Contribution ID: **44** Type: **Oral (16mins + 4 mins)**

ML methods for noise reduction in industrial LLRF systems

Friday, March 8, 2024 9:20 AM (20 minutes)

Typical operational environments for industrial particle accelerators are less controlled than those of research accelerators. This leads to increased levels of noise in electronic systems, including radio frequency (RF) systems, which make control and optimization more difficult. This is compounded by the fact that industrial accelerators are mass-produced with less attention paid to performance optimization. However, growing demand for accelerator-based cancer treatments, imaging, and sterilization in medical and agricultural settings requires improved signal processing to take full advantage of available hardware and increase the margin of deployment for industrial systems. To that end, we applied several machine learning algorithms and one Bayesian filtering algorithm for removing noise from RF signals. We explored the application of different types of autoencoders including recurrent, convolutional, and variational autoencoders. In addition we developed a Kalman filter algorithm to be used as a non-ML benchmark. Our methods were first developed using simulation and then applied to measurement data from an industrial LINAC under development at RadiaBeam. This talk provides an overview of our methods and a statistical analysis of their performance on the simulation data. We will then show results on measurement data prior to and after model retraining.

Primary Keyword

timeseries forecasting

Secondary Keyword

AI-based controls

Tertiary Keyword

anomaly detection

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Session Classification: Methods

Track Classification: Methods