# 4 - 8 Test Experiments of Laser Propagation and Control for Laser Cooling Experiment at the CSRe

Hai Bang, Zhang Dacheng, Wang Hanbing, Wen Weiqiang, Huang Zhongkui and Ma Xinwen

Laser cooling of heavy ion beams is the most promising method to realize crystalline beams at storage rings[1]. In order to perform the laser cooling experiment of $C^{3+}$ at the CSRe[2], we tested the laser propagation and control by using the He-Ne laser at the straight part (about 25 m long) before the experiment. The experimental results indicated that the laser was collimated and stable, and the laser intensity was strong enough after a long distance propagation at the CSRe which satisfied the requirement of laser cooling of heavy ion beams.

Fig. 1 shows the design of the laser propagation and control for the laser cooling experiment. The laser beam is expanded with a telescope to get a long collimated range. However, due to the fact that the length of the collimated range is proportional to the square of the width of beam waist, a telescope with a magnification of 7.5 was chosen by taking account of the parameters of the He-Ne laser. The stabilization of the beam direction is achieved by a feedback control system, including a piezoelectric mirror mount, a detector and several T-cube modules (of Thorlabs, Inc.) as shown in Fig. 1.

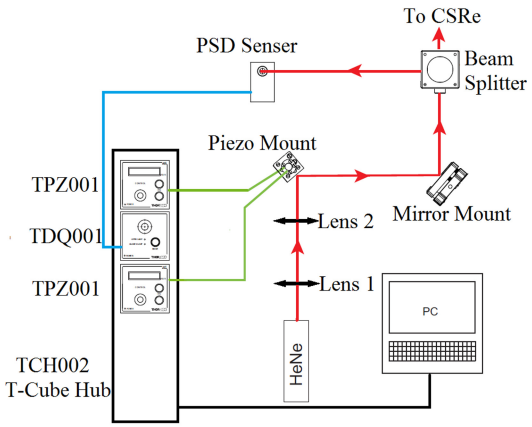


Fig. 1 (color online) The design of laser propagation for laser cooling experiment at the CSRe.

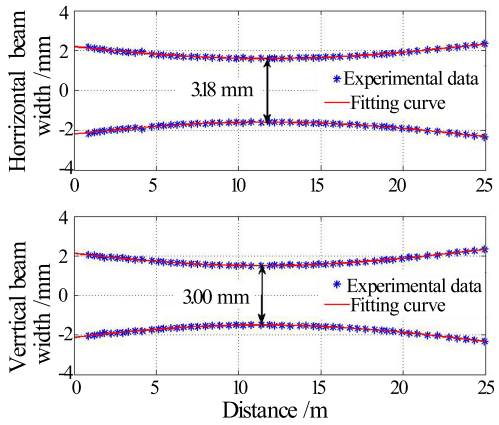


Fig. 2 (color online) The beam profile after expanding and the least square fitting of the measured data.

As shown in Fig. 2, in the length of about 25 m (laser interaction section with the ion beam at the CSRe), the laser beam is collimated. The least square fitting was employed to fit the measured data. The laser beam width at horizontal and vertical directions are both about 3 mm at the position of beam waist and 4 mm at the entrance and exit positions. The laser intensity is enough for the laser cooling experiment. Using the feedback control system, we eventually achieved intense and collimated laser in the range of 25 m with less than 1 mm jitter was eventually achieved.

The test results of laser beam propagation and control indicate that we are able to obtain intense, collimated and stable laser beams for the laser cooling experiment at the CSRe.

## References

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

[2] W. Q. Wen, X. Ma, M Bussmann, et al., Longitudinal dynamics of RF-bunched and electron-cooled ion beam at the CSRe, NIMA (2014).