LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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TMS Primary Mirror Installation Procedure

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1 Introduction

Instruction for Mounting the TMS Primary Mirror in the D1102361 Telescope Frame Mirror Nest.

2. TMS Primary Mirror Installation and Hold Down Clamping Procedure ref. Assembly D1102361 This procedure is also the same for the First Article WBSC6-Y

3. aLIGO TMS Primary Mirror Nest and Clamp (3)

1) Mount the Primary Mirror in The Three Standoff Nest (D1102361), and rotate to align the center line scribe with the scribe line in the back plate.

Nest is formed by parts D1002731(item # 15), D1002728 (item # 6) as shown.

2) Add part D1002732 (item # 8) (the common top clamp) with 1/4-20 SHCS (item # 10) and Belleville washer stack in series (item # 8) as shown.

3) The mirror should be in full back surface contact with the telescope back plate. Turn the set screw in the part D1002731(item # 15) until there is no free play in the nest, do not over tighten, just be sure there is three point contact with the mirror and nest standoffs, with simultaneous back face contact with back plate.

Belleville Spring Data

A Series Stack of 8, .225" ID x .50" OD x .018" thick Stainless Steel

The spring above has a working load of 45 lbs. @ .008" Deflection.

Ref. McMaster Carr part # 9713K61

Belleville Spring Tightening Procedure Data

Note. Linear load / deflection

The **Primary Mirror Mass = 13.5 lbs**

Max Working Load, 45 lbs @.008" deflection

13.5 lbs @ .0024" deflection

8 Series Springs = @ 13.5 lb Load = 8 x .0024" = .0192" ~.02"

Screw (Clamp) (item # 8) 1/4-20 (twenty turns per inch)

One turn (360 deg.) = .05" Travel

.02" (above deflection @ 13.5 lb) divided by .05" (360 deg.) = .4

360 deg. times .4 = **144 deg. rotation** of screw after all slack and free play is taken up in Clamp assembly.

Ref.

A pie chart tool can be used as a turn angle gage, for this operation.

Ref. Below:

Deflection, Series Stacking, Load

Stacking [edit]

Cut-away view of an M14 antipersonnel landmine, showing the firing pin mounted in the centre of a plastic belleville spring

Multiple Belleville washers may be stacked to modify the spring constant or amount of deflection. Stacking in the same direction will add the spring constant in parallel, creating a stiffer joint (with the same deflection). Stacking in an alternating direction is the same as adding springs in series, resulting in a lower spring constant and greater deflection. Mixing and matching directions allow a specific spring constant and deflection capacity to be designed.

Example: 1 Spring is considered to be 1 in Parallel, 1 in Series. (This notation is needed for load calculations)

If n = # of springs in a stack, then: Parallel Stack (n in parallel, 1 in series) - Deflection is equal to that of one spring, Load is equal to that of n x 1 spring. i.e. Stack of 4 in parallel, 1 in series will have the same deflection as that of one spring and the load will be 4 times higher than that of one spring.

Series Stack (1 in parallel, n in series) - Deflection is equal to n x 1 spring, load is equal to that of one spring. i.e. Stack of 1 in parallel, 4 in series will have the same load of one spring and the deflection will be 4 times greater.