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Performance of multiharmonic vector voltage control feedback for the J-PARC Rapid Cycling Synchrotron

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Magnetic alloy (MA) cavities are employed in the J-PARC RCS. The wideband response of the MA cavity enables the dual harmonic rf operation for the bunch shape control, which mitigates the space charge effects, while the wake voltage in a single MA cavity consists of several harmonics. Multiharmonic beam loading compensation is required for high intensity beam acceleration. We decided to employ the vector feedback instead of the multiharmonic rf feedforward, which is implemented in the original LLRF control system. We reported in the LLRF17 workshop on the development of the prototype of the multiharmonic vector rf voltage control feedback. The performance of the prototype was good, but not fully satisfied the requirements. We implemented the feedback in the next-generation LLRF control system with several updates, for example, the number of the harmonics to be controlled and the filters. The new system was deployed in 2019. The system was tested with high intensity beams up to the design intensity of 8.3×10^{13} ppp, which corresponds to the beam power of 1 MW, and the performance of the system is satisfactory. We present the configuration of the new system and the beam test results.

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