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Challenges and solutions for high-intensity beam operations in the J-PARC Linac

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The Japan Proton Accelerator Research Complex (J-PARC) has achieved stable 1 MW operation test on its neutron target and is advancing toward higher power levels of 1.5 MW to support high-power MR operations and a second target station. This progression presents challenges, including increased intra-beam stripping (IBSt) of H^- ions, chop leakage from higher beam currents and emittance, low-energy beam loss due to halo formation, frontend fluctuations affecting beam transmission, and RF phase and amplitude fluctuations. To address these issues, a redesigned lattice mitigates IBSt, a new MEBT1 improves chopping and collimation, and machine learning-based compensation schemes manage frontend and RF fluctuations. Additionally, longitudinal and transverse matching schemes enhance beam quality, validated through benchmarked longitudinal measurements. Results from studies at 50 mA and 60 mA beam currents demonstrate significant progress in overcoming these challenges.

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