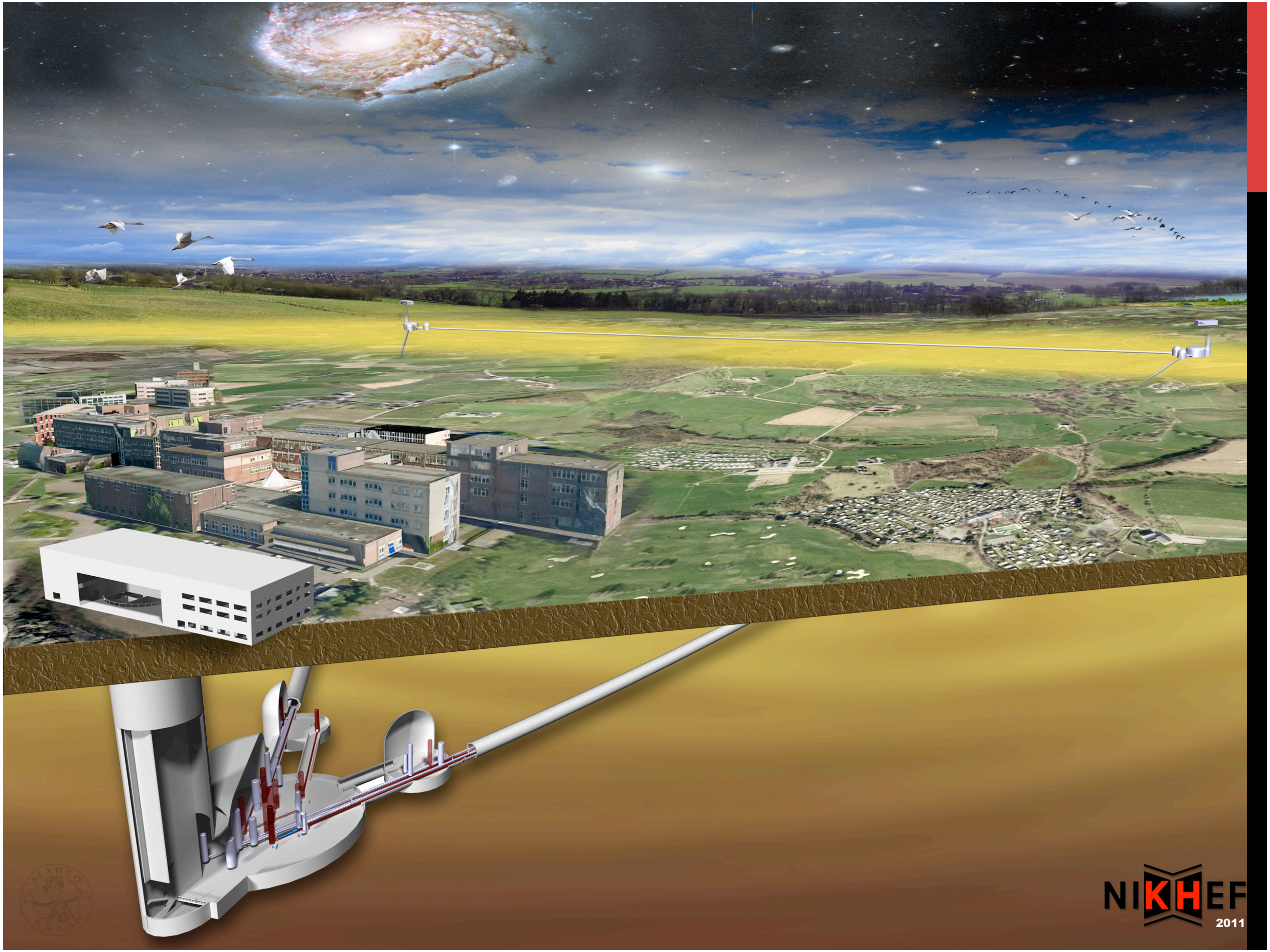
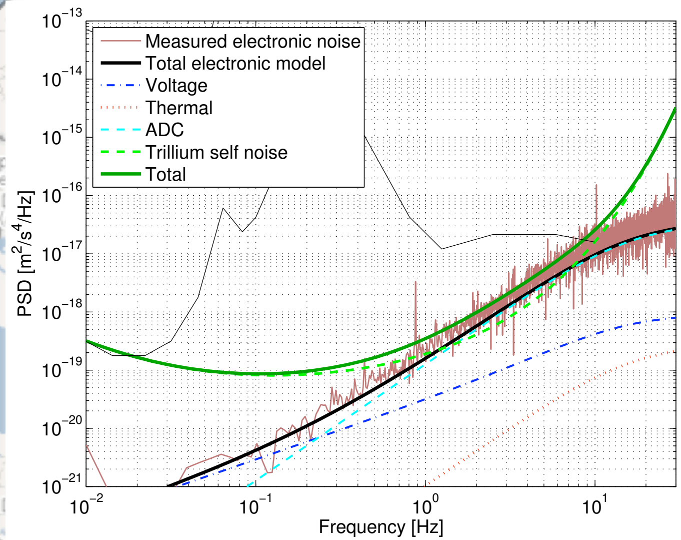
SEISMIC MEASUREMENTS AND NEWTONIAN NOISE PREDICTIONS FOR UNDERGROUND ENVIRONMENTS IN EUROPE

DAVID RABELING, MARK BEKER, ERIC HENNES,
AND JO VAN DEN BRAND

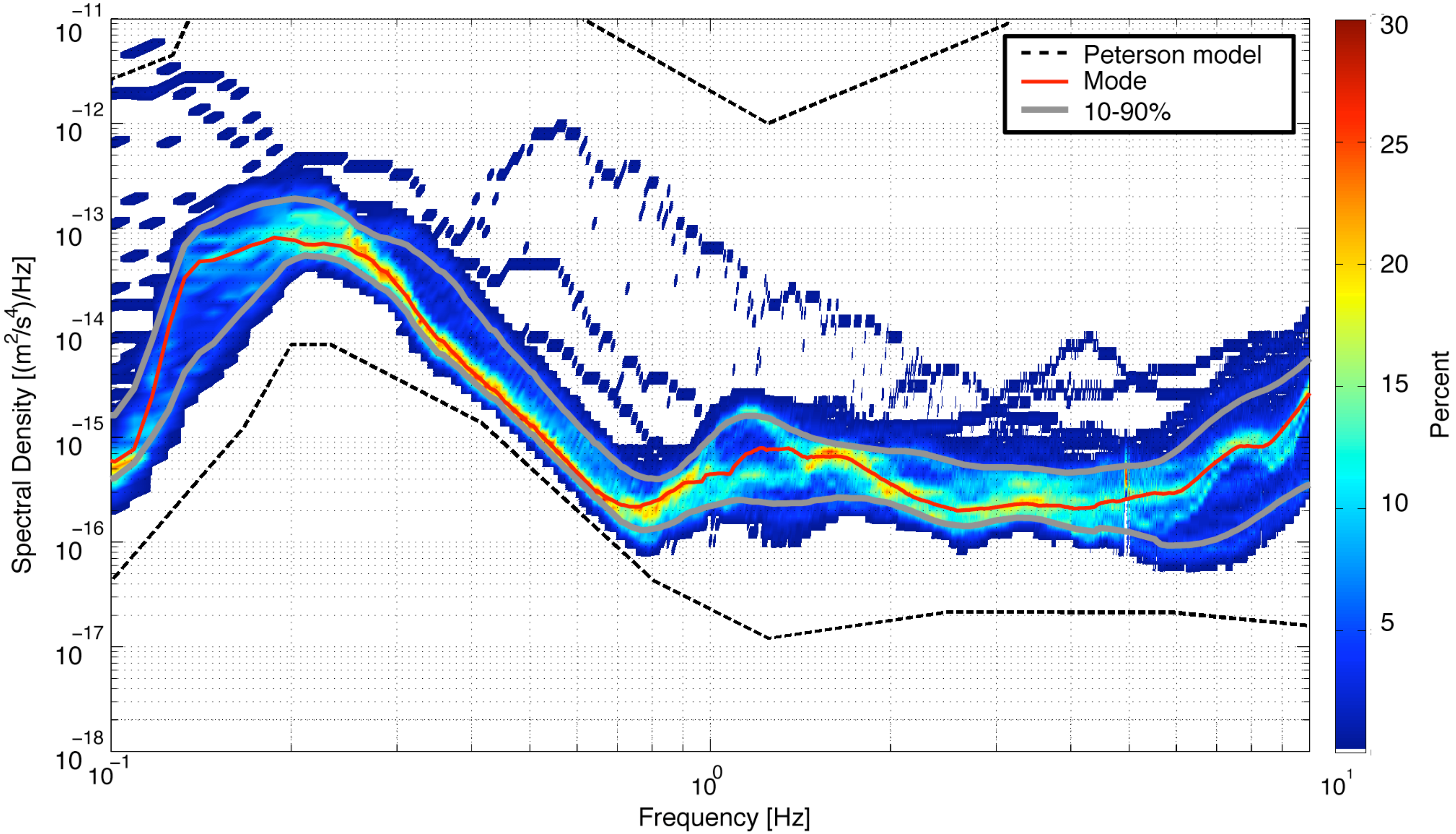
THANKS TO GIANCARLO CELLA FOR USEFUL DISUSSIONS


NIKHEF
2011

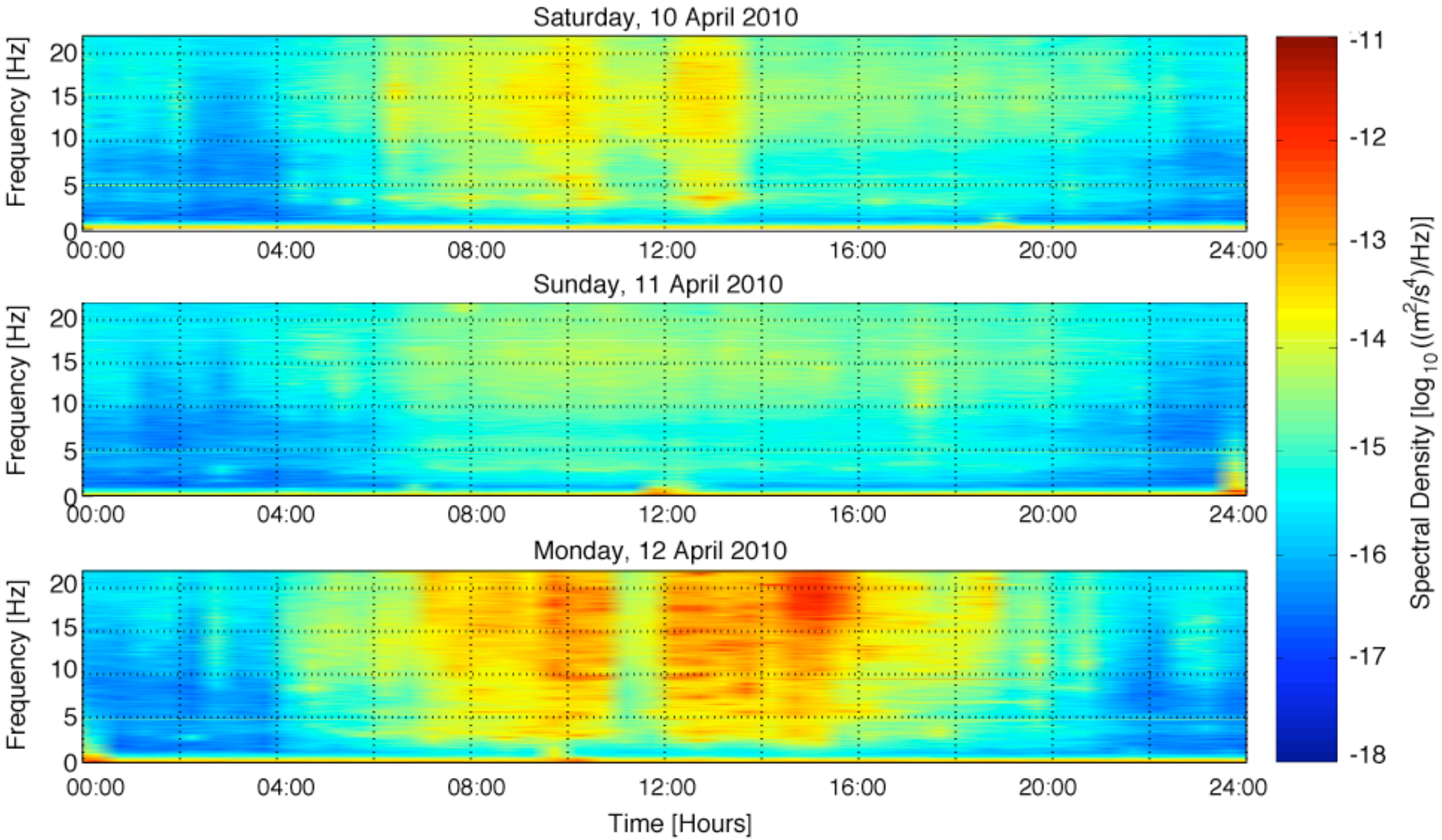
SITES WHERE WE MEASURED:



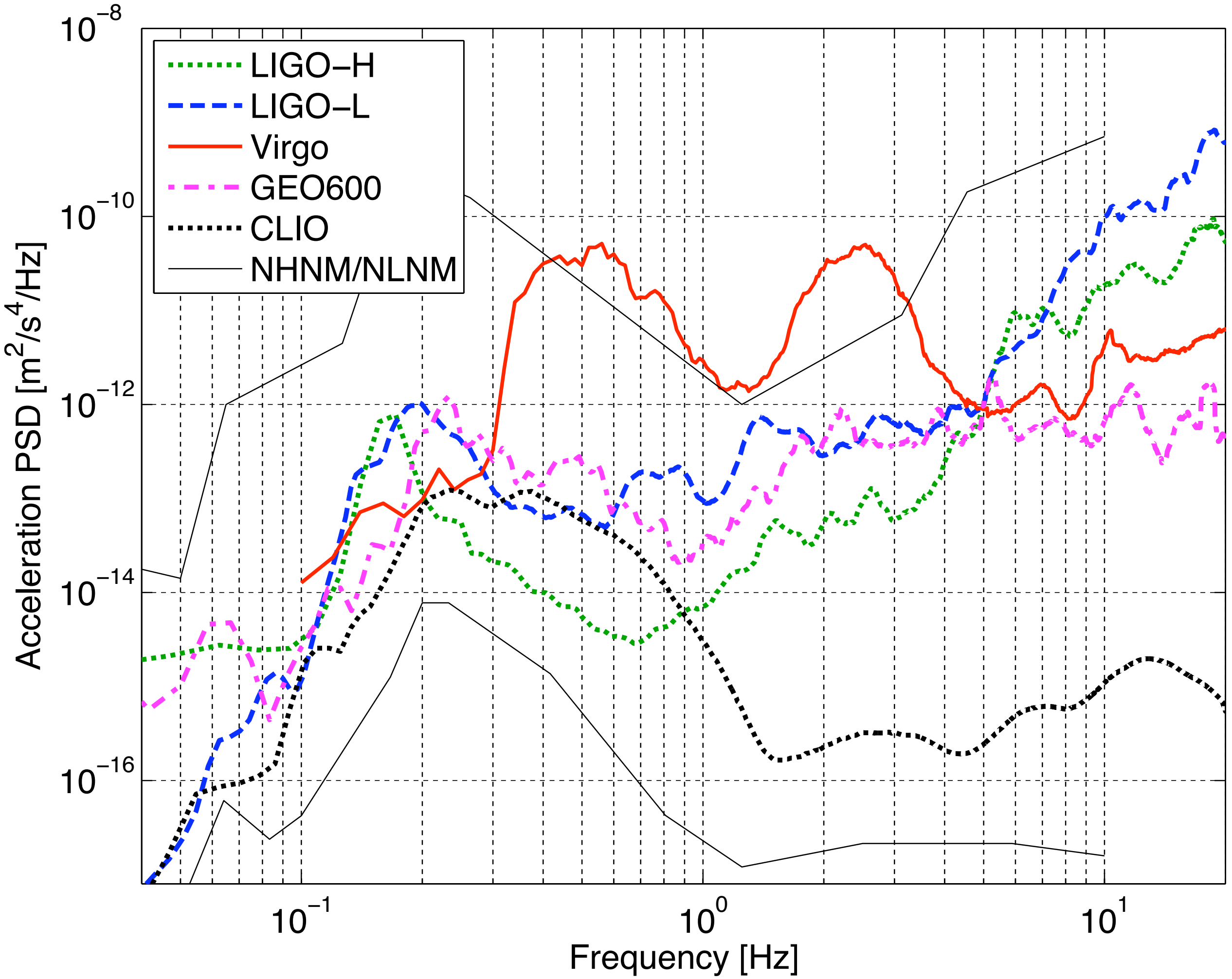
RESULTS PRESENTED AS SPECTRAL VAR. PLOTS



OR WE CAN PRESENT THEM AS SPECTROGRAMS



SEISMIC SPECTRA AT CURRENT GW DETECTOR LOCATIONS



SEISMIC NOISE VS DEPTH?

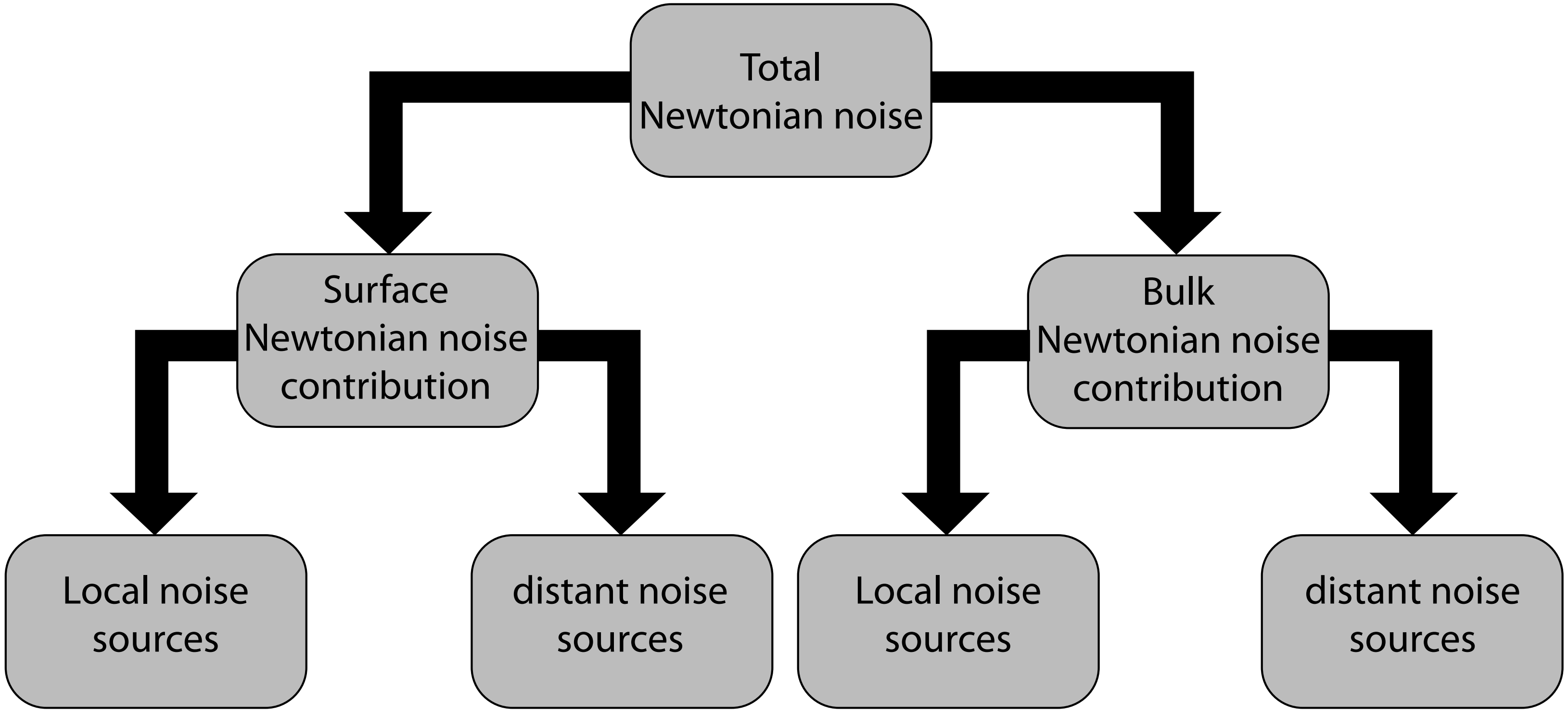
HIGH-FREQUENCY SEISMIC NOISE AS A FUNCTION OF DEPTH

BY JERRY A. CARTER*, NOEL BARSTOW, PAUL W. POMEROY, ERIC P. CHAEL, AND PATRICK J. LEAHY

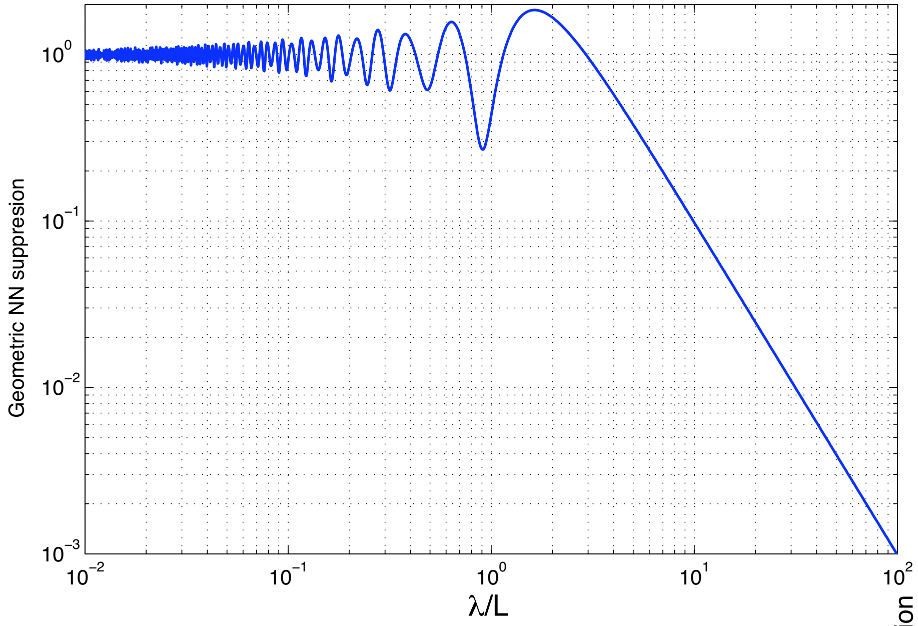
...... They observed that the extent of the decrease was heavily site dependent; that at great depths the variability of noise over time and between regions was much less than at the surface; that in low noise regions the reduction in noise amplitudes occurred only at high frequencies; and that the noise amplitudes stabilized at about 600-m depth at all sites. With one exception, these measurements were made near large industrial cities where the cultural noise levels were high. At all of the sites, the night-time noise levels were less than the day-time levels, which is an indication that cultural noise was not completely avoided at the depths studied.

Jerry A. Carter, **Noel Barstow**, **Paul W. Pomeroy**, **Eric P. Chael**, and **Patrick J. Leahy**
High-frequency seismic noise as a function of depth
Bulletin of the Seismological Society of America (August 1991), 81(4):1101-1114

HOW DO WE COMBINE OUR TWO ESTIMATES?



NN CONTRIBUTION OF SURFACE WAVES (CELLA)



$$\mathcal{F} = 1 - J_0(kL) - J_2(kL) - \frac{1}{2} J_2(kL)$$

$$\Gamma = \frac{2(\beta_T^2+1)e^{\beta_L kz} - (1+2\beta_L+\beta_T^2)e^{kz}}{\beta_L(\beta_T^2-1)}$$

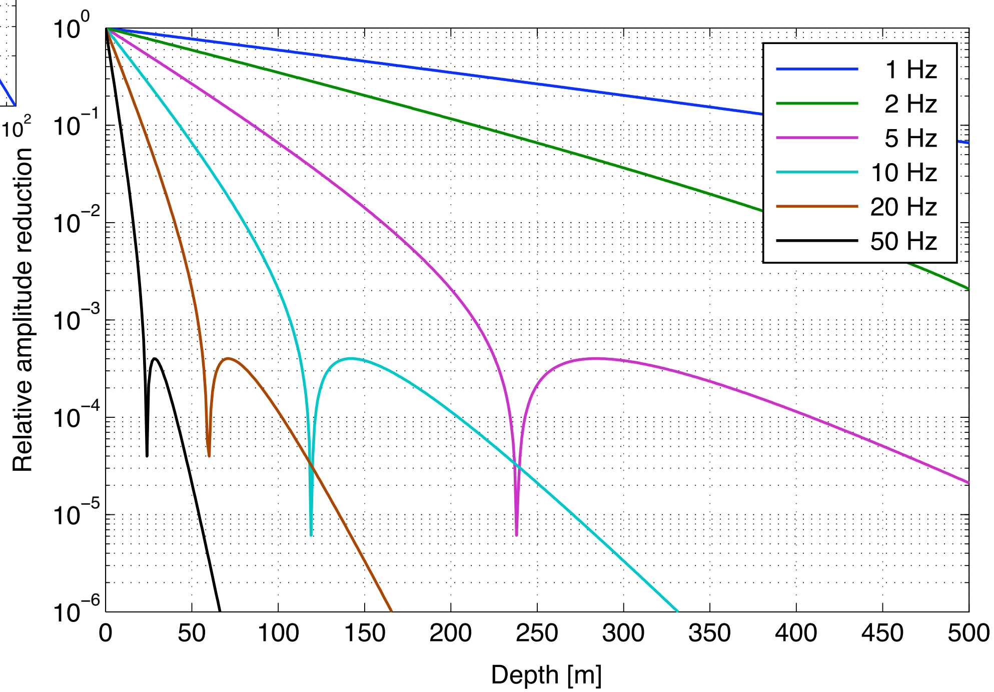
$$(S_{NN})^{1/2} = \frac{4\pi G\rho_0}{L\sqrt{2}(2\pi f)^2}\mathcal{F}\,\Gamma(S_{seism})^{1/2}$$

x is a solution of:

$$x^3 - 8x^2 + 8x(3-2\xi) + 16(\xi - 1) = 0$$

with: $0 < x < 1$

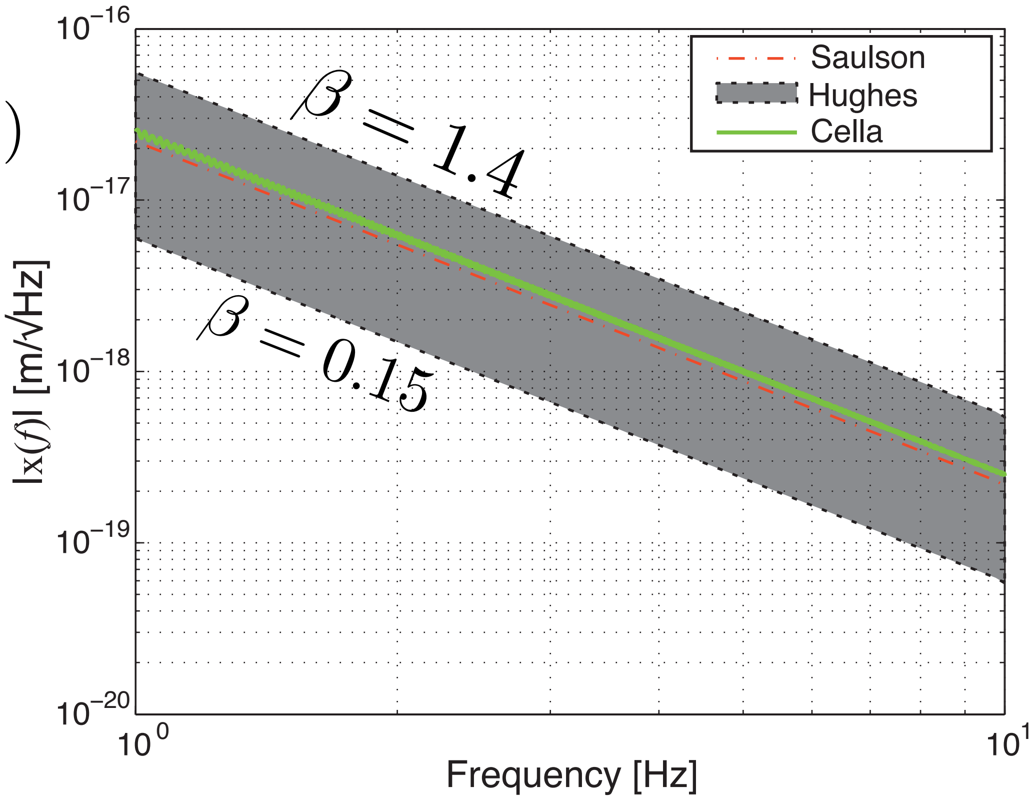
$$k = \frac{\omega}{c_T\sqrt{x}} \qquad \beta_L = \sqrt{(1-\xi x)/x} \qquad \beta_T = \sqrt{(1-x)/x}$$



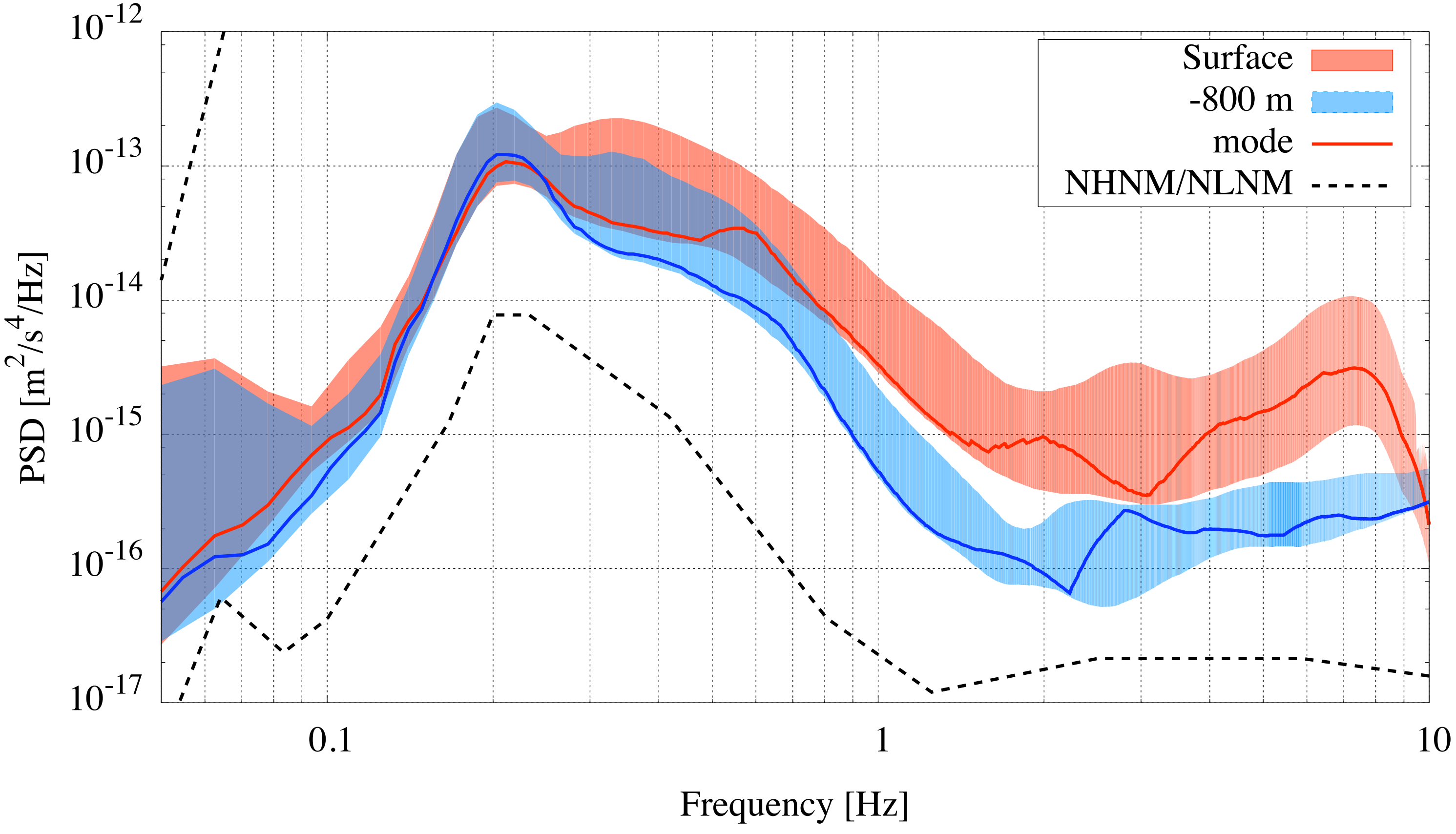
NN CONTRIBUTION OF BULK WAVES (HUGHES AND THORNE)

$$T(f) = \frac{\bar{x}(f)}{\tilde{W}(f)} = \frac{4\pi G\rho}{(2\pi f)^2}\beta(f) \qquad \tilde{W}(f) = 1\times 10^{-9}\frac{m}{\sqrt{Hz}} @ 1 < f < 10\,Hz$$

$$(T_{NN}) = \frac{4\pi G\rho}{\sqrt{2}(2\pi f)}\mathcal{F}\,\Gamma\,\tilde{W}(f)$$

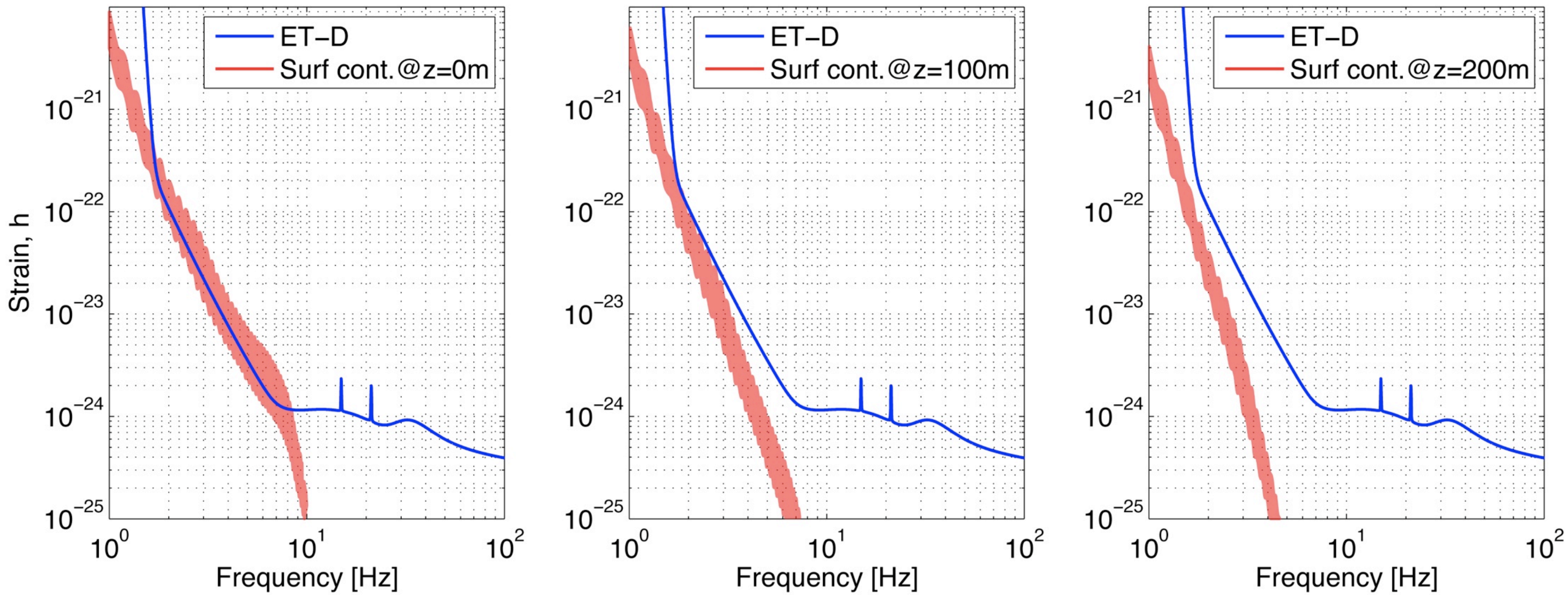


CANFRANC

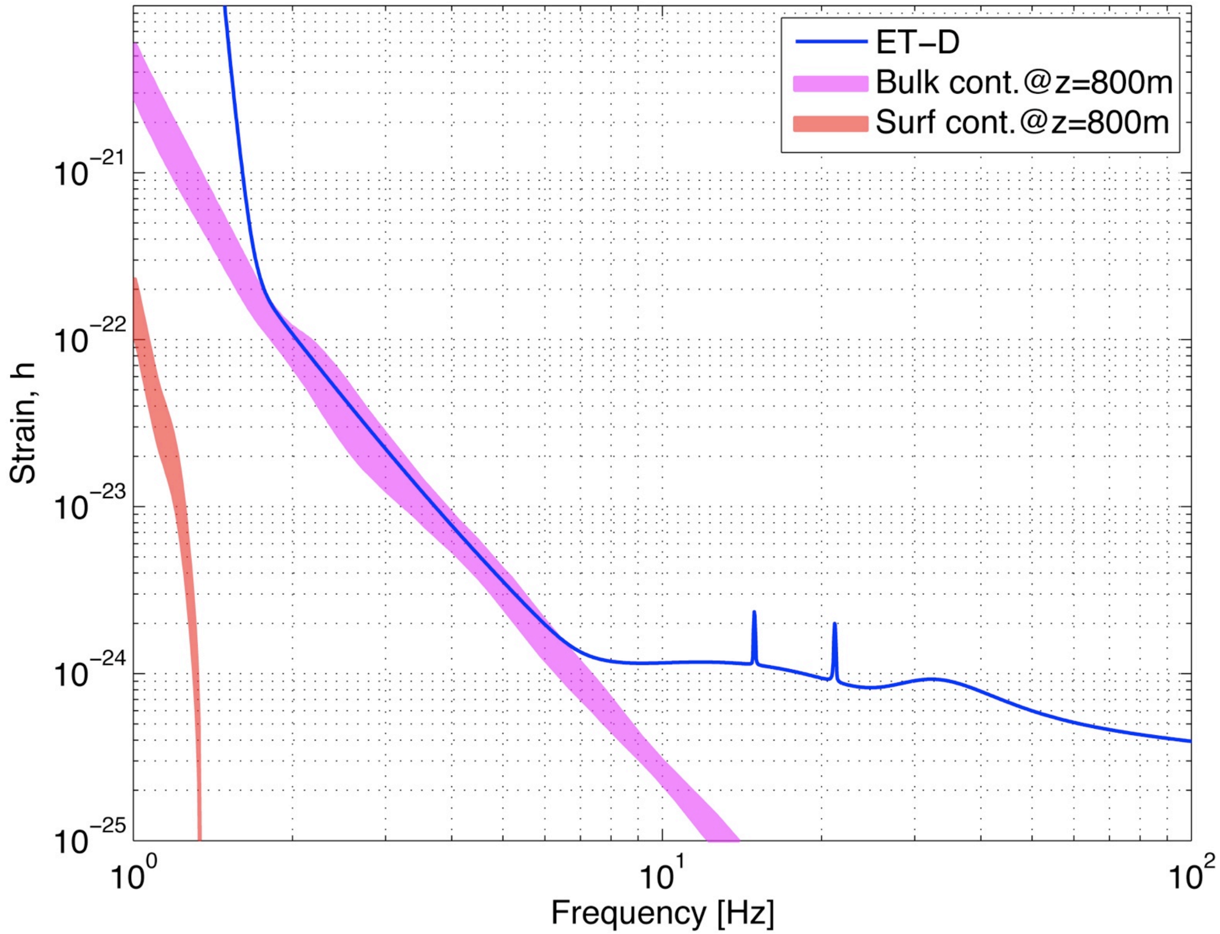


10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
PSD [$m^2/s^4/Hz$]
0.1
1
10
Frequency [Hz]
Surface
-800 m
mode
NHNM/NLNM

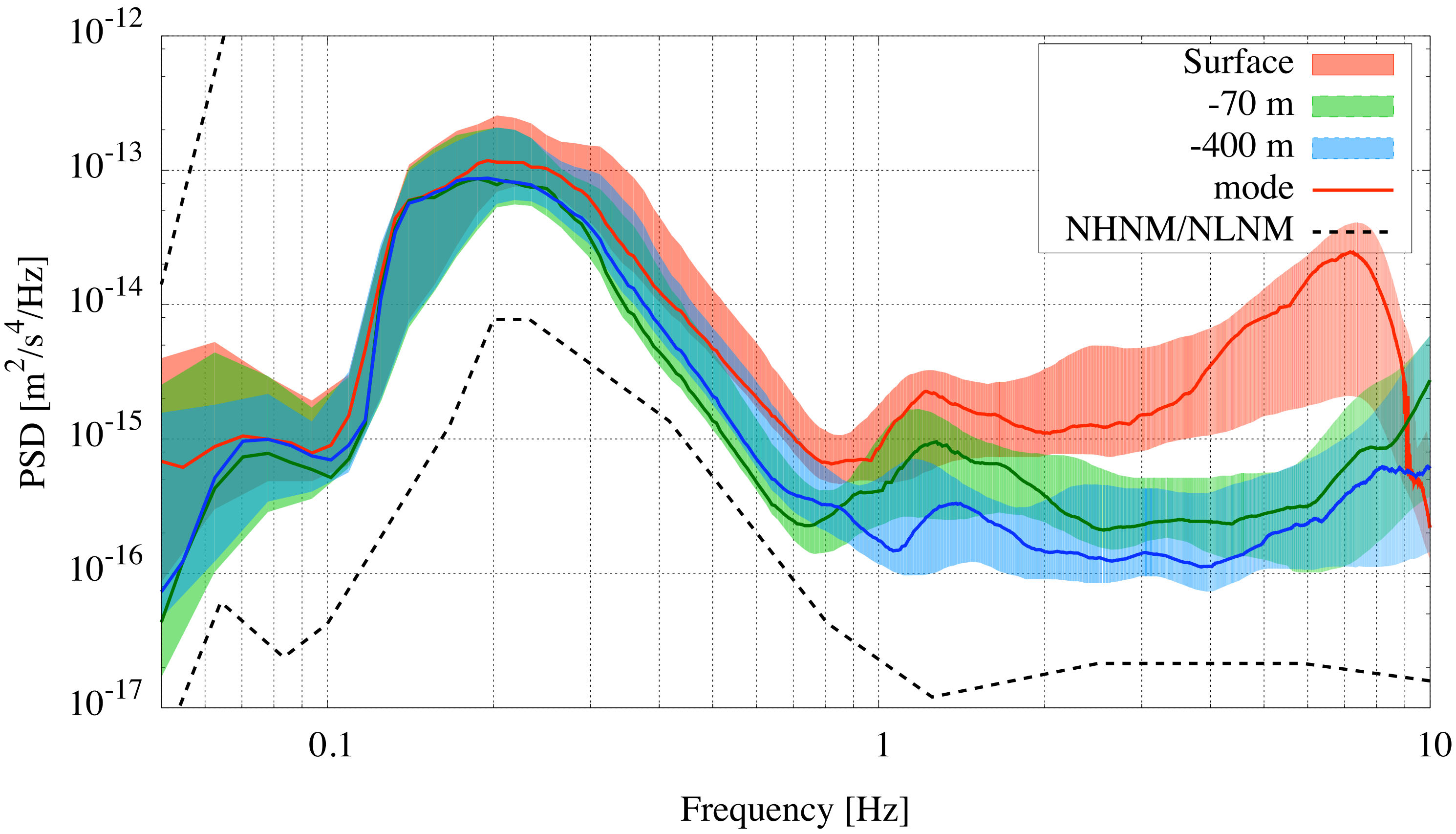
CANFRANC SURFACE NN AT 0, 100, AND 200M DEPTH



CANFRANC NN AT 800 M DEPTH

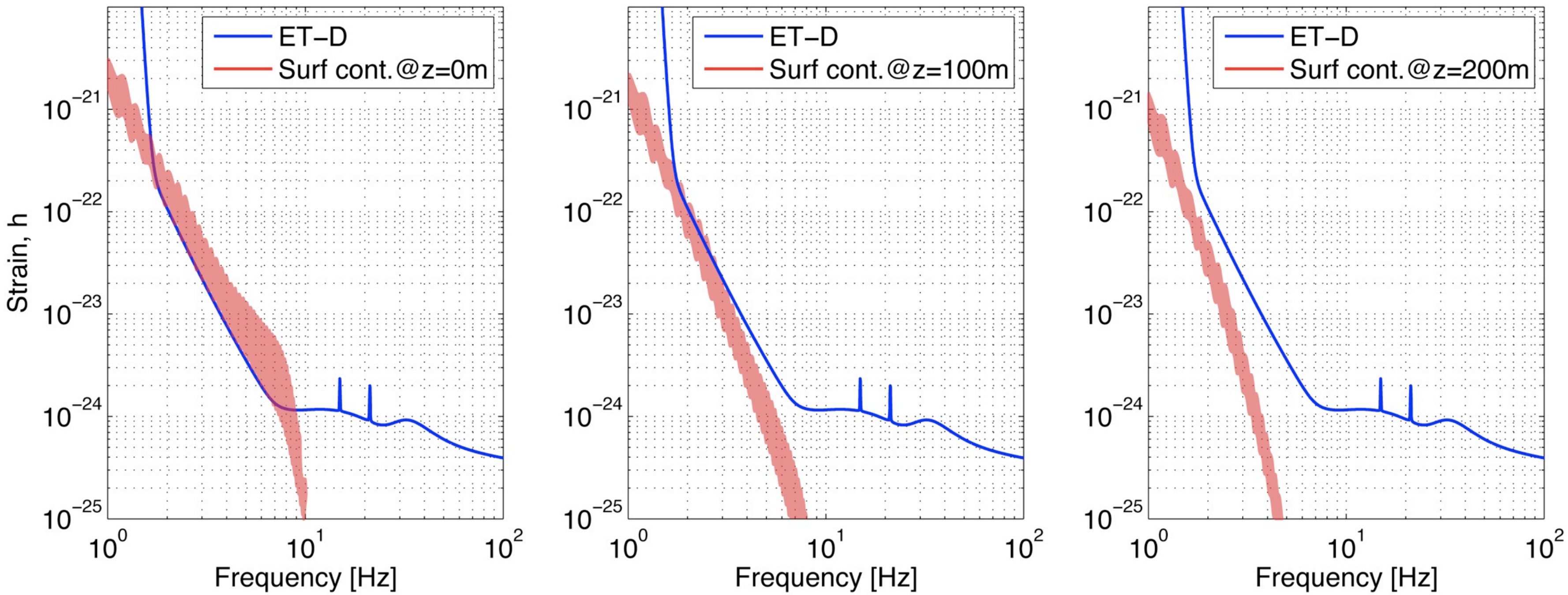


HUNGARY

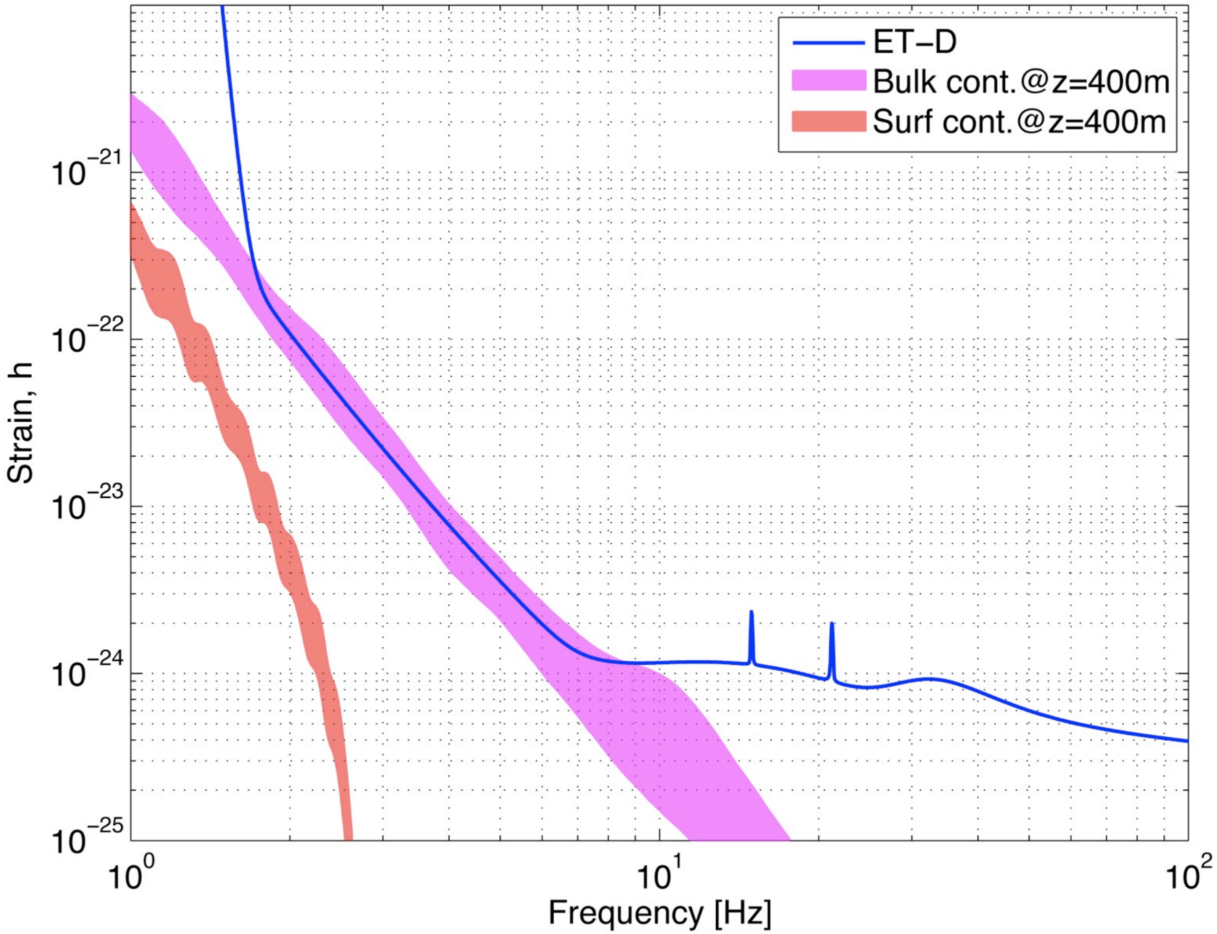


Surface
-70 m
-400 m
mode
NHNM/NLNM
PSD [m^2/s^4/Hz]
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
0.1
1
10
Frequency [Hz]

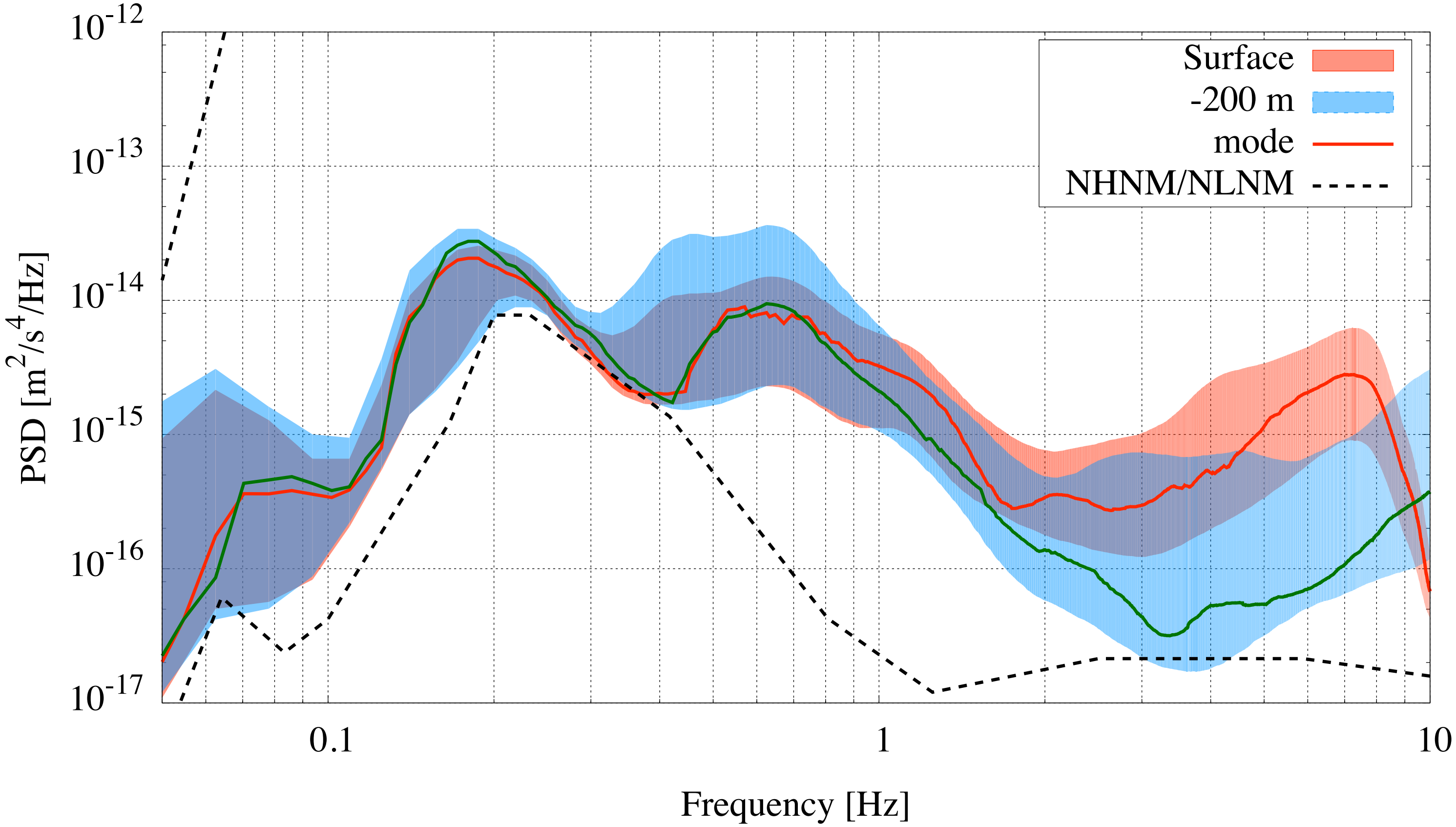
HUNGARY SURFACE NN AT 0, 100, AND 200M DEPTH



HUNGARY NN AT 400 M DEPTH

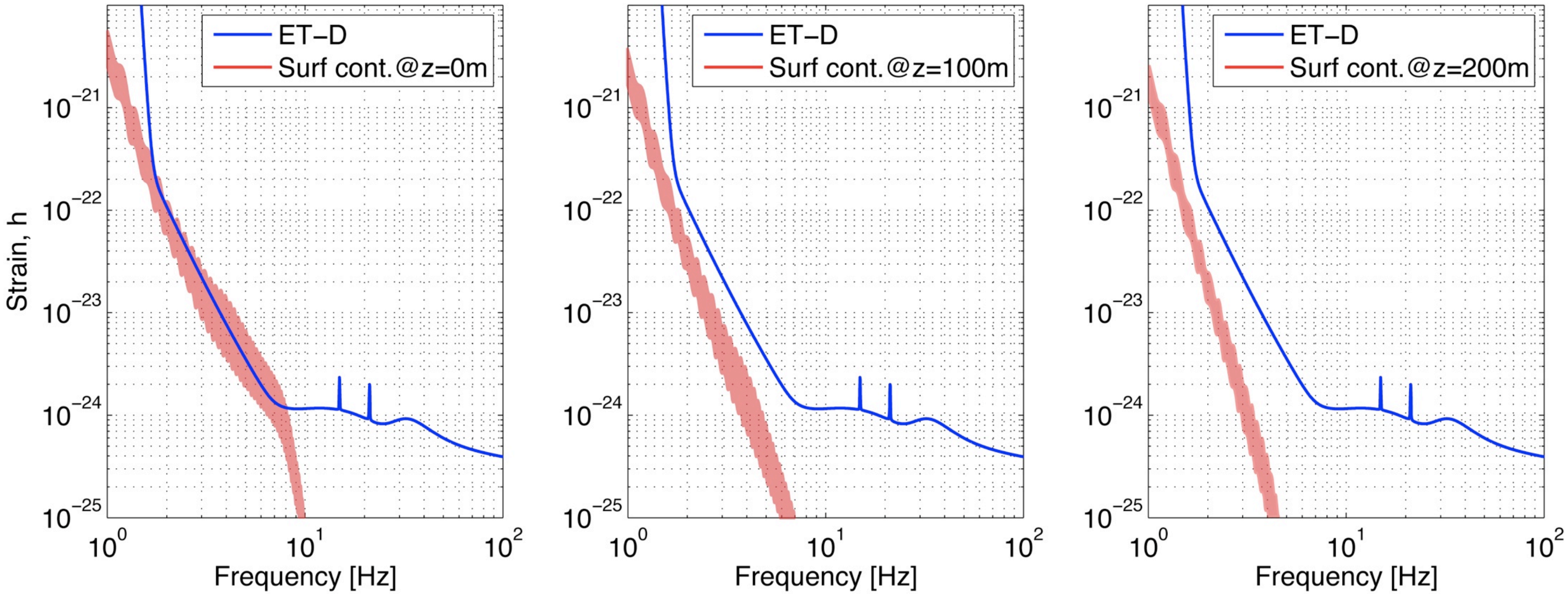


SARDINIA

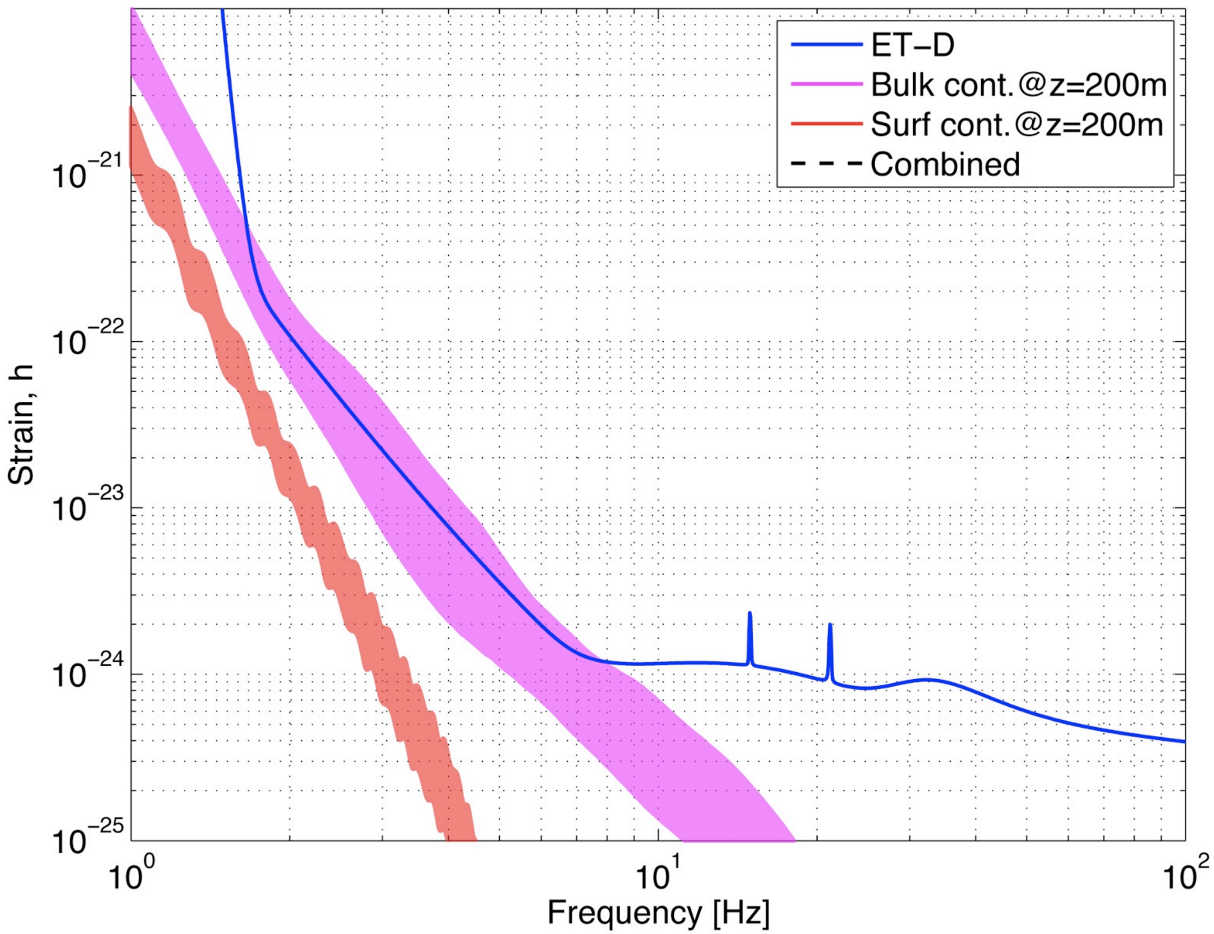


Surface
-200 m
mode
NHNM/NLNM
PSD [m²/s⁴/Hz]
Frequency [Hz]
0.1
1
10
10-12
10-13
10-14
10-15
10-16
10-17

SARDINIA SURFACE NN AT 0, 100, AND 200M DEPTH



SARDINIA NN AT 200 M DEPTH



THANK YOU FOR YOUR ATTENTION