

Status of vacuum pumping systems in accelerator facilities

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A vacuum pumping system in the RIBF accelerator facility comprises cryopump (CRP) systems, turbomolecular pump (TMP) systems, rough pumping systems (mechanical booster pump + rotary pump [RP]), additional chamber pumping systems (TMP + RP), and subpumping systems (TMP + RP) as subvacuum of a resonator.^{1,2)} In addition, module-type vacuum gauges (total pressure gauge [TPG] controller combined with two gauges) are used. In this paper, we report some malfunctions of vacuum pumping system encountered in 2021. Table 1 lists the malfunctions in the pumps, compressors, and gauges from 2018 to 2021. The vacuum pumping systems were relatively stable to maintain and manage in 2021. A malfunction of TMPs (including power supply) and RPs were less in 2021 compared to other years. Additionally, malfunctions of CRP and TPG increased in 2021.

Six cryopump compressors of the SRC malfunctioned around the G01 Faraday cup (SRC deflection beam line) in the uranium beam for the BigRIPS experiments during the months of April to May. The malfunctions of the cryopump compressors were caused mainly in the SRC room by a high environmental radiation dose. Therefore, we plan to relocate 13 compressors to a location far (SRC-north area) from the region of high environmental radiation (SRC-south area) within a few years. In addition, because the existing cryopump compressors (model; C30V, CRC-874) of the SRC and RRC have been discontinued by the manufacturer and cannot be repaired in the future, a new cryopump compressor (model; C30VRT, P-875CA) for the SRC and RRC has been purchased as a spare unit in case of a malfunction.³⁾ Furthermore, because RRC cryopumps were manufactured in 1985 and the replacement of the cryopump to a new model should be realized early, one unused cryopump system set of the IRC-valley cavity was relocated to the RRC-valley cavity in 2020.³⁾

We must update large TMP systems (5000 L/s) in the RILAC and RRC within a few years because they have

been in operation for 35–43 years.³⁾ Therefore, in the fiscal year 2021, one 5000 L/s TMP is scheduled to be updated in the RILAC and another TMP is scheduled to be replaced by a set of smaller TMPs (800 L/s and 1100 L/s).

A large RP in the SRC-RES4 (Resonator 4) has malfunctioned owing to age-related deterioration, and a new spare large RP has been purchased, which has not been installed. In addition, some oil leaks in the small RPs were repaired by installing new O-rings and seals as usual.

Malfunctions in the TPG have increased year by year. The reason is unclear, but it is likely because of age-related deteriorations. Three of the five malfunctioned TPG controllers occurred when the power was restored after an electrical power outage in August and October. This is one common pattern in malfunctions in vacuum pumping systems. Furthermore, all malfunctioned gauges were replaced by spare units due to a contamination of the sensor head.

Regarding vacuum leaks at the RIBF, nearly all of the vacuum leaks were caused by age-related deterioration and repaired by installing new O-rings or applying a repair material. For example, water leaks in the water-cooling parts of the drift tubes in the RILAC cavities were repaired with a sealing agent, and multiple O-rings were replaced with new parts. A water leak from the water-cooling pipe of a small compensation board in the RILAC cavity #2 were also repaired with a sealing agent. A vacuum leak in the coupling of a lower feed-through trim coil (C8) in the AVF was repaired with a sealing agent because it was difficult to replace the O-ring.

References

- 1) S. Yokouchi *et al.*, RIKEN Accel. Prog. Rep. **41**, 101 (2008).
- 2) Y. Watanabe *et al.*, RIKEN Accel. Prog. Rep. **50**, 154 (2016).
- 3) Y. Watanabe *et al.*, RIKEN Accel. Prog. Rep. **54**, 79 (2020).

Table 1. Number of malfunctions from 2018 to 2021.

	Number of units	2018	2019	2020	2021
CRP ^{a)}	> 80	4	6	7	6 (Pump) 8 (Compressor)
TMP ^{b)}	> 138	3	8	4	1 (Pump) 4 (Power supply)
RP ^{c)}	> 146	5	3	7	1 (Pump)
TPG ^{d)}	> 160	4	6	9	5 (Controller) 7 (Gauge)

a) Includes a compressor. b) Includes an attached power supply. c) Excludes an oil leak. d) Includes a controller, Pirani, and cold cathode gauge.

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