Cryomodule Tests in STF Phase-1.0

(Four Tesla-like Cavities)

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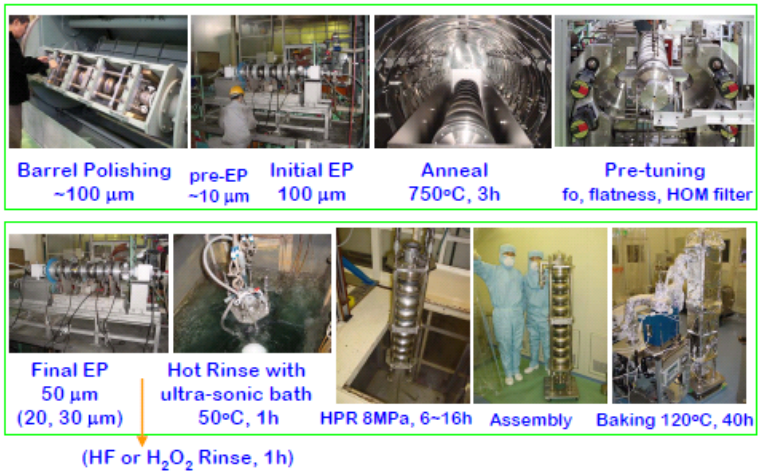
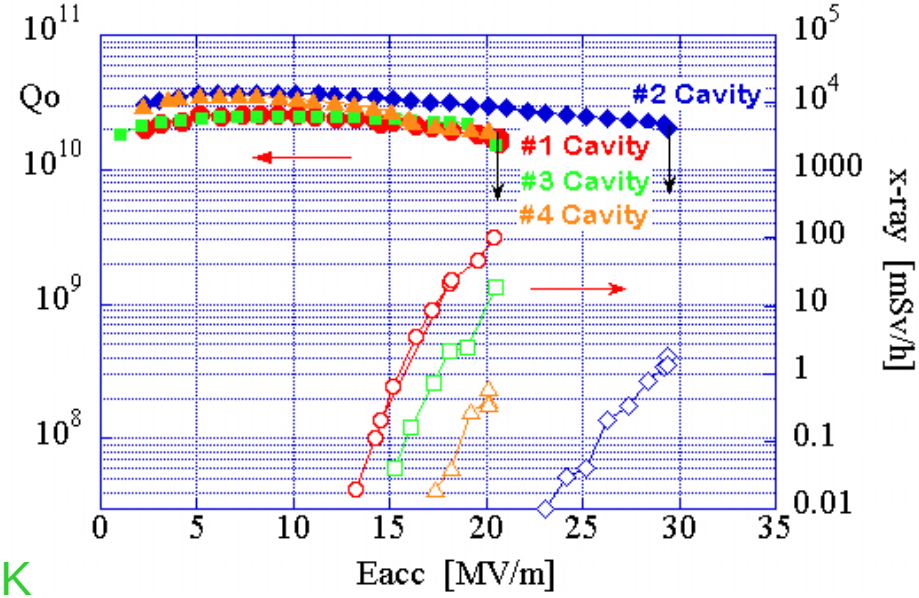
Outline

- Cryomodule Assembly for STF Phase-1.0
- Processing of Input Couplers
- Mechanical Tuner Performance
- High Field Performance
- Lorentz Force Detuning
- Piezo Tuner Performance
- Mechanical Vibration Modes
- Summary

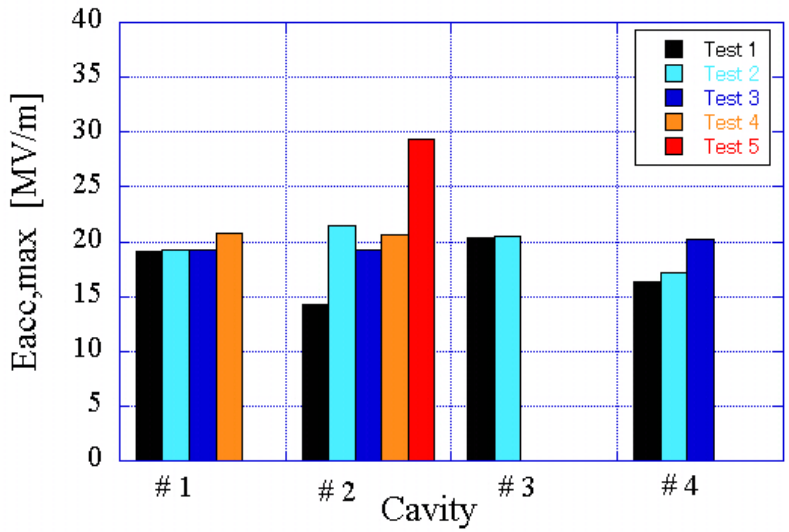
Vertical Tests of STF-BL#1, #2, #3, #4 Cav.





Surface treatment at Nomura Co.

Assembly & Vert. tests in AR-East at KEK



14 tests for 1year (Feb. 2006 ~Feb. 2007)

March, 2007’

String Assembly in Clean Room

Class 10

Class 1000 to Outside

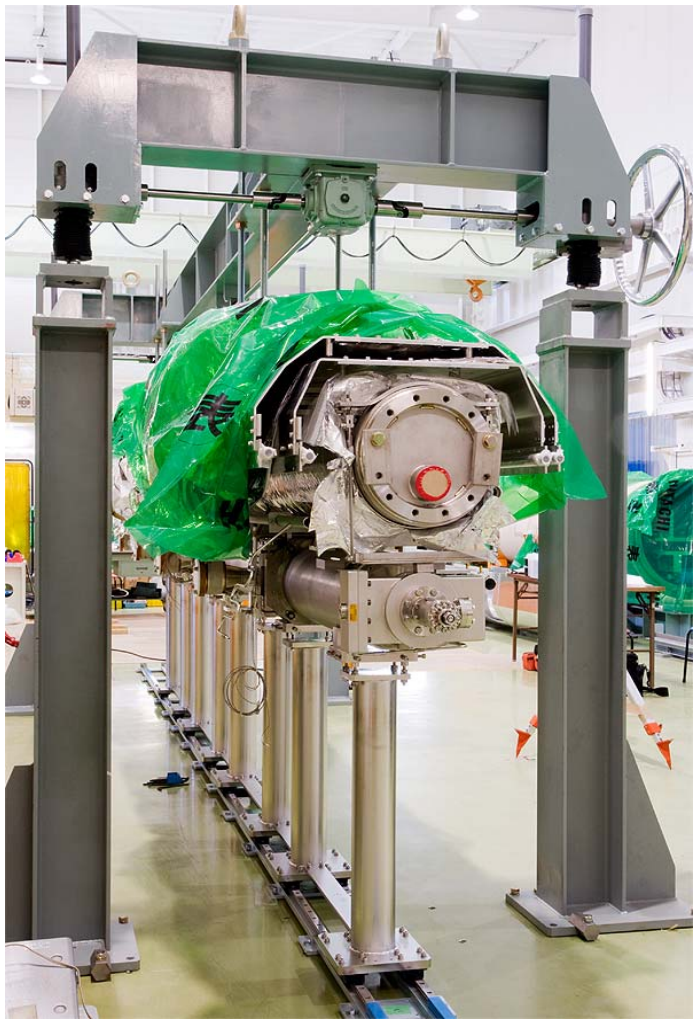
January, 2008’

Alignment of Four Cavities

February , 2008’

Cryomodule Cold Mass Assembly

February ~ March, 2008’



Installation in the STF Tunnel

First cool-down, May, 2008’
Warm couplers, June, 2008’

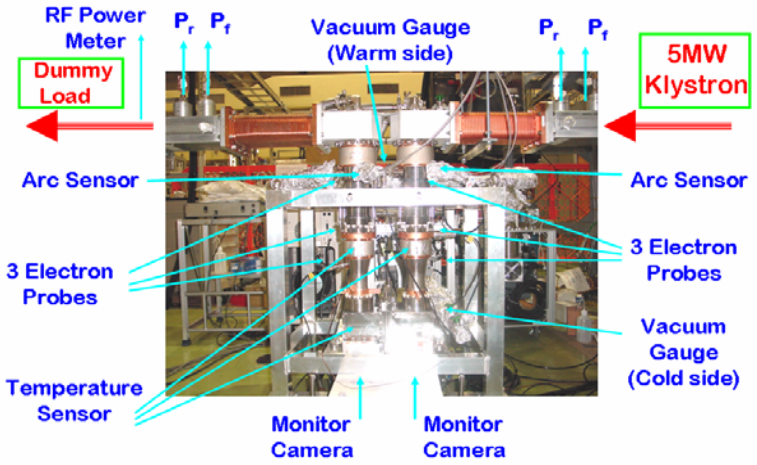
August, 2008’
High power RF distribution system

High power tests of
#2 cavity (29.4 MV/m in V.T)
July, 2008

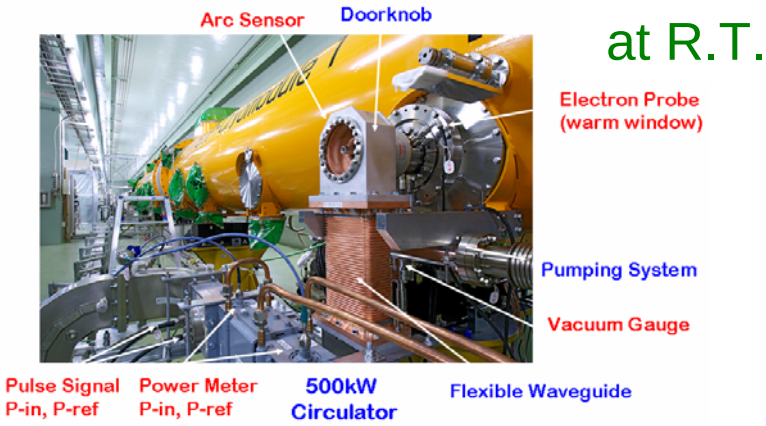
High power tests of #1, #3, #4 cavity
Operation with four cavities
Sept. ~ Dec. , 2008

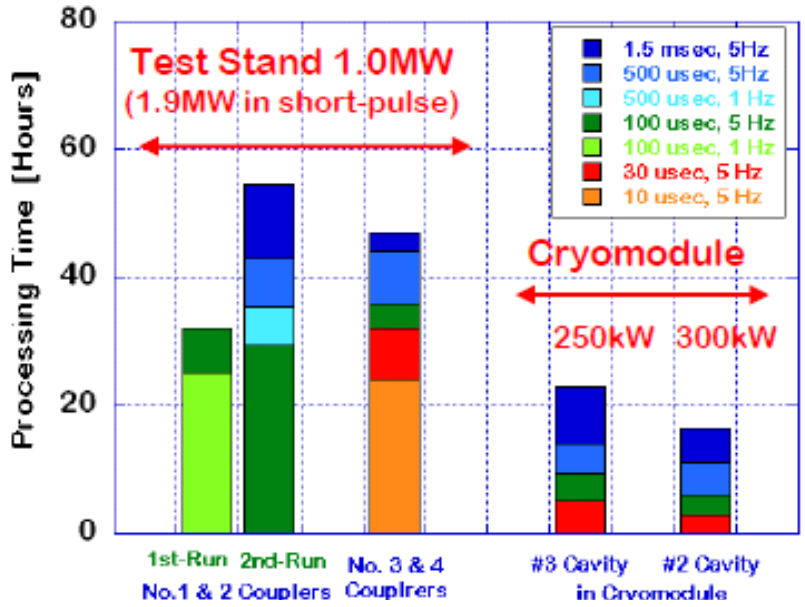
Processing of Input Couplers in STF Phase-1.0

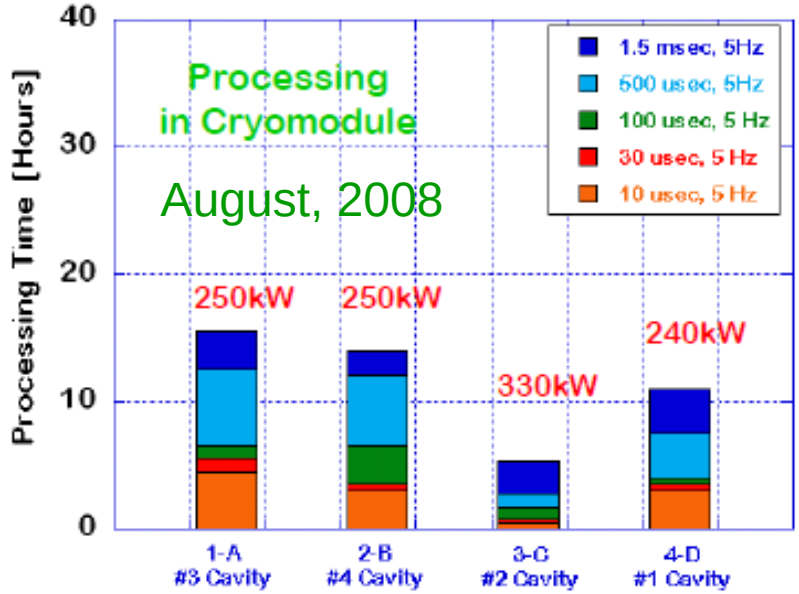
Processing in Test Stand



Processing in Cryomodule at R.T.







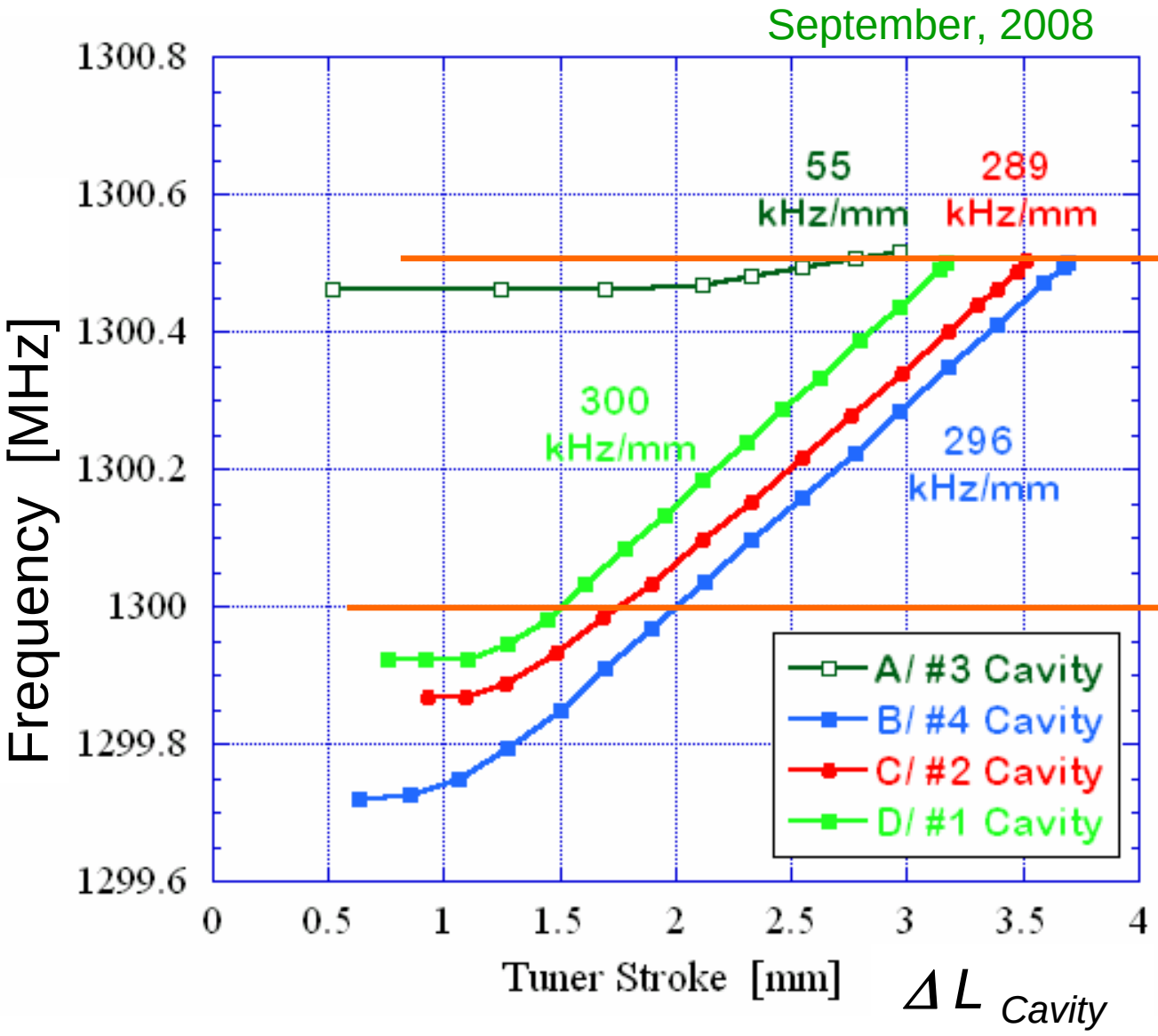
Purpose of Cryomodule Tests in STF Phase-1.0

. To check the performance as a total sc cavity system;
(Finding out the improvement points)

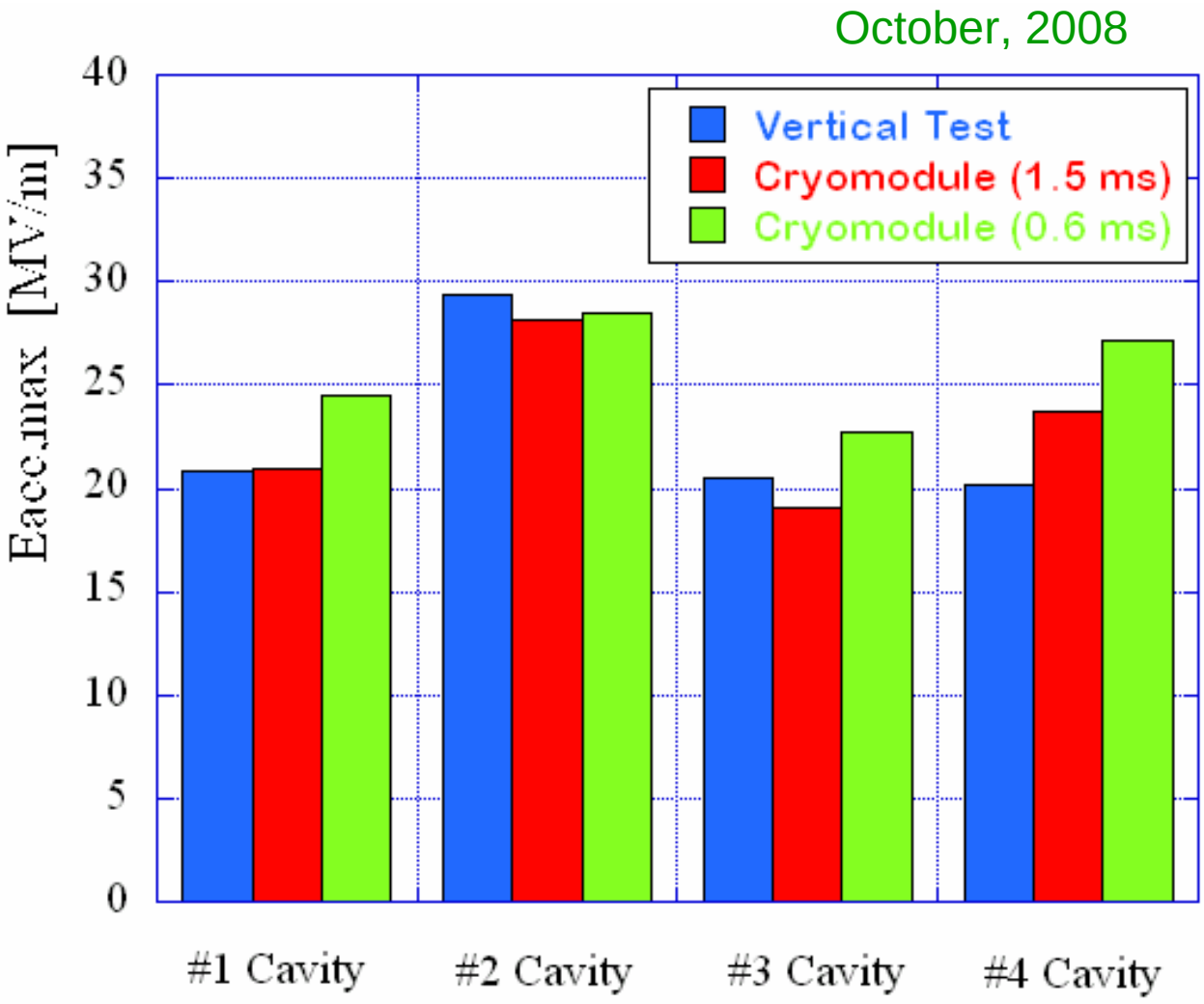
. To confirm a stable pulsed operation at higher fields;
(Comparison of Eacc,max between V.T & Cryo.)

. To demonstrate the compensation of
Lorenz force detuning by a piezo tuner;
(Effectiveness of a stiff cavity support structure)

Tuner Stroke in STF Phase-1.0



Comparison of achieved Eacc,max



5 Hz
5 Hz

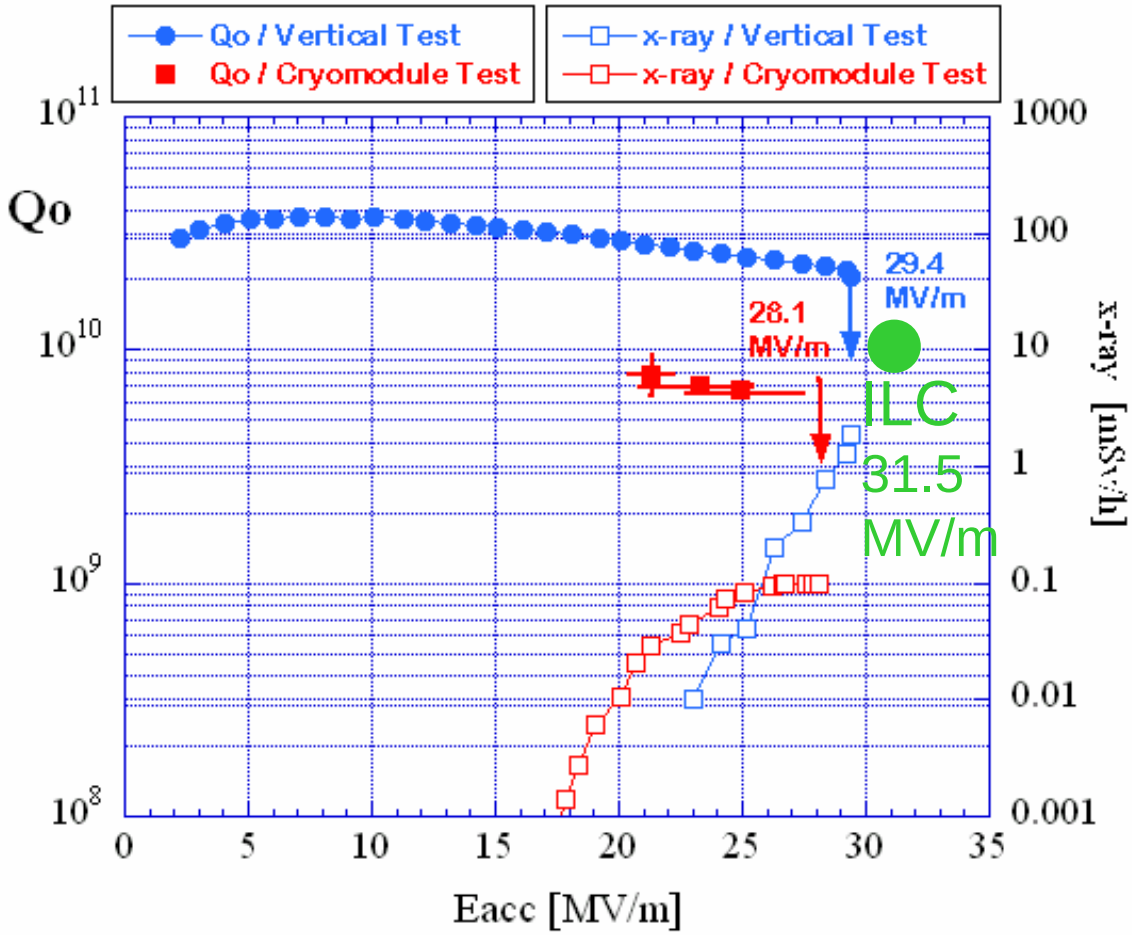
Ave. Eacc,max (V.T)
= 22.7 MV/m

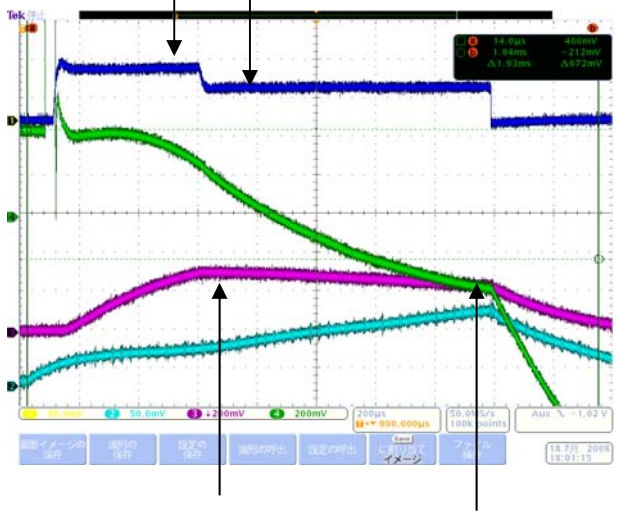
Ave. Eacc,max (Cryo.)
= 23.0 MV/m

Expectation of operational ave. Eacc
= 23 / 1.1 = 21 MV/m

Beam Energy Gain
= 21 x 4 = 84 MeV

Qo - Eacc in #2 Cavity ;
Dynamic rf loss measurement





Ave. 24.9 MV/m
Duty = 0.83 %
Static loss = 9.9 W
RF loss = 0.8 W
Qo = 6.8 E+9

No Compensation
No RF Feedback

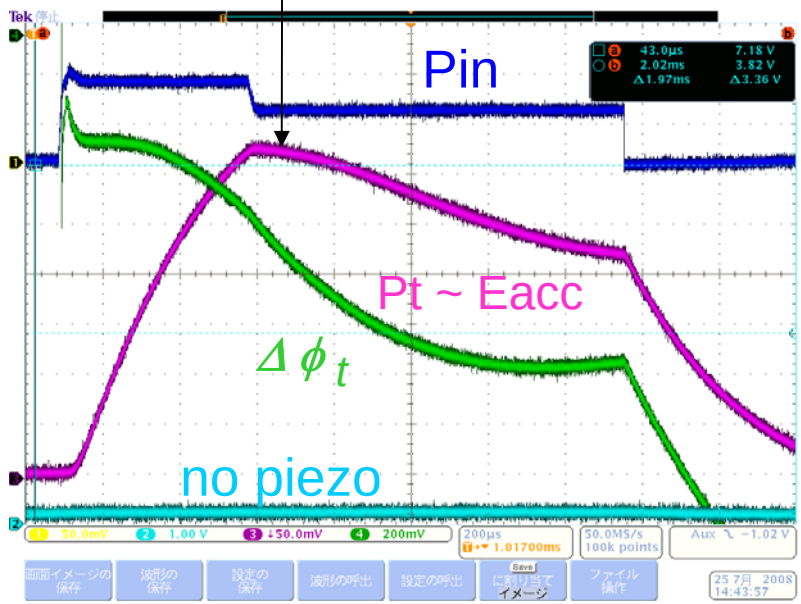
Stable Pulsed Operation ; STF Phase-1.0

July, 2008’

Best Result ; obtained Eacc,max in #2 Cavity

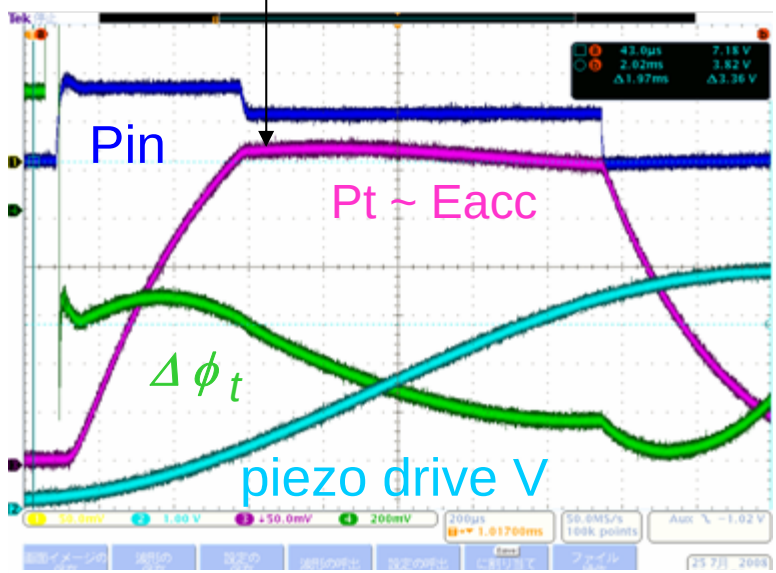
1.5 msec, 5 Hz operation

No compensation
28.1 MV/m



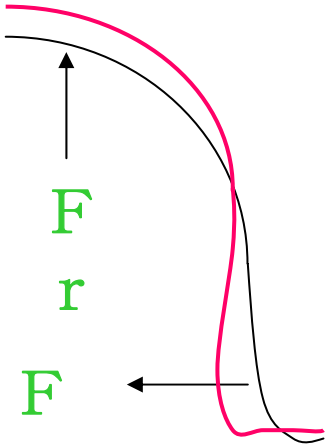
f = 1300.500000 MHz

Compensation by
Piezo and Pre-detuning
28.1 MV/m



Pre-detuning, Δf_D = +200 Hz
Piezo, 250 Hz, 500 V, -0.2 ms

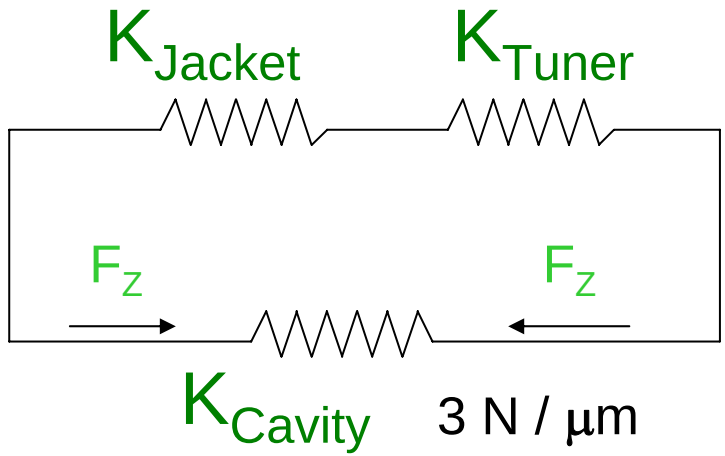
Stiffness of STF-BL Cavity-Tuner System



Lorentz Force Detuning

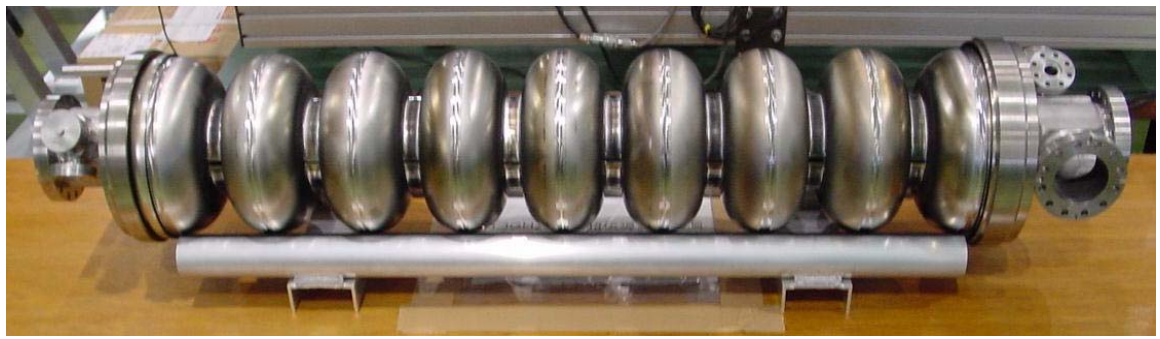
95 N / μm
(endplate, cylinder, flange)

290 N / μm
(slide-jack, piezo)

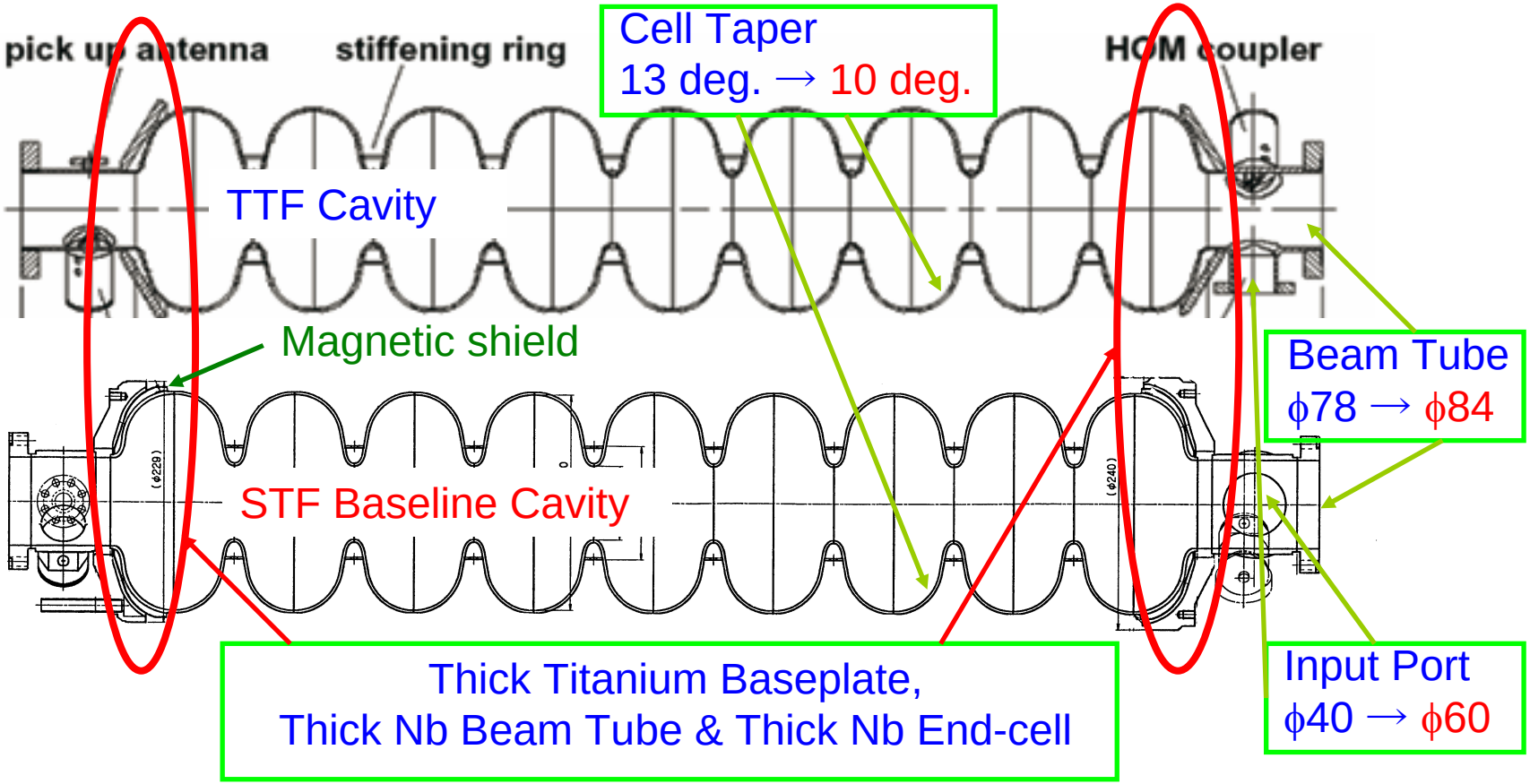


$$\frac{1}{K_S} = \frac{1}{K_{Jacket}} + \frac{1}{K_{Tuner}}$$

K_S = 72 kN / mm



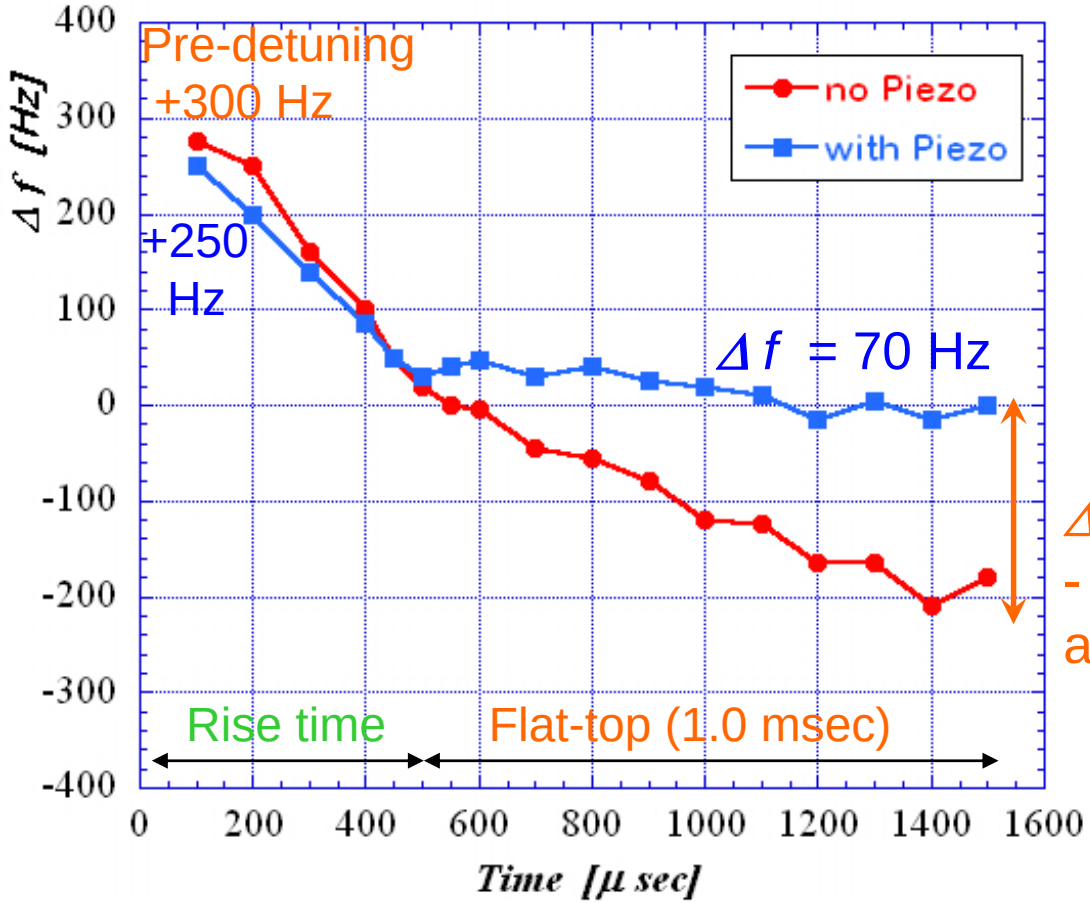
STF Baseline Cavity ; Improved Stiffness

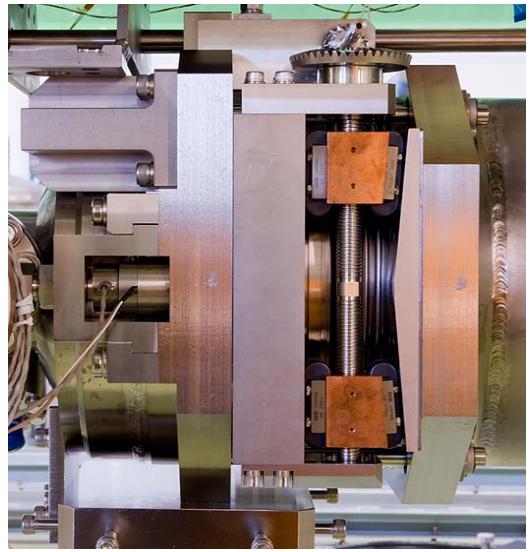


	STF Baseline Cavity	TTF Cavity	
Stiffness of Cavity Sys.	72 kN/mm	22 kN/mm	
Lorentz Detuning at flat-top	Δf = - 150 Hz	Δf = - 500 Hz	Estimation at 31.5 MV/m

Lorentz force detuning in STF Phase-1.0

STF-BL#2 Cavity, Eacc = 26 MV/m





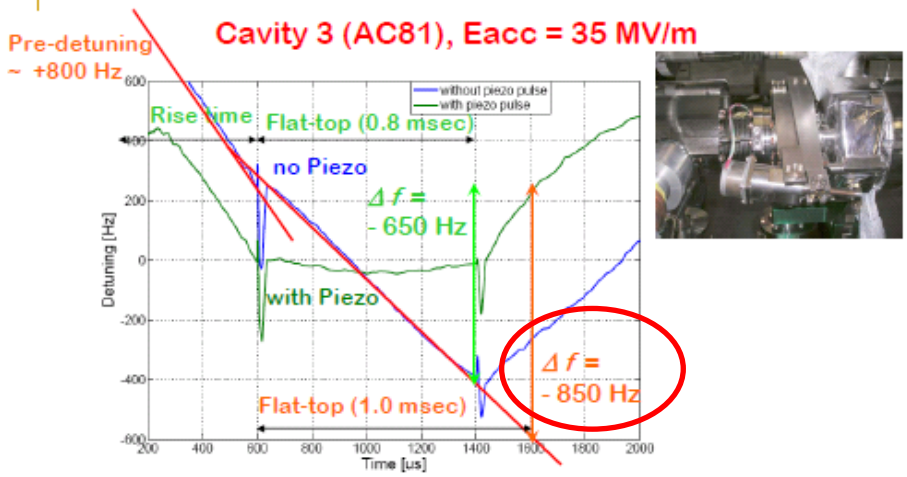
$\Delta f \propto Eacc^2$

Δf = - 300 Hz (Eacc = 31.5 MV/m, Flat-top = 1.0 msec)

Lorentz force detuning in TTF Cavities with a different tuner system

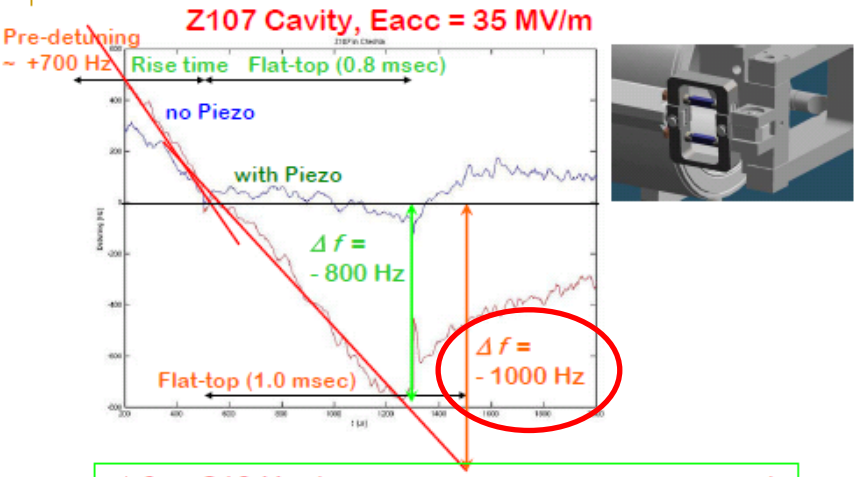
Δf at Eacc = 31.5 MV/m, Flat-top = 1.0 msec

Saclay Tuner tested in Module 6 (by L. Lilje)



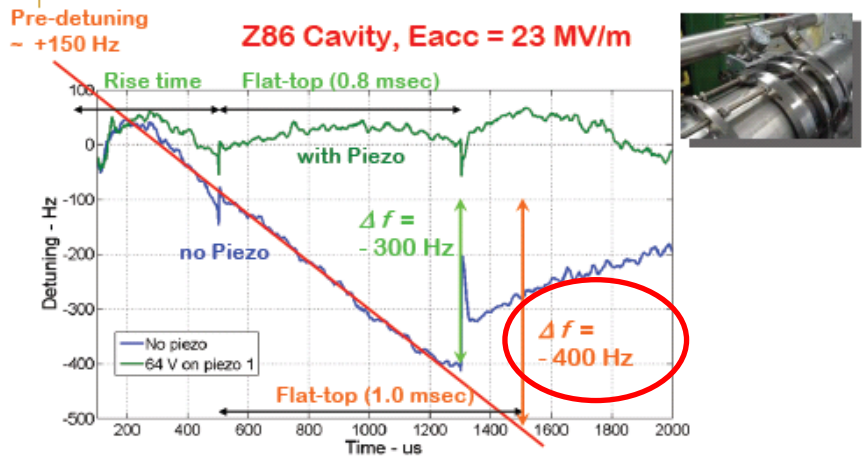
Δf = - 690 Hz (Eacc = 31.5 MV/m, Flat-top = 1.0 msec)

Saclay Tuner tests for XFEL (by L. Lilje)



Δf = - 810 Hz (Eacc = 31.5 MV/m, Flat-top = 1.0 msec)

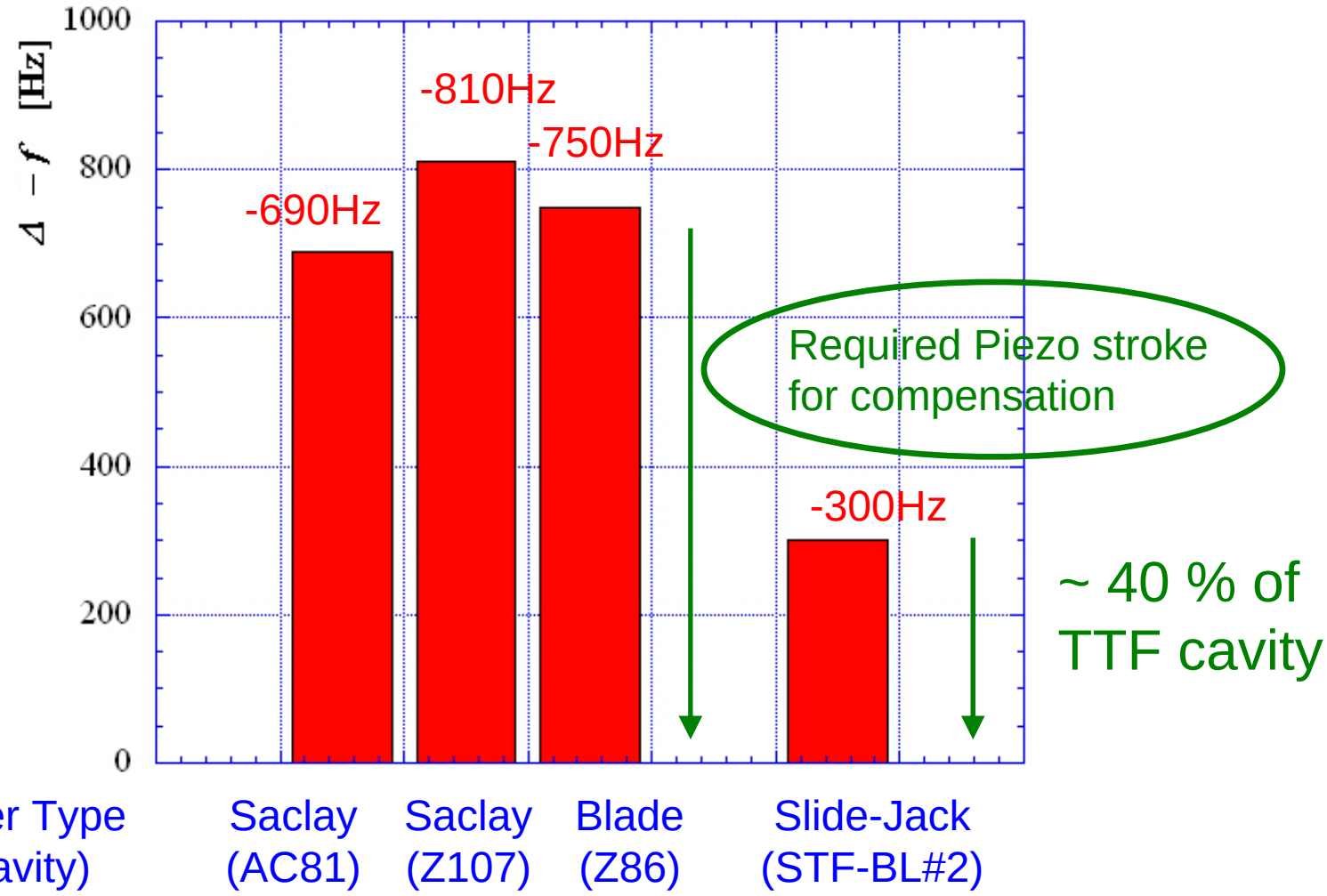
Blade Tuner tested in CHECHIA (by L. Lilje)



Δf = - 750 Hz (Eacc = 31.5 MV/m, Flat-top = 1.0 msec)

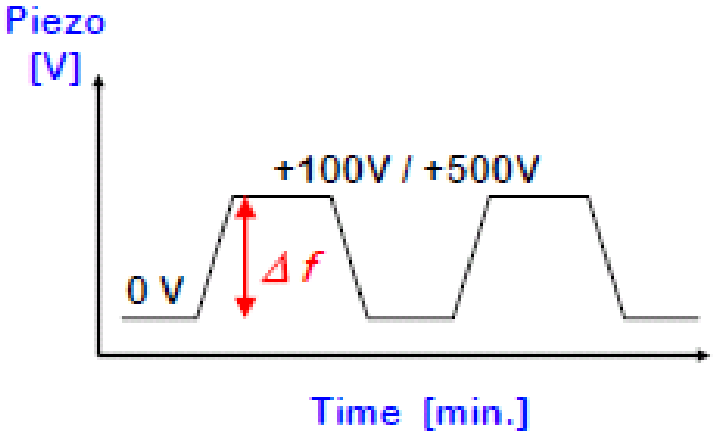
Comparison of Lorentz force detuning

Δf at Eacc = 31.5 MV/m and Flat-top = 1.0 msec

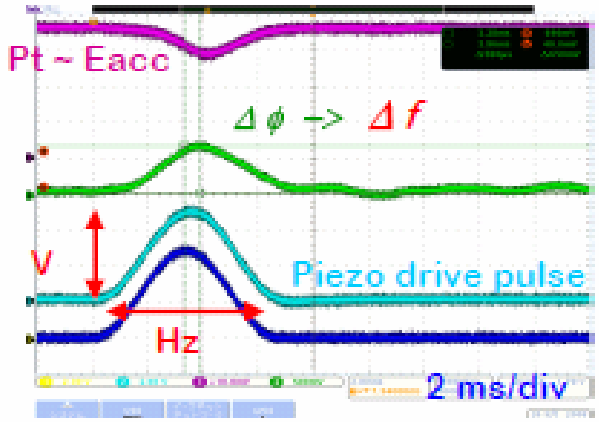


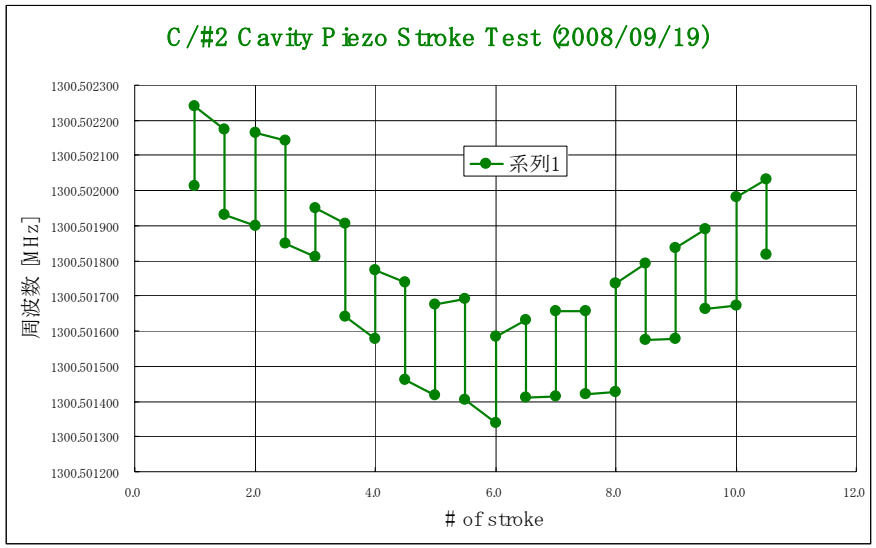
Piezo tuner performance in STF Phase-1.0

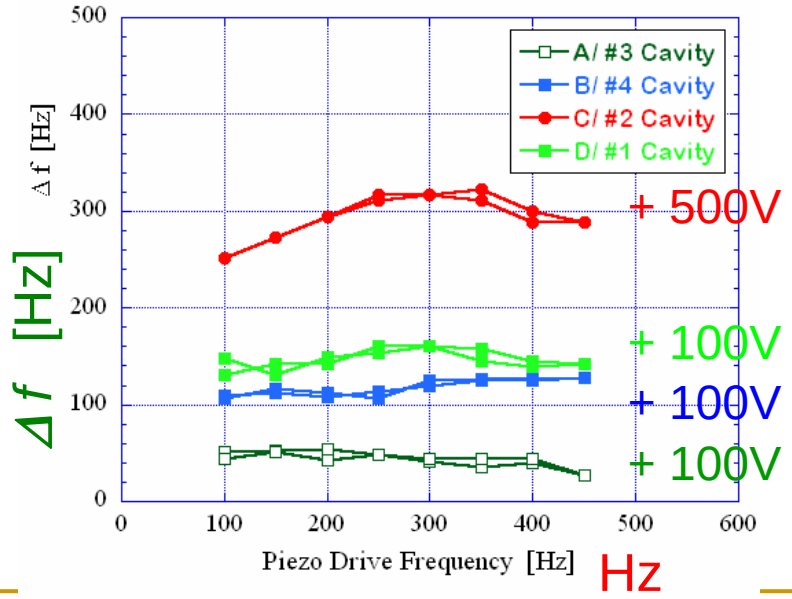
1. Static Stroke



2. One Pulse Response



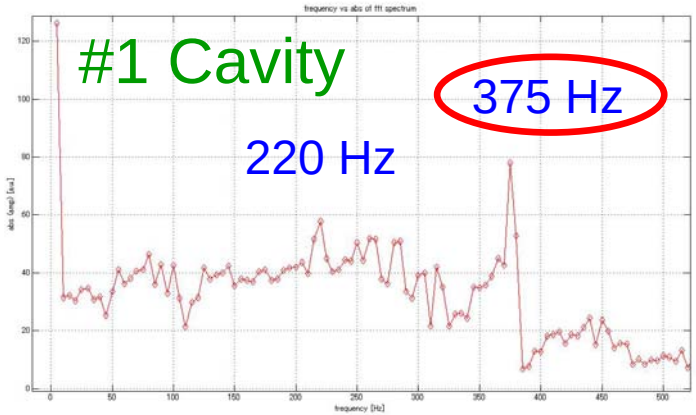


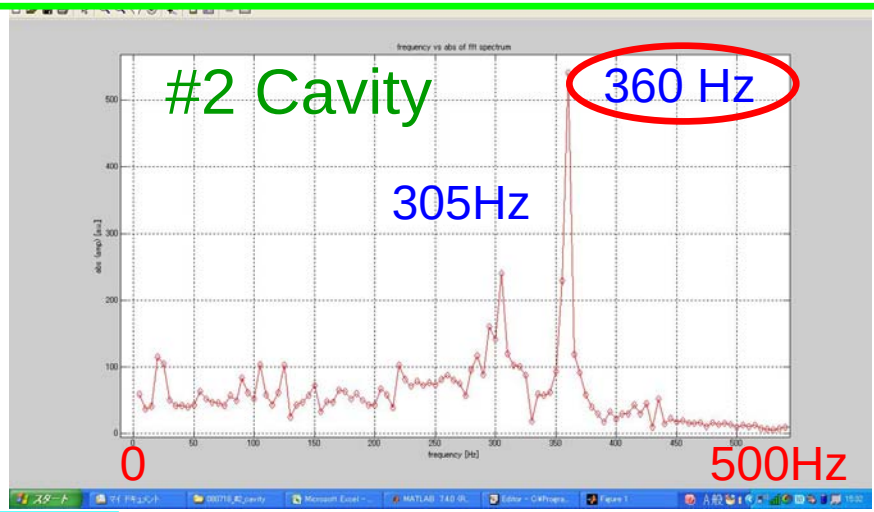


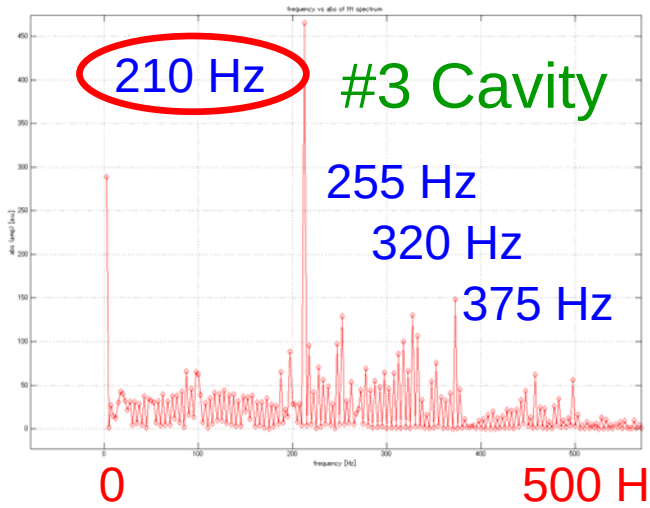
$\Delta f_{ave.}$ = 247 Hz

Mechanical Vibration Modes in STF Phase-1.0

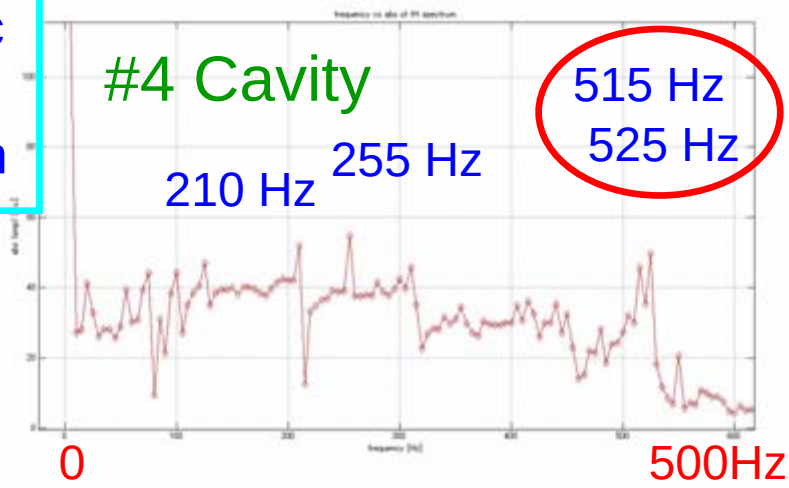
Simulation ; 0. 54 Hz, 1. 204 Hz, 2. 376 Hz, 3. 548 Hz







1.5 msec
5 Hz
operation



Summary

- A stable pulsed operation at high fields was confirmed in four cavities.
- No degradation of the Eacc,max was observed in the cryomodule tests.
- Compensation of Lorentz force detuning was successfully demonstrated at 28 MV/m by a piezo tuner and pre-detuning.
- Four cavity operation by vector-sum is scheduled in the next month.

Thank you for your attention.

The END.