§ 1. Superconducting Riken Heavy Linear Accelerator (SRILAC)

- Synthesis of new super-heavy elements
- Production of RIs for medical use

10 SC-QWRs mounted in 3 CMs

§ 2. Structure of FPC

- Disk-type single vacuum window w/ TIN coating
- Outer conductor: SS + 30 μm Cu-plating
- Inner conductor: Copper
- Assumed maximum RF power: 5 kW (CW)
- Variable coupling: $C_{\text{air}} = 1.0 - 4.5 \times 10^6$

80-K thermal anchor
Vacuum window (KYOCERA A4798)
Bottom part of vacuum vessel

§ 3. History of FPCs and CMs

2018 Apr.-Nov.
- Delivery of FPCs to RIKEN
  - Ultrapure water rinsing & drying
  - Re-assembly
  - RF process
  - Mounting on QWR

2019 Mar.
- Assembly and installation of CMs
  - Evacuation of QWRs and CMs, cool-down test of CMs
    Nov. 17: Vacuum leakage from FPC window (SC05)
    - During warm-up process after 4th cool-down test

2020 Jan.
- 1st beam acceleration test

2021 May
- Installation of outer windows to SC05 and SC06 (~ § 4)

One possible scenario to vacuum leakage
Dew condensation at air side of vacuum window
Galvanic corrosion of metallization of alumina
(Molybdenum-Manganese metallization)
Degradation of brazing of vacuum window
Vacuum leakage

§ 4. Degradation of FPC

- Examination of inside of FPCs (air side) using endoscope.
- For several FPCs, condensed water stood on supporting disk of inner connector.

Endoscope
Condensed water
Spot after water evaporation
Green rust

§ 5. Temperature distribution estimation

- Wrong preconception in design phase: Temperature around vacuum window is almost RT.

<table>
<thead>
<tr>
<th>Component</th>
<th>Temperature at vacuum window</th>
</tr>
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<tbody>
<tr>
<td>Copper</td>
<td>298 K</td>
</tr>
<tr>
<td>Brass</td>
<td>300 K</td>
</tr>
<tr>
<td>Machinable nitride ceramics</td>
<td>398 K</td>
</tr>
<tr>
<td>THPTEV001</td>
<td>800 W</td>
</tr>
</tbody>
</table>

Temperature around vacuum window is possibly cooled to -9°C

§ 6. Installation of outer window

- Usability tests:
  - Two sets were connected together.
  - Vacuum lock test
  - RF test up to 4 kW

- Typical RF power fed for beam acceleration: 700-800 W

- Outer windows were installed to damaged FPCs
- RF power was successfully fed to cavities.
- Outer window will be installed to remaining eight FPCs.

Summary

- In RIKEN, CM operation started from Sep. 2019.
- Leakage from vacuum window of FPC have occurred twice.
- Dew condensation at air side of vacuum window might have caused degradation of brazing of window.
- Outer windows were installed to damaged FPCs
  - RF power was successfully fed to cavities.
  - Outer window will be installed to other cavities.
- Replacement of FPCs is planned.
  - Thermal conduction from bottom flange to vacuum windows should be improved.