New Microbeam Slit System for High Beam Currents

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At the microprobe SNAKE it is possible to quantify three-dimensional hydrogen distributions in materials via proton-proton scattering. With the newly installed high brightness Multicusp source, larger proton current up to 10 \( \mu \text{A} \) [1] has to be transported from the high energy side of the tandem accelerator to SNAKE. Hence smaller divergence is possible, resulting in beam resolution improvement below 1 \( \mu \text{m} \) beam spot [1] at sufficient current. The high current requires new slits with better heat dissipation. Additionally the new slits will offer to be used as high precision measuring slits for tandem accelerator stabilisation system.

![Figure 1: Temperature profile of the coupled heat/flow-simulation in stationary case. The border conditions are an inlet water temperature of 20 °C and thermal radiation in the vacuum and a thermal power input of \( \dot{Q} = 150 \text{ W} \) [2].](image)

Using finite element simulations the requirements for a new microslit system were investigated under maximum power input. The system has to endure 10\( \mu \text{A} \) beam current of protons up to energies of 25 MeV [1]. For this, we use optimum heat conducting material as aluminium nitride as isolator, copper as carrier material and tungsten as slit bracket material with high melting point, but low radioactivity activation. To compensate temporal variable beam load jitter the system is heated by potential-free heating cables to constant temperature and the supplied heat is dissipated by a water cooling. The geometry of the water cooling is configured to circumvent turbulence-induced pressure fluctuations and therefore parasitical vibrations, which would deteriorate the achievable resolution. The simulated attainable temperature profile of the new design is represented in Fig. 1. A very low blur of the object size of <1.7 \( \mu \text{m} \) and a position accurateness of <0.3 \( \mu \text{m} \) is achievable, c.f. [2]. Hence a resolution increase into the sub-\( \mu \text{m} \)-range is estimated.

![Figure 2: Illustration of the design of the new microslit system, which is integrated in x-direction, in y-direction yet resides the old system (0). The new system is mounted to the beam tube (light blue) by a standard flange DIN100CF (1). The shaft bellows (2) maintain the vacuum in the inside against the outer atmosphere and are hard-soldered to a spacer ring (3) and this to the copper bar (4). The actual water cooling consists of two half shafts (4) and (5). These are mounted via a connection plate (12) to the linear table (17), which is moved by a step motor [3].](image)

The construction of the new microslits is illustrated in Fig. 2. During the further development the water circulation is build up and a heat exchanger with a thermal rating of overall \( \dot{Q} = 600 \text{ W} \) [3] is to be integrated. With a suitable temperature control the cooling water feed temperature has to be maintained to a constant level with accuracy better than \( \Delta T_{kw} = 2 \text{ K} \) [3]. Otherwise the slit position deviated excessively and uncompensated due to the thermal expansion. In addition the surface condition of the tungsten plate is of great significance for the beam transportation. Two present surface qualities have to be compared in upcoming experiments, one with a mechanically lapped surface quality of \( Ra = 0.012 \mu \text{m} \), one with a plasma arc polished surface up to \( Ra \approx 0.03 \mu \text{m} \).

REFERENCES

