Update on bonding ears and prisms to the test masses for LASTI

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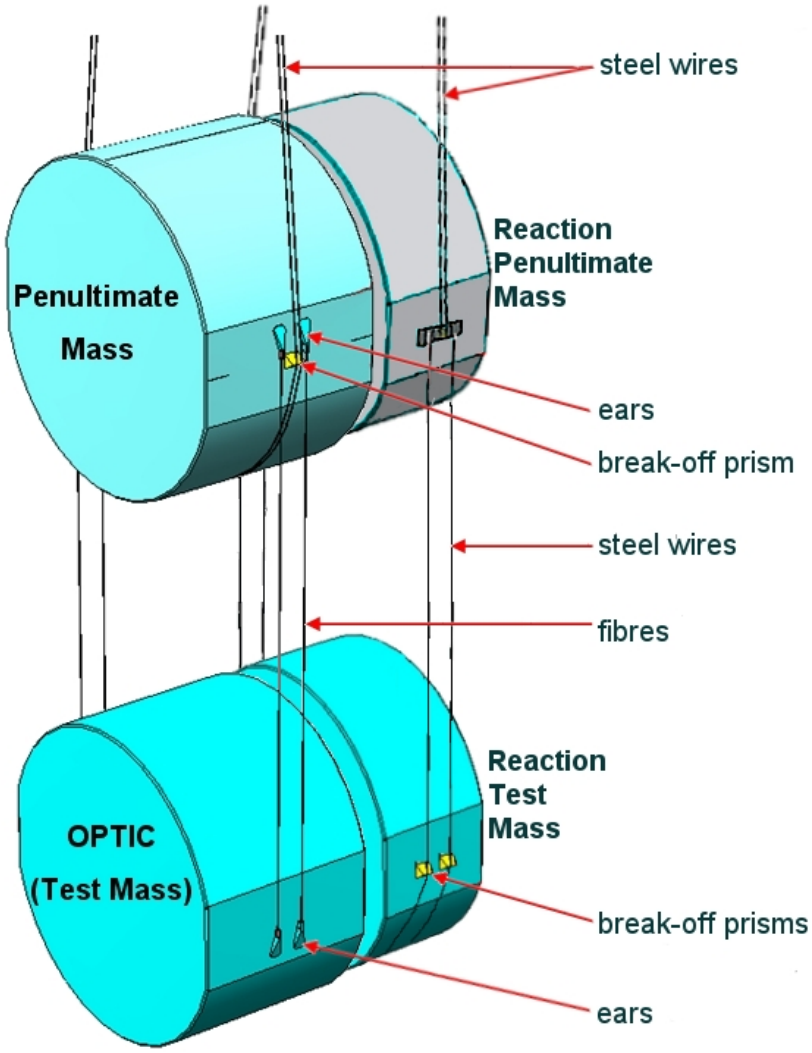
Introduction

- For LASTI the first monolithic bottom stage is being built by the UK groups
- First stages:
  - Bond ears to the two penultimate masses and the test mass
  - Glue prisms to the penultimate masses and the reaction mass



Introduction

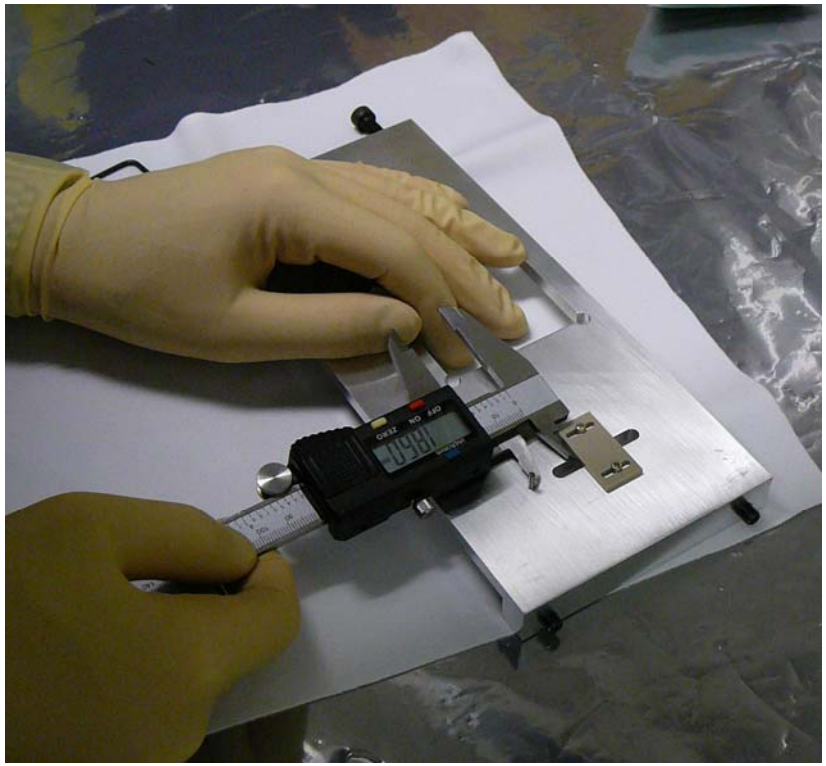
- In bonding exercise on which we reported before:
  - August 2007
  - Bonded ears to the first penultimate mass and to the test mass
- Two subsequent bonding exercises:
  - December 2007 and February 2008
  - Bond ears to the second penultimate mass
  - Bond prisms to the penultimate masses and the reaction test mass
  - Inspection of the bonds and positions of the ears
  - (Weighing of the masses)

Ear bonding procedure (2nd PM)

- Lift the mass from the package onto the washing bath

Ear bonding procedure (2nd PM)

- Lift the mass from the package onto the washing bath
- Prepare bonding template



Ear bonding procedure (2nd PM)

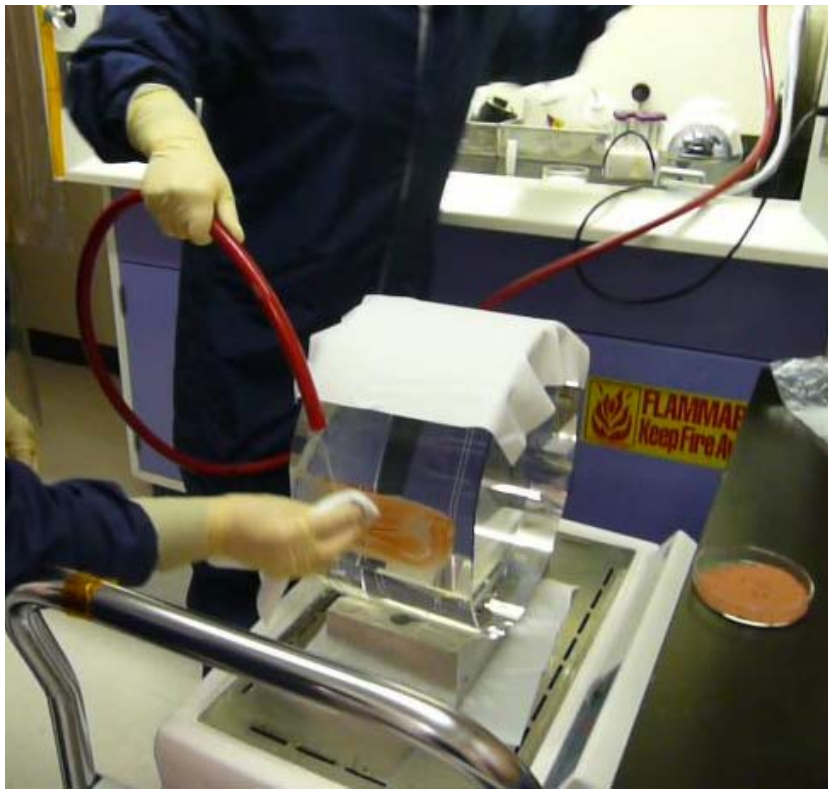
- Lift the mass from the package onto the washing bath
- Prepare bonding template
- Prepare bonding solution

Ear bonding procedure (2nd PM)

- Lift the mass from the package onto the washing bath
- Prepare bonding template
- Prepare bonding solution
- Wash ears for side 1

Ear bonding procedure (2nd PM)

- Lift the mass from the package onto the washing bath
- Prepare bonding template
- Prepare bonding solution
- Wash ears for side 1
- Wash side 1



Ear bonding procedure 2nd PM

- Lift the mass onto the bonding table

Ear bonding procedure 2nd PM

- Lift the mass onto the bonding table
- Set the bonding template

Ear bonding procedure 2nd PM

- Lift the mass onto the bonding table
- Set the bonding template
- Bond the ears

Ear bonding procedure 2nd PM

- Lift the mass onto the bonding table
- Set the bonding template
- Bond the ears
- Bond inspection

Ear bonding procedure 2nd PM

- Lift the mass onto the bonding table
- Set the bonding template
- Bond the ears
- Bond inspection
- Repeat the procedure for side 2
- Pack the mass

Ear bond inspection

- Inspect the bonds

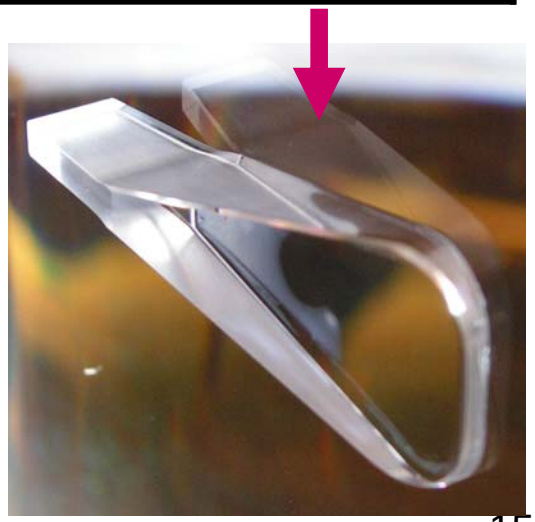
- Inspect the ear positions

Ear bond inspection

- Inspect the bonds
  - All bonds are OK

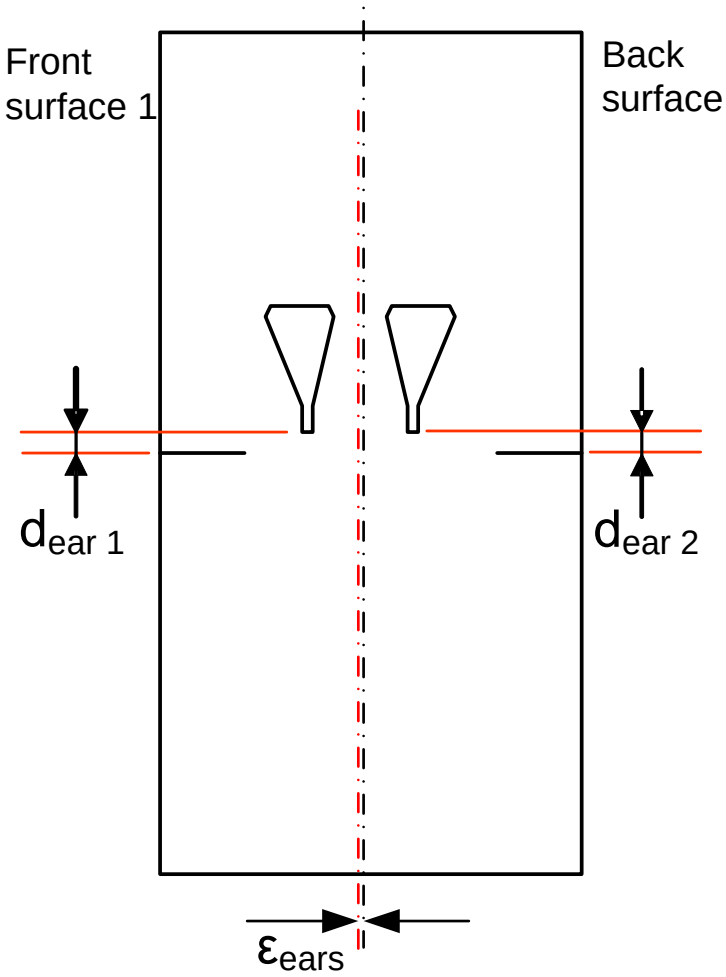
	PM 1	PM 2	TM
Side 1	Clear, no features	Clear, no features	Clear, no features
Side 2	Clear, no features	Clear, a small feature in 1 corner	2/3 clear

- Inspect the ear positions



Ear bond inspection

- Inspect the ear positions



Ear bond inspection

- Inspect the ear positions
  - Penultimate Mass 1

	ε_{ear} [mm]	$d_{ear\ 1}$ [mm]	$d_{ear\ 2}$ [mm]	δd_{ears} [mm]
Side 1	0.25	1.9	2.5	0.6
Side 2	0.25	2.2	2.2	0.0

  - d_{ear} prospected 2.65 mm
  - Measurement accuracy of d_{ear} is 0.3 mm

Ear bond inspection

- Inspect the ear positions
  - Penultimate Mass 2

	ε_{ear} [mm]	$d_{ear\ 1}$ [mm]	$d_{ear\ 2}$ [mm]	δd_{ears} [mm]
Side 1	0.0	2.9	2.2	0.7
Side 2	0.0	2.2	2.2	0.0

  - d_{ear} prospected 2.65 mm
  - Measurement accuracy of d_{ear} is 0.3 mm

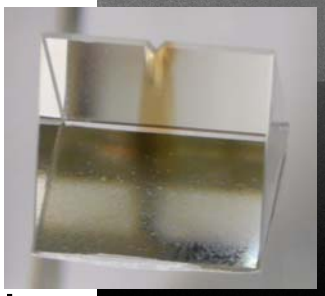
Ear bond inspection

- Inspect the ear positions
  - Test Mass

	ε_{ear} [mm]	$d_{ear\ 1}$ [mm]	$d_{ear\ 2}$ [mm]	δd_{ears} [mm]
Side 1	-0.2	2.4	2.4	0.0
Side 2	-0.1	2.0	2.0	0.0

  - d_{ear} prospected 2.55 mm
  - Measurement accuracy of d_{ear} is 0.3 mm

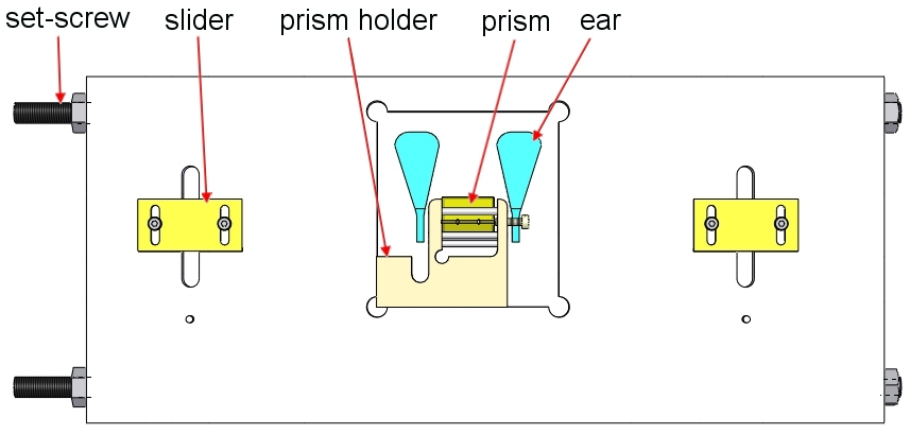
Prism glueing

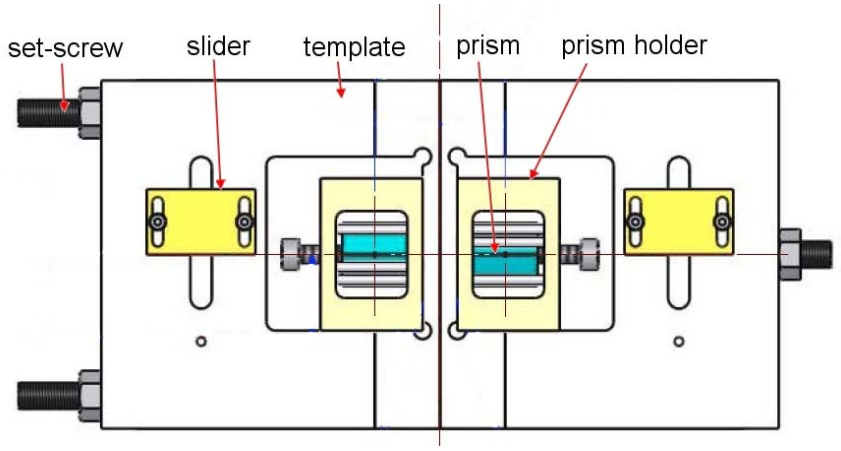


- Penultimate mass
  - Lithosil
  - 2 grooves
  - 1 prism on each side
- Reaction mass
  - F2 glass (15% lead)
  - 1 groove
  - 2 prisms on each side
- Have been made at Strathclyde University using laser ablation
  - Grooves do not show cracks, which improves strength for the wire suspension

Prism glueing procedure (PM's and RM)

- Lift the mass from the package onto the bonding table
- Prepare bonding templates
  - 2 different templates for the PM and RM
  - Set sliders and reference screws
- Wipe bonding sides and prisms with methanol
- Put prisms into prism holders



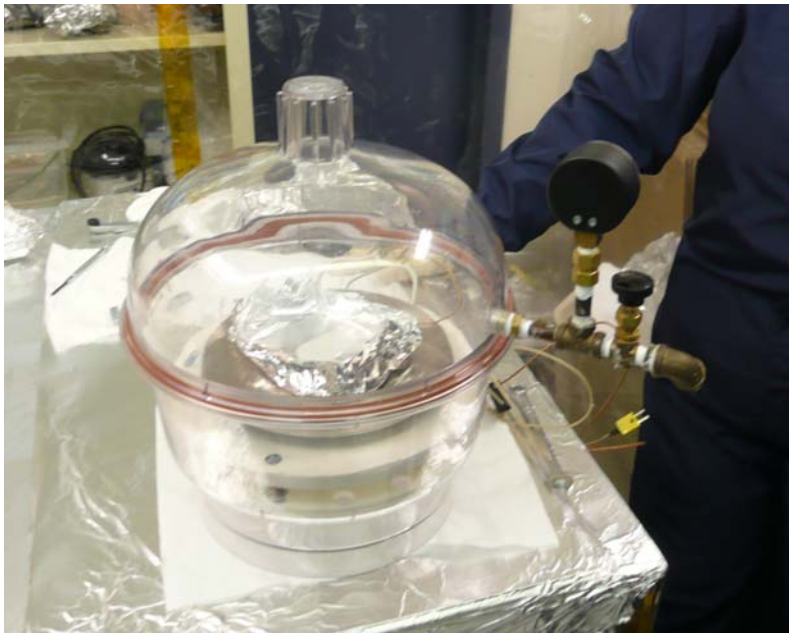


Prism glueing procedure (PM's and RM)

- Place the template onto the mass

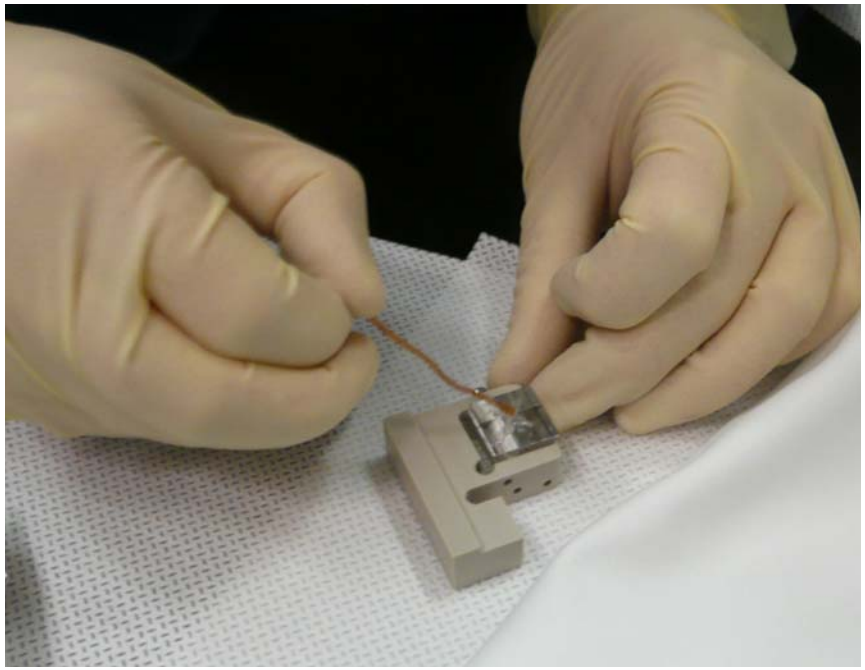
Prism glueing procedure (PM's and RM)

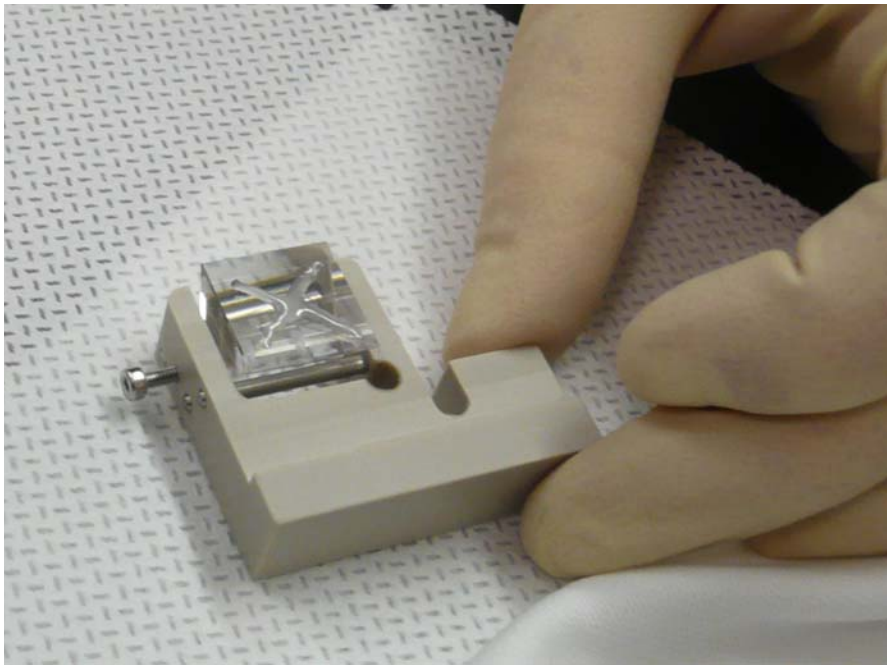
- Place the template onto the mass
- Prepare VacSeal adhesive
  - Mix the adhesive
  - Backing pump



Prism glueing procedure (PM's and RM)

- Place the template onto the mass
- Prepare VacSeal adhesive
  - Mix the adhesive
  - Backing pump
- Apply the adhesive on the prisms in a cross-shape





Prism glueing procedure (PM's and RM)

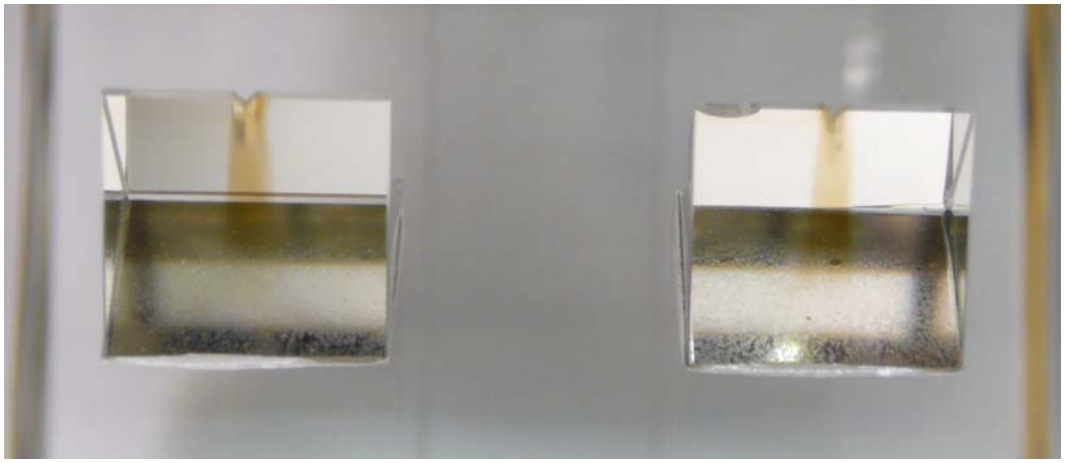
- Place the template onto the mass
- Prepare VacSeal adhesive
  - Mix the adhesive
  - Backing pump
- Apply the adhesive on the prisms in a cross-shape
- Bond prisms

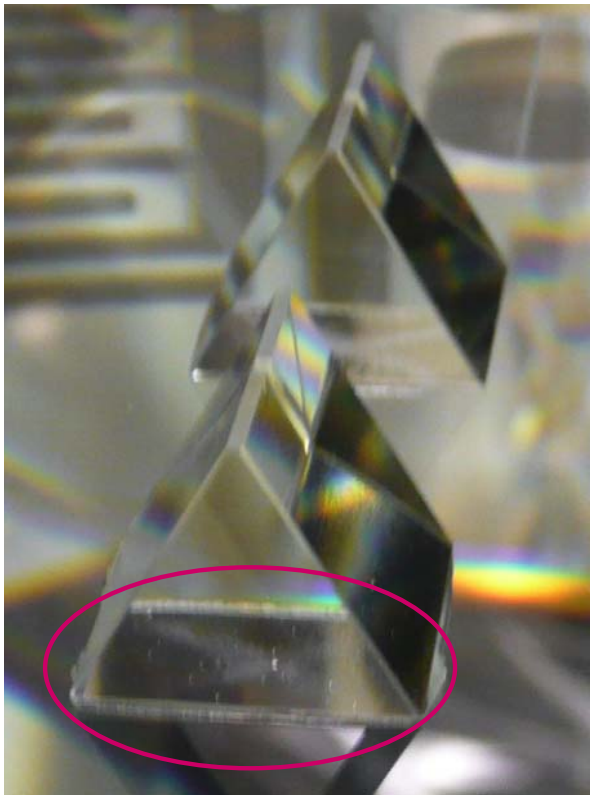
Prism glueing procedure (PM's and RM)

- Place the template onto the mass
- Prepare VacSeal adhesive
  - Mix the adhesive
  - Backing pump
- Apply the adhesive on the prisms in a cross-shape
- Bond prisms
- Cure the bonds for 24 hours before removing the template
  - Of which at least 4 hours under a 250 W heat lamp
  - Temperature ~50°C

Prism bond inspection after curing

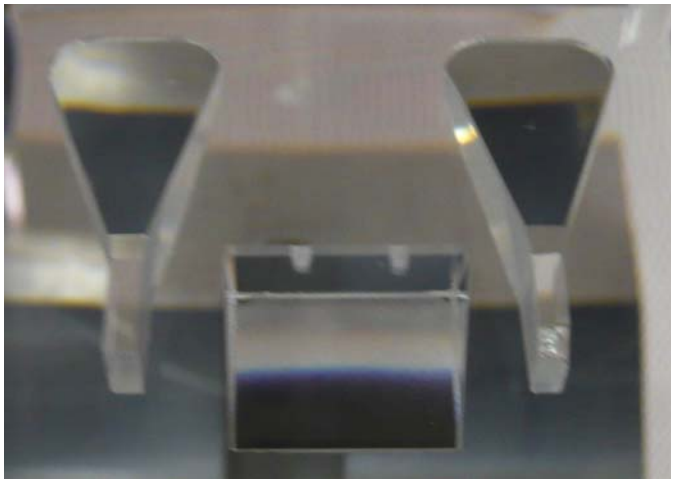
- F2 prisms on the reaction mass
  - a grainy structure
  - the cross drawn with the adhesive visible

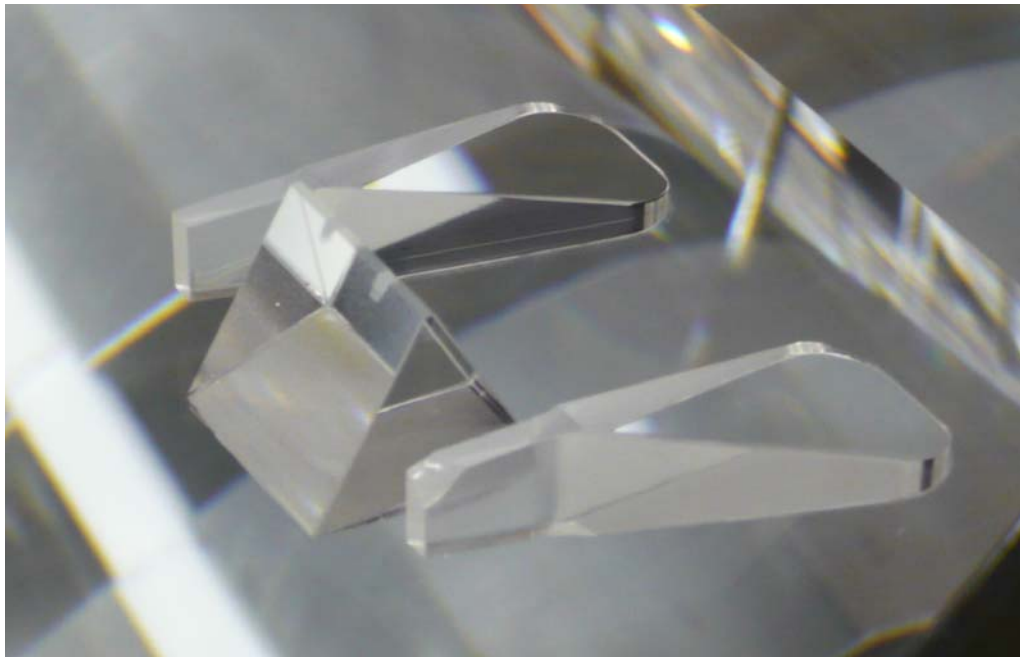




Prism bond inspection after curing

- Lithosil prisms on the penultimate masses
  - Structures in adhesive are not as clearly visible





Conclusions

- All ears and prisms bonded successfully
  - Horizontal alignment within 0.2 mm (except for PM 1)
  - Vertical alignment is accurate within 0.7 mm
  - All ears have clear bonds except one ear on the test mass (2/3 has bonded)
  - Alignment of the prisms is good by eye inspection
  - The prism bonds are ok
    - show a grainy structure and the adhesive cross

Next steps

- Glue the magnets to the penultimate masses
- Vacuum bake the masses
- Weld fibres to the ears
- Installation and testing of monolithic stage in LASTI
- Improvements for advanced LIGO
  - Build a washing bath, especially for cleaning before bonding ears
  - De-bonding tool
  - Measurement device for measuring the positions of the ears
  - Small adaptations to the bonding jigs