ESRF	Experiment title: **Topography in a three-beam case: domains**	**Experiment number:HS-257**
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During a preliminary experiment in white beam diffraction imaging under magnetic field, we had observed unusual contrast of magnetic domains on a weak reflection when it was enhanced through Umweganregung in a three-beam situation. The domain images were then highly reminiscent of parallel-beam topographs, with the small difference in distortion leading to contrast **between domains,** as opposed to the contrast at the walls that is usual in white beam imaging.

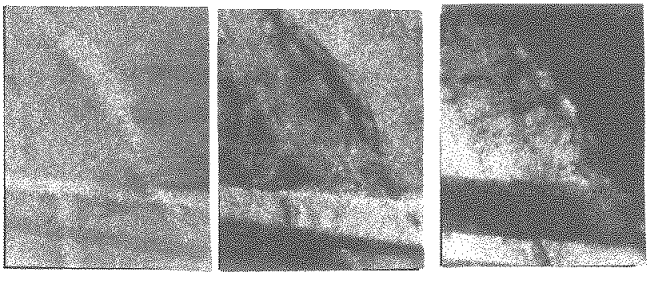
In order to understand this effect, we performed observations, in the two- and three-beam cases, of magnetic domains in the room-temperature ferrimagnetic phase of a sample of magnetite Fe304 , .0.18 mm thick, with its surface parallel to $(1\bar{1}0)$ and of size about 5 x 3 mm2 kindly provided by Prof. Y. Miyamoto, Saitama University, Japan.

The experiments were performed on the imaging and high-resolution diffraction beam-line ID19. The specimen was mounted on a special Eulerian cradle attachment, fitted on ID19's standard diffractometer. The weak **h** = 171 "primary" reflection was always excited. In the three-beam case, when g = 131 was also brought into diffraction through rotation in χ, i.e. around diffraction vector **h,** the 171 reflection was enhanced through detour excitation (Umweganregung) by the 131 + 040 combination, where both contributions are strong (the structure factors modules are respectively 25 for reflection

171, but 271 for reflection 131, and 313 for reflection 040). At the wavelength used, λ = 0.5 A, the absorption factor $\mu t \approx$ 1.2. The topographs, with exposure times 1 to 60 seconds on Kodak SR film, were recorded about 30 cm from the sample.

The specimen contains subgrain boundaries, which are very conspicuous on most topographs. The reflections used also show 109° magnetic domain walls, roughly along (OOl), through the difference in spontaneous distortion associated to magnetostriction (λ_{111} = 7.7 10-5).

A variety of scattering situations was investigated, in pseudo-divergent monochromatic, parallel pseudo-white and white beams. The figures show, in the white beam case, the 171 reflection topograph in the two-beam case (a), and in three-beam cases at fixed ω and for two values of χ differing by 0.01° (b and



a b c 500 μm

c). The property of domain contrast, and of contrast reversal, is conspicuous in the three-beam 171 images. The 131 images remain remarkably unaltered over the various scans

The results confirm that the Umweganregung geometry provides, in white-beam topography, the high sensitivity to distortion usually associated to plane-wave monochromatic-beam experiments. We believe the essence of this effect to be simply the fact that the dispersion relations for the two simultaneously excited reflections are different. This finding may develop into a method for selectively enjoying this high sensitivity through an attachment, while retaining the basic simplicity of white-beam topography.

To our knowledge, this is part of the first investigation of the imaging application of the three-beam approach, which is mainly used in structural crystallography as a way of obtaining information on the relative phases of different Fourier components of the electron density.