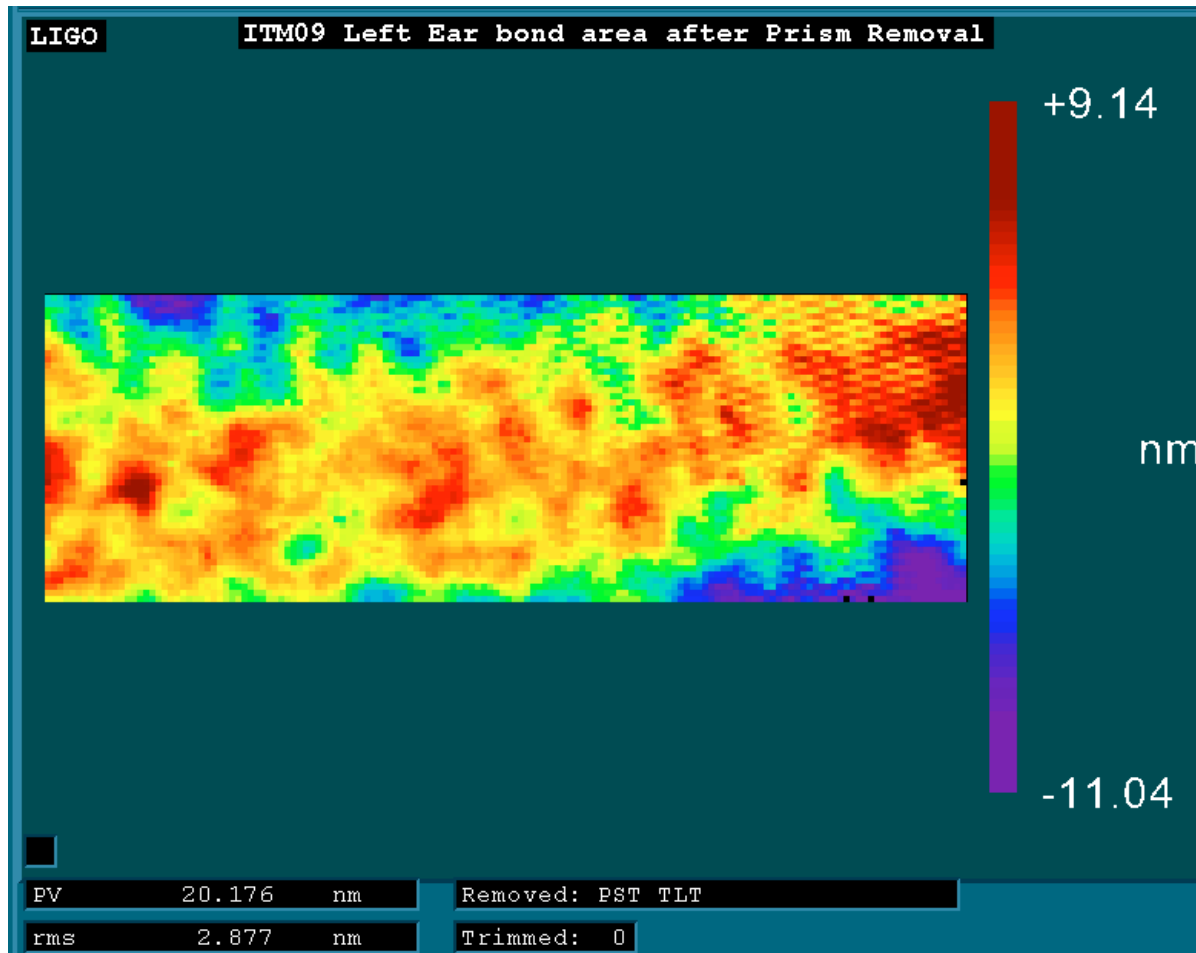
- Glue remained on the Test Mass
- The ITM was soaked in methylene chloride, however the glue would not be rubbed off with a cotton q-tip.
- Eventually, a razor blade was used.
- Great care was taken to avoid the silicate bond area.
- A faint discoloration can be seen on the Left side prism footprint – this measures ~ 10 nm in phase height on the flat figure measurement shown on page 22 .

Entire Left Flat

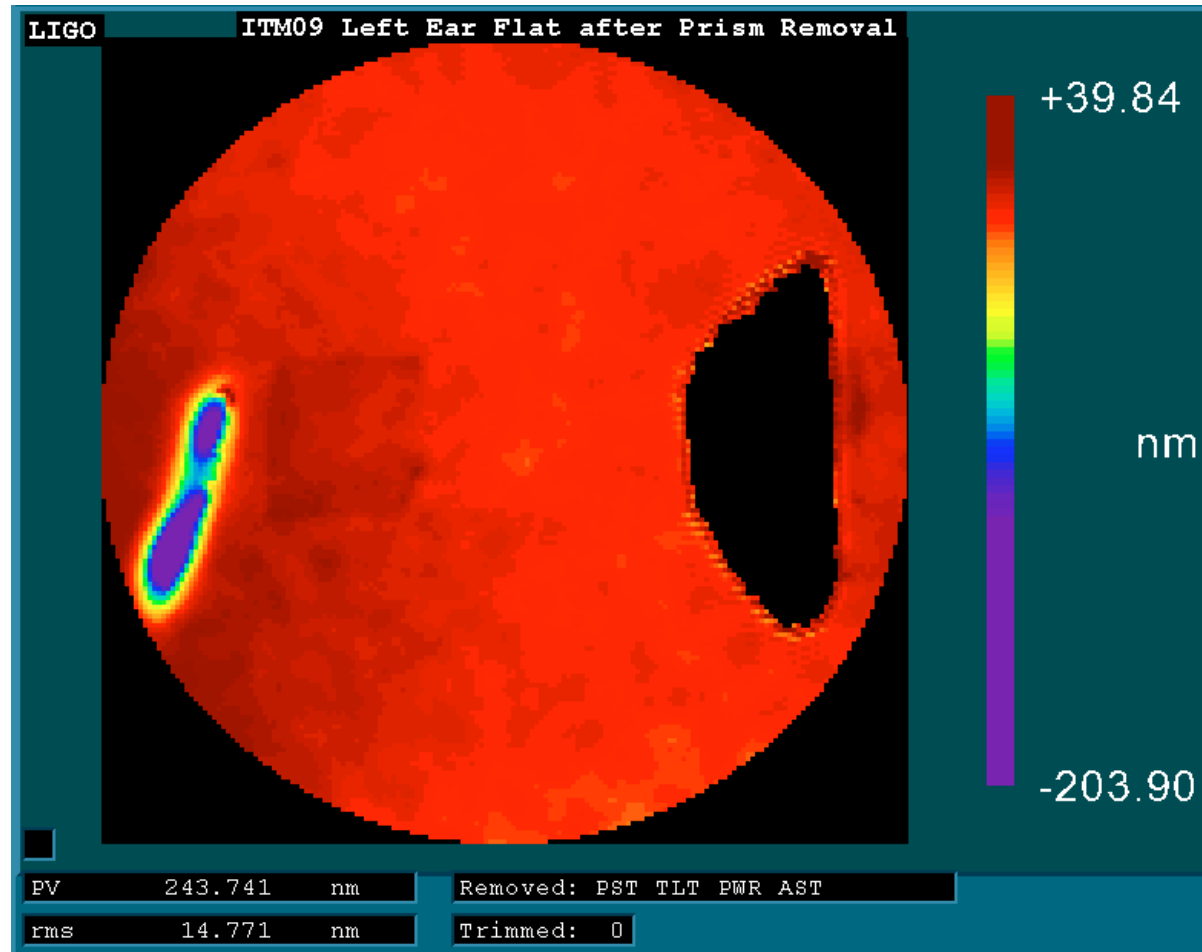
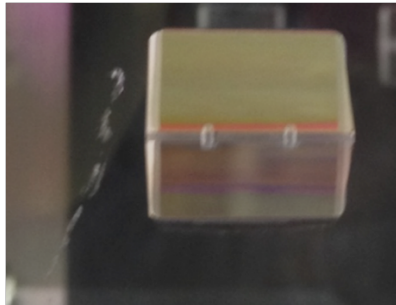
with previous scratch, and missing clamshell



Left Ear Bond Zone $\lambda/31$

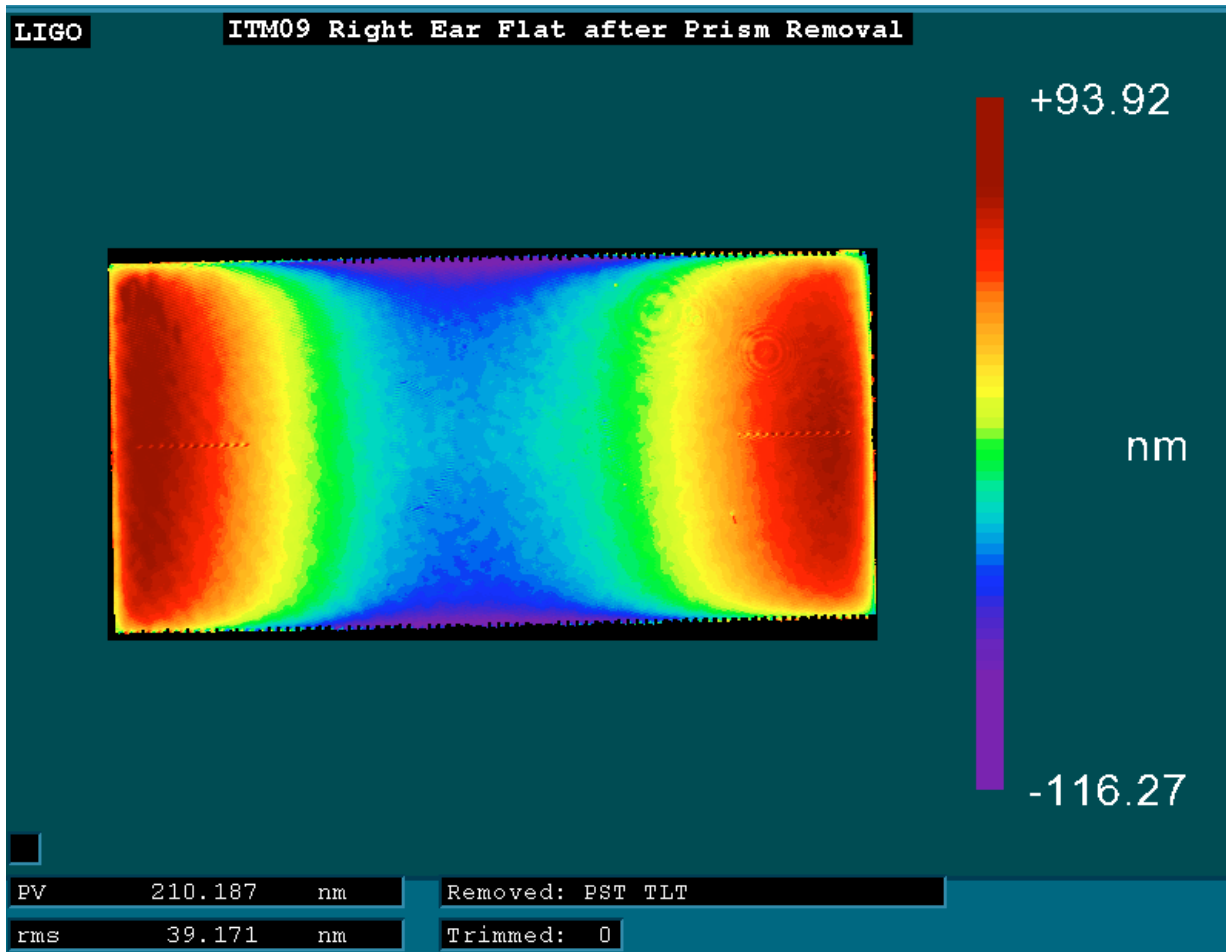


Left flat, former prism position

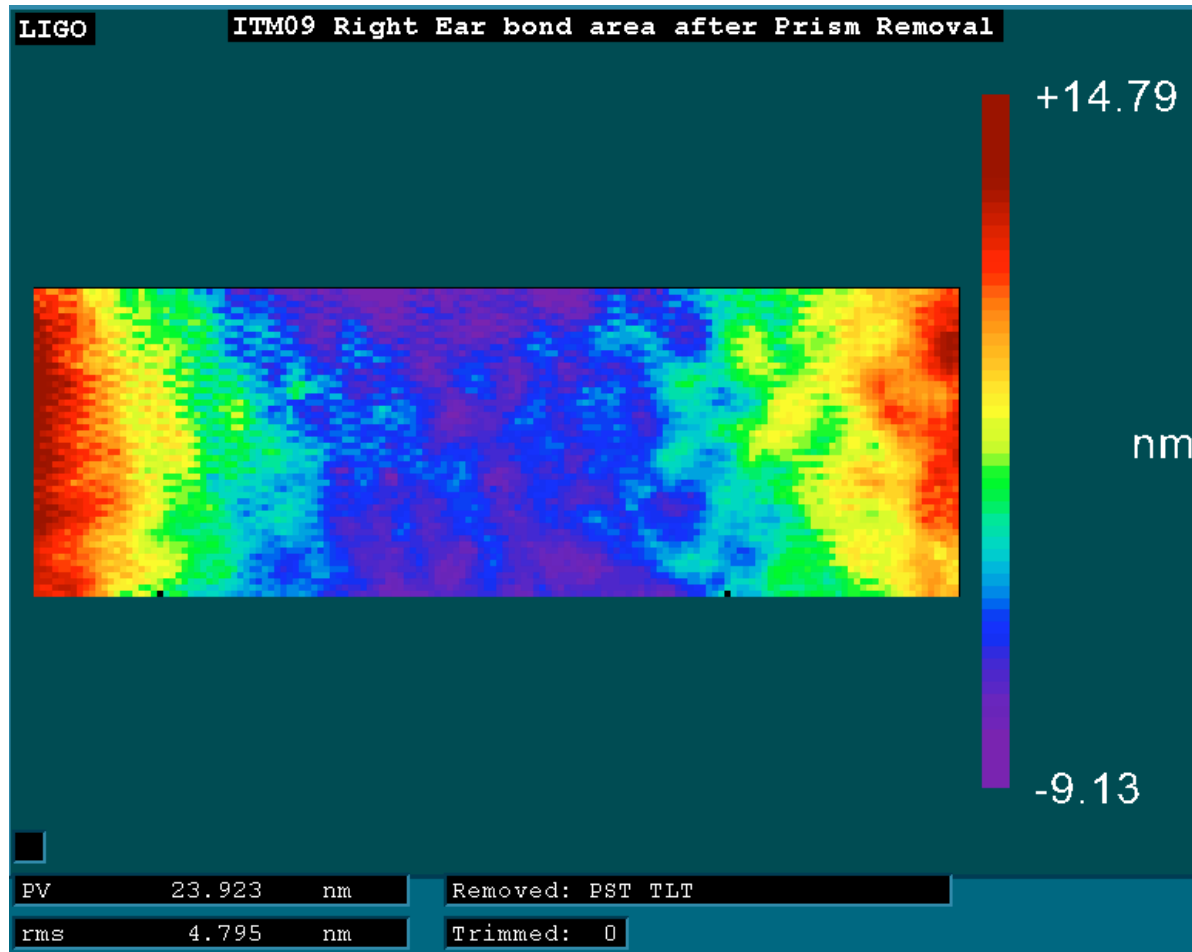


The scratch was present upon return of ITM09 from LMA as shown in the photo.
The prism outline has a phase height of ~ 10 nm LIGO-T1400711-v1

Entire Right Flat

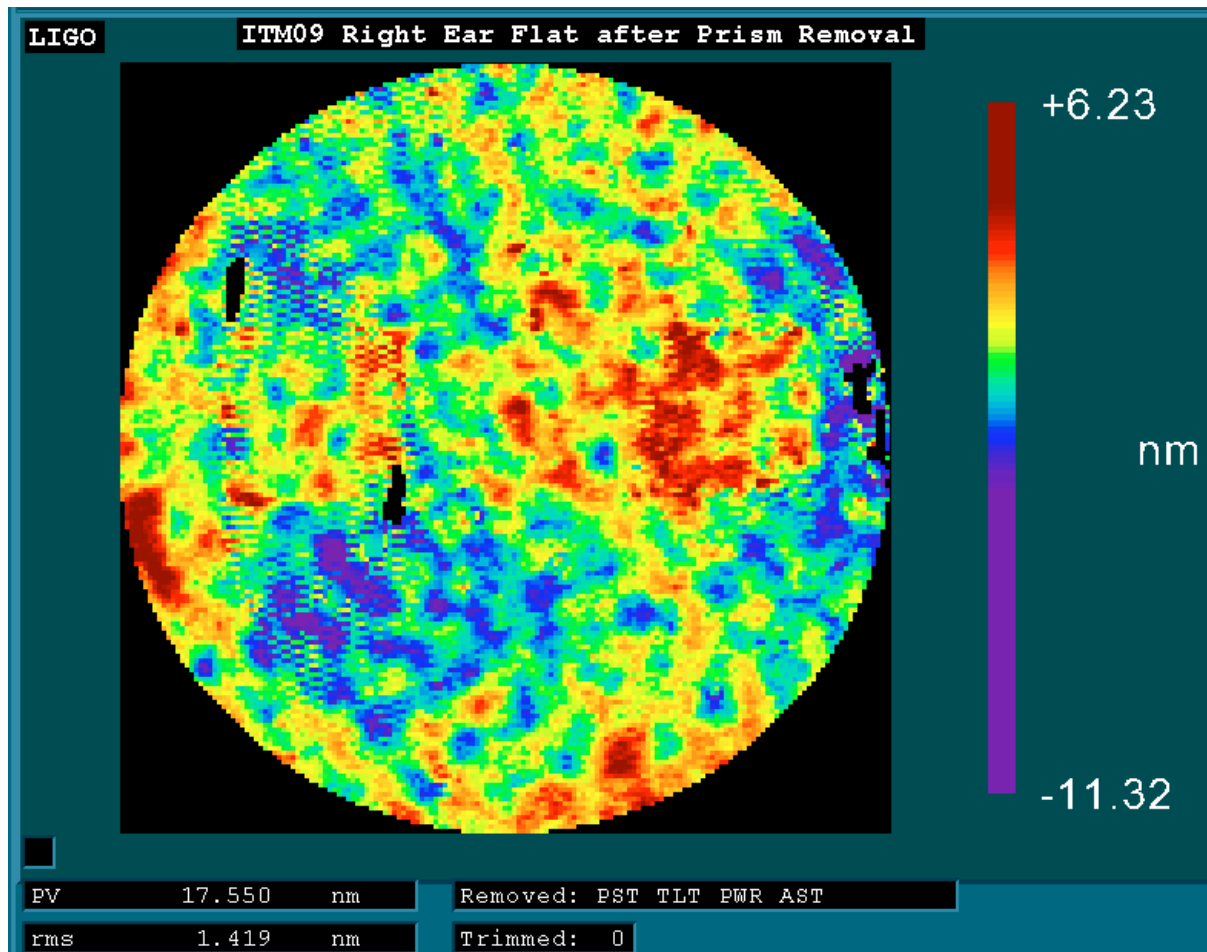


Right Ear Bond Zone $\lambda/26$



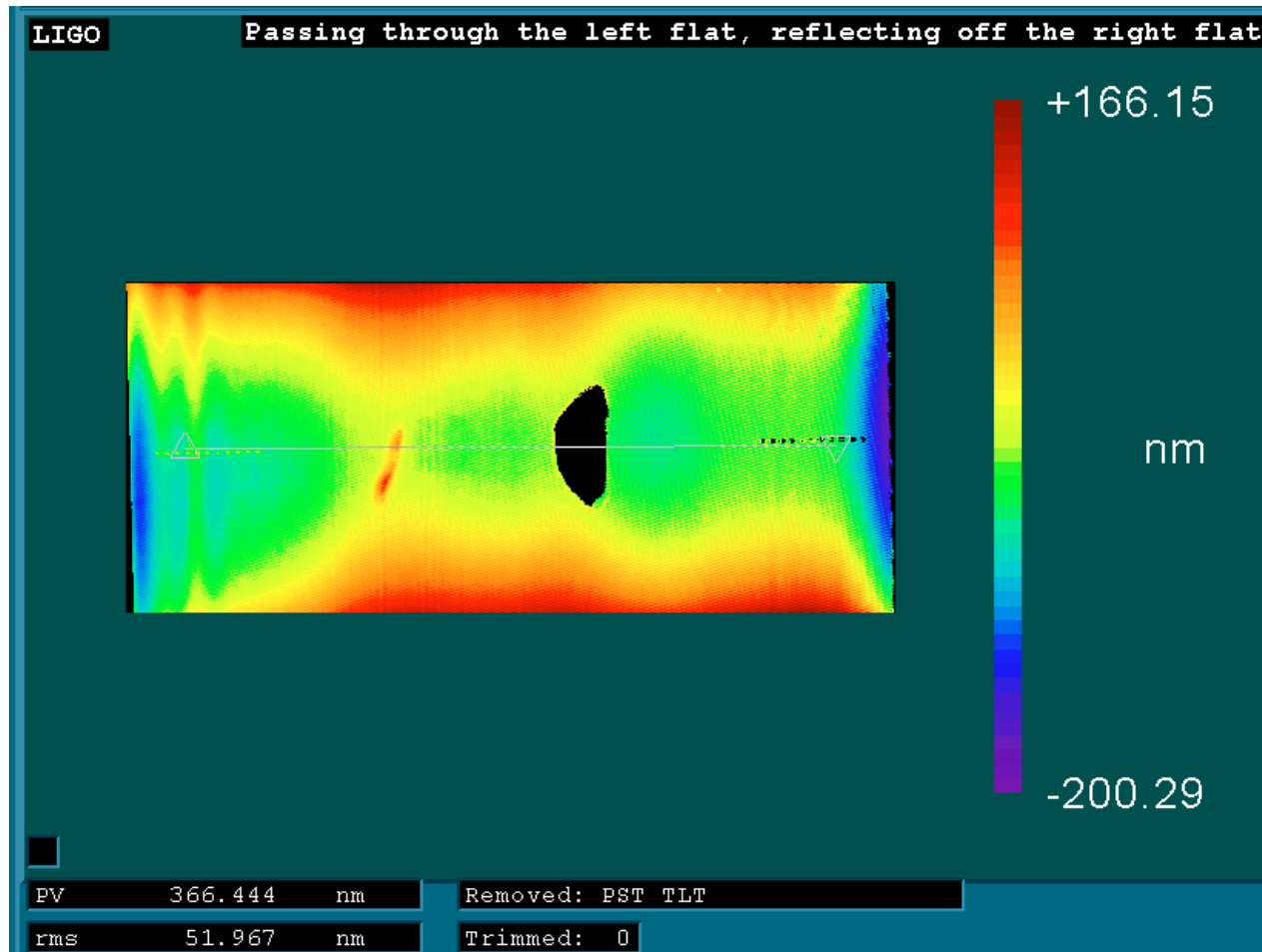
Right Flat, Former Prism Position

reflection noise from the chip on the opposite side is seen at left.



Homogeneity through the glass flats

Just for grins.... Do we see stress at the optical surfaces?



Summary

- Heat was the best method for removing the sapphire prisms bonded with EP30-2 epoxy.
- There appears to be no residual stress in either the clamshell or the former prism positions.
- The silicate bonding zones remain within flatness specification.
- There appears to be no damage due to use of the razor blade for glue removal.