Methods of angular scanning in imaging and topography

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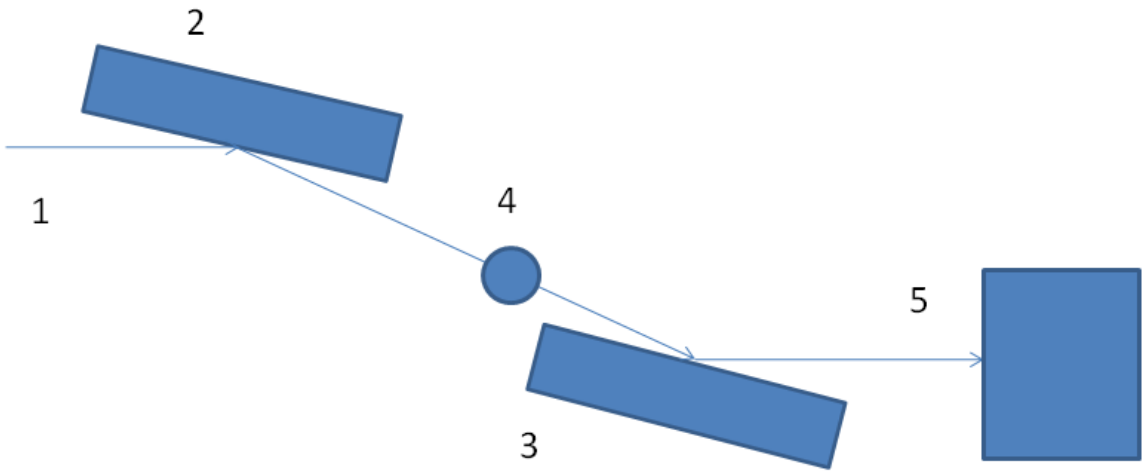
Scattering in imaging

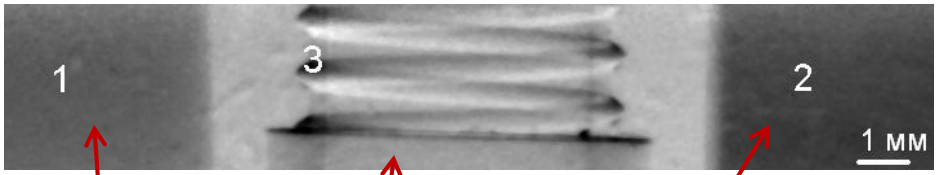
1. Scattering forms contrast
2. Angular resolution required
3. Adequate angular range required
4. Scattering curve for each ROI can be reconstructed
5. Important for ABI and topography

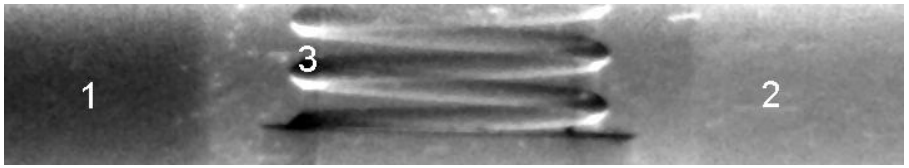
Analyzer based imaging



Experimental scheme: 1 is an incident “white” beam; 2 and 3 are crystals; 4 is the sample; 5 is the detector.

Contribution of high angular resolution





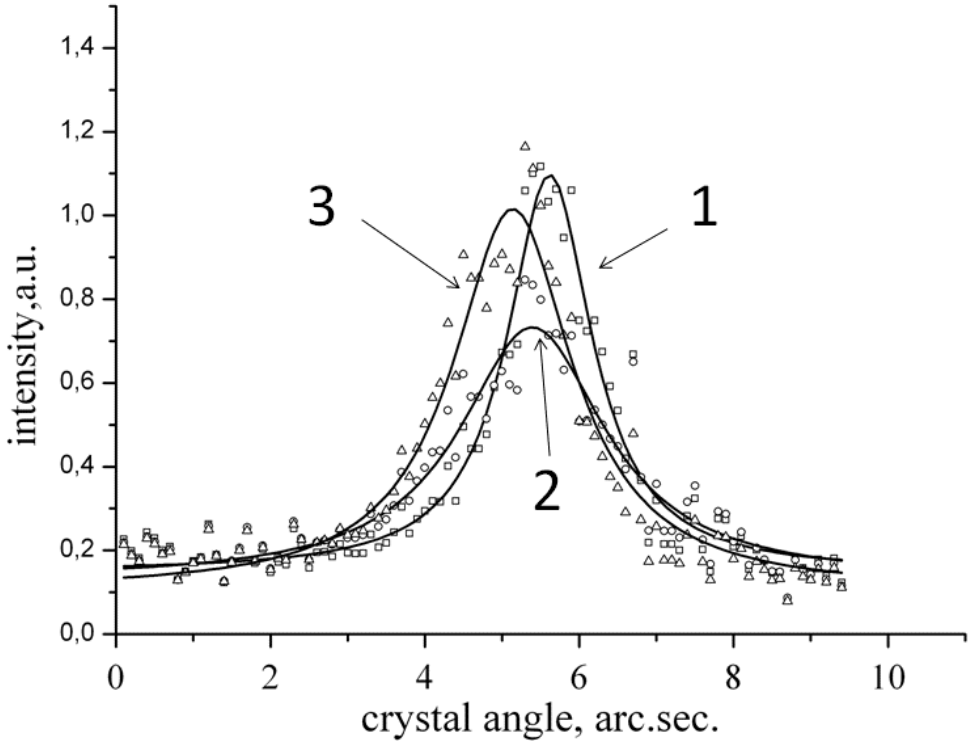
foil

ballpoint pen casing

paper

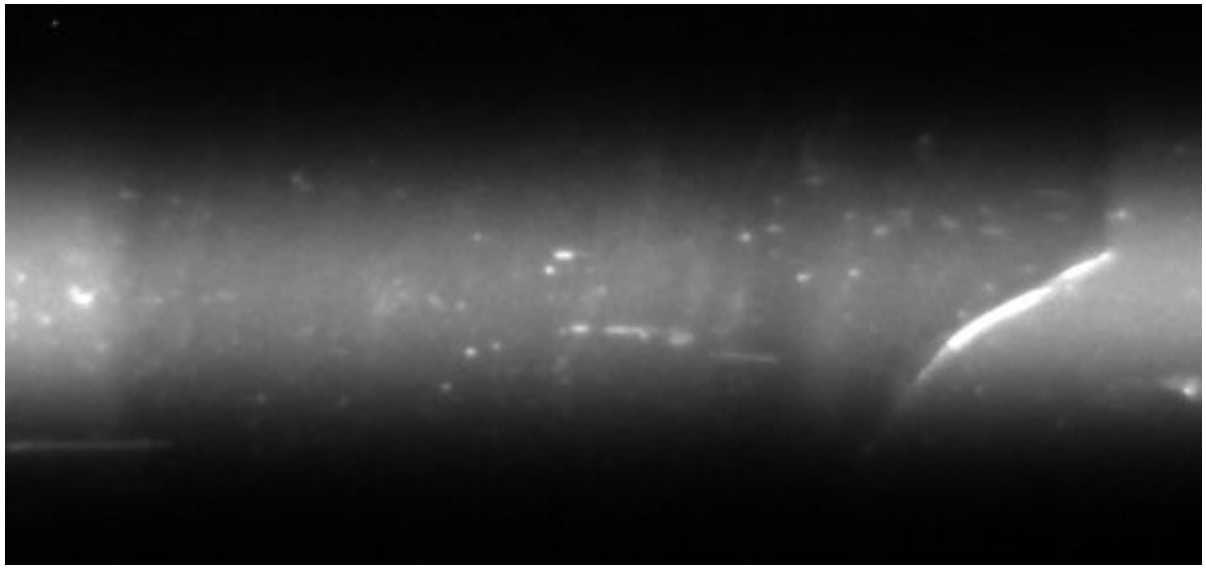
How to distinguish refraction from absorption and small angle scattering?

- *Wide angular scanning!*



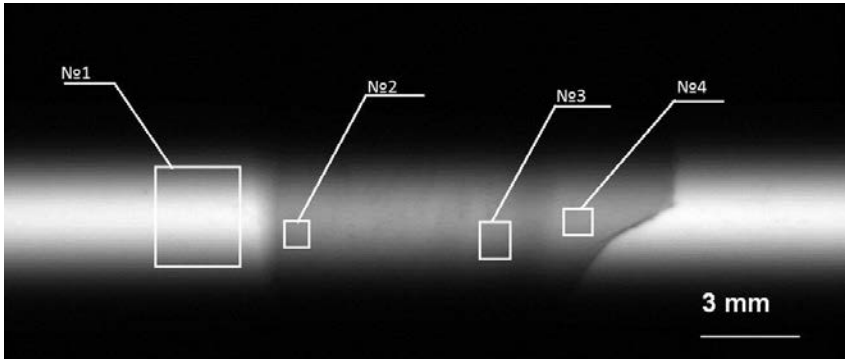
Images of the composite object at the peak of the rocking curve (right), on the slope of the rocking curve (left), and the scattering curves for different parts of the object: foil (1), paper (2), ballpoint pen casing (3).

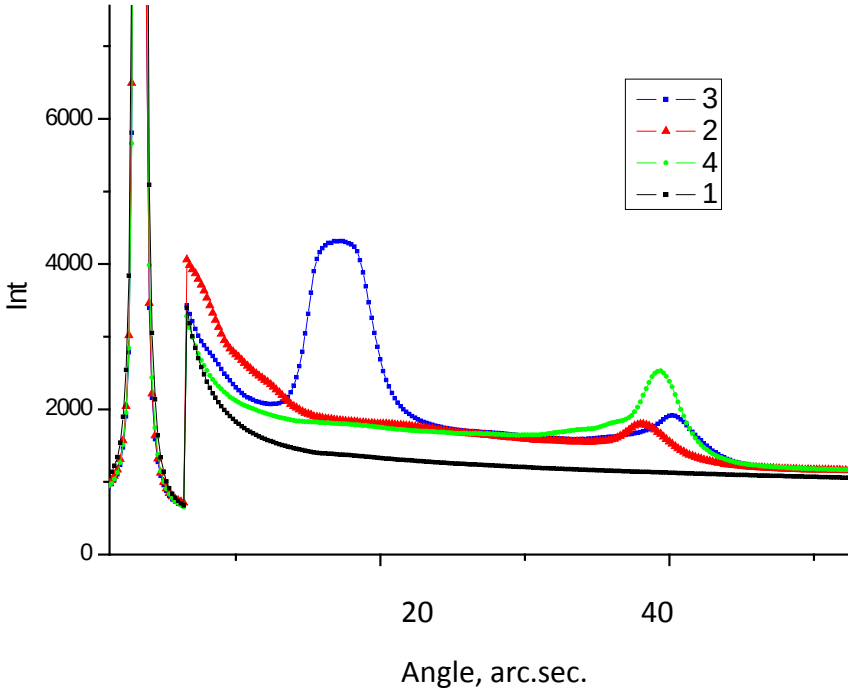
Imaging of artificial opals using wide angle scanning in synchrotron refraction setup



Opal matrix (ISSP, Chernogolovka), *E*=28 keV, scanning range 60 arc.sec., normalized images

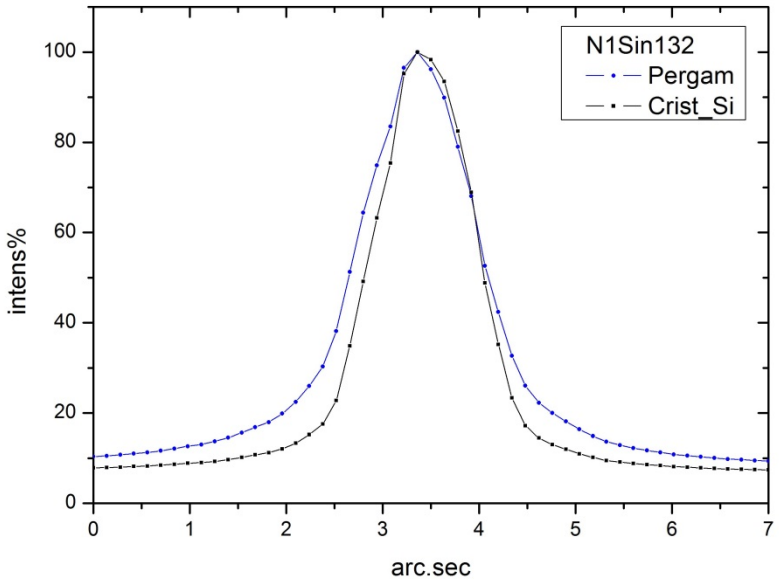
Imaging of artificial opals using wide angle scanning in synchrotron refraction setup

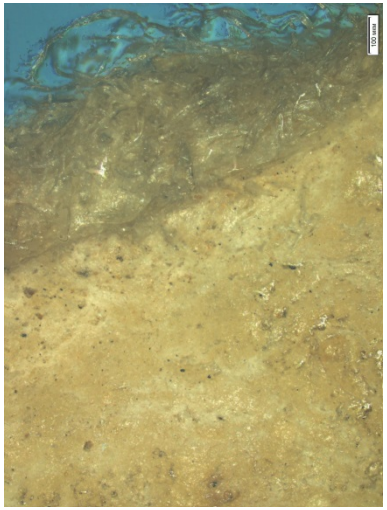




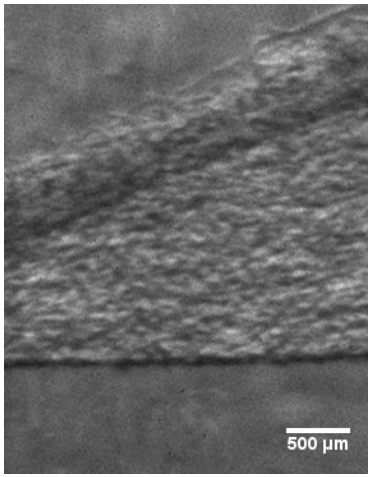
Regions of interest in the sample (left) and corresponding scattering curves plotted by integrating intensity in this regions (right)

Imaging of ancient parchment

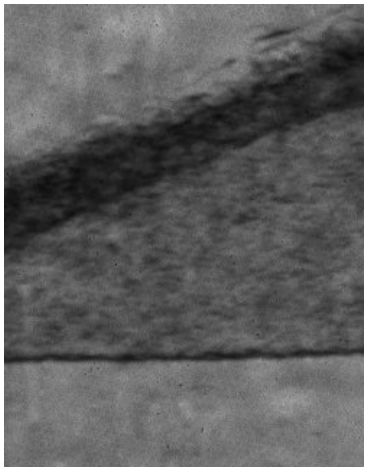




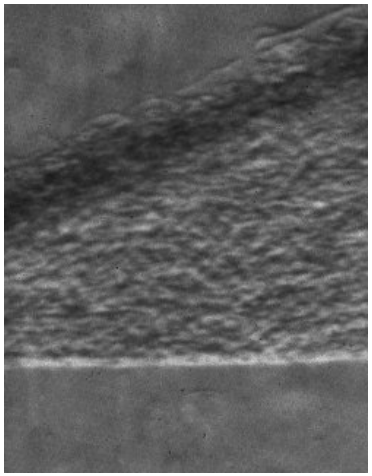
Fibrous structure of parchment is studied .
The dimensional characteristics of the fibers is obtained.
Results compared with optical microscopy



2,6’’



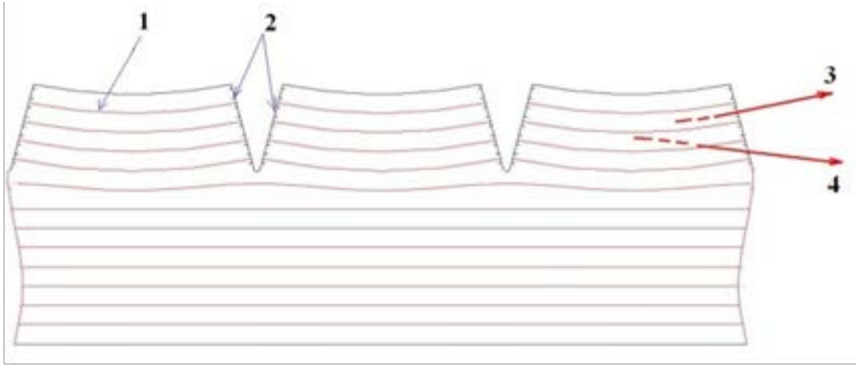
3,4’’



4’’

Topography of the proton beam deflector

Deflection of proton beams up to 10 TeV at LHC and other acelerators



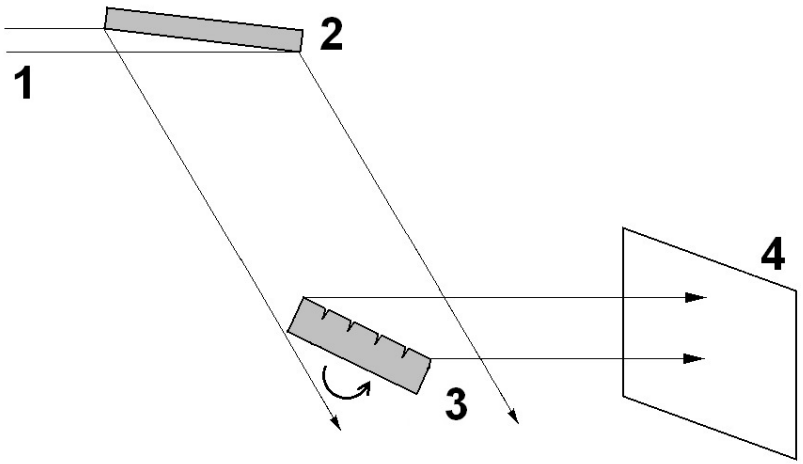
Schematic diagram of the beam deflection :

1 - curved crystallographic planes,
2 – grooves with disturbed surface ,
3 - beam deflected by channeling
4 - reflected beam of particles.

Photo of a silicon wafer with grooves.

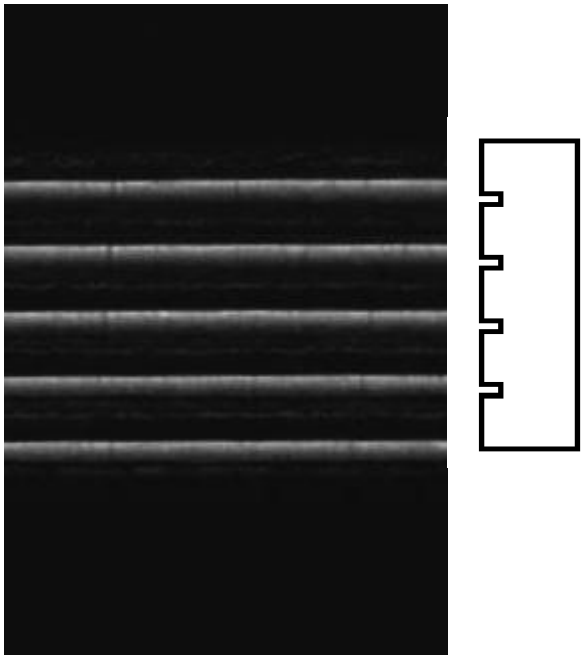
A.A. Kaloyan, S.A. Tikhomirov, K.M. Podurets, Yu.A. Chesnokov, Yu.E.Sandomirskiy Journal of Physics: Conference Series, 2016

Topography of the proton beam deflector

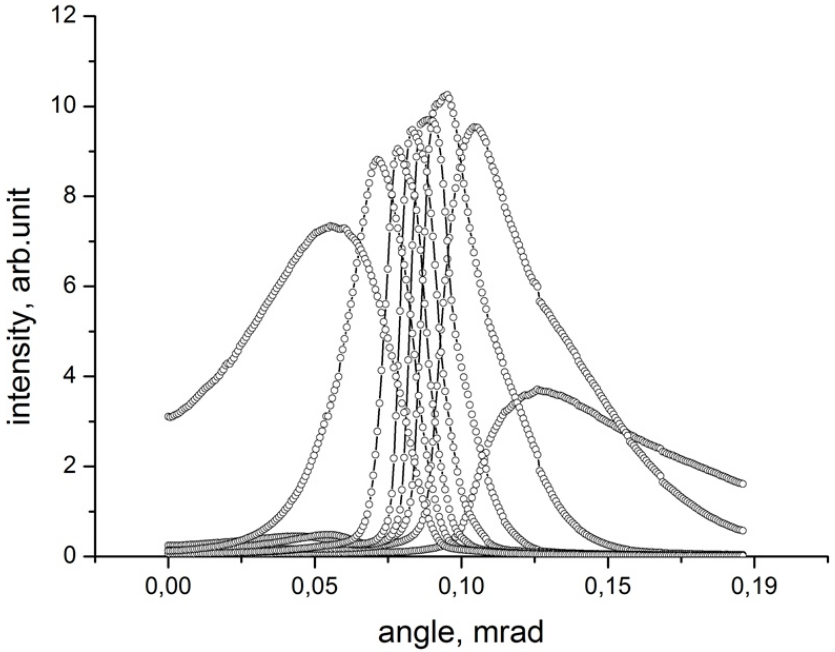


Experimental setup:
1 – SR beam from the source,
2 – monochromator crystal,
3 – sample
4 - position-sensitive detector.

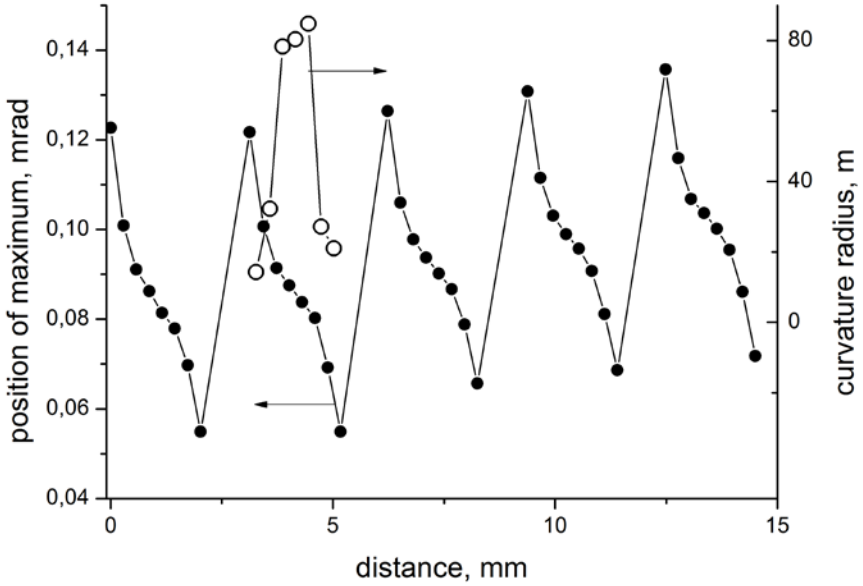
Sequence of topograms of the sample obtained at rotating the crystal



Topography of the proton beam deflector

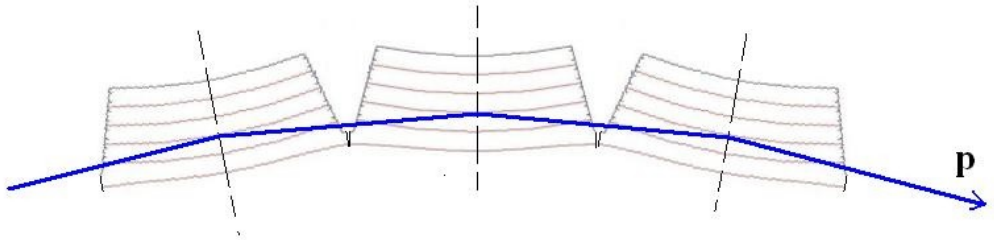


Crystal rocking curves within one strip



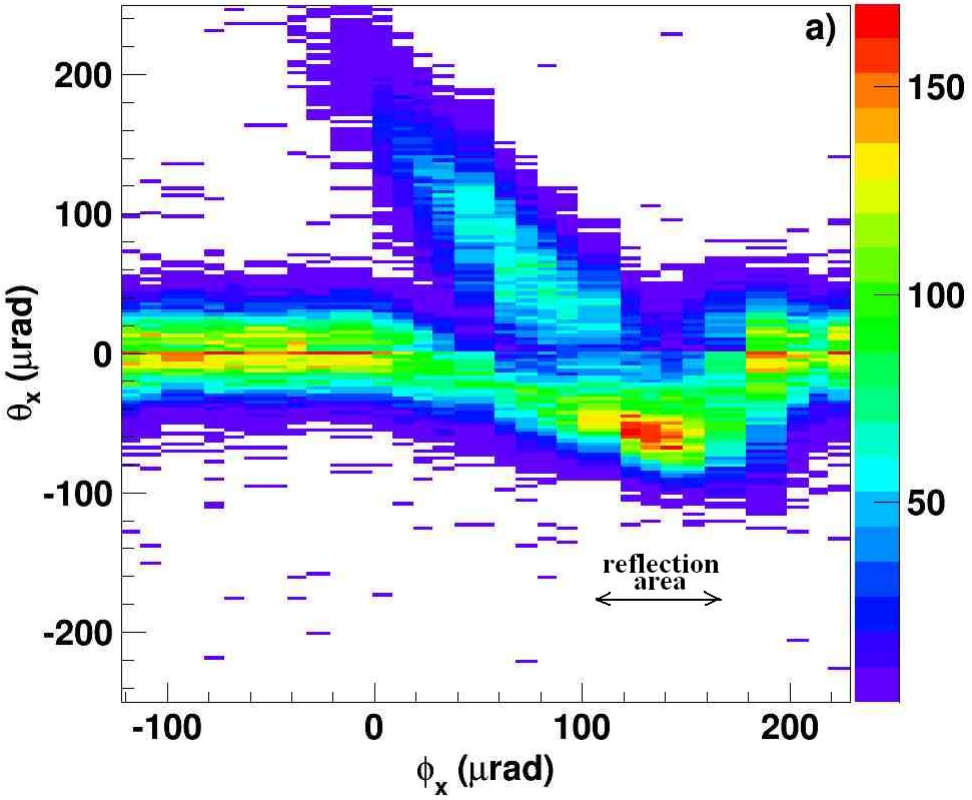
Dependence of the position of local maxima of the rocking curves on the coordinate across the crystal and the bending radius of a stripe, depending on the location.

Topography of the proton beam deflector



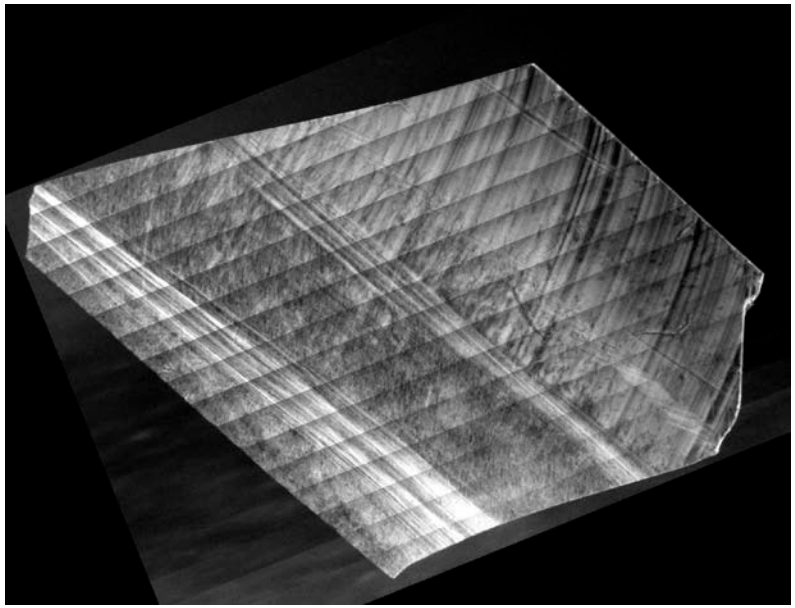
Scheme of optimal turn of proton beam when the angular displacement of successive strips of silicon coincides with the reflection angle of particles separate strip.

Experimental deviation of protons with energy of 400 GeV, depending on the angle of the multistripe crystal orientation. Effective reflection area (width about 60 mrad) is shown by arrows

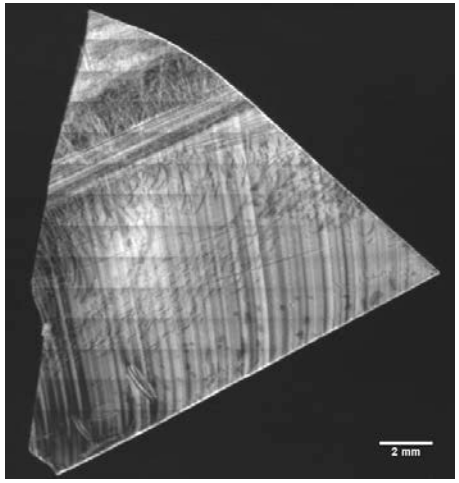


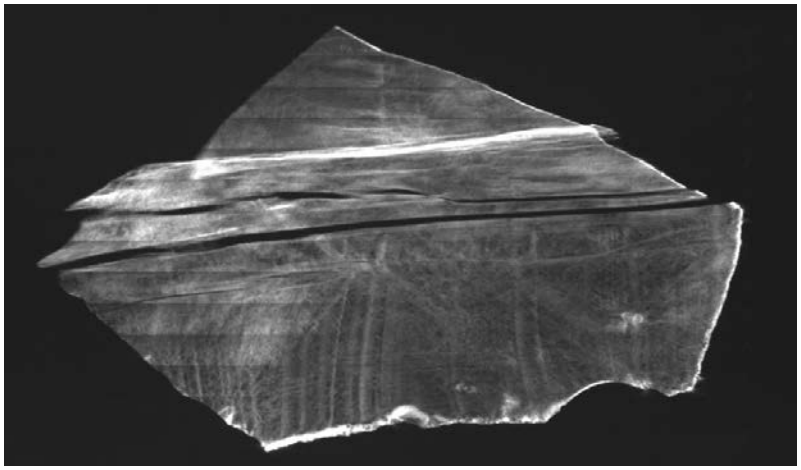
Topography of the $ZnGeP_2$ crystals

$ZnGeP_2$ – nonlinear crystal in the infrared region

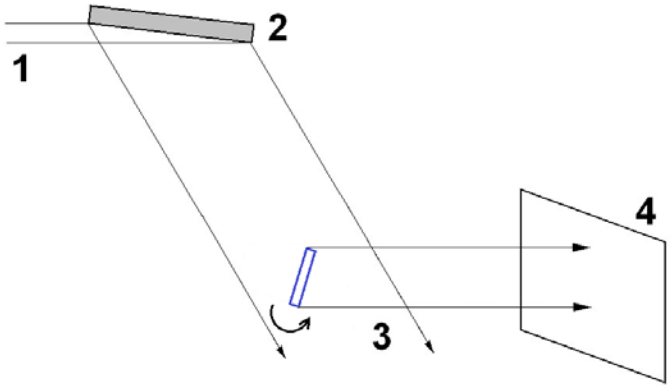


Topography of crystals in white SR beam





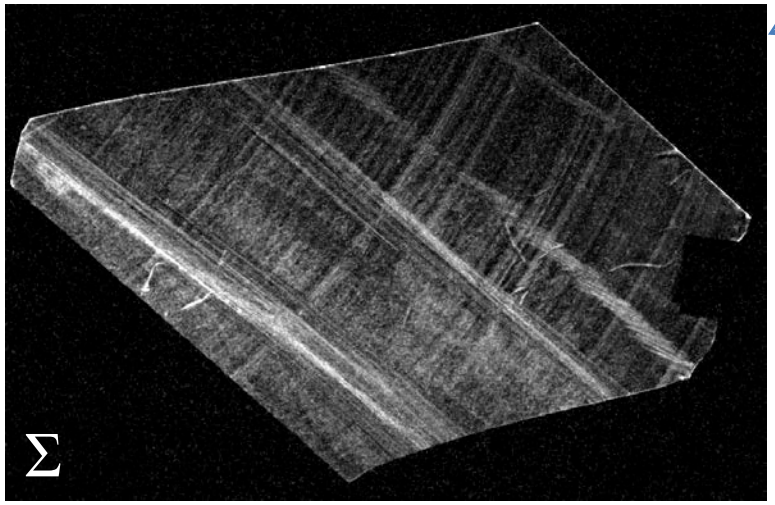
Topography of the $ZnGeP_2$ crystals



Experimental setup: 1 – white beam,
2 - Si (511) *d*=1,045Å, *E*=25 keV,
3 –$ZnGeP_2$ (336) *d*=1,044Å,
4 –detector
dispersion is close to 0

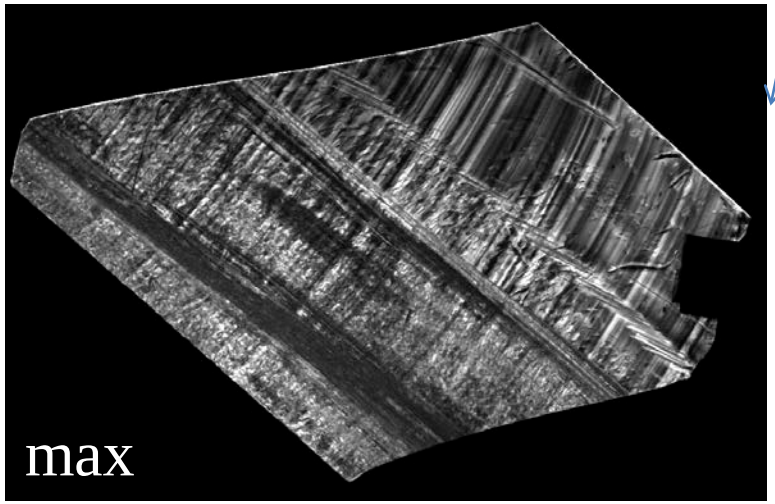
Topograms sequence at the crystal rotation with step of 2 arcsec

Topography of the $ZnGeP_2$ crystals



sum of all the frames of the sequence

the maximum value for each pixel for all frames of the sequence



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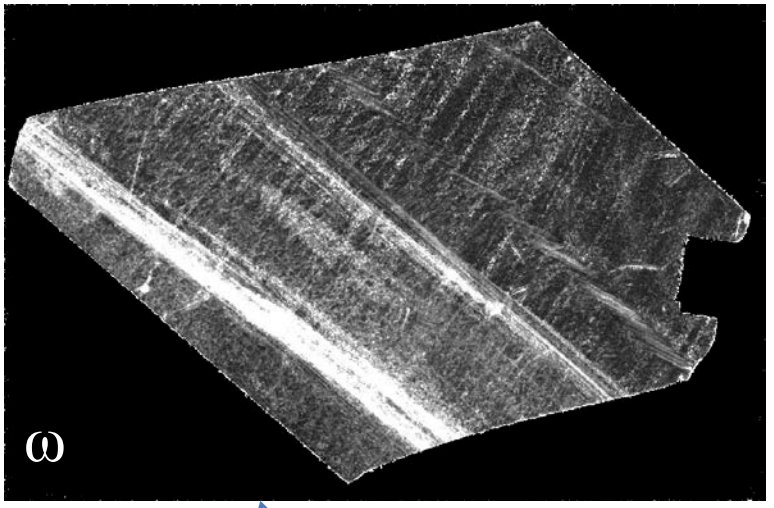
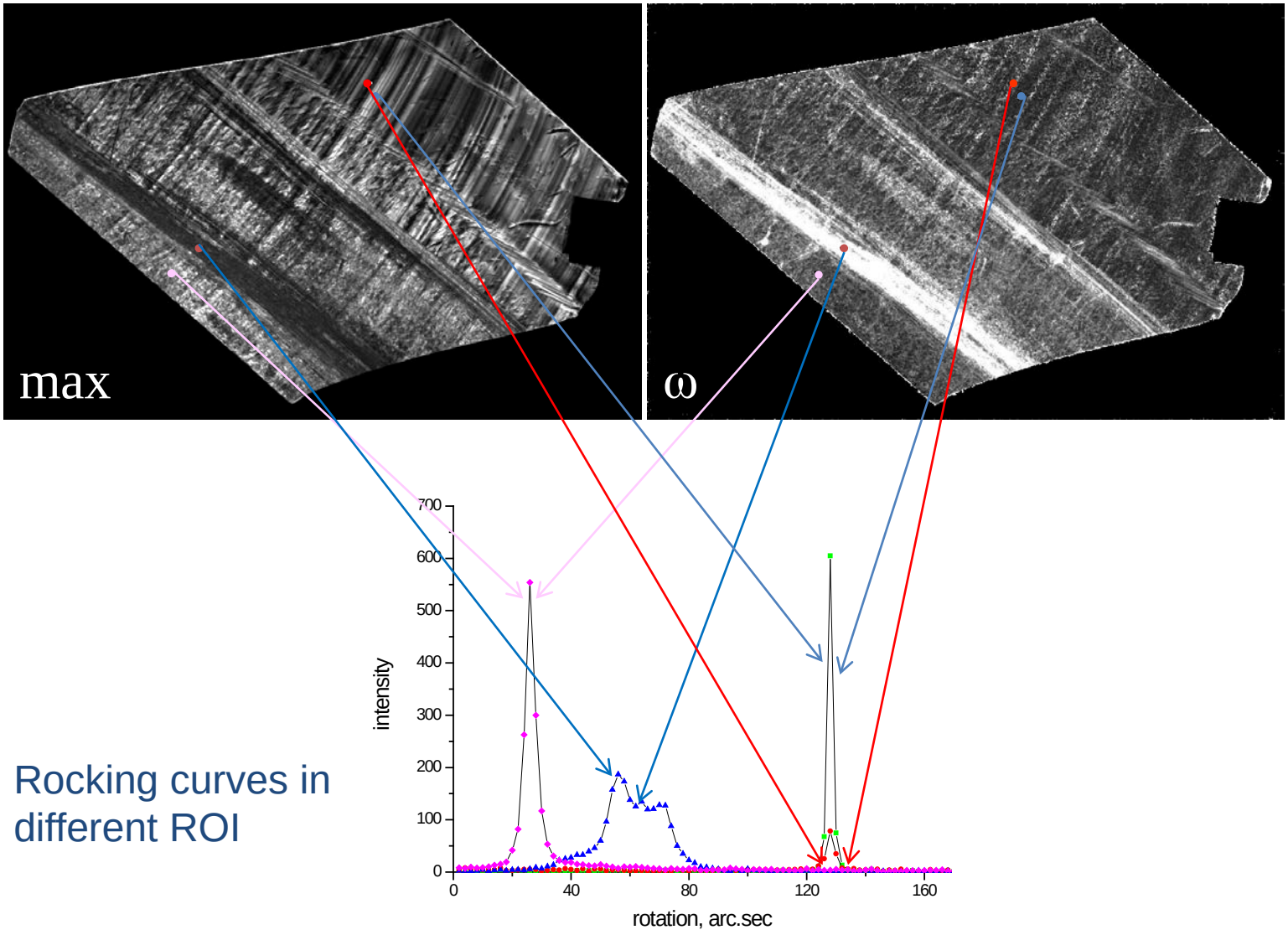


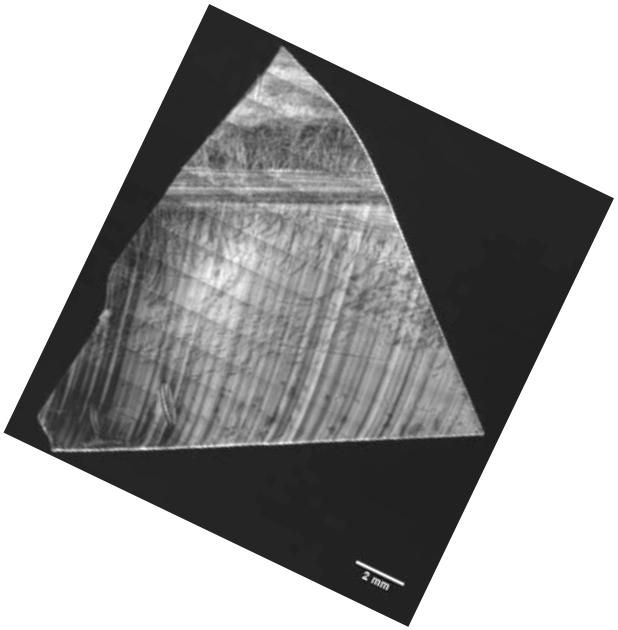
width of the rocking curve for each pixel on the assumption of the same shape of the curve

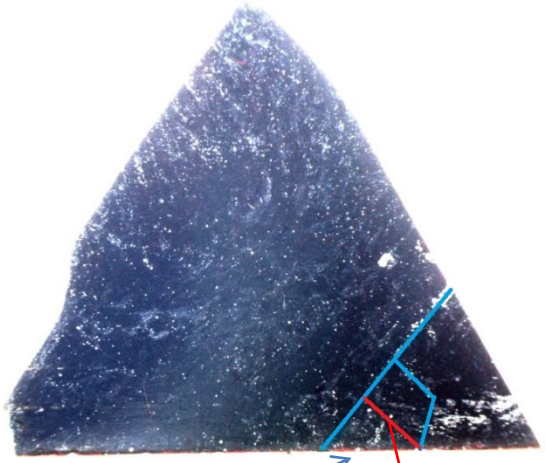
Topography of the $ZnGeP_2$ crystals



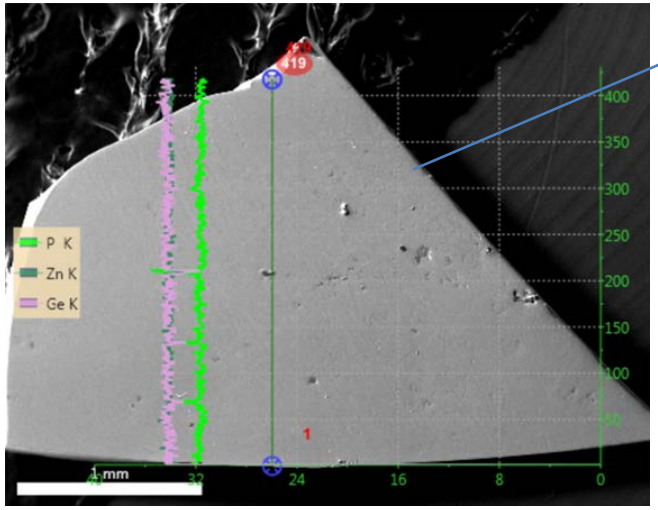
Rocking curves in different ROI

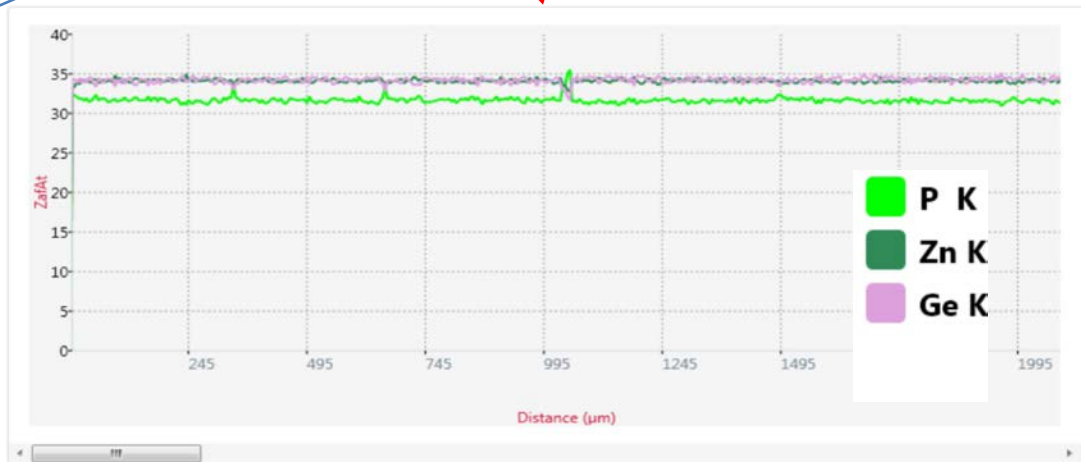
Topography of the $ZnGeP_2$ crystals





SEM elemental analysis





Conclusions

1. Measure scattering to understand contrast
2. Distinguish regions with different SAS
3. Distinguish regions with different defects in topography

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Thank you for attention