Sub micrometer focus of a neutral helium spot

S. Eder[1], B. Holst[1,2]

1. Department of Physics and Technology, University of Bergen, Allégaten 55, 5007 Bergen Norway

sabrina.eder@uib.no

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Surface science has been revolutionized in recent years by nano-resolution imaging techniques such as scanning tunneling microscopy (STM) and atomic force microscopy (AFM). It is often said that the field of nano-technology was born with the invention of the STM in the early 1980s. Helium atom scattering is already known as a powerful probe for investigating the structural and dynamical properties of surfaces [1], providing an important contributions to basic research as well as industrial applications. Last year we presented the first results using a focussed beam of helium as a microscopy tool [2]. The two major advantages are the low energy of the helium beam (less than 100 meV for a de Broglie wavelength of 1 Å) and the fact that the atoms are uncharged. This means that a scanning helium atom microscope can be applied with no sample damage and without additional sample preparation such as conductive coating. Hence it should be possible to investigate insulators, biological materials and all fragile samples which are difficult to examine by other methods, and therefore opens up a promising field for an additional sample characterisation technique.

In this paper we present new results demonstrating the first sub micrometer focus of a neutral helium beam. The small spot size was created using a free standing Fresnel zone plate as optical element and opens the first possibility of taking high resolution images (see Figure 1). Furthermore we present our design for a new neutral helium beam reflection scanning microscope, which we are currently building (see Figure 2). This latest results pave the way for making He-atom microscopy a commercially available microscopy technology.

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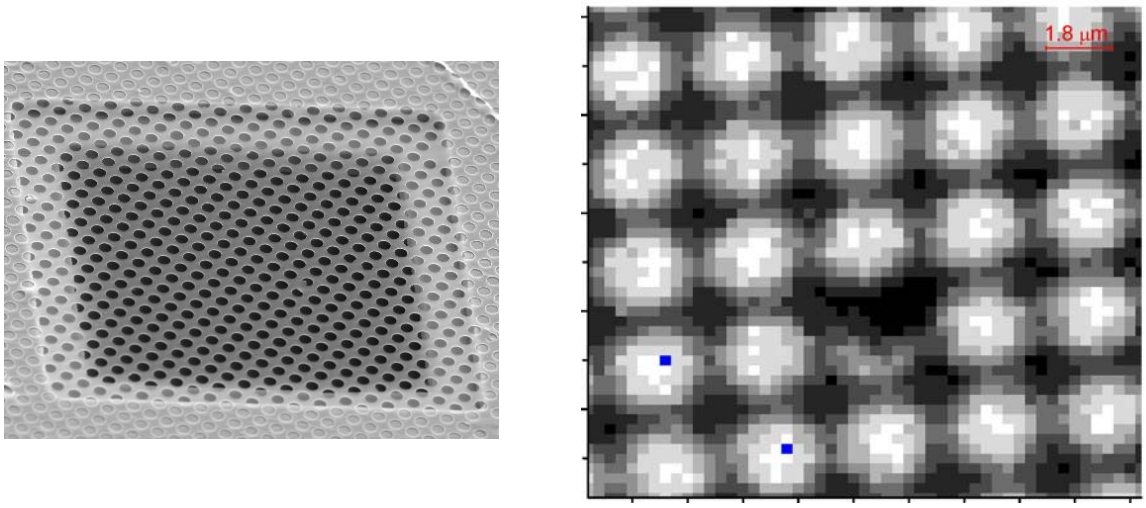

Figure 1. High resolution 2-D image scan of a carbon holey foil taken with a He-beam. Left: SEM image of the 2µm carbon holey foil. Right: He-beam image taken with a beam focus spot diameter of $Ø_{beam} \approx$ 1.5 µm, scanned in steps of 300nm.

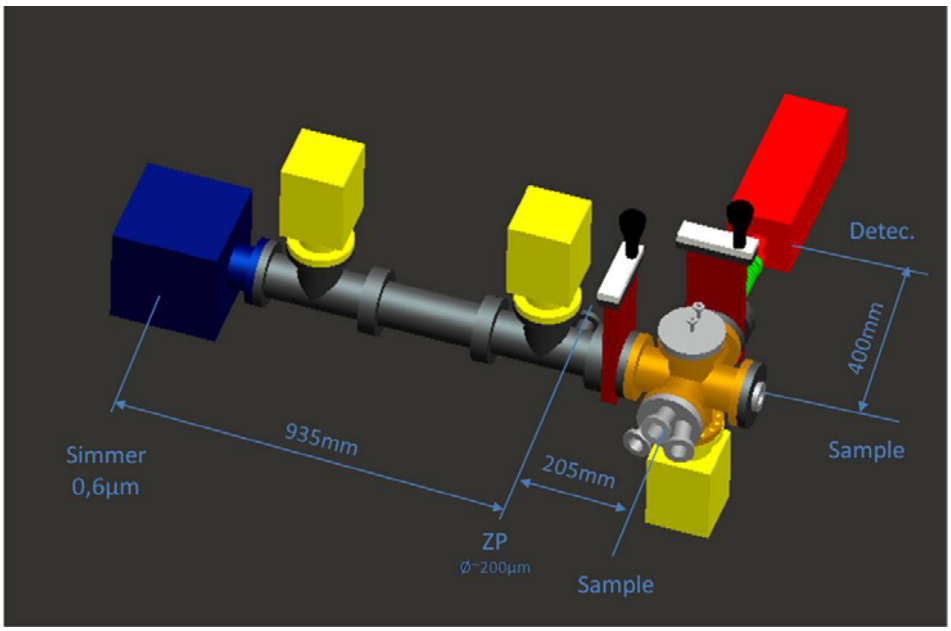

Figure 2. Schematic sketch of the first concept for a new neutral He-beam scanning microscope. The basic idea is to scan the sample with a focused He-beam and collect the reflected intensity.

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