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Influence of environmental parameters on calibration drift in superconducting RF cavities

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Precisely calibrating RF superconducting radio-frequency linear accelerators is crucial for accurately assessing cavity bandwidth and detuning, which provides valuable insights into cavity performance, facilitates optimal accelerator operation, and enables effective fault detection and diagnosis. In practice, however, calibration of RF signals can present several challenges, with calibration drift being a significant issue, especially in settings prone to humidity and temperature fluctuations. In this study, we delve into the effect of environmental factors on the calibration drift of superconducting RF cavities. Specifically, we examine long-term calibration drifts and explore how environmental variables such as humidity, temperature, and environmental noise affect this phenomenon. The results show that environmental factors, particularly relative humidity, significantly influence calibration drifts. We also examine the distribution of temperature and humidity throughout the linear accelerator and their correlations with specific locations, providing both a global and localized understanding of environmental impacts. This insight aids in developing targeted solutions for specific segments of the accelerator. Finally, by analyzing the correlation between the environmental factors and calibration drift, appropriate compensation algorithms can be designed to mitigate and eliminate these effects, thus optimizing calibration accuracy and stability.

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