Status of StochMon, A DMT Monitor of Stochastic Sensitivity

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Presented at the 17th LSC Meeting
DetChar Session 2004 August 18

LIGO-G040327-00-Z

Detectable Ω_{GW}

Basis for figure of merit: Assuming flat GW spectrum ($\Omega_{GW}(f) = \text{constant}$),
the stochastic background strength we could detect in time T is Ω_s:

$$\frac{1}{\Omega_s^2} \propto T \left(\int_{f_{min}}^{f_{max}} df \frac{\gamma^2(f)}{f^6 P_1(f) P_2(f)} \right)$$

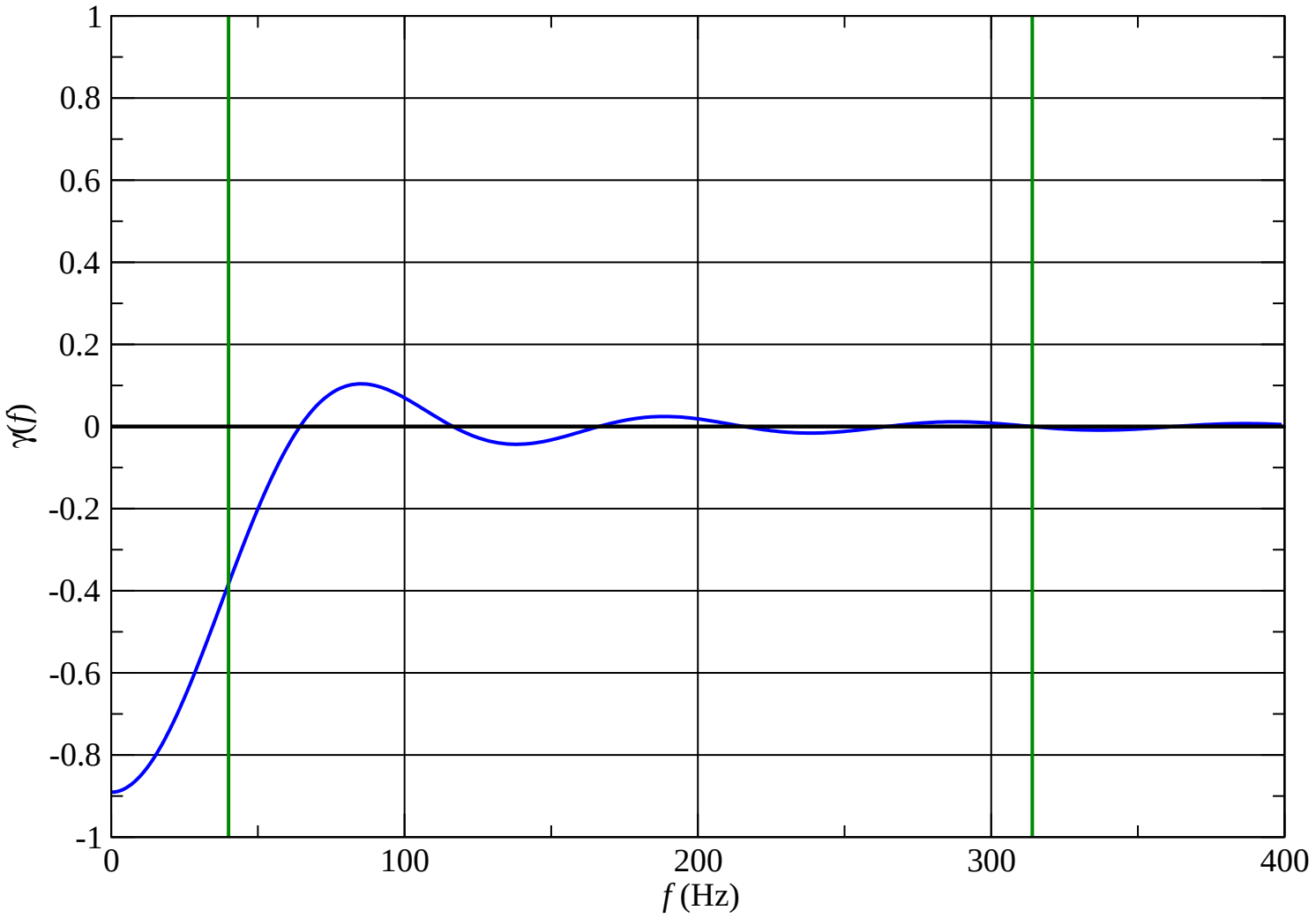
- Use Ω_s^{-2} instead of Ω_s so sensitivity grows linearly with observation time.

- $P_1(f)$ & $P_2(f)$ are (calibrated) noise PSDs of two detectors

- $\gamma(f)$ is the overlap reduction function
(known function of frequency, $\equiv 1$ for H1-H2)

Overlap Reduction Function

LIGO-Livingston / LIGO Hanford



(For correlations between LHO 2km & LHO 4km, $\gamma(f) \equiv 1$)

Strategy

- Hack SenseMonitor code because equations are similar:

$$\text{Inspiral Range} \propto (\text{PreFactor}) \left(\int_{f_{\text{min}}}^{f_{\text{max}}} df \frac{1}{f^{7/3} P(f)} \right)^{3/2}$$

$$\frac{1}{\Omega_s^2} \propto (\text{PreFactor}) \left(\int_{f_{\text{min}}}^{f_{\text{max}}} df \frac{\gamma^2(f)}{f^6 P_1(f) P_2(f)} \right)$$

Strategy (cont.)

- $P_1(f)$ is read online. $P_2(f)$ is obtained from an ASD output by SenseMonitor. This will be a good reference established before the run.

- Modify calculation of Inspiral Range in **Integrand.cc** to calculate Stochastic Sensitivity.

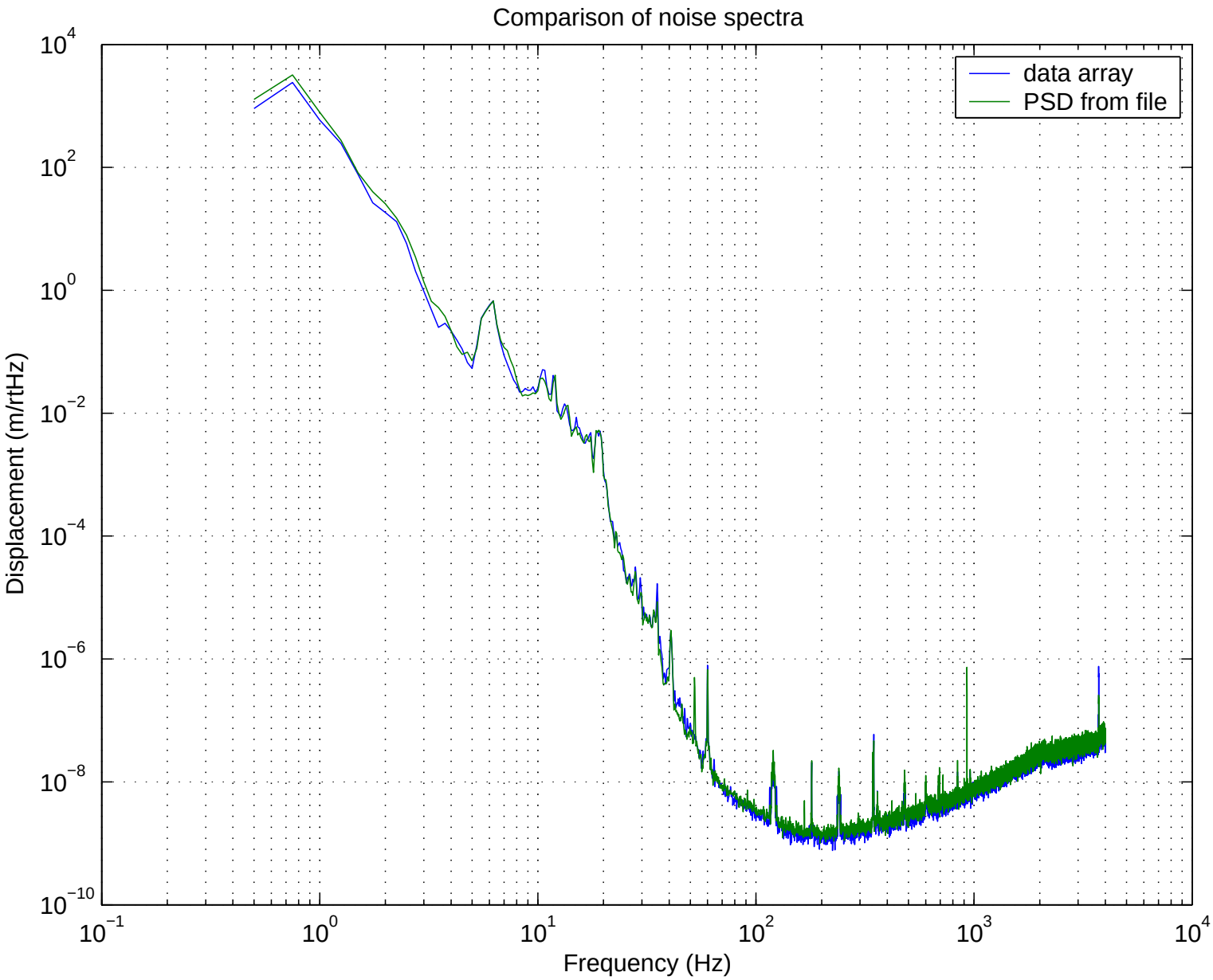
- Write trend data and graphical output.

- **data** is in units of nm^2/Hz.

- **PSDArray** is in units of strain/$\sqrt{Hz}$.

```
 for (int i = 0; i < (nsteps + 1); i++){

     //--   data[i] = pow(data[i],-2);

          data[i] = 1./(data[i]);

//--Multiply ASD by 4000 (arm lenth) and nanofy -->multiply by 1e9
          data[i] *= pow((PSDArray[i]*4.0e12),-2);

          data[i] *= pow(low_freq + (i * f_step),(-6));
     }
```

Did we get the numbers right?


Comparison of noise spectra
data array
PSD from file
Displacement (m/rtHz)
Frequency (Hz)
10^{4}
10^{2}
10^{0}
10^{-2}
10^{-4}
10^{-6}
10^{-8}
10^{-10}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}

- This is the contents of the modified configuration file

```
-OSCfile  LockLoss.conf
-refcal  L1_OpenLoopGain.txt  L1_Sensing.txt
-refline  L1:LSC-DARM_CTRL_EXC_DAQ  927.7  0.5  0.01849
-refdarm 2  L1:LSC-ICMTRX_01  L1:LSC-DARM_GAIN  -0.001592
-refpsd  L1_CalPSD_GPS:752364960.txt
-fmin 30.0
-trend L1
```

Progress

- Ran SenseMonitor offline on alvar on S3 data. (thanks to P. Sutton for help)

- Initially calculated Stochastic Sensitivity with only one PSD.

- Now reads in second PSD from file and outputs good numbers for Stochastic Sensitivity.

- Used a MATLAB script to check the right Stochastic Sensitivity calculation. (JTW)

```
>> sensitivity('../data/L1_CalPSD_GPS:752364960.txt');
Sensitivity at GPS time 752364960:
Calibrated inspiral sensitivity is 834.2105014066 kpc
Raw stochastic sensitivity is 2.7343037677e+74 sec^3
Stochastic prefactor is 1.1300758118e-72 sec^{-3}
Calibrated stochastic sensitivity is 308.997055
```

Part of the current output of StochMon log file after running offline:

Start Time of Segment	FOM for StochSensitvity
752364000	402.659
752364060	402.464
752364120	410.185
752364180	348.945
752364240	357.254
752364300	384.894
752364360	377.852
752364420	413.011
752364480	376.713
752364540	383.955
752364600	362.725
752364660	354.517
752364720	374.01
752364780	298.537
752364840	277.811
752364900	310
752364960	308.677
752365020	319.607
752365080	286.963
752365140	315.636
752365200	366.672

Future plans for StochMon

- Continue working with JTW at Loyola.
- Get an complete working version by the next engineering run.
- Write proper trend data and output for DMT viewer (DMT camp!).
- Add in overlap reduction function for LLO-LHO.
- Add a mode to StochMon to read in two PSDs in real time.
- Write a SURF report and a technical document.