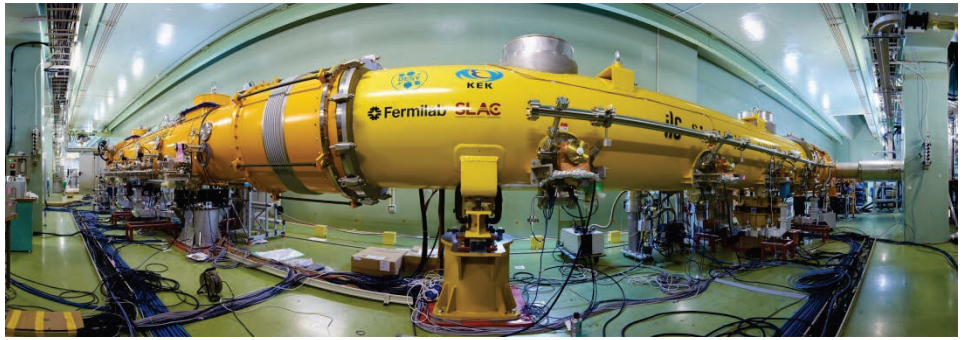
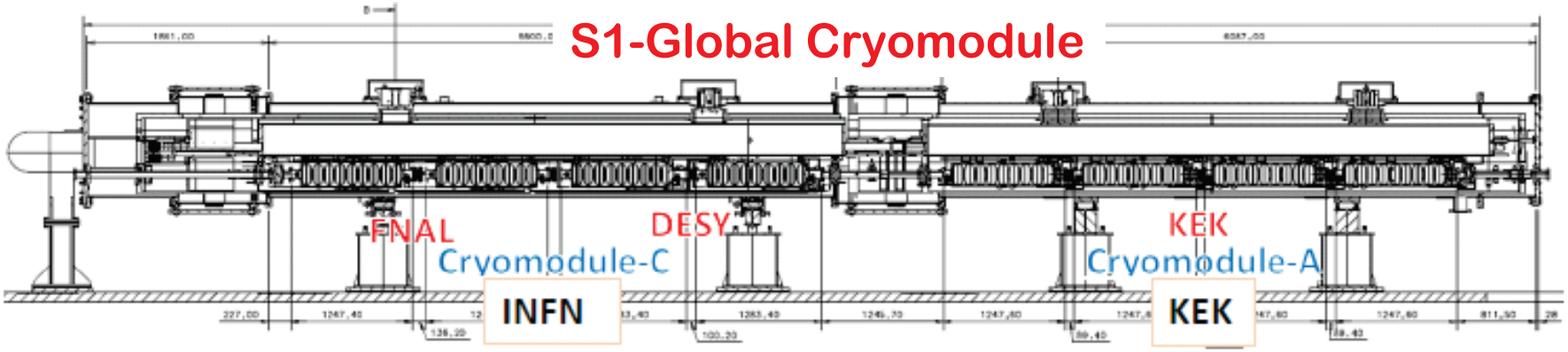
Tuner Performance in S1-G Cryomodule

Eiji Kako (KEK, Japan)
on behalf of S1-Global team

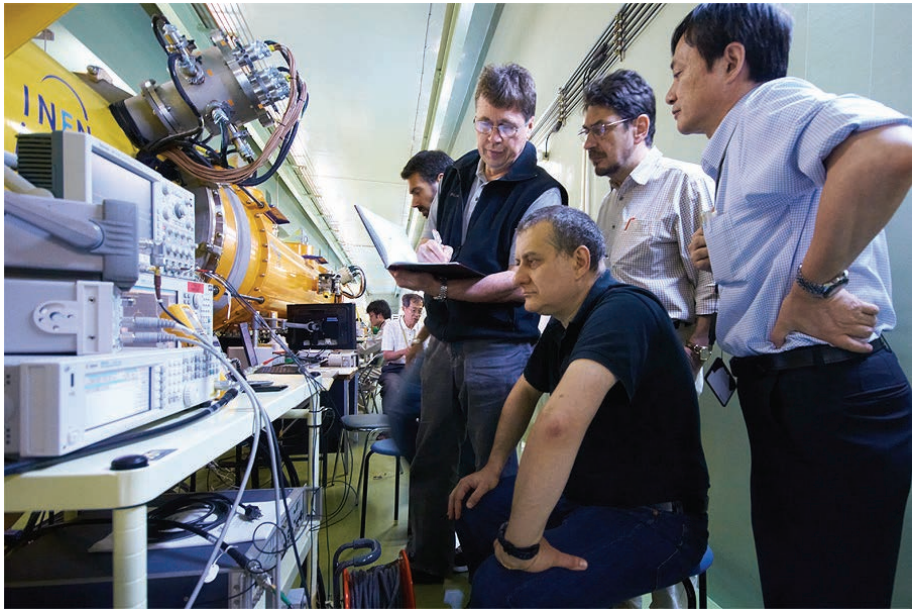
S1-Global Cryomodule



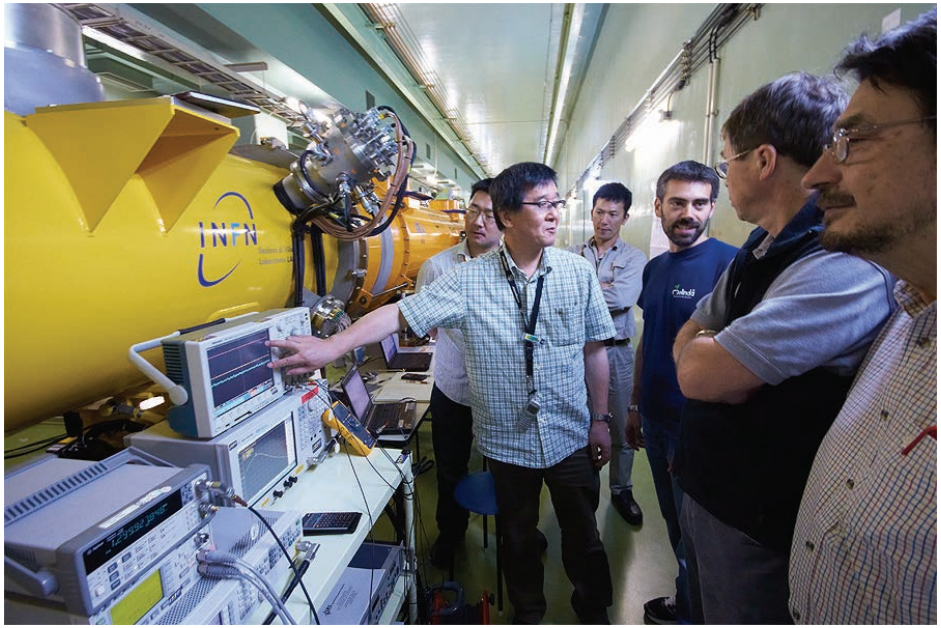


C1	C2	C3	C4	A1	A2	A3	A4
AES004	ACC011	Z108	Z109	MHI-05	MHI-06	MHI-07	MHI-09
FNAL cavity		DESY cavity		KEK cavity			

International Collaboration for tuner tests

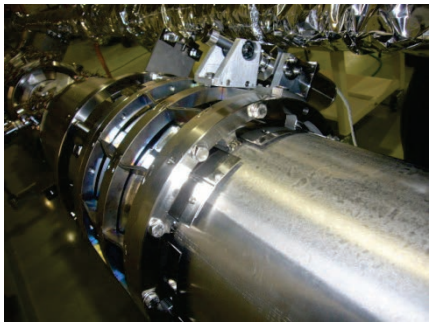


INFN-Milan (Italy)
FNAL (USA)
KEK (Japan)

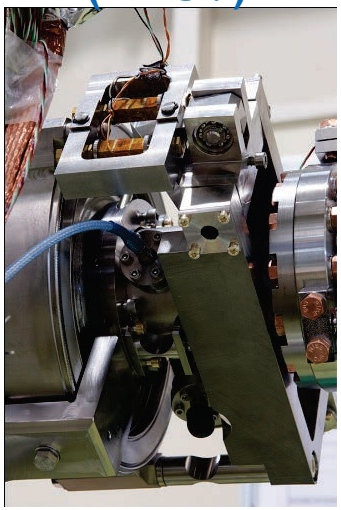


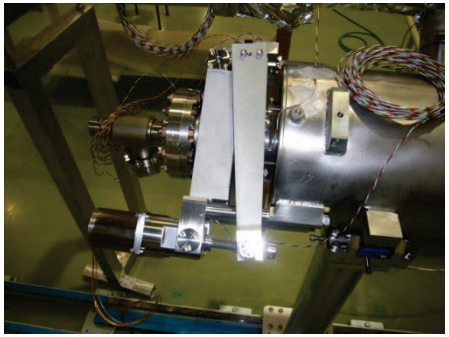
Three Types of Frequency Tuning System

Blade Tuner (INFN/FNAL)

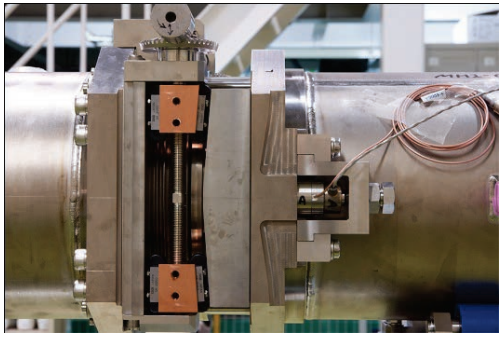


Saclay Tuner (DESY)





Slide-Jack Tuner (KEK)

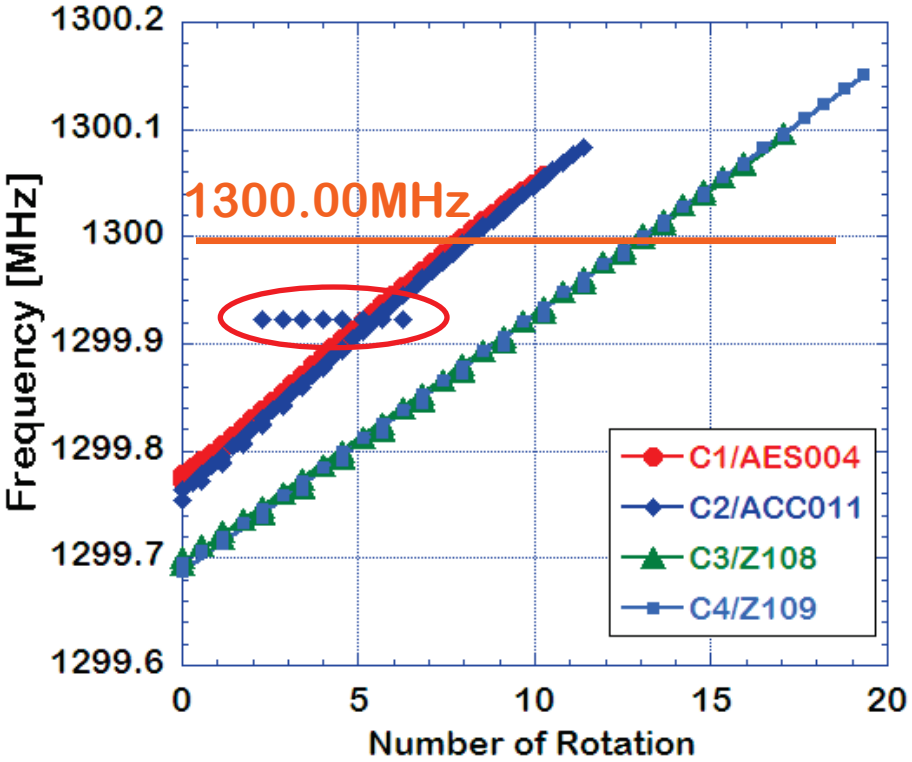


Main Design Parameters of Course Tuners

Parameter	Unit	Blade	Saclay	S. Jack
Range	kHz	600	500	900
Sensitivity @ 1.3 GHz	kHz / turn	25	20	15
	Hz / step	1.5	1	3

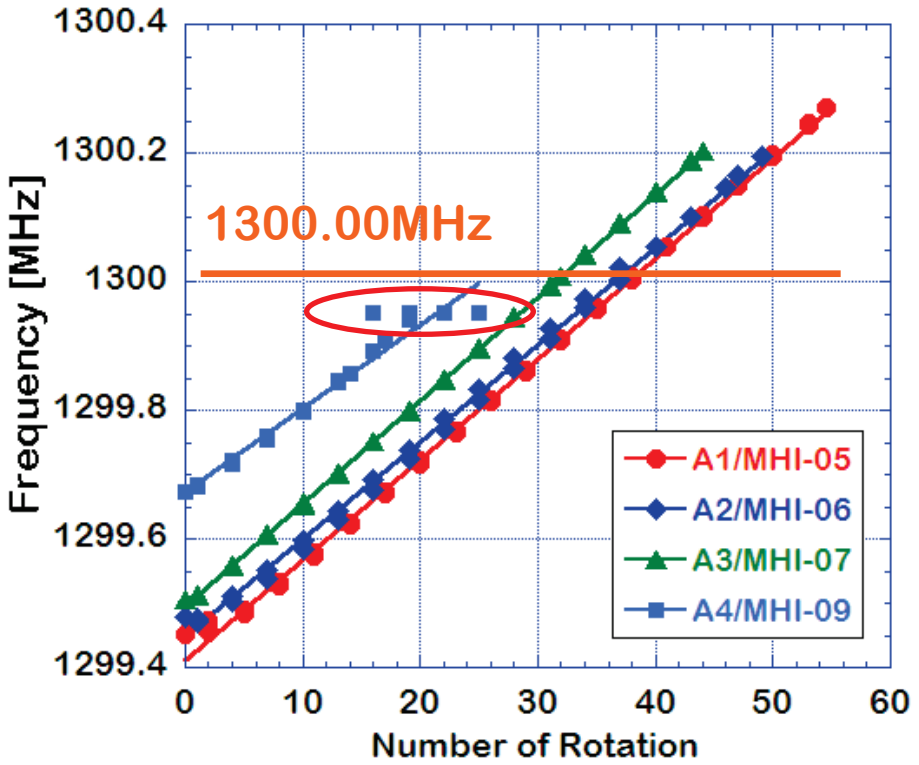
Tuning Stroke of Resonant Frequency

Cryomodule - C



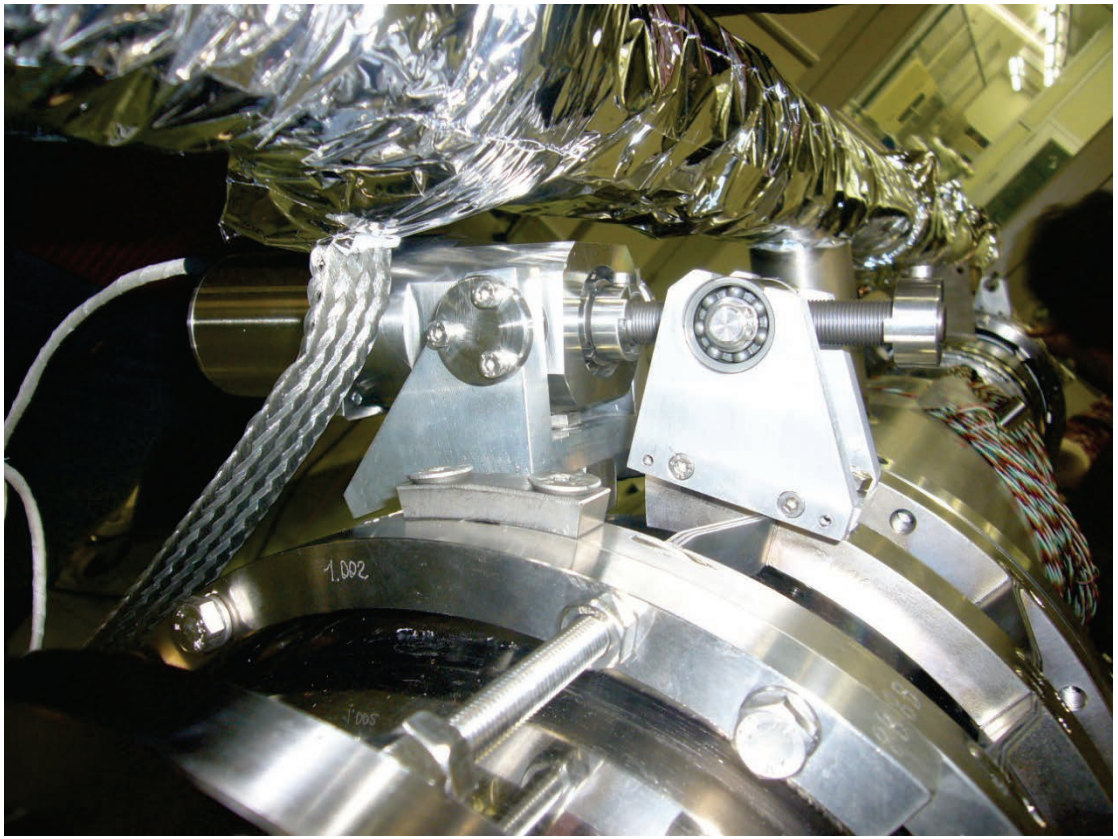
C2/ACC011; Tuner did not work.

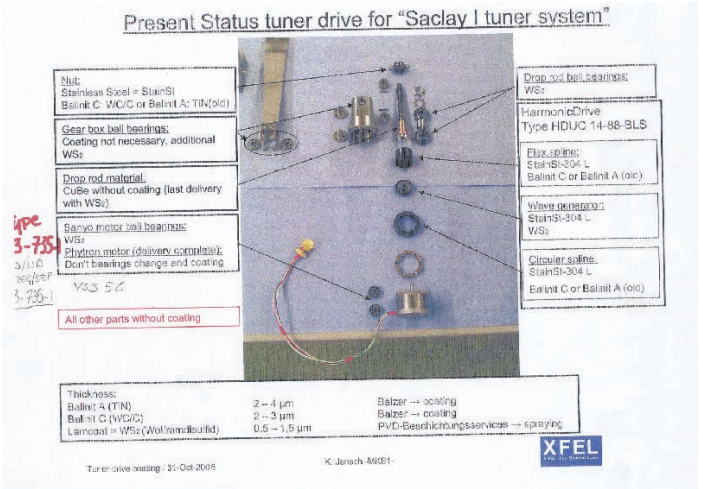
Cryomodule - A

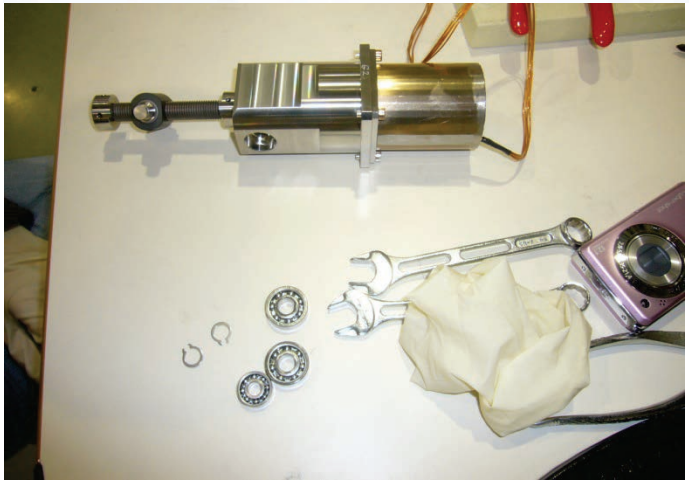


(A4/MHI-09; 1299.91 MHz, limit)

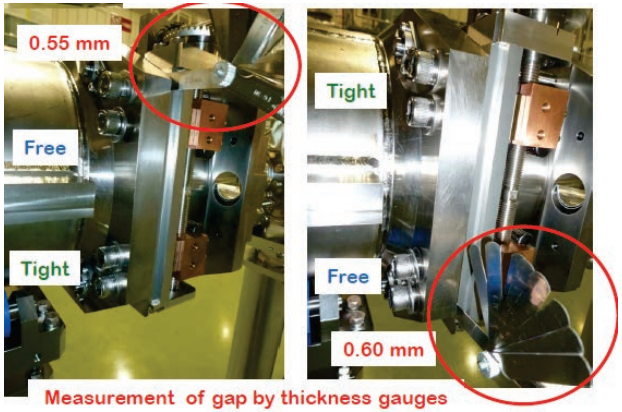
Blade Tuner for FNAL Cavities

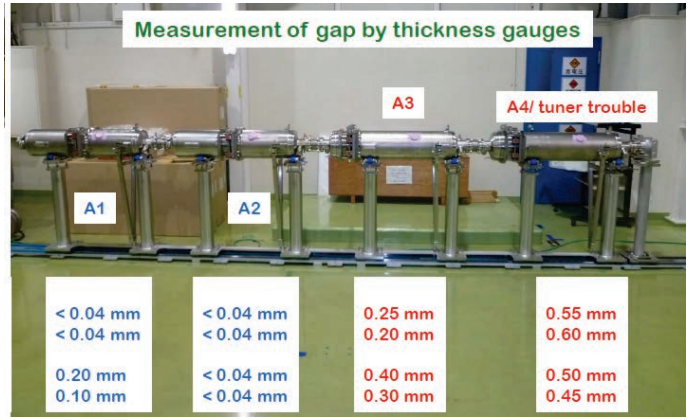


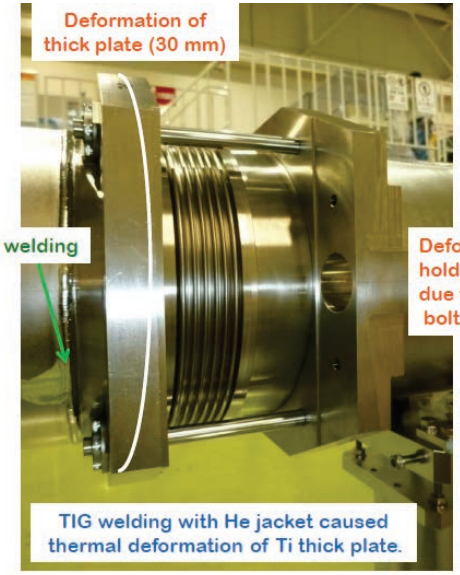


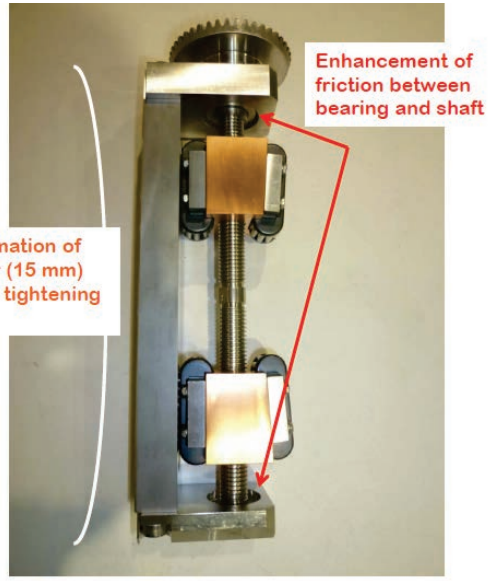


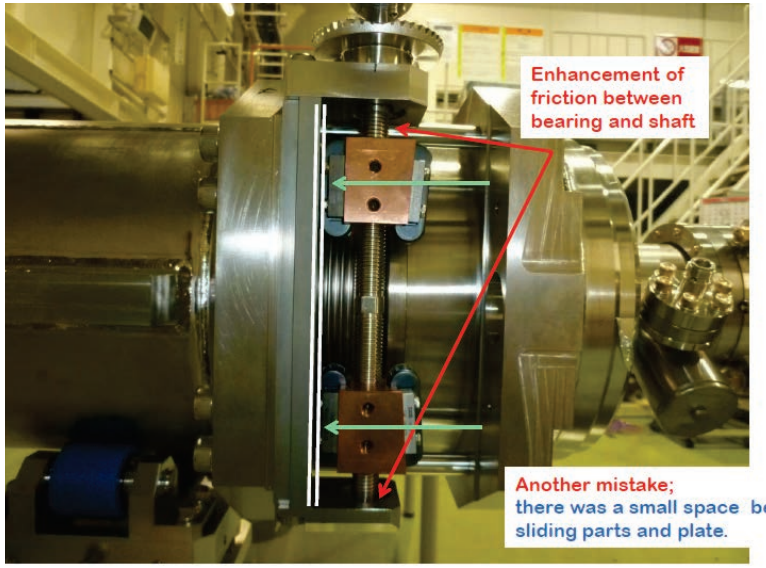
Slide-Jack Tuner for KEK Cavities









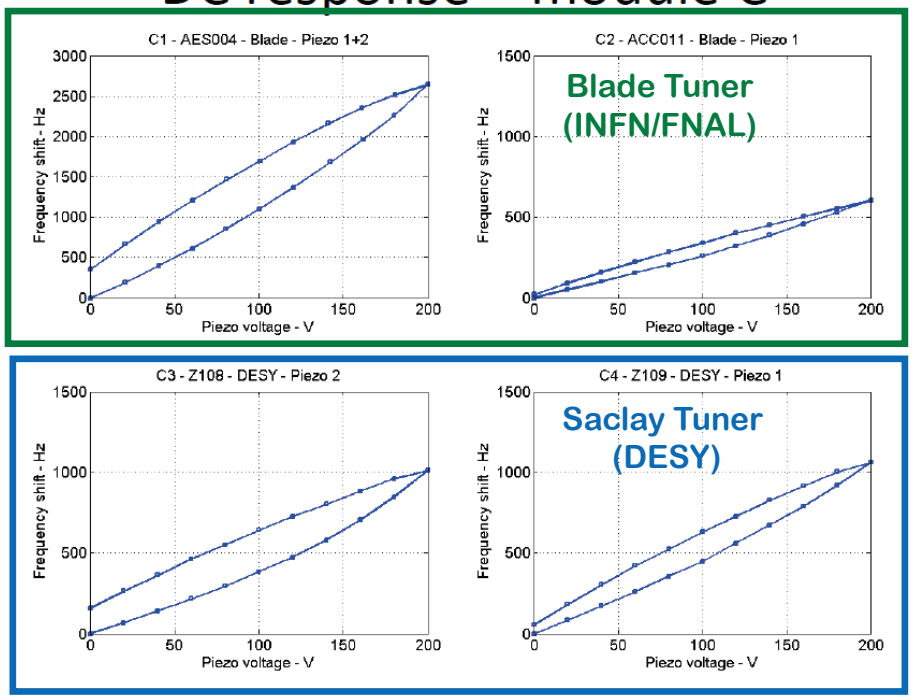


Main Parameters of Piezo Tuners

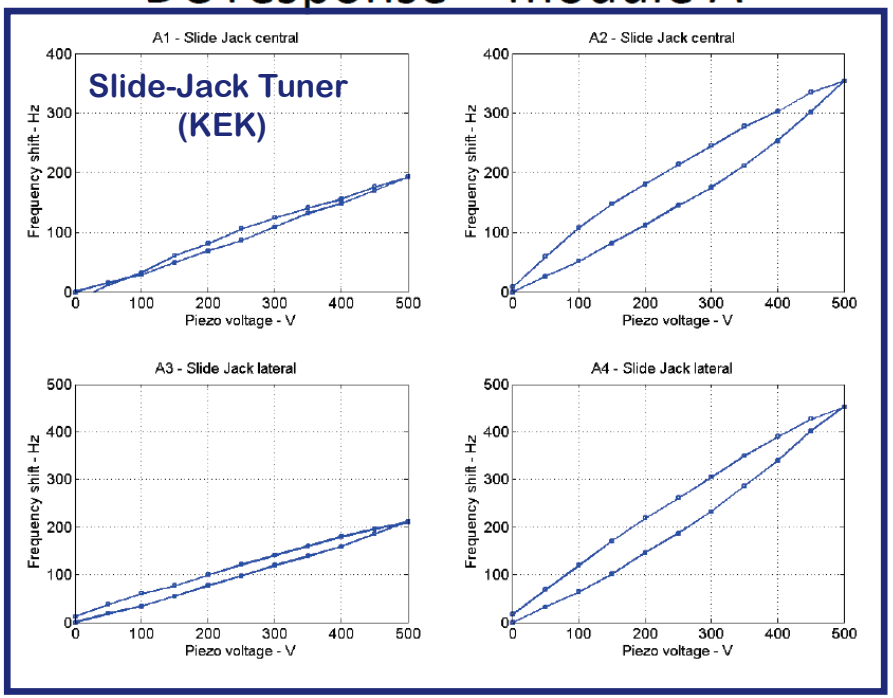
Cavity/Tuner	PZT Max Voltage, Capacitance	Max Static shift	Max dynamic shift	Normalized Ratio
C1-Blade	200 V, 4.1 μF (total pzt 1+2)	2650 Hz @ 200 V	1040 Hz @ 135 V	0.6
C2-Blade	200 V, 3.9 μF (total pzt 1+2)	560 Hz @ 100 V	590 Hz @ 100 V	1.1
C3-DESY	200 V, 2.0 μF (only pzt 2)	1010 Hz @ 200 V	1100 Hz @ 180 V	1.2
C4-DESY	200 V, 1.9 μF (only pzt 1)	1060 Hz @ 200 V	1170 Hz @ 170 V	1.3
A1-S.J cent.	1000 V, 0.19 μF	190 Hz @ 500 V	270 Hz @ 470 V	1.5
A2-S.J cent.	1000 V, 0.21 μF	350 Hz @ 500 V	450 Hz @ 470 V	1.4
A3-S.J lat.	1000 V, 0.20 μF	210 Hz @ 500 V	270 Hz @ 470 V	1.3
A4-S.J lat.	1000 V, 0.21 μF	450 Hz @ 500 V	450 Hz @ 470 V	1.1

Static DC-response by Piezo Tuner

DC response – module C

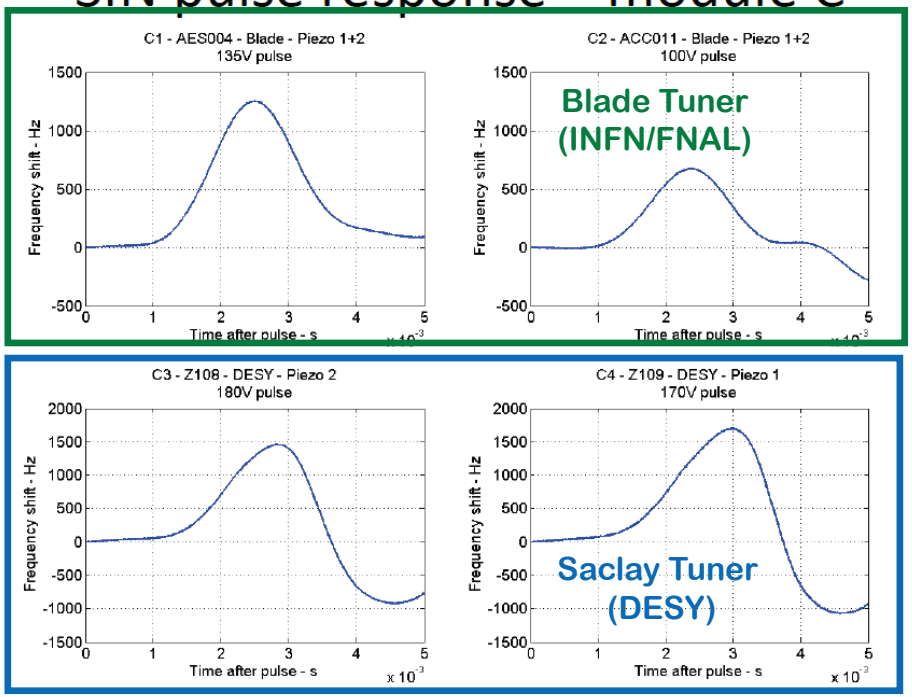


DC response – module A

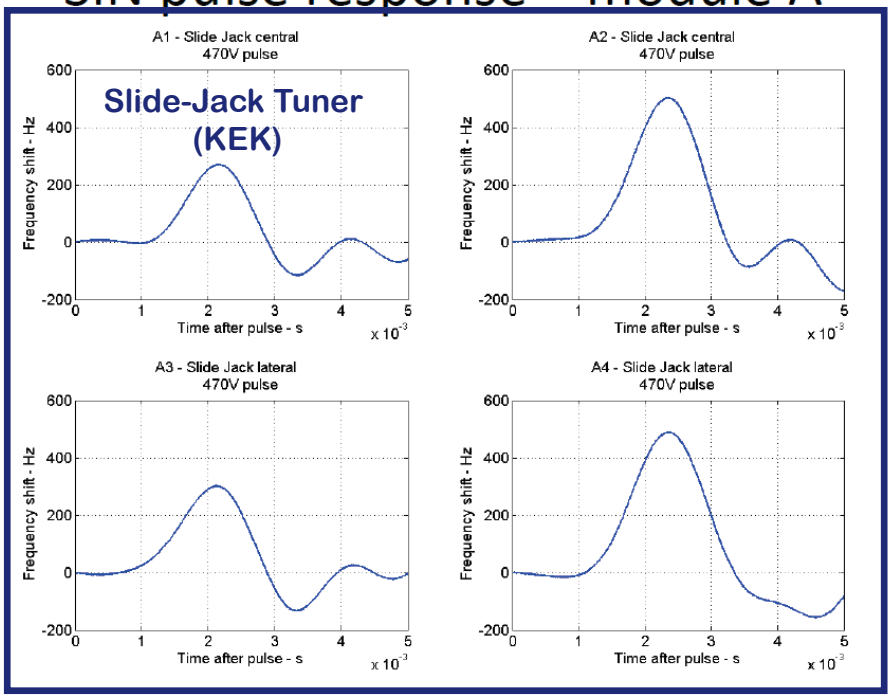


Dynamic Sin-pulse Response by Piezo Tuner (1)

SIN pulse response – module C

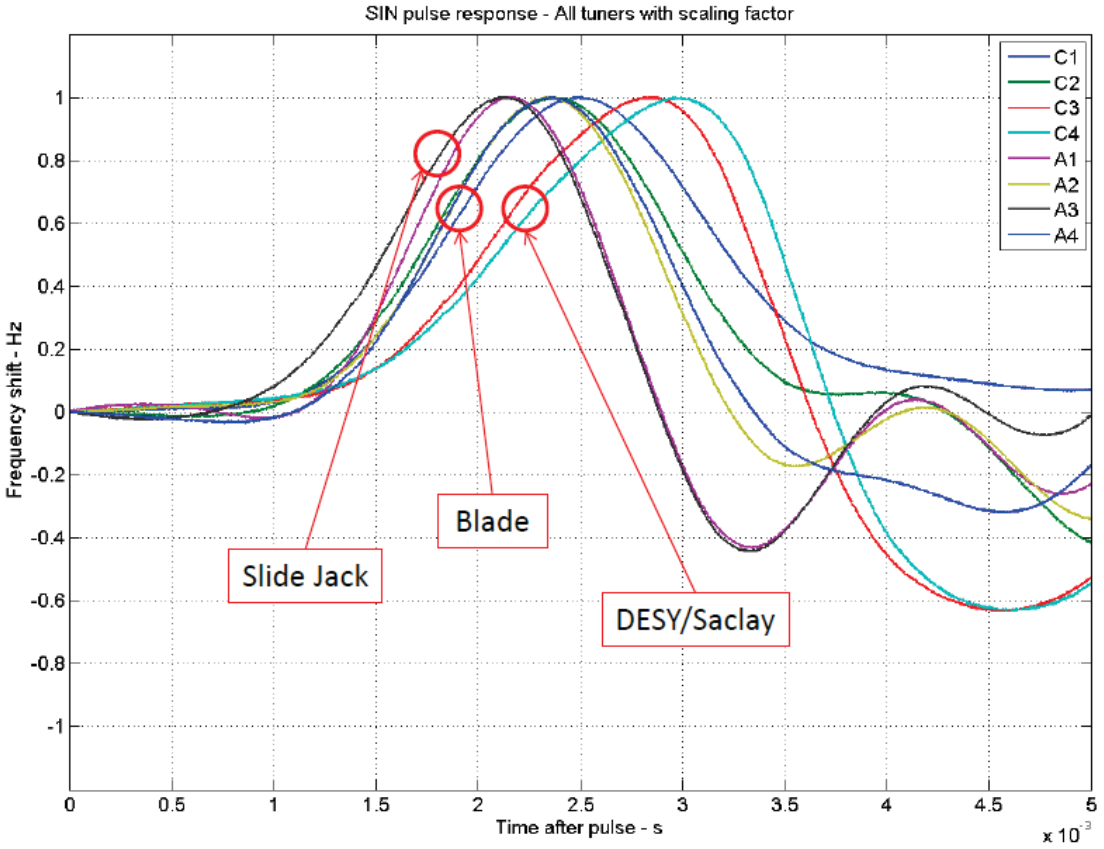


SIN pulse response – module A



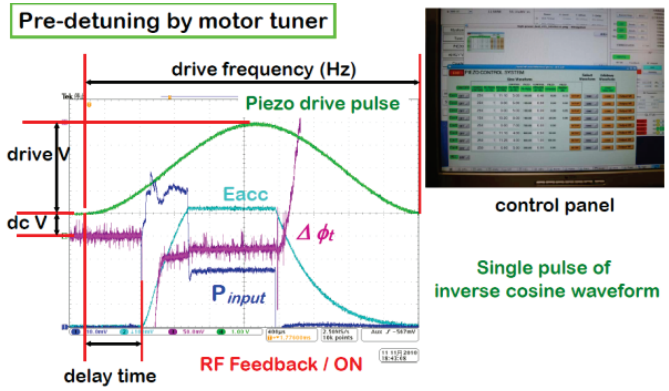
Dynamic Sin-pulse Response by Piezo Tuner (2)

SIN pulse response – All

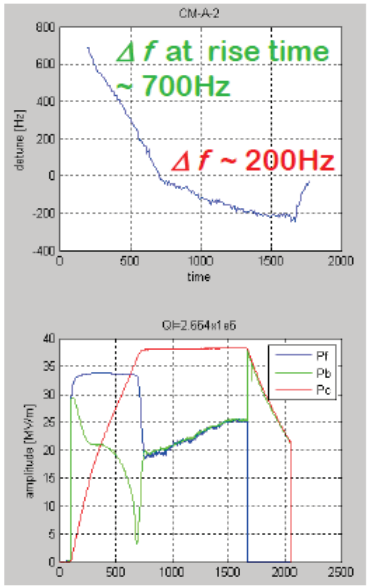


Compensation of Lorentz Detuning by Piezo Tuner (1)

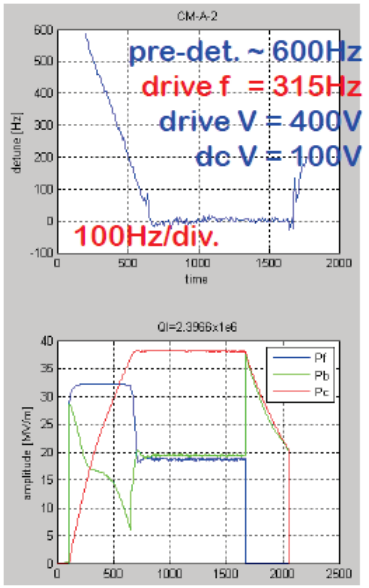
KEK piezo control system



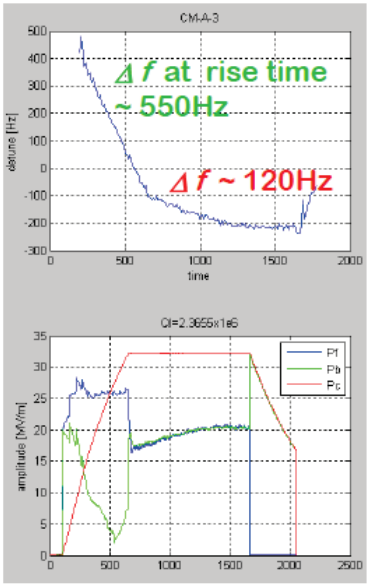
A2/MHI-06
38 MV/m
FB/on, Piezo/off



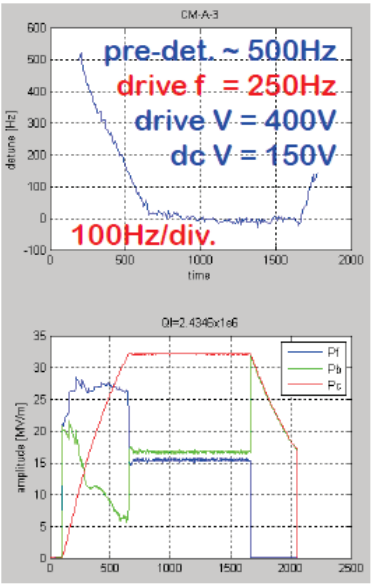
A2/MHI-06 (Slide Jack
38 MV/m
FB/on, Piezo/on



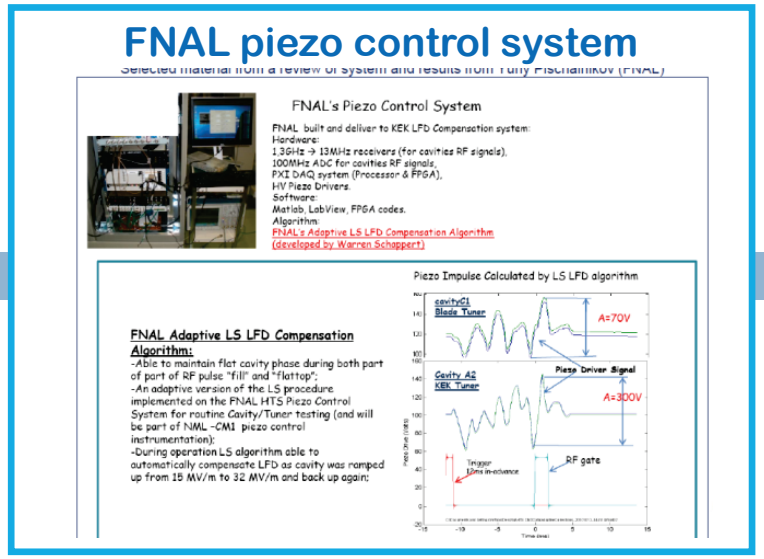
A3/MHI-07
32.5 MV/m
FB/on, Piezo/off

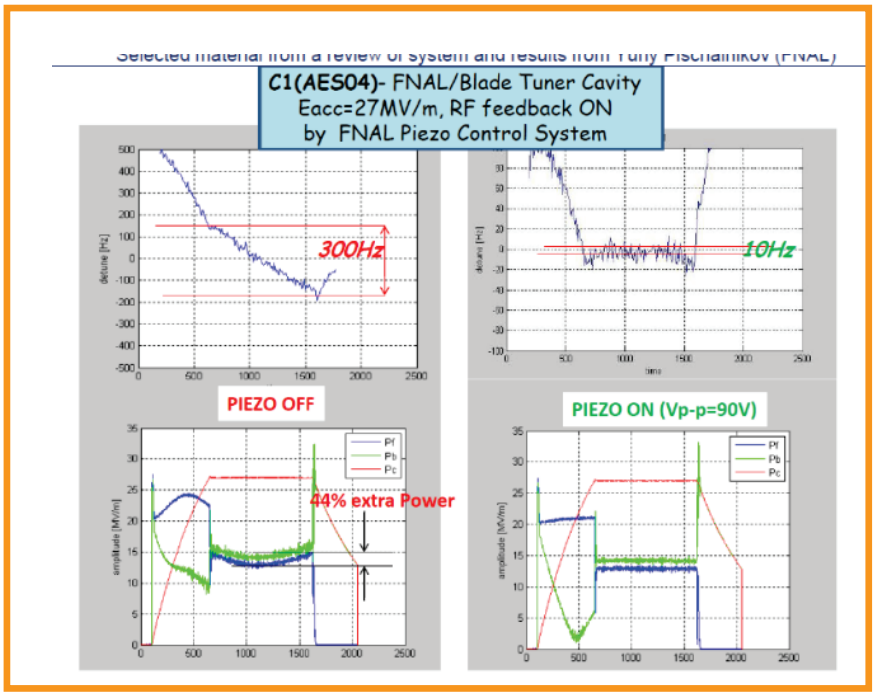


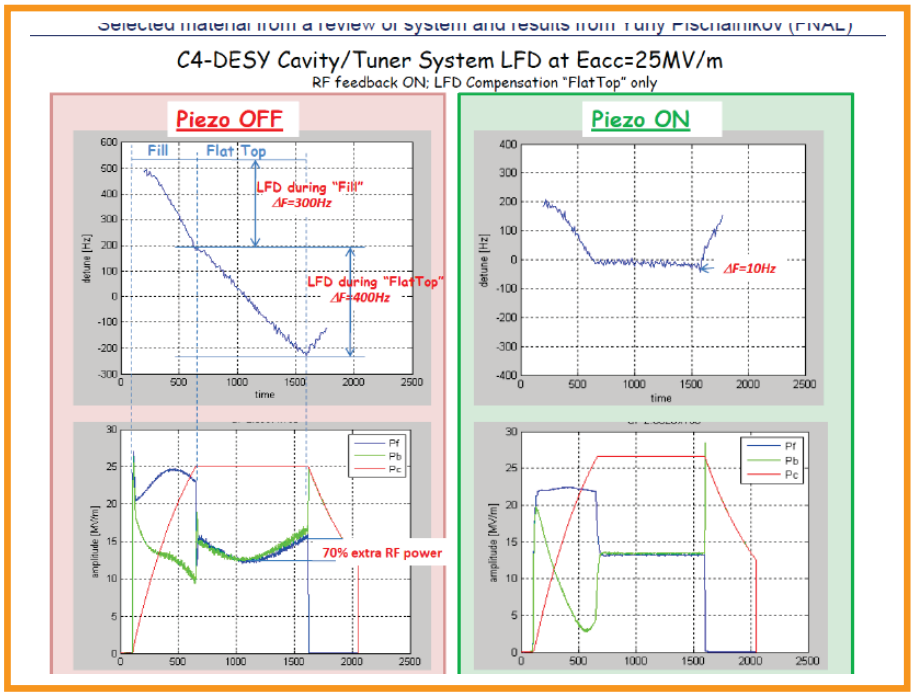
A3/MHI-07 (Slide-Jack)
32.5 MV/m
FB/on, Piezo/on



Compensation of Lorentz Detuning by Piezo Tuner (2)







SUMMARY

- Each of the different types of tuning systems installed in the S1-Global cryomodule proved to be capable to accomplish the main goals.
- Statically cavity tuning with proper resolution to the target frequency was confirmed.
- Pulsed operation at maximum gradient with an active compensation of the Lorentz force detuning up to tens of Hz-level residual detuning was achieved.
- Enough performance margin in Lorentz force detuning compensation in view of ILC-level target gradients was demonstrated.