*LIGO Laboratory / LIGO Scientific Collaboration*

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# ALIGO NP-type: - Preparations of Prism Bonding at LASTI on 11th – 17th February 2008

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## Introduction

In the week of Monday 11th until Friday 15th February 2008 a third exercise will be done at LASTI for glueing prisms to the first and second penultimate mass and the reaction mass as part of the ALIGO ETM/ITM noise prototype activity.

Preceding bonding exercises were done from 27th – 31st August 2007 and 10th – 15th December 2007 during which ears were bonded to the penultimate masses and the test mass. Reports of these exercises have references T070223-00-D and T070305-00-D.

This document is a preparation document for the 3rd exercise. It lists: goals, needed documents, check list of needed materials, list of tasks to be completed before the exercise starts.

# 1 Reference documents

| | |
|---|---|
| ***Design documentation 'glass' essentials*** | |
| D050421-05-K | NP- type ETM Penultimate Mass |
| D050420-06-D | NP-type ETM Reaction Test Mass |
| D060166-05-B | NP-type Reaction Test Mass Wire Break-off Prism |
| D060099-03-B | NP-type Penultimate Mass Break-off Prism |
| ***Design documentation of the alignment jigs*** | |
| D070391-05-D | NP-type ear bonding jig GA |
| D070505-00-D | NP-type penultimate mass prism holder |
| D070507-00-D | NP-type ERM Prism bonding jig |
| D070504-00-D | ERM prism holder bonding |
| ***Measurement reports on 'glass' essentials*** | |
| GNL-4025-R1 | Penultimate mass 1 measurements |
| GNL-4027-R2 | Penultimate mass 2 measurements |
| GNL-4020-R1 | Reaction mass measurements |
| E070163-00-K | Test report on A ears for Advanced LIGO monolithic suspension[1] (update required) |
| E070164-00-K | Test report on B ears for Advanced LIGO monolithic suspension[2] (update required) |
| ***Back ground documents*** | |
| T080023-00-R | Test prism glueing on disc insert plates |
| T070138-00-K | Ribbon/Fibre Length Budget |
| T070156-01-K | Advanced Testing of the Noise Prototype Ear Bonding Jig |
| T070223-00-K | ALIGO NP-type: - Report on Ear Bonding at LASTI 27th August – 31st August |
| T070305-00-D | ALIGO NP-type: - Report on Ear Bonding at LASTI 10th – 14th December 2007 |
| E970154-00-D | Large optics suspension balancing: component specification |

[1] Note there has been a renumbering of the ears characterized in E070163 – "A" replaced with "BB".

[2] Note there has been a renumbering of the ears characterized in E070164 – "B" replaced with "AA".

# 2 Goals

Goals of the visit are to:

1) Glue prisms to the 2nd penultimate mass
2) Glue prisms to the 1st penultimate mass
3) Glue prisms to the reaction mass

# 3 Prospected time schedule

**Table 3.1 Time schedule**

| | Monday 11-02-2008 | | Tuesday 12-02-2008 | | Wednesday 13-02-2008 | | Thursday 14-02-2008 | | Friday 15-02-2008 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Preparations | | | | | | | | | | |
| Measure position of the ears on 2nd penultimate mass | | | | | | | | | | |
| Glue prisms to side 1 2nd PM | | | | | | | | | | |
| Glue prisms to side 2 2nd PM | | | | | | | | | | |
| Glue prisms to side 1 ERM | | | | | | | | | | |
| Glue prisms to side 2 ERM | | | | | | | | | | |
| Glue prisms to side 1 1st PM | | | | | | | | | | |
| Glue prisms to side 2 1st PM | | | | | | | | | | |
| Pack masses and clean | | | | | | | | | | |

# 4 Preparations

Fill in safety forms with David Schoemaker and Rich Mittleman. Main safety risk is the lifting of the masses. There are no chemical safety risks as the bonding solution is not hazardous. Vac Seal also poses minimal safety hazards.

Check if all required items are accounted for.

Set-up the cleanroom and clean equipment.

# 5 Measure positions of ears on the 2nd penultimate mass

### 5.1.1 Measure position of the ears on 1st PM

Measure the distance of the outer part of the weld horn of the ear closest to surface 1 to surface 1 ($d_{ear}$ in Figure 5.1).

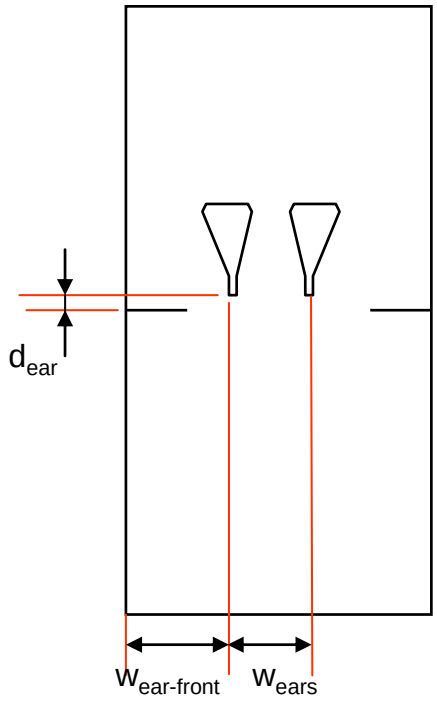


**Figure 5.1 Measurement of position of ears**

$w_{ear\text{-}front}$ and $w_{ear\text{-}back}$ should be 100.2 – 14.75 = 85.45 mm

$w_{ears}$ should be 29.5 mm

The vertical position of the ears should be:

$d_{ear}$ = d-pin + $d_{jig}$ – d-slider = 19.0 + 2.25 – 18.6 = 2.65 mm

**Table 5.1 Fill in table for measurements of the position of the ears on the 1st PM**

| **Parameter** | **Measured value [mm]** |
|---|---|
| $w_{ear\text{-}front}$ | |
| $w_{ears}$ | |
| $w_{ear\text{-}back}$ | |
| $d_{ear\ 1}$ | |
| $d_{ear\ 2}$ | |
| | **Error value [mm]** |
| $\varepsilon_h = 100 - (w_{ear\text{-}front} + w_{ears}/2)/2$ | |

# 6 Prism glueing

## 6.1 Prism allocation

Prisms will be glued to the 1st penultimate mass, 2nd penultimate mass and the reaction mass.

**Table 6.1 Allocated prism numbers for the different masses**

| **Mass** | **Side 1** | **Side 2** |
|---|---|---|
| 2nd penultimate mass | Litho_prism_1 | Litho_prism_2 |
| 1st penultimate mass | Litho_prism_3 | Litho_prism_4 |
| Reaction mass left prism | Silica_prism_1 | Silica_prism_2 |
| Reaction mass right prism | Silica_prism_3 | Silica_prism_4 |

Penultimate mass spares: Litho_prism_5, Litho_prism_6

Reaction mass spares: Silica_prism_5, Silica_prism_6

## 6.2 Template settings

### 6.2.1 Template for the penultimate masses

- The template for the penultimate masses is shown in Figure 6.1. The following distances need to be set for the two penultimate masses: D-screw1, D-screw2 and D_slider.
- D-slider for the penultimate masses will be set such that the tip of the prisms is D_prism = 7 mm above the centre of mass (the flexure points are 1 mm below the centre of mass).

  Djig_prism = 8.4 + 19.0 = 27.4 mm

  D_slider = Djig_prism – D_prism = 27.4 – 7 = 20.4 mm (TBC)
- The presumption is made that the fiducial lines on the masses match up with the centre of mass.
- The measured width of the 1st penultimate mass $W_{1st\ PM}$ = 200.5 mm (single measurement) [3]

[3] GNL-4025-R1 "1st Penultimate mass measurements"

- The average width of the 2nd penultimate mass $W_{2nd\ PM}$ = 200.415 mm (average of 6 measurements)[4]
- The distances $W_s$ and $W_l$ of the jig sides from the centre line are $W_s$ = 100.5 mm and $W_l$ = 107.96 mm (TBC at LASTI).

  The distance from the side to the prism reference surface of the prism holder has been measured in Glasgow to be: $W_{prism\ holder}$ = 19.1 mm. The width of the prism $W_{prism}$ = 15.0 mm. The distance of the template rectangular hole to the centre $W_{hole}$ = 26.25 mm.

  The offset of the prism from the centre is:

  $e_{prism\ holder} = W_{hole} - W_{prism\ holder} - W_{prism}/2 = 26.25 - 19.1 - 7.5 = -0.35$ mm

  The settings of the screws for the 1st PM can be calculated from:

  Bonding on flat 1 D-screw1 = $W_s - W_{1st\ PM}/2 - e_{prism\ holder}$ = 0.60 mm

  Bonding on flat 2 D-screw2 = $W_l - W_{1st\ PM}/2 + e_{prism\ holder}$ = 7.36 mm

  The settings of the screws for the 2nd PM can be calculated from:

  Bonding on flat 1 D-screw1 = $W_s - W_{2nd\ PM}/2 - e_{prism\ holder}$ = 0.64 mm

  Bonding on flat 2 D-screw2 = $W_l - W_{2nd\ PM}/2 + e_{prism\ holder}$ = 7.40 mm
- The distances D-slider1 and D-slider2 are to be set using a set of calipers and a screw driver.
- The distances D-screw1 for flat 1, and D-screw 2 for flat 2 are to be set using a combination of slip gauges and feeler gauges and Allen keys and a spanner.

**Table 6.2 Bonding jig setup for the 1st penultimate mass**

| | **1st Penultimate Mass[5]** | |
|---|---|---|
| | **Flat 1[6]** | **Flat 2[7]** |
| **D-slider1 or D-slider 2** | 20.4 mm | 20.4 mm |
| **D-screw1** | 0.60 mm (±0.1) | (contact with sprung bolts) |
| **D-screw2** | (contact with sprung bolts) | 7.36 mm (±0.1) |

**Table 6.3 Bonding jig setup for the 2nd penultimate mass**

| | **2nd Penultimate Mass[8]** | |
|---|---|---|
| | **Flat 1** | **Flat 2** |
| **D-slider1 or D-slider 2** | 20.4 mm | 20.4 mm |
| **D-screw1** | 0.64 mm (±0.1) | (contact with sprung bolts) |
| **D-screw2** | (contact with sprung bolts) | 7.40 mm (±0.1) |

[4] GNL-4027-R2 "2nd Penultimate mass measurements"

[5] D050421-05-K_Serial number 001 (1st of the two penultimate masses).

[6] D050421-05-D_Surface "S2" in zone "D8". Template referenced to front face, surface "S3".

[7] D050421-05-D_Surface "S1" in zone "D8". Template referenced to front face, surface "S3".

[8] D050421-05-K_Serial number 002 (the second of the two penultimate masses).

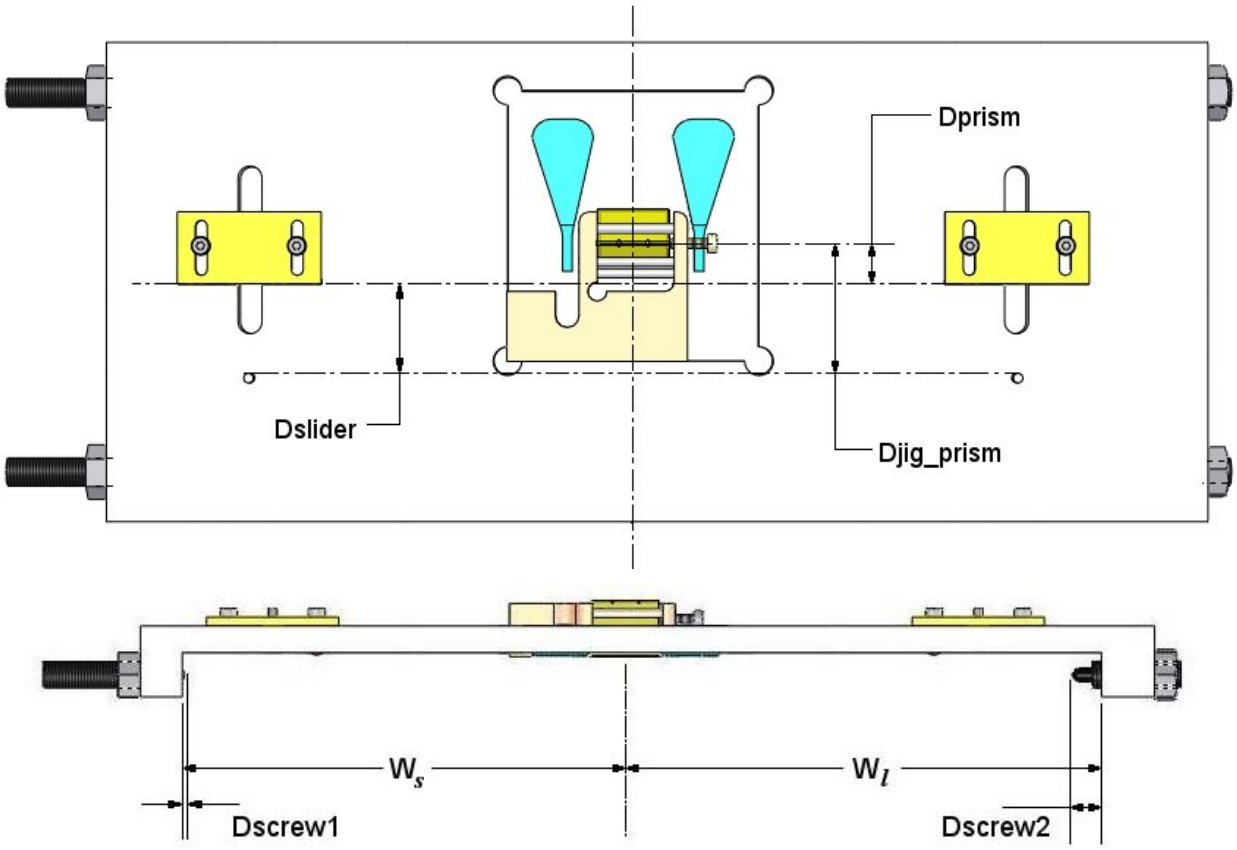


**Figure 6.1 Template for penultimate masses**

### 6.2.2 Template for the reaction mass

- The template for the penultimate masses is shown in Figure 6.2. The following distances need to be set for the two penultimate masses: D-screw1, D-screw2 and D_slider.
- D-slider for the reaction mass will be set such that the tip of the prisms is D_prism = 7 mm above the centre of mass.

  Djig_prism = 19.0 = 19.0 mm

  D_slider = Djig_prism – D_prism = 19.0 – 7 = 12.0 mm
- The presumption is made that the fiducial lines on the masses match up with the centre of mass.
- The measured width of the reaction mass $W_{RM}$ = 129.98 mm (single measurement)[9]
- The distances $W_s$ and $W_l$ of the jig sides from the centre line are $W_s$ = 70.0 mm and $W_l$ = 70.0 mm (confirmed).

  The settings of the screws for the 1st PM can be calculated from:

  Bonding on flat 1 D-screw1 = $W_s – W_{RM}/2$ = 5.01 mm

[9] GNL-4020-R1 “Reaction mass measurements”

Bonding on flat 2 D-screw2 = $W_l - W_{RM}/2$ = 5.01 mm

- The distances D-slider1 and D-slider2 are to be set using a set of calipers and a screw driver.
- The distances D-screw1 for flat 1, and D-screw 2 for flat 2 are to be set using a combination of slip gauges and feeler gauges and Allen keys and a spanner.

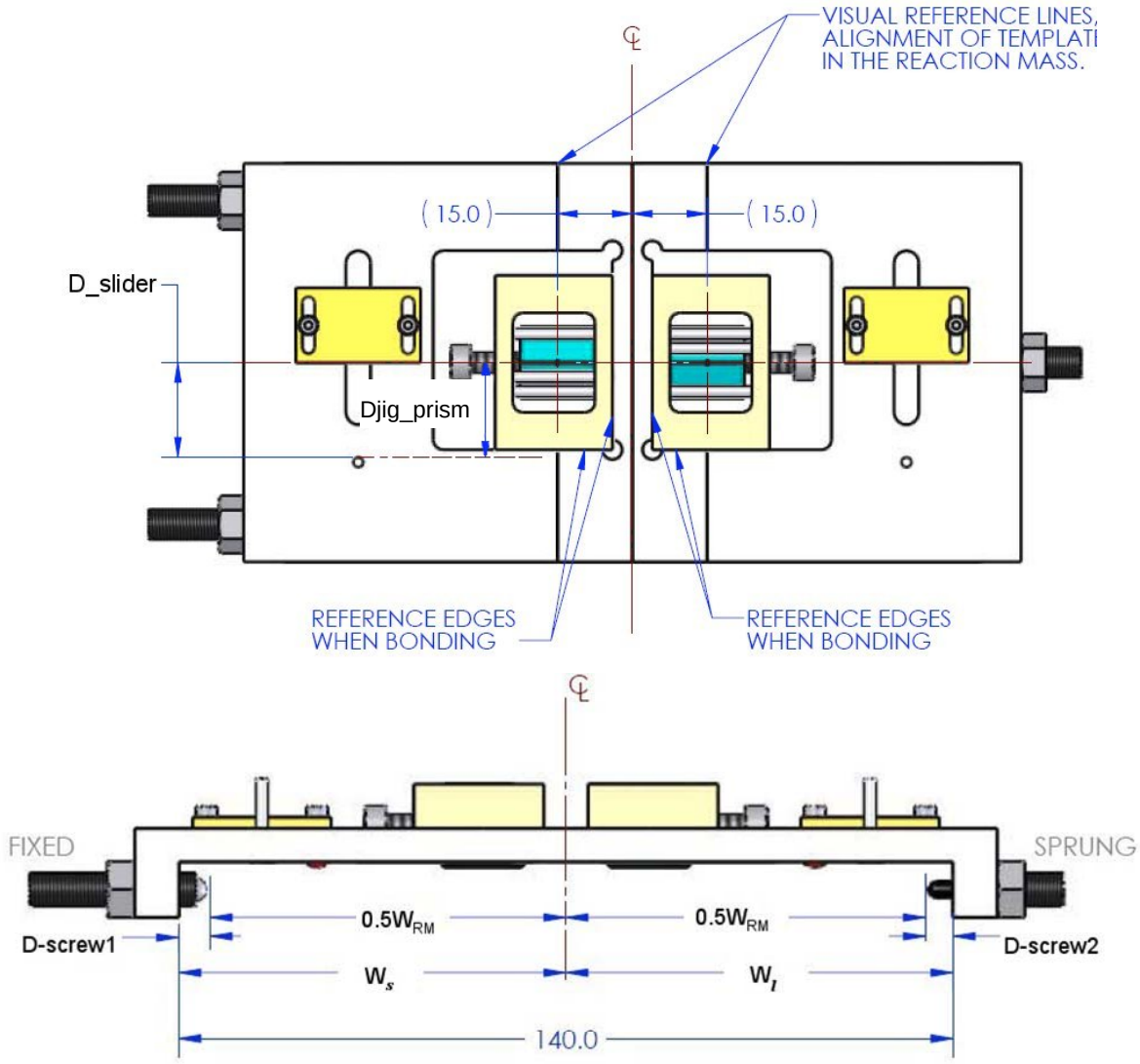


**Figure 6.2 Bonding jig set-up for the Reaction Test Mass prisms**

### 6.2.3 Prism glueing

The procedure for glueing the prisms using Perkin-Elmer Vac Seal adhesive is based on the procedure stated in E970154-D-D "Component specification".

- Prepare prisms
- Clean flat by wiping with methanol
- Setting prism glueing template on mass
- Clean prisms by washing with cerium oxide and sodium bicarbonate, followed by rinse with methanol.

- Put prism(s) into prism holder(s)
- Wipe prism with methanol
- Clean copper wire with a lint-free wipe and acetone and alcohol
- Prepare Vac Seal adhesive: mix the two epoxy components of a V ac Seal “bipax” together thoroughly, approximately 2 minutes. Dispense from the middle of the container into a boat made of clean UHV aluminum foil.
- Put prepared Vac Seal in backing pump to evacuate possible airbubbles.
- Glue prism(s) to side 1: dip the applicator wire in epoxy and withdraw it, leaving a drop of epoxy on the wire. Apply epoxy on the wire as a drop to the bonding side of the prism. Spread the adhesive as a cross towards the corners of the prism over the surface. Lower the prism onto the flat of the mass.
- Cure/bake the glued prism for at least 4 hours: using a heat lamp on a post lighting the prisms
- Remove holders and template

# 7 List of required items

Essentials

- Prisms (2x 2-Groove Lithosil for the 1$^{st}$ and 2$^{nd}$ penultimate masses, 4x 1 groove Silica for the reaction mass, plus spares). We have 12 prisms.
- Masses (2 penultimate masses and reaction mass)

Bonding Jigs

- 1 full bonding jigs for the penultimate masses is available for use (including templates, holders, t-pieces etc)
- 1 full bonding jig for the reaction mass is available for use
- Tools for setting up jig (Allen keys/wrench/tweezers)

Bonding equipment and consumables

- Flowing de-ionised water
- Methanol
- Deionising gun with pure, filtered nitrogen (low pressure)

Glueing equipment

- Perkin-Elmer Vac-Seal epoxy resin
- Backing pump
- Heat lamps on posts
- Copper wire
- Acetone
- Alcohol

Large items

- Ergo arm and ring clamp
- V-blocks
- 2 tables (one for set-up and one for bonding)

Measuring devices

- Plastic ruler
- Digital callipers

- Height gauge
- Metric Feeler gauges
- Metric Slip gauges

Other items

- Lighting: Osram LED work light
- Magnifying glass
- Clothing: Clean room suits, overshoes, gloves, hairnets, face covers
- First Contact™ surface polymer
- Crash mat: used below ergo arm when manipulating the mass in free space
- Photo camera
- UHV aluminium foil