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Machine protection measures for malfunctions of accelerator devices in J-PARC Main Ring

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J-PARC Main Ring currently delivers 30 GeV, 65 kW (7 × 1013 ppp) slow-extracted proton beams over 2 s to the hadron experimental facility to drive various nuclear and particle physics experiments. A high-intensity beam triggered by risky machine trips could cause serious damage to an electric septum or a production target. The Hadron Hall incident that occurred in 2013 was the most serious in the J-PARC facility. A production gold target in the Hadron Hall was evaporated by an accidental short pulsed SX beam, which was caused by a malfunction of the spill feedback quadrupole (EQ) power supply. In 2021, a vacuum circuit breaker (VCB) malfunction for the quadrupole power supplies in straight sections caused serious damage to the electrostatic septum. We predicted trips of the main bending and defocusing quadrupole power supplies could generate a short-pulse beam to the target. We have analyzed beam behaviors of past incidents and predicted risks and then executed their measures, that are indispensable for a high-intensity SX run.

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