



# Bonding ears on the penultimate mass and test mass at LASTI

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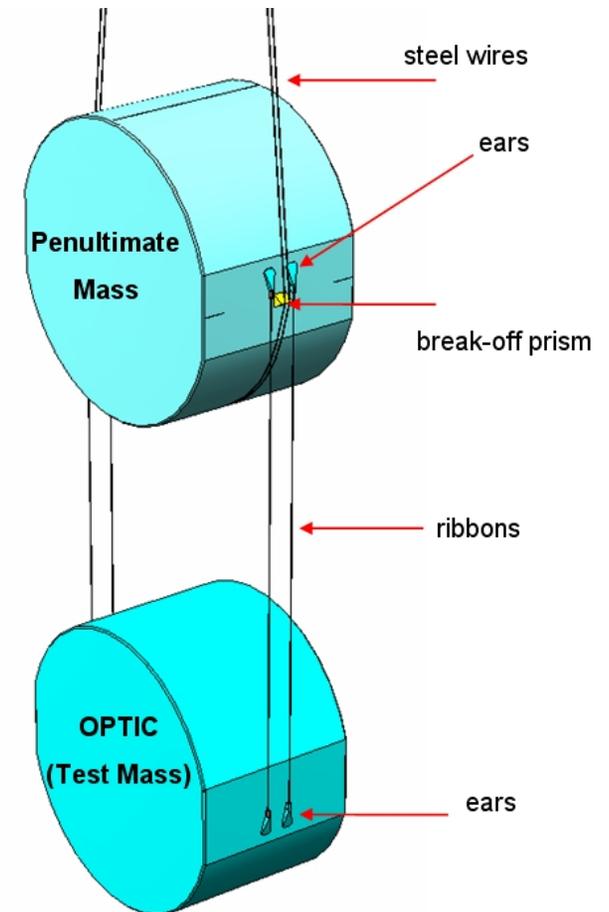
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# Introduction

- For LASTI the first monolithic bottom stage is built over the next 5 months
- First stage:
  - Bond ears to the two penultimate masses and the test mass
- 27<sup>th</sup> - 30<sup>th</sup> August visit to LASTI/MIT
  - After thorough preparations
  - Goal: Bond 4 ears to the first penultimate mass and the 4 ears to the test mass





# Introduction

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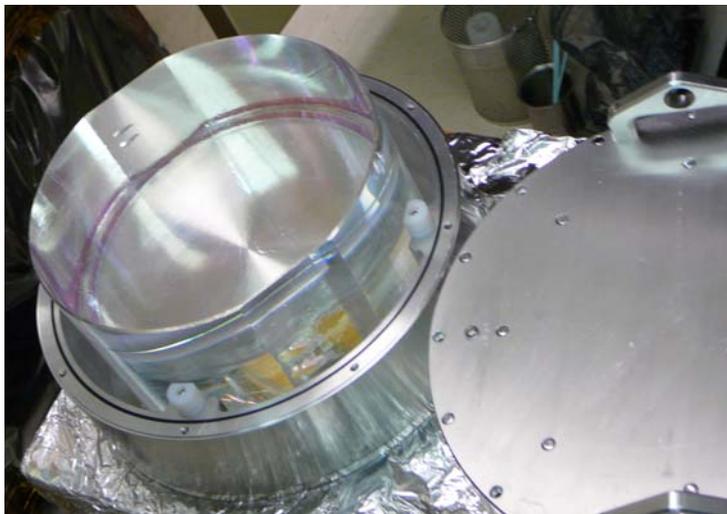
- Subsets of activity
  - Packaging of masses
  - Handling and lifting masses
  - Setting a bonding jig
  - Cleaning the ears and masses
  - Bonding ears
  - Inspection of the bonds
- Recommendations and future



# Packaging of the masses

## ■ Test mass

- with low loss HR coating
- faces protected with First Contact
- packed in an aluminium container
- container was inside a padded plastic crate



## ■ Penultimate mass

- no coating
- packed in cotton cloth in padded aluminium crate
- aluminium crate was inside a bigger padded aluminium crate





# Handling and lifting of the masses

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- Handling and lifting was necessary to
  - Remove the masses from packaging
  - Move the masses from the bonding table to the bath
  - Rotate the masses to get bonding side up for bonding or washing
- Two options for handling
  - Ergonomic arm (ergo-arm)
  - Ring clamp

# Handling and lifting of the masses

- Using the ergo arm
  - Convenient for accurately moving and turning the masses and placing the masses on the V-blocks



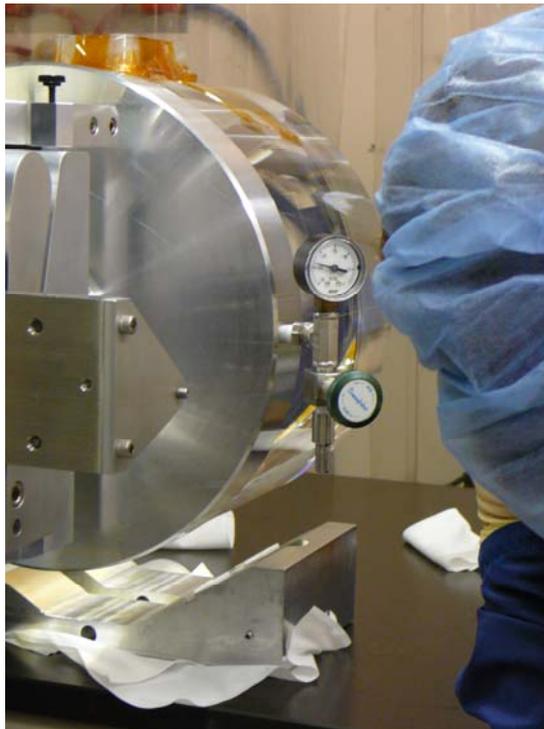
Step 1: Aligning the ergo-arm vacuum ring with the mass



Step 2: Creating vacuum pressure

# Handling and lifting of the masses

- Using the ergo arm



Step 3: Lifting mass and checking vacuum pressure stability



Step 4: Moving mass and lowering it on a V-block again

# Handling and lifting of the masses

- Using the ring clamp
  - Convenient for 'quick' basic handling
  - Benefit is that coating protection (First Contact) does not need to be removed





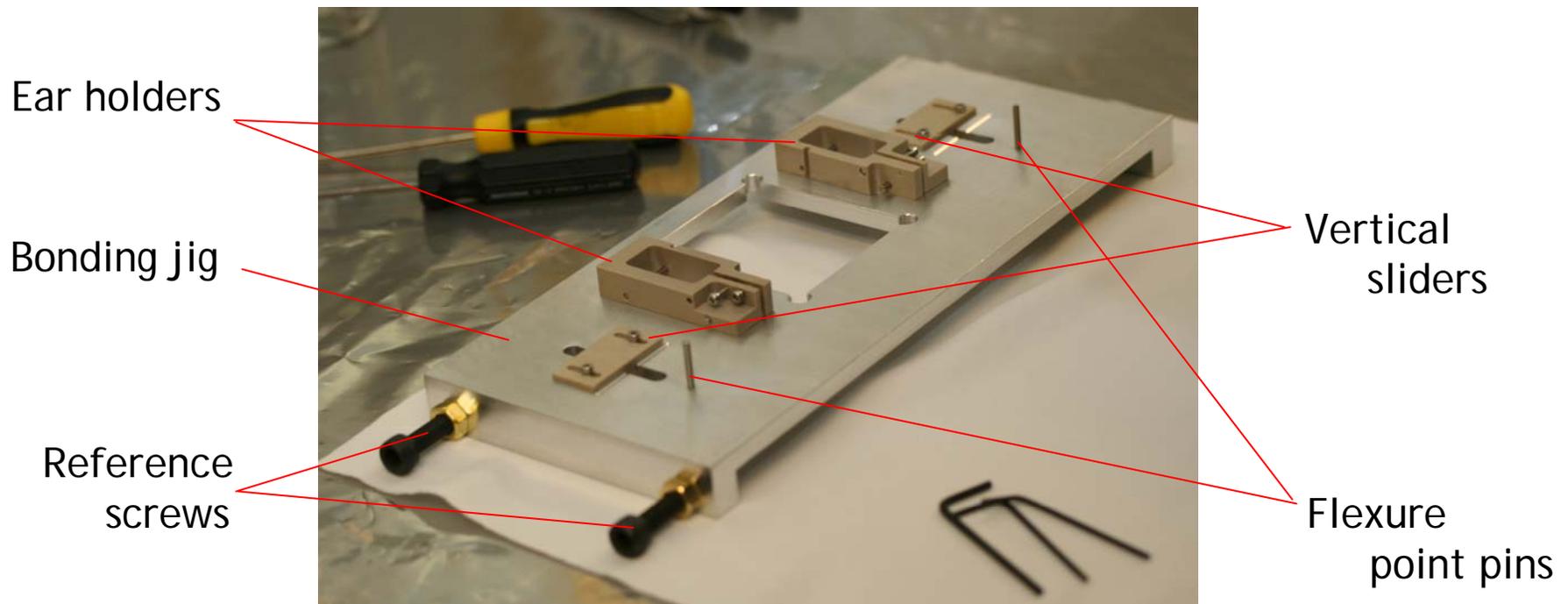
## Setting the bonding jig

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- Ears should be positioned to the sides of the masses with 0.25 mm accuracy to get flexure point in the right place
  - The flexure point should be 1 mm above/below the centre of the test mass/penultimate mass.
- Therefore a bonding jig was used (developed with RAL)

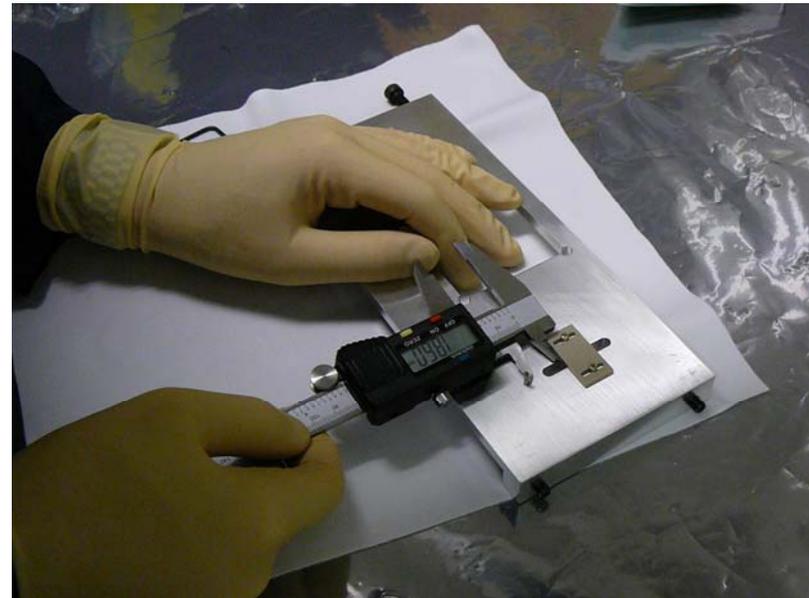
## Setting the bonding jig

- The bonding jig is used for aligning the ears on the test mass



## Setting the bonding jig

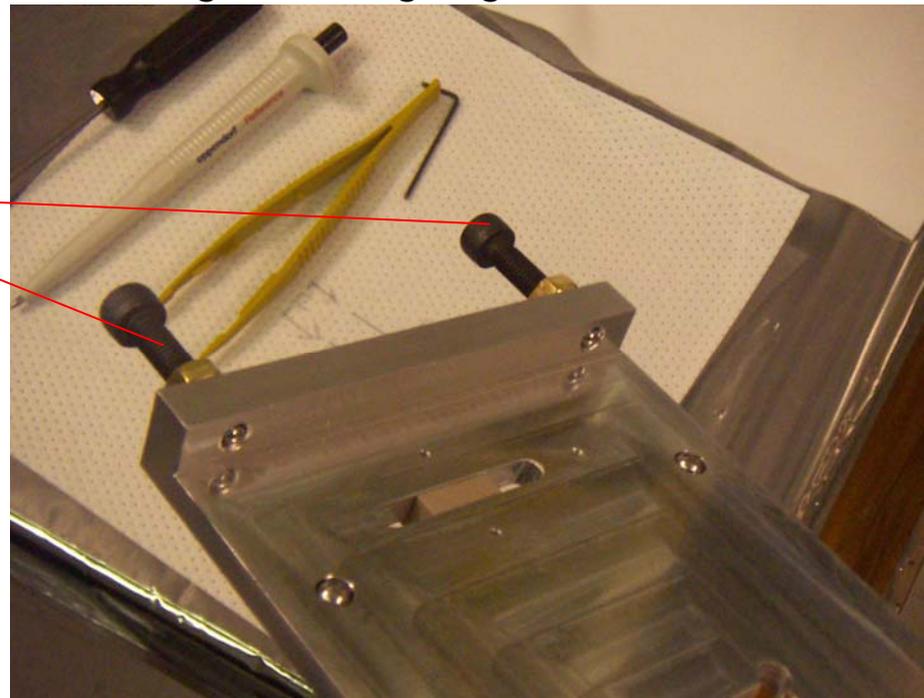
- Setting the distance of the vertical sliders from the flexure point pins
  - This distance is based on the distance of the flexure point of the ribbons from the ear.
  - The distance of the slider to the pin was determined using FE modelling to be
    - D-slider<sub>PM</sub> = 18.6 mm
    - D-slider<sub>TM</sub> = 18.7 mm



## Setting the bonding jig

- Setting the reference screws
  - To horizontally centre the position of the ears.
  - Referenced to the face of the mass
  - This was done using feeler gauges

Reference  
screws



# Cleaning the ears and masses

- Cleaning the masses
  - A bath was made on which the mass in V-block could sit to be cleaned.
  - Penultimate mass: flats were washed one at a time
  - Test mass: flats were washed in one go
    - First contact was used to protect the HR coating
  - Just prior to aligning the jig onto the mass the mass was wiped with methanol



# Cleaning the ears and masses

- Cleaning the ears
  - 2 ears were cleaned sequentially at the sink
  - The ears were then put into the ear holders
  - Ears were wiped with methanol just prior to bonding



Cleaning ear



Ear in ear holder

## Setting the bonding jig

- Aligning the bonding jig on the mass
  - Such that the vertical sliders in the jig line up with the fiducial lines on the mass (placed by the vendor)



## Bonding the ears

- 1/6 sodium silicate bonding solution was prepared, prior to cleaning
- 0.7  $\mu\text{l}$  of bonding solution was applied per ear (1.77  $\text{cm}^2$ )
- the left ear in ear holder was carefully lowered onto the mass flat, immediately followed by the right ear



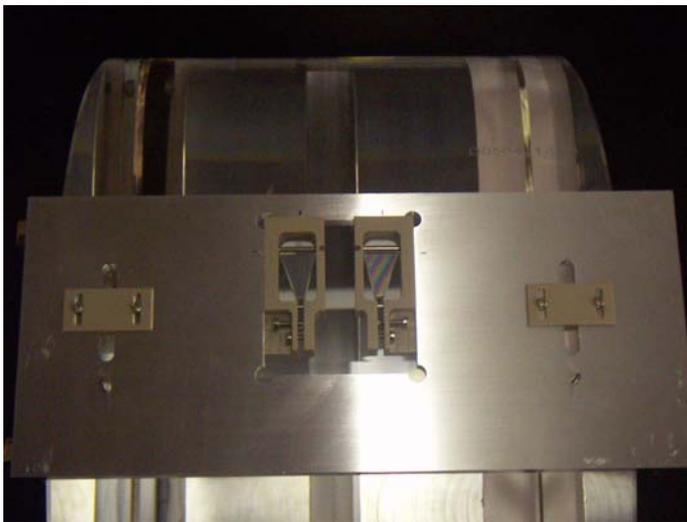
Applying bonding solution



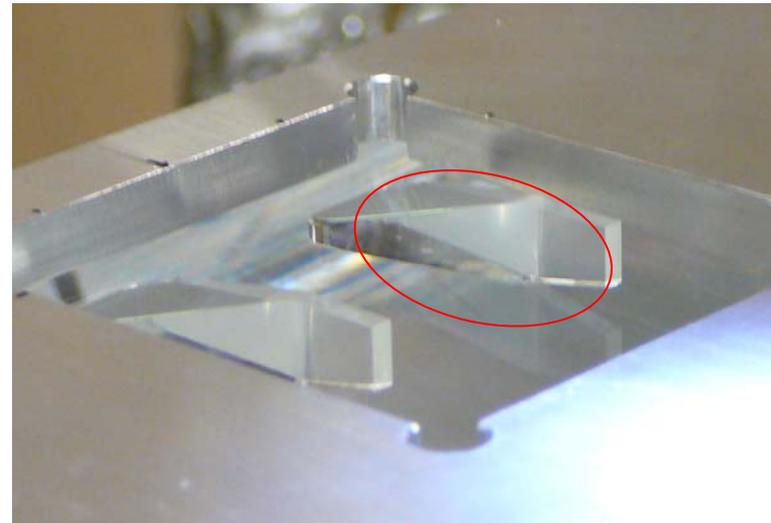
Lowering the ear

# Inspection of the bond

- All bonds settled well (coloured fringes disappeared in a matter of hours)
- The last bond on the test mass showed a few dirt spots and a bubble near the neck region of the ear. It was decided that the bond was good enough.



Initial fringes in the right ear  
on the penultimate mass



Speck in the right ear on the  
test mass



# Recommendations

- A few improvements to the ergo-arm
  - other wheels, vertical lever, crash mat
- A specially designed washing trolley for washing the masses and ears
- Improvement on the bonding jig
  - Central vertical lines on the mass and a horizontal slider on the bonding jig to give higher tolerance for the horizontal alignment
- Each side of the mass should be cleaned just prior to bonding



# Recommendations

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- Investigation on how best to light the bond to see the bonding fringes
- In case of need for de-bonding
  - Design of a de-bonding tub that is stuck onto the flat of the mass
  - Determination of the latest moment of decision to de-bond



## Next steps

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- Bond ears to 2<sup>nd</sup> penultimate mass (next month)
- Weld fibres to the ears
- Installation and testing of monolithic stage in LASTI

# Conclusion

