

Commissioning of electron cooling devices at HIRFL-CSR

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Abstract

Electron cooling plays an important role in the Heavy Ion Research Facility of Lanzhou cooler storage ring (HIRFL-CSR). Two electron coolers were equipped in main ring (CSRm) and experimental ring (CSRe) in HIRFL-CSR respectively.

Two electron cooling devices have commissioned for twelve years since they were installed and completed in 2004.

The function and operation procedure of electron cooler were presented in this report. Their performance and the highlights of experiments results were described. Their commission and optimization were summarized here. The issues and troubles during the commission were enumerated and collected in this presentation. The future upgrade and improvement were suggested, and the new operation scenario and requirement were proposed.



Fig. 1 Layout of HIRFL-CSR

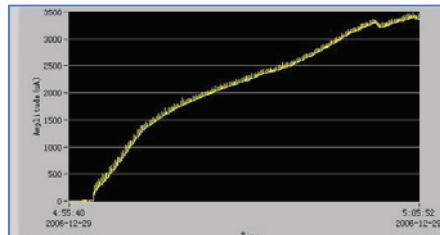


Fig. 3 Beam accumulation in 10 minutes in 2006

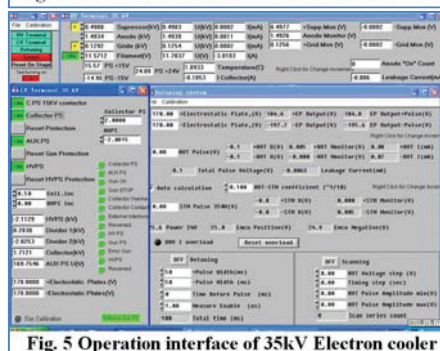


Fig. 5 Operation interface of 35kV Electron cooler

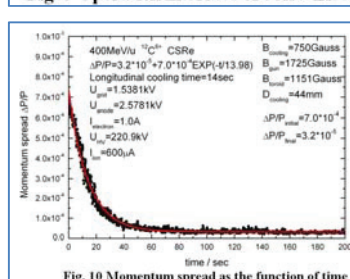


Fig. 10 Momentum spread as the function of time

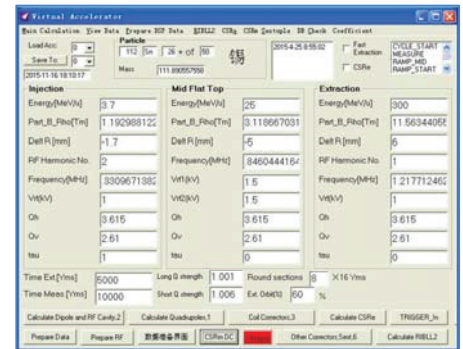


Fig. 2 Interface of HIRFL-CSR Operation

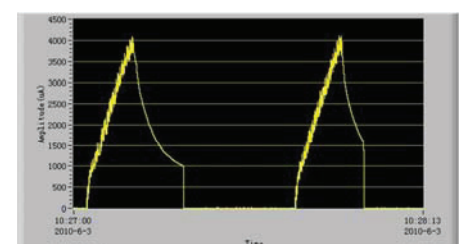


Fig. 6 $^{12}\text{C}^{6+}$ Accumulation in 10 sec in CSRm in 2010

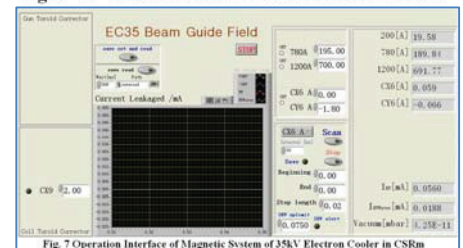


Fig. 7 Operation Interface of Magnetic System of 35kV Electron Cooler in CSRm



Fig. 4 Electron cooler of CSRm 35kV

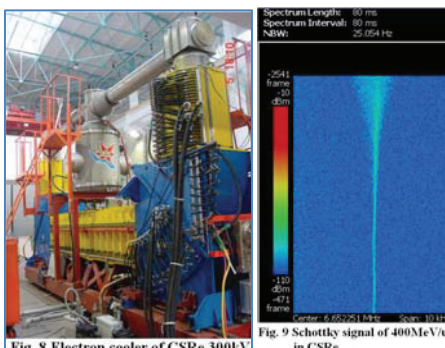


Fig. 8 Electron cooler of CSRe 300kV

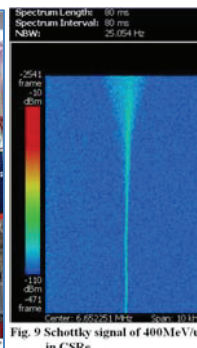


Fig. 9 Schottky signal of 400MeV/u in CSRe

Issues during operation (2)

9. Operation system of Computer(win98,winXP)
10. Different version of drive PCI 7841 (Dual-Port Isolated CAN Interface Card)
12. Dynamics Link Library (.DLL)
9. Virus from removable storage disk
12. Requirement over the design parameters
13. Instability of High Voltage System
14. Instability of Electron beam position
15. Instability of Electron beam current

Improvements and upgrade

- Real-time monitoring of ion beam position.
- Real-time monitoring of electron beam position.
- Automatically ion beam orbit correction.
- Automatically electron beam orbit correction.

In order to improve the performance of electron cooling system, a real-time monitoring system of the position of electron and ion beam was taken into account, an automatically ion beam orbit correction.

Summary

From 2006, the electron cooler have operated well for ten years. Electron cooling, ion beam accumulation and electron cooling experiments were performed in HIRFL-CSR. Several physics experiments were completed with the help of electron cooling in CSR. The results show the electron cooling had well performance in the commission. In the future, the application of electron cooling should be extended according to the physics experiments. The performance of electron cooling should be improved carefully, and the reliability and stability of electron cooling should be upgraded in the future.

What we have done

1. Temperature stabilization system
2. Electrical and Magnetic Screen
3. Electric network voltage stabilization
4. Improvement of HV stability
5. Decreasing influence of EM on the BPM
6. Screen of amplifier of BPM
7. CAMAC into NI card in the BPM
8. Replace the correction power supplies
9. Drying of SF₆

Issues during operation (1)

1. Leakage of vacuum
2. Pollution of cathode by oil from Vacuum
3. Pollution of insulator of Electron Gun
4. Pollution of insulator of BPM
5. Not enough resistance of cooling water
6. Water leakage of solenoid coil
7. Leakage of collector cooling water
8. Destroy of power supplies of cooler

New requirements

- Switch on and off the electron beam momentarily. The electron beam was required to turn on and off in the different period of the atomic physics experiments.
- Change the energy of electron beam momentarily. The energy of the electron beam was required to change in the different cases of the atomic physics experiments.
- Energy modulation of electron beam. The energy of the electron beam was required to modulate in the different cases of the atomic physics experiments.
- Density modulation of electron beam. The radial density distribution of the electron beam was required to modulate in the different cases of the atomic physics experiments.
- Electron beam bunch. In order to demonstrate the cooling of bunched electron beam, the formation of electron beam bunch was taken into account recently.

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