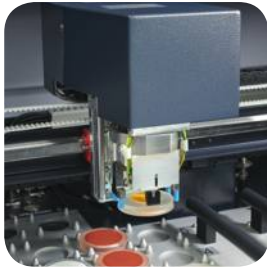




# D8 ENDEAVOR

● Diffraction Solutions

# D8 ENDEAVOR – process and quality under control



Sample gripper



Touch screen



X-ray on LED lights



Automation interface



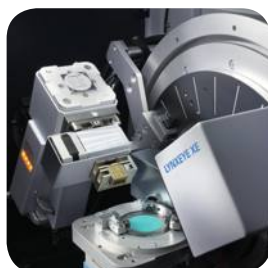
Motorized anti-scatter screen



Sample tray



Ca-channel



LYNXEYE XE detector

The D8 ENDEAVOR is an advanced X-ray diffraction (XRD) system for powder applications in industrial process optimization and quality control. Based on close collaboration with customers in industry and major suppliers of laboratory automation, the D8 ENDEAVOR has been specifically designed and optimized to deliver a reliable and robust solution which provides the fastest, most-accurate, and cost-efficient XRD results in any industrial environment.

The D8 ENDEAVOR is the latest member of the comprehensive D8 diffractometer family with DAVINCI design, combining the very latest advances in instrument and data-evaluation technologies with a unique sample handling and networking concept. Whether the instrument is used alone in a multi-user environment, taking advantage of its huge sample changer and push-button operation, or integrated into a laboratory environment for fully automated operation – the D8 ENDEAVOR delivers superior data quality identical to that of high-end research systems.

The D8 ENDEAVOR provides flexible configuration options which allow it to be tailored to any XRD application for best performance.

Further, dedicated versions of the D8 ENDEAVOR are available for the cement, minerals, pharma, aluminum, and metals industries which include task specific instrument configurations, highly optimized data acquisition and evaluation packages, and industry specific application training and support. Ready-to-use and capable of any level of automation.

- Highest data quality available in the market
- Reliable, accurate and cost-effective production control
- Standalone robust operation or seamless integration in automation environments
- Perfect integration in multi-user environments
- Fully traceable user and data handling management
- Tailored turnkey solutions, extended application support
- Unique instrument alignment and detector guarantees

The D8 ENDEAVOR can be easily adapted to demanding industrial environments by selecting the HE or ECO options. The "HE" or Harsh Environment option allows the reliable use of the instrument in locations that are unusually warm or dusty by adding additional cooling and dust-protection. The "ECO" option features a high-efficiency 1 kW generator and allows operation without external cooling water and extremely low power consumption.

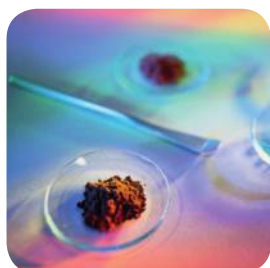
The D8 ENDEAVOR brings user-friendliness to a new level. Thanks to its touchscreen, instrument operation has never been so simple and intuitive. "Walk-up" functionality enabling parallel usage in multi-user environments with anytime instrument access and priority sample handling, combined with a fully traceable user and data handling management, makes the D8 ENDEAVOR the highest productive and most economic process diffractometer available on the market.



# D8 ENDEAVOR – process control at anytime



Cement



Chemistry / Pigments



Mining



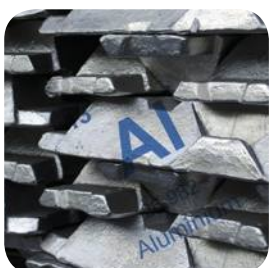
Oil & Gas Exploration



Pharma



Health and Occupational safety



Aluminum



Ceramics / Refractories



Metals



Process mineralogy

Process control with the D8 ENDEAVOR helps to ensure a constant product quality, optimal processes, increasing profitability and a safe work environment. The phase composition of a material can uniquely be determined from XRD data. XRD is the most direct and efficient way to quantify ratios of crystalline and amorphous material, and to characterize microstructural properties such as crystallite size and microstrain, but also macroscopic properties like stress and strain in a workpiece.

## Industry-specific turnkey solutions

The D8 ENDEAVOR can be used in all industries where inspection of incoming materials, production and quality control are important. Its versatility makes it the most functional powder diffractometer for a large number of applications and industries. Dedicated versions, bundled with tailored software solutions and application support, are readily available for the following industries:

- D8 ENDEAVOR Cement
- D8 ENDEAVOR Minerals
- D8 ENDEAVOR Pharma
- D8 ENDEAVOR Aluminum
- D8 ENDEAVOR Metals

The D8 ENDEAVOR can be operated in combination with Bruker XRF instruments of the S8 family of WDXRF systems and the S2 PUMA EDXRF spectrometers via the common automation interface, AXSLAB and the joint use of databases.

Plug'n Analyze™



On-Site Ready



No Water Supply



No High Power



High Altitude



Eco



Dust protected



Island Mode



The D8 ENDEAVOR is the only process diffractometer on the market which can be perfectly adapted to virtually any laboratory environment. Limited resources and non-ideal environmental conditions can make it difficult or impossible to maintain properly functioning X-ray analytics. The D8 ENDEAVOR can handle the challenge.

### Harsh environment option

High ambient temperatures and dust present a harsh working environment for X-ray analytical equipment.

The D8 ENDEAVOR HE addresses these issues with 3 kW power, extra cooling, and additional dust filtering. The D8 ENDEAVOR enables uncompromising process control even in difficult conditions.

### ECO option

Featuring a high-brilliance 1 kW line focus X-ray source the D8 ENDEAVOR ECO has very low energy consumption, does not require external water cooling and has no special needs concerning lab infrastructure. All that is necessary is a simple single phase socket. Thus, the installation and positioning of the unit is easy and flexible: Plug'n Analyze.

The D8 ENDEAVOR ECO has a minimum cost of ownership and the smallest ecological footprint of any process diffractometer on the market.

- About 50 % less consumption of electrical energy
- Potentially saves up to 1.700 m<sup>3</sup> tap water per year



- Application development
- Sample preparation methodology
- Data acquisition and evaluation methodology
- cGxP support
- Tailored training packages

# Maximum flexibility – sample handling with the D8 ENDEAVOR

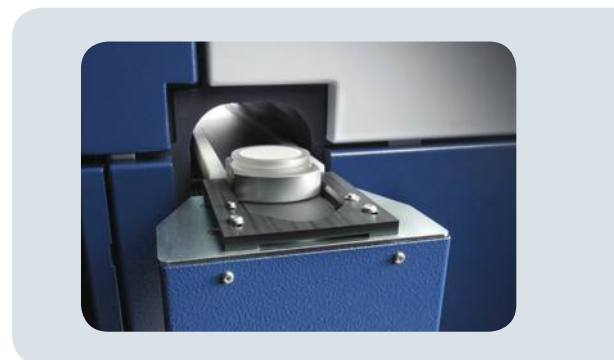
Sample preparation efforts for the D8 ENDEAVOR are minimal, as a wide range of sample sizes and types can be handled simultaneously. Fine grained powder is filled into sample holder cavities of various diameter or depth matching the sample amount. Back-loading is available to reduce preferred orientation. Very small amounts of powder can be prepared on background-free holders. Specialized holders for filters, clays, solids, and environmentally sensitive samples are further options of a broad choice.

## Insert sample – get started right away

Manual loading of a single sample onto the large magazine or multi-sample tray can be done at any time; even during measurement. Automatic sample loading with external robot or conveyor belt interface is an additional option. The mechanical gripper transfers the samples very quickly to minimize processing time. Samples can be given priority status to be immediately placed at the top of the measurement queue for quick measurement and processing.

## Simple and intuitive – anyone can perform measurements

The measurement software shows the geometry of the sample magazines and supports different modes to start measurements. Individual measurement jobs, scheduled jobs, a push-button loader interface, or the probing schedule of an aluminum smelter line – operation of the D8 ENDEAVOR was made having the needs of industry users in mind.



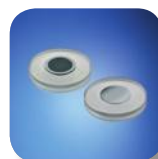
Holders with various cavities



Holder for automated sample preparation



Holder for clays



Low background holders for small sample amounts



Airtight holder for environment-sensitive samples



Holder for filter samples



Holder for irregularly shaped samples

- Most flexible handling of different sample holders
- Mechanical gripper to support all automation environments
- Convenient loading with trays and online operation
- Fastest loading time through pre-loading
- Safe sample handling while X-rays are on

### Sample magazine

- Two layouts for handling common industry standard sample sizes
  - 66 positions for Ø 51.5 mm (2.0") samples
  - 72 positions for Ø 40 mm (1.6") samples
- Automatic recognition of different sample holders and heights
- Combination with online operation

### EasyLoad trays

- 43 positions in total
- Two trays, each holding up to 20 samples of Ø 51.5 mm (Ø 2")
- 3 fixed positions for special samples (e.g. reference samples, priority samples, automation buffer, etc.)
- Combination with online operation

### Online operation

- Fully automated loading of samples from robotic or conveyor based sample preparation and handling systems
- 51.5 mm and 40 mm diameter samples are fed from the backside of the instrument
- Interface can be positioned at left or right back side of the instrument



Automation solution with S8 TIGER and D8 ENDEAVOR



Loading tray with mechanical gripper



EasyLoad tray



Dome holder



Spring loaded cases

# D8 ENDEAVOR – the ultimate in powder diffraction

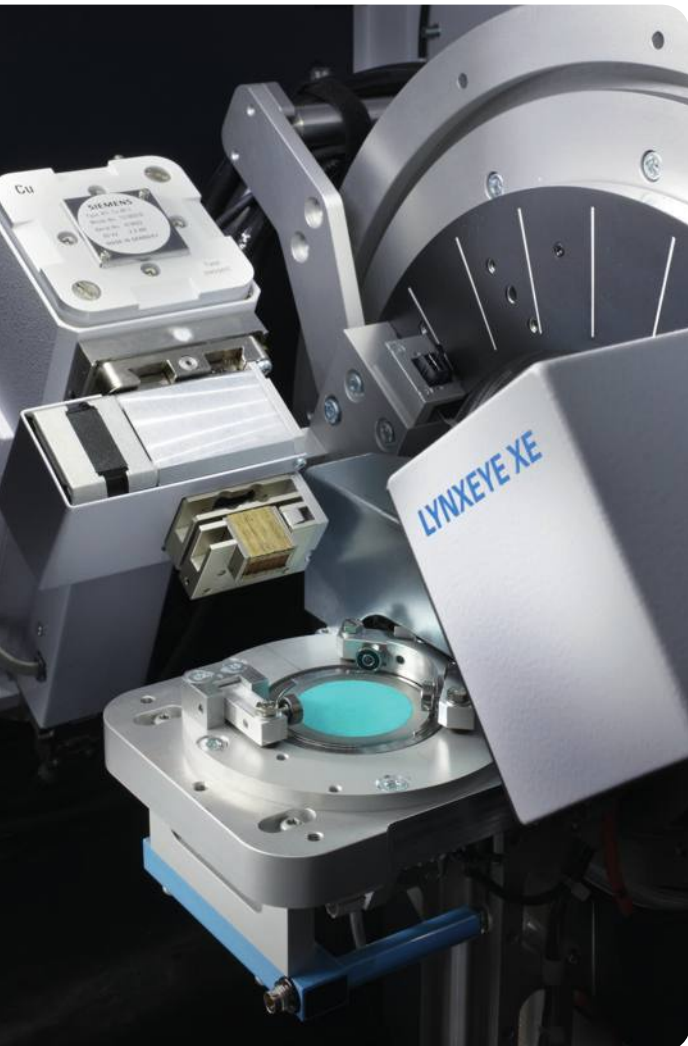
- Highest accuracy and precision data
- Highest intensities, fastest data acquisition, highest sample throughput
- Outstanding peak-to-background ratio for highest sensitivity and data quality
- Lowest limits of detection and quantification

The demands on production control are ever increasing and so are the possibilities offered by XRD: Bruker's recent detector and beam path developments have resulted in dramatic improvements of data quality, greatly benefitting all industrial XRD applications.

The outstanding capabilities of the D8 ENDEAVOR are due to the fact that it is based on the D8 diffractometer family platform. By utilizing the same instrument components as the high-end D8 research systems, the D8 ENDEAVOR incorporates all the latest advances in XRD technology. The D8 ENDEAVOR thus provides a level of analytical capabilities and data quality, until recently only achievable with high-end research systems.

The central component of the D8 ENDEAVOR is its completely maintenance-free two-circle goniometer. Driven by independent stepper motors equipped with optical encoders, the goniometer offers the highest angular accuracy available on the market, backed-up by Bruker's unique alignment guarantee. Thanks to the theta/theta configuration, the sample is always kept horizontally.

Equipped with the unique energy-dispersive LYNXEYE XE detector, the D8 ENDEAVOR is the fastest and most sensitive process diffractometer on the market. The LYNXEYE XE yields an enormous gain in intensity and thus measurement speed – up to 450 times higher than conventional detection systems. In addition, the LYNXEYE XE's excellent energy-resolution effectively filters fluorescence radiation, making intensity killers such as expensive monochromators and mirrors redundant. When also equipped with the unique motorized anti-scatter screen the D8 ENDEAVOR delivers data virtually free of instrument and air scattering, allowing high-quality data acquisition starting from angles below  $1^\circ$  in  $2\theta$ .

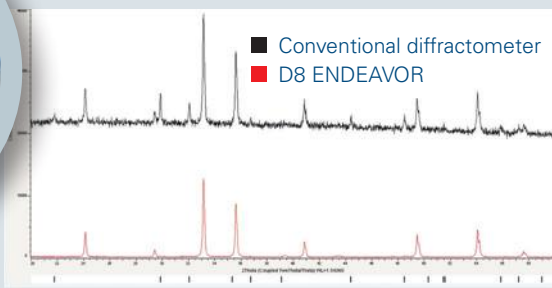




## Effective filtering of fluorescence

### LYNXEYE XE

- Superb energy resolution allowing effective filtering of fluorescence radiation
- Operation with all common characteristic X-ray emission lines
- Enabling outstanding angular resolution (FWHM) and perfect line profile shapes
- No defective strips at delivery time – guaranteed

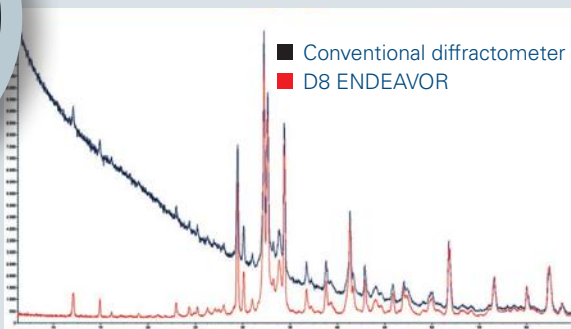


Unfiltered (black line) and filtered (red line) demonstrating the superb filtering of fluorescence radiation by the LYNXEYE XE.

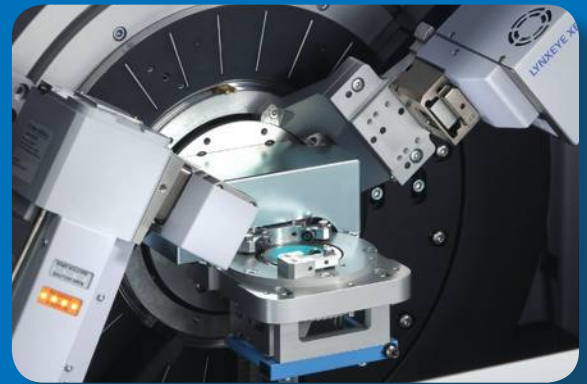
## Background suppression

### Motorized Anti-Scatter Screen

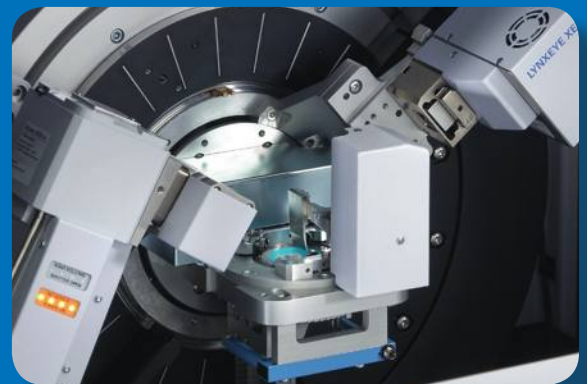
- Maximum suppression of background caused by instrument and air scattering
- Data acquisition starting from angles  $< 1^\circ 2\theta$
- Combination with variable or fixed divergence slit
- Improved limit of detection for amorphous and nano-crystalline materials such as clays



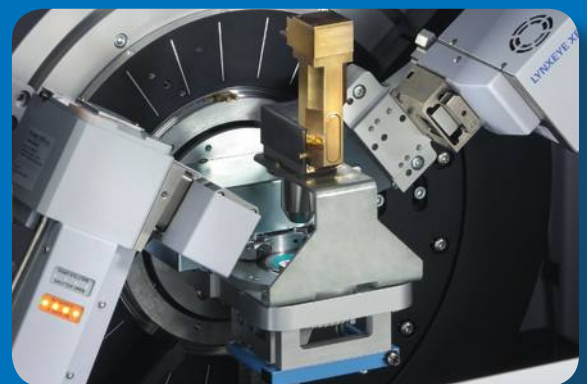
NIST SRM 8486 (Ordinary Portland Clinker) without (black scan) and with motorized anti-scatter screen (red scan).



D8 ENDEAVOR Metals configuration with divergence slit and LYNXEYE XE detector



D8 ENDEAVOR with LYNXEYE XE, motorized anti-scatter screen, and variable divergence slit for Cement, Minerals, or Pharma



D8 ENDEAVOR Aluminum with Ca-channel counter and LYNXEYE XE detector

# D8 ENDEAVOR – XRD analysis has never been easier!

DIFFRAC.SUITE makes data collection, data evaluation and reporting of results straightforward and can be adapted to all industry requirements. No matter if your D8 ENDEAVOR is operated standalone or integrated in a lab automation – DIFFRAC.SUITE does it all.

## Ease of use

The intuitive design of DIFFRAC.SUITE separates push-button routine operation from expert operation.

In expert mode, DIFFRAC.SUITE provides full access to all software features allowing development of highest performant methods from data acquisition, data evaluation to reporting of results. For the majority of industrial applications ready-to-use methods are available for instant use or adaptation to special requirements.

In routine mode, DIFFRAC.SUITE provides a highly intuitive user-interface for all kinds of everyday operation, and does not require any XRD-specialist knowledge. Single samples or sample batches can be analyzed by clicking a single button. The optionally available touchscreen defines a new level of user-friendliness – XRD analysis has never been easier!

## Networking

DIFFRAC.SUITE is fully network capable and perfectly integrates into multi-user environments. A practical users management system with definable user levels and user rights guarantees secure log-ons.

Authorized users have any-time access to the D8 ENDEAVOR, diffraction data, and results – no matter if the instrument is located next door or anywhere else around the globe.

## Walk-up

New samples, measurement and evaluation tasks can be added at any time, no matter if your D8 ENDEAVOR is operated standalone or integrated in a lab automation system. The sample changer is outside the radiation enclosure and can be safely accessed for sample introduction at all times, even while another sample is being measured. Priority measurements can be initiated at any time by users with appropriate user-rights; any interrupted measurements will be resumed automatically.

## Automation

To maximize lab and production efficiency, the D8 ENDEAVOR can be easily integrated into lab automation systems. Bruker AXS works together with all major suppliers of laboratory automation systems. Samples can be received either through conveyor belt or robot interface or manually through the sample magazine – or altogether! All advantages offered by DIFFRAC.SUITE's networking and walk-up capabilities can be exploited to the maximum.

## Compliance

The D8 ENDEAVOR perfectly integrates in cGxP / 21CFR Part11 regulated environments, making compliant work safer, easier, and faster than ever.

# DIFFRAC.SUITE – welcome to the world of XRD

## Phase identification

- ICDD PDF2 / PDF4 and COD databases
- User-defined databases

## Cluster analysis

- Similarity analysis of large amounts of samples
- Automatic mixture detection
- Automatic detection of amorphous samples
- Pass-fail analysis

## Quantitative phase analysis

- Amorphous and crystalline content
- Single peak methods and full pattern methods
- Traditional Rietveld method
- Internal standard method
- External standard method
- PONKCS method
- Pattern scaling
- Degree of crystallinity method
- Calibration
- Combined XRD-XRF analysis <sup>1)</sup>

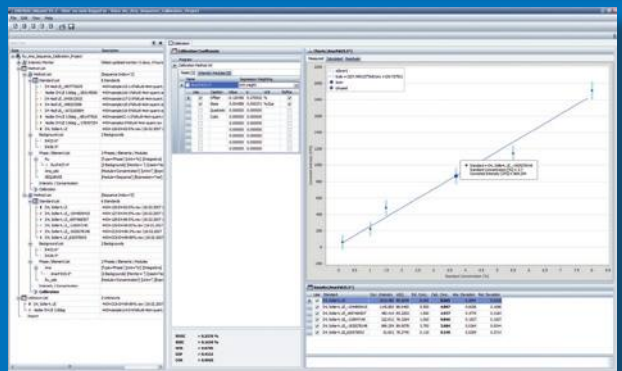
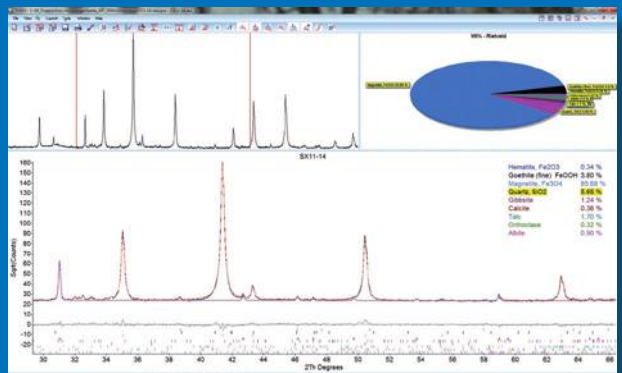
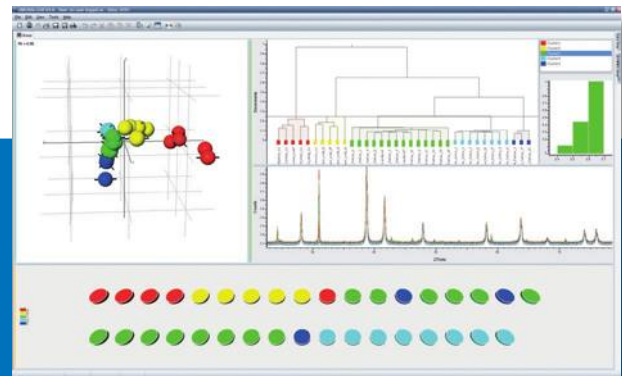
1) Patent: US 7184517, US 20050074089 A1  
DE 10346433 B4, DE 10346433 A1,  
DE 502004009073 D1  
EP 1522847 A1

## Crystal structure analysis

- Indexing
- Lattice parameter determination and refinement
- Crystal structure determination and refinement

## Microstructure analysis

- Crystallite size and microstrain
- Macroscopic stress and strain



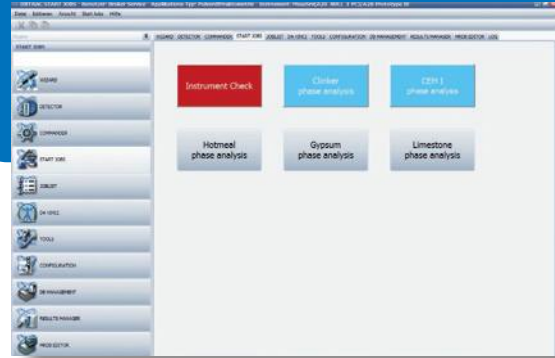
## TouchControl

- Easiest operation due to intuitive touch-screen interface
- No operator training required
- Standalone operation in tough environments without extra computer, mouse, or keyboard
- Highest data integrity by separation of routine from advanced tasks (calibration, manual data evaluation and reporting)
- Multi-lingual user interface



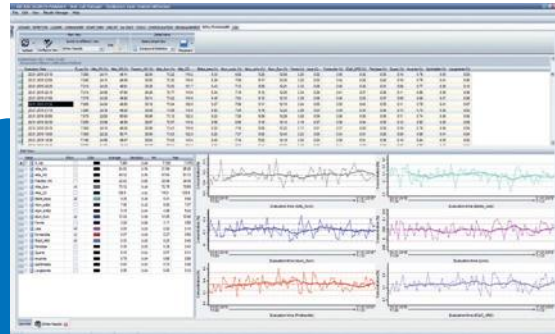
## Push-button Solutions

- No training required
- Start combined measurement method and data evaluation just at the push of a button
- Operator only needs to provide sample ID and sample position in loader.
- Data evaluation starts automatically after measurement is finished
- Results are stored in internal database and/or forwarded to external laboratory information systems (LIMS)



## Loader Software

- 1 Loader display for selecting a sample position
- 2 Template area for assigning a predefined method to the selected sample
- 3 Basic instrument control
- 4 Specimen and measurement status for the selected position
- 5 Log window and results display for automated data evaluation



## Results Manager

- Measurement data and results from DIFFRAC.TOPAS BBO and DIFFRAC.DQUANT are collected in the same database
- Tabular results monitor for last data evaluated and graphical results representation
- Statistical Process Control (SPC) charts with limit check and outliers detection
- Statistical analysis (average, floating average, minimum, maximum, standard deviation)

# D8 ENDEAVOR – the touch of your finger is all it takes

Technology and software of the D8 ENDEAVOR are the continuation of the fully automated measurement, analyses and sample changing philosophy that was introduced for the first time with its successful predecessor – the D4 ENDEAVOR. Now we have made great even better!

The EasyLoad sample trays allow maximum compatibility of the D8 ENDEAVOR with the S8 TIGER and S2 PUMA XRF spectrometers. The trays, loaded with 51.5 mm sample rings, can directly be exchanged between those instruments allowing for same-sample XRD and XRF analysis on pressed pellets. Common unique sample IDs allow highest data integrity, during measurement and in reporting without retyping.

Operator training is reduced to the absolute minimum. Loading and measuring the sample, evaluating data and reporting results – all can be assigned to a single button in the software. Initiating the entire process does not even need a keyboard or mouse anymore. The simple and intuitive operation on the touch screen allows to perform all important operations.

The D8 ENDEAVOR can be operated in island mode, i.e. standalone, without a separate computer or network just via the touchscreen.

## **D8 ENDEAVOR – just start working!**

- Touchscreen with loader software
- Ergonomic and quick sample loading
- Start priority samples right away
- “Walk up” multi-user system
- Fully automated solutions



# D8 ENDEAVOR – safety, quality and service without any compromises

## Absolute safety is our top priority

The D8 ENDEAVOR is the safest instrument available on the market. It fully complies with all current EU directives, therefore establishing and guaranteeing the world's highest standards for analytical X-ray equipment including, but not limited to, machinery safety, X-ray safety, electrical safety, and electromagnetic compatibility.



## Full CE compliance

- Machinery Directive (2006/42/EC)
- Electrical Equipment (2006/95/EC)
- Electromagnetic Compatibility (2004/108/EC)
- and more

## Quality by design

The D8 ENDEAVOR has been developed following a formal design process and product development life cycle compliant with ISO 9001:2008 and cGAMP processes and procedures. The instrument perfectly integrates in cGxP / 21CFR Part11 regulated environments. Tools and expertise are available to help meeting the requirements of equipment qualification (DQ, IQ, OQ, PQ) for system validation according to 21 CFR Part11, §B11.10a.

## Alignment guarantee

The D8 ENDEAVOR is prealigned and comes with a unique alignment guarantee: The accuracy of each peak position is equal or better than  $\pm 0.01^\circ$  in  $2\theta$  over the accessible angular range. Before delivery and at installation each instrument has to pass a strict test based on the internationally accepted Standard Reference Material SRM1976b by NIST. This standard is always included with each instrument enabling to monitor instrument performance at any time.

## Detector guarantee

Thanks to Bruker AXS' proprietary detector design, the LYNXEYE XE detector is guaranteed to be free of defective strips or even dead areas at delivery time. This unique guarantee, together with a factory-made calibration, guarantees the highest quality data available on the market.





- Video control of sample
- Innovative tool programs for simple instrument control and troubleshooting
- WebEx support with worldwide 24/7 availability

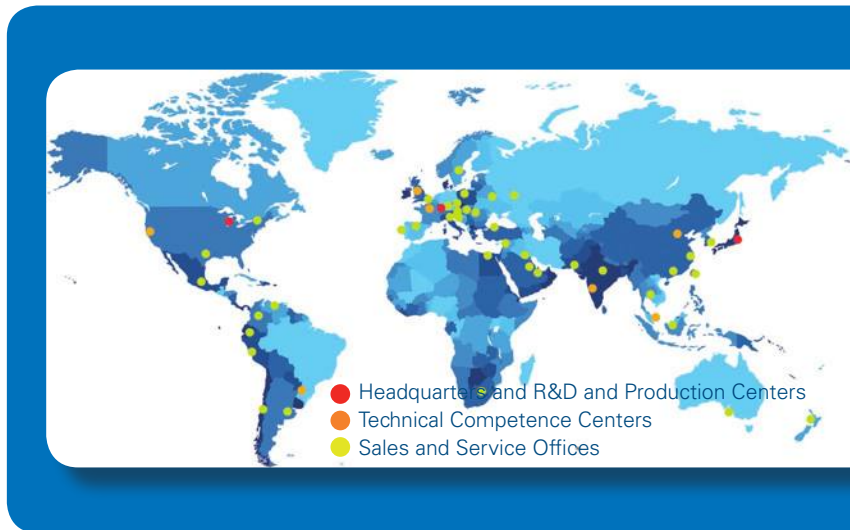
Bruker offers comprehensive support in every discipline including information and communication, consumables and spares, support and upgrades, as well as education and training. Our global organization has offices in every major area of the world providing sales, applications, and engineering support for all our products.

### Local support and global organization

Support can be requested in your local language via well trained, experienced local service engineers. They are assisted by our worldwide network of regional competence and global production centers.

### Multiple level service contract packages

Customers can select from an extensive range of service and experience support up to customized solutions for their businesses. For process customers, 24/7/365 support under special expanded service contracts is available including guaranteed round-the-clock phone support.



Technical Data			
<b>Goniometer</b>			
Operating mode	Vertical configuration, Theta/Theta		
Max. useable angular range	0° - 154° 2 $\theta$ (depending on accessories)		
Smallest selectable step size	0.0001°		
Reproducibility	±0.0001°		
Verifiable absolute accuracy	≤ ±0.01°		
Max. speed	25°/s (depending on accessories)		
<b>X-ray optics</b>			
Slits	Motorized or manual (plug-in)		
Anti-scatter screen	Motorized or manual		
Axial Soller slits	1.5°, 2.5°, or 4°		
<b>Detectors</b>			
Calcium Channel	Ne-CO <sub>2</sub> filled proportional counter for aluminum bath analysis		
LYNXEYE XE	High-resolution, energy-dispersive 1D detector		
<b>Sample handling</b>			
Standard sample magazines	66 sample positions for Ø 51.5 mm (2.0") 72 sample positions for Ø 40 mm (1.6")		
EasyLoad sample magazine	43 sample positions for Ø 51.5 mm (2.0") with support of EasyLoad trays		
Automation interface	Optional, interfaces to robotic automation environments or to conveyor belts		
<b>Room planning</b>		<b>Systems</b>	
Outer dimensions		Without touchscreen	With touchscreen
	Height	1585 mm (62.4")	1585 mm (62.4")
	Depth	1318 mm (55.9")	1318 mm (55.9")
	Width	840 mm (33.1")	1342 mm (52.8")
		<b>D8 ENDEAVOR</b>	<b>D8 ENDEAVOR ECO</b>
Weight	~600 kg (depending on accessories)		
External cooling water	Yes	No	
Power supply	200 V - 230 V, 32 A single phase 200 V - 230 V, 32 A three phases		200 V - 230 V, 16 A single phase
Max. power consumption	Max. 6 kVA		max. 3 kVA
Compressed air	Not required		
Operating temperature	15 °C - 35 °C		15 °C - 30 °C at 0 m NN
	15 °C - 40 °C* * With harsh environment option		15 °C - 25 °C at 2000 m NN
Altitude	3000 m *		2000 m
	* Higher altitudes on request		