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Spatio-temporal neutron tomography of dynamic processes

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The study of evaporation and transport processes using neutron tomography is often difficult due to the fact that these are dynamic processes. The motion time-scale is faster than the time required to acquire a complete data set for computed tomography. Under such conditions the reconstructed data will be corrupted by motion artifacts which are observed as streaky intensity variations. Motion artifacts may spoil the purpose of the experiment. One way to reduce the motion artifacts is to shorten the scan time to match the process dynamics. This may be inconvenient since the image quality will suffer from the loss in detected neutrons. An alternative method to reduce the artifact is to use an irregular projection acquisition process in contrast to the traditional sequential incremental method. Application of the Golden ratio was suggested by Köhler [1] as an angle increment which results in a scan where two subsequent projections are acquired at roughly orthogonal angles. The first feature of this increment is that it reduces the impact of the motion artifacts to the region described by maximum boundaries of the moving shape. The second feature takes us to the realm of spatio-temporal imaging. This means that a single scan which lasts over the complete experiment duration can be used to either describe the static parts with high spatial resolution alternatively the dynamic process can be studied in several steps with lower spatial resolution. An experiment with an evaporation process is used to demonstrate the features of the Golden ratio scan. The experiment was made at the cold neutron imaging beamline ICON at Paul Scherrer Institut, Switzerland.

[1] T. Köhler, "A projection access scheme for iterative reconstruction based on the golden section," in Nuclear Science Symposium Conference Record, vol. 6. IEEE, 2004, pp. 3961–3965.