ESRF	**Experiment title:** Test of a sagittal bent high-energy monochromator prototype	**Experiment number**: MI 1170
Beamline: ID15A	**Date of experiment**: from: 05 Mrz 2014 to: 11 Mrz 2014	**Date of report**: 28.02.2016
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Report:

Objective: It appears advantageous under certain conditions to exploit symmetric Laue geometry for high-energy monochromators. The desired bandwidth broadening can then be produced by a sagittal curvature which in turn also generates, due to anticlastic bending, a meridional curvature which should coincide with the Rowland circle geometry. The bandwidth broadening arises only due to elastic anisotropy of Silicon. This scheme is considered for a novel high-energy beamline at the PETRA III synchrotron facility. A prototype bender was constructed and should be characterized.

Setup: A working energy of 100 keV was selected. The beam was pre-monochromatized by two meridional bent (asymmetric) Si111 crystals in the optics hutch. A bandwidth close to the intrinsic Si111 was obtained by selecting a narrow beam size (0.1x0.1 mm) and placing a perfect Si111 monochromator crystal on the monochromator axis of the 3-axis diffractometer. The crystal bender including a flat Si111 reference crystal was mounted on a translation perpendicular to the beam on the sample tower. A scintillation counter and attenuators were used as detector.

Experiments

Bandwidth:

The bent crystal was rocked through the incident narrow bandwidth beam. An inverted reflectivity curve is obtained as a dip (**Figure 1**). This curve does not provide information about the attenuation which however at 100 keV and 1.5 mm Si thickness is negligible. The width of ≈45 μrad is in good agreement with predictions by non-isotropic elasticity and provides a very useful bandwidth of 0.2% at 80 keV.

Meridional curvature:
The slope was measured by translating the crystal perpendicular to the beam and rocking to find the reflection centre positions. The curvature is the derivative of the slope, and in **Figure 2** the radius (inverse curvature) is plotted. The flat reference crystal is used to calibrate wobbling of the translation stage. The general shape of the curvature is due to the “double-T” -profile of the crystal and is predicted by FEM. At the edges the ratio between sagittal and meridional curvatures approaches the Poisson ratio but is significantly reduced at the crystal centre. This is a welcome effect since stronger sagittal bending is required to produce a prescribed meridional radius which enables a larger bandwidth.

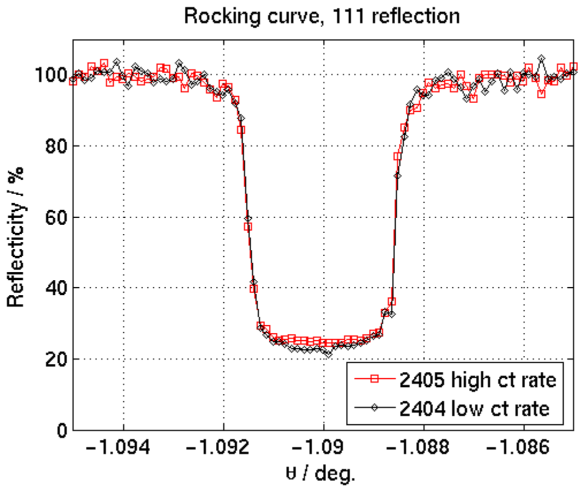

Figure 1**:** “inverted” Rocking curve indicating the box profile typical for bent Laue reflections.

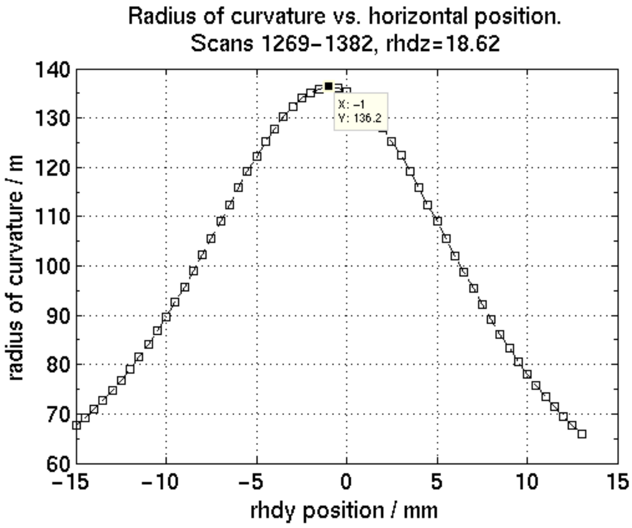

Figure 2**:** meridional bending radius.

Other observations:
It was experimentally demonstrated that the crystal after clamping but before bending was flat meridionally. This is crucial to apply elasticity theory to predict bending deformation. It was found that the weight of the leaf spring bending mechanism pre-bent the crystal by a significant amount against the intended direction. This is not a problem but needs to be taken into account for the actuator setting producing a desired bending.

Conclusion

The crystal bending mechanism was found to be well controllable and the crystal behaviour to be well explained by anisotropic elasticity. The symmetric Laue geometry and the actual bender design should be suitable to be used in a monochromator design.