Downsampling of STEM images: a study on the effect of electron dose reduction on the quality of 3D reconstructions

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Scanning transmission electron tomography (STET) is a 3D imaging method that was initially mainly used in material sciences and was much appreciated compared to transmission electron tomography (TET) for several reasons[1,2]. Thanks to the beam geometry and the absence of lens post-specimen, STET allows to get high signal-to-noise ratio and high contrast images of micron size thick specimens, it also has the advantage of separately collecting transmitted and scattered electrons thanks to the bright field and the dark field detectors respectively. Since few years some studies have shown the use of STET for biological samples and life scientists show more and more interest in this method, especially for thick specimens[3,4,5]. One study in particular, showed that compared to cryo-TET, cryo-STET generates 3D volumes of equivalent quality while using less electron dose[4]. Since biological samples are very beam-sensitive, there is a constant need to reduce the electron dose. Furthermore, signal processing approaches such as compressive-sensing or inpainting have been used in this perspective[6,7,8]. In TET, these methods are used to reduce the number of tilt-views (tilt downsampling), while in STET, the point-to-point imaging process allows to go further by reducing the number of collected pixels per tilt-view (image downsampling). Image downsampling has been tested in material science studies and is usually performed using of a fast electromagnetic shutter that randomly blanks the electron beam while it is scanned linearly.

On our JEOL 2200FS we do not have an electromagnetic shutter installed, we then blank the beam using the scanning coils by shifting the electron beam outside of the area of interest. Using this method, we are able to collect downsampled images of biological samples. The missing data is recovered using inpainting on the 2D downsampled images. The reconstruction is then processed using standard tools (prior information cannot be known in biological samples). We first tested the strategy on an electron-resistant material. Secondly, this strategy has been applied on a 500nm thick section of chemically-fixed resin-embedded *Trypanosoma brucei* cells. We then compared the 3D reconstructions obtained from various image-downsampled tilt-series and explored the limits of electron dose reduction.

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