Evaluation of multiple-axis tomography in TomoJ, a freeware plug-in for the JAVA based public software ImageJ

C. Messaoudi[1], S. Marco[1], C.O. Sorzano[2] and T. Boudier[1].

1 : Institut Curie, INSERM U759, Campus Universitaire dOrsay, 91405, Orsay Cedex, France.
2 : Unidad de Bioinformática. Centro Nacional de Biotecnología (CSIC). Campus Universidad Autónoma (Cantoblanco). 28049 Madrid, Spain
Correspondence: sergio.marco@curie.fr

Transmission electron tomography is becoming a powerful tool for studying the three dimensional structure of sub-cellular components. However, it presents different bottlenecks such as information loss due to the missing wedge, requirement of specialized equipments and software. Several efforts have recently been made to solve these limitations. Thus dual-axis [1] and conical tomography [2] allow a better compensation of the missing wedge and powerful algorithms such as ADA-SIRT [3] have been developed. In this context we have set-up a new approach to better fulfil the Fourier space in medium tilt-range acquisition, called multiple axis-tomography [4], and we have implemented a JAVA based public user-friendly software (TomoJ; figure 1) for multiple axis tilt-series alignment (with or without the use of fiducials markers) and 3D reconstruction including algorithms such as WBP [5] ART [6] or SIRT [7].

Multiple-axis tomography consists in the recording of multiple tilt-series at different orientations in the plane after rotating the sample inside the holder. Multiple-axis tomography does not strictly require the use of rotary holders as the grid can be manually rotated after recording each tilt series. And in the case of important sample damage the tilted-series already recorded can be combined to obtain a 3D reconstruction. Consequently, we suggest to record of a maximum number of tilt series at the following rotation angles: 0, 90, 45, 135, 30, 120, 60 and 150°.

Multiple-axis tomography requires the correct 3D alignment and merging of all independently computed reconstructions. To this purpose we have implemented in TomoJ three algorithms: alignment by cross-correlation using reference, RFA [8] and PSPC [9] and validated them by using phantoms. Hence multiple-axis approach has been evaluated on phantoms and experimental data set. Our results evidenced that multiple-axis tomography ensures to get results equivalent to those obtained by dual-axis approach without the need of high-tilt devices. Therefore, multiple-axis tomography can improve the quality of the reconstructions obtained by laboratories having basic equipments for electron tomography, enlarging the number of laboratories able to use this technique

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FIG 1. TomoJ Interface. Software runs as a plug-in for ImageJ and is freely available from authors at the e-mail address tomoj@curie.u-psud.fr