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Ribbon-ear interface for ETM/ITM monolithic suspensions

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1 Introduction

The monolithic suspension stage of the ETMs/ITMs will consist of a fused silica penultimate mass and fused silica test mass each with four silicate-bonded ears between which silica ribbons will be welded. The ears will be silicate bonded in pairs separated by approximately 30 mm (along the direction of the beam axis) on specially polished flats ($\lambda/10$) on the sides of the masses (flat width 200 mm; height 95 mm). The baseline is to use the CO_2 laser machine (currently being developed in Glasgow) to fabricate the ribbons and perform the welding of the ribbons to the ears. The baseline dimension for the ribbons is 113 μm × 1.13 mm with length 600 mm (dynamic flexure point to dynamic flexure point).

2 Ribbon-ear interface

The main configurations initially considered for the interface between the ribbons and the ears are described below:

(a) ***H-piece interface***

Description:

Silica H-pieces with two ribbons welded to the upper (or lower) legs (depending on whether the H-piece is for the test mass or penultimate mass). The free legs of the H-piece are then welded to the two pre-bonded ears on the mass.

Advantages:

This allows ribbon pairs to be aligned vertically with respect to each other forming a cartridge for ease of assembly and precision alignment.

Note that the H-piece and the ear to which it interfaces could be designed to accommodate a ribbon weld either of the butt or lap type.

The H-pieces were originally designed to allow us to anneal the fibres or ribbons which would be a requirement should the ribbons or fibres not have thick end pieces (i.e. tapered necks).

Disadvantages:

The number of welds per ribbon/ear interface is increased from one to two (ribbon to H-piece / H-piece to ear). Since the welds are considered to be the weakest points within the mass-to-mass interface (bonds/welds/ribbons) in the monolithic stage it follows that the fewer the number of welds the lower the risk.

Since we now plan to use necks on the ribbons (or fibres) there is less of a requirement for the H-pieces.

Additionally, the fewer the handling stages for the ribbons / fibres the better since this reduces the risk of contamination and damage.

(b) ***Ribbon welded directly to ear***

Description:

The current design is for the ribbon to be laser fabricated in such a way that each end is thicker tapering down (exponential neck shape TBD) from approximately 1.5 mm × 3 mm to 113 μm × 1.13 mm (baseline ribbon dimension). The thick end piece is then laser welded directly to the ear. Figure 1 shows the current triangular faced preliminary ear design. The ribbon sketch is for illustration only and is not to scale.

Note that the design details of horn to accommodate the thick end piece of the ribbon will

be refined as laser welding technique is further developed.

Advantages:

The number of welds per ribbon / ear interface is minimized to one.

The ear can be designed to accommodate either a butt or lap type weld. If a lap weld is used and the thick end piece is fabricated with excess length this has the extra advantage of allowing margin in the positioning of the ribbon flexure points during the welding process. This also allows the ribbon to be fabricated, handled and welded into position using a clamp for ease of assembly. The thick end pieces of the ribbons that were held by the clamps can then be removed after welding meaning that at no point in time is there a requirement to touch any part of the ribbon/fibre that will be installed in the system.

The clamps on the end can be the clamps used for initial pulling. They can also be used for holding the piece in position for optical profiling and bounce frequency testing.

Disadvantages:

Laser fabrication and welding requirements could be considered to be more onerous. However it is anticipated that the level of shape control required for the tapered necks will be achievable using the CO_2 laser machine. Lap welded ribbons require to be fully tested for strength since GEO used butt welding.

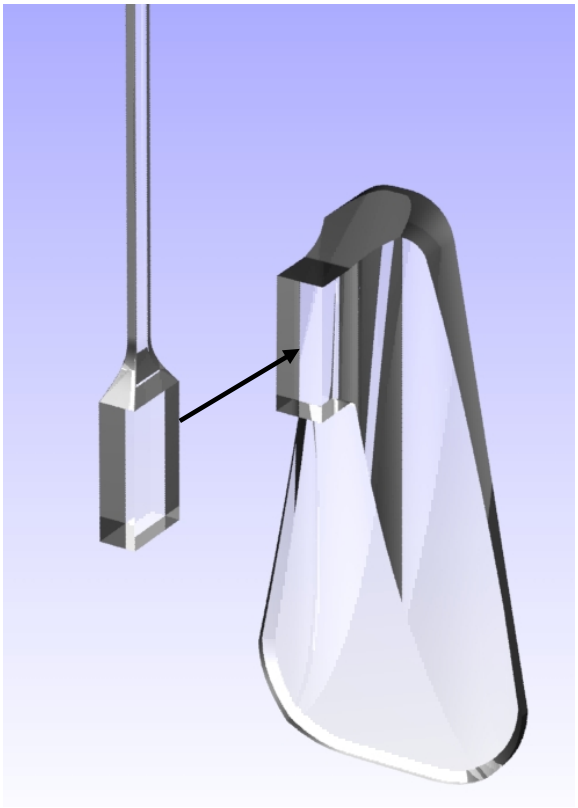

Figure 1 *Preliminary ear design (triangular face) to accommodate lap-welded ribbon with thick end piece (Drawing No: D050169-07).*
Details of horn design to accommodate thick end piece will be refined as laser welding technique is further developed.

3 Summary & Future Work

Option (b) is the current baseline for the ribbon-ear interface of the ETM/ITM monolithic suspensions.

Fabrication of the desired shape of ribbons must be demonstrated using the CO_2 laser system currently being developed.

Lap welding of the ribbons to the preliminary test ears using the CO_2 laser must be demonstrated.

The horn shape for laser welding of the ribbons must be optimized.

The ribbons and welds for this configuration must be fully strength tested and validated.

The assembly procedure must be fully developed and tested.