# Recent Developments on Incoatec´s Microfocus Source IμS for Material Science Applications

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10 years IμS – Celebrate the power

## IμS for X-ray Diffraction

The IμS is a low power air cooled X-ray source for diffractometry applications. The source is equipped with a Montel optics. Montel optics consist of two mirros mounted side-by-side in an L-shape enabling a 2-dimensional beam shaping. Therefore, we can form either a highly collimated beam with a low divergence (below 0.5 mrad) or a focusing beam with higher divergence (up to 10 mrad) and very small focal spots at the sample (diameters downto 100 μm). The Cu-IμS with collimating optics can be used for (GI)SAXS and X-ray diffraction studies. With focusing optics experiments can be carried out in transmission geometry, especially in powder diffraction applications. With the Mo- and Ag-IμS highly absorbing and radiation-damage sensitive materials can be investigated. Consequently, these sources are often used for chemical crystallography and become more and more interesting for investigation of soft matter samples or for XRD measurements during the growth of nanosized materials.

## Upgrading Existing Diffractometers with the Microfocus Source IμS

You have a Bruker AXS, Marresearch, Nonius, Rigaku, Huber or some other system?

Incoatec offers a unique possibility to upgrade your existing diffractometer by installing the high-performance, air-cooled and low-power microfocus source IμS.

### Your upgrade benefits:

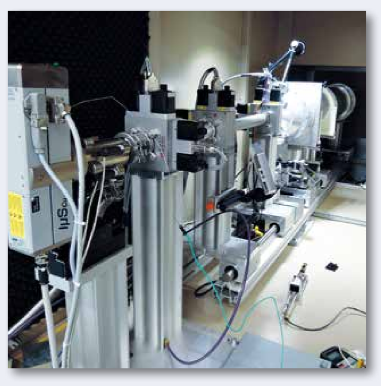
- No maintenance, only single phase power and no water cooling required
- 3 years warranty
- Maximum installation down time of only 2-4 days
- Full integration into existing safety circuits for Bruker equipment, new safety concept development on request
- Full compliance with European Machinery Directive 2006/42/EC

### Your upgrade options:

- Source, optics and scatterless slits
- Single source upgrade for XRD, SCD, (GI)SAXS, XRR and many more applications
- Dual wavelength setup by adding IμS as complementary source
- Cu, Mo, Ag, Co and Cr radiation (others on request)

Nonius Kappa APEX II with FR 590 enclosure in Jena, Germany

Bruker APEX II DUO IμS in Düsseldorf, Germany



IμS and SCATEX upgrade on a customized SAXS setup in Hamburg

XRD/XRR setup in synchrotron optics lab at ESRF in Grenoble, France

Marresearch 345 dtb in Basel, Switzerland

Replacement of Rigaku RU-200 generator in Boulder, USA

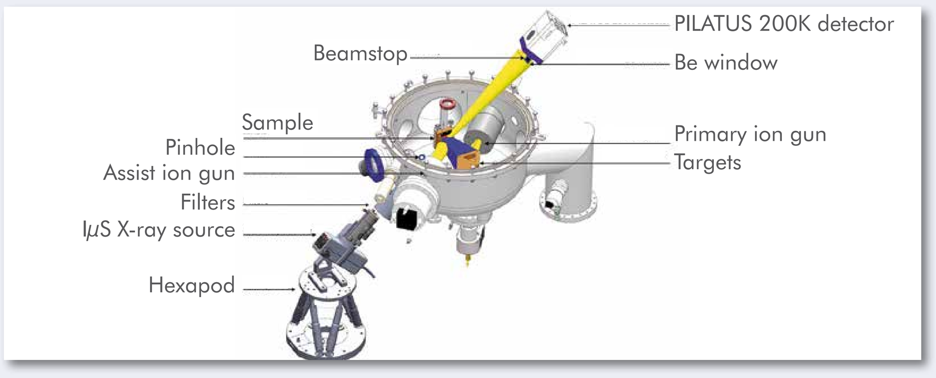
STOE IPDS II in Mainz, Germany

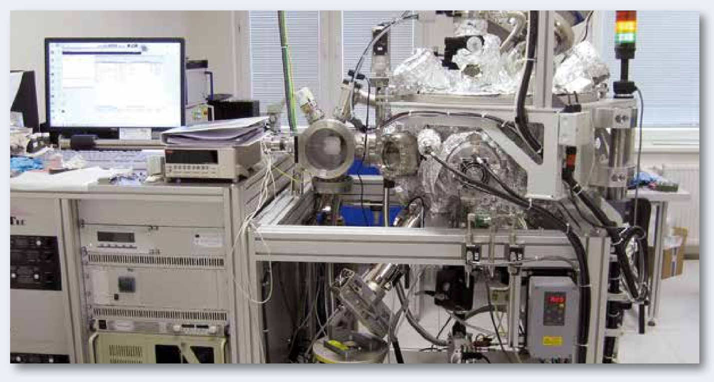
Huber goniometer with APEX II detector in Newcastle, UK

## IμS for In-situ GISAXS during Thin Film Growth

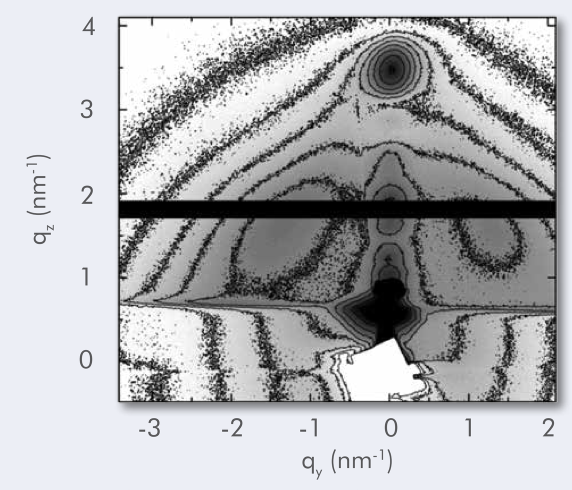
By using in-situ GISAXS in the home-lab we investigated how multilayers grew during thin film deposition. This kind of experiments is typically done only at synchrotrons. With an IμS it is now also feasible in the home-lab (datas and pictures by courtesy of P. Siffalovic, Slovak Academy of Sciences, Bratislava, Slovakia).

### IμS for in-situ GISAXS with Pilatus 200K

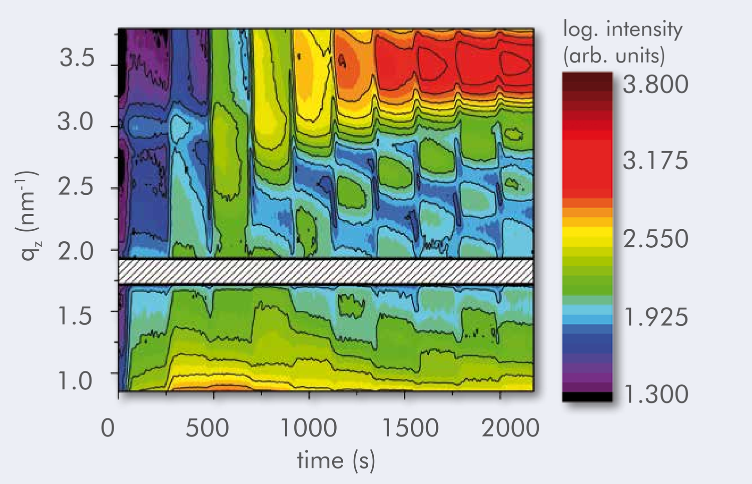


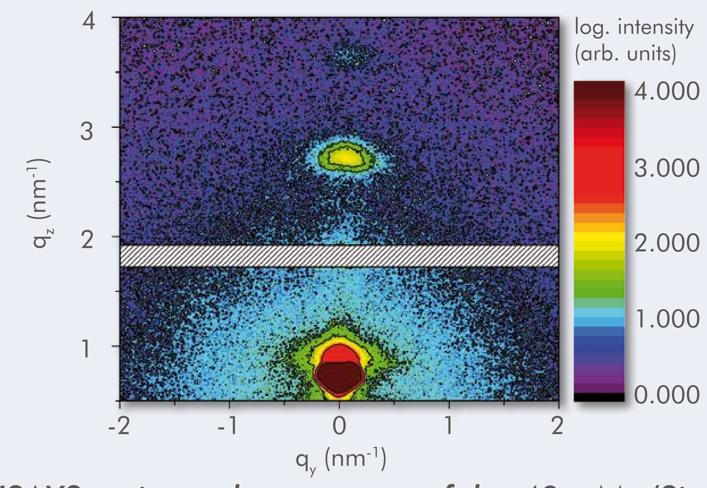
*The Dual Ion-beam sputtering unit in Bratislava was upgraded with an in-situ GISAXS set-up. As a source an IμS with a special collimating optics for SAXS is mounted on a Hexapod. Together with the 2-dim detector Dectris Pilatus 200K dynamic measurements during thin film growth become feasable.*



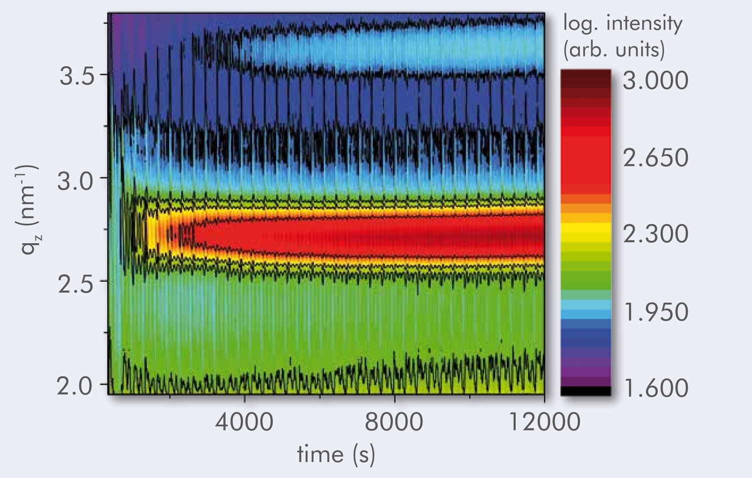

*Reciprocal space map of 10 periods W/B4C multilayer mirror with 1.5 nm period thickness measured ex-situ by GISAXS in deposition chamber*




*Time resolved evolution GISAXS reciprocal space map of the 10x W/$B_4C$ multilayer mirror with visible Bragg peak and Kiessig fringes*




*GISAXS reciprocal space map of the 40 x Mo/Si multilayer mirror with period 6.9 nm*

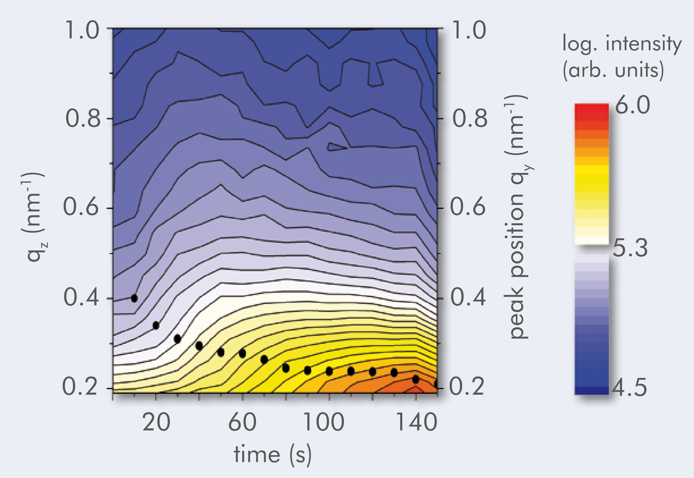



*Time resolved evolution GISAXS reciprocal space map of the 40x Mo/Si multilayer mirror with visible Bragg peaks*

GISAXS plots show the perfect growth of the multilayers. Even thin films with a total thickness in the range of 15 nm could be measured. The time resolved evolution of the specular signal enables the measurement of the Bragg peaks and the Kiessig Fringes dynamically.

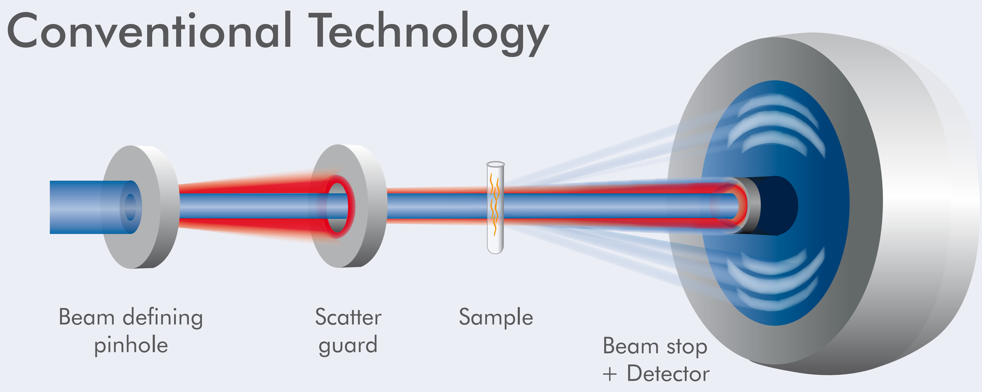
### NEW and in progress: In-situ time-resolved GISAXS of metal films on graphene

- This method revealed kinetics of Cu cluster growth on CVD graphene.
- It allows rapid optimization of metal deposition processes in laboratory conditions.
- Further growth studies of Au, Ag,..., on graphene surface are in progress.

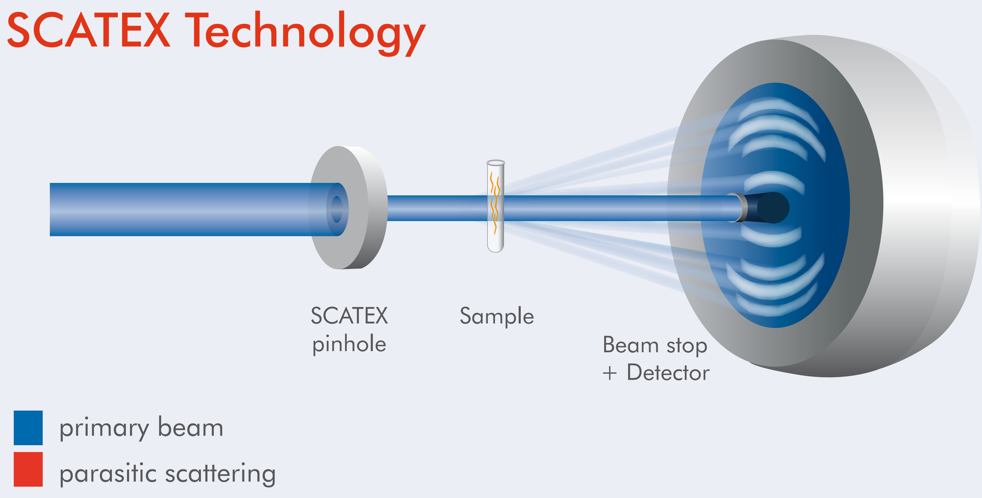



## SCATEX - Incoatec´s Scatterless Pinholes for SAXS Home-Lab Systems

### Conventional Technology




### SCATEX Technology




### Main SCATEX features:

- Germanium pinholes for lower and Tantalum pinholes for higher photon energies
- available sizes:
  100-2000 μm for Ge
  20-2000 μm for Ta

### Your benefits:

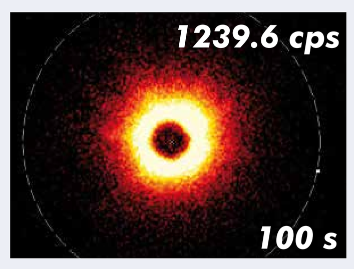
- strongly reduced parasitic aperture scattering
- resolution and photon flux enhancement
- easier and faster pinhole alignment
- no scatter guard needed
- system size shrinks
- data quality improves

## Home-lab SAXS Instrumentation: Performance of SCATEX Pinholes

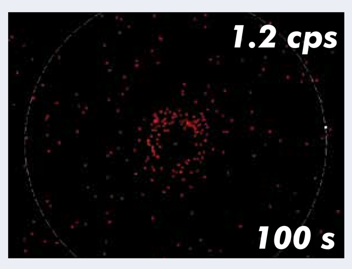
*Comparison of a conventional Pt/Ir and a SCATEX-Ge pinhole, both with 300 μm diameter, measured in a 2-pinhole home-lab SAXS setup. The tested apertures are aligned centrically in the primary beam and act as the beam defining pinhole. No scatter guard is installed.*

- 3 orders of magnitude less parasitic aperture scattering with SCATEX pinholes

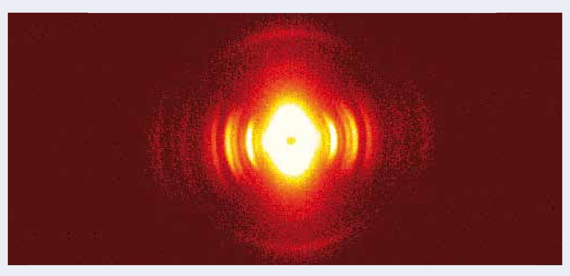
Conventional Pt/Ir Pinhole




SCATEX-Ge Pinhole



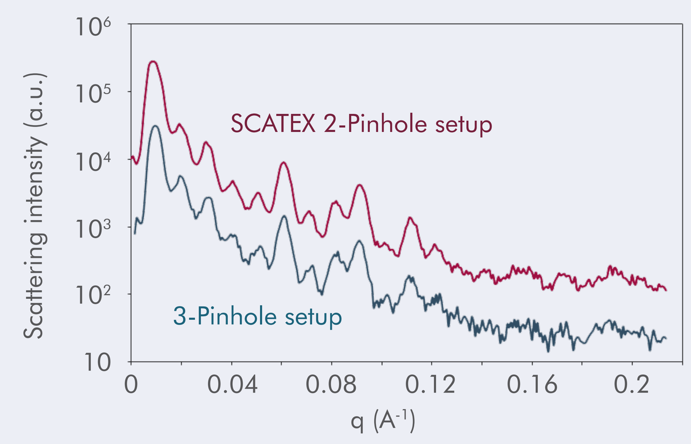

## Comparison of a SCATEX 2-Pinhole Setup and a Standard 3-Pinhole Setup



*SAXS image of a thin fiber of a rat tail tendon, measured with a Bruker NANOSTAR equipped with an IμS.*

### Advantages of a SCATEX 2-pinhole setup

- higher flux and smaller $q_{min}$ possible due to a larger beam defining pinhole and a smaller beamstop
- faster data acquisition possible
- smaller footprint due to less pinholes and shorter beam path




*Scattering intensity vs. q-plot, measured with a 3-pinhole high resolution NANOSTAR and a modified 2-pinhole NANOSTAR equipped with SCATEX pinholes. With a similar resolution the SCATEX setup gives a considerably higher scattering intensity.*

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