



S3 calibration status

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for the Calibration team

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News on calibration since Aug LSC meeting

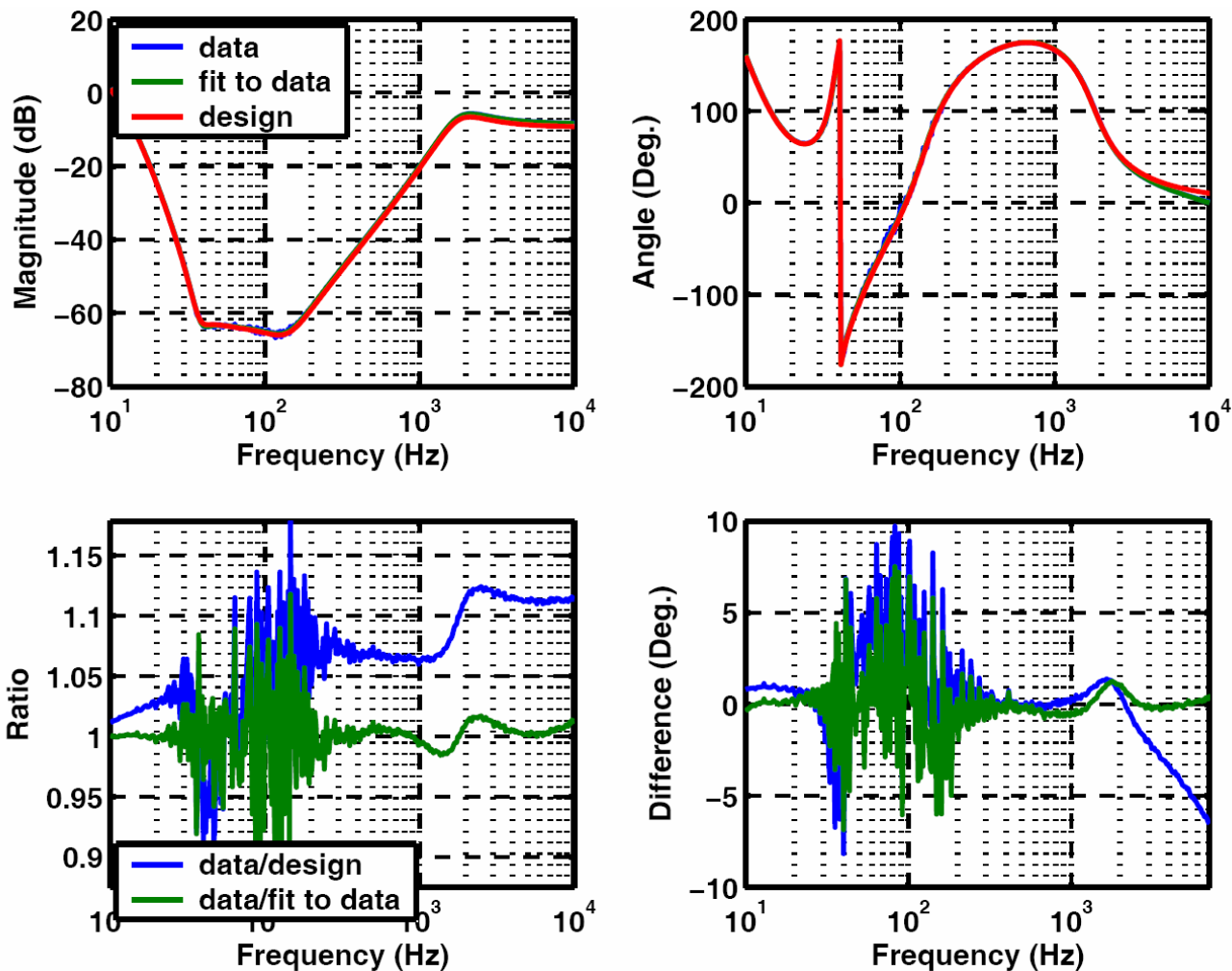
Not enough!...

- Coefficients: validation studies of “new” method (using demodulated line)
- Models:
 - » Codes were successfully reviewed (P. Fritschel), no errors found.
 - V2 model version reviewed; V3 mods will need to be assessed
 - » Work in progress on LHO models (to incorporate hardware/digital filters)
 - » Work in progress: systematic model/measurement comparison for different calibration runs in L1.
- Validation (use of!) X. Siemen’s $h(t)$ frames has started...
 - » Stochastic group has begun to use $h(t)$



Hardware measurements

Dewhiting as example; also anti-imaging, anti-aliasing and whitening





S3 V3 α, β coefficients

- V2 (from P. Sutton's SenseMon)
 - » β from SenseMon averaging input matrix
 - » α from SenseMon's line amp, β , and $G_0(f_0)$
- V3: use Xavier Siemens's code to generate demodulated lines in ASQ, DARM, EXC
 - » Complex $\beta = (1/D_0) * (DARM-EXC) / ASQ$
 - » Complex $\alpha = -(D_0/G_0) * ASQ / DARM$
 - » Complex $\alpha\beta = -(1/G_0) * (DARM-EXC) / DARM$
 - » Non-zero mean of imaginary part indicates errors in reference functions D_0, G_0 (at cal freq).
 - » Standard deviations of imaginary parts are error estimates in real part (and depend on sampling frequency).
- Compare consistency of Xavi's output and existing model



“New” method: validation steps

1. Calculate coefficients at the *reference* time

- » Q: Is $\langle \text{Im}(\beta) \rangle = 0$? (There's not a fix if it isn't!)
ANS: YES
- » Q: Is $\langle \text{Re}(\beta) \rangle$ equal to one? If not, check consistency with input matrix coefficients used for D_0
A: Differences from unity are consistent with precision used in input matrix coefficient (!).
- » Q: Is $\langle \text{Im}(\alpha) \rangle = 0$, and $\langle \text{Re}(\alpha) \rangle = 1$? If not, check whether error in G_0 mag and phase are consistent with previous estimates
A: G_0 “Errors” found are ~ 2 deg, 2% , consistent with error estimates for model parameters and comparison with measurements.



“New” method: validation steps

2. With “fixed” D_0 , G_0 , calculate coefficients at some selected long science segments.
Q: Are $\langle \text{Im} \rangle = 0$? Are $\langle \text{Re} \rangle$ consistent with V2?
ANS: yes.
3. Calculate coefficients α , β at reference time and selected segments, with same method, but using the calibration line at 150 Hz.
Q: Are $\langle \text{Im} \rangle = 0$? (If not, are errors in D_0 , G_0 reasonable?)
A: yes (H1, H2), maybe (L1)
Q: Are $\langle \text{Re} \rangle$ same as from 900 Hz line?
A: yes (within larger errors, due to smaller SNR).



“New” method: validation steps

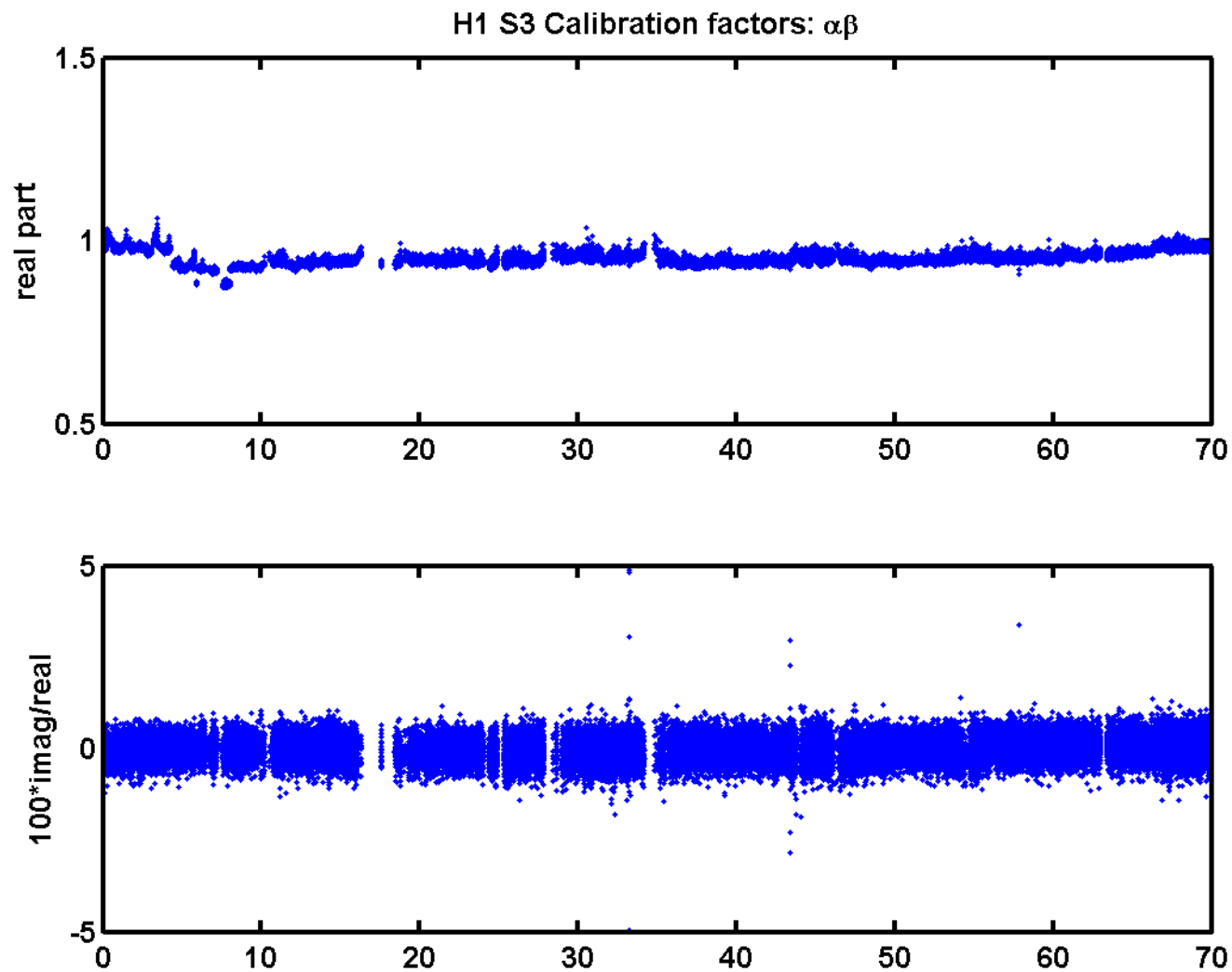
4. Calculate coefficients for all of S3.

Q: Is $\langle \text{Im} \rangle = 0$? Is the distribution of $\langle \text{Im} \rangle$ Gaussian? Is time series of $\langle \text{Im} \rangle$ stationary?

A: yes (H1, H2), no (L1). Observed drift in L1 is $\sim \pm 1$ deg: not explained (yet), but is within error in phase for G_0 (927.7 Hz).



S3 V3 $\alpha\beta$ coefficient: H1





S3 Calibration errors

- Errors from reference models in S3 ~ errors in S2 (5-10%)
- Random variations, errors in alpha, beta (60 sec integration time):

	α error	α S3 variation	$\alpha\beta$ S3 variation
L1	0.5%	15%	4%
H1	0.3%	4%	1%
H2	0.7%	6%	2%

In S2: 0.7% (L1), ~3% (H1, H2).



Conclusions

- V3 almost ready, should be released in ~2 weeks.
- Will include calibration for science times, and times of hardware injections.
- M5 used a circa S3 calibration, E11 will use a fully updated one
- Propose to have calibration run prior to E11 in the event online analyses are in fact ready (good for Sensemon, too). Propose early calibration for S4 as well.
- S4:
 - » Will use same methods at LLO, LHO for DC measurements, maybe including new methods (DC calibration=largest source of error)
 - » Will have models, "good" reference measurements BEFORE run starts...
 - » On-line calibration (P. Sutton)
 - » Will have ~real time comparisons of different methods for calibration coefficients
 - » Photon calibrators in place for cross check