Contribution ID: **6**   Type: **Oral presentation (preferred)**

Virtual Spectroscopy and Surrogate Models at the European XFEL

Friday, 8 November 2024 10:15 (30 minutes)

This talk will cover a selective summary of recent activities related to virtual spectroscopy and diagnostics at the European XFEL. Virtual diagnostics can complement physical ones by combining information from several sources, thereby profiting from the advantages of each one. To this end, we present the Virtual Spectrometer, which maps data from a low-resolution time-of-flight spectrometer to a high-resolution one. While the low-resolution spectrometer is non-invasive, it can operate at 4.5 MHz and has complex calibration procedure. On the other hand, the high-resolution spectrometer is invasive, operates at 10 Hz, but has a simpler calibration procedure. Such a map, allows one to obtain a spectrometer with higher resolution than the time-of-flight spectrometer while maintaining its other benefits. For example, after a short (approx. 30 minutes) setup and training period with the invasive grating spectrometer, it is removed from the beamline. The resulting virtual spectra are obtained at 4.5 MHz non-invasively with an up to 40% increased resolution.

The talk will also discuss an on-going effort that, leveraging the Virtual Spectrometer's success, aims to predict the x-ray pulse properties from the machine settings and available diagnostics by creating a surrogate model of the machine. While still at an early stage, preliminary results are shown. The fulls scope involves creating a mathematical model of the injector, LINAC, undulators, and potentially also optical components. The goal of the program is not only to provide a surrogate model of the machine, but also to allow for its inversion; i.e. providing a systematic method to obtain machine setting ranges that produce the desired photon beam properties.

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Session Classification: Virtual Diagnostics 1