Noise properties in spectral acquisitions

Novel energy dispersive imaging detectors are becoming generally available for X-ray measurements. Current detector technology provides information about the signal by integrating the total energy of the photons regardless of their place in the spectrum. This corresponds to black and white photography. Imaging Spectral detectors can simultaneously give us spatial information and spectral or “color” information.

For all modes of measurements involving x-ray the interaction between sample and x-ray photon has a significant energy dependence. Detectors that resolve the energy information or spectral detectors provide us with much better details about our samples if we can understand how to accurately interpret the signal they provide. For regular computational tomography, spectral information allows us to have both better contrast between materials and also reduces artifacts like metal streaks and beam hardening. In other cases, it allows us to make advanced diffraction imaging at local broad-spectrum instruments instead of travelling to a synchrotron beamline.

In this project you will investigate the statistical framework for spectral acquisitions. Since the same number of photons reach the detector, what is the optimum division of energy bins that balance accurate energy information with precise intensity information. The evaluation is done both on radiographs and on reconstructions. For reconstruction, the use of multichannel regularization functionals are employed to further enhance the utilization of spectral information.

![Figure 1: Diffraction image for a single energy. The radius of the diffraction rings are highly dependent on the photon energy. Using conventional detectors for a polychromatic beam would thus result in smeared rings](image1)

![Figure 2: Plot of spectral dependency of Attenuation Coefficients for different multichannel regularizations. Shaded areas correspond to the variation within a reconstructed segment](image2)

Skill requirements:

- Basic knowledge of C language or similar programming languages
- Basic knowledge of Matlab data analysis

The required skills depend on the exact formulation of the project, for more advanced evaluation, knowledge of reconstruction techniques is an advantage.

Skills learned:

- Experience with x-ray analysis
- Experience with spectral detectors and data