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Status of Beam-Based Feedback Research and Development for CW Linac ELBE

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The CW operation mode of the superconducting linear accelerator ELBE allows reinterpreting a beam-based feedback control problem as a regulation goal. By moving the focus of attention to low-frequency RF noise, i.e. the disturbance that makes a significant contribution to electron beam fluctuations, the necessity to pursue a bandwidth-demanding bunch-by-bunch control can be avoided. Simultaneously, the fundamental bandwidth limitation of a superconducting RF cavity, i.e. the usual actuator in such control schemes, no longer poses a problem.

Furthermore, the benefit of implementing the resulting beam-based feedback regulator using an FPGA is twofold. Firstly, the low-latency nature of FPGAs allows dealing with fast processes, such as the regulation of an electron bunch arrival time. Secondly, the high configurability of FPGAs enables the implementation of sophisticated regulation algorithms, e.g. an optimal H2 regulator in its state-space representation.

Accordingly, in this report we provide the details of the work that has been done so far, both in control engineering and digital logic domains. We support our work by demonstrating the results of the latest machine studies at ELBE. These results show not only a reduction in the bunch arrival time jitter, but also a correspondence between a model and a measured data.

Summary

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