

LIGO's Thermal Noise Interferometer

Progress and Status

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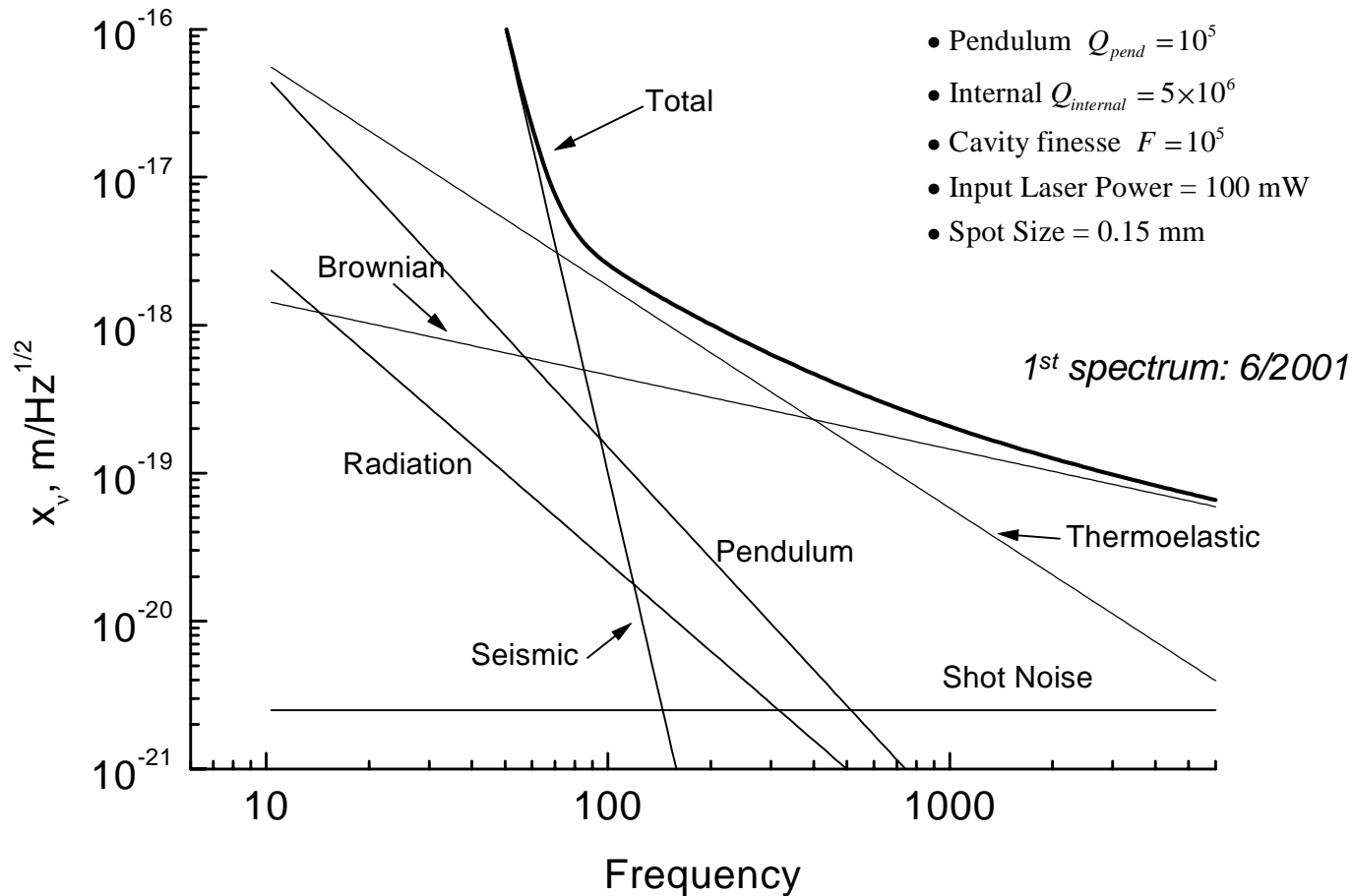
LIGO-G010182-00-D

2001 Conference on Gravitational Waves and Their Detection, Aspen CO

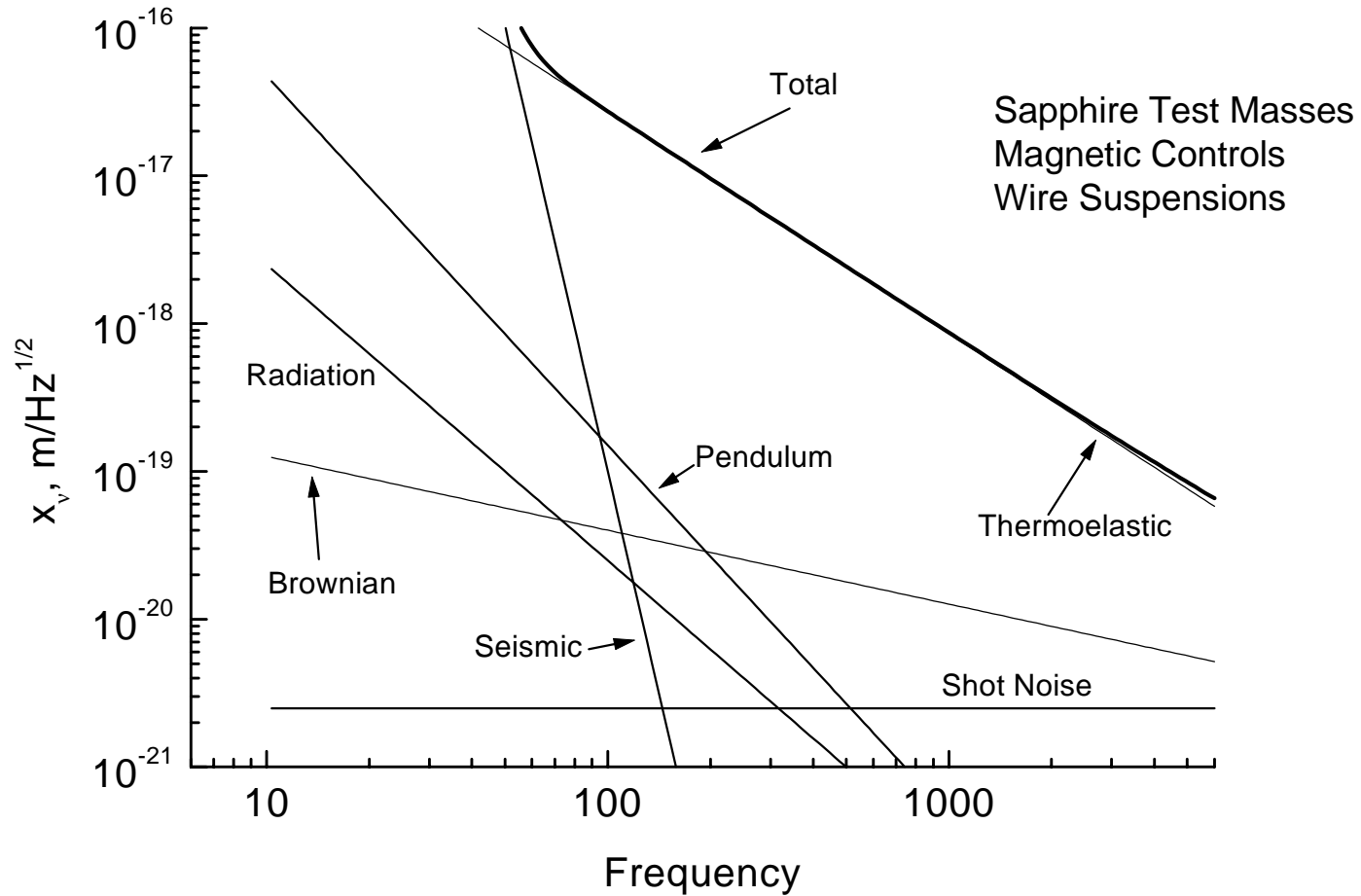
TNI Objectives

- 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

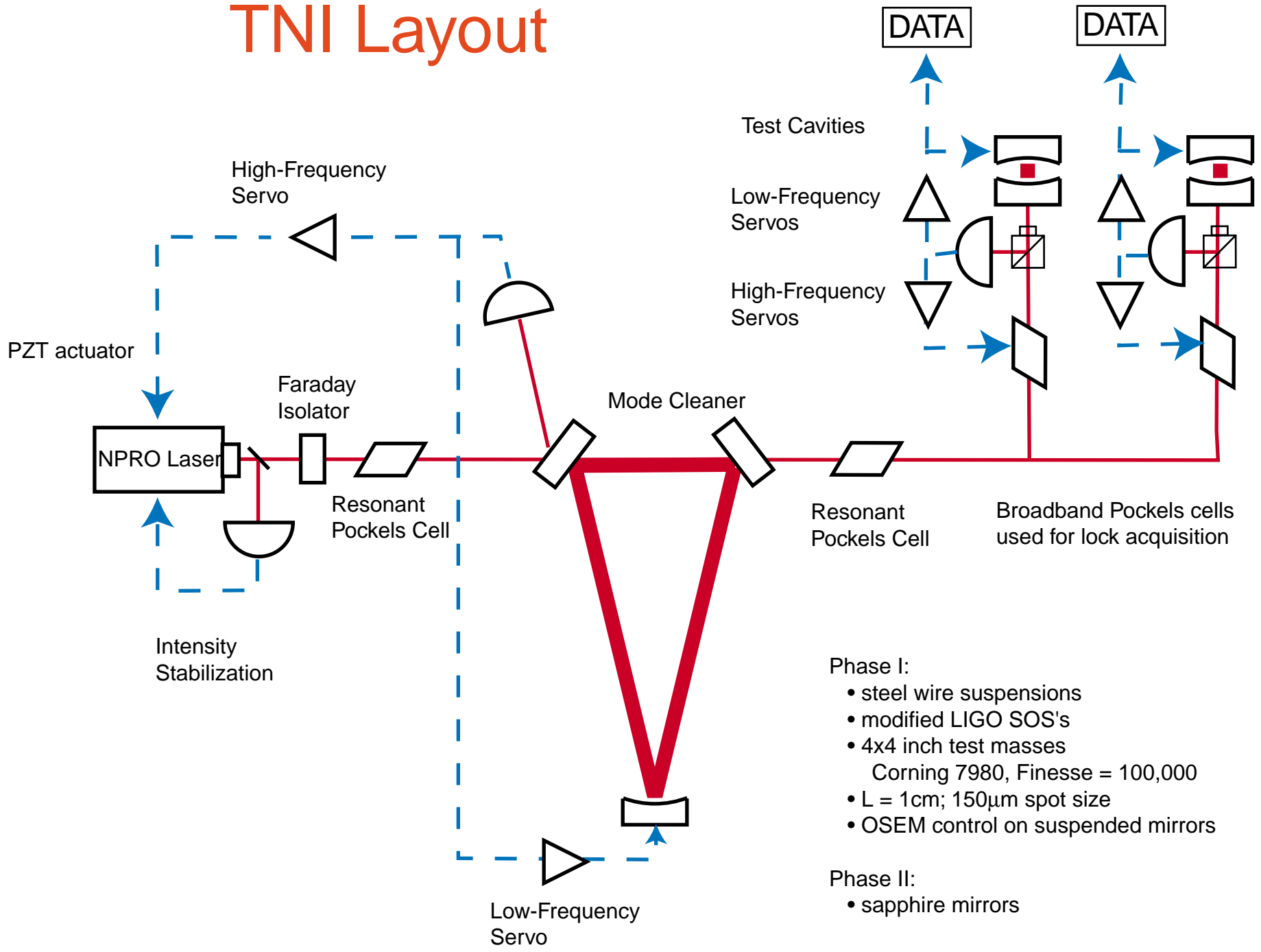
TNI Phase I Expected Spectrum



TNI Phase II Expected Spectrum



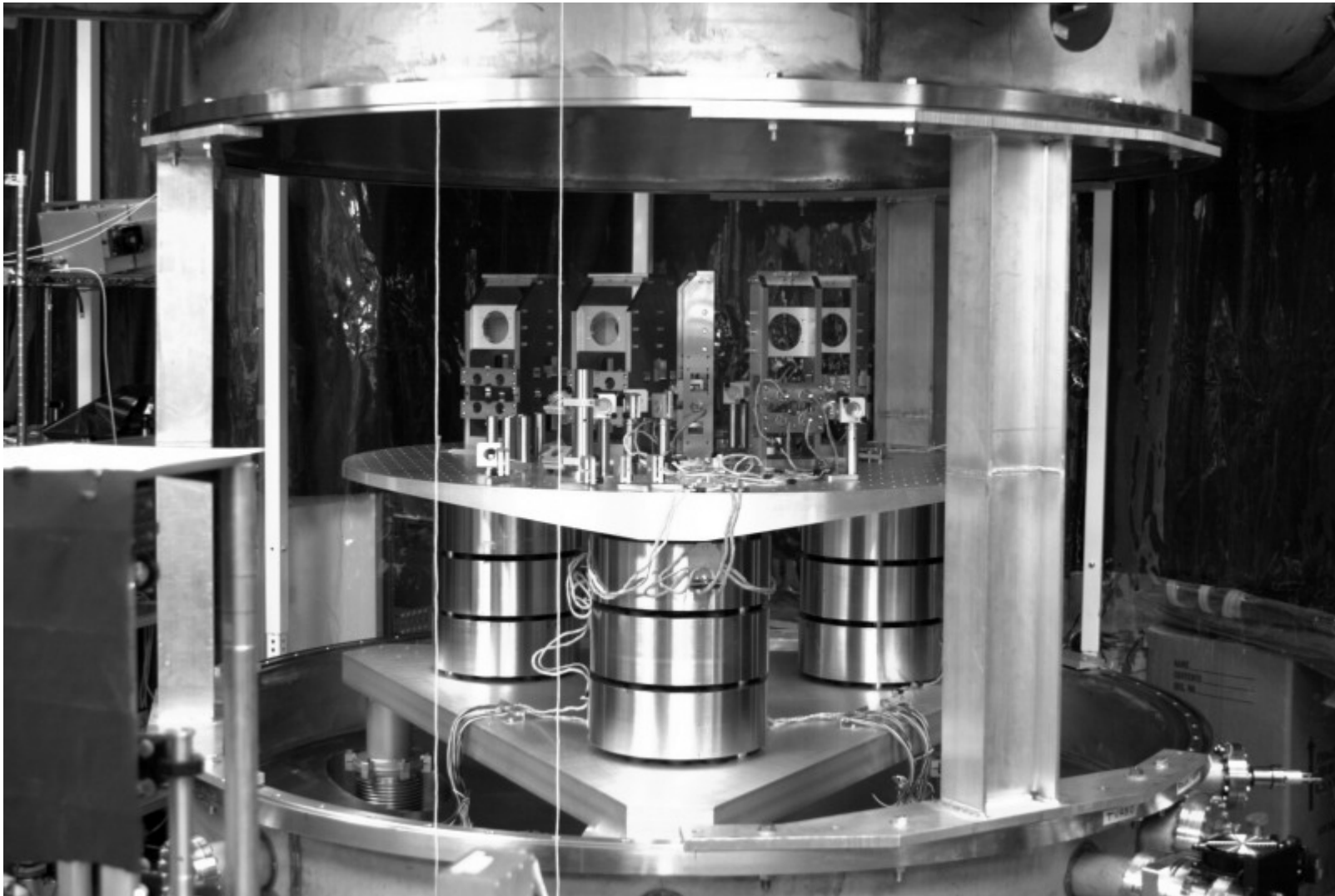
TNI Layout



- Phase I:
- steel wire suspensions
 - modified LIGO SOS's
 - 4x4 inch test masses
Corning 7980, Finesse = 100,000
 - $L = 1\text{cm}$; $150\mu\text{m}$ spot size
 - OSEM control on suspended mirrors

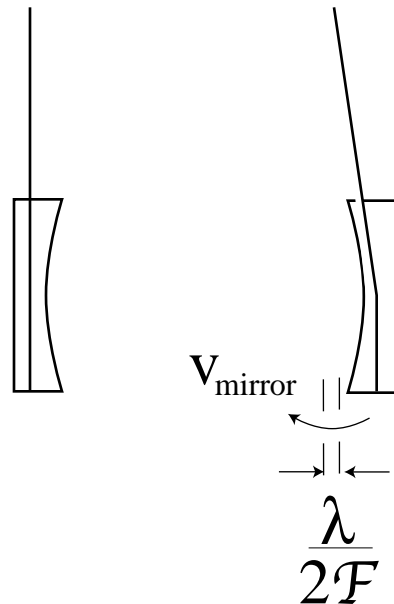
- Phase II:
- sapphire mirrors

TNI View inside vacuum chamber



Bandwidth requirements for lock acquisition

- Servo must be fast enough to “catch” while the cavity is resonant.



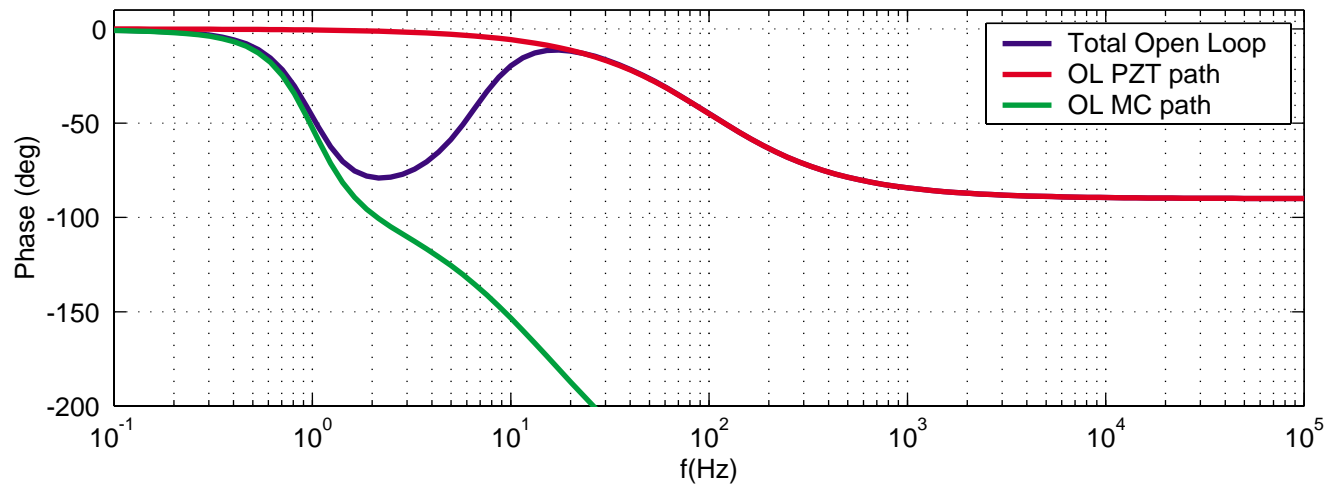
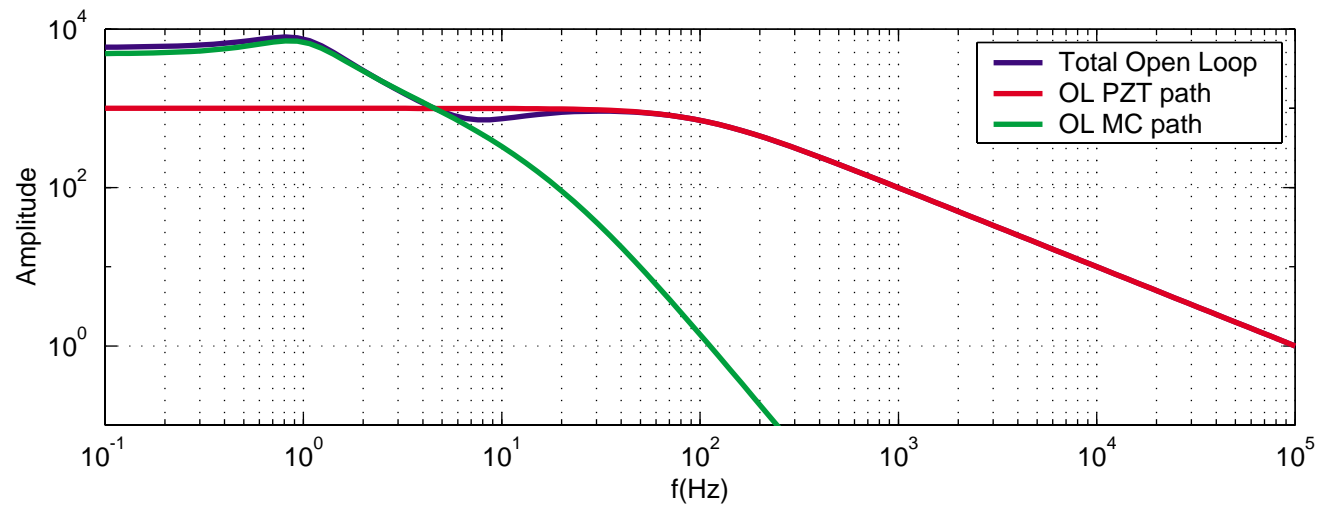
$$\tau \approx \frac{\lambda/2F}{v_{mirror}}$$

$$v_{mirror} \approx 1 \frac{\mu m}{s}; \quad \lambda \approx 1 \mu m;$$

$$F \approx 100,000;$$

$$\text{Required Bandwidth} \geq \frac{1}{\tau} \approx 200 \text{kHz}$$

Dual-path mode cleaner servo (100kHz)



August, 2000

- Locked mode cleaner/laser system with prototype electronics (SR560's) and borrowed laser.

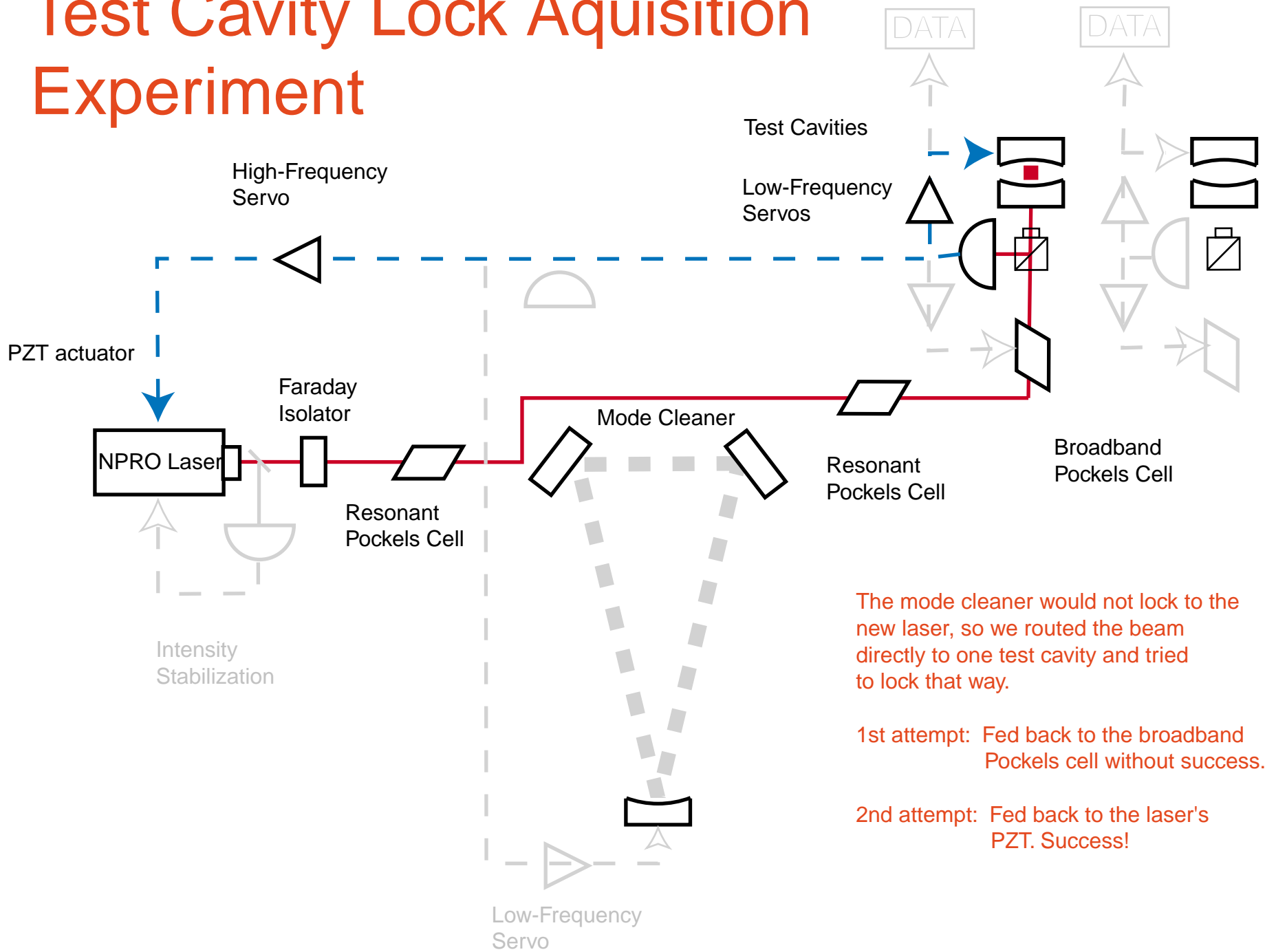
September-November, 2000

- Constructed custom module to replace mode cleaner prototype electronics.
- Glued magnets and fixtures on test mirrors.
- Installed test mirrors.
- Designed, constructed, and installed satellite amplifiers and necessary cabling for test mass damping and control.
- Returned borrowed laser; ordered new laser from Lightwave Electronics; borrowed another laser while waiting for the new one to come in (ETA 2/28/01).

December, 2000

- Test cavity lock acquisition, but...
- **Temporary laser would not lock to mode cleaner!**

Test Cavity Lock Acquisition Experiment



The mode cleaner would not lock to the new laser, so we routed the beam directly to one test cavity and tried to lock that way.

1st attempt: Fed back to the broadband Pockels cell without success.

2nd attempt: Fed back to the laser's PZT. Success!

Progress

- Hardware acquisition, construction, and assembly $\geq 90\%$ complete.
- All 7 suspended optics installed and damped.
- 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 borrowed laser (expect new one by 3/01).
- Lock arm cavity using broadband Pockels cell.
- Lock second arm cavity.

Anticipate data by June, 2001