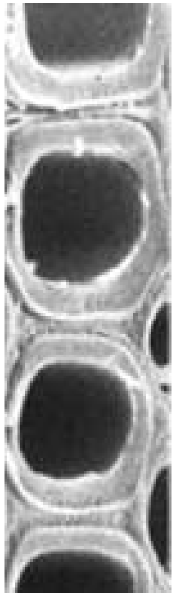
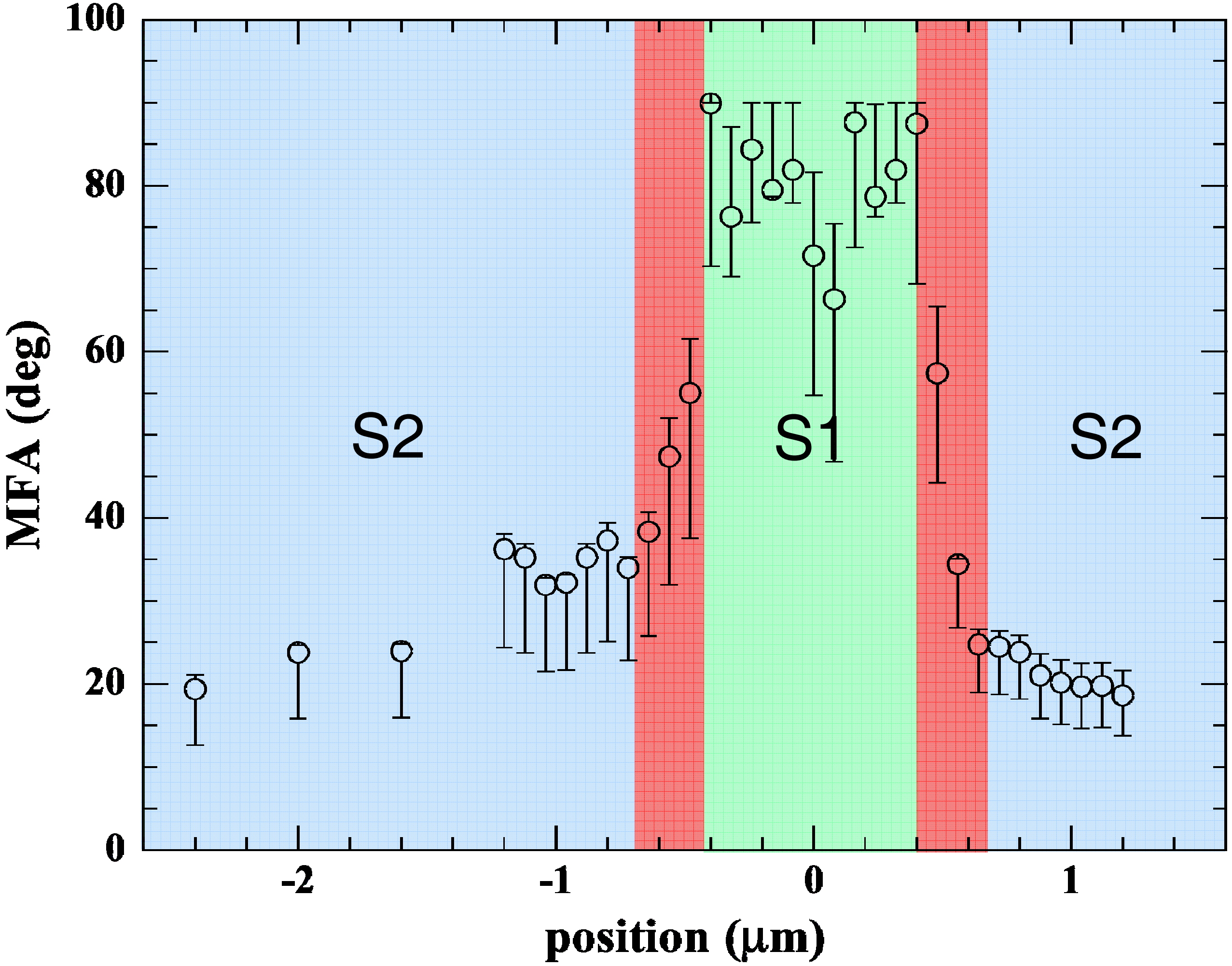
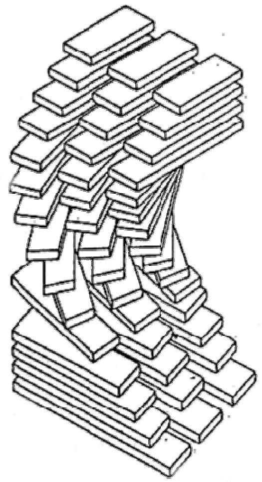
Helikoidaler Übergang zwischen S1 und S2?



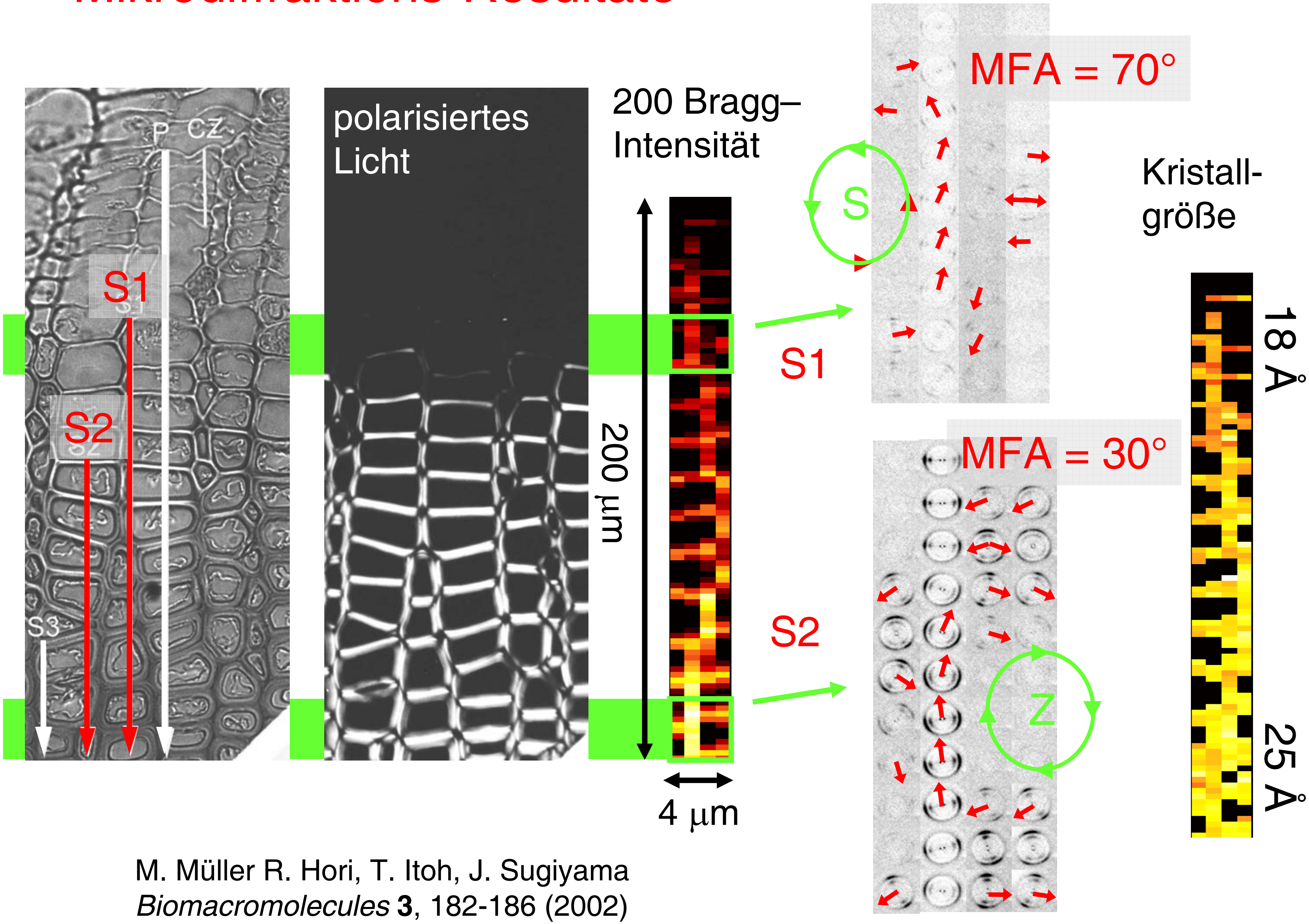




M. Müller, K. Kölln, J. Keckes, H. Lichtenegger, M. Burghammer

06/2001 (unveröffentlicht)

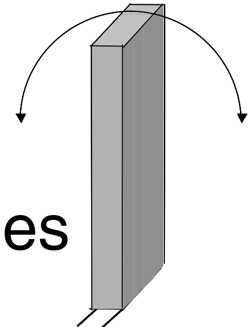
Mikrodiffraktions-Resultate

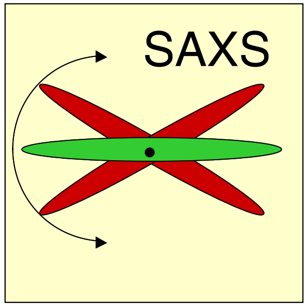


M. Müller R. Hori, T. Itoh, J. Sugiyama
Biomacromolecules **3**, 182-186 (2002)

Scanning SAXS microscopy

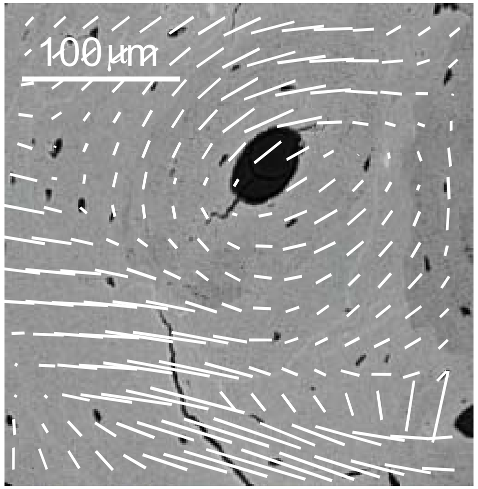
2D SAXS scans
→ size & orientation
of mineral nanoparticles



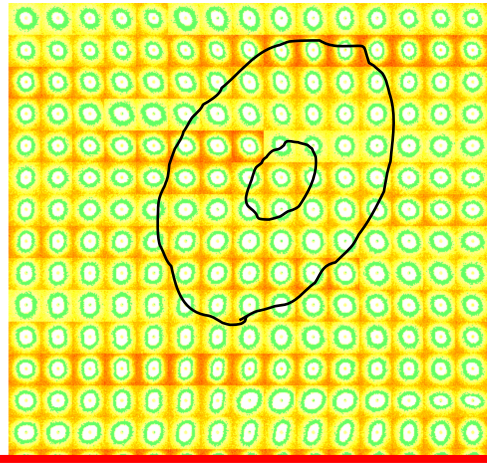


bone
(femur)

SEM image



scanning SAXS
(20 µm beam)

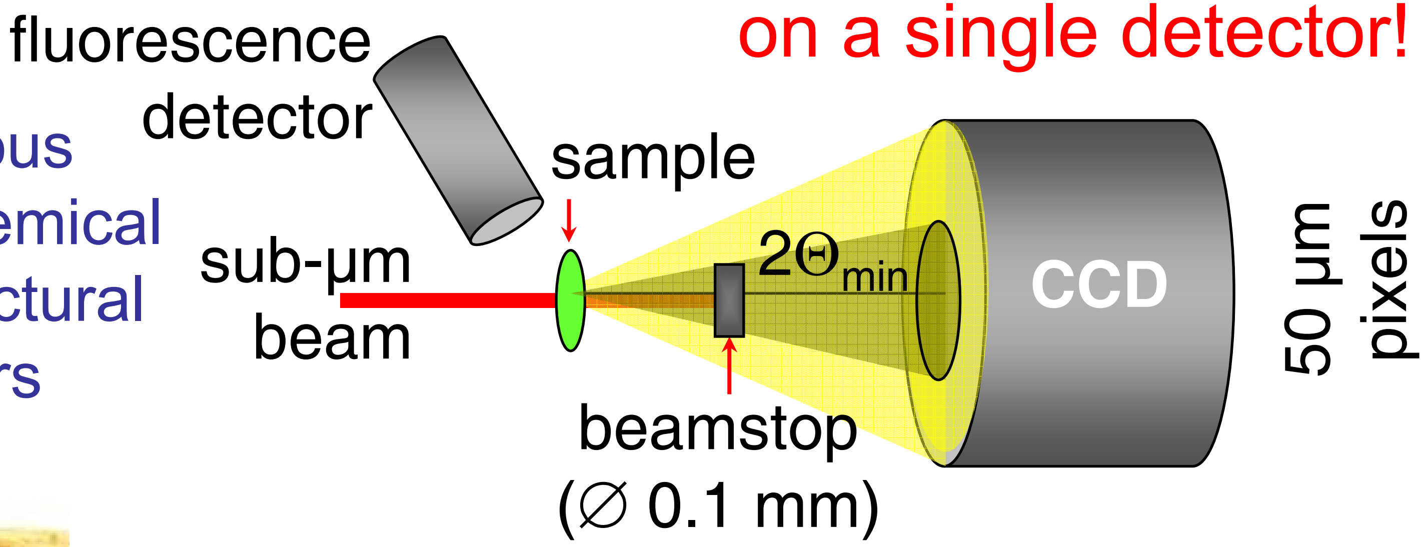


- better resolution?
- chemical information?

O. Paris, I. Zizak, H. Lichtenegger, P. Roschger,
K. Klaushofer, P. Fratzl. *Cell. Mol. Biol.* 46 (2000) 993.

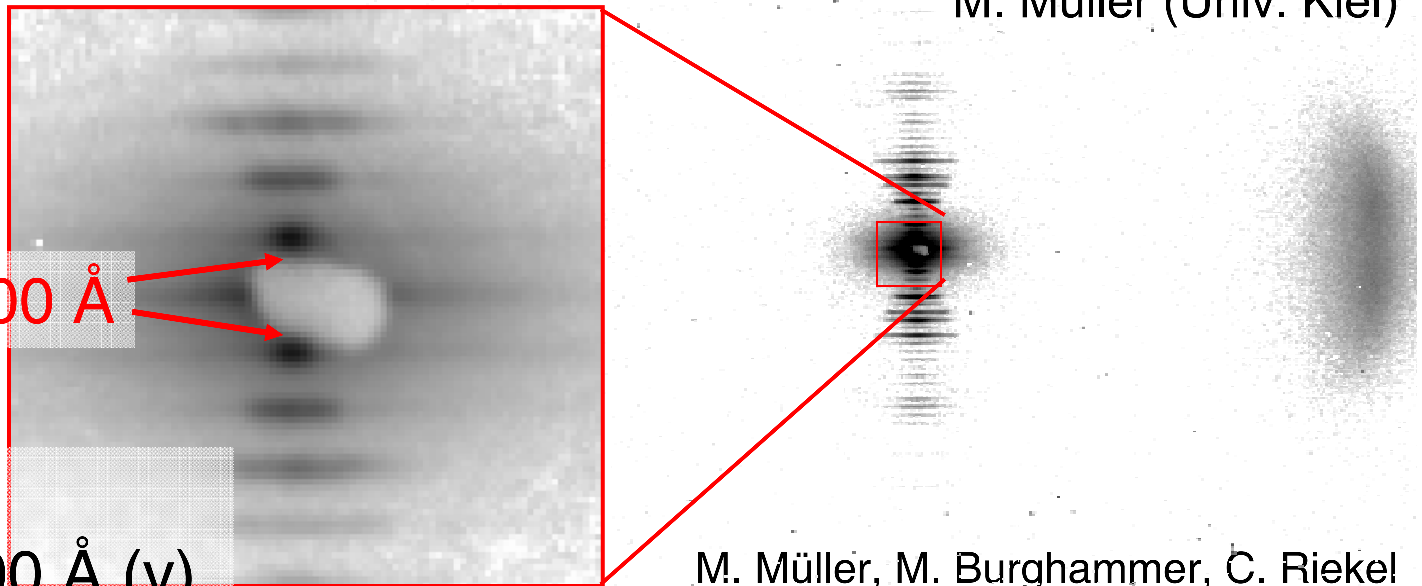
Simultaneous small- and wide-angle scattering on a single detector!

Simultaneous imaging of chemical *and* nanostructural parameters



P. Fratzl, O. Paris (Dept. Biomaterials, MPI-KG Golm)
M. Müller (Univ. Kiel)

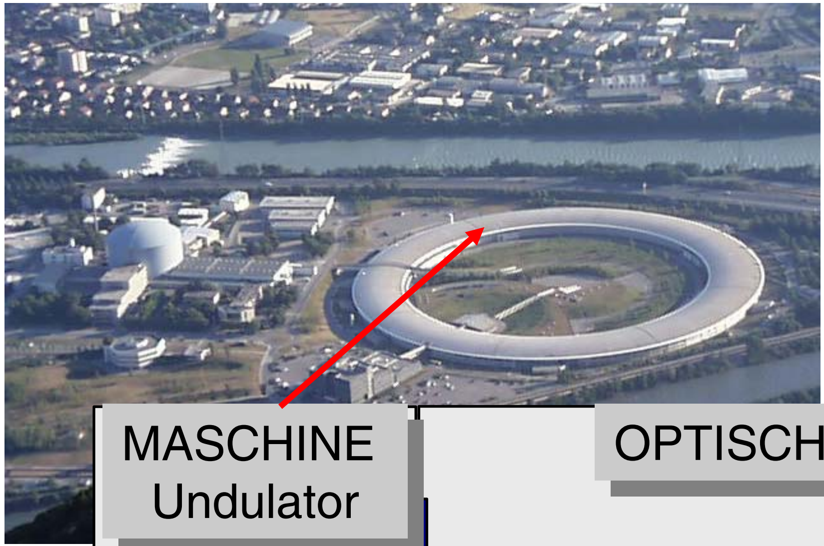
SAXS resolution:
$2\Theta_{min} \rightarrow d_{max}$

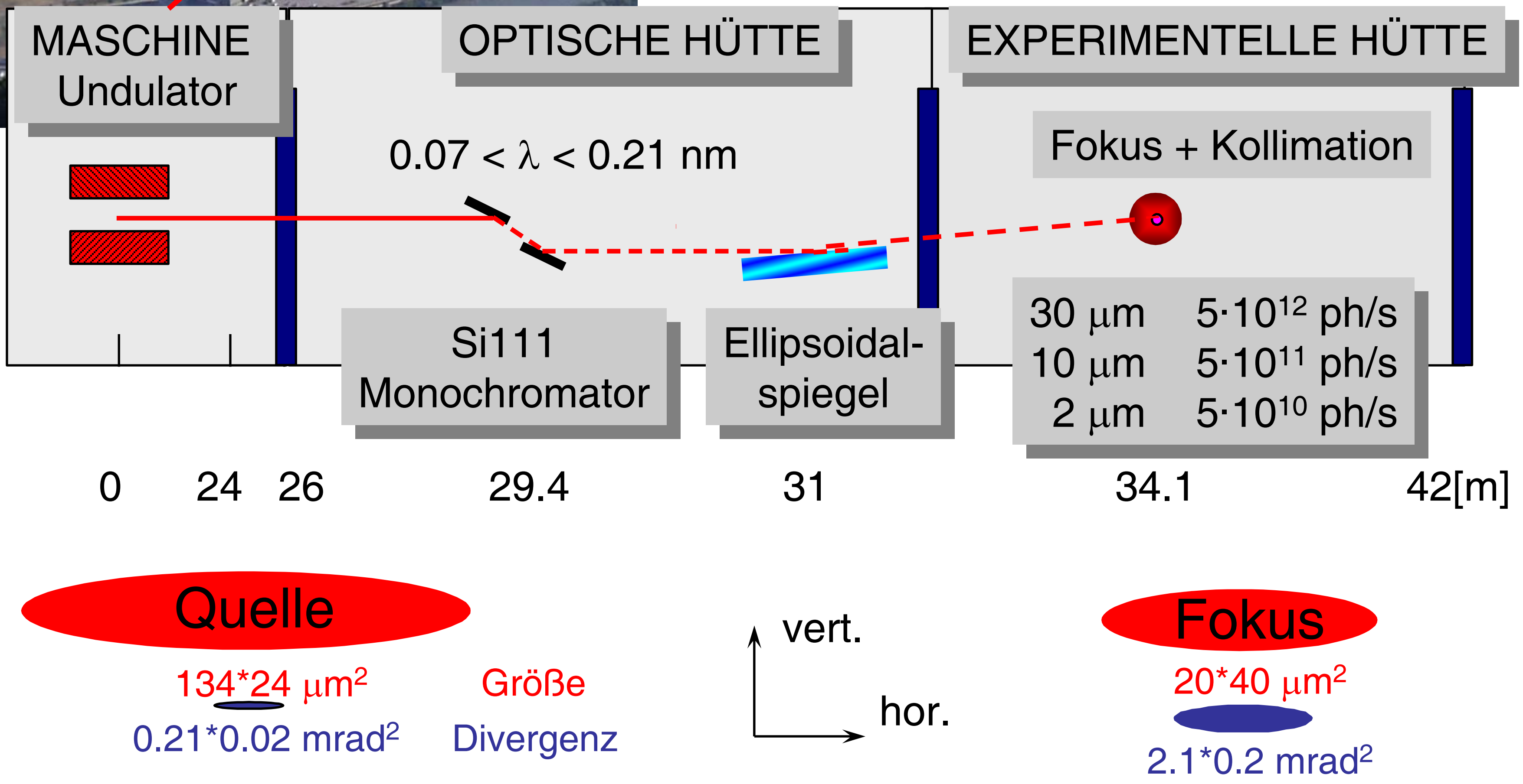


PETRA III:
1000 (h) – >5000 Å (v)

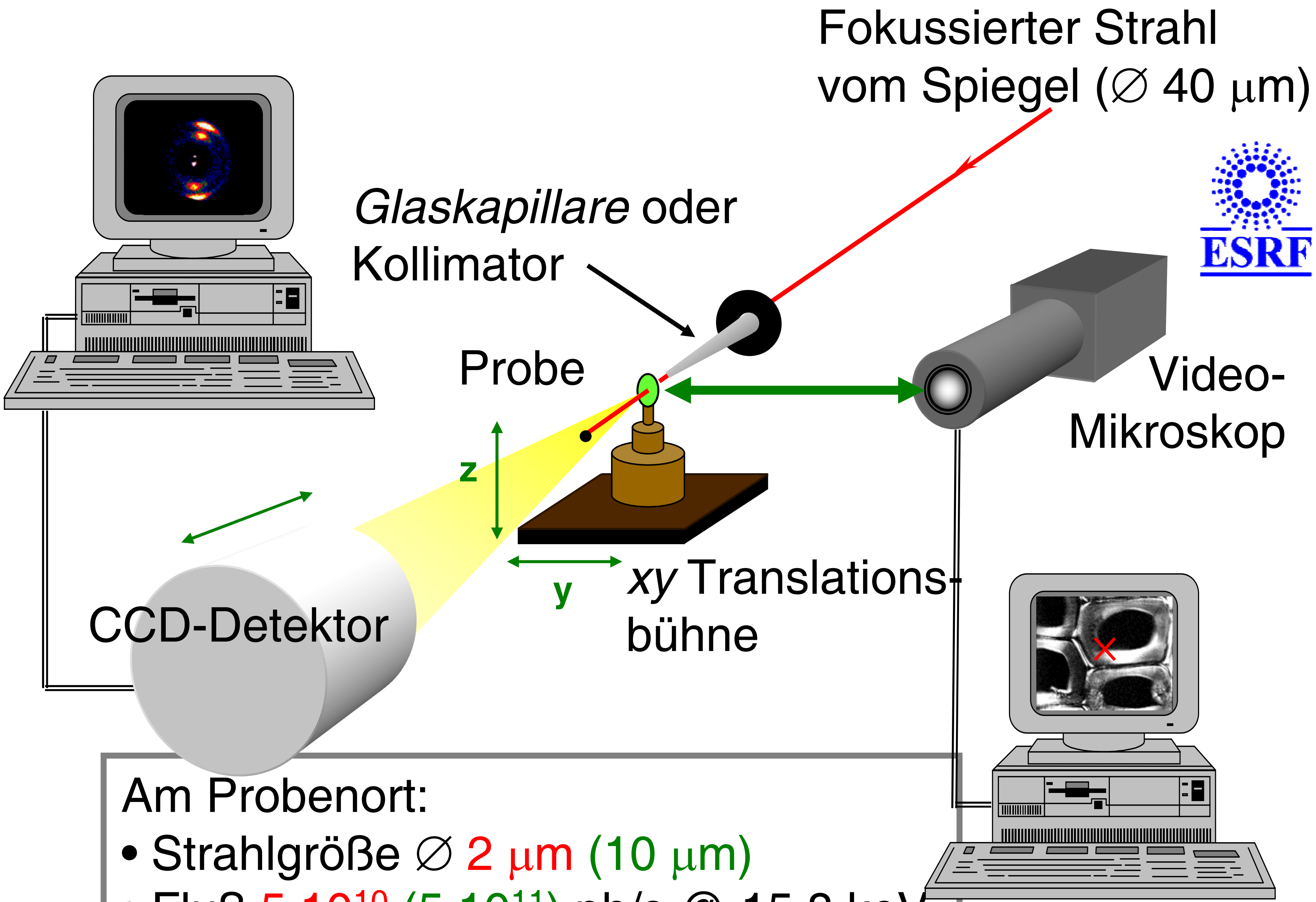
M. Müller, M. Burghammer, C. Riekel
Nucl. Instrum. Meth. A **467-468**, 958-961 (2001)

Beispiel:
Mikrofokus Beamline ID13





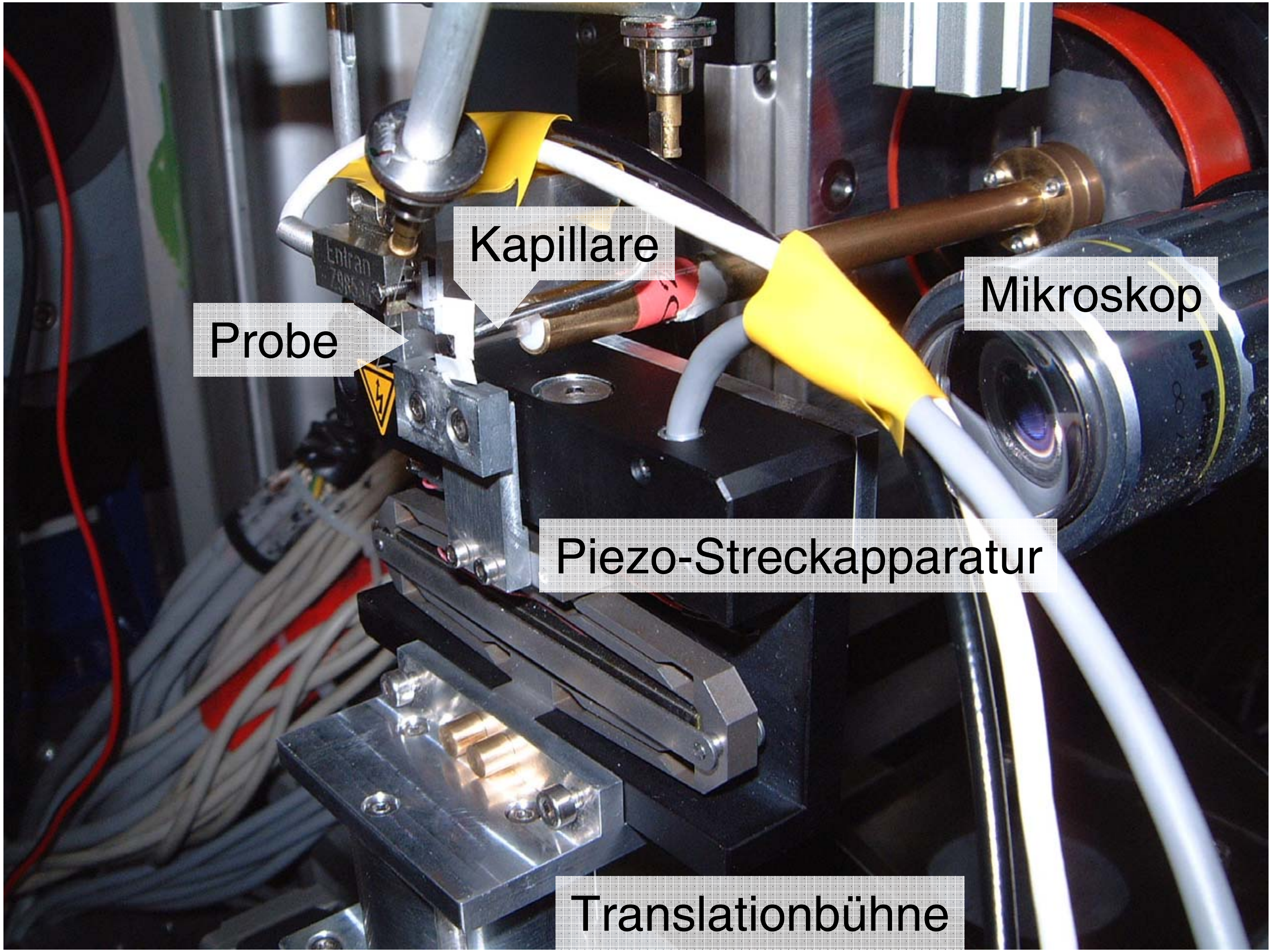
Ortsaufgelöste Mikrodiffraktion (ID13)



Am Probenort:

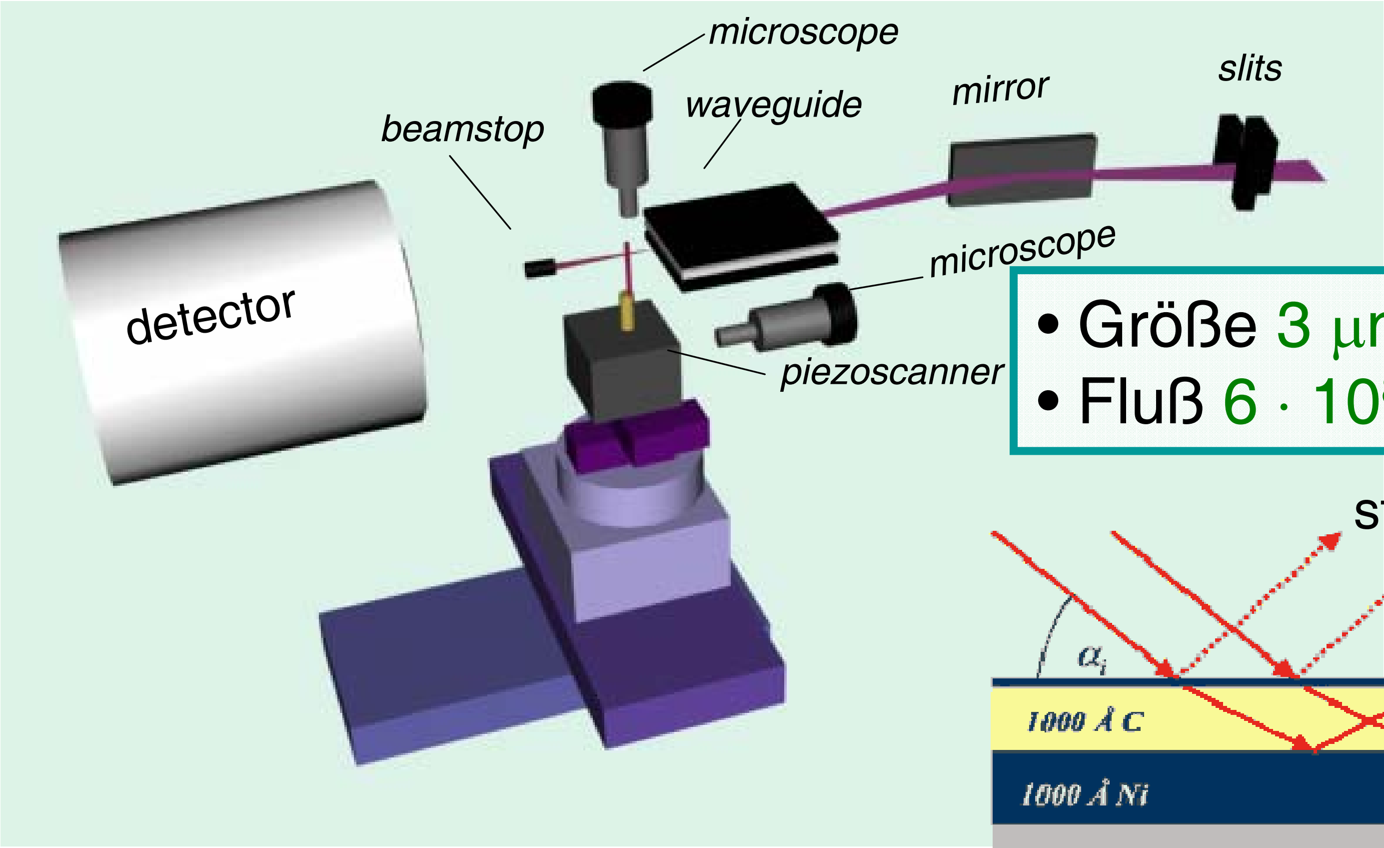
- Strahlgröße ∅ 2 μm (10 μm)
- Fluß $5 \cdot 10^{10}$ ($5 \cdot 10^{11}$) ph/s @ 15.8 keV

“Scanning” Mikrodiffraktion an ID13



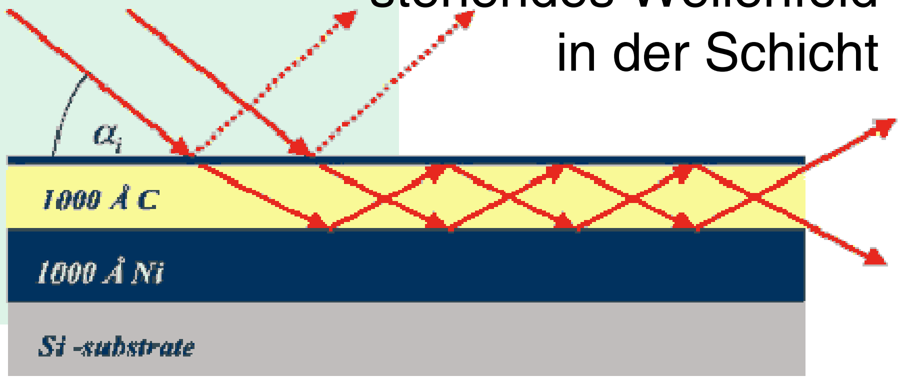
Sub-Mikrometer-Ortsauflösung

ID13 Diffraktion mit **Röntgen-Wellenleiter**



- Größe 3 µm × 100 nm
- Fluß $6 \cdot 10^8$ ph/s

stehendes Wellenfeld in der Schicht

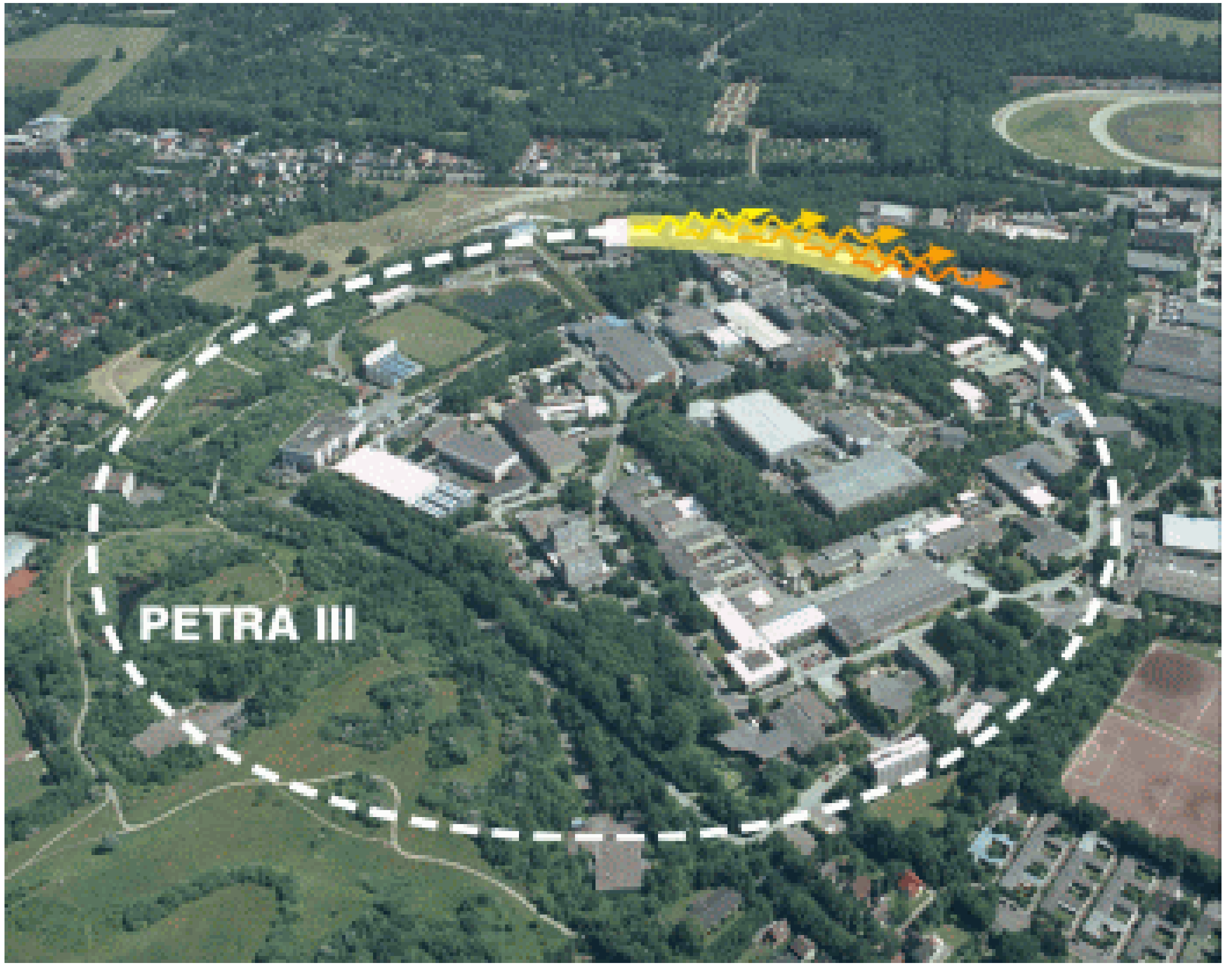


M. Müller, M. Burghammer, D. Flot, C. Riekel, C. Morawe, B. Murphy, A. Cedola
J. Appl. Cryst. **33**, 1231-1240 (2000)

S. Di Fonzo, W. Jark, S. Lagomarsino, C. Giannini, L. De Caro, A. Cedola, M. Müller
Nature **403**, 638-640 (2000)

Eine neue Beamline an einem neuen Synchrotron

- Umbau des Speicherrings PETRA III zur Synchrotronstrahlungsquelle
- Bau einer µSAXS/WAXS-Beamline (HASYLAB, Stephan Roth)
- Nanofokus-Messplatz an dieser Beamline (BMBF-Projekt, AG Müller)



List of experiments

#	ID	Experiment 1	Experiment 2	Comment	Inst. In charge
1	20m	Nuclear resonant scattering, ps-timing	Inelastic X-ray scattering	under discussion	DESY, **H. Franz**
2	2m	Hard X-ray scattering	high pressure	straight	DESY
	2m	Micro focus SAXS/WAXS		side	DESY, **S. Roth**
3	5m	XUV/VUV			DESY, **J. Viefhaus**
4	2m	Micro- and nano-tomography, imaging		side	DESY/GKSS
	2m	Hard X-ray micro probe, imaging		straight	DESY
5	5m	High energy materials science	High energy X-ray diffraction		GKSS/DESY, **N. Schell**
6	2m	Resonant X-ray scattering		straight	DESY, **J. Strempfer**
	2m	High resolution X-ray diffraction		side/top	DESY, **O. Seeck**
7	5m	Coherence applications			DESY, **O. Leupold**
8	2m	BioSAXS	ASAXS	straight	EMBL, **M. Rößle**
	2m	Bio imaging/diffraction		side	MPI, HGF, DESY
9	2m	Macro molecular crystallography			EMBL, **M. Cianci**
	2m	Macro molecular crystallography			EMBL, **G. Bourenkov**

Legend:	high beta section	source size (sigma)	142x5 µm
	low beta section	source size (sigma)	35x6 µm

Folie von Stephan Roth, HASYLAB

HASYLAB – PETRA III

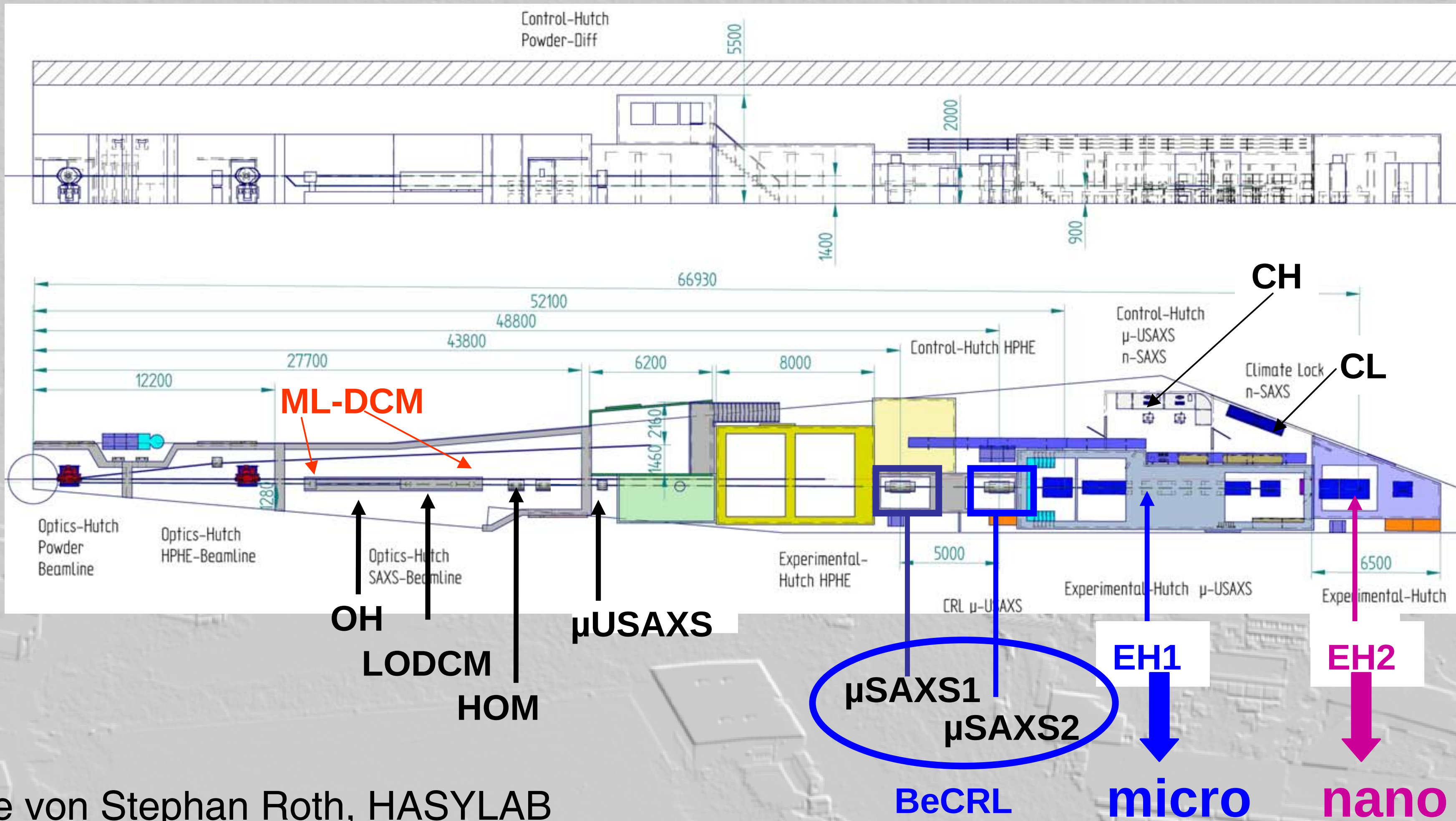
Folie von Stephan Roth, HASYLAB

Layout µSAXS/WAXS P03

High-beta undulator (2m, canted)

8keV<E<24keV

Beam size: 42µm/10µm/5µm/100nm Focal spot on sample



Folie von Stephan Roth, HASYLAB

Standard BeCRL holder

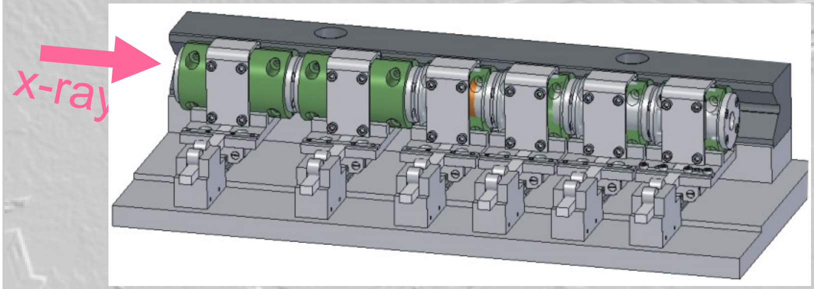
E=8-25keV
- μSAXS1: N= 4-25: 42x2.6μm²
- μSAXS2: N= 9-56: 17x1μm²

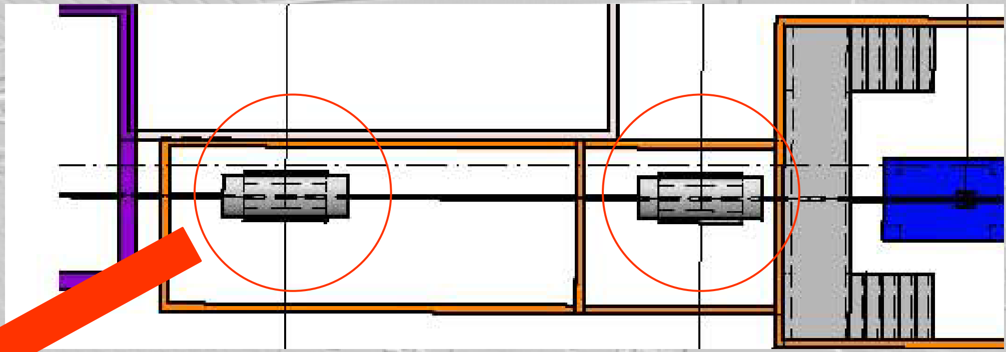
Focal length: f~R*E/N

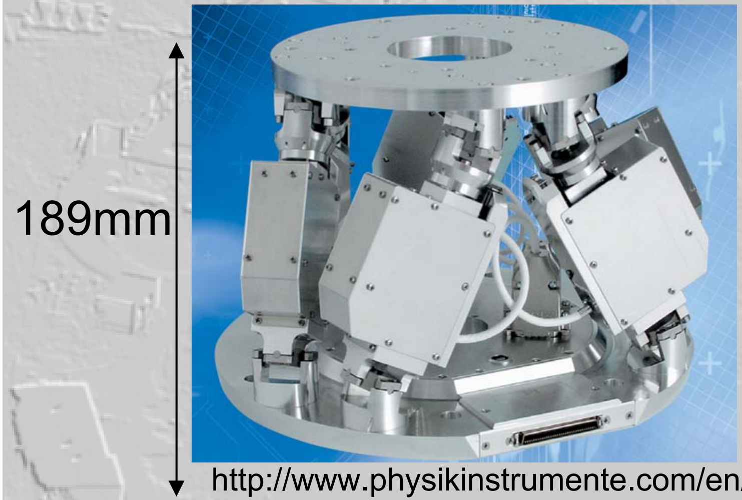
R=0.2mm – Standard!

Different energy = different position+number of lenses

N=32 .... N=1







http://www.physikinstrumente.com/en/primages/pi_m824_blu_i4c_o.jpg

- One optical bench
- One goniometer
- Full vacuum

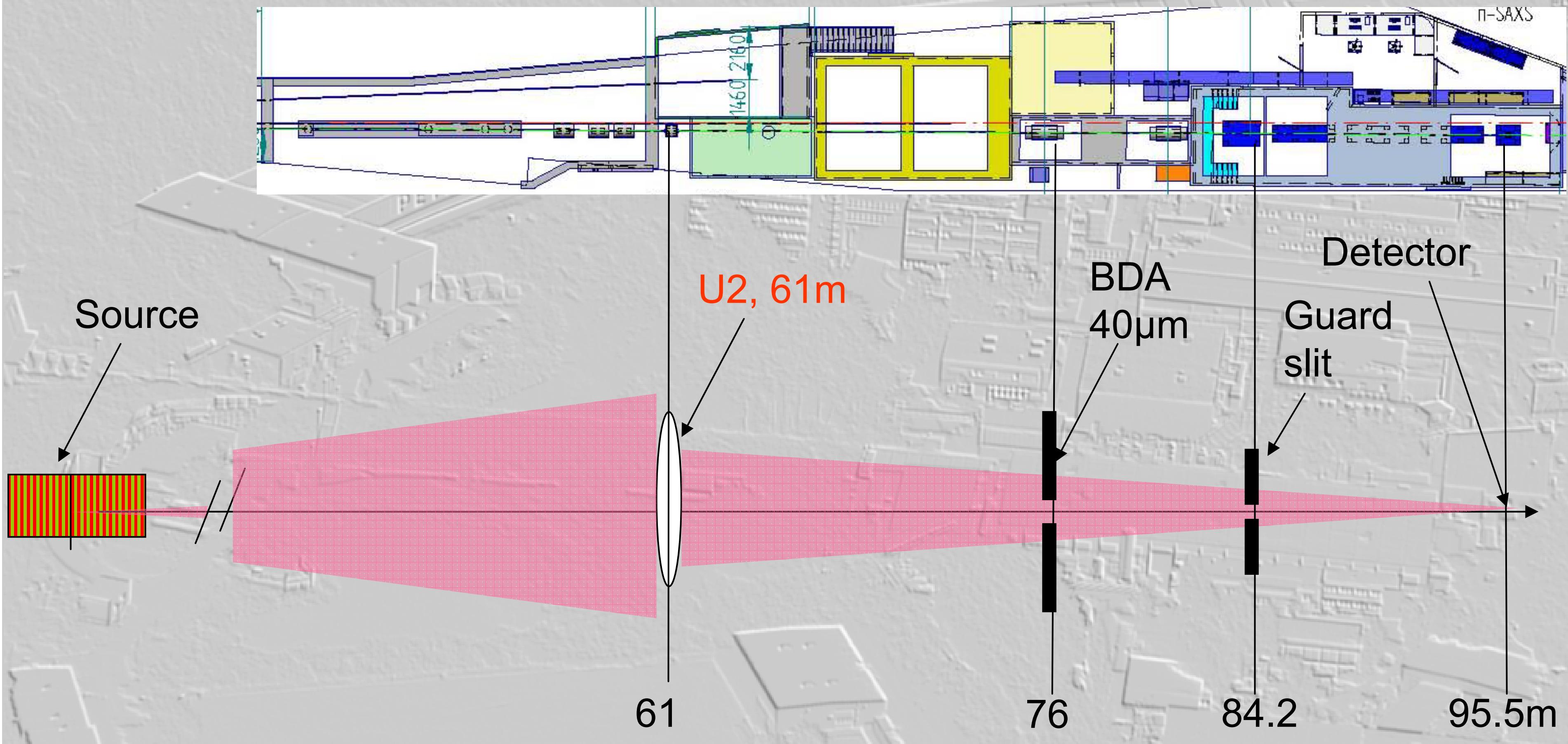
BeCRL-exchanger development: T. Schubert
Hexapod: M. Dommach, first test at BW4 03/2007

Folie von Stephan Roth, HASYLAB

Simulations for µUSAXS

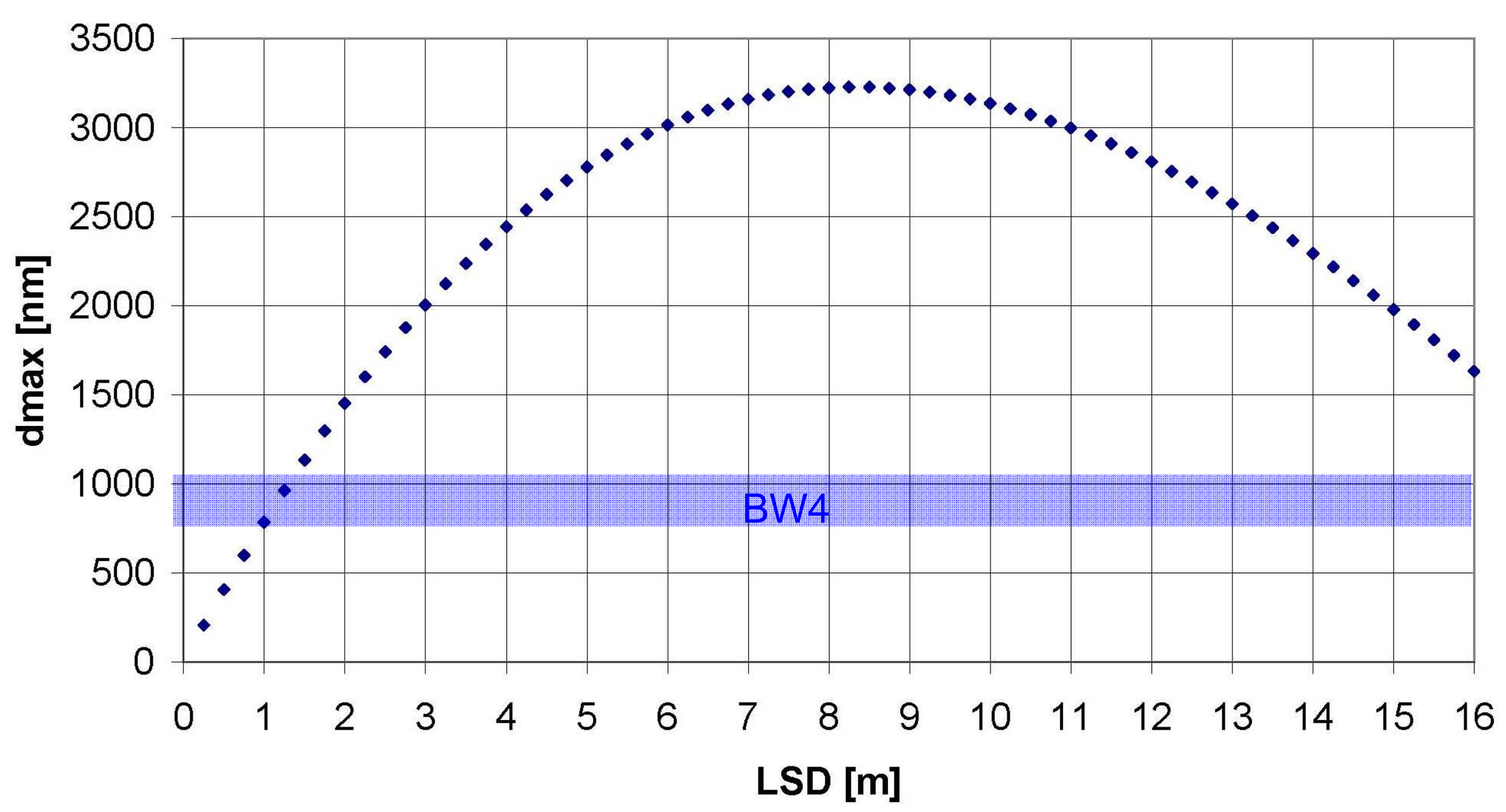
- We use the two-lens setup
- We focus on the detector

N=4, f_2=88m
R=0.6mm
f_{ges}=22m



Folie von Stephan Roth, HASYLAB

Resolution µUSAXS with HOM

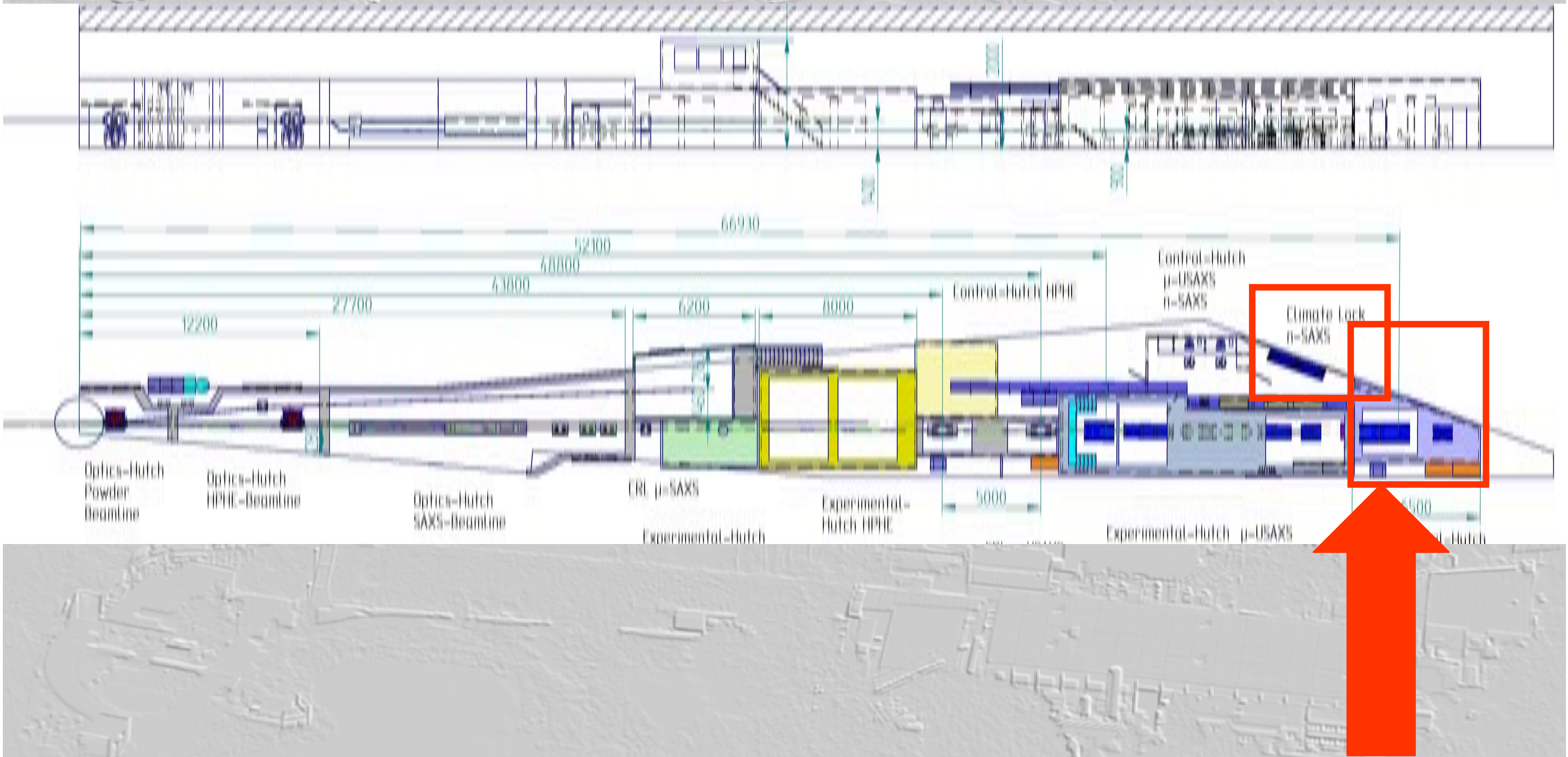


Beam requirements fulfilled:

- 10µm < beam size=70µm at sample < 100µm in H
- dmax>1µm

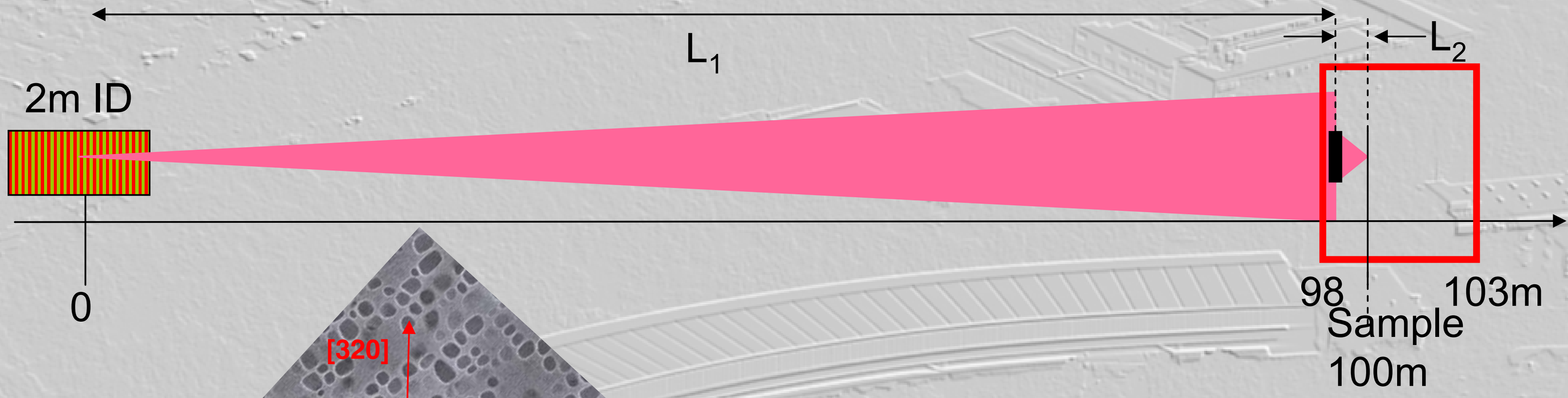
Folie von Stephan Roth, HASYLAB

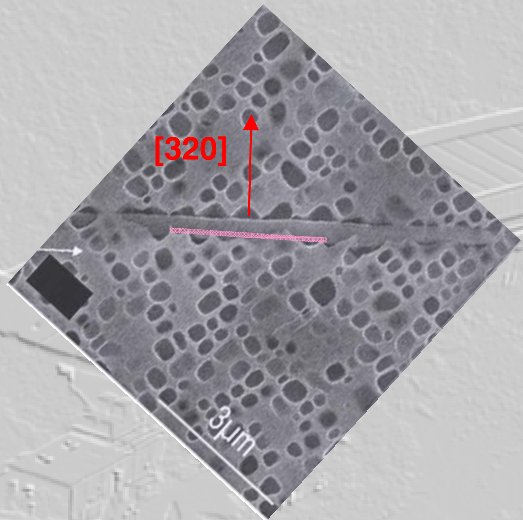
Nanofocus end station EH2



Folie von Stephan Roth, HASYLAB

Nanofocus end-station



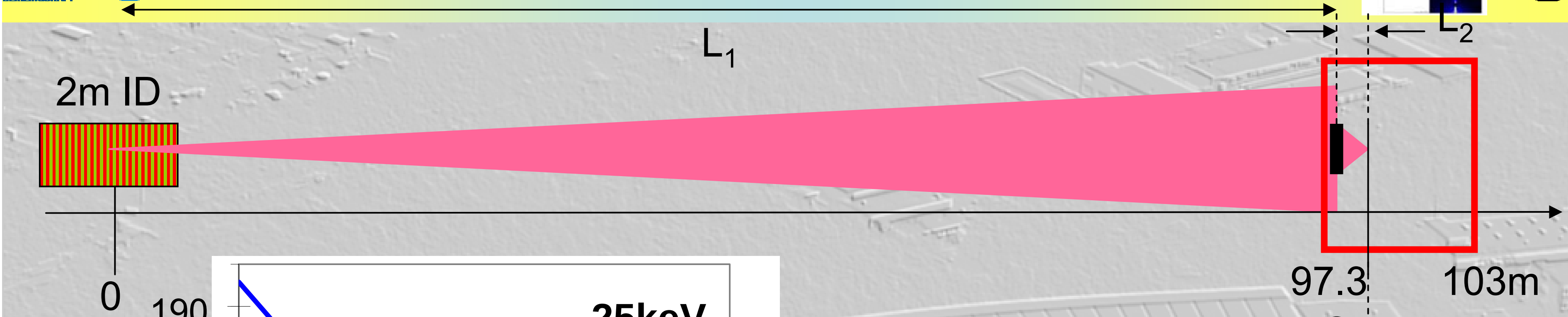


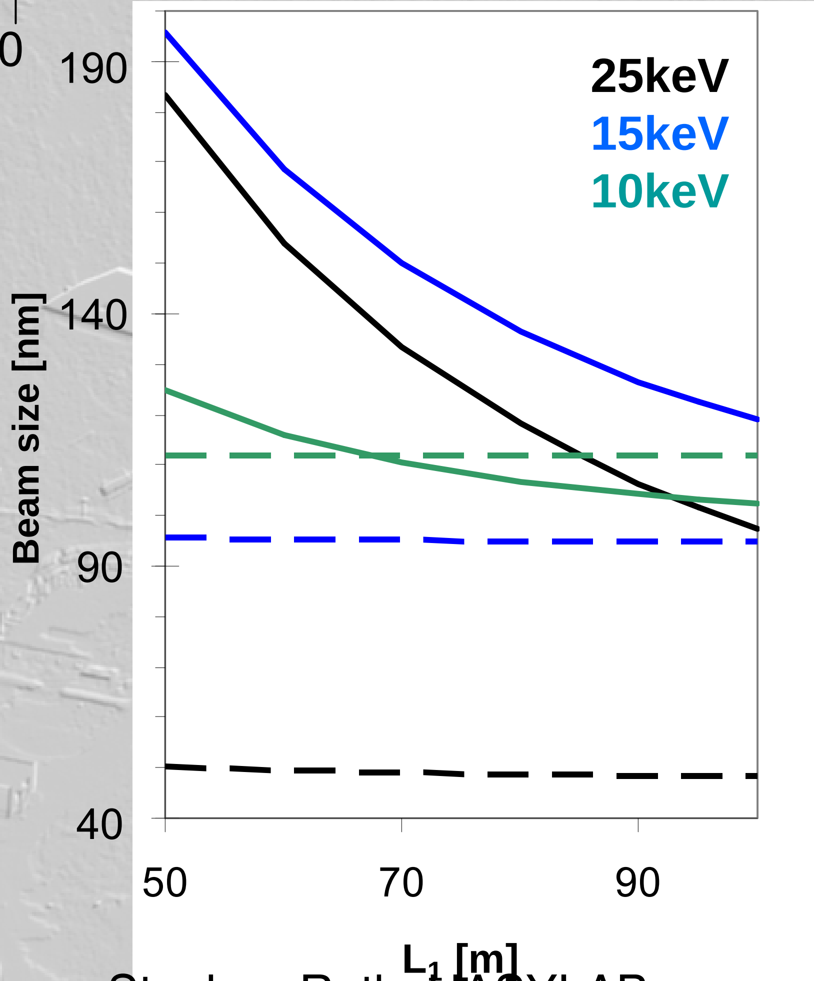
- 1D/2D **waveguides** (Salditt et al., Müller et al.)
- **Fresnel zone plates** (David et al.)
- **Nanofocusing lenses** (Schroer et al.)
- **Kirkpatrick-Baez mirrors** (Hignette et al.)

- Smallest beam size
- Use waveguide itself as sample
- Adapted to fibre scanning (1D)
- Achromatic optics
- Prefocusing (x100) & ML (x10)

Folie von Stephan Roth, HASYLAB

Nanofocus end-station

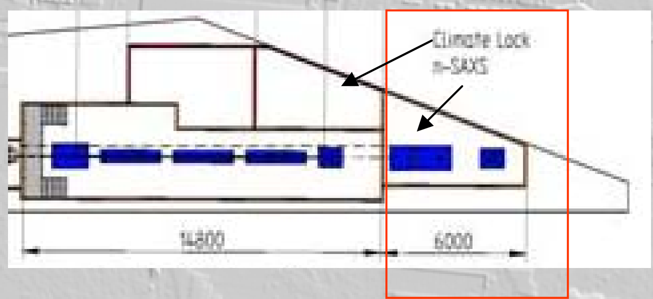




NFLs / Trend: $\mathbf{L_1 \geq 97m}$

$\mathbf{L_{SD}=2m}$

Calculation using
http://www.institut2b.physik.rwth-aachen.de/xray/applets/nflcalc.html

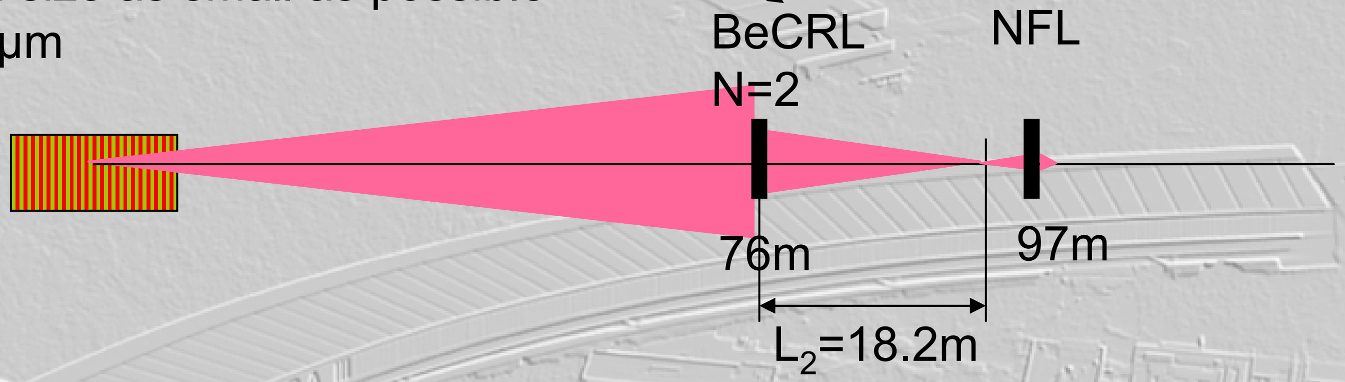


Condition: **hutch operated independently**

Folie von Stephan Roth, HASYLAB

Prefocusing (example: 10keV)

- Beam size as small as possible
- H < 1µm



Gain in comparison to direct beam ~270

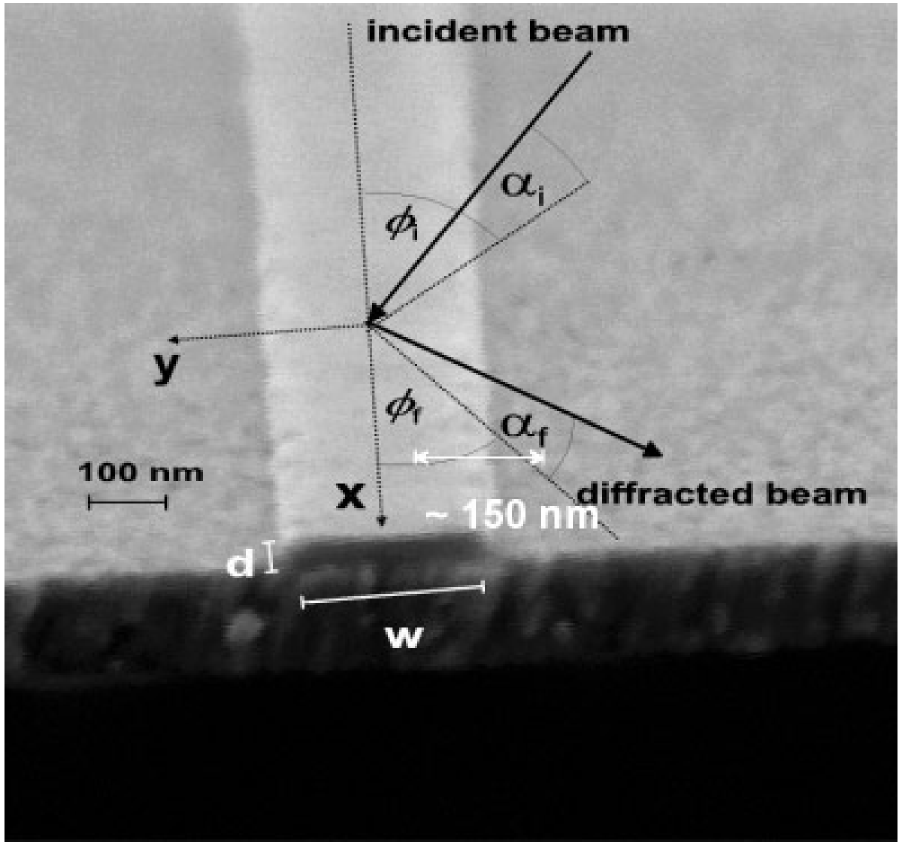
Beam size ~1.3x0.16µm^2 HxV

Combine with other optics, e.g.
FZP: Ap 600µm , 150µm, L_2~4cm

...And use multilayers!!!

Folie von Stephan Roth, HASYLAB

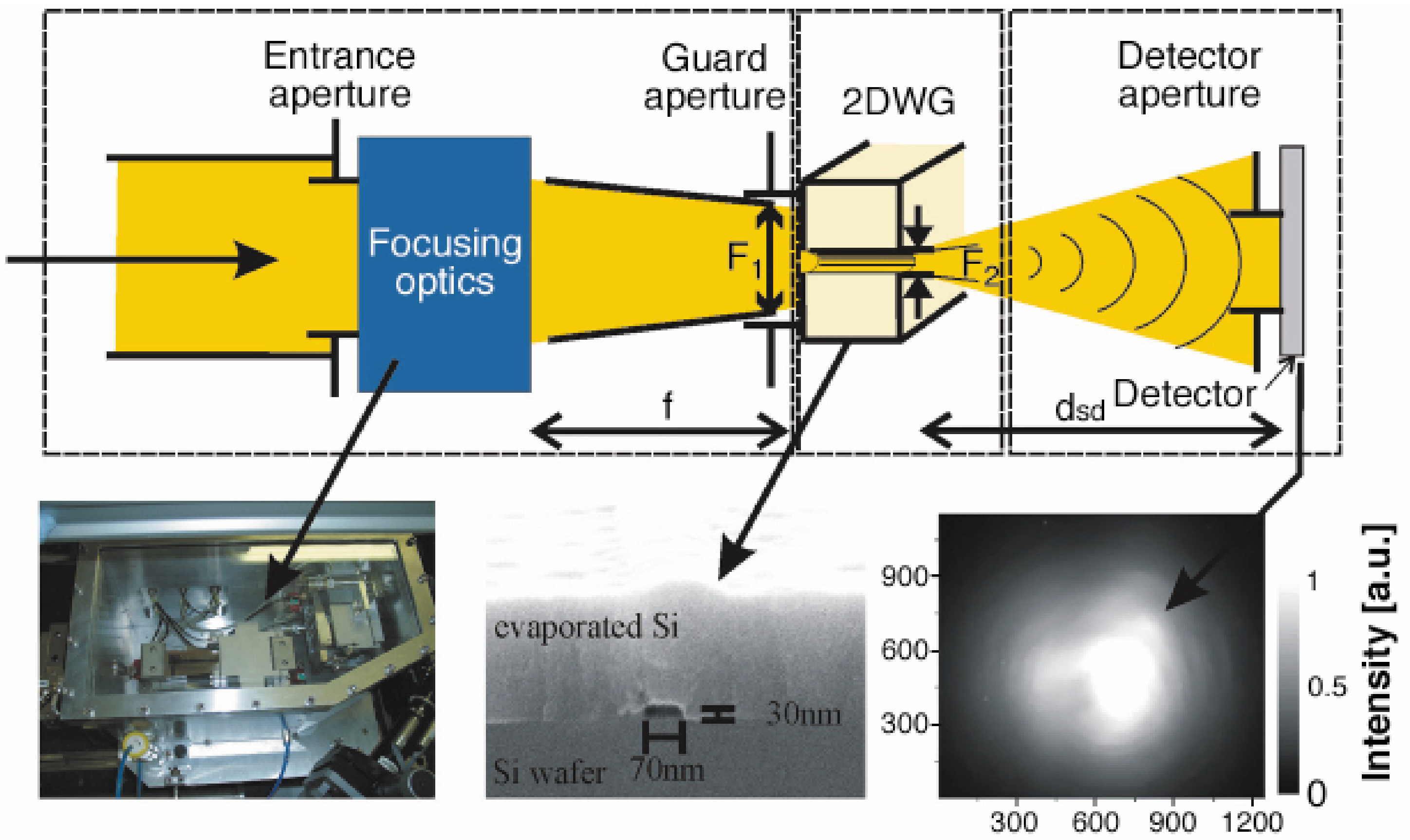
2D-Waveguides als (erste) Optik des Nanofokus-Messplatzes



- Elektronenstrahllithographie
- Kanal aus PMMA (Polymer)
- Abmessungen 30 x 70 nm^2
- Abdeckung aus Silizium
- Länge 4.05 mm

Pfeiffer et al., ESRF Highlights 2005

2D-Waveguides als (erste) Optik des Nanofokus-Messplatzes

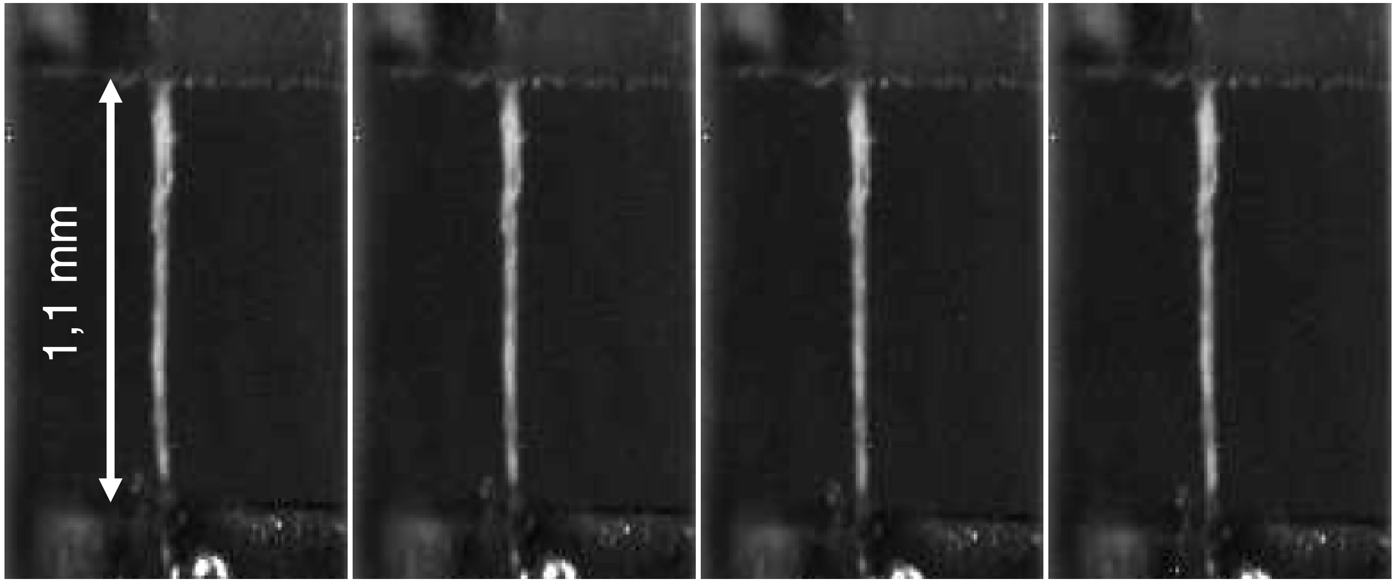


- Strahlgröße 25 x 47 nm^2
- Fluss 3.5 x 10^6 ph/s

Pfeiffer et al., ESRF Highlights 2005

Mikroskopische Streckexperimente

einzelne Kiefernholzzelle



Wandern im Strahl
(immer Zellulose-Reflex 200)