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Field Detection using Carrier Suppression in the Attosecond Regime for CW Signals

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Latest free electron lasers (e.g. the EuropeanXFEL) produce x-ray light pulses of below 100fs duration. For this type of accelerator a most precise field detection is required to control the accelerating field inside the superconducting RF cavities. Latest low level RF (LLRF) controls, which are working with the non-IQ detection scheme, are limited to a few femtosecond timing jitter resolution and a noise floor of -150 dBc/Hz to -160 dBc/Hz, typically. A nearly invincible boundary for digital LLRF regulation systems is the limited noise spectral density of available ADCs. Possible solutions to overcome this issue in field detection are named and one promising answer to the problem is explained in detail: A detection scheme based on the suppression of the carrier signal (Carrier Suppression Interferometer, abbr. CSI) is implemented as a receiver front-end for the LLRF MicroTCA.4 standard at DESY. First measurements under laboratory conditions were promising with a noise floor of -184dBc/Hz and below 90as integrated timing jitter in a bandwidth of 20kHz. The next step is the system implementation for CW-operation in the field at CMTB (DESY). For this, all mechanical devices need to be characterized on the sub-as scale and exchanged by electronically controlled devices with an automated carrier suppression algorithm. First results will be presented and discussed.

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