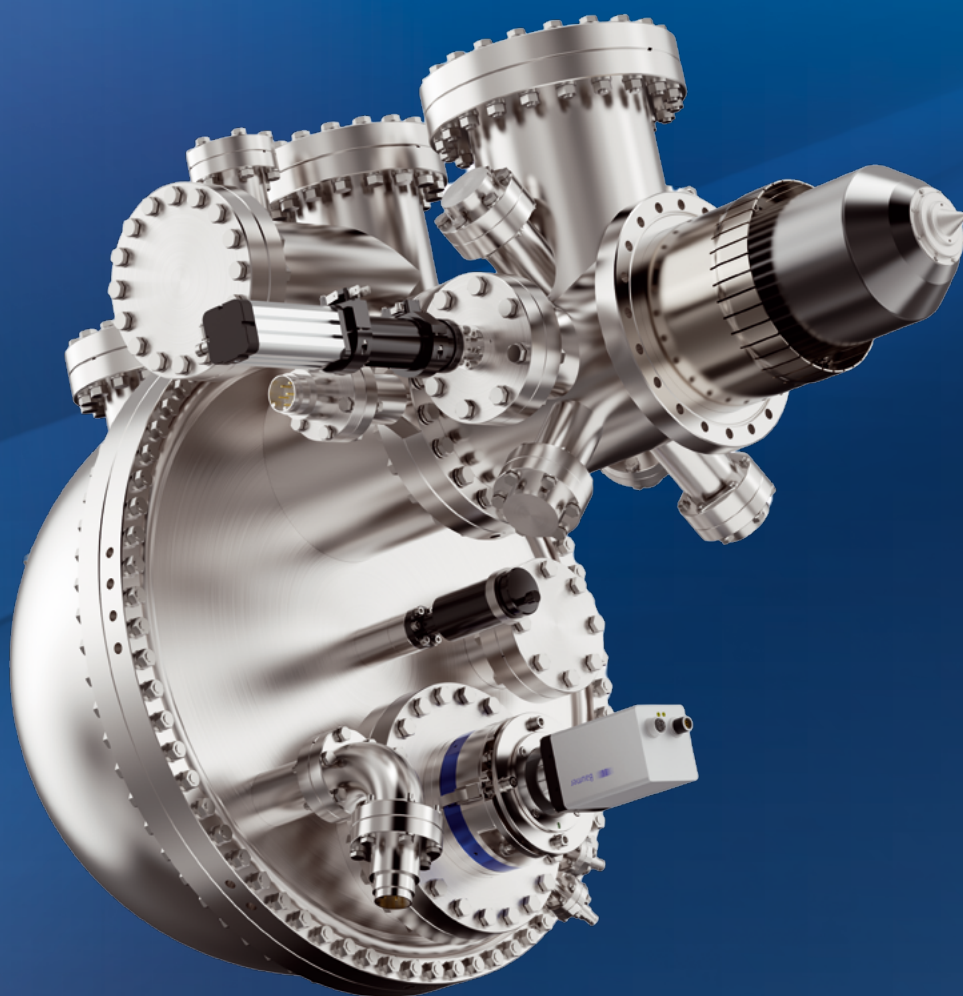


AEOLOS 150

ADVANCED XPS, HAXPES AND PARXPS FROM UHV
TO NEAR-AMBIENT PRESSURE CONDITIONS

KEY FEATURES

- Adaptive beam-forming lens for angle resolved or enhanced transmission mode
- Operation up to 10 keV
- Wide angle detection with 60° acceptance angle for UHV and 44° for NAP operation
- Unique AD-CMOS true pulse counting detector



SPECS[™]
A member of SPECSGROUP

AEOLOS 150

THE MOST VERSATILE ELECTRON ANALYZER

Made for ultimate performance

The AEOLOS 150 is a cutting edge hemispherical electron analyzer answering the demands of modern surface analysis and metrology. Its versatile design covers many research areas, such as classical high throughput UHV surface analysis, chemical analysis at near-ambient pressure conditions (NAP) and layer thickness studies for buried interfaces and device development.

The AEOLOS 150 unifies the capabilities of the PHOIBOS 150 HV, WAL and NAP analyzers in one compact and flexible unit with uncompromising performance for XPS, HAXPES, PARXPS and NAP-XPS. Its modular design is interoperable with a wide variety of experimental setups.

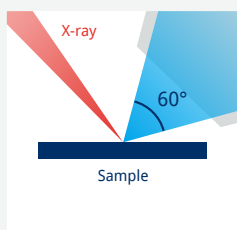
The AEOLOS 150 adds Parallel Detection Angle Resolved measurements to all methods based on XPS (PARXPS), a unique approach to XPS. It enables fast, non-destructive depth profiling of thin films and layer stacks without mechanical sample tilting.

Technology and design

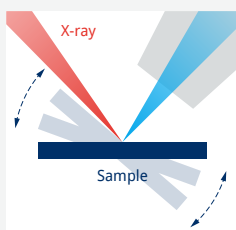
The core of the AEOLOS 150 is a fully redesigned lens system, combining a wide angle lens with 60° acceptance optimized for small spot analysis in UHV with the benefits of a seamless operation under near ambient pressure conditions.

To ensure optimum signal intensity a beam forming lens for adaptive transmission enhancement has been developed. This lens ensures optimum conditions for various applications: the AEOLOS 150 can be switched between UHV application and NAP operation in-situ without change in performance and in each operation mode it can be used for angle resolved or high transmission analysis. Especially the wide acceptance angle in combination with the new beam forming lens mode yields best signal intensity and optimal spectral performance in XPS, HAXPES and PARXPS. The shortened design without pre-lens requires less pumping at identical performance strengthening the economic aspects next to the scientific benefits.

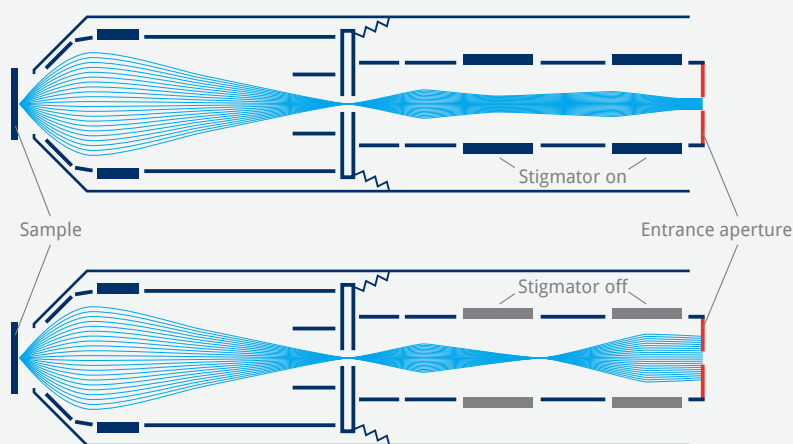
AEOLOS 150



Common tilting setups



Precision and time advantage of non-tilt measurement in AEOLOS 150 vs. common tilting setups.



Higher countdown rates (up to 2x) at constant resolution with patented beam forming lens.

Depth profiling

For non-destructive depth profiling, the analyzer's 60° wide acceptance angle can be combined with high energy capabilities up to 10 keV for multiple wavelength analysis, e.g. using the new μ FOCUS 450 or μ FOCUS 195 monochromatic X-ray sources. The application of PARXPS at multiple excitation energies offers a comprehensive analysis of layer thickness with unrivaled precision.

Near-ambient pressure operation

To perform experiments at higher pressure, a dedicated entrance nozzle with a 44° acceptance angle is added to the analyzer cone. The nozzle can be removed in-situ to switch between UHV-XPS and NAP-XPS without breaking vacuum.

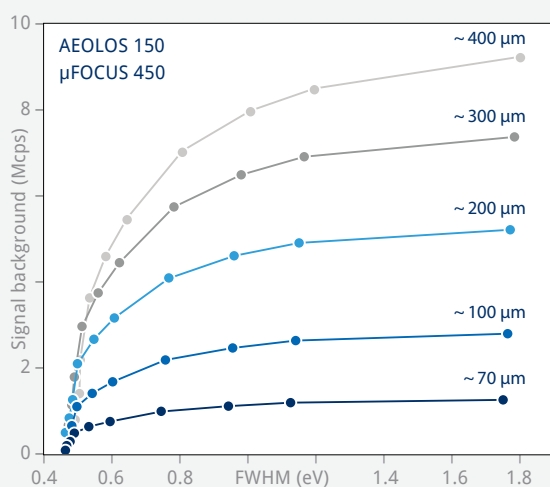
AEOLOS 150 specifications remain uncompromised in the NAP range. They are complemented by the extensive SPECS NAP portfolio of excitation sources, systems and vacuum automation.

Synchrotron-ready

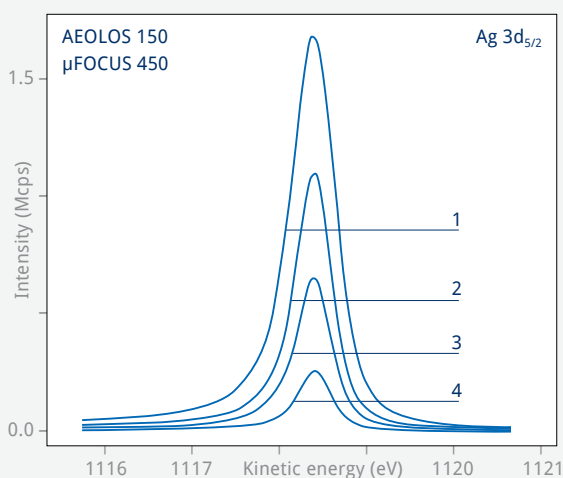
Every AEOLOS analyzer supports 10 kV operation, allowing laboratory units to move to HAX-PES beamlines with just a detector and electronics upgrade. The low-energy performance (UPS, SXPS, XPS) remains unaffected. At the beamline, the 60° acceptance angle captures the angular distribution in parallel, which enables depth profiles without sample tilting or changing the beam footprint.

The AD-CMOS pulse counting detector handles count rates up to 15 Mcps with high linearity and low noise, keeping spectra quantitative even at high-flux beamlines. Snapshot mode and 12 parallel angular channels make efficient use of limited beamtime.

With the NAP extension, the analyzer operates up to 100 mbar, covering UHV and NAP experiments in a single endstation. Typical studies include operando catalysis, gas-solid, electrochemical and battery interfaces.



Intensity as a function of FWHM for the Ag 3d_{5/2} transition for various diameters of the Al K α excitation spot.



High resolution (FWHM < 500 meV) and maximum throughput (> 1.5 Mcps) recorded with Al K α excitation at 50 W, 100 μ m.

Techniques

Non-destructive depth profiling: PARXPS & HAXPES

Techniques: HAXPES / PARXPS

Research fields / applications:

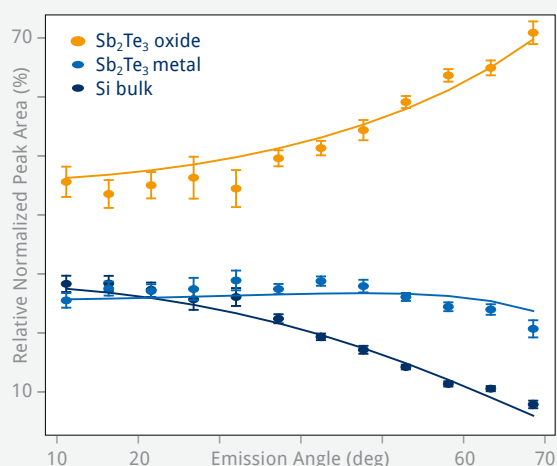
- Buried interfaces
- Semiconductor gate stacks and multilayers
- Battery electrode interfaces
- Oxide growth and surface segregation
- Ultra-thin functional coatings

Combining parallel angle-resolved XPS (PARXPS) with hard X-ray photoelectron spectroscopy (HAXPES) enables non-destructive depth profiling from the topmost atomic monolayer down to buried interfaces tens of nanometres deep. Leveraging the AEOLOS 60° wide acceptance cone, PARXPS records the full angular distribution simultaneously without tilting the sample. Grazing emission highlights the outermost surface while near-normal emission probes deeper, making it ideal for non-destructive modelling of ultra-thin functional films, native oxides, and surface segregation.

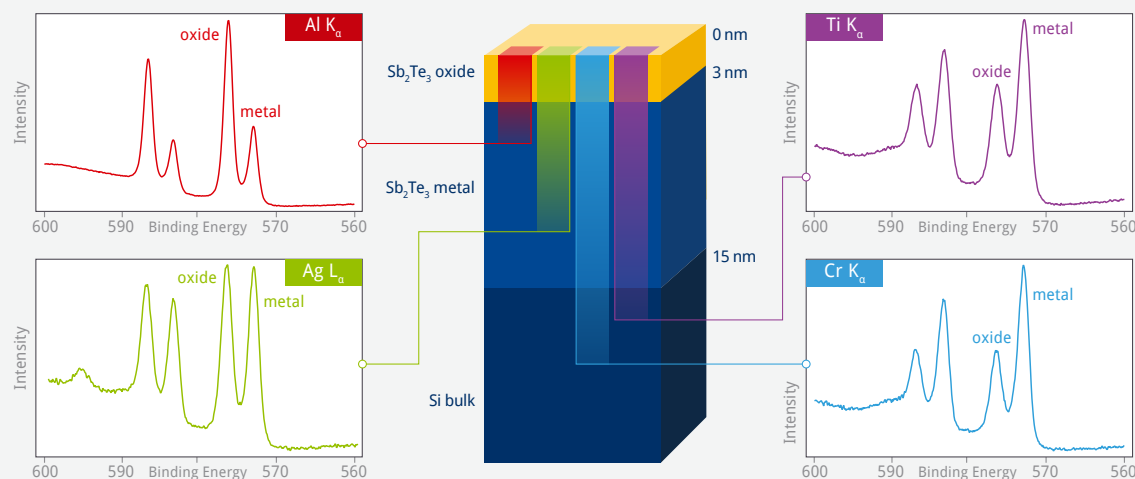
To probe even deeper, higher-energy excitation (such as Ag L_{α} , Ti K_{α} or Cr K_{α}) extends the infor-

mation depth up to 20–30 nm, with high-flux sources like Ti K_{α} ensuring rapid acquisition and excellent statistics.

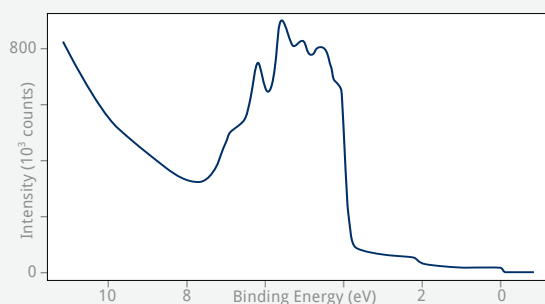
Together, PARXPS and HAXPES provide a complete, non-destructive chemical picture of layered architectures and advanced materials in daily routine laboratory analysis.



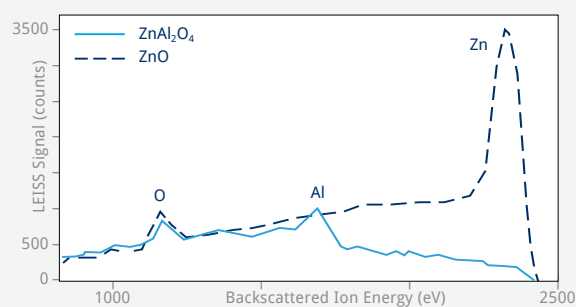
Depth profile of the Sb₂Te₃ sample on Si substrate (see image below).



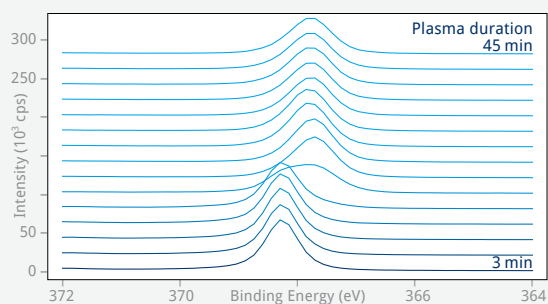
High-resolution Te 3d core-level spectra of a Sb₂Te₃ sample on Si substrate, measured with four X-ray lines (Al K_{α} , Ag L_{α} , Ti K_{α} and Cr K_{α}).



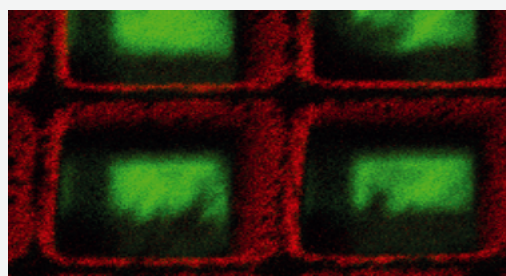
UPS valence band spectrum of Ag: AEOLOS 150 analyzer, UVS 10/35 He I source (21.22 eV), pass energy 3 eV.



LEISS spectra of zinc oxide (ZnO) and spinel oxide (ZnAl_2O_4).



High-resolution Ag 3d spectra acquired in oxidizing ambient air plasma.



SAM chemical map of a Cu grid (25 μm bars) on Ag – Cu LMM (red), Ag MNN (green).

Electronic structure

Techniques: UPS / REELS

Research fields / applications:

- Organic electronics
- OLED materials
- Quantum materials
- 2D materials
- Work function studies
- Band gap and near-surface electronic transitions

Top atomic layer sensitivity

Technique: LEISS

Research fields / applications:

- Catalysts
- Surface segregation
- Adsorbates
- Contamination layers
- Functional surfaces
- Ultra-thin coatings

Variable environments

Techniques / modes: UHV to NAP

Research fields / applications:

- Operando catalysis
- Gas-solid interfaces
- Surface reactions
- Environmental exposure studies
- Near-realistic surface chemistry
- Pressure-dependent chemistry

Morphology & elemental mapping

Techniques: SEM / SAM / XPS mapping

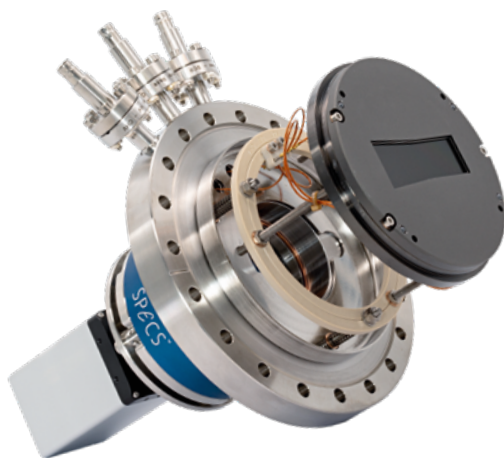
Research fields / applications:

- Heterogeneous samples
- Microstructured devices
- Coatings
- Particles and powders
- Defects
- Patterned materials
- Spatially resolved surface chemistry

Analyzer Technology

Detector AD-CMOS

With the AD-CMOS detector, the AEOLOS 150 is equipped with the most modern detection system available.



A camera based true pulse counting mechanism ensures best count rates at highest linearity, as well as lowest noise operation and full flexibility in multi dimensional operation. The detector can be operated in single channel mode with full snapshot capability and in adaptive dimension modes to collect up to 12 ARXPS channels for depth profiling simultaneously.

Software SpecsLab Prodigy

Designed for effortless workflow automation, SpecsLab Prodigy provides full, centralized control over the AEOLOS 150. Users can seamlessly define multi-region experiments, automated angle-resolved (ARXPS) loops, and real-time 2D AD-CMOS detector visualization. With one-click mode switching and dynamic lens table interpolation, complex spectroscopy workflows become fast, repeatable, and accessible.

Electronics HSA

The AEOLOS 150 is driven by SPECS' flagship HSA power supply platform, engineered to transform high-voltage precision into real experimental freedom. Designed with high-resolution 21-bit DAC architecture, the HSA offers stepless, continuously selectable pass energies from 0 to 220 eV, allowing researchers to fine-tune transmission and resolution to their exact experimental needs rather than being locked into rigid presets.

For multi-wavelength and laboratory HAXPES workflows, the system effortlessly covers wide-energy surveys, enabling continuous, seamless scans from 0 to over 5400 eV in a single sweep without relay interruptions, step artifacts, or spectrum stitching. Its synchronized dual-unit topology powers the adaptive beam-forming lens while keeping analyzer dispersion fields completely drift-free. Furthermore, because every AEOLOS 150 analyzer body is built with 10 kV electrical isolation, your laboratory is future-ready: scaling from standard laboratory XPS (3.5 kV) to higher photon energies like Cr K_α (7 kV) or synchrotron HAXPES (10 kV) requires only an electronics upgrade, protecting your investment for years to come.

Accessories and system integration

The AEOLOS 150 is engineered for effortless synergy across the SPECS ecosystem. Its adaptive beam-forming lens is tailored for small-spot analysis, pairing perfectly with the μ FOCUS 450 monochromatic X-ray source. Combining variable-energy excitation (Al, Ag, Ti, Cr) with the analyzer's 60° ARXPS collection enables powerful, non-destructive depth profiling. Mounted on a standard DN150 CF flange, the analyzer integrates smoothly into custom UHV systems, cluster tools, synchrotron endstations, or turnkey platforms like EnviroMETROS and EnviroESCA. Complemented by flood guns, UV lamps, and ion sources.

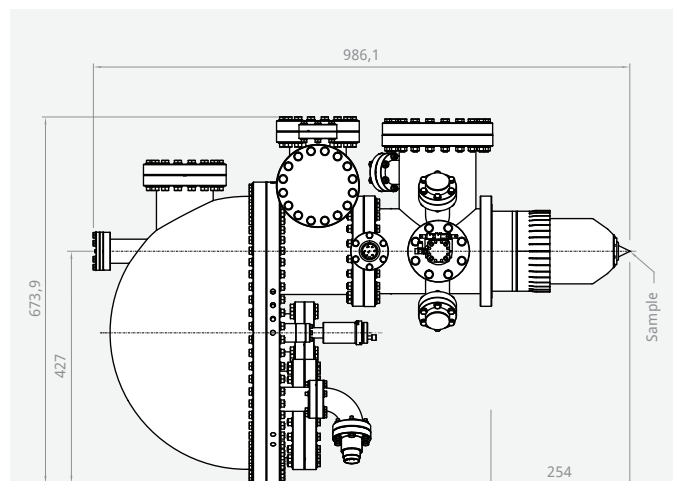
Technical data

Specification	Value
Kinetic energy range, E_{kin}	1–3500 eV, 1–7000 eV, 1–10000 eV, depending on electronics
Pass energy, E_p	1 to 200 eV, continuously adjustable
Retarding ratio, E_{kin}/E_p	1–500
Lens modes	Angle resolved mode Beam forming mode
Acceptance angle	60° in UHV 44° in NAP configuration
Ultimate energy resolution	< 5 meV for 3.5 kV versions < 15 meV with 7 and 10 kV versions
Angular accuracy	$\pm 2.5^\circ$ in angle resolved mode
Focus area*	decreases with retarding ratio, minimum < 0.1 mm ²
Acceptance area**	decreases with retarding ratio, minimum < 0.8 mm ²
ISS for E_{kin}	< 3500 eV
Detector	AD-CMOS
Detector linearity	within 10% up to 10 Mcps
Detector energy window	$\pm 0.1 \cdot E_p$
Average dark count rate	< 7 cps
Pressure at sample	Up to 100 mbar with 0.3 mm dia. nozzle
Pumping requirements (NAP)	3 pumping stages
Separating valves	Available for NAP operation
Magnetic shielding	Dual μ -metal shield
Working distance	24 mm without nozzle, one nozzle diameter with nozzle
Mounting flange	CF 160

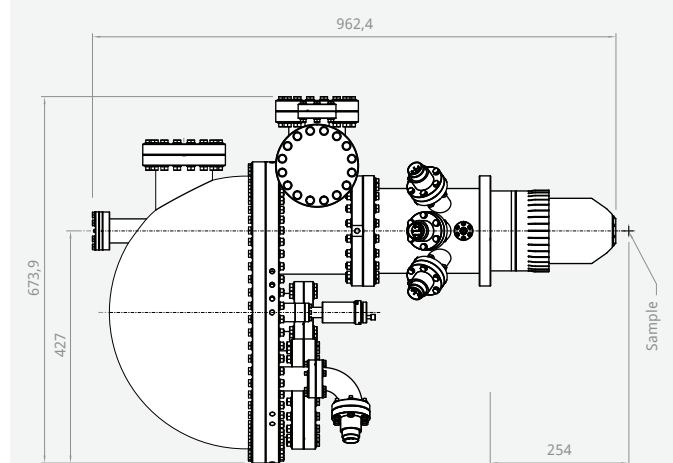
* Focus area is the area on the sample where the full specifications are reached, i.e., $\pm 30^\circ$ angle range, specified energy resolution, optimum transmission.

** Acceptance area is the area on the sample from which the spectrometer accepts electrons. Here defined as peak cross-section area at half maximum transmission.

Dimensions



AEOLOS electron analyzer, NAP version; dimensions in mm



AEOLOS electron analyzer, UHV version; dimensions in mm

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