# Simulation of High Energy Proton Beam in EicC

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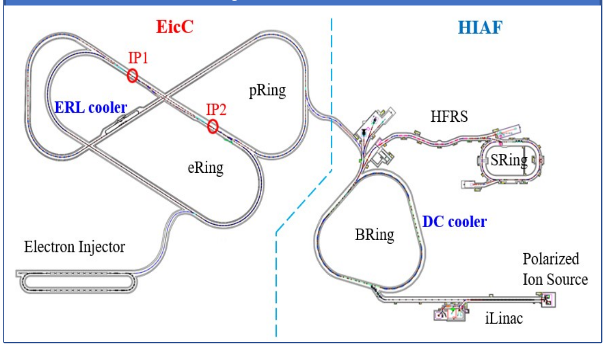
## Abstract

The hadron beam cooling plays an important role in the future e-i collider machines to achieve various physical goals. In EicC, two-stage beam cooling scheme is proposed to maintain the luminosity during the long time collision. First, a traditional electron cooler will be used to pre-cool the low energy proton beam in the Bring. Then, an ERL-based electron cooler will be applied at the pRing to cool the proton beam at high energy. The high energy beam cooling is important and challenging.

## Layout of EicC

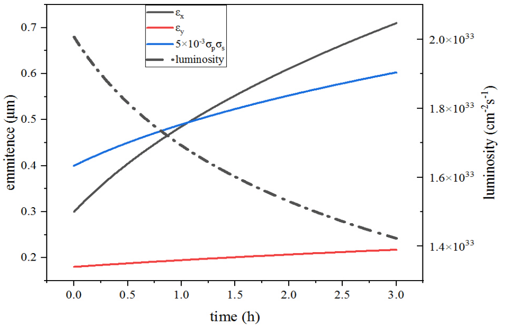



## Introduction

EicC will be constructed based on the High Intensity heavy ion Accelerator Facility (HIAF) with an additional newly constructed electron ring and a proton ring. The proposed collider will provide highly polarized electrons (with the polarization ~80%) and protons (with the polarization ~70%) with the variable center of mass energies from 15 to 20 GeV and the luminosity of (2-4) × $10^{33}$ $cm^{-2}s^{-1}$. The ion accelerator complex of the EicC accelerator facility mainly consists of a polarized ion source, the iLinac, the booster ring BRing, and the collider ring pRing with proton beam energy up to 19.08 GeV, and the electron accelerator complex is composed of an electron injector and an electron collider ring eRing. Two identical interaction regions will be available in the EicC accelerator facility.

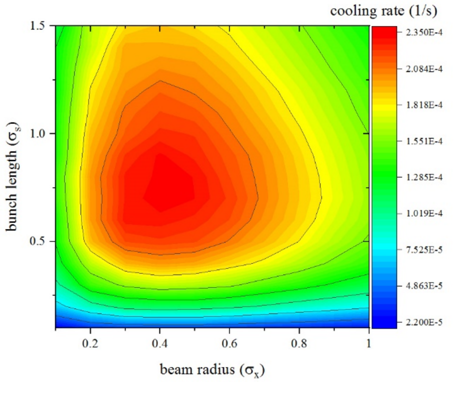
## Simulation parameters and IBS effect

| | |
|---|---|
| Particle type | proton |
| Kinetic energy | 19.08 GeV |
| Number of particles per bunch | 1.25e11 |
| rms emittance x/y | 0.3/0.18 π.mm.mrad |
| rms momentum spread | 0.002 |
| rms bunch length | 4 cm |
| Number of electrons per bunch | 2.5e10 |
| Electron beam size ($\sigma_x/\sigma_y/\sigma_s$) | 3/3/40 mm |
| Electron beam normalized rms emittance | 2.5 π.mm.mrad |
| Electron beam rms momentum spread | 0.0005 |
| Length of cooling section | 50 m |
| Longitudinal magnetic field in the cooling section | 1.5 T |
| Parallelism of magnetic field | 1e-4 |
| Betatron function in the cooling section | 30 m |
| Dispersion function in the cooling section | 2 m |



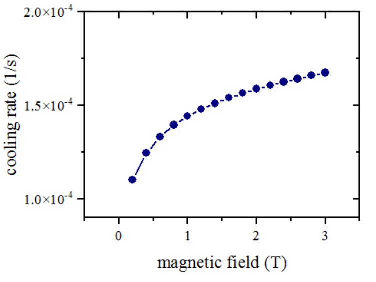

Cooling is necessary

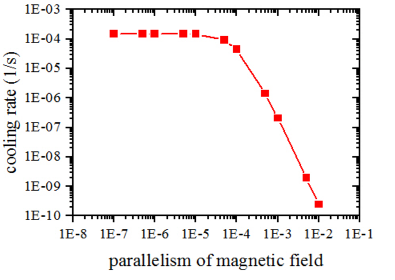
## Proper electron bunch size



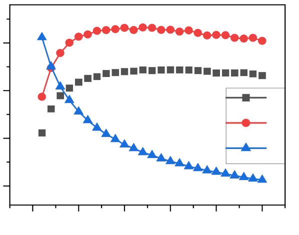

A smaller electron bunch size is better.

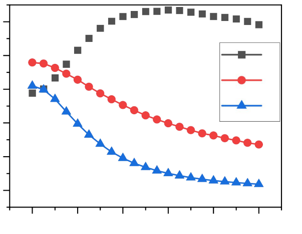
## Magnetic field parameters and lattice function



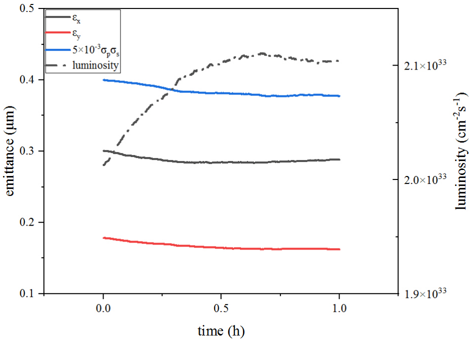

1.5 T and <1e-4 is chosen based on the cooling requirement and technical risk.





The betatron function and dispersion function are selected as 30 m and 2 m respectively in the cooling section.

## Cooling process




## Summary

By optimizing the above parameters, the proton beam can be cooled more effectively in all three dimensions with the luminosity stays above 2 × $10^{33}$ $cm^{-2}s^{-1}$.