AstroPhotonica Europa partnership

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Login: Astrophotonica/Europa

OPTICON WP3
Astrophotonics
Report Oct 2012

Presented by Martin Roth
(prepared by Jeremy Allington-Smith
AstroPhotonica Europa coordinator)
CfAI Durham University

Main activities

- Progress Meeting May 2012
- Summer School in Astrophotonics Sep 2012
- R&D update
- Document update

Astrophotonics Summer School

September 2012 Schloss Wiesenburg, Brandenburg, Germany

OPTICON Mid Term Review. Brussels
October 2011

Summer School Activities

- 35 Students from 8 countries
- 17 Lecturers
- 17 Lectures on Astrophotonics including guest lecture by Philip Russell (MPL)
- Poster session – with prize for best poster
- Extracurricular activitites
  - Visit to Potsdam, tour of Sans Souci and AIP
  - Barbecue & reception
  - GoKarting (winner Nicolas Joly, MPL)
- Archive of lecture material, proceedings?
- Keen interest by local people (castellans, mayor..)

Topics

Title	Lecturer	Topics Covered
1. Requirements		
1.1. Answering the big questions in Astronomy	Joss Bland-Hawthorn	*Astronomy roadmaps, challanges, etc (Ground & Space)*
1.2. Building instruments for new observatories	Mark Casalli	*Requirements and technology challenges, Ground & Space*
2. Current state of the art		
2.1. Spectroscopy	Roelof de Jong	*Basic requirements, techniques & challenges*
2.2. Highly multiplexed spectroscopy	Gavin Dalton	*Basic requirements, techniques & challenges*
2.3. Interferometry	Paulo Garcia	*Basic requirements, techniques & challenges*
3. The power of photonics		
3.1. Basic principles of photonics	Nicolas Joly	*Overview of mostly linear photonics*
3.2. Major applications		
3.2.1. Photonic Filters	Simon Ellis	*Drivers, FBG's, Resonators and alternatives*
3.2.2. Integrated Spectrographs	Jon Lawrence	*Drivers, AWGs, SWIFT, etc, State of the Art*
3.2.3. Photonic Calibration	Ronald Holzwarth	*Drivers, Alternative approaches, state of the art, etc*
3.2.4. Photonics in interferometry	Pierre Kern	*Drivers, State of the art, combiners, spatial filters, etc*
3.2.5. Photonic Reformating (Pupil/Image)	Roger Haynes	*Drivers, PL, Dragonfly, Chronography, etc*
3.2.6 Photonic Switching	Jeremy Allington-Smith	*Drivers, State of the art*
3.3. Photonic technologies		
3.3.1. Structured Fibres	Tim Birks	*PL, Multicore, PCF's, etc*
3.3.2. 3D Waveguides Structures	Robert Thomson	*ULI, Dragonfly, Fan-out, PLs, etc*
3.3.3. Plane Lightwave Circuits	Stefano Minardi	*Basics, AWGs, Resonators, Couplers, etc*
3.3.4 Technology for the mid-infrared	Lucas Labadie	
4. New instruments		
4.1. Implementation roadmap	Martin Roth	*Photonics and Astronomy Roadmaps*
Guest Lectures		
The future of photonics	Philip Russell	*Future trends in photonics of relevance to astronomy*
Wiesenburg Castle	Arne Ahlert	*History of the castle and region*
Other presentations		
Mayor of Wiesenburg	Barbara Klembt	*Welcome*
Poster session		
Organiser	Robert Harris	

Schedule

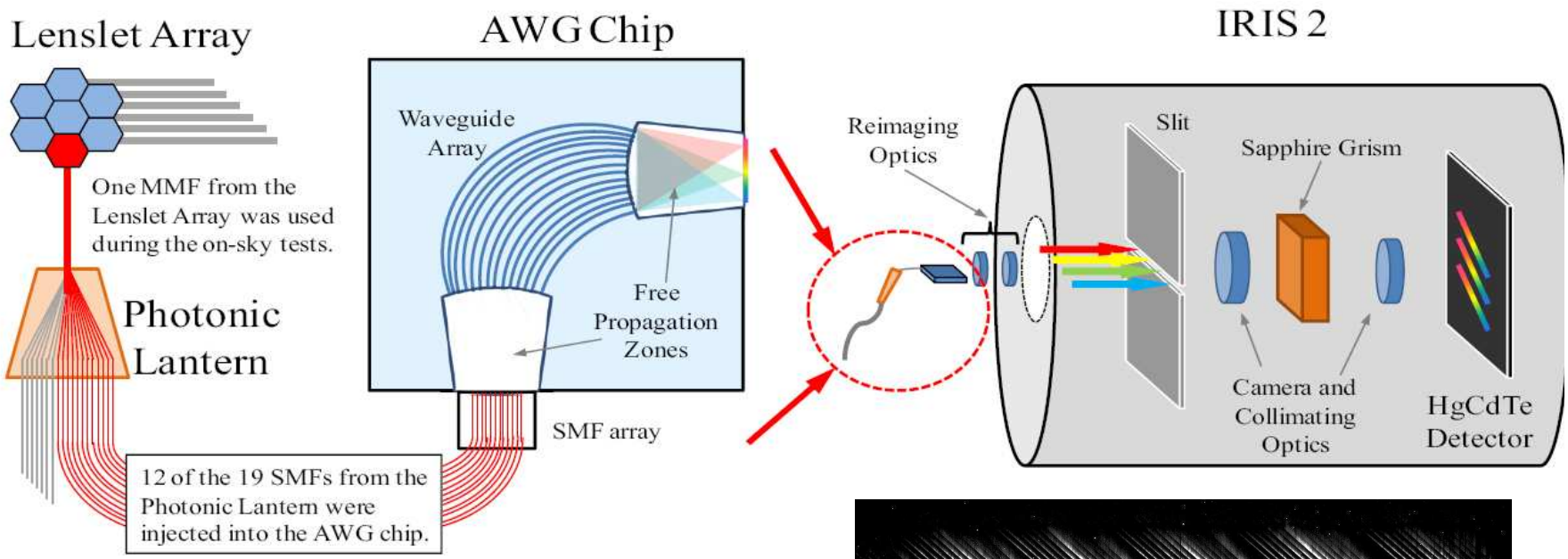
Astrophotonics Summer School program

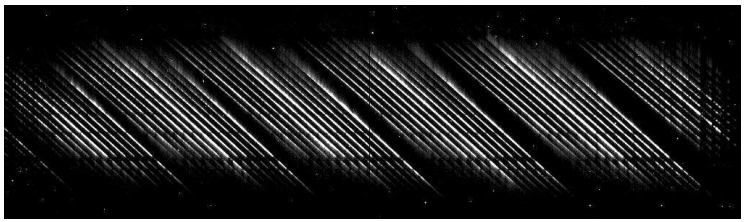
September	24	25	26	27	28
	Mon	**Tue**	**Wed**	**Thu**	**Fri**
8:00		Breakfast			
9:00		DeJong	Kern	Haynes	Labadie
10:00		Dalton	Minardi	Thomson	Holzwarth
11:00		Break			
11:30		Ellis	Joly	Allington-Smith	Roth
12:30		Lawrence	Lunch	Birks	Forum + Farewell
13:30		Lunch	GoKart	Lunch	
14:00	Ahlert	Sans Souci/AIP		Student activity (e.g. poster pop)	
15:00	Bland-Hawthorn				
16:00	Casalli				
17:00	Garcia				
18:00	Mayor's Welcome **Response Allington-Smith** Reception			Russell	
19:00		Dinner		Barbecue	
20:00			Jarke		

Updates on R&D

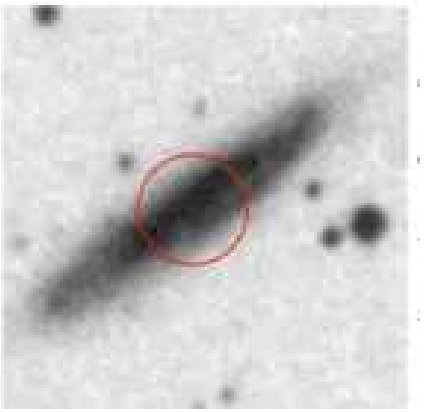
- This is not a comprehensive list
- These activities are inspired and coordinated by OPTICON but not directly funded by it
- See MTR for the baseline status

On-telescope tests of IPS

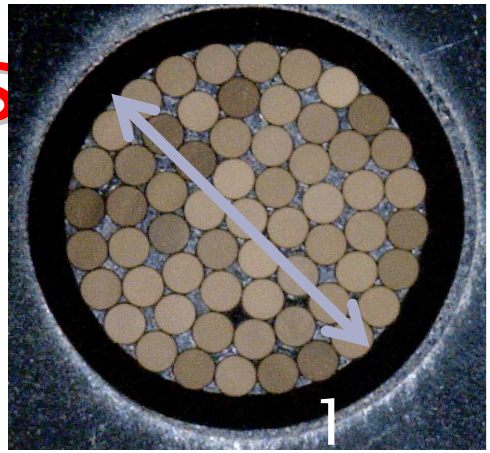




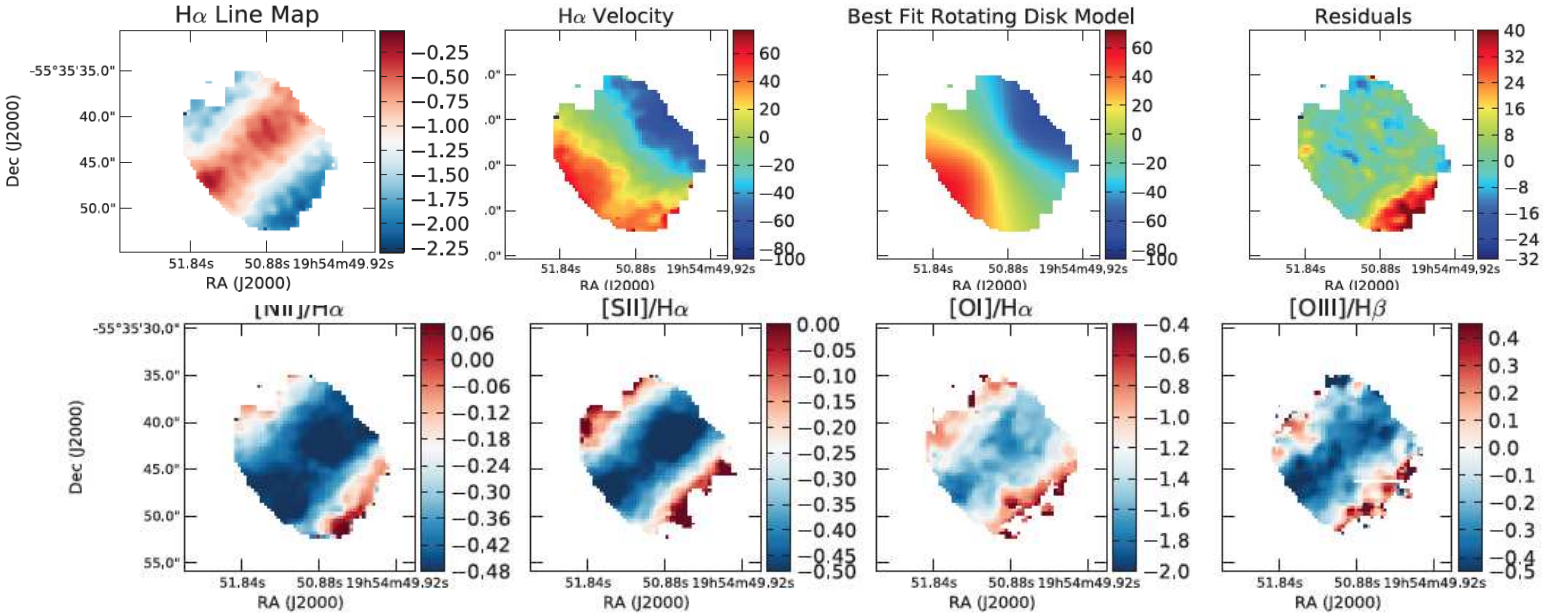
- Used IRIS2 spectrograph at the AAT
- With photonic lantern injection and multi-fibre input
- Cross-disperser system too high detector noise
- IRIS2 used for cross-dispersion and detection



SAMI: Hexabundles



- Cladding stripped to 2 microns
- Lightly fused over 2-3cm length
- Fill fraction ~84%
- Good optical performance
- Cross-talk < 0.5%
- FRD performance good as single fibre



Fogarty et al. (2012)

OPTICON Report October 2012

OHS with ring resonators

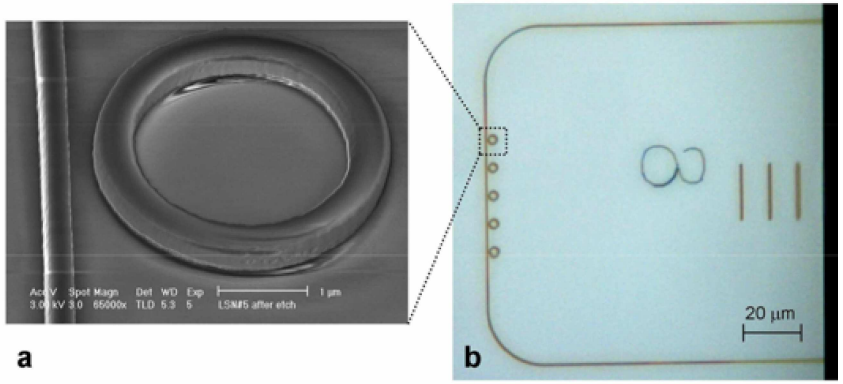
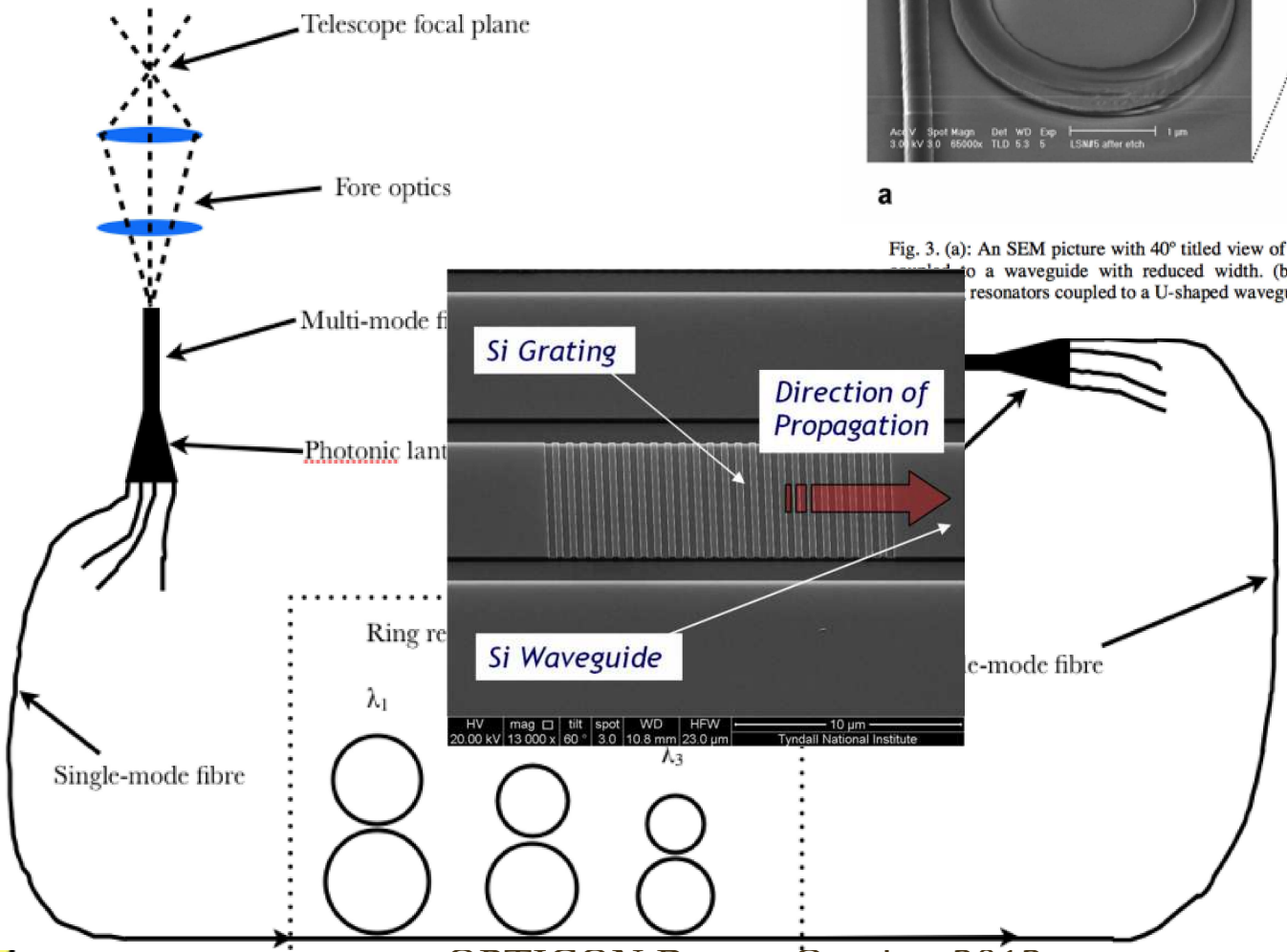
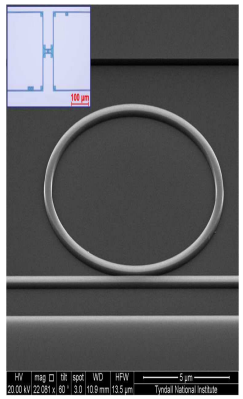


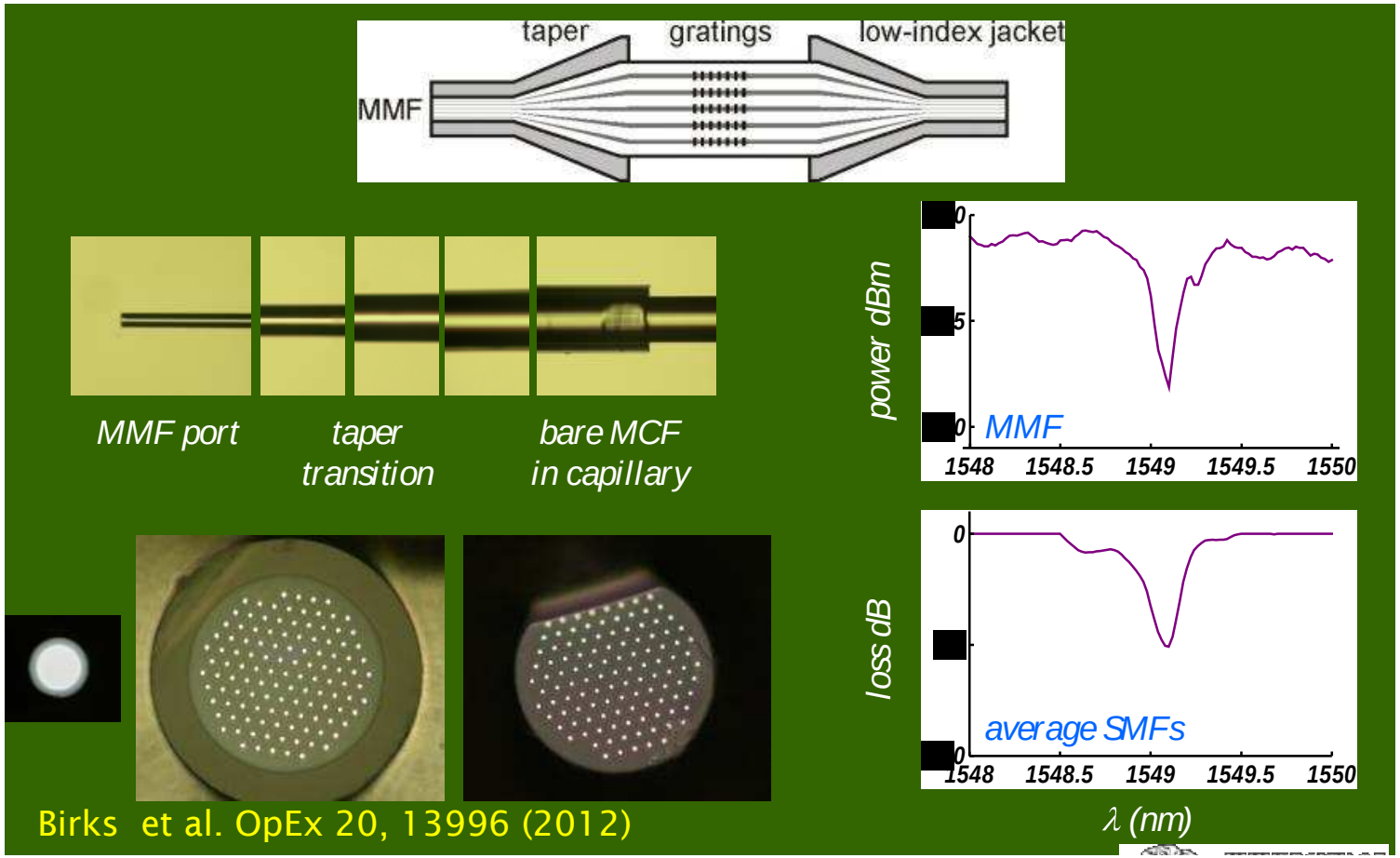
Fig. 3. (a): An SEM picture with 40° titled view of the microring resonator with 1.5-µm radius coupled to a waveguide with reduced width. (b): A microscope picture of the cascaded resonators coupled to a U-shaped waveguide at the edge of the chip.





Simon Ellis et al.

Photonic lantern: multicore fibres



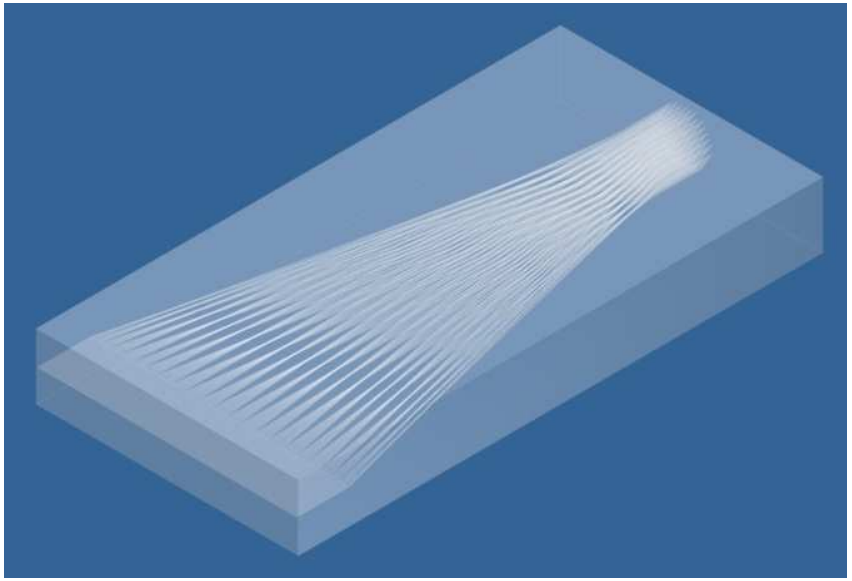
Birks et al. OpEx 20, 13996 (2012)

Laser-inscribed 3D reformatter

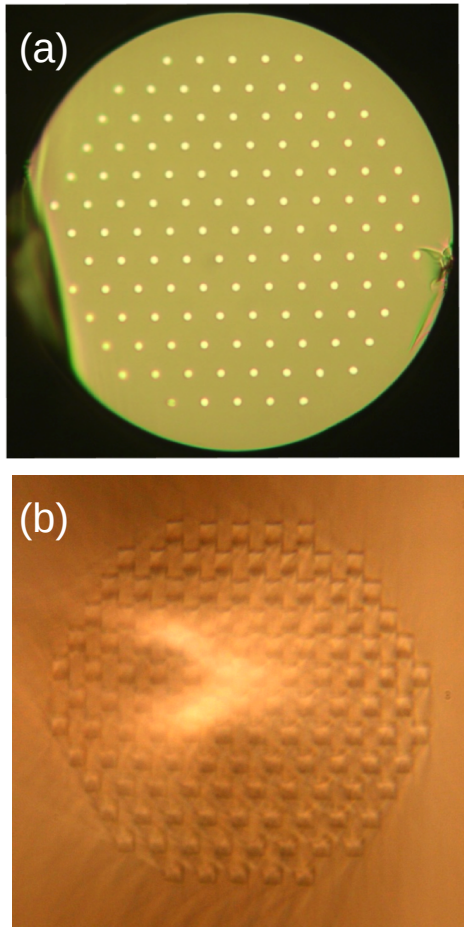
Ultrafast laser inscription of a 121-waveguide fan-out for astrophotonics

R. R. Thomson,[1,*] R. J. Harris,[2] T. A. Birks,[3] G. Brown,[1] J. Allington-Smith,[2] and J. Bland-Hawthorn[4,5]

June 15, 2012 / Vol. 37, No. 12 / OPTICS LETTERS 2331

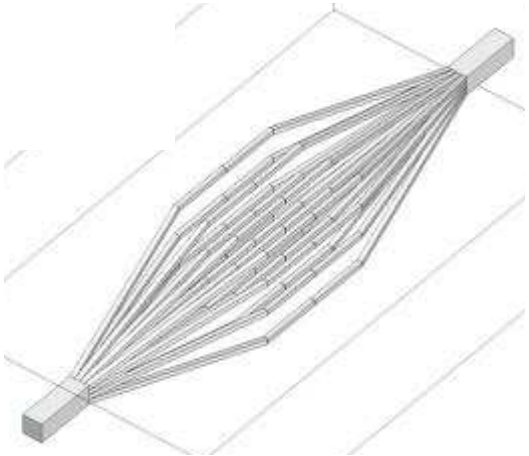


Conceptual diagram of the 3D fan-out device



Optical micrograph of (a) the 120 core MCF and (b) the MCF coupling end of the 3D fan-out

Integrated photonic lanterns



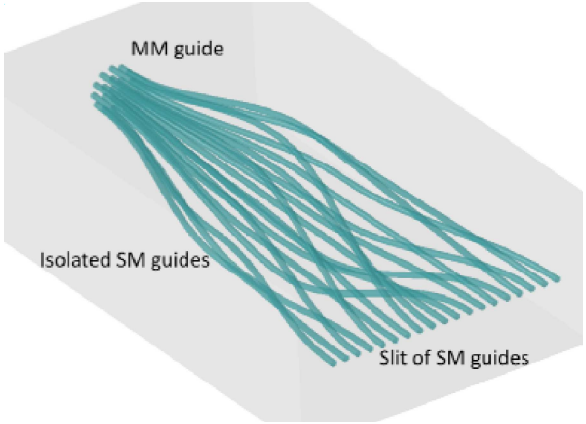
son, S. Campbell, B. Pope, C. Betters, S. Leon-Saval, T. Birks, R.

February 15, 2012 / Vol. 37, No. 4 / OPTICS LETTERS

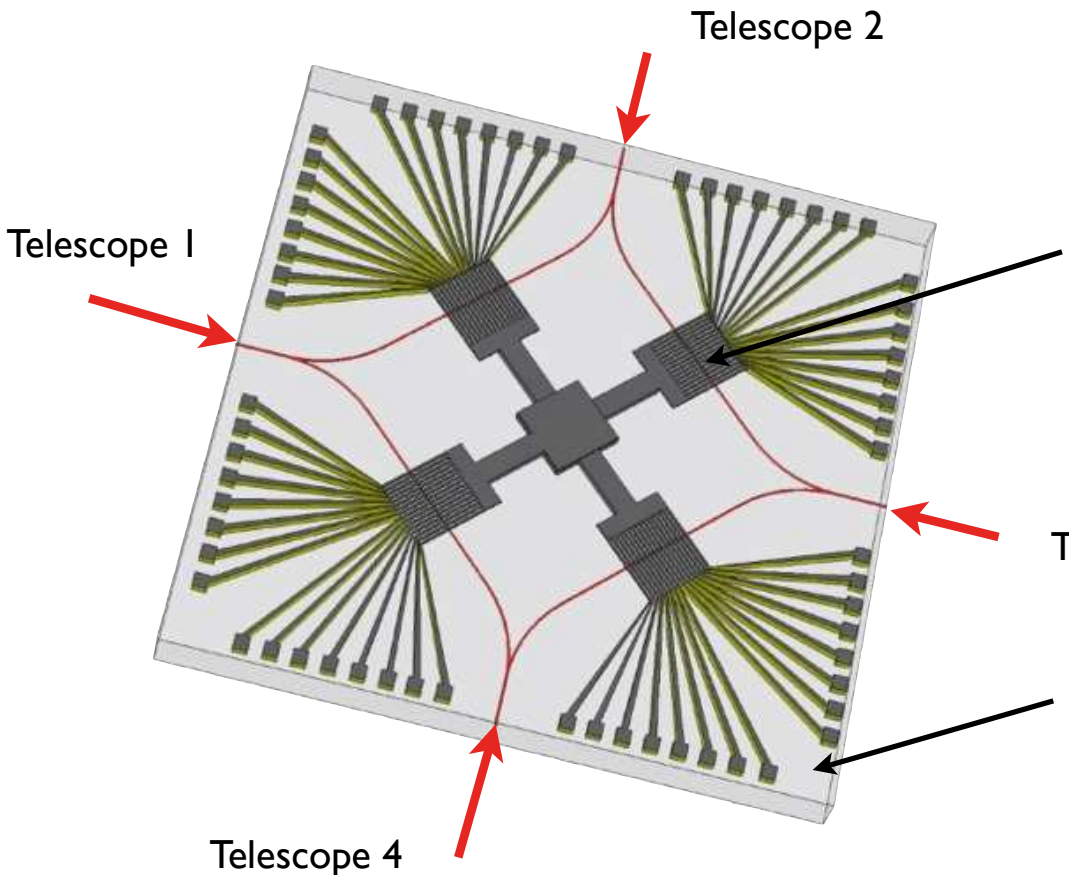
Ultrafast laser inscription of Bragg-grating waveguides using the multiscan technique

Integrated photonic building blocks for next-generation astronomical instrumentation I: the multimode waveguide

Nemanja Jovanovic,[1,2,3*] Izabela Spaleniak,[1,2] Simon Gross,[1,4] Michael Ireland,[1,2,3] Jon S. Lawrence,[1,2,3] Christopher Miese,[1,4] Alexander Fuerbach,[1,4] and Michael J. Withford[1,2,4]



NIR Fringe-tracker using SWIFTS



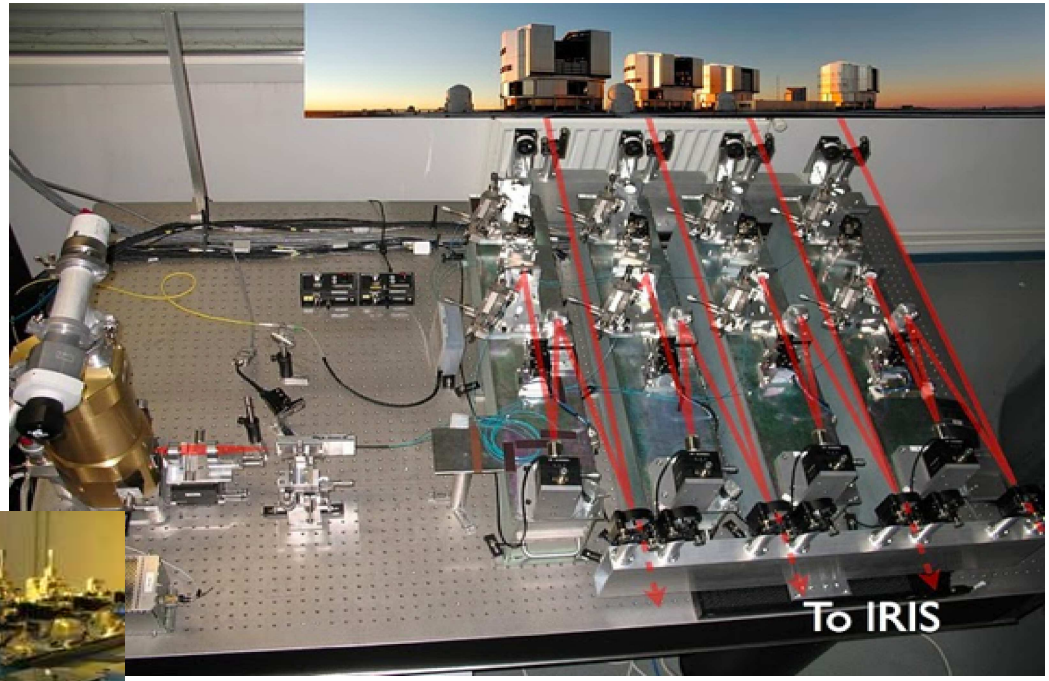
- 4 fringes sampled with
- 16 SSPD wires 70 nm thick
- 125 nm pitch
- over a 2 µm length
- provide a resolution of 8

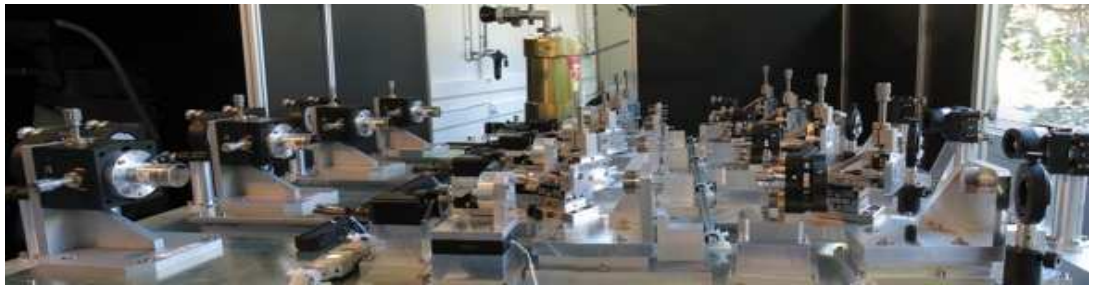
Sapphire substrate (n=1.7 @ 1.5 µm)

P. Feautrier et al , SSPD High-speed Superconducting Single Photon Detectors, Journal of Physics, 2008
Paul Cavalier PhD Thesis 2011, Cavalier et al AIP Advanced 2011

Interometry R&D: Pionier

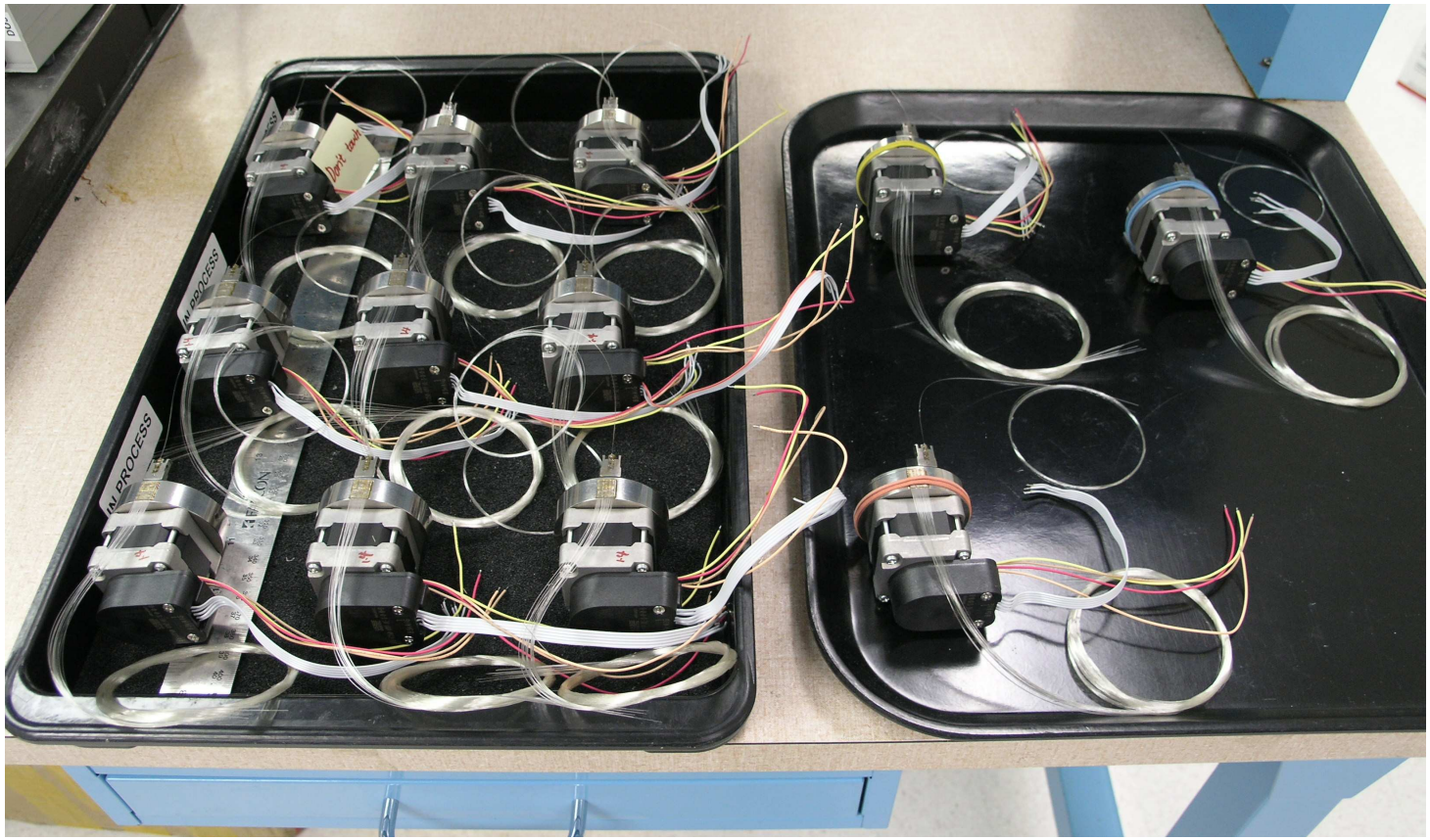
Installed at VLTI 2010-12. Formerly proposed as astrophotonic testbench





Field resampling

Diverse Field Spectroscopy: optimum sampling of sky



Demonstrator switch network hardware

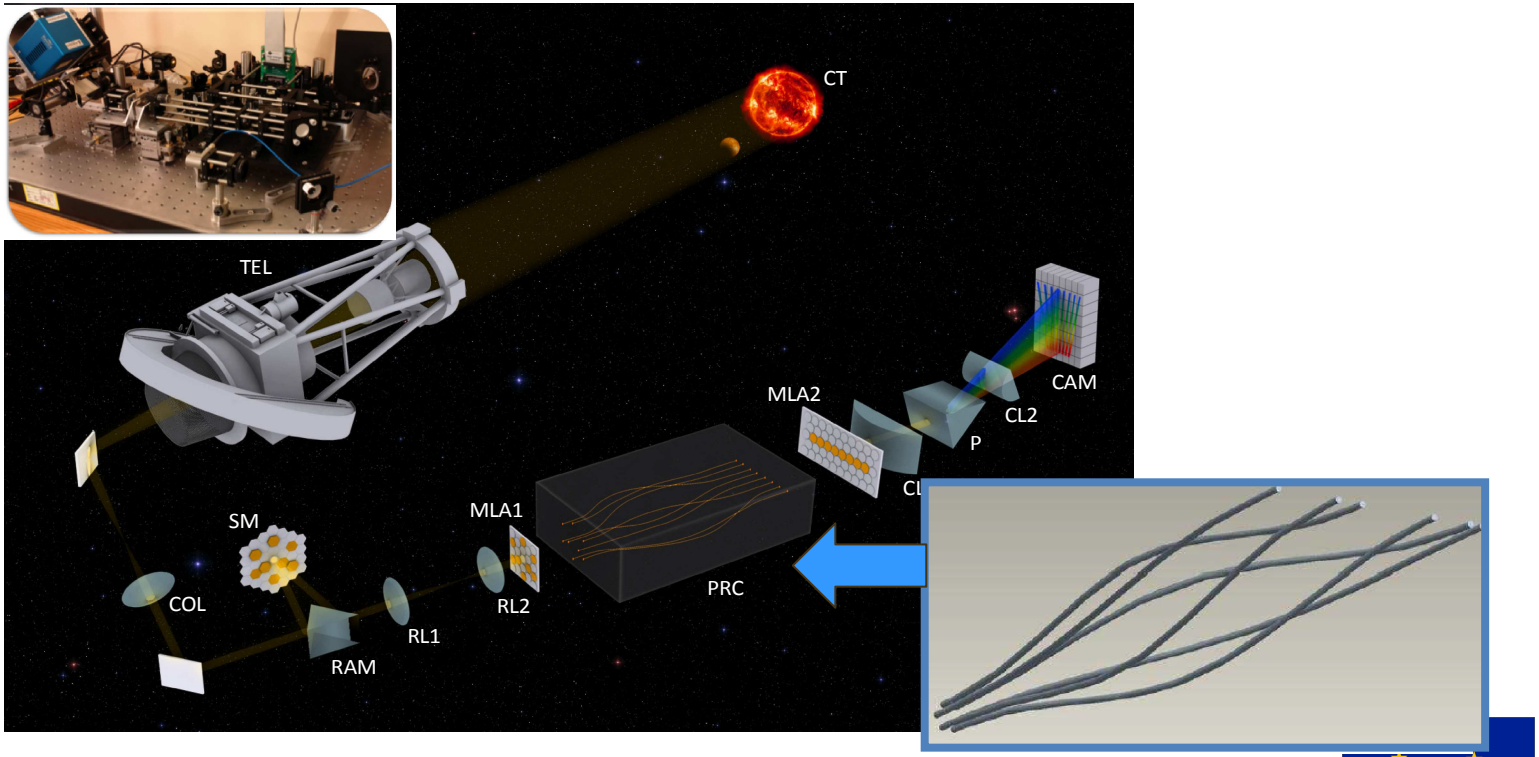
OPTICON Report October 2012

Photonic pupil remapping

Starlight Demonstration of the Dragonfly Instrument: an Integrated Pupil Remapping Interferometer for High Contrast Imaging

N. Jovanovic,[1,2,3?] P. G. Tuthill,[4,5] B. Norris,[4] S. Gross,[1,5] P. Stewart,[4] C. Niel,[1,2] J. G. Robertson,[4] G. D. Marshall,[1,5] M. Ireland,[1,2,3] A. Fuerbach,[1,5]
N. Charles,[4] S. Lacour,[6] M. Ams,[1,5] J. S. Lawrence,[1,2,3] A. Lehmann,[1,2] and M. J. Withford,[1,2,5]

Accepted for publication in Mon. Not. R. Astron. Soc.



Mid-IR 3D beam combiners

Three-dimensional mid-infrared photonic circuits in chalcogenide glass

Airán Ródenas,[1,6] Guillermo Martin,[2] Brahim Arezki,[2] Nickolas Psaila,[3] Gin Jose,[4] Animesh J
Lucas Labadie,[5] Pierre Kern,[2] Ajoy Kar,[1] and Robert Thomson[1,7]

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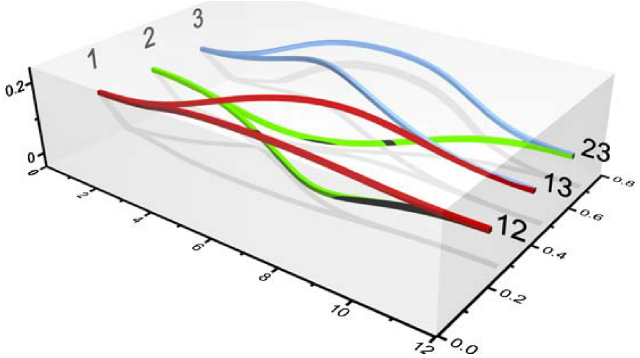
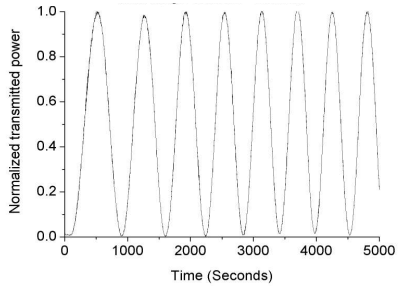
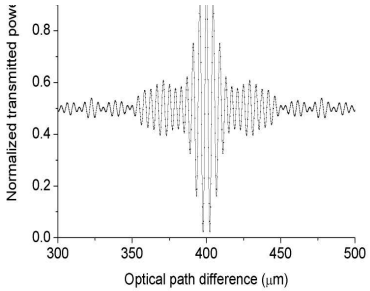




Fringes measured using 10.6 μm light.



Interferogram measured using 8→12 μm light

Three-dimensional photonic component for multichanne coherence measurements

Stefano Minardi,* Felix Dreisow, Markus Gräfe, Stefan Nolte, and Thomas Pertsch
Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1,07743 Jena, Germa
*Corresponding author: stefano@stefanominardi.eu

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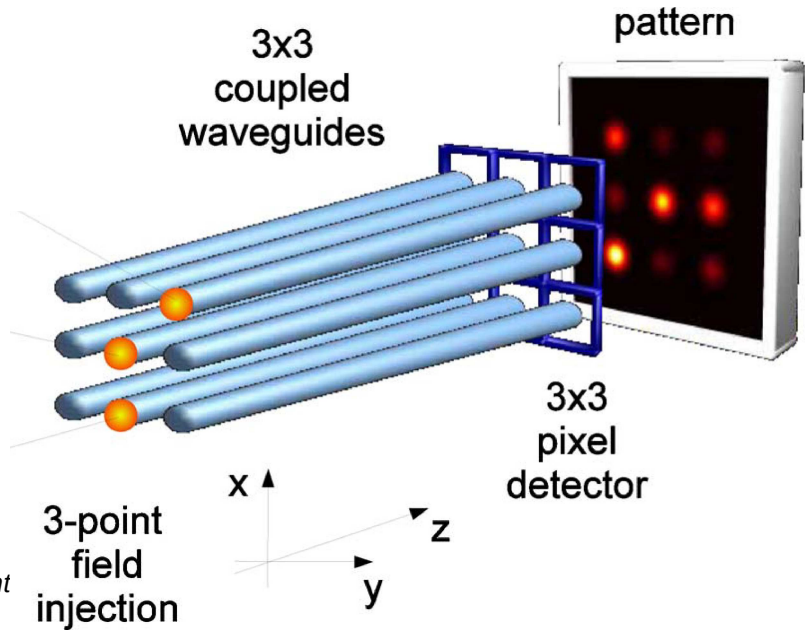

Astrophotonica Europa

Partnership* which executes FP7 programme and brings together:

- **Astronomers & photonicists**
- **Spectroscopists & interferometrists**
- **Required capabilities & technological solutions**

APE brings OPTICON:

- **Access to Intellectual Property of much larger regional programmes**
- **Coordination and rationalisation of research activities**

As a forum/network *APE* is unique and valuable

* Europe plus strategic partners in Australia

Astrophysics ⇔ technology

Top down

Investigations
- Cosmic equation of state
- First light
- Galaxy assembly
- AGN
- Exo-earths……

Techniques
- Waveguide networks
- Mode conversion
- Integrated optics
- Optical switching…….

Telecommunication
Photonic technology

Allington-Smith et al. SPIE 7739, 773925 (2010) & APE-REP-01

Capabilities
- Background suppression
- Highly-multiplexed spectroscopy
  - Miniaturised spectroscopy
  - Diverse field spectroscopy
- Precision spectroscopy
- Interferometry & coronography

Technology
- Ultrafast-laser inscription
- Planar lithography
- Multicore fibres
- Photonic crystal fibres
- Resonance filters
- Bragg grating inscription……

Bottom up

Documents

Documents from WP3

- 3.1.1: APE-REP-01: Science Applicability: complete/published
- 3.1.2: APE-REP-01: Technical requirements: complete/published
- 3.1.3: APE-REP-02: Technology survey: advanced draft (IPAG-TRE-APE-WP3131, 63 pages))

- Note: concordance between stated deliverables and actual deliverables is not stated here. This can be established but not via a simple mapping.

Conclusions

- OPTICON/WP3 has
  - Identified key technologies necessary to achieve major goals in astrophysics
  - Brought together instrument builders and providers of enabling technologies
  - Coordinated the groups involved
  - Tapped into regional technology development activities
  - Produced an extensive literature
- Next steps
  - Refine devices through laboratory and on-sky testing
  - Design and develop complete systems
  - Demonstrate complete systems and relevance to future observatory plans

End