

# Sample Size Effects in the THEMIS 1000

## Technical Note

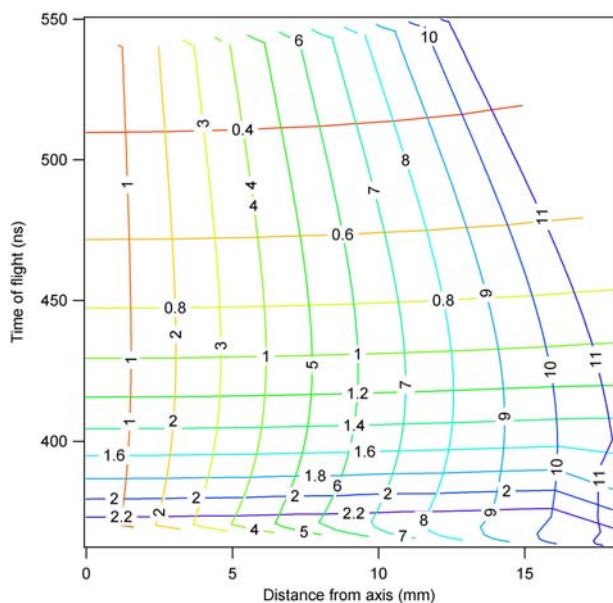
The THEMIS time of flight spectrometer is typically used as a spectrometer for Laser excited photoemission with photon energies below 7 eV. Thus, the excited photoelectron spectrum ranges from a few eV kinetic energy to zero eV at the secondary cut-off. At these low energies, the difference in work function between the spectrometer and the sample can influence the electron-optical performance. There are two effects to be considered.

When the sample is at unknown chemical potential, the kinetic energy with which the electrons travel through the spectrometer is unknown, too. Electrons at the secondary cut-off, which leave the sample with 0 eV kinetic energy, might be accelerated into the spectrometer and fly with a kinetic energy corresponding to the chemical potential difference. This effect is discussed in a different technical note. Basically, the spectrometer has to be floated to a voltage that cancels the difference in chemical potential. Or alternatively, the actual kinetic energy of the electrons at the cut-off has to be deduced from their flight time using electron optical simulations.

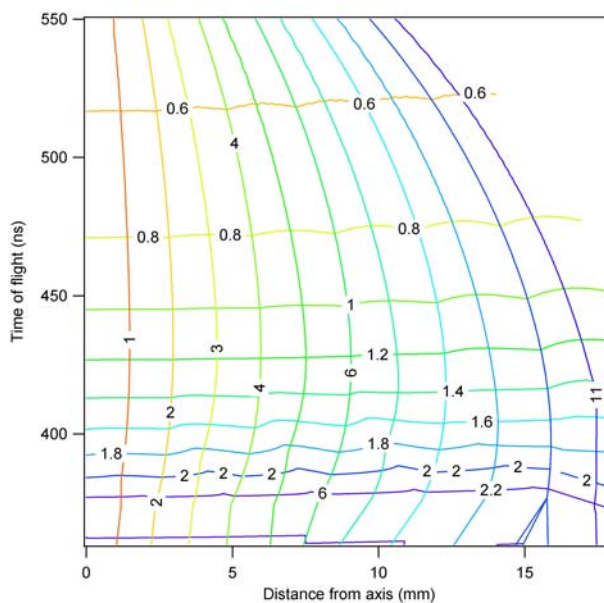
The second effect, discussed in this technical note, is the influence of a finite sample size. If the sample is small, and is held in a sample holder with a different work function, then this arrangement acts as an electron-optical immersion lens. This application note shows the comparison of look-up diagrams for different geometrical situations: the standard lens at 53 mm distance, a lens that has a grounded cone extending to 1 mm away from the sample, and two different sample sizes, 1 mm and 3 mm. The sample is always on the same chemical potential as the spectrometer, and the holder surrounding the sample is at  $-0.5$  eV different potential. The next pages show the following comparisons:

- A) Large sample and 3 mm sample, both with standard lens at 53 mm
- B) Standard lens and conical elongation, both with large sample
- C) 3 mm sample and 1 mm sample, both with conical elongation

**A) Large sample and 3 mm sample, both with standard lens at 53 mm. Spectrum from 0.3 – 2.3 eV with +/- 7° mode.**



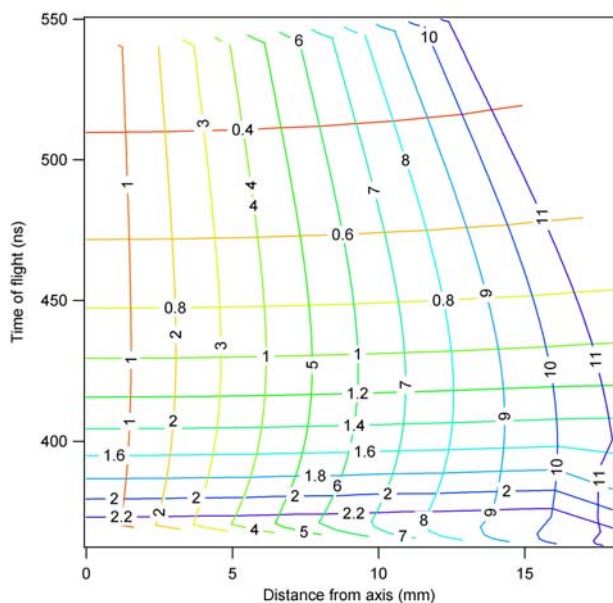
Look-up diagram for a large sample in front of the standard lens at 53 mm distance



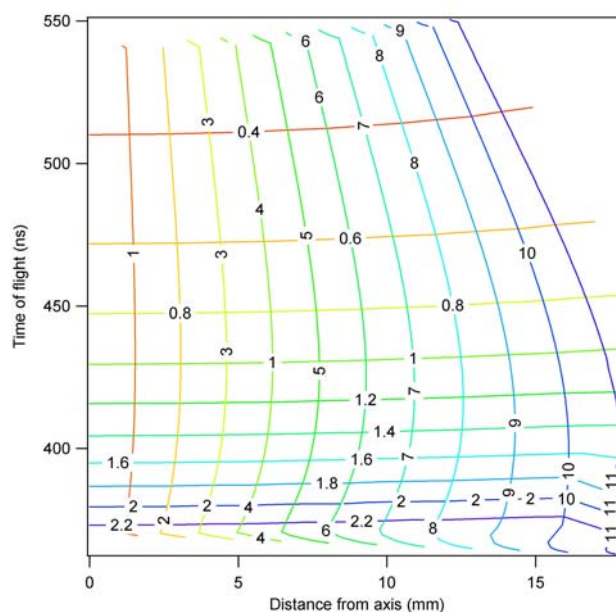
Look-up diagram for a 3 mm sample in front of the standard lens at 53 mm distance. Sample holder at -0.5 eV.

The comparison shows that a 3 mm diameter sample within a sample holder that has -0.5 eV lower work function has a significant effect on the electron optical behavior of the spectrometer.

**B) Standard lens and conical elongation, both with large sample. Spectrum from 0.3 – 2.3 eV with +/- 7° mode.**



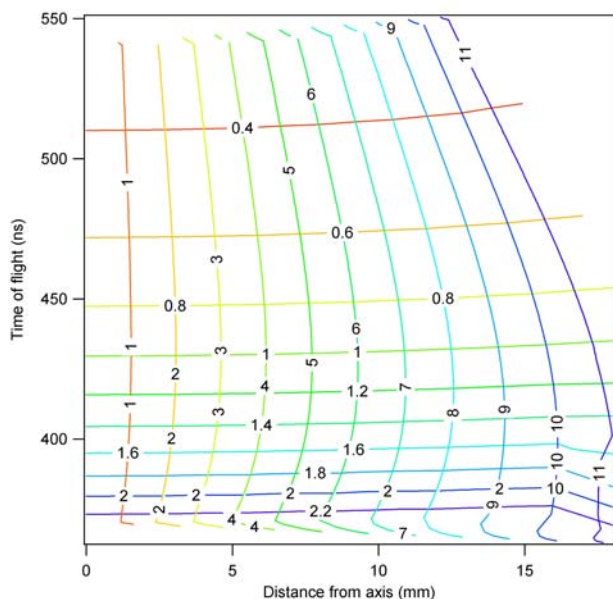
Look-up diagram for a large sample in front of the standard lens at 53 mm distance



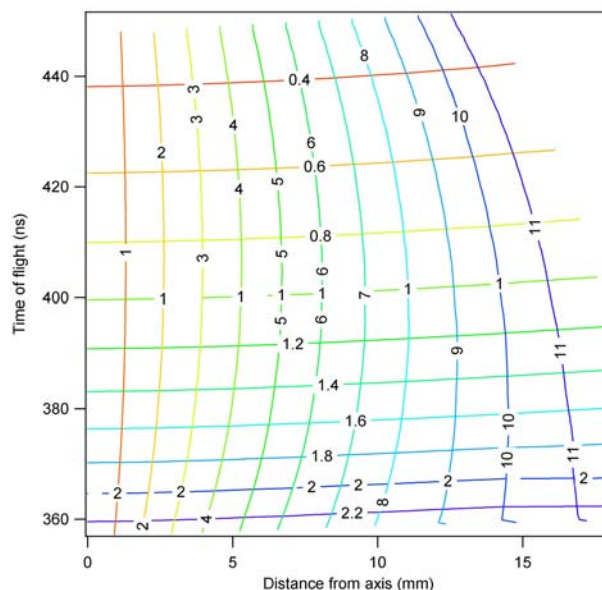
Look-up diagram for a large sample in front of the lens that has been extended with a grounded cone.

The comparison shows that the elongation with a grounded cone extending towards a large sample has no noticeable effect on the electron optical behavior of the spectrometer. The cone used in this simulation ends 1 mm in front of the sample and has a 1 mm diameter opening.

**C) 3 mm sample and 1 mm sample, both with conical elongation.  
Spectrum from 0.3 – 2.3 eV with +/- 7° mode.**



Look-up diagram for a 3 mm sample in front of the lens with conical extension. Sample holder at  $-0.5$  eV.



Look-up diagram for a 1 mm sample in front of the lens with conical extension. Sample holder at  $-0.5$  eV.

With a conically elongated lens, the 3 mm sample behaves exactly like a large sample (see diagram on last page for comparison). Thus, the conical extension allows to work on smaller samples with minimum influence on the electron-optics. Even a 1 mm sample can be used in a holder with  $-0.5$  eV work function difference. The influence on the electron optics is pronounced, but the spectrometer still works. Without the conical extension, the influence of the 1 mm sample on the electron-optics would be too strong.



In summary, the THEMIS 1000 spectrometer should be equipped with a grounded conical extension to the lens. This allows to work on small samples which have a different work function than the surrounding sample holder. The THEMIS spectrometer can be equipped with cone pieces of different size. These pieces can easily be installed and exchanged on-site. For samples in the order of 10 mm diameter, no lens extension is necessary.

**SPECS GmbH**  
Surface Analysis  
and Computer Technology  
Voltastrasse 5  
13355 Berlin  
Germany

Phone: +49 30 467824-0  
Fax: +49 30 4642083  
E-mail: [support@specs.de](mailto:support@specs.de)  
<http://www.specs.de>