# Ground Motion studies

ATF internal note: ATF-15-01

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collaborating with Araki-san (KEK) and M.Patecki (CERN)

Sensors provided by LAPP

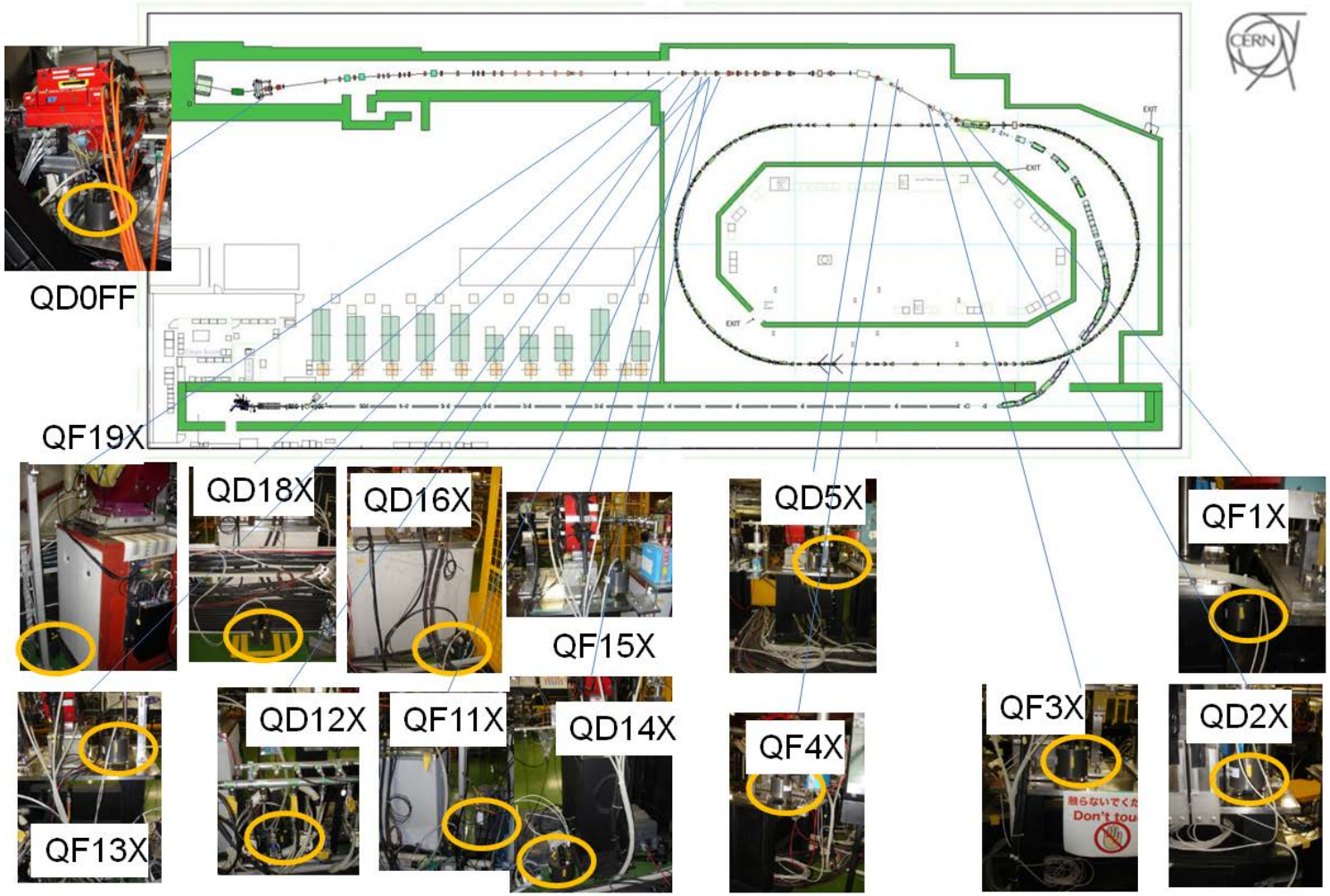
DAQ and cables provided by CERN

Help and infrastructure provided by KEK

# GM studies

- Coherence length
- QF1FF support
- Conclusion and next steps

# 14 Guralp 6T sensors all along ATF2




Guralp 6T: 0,5Hz-100Hz, two directions connected (vertical and horizontal can be placed parallel or perpendicular to beam direction), mainly in Extraction line, 2 sensors easily relocated

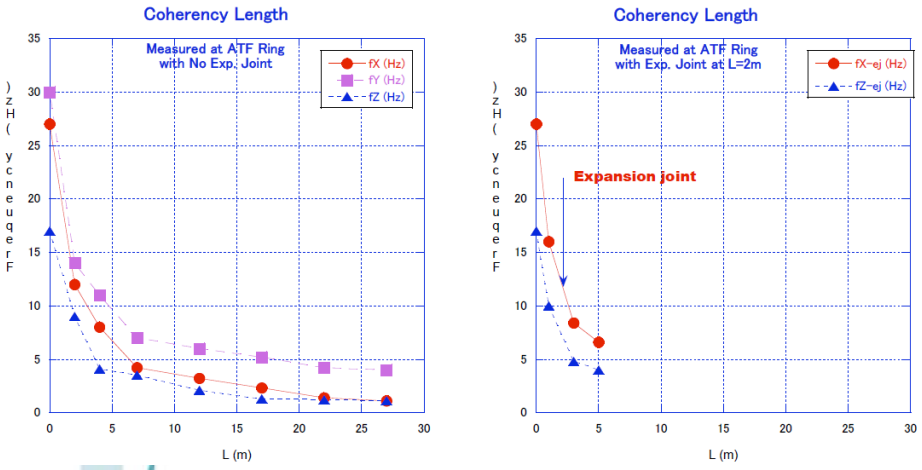
# Measurements along FF line

(from QF1FF since QD0FF or Shintake monitor floor too crowded)

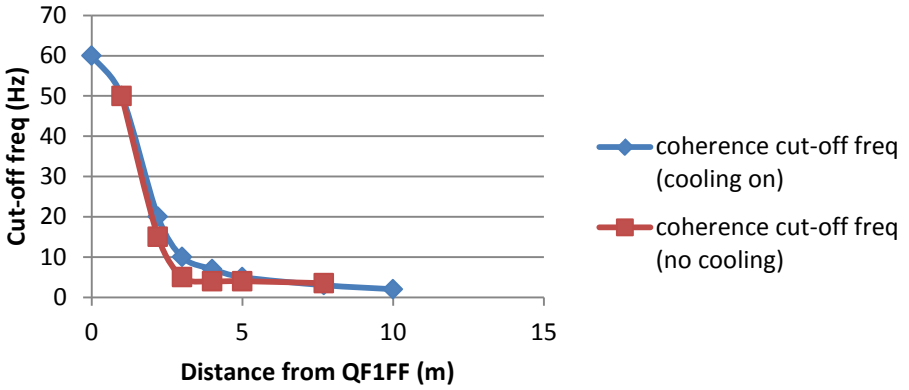
October 2006 in Damping ring

**R. Sugahara, M. Masuzawa, H. Yamaoka**

**Estimated Frequency Area of Good Coherency versus Distance, L**



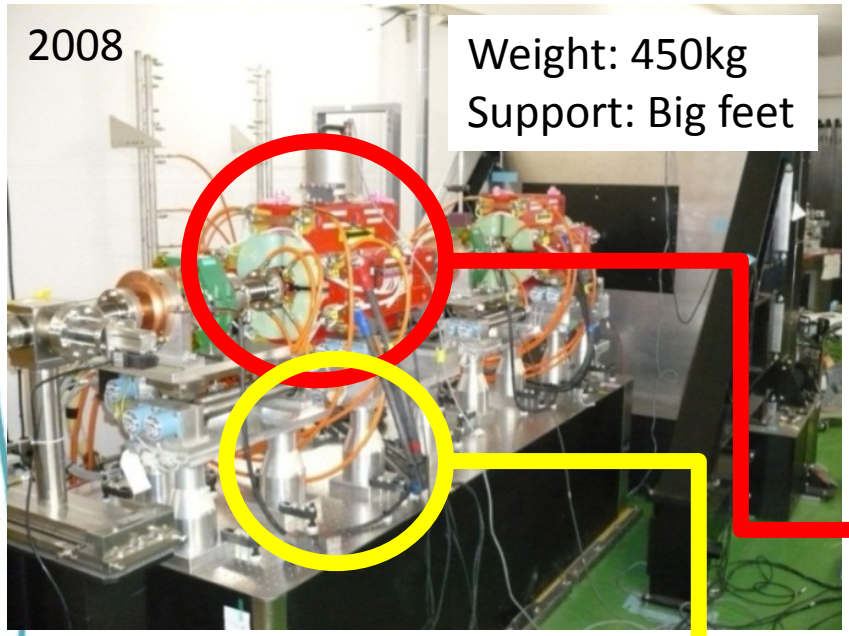

**Cut-off freqency vs distance from QF1FF**

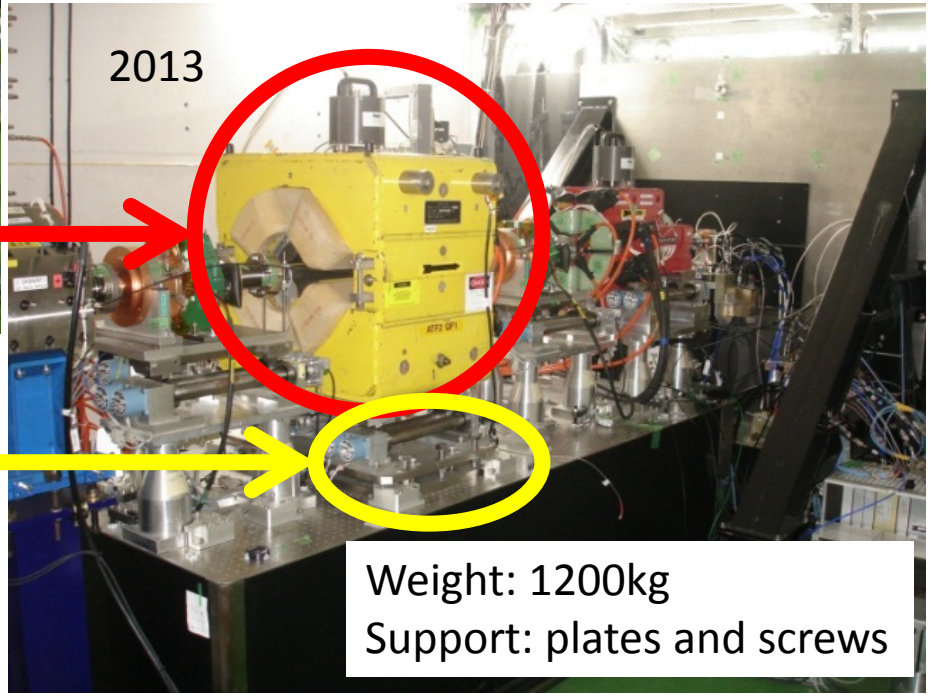



From QF1FF, coherence length seems to be 3m

# Why make new study?

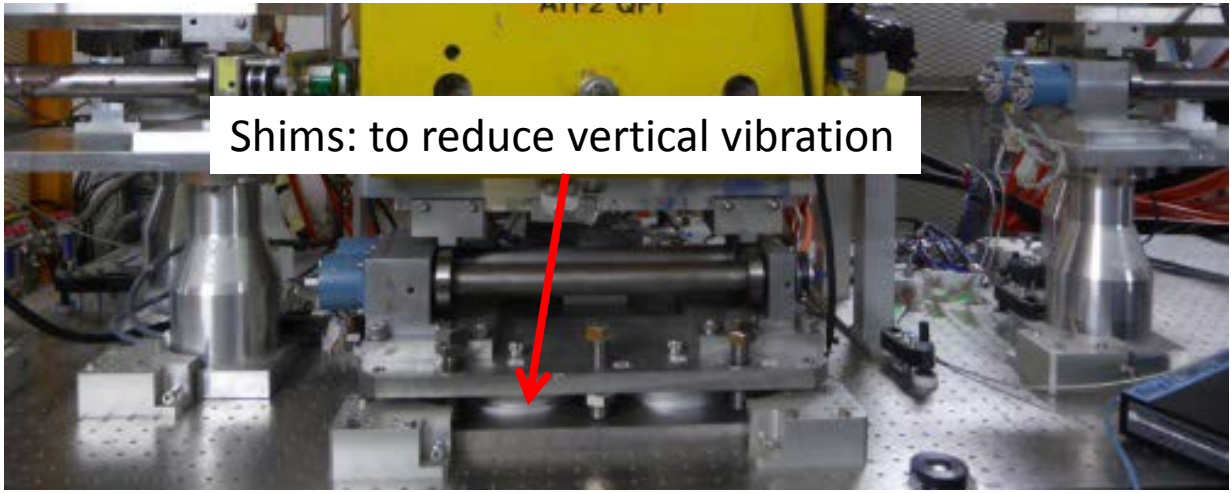
QF1FF has been replaced by a heavier magnet with better field quality and larger radius

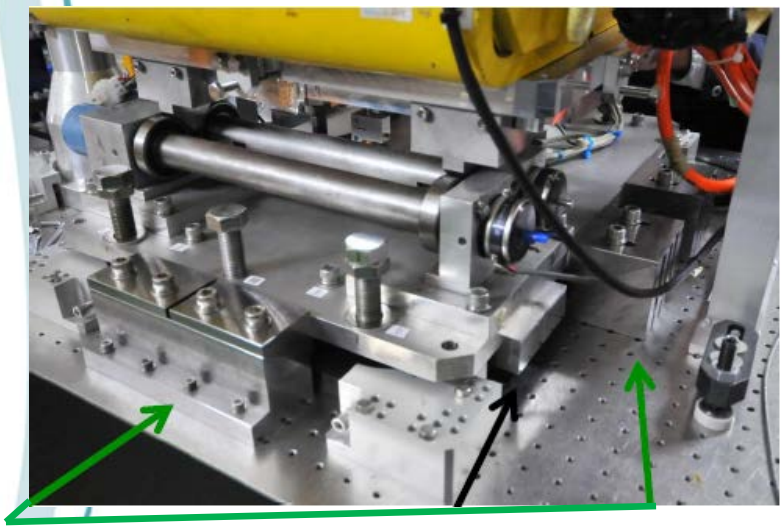


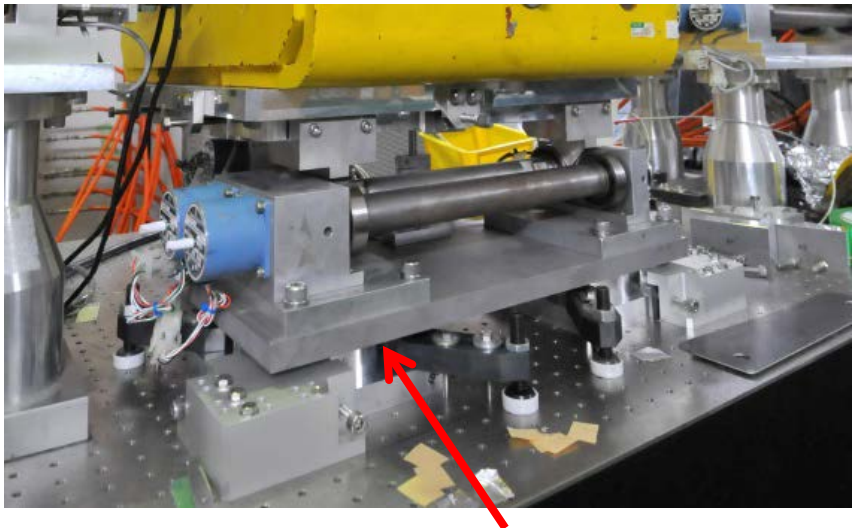

A larger mass reduces resonance frequency, thus increasing the relative displacement level
=> Push all resonance frequencies to higher values

# Different support configurations

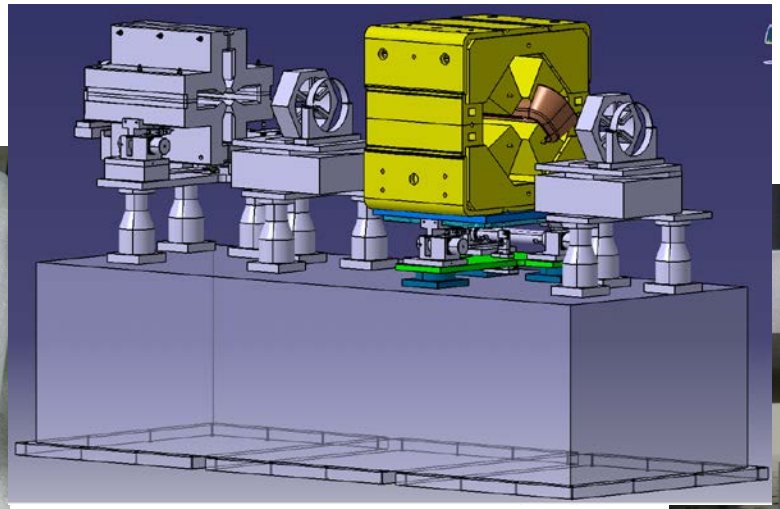



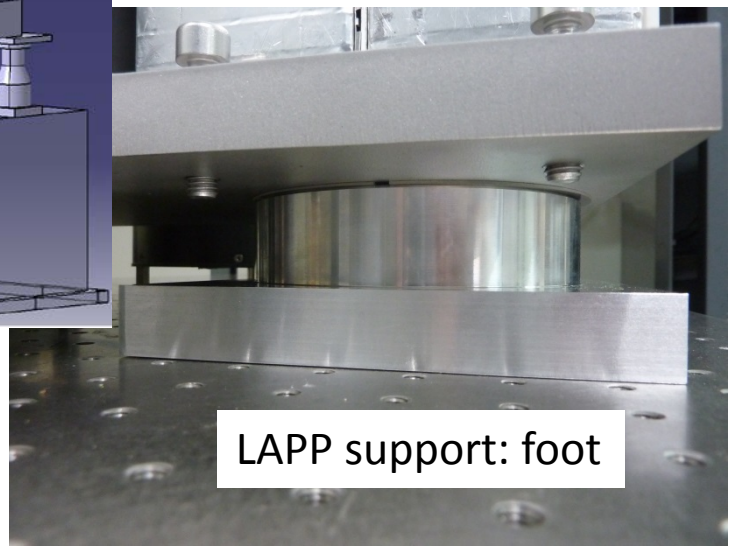
Side blocks: to reduce horizontal vibration



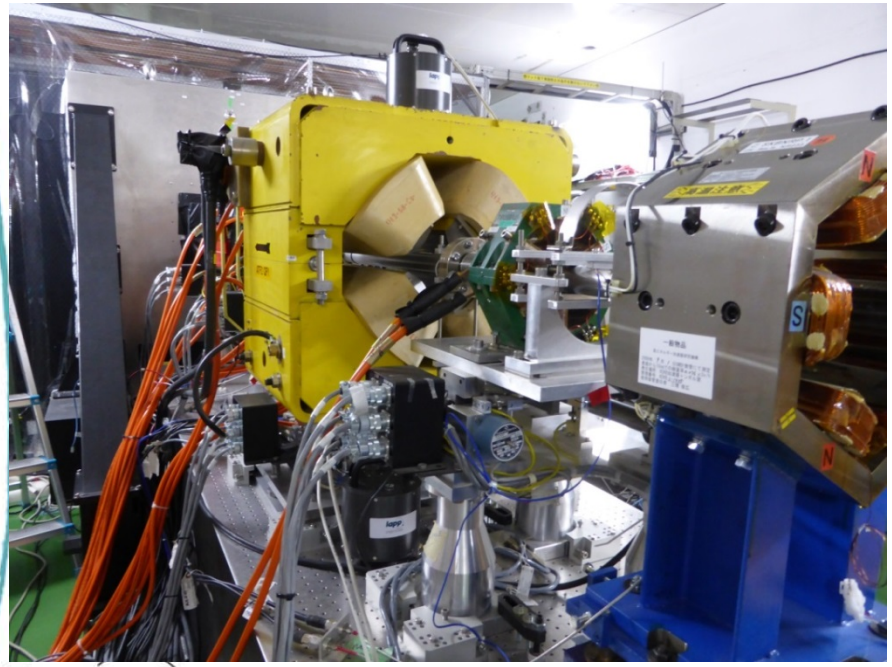
LAPP support: feet and T-plate

LAPP support: T-plate



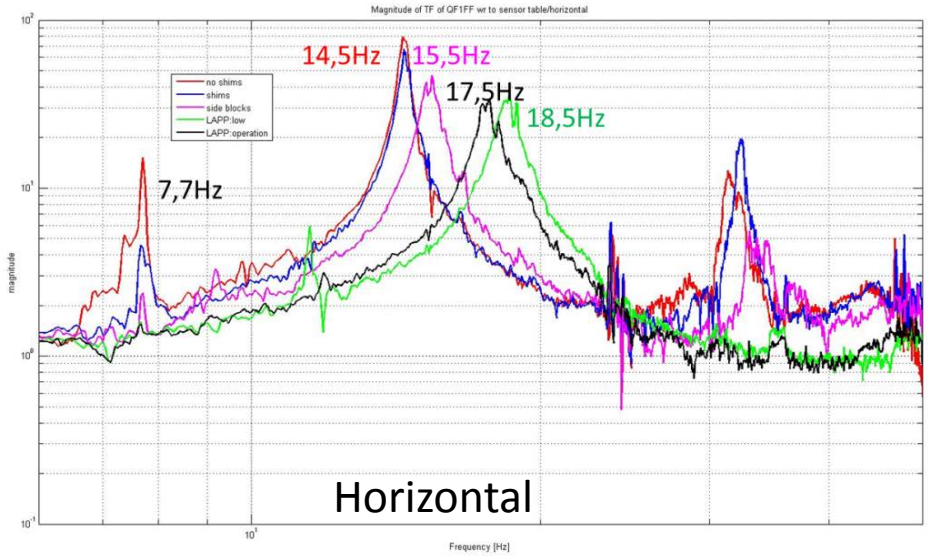


LAPP support: foot



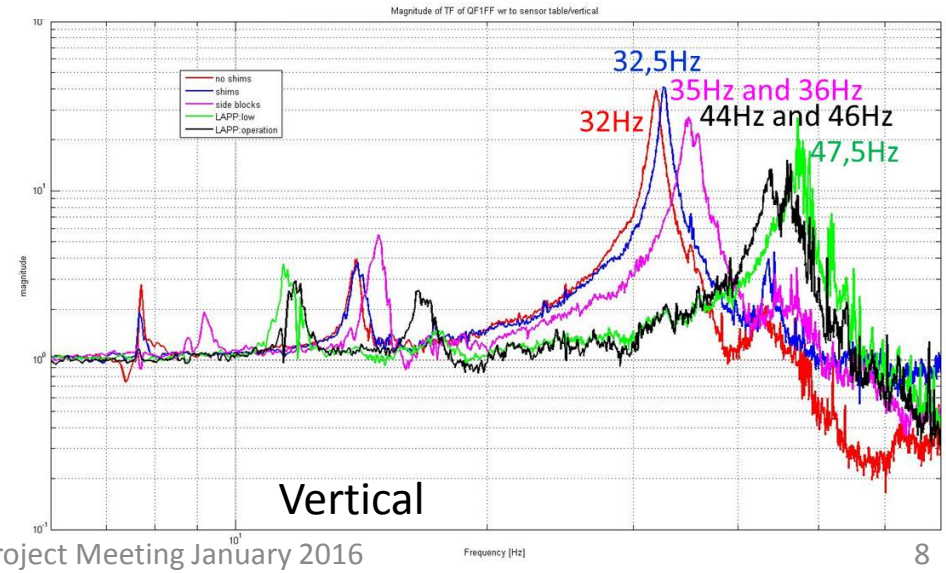
- Measurement set-up: one sensor on magnet, another one on FD table
- Transfer function measures Magnet + Mover + Support
- The main difference between measurements is the support configuration (and magnet height on mover).

# Transfer functions

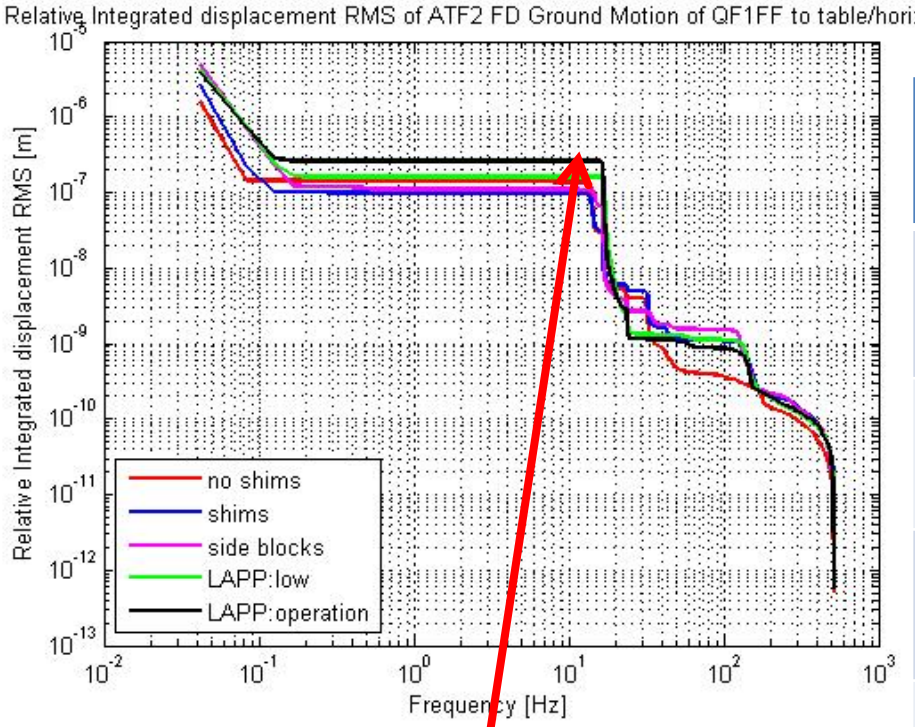



- Main resonance peak shifted to higher frequencies and less parasitic vibrations with LAPP support
- Better vibration behaviour expecting lower relative displacement

Red: no shims
Blue: shims
Pink: side blocks
Black and green: LAPP support



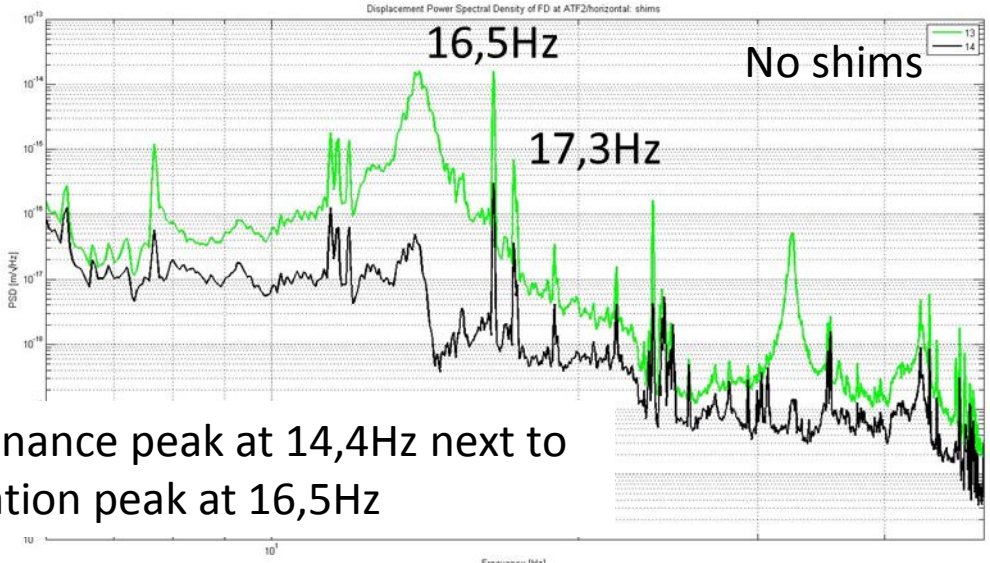
# Suprise in Relative displacement!




Even if Resonance peak shifted to higher frequencies, the relative displacement in horizontal direction is deteriorated (much higher!)!

| QF1FF/tabletop | Vertical (nm) | Horizontal (nm) |
|---|---|---|
| No cooling (red)<br>No shims | 20 | 150 |
| Cooling (blue)<br>Shims | 16 | 120 |
| Cooling (pink)<br>Shims + side blocks | 15 | 109 |
| LAPP support low position (green) | 14 | 161 |
| LAPP support (black)<br>Operation position | 17 | 244 |

# Vibration source!




Resonance peak at 14,4Hz next to vibration peak at 16,5Hz

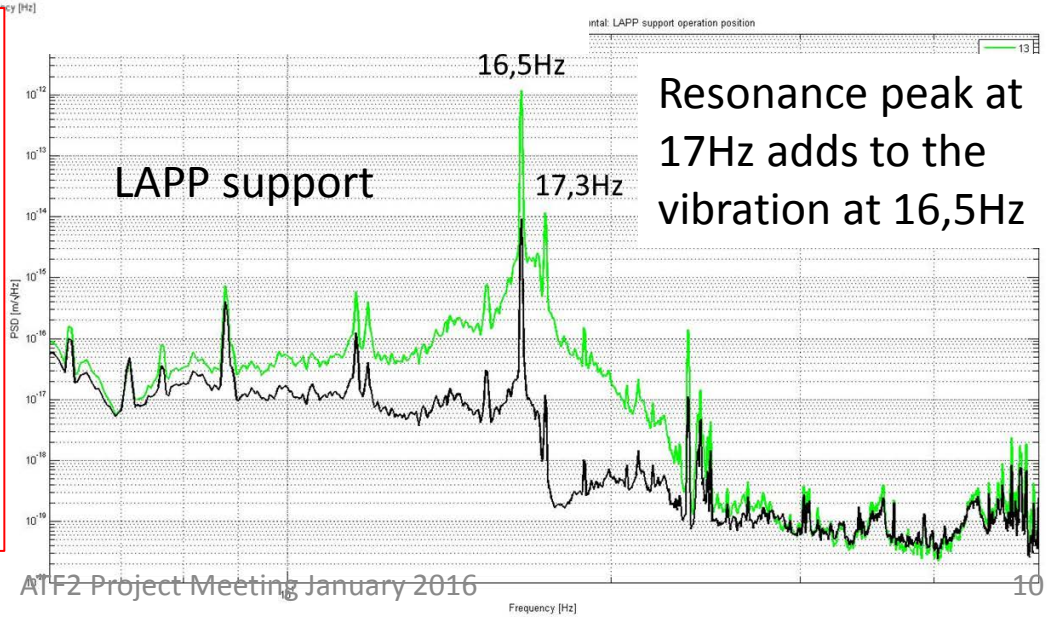
Horizontal PSD

- Green on magnet
- Black on FD table
- Resonance peak of « magnet+mover+support »

We need to identify the source of this strong 16,5Hz vibration

Maybe mechanical source:

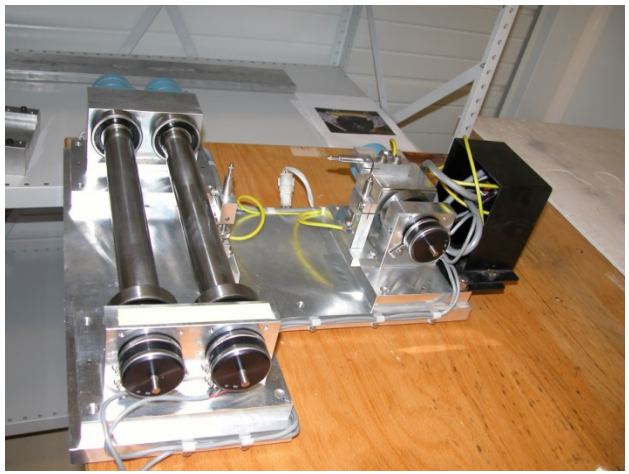
- motor turning at about 1000tpm
- pipe vibrating
- mover motors
- magnet cooling pipes
- ventilation
- Other suspects?




Resonance peak at 17Hz adds to the vibration at 16,5Hz

# Does the mover limit performance?

SLAC movers (Bowden et al)



- under QF1FF
- micron-level displacement
- range of a few millimeters depending on the initial position
- composed of cams, motors
- does not allow QF1FF to be fixed to a solid support
- Can be considered as *soft*

# Does the mover limit performance?

ICEPP/KEK movers (Morita et al)

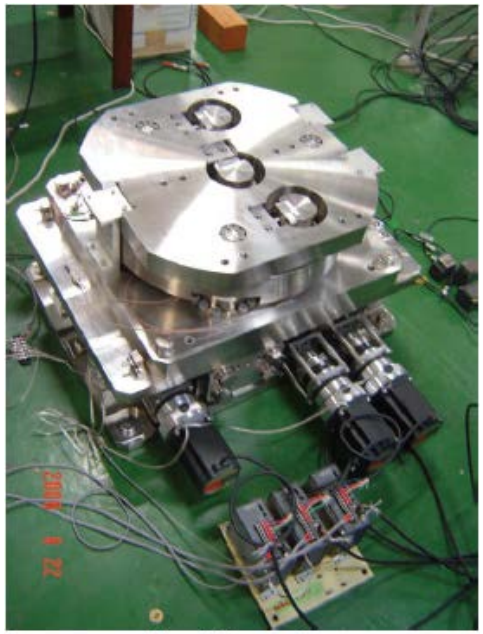


Figure 1: Picture of the mover

Similar mover but with extra piezoelectric stage for nm displacements

Measurements with sensor on table and on stage:

- Only « cam » stage gives *soft* behaviour, peaks at 30-50Hz in horizontal and 50Hz in vertical
- When stoppers were added, peaks moved to 70Hz in horizontal and 100Hz in vertical

But we need the dynamic characteristic of mover during beam operation!

# Conclusion

- By replacing the original support under QF1FF by the LAPP support, the aim of building a support with an improved vibration behavior has been achieved, with resonance moved to higher frequencies.

- However, the effect is overshadowed by the detrimental effect of external perturbations at frequencies at 16.5Hz. It is thus very important to identify the source of these perturbations.