Vacuum leak at feed-through of trim coils in AVF

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A small vacuum leak occurred in the sub-vacuum chamber of the AVF in 2021. We found that the vacuum leak was occurring at a lower feed-through of the trim coil C8 line in the sub-vacuum chamber of the AVF, as shown in Fig. 1. However, this vacuum leak was unstable and disappeared during its investigation. Thus, we concluded that it would be impossible to temporarily repair the vacuum leak at a narrow section under time constraints during the beam time schedule.

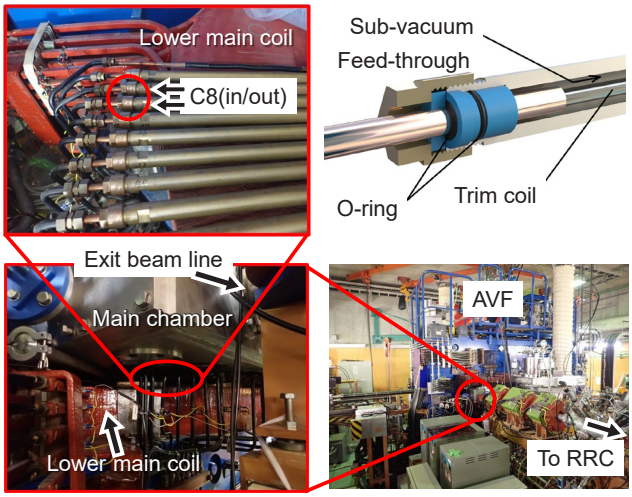

Fig. 1. Feed-through of trim coils. The feed-through of the trim coil C8 line where the vacuum leak occurred is located near the exit beam line between the main chamber and the lower main coil. Two O-rings per feed-through are used.

In April 2023, the vacuum leak at the lower feed-through of the trim coil C8 line occurred again during a beam tuning procedure.[1)] This beam time was safely conducted after adjusting the electric current of the trim coil C8 line to lower current values to avoid a vacuum leak. Following this beam time, we decided to lift the main chamber and replace certain O-rings in the feed-through of the trim coils because it is impossible to repair the vacuum leak at the narrow section between the main chamber and lower main coil without lifting the main chamber. A replacement of certain O-rings in the feed-through of the trim coils was undertaken within 5–13 April 2023 as per the following steps:

(1) Preparatory works: This included checking the position of certain probe units, atmospheric release of the chambers, draining water from the cooling water pipes of some units, removal of certain cables and compressed air pipes, *etc.*

(2) Removal of certain accessory units of AVF—Part 1:

Certain following units that are accessible from outside the main chamber were removed before the lifting of the upper yoke: injection traverse unit, electrostatic deflection channel (EDC), magnetic deflection channel, and two RF amplifiers.

(3) Lifting of upper yoke.

(4) Removal of certain accessory units of AVF—Part 2: Certain of the following units that are accessible from inside the main chamber were removed after the lifting of the upper yoke: main probe/duct, deflector probe/duct, phase probe/slit, two main resonators/dee electrodes, cryopump/gate valve (only AVF-CRP1), and beam transfer duct.

(5) Lowering of upper yoke.

(6) Lifting of main chamber and upper yoke: The main chamber was fixed to the upper yoke, and lifted together.

(7) Replacement of certain O-rings in feed-through of trim coils: The removed two O-rings in the feed-through of the trim coil C8 line were extremely hardened compared to the other lines. The reason for the hardening of O-rings is attributable to thermal deterioration because the trim coil C8 line had a higher adjusted current value than other trim coil lines. Owing to the beam time schedule, only the O-rings in the feed-through of the trim coils C7-C9 lines were replaced, and other feed-throughs were simply retightened without replacing O-rings.

(8) Lowering of main chamber and upper yoke: The main chamber was separated from the upper yoke after this.

(9) Lifting of upper yoke only.

(10) Restoration of certain accessory units—Part 1: All accessory units described in (4) were restored after cleaning the sealing surfaces, and operationally tested to the extent possible.

(11) Lowering of upper yoke.

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(12) Reinstalling of certain accessory units—Part 2: The EDC was overhauled before the reinstallation. All accessory units described in (2) were restored after cleaning the sealing surfaces and some parts.

(13) Vacuum leak test, restoration of all pipes and cables described in (1), and operation checks: A vacuum leak and an operation of the AVF were checked immediately. A cooling water leak in the phase slit was repaired eventually by replacing a part with a new one. All beam times following this replacement of O-rings were successfully conducted.

Reference

1) M. Nishimura *et al.*, Proc. PASJ2023, TWSP12 (2023).