At the European X-ray Free Electron Laser facility Si(111) channel (cut) crystal X-ray monochromators (K-monochromator) are planned for photon beam based alignment: gap tuning of the undulator segments and phase tuning of the phase shifters during commissioning and maintenance of the undulators. A prototype device with a single channel-cut crystal was characterized at PETRAIII / P01 by applying undulator adjustment methods, intended for the European XFEL, that use imaging and intensity detection.

1. Experimental setup

A sketch of the setup with the relevant beamline components is given in Figure 2. The beamline was equipped with two undulator segments (not shown in sketch), slits, double crystal high-heatload monochromator (HHM), and high-resolution monochromator (HRM).

The K-monochromator was placed to simulate the 4-bounce operation with the HHM (as illustrated in Figure 2). This first prototype of the K-monochromator was equipped with a single channel-cut Si(111) crystal, mounted on a rotational stage with a repeatability accuracy of 1 µrad. When the K-monochromator was used, the HRM was removed from the beamline.

For angle integrated flux measurements, a PIPS diode with current amplifier was used. For alignment and beam profile observation an imager with YAG screen and sCMOS camera with macro lens was used. A linear stage allowed switching between diode and YAG screen.
2. Measurements

For reference and estimation of the theoretical limits of the gap scan method set of reference scans were taken with the HRM. The HHM and the HRM were set at 14.4keV, measuring with the diode. The aim was to obtain reference scans for this method with the ultimate energy resolution.

**Gap tuning with the K-Monochromator**: The main tuning method applied was the gap scan, as other methods would require changing the e-beam energy or having a phase shifter between the undulator segments. Figure 3 shows a set of gap scans each with a slightly different energy setting of the Monochromators which corresponds to a variation in K of $\Delta K/K = 2\times10^{-4}$, which is the sensitivity we need for photon beam based K-tuning. The inset shows that the curves are well separated and K-tuning with sufficient accuracy should be possible.

**Imaging method**: For estimation of the imaging methods also images of the beam, transmitted through either only HHM or HHM and K-monochromator, were taken after detuning the gap up to 2% in energy. This resulted in the circular shapes with local maxima in the vertical when observing the fundamental, as expected from numerical simulations. Shown in Figure 3 is the observation of the fundamental at 10 keV, with the imaging setup, only using the HHM. The inset shows the simulation carried out with SPECTRA.

![Figure 3: typical gap scan of U2 with HHM and K-Mono](image1)

![Figure 4: Test image; Mono ~1% detuned / Spectra simulation](image2)

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**References**