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
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

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).

How to distinguish refraction from absorption and small angle scattering?
- Wide angular scanning!
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.
Topography of the proton beam deflector

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

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.

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
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 ZnGeP₂ crystals

Experimental setup: 1 – white beam, 2 - Si (511) \(d=1,045\text{Å}, E=25\text{ keV},\) 3 –ZnGeP₂ (336) \(d=1,044\text{Å},\) 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
- Maximum value for each pixel for all frames of the sequence
- 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 ZnGeP₂ crystals
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