

Recent Improvements and Developments of Vacuum System of J-PARC 3 GeV Rapid Cycling Synchrotron

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The 3 GeV rapid cycling synchrotron (RCS) of J-PARC delivers a 1 MW proton beam. The RCS vacuum system has two main characteristics: turbomolecular pumps as the main evacuation and 200-400 mm large aperture, 1-3 m long alumina pipes. To realize the high intensity beam operation, the RCS beam and the beam pipes are thick for reducing space-charge force, and the extraction kicker magnets having large surfaces are installed inside the vacuum to prevent discharge due to high voltage application. Turbomolecular pumps are suitable to evacuate the high volume vacuum chamber including high outgassing rate components. The electromagnets are excited at 25 Hz (up to MHz order for injection shift bump magnets), and alumina beam pipes are utilized inside the all electromagnets to prevent eddy currents. To stabilize and maintain the vacuum system, we are improving the fore-line pumps from dry scroll pumps requiring unexpected maintenances up to three times in a year to Roots pumps, and we are re-developing the alumina beam pipes to manufacture small-quantity spares because fifteen years have past from manufacturing the pipes in mass production during construction. Roots pumps have not been require unexpected maintenances over 5 years operation. In addition, we are upgrading the vacuum level with installing non-evaporable getter pumps to realize future heavy ion acceleration and/or more than 1.5 MW operation in J-PARC. The vacuum pressure successfully decreased with NEG pumps installed at low outgassing sections from around $1\text{e-}6$ Pa to less than around $1\text{e-}7$ Pa due to evacuation of hydrogen as expected.

Summary

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