Innovative Technology for optical and infrared astronomy: an updated roadmap

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What is Disruptive or Revolutionary Technology?

Disruptive technology can be defined as new technology that has a serious impact on the status quo and changes an entire way of doing things

Christensen, C.M.: The Innovator's Dilemma. Harvard Business Press (1997)

Why is it rare? -

- We want to make our telescopes and instruments to work and be built to budget –Engineering, not Invention
- Limited money for low-TRL developments
- Big breakthroughs often need big money
  - **Many innovations come from elsewhere**

How can we explore innovation in astronomy in the hope of expanding parameter space?

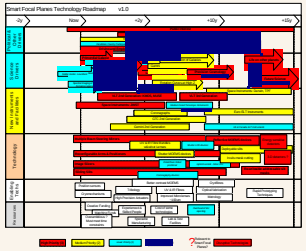
OPTICON Key Technology Network

ESA/ESF Techbreak

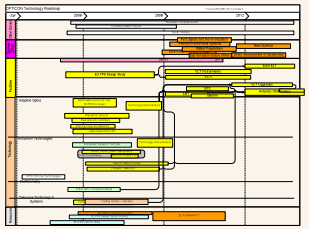
OPTICON Roadmapping

OPTICON KTN

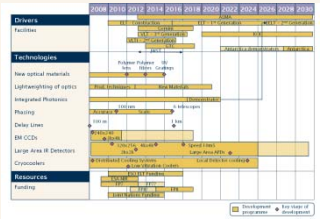
Smart Focal Planes Jan 03



OPTICON KTN Roadmap V1 June 06



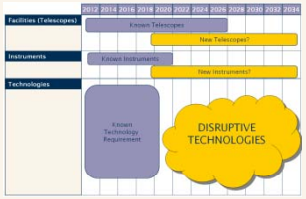
OPTICON KTN Roadmap V2 Nov 08



OPTICON KTN Focused Workshops

- Position Sensing
- Real-Time Comp.
- Polarimetry
- Deformable Mirrors

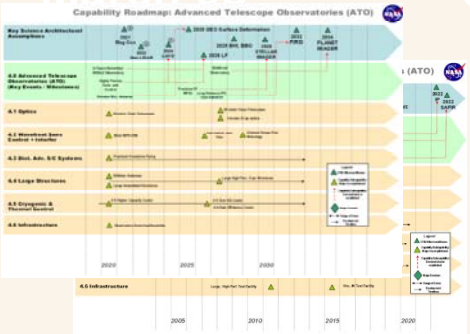
OPTICON KTN Roadmap V3 2011



Others

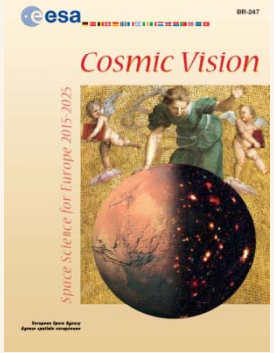
Telescope & Observatories

NASA Adv. March 05

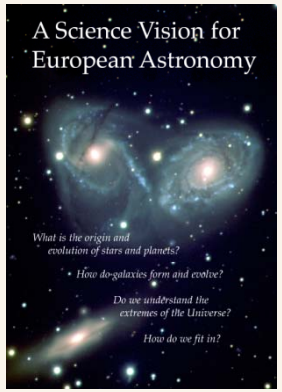


Cosmic Vision Oct

Esa 05



Astronet Science Vision Oct 07

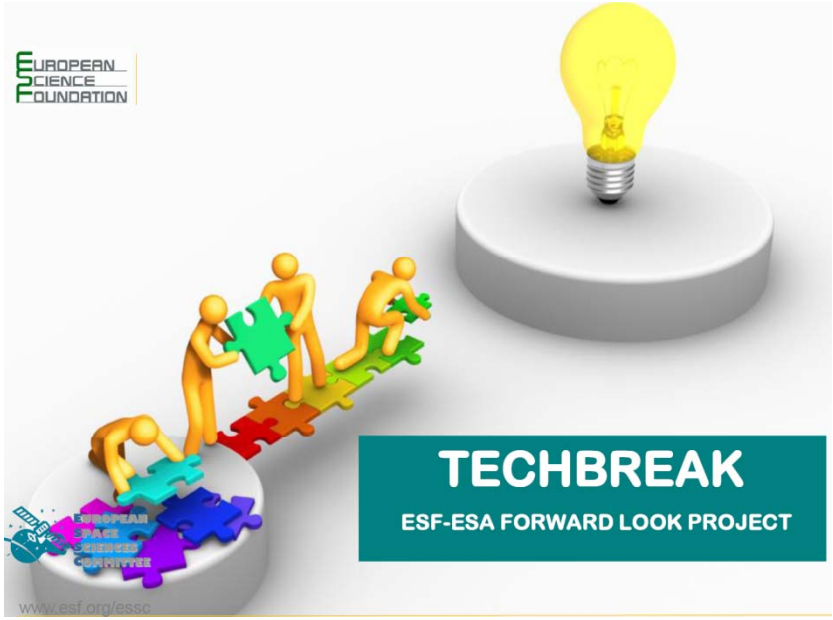


Astronet Infrastructure Oct 08

ESF-ESA TechBreak

Aims:

- Take stock of breakthrough scientific objectives ·
- Foresee the evolution of the technologies, in space and non-space domains
- Forecast the development of technologies for the achievement of scientific breakthroughs
- Characterize risks and propose mitigation schemes
- Identify partnership schemes, space and non space

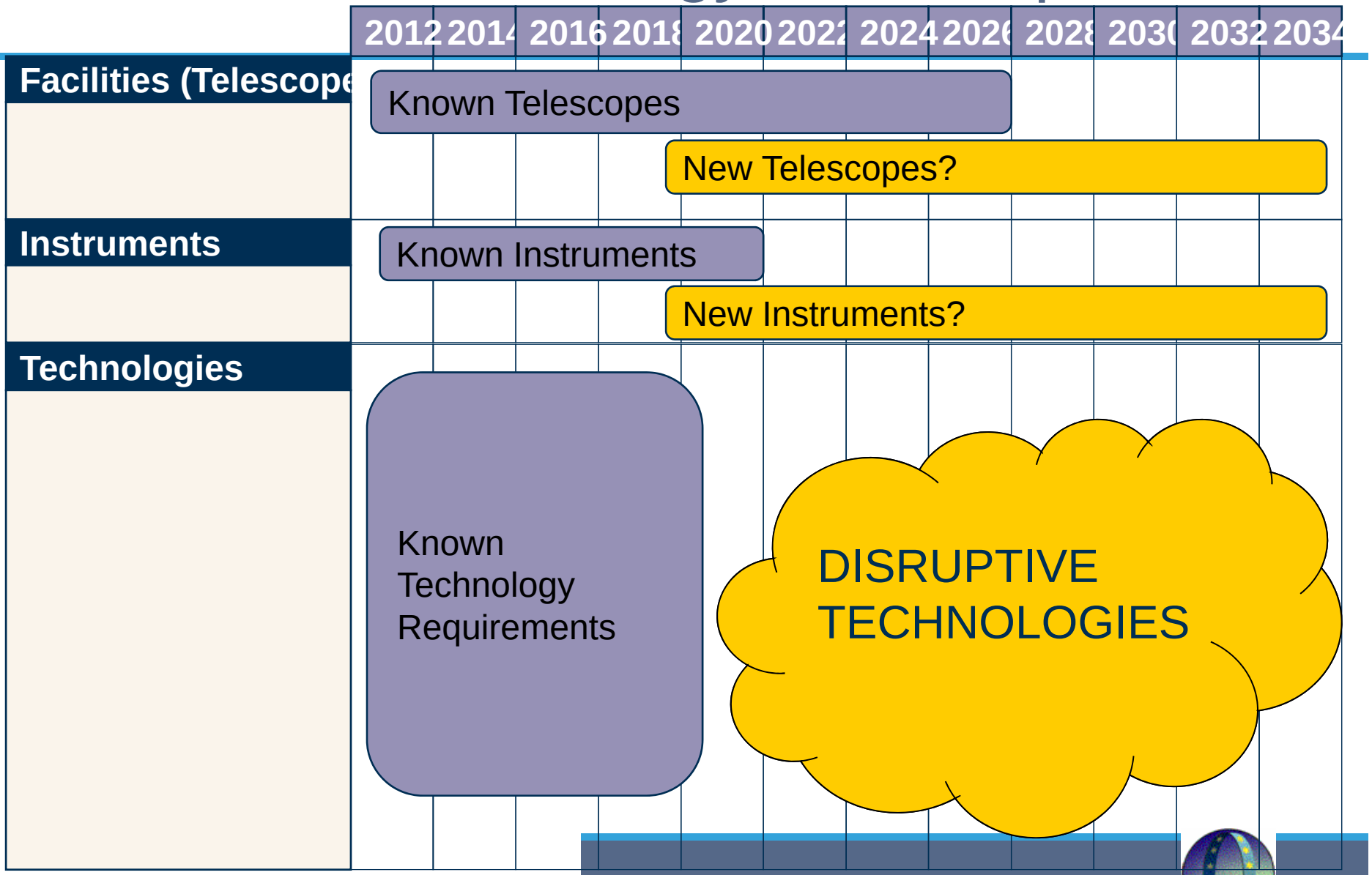


OPTICON Marseille Workshop on Disruptive Technology

Participants:

Chris Evans, Colin Cunningham, John Davies, Matt Kenworthy, Roger Haynes, Jeremy Allington-Smith;, Sarah Kendrew, Marc Ferrari, William Taylor, Kjetil Dohlen, Filippo Zerbi, Martin Cullum, Gert Finger; Pierre Kern, Frank Molster, Ian Parry, Frans Snik

OPTICON Technology Roadmap V3

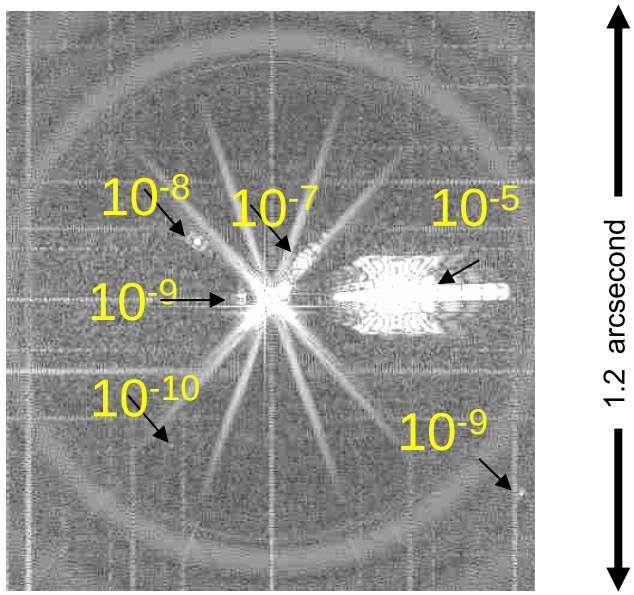


We chose some Grand Challenges

- Exoplanet characterisation
- Optical imaging of stellar populations
- Redshift surveys in the era of ELTs

Concentrated on one big challenge: exoplanet characterisation

- Direct Imaging and spectroscopy:
  - **High density, high dynamic range, fast wavefront correction: XAO with 10,000 to 100,000 actuators**
  - **Speckle reduction**



Simulated image courtesy of EPICS team

So, get rid of the telescope structure

And get rid of deformable mirrors

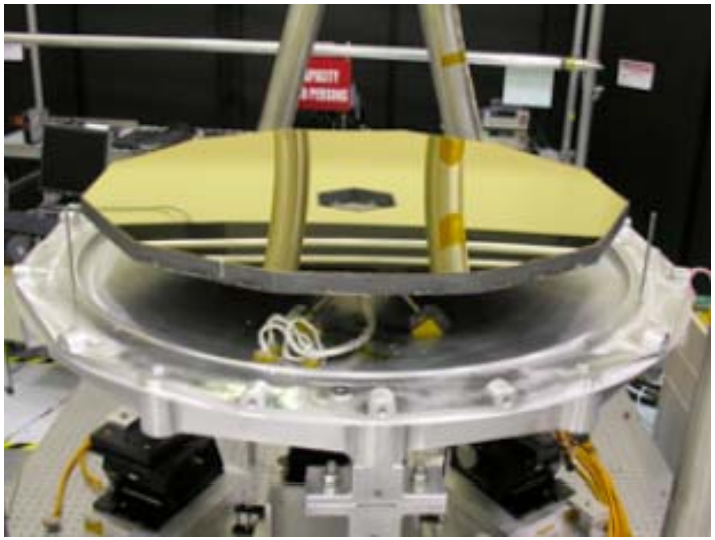
But still carry out the functions of a telescope and its instruments

- Measure information, usually spatial and spectral, encoded in light waves
- Reject or avoid distortion, noise and interference

Sounds easy!

Space: big challenge

- Large Primary Mirror – or Lens?
- Recent studies on 8m monolithic and 16m segmented telescopes
- What would be needed for a 30m telescope in space?

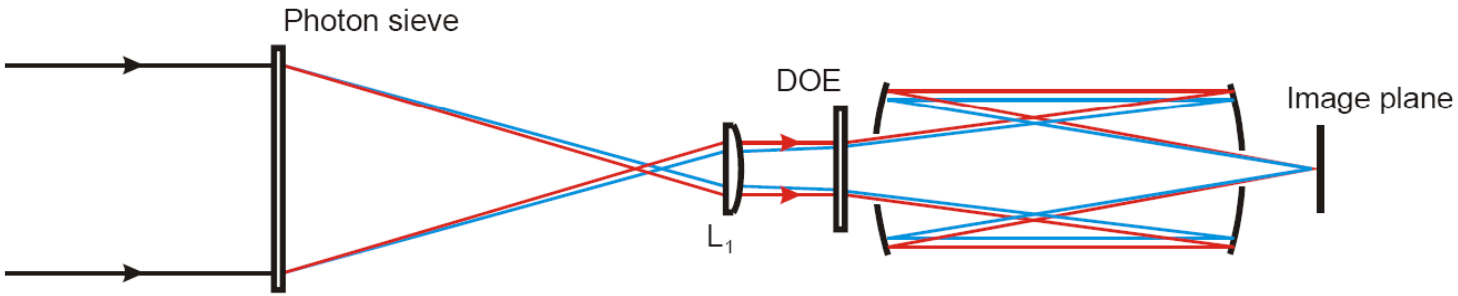


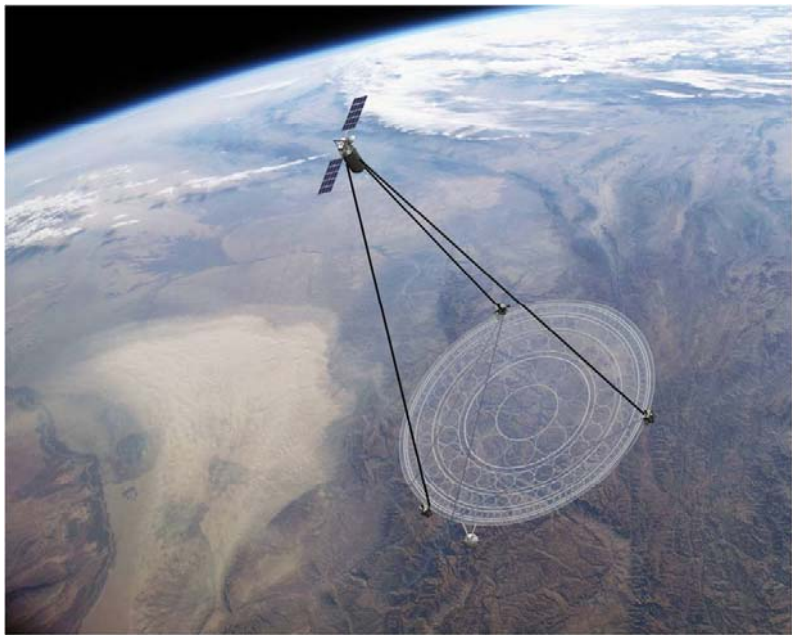
How can you make a giant light collector?

- Segmented mirror
- Membrane mirror
- Fresnel lens or mask

- Need to minimise or correct wavefront errors
- Why not off-load the errors to a corrector in the instrument module

Example: Photon Sieve Membrane Telescope





Geoff Anderson, USAF

For the full story: SPIE Paper in Press

Innovative Technologies for Optical and Infrared Astronomy

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The end