LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

LIGO-T070133-00-D *Advanced LIGO* 06/07/2007

A Quick Test of Laser Safety Eyewear

Peter King

Distribution of this document:
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

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

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

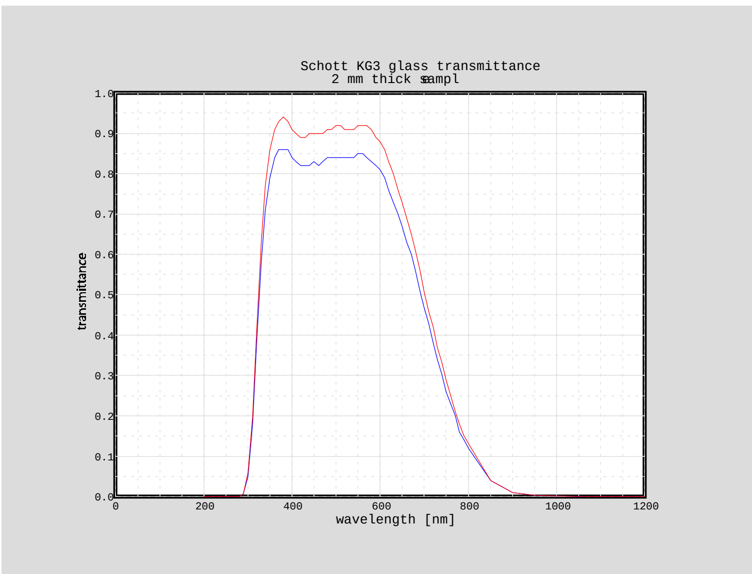
http://www.ligo.caltech.edu/

1 Introduction

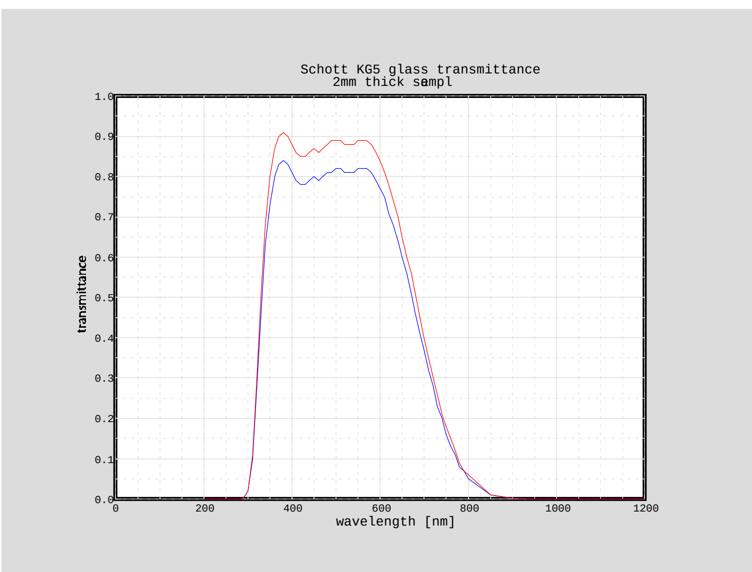
With the planned upgrades to the LIGO detector involving higher laser powers, a natural question to ask is whether the laser safety eyewear currently in use is still sufficient. Therefore, a quick test of some old laser safety eyewear was performed with the 35-W Front-end laser and the 200-W Advanced LIGO Laser. The test involved exposing the laser safety eyewear material to the laser and making a note of the result.

2 The Lens Material

The material used for the laser safety eyewear was Schott glass KG3 and KG5. These are typically used as infrared filters and are listed as suitable for protective glasses by Schott. The transmission of the materials is shown below.



The transmission of KG3 for a 2 mm thick sample.



The transmission of KG5 for a 2 mm thick sample.

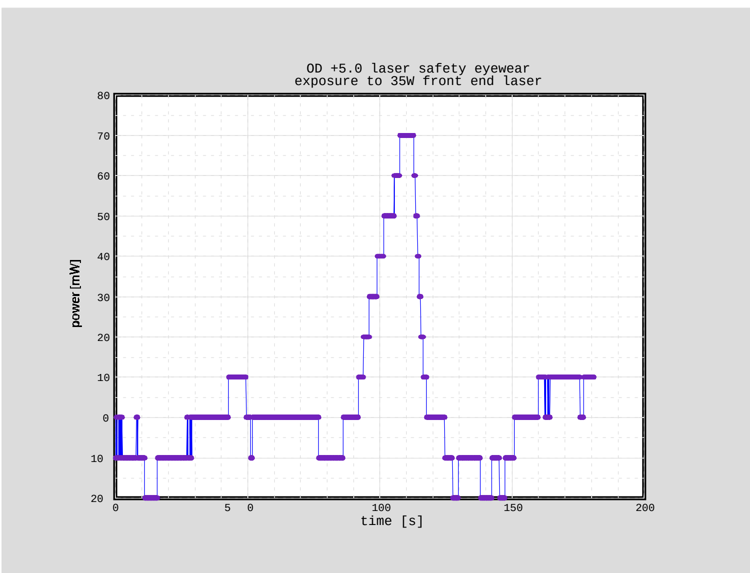
Note that the materials tested were glass *not* polycarbonate.

3 Exposure Tests

Due to some laser problems, the Advanced LIGO Laser only delivered about 140 W. The Front-end Laser delivered 35 W. The lens was setup in the beam path and a calorimeter was installed behind the lens to see if any power was transmitted by the lens upon impact. The lens was then exposed to the laser beam for a short duration and the result was recorded.

3.1 KG3

The KG3 lens was placed in the output of the Front-end Laser where the beam diameter was approximately 3 mm. An Ophir LaserStar FL300A-SH calorimeter was used to record the power transmitted through the lens.

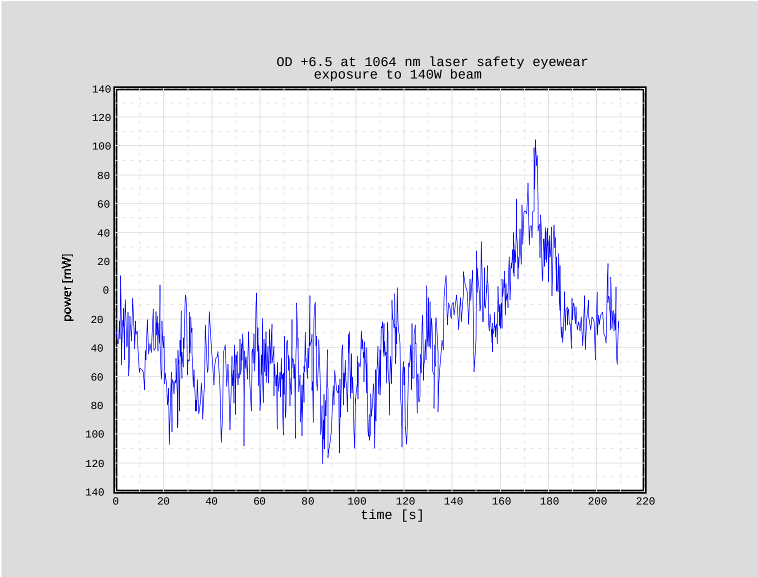


The maximum transmitted power measured was 70 mW. The video recording can be viewed here[1]. The streak present in the video is due to saturation of the CCD element and is not the laser beam.

3.2 KG5

The KG5 lens was placed in the output of the Advanced LIGO Laser where the beam diameter was approximately 5 mm. A Coherent LM-45 HTD calorimeter was used to record the power transmitted through the lens.

[1] At the time of writing this document, the Apple's QuickTime extension – or any media player capable of handing .mov files – is required to view the videos.



The maximum transmitted power measured was approximately 90 mW. The video recording can be viewed here.

4 Results

In both cases, there was no transmitted power for a period of at least a few seconds. Unfortunately, a synchronized time resolved measurement was not possible but observing the calorimeter during the exposure period revealed no significant departures from zero during the early stages. After removing the beam, the damage to the glass is apparent, with a small crater being present with small cracks where the beam hit. As each lens cooled down the whole lens cracked.

In the case of KG5, a hole was made through the glass. There is evidence that the beam melted the glass material.

5 Conclusions

My personal conclusion from seeing this test is that we should follow the CE standard and require a period of time where the laser safety eyewear can withstand a direct hit. It is doubtful that some of our polycarbonate-based laser safety eyewear would withstand the worst-case scenario of a direct hit. Even the small extra time afforded by CE certified laser safety eyewear would give a laser operator time to get out of harm's way. Frankly, after seeing the video, if a person couldn't tell that they were being hit by the laser then there are more immediate problems at hand.