Overview of Calibration Use in Astrophysical Searches

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Subsession on Use of Calibration Info in Astrophysical Searches and Effects of Calibration Errors

Review of Calibration

❖ Sensing function: $C(f)$ (units ct/strain)

❖ Servo gain: $G(f)$ (units ct/ct)

❖ Actuation function: $A(f)$ (units strain/ct)

❖ Open loop gain: $H(f)$ (units ct/ct)

❖ Response function: $R(f)$ (units strain/ct)

$$H(f) = C(f)G(f)A(f)$$

$$R(f) = \frac{1 + H(f)}{C(f)}$$

Calibration Drift

❖ Change in alignment: $C(f) \rightarrow \alpha C(f)$

❖ Change in servo gain: $G(f) \rightarrow \beta G(f)$

❖ Reference calibration: $C_0(f), H_0(f), R_0(f)$

❖ Calibration lines used to monitor drift:

$$C(f) = \alpha C_0(f)$$

$$H(f) = \alpha\beta H_0(f)$$

$$R(f) = \frac{1 + \alpha\beta H_0(f)}{\alpha C_0(f)} = \frac{1 + \alpha\beta\left(C_0(f)R_0(f) - 1\right)}{\alpha C_0(f)}$$

Calibration Data

S1 Run:

❖ Reference spectra in frame files and ILWD files: generated by hand

❖ Calibration factors in frame files and ILWD files: generated by hand

S2 Run:

❖ Reference spectra in frame files and ILWD files: generated by hand

❖ Calibration factors in frame files: computed by `SenseMonitor`

LAL Calibration Functions

- ❖ LAL Library Functions: (package `tools`)
  - » `LALUpdateCalibration()`: updates reference spectra given current values of calibration factors
  - » `LALResponseConvert()`: interpolates/inverts/scales response function to get in desired form
- ❖ LALWrapper Functions:
  - » `LALExtractResponse()`: automatically extracts reference spectra and calibration factors from wrapper's `inPut` structure and interpolates/scales/inverts it to required form
  - » Search code must get calibration data from frame files or response ILWD files (`-framequery` or `-responsefiles` options to LDAS `dataPipeline` command respectively)

LDAS Calibration Functions

❖ `dataconditionAPI` Function:

» `respfilt()`: applies a transfer function (or response function) to input series; transfer function is computed using reference spectra and updated with calibration factors

» `dataconditionAPI` must get calibration data from frame files *only* (these ILWD calibration files can't be imported into `dataconditionAPI` for any purpose other than to pass to the `wrapperAPI`)

Making Calibration Files

❖ Calibration data is available at:

`http://blue.ligo-wa.caltech.edu/engrun/Calib_Home`

`http://www.ligo-la.caltech.edu/~irish/S2/calibration`

» Files are in ascii format

» S1 has spectra and factors; S2 has spectra only (factors are computed by DMT monitor)

❖ LALApps programs used to create ILWD and frame files

» `lalapps_mkcalref`: makes calibration reference spectrum ILWD and frame files from ascii files (S1 & S2)

» `lalapps_mkcalfac`: makes calibration factors ILWD and frame files from ascii files (S1 but not S2)

Future Options…

❖ Calibration reference spectra and factors should be kept together in frame files to avoid confusion about which reference was use for particular factors

❖ LAL routines to compute factors α and β given `LSC-AS_Q`, `LSC-DARM_CTRL`, and `LSC-ETMX_EXC_DAQ`… only need a reference spectrum

❖ Keep calibration information in segment tables in database