

Stones in the Road:

things to watch out for, and some potentially useful tools, as we work toward a better LIGO1 detector

- ◆ Changes affecting Acquisition and Control Robustness
 - » Sideband mode-matching and thermal compensators
 - » 4k Schnuup asymmetry issues
 - » Non-resonant sidebands as a part of the LSC control system
- ◆ Noise Hunting with SimLIGO
 - » What will lower shot noise reveal?
 - » When do we need to turn off the OSEM damping loops?
 - » How much does noise on POB matter?
 - » Can we get to the SRD noise level?
 - » ASC control schemes: can we use the QPDs to control the TMs?
 - » What is the source of this line?

Sideband Mode-matching and Thermal Compensators

- ◆ Current best SB recycling gain at H1 is 25
 - » Should be about 37
 - » Unmatched SB provides “stable” reflected SB field (used in REFL_I to make error signal for CM servo)
- ◆ Increased Thermal Lens
 - » Maximum recycling gain reached at 2.5 W
 - » Thermal compensators may provide better mode-matching
- ◆ ...but is this a good thing?

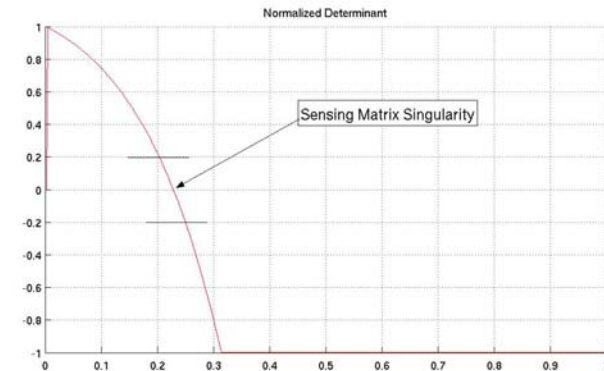
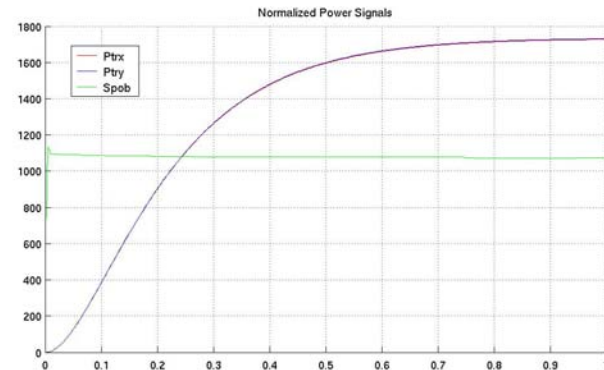
Sideband Mode-matching continued...

◆ Pros...

- » Lower shot noise
- » More stable LSC/ASC sensing matrix
- » Decreased SPOB fluctuation

◆ Cons...

- » LSC sensing matrix singularity moves to higher power (usually near PTR-SPOB crossing)
- » Lock acquisition becomes more difficult as singularity crossing happens later (and slower)
- » Lock robustness decreases as REFL_I gain becomes less stable



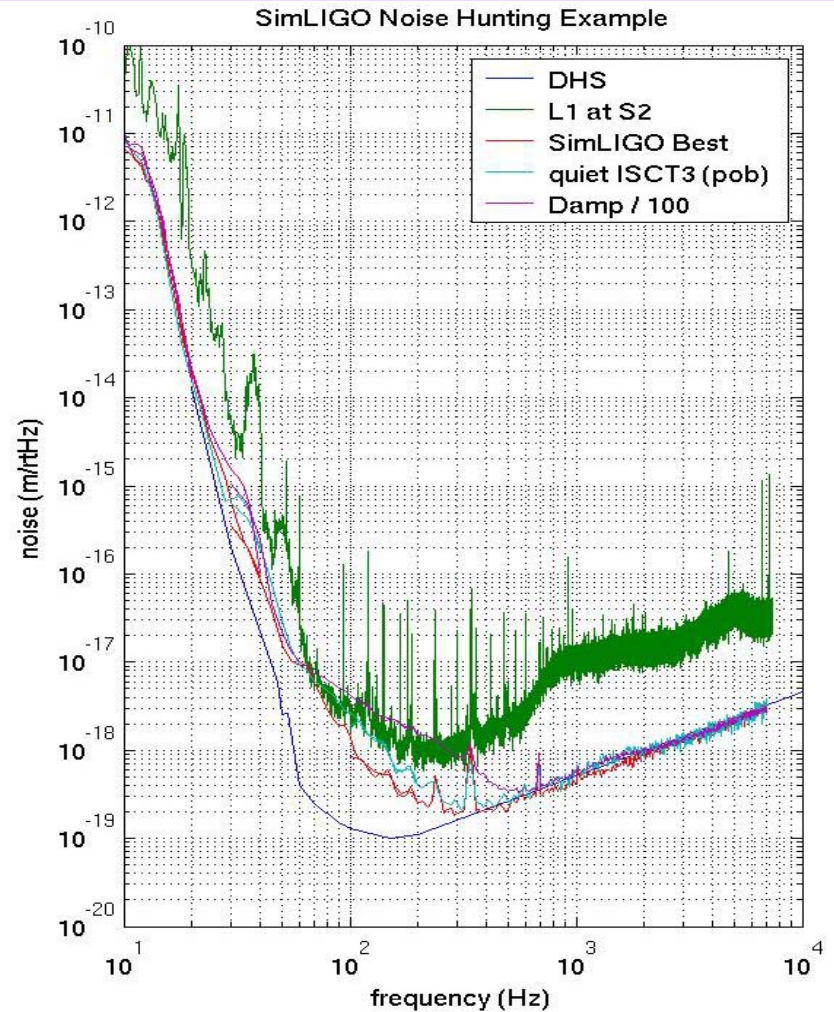
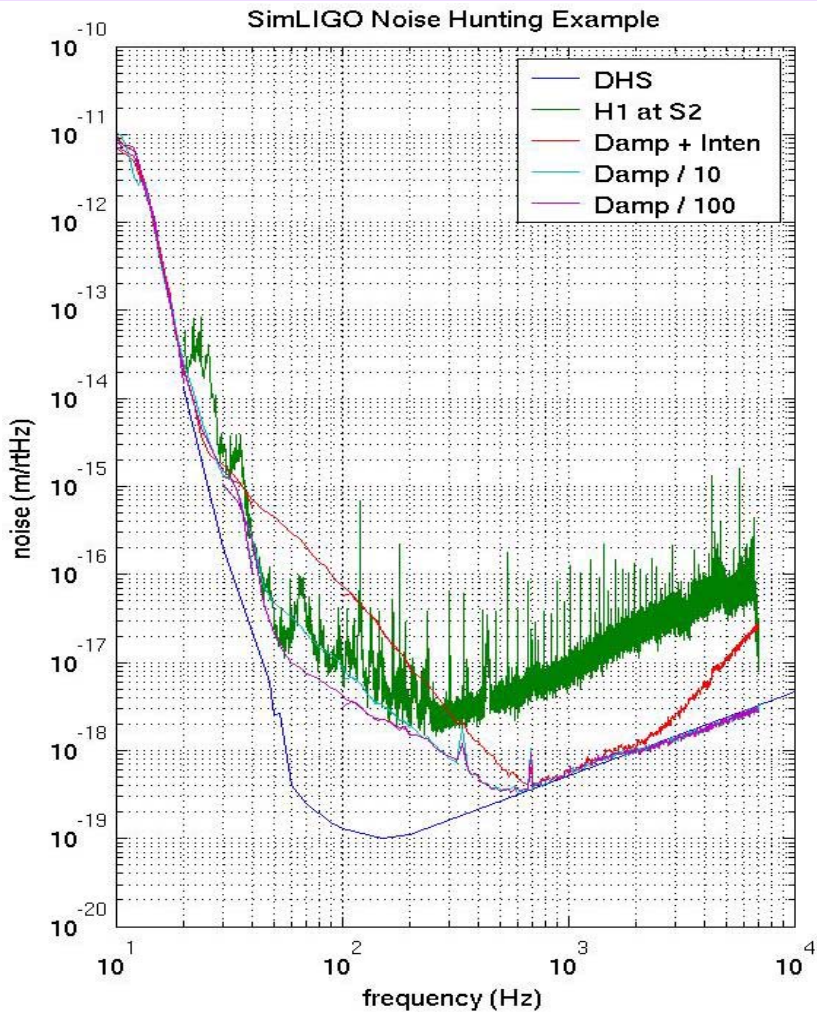
4k Asymmetry Issues

- ◆ Asymmetry for H2 is 300mm
 - » About 3% power transmission to AS port
 - » Gives 10% SB amplitude reflectivity, as intended
 - » Alignment imperfections effectively increase reflectivity
- ◆ H1 was 323mm, now 379mm
 - » Increased optimal SB amplitude reflectivity to ~10% (was near zero)
 - » Lower reflectivity moves sensing matrix singularity to higher power
- ◆ L1 asymmetry 310mm
 - » About 2.7% power transmission to AS port
 - » Very near critical coupling
 - » Alignment fluctuations may cause large SB reflectivity fluctuations, but not until the SB recycling gain is improved

Non-resonant SBs as part of LSC control system

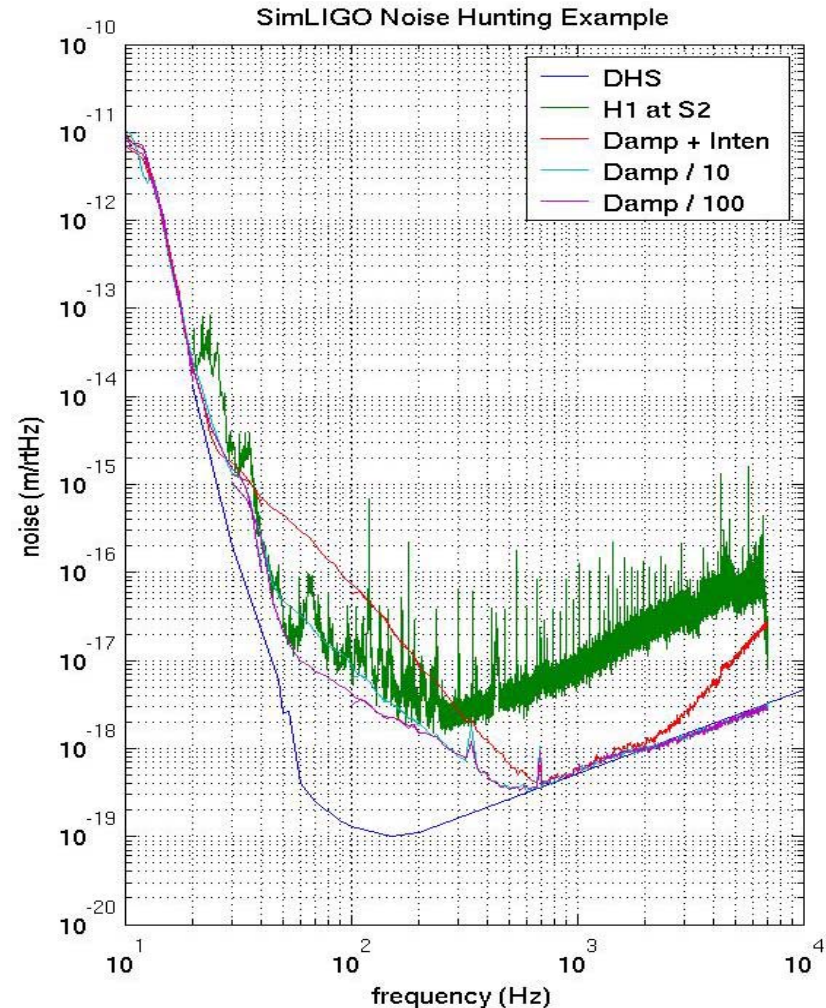
- ◆ ~60 MHz non-resonant sidebands
 - » Included for use in ASC system
 - » Not resonant in any part of the IFO
 - » Added in series modulation with resonant sidebands
 - » Could replace REFL_I as error signal for CM servo
- ◆ Pros...
 - » Better signal separation, but not perfect (SB on SB contribute)
 - » Moves matrix singularity to much lower power
 - » Eliminates some technical detection problems (REFL_Q saturation, WFS3 and WFS4 sensitivity to CARM)
- ◆ Cons...
 - » Noisier signal on smaller photo-diode
 - » Not in original design, so not thought out as carefully?

...and now for something a little different...



Noise Hunting with SimLIGO

- ◆ Some things to think about
 - » What will lower shot noise reveal?
 - Intensity noise
 - Frequency noise
 - OSEM damper noise
 - » When do we need to turn off the OSEM damping loops?
 - Design calls for loops to be turned off, but they never are.
 - Critical (red)
 - Down by 10 (cyan)
 - Down by 100 (purple)
 - The loops should be disabled, or should use better filters.

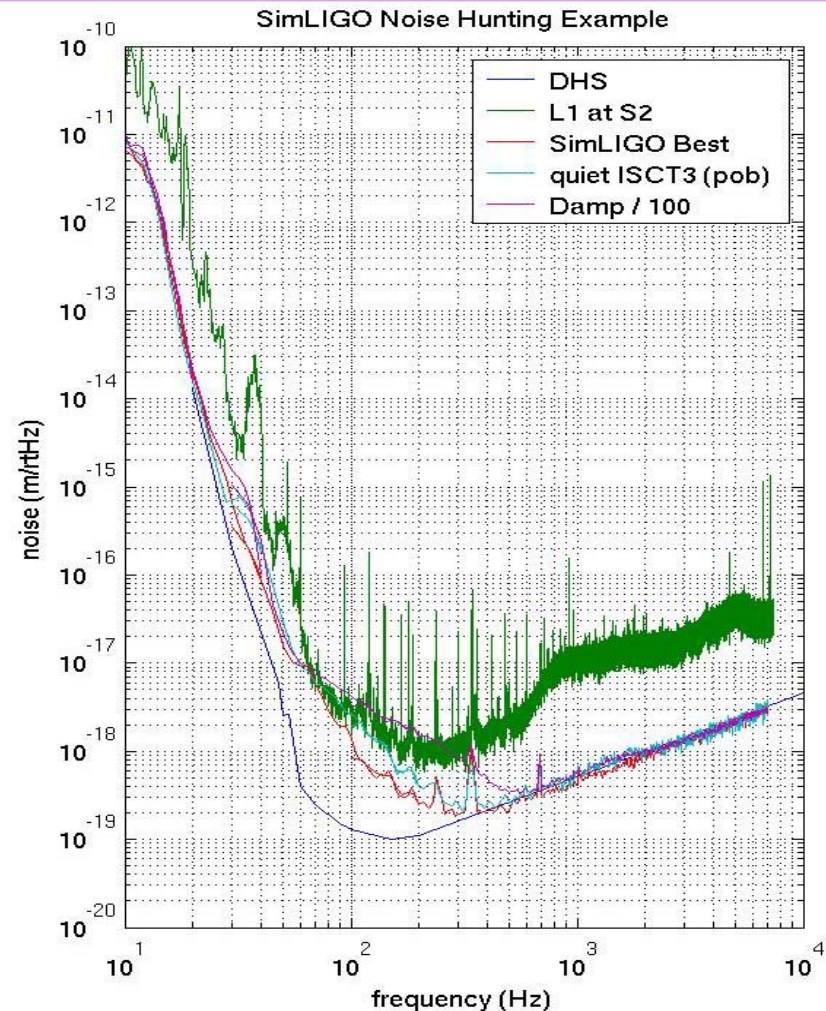


Noise Hunting with SimLIGO

- » How much does noise on POB matter?
 - Nominal shot noise (purple)
 - No shot noise (yellow)
 - Reduces PRC and MICH noise
- » Can we get to the SRD noise level?
 - Eliminate all other noise sources
 - More realistic estimate given by David Shoemaker et. al.

◆ Other uses

- » ASC control schemes
 - Various control matrices: QPDs?
 - Sidebands on sidebands...who knew?
 - Self-stabilizing alignments?
- » What is the source of this line?



Conclusion

- ◆ Changes affecting Acquisition and Control Robustness
 - » Thermal compensators...a mixed blessing
 - » 4k Schnuup asymmetry...still not enough?
 - » Non-resonant sidebands in LSC...good, but not great...wait until we really know that need them?
- ◆ Ongoing work with SimLIGO
 - » Semi-quantitative estimates of when to expect limiting noises to appear
 - » Qualitative view of possible contributions from some sources
 - » Some help with ASC system, though this is limited by current mode-matching (outside of the range of the SimLIGO modal model)
 - » Possibility for tracking down specific features
- ◆ Thanks to Hiro and Rana