Surface processing and the first VT result of QWRs for the SRILAC

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SRILAC, upgrade of the RIKEN heavy ion LINAC

- Energy and intensity upgrade
- Super heavy element synthesis, RI production

28 GHz SC-ECRIS

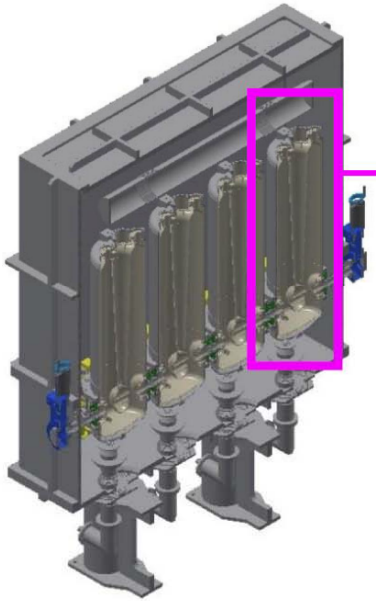
3 cryo-modules
10 SC-QWRs

SHE

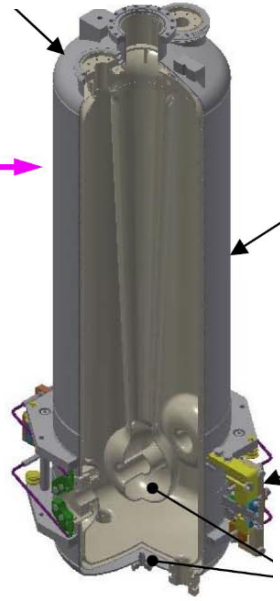
RI

18 MV

E **: 6.5 MeV/u, *M/q*=5**

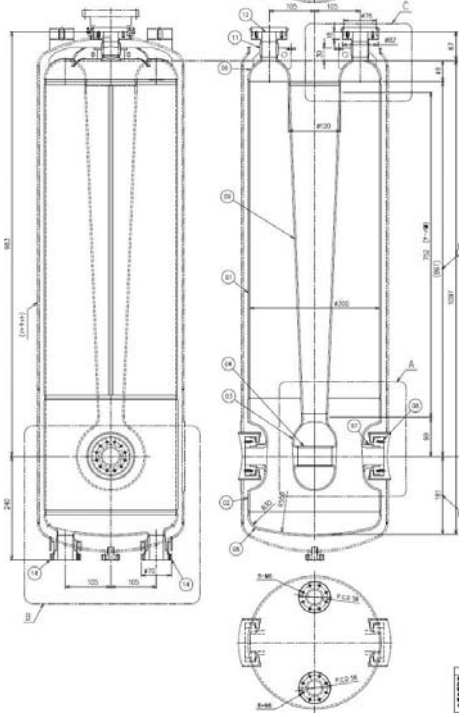


Ti jacket



Bulk Nb cavity

Tuner

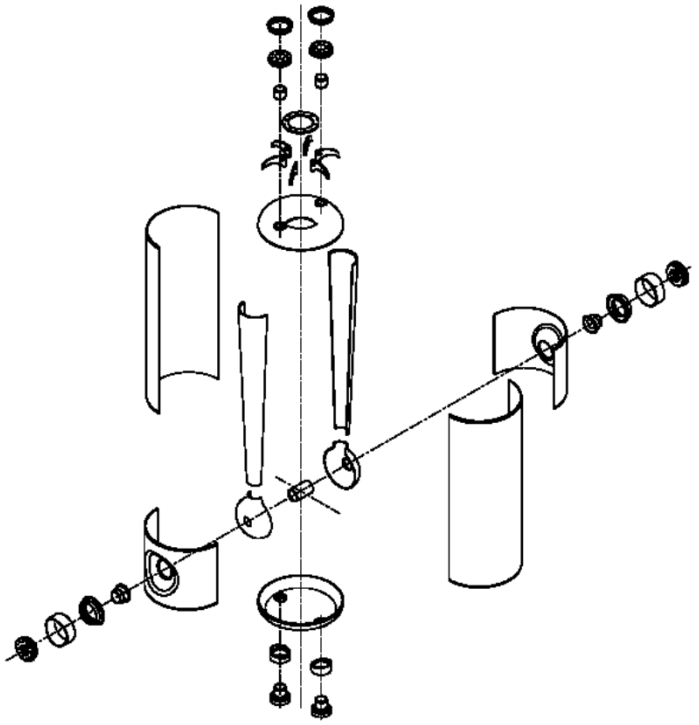


QWR for the SRILAC

Table 1: Design parameters of the SC-QWR. Surface resistance was assumed to be 22.4 nΩ in the calculation.

Frequency [MHz] at 4.2 K	73.0
Duty [%]	100
β_{opt}	0.078
Aperture [mm]	ϕ40
G [Ω]	22.4
R_{sh}/Q_0 [Ω]	579
Q_0	1.0×10^9
P_0 [W]	8
V_{acc} [MV] at E_{acc} = 6.75 MV/m, β = 0.078	2.16
E_{acc} [MV/m]	6.75
$E_{\mathrm{peak}}/E_{\mathrm{acc}}$	6.2
$B_{\mathrm{peak}}/E_{\mathrm{acc}}$ [mT/(MV/m)]	9.6

- 4.2 K operation
- Consists of four partial components
- RRR 250 Nb (Tokyo Denkai Co., Ltd.)
- Grade 2 Nb flanges and ribs (ULVAC, Inc.)
- Compatible with High Pressure Gas Safety Act in Japan

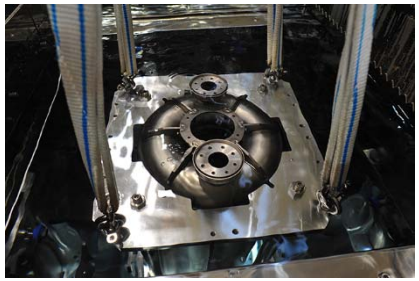


Procedure of Surface Processing

・Based on the ILC recipe introduced from KEK

BCP1(110 μm)

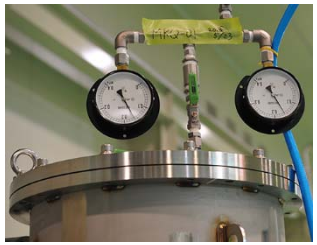
Ultrasonic cleaning with PW



Annealing(750℃, 3hr)

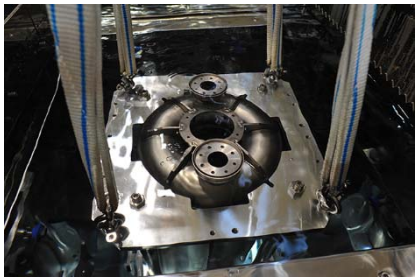
Pre-tuning

Pressure test for High Pressure Gas Safety Act



BCP2(20 μm)

Ultrasonic cleaning with detergent



Rinse by PW

HPR

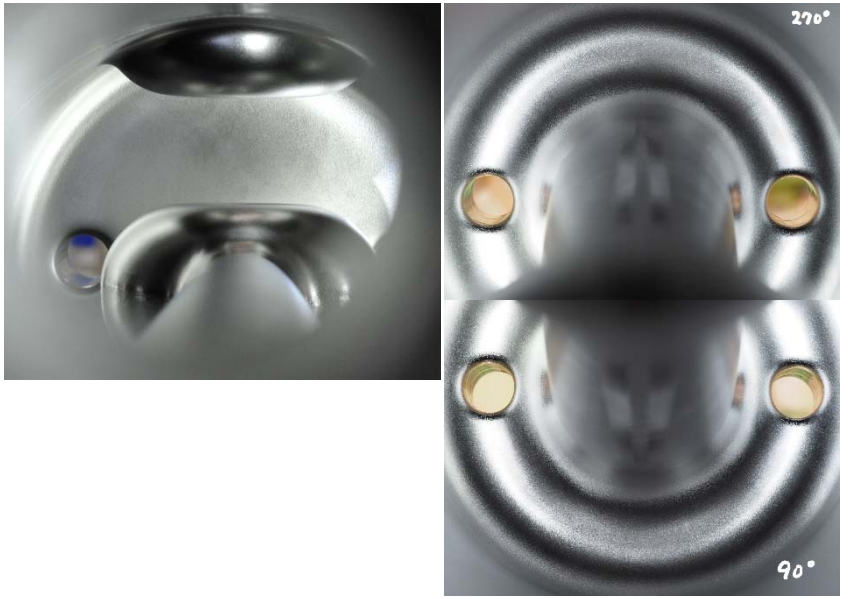
CR work

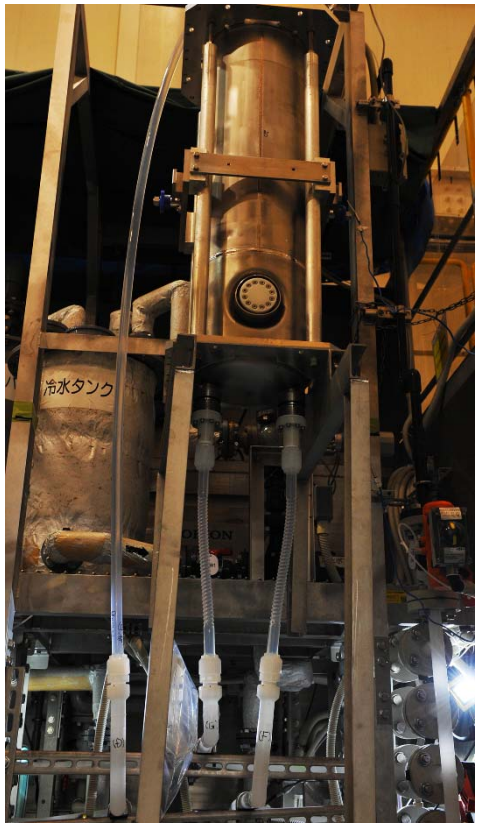
Baking(120℃, 48hr)

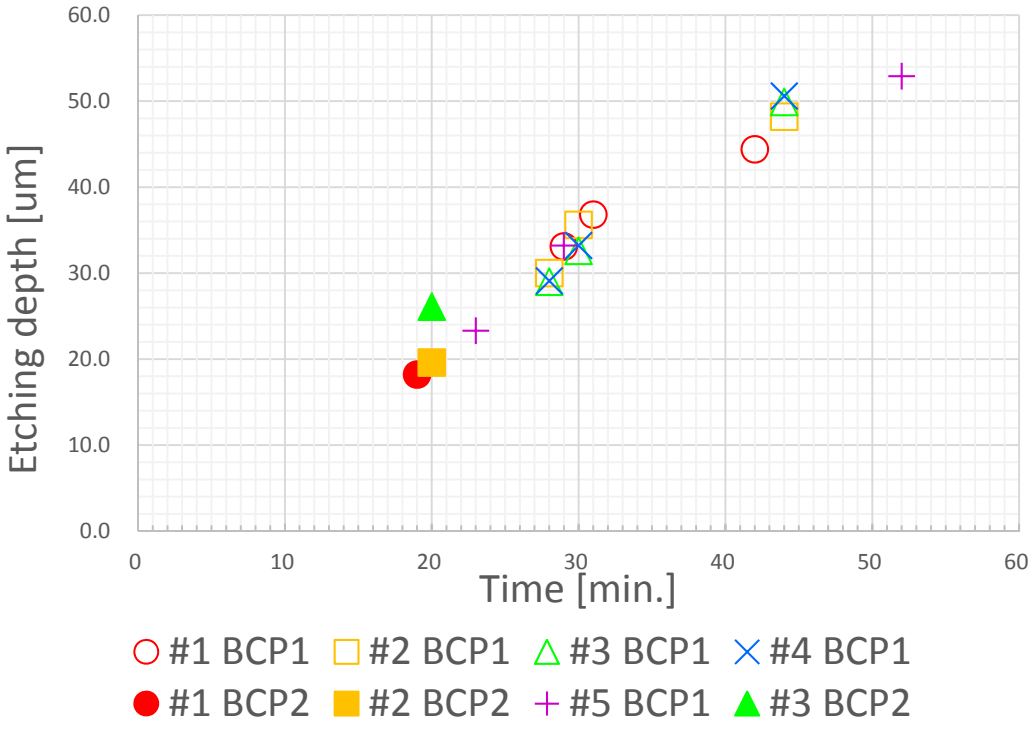
BCP

- Solution HF:HNO_3:H_3PO_4 = 1:1:2
  (Change guideline:15 g/L)
- Temperature: 16～17 ℃ (only cooling)
- Flow rate: 56～57 L/min
- Etching rate: 1.0 ～ 1.3 μm/min.
- Automatically processed by air controlled valve

- BCP1 110 μm (normal, upside down, normal)
- BCP2 20 μm (normal)

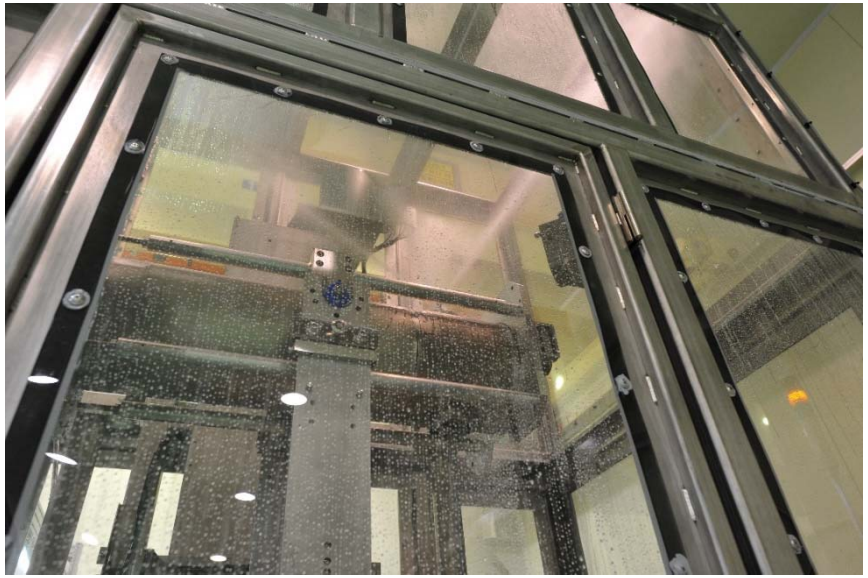




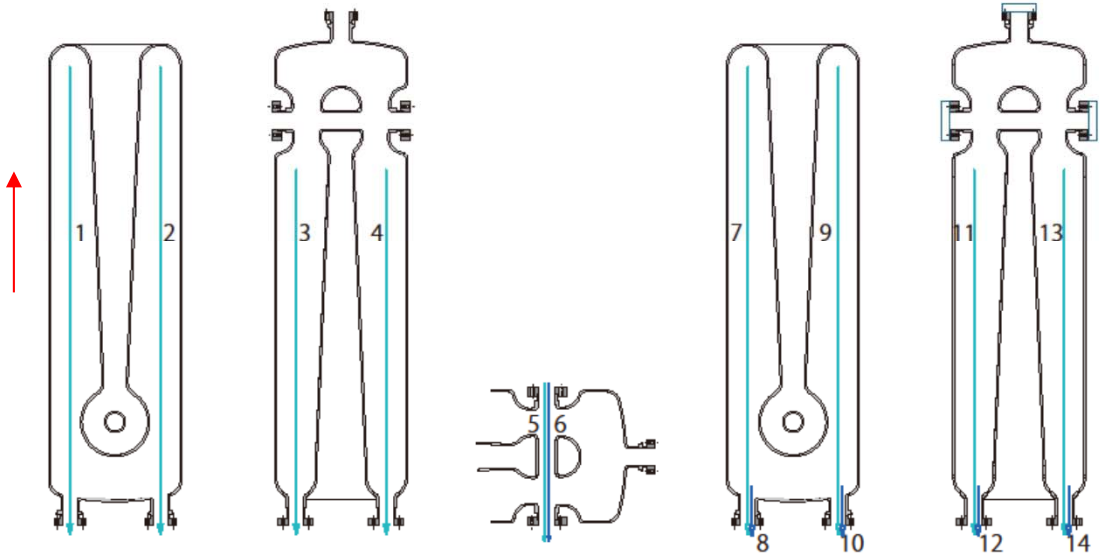


HPR

- Ultra Pure Water: ρ ～18.2 MΩ･cm
- Pressure: 8 MPa
- Total time: ～400 min.
- QWR is moving up and down
- Nozzle is rotating

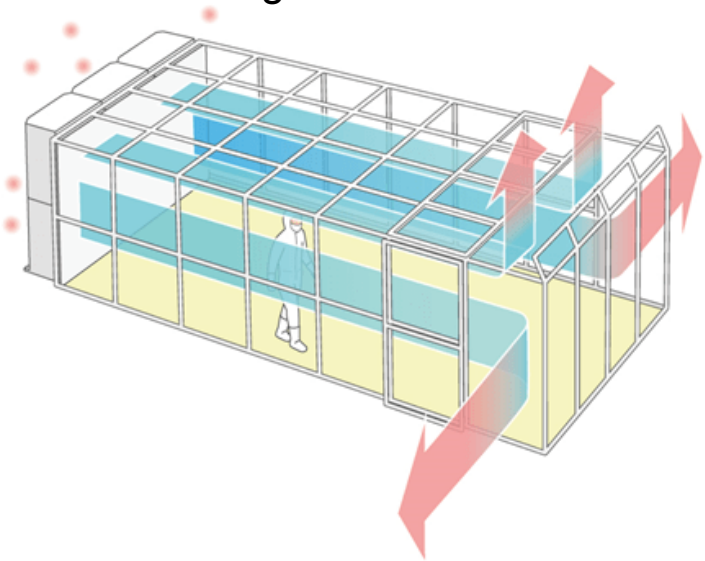


- 1～5: Rough rinsing
- 6～14: Finish rinsing
- Moving up by 40 mm/min: 1～5, 7,9,11,13
- Moving up by 10 mm/min: 6, 8, 10,12,14



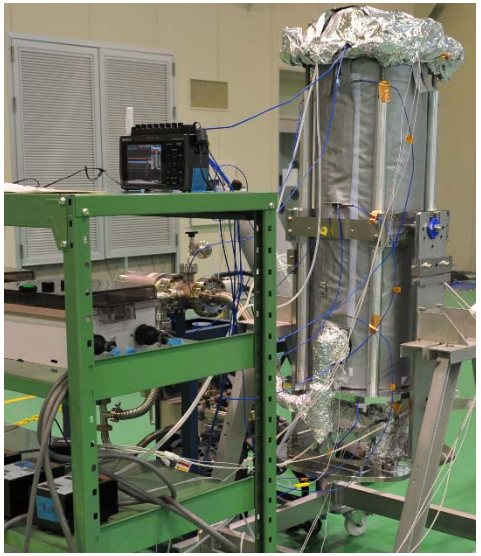
CR Work and Baking

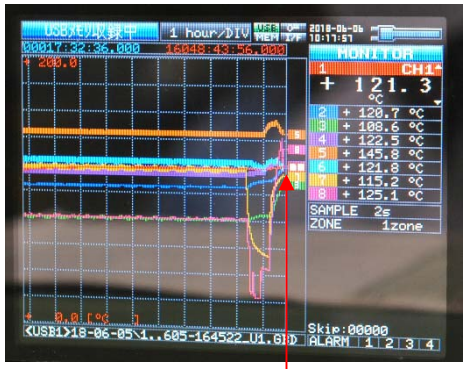
- Assembling in an ISO clas1 super clean area (KOKEN floor coach) built in an ISO class 7 clean room
- 120℃ 48hr baking in the ISO class 7 clean room



Assembly of QWR #1 (June 5, 2018)

Baking of QWR #1 (June 6, 2018)



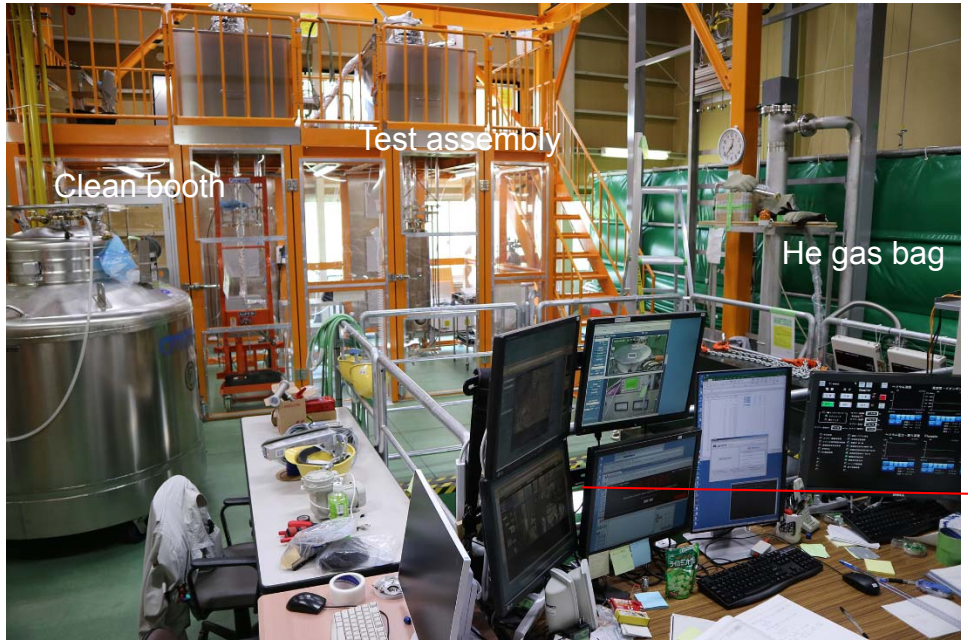


Baking start

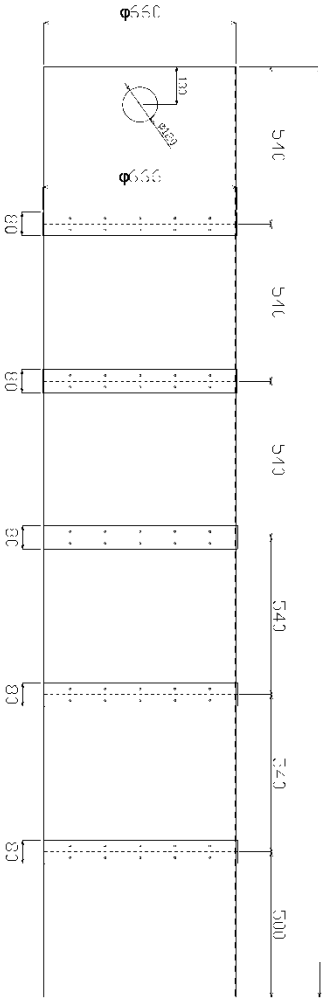
Test Stand at RIKEN

- Newly constructed in the last winter.
- Cryostat: ID700 × H3220
- Magnetic shield: RT Permalloy 3 mmt@ 4.2 K
  Residual filed ～10 mGauss
- Open clean bench (KOKEN table coach) is used for the QWR to connect to a test assembly in a clean booth.

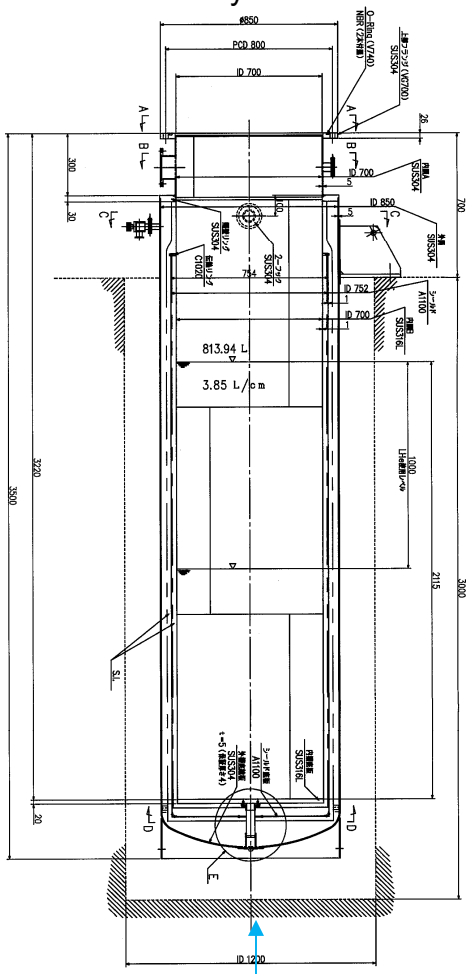
KOEKN table coach



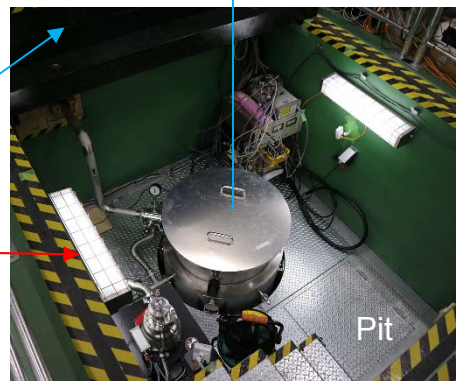
Magnetic shield



Cryostat

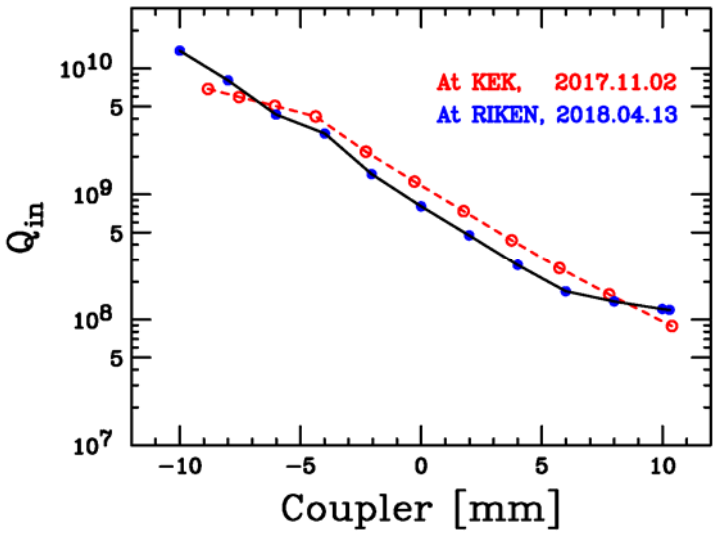


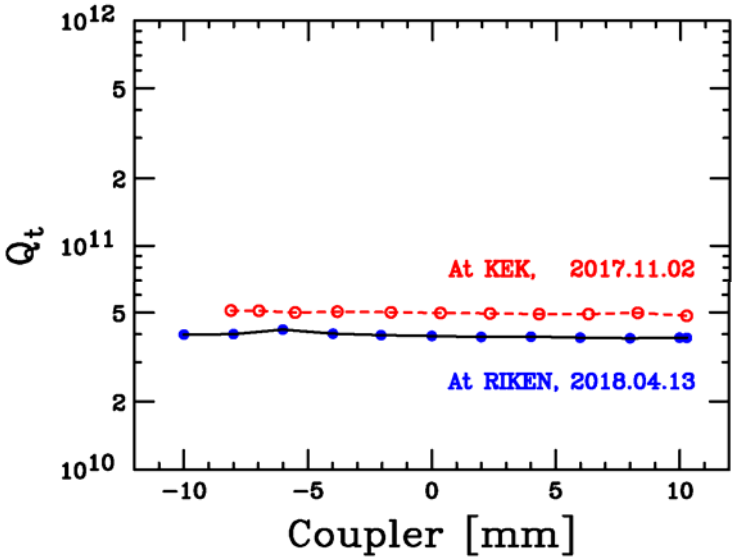
X-ray shield

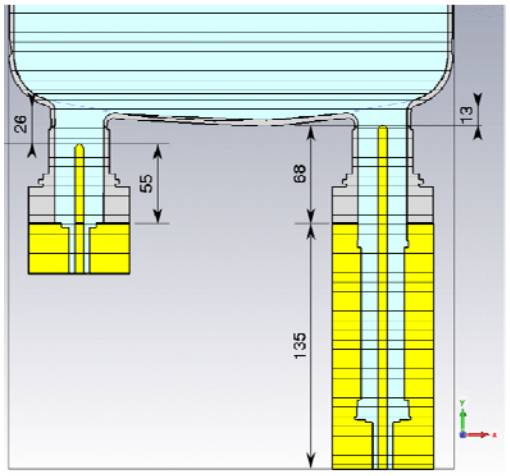


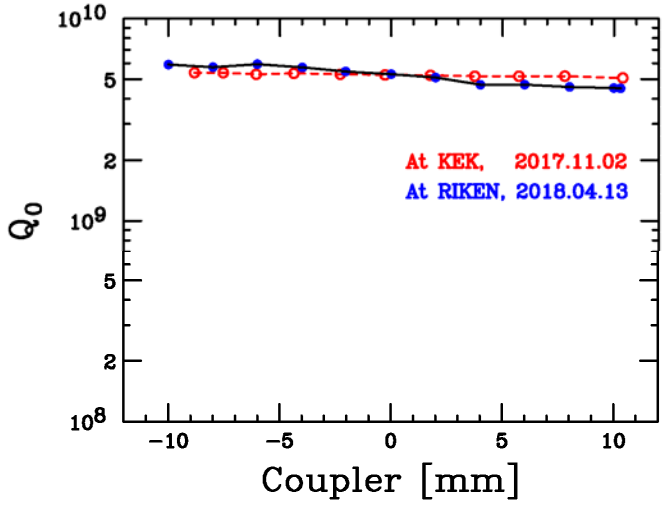
Result of performance test

- Prototype QWR: The VT result at RIKEN compared with the VT result at KEK.
  (Reported by N. Sakamoto at the last TTC meeting).



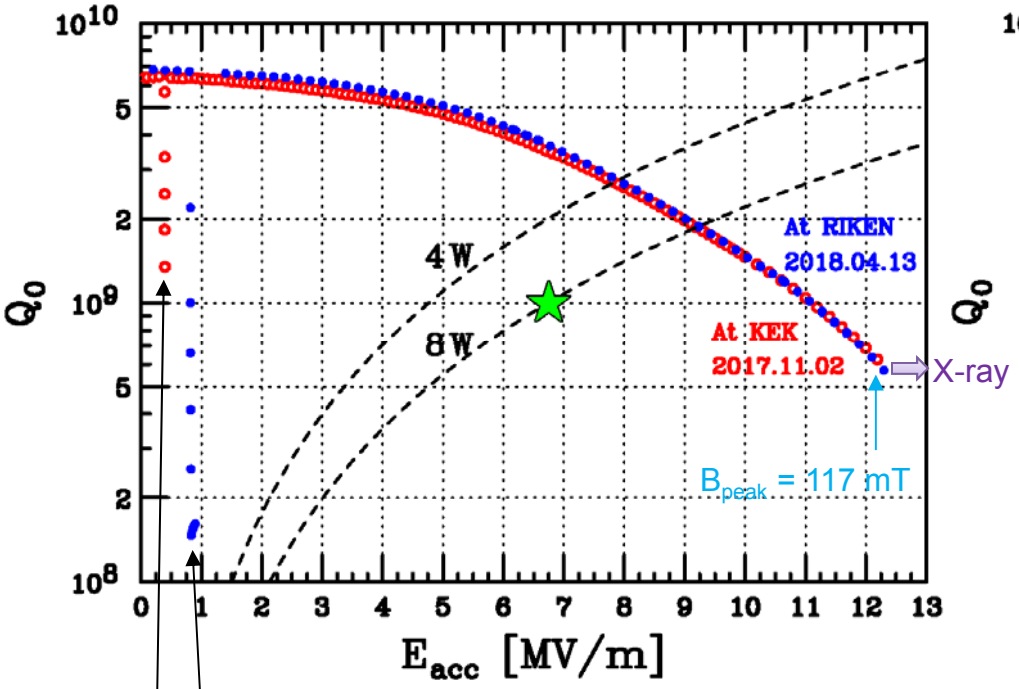


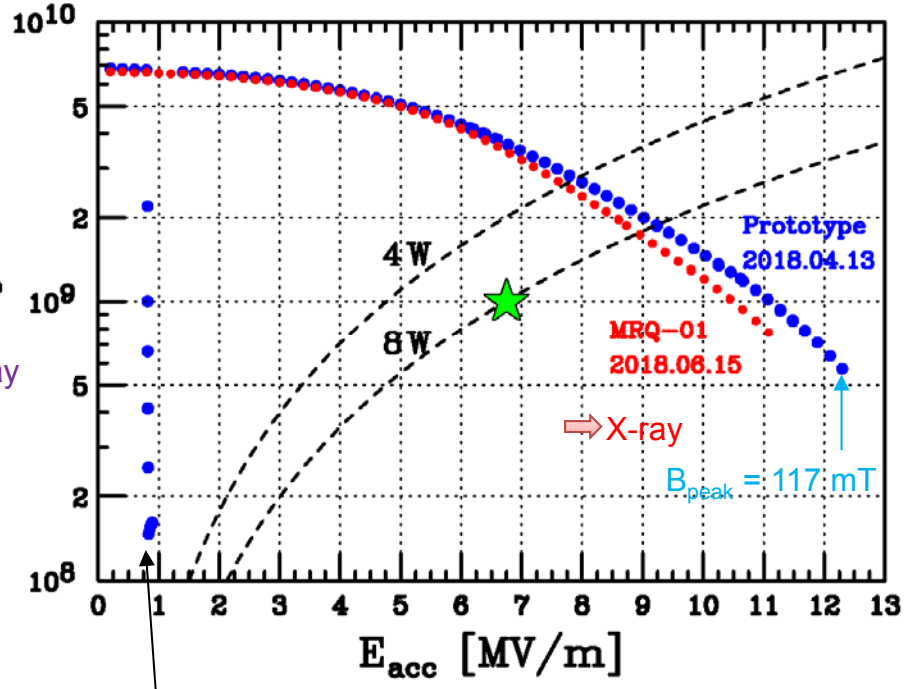




Result of performance test

- Prototype QWR: VT result at RIKEN corresponds to VT result at KEK.
- Actual QWR #1: The result was compatible with prototype (July 15th, 2018).
  Q_0 of 3.5E+9 at Eacc of 6.75 MV/m.
- Various multipactors: 0.02 MV/m can not be processed but overcome.
  0.4 MV/m can be processed less than 1 hour.
  0.9 MV/m can be processed less than 1 hour.





Multipactor (0.9 MV/m)

Multipactor (0.4 MV/m)

The same plot

Multipactor (0.9 MV/m)

Multipactor of QWR #1 was already processed before the measurement.

Cold leak of QWR #2

- Cold leak was happened at June 22nd when the first cooling down of QWR #2 was performed.
- Immediately we raised the temperature and now the leak hunt is in progress.
  ICF flange connection is suspicious.
- VT will be performed in the next week.