Device for the transformation of charged particle beams using glass capillaries

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Although there have been reports for transmission of ions through nano- and micro-scale single and multiple capillaries, ion transmission through tapered glass capillaries has rarely been reported so far [1]. With a length of several centimeters and a diameter of a few micrometers at the exit, these capillaries have nevertheless the same aspect ratio as the etched pores (length/diameter ≈ 100). One of the leading goals of this research on single capillaries is to produce multi-charged ion beams with diameters smaller than a micrometer (nano-beams). These glass capillaries offer the opportunity to be used as an ion funnel due to their amazing properties of guiding and focusing highly charged ion beams without altering either their initial charge state or the beam emittance ($<10^{-3}$ π·mm·mrad). However, the understanding of the underlying process is not complete and relies on models assuming charge patches distributed along the capillary and which still need to be tested.

The effect of the accumulated charge presented on figure 1, shows the time dependencies for 240 keV protons transmitted through a capillary. Competition of the processes of charging of the inner surface and charge leakage in narrow capillaries results in an oscillating time dependence of the transmitted ion current. The studied effects have allowed developing and approving the device for interruption of the ion beams on series pulse to form miscellaneous, duration, periodicity and intensities [2].

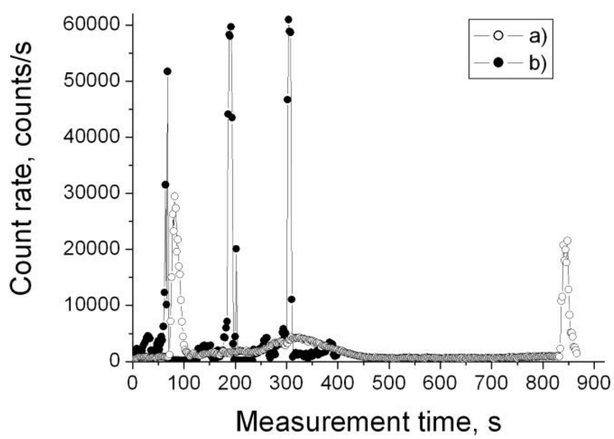

Figure 1: Time distributions of protons transmitted through a capillary with a diameter of 0.1 mm and a length of 30 mm at the axial entry angle of particles ± 0.0º. The proton current at the input of the capillary is (a) 0.85 and (b) 10 pA.

References.

[1] A. Lagutin. Proceedings of HRDP7. Singapore, 2013. http://www.hrdp7.org

[2] A. Lagutin. Abstract book of ICACS-26. P. 124-125.