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Preliminary Integration of the Python-based Optics and Beam Tracking Tools into Low Energy Beam Transferline Design for the Sarajevo Ion Accelerator

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The University of Sarajevo Physics Department in collaboration with CERN's Accelerator Beam Physics group propose a compact linear accelerator design for applied physics research spanning from beam dynamics studies to material surface analysis. The Sarajevo Ion Accelerator (SARAI) consists of an electron cyclotron resonance (ECR) ion source, a low energy beam transferline (LEBT) and a radiofrequency quadrupole (RFQ). The current design methodology for SARAI's LEBT relies on iterative parameter optimization using CERN's in-house simulation tools. However, these tools operate within disconnected environments, leading to inefficiencies in the optimization process. To address this, we propose a Python-based framework that incorporates a set of linear and nonlinear optics operators, enabling efficient beam tracking and manipulation throughout the LEBT. This framework serves as a first step toward reimagining LEBT optimization workflows, with the potential to enhance the beam matching process to the RFQ and streamline design protocols across various accelerator types. Preliminary results suggest that this Python-based approach could effectively serve as a practical alternative for beamline design. However, comprehensive benchmarking is required to evaluate its performance relative to CERN's existing beam dynamics tools, as well as established software such as Methodical Accelerator Design –eXtended (MAD-X) and the Python adaptation of the Accelerator Toolbox (pyAT).

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