Contribution ID: **61** Type: **Poster/Demo**

Simulation methods of 3D coupled storage ring based on SLIM formalism

Thursday, March 7, 2024 3:01 PM (1 minute)

Over last decades, most synchrotron radiation light source designs are based on planar storage rings. Under the linear uncoupled condition, we can describe the physics of these storage rings using the auxiliary functions such as Twiss parameters. We can also give the effects of coupling on emittance by some approximations under the hypothesis of weak coupling. However, in recent years, the emittance of the synchrotron radiation light source storage ring has been reduced to the diffraction limit, the coupling effect can no longer be ignored. At the same time, some new light sources are also trying to use coupling effects to achieve higher goals. Therefore, it is very important to study and calculate coupling effects accurately and self-consistently without too many hypothesis. The SLIM formalism, developed by Prof Alexander Chao, can help solve the problem. SLIM is a linear storage ring beam dynamic formalism based on matrices. It can directly calculate the trajectory of the electron distribution center and the equilibrium beam size and shape in phase space without tracking or introducing auxiliary functions. It also naturally includes the coupling of horizontal, vertical and longitudinal motions in the result. It is a good tool for linear storage ring (with or without coupling) design. However, few researchers are currently using SLIM. We did some exploration of SLIM's application. We introduced the thick lens 7-dimensional matrix and the analytical solution of the contribution to the quantum diffusion rate from radiation elements into SLIM to avoid slicing the element and then improve the computational efficiency of the code. Then we tried to combine the speed-up SLIM with MOGA for a new coupling based storage ring design and optimization. In the future, the speed-up SLIM may provide a fast physical computing kernel or fast generation of datasets for machine learning based storage ring designs.

Primary Keyword

foundation models

Secondary Keyword

ML-based optimization

Tertiary Keyword

surrogate model architectures

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Session Classification: Poster/Demos

Track Classification: Methods