

3D lens-free time-lapse microscopy for 3D cell culture

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We present a new 3D lens-free microscope for large 3D biological samples and a dedicated reconstruction algorithm based on the Fourier diffraction theorem as used in standard diffractive tomography [1, 2]. It uses a regularised inverse problem formalism directly applied on the whole dataset and the 3D object to retrieve. To our knowledge, this is the first time that such an inverse problem approach is implemented in the context of lens-free diffractive tomography to reconstruct large volumes of unstained biological samples. Reconstructed volumes as large as $\sim 5 \text{ mm}^3$ are given (see 1) with a resolution sufficient to resolve isolated single cells (reconstruction parameters: $N = 16$, $\Delta\varphi = 18.8^\circ$, $512 \times 512 \times 300$ voxels of $3.34 \times 3.34 \times 5.32 \mu\text{m}^3$, final volume: $1.7 \times 1.7 \times 1.6 \text{ mm}^3 = 4.7 \text{ mm}^3$). First results of a 3D reconstruction along time will be also presented.

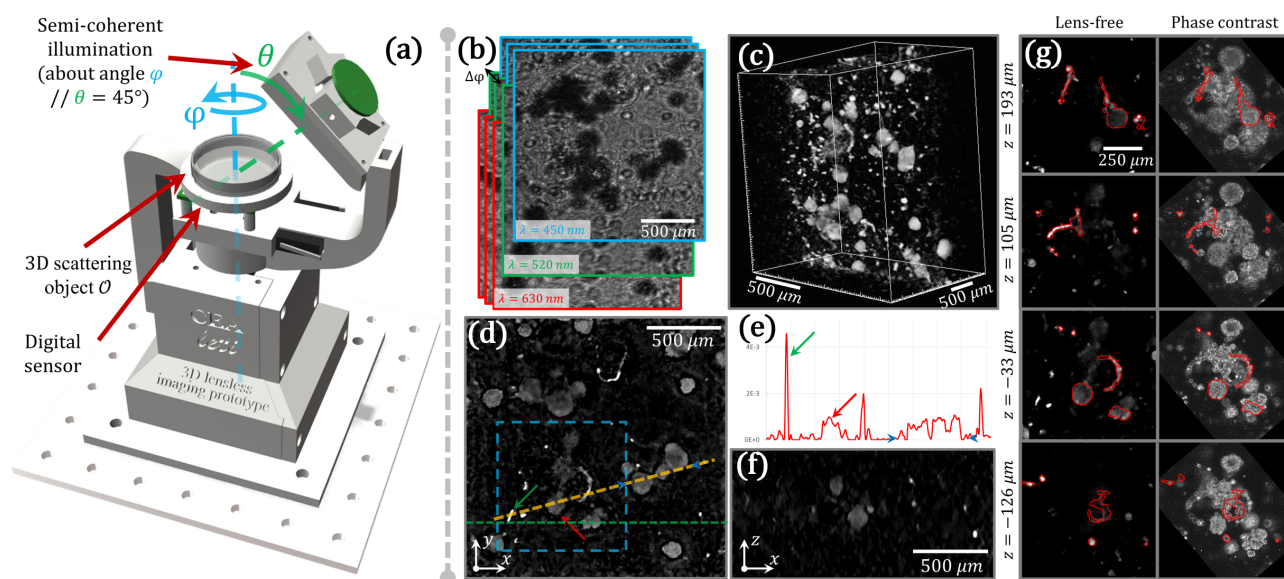


Fig. 1 : (a) Experimental setup dedicated to lens-free diffractive tomography and its optical scheme. (b-g) Reconstruction of a 3D RWPE1 cell culture. (b) Raw data at different angle and in the three available wavelengths. (c) 3D visualisation of the reconstructed volume. (d) xy -slice at $z = -48 \mu\text{m}$. The blue square zone was compared with a standard microscope. (e) Profile drawn along the yellow dashed-lines. The different arrows point at the structures in the 3D reconstruction and their counterpart on the profile. (f) Cropped view on the xz -plane orthogonal to the green dashed-line. (g) Comparison of a fully 3D reconstructed volume at a higher resolution (*left*) with the microscope views of phase contrast imaging (*right*).

RÉFÉRENCES

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