NEWSFLYER WINTER 2023

WORLD WIDE CONFERENCES

Meet your team - ESPEC conferences during the year

Come and discuss your applications with the local teams and find out about how our new DFS30 analyser improves your µARPES capability, how to measure XPS at 1000 mbar, or how the Materials Innovation Platform boosts your deposition capability including a full range of analysis techniques such as SPM, LEED, PEEM, and XPS.

Greetings from Scienta Omicron! We are thrilled to connect with you through our bi-annual newsflyer, where we bring you the latest updates on our regional teams, product experts, and the exciting developments in the world of scientific research.

Join us at upcoming conferences to engage with our dedicated teams and discuss your latest research results and future endeavors. At Scienta Omicron, we are always eager to explore and learn more about the diverse applications of your research.

In our recent endeavors, we had the privilege of attending the ALS user meeting in Berkeley, USA. This experience provided valuable insights into the intersection of machine learning and multimodal measurements, showcasing how these advancements are accelerating research. Our proximity to SLAC also allowed us to engage in discussions about their upcoming endstation upgrade, featuring the DFS30 analyzer.

Meanwhile, the 10th CORPES conference unfolded at the Institute of Physics in Beijing, China. The event featured a diverse array of ARPES talks, covering applications with small excitation spots, including ultrafast photoinduced transitions and strain gradients. Notably, the Hefei Advanced Light Facility showcased the SX-ARPES and nanoARPES endstations, accompanied by the anticipation of exciting results from the two DFS30 analyzers.

A highlight of our technological advancements is the DFS30's electronic alignment capability, rendering traditional mechanical alignments of samples and light sources relative to the analyzer obsolete. This groundbreaking feature enhances precision and efficiency in your research processes.

Stay tuned for more updates in our newsflyer as we continue to share insights, breakthroughs, and the latest in scientific innovation. Scienta Omicron is dedicated to supporting your research journey, and we look forward to further collaboration and discovery together.

Meet with us at:

- JSR2024, Hyogo (January 10-12)
- JSI2024, Grenoble (January 24-26)
- APS Meeting, Minneapolis (March 3-8)
- DPG Spring Meeting, Berlin (March 17-22)
- JSAP Spring Meeting, Tokyo (March 22-25)
- JNSPE 2024, Lille, France (May 15-17)

HAXPES LAB AT BINGHAMTON UNIVERSITY

Analytical and Diagnostic Laboratory (ADL)

The Analytical and Diagnostics Laboratory (ADL) at Binghamton University provides technical and instrument support for materials research, process and device characterization and failure analysis. This prestigious lab was established in 2007 and is staffed by highly educated material scientists and engineers with focus on scientific understanding and problem solving. Apart from academic partners, the ADL team collaborates with industry and government partners in planning complex analytical investigations, optimizing the techniques applied and interpreting results.

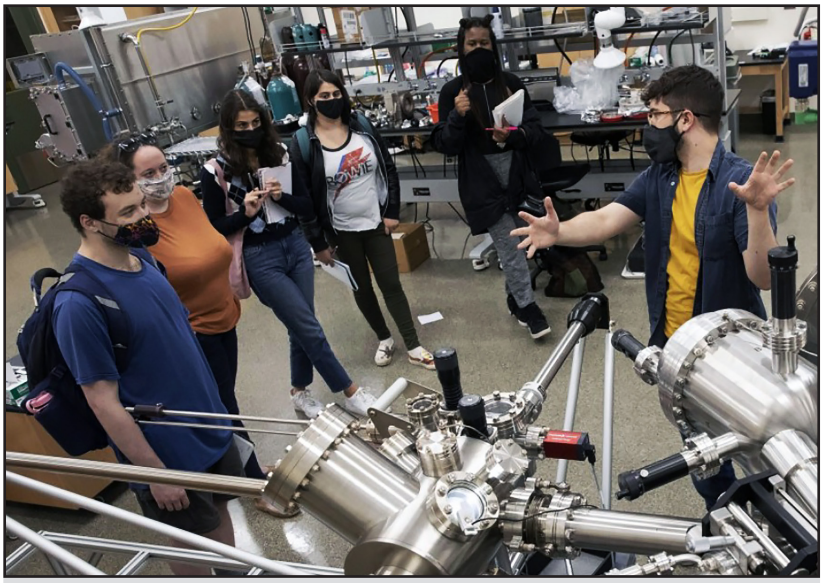
The recent addition of a Scienta Omicron HAXPES Lab enables ADL partners to gather synchrotron comparable HAXPES data in very accessible and adaptable academic laboratory setting. Such system allows non-destructive investigation of electronic and bulk material properties, buried interfaces in thin film structures, operando changes in devices etc. All the experiments are supported by the highly trained staff at ADL if needed.

For more information about the HAXPES Lab at ADL lab facilities, e-mail ADL@binghamton.edu or visit binghamton.edu/ADL.

HAXPES Lab at ADL:

- Increased probing depth with HAXPES (9.25 keV)
- Non-destructive bulk analysis
- Buried interfaces inof thin films
- Operando measurements of electronic devices

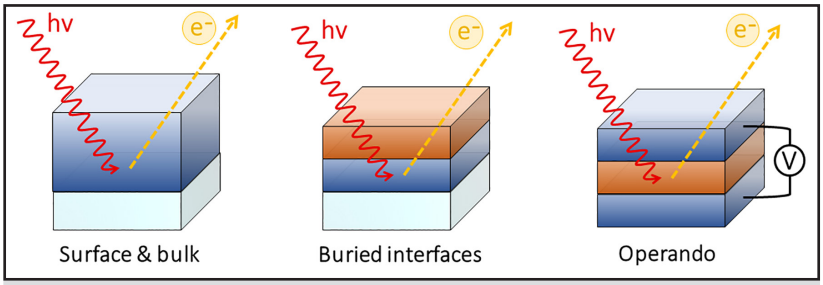
Non-destructive depth analysis: probing depth with a HAXPES source goes down to tens of nm depth (e.g. 34 nm for Si 2p in Si) which is inaccessible with a traditional XPS source (only 3-4 nm). By focusing both sources on the same spot, a direct comparison of surface and sub-surface elemental composition, oxidation states and other important material properties is possible.



HAXPES Lab at ADL laboratory at Binghamton University.

Buried interfaces: interfacial phenomena are often impractical to study with surface sensitive methods as XPS, which cannot probe deeper than a few nm. With a HAXPES Lab, thin film interfaces are easily investigated in academic laboratory settings instead of at synchrotron endstations.

Operando device measurements: biasing a thin film device (i.e. solar cell, battery, transistor) in an operando measurement requires an electrical contact on the top surface. This makes traditional XPS chemical characterisation of the sample impossible, but with the increased probing depth of the HAXPES Lab this is an easily achievable experiment.



Applications of HAXPES on thin film samples. Apart from typical non-destructive HAXPES measurements of bulk and buried interfaces, one can apply a bias via electrical contacts of the sample plate and measure the device in operando environment. Apart from typical non-destructive HAXPES measurements of bulk and buried interfaces, one can apply a bias via electrical contacts of a carefully designed sample plate and measure the device in operando environment. 140-1 000 K in situ heating and cooling is also available, including the preparation chamber for sample processing.

THE INFINITY SPM LAB

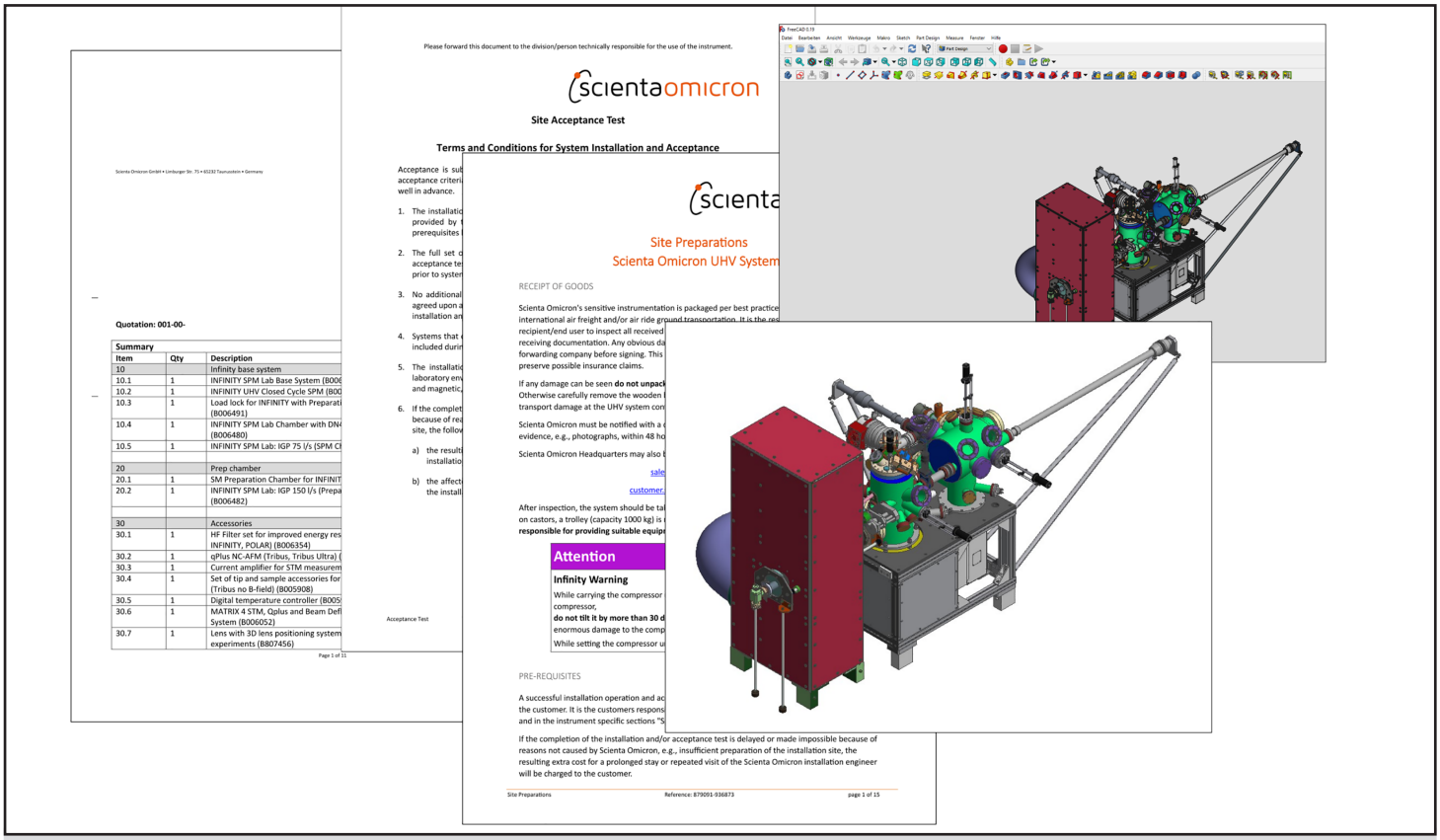
Newest Member of the CREATE Family

Scienta Omicron's CREATE family welcomes the INFINITY SPM Lab as its newest member!

CREATE systems are a broad, modular portfolio of options designed around one core product. Based on our own experience and the feedback from our large customer base, CREATE systems are designed for optimal ease of use, maintainability, reliability and performance. The inherent logic that is built into the CREATE configurator allows our sales team to adapt their offer to the customer's individual needs without any time-consuming interaction with our engineering team.

The INFINITY SPM Lab allows the combination of the INFINITY closed-cycle SPM with different preparation chambers, ranging from an inexpensive preploc chamber to full-blown preparation chambers for all major surface preparation techniques, such as a sputter source, a LEED/Auger, up to three evaporators, gas inlets, a quartz microbalance or an RGA. Various sample heating and cooling options are available, including cooling with LHe and transfer of the cold sample from the preparation chamber into the SPM chamber with a long-travel manipulator to ensure that the sample stays cold, e.g. to preserve a certain reconstruction or prevent deposited material from desorbing. SPM options include tip preparation, an optical microscope, ports for evaporators and gas inlets for in-situ deposition, as well as ports for optical access to the tip, e.g. for TERS. The system offer is rounded off by the option to attach a UHV suitcase for sample exchange with other UHV systems and our MISTRAL system control that ensures safe and convenient touch-screen operation.

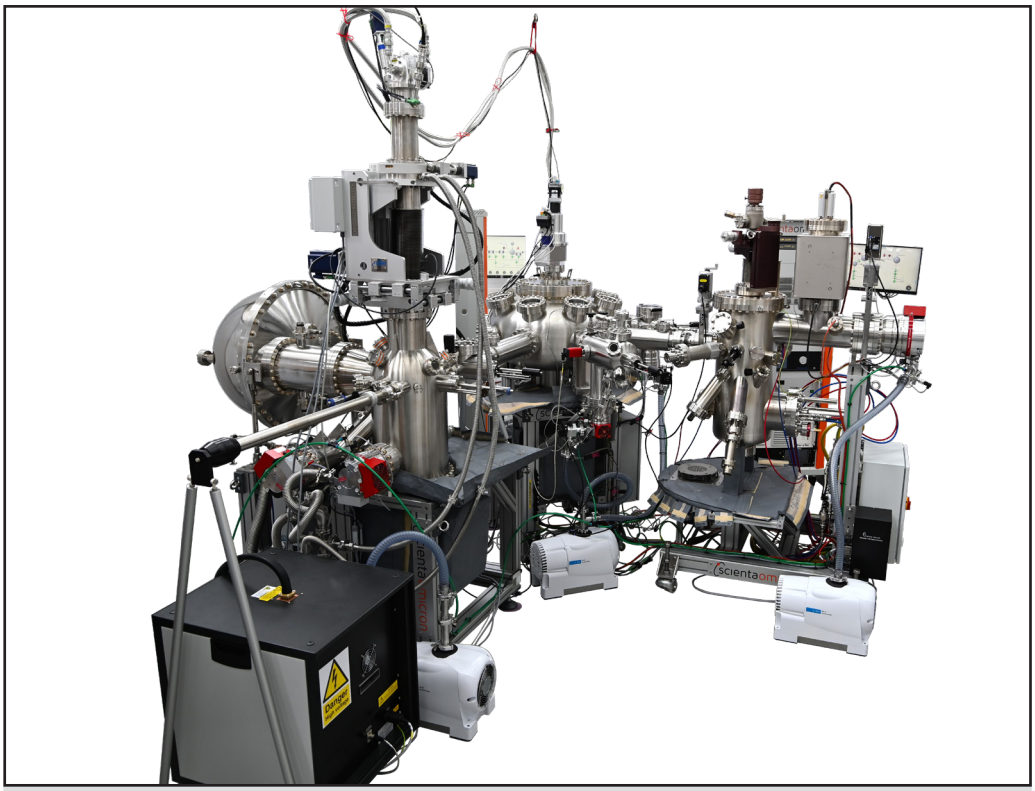
Our customers benefit from an accelerated sales process: CAD images, site preparation requirements and acceptance criteria for the individual system are readily available with the quote. The overall time from quote to delivery is reduced, compared to a custom-designed system, and in-field service and support are enhanced.



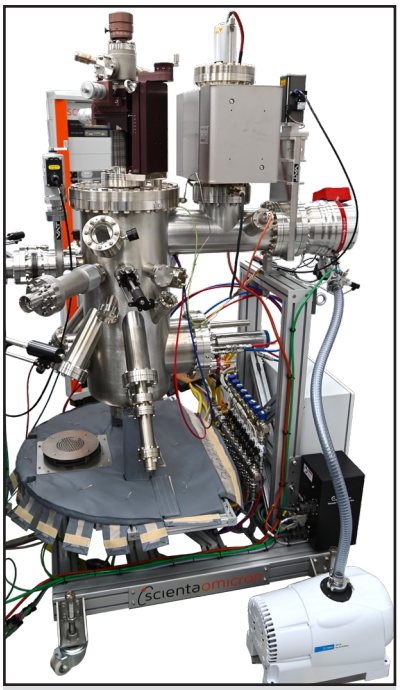
CREATE allows our sales team to provide tailor-made quotes with all key documents in a fast and fault-proof way.

MATERIALS INNOVATION PLATFORM (MIP) AT DUKE UNIVERSITY

Synergizing MBE and ARPES for Cutting-edge Research



The MIP consists of an ARPES Lab (left), RDC (center), and an EVO Compact MBE system (right)



The EVO Compact MBE system with its multipocket electron evaporator is ideally suited for the growth of layers containing low vapour pressure elements, like refractory metals.

We are happy to announce that the next Materials Innovation Platform (MIP) cluster has been delivered. With thousands of options, a MIP can be adapted to diverse research needs with customizable configurations, accommodating various experimental setups and methodologies.

The surface science cluster built for Duke University consists of an EVO Compact system for material growth by molecular beam epitaxy (MBE), an ARPES Lab system to analyse the band structure of in-situ synthesized materials, and a radial distribution chamber (RDC) with load lock and preparation chamber to enable sample transfer between the modules without breaking the ultrahigh vacuum (UHV) environment. The system will be complemented by a self-built deposition system configured for the growth of oxide materials.

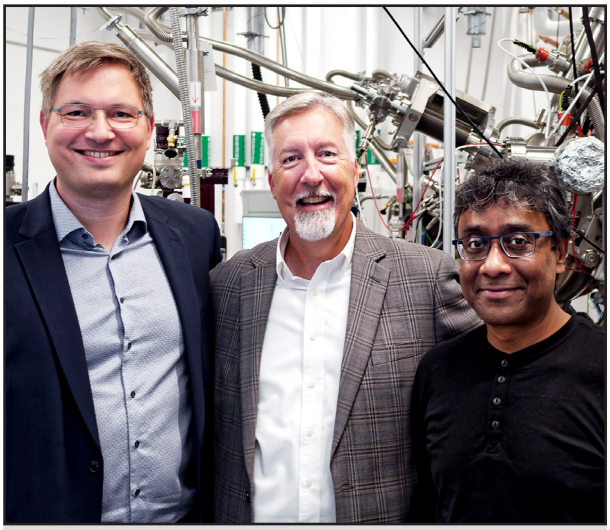
The EVO Compact system has been specifically designed for researchers developing novel 2D material systems, such as 2D transition metal dichalcogenides (2D TMDs) and complex hetero-epitaxy structures involving low vapour pressure or rare-earth elements. A multi-pocket electron beam evaporator enables the efficient deposition of multiple transition metals in this small-footprint system design. The source configuration is complemented by five DN63CF (O.D. 4.5”) ports for conventional MBE sources and chalcogenide crackers. The unique EVO Compact offers the flexibility of a small deposition system with the capability to realise the full complement of MBE capabilities.

Our state-of-the-art ARPES technology offers high-resolution insights into electronic structures, Fermi surfaces, and band dispersions, empowering researchers to uncover the fundamental properties of materials at the atomic level in their home laboratory.

Experience the synergy of cutting-edge ARPES and MBE technologies within our Materials Innovation Platform (MIP) clusters. Elevate your research capabilities, unlock new possibilities, and lead the way in groundbreaking discoveries. Collaborate with us and embark on a journey of innovation and scientific advancement today!

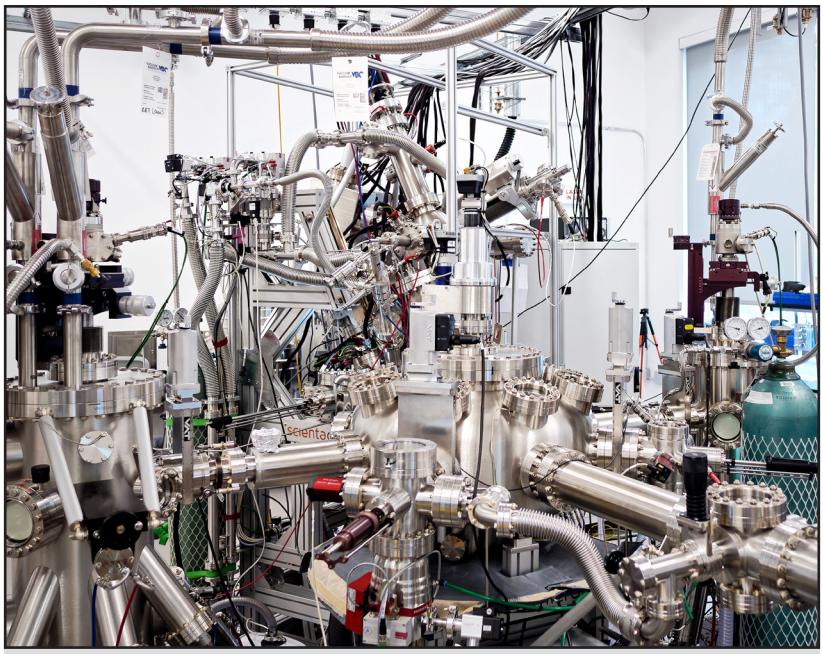
EXCITING DEVELOPMENTS IN OUR PARTNERSHIP

FOCUS and Scienta Omicron Unite for Innovation



From left to right: Marten Patt, CEO FOCUS GmbH, Fred Henn, Regional Sales Manager Scienta Omicron North America and Prof. Swastik Kar, Northeastern University.

In the world of scientific innovation, collaborations often hold the key to groundbreaking discoveries. Therefore, we are very happy to share that the partnership between Scienta Omicron GmbH and FOCUS GmbH remains as strong as ever! Scienta Omicron GmbH and FOCUS GmbH have a long-standing history of close collaboration, delivering cutting-edge instruments for research in surface science and nanotechnology working side by side. Recently, one of our regional sales managers, Fred Henn, and Marten Patt, CEO of FOCUS GmbH visited Prof. Swastik Kar at Northeastern University's Innovation Campus in Boston, USA. This is also the home of the new Experiential Quantum Advancement Lab (EQUAL) is set up to synthesize and test new quantum materials. EQUAL is a result of the partnership between Northeastern University and the Massachusetts Technology Collaborative. The system is equipped with 2 state-of-the-art Molecular Beam Epitaxy (MBE) modules, a Physical Vapor Deposition module, and a fully equipped NanoESCA Momentum Microscope with Imaging Spin Filter capabilities.



Overview image of the Scienta Omicron MIP in Northeastern's EQUAL facility. In the center of the image is the Rotary Distribution Chamber which connects all other modules. Clockwise from the left: EVO Compact MBE, NanoESCA with Imaging Spin Analyzer, Lab 10 MBE

All of the modules are linked together by a Rotary Distribution Chamber (RDC) allowing for fully in-situ sample transfer. Collectively, these tools provide a comprehensive platform for materials discovery and analysis, setting the stage for a new era of scientific discovery.

We extend our heartfelt thanks to Prof. Kar for his invaluable contribution to this venture, showcasing the possibilities that EQUAL offers. We're excited to witness scientists from around the world embark on their journey of exploration and discovery within the walls of EQUAL.

With a shared vision of advancing our understanding of science, FOCUS GmbH and Scienta Omicron are set to make an impact in the world of research and discovery.

The journey ahead promises to be exciting, and we invite you to join us in uncovering the mysteries and revealing the future.

Stay tuned for more updates and discoveries from this extraordinary partnership.

A JOURNEY OF DEDICATION

Personal portrait of Service Engineer Eike Schrenk

Eike Schrenk is a dedicated member of Scienta Omicron's North & South American Service Team. In this article he offers a unique perspective on both his professional and personal life.

Eike is currently residing in Edmonton, Alberta, together with his family. Eike gives the impression of being a real family man, and his face lights up when he speaks about his two daughters and his wife. Originally Eike is from Germany, and that is where his journey with Scienta Omicron began. Now, about 20 years later, his job has taken him around the world, all while maintaining a steadfast commitment to serving the scientific community.

Eike's journey with Scienta Omicron began unexpectedly, just after completing his university education. Little did he know that what started as a fluke would become a lifelong passion. He found himself drawn to the dynamic nature of his work, where no two cases are alike. Each day presents new challenges, making his role endlessly exciting and fulfilling.

One of the perks of Eike's profession is the opportunity to travel, especially since it's not your typical tourist experience. Instead, his work takes him deep into local cultures, offering unique insights. His favorite destination so far being Australia, where he encountered both koalas and kangaroos.

Eike's academic background is in physics, with a specialization in semiconductor impurities spectroscopy, although Eike adds “I’m not sure if anybody is still doing that kind of research today”.
His work revolved around probing and understanding the intricate energy levels within these materials. He notes, "To this day, I still find it absolutely cool each time I see atoms!"

Eike emphasizes that strong people skills are vital in his line of work. With most customers, it's about setting the right tone, connecting on a personal level, and understanding their needs. Listening is key, as it paves the way for transparent discussions. Eike firmly believes that honesty is the best policy. He says, "What our customers see is what they get. I do not want to be a car salesperson. Instead, I am always honest and direct, even if the truth sometimes can be harsh." Eike finds that this builds a stable foundation for a good relationship from the start, and even when things don't go as planned, Eike is ready to handle the consequences.

One memorable installation experience illustrates the unpredictable nature of his work. While installing a LT STM lab in Chile, he encountered a series of challenges, from missing parts to a flooded lab, delays caused by COVID-19, and technical issues. Eike's creative problem-solving skills

Service Engineer Eike Schrenk, balancing technical expertise and personal touch worldwide.

came to the forefront when he fashioned a makeshift solution for a missing c-clip using a bread bag twist tie, showcasing his dedication to minimizing downtime for the customer.

Eike typically works alone but is never truly isolated. He relies on his supportive colleagues who are always just a message away, ready to offer their assistance. He explains, "Yes, I am alone a lot of the time, but I never really feel alone."

His work is a balanced mix of customer interactions and behind-the-scenes tasks, roughly a 50/50 split. Whether troubleshooting technical issues or building relationships, Eike Schrenk’s journey embodies the essence of Scienta Omicron, where service, science, and innovation converge.

PEAK API

Use case tr-ARPES

With tr-ARPES access to the electronic states in the conduction band is possible by first exciting electrons with low energetic photons from the valence band to the unoccupied states of the conduction band. A following pulse of higher energy photons then causes photoemission. To do this in a controlled fashion, the delay between these two photon pulses is controlled by a delay stage. PEAK is designed to integrate such additional hardware in your experiment and synchronize it with the analyser acquisition in a straightforward way using the PEAK API.

To get started with the PEAK API (application programming interface), we offer the PEAK SDK (software development kit) including a training course. Our programmers explain the PEAK system architecture and run several development examples using the PEAK API. With the included python package for PEAK, it is easy to start running measurements through the PEAK API.

Anders Frisk – PEAK programmer:

"Measurements with frequent adjustment of external hardware (e.g. delay stage)
*require minimization of idle times due to internal communication and avoiding unnecessary steps. For this we directly control the **analyser server** instead of using the higher-level **experiment server**. This reduces communication delays and allocates resources to hold a single spectrum once only."*

To set up the experiment (Figure 1), the peak python package is imported and a connection to the analyser control computer is established. Subsequently the type of measurement at each delay stage position is defined including lens mode, pass energy, acquisition time and if one of the axes (e.g. deflection for a DFS30 analyser) is used. After this definition, the analyser server reserves computer resources to hold such a spectrum in memory.

In the next step (Figure 2), the measurement is setup with an outer loop to improve signal to noise ratio (averaging over intensity fluctuations) and an inner loop which controls the delay stage position. After updating the delay, the allocated memory is cleared from any data, the custom meta data is defined (stored with the spectrum data), and the current acquisition is started. Finally, the acquired spectrum with attached metadata is stored together with all the other spectra in the tr-ARPES measurement series. Either to memory or directly to a data file like HDF5. Figure 3 shows an example of three slices from such a deflection scan for the upper Dirac cone of Bi_2Se_3 shortly after excitation.

```python
# Import peak-sdk package
import peak
import sys
from visualization_peak import VisualizationPeak

# connect to PEAK & analyser server
peak_client = peak.PeakClient()
peak_client.connect()
analyser_client = peak_client.get_acquire_spectrum_client()
analyser_client.connect()

# define the measurement
analyser_client.start_measurement()
analyser_client.set_lens_mode("DA30L_01")
analyser_client.set_pass_energy(10.0)
analyser_client.set_dwell_time(5)

# energy axis - fixed mode
analyser_client.set_acquisition_mode(peak.PeakAcquisitionMode.IMAGE)
analyser_client.set_energy_mode(peak.PeakEnergyMode.KINETIC)
analyser_client.set_x_axis_mode(peak.PeakAxisMode.FIXED)
analyser_client.set_x_axis_center(10.0)

# theta-y axis - deflection scan
analyser_client.set_z_axis_mode(peak.PeakAxisMode.SWEEP)
analyser_client.set_z_axis_min(-15.0)
analyser_client.set_z_axis_channel_size(1.0)
analyser_client.set_z_axis_max(15.0)

# important for performance
analyser_client.set_store_spectrum(False)
analyser_client.set_store_acquisition_data(False)
analyser_client.set_use_region_delay(False)

# allocate required memory for this spectrum definition
analyser_client.setup_spectrum()
```

Figure 1: Defining the kind of spectrum to be acquired at each delay stage position in PEAK is straight forward.

```python
delays = range(-100,500,100)
cycles = 1
spectra = []

for c in range(1,cycles+1):
    for d in delays:
        delay_stage.set(d)
        # clear the memory, set current meta data, acquire spectrum
        analyser_client.clear_spectrum()
        analyser_client.set_user_data({'Cycle': c, 'Delay': d})
        analyser_client.acquire_spectrum()

        # Not memory efficient but fast. For large datasets use HDF5
        spectra.append(analyser_client.get_spectrum())
        spectrum = analyser_client.get_spectrum()
```

Figure 2: Setting up a basic example with an outer loop for averaging and an inner loop controlling delay stage position and the spectrum acquisition.

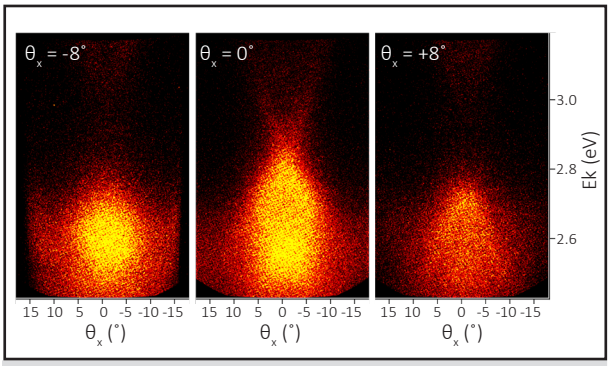


Figure 3: Example of a tr-ARPES measurement acquired with PEAK showing three slices for the upper (normally unoccupied) Dirac cone of Bi_2Se_3 shortly after excitation.

Data courtesy of H. Soifer, Ultrafast Quantum Materials Lab, School of Physics and Astronomy, Tel Aviv University.