

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
-LIGO-
CALIFORNIA INSTITUTE OF TECHNOLOGY
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SLC Signal Recycling Cavity Baffle Install Hazard Analysis	
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CHANGE LOG

Date, version	Summary of Changes
2012-03-15 V3	<ul style="list-style-type: none">• Added Change Log• Corrected HAM references in Section 1.• Added hyperlinks as needed• Updated Sections: 2. Summary of hazards, 3. Overview, 5. Hazards Analysis, and 6. Signal Recycling Cavity Baffles Hazard Analysis Severity Table
2012-04-23 V4	<ul style="list-style-type: none">• Corrected Cal Tech mail stop on page 1.• Updated Section 6 with comments committee review.

1. Scope

This document covers safety concerns related to the assembly and installation of the Signal Recycling Cavity Baffles in HAM4, HAM5, HAM10, and HAM11.

It must be read before beginning the installation of the Signal Recycling Cavity Baffles, and used in conjunction with the SLC and Viewports Installation Plan Document, document number [LIGO-E1000099-v1](#).

2. Summary of Hazards

There are 5 Hazards to be concerned with in the installation of the Signal Recycling Cavity Baffles

1. Eye damage from exposure to infrared autocollimator beam (4E)
2. Back strain due to heavy lifting and bending
3. Bumping one's head or body in the tighter spaces of the HAM chamber
4. Finger damage from torque wrench
5. Contamination hazard of the vacuum system

These hazards are described in detail later in the document.

3. Overview

During the assembly, installation and alignment of the signal recycling cavity baffles, a task leader shall be assigned to supervise all activities.

Most of the signal recycling cavity baffles weigh < 30 lbs, and they will be lifted manually onto the HAM ISI table and slid into position. The SR2 Scraper Baffle weighs approximately 66 lbs, and must be lifted by two persons onto the HAM ISI table and slid into position. The baffle base will be clamped with appropriate dog-clamps.

As work will be done in a semi-enclosed space, O₂ levels should be measured in the area of work (HAM chamber) prior to the start of the work.

The baffles may be installed when HAM tables are occupied with their optics.

Following installation, the baffles will be aligned by projecting an infrared autocollimator beam onto an alignment target attached to the baffle. Serious eye hazard could result if the installer does not wear proper safety goggles/glasses. The IR beam will **require** the use of protective goggles/glasses to avoid eye damage.

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 and installation, and be aware of the hazards associated with working near a high power infrared light beam. All personnel must have appropriate safety training to work at a LIGO facility.

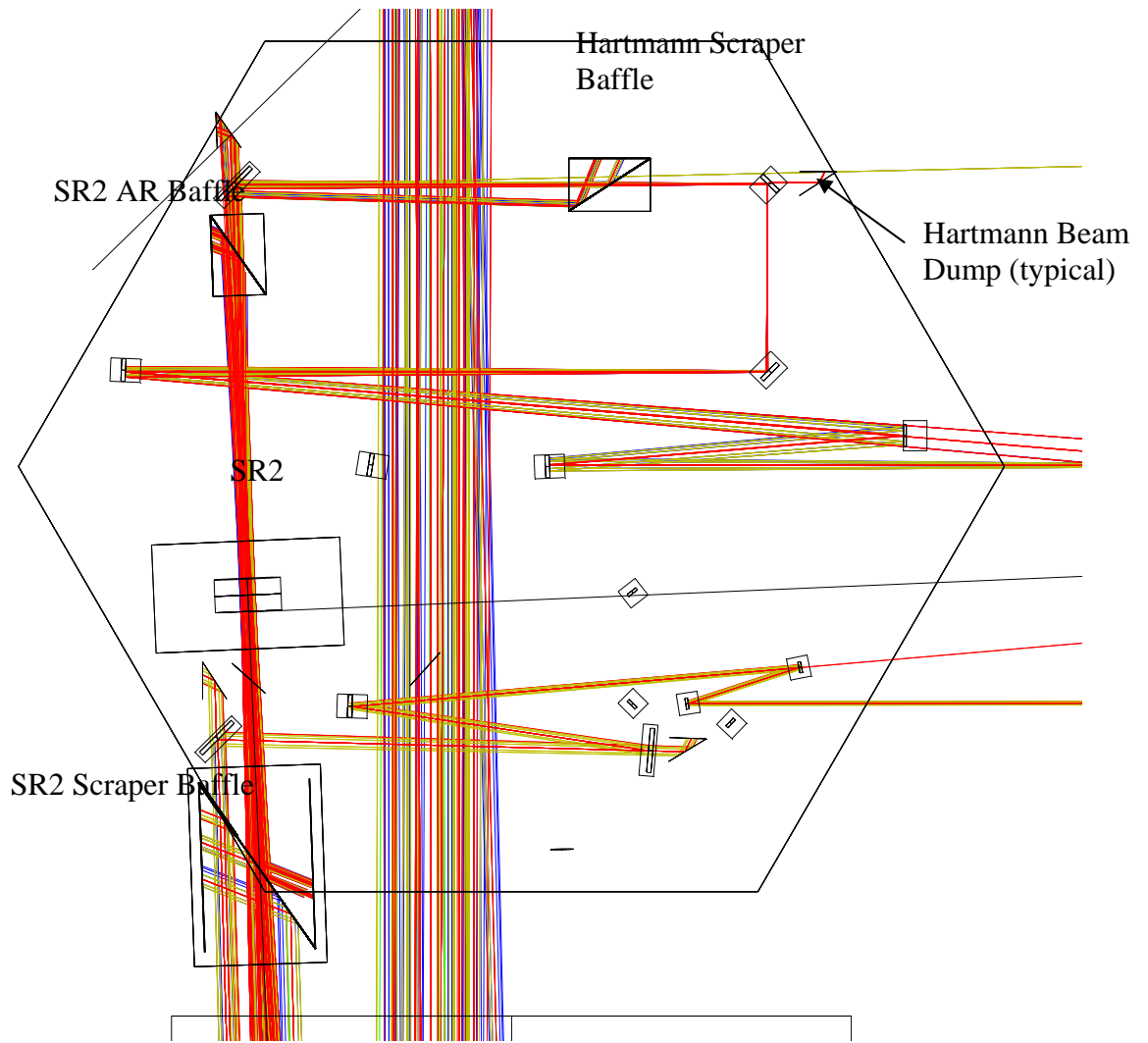


Figure 1: H1 & L1 HAM4: SR2 Scrapper Baffle, SR2 AR Baffle, Hartmann Scrapper Baffle, Hartmann Beam Dump

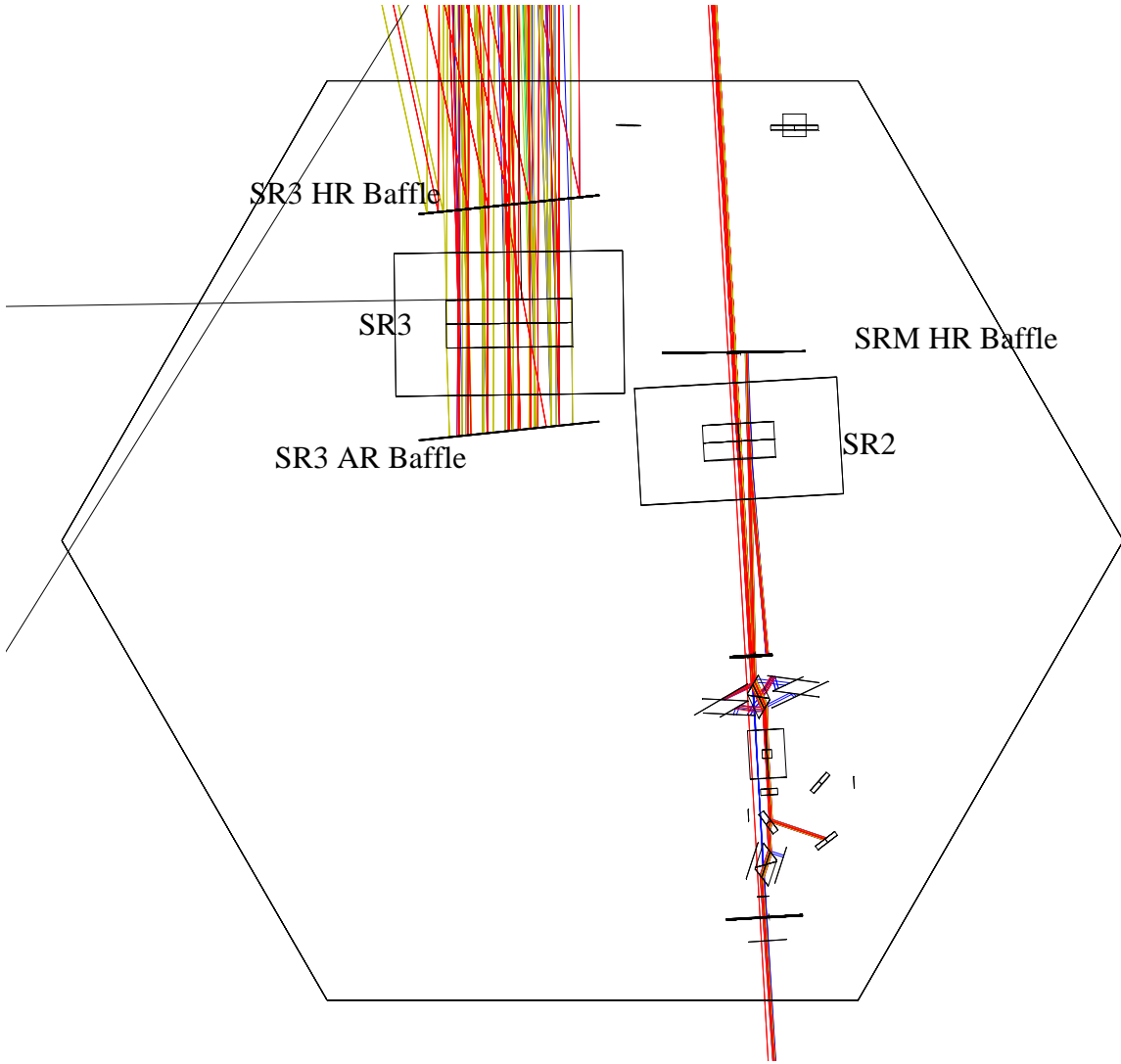


Figure 2: H1 HAM5: SR3 HR Baffle, SR3 AR Baffle, SRM HR Baffle

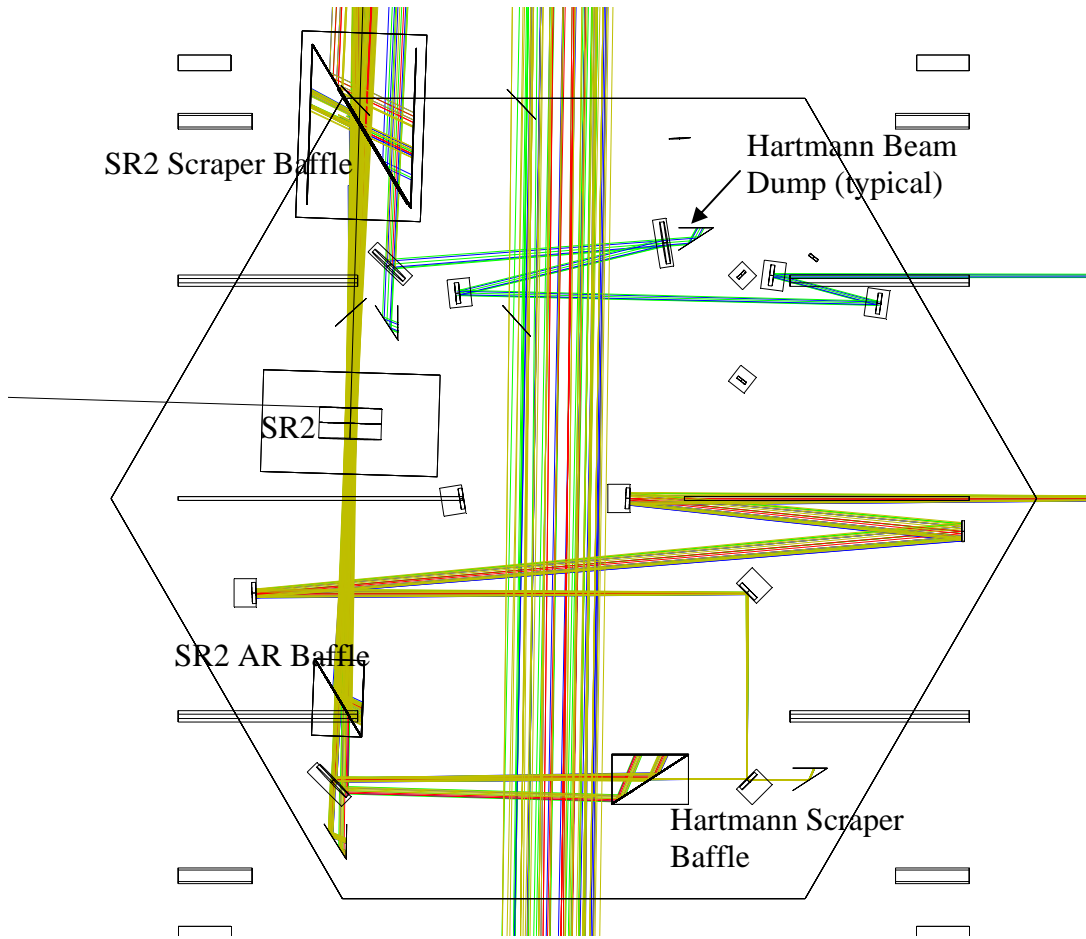


Figure 3: H2 HAM9: SR2 Scrapper Baffle, SR2 AR Baffle, Hartmann Scrapper Baffle, Hartmann Beam Dump

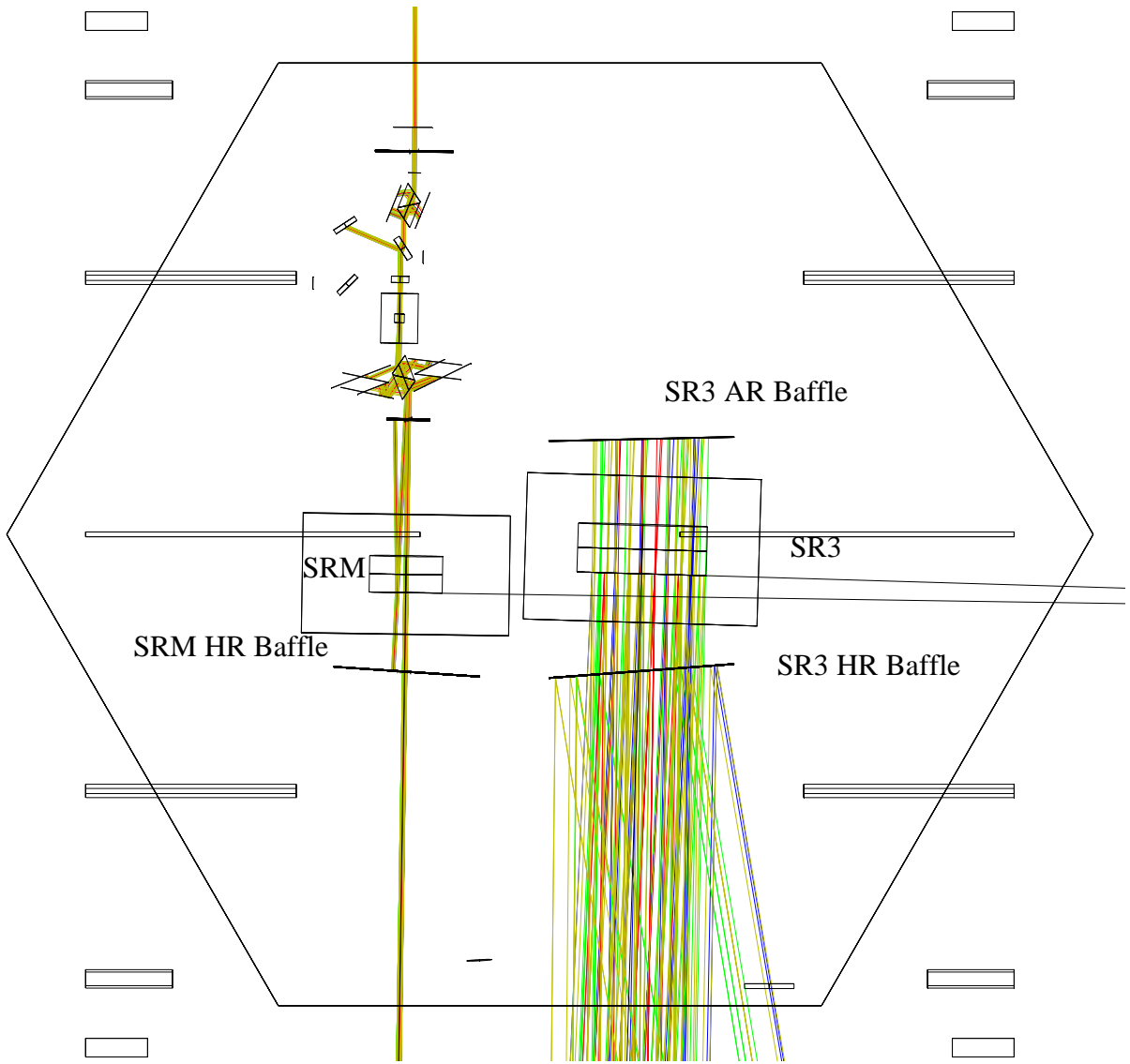


Figure 4: H2 HAM10: SR3 HR Baffle, SR3 AR Baffle, SRM HR Baffle

4. Related Documentation

SLC and Viewports Installation Plan (LIGO- LIGO-E1000099-v1)

Advanced LIGO Safety: Processes and Guidelines (LIGO-M070360)

LIGO Project System Safety Plan (LIGO-M950046)

LIGO Hanford Observatory Contamination Control Plan (LIGO-M990034)

Chamber Entry/Exit Checklist (LIGO-E000065)

LIGO Hanford Observatory Laser Safety Plan (LIGO-M020131)

LLO Safety Procedure documents (<http://www.ligo-la.caltech.edu/contents/internalmain.htm>)

5. Hazard Analysis

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

5.1. Eye Hazard

The infrared autocollimator beam may have a power level exceeding 1 W; looking directly into the beam may cause retinal damage.

5.2. Lifting and Bending Strain

Each piece of the baffle weighs no more than 35 lbs. Back strain may occur from improperly lifting and bending to place a heavy baffle onto the HAM ISI table. This may be mitigated by using proper bending and lifting techniques while installing the baffles.

5.3. 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.

5.4. Pinching/Cutting of Hands

The installer could hurt their hand or fingers by improper use of the torque wrench used to tighten the dog-clamp bolts, 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).

5.5. 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. Signal Recycling Cavity Baffles 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
Eye damage	Looking directly into IR autocollimator beam	Injury to Personnel	Critical	occasional	2C	May cause serious retinal damage	Wear appropriate laser safety glasses/goggles; laser trained personnel required	marginal	remote	3D
Lifting and bending strain	heavy lifting and bending	Injury to personnel; damage to equipment	Marginal	occasional	3C	Individually, the parts weigh no more than 30 lbs	Use appropriate lifting techniques and precautions	minor	improbable	4E
Head Bumping in vacuum tight spaces	Unawareness of surroundings	Injury to personnel; damage to equipment	Marginal	occasional	3C	At least two people must be in vacuum for lifting purposes and spotting as well	Due to limited space, persons entering should plan how they will maneuver around the space safely.	minor	improbable	4E
Finger/Hand Pinching and cutting	Hands caught in between parts when installing	Injury to personnel; damage/contamination to equipment	Marginal	remote	3D		Use appropriate tool precautions and be aware of pinch points and wrench leverage and swing radius.	minor	remote	4D
Vacuum Contamination	Exposed Vacuum Chamber; removal of covers/ wraps	damage to environment	marginal	occasional	3C		All parts handled in clean rooms outside of vacuum; all personnel 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 damage.
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.

PROBABILITY

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
<p>1A, 1B, 1C, 2A, 2B, 3A 1D, 2C, 2D, 3B, 3C 1E, 2E, 3D, 3E, 4A, 4B 4C, 4D, 4E</p>

Risk Code Criteria
<p>Unacceptable Undesirable (Directorate decision required) Acceptable with review by Directorate Acceptable without review</p>