Simulations of the BNS foreground for the ET Mock Data Challenge

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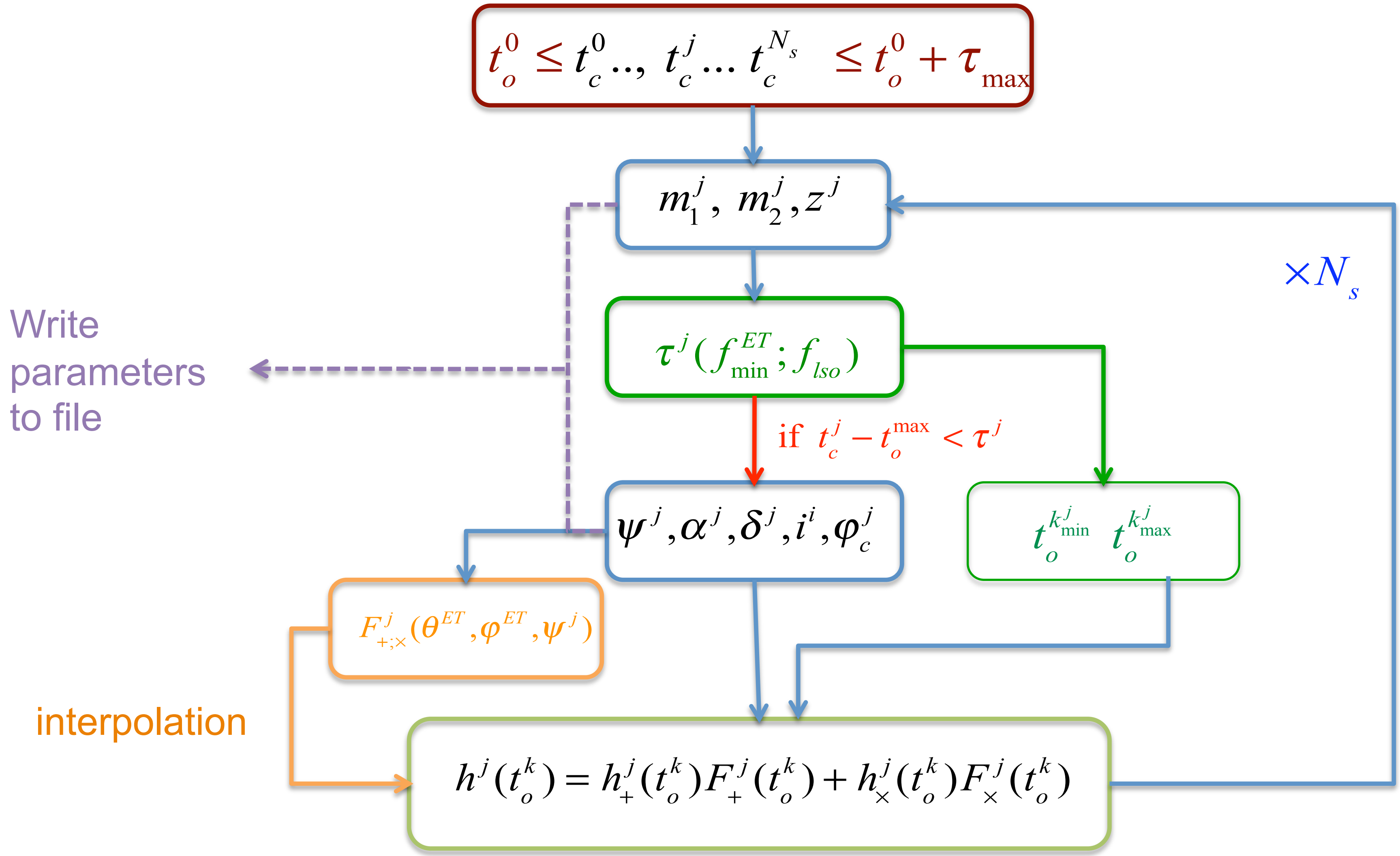
ET telecon 10/02/09

Simulation Code



LALapps Code

- BNSSeries.c in LALApps, package stochastic

-

```
Noa:ETmdc taniaregimbau$ ./BNS -h
Usage: pipeline [options]
Options:
 -h                      print this message
 -v                      display version
 --verbose               verbose mode
 --ascii                 write to ascii files
 --catalog               write source parameters to files
 -s                      seed for coalescence times
 -S                      seed for source parameters
 -j                      job number
 -n                      number of nodes
 -t                      start time of the serie
 -d                      duration of the time serie
 -r                      sampling rate of the time serie
 -p                      time interval between successive coalescences, 13.7 for zmax=6
 -f                      minimal frequency
 -z                      maximal redshift
 -i                      ifo name
 -a                      first arm, 1, 2 or 3
```

Distributions

- **coalescence time** (Poisson process):

$$p(\Delta t) \propto \exp(-\Delta t / \lambda) \text{ with } \lambda = \left[\int_{z_{\min}}^{z_{\max}} \frac{dR_c^o}{dz}(z)\, dz \right]^{-1}$$

- **masses**: gaussian distribution
- **redshift:** $p(z) \propto \dfrac{dR_c^o}{dz}(z)$
- **position in the sky:** uniform distribution
- **polarization:** uniform distribution
- **phase at the last stable orbit:** uniform distribution

Coalescence Rate

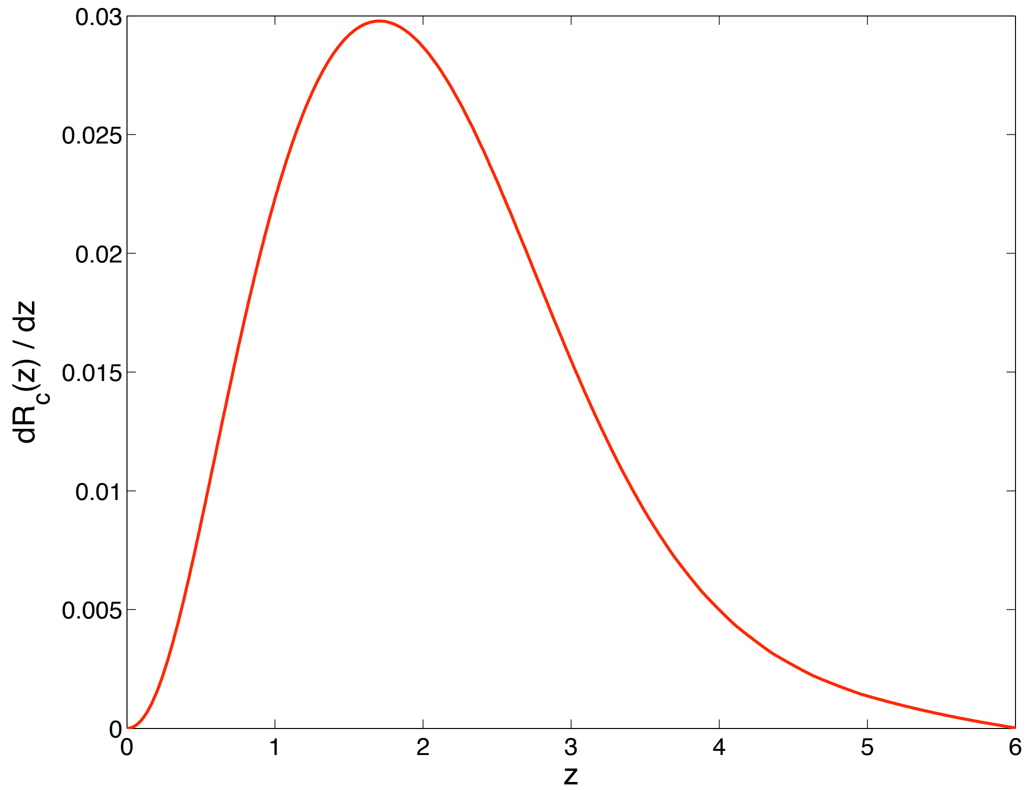
$$\frac{dR_c}{dz}(z) = \dot{\rho}^o(z)\frac{dV}{dz}(z)$$

with $\dot{\rho}_c^o(z) \propto \int \frac{\dot{\rho}_*(z_f)}{1+z_f} P(t_d)\, dt_d$

for:

$$\begin{cases} \dot{\rho}_c^o(0) = 1 \text{ Myr}^{-1}\text{Mpc}^{-3} \\ P(t_d) \propto 1/t_d \text{ with } t_d > 20 \text{ Myr} \\ \text{SFR of Hopkins \& Beacom 2006} \\ H_0 = 0.7,\ \Omega_m = 0.3 \text{ and } \Omega_\Lambda = 0.7 \end{cases}$$

$N =$ 2.3e6 yr^{-1} and λ=13.7 s

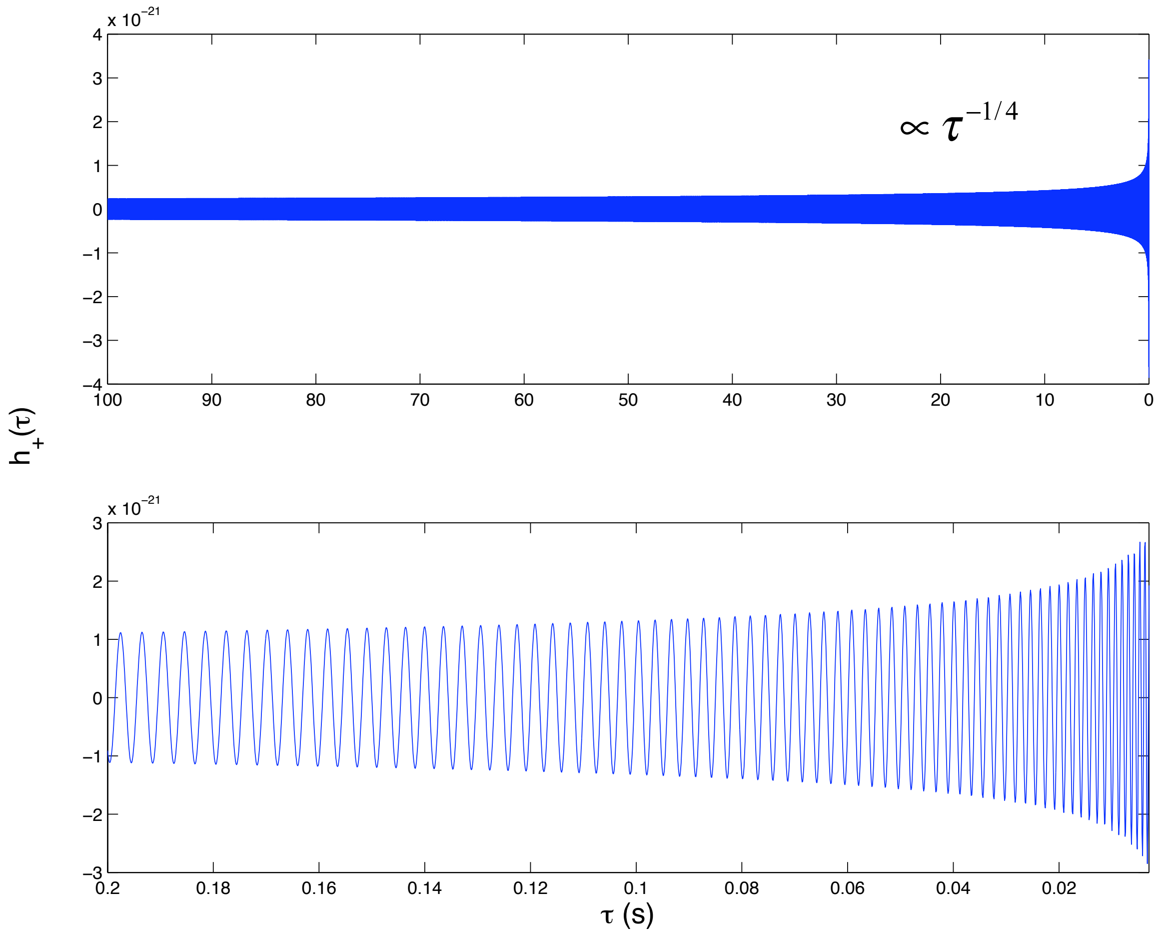


Signal Duration

$$\tau(s) \sim 465245 \frac{M_c}{1.22}(1+z) f_L(\text{Hz})^{-8/3}$$

f_L (Hz)	1.4+1.4	1+1
10	16.7 m	29.3 m
5	1.8 h	3.1 h
3	6.9 h	12.1 h
1	5.4 d	9.4 d

Waveforms



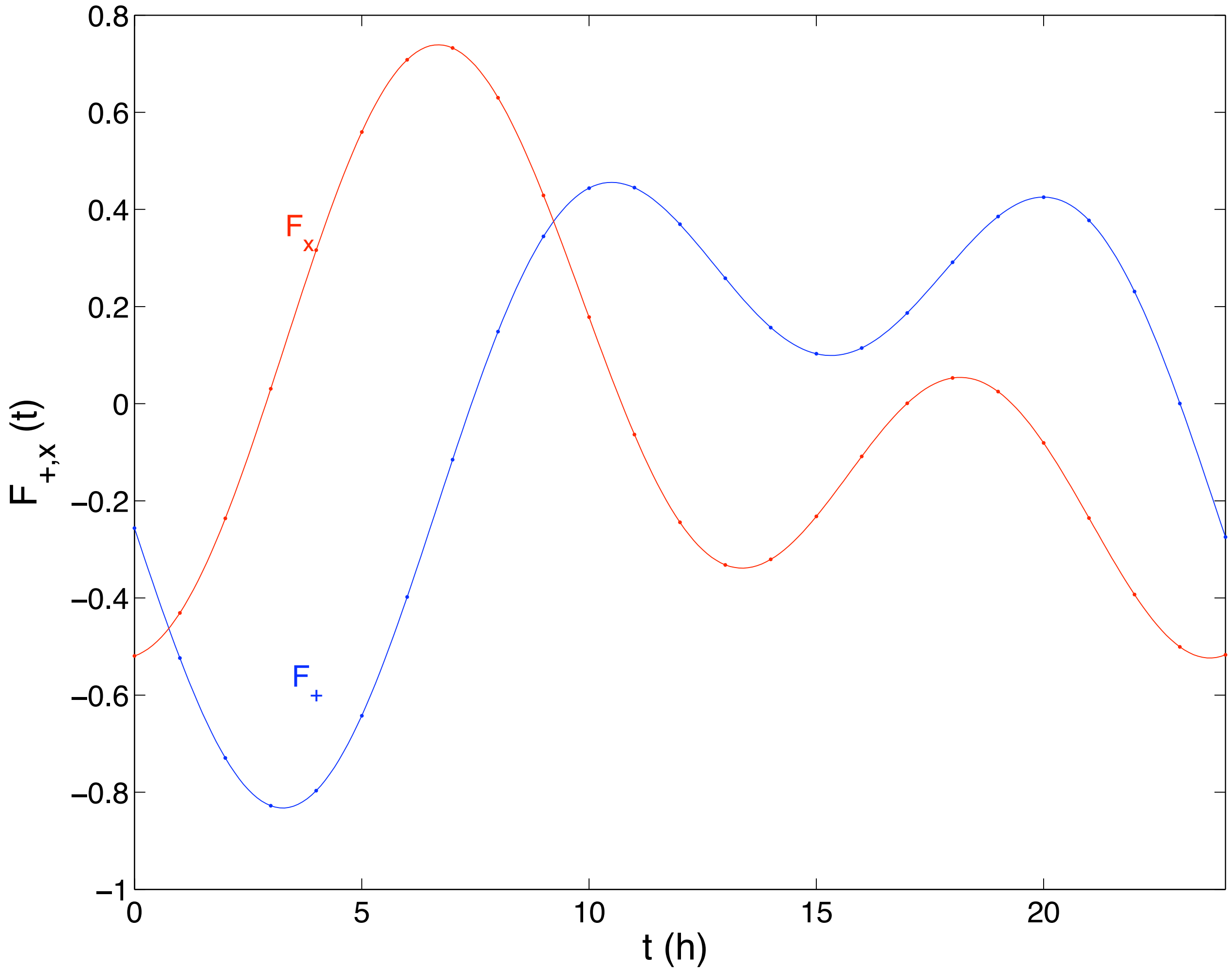
$$\begin{cases} h_+(\tau) = A(1+\cos^2 i)\cos(2\pi f\tau + \varphi_c) \\ h_\times(\tau) = 2A\cos i\cos(2\pi f\tau + \varphi_c) \end{cases}$$

where:

$$A \sim 2.2\times 10^{-21}\frac{f^{2/3}(\mathrm{Hz})}{d_L(z)(\mathrm{Mpc})}\left(\frac{M_c(1+z)}{1.22\mathrm{M}_\odot}\right)^{5/3}$$

$$f(\mathrm{Hz}) = 134\left(\frac{M_c(1+z)}{1.22\mathrm{M}_\odot}\right)^{-5/8}\tau^{-3/8}(\mathrm{s})$$

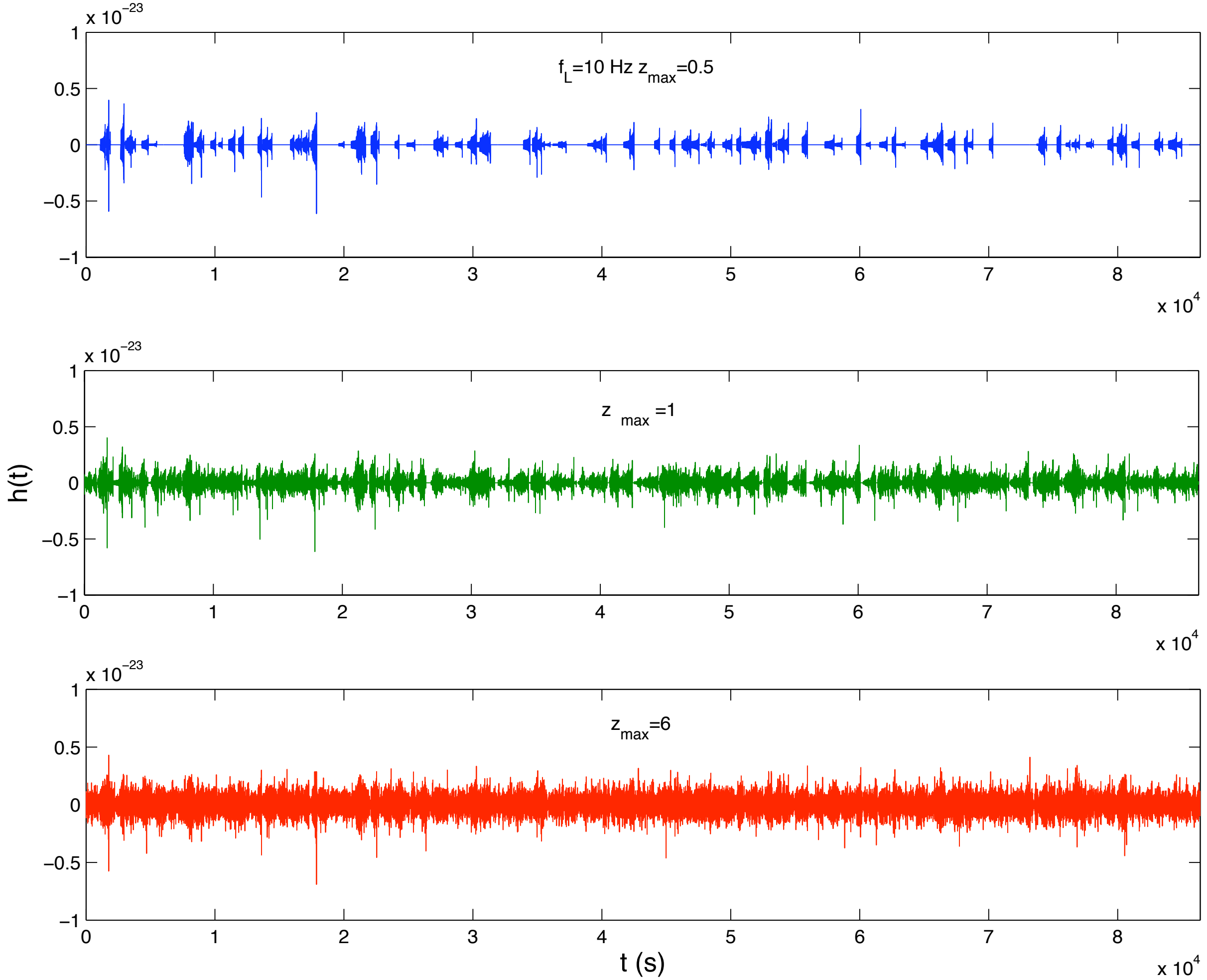
Beam Functions



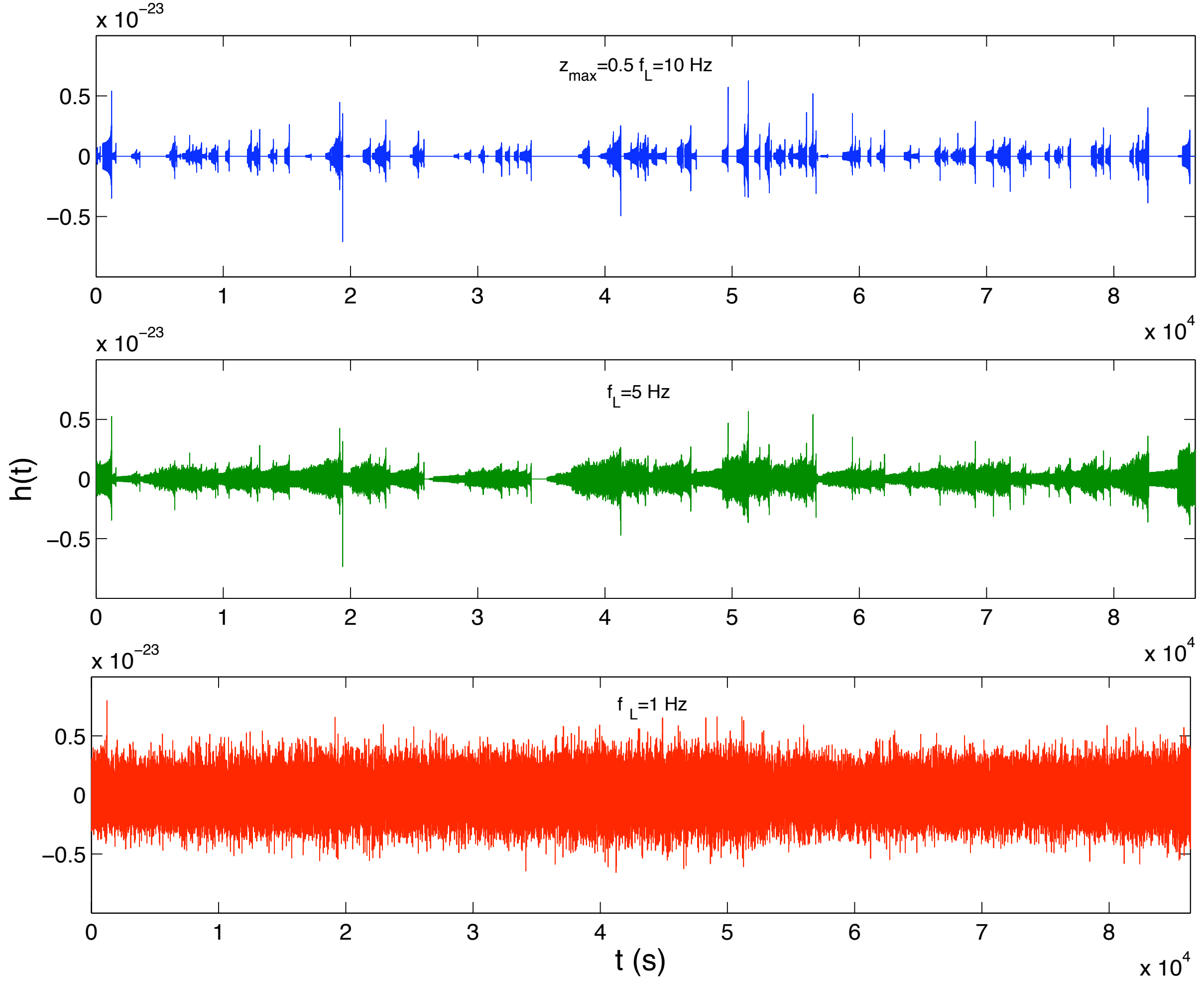
Confusion Horizon: NS-NS

f_L (Hz)	ρ_o	z_* ($\Delta=1$)	z_{**} ($\Delta=10$)
10	0.01	-	-
	0.4	0.8-0.9	-
	1	0.5-0.6	>2
	10	0.2	0.5-0.6
5	0.01	-	-
	0.4	0.4	1-1.2
	1	0.25	0.6-0.7
	10	0.1	0.25
1	0.01	0.3	0.8
	0.4	0.08	0.2
	1	0.06	0.13
	10	0.03	0.06

Evolution with z_{max}



Evolution with f_L



Next steps…

- generate frames down to 10 Hz for the 3 detectors (running on cluster)

- generate frames down to 1-5 Hz for the 3 detectors (running on cluster)

- if too costly, can generate the Gaussian background separately i the frequency domain.

- analyze the data with the LIGO codes

- develop methods to extract individual sources from the confusion background

Gaussian background

no PN corrections, first harmonic in eccentricity