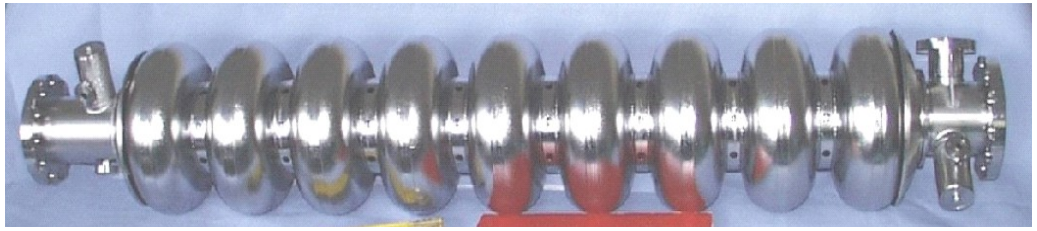
Piezo Control at ACC1, ACC3, ACC5-7

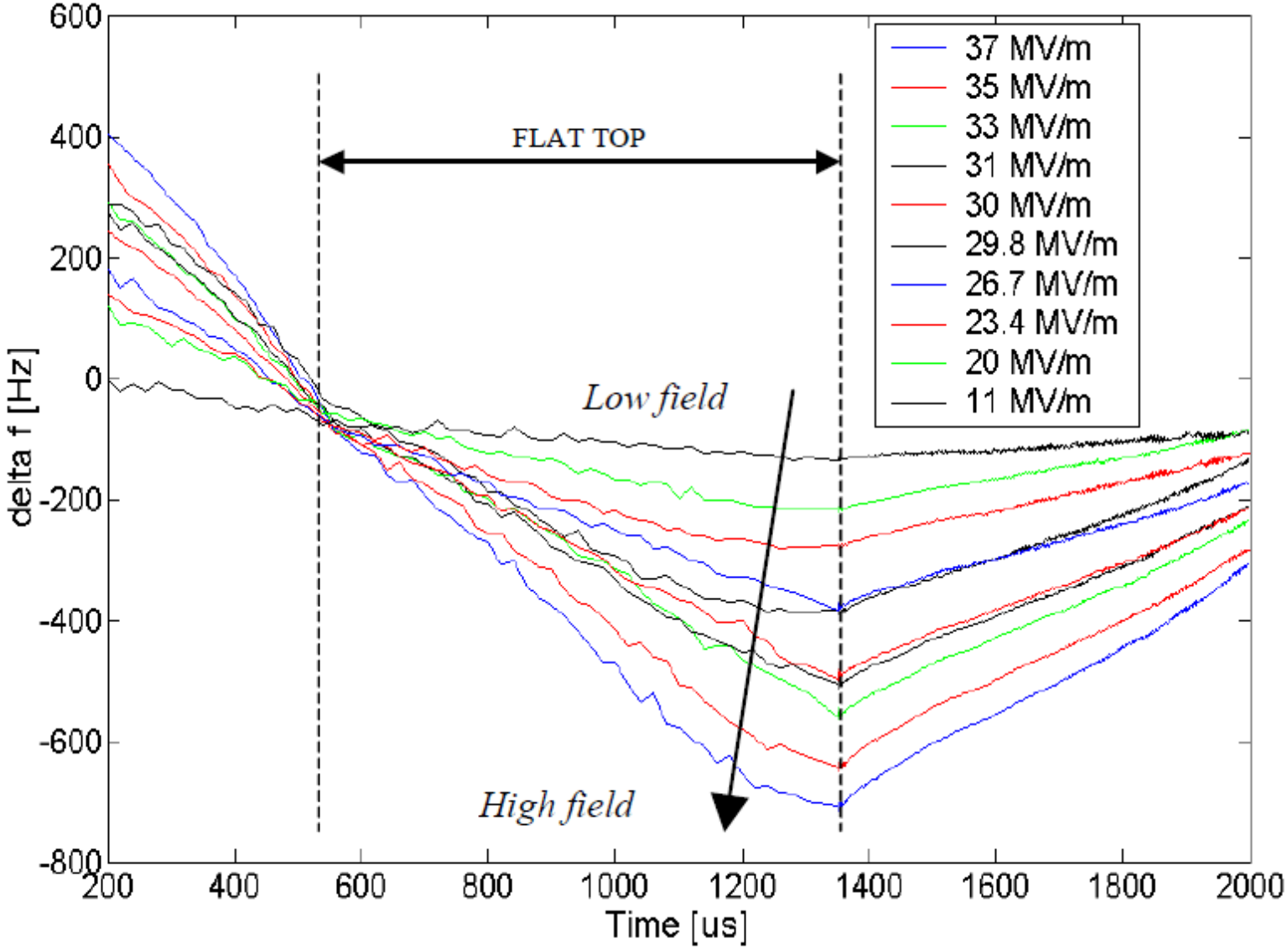
Mariusz Grecki for LLRF collaboration



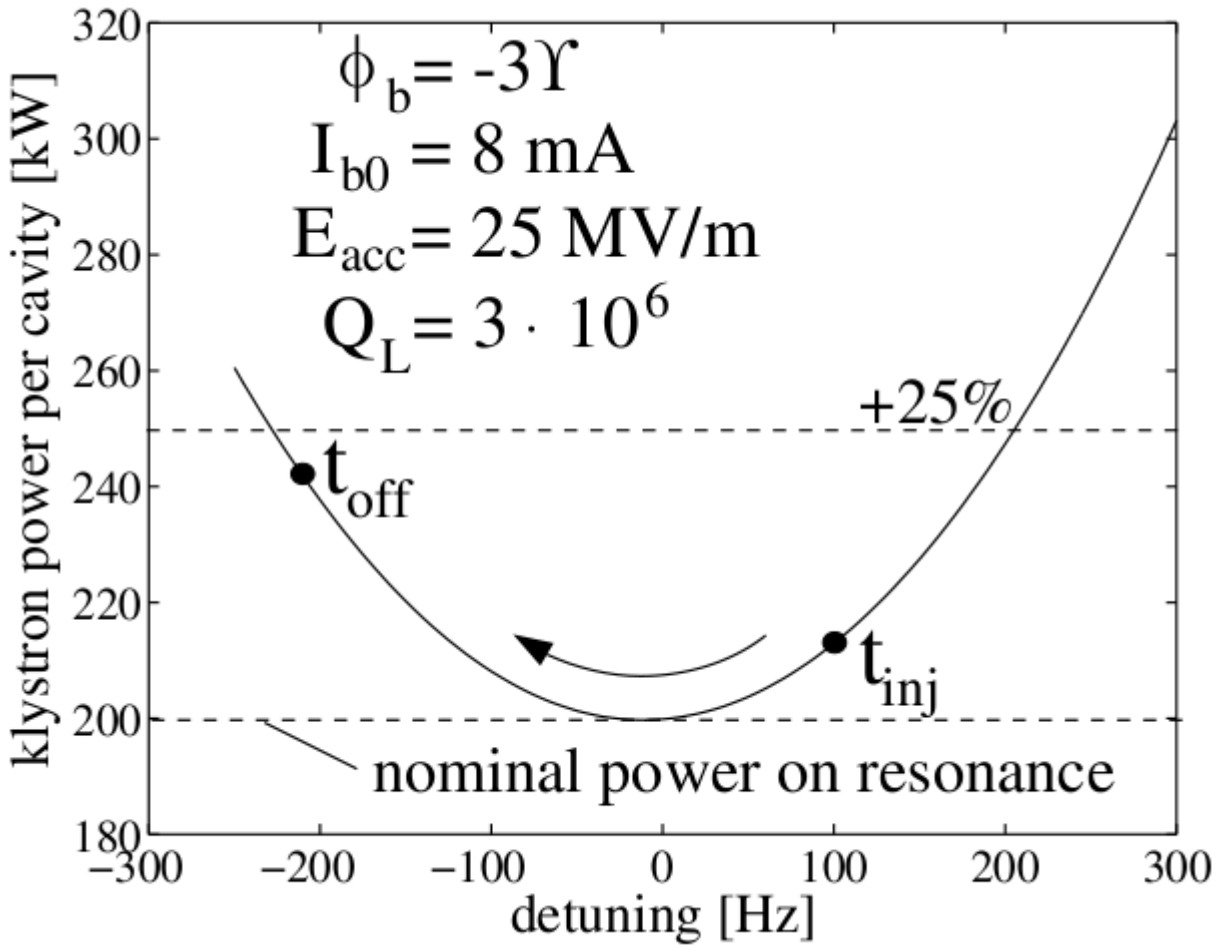
Agenda

- Lorentz Force Detuning (LFD) and it's compensation by piezo
- Upgrade of FLASH and piezo control system in 2009/2010
- Piezo control
- Experience at FLASH
- Conclusion

LFD vs Gradient

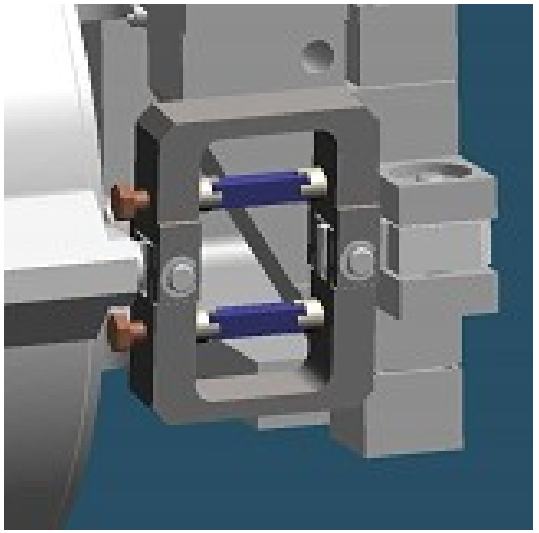


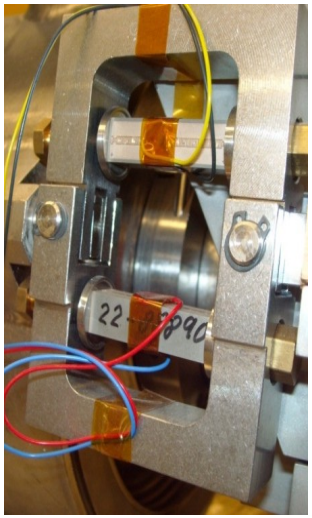
RF Power Excess due to LFD

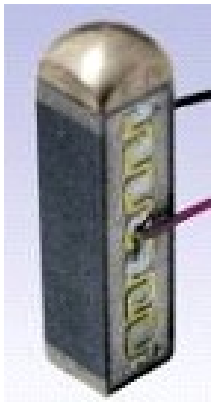


Goal of Piezo Control system

- Drive the piezoelements assembled in fast tuners frames to minimize the Lorentz force and microphonics effects
- On-line frequency detuning calculation
- Microphonics measurement







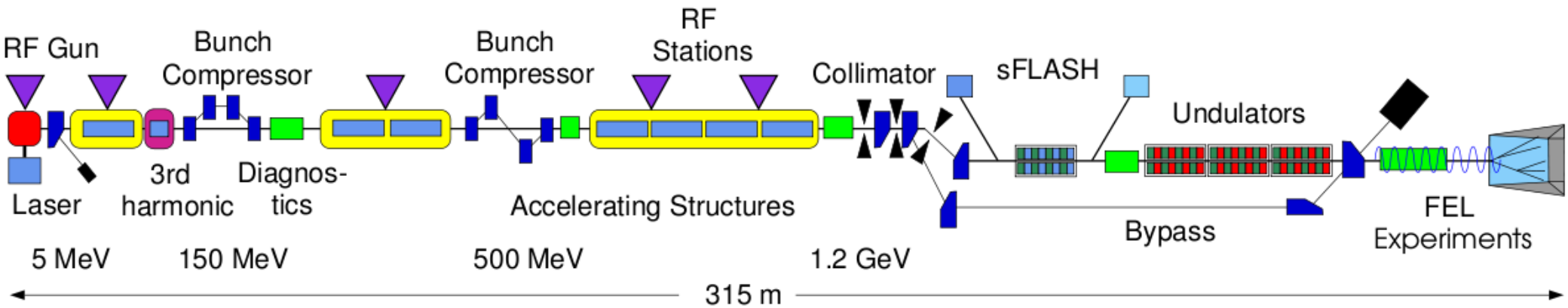
Dimensions: **10x10x36mm**
Manufacturer: **PI**

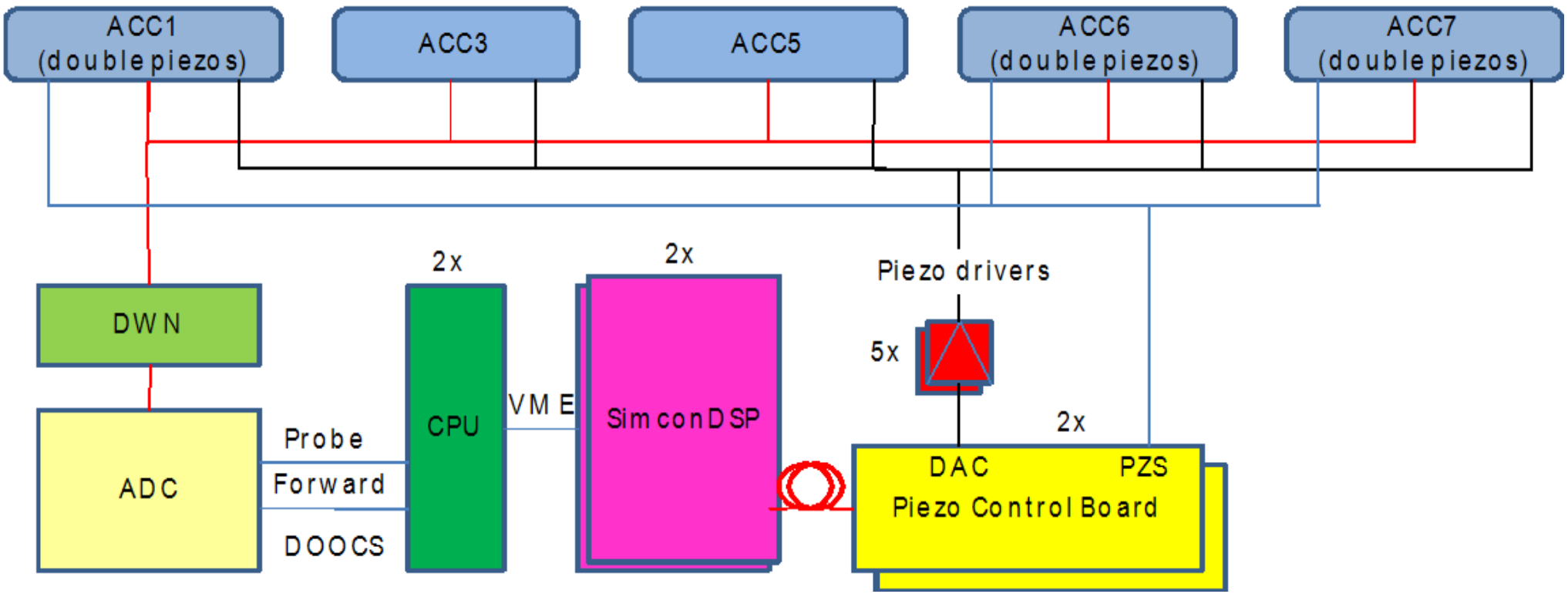
Dimensions: **10x10x30mm**
Manufacturer: **NOLIAC**

Piezos Installed in ACC1,3,5,6,7

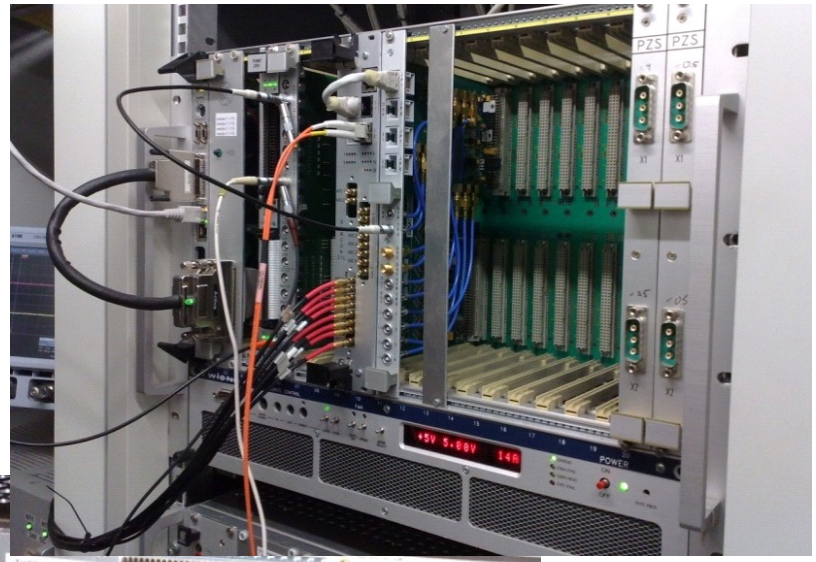
Producent ratings	Noliac	PI ceramic
Model:	SCMAS/S1/A/10/10/30/200/42/6000	P-888.90
Cells:	8	8
Voltage:	< 200 V	< 120 V
Blocking force:	6 kN	3 kN
Size:	10 mm x10 mm x 30 mm	10 mm x10 mm x 35 mm
Capacitance:	6 μF	12 μF

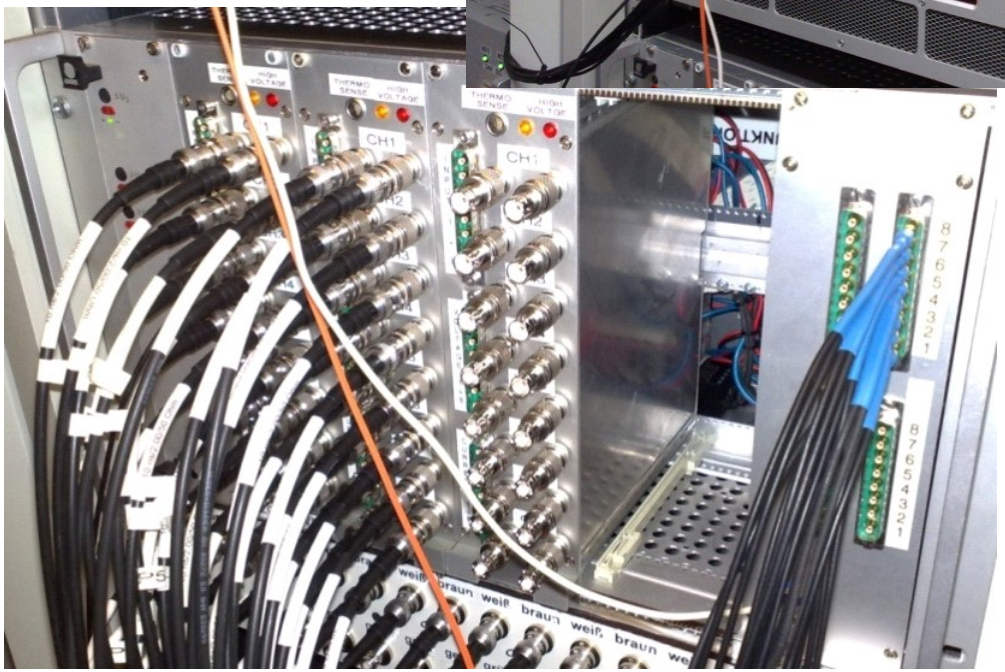
Piezo tuners at FLASH

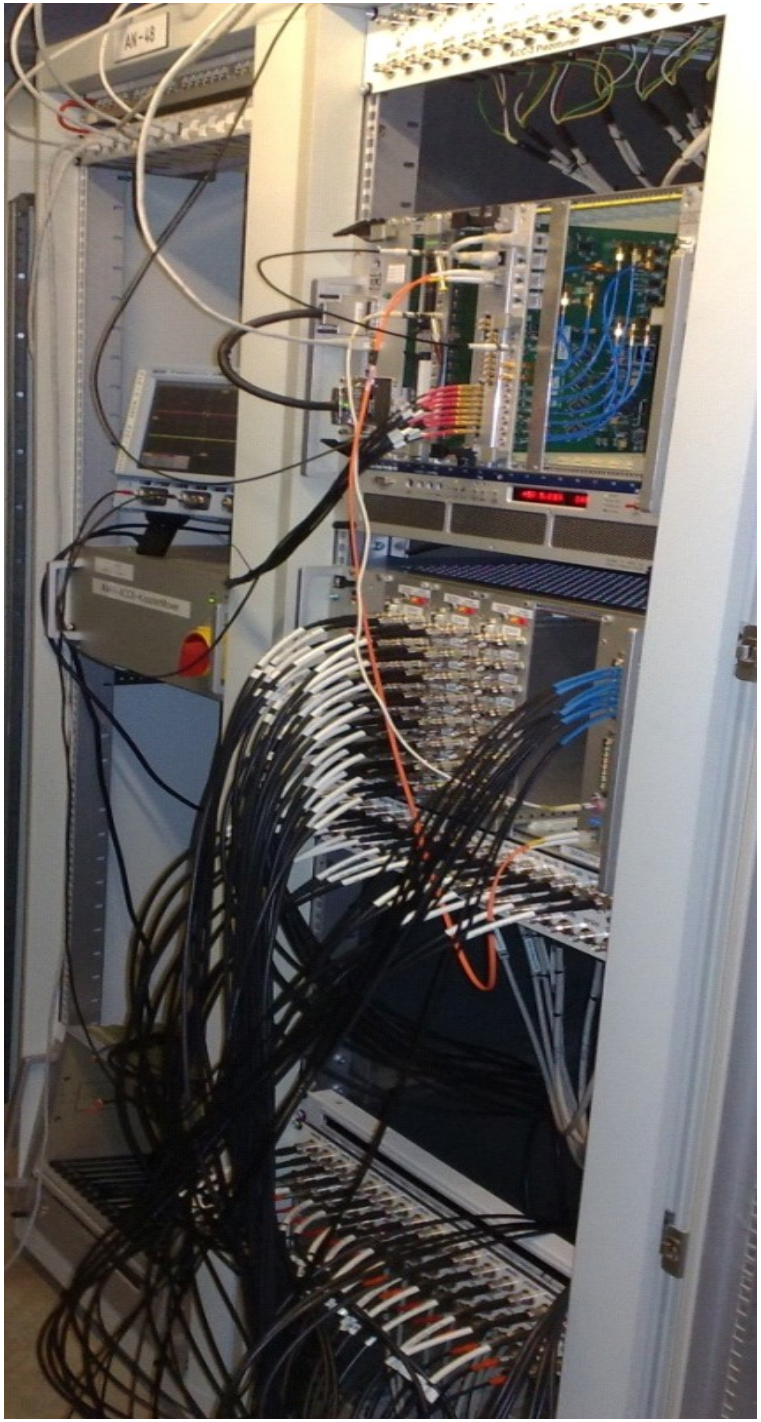




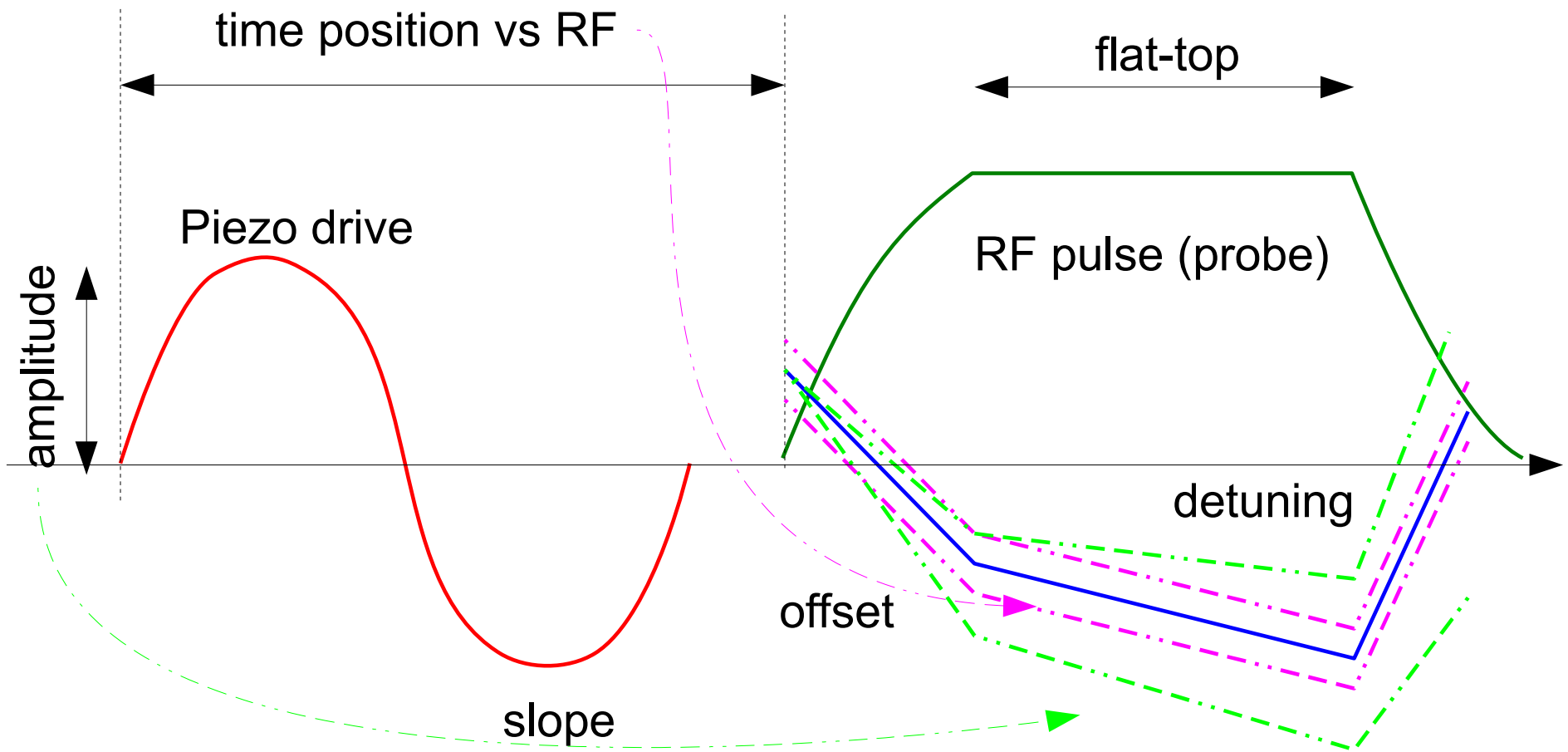
Piezo Control at ACC3,5,6,7



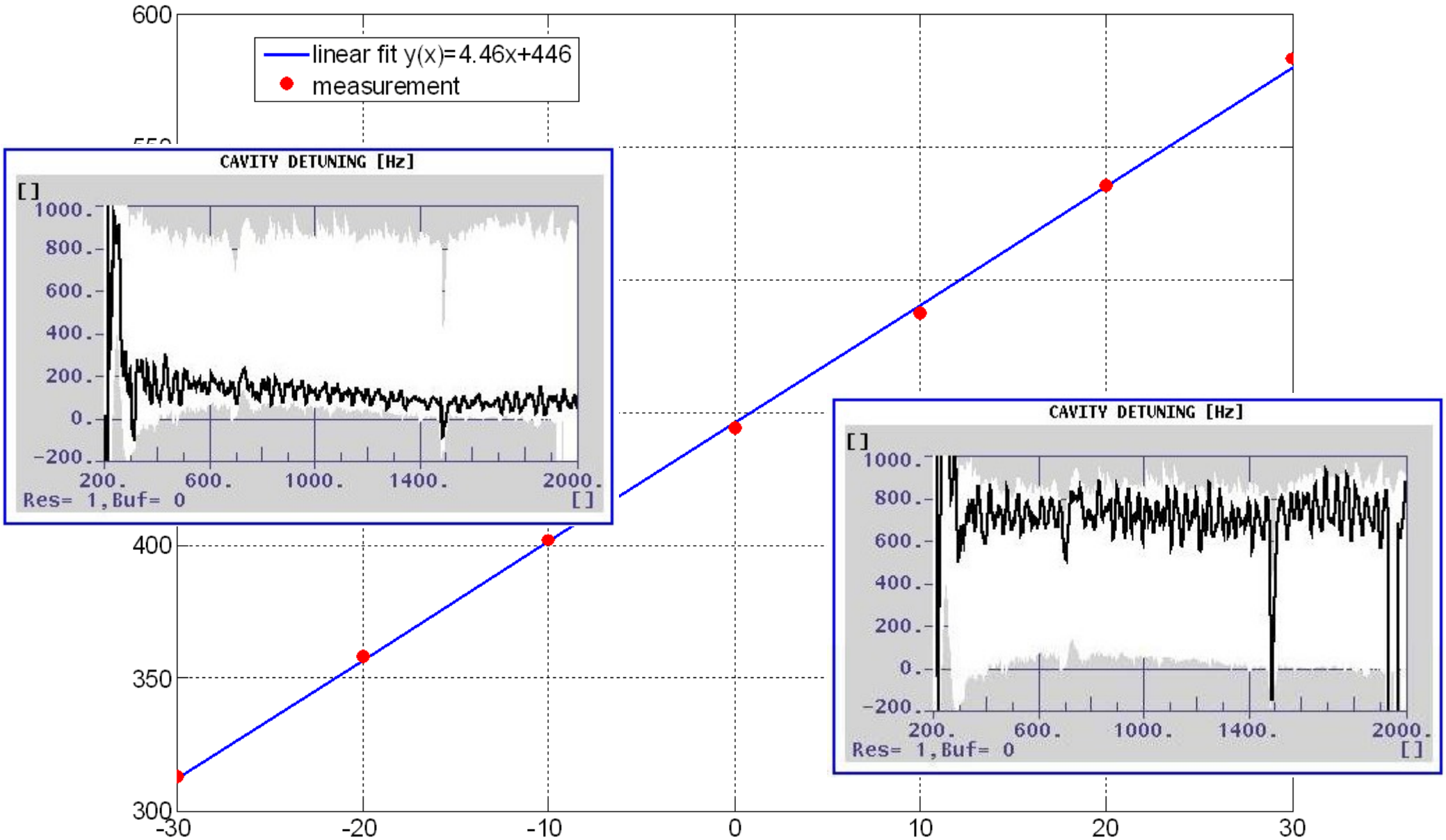




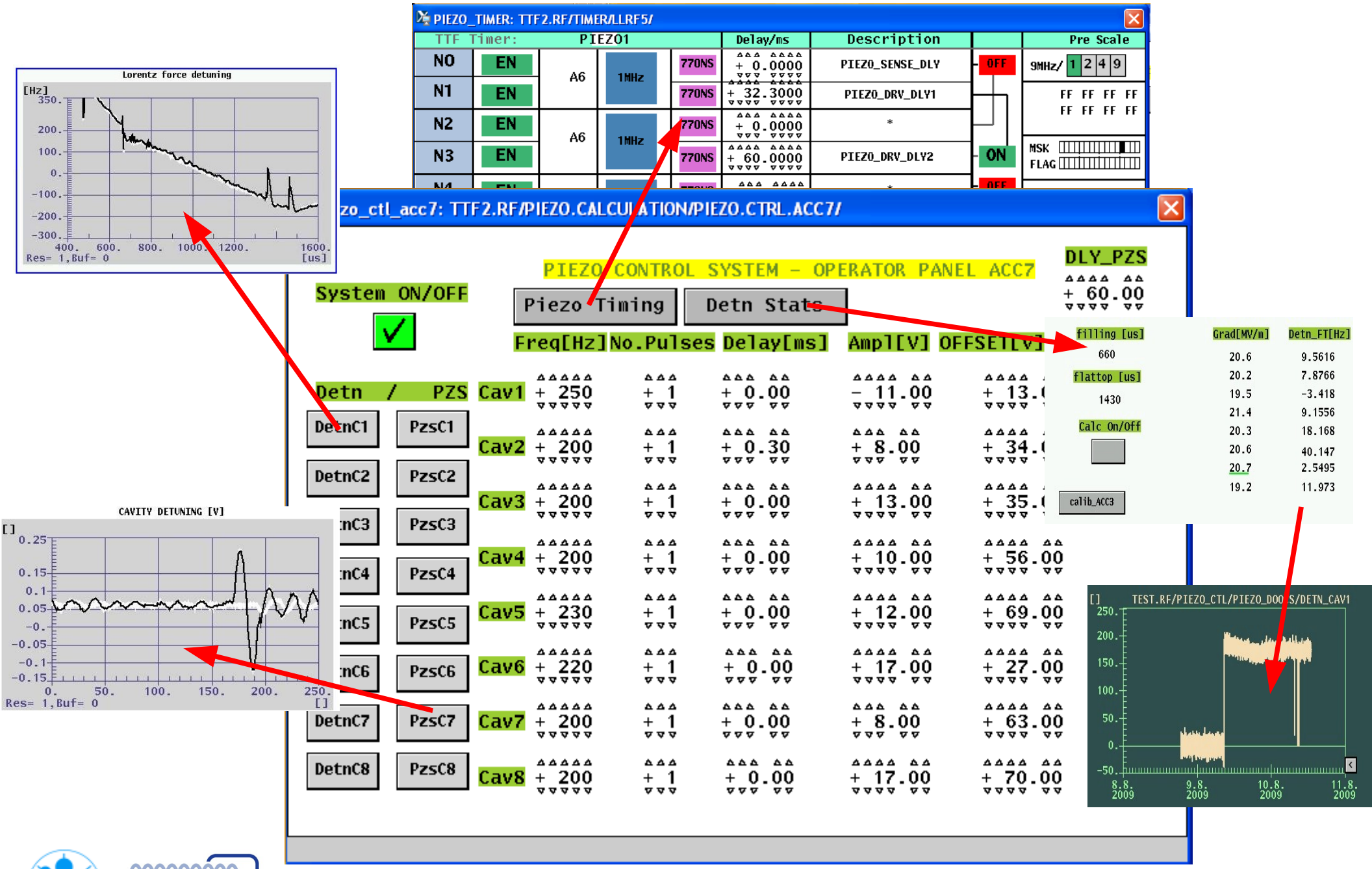
Piezo Control



Transfer function (ACC5 cav. 8)



Piezo Control Panel



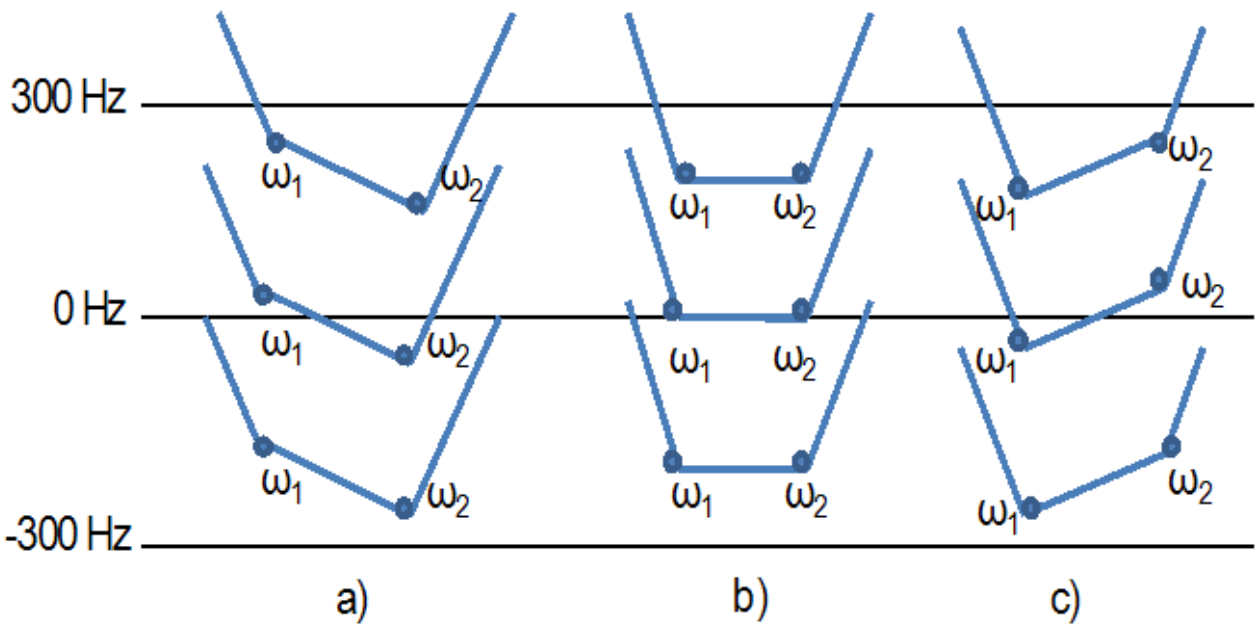
Automatic control algorithm

$$\Delta\omega = -\frac{1}{2\cdot\pi}\left(\frac{d\phi_{probe}}{dt} - 2\cdot\omega_{1/2}\cdot\frac{|U_{forward}|}{|U_{probe}|}\cdot\sin\left(\phi_{forward} - \phi_{probe}\right)\right)$$

detuning computation $\Delta\omega$ (t)

correction $k_p\cdot\{\omega_1(t) - \omega_2(t)\}$

driving signal update u(t) = u(t-1) ± correction

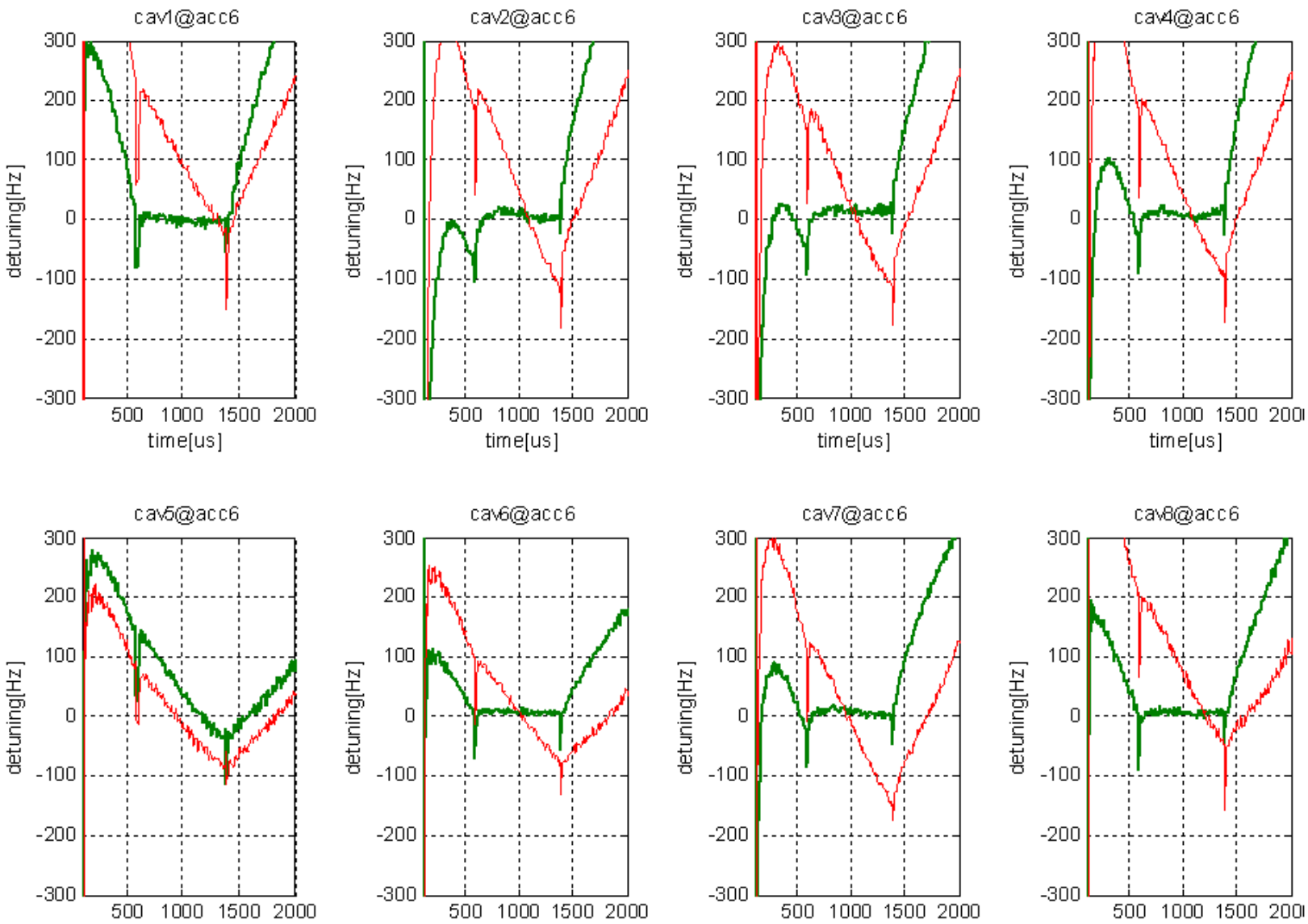


a) u(t) = u(t-1) + corr.

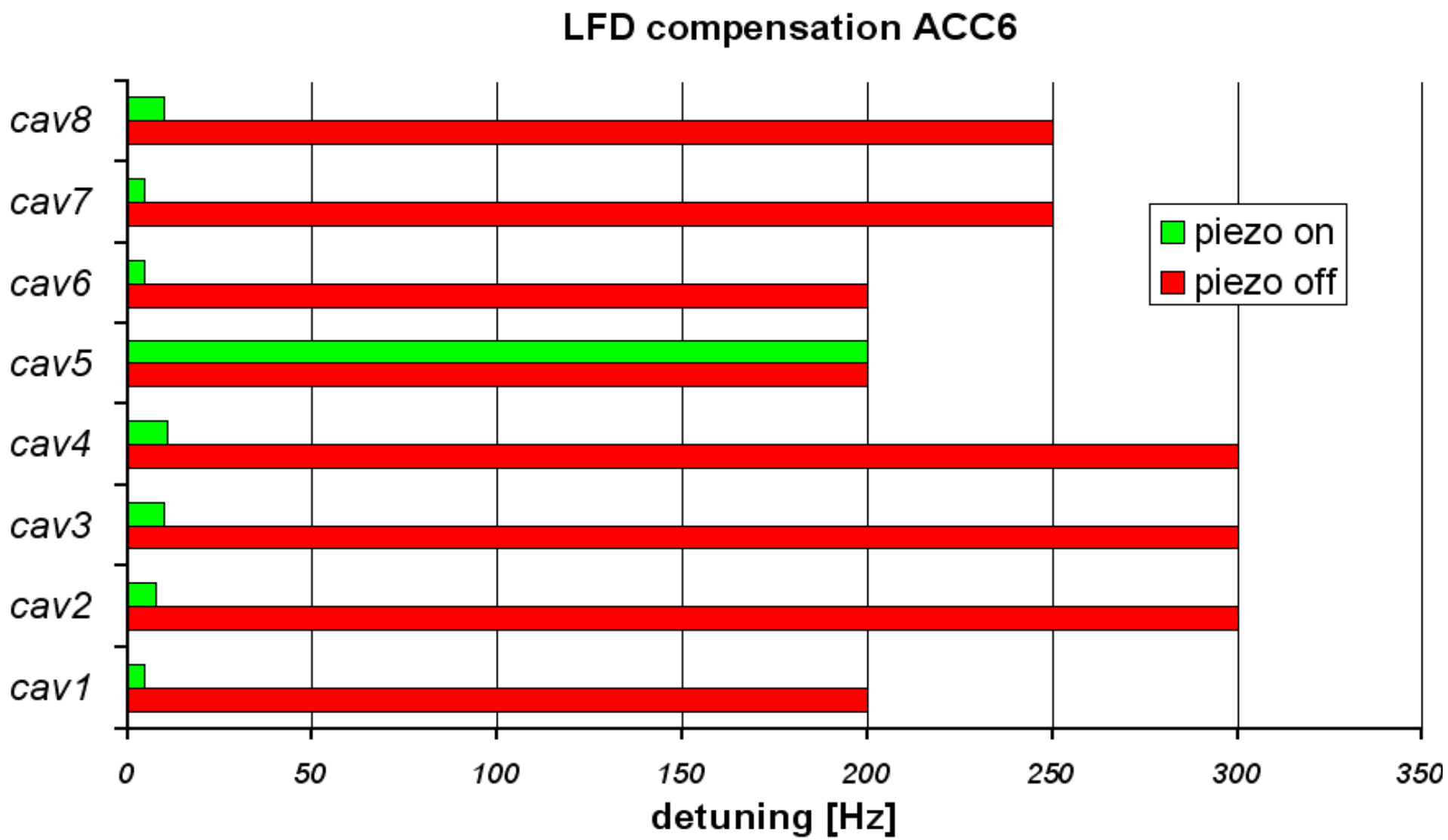
b) u(t) = u(t-1)

c) u(t) = u(t-1) – corr.

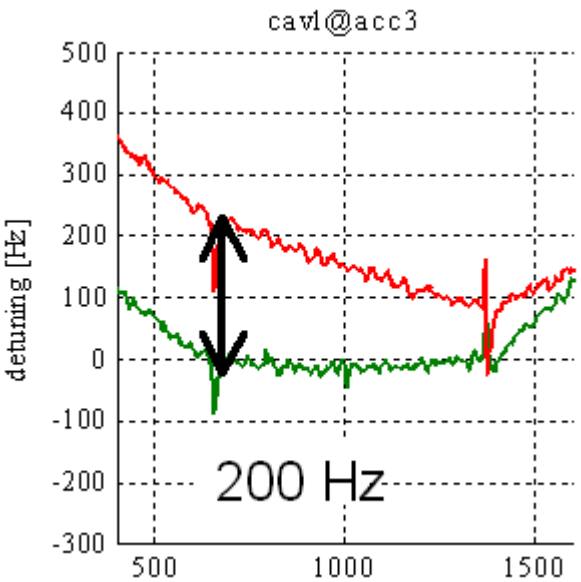
ACC6 (SP = 20 MV/m, rep = 5 Hz)

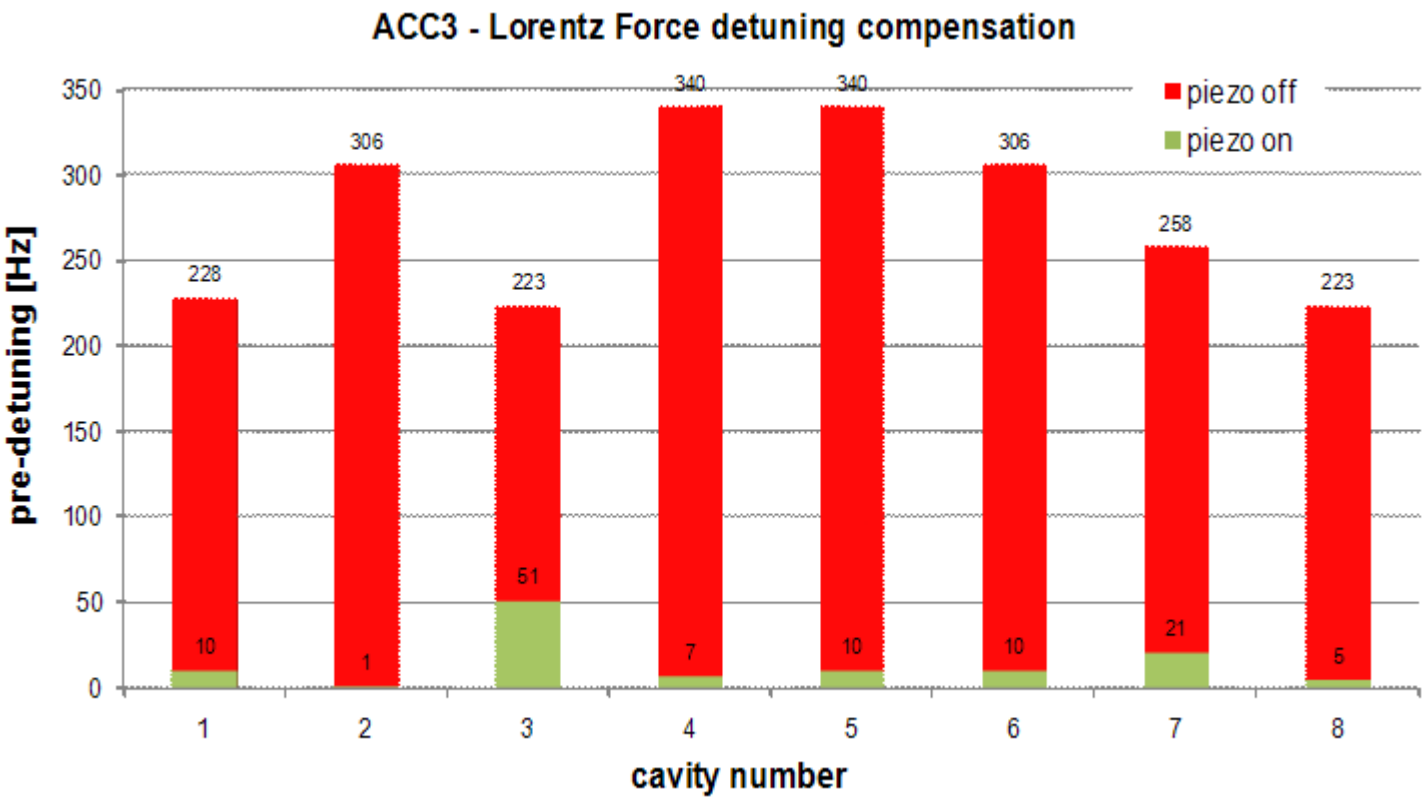


ACC6 (SP = 20 MV/m, rep = 5 Hz)

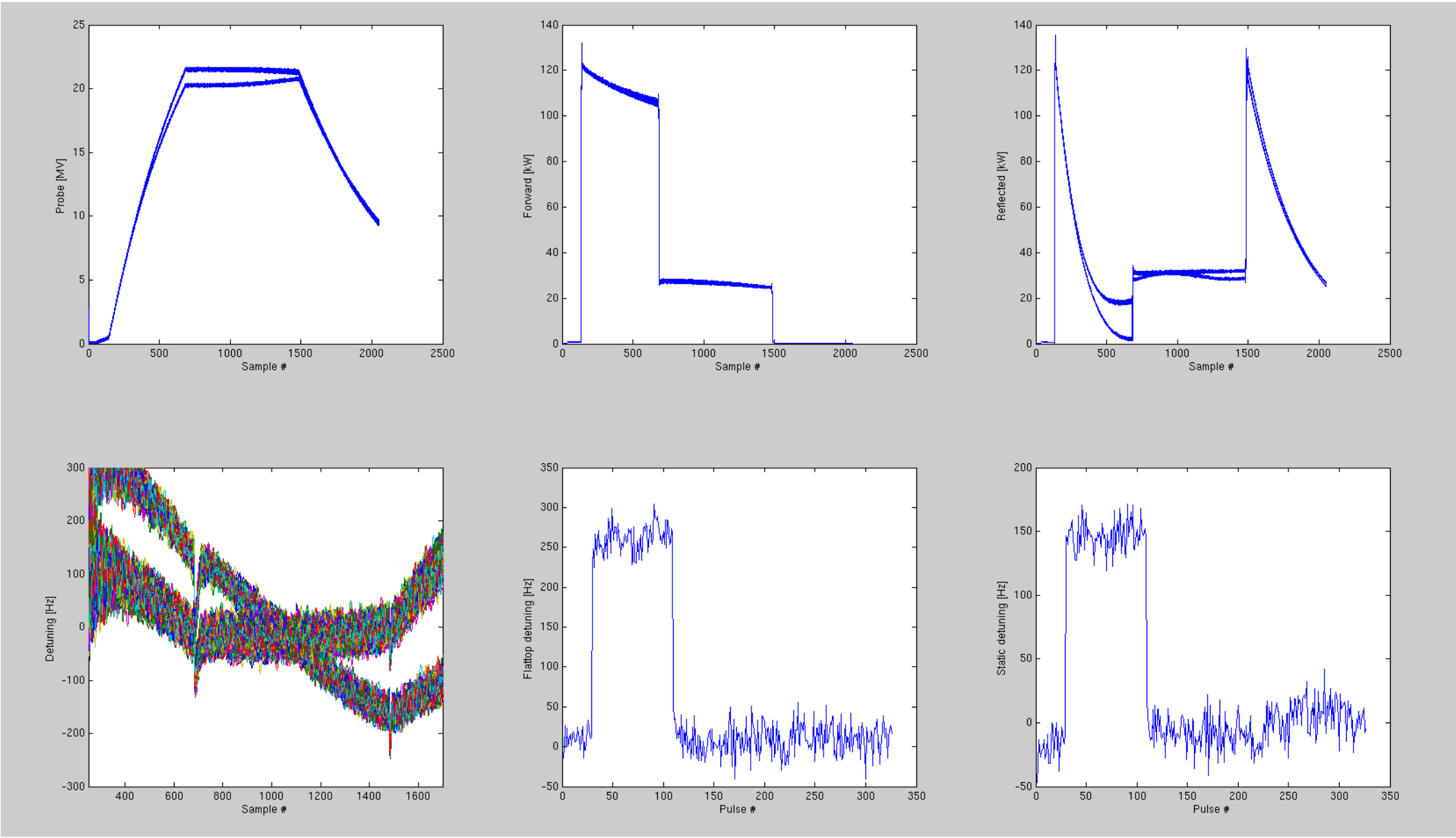


LFD during 9mA tests

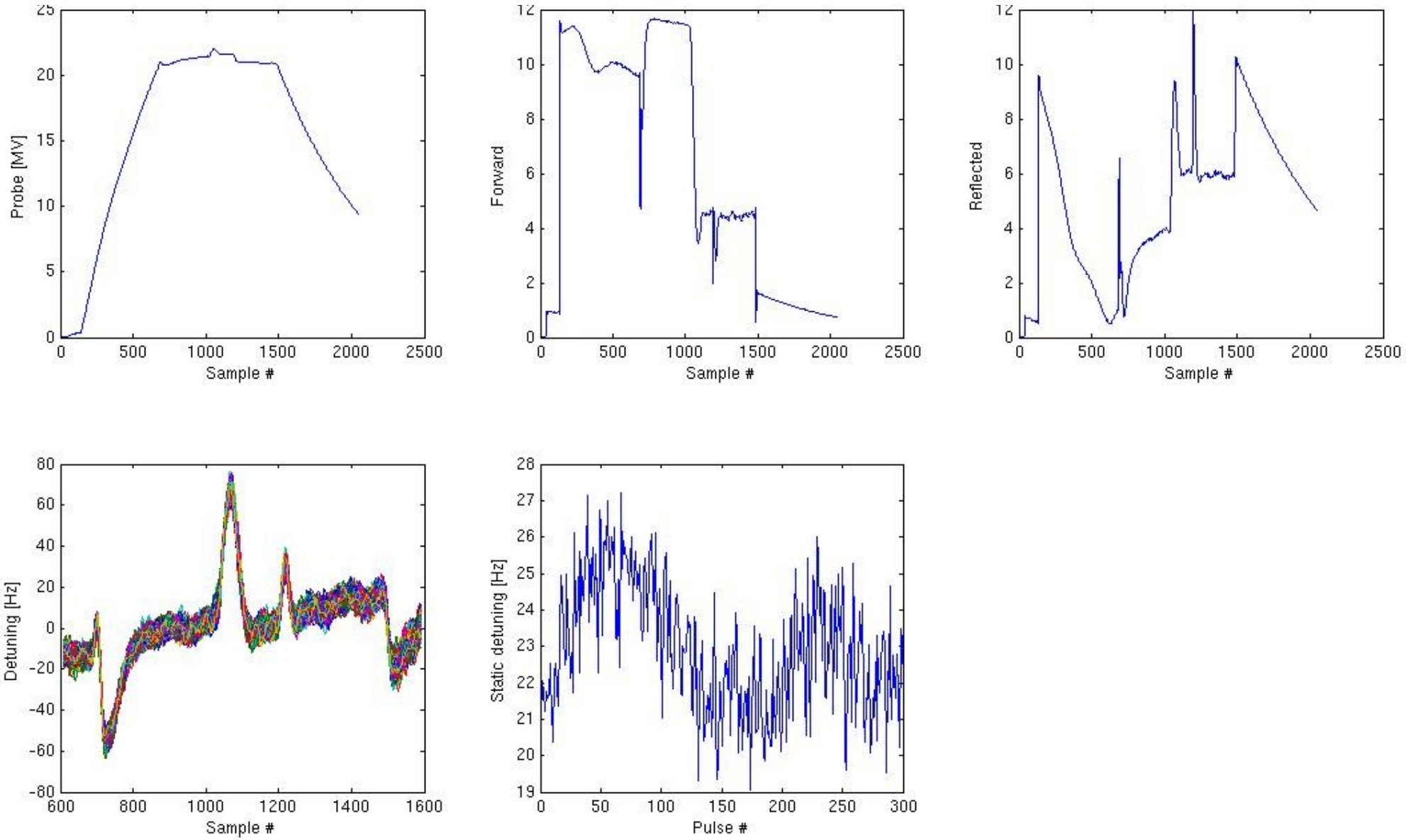




ACC3 cav. 4 (no beam)

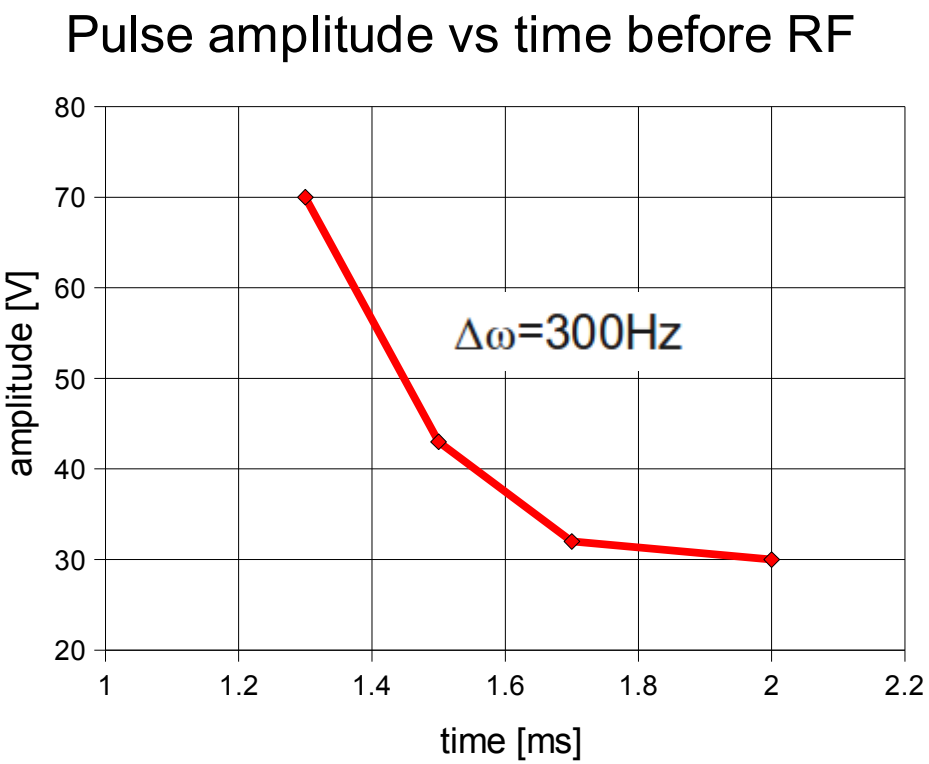


ACC1 cav.1 (with beam)

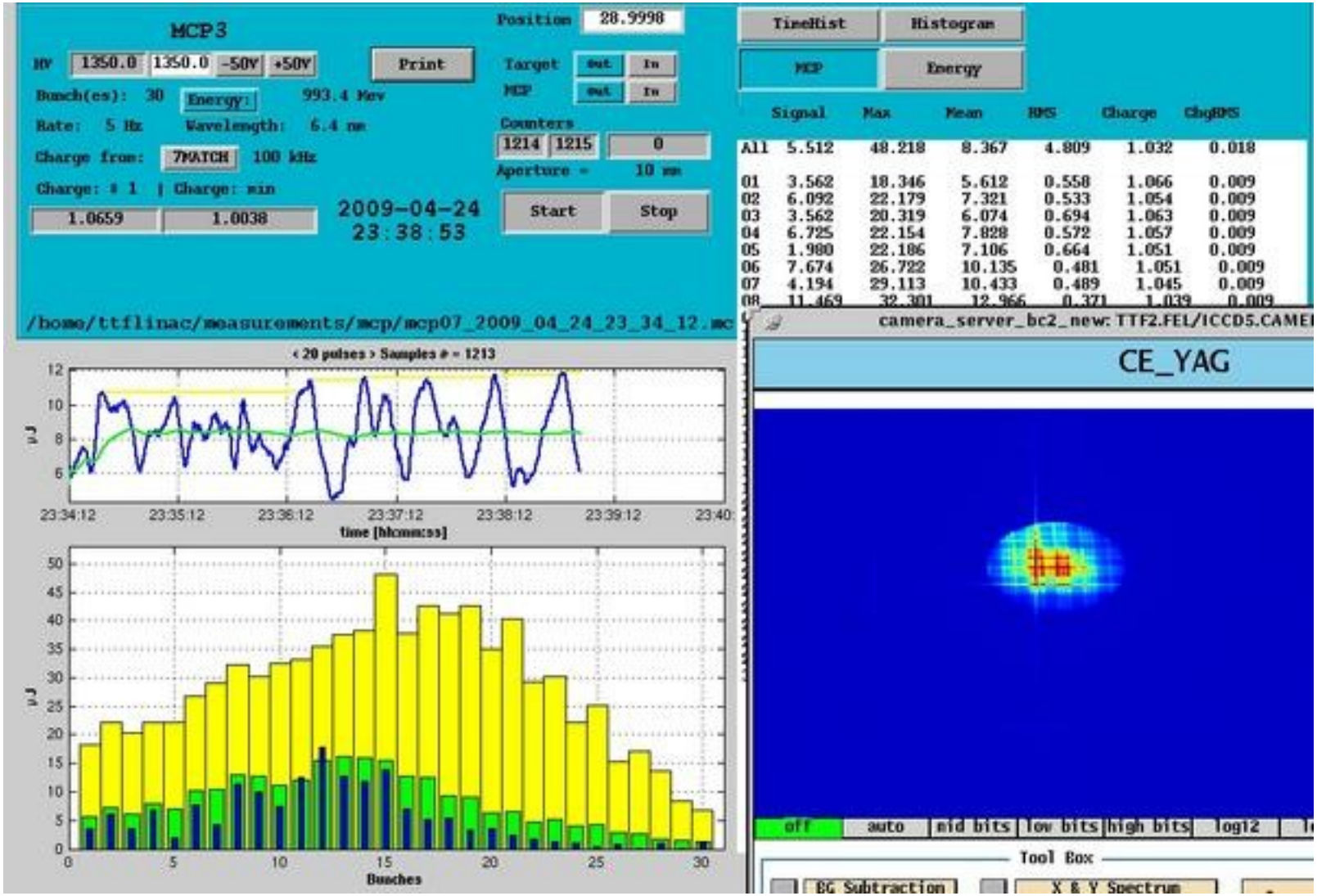


Microphonics

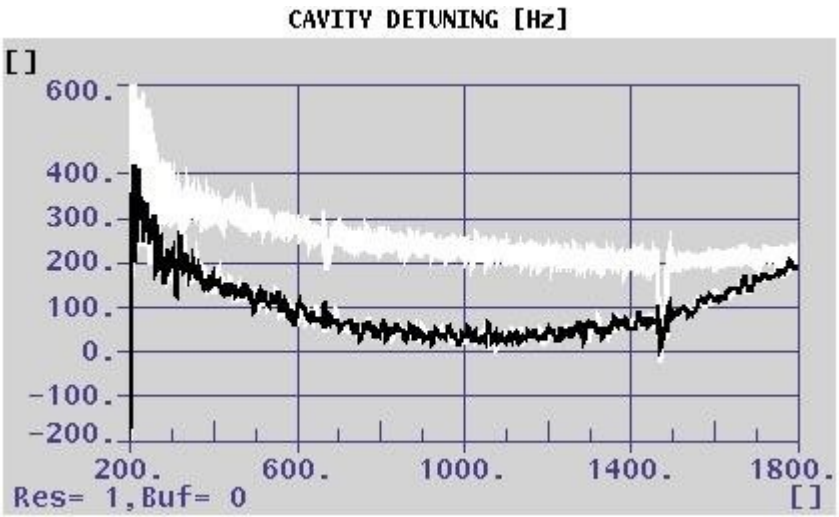
- Due to limited speed of acoustic wave propagation through the cavity it is not possible to react within the RF pulse for variable microphonics
- Microphonics must be measured in advance (before RF pulse - either second piezo used as a sensor of some RF must be present before the pulse) and compensated as soon as possible



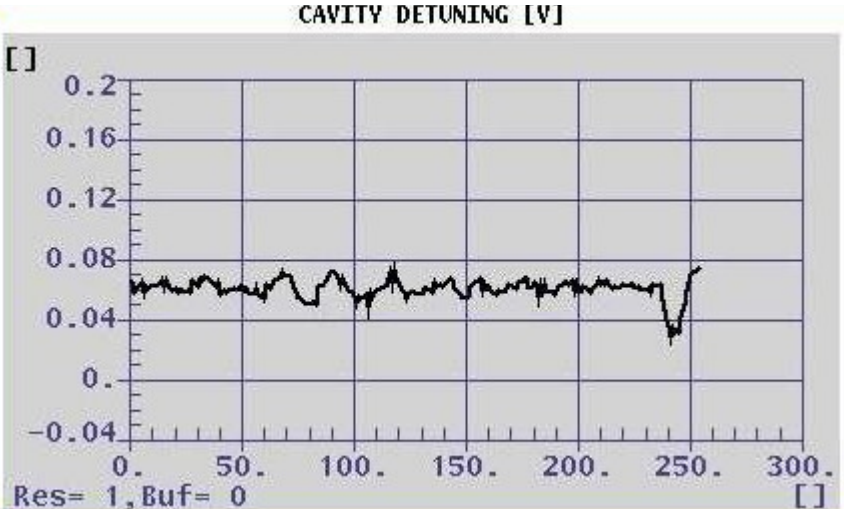
Piezo operation influence on SASE level



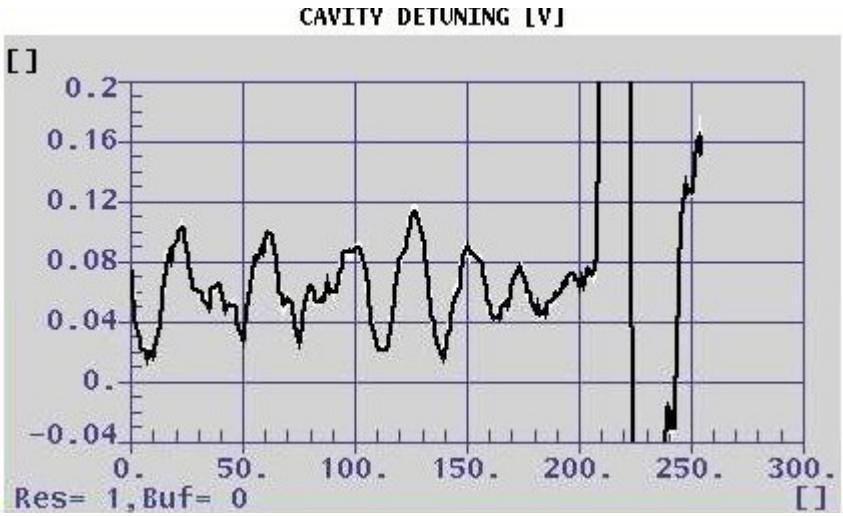
Cavity vibrations



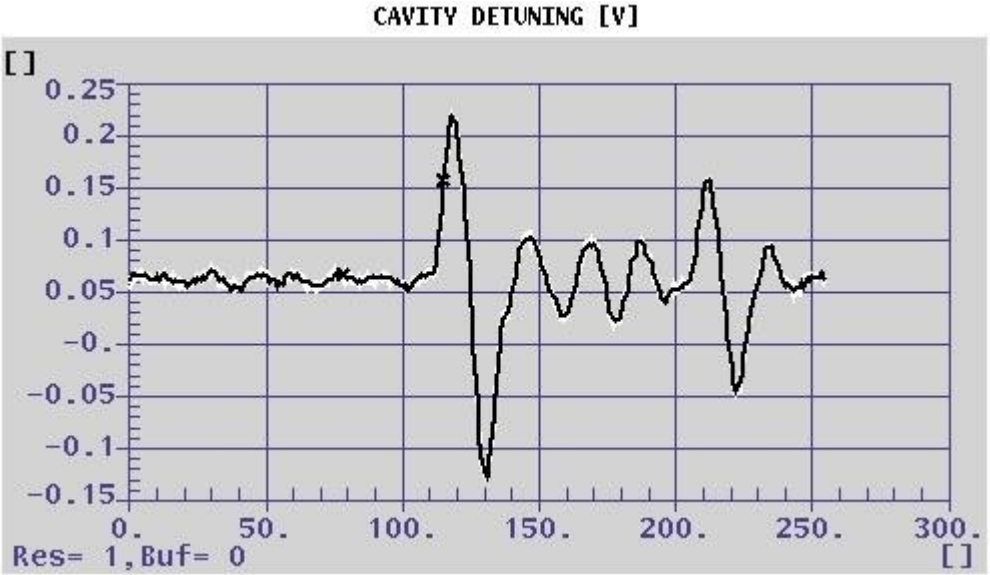
Detuning without and with LFD compensation by piezo



Piezo sensor - only RF

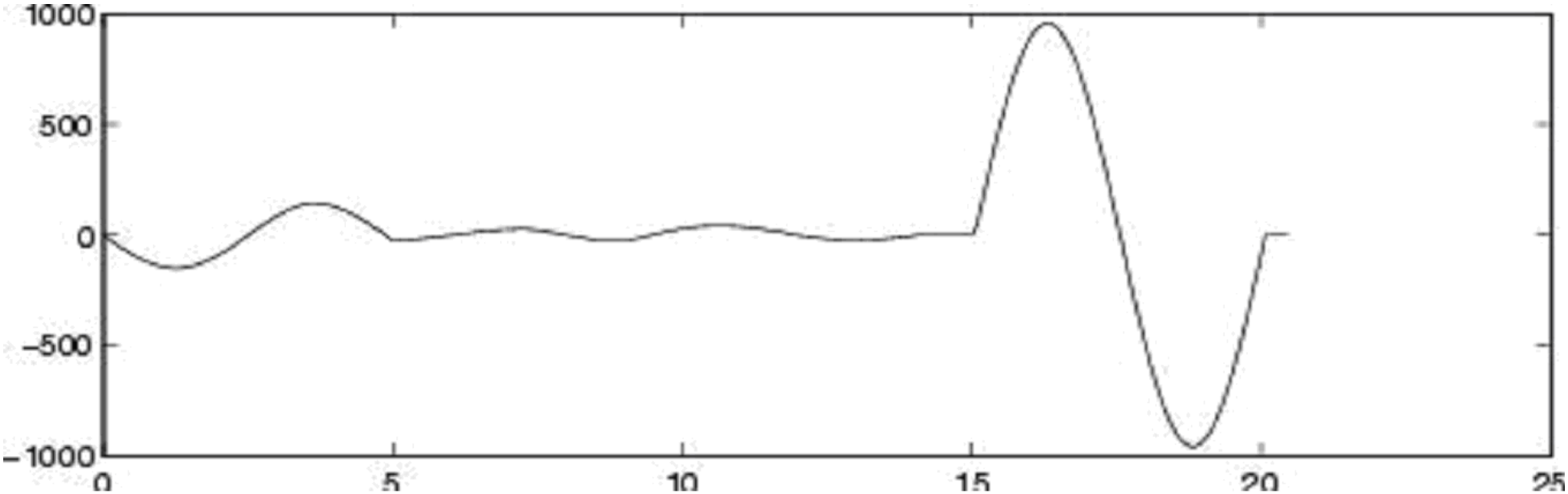


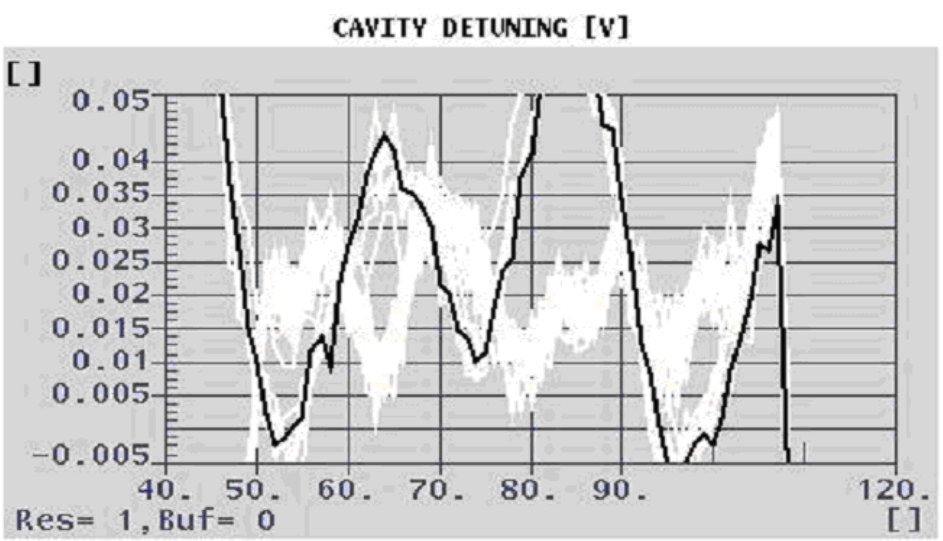
RF plus LFD compensation by piezo

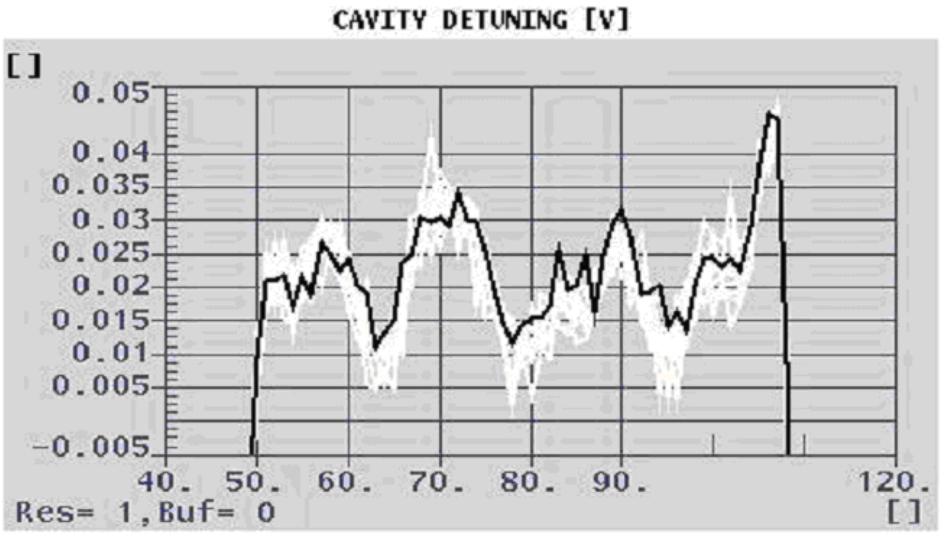


RF plus LFD compensation by piezo plus active attenuation

Active vibration attenuation (ACC7C5)







Conclusion

- LFD has negative influence on cavity operation but can be compensated with fast piezo tuners.
- Fast tuners with piezos are installed at FLASH (ACC1,3,5,6,7) and are operable. ACC1 control needs a special fibre connection due to overloaded CPU in ACC1 crate.
- Piezo control system was developed, implemented and installed. The implemented functionality was tested and works well.
- There is a lack of automation. The experts are needed to operate piezos.
- The influence of piezo operation on SASE is still not clear. More experiments needed.

Thank you for your attention