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Time-drift aware RF optimization with machine learning techniques

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The Fermilab Linac delivers 400 MeV H- beam to the rest of the accelerator chain. We are exploring several machine learning (ML) techniques for automated RF tuning, with an emphasis on time-evolving modeling that can account for parameter drift. Providing stable intensity, energy, and emittance is key since it directly affects downstream machines. To operate high current beam, accelerators must minimize uncontrolled particle loss; this ca be accomplished by minimizing beam longitudinal emittance via RF parameter optimization. However, RF tuning is required daily since the resonance frequency of the accelerating cavities is affected by ambient temperature and humidity variations and thus drifts with time. In addition, the energy and phase space distribution of particles emerging from the ion source are subject to fluctuations. Such drift is not unique to Fermilab, but rather affects most laboratories. Our methods include several variations of RF system modeling based on diagnostics data from beam position monitors (transverse positions and longitudinal phase). We will present the status of each approach and future plans.

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Footnotes

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Yes

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