

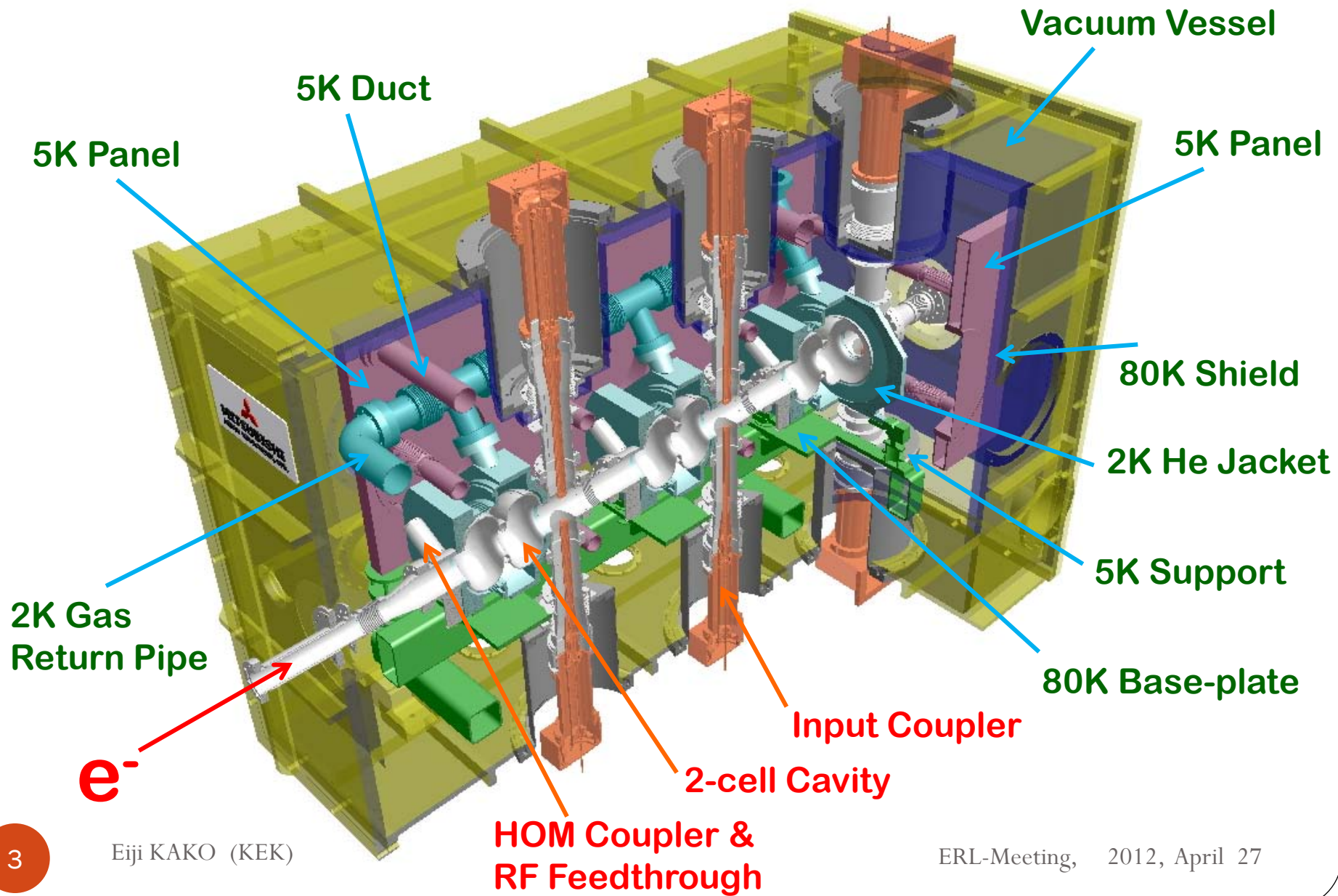
Current Status of cERL Injector Cryomodule

E. Kako, Y. Kondo, S. Noguchi, T. Shishido,
K. Watanabe, Y. Yamamoto
(KEK, Japan)

Outline

- Overview of Injector Cryomodule
- 2-cell Cavities
- HOM RF Feedthroughs
- CW Input Couplers
- Injector Cryomodule
- Schedule
- Summary

Injector Cryomodule for cERL



Key Components for Injector Cryomodule



Three 2-cell Cavities



Six CW Input Couplers



Fifteen HOM Couplers



Fifteen RF Feedthroughs

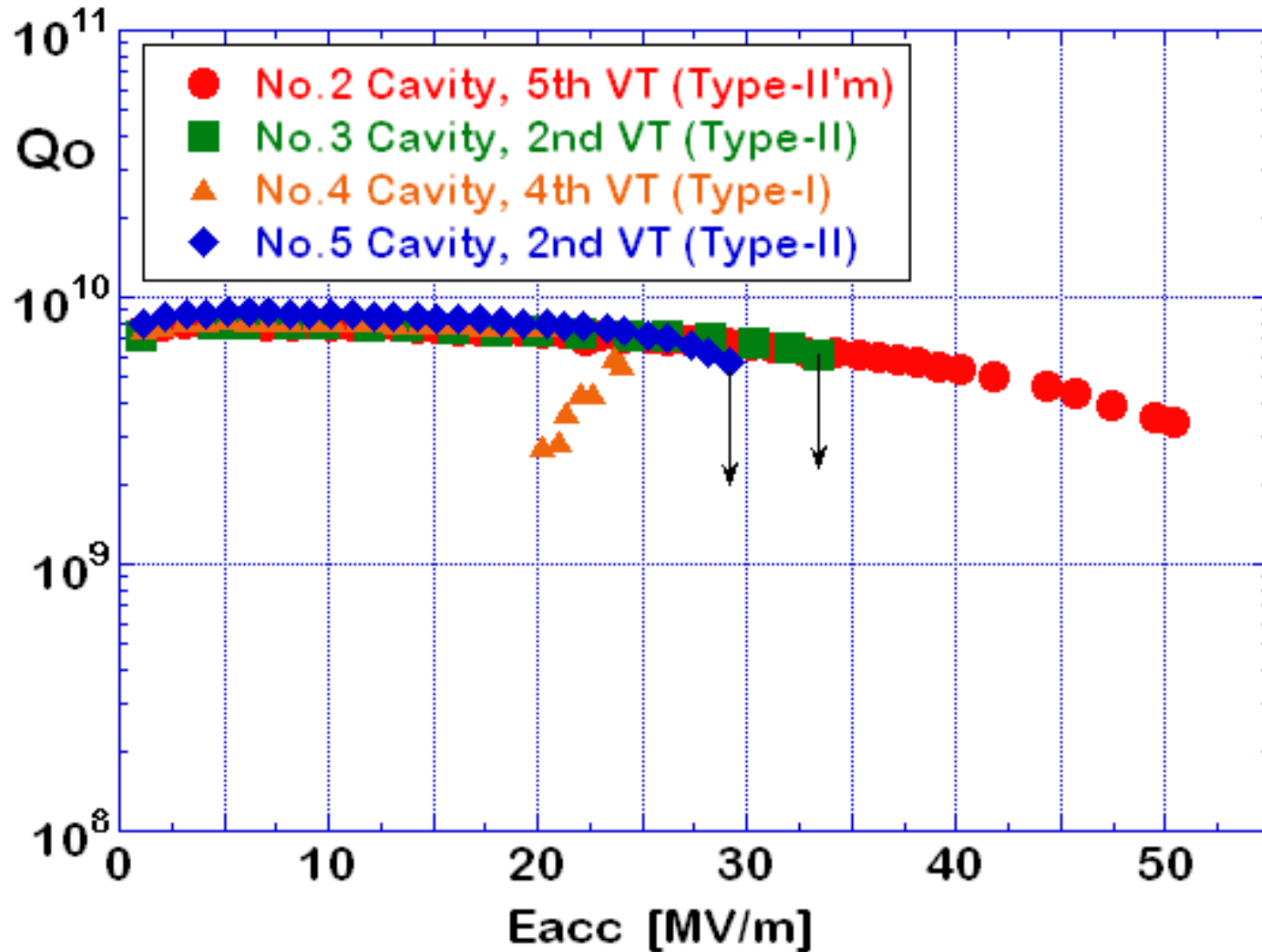
Main Specification for Injector Cryomodule

(Q_L /coupler, P_{rf} /coupler, $I_{beam} = 10$ mA, $E_{beam} = 5$ MeV)

	Cavity - I	Cavity - II	Cavity - III
Cavity	#3 cavity	#4 cavity	#5 cavity
Input coupler	#3 & #4 couplers	#5 & #6 couplers	#7 & #8 coupler
Operational gradient	6.5 MV/m (1.5 MV)	11 MV/m (2.5 MV)	11 MV/m (2.5 MV)
Loaded Q (Q_L)	10×10^5	4×10^5	4×10^5
Required RF Power	10 kW	20 kW	20 kW

(#1 cavity, #2 cavity, #1 & #2 couplers : Prototype)

Cavity Vertical Tests Results (Final)



RF Feedthroughs with HOM pick-up antenna



Type-0 (i.c: Kovar, o.c: Kovar)



Type-I (i.c: Mo, o.c: Kovar)



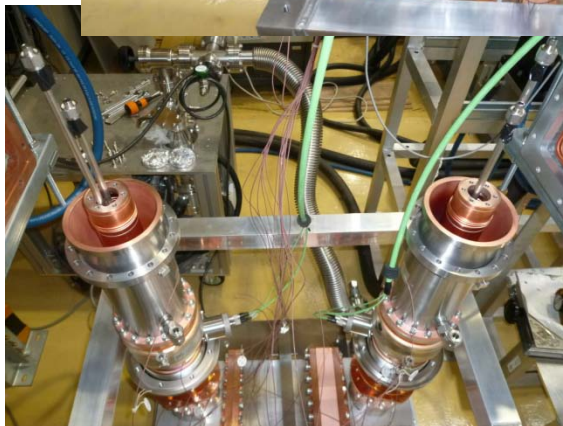
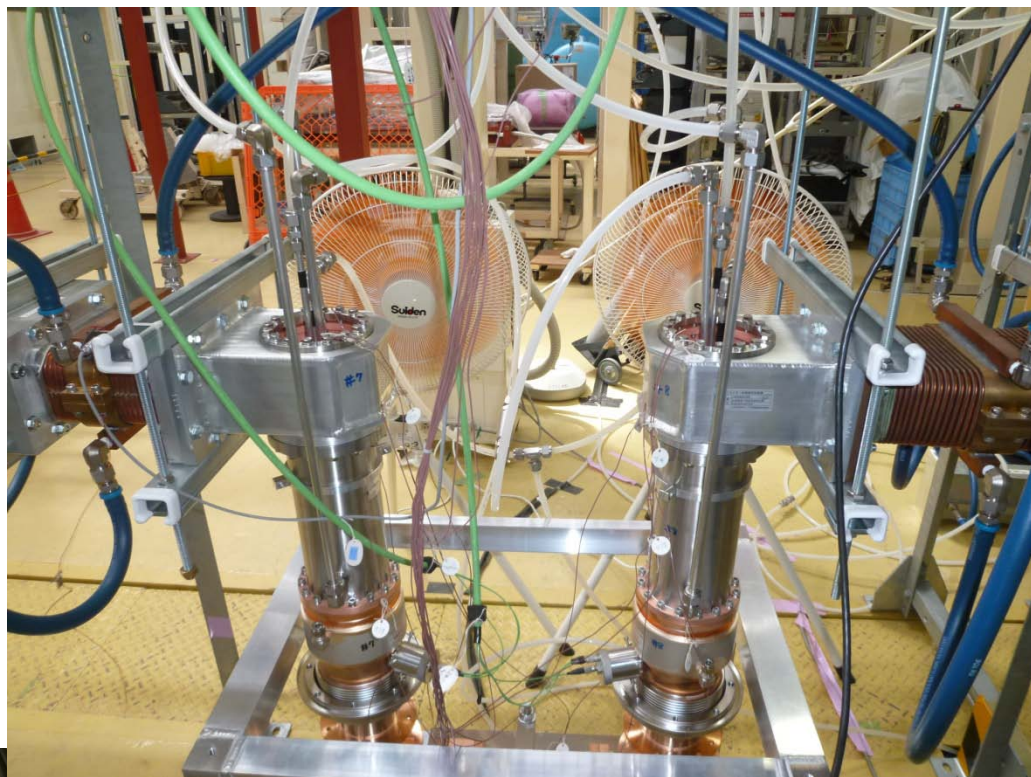
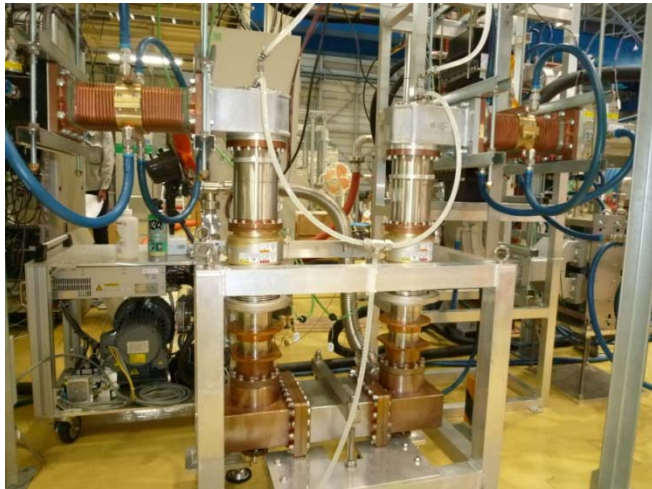
Type-II (i.c: Mo, o.c: Cu)



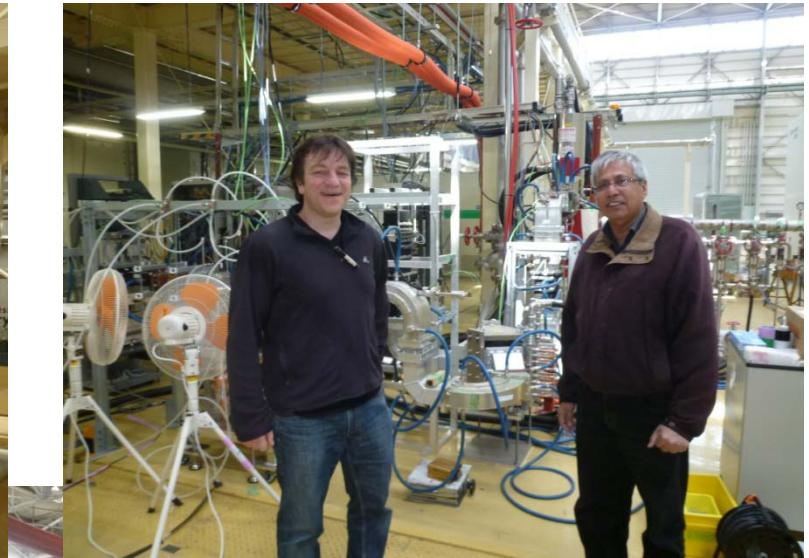
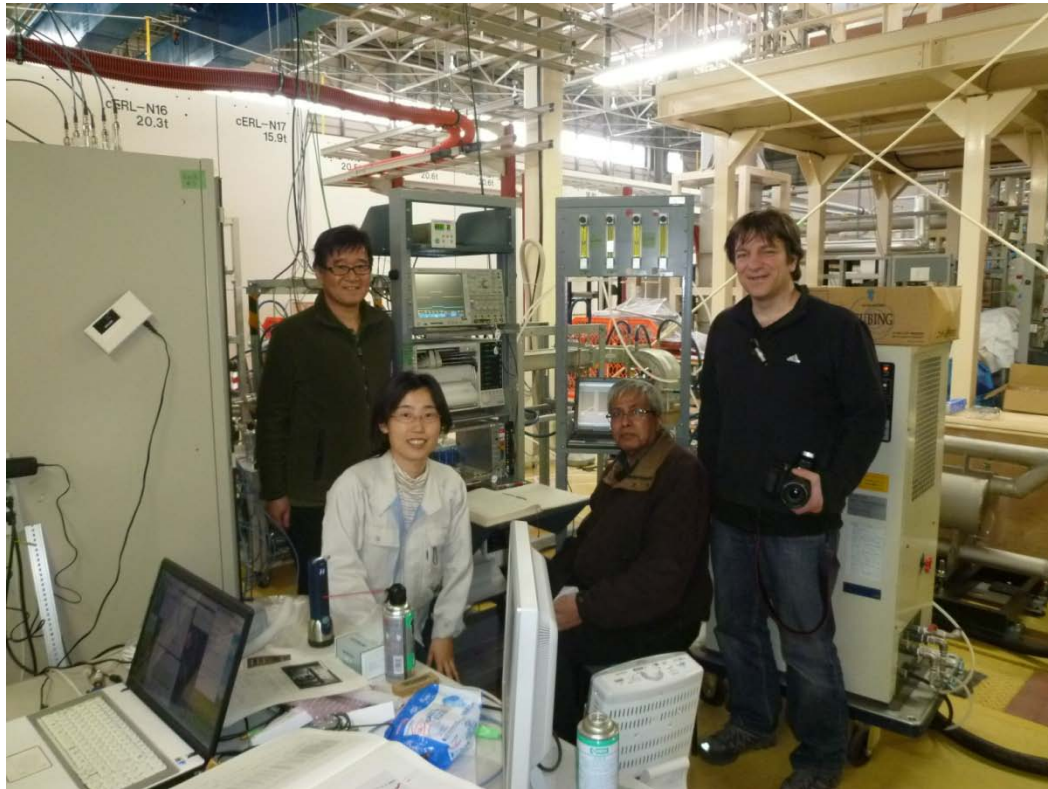
Type-II'm (i.c: Mo, o.c: Cu) "male pin"

RF Conditioning of CW Input Couplers

Prototype (#1) Couplers



Collaboration on CW Input Couplers between HZB/TRIUMF/KEK

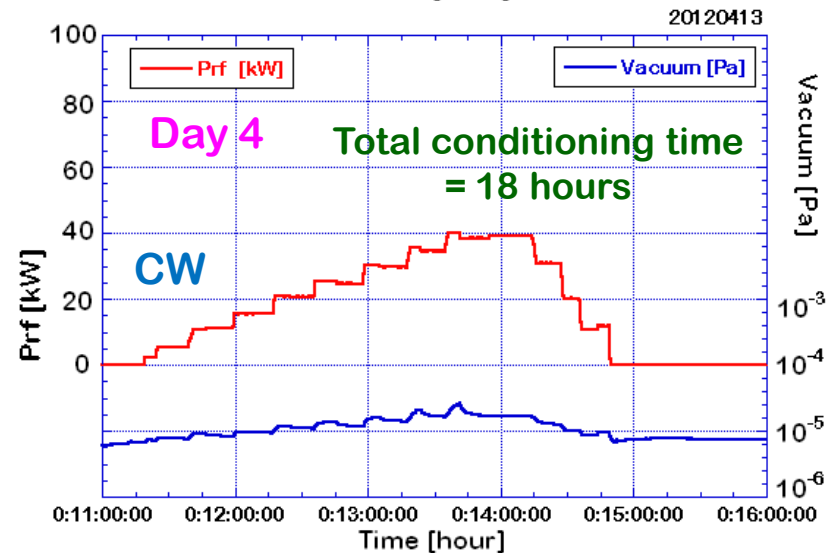
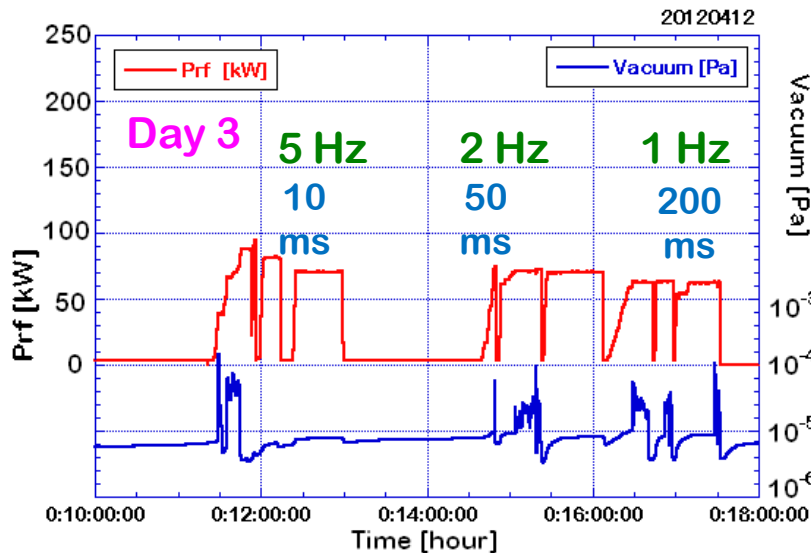
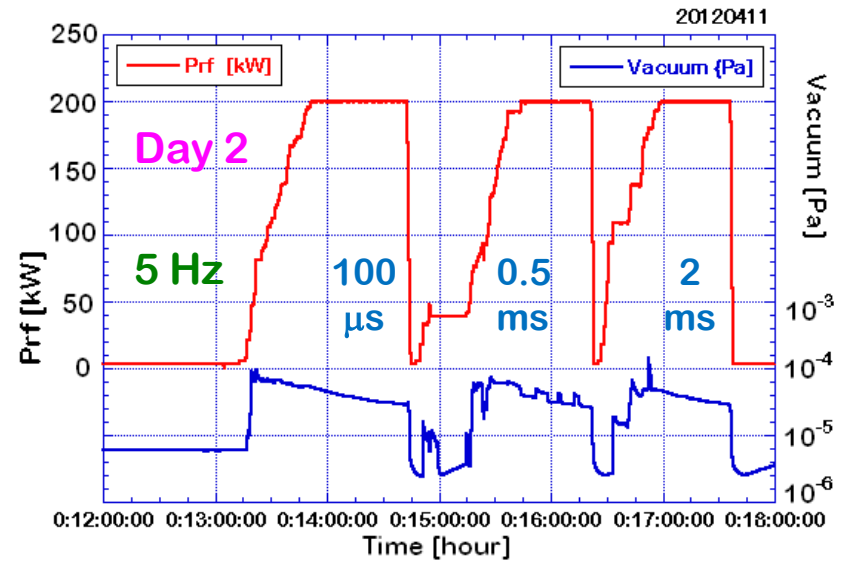
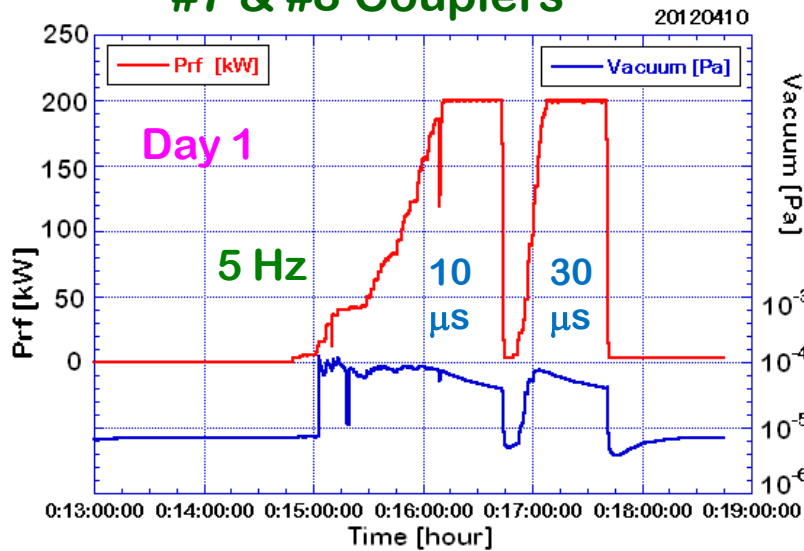


Oliver Kugeler (HZB)
Amiya Mitra (TRIUMF)
Takako Miura (KEK-RF)

April, 10th ~ 13th, 2012 : (4 days)

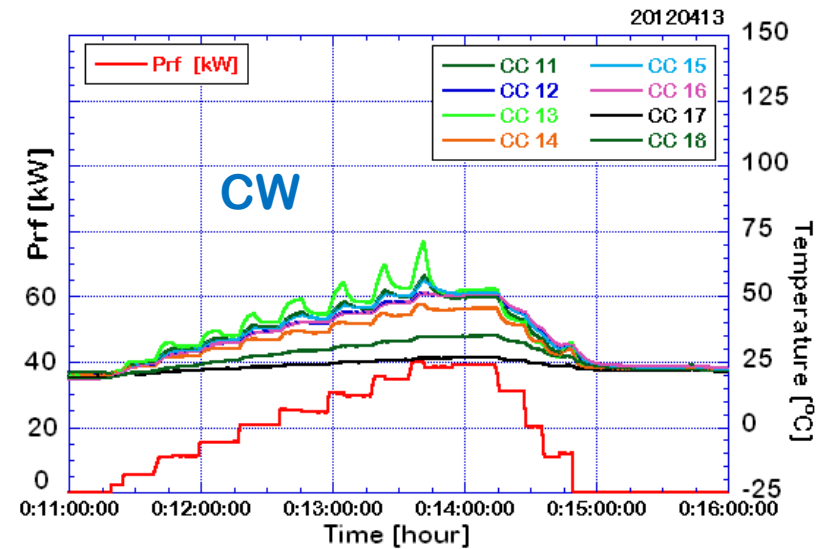
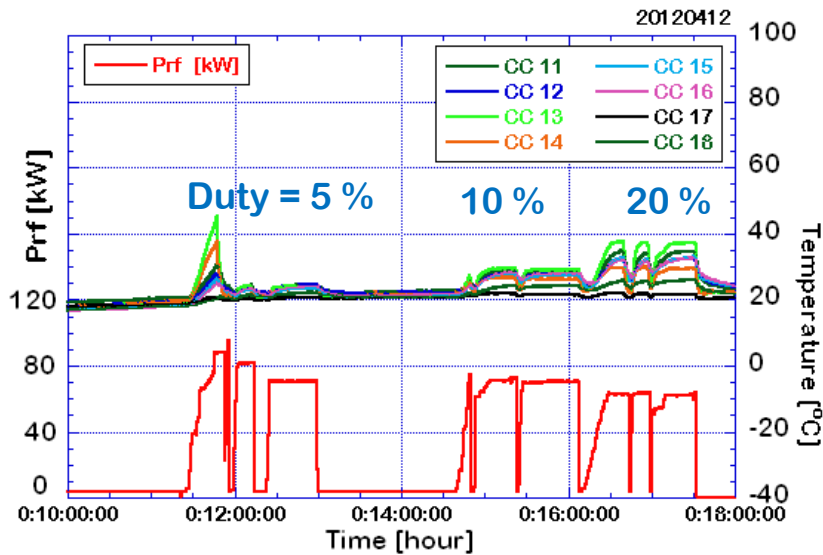
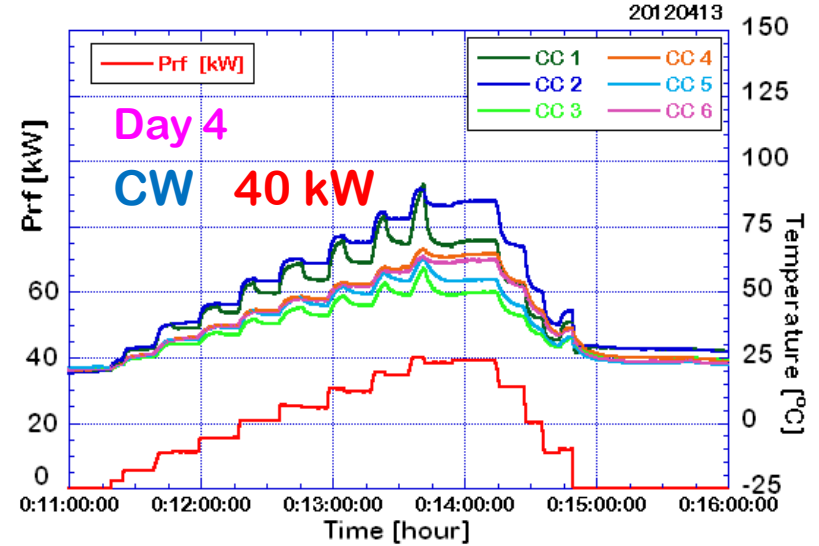
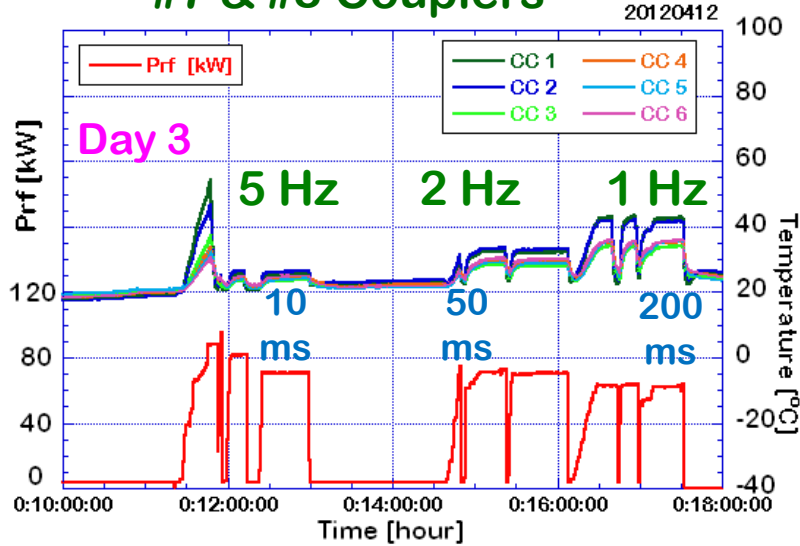
Conditioning Results of CW Input Couplers (1)

#7 & #8 Couplers



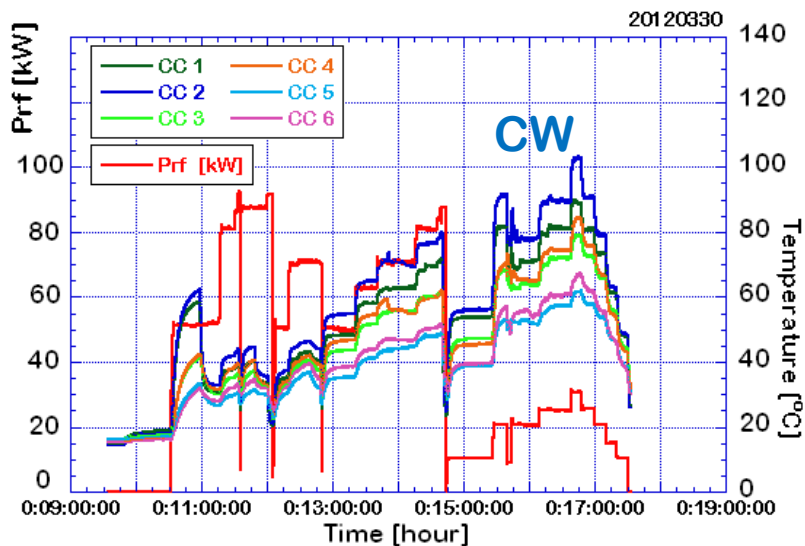
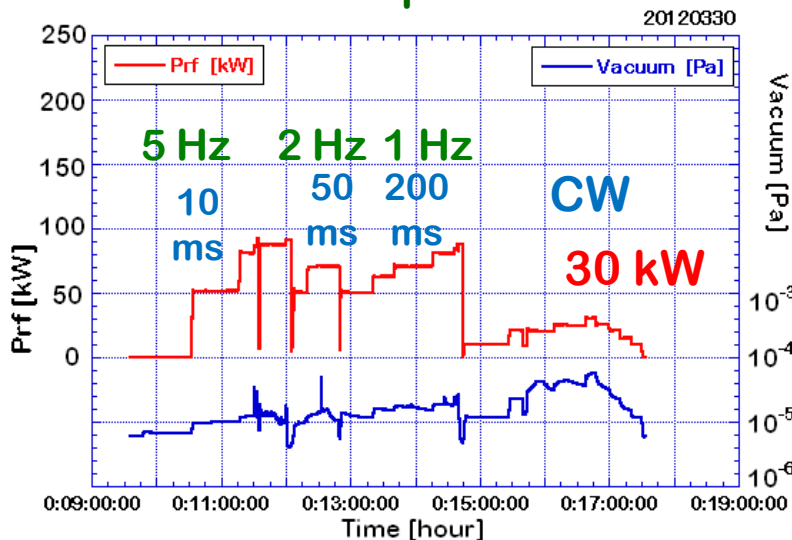
Conditioning Results of CW Input Couplers (2)

#7 & #8 Couplers

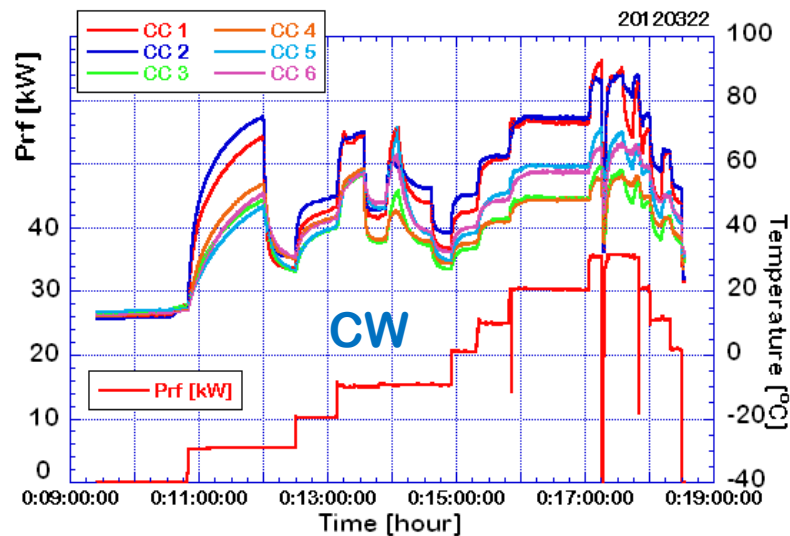
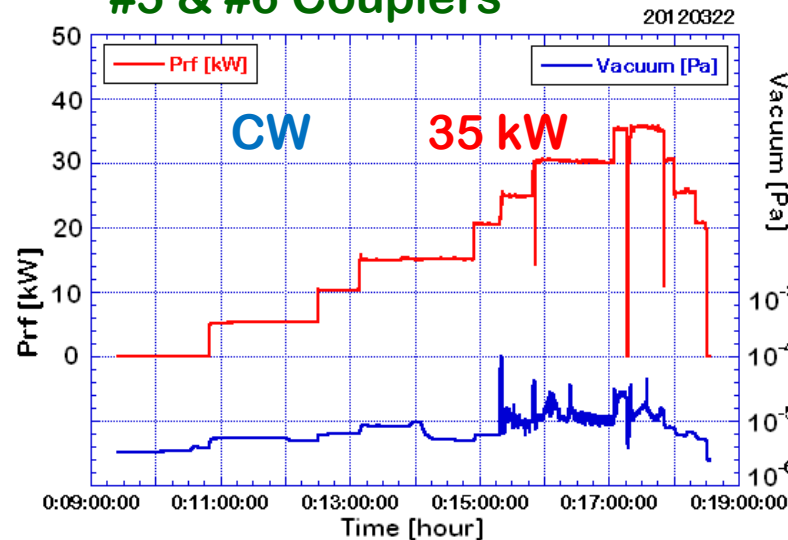


Conditioning Results of CW Input Couplers (3)

#3 & #4 Couplers



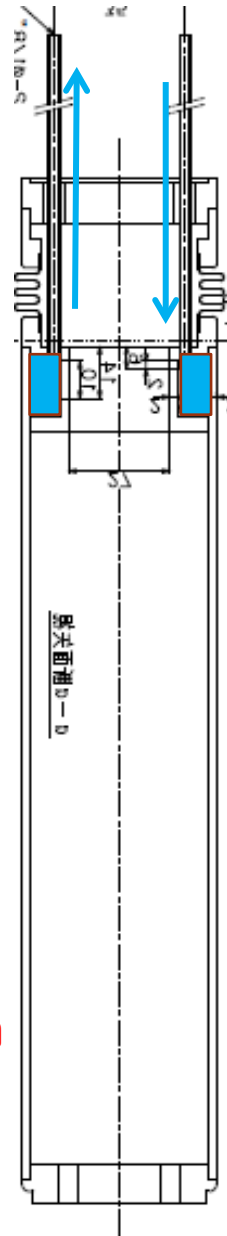
#5 & #6 Couplers



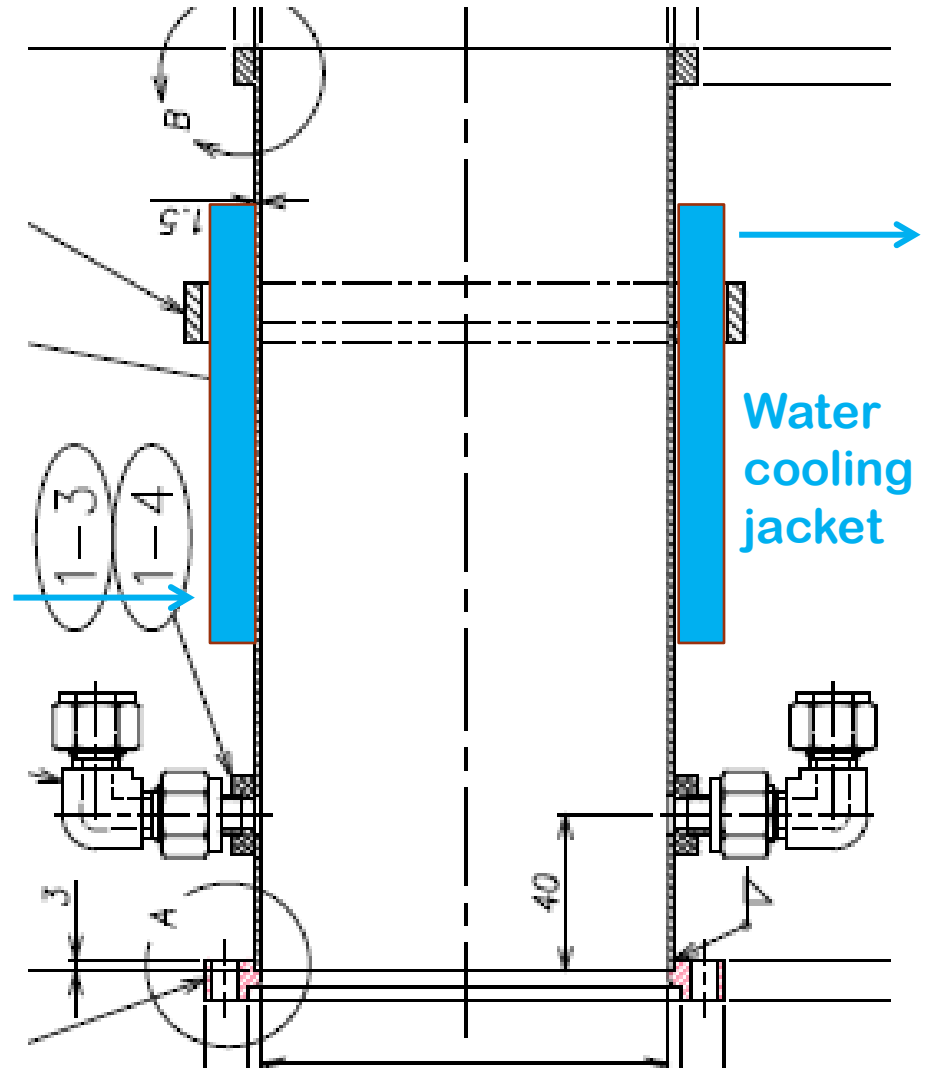
Further Improvement for efficient cooling

Inner conductor

Water cooling channel



Outer conductor



Thermal Calculation
by "ANSYS"

High Pressure Gas Inspection by KHK

December 21st, 2011

January 25th, 2012



$0.13 \text{ MPa} \times 4.0 =$
 0.52 MPa (water)



He Panel : $0.13 \text{ MPa} \times 1.50 = 0.2 \text{ MPa (water)}$
2-cell Cavity : $0.13 \text{ MPa} \times 1.25 = 0.17 \text{ MPa (He gas)}$

Assembly Check at Factory, MHI-Kobe



March 23rd,
2012



Assembly of cERL-Injector Cryomodule (1)



April 3rd,
2012

3 two-cell cavities with He jacket



Base-plate for cavity support

April 12th, 2012

Assembly of cERL-Injector Cryomodule (2)

Okada (K-Vac)

Hitomi (MHI)

Watanabe (KEK)

Imada (NAT)



15 Type-II'm



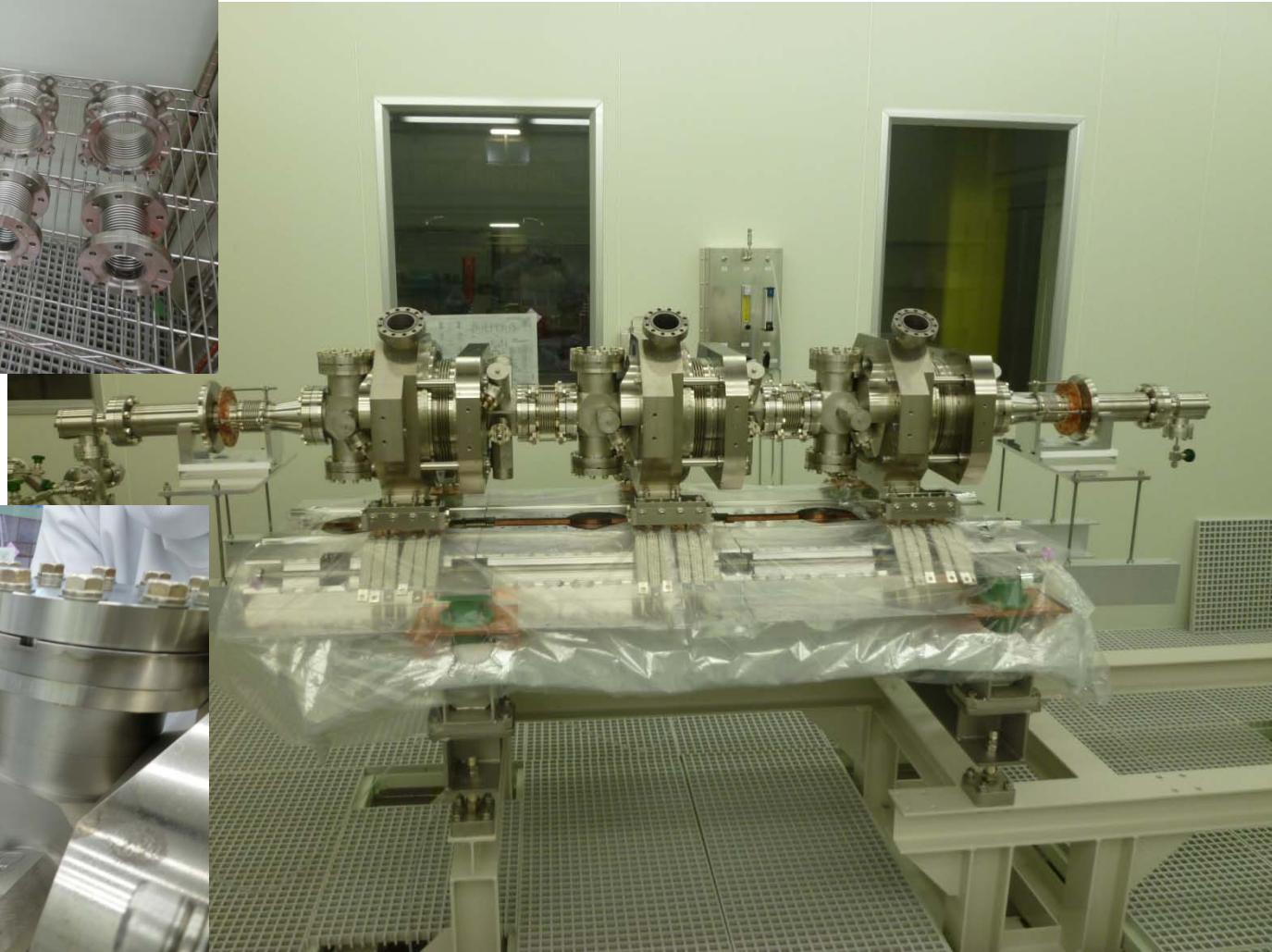
April 19th, 2012

Assembly of cERL-Injector Cryomodule (3)

April 23rd, 2012



2 Beam tubes
2 Bellows



Assembly of cERL-Injector Cryomodule (4)

April 25th, 2012



6 Input couplers



Temperature Measurement System

No.1 Cavity

Cernox: 1 ~ 15

Pt-Co: 1 ~ 8

- 1: Up-stream beam pipe
- 2: Down-stream beam pipe
- 3: No.1 Upper input 5K anchor
- 4: No.1 Lower input 5K anchor
- 5: No.2 Upper input 5K anchor
- 6: No.2 Lower input 5K anchor
- 7: No.3 Upper input 5K anchor
- 8: No.3 Lower input 5K anchor

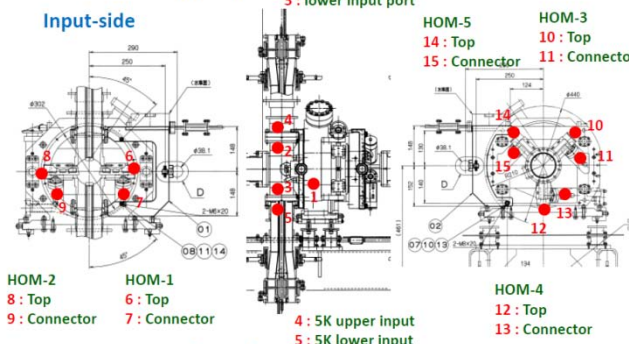
Upper Input

- 1: He Jacket
- 2: upper input port
- 3: lower input port

Monitor-side

- HOM-5 14: Top
- HOM-3 10: Top
- 15: Connector
- 11: Connector

Input-side



- HOM-2 8: Top
- HOM-1 6: Top
- 9: Connector
- 7: Connector

Lower Input

- 4: 5K upper input
- 5: 5K lower input

- HOM-4 12: Top
- 13: Connector

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No.2 Cavity

Cernox: 17 ~ 31

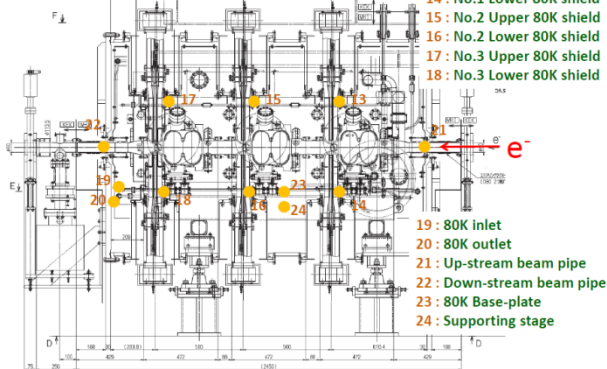
No.3 Cavity

Cernox: 33 ~ 47

CC-II: 13 ~ 24 (80K Shield, beam tube)

No. 3 cavity No. 2 cavity No. 1 cavity

- 13: No.1 Upper 80K shield
- 14: No.1 Lower 80K shield
- 15: No.2 Upper 80K shield
- 16: No.2 Lower 80K shield
- 17: No.3 Upper 80K shield
- 18: No.3 Lower 80K shield



- 19: 80K inlet
- 20: 80K outlet
- 21: Up-stream beam pipe
- 22: Down-stream beam pipe
- 23: 80K Base-plate
- 24: Supporting stage

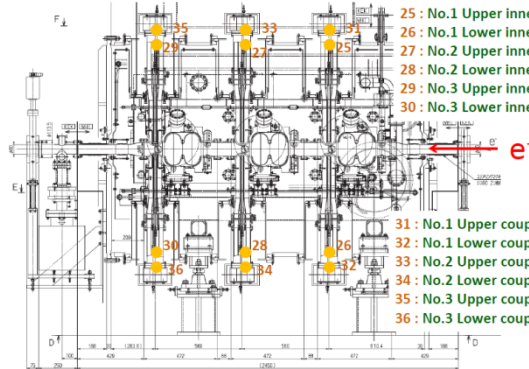
E. Kako (KEK)

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CC-III: 25 ~ 36 (Outside of Cryomodule)

No. 3 cavity No. 2 cavity No. 1 cavity

- 25: No.1 Upper inner conductor
- 26: No.1 Lower inner conductor
- 27: No.2 Upper inner conductor
- 28: No.2 Lower inner conductor
- 29: No.3 Upper inner conductor
- 30: No.3 Lower inner conductor

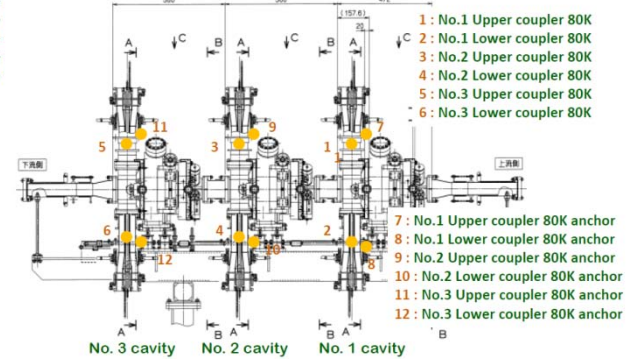


- 31: No.1 Upper coupler doorknob
- 32: No.1 Lower coupler doorknob
- 33: No.2 Upper coupler doorknob
- 34: No.2 Lower coupler doorknob
- 35: No.3 Upper coupler doorknob
- 36: No.3 Lower coupler doorknob

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CC-I: 1 ~ 12 (Input 80K)



- 1: No.1 Upper coupler 80K
- 2: No.1 Lower coupler 80K
- 3: No.2 Upper coupler 80K
- 4: No.2 Lower coupler 80K
- 5: No.3 Upper coupler 80K
- 6: No.3 Lower coupler 80K
- 7: No.1 Upper coupler 80K anchor
- 8: No.1 Lower coupler 80K anchor
- 9: No.2 Upper coupler 80K anchor
- 10: No.2 Lower coupler 80K anchor
- 11: No.3 Upper coupler 80K anchor
- 12: No.3 Lower coupler 80K anchor

E. Kako (KEK)

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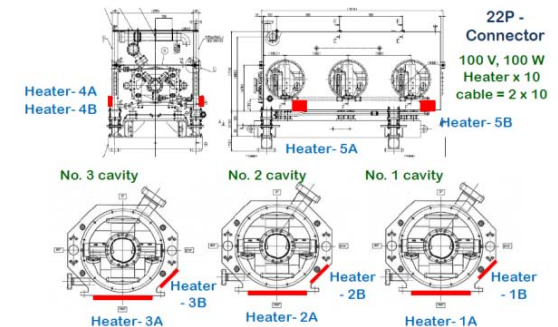
Total : 96 Sensors

48 Cernox

12 Pt-Co

36 CC

Heater location list of cERL injector cryomodule



22P - Connector
100 V, 100 W
Heater x 10
cable = 2 x 10

Heater-4A
Heater-4B

Heater-5A

Heater-5B

No. 3 cavity

No. 2 cavity

No. 1 cavity

Heater-3A
Heater-3B

Heater-2A
Heater-2B

Heater-1A
Heater-1B

Schedule of cERL-Injector Cryomodule (1)

April, 2012

SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3 KEK 納入	4	5	6	7
8	9	10	11	12	13	14
		Coupler processing (#7 & #8, long) ← A. Mitra (TRIUMF) & O. Kugeler (HZB) →				
15	16	17 Dismount of couplers	18 Cleaning of vac. parts	19	20 Exchange of HOM feedthroughs	21
22	23 Attachment of Beam pipes, Pumping, LT	24	25 Attachment of 6 couplers Pumping, Leak check, Ar slow leak	26	27	28
29	30 G.W. Holidays					
						CR内作業完了

高エネルギー加速器研究機構

Schedule of cERL-Injector Cryomodule (2)

May, 2012

SUN	MON	TUE	WED	THU	FRI	SAT
4/29	4/30	1 G.W. Holidays	2	3	4	5
6	7 Tuner assembly, HOM filter meas.	8	9	10 Alignment of 3 Cavities	11	12
13	14	15 真空容器 KEK納入	16 Connection of 2K pipe line, LT Attachment of HOM anchors	17	18	19
20	21 5Kパネル 設置	22 Connection of 5K pipe line, LT Temperature sensors, Heaters, RF cables	23	24	25	26
27	28 Connection of 80K pipe line , LT Attachment of thermal anchors, RF & monitor cables	29	30	31		

Schedule of cERL-Injector Cryomodule (3)

June, 2012

SUN	MON	TUE	WED	THU	FRI	SAT
					1	2
3	4 真空容器内への 空洞挿入作業完了	5	6	7	8	9 Alignment of 3 Cavities & Vacuum Vessel
10	11	12	13	14	15	16 Connection of 2K, 5K, 80K pipe line, Leak tests Temperature sensors, Heaters, RF & Monitor cables
17	18 Thermal shields & anchors SI, Close of port flanges	19	20	21	22	23 Attachment of Endplates, Pumping system, Gate Valves
24	25 Pumping of Vacuum Vessel, Leak tests & Pressure test	26	27	28	29 入射部への 移動・設置完了	30

SUMMARY

- Tests of key components (cavities, RF-feedthroughs, input couplers) had successfully finished.
- Assembly of injector cryomodule was just started.
- Completed injector cryomodule will be installed in the beam line in the end of June, 2012.

END

Thank you for your attentions.

