

# NSF Technical Review of the LIGO Project

---

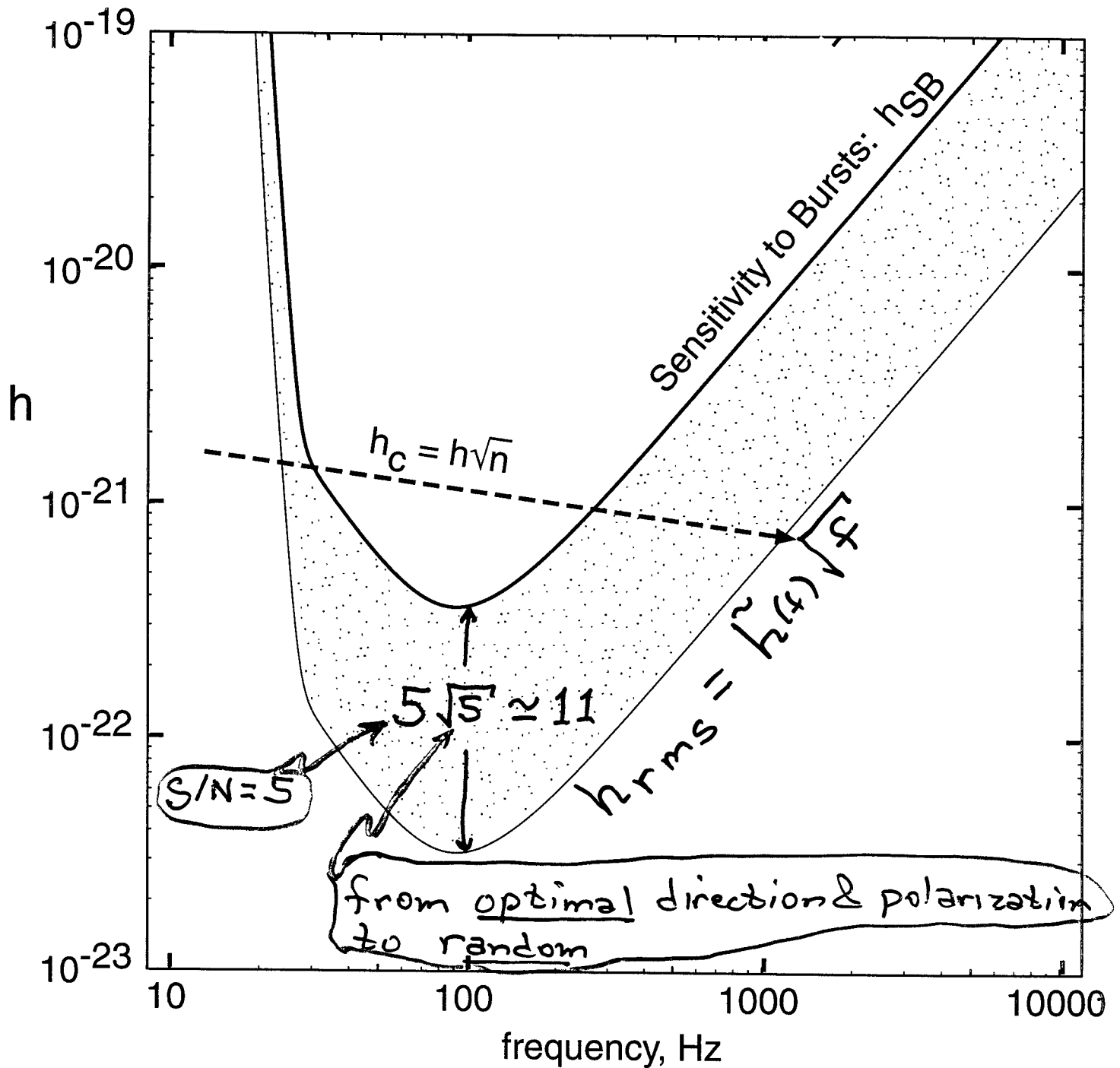
## Advanced R & D Proposal

**Kip Thorne**

**October 22, 1996**

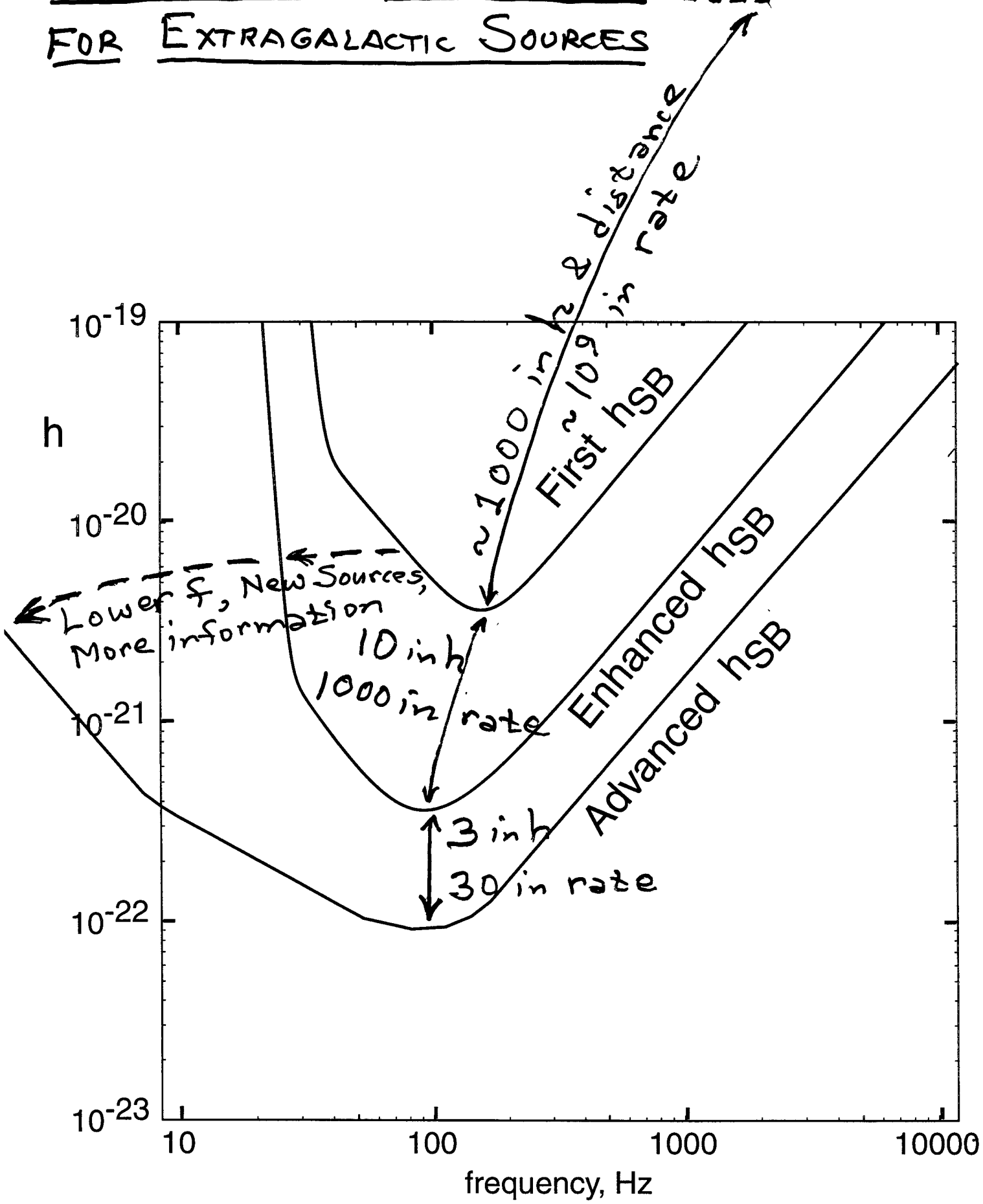


# SENSITIVITIES AND SOURCE STRENGTHS



If: Source line  $h_c$  anywhere lies above  $h_{SB}$ ,  
Then: detectable with high confidence in  
 absence of EM or  $\nu$  signal.

EVENT RATE IMPROVEMENTS FOR EXTRAGALACTIC SOURCES Search Best Past



# NEUTRON STAR BINARY INSPIRAL & MERGER

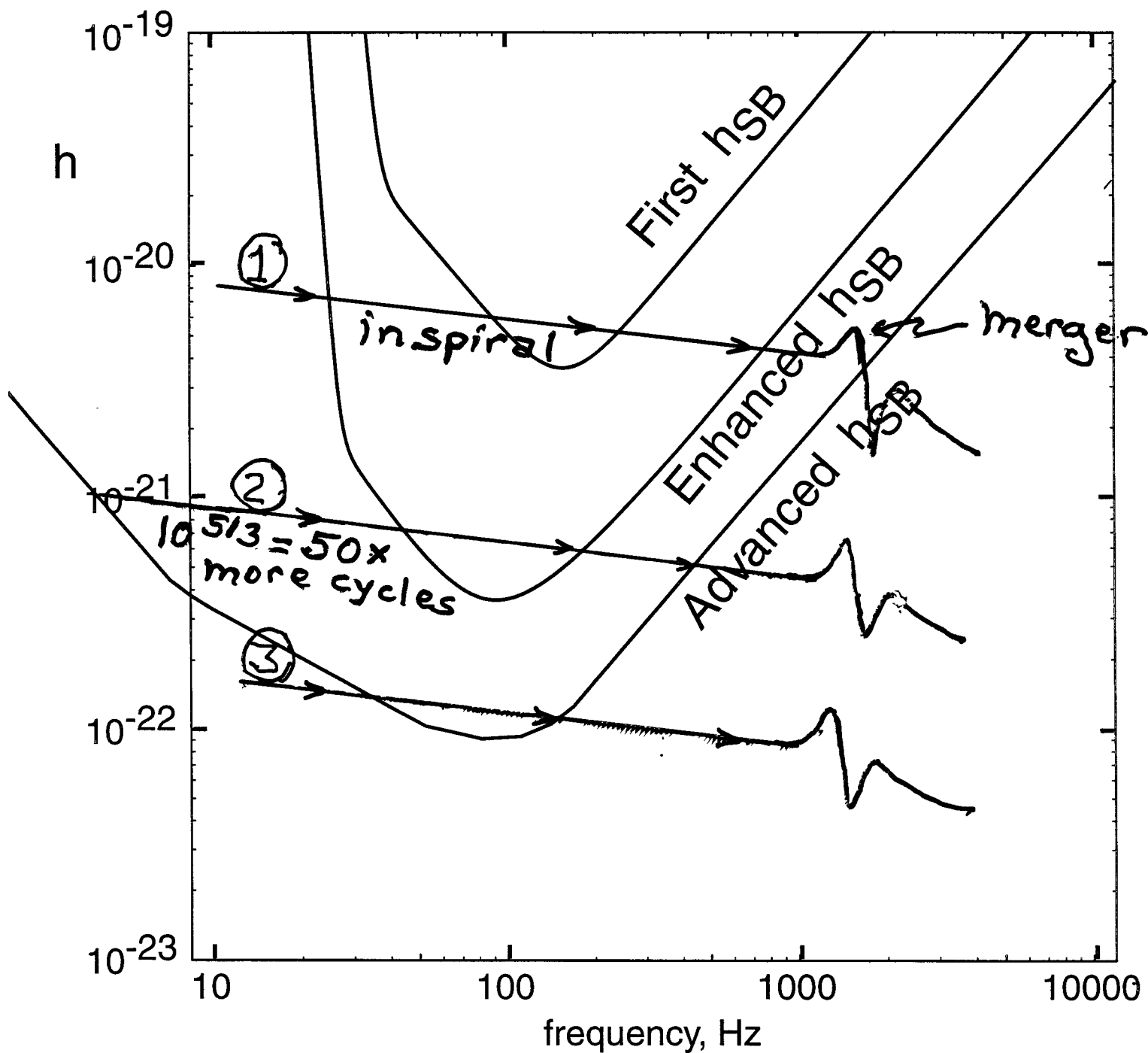
(our best understood source)

Estimated Distances for One Event Per Year

① Extreme Optimistic:  $50 \times 10^6$  yrs. (VIRGO)

② Conservative Best Guess:  $500 \times 10^6$  yrs.

③ Extreme Pessimistic:  $2 \times 10^9$  yrs.



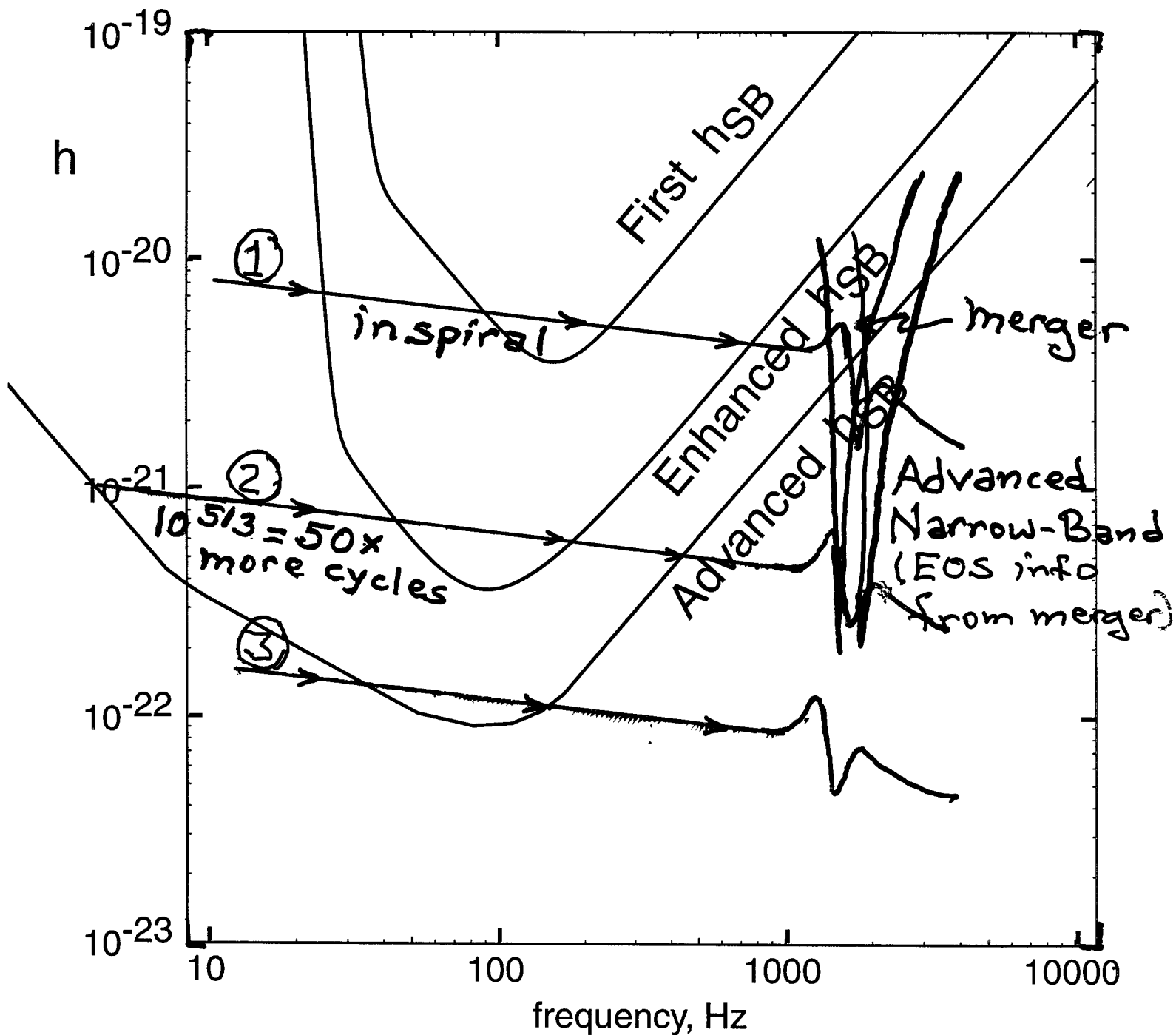
(3)

# NEUTRON STAR BINARY INSPIRAL & MERGER

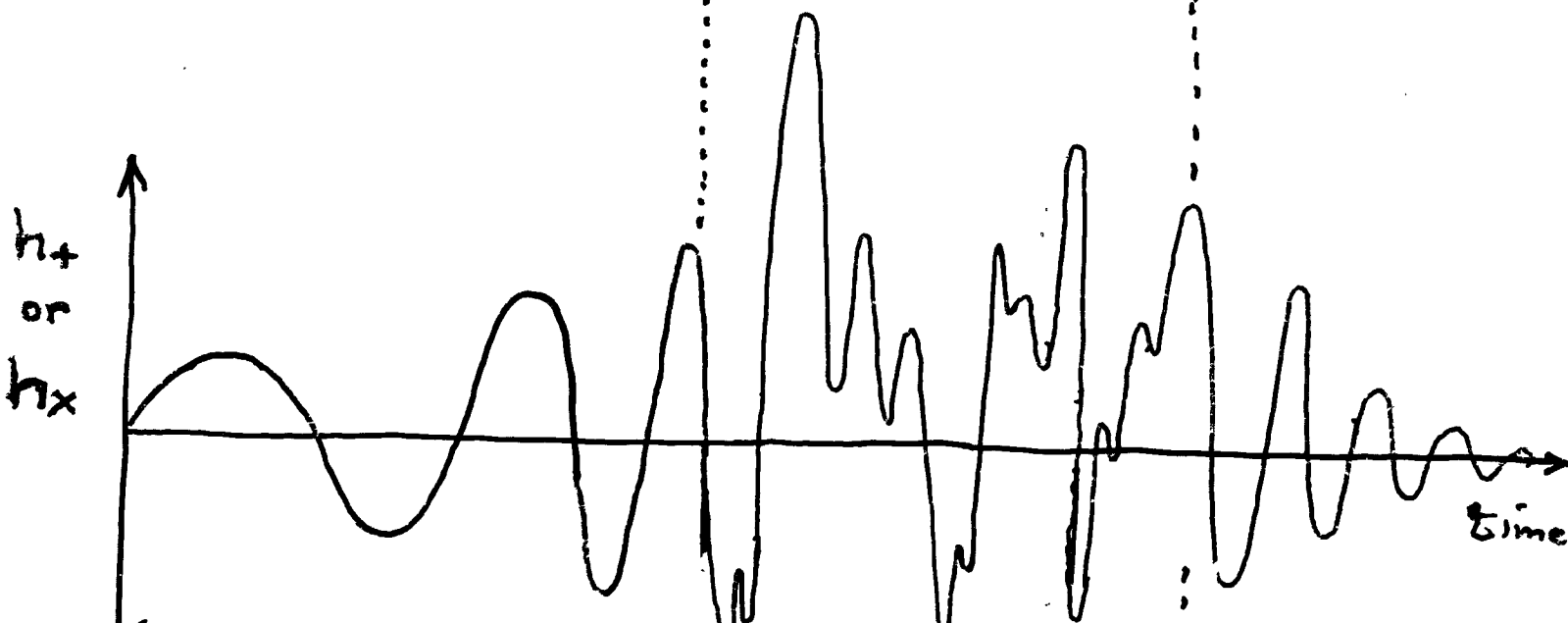
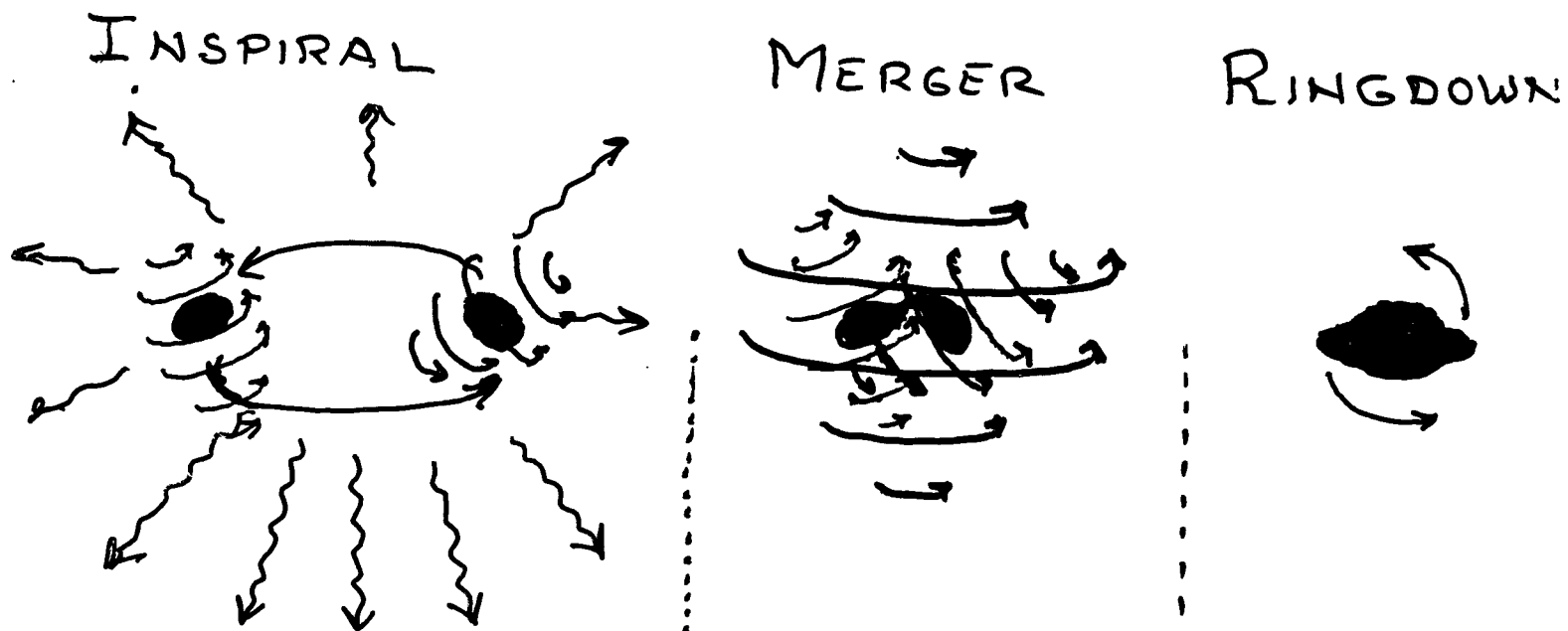
(our best understood source)

Estimated Distances for One Event Per Year

- ① Extreme Optimistic:  $50 \times 10^6$  l.yrs. (VIRGO)
- ② Conservative Best Guess:  $500 \times 10^6$  l.yrs.
- ③ Extreme Pessimistic:  $2 \times 10^9$  l.yrs.



# BLACK-HOLE BINARY COALESCENCE, $M_1, M_2$ (Perhaps the Strongest Source)



Known: Post-Newton Expansions...

- Blanchet - Damour - Iyer
- Will - Wiseman

Numerical Relativity  
A. Einstein Institute - Schutz, Seidel, ...  
BBH Alliance:

- Texas, • Cornell,
- Illinois (NCSA),
- North Carolina,
- Northwestern, • Penn State, • Pittsburgh

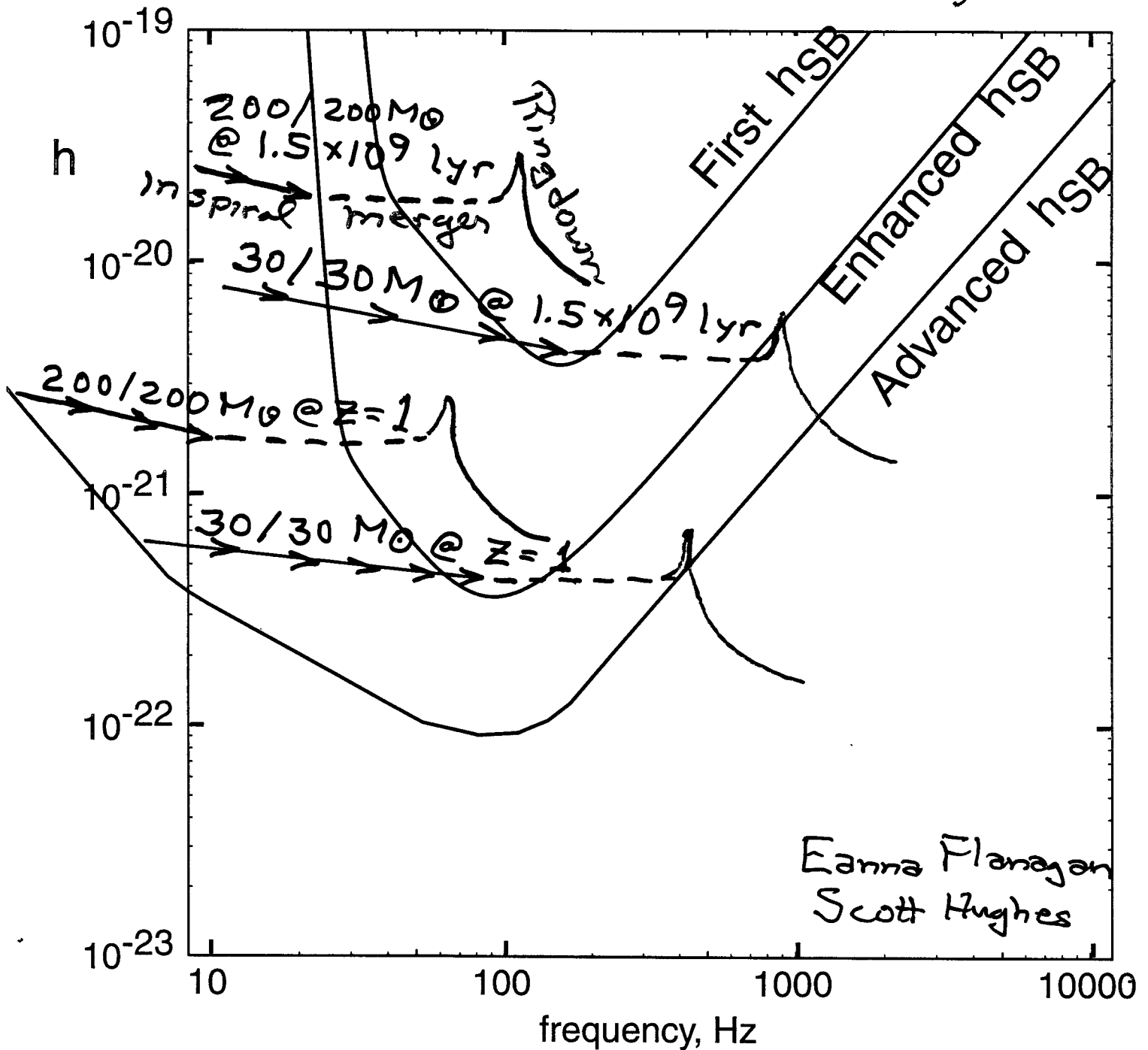
Known: Teukolsky Formalism

- Detweiler
- Chandrasekhar
- Sasaki, Nakamura
- Leaver

# BH / BH

First Interf's :  $t_0 \sim 10^9$  l.yrs.

Enhanced Interf's :  $t_0 \sim 10^{10}$  l.yrs.  
( $z=1$ )



# OTHER SOURCES

<u>Source</u>	<u>First</u>	<u>Enhanced</u>	<u>Advanced</u>
Nonaxisymmetric Stellar Core Collapse (Supernovae)	$\sim 50 \times 10^6$ l.yr.	$\sim 500 \times 10^6$ l.yr.	$\sim 1.5 \times 10^9$ l.yr.
[if can develop near optimal data analysis algorithms]			
Spinning N.S.'s (pulsars)	$\left( \frac{\epsilon}{10^{-6}} \right) \left( \frac{30,000 \text{ l.yr.}}{r} \right) \left( \frac{1 \text{ msec}}{P} \right)^2$		
Broad-Band	1	0.2	....
Narrow-Band	....	....	$2 \times 10^{-3}$
Stochastic Background	$\Omega_g = \left( \frac{\text{GW energy in } \Delta f = f}{\text{Energy to close Universe}} \right) \gg$		
Broad-Band	$\sim 3 \times 10^{-7}$	$\sim 3 \times 10^{-9}$	$\sim 3 \times 10^{-10}$
Narrow-Band	....	....	$\sim 1 \times 10^{-10}$