



LIGO Laboratory / LIGO Scientific Collaboration

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ADVANCED LIGO

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Advanced LIGO Quad Installation Fixtures
Preliminary Design Suggestion

Oddvar Spjeld

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LIGO Science Collaboration

This is an internal working note
of the LIGO Project.

California Institute of Technology
LIGO Project – MS 18-34
1200 E. California Blvd.
Pasadena, CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

LIGO Hanford Observatory
P.O. Box 1970
Mail Stop S9-02
Richland WA 99352
Phone 509-372-8106
Fax 509-372-8137

Massachusetts Institute of Technology
LIGO Project – NW17-161
175 Albany St
Cambridge, MA 02139
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

LIGO Livingston Observatory
P.O. Box 940
Livingston, LA 70754
Phone 225-686-3100
Fax 225-686-7189

<http://www.ligo.caltech.edu/>

1. INTRODUCTION

In order to install the Advanced LIGO Quad Suspension Structures into the BSC chambers at LLO, LHO and LASTI, new installation fixtures must be designed. The purpose of these fixtures is to transfer the lower quad section into the BSC through the chamber door, position the section below the upper section, lift it to the correct height and perform fine adjustments (linear and angular) of the complete suspension assembly. Because of the limited clearance between the bottom of the lower quad section and the rails inside the BSC which have been used to support the previous LOS installation fixtures and also the increased weight of the new quad structure, all previous components must be redesigned.

2. OLD INSTALLATION FIXTURES

The fixtures used to install the original BSC LOS consisted of the following components:

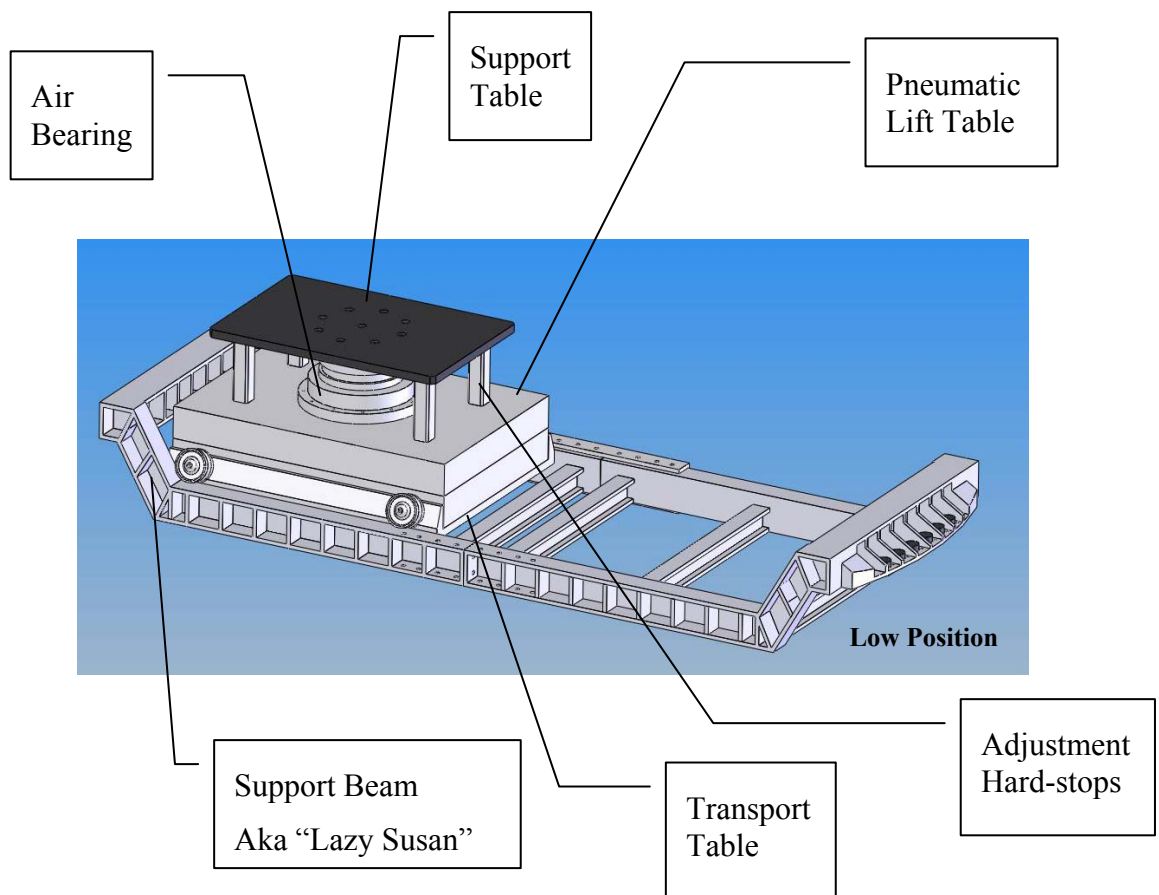
1. Transport table – used to transfer the suspension into the chamber through the door
2. Support beam (Lazy Susan) – supported the load of the suspension unit once transferred into the chamber, resting on the rails inside the BSC chambers. Capable of limited horizontal angular motion, so that the suspension unit could be rotated within the chamber.
3. Shuttle table – used to position the suspension unit in horizontal linear translation. Riding on casters on top of the support beam.
4. Lift table – used to lift the suspension unit so that it could be mounted to the optics table. Range of motion approx. 2.2 inches in vertical linear translation.
5. Tilt table – use to angularly align suspension unit to be mounted to the optics table.

As previously mentioned none of the old components can be utilized for the new quad suspension because of increased weight, decreased clearance and also functionality issues with the old fixtures, such as bending of the tilt table due to over-constraining and issues with manually cranking the lift table.

3. NEW FIXTURES DESIGN REQUIREMENTS

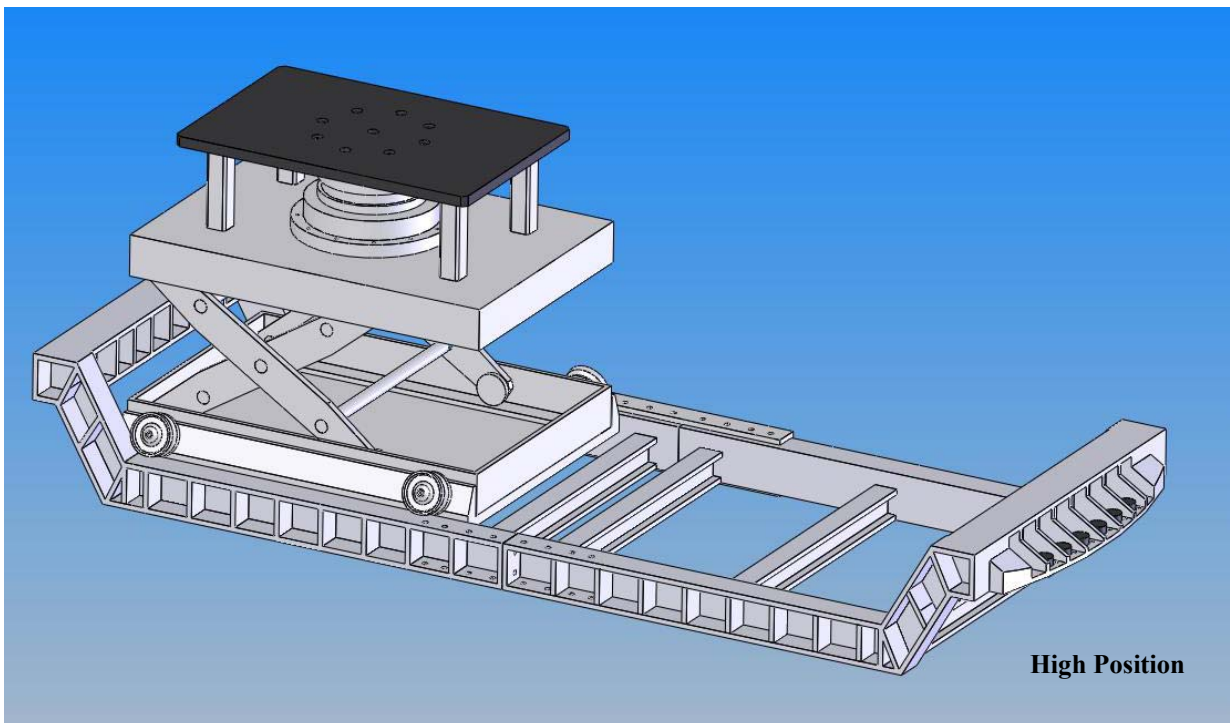
The load capacity of the installation fixtures for the new quad suspension should be at least 2,500 lbs, which allows support of the up and lower structures with a safety factor of 2.5. As before the fixture must fit through the BSC chamber door and be less than 11 inches tall, as this is the maximum clearance between the rails inside the chamber and the bottom of the lower suspension section. The fixtures must provide the same functionalities as the old and provide the same safety features for clamping the section while transporting and lifting. All components of the fixtures must comply with the approved vacuum materials list. Since the base of the suspension structure was designed for minimal weight, lifting is better done with a cage picking up the section at its center of gravity or alternatively lifting from the upper portion of the structure. In addition the fixtures must be removable after installation, without causing any disturbance to the suspension, structure, chamber, seismic isolation and optics table. It must also be minimized in weight to allow easy transportation and functionality.

4. NEW FIXTURES DESIGN SUGGESTION



Components of new design

1. Support Beam (Lazy Susan) – lowered and widened to accommodate space for pneumatic lift table. The beam has also been designed in two sections for easier installation and removal. It has been dimensioned for a total load of approx. 3,000 lbs.
2. Transport Table – designed with a low profile with a support area large enough to hold the base of the pneumatic lift table, which will be bolted to the transport table. Rolls on stainless steel castors along the inner sides of the support beam.
3. Pneumatic Lift Table – based on existing scissor lift tables powered by pneumatic lift. Will have to be custom made from stainless steel and air enclosure made from a bellow rather than the commonly used rubber bladder. Capacity 3,000 lbs with a maximum travel of 12 inches (minimum height 8 inches / maximum height 20 inches).
4. Air Bearing – using existing parts removed from chambers at LLO; provides both tilt and lateral adjustments. Minimum height approx. 9 inches. Utilized for fine alignment.
5. Support Table – breadboard type support table bolted to air bearing.
6. Adjustment Hard-stops – removable stops to prevent unwanted motion when transferring the load to the support table and while performing course alignment.



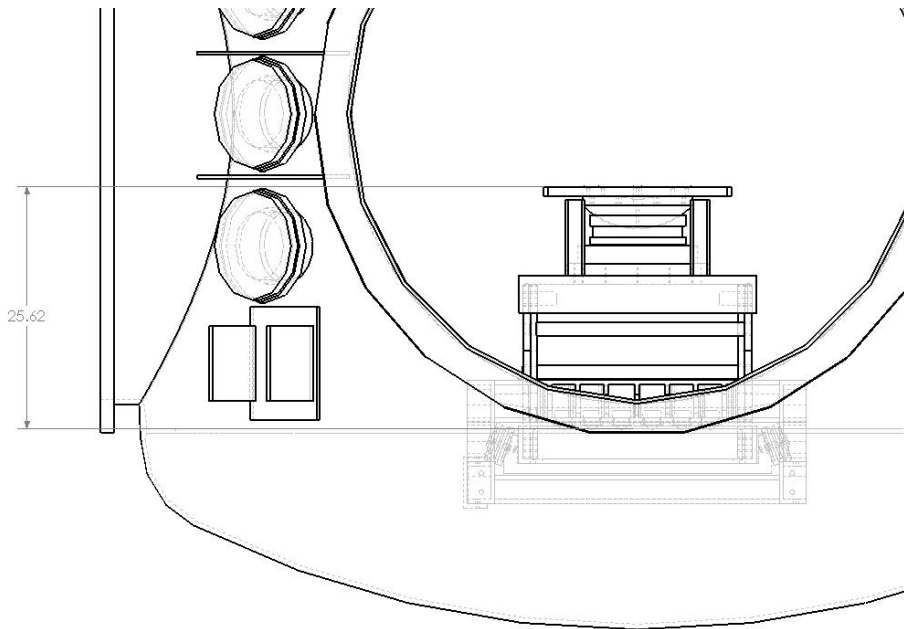
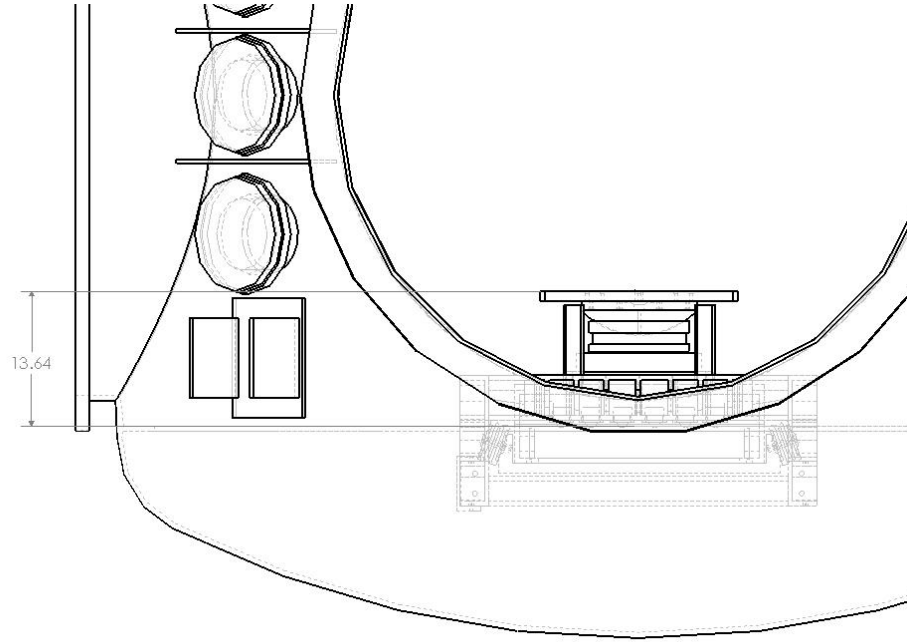
The pneumatic lift table allows maximum 12 inches of travel.

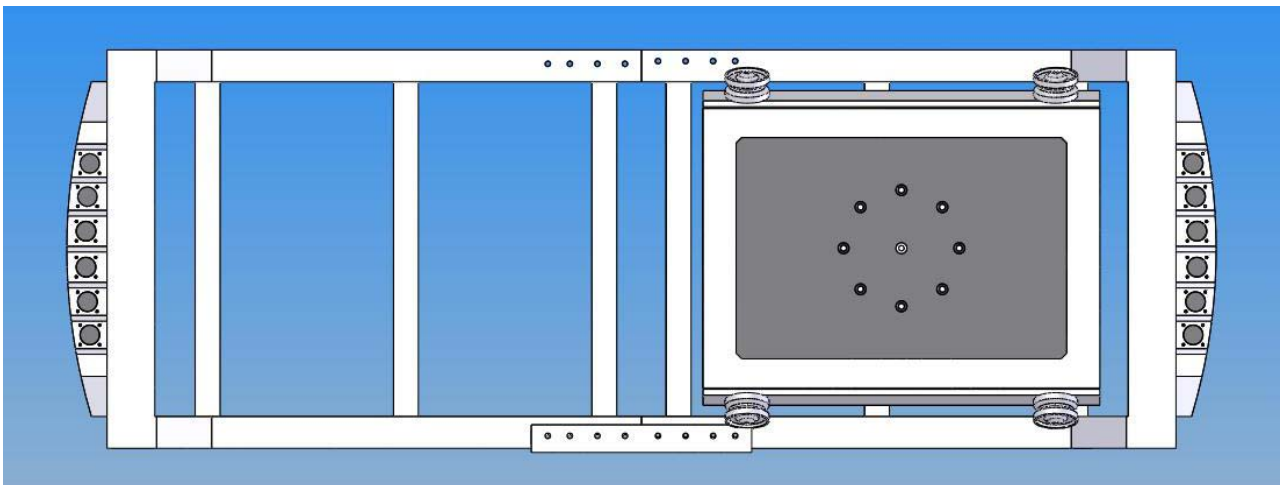
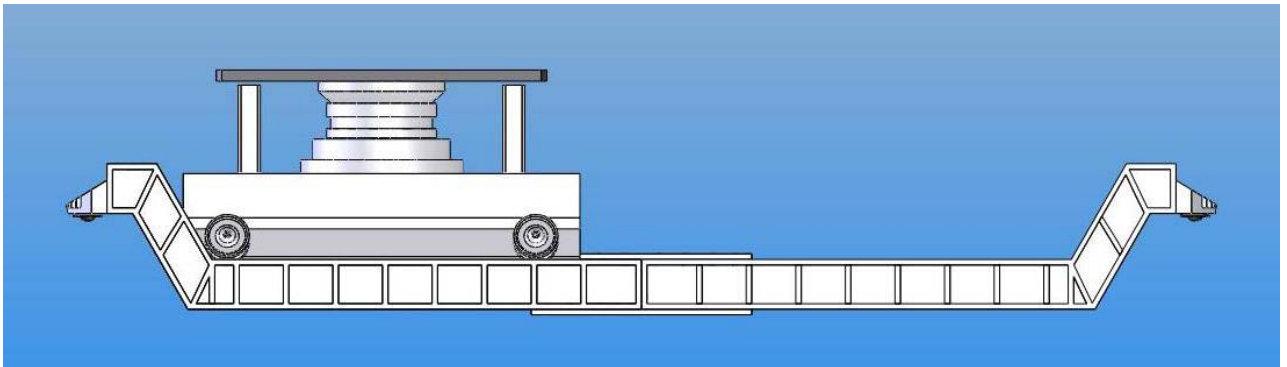
Remaining design tasks

1. Create spring-loaded rollers which will push against the chamber walls to assist in centering the support beam.
2. Create removable supports for each section of the support beam, which will lift and hold the sections in the correct height while joining them. These supports will rest on the floor of the chamber.
3. Create stops for the transport table so that it can be locked in position without rolling.
4. Load transfer cage for lower-section still has to be designed.
5. Load transfer onto the support table still has to be resolved; is someone currently working on the design of the swing-arm?

Design concerns and challenges

1. Not satisfied with the current design of the air bearing; should be re-designed to a lower profile with less travel than current air bearing.
2. The support beam may be lowered further to allow for height of fine alignment fixture.
3. Stainless V-groove castors may create too much friction due to the higher load; may cause jamming of transport table.
4. Load capacity on inner rail of chamber still of some concern; need to locate calculations on this or at minimum perform analysis on accurate model.





5. DESIGN STATUS

All components for the preliminary design have been created and the support beam FEA analyzed. Total weight and cost estimates are in progress. After comments/inputs, necessary design changes will be done to prepare for quotable drawings. It should also be established which concepts need to be tested before a decision is made to follow this solution, such as the air bearing for fine alignment.

The installation fixtures will be needed in June/July 2005. Although the Advanced LIGO Seismic BSC Prototype is being delayed, the fixtures are planned used to remove the initial stack at LASTI and replace it with a solid stack of equal height as the Advanced LIGO Suspension Structure.