

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY  
-LIGO-

CALIFORNIA INSTITUTE OF TECHNOLOGY  
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Technical Note	LIGO-T030299- 00- D	12/05/03
<b>Scatter from 2ITM01 viewed with a Dark Field Microscope</b>		
Helena Armandula, GariLynn Billingsley		

This is an internal working note  
of the LIGO Project.

**California Institute of Technology**  
**LIGO Project – MS 51-33**  
**Pasadena CA 91125**  
Phone (626) 395-2129  
Fax (626) 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>

## **INTRODUCTION**

W. Kells has estimated scatter on the order of 70ppm per core optic based on measurements at Hanford (G030660-00-D). The loss appears to be dominated by scatter from point defects. This loss is not consistent with the estimated loss based on LIGO1 metrology and scatter measurements. In an effort to discover the loss mechanism H. Armandula has taken a sampling of scatter points on 2ITM01 using a dark field microscope. The mean occlusion of these points is 1560 parts per million.

## **Method**

2ITM01 was the optic examined. It had previously been installed at Hanford, but was removed because of a chip. The mirror was cleaned before measurement. Data were taken using the dark field microscope in the OTF at Caltech. Eight separate fields of view were analyzed at a magnification of 5x. In each field of view the number of visible spots were counted, and the size of the spots were estimated with a resolution of roughly 5 micrometers and ranged from 5 to 25 micrometers in diameter. In cases where there was confusion as to whether a spot was dust or imbedded, the operator would locally clean the mirror to remove dust or cleaning marks.

## **Results**

The view field data were divided into quadrants; the average density of occlusion (occluded area/field area) was analyzed with the following results:

Standard Deviation	698 ppm
Mean	1560 ppm
Confidence Level	95%
Confidence Interval:	
Lower Limit	1310 ppm
Upper Limit	1810 ppm

## **Observations**

H. Armandula observed that the various spots appeared to focus at different depths. There was no way to estimate the variation in depth.

## **Recommendations**

- Examine a polished/uncoated blank to determine if characteristic scatter spots appear.
- Examine the same optic with 1064nm illumination to determine if some scatter spots are deep in the coating where they may have little effect on total scatter.

## **Conclusions**

This measurement describes an upper limit on scatter that could occur due to occlusions in the coating or on the surface of the substrate. This measurement does not preclude the possibility that these occlusions are a source of loss in LIGO 1, since the loss estimated by this method exceeds the loss measured by Kells.