

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
LIGO
CALIFORNIA INSTITUTE OF TECHNOLOGY
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LLO SLC Mode Cleaner Tube Baffle Install Hazard Analysis	
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CHANGE LOG

Date, version	Summary of Changes
2011-10-28 V2	<ul style="list-style-type: none"> • Added more detail to V1 • Updated section 2 (Summary of Hazards) • Added 3 new hazards and their respective details • Updated section 4 (Related Documents)
2011-11-29 V3	<ul style="list-style-type: none"> • Updated Title • Add detail in regards to gloves being pinched • Updated Severity table
2011-12-05 V4	<ul style="list-style-type: none"> • Remove reference to Assembly and Installation version
2011-12-06 V5	<ul style="list-style-type: none"> • Changed required personnel from 3 to 5 • Specified that clean practices <u>must</u> be followed rather than <i>should</i> be followed • Added more detail to “Summary of Hazards” (section 2) • Updated Related Documents Section
2011-12-07 V6	<ul style="list-style-type: none"> • Added inspection concerns to section 5.3 • Added O2 level check prior to start of installation (section 3)

1. Scope

This document covers safety concerns related to the assembly and installation of the Mode Cleaner Tube Baffles into the manifold tubes for Advanced LIGO. It must be read before beginning the installation of the Mode Cleaner Tube Baffle, and used in conjunction with the SLC Mode Cleaner Tube Baffle Assembly and Installation Procedure, document number LIGO-E1100718.

2. Summary of Hazards

There are 4 Hazards to be concerned with in the installation of the Mode Cleaner tube baffles

- 1) Strain from holding/ and lifting the larger parts
- 2) Bumping one's head or body in the tighter spaces of the viewport adapter flanges and mode cleaner tubes
- 3) Pinching/ Cutting of hands against the parts being assembled
- 4) Contamination hazard of the vacuum system

3. Overview

A Solid Works model of one of the Mode Cleaner Tube Baffles (MCA1) is shown in Figure 1. The baffles are installed at each end the mode cleaner tubes. MCA1 is installed next to HAM 2, MCB1 is installed next to HAM 3, MCB2 is installed next to HAM 4, and MCA2 is installed next to HAM 5. Though the baffles are slightly different in design, they are installed with same procedure as described in E1100718.

As work will be done in a semi-enclosed space, O₂ levels should be measured in the area of work (Input mode cleaner tube, etc) prior to the start of the work.

The baffles must be installed before both HAM tables (for the respective arm under installation) are occupied with their optics.

At least 5 personnel are required to perform this installation. Two people will be required to remain outside the vacuum chamber, and the other three will be working within the vacuum chamber and tubes.

- 1) The outer support ring for the baffle is inserted and expanded inside the mode cleaner tube.
- 2) In a clean room, the outer annular portion of the baffle is pre-assembled in halves. Afterwards, each half is handed through the HAM chamber opening at the end of

the mode cleaner tube to the people inside the viewport adapter tube, who carry it to the person inside the mode cleaner tube.

- 3) The person inside the mode cleaner tube will connect the two halves of the annular portion to the outer support ring, and then exit the mode cleaner tube.
- 4) Inside a clean room, the inner portion of the baffle is pre-assembled in halves and handed to the people standing just outside the opening to the mode cleaner tube. From this position, the inner portion of the baffle will be attached to the annular portion.

During the assembly and installation of the Mode Cleaner Tube Baffle, a task leader shall be assigned to supervise all activities and this person may count as one of the five required personnel.

This assembly and installation requires overall common sense and good lab practices. Personnel must have good working knowledge of how to safely use the tools associated with the build. All personnel must have appropriate safety training to work at a LIGO facility and must be knowledgeable with the contents of E1100718.

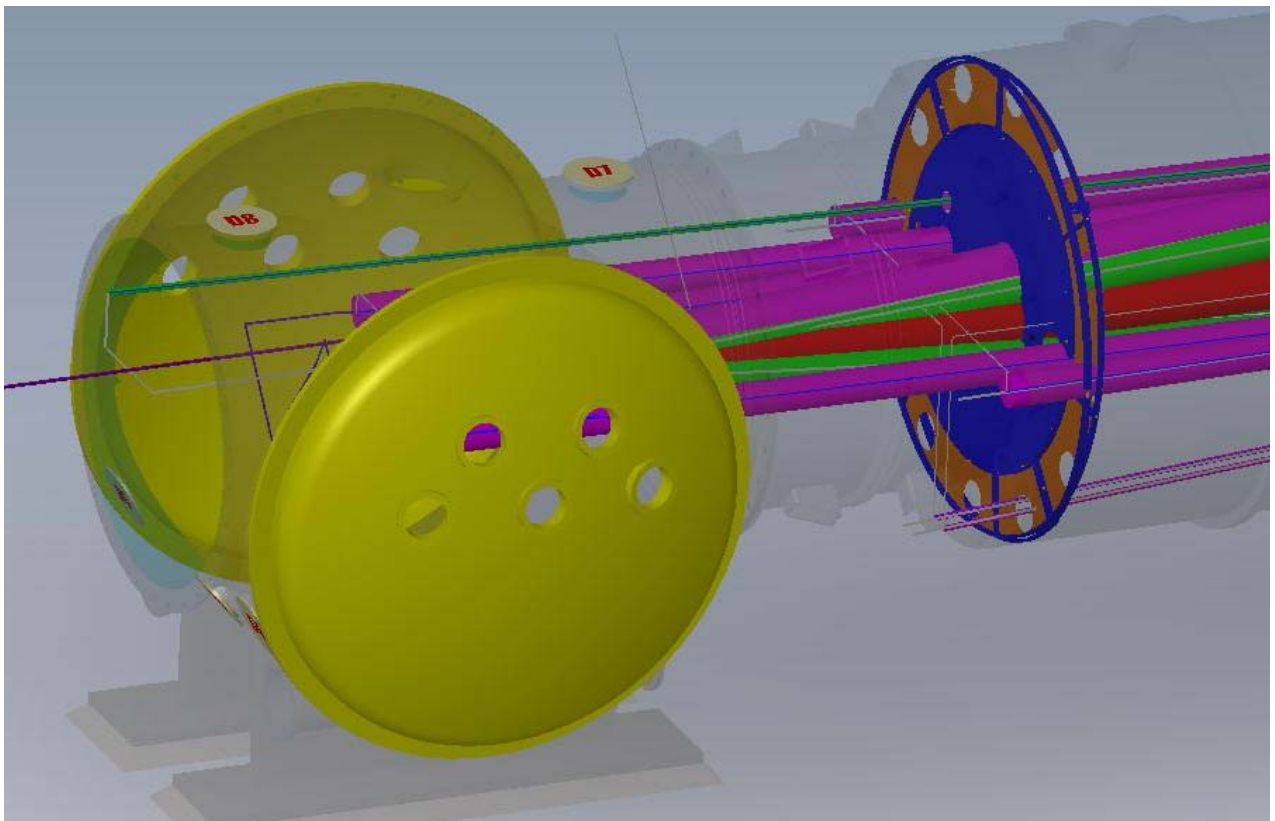


Figure 1) Installed MCA1 Baffle by Ham 2

4. Related Documentation

- LIGO-E1100718: SLC Mode Cleaner Tube Baffle Assembly and Installation Procedure

- LIGO-M070360: Advanced LIGO Safety: Processes and Guidelines
- LIGO-M950046: LIGO Project System Safety Plan
- LIGO- E0900047: Contamination Control Plan
- LIGO-E000065: Chamber Entry/Exit Checklist
- LIGO-T1000629: aLIGO General Safety Rules for De-Install/Install Activities

5. Hazard Analysis

Each hazard and mitigation approach or measure is listed in the severity table in the next section.

5.1 Lifting Strain

Each Piece of the baffle weighs no more than 35 lbs; however, some pieces are as long as 7ft and as wide as 3ft, which may make it cumbersome to hold and pass along. Personnel should be aware of their surroundings when passing pieces along as to not damage nearby objects and the pieces themselves. Should prolong lifting occur, personnel should find a way to cleanly offload the weight or secure the piece to avoid strain. This strain can be mitigated by utilizing two personnel to pass and hold the various pieces.

5.2 Vacuum Spatial Awareness

As there will need to be assembly inside the vacuum chamber, personnel should be mindful of where they stand and move as to not damage nearby objects and bump their heads, knees, etc. Damage from accidental bumps can be mitigated from being spatially aware of the working area and by spotting one another.

5.3 Pinching/Cutting of Hands

The individual pieces of the baffle are thin pieces of metal, and though the edges have been beveled, there is a potential to receive cuts if parts are handled improperly. Not only this, but should a glove tear due to cuts, there is a potential to cause contamination problems. Hands may also be pinched when assembling parts to one another, but this can be mitigated with proper attention to how parts are handled. The team must inspect all parts before handling to identify locations of potential hazards (sharp edges and the like).

5.4 Vacuum Contamination

The vacuum system will be opened during this installation process and has the potential to be contaminated. All work must be done in positive pressure clean rooms and all personnel must be garbed in appropriate Class A garb. Standard Class A procedures must be practiced at all times.

6. Hazard Analysis Severity Table

Hazard	Cause	Effect	Unmitigated Severity	Unmitigated Probability Level	Unmitigated Risk Index	Comment	Mitigation	Mitigation Severity	Mitigated Probability Level	Mitigated Risk Index
Lifting strain	Lifting and passing of several parts (or prolonged holding of parts)	Injury to personel; damage to equipment	marginal	occasional	3C	Individually, the parts wiegh no more than 30 lbs; however, completely assembled, the baffle wieghs around 150	At least two people must assist in lifting parts. In vacuum, at least 2 people should hold the baffle while a 3rd fastens.	minor	Improbable	4E
Head Bumping in vaccum tight spaces	Unawareness of surroundings	Injury to personel; damage to equipment	marginal	occasional	3C		At least two people must be in vacuum for lifting puposes and spotting as well	minor	Improbable	4E
Finger/Hand Pinching and cutting	Hands caught in between parts when assembling	Injury to personel; damage/ contamination to equipment	marginal	remote	3D	All edges are beveled; however, parts are thin metal and may still cut	Mindfulness of hand placement; two people assembling together increases awareness	minor	remote	4D
Vacuum Contamination	Exposed Vaccum Chamber; removal of covers/ wraps	damage to enviroment	marginal	occasional	3C		All parts handled in clean rooms outside of vacuum; all personel dressed in Class A approved garb	minor	remote	4D

Hazard Severity	Category	Definition
Catastrophic	1	Death or permanent total disability, system loss, major property damage or severe environmental damage.
Critical	2	Severe injury, severe occupational illness, major system or environmental damage.
Marginal	3	Minor injury, lost workday accident, minor occupational illness, or minor system or environmental dam
Minor or Negligible	4	Less than minor injury, first aid or minor supportive medical treatment type of occupational illness, or less than minor system or environmental damage.

Probability	Level	Individual Item
Frequent	A	Likely to occur frequently or continuously experienced.
Probable	B	Will occur several times in the life of an item.
Occasional	C	Likely to occur some time in the life of an item.
Remote	D	Unlikely but possible to occur in the life of an item.
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced.

SEVERITY OF CONSEQUENCE	PROBABILITY				
	E Improbable	D Remote	C Occasional	B Probable	A Frequent
1 Catastrophic					
2 Critical					
3 Marginal					
4 Negligible					

Hazard Risk Index
1A, 1B, 1C, 2A, 2B, 3A
1D, 2C, 2D, 3B, 3C
1E, 2E, 3D, 3E, 4A, 4B
4C, 4D, 4E

Risk Code Criteria
Unacceptable
Undesirable (Directorate decision required)
Acceptable with review by Directorate
Acceptable without review