

FOCUS SPLEED

Spin-Polarization Detector for Electron Spectroscopy and Microscopy Applications



- Simultaneous measurement of both transversal spin components
- High asymmetry factor and figure of merit
- Long duty cycle
- Automated diffraction crystal cleaning
- Low voltage operation
- Extra channel for spin-integrated analysis
- Compact, fully UHV compatible design
- Fully featured integration packages



SPLEED with pumping chamber.



SPLEED with energy analyser CSA 300



SPLEED with angle-resolved analyser SHA 50 RD

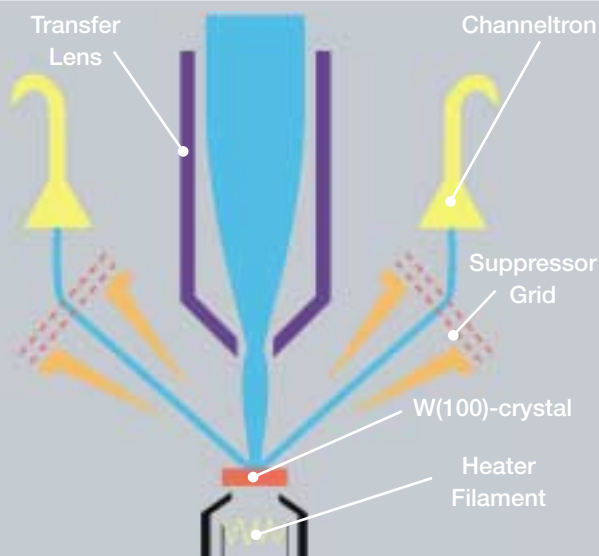


SPLEED with FOCUS IS-PEEM



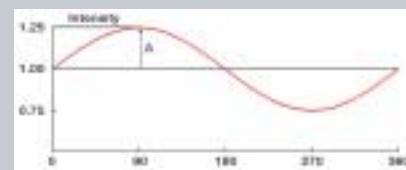
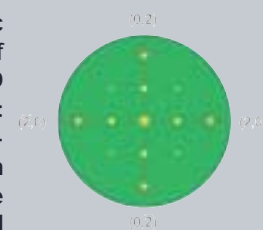


The SPLEED detector is a highly compact self-contained unit. The transfer lens allows for the adaptation to specific applications.



The transfer lens produces a parallel beam of 104 eV electrons. Suppressor grids keep secondary electrons from reaching the channeltron detectors.

The basic principle of the SPLEED detector: The LEED-pattern shows the analysed spots at about 104 eV. The dashed circles indicate the areas seen by the four channeltrons.



The asymmetry function specifies the intensity variation detectable on rotation of the polarization vector of a 100% polarized electron beam.

Spin-resolved analysis of electrons plays an important role in the investigation of magnetism at surfaces, in thin films and in the bulk material. The FOCUS SPLEED (Spin-Polarized Low Energy Electron Diffraction) is a spin-polarization detector designed for both spectroscopy and microscopy applications. Typical applications include spin-resolved UPS, XPS, AES, spin-dependent metastable deexcitation spectroscopy (MDS), spin-resolved electron energy loss spectroscopy (EELS), spin-selective electron diffraction, calibration of spin-polarized electron sources and secondary electron microscopy with polarization analysis (SEMPA). Spin-polarized photoemission with circularly polarized light (from a synchrotron) allows the experimental determination of band structure symmetries and of the hybridization between bands.

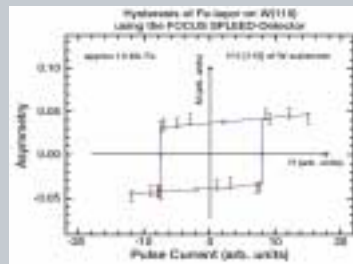
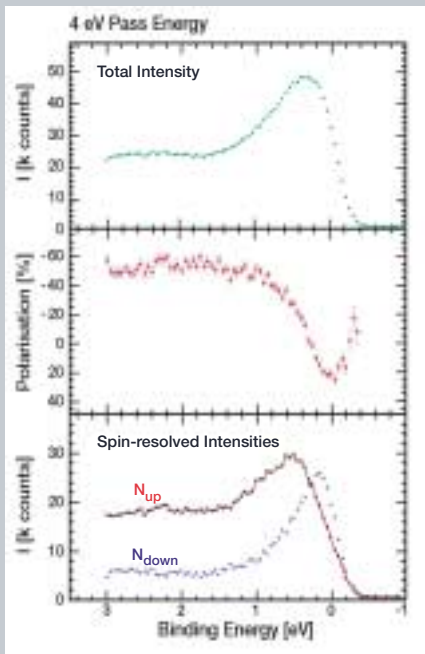
SPLEED principle offers the best figure of merit of all spin detectors. The SPLEED detector (patented* design by Prof. J. Kirschner, KFA Jülich) uses low voltages (scattering energy is 104 eV) and features a very high asymmetry function (Sherman) of > 0.2 . Electrons diffracted by the W(110) crystal are detected by one or two pairs of channeltrons. The use of four integrated channeltrons allows the simultaneous measurement of both transversal spin vector components. The degree of polarization can be derived from the intensity asymmetry between two corresponding diffraction spots.

Compared to conventional Mott detectors, this device has the advantage that it operates near ground potential and is very compact. This allows the SPLEED to be easily integrated into energy analysers. Its efficiency typically exceeds 10^{-4} and is thus an order of magnitude higher than for other spin polarization detectors. The detection of the LEED spots allows the use of channeltrons operating in pulse counting mode, resulting

Highly Efficient Spin Analysis

The spin-polarization detector is based on spin-polarized low energy electron diffraction (SPLEED) from W(110). The

*DE 264639402 for Germany and 4153844 for USA



Left: Spin-resolved electron spectroscopy of Fe (10 ML) on W near the Fermi edge measured with CSA 300 with SPLEED, pass energy 4 eV; excitation HeI, assumed Sherman function of 0.2.

Top: The corresponding hysteresis curve was derived from the measured asymmetry.

Using a 90° deflector, spin vector components parallel and perpendicular to the surface can be detected simultaneously after 90° deflection of the emitted electrons as illustrated.

in superior signal to noise ratios compared to analogue detection. The electron beam whose polarization is to be measured enters the SPLEED via an electrostatic transfer lens matched to the special demands of the experiment. The W(100) single crystal - precleaned by about 150 cycles of heating in an oxygen atmosphere - is mounted inside the compact detector. For daily preparation cycles the SPLEED is equipped with a solid state oxygen source and an electron beam heating facility for flashing off of the tungsten oxides at 2300 K. All preparation cycles are automated and can be operated either from the control unit or remotely by computer. An external gas inlet is not required.

The SPLEED control unit supplies focusing voltages for the entrance lens, retard voltages for the suppression of secondaries, and deflection voltages for the adjustment of the electron beam. All voltages can be referenced to the sweep voltage of an energy analyser. The FOCUS SPLEED can be adapted to

various instruments. In practice an extra channeltron for effective spin-integrated spectroscopy is often incorporated. The cylindrical sector analyser CSA 300 features $\pm 15^\circ$ acceptance angle for high transmission and 90° deflection, and is a powerful solution for spin-resolved electron spectroscopy in combination with SPLEED. Due to the 90° total deflection, two transversal vector components (parallel and normal to the surface) may be measured simultaneously.

Simultaneous Detection of Two Transversal Spin Components

In conjunction with the SHA 50 RD analyser, the SPLEED adds spin-resolved analysis to angular resolved spectroscopy. The SPLEED can also be used with a FOCUS IS-PEEM photoemission electron microscope for the examination of the local spin vector composition contributing to the PEEM image. For SEMPA, the SPLEED is integrated into a scanning electron microscope and used as an independent detector.

SPLEED achieves optimum performance in conjunction with either the CSA 300, SHA 50, with the FOCUS PEEM, or as a stand-alone detector for SEMPA.

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Specifications

Asymmetry function $A > 0.2$

$I/I_0 > 0.1$ % detection sensitivity = ratio of detected to incoming current

$E_0 = 104 \pm 2$ eV

Bakeable to 180 °C

FOCUS SPLEED Configurations: The FOCUS SPLEED can be configured with 2 or 4 channels; 4 channels allow simultaneous measurement of 2 spin vector components.

SHA 50 RD SPLEED: Flange mounted SPLEED detector unit for the SHA 50 RD analyser (with built-in 90°-deflector). Fits directly into the spectrometer. An optional extra channel for spin-integrated spectroscopy in the 90°-deflector is available.

CSA 300 SPLEED: Adaptation of the FOCUS SPLEED to a CSA 300 analyser using a μ -metal shielded chamber with independent pumping; an additional ion pump (45 l/s) and/or TSP is recommended. An optional extra channel for spin-integrated spectroscopy can be fitted.

FOCUS PEEM with SPLEED: 90°-deflector unit to attach the FOCUS SPLEED to a FOCUS PEEM allowing switching between micro-spot SPLEED analysis and regular PEEM observation.

SEMPA: Stand-alone detector in a μ -metal shielded chamber with independent pumping.

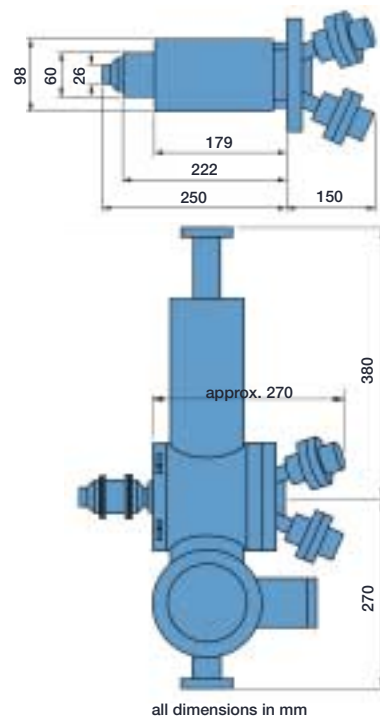
90°-Deflector: 90°-deflector unit with optional extra detection channel for spin-integrated spectroscopy. Recommended for SPLEED applications where the deflection condition of an odd multiple of 90° is required.

Electronics and Software

SP CU 2/4 Control unit for the FOCUS SPLEED detector, including channeltron matching unit and two/four pulse preamplifiers with discriminators.

SP FC Power supply for automated cleaning and flash control of the tungsten crystal (1000 V and 300 mA).

SP RM Optional ratemeter with switchable signal input.



The standard SPLEED chamber provides ports for pumping and pressure measurement. The dimensions of the lens may vary according to the individual application.