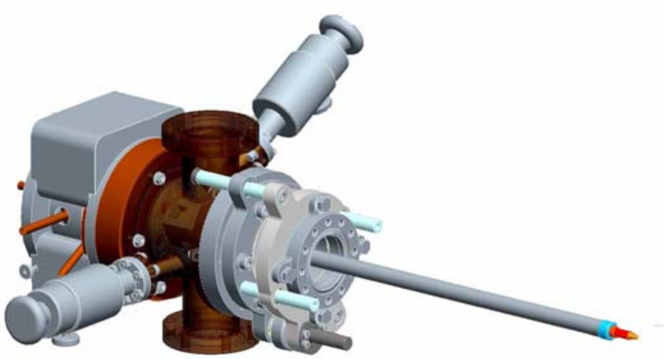
Small Spot UV Source

UVS 300

Application Notes

High resolution photoemission measurements demand not only the highest performance electron spectrometer, but also a UV source with high flux density and small spot size, especially for experiments with angular resolved data.

SPECS has developed a focused UV source on the basis of the proven technology of the UVS 300 source. The UVS 300 generates a high density plasma by guiding the electrons extracted from a hot cathode filament along the lines of a strongly inhomogeneous magnetic field towards the small discharge region (duo-plasmatron principle). This results in an extremely high but also a very stable VUV light output of high spectral purity, i.e. >200nA sample current with the standard 1.5mm ID capillary. The UVS 300 can also be operated with other gases like H_2, Ne, Ar, etc., and the high density plasma generates unusually high intensities of the ion lines as well, e.g. HeII.



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In order to estimate key parameters of the focusing geometry, we have performed preliminary measurements on trial geometries. In addition, we have developed a simulation program to accurately predict the spot profile and current density on the sample. This program uses true 3D multiple scattering ray-tracing and a Monte-Carlo statistical algorithm.

Both the theoretical and the experimental data are shown in Figure 1. A spot size of less than 0.5 mm is predicted by the simulations and confirmed by the test measurements. In addition, the flux density increases by a factor of 10.

Here, the spot size of the excitation source is crucial for the angular resolution in angular dispersive measurements, that is, bandstructure measurements and Fermi surface mapping.
In angular dispersive lens modes the emission angle distribution is imaged rather than the real surface. All lateral resolution is lost, but the emission angle information is easily obtainable.

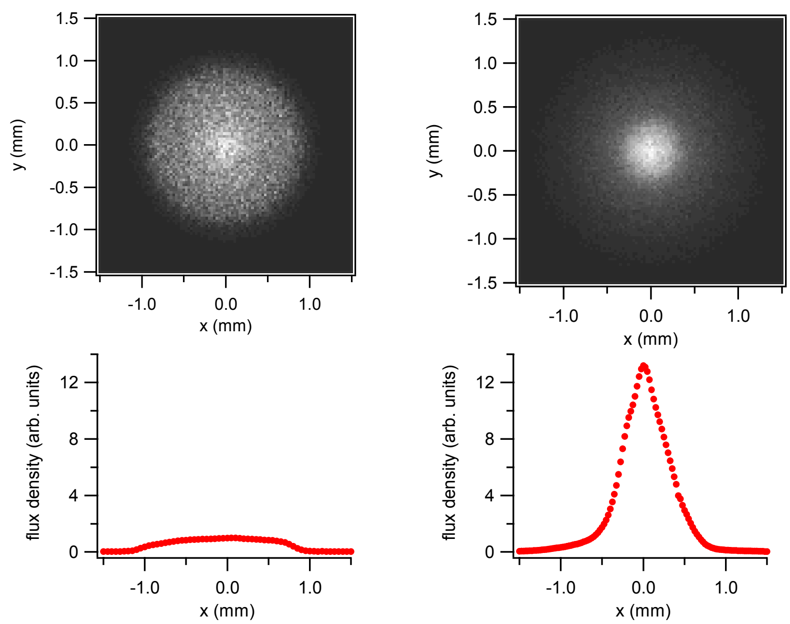

Figure 1: Spot profiles of a standard (left) and a focussing quartz capillary (right). Upper row shows simulated spot profiles using a Monte-Carlo multiple scattering ray-tracing program. Lower row shows spot profiles measured using a Faraday cup with a 115 μm entrance aperture.

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Due to the lateral spread of rays emitted $\Delta z_D = C\,\Delta z_S$ on the detector (*D*) within the same angular range from the sample (S), the angular resolution depends on the spot size in the non-dispersion direction (in mm) of the source. The angular broadening FWHM is described by the lens aberration quantity C and the dispersion D of the lens mode, i.e.

$$FWHM = C / D \times SpotSize$$

With standard UV lamps the spot size on the sample is usually around 2 mm. With the small spot UVS 300 and a spot size of 0.5 mm the angular resolution is increased by a factor of 4!

Another advantage of the small spot UV source is the high photon flux density. The UVS 300 with focussing capillary is particularly suited for laboratory based PEEM experiments, which so far have only been possible on synchrotron light sources. Figure 2 shows k-space maps that have been acquired from a micron-sized silver island grown on Si(111) using the SPECS FE-LEEM P90. The two crystallites within the island show the characteristic band structures of Ag(111) and Ag(100). Each k-space map was integrated for only 20 seconds.

Ag(111)/Si, d-band photoemission

Ag(100)/Si, d-band photoemission

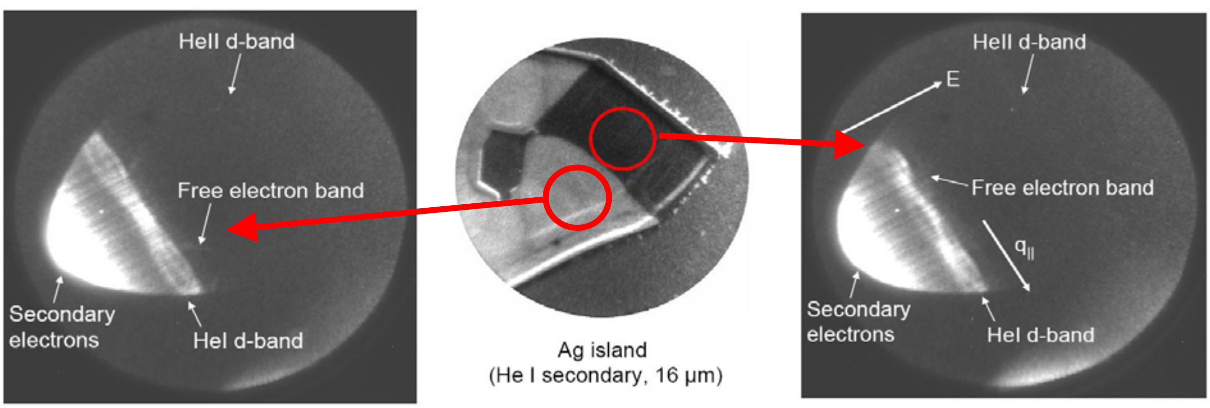

Figure 2: PEEM image and band structures of different oriented Ag islands excited with a focused UVS 300 and taken with the FE-LEEM P90

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