High-resolution holographic micro-endoscopy and manipulation

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Motivation

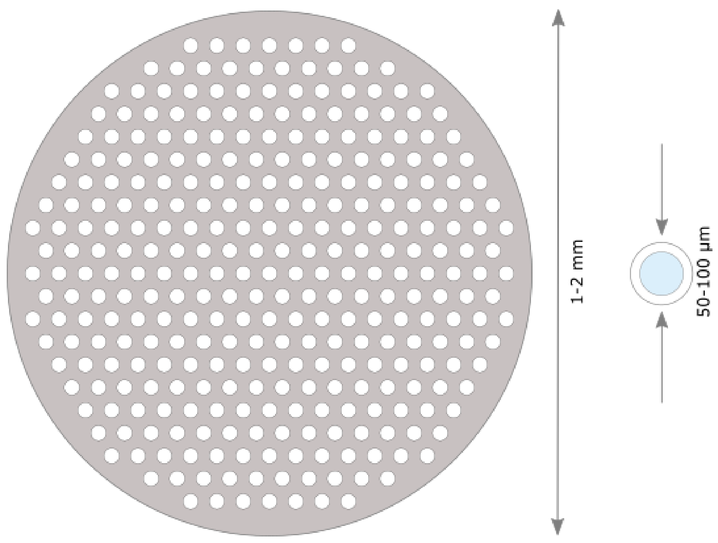
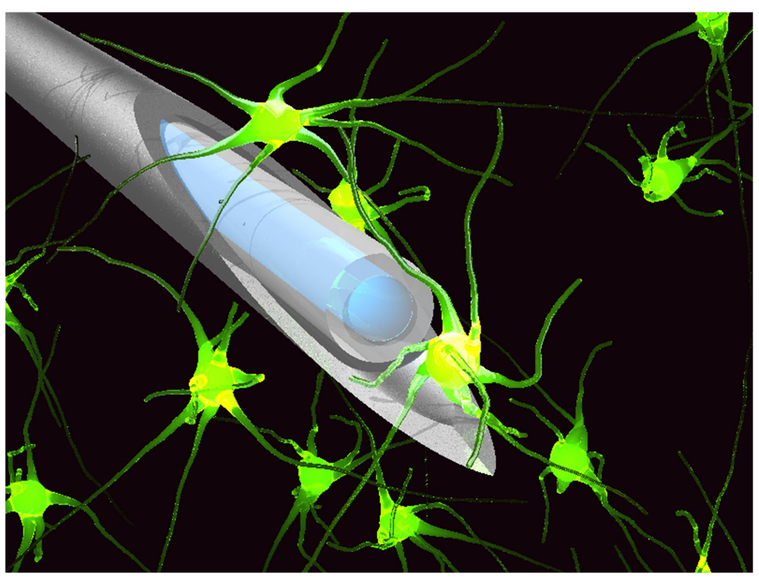


Figure 1 – Comparison between the cross-sections of a typical endoscopic probe composed of a bundle of optical fibres and a multimode fibre (MMF).

Applications



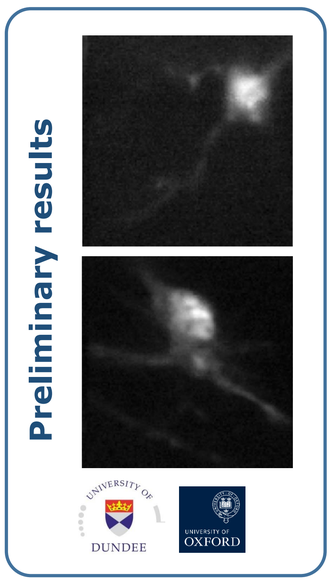


Figure 2 – *(left)* Imaging through a single MMF may enable optical access to exciting applications such as *in vivo* deep brain imaging. *(right)* Preliminary results on *ex-vivo* imaging of neurons in rat models.

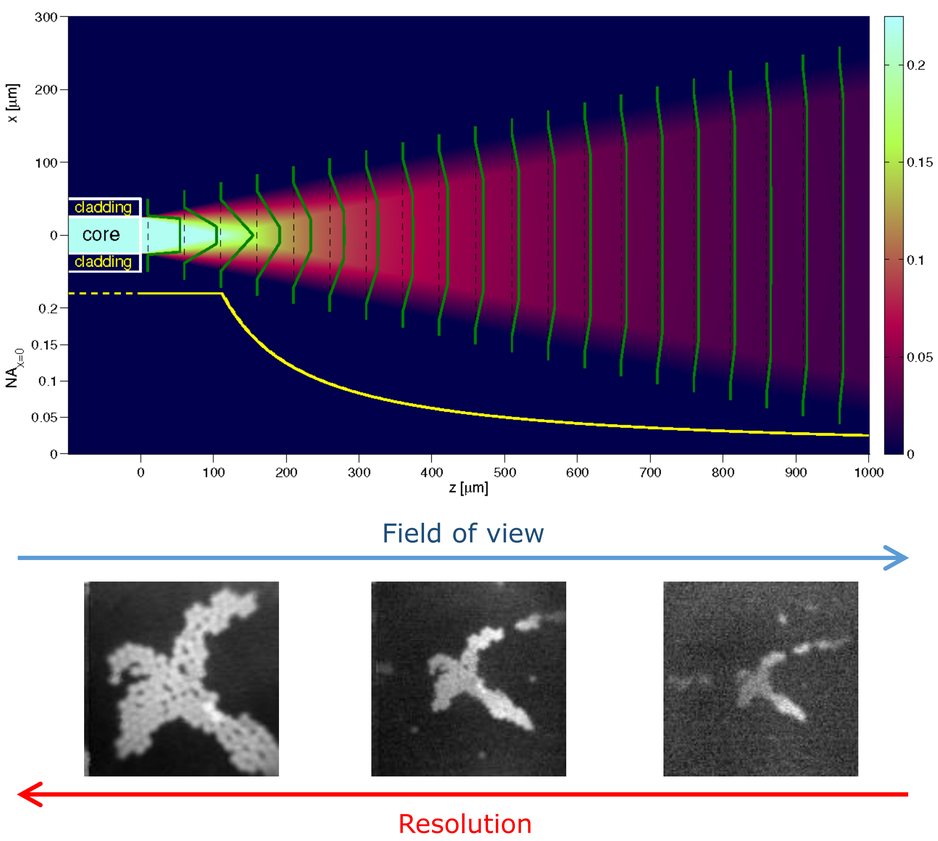


Figure 3 – Numerical aperture of sample modes at different distances from the fibre facet (simulation using parameters NA=0.22 and core diameter 50µm).

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Aims

- Exploiting novel multimode fibres for high-resolution minimally invasive imaging.
- 2D and 3D optical manipulation via minimally invasive endoscopes.
- Translation into biological and medical instruments.

Objectives

- Demonstration of a new geometry for beam-shaping of outputs through high-numerical aperture multimode optical fibres.
- Assessment of resolution limits for novel optical fibres.
- In vivo fluorescent imaging of tissues.
- Application to identify onset and progression of disease from morphological changes of tissue observed at sub-cellular level.
- Development of new geometries for optical manipulation using minimally invasive endoscopes.

Principles

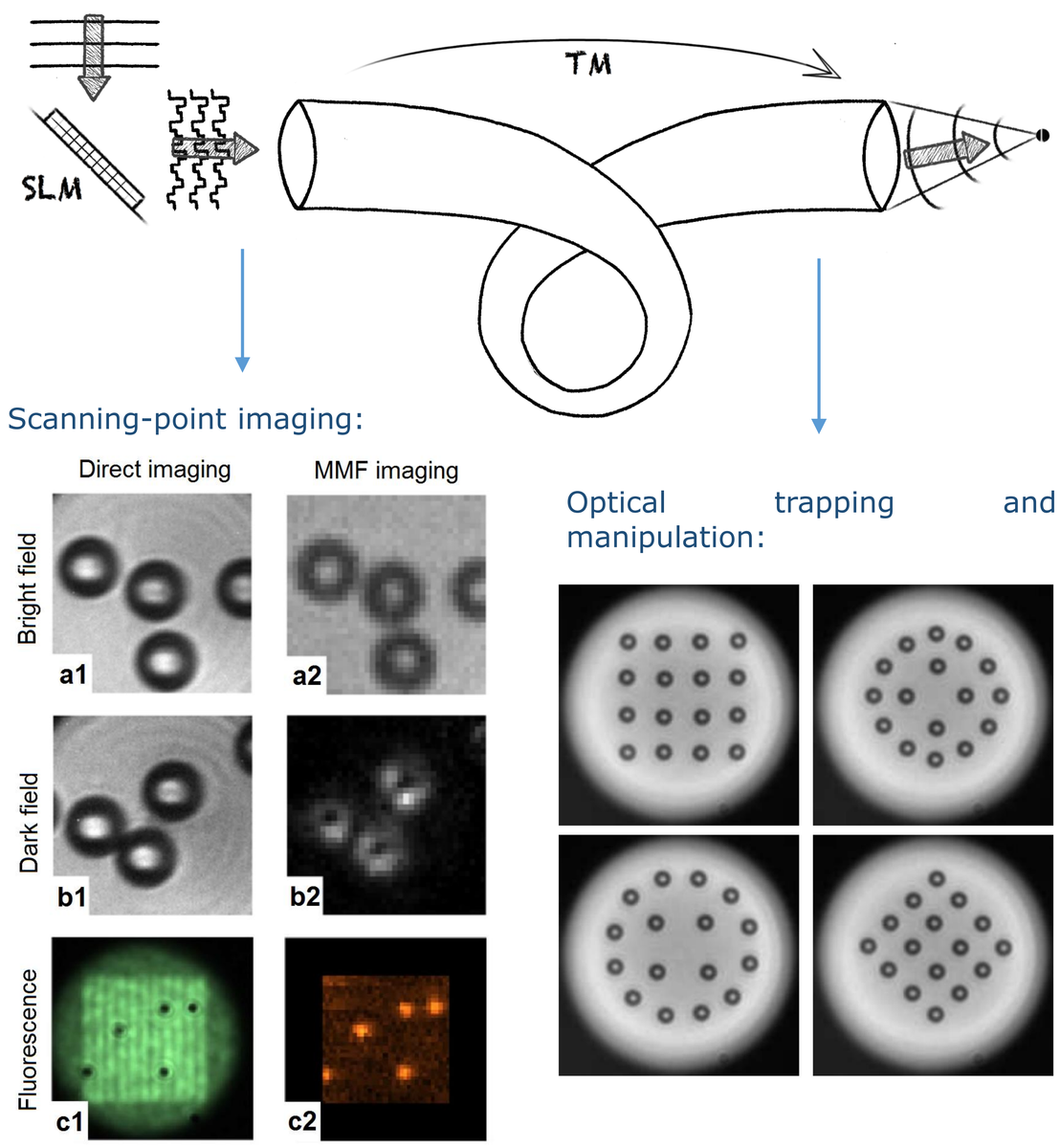

Figure 4 – By shaping the wavefront of the incident beam on the proximal end of a MMF, it is possible to produce a diffraction-limited focus at a given distance from the distal fibre facet. This can be used to perform scanning-point based imaging, or to trap and dynamically manipulate micro-objects through the MMF.

References

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