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

Technical Report **LIGO-T970096-00 -** **D** Apr. 17, 97

Dumbbell-type Standoff for Magnet/Standoff Assembly

S. Kawamura, M. Fine, and J. Hazel

This is an internal working note
of the LIGO Project.

California Institute of Technology
LIGO Project - MS 51-33
Pasadena CA 91125
Phone (818) 395-2129
Fax (818) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project - MS 20B-145
Cambridge, MA 01239
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

WWW: http://www.ligo.caltech.edu/

1 ABSTRACT

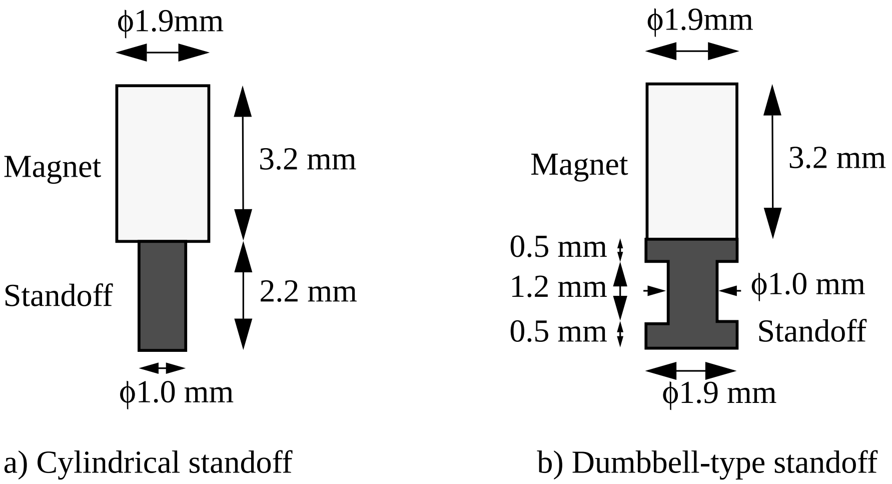
A magnet/standoff assembly using a dumbbell-type standoff, which are much more robust and easier to handle than that using a conventional cylindrical standoff, was found not to degrade mechanical losses of the LIGO large test mass around 100 Hz. We decided to use dumbbell-type standoffs for LIGO.

2 INTRODUCTION

A. Gillespie and F. Raab have found that an aluminum cylindrical standoff inserted between a magnet and a test mass protects internal mode *Q*s of the test mass from the lossy magnet. However, fragility of the magnet/standoff assembly has been a concern. During the recent adhesive testing to measure the bonding strength of various glues, many magnet/assemblies have been broken off even with careful handling.

3 DUMBBELL-TYPE STANDOFF

Possibility of using a dumbbell-type standoff was suggested by R. Drever. As shown in Fig. 1, the dumbbell-type standoff has much larger contact area (~4 times) both between the magnet and the standoff, and between the standoff and the test mass, compared with the cylindrical standoff. This makes the assembly much more robust and easier to handle.



a) Cylindrical standoff

b) Dumbbell-type standoff

Figure 1: Dimensions of magnet/standoff assemblies using a) a conventional cylindrical standoff and b) a dumbbell-type standoff.

4 *Q* MEASUREMENT

In order to verify that the dumbbell-type standoffs do not degrade mechanical losses of the test mass, we measured internal mode *Q*s of the pathfinder mass (25 cmϕ × 10 cmL) with the dumbbell-type standoffs. Four magnet/standoff assemblies were glued on the rear surface of the mirror with Vacseal, and two assemblies on the sides. The results are shown in Table 1 together with *Q*s with cylindrical standoffs (three assemblies on the rear surface of the mirror, and none on the sides). *Q*s with the dumbbell standoffs turned out to be higher than those with cylindrical standoffs for most of the modes. Considering that much less losses are induced into the test mass by the magnet/standoff assemblies around 100 Hz than 10 kHz to 50 kHz because of high resonant frequencies of the magnet/standoff assemblies[1], we can conclude that mechanical losses of the optics added by the dumbbell standoffs will be negligible for the LIGO required loss around 100 Hz.

Table 1: Measured internal mode *Q*s with dumbbell standoffs and cylindrical standoffs.

Resonant frequency[a]	*Q with dumbbell standoffs*[b]	*Q*[c] *with cylindrical standoffs*[d]
9.4764 kHz	1.3×10^6	5.3×10^5
22.4215 kHz	4.6×10^5	1.9×10^6
25.6323 kHz	2.6×10^6	6.0×10^5
29.4842 kHz	1.1×10^6	5.6×10^5
29.8662 kHz	Not Measurable	7.3×10^5
38.7632 kHz	8.8×10^5	Not Measurable
42.7583 kHz	4.8×10^6	7.0×10^5
47.3324 kHz	5.4×10^6	1.7×10^5

[a] These are resonant frequencies for the dumbbell-type standoffs. Resonant frequencies for the cylindrical standoffs are slightly different.

[b] Four assemblies on the rear surface of the mirror and two on the sides

[c] Measured by J. Carri

[d] Three assemblies on the rear surface and none on the sides

The first two resonances of the new magnet/standoff assembly attached to the test mass was also measured and the results are summarized in Table 2 together with that of the cylindrical standoff. The first resonant frequency of the assembly with the dumbbell-type standoff (9.7 kHz) is slightly higher than that with the cylindrical standoff (7.7 kHz). This is good because it is further from the unity gain frequency (at most ~2 kHz) of any control paths to the test mass.

---

[1] See “Magnet Induced Losses in LIGO Large Optics” J. Carri, LIGO-T960166-00-C

Table 2: Resonances of the magnet/standoff assembly attached to the test mass.

Dumbbell standoffs		*Cylindrical standoffs*	
Resonant frequency	*Q*	*Resonant frequency*	*Q*
9.7 kHz	130	7.7 kHz	10
34.6 kHz	>30	Not Measured	