


## DIFFRACTION SOLUTIONS

# D6 PHASER

Ingenious XRD Analysis

Innovation with Integrity


BRUKER
D6 PHASER

# D6 PHASER – Powerful. Versatile. Accessible.

The D6 PHASER sets new benchmarks and is the perfect tool for XRD measurements ranging from phase identification and pair distribution function analysis to texture and X-ray reflectometry. Up to 1.2 kW of power, dynamically controlled optics, and the world's best detectors combined with a small measurement circle results in levels of detection and sample throughput that challenge floor standing solutions.

Whether the task is development or manufacturing support, the ability to adapt to new workflows is key to success. The D6 PHASER was designed from the ground up for the integration of accessories, including easy-to-add stages and optics, to support the latest analytical techniques.

The user experience is a fundamental part of the D6 PHASER. From the compact form and standard power requirement to its easy-to-exchange configuration and intuitive software interface, the D6 PHASER makes XRD available to a wider user community than ever before.

Although the D6 PHASER comes in a smaller form factor, it shares the same analytical instrument DNA as all Bruker X-ray diffraction solutions, including the focus on data quality, robust hardware design, and reliable results.

**The D6 PHASER defines a new class of X-ray diffractometers.**

# Redefining ease-of-use

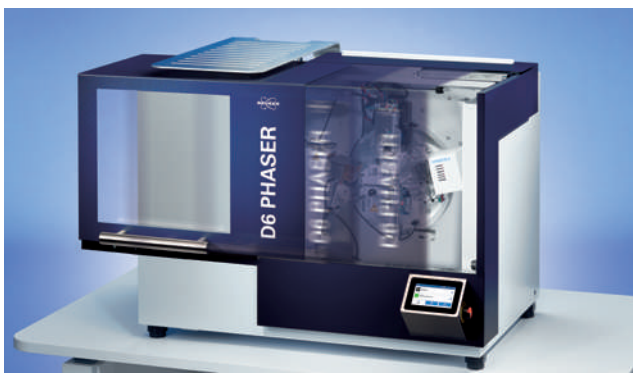
An analytical instrument should assist and simplify the common workflows in the laboratory. We distilled decades of experience into the user interactions with the D6 PHASER. Innovated physical and electrical component interfaces make reconfiguration a breeze while the touch panel ensures that the right information and commands are literally at your fingertips.

While the touch panel allows direct access to the most important functions and information when you are standing in front of the instrument, DIFFRAC.SUITE offers full control of the instrument. From instrument setup in DAVINCI to method planning in WIZARD and measurement execution in COMMANDER, DIFFRAC.SUITE offers a scalable user experience which supports both novice and expert users.

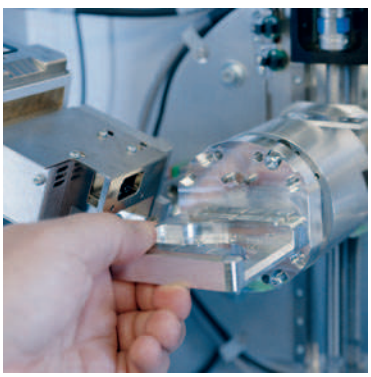
The X-ray tube is cooled by an internal chiller, eliminating the need for an external chiller. This reduces infrastructure requirements to a minimum and keeps the ecologic footprint and the costs of ownership low. Of course, users who already have a cooling circuit available can optionally continue to use their existing infrastructure.

**Ease-of-use in the D6 PHASER brings success to your XRD analysis.**

Wide opening sliding door




Transmission/reflection sample stage

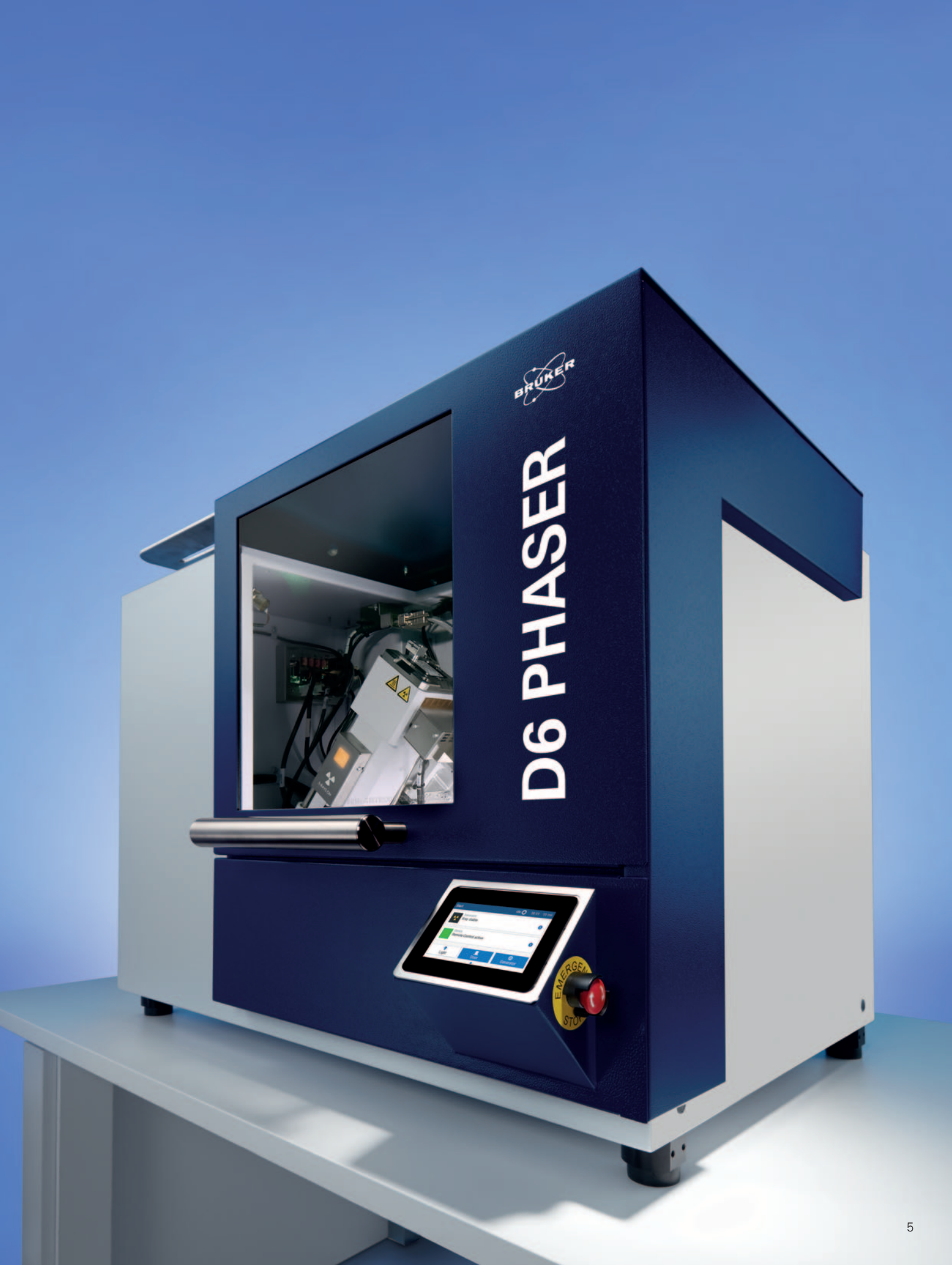




Internal water chiller



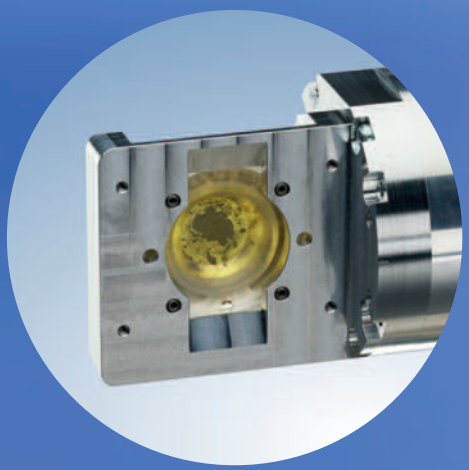
X-ray warning lights


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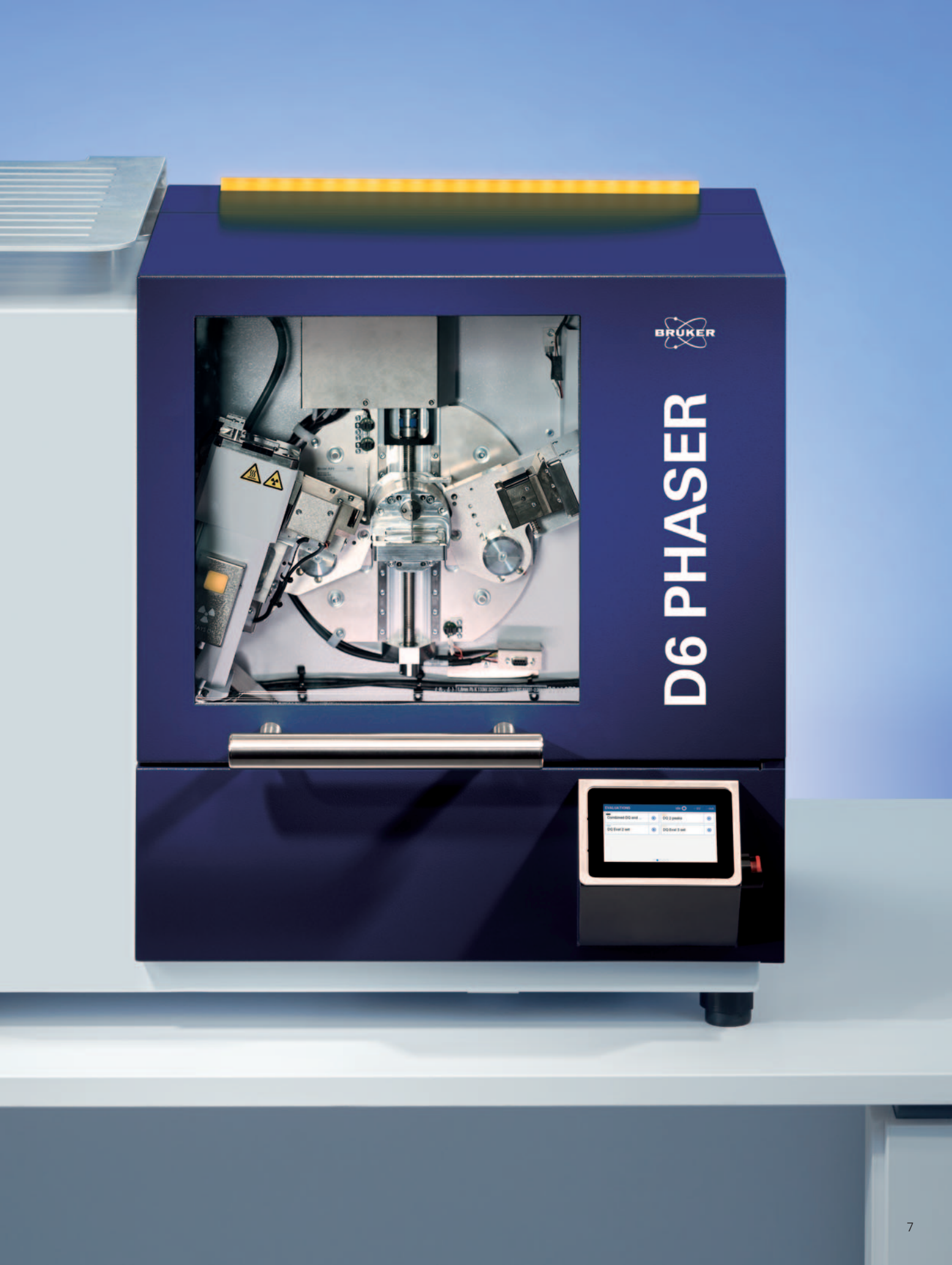
# D6 PHASER – performance for powder diffraction

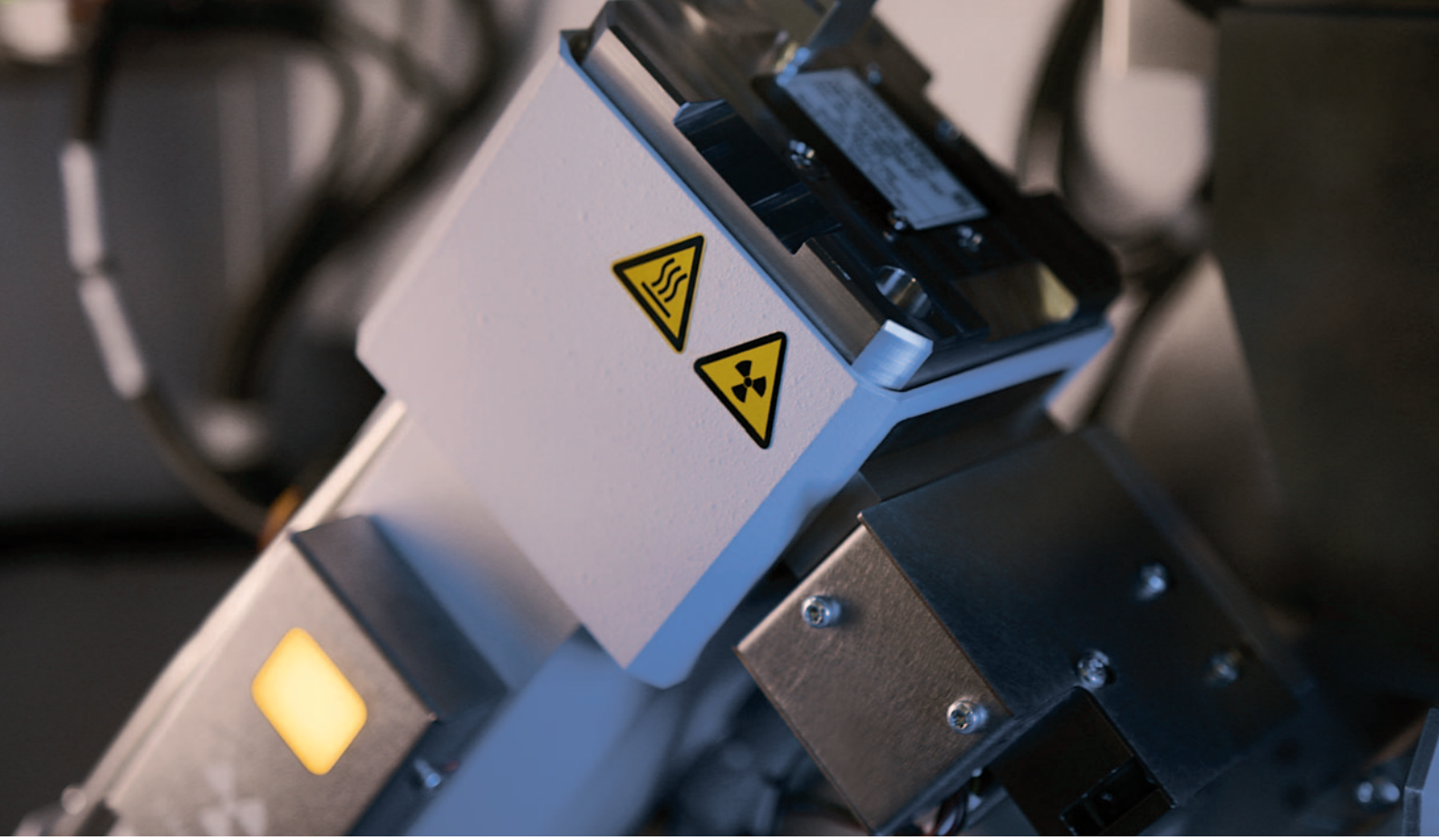
- Phase Identification
- Quantification
- Crystallinity
- Structure Solution & Refinement
- Non-Ambient
- Microstructure Analysis

The **D6 PHASER** is the foundation for state-of-the-art XRD analysis. The essential configuration comes with a **600 W** high-voltage generator, plug-in divergence slit, and an **SSD 160-2** proprietary 1-dimensional silicon strip detector providing exceptional results in minutes. The **air scatter screen** is magnetically attached allowing simple optimization of low or high diffraction-angle data. The **transmission/reflection stage** offers exceptional versatility supporting an extensive line-up of sample holders.

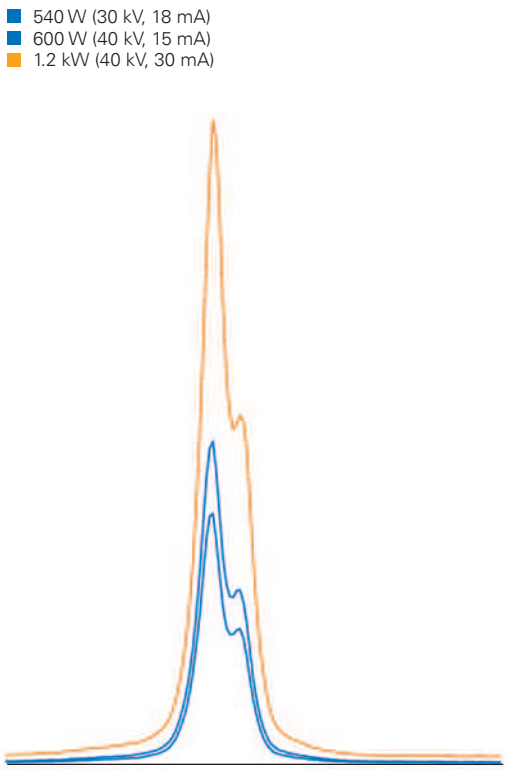


Stage in transmission geometry


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X-ray source power options: 540 W, 600 W, or 1.2 kW




100% peak of Corundum

Cr Cu Co Mo

# Supercharged X-ray engine

The D6 PHASER equipped with the 600 W generator is the most powerful and versatile benchtop X-ray diffractometer on the market.

With the optional 1.2 kW generator, the D6 PHASER challenges the performance of traditional floor-standing systems. This power, combined with the small goniometer radius, increases the amount of signal to over 4 times compared to our previous benchtop model. The user benefits from approximately 2 times lower detection and quantification limits or faster measurement and sample turnaround times.

The X-ray tube can be exchanged by the user for specific applications. For example, to use a Cr tube for retained austenite analysis, Mo for pair distribution function analysis, or Cu for general diffraction. After the tube exchange, simply pressing the automated reference and verification button prepares the system for use.

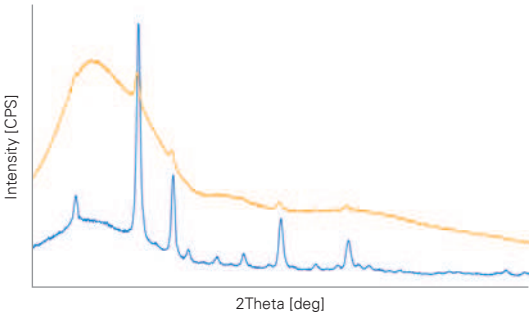
# Top efficient detectors

The LYNXEYE family of silicon strip detectors includes three members: SSD160-2, LYNXEYE-2, and the LYNXEYE XE-T.

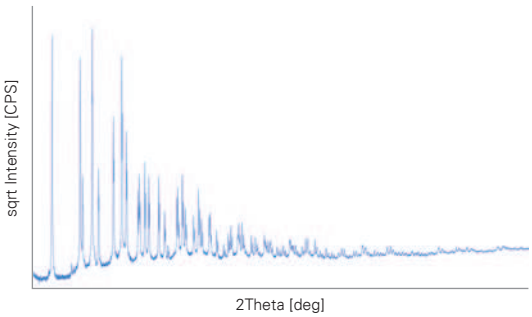
All detectors can be operated in 0D, 1D, or 2D measurement mode. The 0D mode is used for materials research methods such as XRR, GID, and texture. Typical powder measurements are performed with scanning 1D mode, while snapshot 1D mode can be used for rapid residual stress and non-ambient experiments. Unlike traditional 2D measurements which limit the beam footprint to a small area of the sample, BRAGG2D and PHI1D allow 2D measurements using the full beam footprint revealing issues with sample preparation.

The LYNXEYE family members differ in their sensor size and energy discrimination capability. While the SSD160-2 offers 160 detection channels, the LYNXEYE-2 and the LYNXEYE XE-T feature 192 channels. Both, the SSD160-2 and LYNXEYE-2, enable an energy discriminator capable of reducing the effects of sample fluorescence. The LYNXEYE XE-T has defined a new standard of energy discrimination with capability to not only further reduce fluorescence background, but also discriminate Kβ without the use of signal-reducing metal filters.

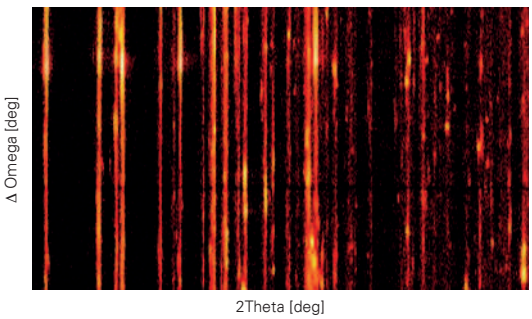
GID measurement performed in 0D mode



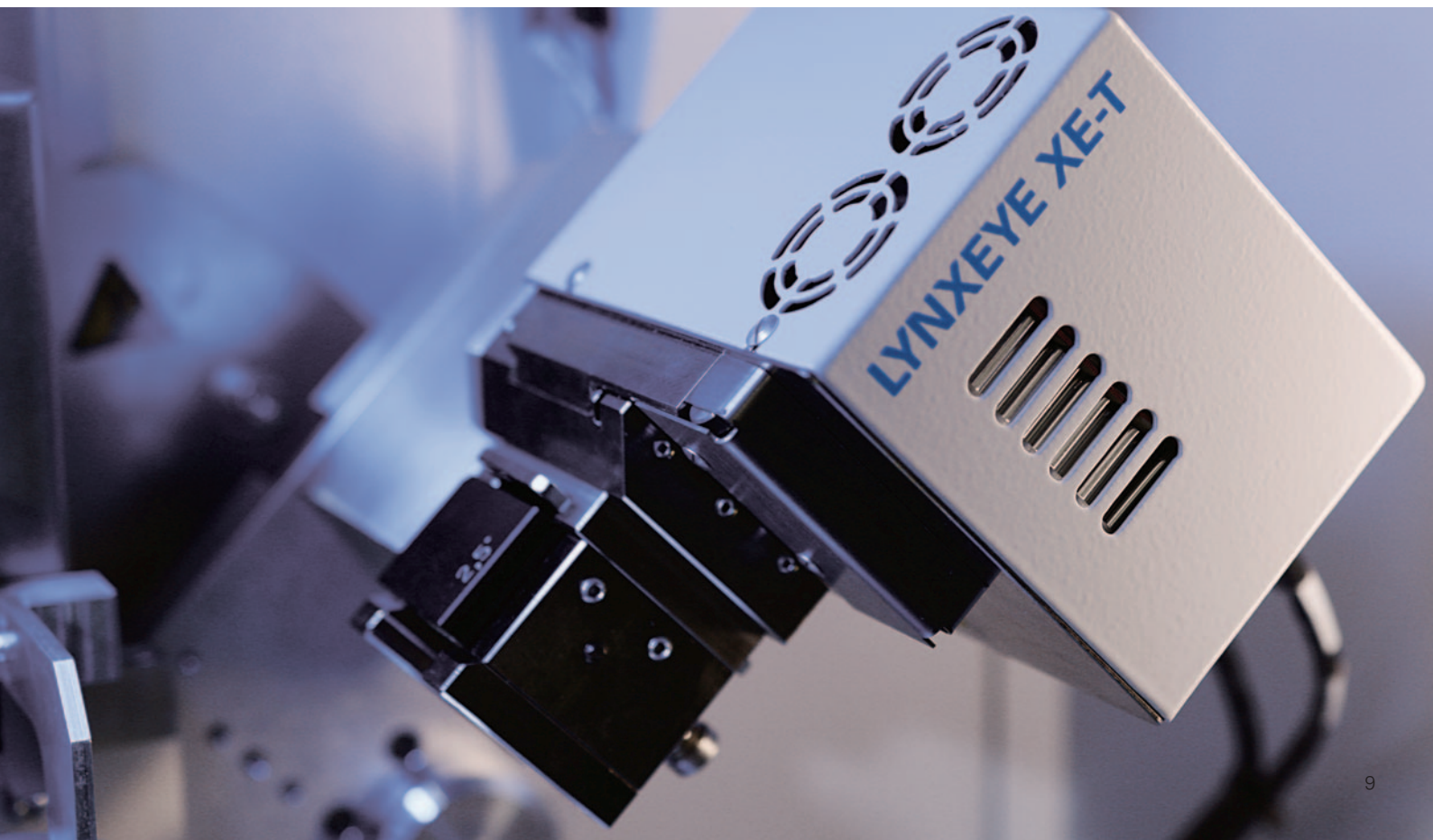

Powder measurement performed in 1D mode

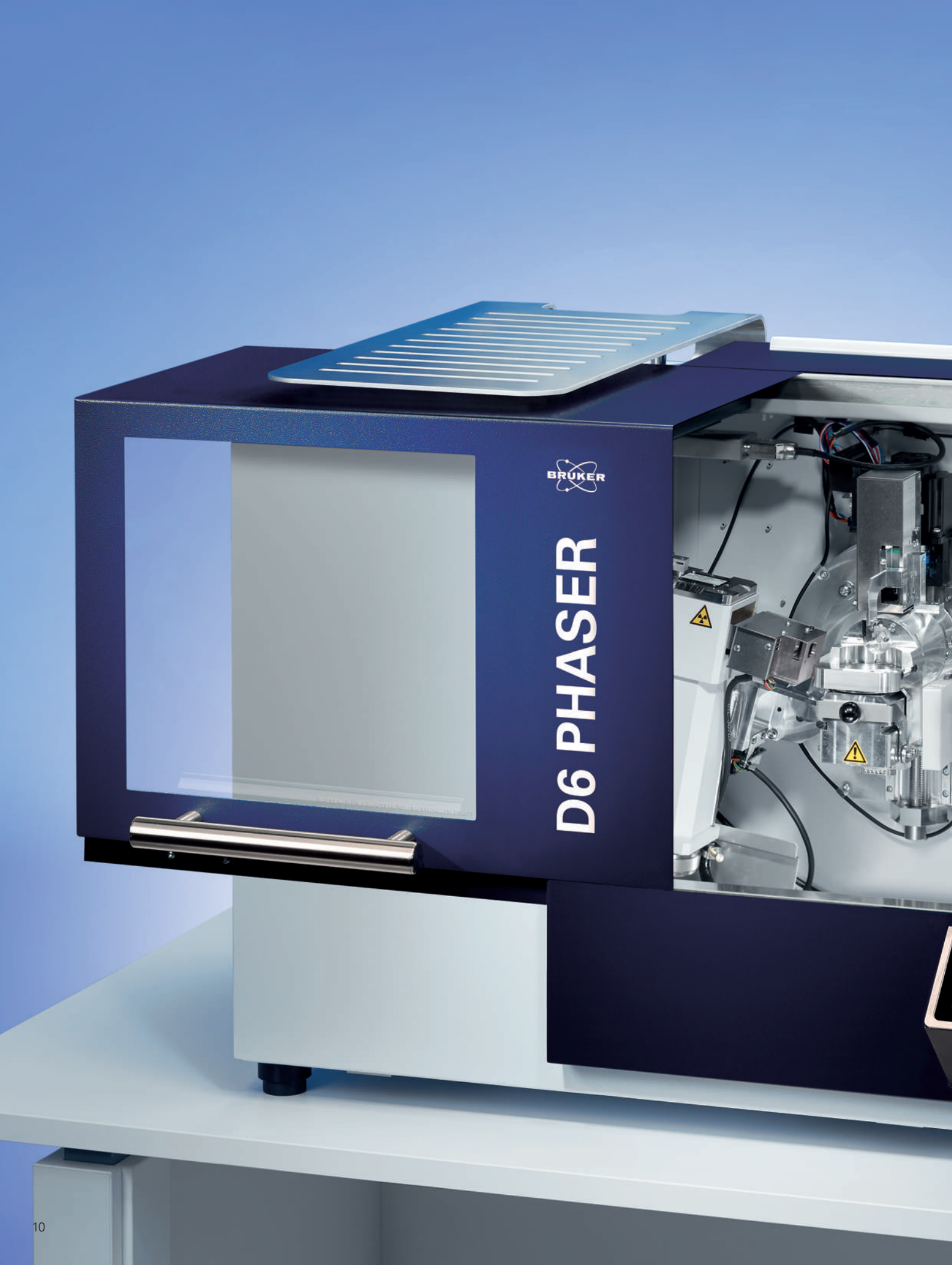



BRAGG2D showing large crystallite size in 2D mode




Detector options: SSD 160-2, LYNXEYE-2, LYNXEYE XE-T



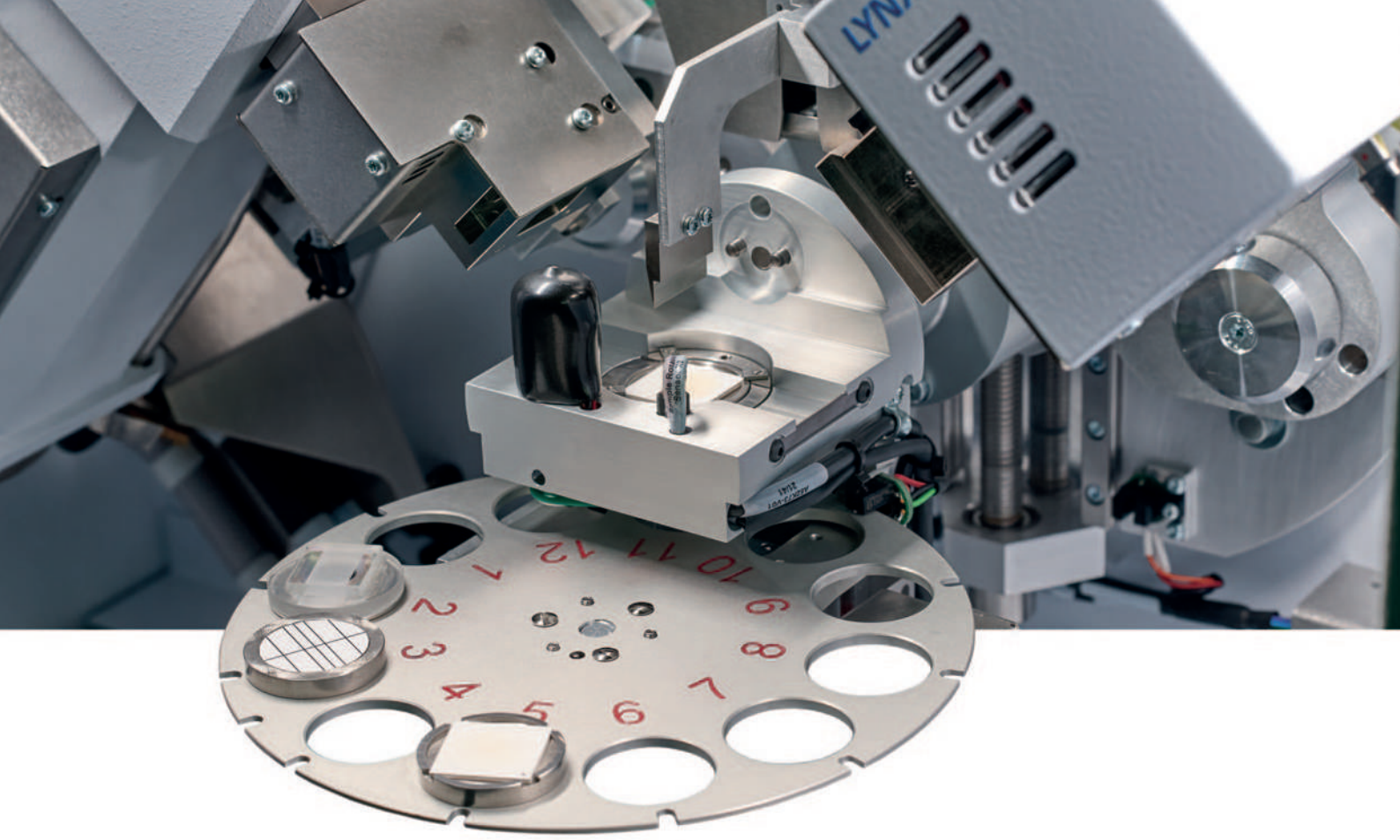

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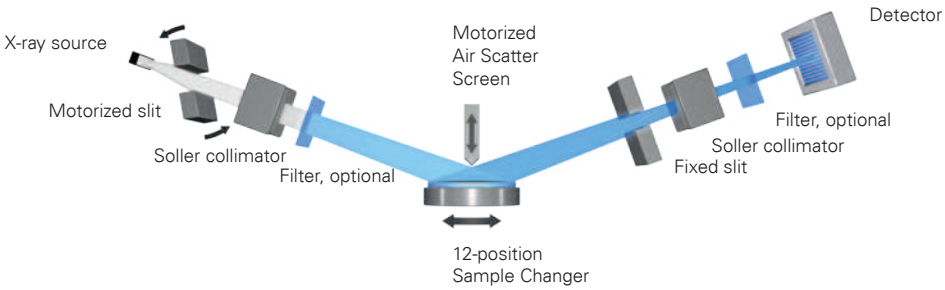
- Phase Identification
- Quantification
- Crystallinity
- Structure Solution & Refinement
- Non-Ambient
- Microstructure Analysis
- Pair Distribution Function

# D6 PHASER – mastering ambitious analytical tasks




When equipped with Dynamic Beam Optimization (DBO), a **1.2 kW** generator and **LYNXEYE XE-T**, the **D6 PHASER** provides top class powder diffraction data. Whether the task is lowest limit of detection or fastest sample throughput, the system automatically positions the **Motorized Slit**, **Motorized Air Scatter Screen**, and **Variable Detector Opening** for ideal data without user intervention. To improve sampling statistics, a **Rotation Stage** is used. For maximum instrument utilization, the D6 PHASER can be upgraded with a **12-position Sample Changer**.





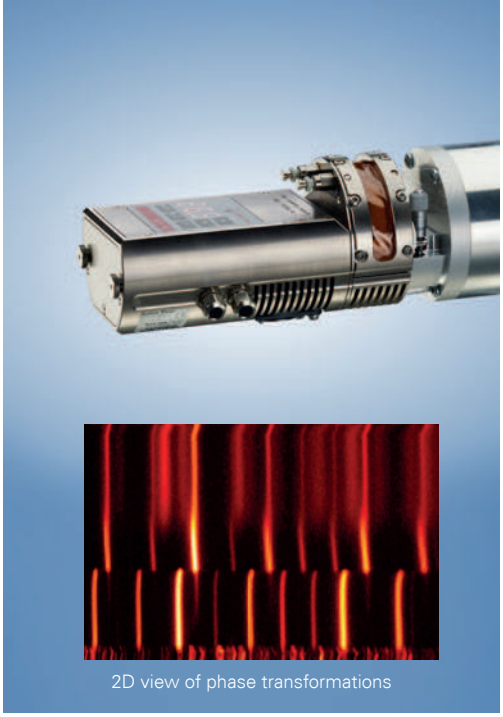

# Push the limits of powder diffraction

Collecting perfect XRPD data with the D6 PHASER when applying the Dynamic Beam Optimization (DBO) is easy; all you need to do is enter the size of the sample, and the beam path of the D6 PHASER is automatically optimized based on the scan range. At low incident angles, the slit closes, and at high angles it opens to maintain coverage of the entire sample surface while maximizing the X-ray flux. The Motorized Air Scatter Screen (MASS) and variable detector opening are kept in perfect synchronization to automatically obtain ideal powder diffraction data. DBO is exceptionally good at collecting low angle data where the beam shape needs to be accurately controlled to prevent high background.

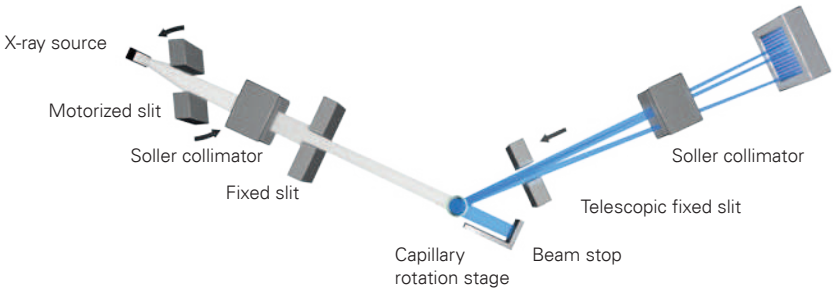
With the automated optimization using DBO and the high signal of the D6 PHASER, measurements become amazingly fast. The optional 12-position Sample Changer allows users to load it up and walk away. Each position can be programmed with a different method and filled with a different sample holder from our extensive catalogue.

# Outlook: freezing hot

Whether it is the ceramic in a car brake pad or a pharmaceutical in a shipping container, the temperature materials can be exposed to often deviates from standard room temperature. Measurement stages which mimic these conditions are important in determining performance characteristics of products in daily life. Two temperature chambers, the BTS-150 and BTS-500, covering ranges spanning from -10°C to 150°C and from room temperature to 500°C, respectively, are seamlessly mechanically and electronically integrated into the D6 PHASER. This extensive integration goes beyond the hardware, with full software support, including stage exchange in DAVINVCI, direct control in MEASRUREMENT, and planning in WIZARD.




Benchtop heating stages, BTS 150: -10 to 150 °C and BTS 500: Room temperature to 500 °C




# No half measures – capillary diffraction

Capillary transmission diffraction geometry offers various benefits compared to Bragg-Brentano reflection. This includes investigating small sample amounts, spinning to mimic a perfectly random crystallite orientation, measurements of air-sensitive samples, and easy sample recovery. The capillary solution for the D6 PHASER includes thoughtfully designed components to support the entire measurement process from capillary pre-alignment to data acquisition. The result is an entire ecosystem of accessories, with holders and alignment tools tailored for the variety of capillary shapes and sizes that are used in the laboratory.

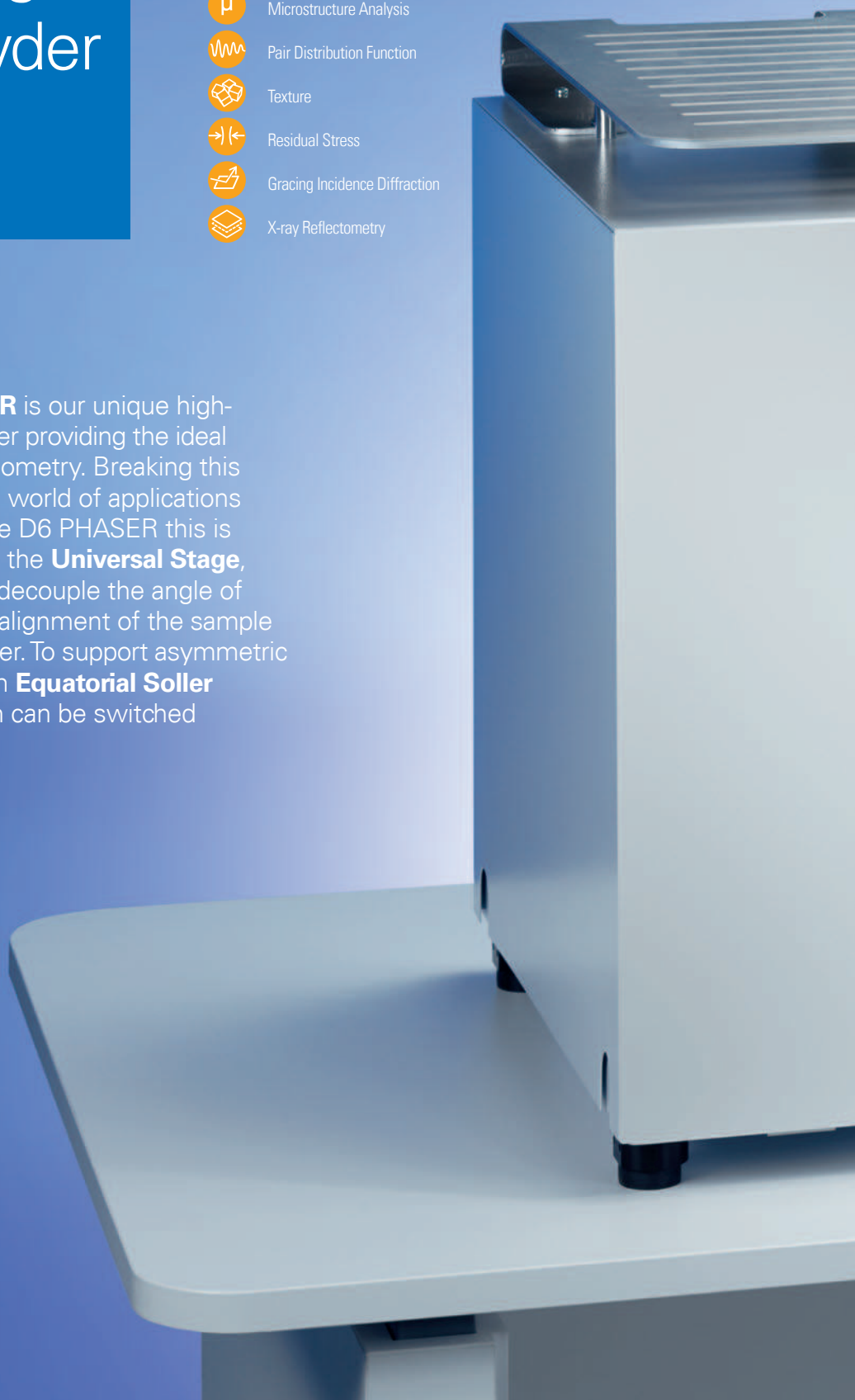
Capillary spinner stage with static head for Ø 0.5 to 1.8 mm or fine adjustment head for Ø 0.1 to 0.5 mm



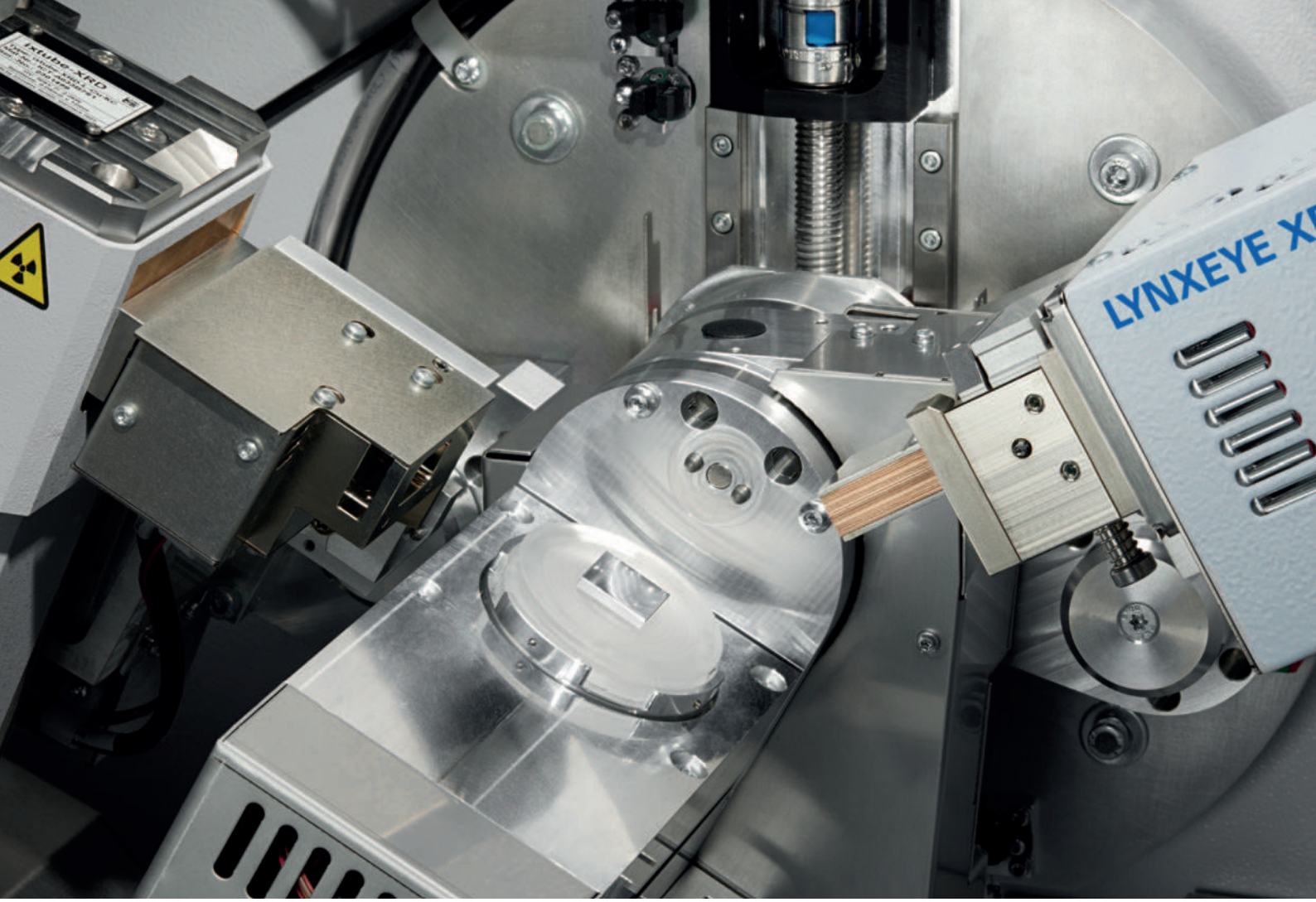
# D6 PHASER – unlock your potential to go beyond powder diffraction

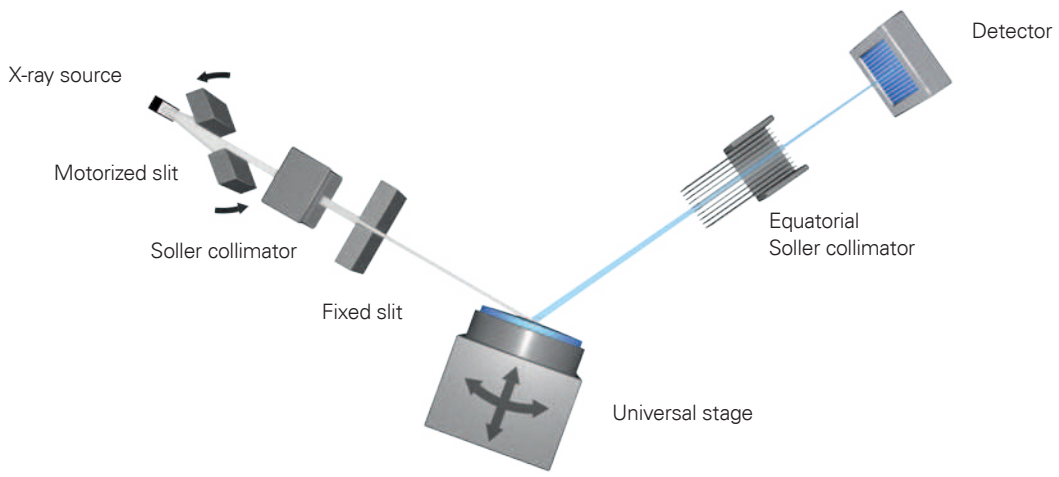
- Phase Identification
- Quantification
- Crystallinity
- Structure Solution & Refinement
- Non-Ambient
- Microstructure Analysis
- Pair Distribution Function
- Texture
- Residual Stress
- Gracing Incidence Diffraction
- X-ray Reflectometry

The core of every **D6 PHASER** is our unique high-precision, compact goniometer providing the ideal symmetric bisecting beam geometry. Breaking this symmetry allows access to a world of applications beyond standard XRPD. In the D6 PHASER this is achieved by upgrading it with the **Universal Stage**, adding not only the ability to decouple the angle of incidence, but also a precise alignment of the sample in the center of the goniometer. To support asymmetric measurement geometries, an **Equatorial Soller Collimator** is available, which can be switched without alignment.




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LYNXEYE

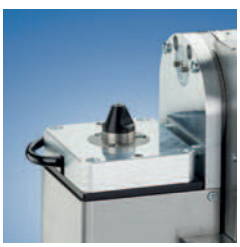
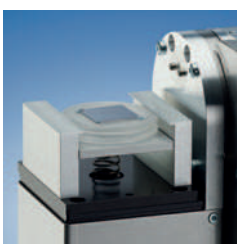

Detector
X-ray source
Motorized slit
Soller collimator
Fixed slit
Equatorial
Soller collimator
Universal stage

# Peerlessly universal

The universal sample stage is the key to activate a wide range of materials research applications. From Grazing Incidence Diffraction (GID) and X-Ray Reflectometry (XRR) for the analysis of thin coatings to residual stress and texture measurements for materials property investigations, the universal stage opens the door to new information on the investigated samples.

While larger samples can be mounted on the spring-loaded fixture, the vacuum finger is available to steadfastly hold thin film samples. If biaxial stress or texture analysis is of interest, the phi attachment allows precise rotational positioning of the sample. Not only does the stage accommodate standard diffraction sample holders, but also epoxy mounted metallurgical specimens. In addition, the universal stage with phi attachment is an ideal combination for powder measurements.

For many analysis methodes in materials-research conditioning of the diffracted beam is also required. The D6 PHASER employs a Universal Detector Optics Shaft which supports mounting interchangeable diffracted beam optics. The telescopic slit shaft is the tool to reduce air scattering in capillary and XRR measurements by positioning an antiscatter slit close to the sample. The equatorial Soller collimator is used for GID, texture, and stress measurements to ensure the accurate determination of the angular positions of diffraction peaks.

## Attachments

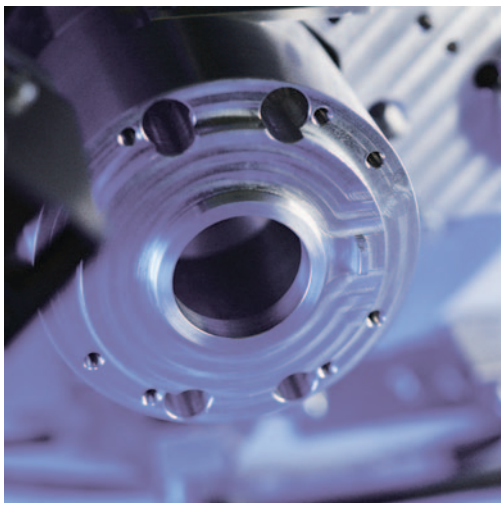
**Left:** Phi attachment with Motorized Anti-Scatter Screen (MASS) for automatic beam optimization
**Center:** Vacuum finger for fixing small solid samples
**Right:** Standard spring-loaded clamp holder for samples of 51.5 mm size





## Detector Optics

**Left:** Axial Soller collimators, 1.5°, 2.5°, and 4°, to reduce axial divergence
**Center:** Telescopic slit shaft for capillary or XRR measurements
**Right:** 0.1°, 0.2°, and 0.4° Equatorial Soller collimators for asymmetric diffraction geometries like grazing incidence diffraction



High precission mechanical stage mount



Touch panel for system operation and verification, job template launch, and results display

# Data quality which stands up to any comparison

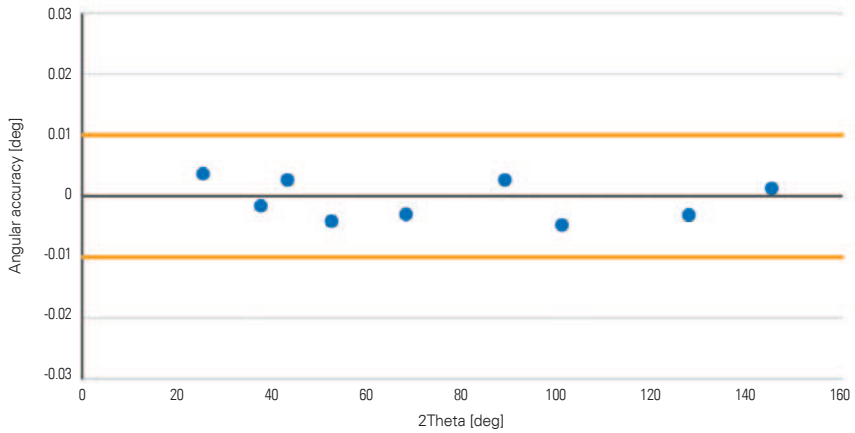
The data quality in X-ray diffraction is determined by several parameters including the accuracy of peak positions, absolute and relative peak intensities, and minimum instrumental broadening. This requires exact alignment of both, diffractometer components and the sample position to the center of the instrument over the entire measurement range. The D6 PHASER's patented, compact goniometer design, combined with the precise stage and optics mounting interfaces, ensures reliable, first-class data for all applications.

**Unmatched versatility combined with highest data quality are key features of the D6 PHASER.**

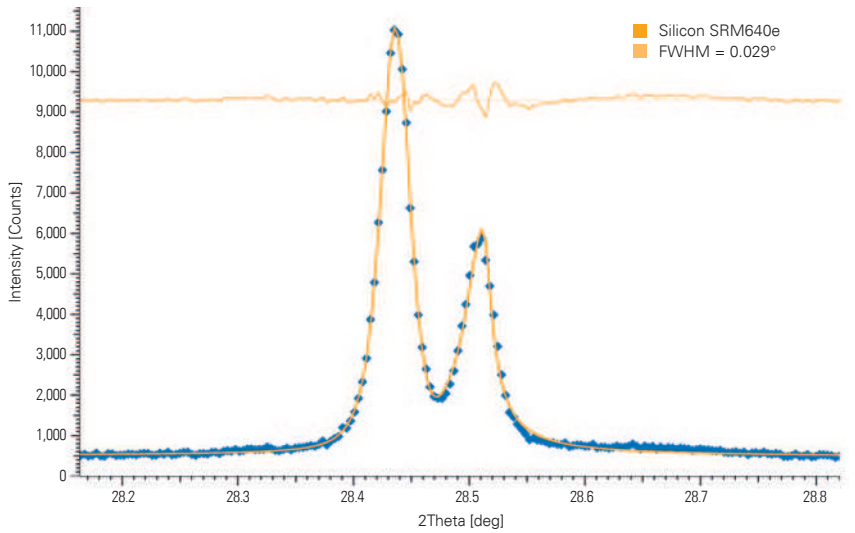
The assurance of high-quality data does not stop at claims, but is backed by an industry leading guarantee. Every D6 PHASER includes a standard reference sample. All peaks across the measurement range will be within 0.01° of their expected locations. In addition, for systems equipped with a sample rotation stage, the relative intensity of the peaks will be within 10%, and the peak width will be verified as well. This is not a test of the goniometer accuracy on a single peak only, but rather a test of the entire diffraction solution accuracy.

**The Bruker Accuracy Guarantee ensures that not only the individual components, but the entire system is capable of reliable accurate measurements.**

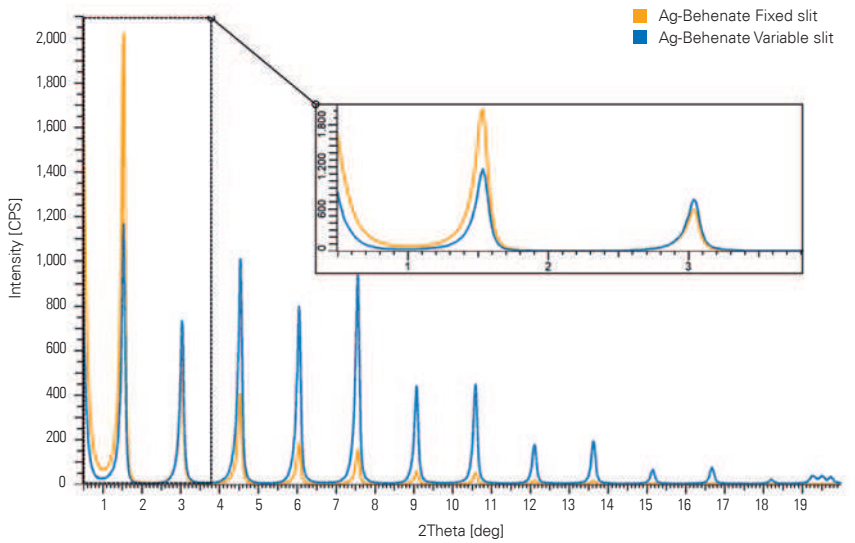
The user can prove the accuracy of the D6 PHASER at any time. For this purpose a simple verification check can be triggered directly from the touch panel. After simply mounting the standard sample and pressing the button, the D6 PHASER will measure multiple peaks across the angular range and then generate a report. If the system is within specifications, a green icon will be displayed. If it does not pass, simply press the reference button and the system will be brought back into specification. These checks work across all stages, so whether the fixed, rotation, 12-position, or capillary stage is mounted, verification is as simple as pressing a button.




Superior 2Theta linearity < 0.01° 2Theta over the whole angular range – warranted by Bruker's unique alignment guarantee.




Best resolution in class. Silicon data with a full width at half maximum (FWHM) below 0.03° 2Theta.



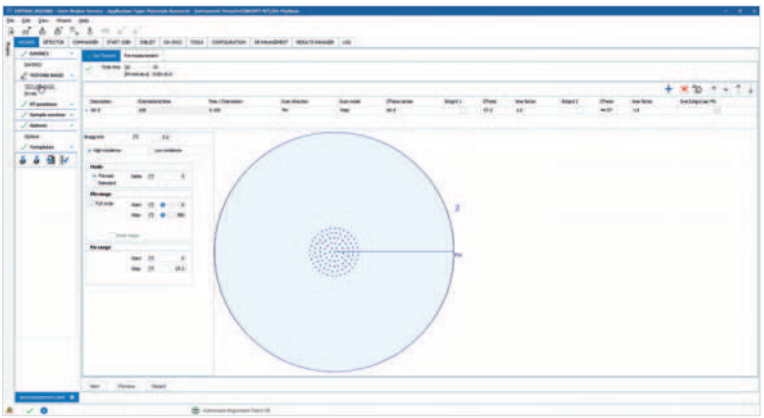

Ag-behenate data demonstrating the superior low angle and low background performance of the D6 PHASER, even below 1° 2Theta. The variable slit data demonstrate the additional intensity gain at larger diffraction angles while maintaining the impressive low-angle performance.


D6 PHASER

# DIFFRAC.SUITE – the intuitive guide

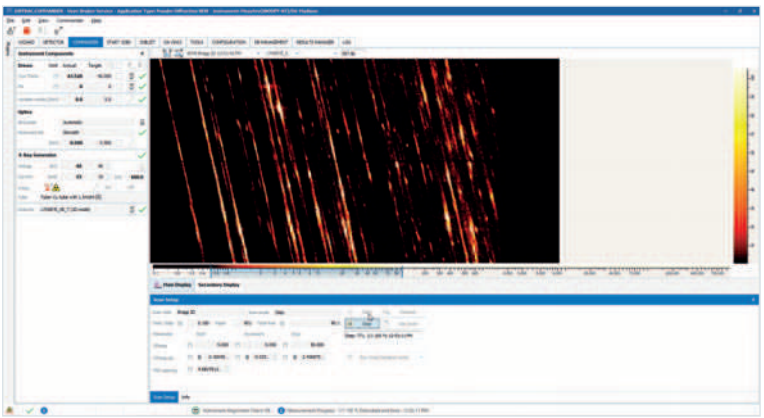
## PLAN

WIZARD offers step-by-step user guidance to walk users through the setup of methods. These can range from a standard powder diffraction scan to a complex temperature profile a texture measurement sequence. WIZARD represents the compiled knowledge of decades of experience from our application experts.



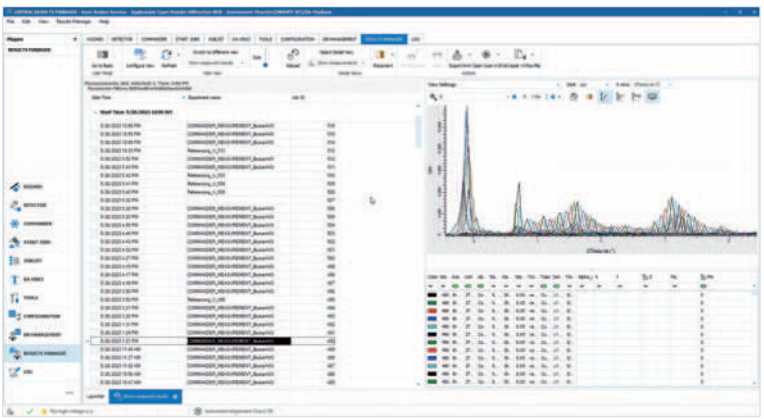
## MEASURE

Measurements can be launched directly via the intuitive COMMANDER interface where direct control of the instrument is readily available. The JOBS interface allows execution of planned measurements, either through a spreadsheet style form or via push-button interface.



## ANALYZE

Once measurements are completed, they are stored in the RESULTS MANAGER database. This not only includes the scan data, but also metadata such as instrument and user settings. Alternatively, measurement data can be saved as separate files. Analysis programs range from phase identification and quantification to residual stress, orientation distribution, and film thickness analysis.



## DIFFRAC.EVA

EVA provides tools for the quick analysis of one- and two-dimensional diffraction data. It supports all Bruker detectors and XRD scan types. The EVA functionality covers a broad analytical spectrum from data reduction, basic scan evaluation and presentation, detailed peak analysis, phase identification and quantification, to the determination of crystallinity and crystallite size.



## DIFFRAC.DQUANT

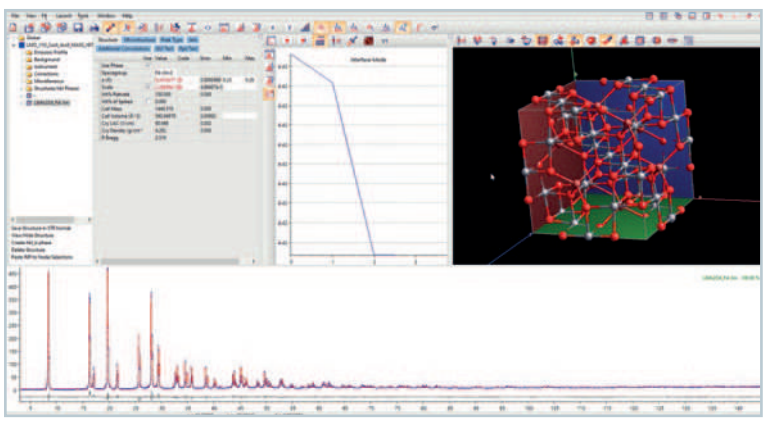
DQUANT features predefined workflows for several analytical methods:
- Calibration with reference materials
- Drift correction
- Modules and logical sequences
- Addition method
- Absorption method for filters
- Ratio method

The calibration is defined interactively while unknown samples are evaluated in a simplified GUI or fully automated console mode.

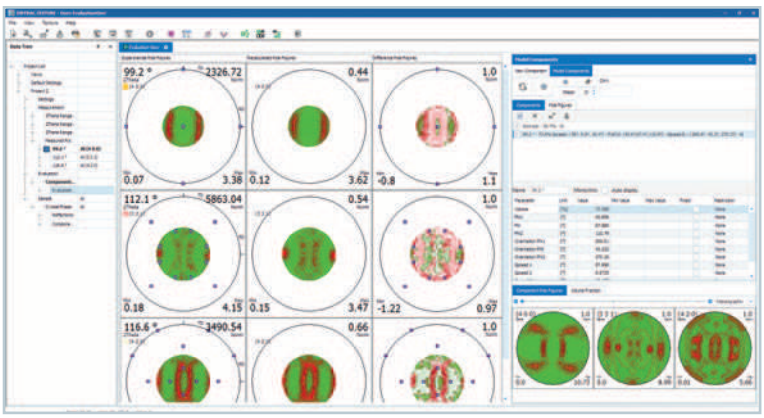


## DIFFRAC.TOPAS

TOPAS is a profile fitting based software for quantitative phase analysis, microstructure analysis, and crystal structure analysis. TOPAS is built around a general non-linear least-squares system written specifically to integrate various types of data. As a result of its unique analytical capabilities, TOPAS is the most used refinement software for XRPD and PDF data in both, industry and academia.

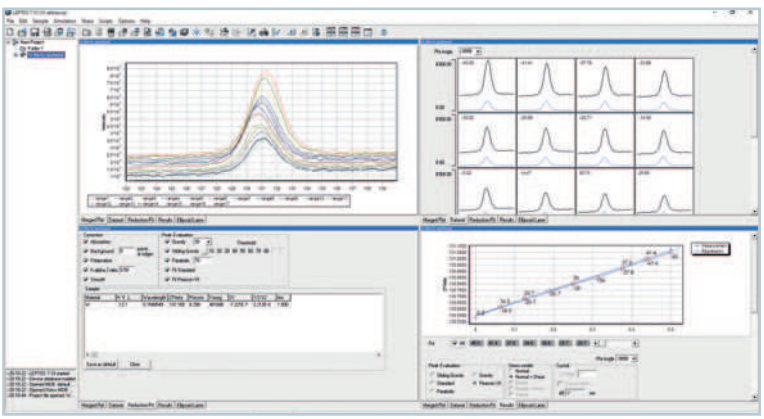


# Comprehensive, powerful and most cited



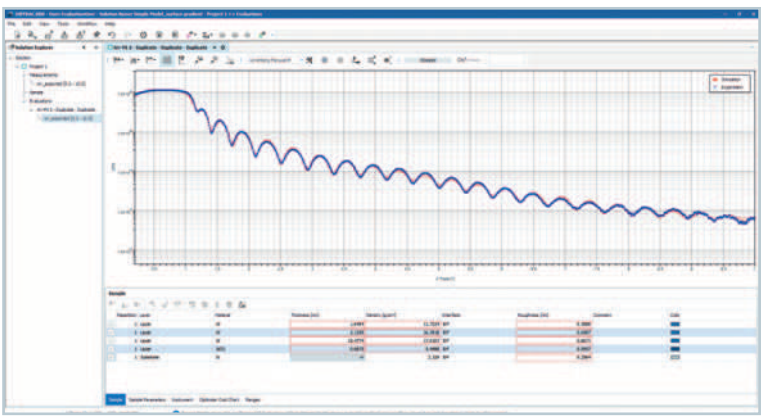
## DIFFRAC.TEXTURE

TEXTURE is the powerful and easy-to-use software suite designed to analyze texture measurements. With a systematic approach to analysis, TEXTURE delivers texture information with just a few mouse-clicks. TEXTURE features two techniques to provide reliable results: the Spherical Harmonics method and the Component Method. This ensures that a huge diversity of textures can be handled.



## DIFFRAC.LEPTOS S

LEPTOS S is an innovative, powerful and comprehensive module for the analysis of Residual Stresses. This includes normal, shear, biaxial, and triaxial analysis using the $\sin^2\psi$ method and the multi-hkl method for stress analysis in grazing incidence geometry.



## DIFFRAC.XRR

The DIFFRAC.XRR module features two different analysis approaches for the analysis of X-ray reflectometry data. The Fast Fourier Transform (FFT) method allows quick layer thickness estimation with a single mouse-click, while detailed XRR analysis is accomplished via sample model based fitting using dynamical scattering theory. DIFFRAC.XRR is designed to guide the user through the entire analysis process from the creation of the sample model to the reporting of the results.

## Technical Data

| | |
|---|---|
| **Geometries** | Theta/Theta or Omega/2Theta |
| **Max. useable angular range** | -3 to 152° 2Theta |
| **Accuracy** | ± 0.01° throughout the entire measuring range |
| **Achievable peak width** | < 0.03° (FWHM) |
| **X-ray wavelengths** | Cr, Co, Cu, standard ceramic sealed tube (Mo and others on request) |
| **X-ray generator options** | 540 W (30 kV, 18 mA)<br>600 W (40 kV, 15 mA)<br>1.2 kW (40 kV, 30 mA) |
| **Detector options** | SSD 160-2<br>LYNXEYE-2<br>LYNXEYE XE-T |
| **Stage options** | Reflection/transmission stage<br>Sample rotation stage with programmable rotation speed<br>12-position sample changer, Ø 32 mm, with programmable rotation speed<br>Capillary stage with programmable rotation speed<br>Non-ambient stages: RT to 500 °C or -10 °C to 150 °C<br>Universal stage for materials analysis with optional phi-rotation stage |
| **Sample holders** | Various cavities, low background with and without cavity, air-tight, sealed, filter samples, back loading, oriented slides (clay) |
| **Exterior dimension** (h x d x w) | 70.0 cm (27.6") x 66.7 cm (26.7") x 88.5 cm (35.0"), width 110 cm (43.3") with open door |
| **Max. weight** | 160 kg (353 lbs) |
| **Power supply** | 100 V – 240 V (600 W and 540 W), 200 V – 240 V (1.2 kW) |
| **Cooling water supply options** | Internal water-to-air cooling (540 W, 600W, 1.2 kW)<br>Connection to laboratory supply, 3.6 l/min at 3 – 4.5 bar |
| **Computer** | PC connected via LAN interface |

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