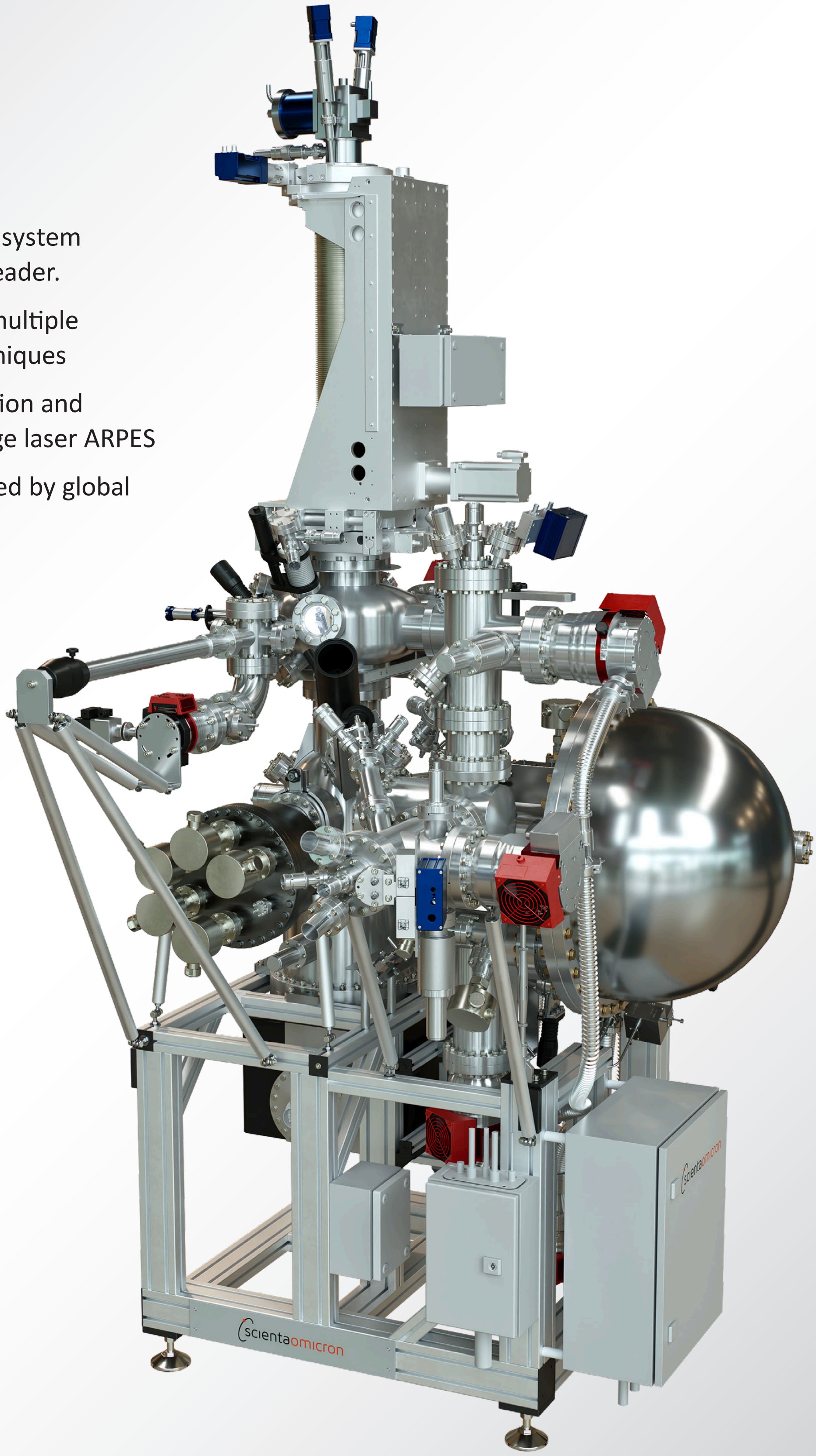
ARPES Lab

The full-spectrum ARPES solution

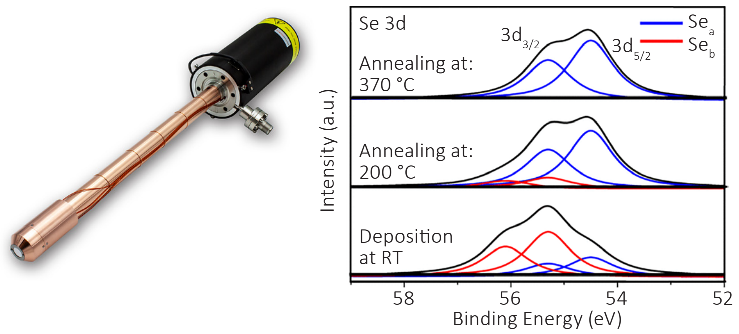
ARPES Lab advantages:

- Accelerate discovery with a system engineered by the market leader.
- Uncover new physics with multiple electron spectroscopy techniques
- Best combination of resolution and temperature for cutting-edge laser ARPES
- Future-proof platform backed by global support



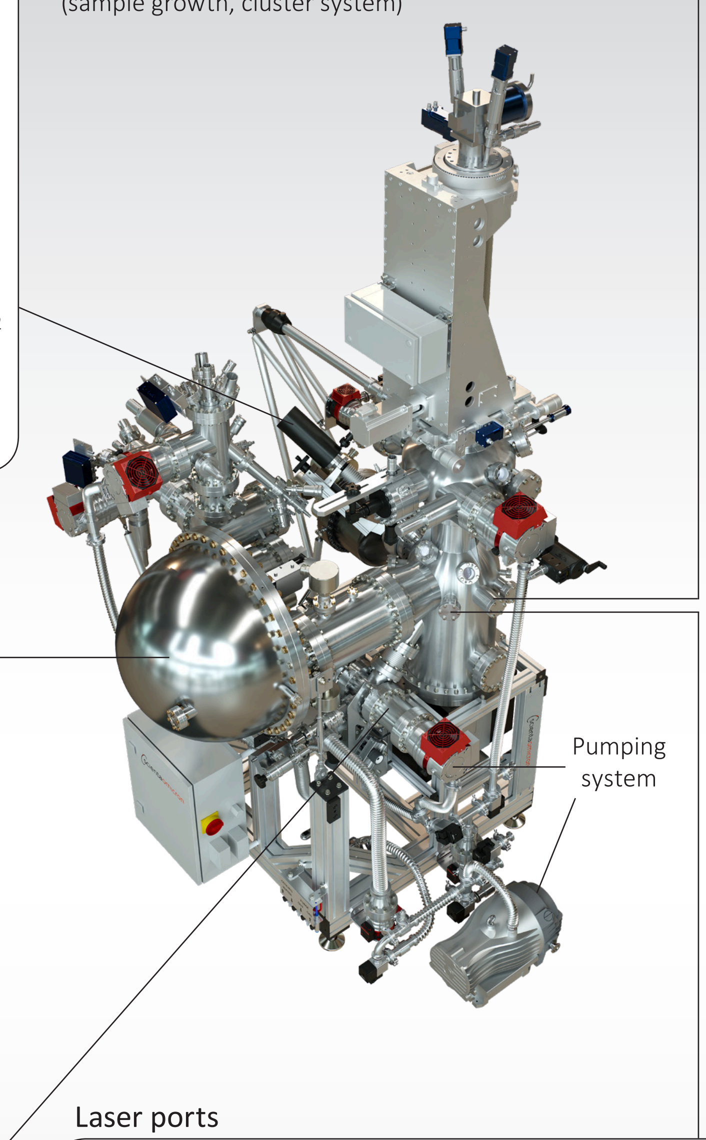
(b) Chemical analysis

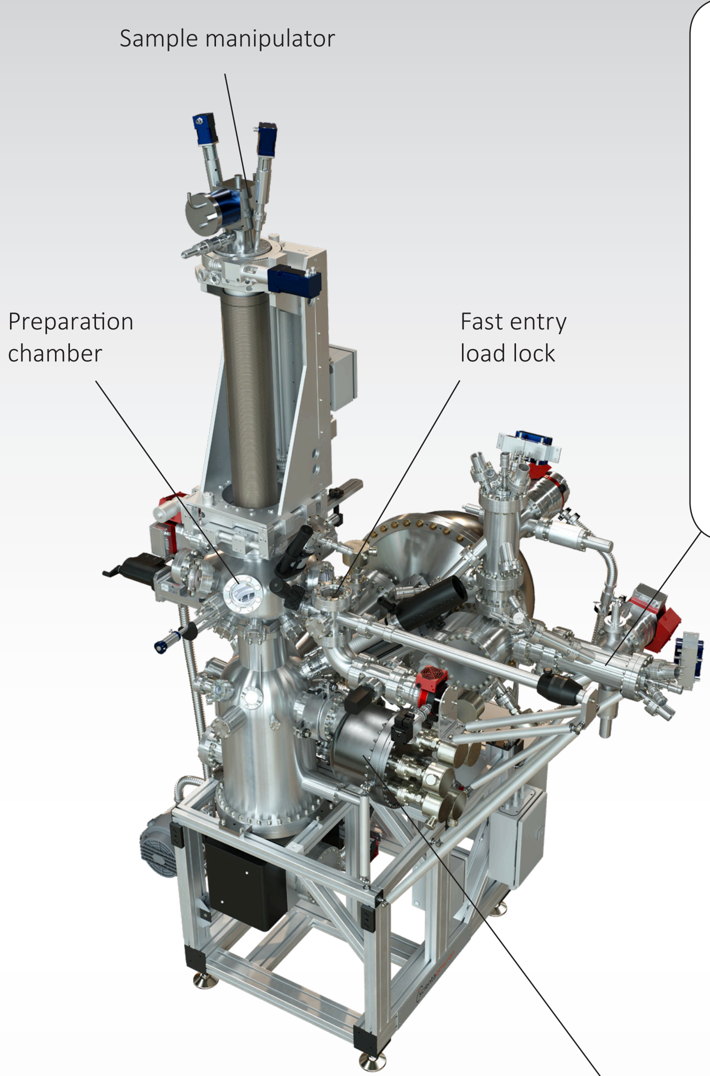
(XPS with a X-ray source)



Core level spectra of metal chalcogenides AlSe surface alloy at different annealing conditions

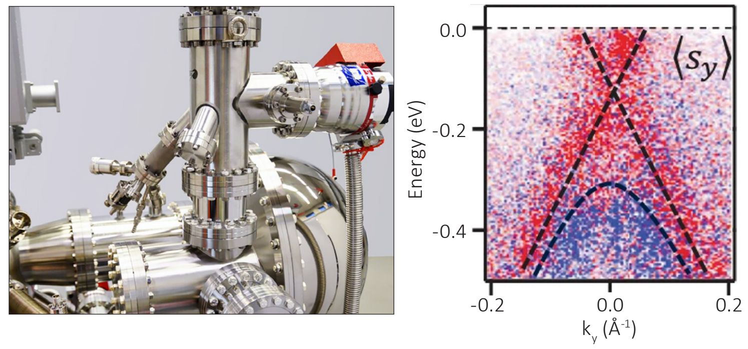
Data courtesy:
E. Shao et al., ACS Omega, 7, 45174 (2022). arXiv:2210.08739, licenced under CC BY 4.0





(c) Spin texture

(Spin-resolved ARPES with VLEED spin detectors)

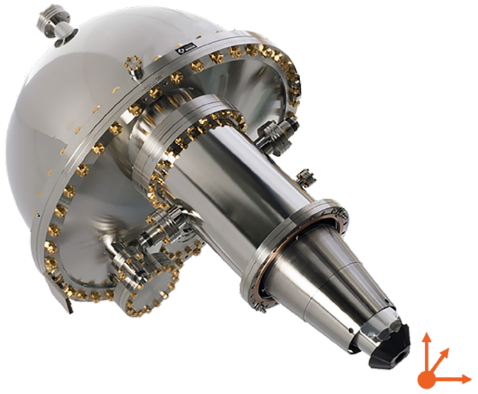


Spin texture of 2D Wely semimetal monolayer bismuthene

Data courtesy:
Q. Lu et al., Nature Communications 15, 6001 (2024)

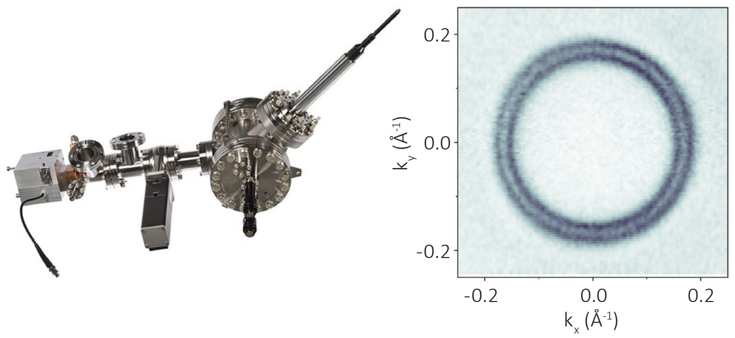
(g) Hemispherical analyser

(DFS30 analyser with Electrostatic 3D Focus Adjustment)



(a) Electronic band structure

(ARPES with the VUV5k UV source)

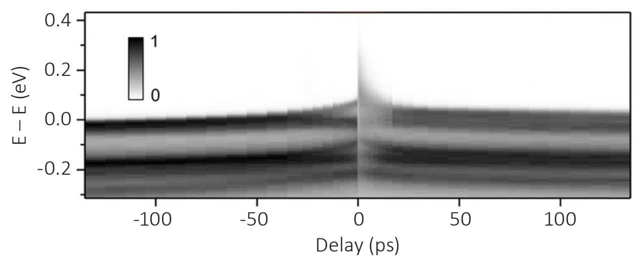


Fermi surface map of Au(111) surface state with Rashba splitting.

The spectrum was recorded using DA30-L hemispherical anlayser (deflector mode) and VUV5k monochromatic UV source (He Iα, 21 eV).

(e) Electron dynamics

(Time-resolved ARPES with pump-probe lasers)

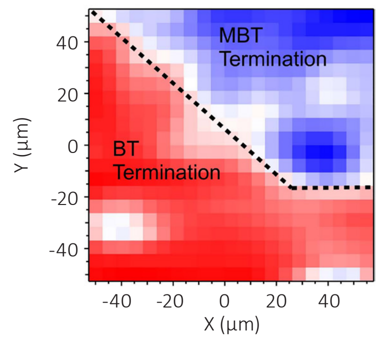


Transient surface photovoltage effect in magnetic topological insulator $Mn(Bi,Sb)_6Te_{10}$

Data courtesy:
K. D. Nguyen et al., Nanoscale 17, 10663 (2025).

(f) Microscopic electronic structure

(Micro-ARPES with a focused laser)

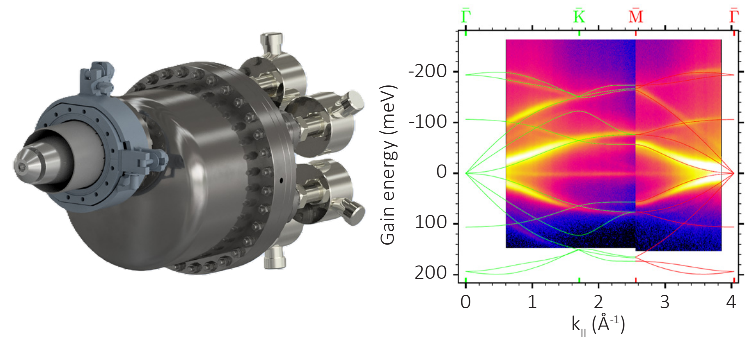


Termination dependence of antiferromagnetic topological insulator $MnBi_4Te_7$

Data courtesy:
C. Yan et al., Rev. Sci. Instrum. 92, 113907 (2021). arXiv:2109.13075, licenced under CC BY 4.0

(d) Collective excitations

(HREELS with the MCES150 electron source)



Phonon dispersion of graphite (HOPG)

Data courtesy:
Dr. F. C. Bocquet and Prof. F. S. Tautz, PGI-3 @ FZJülich,
Dr. S. Tanaka, Osaka Univ

Figure 1. Building blocks for ARPES Lab and application examples. ARPES Lab offers multiple photoemission techniques including X-ray photoelectron spectrocsopy (XPS), spin-resolved ARPES, and high-resolution electron energy loss spectroscopy (HREELS). ARPES Lab is ready for seamless integration with the laser system of your choice.

Angle-resolved photoemission spectroscopy (ARPES) is one of the most powerful techniques to study quantum materials, which enables the study of electronic band structures, energy gaps, topological characteristics, many-body effects, and more. The Scienta Omicron ARPES Lab is a laboratory-based ARPES solution with comprehensive system integration, efficient workflow, and high resolution. The ARPES Lab is capable of multiple electron spectroscopy techniques, ready for laser-based ARPES, and can be connected to other modules such as molecular beam epitaxy.

Comprehensive ARPES solution by the market leader

Do you want to expand your research capability with an ARPES instrument at your lab? Or do you want to focus on the development of advanced lasers for ARPES instead of spending years to develop a new ARPES instrument yourself? Look no further.

The ARPES Lab integrates state-of-the-art hardware technologies, including hemispherical electron analysers, UV sources, magnetically shielded chambers, cryogenic sample manipulators, and pumping systems. Comprehensive software control of the vacuum system, sample manipulator, and data acquisition ensures a fully unified and efficient workflow. The total ARPES performance is demonstrated of each system before and after delivery. You can fully focus on scientific discoveries by getting a well-designed and tested system right away, instead spending your limited time and resources for system design decisions, assembly, and testing.

Efficient high resolution ARPES measurements are achieved by the combination of the hemispherical analyser and the UV source (Figure 1a). DFS30/DA30-L/DA20 analysers (patent protected) with in-lens deflectors allow measurements without sample rotation, and VUV5k UV source delivers both high flux and a narrow energy bandwidth simultaneously. Operation is straightforward and efficient, featuring configurable safe-movement zones for different measurement positions (ARPES, LEED) and automatic predefined transitions between these positions. This significantly reduces the risk of an accidental collision while conducting experiments.

Scienta Omicron has vast experience in system manufacturing in a broad range of surface science and material science applications with more than 500 PES analysers and approximately 1,000 systems deployed worldwide. This includes >40 ARPES Lab systems and ~100 analysers installed in synchrotron facilities worldwide. Utilizing our expert knowledge and experience, Scienta Omicron offers tailor-made solutions for your specific research project.

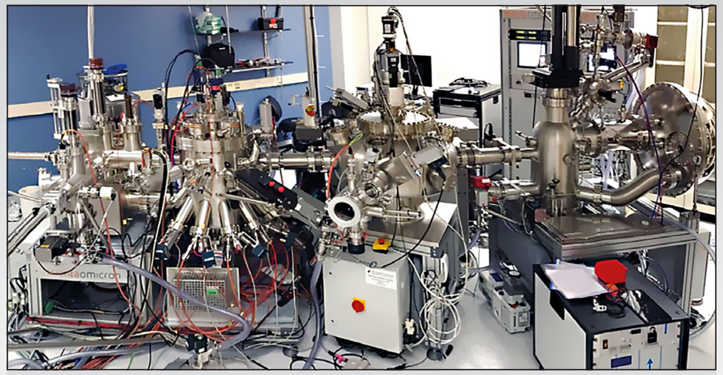


Figure 2. Materials Innovation Platform (MIP) at Pennsylvania State University - 2D Crystal Consortium (2DCC-MIP). The 2DCC is developing deposition tools with *in situ* and real time characterisation and facilities for single-crystal 2D materials. The system comprises of ARPES Lab, EVO 50 Molecular Beam Epitaxy (MBE) system for sample growth, and LT nanoprobe Scanning Probe Microscope (SPM) for real space imaging. The ARPES Lab is designed to be easily interfaced to the transfer backbones of the MIP.

The ARPES Lab is fully interoperable and can be integrated with other modules, such as molecular beam epitaxy (MBE), to create an *in situ* growth and characterisation system, forming a comprehensive platform for materials innovation (Figure 2). The ARPES Lab enables efficient optimisation of sample preparation by providing convenient access to ARPES measurements. This offers an excellent complement to synchrotron-based 3D band-structure experiments (Figure 3).

Multiple electron spectroscopy techniques at your hands

In addition to highly efficient ARPES with UV sources, a range of photoemission spectroscopy techniques is available as options. X-ray photoelectron spectroscopy (XPS) for chemical analysis is enabled by attaching an X-ray source to the ARPES Lab (Figure 1b). 3D Spin texture (s_x, s_y, s_z) in materials with strong spin-orbit coupling is observable by spin-resolved ARPES (Figure 1c). VLEED spin detectors can be added to the hemispherical analyser, even as an upgrade at a later stage, as your research project progresses.

Go multimodal by attaching MCES150 monochromated electron source to the analysis chamber. It enables high resolution electron energy loss spectroscopy (HREELS) to study the interplay between various surface excitations and electronic band structure, for example, electron-phonon coupling, phonons, magnons and excitons (Figure 1d). The combination of the MCES150 and the hemispherical analyser with a 2D detection scheme is orders of magnitude more efficient than traditional single-channel HREELS instrumentation. Scienta Omicron has partnered with Peter Grünberg Institut (PGI-3) in Jülich to offer MCES150.

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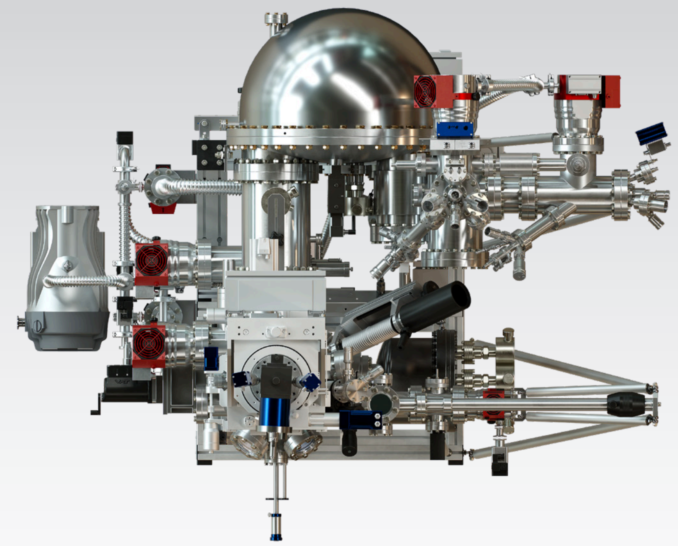
Ready for advanced laser ARPES

Advanced laser sources bring about a unique enhancement to ARPES applications: high photon flux, tight focusing, and ultra-short pulses. ARPES Lab is designed with dedicated laser ports and a range of compatible configurations, making it ready for seamless integration with the laser system of your choice.

Enhancing ARPES energy resolution enables revealing fine features such as energy gaps, kinks, and spin-orbit effects that are otherwise inaccessible. The high-resolution configuration of ARPES Lab features the analyser energy resolution of <1.0 meV (DA30-L/DFS30-8000) and the lowest temperature of <3.5 K – a perfect match for the excitation with narrow-bandwidth lasers.

Time-resolved ARPES captures the ultrafast evolution of electronic structures following optical excitation by scanning time delay between pump–probe laser pulses (Figure 1e). Efficient high-throughput measurements require tight synchronisation between the delay stage and data acquisition. This is achieved using fast electronic trigger signals from the delay stage to the digital camera detector of the hemispherical analyser, which start the data acquisition with minimal delay and minimize communication overhead.



In micro-ARPES; focused laser spots enable the mapping of spatially varying electronic structures in inhomogeneous or microfabricated materials (Figure 1f). The DFS30 analyser (Figure 1g) makes the sensitive alignment of these features easy with Electrostatic 3D Focus Adjustment. Here we electronically shift the analyser focal point 3D (x, y, z) to the desired location and increase the speed and precision of alignment.

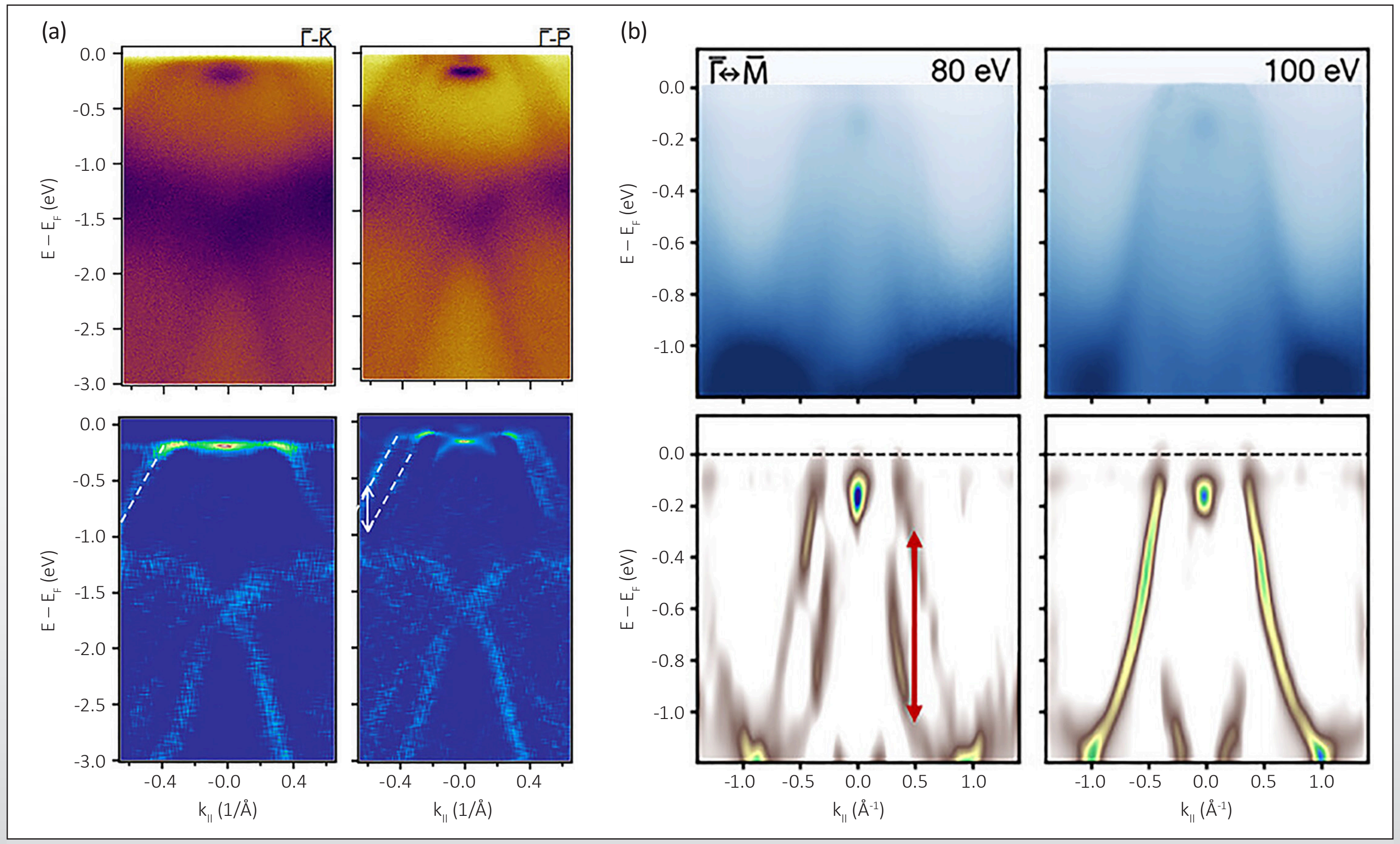


Figure 3. Altermagnetic band splitting in 10 nm epitaxial CrSb thin films using combination of ARPES Lab and synchrotron beamlines

(a) The ARPES Lab is used for optimising sample growth procedure and observe band structure along different in-plane momenta direction. The samples are grown in a MBE system connected to an ARPES Lab. (b) Synchrotron measurements at (BL 5-2 @SSRL and BL 10.0.1.2 @ALS) to study 3D band structure by excitation energy dependence. The out-of-plane momentum dependence shows that the band splitting only appears at certain momenta, demonstrating the bulk nature of the 10 nm film.

S. Santhosh et al., Adv. Mat. 37, e08977 (2025).

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Technical Data

ARPES Lab (example configuration):	DA30-L analyser, VUV5k UV source, open-cycle LHe 5-axes manipulator *
Property	**Specification**
Energy resolution (analyser) **	1.8 meV
Energy range	3 – 1,500 eV (angular mode)
Angular resolution (analyser) **	0.1°
Angular resolved range	30° (+/- 15°)
Analysis chamber	Stainless steel chamber with double mu-metal liners
Residual magnetic field	< 0.1 µT (analysis chamber)
Pumping system	Ion getter, Ti sublimation, turbo-molecular, and dry scroll pumps
Base pressure	< 1E-10 mbar (analysis chamber)
UV excitation energy	21 eV (He Iα), 41 eV (He IIα)
UV photon flux	3.2E11 photons/s (He Iα)
UV bandwidth	1.2 meV (He Iα)
Manipulator axes	x, y, z, polar, azimuthal (motorised)
Manipulator temperature range	< 4.5 K – 400 K
System control	Mistral (touch screen for vacuum system control) PEAK (analyser, manipulator)

Options

Tailor the system to your research: A wide range of options.

XPS	
Monochromatic X-ray source	SX300: 1,487 eV (Al)
Dual anode X-ray source	DSX400: 1,487 eV (Al), 1,254 eV (Mg)
Spin-resolved ARPES	
Spin detector	2D/3D VLEED (s_x, s_y, s_z, upgradable)
HREELS (High resolution electron energy loss spectroscopy)	
Electron source	MCES150 monochromatic source
Kinetic energy range	3 – 150 eV
Observables	Phonons, magnons, plasmons, excitons, and vibrational modes
Multimodal characterisation	HREELS + ARPES in one system using the same analyser
Laser ARPES (high resolution, micro focus, and/or pump-probe)	
Laser ports	2 x DN40CF port
High analyser energy resolution	< 1.0 meV (DA30-L/DFS30 8000 analyser)
Electrostatic 3D Focus Adjustment	DFS30 type analyser
Advanced charged particle spectroscopy techniques *	
Time of flight ARPES	Delay line detector or ARTOF-2 analyser
Photoelectron coincidence spectroscopy	Dual ARTOF-2 analysers
Ion scattering spectroscopy	Modified hemispherical analyser
Manipulators options	
Axes	x, y, z, polar, azimuthal, tilt (motorised)
Cooling system	Open cycle / Closed cycle
Base temperatures	3.5 K – 10 K (depending on model)
Sample stage options	4 electrical contacts, sample bias, etc.
Sample preparation and transfer	
Sample introduction	Fast entry load lock
Sample preparation chamber	Upper preparation chamber (above analysis chamber) Multiprobe prep (side)
Preparation capabilities	LEED, sputter source, heater stage, etc.
System extension	MBE system, linear transfer line, radial distribution chamber, etc.
UHV suitcase	Available

* Please contact us for configurations for your research project.
** The values are component specification. The total performance depends on the configuration. Please contact us for details.
*** Pulsed light source or ion source can be seamlessly integrated to an ARPES Lab.

Learn more at **www.scientaomicron.com/ARPES-Lab**