Report of the Optics Working Group to the LSC

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Summary

- **Lots of Progress**
  - » Sapphire properties and limitations
  - » Fused silica Q
  - » Coatings properties and optimization
  - » New ideas
- **Lots of Challenges**
  - » Thermal noise in coatings of concern
  - » Sapphire hitting an absorption wall
  - » Absorption Inhomogeneities?
- **Lots of Work to Do**
  - » AdLIGO test mass material downselect approaching (July-August)
  - » Coatings, coatings, coatings…

Sapphire mechanical properties Q

Willems/Billingsley

- Q measurement by Phil Willems
  - » Two 314 mm x 130 mm boules measured
  - » Highest Q ~ 260×10^6 radial antisymmetric mode
  - » Lowest Q ~ 28×10^6
- Similar for "good" and "not" substrates
  - » Slightly better for "not!"
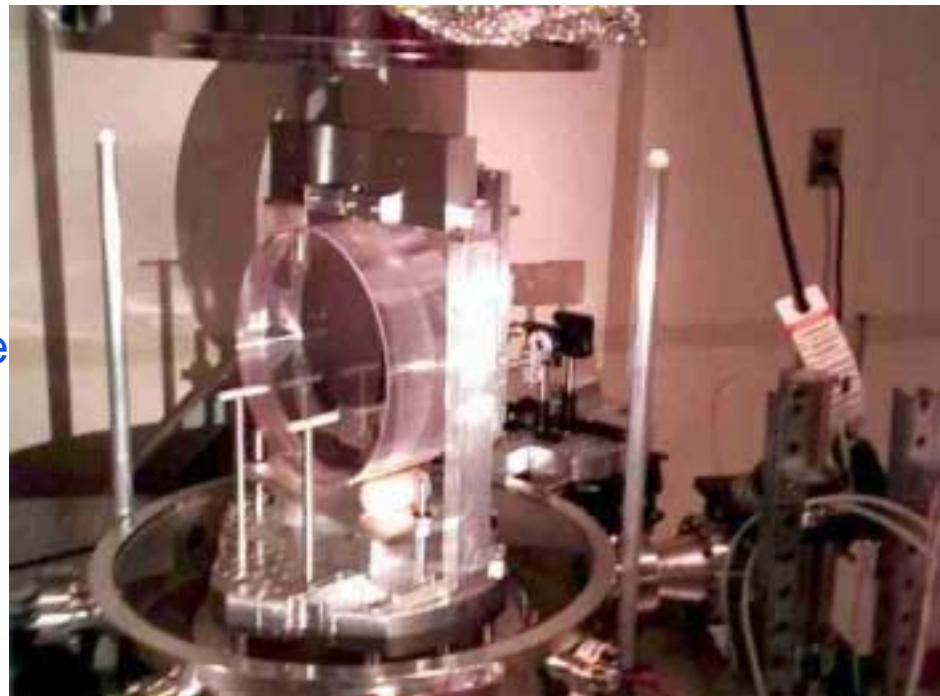
Sequential z-scans of 23-1-B heated to 1200⁰ C in N2 and cooled at rates shown

LIGO-G030154-00-Z

4

LIGO
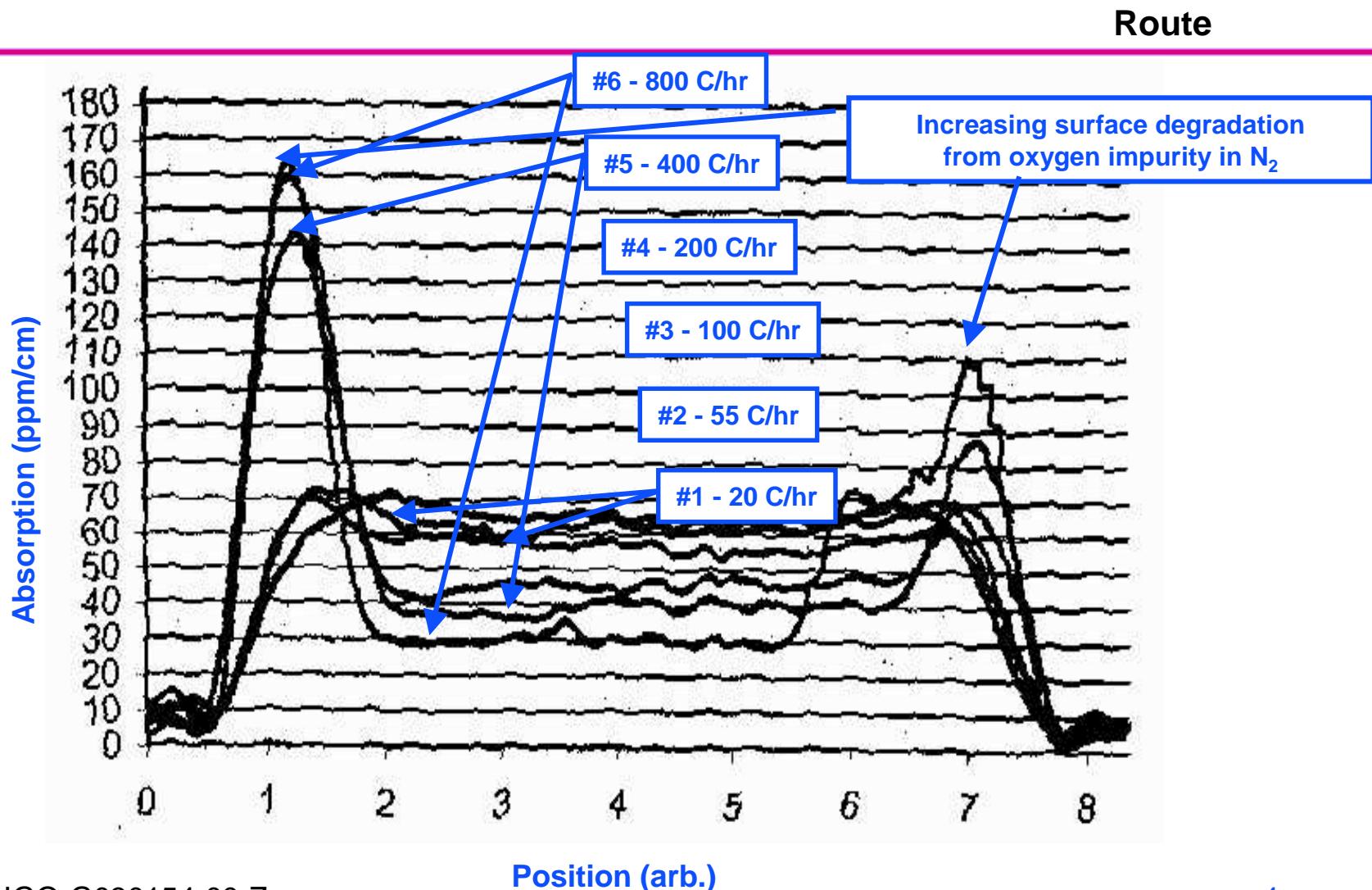
# ACIGA Gingin Facility

$$T = \frac{c^4}{8\pi G} \, G$$

● **MH beam shape:**

  » Superposition of minimal-spreading Gaussians -- axes uniformly distributed inside a circle of radius D

  » Choose D so diffraction losses
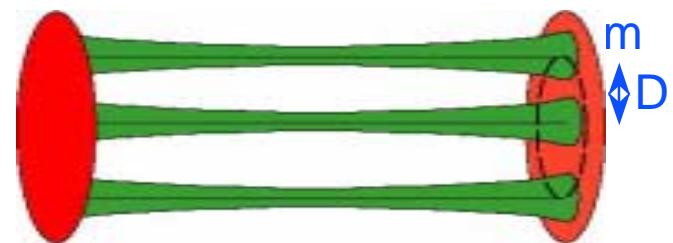
● **MH mirror shape: matches phase fronts of MH beam**

Mexican Hat

Spherical, Rcurv = 78 km

LIGO-G030154-00-Z
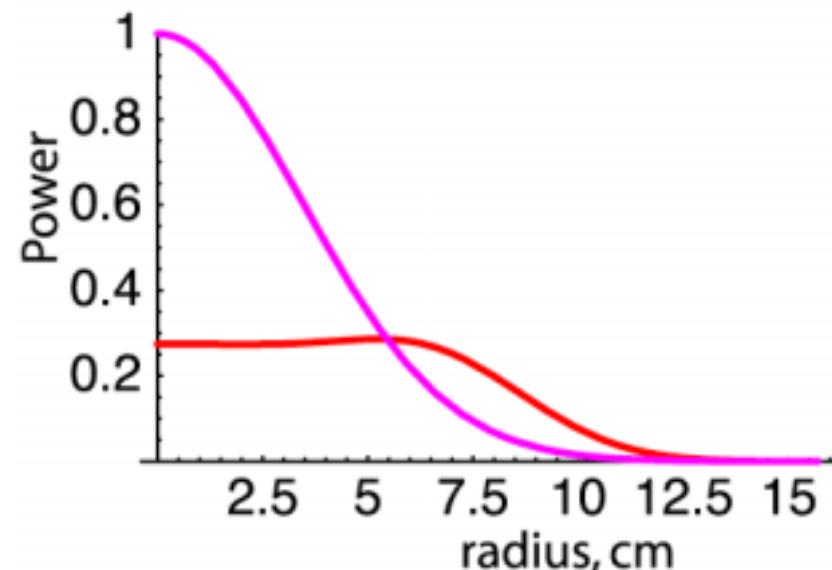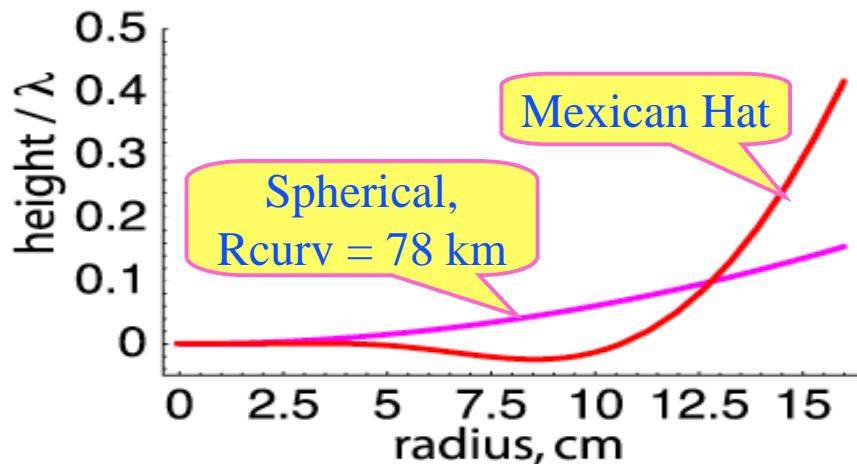
Material downselect
Coating loss

Harry

BNS Range Y_{coat} = 70 GPa — BNS Range Y_{coat} = 200 GPa
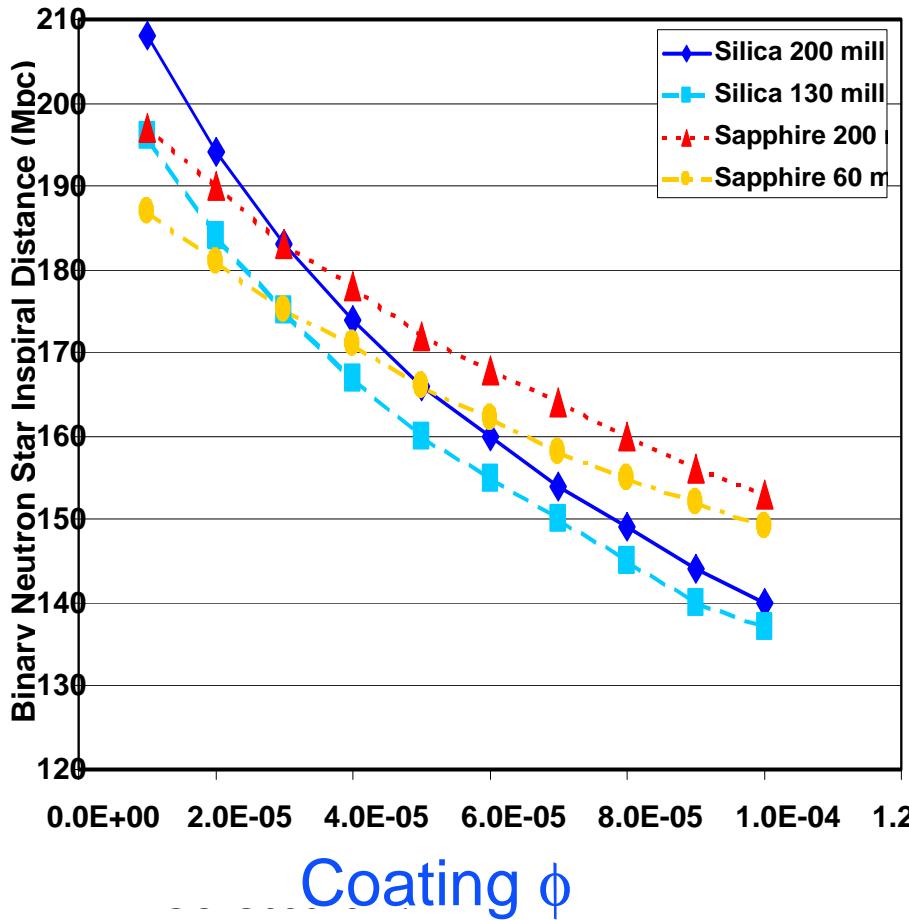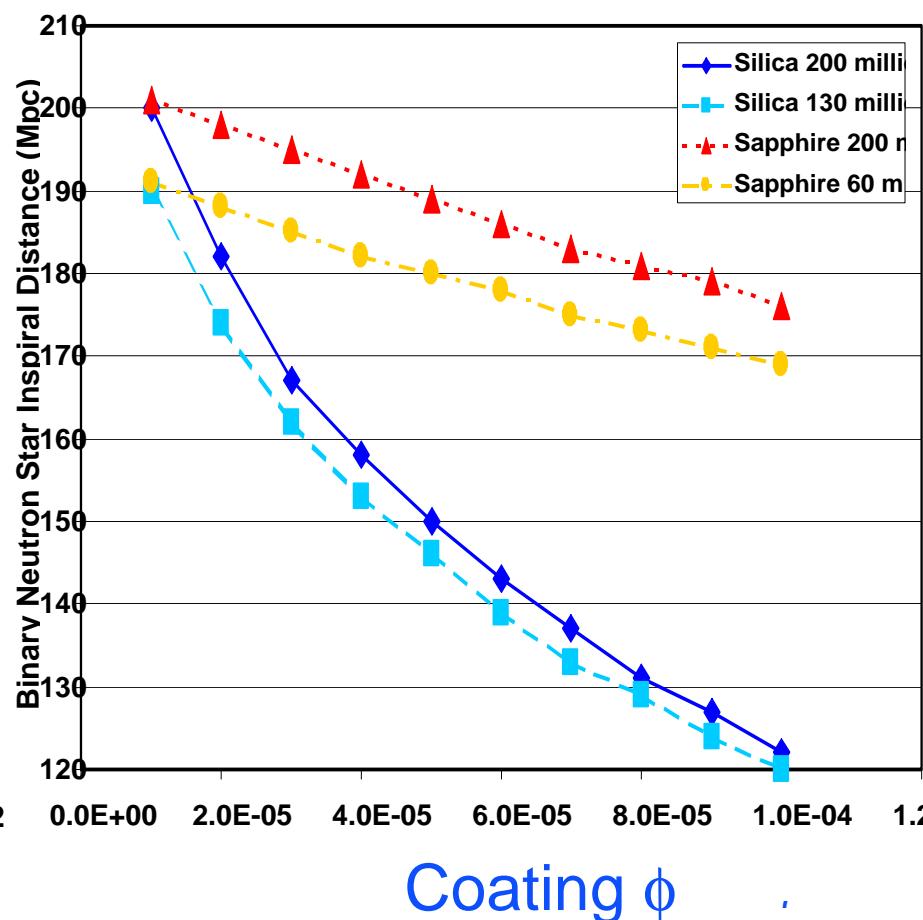
Coating thermoelastic noise: Al_2O_3/Ta_2O_5 on sapphire substrate

Fejer and Rowan

x(f) in m/√Hz

Advanced LIGO displacement noise requirement for each test mass at 100Hz
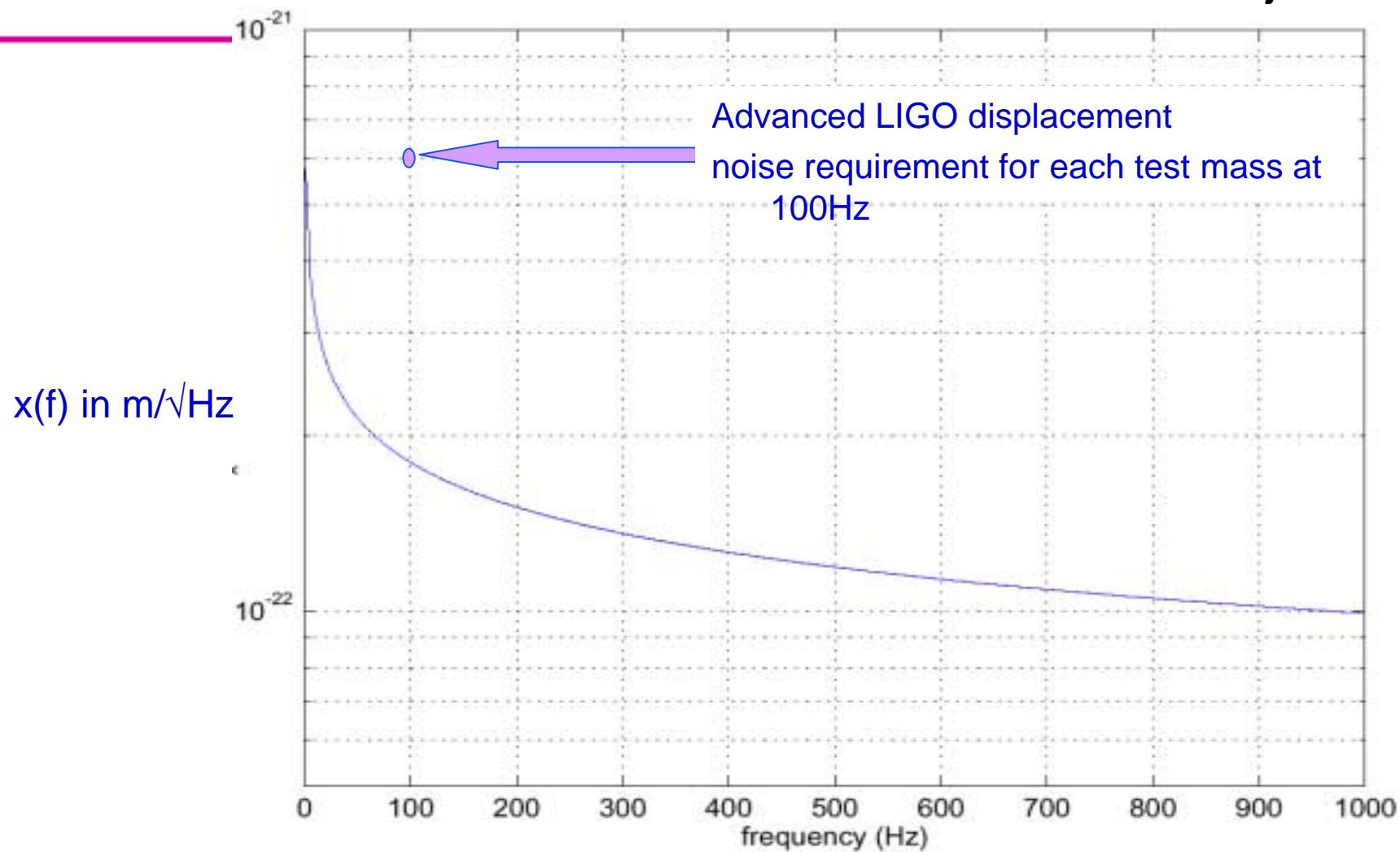
TNI Sensitivity after Second Round of Improvements

Black

TNI Total Noise, 03/05/03

Conclusions

LIGO
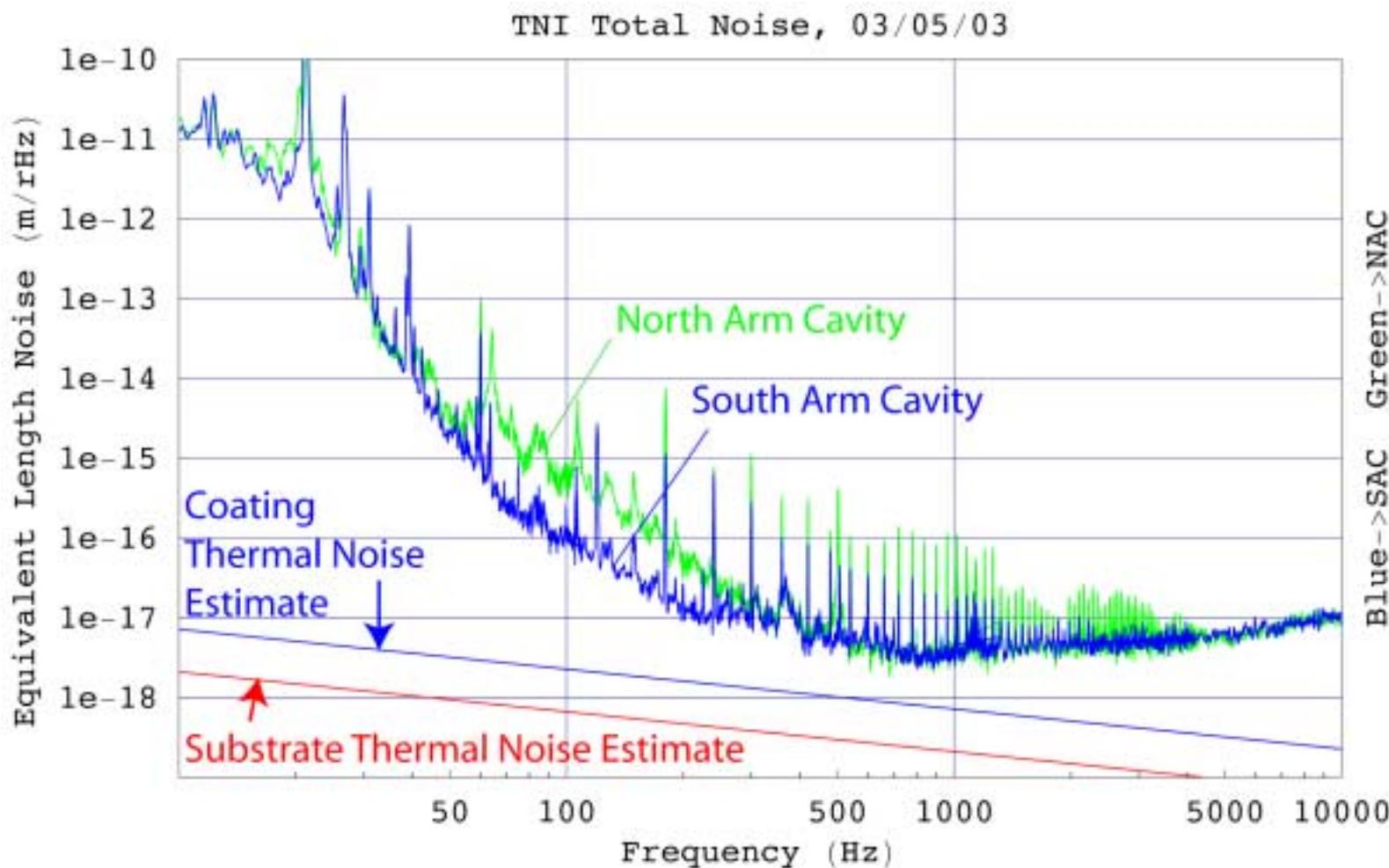
- Lots of Progress

- Lots of Challenges

- Lots of Work to Do…