ESRF

| ESRF | **Experiment title:** A meV topography study of sapphire crystals for backscattering monochromatization | **Experiment number**: MI-1163 |
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| **Beamline**: ID18 | **Date of experiment**: from: 06/02/2014 to: 11/02/2014 | **Date of report**: 01/03/2014 |
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**Report:**

The aim of this proposal was to characterize high quality sapphire (technically corundum) crystals grown at the Shubnikov Institute for Crystallography, Moscow by different methods using high-energy-resolution backscattering topography. These crystals have been already characterized using white beam topography at ANKA. The combination of both methods is important for the identification of the most promising growth technique for the sapphire in order to provide crystals with $10^{-8}$ ideal planes.

The setup of this experiment is shown in Fig.1. The important parts are the high resolution monochromator(HRM) (1) which provides the energy resolution ΔE=0.9 meV at 23.878 keV, two asymmetric crystals (2) which increase the vertical beam size from 0.5 to 3.5 mm, the sapphire crystal under study on the motorized stage (3), and the camera used to record the reflected image with 50 μm pixel size.

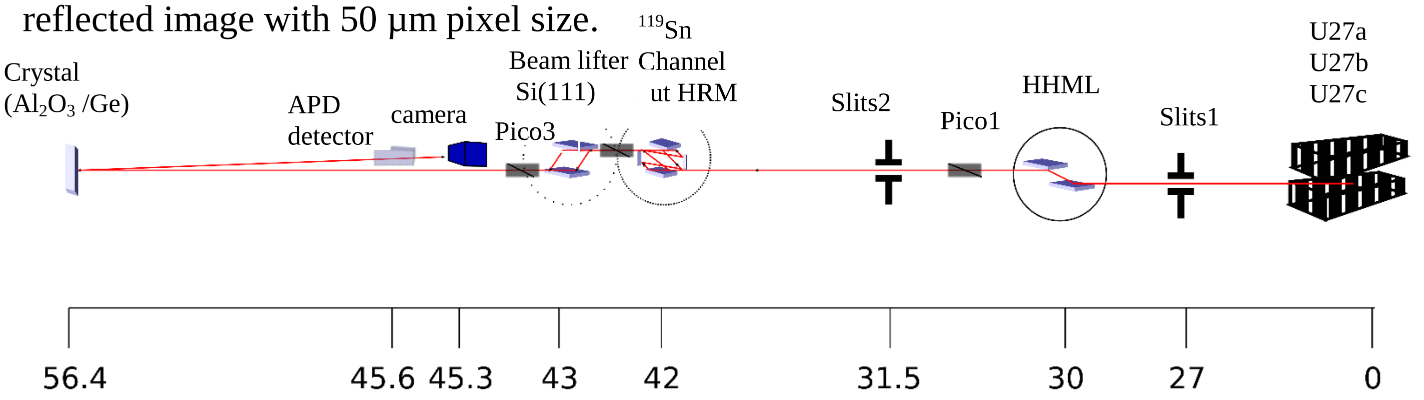


**Fig. 1** Schematic experimental setup. Distances between elements in m.

The energy of HRM was adjusted to the energy of the backreflections (0 1 50) and (7 10 18) depending on the crystal cut orientation (0 0 1) or (1 0 2), respectively. Energy scans of HRM have been performed with measurement of the reflected image of 5x5 $mm^2$ with spatial resolution of 50 x 50 $\mu m^2$. The entire area of each crystal was measured by translating the sapphire crystal across the beam. Further analysis of the obtained results will combine all images from a particular crystal for each point in the energy scan.
From the final images we will obtain several spatial maps, such as characteristic energy resolution of the reflection and the energy corresponding to the center of the rocking curve. The latter will provide a distribution of the lattice parameters across the sapphire, with $<10^{-7}$ relative resolution. Both maps give quantitative information about quality of the sapphire. They will be compared with the white beam tropography images in order to correlate the two methods. We could scanned seven crystals out of the fifteen expected, because of the alignment of three successive monochromators took more time than it was expected as well as some beam losses.

The first preliminary comparison of the white beam topography data and the inverse energy resolution map obtained in this experiment are shown in Fig.2. The results shown were obtained with a sapphire crystal grown by the Kyropoulos method with (0 0 0 1) growth direction. Correlations between defects in the white-beam topography and the quality of the reflection are clearly seen. Note however, that meV resolved backscattering topography reveals structures and defects even within regions nominally defect free in the white beam topography (center bottom of images in Fig. 2). A more precise treatment of the results is ongoing.
We are grateful to Dr.Dimitrios Bessas; our local contact, for his help and support during this experiment.

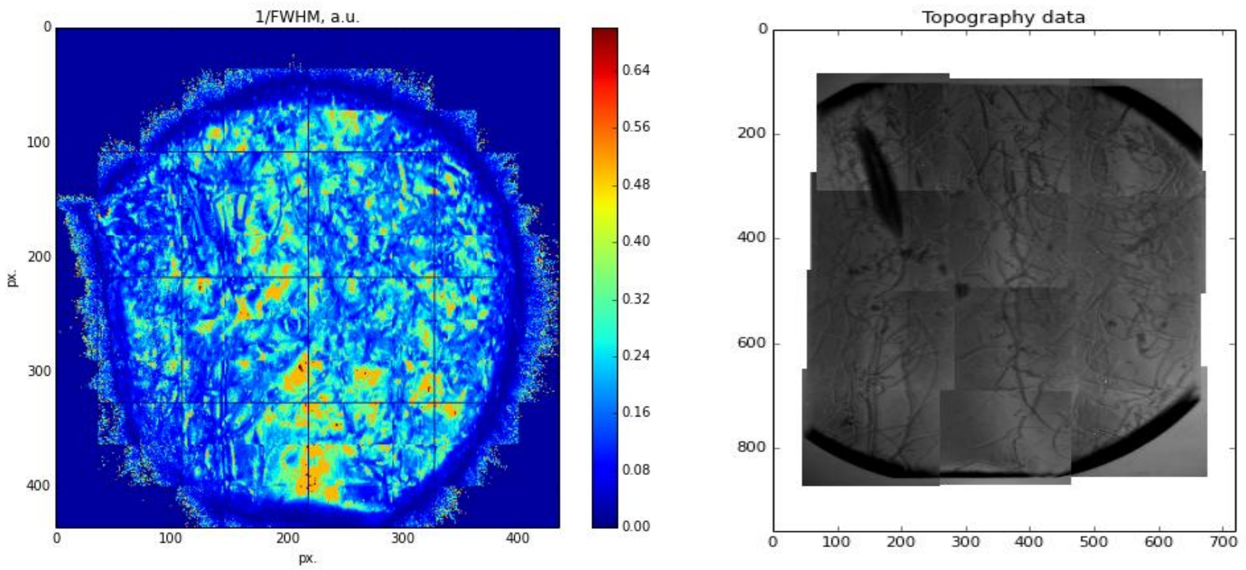


**Fig. 2:** (left) resolution map of Sapphire crystal (right) white beam topography result of same crystal, expeiments performed at at ID18, ESRF and ANKA, respectively.