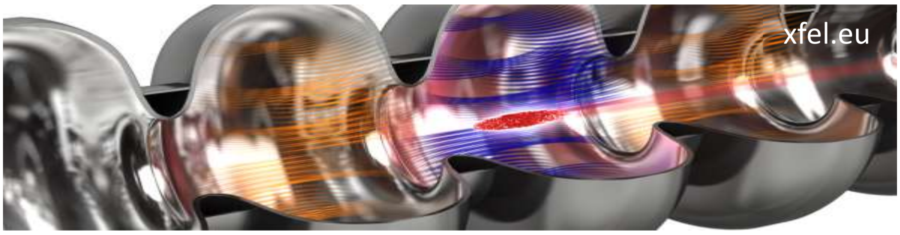
Masterthesis **21.02.2020**

Titel **Nonlinear System Identification of Superconducting Radio Frequency Cavities for the European XFEL using Koopman Operator Techniques**

Problem description:

The European XFEL is currently the largest linear accelerator. Designed to obtain high energy light flashes in the femtosecond range it is used by researchers all over the world to conduct their scientific experiments. At the heart of the accelerator are the 808 superconducting radio frequencies (SRF) cavities in which bunches of electrons are accelerated to high energy levels. In order to detect faults that immediately jeopardize the safe operation of the accelerator a model-based fault detection system is currently developed using unscented Kalman filter techniques to cope with the nonlinear dynamics of the cavities. With Koopman operator techniques a nonlinear system can be represented by a higher dimensional linear system. With such a system representation, a linear Kalman filter can replace the unscented one, which might allow coping with the challenging real time requirements posed by the sampling rate of 9 MHz.

The goal of this project is to apply Koopman operator techniques to identify a high-order linear cavity model which represents the nonlinear system dynamics of the SRF cavities. It has been shown that the choice of the basis functions is crucial for the accuracy of the model. Since the physical processes of the cavities are well understood, physically motivated basis functions are to be applied and compared with general choices. Based on the model identified, a linear Kalman filter is to be designed for fault diagnosis and analyzed using real operational offline data.



This master thesis will be performed as cooperation of the Institute of Control Systems, TUHH, and the Machine Control Group at DESY.

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