Challenge 3 Specification

MLDC taskforce

Dec 6, 2007

3.1: Galaxy with chirping binaries

A two-year dataset (2^{22} samples with 15 s sampling time) with signals from $\sim 3 \times 10^7$ Galactic binaries.

Binaries are drawn from a randomized Nelemans population [**Neil: provide ref., description**], and orbital frequency may be increasing or decreasing depending on whether gravitational radiation or mass transfer is the dominant mechanism. The evolution of frequency is always linear (i.e., $\dot{f}$ is a relevant parameter, but $\ddot{f}$ is not). The set includes also 5–15 [**Shane: provide list**] verification binaries chosen from the original Nelemans population, with randomized extrinsic parameters.

Instrument noise is secondary-only, Gaussian, stationary, and equal on all spacecraft.

3.2: Massive–Black-Hole binaries over Galactic confusion

A two-year dataset (2^{22} samples with 15 s sampling time) with signals from 4–6 (with equal probabilities) spinning MBH binary inspirals.

The spinning-binary signals are modeled as 2PN circular adiabatic inspirals with uncoupled orbital frequency evolution and spin and orbital precession. No higher-PN harmonics are included. [**Neil and Stas: add more detail, link to full descriptive document**] The end of the inspiral is handled with an exponential taper, as in Challenge 2. Masses, SNRs, and times of coalescence are chosen as in Challenge 2; spin amplitudes are drawn uniformly between 0 and maximal, and spin angles are randomized over spheres.

The dataset includes also a Galactic confusion background generated from the same population as Challenge 3.1, by withholding all binaries with individual SNR [**Neil: TDI X? Sky-averaged?**] greater than XX [**Neil?**].

Instrument noise is secondary-only, Gaussian, stationary, and equal on all spacecraft.

3.3.X: EMRIs

Five two-year datasets (2^{22} samples with 15 s sampling time), each with a signal from an "MLDC EMRI", with parameters drawn as in Challenge 1B [**Excerpt MLDC 1B description here.**], but with SNRs uniformly distributed between 10 and 30. The number of eccentric-orbit harmonics does not vary along the evolution (as in Challenge 1B), but is fixed to 4 [**Stas: check**].

Instrument noise is secondary-only, Gaussian, stationary, and equal on all spacecraft.

3.4: Bursts

One "MLDC month"-long dataset (2^{21} samples with 1 s sampling time) with Poisson-distributed cosmic-string–cusp bursts, defined as in the accompanying document [**To be included as a chapter here**]. The Poisson even rate is 5 per "MLDC month". SNRs will be uniformly distributed between 10 and 100. The logarithm of the maximum frequency (see accompanying document) will be uniformly distributed as $\log_1 0 f_{\max} \in [-4, 1.0]$.

Instrument noise is Gaussian and stationary; it includes secondary noise, where the levels of proof-mass and photo-detector noises are randomized independently on each optical bench by a uniform draw in $[-20, +20]\%$ w.r.t. their nominal value; it also includes laser noise, also randomized, with nominal amplitude reduced to $10\times$ the nominal amplitude of secondary noises at 1 mHz [**Michele: check**.] The datasets include the standard X, Y, Z TDI observables *and* the 12 inter-spacecraft and inter-spacecraft raw phase measurements. The datasets will be distributed only as fractional-frequency–fluctuation time series (i.e., as *Synthetic LISA* datasets).

3.5: Stochastic Backgrounds

One "MLDC month"-long dataset (2^{21} samples with 1 s sampling time [**Michele: check**]) with an isotropic stochastic background with $S_h(f) \propto f^{-3}$, realized by placing 192 "pseudosources" (independent pseudorandom processes for both h_+ and $h_\times$, with f^{-3} spectra) at Healpix-distributed points across the sky [**Michele: ref.**]. The level of the background is raised to 3–6 times the secondary noise at the best frequency [**Michele: check**]

The instrument noise and the distributed observables are handled as in Challenge 3.4.