

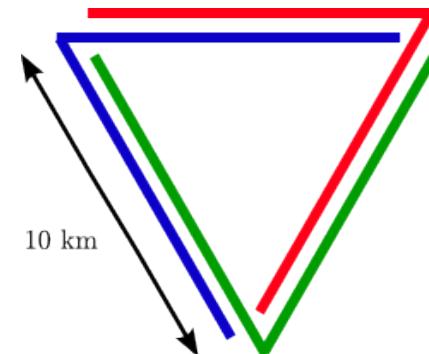
Mock Data Production, Characteristics, and Confusion Background

WG4 f2f – Nice 09/01/10

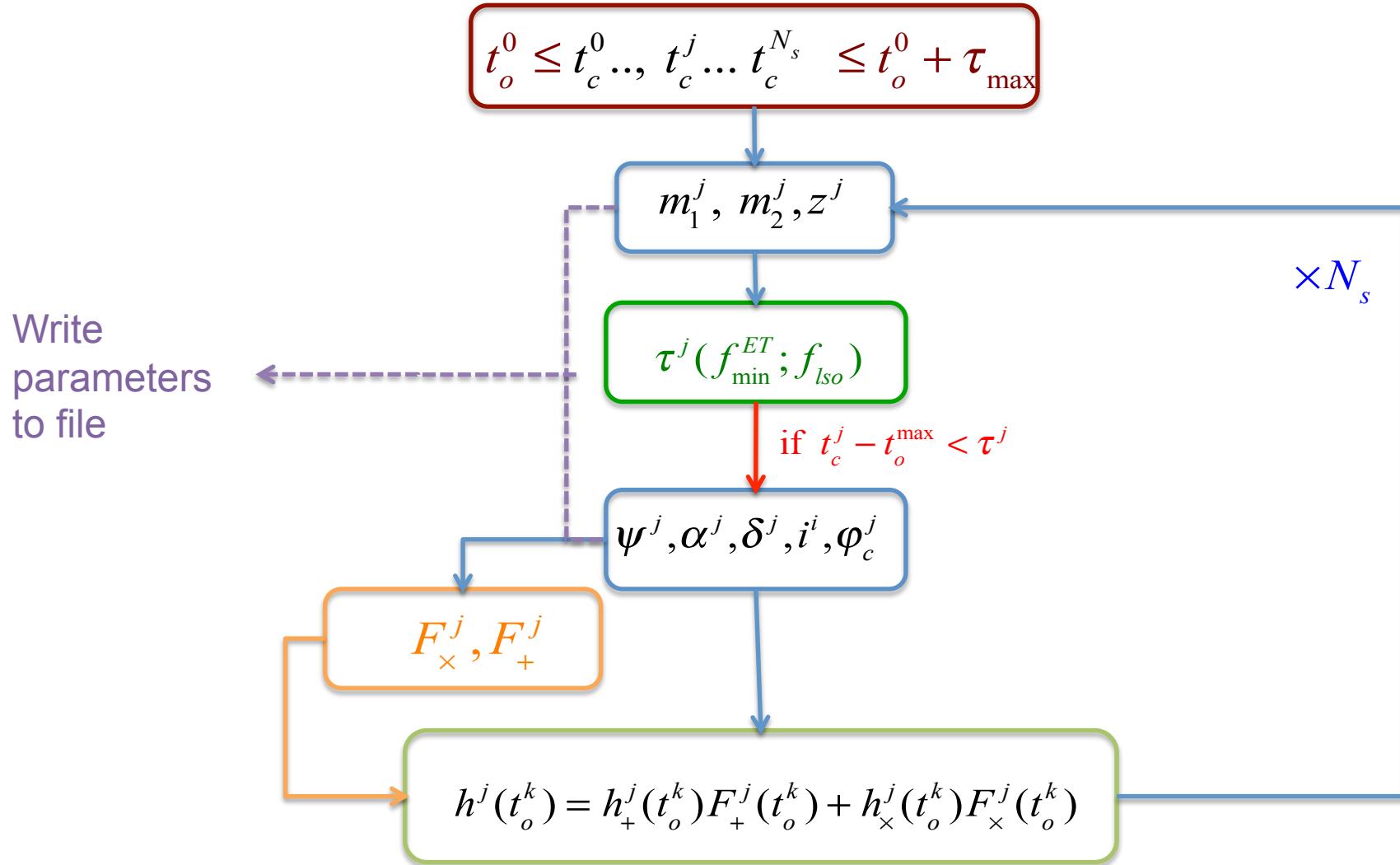
Tania Regimbau

ET Mock Data

- time series at the detector outputs E1, E2, E3
- Noise : colored Gaussian noise based on ET-B sensitivity
- GW signal : extra galactic population of BNS
- 1 month of data on Atlas frames :
 - ✓ duration 2048 s
 - ✓ sample rate 8192 Hz
 - ✓ $f_L = 10$ Hz



Simulation Code (GW signal)



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

Coalescence Rate

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

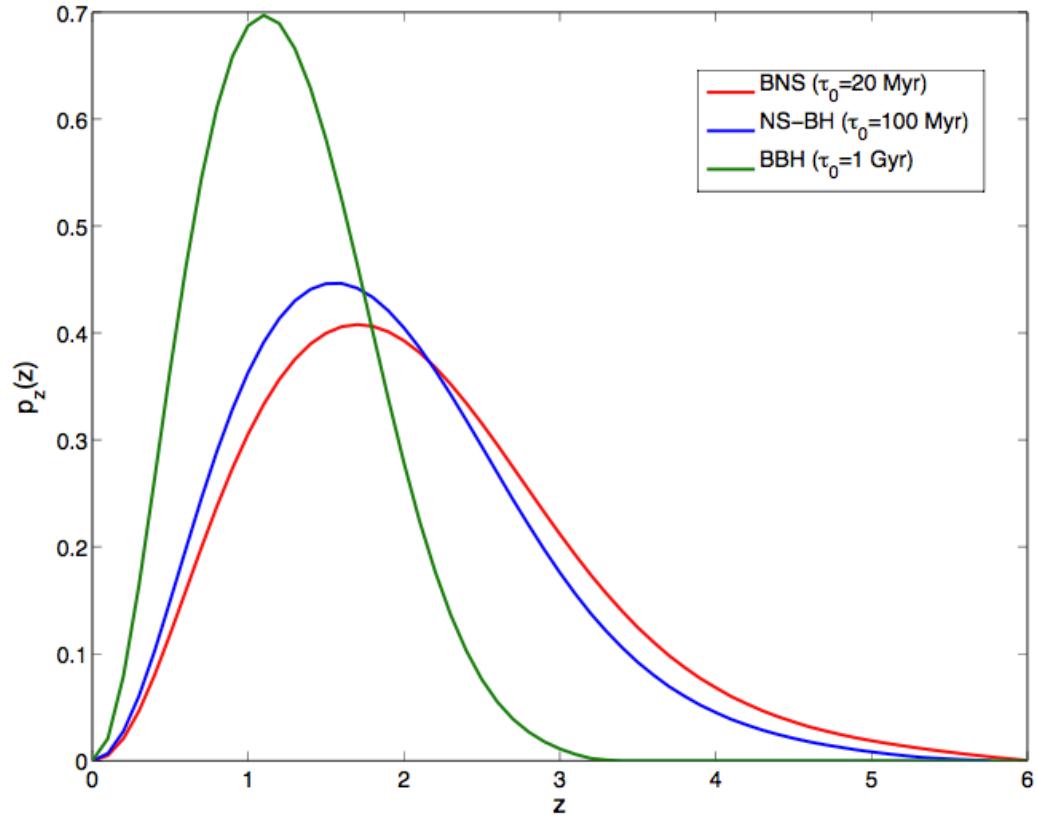
for:

$$\begin{cases} \text{SFR of Hopkins \& Beacom 2006} \\ H_0 = 0.7, \Omega_m = 0.3 \text{ and } \Omega_\Lambda = 0.7 \end{cases}$$

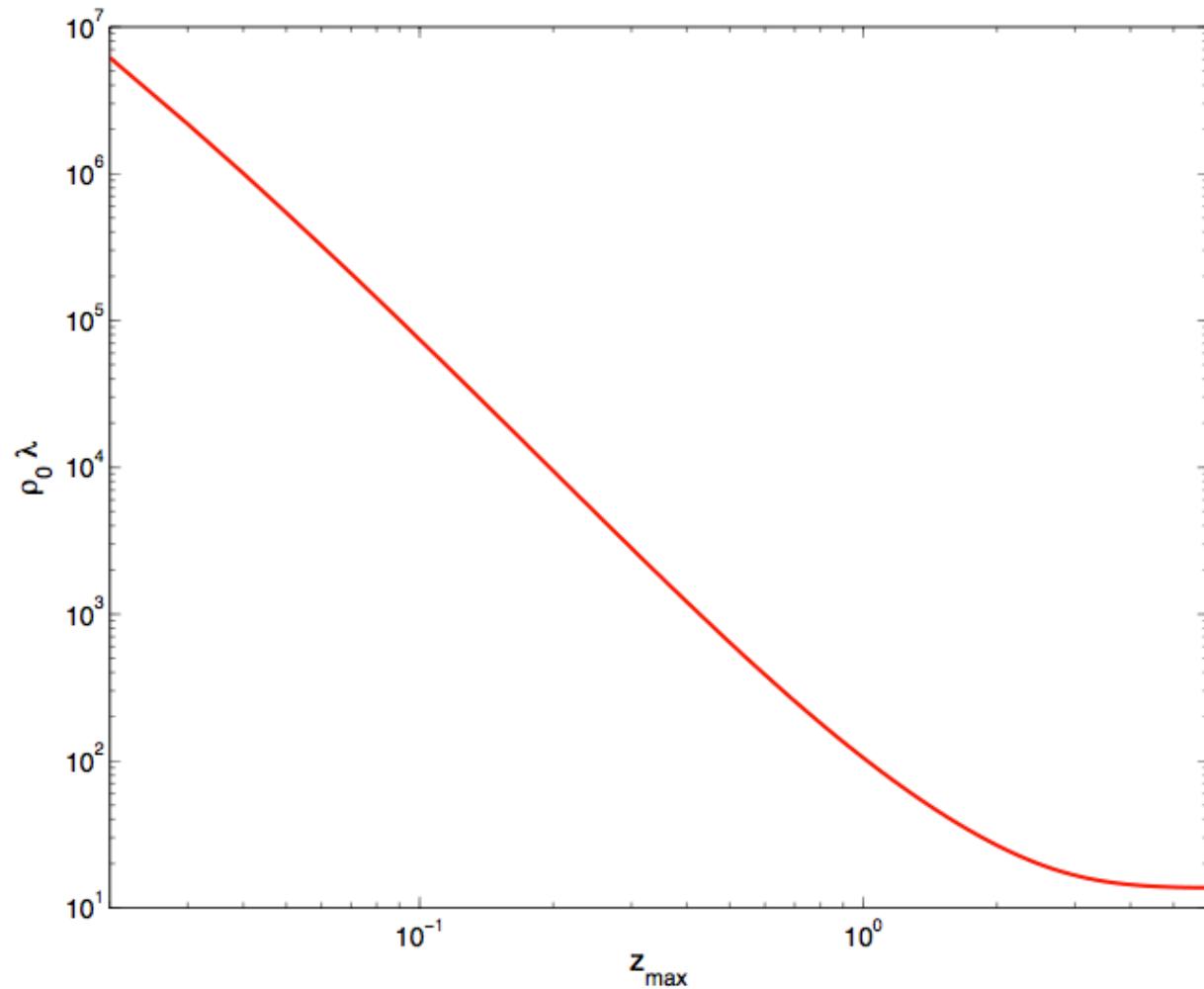
and (BNS):

$$\begin{cases} \dot{\rho}_c^o(0) = 1 \text{ Myr}^{-1} \text{Mpc}^{-3} * \\ P(t_d) \propto 1/t_d \text{ with } t_d > 20 \text{ Myr} \end{cases}$$

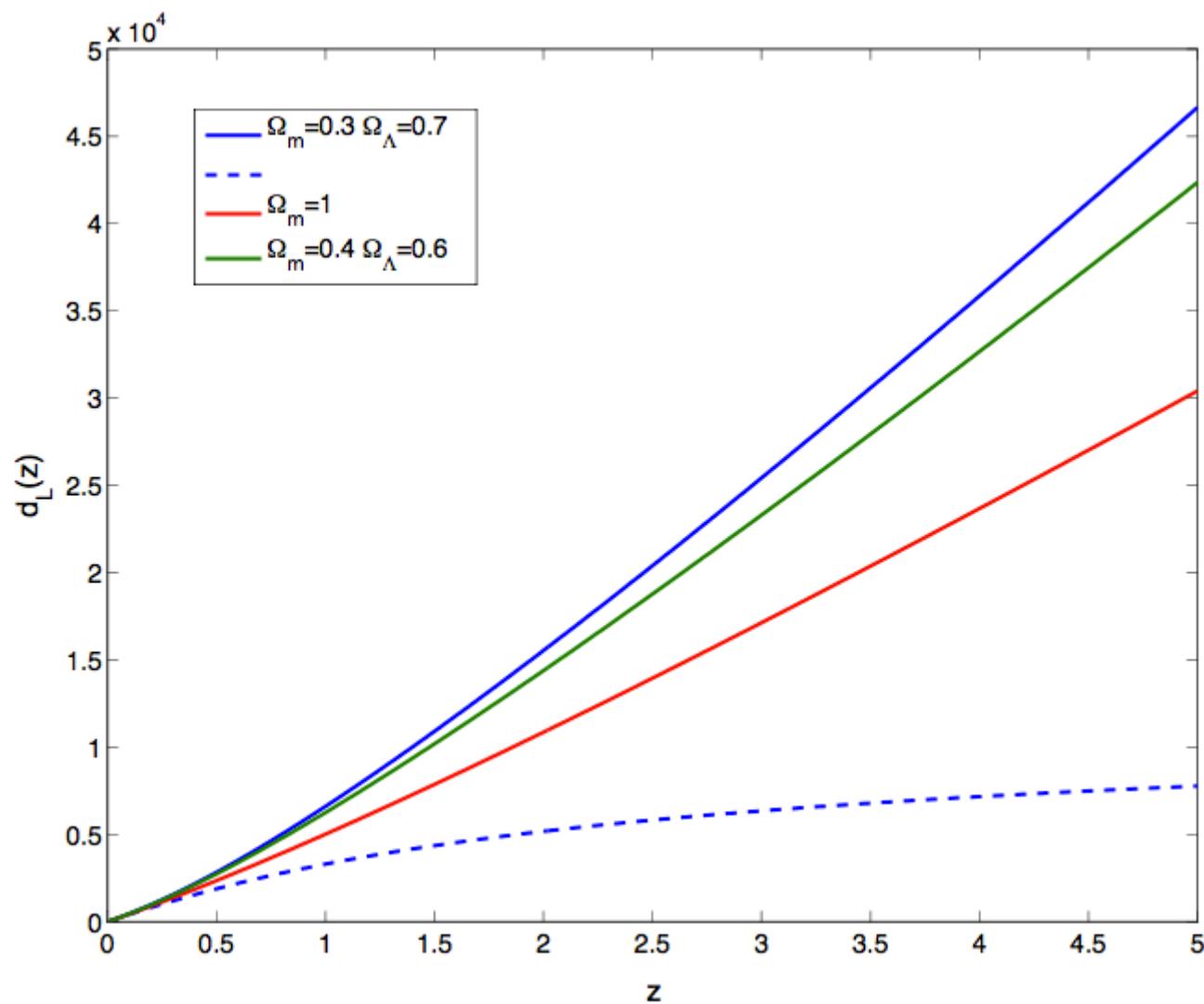
* 'realistic' rate from the LIGO rate paper



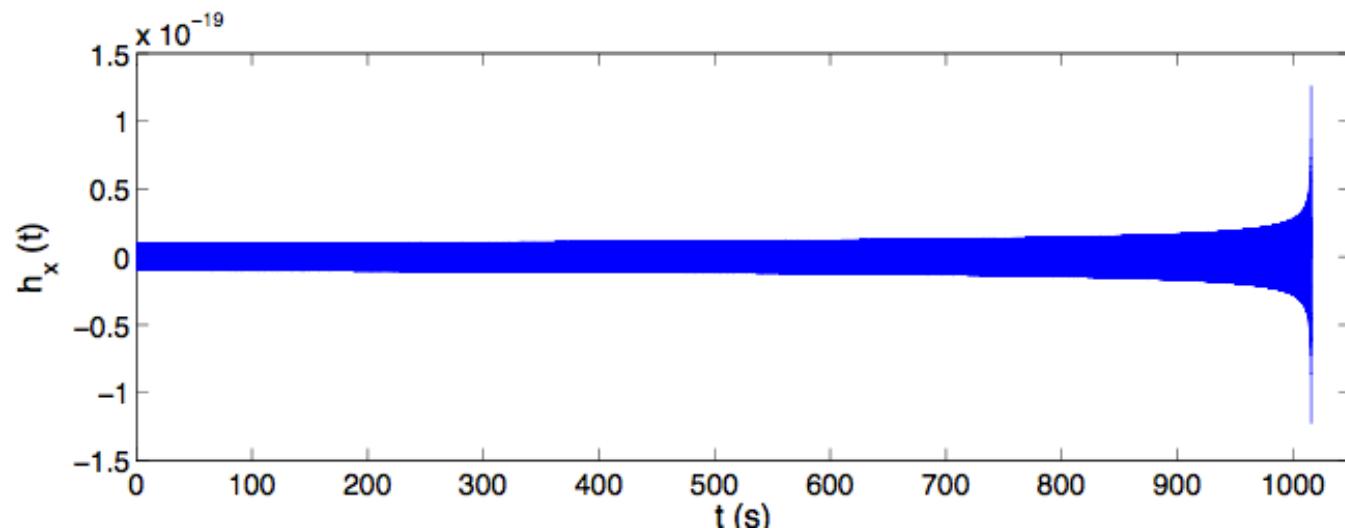
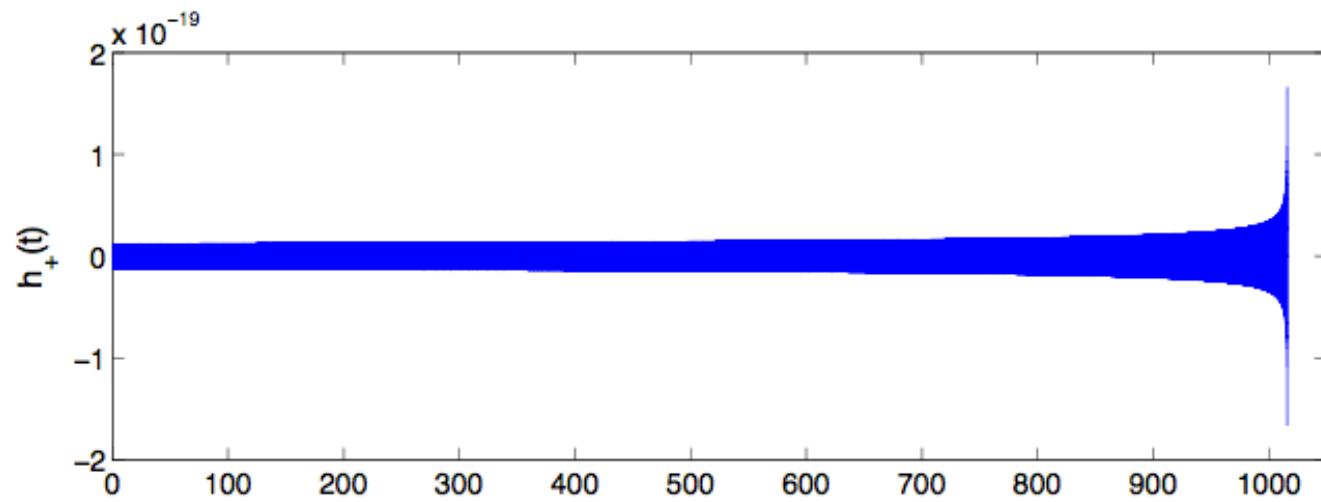
average time step



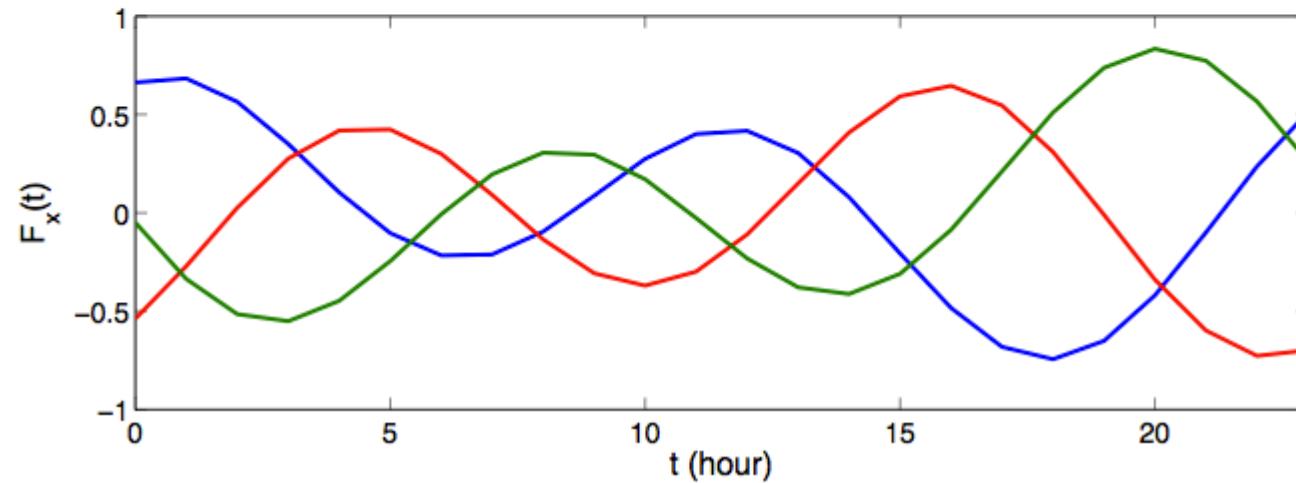
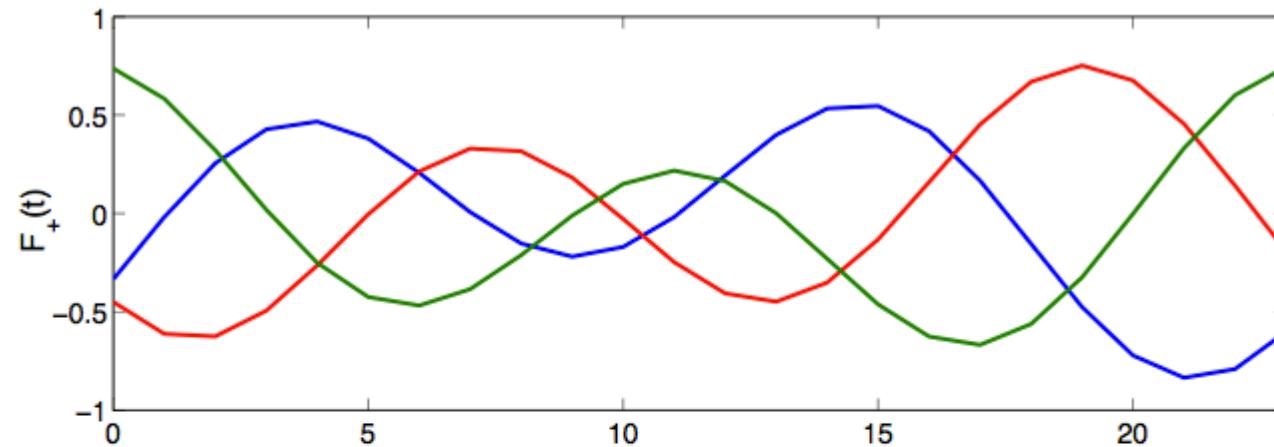
Luminosity Distance



Waveforms: Taylor T3 3.5 PPN



Beam Functions



Detection Regimes

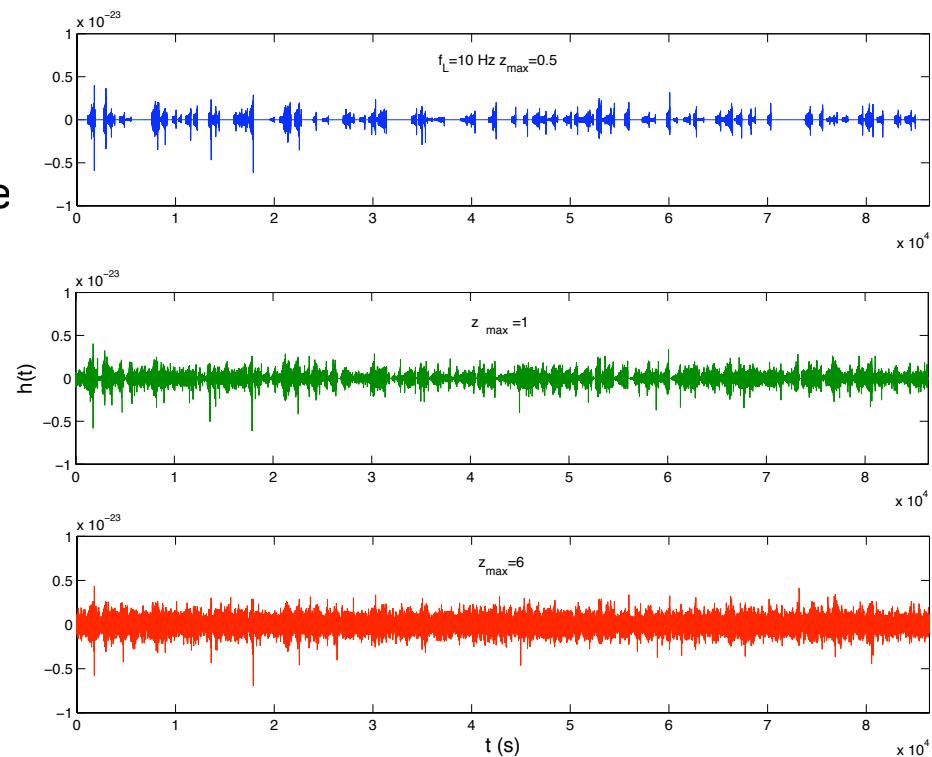
Defined by the duty cycle i.e the ratio between the average duration of the waveforms and the time interval between successive waveforms (also the average number of sources present at the detector)

$$\Delta(z) = \int_0^z (1+z')\bar{\tau} \frac{dR_c^o}{dz'}(z') dz'$$

➤ Resolved sources at close redshifts
Sources separated by long stretches of silence

➤ Popcorn background
Sources start to overlap

➤ Continuous stochastic background
Superposition of unresolved sources

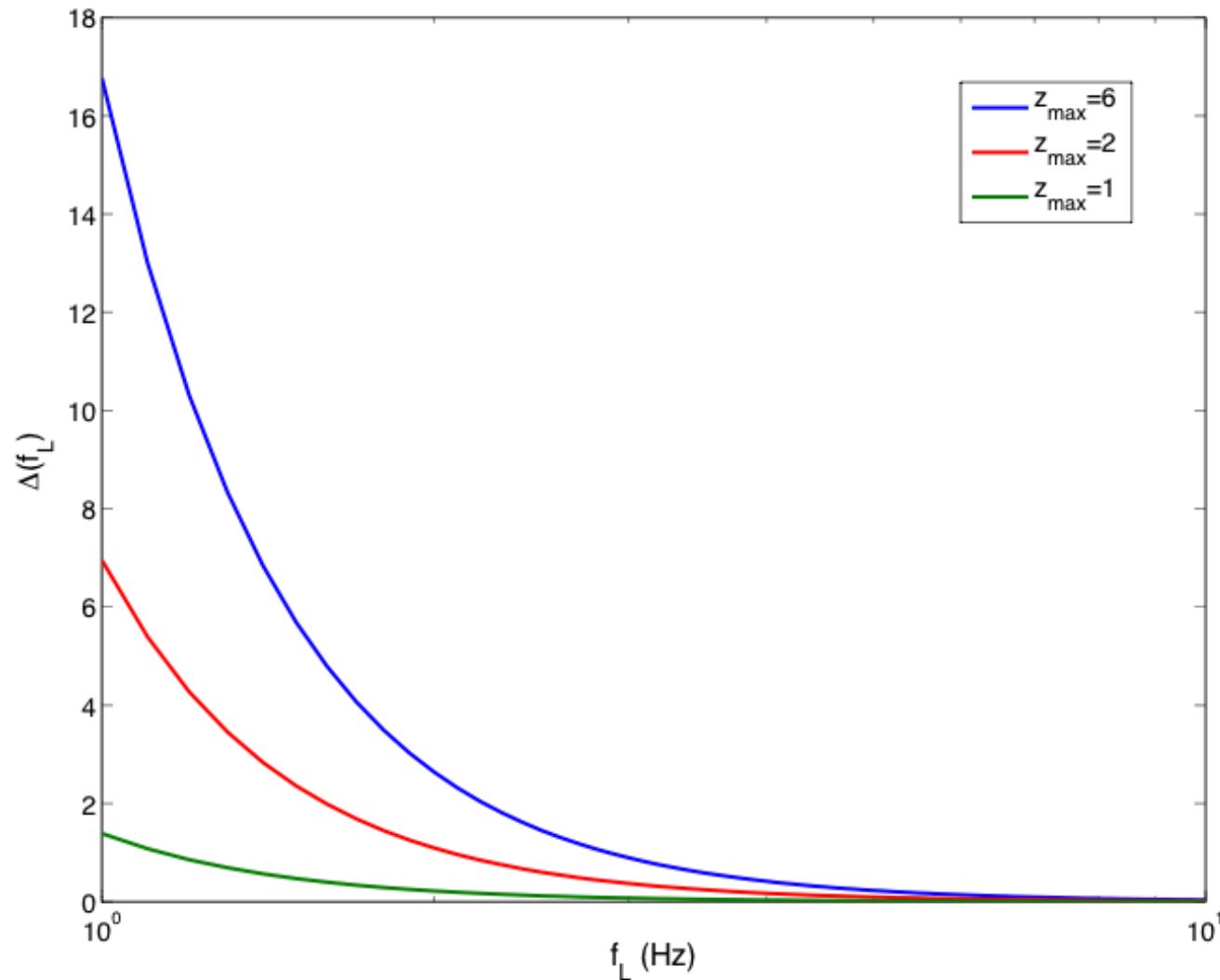


Signal Duration

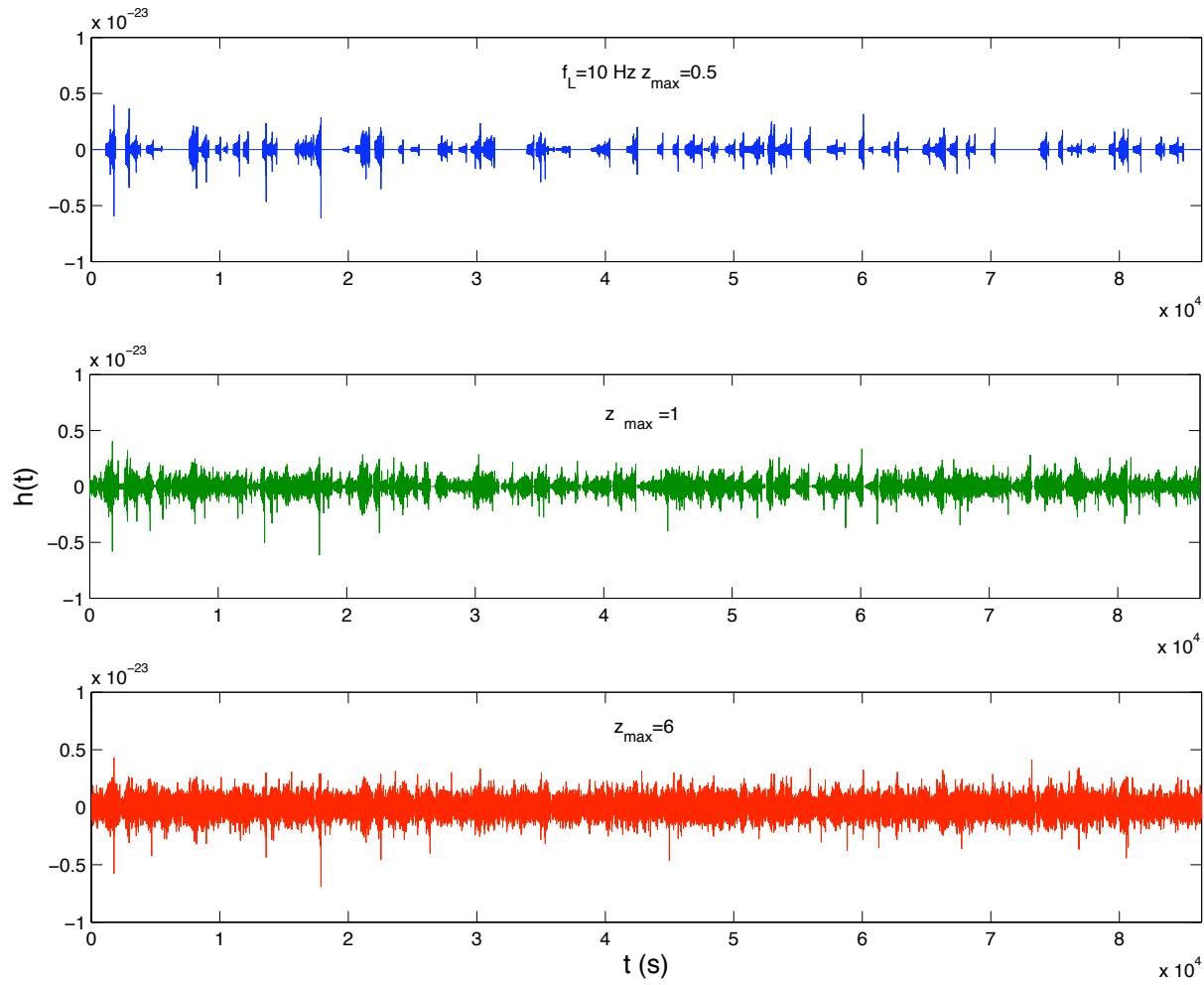
$$\tau(\text{day}) \sim 5.4 \left(\frac{M_c^{-5/3}}{1.22 M_\odot} \right) f_L^{-8/3}$$

f_L (Hz)	NS-NS (1.4+1.4)	NS-BH (1.4+10)
40 (initial)	25 s	5.8 s
10 (Ad LIGO)	16.7 m	3.9 m
5 (Ad Virgo)	1.8 h	24.6 m
3 (possible ET)	6.9 h	1.6 h
1 (planned ET)	5.4 d	1.2 d

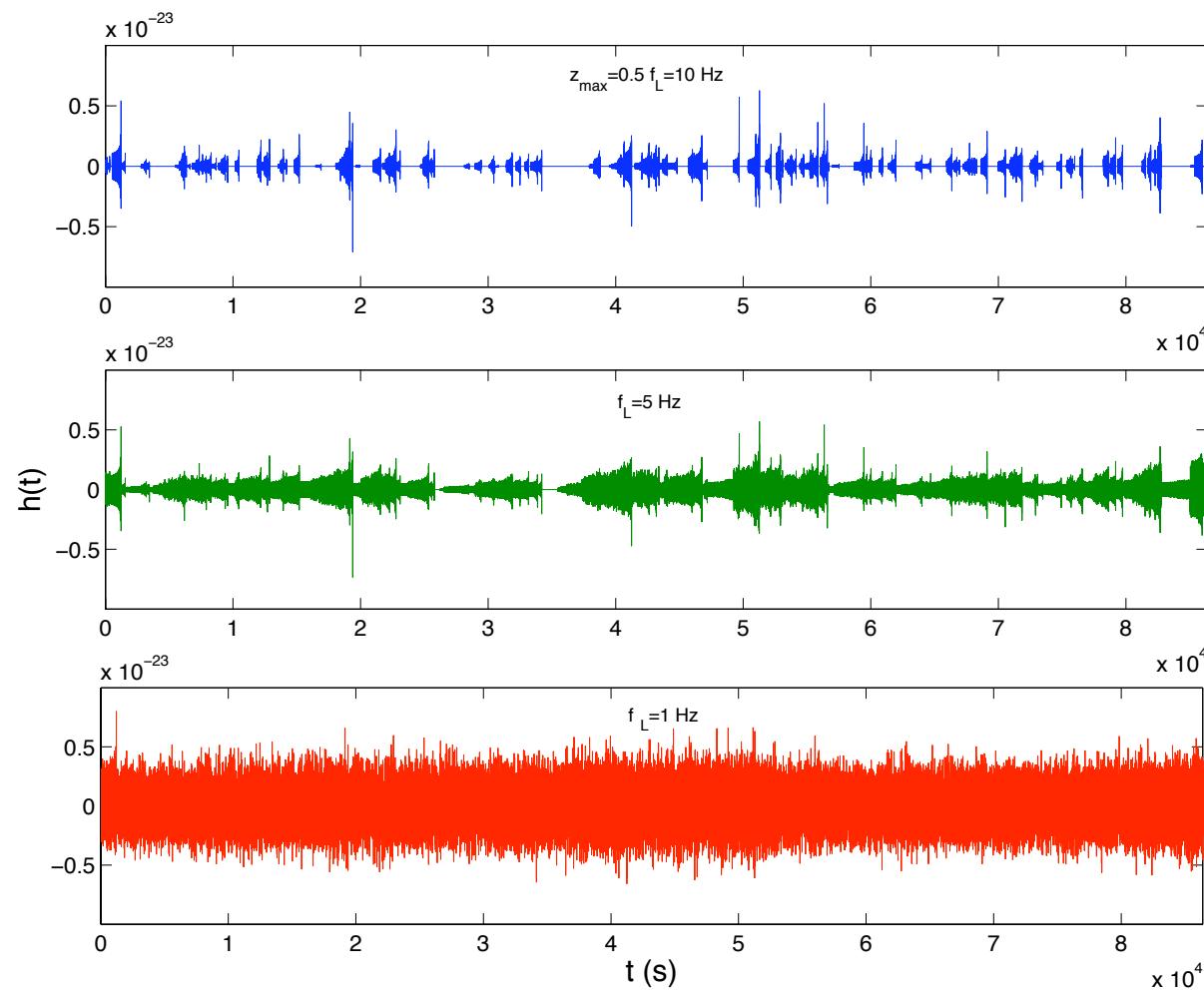
Duty Cycle



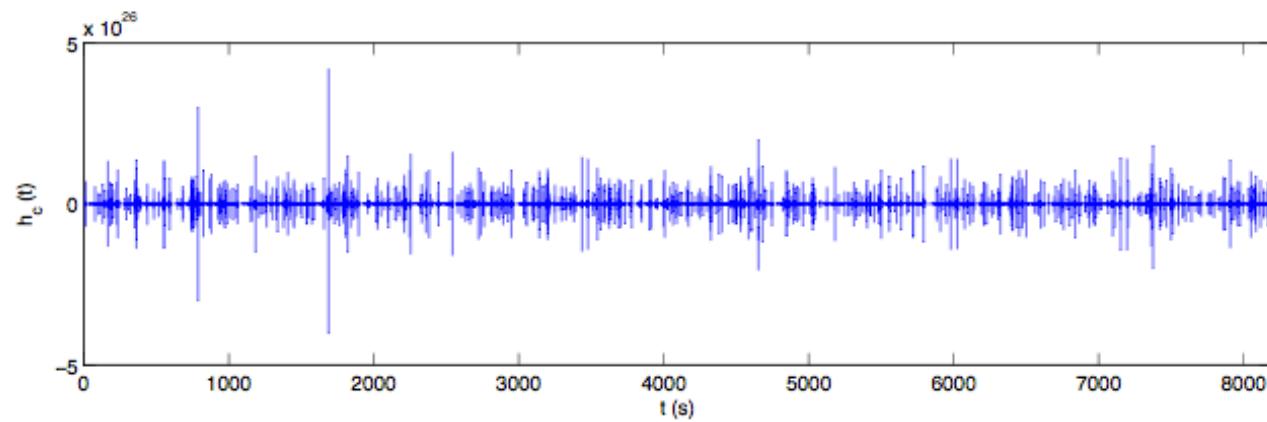
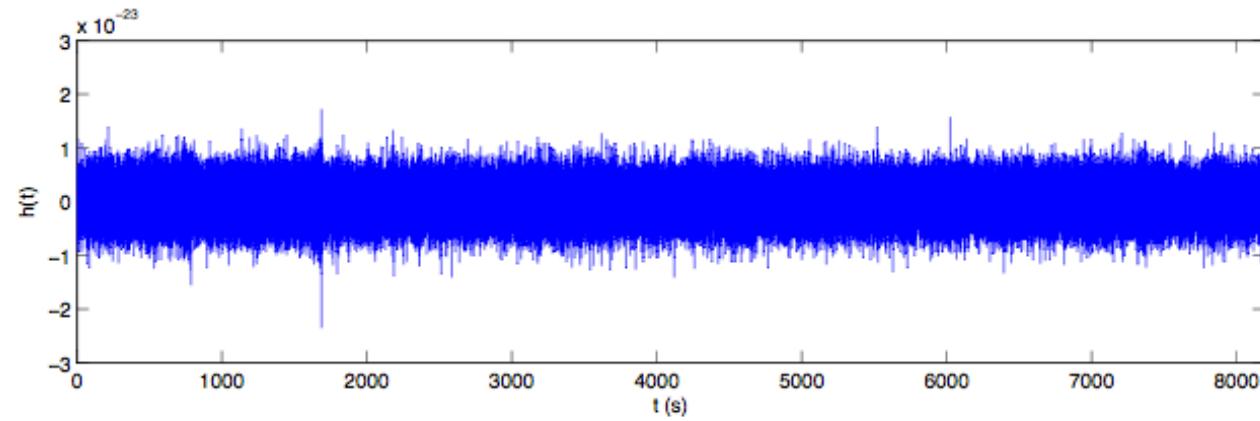
Evolution with z_{\max}



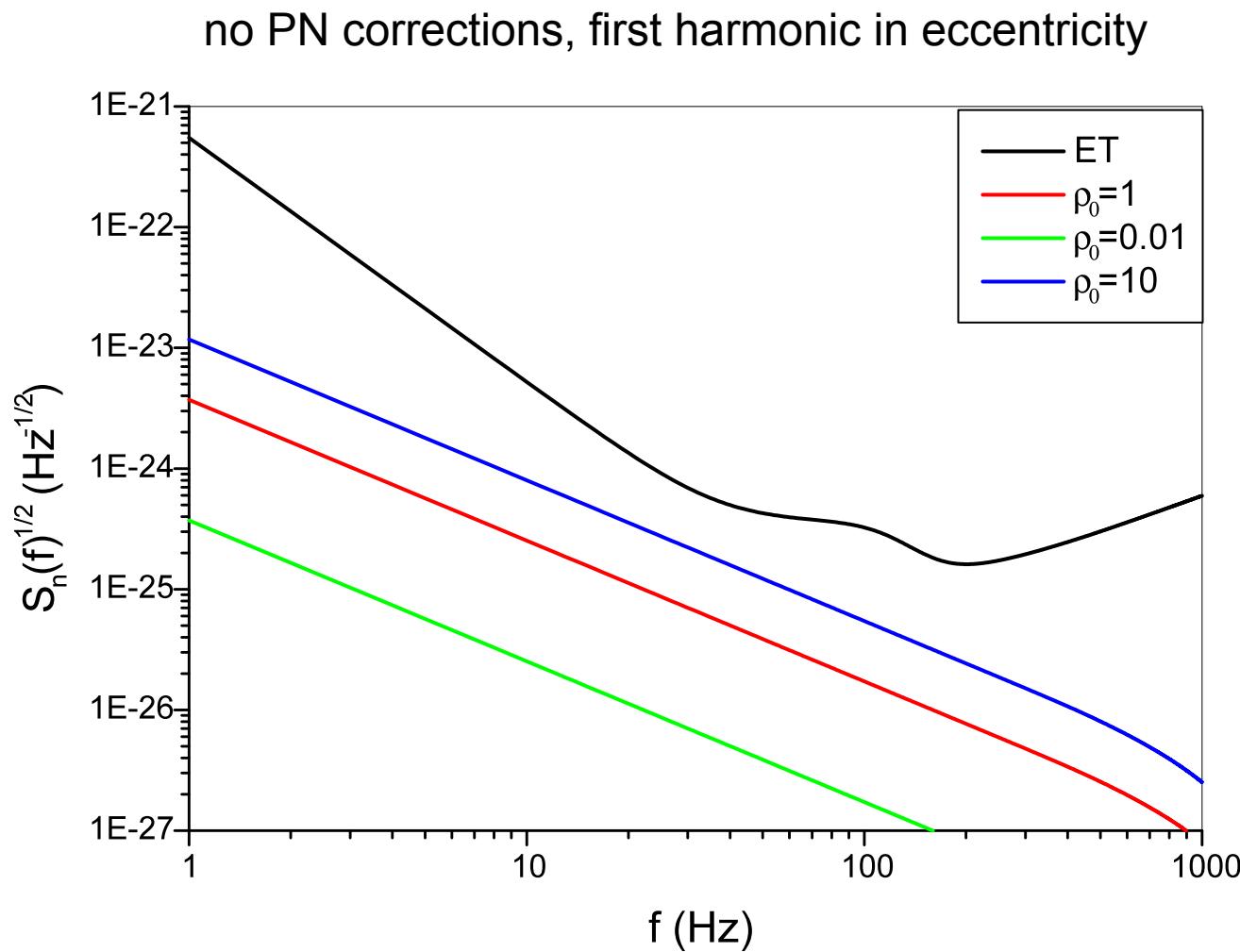
Evolution with f_L



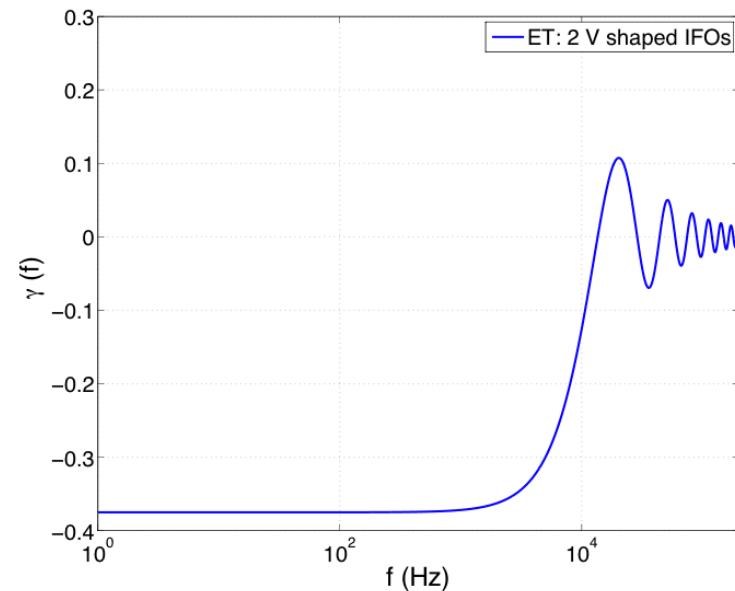
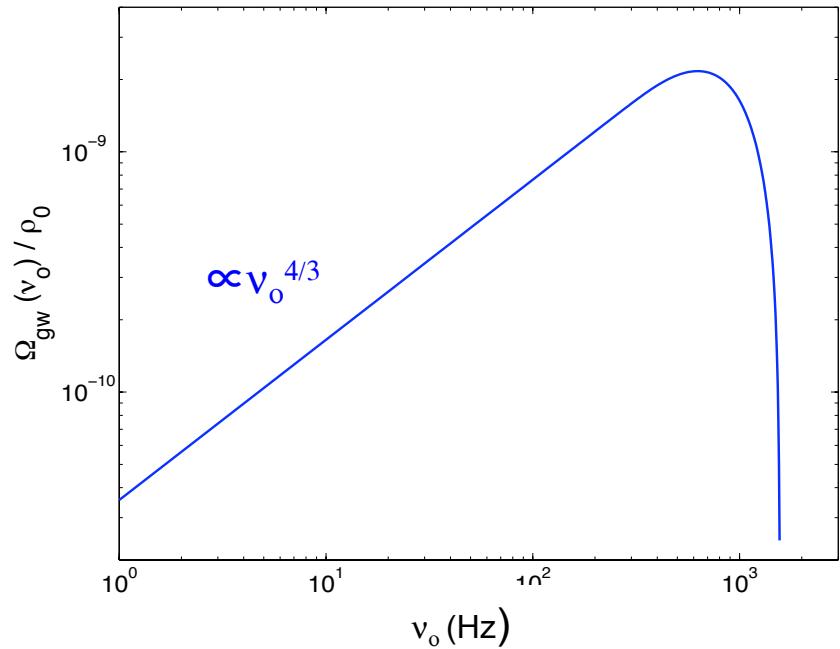
Filter



Confusion Background NS-NS



Stochastic analysis



CC statistic on 100000 s:

Pt estimate (100 Hz) = 7.4e-10
Error = 3.5e-11

To continue with Craig's talk...