



LIGO Laser Power Calibration Standards

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■LIGO Power C



Power Calibration Standards



LIGO Earlier Power Sensor Configuration





- Two spacers with apertures between integrating sphere and photodetector.
 - Less sensitive to radial position.
 - Increased laser speckle amplitude.
 - Less robust mechanically



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Mechanical Robustness

- Radial dependence
 - No spacers: 4 %/mm
 - One spacer: 1 %/mm

- Lateral dependence
 - 1 % per 16 µm offset







Laser Speckle

- Increases with decreasing viewing area
 - Less detector spacers better



IGOPhotodetector mounting



- Monolithic photodetector housing front plate
- Two-piece assembly draws PD assembly against sphere port.





Pneumatic Sliders for Automated Measurements





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Working Standard Calibration Procedure







- WS/GS calibrations use:
 - Simultaneous measurements eliminate laser power variations
 - Swapping positions eliminates beamsplitter variations

$$\sqrt{\frac{V_{WS}(\text{refl}) * V_{WS}(\text{tran})}{V_{GS}(\text{refl}) * V_{GS}(\text{tran})}} = \boxed{\frac{\rho_{WS}}{\rho_{GS}}}$$



Responsivity ratio measurements



100-second samples; 1000 measurements over weekend







Histogram of values for 1000 measurement set







- Heat one WS to 35 °C in oven
- Measure resp. ratio as temp. relaxes



Temp. dependence $\,\sim 0.07$ % / °C.

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Gold Standard Stability Before/After NIST Calibration



Finally,

Working Standard	Before	After	Ratio
WSH	1.1181	1.1176	$0.9996\ (0.04~\%)$
WSL	1.0723	1.0712	$\begin{array}{c} 0.9990 \\ (0.10 \ \%) \end{array}$
WSS	1.0045	1.0048	$\frac{1.0003}{(0.03~\%)}$





EXTRA SLIDES

Gold Standard Stability Before/After NIST Calibration





IGO Temperature Dependence of Photodiodes





- Installed temperature sensors by photodiodes to investigate trends
- Thermalized WS at 35°C, measured against WS at ~20°C
- Ratio changes by ~0.07%/°C difference in WS temperature.





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• Believed to have stable enough measurements to see laser speckle in timeseries ratios

