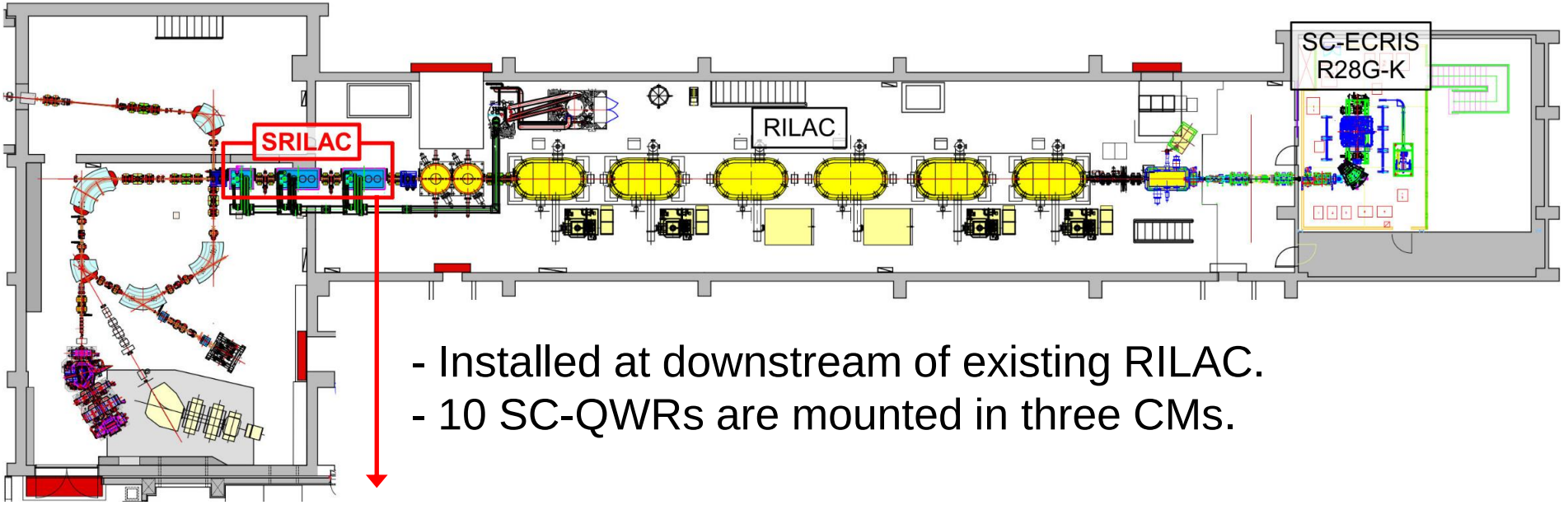
Present status of RIKEN power coupler

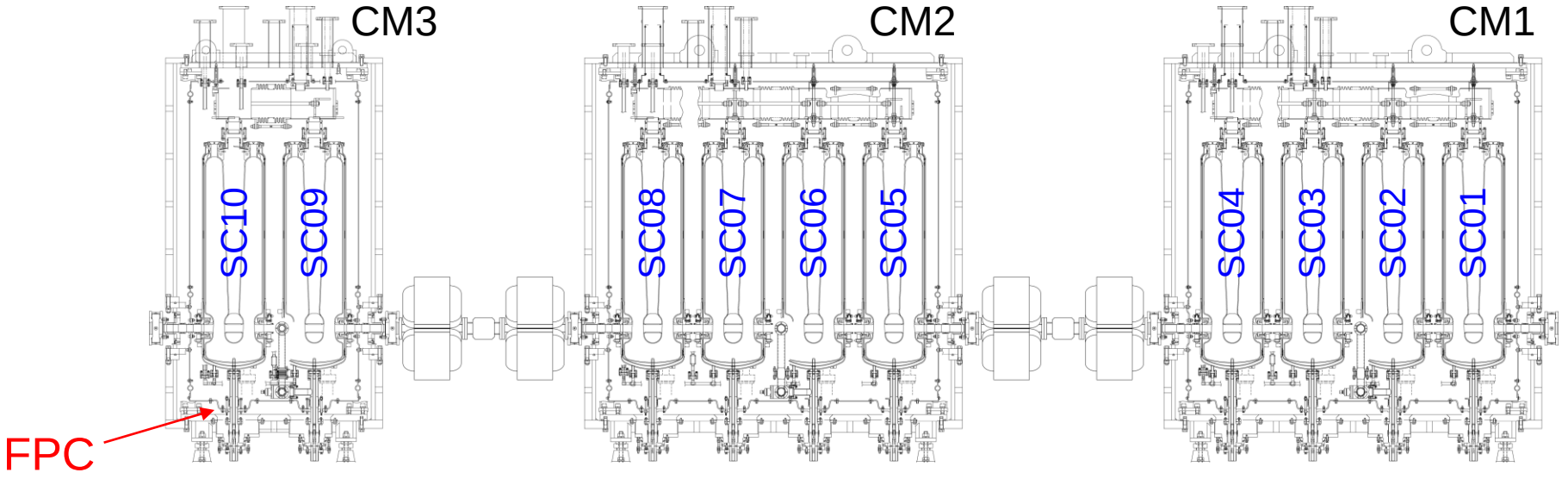
OZEKI, Kazutaka
RIKEN Nishina Center, Wako, Japan

Overview of SRILAC

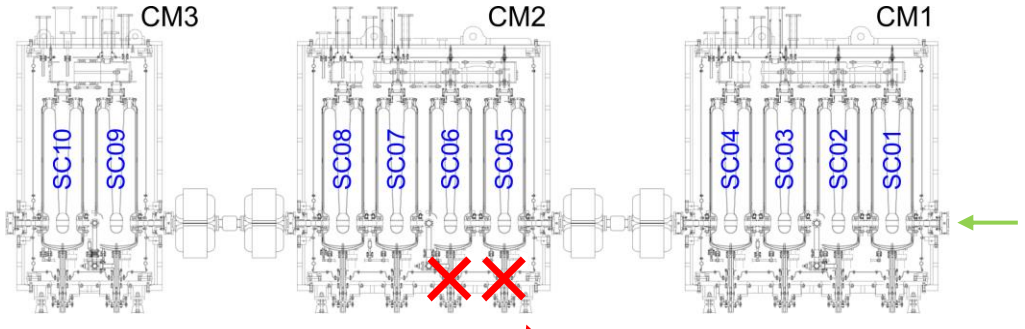
Superconducting Riken Heavy Linear Accelerator



- Installed at downstream of existing RILAC.
- 10 SC-QWRs are mounted in three CMs.



History of CMs and FPCs



Machine availability and reliability in SRILAC at RIKEN
K. Yamada, Oct. 12 16:00~

2019	Mar.	Assembly and installation of CMs.
	Sep.~	Evacuation of QWRs and CMs, cool-down test of CMs.
		Nov. 17: Vacuum leakage from a FPC window.
2020	Jan.	1st beam acceleration test.
	Jun.~	Beam delivery to experiments.
		Oct. 27: Vacuum leakage from another FPC window.
	Dec.	Redesign and production of new FPCs.
2021	May	Installation of outer windows to SC05 and SC06.
	Aug.	Delivery of four new FPCs.
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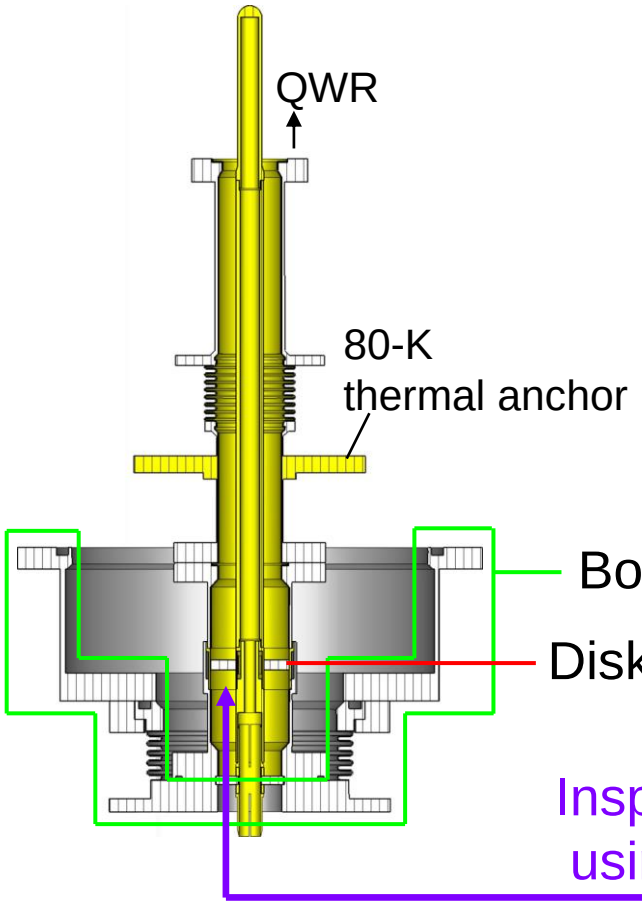
2022	Nov.	Six new FPCs will be delivered.

Vacuum leakage from FPC windows



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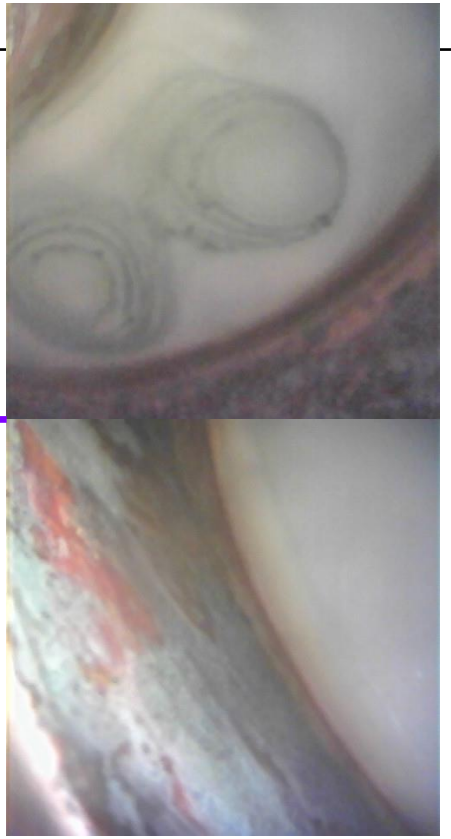


Most probable process to vacuum leakage:

Dew condensation on air-side of vacuum window

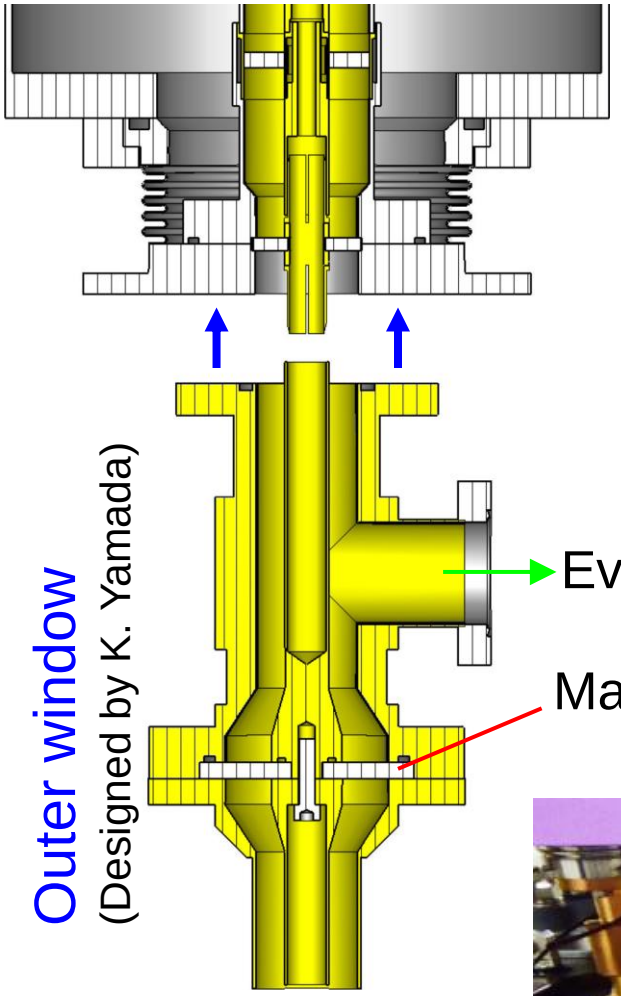
↓

Galvanic corrosion of metallization of alumina

↓

Degradation of brazing of vacuum window

Outer windows



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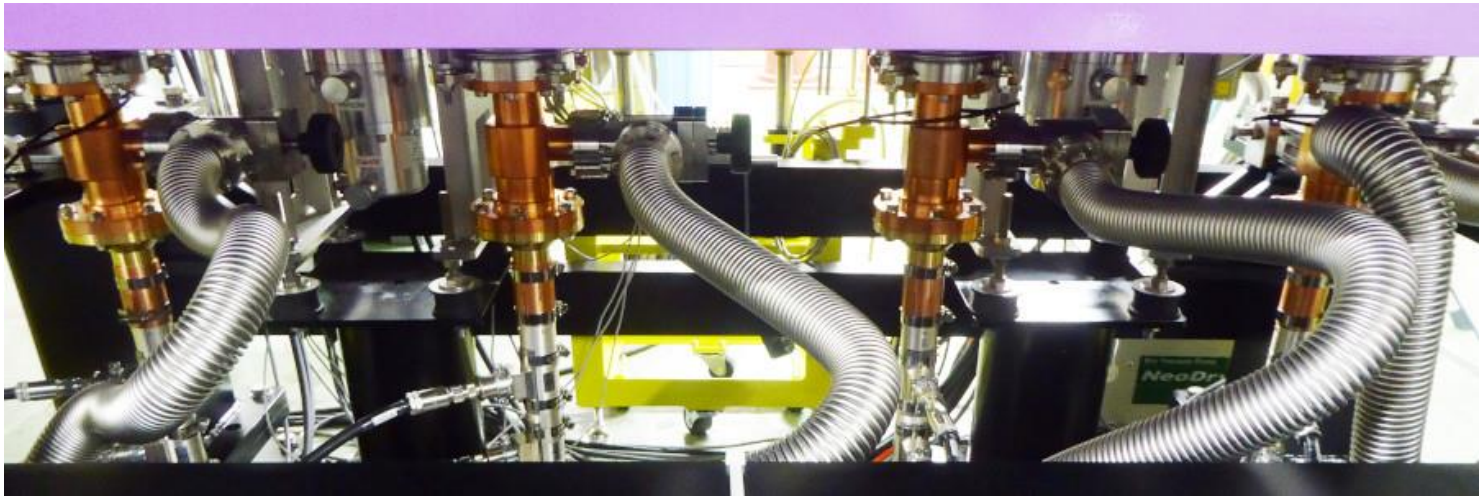
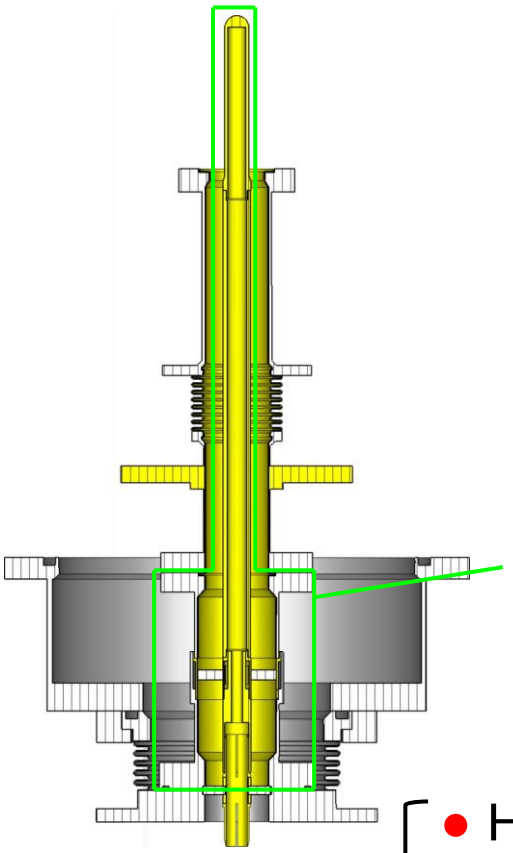


Redesign of new FPCs



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Components to be replaced:

- Inner conductor
- Vacuum window
- Lower part of outer conductor

- Higher thermal conduction at lower part of outer conductor.

	Material of outer conductor below Vac. Win.	Estimated Temp. at vacuum window (Assumed Temp. of lower end of IC and OC are both 300 K)
Present FPCs	SS + Cu-plating	~283 K
New FPCs	**Thick copper**	~298 K

- Installation of heater around vacuum window.

Pre-processing of new FPCs

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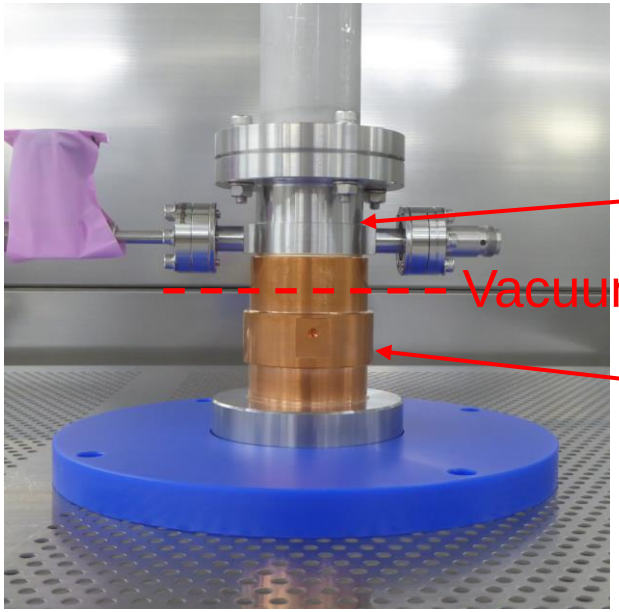


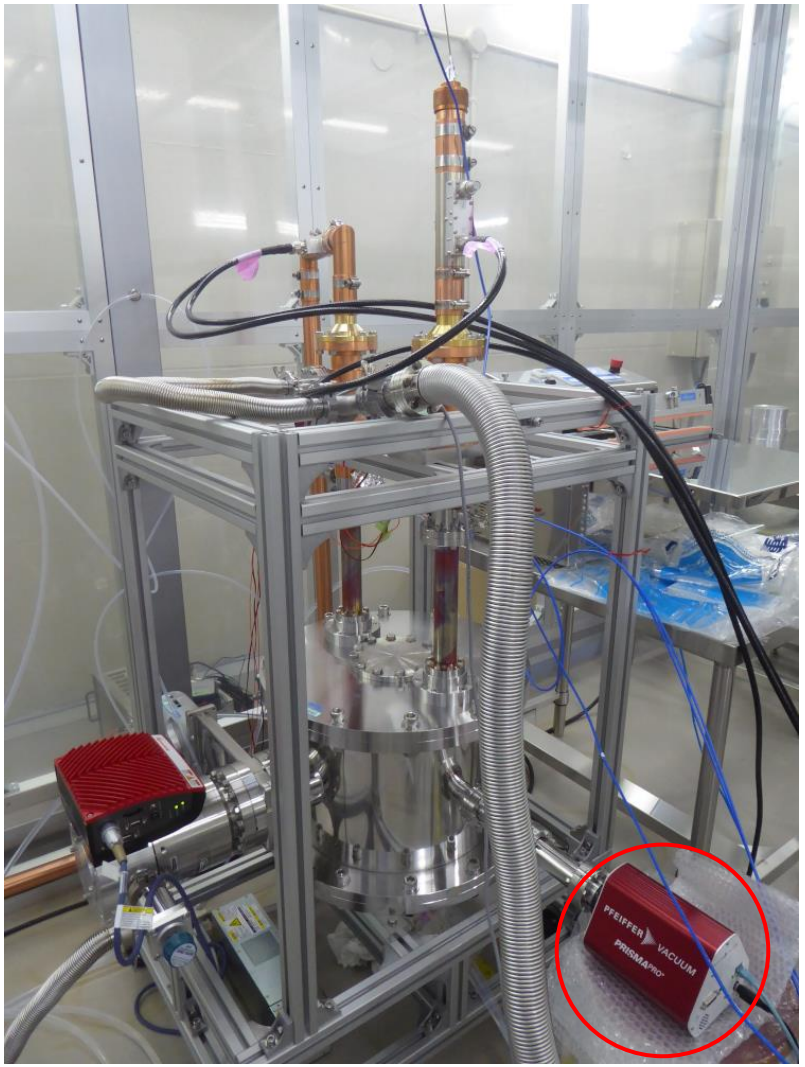
Pre-processing in ISO class-1 clean room:

- Particle removal (blow only)
- Installation to RF test chamber
- Evacuation
- Baking (2 days)
- RF process (w/ outer window)

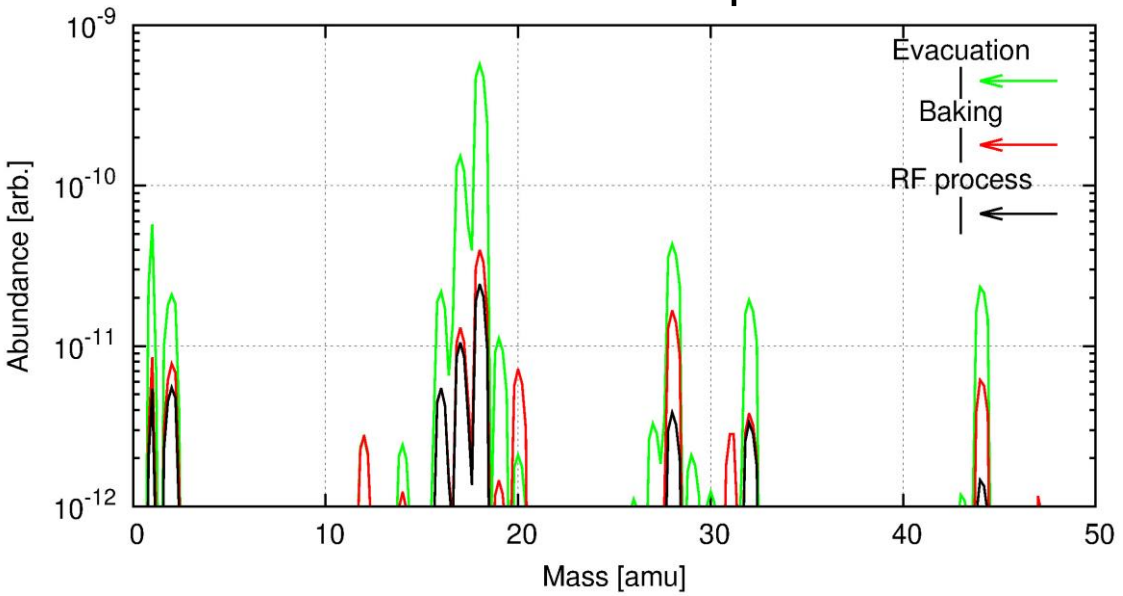
} Outgas measurement

- Sealing w/ dry N_2

Outgas measurement (1)



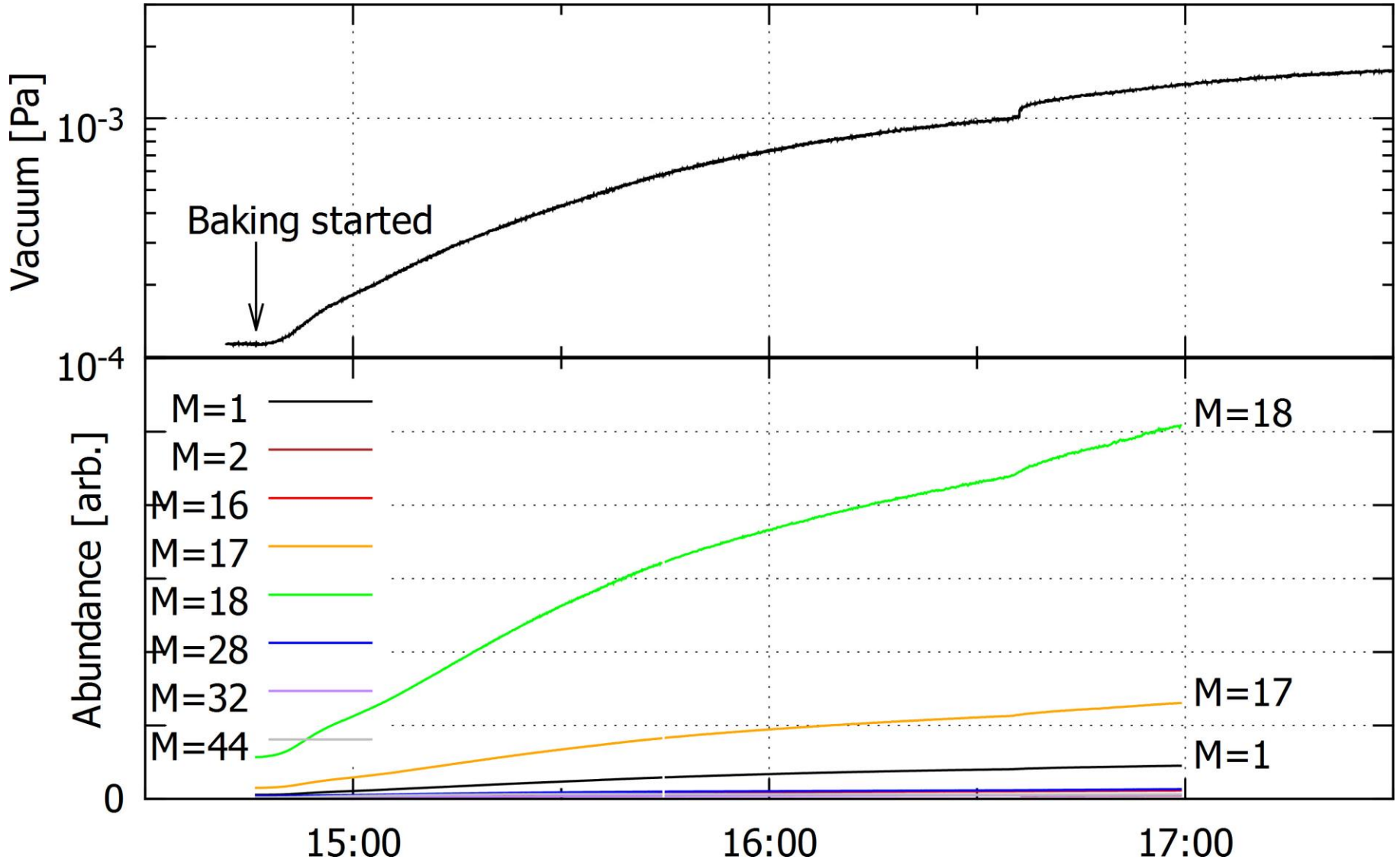
Mass distributions of residual gas
at each step



RGA
PrismaPro QMG 250 (Pfeiffer Vacuum)

Outgas measurement (2)

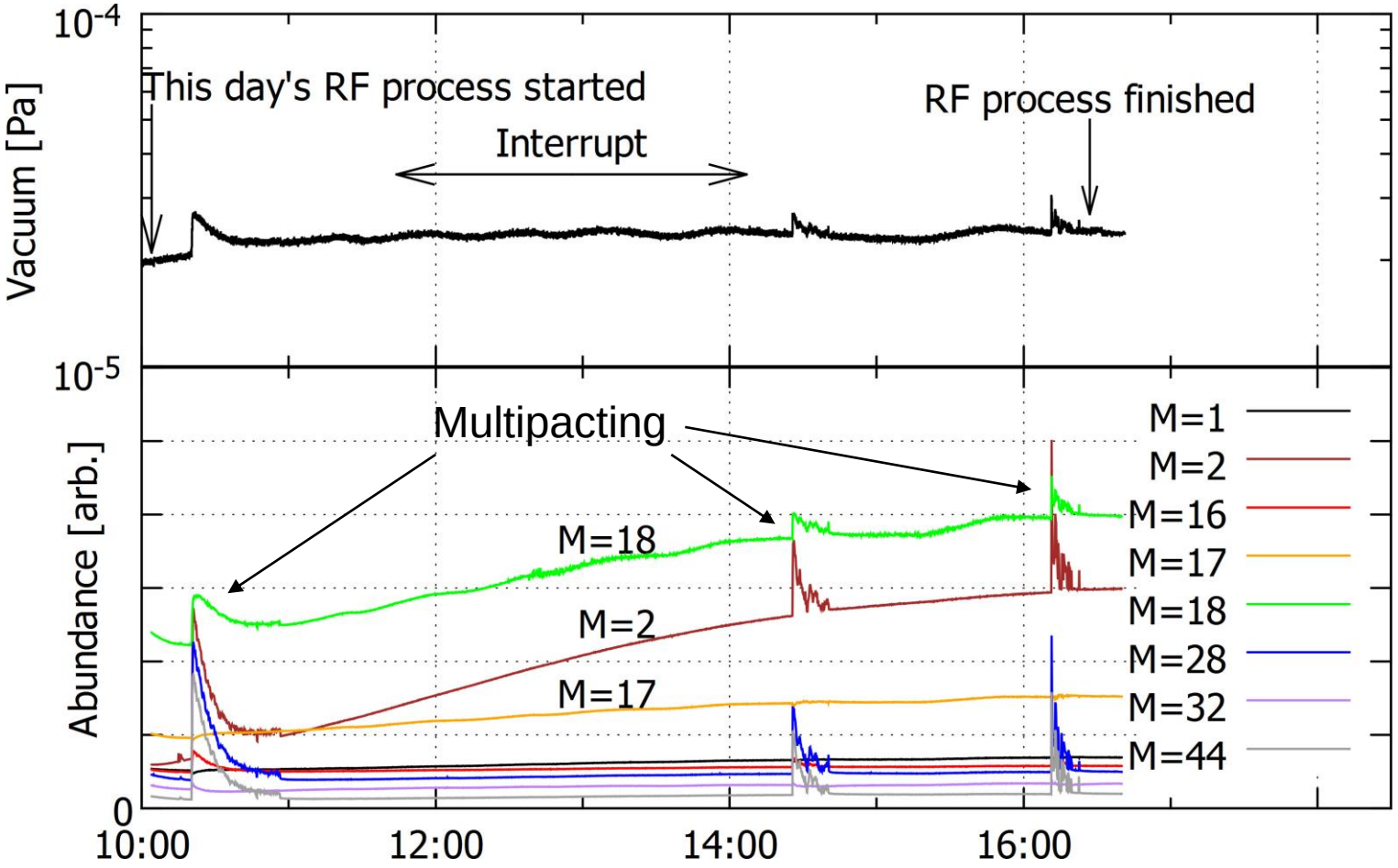
Outgas induced by baking



- *M* = 1, 17, 18 increased by baking.

Outgas measurement (3)

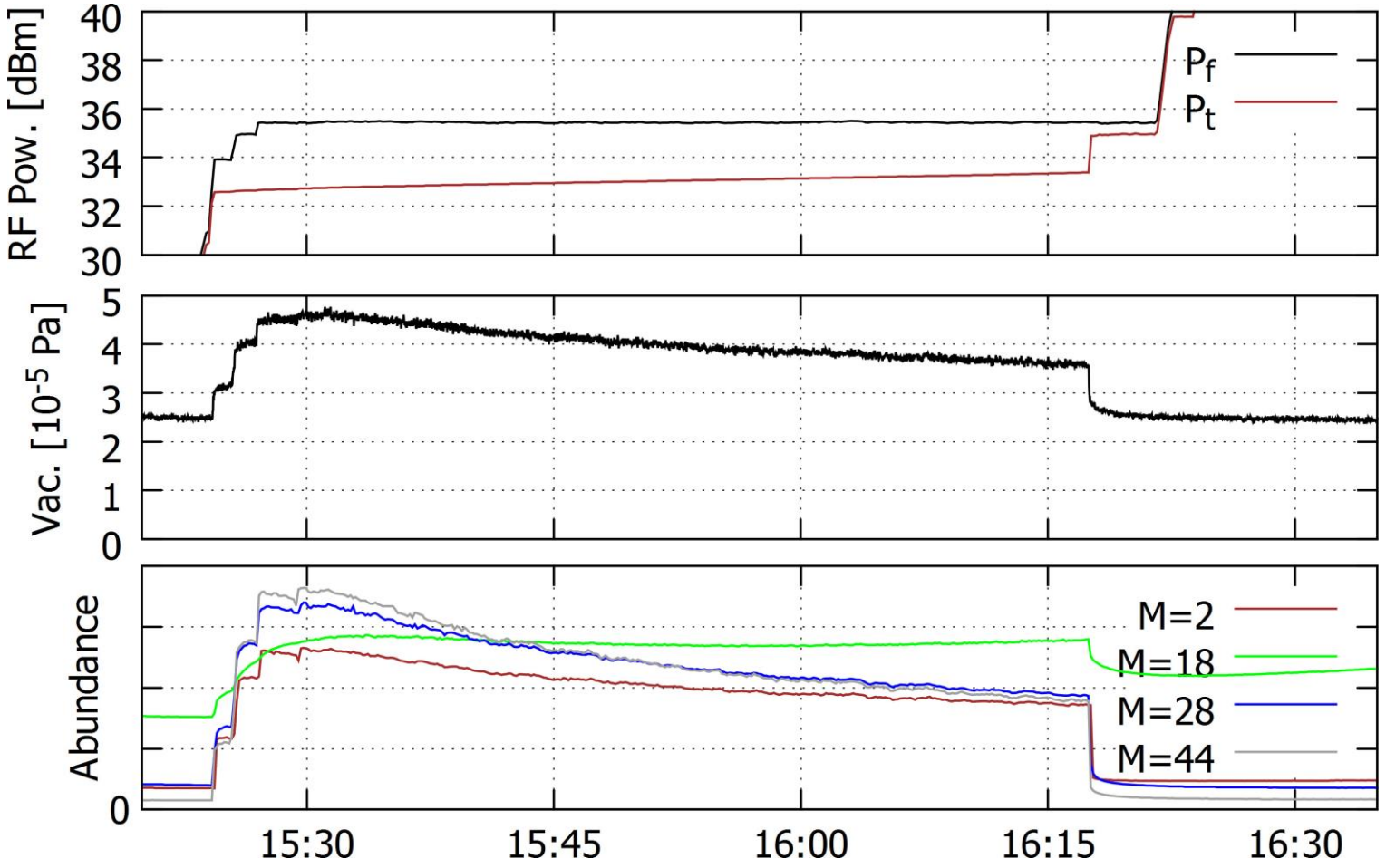
Outgas induced by RF process

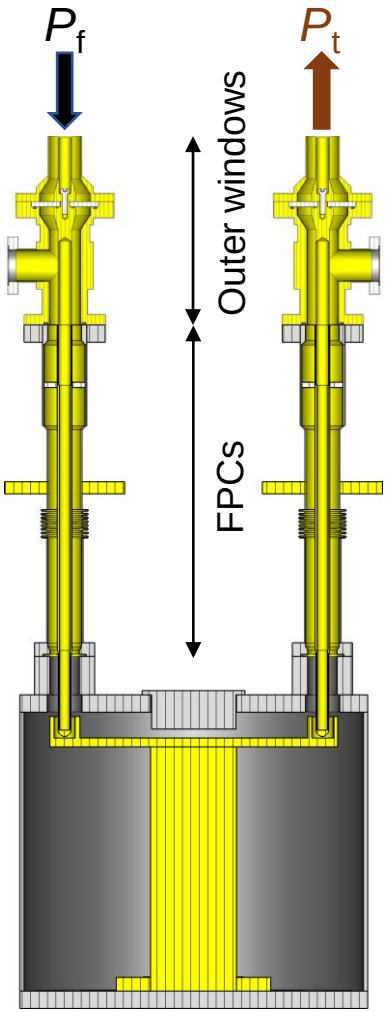


- *M* = 2, 17, 18 gradually increased by RF supply.
  (continued to increase even if RF wasn't supplied.)
- *M* = 2, 18, 28, 44 largely increased by multipacting.

Outgas measurement (4)

Another example of outgas induced by multipacting

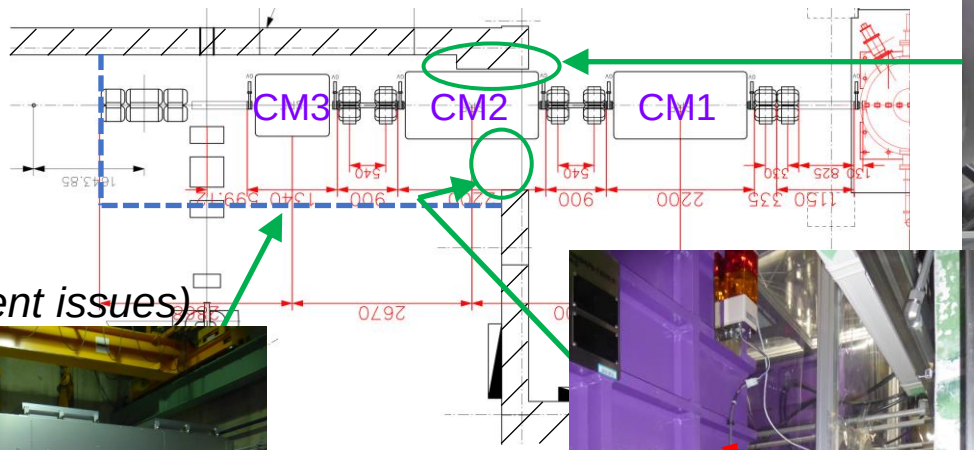




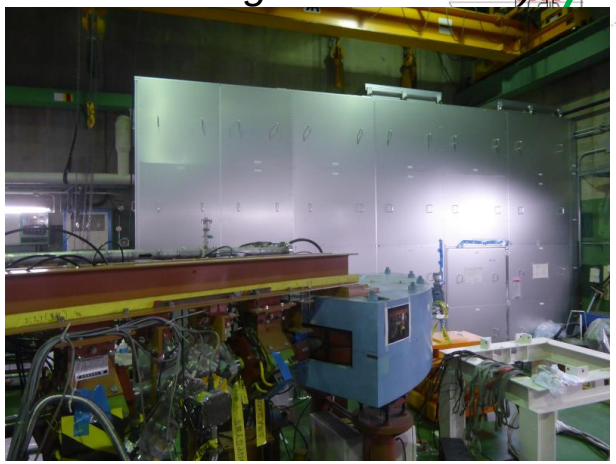
RF test stand

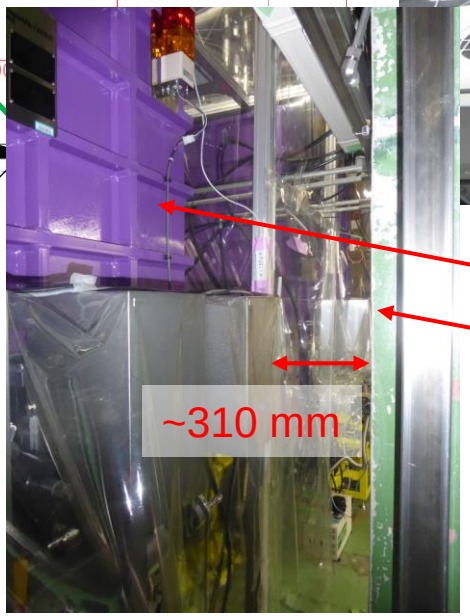
Preparation for replacement of FPCs (1)

Floor plan around SRILAC



(radiation management issues)





Hard to move CMs to other clean place → On-site replacement of FPCs

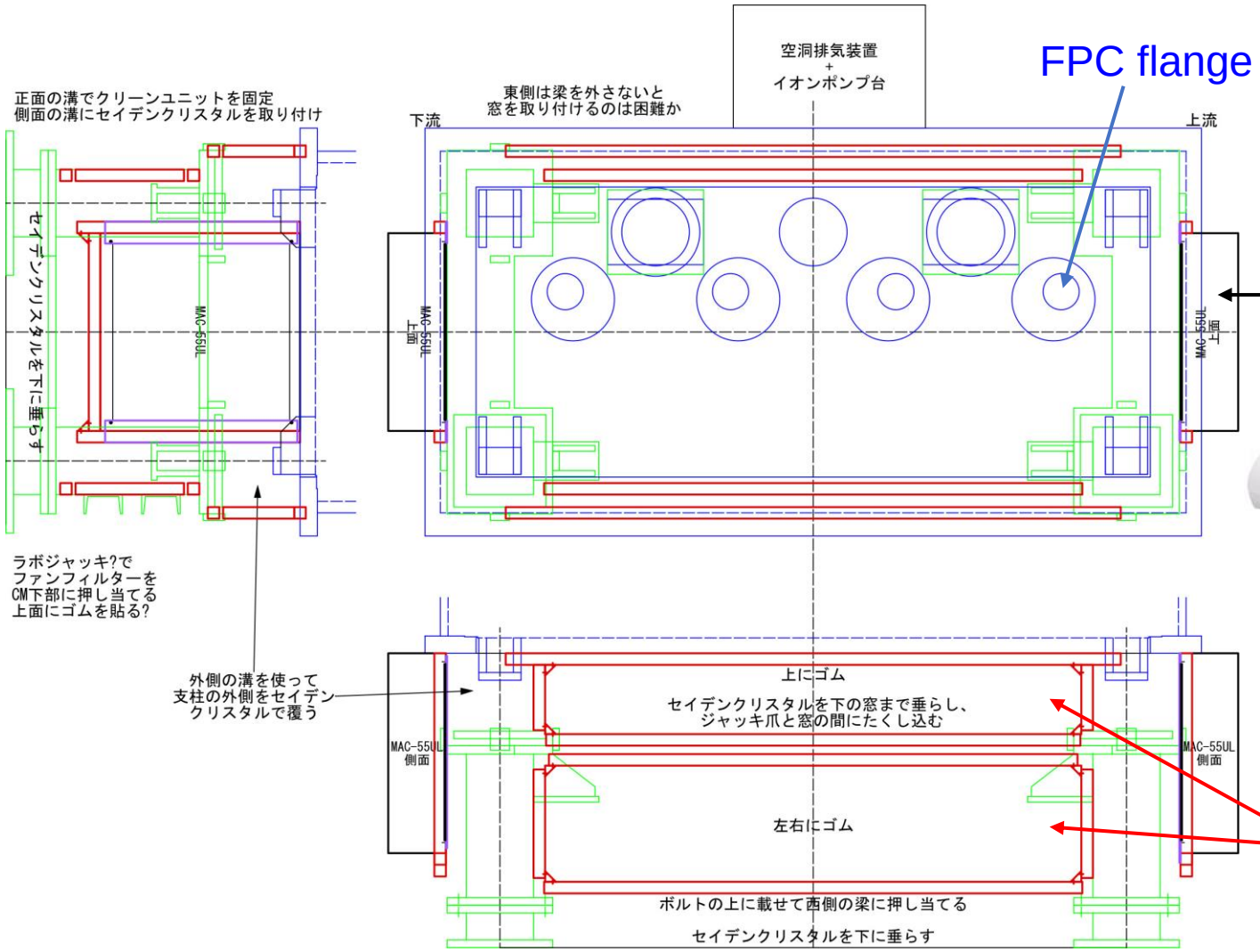
- Clean environment under CM
- FPC elevating device
- Full-scale model of lower part of CM
  → Simulate FPC replacement process in advance.

Under consideration

Preparation for replacement of FPCs (2)

Plan for clean booth under CM

- Vinyl chloride film enclosing whole area under CM
- Clean air-flow from upstream and down stream of CM

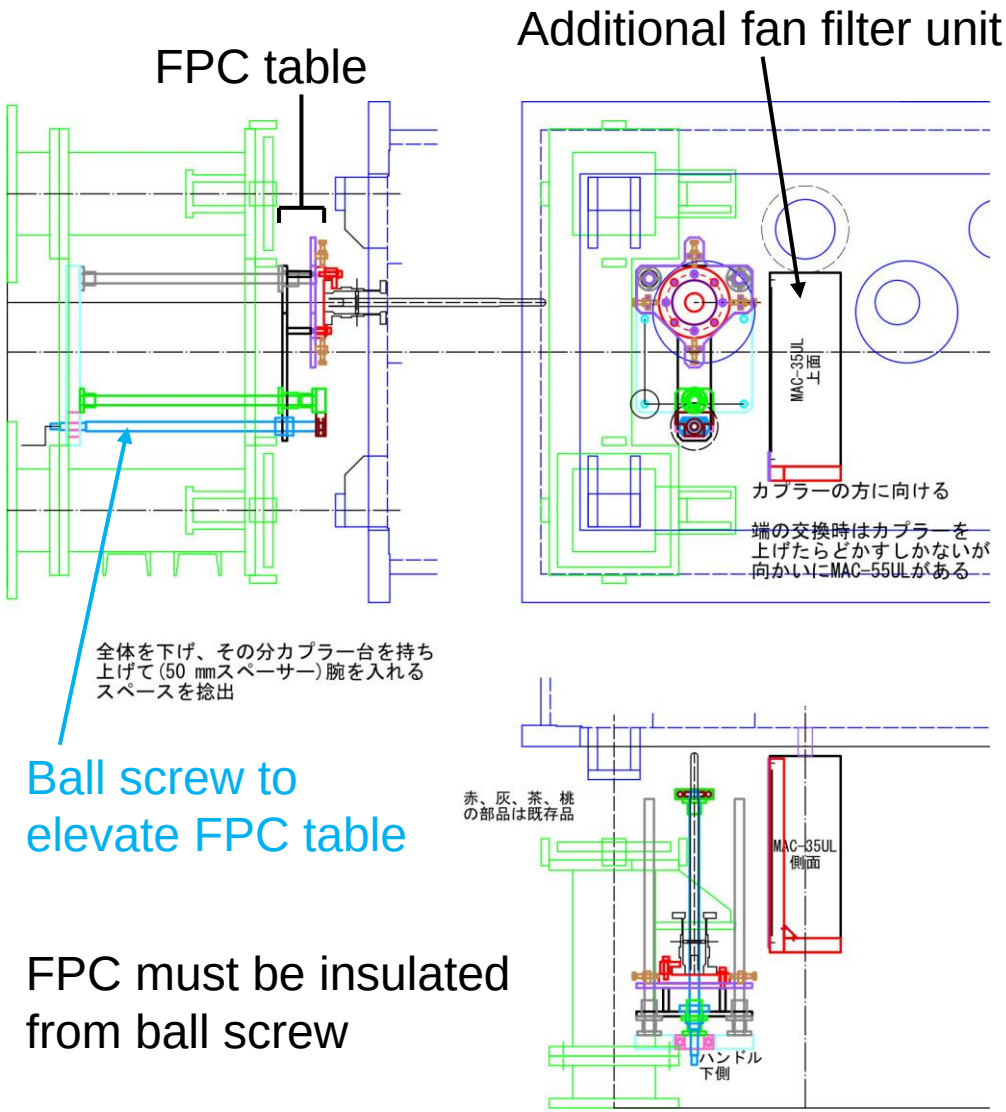


AIRTECH JAPAN, LTD.
Multipurpose fan filter unit
SS-MAC series
ULPA filter

Aluminum frame
(MISUMI Corp.)
+
Vinyl chloride film

Preparation for replacement of FPCs (3)

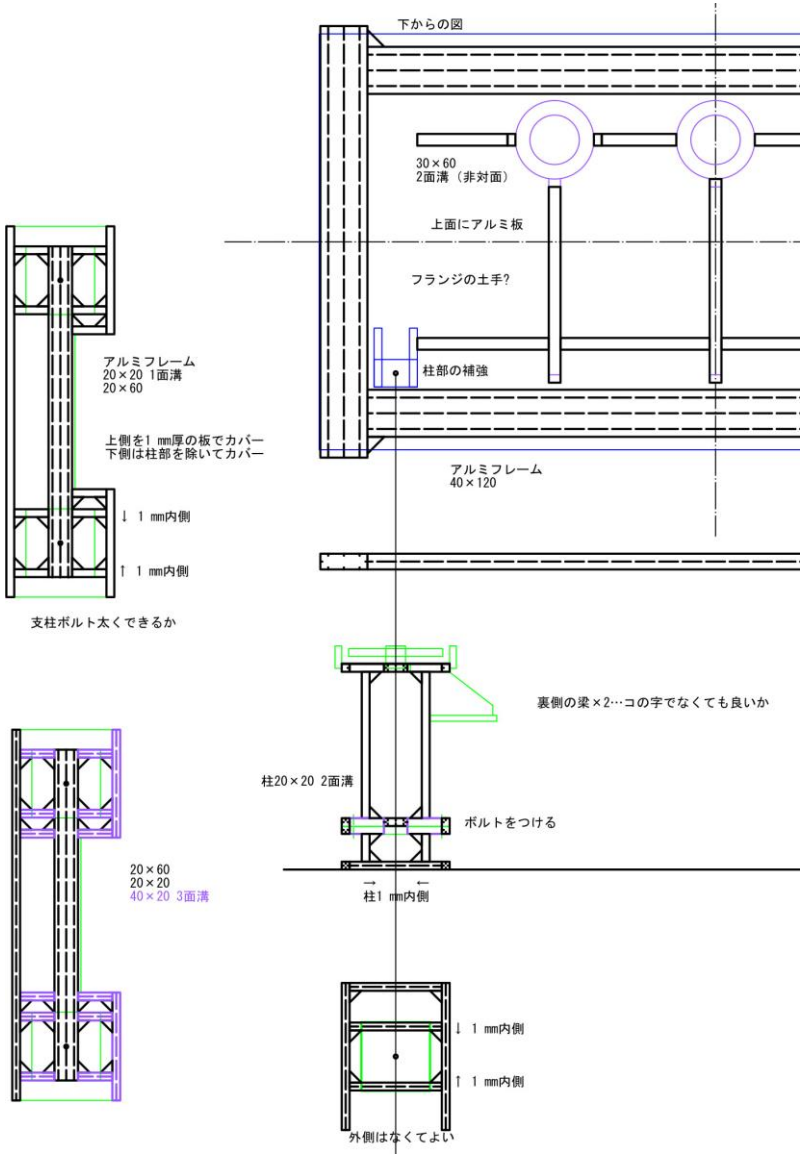
Plan for FPC elevating device



Ball screw to elevate FPC table

FPC must be insulated from ball screw

Plan for full-scale model of CM

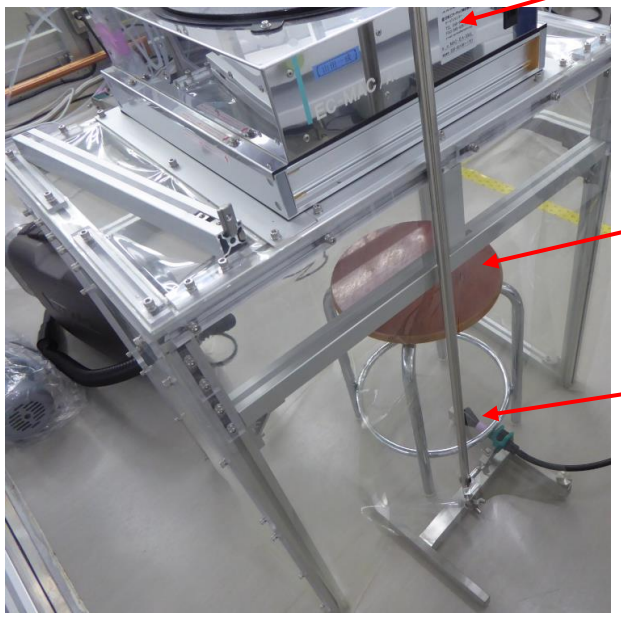


Aluminum frame (MISUMI Corp.), Aluminum plate, *etc*….

Preparation for replacement of FPCs (4)

Test: Cleanliness of fan filter unit

Simple clean booth



AIRTECH JAPAN, LTD.
Stainless steel fan filter unit
EC-MAC (equivalent to SS-MAC)
ULPA filter

Obstacle

Bell-mouth of particle counter

LASAIR III 100
(Particle Measuring System)

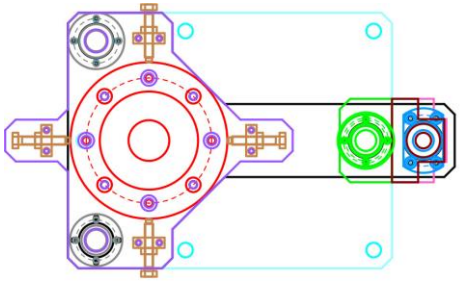
(Outside of clean booth: ISO class 4)

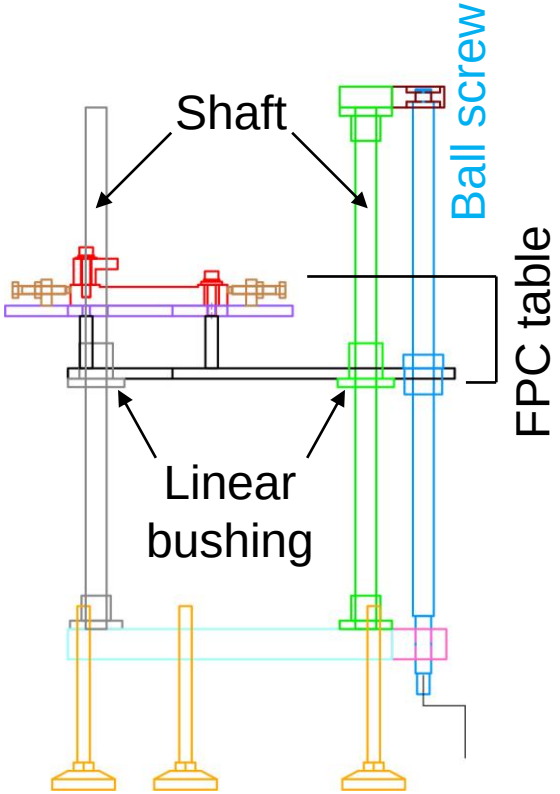
Clean booth (Plastic curtains)	Number of ≧ 0.1 μm particles measured [counts/s]
Closed	ND
Open	< 10 (ISO class ~ 3 ?)

A system to enclose additional fan filter unit and FPC may be needed.

Preparation for replacement of FPCs (5)

FPC elevating device





Test: Dust emission from linear bushing

(Similar FPC elevating device)

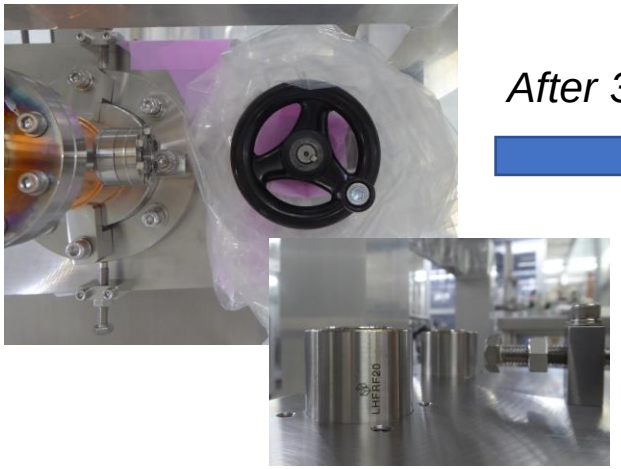
Ball screw
BSSC2005 (MISUMI Corp.)
enclosed with poly bag.

LHFRF (MISUMI Corp.)
w/o low dusting grease

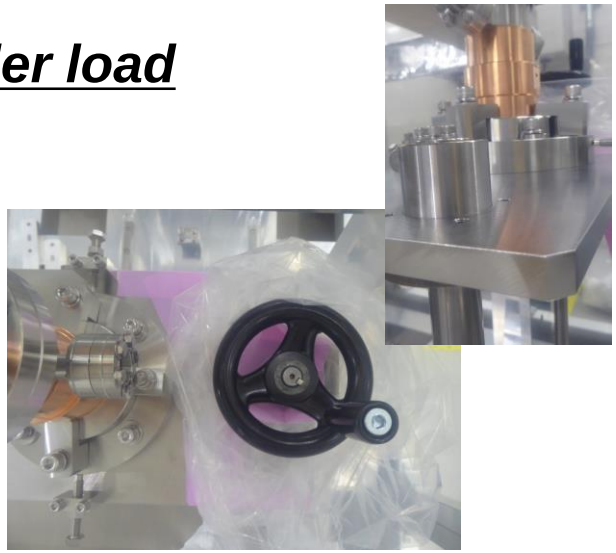
No dust emission while raising and lowering FPC table.

Test: Rotation of ball screw under load

FPC table (with new FPC on it) was raised to the top of shaft.



After 3 days



No rotation

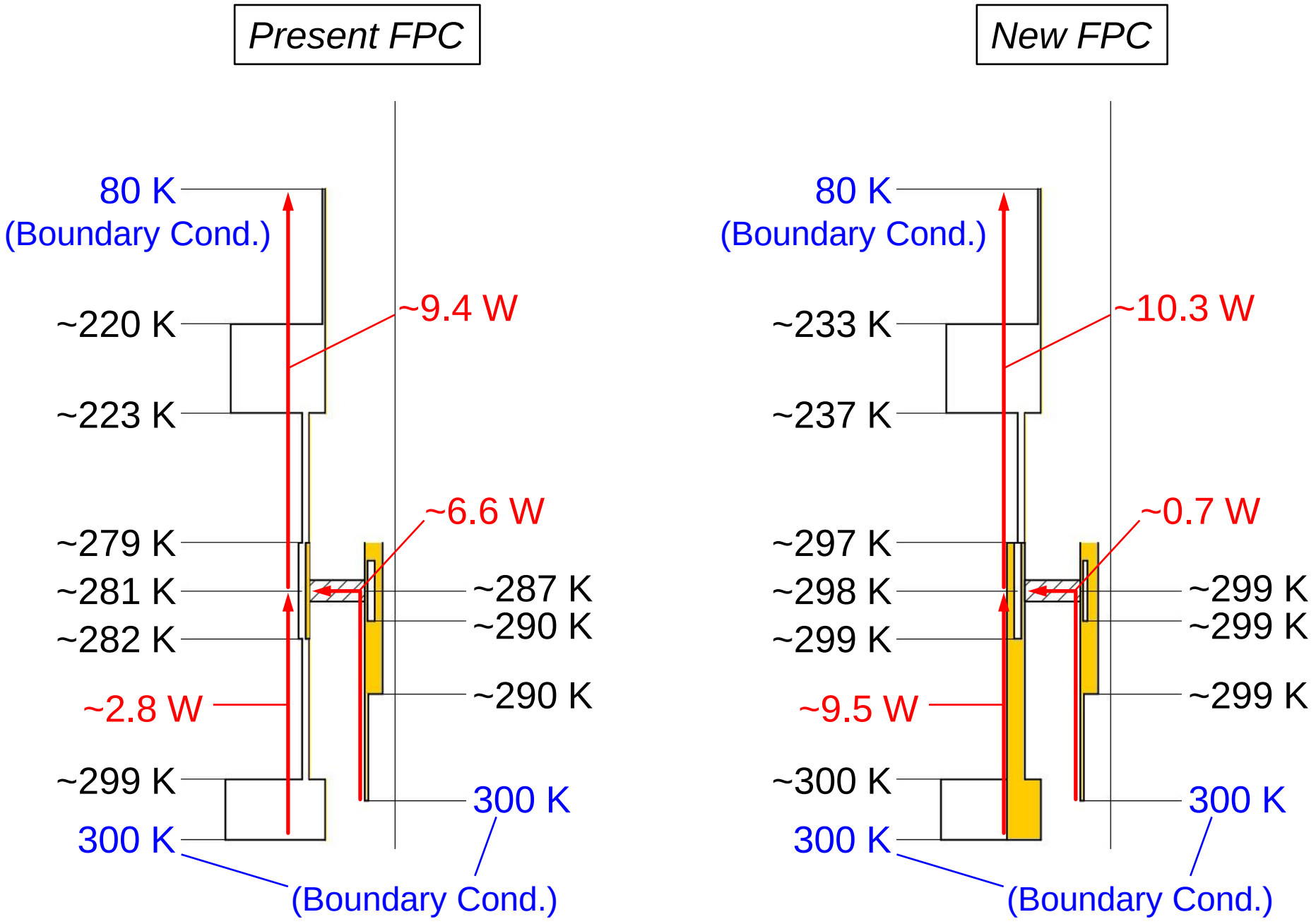
Summary

- In RIKEN, CM operation started from Sep. 2019.
- Since then, vacuum leakages from FPC window occurred twice.
  - May be due to dew condensation at air side of vacuum window.
- Outer windows were installed to all 10 FPCs
  for provision and prevention to the vacuum leakage.
- New FPCs were redesigned and are now being produced.
  - Improve thermal conduction at lower part of outer conductor.
- Four new FPCs were already delivered and pre-processed.
  - RGA was introduced to measure outgas during pre-processing.
- Preparation for replacement of FPCs are now under progress.
  - Clean environment under CM.
  - FPC elevating device.
  - Simulation of FPC replacement process.

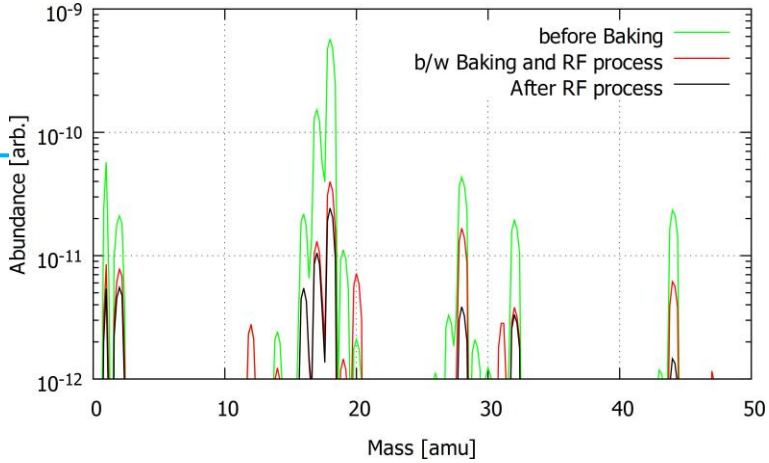
Replacement of FPCs: After present experiment ?

(Super-heavy element synthesis experiment has been ongoing since Jun. 2020.)

Estimation of temperature distribution



Outgas induced by multipacting



All detected masses are plotted.