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Active deep learning for nonlinear optics design of a vertical FFA accelerator

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Vertical Fixed-Field Alternating Gradient (vFFA) accelerators exhibit particle orbits which move vertically during acceleration. This recently rediscovered circular accelerator type has several advantages over conventional ring accelerators, such as zero momentum compaction factor. At the same time, inherently non-planar orbits and a unique transverse coupling make controlling the beam dynamics a complex task. In general, betatron tune adjustment is crucial to avoid resonances, particularly when space charge effects are present. Due to highly nonlinear magnetic fields in the vFFA, it remains a challenging task to determine an optimal lattice design in terms of maximising the dynamic aperture.
This contribution describes a deep learning based algorithm which strongly improves on regular grid scans and random search to find an optimal lattice: a surrogate model is built iteratively from simulations with varying lattice parameters to predict the dynamic aperture. The training of the model follows an active learning paradigm, which thus considerably reduces the number of samples needed from the computationally expensive simulations.

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Footnotes

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Yes

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