First Tests with the Timepix3 Detector for Holmium (Ho) thin film X-ray Photon Correlation Spectroscopy (XPCS)

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Modern electronic devices heavily depend on nanoscale thin-film materials with fluctuating magnetic domains for efficient data storage. Understanding the dynamics of these tiny domains is key to understanding the magnetization reversal process and improving magnetic data-storage capabilities. X-ray photon correlation spectroscopy (XPCS) is a powerful technique for studying slow nanoscale fluctuations through the temporal correlation of speckle patterns created when coherent X-rays interfere from different domains[1]. Helical antiferromagnetic holmium (Ho) samples have previously been studied via domain-wall fluctuations over a wide range of time scales[2]. However, temporal resolution in the soft X-ray range has been limited by the slow readout of frame-based detectors, as well as by the lack of sufficiently coherent X-ray beams.
Recent advances in coherent X-ray sources at fourth-generation synchrotrons, like MAX IV, together with advanced photon-counting detectors, have expanded the accessible time scales down to the nanosecond regime. We have commissioned a mobile end-station with cryogenic capabilities and an advanced Timepix3 detector at the high-coherent-flux scattering beamline SoftiMAX at MAX IV in Sweden. The detector configuration consists of a pixelated readout using a quad assembly of Timepix3 ASICs placed directly below microchannel plates (MCPs) in vacuum, providing event-based timing resolution at nanoscale. Single X-ray bunch patterns at the MAX IV facility, operating with 10 ns gaps between individual synchrotron bunches, have been resolved via a histogram. The goal of this experiment is to push the temporal resolution into the nanosecond regime and provide new insights into the dynamics of Ho domain fluctuations using soft X-ray XPCS. This study will help understand nanoscale domain dynamics as a function of temperature and investigate phase transitions between 2D thin films and 3D bulk structures.

References:

[1] O. G. Shpyrko, Journal of Synchrotron Radiation, 21 (2014) 1057-1064.
[2] S. Konings, et al., Physical Review Letters, 106 (2011) 077402.