4 - 9 Progress of Laser Cooling of $^{12}C^{3+}$ Ions at the CSRe*

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Laser cooling is one of the most promising techniques to reach high phase-space densities and achieve phase transition, ordered beam even crystalline beam for relativistic heavy ion beams at storage rings[1]. In order to realize laser cooling at the CSRe in IMP, we performed a test experiment by using a pulsed laser system to cool the relativistic $^{12}C^{3+}$ ion beams on the CSRe in September 2014. Fig. 1 is the schematic view of the experimental setup.

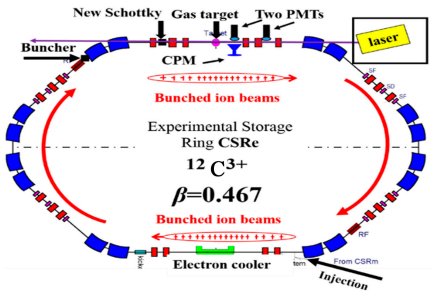

Fig. 1 (color online) Schematic view of the experimental setup at the CSRe, the locations of the new Schottky pick-up, RF-buncher, UV-PMTs, and CPM detector are shown.

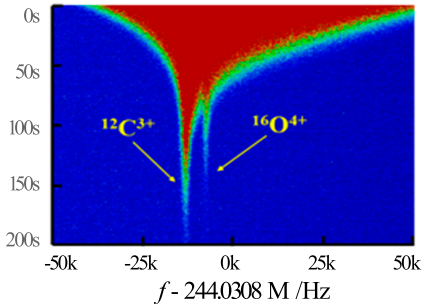

Fig. 2 (color online) Schottky spectrum of $^{12}C^{3+}$ and $^{16}O^{4+}$ ion beams with electron cooling.

Many progress have been achieved during this test experiment. 1) The separation of $^{12}C^{3+}$ ions and $^{16}O^{4+}$ ions in the Schottky spectrum was observed by operation of electron cooling (see Fig. 2). 2) The newly installed CPM (Channeltron photomultiplier) detector was tested systematically, and the lifetime of the $^{12}C^{3+}$ ion beam was determined to 20 s by detecting the photons from the collision of ion beams with the residual gas. This CPM detector is movable and ultraviolet sensitive (130∼210 nm) and will be used to detect the fluorescence from the de-excitation of $^{12}C^{3+}$ ions from $2p_{1/2}$ - $2s_{1/2}$ and $2p_{3/2}$ - $2s_{1/2}$ during the laser cooling experiment. 3) The injected number of C^{3+} ($\sim 5\times10^8$) was sufficient for testing laser cooling, and the dynamics of the electron-cooled and RF-bunched ion beams were investigated systematically. 4) The first experience of laser cooling at the CSRe was obtained from this test experiment by combining a pulsed laser system from HZDR during the experiment. The fluorescence from the ions, measured by UV-CPM and UV-PMT detectors, is of great interest since it reflects the interaction between laser and ion beam. However, first results did not yet indicate a strong interaction of the laser with the ions. Further data analysis is currently in progress.

Reference

[1] U. Schramm, D. Habs. Crystalline ion beams, Progress in Particle and Nuclear Physics, 53(2004)583.

* Foundation item: NSFC(11221064) and External Cooperation Program of CAS(GJHZ1305)