SOLARIS
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UARPES BEAMLINE – Angle-Resolved Photoelectron Spectroscopy

Angle-Resolved Photoelectron Spectroscopy (ARPES) allows for measurements of fundamental quantities, i.e. the energy and the momentum, describing a photoelectron state in the space outside the solid sample.

Within a so-called sudden approximation, the energy and momentum measured over the sample surface may be related, to binding energy and quasi-momentum, that the electron had before the photoelectric event took place. If a spin selector is additionally used, a complete set of quantum numbers for the electron is obtained. Thus the electronic band structure of the solid and its surface is obtained experimentally. Beside this simple picture ARPES gives also detailed insights into complex electron – electron and electron – lattice interactions in the solid.

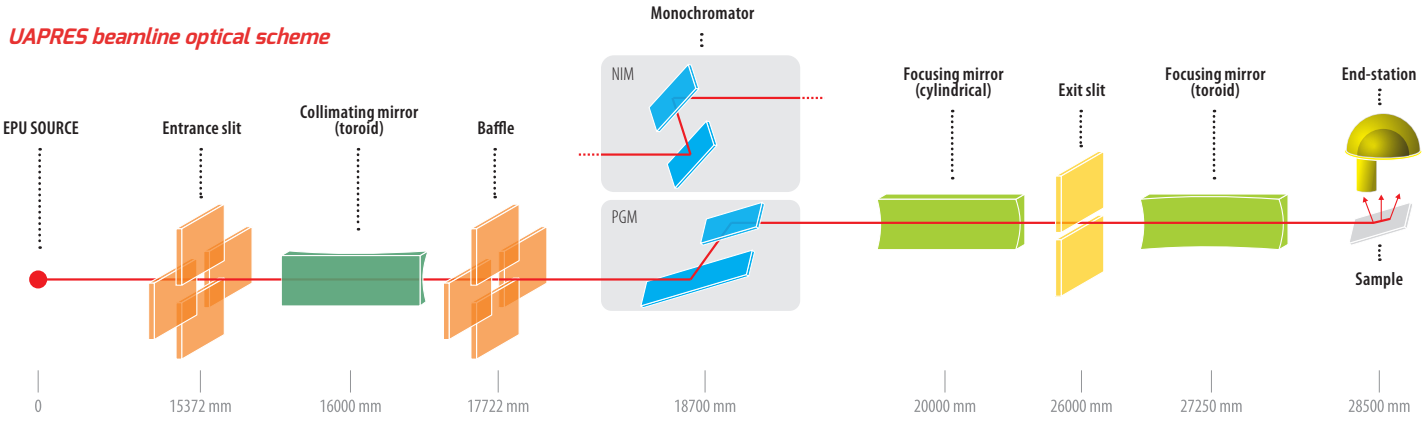
Many recent advances in materials science have been enabled by better understanding of the electronic structure of complex systems, gained due to ARPES studies. Examples include: high temperature superconductors, topological insulators, graphene and other low-dimensional materials.

The importance of the ARPES technique for contemporary science and technology is widely recognized. Dedicated ARPES beamlines exist at almost all synchrotron radiation centers worldwide. For these beamlines, demanded beam time surpasses the offered one many times. Therefore a beamline dedicated for Angle Resolved Photoelectron Spectroscopy is constructed at SOLARIS synchrotron facility. It has been given an acronym UARPES (after 'Ultra-ARPES').

The UARPES beamline has been designed in cooperation with specialists from Italian synchrotron Elettra. In accordance with safety regulations the user area is protected with a heavy radiation shielding. Elliptically polarizing, APPLE-II type undulator is a radiation source. The undulator has a quasi-periodic geometry for suppression of unwanted harmonics. The beamline monochromator combines normal (NIM) and grazing incidence (PGM) optics. The beamline is controlled via a user friendly graphical interface.

The experimental end-station is composed of several ultrahigh vacuum chambers designed for sample processing and analysis, as well as devices for the sample storage and transfer. Cryogenic, 5-axes manipulator is capable of stabilizing the sample temperature in wide range, as well as of precise

UAPRES beamline optical scheme



positioning of the sample surface for experiments. State-of-the-art electron energy spectrometer VG SCIENTA DA 30L is capable of massively parallel recording of angle-resolved spectroscopic data. The system offers a 3D visualization of the electronic band structure. Low energy electron diffractometer (LEED), with an image amplifier, is available for a precise sample orientation and for surface structure studies. Processing devices allow for typical in situ sample surface preparation techniques such as sputter cleaning, thermal annealing, thin film growth, sample cleaving, surface reactions in the gas phase. Sample surface composition and crystallographic order may be monitored in situ during preparation processes using combined LEED/AES device.

SOLARIS synchrotron welcome users to apply for a beam time on the UARPES beamline. The applications may be submitted via a dedicated website. Due to uniqueness of each experiment users are kindly asked to contact beam manager for a discussion about planned activities.

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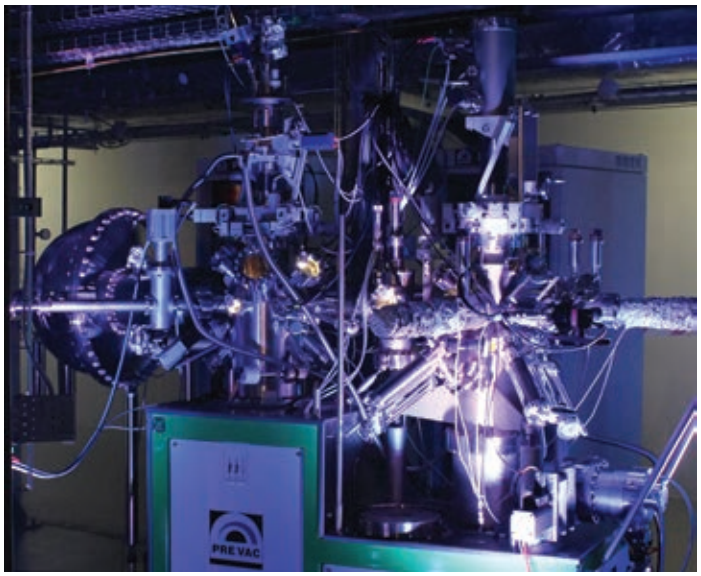

UARPES end-station

UARPES beamline parameters

Source	Elliptically polarizing undulator (EPU) APPLE II type, quasiperiodic	Magnetic period length: 120 mm
Available energy range	Total NIM PGM	8–100 eV 8 eV–30 eV 16 eV–100 eV
Light polarisation	Linear vertical, linear horizontal, circular, eliptical Linear skewed	For the linear skewed polarisation the lower energy limit is 12 eV
Resolving power (RP)		20 000
Beam size at sample (H x V)	NIM PGM	350 µm x 60 µm 270 µm x 30 µm
Photon flux at a sample		min. 5 x 10^{11} photons/s @ 20 000 RP
Available techniques		Angle-resolved photoelectron spectroscopy (ARPES) at sample temperature 8–500 K, low energy electron diffraction (MCP-LEED), Auger electron spectroscopy (AES)
Electron spectrometer energy resolution		1.8 meV
Angular resolution		0.1°
Available sample preparation techniques		Cleaving, thermal annealing up to 1800 K, Ar^+ ion bombardment, thin firm growth, surface reactions in the gas phase

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