Operational Experience of the Drift Compensation Module at the European XFEL and FLASH.


Abstract
The European XFEL and FLASH are high performance free electron lasers operated at DESY, demanding very precise RF field regulation as well as long term stability and reproducibility of given machine setups. Operational experience shows that environmental influences, especially humidity changes, have strong impact on the RF field measurement. In order to minimize these effects a drift compensation module has been developed, installed and commissioned for each RF station within these machines. The module itself induces a reference pulse with a 10 Hz repetition rate to detect and correct for changes in the measurement chain. Here we are going to present results from the commissioning phase as well as regular machine operation within the last year. Possible limitations and further improvements are discussed.

Component description / functionality and method
• Switching in between the RF pulses to a reference source and apply changes of this measurement to the used field detector
• Absolute amplitude measurement due to independent amplitude detector inside the DCM box
• Pre-pulse measurement and application for the upcoming pulse, correction steps down to 10 Hz
• Temperature controlled and sealed electronics
• Exception handling (switch check, compensation limit)

Measurement results
• Goal: Proof the functionality of the DCM in terms of stabilization of the measured RF signals. Crosscheck with the electron beam as ultimate out of loop measurement.
• Measurement of a strong correlation between RF phase changes and humidity changes
  • 0.1 deg / °RH @ 1.3 GHz; 0.3 deg / °RH @ 3.9 GHz
  • DCM on beam based compression feedback shows almost no corrections on the RF phases

Operational experience and adjustments
Timing adjustment
• Goal: Optimal setup of the switching period between Reference and cavity signal
  • Period in operation is 15 ms long switch time between 2 ms before the RF pulse starts
  • Reference measurement takes place about 2 ms after switching

Conclusion and Outlook
• DCM is installed and commissioned for FLASH and XFEL
• Running continuously in operation, so far 1 malfunction in operation
• Long term drift compensation is proven, using beam based methods
• DCM stabilizes to 0.02 deg_pp and 0.02 %_pp at 1.3 GHz
• Currently in a stage of gaining further experience and optimization of:
  • Hardware settings and firmware
  • Software, including exception handling and interface
  • CW under development, 2nd latching integration, method change

*christian.schmidt@desy.de