Development and test of an absorption bench to characterize KAGRA mirrors - Status report

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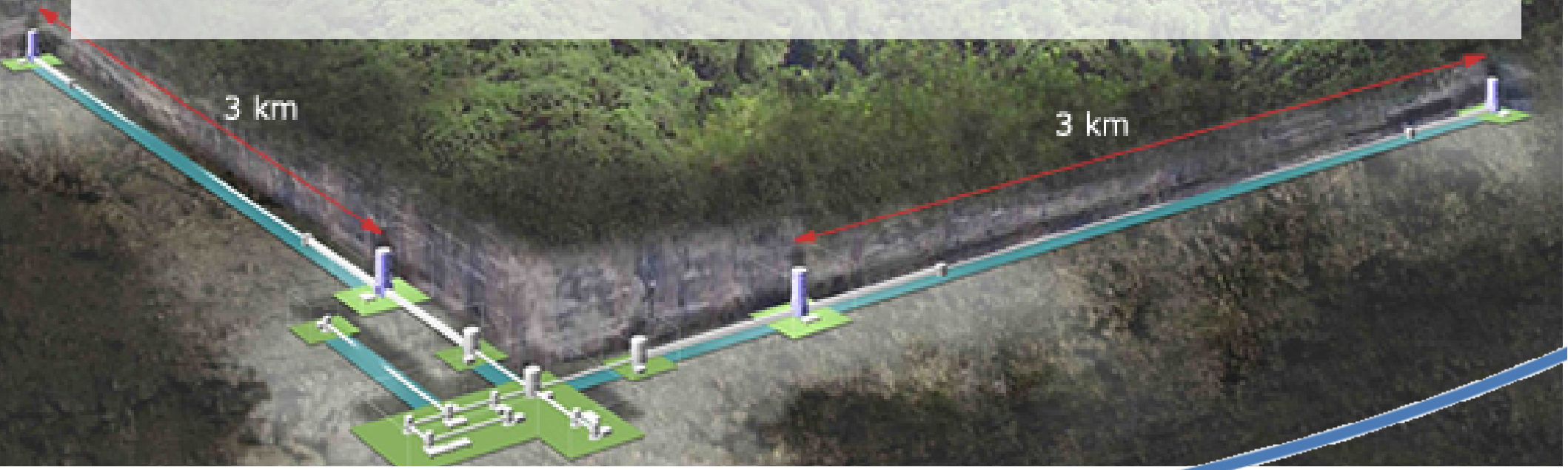
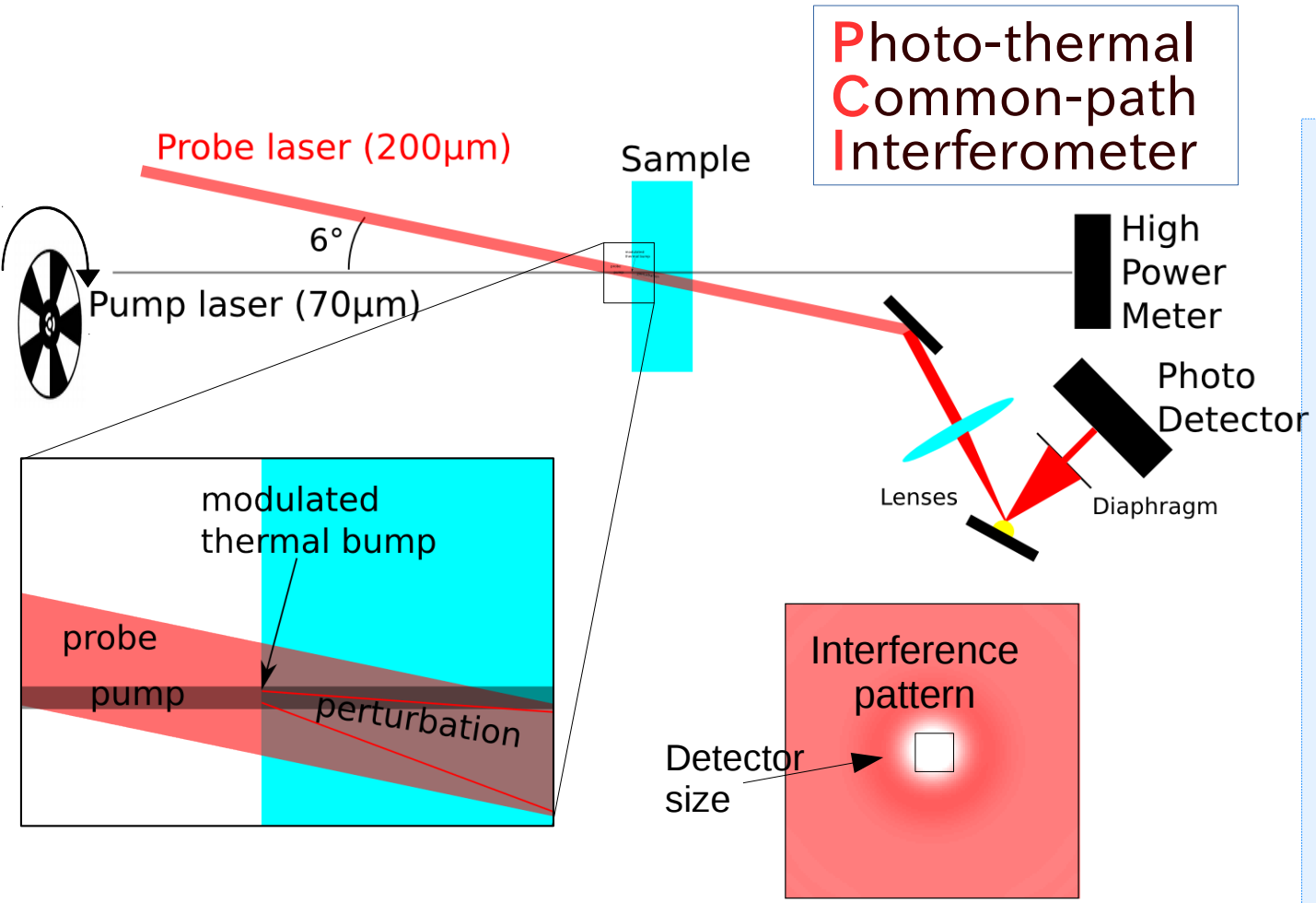
Motivation

- Study the absorption of Sapphire, bulk scans and surface maps
- Characterize the KAGRA mirrors absorption
- R&D – Investigate on Crystalline coating to reduce mechanical losses.



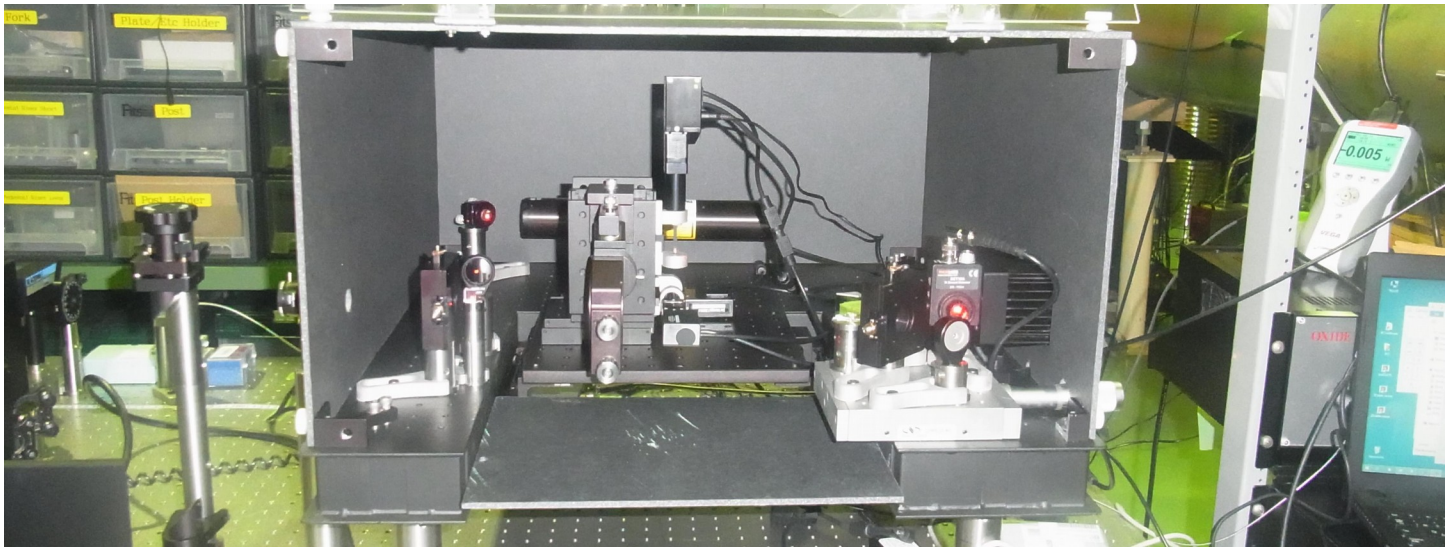
Absorption measurement method at NAOJ



- The 1064nm pump periodically changes the temperature of the sample
- The thermal lens effect changes the probe wavefront
- The perturbation makes interference with the main mode
- The detector sense the intensity variation of the central part of the spot.
- This variation is proportional to the pump **absorption rate**

from the company
Stanford Photo-Thermal Solution

Experimental setup – Previous configuration



- Scan along the sample depth
- 2D maps of the surface and inside the substrate
- High power pump laser (25W)
- Best sensitivity:
  - Silica: <1 ppm/cm (bulk) <0.1 ppm (surface)
  - Sapphire: <5 ppm/cm (bulk) <0.5 ppm (surface)

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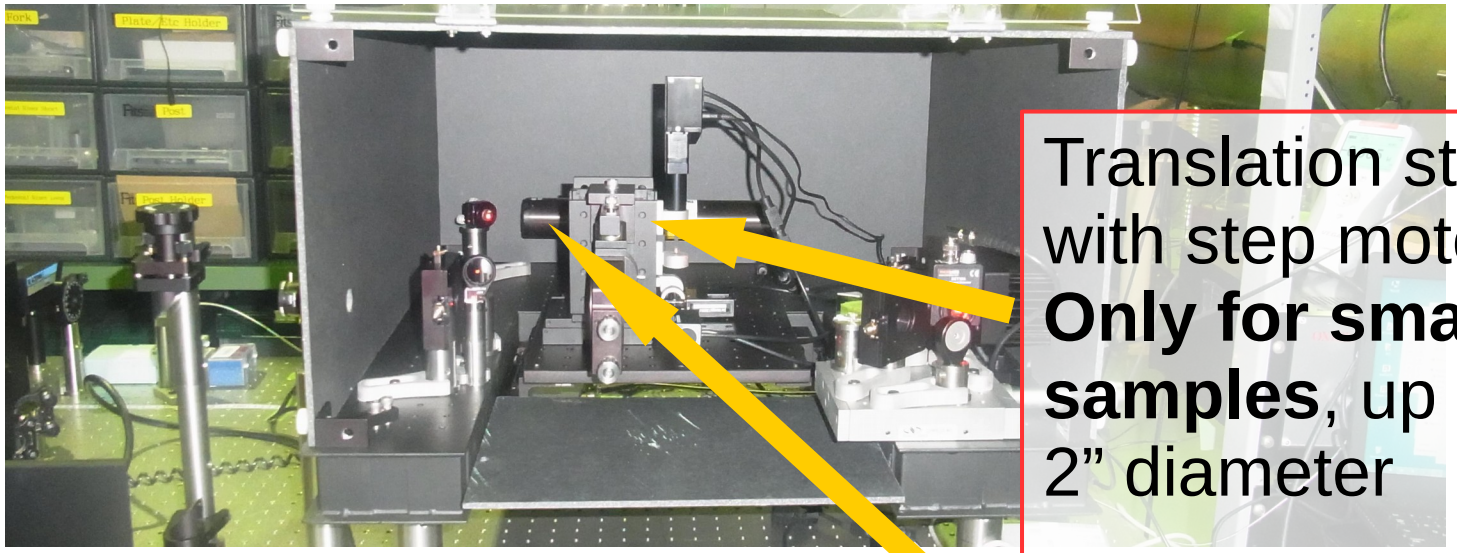

Translation stage with step motors **Only for small samples**, up to 2” diameter

HeNe probe **Only for transparent materials**

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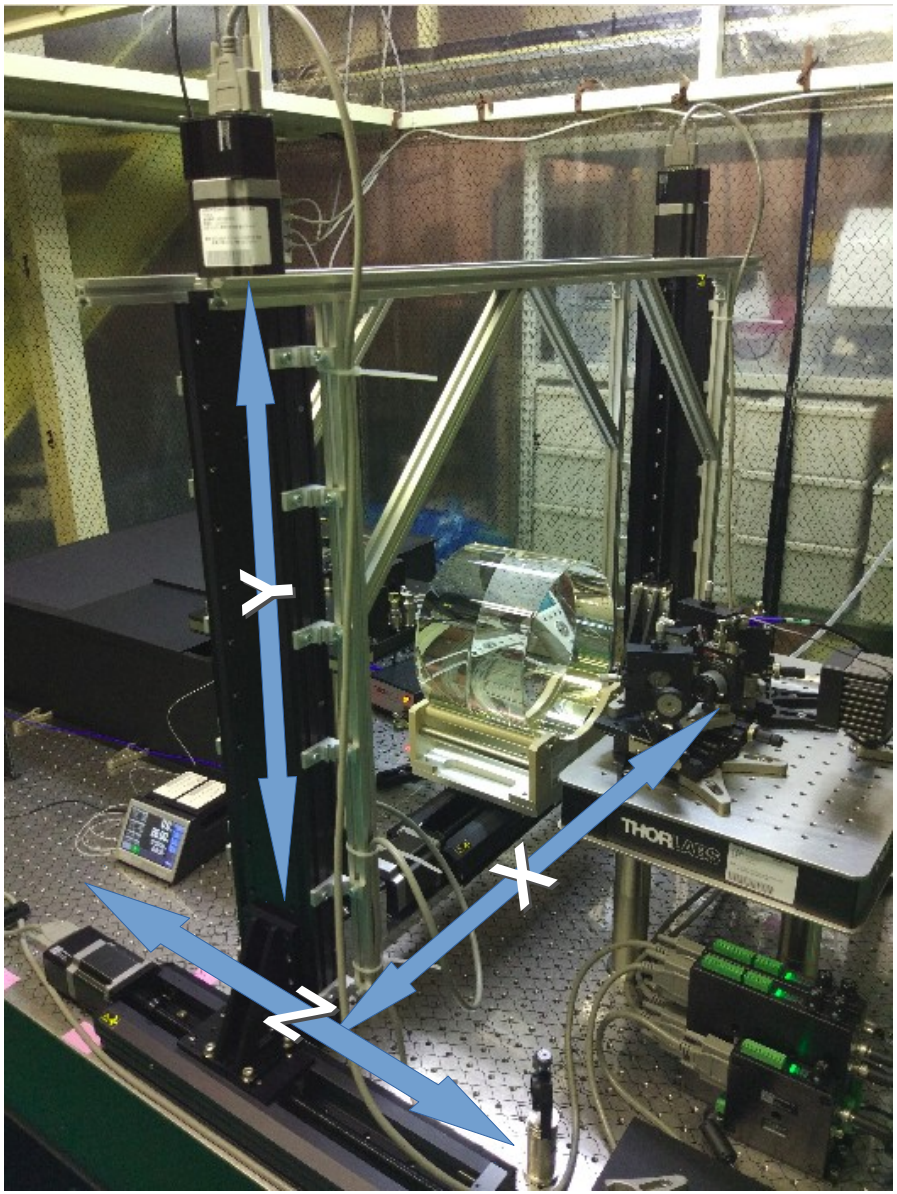
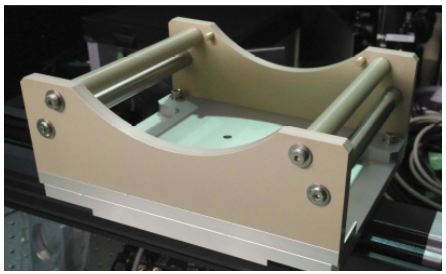


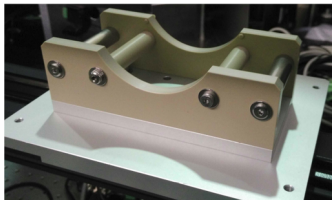
- TO MEASURE
  KAGRA MIRRORS
  → Large translation stage

- Step motors 1/8063 mm (~0.1μm)
- Move range 250mm in x,y,z
- Designed to bear heavy objects
- Added a cage structure for rigidity

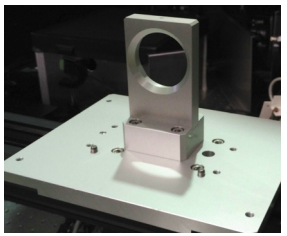
KAGRA mirror size



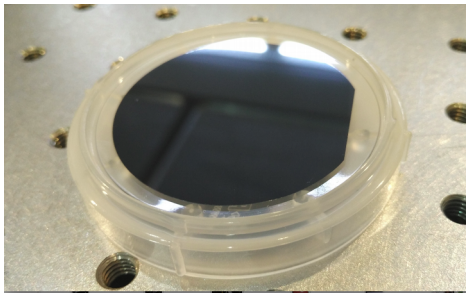
TAMA300 mirror size



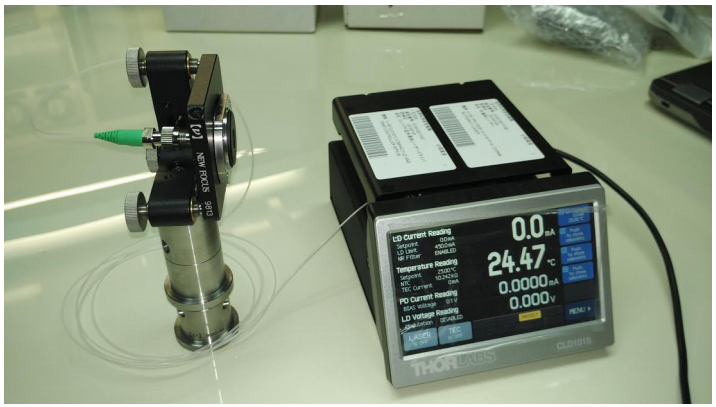
Up to 2” mirror size



Experimental setup – NEW configuration



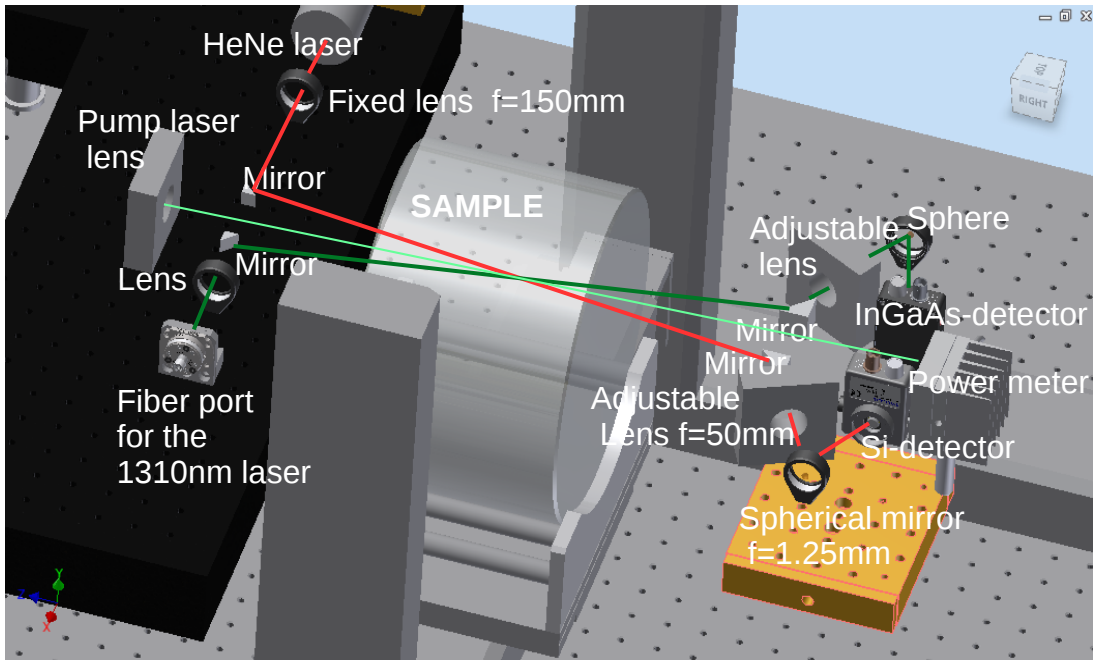
- Not transparent to visible light
- Cannot use HeNe probe laser
- Use of 1310 nm laser



- TO MEASURE
  GaAs CRYSTALLINE COATINGS
  → 1310nm laser probe

Experimental setup – NEW configuration

Design of two probe lasers (633nm and 1310nm)

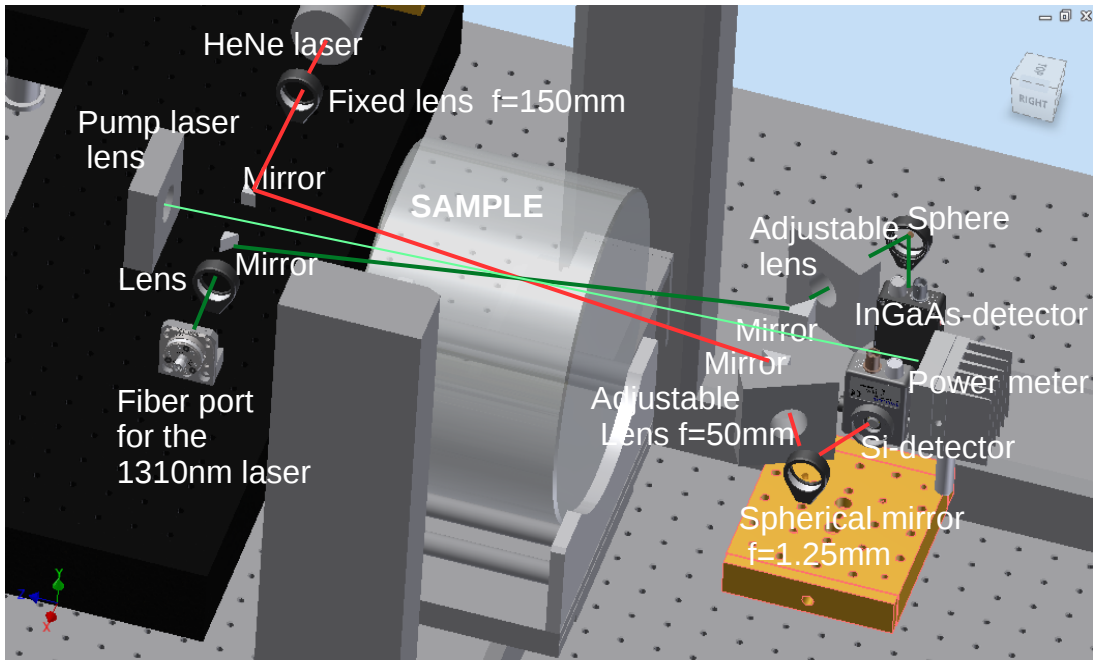


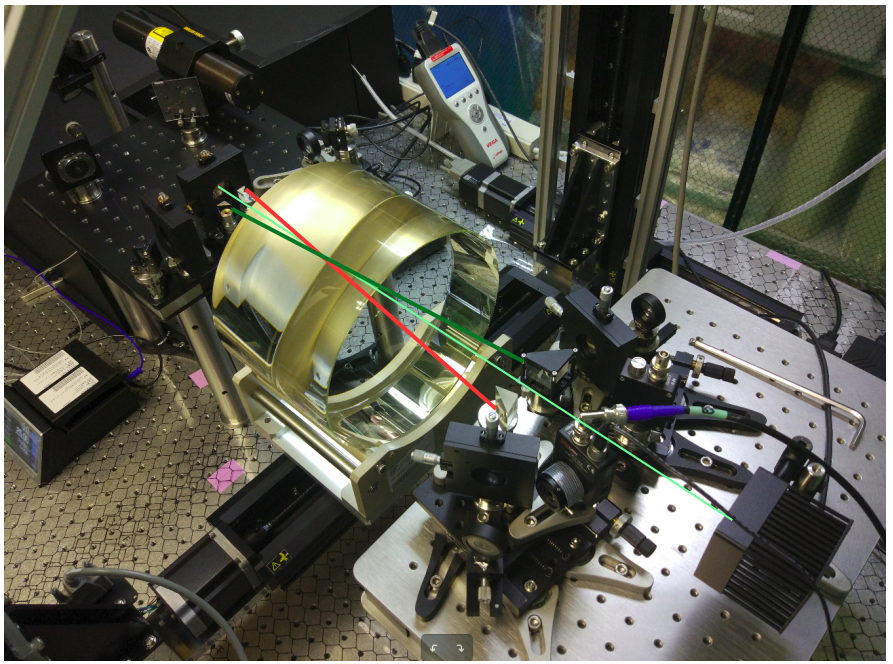
- TO MEASURE
  KAGRA MIRRORS
  → Large translation stage

- TO MEASURE
  GaAs CRYSTALLINE COATINGS
  → 1310nm laser probe

...with the same setup

Experimental setup – NEW configuration





Assembly completed !

Cleaness improvement

- Replaced the HEPA filters with new ones
- Covered optical table holes
- Added a pre-clean booth, with clean suits, air-shower, sticky mats.

- **Secret: CLEAN OFTEN !**

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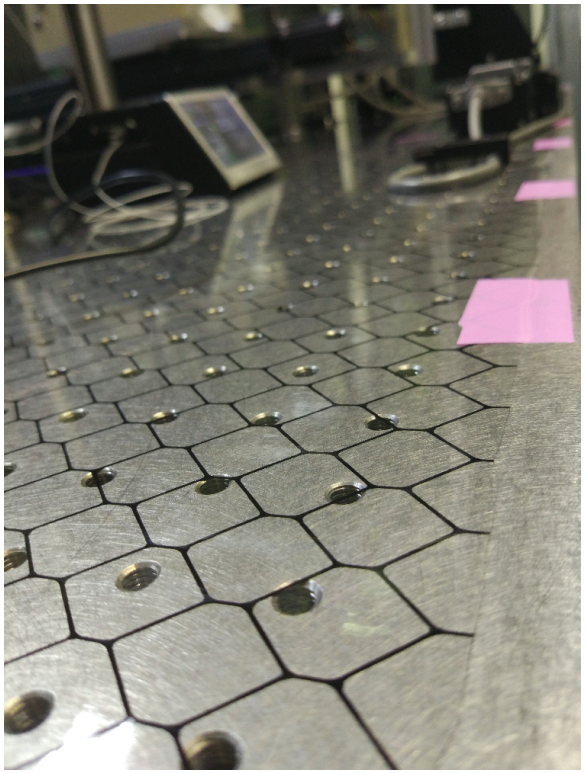

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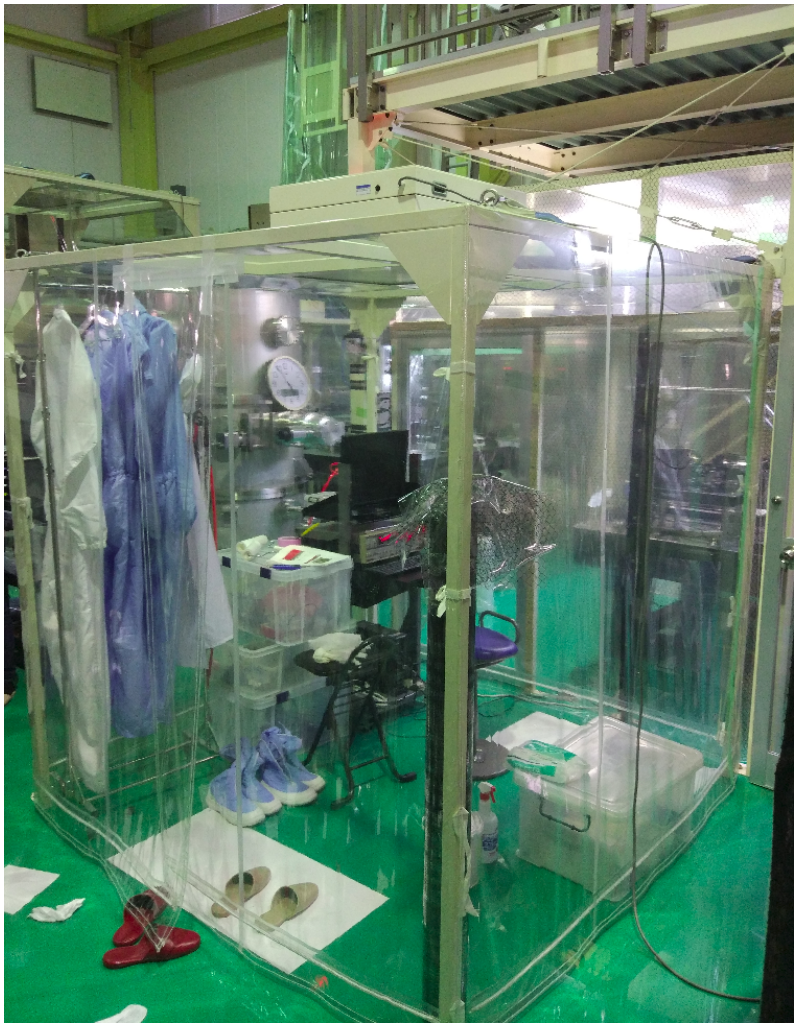

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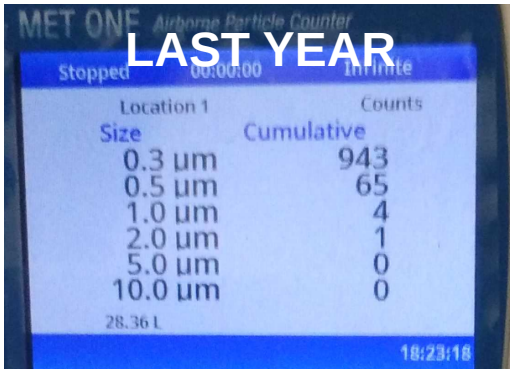

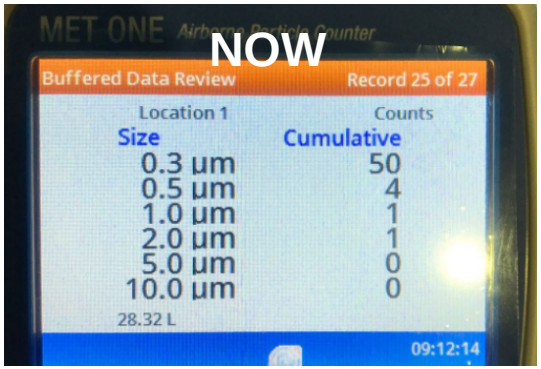

Next steps

- Get some sapphire substrates to test
- Make sure of the correctness of calibration
- Take measurements of sapphire mirrors and GaAs crystalline coatings

Conclusions

- We worked hard to make a clean space in TAMA300
- We are almost ready to measure KAGRA mirrors
- We will measure GaAs samples soon

Thank you for
your attention