MANUFACTURING METROLOGY TEAM

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Simulation of continuous high aspect ratio tomography for surface topography measurements

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0. Introduction

High aspect ratio tomography (HART) has been proposed in the past to optimise the number of projections in an XCT acquisition [1,2].

For objects with a large geometrical aspect ratio around the centre of rotation, it allows an irregular spacing of projections around an object, and thus a reduction of the *total* number of projections.

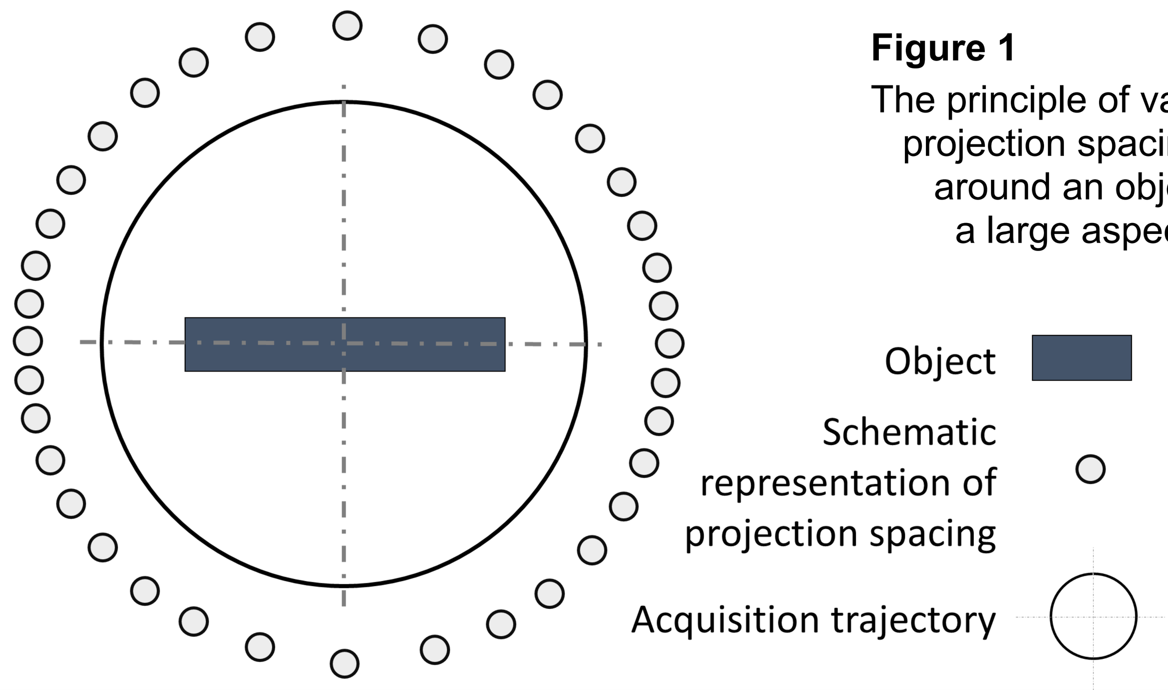

Figure 1
The principle of varying projection spacing around an object with a large aspect ratio.

1. Projection calculation

The angular spread function of the projections is calculated from a discrete evaluation of the works of [1,2,3], for an example see figure 2. For the investigated case study, this results into a reduction of 25% in acquisition time.

For continuous motion acquisitions, i.e. taking radiographs whilst the rotation stage is moving, the projection distribution function can be restricted to avoid motion blurring.

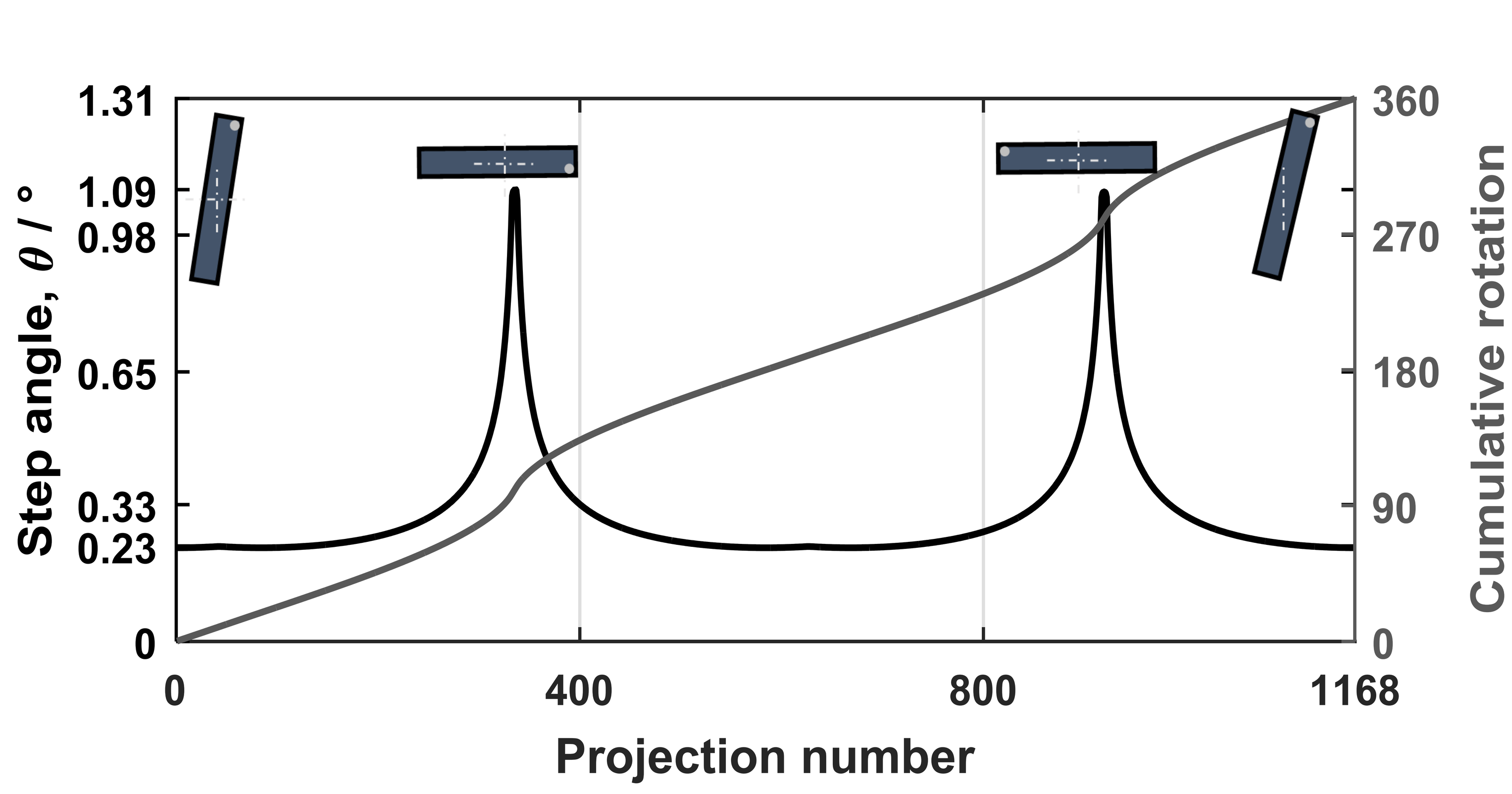

Figure 2
The HART projection distribution for rectangle with an aspect ratio of 14 rotating around its centroid.
A conventional acquisition method (uniform angular spacing) would require 1571 projections. For this part, the acquisition time is reduced by around 25%.

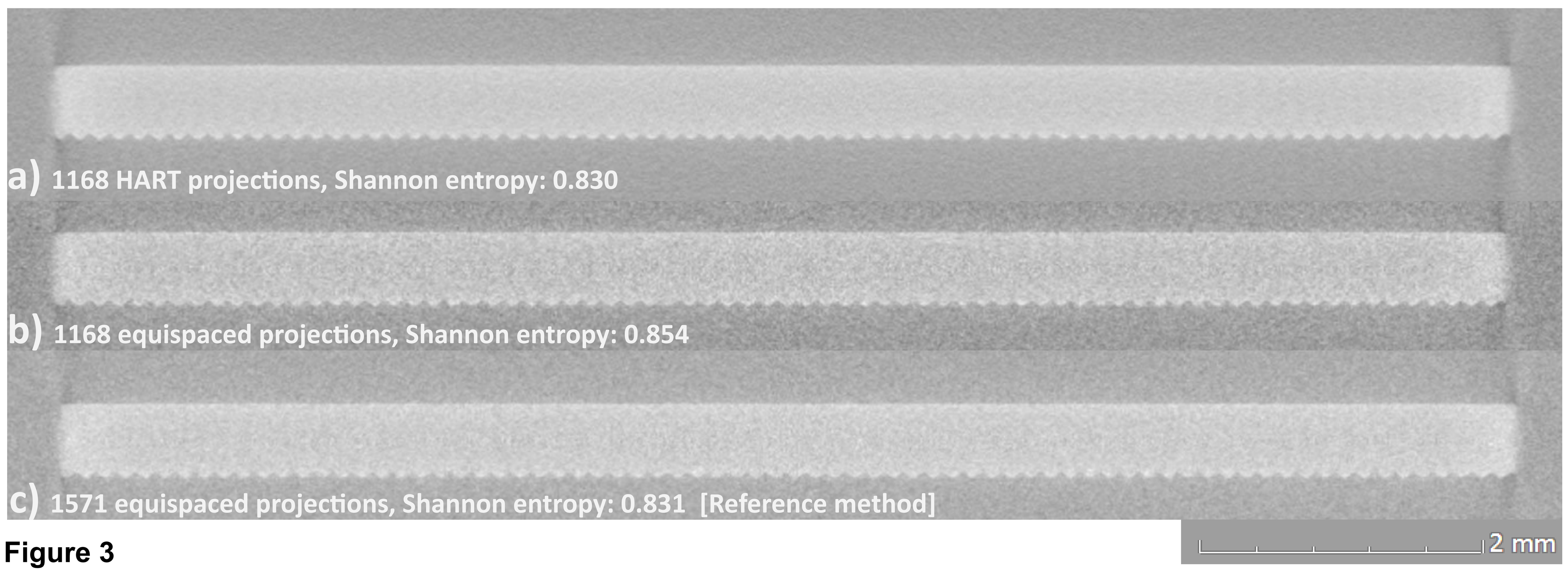

Figure 3
a) One reconstruction using 1168 HART projections as seen in Figure 2; b) a reconstruction using 1168 equispaced projections; c) a reference scan using the conventional acquisition method with 1571 equispaced projections.

2. Reconstructed volumes

The Shannon entropy [4] was used to quantify the image quality of the reconstructed volumes, see figure 3. The HART acquisition showed similar Shannon entropy levels as the reference method.

An edge spread function was used to quantify the resolution [5]. No significant differences in terms of resolution were found.

3. Effects on surface texture

The surface topographies extracted were evaluated using statistical topography models [5, 6]. The precision of the repeated noisy simulations was assessed though the mean confidence interval width of the topography data points, see figure 4. The agreement with the reference method was quantified by a discrepancy ratio [5, 6].

The HART acquisition showed both better agreement with the reference method and better precision than the same number of projections using equispaced acquisition.

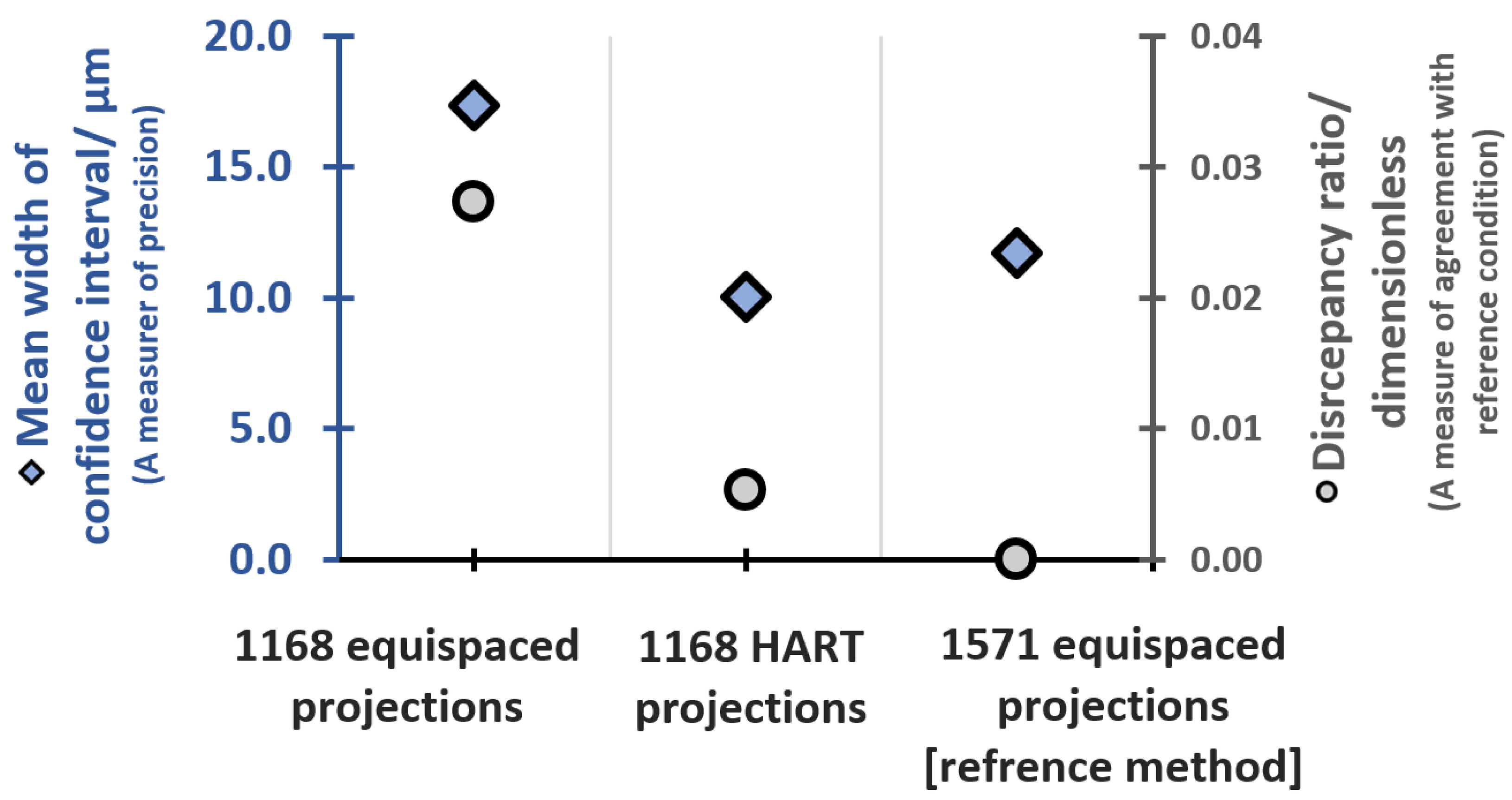

Figure 4
The HART case performs better in terms of precision than an equispaced reduction of the number of projections.

The HART case shows a much better agreement to the reference method than an equispaced reduction of the number of projections.

4. Conclusion

In the presented case study, a reduction of projections with HART is feasible without any significant sacrifices in noise, resolution nor any notable losses in precision of the investigated surface topographies.

References

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