

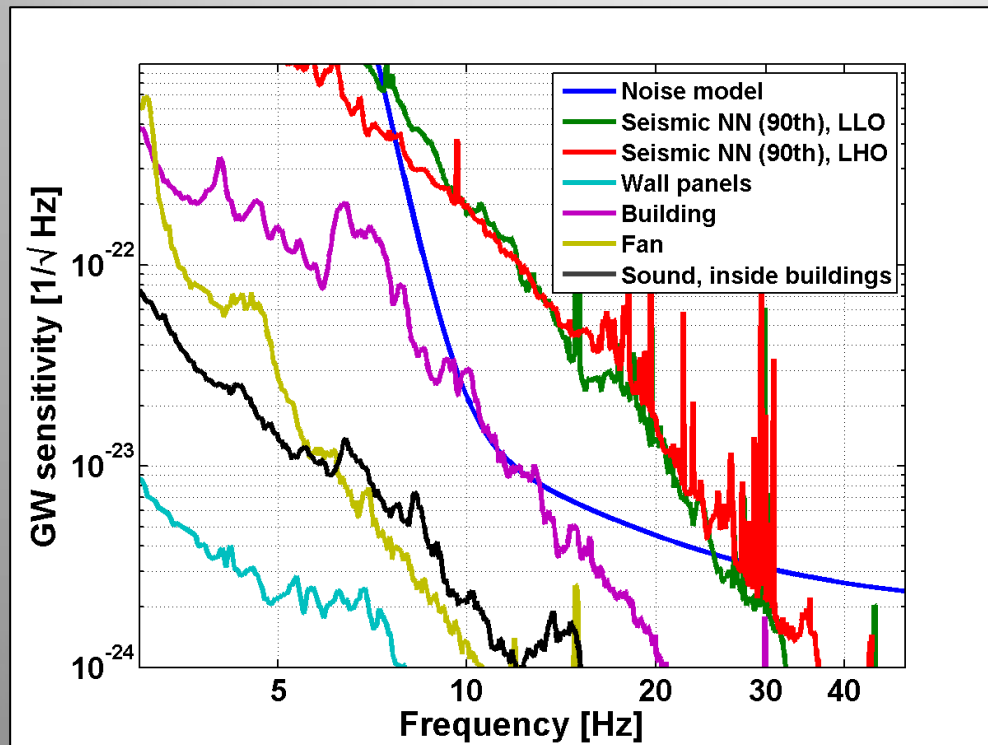
# How to Design your Favorite Gravity Perturbations

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# Newtonian Noise Haunts the Strawman



Completely dominated by seismic NN.

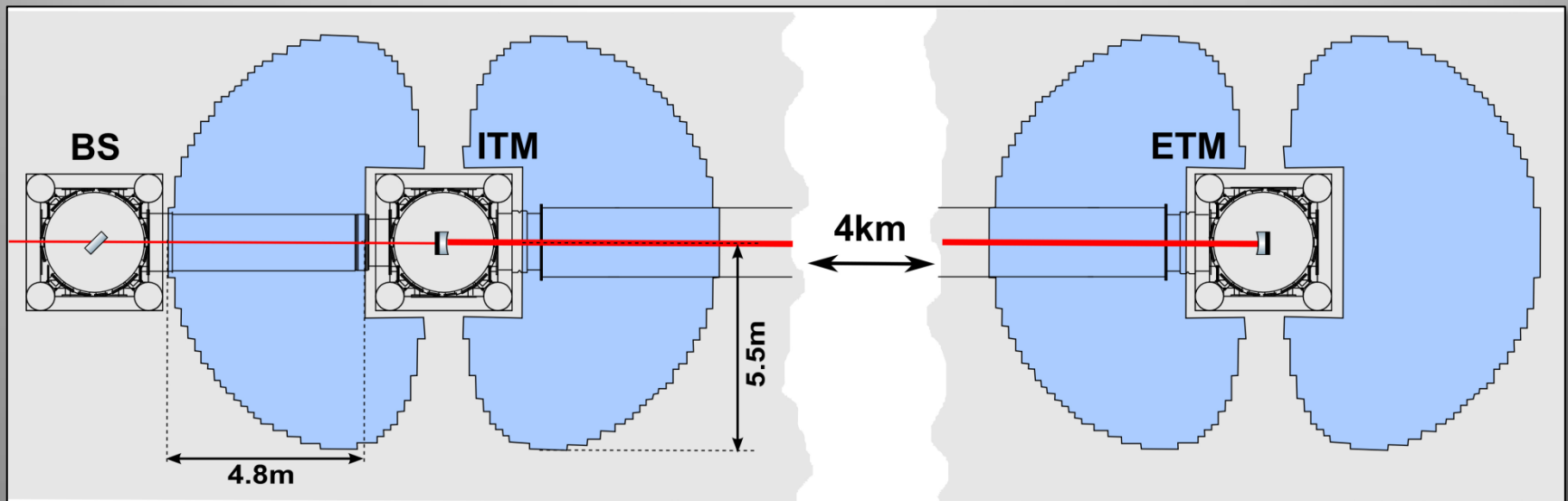
Structure around the test masses with significantly stronger vibration amplitudes still produce less NN.

## Recess or Moat

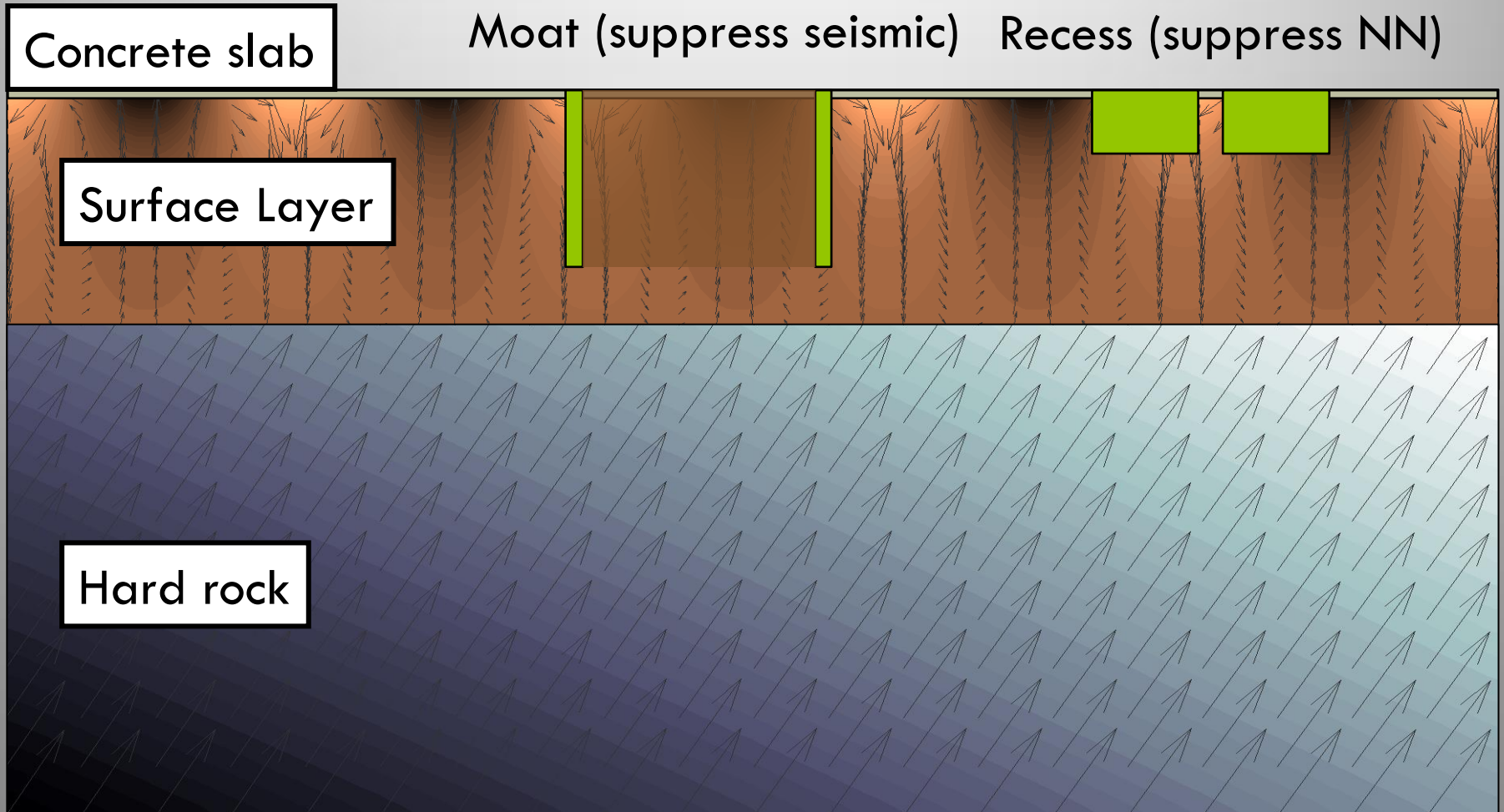
Idea 1: Lowering mass density around test masses lowers NN.

Idea 2: One can block seismic waves on their way to the TMs.

Possible to lower NN substantially?

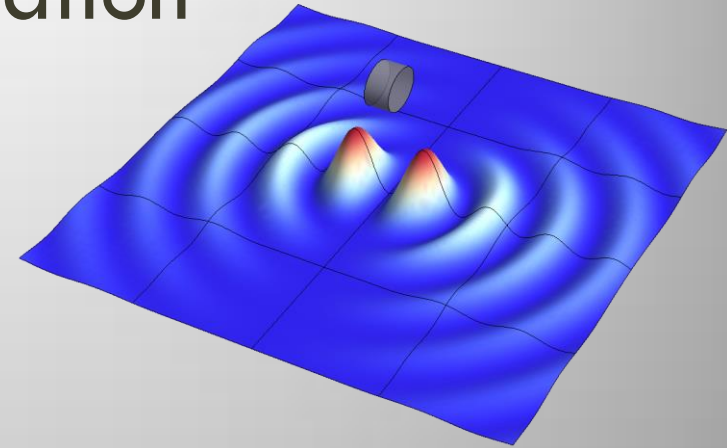
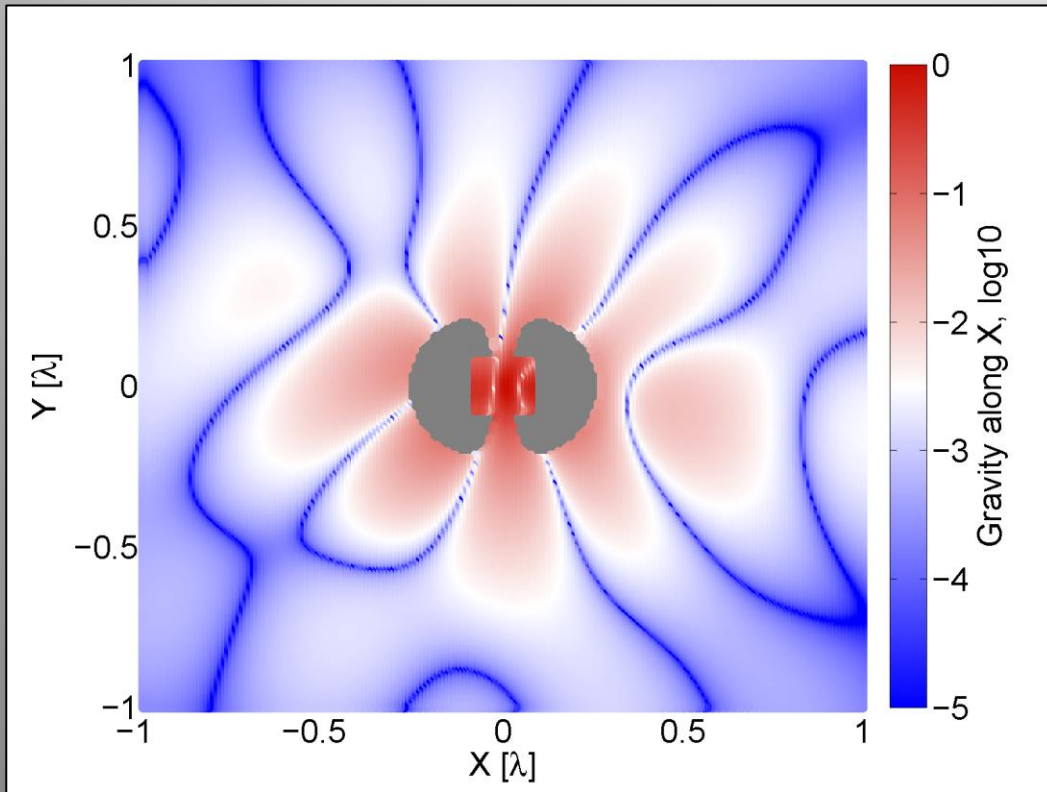


# Moat/Recess: Rayleigh Wave NN

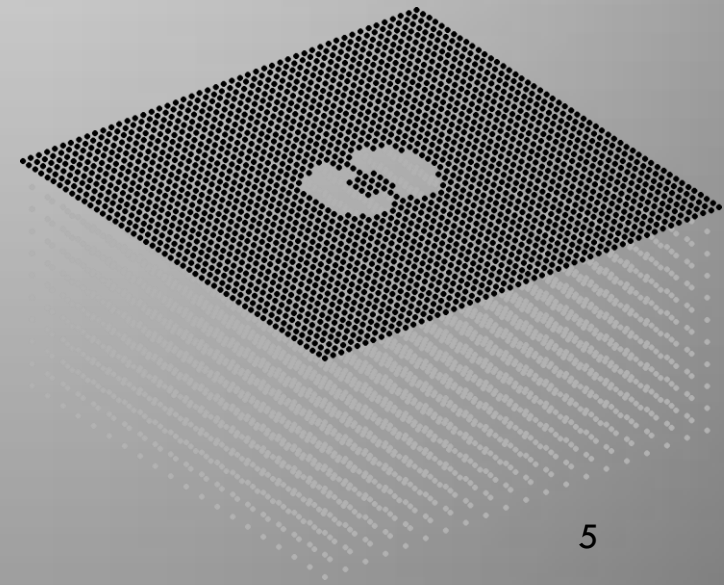


# Tool: FEM Simulation

Gravity perturbations from a seismic field at a specific time.



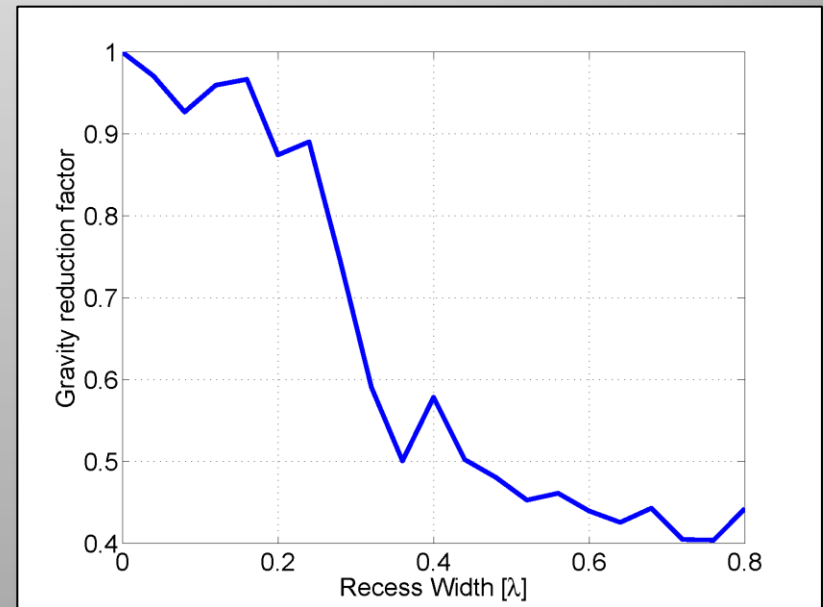
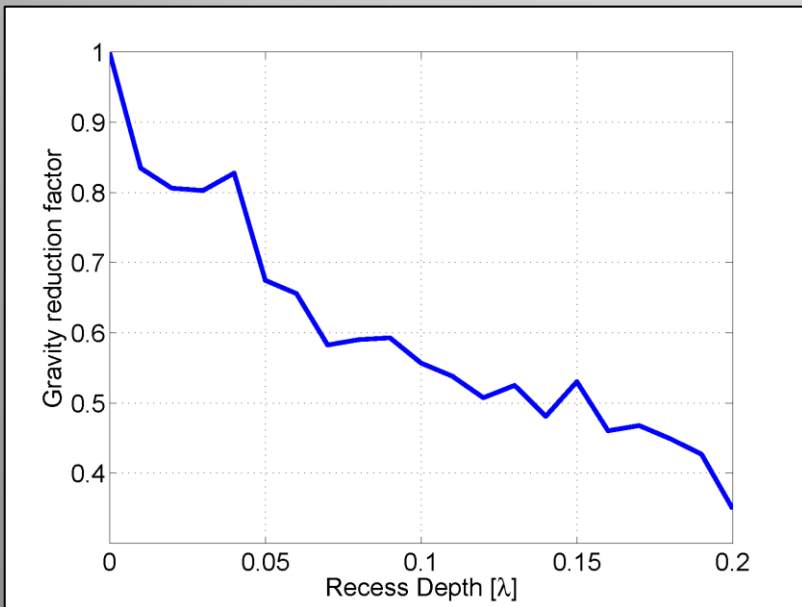
Plotted with less density:



# Effect of Recess on NN

Study dependence on recess depth [Rayleigh wavelength].

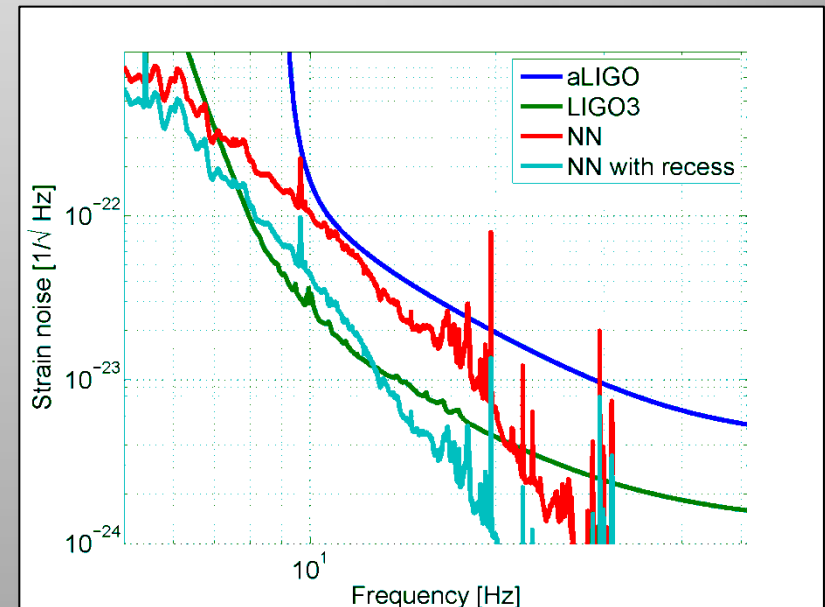
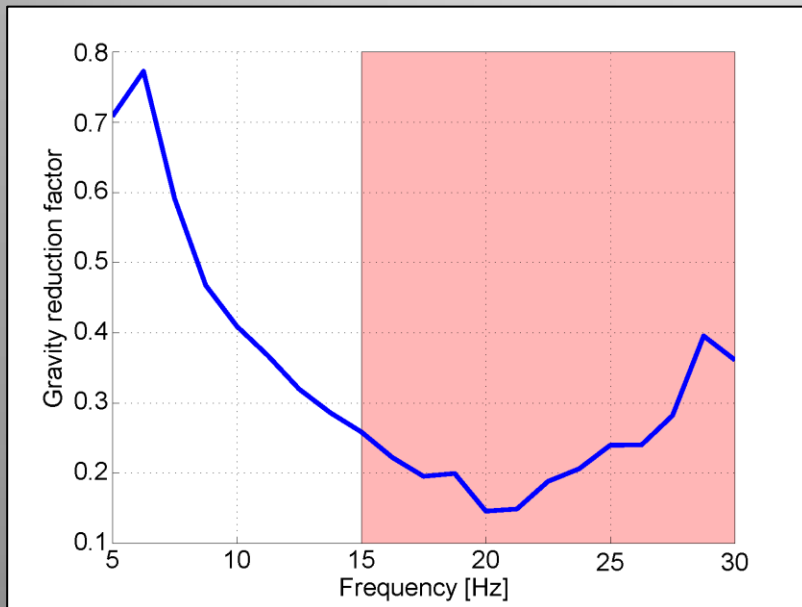
Study dependence on recess width [Rayleigh wavelength].



# Strawman Strikes Back

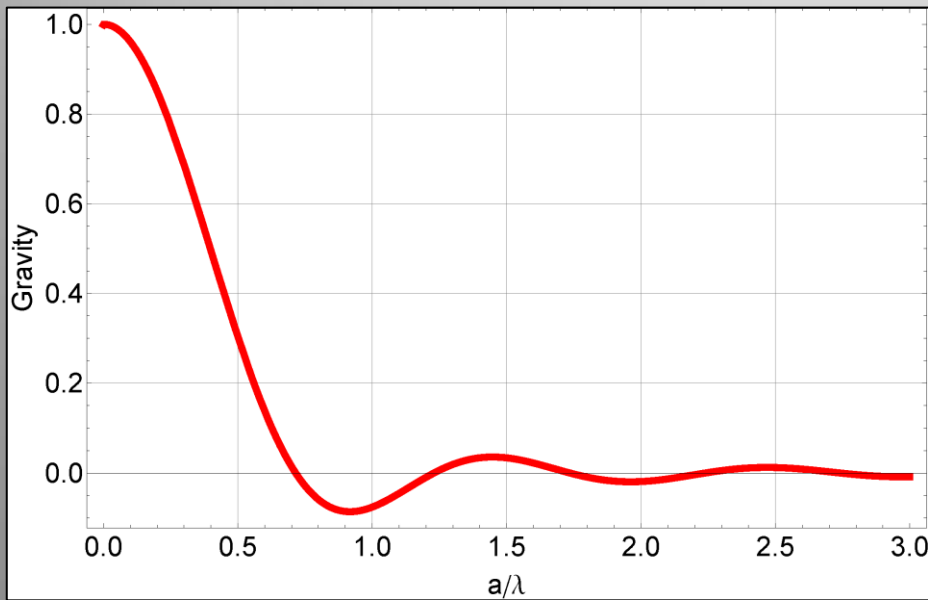
Reduction can be substantial.  
 Red zone marks scattering regime.

Recess could reduce NN almost  
 to the level of other  
 instrumental noise.



# Recess: Only Effective at Surface

Underground NN reduction as function of cavity radius.



The main problem is that seismic waves are much longer underground (by a factor 10).

For a factor 2 reduction at 10Hz: cavity radius about 100m

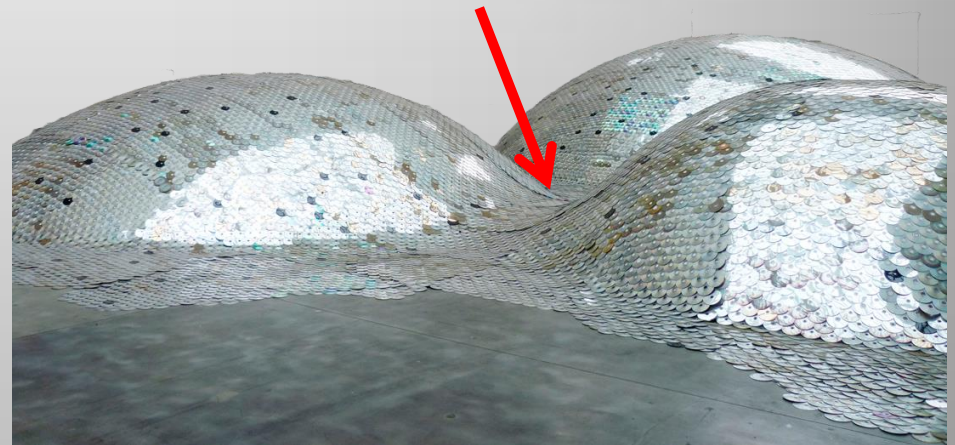


# Brief Recess Summary

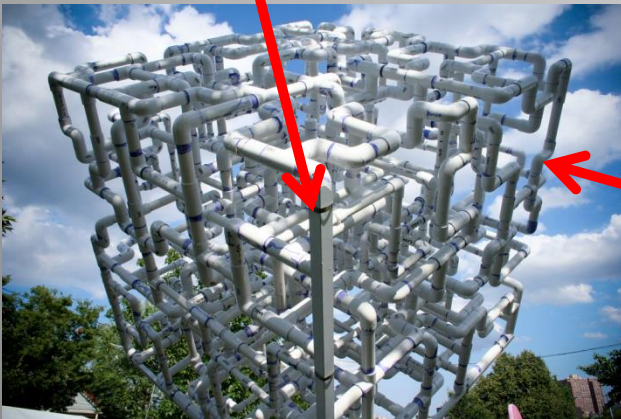
- You need space on both sides of the test masses (ITMs cannot be placed close to BS).
- Noise mitigation gets less with increasing seismic speed (recess may be inefficient at some sites).
  1. Low-speed surface layer (at least about 1.5m thick)
  2. Inefficient for NN mitigation from body waves (independent of surface geology)

# Optimizing 3D Topography?

Test mass here



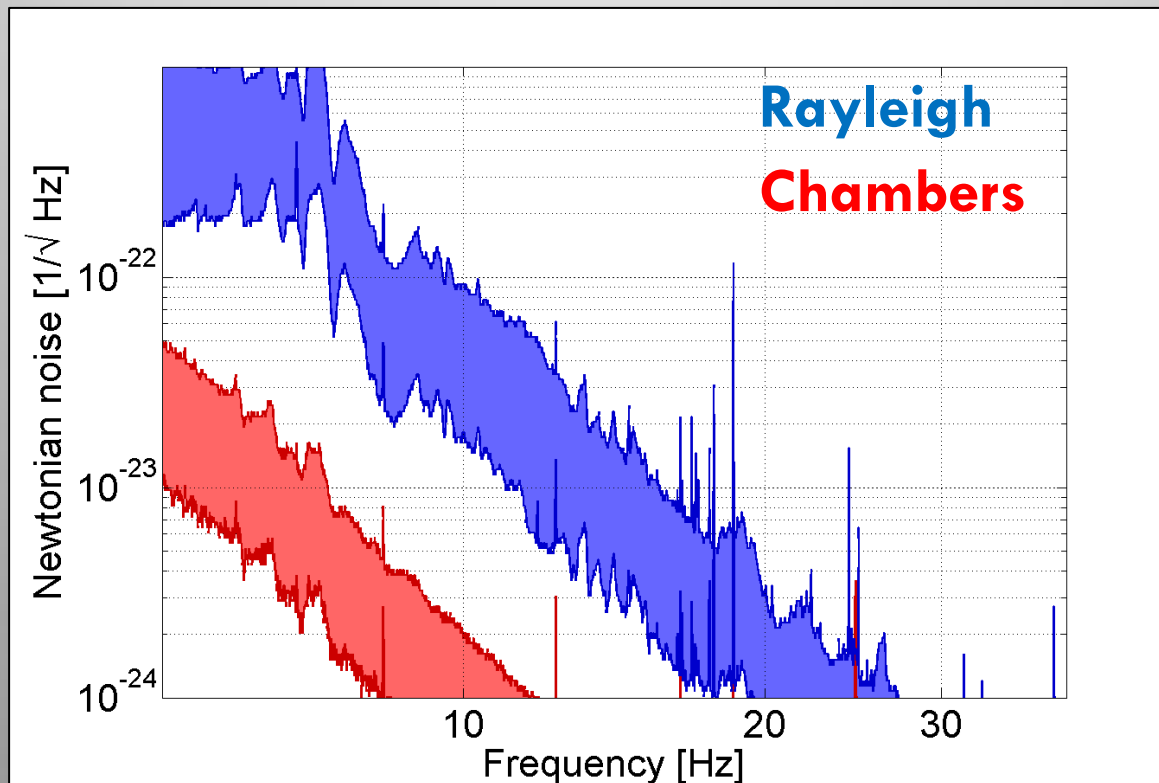
Test mass inside



Stiff or flexible  
joints?

## Example: Test-Mass Chambers

Virgo NN from neighboring chambers is almost 2 orders of magnitude weaker than from ground displacement.



$m = 9 \text{ tons}$   
 $R = 6 \text{ m}$

# Simple NN Scaling Laws

Can mass be distributed around TM such that NN is reduced?

Seismic NN (acc.):

$$c G \xi \rho$$

Point mass NN (acc.):

$$c G \xi \rho \frac{\delta V}{r^3}$$

'c' are different numerical constants of order unity

Max NN cylin-sph (acc):

$$c G \xi \rho f(r; R, d)$$

