

Erzeugung hochbrillanter Röntgenstrahlung im Labor: Status und Zukunft

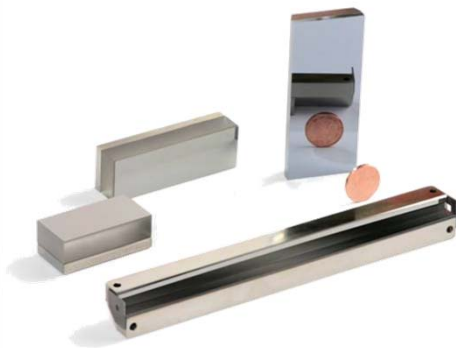


Jörg Wiesmann – Geschäftsführer und Mitgründer der Incoatec GmbH

Incoatec: Innovative Coating Technologies



- joint venture mit der Bruker AXS, gegründet 2002 als spin-off aus GKSS
- Produktion & Entwicklung von Röntgenoptiken und Mikrofokusquellen
- für Laborgeräte und Synchrotrons wie z.B. DESY



Umsatz: > 7 Mio. €

Personal:

50 Personen: 7 Physiker (u.a. GF), 2 Chemiker, 13 Ingenieure (v.a. FH), 3 IT, 16 Techn. Pers., 6 Verwaltung (u.a. BWL, Bio), 3 Aushilfen „400 EUR“, Praktikanten...

Ø Alter: 42 (9/14/12/13/2), 39m / 11w

Geschäftsausstattung:

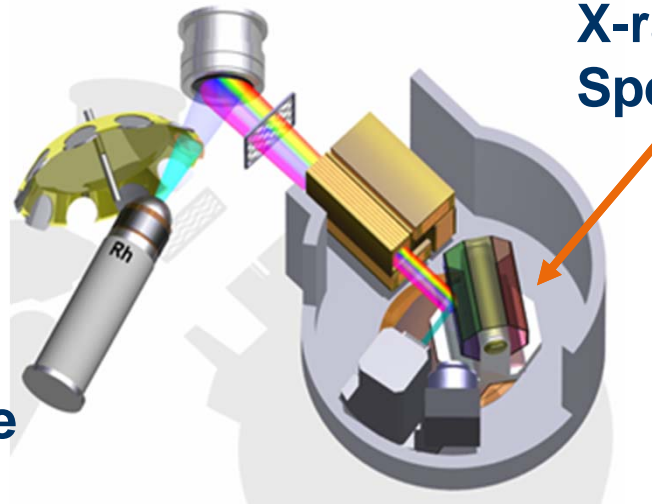
Alles für Produktion und F&E, wichtige Maschinen mind. gedoppelt

Auf > 4000 m²

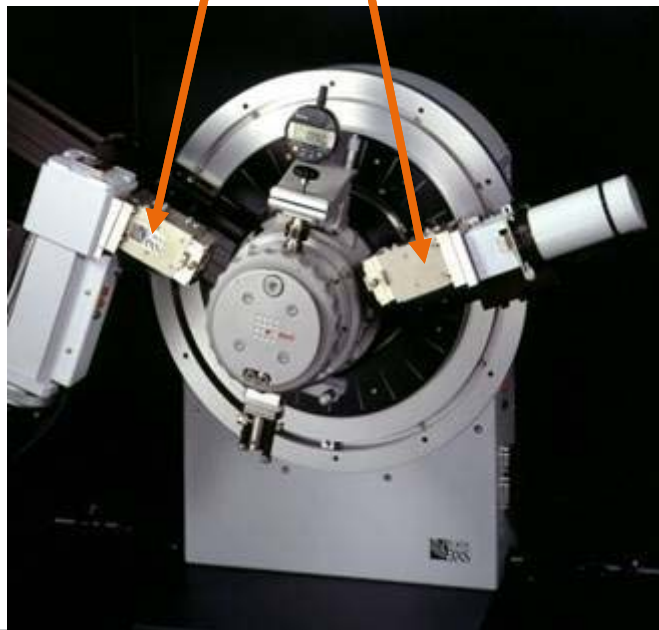
Vorhanden: F&E, Applikationslabor, Special Engineering

Ausgaben für Entwicklung > 10 % vom Umsatz

X-ray Fluoreszenz Spektrometrie



Diffraktometrie



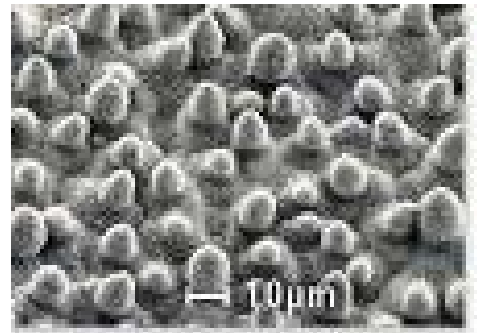
Synchrotron Beamlines

Kunden: große Diversifizierung

Cement Plants



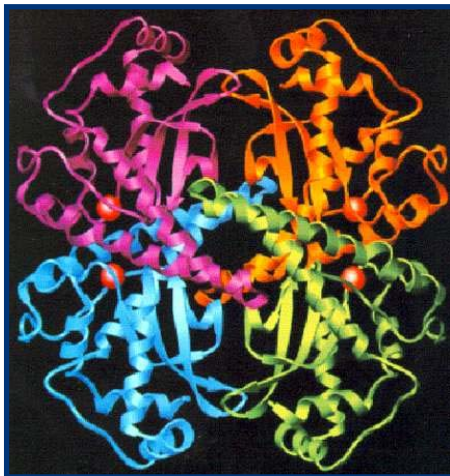
Nanotechnology



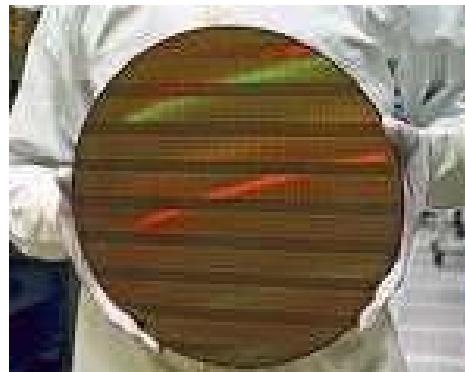
Pharmaceuticals



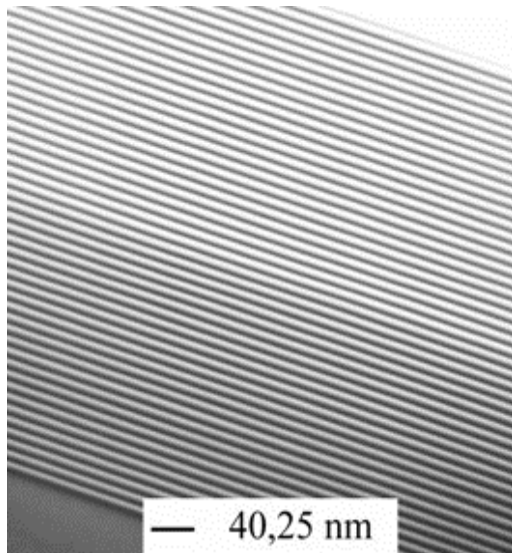
Life Science



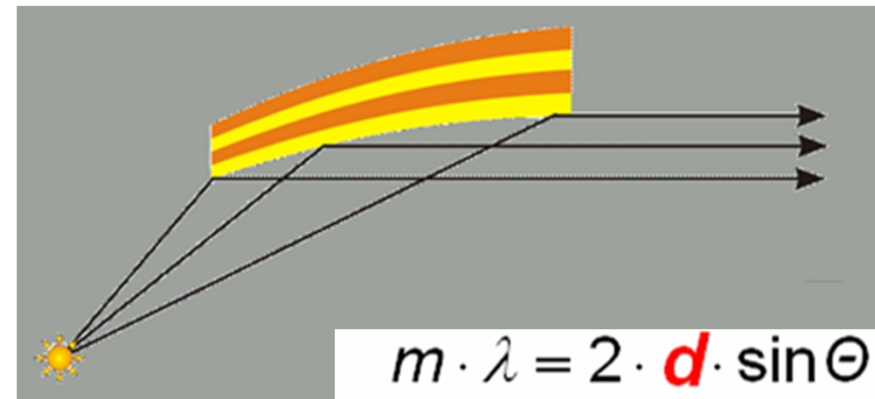
Semiconductor Industry



Mining & Minerals



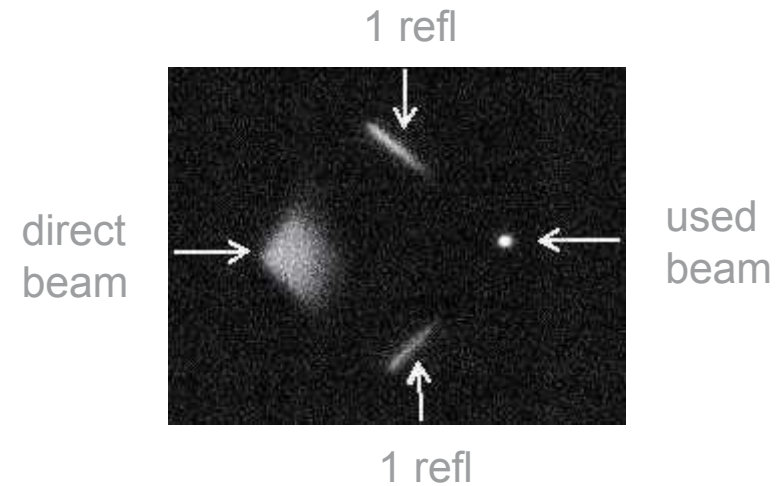
Schichtdicken
Einzellagen 1..10 nm
Gesamtdicken: 0.4 – 1 µm



Geformte Oberflächen (2D und 3D)
Sehr präzise Parabeln, Ellipsen...

Schichtdickenverläufe
bis +/- 0.1% am Ideal

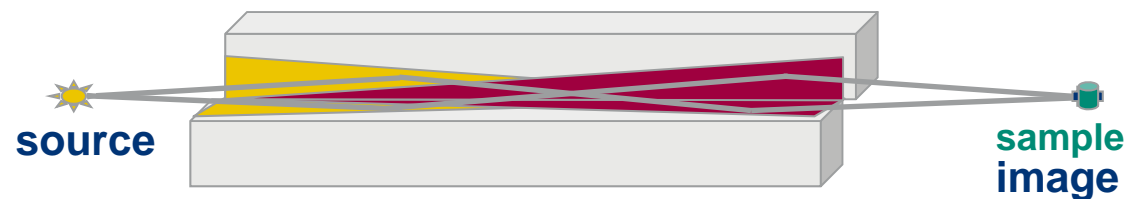
2-dim beam shaping: Montel Optics

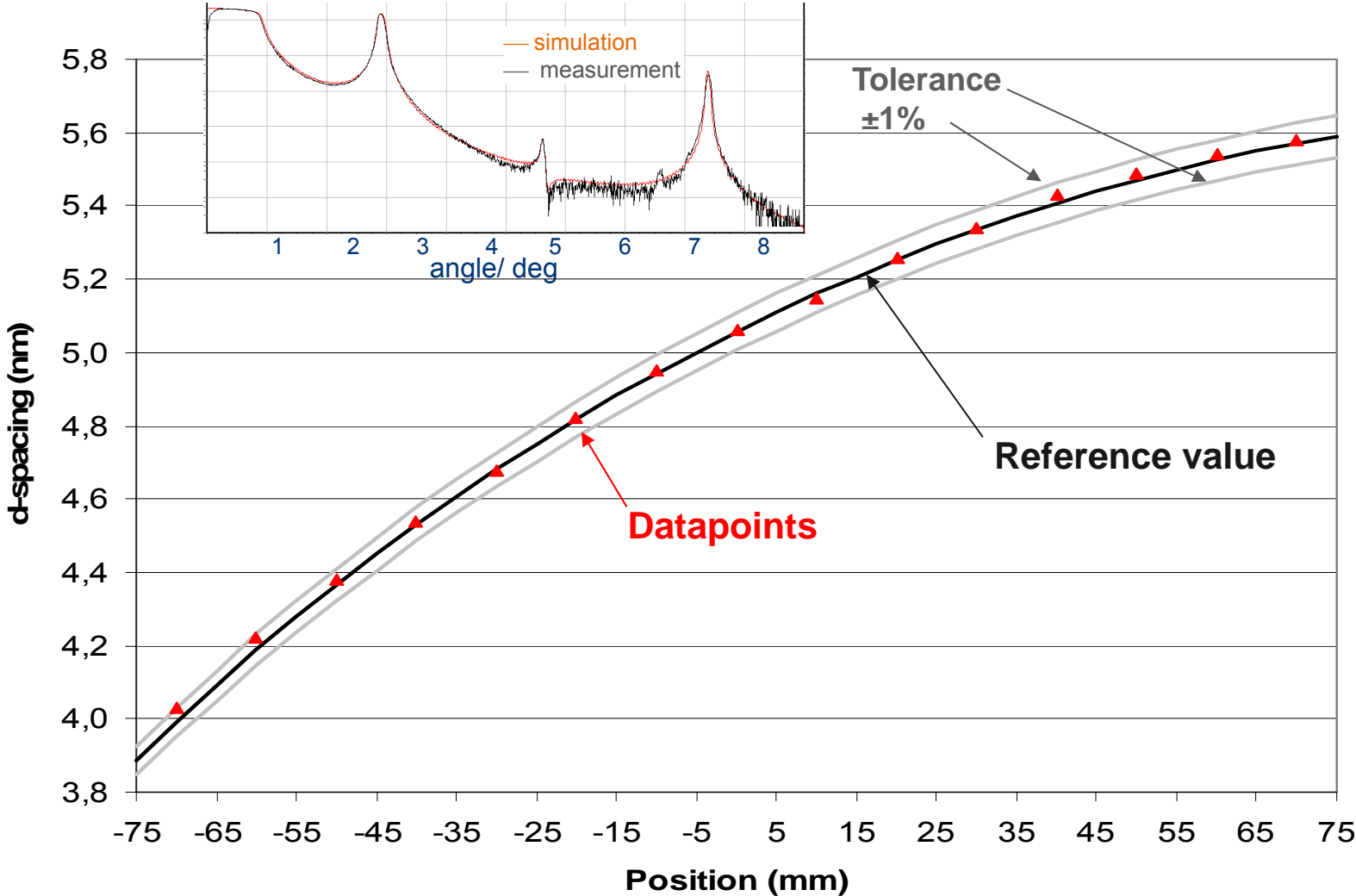


6 - 15 cm

for Cu, Mo, Ag, Cr, Co, ...

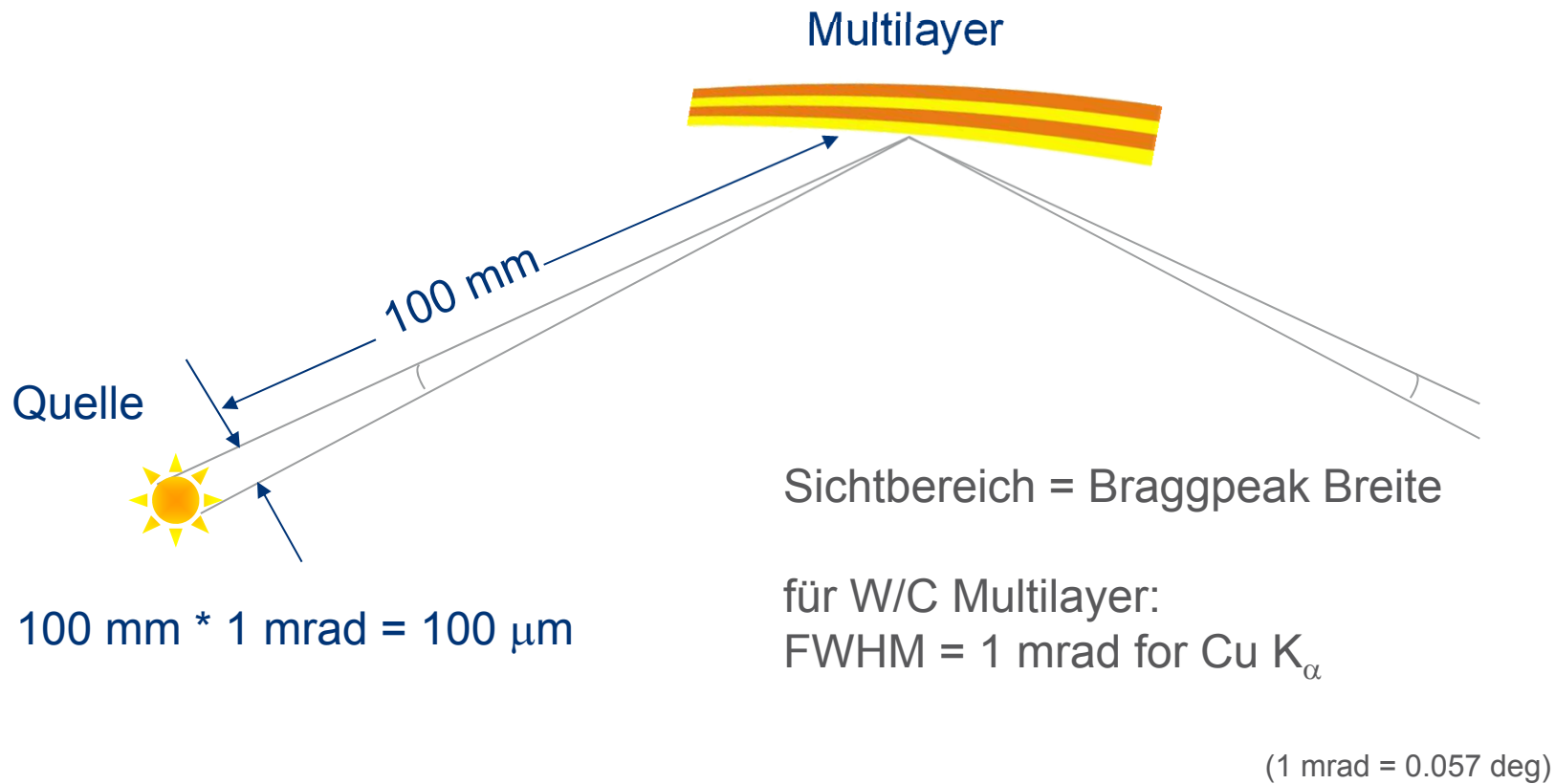
for 2-dim foc, 2-dim coll,
foc+coll (hybrid)





d-spacing accuracy within the tolerance of 1%

Effektive Quellgröße und Sichtbereich der Optik



Von der Optik zur Mikrofokusröhre



Von der Optik zur Mikrofokusröhre



Incoatec Microfocus Source I μ S

- Mikrofokus Quelle für Cu, Mo, Ag, Co, Cr
- < 50 μ m Spot
- 30W, luftgekühlt
- 3 Jahre Garantie
- > 500x verkauft



Integriertes Produkt

- Optik: Beschichtung und Formung
- Gehäuse: Mechanik und Motorisierung
- Röhre: Zulieferer, Design, Elektronik&Mechanik
- Produkt: Vertrieb, Marketing, OEM, Kunden, Zuverlässigkeit, Garantie, Service & Installation

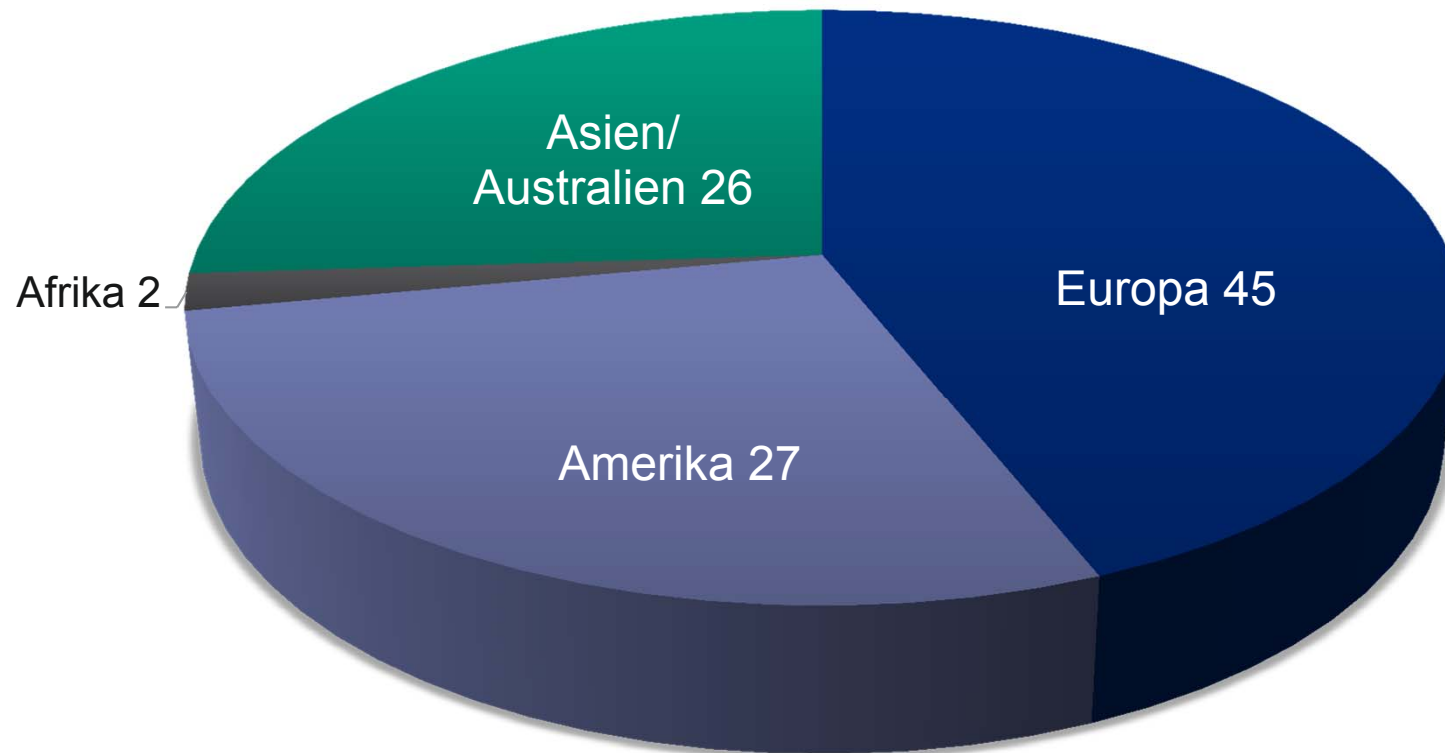




**Röhre:
definiert**
- Wellenlänge
- Brillianz
- Anodenspot

**Optik:
definiert**
- Divergenz
- Fokusgröße
- Fokusabstand

**Röhre + Optik:
definiert Fluss & Flussdichte**



Anwendung: 78% SCXRD 22% XRD

Wellenlänge: 67% Cu, 28% Mo, 3.5% Ag, 1% Cr, 0.5% Co

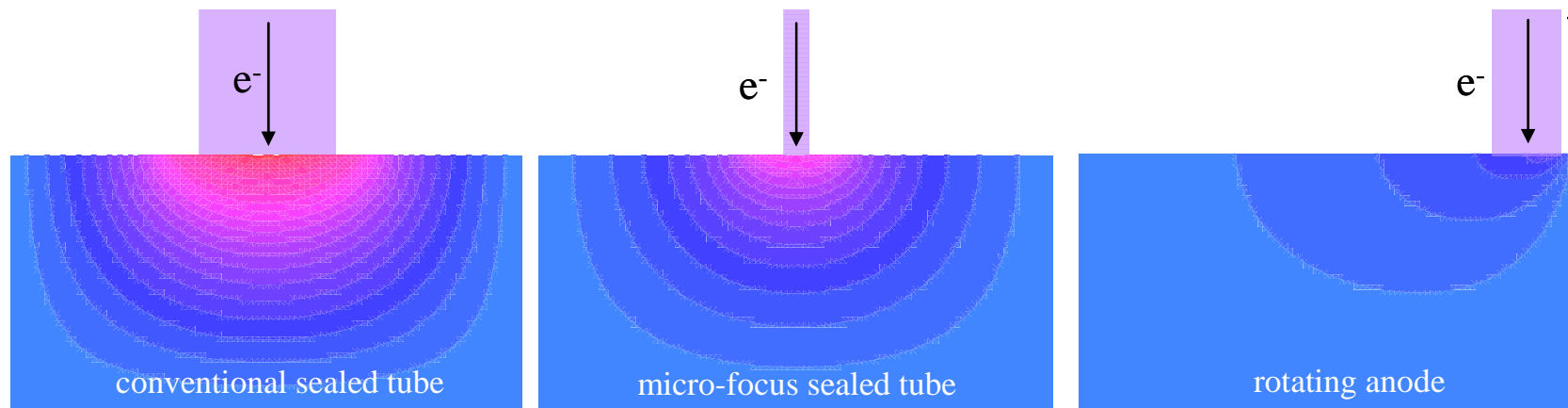
Übersicht: typische Laborröntgenquellen



	Conventional Sealed Tube	Air-cooled Microfocus Tube	“Traditional“ Rotating Anode	Microfocus Rotating Anode
Power (W)	1200	30 - 50	4000 - 6000	2000 - 3000
Typical anode size (mm ²)	0.4 x 8	0.04 x 0.16	0.3 x 3	< 0.15 x 1.5
Power density (W/mm ²)	375	> 5400	5500	> 15000

Laborröntgenquellen: limitiert durch Wärmeabführung

Power loading in all solid-target X-ray sources is limited by heat dissipation



- Large spot
- Quasi-one dimensional heat flow limits power loading

Relative brightness: 1

- Small spot
- Two dimensional heat flow (more efficient cooling)

**Relative brightness:
> 10 times**

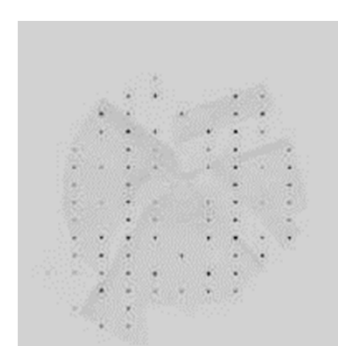
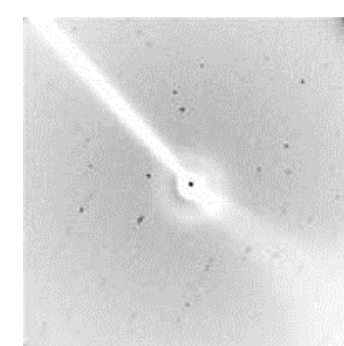
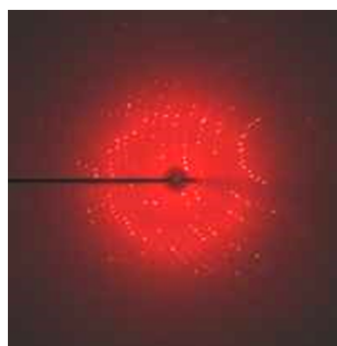
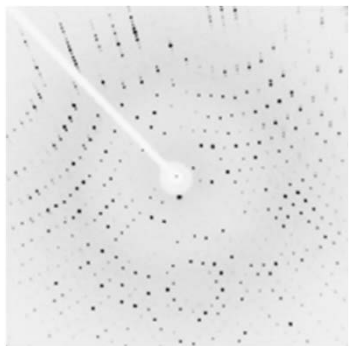
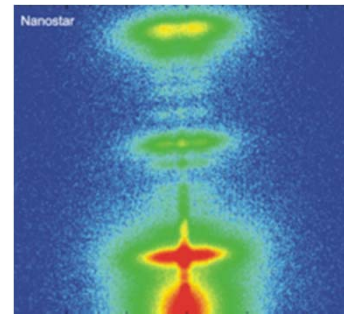
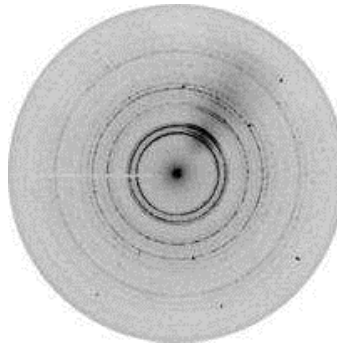
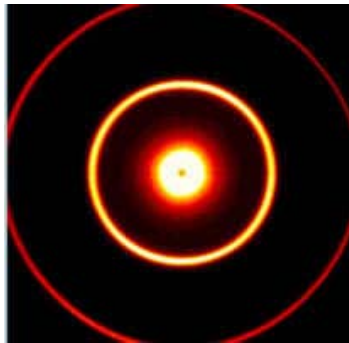
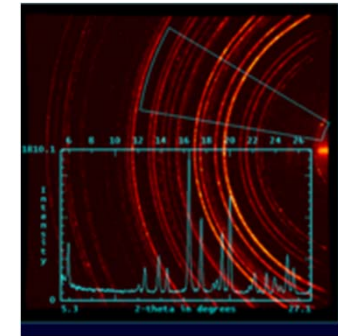
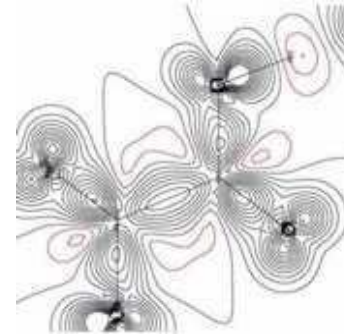
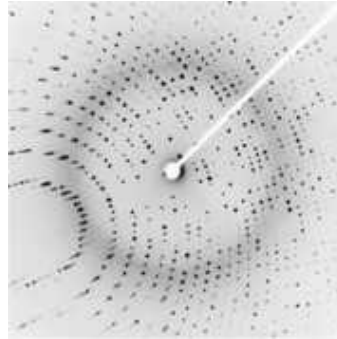
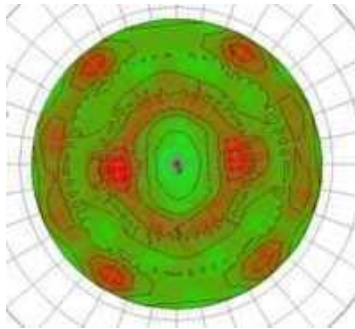
- Large or small spot
- Heat spread by rotation

**Relative brightness:
> 100 times**

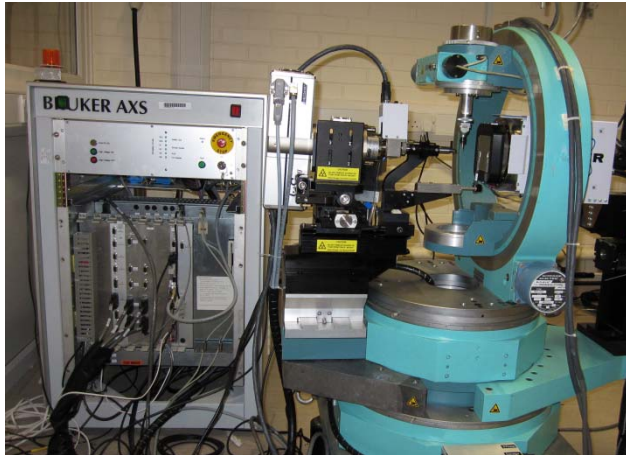
Neue Instrumente für Kristallographie: luftgekühlt mit einer oder zwei μ S



Bruker AXS *D8 Quest & Venture*



Upgrade Fälle: Incoatec bietet an, installiert und leistet Service



Huber, replacement of old sealed tube
(Durham, UK)



Upgrade with 2nd source for a **STOE/Dectris**
System (Vienna, Austria)

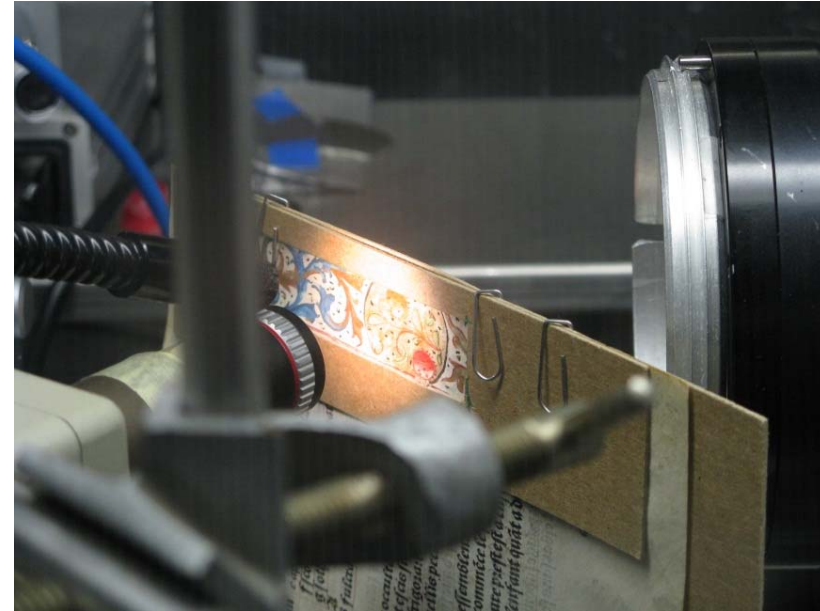
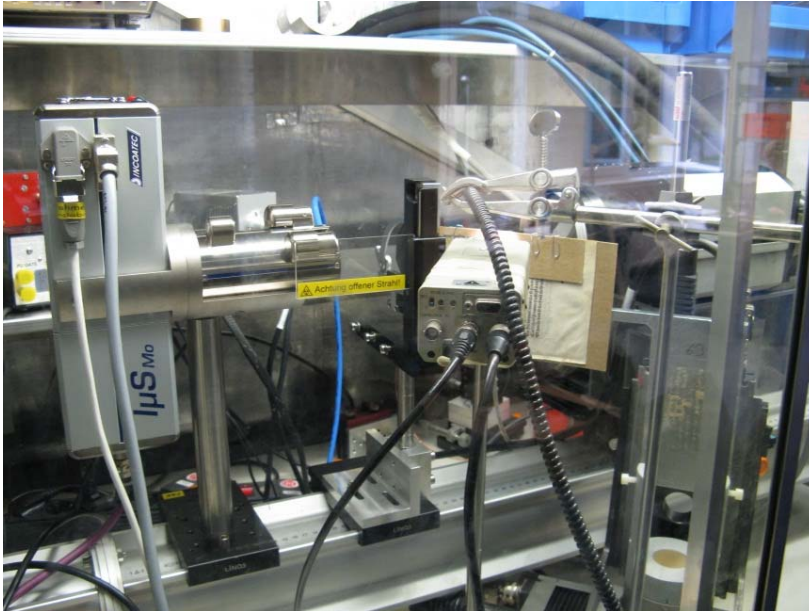


Rigaku R-AXIS IV (Boulder, USA)



Nonius Kappa APEX II (Jena, Germany)

Measurement of a Manuscript



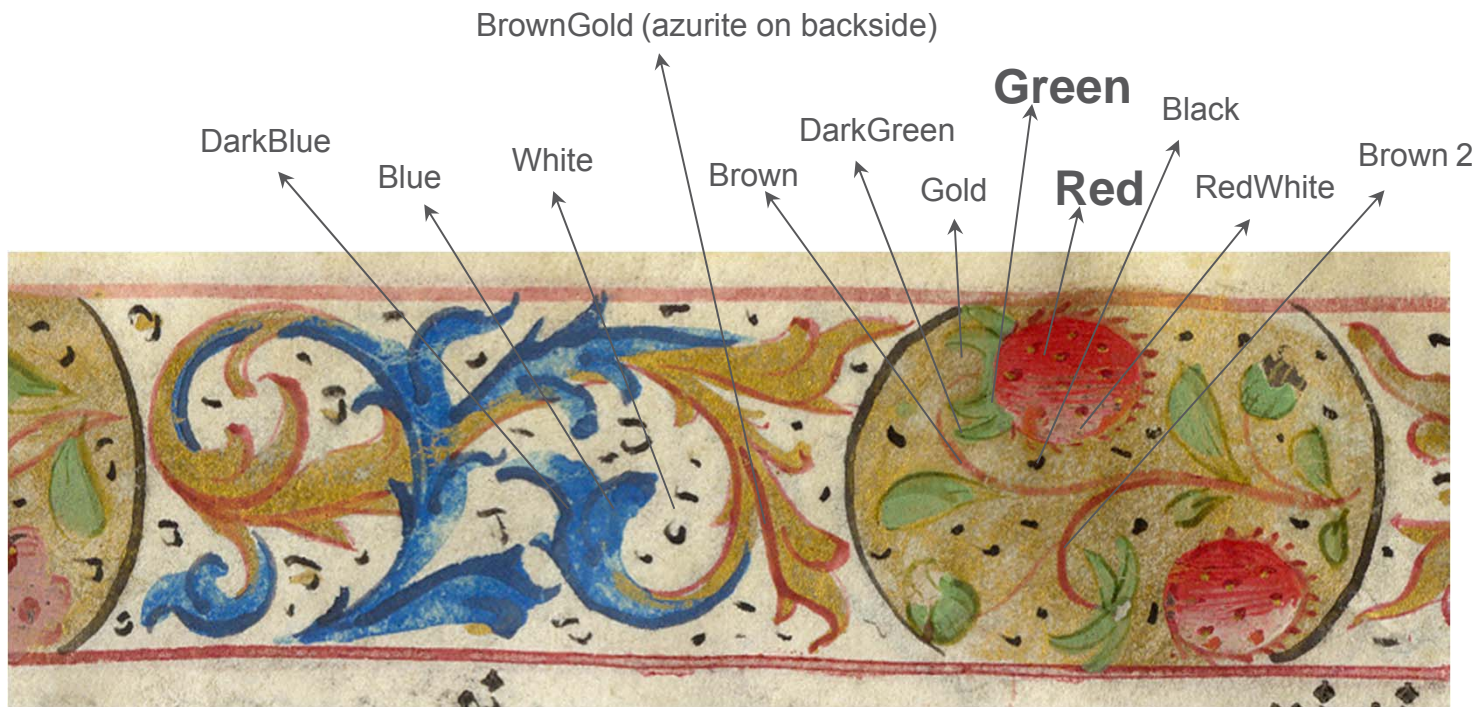
Simultaneous XRD and XRF measurements

Position sensitive measurements using focusing Mo- μ S

- Resolution 150 μ m

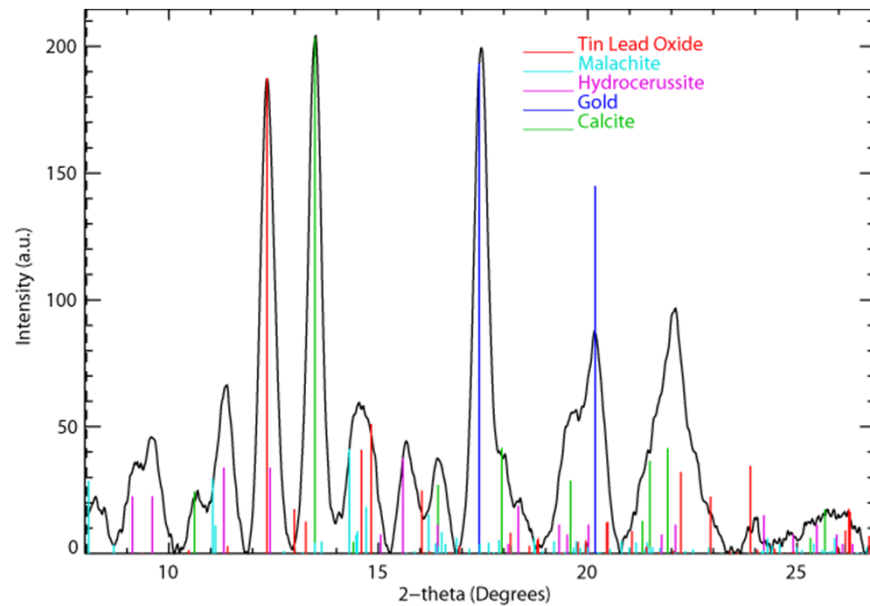
K. Janssens, Antwerpen

Illuminated Manuscript Point Measurements

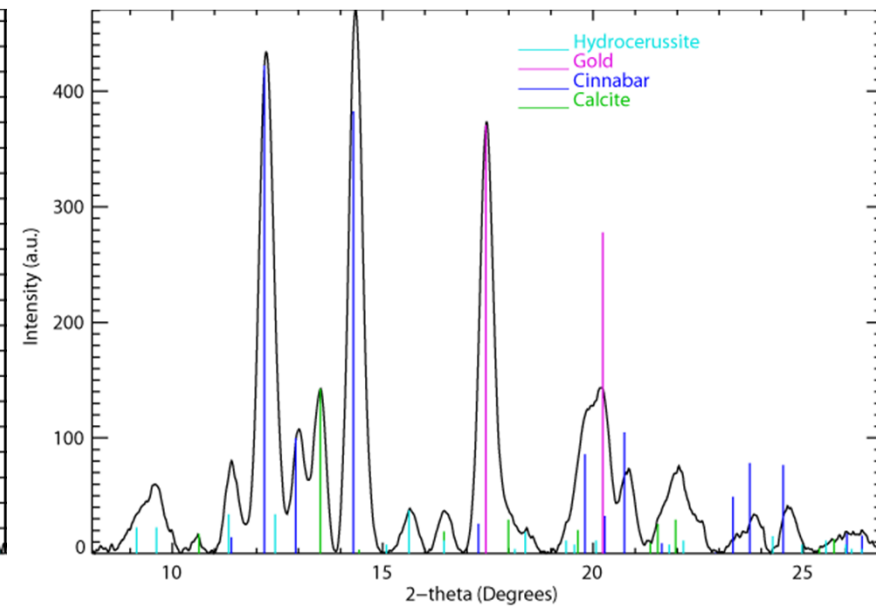


K. Janssens, Antwerpen

Green



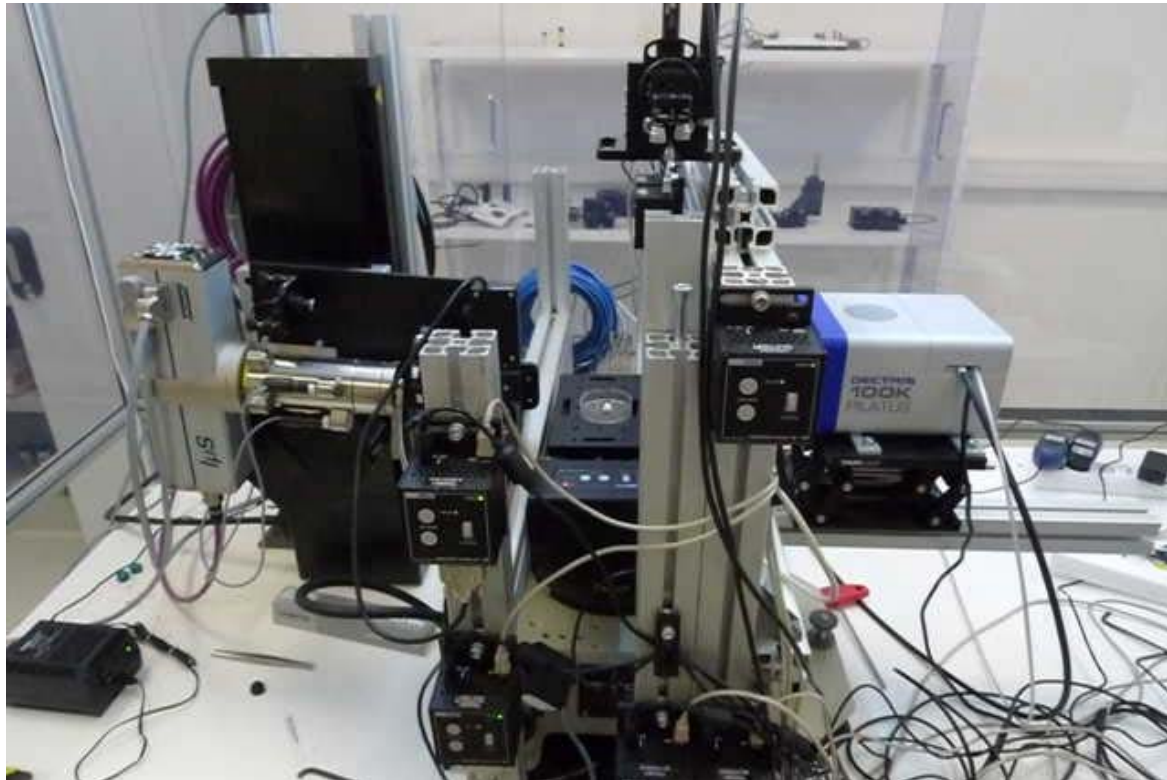
Red



- Mo-I μ S: 50 kV, 600 μ A, 30 sec exposure time
- Scanning Micro diffraction (combined with XRF):
 - 4 x 4.5 mm², resolution 150 μ m, Total measurement time: 18 h
- Measurements and data evaluation by Frederick Vanmeert

K. Janssens, Antwerpen

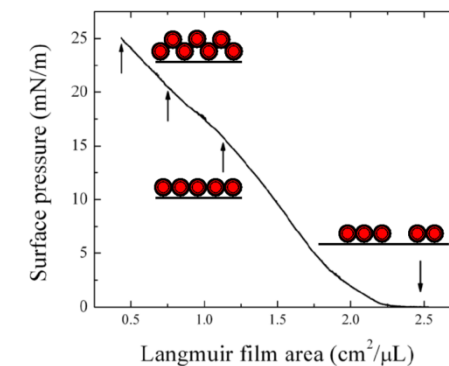
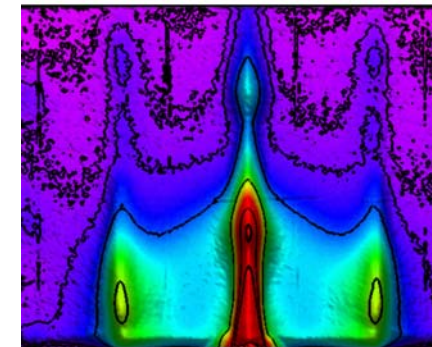
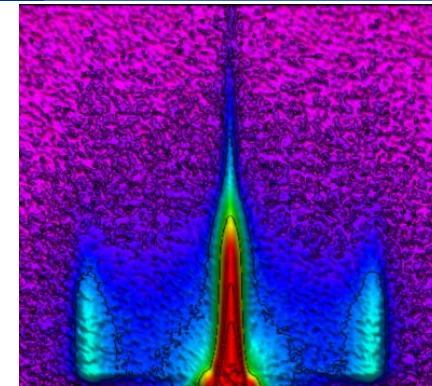
GISAXS measurements



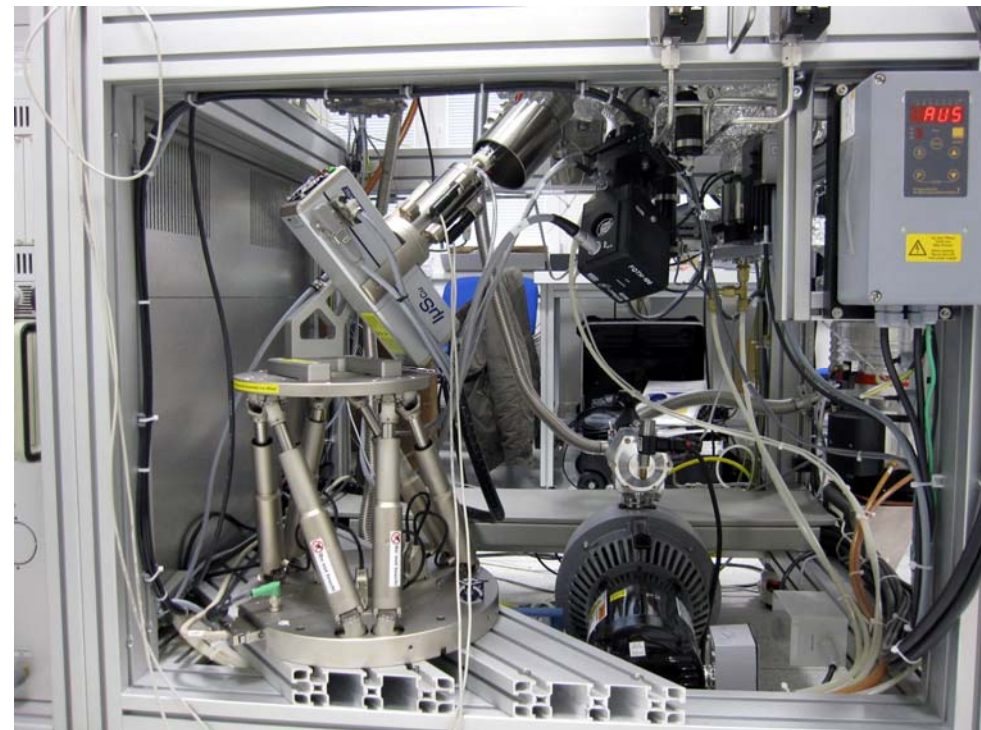
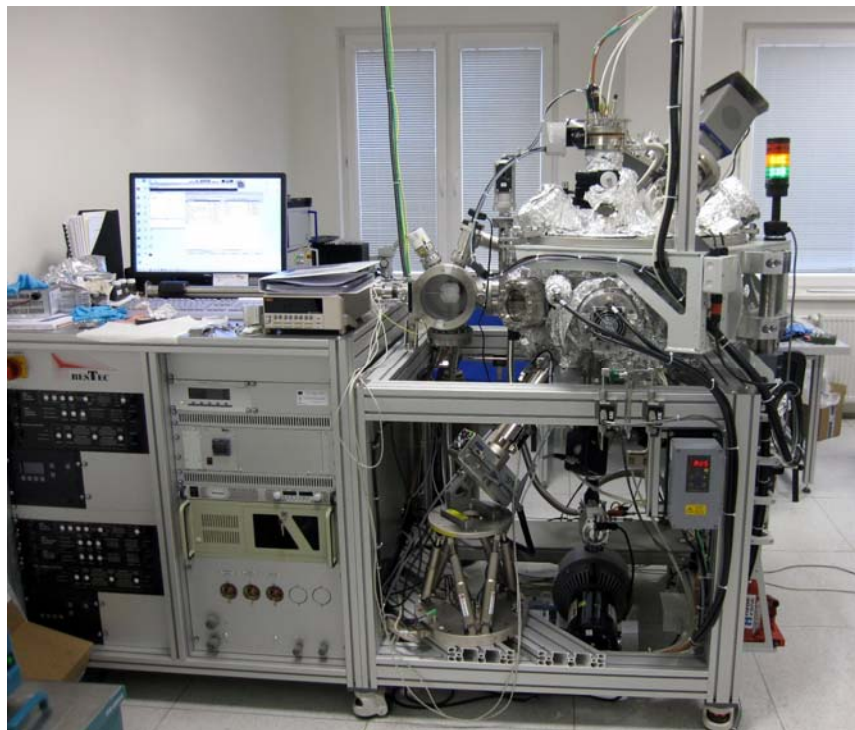
Special setup with I μ S:

- Characterization of liquid surfaces
- Time resolved measurement of compressed surface

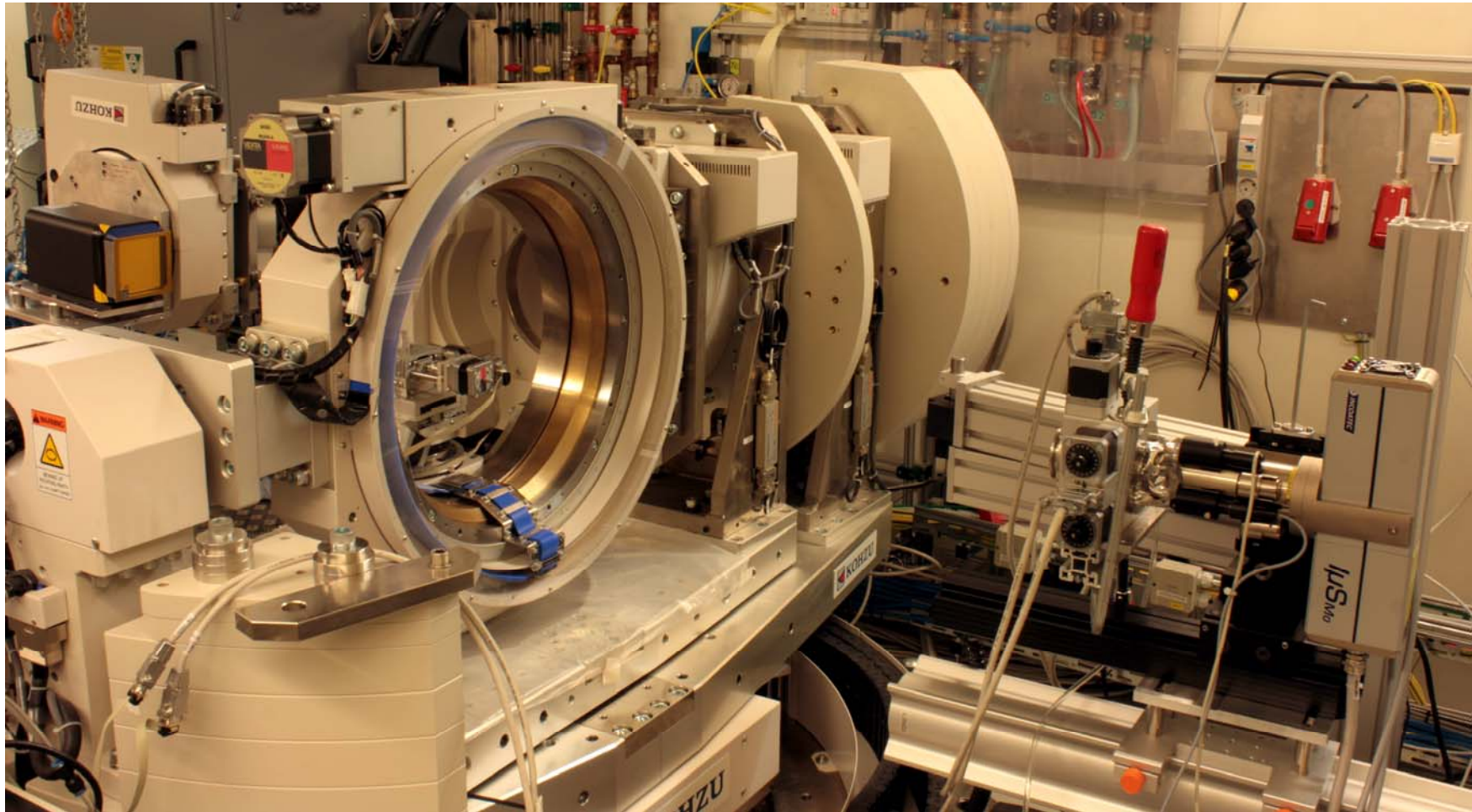
P. Siffalovic, Slovak Academy of Science, Bratislava



Engineering special adaptation of μ S Cu HB to ion beam deposition UHV chamber:
Pilatus 200k, PI Hexapod + full safety concept (Bratislava, Slovakia)

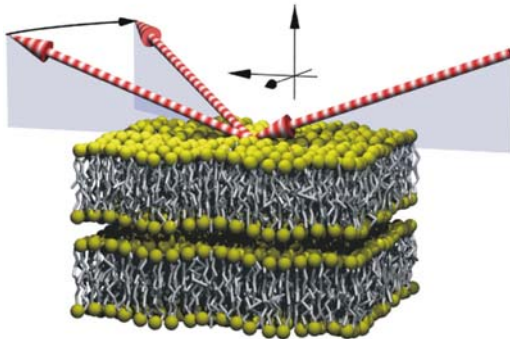


Synchrotron Shutdown? μ S takes care!



Engineering Special: Adaptation for high resolution XRR / XRD / (GI)SAXS plus KOHZU diffractometer, DECTRIS Eiger 1M (HRXRD Beamline P08, PETRA III, DESY, Hamburg)

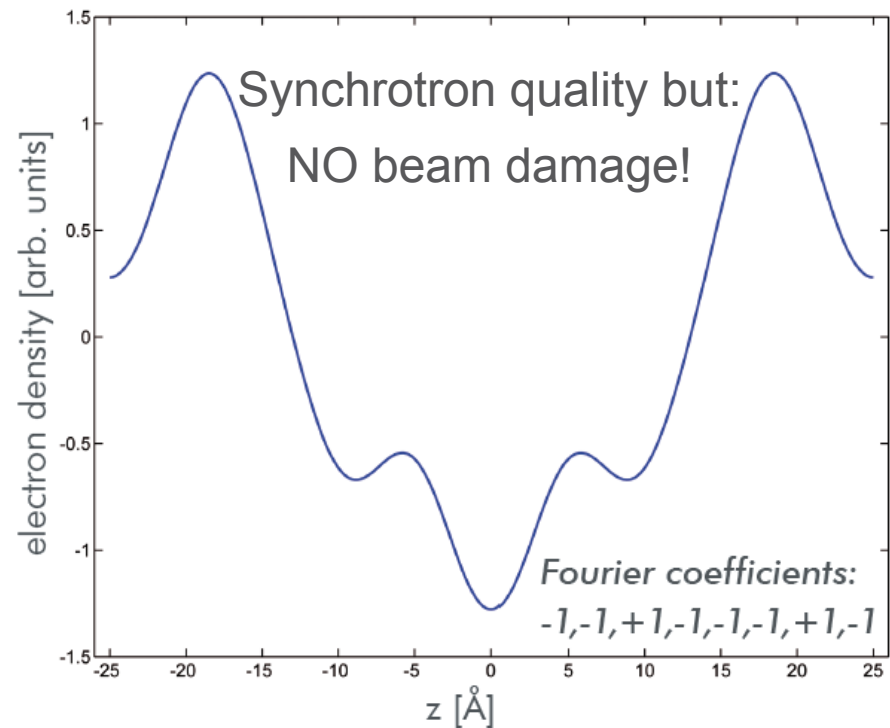
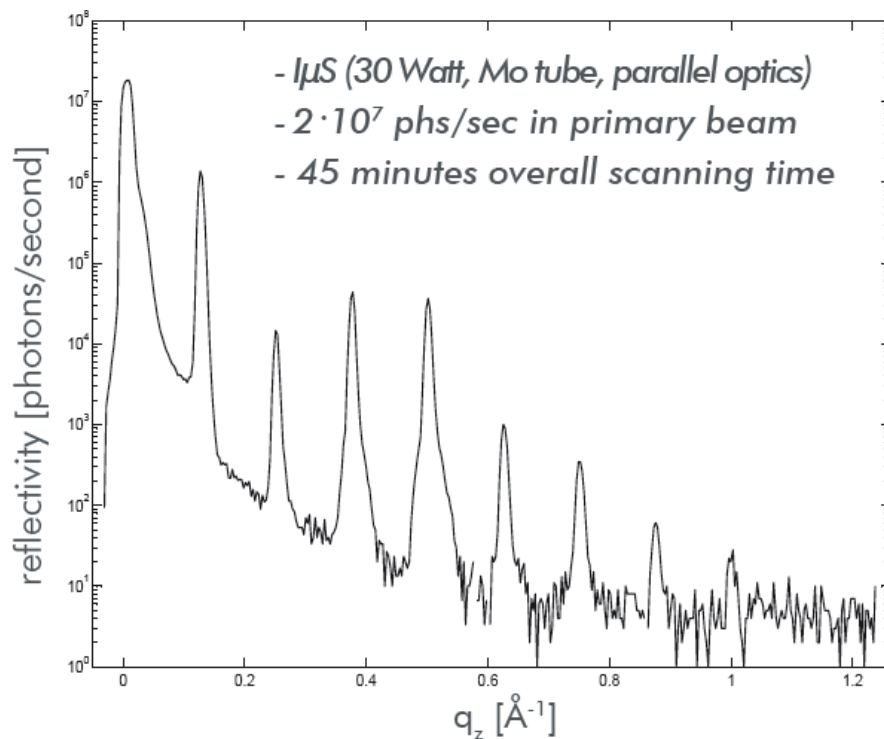
Engineering specials: XRR of Multilayer Lipid Membrane Stacks



High resolution structure analysis liquid crystalline DOPC multilayer lipid membrane stack on silicon support (99% RH, RT)

Left bottom: Reflectivity scan with Incoatec $1\mu\text{S}$ Mo 30W with parallel beam optics ($q_z < 0.6 \text{ \AA}^{-1}$: 3 sec/step, $q_z > 0.6 \text{ \AA}^{-1}$: 10 sec/step)

Right bottom: Reconstructed electron density profile (fourier synthesis) comparable to previously achieved synchrotron results!



NEU: μ S Upgrade Flyer

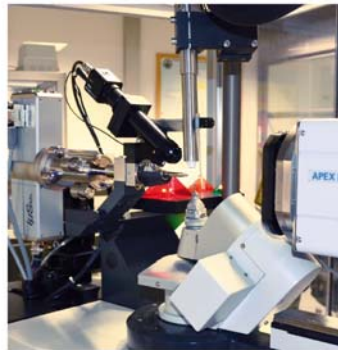


μ S upgrades



Upgrading X-Ray Diffractometers with a Unique Microfocus Source

Old systems shining in new bright light ...



Nonius Kappa APEX II in Jena, Germany



Huber goniometer with APEX II detector in Durham, UK



Marresearch 345 in Liege, Belgium

Incoatec offers a unique possibility to upgrade your existing diffractometer by installing our high-performance, air-cooled and low-power microfocus source μ S. You have a Bruker AXS, Marresearch, Nonius, STOE, Rigaku, Huber or some other system?

Your upgrade options:

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

Your benefits:

- No maintenance, only single phase power and no water cooling required
- 3 years warranty
- Implementation into Bruker software or stand-alone operation (remote control)
- Maximum installation down time of only 2 - 4 days
- Full integration into existing safety circuits, new safety concept development on request
- Full compliance with European Machinery Directive 2006/42/EC

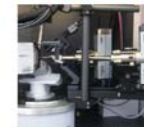
... and everything becomes possible!

μ S upgrades

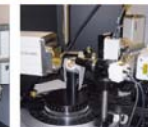


Your home lab diffraction system lacks intensity? Brighten it up with Incoatec's state-of-the-art microfocus X-ray source μ S! A significant increase in flux density of up to $2 \cdot 10^{10}$ ph/(s·mm²) and smallest beam cross-sections of down to 95 μ m can be obtained. With an μ S upgrade you will get the highest standard of quality, precision and safety *Made in Germany*. Our long-standing experience is based on more than 60 upgrades of μ S integrations into nearly all existing X-ray diffractometers worldwide. Your local service contact can be involved in the on-site installation. Additionally, Incoatec provides profound customer support during the whole project and beyond. We take care!

Upgrades on Bruker AXS systems



Bruker APEX II DUO μ S in Düsseldorf, Germany



Bruker SMART APEX DUO μ S in Aachen, Germany



Bruker NANOSTAR in Vienna, Austria



Bruker DS DISCOVER GADDS in Karlsruhe, Germany

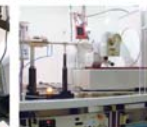
Upgrades on other systems



Nonius Kappa APEX II in Basel, Switzerland



STOE/Dectris dual source setup in Vienna, Austria



Marresearch 343 diffractometer in Basel, Switzerland



STOE IPDS II in Mainz, Germany

Special engineering



Combined XRF/XRD setup for painting analysis in Antwerp, Belgium



Adaptation to UHV deposition chamber for in-situ studies in Bratislava, Slovakia



Replacement of Rigaku RU-200 generator in Boulder, USA



Huber system for SAXS in Tamkang, Taiwan



HRXRD setup at synchrotron beamline (Petra III, DESY) in Hamburg, Germany



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

Is your diffractometer ready to shine brightly again?

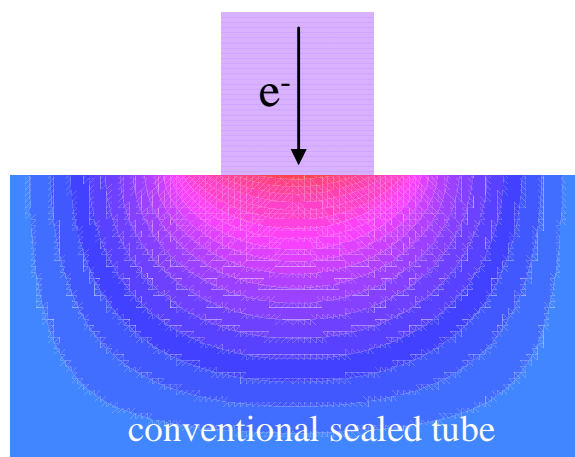
Contact and challenge us!

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Dr. André Beerlink
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www.incoatec.de

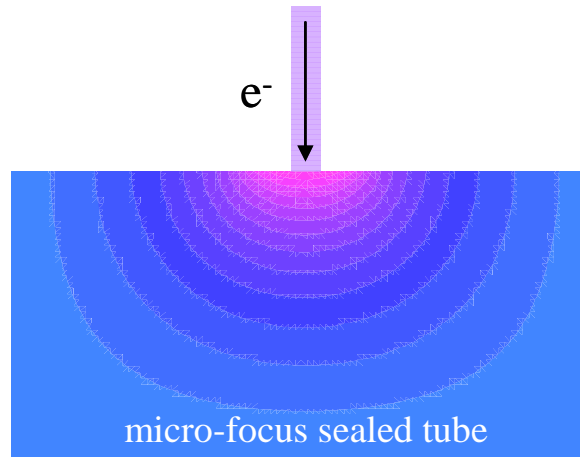
All configurations and specifications are subject to change without notice. IDO-F20-007C © 2014 incoatec GmbH

Power Load is Limited by Heat Dissipation in All Solid Anode Sources



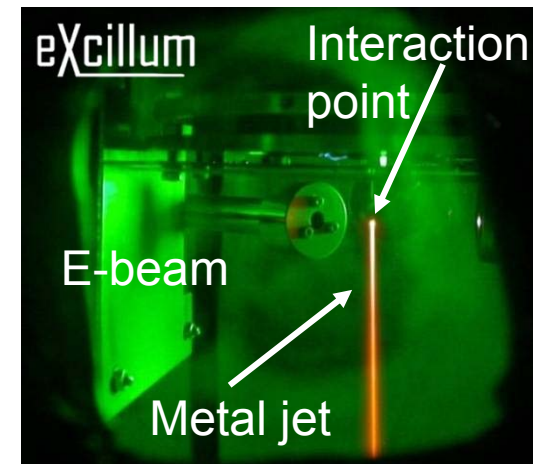
- Large Spot
- Quasi-1D heat flow limits power density
- $\sim 0.5 \text{ kW/mm}^2$

Relative B: 1



- Small Spot
- 2D heat flow allows more efficient cooling
- $\sim 5 \text{ kW/mm}^2$

Relative B: > 10



- Very small Spot
- High speed jet of liquid metal alloy
- $> 100 \text{ kW/mm}^2$

Relative B: > 100

Excillum's Liquid-Metal-Jet X-Ray Source



**Electrons generated by flat LaB_6 cathode
(70 kV, 2.8 mA)**

Focusing through electro-magnetic lenses

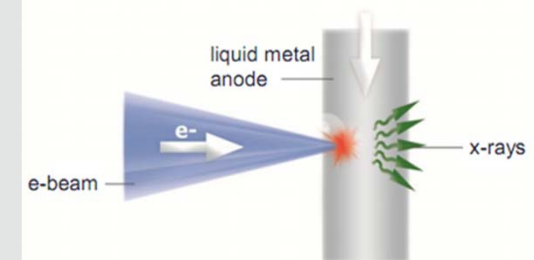
High-speed liquid-metal-jet anode

Self-healing, self-cooling

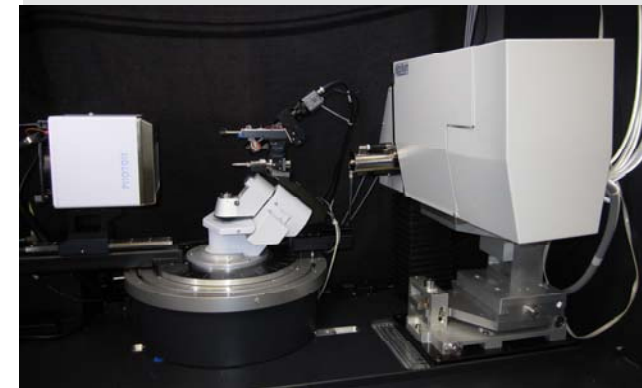
No longer limited by melting

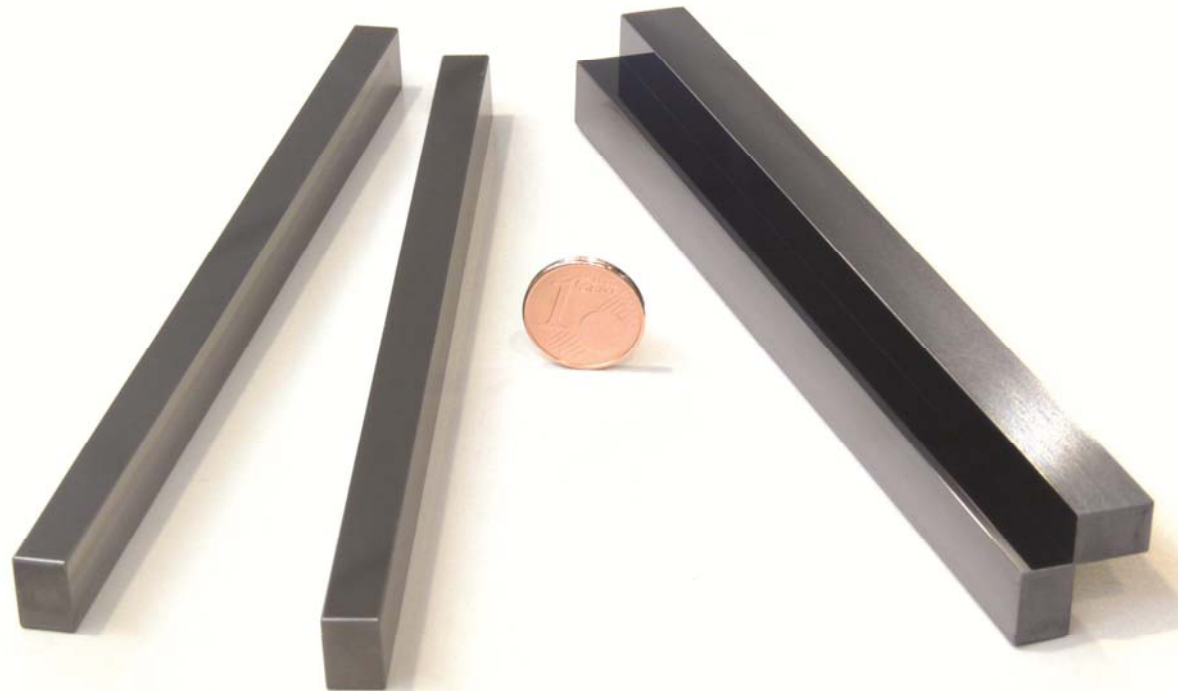
Power load > 100 kW/mm² at max. 200 W

**Typical spot sizes for diffraction:
(60..80) x 20 μm^2**



eXcillum





- **Beschichtung ähnlich wie für konventionelle Röhren, aber enge Toleranzen**
- **vorgeformte Siliziumsubstrate: Qualität muss passen zur Quellbrillanz**

- **Beschichtung von Multilayern: nahezu perfekt**
- **Qualität wird immer günstiger**
- **Optiken werden an Quellen angepasst**
- **Quellen können optimiert werden**
- **Anwendung wird besser berücksichtigt → kundenspezifische Lösungen**

Incoatec

- Your partner for X-ray optics and microfocus sources!
- Continuous innovation is our goal!



10 years
of innovations

Monel Optics
Microfocus Sources

Göbel motors
development
multilayer X-ray optics
made in Germany
1µS High Brilliance
production