What could we do with cutting-edge visible detectors, fibres and photonics?

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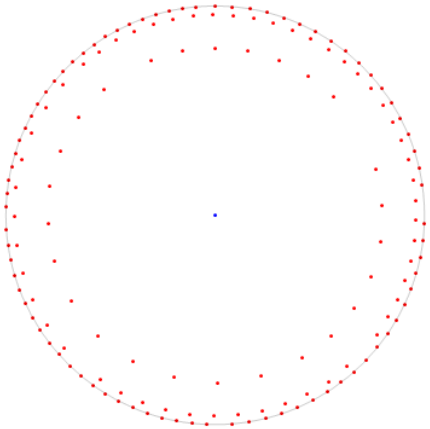
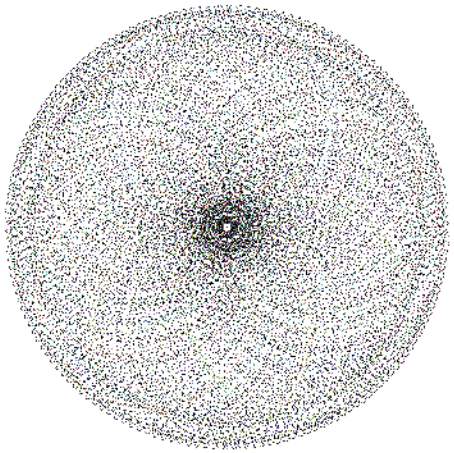
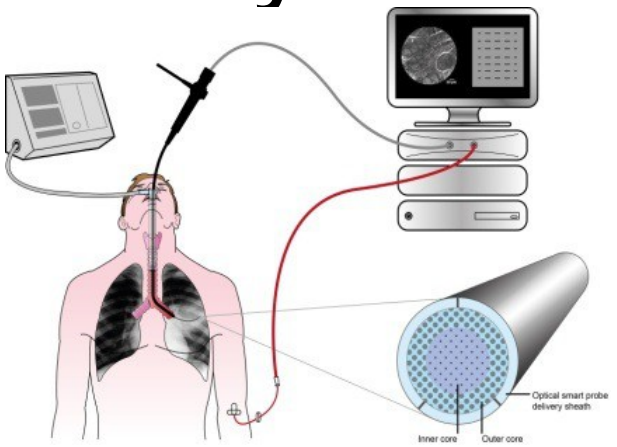
Biomedical “Astronomy”



Fibre-core arrangement



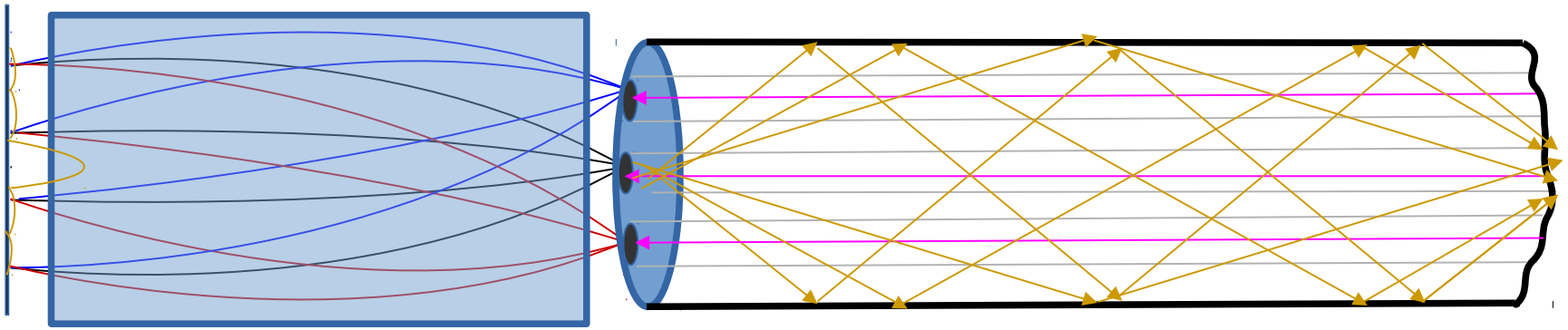
Snapshot *uv* coverage



- Critical care need.
- Imaging with a few fibre cores.
- Most cores reserved for physiological sensing.

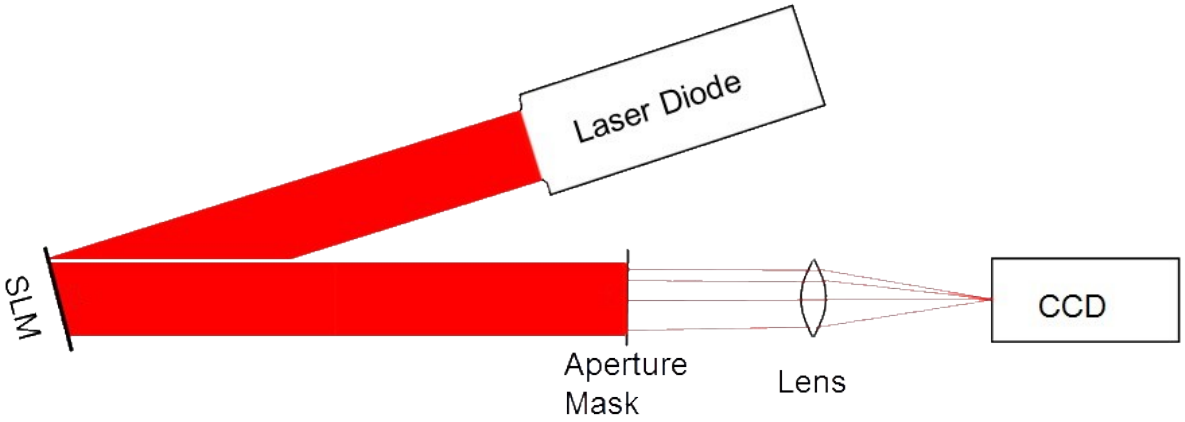
Biomedical “Astronomy”

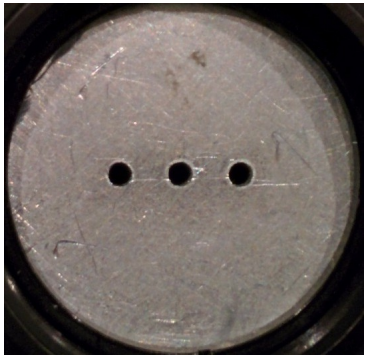
- Fibre cores take the role of telescopes.
- How to collect light?
- Fibre cores will collect almost no light.



Fourier Telescopy Risk Reduction

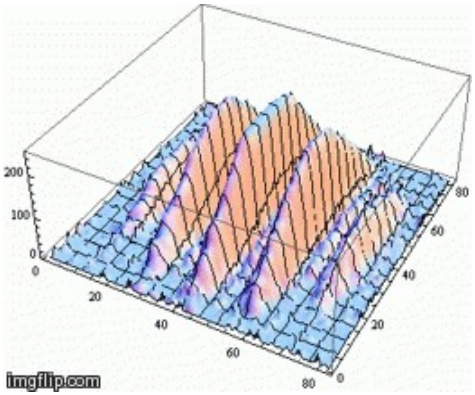
- Bulk optics experiment to risk reduce instrument.
- Two apertures modulated in phase by SLM (4th year student project).





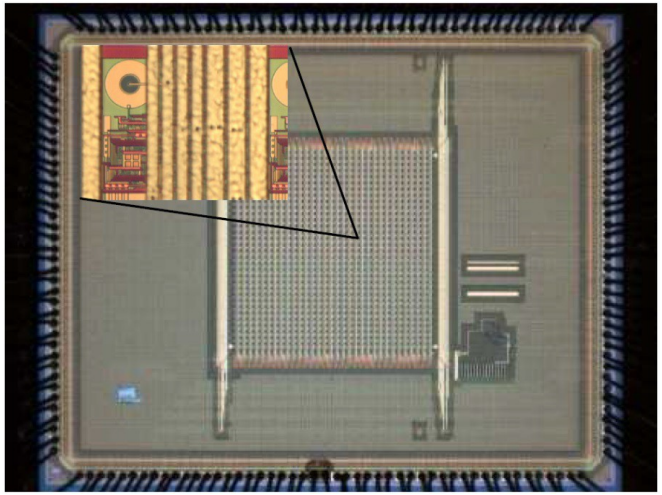
Fourier Telescopy Risk Reduction

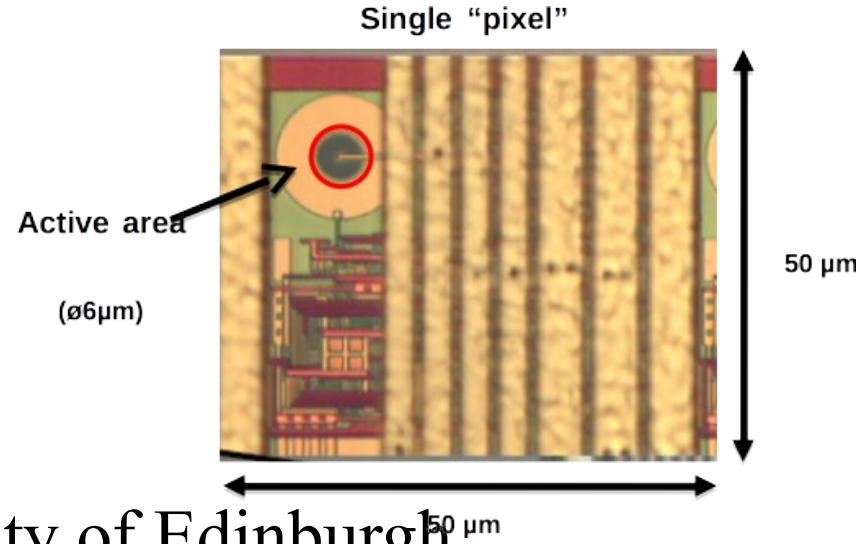
Aperture	1	2	3
1	0	0	0
2	0	$\frac{2\pi}{9}$	$\frac{2\pi}{3}$
3	0	$\frac{4\pi}{9}$	$\frac{4\pi}{3}$
4	0	$\frac{2\pi}{3}$	2π
5	0	$\frac{8\pi}{9}$	$\frac{2\pi}{3}$
6	0	$\frac{10\pi}{9}$	$\frac{4\pi}{3}$
7	0	$\frac{4\pi}{3}$	2π
8	0	$\frac{14\pi}{9}$	$\frac{2\pi}{3}$
9	0	$\frac{16\pi}{9}$	$\frac{4\pi}{3}$
10	0	2π	2π



Technologies from IRC Collaboration

Megaframe CMOS SPAD Array





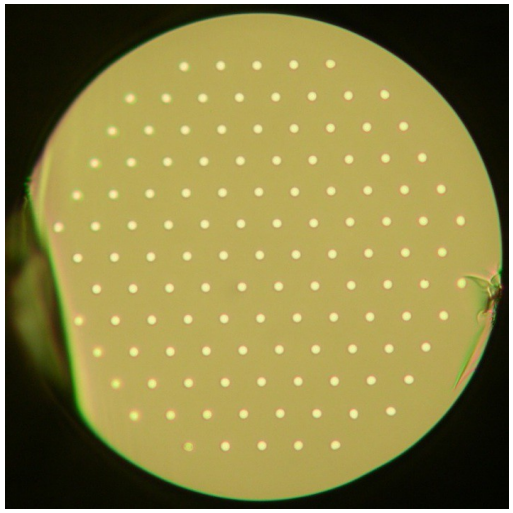
- Collaboration with University of Edinburgh.
- 32 x 32 (1024) single photon detectors.
- Each pixel has independent Time-Correlated Single Photon Counting (TCSPC) circuitry.
- No additional electronics, single DC power supply, USB PC input.

Megaframe CMOS SPAD Array

	MPD PDM	τ - SPAD	Megaframe
Pixels	1	1	32 x 32
Pixel Area	20 µm	150 µm	5 µm (50 µm)
QE (530 nm)	50 %	45 %	28 %
Dark Counts	5 – 500 Hz	20– 250 Hz	< 50 Hz
Timing Resolution	~ 50ps	~ 500ps	~ 100ps
Dead Time	70 ns	70 ns	50 ns
Frame Rate	-	-	1 MHz
Cost	£2-10K	£2-10K	£1K

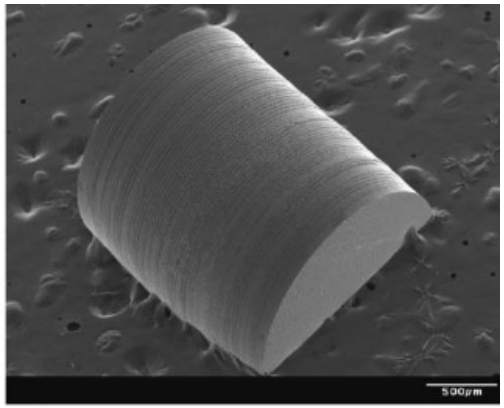
Multi-Core Fibres

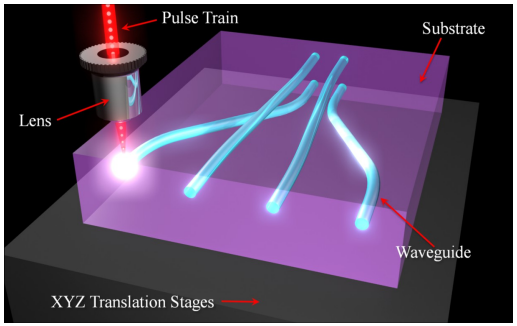
- Collaboration with the University of Bath (England).
- Multi-core custom-made fibres.
- Photonic-crystal fibres (propagation up to 3 microns wavelength in silica).

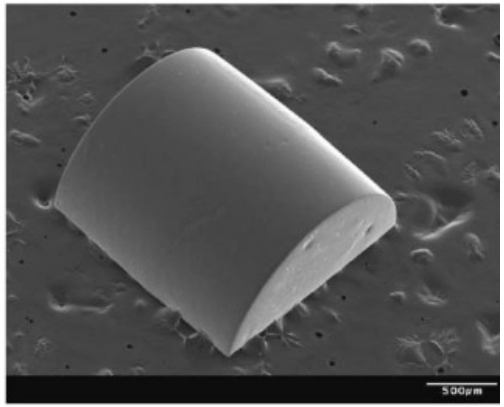


Ultrafast Laser Inscription (ULI)

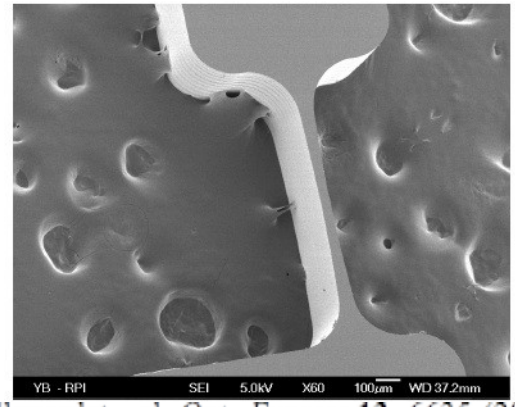
- Write 3D structures in glass.
- Selective etching.
  - Micro optics.
  - Micro mechanics.







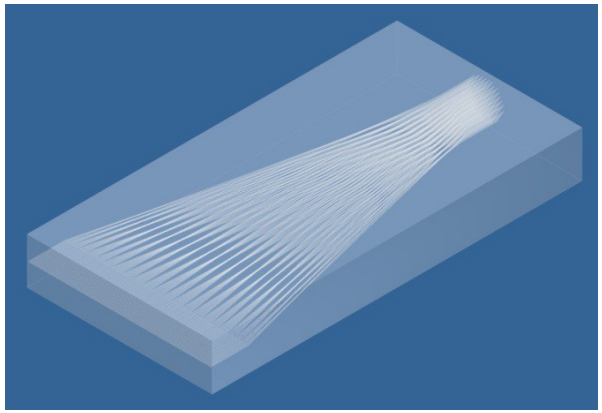
Cheng et. al.,*Appl. Phys. A*.**85**, 11 (2006)



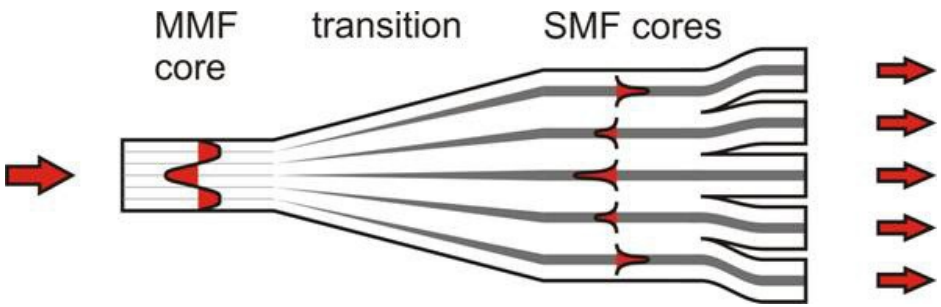
Bellouardet. al.,*Opt. Express*.**13**, 6635 (2005)

Ultrafast Laser Inscription (ULI)

- 3D fanout device from multi-core fibre to spectrograph slit.
- Photonic lantern adapts multi-mode input to single mode outputs.



R. R. Thomson et al, Opt. Lett.12, 37 (2012)



S. G Leon-Saval et al, Opt.Lett.30, 2545(2005)

Possible applications

- Intensity interferometry using the Megaframe camera with picosecond accuracy time stamps.
- Slice the pupil of the 1m telescopes with lens-lets arrays, feed to single-mode multi-core fibres and combine (eg. angular encoding).

Possible Applications

- Pupil slicer for each telescope beam: diffraction limited sub-pupils
- Beam combiner with fringes encoded angularly. Each core produce fringes.