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Development of faults identification pipeline for SPIRAL2 LLRF data

Tuesday 23 September 2025 14:30 (3 hours)

SPIRAL2 is a state-of-the-art superconducting linear accelerator for heavy ions, utilizing 26 bulk niobium cavities. The radiofrequency (RF) operation of the SPIRAL2 linac can be disrupted by anomalies that affect its reliability. This work leverages fast, multivariate time-series postmortem data from the Low-Level RF (LLRF) system, processed using a Field-Programmable Gate Array (FPGA), to differentiate anomaly groups. However, interpreting these anomalies traditionally relies on expert analysis, with certain behaviors remaining obscure even to experienced observers.

By adapting the Time2Feat pipeline and applying parameter space reduction techniques such as PCA and t-SNE, this study explores the interpretability of anomalies through intelligent features selection, paving the way for real-time state observers. Clustering performance is benchmarked using DBSCAN, HDBSCAN, K-Means, and OPTICS. A case study on distinguishing hard quenches in postmortem data is highlighted. As a result, a fast and reliable quench detection method is proposed.

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Yes

Footnotes

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