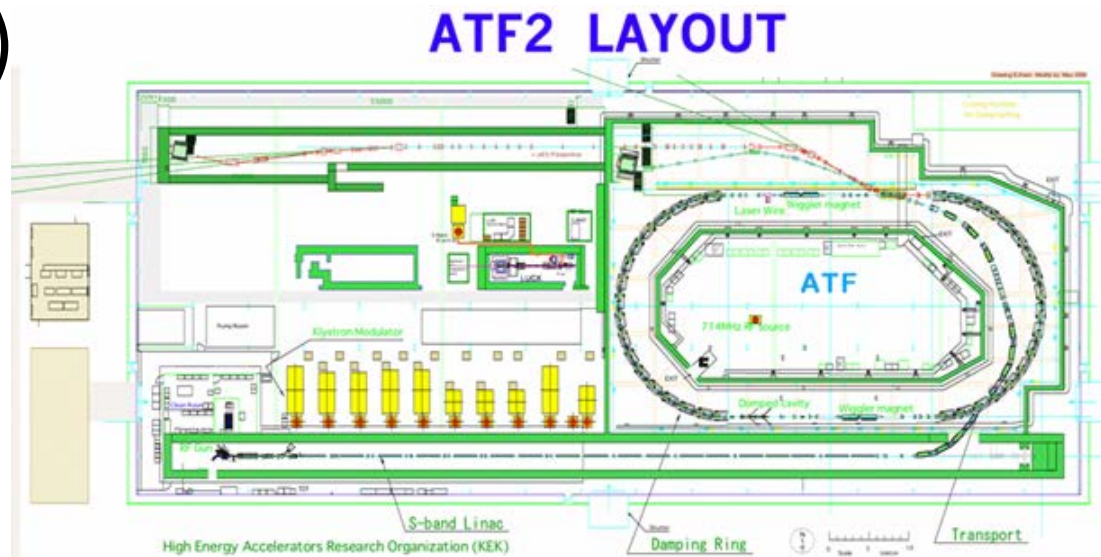


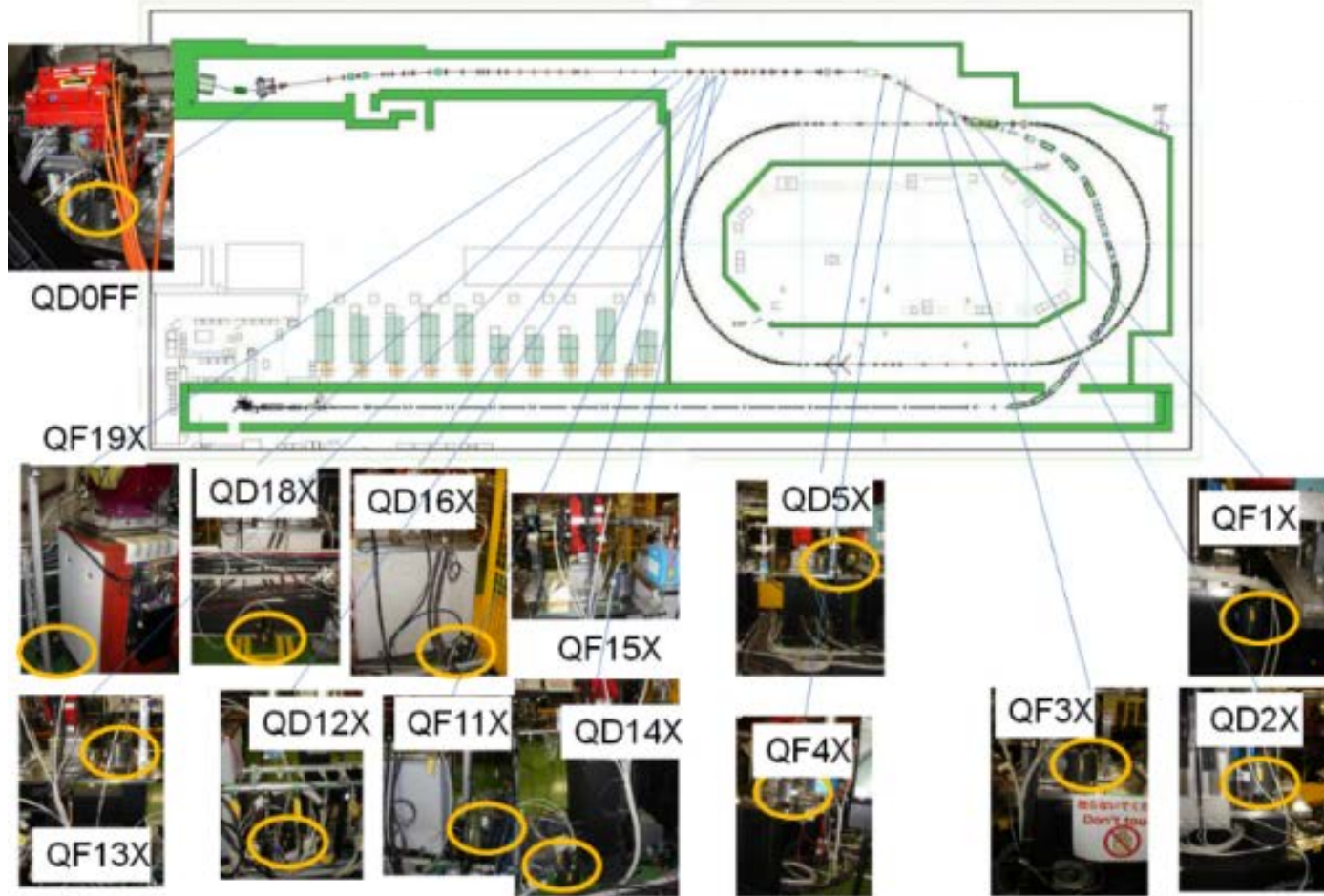


Recent progress on GM studies at ATF2

A.Jeremie, G.Balik, L.Brunetti, M.Serluca
J.Breunlin, V.Cilento, D.Bett, R.Tomas
and help from FONT team and KEK staff
Tuesday January 23, 2018

- GM measurements for GM Feedforward and GM simulations
- Vibration source identification
- GM Feedforward and MADX, PLACET GM simulations presented by Jonas this morning (part 1)



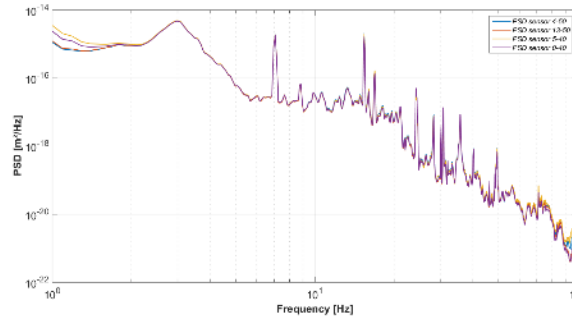


Guralp 6T:
 0,5Hz-100Hz,
 two directions
 connected
 (vertical and
 horizontal can be
 placed parallel or
 perpendicular to
 beam direction),
 mainly in
 Extraction line,
 and 2 sensors on
 Final Doublet

Note: we are considering removing 4 sensors from the EXT line for long term measurements on site at KEK (other experiment). We would keep 5 sensors near QD2X, 2 sensors on FD, and 3 sensors in between.

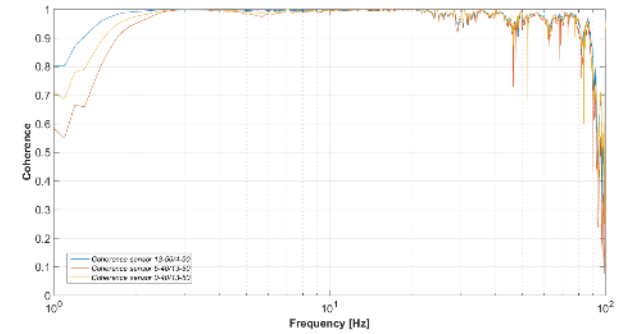
LAPP GM sensor coherence measurements

Start EXT
(near QD4X)

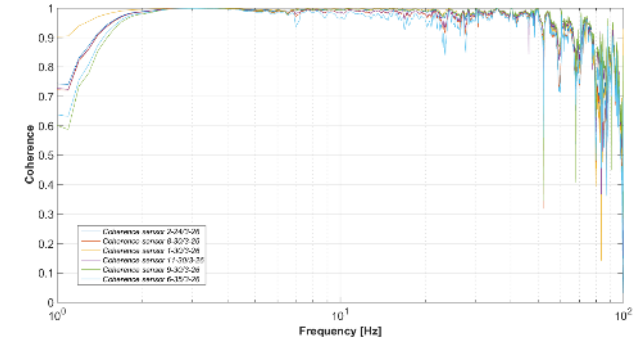
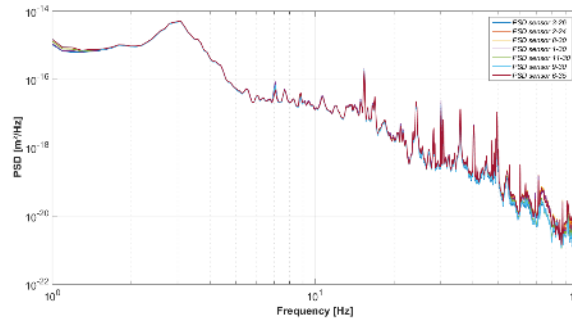


2Hz

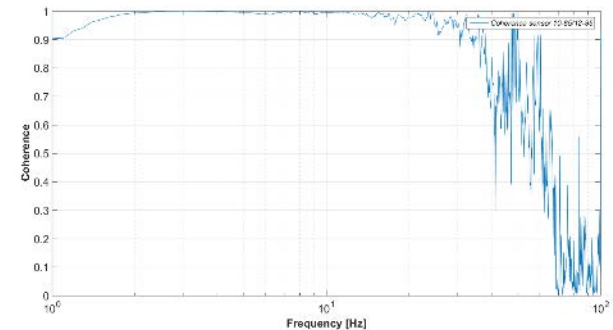
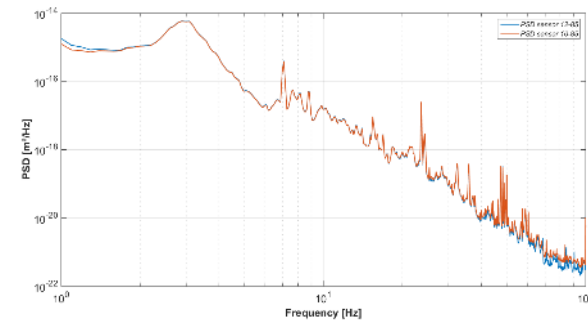
40Hz



Middle EXT
(near QD12X)



2 sensors at FD



LAPP GM sensor coherence measurements

Start EXT
(near QD4X)

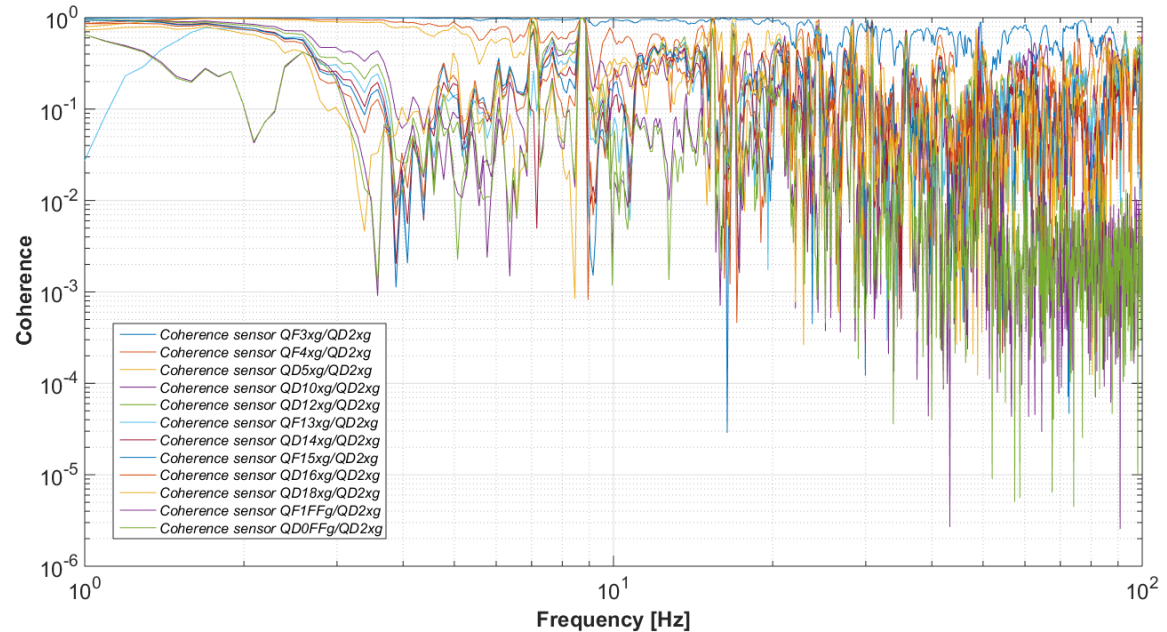


Middle EXT
(near QD12X)



2 sensors at FD

Coherence of all sensors on ground w/r to sensor near QD2X

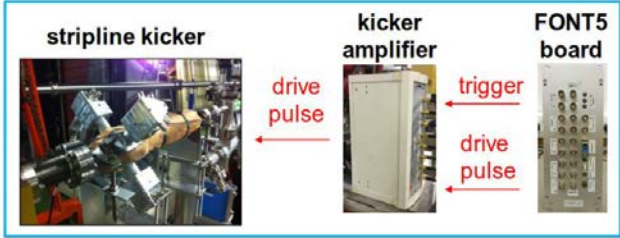


- One can distinguish the sensor “groups”: the coherence is worse when sensors separated by greater distance.
- Coherence length is 3-4m (previous measurements by Sugahara-san, Masuzawa-san 2006 in Damping ring, A.Jeremie 2014 in FF section)

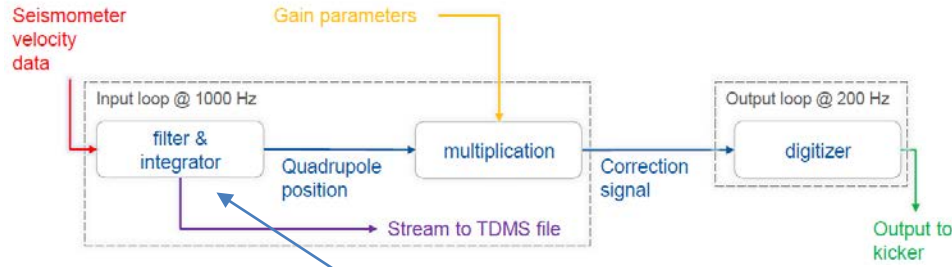
FF related GM measurements

FONT hardware

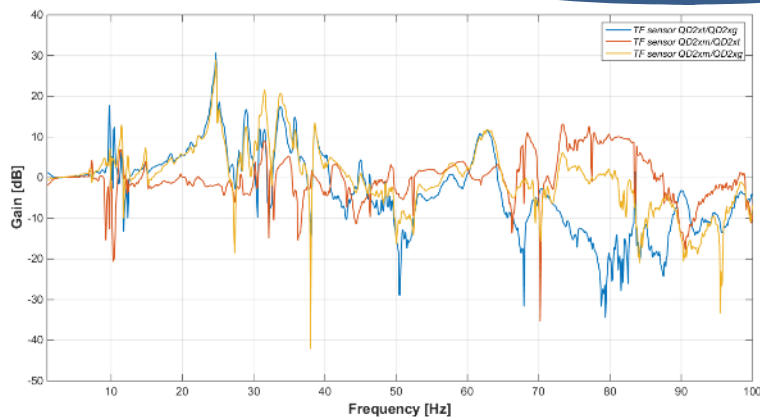
seismometers



Labview real-time VI on the cRIO

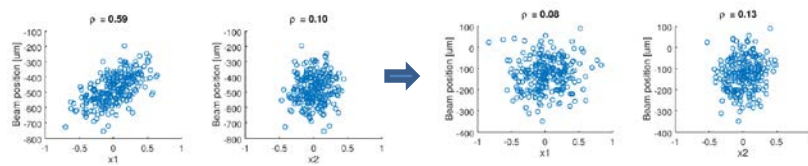


Slide by D. BETT



To avoid having to put sensors on top of magnet, we could put them on the floor and include system (support and magnet) transfer function (TF) in correction software
 Transfer functions between ground/table/QD2X
 => implement in GM feedforward
 Main difficulty => model such a TF!

An attempt was made in June of a MIMO FF, with hints of some effect, but not conclusive yet. Need more work.



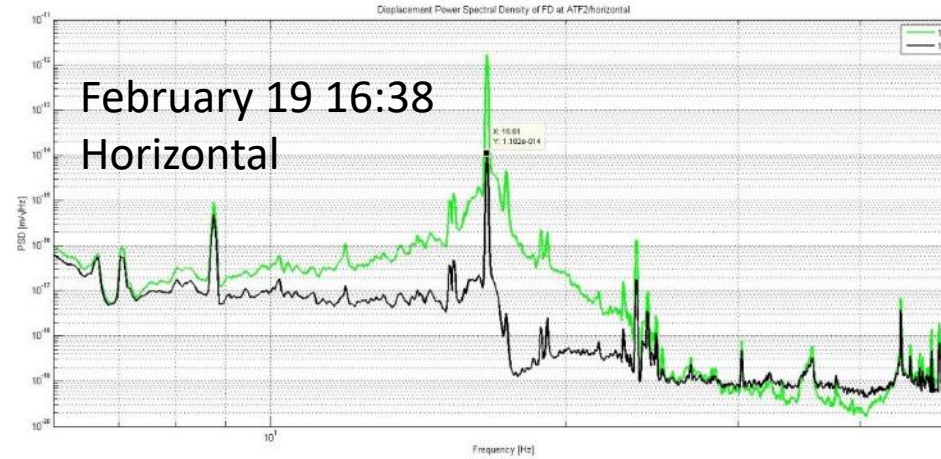
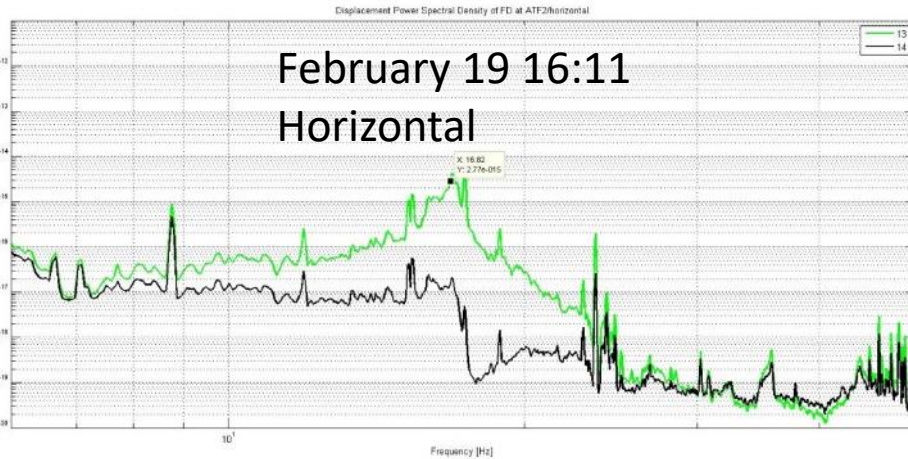
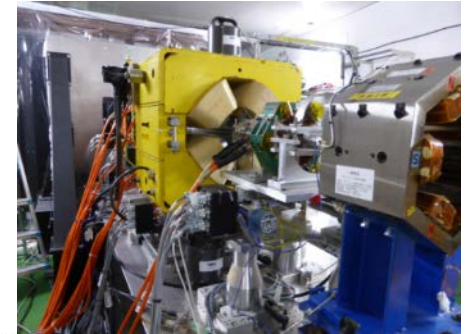
While studying QF1FF support

New Ground Motion data taken by D.Bett:
 February 19 2016 at 16:11, 16:38 and 17:06
 February 25 2016 at 18:11, 18:28, 18:49 and 19:07

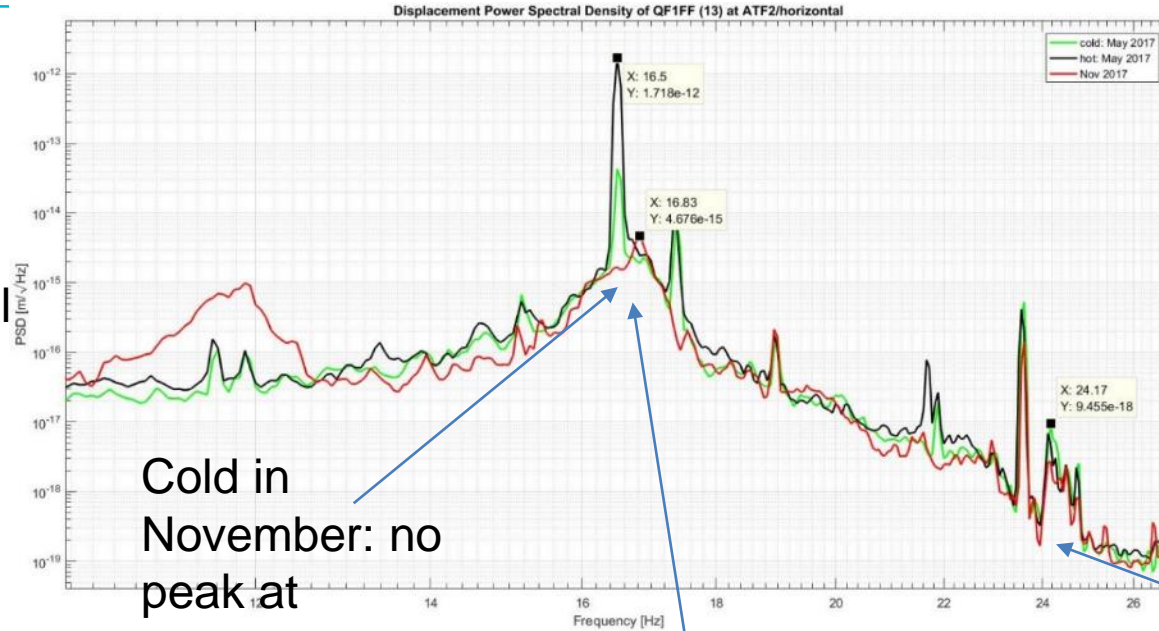
Measurement	Vertical Rel. displ. RMS (nm)	Horizontal Rel. displ. RMS (nm)
Feb 19 @ 16:11	7	58
Feb 19 @ 16:38	21	356

Black: on FD table, green on QF1FF

At 16:11, very quiet measurement
 27 minutes later at 16:38, a vibration at 16.5Hz appears.
 What can it be?
 Was anything turned on between both measurements?
 Dramatic difference in relative displacement RMS!



Horizontal direction shown. The peak is also present in vertical direction.

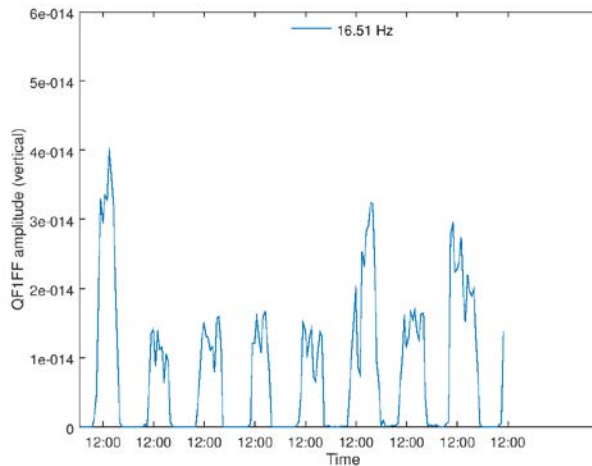
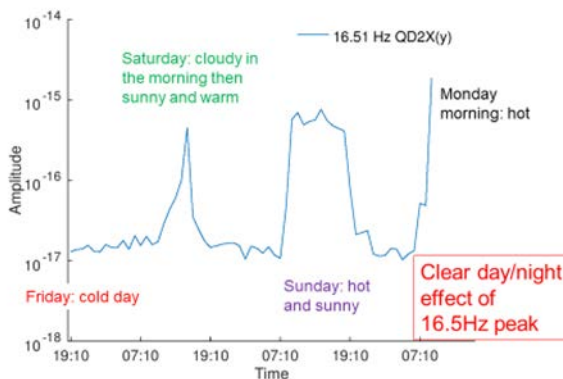


Cold in November: no peak at 16.5Hz

Support resonance peak

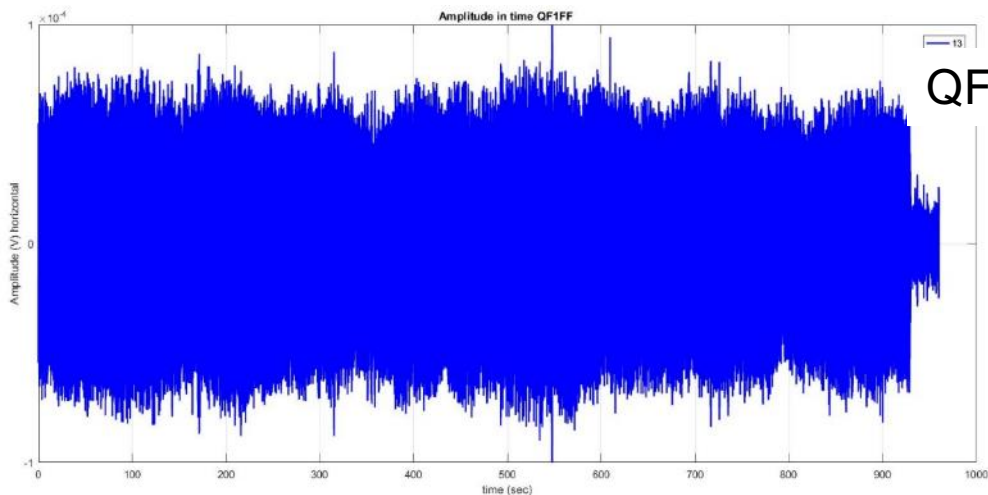
General cooling water pipes: no difference

Continuous measurement over weekend: Friday May 26 to Monday May 29 2017



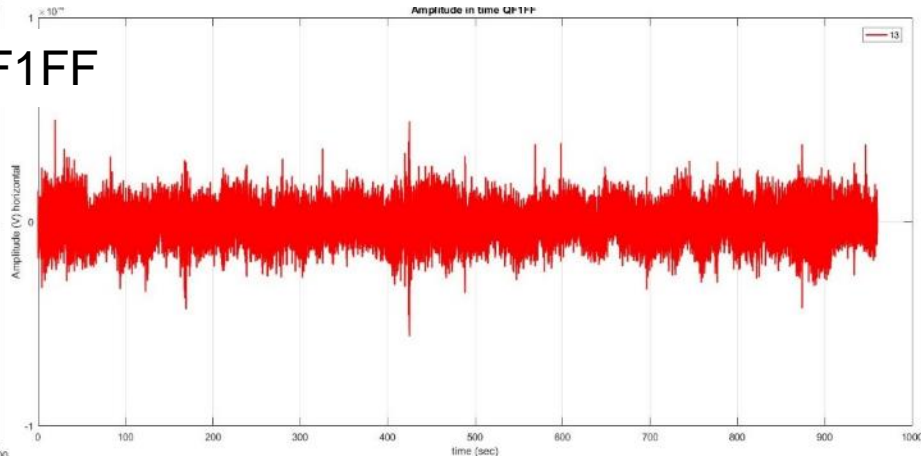
Strong temperature dependence

Corresponding time plots (same scale)



With 16.5Hz

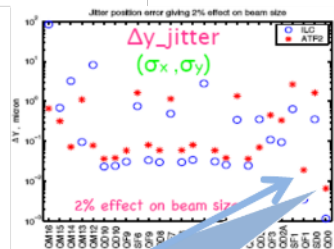
QF1FF



Without 16.5Hz

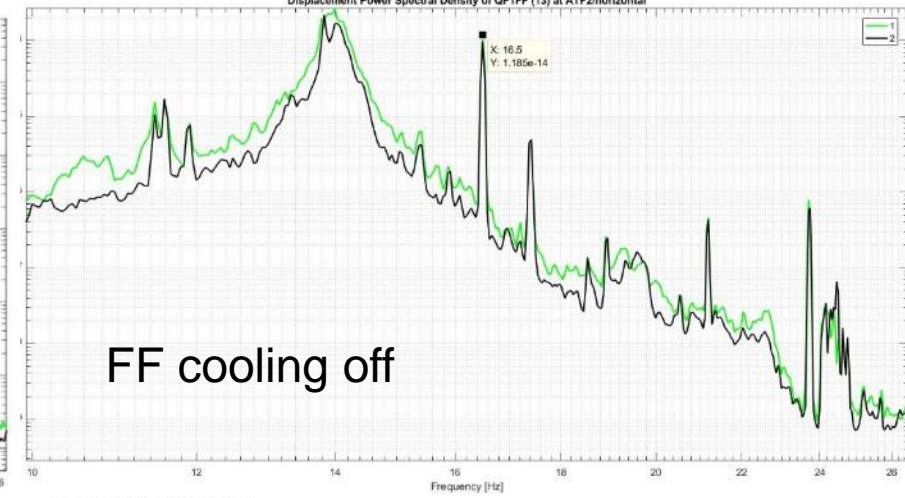
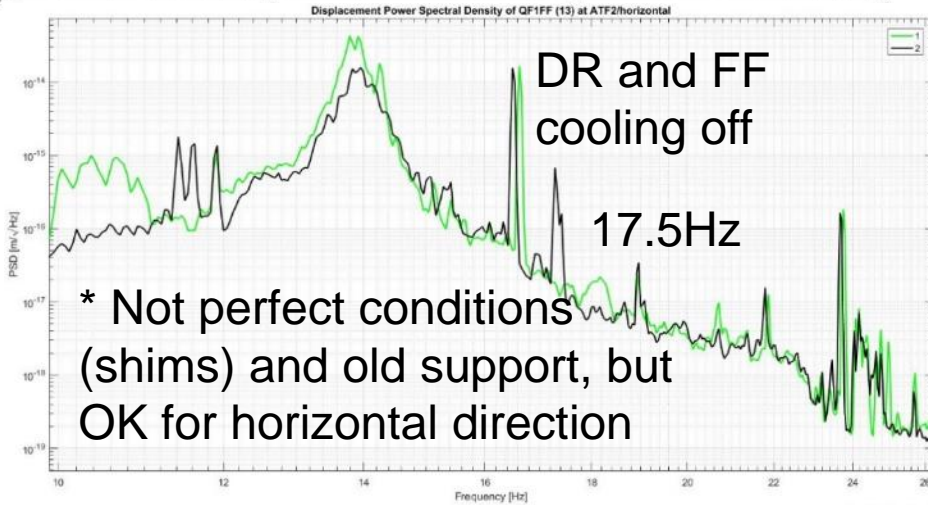
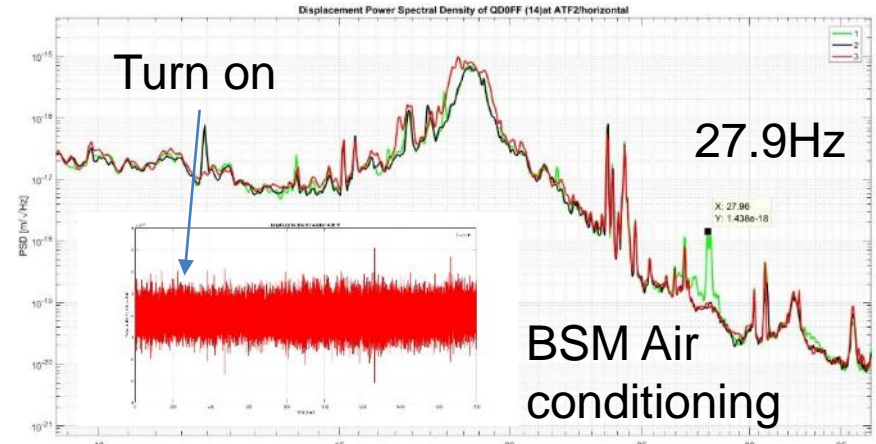
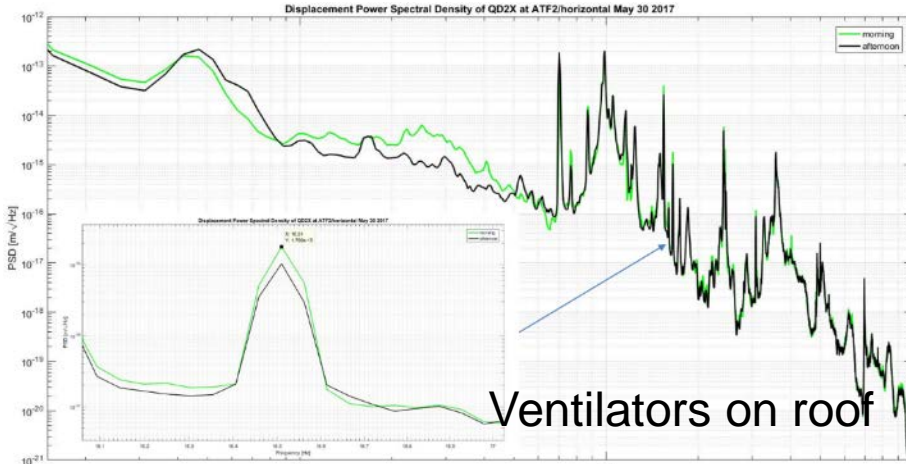
Vertical specs: should be in the 10-20nm range...
34nm is outside 2% beam size growth specs!

ATF2 Proposal vol 1

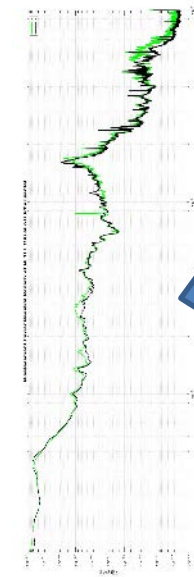
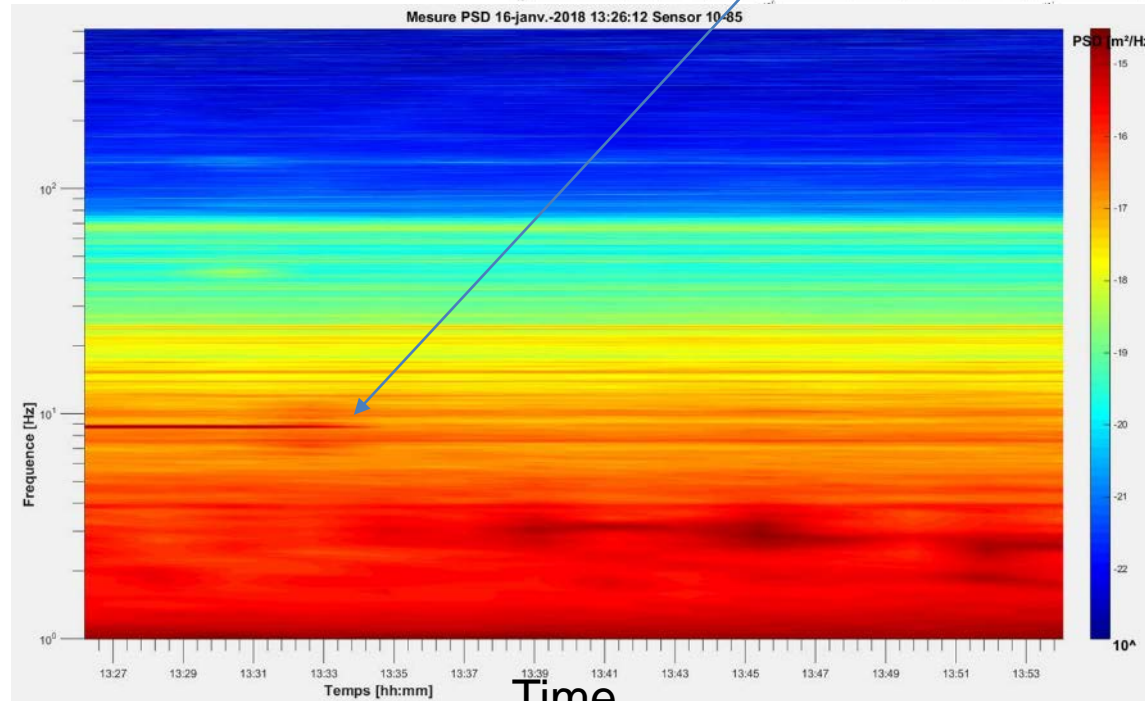
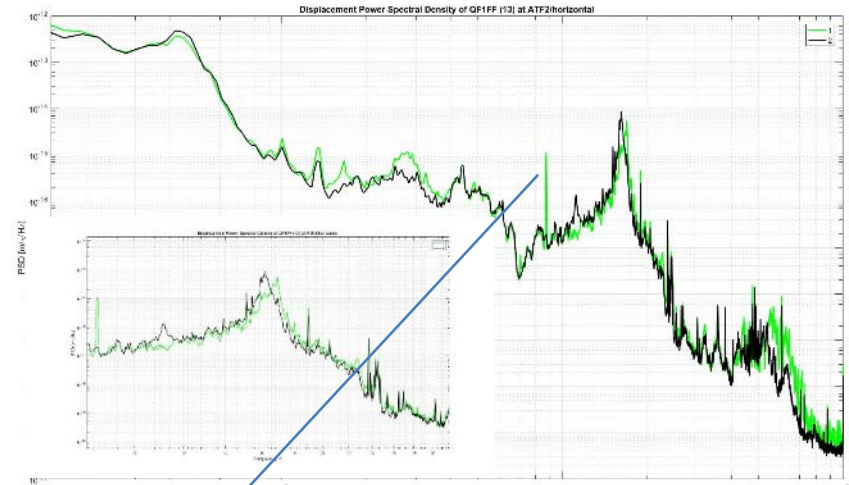
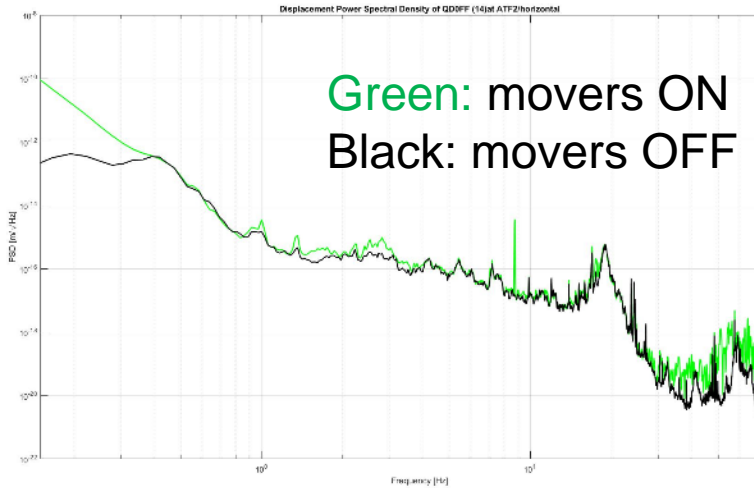


For QD0 at ATF2: 7 nm tolerance
For QF1 at ATF2: 20 nm tolerance

	Rel. disp. QF1FF vs QD0FF at 1Hz (vertical)	Rel. disp. QF1FF vs QD0FF at 1Hz (horizontal)
Cold May 2017	13nm	91nm
Hot May 2017	34nm	380nm
Very Cold Nov 2017	9nm	60nm



FONT table

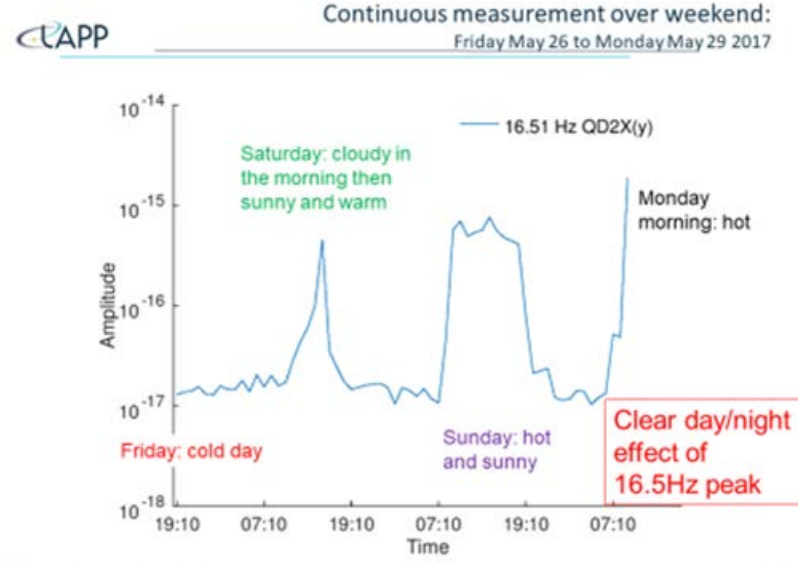
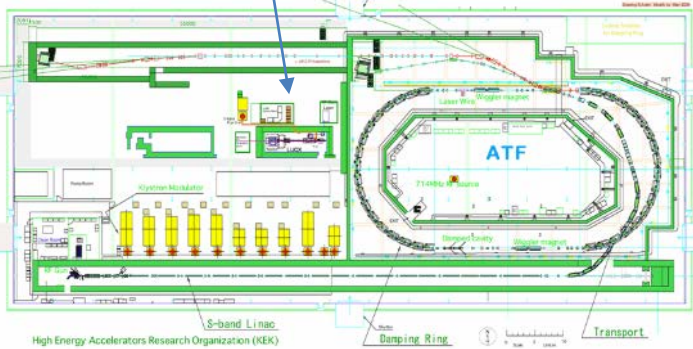


Spectrogram

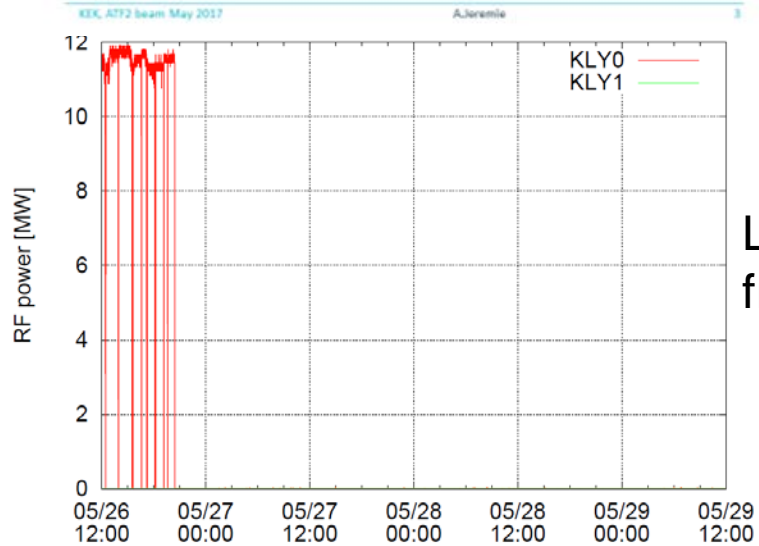
Nothing changes in the 16,5Hz region.
Only the 8.7Hz peak changes: this peak probably due to movers.



ATF2 LAYOUT



16,5Hz peak

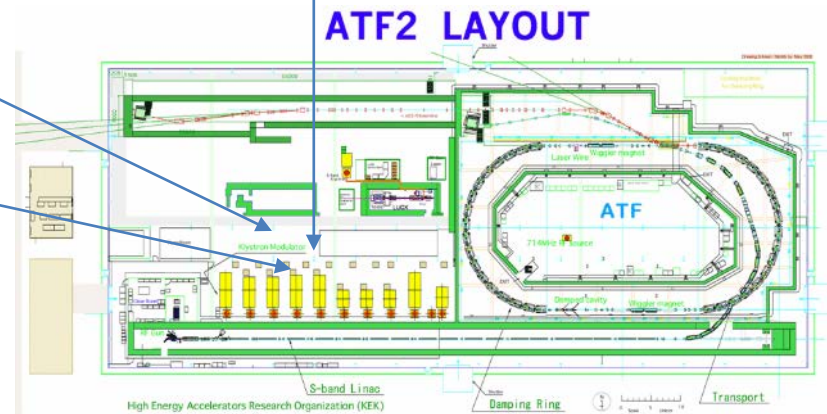


LUCX RF power from Fukuda-san

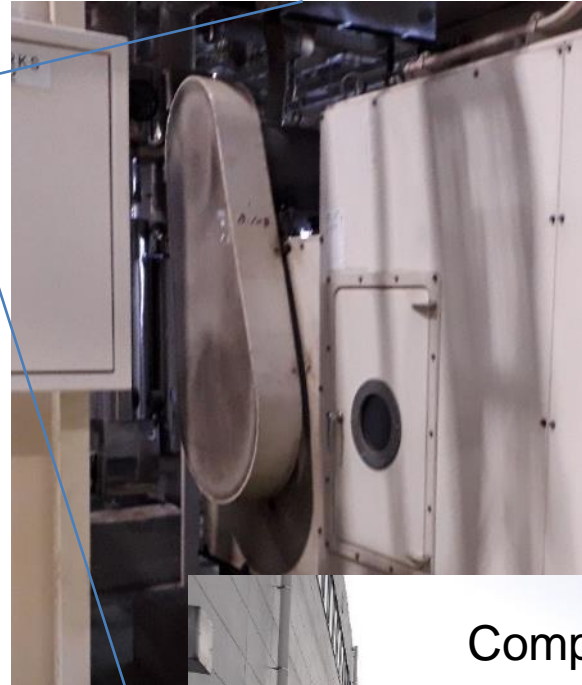
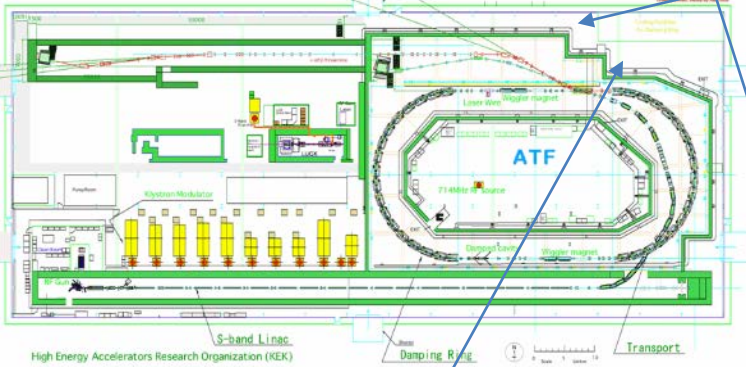
Over the same period



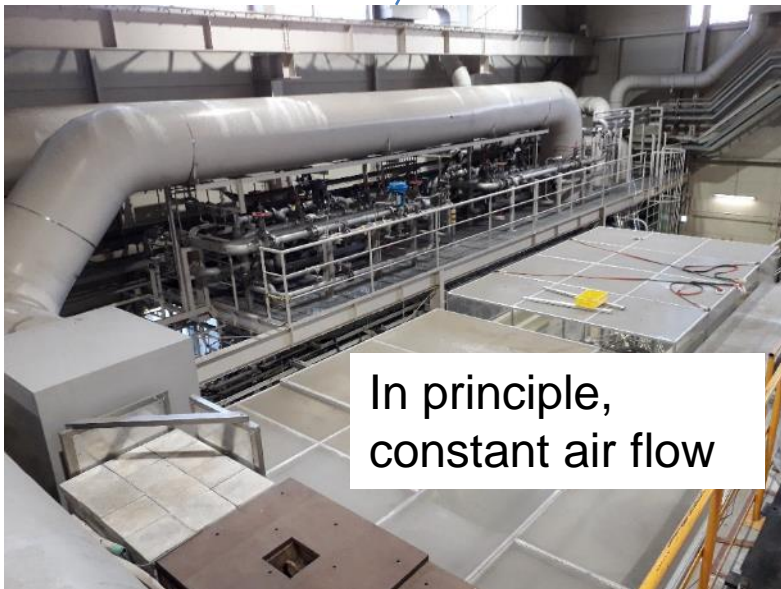
Off, but used only in radiation emergency



ATF2 LAYOUT



Fan belt for damping ring ventilation



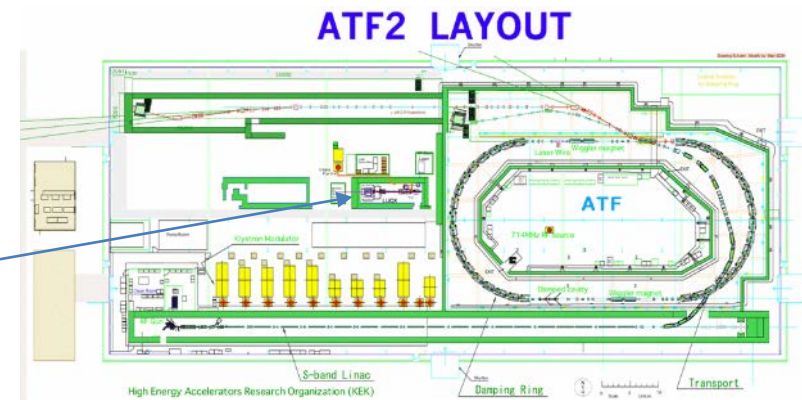
In principle, constant air flow



Compressor might work more in hot weather

What it is not:

- Ventilators on top of roof
- Main cooling water pipes (general cooling, FF cooling) => **although needs more investigation**
- BSM air conditioning
- FONT system (for QD12X)
- FD Magnet movers
- LUCX RF power



Still to investigate:

- Other items in ATF Hall
- Painstaking investigation...



Fan belts

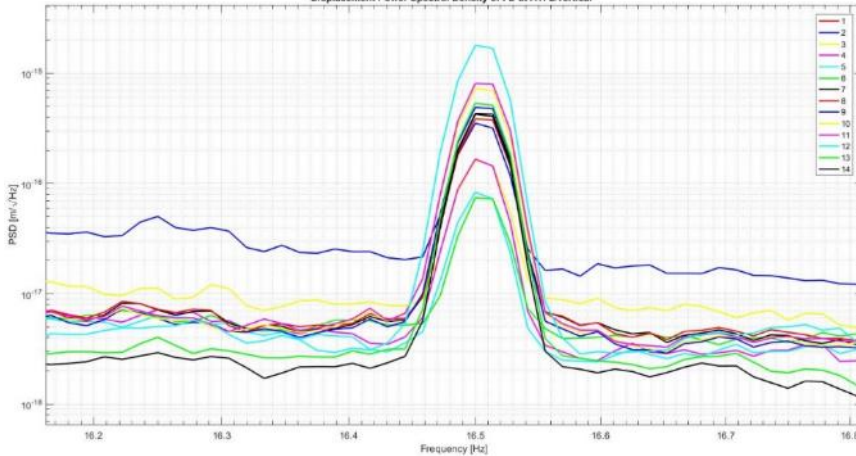
Ventilation



...

All sensors measure this vibration on a hot day (extraction, FF and FD)
 => probably a general phenomenon

Displacement Power Spectral Density of FD at ATF2/vertical



Looked back at data since 2013:

- 8.7Hz is always there (attributed to movers), 7Hz and 7.7Hz often
- 16.5Hz peak not present until May 2014
- First appears October 2014
- Summer 2014: installation of new cooling water refrigerator
- Smallest beam size achieved June 2014...
- But in December 2017, the 16,5Hz peak was not there, and small beam size was not reached

Renewal of the Refrigerator for EXT/ATF2 cooling water



Renewed in this summer 2014.

Previous: operated in 25 years
 Powerful but only used less than ¼, 15 min operated every an hour.
 Simple ON/OFF control. Heavy current load when it turns on → disturb primary 400V line → Linac RF, ...

Failures:

- 2010 Aug/Sep... long shutdown but no damage on beam schedule
- 2013 Sep/Oct... same as above
- 2014 Apr... lost a week of beam operation

Renewed:

inverter control → smooth then 400V line should be stable.



St. Thomas (PSD) ATF2 meeting in the LEP204 Oct 8, 2014. Belgarda

Needs to be checked for vibrations and possibly mitigation

- Study possibility to implement Transfer function (TF) to be able to put sensors on table or floor (less risky and leaves magnet top free for accelerator alignment)
- Continue work on multiple sensor/corrector Feedforward
- Identify 16,5Hz vibration source: look at fan belts and cooling water refrigerator...
- For the GM feedforward work, there is a risk of loosing continuity of expertise: mainly newcomers with very little overlap