Working Group on Environmental Control

Fast Ground Motion and Vibration…
– introduction

Snowmass 2001, July 5
Andrei Seryi
SLAC

Rough scale of tolerable uncorrelated ground motion

- TESLA: ~10nm above 0.2 Hz; much more relaxed with fast intratrain correction
  - Produce 0.1σ_y offset at IP
    - Fast intratrain correction is required
- NLC: ~10nm above 6 Hz;
  - Produce 0.25σ_y offset at IP
    - Achievable. Care about in-tunnel noises

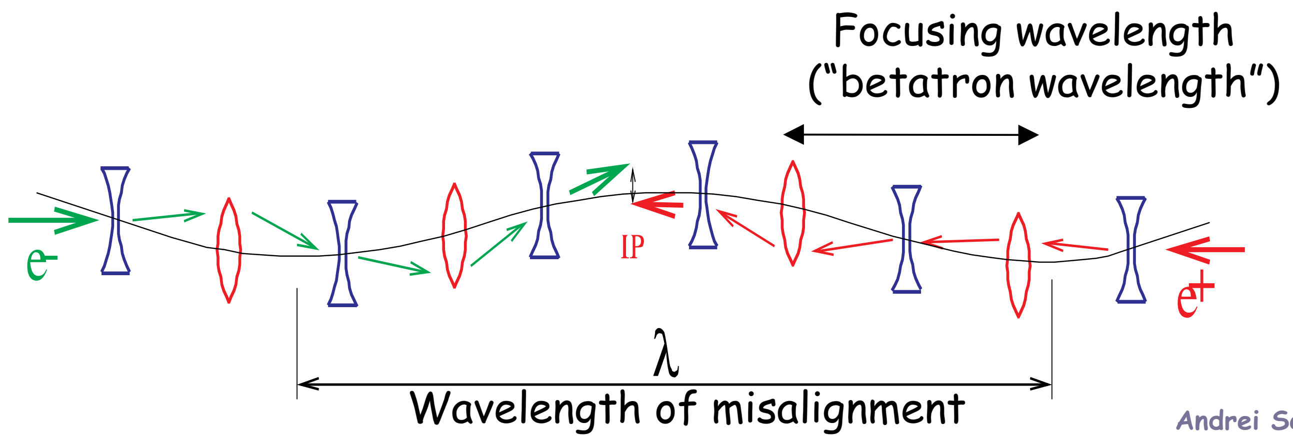
Correlation in time and space

Correlation: relative motion of two elements with respect to their absolute motion

Correlation is a function of separation in **time** and in **space** :

> **time** is important : since a collider has certain repetition rate

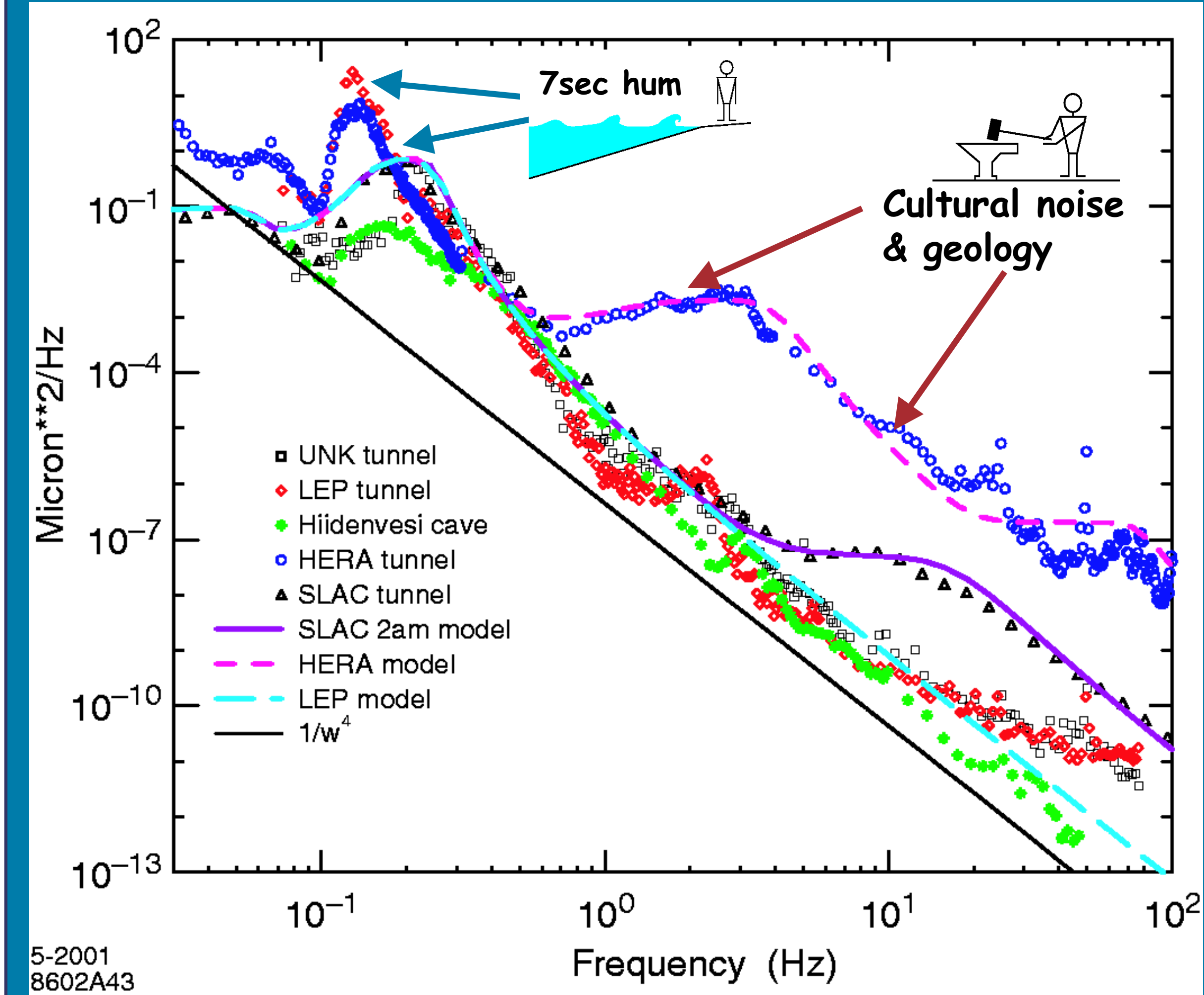
> **space** is important : since a collider has certain focusing wavelength



In addition to absolute motion, one needs correlation data

- This is **absolute** motion (one point with respect to "stars").
- One needs **correlation** data to find **relative** motion
- and to build a **2D** spectrum of ground motion **P(ω,k)**

Power spectral density of absolute position

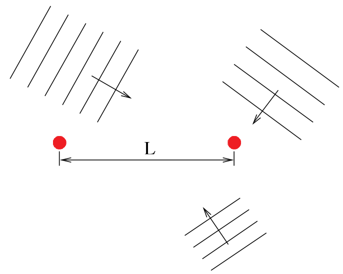


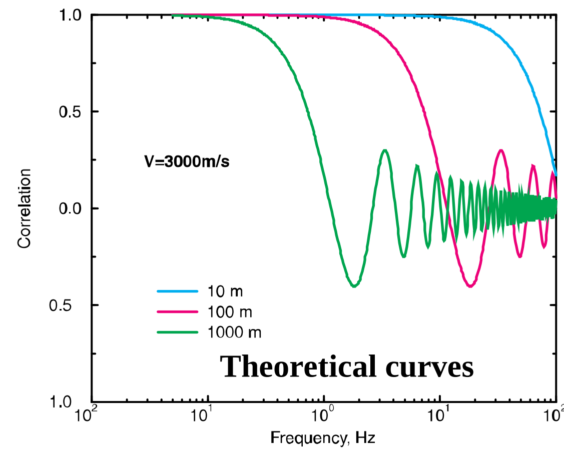
Correlation measurements and interpretation

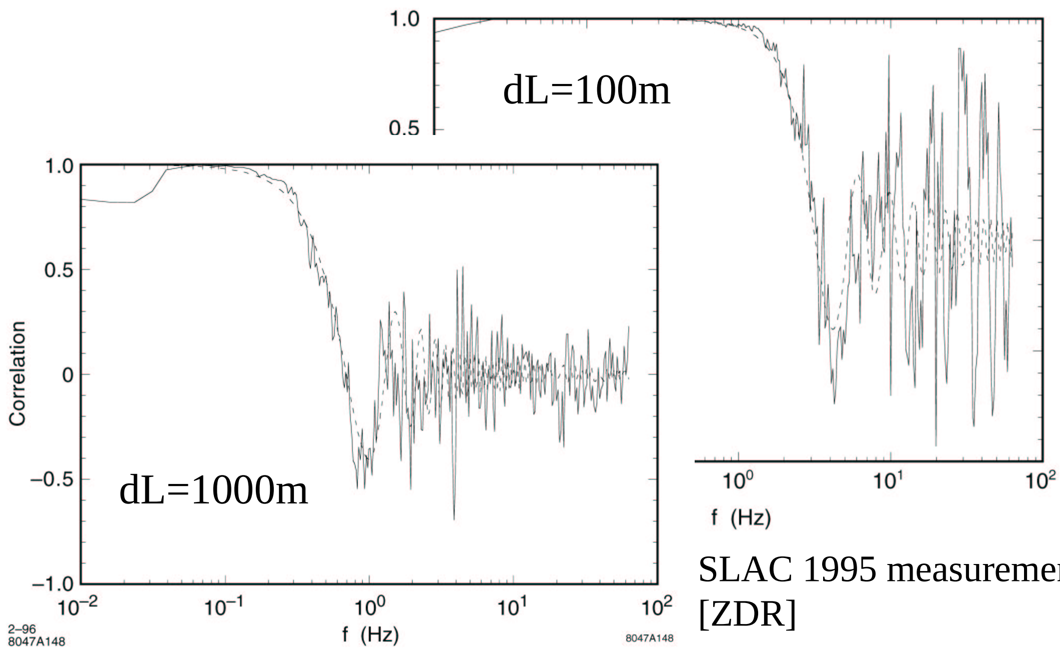
In a model of plane wave propagating on surface

correlation = $\langle \cos(\omega \Delta L/v \cos(\theta)) \rangle_\theta$ =

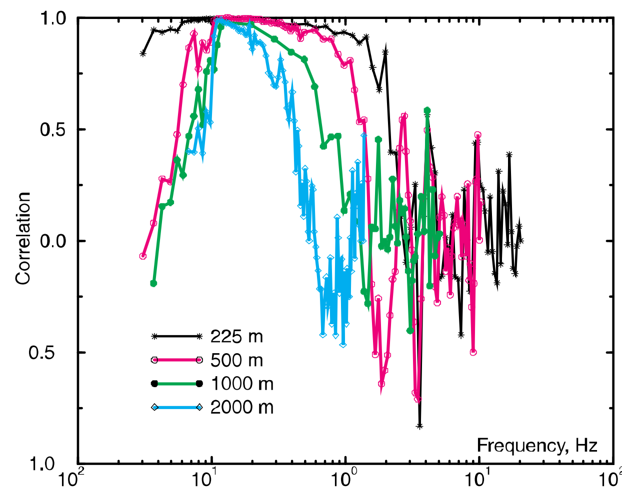
$= J_0(\omega \Delta L/v)$ where **v-** phase velocity







SLAC 1995 measurements [ZDR]



BINP@CERN LEP 1993 measurements [V.J. et al.]

Ground motion vs geology, location, depth

- Geology: hard rock is preferable

  => fast motion is better correlated (as v larger and λ longer)

- Location:

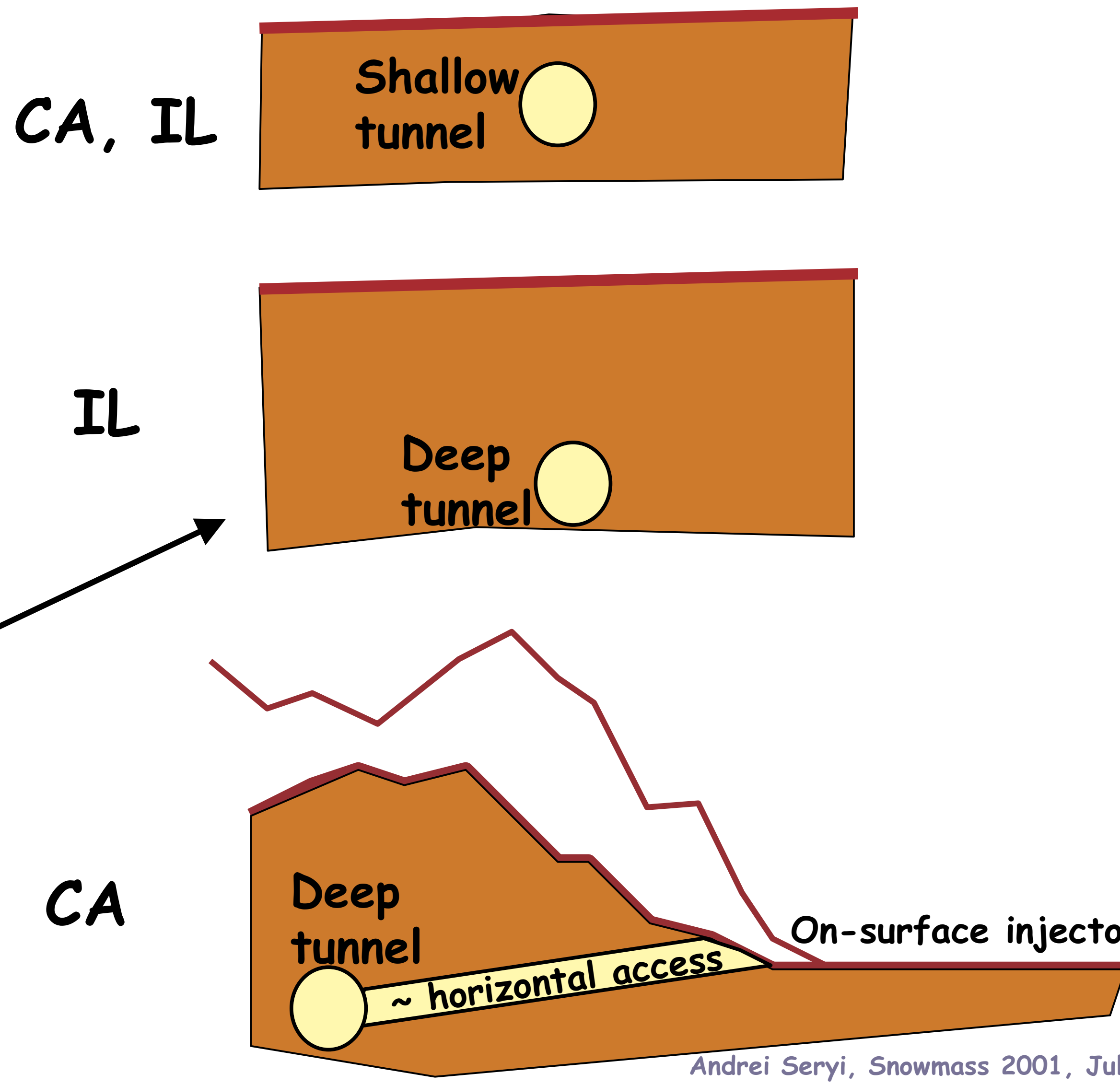
  => avoid external <u>cultural noise</u>, especially for shallow tunnel

- As geology and noise depend on depth, we have one more degree of freedom

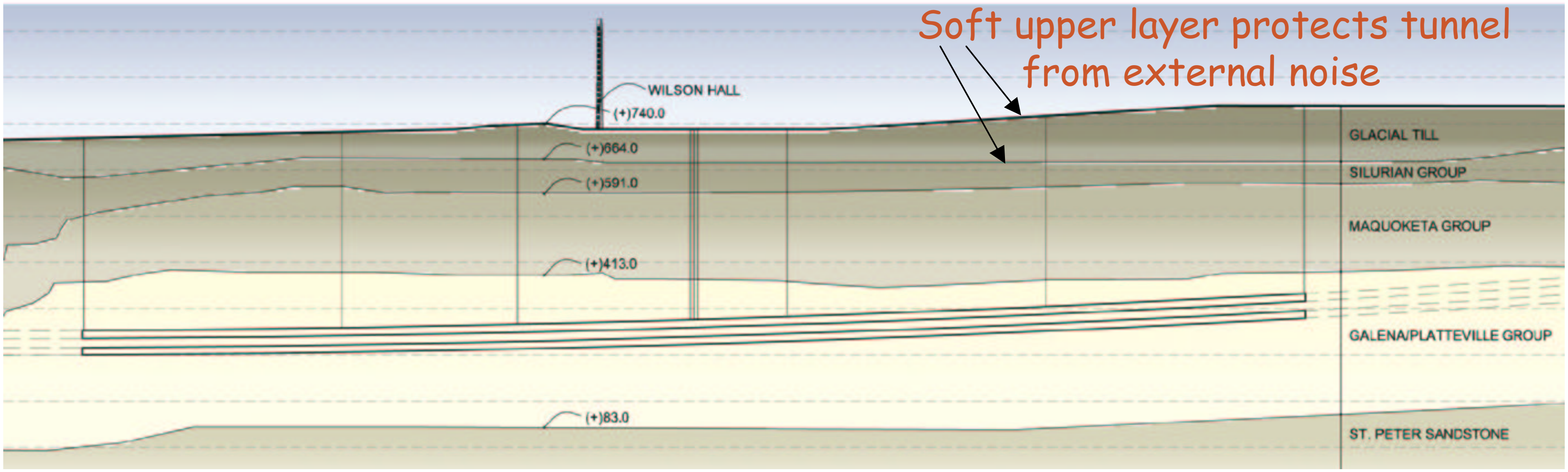
NLC sites & Ground motion

- NLC sites considered in California and Illinois so far:

Also considered for VLHC



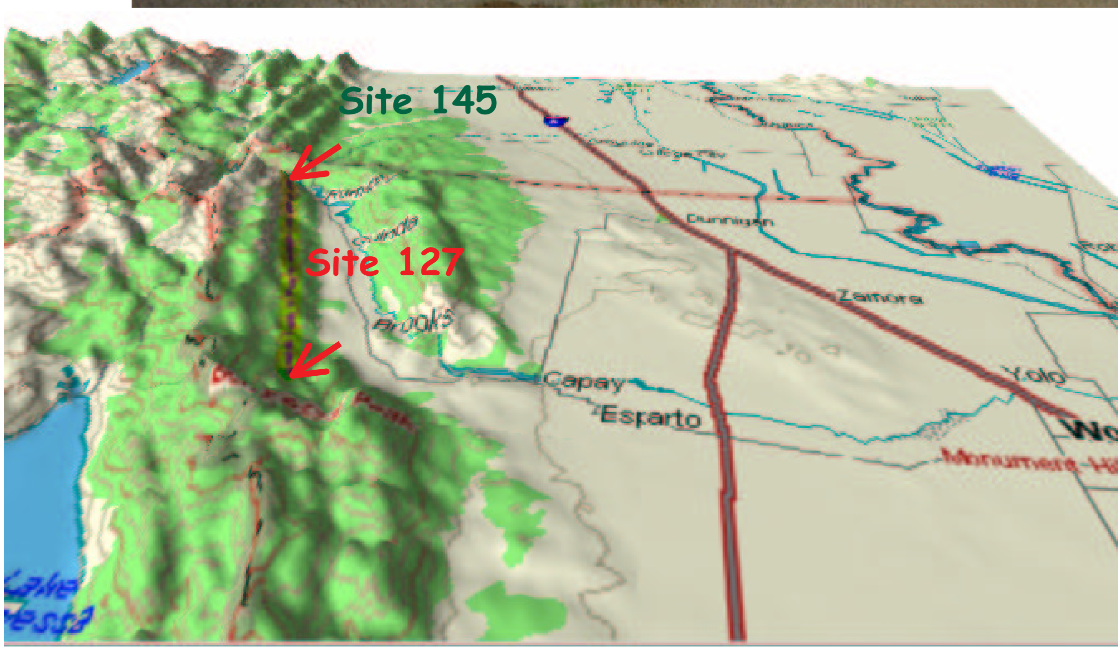
NLC deep tunnel @ Fermilab

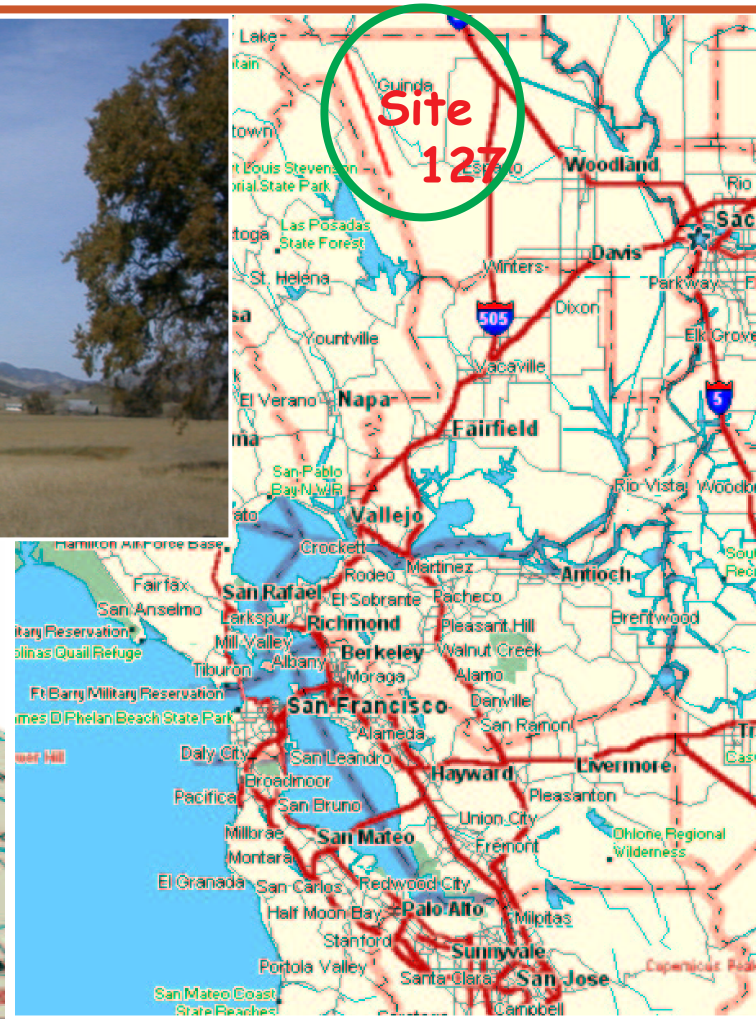


- Tunnel is placed **~100m deep in geologically perfect Galena Platteville dolomite platform**
- **Top ground layer is soft** (NUMI geological studies : $v_2/v_1 \sim 5/1$ for 1^{st} transition) – **this increase isolation from external noises**
- When choosing depth – **optimize** not only for boring conditions, but **also for vibration attenuation – each layer makes tunnel more quiet**

NLC

NLC deep tunnel CA sites 127&145



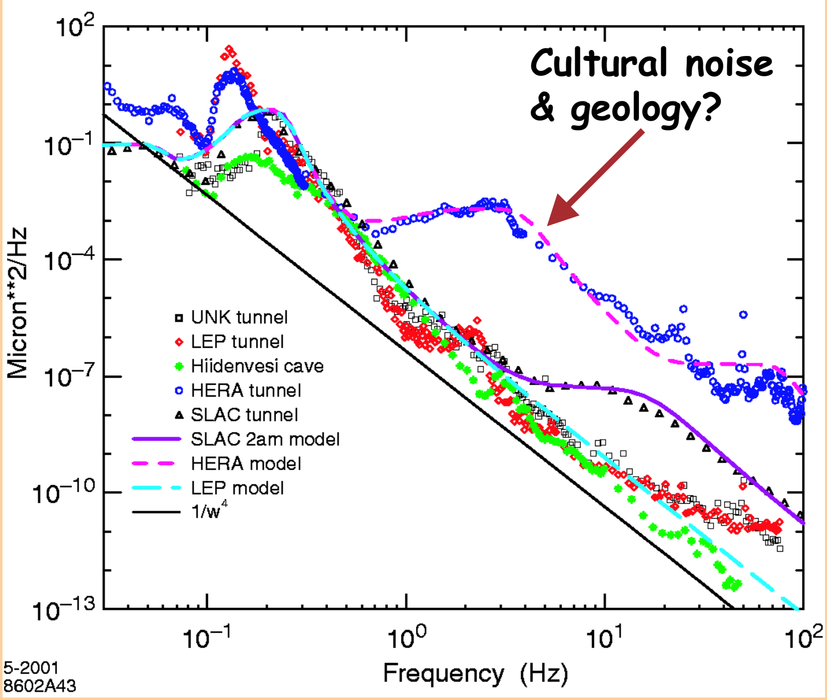


Andrei Seryi, Snowmass 2001, July 5

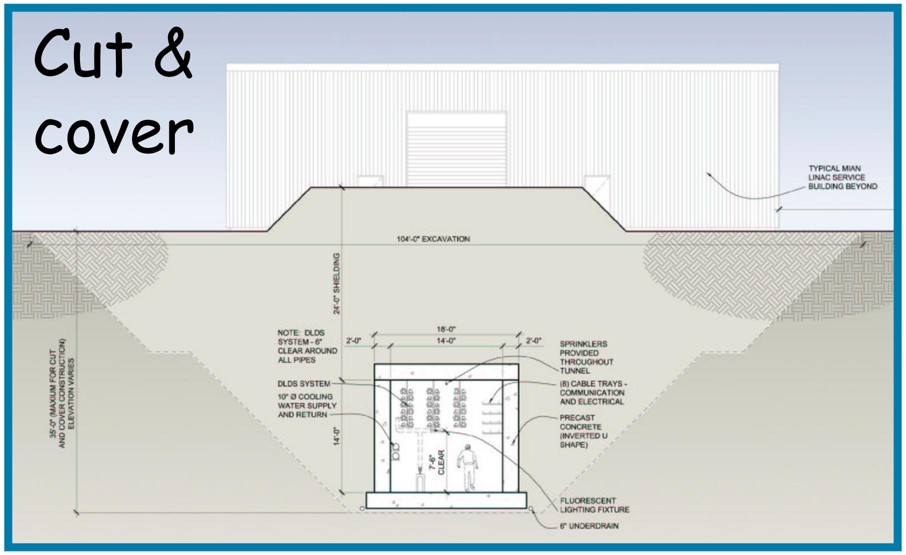
What is the reason of larger noise at HERA ?

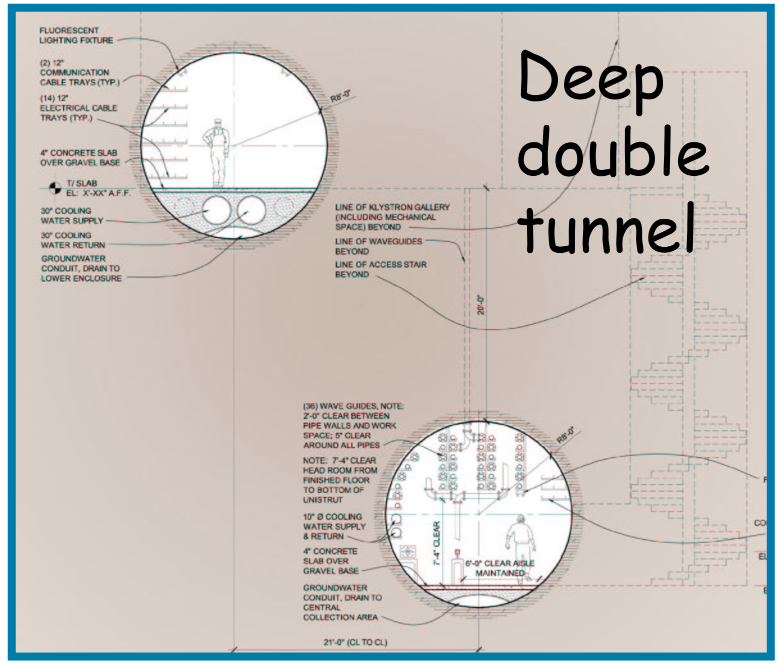
- Reasons for larger noise
  - Cultural noise
  - Resonance of clay/sandy site itself ?

Fragment of picture from TESLA TDR



Rescued from external noise, care about on-site generated





- Utility induced vibrations on the floor not to exceed 3nm for F>3Hz
- One need to isolate noise sources from the tunnel

NLC

Questions

- Best way to hide from vibrations?
- Possibility to measure/predict noise vs depth
- What is the reason for larger noise at HERA? Can we predict noise level at TESLA site?
- How to suppress conventional facility noise?