Status of sapphire test masses and coating research

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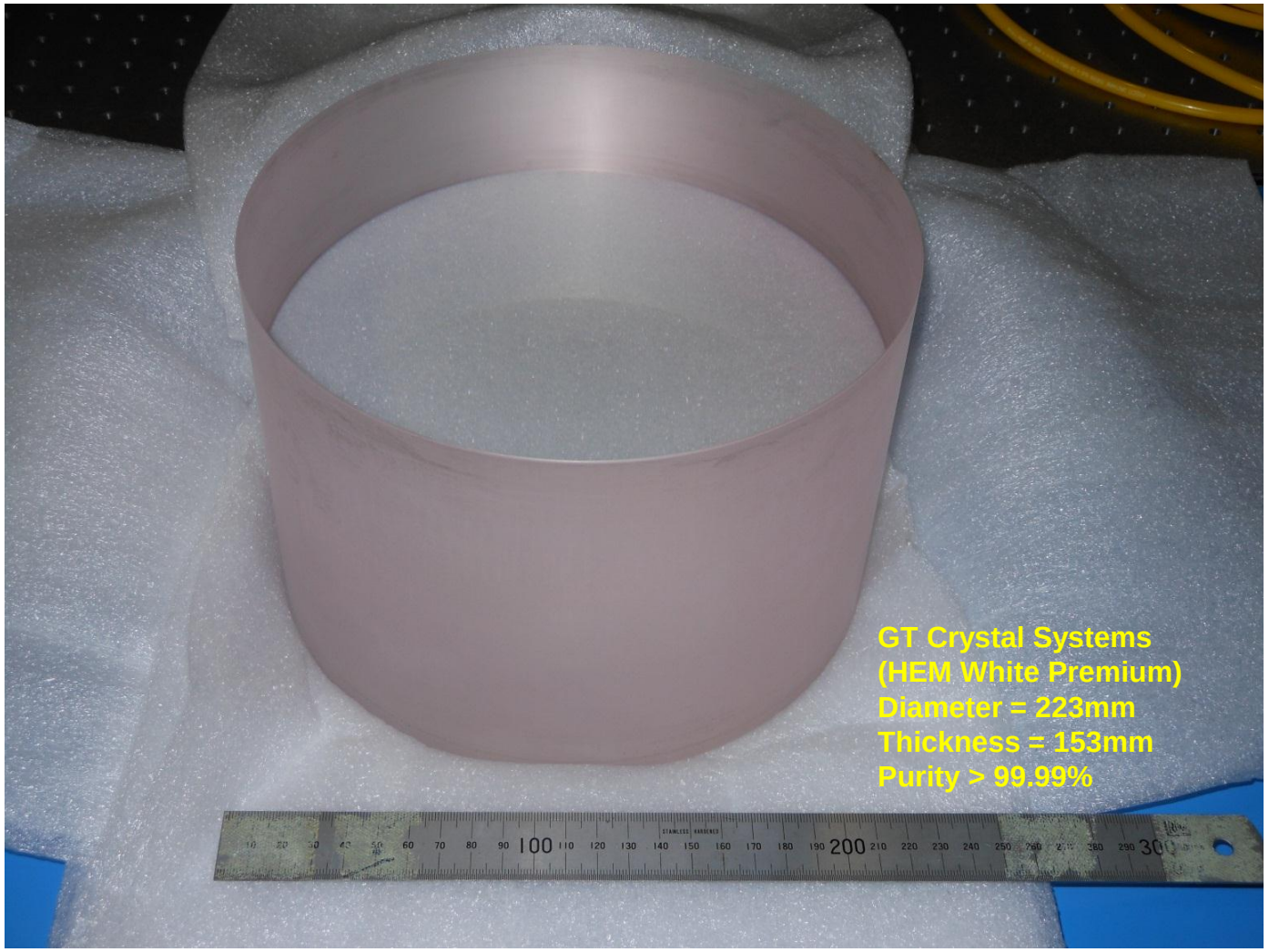
- Status of sapphire mirrors

E. Hirose, N. Mio (UT-PSC)

- Coating Q measurement at ICRR

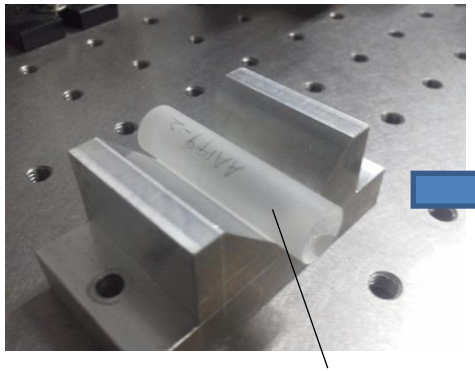
E. Hirose, K. Yamamoto, T. Suzuki (KEK), K. Waseda (NAOJ), M. Ohashi

Status of sapphire mirrors

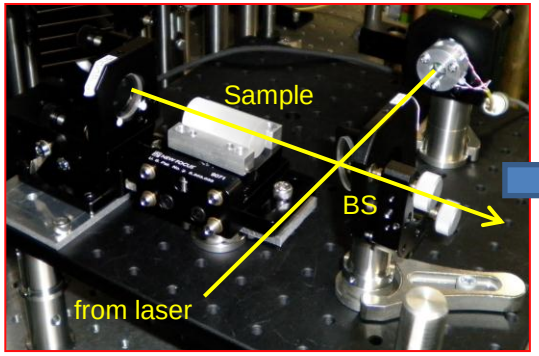


Absorption of small samples

(K. Watanabe, N. Mio)



HEM White Premium C-axis rod (D = 10mm, L = 40mm)

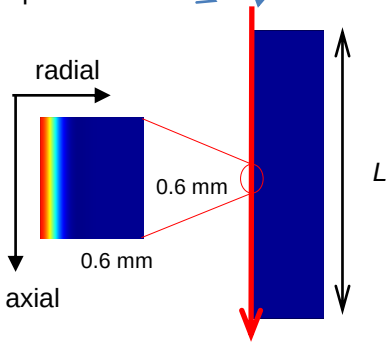


Putting the rod in a Michelson to see path length change bet. cold and hot

$$c\rho\frac{\partial T}{\partial t} = \beta P + \kappa\nabla^2 T$$

Heat Equation

energy source from laser light

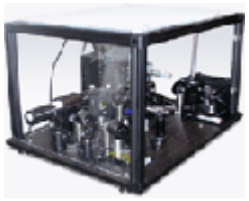


Power absorption estimated by COMSOL

Preliminary result [ppm/cm]

AA149	48	47		
AC150	229	138	682	687
P401	34	32	65	67

- Lots of variation between samples
- Must be modified to scan large samples
- Another method for comparison (in consideration)



Stanford Photo-Thermal Solution's product (adopted by CSIRO, GT Crystal Systems etc)

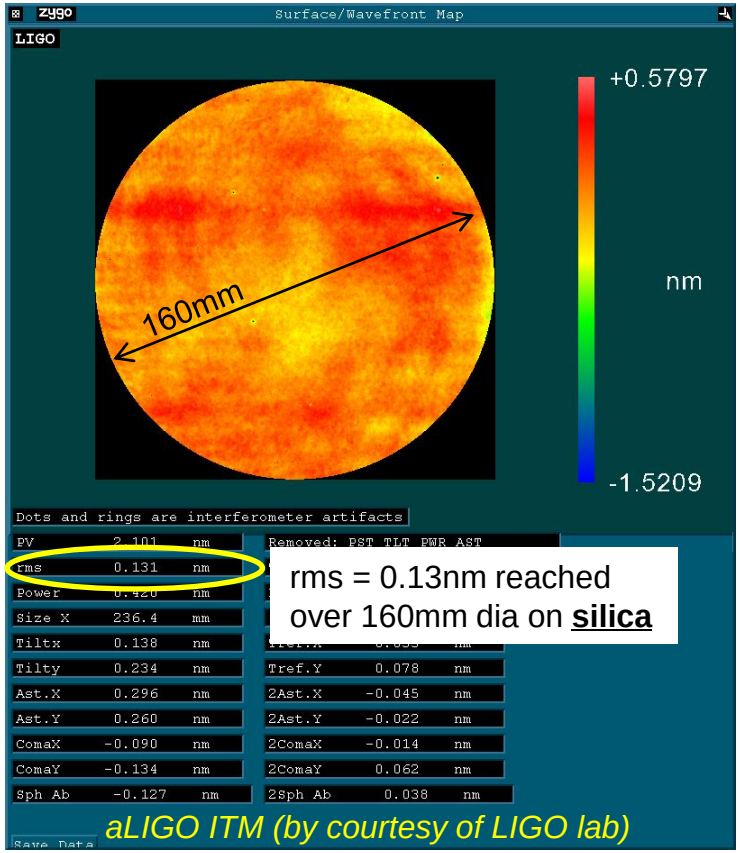
Specifications (HR, highlight)

Parameters	Requirement	Loss
Radius of curvature	1.9km (±0.5%)	N/A
Roughness (λ < 1mm)	rms = 0.16nm	5ppm
Figure (λ > 1mm)	rms < 0.5nm @ d < 140mm rms < 2nm @ d > 140mm	30ppm
Defects	2e4 [μm2] @ d < 100mm 3e5 [μm2] @ d > 100mm	1ppm
Point scattering	-	9ppm
Absorption (coating)	-	1ppm

Total loss < 45ppm
(required by IFO)

Nobody knows yet if we can reach this level on **sapphire** (hard to polish)

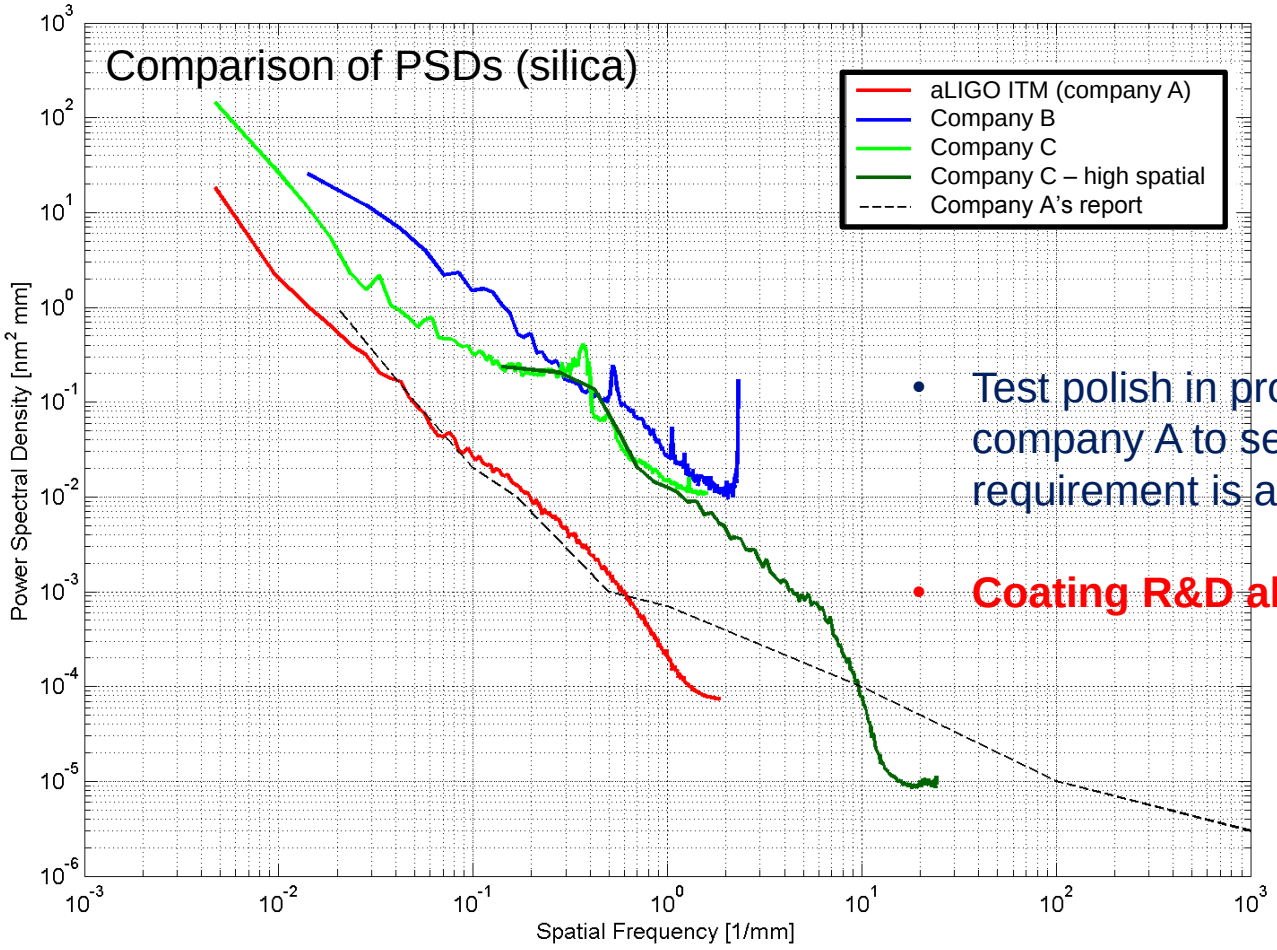
Some R&D effort is necessary



rms = 0.13nm reached over 160mm dia on **silica**

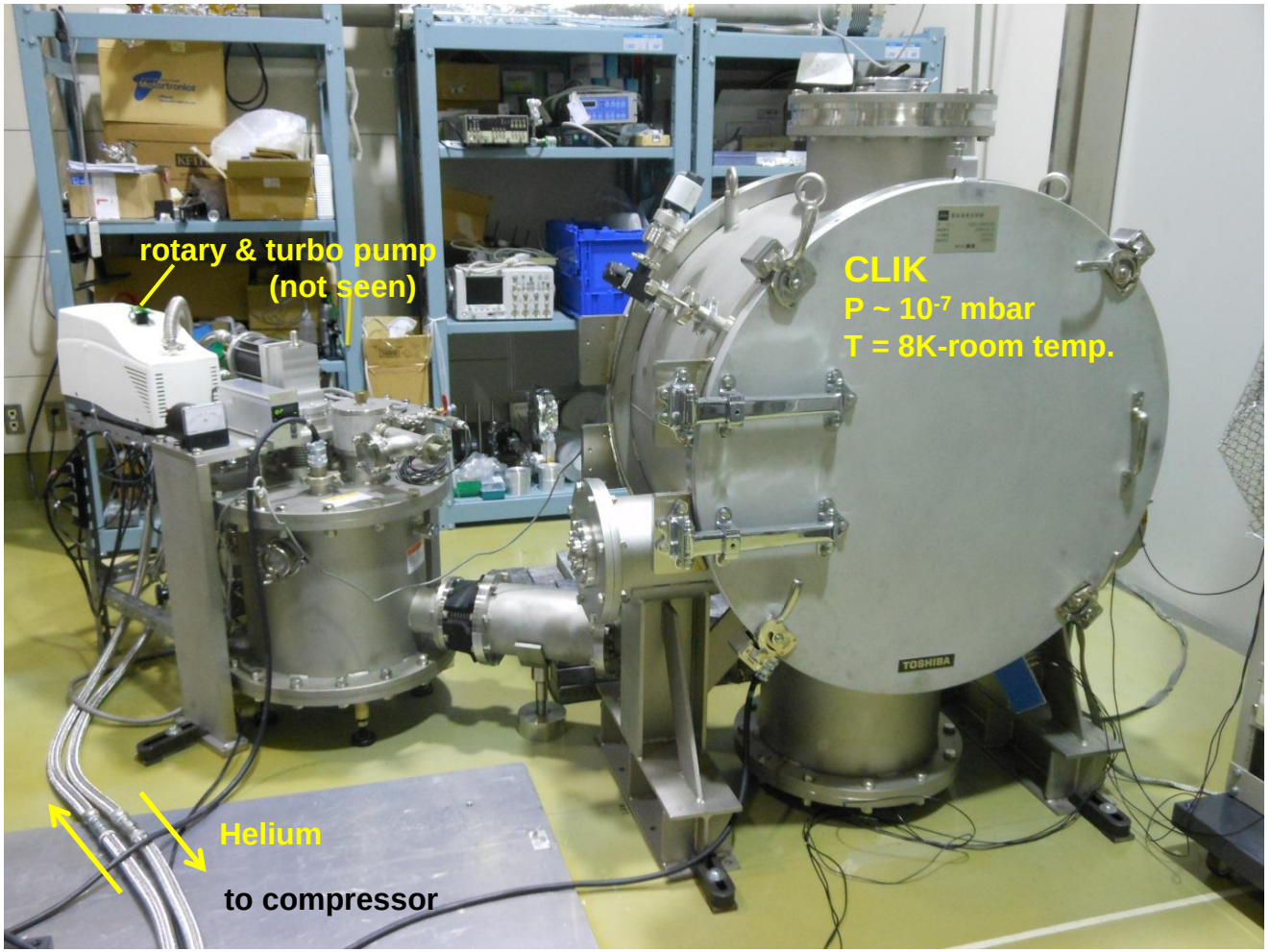
aLIGO ITM (by courtesy of LIGO lab)

Sapphire pathfinder



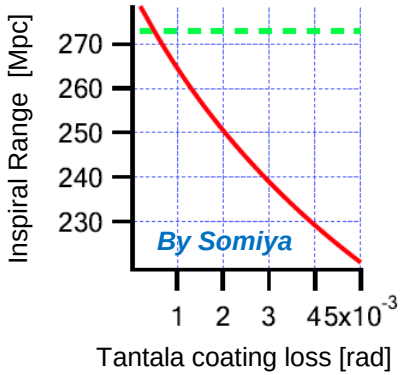
- Test polish in progress with company A to see if our requirement is achievable
- **Coating R&D also needed!**

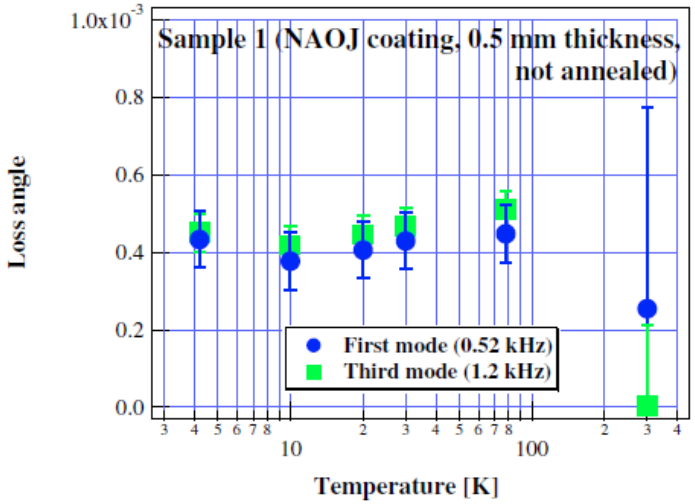
Q measurement at ICRR

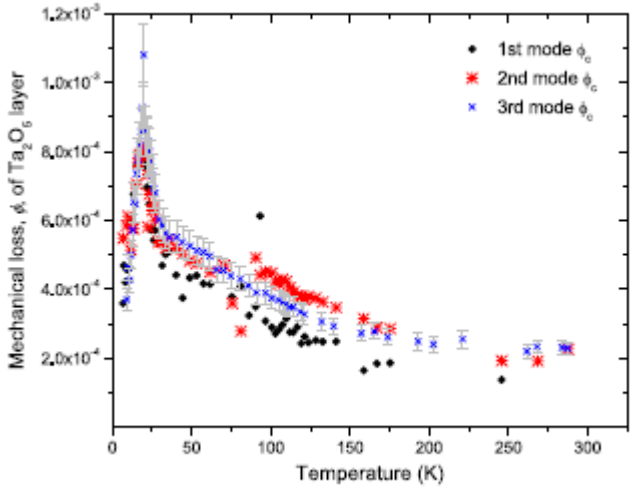


Background

- Silica (SiO_2) and tantalum pentoxide (Ta_2O_5, tantala in short) will be used in KAGRA's mirror coating, and coating thermal noise may limit the performance
- Univ. of Tokyo and Glasgow's measurements have different character in cryogenic temperature, especially around 20K



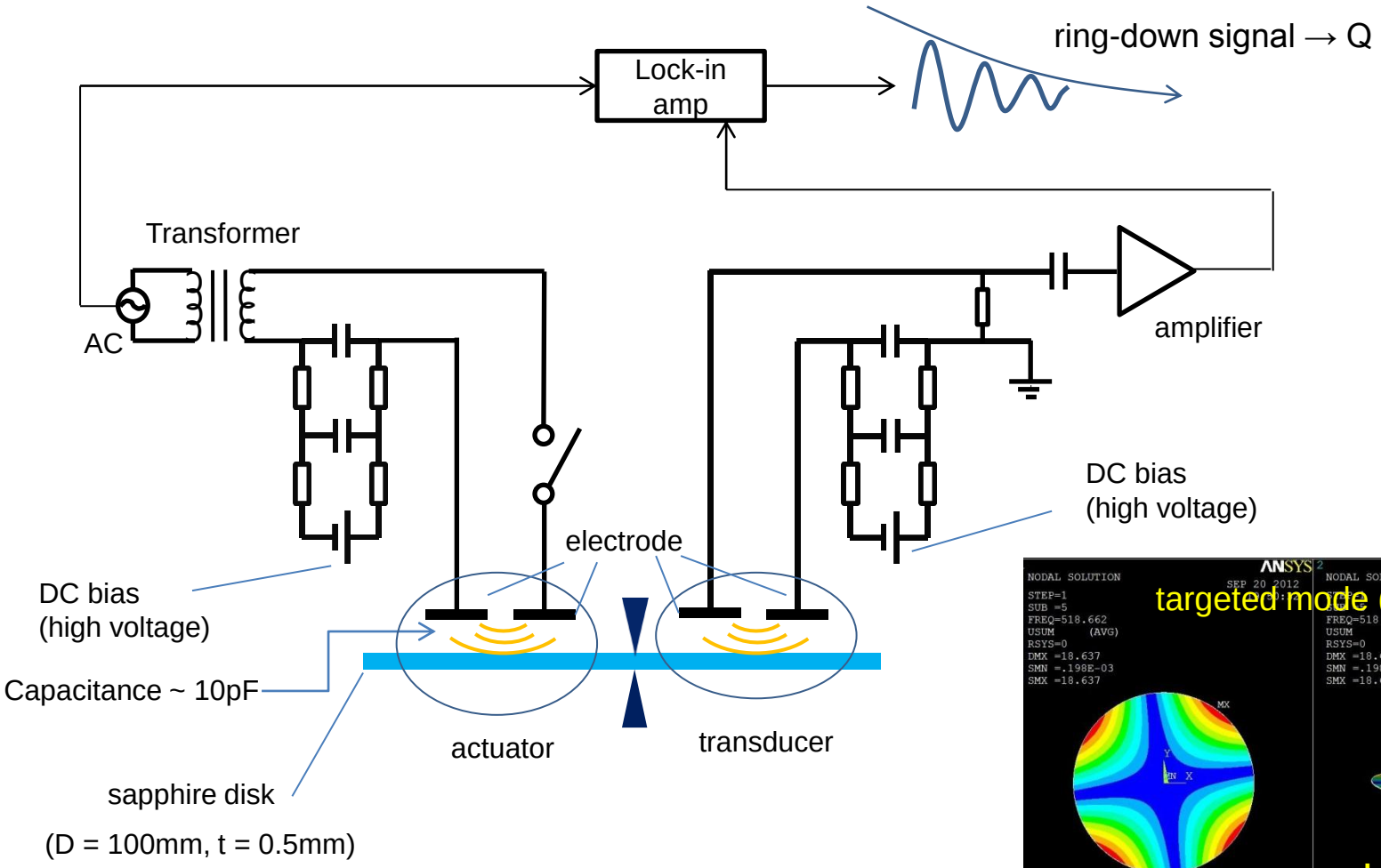




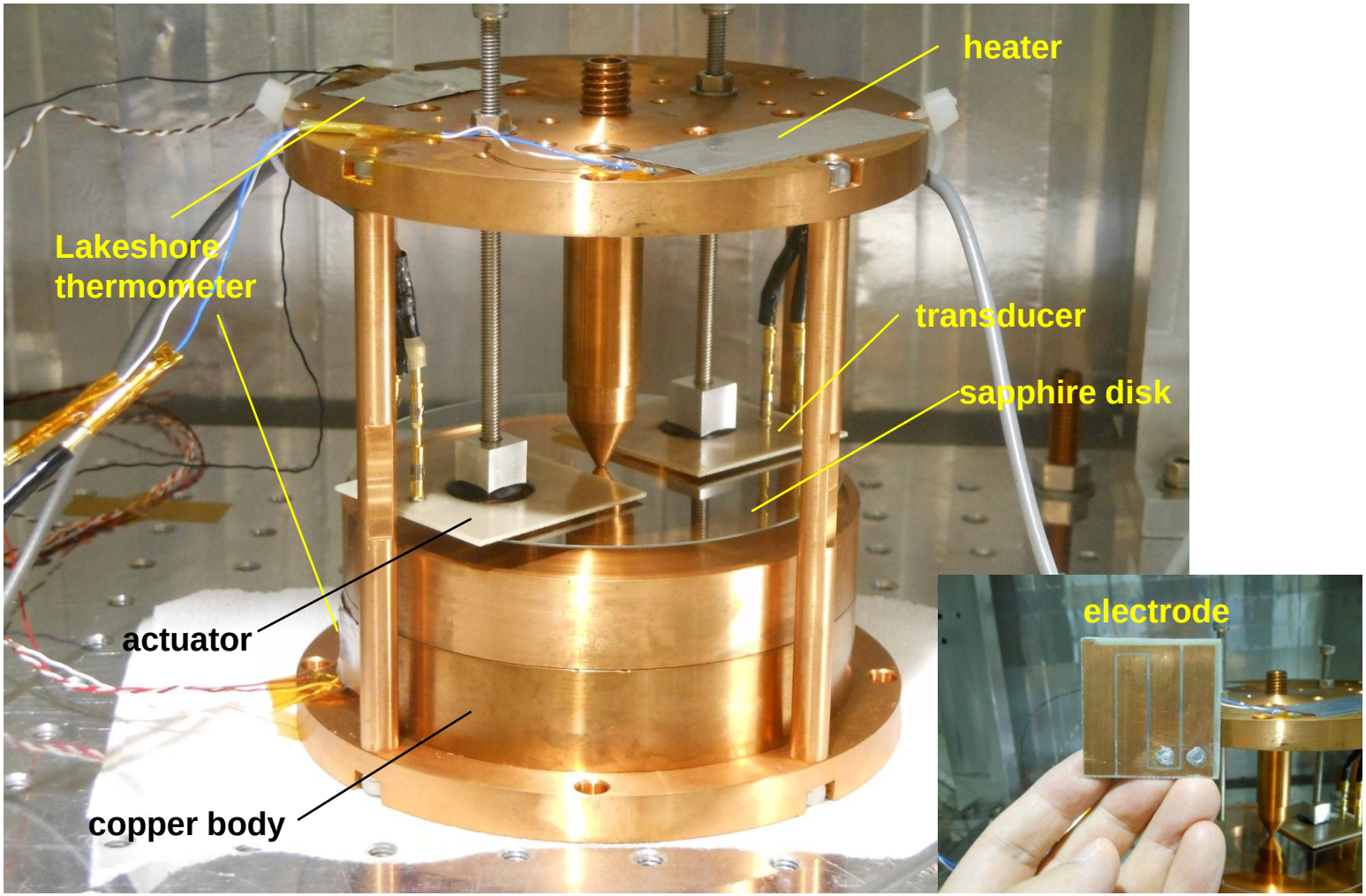
K. Yamamoto et al, Physical Review D 74, 022002 (2006)

I. Martin et al, Class. Quantum Grav. 25 (2008) 055005

Experimental setup



Disk with actuator/transducer



Current status and plans

- In preparation (vacuum leakage fixed, system built, ring-down signal not seen yet)
- Kieran Craig and Peter Murray from Glasgow will join our measurement in the next couple of weeks
- Yusuke Sakakibara will visit Glasgow for one month to learn their experiment and measure some disks, which were measured by Yamamoto et al.

Will look into difference in behavior around 20K, making the best use of ELiTES collaboration!

Summary

- Sapphire blanks for TMs arrived at ICRR
- Absorption measurement is being prepared
- Test-polish is in progress
- Coating R&D on sapphire is a must
- Preparation of coating mechanical Q measurement is in progress, and we are looking forward to working with Glasgow fellows (esp. Kieran Craig and Peter Murray)

Thank you!