Institute of High Energy Physics
Chinese Academy of Sciences

IPAC21

MOPAB052

STUDY OF BEAM TRANSMISSION EFFICIENCY IN INJECTION AND RAMPING PROCESS OF THE HEPS BOOSTER*

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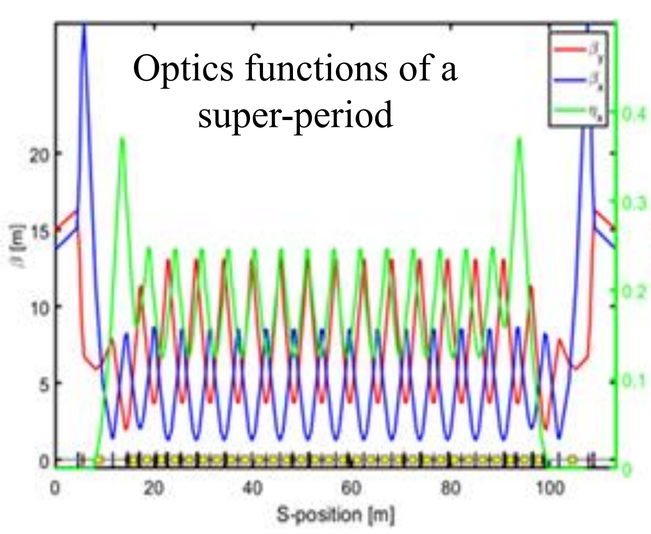
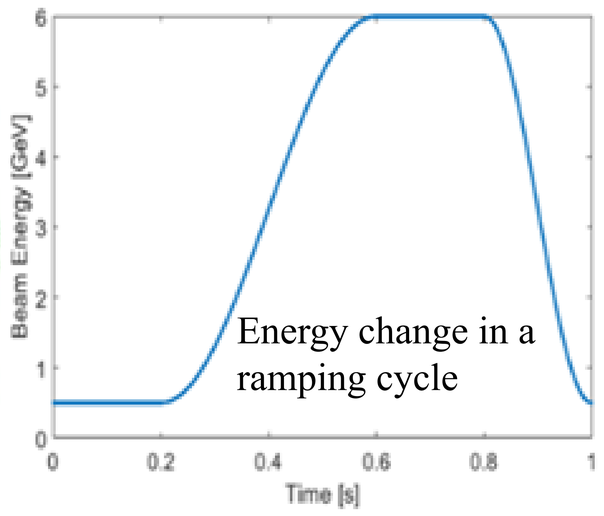
Abstract

A high-bunch-charge mode, with a bunch charge of approximately 14.4 nC at 200 mA, has been proposed for the storage ring of High Energy Photon Source (HEPS). In order to reduce the bunch charge requirement to the injector, “high-energy accumulation” in the HEPS booster is proposed to combine with the on-axis swap-out injection. This allows to reduce the requirement of bunch charge accelerated in HEPS booster (500 MeV-6 GeV) from over 14.4 nC to about 5 nC. It is expected that the overall transmission efficiency (TE) during the low energy injection and ramping process of the booster should be higher than 80% to fulfil the requirement. In this paper, we present the simulation results of transmission efficiency and potential improvement measures.

CONDITIONS USED IN THE SIMULATION





The three lattices with errors and orbit corrections
314# lattice: which with the biggest vertical COD (closed orbit distortion) and the smallest DA (dynamic aperture) in vertical plane.
247# lattice: which with the biggest average orbit (the average value of the absolute value of all COD) in horizontal plane.
026#lattice: which with the biggest average orbit (the average value of the absolute value of all COD) in vertical plane.

Distribution of Particles

Gaussian beam : 1000 random particles with the Gaussian distribution, emittance 80 nm·rad both in the horizontal and vertical plane, energy spread 0.5% ,bunch length 3mm
simulation beam: the simulation results from the Linac and the low energy transport, sampling 2% , about 1000 particles
Simulation code: Elegant

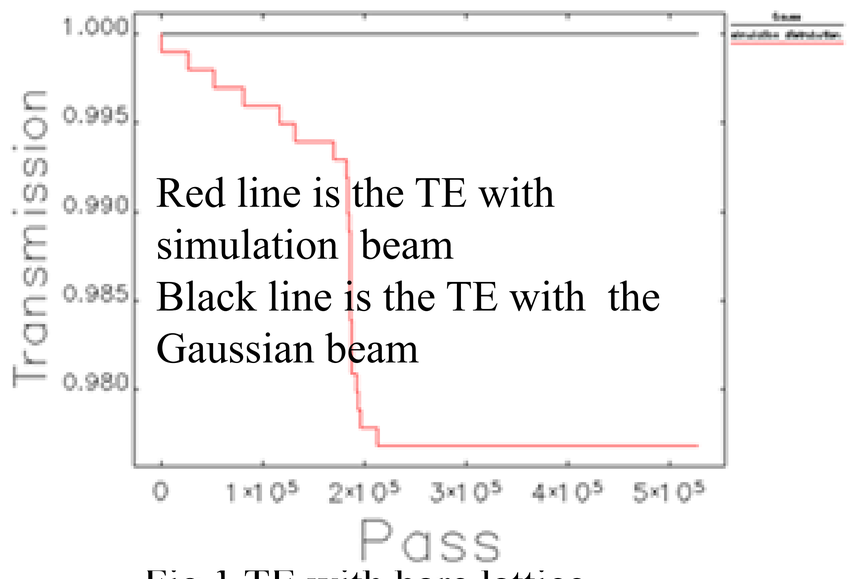
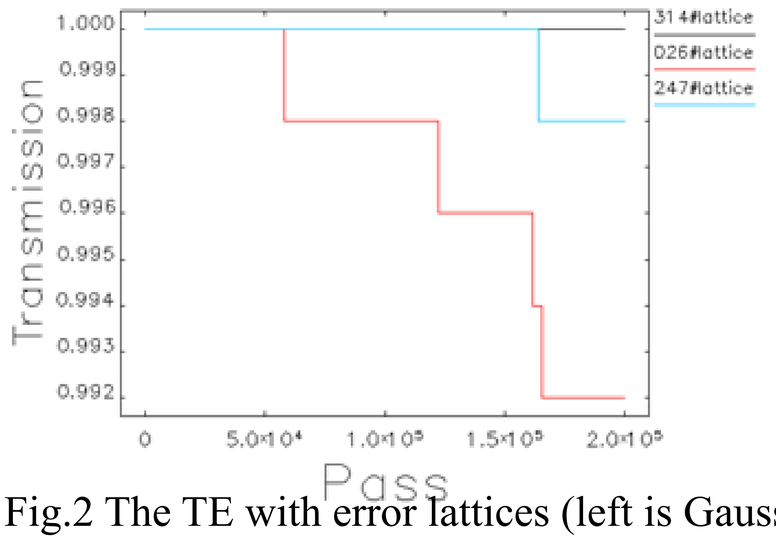


Fig.1 TE with bare lattice



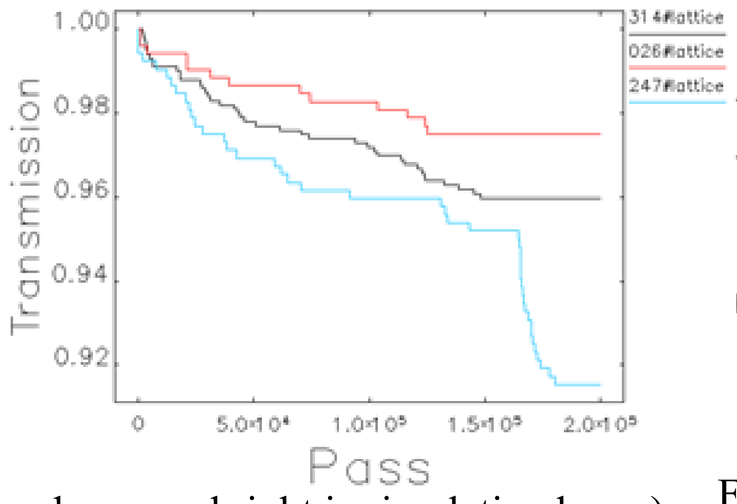


Fig.2 The TE with error lattices (left is Gaussian beam and right is simulation beam)

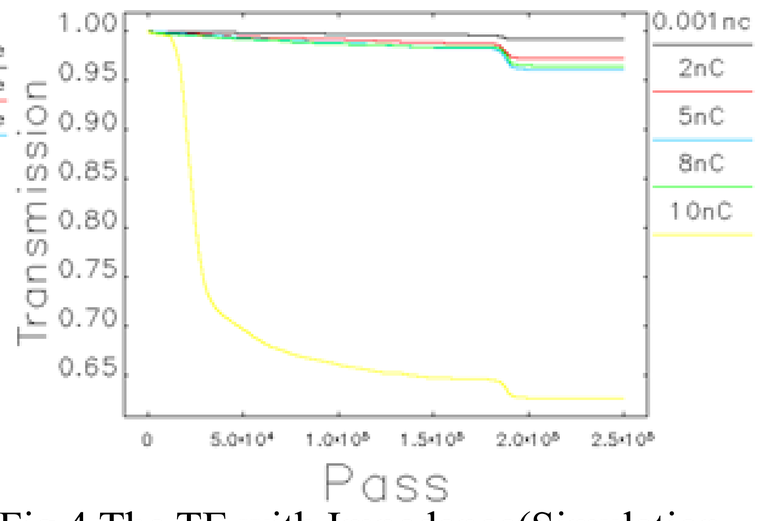


Fig.4 The TE with Impedance(Simulation beam ,bare lattice)

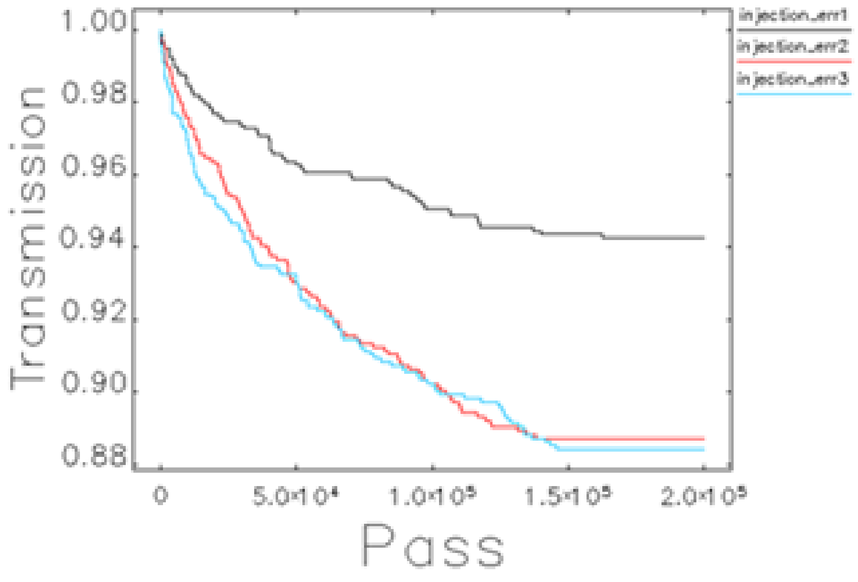


Fig.3 With injection errors(314#lattice,simulation beam)
Black line: with 0.5mm orbit and 0.1mrad angle deviation
Red line: with 0.5mm orbit and -0.1mrad angle deviation
Blue line: with -0.5mm orbit and -0.1mrad angle deviation

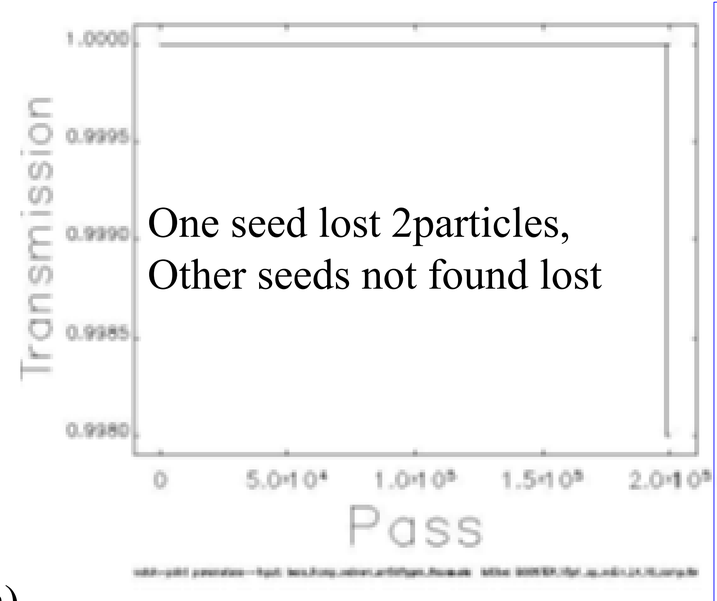


Fig.5 with 500ppm tracking error (Gaussian beam, bare lattice, 20seeds)

SUMMARY

We simulated the TE of lattice with errors and without error. The results show that the distribution of injected particles and the injection angle have obvious effects on the TE. We can optimize the injection beam distribution by adjusting the strength of quadrupoles in the low energy transport line and the strength of kicker to reduce the injection angle deviation. When the bunch charge is no more than 8 nC, the effect of impedance on the TE is slightly.

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* Work supported by NSFC (12005239, 11922512), Youth Innovation Promotion Association CAS (2021012,2019016)