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Design and optimization of diffraction-limited storage ring lattices based on many-objective evolutionary algorithms

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Multi-objective evolutionary algorithms (MOEAs) are usually used to optimize two or three objectives in the accelerator field and perform well. However, the optimization objectives are often equal to or greater than four for an accelerator, which causes severe deterioration of the performance of these algorithms. Recently, many-objective evolutionary algorithms (MaOEAs) that can solve the problems with four or more optimization objectives have received extensive attention. In this paper, two diffraction-limited storage ring (DLSR) lattices of ESRF-EBS type with different energies are designed and optimized using three MaOEAs and a widely used MOEA. The initial population has been found to have a significant impact on the performance of the algorithms, and this impact has been carefully studied. The performance of the four algorithms is compared, and the results demonstrate that the grid-based evolutionary algorithm (GrEA) has the best performance. MaOEAs are applied in many-objective optimization of DLSR lattices for the first time and lattices with the natural emittance of 116.70 pm·rad and 23.08 pm·rad are obtained at energies of 2 GeV and 6 GeV, respectively, both with reasonable dynamic aperture and local momentum aperture (LMA). This work provides a valuable reference for future many-objective optimization of DLSRs.

(The corresponding paper is under PRAB review)

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Footnotes

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