The Modular Solution for Nanostructure Analysis

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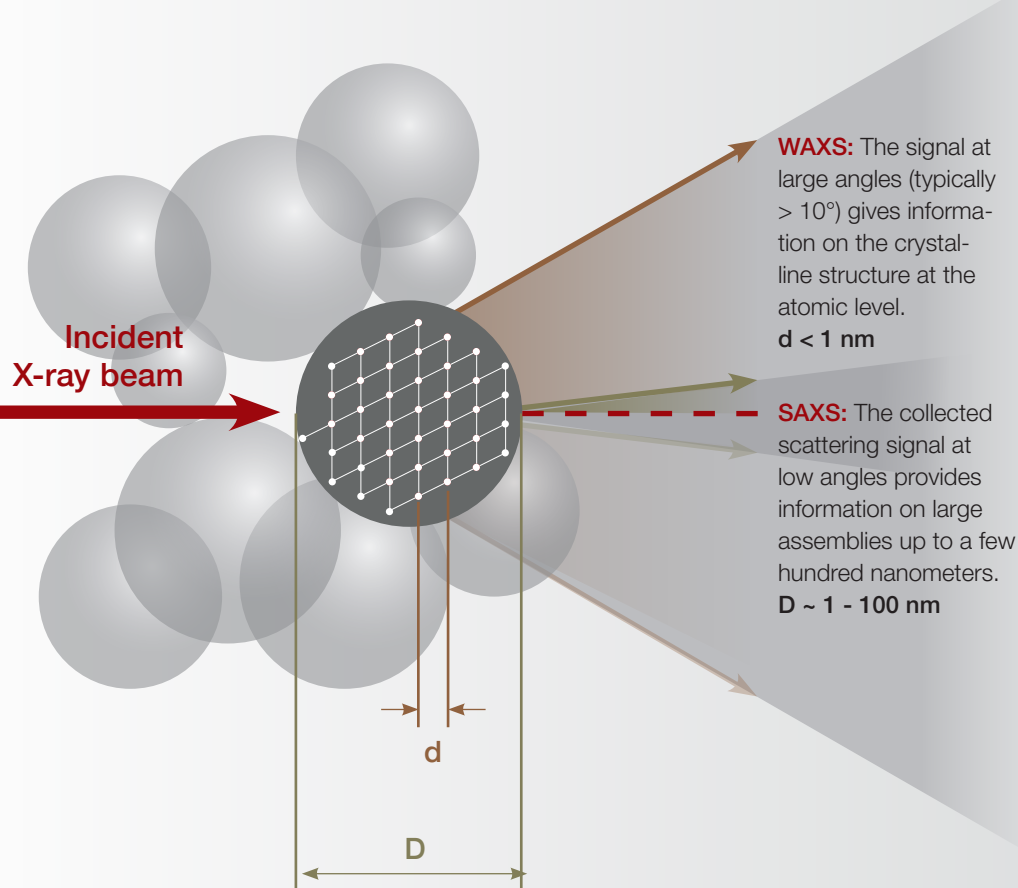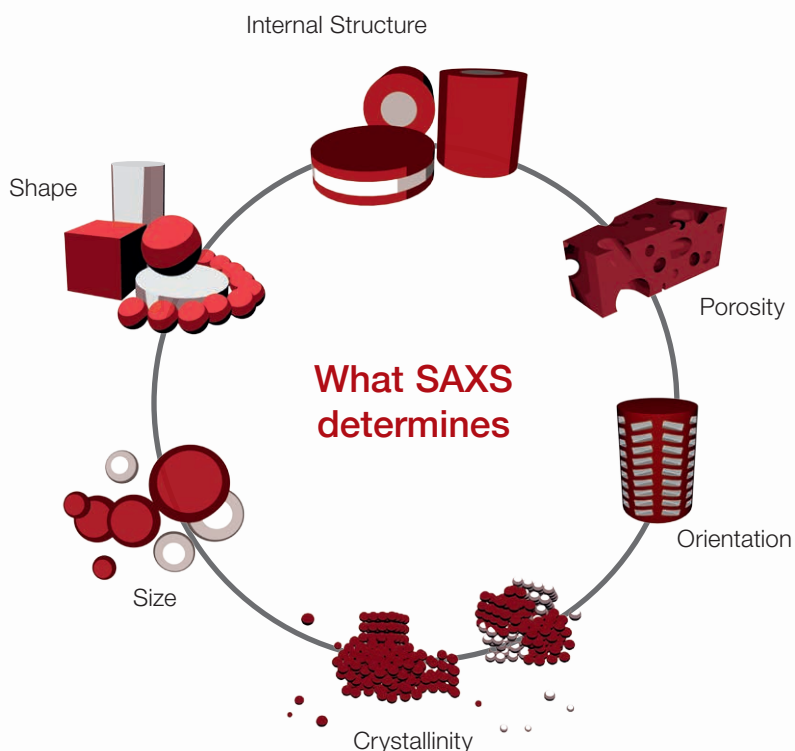
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SAXSpace
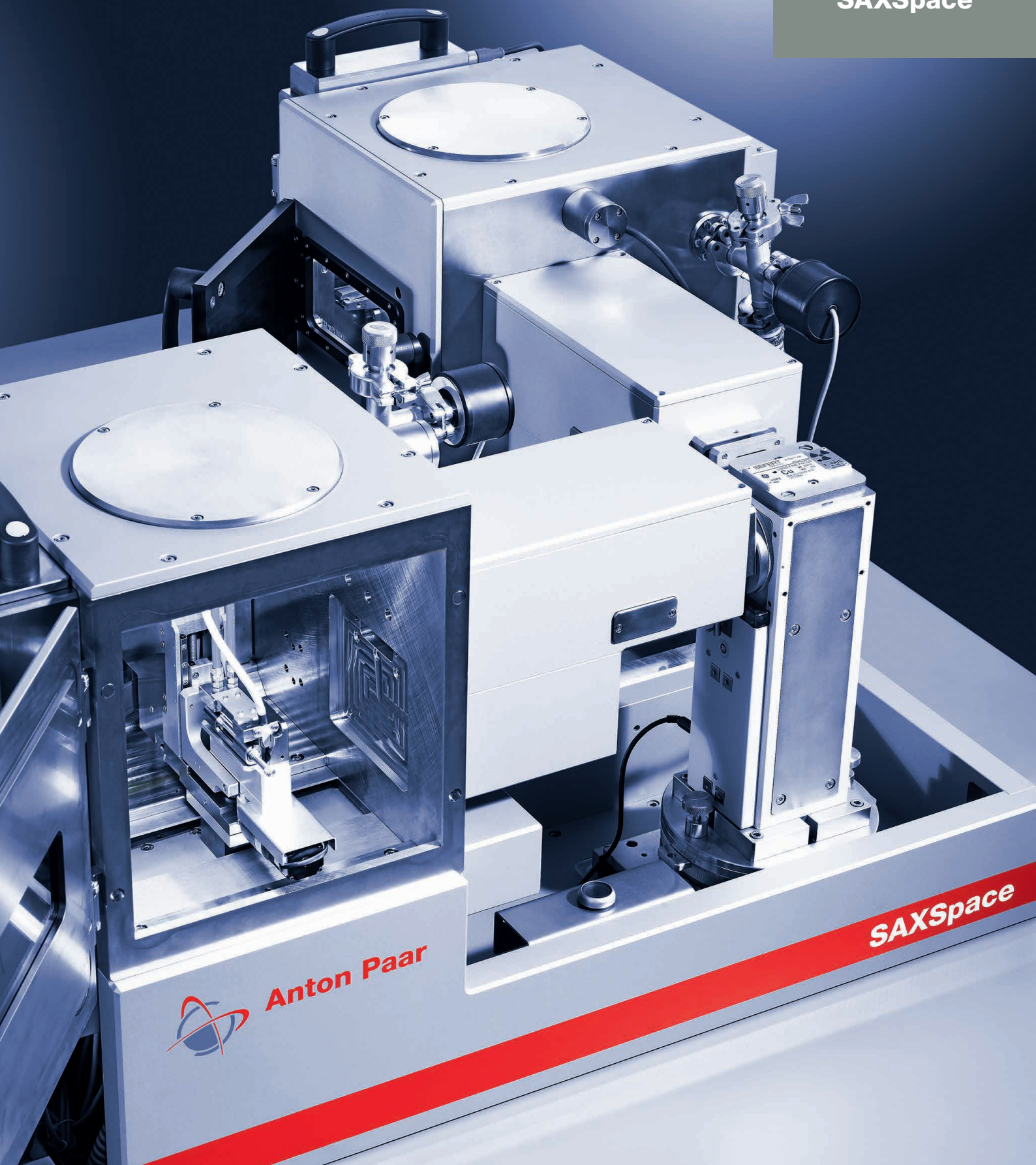
New to SAXS?
Here are some essentials.

What SAXS is

SAXS, Small-Angle X-ray Scattering, is a non-destructive method for investigating nanostructures from 1 nm to 200 nm in size. SAXS results are representative of an entire sample, so SAXS ideally complements methods that only provide local information, such as electron microscopy.

SAXS also stands out for enabling studies on biological samples in their native state. This popular application is known as **Bio-SAXS.**

Another important SAXS discipline is called **GISAXS** (GI = Grazing Incidence). This technique is used for investigating nanostructured surfaces and thin-film samples.

Internal Structure

Shape

What SAXS determines

Porosity

Orientation

Size

Crystallinity

Small or wide angles – different results

Incident X-ray beam

WAXS: The signal at large angles (typically > 10°) gives information on the crystalline structure at the atomic level.
d < 1 nm

SAXS: The collected scattering signal at low angles provides information on large assemblies up to a few hundred nanometers.
D ~ 1 - 100 nm

d

D

X-rays are sent onto a sample and are scattered by its particles and domains, producing a scattering pattern characteristic of the sample's nanostructure. The scattered X-rays can be resolved at different angles.

In SAXS, you resolve small angles (< 10° 2θ) to measure molecular structure sizes up to 200 nanometers.

Smaller structures, such as crystal lattices on the atomic level, can be analyzed by resolving the scattered X-rays at wider angles (> 10° 2θ). This method is called WAXS (Wide-Angle X-ray Scattering).
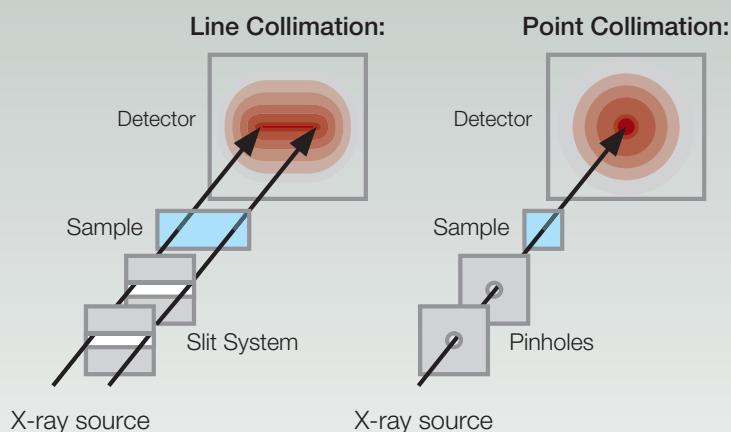
Two beam shapes – different benefits

Before scattering, the X-rays are transformed into a well-defined line-shaped or point-shaped beam. This process is called collimation.

Line collimation is ideally suited for measuring non-oriented (isotropic) systems, especially weakly scattering samples such as diluted dispersions and emulsions.

Point collimation is the right choice for analyzing oriented samples, solids with inhomogeneous structures as well as nanostructured surfaces by using GISAXS.

You need both collimation modes to optimally cover the entire range of potential SAXS applications.

Line Collimation:

Detector

Sample

Slit System

X-ray source

Point Collimation:

Detector

Sample

Pinholes

X-ray source

Isotropic samples
Non-oriented samples, weakly scattering samples

Anisotropic samples
Oriented samples, stressed or sheared samples

SAXS Applications

▸ Colloidal Dispersions

 Nanocrystals, pigments in paints, inks and sun screens, metal dispersions, blood cells

▸ Surfactants

 Detergents, food additives, nutrients, pharmaceuticals, personal care products

▸ Emulsions

 Food, drug carrier systems, micro-emulsions, personal care products

▸ Biological Materials (Bio-SAXS)

 Proteins, protein complexes, lipids, peptides

▸ Nano-composites

 Nano-filled polymer composites (clays, carbon nanotubes)

▸ Polymers & Fibers

 Semi-crystalline polymers, block copolymers, polymer blends, synthetic fibers

▸ Catalysts

 Petroleum refinement and processing, polymerization, gas purification, fuel cells

▸ Liquid Crystals

 Liquid crystal displays, lyotropic liquid crystals used as detergents, food and drug delivery systems, biological membranes

▸ Nanostructured Surfaces (GISAXS)

 Layered thin-film samples, mesoporous oxide thin films, block copolymer thin films, nanoparticle superlattices

SAXSpace
Brilliance Your Way

SAXSpace is a modular nanostructure analyzer for **SAXS, WAXS, GISAXS, Bio-SAXS** and more. The system delivers high data quality at minimal measuring times – that's a given.

What's unique about SAXSpace is its readiness to meet your needs.

Some will breathe a sigh of relief at the system's user-friendliness, facilitating easy work at a fast pace. Other SAXS users want a sophisticated work space for full experimental flexibility. SAXSpace delivers on all counts.

Space to build on

Large all-in-one sample chamber with built-in alignment stage for full experimental flexibility

Wide range of measurement options

Sample holders and stages for virtually any kind of sample and measurement conditions

More beams, more results

SmartSAXS feature: Choice of differently collimated beams, optionally even employed at once, for increased productivity and a wider range of analyses

Time-saving alignment

TrueFocus feature: Fully automatic and intelligent self-alignment of components with X-ray beam for unprecedented ease-of-use

SAXS and WAXS at once

TrueSWAXS feature: Simultaneous and continuous SWAXS studies up to 74° 2θ, at uniform resolution

The following features are only found in SAXSpace.

SmartSAXS

SAXSpace measures isotropic as well as oriented samples without requiring any setup change. Simply choose the collimation mode that best suits your needs.

The instrument's SmartSAXS multiple beam concept even enables you to employ line and point collimation at once, with several beam lines connected to a single X-ray source.

Measurement times are reduced to a minimum and your throughput is considerably increased.

TrueFocus

In former SAXS systems, the alignment of X-ray optics and collimating components with the X-ray beam has never been known as a simple procedure. SAXSpace stands out for quick and easy alignment at the push of a button.

Based on its TrueFocus feature, SAXSpace aligns all X-ray components automatically. Even experienced SAXS operators will tell you how much easier life in the lab becomes without the need for complex, time-consuming manual alignment.
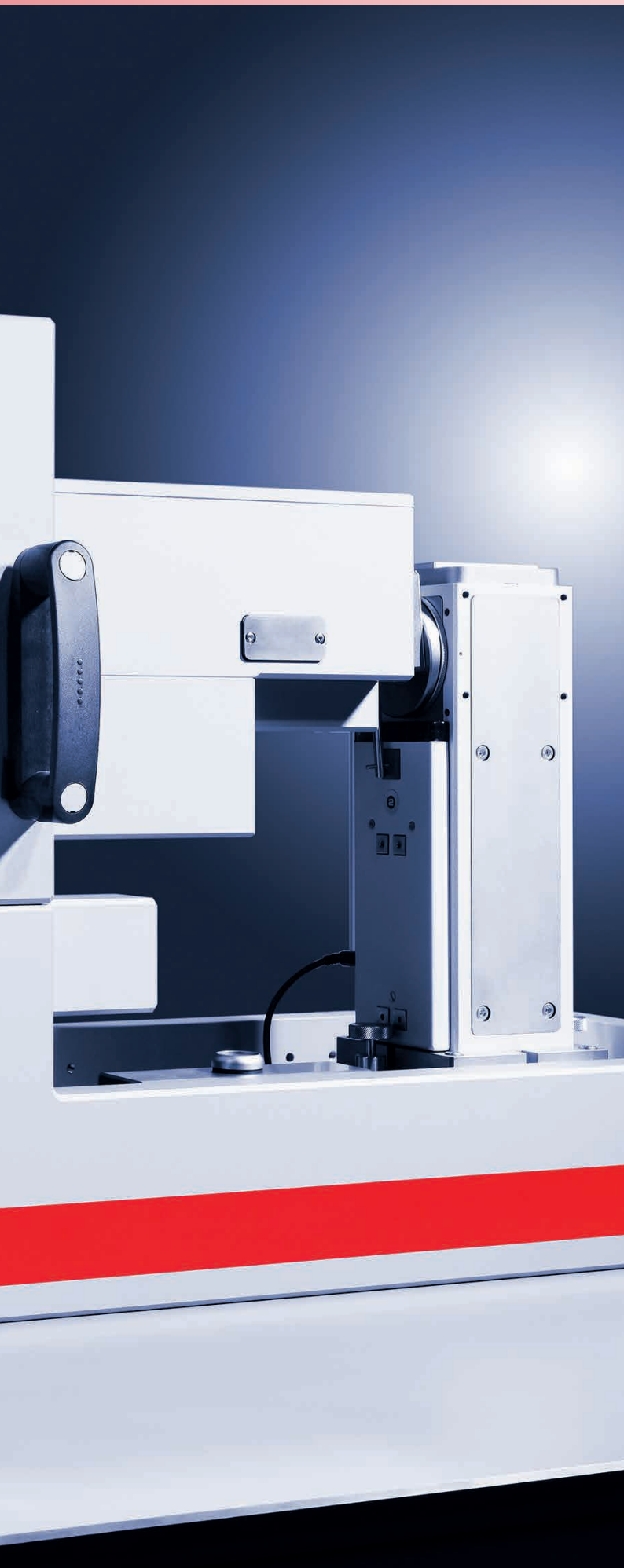
A source of quality

Apart from component quality, SAXS and WAXS data quality largely depends on smart **scatterless beam collimation** and the quality of the X-ray beam itself. SAXSpace employs an intense monochromatic beam with very low background radiation, providing reliable data even on very low-contrast samples.

This beam quality is achieved with a Kratky-based block collimator, the outstanding result of over 50 years of continuous refinement. The basic system was initially developed by SAXS "founding father" Otto Kratky together with Anton Paar in the 1950s.

TrueSWAXS

Analyze your samples' overall nanostructure (< 200 nm) as well as their crystal structures at the atomic level (< 1 nm) – by performing continuous SAXS and WAXS measurements at wide angles up to 74° 2θ. You can also run these measurements simultaneously.

This unique TrueSWAXS functionality is based on an ingenious, space-saving set of component movements. With TrueSWAXS, there is no need to re-align your system. You can be sure of uniform resolution and reliable results.

Full Experimental Flexibility

Innovative SWAXS-based research requires a smart and versatile framework. SAXSpace's all-in-one sample chamber is open to countless analysis options, providing you with full experimental flexibility.

Choose from a wide variety of sample stages and holders easily incorporated in unprecedented Plug and Play fashion. The system's Stagemaster feature automatically recognizes new stages and configures the instrument for you.

SAXSpace's large sample chamber gives you sufficient space for your own experimental setups, for which Anton Paar provides you with comprehensive support tailored to your needs.

In any case, you are covered by precise temperature control, optionally ranging from -150 °C up to 500 °C.

Wide range of sample holders:

▸ **µ-Cell** – for lowest sample volumes (> 8 µL)

▸ **FlowCell** – for automated sampling

▸ **PasteCell** – for viscous and powder samples

▸ **RotorCell** – for averaging microcrystalline domains

▸ **TubeCell** – for online experiments (disposable fluid pathway)

▸ **TCS Capillary Holder** – for disposable capillaries

▸ **Humidity Stage** – for SWAXS studies under relative humidity

Autosamplers for liquids and solids:

▸ **ASX autosamplers** – for high-throughput screening of up to 192 liquid samples
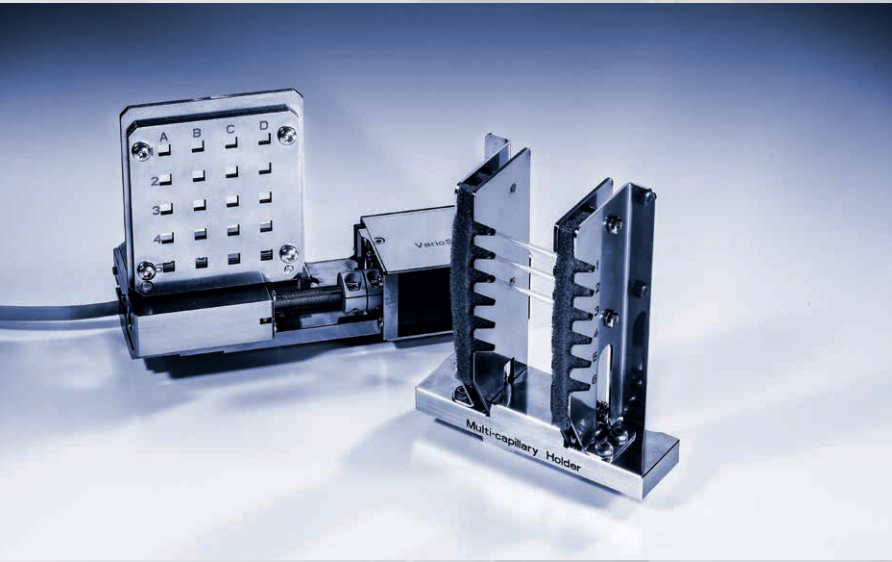
▸ **VarioStage** - for multi-purpose SWAXS studies
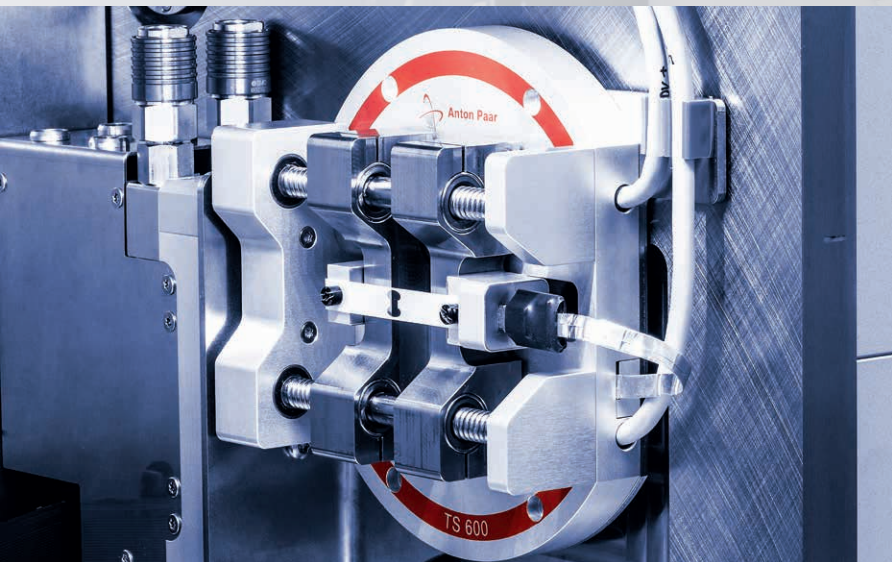
TCStages
for SWAXS studies from -150 °C to 500 °C

GISAXS Stage
for analysis of nano-structured surfaces
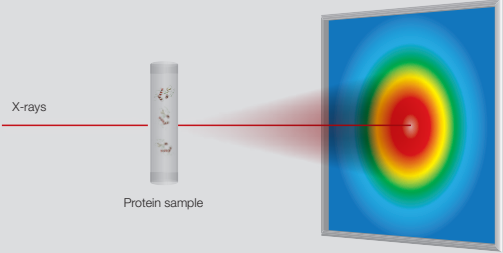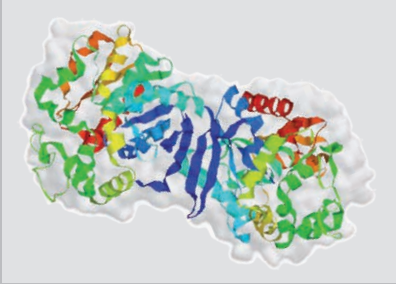
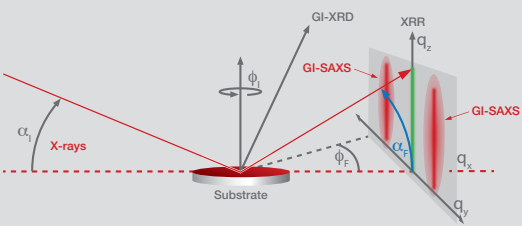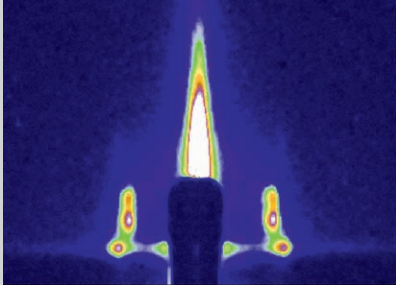**VarioStage**
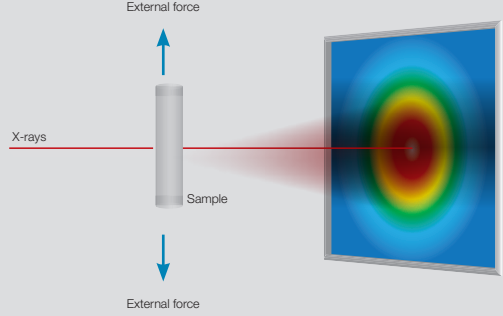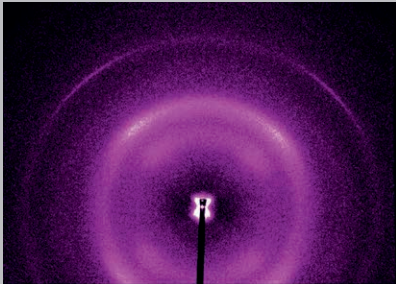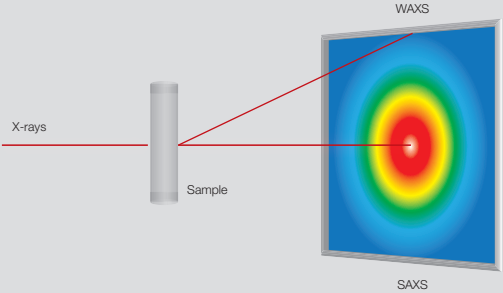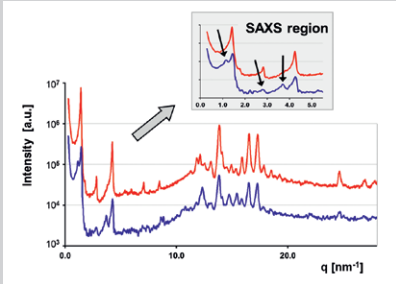for multi-purpose SWAXS studies

Tensile Stage
for SWAXS studies under mechanical load

Selected SWAXS Application

The small- and wide-angle X-ray scattering (SWAXS) method allows you to obtain information about the nanostructure of a huge variety of materials, ranging from nanoparticles, proteins and pharmaceuticals to polymers and thin-film samples.

Application		Results	Parameters
Proteins (Bio-SAXS)			▸ Size and shape of proteins in solution ▸ Calculation of 3D envelopes ▸ Protein folding/ unfolding studies
Thin-film samples (GISAXS)			▸ Structure of nano-structured thin films ▸ Surface roughness
Mechanical testing			▸ SWAXS studies of structural changes of polymer foils and fibers induced by tensile stress
SAXS/WAXS studies			▸ Combined SAXS/ WAXS studies ▸ Temperature-dependent structure changes

SAXSpace Software
The Essence of SAXS Intelligence

Dedicated software is one of the most important components of a modern SAXS system. SAXSpace comprises three different programs for automated system control and data acquisition as well as fast and easy template-based processing and analysis of 2D and 1D SWAXS data.

SAXSdrive™
Measurement and control software

The new powerful SAXSdrive™ software automatically detects and controls SAXSpace's system components, including X-ray sources, sample stages and detectors. SAXSpace is aligned automatically; several alignment modes are stored and easily recalled.

SAXSdrive™ enables you to perform automated SAXS and WAXS experiments, including temperature-dependent and time-resolved studies as well as high-throughput screening experiments.

SAXSquant™
2D and 1D SWAXS data treatment, processing and analysis

SAXSquant™ simplifies the treatment of 2D and 1D SWAXS data which are processed using fully customizable templates. Large data sets for multiple samples are handled at the push of a button.
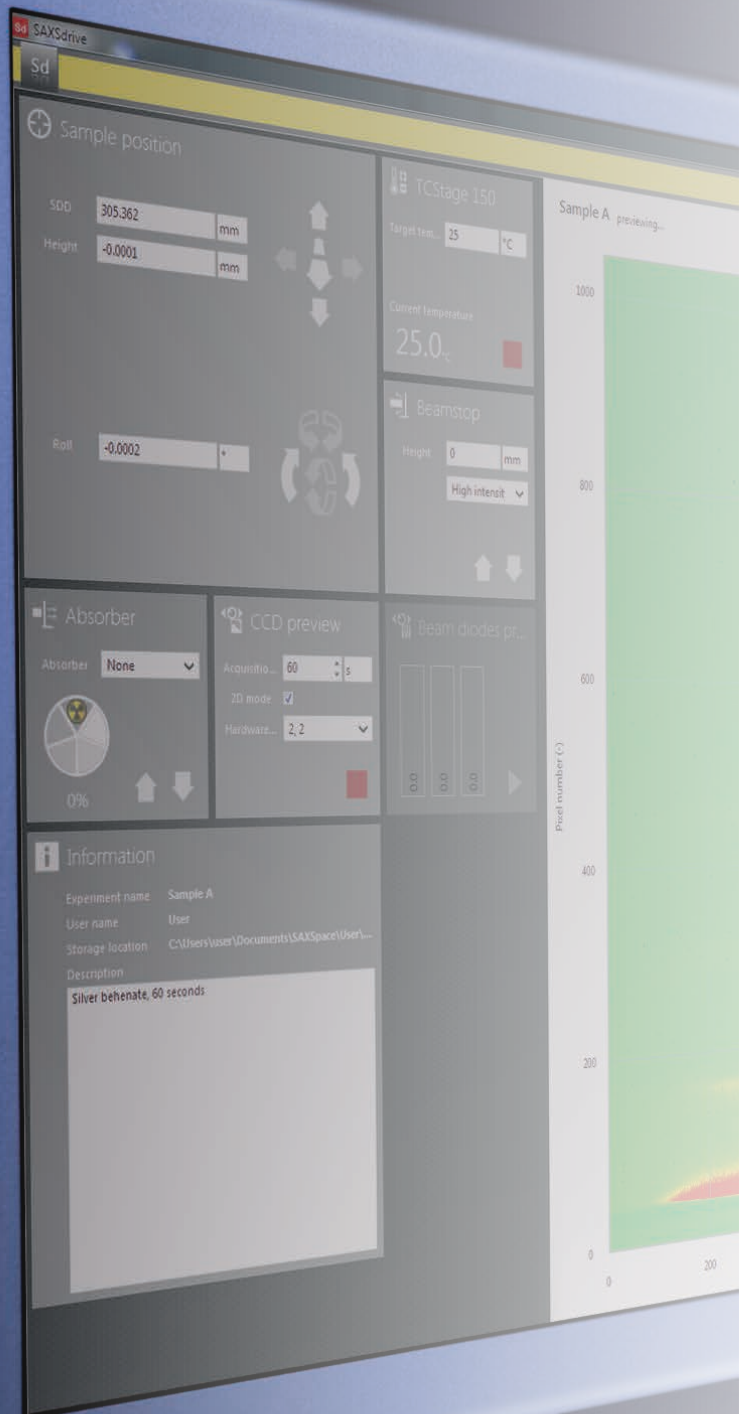
SAXSquant™ features all essential evaluation routines and calculates important parameters like the radius of gyration R_G, particle size, specific volume and more. The generated data files (ASCII text format) can be opened and processed in any SAXS data evaluation software, such as ATSAS, SASView, SASfit.

Advanced data interpretation software
Particle structure and interaction

The PCG software retrieves structural information from experimental SAXS data using mathematical methods which allow you to determine your samples' particle shape, size and size distribution.

The software offers you a unique advantage: You can interpret data of interacting (i.e. concentrated or charged) particle systems based on a single experiment only. This considerably speeds up your work, since you no longer need to run measurement series at different concentrations.

Specifications

System resolution	q_{min}: 0.03 nm^{-1} (0.003 Å^{-1})
Accessible q range	0.03 nm^{-1} to 49.0 nm^{-1} (0.003 Å^{-1} to 4.90 Å^{-1}) 200 nm to 0.13 nm
Measuring time	< 1 minute to 30 minutes (typical)
Special features	SmartSAXS: multiple beam line option TrueFocus: self-alignment with X-ray beam TrueSWAXS: continuous and simultaneous SWAXS studies up to 74° 2θ Stagemaster: YZ stage with auto-recognition of sample stages
Sample environment: **- Temp. range** **- Atmosphere**	-150 °C to 500 °C Vacuum, air, inert gas, humidity, (reactive gases on request)

X-ray source	Various X-ray sources available
X-ray optics	Multilayer optics Advanced Kratky-based line and point collimator
Sample stages / **Autosamplers**	TCStages Humidity Stage Tensile Stage GISAXS Stage ASX autosamplers Customized stages on request
Sample holders	Quartz capillaries for liquids Sample holder for solids µ-Cell FlowCell PasteCell RotorCell TubeCell TCS Capillary Holder
Detectors	Imaging plate detector (2D data acquisition) CCD detector (2D data acquisition) CMOS detectors (1D and 2D data acquisition)
Software	SAXSdrive™ control and data acquisition software SAXSquant™ data analysis software Advanced data interpretation software (PCG)
Dimensions (footprint)	1.8 m x 0.9 m (L x D)

The birthplace of SAXS analysis

1957

First commercial SAXS analyzer built by Prof. Otto Kratky together with Anton Paar in Graz, Austria

1981

Kratky compact camera developed, over 800 instrument produced by Anton Paar and sold worldwide

2003

Introduction of SAXSess, featuring X-ray beam monochromatization and 2D detection

2012

Introduction of SAXSpace with unique SmartSAXS, TrueFocus and TrueSWAXS features

High uptime – profound knowledge

Rely on Anton Paar's worldwide network of experienced service engineers to provide swift support, ensuring smooth SAXSpace operation and maximizing your instrument's uptime.

In thorough user trainings during and after installation and by profound SWAXS application knowledge made available by our dedicated application specialists, we aim to help you make the most of your SAXSpace system.

www.anton-paar.com