lapp
Laboratoire d'Annecy-le-Vieux
de Physique des Particules

ATF2: final doublet support

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With constant interaction with colleagues from KEK, SLAC and KNU

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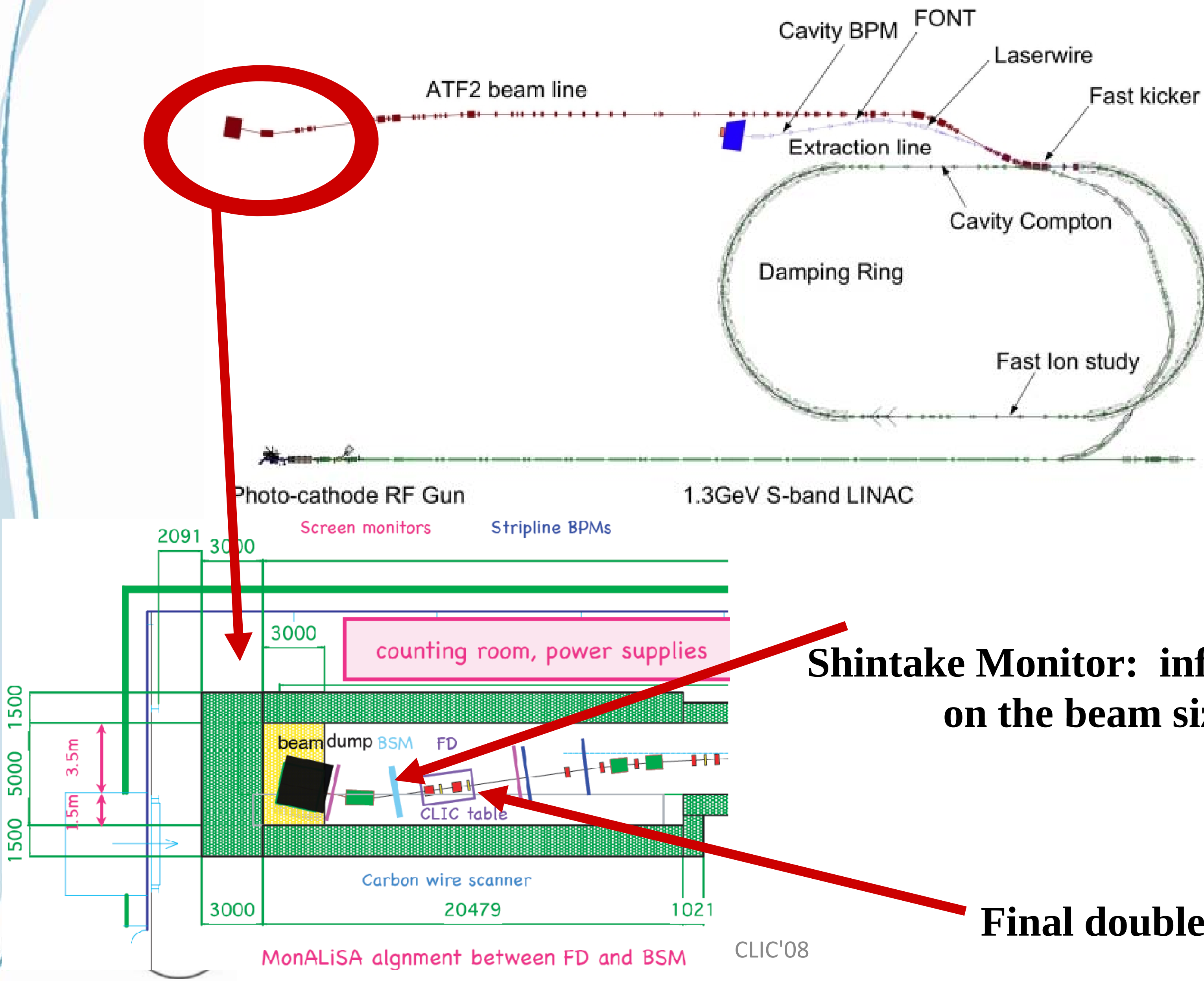
Outline

- FD support specifications
- Initial active support study
- Rigid support on intermediate feet
- Final rigid support
- Measurements with water flow
- Installation photos
- Conclusion

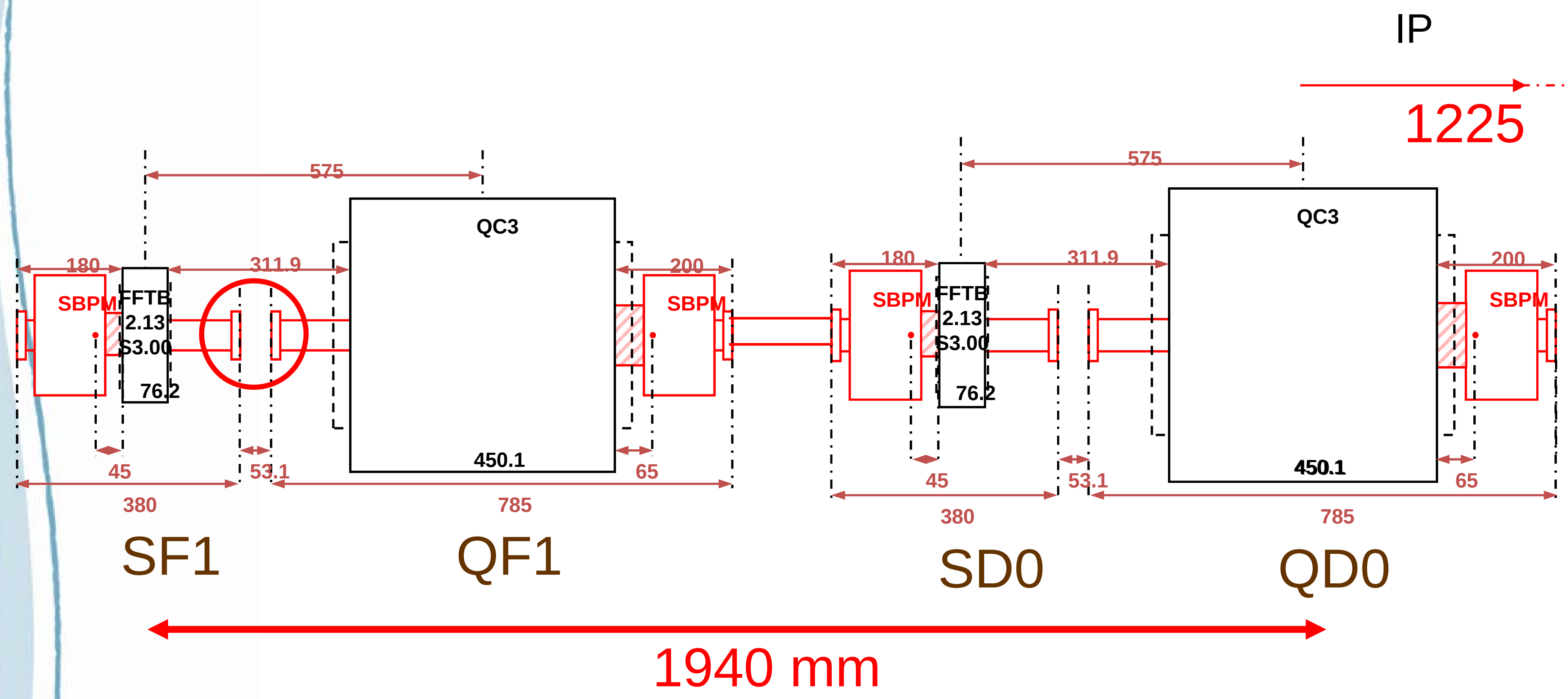
ATF2 Layout



Shintake Monitor: information on the beam size

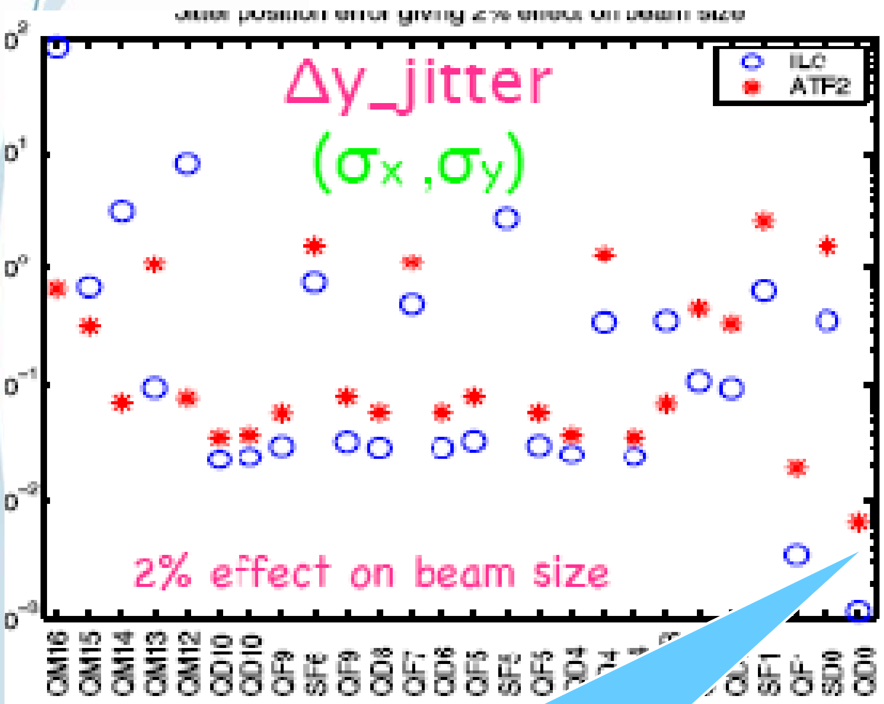
Final doublets

FD layout

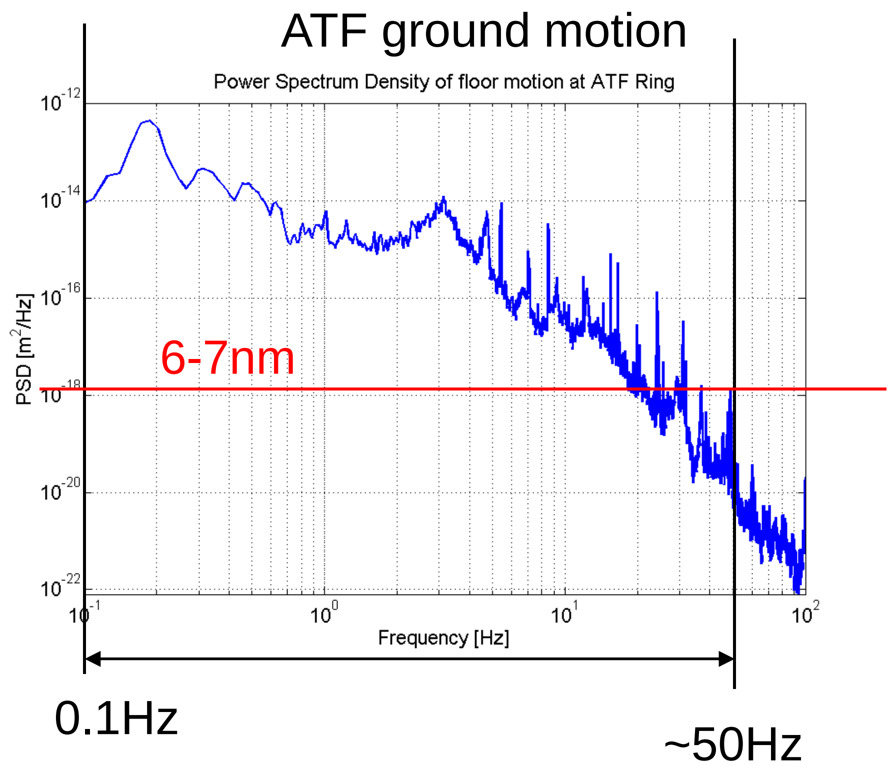


What is needed to support all these components?

ATF2 specifications



For QD0 at ATF2: 6-7nm tolerance



Repetition rate 1Hz=> need a “mechanical” stabilisation from 0.1Hz (below, the beam based alignment works)

Two solutions possible:

1. Isolate/cut vibrations in the desired frequency range
2. Push the first resonance peaks at higher frequencies where ground motion is lower

FD support specifications

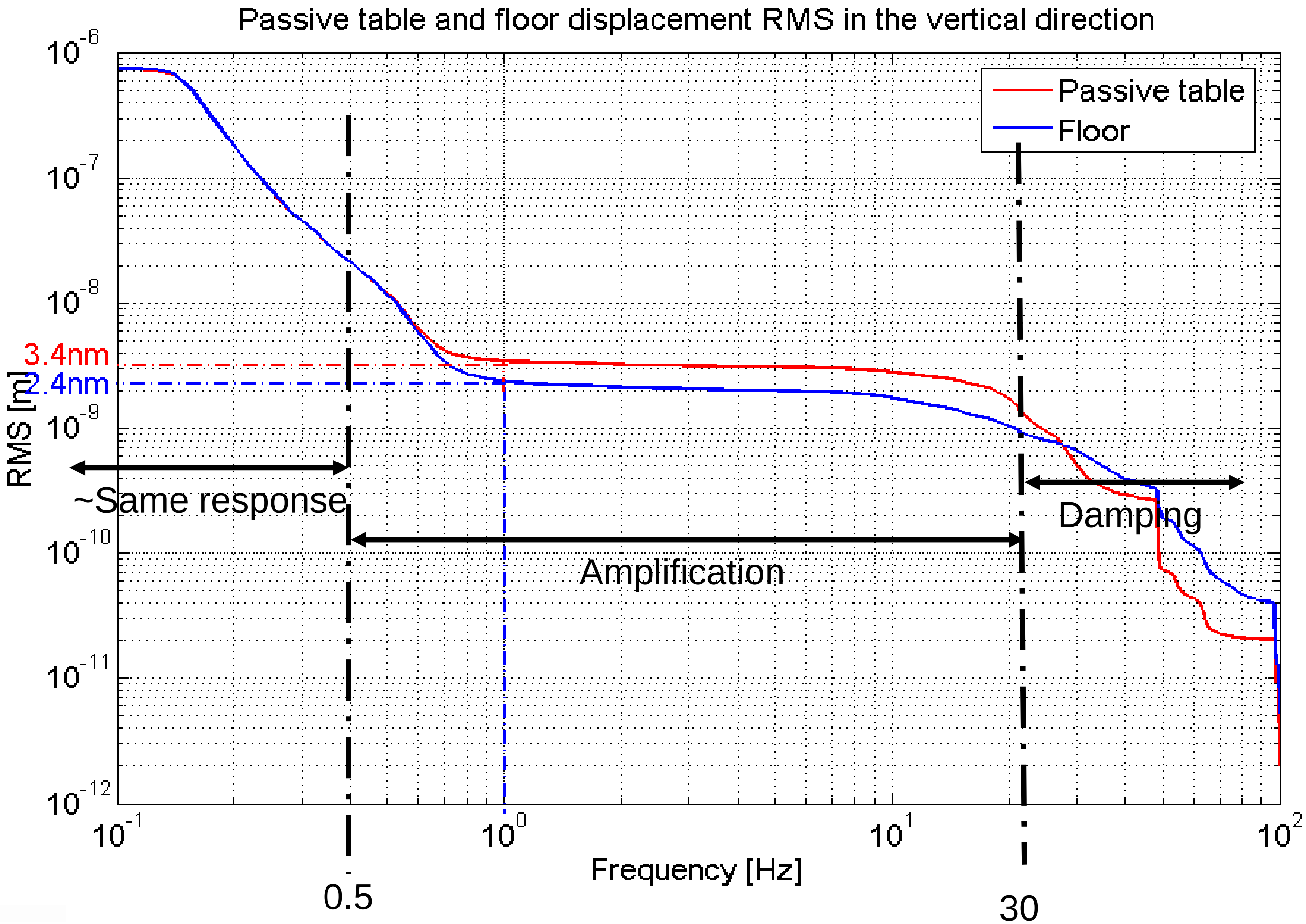
- Desired frequency range : 0.1Hz-50Hz
- Support that can evolve as Final Focus design evolves (should be able to change support)
- 6-7nm jitter tolerance
- 1.2m beam height

Initial suggestion: CERN wanted to contribute by sending the commercial TMC table

Isolator:
Passive => turned OFF
Active => turned ON

Vibrations of the passive TMC table

Vertical direction: Integrated RMS



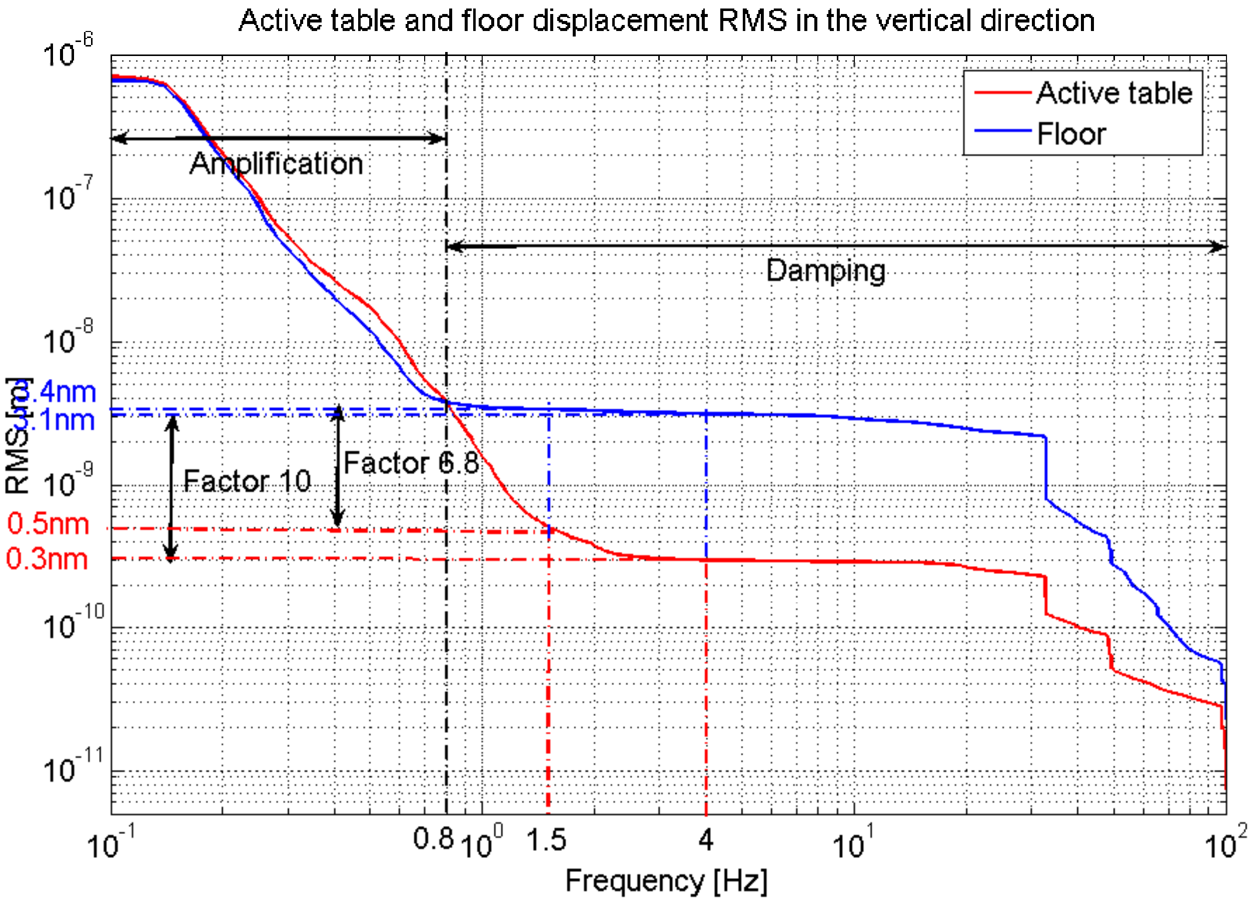
✓ **Below 0.5Hz:** No amplification or damping on the table

✓**Above 0.5Hz:** Amplification

✓Above 30Hz: damping begins

Vibrations of the active TMC table

Vertical direction: integrated RMS

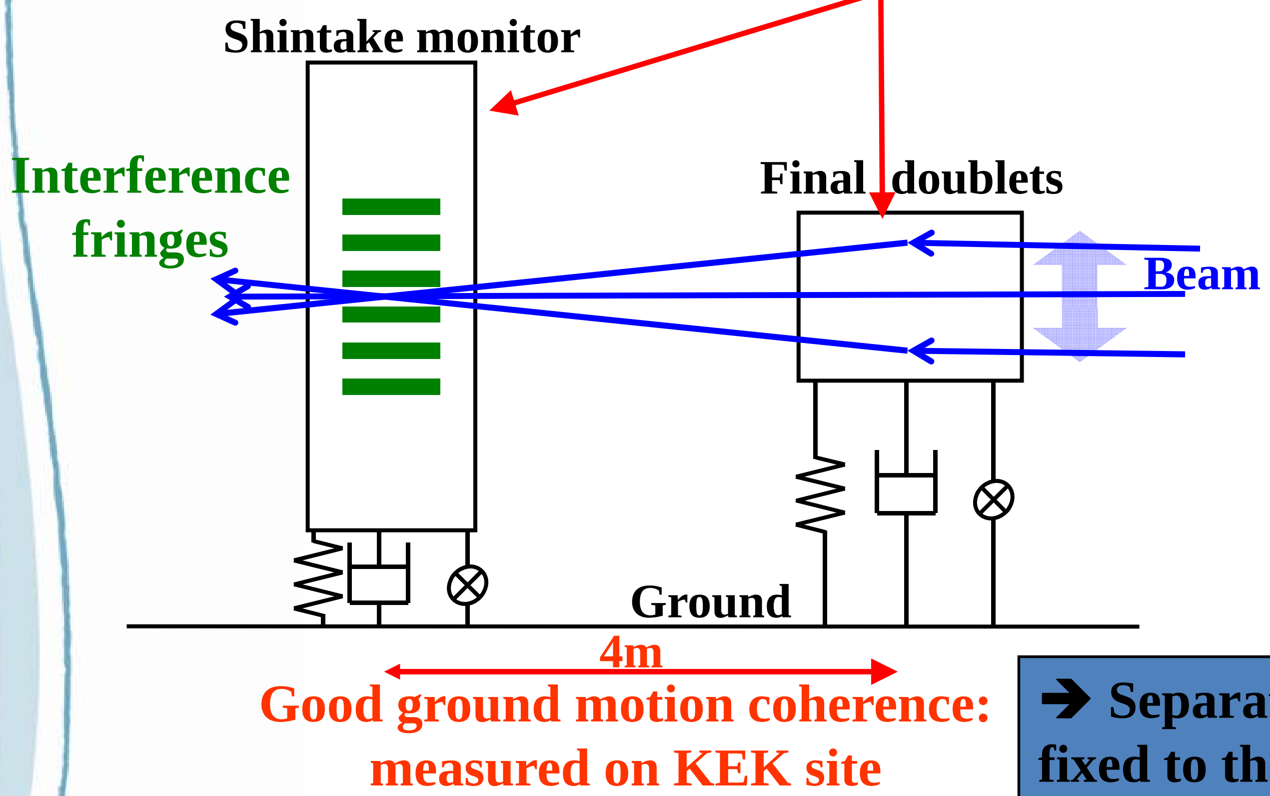


- ✓ **Below 0.8Hz:** Amplification on the table
- ✓ **Above 0.8Hz:** Damping on the table

→ Factor 7 of damping above 1.5Hz

Specifications

We want the measurement to have a coherent behaviour with respect to the "beam" => Relative motion between Shintake monitor and final doublets: 6-7nm in the vertical axis above 0.1Hz



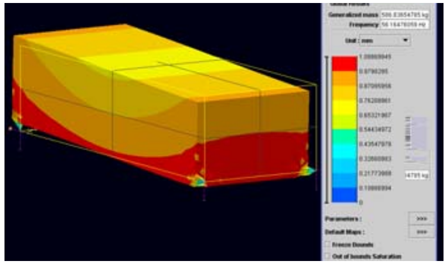
If Shintake Monitor and FD on separate active supports, coherence is lost

➔ **Separate stiff supports rigidly fixed to the floor**

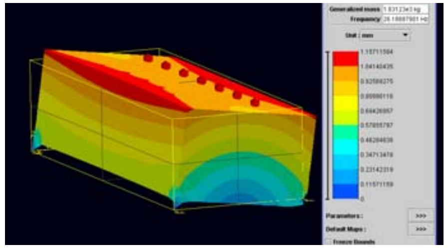
Study the honeycomb block but without feet

“simple” Simulation: just a block with the right boundary conditions=> to see the evolution

Boundary conditions: table put on / fixed to 4 rigid supports at its corners



Too low!

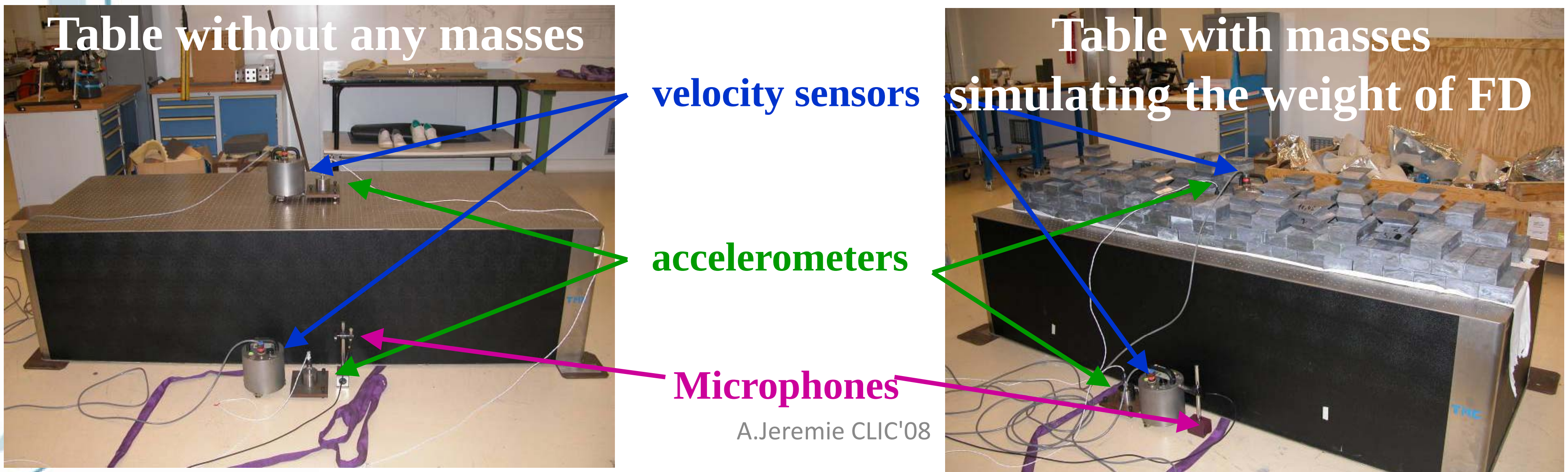


- **Without any masses: 56.2Hz**

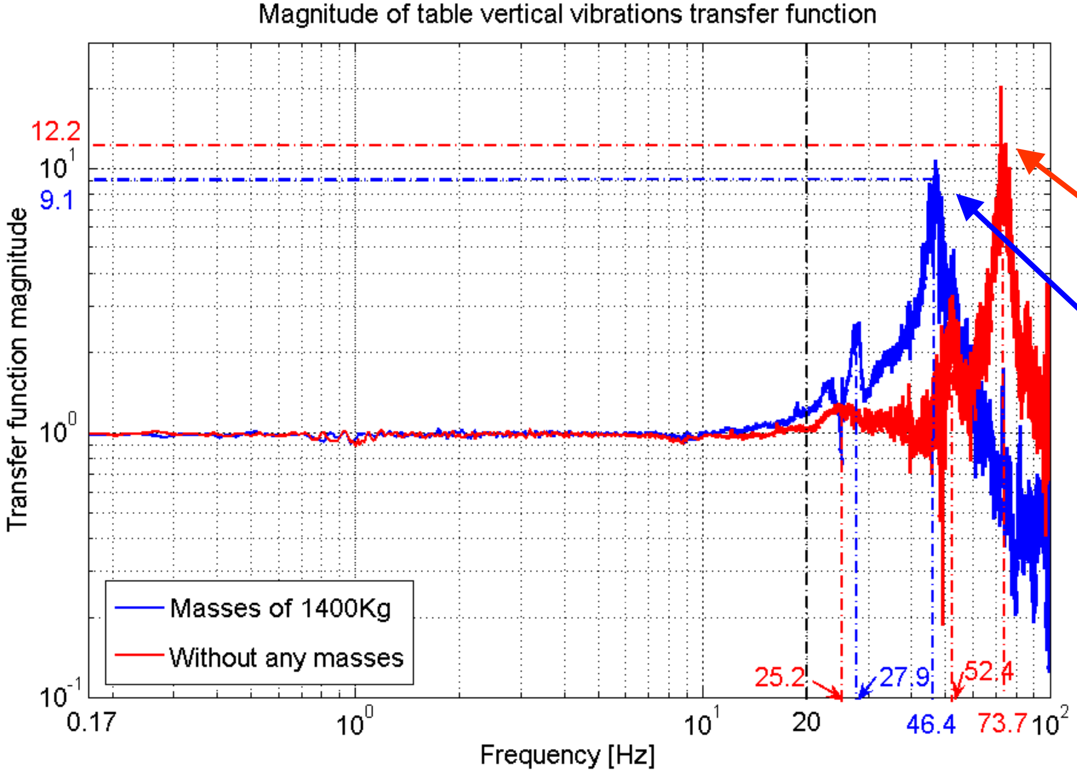
→ Lower than in free configuration!

- **With masses: 26.2Hz**

→ Fall of the eigenfrequency



Transfer functions of the table with its feet



First resonance (phase: 90°)

No masses: 74Hz

With masses: 46Hz

Higher displacements because increase of ground motion with decrease of frequency

➔ Impact of the different vibration peaks on relative motion

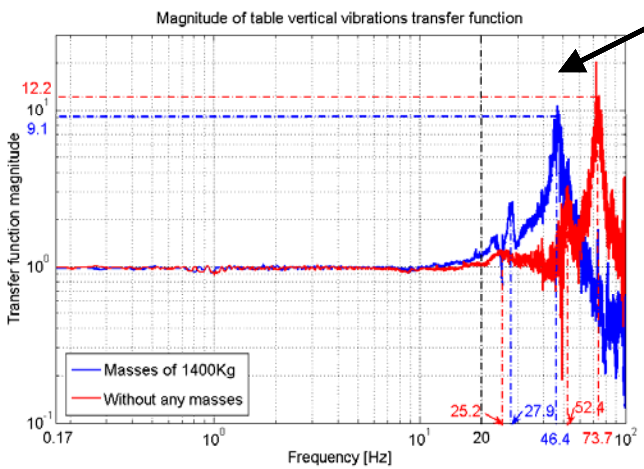
Relative motion between table and floor

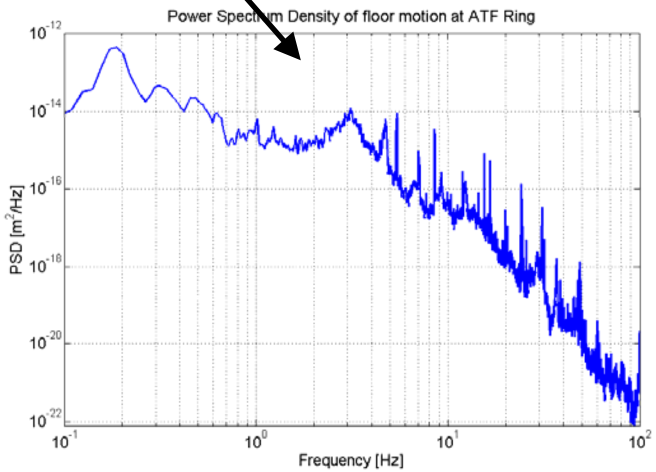
Integrated RMS of relative motion between table and floor to predict on the ATF site

Calculation to perform by integrating the vibratory behaviour of the table measured at LAPP and the data of ATF ground motion

Calculation performed for these specific needs:

$$RMS_{int\,y\text{-}x}(k) = \sqrt{\sum_{k_1}^{k_2} [H(k)-1][H^*(k)-1]DSP_x(k)}$$



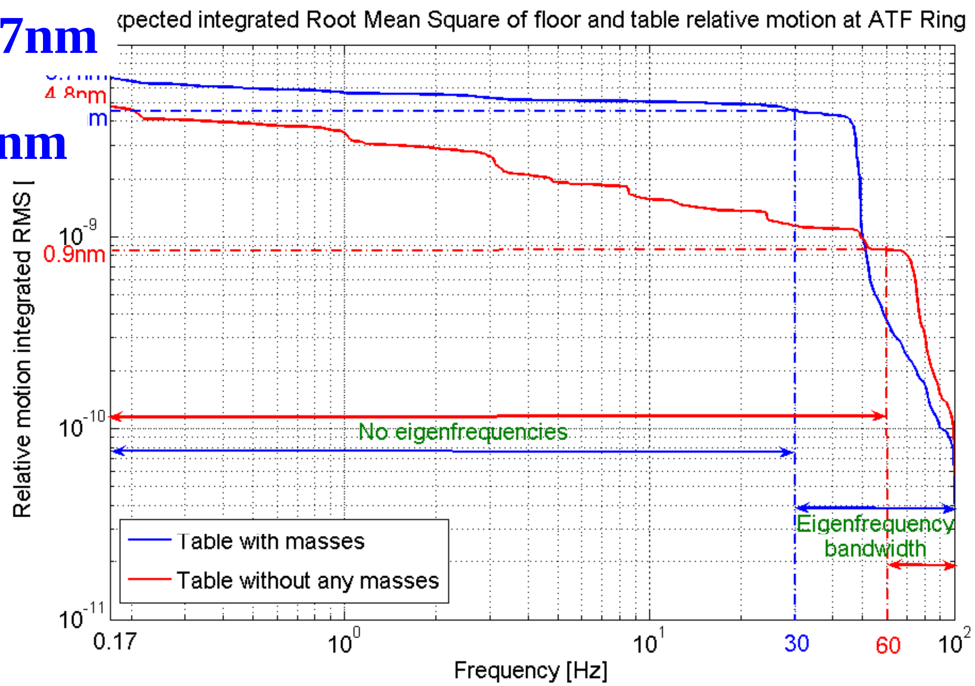


Relative motion between table and floor

Integrated RMS of relative motion at ATF

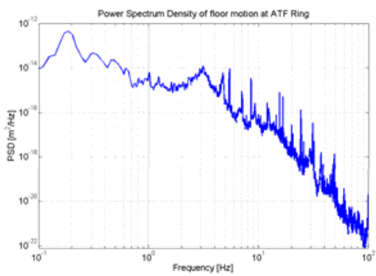
6.7nm

4.6nm



✓ Total relative motion ([0.17; 100]Hz): 6.7nm → Above tolerances (6nm)!

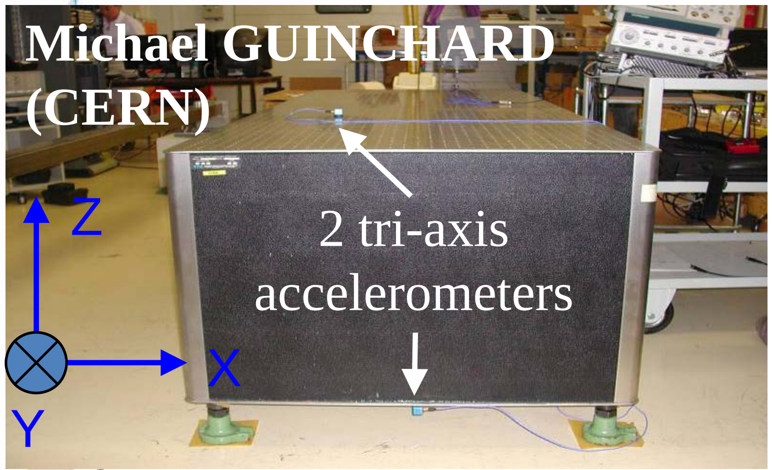
✓Contribution of the peak alone: [30; 100]Hz: 4.6nm



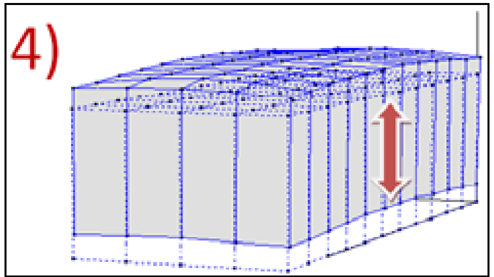
➔ Need to push resonances to higher frequencies where ground motion is lower

Is the honeycomb table rigid enough?

Table fixed on 4 rigid supports at the 4 corners



- ✓ Impact hammer on table
- ✓ **Modal deformations**
  - ➢ for each resonance (up to 150Hz)
  - ➢ In the three axis



✓ **6 first modes:** rigid body modes in 6 degrees of freedom

Modes	**1) T-X**	**2) T-Y**	**3) R-Z**	**4) T-Z**	**5) R-Y**	**6) R-X**
Frequency (Hz)	34.8	41.8	60.6	**80.6**	103.9	136.0
Damping (%)	2.8	2.6	2.4	**2.3**	2.1	4.0

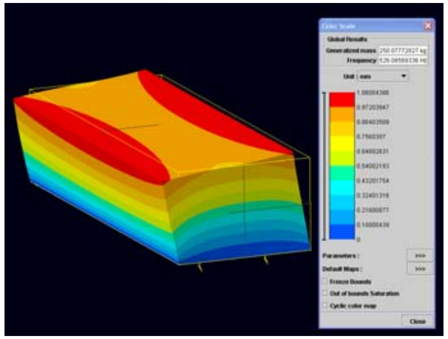
T: Translation

R: Rotation

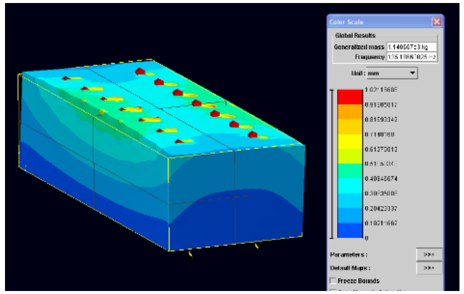
The table is a rigid body, but the feet are not

➔ Fix table on whole surface to remove these modes

Table fixed directly to the floor **on 1 entire side**



simulation



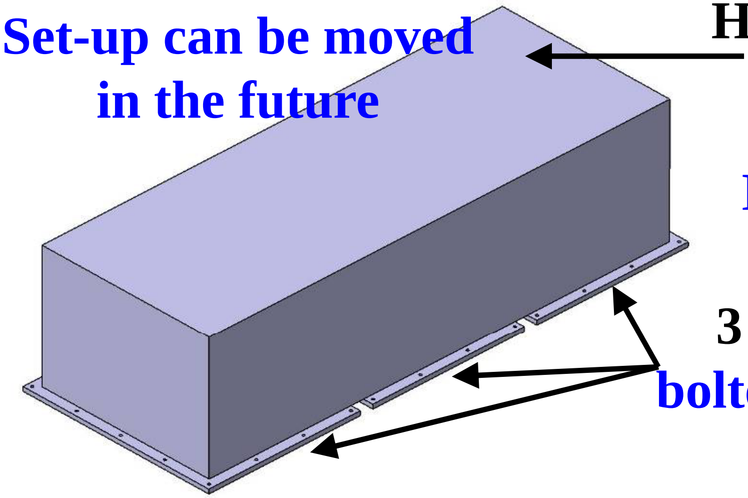
- **Without any masses: 526.1Hz**

→ Even higher than in free configuration!

- **With masses: 135.2Hz**

→ Fall of the eigenfrequency but still high

Choice of the ATF2 collaboration:
Get the same table to send it to Japan and fix it to the floor



Bees wax: good vibration transmission, can be unglued, stable in time, rad hard

FD configuration

Quads, sextupoles and movers :SLAC (from FFTB)
From floor to mover: LAPP (new)
BPM+support: KNU, LAPP

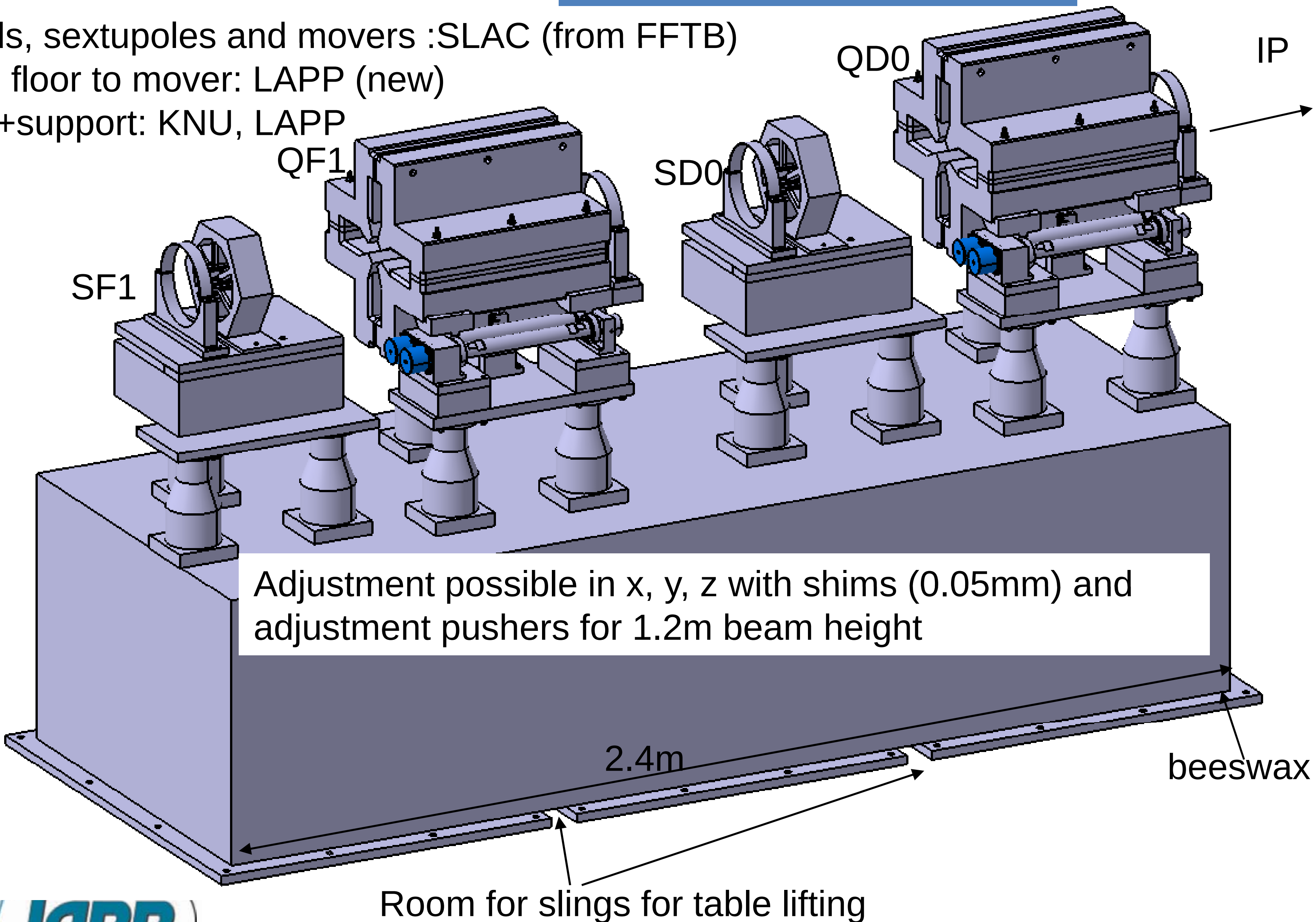
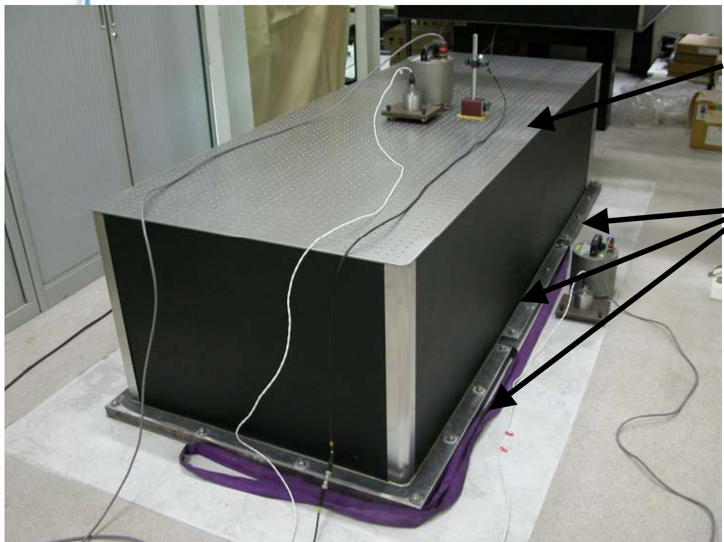


Table fixed on one entire face to the floor

Experimental set-up

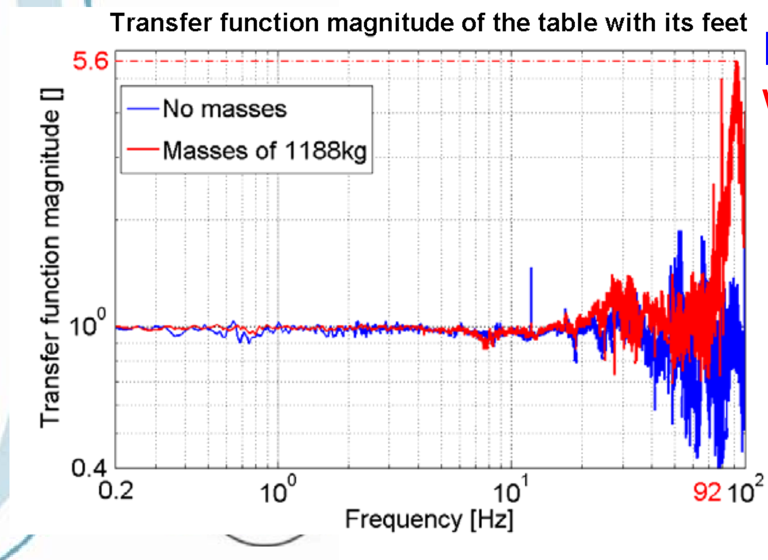


Honeycomb table

Bees wax

3 steel plates

bolted to the floor



No masses: no peak

With masses: 92Hz

➔ **Good boundary conditions chosen for the table: Relative motion should be very low compared to tolerances**

Impact of the resonance peak on the RMS

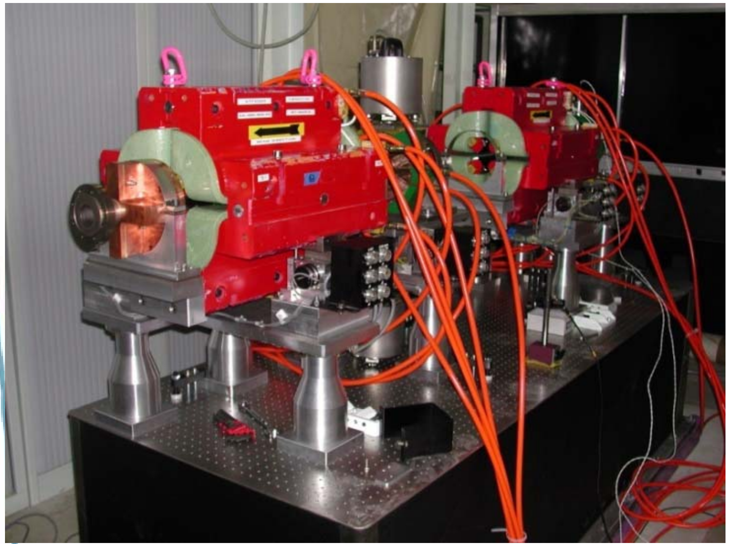
Object	Peak position	Integrated RMS
4-feet table with weight	46Hz	4.6nm
Glued table with weight	92Hz	0.3nm
Sextupole on mover/support	100Hz	0.26nm
Quad on mover/support	76Hz	1.1nm

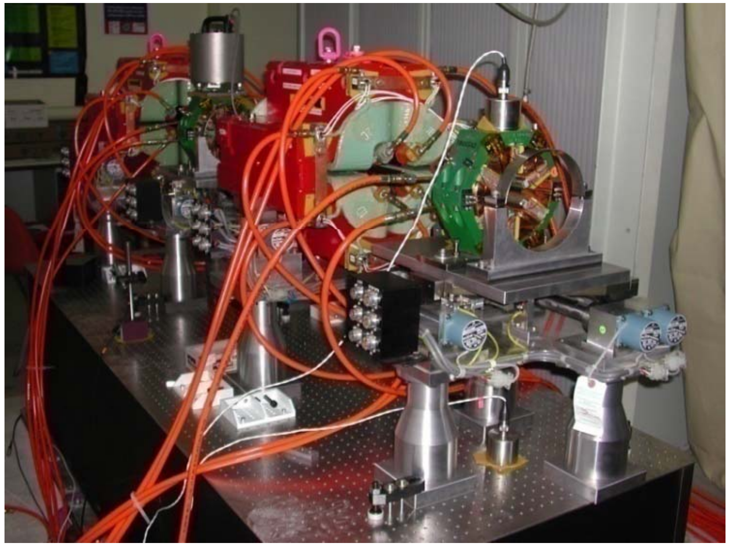
Adding up the integrated rms values keeps us under the 6-7nm tolerances

The honeycomb table fixed to the floor on whole surface, with adjusted movers validated for ATF2 Final Doublet support

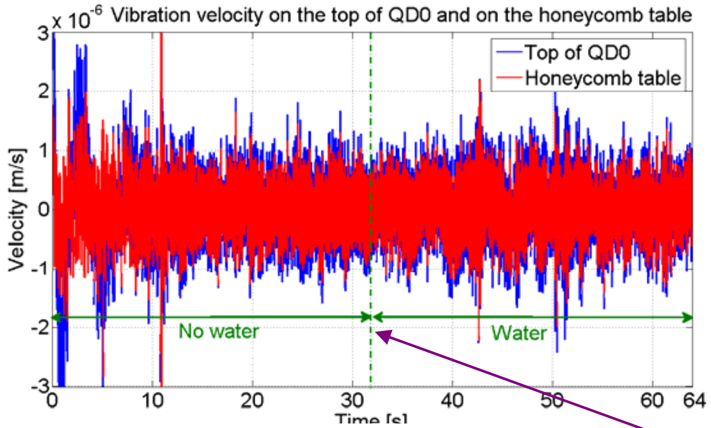
Effect of flowing water in FD magnets

- ✓ **Study done at LAPP at the end of July 08**
- ✓ **Effect of cooling water on the vibrations of final doublets**



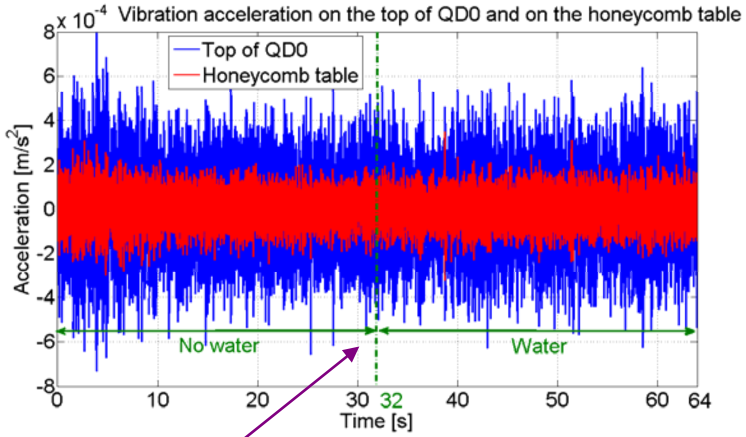


Quadrupole (QD0) with water flow

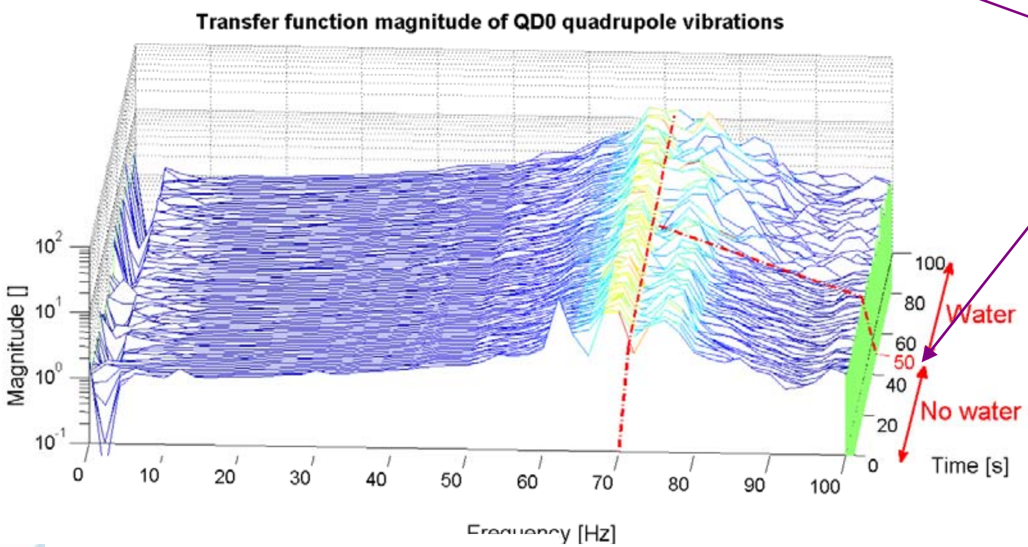


GURALP sensors (0.2Hz – 50Hz)

Measurement in time



ENDEVCO sensors (10Hz – 100Hz)

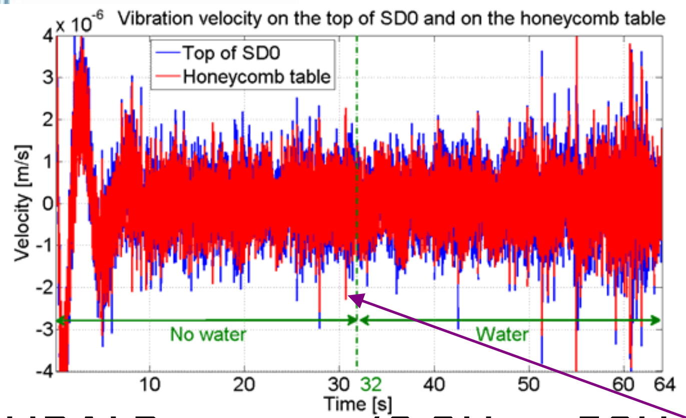


Start flowing water

- No significant increase of vibrations with cooling water flowing=>impact of peak on integrated rms : 1.1nm

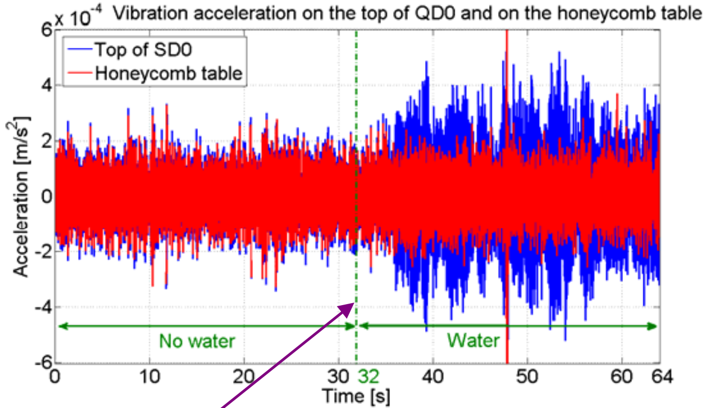
3D frequency analysis

Sextupole (SD0) with water flow



GURALP sensors (0.2Hz – 50Hz)

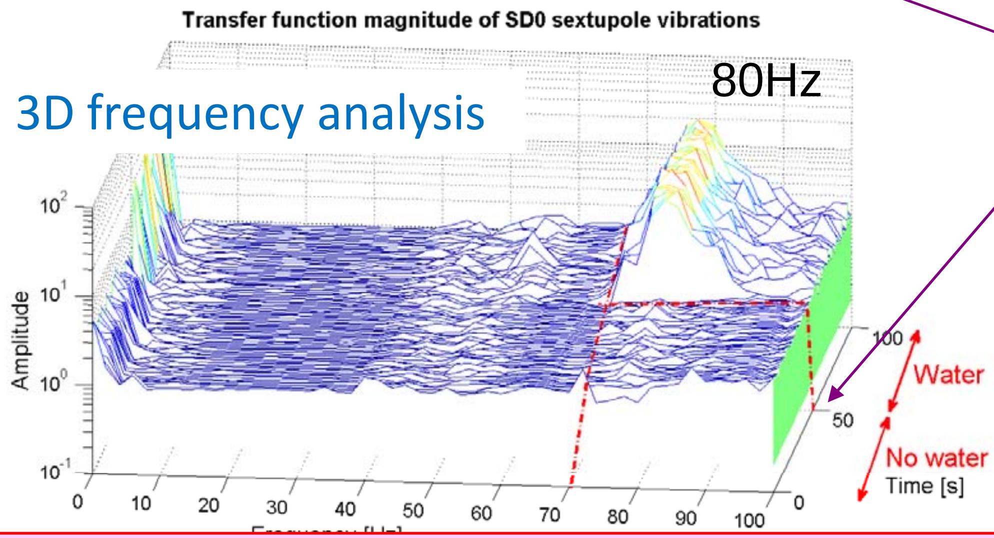
Measurement in time



ENDEVCO sensors (10Hz – 100Hz)

3D frequency analysis

80Hz



Start flowing water

- ➢Some increase at higher frequency=> impact of peak on integrated rms: 0.7nm=>not significant

Water flow in magnets has no significant effect on vibrations

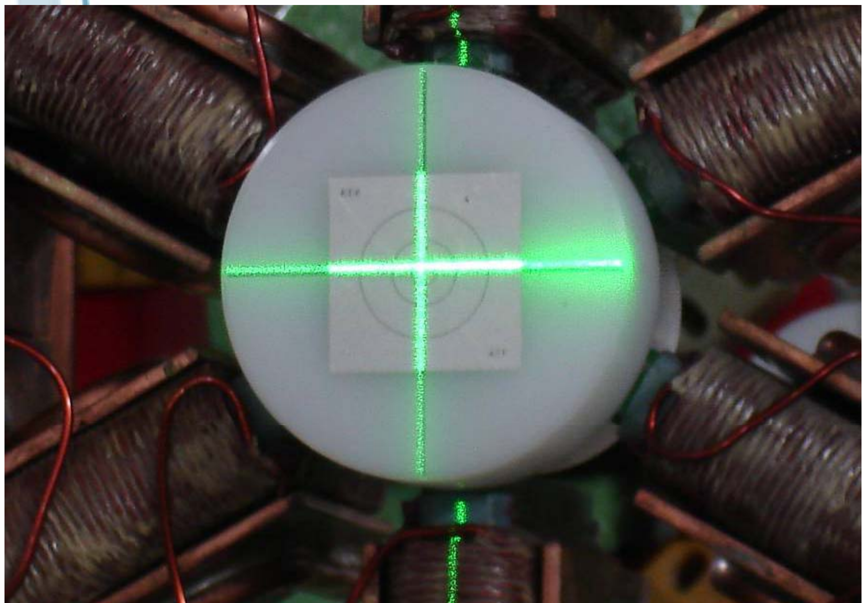
Installation at KEK from September 16 to September 25 2008


Unpacking


Installing beeswax on plates bolted to the ground

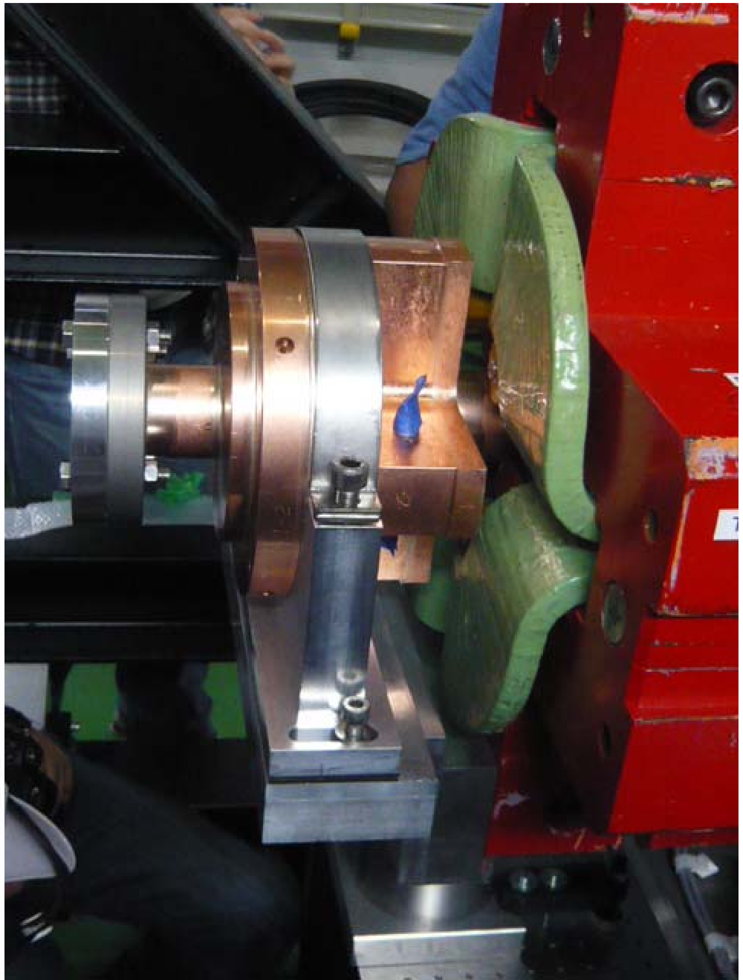

Beam dump
Table comes down
Bending magnet
Shintake monitor

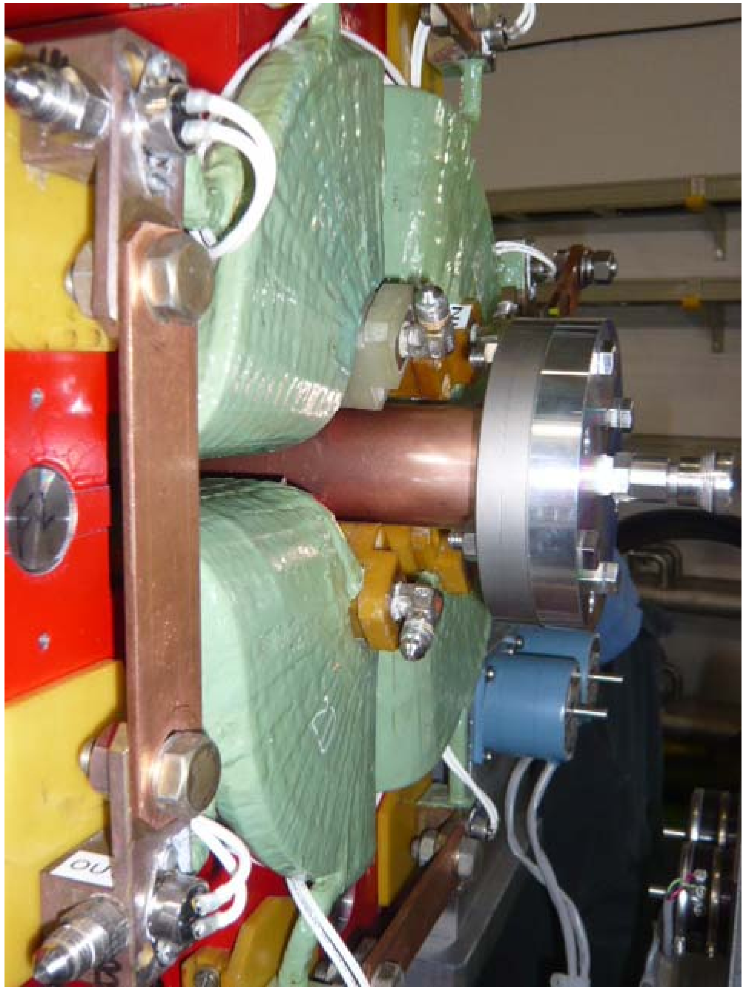

Installing “feet” and movers



Everything installed, centered and aligned in x, y and z,
Thursday September 25 2008; Next step: BPM installation

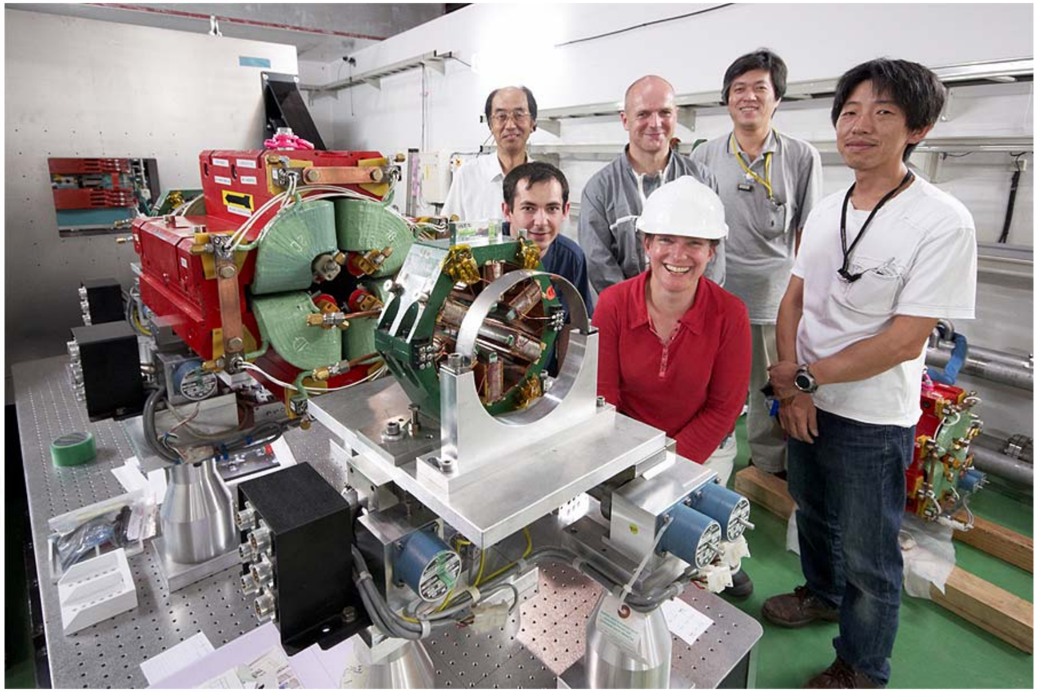
S-BPM installation October 15, 2008





Conclusion

- ATF2 rigid Final Doublet support chosen (vs. active support)
- SLAC FFTB movers adjusted to meet beam height
- Vibration measurements validate the rigid support choice
- Water flow in magnets has no significant effect on vibrations
- ATF2 Final Doublet support installed at KEK



Impatiently waiting for the beam to start!