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An Easy Calibration Tool for Strain-Based DMT Monitors

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Outline

- Need for a simple & robust calibration class.
- Existing class: `Calibrate`
- New calibration classes
  - » philosophy
  - » documentation
  - » sample use
- What's next

Sensitivity Monitors

- SenseMonitor has demonstrated the value of monitoring the sensitivity of the IFOs to astrophysical sources of GWs.
- Major task of strain-based monitor is to calibrate the AS_Q data.
- SenseMonitor:

$$r = \left(\frac{5\mathcal{M}^{5/3}\theta^2}{96\pi^{4/3}\rho_0^2} \int_{30\mathrm{Hz}}^{1400\mathrm{Hz}} df \frac{f^{-7/3}}{S_h(f)} \right)^{1/2}$$

constants **strain noise (time dependent)**

- Expect more sensitivity monitors for S4 (stochastic, bursts, periodic).
- Requires a simple, flexible DMT tool for AS_Q $\Rightarrow$ strain calibrations.

Calibration

- Done in frequency domain
- Strain related to AS_Q via

$$x_h(f) = \frac{1 + \alpha(t)\beta(t)G(f)}{\alpha(t)C(f)} x_{AS\_Q}(f)$$

time-dependent gains

reference sensing and open-loop gain functions

- *C*, *G* fixed and measured during "calibration run"
- α computed from calibration line
- β computed from certain IFO channels (**`DARM_GAIN`**, **`ICMTRX_01`**).

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Current Code: Calibrate.hh

- SenseMonitor's `Calibrate` class:
  - » Frequency domain
  - » Computes response function by comparing current calibration-line amplitude and control feedback gains to reference values
  - » It exists and it works, but …

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- SenseMonitor's **`Calibrate`** class:
  - » Frequency domain
  - » Computes response function by comparing current calibration-line amplitude and control feedback gains to reference values
  - » It exists and it works, but …
  - » It's cumbersome – user has to supply a lot of reference information by hand to the class. *Makes use difficult and prone to error.*

New Calibration Tools: Philosophy

- Simple: Hide the nuts and bolts of the calibration from the user.
  - » Put all reference calibration data in a single file of specified format which the code can parse on its own
- Robust: Separate the different types of functions according to function:
  - » Put methods for calculating α, β into one class
  - » Put methods for applying response function into another
  - » Simple high-level class to drive it all
- Flexible:
  - » Allow calibrations using α, β computed on-the-fly or using stored values from the reference calibration file.

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Current Status

- Most of the code is already written
  - » Taken from SenseMonitor's old `Calibrate` class
- Still to do:
  - » Specify format for reference calibration file – must hold scalars, time series, frequency series. Frames? LIGO_LW? Other? *Must coordinate with calibration team, DMT, search code programmers.*
  - » Finish coding and debugging (weeks)

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Summary

- New calibration tools are being developed for the DMT
  - » performs frequency-domain calibrations of power spectra
  - » simple, easy to use
  - » logical structure makes codes more flexible and easier to maintain
- Timeline for release ~ 1 month
  - » *get your requests in now!*