Journal of Physics: Conference Series

PAPER • **OPEN ACCESS**

Combined theoretical and experimental study of the transmission of tilted ion beams through macroscopic conical glass capillaries

To cite this article: E Giglio *et al* 2015 *J. Phys.: Conf. Ser.* **635** 042011

Journal of Physics: Conference Series **635** (2015) 042011 doi:10.1088/1742-6596/635/4/042011

Combined theoretical and experimental study of the transmission of tilted ion beams through macroscopic conical glass capillaries

E. Giglio[1], H. Zhang[2], S. Guillous[1], A. Agnihotri[1], F. Ropars[1], W. Iskandar[1], A. Mery[1], H. Merabet[3], A. Cassimi[1]

[1]Centre de Recherche sur les Ions, les Matériaux et la Photonique (CIMAP), F-14000, Caen, France, EU

[2]School of Nuclear Science and Technology, Lanzhou University, Lanzhou, China

[3]Qatar University, P.O. Box 2713, Doha, Qatar

Synopsis The transmission as a function of the tilt angle of a 3 keV Ar^+ ion beam through a conical macroscopic glass capillary is studied theoretically and experimentally. It was found that the charge patches which are responsible for the ion guiding also compress the beam spatially in the direction orthogonal to the patches, resulting into an enhancement of the transmission with increasing tilt angle.

The transmitted intensity of a low intensity and low energy Ar^+ beam through a tilted insulating conical capillary is measured, for tilt angle between -1.5° and +1.5° with respect to the beam axis. The first 3rd of the borosilicate glass capillary has a cylindrical shape with 0.86 mm inner diameter, then becomes quickly conical with an outlet of 0.44 mm diameter and has a total length of 80 mm. Only the cylindrical part is covered with conductive paint. It was found that the transmitted intensity increases with the tilt angle up to 0.8°, then decreases until to vanish for larger angles (see figure 1), a behavior already shown by other authors [1].

Using a home-made numerical code [2], the same observables were simulated and compared to the experimental data. While the guiding of ions through glass-capillaries due to charged patches is qualitatively understood, the complex nature of the electric conduction in such insulators makes quantitative predictions still a challenging task. Indeed, for a given ion beam, the guiding is entirely determined by the discharge dynamics of the charge patches at the surface [3], which in turn depend (i) on the electrical properties of insulators under ion beam irradiation and (ii) on the position and nature of grounded electrodes. That is why the theoretical model, on which the simulations are based, include a realistic description of the surface and bulk conductivity of glass capillaries. It was found that the surface charge density of the patches increases with increasing tilt angle. The patches not only rotate/guide the beam but also compress it spatially in the direction orthogonal to the surface patch. As a result, the transmitted beam intensity increases with tilt angle. For zero tilt angle, this effect is absent, explaining the local minimum in the transmission curve in figure 1. For angle above 0.8°, the patches are not sufficiently intense and the guiding/rotating is not efficient enough, resulting into a lower and lower transmission.

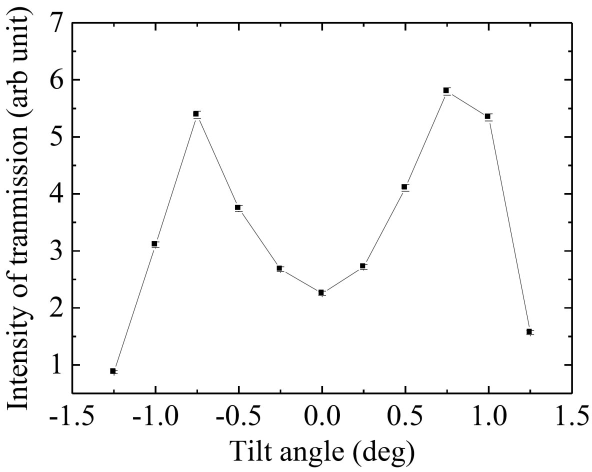

Figure 1. – Transmitted intensity of a 1 keV Ar^+ ion beam as a function of the tilt angle through a conical borosilicate glass capillary.

References:
[1] E. Gruber, N. Stolterfoht, P. Allinger, S. Wampl, Y. Wang, M.J. Simon, F. Aumayr, NIM B **340** (2014) 1
[2] E. Giglio, R.D. Dubois, A. Cassimi, K. Tökési, NIMB B, doi:10.1016/j.nimb.2014.11.056
[3] N. Bundaleski, H. Khemliche, P. Rousseau, A. Cassimi, L. Maunoury, P. Roncin, J. Phys: Conf. Ser. **133** (2008) 012016

E-mail: giglio@ganil.fr