Centre for
EO Instrumentation

4th CEOI Emerging Technologies Challenge Workshop

3rd/4th May 2017

Mick Johnson, Chris Brownsword

Workshop Objectives

To provide a forum for the presentation of new technology ideas for EO and an event to bring together the EO technology community

Main Topics

- Emerging technologies for EO instrumentation
- CEOI and UKSA Strategy for EO Technology 2017-2020
- Innovative new technologies for commercial EO missions
- New mission opportunities
- A look into the future
- Consultation on EO technology strategy

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Day 1: 3rd May 2017

Session 1: Welcome and introductions

9:30	Coffee & registration		
10:20	Introduction	Mick Johnson & Chris Brownsword	CEOI
10:40	Pathways for Broader Exploitation of EO Technologies	Robin Higgons	QI3

Session 2: CEOI Technology in Missions

11:00	GNSS Reflectometry for Global Ocean Wind Monitoring & Services: the UK TechDemoSat-1 Success Story	Christine Gommenginger (Spkr) & 3 Others	National Oceanography Centre
11:20	Tea & Coffee break		
11:40	SEASTAR: a New Satellite Mission Concept to Observe Sub-mesoscale Ocean Surface Currents & Atmosphere/Ocean Coupling	Christine Gommenginger (Spkr) & 4 Others	National Oceanography Centre
12:00	UrtheCast	Ryan Kraliz	SSTL
12:20	TRUTHS - Technology Demonstration	Lydia Zajiczek	NPL
12:40	Lunch		

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12:40	LUNCH		
SESSION 3: MINIATURE SYSTEMS			
13:30	LASER SOURCE DEVELOPMENT AT FRAUNHOFER CAP FOR LIDAR, REMOTE SPECTROSCOPY AND SPACE-BASED QUANTUM TECHNOLOGIES	LOYD MCKNIGHT	FRAUNHOFER INSTITUTE UK
13:50	DEVELOPMENT OF A SOLO SPECTROSCOPY GAS SENSOR IN THE MID-IR	STEPHEN SWEENEY	ZINIR
14:10	MINIATURIZED HIGH PERFORMANCE SPECTROMETERS FOR MICROSAT ATMOSPHERIC MISSION	DAMIEN WIEDMANN	STFC RAL SPACE
14:30	CUBESAT CAPABILITY – ENABLING EO MISSION COST REDUCTION	ALASDAIR GOW	CLYDE SPACE LIMITED
14:50	SINGLE-PIXEL CAMERA FOR REMOTE SENSING	WOJCIECH ROGA	STRATHCLYDE UNIVERSITY
15:10	COFFEE & TEA BREAK		
SESSION 4: CEOI & UKSA PLANS FOR THE NEXT 3-5 YEARS			
15:30	UKSA PLANS FOR EO	BETH GREENAWAY	UKSA
15:50	CEOI STRATEGY TOWARDS 2020 & BEYOND	MICK JOHNSON	CEOI
16:10	Q/A SESSION ON CEOI PLAN	ROB SCOTT (MOD)	CEOI
17:30	CLOSE OF DAY 1		
19:30	DINNER AT COSENER'S HOUSE		

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DAY 2 4TH MAY 2017

09:00	WELCOME	ROB SCOTT	STFC RAL SPACE
09:05	EO TECHNOLOGY NEEDS AT ESA	MASSIMILIANO PASTENA	EUROPEAN SPACE AGENCY
SESSION 5: INNOVATIVE MICROWAVE & RADAR DEVELOPMENTS			
9:30	NOVASAR	MARTIN COHEN	AIRBUS DEFENCE & SPACE
9:50	INNOVATIVE SAR TECHNOLOGY	DAVID HALL	AIRBUS DEFENCE & SPACE
10:10	94GHZ POLARISATION DIVERSITY DOPPLER RADAR TO OBSERVE GLOBAL IN-CLOUD WINDS	ILLINGWORTH/ BATTAGLIA	UNIVERSITY OF READING & UNIVERSITY OF LEICESTER RESP.
10:30	INSTRUMENTATION FOR 1-5 THZ HETERODYNE SOUNDERS	BRIAN ELLISON	STFC RAL SPACE
10:50	FILTERBANK SPECTROMETERS FOR HYPERSPECTRAL MICROWAVE ATMOSPHERIC SOUNDING (HYMAS)	PETER HARGRAVE	UNIVERSITY OF CARDIFF
11:10	TEA & COFFEE BREAK		
11:30	MICROWAVE RADIOMETRY FOR ACCURATE COASTAL ALTIMETRY	JANET CHARLTON	JCR SYSTEMS
SESSION 6: DETECTORS			
11:50	QUANTUM CASCADE LASERS FOR HETERODYNE TECHNIQUES	ALEX VALAVANIS	UNIVERSITY OF LEEDS
12:10	DETECTORS FOR MM WAVE & THZ	PETER HUGGARD	STFC RAL SPACE
12:30	LATEST DEVELOPMENTS AT LEONARDO IN IR DETECTION FOR EARTH OBSERVATION	PETER KNOWLES	LEONARDO
12:50	TECHNOLOGY DEVELOPMENTS IN EARTH OBSERVATION IMAGING	JOE GANNICLIFFE	TELEDYNE E2V
13:10	LUNCH		

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13:10	Lunch		
14:00	Low and High Voltage ASICS for Space Imaging	Nick Waltham	STFC RAL Space
Session 7: New Techniques and Future trends			
14:20	Plans for AIT & Cals at RAL's R100	Chris Mutlow	STFC RAL Space
14:40	Optical Metamaterials & Novel Techniques	Robert Lamb	Leonardo
15:00	Simulation Study For Ku-Band Microwave Radiometry Of The Polar Atmosphere	David Newnham	British Antarctic Survey
15:20	Innovative Materials for EO Missions & Beyond	Alex Brinkmeyer	Oxford Space Systems
15:40	Cold Atom Techniques in Gravity mapping	Tristan Valenzuela	STFC RAL Space
16:00	Tea/Coffee and posters		
16:20	Plenary Questions with the Speakers		
17:00	Close of Workshop		

CEOI Review - November 2015

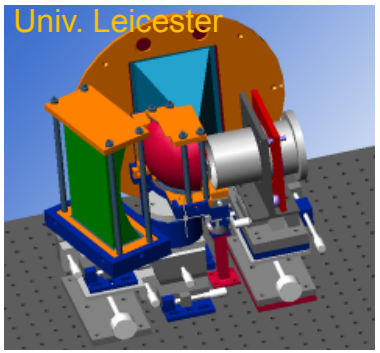
- Expert panel chaired by David Southwood:
  - "The panel believes that the programme has had a significance beyond its funding level."
  - "The community satisfaction with the programme seems close to exemplary."
- Some statistics:
  - £9.3M : Total project grant funding
  - £152M : Leveraged funding achieved
  - 16.3 : Return on government investment in the programme
  - 14 companies, 4 national institutions, 16 universities funded
  - 4 Patents
  - 185 scientific/technical papers
  - 18 Challenge workshops , >400 attendees from 100 organisations
  - 28 CASE and PhD students enabled

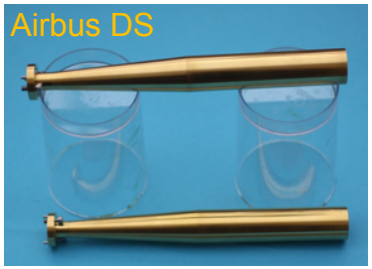
Current EO Landscape

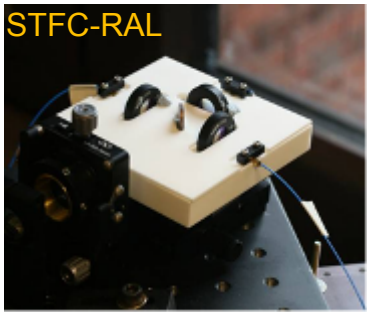
- ESA CMin 2016
  - UK equal largest contributor to EOEP-5
  - Technologies for ESA taking a higher priority
- Copernicus
  - Sentinel mission evolution
- UKSA EO strategy
  - Linking upstream developments to future downstream requirements
- Commercial EO - Space Growth Partnership
  - Commercial opportunities – national and global

CEOI - 2020 Vision

- To build a much strengthened UK EO technology capability, with enhanced breadth and depth:
- Organise technology calls and community events to strengthen academic/industry partnerships;
- Fund innovative technologies for global EO mission opportunities;
- Support developments for commercial exploitation opportunities;
- Maximise leverage of investment in EO from industry and elsewhere to create new UK jobs and economic growth.







Delivered by the established CEOI partnership

Science & Technology Facilities Council
Rutherford Appleton Laboratory

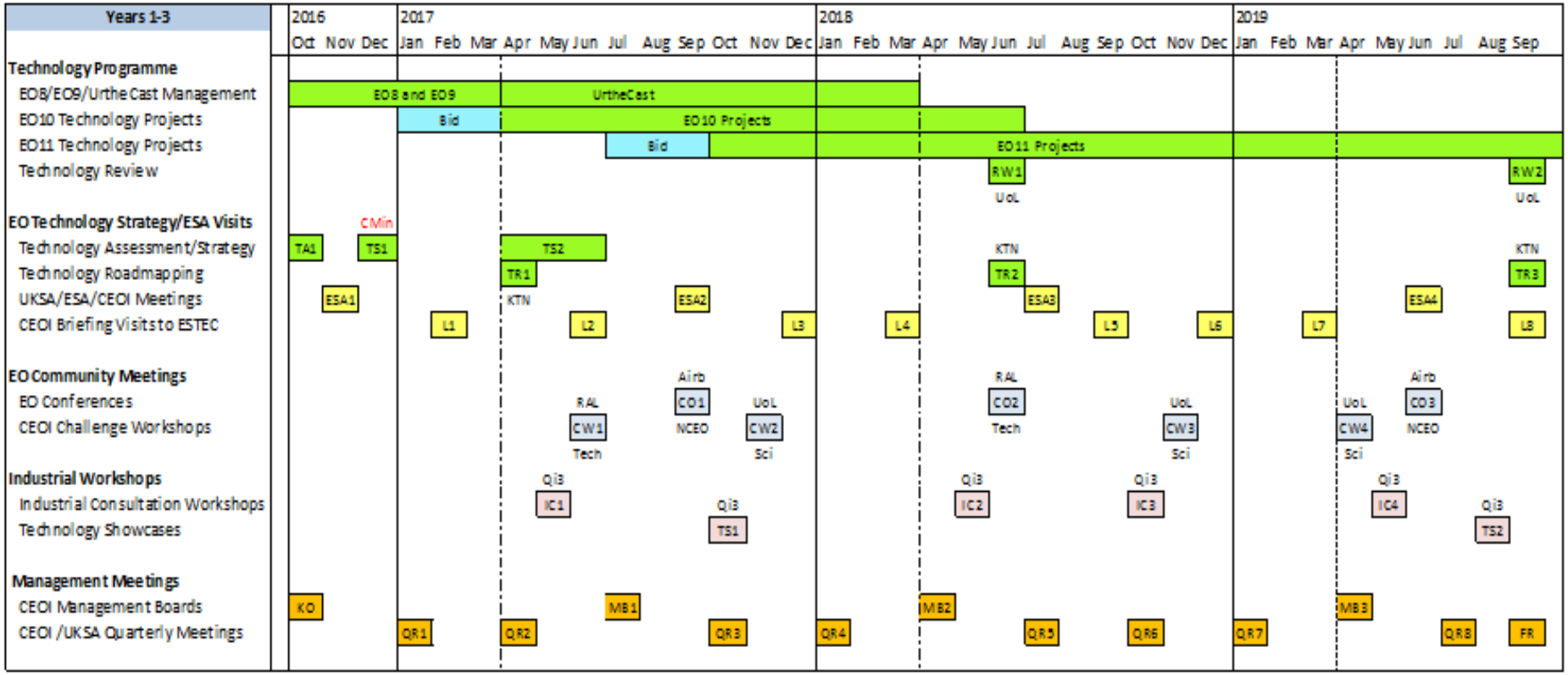
University of Leicester

QinetiQ

AIRBUS DEFENCE & SPACE

Detailed Plan for CEOI-2020

The first 3 years:



Added Value Program - Aims

- **To promote UK capabilities and technologies** within the UK to other government agencies, and internationally to ESA and other bodies
- To build a highly capable UK EO technology community, encouraging **academic/ industrial collaboration**
- To strengthen the contact between EO technologists with the scientists and other users of EO data**, to ensure the technology developments are well targeted**
- To **improve the understanding of the UK EO community** in the programmes and opportunities presented by ESA, the EU/Copernicus and other international programmes
- To **maximise the economic growth potential** resulting from an increasing UK capability in EO space instrumentation and technologies
- To enable **knowledge transfer** to and from the non-space industry so as to maximise the benefit from the investment and to improve the development of a skilled UK EO technology capability
- To provide **publicity for the achievements** of the UKSA funded EO technology programme

Added Value Program - Critical Elements

- **CEOI Challenge Workshops** draw through the drivers in each of the science, commercial or strategic areas and begin to assess the requirements for instrumentation and technology.
- **Knowledge Exchange,** events aim to ***publicise*** the outputs of CEOI to the non-space community.
- **Technology showcases** bring a wide mixture of technology providers and users together to drive tangible exploitation from the technology investments.
- **Engagement with industrial users** to understand future commercial EO requirements and how these may impact on EO instrument designs
- **Collaboration gearing** for growth activity by working with national and international bodies.

CEOI Programme for 2017

- **Industrial Consultation Workshop (6th April 2017)**
  - Focused workshop with 16-20 attendees from non-space community (CEOI Industry Club)
  - Theme is advanced manufacturing techniques for EO
- **Emerging Technologies Challenge Workshop (3rd and 4th May 2017)**
  - Targeting CEOI technology and EO science community, to investigate future needs and opportunities.
  - Expected attendance ~40-60
- **Joint Annual EO Science Conference with NCEO (27-30th June 2017)**
  - 100 EO scientists and 40 technologists
  - Venue is University of Bath
  - Call for Abstracts closes 12 May
- **CEOI Technology Showcase (autumn 2017)**
  - Joint event with Satellite Applications Catapult
  - To publicise the work of CEOI projects to broader space and non-space community (including ESA, InnovateUK, Research Councils, industry etc)

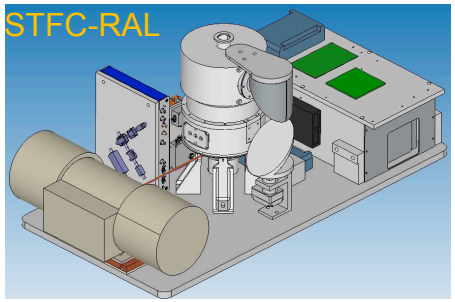
CEOI Meeting with ESA (22 March)

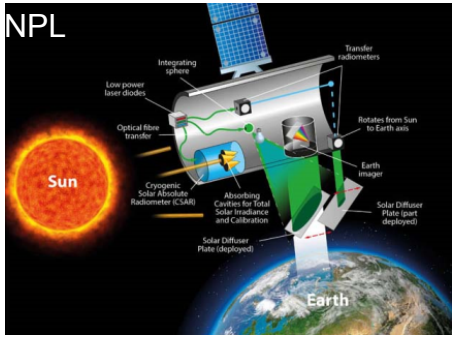
- Lots of interest from ESA (EO Future Programmes and DTEC).
  - Pierluigi Silvestrin, Jose Calles, Max Pastena plus ~6 others attended.
  - We have a number of new points of contact, follow up actions and opportunities for further interaction.
- CEOI collected a lot of information from the CEOI technology projects to present to ESA.
- Detailed presentation from ESA on their current plans for EOEP5 and related programmes (Including future Copernicus architecture, options for Sentinels 7-10 and the 2nd Generation Sentinels 1-5).
- ESA are putting significant funding into the GNSS-R, to build on the work that SSTL pioneered, with initial CEOI funding.
- CEOI will make more formal contact with the ESA DTEC, who are responsible for the TRP and GSTP technology programmes
- ESA are organising a CubeSat competition, offering I.0 ME for the 'best' CubeSat idea, with launch on VEGA.

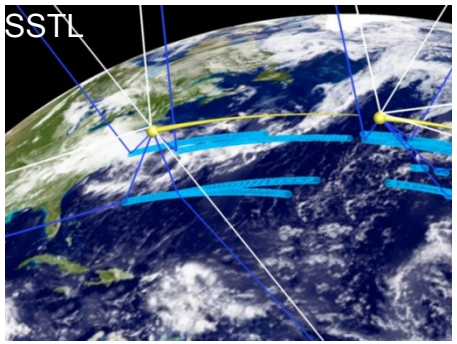
CEOI Technology Programme

Developing technologies for future EO missions

- UV/visible high resolution spectrometer
  - CompAQS instrument for air quality
- Advanced millimetre wave and TeraHz technologies
  - Microwave Sounder (MWS) for MetOp-2G
  - Development of LOCUS mission and technologies
- Climate and GHG Monitoring
  - In-orbit SI-traceable calibration (TRUTHS)
  - Technologies for CNES bilateral (MicroCarb)
- Advanced Radar Systems and Missions
  - Ocean currents and global winds
- GNSS reflectometry for sea surface winds
- Low cost EO imaging systems







Recent CEOI Calls

EO 8th Call – TRL raising

Project	Partners	Mission	Technology development
Compact Air Quality Spectrometer	University of Leicester, SSTL	Compact optical spectrometer for NO2 and aerosols	Advance design of structure, thermal control, focal plane & electronics; lab, airborne and environmental testing of "flight" system
Critical Technology Advancement of the LOCUS Mission	UCL, RAL STAR-Dundee, Leeds Univ, Glyndwr Univ, JCR Systems	Passive THz radiometry to measure Earth's Mesosphere and Lower Thermosphere	Verify payload performance, reduce power use, and environmental testing
Industrial Research for Next-generation Radar Electronics	Airbus Defence and Space	Develop Radar Electronics products to support a broader range of future missions	ICE Receive Module Developments Virtex-5 FPGA Qualification NIA Computer Breadboard Development
TRUTHS: Traceable Radiometry Underpinning Terrestrial and Helio Studies	NPL, Airbus DS Ltd	Benchmark measurements of incoming and outgoing radiation to support climate variability studies	Increasing TRL of the Cryogenic Solar Absolute Radiometer and the in-flight calibration system
Compact Infrared Imager and Radiometer	Univ Oxford, RALSpace Clyde Space Satellite Applications Catapult	6U CubeSat IR limb sounding spectrometer for water vapour and ozone	Feasibility study of the instrument design and performance

EO 9th Call – Earth Explorer 9 support

- Mission Preparation activities for candidate missions with a prospective UK PI or Co-PI
- Technology Development to de-risk/mature UK mission critical technologies
- 6 projects funded; TCM, OSCM, WIVERN, LOCUS, TRUTHS and SWIR detectors

CEOI 10th Call

Theme	Funding and Duration	Eligible Activities
New and innovative ideas for EO technology development	Fast Track grants of up to £200k, expected to be up to 15 months duration; Pathfinder grants of up to £75k, expected to be up to 9 months duration.	Feasibility studies Industrial research Experimental development
Achieving higher TRL through airborne demonstration	Flagship grants of up to £500K, normally expected to be up to 18 months duration	Industrial research Experimental development
Development of EO CubeSat flight model payloads for commercial service demonstration	Flagship grants of up to £500K, expected to be up to 18 months duration	Industrial research Experimental development

- ❑ % of EOIs becoming bids was comparatively high
- ❑ Good response ~ 4.5x over subscribed
- ❑ Independent Peer Review of proposals
- ❑ 18 projects funded, total grant £2.4M

CEOI 10th Call - Lessons Learned

Reviewers comments:

- "Generic, generalises risks without much thought to the project issues."
- "Schedule lacks detail; a few blocks end-to-end is not a Gantt chart"
- "The quality of proposals, especially PM issues, continues to decline. "
- Proposals often assume the reviewers know history – haven't shown clearly how this step will fit into the technology development story.
- Simplistic business plans – e.g. there is a global market £4B; we will win 1% ; therefore this business is worth £40M. Not convincing!

Improvement to CEOI AofO

- Tender launch meeting to educate community
- Ensure assessment criteria are independent of each other
- Clarify difference between partners and sub-contractors (suppliers of goods and services) - and impact on contributions
- Review ways to encourage partnerships e.g academic/industrial