6 - 4 Longitudinal Electron Cooling Experiments at HIRFL-CSRe

Zhao He, Mao Lijun, Yang Xiaodong, Li Jie, Tang Meitang, Ma Xiaoming, Yan Tailai,
Shi Jian, Yin Dayu, Chai Weipin, Sheng Lina, Zhang Xiaohu, Li Peng,
Zheng Wenheng, Yang Jiancheng and Yuan Youjin

The electron cooler was installed in one of the straight sections of CSRe which is used to provide high-quality beams for experiments. Longitudinally the dynamics of the cooling process have been studied for a series of electron beam parameters and the friction force was measured with the aid of an RF-buncher for C^{6+} (122 MeV/u) and O^{8+} (122 MeV/u) ions. The cooling time at different electron beam state have been measured, too.

Longitudinal electron cooling is investigated with the aid of a resonant Schottky detector, which can be used to measure the momentum distribution of the stored ions. According to that, the cooling time at different electron beam current and different radio of grid to anode potential was measured as shown in Fig. 1. For a fixed electron beam transverse profile ($U_{\rm grid}/U_{\rm anode}$=0.2), the cooling time shows a different tendency with the increase of electron current. It is mainly attributed to the space charge effect of the higher density electron beam. As the radio of grid to anode potential increased, the electron beam distribution changes from a parabolic beam to a hollow beam[1]. Because the ion beam radius is much smaller than electron beam, the cooling time increases with the increase of the grid to anode potential radio at a constant electron beam currents 325 mA.

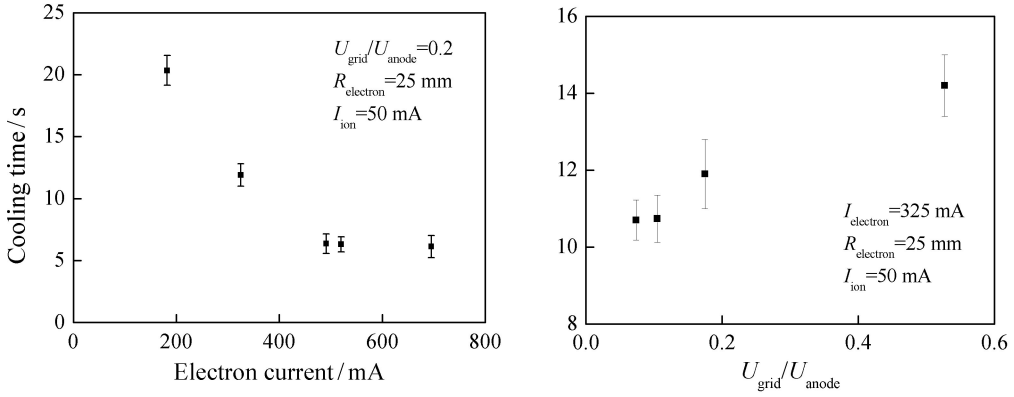

Fig. 1 The measured cooling time as function of electron beam current and electron beam profile.

For electron cooling, friction force is a very important parameter which is dependent on the electron-ion relative velocities. A precise measurement of longitudinal friction force was carried out at CSRe for C^{6+} and O^{8+} ions at the energy of 122 MeV. A small relative velocity can be introduced by changing the RF-buncher frequency. After turn off the RF-buncher, the ions will be cooled down to equilibrium state again. According to the development of ion beam revolution frequency during the cooling process, the cooling force can be measured. The result is shown in Fig. 2 which have a good agreement with theory[2].

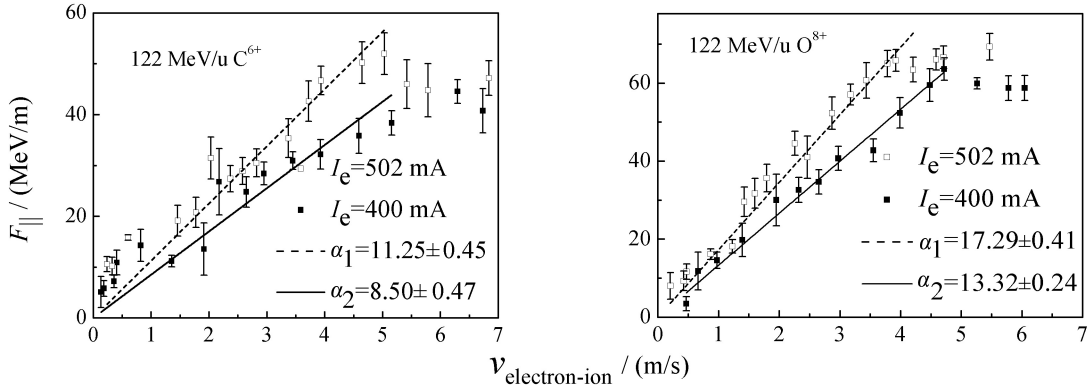

Fig. 2 (color online) The longitudinal cooling force of C^{6+} (122 MeV) and O^{8+} (122 MeV), for electron beam currents 400 and 502 mA.

References

[1] V. Parkhomchuk. AIP Conference Proceedings; 2006: IOP INSTITUTE OF PHYSICS PUBLISHING LTD.

[2] H. Poth. Physics Reports, 196(1990)135.