

International Workshop on Future Linear Colliders

 **LCWS13**

11-15 November 2013, The University of Tokyo

# Status of STF2 Input Couplers

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(KEK, Japan)

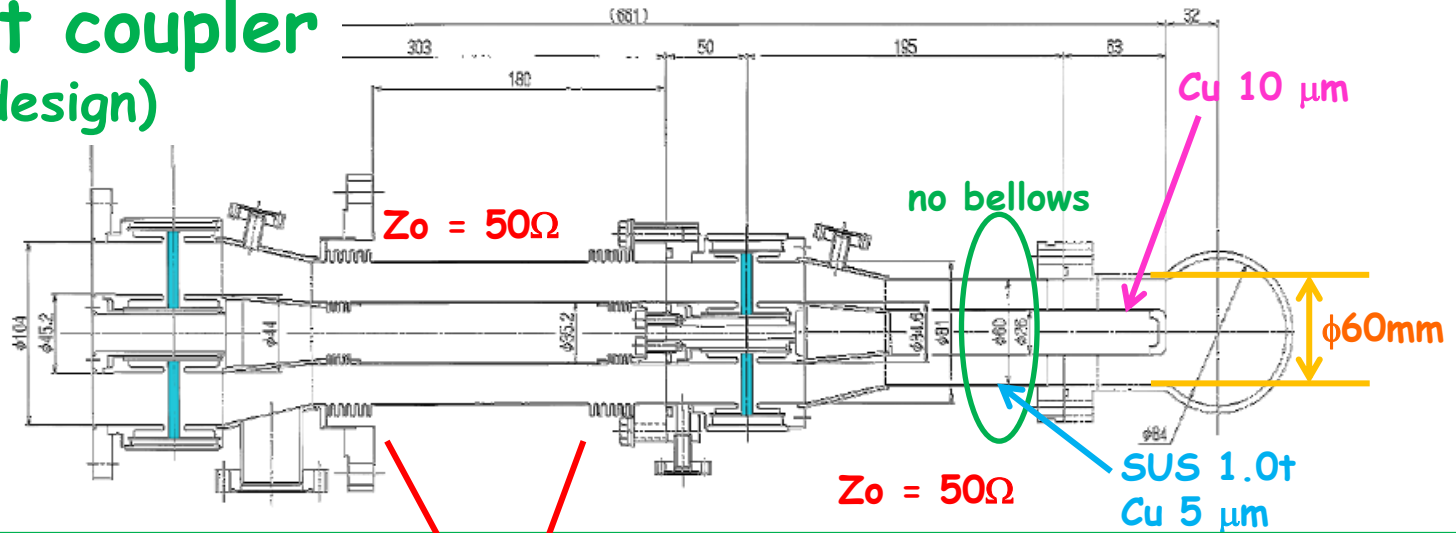
# OUTLINE

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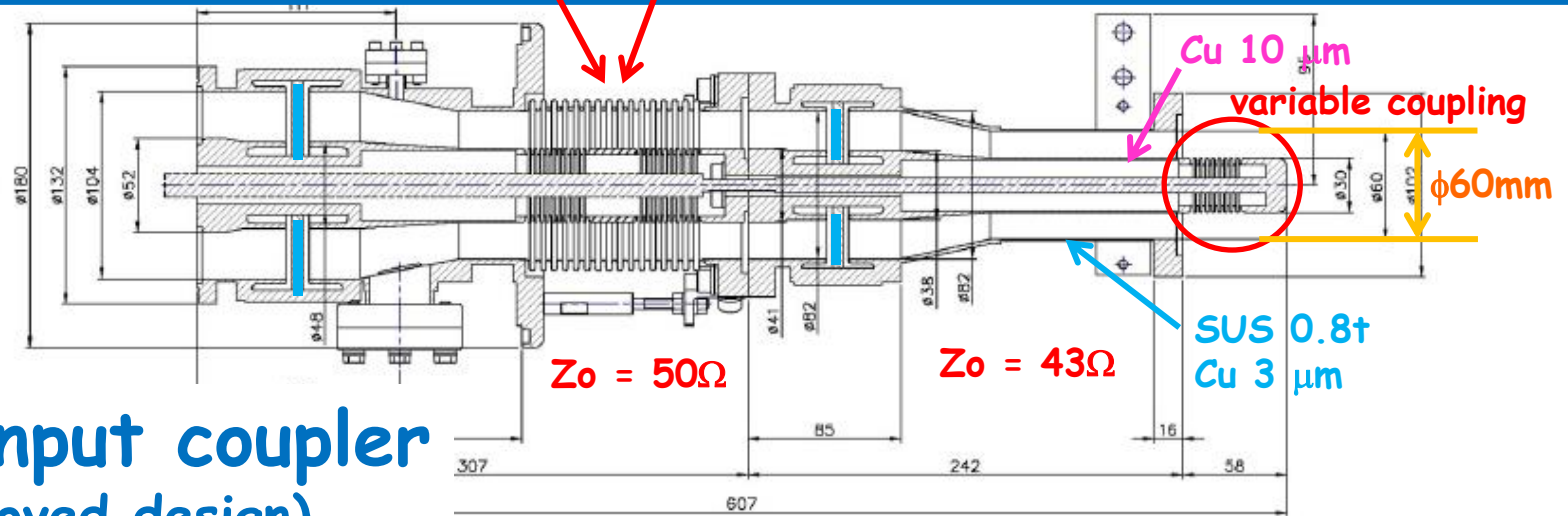
1. **STF2 couplers for STF-CM1**
2. **Results from S1-G cryomodule**
3. **Collaboration with Japanese companies  
(Introduction to the next talks)**
4. **Summary**

# STF-1 and STF-2 Input Couplers

## STF1 input coupler (initial design)



## STF2 input coupler (improved design)



# Cryomodule Operation in STF

## STF Phase-1

Four 9-cell cavities (2008')



4 x STF1 input couplers

Total 22 STF1,2  
input couplers  
were fabricated  
and tested.

## S1-Global

(4+4) 9-cell cavities (2010')



4 x STF2 input couplers

## STF2 - Capture Cryomodule

Two 9-cell cavities (2011')



2 x STF2'  
input couplers

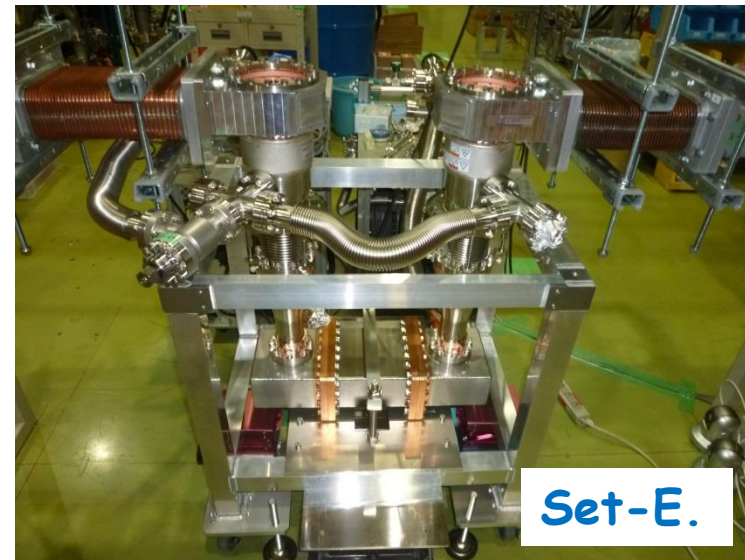
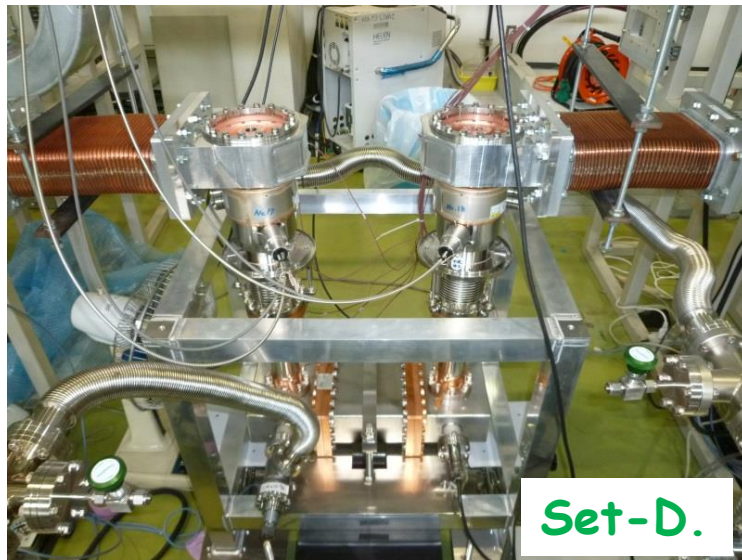
## STF2 - CM1 Cryomodule (+CM2a)

Eight (+4) 9-cell cavities (2014')



8 (+4) x STF2'' input couplers

# RF conditioning of 12 STF2 input couplers

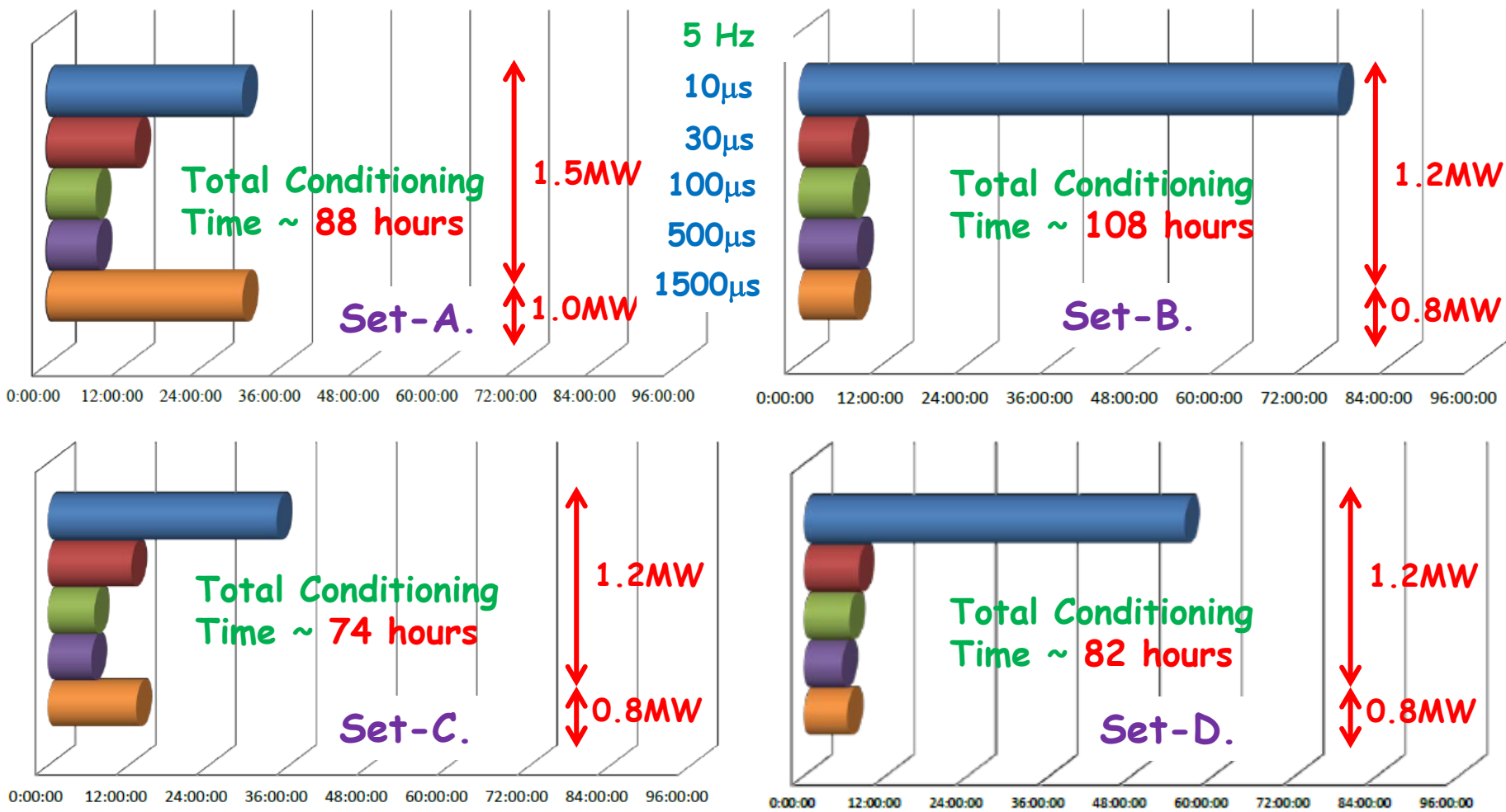


Set-F.  
not  
delivered.

# RF conditioning of 8 STF2 input couplers

8 pairs of STF2 input couplers

2013' Jan. ~ May



# Cavity string assembly for STF2-CM1 cryomodule



2013' Sept. ~ Nov.



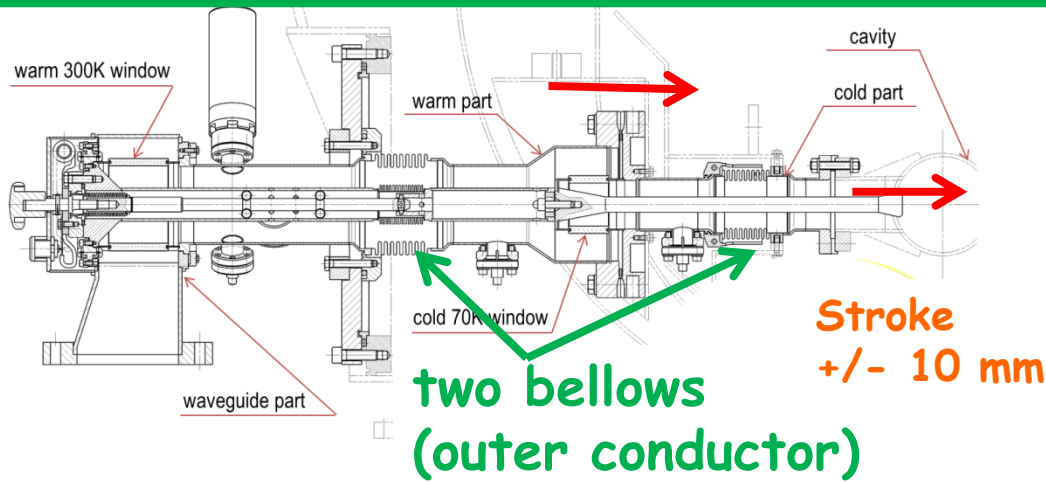
in the STF tunnel

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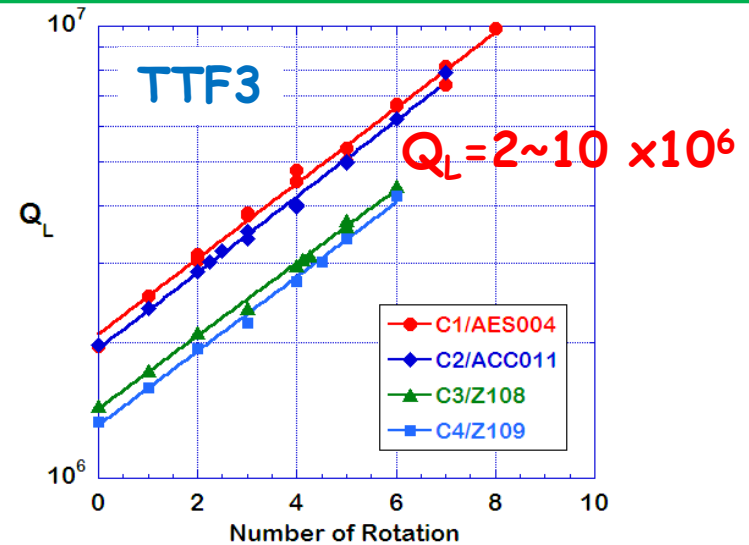
# TTF3/STF2 input couplers in S1-Global Cryomodule



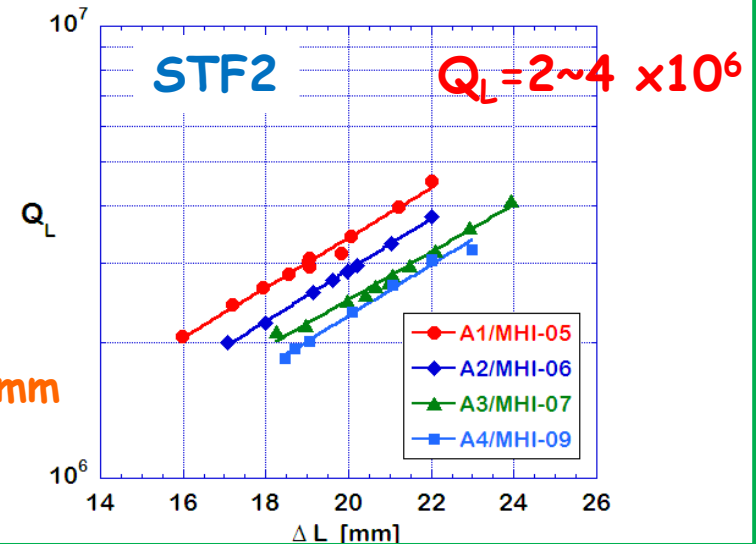
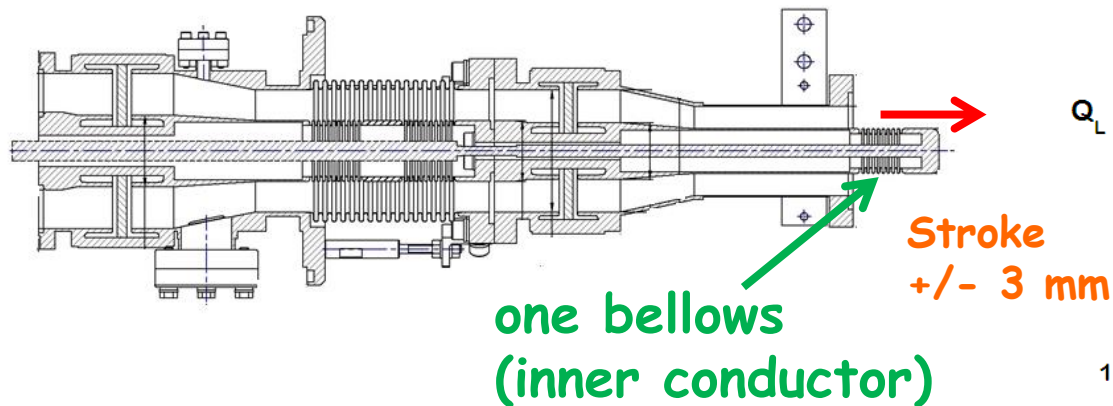
# Input coupler performance in S1-G



TTF3 Input Coupler

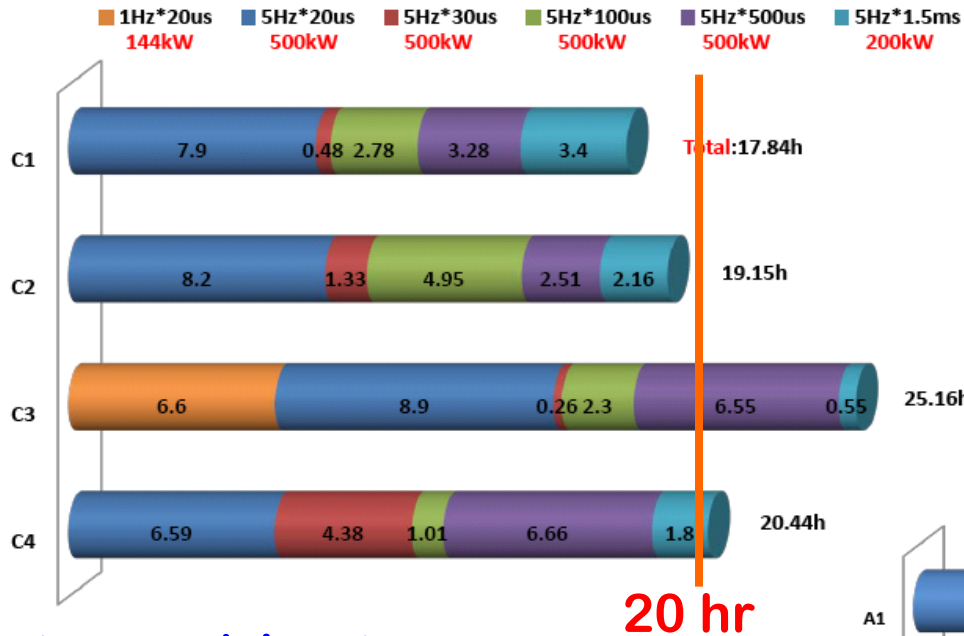


STF2 Input Coupler



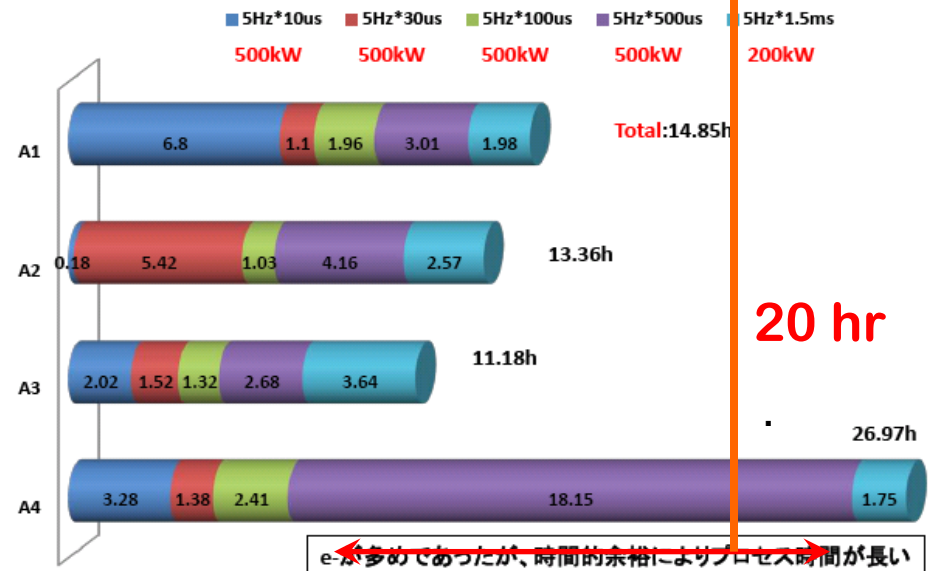
# Input coupler performance in S1-G

at Room Temperature;  
 0.5 ms, 5 Hz, 500 kW  
 1.5 ms, 5 Hz, 200 kW



Cryomodule-C  
 (four TTF3 couplers)  
 ave. processing time  
 ~ 21 hours

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

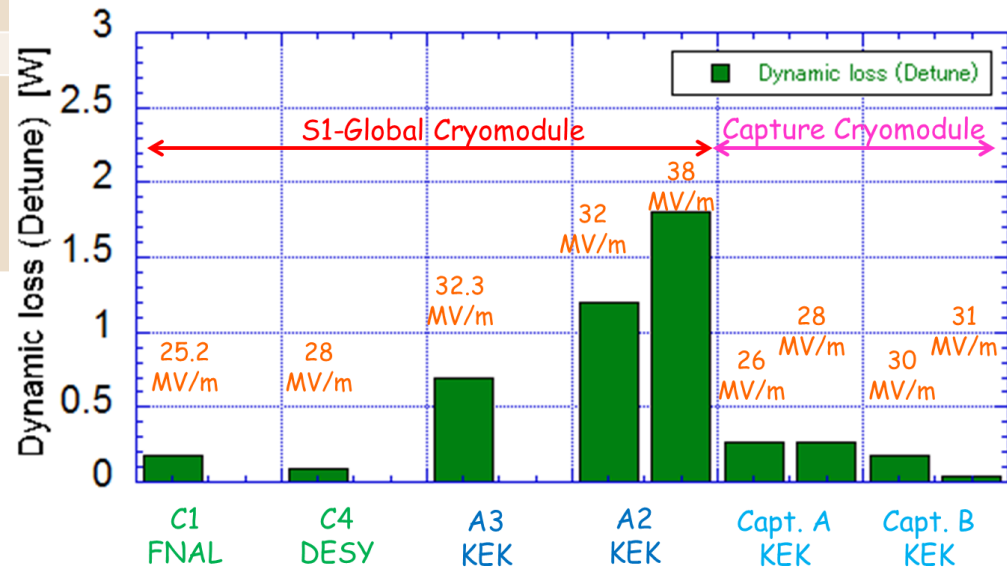


Cryomodule-A  
 (four STF2 couplers)  
 ave. processing time  
 ~ 13 hours

# Input coupler performance in S1-G

	TTF3		STF2			TTF3	STF2	4 C Cavities	4 A Cavities	7 Cavities	7 Cavities
	C-4	C-1	A-3	A-2	A-2	4 C Cavities	4 A Cavities	4 C Cavities	4 A Cavities	7 Cavities	7 Cavities
Date	Nov. 17	Nov. 19	Nov. 23	Nov. 24	Nov. 25	Nov. 26	Nov. 30	Dec. 2	Dec. 3	Dec. 9	Dec. 10
Gradient	28 MV/m	25.2 MV/m	32.3 MV/m	38 MV/m	32 MV/m	32 MV/m Detune	32 MV/m Detune	20.0 MV/m	26.9 MV/m	25.4 MV/m	20.4 MV/m
Dynamic Loss	0.84 W	1.44 W	2.8 W	4.8 W	2.6 W			2.7 W	6.9 W	9.6 W	4.8 W
Detuned Loss	0.09 W	0.18 W	0.7 W	1.8 W	1.2 W	0.5 W	4.6 W	0.2 W	2.5 W	2.6 W	1.6 W
Dynamic Loss at Cavity	0.75 W	1.26 W	2.0 W	2.9 W	1.3 W			2.5 W	4.4 W	7.0 W	3.2 W
$Q_0$	8.8E9	4.3E9	4.3E9	4.2E9	6.5E9						

Dynamic losses of KEK couplers was 9 times larger than those of TTF3 couplers.

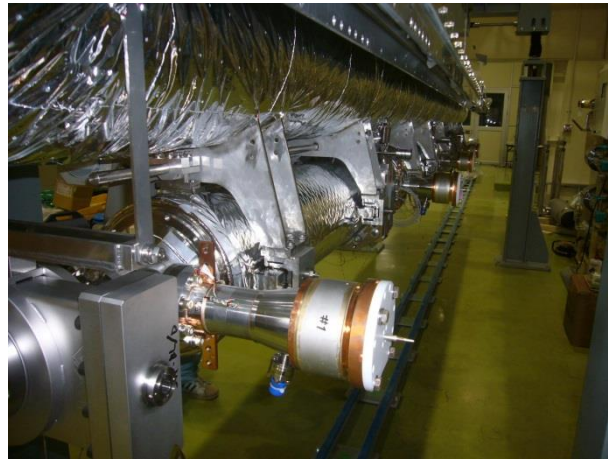


ILC Specification  
< 0.02 W (2K dynamic)

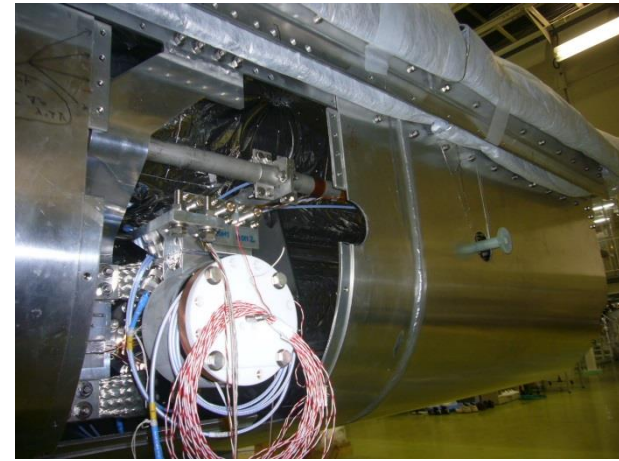
# S1-G cryomodule assembly (STF2 coupler)



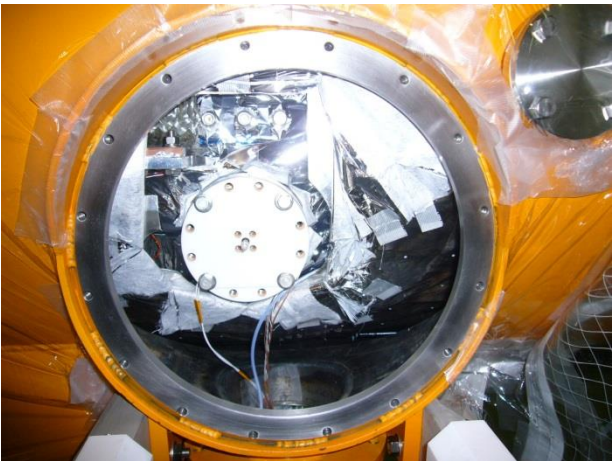
Cavity string assembly



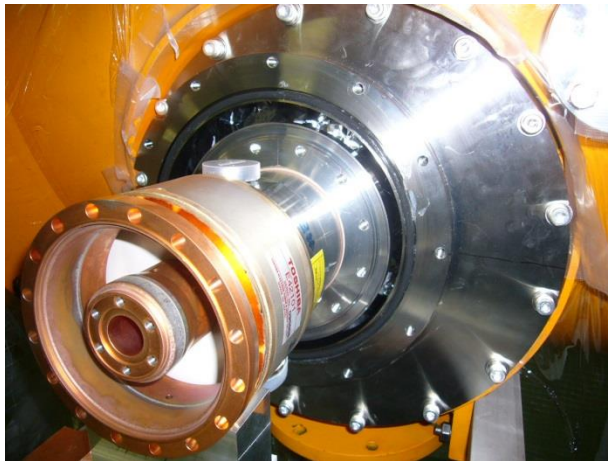
Hanging under He-GRP



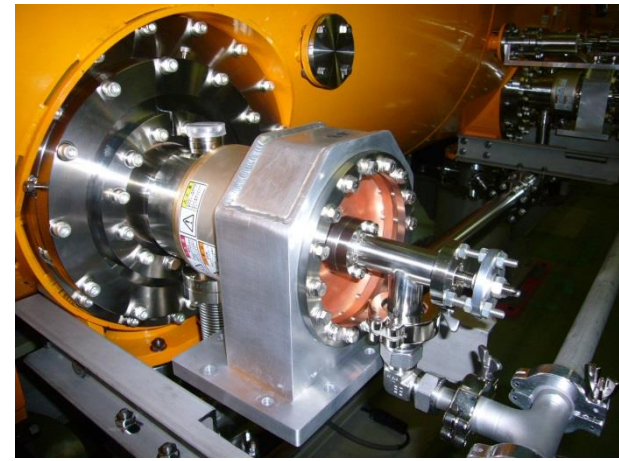
5K, 80K thermal anchor



Installation into vacuum vessel



Warm coupler assembly



Attachment of doorknob WG

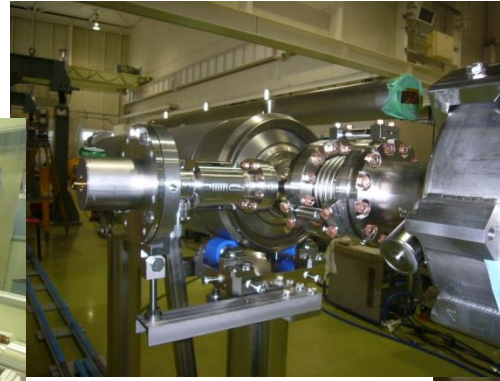
# S1-G cryomodule assembly (TTF3 coupler)



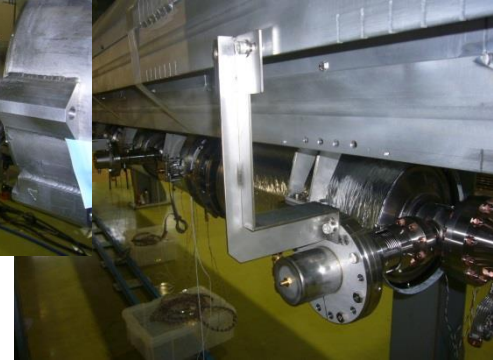
Transportation  
with coupler



Cavity string assembly



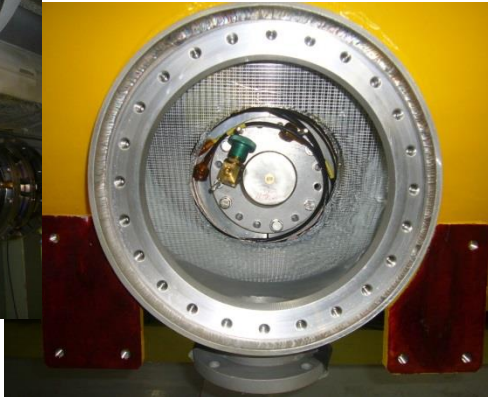
Welding of  
2K-He pipe



Hanging under He-GRP



5K and 80K  
thermal anchor



Installation in  
vacuum vessel



Warm coupler  
assembly

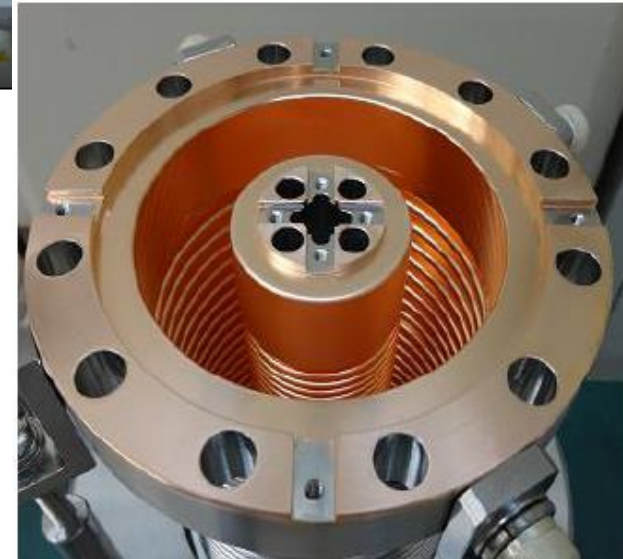
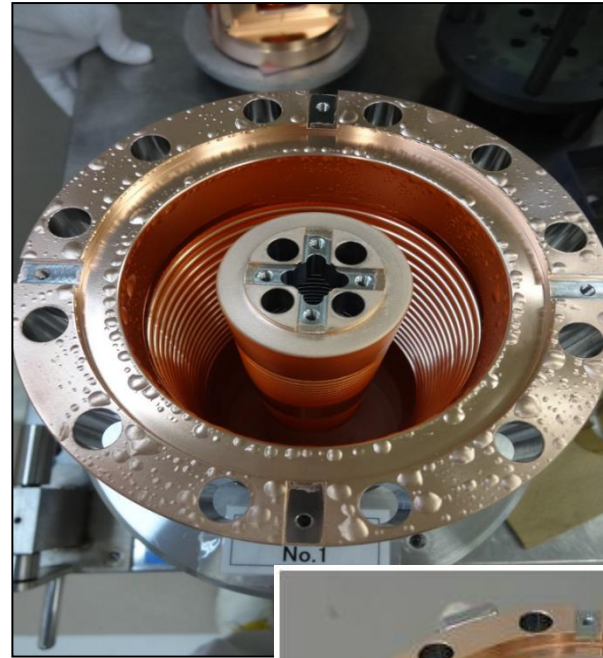
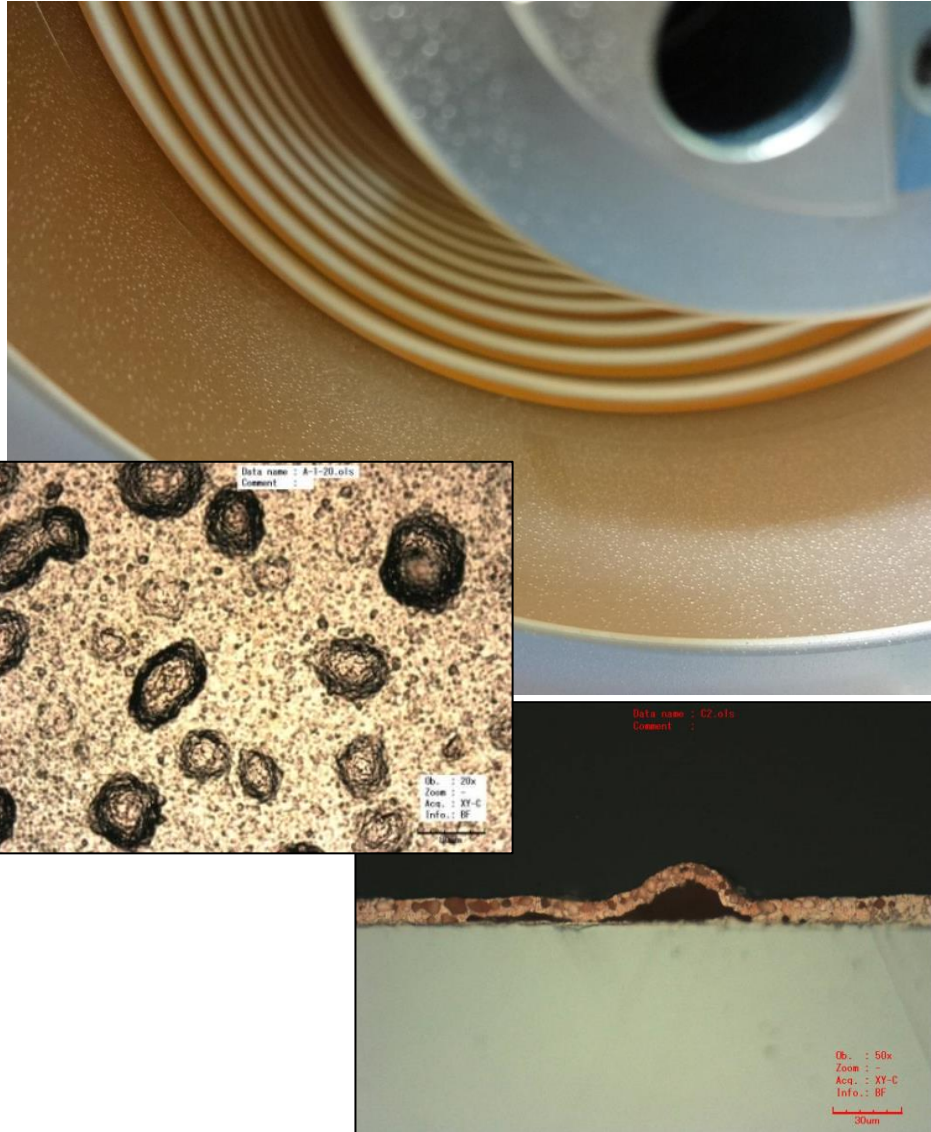


Waveguide  
assembly

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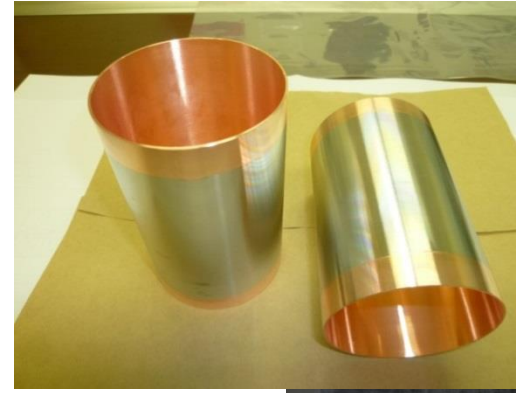
# Collaboration with Companies on STF2 Input Couplers

# 1. Quality control of Cu-plating at Nomura-Plating



# 2. RRR measurement of Cu-plating at Tokyo-Denkai

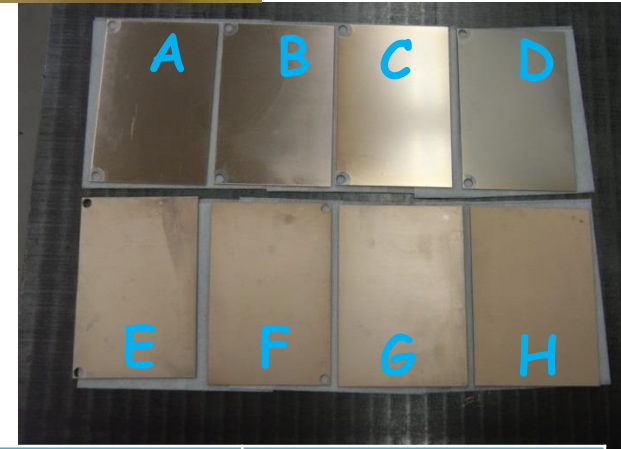
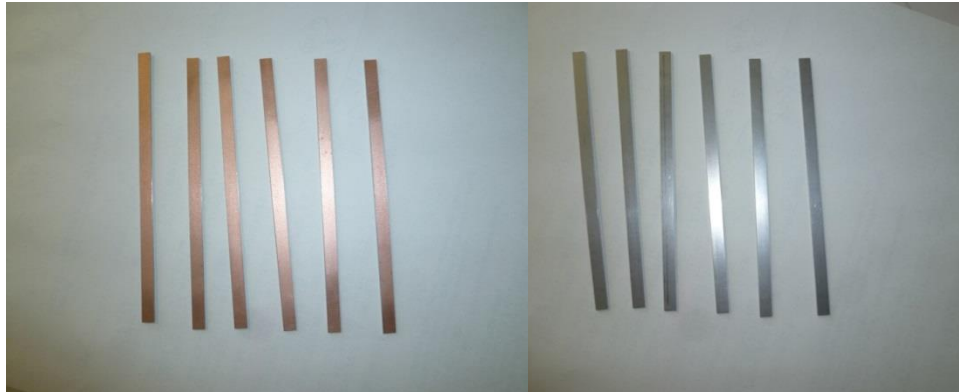
Cu-plating  
 Samples :  
 SUS 1.0t  
 Ni-strike 0.2  $\mu\text{m}$   
 Cu 5  $\mu\text{m}$   
 (2005')



0.2  $\mu\text{m}$  Au-strike  
 + 3  $\mu\text{m}$  Cu-plating  
 on 0.8t SUS pipe



after anneal  
 at 800  $^{\circ}\text{C}$   
 in hydrogen furnace

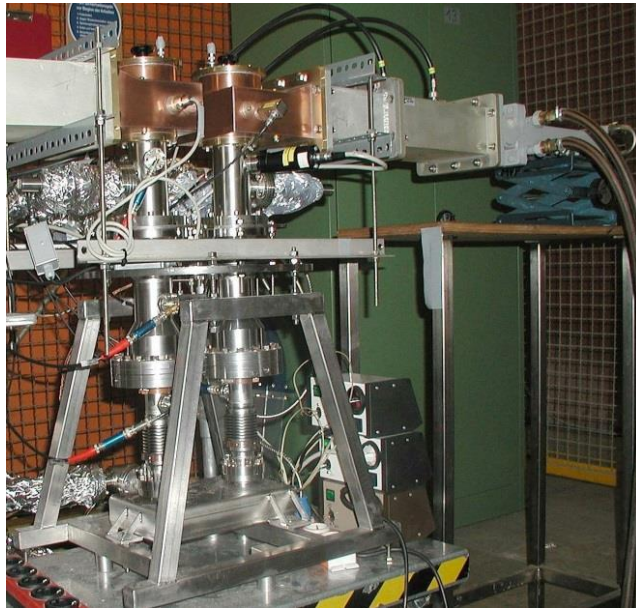


Sample	X1	X2	X3	X4
RRR (Cu+SUS)	1.43	1.44	1.44	1.42
RRR (SUS)	1.42	1.43	1.41	1.43
RRR (Cu)	1.53	1.07	2.18	1.47



# 3. Coupler fabrication techniques at Toshiba

2012' March



Toshiba fabricated  
2 TTF3 input couplers  
for LAL.



Toshiba fabricated 22 STF input couplers for KEK.

# SUMMARY

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- 12 STF2 couplers for STF-CM1+CM2a;  
8 couplers were conditioned and assembled.  
2 couplers under conditioning.  
2 couplers under fabrication.
- Coupler performance of TTF3/STF2 couplers in S1-G cryomodule was shown for comparison.
- Improvements of poor adhesion and low RRR of Cu-plating are necessary.  
(Detail will be presented in the next talks.)

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**END**

**Thank you for your attention.**