

Proton microbeam transmission between flat plates

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Synopsis The transmission of 1 MeV proton microbeam passing through between two parallel flat plates was investigated. During the measurements the surface of the plates was parallel to the beam axis. The energy and deflection of the beam were measured as a function of the sample position relative to the beam axis. We found significant differences in the proton transmission for metallic and insulator plates.

Charged particle beams are able to pass through insulator capillaries keeping their initial energy and charge state even if the capillary axis is tilted with respect to the incident beam axis larger than the geometrical limit. The phenomenon is called ion guiding and caused by the self-organized charge up of the insulator material.

During the last decade there has been a growing interest in the study of charged particle interactions with cylindrical surfaces based on various capillary targets from nano- to macrometer size. In our research these experiments are simplified further, using flat plates instead of a cylindrical shaped target and proton microbeam as projectile [1].

In this work, we examine only that case where the axis of the plates is aligned in the same direction as the axis of the proton microbeam. We investigate the possible similarities and deviations in the particle transport for metallic and insulator plates.

Our samples consisted of two, side by side placed flat plates with the length of $L_c=20$ mm and $d=150$ μm gap between them. Three different materials were used: Teflon and glass as insulators and glass with gold layer on the top surface of the glass as a conductor. The energy of the proton microbeam was 1 MeV, and the spot size was 2 μm .

The schematic diagram of the measurements can be seen in Fig. 1. First the centre of the gap between the two plates was positioned to the beam axis. Then the sample was moved towards the beam, so the beam was closer and closer to one of the plates. When the plate was close enough to the beam axis, a fraction of the particles suffered close collision with the sample due to the beam divergence. The other fraction of the particles passed the plates without collision. The deflection of the beam spot was measured with the help of a fluorescent screen that emits visible light where the beam hits it. Without the target the beam divergence on the screen was visible. The energy distribution of the transmitted beam was also measured by a particle detector.

When a sample was inserted into the position of the measurement and aligned precisely to the center plane, we did not observe any difference in the image on the screen between this and the sample free case. This was a good test of our measurements and also indicated that the divergent beam really was far from the plates and that the beam passed through without appreciable interaction with the sample.

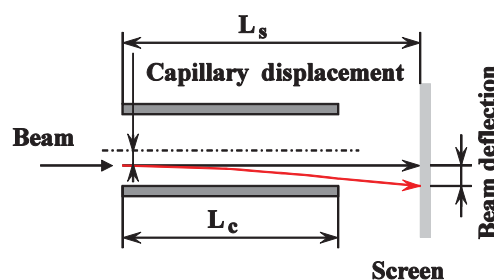


Figure 1. A schematic diagram of the setup used in our experiments.

This combination of the target with the proton microbeam allows us to investigate distance dependent features of the interaction between charged particles and surfaces. We measured the beam deflection at $L_s=103$ mm from the entrance of the capillary as a function of the capillary displacement with respect to the geometrical axis of the capillary. We found that the 1 MeV proton beam suffered significant deflection due to the image acceleration. Furthermore we observed systematic differences in the transmission for the insulator and conductor samples.

Acknowledgements

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References

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