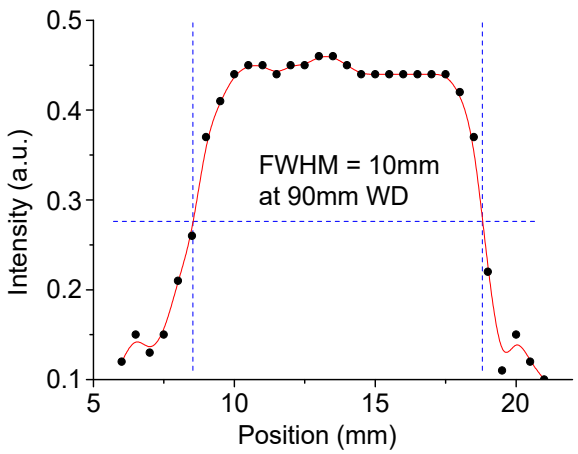
Hot filament ion sources

FDG 15 & FDG 150

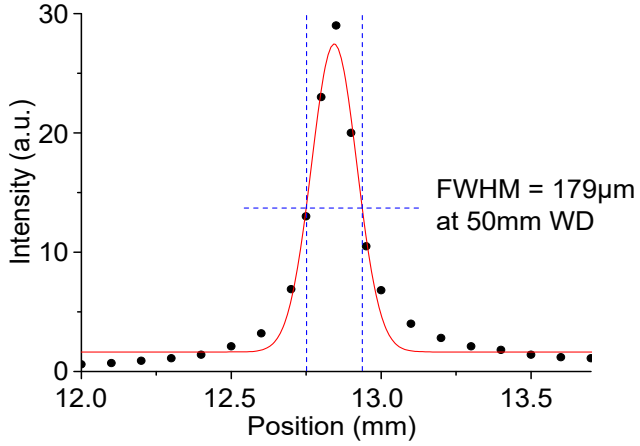
- From 5 keV down to 10 eV kinetic energy
- 30 - 300 mm working distance
- Spot size < 150 µm at 50 mm working distance
- Raster unit with keystone correction
- XPS depth profiling
- Low operating pressure of 10^{-8} mbar

FOCUS

FDG 15
Variable focus ion source



Large spotsize at 2 keV and 4.4 µA beam current.



Minimum spotsize at 5 keV and 1.7 µA beam current
Apt. corrected real width: (165±7)µm

A dedicated ion focusing optics allows to reduce the spot size down to 300 µm at 50 mm working distance for sputtering of small crystals and to adapt for large working distances up to 300 mm.

Alternatively a broad spot profile can be chosen for homogeneous large area sputtering.

The optional low energy mode provides a comparable large ion current of > 1 µA at 50 eV.

It has been found that ion sputtering at low energies of semiconductors close to the threshold energy is critical to minimise ion implantation and surface damage [1)-4)].

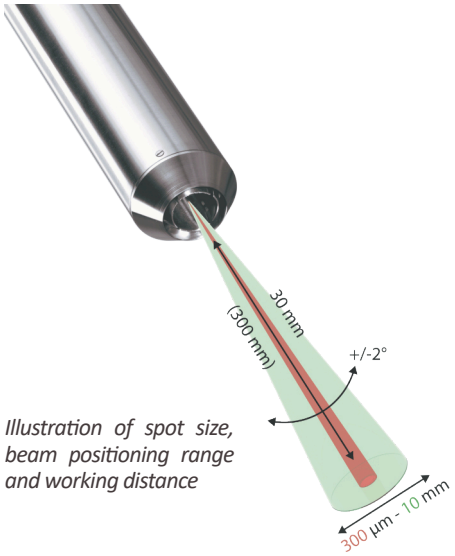
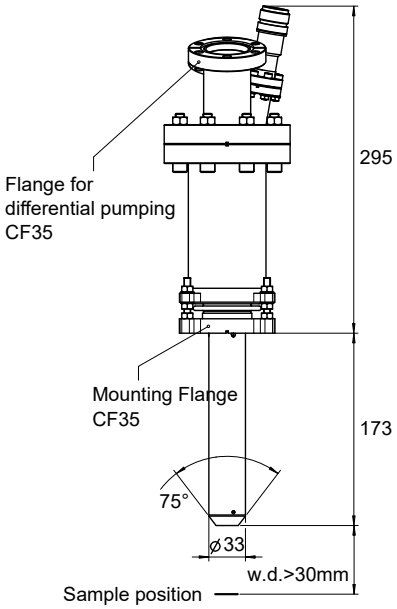
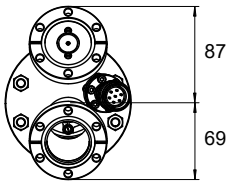


Illustration of spot size, beam positioning range and working distance

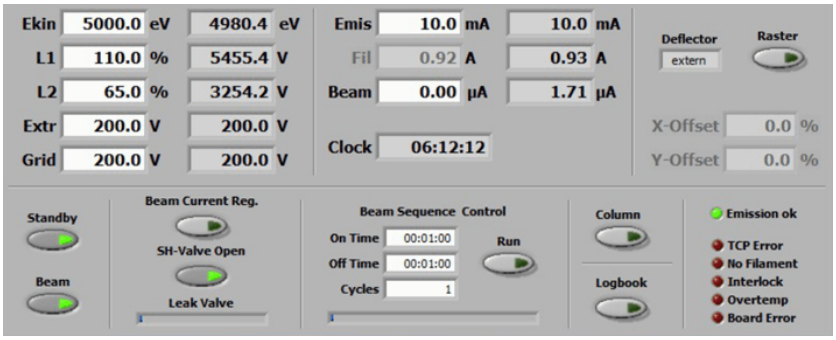
Lower energy ion sputtering, at 50 eV, has been shown to even maintain the sample magnetisation during XPS depth profiling [5)].

The source can be operated with or without differential pumping. The latter provides improved residual gas pressure of typ. 10^{-8} mbar.



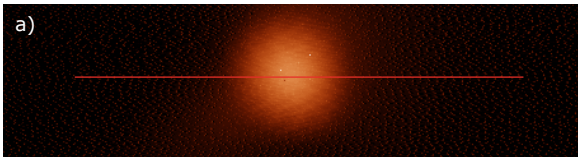


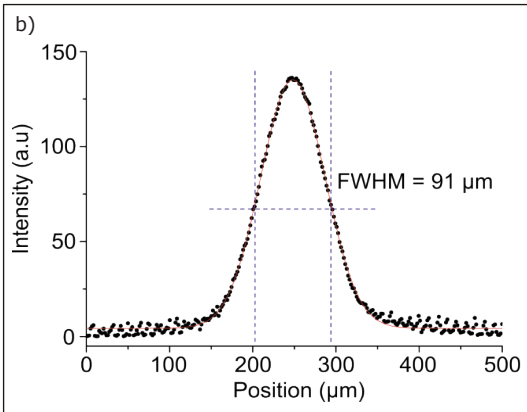
FDG 150
Fine Focus Scanning ion source



The power supply can be fully controlled with the front panel or via a TCP/IP interface. ProIon, an easy to use LabVIEW™ – based PC software is provided.

The FDG 150 in addition to FDG 15 provides a rasterized small spot down to less than 150 µm at 50 mm working distance for depth profiling XPS/Auger incl. key stone correction, charge neutralization at low energies for ESCA applications and sensor cleaning in scanning probe microscopy.





a) Image of the argon ion spot scanned across a 50 µm aperture.

b) Cross section along the red line of a) showing a minimum spotsize at 5 keV and 1.6 µA.
Apt. corrected real width: **(76.4±0.4) µm**

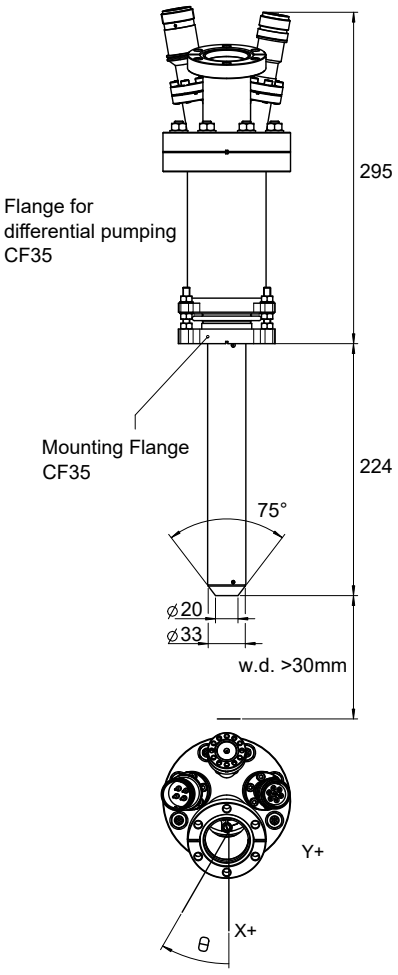
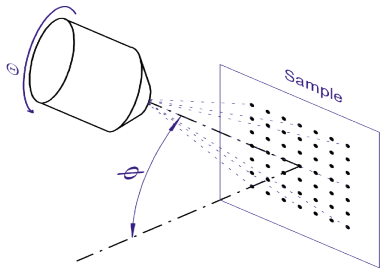
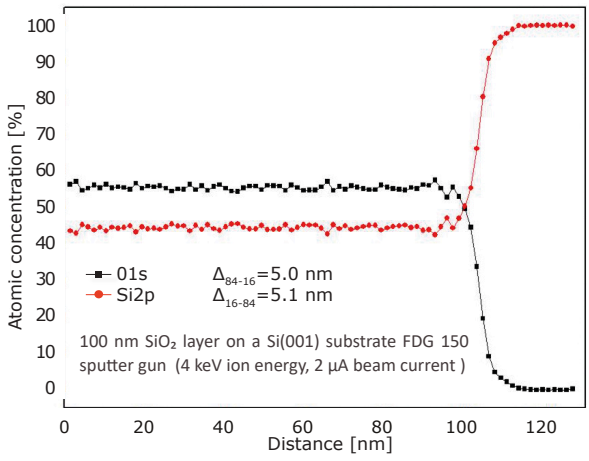


Illustration of keystone correction: In order to achieve a homogeneous sputter rate across the sputtered sample area any tilt φ or rotation θ, between ion source and sample, can be compensated to maintain an undistorted raster field.





XPS depth profiling through a 100 nm SiO_2 layer on Si (001): The cross-over position of the Oxygen peak (O1s) and Silicon peak (Si2p) intensities indicates the thickness of the oxide layer. The FDG 150's small spot size of 150 µm and the Keystone correction are essential to achieve high precision in depth resolution.

SPECIFICATIONS

	FDG 15 & power supply	FDG 150 & power supply
Mounting flange	DN 40 CF	
Working Distance (WD)	30 to 300 mm	
Min. beam diameter (D)	< 300 µm (at 5 keV and 50 mm WD)	< 150 µm (at 5 keV and 50 mm WD)
Beam energy range 1	500 eV to 5 keV > 15 µA (at 5 keV and 50 mm WD)	
Beam energy range 2	optional	10 eV to 500 eV; > 1 µA @ 50 eV
Beam current density	> 2 mA/cm² with > 5 µA, D < 400 µm (at 5 keV and 50 mm WD)	> 2 mA/cm² with > 5 µA, D < 300 µm (at 5 keV and 50 mm WD)
Scan area	not available	up to 10 mm x 10 mm (at 5 keV and 50 mm WD)
Beam current regulation	✓	✓
Integrated Port Aligner	✓	✓
Current measurement	✓	✓
TCP/IP Interface	✓	✓
LabVIEW based software	✓	✓
Fully non-magnetic	✓	✓
Yttria coated iridium filament (compatible with O_2)	✓	✓
Gases	Argon and other noble gases, Hydrogen and Oxygen	
Bake Out Temperature	Up to 180°C	
Tungsten filament (compatible with H_2)	optional	
Leak Valve	optional	

*Differential pumping improves the beam purity and saves significant time during outgasing and when changing gas flow to different values.

1) Chebotarev, S. N. et al. “Low-Energy Ion Technique for Semiconductor Surface Preparation.”

Solid State Phenomena, doi:10.4028/www.scientific.net/ssp.284.198;

2) Dongwan Seo et. al. „Behavior of GaSb (100) and InSb (100) surfaces in the presence of H_2O_2 in acidic and basic cleaning solutions”, doi.org/10.1016/j.apsusc.2016.12.114

3) Shiou-Min Wu et al. “Sputtering yields of Ru, Mo, and Si under low energy Ar+ bombardment”, Journal of Applied Physics 106, 054902 (2009); doi: 10.1063/1.3149777

4) Hye Chung Shin et al. “Sputter damage in Si surface by low energy Ar+ ion bombardment”, Current Applied Physics 3 (2003) 61–64

5) B. J. McMorran et al., Measuring the effects of low energy ion milling on the magnetization of Co/ Pd multilayers using scanning electron microscopy with polarization analysis. Appl. Phys. 107, 09D305 (2010);

https://doi.org/10.1063/1.3358218

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