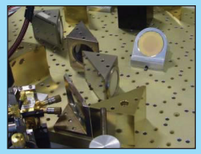
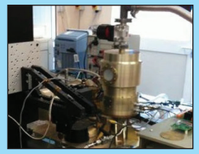
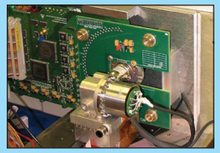
EO Enabling Technologies and Techniques:

- Very low loss filters at microwave and submillimetre wave frequencies exploiting computational electro magnetics, precision micromachining and mm-wave metrology.
- Stabilisation of 3.5 THz quantum-cascade laser local oscillators using Schottky diode technology for observation of the upper atmosphere.
- On-board processing requirements for IR Detectors and SAR instruments.
- Development of a wideband spectrometer for millimetre wave observations using an efficient FFT processing technique.

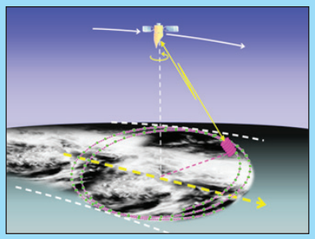
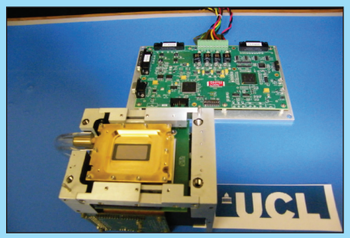
Project leads: Queens University Belfast, University of Leeds, Airbus DS; Leonardo; STAR-Dundee Ltd

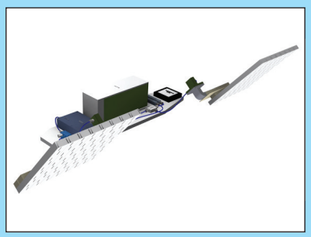





Investigation of Future Mission Concepts

- The Tropical Carbon Mission will provide unique observations of CO_2 over the tropics with the precision and frequency that are required by scientists and policy makers.
- WaveMill/SEASTAR is a mission to provide high-resolution wide-swath synoptic maps of global ocean surface currents from space
- WIVERN uses a conical scanning 94GHz radar to measure the Doppler shift from cloud particles to derive wind profiles within clouds.
- A low-cost EO mission to measure global wind fields (MISRlite/FLIRt) using uncooled very low mass thermal infra-red detectors
- A lightweight highly efficient radar instrument to provide ship position, detection, and tracking capabilities.

Project leads/partners: Univ. of Edinburgh, Leonardo, NOC, Univ of Reading, UCL/MSSL, Airbus DS, TAS-UK.



Capability Development

A major CEOI objective is to develop the highly skilled workforce and leadership necessary to maintain the UK at the forefront of the world-wide EO community. The CEOI technology and workshop programmes provide challenging opportunities for the academic and industrial community at all stages, from early stage training through to leadership development. CEOI funded projects are encouraged to use the development activities as a training opportunity for younger staff.

Further Information

More information is available at ceoi.ac.uk, or from the CEOI Director:

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UK SPACE AGENCY

Centre for EO Instrumentation

Developing New Technologies to Observe the Earth from Space

Credit ESA

The Centre for Earth Observation Instrumentation (CEOI) is funded by the UK Space Agency to advance the development of innovative instrumentation technologies for Earth observation and to maintain the UK position as a world-leader in Earth observation satellite technology.

The Centre was created in 2007 with the aim to develop key capabilities in EO instrumentation through the teaming of scientists and industrialists. The CEOI is a partnership led by Airbus DS together with the University of Leicester, STFC Rutherford Appleton Laboratory and QinetiQ.

In October 2016 when the CEOI contract was renewed by the UK Space Agency, the Minister of Science stated:

"The UK is already a world-leader in Earth observation satellites technology … this investment helps our sector keep the competitive edge in the design, development and build of instruments on future spacecraft."

The CEOI is focusing on development of technologies for ESA and for export, to maximise the return from the UK investment and to ensure that UK capability is enhanced, leading to important economic benefits.

Technology Programme

The development of new EO instruments and technologies is the main objective of the Centre, including projects carried out by the CEOI partners and those selected through a series of Technology Calls, with participation of many industrial and academic groups throughout the UK. The Centre has funded more than 50 new technologies, including instruments to measure air quality, monitor forests and climate change, and to increase our understanding of the polar regions, oceans and winds. Over the period 2017-2021, CEOI will be responsible for managing EO technology projects with a total value of up to £20m including industrial co-investment, ensuring the UK remains competitive in the global space sector, supporting a growing community of SMEs and maintaining a leading role for UK scientists.

Horizon Scanning

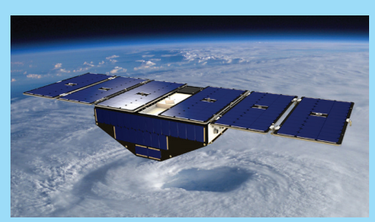
Challenge Workshops and Annual Conferences run by the Centre bring together technologists and scientists to identify future science and technology priorities for Earth observation instrumentation. The CEOI has a close working relationship with the National Centre for Earth Observation (NCEO), whose scientists play a key role in the success of the Challenge Workshops. In total the CEOI has held 25 Challenge Workshops, with participation from more than 400 scientists and technologists.

Leveraged Funding

Previous grant winners have achieved remarkable success by developing technologies and positioning UK industry to win more than £150 million in external European contracts over the 10 year period, giving an excellent return on government investment.

Airbus DS won a major ESA contract to develop the MWS Microwave Sounder for the MetOp Second Generation meteorology mission, utilising technology and capability developed under the CEOI technology programme.

Following CEOI funded technology projects, SSTL secured a 10 M€ ESA project to develop the short wave IR instrument for the Sentinel 5 Pre-cursor mission and a £5M contract to supply eight SGR-ReSI instruments for the NASA Cyclone Global Navigation Satellite System (CYGNSS) microsatellite constellation to monitor ocean surface winds near the centre of hurricanes.



Credit: NASA

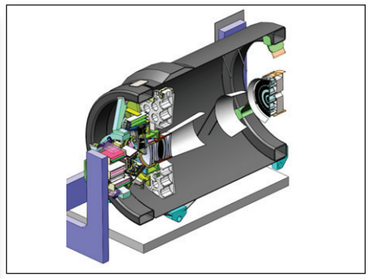
CEOI Technology Programme

The technology programme supports large Flagship projects, strategic Fast Track projects and smaller Pathfinder projects, selected through open technology calls to the EO community. The main technical drive has been to produce instruments and technologies for space applications, but in many cases the resulting technologies have non-space applications.

Low Cost Optical Imaging Technologies

SSTL is developing a high resolution optical imaging instrument for a constellation of low-cost spacecraft. The instrument uses advanced technologies for mirror manufacture, panchromatic CCD imagery and high-resolution video. The project is also developing technologies to handle the very high data throughput.

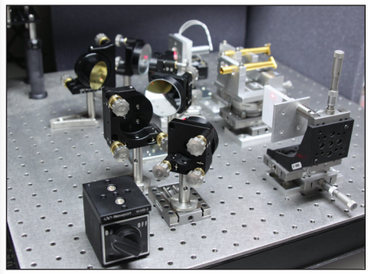
Project lead: SSTL



Passive Microwave and TeraHz Technologies

Projects are developing important technologies and capabilities needed for the next generation of microwave and THz instruments. These include the quasi-optics, mixers, receivers, on-board calibration scheme and the mechanical scanning mechanism for future meteorological missions. Next generation receivers at 1-5 THz with quantum cascade laser sources are being developed for climate monitoring missions.

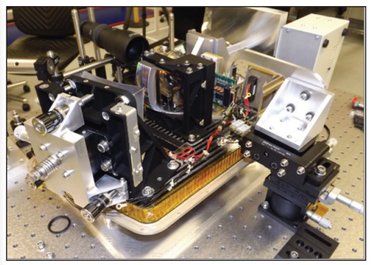
Project partners: STFC-RAL Space, UCL/MSSL, Airbus DS, Univ of Huddersfield, TAS-UK, JCR Systems and Star Dundee



CompAQS - UV/Visible Spectrometer For Monitoring Air Quality

Project to develop a compact optical ultraviolet-visible (UV/visible) spectro-photometer to measure regional air quality from space. Further development has led to the 'CityScan' project with terrestrial rooftop mounted spectrometer systems for the retrieval of 3D nitrogen dioxide and aerosol concentrations (420 to 590 nm) across whole urban areas every 10 minutes.

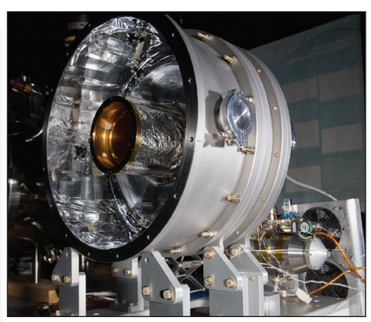
Project partners: University of Leicester with SSTL

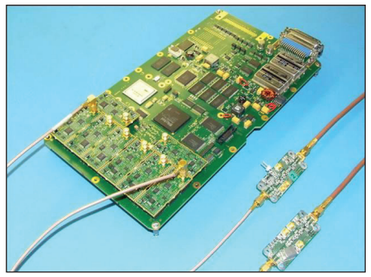


Technologies for the TRUTHS In-Flight Calibration System

The TRUTHS mission is designed to provide benchmark measurements of Earth and solar radiance to detect the fingerprint of climate change. The project is developing and demonstrating the vital and highly accurate on-board calibration system in a flight representative vacuum cryostat with an optimised Airbus DS Stirling cooler.

Project partners: National Physical Laboratory (NPL) with Airbus DS

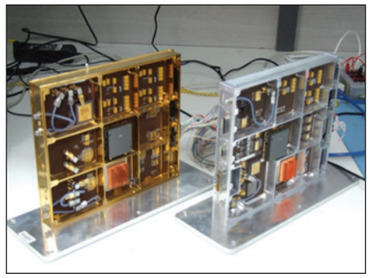




GNSS Reflectometry

This project has developed a flexible multi-channel receiver of reflected signals from GPS/ GNSS navigation satellites. Signals reflected from land, ice and ocean are analysed with an instrument flying on a separate small satellite to derive important scientific data on the nature of the reflecting surface and the atmosphere. The receiver was demonstrated on UK TechDemoSat-1 and is flying on the NASA CYGNSS constellation, measuring surface wind speeds near the centre of hurricanes.

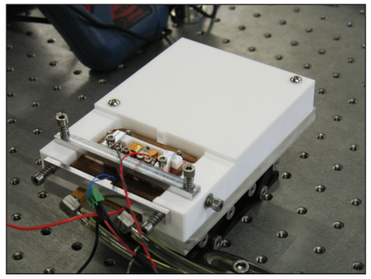
Project partners: SSTL with NOC, Universities of Surrey and Bath



Next Generation Radar Electronics

The project is carrying out research and critical developments of the next generation hardware for Synthetic Aperture Radar (SAR) missions. Developments include a new receive module with enhanced flexibility for low frequency radar operation, space qualification of Virtex-5 FPGA technology and development of an embedded radar control computer.

Project Lead: Airbus DS



High Resolution Radiometry In The Infra-Red

The Laser Heterodyne Radiometer uses a low-power, highly-stable quantum cascade laser to down-convert incoming infra-red radiation into the radio-frequency domain, providing high spectral resolution, sensitivity and spatial resolution. It utilises hollow optical waveguide technology to provide a highly robust and stable optical system.

Project partners: STFC-RAL Space with HollowGuide Ltd

Pathfinder Studies

These are smaller studies to investigate innovative ideas which can enable future EO missions. Example projects include:

Optical Technology:

- The use of immersed diffraction gratings or 'Grisms' to provide higher spectral resolution than conventional gratings of the same size
- Hollow optical waveguides to enable compact, low mass, low cost optical systems for optical and laser systems. They maintain alignment in harsh vibration and thermal environments.
- A study of an instrument using a precision image slicing mirror to reformat the focal plane and feed into a long-slit spectrometer, for use in climate monitoring
- Precision bonding of optical components.

Project partners: SSTL, STFC RAL, Hollowguide, STFC ATC, University of Durham, University of Glasgow, Gooch and Housego