ATF2 week meeting: Impact of cooling water on the final doublets vibrations

Laboratories in Annecy working on Vibration Stabilization

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15/10/08

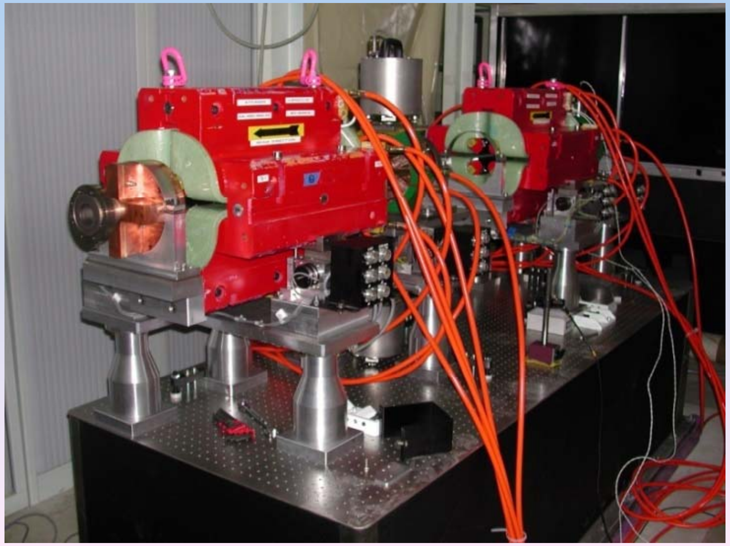
Introduction

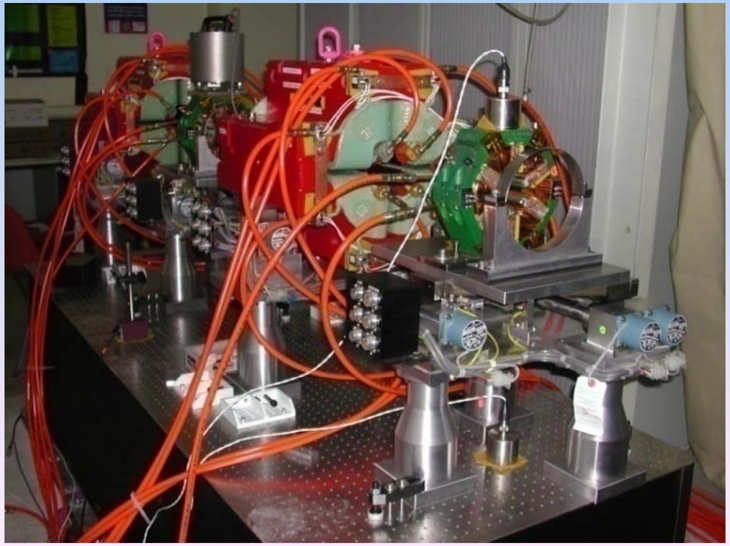
✓ **Presentation at Nanobeam 08 (1 June 08): Study of supports for ATF2 final doublets**

- Appropriate supports found and built
- Vibratory behavior of supports and of final doublets when subjected to ground motion measured at LAPP
- Relative motion tolerances checked

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

- Final doublets installation at LAPP as it will be at KEK





Plan of my presentation

ATF2 specifications of final focus vibrations for LAPP team
Relative motion of final doublets to the floor below 10nm above 0.1Hz

Vibration measurements with and without cooling water
On the final doublets and the honeycomb table
From 0.1Hz to 100Hz with GURALP and ENDEVCO sensors

↓ ***Stationary of vibrations?***

Stationary study of cooling water vibrations
Temporal data analysis
3D frequency analysis: Transfer function at each second versus frequency

↓ ***If stationary***

2D Frequency analysis in [0.1; 100] Hz range
50 averages on 64 seconds data set of:
Transfer function, coherence, integrated relative motion RMS

Vibration measurements with and without cooling water

Experimental set-up

SD0

SF1

QF1

QD0

GURALP sensors
O.1Hz – 50Hz

ENDEVCO sensors
10Hz – 100Hz

- ✓ **Same water flow as specified for ATF-2 (20 litres/minute)**
- ✓ **Measurements done on each final doublet**
  - ➢ Simultaneously on the magnet and on the table
  - ➢ With and without cooling water

Stationary study of cooling water vibrations

Introduction

Vibratory behavior study of final doublets subjected to cooling water: Stationary of vibrations?

1. **Measurements:** Cooling water activated at half of their time lenght

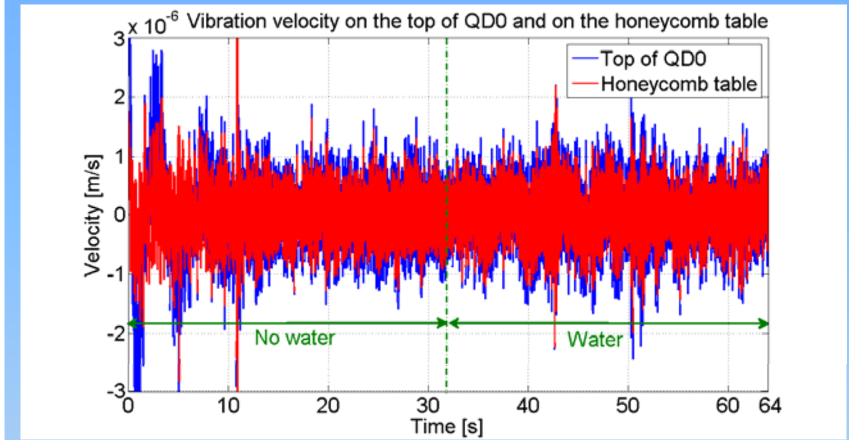
2. **Temporal analysis (digital high-pass and low-pass Butterworth filter of 5th order) with:**
   - GURALP geophones (0.2Hz-50Hz)
   - ENDEVCO accelerometres (10Hz-100Hz)

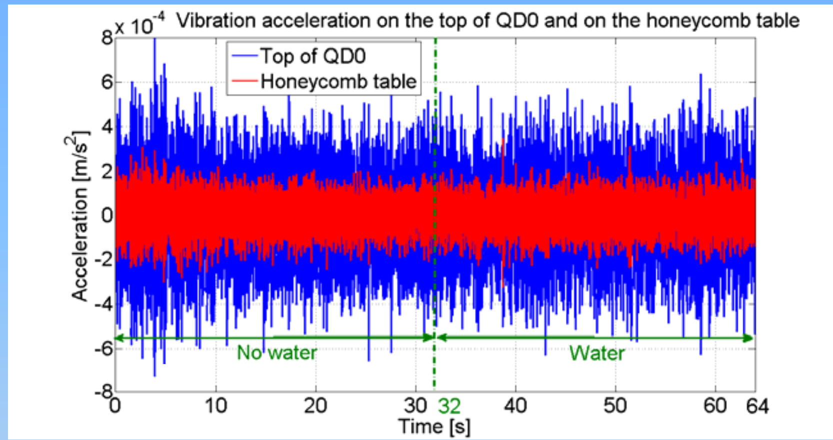
3. **3D frequency analysis: transfer function, time, frequency**
   - Window: Hanning
   - Overlap: 66.67%
   - Frequency resolution: 2Hz (only ENDEVCO sensors used)
   - Time resolution: 0.5s
   - Averaging: Exponential (2*Tau=1.167s) and 5 averages

Stationary study of cooling water vibrations ⟹ Quadrupoles Sextupoles

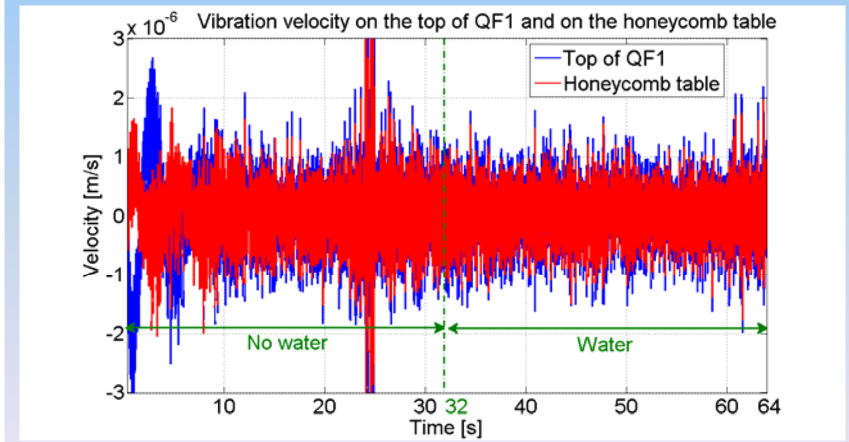
Temporal vibrations of QD0 and QF1 quadrupoles

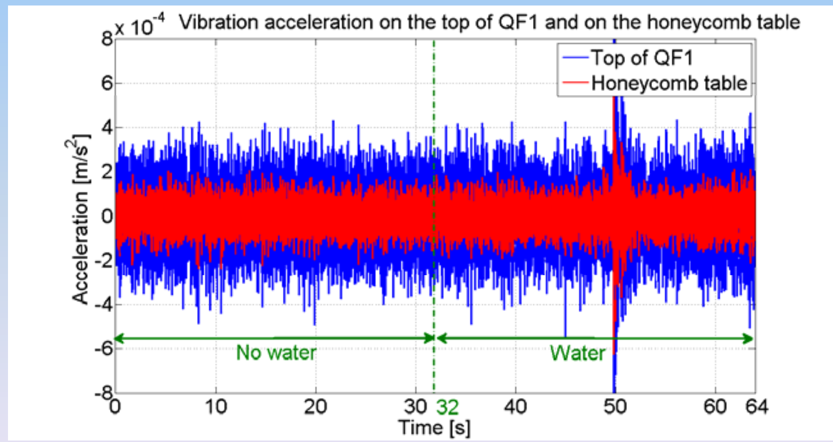
Stationary of ground motion checked to compare with/without water





QD0





QF1

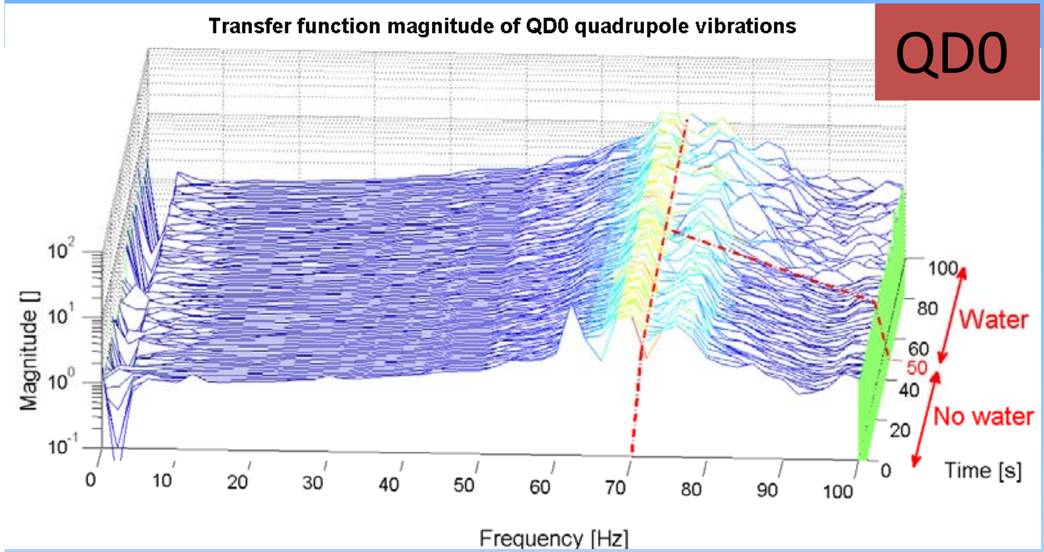
GURALP sensors (0.2Hz – 50Hz)

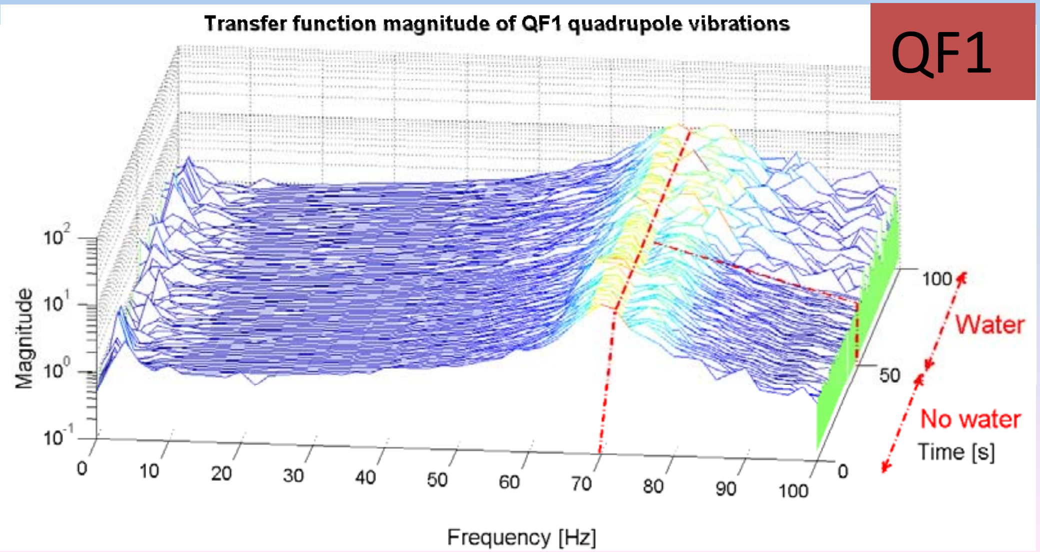
ENDEVCO sensors (10Hz – 100Hz)

- **No significative increase of vibrations with cooling water**

Stationary study of cooling water vibrations ⟹ **Quadrupoles** Sextupoles

3D frequency analysis of QD0 and QF1 quadrupoles



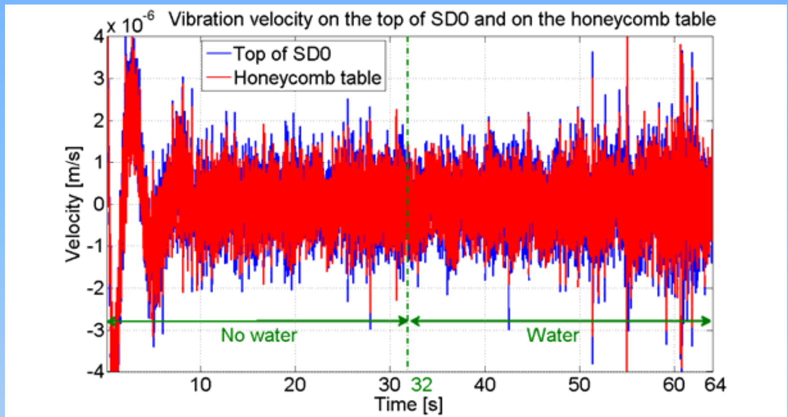


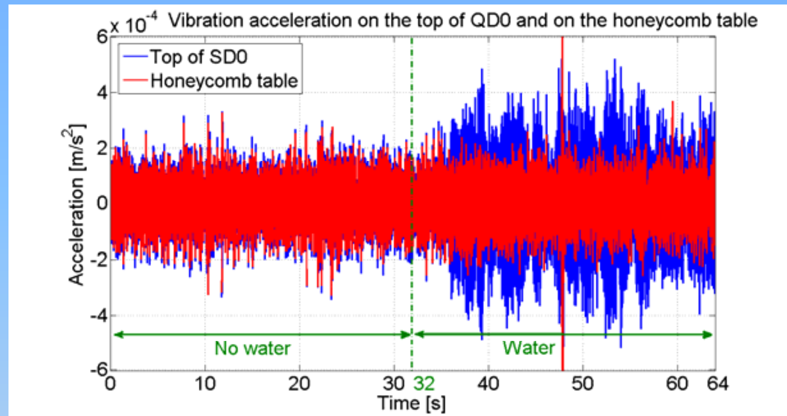
- ✓ For QD0 and QF1, almost the same vibratory behavior
- ✓ With cooling water, very low random vibrations above 70Hz
- ✓ Stationary of these random vibrations

Stationary study of cooling water vibrations ⟹ Quadrupoles / Sextupoles

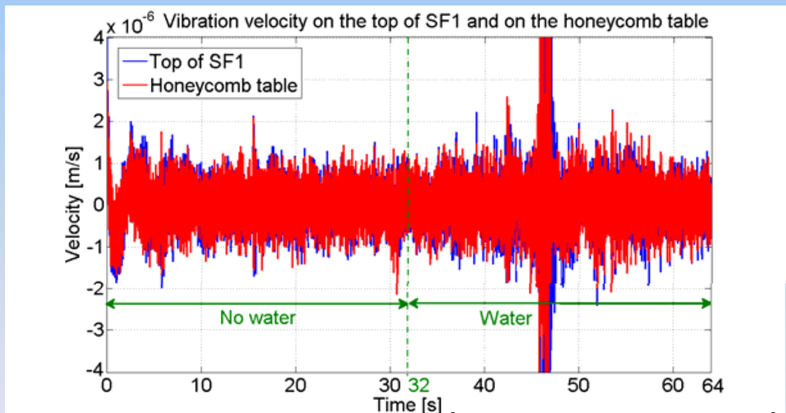
Temporal vibrations of SD0 and SF1 sextupoles

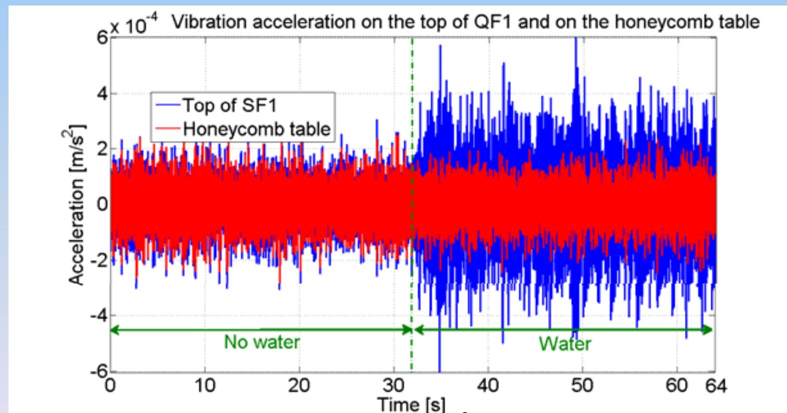
Stationary of ground motion checked to compare with/without water





SD0





SF1

GURALP sensors (0.2Hz – 50Hz)

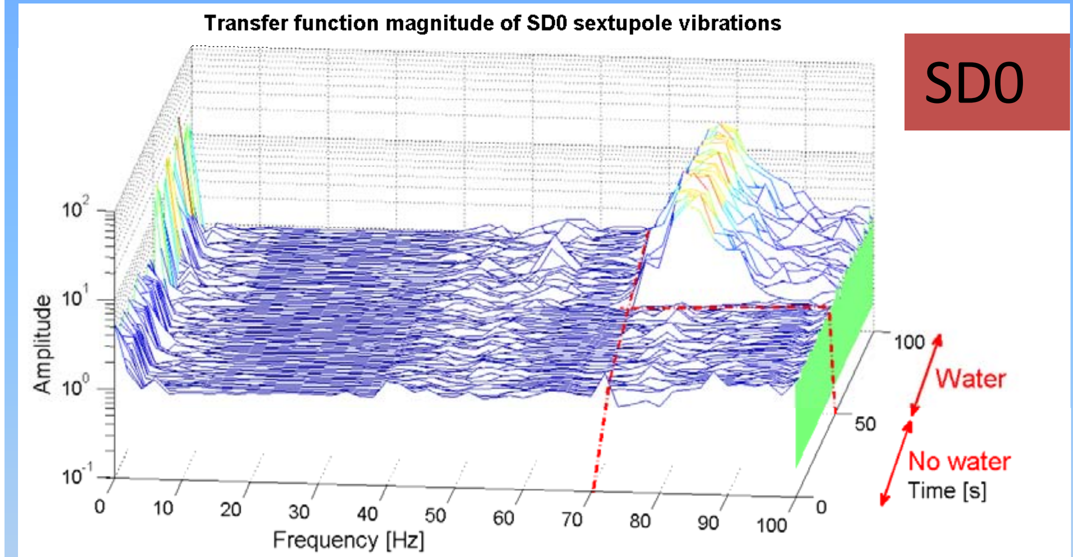
- No significative increase at low frequencies

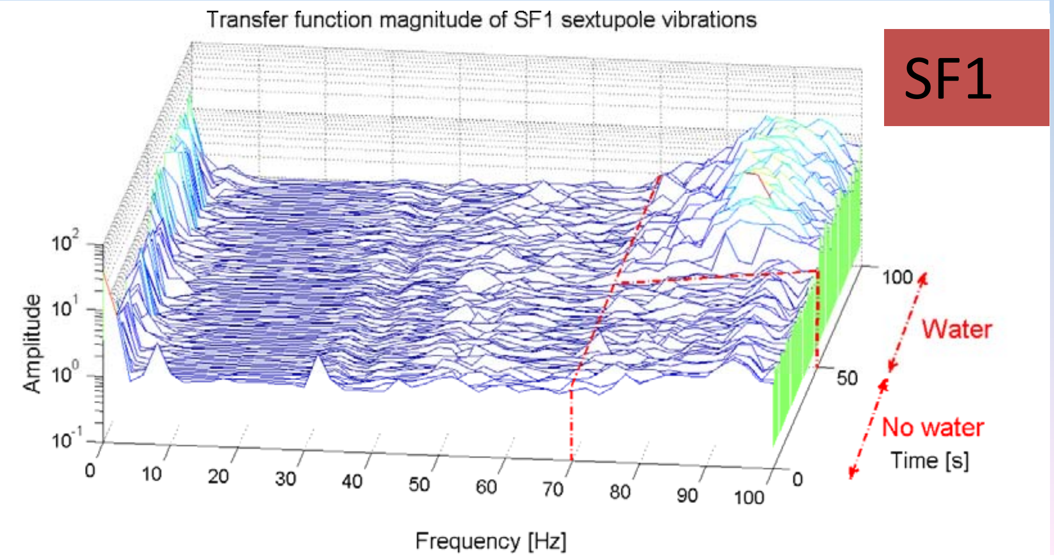
ENDEVCO sensors (10Hz – 100Hz)

- Increase at medium frequency
- Stationary of vibrations

Stationary study of cooling water vibrations ⟹ Quadrupoles **Sextupoles**

3D frequency analysis of SD0 and SF1 sextupoles





- ✓ For SD0 and SF1, quite the same vibratory behavior
- ✓ With cooling water, a high vibration peak appears above 70Hz for bothe SD0 and SF1
- ✓ Stationary of this vibration peak

2D Frequency analysis in [O.1; 100] Hz range

Study done on the impact of cooling water on final doublets vibrations: Stationary of vibrations checked

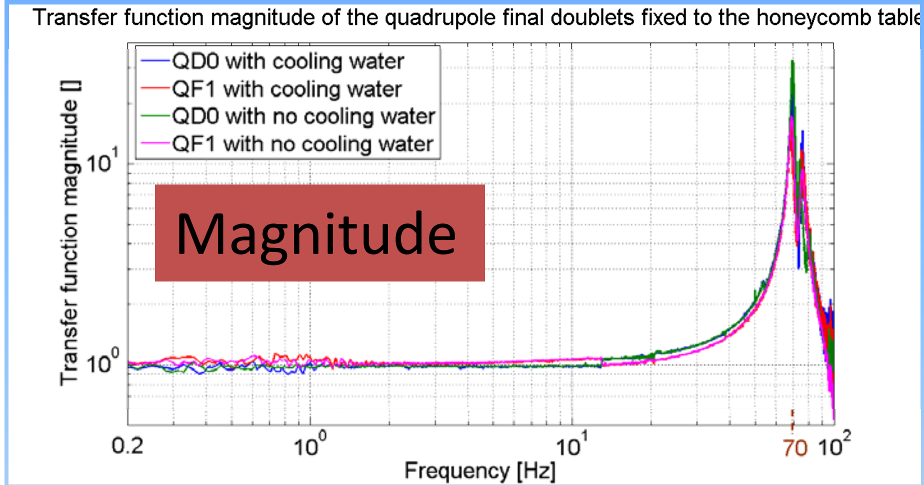
- ✓ 2D Frequency analysis in [0.1; 100] Hz range can be now done
  - ➢ Frequency resolution: 0.016Hz
  - ➢ Window: Hanning
  - ➢ Averaging: Linear and 50 averages
  - ➢ Overlap: 66.67%
- ✓ 2 sets of vibration measurements done during 17min40s
  - ➢ First set with no cooling water
  - ➢ The other set with cooling water
  - ➢ GURALP (0.1Hz-13Hz) and ENDEVCO (13Hz-100Hz) sensors used

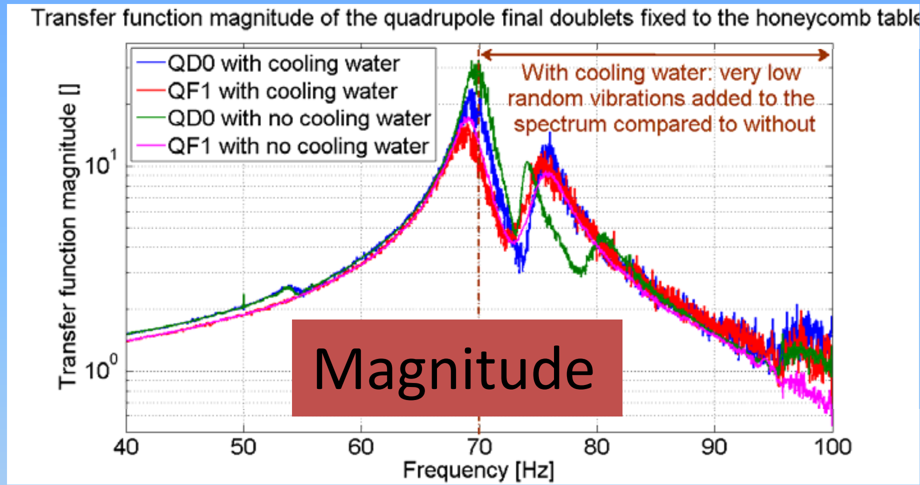
➔This analysis allows us knowing accurately transfer function, coherence, integrated RMS of relative motion in [0.1; 100] Hz range

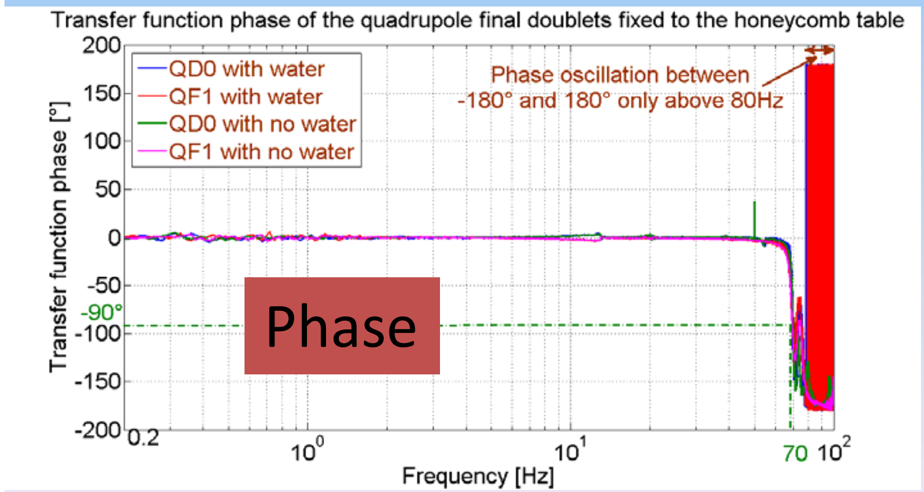
2D Frequency analysis in [O.1; 100] Hz range

⟹ **Quadrupoles**
Sextupoles

Transfer function of the QD0 and QF1 quadrupoles







✓ QD0 and QF1: Almost the same vibratory behavior with and without cooling water

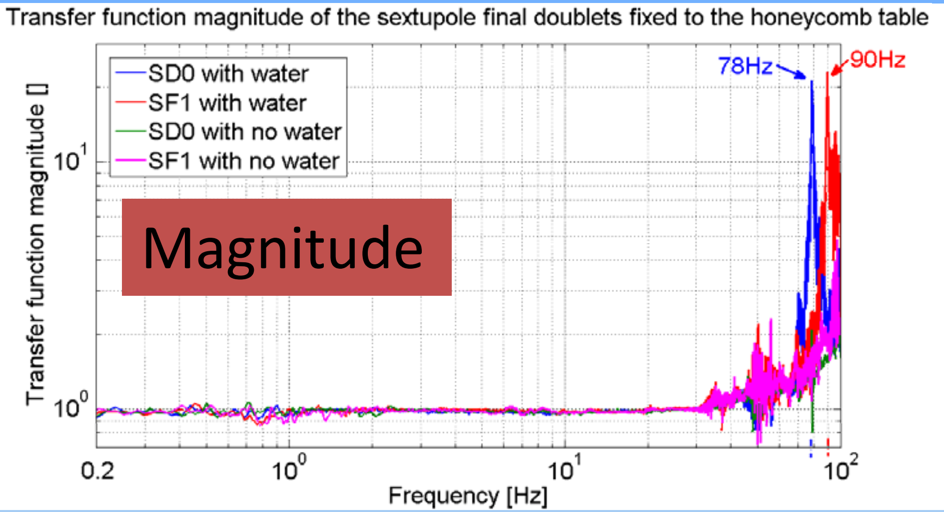
✓ **Same results than the one obtained from measurements done with no water for Nanobeam 08**

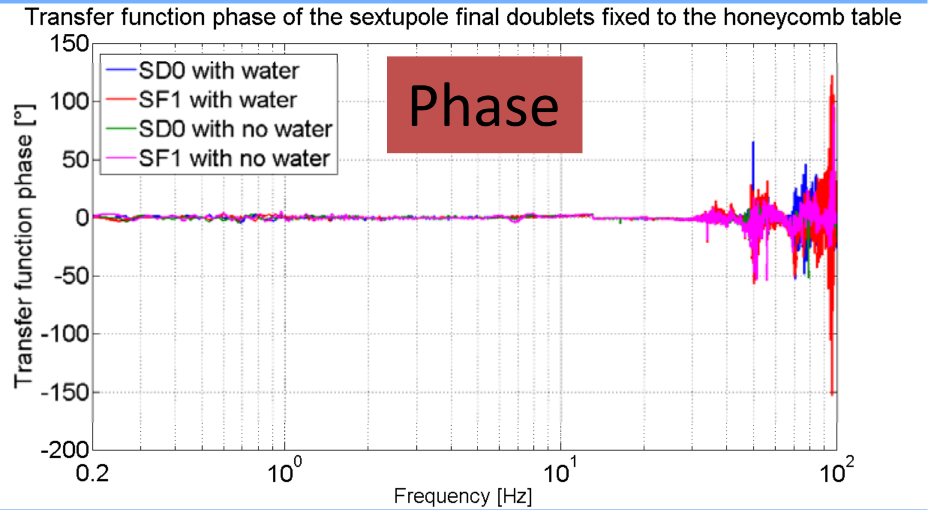
➢ **Relative motion between quadrupoles and table within tolerances**

2D Frequency analysis in [O.1; 100] Hz range

⟹ Quadrupoles
Sextupoles

Transfer function of the SD0 and SF1 sextupoles





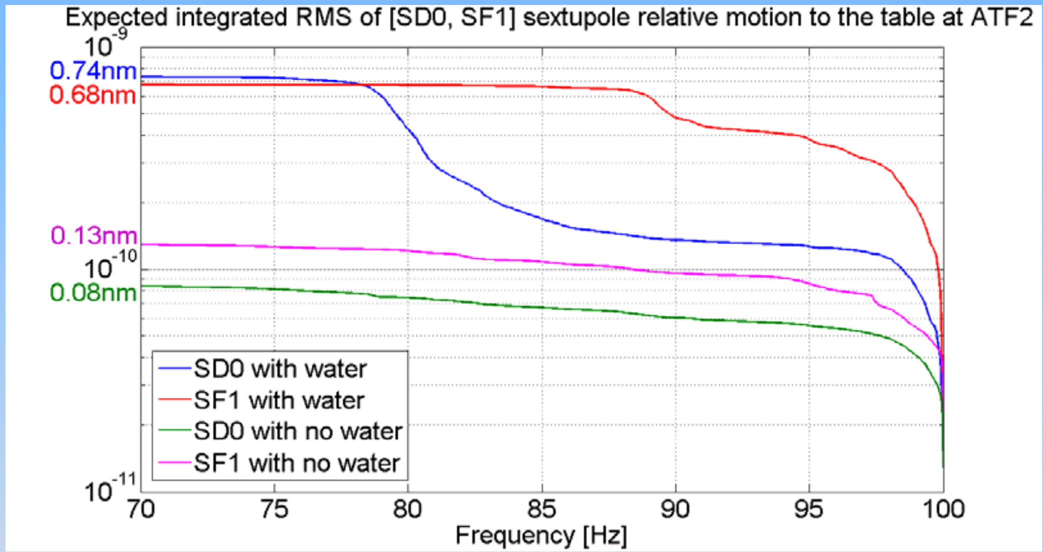
- ✓ **With no water: SD0 and SF1 almost the same vibratory behavior**
  - ➢ Same results than the ones obtained from measurements done for Nanobeam 08 (relative motion within tolerances)
- ✓ **With cooling water, vibration peak appears (≠90°: not a resonance)**
  - ➢ For SD0: 78Hz and for SF1: 90Hz (high frequency for ATF2)

➔ **Need to evaluate the impact of these peaks on relative motion**

2D Frequency analysis in [O.1; 100] Hz range ⟹ Quadrupoles **Sextupoles**

Integrated RMS of SD0 and SF1 relative motion to the table at ATF2

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



- ✓ **Relative motion to the table due to cooling water vibration peak :**
  - ➢ SD0: 0.74nm and SF1: 0.68nm

Since results of Nanobeam 08 show low relative motion of sextupoles to the floor above 0.2Hz compared to tolerances

➔ Sextupole relative motion to the floor within tolerances with water