

LIGO-VIRGO Stochastic Backgrounds Update

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[LIGO-G070088-00-Z](#)

LIGO - Virgo Stochastic Searches

- S5/WSR sensitivities
- Expected upper limits
- Project 1b simulated data results

LIGO-VIRGO stochastic search

- Cross correlation:

$$Y = \int dt \int dt' s_1(t) s_2(t') Q(t - t') \quad (1)$$

$$= \int df \int df' \delta_T(f - f') \tilde{s}_1(f) \tilde{s}_2(f') \tilde{Q}(f') \quad (2)$$

- Expectation value

$$\langle Y \rangle = \frac{3H_0^2 T}{20\pi^2} \int df |f|^{-3} \Omega_{\text{gw}}(|f|) \gamma(|f|) \tilde{Q}(f) \quad (3)$$

Sensitivity

Faintest background that can be detected: constant Ω_{gw} spectrum

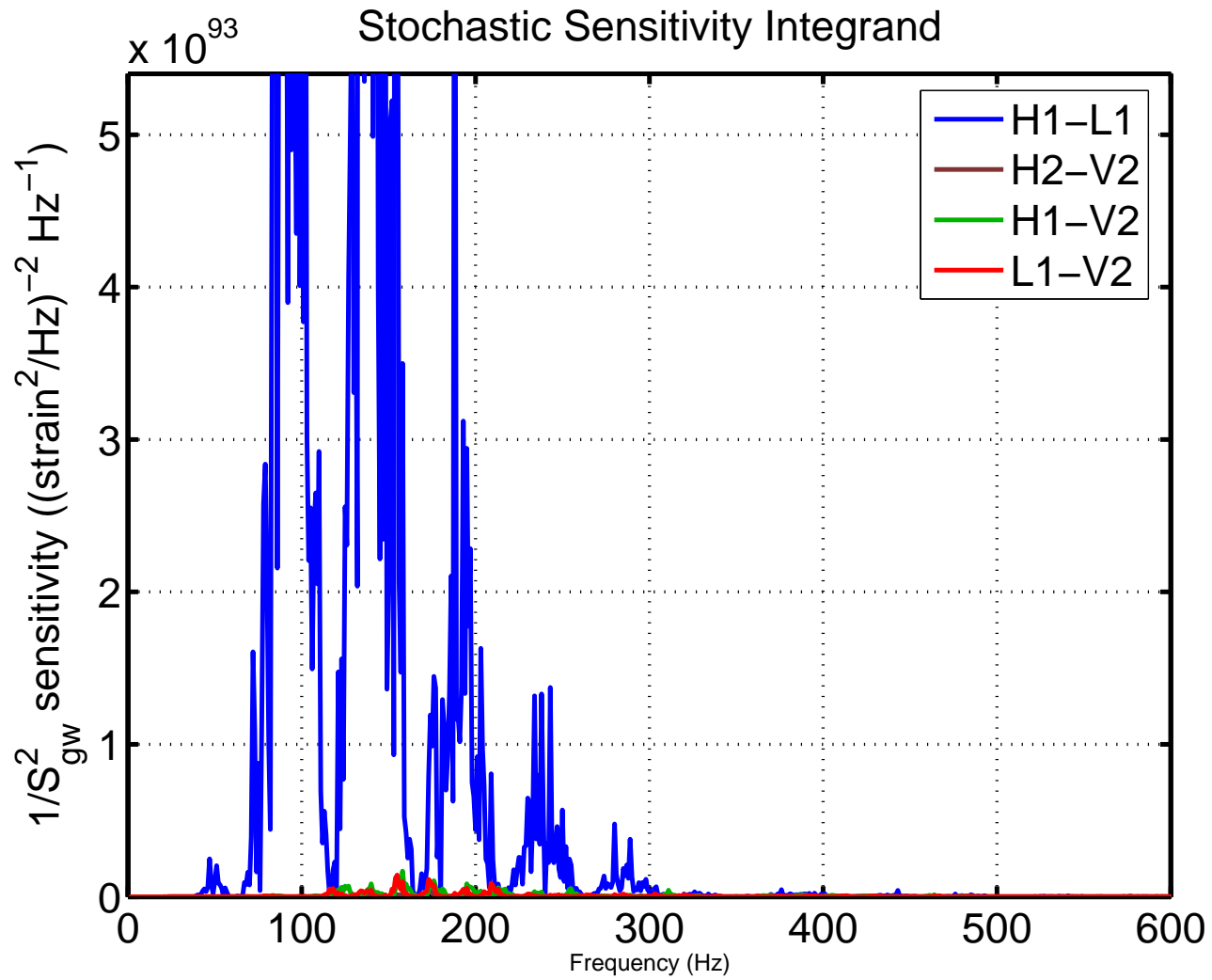
$$\Omega_0 = \frac{\mathcal{S}}{\sqrt{T}} \frac{10\pi^2}{3H_0^2} \left(\int_{-\infty}^{\infty} \frac{[\gamma_{12}(f)]^2}{f^6 P_1(f) P_2(f)} df \right)^{-1/2} \quad (4)$$

white background

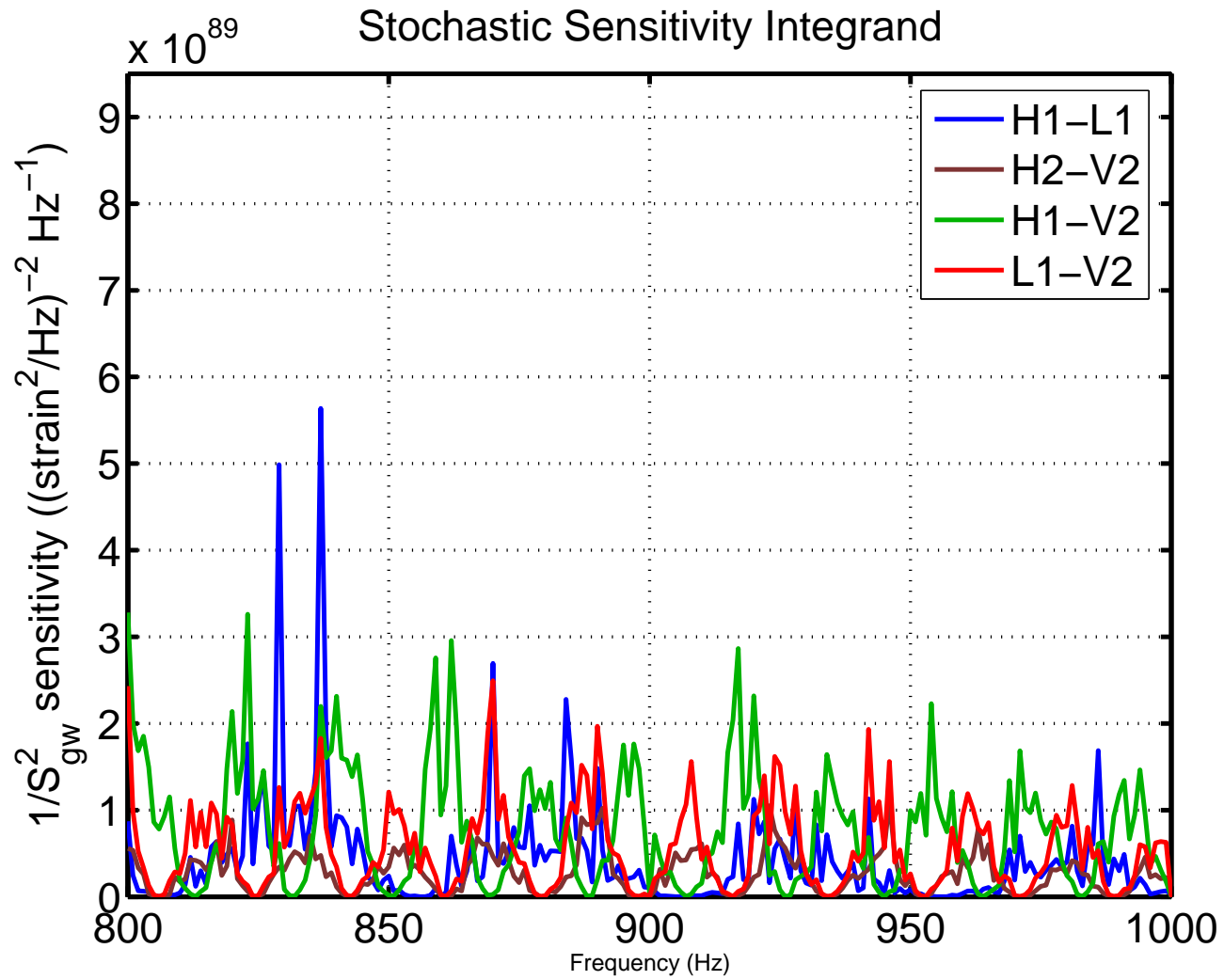
$$S_{\text{gw}} = \frac{\mathcal{S}}{\sqrt{T}} \left(\int_{-\infty}^{\infty} \frac{[\gamma_{12}(f)]^2}{P_1(f) P_2(f)} df \right)^{-1/2} \quad (5)$$

Sensitivity integrands: for a stochastic background with power spectrum $S_{\text{targ}}(f)$, we can define

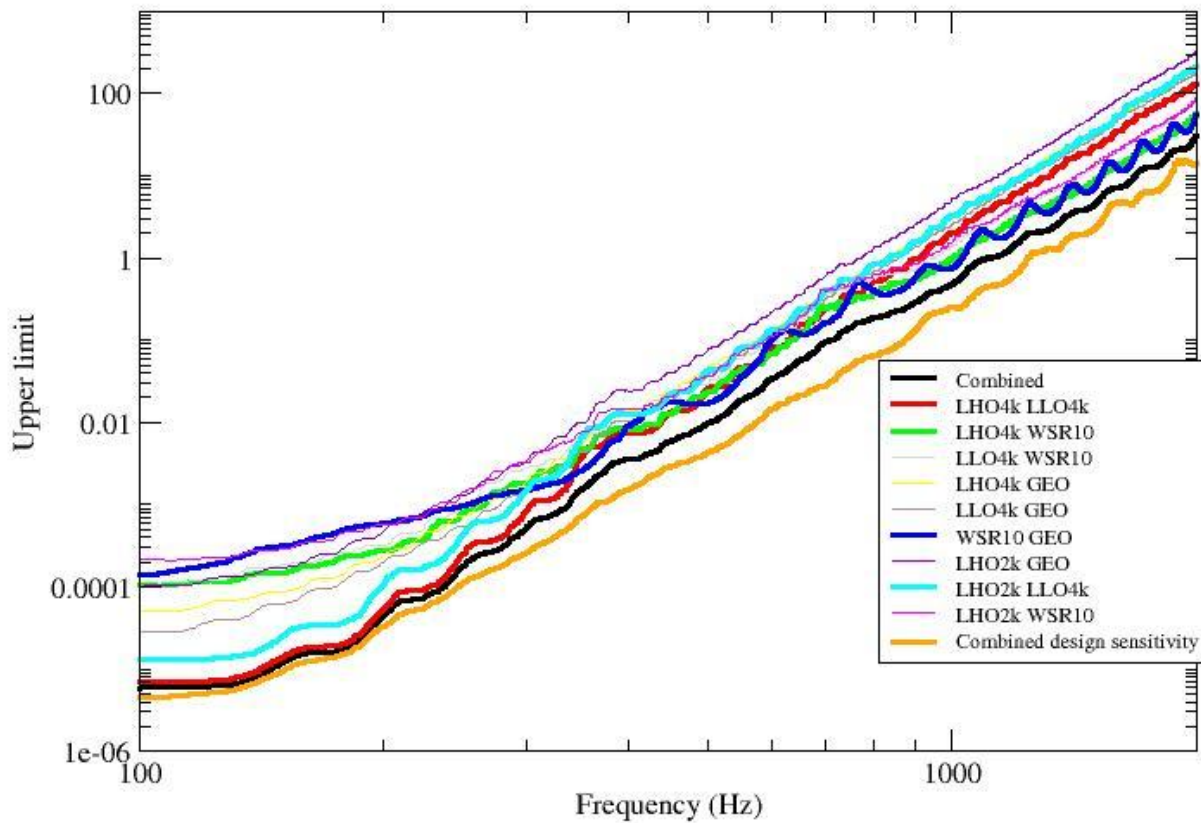
$$\mathcal{I} \propto \frac{[\gamma_{12}(f) S_{\text{targ}}(f)]^2}{P_1(f) P_2(f)} \quad (6)$$



Sensitivity integrand for a white spectrum signal.



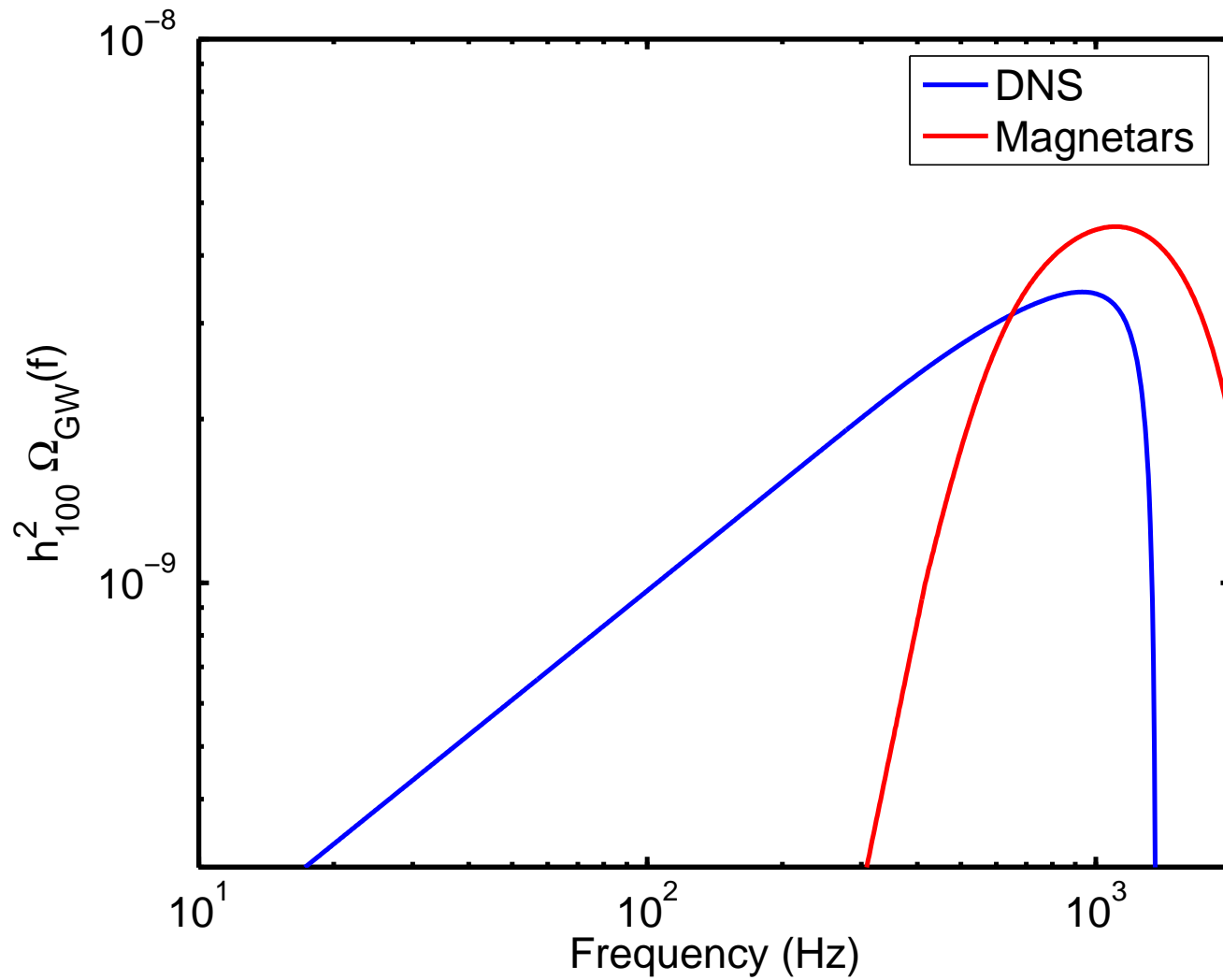
Sensitivity integrand for a white spectrum signal.



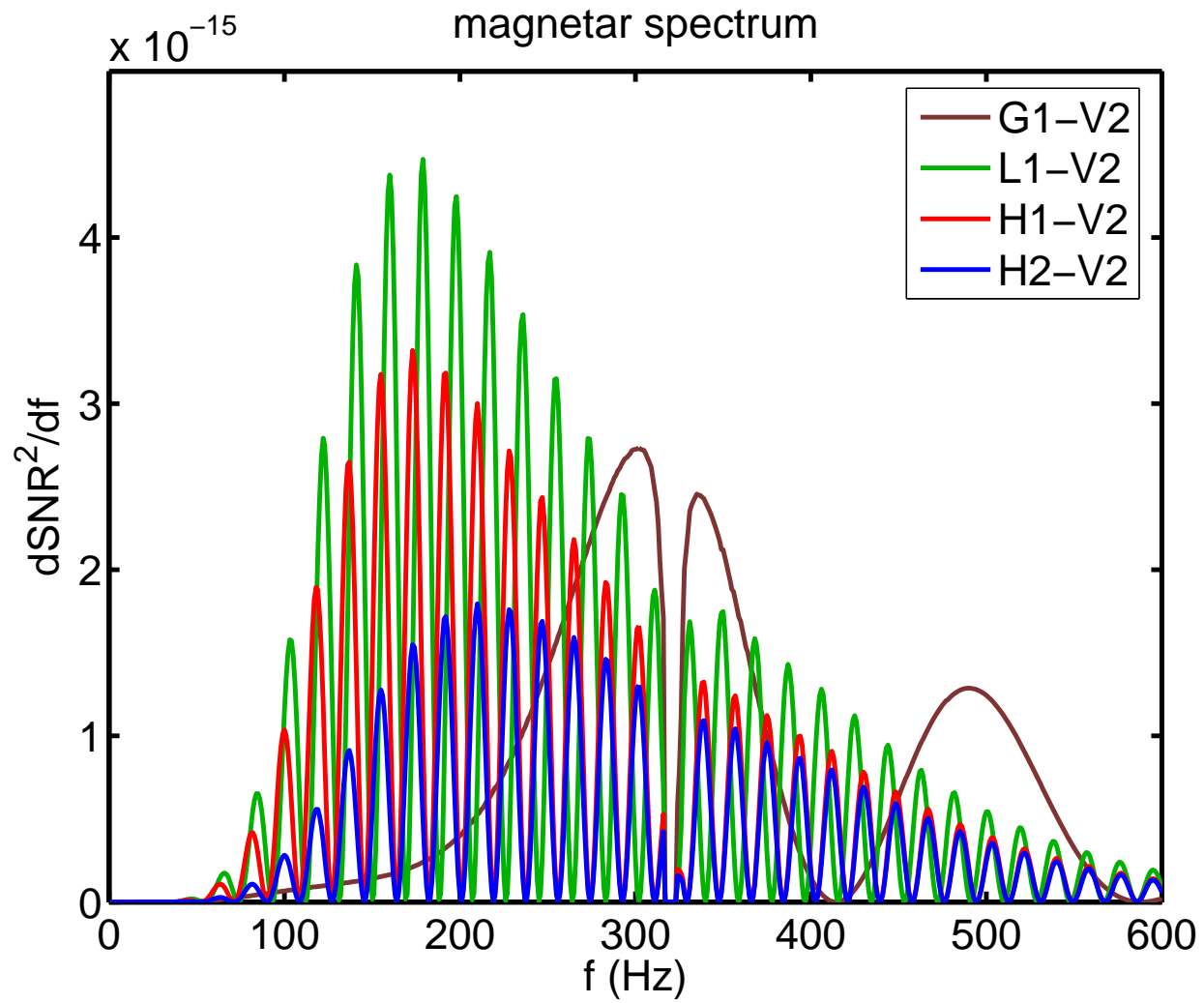
Upper limit evaluated over a 100Hz band, as function of central frequency of the band, for constant Ω_{gw} spectrum.

Project 1b simulated data – results

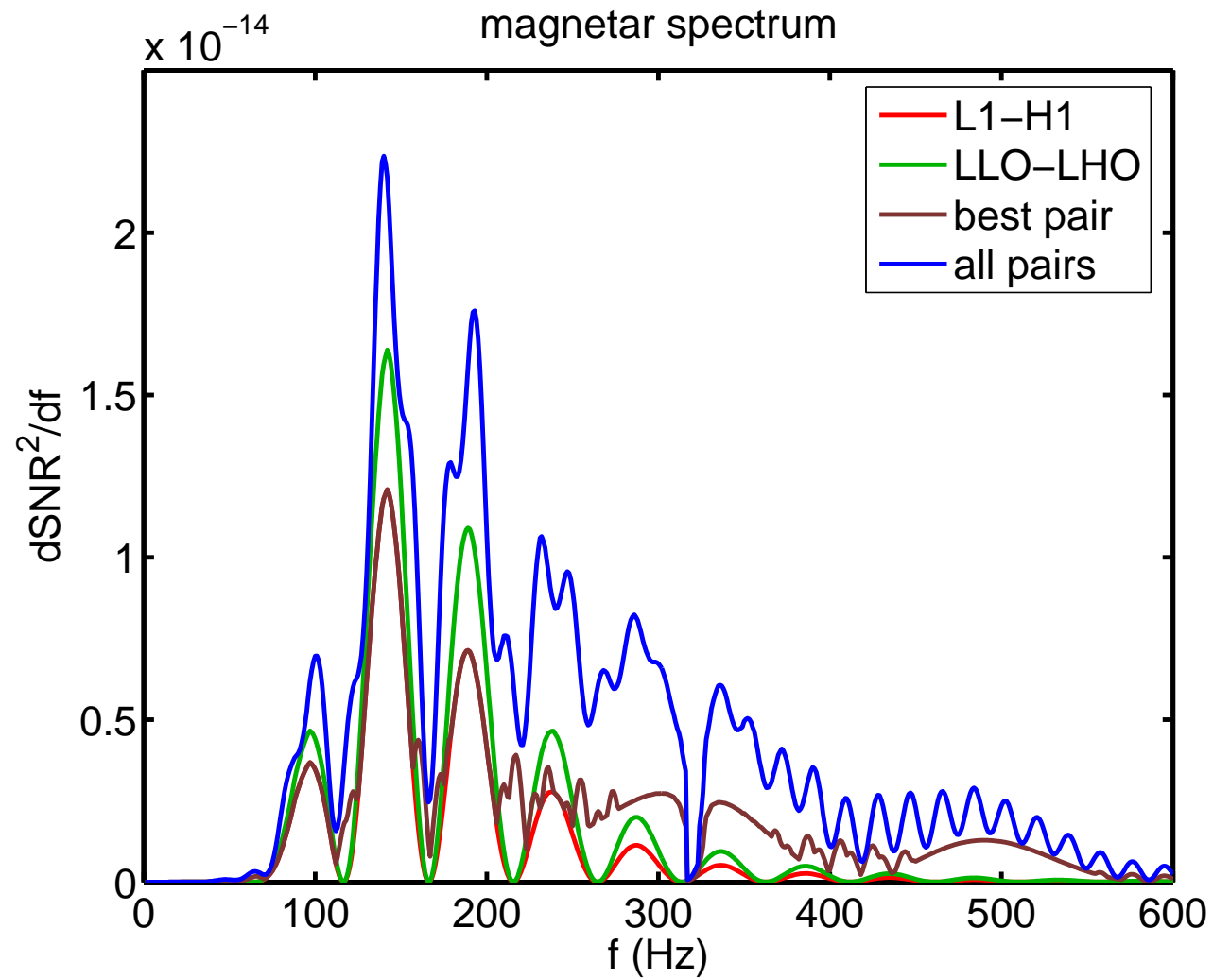
- 24 hours simulated data H1, H2, L1, V2
- analysis carried out for all pairs of detectors (except H1-H2)
- injected magnetar signal – filter $\propto f^4$



Magnetar spectrum, injected into project1b data.

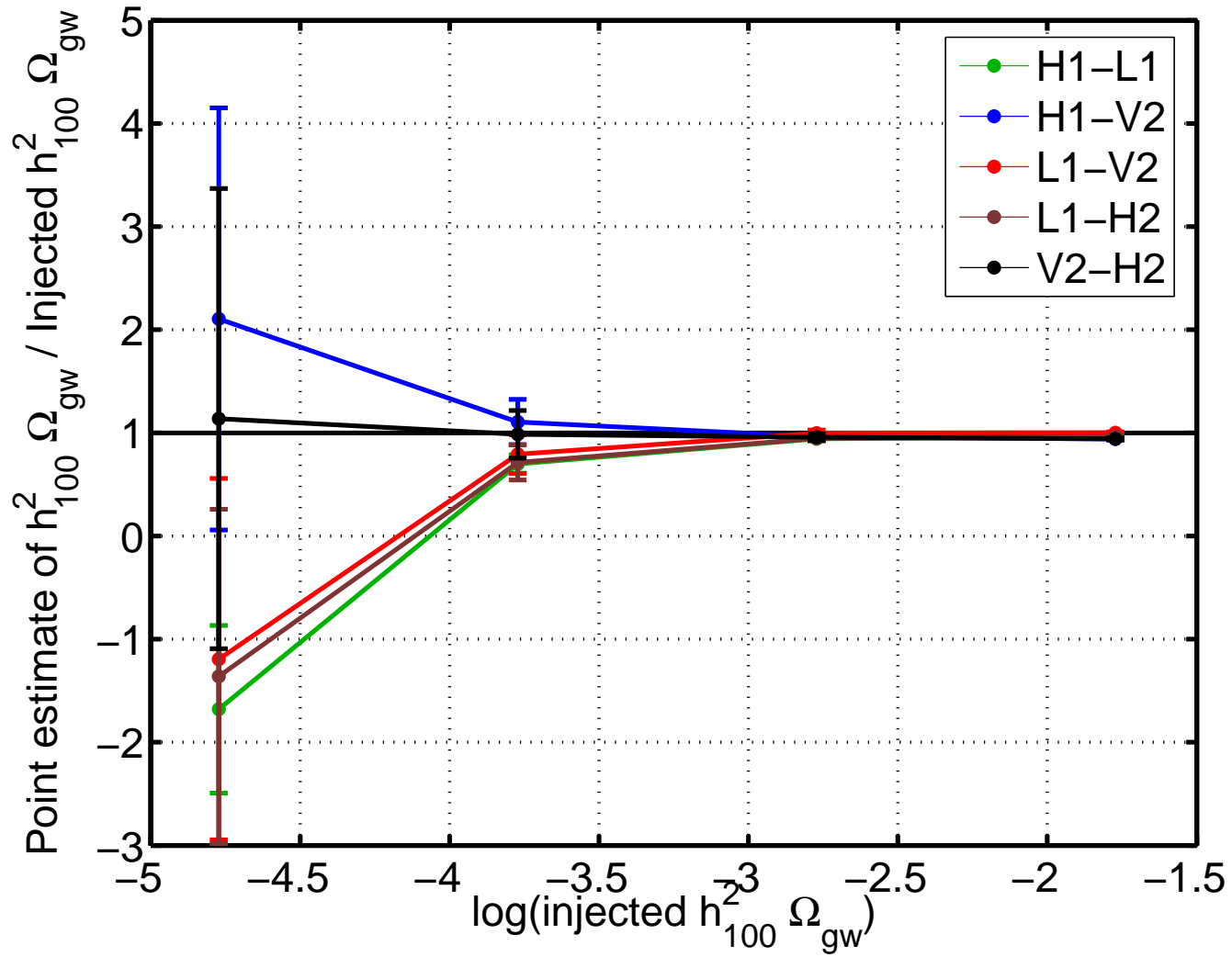


Sensitivity integrand for a magnetar signal.

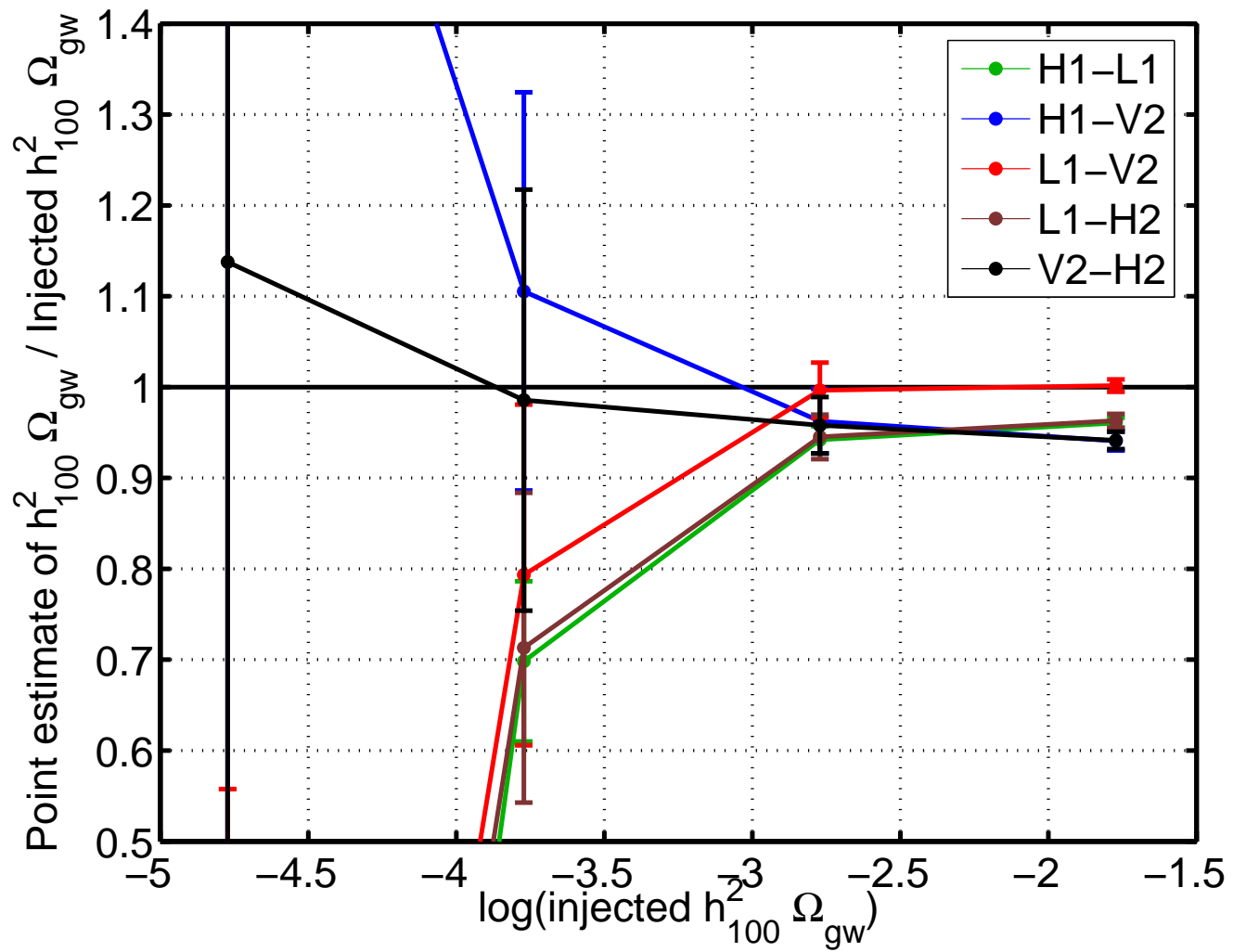


Project 1b simulated data – results

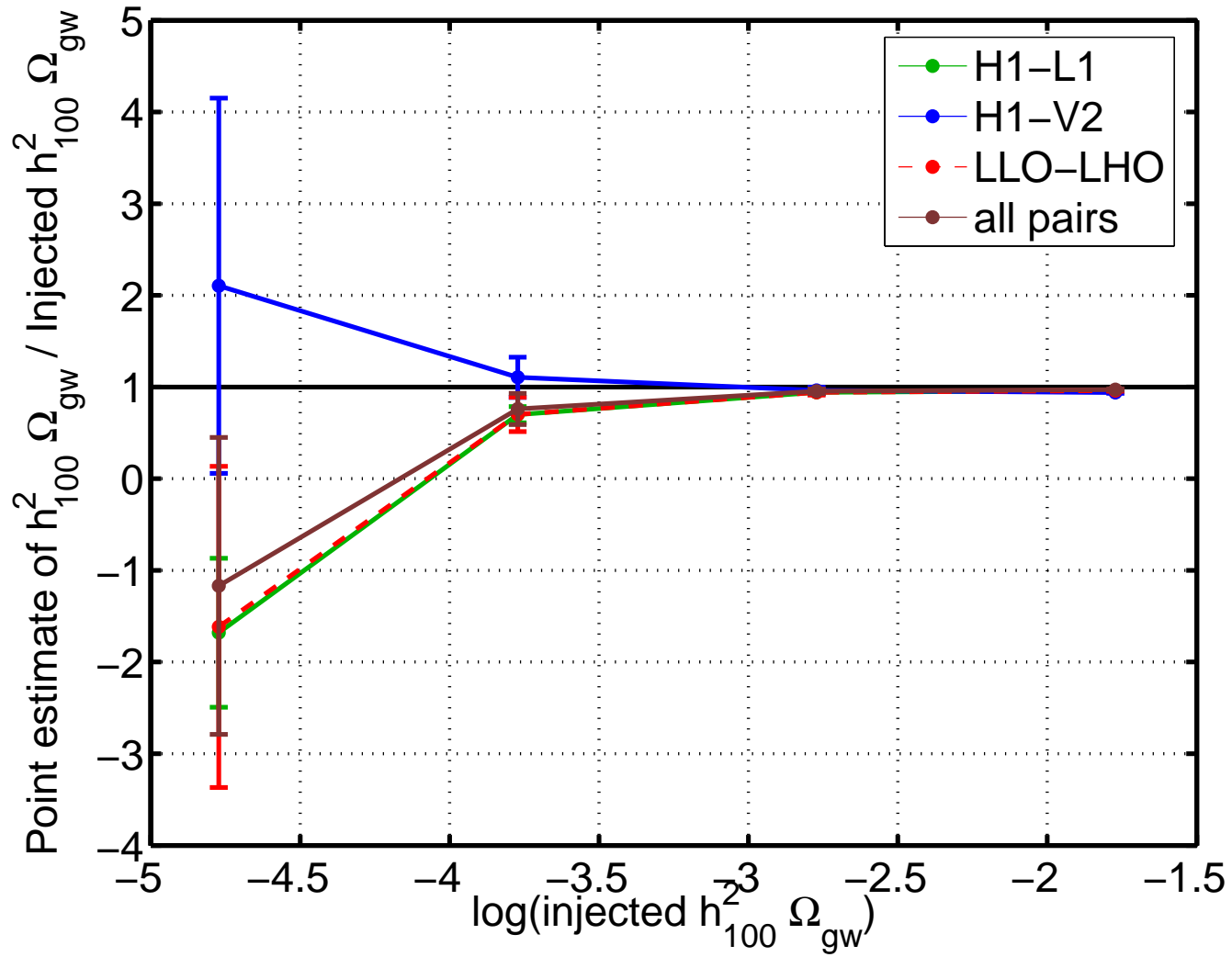
SNR	Injected value	H1-L1		H1-V2	
		point estimate	error bar	point estimate	error bar
1	1.69×10^{-5}	-2.84×10^{-5}	1.37×10^{-5}	3.56×10^{-5}	3.46×10^{-5}
10	1.69×10^{-4}	1.18×10^{-4}	1.49×10^{-5}	1.87×10^{-4}	3.70×10^{-5}
100	1.69×10^{-3}	1.59×10^{-3}	2.53×10^{-5}	1.63×10^{-3}	5.99×10^{-5}
1000	1.69×10^{-2}	1.62×10^{-2}	9.76×10^{-5}	1.59×10^{-2}	1.75×10^{-4}
SNR	Injected value	LHO-LLO		combined	
		point estimate	error bar	point estimate	error bar
1	1.69×10^{-5}	-2.73×10^{-5}	1.23×10^{-5}	-1.98×10^{-5}	1.17×10^{-5}
10	1.69×10^{-4}	1.19×10^{-4}	1.32×10^{-5}	1.29×10^{-4}	1.27×10^{-5}
100	1.69×10^{-3}	1.59×10^{-3}	2.16×10^{-5}	1.61×10^{-3}	2.12×10^{-5}
1000	1.69×10^{-2}	1.62×10^{-2}	7.72×10^{-5}	1.64×10^{-2}	6.86×10^{-5}



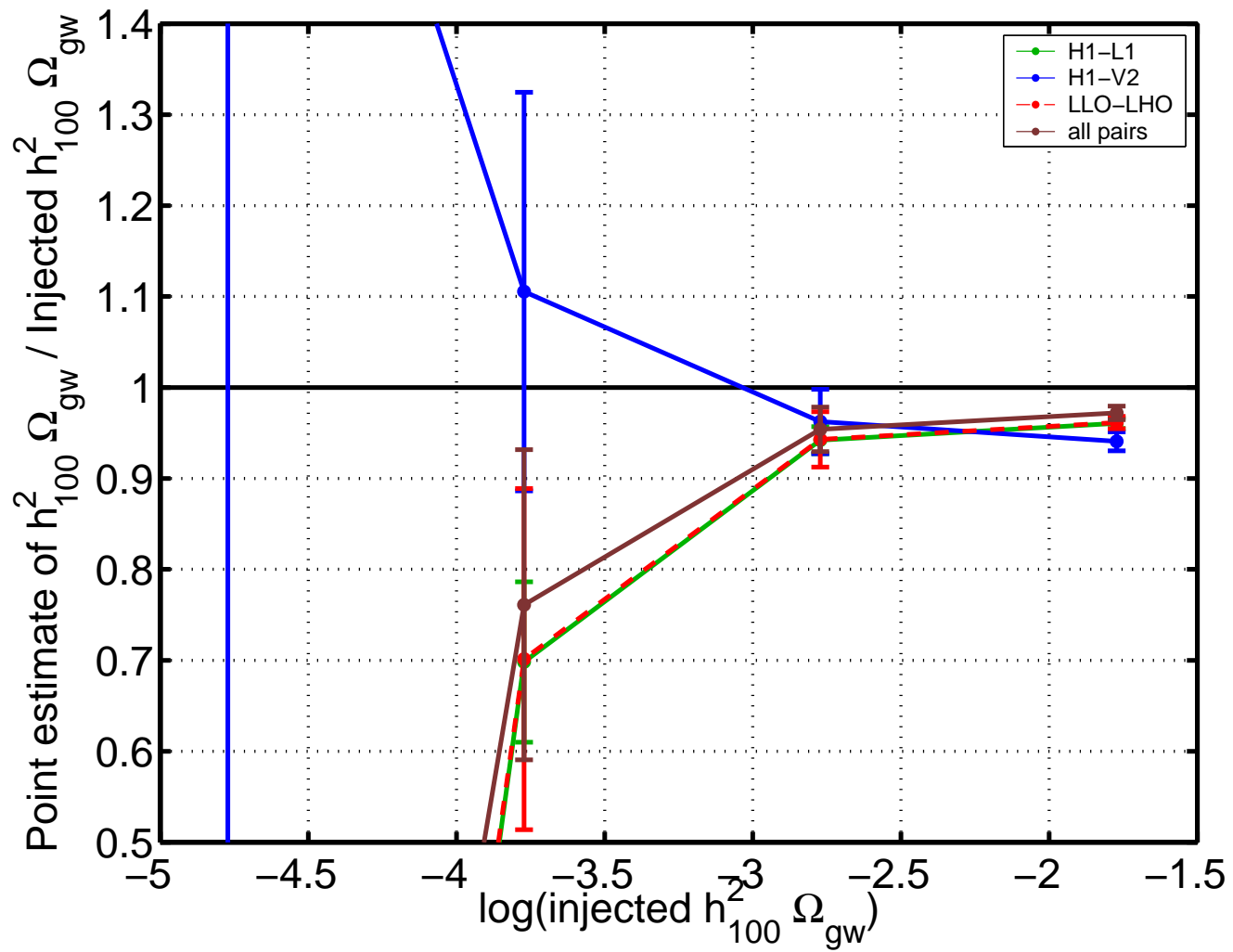
Project1b results



Project1b results



Project1b results



Project1b results

Summary

- VIRGO/LSC collaboration can improve the sensitivity and robustness of the network
- We are testing the data analysis procedures that will be applied during the real analysis
- Targeted searches
- Scientific data exchange