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SenseMonitor Updates for S3

Patrick Sutton
LIGO-Caltech

LIGO-G030572-00-Z

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Outline of Talk

- SenseMonitor review.
- SenseMonitor updates for S3.
- Preliminary S3 performance.

SenseMonitor

- Estimates average range to which IFO can detect the inspiral of 1.4-1.4$M_\odot$ neutron star binary:

$$\text{Range} = \left[\frac{5\mathcal{M}^{5/3}\Theta^2}{96\pi^{4/3}\rho^2} \int_{f_l}^{f_h} df \, \frac{f^{-7/3}}{S(f)} \right]^{1/2}$$

constant — noise power varies

- Major task is estimating strain noise spectrum (tracking the AS_Q-to-strain calibration).
- Outputs range and calibration data to DMTViewer, trend frames, web log files.

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SenseMonitor (cont'd)

- Calibrating the noise S(f):

$$X_h(f) = \frac{1 + \alpha\beta G(f)}{\alpha C(f)} X_{AS\_Q}(f)$$

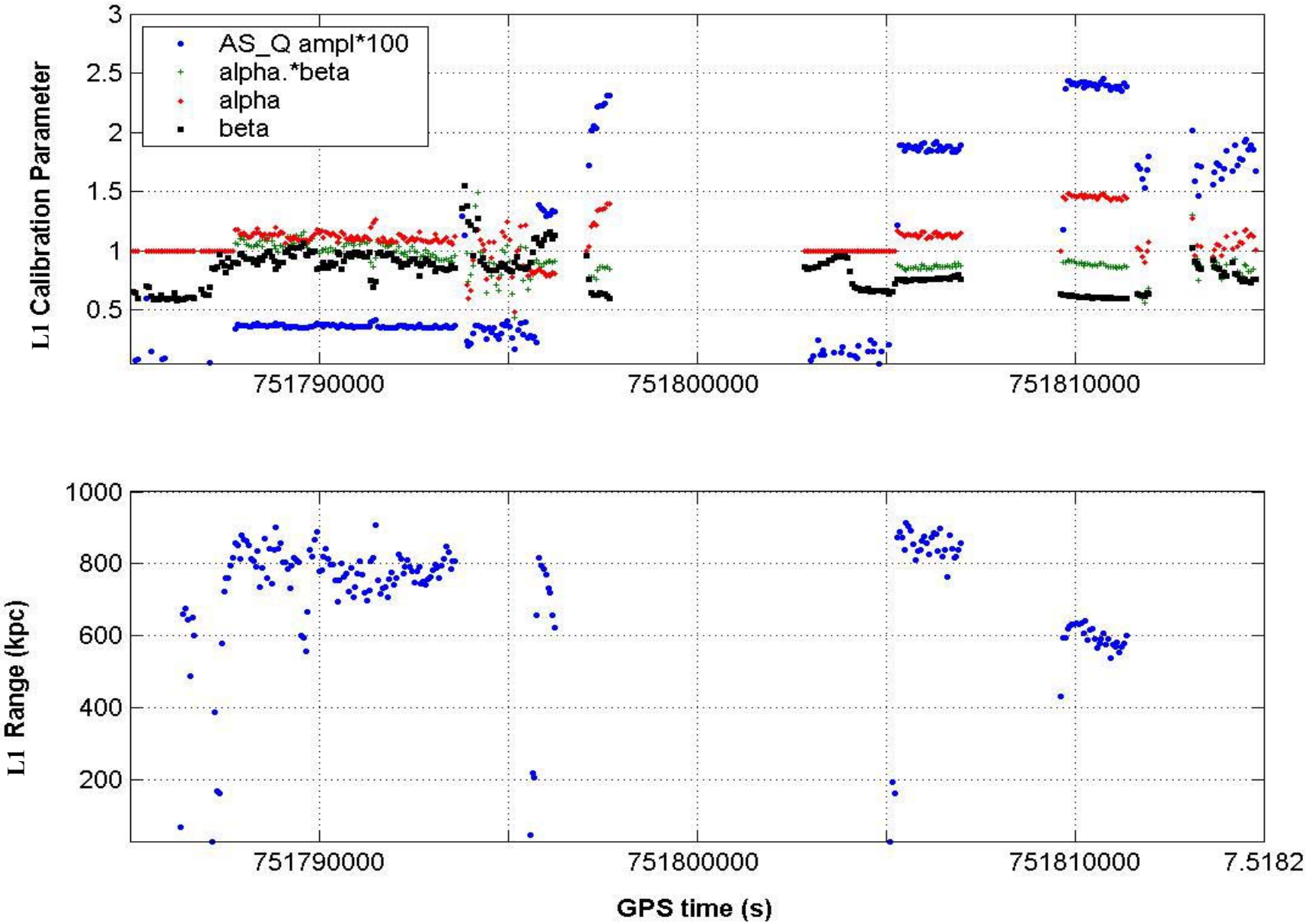
- Reference calibrations (open-loop gain G, sensing function C) measured during a calibration run. Fixed.
- α is optical gain change:
  - » varies over ~minutes
  - » get from amplitude of calibration line
- β is DARM gain change
  - » fixed during S2, varies over ~minutes in S3
  - » get from DARM_GAIN, ICMTRX_01 channels

Upgrade for S3: More Robust Calibration

- Problem: Injected amplitude of calibration line changed several times during S2 for H1, L1, causing unphysical changes in α.
- Solution: SenseMonitor now monitors injection channel to determine amplitude at which line is injected.

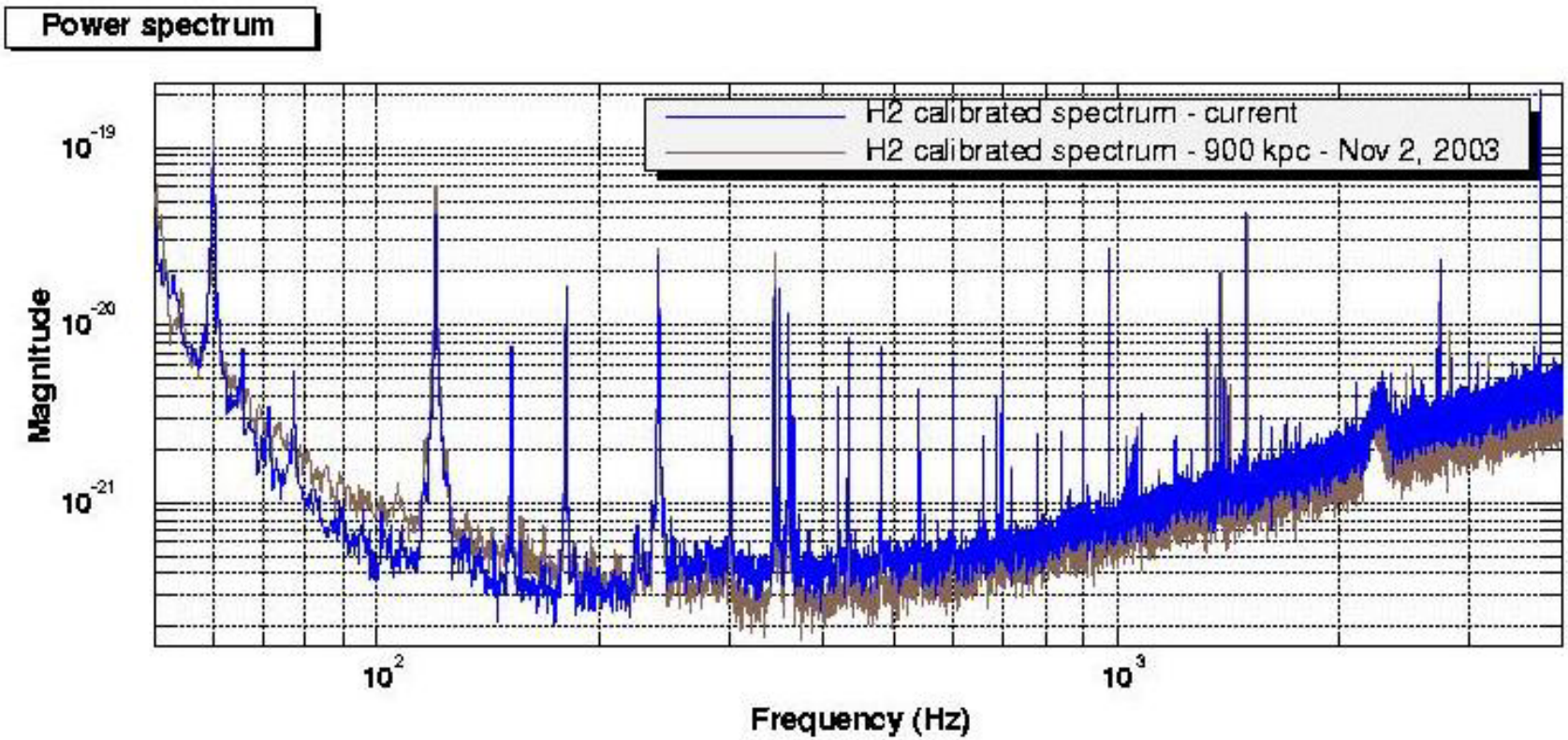
- Problem: For S3 have time-dependent ICMTRX_01 (β).
- Solution: SenseMonitor now monitors relevant DARM channels to track β.

ex: L1 in S3


AS_Q ampl*100
alpha.*beta
alpha
beta
L1 Calibration Parameter
3
2.5
2
1.5
1
0.5
751790000
751800000
751810000
L1 Range (kpc)
1000
800
600
400
200
751790000
751800000
751810000
7.5182
GPS time (s)

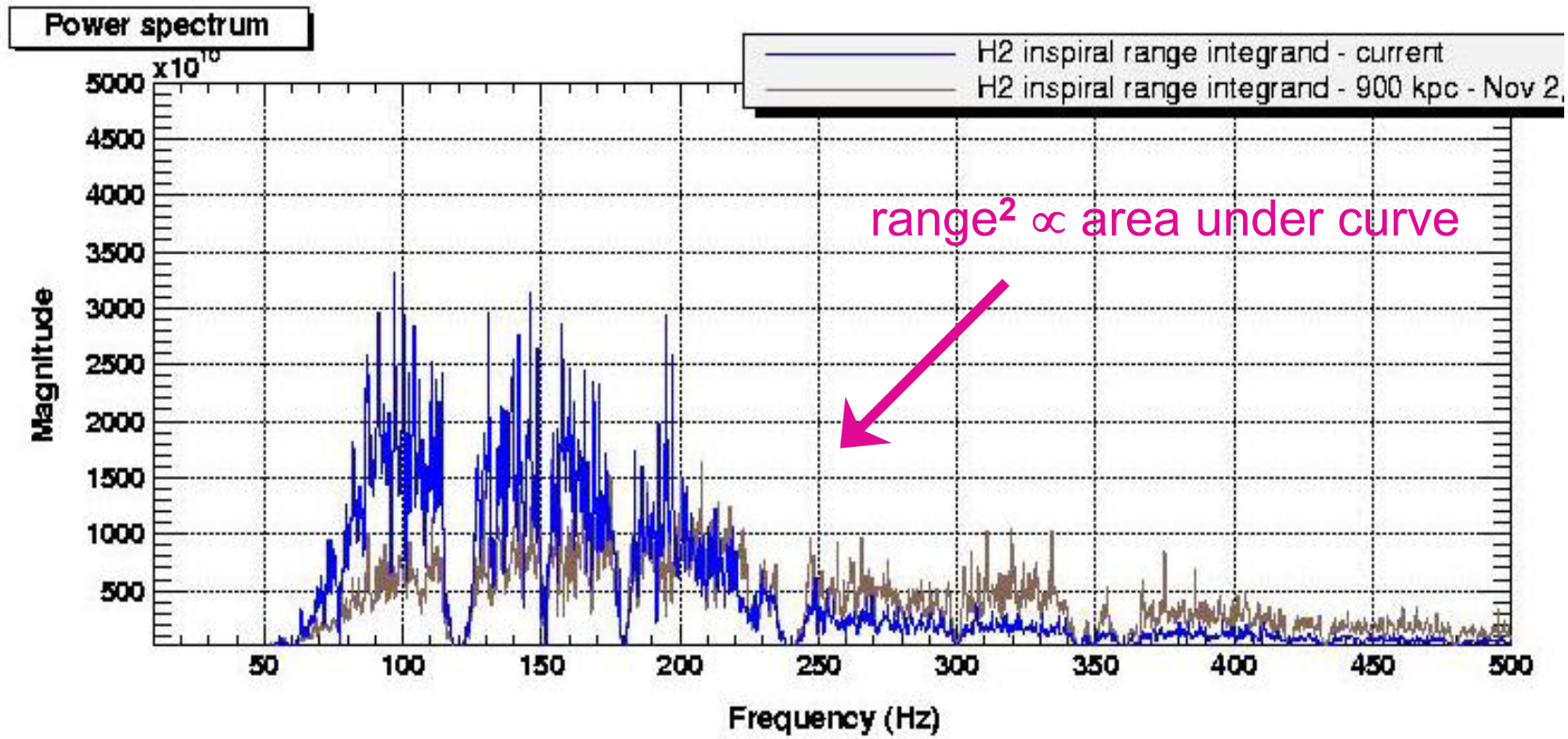
Upgrade for S3: Additional Plots

- Calibrated noise spectra available in DMTViewer :



Upgrade for S3: Additional Plots

- Range integrand $f^{-7/3}/S_h(f)$ available in DMTViewer :



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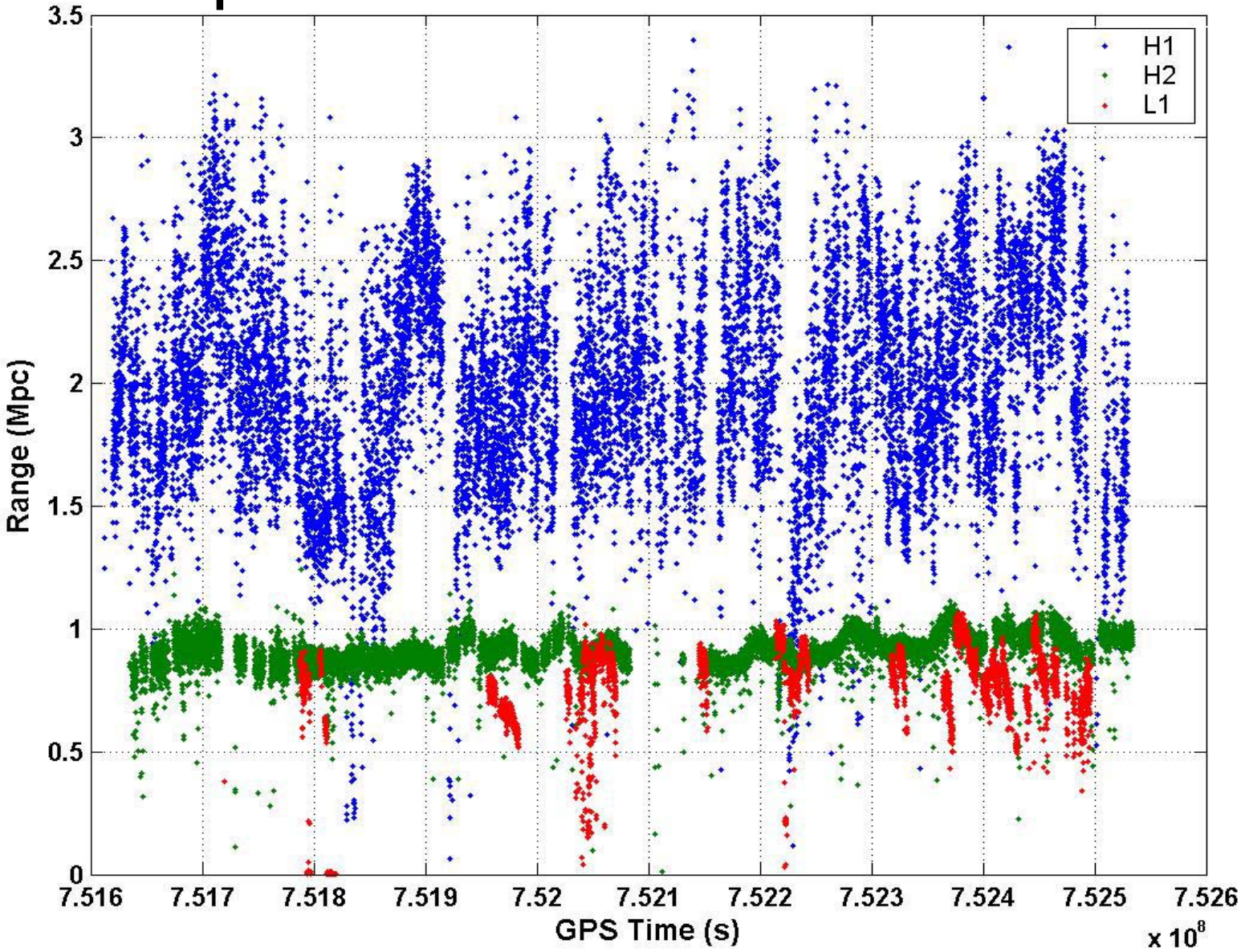
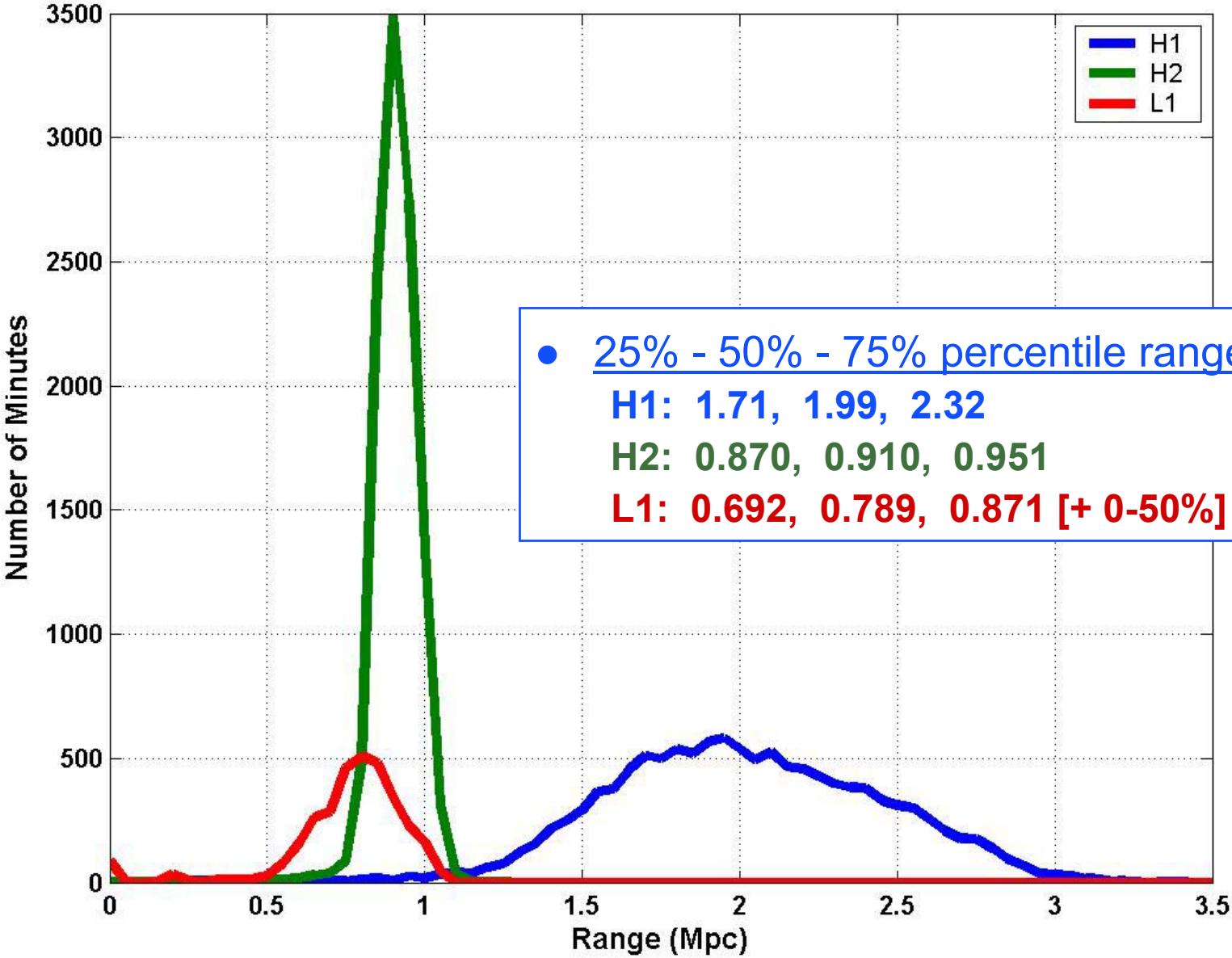
S3 Status

- SenseMonitor running for all IFOs.
- LHO:
  - » Reference calibrations measured during E10.
  - » E10/S3 SenseMonitor range estimates for H1, H2 have been verified independently (few %) by Mike Landry's AutoCalibrator. (Only common assumptions are DC calibrations.)
- LLO:
  - » E10 references out of date due to ongoing commissioning; recently restarted using updated interim references (~25% range change). Validation ongoing.

IFO performance since start of S3





- 25% - 50% - 75% percentile ranges (Mpc):
  - **H1: 1.71, 1.99, 2.32**
  - **H2: 0.870, 0.910, 0.951**
  - **L1: 0.692, 0.789, 0.871 [+ 0-50%]**

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Summary

- SenseMonitor now tracks excitation and darm channels for more robust calibration tracking – less user intervention required.
- Independent range verification available from AutoCalibrator (LHO) and InspiralRange (LLO) tools.
- Calibrated noise spectra, range integrals sent to DMTViewer.
- Up-to-date documentation is available from the DMT spi page at the sites.