Vibration measurement of Shintake monitor -Analysis of impulse response-

ATF2 project meeting (Apr. 18, 2007)

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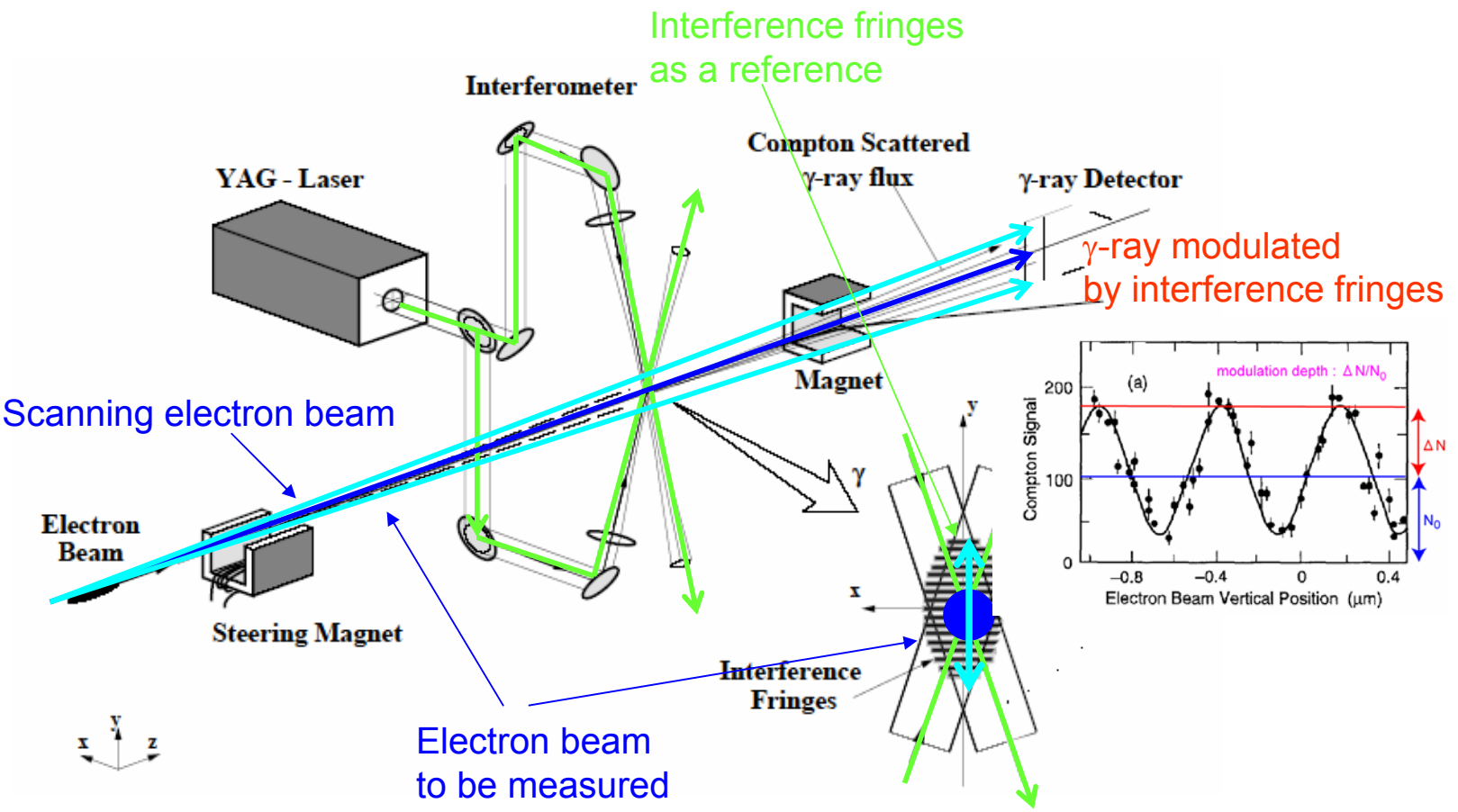
Schematics of Shintake Monitor

Measure beam size using phase (=position and period) of interference fringe as a reference



Performance expected for Shintake monitor in ATF2 project

- Measure size of electron beam converged to 37 nm of radius (σ) with 2~3 nm of resolution

Methods to realize expected performance

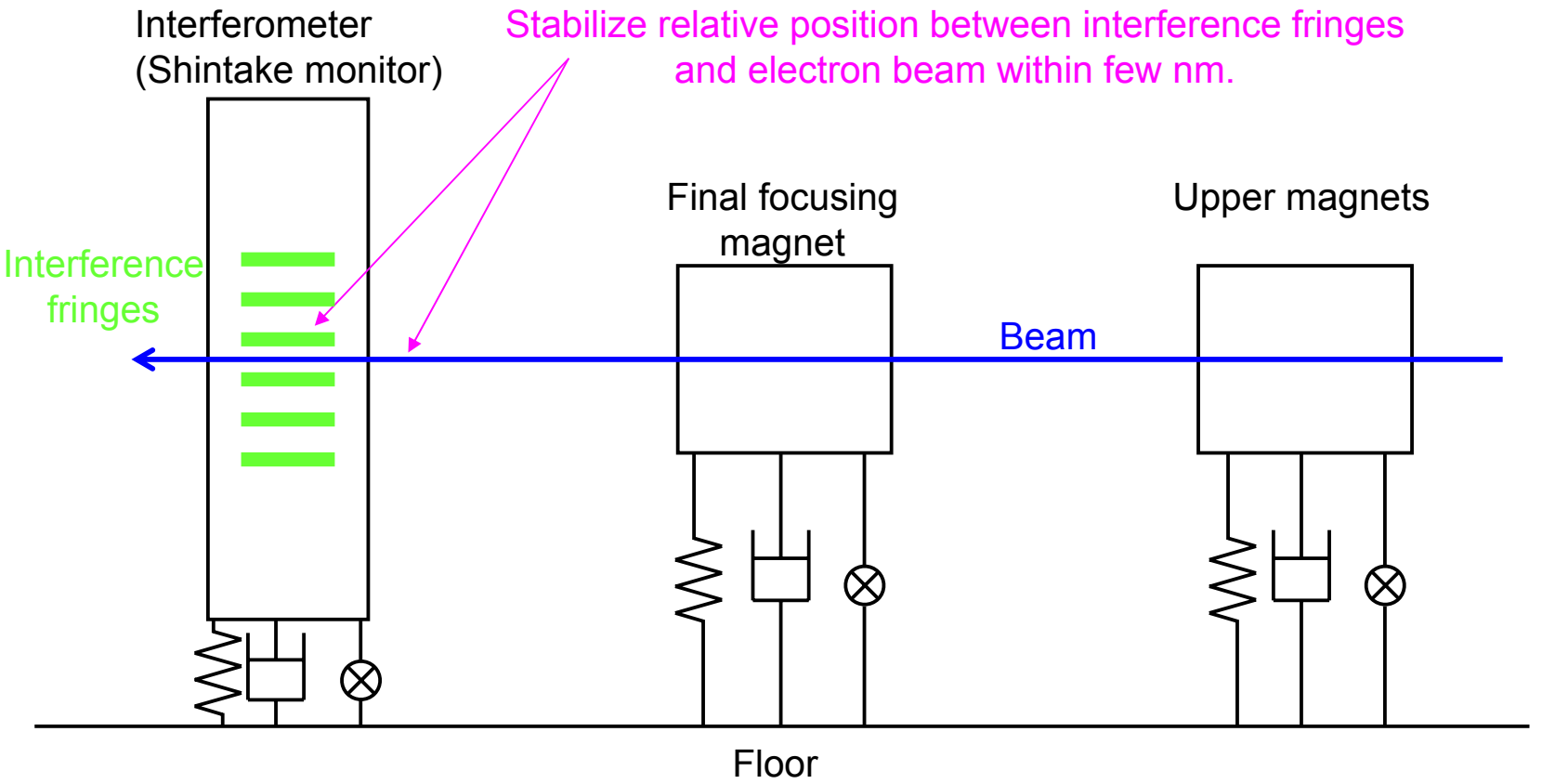
- Use shorter (1064->532 nm) wavelength of laser
  ->Obtain higher modulation of γ-ray for narrower (60->37nm-in design) electron beams

- Stabilize phase and visibility of interference fringes

- Stabilize interferometer

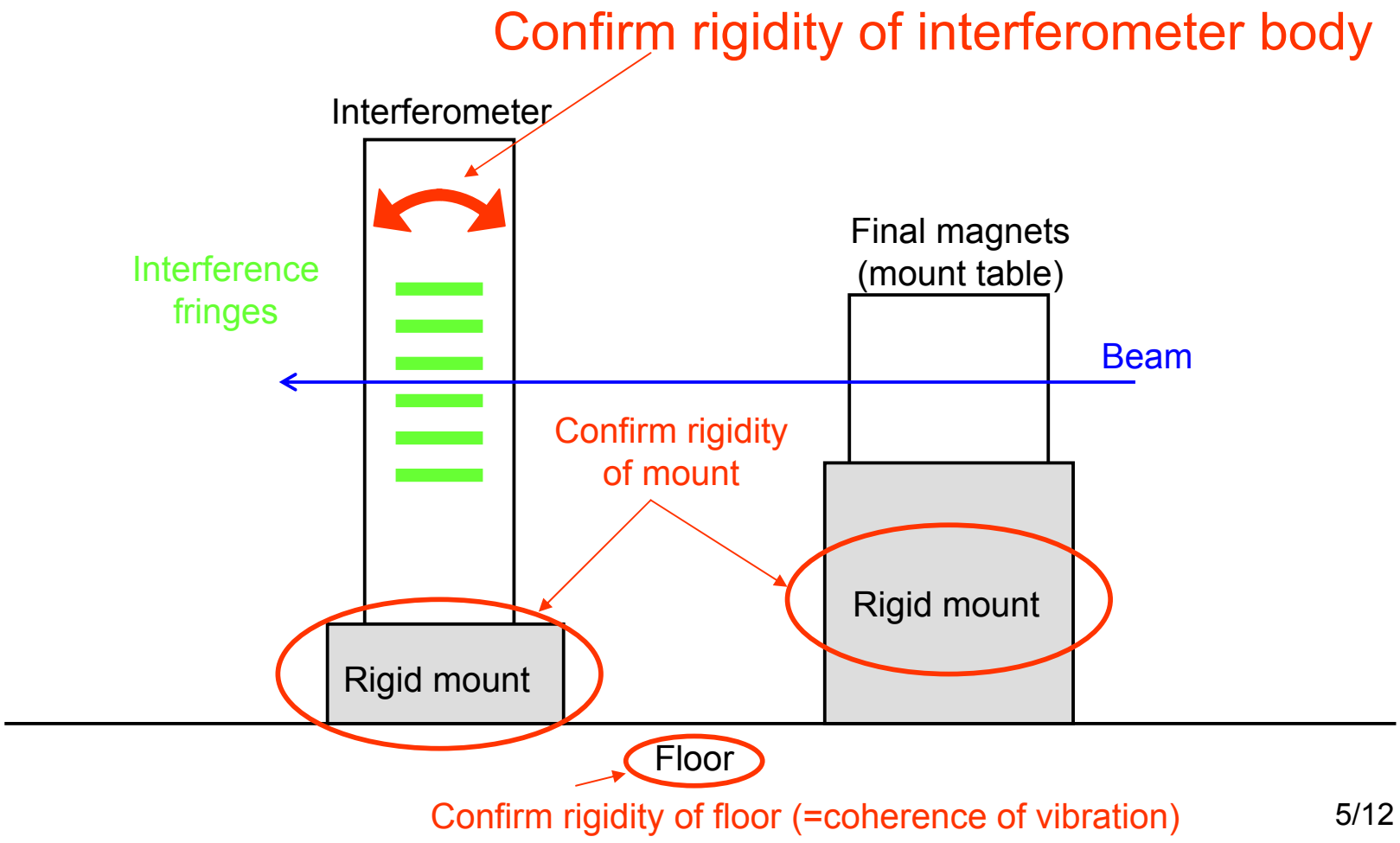
Goal of stabilization for Shintake monitor

In order to measure beam size with 2~3 nm of resolution



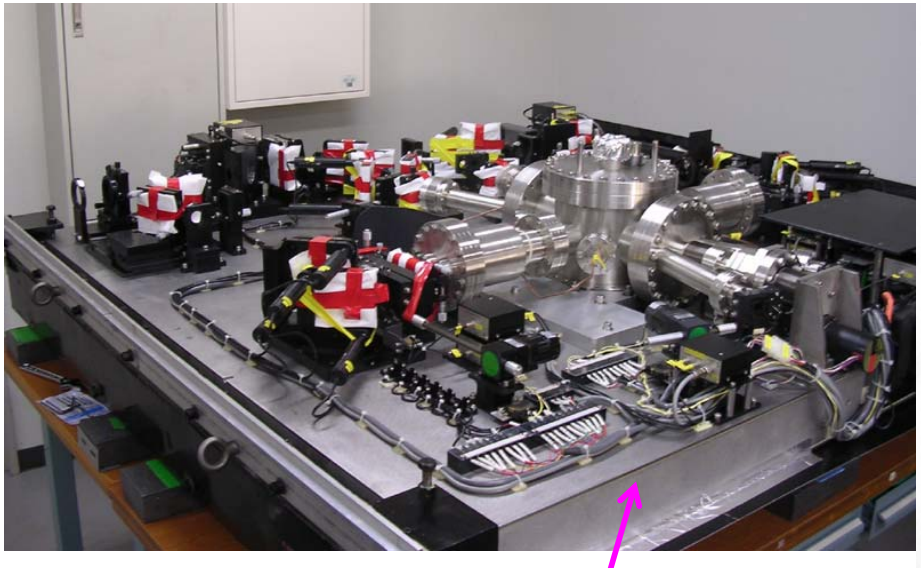
Rigid mount on floor for 1st step consideration

using individual rigid mount for supporting interferometer (Shintake monitor)
and Final focusing magnets (and their mount table)

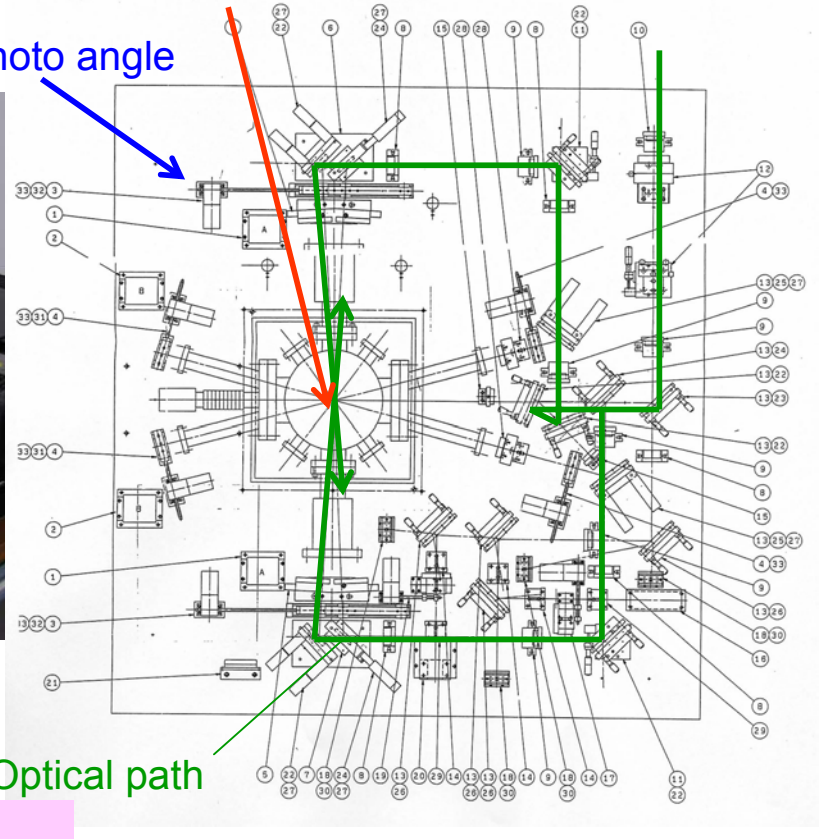


Interferometer of Shintake monitor

Using optical table (1.6 × 1.5 × 0.11 m) to mount optics, total weight of ~740kg



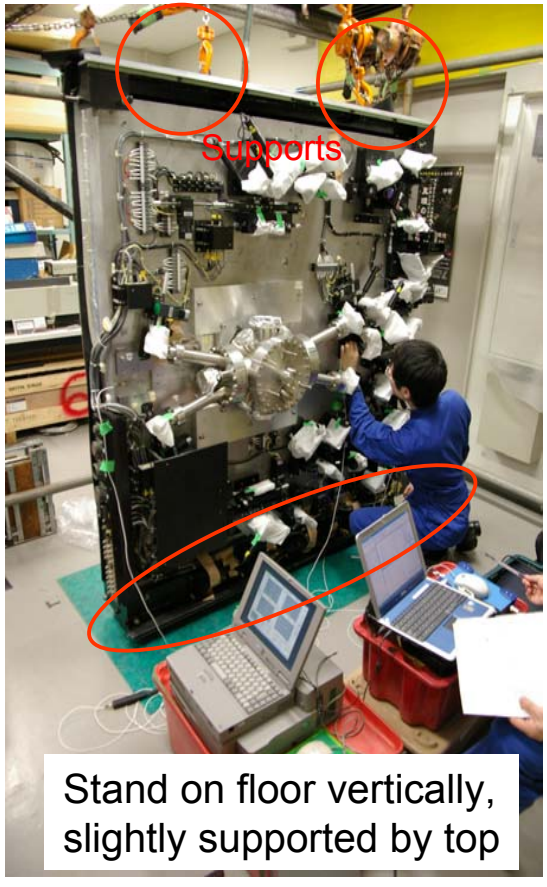
Photograph of the interferometer laid for adjustment,
The optical table is supported vertical in usage.

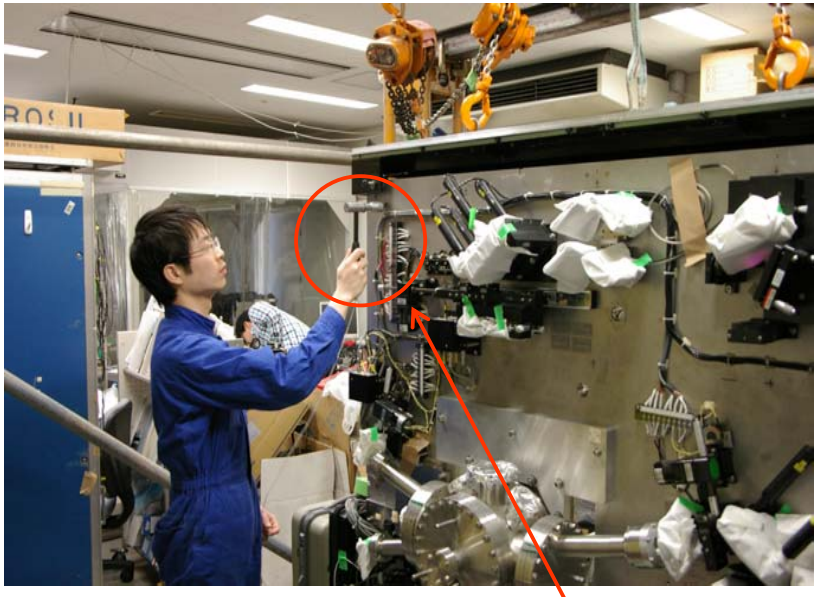


Optical table has 110 mm-t, and ~220 kg-w,
consisted of 5 mm-t top and bottom of stainless steel plates
and ~100 mm-t Al honeycomb core (AL3/8-5052-003)

Analysis of impulse response for confirming rigidity of interferometer

(by Herz co. ltd., Feb. 2007, 11F of building @Univ. of Tokyo)





Hit by impulse hammer and measure response by Acc. sensor.

Acc. sensor
~10mV/m/s^2, f_0~33kHz

Measurement points and an example of measured impulse responses

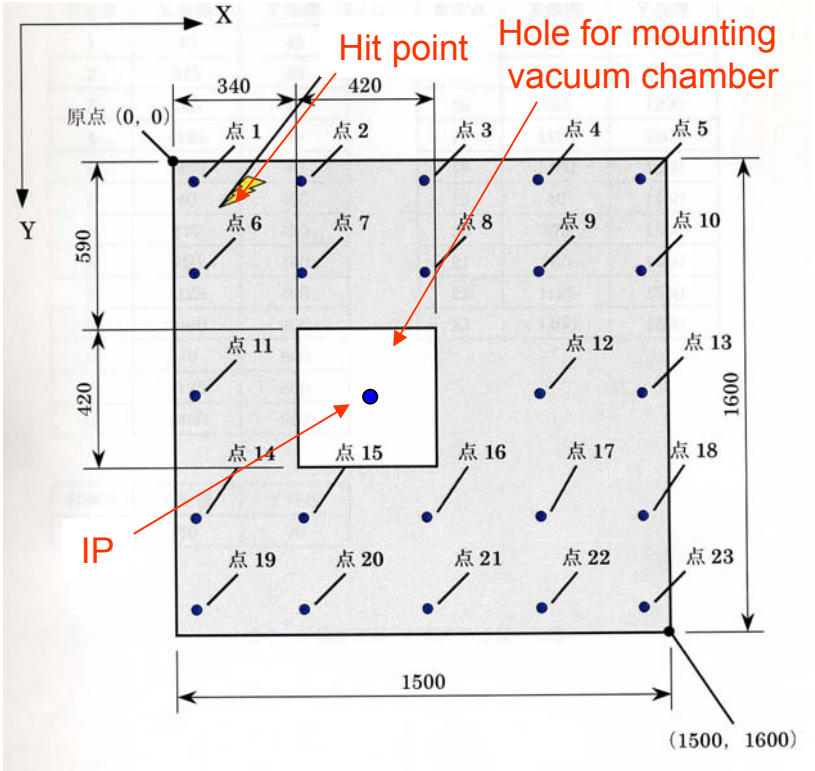


Fig. Measurement points (23 points) and a hit point on optical base plate.

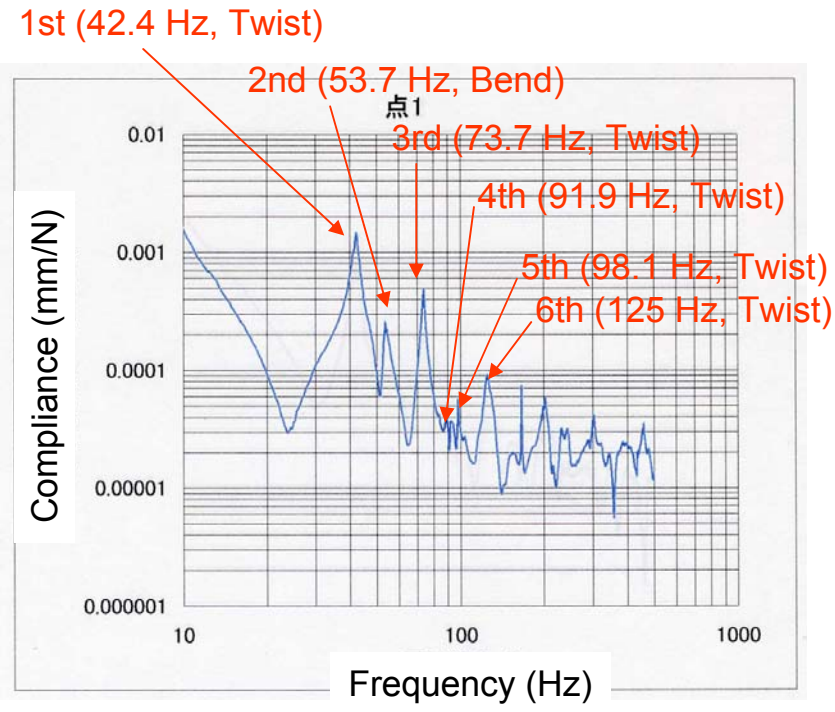
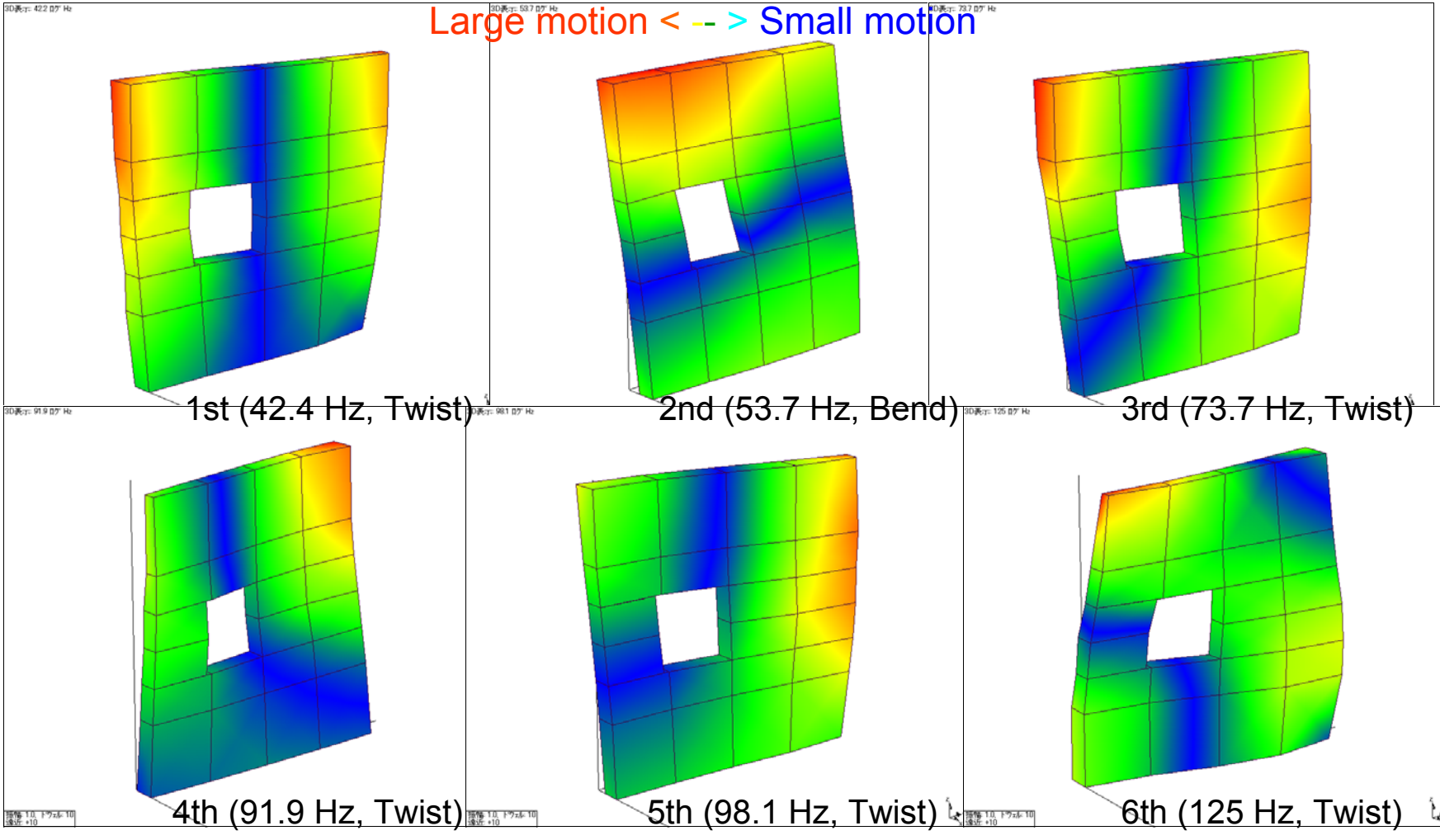


Fig. Example of measured impulse response at measurement point 1.

Analysis results for deformation mode of interferometer (1st ~6th)

Large motion < -- > Small motion



1st (42.4 Hz, Twist)

2nd (53.7 Hz, Bend)

3rd (73.7 Hz, Twist)

4th (91.9 Hz, Twist)

5th (98.1 Hz, Twist)

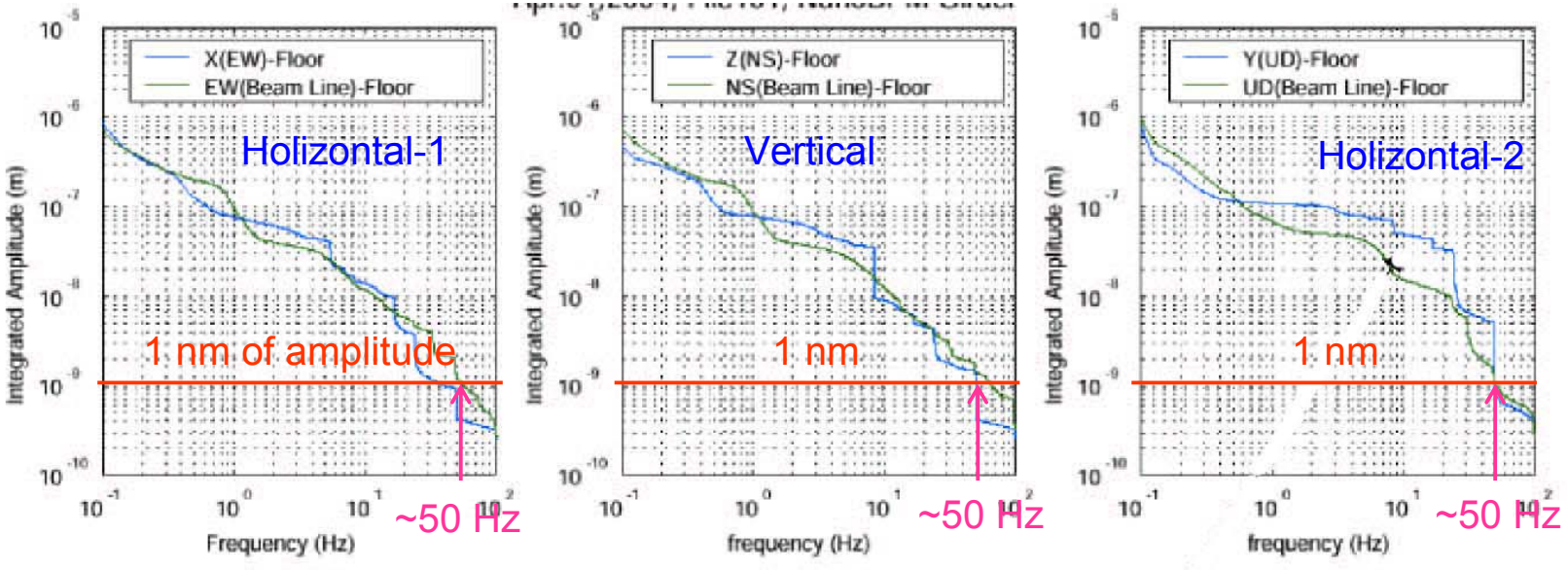
6th (125 Hz, Twist)

Floor motion at ATF beam line

from “Floor tilt and vibration measurements at the ATF”, Masuzawa, Second Mini-workshop on Nano Project at ATF 11 Dec. 2004,
(measured by Yamaoka using acc. sensor, Apr. 1, 2004)

【Assumption】 Floor motion higher than ~50 Hz is small enough to be neglected.

Interferometer body is rigid by making lowest deformation mode higher than 50 Hz.



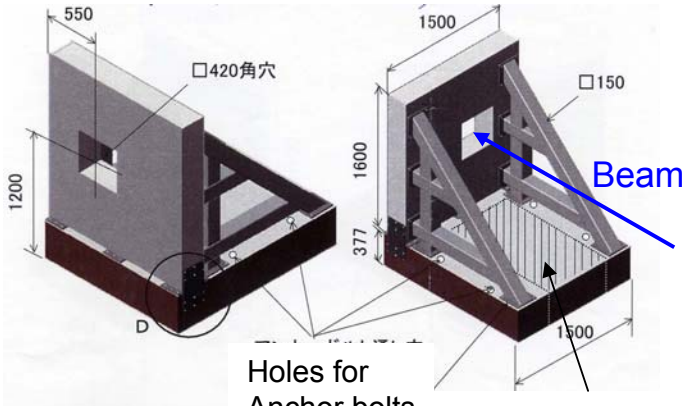
Recommendation for rigid mount considering floor vibrations

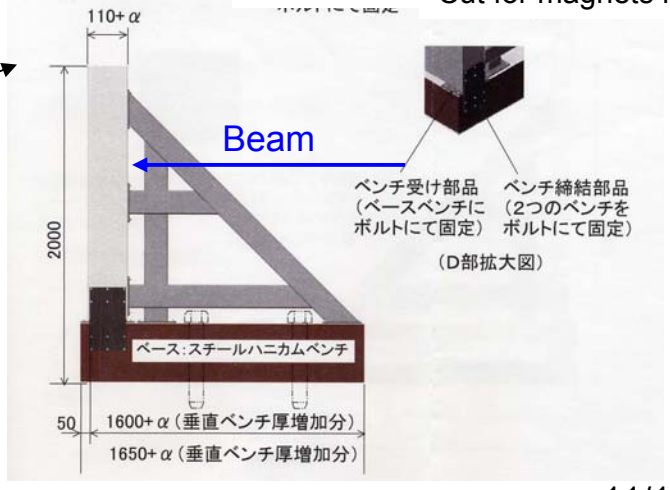
Increase rigidity of interferometer body

- by using 250 mm-t Al honeycomb plate
  -> ~74 Hz

- by using 200 mm-t steel honeycomb plate
  -> ~82 Hz

- by using 250 mm-t steel honeycomb plate
  -> ~112 Hz





Example of mount structure
-> Mount on base plate made of steel honeycomb.
-> Fix the mount on floor by anchor bolts tightly.

Requirements

- Design rigid mount for interferometer
  - Computer simulation seems to be not effective to obtain precise results enough to design mount.
  - Based on knowledge of experienced engineers in anti-vibration area.

- Vibration data of ATF
  - Floor motion
  - Sound, etc.

- Ensure tolerance for vibration more precisely
  - Frequency
  - Amplitude
  - Period, etc.