Astrophotonics for small telescopes

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Astrophotonics

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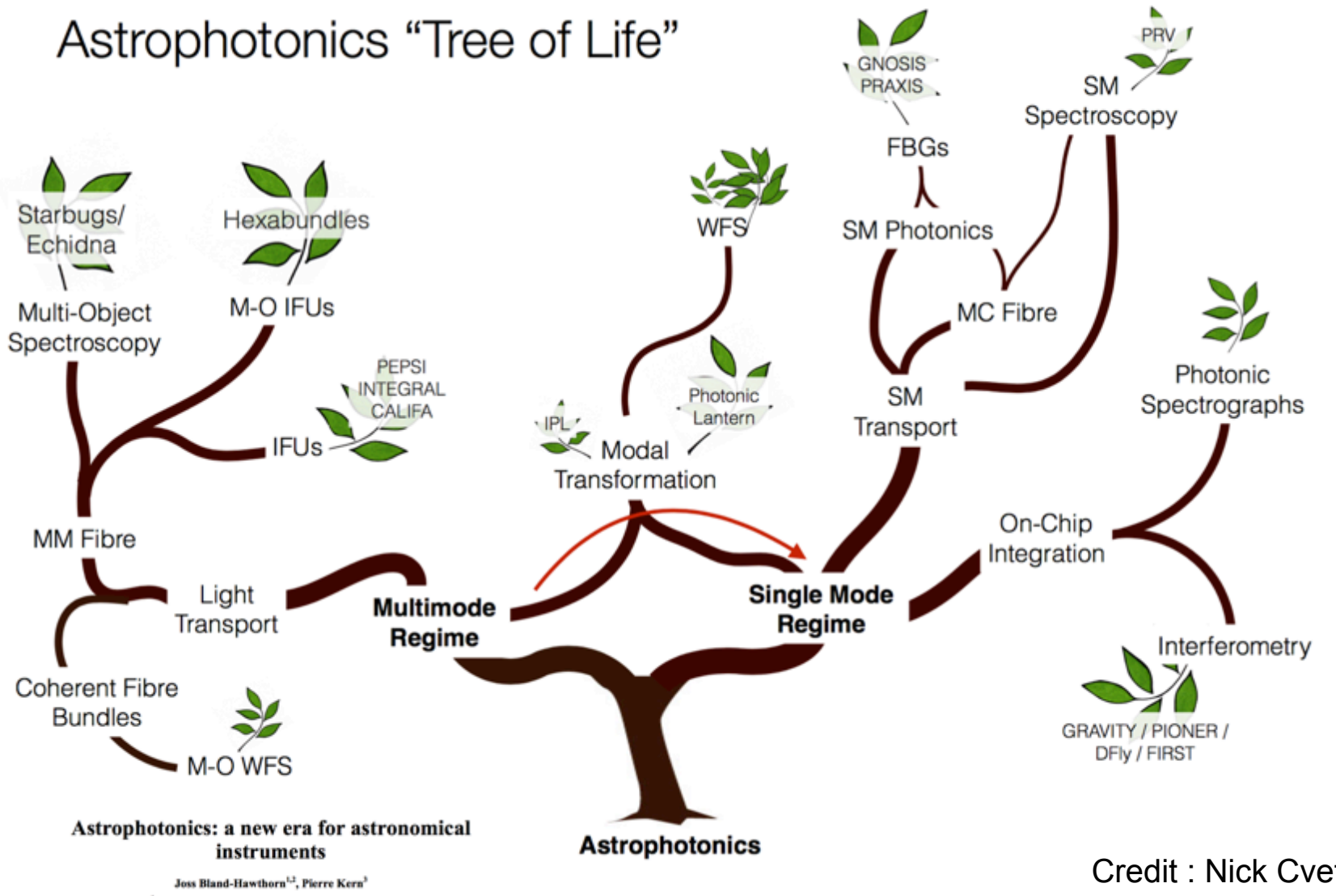

Credit : Nick Cvetojevic

Astrophotonics and Telescopes

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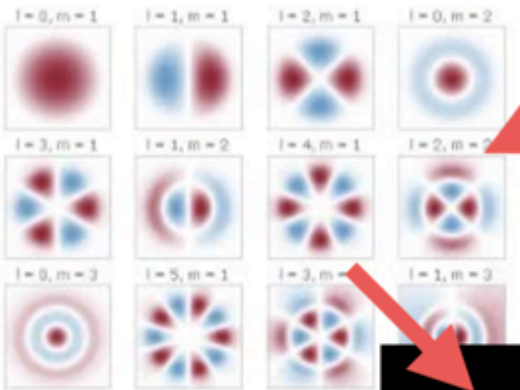
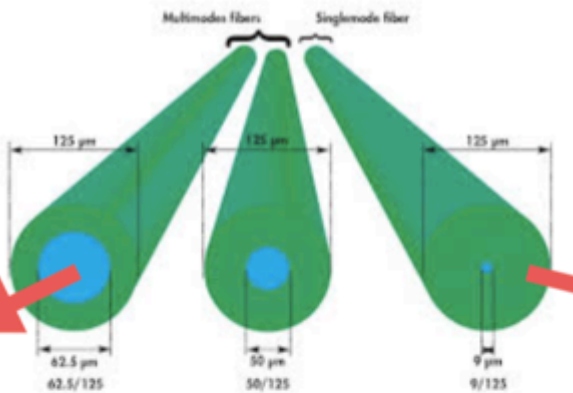
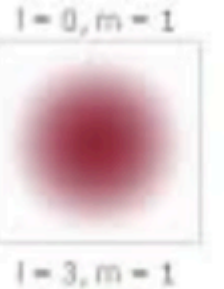
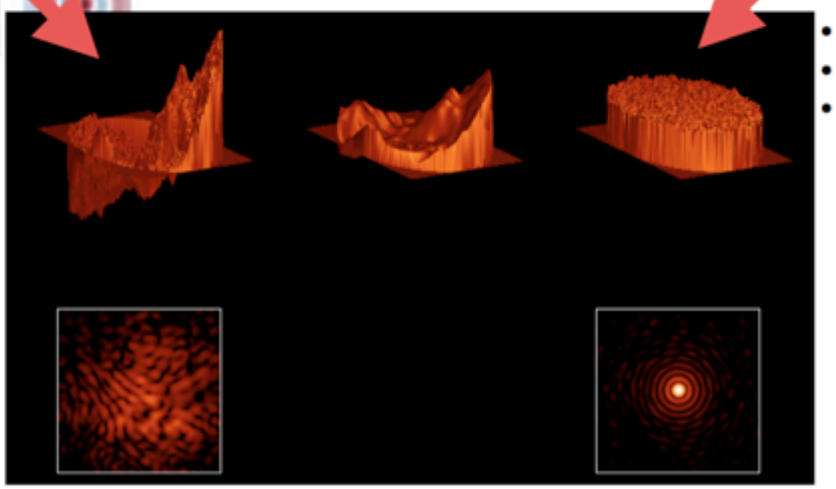
Multimode Fibre - Light Buckets
Easy* to inject light efficiently





Single Mode Fibre - Spatial Filter
Very difficult* to inject light efficiently

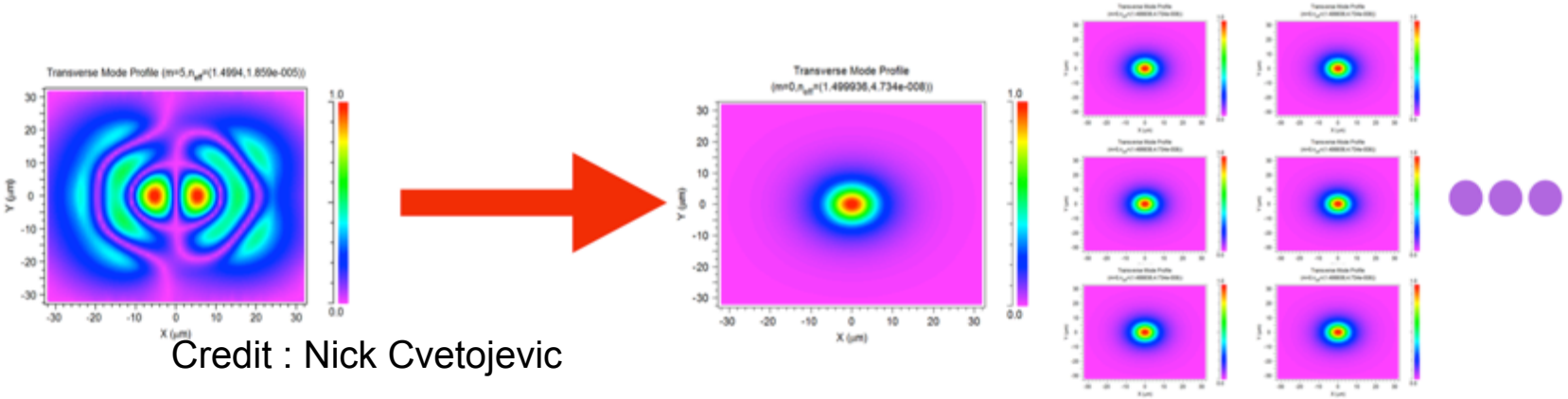




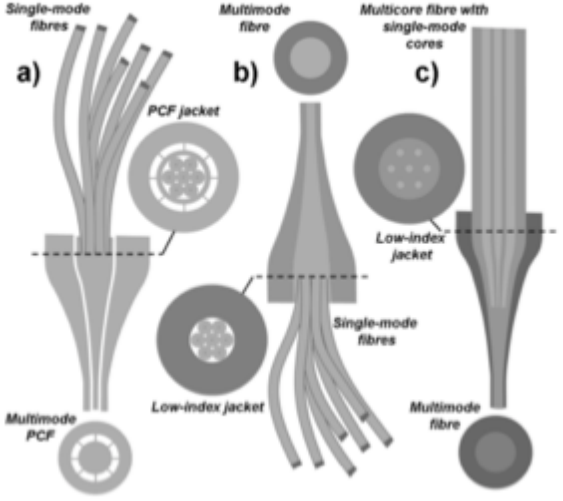
- V <2.4048
- Flat wavefront
- Gaussian intensity profile

Credit : Nick Cvetojevic

Can we convert between the two?



Credit : Nick Cvetojevic



Multimode fiber devices with single-mode performance

S. G. Leon-Saval and T. A. Birks
Department of Physics, University of Bath, Claverton Down, Bath BA2 7AY, UK

J. Bland-Hawthorn
Anglo-Australian Observatory, P.O. Box 296, Epping, NSW 2121, Australia

M. England
Redfern Optical Components, Australian Technology Park, Eveleigh, NSW 1430, Australia

Modes

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In photonics, modes govern how big your fibre device is

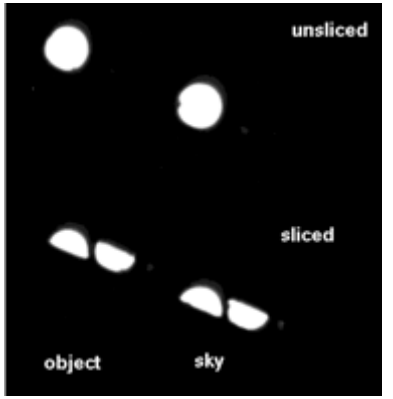
Modal equation $$M = \left(\frac{\pi \chi D_{\mathrm{T}}}{4\lambda} \right)^2 .$$

For simplicity my research focuses on low mode counts.

This makes it ideal for longer wavelengths, extreme AO, space based or **small telescopes**.

So, what are we working on?

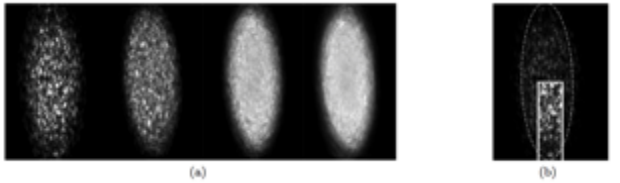
Reformatting fibres at spectrograph



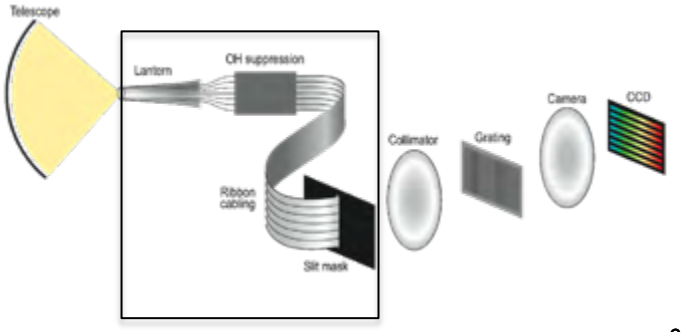
Fibres good to feed spectrographs, more stable than slits and spectrograph can be placed remotely

Particularly good for high resolution spectrographs

To increase resolving power use an image slicer



Can still have stability problems (scrambling and modal noise)



Solve using photonic image slicer, reformatter

Reformatting

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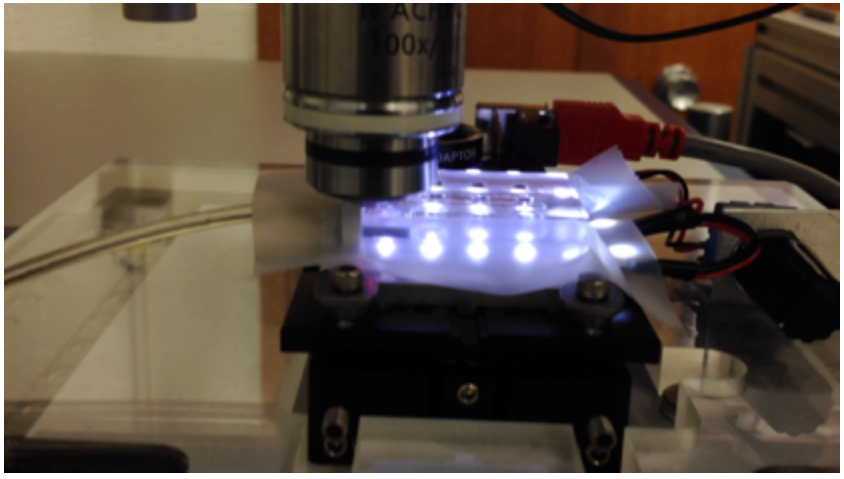
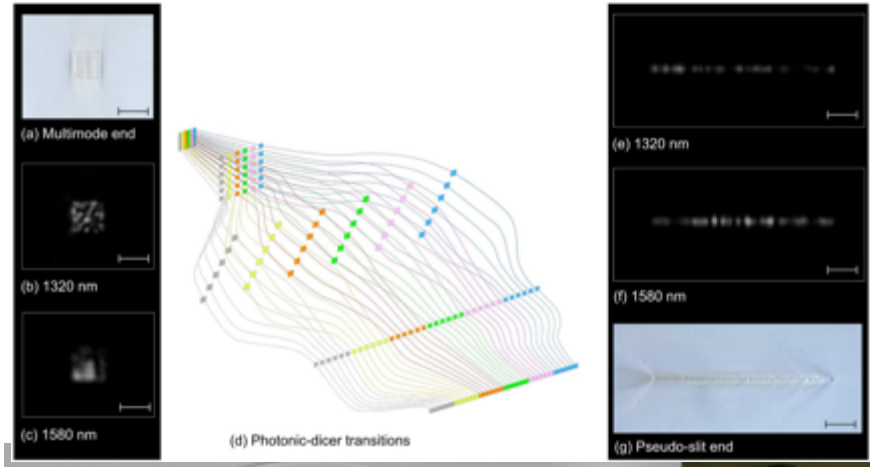
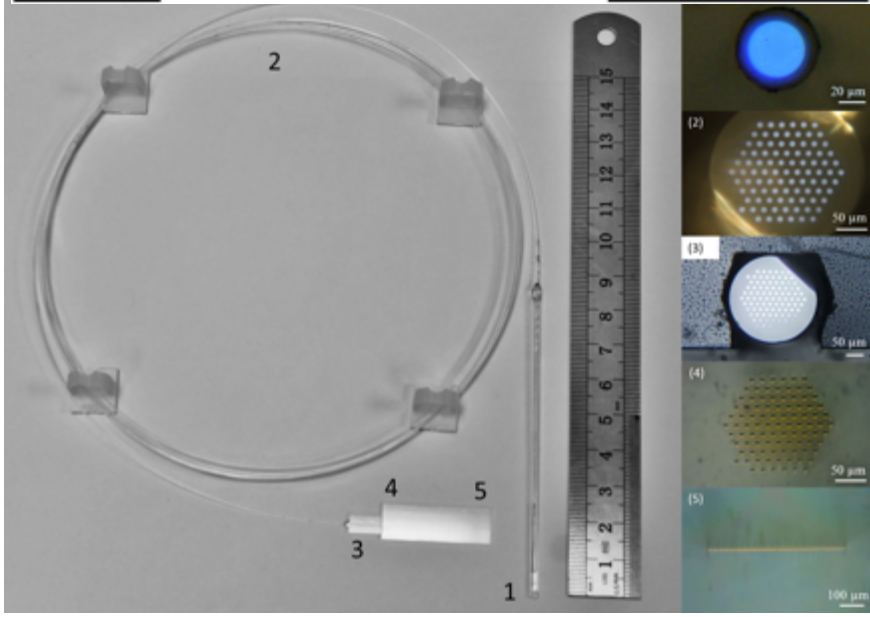
Single mode in one axis, multimode in the other (long slit)

Created using Ultrafast laser inscription

Developed with Heriot-Watt and Bath Universities during my PhD







What are we doing with this now?

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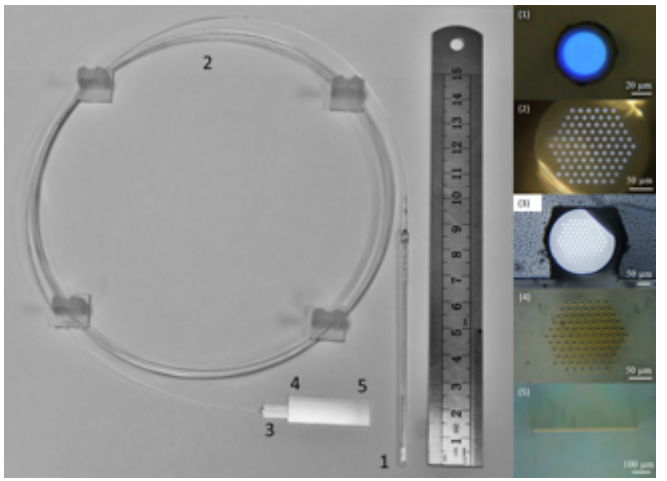
Needed time to show it would work and mature process

Happy that it does…

Theodoros Anagnos is working on a reformatter for Minerva-Red (70cm telescope) spectrograph

Next challenge is packaging so it is viable for long term use



3D printing devices for astronomy

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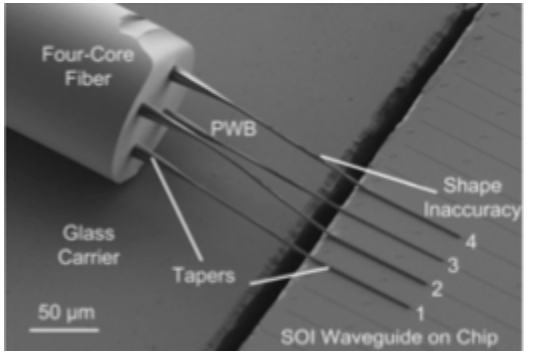
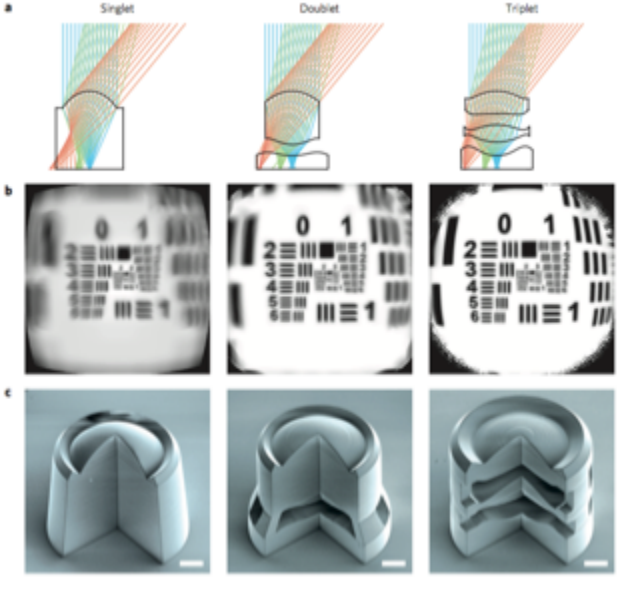
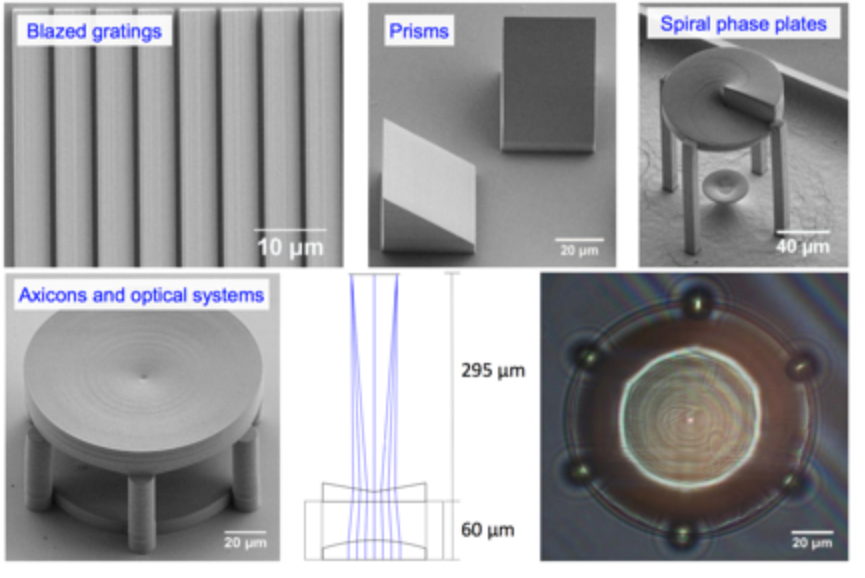
Working with KIT in Germany, who normally work with telecoms devices

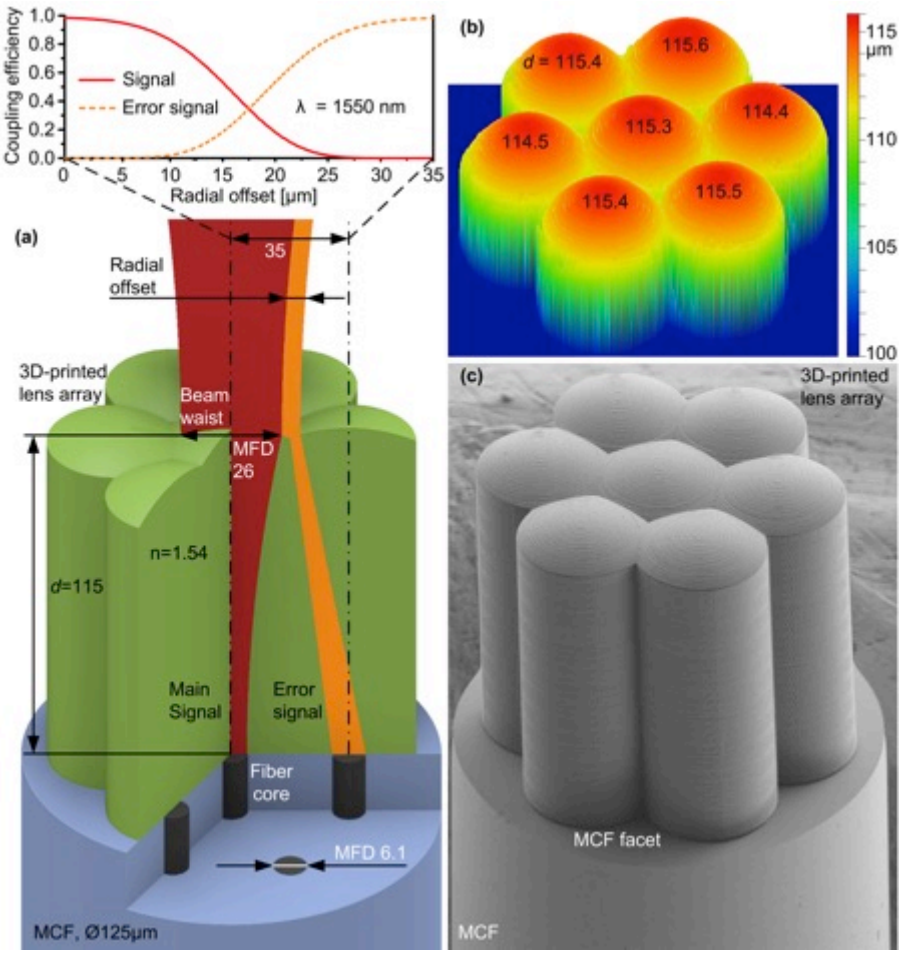
Developing devices for use in astronomy







3d printed microlenses for tip-tilt sensing



Printed freeform lens arrays on multi-core fibers for highly efficient coupling in astrophotonic systems

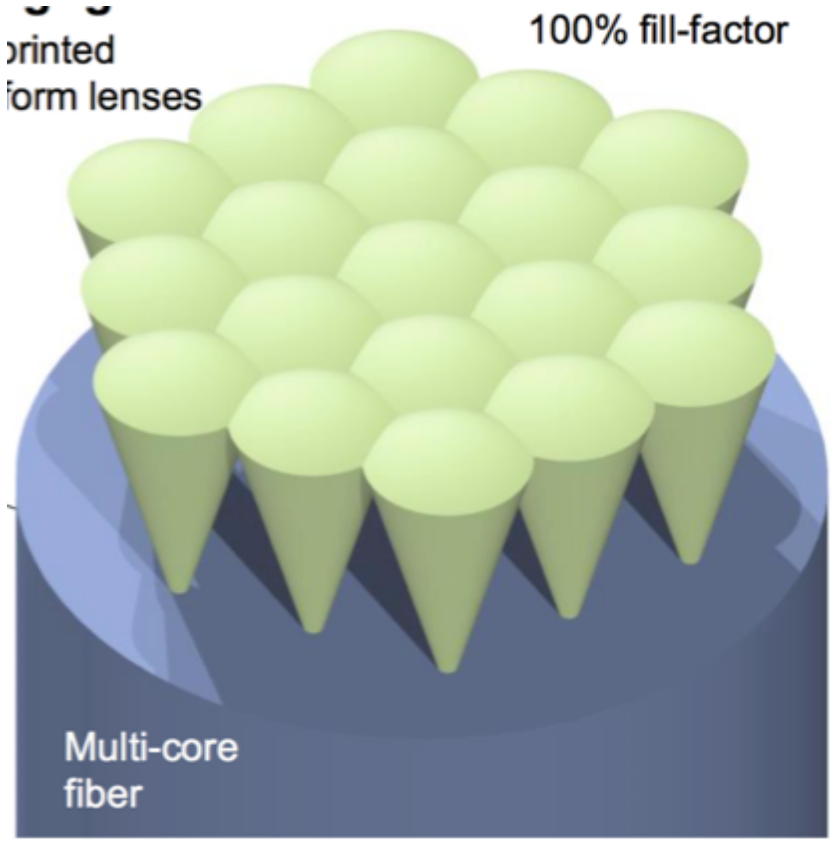
Philipp-Immanuel Dietrich, Robert J. Harris, Matthias Blaicher, Mark K. Corrigan, Tim J. Morris, Wolfgang Freude, Andreas Quirrenbach, and Christian Koos

Expand for use as an IFU

Multicore fibers now exist with hundreds of corse, so the devices can be used as a single mode IFU.

Theodoros Anagnos is developing this for the RHEA-spectrograph in Australia

In development at the moment.



Modifications

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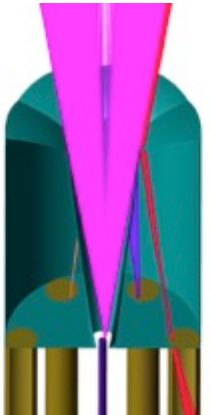
Philipp Hottinger has modified the tip-tilt concept to make it easy to retrofit to existing systems.

Working on device to be tested at LBT

Will also be trialed with small telescopes to see if we can increase coupling efficiency.



Testing

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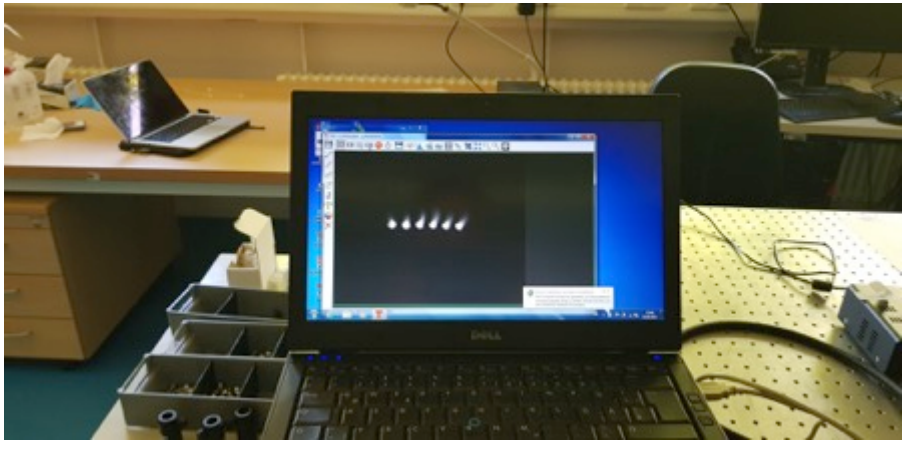
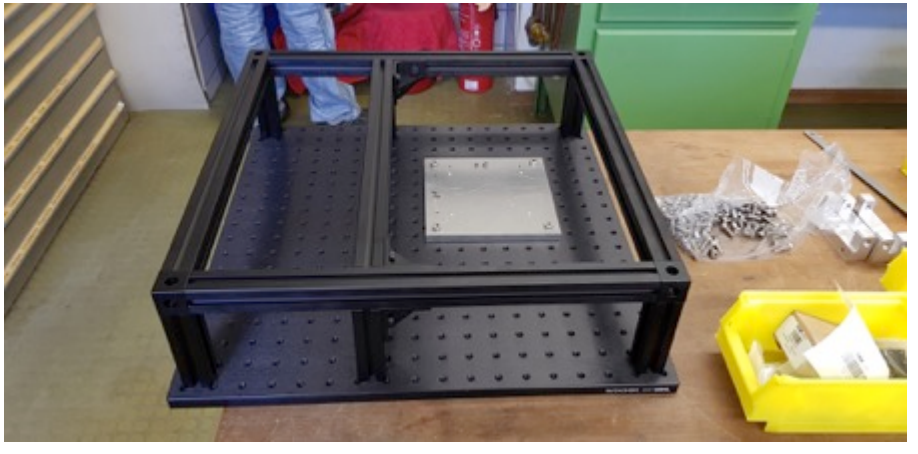
Lab is mostly setup

Components have arrived

Testing will soon be underway

Telescope in January?





Conclusions

Developing photonic devices that can be easily integrated into existing systems.

Helps improve accuracy, ease of alignment

Need to be high throughput

If you have any other ideas or want to try let me know ☺