First results of scientific performance for the design of ESA space based gravitational wave detector (*ELISA*)

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Abstract.
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1. Instrument configurations : noises, orbits and sensitivity

('section captain' : Antoine Petiteau)

We show results for detectors LISA, C4, C5, C2, C3 and C5, assuming a single Michelson interferometer.

Configuration	C5	C4	C3	C2	C1	LISA
Armlength ($\times 10^9$ m)	2	3	1	1	1	5
Orbits	analytic	analytic	analytic	10^o	closest	20^o
Diameter telescope (m)	0.28	0.25	0.25	0.4	0.4	0.4
Laser power (W)	2	0.7	0.7	2	0.05	2
Acceleration system	DRS	DRS	DRS	DRS	$\text{LPF}_{\text{(margin 2 times)}}$	DRS
Acceleration ($10^{-48} f^{-2}\text{Hz}^{-1}$)	6	6	6	6	$8.2\left(1+\frac{0.00018}{f^2}\right)^2$	-
Shot noise ($10^{-38} f^{2}\text{Hz}^{-1}$)	2.05	20.07	2.31	4.92	$0.06_{\text{(bad laser noise power)}}$	-
Fixed noise ($10^{-38} f^{2}\text{Hz}^{-1}$)	2.81	2.81	2.81	2.81	2.81	-

Table 1. Summary of configuration. Noise are given in $\delta\nu/\nu$ unit

2. Galactic binaries : confusion noise and galactic binaries

('section captain' : Tyson Littenberg)

3. Massive Black Hole binaries

('section captain' : Alberto Sesana)

3.1. Parameter estimation

('section captains' : Neil Cornish & Emanuele Berti)

3.1.1. PhenomC results from AEI (S. Babak, A. Petiteau, A. Sesana, F. Ohme, E. Robinson) We use PhenomC waveforms described in [1]. Waveforms include merger and ringdown and assume aligned spins. Given the latter assumption, we apply them to efficient accretion models (SE, LE) only. Moreover, since the waveforms can not handle too extreme cases, we lower the maximal spin limit to 0.98, and considered only sources with mass ratio larger than $q = M_2/M_1 = 0.05$, thus loosing 10-20% of the sources (depending on the MBH population model) in our analysis.

We consider a threshold SNR= 6 for detection, and SNR= 10 for trustworthy parameter estimations. We show results for detectors LISA, C4, C5, C2, C3 and C5, assuming a single Michelson interferometer.

Figures 1 and 2 show histograms of parameter estimation accuracy for the ten realizations of model SE and LE respectively with LISA, C2, C4 and C5; only sources with SNR> 10 are included.

The median parameter estimation accuracy with LISA, C2, C4 and C5 as a function of redshift is shown in figures 5-to-6.

The median source SNR with LISA, C2, C4 and C5 as a function of redshift is shown in figures 5-to-6.

For comparison we also add results comparing about C1, C2 and LISA and SNR for C3 :

Figures 7, 8, 9 and 10 show the performances of LISA, C2 and C1 respectively, assuming the SE MBH binary population model.

Figures 11 and 12 show histograms of parameter estimation accuracy for the ten realizations of model SE and LE respectively; only sources with SNR> 10 are included.

The median source SNR and parameter estimation accuracy as a function of redshift is shown in figures 14-to-16.

3.2. Model selection

('section captain' : Alberto Sesana)

4. EMRIs

('section captains' : Jon Gair & Ed Porter)

[1] L. Santamaria, F. Ohme, P. Ajith, B. Bruegmann, N. Dorband, M. Hannam, S. Husa, P. Moesta, D. Pollney, C. Reisswig, E. L. Robinson, J. Seiler and B. Krishnan, Phys. Rev. D **82**, 064016 (2010)

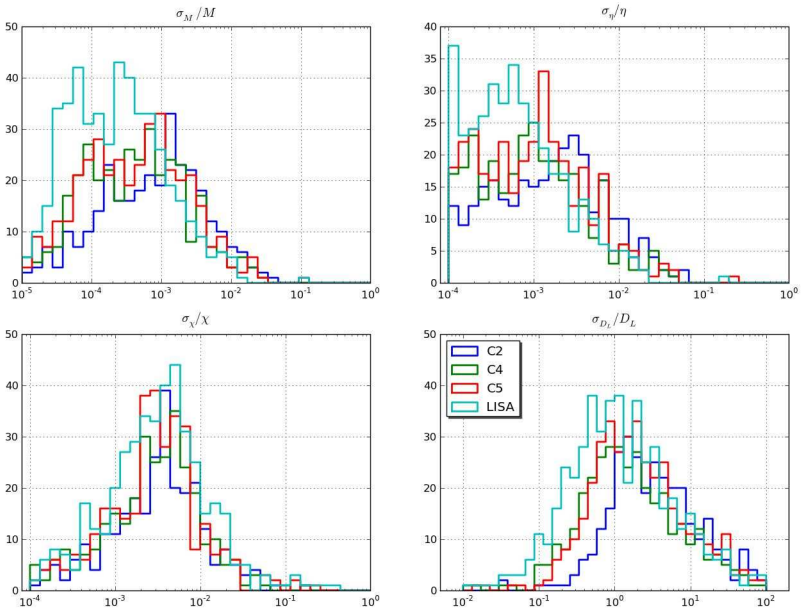

Figure 1. 1-σ errors on source parameters: redshifted mass (upper left); symmetric mass ratio (upper right); spin parameter (lower left); luminosity distance (lower right). Histograms collect all the events in the SE catalogue (small seed), with SNR$>$ 10. Ligth blue histograms are for LISA, blue histograms are for C2, green histograms are for C4 and red histograms are for C5.

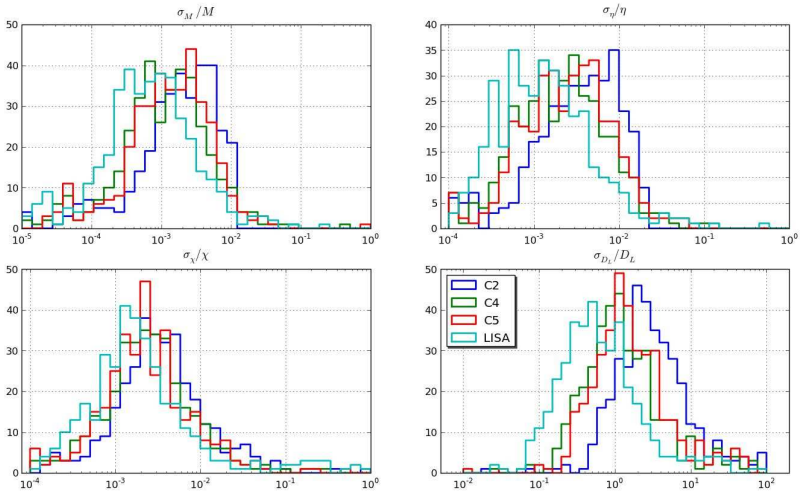

Figure 2. 1-σ errors on source parameters. Similar as 1 with LE catalogue (large seed).

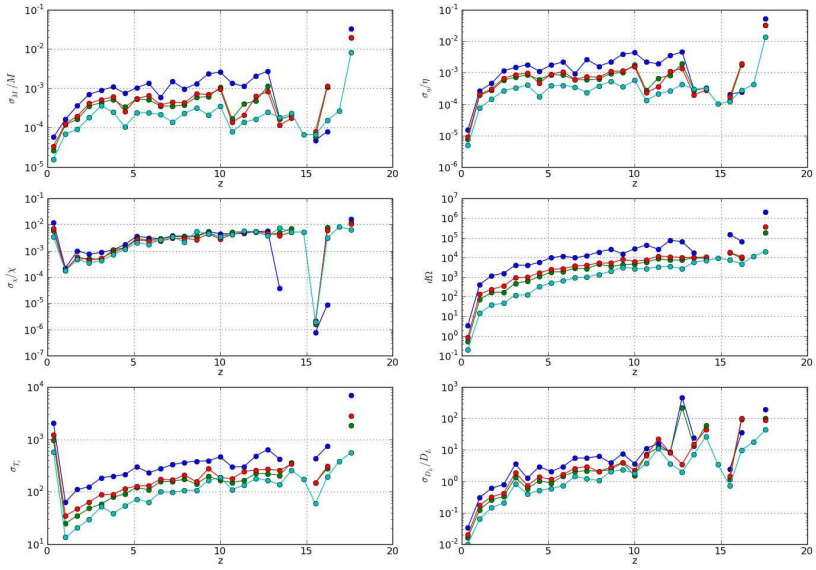

Figure 3. Median 1-σ errors on the source parameters as a function of z: redshifted mass (upper left); symmetric mass ratio (upper right); spin parameter (middle left); sky location in deg^2 (middle right); coalescence time in seconds (lower left); luminosity distance (lower right). Colorstyle as in figure 1 : ligth blue histograms are for LISA, blue histograms are for C2, green histograms are for C4 and red histograms are for C5. Model SE (small seeds) is assumed.

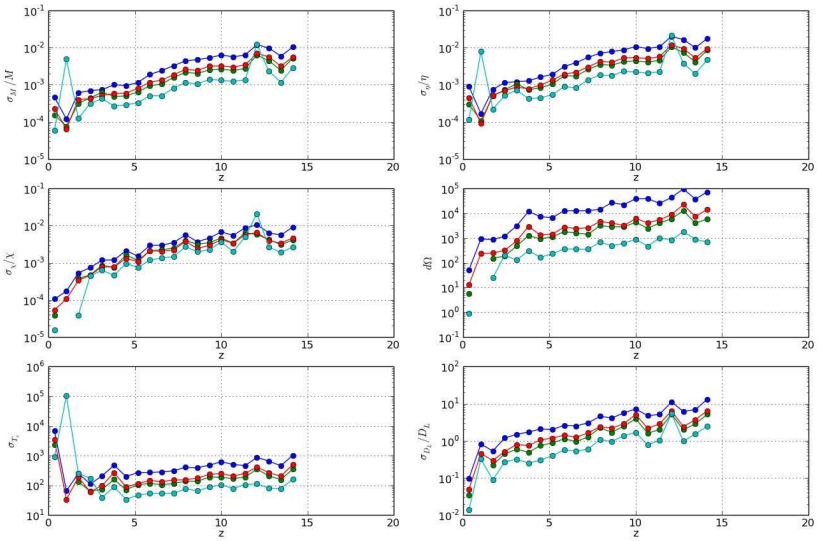

Figure 4. Same as figure 3 but for the LE (large seed) catalogue.

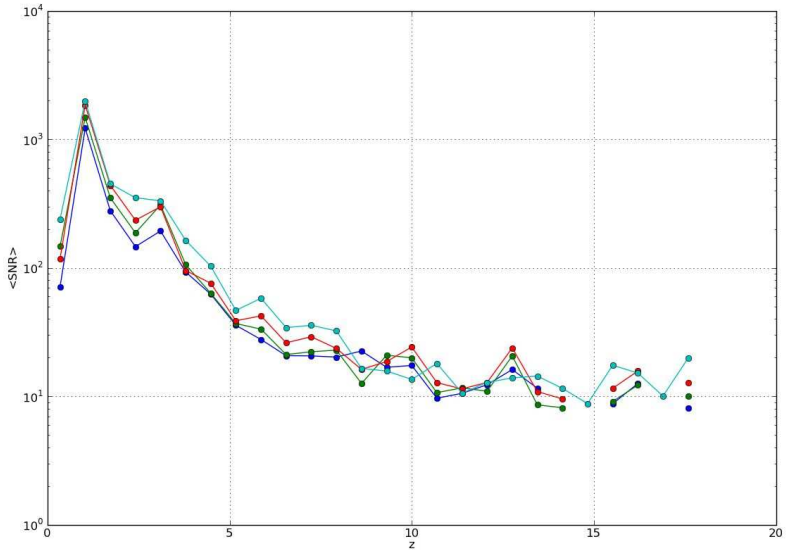

Figure 5. Median SNR s as a function of z. Colorstyle as in figure 1 : ligth blue histograms are for LISA, blue histograms are for C2, green histograms are for C4 and red histograms are for C5. Model SE (small seeds) is assumed.

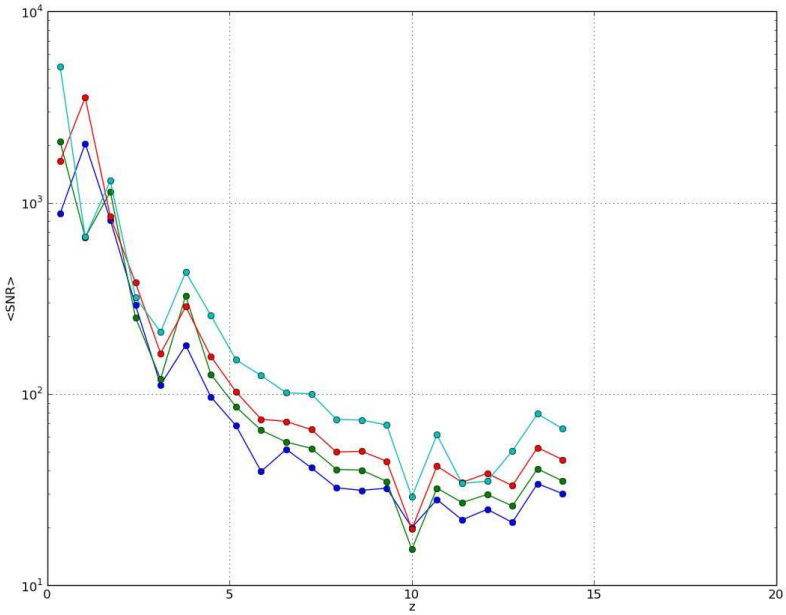

Figure 6. Same as figure 5 but for the LE (large seed) catalogue.

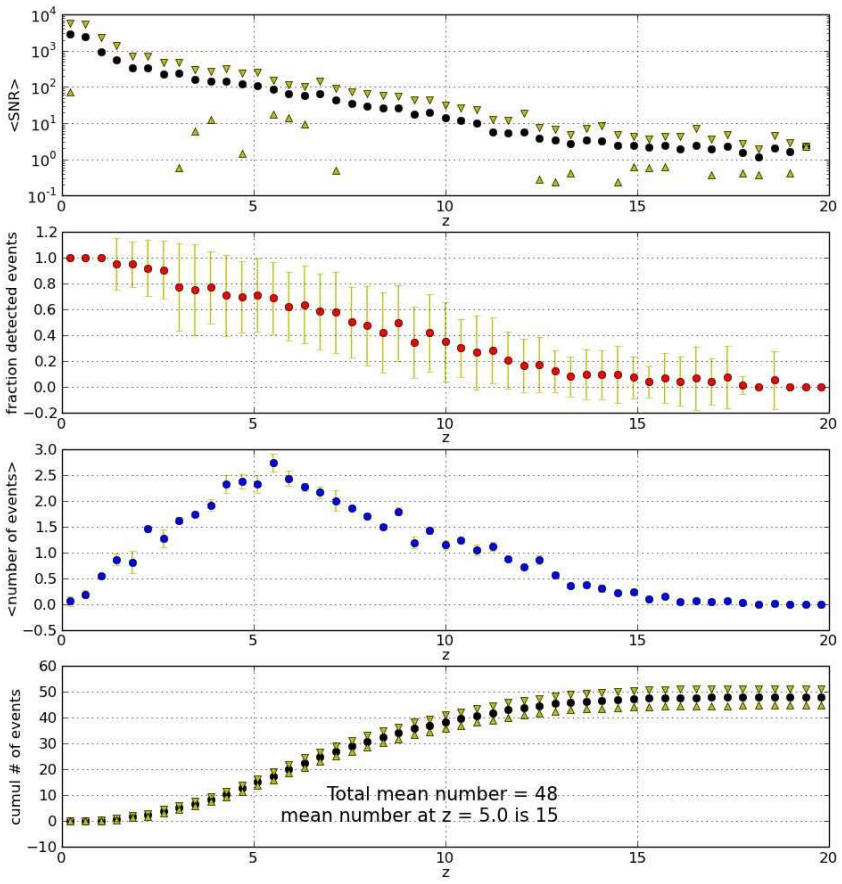

Figure 7. LISA performances as a function of redshift. From the top to the bottom we plot the average source SNR, the fraction of detectable sources (SNR> 6), the mean number of detected sources, and the cumulative number of detected sources. Error bars are standard deviations; SE population model is assumed.

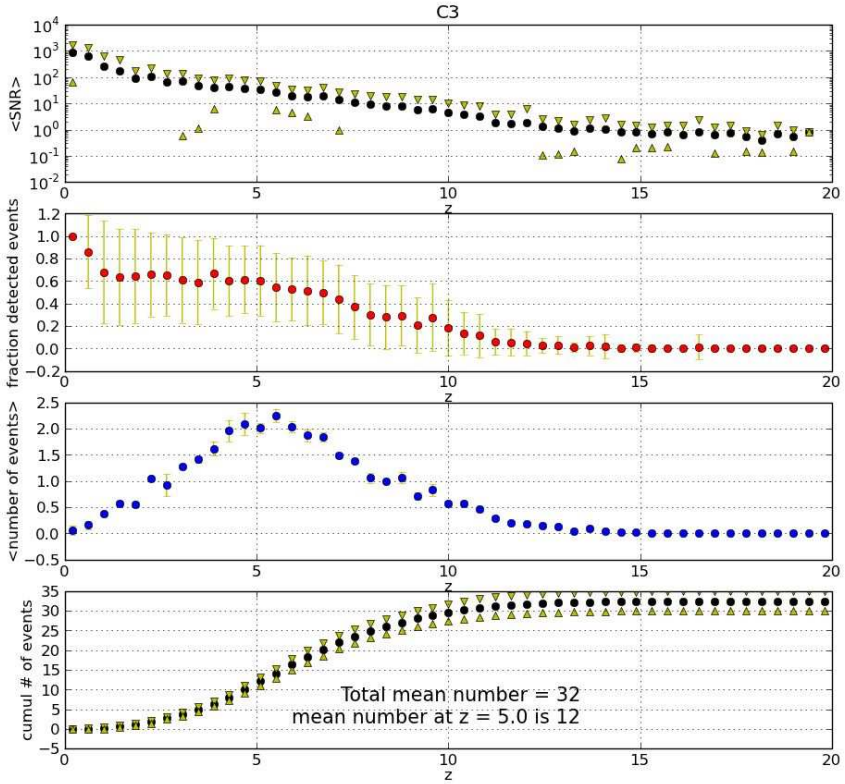

Figure 8. Same as figure 7 but for C3.

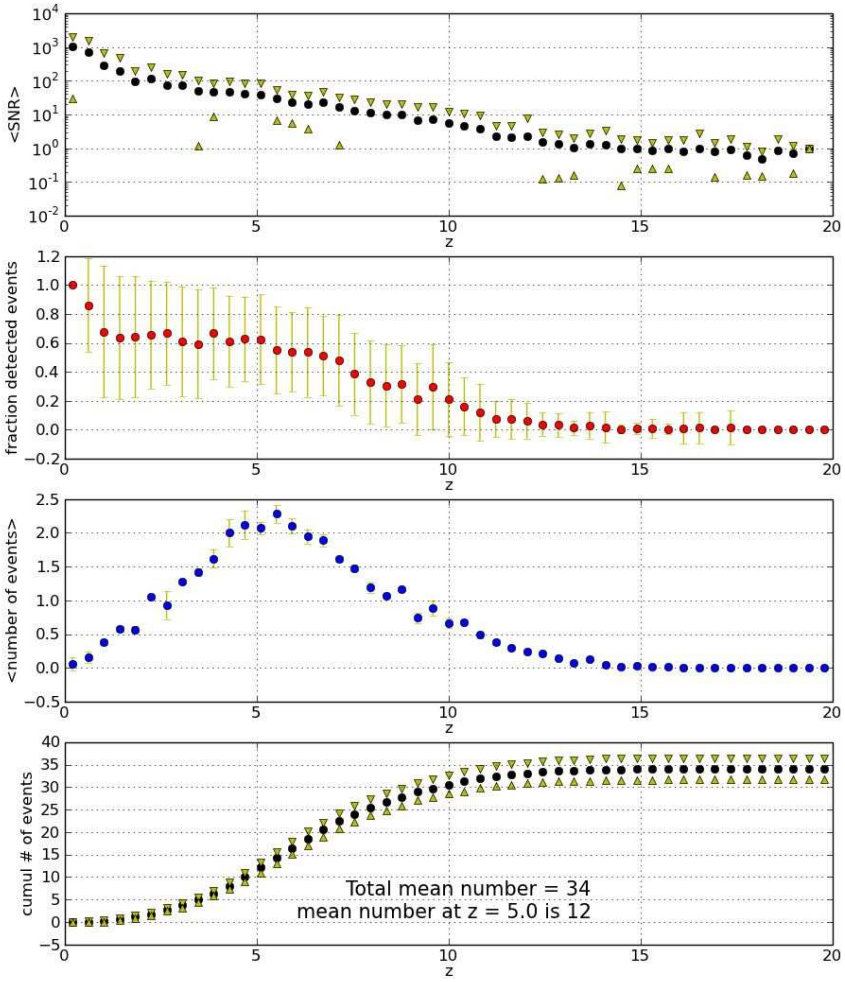

Figure 9. Same as figure 7 but for C2.

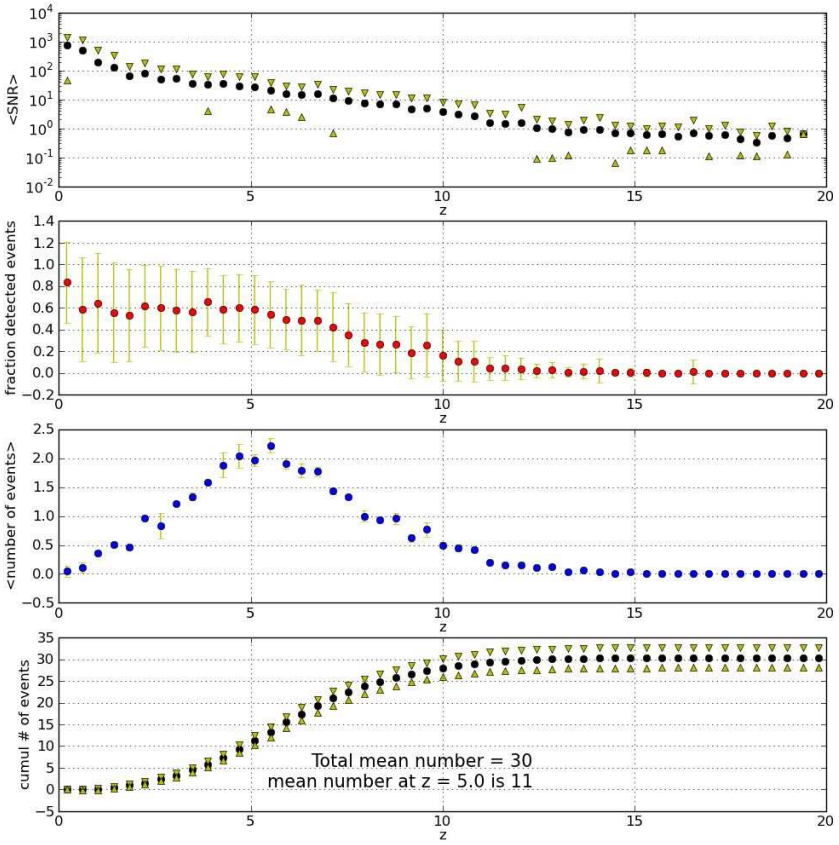

Figure 10. Same as figure 7 but for C1.

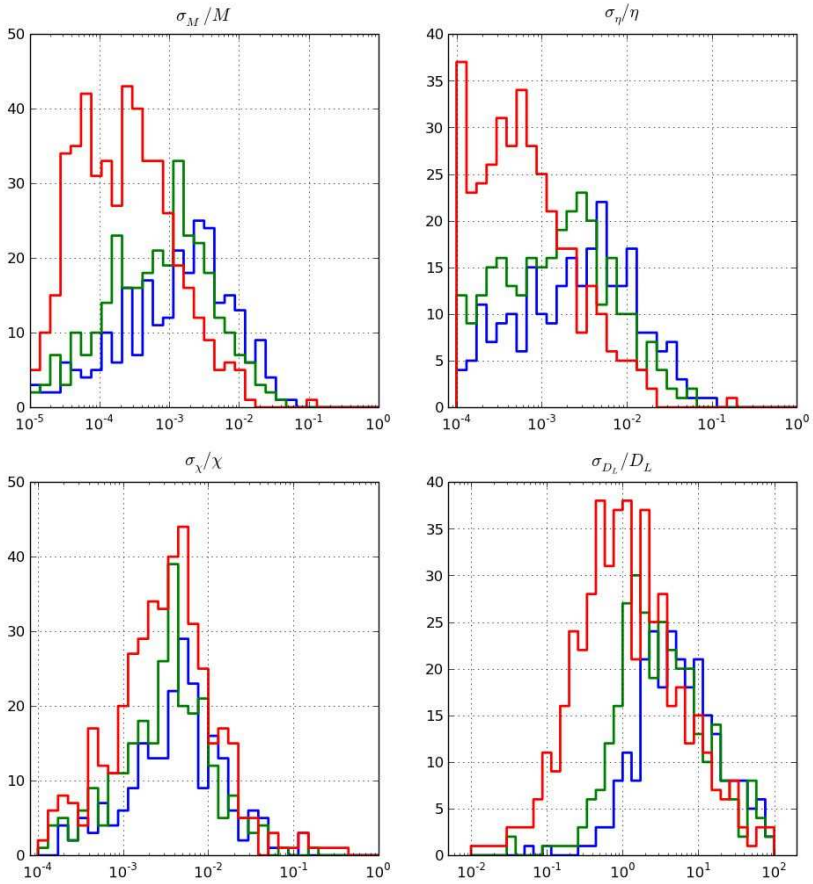

Figure 11. 1-σ errors on source parameters: redshifted mass (upper left); symmetric mass ratio (upper right); spin parameter (lower left); luminosity distance (lower right). Histograms collect all the events in the SE catalogue, with SNR$>$ 10. Red histograms are for LISA, green histograms are for C2 and blue histograms are for C1.

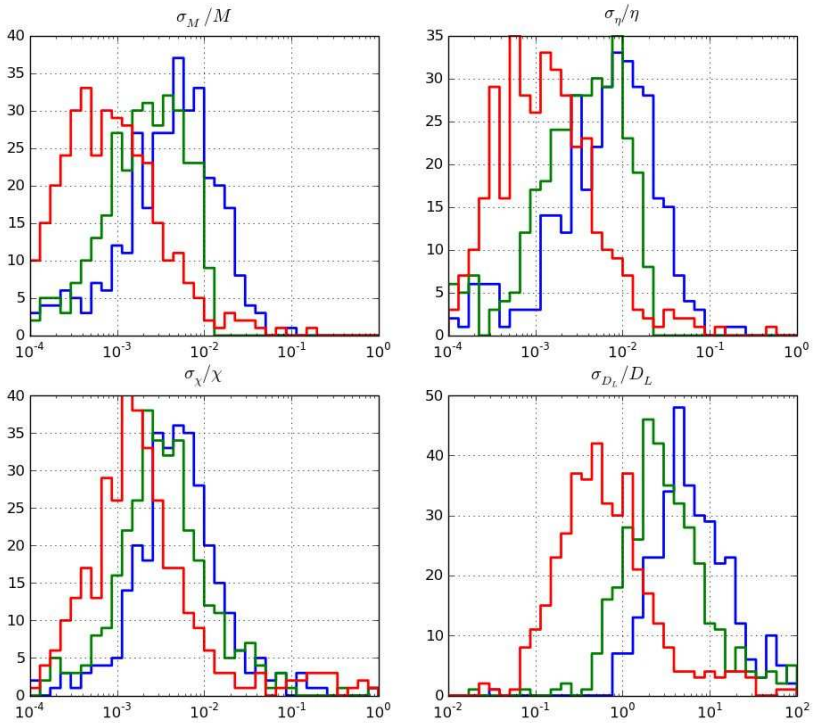

Figure 12. Same as figure 11 but for the LE catalogue.

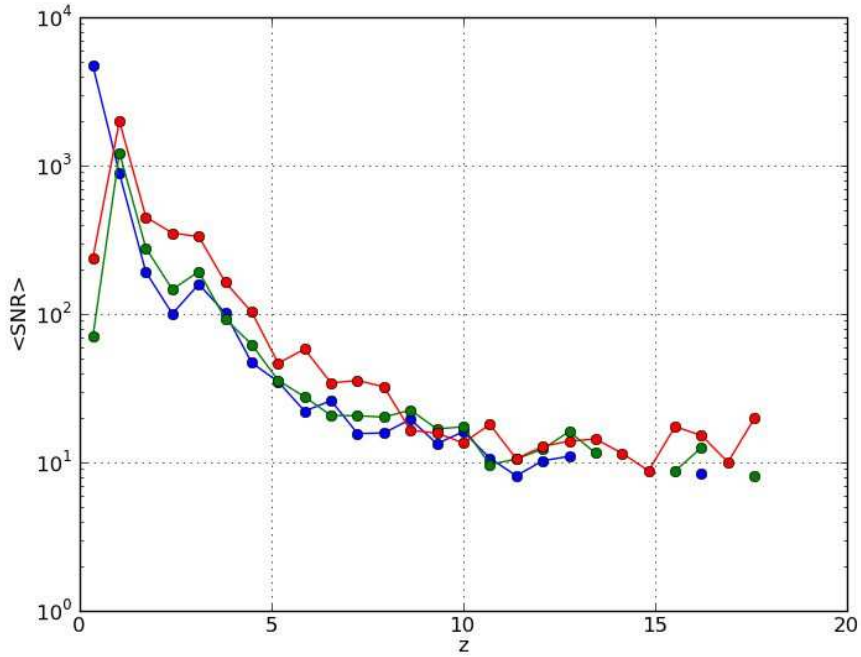

Figure 13. Median source SNR as a function of z. Colorstyle as in figure 11. Model SE is assumed.

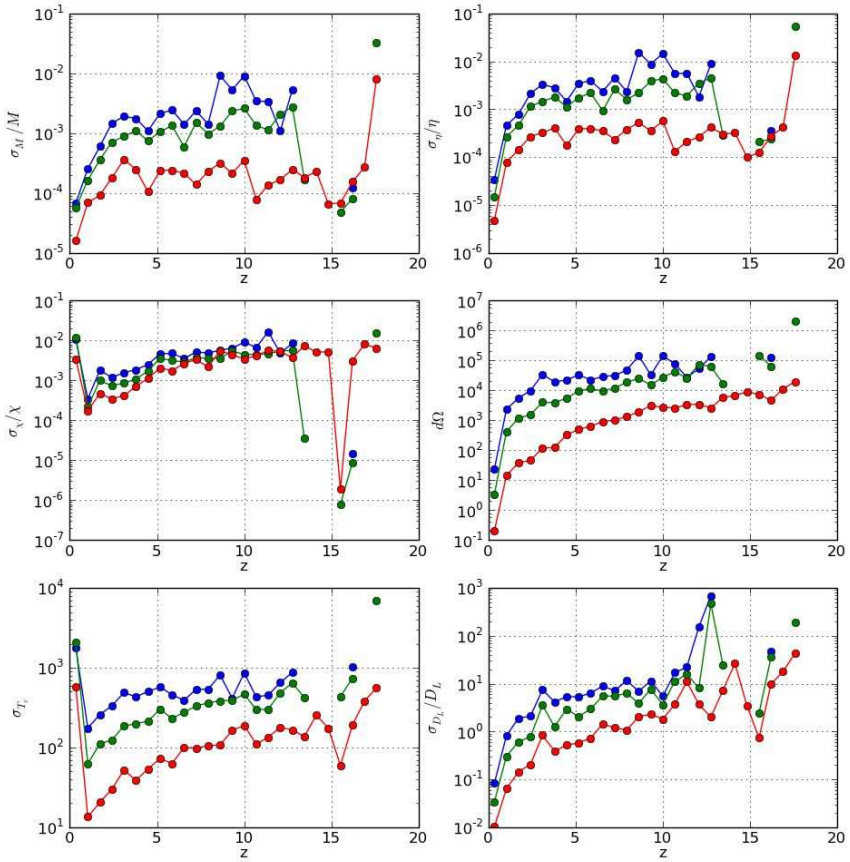

Figure 14. Median 1-σ errors on the source parameters as a function of z: redshifted mass (upper left); symmetric mass ratio (upper right); spin parameter (middle left); sky location in deg^2 (middle right); coalescence time in seconds (lower left); luminosity distance (lower right). Colorstyle as in figure **??**. Model SE is assumed.

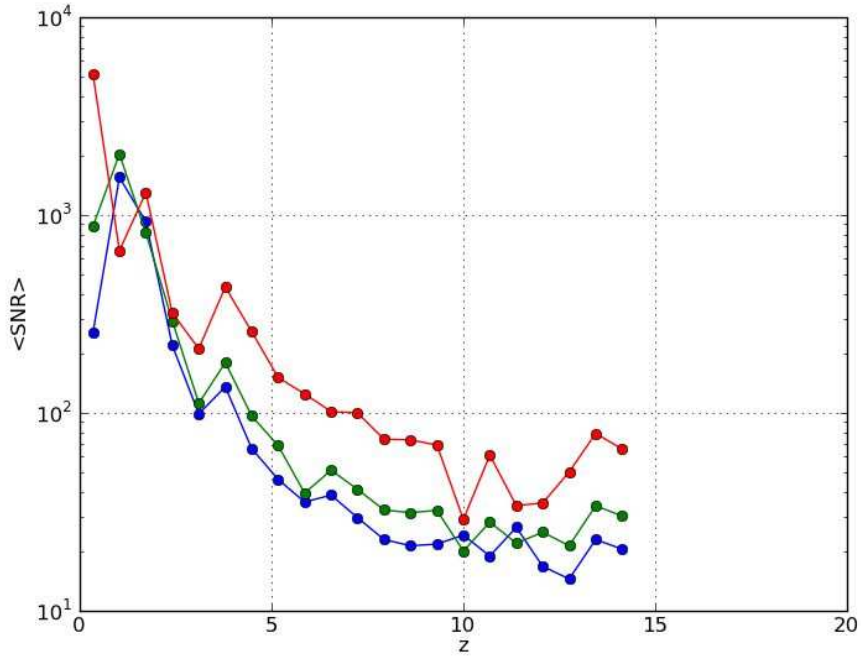

Figure 15. Same as figure 14 but for the LE catalogue.

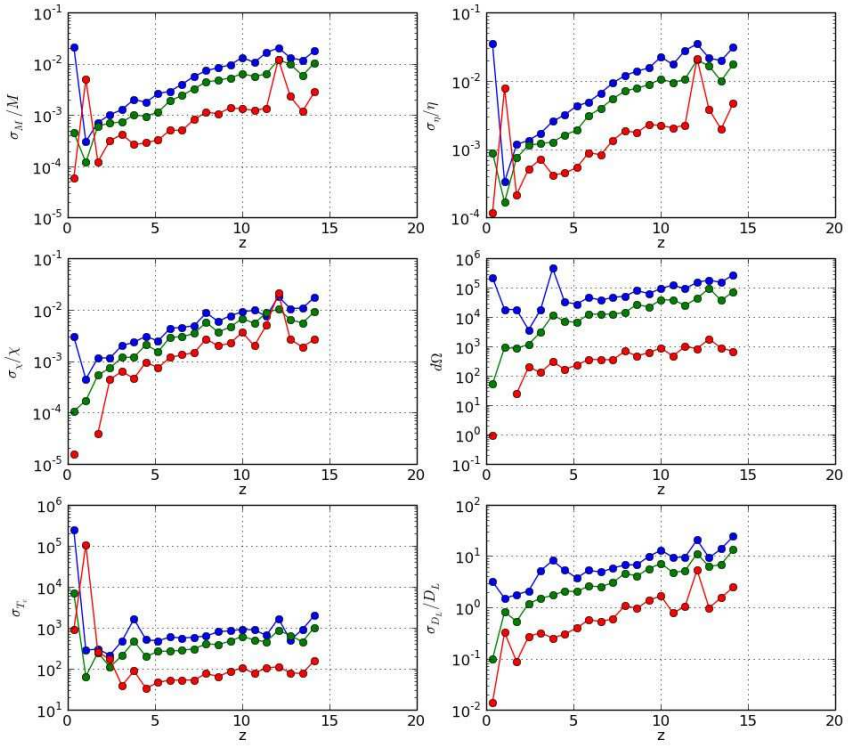

Figure 16. Same as figure 14 but for the LE catalogue.