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Ultra-linear Receivers for Digital LLRF Control Systems

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Superconducting Accelerators, worldwide, are appealing to digital Low-Level RF (LLRF) control systems in order to achieve high-precision RF gradient and phase regulation, typically less than 0.1% and 0.01 degrees, respectively.

Although mostly digital, these high-performance systems still rely on analog front-end receiver components for down-conversion, amplification, and pre-filtering. The linearity aspects of digital and numerical stages are undisputed, but in most cases, the effects of non-linear signal corruption within the analog RF components are not easily corrected, and can ultimately limit the system performance. Therefore, special design efforts are required to achieve ultra-linear performance, while controlling dynamic range, sensitivity, power consumption, and cost.

This discussion presents some of the non-linear front-end parameters, and quantitatively relates them to system specifications. In addition, techniques used to predict, measure and quantify these effects are presented.

Primary author: Mr MUSSON, John (Jefferson Lab)

Presenter: Mr MUSSON, John (Jefferson Lab)

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