

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY  
- LIGO -  
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<b>Calibration Uncertainty Budget Requirements for early aLIGO</b>		
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## Calibration uncertainty budget requests and requirements

This section outlines the calibration requirements for Advanced LIGO. Input was requested from the four search groups regarding their requirements for aLIGO and Advanced Virgo calibration uncertainties. The following are detection era values that cover the first few years of science runs or first few detections. These values will be reassessed after the first set of detections has been made. Below is a table summarizing those requirements.

Search group	Frequency band	Amplitude	Phase	Timing	Latency
CBC	10Hz-500Hz	10%	5°	–	~ 10s
Bursts	10Hz-2000Hz	10%	5°	50	~ 10s
CW	10Hz-1500Hz	10%	18°	25	–
Stochastic	10Hz-500Hz	9%	9°	24	–

The following are the largest values that satisfy all groups (10Hz-2000Hz) and therefore the **calibration requirements for aLIGO**:

Amplitude	Phase	Timing	Latency
9%	5°	24	~ 10s

The uncertainties quoted correspond to the maximum 1-sigma variation at any frequency over the 10Hz-2kHz frequency band.

The requirements quoted above are a single number that must be derived from a collection of measurements, historically taken over the course of years, arising from several different techniques – some taken sporadically, others often – over a large frequency span, and over several configurations of the interferometers.

In the past, quoting such a number proved difficult given these circumstances. Below, we briefly recap the S5 uncertainty estimate to show how measurement statistical variations and systematic uncertainties can vary between interferometers, over frequency, and with time. As such, in order to distill this information down to one number, the systematic uncertainties and statistical variations were added in quadrature for each frequency point, and the maximum uncertainty over a given frequency band was used.

The following two bode plots of the uncertainty budgets for H1 and L1 during the third calibration epoch of S5 illustrate the different components of the estimate of the overall uncertainty. As the plots show there was a large systematic uncertainty (dark blue line) as well as frequency dependent statistical variations, which were combined in quadrature into the overall uncertainty (black dashed line). The single values quoted were the maximum values of the black dashed lines across all frequencies. For more details see LIGO-P0900120.

We expect the aLIGO measurement suite to be no different in diversity and complexity. As such we don't restrict the method for composing these numbers. However, the requirement is

that for each frequency point in the 10-2000 [Hz] band, the overall, 1-, uncertainty estimate is no larger than the values quoted above.

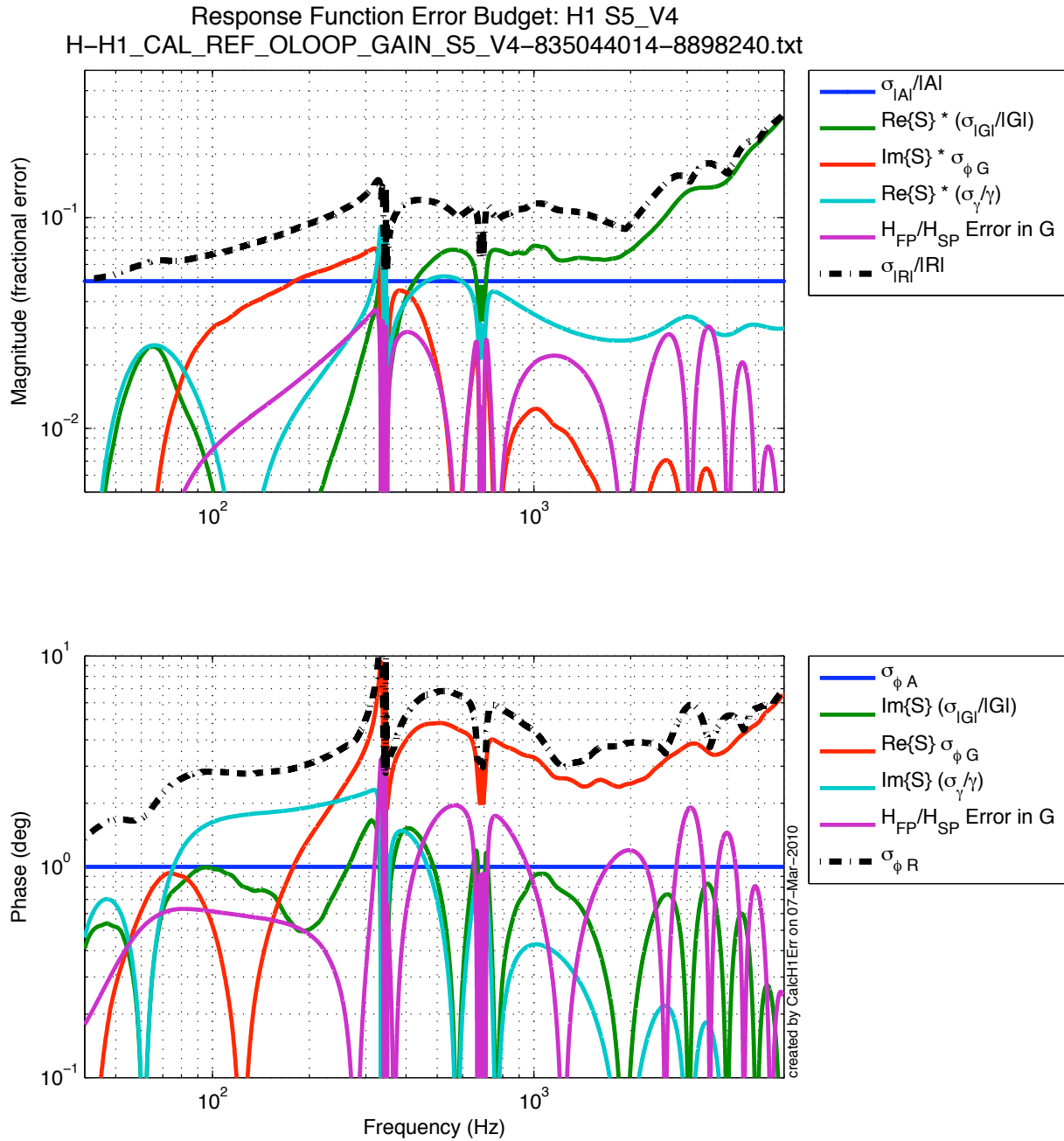


Figure 1: Bode plot for H1 during the third calibration epoch on S5. A large systematic uncertainty is shown with the dark blue line as well as a frequency dependent statistical variations. These were combined in quadrature into the overall uncertainty shown with black dashed line.

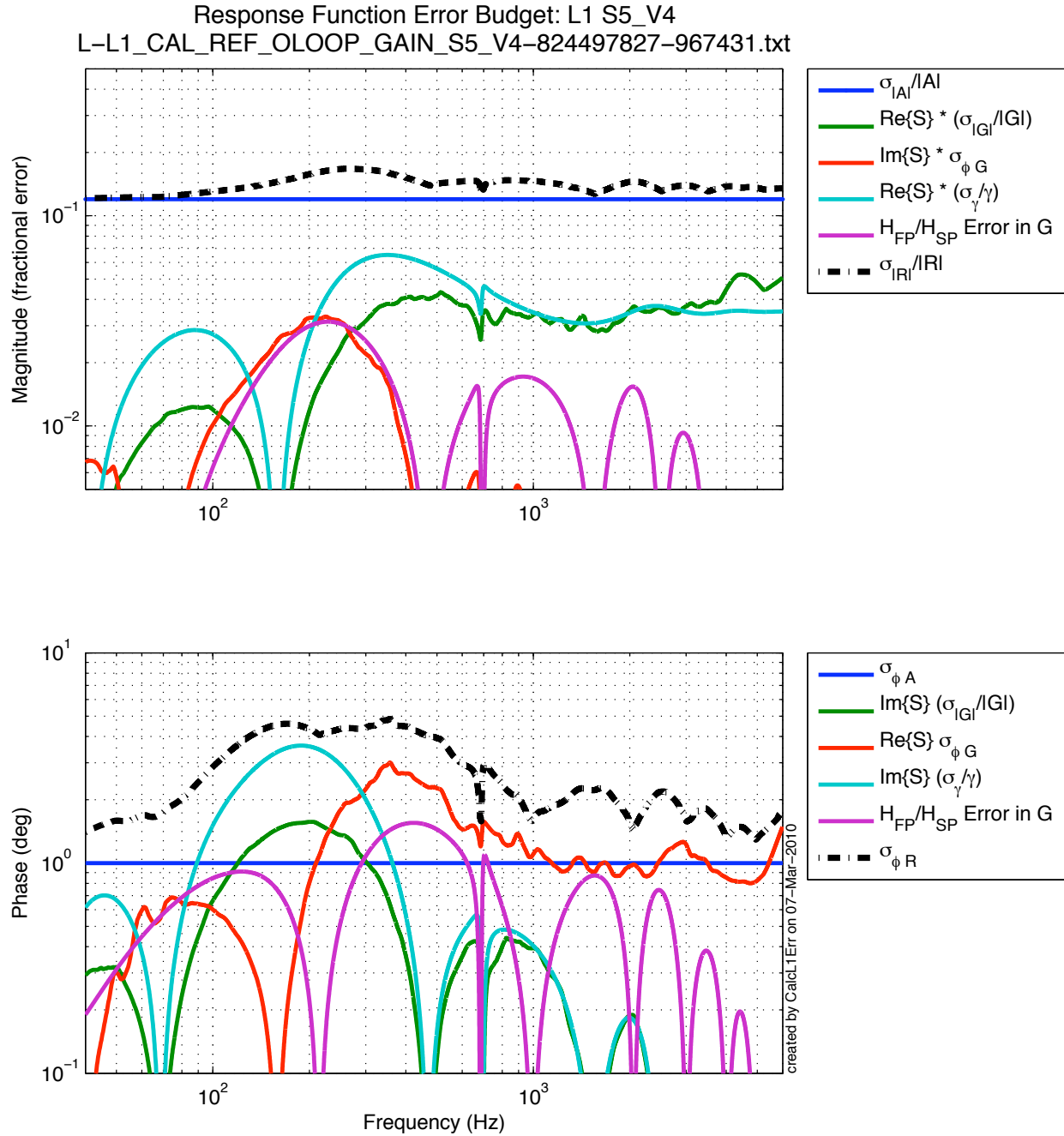


Figure 2: Same as Fig. 1 for L1