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Machine learning-based optimization of storage ring injection efficiency

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The electron injection chain of the DELTA accelerator facility starts with a 90 keV electron gun, followed by a linear accelerator (70 MeV), a first transfer line (T1) between linac and booster, a booster synchrotron (70 MeV to 1.5 GeV) and a second the transfer line (T2) connecting the booster and the storage ring (1.5 GeV). Since DELTA does not use a fast topping-up injection mode, each software-driven injection ramp cycle takes about 7 seconds. Depending on the injection efficiency, 250 to 400 ramp cycles are required to reach the maximum beam current of 130 mA in the storage ring. Therefore, for fast post-injection a high electron transfer rate is crucial. During the injection, a large number of parameters (e.g., magnet settings, timings of pulsed elements) have to be adjusted manually. The injection efficiency depends mainly on the settings of the booster extraction elements, the transfer line magnets, and the storage ring injection components. In order to automate the injection procedure and to improve the electron transfer efficiency, the application of innovative machine learning concepts (e.g., neural networks, Gaussian processes and decision trees) was studied.

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Footnotes

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Primary author: SCHIRMER, Detlev (TU Dortmund University)

Co-authors: ALTHAUS, Andre (TU Dortmund University); HÜSER, Sabine (TU Dortmund University); KHAN, Shaukat (TU Dortmund University); SCHÜNGEL, Torben (TU Dortmund University)

Presenter: SCHIRMER, Detlev (TU Dortmund University)

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