



# Cavity Assembly Status of S1-Global Cryomodule



**Eiji Kako**  
**(KEK, Japan)**



# Outline

1. Overview of S1-Global Cryomodule
2. Final VT Results of 8 Cavities for S1-G
3. Cavity Assembly for Cryomodule-C
  - . Cavity string assembly by DESY & FNAL
  - . Tuner assembly by INFN & FNAL
  - . Warm Coupler assembly by DESY
4. Cavity Assembly for Cryomodule-A
  - . Cavity string assembly by KEK
  - . Tuner assembly by KEK & MHI
5. RF Measurement of 8 Cavities
6. Next step of schedule in 2010'



# Acknowledgements

**Special thanks go to .....**

**. Cavity string assembly team;**

Tug Arkan (FNAL), Brian Smith (FNAL),

Marco Battistoni (FNAL), Axel Matheisen (DESY)

Manuela Schmoekel (DESY), Patrick Schilling (DESY)

**. Tuner assembly team;**

Carlo Pagani (INFN), Rocco Pararella (INFN),

Angelo Bosotti (INFN), Serena Barbanotti (FNAL)

**. Warm coupler assembly team;**

Denis Kostin (DESY)

**KEK staffs in STF group**



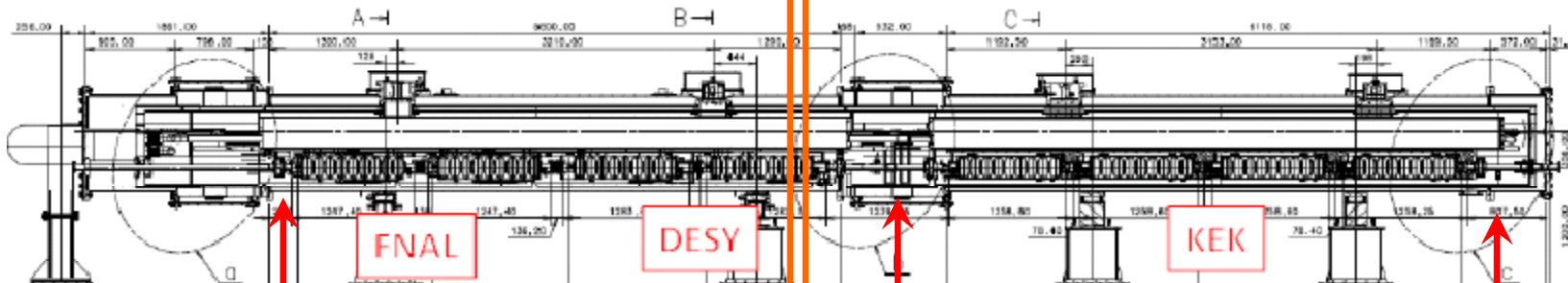
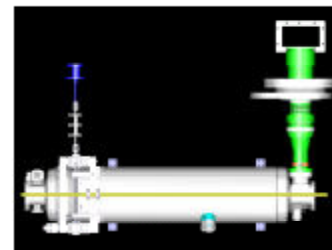
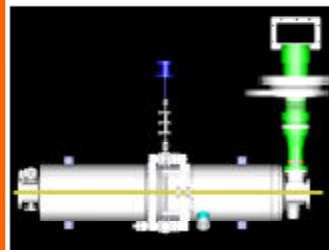
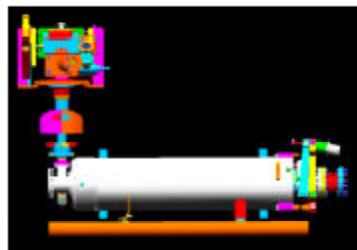
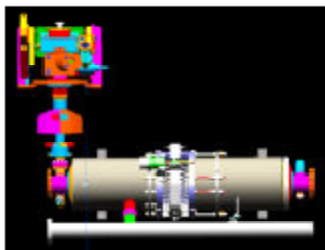
# Overview of S1-Global Cryomodule

**FNAL#1,#2**  
**AES004, ACC011**

**DESY#1,#2**  
**Z108, Z109**

**KEK#1,#2**  
**MHI05, MHI06**

**KEK#3,#4**  
**MHI07, MHI09**



Connection to 2K cold box

Cryomodule-C

Cryomodule-A

Pumping system  
Up stream

Gate-valve

No connection  
No beam tube  
No gate-valve  
Closed by Blind Flange

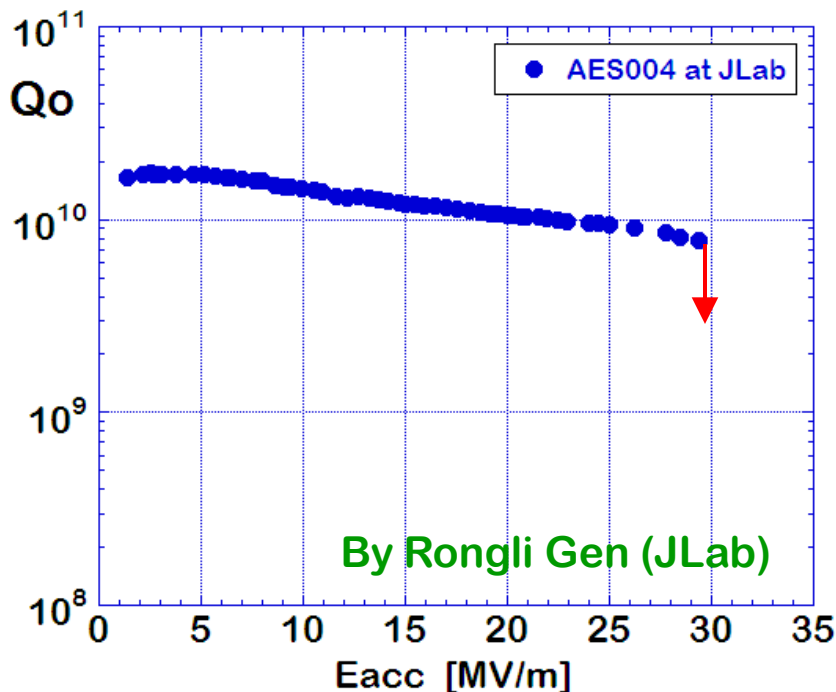
Gate-valve  
Down stream

Pumping system



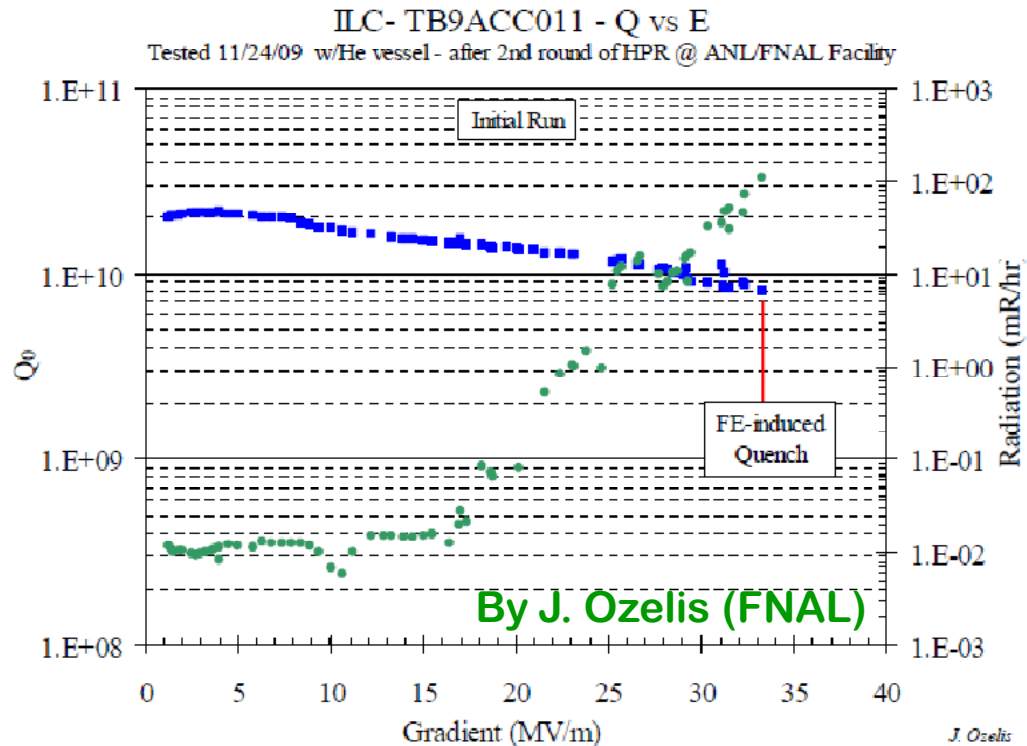
# Vertical Test Results of FNAL Cavities

## AES004 Cavity



**Eacc,max = 29.4 MV/m**  
 **$Q_0 = 7.8 \times 10^9$**   
**Limitation  $\rightarrow$  Quench**  
**VT at JLab  $\rightarrow$  HT at FNAL**

## ACC011 Cavity



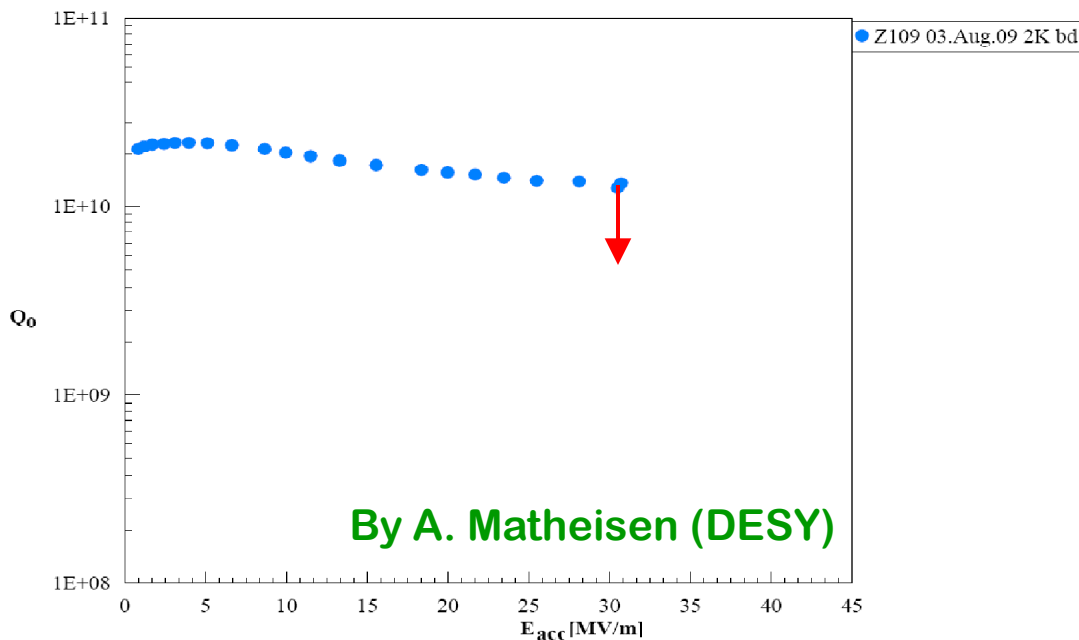
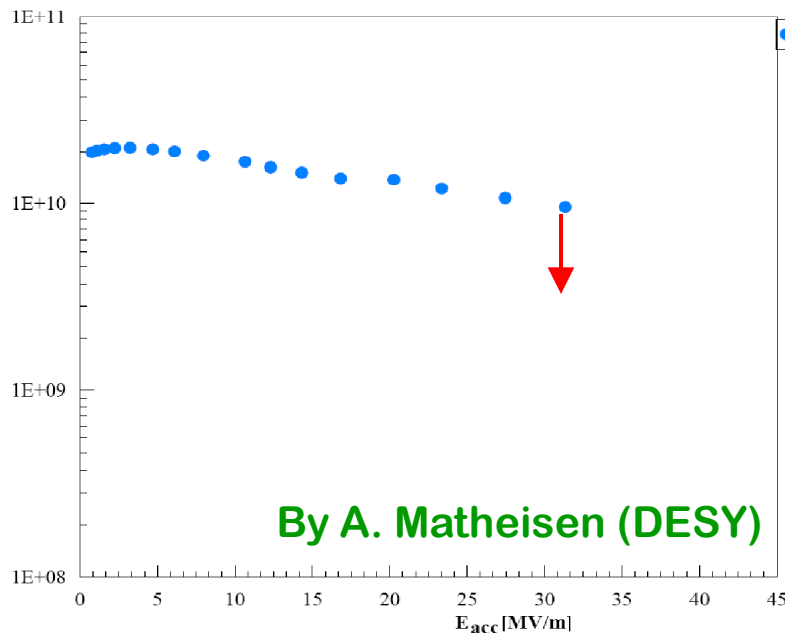
**Eacc,max = 33.3 MV/m**  
 **$Q_0 = 8.1 \times 10^9$**   
**Limitation  $\rightarrow$  Quench**  
**Vertical Test at FNAL**



# Vertical Test Results of DESY Cavities

## Z108 Cavity

## Z109 Cavity



**$E_{acc,max} = 31.3$  MV/m**

**$Q_0 = 9.6 \times 10^9$**

**Limitation  $\rightarrow$  Quench**

**Vertical Test at DESY**

**$E_{acc,max} = 30.7$  MV/m**

**$Q_0 = 1.3 \times 10^{10}$**

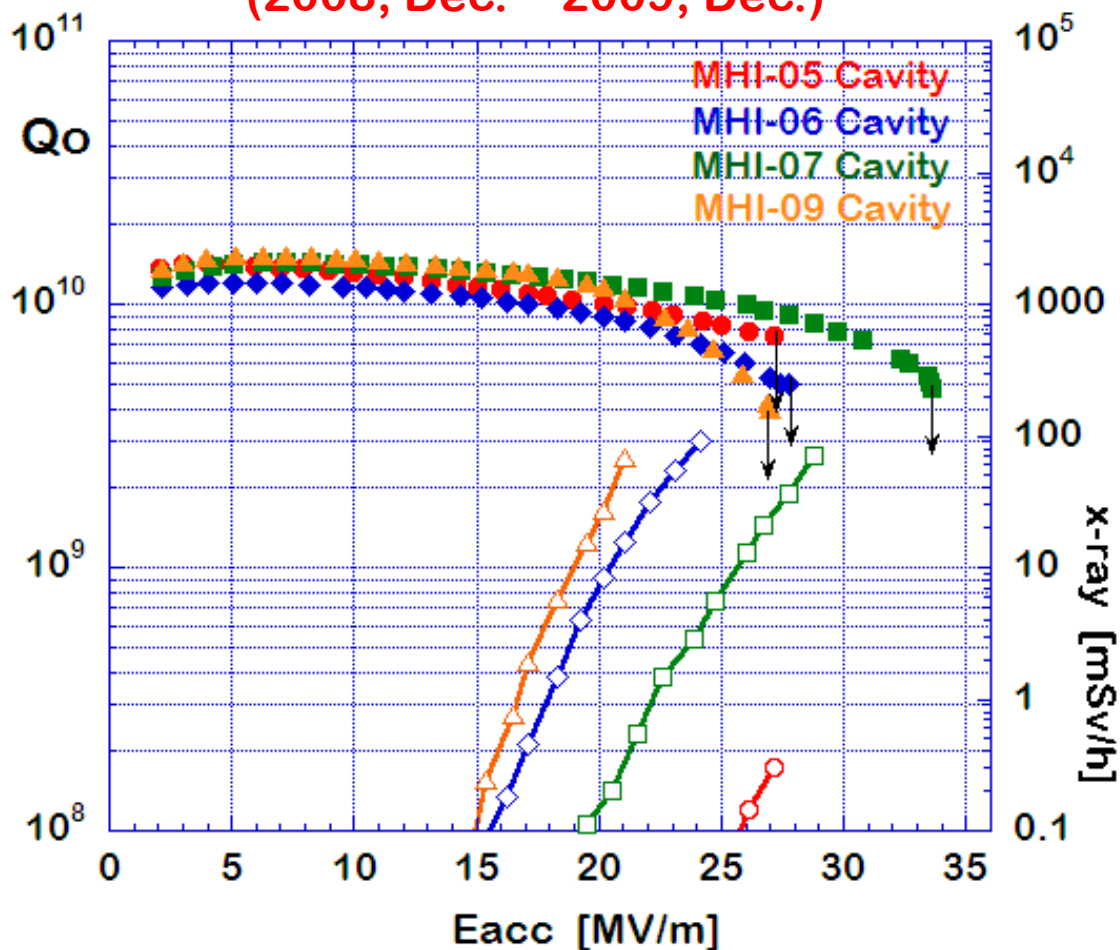
**Limitation  $\rightarrow$  Quench**

**Vertical Test at DESY**



# Final VT Results of 4 KEK Cavities

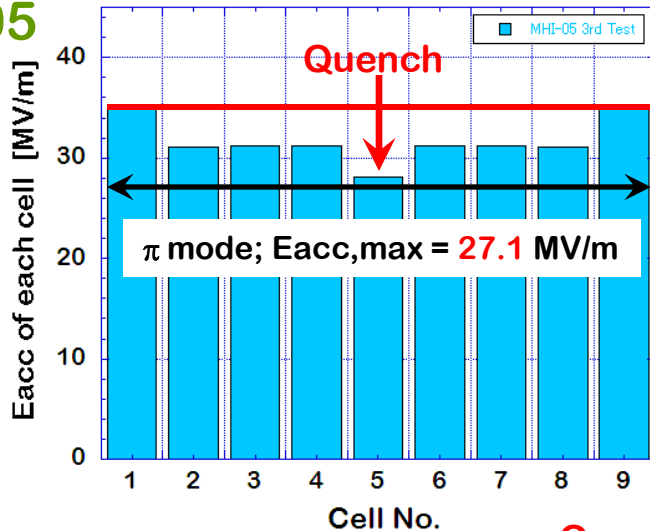
4 MHI cavities for S1-G  
ave. Eacc,max = 29 MV/m  
(2008, Dec. ~ 2009, Dec.)



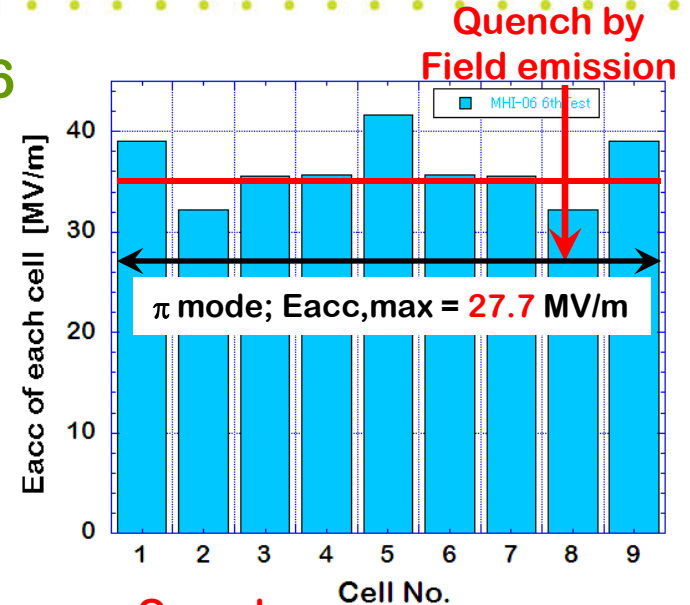


# Eacc,max (cell) by Passbands modes Meas.

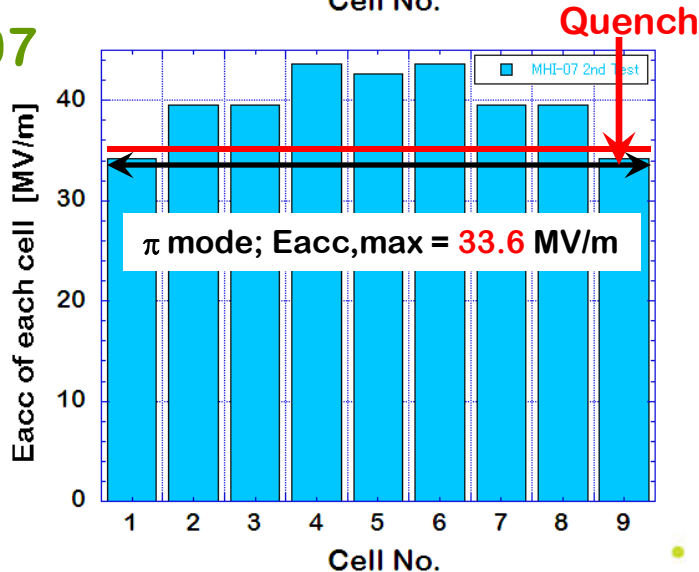
MHI-05  
3rd



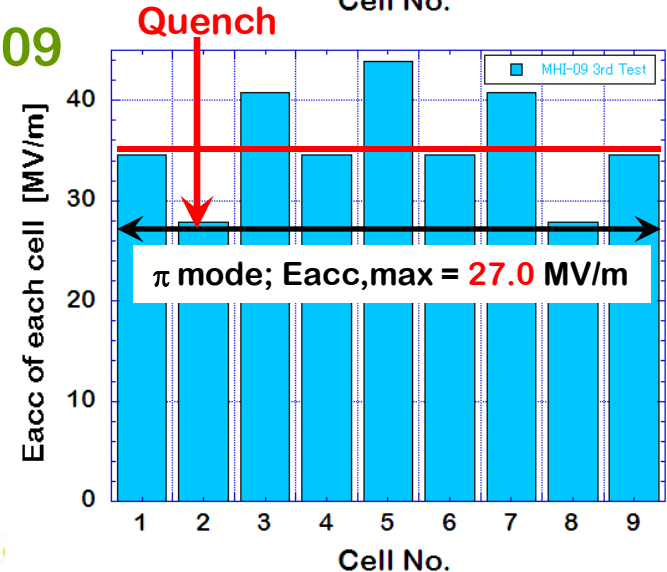
MHI-06  
6th



MHI-07  
2nd



MHI-09  
3rd







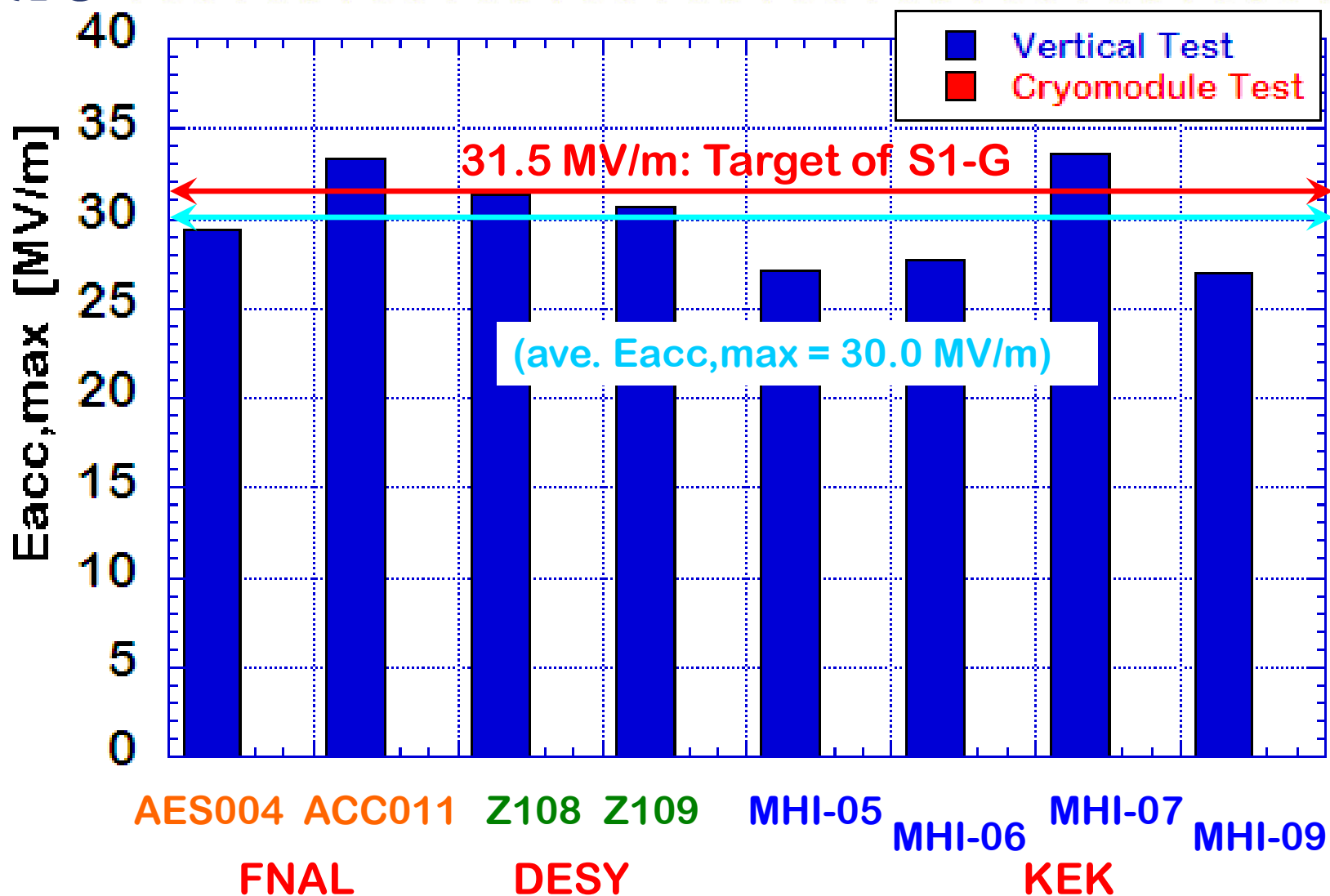
# Eight Cavities for S1-G Cryomodule

<b>Cavity</b>	<b>(Eacc,max@VT)</b>	<b>Type of Tuner (Location)</b>
1. AES-004	(29.4 MV/m)	; Blade tuner (center)
2. ACC-011	(33.3 MV/m)	; Blade tuner (center)
3. Z108	(31.3 MV/m)	; Saclay tuner (end)
4. Z109	(30.7 MV/m)	; Saclay tuner (end)
5. MHI-05	(27.1 MV/m)	; Slide-Jack tuner (center)
6. MHI-06	(27.7 MV/m)	; Slide-Jack tuner (center)
7. MHI-07	(33.6 MV/m)	; Slide-Jack tuner (end)
8. MHI-09	(27.0 MV/m)	; Slide-Jack tuner (end)

**Average Eacc,max @VT = 30.0 MV/m**

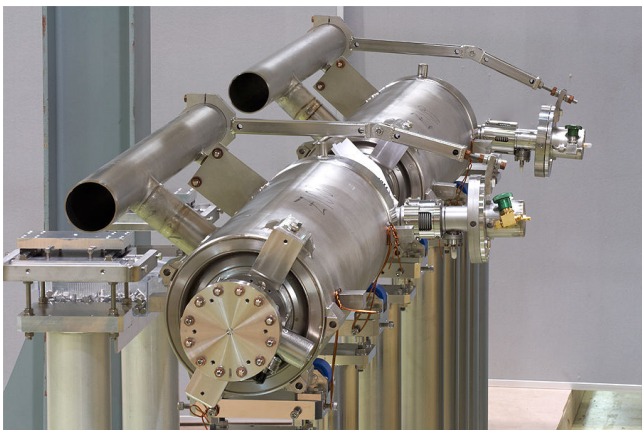


# VT Results of FNAL/DESY/KEK Cavities





# Transportation of FNAL & DESY Cavities



Tools and jigs for assembly

Two DESY cavities (Z108 and Z109) arrived at KEK in Dec. 4<sup>th</sup>, 2009'.

FNAL, ACC011 cavity arrived at KEK in Dec. 25<sup>th</sup>, 2009'.

FNAL, AES004 cavity arrived at KEK in Jan. 8<sup>th</sup>, 2010'.



# Preparation of Cavity Assembly in c-1000 CR

12th,  
January  
2010'



**Class-1000  
Clean Room**

**DESY#2, #1  
Z109, Z108**

**FNAL#2, #1  
ACC011, AES004**

E. KAKO (KEK)  
2010' Mar. 29

**ILC10 @ Beijing  
Global Design Effort**



# Cavity String Assembly Team

17<sup>th</sup>, January  
2010'



Patrick Schilling (DESY)

Marco Battistoni (FNAL)

Brian Smith (FNAL)

Shuichi Noguchi (KEK)

Tug Arkan (FNAL)

Manuela Schmoekel (DESY)

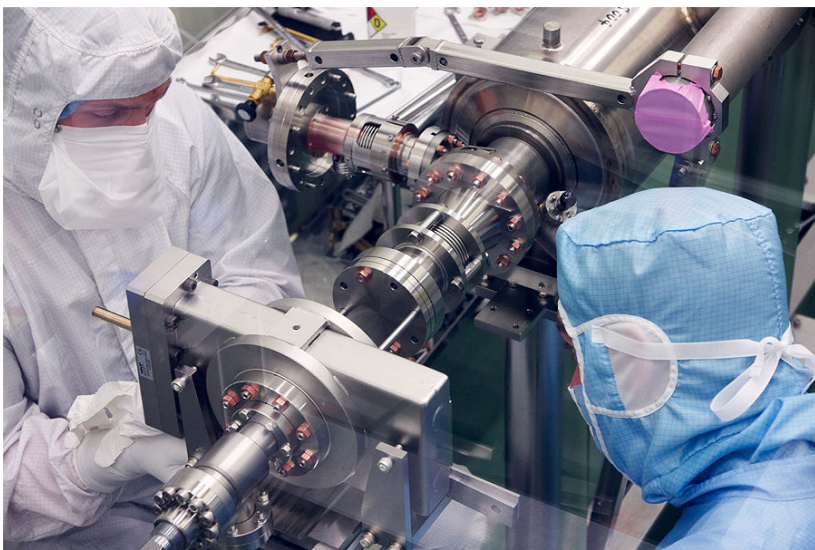
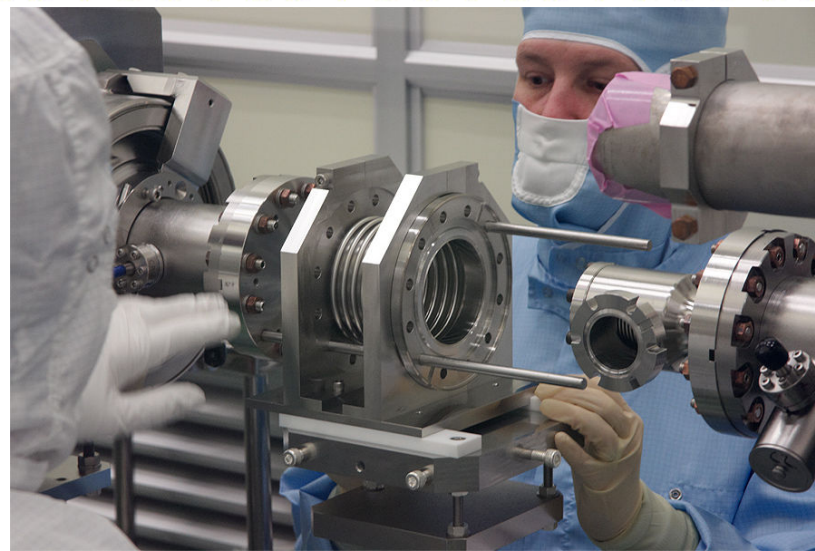
Eiji Kako (KEK)

E. KAKO (KEK)  
2010' Mar. 29

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# Cavity String Assembly in c-10 CR





# Four Cavities after String Assembly

**FNAL#1**  
**AES004**

**FNAL#2**  
**ACC011**

**DESY#1**  
**Z108**

**DESY#2**  
**Z109**

**Class-10**  
**Clean Room**



**19th, January**  
**2010'**

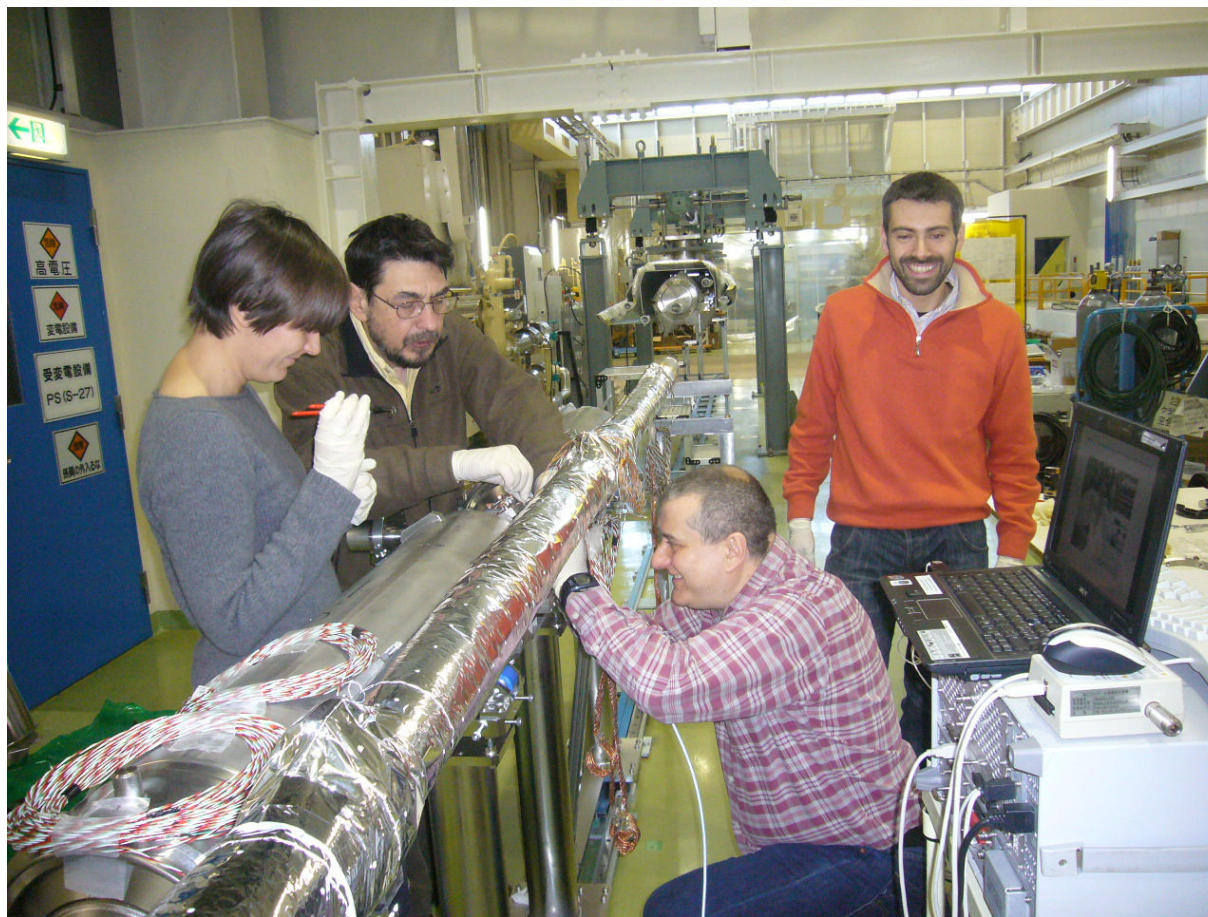
E. KAKO (KEK)  
2010' Mar. 29

**ILC10 @ Beijing**  
**Global Design Effort**



# Tuner Assembly Team for S1-Global

2010'  
08<sup>th</sup>, Feb



Carlo Pagani (INFN)

Rocco Pararella (INFN)

Serena Barbanotti (FNAL)

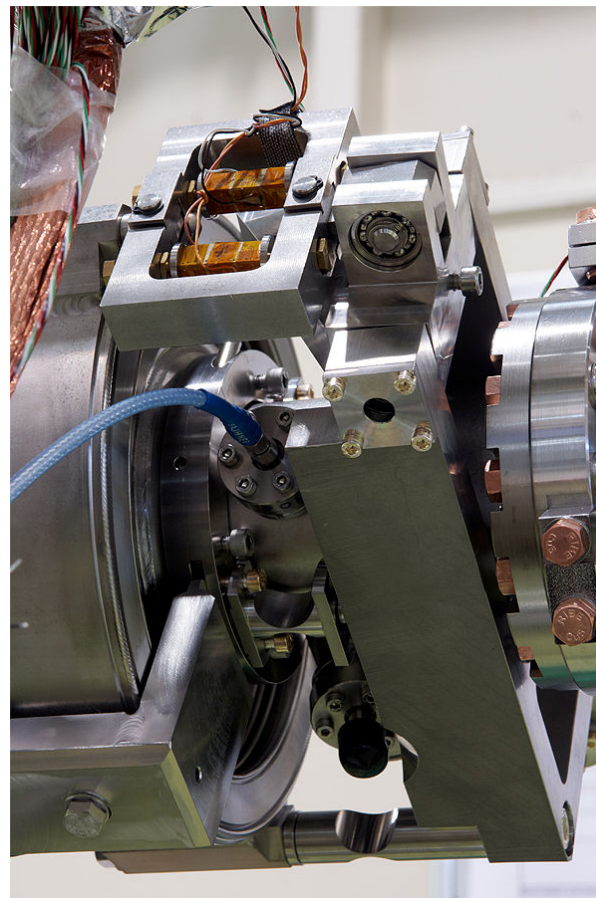
Angelo Bosotti (INFN)



# Assembly of Blade Tuner & Saclay Tuner

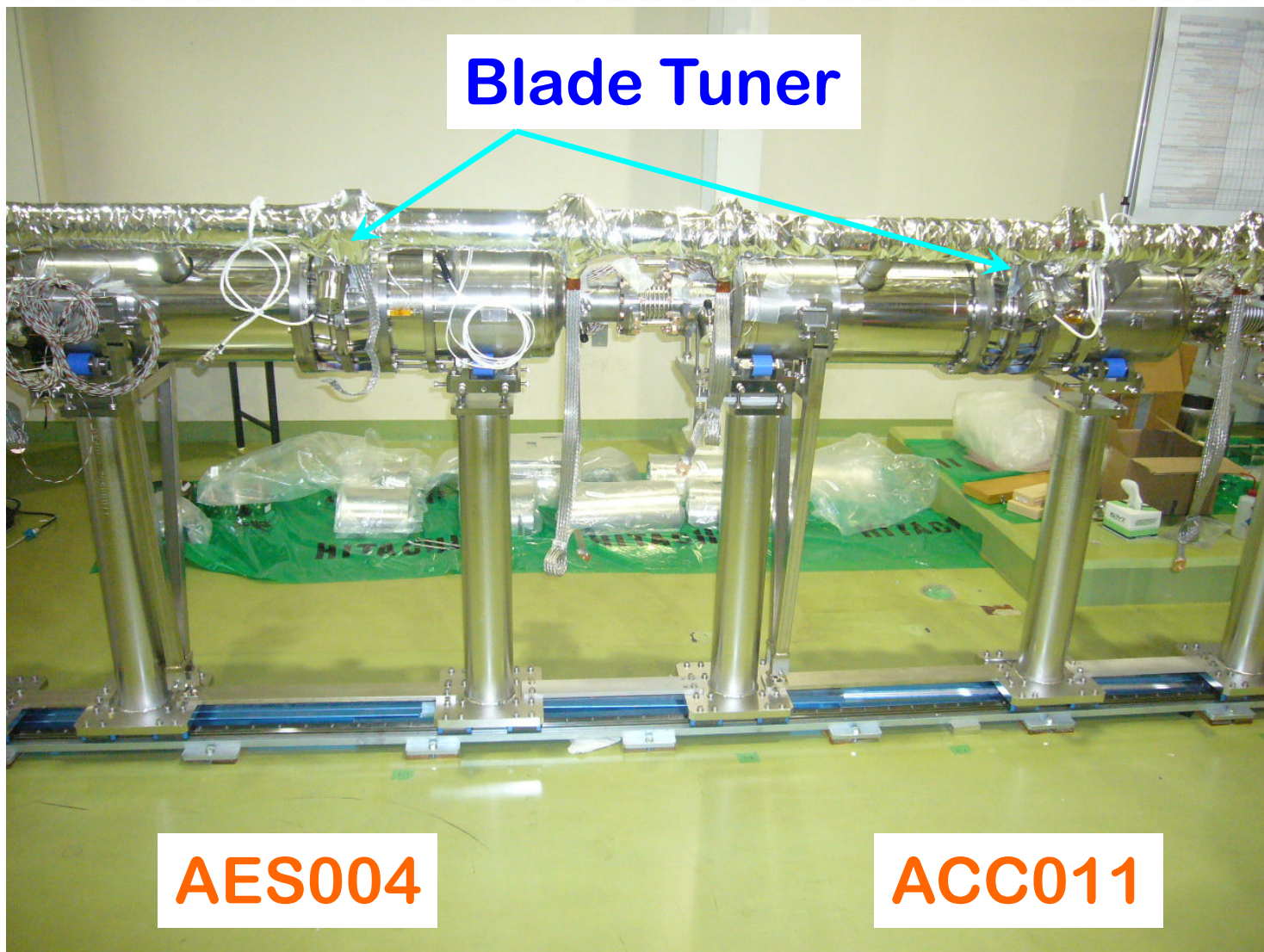


**Blade Tuner  
for FNAL Cavity**



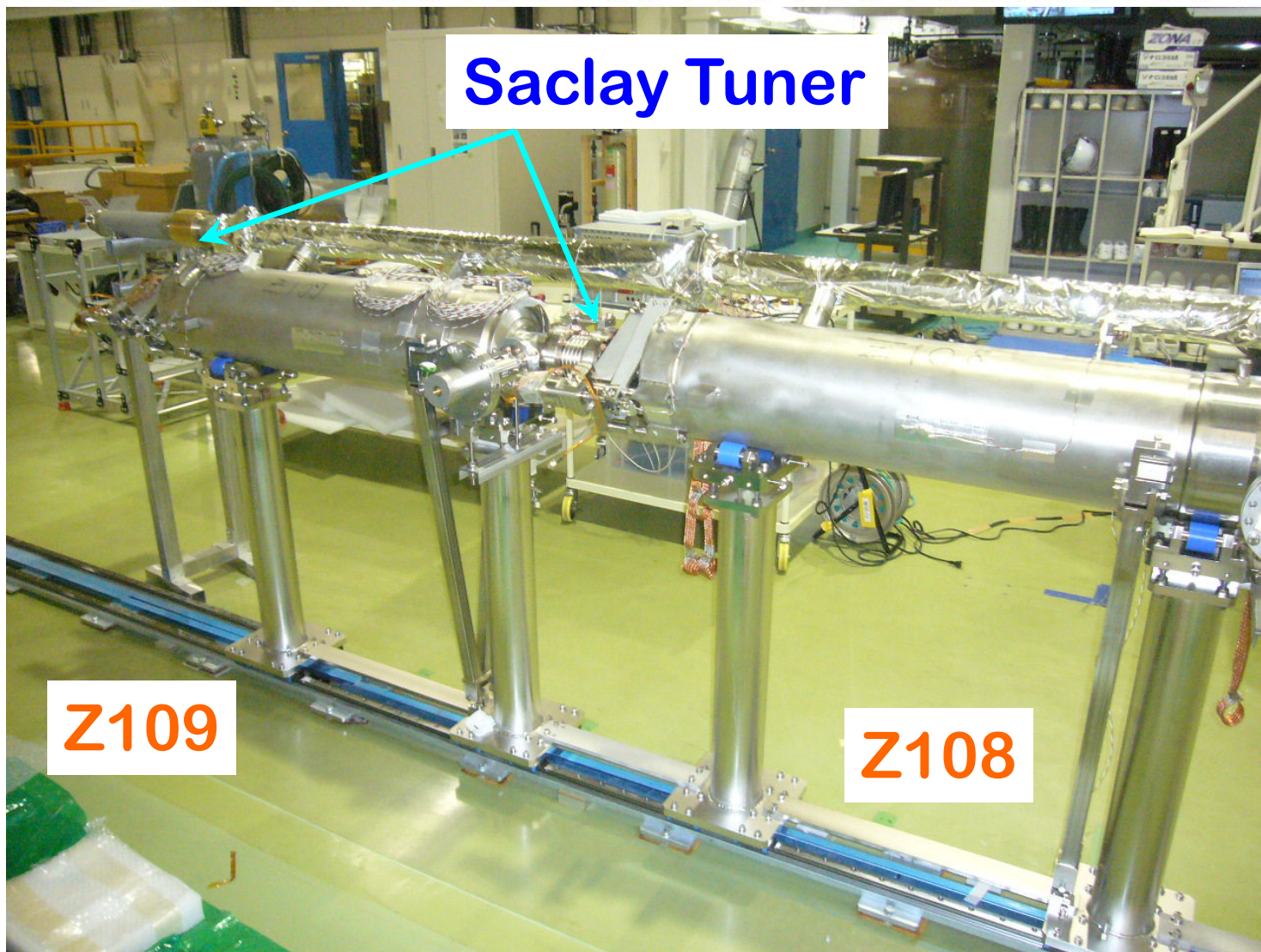
**Saclay Tuner  
for DESY Cavity**

# Blade Tuner for FNAL Cavities





# Saclay Tuner for DESY Cavities





# Installation of 4 cavities under GRP

2010'  
Feb. 09

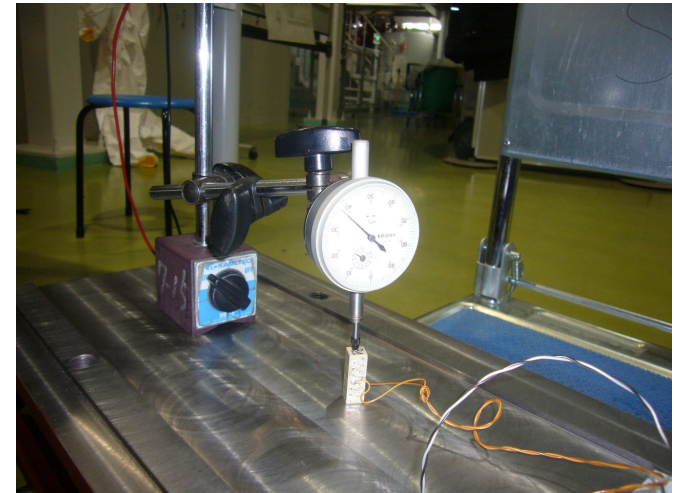
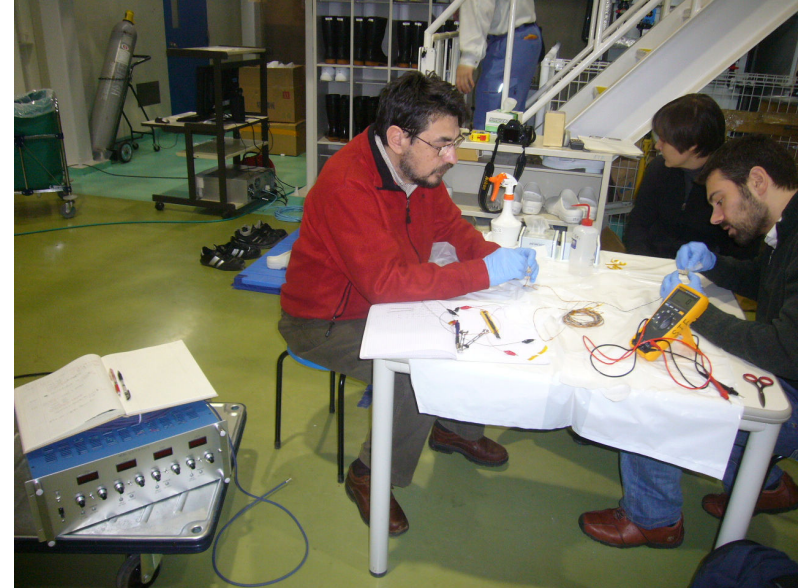


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# Tuner Drive Test of FNAL/DESY Cavities



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# TTF-III Warm Coupler Assembly

March 16<sup>th</sup>, 2010'



TTF-III Warm Coupler



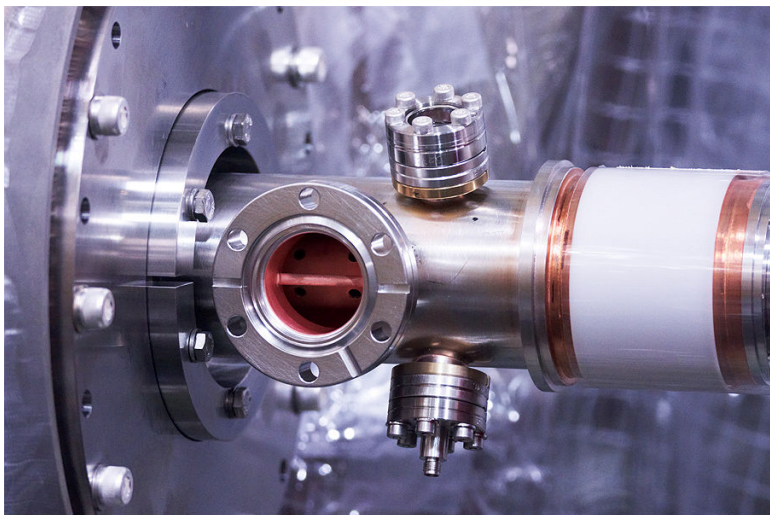
Two from DESY, Two from FNAL/SLAC

E. KAKO (KEK)  
2010' Mar. 29

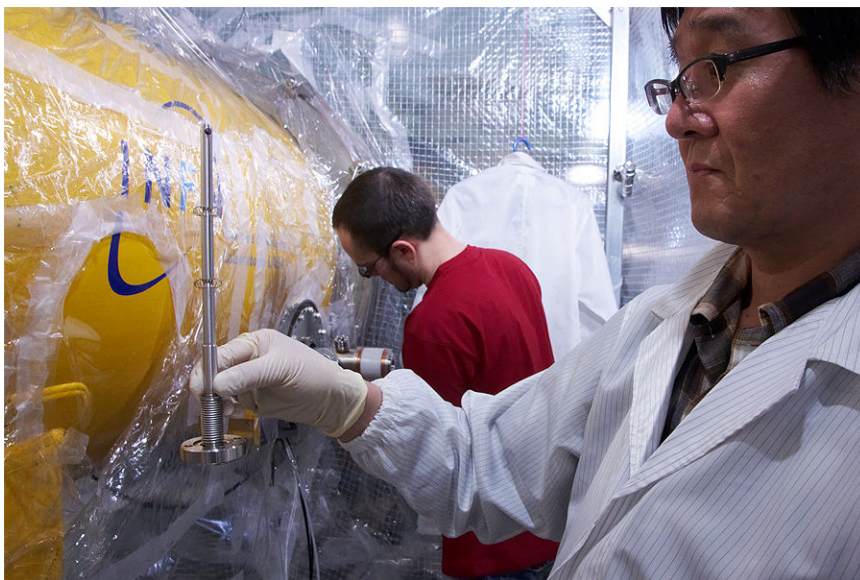
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Global Design Effort



# TTF-III Warm Coupler Assembly



Denis Kostin (DESY)



E. KAKO (KEK)  
2010' Mar. 29

**ILC10 @ Beijing**  
Global Design Effort



# TTF-III Warm Coupler Assembly



March 19<sup>th</sup>, 2010'

Denis Kostin (DESY)

E. KAKO (KEK)  
2010' Mar. 29

**ILC10 @ Beijing**  
Global Design Effort





# TTF-III Warm Coupler Assembly



Z109

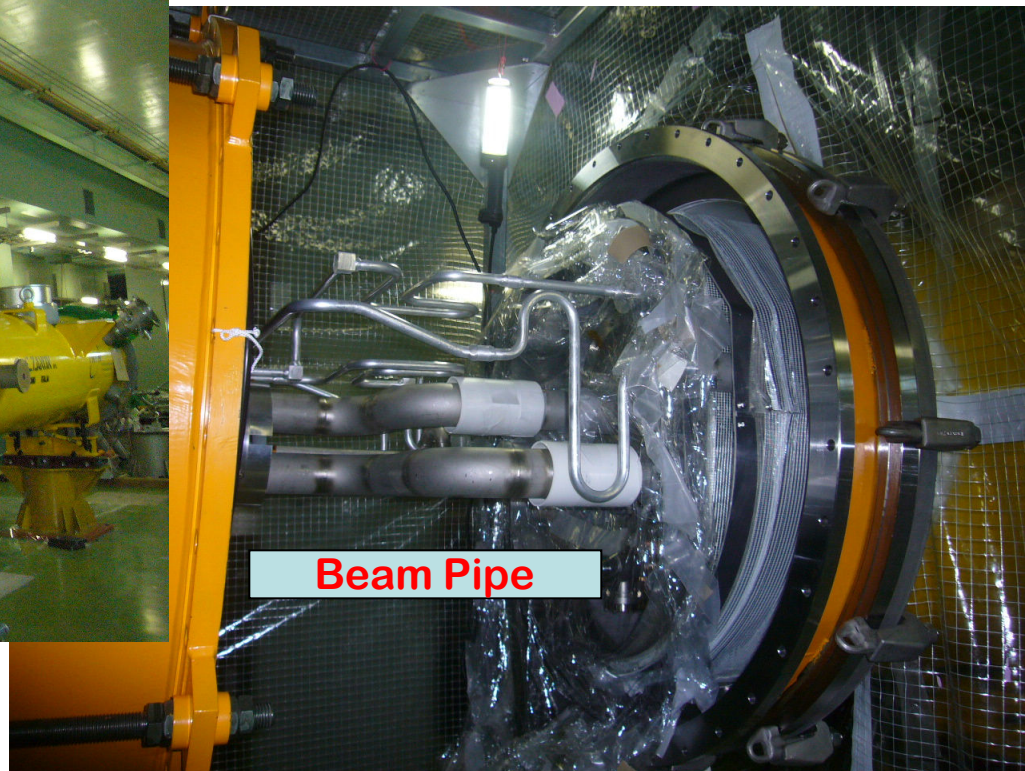
Z108

ACC011

AES004

March 23, 2010'

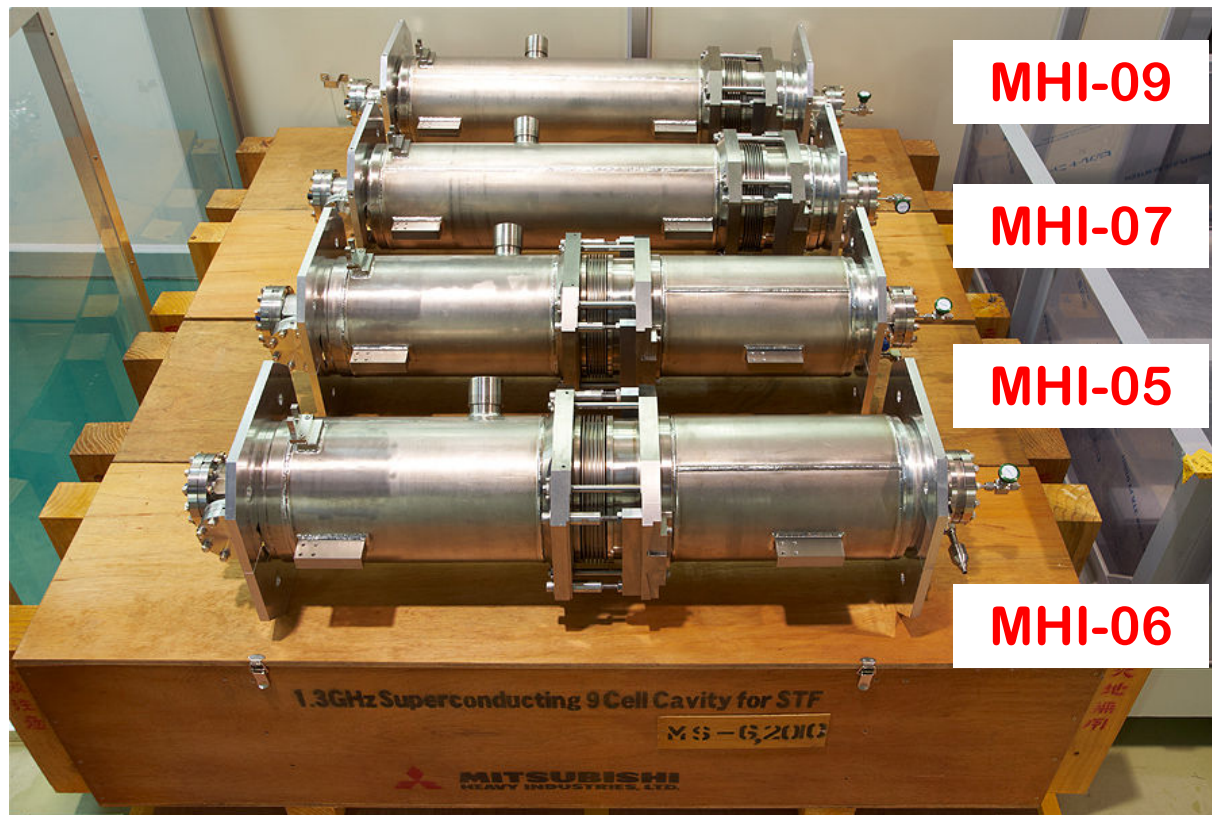
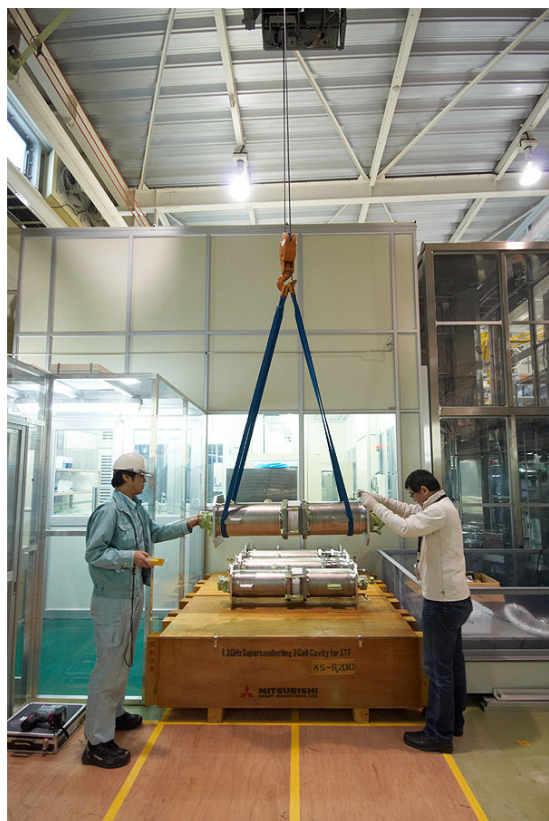
# Connection of Beam Pipe for Cryomodule-C



Scheduled in April, 6<sup>th</sup> - 7<sup>th</sup>



# Delivery of 4 MHI Cavities at KEK

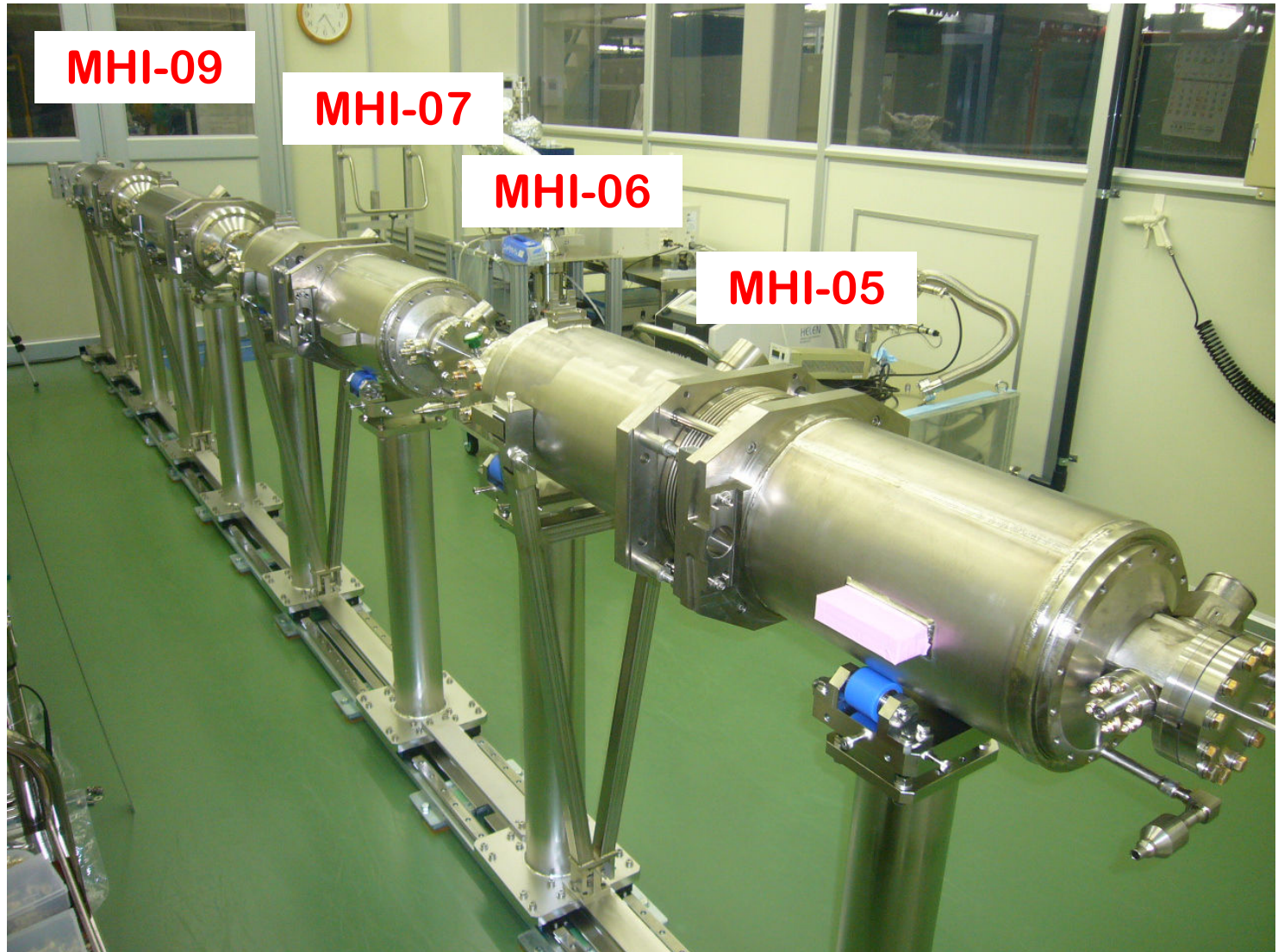


Four MHI cavities (MHI-05, 06, 07, 09)  
arrived at KEK in 16th, February.



# Preparation of Cavity String Assembly

23rd,  
February  
2010'



Class-1000  
Clean Room



# Cavity String Assembly of 4 KEK Cavities



E. KAKO (KEK)  
2010' Mar. 29

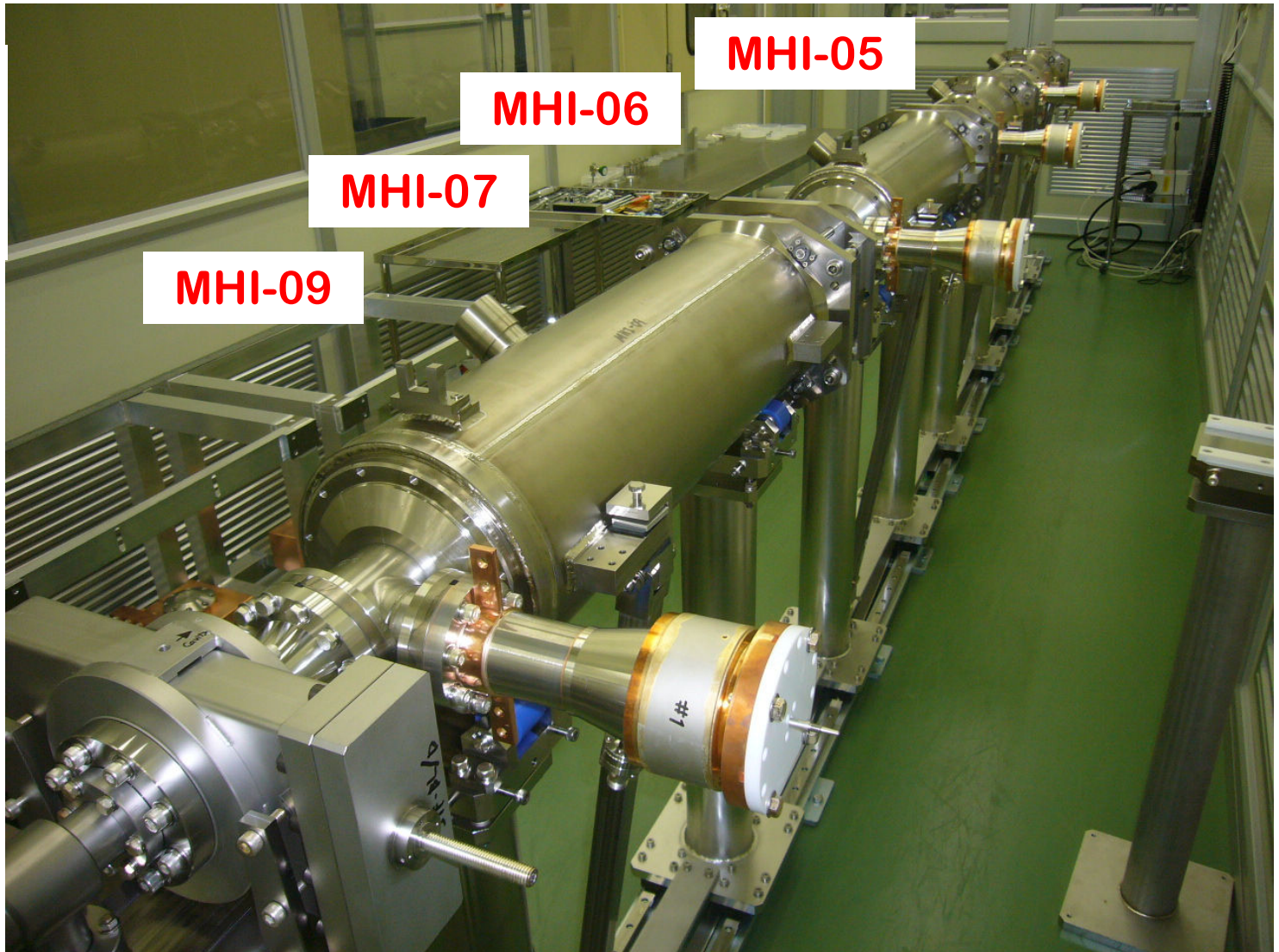
**ILC10 @ Beijing**  
Global Design Effort

**Class-10**  
Clean Room



# Completed String Assembly of KEK Cavities

5th,  
March  
2010'



MHI-09

MHI-07

MHI-06

MHI-05

Class-10  
Clean Room

E. KAKO (KEK)  
2010' Mar. 29

ILC10 @ Beijing  
Global Design Effort

**Memorial Photo  
(8th, Mar. 2010')**

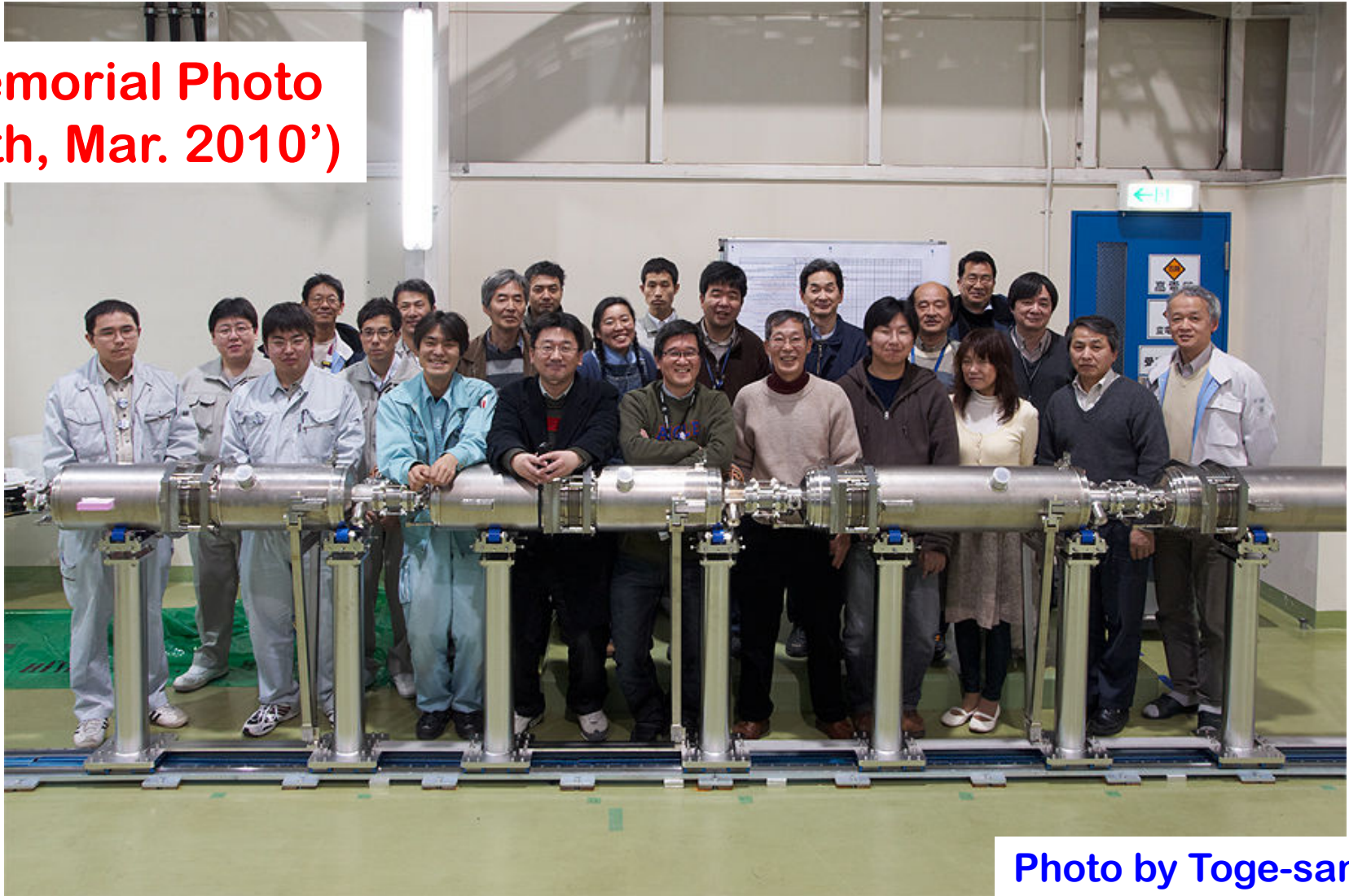
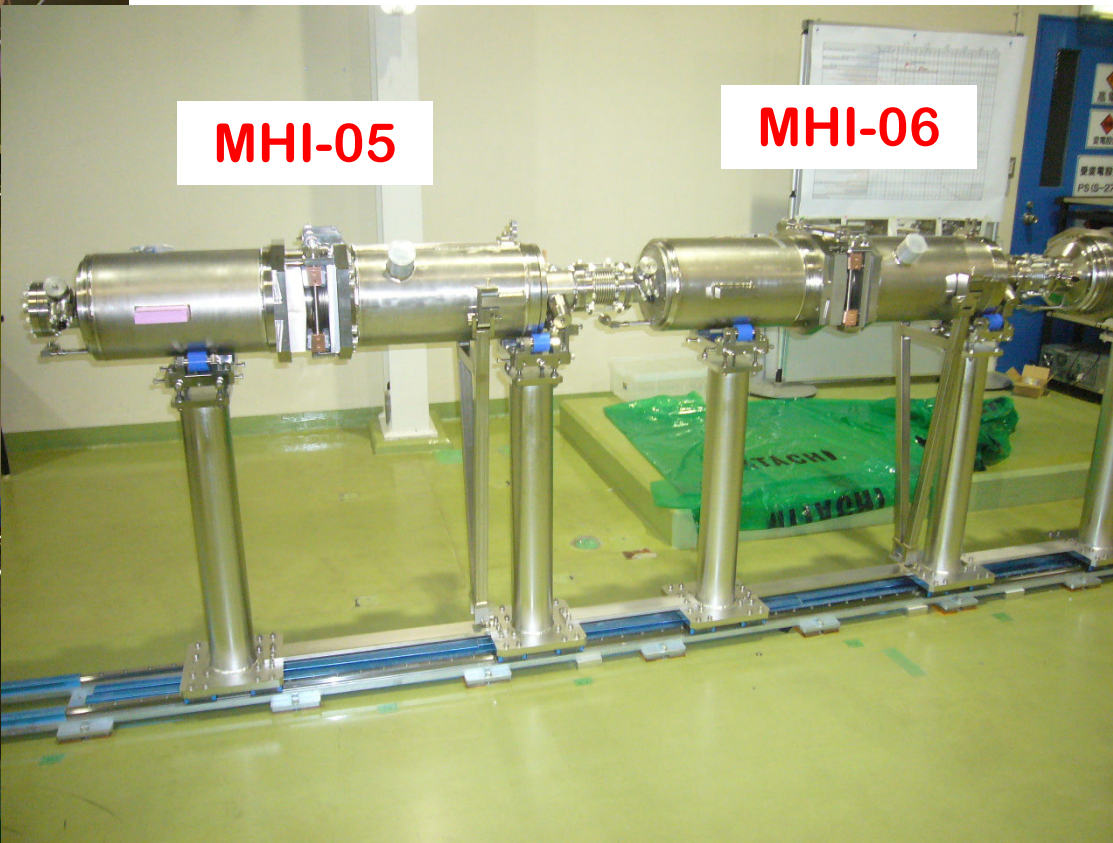
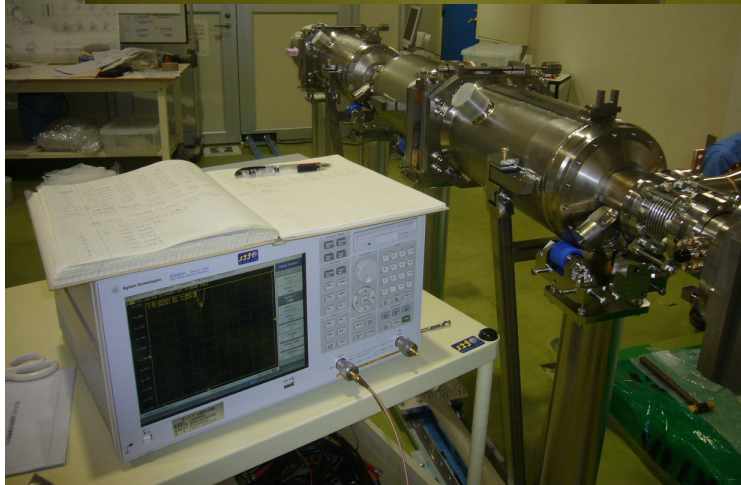
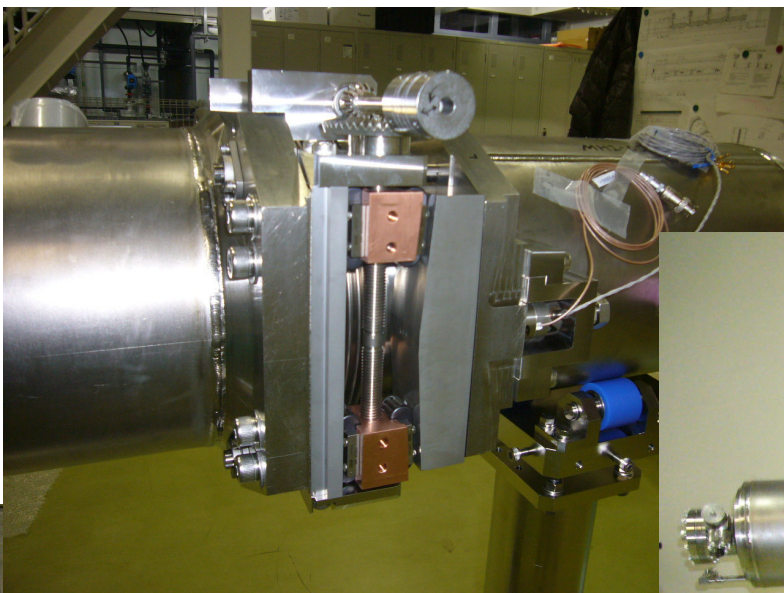


Photo by Toge-san



# Slide-Jack Tuner Assembly

9th, March  
2010'



E. KAKO (KEK)  
2010' Mar. 29

**ILC10 @ Beijing**  
Global Design Effort

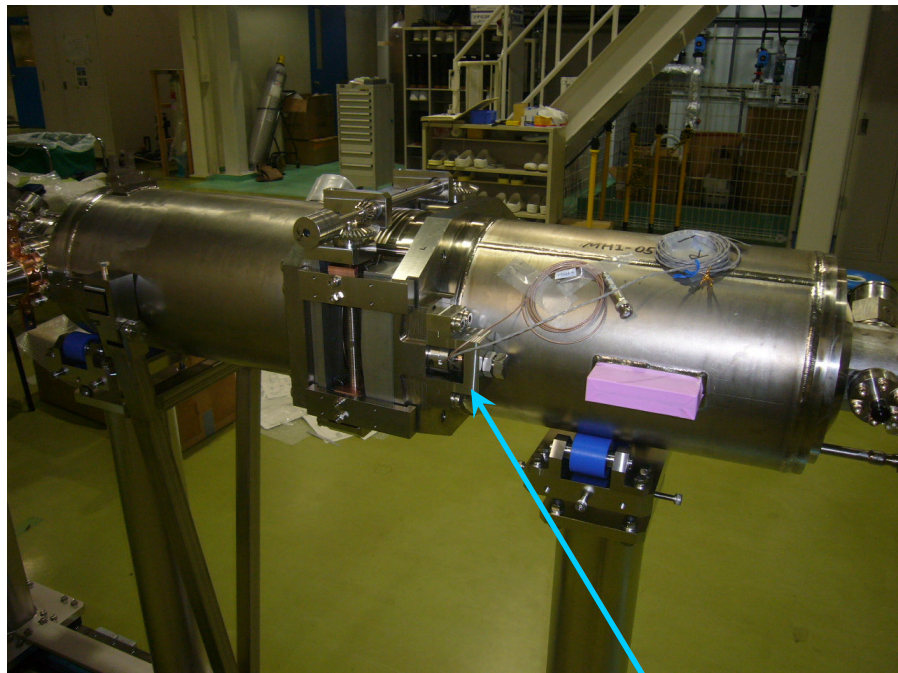




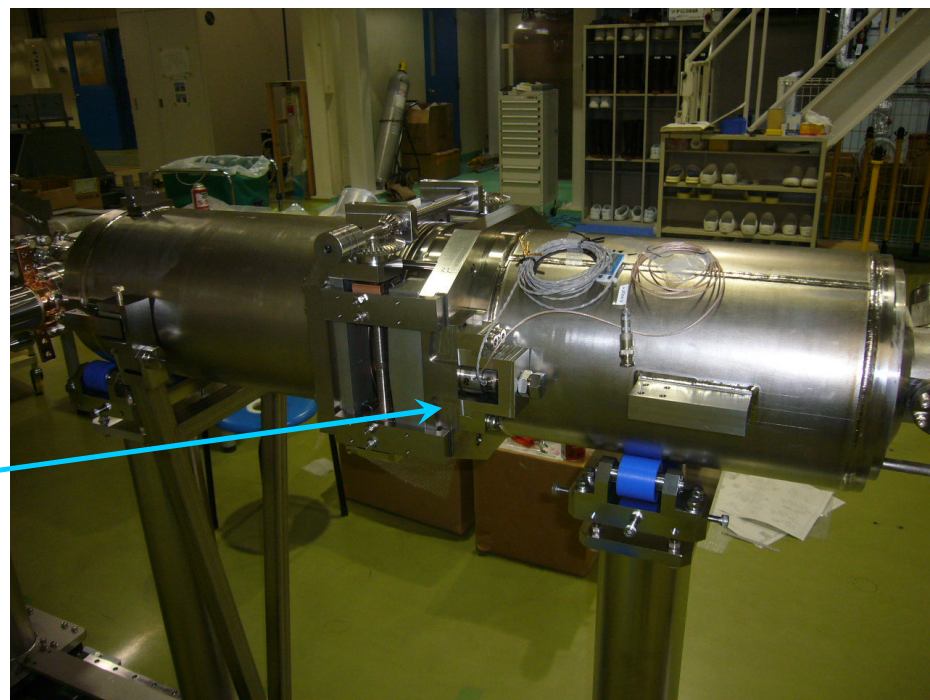
# Slide-Jack Tuner Assembly

MHI-05

23rd, March  
2010'



MHI-06



Piezo Tuner  
& Load Sensor

## Slide-Jack Tuner Center

E. KAKO (KEK)  
2010' Mar. 29

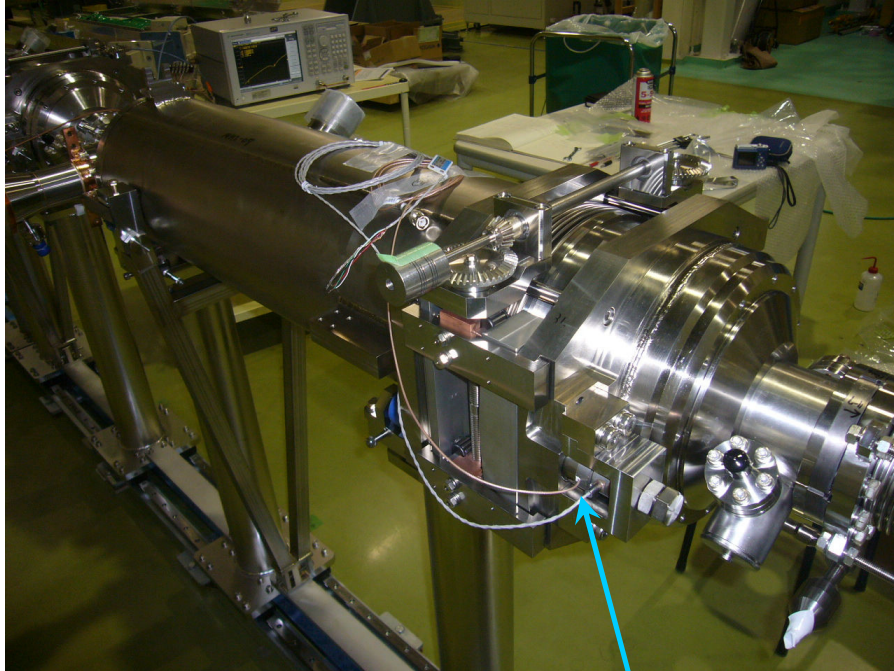
ILC10 @ Beijing  
Global Design Effort



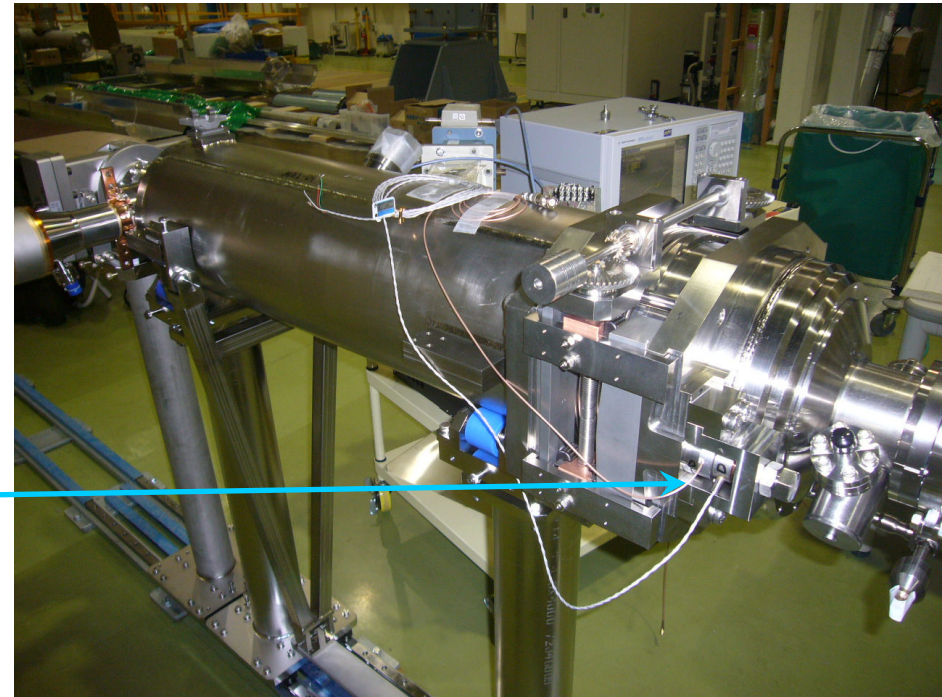
# Slide-Jack Tuner Assembly

MHI-07

23rd, March  
2010'



MHI-09

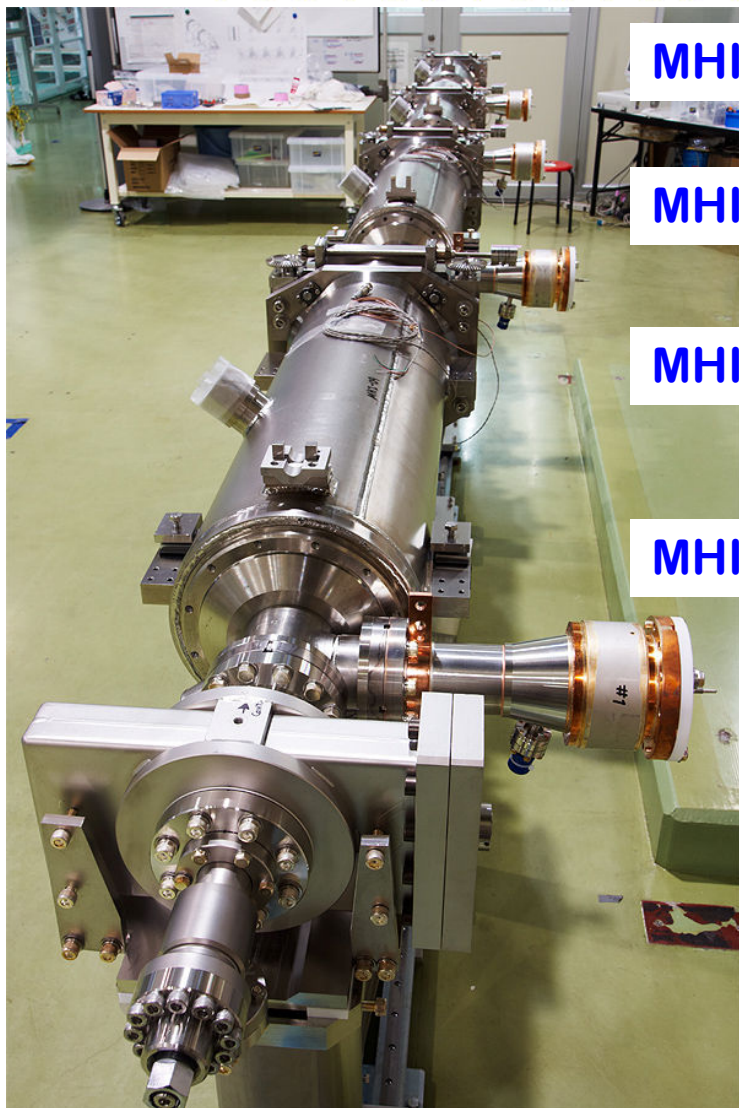


Piezo Tuner  
& Load Sensor

Slide-Jack Tuner  
End



# Slide-Jack Tuner Assembly

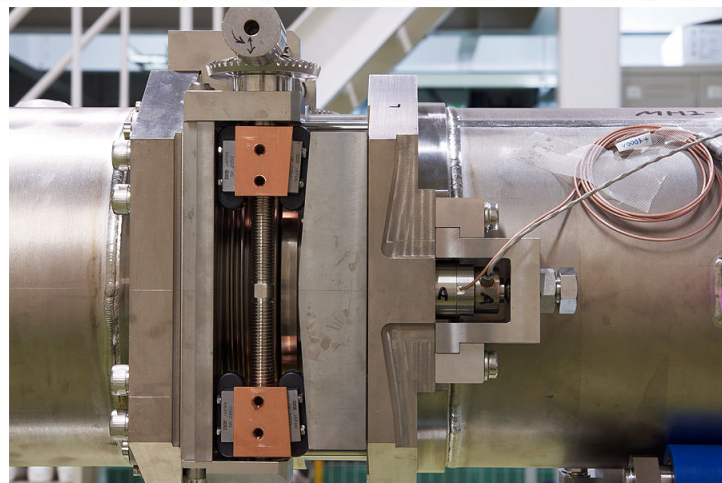


MHI-05

MHI-06

MHI-07

MHI-09





# Meas. of Cavity Frequency at KEK

<b>Cavity</b>	<b>as received (vacuum)</b>	<b>after string assembly (Ar gas 1 bar)</b>
<b>1. AES-004</b>	<b>(Ar) (1297.532)</b>	<b>1297.518 MHz</b>
<b>2. ACC-011</b>	<b>1297.650</b>	<b>1297.280 MHz</b>
<b>3. Z-108</b>	<b>1297.677</b>	<b>1297.377 MHz</b>
<b>4. Z-109</b>	<b>1297.683</b>	<b>1297.370 MHz</b>
<b>5. MHI-05</b>	<b>-</b>	<b>1297.081 MHz</b>
<b>6. MHI-06</b>	<b>-</b>	<b>1297.155 MHz</b>
<b>7. MHI-07</b>	<b>-</b>	<b>1297.033 MHz</b>
<b>8. MHI-09</b>	<b>-</b>	<b>1297.142 MHz</b>



# Cavity Frequency after Tuner Assembly

<b>Cavity</b>	<b>before (free)</b>	<b>after Tuner Assembly</b>
<b>1. AES-004</b>	<b>1297.490</b>	
<b>(Deformation)</b>	<b>1297.319</b>	<b>1297.354 MHz</b>
<b>(Piezo, Preload = + 50 kHz)</b>		<b><u>1297.404 MHz</u></b>
<b>2. ACC-011</b>	<b>1297.268</b>	<b>1297.313 MHz</b>
<b>(Piezo, Preload = + 100 kHz)</b>		<b><u>1297.413 MHz</u></b>
<b>3. Z-108</b>	<b>1297.387</b>	<b>1297.351 MHz</b>
<b>4. Z-109</b>	<b>1297.355</b>	<b>1297.367 MHz</b>
<b>5. MHI-05</b>	<b>1297.041</b>	<b>1297.174 MHz</b>
<b>6. MHI-06</b>	<b>1297.109</b>	<b>1297.184 MHz</b>
<b>7. MHI-07</b>	<b>1296.944</b>	<b>1297.288 MHz</b>
<b>8. MHI-09</b>	<b>1297.142</b>	<b>1297.338 MHz</b>



# Tuner Stroke Measurement

Cavity	Tuner Type	Motor ( 1 turn)	Piezo ( V = + 200 V )
1. AES-004	Blade Tuner	~ 23 kHz	~ 13 kHz
2. ACC-011	Blade Tuner	~ 31 kHz	~ 18 kHz
3. Z-108	Saclay Tuner	~ 19 kHz	~ 3 kHz
4. Z-109	Saclay Tuner	~ 23 kHz	~ 4 kHz (~40 $\mu\text{m}$ )
5. MHI-05	Slide-Jack Tuner	15.5 kHz, (317 kHz/mm)	-
6. MHI-06	Slide-Jack Tuner	15.6 kHz, (321 kHz/mm)	-
7. MHI-07	Slide-Jack Tuner	15.3 kHz, (314 kHz/mm)	-
8. MHI-09	Slide-Jack Tuner	15.1 kHz, (349 kHz/mm)	-

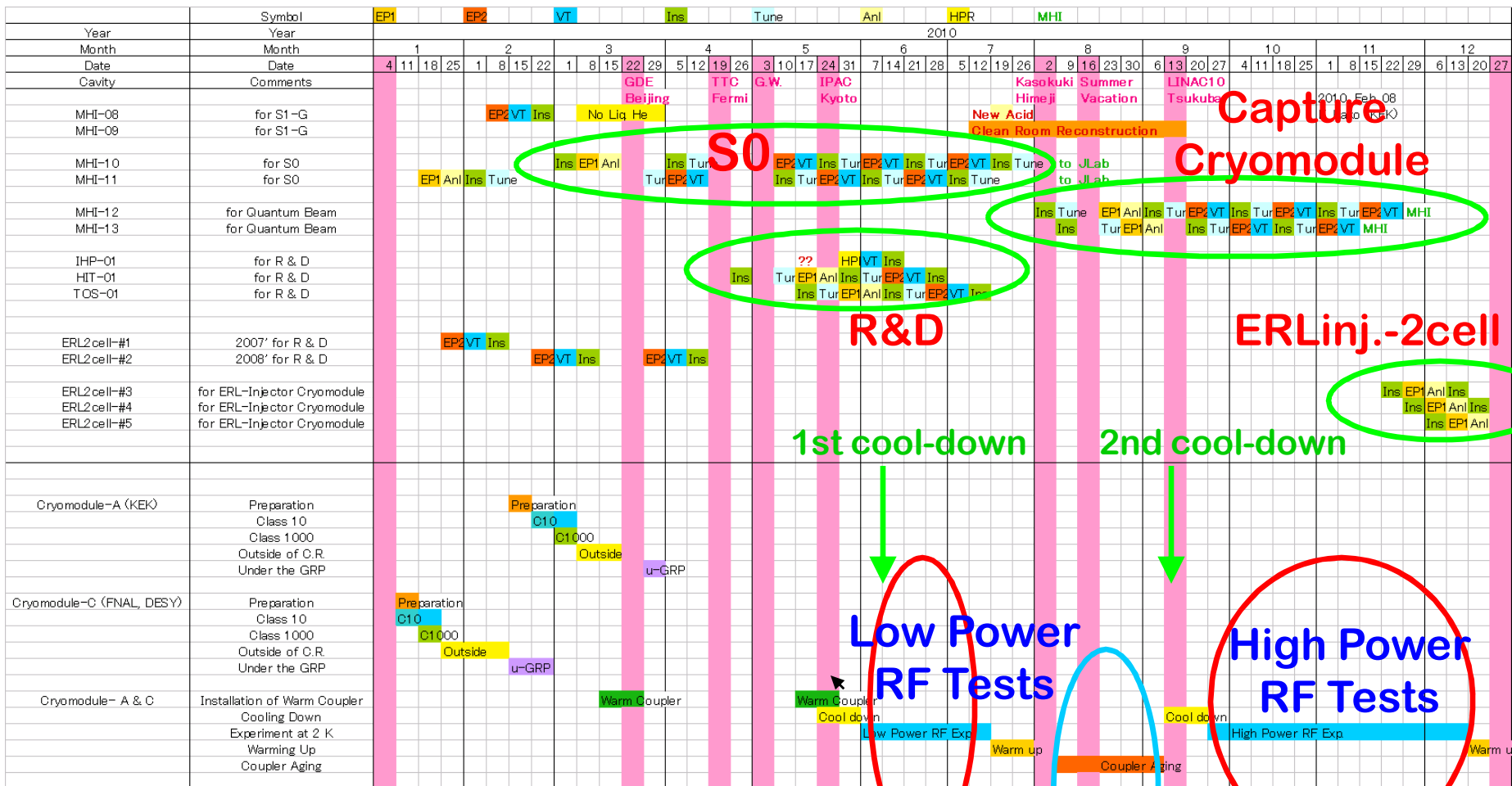


# Schedule of KEK cavities / Cryomodule-A

- April 01 ; Hanging on He-GRP**
- April 30 ; Installation in the STF tunnel**
- May 10 ~ ; Warm coupler assembly**
- May 17 ~ ; Connection of beam pipe**  
**Connection of RF cables**
- May 31 ~ ; Assembly of vacuum duct and**  
**pumping system for input couplers**  
**→ Ready for pumping the vacuum vessel**
- June 07 ~ ; → Ready for cool-down**



# Schedule of S1-Global in 2010



Capture Cryomodule

R&D

ERLinj.-2cell

1st cool-down

2nd cool-down

Low Power RF Tests

High Power RF Tests

Input Coupler Conditioning

June/July

August

Sept./Dec.