Trindex - 3D Grain Mapping with Neutrons

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The mechanical and functional properties of polycrystalline materials have significant contributions from the 3D interaction of grains that form their micro-structure. Such grain maps can be extracted from existing characterisation techniques that utilise X-rays or electrons. However, complimentary techniques using neutrons have not yet developed to maturity. Furthermore, neutrons provide distinct advantages where, due to their lower attenuation, larger materials can be analysed, such as real-world engineering materials.

Here, a novel 3D grain mapping methodology, known as *Trindex*, has been demonstrated to reveal the micro-structure of a prototypical cylindrical iron material. While there already exist several methods on grain mapping with neutron imaging [1,2], *Trindex* provides a robust and relatively straightforward approach. *Trindex* is a pixel-by-pixel neutron time-of-flight reconstruction method which extracts the morphology of grains throughout the sample, in addition to their pseudo-orientations.

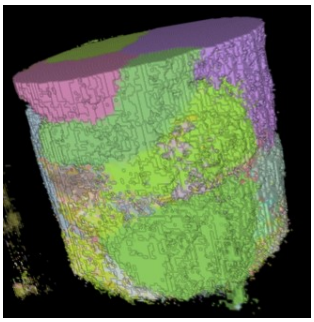

Figure 1. 3D reconstruction of grain map from a prototypical Fe sample. Colours represent different grain orientations. Sample height of approx. 4 mm.

Experiments were performed at the SENJU beamline of the Japan Proton Acceleration Research Complex (J-PARC). For the setup, an imaging detector was placed behind the sample with diffraction detectors simultaneously collecting the backscattering from the sample. Such diffraction will be used to confirm grain orientations. Details of the methodology and the resulting 3D grain maps of materials will be presented.

1. Cereser, A., et al. "Time-of-flight three dimensional neutron diffraction in transmission mode for mapping crystal grain structures." *Scientific reports* 7.1 (2017): 1-11.

2. Peetermans, S., et al. "Cold neutron diffraction contrast tomography of polycrystalline material." *Analyst* 139.22 (2014): 5765-5771.