

LIGO Laboratory / LIGO Scientific Collaboration

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**ELI SEPTUM WINDOW ASSEMBLY AND
INSTALLATION PROCEDURE**

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Distribution of this document:
Detector Technical Review Board

This is an internal working note
of the LIGO Laboratory.

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Introduction & scope

This is the procedure for assembling the fused silica ELI septum window into its o-ring sealed holder, and then installing this holder in situ on the ELI septum, working within HAM6.

The orientation of the wedged optic's thinnest point, and of the angled seat's thinnest point, are critical to controlling stray reflections and scattered light.

The flange has features to allow a definite compression of the optic under a second (thick) O-ring. Precise control of this compression is critical to prevent damage to the optic, while providing adequate sealing force to counteract atmospheric pressure from either direction. Under no circumstances should the fasteners be "hand tightened" or torqued without following the prescribed sequence below.

Similarly, installation of the assembly to the septum must follow nominal ConFlat torque procedures to avoid warping the holder and risking damage to the optic.

Starting conditions

- Vertex volume vented to atmosphere
- Cleanroom operating over entry/egress door, particle counts below limit
- At least one door removed from HAM6 for access
- Septum installed between HAM6 and output mode cleaner tube, see procedure [E070250](#)
- PSL locked/tagged out

Equipment & materials

Vacuum Hardware, Class A preparation

- 1 ea. Septum Window [D070082](#)
- 1 ea. Window Flange [D070267](#)
- 1 ea. Window Clamp [D070268](#)
- 6 ea. Vented SST SHCS, silver plated, 5/16-24 NF x 1.25
- 24 ea. Vented SST SHCS, silver plated, 5/16-24 NF x 1.5
- 24 ea. SST split washer, 5/16
- 6 ea. SST flat washer, 5/16
- 6 ea. SST SHCS, silver plated, 1/4-20 NC x 1/2
- 1 ea. Viton™ O-ring, size #2-254 (0.139" cord x 5.48" ID)
- 1 ea. Viton™ O-ring, size #2-358 (0.210" cord x 5.60" ID)
- 2 ea. blank ConFlat flanges, 10" nominal OD
- 3 ea. gasket, OFHC copper, to fit 10" nominal OD ConFlat™

Vacuum Installation Tooling, Class B preparation

- 5/16-24 bottoming tap, TiN or TiCN coating, new

- ¼-20 plug tap, TiN or TiCN coating, new
- Tap handles for above
- UHV grade aluminum foil
- Cleanroom wipes
- Lens tissue (8" square minimum)
- Spec-grade isopropanol in approved dispensing container
- Approved cotton swabs
- Spare gloves
- Flashlights (tested)
- Inspection lights (tested)
- Inspection mirror
- Flat feeler gauge set
- Carbide tipped marking scribe
- Camera for recording procedure & configuration
- 2-way radios (2 ea., tested, same channel w/ outside man)
- 6" or 150 mm steel scale
- 6" or 150 mm dial or digital caliper, .0005" or .01 mm resolution
- 1/8" hex ball end handled screwdriver tool
- 1/8" hex ball end long hex "L" key
- 1/8" hex x 3/8 square drive socket, standard
- 1/4" hex ball end handled screwdriver tool
- 1/4" hex ball end long hex "L" key
- 1/4" hex x 3/8 square drive socket, standard
- 3/8 square drive fine ratchet
- 3/8 square drive breaker bar, 9-12" or equivalent
- 3/8 square drive click type torque wrench, 250 inch-pound range

Task steps

Flange Marking QA Check (cleanroom bench)

NOTE: ON SOME INSTANCES OF D070267 "SEPTUM WINDOW FLANGE" THE SERIAL NUMBER AND ANGLE REGISTRATION MARK WERE REVERSED! BEFORE STARTING ASSEMBLY, PERFORM THE FOLLOWING TEST.

1. Unpack Window Flange and place on protected clean bench with window recess and o-ring groove facing upward.
2. Orient scribed registration mark away from you and part/serial number facing you.
3. Using the depth rod of Class B clean dial caliper, carefully measure the step depth from the flange face to the lip at two points on the right and left sides, about 90 degrees away from the registration mark. **DO NOT ALLOW THE TOOL TO ENTER OR TOUCH THE O-RING GROOVE!**
4. Depth readings should differ by approximately 0.028" (0.71mm). Note which side is deeper, right or left.

5. If the **DEEPER** measurement is on your **RIGHT** with the serial number facing you, the flange is **OK**. Skip the following two steps and proceed to assembly.
6. If the **DEEPER** measurement is on your **LEFT** with the serial number facing you, the flange markings are **REVERSED**. **Take a clean carbide scribe and carefully scribe a deep X through the center of the registration mark.**
7. In all following steps, **if there is an X scribed through the registration mark**, then wherever “Registration Mark” is specified for orientation, **use the engraved serial number** as the angle reference instead.

Window Flange Assembly (cleanroom bench)

1. Unpack Window Flange, Window Clamp, o-rings and all fasteners
2. Test every threaded hole in Window Flange with representative 5/16-24 bolts to insure threads are clear to required depth. Inspect all bolts for burrs or thread damage; discard and replace any questionable fasteners.
3. If thread resistance or binding is found, carefully chase internal Flange threads with 5/16-24 tap, using isopropanol as lubricant. Thoroughly clean holes of chips and debris using swabs and additional isopropanol. Set aside to dry thoroughly. Retest bolt insertion before proceeding.
4. With Window Flange flat on bench with seat facing up, insert size #2-254 (smaller) o-ring into seat.
5. Insert six ¼-20 SHSS into threaded holes in Window Clamp from beveled side. Do not allow them to protrude from flange side at this time.
6. Arrange Window Flange flat on bench with seat upward and the Flange Registration Mark (note 1 on D070267) to your **LEFT**.
7. Change gloves.
8. Carefully unpack Window D070082, taking care not to touch either face of optic
9. Locate Window Edge Registration Mark on the cylindrical face (should be opposite the serial number). This designates the thickest part of the optic. The arrowhead on this mark designates the “front surface.”
10. Hold the Window flat such that the arrowhead points toward the ceiling.
11. Rotate the Window Edge Registration Mark to match with the Flange Registration Mark and insert the optic into the Flange seat. Optic should be rotated in the seat until the Registration Marks are aligned within 1 degree or better (about 1 mm tangentially). Insure that the o-ring remains properly seated. Inspect for uniform contact around the periphery.
12. Carefully arrange size #2-358 (larger) o-ring on the periphery of the optic, without allowing it to touch inner clear aperture.
13. Invert and lower the Window Clamp, checking that the o-ring finds its seat. Rotate the Clamp in position to align the 5/16 clearance holes with threaded holes in the Window Flange
14. Insert 5/16-24 x 1.25” bolts with flat washers in six places and *finger spin only* to reach contact. **DO NOT TIGHTEN**.

15. Using $\frac{1}{4}$ hex L key and noting the initial angle of the handle, tighten each of the six bolts exactly **ONE HALF TURN**, following a cylinder torque pattern¹
16. Repeat above step three times, such that each screw has advanced $2/24'' = 0.083''$ past the point of first contact.
17. The gap around the edge of the Clamp will NOT be uniform, due to the wedge angle of the optic. This is OK.
18. With the inspection lamp, carefully inspect both o-rings through the glass, lifting the assembly from the bench to look from the back. The thinner o-ring should be fully compressed into its groove. The thicker o-ring should *not* be fully compressed, but should display a uniform contact all around.
19. If all is satisfactory, use a $1/8''$ hex screw driver to drive all the $1/4$ -20 SHSS locking screws in to contact the Flange. Snug *hand tight* using the cylinder head pattern. Do not overtighten.
20. Protect both optic faces with multiple layers of lens tissue and then package the assembly in UHV foil to await installation.

Installation (inside HAM 6)

21. Follow established procedures for gaining chamber access
22. Establish foil-lined tool laydown and task lighting inside HAM6
23. Inspect and verify cleanliness of three 10" ConFlat seal knife edges and female threads in Septum, D070107.
24. Unpack and assemble Window Assembly to the **MIDDLE** position on the Septum (port "B" on D070103), trapping a fresh copper gasket. Have a helper hold this in place.
25. Rotate the assembly until the Flange Registration Mark is on a horizontal diameter pointing to your **LEFT** (that is to say, toward the PSL, LIGO global minus x).
26. Insert three $5/16$ -24 x 1.5" fasteners with split washers and spin finger tight to capture the gasket. Have the helper release the assembly.
27. Insert remaining $5/16$ -24 x 1.5" fasteners with split washers
28. Inspect gap from edge to insure the copper gasket is still in place and the gap is even all around; if not, remove and correct, if necessary with a new gasket.
29. Torque bolts gradually in 24-position cylinder head sequence, per nominal ConFlat procedure (LIGO-E95xxxx)
30. Repeat process assembling the two blank ConFlat flanges onto the outer two Septum positions.
31. Gather and remove all tools and materials.
32. Notify ID to request exit QA inspection.

¹ Numbering the bolts 1 through 6 clockwise, tighten in sequence 1, 4, 5, 2, 3, 6

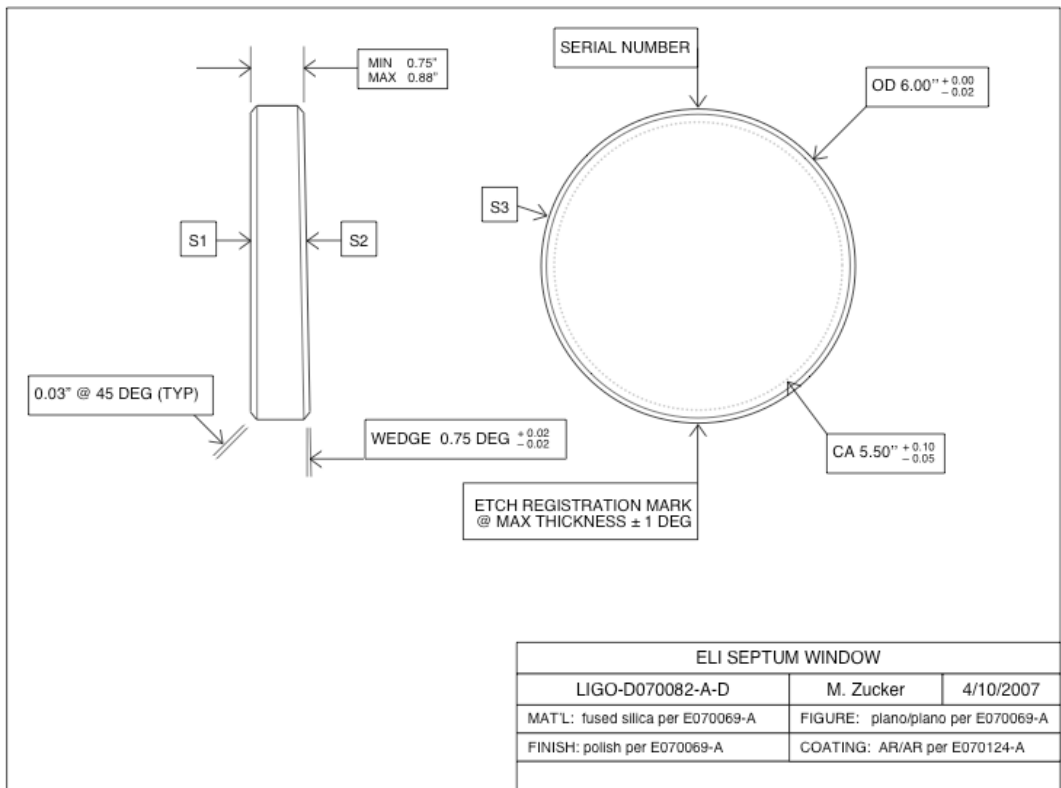


Figure 1: Septum Window

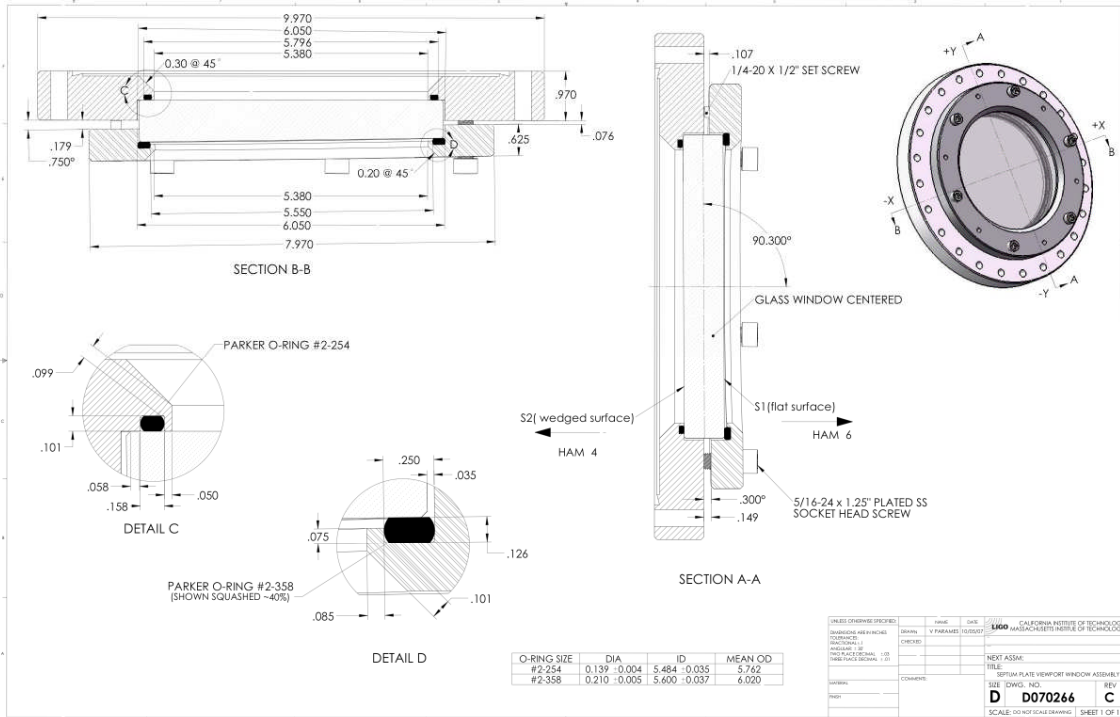


Figure 2: Septum Window Flange Assembly

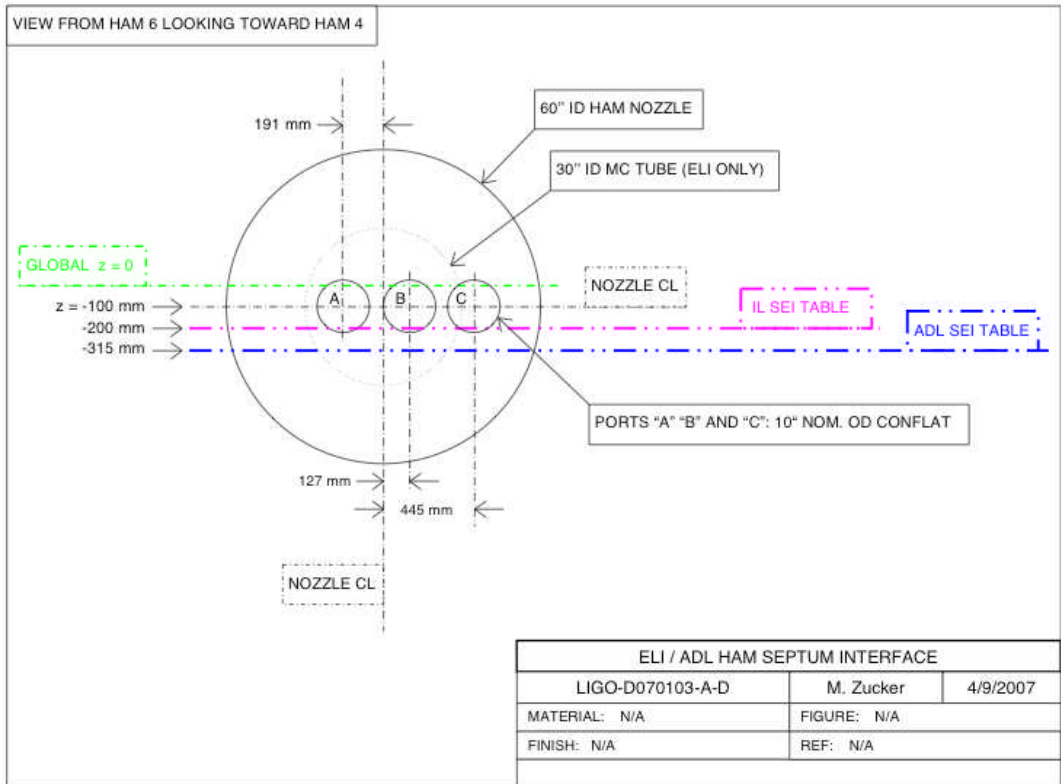


Figure 3: Septum Flange Interface Configuration