



First Results from the Syracuse University Scatter Imaging Lab

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Motivation and Goals



- Motivation:
 - Scatter loss in initial Ligo large, inhomogenous (concentrated in point scatter)
 - Limits the power buildup in optical cavity translating to reduced shot-noise limited sensitivity
 - » Advanced Ligo and beyond require reduced scatter loss
 - » Refer to yesterday's talk by Bill Kells
- Goals:
 - » To measure backscatter coefficient at large angles from coated mirrors
 - To distinguish scatter from point sources and glow/speckle using photography

Image of mirror ETMX (End Test Mass, X-arm) at LIGO Hanford site. Courtesy Kells and Vorvick.

LIGO Starting point: look closely at images from Ligo mirrors



- Grad Lab project of **Don Bunk**
- Techniques tested:
 - **Cross section 》**
 - Histogram guided threshold[™]
 - Matched filtering **》**
 - Perimeter method
- Significant fraction in point scatter









Backscatter Conventions







Crystalaser 350mW

Experimental Setup

Class 100 clean-room







Test Mirror: Example Images



G080159-00-R





Test Mirror Movie I

- Using f/#
 3.5, 0.5m
 distance
- 13 images angles from 17 To 77 degs

QuickTime[™] and a decompressor are needed to see this picture.





Test Mirror Movie II

- Using f/# 11 (better depth of focus), 0.3m distance
- 34 images angles from 16 To 67 degs both directions

QuickTime[™] and a decompressor are needed to see this picture.

LIGO Calib.: Find relative factor measuring on same system



- Determining solid angle subtended by compound lens non-trivial
 - Use diffuse scatterer
 - Unlike mirror, this is dominant scatter source in the setup
 - » Large back-scatter coefficent allows measurement with power meter
 - Compare:
 - » BRDF measured by power meter (or bare CCD)
 - » to un-calibrated measurements from CCD+Lens system.
 - » The ratio is our calibration factor, Fcal G080159-00-B Coating





LIGO







Initial tests on AdvLigo coating sample



- Ion sputtered LMA Ti doped Ta2O5/Si 30 layer coating for normal incidence
 - » Advanced Ligo Baseline Harry talk from this morning
- Scatter much, much lower than test mirror
 - » Initial tests indicate > 2 orders lower, ie B<10-6</p>
 - » Required better beam dumping AND smaller beam to avoid bleeding from bright mirror holder scatter dominating mirror scatter





Outlook



- Finish measurements for AdvLigo sample
- 3-inch samples with differing levels of polish
- Continued work on point vs glow/speckle accounting
- Logbook and other info:
 - » <u>https://www.gravity.phy.syr.</u> <u>edu/dokuwiki/doku.php?id=</u> <u>scattering:home</u>

QuickTime[™] and a TIFF (Uncompressed) decompressor are needed to see this picture.