

# LIGO's Thermal Noise Interferometer

Progress and Status

Eric Black, Ken Libbrecht, Luca Matone,  
Shanti Rao, Kevin Schulz  
*LIGO, Caltech*

Seiji Kawamura  
*TAMA, Tokyo*

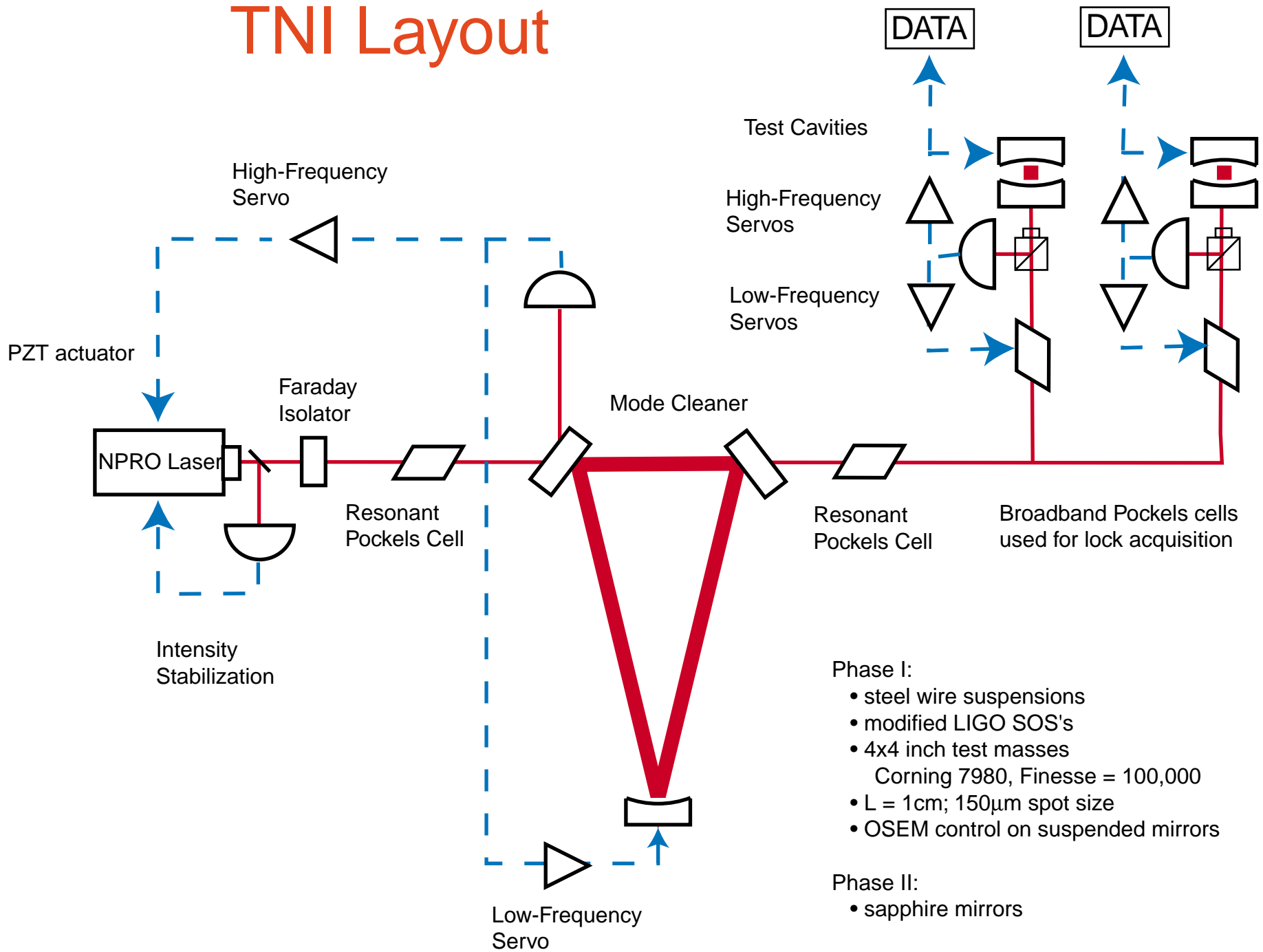
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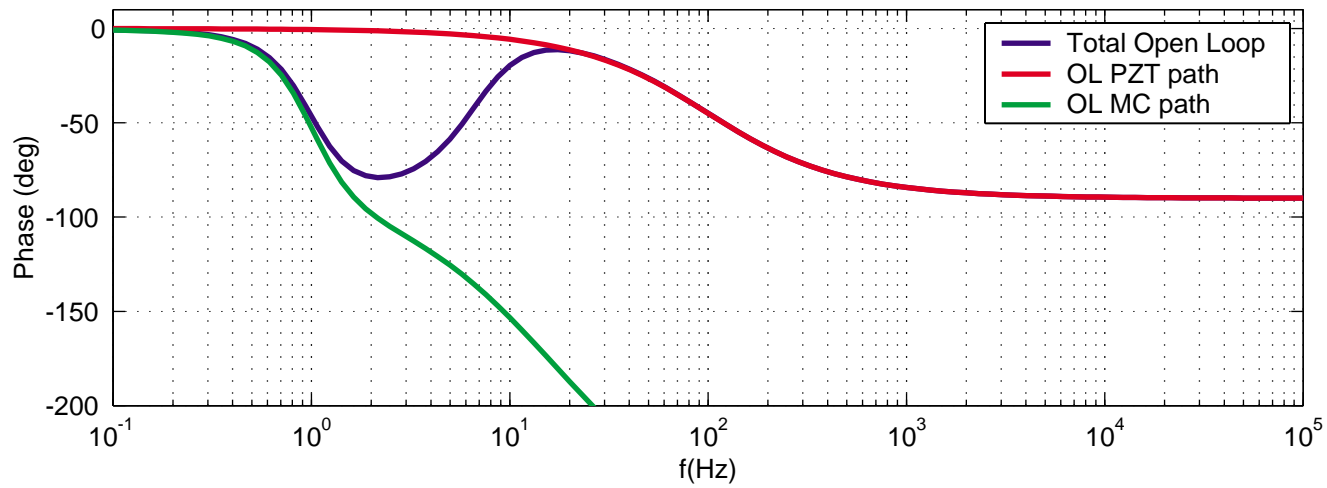
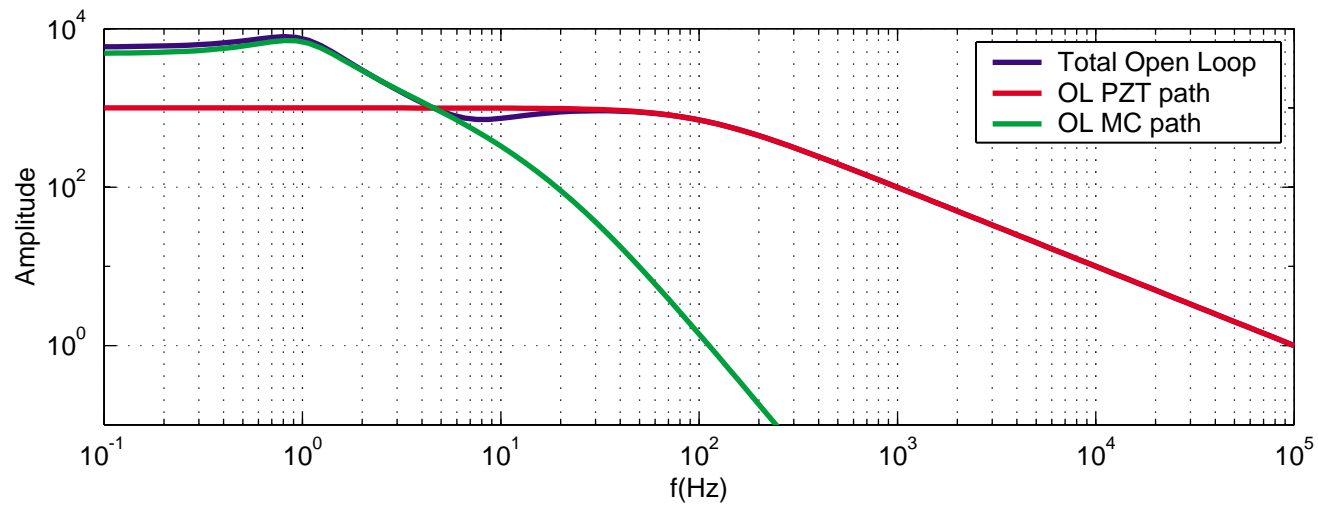
*2001 Conference on Gravitational Waves and Their Detection, Aspen CO*

# TNI Objectives

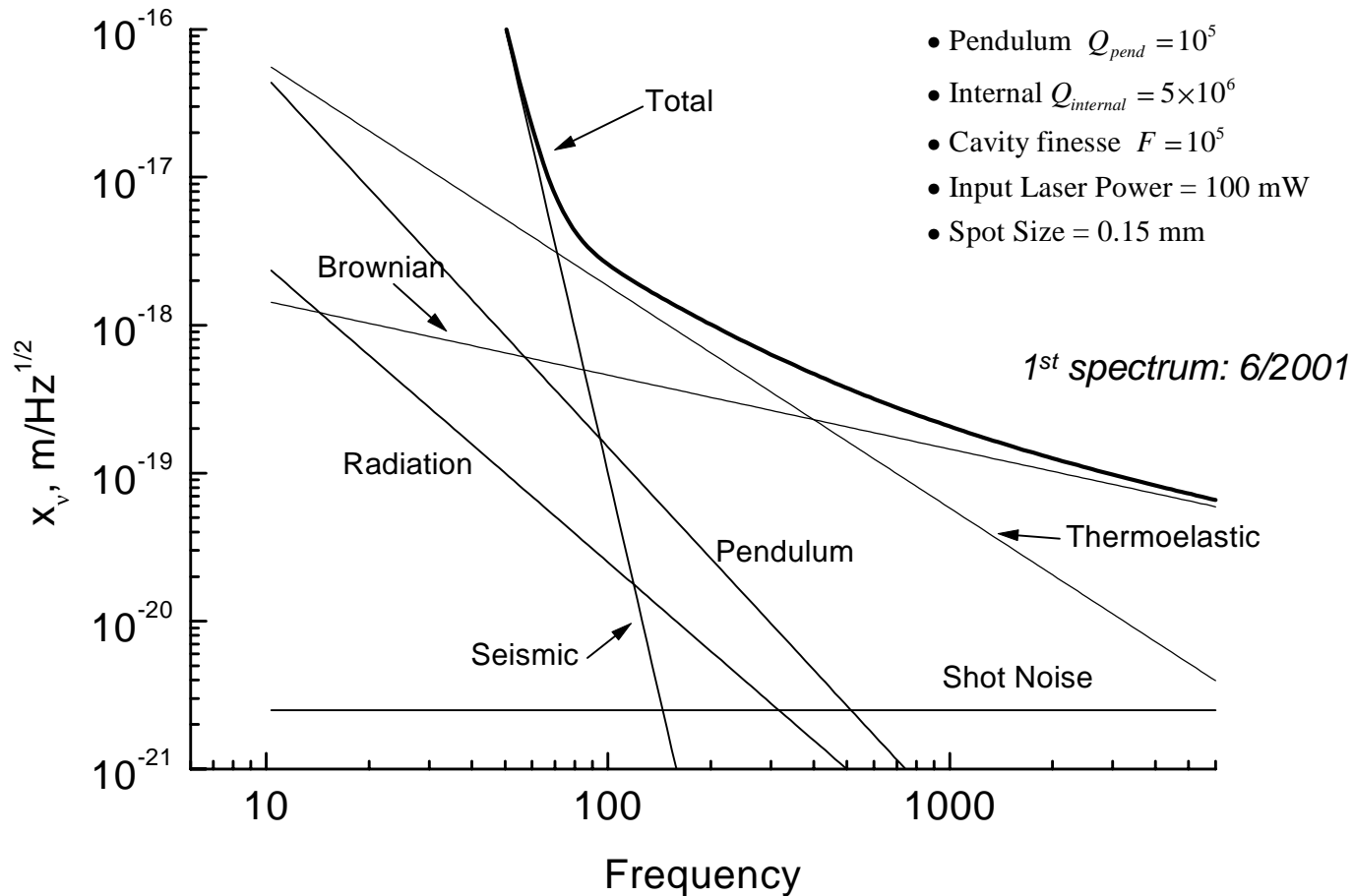
- Study the physics of fundamental noise sources
  - ⇒ Isolate and study noise sources in mirrors and suspensions
  - ⇒ Test existing thermal noise models in very low-loss systems using a small spot size
  - ⇒ Characterize non-Gaussian noise in mirrors and suspensions
- Part of a larger program that includes
  - ⇒ Thermal Noise Interferometer
  - ⇒ Photothermal noise experiment
  - ⇒ Observation of SQL

# TNI Layout

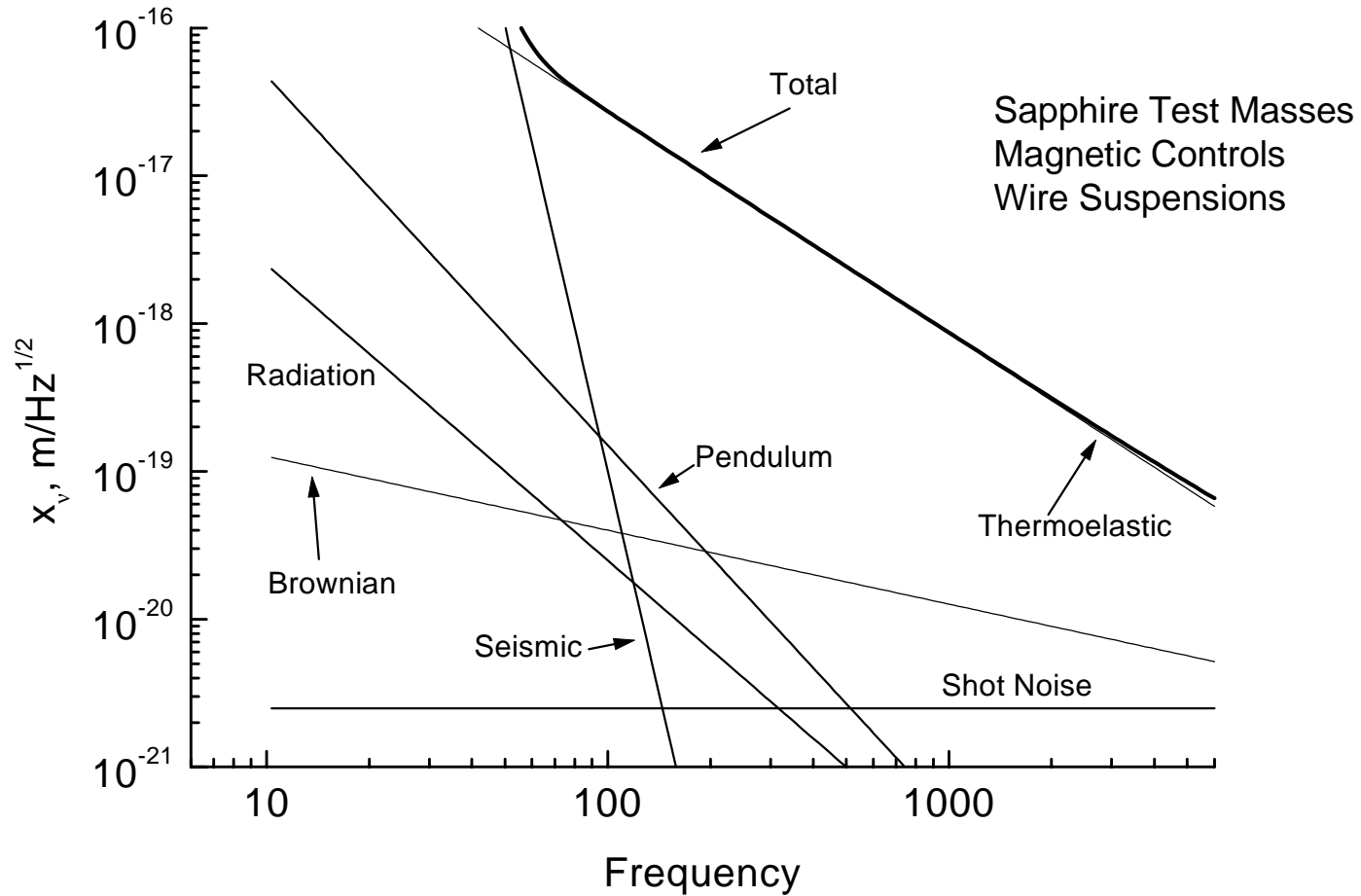




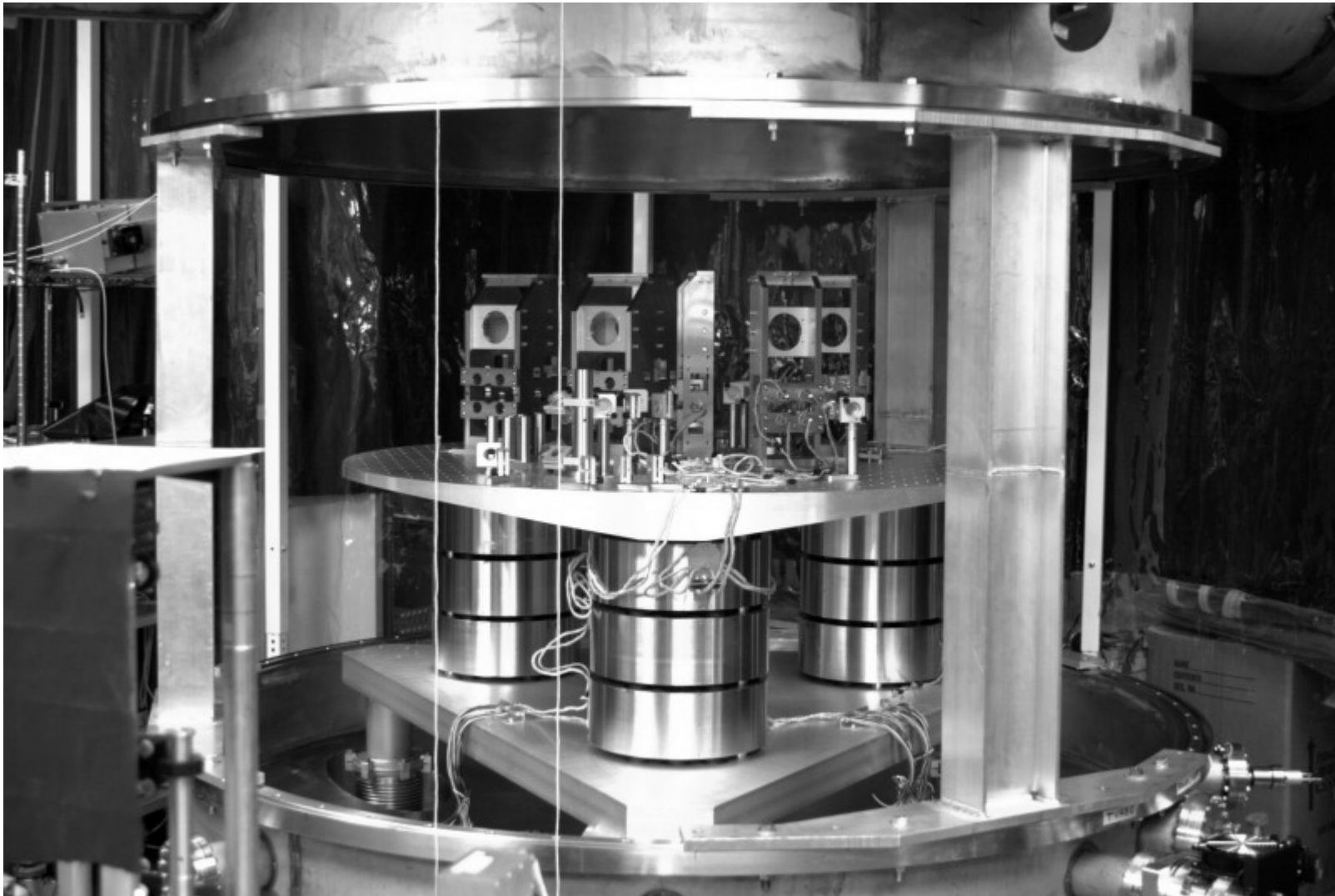
# TNI Phase I Expected Spectrum



# TNI Phase II Expected Spectrum



TNI View inside vacuum chamber



## Progress

- High finesses achieved in both the mode cleaner and one arm cavity
- Mode cleaner successfully locked in final (?) configuration
- Arm cavity locked using laser's PZT input

## Remaining tasks before first spectrum

- Replace laser (pathological behavior)
- Lock arm cavity using broadband Pockels cell
- Lock second arm cavity



## Observations on lock acquisition

- Naive bandwidth requirement: servo must be fast enough to “catch” while the cavity is resonant

$$\frac{1}{\tau} \approx \frac{2F}{\lambda} v_{mirror}$$

$$v_{mirror} \approx 1 \frac{\mu m}{s} ; \quad \lambda \approx 1 \mu m ; \quad F \approx 100,000 ;$$

$$\frac{1}{\tau} \approx 200 kHz$$

Observe: successful lock acquisition for bandwidths  $\leq 50 kHz$   
 $\Rightarrow 1 \mu m/s$  is the *maximum* mirror velocity.  
 $\Rightarrow F$  closer to 50,000.

## Conclusions

- We are building a dedicated interferometer to study displacement noise in mirrors and suspensions.
- Most of the hardware is assembled, and all optics (7) are suspended and damped.
- Initial, lock-acquisition stage is nearly complete.  
Remaining: Switch PZT actuator to broadband Pockels cell on arm cavity lock.
- We anticipate a preliminary noise spectrum by June, 2001.