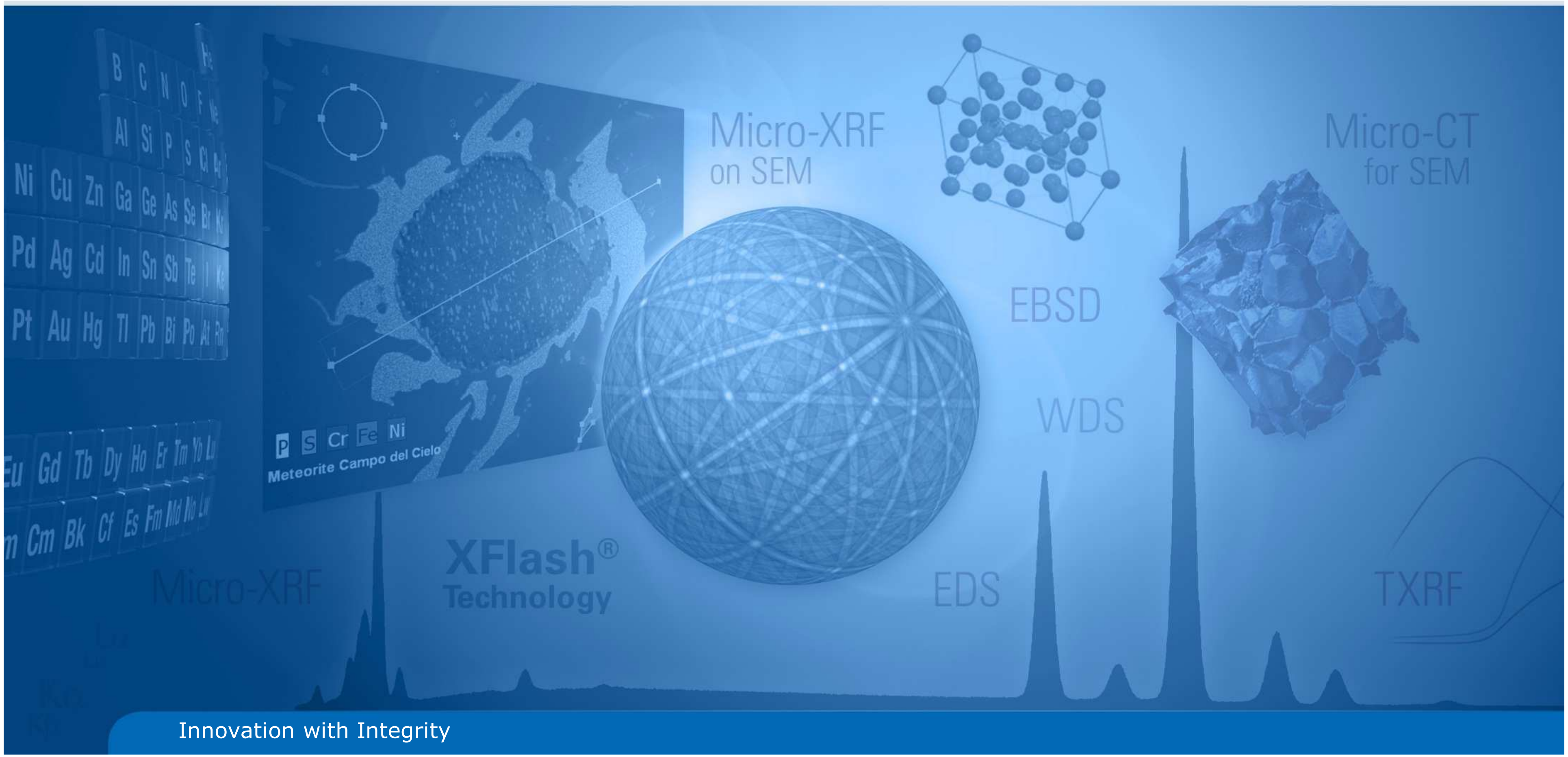
Bruker Nano Analytics

X-ray Spectrometers for science and research

Paris Spectroscopy Meeting March 16th 2015

Thomas Reul, Martin Rohde, Bruker Nano GmbH



Bruker Nano Analytics
Headquarters in Berlin Adlershof

Science and Technology Park in Berlin-Adlershof (WISTA)

- > 400 High-Tech companies with over 4,000 employees
- 11 Research Institutes (PTB, BESSY, BAM, DLR, HMI, IKZ,…)
- Humboldt University (natural sciences, 7,000 students, 850 staff)

Bruker Nano Analytics
Headquarters in Berlin Adlershof

Bruker Nano GmbH Facility

- 10,000 sqm self-owned building
  (partly sub-leased)
- Development and manufacturing of all BNA products
- International Sales and Service Management
- Demo-, Application and Training Center
- 150 Employees

Bruker Nano Analytics
Corporation

- Bruker Corp. publicly traded at NASDAQ (BRKR)
- Revenue > $1.79 bn (2012)
- > 6.000 employees

Bruker Scientific Instruments Segment

- **Bruker BIOSPIN Group**
  - **MR Spectroscopy Division** – NMR, EPR, CMR
  - **Preclinical Imaging Division** – MRI, MPI, µCT
- **Bruker CALID* Group**
  - **Optics Division** – FT-IR, FT-NIR, Raman
  - **Daltonics LSC Division** – Mass spectrometry
  - **Daltonics CAM Division** – ICP-MS,chromatography
  - **Detection Division** – CBRNE detection
- **Bruker MAT Group**
  - **AXS Division** – XRD, XRF, SC-XRD, µCT
  - **Nano Surfaces Division** – AFM, SOM, TMT
  - **Nano Analytics Division** – EDS/EBSD, µXRF, TXRF
  - **Elemental Division** – HH-XRF, OES, CGA

Bruker EST Segment

- LT superconductors
- HT superconductors
- Hydr. extr. Magnets
- Synchrotron Instr.
- Research Instr.

(„big science infrastructure")

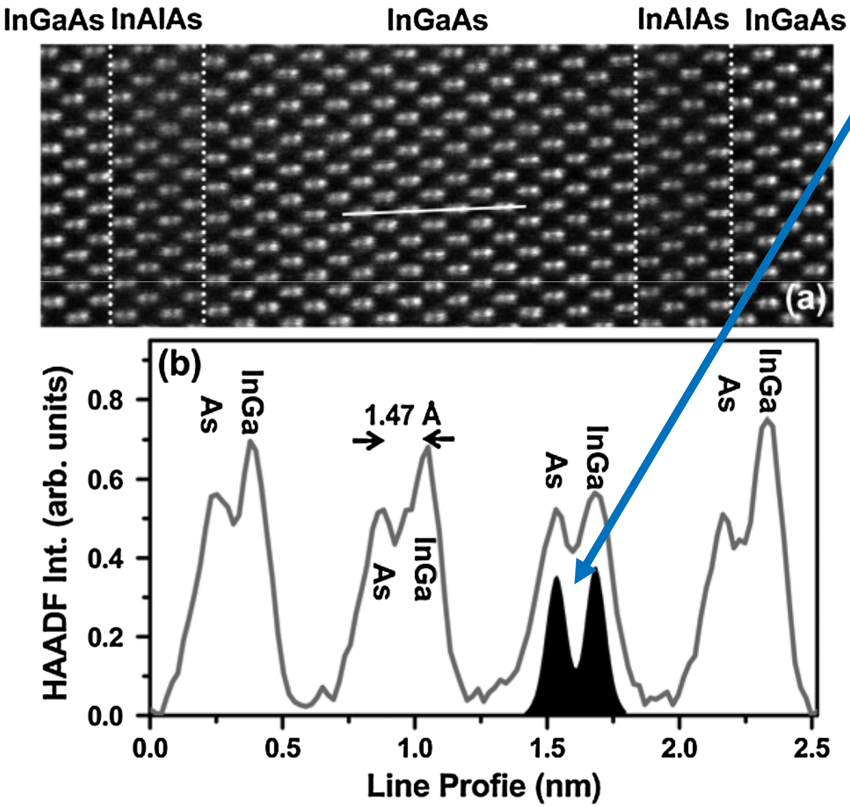
*CALID: Chemical, Applied, Life Science, IVD and Detection

Bruker Nano Analytics

Nano - EDS Mapping on atom columns

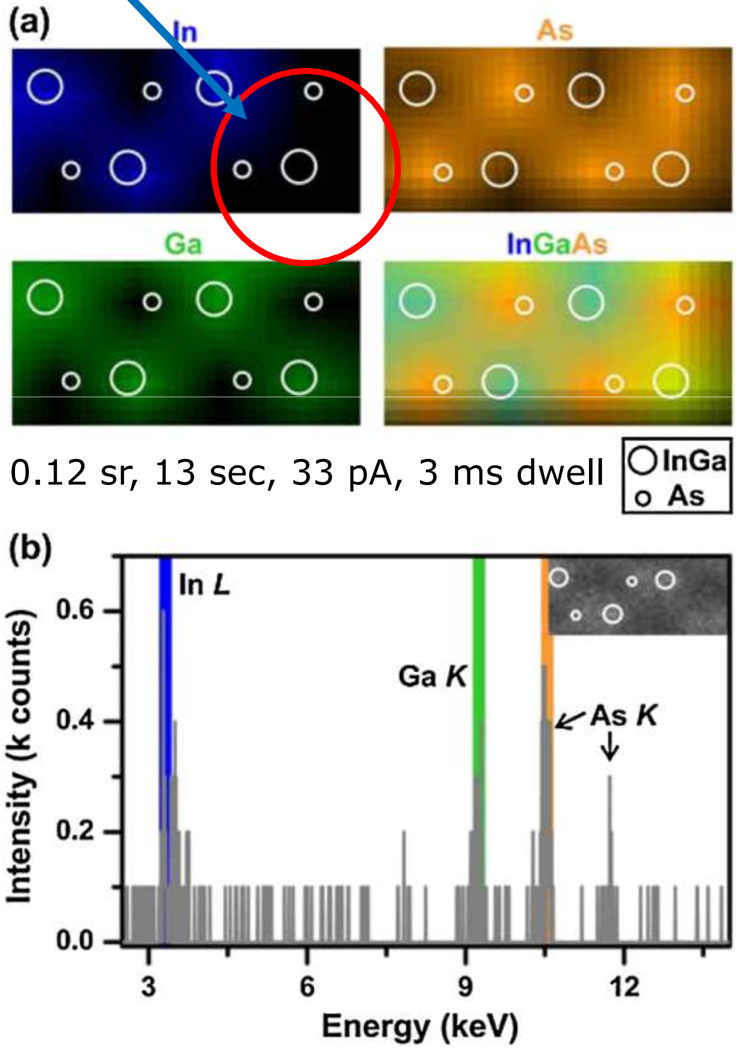
Indium missing in one atomic column

SDD for STEM (30mm^2, ~0.1sr)



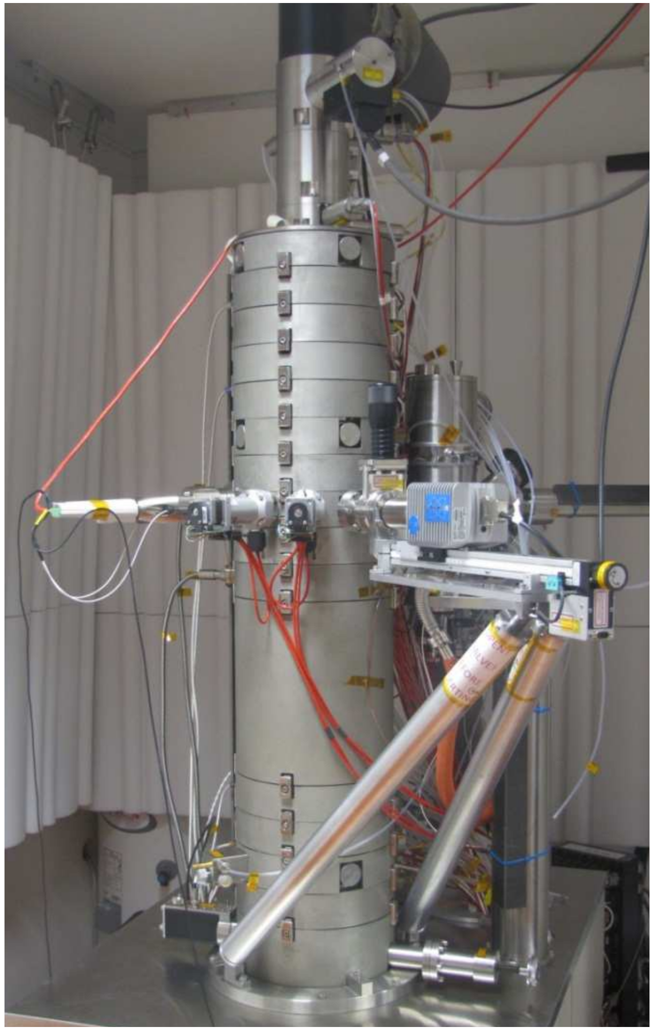
M. W. Chu et al.

Phys. Rev. Lett. 104, 196101 (2010)



0.12 sr, 13 sec, 33 pA, 3 ms dwell

Single Atom EDS



EDS with 100 mm² SDD
oval detector area, no window

60kV Nion UltraSTEM

$$R=(N\cdot\sigma/A)(\omega\cdot\Omega/4\pi\cdot\varepsilon)$$

R: count rate, X-rays / s / atom
A: scanned area
N: beam current, electrons / s
σ: cross section for particular atom and shell
ω: fluorescence yield
$\Omega/4\pi$: geometrical efficiency (solid angle)
ε: quantum efficiency

	theo	~ 2x	exp
Si-K	7 cts/s		4 cts/s
C-K	2 cts/s		1 cts/s
Pt-M	28 cts/s		14 cts/s

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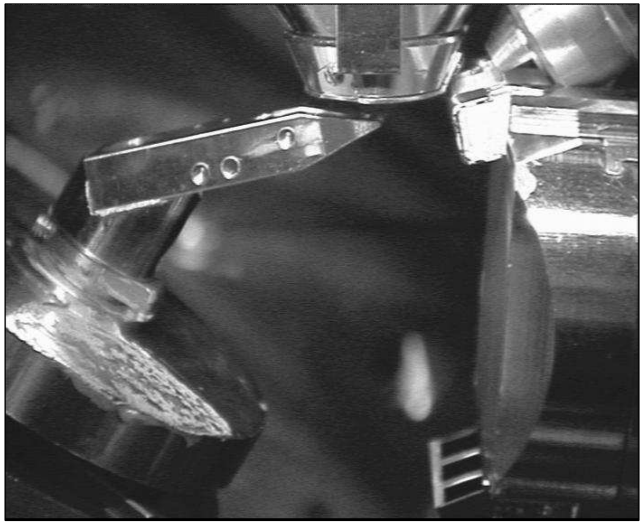
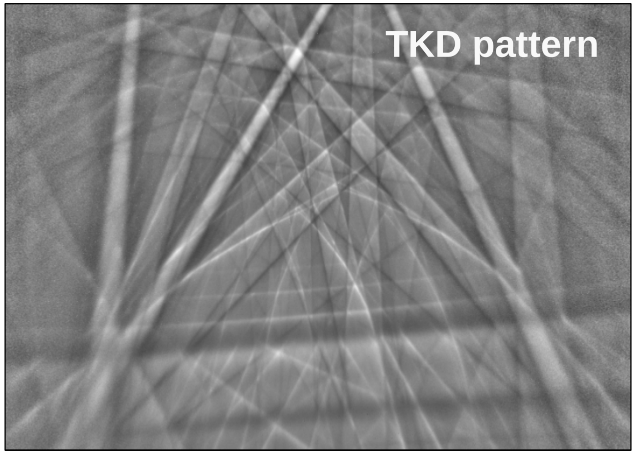
Transmission Kikuchi Diffraction in SEM

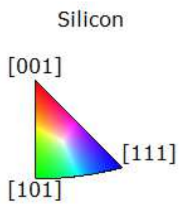


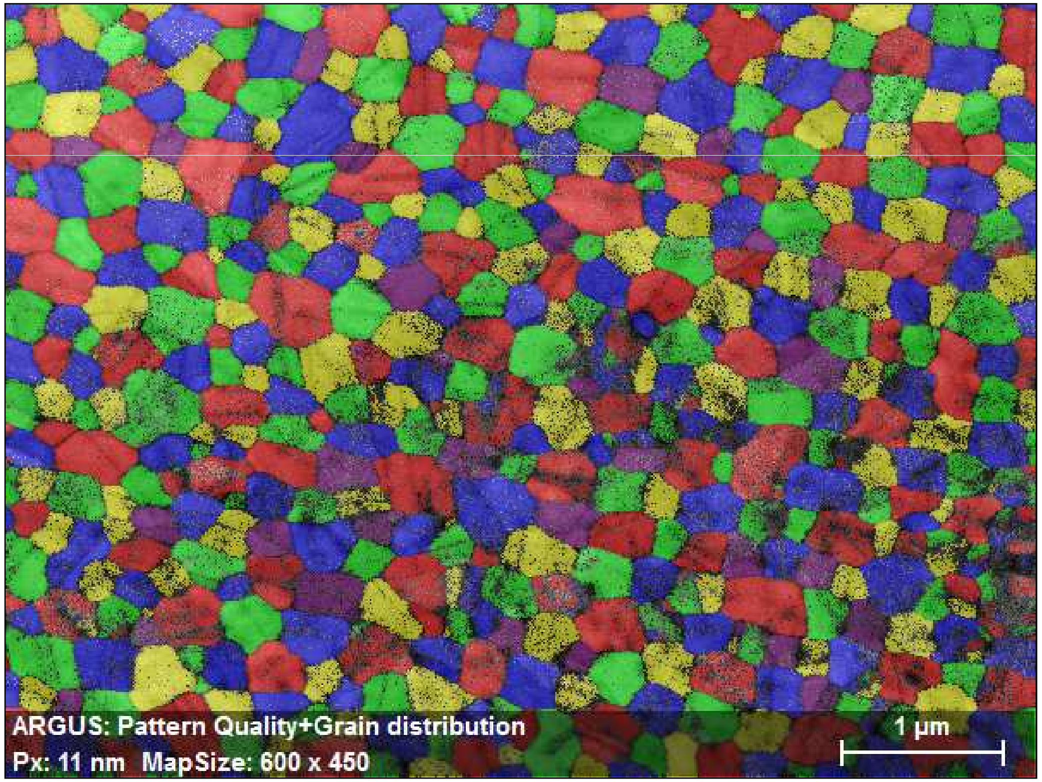


Polycrystalline Si thin film

30 kV EHT

11 nm step size

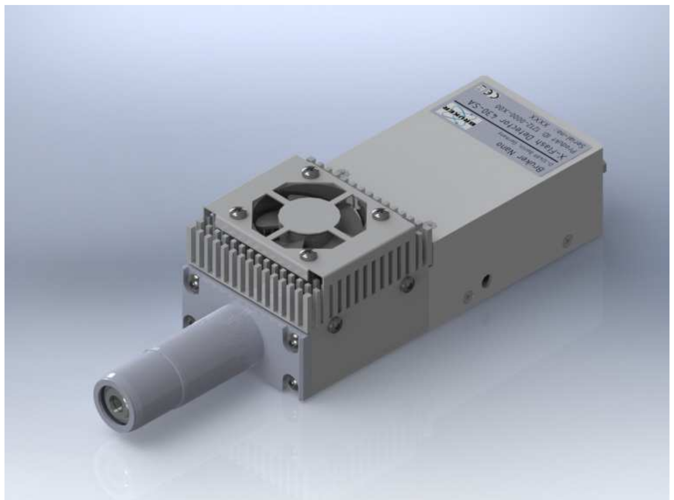




Bruker Nano Analytics
XFlash detectors (SDD)

XFlash®6
EDS Detector Series for elemental analysis

Ultimate performance in **elemental analysis** on
- Scanning electron microscopes (SEM/FE-SEM)
- Dual beam systems (FIB-SEM)
- Transmission electron microscopes (TEM/STEM)
- Synchrotron and other XRF applications



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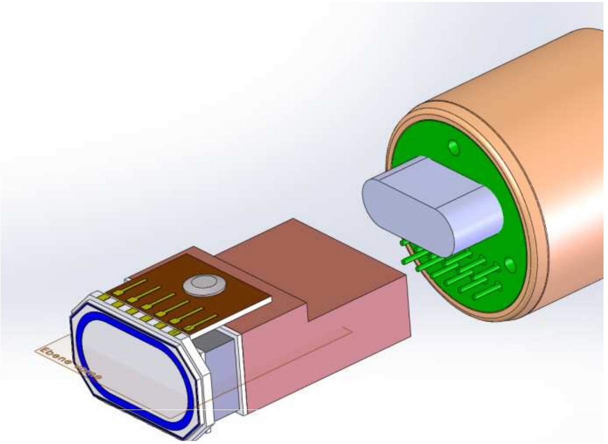
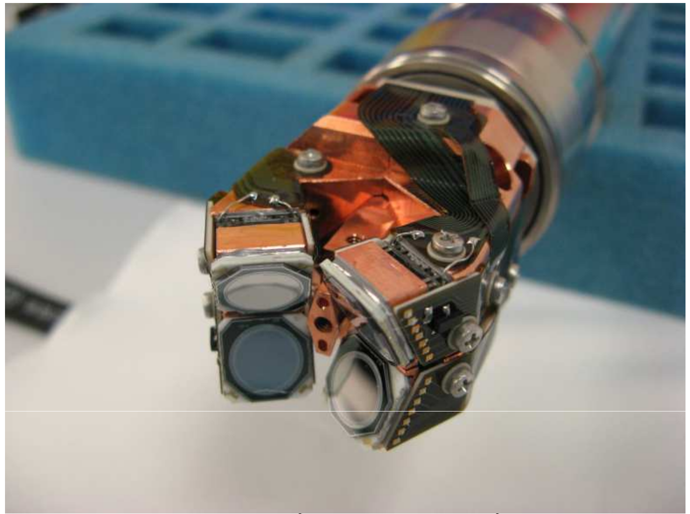
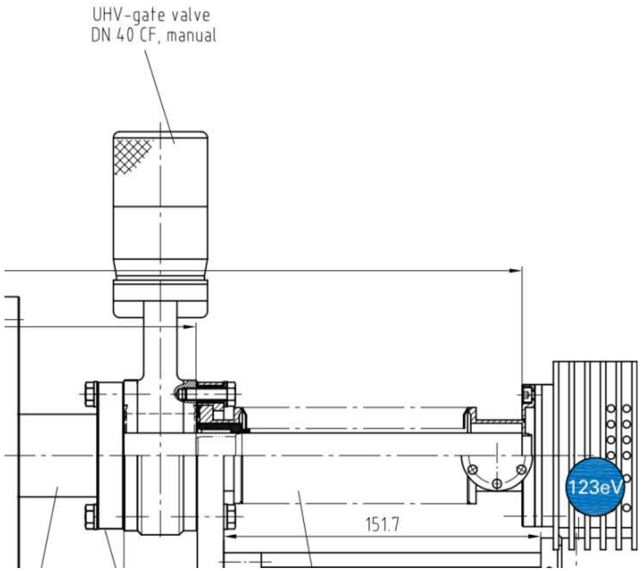
Specific detector design (examples)



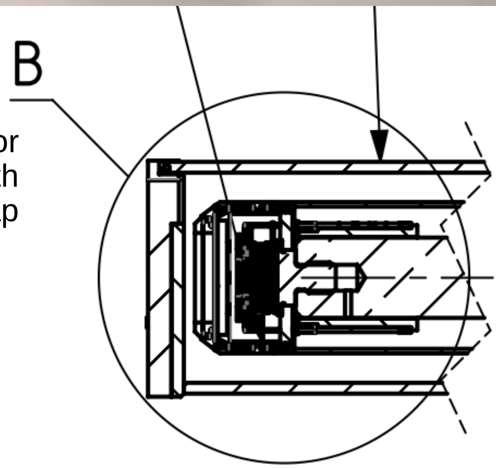
Open oval 100 mm² SDD with electrical and thermal UHV feed trough



4 x 30 mm² SDD arrangement for TEM (top and bottom view on sample)



Fully retractable detector with UHV gate valve



Detector for synchrotron use with protecting rod and flap

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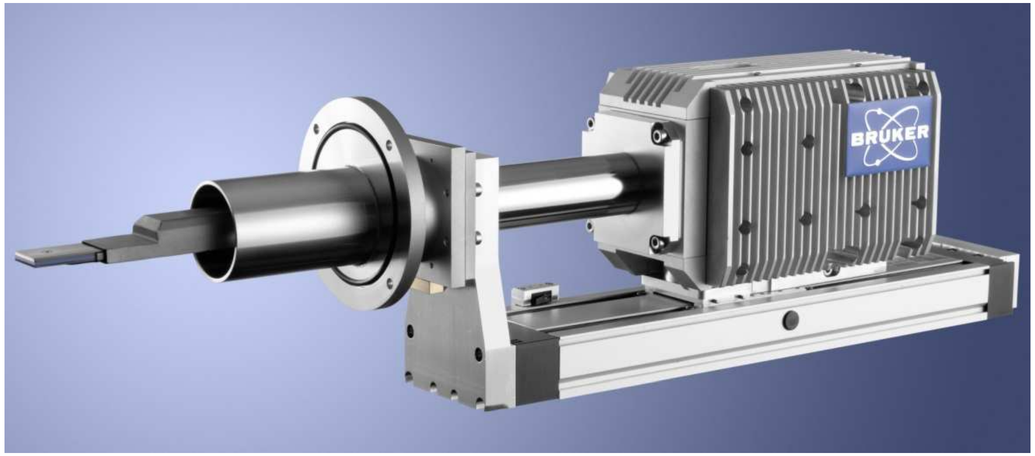
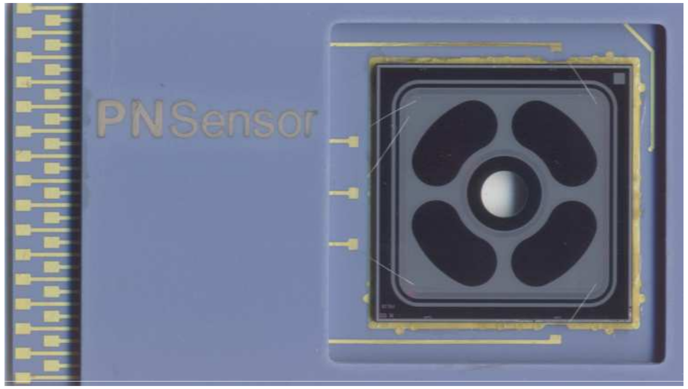
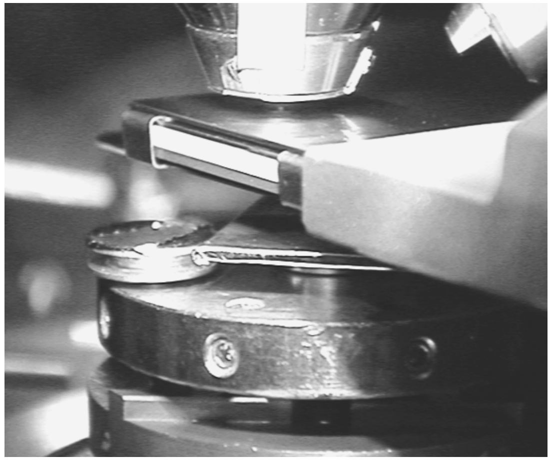
The Flat QUAD XFlash 5060 F





- Annular design, 4x15 mm² = 60 mm²
- Integrated window changer
- Energy resolution Mn $K\alpha \leq 133$ eV
- Combination of high count rate capability and high solid angle ($\Omega \sim 1$ sr)

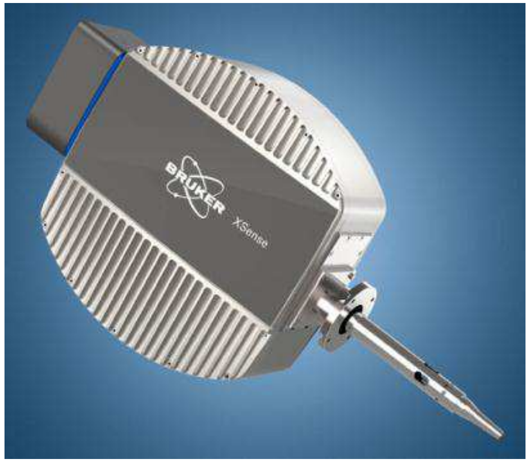


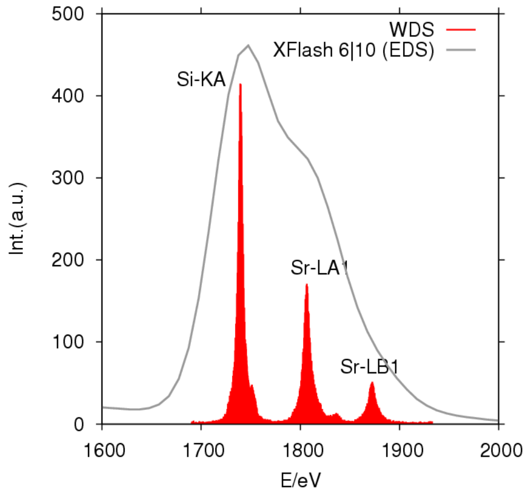
Bruker Nano Analytics
WD Spectrometer

QUANTAX WDS

… maximum sensitivity in the low energy range

- **XSense** parallel beam WD spectrometer with 3-cone grazing incidence optics
- Sophisticated 3-axis auto-aligning optical system (non-magnetic optics to avoid image distortions)
- Energy range 100 eV up to 3,600 eV (six diffractors: 200Å, 80Å, 60Å and 30Å multilayers, TAP and PET)
- Fully motorized, advanced kinematics for maximum X-ray yield
- Proportional counter with unique gas flow and pressure control, fully automatic counter setup
- <4.6 eV (FWHM) measured at Si-KA
- Compact design with slim 26mm OD optic mount
- Integrated gate valve, optics fully retractable
- Seamless integration with EDS under ESPRIT 2.0 Software

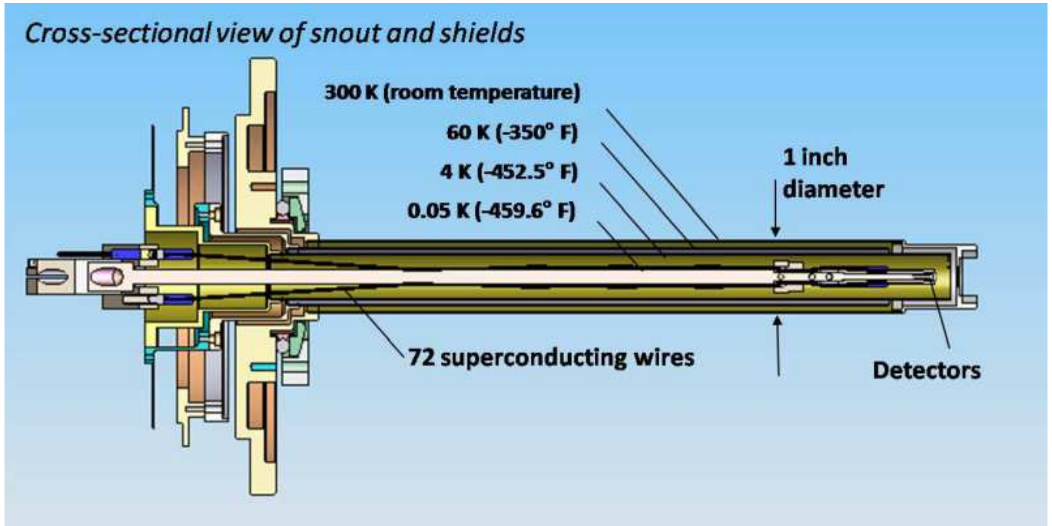




Bruker Nano Analytics
Microcalorimeter MICA 1600

16 channel microcalorimeter system

- Cryogen free cooling system – no consumables
- Fully automatic operation
- Slim 1 inch detector snout
- FWHM ~ 10 eV @ Si-Ka
- 4 mm² total detector area



Bruker Nano Analytics
Signal Processing Units (examples)

SVE 6

- Up to four individual XFlash detectors
  or One quad XFlash detector
  or Up to two XFlash + one WDS
- Detector and cooler supply
- MCA and real-time data
- Interfaces Bruker MegaLink and RS232

MIN SVE

- One single XFlash detector
- Detector and cooler supply
- MCA and real-time data
- Interfaces Bruker MegaLink and USB
  (alternatively RS232)

Scan Generator

- Connects to up to four BRUKER SVE (SVE6, MIN SVE …)
- XY-Output, 2 video inputs, 8 counter inputs, control in- and outputs
- Time and positon tags, data Buffer
- Possible interfaces RS232, USB 2.0, 100 BaseT, Gbit Ethernet

Bruker Nano Analytics
Outlook

- **Silicon** as a detector material and **SDD** will stay the first choice for X-ray elemental analysis over still a long period
- **Multi element** detector arrangements will grow more common as the prices for the signal processing will decrease
- **APDs** will gain its share in ultra high count rate applications
- **Output** count rates (OCR) will exceed 1 Mcps per detector

BRUKER

Innovation with Integrity