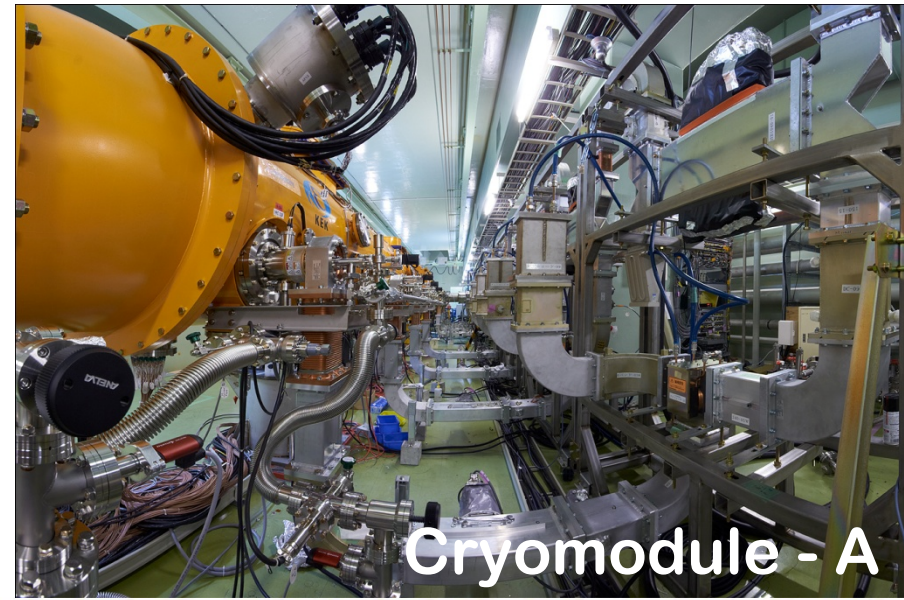
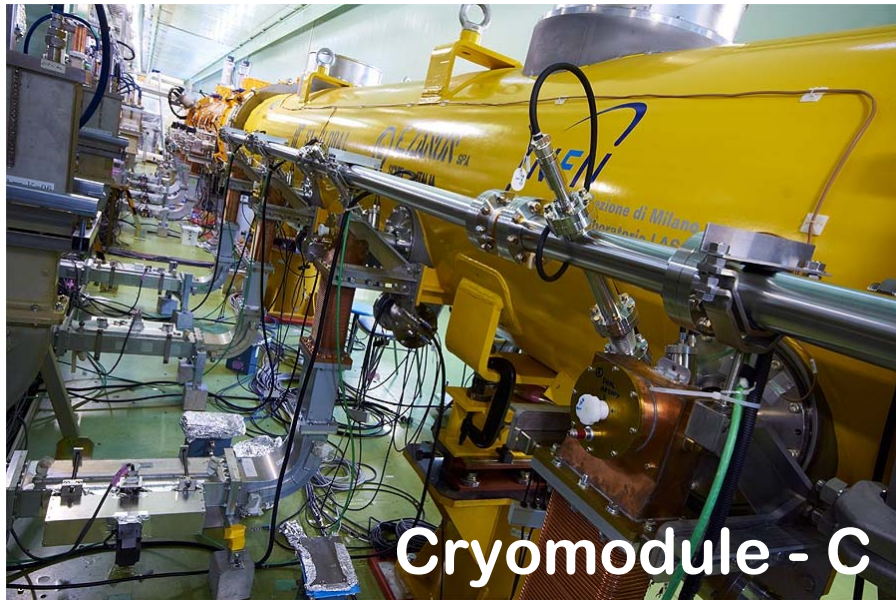


# Summary of Cavity Performance in S1-Global



- Overview of S1-Global Cryomodule
- Cavity Performance
- 4-cavity, 7-cavity operation
- Summary





# International Team for S1-Global

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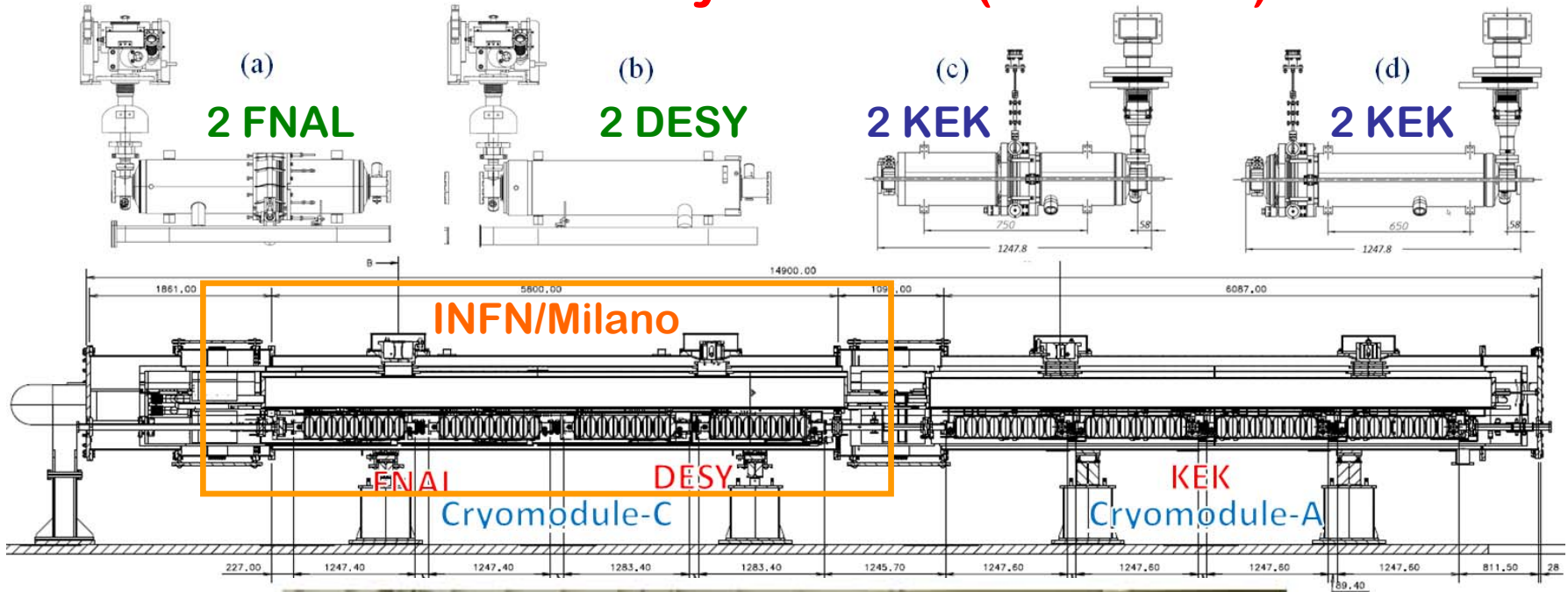
C. Adolphsen, C. Nantista, SLAC (USA)

M. Akemoto, S. Fukuda, K. Hara, H. Hayano, N. Higashi, E. Kako,  
H. Katagiri, Y. Kojima, Y. Kondo, T. Matsumoto, S. Michizono, T. Miura,  
H. Nakai, H. Nakajima, K. Nakanishi, S. Noguchi, N. Ohuchi, T. Saeki,  
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A. Yamamoto, Y. Yamamoto, K. Yokoya,  
KEK (Japan)



# S1-Global Cryomodule

## S1-Global Cryomodule (8 cavities)





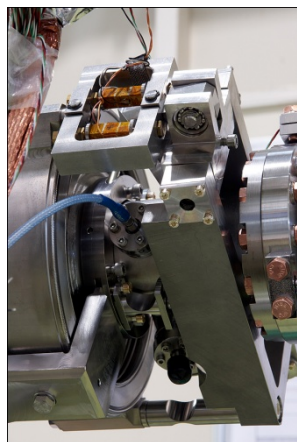
# Cavities, Tuners, Couplers in S1-G Cryomodule



TESLA Cavity (DESY/FNAL)



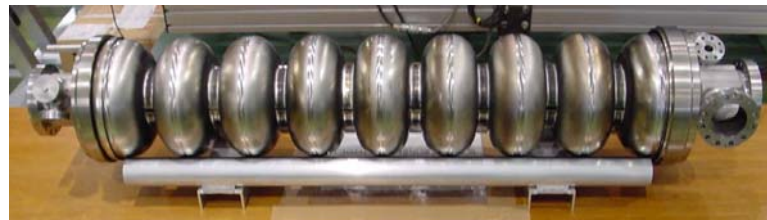
Blade Tuner (FNAL)



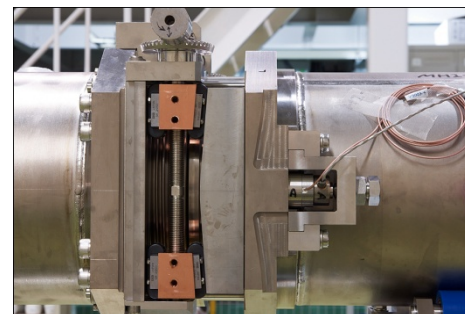
Saclay Tuner (DESY)



TTF-III Coupler (DESY/FNAL)



Tesla-like Cavity (KEK)



Slide-Jack Tuner (KEK)



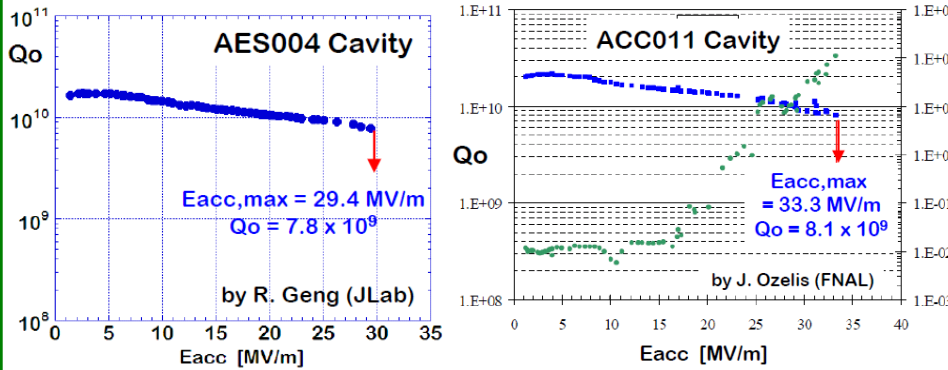
STF-II Coupler (KEK)

Comparison of Performance

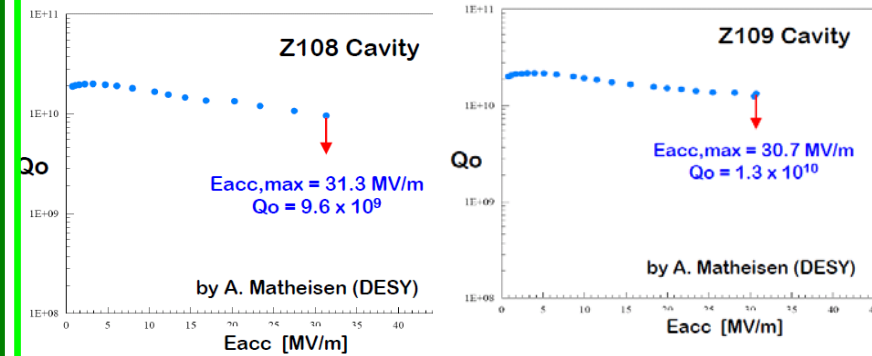


# Vertical Test Results of 8 Cavities

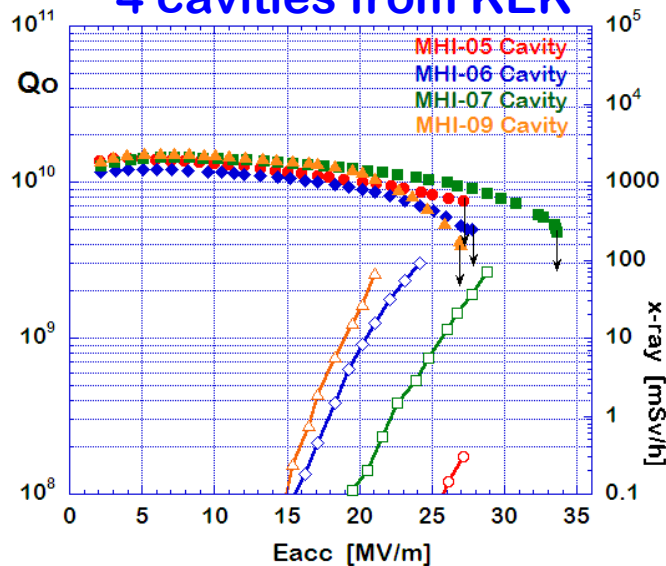
## 2 cavities from FNAL



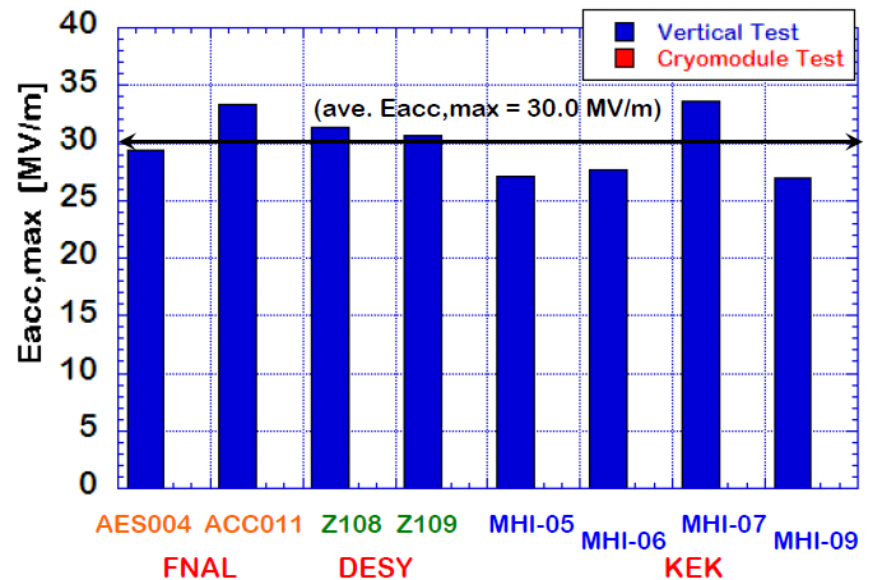
## 2 cavities from DESY



## 4 cavities from KEK



## 8 Cavities for S1-Global (ave. 30 MV/m)

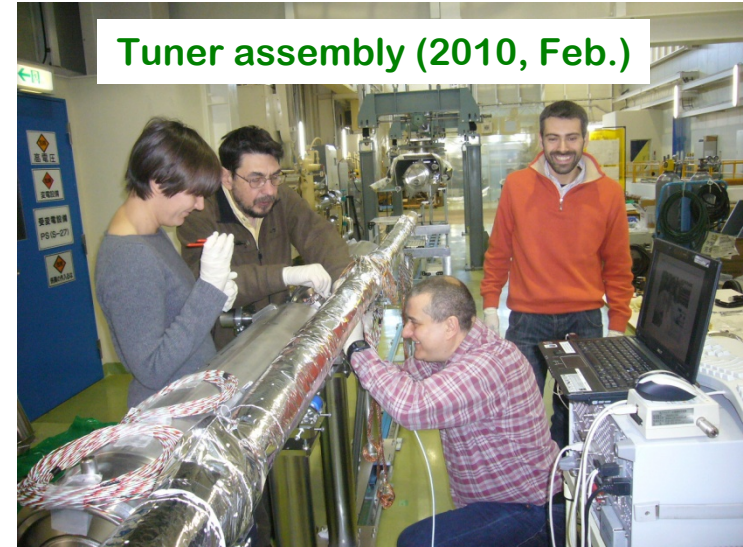




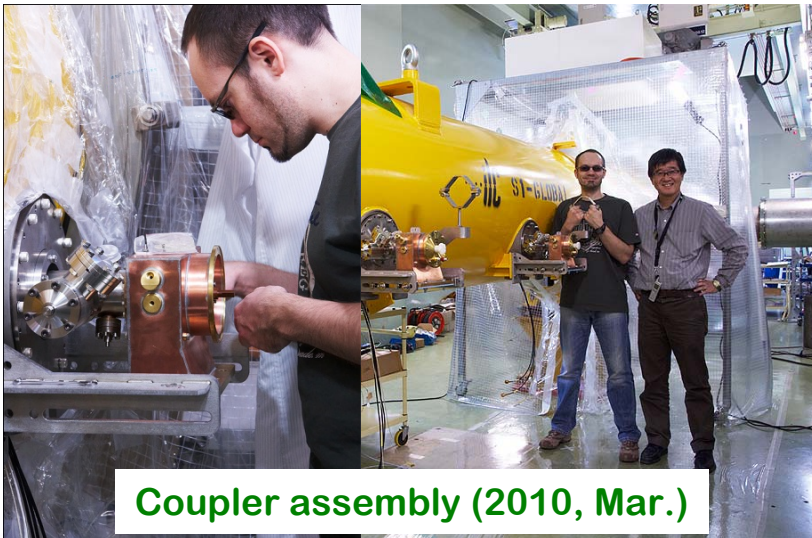
# Collaboration for Cryomodule Assembly



Cavity string assembly (2010, Jan.)



Tuner assembly (2010, Feb.)



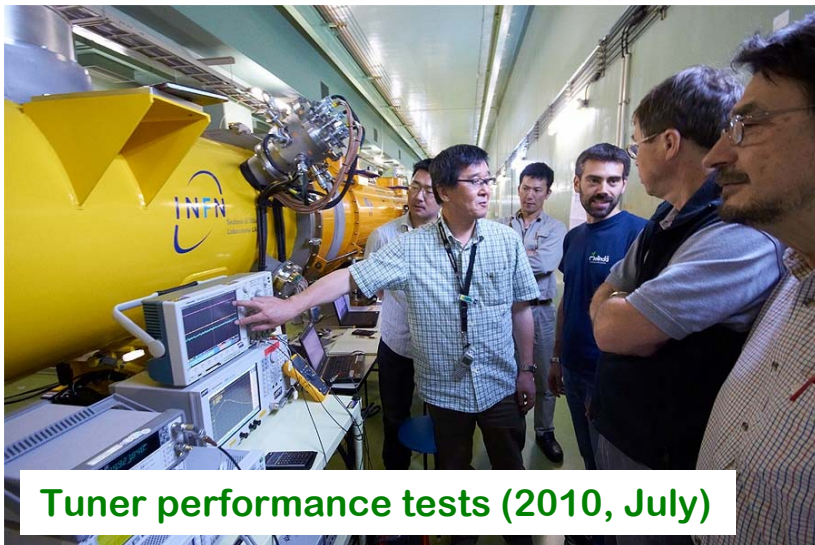
Coupler assembly (2010, Mar.)



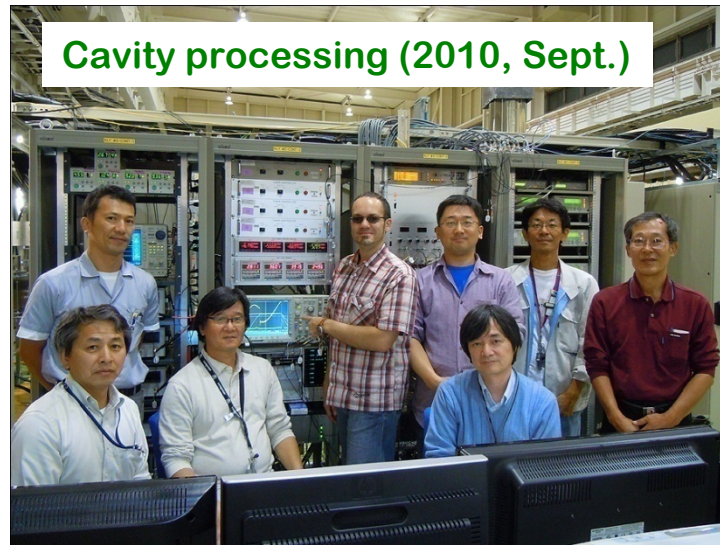
KEK Cavity string assembly (2010, Mar.)



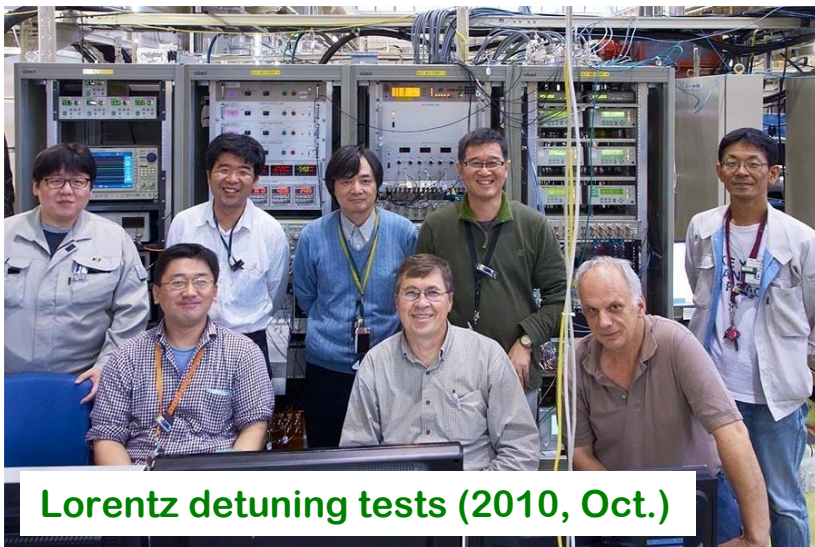
# Collaboration for Cryomodule Tests



Tuner performance tests (2010, July)



Cavity processing (2010, Sept.)



Lorentz detuning tests (2010, Oct.)

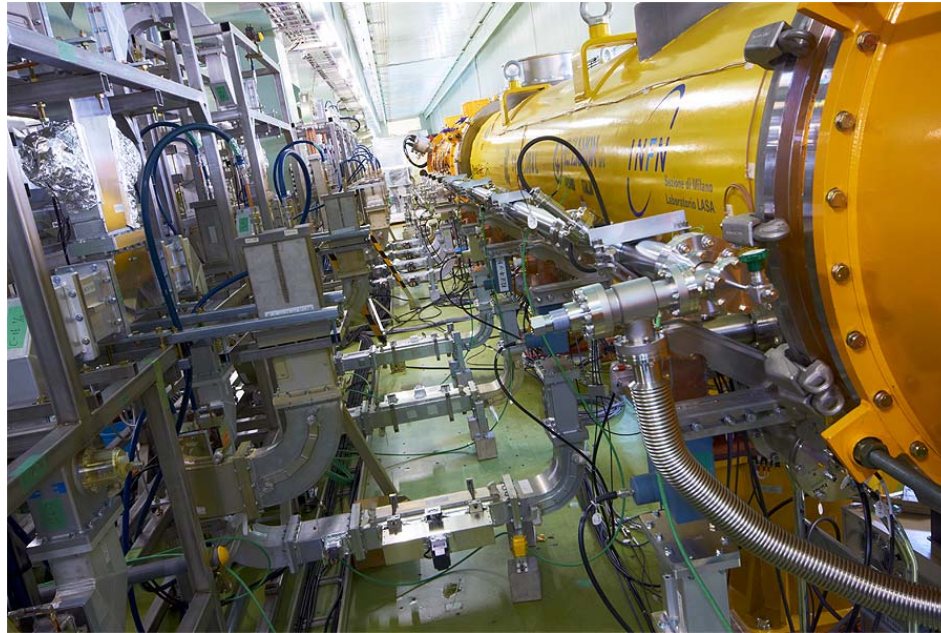


Dynamic loss meas. (2010, Nov.)





# 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, 60 $\phi$ )

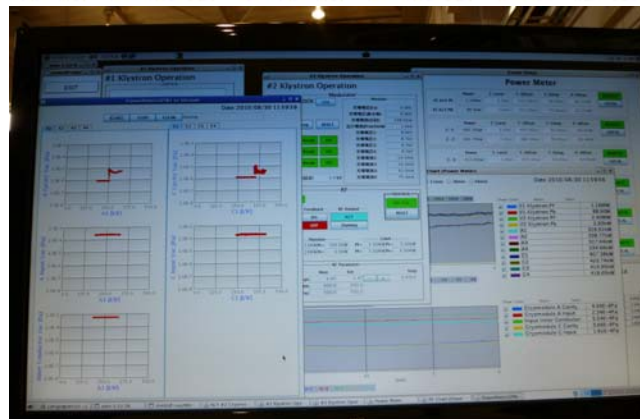
**Cryomodule-C**  
FNAL (AES004, ACC011) cav.  
DESY (Z108, Z109) cavities  
4 TTF-III couplers  
(cylindrical rf window, 40 $\phi$ )







# 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)**

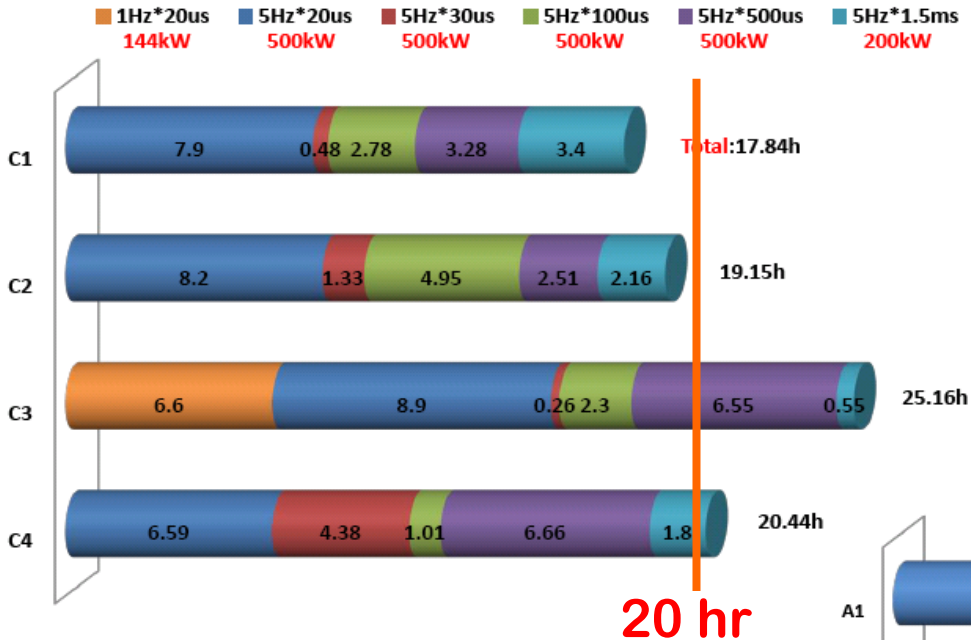




# RF processing time of input couplers

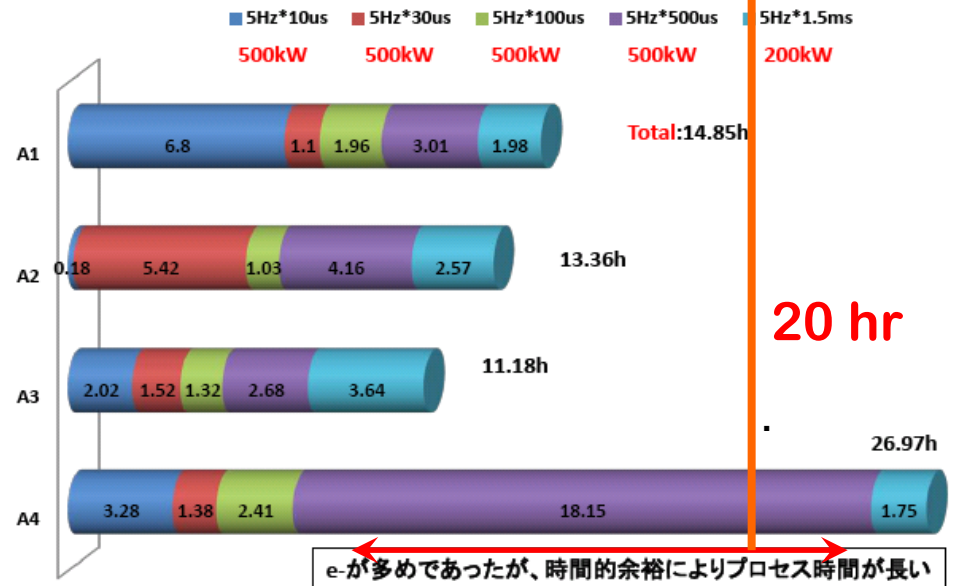
at room temperature

**Cryomodule-A**  
(STF-II couplers)  
ave. processing time  
~ 13 hours



**Cryomodule-C**  
(TTF-III couplers)  
ave. processing time  
~ 21 hours

Vacuum I/L ;  $2 \times 10^{-4}$  Pa



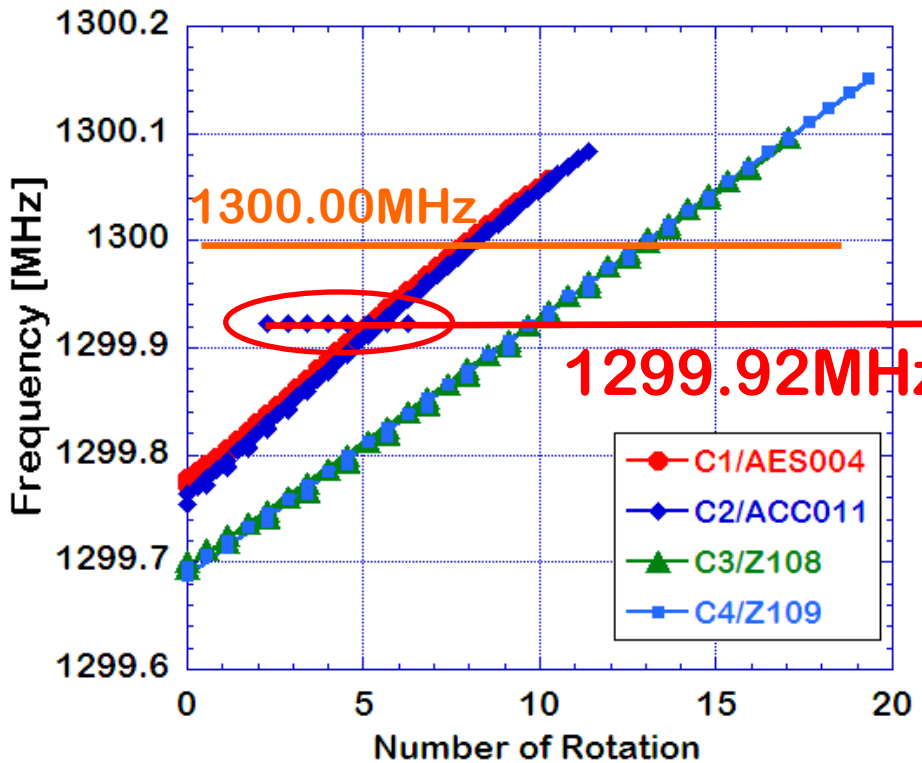
e-が多めであったが、時間的余裕によりプロセス時間が長い



# Adjustment of frequency ( $f_0$ )

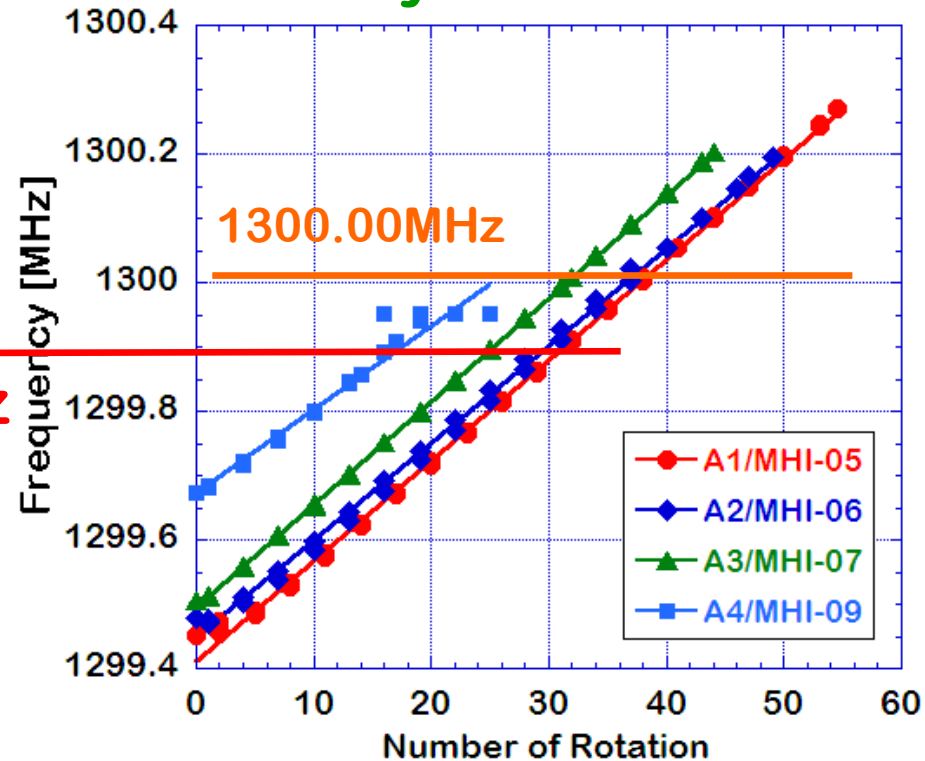
**$f_0 = 1299.92 \text{ MHz}$**

## Cryomodule - C



**C2/ACC011; Tuner did not work.**

## Cryomodule - A



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



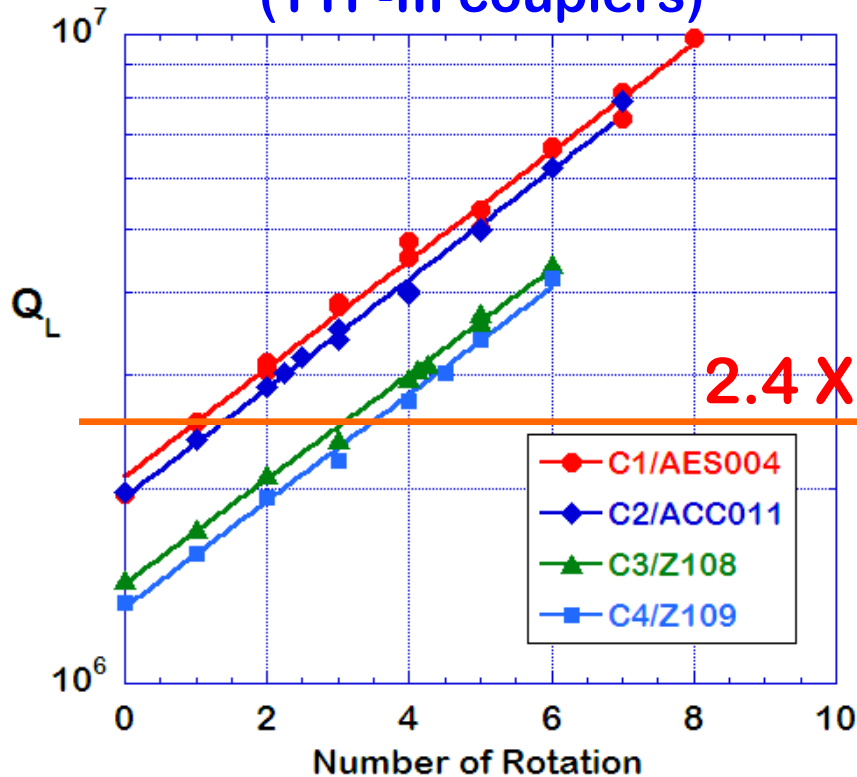


# $Q_L$ of Variable Input Coupler

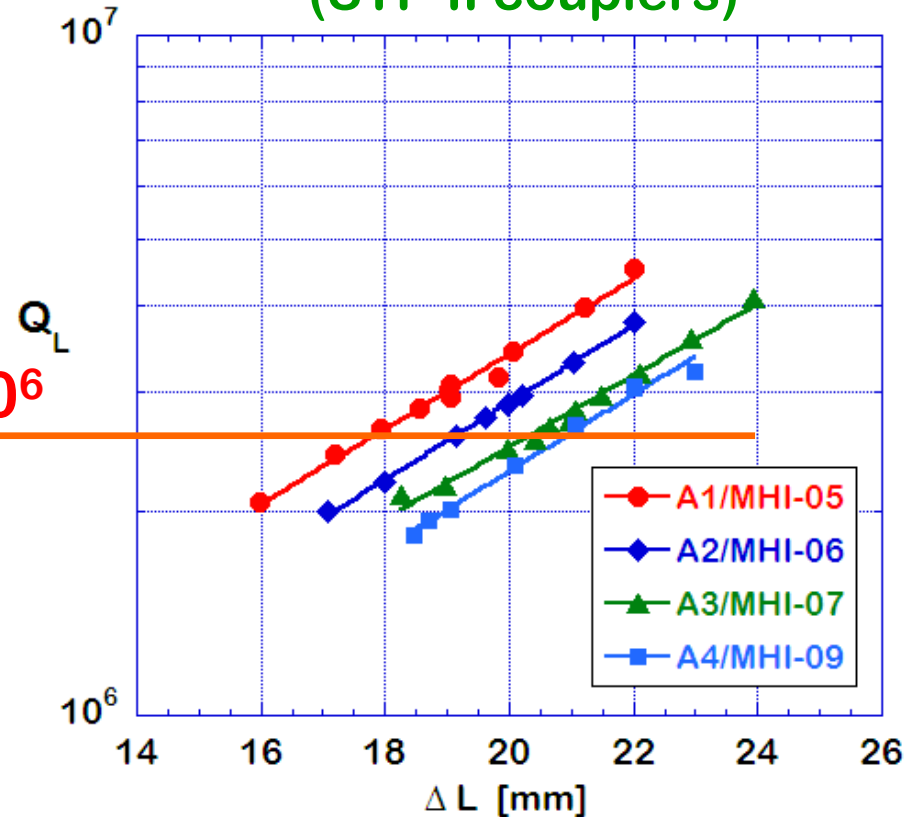
$$Q_L = 2.4 \times 10^6$$

$$\Delta f_{bw} = 542 \text{ Hz}$$

Cryomodule – C  
(TTF-III couplers)

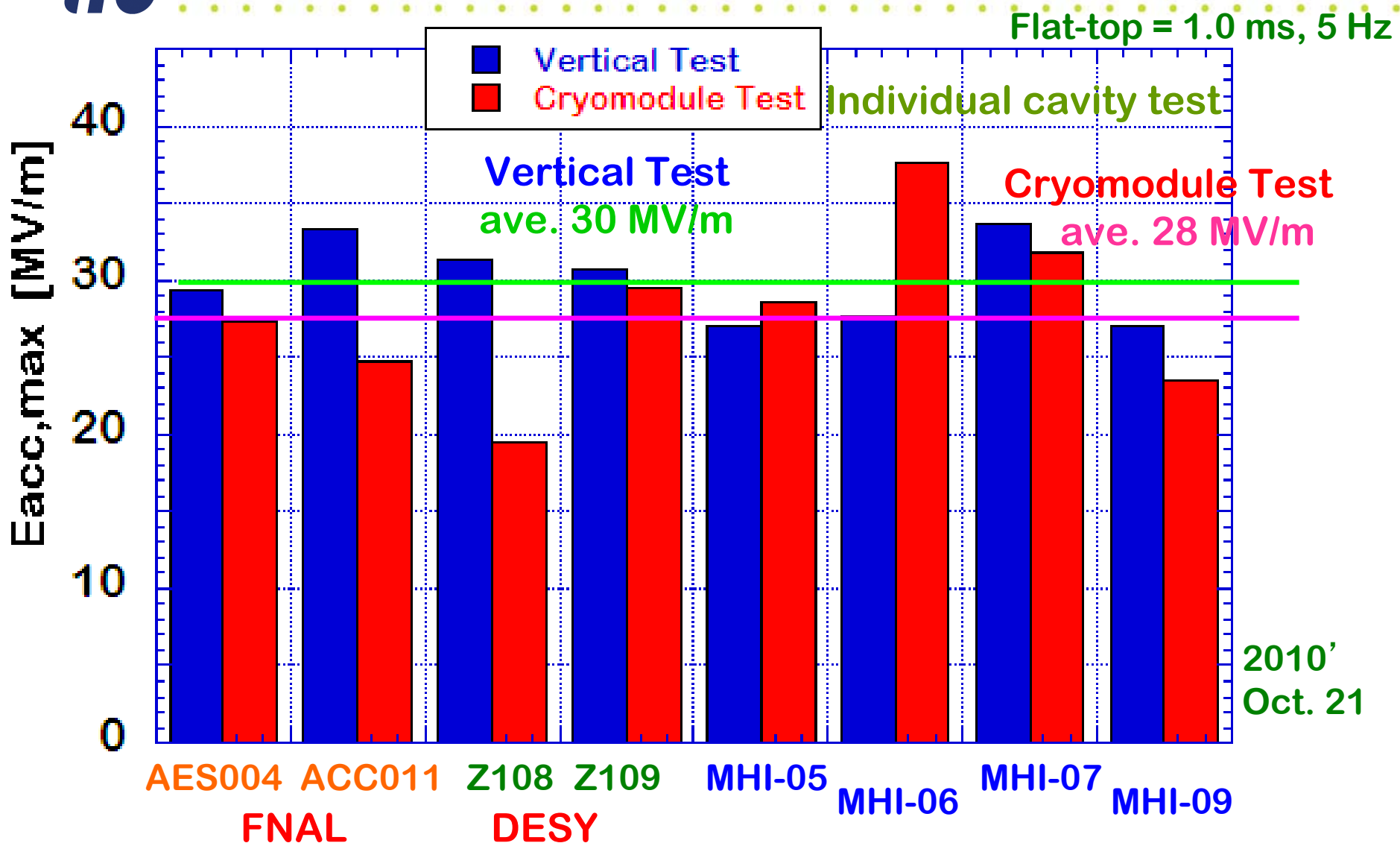


Cryomodule – A  
(STF-II couplers)





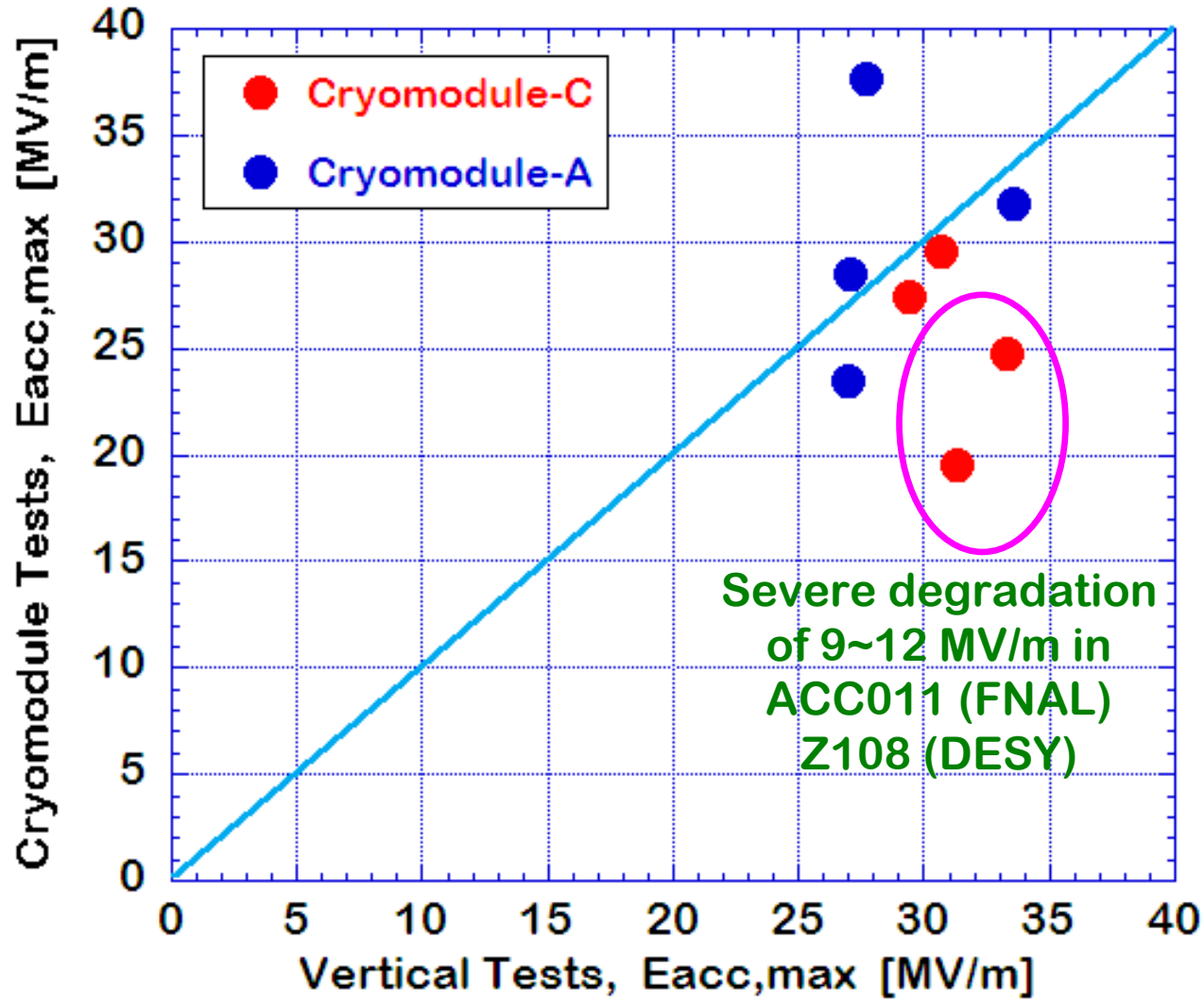
# Comparison of VT and CT







# Comparison of VT and CT

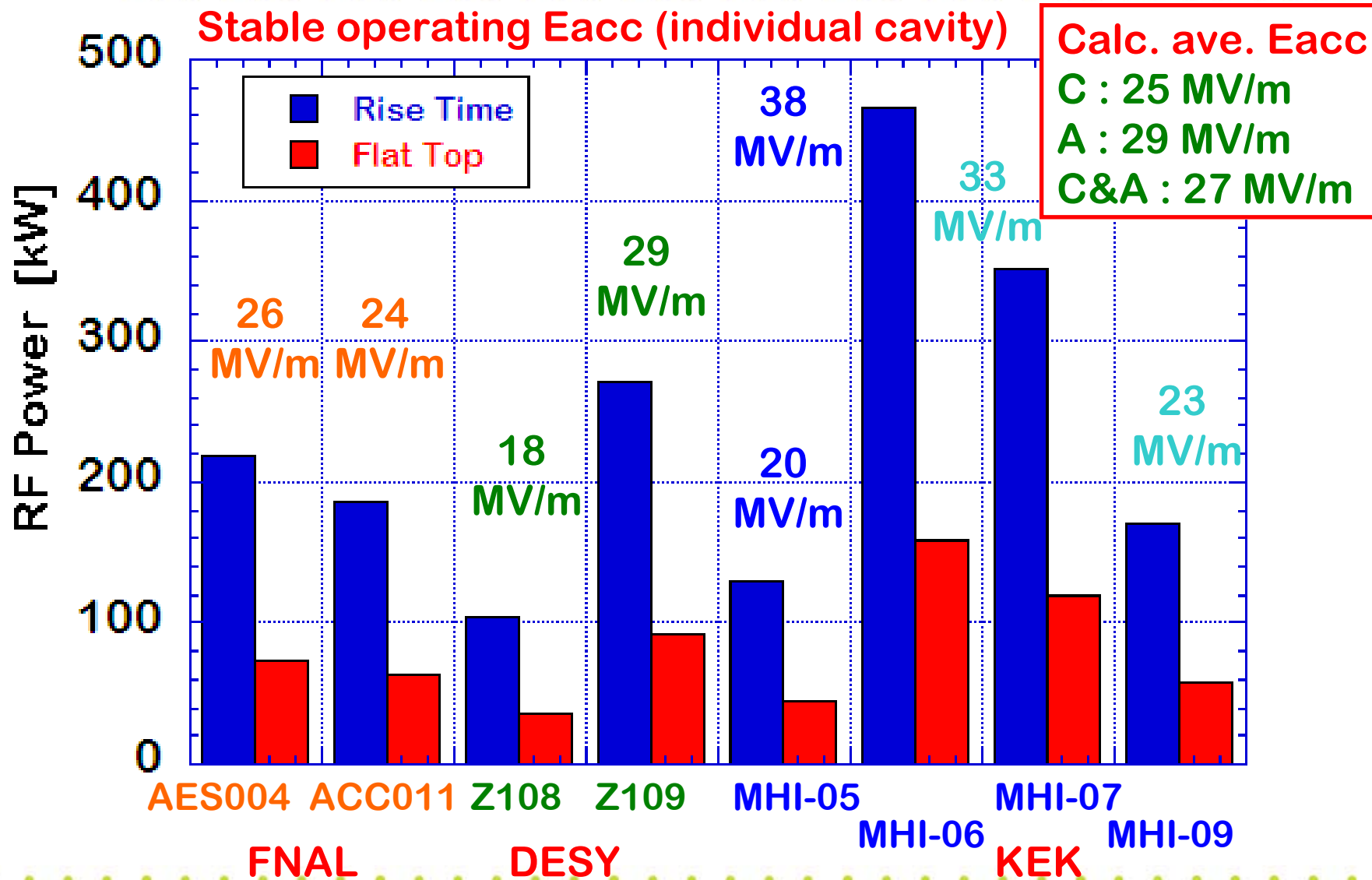


ave. Eacc,max  
= 25.3 MV/m  
(Cryomodule-C)

ave. Eacc,max  
= 30.4 MV/m  
(Cryomodule-A)



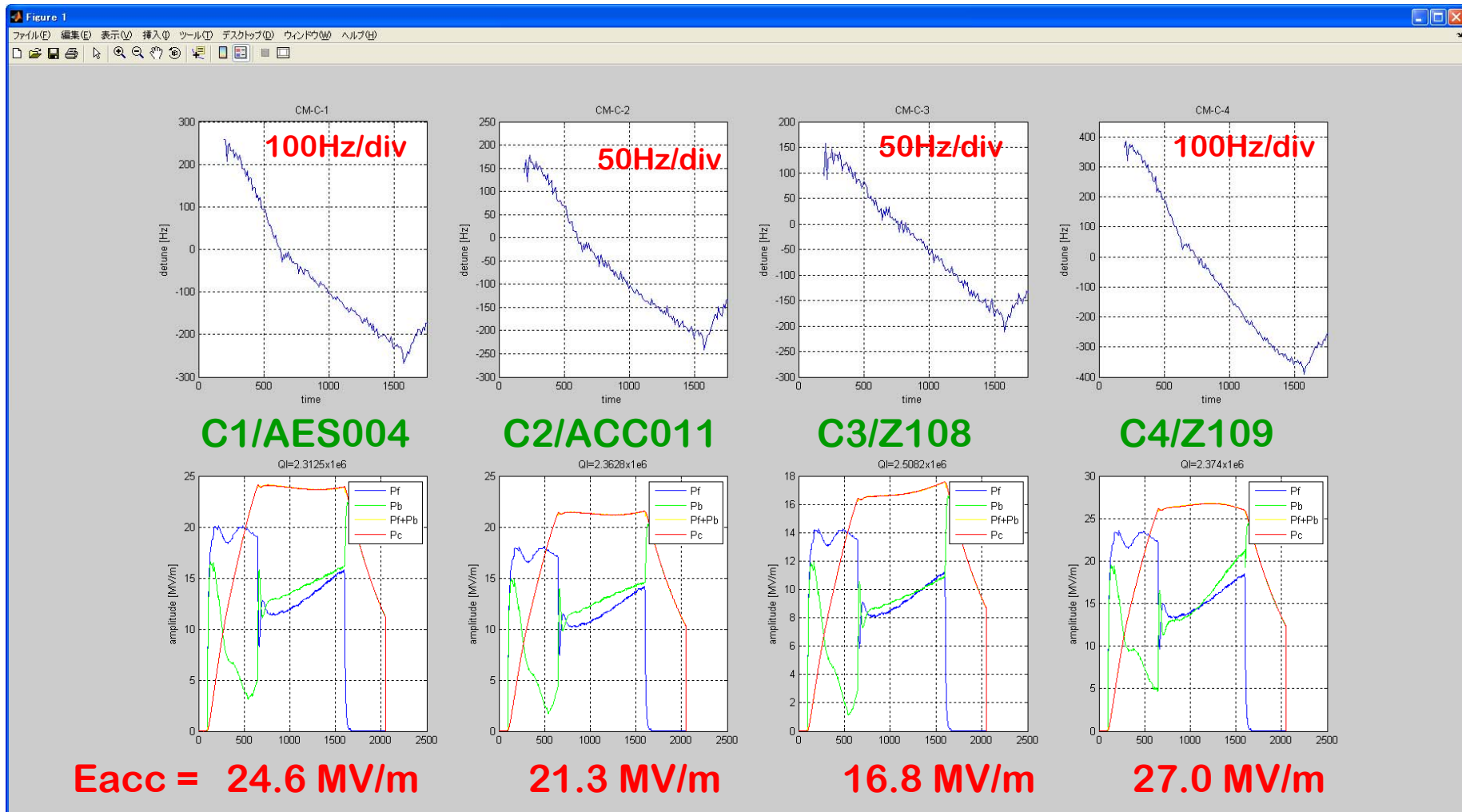
# Required rf power for 8-cav. operation





# 4-Cavity Operation in Cryomodule-C

FB/on, Piezo/off, ave.  $E_{acc} = 22.5$  MV/m

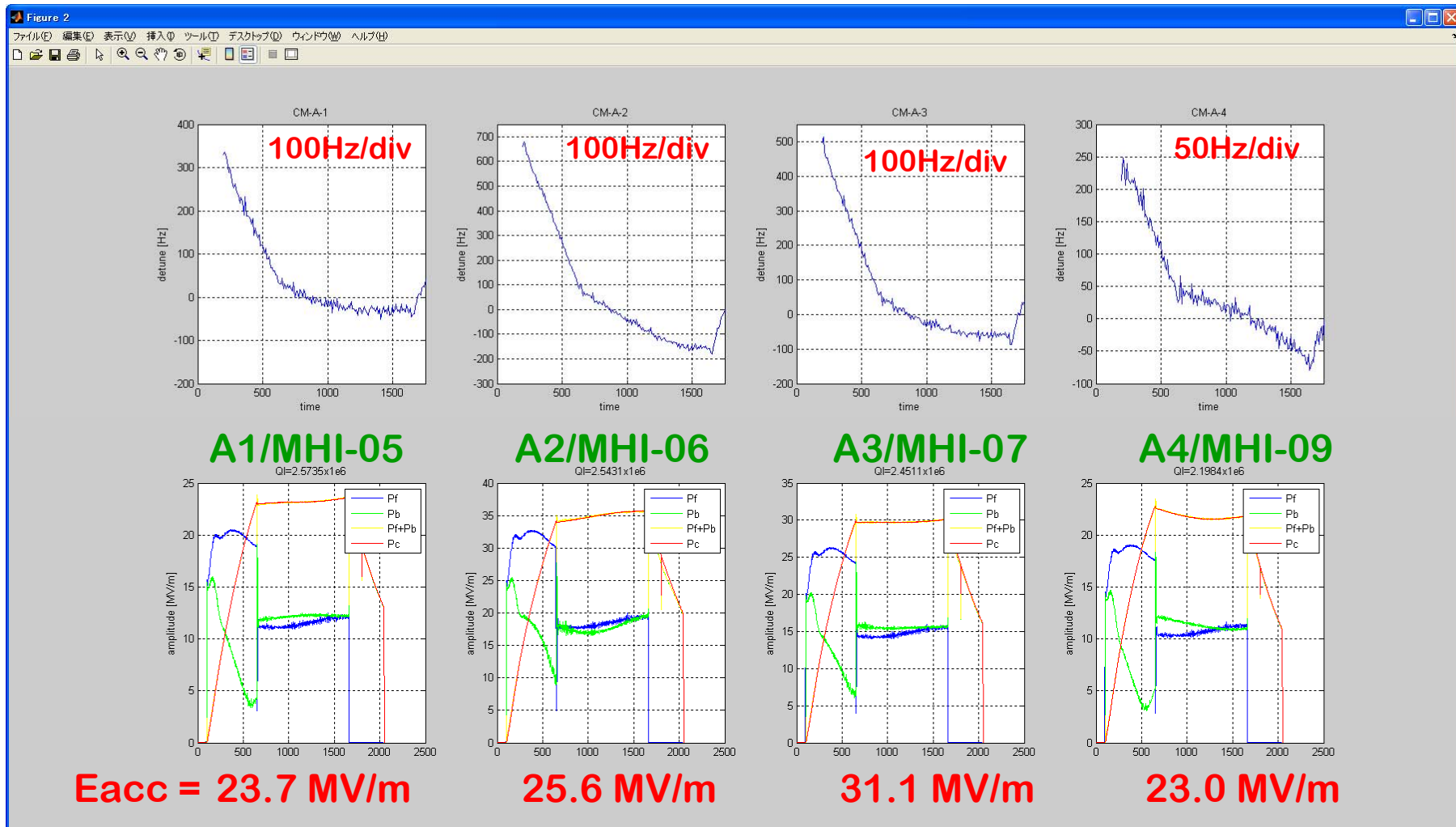






# 4-Cavity Operation in Cryomodule-A

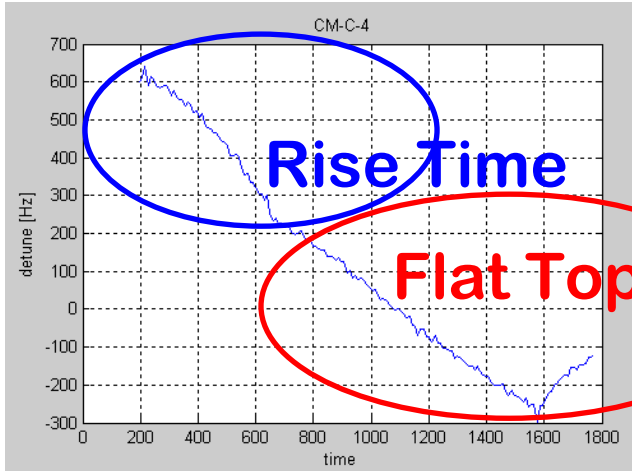
FB/on, Piezo/off, ave. Eacc = 28.4 MV/m



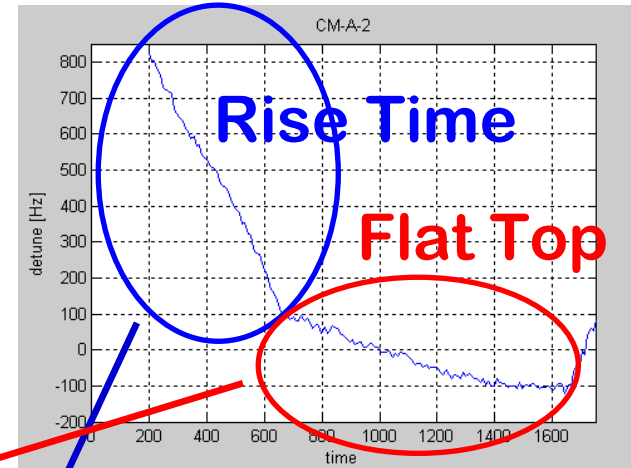


# Frequency shift due to Lorentz detuning

## C4/Z109 (29MV/m)

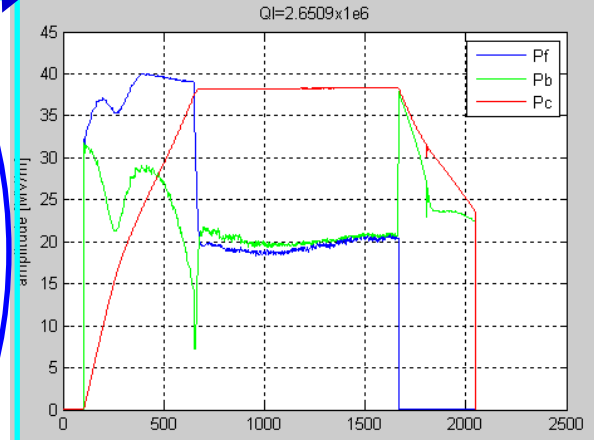
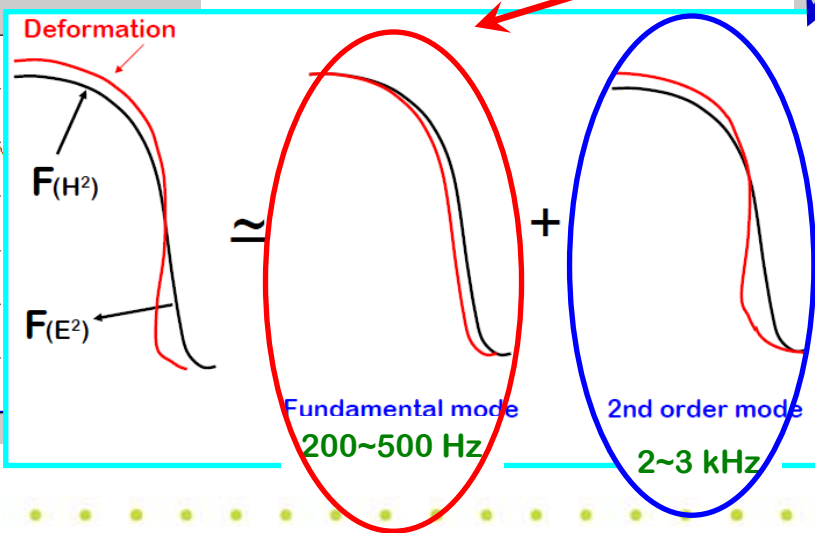
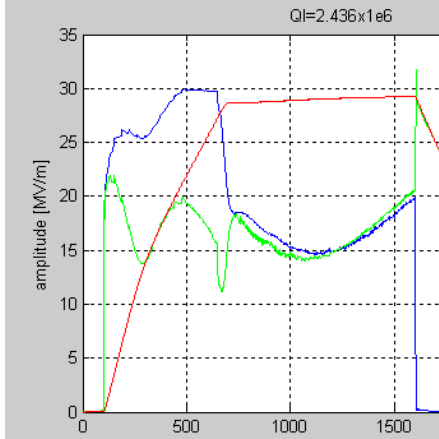


## A2/MHI-06 (38MV/m)



Pre-detuning  
by motor tuner  
& piezo tuner  
with DC voltage

Compensation  
by piezo tuner in  
pulsed operation



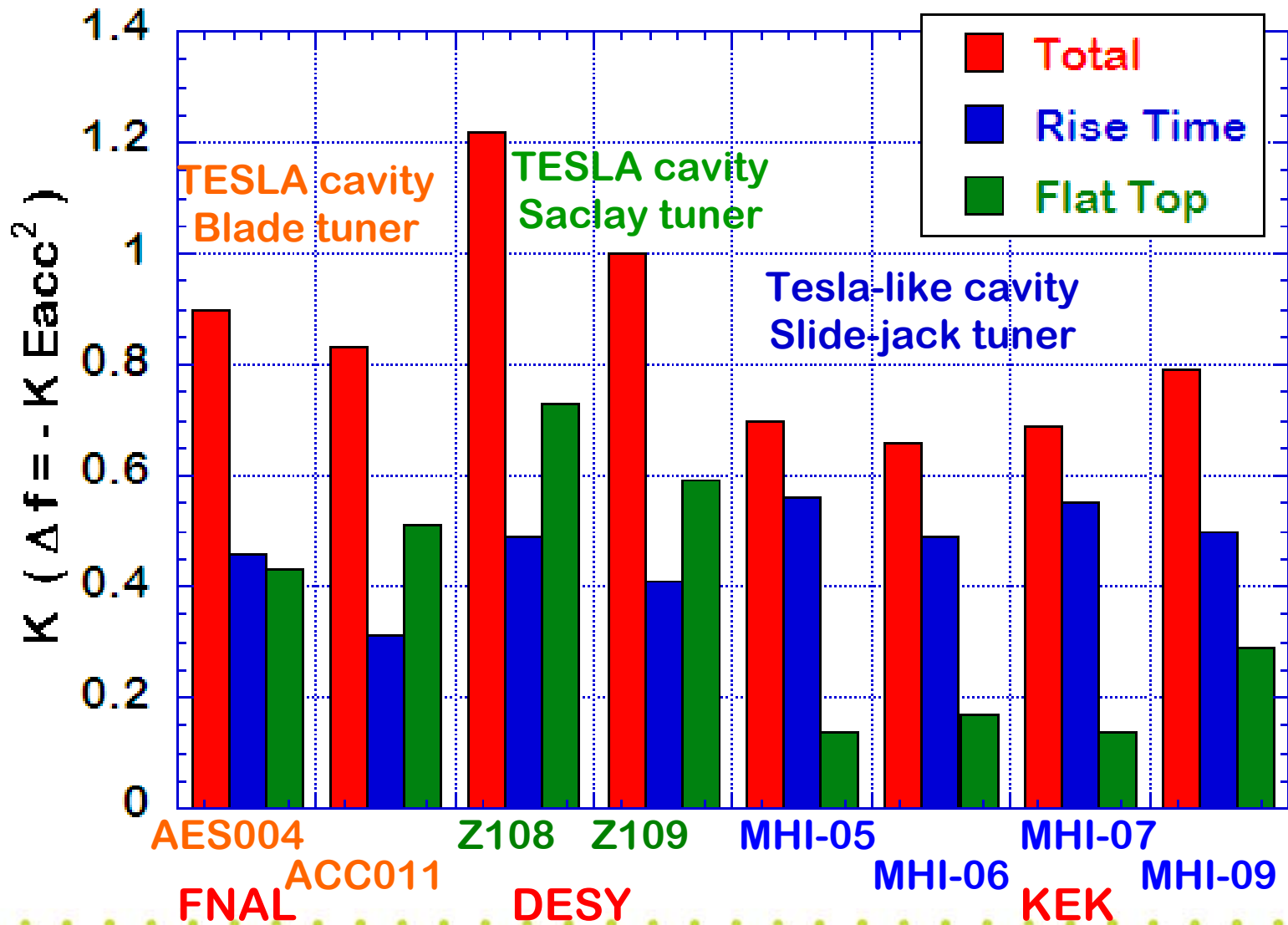
FB/on, Piezo/off

FB/on, Piezo/off





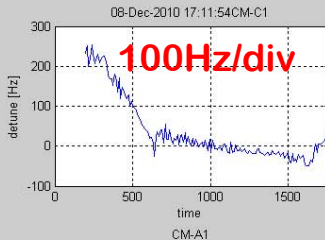
# Comparison of Detuning Frequency by LFD



# 7-cavity operation in Cryomodule-C&A

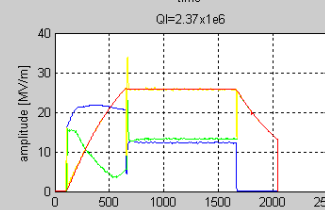
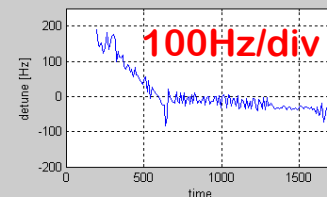
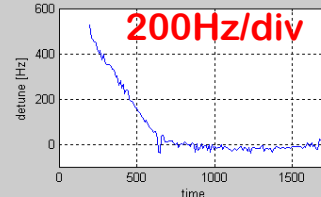
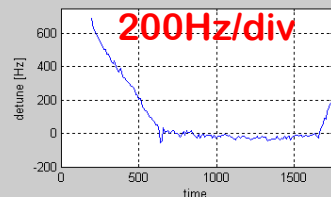
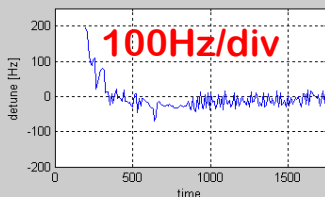
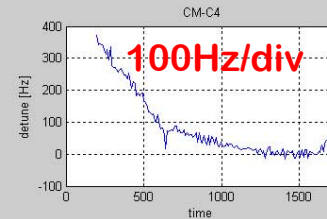
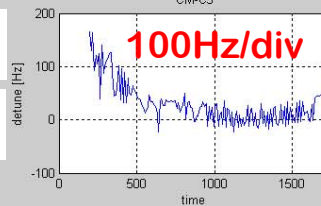
**Ave. Eacc = 26.2 MV/m ; FB/on, Piezo/on, 1299.900 MHz**

**C2 :  
Detune**



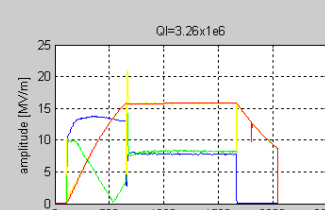
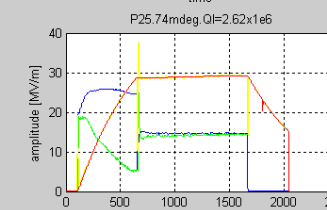
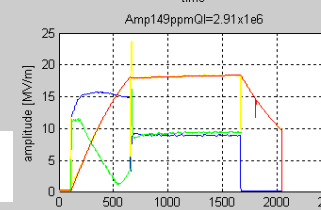
**C : ave. 25 MV/m**

**A : ave. 27 MV/m**

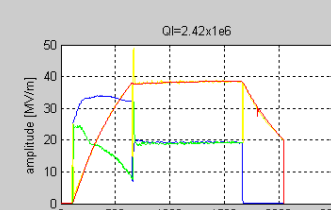


**C1 : 26 MV/m**

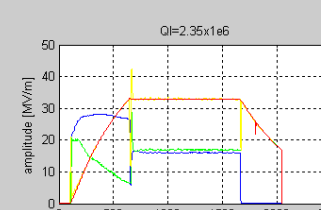
**C3 : 18 MV/m**



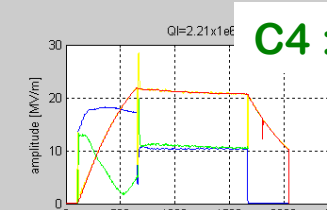
**A1 : 16 MV/m**



**A2 : 39 MV/m**



**A3 : 34 MV/m**



**A4 : 22 MV/m**

**C4 : 30 MV/m**



# 7-cavity operation in Cryomodule-C&A

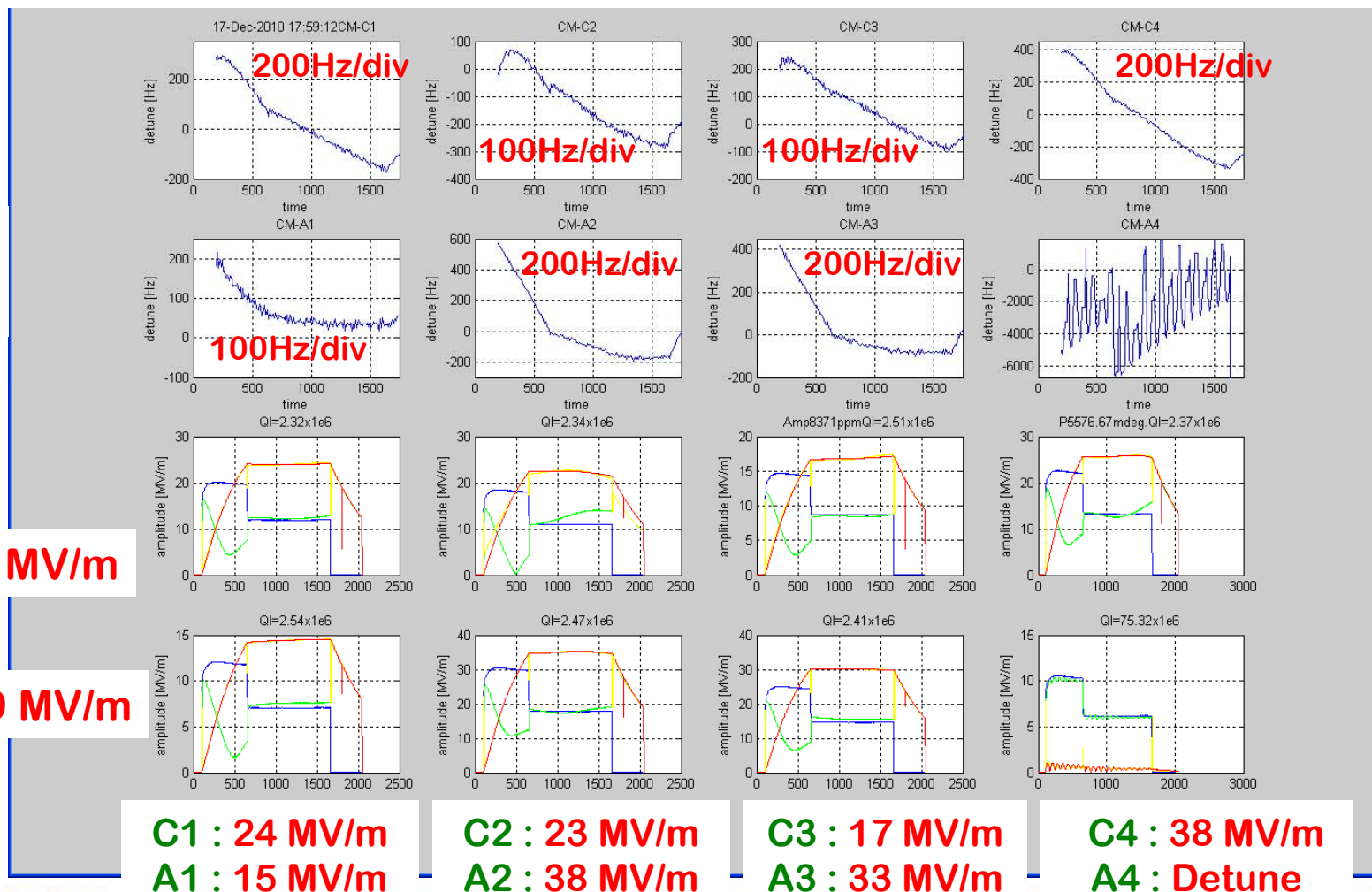
Figure 1

**Ave. Eacc = 25.4 MV/m ; FB/on, Piezo/off, 1299.923 MHz**

**A4 :  
Detune**

**C : ave. 23 MV/m**

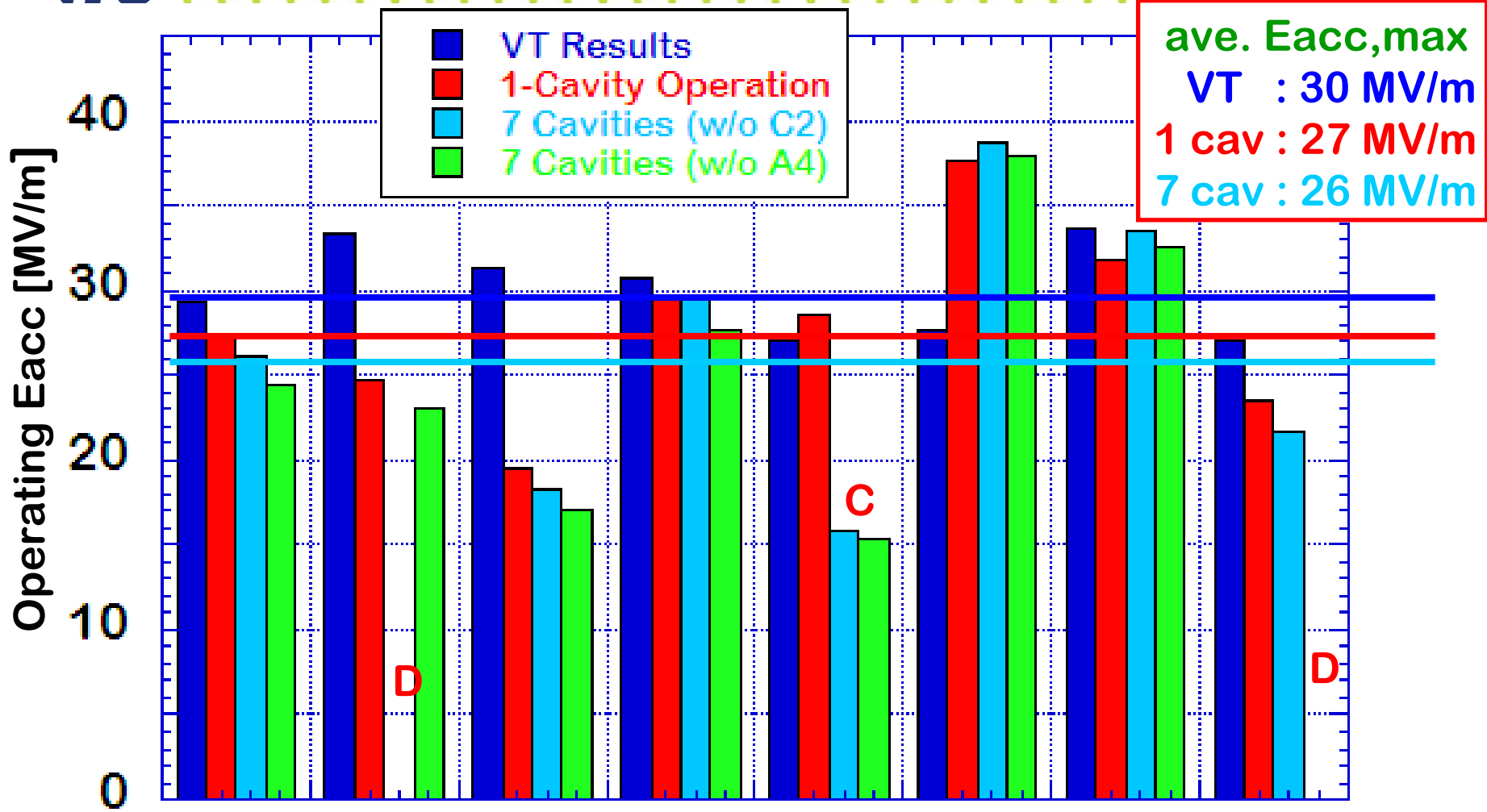
**A : ave. 29 MV/m**







# Comparison of cavity performance



ave. Eacc,max  
 VT : 30 MV/m  
 1 cav : 27 MV/m  
 7 cav : 26 MV/m

D : Detune  
 C : Coupler

AES004 ACC011 Z108 Z109 MHI-05 MHI-06 MHI-07 MHI-09  
 FNAL DESY KEK

# Summary

- Achieved ave. 27 MV/m in cryomodule tests was 10% reduction from ave. 30 MV/m in vertical tests.
- Ave. Eacc of 26 MV/m was successfully demonstrated in the 7-cavity operation by the vector-sum control.
- Stable operation with a dynamic Lorentz-detuning compensation by a piezo tuner was achieved.
- Two cavities showed the performance degradation of the Eacc,max from vertical tests to cryomodule tests.
- Two frequency tuning systems did not work correctly.
- Vacuum I/L in a warm coupler limited the performance.
  
- For the next step:  
Disassembly of S1-Global cryomodule is scheduled in order to understand above troubles.

**END**

**Thank you for your attention.....**