First Submicron Beam at the Scanning Ion Microprobe SNAKE

G. Dollinger, G. Datzmann, C. Goeden, A. Hauptner, P. Reichart, O. Schmelmer, and H. J. Körner

The scanning ion microprobe SNAKE (**S**uperconducting **N**anoprobe for **A**pplied Nuclear (**K**ernphysikalische) **E**xperiments) was installed during 1999 at the Munich tandem accelerator.

It is situated at the 0° beam line of the experimental hall I and consists mainly of high precision slits [1], a magnetic and electric scanning unit, a superconducting multipole lens [2,3] and the target chamber which includes a four axis precision goniometer and an optical microscope for target and beam positioning [4]. In the first stage of installation only 5 pairs of the 9 planned microslit systems are installed: one in front of (x slits), two behind the 90° analysing magnet (x and y slits) of the tandem accelerator and two in front of the first stage of demagnification (x and y direction). The superconducting lens worked without any problems. The magnets are driven by power supplies from Danfysik company which deliver a current up to 10A with $2 \cdot 10^{-6}$ stability.

During the first experiments $20MeV$ protons and $90MeV$ ^{32}S ions were used to test all the equipment installed up to now. Using a regular 1/30 beam reducer of the 0° beam line which cuts the beam in individual parts with an angular separation of about $25\mu rad$ the focusing of the magnet was investigated by an experimental ray tracing procedure. The individual parts of the beam are bright spots obtained from a CsI crystal situated near the focus point of the ion microprobe which is viewed by the optical microscope in the target chamber. Some field distortions were detected (Fig. 1) which will be studied offline during the next months. However, with a reduced divergence of the beam, a focus less than $1\mu m$ was achieved. It was demonstrated by scanning a gold grid with the focused beam and counting for transmitted ions with no energy loss at each position. The obtained image is shown in Fig. 2a. The line scan in y direction, Fig. 2b, shows the achieved lateral resolution of $700nm$ at an edge of the grid.

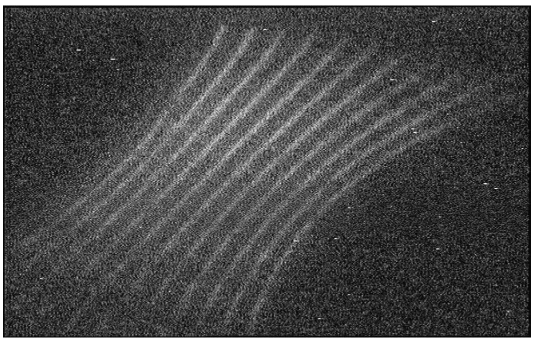

Fig. 1: Bright beam spots on a CsI crystal resulting form individual parts of the beam.

The first tests show the possibility to obtain submicron ion beam spots for protons up to $30MeV$ and for heavy ions at the Munich tandem accelerator. Furthermore, it shows that mechanical vibrations and fluctuating magnetic fields contribute less than $1\mu m$ to the lateral resolution. Although the lateral resolution was obtained using an aperture in front of the superconducting lens with about 1/50 of the total bore radius of the lens the experiments also show that beam quality is in the desired range and the superconducting lens can be operated under stable conditions. However, further improvements for optimum multipole fields and adjustment have to be obtained to achieve submicron beam spots for higher beam currents.

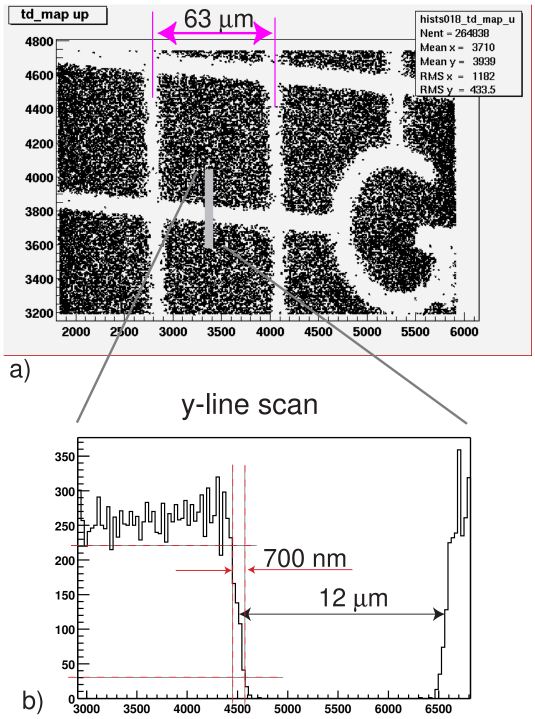

Fig. 2: a) Transmission image of a gold grid (pitch $63\mu m$). b) Line scan of one edge of the grid shows a resolution of $700nm$.

In addition to the beam transport experiments some of the detector equipment of the scanning ion microprobe was tested. The first instrumentation covers a stacked silicon detector (total thickness $3mm$) to analyse transmitted protons for their energy (for **S**canning **T**ransmission **I**on **M**icroscopy, STIM), a similar structure to detect backscattered ions, a $2sr$ silicon ring detector to detect forward scattered ions, especially proton-proton coincidences from p-p-scattering events for hydrogen analysis [5], a HPGe detector for PIXE (**P**article **I**nduced **X**-ray **E**mission) and PIGE (**P**article **I**nduced **G**amma-ray **E**mission) experiments and a channeltron detector for secondary electron detection.

In order to perform high resolution STIM experiments with high count rate performance the 90° vertical magnet situated behind SNAKE was used as a 0° magnetic spectrograph by installing two additional quadrupole singlets in front of the magnet and a CCD linear detector at the focal plane of that magnetic arrangement [6].

References

[1] O. Schmelmer *et al.*, Jahresbericht 1998, p. 101
[2] G. Datzmann *et al.*, Jahresbericht 1997, p. 107
[3] G. Datzmann *et al.* this report, p.90
[4] O. Schmelmer *et al.*, Jahresbericht 1998, p. 100
[5] P. Reichart *et al.*, this report, p.91
[6] A. Hauptner *et al.* this report, p.92