



**Malvern
Panalytical**

Empyrean

The complete platform for X-ray analysis



Future-proof your X-ray analysis

One multipurpose platform. Endless possibilities.

Empyrean is the only modular, multipurpose X-ray instrument that combines advanced X-ray diffraction (XRD), scattering, imaging and laboratory-based X-ray absorption spectroscopy (XAS) in a single instrument. The result: comprehensive structural and electronic characterization of your materials in one flexible system.

Empyrean combines powerful analytical capabilities with intelligent automation. Its MultiCore Optics, featuring iCore and dCore, automatically configures the instrument for a wide range of measurements, so you can run sample batches overnight and maximize instrument utilization.

- **Unlock multiple measurement techniques** to get a more complete understanding of your samples.
- **Accelerate research** by performing more experiments in-house and reducing reliance on external facilities.
- **Simplify training** and get new users up to speed faster, lowering the barrier to performing advanced X-ray applications and reducing costly delays caused by mistakes.
- **Automate data analysis** with user-independent workflows using software such as our industry-leading HighScore package.

Synchrotron-level insights – without leaving your lab.

Structural and electronic insight in one platform

Traditional XRD reveals how atoms are arranged in a crystal lattice. But many material properties, such as catalytic activity, battery performance, or chemical reactivity, also depend on the local chemical state and electronic structure of elements. Empyrean uniquely combines XRD structural analysis with XAS, enabled by its modular architecture and advanced optics, to deliver a more complete understanding of your materials.

Traditionally, XAS requires access to synchrotron facilities with limited availability and long waiting times. With Empyrean, many of these experiments can now be performed directly in your own laboratory – allowing researchers to run more experiments, iterate faster, and accelerate discovery.



Empowering research across disciplines

Empyrean combines multiple X-ray techniques in one platform, supporting advanced materials characterization across a variety of fields.



Academia

High-quality data for breakthrough research and education. Get the best data for your publications while training and inspiring the next generation of scientists. Empyrean reveals the finest details of your samples through non-destructive, cutting-edge characterization. Its flexible configuration supports a wide range of research applications while remaining accessible for teaching laboratories.



Energy storage/batteries

Understand battery materials from structure to operation. XRD reveals phase purity and crystallite size of anode and cathode compounds. Empyrean, equipped with the GaliPIX^{3D} detector, also allows in situ and in operando measurements of long-lasting cells using hard X-radiation.



Pharmaceuticals

Advanced characterization for next-gen pharmaceutical materials. X-ray powder diffraction, a rapid non-destructive analytical technique, is widely applied in drug discovery, formulation, stability testing, and final product quality control. This proven and comprehensive method is also available with 21 CFR Part 11 Audit Trail support. Empyrean can also perform in situ non-ambient analysis without manual intervention and high-throughput measurements on well plates.



Specialty chemicals

Assess the unique performance properties of your materials. Empyrean enables detailed phase identification and analysis of the structure-property relationships in crystalline and semi-crystalline compounds, including custom-manufactured materials.



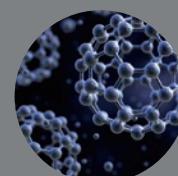
Forensics

Get the evidence you need – without destroying the sample. The use of non-destructive analytical instrumentation plays a key role in today's forensic laboratories, where the full chain of custody and data control is desired across all stages of the process. Empyrean can reveal the smallest traces of evidence, providing vital information for criminal investigations and forensic science.



Metals

Precision insights to master metal quality control. Process control and quality control in the metal industry – whether it concerns primary metals or special products – need rapid and accurate chemical analysis as well as microstructural characterization of metals and alloys. From retained austenite to stress and texture analysis, Empyrean delivers essential measurements for metal production and quality control.



Nanomaterials

Reveal the dimensions and structures of your nanomaterials. X-ray scattering and diffraction are powerful nanometrology tools for determining nanoscale dimensions, shapes, and structures, as well as crystalline phases and local atomic structure. Empyrean delivers highly accurate scattering data for all types of nanomaterials.



Thin film metrology

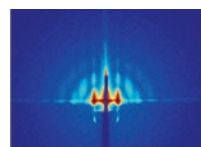
Unlock the critical parameters of thin films. X-ray diffraction and X-ray reflectivity can provide non-destructive, reliable, and accurate data for the characterization of thin films, from ultra-thin single layers to complex multi-layer stacks. Empyrean enables ultra-fast reciprocal space mapping, X-ray reflectivity, and rocking curve analysis.

More experiments, less manual effort

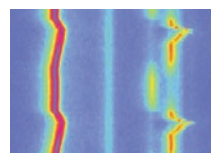
Main benefits of the MultiCore system

- **Run multiple sample types and applications in one uninterrupted batch**, enabling complete experiment series to run overnight
- **Increase sample throughput by at least 30%**, helping your lab generate results faster
- **Reduce user training time by 30%**, making advanced X-ray techniques accessible to more users
- **Automatically optimize resolution and intensity**, ensuring every experiment runs with the ideal configuration
- **Detect impurities or minor phases that impact your experiment**, with up to 40% better sensitivity or 40% faster measurements
- **Save time on method development** with pre-defined measurement strategies

Grazing incidence small-angle X-ray scattering for characterization of nanostructure on surfaces



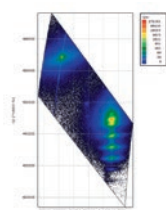
Hard radiation applications e.g. for in operando studies of batteries



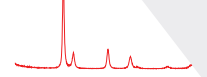
Synchrotron-level insights – now in your lab.

XAS provides insight into the electronic structure and local atomic environment of materials, including oxidation state, coordination environment, and chemical bonding. By combining XRD structural analysis with XAS electronic characterization, Empyrean delivers a more complete understanding of your materials, from long-range crystal structure to local chemical state.

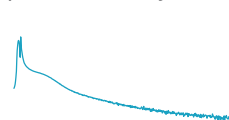
Ultra fast reciprocal space maps for epitaxial layer analysis



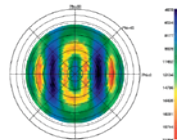
Grazing incidence XRD for surface analysis and depth profiling



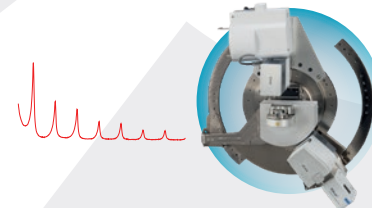
Small-angle X-ray scattering for particle size analysis



Pole figures for texture analysis



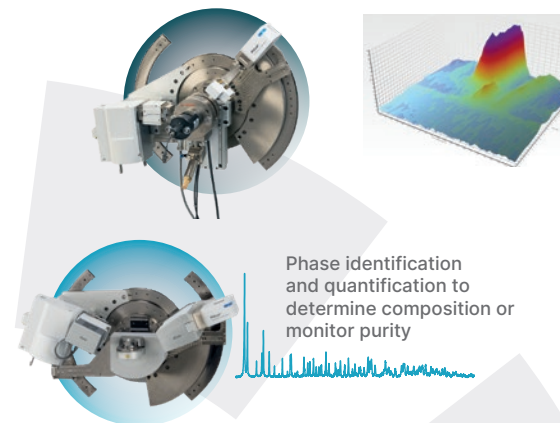
Transmission XRD for characterization of organic materials



Computed tomography for investigating the internal structure of objects



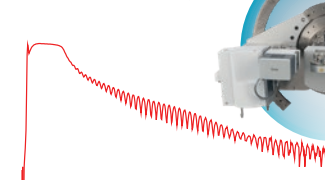
Non-ambient X-ray analysis for *in situ* studies of advanced materials



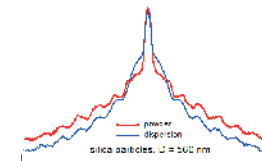
Phase identification and quantification to determine composition or monitor purity



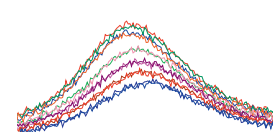
X-ray reflectometry to determine thin film thickness and roughness



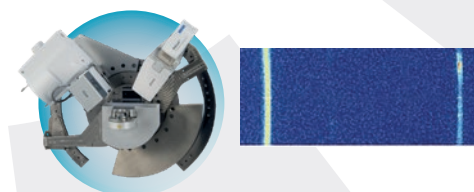
Ultra small-angle X-ray scattering for accessing very large d-spacings



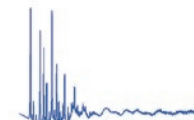
Residual stress for component and failure analysis



2D XRD for microstructural analysis



Pair distribution function for studying the local atomic structure of disordered materials



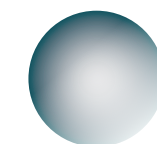
Intuitive for beginners, flexible for advanced users

Empyrean's MultiCore Optics simplifies access to advanced techniques even for the novice user. X-ray optics can be exchanged quickly without realignment thanks to our proven PreFIX concept, allowing advanced users to achieve optimal data quality for the most advanced applications.

Empyrean is a future-proof addition to your lab, ready to adapt to new tasks and emerging X-ray applications.



MultiCore Optics



Example of advanced techniques

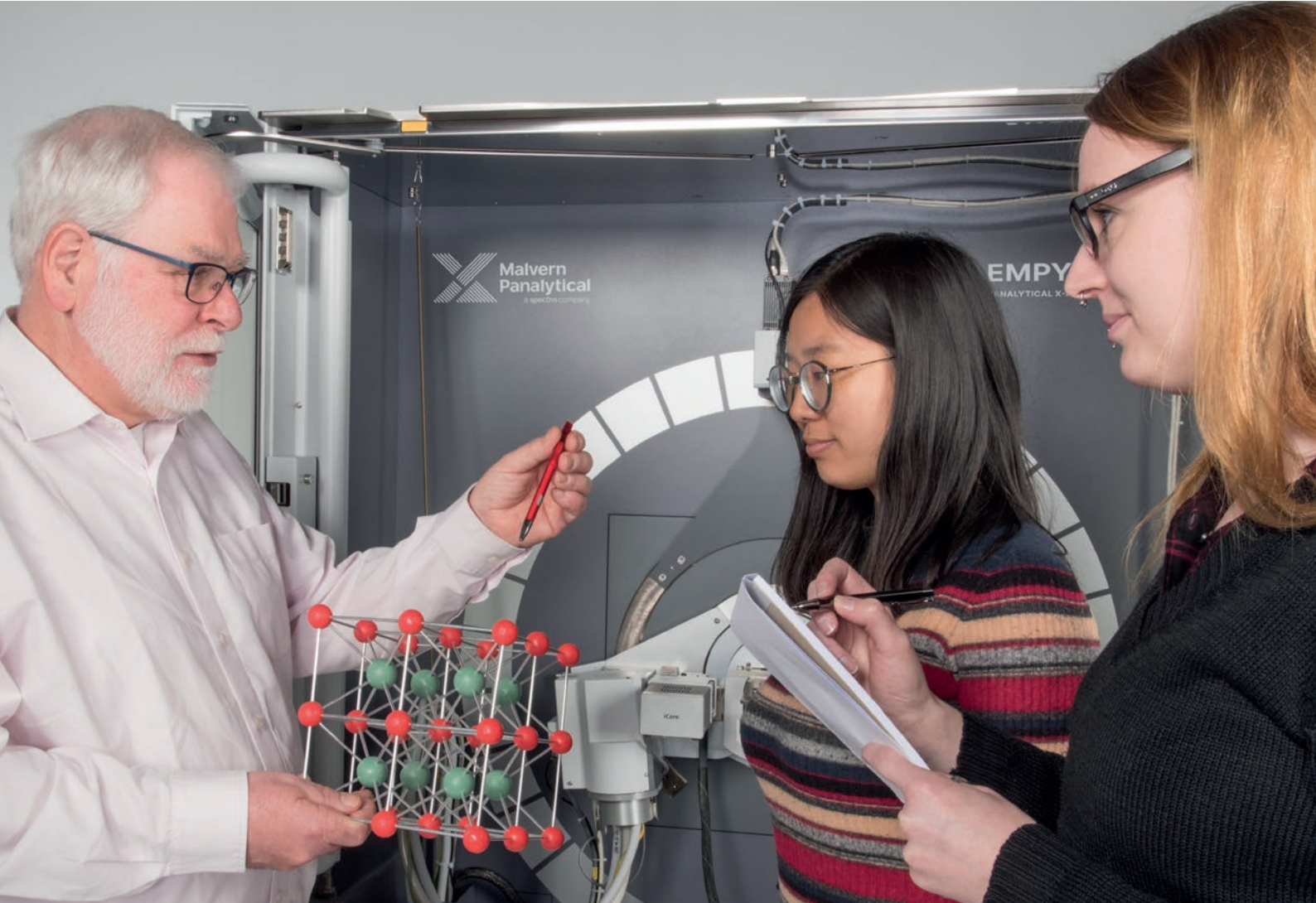
Customization possibilities

Empyrean is a true multipurpose platform, designed to support a wide range of applications. Yet, we often meet scientists and analysts who would like to extend the possibilities even further, according to their own ideas for their research.

Whether it's new sample holders, modified stages, optical modules, or advice on analytical techniques, our creative and motivated development team can find a solution that satisfies your needs. Discuss your requirements with your local Malvern Panalytical sales representative for a tailor-made solution.



Jig for orienting large single crystals prior to cutting and polishing



Product specification at a glance

X-ray generation	
X-ray generator	4 kW (max 60 kV, max 100 mA)
Line/point focus switch	Easy and quick, without tooling
Goniometer	
Maximum usable range (depending on accessories)	-111 < 2theta < 168°
Smallest addressable increment	0.0001°
Angular reproducibility	< 0.0002°
2theta linearity over whole range	Equal or better than +/- 0.01°
Maximum angular speed	15 deg/s
Angular resolution (FWHM on LaB ₆)	0.026°
Sample stages	
Ambient sample stages	• Reflection-transmission spinner with optional 45 position sample changer • Capillary spinner • Micro-diffraction spinner • 3-axes (chi,phi,z) cradle with optional manual x,y platform • 5-axes (chi,phi,x,y,z) cradle • Programmable XYZ stage • High-throughput stage • Multipurpose sample stage • Pre-aligned capillary holder stage • Flow cell for <i>in situ</i> crystallization research • Modular sample stages (x, y, z) both manual and programmable • ScatterX78 (vacuum chamber for SAXS/WAXS) with optional non ambient attachment • Computed tomography stage
Non-ambient sample stages	• Anton Paar HTK1200N (oven); HTK16N and HTK2000 (strip heater) • Anton Paar domed stage DHS1100 (hot) and DCS500 (cold and hot) • Anton Paar TTK600 (low-temperature chamber) • Anton Paar CHC plus+ (cryo and humidity) and MHC-trans (humidity transmission) • Anton Paar XRK900 (reaction) and HPC 900 (high pressure) • Oxford PheniX cryostat and Oxford Cryostream Plus • Flow cell for <i>in situ</i> crystallization research
Detectors	
Point detectors	Proportional counter (20 × 24 mm) Scintillation detector (30 mm Ø)
Strip detectors	PIXcel ^{1D} , 256 strips of 55 µm 'all live', compatible with Cr to Cu radiation
Area detectors	PIXcel ^{3D} , 256 × 256 pixels of 55 µm, compatible with Cr to Cu radiation GaliPIX ^{3D} , 501 × 465 pixels of 60 µm, compatible with Co to Ag radiation (with 100% efficiency)
Cabinet	
Exterior dimensions	1400 (w) × 1162 (d) × 1947 (h) mm. The instrument is on wheels. It can pass a 989 mm door opening. For transportation the minimum achievable instrument width is 867 mm.
Accessibility of interior area	1360 (w) × 1100 (h) mm, allowing access to the experimental area by at least four people simultaneously (ideal for teaching)
Weight	1050 kg (2310 lbs.)
Radiation level	Radiation level less than 1 microSievert per hour, measured at 10 cm distance, determined with a Mo source @ 60 kV, 50 mA. No power restrictions with all anode types
Cooling water supply	4 - 6 liters/min, pressure up to 8 bar, temperature 15 to 35 °C > dew point
Compressed air supply	House line, compressor or air bottle; 2-5 bar (0.2 - 0.5 MPa)
Power supply	Single phase 210 – 230 V (with +/- 10% grid variations); 50/60 Hz
Maximum power consumption*	4.6 kVA

* without controllers for optional equipment



About Malvern Panalytical

Malvern Panalytical provides market-leading, material characterization technologies for the world's most innovative companies, academic institutions, and government laboratories to optimize and accelerate the development of advanced materials.

We support our customers through their biggest challenges by uncovering critical insights in material properties. From developing lifesaving vaccines and next-generation therapeutics to advancing clean energy solutions and sustainable industrial processes, we give scientists the confidence to make important decisions that shape the world we live in.

We wake up every day to delight our customers and help them solve the problems that matter. Through innovation, high-quality solutions and workflows, and excellence in customer satisfaction, we help reduce lead times, increase repeatability, and deliver data that is actionable and easily understood.

Our vision is to continue to be a trusted and recognized leader for quality and insights in material characterization, helping our customers navigate complex scientific topics with accuracy and ease.

We win customers with performance and keep them with service and insights. We are the 'Best together.' Our people are experts in their fields, delivering value and innovation for each other and for our customers. With diversity in experience and customer-centric thinking, we are the best choice for researchers and scientists seeking competitive advantage in the market.

We have a high-performance culture - empowering teams, quick decision-making and serving customers more effectively - grounded in agility, clarity and transparency, with speed and focus critical to our success, all shaped by our values: Own it. Aim High. Be True.

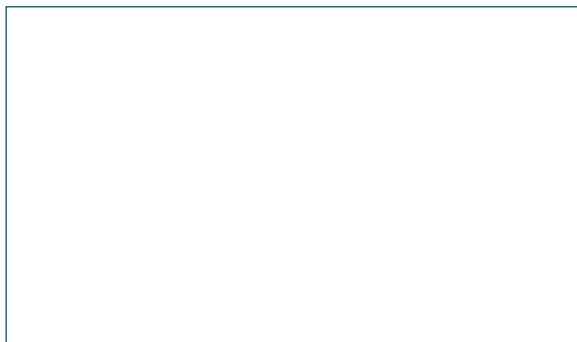
We are committed to helping to solve our customers' greatest challenges to make the world cleaner, healthier and more productive for the future.

Service & Support

Malvern Panalytical provides the global training, service and support you need to continuously drive your analytical processes at the highest level. We help you increase the return on your investment, and ensure that as your analytical requirements grow, we're there to support you.

Our worldwide team of specialists adds value to your business processes by ensuring applications expertise, rapid response, and maximum instrument uptime.

- Proactive local and remote support
- Full and flexible range of service agreements
- Compliance and validation support
- Onsite or classroom-based training courses
- e-Learning training courses and web seminars
- Digital services, including MyStore and My Customer Support Portal
- Sample analysis, method development, and applications consultancy



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