Horizon 2020 Space – UK University/RTO Expertise & Interest

UK academia has traditionally been a very strong player in EU research funding, and their knowledge and expertise of the proposal process and coordination administration is a key and valuable asset. However, with the introduction of Horizon 2020 and its shift from science and research to innovation and demonstration, the importance of having a balanced consortium with a clear market potential and commercialisation route for the project's technology or service has never been greater. UK universities and research institutes can no longer act alone in EU funding, and need the market knowledge and experience industry can offer. Likewise, industry can often have little or no knowledge of the proposal process and don't have the resources or capability to write, submit or coordinate a proposal.

Please click on a title below, or click on the X to jump to the organisation's profile for that topic.

SPACE CALL TOPIC 2016/17	Aberystwyth University	Cardiff University	De Montfort University	Heriot-Watt University	National Centre for Earth Observation	Open University	Science and Technology Facilities Council	University College London	University of Bradford	University of Brighton	University of Glasgow	University of Kent	University of Leicester	University of Nottingham	University of Oxford	University of Portsmouth	University of Reading	University of Southampton	University of St Andrews	University of Surrey	University of the West of England, Bristol
EARTH OBSERVATION																					
EO-1-2016/17: Downstream applications	Х	Х			Х								Х	Χ	Х	Х	Х			Х	Х
EO-2-2016: Downstream services for public authorities	Х	Х			Х								Х	Χ	Х	Х	Х			Х	Х
EO-3-2016: Evolution of Copernicus services	Х				Х								Х	Χ	Х		Х			Х	Х
EO-2-2017: EO Big Data Shift	Х				Х		Х		Х				Х	Χ	Х	Х	Х			Х	Х
APPLICATIONS IN SATELLITE NAVIGATION																					
GALILEO-1-2017: EGNSS Transport applications			Х											Χ							
GALILEO-2-2017: EGNSS mass market applications			Х											Х							
GALILEO-3-2017: EGNSS professional applications			Х											Х							
GALILEO-4-2017: EGNSS awareness raising and capacity building			Х											X							
COMPETITIVENESS OF THE EUROPEAN SPACE SECTOR																					
COMPET-1-2016: Technologies for European non- dependence and competitiveness	х	х					х		Х	х			х							X	
COMPET-2-2016: Maturing satellite communication technologies				Х			x					X	х		X					X	
COMPET-3-2016: SRC – In-Space electrical propulsion and station keeping																		X		X	
COMPET-4-2016: SRC – Space Robotics Technologies	Χ			Χ			Χ					Χ	Χ		Χ					Χ	
COMPET-5-2016: Scientific instrumentation	Χ	Х		Χ		Χ	Х	Х		Х	Χ	Χ	Χ		Χ	Х				Χ	
COMPET-1-2017: Technologies for European non- dependence and competitiveness										x			Х							X	
COMPET-2-2017: Competitiveness in Earth observation mission technologies		X					X	Х					Х		X					X	
COMPET-3-2017: High speed data chain									Х				Х		Х					Х	
COMPET-4-2017: Scientific data exploitation	X	X			Х	Х	Χ		Х		Х		Х	Χ	Х	Х	Х		Х	Х	
COMPET-5-2017: Space Weather	X					Х	Х				Х		Х	X	Χ		X	Х	X	Х	

Earth Observation

The profiles under the heading *Earth Observation* have relevance to the following topics:

- EO-1-2016/2017: Downstream applications
- EO-2-2016: Downstream services for public authorities
- EO-3-2016: Evolution of Copernicus services
- EO-2-2017: EO big data shift

An outline of *Earth Observation* resources and expertise can be found below from the following organisations:

- <u>Aberystwyth University</u>
- <u>Cardiff University</u>
- <u>National Centre for Earth Observation</u>
- <u>Science and Technology Facilities Council</u>
- <u>University of Bradford</u>
- University of Leicester
- <u>University of Nottingham</u>
- University of Oxford
- <u>University of Portsmouth</u>
- <u>University of Reading</u>
- University of Surrey
- University of West of England, Bristol

Aberystwyth University

The Earth Observation and Ecosystem Dynamics (EOED) Laboratory are internationally recognised for their expertise in open source software development and large scale data processing with the field of remote sensing and earth observation. EOED are primarily focused on the application of remotely sensed data for terrestrial (primarily vegetation) studies, with current projects spanning the globe. EOED led on the development of the National Phase 1 habitat map for Wales and have worked with the governments in New Zealand and Queensland in their national mapping programmes. For example, EOED have provided key software tools for producing the current forest height and structure map for Australia (30 m resolution), atmospheric correction tools that are being used widely and expertise and software tools for image processing, object oriented classification and change detection which are being used to build monitoring systems, such as the Global Mangrove Watch. EOED have a strong track record in implementing EO systems using high performance computing (HPC) and 'big data' well beyond the capabilities of the off the shelve EO software.

EOED have specific expertise in:

- Land cover / habitat classification and monitoring using EO data
- Retrievals of Energy Fluxes & Soil Moisture using EO data
- Habitat suitability modelling and fusion / parameterisation with EO data
- Large scale LiDAR data processing and analysis including full waveform
- Estimation of above ground biomass and forest growth modelling

We also have a large equipment pool, including multiple UAV's (fixed wing and multicopter) with many instruments which can be flown on these platforms.

EOED is part of the Aberystwyth Centre for Space and Earth Monitoring (ACSEM; http://www.aber.ac.uk/acsem/). More information is available from http://www.aber.ac.uk/en/iges/research-groups/earth-observation-laboratory/

Cardiff University

- EO instrumentation concept, modelling, design, build
- Overall system design, detectors, optics, cryogenics, filters, readout, etc.
- Particular expertise in IR/FIR/sub-mm
- Icecloud observation instrument concept
- Temperature & humidity sounding (meteorology) instrument concept

National Centre for Earth Observation

NCEO is a NERC research centre with more than 80 scientists distributed across leading UK universities and research organisations and led by Professor John Remedios at the University of Leicester.

NCEO provides the UK with core expertise in:

- Earth observation science
- Earth observation data sets and merging techniques
- Model evaluation using Earth observation data and data assimilation methods to underpin Earth system research.

NCEO provides a key component of the UK's international contribution to environmental science.

NCEO scientists have expertise across the complete range of Copernicus services focusing particularly on land, ocean, atmosphere, climate and emergency management. In principle, therefore, NCEO scientists and facilities managed by NCEO (Centre for Environmental Data Archival, Field Spectroscopy Facility and NERC Earth Observation Data Acquisition and Analysis Service) could contribute to a wide range of applications and services, including big data.

Science and Technology Facilities Council

Data archive capabilities – Victoria Bennett

University of Bradford

Cloud computing expert to manage Big data processing in real time

University of Leicester

Our **Earth observation science** expertise is internationally recognised with research into remote sensing, atmospheric and surface science. Using satellite data, the University studies key challenges such as climate change, air quality and monitoring of land use. It

carries out research into the design, build, data analysis and use of sophisticated sensors to support EO missions.

(see <u>www.le.ac./space</u> for further details and detailed contacts)

The University has considerable expertise in large data sets and analysis. Latter includes Mathematics and Computer Science Departments. Specific interests include:

- Land cover, forest monitoring and other land surface applications of EO
- LiDAR, SAR and optical as well as hyperspectral remote sensing applications
- Sentinel-1 and 2 monitoring application development and validation
- Copernicus land monitoring service and its evolution

University of Nottingham

The Nottingham Geospatial Institute (NGI) is a leading cross-disciplinary research and postgraduate teaching institute at The University of Nottingham. It brings together the expertise of the Faculty of Engineering and the School of Geography on our campuses in the UK and China. In addition, it provides support to start-ups, SMEs and companies through its knowledge transfer unit GRACE.

The NGI is able to provide expertise in:

- Environmental monitoring
- Health monitoring of structures and Building Information Monitoring
- Photogrammetry
- Remote sensing, (digital, multi-spectral, conventional imagery, terrestrial laser scanning) through space-based, airbourne (including UAVs) and terrestrial systems
- Novel use of Copernicus I data for land deformation monitoring
- Sensor integration
- Geoinformatics and data modelling
- Algorithm development
- System optimisation
- Geospatial intelligence
- Open source GIS
- Location based services
- Computer visualisation
- Semantics, including open or crowd sourced data and software
- Reasoning and cognition

The cross-disciplinary research of the NGI supports the following application-focussed themes:

- Disaster response and mitigation
- Environmental monitoring
- Global food security
- Integrated transport

University of Oxford

- Atmospheric remote sensing of temperatures, composition and aerosols
- Surface observation (ocean, biosphere, GIS)
- Geophysics (tectonics, volcanism, data pipelines)
- Computer science: Big data shift
- Testing facilities (https://www2.physics.ox.ac.uk/enterprise/services-and-specialist-equipment/space-instruments)

University of Portsmouth

Institute of Cosmology and Gravitation: The ICG is engaged in a "citizen science" project partnered with Hampshire County Council explore the use of satellite imaging for determining land-use. We have expertise in running citizen science projects, handling of large imaging data, and explore citizen science as a tool for public engagement.

University of Reading

The University of Reading (Institute for Environmental Analytics) has considerable expertise in exploiting EO data, both in terms of scientific application (e.g. through the National Centre for Earth Observation) and the early-stage development of services, working with commercial partners.

The University has recently formed the Institute for Environmental Analytics with some of these partners to better enable the exploitation of EO data in the public and private sectors. The IEA includes "big data" expertise and is involved in a number of projects to design and build infrastructures for better EO data exploitation.

University of Surrey

Earth Observation applications, with a particular emphasis on the use of SAR (EO-1-2016/17; EO-2-2016; EO-3-2016; EO-2-2017; COMPET-4-2017)

University of the West of England, Bristol

European Smart Cities Innovation – challenge the delivery of public services is undergoing fundamental transformation stimulated by both internal management reform and external technological ICT innovation. Internal management reform is a response to the complexity of city management, a challenge too great for expert topdown governance alone. The stimulation of bottom-up ideas as well as top-down sponsoring and steering embodied in open urban governance and the integrated management approach, is now accepted as an essential framework for the definition of co-ordinated policy models securing sustainable urban development.

Opportunity - ICT driven technological innovation provides the essential catalyst for the realisation of the full potential of open integrated urban development at the local scale, by leveraging social networking, crowd sourcing and collaborative ICT technologies. This bottom-up engagement with urban stakeholders secures not only greater understanding of complex city processes, but also enhanced citizen empowerment, and democratic legitimacy for the challenge of change. Bottom-up engagement is now viewed as an essential dimension of city management. Open urban governance, developed in the context of European Smart Cities research and peer reviewed publication, aims to secure the full deployment of ICT tools embedded within existing systems of urban governance, to support collaborative e-governance and policy modeling, and to offer in-depth analysis of local assets and needs, as expressed by the local community.

Focus:

- Targets EU Copernicus Land monitoring system, extending the in-situ components of Copernicus Urban Atlas applications through the empowerment of citizens and citizen associations in decision-making and co-production of city region strategies and action plans, supporting smart, green and inclusive growth;
- Extends the operational capacity of the Urban Atlas and generates geospatial assessment methodologies and applications to specify the development potential of urban land;
- Facilitates the development of common solutions, based on breakthrough applications conceptualised as common and generic ICT applications applicable to the 695 Urban Atlas cities throughout Europe (EU investment 87meuro 2014-2020);
- Develops a sustainable business model based on highly effective ICT enabled userdefined solutions, supporting a knowledge-based economy driven by SME's, and the exponential take-up of the policy making tools developed (Copernicus Programme 48,000 jobs 2030)

EU Research - selected

- URBIS urban vacant land applications for urban atlas (ICT-PSP, European Commission, 2014 2017)
- **DECUMANUS** EO and smart city applications (FP7 Space call, European Commission, 2013 2016)
- urbanApi urban planning tools and intelligence (FP7 DG INFSO, European Commission, 2011 – 2014)

- Lifewatch Biodiversity infrastructure service plan (FP7, European Commission 2008 2011)
- **HUMBOLDT** Data Harmonisation and Service Integration (FP6, European Commission, 2006 2010)
- **BOSS4GMES** integrated sustainable services for GMES (FP6, European Commission, 2006 2009)
- European Topic Centre -- Spatial Information Analysis (ETC-SIA) Scientific support for European Environment Agency urban programme (European Environment Agency, 2011 - 2014)
- **GSELand Information Services** (European Space Agency, 2006 2008)
- IntelCities Integrated Project (FP6 European Commission, 2004 2006)
- **GMES Global Monitoring for Urban Europe** (European Space Agency, 2003 2005)

Satellite Navigation

The profiles under the heading Satellite Navigation have relevance to the following topics:

- GALILEO-1-2017: EGNSS transport applications
- GALILEO-2-2017: EGNSS mass market applications
- GALILEO-3-2017: EGNSS professional applications
- GALILEO-4-2017: EGNSS awareness raising and capacity building

An outline of *Satellite Navigation* resources and expertise can be found below from the following organisations:

- <u>De Montfort University</u>
- <u>University of Nottingham</u>

De Montfort University

We have particular expertise in the commercial exploitation of Global Navigation Satellite Systems (GNSS) data. Designing systems that use GNSS modules, covering both hardware and embedded software. Applications include asset tracking, location and recovery; assisted living for dementia sufferers; and distributed environmental monitoring. We also assisted with the development of the RF components, and the embedded Software Defined Radio for the first commercially available multiconstellation GNSS receiver for NSL Ltd.

We have worked with industry and other academic partners to commercially exploit GNSS data. Projects include:

AutoTxt – the first vehicle alarm, immobilisation and recovery system that met the Thatcham Cat 5 requirement for a factory fitted device. We also developed line-side testing of Autotxt for Aston Martin

PRIMO – a KTP with NSL Ltd which developed the first multi-constellation GNSS receiver for GALILEO/GPS/COMPASS and SBAS data by the used of Software Defined Radio

iCARE – A TSB collaborative project that integrated disparate assisted living devices on to a single platform for inter-operability. This included the use of GNSS devices to locate people suffering from dementia who have wandered. Trialled with Leicester City Council.

Ringtrack – a KTP to assist with the development of commercial applications to operate on the Ringtrack Telematics Platform, which is one of the most compact GNSS enabled telematics platform available on the market.

MoTECH – design consultancy to validate the design of a GNSS enabled mobile telecare device, now in production

iTRAQ – a highly innovative system that uses GNSS derived congestion data to deliver intelligent traffic management that balances the need to reduce congestion with air quality enhancement. Now the basis of a major H2020 bid entitled INTRAMO Galileo Masters – not a project but an award – UK & Eire regional Winner 2007 for the proposal to use GNSS as part of a mobile telecare system. EU runner up.

https://www.dmu.ac.uk/business-services/a-z-business-services/technology/telematicsand-satellite-navigation-applications.aspx

University of Nottingham

The Nottingham Geospatial Institute (NGI) has been involved in the development of the European GNSS programme since its inception. The Nottingham Geospatial Building was

built as a test facility for satellite positioning and navigation technologies. It incorporates a roof-top testing track for GNSS and INS, and a simulation laboratory.

The core of Institute research activity in this area has traditionally focused around satellite navigation and positioning systems.

More recently, this has expanded with R&D into ubiquitous positioning and navigation technologies using: different grades of inertial sensors; signals of opportunity, for example: Locatalites, pseudolites, Ultra-wide band, GSM/GPRS, Wi-Fi, DAB, DTV, IMES, Bluetooth, and computer vision systems.

EGNSS awareness raising and capacity building

The NGI works with UK and European partners to provide professional training and awareness courses in GNSS and Geospatial Technologies for specific sectors of industry. It has experience of running a range of courses form half-day introduction workshops to MSc level training modules adapted to user needs. These have been carried out at the NGIs own training centre and across Europe.

Current research ranges from fundamental science to wider engineering and environmental applications, with an ever increasing diversity, from network-based GNSS RTK, Precise Point Positioning, software receiver engineering, and mobile phone applications, to imagery and communications based positioning and navigation.

The NGI is able to provide expertise and testing facilities for:

- Multi-constellation satellite navigation and other positioning systems
- Integration of sensors and multi-GNSS constellations with signals of opportunity
- Ubiquitous positioning from low-cost to ultra high precision positioning and navigation solutions
- Software defined receivers
- Development of advanced algorithms
- Wider exploration of bioscience, engineering and environmental applications

Each of these topics supports the NGIs main application themes:

- Disaster response and mitigation
- Environmental monitoring
- Global food security including precision agriculture and machine control)
- Integrated transport (including autonomous systems)

Since 2002 the NGI has hosted **BIGF**, a unique archive of RINEX format GNSS data, metadata and derivative products for use in research, funded by NERC. This provides 15 minute interval updates of atmospheric water vapour across the UK.

Telecommunication

The profiles under the heading *Telecommunication* have relevance to the following topic:

• COMPET-2-2016: Maturing satellite communication technologies

An outline of *Telecommunication* resources and expertise can be found below from the following organisations:

- Heriot-Watt University
- <u>Science and Technology Facilities Council</u>
- University of Kent
- University of Leicester
- University of Oxford
- <u>University of Surrey</u>

Heriot-Watt University

Expertise in RF, mm-wave and antenna engineering including:

- Multibeam antenna technology
- Power handling and multipactor
- Filter diplexer and multiplexer technology
- Small cubesat antennas
- VHF/UHF components
- Ground segment RF electronics and antennas (Ka-band solid-state power amplifier, Ku-/Ka-band flat scanning antennas)

Science and Technology Facilities Council

Propagation science for high frequency (Q/V/W-band) communications – Spiros Ventouras

University of Kent

Professor Gao has expertise in space antennas, smart antennas, phased arrays, reflect arrays, microwave and millimter-wave antennas, and microwave power amplifiers.

He has strong links with business and a good track record of EU expertise:

- Millimeter-wave intelligent array antennas for next-generation mobile satellite communications (FLEXWIN, funded by European Union FP7 ICT Program)
- Advanced reflectarray antennas for space-borne synthetic aperture radars (funded by the Royal Academy of Engineering, UK)
- Gallium Nitride integrated millimeter-wave active phased array multi-beam transceivers for SATellites (GaNSat, funded by European Union FP7 Space Programme)
- Digital Beamforming Synthetic Aperture Radars onboard micro-satellites constellations (DIFFERENT, funded by EU FP7 Space Programme)

Professor Gao's academic profile can be viewed here: https://www.eda.kent.ac.uk/school/staff_detail.aspx?pid=95

University of Leicester

The University is home to wide-ranging engineering expertise of relevance to Space and other applications including embedded (FPGA and processor) systems.

University of Oxford

- Metamaterials,
- Optical wireless communications
- RF and Microwave systems & antennae
- Ultrawideband communications
- Anechoic chamber for antennae testing

University of Surrey

5G Innovation (COMPET-2-2016)

Space Technology

The profiles under the heading *Space Technology* have relevance to the following topics:

- COMPET-1-2016/2017: Technologies for European non-dependence and competitiveness
- COMPET-3-2016: Electronic propulsion
- COMPET-4-2016: Space robotics technologies
- COMPET-2-2017: Competitiveness in Earth observation mission technologies
- COMPET-3-2017: High speed data chain

An outline of *Space Technology* resources and expertise can be found below from the following organisations:

- <u>Aberystwyth University</u>
- <u>Cardiff University</u>
- Heriot-Watt University
- <u>Science and Technology Facilities Council</u>
- University College London
- University of Bradford
- University of Kent
- University of Leicester
- University of Brighton
- University of Glasgow
- University of Oxford
- University of Southampton
- <u>University of Surrey</u>

Aberystwyth University

The Space Robotics research group at Aberystwyth University has been involved in space robotics since the days of the Beagle 2 mission, in which we were responsible for the modelling, calibration and commanding of the lander's robotic arm. Since then we have sought to build up our capabilities and infrastructure in space robotics, and now we are able to play a role in major space missions such as ExoMars. The Space Robotics group is part of the Intelligent Robotics group within the Institute of Maths, Physics and Computer Science, and draws on the expertise and facilities of the wider organisation. It also forms part of the Aberystwyth Centre for Space and Earth Monitoring (ACSEM).

Much of our activity is cross-disciplinary. Collectively, we have specific interest and expertise in the following main areas:

- Kinematic simulation and calibration of robotic manipulators
- Radiometric calibration and data processing for imaging systems
- Multispectral and hyperspectral imaging systems (for planetary science, exobiology and precision agriculture)
- Illumination models, shape-from-shading and photometric stereo (including generating terrain models from planetary satellite imagery)
- Autonomous planetary science (science target assessment, instrument deployment, sample retrieval)
- Visual navigation (using both conventional and panoramic cameras)
- Autonomous power management and longevity

Our involvement in many large, collaborative projects has given us a wealth of experience in practical robotics. We have a number of significant resources available for helping to conduct experimental studies both in the laboratory and outside on field trials, including:

- Mars analogue terrain laboratory (with simulated regolith & tracking system)
- Large (outdoor, all-terrain) and small (in-lab) rover vehicles
- Camera systems (ExoMars PanCam emulator; hyperspectral camera prototype)
- Machine workshop (capable of producing precision optical and mechanical systems for prototyping, development and testing activities)
- Field trial support van (transport, communications, power, accommodation)
- Outdoor mobile laser scanning capabilities (on land and sea)

Our association with the Physics department gives us access to further expertise and equipment, including low temperature and vacuum systems, which can be used to probe the properties of materials and small items under space-like conditions.

The Space Physics group has substantial expertise in modelling the effects of the radiation in the space environment on satellite instrumentation, as witnesses by our UKSA funded work optimising the radiation shielding for the six instruments comprising the PEP Particle environment Package on JUICE, the ESA flagship mission to the icy moons of Jupiter.

Cardiff University

Detector expertise. Leading EU-FP7 project "SPACEKIDS" and led ESA review on novel TIR detectors for satellite applications. Running current ESA contract on low dark current MCT arrays. Development of Type-II superlattice arrays.

Heriot-Watt University

Robotics expertise in autonomy; control; robot motion planning; human-robot cooperation; robot safety; AUV fault diagnosis and recovery; Human-Robot Interaction; Evolutionary Robotics; Swarm Robotics; Biologically-Inspired Controllers; machine learning; reconfigurable mechanisms and robots; compliant mechanisms; haptic interfaces; micromanipulation.

University College London

Physics & Astronomy Department:

- a) Optical metrology OSL (Optical Science Laboratory)
- b) Infrared spectroscopy and calibration measurements

University of Bradford

- Building complex simulation which require extreme computing to process them
- Machine learning to find data patterns

University of Kent

Professor Gao has expertise in space antennas, smart antennas, phased arrays, reflect arrays, microwave and millimter-wave antennas, and microwave power amplifiers.

He has strong links with business and a good track record of EU expertise:

- Millimeter-wave intelligent array antennas for next-generation mobile satellite communications (FLEXWIN, funded by European Union FP7 ICT Program)
- Advanced reflectarray antennas for space-borne synthetic aperture radars (funded by the Royal Academy of Engineering, UK)
- Gallium Nitride integrated millimeter-wave active phased array multi-beam transceivers for SATellites (GaNSat, funded by European Union FP7 Space Programme)

• Digital Beamforming Synthetic Aperture Radars onboard micro-satellites constellations (DIFFERENT, funded by EU FP7 Space Programme)

University of Leicester

The University is home to wide-ranging engineering expertise of relevance to Space and other applications including: mechanical, thermal and optical engineering; space nuclear power systems; orbital and radiation analysis; digital and analogue electronics (including high speed electronics), and embedded (FPGA and processor) systems. Space Research Centre's expertise includes concepts for the next generation of instrumentation, tools and techniques for surface planetary science which may have applications to robotics. Science activities, see Space Exploration and Science) may also have such applications. **(see www.le.ac./space for further details and detailed contacts)**

Science and Technology Facilities Council

- Bespoke electronics for use with detector arrays Nick Waltham
- Field trials for autonomous robotic operations Rain Irshad
- Advanced optics and electronics for EO systems using TDI, large focal planes & hyperspectral imaging – Nick Waltham
- Atmospheric sounding instruments development Brian Ellison/Damien Weidmann

University of Brighton

School CEM: We are expert in thermal management of space components. We are particularly expert in two-phase passive systems such as heat pipes, loop heat pipes. We are carrying out experimental tests, and also design and simulations of the thermal systems. We are using our own codes, but we may use also standard software such as SINDA/FLUINT and ESATAN.

We are interested in participating in projects where the heat transfer can be an issue, such as for cryo-coolers, thermalization of mirrors, electronic cooling, radiator design. Moreover we are expert in planning, building and performing tests in microgravity conditions, such as parabolic flights, sounding rockets and even on the International Space Station.

University of Glasgow

Expertise in development of mass spectrometer technologies for space flight and rover deployment, specifically, development of technologies for in situ planetary geochronology.

Resources: state-of-the-art Ar/Ar dating facility and close working relationship with Thermo Scientific.

University of Oxford

- Robotics Paul Newman (Eng. Sci)
- Deployable structures Zhong You (Eng Sci)
- Entry vehicles / Hypersonic satellite drag & deorbit Matt McGilvray (Eng Sci)
- Telecomms Chris Stevens (Eng. Sci)
- EO Mission Technology Don Grainger (Physics)
- High Speed data chain David Wallom (e-Research Centre)

University of Southampton

Electric propulsion including:

- Gridded ion engines(GIEs)
- Hollow cathode thrusters
- Hollow cathodes(conventional(heater) and heaterless)
- Pulsed plasma thrusters
- Advanced high power, high thrust and high specific impulse GIEs using three grids(DS3G)

University of Surrey

- a) Micro/Nano-satellite technologies (COMPET-1-2016; COMPET-1-2017; COMPET-2-2017); Space power systems (COMPET-1-2016; COMPET-1-2017)
- b) Electronic propulsion (COMPET-3-2016)
- c) Space robotics (COMPET-4-2016)
- d) Space autonomous systems (COMPET-4-2016)
- e) In-orbit constellation maintenance (COMPET-3-2016)
- f) On-board data handling (COMPET-1-2016; COMPET-1-2017; COMPET-2-2017; COMPET-3-2017)

g) Structural integrity of satellite & payloads, including spacecraft structures, space mechanisms and materials (COMPET-1-2016; COMPET-3-2016; COMPET-1-2017)
h) Space debris removal (COMPET-1-2016; COMPET-4-2016; COMPET-1-2017)

Space Exploration and Science

The profiles under the heading *Space Exploration and Science* have relevance to the following topics:

- COMPET-5-2016: Scientific instrumentation
- COMPET-4-2017: Science data exploitation
- COMPET-5-2017: Space weather

An outline of *Space Exploration and Science* resources and expertise can be found below from the following organisations:

- <u>Aberystwyth University</u>
- <u>Cardiff University</u>
- Heriot-Watt University
- <u>National Centre for Earth Observation</u>
- Open University
- <u>Science and Technology Facilities Council</u>
- <u>University College London</u>
- <u>University of Bradford</u>
- <u>University of Brighton</u>
- University of Glasgow
- University of Kent
- <u>University of Leicester</u>
- <u>University of Nottingham</u>
- University of Oxford
- <u>University of Portsmouth</u>
- University of Reading
- <u>University of Southampton</u>
- <u>University of St Andrews</u>
- University of Surrey

Aberystwyth University

Science data exploitation: The Space Physics group specialises in the development of image processing, data analysis and modelling tools for solar & heliospheric, planetary and magnetospheric observations. Members of the group publish regularly in high-impact journals (>100 unique refereed publications from 2010-2014, see *http://users.aber.ac.uk/hum2/SSP_publications_2010_2015.pdf*).

The group has specific expertise in:

- Advanced magnetohydrodynamic modelling of the solar atmosphere (coronal loops & jets), of critical importance in understanding coronal heating and interpreting data from the latest solar missions.
- Analysis of lunar surface composition, morphology and resources.
- Study of atmospheric loss at Venus
- Development of widely-used image processing tools for solar remote sensing data, revealing previously undetected phenomena
- Advanced data analysis of near-Earth solar wind plasma conditions
- Observation and modelling of energetic particles in the terrestrial magnetosphere ring current and radiation belts

Instrumentation: The group has expertise in the development of bespoke instrumentation for materials characterisation and remote sensing, design of optical systems and embedded control. We have extensive manufacturing facilities, both manual and CNC, enabling in house manufacture of flight hardware. Extensive research facilities enable inhouse characterisation and calibration of both active (sensors etc.) and passive (calibration targets etc.) instrument components. We are involved in the following projects:

- World class expertise in planetary X-ray fluorescence instrumentation. CoPi on ESA BepiColombo SIXS, PI on Indian Chandrayaan1 C1XS, PI on ESA Smart1 DCIXS
- Group members are Co-Is on the international instrument teams for the ExoMars PanCam, CLUPI and ISEM instruments and are designing, developing, manufacturing and characterising the radiometric calibration targets for all three instruments. The group is responsible for developing and implementing the radiometric calibration process, facilities and data processing pipeline for the PanCam instrument.
- Technology Development for PanCam 2020 project. The group is involved in a project to develop hyperspectral camera technology based on a linear variable filter, which would be suitable for future planetary exploration missions.
- Aurora Technology Transfer developing terrestrial applications for space technology. Development of a technology demonstrator using the linear filter technology from the PanCam 2020 project to create a hyperspectral camera for UAV-based crop inspection, targeting the spectral region around chlorophyll absorption edge.
- Solarwind Sherpas the group is part of this world-leading group of eclipse scientists, leading to new discoveries of the corona and of importance in testing new instruments concepts for future ground- and space-based missions. The group has recently proposed a 4-channel high-resolution spectrometer for eclipse studies, with an element of development for future space proposals.

Space weather: The group is becoming increasingly involved in space weather, and is developing some of the most advanced tools for calibration & analysis of coronagraph data of the extended corona (detection/analysis of Coronal Mass Ejections, and tomography of the quiescent background corona/solar wind). A group member is vice- chair of the COSPAR Space Weather Panel and an author of the recent COSPAR Space Weather Roadmap *DOI:10.1016/j.asr.2015.03.02*. We are co-leaders of the EU funded Planetary Space Weather activity of Europlanet 2020. The group is heavily involved with the CORIMP CME catalogue (currently *http://alshamess.ifa.hawaii.edu/CORIMP/*, soon to moved to Aberystwyth), a major new web server for solar/coronal data products with emphasis on space weather (*http://eagle.imaps.aber.ac.uk/*, under development), and has a Leverhulme award for further space weather prediction development. Our science expertize also covers terrestrial and planetary effects of space weather (geoeffectiveness), space radiation environments and ionospheric radio propagation (in collaboration with Qinetiq).

Cardiff University

- PI institute for Herschel-SPIRE
- Build & testing of Planck-HFI focal plane instrument
- JWST-MIRI & NIRSPEC calibration sources & optical coatings
- Filters for many projects, including Mars rovers/orbiters

Heriot-Watt University

Expertise in imaging techniques in radio and optical interferometry, cosmological data analysis

National Centre for Earth Observation

NCEO scientists support the development of EO missions in a number of ways outlined below. Their primary interest is as customers for data from new space missions. In order to ensure new missions meet scientific requirements they participate in:

Studies for concepts for new missions: Support for the development of future
mission concepts in preparation for the next generation of space missions. The
activities include consideration of new observations not previously measured from
space, participation in airborne campaigns to demonstrate the feasibility of mission
concepts under study by space agencies, targeted studies to consolidate promising
but scientifically immature mission concepts, toolboxes (including models, simulation
tools, spectral libraries and algorithms) to stimulate the development of future
mission concepts.

- Science team membership: Many missions include mission science teams, which are intimately involved with mission development (eg participate in key meetings) to ensure mission development continues to meet science needs and to place them in a good position to exploit mission data early after launch.
- **Pre-launch development:** development of algorithms in anticipation of launch of planned missions to develop methods to exploit data, eg retrievals and observation operators for data assimilation.

In general we would encourage technologists to work closely with the scientific community.

Open University

The Open University (OU) is home to a large group of researchers involved with research into space and planetary sciences (formerly this collective was known as the Planetary and Space Sciences Research Institute, but owing to expansion the group is currently configured around two main areas – (1) Planetary and Space Sciences and (2) Space Instruments.

The groupings currently have interests in both laboratory investigations (analyses of meteorites, cometary dust, lunar samples, and materials from Mars, along with space environmental simulations of various kinds and studies of hypervelocity impacts) and space missions (such as Rosetta, Gaia, Juice, BepiColombo, ExoMars TGO, UKube-1, and so on). The OU has an extensive interest in space instrument developments (mass spectrometry, spectroscopy, imaging, dust detection, physical properties).

The OU is a key member of the Europlanet consortium – a group of around 50 European organisations interested in planetary science. It coordinates the Research Infrastructure project of the same name and is partner is seven other Space related H2020 projects.

COMPET-4-2017 Scientific data exploitation;

OU expertise lies in Exoplanets (Haswell), outreach, lunar geology and mapping tools (Patel) and cosmology (Grady). Research interests of the latter are in the geochemistry of carbon and nitrogen in the Solar System, and particularly in their occurrence in martian meteorites. She has great experience and expertise in a wide range of public engagement activities, including the nationally televised Royal Institution Christmas Lectures in 2003.

The OU has facilities able to study lunar samples and already has EU funding (EuroCares) that utilises this.

COMPET-5-2017: Space weather;

The OU is engaged in projects (e.g. Asterics and VAMDC database) consideING space weather, so OU has project experience and expertise to engage here.

The OU has a unique combination of analytical and environmental laboratories for characterising the chemical and isotopic composition of Solar System materials and for simulating planetary environments. The Planetary Environments group has access to high-spec computing (both GIS workstations and a cluster) for processing planetary imagery. Importantly, they have access and to SocetSet software for photogrammetry.

COMPET-5-2016: Scientific instrumentation

The OU houses the Centre for Electronic Imaging (CEI), a collaboration between The OU and e2v technologies plc. The CEI is dedicated to the research and development of advanced technologies for electronic image sensing and provides knowledge exchange between the UK technology industry and academia. The primary focus of CEI's work relates to the development of imaging sensors for space applications, with expertise in X-ray spectroscopy and the study of the effects of radiation damage. The CEI are involved in detector development for many current and future missions, such as Gaia, Euclid, IXO/Athena, Chandrayaan-1 & 2, UKube-1. Astronomers at the OU have leading roles in many major international projects and facilities, including SuperWASP, JCMT Legacy Surveys, LOFAR, and Herschel

Staff within CEPSAR, the Research Centre for Physical and Environmental Sciences at the OU have experience in cosmochemistry and planetary science. Interests include early evolution of the Solar System and planetary formation. Franchi is a member of the science team for the NASA Osiris Rex asteroid sample return mission and was a Science Team member for the NASA Genesis mission and participated in several Preliminary Examination Teams for the NASA Stardust mission. He has extensive experience of a wide range of instrumentation, developing new instruments and methodology.

Additional expertise:

- Performance low mass valves for gas tight storage and precise flow control in propulsion systems (Sheridon)
- CCD and CMOS imaging sensor technologies for all space applications (e.g. GNC cameras) (Burgon)
- Space technology translation and knowledge exchange for terrestrial applications (Morgan)

Science and Technology Facilities Council

- Scientific instrumentation for exploration missions, including evolved gas analysers Nick Waltham/Chris Howe
- Space physics data analysis and exploitation Chris Perry
- Space weather expertise Mike Hapgood

University College London

Physics & Astronomy Department: Experience on infrared and mm-wave instrumentation (both ground and space-based).

UCL (P&A) currently has a FP7 project, FISICA (Far-Infrared Space Interferometry Critical Assessment) which brings together both astronomers and instrumentation experts with the purpose of advancing some of the critical elements required for such a concept (the FISI part) and bringing together the specification that such a concept should have.

UCL (P&A) is also the Payload Lead for the TWINKLE mission concept (Low Earth Orbit satellite for Exo-planet spectroscopy observations in the near infrared) as well as lead for the LOCUS satellite (a Low Earth Orbit limb sounding mission for detection of key molecular signatures related to Thermosphere modelling and climate change).

University of Bradford

- Building complex simulation which require extreme computing to process them
- Machine learning to find data patterns

University of Brighton

School CEM: We are expert in thermal management of space components and we have already participated in projects linked to the cooling of scientific instruments, such as for AMS.02 experiment on the ISS. We are able to design and build wo-phase passive systems such as heat pipes, loop heat pipes and pulsating heat pipes. We use our own codes, but we use also standard software such as SINDA/FLUINT and ESATAN, and open source software such as OPEN FOAM.

We are interested in participating to projects where the heat transfer can be an issue, since it may change the operating conditions of the scientific instrumentation. We are expert in planning, building and performing tests in microgravity conditions, such as parabolic flights, sounding rockets and even on the International Space Station.

University of Glasgow

- a) i) Knowledge of solar activity (especially solar flares); ii) Analysis of space-based solar imaging data and spectroscopy data, across the entire electromagnetic spectrum (radio wavelengths to gamma-rays); iii) Morphological image processing, Bayesian approaches to signal analysis; iv) Theory and modelling of physics of space plasmas and radiation production mechanisms
- b) Expertise in development of mass spectrometer technologies for space flight and rover deployment, specifically, development of technologies for in situ planetary geochronology. Exploitation of isotope data for temporally constraining processes and events in geological histories of planetary, asteroid and lunar bodies. Resources: state-of-the-art Ar/Ar dating facility.

 c) Expertise in the analysis of extraterrestrial samples (cosmic dust, meteorites). Resources include scanning and transmission electron microscopes and Raman microscopes.

University of Kent

Professor Gao has expertise in space antennas, smart antennas, phased arrays, reflect arrays, microwave and millimter-wave antennas, and microwave power amplifiers.

He has strong links with business and a good track record of EU expertise:

- Millimeter-wave intelligent array antennas for next-generation mobile satellite communications (FLEXWIN, funded by European Union FP7 ICT Program)
- Advanced reflectarray antennas for space-borne synthetic aperture radars (funded by the Royal Academy of Engineering, UK)
- Gallium Nitride integrated millimeter-wave active phased array multi-beam transceivers for SATellites (GaNSat, funded by European Union FP7 Space Programme)
- Digital Beamforming Synthetic Aperture Radars onboard micro-satellites constellations (DIFFERENT, funded by EU FP7 Space Programme)

Professor Gao's academic profile can be viewed here: https://www.eda.kent.ac.uk/school/staff_detail.aspx?pid=95

University of Leicester

Research scientists at the University of Leicester have a long and distinguished record of discovery in space science. Every year since 1967 has seen a Leicester-built instrument operating in space. We hold, and have held, vital roles in many space missions for space agencies including NASA, European Space Agency, UK Space Agency, ISRO (India) and JAXA (Japan), covering astronomical, planetary and Earth observation science missions. These include NASA/ESA's James Webb Space Telescope, ESA's Bepi-Colombo mission, and ESA's and EUMETSAT's Meteosat Second Generation missions.

4 directly relevant research groups:

X-ray and Observational Astrophysics: one of the world's leaders in high energy and observational astrophysics. This Group has a broad multi-wavelength research programme ranging from Gamma-ray through to gravitational wave and detection of exoplanets.

Radio and Space Plasma Physics: at the forefront of research into the interaction of planetary environments with the solar wind, including space weather. Experimental studies are conducted with spacecraft and ground based facilities including radars, some of which are designed and built in-house.

Activities within our Space Research Centre: are focused on novel sensors and optics for both space and interdisciplinary applications; engineering capability in space; and planetary science including concepts for the next generation of instrumentation, tools and techniques and planetary materials and their analysis. (see www.le.ac./space for further details and detailed contacts) Theoretical Astrophysics: detailed theoretical modelling of astrophysical phenomena ranging from black holes to planetary formation and comparison to data.

Relevant details include:

- Experience of working with major space science data sets, such as from ESA missions including Cluster, Mars Express, Venus Express, NASA missions such as Polar, IMAGE, Van Allen Probes, other missions such as DMSP, AMPERE.
- Experience of bringing together different data sets, e.g. Space and ground based to provide added value for example EU Framework 7 project ECLAT.
- Space Weather expertise at Earth and Mars. Use of data to understand the physical principles behind Space weather as well as the investigation of effects of large Space weather events as well as small, but continuous space weather disturbances. Use of ground based and space based facilities.
- Operation of SuperDARN radars continuously to provide the measurements of electric field in the ionosphere crucial to predicting the response in the ionosphere and upper atmosphere of space weather events.
- Expertise in X-ray/EUV/UV detectors and optics, data analysis and satellite operations, science expertise in study of stars and interstellar space

University of Nottingham

The Nottingham Geospatial Institute has concentrated significant research effort into monitoring and studying the effects of the disturbed ionosphere as a result of solar irregularities that cause GNSS signal scintillation.

This information supports research into the following topics:

- Ionospheric Scintillation Monitoring & Mitigation
- GNSS Tropospheric Effects & Meteorology

University of Oxford

- Planetary Science: IR radiometry & spectrometry; meteorological sensing. Neil Bowles (Physics)
- Astrophysics & cosmology: wide range of data exploitation topics; also new detectors & technologies Dmitra Rigopoulou, Physics.
- Plasma Physics modelling Alexander Shekochin

University of Portsmouth

Institute of Cosmology and Gravitation: The ICG is a world-leading department in the study of observational tests of the laws of gravity, dark matter and dark energy on cosmic scales. We have 11 members of staff, 20 postdoctoral researchers and 20 PhD students examining different aspects of theoretical and observational cosmology.

We are experts in the exploitation of data from space telescopes. We have also been involved in the definition of space instrumentation with ESA. We own a 3700 core HPC system, SCIAMA-2, which we use for the required processing of observations, data analysis, and comparison with theory.

University of Reading

Institute for Environmental Analytics: The Department of Meteorology at the University of Reading includes the Space and Atmospheric Electricity (SPATE) group, whose research interests include Atmospheric electricity and Ionospheric physics, Heliospheric physics, Magnetospheric physics, and Space weather and climate.

University of Southampton

- Atomic oxygen and UV sensors (already flown on ISS)
- Modelling of radiation environments, in particular Solar Energetic Particle Events(SEPEs) and radiation effects on electronics
- Space debris modelling

University of St Andrews

Solar and Magnetospheric Theory Group (School of Mathematics & Statistics): Academic staff at SMTG are: Prof Alan W. Hood (Head of Group), Prof Thomas Neukirch, Prof Clare E. Parnell, Prof Ineke De Moortel, Dr Andy N. Wright, Dr Duncan H. Mackay and Dr Vasilis Archontis.

The Head of Group, Prof Alan Hood, is given as the first point of contact below. SMTG members are at the forefront of:

• Flux emergence simulations (studied the emergence through the photosphere to the corona; showed the formation of standard and blowout jets and eruption of coronal flux ropes in a CME-like manner)

- **Coronal MHD waves and forward modelling** (revised the spatial damping profile for propagating transverse waves in a flux tube with a wide inhomogeneous layer; modelled the effect of the optically thin line-of-sight integration on observed Doppler shift oscillations to clarify the interpretation of observed waves and oscillations)
- **3D magnetic reconnection** (established many new characteristics of 3D reconnection and then proposed many regimes for 3D reconnection -spine, fan, separator, quasi-separatrix layer)
- Long term global coronal field modelling (the only long term simulations of the Sun's global coronal magnetic field to incorporate observational data as a boundary driving mechanism)
- **Magnetospheric MHD waves** (founded the 'waveguide' model of the magnetosphere, established the theory for wave coupling in 2D, identified nonlinear mechanisms for producing small scales in auroral Alfven waves through coupling to a responsive ionosphere)
- Solar particle acceleration mechanisms (developed a fully analytical theory of collapsing magnetic traps)
- **Kinetic theory of current sheets** (first ever analytical solution for a nonlinear, force-free, collisionless current sheet)
- **Space weather**: development of a new real time, data-driven mathematical model to simulate the storage and release of energy in the Sun's atmosphere. The science model has been highly successfully and is able to reproduce the timing and energy release of a Coronal Mass Ejection. The simulation technique is highly relevant for space weather prediction (and is currently being tested as a real-time, data-driven operational framework).

University of Surrey

- a) Radiation environment & effects (COMPET-5-2017); Scientific instrumentation (COMPET-5-2016)
- b) Space weather (COMPET-5-2017)

In-orbit instruments and data sources, high level expertise from several research academics / fellows, with focus on space weather effects (in space and within atmospheres). Space weather measurements and models.

On-site facilities include the Realistic Electron Environment Facility (REEF). Currently involved in EU Spacestorm project.