Holistic Monte Carlo virtual prototyping of biological imaging

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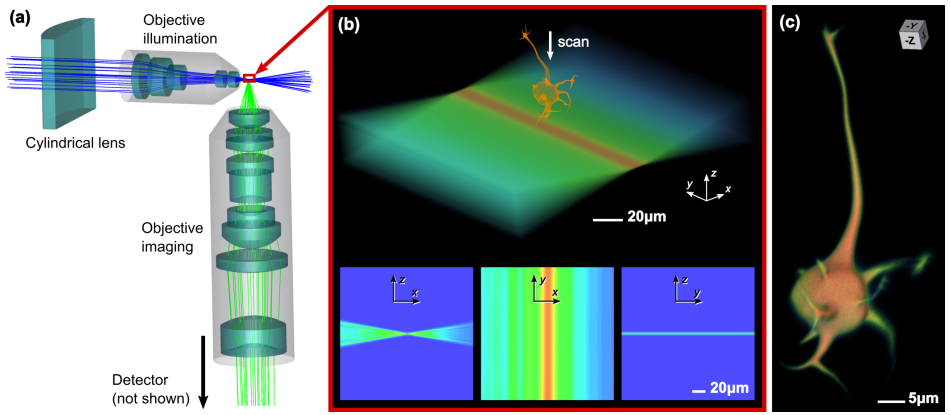
Abstract

The invention and advancement of biological microscopy depends critically on an ability to accurately simulate imaging of complex biological structures embedded within complex scattering media. We report for the first technique able to do this - by repurposing the ray-tracing capability of an optical-design programme.



Project Description

Monte-Carlo modelling is the gold standard for the modelling of light propagation in tissue, but is somewhat laborious to implement and does not incorporate the rejection of scattered light by the microscope. On the other hand microscopes may be rigorously and rapidly modelled using commercial ray-tracing software, but excluding the interaction with the biological sample. We report a hybrid Monte-Carlo optical ray-tracing technique for modelling of complete imaging systems of arbitrary complexity. We make the software available to enable user-friendly and rigorous virtual prototyping of biological microscopy of arbitrary complexity involving light scattering, fluorescence, polarised light propagation, diffraction and coherence.

Project outcomes

- The only technique for holistic modelling of imaging that incorporates both microscope and sample.
- Rigorous models can be constructed in hours rather than years
- (Mainly) OpenSource code is available
- Collaboration welcome

1. G. Carles, P. Zammit and A.R. Harvey, "Holistic Monte-Carlo optical modelling of biological imaging," Scientific Reports **9**, 603 (2019).