

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY  
- LIGO -  
CALIFORNIA INSTITUTE OF TECHNOLOGY  
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Correspondence

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## Linear motor specification

J Fishner, P Fritschel, and S J Waldman

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

Massachusetts Institute of Technology  
LIGO Project, Room NW22-295  
Cambridge, MA 02139  
Phone (617) 253-4824  
Fax (617) 253-7014  
E-mail: info@ligo.mit.edu

LIGO Hanford Observatory  
Route 10, Mile Marker 2  
Richland, WA 99352  
Phone (509) 372-8106  
Fax (509) 372-8137  
E-mail: info@ligo.caltech.edu

LIGO Livingston Observatory  
19100 LIGO Lane  
Livingston, LA 70754  
Phone (225) 686-3100  
Fax (225) 686-7189  
E-mail: info@ligo.caltech.edu

## 1 Introduction

This specification is for an in vacuum linear motor. As detailed below, the motor must meet requirements for function, for materials, and for dimensions. The motor will be engineered and built by the vendor. This request for quote includes a first article delivered and the design package. The design package will include CAD models (SolidWorks preferred), machine drawings, and if necessary assembly procedures. The specifications listed here are not absolute, and we welcome discussion wherever modifications are necessary.

The linear motor will actuate a vertically moving mirror using a moving coil geometry. Both for efficiency and for shielding, the motor will have a substantial flux return for the magnet(s). A sketch of the motor and its intended use is shown in Figure 1. This design work includes the magnets, flux return, coil, and coil holder. The method of mechanically attaching to the coil will be decided jointly by the vendor and LIGO.

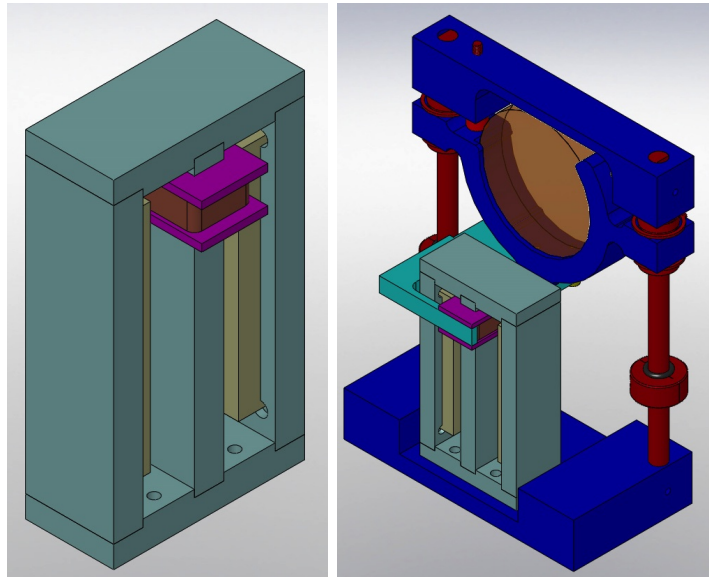


Figure 1: Left: A sketch of a linear motor with moving coil. Right: The motor integrated with the moving mirror. The interface piece, to be negotiated, is shown in cyan.

## References

- [1] **LIGO vacuum compatible materials list** E960050-v5
- [2] **Qualifying Parts for LIGO UHV Service** E1000088-v1
- [3] **Metal components intended for use in the Adv LIGO Vacuum System.** E0900364-v3
- [4] **Galling Tendencies and Particles Produced by Ultra Clean Screw Threads.** T040111-v1

## 2 Requirements

1. Approximately 2" of travel. Minimum travel of 1.5".
2. 0.5 lbs. of force or greater.
3. Less than 10 W power dissipation.
4. Total foot print less than 1.5" wide and 3" long. Total height less than 3.0". Best effort for 0.75" x 1.75" x 2.75".
5. Motor must have tapped mounting holes on the bottom, 8-32 or 1/4-20 preferred.
6. Moving coil must have an interface to LIGO hardware, to be negotiated.
7. Preference for MWS Wire Industries 32HML or 32QML polyimide insulated copper wire.
8. All materials must be compatible with the LIGO UHV service. Such materials include:
  - ceramics: alumina, boron nitride, macor
  - wire: MWS Wire industries 32HML or 32QML polyimide insulated copper wire.
  - Aluminum and aluminum alloys (wrought form)
  - Carbon steel (particularly if electroless nickel plated)
  - OFHC copper, copper nickel alloys, beryllium copper
  - NdFeB or SmCo magnets, bare or nickel coated
  - Stainless steels including A286 and 400 series. (Don't use 303 stainless)
  - PEEK, Victrex grade TDS-450G

More materials, and a list of explicitly rejected materials can be found in Ref. [1].

9. All construction must be fabricated according to E0900354, Ref [3]:
  - Remove all sharp edges, R.02 min.
  - All machining fluids must be fully synthetic, fully water soluble and free of sulfur, silicone, and chlorine.
  - All surfaces must be machined to remove oxides and mill finish
  - Use of abrasive techniques is not allowed.
  - Surfaces should have 32  $\mu$ inch finish.
  - All holes should be vented and hardware chosen to minimize galling (eg. silver plated where required. See Ref. [4])

More details can be found in the (long) Ref. [2] or the (short) Ref. [3] if necessary.

10. Any additional ferromagnetic material not listed here should be low phosphorous electroless nickel plated to prevent corrosion