Thermal Noise Interferometer: Update and Status

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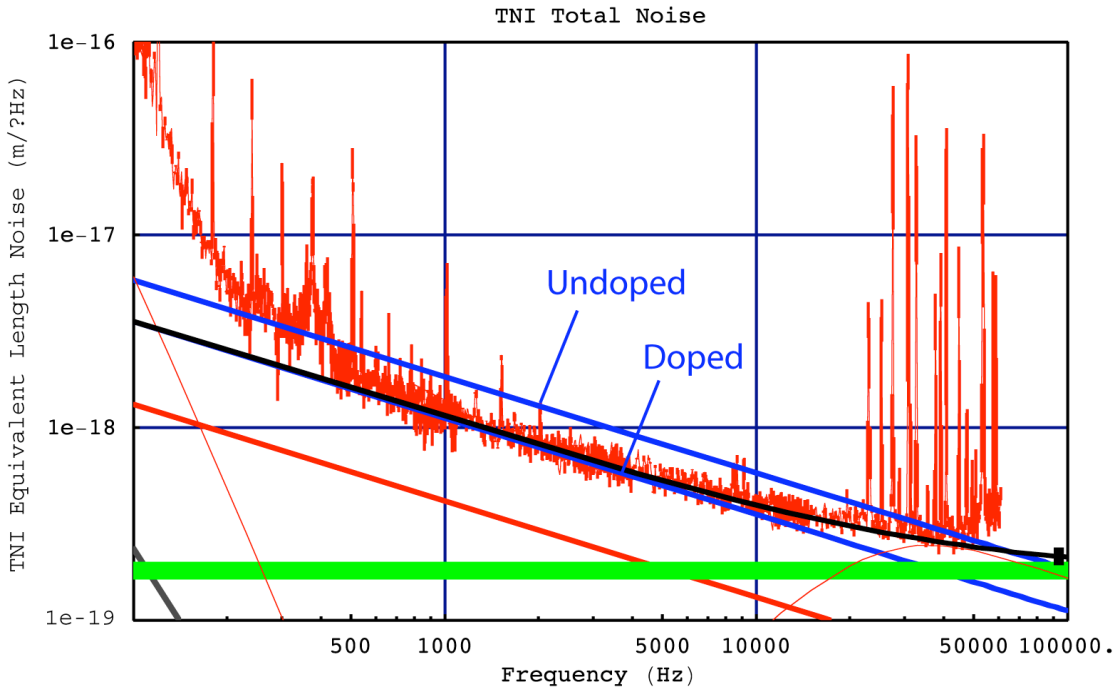
Part I:
Recent Results

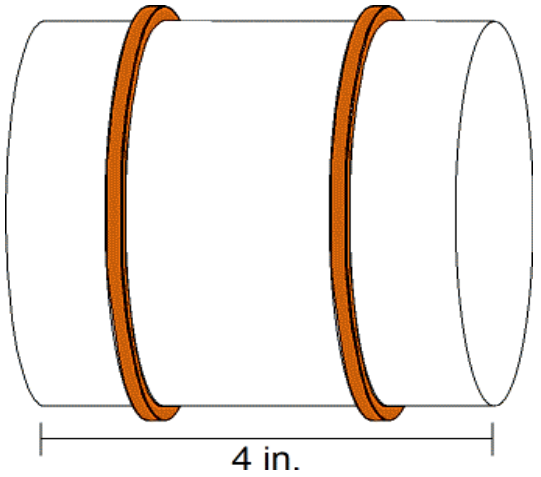
Doped Coatings

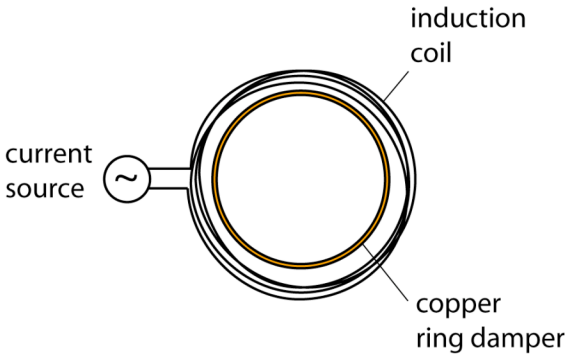
- Periodic coatings with both plain tantala (REO) and doped tantala (LMA) were measured.
- Noise floor reduction of 20% is consistent with predictions from Q measurements.

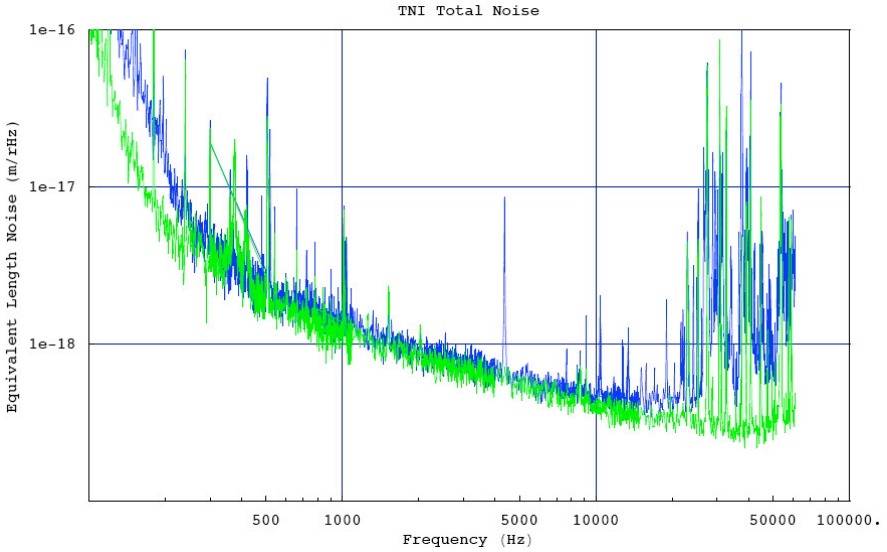


Ring Dampers

- Parametric oscillations are expected to be a problem in advanced interferometric detectors.
- Three possible mitigation schemes
  - Active damping of individual modes
  - Thermal compensation (detuning)
  - Q suppression
- Monolithic copper rings found to suppress Qs in all modes tested, did not disturb broadband noise floor within our measurement band.
- Next: Gold coatings for damping rings.

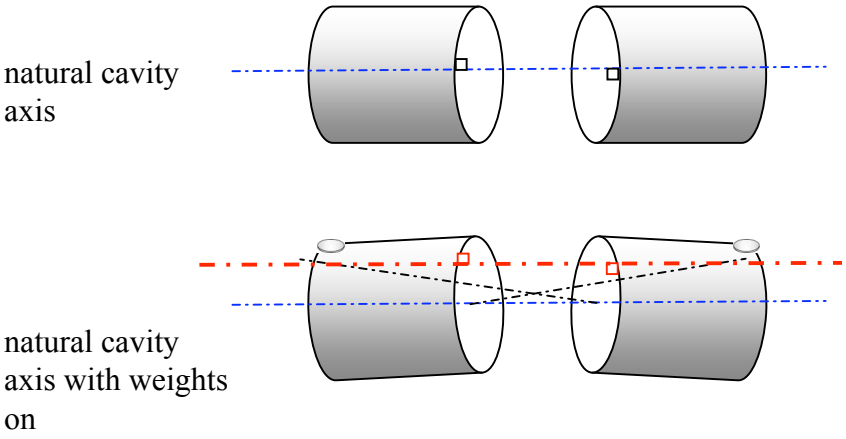


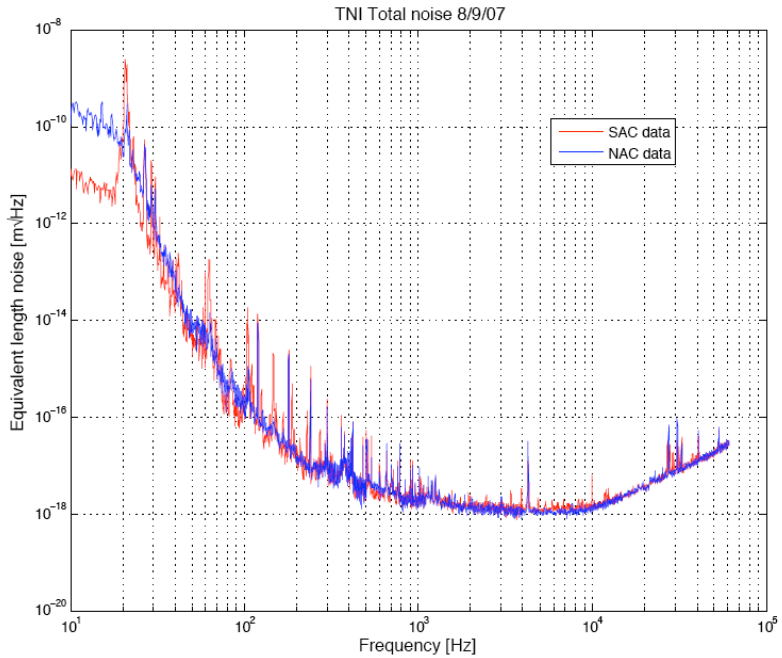




Homogeneity

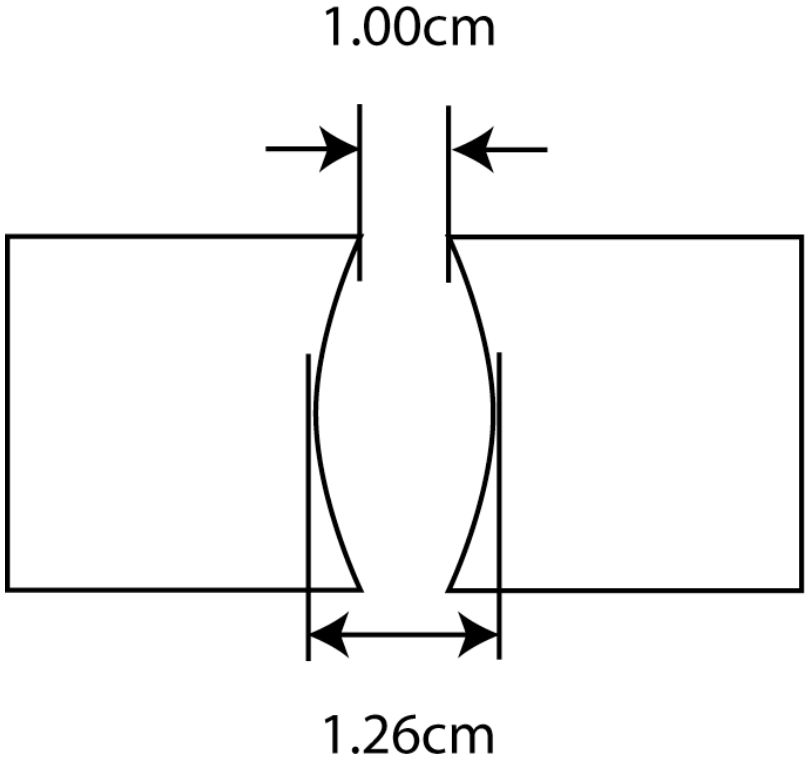
- Big question: Does the thermal noise depend on the position of the spot?
- "Big" interferometers use centimeter-scale spot sizes, whereas in the TNI w=160μm.
- Larger spots are not practical with short (1cm) arm cavities, so an alternative solution is to move the small spot around, sampling over an area centimeters across.
- First results: No change in thermal noise for 3mm translation.

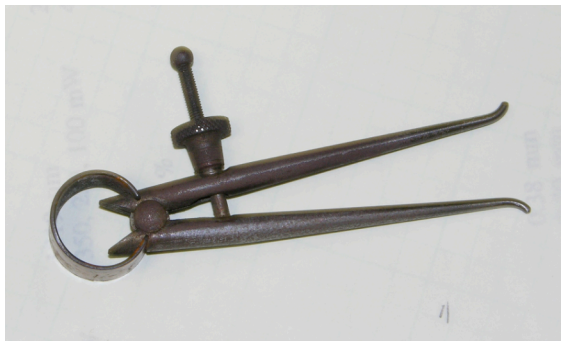




Calibration

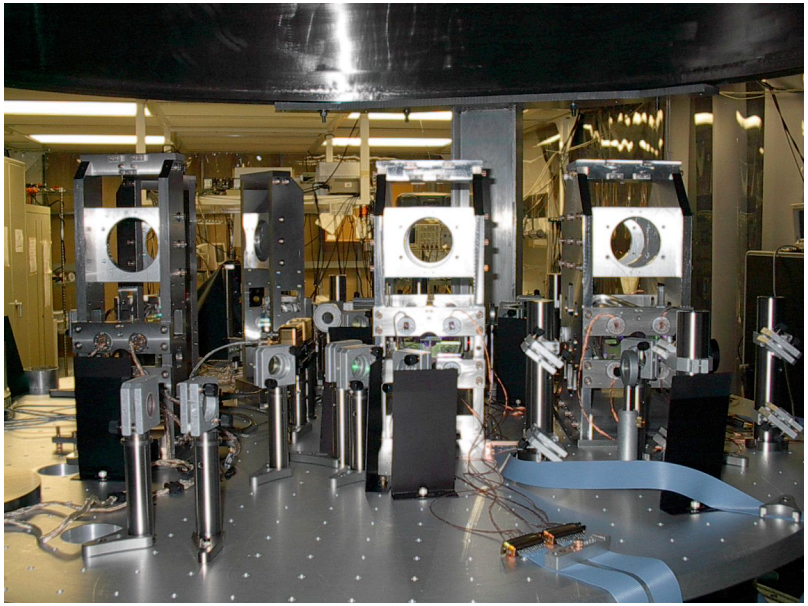
- Doped-tantala results had initially been slightly different (~20%) from predictions from Q measurements.
- Scientific conclusions about coatings are based on a differential measurement of doped vs. undoped, which is not affected by a common, systematic calibration error.
- Checked calibration (see Akira's talk). Found that the origin of the discrepancy was due to incorrect cavity length L.
  - Direct measurement (calipers)
  - Spot-size measurement (160->163.6μm)
- After correcting L, our measurements are in good agreement with predictions based on Q measurements.
- Coating-improvement conclusions remain unchanged.





Lab Move

- Caltech PMA division requested that the TNI be completely out of our old location by 1 September, 2007.
- Optimized mirrors delivered end of July.
- TNI cutoff for experiments - 10 August.
  - Finish homogeneity experiment by then.
- R. Desalvo occupied new location, was on-time for removal.
- Move, including wiring, floor treatment, etc. in new location went without significant problems.
- TNI reassembly, installation of optimized mirrors, recommissioning from 1 Sept. to 17 Oct.
- Simple replacement of the mirrors typically requires six weeks under ideal conditions.



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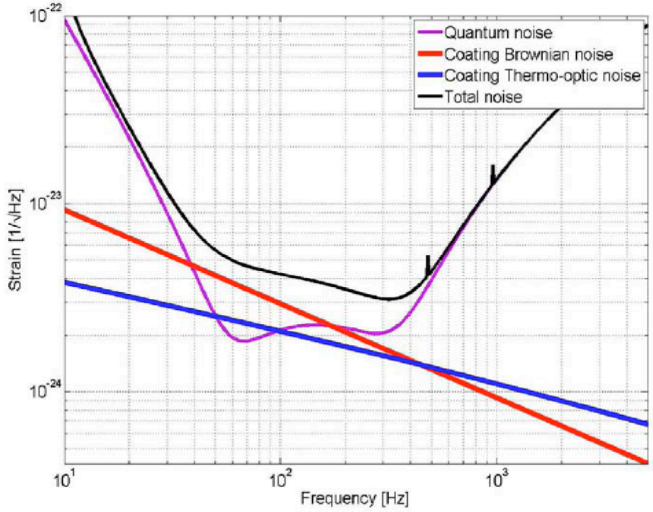
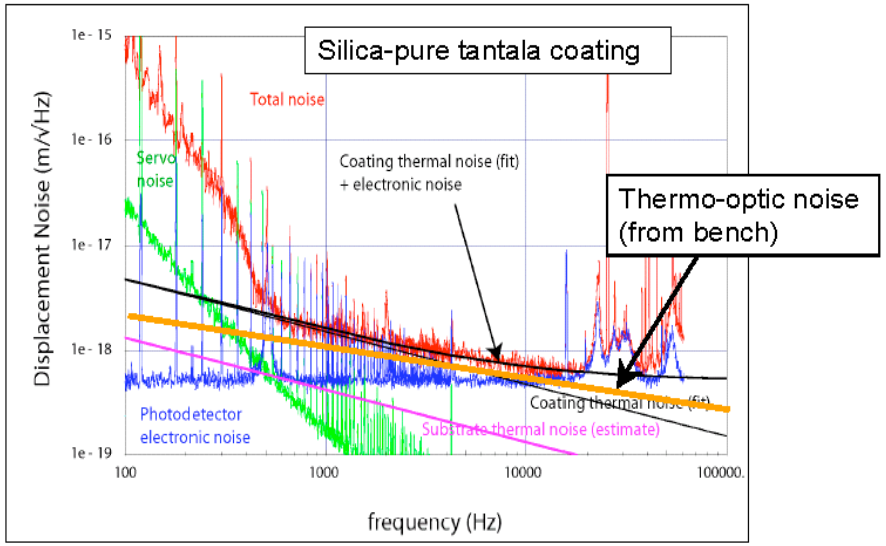
Part II:
Future Plans

Direct Measurement of Thermo-Optic Noise

- Thermomechanical + thermo-optic noise is expected to be significant in advanced detectors.
- May be accessible to the TNI.
  - T=300ppm -> 30ppm
  - Reduce shot noise level





Photothermal Measurements of Advanced Coatings

- Photothermal apparatus allows us to measure thermomechanical parameters, separate from thermo-optic dn/dT.

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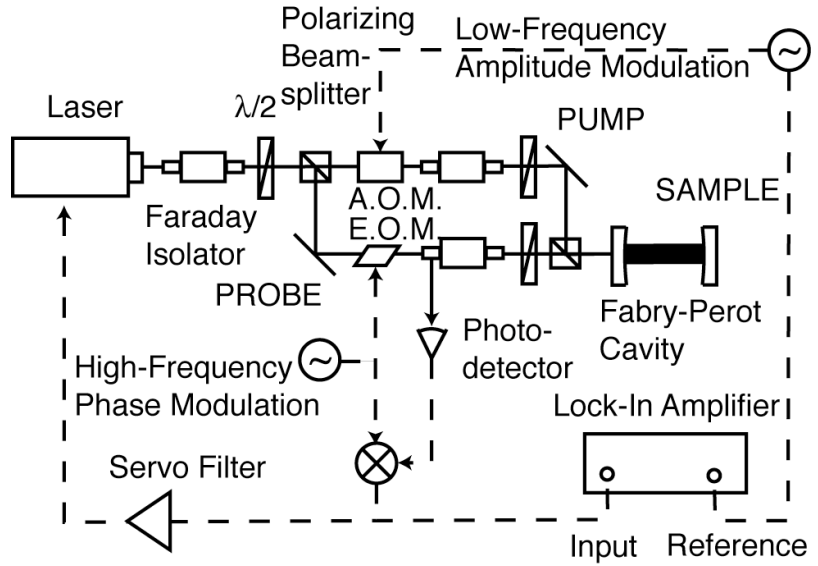
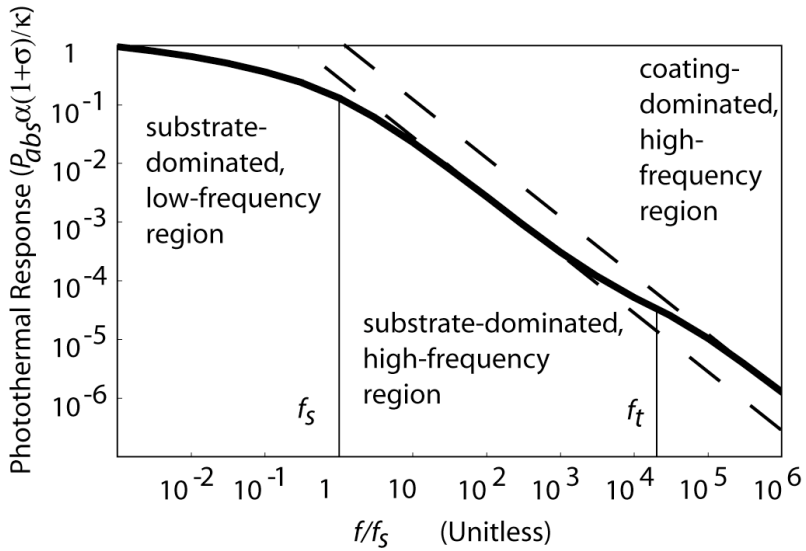
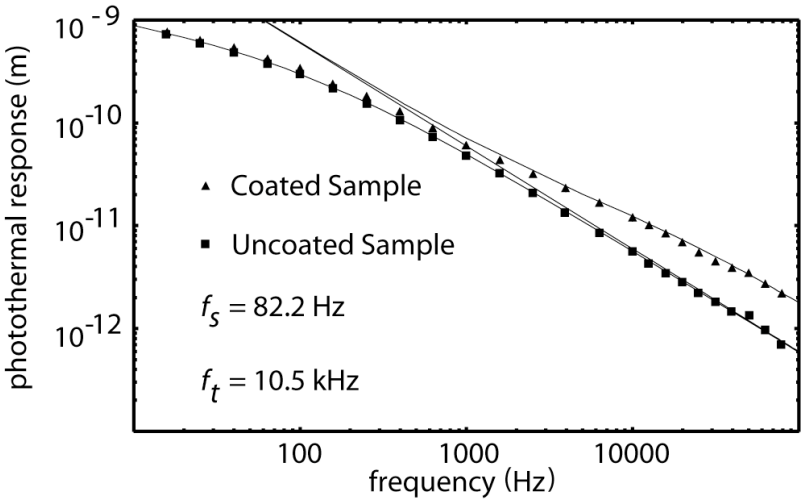
- Faster turnaround time than TNI.
- Plain-tantala/silica coating measured, advanced coatings to follow.







TNI Future Plans

- Optimized, plain-tantala/silica coatings
  - In progress
- Optimized, doped-tantala/silica coatings
  - Funding approved, contingent on undoped, optimized coating results
- Gold coatings for ring dampers
- Charging noise and charge-mitigation schemes
- Photothermal measurements of thermophysical properties
- Direct measurement of thermo-optic noise