

# STFC Research at the Centre for Advanced Instrumentation [excluding AO & MKIDS]

Ray Sharples

Centre for Advanced Instrumentation,  
Department of Physics,  
Durham University, UK

[r.m.sharples@durham.ac.uk](mailto:r.m.sharples@durham.ac.uk)

# Centre for Advanced Instrumentation Overview

66 Members:

7 Academic staff (+2 emeritus)  
17 Instrument scientists  
16 Engineers (optical, mech, elec, soft)  
4 Operations  
19 PhD students

- Astronomical Instrumentation
- Applied Optics & BioPhotonics
- Precision Optics Manufacture/Metrology
- Remote Sensing
- Fusion Diagnostics (EPSRC CDT)
- Gamma Ray Astronomy



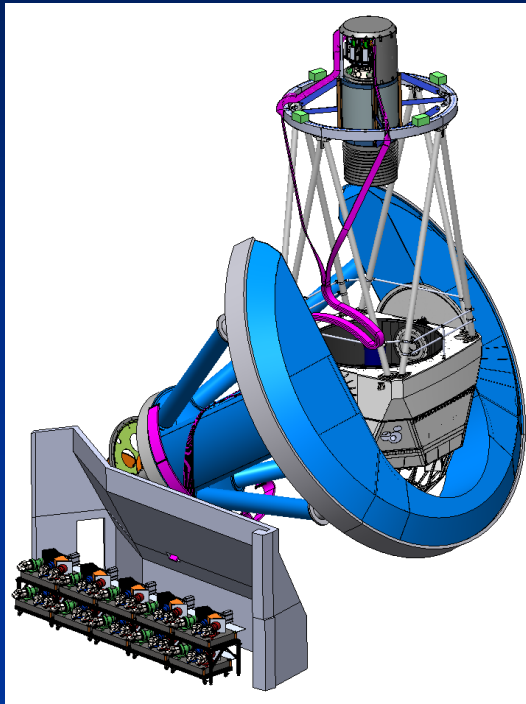
Ogden Centre West



NETpark Research Institute

# DESI: Dark Energy Spectroscopic Instrument

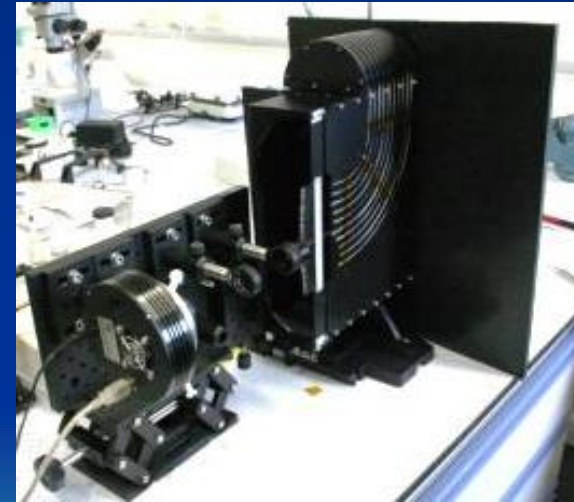
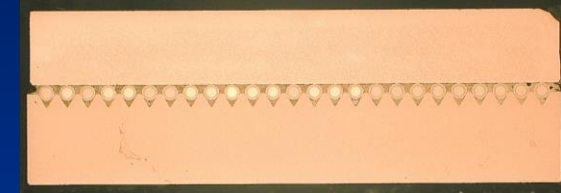
5000 fibres  
Mayall 4m KPNO  
3 deg<sup>2</sup> FoV



10 x 50m fibre cables

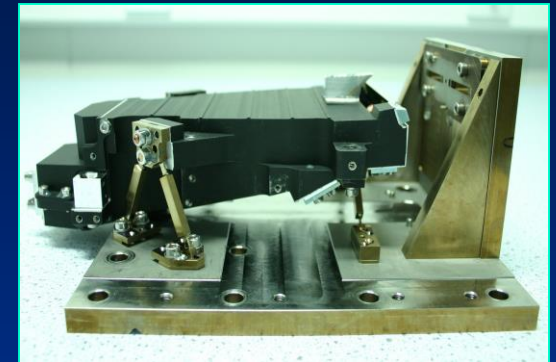


Spectrograph Slits



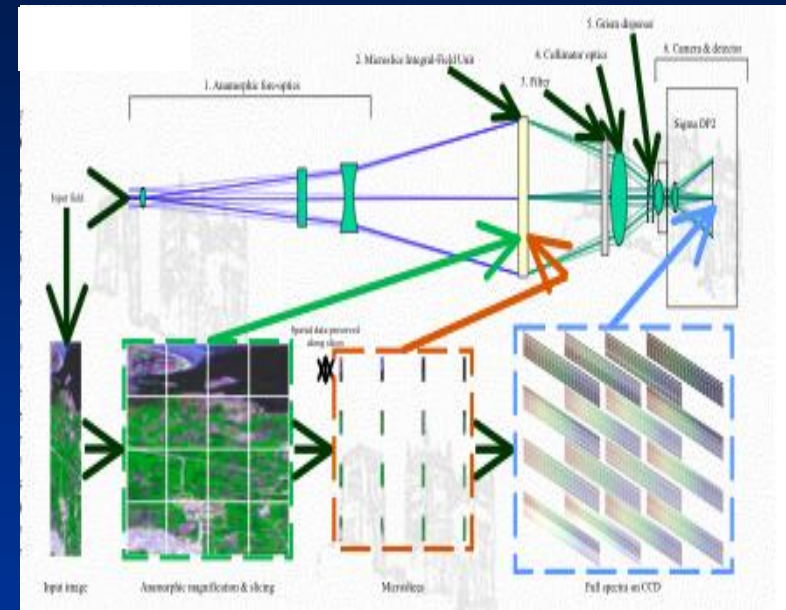
# JWST NIRSpec IFU

- Collaboration with Surrey Satellites Technology Ltd
- SSTL: Prime, Design, AIV
- CfAI: Consultant on Design, Manufacture, Thermal Vac Test
- Flight model at Northrop Grumman
- Launch 2018 2021



# Hyperspectral Imager (UKSA-CEOI)

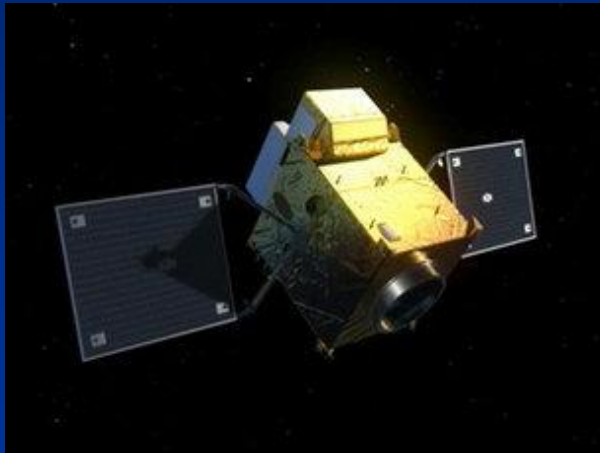
- Laboratory prototype of compact snapshot hyperspectral imager for remote sensing
- 'Microslice' technology demonstrator
- Funded as seedcorn project via Centre for Earth Observation Imaging (CEOI)
- Partner with Durham Geography Dept (Prof D Donoghue) for science exploitation
- Aimed at airborne (UAV, aircraft) and space (microsat) platforms (<5 kg)
- Content et al Remote Sensing Vol 5, 1204 (2013)



# Optical Ground Segment Equipment (with MSSL)

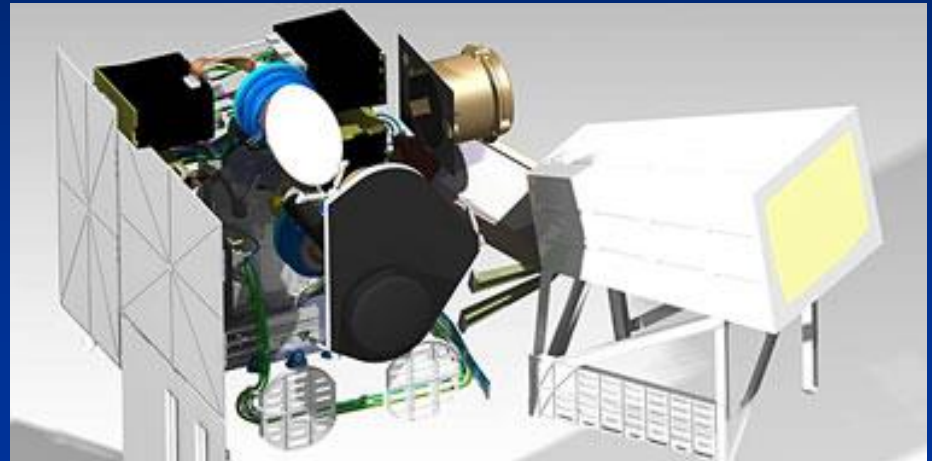
## Sentinel-4 (ESA)

Airbus D&S (Ottobrunn)



## METImage (DLR)

Airbus D&S (Friedrichshafen)



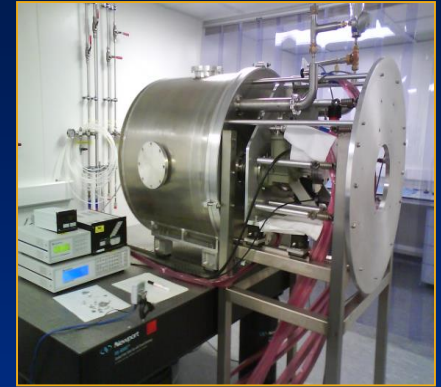
- Calibration and characterisation of ESA Sentinel-4 geostationary remote sensing satellite. Atmospheric pollution monitor.

- Alignment & calibration of DLR METImage multispectral imaging radiometer. Weather forecasting.

# Test & Verification Lab

## Other Testing Capabilities

- Clean Room (Class 1,000 with Class 100 area)
- Cryogenic Test Facilities (temperatures to  $<30\text{K}$ )
- Environmental Chamber (Temperature & Humidity Control)
- Flexure Test Rig (up to 4,000Kg)
- Optical/Infra-Red Test Cameras



Clean Room  
Cryo-Test Facility



Environmental Chamber



4Tonne Flexure Rig



Large Volume  
Cryo-Test Facility

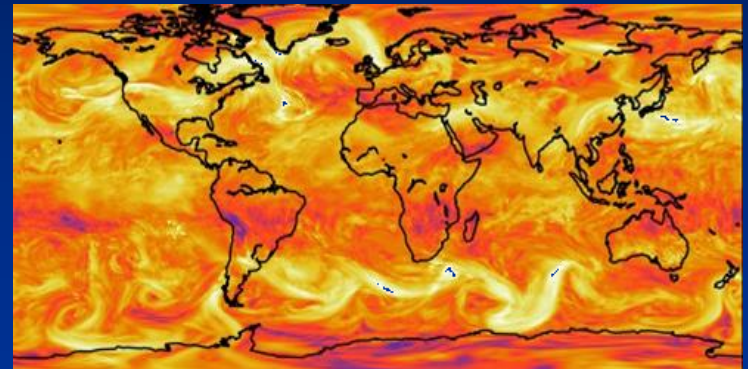
# Atmospheric Turbulence Characterisation / Mitigation for Free-Space Optical Communications



[james.osborn@durham.ac.uk](mailto:james.osborn@durham.ac.uk)  
<http://community.dur.ac.uk/james.osborn/>

- Turbulence characterisation beyond astronomical observatories
  - Low altitude
  - Urban
  - Daytime
  - Low elevation angles
- Instrumentation
- Theoretical Models
- Numerical Models, Simulation and Forecasts
- Mitigation
  - Adaptive Optics
  - Photonics
- Artificial Neural Networks

## Global turbulence forecasts



LATTE / CANAPY: Astronomical / Optical Communications test facility



Photo: Lisa Bardou

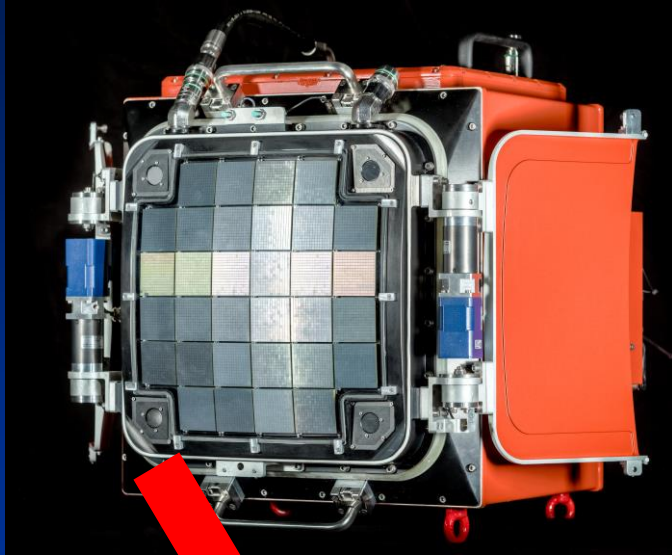


# Cherenkov Telescope Array

[p.m.chadwick@durham.ac.uk](mailto:p.m.chadwick@durham.ac.uk)



UK



Camera for the small (6m diameter!) telescopes – flatfielding system based on ns-pulsed, programmable UV LEDs. Use of these ‘flashers’ on board a UAV for inter-telescope array calibration.



Also UAV-based systems for calibrating IceCube and SKA...and for agriculture, e.g. spotting disease in coffee plants from the air.



# Precision Optics Manufacture



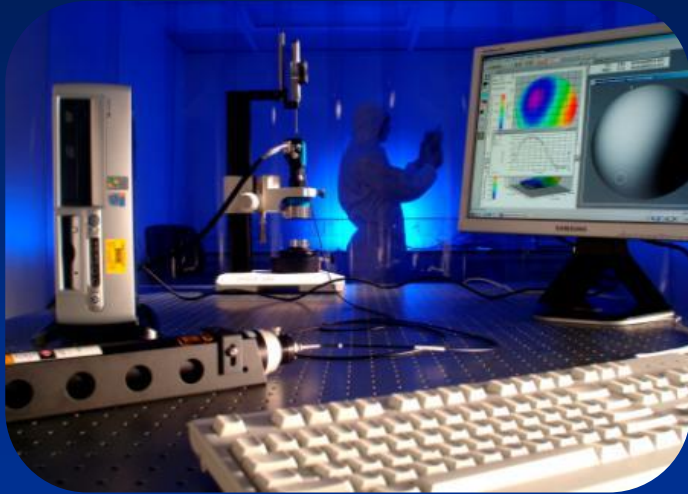
[cyril.bourgenot@durham.ac.uk](mailto:cyril.bourgenot@durham.ac.uk)

## Basic Specification

- 3-Axis Configuration (X, Z, C)
  - Workpiece Capacity :  $\phi$  250mm
- 5-Axis Configuration (X, Y, Z, B, C)
  - Workpiece Capacity :  $\phi$  500mm
- Programming Resolution
  - 1nm - Linear Axes
  - 0.036 arcsecs - C-axis
  - 0.02 arcsecs – B-Axis
- Feedback Resolution 0.034nm on linear axes



# Precision Optics Metrology



## Form Measurement

- Fisba Phase Shifting Interferometer (4 systems)
- Up to 100mm Full Aperture
- 5nm rms Resolution on Surface Form
- Plano, Spherical and Aspheric Modes

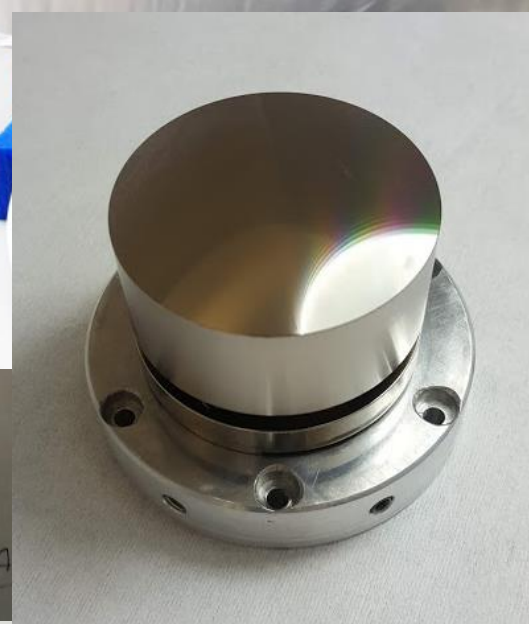
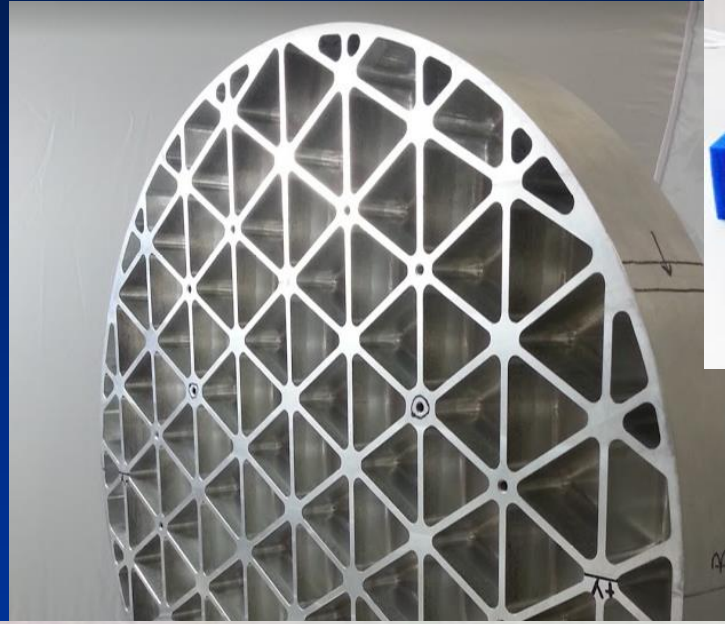


## Roughness/Step Height

- Zygo Scanning White Light Interferometer
- 0.1nm Height Resolution
- Surface Stitching allows 50mm x 50mm Area Measurement

# Precision Optics Applications

- Astronomy
- Space
- Car lighting
- Ophthalmic
- Laser Optics
- Gratings



# Selection of Current Projects

- Project 1 : PMMA Plasma mirrors with STFC RAL and U.Strathclyde
- Project 2 : LOCUS mission : “Linking Observations of Climate, the Upper atmosphere and Space Weather” with RAL SPACE
- Project 3 : High NA metallic focusing off axis parabola with STFC RAL
- Project 4 : Additive manufacturing of CubeSat mirrors with UKATC
- Project 5 : Development of freeform gratings - EPSRC

# Thank You

[www.dur.ac.uk/cfai](http://www.dur.ac.uk/cfai)