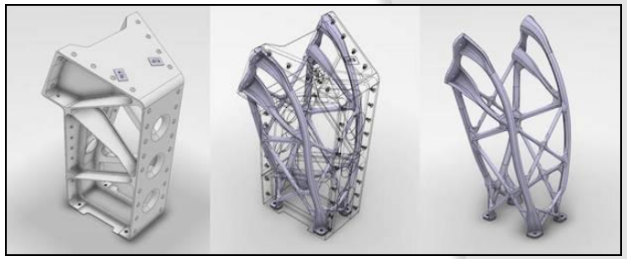
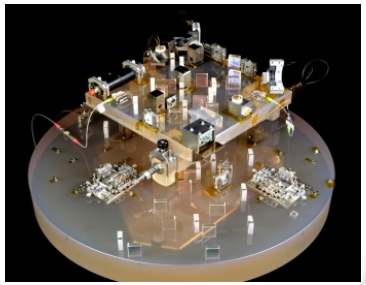
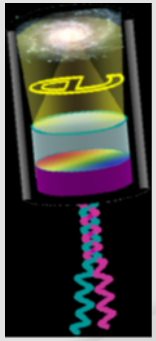
WP14: Technology & Innovation Network







Wayne Holland (WP Lead)

UK Astronomy Technology Centre

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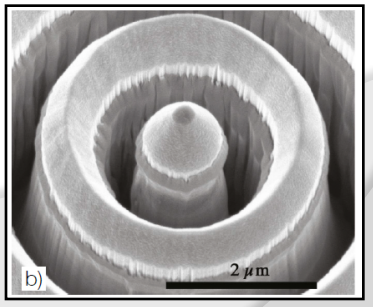
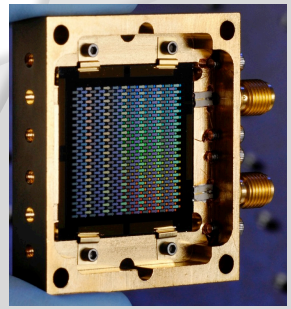




OPTICON Board Meeting
FORTH, Heraklion
5/6th Nov 2018

Objectives

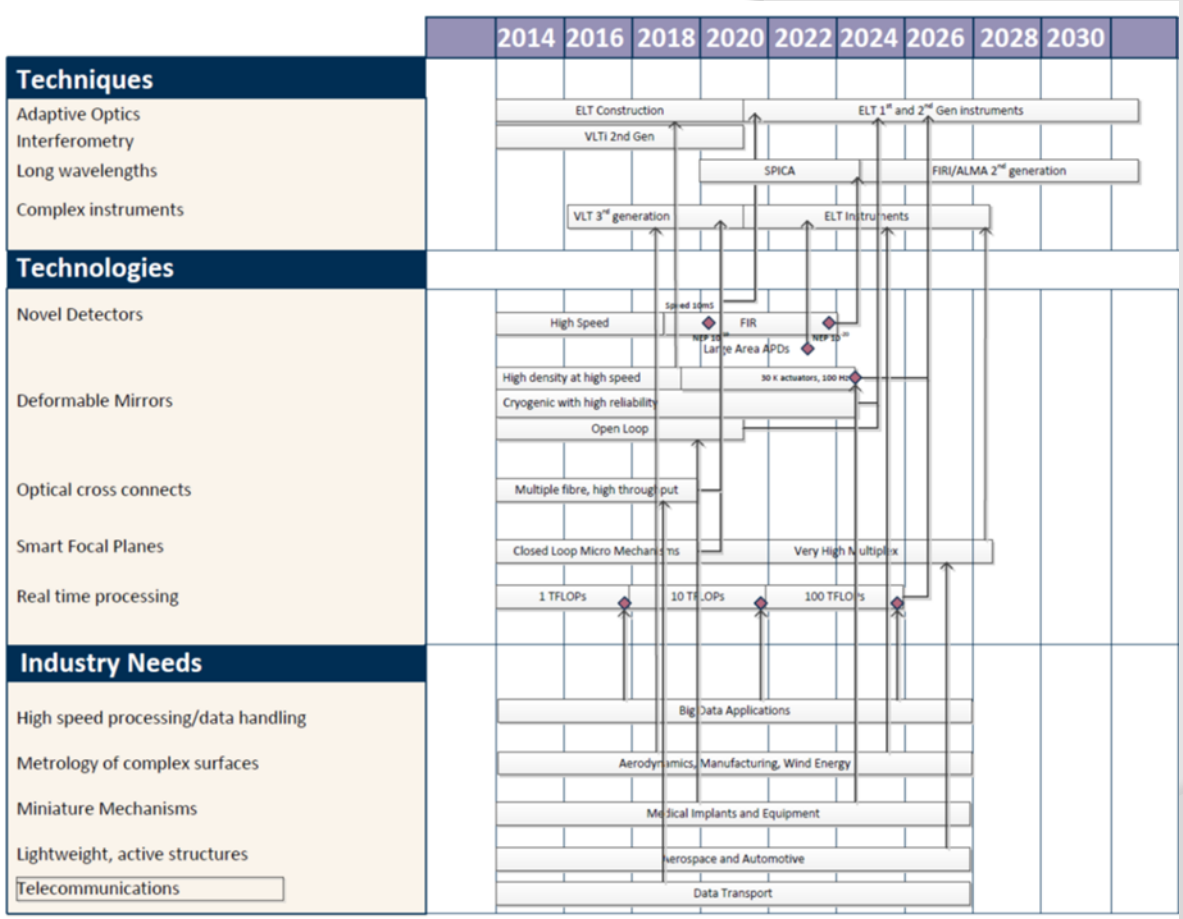
- To engage astronomers, engineers and industrial partners across Europe to stimulate scientific progress and economic development

How to do this?

- Generate and update technology road-maps
- Run a series of technology-themed workshops based on the science drivers for new optical/IR instrumentation

T&I network roadmaps

- Last roadmap update was in 2013 (there was a published version prior to this in 2012)
- Highlighted a number of techniques, technologies and needs for the community

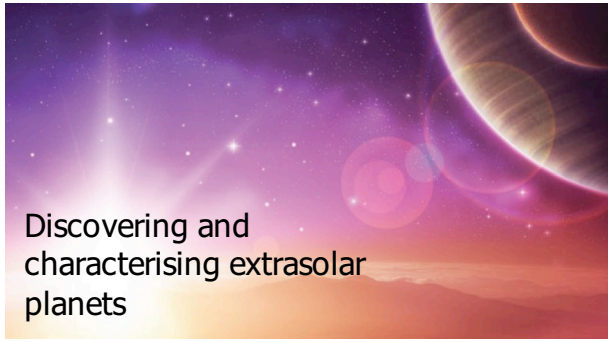


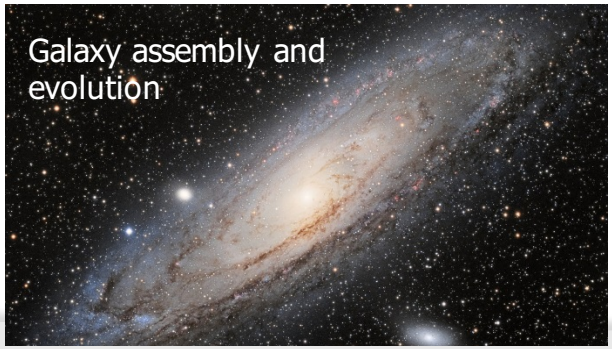
- Major update ("T&I Network Roadmap 2018") is now underway

Roadmap methodology

- Science drivers updated based upon "Cosmic-vision" exercises and the cases for new telescopes/instruments

- Top-level science themes identified:





Science drivers

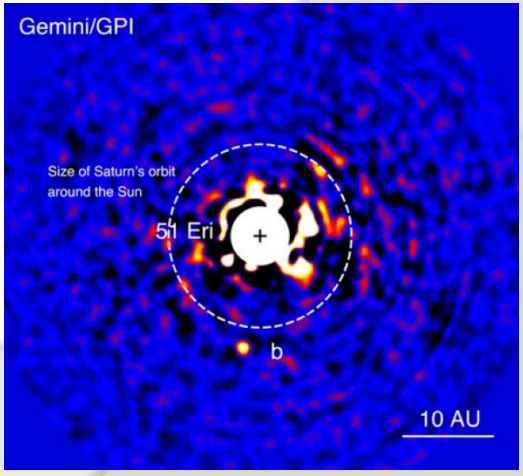
Example: Discovering and characterising extrasolar planets

- Major questions

➢ Are planetary systems like our Solar System commonplace?
➢ How frequently do rocky planets settle in the "habitable zone"?
➢ Do atmospheres of exoplanets resemble the ones in the Solar System?
➢ How is pre-biotic material distributed in proto-planetary discs?
➢ Are there signs of life on any exoplanet?

- Techniques

➢ Coronographic techniques to give high contrast
➢ Optical/Near-IR interferometry
➢ Near-mid IR spectroscopy
➢ Heterodyne (very high R) spectroscopy



Facilities and instrumentation

- European current facilities

	Telescope/facility	Main instruments (and coming soon)
European access facilities	Very Large Telescope (VLT)	KMOS[8], VISIR[11], NACO[5], UVES[3], MUSE[3], SPHERE[2,6]… (CRIRES+[7], ERIS[5,7], MOONS[8])
	Gran Telescopio Canarias (GranTeCan/GTC)	OSIRIS[1,3], EMIR[5,7], MEGARA[3,4], HiPERCAM[1]… (MIRADAS[8], FRIDA[7])
	VISTA	VIRCAM[5] (4MOST[4])
	4-m class telescopes	*UKIRT:* WFCAM[5], CGS-4[7] *WHT:* ISIS[1,3], LIRIS[4,6], ACAM[1,3], HiPERCAM[1]
	VLT interferometry	PIONIER[10], GRAVITY[11] (MATISSE[12])
	2-m class telescopes	

Facilities and instrumentation

- Current world-wide facilities

	Telescope/facility	Main instruments (and coming soon)
World-wide access facilities	Keck	HIRES[3], NISPEC[7], KCWI[3], NIRC[5,6,7], OSIRIS[7]… (KCRM[1], KPF[2,3]…)
	Subaru	HSC[1], HDS[3], IRCS[5,7], FOCAS[1,2,3], COMICS[9], MOIRCS[5,7]… (PFS[4], Ultimate-Subaru[5,7]…)
	Gemini telescopes	GMOS[3], NIRI[4,6], NIFS[6], GNIRS[6], GPI[5,6]… (SCORPIO[1,3,4,6], GHOST[3]…)
	South African Large Telescope (SALT)	RSS[3,4], SALTICAM[1], BVIT[1], HRS[3,4]
	CHARA array	MIRC[11], JOUFLU[11], VEGA[2,3] (ALOHA[10,11]…)
	4-m class telescopes	

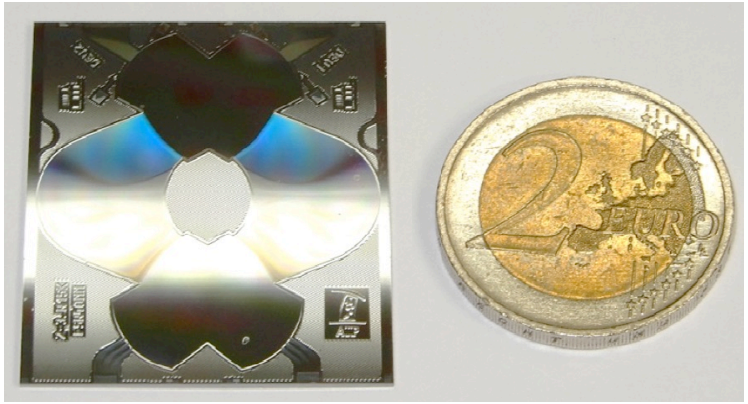
Observing & calibration techniques

- Looks at trends in the main observing techniques
- Attempt to identify where the next major developments are needed in areas of:

- Imaging
- Spectroscopy
- Polarimetry
- Coronography
- Wavefront sensing and correction

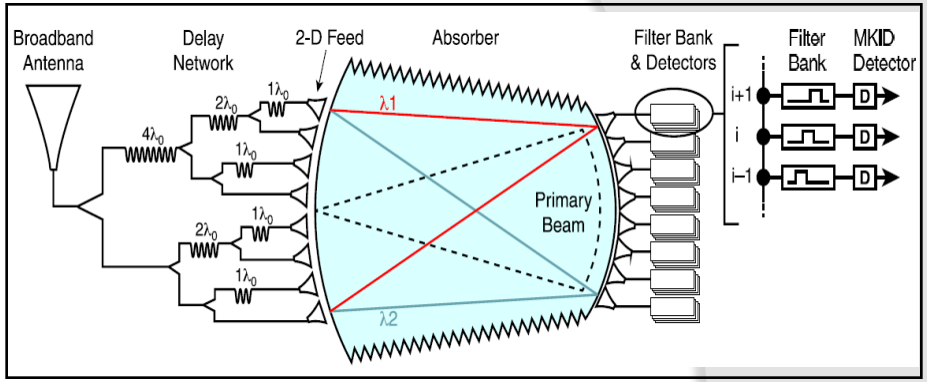
Example: Spectroscopy

- Photonic spectrographs



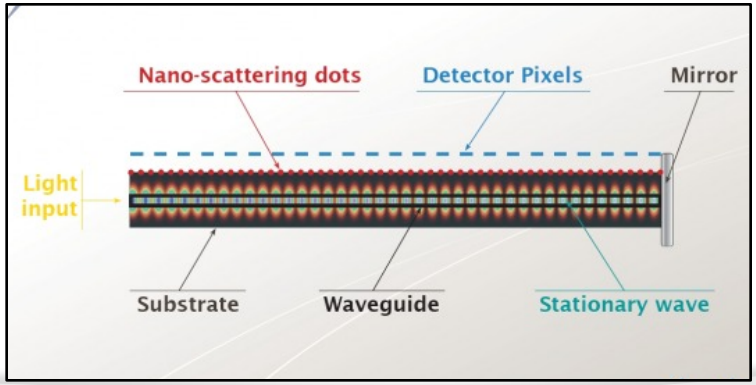
Arrayed waveguide grating photonic spectrometer (Zhang et al. 2018)

- On-chip spectrometer



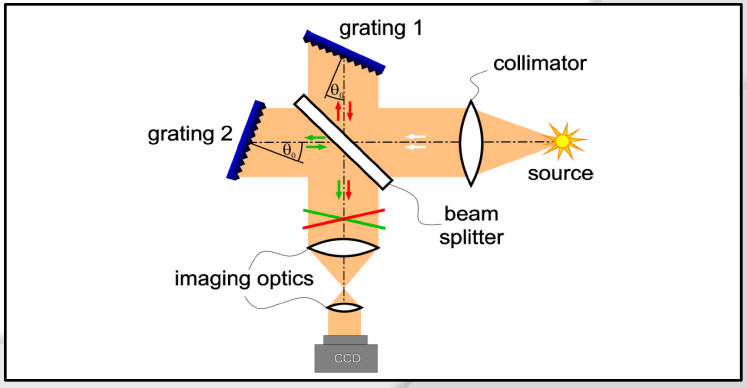
Micro-spec (μ-Spec) on-chip spectrometer (Cataldo et al. 2014)

- No-moving parts FTS



RESOLUTION Spectra Systems

- Spatial heterodyne spectrographs



Spatial heterodyne spectrometer (Lenzner & Diels 2016)

Key technology developments

- Optical technologies
  - mirrors, lenses, dispersive optics, polarisation, filters, coatings, baffles, photonic devices, coronographs, new materials…
- Detectors
  - CCDs, CMOS, IR arrays, energy sensitive, single photon devices…
- Instrument technologies and mechanisms
  - cryostats, cryo-coolers, mechanical structures, cryo-mechanisms…
- Measurement, calibration and control
  - positional metrology, surface measurement, calibration units, control systems, monitoring…
- Manufacturing and fabrication
  - additive manufacturing, capture range replication…

General trends emerging

- Larger aperture telescopes (ground and space…)
- Advanced techniques such as AO, coronography…
- Larger multiplex capability spectrometers (optical to millimetre-wave?)
- Larger format (+energy resolving and photon counting) imagers and cooled detectors
- Precision measuring systems (metrology)

Roadmap status update

- Reasonable draft (v0.1) now available
- Still has sections to add and update/correct
- Aim to have complete draft by Christmas

Would very much welcome input!

Document available:

https://drive.google.com/drive/folders/1QjQvgRpvkr4NrZa-CFv3xXE_CCu3ecE0

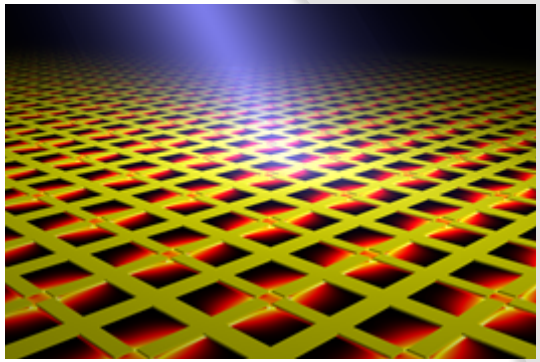
Please let me know if you'd like access.

Workshops

- Workshop brought together 70 astronomers, engineers and industrialists
- Focus was mainly on dispersing elements based on gratings and prisms and what the future developments are likely to be
- Article in ESO's The Messenger and Andrea gave a great talk at SPIE Austin meeting (June 2018)

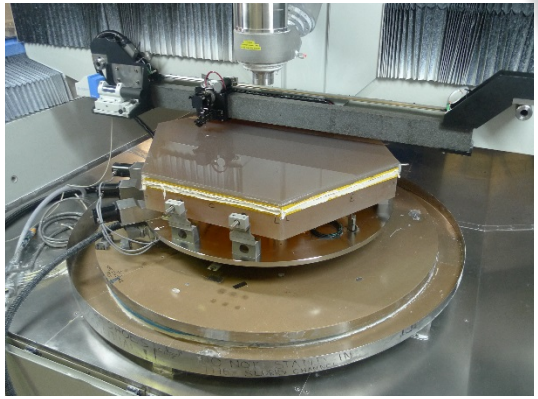
Workshop plans

Metamaterials for optical devices
(Cardiff, Spring 2019)

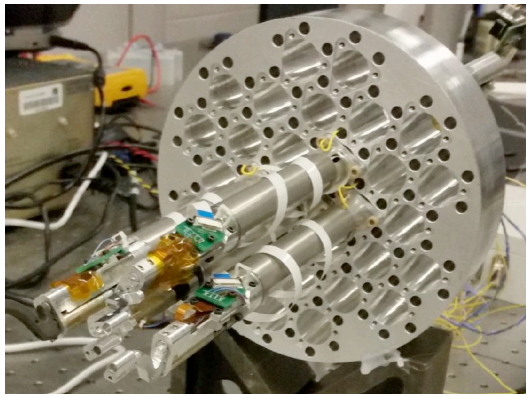


Concept for metamaterial IR detector array (Suen et al. 2017)

Positional and surface metrology
(NPL, June/July 2019)



Non-contact measurement of prototype ELT segment (Atkins et al. 2011)



MOONS prototype positioners (Montgomery et al. 2016)

Mechatronics for astronomical instruments
(A nice place…, Oct 2019)

I'd really welcome any other ideas/suggestions!