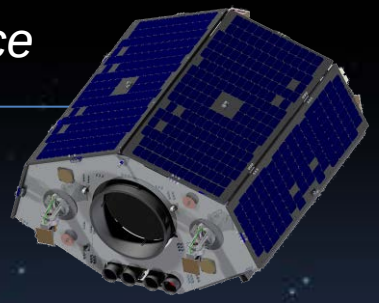
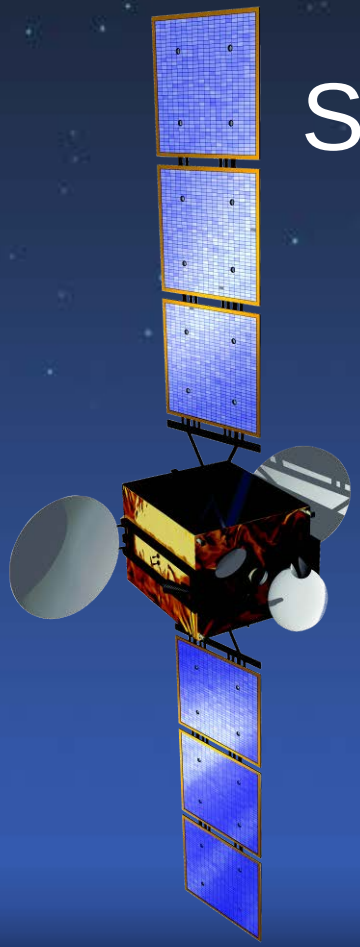
SURREY SATELLITE TECHNOLOGY LTD

Changing the economics of space





Space Imaging Optical Technology Challenges

Dr Mike Cutter

Business Development Manager

CEOI Technology Workshop, April 2014

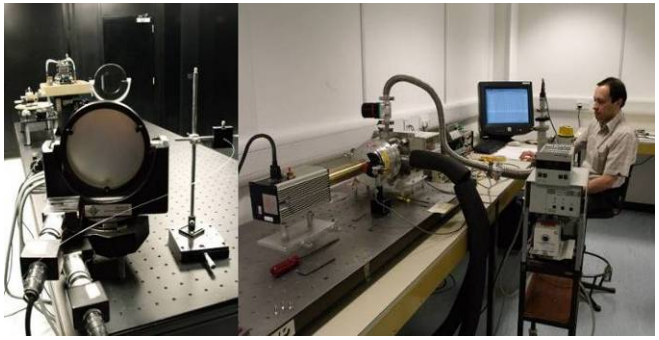
Contents

- Company Background
- Key optical technology areas
  - Earth imagers
  - Earth science
- Summary

SSTL - The Company

UK satellite manufacturer is owned by
99% Airbus S&D 1% University of Surrey

Since 1985, employing ~620 staff
Facilities in Surrey, Kent, Hampshire & Colorado



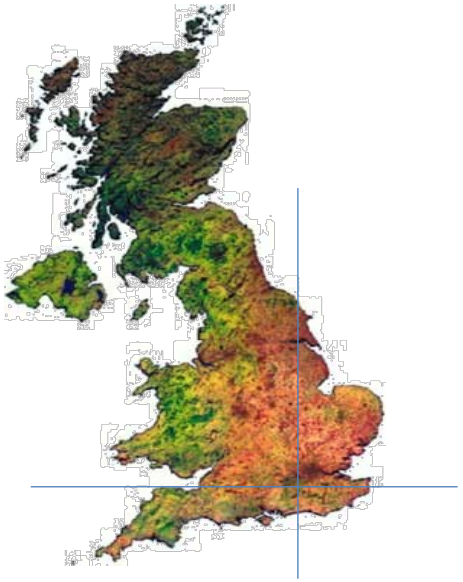
The Kepler Building

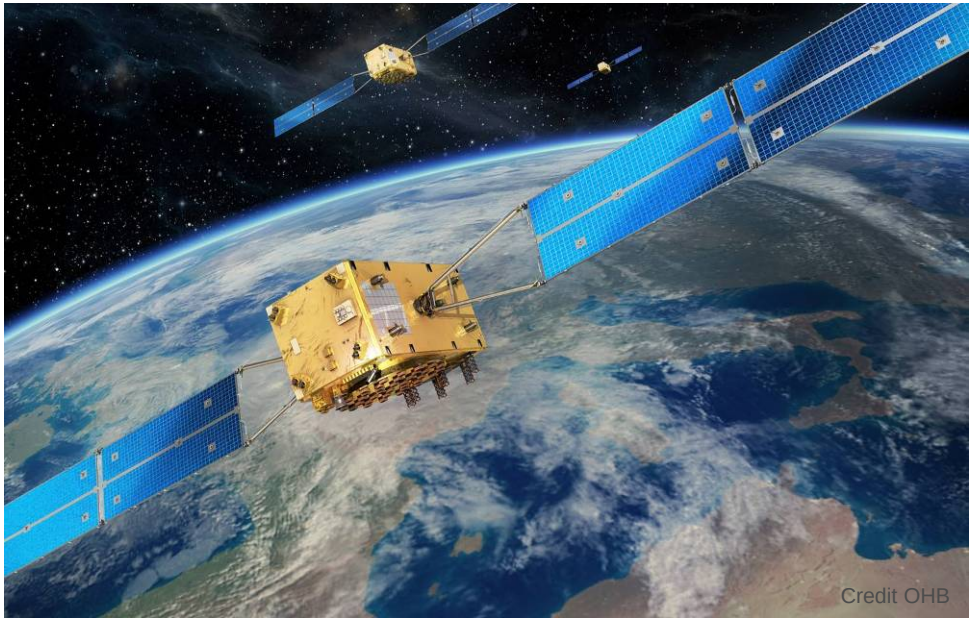
SSTL's technical facility with offices, stores, laboratories, manufacturing, hi-bay clean rooms and testing

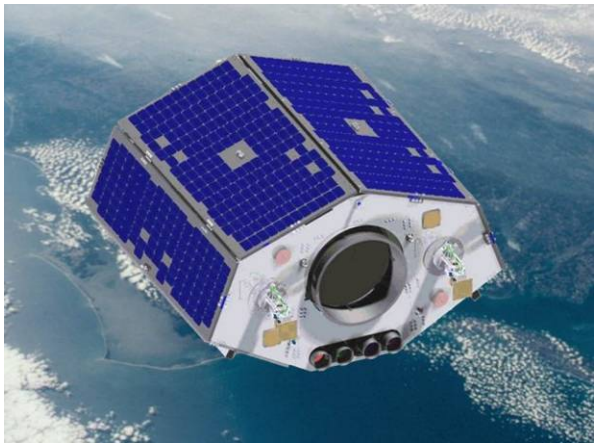
Changing the Economics of Space

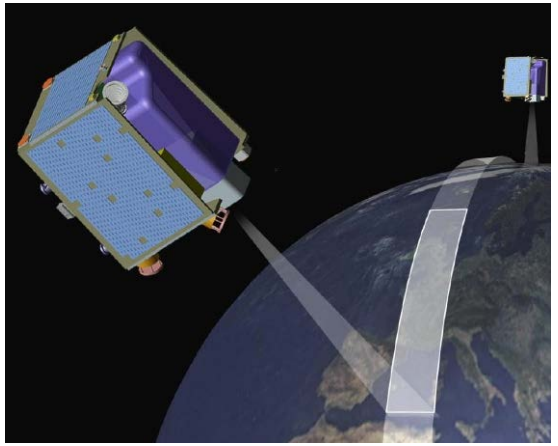
This is achieved through:

Rapid manufacture using advanced terrestrial technologies

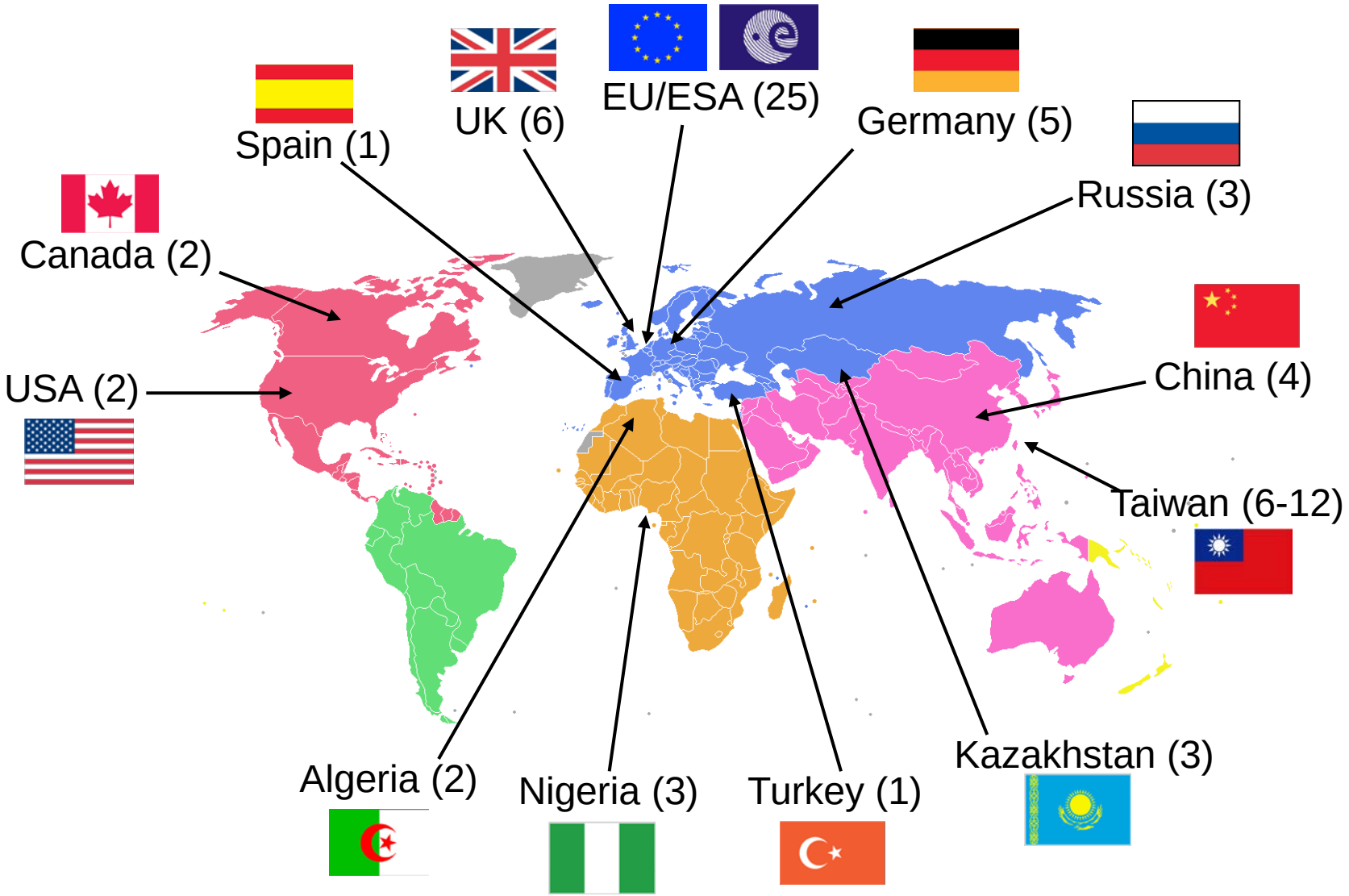








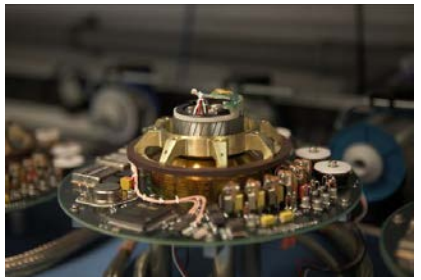
SSTL is an Exporter



*Major contracts (2003-) : platform, payload or complete mission

Development & Manufacturing Strategy

- Assess market
  - Typical customer budgets
  - Key price points
  - Performances requirements



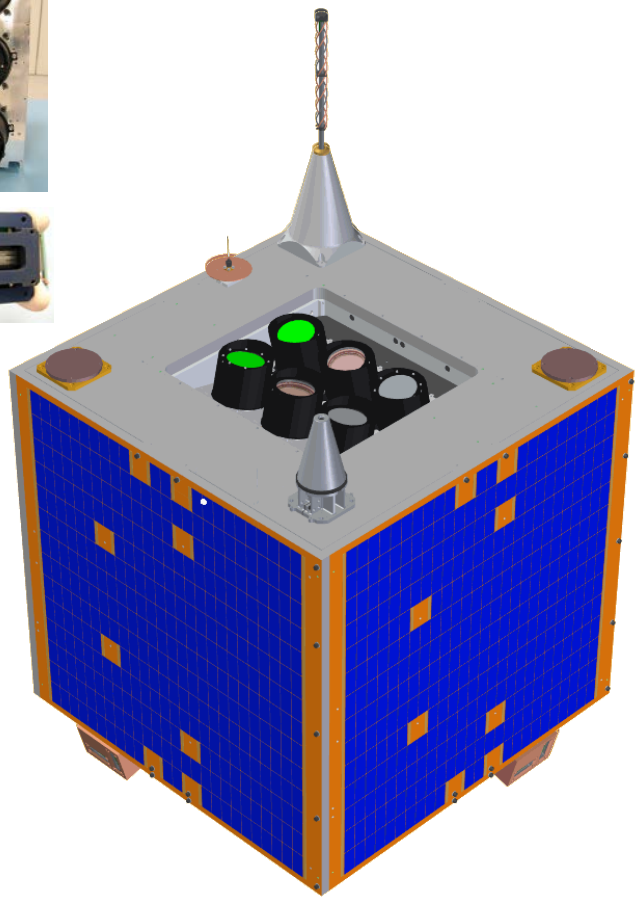
Momentum wheel

- Development & Manufacturing strategy
  - Build on heritage to minimise risk & schedules
  - Adopt iterative development approach
  - New developments qualified in orbit in earlier missions
  - Adopt system approach to development:
    - payload
    - on-board processors
    - avionics (sensors, actuators, controllers & software)
    - downlink
    - power systems
    - structures.
  - Reduce size of supply chain: to control schedules & margins
  - Aim for rapid schedules to control costs
  - Optimise specifications to address risk, schedule & costs

41 satellites completed, 19 further satellites in progress, 27 payloads in progress

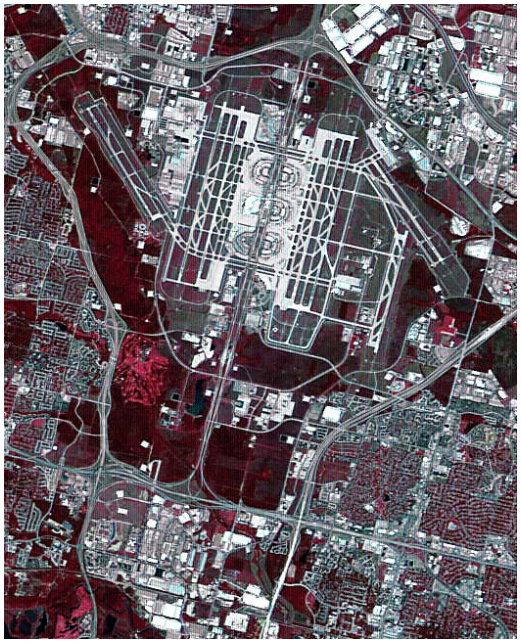
EO Imager Development

SSTL 100 - Compact Modular Platform



Key parameters:

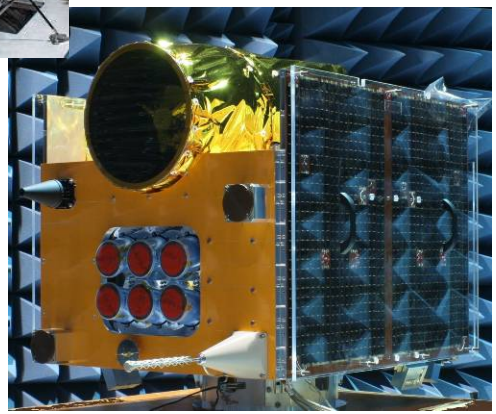
- Three spectral bands
- 32 & 22m GSD
- 600km swath width
- 5-year design life
- Butane propulsion
- High speed downlink (X-Band)
- Platform mass 100kg



Microsat-70 (14 missions) SSTL-100 (8 missions)
AlSat-1 Bilsat NigeriaSat-1 UK-DMC Deimos-1 UK-DMC2
ADS-1B NigeriaSat-X

SSTL-150

First launched 2005

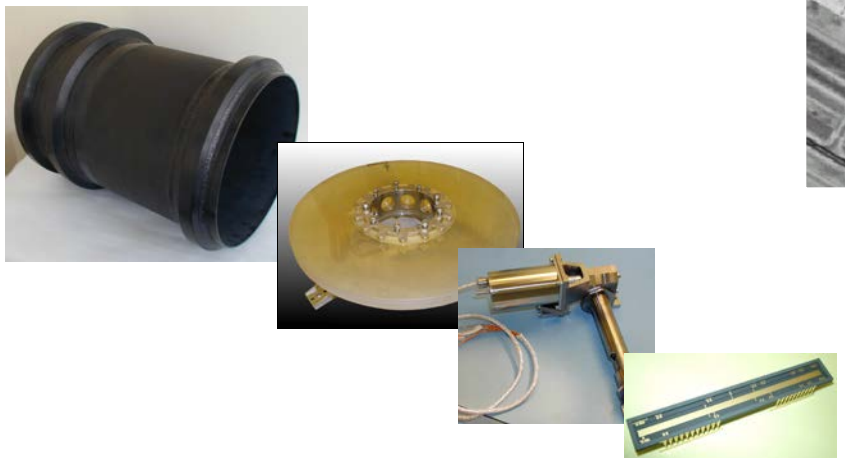


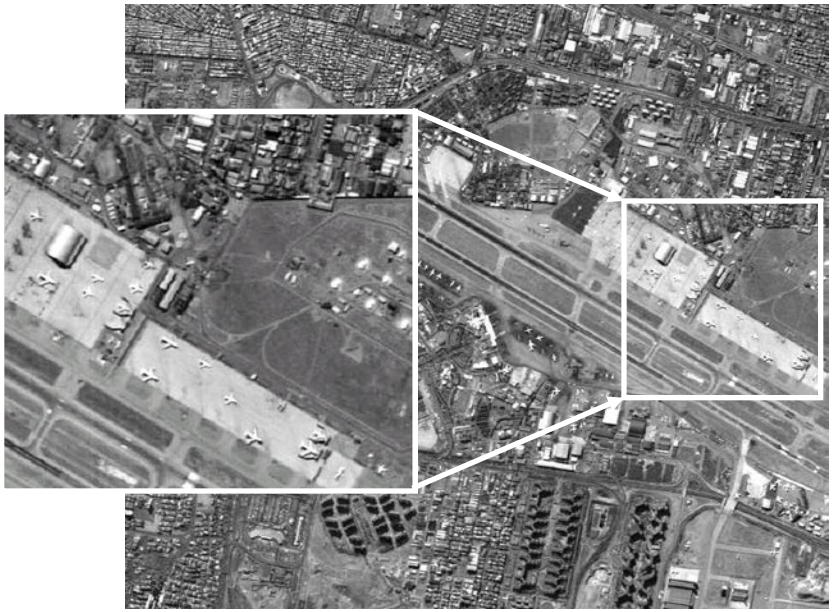
Key parameters:

- Panchromatic band
- 4m GSD
- 24km swath width
- Xenon Propulsion
- 3-axis attitude control
- High speed downlink (X-Band)

New Developments:

- Carbon fibre structure
- Mirror mounting techniques
- Active focusing mechanism

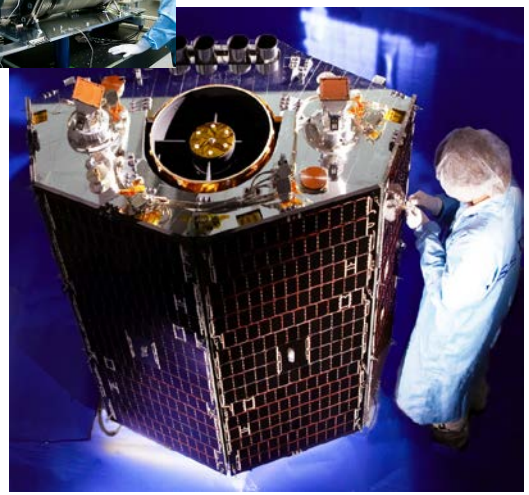




Tehran Airport 2006

SSTL-300i

Launched 2011

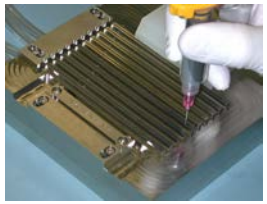


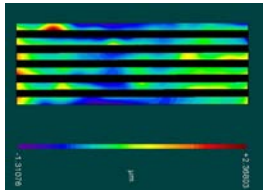
Key parameters:

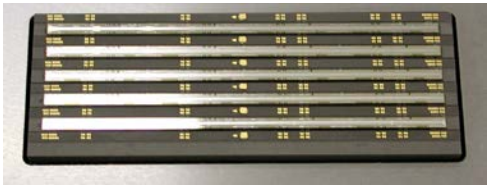
- 2.5m Pan 20km swath
- 5m 4-band multispectral, 20km swath
- 32m 4-band multispectral 320km swath
- Xenon Propulsion
- 3-axis attitude control
- 32GB on-board storage
- 210 Mbps X-band downlink

New Development:

- Multi-element co-planar focal plane
- Antenna pointing mechanism
- Momentum wheels & strategy

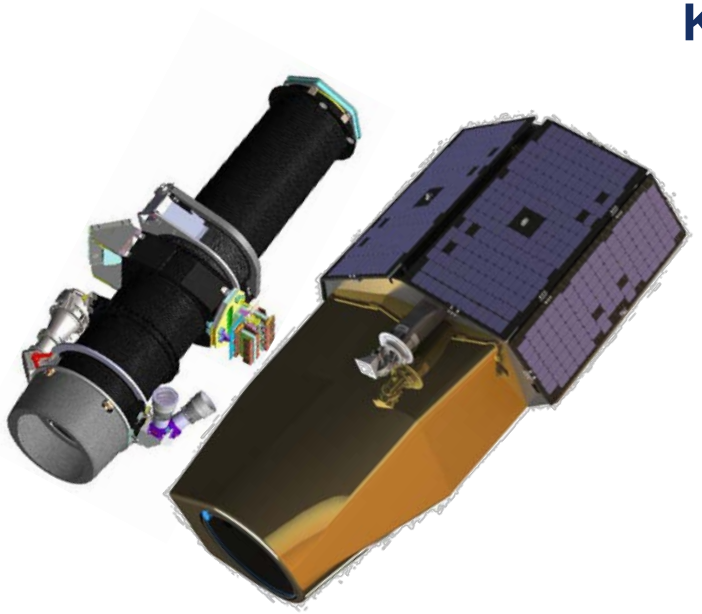






Burj Khalifa, Dubai

SSTL-300S1 Imager

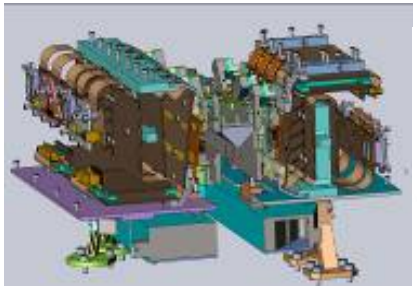


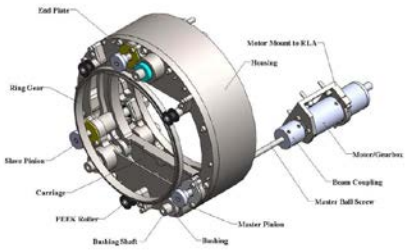
Key parameters:

- 1m Pan, 22.6km swath
- 4m 4-band multispectral, 22.6km swath
- 3-axis attitude control & highly agile
- 544GB on-board storage
- 500 Mbps X-band downlink
- 57,000 sq.km per day

New Developments:

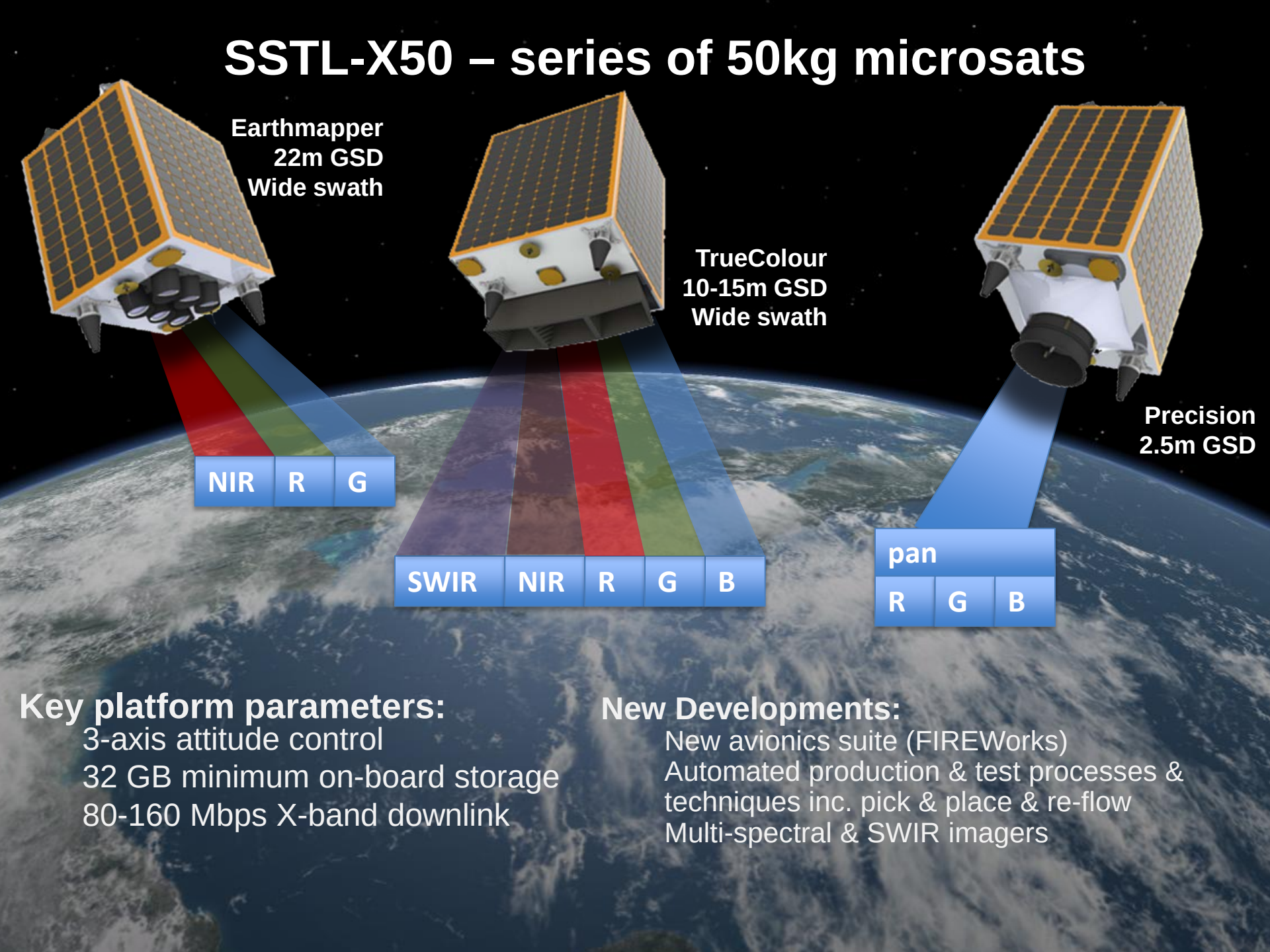
- Optical design
- TDI detectors
- Complex focal plane assembly
- New focusing mechanism





Simulated S1 image

SSTL-X50 – series of 50kg microsats



Key platform parameters:

- 3-axis attitude control
- 32 GB minimum on-board storage
- 80-160 Mbps X-band downlink

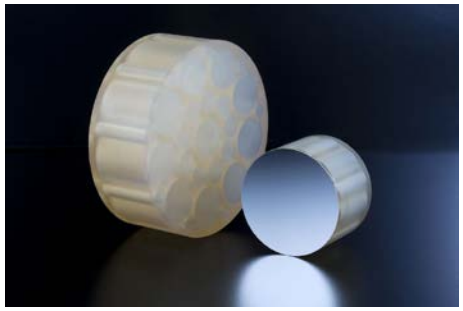
New Developments:

- New avionics suite (FIREWorks)
- Automated production & test processes & techniques inc. pick & place & re-flow
- Multi-spectral & SWIR imagers

Future image developments - SSTL X-300

- Future developments
  - Reduced platform mass (20-30%)
  - New avionics derived from X-series (faster build cycle)
  - Higher downlink capability (Ka or optical?)
  - Improved spatial performance (ground sampling ≤ 0.5m)
  - Novel image processing techniques
  - Sparse apertures?

N2 LW Mirror 385mm dia.



Gooch & Housego LW Mirrors
150mm & 80mm dia.

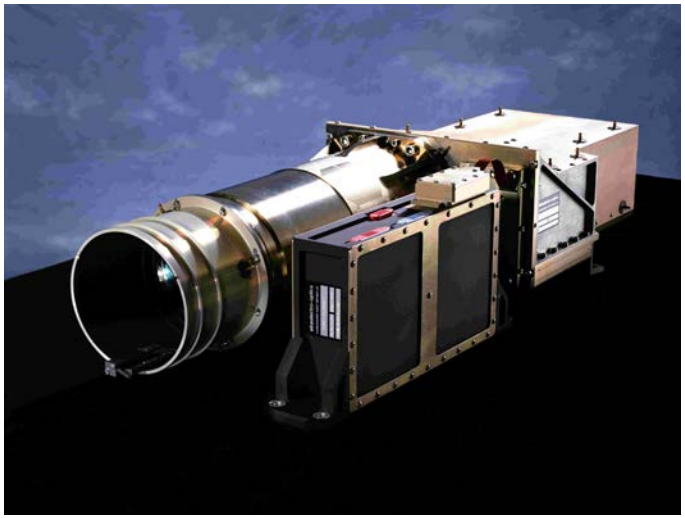
Short Summary
of
Earth Science Technologies

High Resolution - Spectrometer Technologies

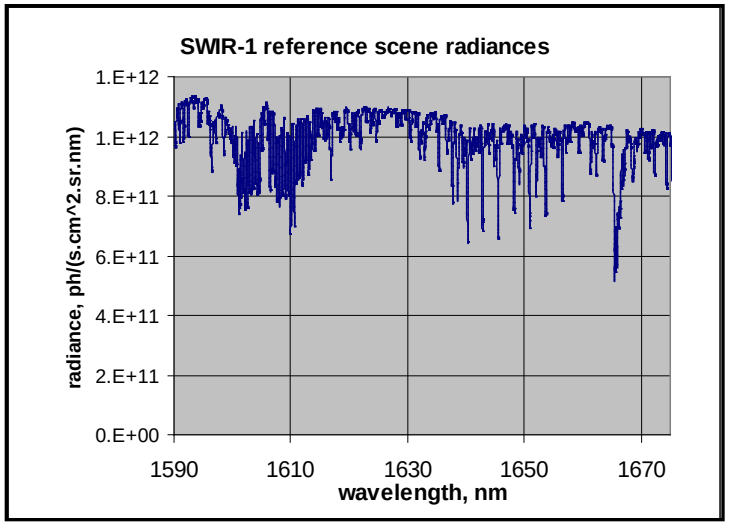
Technology approach:

- Conventional spectrometers ($\Delta\lambda \geq 1$nm) – gratings/prisms but long.
- High spectral resolution ($\Delta\lambda \leq 1$nm) - immersed diffraction gratings.

- Immersed gratings receive & diffract light in a refracting media
- They give higher angular dispersion than gratings in air/vacuum.
- Reduces the size of the optical system by the refractive index and this tends to produce a mass of approx. $1/L^3$

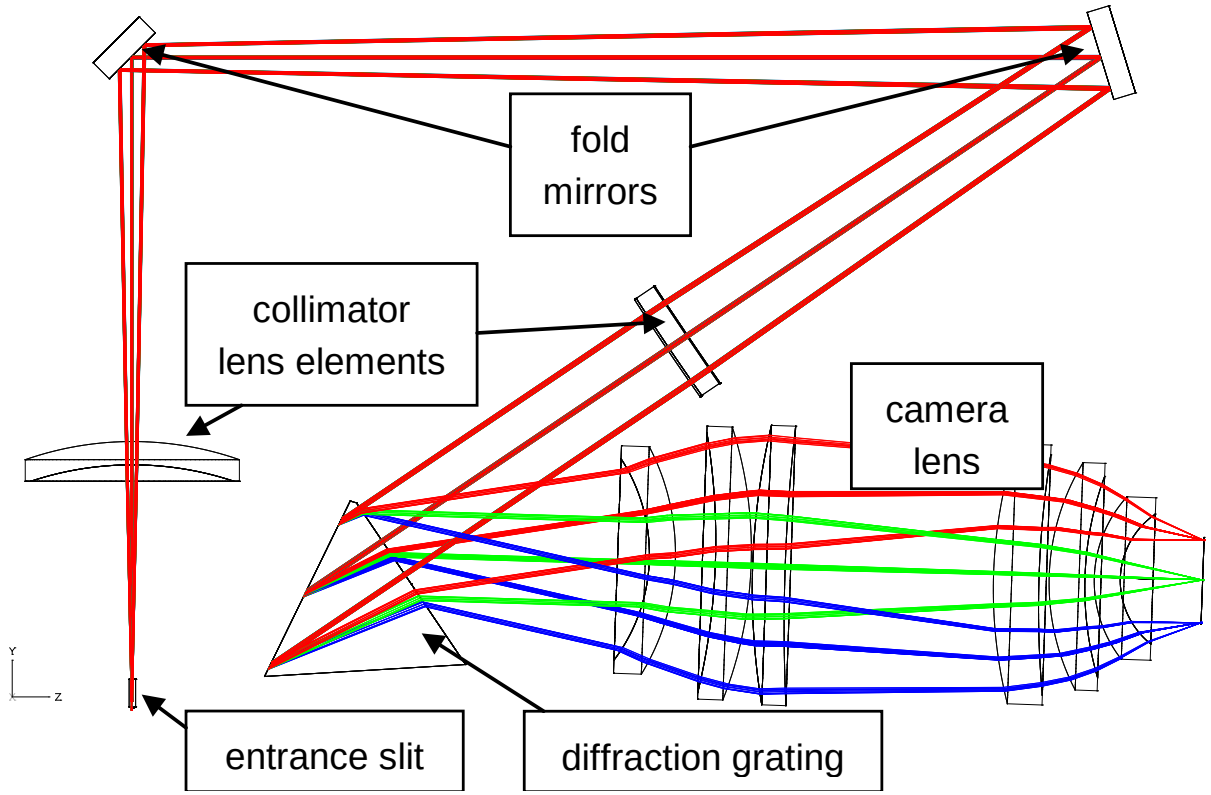


CHRIS Hyperspectral Imager



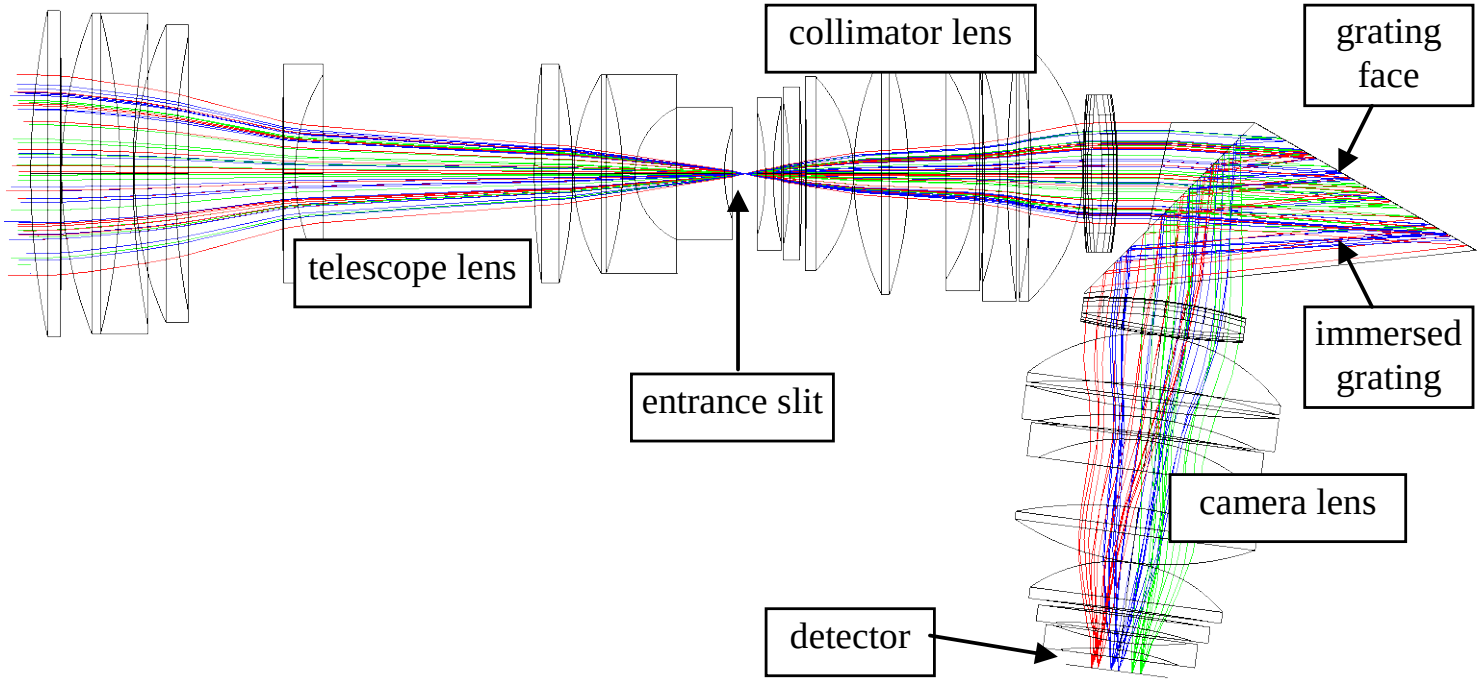
Short-wave IR spectrometer design

- Spectral range: 2308nm to 2385nm, for CH_4 and CO
- Spectral resolution 0.25nm
- Grating aperture: 25mm x 50mm

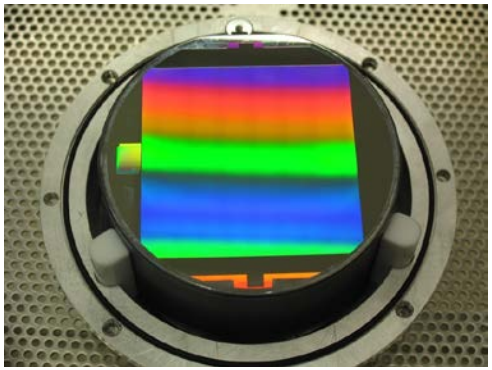


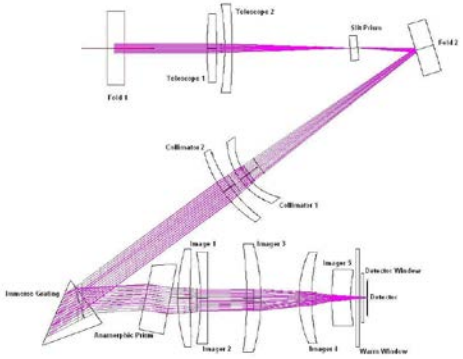
High-resolution spectrometer design for FLEX

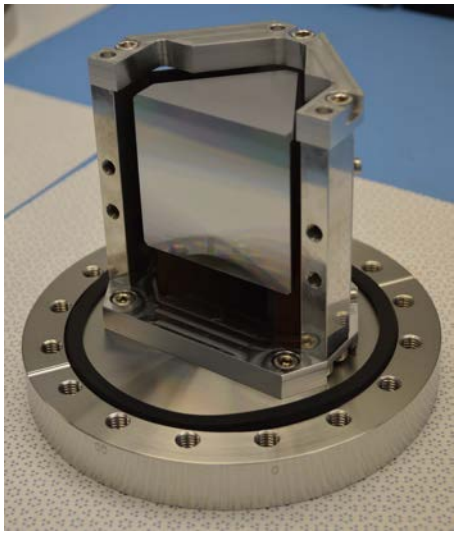
- Spectral range: 745nm to 775nm (O_2A band)
- Spectral resolution 0.1nm
- Aperture: 100mm diameter (80mm along-track)



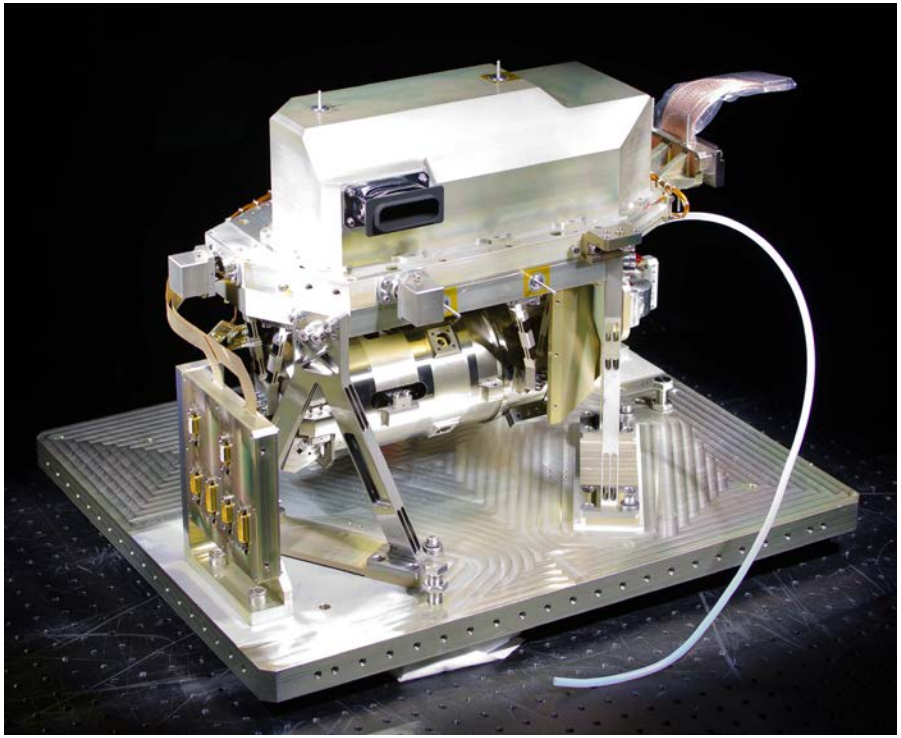
Immersed grating technologies (1)







SRON Silicon Immersed Gratings



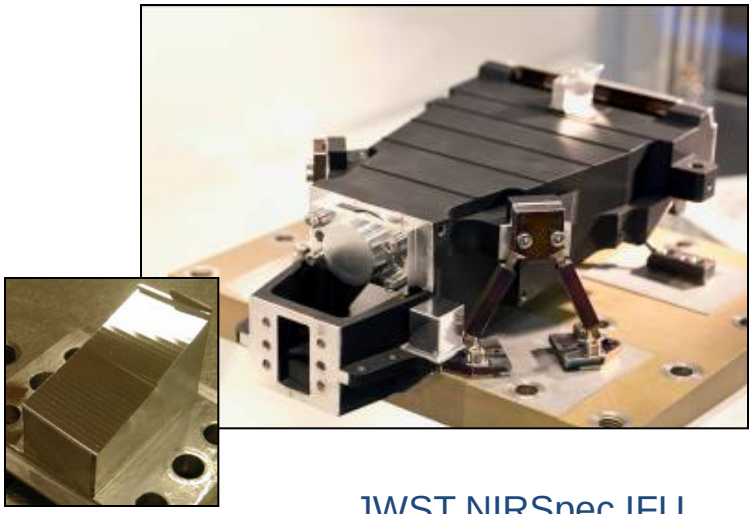
TROPOMI SWIR Spectrometer

Summary

- SSTL provides a range of optical instruments;
  - High resolution optical imaging systems
  - Earth observation science payloads
  - Space science instruments (IFU JWST)

- Solutions can be challenging & require a mix of engineering technologies
  - Optical design
  - Mechanisms
  - Detector technology (visible - IR)
  - Lightweight mirrors & structures

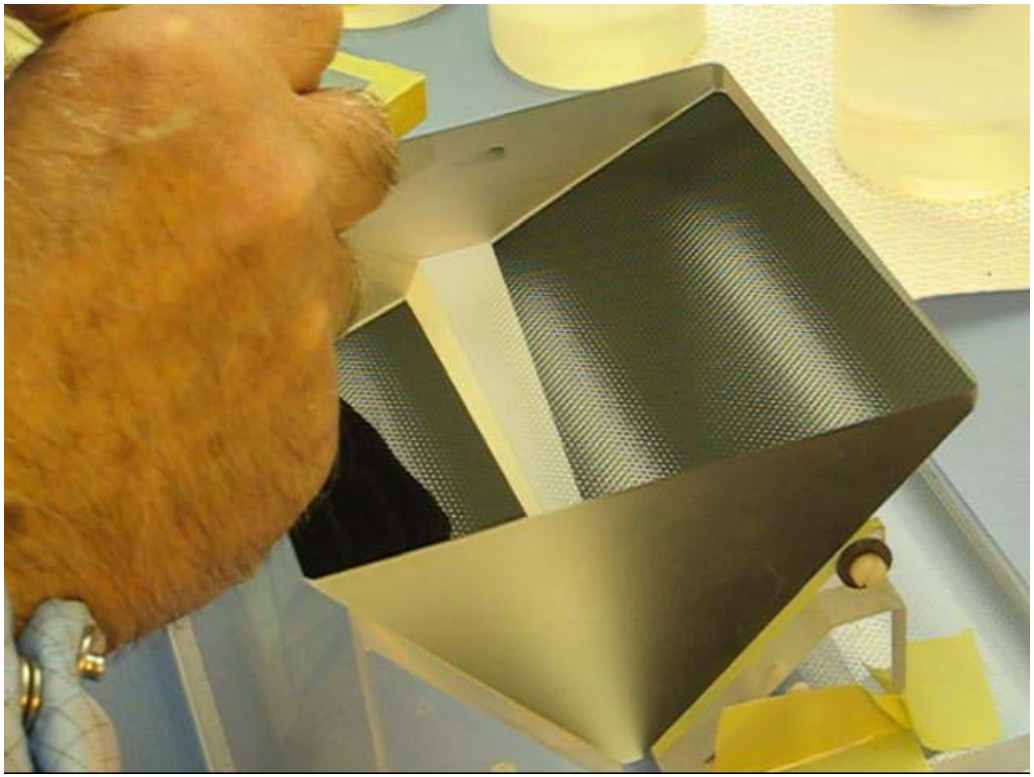
EarthCARE MSI

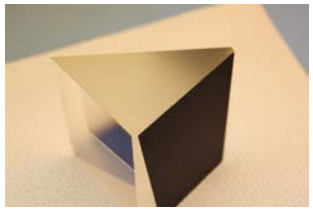


Micro-slicer

JWST NIRSpec IFU

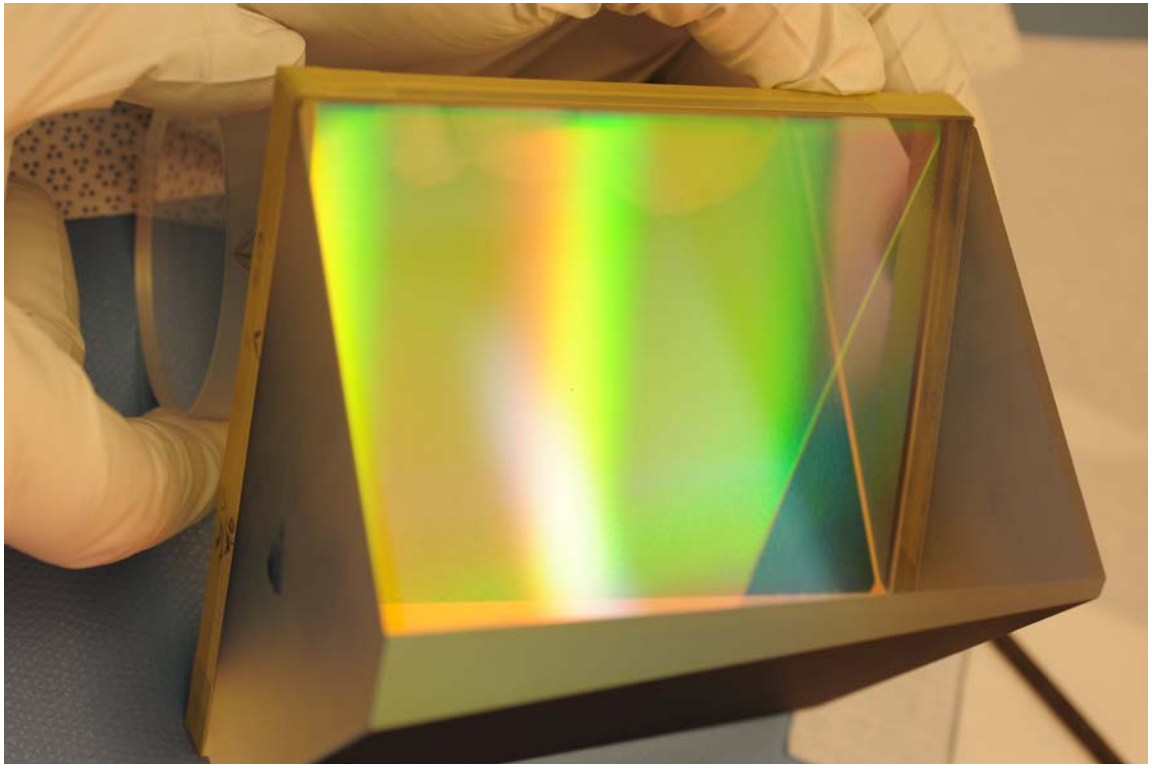
Immersed grating technologies (2)

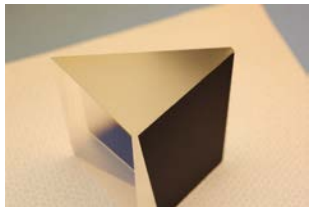




The magic of the optical contact technique grating supplied by Horiba (Jobin Yvon)

Immersed grating technologies (3)





The magic of the optical contact technique
grating supplied by Horiba (Jobin Yvon)

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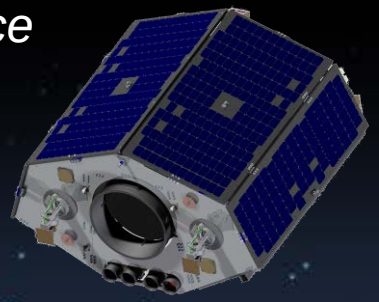

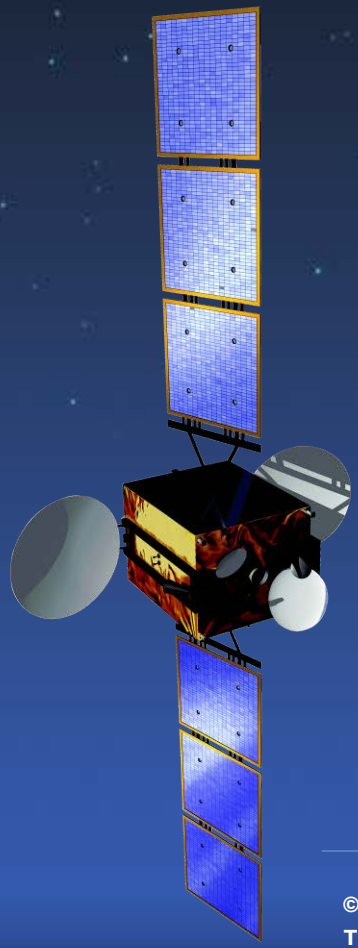

Thank you

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