Cryomodule Tests in S1-Global

International Collaboration
DESY-FNAL-INFN-SLAC-KEK

International Team for S1-Global

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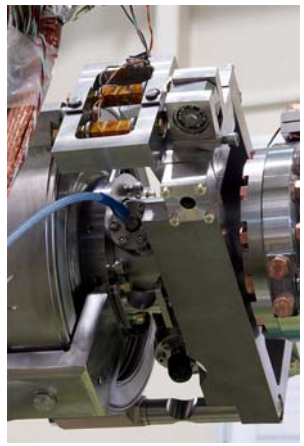
Outline

- Schedule of high power tests
- Coupler processing at room temp.
- Adjustment of fo & QL
- Cavity conditioning for high gradients
- Experiments of Lorentz force detuning
- Schedule in Nov. and Dec.
- Summary

Main components in S1-G cryomodule

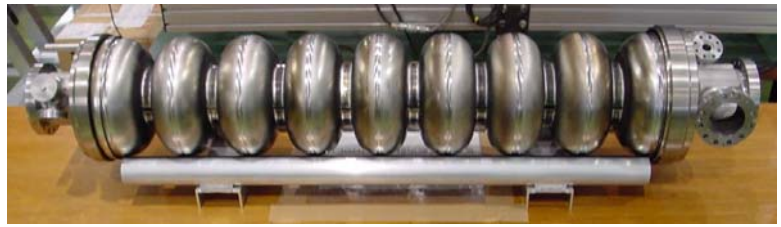
TESLA Cavity (DESY/FNAL)

Blade Tuner (FNAL)

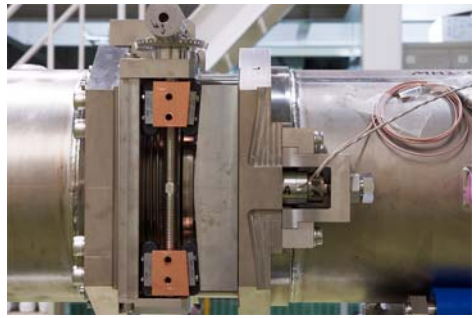


Saclay Tuner (DESY)

TTF-III Coupler (DESY/FNAL)



Tesla-like (KEK)

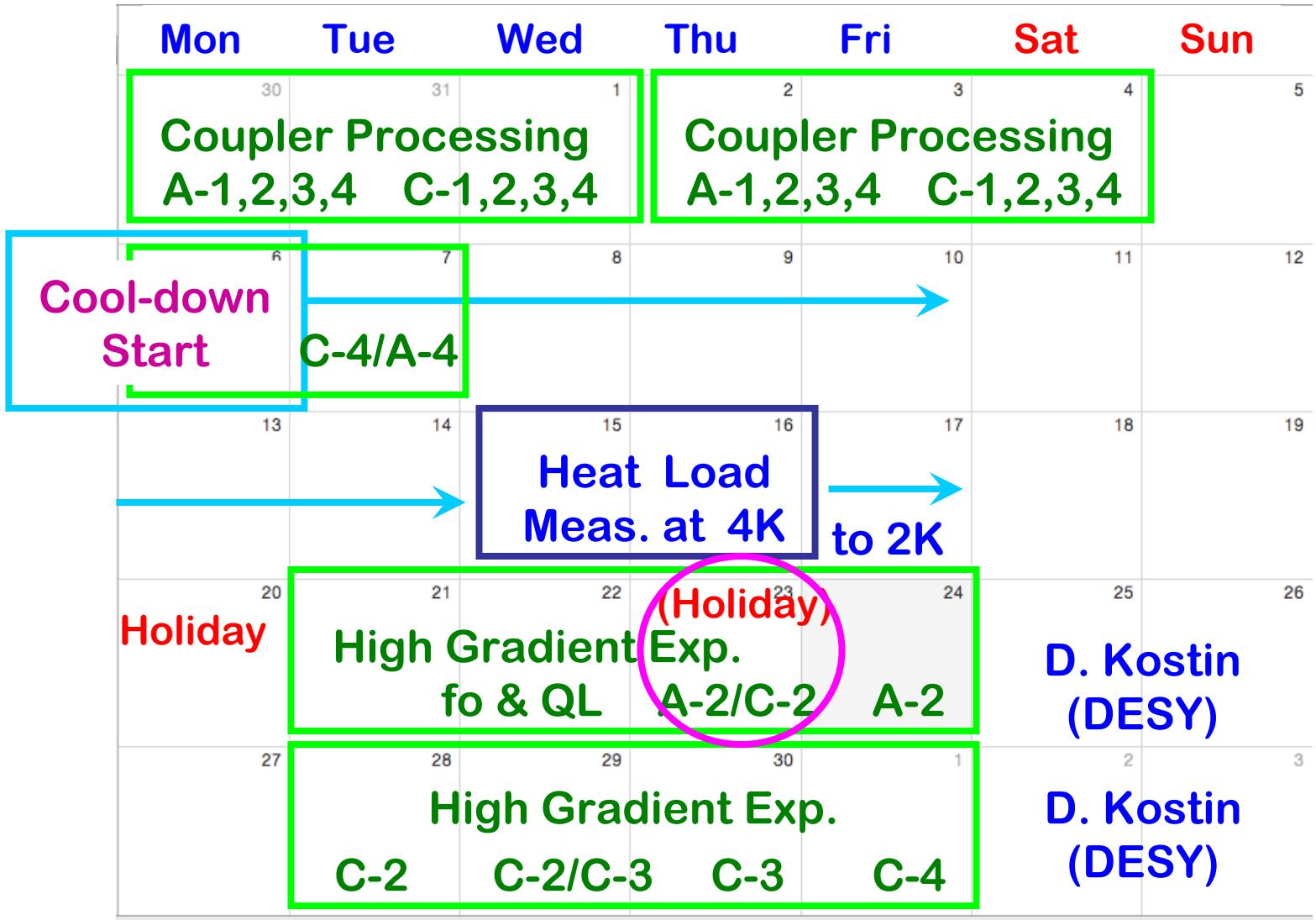


Slide-Jack Tuner (KEK)

Comparison of Performance

STF-II Coupler (KEK)

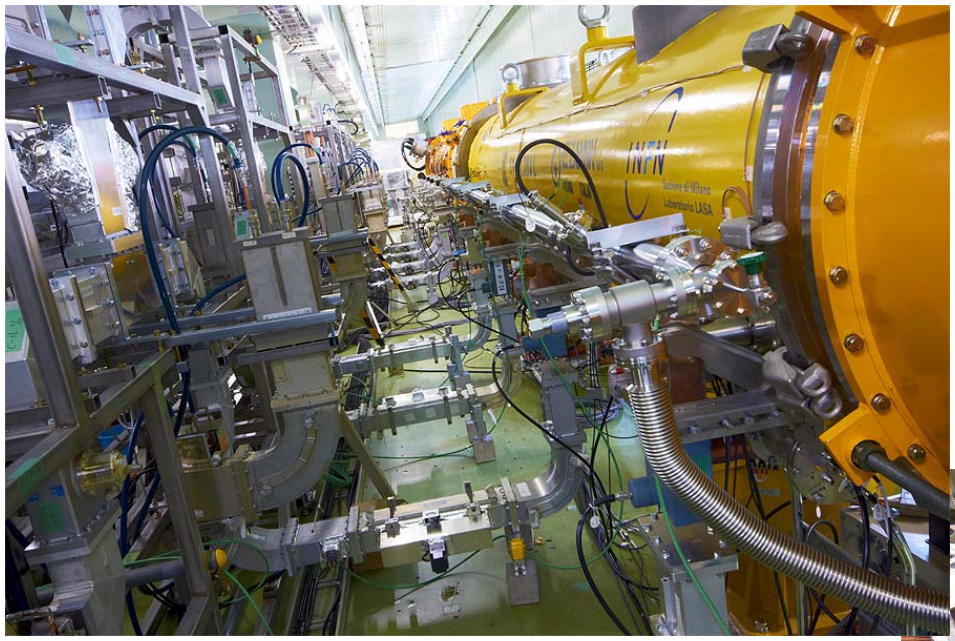
September, 2010



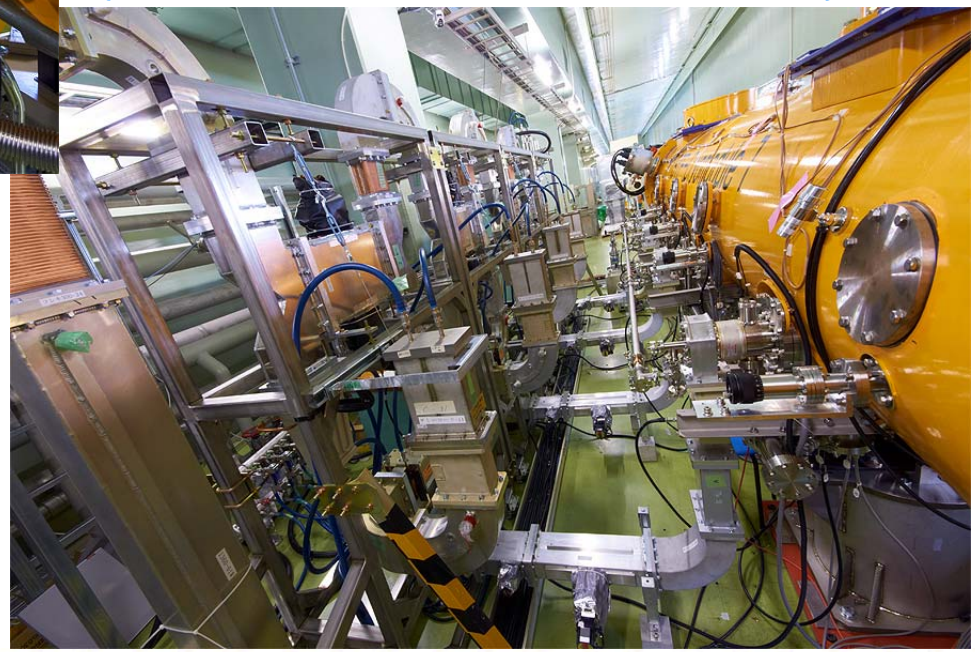
October, 2010

Mon	Tue	Wed	Thu	Fri	Sat	Sun
27	28	29	30	1	2	3
	High Gradient Exp. C-2	C-2/C-3	C-3	C-4	D. Kostin (DESY)	
4	5	6	7	8	9	10
	H.G. C-1	Lorentz Detuning Comp. C-1	C-2	C-3	C-4	Y. Pichalnikov W. Schappert (FNAL)
11	12	13	14	15	16	17
Holiday		Lorentz Detuning Comp. A-2	C-1 /(A-3)	A-3 C-3,4		
18	19	20	21	22	23	24
GDE @ CERN	High Gradient Exp. A-1	A-4		L.D.C. C-1,2,3,4		
25	26	27	28	29	30	31
	Dynamic Loss C-1	C-2	Meas. C-3	C-4	A. Hocker (FNAL)	

High power system in S1-Global

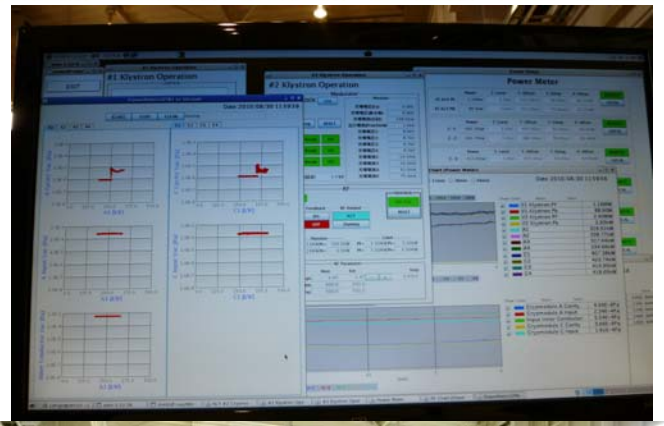


Cryomodule-A
4 KEK cavities
(MHI-05, MHI-06, MHI-07, MHI-09)
4 STF-II couplers
(coaxial disk rf window, 60ϕ)



Cryomodule-C
FNAL (AES004, ACC011) cav.
DESY (Z108, Z109) cavities
4 TTF-III couplers
(cylindrical rf window, 40ϕ)

RF processing of input couplers



Cryomodule-C /KLY#1 (2MW)

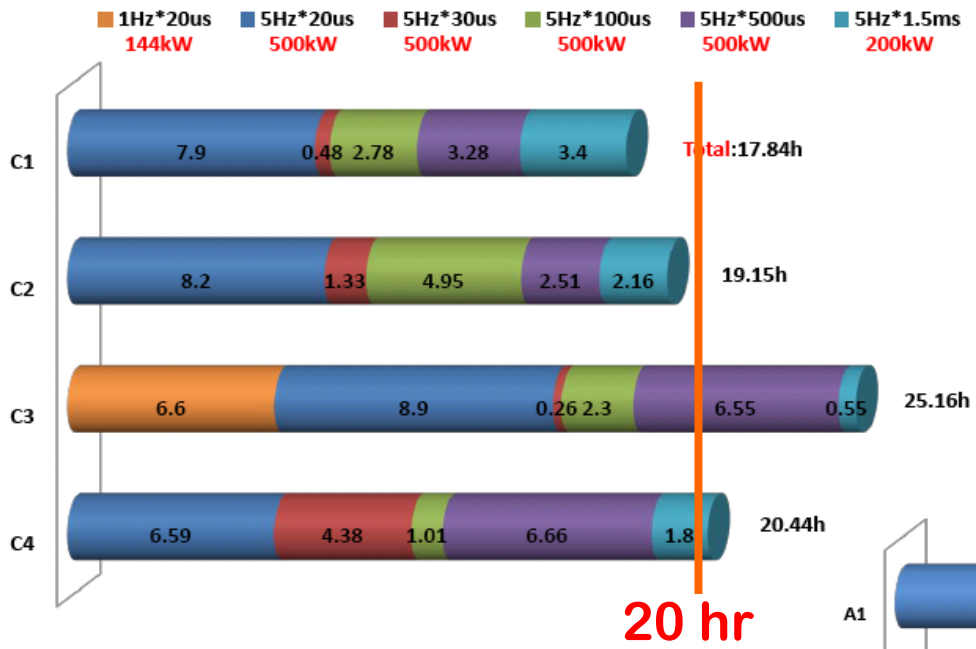
Cryomodule-A /KLY#2 (5MW)

0.5 ms, 5 Hz, 500 kW

1.5 ms, 5 Hz, 200 kW

Aug. 25 ~ Sept. 07 (10 days)

RF processing time of input couplers



Cryomodule-A (STF-II couplers)

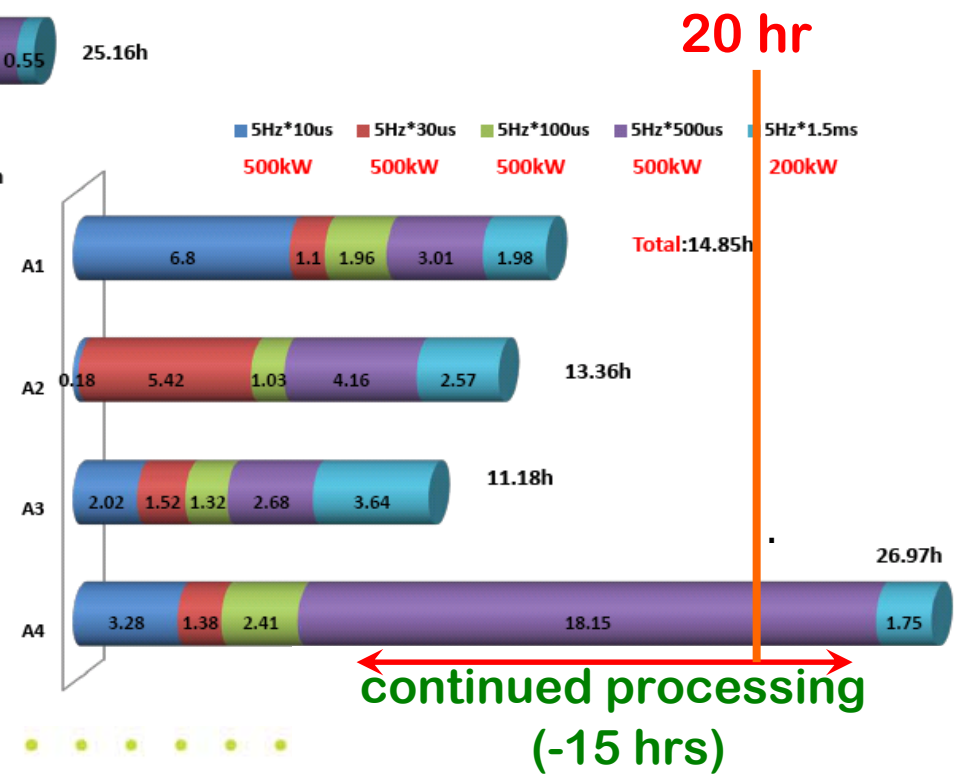
ave. processing time

~ 13 hours

Cryomodule-C (TTF-III couplers)

ave. processing time

~ 21 hours

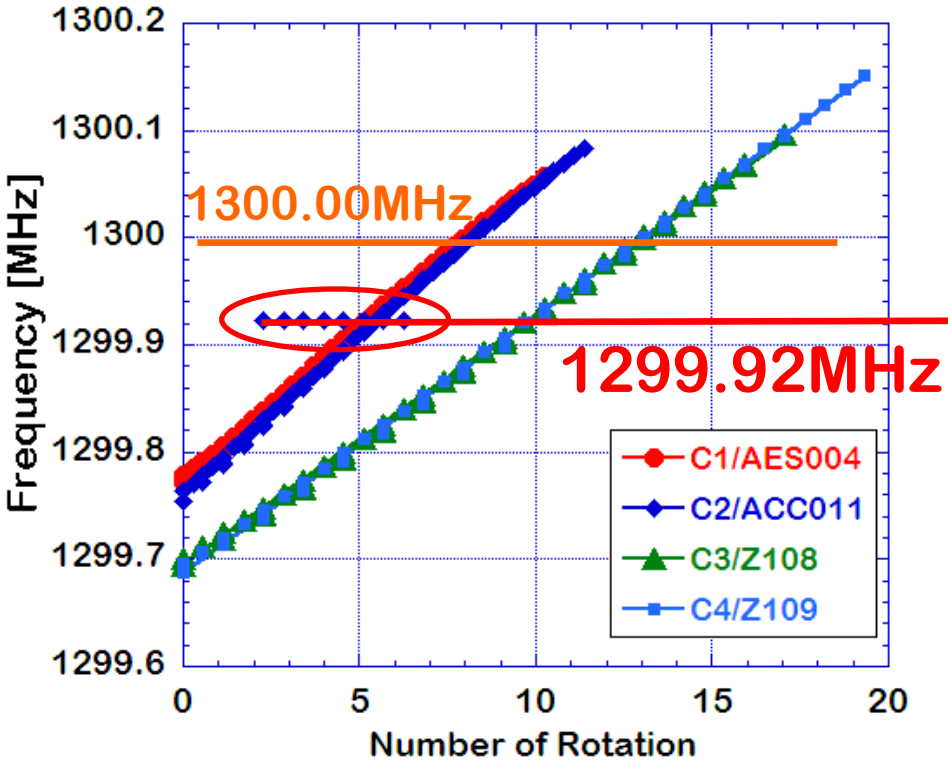


Vacuum I/L ; $2.x10^{-4}$ Pa

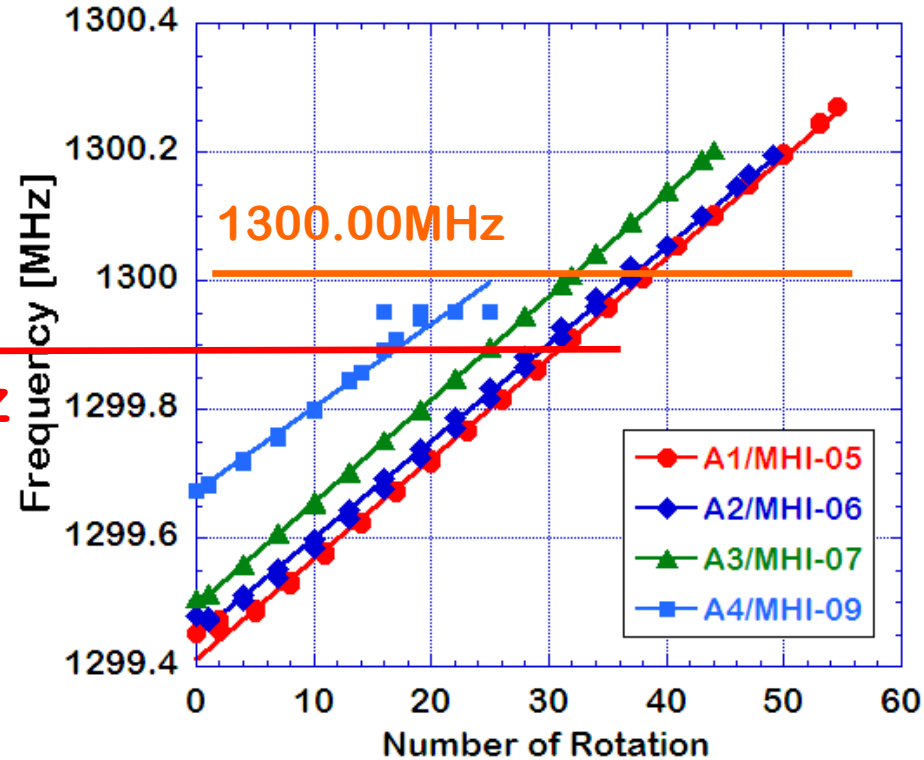
Adjustment of frequency (f_0)

fo = 1299.92 MHz

Cryomodule - C



Cryomodule - A



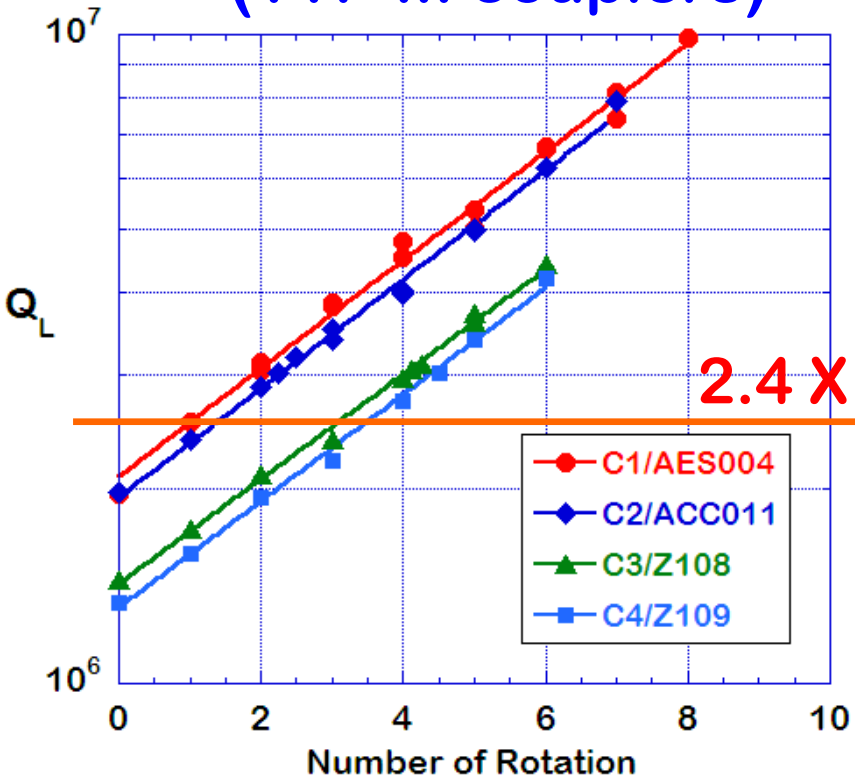
C2/ACC011; Tuner did not work.

(A4/MHI-09; 1299.90 MHz)

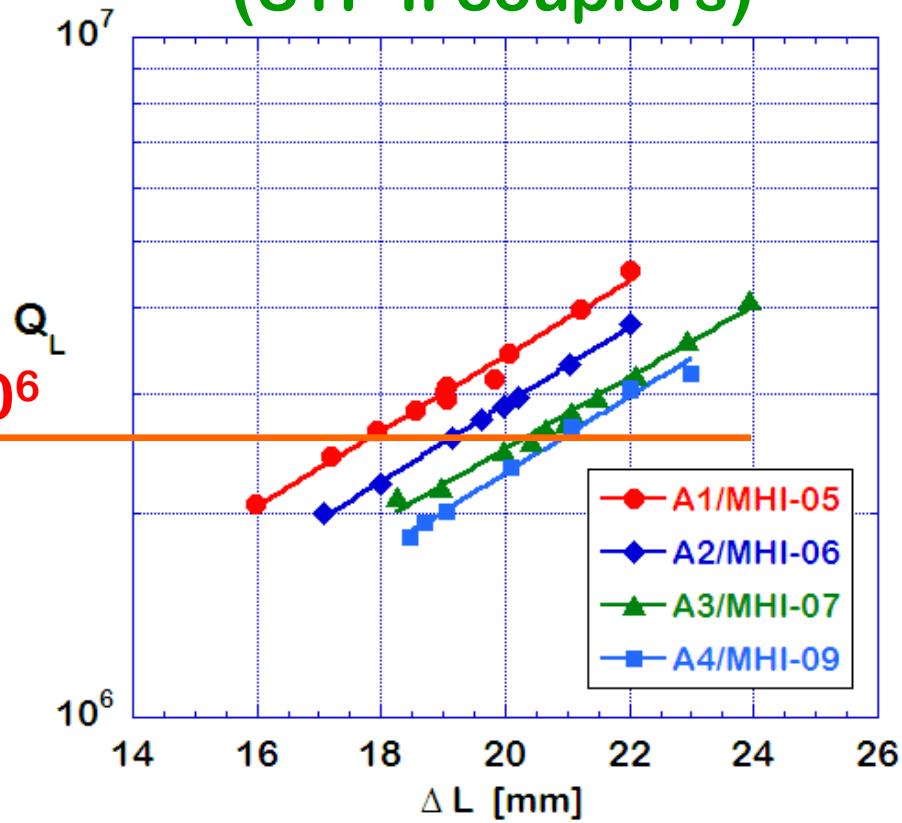
Q_L of Variable Input Coupler

$Q_L = 2.4 \times 10^6$ $\Delta f_{bw} = 542$ Hz

Cryomodule – C
(TTF-III couplers)



Cryomodule – A
(STF-II couplers)

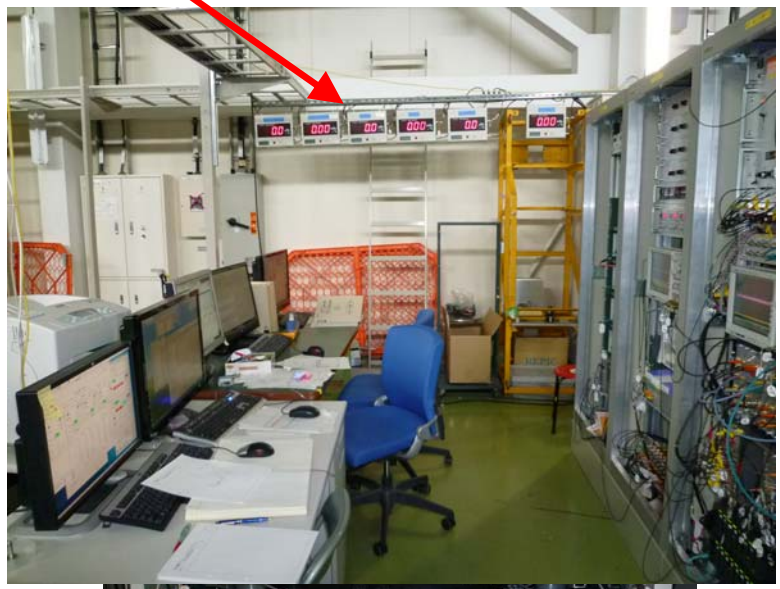


2.4×10^6

Cavity conditioning for high gradients

Denis Kostin from DESY
and KEK staffs
(Sept. 21st ~ Oct 1st)

6 x-ray radiation monitors



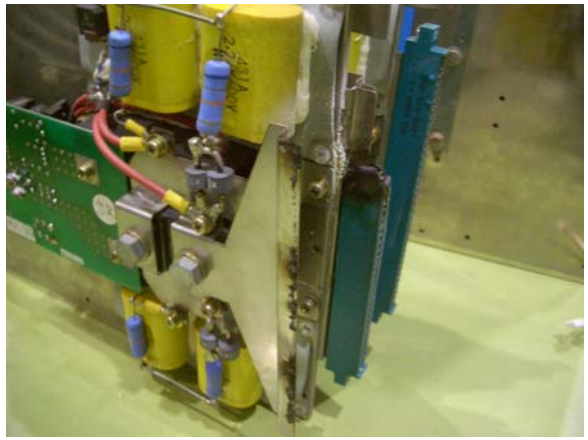
electron interlock from DESY

Pulsed operation ; rise + flat-top, 5 Hz
Short pulse ; 0.54 ms + 0.1 ms
Full pulse ; 0.54 ms + 1.0 ms

Cavity conditioning for high gradients

#1 Klystron for Cryomodule-C

#2 Klystron
for Cryomodule-A

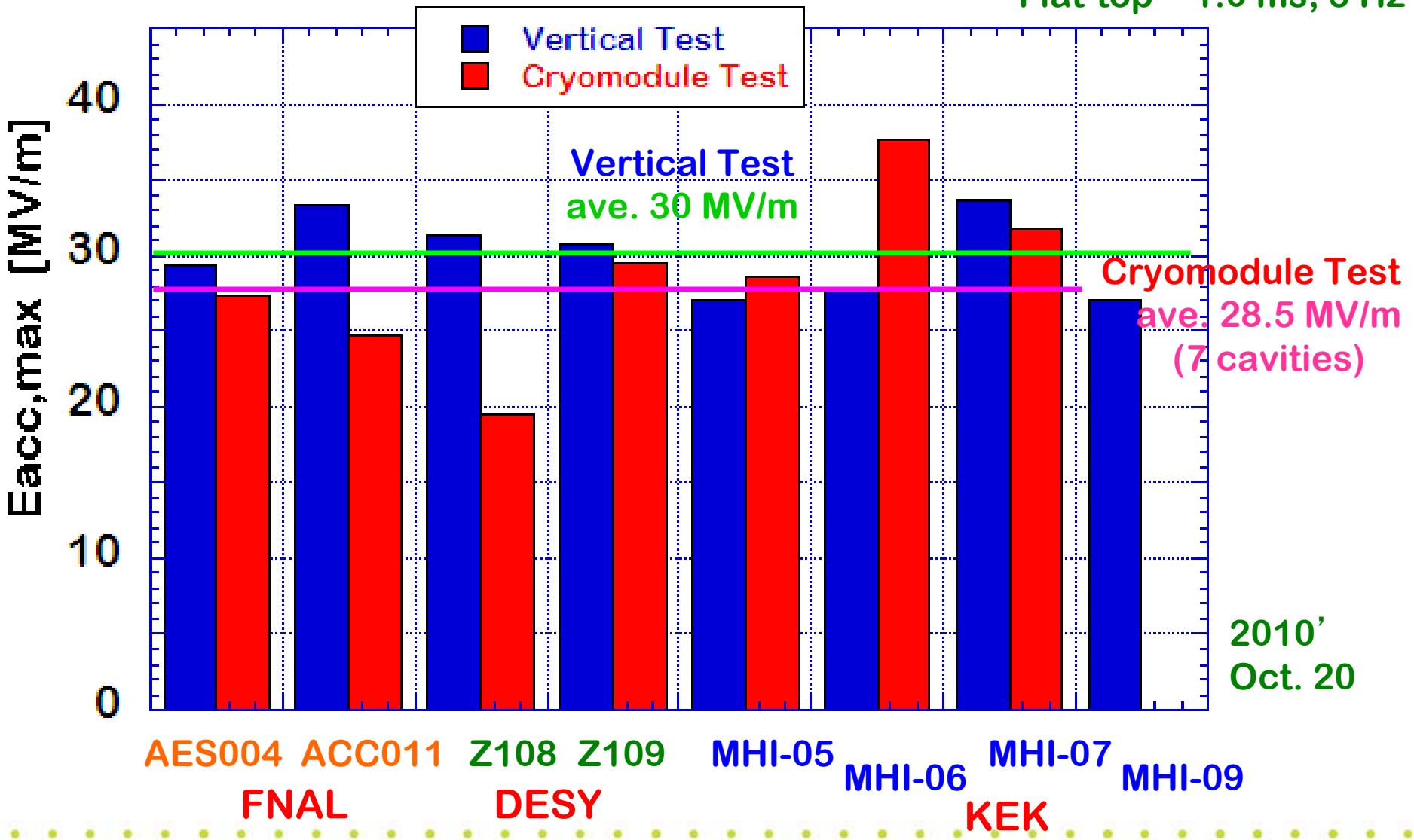


Trouble of #1-Klystron power supply (IGBT) occurred in Sept. 23rd.

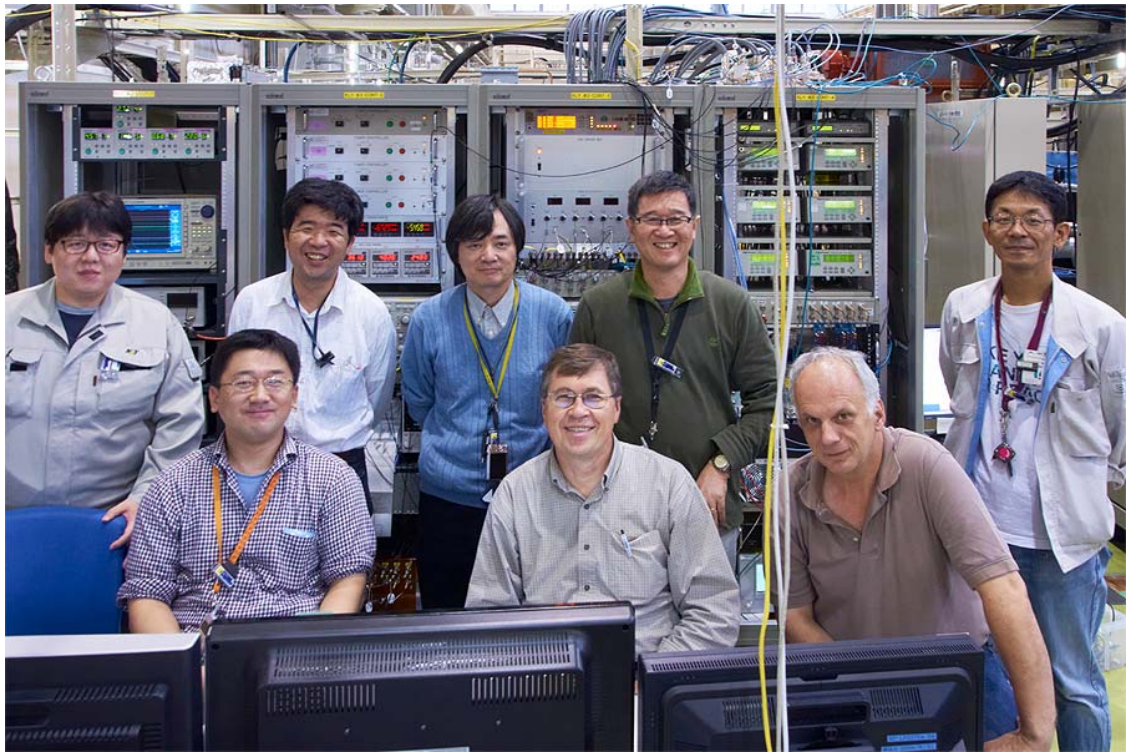
#1-Klystron was recovered after only 2 weeks, by very hard work of the STF-HLRF group.

Comparison of VT and CT

Flat-top = 1.0 ms, 5 Hz



Lorentz detuning experiments



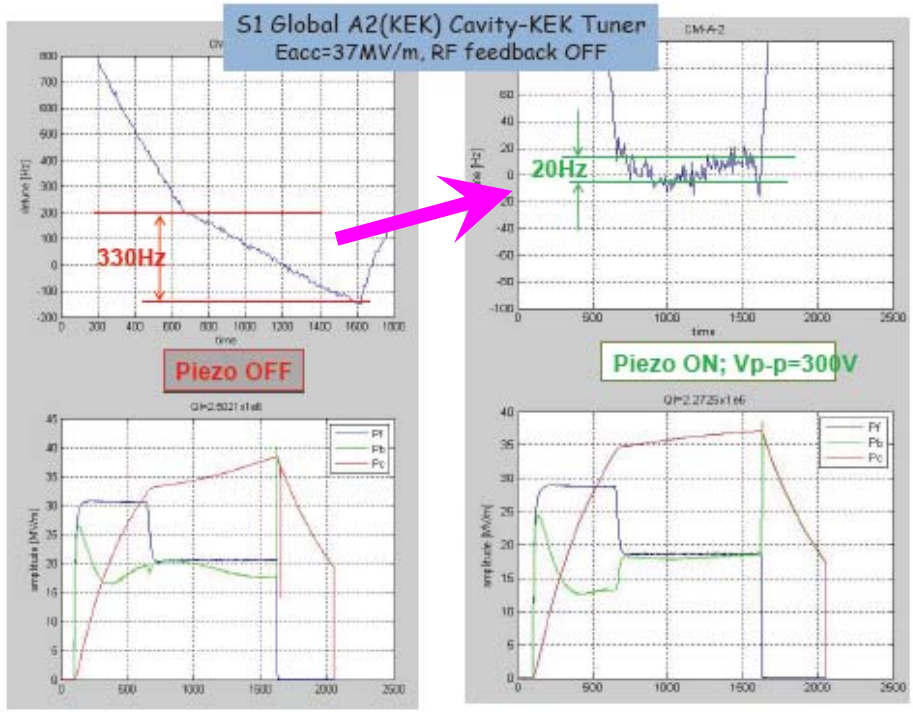
Yuriy Pischalnikov &
Warren Schappert from FNAL
and KEK staffs
(Oct. 4th ~ Oct. 15th)

Piezo control system
from FNAL

Lorentz detuning experiments

One example;

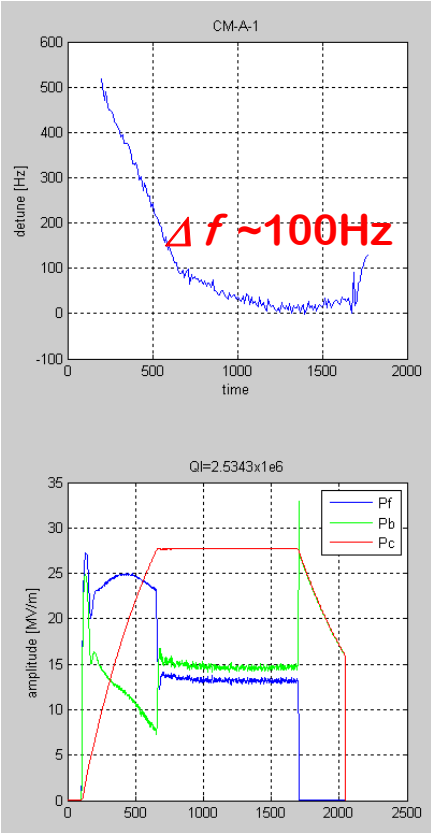
Successful compensation of Lorentz force detuning by FNAL's piezo control system. (A2/MHI-06 cavity at 37 MV/m)



More detailed results will be reported by Yuriy and Warren (FNAL).

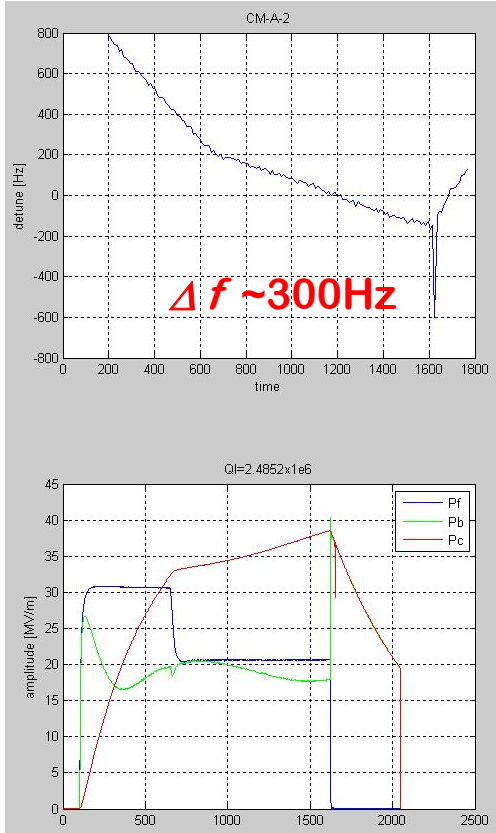
Lorentz detuning experiments

A1/MHI-05
28 MV/m



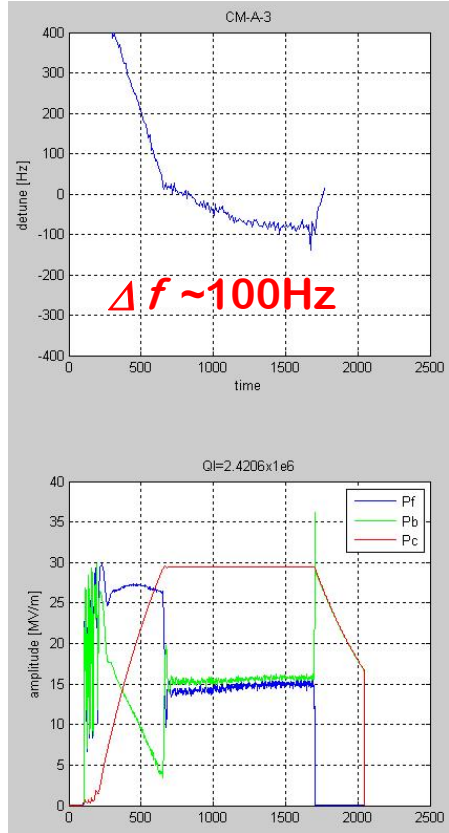
FB/on, Piezo/off

A2/MHI-06
35 MV/m



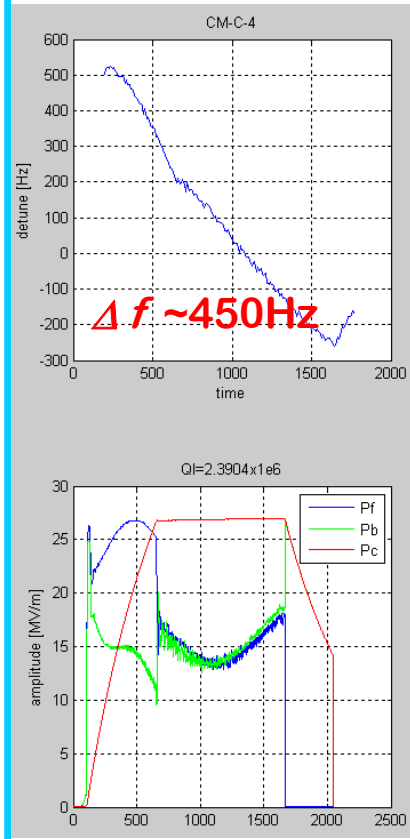
FB/off, Piezo/off

A3/MHI-07
30 MV/m



FB/on, Piezo/off

C4/Z109
27 MV/m

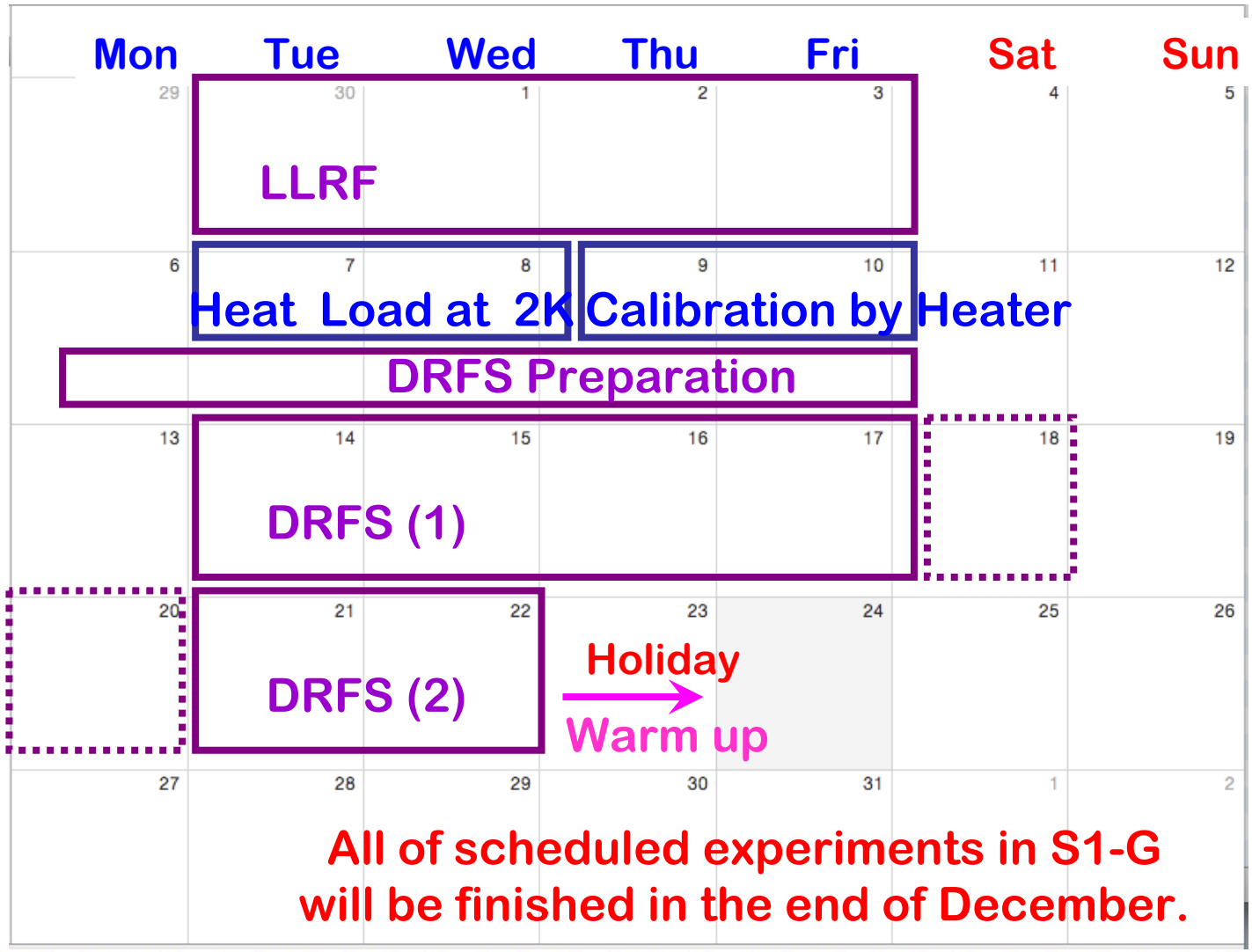


FB/on, Piezo/off

November, 2010

Mon	Tue	Wed	Thu	Fri	Sat	Sun
1	2	3 (Holiday)	4	5	6	7
	Lorentz Detuning Compensation					
	A-1/C-1	A-2/C-2	A-3/C-3	A-4/C-4		
8	9	10	11	12	13	14
	Dynamic Loss		Meas.			
	A-1	A-2	A-3	A-4		
15	16	17	18	19	20	21
	4 Cavity Control		Dynamic Loss			
			A 4 cav.	C 4 cav.		
22	23 (Holiday)	24	25	26	27	28
	8 Cavity Control		Dynamic Loss			
			8 cav.	8 cav.		
29	30	1	2	3	4	5

December, 2010



Summary

- High power rf tests in the S1-Global cryomodule have been going on, nearly on schedule.
- In the preliminary test results, two cavities showed a performance degradation at high gradients.
- Compensation of Lorentz force detuning by FNAL's piezo control system was successfully demonstrated in three types of tuner system.
- Relatively small detuning frequency due to Lorentz force was observed in the KEK/MHI cavities with a high stiffness structure.