



European  
Commission

Beyond the Sky

# Beyond the Sky

## Space Research

*Space Research projects under the  
7th Framework Programme for Research  
(5th call)*

Enterprise  
and Industry



## BEYOND THE SKY

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Civilisations have always wondered what is beyond the sky. But it is only recently that the limitless possibilities provided by space science and technology came into stronger spotlight and started to be used to the full. The European Union has been playing a significant role in this process, in particular through the FP7 Space Research Programme. The **5th FP7 Space call brochure** – through presentation of **50 projects divided into 4 categories** (Copernicus applications and data; space technologies; space science and data exploitation; cross-cutting issues) – aims at giving a comprehensive overview of Europe's endeavours to fully, yet sustainably, use space for purposes ranging from excellent reception of TV signal to helping victims of earthquakes and other natural disasters.

The 5th call of the FP7 Space Programme is centred – in the domain of **space-based applications** – on: (pre-)operational validation of Copernicus (formerly GMES) services and products, stimulating development of downstream services and service evolution, and remote sensing methods. Other important issues include: integration of satellite communication and satellite navigation solutions with space-based observing systems, integrated downstream service activities and applications, support to the coordinated provision of observation data and development of Earth observation satellites.

Equally important have been the efforts to **strengthen the foundations of space science and technology** by offering funding to research supporting space science and exploration, data exploitation and Earth-analogue research. Research supporting space transportation, space critical technologies, research into reducing the vulnerability of space assets and space-weather events also constituted important programme elements.

Last but not least, the importance of **cross-cutting activities** has been acknowledged by providing financial support to SME space technology research and technology transfer and initiatives undertaken in the framework of international cooperation, including cooperation with third countries. Moreover, dissemination actions – especially transnational and international cooperation among National Contact Points – and studies and events in support of European Space Policy have been envisaged and funded.

You are invited to discover the 50 projects touching upon the above-mentioned subjects. This overview will be followed by a 6th call brochure that will be the last one presenting the FP7 projects.

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# Listed below are the projects co-financed by the European Commission and managed by the Research Executive Agency (REA) under the 5th call of the 7th Framework Programme for Space Research in the domains of Copernicus services and Space Foundations.

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"Beyond the Sky" is the fifth in an existing series of brochures featuring EU Space Research projects funded under the FP7. In view of continuity, this publication was produced to include the projects supported under the 5th FP7 Space call.

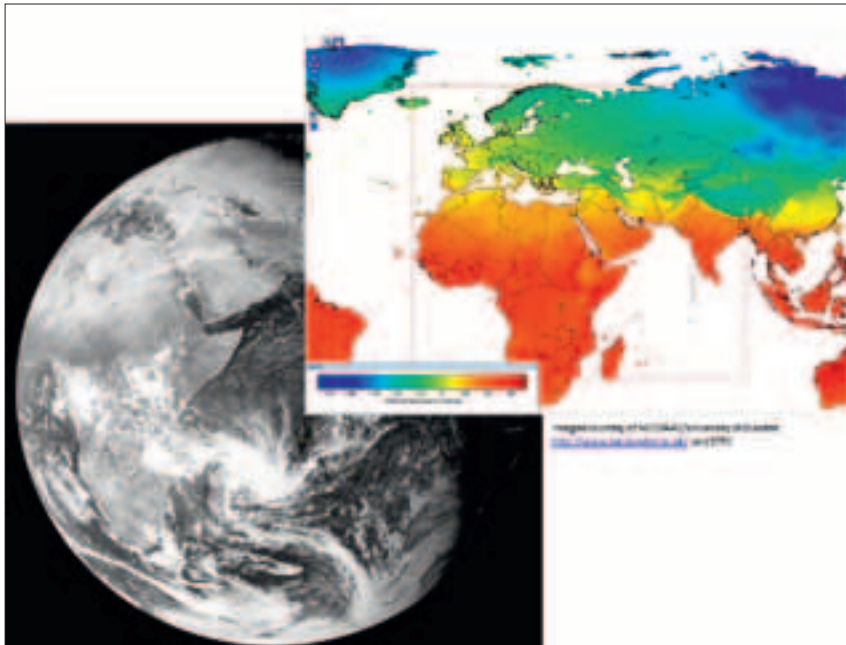
All electronic versions of the brochure series are available on the EU bookshop website: [www.bookshop.europa.eu](http://www.bookshop.europa.eu)

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# CHARMe

Characterization of metadata to allow high-quality climate applications and services



CHARMe – sharing knowledge about climate data.

## ABSTRACT

*The objective of CHARMe is to help users to judge whether climate data is fit for their purpose, by enabling this information to be consistently encoded and discovered. The project will develop tools to enable users to access this information to aid decision making and exploitation by the downstream sector, and produce applications that show how this information can be used to tackle real scientific problems.*

## PROVIDING ESSENTIAL LINKS BETWEEN CLIMATE DATA AND SUPPORTING INFORMATION TO ENABLE A VARIETY OF USERS TO FIND THE DATA THEY NEED

A challenge faced by potential users of climate data is how to judge whether the data is fit for purpose. This challenge is a serious impediment to widening the use of climate data by both expert and non-expert users for diverse applications. Different users require different kinds of supporting information; we term this 'Commentary' metadata. For this project, we define the scope of Commentary metadata to include post-fact annotations, results of assessments, provenance, properties of data distribution such as data policy and licensing and external events that may affect the data, such as volcanic eruptions.

Much work has been done on producing aspects of Commentary metadata, but there is as yet no robust and consistent mechanism to link it to the datasets themselves. CHARMe will provide these essential links.

CHARMe will create a repository of Commentary metadata (hosted by CHARMe or elsewhere) plus a set of interfaces through which users can interrogate the information over the Internet. The project will build some example applications that show the value of exploiting this information in real scientific problems.

The significant and lasting legacy of the project will be: robust and reusable frameworks for linking datasets with Commentary metadata, wherever it is held; reusable software tools that allow climate scientists and users to exploit this information in their own applications; development of best-practice procedures for owners of data archives to exploit these innovations to maximum effect; improved search, intercomparison and time-series analysis tools for large and diverse datasets.



Rhona PHIPPS  
Project Coordinator

## QUESTIONS & ANSWERS

### **What is the project designed to achieve ?**

We aim to widen the accessibility and usability of climate data, particularly to new user communities, by linking datasets to the key pieces of supporting information required to allow those users to judge whether the data is fit for their purpose.

### **Why is this project important for Europe and how does it benefit European citizens ?**

Europe has made large investments in gathering climate data, yet it can still be difficult for users of that data to exploit it to its full potential. Environmental concerns affect all of us, and better use of the data we already have will serve all European citizens, through better science, better evidence-based policymaking and more cost-effective and efficient commercial services.

### **How does the project exceed the current state of knowledge ?**

Although many types and sources of supporting information for climate data currently exist, a mechanism to link this information to the data itself does not. This project will build on existing knowledge and practice to allow data centres around the world to harvest this key supporting information and supply it to the users of their data.

# CHARMe

Characterization of metadata to allow high-quality climate applications and services

## LIST OF PARTNERS

- University of Reading, United Kingdom
- Infoterra Ltd (trading as ASTRIUM Geo-Information Services), United Kingdom
- Science and Technology Facilities Council, United Kingdom
- Deutscher Wetterdienst, Germany
- European Centre for Medium-Range Weather Forecasts (ECMWF)
- Koninklijk Nederlands Meteorologisch Instituut, the Netherlands
- Logica, United Kingdom
- Spot Infoterra Hellas (trading as ASTRIUM Geo-Information Services), Greece
- UK Met Office, United Kingdom

## COORDINATOR

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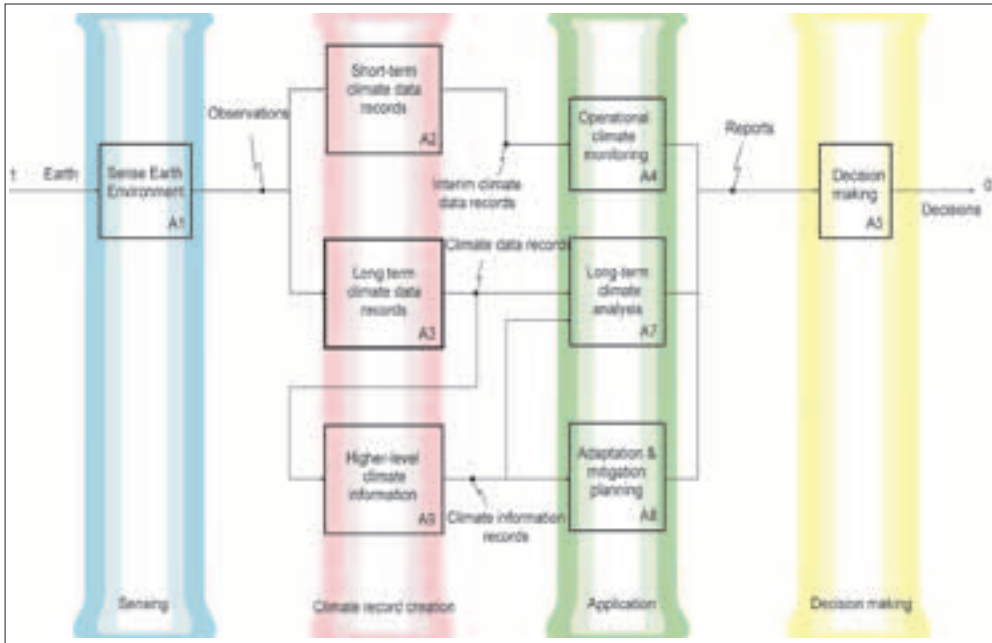
## PROJECT INFORMATION

Characterization of metadata to allow high-quality climate applications and services (CHARMe)

Contract N°: 312641  
Starting Date: 01/01/2013  
Duration: 24 months  
EU Contribution: €1.911.294,65  
Estimated total cost: €2.737.429,00

# CORE-CLIMAX

Coordinating Earth observation data validation for RE-analysis for CLIMate Services



© CORE-CLIMAX

Decomposition of the four pillars of a logical view for an architecture for Climate Monitoring, where the project will focus on “Climate Record Creation” and “Application”.

## ABSTRACT

CORE-CLIMAX aims to coordinate the identification of essential climate variables and the creation of long term climate data records. The project will help to substantiate how Copernicus observations and products can contribute to climate change analyses.

## PRODUCE UNIFORM AND CONSISTENT CALIBRATION AND VALIDATION STRATEGIES FOR CDRS AND ECVS

CORE-CLIMAX will coordinate the identification of available physical measurements, which can be reconciled with previously existing data records, to form long time series. It will help to substantiate how Copernicus (former GMES) observations and products can contribute to climate change analyses, by establishing the extent to which Copernicus observations complement existing Climate Data Records (CDR).

CORE-CLIMAX will coordinate with GCOS, Copernicus and ESA CCI projects, and EUMETSAT including its Satellite Application Facility (SAF) network, as well as with specific efforts to be undertaken by new FP7 projects to further upgrade their product catalogues to include the climate relevant validation and information and lay the observational basis for service activities.

CORE-CLIMAX will identify the integration of Essential Climate Variables (ECVs) into the reanalysis chain by proposing a feedback mechanism ensuring that the results of the re-analysis process get appropriately reflected into updates of the ECVs. Together with intercomparing different reanalyses, CORE-CLIMAX will contribute to establishing a European truly coupled gridded re-analysis which incorporates full exchanges and interactions between atmosphere, ocean, land, including the hydrological cycle.



Zhongbo (Bob) SU  
Project Coordinator

## QUESTIONS & ANSWERS

### What is the project designed to achieve ?

The aim of this project is to coordinate global observation initiatives and products that are related to climate change analysis. This is in order to come up with a structured process for delivering ECVs, a validation process aimed at qualifying the accuracy of these products, a feedback mechanism for re-analysis purposes and a process to compare these reanalyses.

### Why is this project important for Europe and how does it benefit European citizens ?

The project contributes to the European ambition articulated by the 2011 European Commission report on the Global Monitoring for Environment and Security (GMES) Climate Service by providing protocols and strategies that will deliver information products of climate quality. European citizens will benefit from an improved monitoring of the climate system and an improved detection and impact assessment of climate change.

### How does the project exceed the current state of knowledge?

The project will coordinate the identification of available physical measurements, which can be reconciled with previously existing data records, to form long time series. As such this project will help to substantiate how Copernicus observations and products can contribute to climate change analyses by establishing the extent to which Copernicus observations complement existing climate data records.

# CORE-CLIMAX

Coordinating Earth observation data validation for RE-analysis for CLIMAtE ServiceS

## LIST OF PARTNERS

- Faculty of Geo-Information Science and Earth Observation, University of Twente, the Netherlands
- The European Organisation for the Exploitation of Meteorological Satellites, International
- European Centre for Medium-Range Weather Forecasts, International
- Deutscher Wetterdienst, Germany
- Flemish Institute for technological research, Belgium
- Finnish Meteorological Institute, Finland
- Météo France, France
- Institute of Tibetan Plateau Research, Chinese Academy of Sciences, China
- Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, China

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## PROJECT INFORMATION

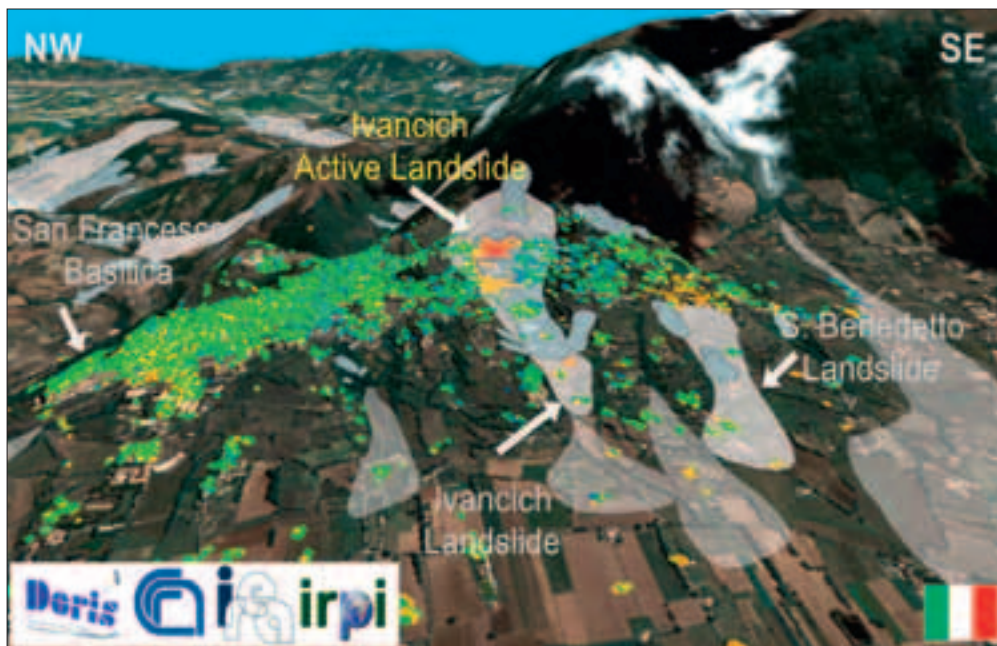
Coordinating Earth observation data validation for RE-analysis for CLIMAtE ServiceS (CORE-CLIMAX)

Contract N°: 313085  
Starting Date: 01/01/2013  
Duration: 30 months  
EU Contribution: € 1.997.635,00  
Estimated total cost: € 2.783.125,74



# DORIS

## Ground Deformations Risk Scenarios: an Advanced Assessment Service



View of the Ivancich Landslide, Assisi, Italy. Coloured dots show points where the rate of deformation was measured from February 2009 to February 2012 using Cosmo-SkyMed SAR data.



Fausto Guzzetti  
Project Coordinator

### ABSTRACT

*DORIS intends: (i) to develop an advanced downstream service for the detection, mapping, monitoring and forecasting of ground deformations, including landslides and ground subsidence, at different temporal and spatial scales and in various physiographic and environmental settings by exploiting multiple Earth Observation and ground based technologies, (ii) to improve the preparedness and response capability of civil protection authorities by increasing our understanding of the phenomena that cause ground deformations.*

### EXPLOIT EARTH OBSERVATION DATA AND TECHNOLOGIES TO DETECT, MAP AND MONITOR LANDSLIDES AND GROUND SUBSIDENCE

DORIS is an advanced downstream service for the detection, mapping, monitoring and forecasting of ground deformations, including landslides and ground subsidence, at different temporal and spatial scales and in various physiographic and environmental settings. DORIS integrates traditional and innovative Earth Observation (EO) and ground based (non-EO) data and technologies to improve our understanding of the complex phenomena that result in ground deformations, and to foster the ability of Environmental and Civil Protection authorities to manage the risks posed by ground deformations. DORIS delivers innovative products at the regional and local levels, tailored to the needs of national and local civil protection authorities.

DORIS exploits the unique ESA ERS-1/2 and ENVISAT C-band, ALOS L-band, COSMO-SkyMed and TerraSAR-X X-band Synthetic Aperture Radar (SAR) archives to provide unprecedented, very long time-series of ground deformations.

DORIS moves forward the combined application of satellite and ground-based differential SAR interferometry, coupled with GPS measurements and geophysical probing, for an improved monitoring and forecasting of ground deformations. DORIS also exploits high and very-high resolution multi-spectral images to help map ground deformations, to identify and classify the elements at risk, for a timely and accurate assessment of the damage, and in the design of dynamic risk scenarios.

A specific action of DORIS is dedicated to the design of an appropriate business model for the long term self-sustainability of the service, in order to deliver a service that is useful, economically viable, reproducible, and beneficial to a wide range of stakeholders in Europe.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

DORIS intends to realise an advanced downstream GMES service for the detection, mapping, monitoring and forecasting of ground deformation (primarily landslides and ground subsidence) by exploiting and integrating satellite data and technology already in use, ground-based information and innovative modelling tools.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

DORIS is advancing the current capabilities of detecting and mapping landslides in different physiographical and climatic environments. The results will be beneficial for civil protection and environmental authorities interested in knowing the extent of a landslide event and in assessing the impact of ground deformations shortly after an event.

#### **How does the project exceed the current state of knowledge ?**

DORIS goes beyond the state-of-the-art in the science and technology currently used to detect, map, monitor, and forecast ground deformations. Improvements consist in the innovative exploitation of EO data and technologies like Synthetic Aperture Radar (SAR) archives to provide unprecedented, very long time-series of ground deformations and optical images for semi-automatic landslide map production.

### LIST OF PARTNERS

- National Research Council, Italy
- University of Florence, Italy
- Italian Space Agency, Italy
- Dipartimento della Protezione Civile, Italy
- Tele-Rilevamento Europa, Italy
- ALTAMIRA Information, Spain
- Gamma Remote Sensing, Switzerland
- Institute of Geology and Mineralogy of Spain, Spain
- Booz & Company GMBH, Germany
- Eotvos Lorand Geophysical Institute of Hungary, Hungary
- Federal Office for the Environment, Switzerland
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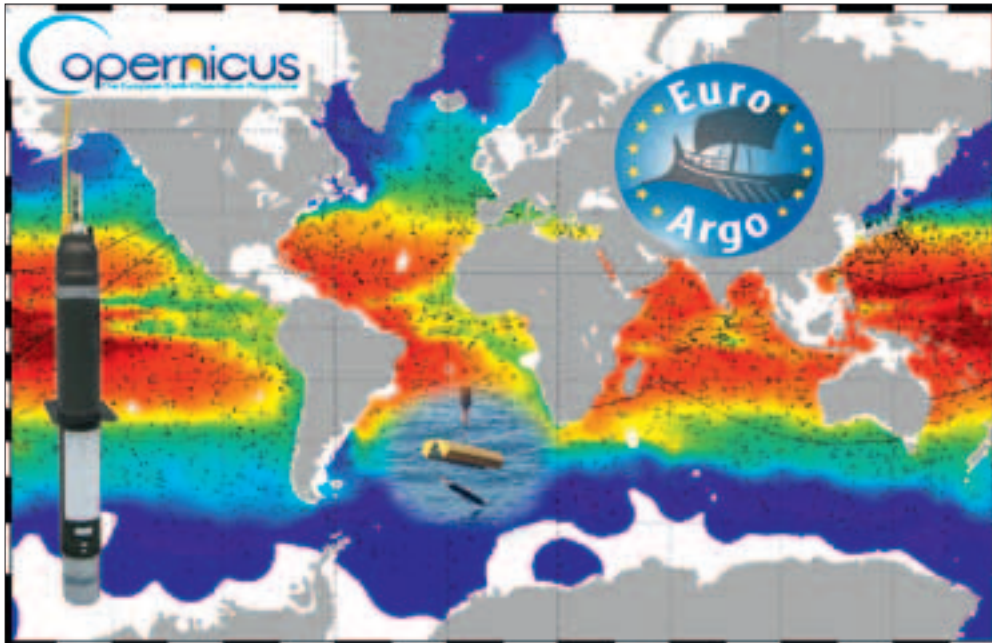
### PROJECT INFORMATION

Ground Deformations Risk Scenarios: an Advanced Assessment Service (DORIS)

Contract N°: 242212  
Starting Date: 01/10/2010  
Duration: 36 months  
EU Contribution: € 3.395.865,98  
Estimated total cost: € 4.574.904,12

# E-AIMS

## Euro-Argo Improvements for the GMES/Copernicus Marine Service



© Ifremer

An Argo profiling float superimposed on a global map of ocean temperature derived from Argo observations.

### ABSTRACT

*E-AIMS goal is to organise an end-to-end evaluation of improved and new float capabilities required for the Copernicus Marine Service. E-AIMS will demonstrate the capability of the Euro-Argo infrastructure to conduct R&D driven by Copernicus needs and demonstrate that procurement, deployment and processing of floats for Copernicus can be organised at European level. These are key aspects for the long term sustainability of the Copernicus in-situ component.*

### RESEARCH AND DEVELOPMENT FOR IN-SITU COMPONENT

Argo is an international array of 3000 profiling floats that measure temperature and salinity throughout the global oceans, down to 2,000 metres. It is the single most important global in-situ observing system providing critical observations of the ocean interior that are required to constrain, together with satellite observations, Copernicus Marine Service modelling and forecasting systems.

The European long-term contribution to Argo is organised as part of the Euro-Argo research infrastructure (Euro-Argo ERIC). The main challenges for Argo and Euro-Argo are: to maintain the global array and to prepare the next phase of Argo (biogeochemistry, polar oceans, marginal seas and deep ocean measurements). This requires major improvements in Argo float technology. New floats with improved capabilities are or will be soon available from float manufacturers. They require, however, extensive testing at sea before they can be used for operational monitoring. The Euro-Argo data centers need also to be upgraded so that they can handle these new floats.

E-AIMS will organise an end-to-end evaluation of these floats - from float design down to the use by Copernicus. Observing System Evaluations and Sensitivity Experiments will also be conducted to provide robust recommendations for the next phase of Argo.



Pierre-Yves LE TRAON  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The main goal is to prepare the evolutions of Argo floats for the next decade: improved reliability and life time, telecommunication capabilities, biogeochemical observations, deeper measurements, under ice operations in the polar seas, sampling of marginal seas.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Understanding and predicting climate change are needed to guide European actions and to optimise governments' policies. Oceans play a dominant role in Earth's climate and, hence, the evolution and long-term sustainability of Argo as a European contribution to the international program is indispensable to improve our knowledge on climate change and for the Copernicus Marine Service.

#### **How does the project exceed the current state of knowledge ?**

Improved and new capabilities in Argo float technology require extensive testing at sea and evolution of data processing centres before these new float data can be used for operational monitoring. Observing System Evaluations and Sensitivity Experiments will also be conducted to provide robust recommendations for the next phase of Argo.

### LIST OF PARTNERS

- Institut Français de Recherche pour l'Exploitation de la MER, France
- Met Office, United Kingdom
- National Institute of Oceanography and Applied Geophysics, Italy
- Natural Environment Research Council, United Kingdom
- Royal Netherlands Meteorological Institute, the Netherlands
- Spanish Oceanographic Institute, Spain
- Institute of Marine Research, Norway
- University of Sofia - Department of Meteorology and Geophysics, Bulgaria
- Institute of Oceanology - Polish Academy of Science, Poland
- Helmholtz Centre for Ocean Research Kiel, Germany
- Mercator Océan - Ocean Forecasters, France
- National Institute of Geophysics and Volcanology, Italy
- Collecte Localisation Satellite SA, France
- ACRI-ST SA, France
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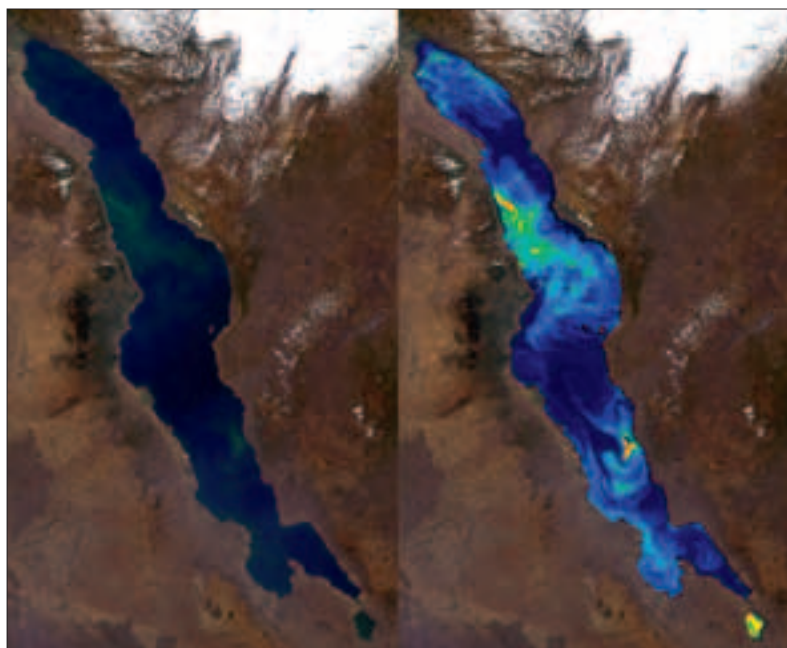
### PROJECT INFORMATION

Euro-Argo Improvements for the GMES Marine Service (E-AIMS)

Contract N°: 312642  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.990.817,00  
Estimated total cost: € 2.872.863,00

# GLaSS

## Global Lakes Sentinel Services



MERIS image © ESA

Turning water colour observations into water quality information.

### ABSTRACT

*The objective of GLaSS is to prepare for the use of Sentinel 2 and 3 data for monitoring of lakes and reservoirs. To turn the satellite data into water quality products that are easily accessible, GLaSS will develop a system for the ingestion, archiving, processing and distribution of data. This system will have innovative functionalities for the integrated use of Sentinel 2 and 3 data, time series generation and data mining.*

### GETTING READY TO USE SENTINEL 2 AND 3 FOR INLAND WATER MONITORING

Lakes are important ecosystems providing many beneficial goods and services, but they are under significant pressure from agriculture, economical development and climate change. Monitoring changes in the ecological status of lakes is an important part of water resource management. Optical remote sensing techniques can provide water quality information at the high spatial and temporal resolution required for monitoring.

The upcoming ESA satellites Sentinel 2 and 3 will provide unprecedented monitoring capabilities for inland waters, thanks to the high overpass frequency of Sentinel 3 and the high spatial resolution of Sentinel 2. However, the large amounts of data they will produce also pose a number of challenges: systems are needed that allow for the ingestion, archiving, processing and distribution of these data efficiently. To be turned into information useful for water management, the large quantity of data also requires new methods of data mining and aggregation.

The GLaSS project will develop such a prototype enhanced service infrastructure for Sentinel 2 and Sentinel 3 data to make them accessible to a larger user community in a harmonised and user-friendly way. Particular focus will be put on adaptation of water quality algorithms to Sentinel 2 and 3 data, and on the development of user-relevant value adding services.

The quality of the GLaSS system and its products will be ensured by testing it against simulated datasets, and by validating the products through a number of field studies and demonstration cases. The global case studies will demonstrate the applicability of the GLaSS system to very different lake types and management questions.



Steef PETERS  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The GLaSS project aims at developing an integrated system to ingest, archive, process and distribute large quantities of data from the upcoming ESA satellites Sentinel 2 and 3 for lake and reservoir monitoring. The GLaSS system will have innovative functionalities for integrated use of Sentinel 2 and 3 data, time series generation, data mining and further analysis.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Lakes and reservoirs provide many beneficial goods and services, but are under high pressure from pollution and global warming. GLaSS will help to make use of the large amounts of data produced by the Sentinel 2 and 3 satellites to derive aggregated information products such as the frequency, extent and intensity of harmful algal blooms to support water management from a local to global scale.

#### **How does the project exceed the current state of knowledge ?**

GLaSS will develop algorithms for atmospheric correction, lake type classification and synergistic use of the high overpass frequency of Sentinel 3 and the high spatial resolution of Sentinel 2 to produce inland water quality data of unprecedented coverage and accuracy. Moreover, GLaSS will develop innovative data mining techniques to turn these data into information products at an aggregation level useful for water management.

### LIST OF PARTNERS

- Water Insight BV, the Netherlands
- Suomen Ympäristökeskus, Finland
- EOMAP GmbH & Co KG, Germany
- Vereniging voor Christelijk Hoger Onderwijs Wetenschappelijk Onderzoek en Patientenzorg, the Netherlands
- Brockmann Consult GmbH, Germany
- Consiglio Nazionale delle Ricerche, Italy
- Tartu Observatory – Estonian Ministry of Education and Research, Estonia
- Brockmann Geomatics Sweden AB, Sweden

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### PROJECT INFORMATION

Global Lakes Sentinel Services (GLaSS)

Contract N°: 313256  
Starting Date: 01/03/2013  
Duration: 36 months  
EU Contribution: € 1.999.961,00  
Estimated total cost: € 2.540.625,00

# GMES-PURE

## GMES-Partnership for User Requirements Evaluation



© GMES-PURE

Copernicus (formerly GMES) aims to ensure operational monitoring of atmosphere, oceans and continental surfaces, and to provide information services for environmental and security applications.

### ABSTRACT

*GMES-PURE has two objectives: 1) The definition and documentation of a process for involving users in a transparent and coherent definition of emerging user requirements and service specifications for Copernicus services. This includes their translation into service data requirements and technical requirements, focusing on the space component of the observation infrastructure; 2) The application of such a process for the Copernicus marine and atmosphere service.*

### A PROCESS FOR COPERNICUS USER, SERVICE, AND DATA REQUIREMENTS

Copernicus, a joint initiative of the EU and ESA, aims to ensure operational monitoring of the atmosphere, oceans, and continental surfaces, and to provide reliable, validated information services for environmental and security applications. Based on the exploitation of data from space-based and in-situ observation systems, Copernicus will provide six main services – land, marine, and atmospheric monitoring, emergency management, security and climate change. Full operations of Copernicus will start in 2014, funded by the EU under its Multiannual Financial Framework 2014-2020. Copernicus services which address the monitoring of the ocean and atmospheric composition will become operational in 2014, capitalizing on demonstrated pre-operational projects, funded by the EC under the 7th Framework Programme.

Looking at the long-term future of Copernicus, the EC released a call for a two-year project aimed at consulting the users of the services on their prospective needs.

GMES-PURE constitutes a unique opportunity for users to ensure that their current and emerging requirements are captured in time and eventually guide the future evolution of the Copernicus services and the necessary space observation infrastructure.

EuroGOOS, the European Global Ocean Observing System, leads the user requirements definition for the marine service.

RAL, the Rutherford Appleton Laboratory, supported by FMI, the Finnish Meteorological Institute, leads the user requirements definition for the atmosphere service.

EUMETSAT, the European Organisation for the Exploitation of Meteorological Satellites, coordinates the project and provides and manages the overall process, based on the experience gained during the user requirement definition for its future satellite programmes.



Lorenzo SARLO  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The aim of this project is two-fold: To allow the EC to successfully capture user requirements for shaping the future evolution of their services and the supporting observation infrastructure, and to show that the proposed process actually works and brings good and useful results.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Reliable and validated information is crucial to understand environmental change, and to allow well-informed decisions to be made which affect the daily lives of many. The current Copernicus services already provide very valuable information in different thematic domains, e.g. to ensure sustainable fisheries, to monitor oil spills, to identify optimal locations for offshore windmill parks, to monitor the ozone hole, greenhouse gases and air quality. However, the user requirements and the technical and scientific capabilities evolve continuously, and the continued success requires regular reanalysis of the requirements to make the best possible future investments in the observation infrastructure.

#### **How does the project exceed the current state of knowledge ?**

The current user requirements for the Copernicus services are formulated with the current technological and scientific capabilities in mind. GMES-PURE will analyse the expected evolutions both in the application and the service areas. In close interaction with the users, supported by leading experts in the field, GMES-PURE will create the foundation for the long-term evolution of the services, and of the supporting space-based observation infrastructure.

# GMES-PURE

## GMES-Partnership for User Requirements Evaluation

### LIST OF PARTNERS

- EUMETSAT, Europe
- EuroGOOS, Europe
- Rutherford Appleton Laboratory / Science and Technology Facilities Council , United Kingdom
- Finnish Meteorological Institute, Finland

### COORDINATOR

EUMETSAT, Europe

### CONTACT

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### PROJECT INFORMATION

GMES - Partnership for User Requirements Evaluation (GMES-PURE)

Contract N°: 312256  
Starting Date: 01/01/2013  
Duration: 24 months  
EU Contribution: € 1.974.372,44  
Estimated total cost: € 2.554.890,00



# G-NEXT

## Pre-operational Copernicus Services in support of EU External Action



© Cruz Roja Española

Services provided by G-NEXT will support crisis management operations.

### ABSTRACT

*G-NEXT aims to develop a set of Earth Observation information services in order to support the operations of EU External Action users and stakeholders. It will focus on the enhancement of geo-spatial crisis management services in both rush (event-driven) and non-rush (periodic or non-event driven) modes.*

### Enhancing geospatial crisis management services (rush and non-rush mode) in support to EU external action

G-NEXT aims to develop a set of Earth Observation information services to support the operations of EU External Action users and stakeholders. Building on the capacities and service components developed within G-MOSAIC, and the potential application areas identified by the Copernicus Security working group in Support of External Action, G-NEXT will focus on the enhancement of geo-spatial crisis management services in both rush (event-driven response) and non-rush (periodic or non-event-driven) modes.

The objective of G-NEXT is to address the gap between research-based and operational services in the programmatic context of Copernicus Services for Security Applications.

G-NEXT addresses six categories of services: reference mapping/contingency plan preparation, event mapping, critical assets monitoring, crisis area monitoring/mapping, monitoring of settlements (population movements and temporary settlements), and damage assessment.

The reference users will include the main actors and stakeholders involved in the context of Missions and Operations in support of EU External Action (European External Action Service, national institutions, Law Enforcement and Intelligence entities, and international institutions).

The main goals are: demonstrate the benefits of integrating EO products with in situ data and intelligence in response to the needs expressed within SEA user-driven scenarios; collect user feedback, measuring the adequacy of the services and products in relation to the future operational phase; ensure the continuity of the work performed in previous GMES projects; implement synergies with future Copernicus projects and initiatives; perform a comprehensive cost-benefit analysis of the future services; address the potential service evolution from 2014 onwards.



Francesca LORENZON  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

G-NEXT will enhance the geo-spatial crisis management services identified by previous projects as having reached a maturity level that would allow them to become operational after 2014. These services are performed either in rush (event-driven response) or non-rush (periodic or non-event-driven) modes. G-NEXT will address the relevant gaps (both technological and governance-related) in order to ease the transition from the pre-operational to the operational phase.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

The project is important for Europe as it facilitates the transition of Copernicus services in Support of EU External Action from a pre-operational state into operations. European citizens will benefit from the enhancement of those services supporting intelligence and early warning as well as crisis management operations (such as EU Member State interventions during crises, for the protection of EU citizens).

#### **How does the project exceed the current state of knowledge?**

G-NEXT will go beyond the current state-of-the-art on a number of subjects, including tackling issues of confidentiality while accessing products and services in a pre-operational framework, updating user requirements in the service access phase and addressing economic and governance issues, in the context of transitioning from research to operations.

### LIST OF PARTNERS

- e-Geos Spa, Italy
- European Union Satellite Centre, Spain
- Paris – Lodron – Universität Salzburg, Austria
- Istituto Affari Internazionali, Italy
- Deutsches Zentrum für Luft – und Raumfahrt, Germany
- Indra Sistemas S.A., Spain
- Gisat S.R.O., Czech Republic
- GMV Aerospace and Defence SA, Spain
- Joanneum Research Forschungsgesellschaft MbH, Austria
- Centrum Badan Kosmicznych Polskiej Akedemii Nauk, Poland
- SpaceTec Partners SPRL, Belgium
- Systèmes d'Information à Référence Spatiale SAS, France
- Planetek Hellas, Greece
- Telespazio Iberica Unipersonal, Spain
- Trabajos Catastrales S.A., Spain

### COORDINATOR

E-GEOS SPA (Italy)

### CONTACT

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### PROJECT INFORMATION

Pre-operational Copernicus Services in support of EU External Action (G-NEXT)

Contract N°: 312703  
Starting Date: 01/01/2013  
Duration: 27 months  
EU Contribution: € 4.000.000,00  
Estimated total cost: € 5.981.822,61

# IGAS

## IAGOS for the GMES (Copernicus) Atmospheric Service



Photo Inlet plate: © Harts Werner Pätz; Photo Lufthansa A340: © Harts Schulze; Photo China Airlines A340: © Kimono Kuu.

Passenger aircraft equipped with atmospheric measurement systems and air sampling plate.

### ABSTRACT

*The objective of IGAS is to better link data streams of atmospheric measurements from a fleet of globally operating commercial airliners provided by IAGOS to the Copernicus Atmosphere Service. IGAS will focus on transmitting these data in near-real-time, harmonizing the data quality and documentation, and developing database tools to ensure that the measurements are accessible. Furthermore, the observational capabilities of IAGOS will be enhanced through targeted instrument development.*

### PROVISION, HARMONIZATION AND ENHANCEMENT OF IN-SITU MEASUREMENTS FROM PASSENGER AIRCRAFT

The project IGAS (IAGOS for the GMES Atmospheric Service) aims to better link data streams of atmospheric measurements from commercial airliners provided by IAGOS (In-service Aircraft for a Global Observing System) to scientific users and to the Copernicus Atmospheric Service. IAGOS is establishing a distributed infrastructure for long-term observations of atmospheric composition on a global scale from an initial fleet of 10-20 long-range in-service aircraft of internationally operating airlines. IAGOS will provide accurate in-situ observations of greenhouse gases (GHGs), reactive gases, aerosols, and cloud particles at high spatial resolution, thereby covering the essential climate variables (ECVs) for atmospheric composition as designated by the GCOS programme (Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC, 2010).

The IGAS project aims to provide data streams in both near-real-time and delayed mode to the Copernicus Atmospheric Service, currently represented by MACC-II in its pre-operational state. A major focus is to increase accessibility and interoperability by developing and implementing data base tools, as well as to evaluate and harmonize the data quality. Furthermore, IGAS seeks to enhance IAGOS measurement capabilities through targeted instrument development for the measurement of aerosols, VOCs, speciated cloud water/ice/volcanic ash particles, and water vapour.



Christoph GERBIG  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The objective of this project is to significantly enhance the accessibility, capability, and scientific application of global atmospheric observations already being made from a fleet of passenger aircraft within the IAGOS research infrastructure. This will be achieved by harmonizing databases and data quality, implementing near-real-time data transfer, and developing new instrumentation to augment the current suite of observations.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Long-term observations are key to understanding on-going changes in the atmosphere associated with a changing climate. The IGAS project brings together a group of experts on atmospheric observations and modelling that will realize the utilization of climate-relevant gas, pollutant, and aerosol observations in the Copernicus Atmospheric Service. This will help improve air quality forecasts and simulations of our future climate.

#### **How does the project exceed the current state of knowledge?**

The measurements made by IAGOS and made available by IGAS represent a new data stream, providing observations of important climate variables in critical and under-sampled areas of the world. The airborne measurements provide representative information about the climate-sensitive tropopause region, and the globally distributed vertical profiles help us understand factors influencing local and regional air quality.

### LIST OF PARTNERS

- Max Planck Institute for Biogeochemistry and Max Planck Institute for Chemistry, Germany
- Forschungszentrum Jülich, Germany
- European Centre for Medium-Range Weather Forecasts, United Kingdom
- Météo-France CNRM, France
- Karlsruhe Institut für Technologie, Germany
- University of Manchester, United Kingdom
- Deutsches Zentrum für Luft- und Raumfahrt, Germany
- Koninklijk Nederlands Meteorologisch Instituut, the Netherlands
- Université Paul Sabatier Toulouse III and CNRS, France
- HILASE Fejlesztő, Gyártó, Szolgáltató és Kereskedelmi, Hungary
- Tropos: Leibniz Institut für Troposphärenforschung, Germany
- World Meteorological Organization, International

### COORDINATOR

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### PROJECT INFORMATION

IAGOS for the GMES Atmospheric Service (IGAS)

Contract N°: 312311  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.999.175,00  
Estimated total cost: € 2.649.681,00

# IMAGINES

## Implementation of Multi-scale Agricultural Indicators Exploiting Sentinels



© Roselyne Lacaze

Wheat fields, vineyards and managed pastures in heterogeneous cropland landscape.



Roselyne LACAZE  
Project Coordinator

### ABSTRACT

*IMAGINES aims at developing qualified software able to process multi-sensor data over the whole globe to generate multi-scale biophysical variables. It also aims to describe the state of the continental vegetation and is useful to assess the crop and fodder production, the water and carbon fluxes, and to derive drought indicators. Thus, IMAGINES will contribute to the continuity of the operations of the Global Component of the Copernicus Land service.*

### MONITORING CONTINENTAL VEGETATION FOR AGRICULTURAL ISSUES

The Copernicus Land Service has been built in the framework of the FP7 geoland2 project, which has set-up pre-operational infrastructures. IMAGINES intends to ensure the consolidation and the continuity of the research and development efforts to support the operations of the Global Component of the Copernicus Land Service, preparing the exploitation of the Sentinel data. IMAGINES will favor also the emergence of new activities dedicated to the monitoring of crop and fodder production.

The main objectives of IMAGINES are: to produce multi-sensor and multi-scale biophysical variables, identified as Essential Climate Variables, exploiting Sentinel sensors data, jointly with other missions like Proba-V; to develop qualified software able to process multi-sensor data over the whole globe on a fully automatic basis; to build an agricultural service able to assess the vegetation biomass through the assimilation of above-mentioned satellite products into land surface models, in order to monitor the crop/fodder production together with the carbon and water fluxes, and to demonstrate

the added value of this agricultural service for a community of users acting at global, European, national, and regional levels.

The added value of IMAGINES is to build a framework to perform the research and development activities needed for the evolution of the Global Component of the Copernicus Land Service, in response to user needs and to new sensors, and to cover the whole value chain from satellite data to the final agricultural indicators, directly readable by the end-users, thus bridging the gaps between different communities.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The IMAGINES project aims to contribute to the continuity of the Global component of the Copernicus Land Service with software able to process Sentinels data, jointly with other contributing missions data, around the globe to produce biophysical variables at 300m resolution. These generic products can then be used to derive crop production, drought indicators, and water and carbon fluxes estimates.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

There are growing needs to improve the quality, reliability, accuracy, timeliness and comparability of information on agricultural markets (production, consumption, stocks) to address food price volatility. IMAGINES will contribute to addressing the "production" issue by developing tools able to analyse Sentinel data and integrate them into models across scales, from the European regions to the entire globe.

#### **How does the project exceed the current state of knowledge ?**

IMAGINES builds a framework to consolidate and continue the research and development activities which have set-up the Global Component of the Copernicus Land service. Further, IMAGINES covers the whole value chain from satellite data to the advanced agricultural indicators, directly readable by end-user, thus bridging the gaps between the communities.

# IMAGINES

## Implementation of Multi-scale Agricultural Indicators Exploiting Sentinels

### LIST OF PARTNERS

- HYGEOS, France
- Le Centre national d'études spatiales, France
- European Centre for Medium-Range Weather Forecasts, United Kingdom
- Earth Observation Laboratory, Spain
- French National Institute for Agricultural Research, France
- Meteo-France, France
- Országos Meteorológiai Szolgálat, Hungary
- Université Catholique de Louvain, Belgium
- VITO Vision on technology, Belgium

### COORDINATOR

HYGEOS, France

### CONTACT

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### PROJECT INFORMATION

Implementation of Multi-scale Agricultural Indicators Exploiting Sentinels (IMAGINES)

Contract N°: 311766  
Starting Date: 01/11/2012  
Duration: 40 months  
EU Contribution: € 1.998.246,09  
Estimated total cost: € 2.851.285,28



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BEAM products (Basic European Assets Maps) for Hungary and Romania - enabling cross-border evaluation of damage potential.

### ABSTRACT

*The objective of IncREO is to provide actors responsible for civil protection and disaster management with EO-based solutions, contributing to an improved preparedness and mitigation planning for areas highly vulnerable to natural disasters and already noticeable climate change trends. As a multi-risk designed project, any type of natural disaster is addressed. However, selected use cases and the transfer of solutions to a specifically multi-risk prone area are covered as well.*

### ASSETS MAPPING, MULTI-RISK AND VULNERABILITY MAPPING ENHANCING MITIGATION AND PREPAREDNESS

Within IncREO, “Resilience” is understood as the capacity of a system, community or society (potentially) exposed to hazards to adapt – by resisting or changing – in order to reach and maintain an acceptable level of functioning and structure.

The “Increase” of resilience is achieved by providing actors responsible for civil protection and disaster management with Earth Observation (EO)-based solutions contributing particularly to an improved preparedness and mitigation planning in areas highly vulnerable to natural disasters and with already noticeable climate change trends.

Besides the objective to increase resilience, IncREO also pursues a multi-hazard approach – either hazards triggered simultaneously (coupled hazards) or concatenated hazards (domino effect) – as a fundamental basis to identify highly vulnerable and risk-prone areas.

Relevant national and European legislature plus national and supranational legal frameworks incl. global mechanisms, if applicable, are taken into account as well to provide solutions, meeting the respective administrative and technical user requirements.

The types of products to be provided are mainly “assets maps” and “hazard / risk and vulnerability maps”. Whereas “crisis phase” products, such as damage extent / assessment maps and emergency support maps are already based on consolidated user requirements with corresponding product specifications available, there is still a certain R&D need in this regard concerning the aforementioned “non crisis phase” products.

The geo-information content of the final products usually corresponds to a multiple set incl. value-adding of EO data and various geo-formation layers, among them, for example, optical and / or radar satellite data, information about topography, population density and critical infrastructure.



Marc MUELLER  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The project is designed to achieve a significant contribution to the operational capacities of Copernicus (formerly GMES) by developing customized mapping and geo-information products ready for deployment in the prevention and preparedness phases – as a complementary to the Emergency Management (crisis) Service of the Copernicus Initial Operations. To achieve this, the transferability of solutions to other geographical areas is essential.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

IncREO is important for Europe because it contributes to an up-to-date assessment of areas vulnerable to natural disaster(s) incl. state-of-the-art mapping, supporting civil protection, disaster management and spatial planning actors, for the benefit of every single European citizen. The latter applies also to the project’s assets mapping approach, as it provides cross-border and regional/local solutions.

#### **How does the project exceed the current state of knowledge?**

By reviewing existing Copernicus solutions and defining those as the starting point. Progress will then be achieved by the use of new EO data with higher resolution, refined mapping concepts (e.g. assets mapping) and customized workflows (e.g. for producing [multi]-risk and vulnerability maps). The analysis of newly available EO-based products (e.g. terrain data) for risk-related applications is the purpose of the research, too.

### LIST OF PARTNERS

- Spot Image SA (Astrium GEO), France
- geomer GmbH, Germany
- GeoVille, Austria
- University Twente (ITC), the Netherlands
- UNESCO, France/Italy
- NIMH, Bulgaria
- Meteo France, France
- Romanian Space Agency, Romania
- Infoterra GmbH (Astrium GEO), Germany

### COORDINATOR

Spot Image SA (Astrium GEO), France

### CONTACT

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### PROJECT INFORMATION

Increasing Resilience through Earth Observation (IncREO)

Contract N°: 312461

Starting Date: 01/01/2013

Duration: 24 months

EU Contribution: € 1.924.718,00

Estimated total cost: € 2.890.082,00



# LOBOS

## Low time critical Border Surveillance



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Space and Border Surveillance.

### ABSTRACT

*The objective of LOBOS is to design and build a pre-operational border surveillance system using satellite imagery and other data. The project only deals with those elements that are low time critical. The sister project SAGRES deals with the high time critical element.*

### BORDER SURVEILLANCE

The LOBOS project involves a consortium of fourteen partners including large companies, SMEs and institutional entities from eight European countries.

LOBOS aims at testing the low time critical scenarios of the CONOPS in order to deliver a draft of specifications for a GMES operational border surveillance support service in 2014.

Thus LOBOS will implement an initial pre-operational service three months after the contract kick-off, which will be evaluated and refined through a phased development all along the project. Three successive upgraded versions of the service will be run during the two year project time period. This pre-operational service is designed to be activated by FRONTEX, through EUSC or EMSA over any geographical location.

Around 60 activations using more than 450 satellites images and ancillary data are foreseen.

LOBOS will put emphasis on modelling, statistics and analysis, relying on satellite imagery but also on Open Source Intelligence and other environmental information (meteorology, sea currents) to produce CONOPS products.

In the LOBOS approach, the R&D outcome aims at improving the services performance along its phased implementation, in terms of content, cost (automation) and delivery time capabilities. It will not prevent the delivery of the core pre-operational service.

The progress of the project will be permanently available on a dedicated web site. Moreover, the results of the project will be presented during a workshop in Warsaw in conjunction with the annual European Border Guards day in May 2014.



David HALBERT  
Project Coordinator

### QUESTIONS & ANSWERS

#### ***What is the project designed to achieve ?***

The project is designed to achieve a pre-operational border surveillance system utilising satellite data and other imagery.

#### ***Why is this project important for Europe and how does it benefit European citizens ?***

Illegal immigration and cross border crime are a major detriment to the economy of Europe and the safety of its citizens. This project will allow a more complete border surveillance system to be put in place.

#### ***How does the project exceed the current state of knowledge ?***

Except for militarised borders, and in case of a crisis event, the use of satellite data to support border surveillance is uncommon. LOBOS will lead to a system that will be the state of the art in border surveillance and monitoring.

### LIST OF PARTNERS

- Spot Image, France
- Infoterra Ltd, United Kingdom
- TNO, the Netherlands
- GMV Aerospace and Defence SA, Spain
- GMVIS Skysoft, Portugal
- Cassidian, France
- Spot Infoterra Hellas, Greece
- IABG, Germany
- European Union Satellite Centre, Spain
- Infoterra GmbH, Germany
- Astri Polska, Poland
- Center for Security Studies, Greece
- Mercator, France
- Interdisciplinary Centre for Mathematical and Computational Modelling, University of Warsaw, Poland

### COORDINATOR

Spot Image

### CONTACT

Dave Halbert  
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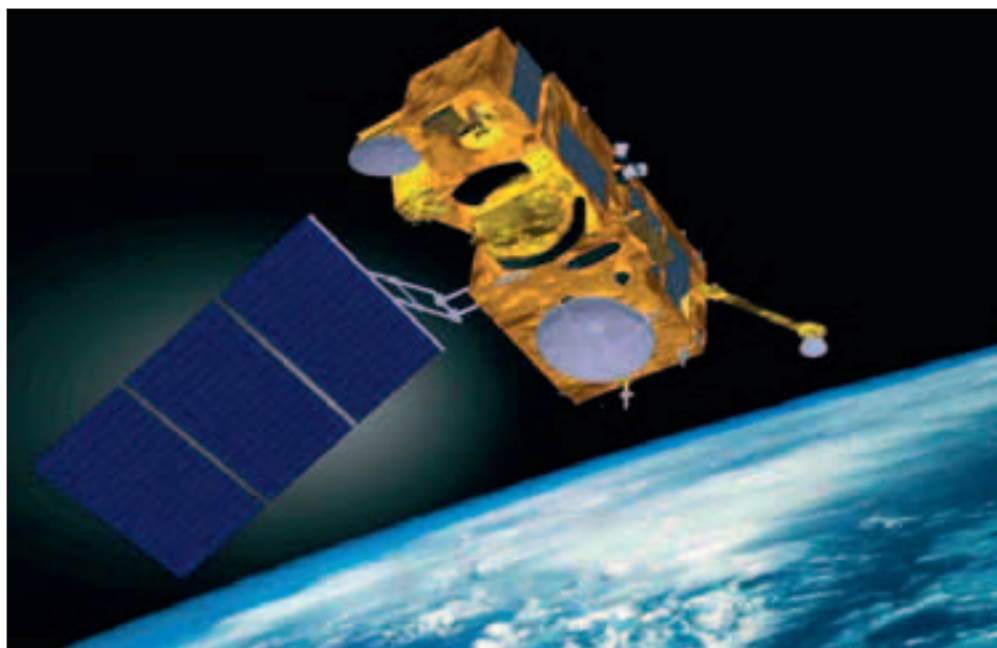
### PROJECT INFORMATION

Low time critical Border Surveillance (LOBOS)

Contract N°: 312584  
Starting Date: 01/01/2013  
Duration: 24 months  
EU Contribution: € 2.000.000,00  
Estimated total cost: € 3.371.352,40

# LOTUS

## Preparing Land and Ocean Take Up from Sentinel-3



© ESA

The Sentinel-3 satellite.



Per Knudsen  
Project Coordinator

### ABSTRACT

*The objective of the LOTUS project is to support the development of Copernicus (former GMES) by developing applications of Sentinel-3 to complete the space observation infrastructure that are designed for land and ocean monitoring for Copernicus.*

### NEW PRODUCTS FOR COPERNICUS FROM SENTINEL-3: SEA LEVEL, RIVER & LAKE LEVELS, WAVES, WIND, SOIL MOISTURE, SNOW

The radar altimeter onboard Sentinel-3 will provide observations of sea-surface and land-ice topography, in continuation of altimeter missions such as ENVISAT, Jason-1 and Jason-2. This instrument will operate in a SAR mode and provide along-track high-resolution heights of the sea surface in the open oceans, in the coastal seas, in-land water and sea ice areas. The SAR capability is a new feature and no data products based on this SAR mode data are provided or used operationally.

New methodologies and new data processing chains need to be developed to prepare the take-up of the Copernicus Sentinel-3 data. The LOTUS project will develop new methodologies, data processing chains, and applications of the SAR mode data for the high resolution sea surface heights, wave heights and wind speeds in the open oceans, coastal seas as well as in sea ice covered regions for operational marine services.

For the operational land services, the LOTUS project will develop new methodologies, data processing chains, and applications of the SAR mode data for the in-land water levels in rivers and lakes, soil moisture, and snow water equivalents. In turn, the new products based on the SAR mode data will support operational services for emergency response and security in the events of, e.g., storm surges and flooding. The new land products will support services on monitoring hydrological parameters for climate change.

Through a strong involvement of innovative companies and SMEs the LOTUS project will stimulate new commercial activities in the value-adding sectors.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The LOTUS project is designed to support the development of the land and ocean monitoring of Copernicus utilising the full potential of the new space based technologies and infrastructures. LOTUS will develop innovative applications of the new radar altimeter onboard the Sentinel-3 satellite such as sea surface heights, wave heights and river and lake levels.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

The European citizens will benefit from the improved ocean monitoring service through its support of shipping, fisheries and off-shore activities. The monitoring of land hydrology will support fresh water supplies and farming worldwide. A majority of the LOTUS partners are active in the value-adding sectors. To further promote the commercial use LOTUS will disseminate information to a wide range of SMEs.

#### **How does the project exceed the current state of knowledge ?**

The LOTUS project will develop new methodologies and applications of the new along-track high-resolution data. The radar altimeter onboard Sentinel-3 will apply the delay Doppler technology and operate in a SAR mode, providing high resolution data along track at 20 Hz or every 300 m compared to 7 km for conventional altimetry, hence improving the observation capabilities substantially.

### LIST OF PARTNERS

- Technical University of Denmark, Denmark
- Starlab Barcelona SL, Spain
- Collecte Localisation Satellites SA, France
- DHI, Denmark

### COORDINATOR

Technical University of Denmark, Denmark

### CONTACT

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Email: pk@space.dtu.dk

### PROJECT INFORMATION

Preparing Land and Ocean Take Up from Sentinel-3 (LOTUS)

Contract N°: 313238  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.994.162,00  
Estimated total cost: € 2.912.435,26

# PREFER

## Space-based Information Support for Prevention and REcovery of Forest Fires Emergency in the MediteRanean Area



Artist's concept showing the PREFER project subject.



Giovanni LANEVE  
Project Coordinator

### ABSTRACT

*PREFER will design, develop and demonstrate a space-based end-to-end information service to support prevention/preparedness and recovery phases of the Forest Fires emergency cycle in the EU Mediterranean Region. The Information Service will consist of a centralized system for archiving, visualization and delivery of the product and complete Earth Observation satellite data processing chains for 2 main services providing: Innovative products for the Preparedness/Prevention phase; Innovative products for the emergency Recovery phase.*

### SPACE BASED PRODUCTS FOR FIRE PREVENTION AND RECOVERY

PREFER aims at responding to major fire prevention needs in Southern Europe. All reports on the state of Europe's forests indicate that the broad Mediterranean area is systematically affected by uncontrolled forest fires with large impact on ecosystems, soil erosion, slope instability, desertification trends, and local economies as a whole, and a negative mid-to-long term prospect because of climate change. In this scenario, the need to improve the information and the intelligence support to forest fire prevention is widely recognized to be relevant.

PREFER intends to contribute to responding to such a pragmatic need of Southern Europe's forests by: providing timely information products based on the exploitation of all available spacecraft sensors within the project time frame (the next 3 years);

offering a portfolio of products focused both on pre-crisis and post-crisis forest fire emergency cycle which, due to the synoptic nature of the satellite based data, can be exploited by users in the different countries of the EU Mediterranean area and in compliance to the local regulations for Forest Fire Management; preparing the exploitation of new space borne sensors available by 2020 and contributing to the definition of user requirements for the new Earth Observation missions.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

PREFER aims at developing a pre-operational space-based information service capable of supporting pre- and post-event management of the forest fires emergency cycle. The Information Service will provide several innovative products whose effectiveness, accuracy and reliability will be demonstrated, in strict collaboration with a group of users, on 5 test areas representative of the EU Mediterranean region.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

The occurrence of forest fires is very common in Mediterranean regions and it has significant impacts on the environment and territory. Notwithstanding the improvements in the efficiency of fire-fighting the phenomenon is not showing a tendency to decrease. Fire prevention is still the most cost-effective strategy when compared to fire fighting and suppression able to mitigate efficiently this major environmental threat.

#### **How does the project exceed the current state of knowledge ?**

The PREFER information products, based on the exploitation of all available satellite sensors, are focused on prevention/preparedness and recovery phases of the forest fire emergency cycle in the EU Mediterranean area. Such innovative products are obtained mainly by exploiting satellite data and applying results of previous research for delivering a pre-operational service within the GMES program. Therefore, the services will be ready for operational deployment at the end of the project, as a powerful new tool at the disposal of the authorities in charge of forest fire management in the Mediterranean area.

# PREFER

## Space-based Information Support for Prevention and REcovery of Forest Fires Emergency in the MediteRanean Area

### LIST OF PARTNERS

- CGS SpA - Compagnia Generale per lo Spazio, Italy
- Intelligence for Environment and Security- IES Consulting S.r.l., Italy
- GMV Aerospace and Defence SA, Spain
- Satways- Proionta Kai Ypiresies Tilematikis Diktyakon Kai Tilepikioniakon Efarmogon Etairia Periorismenis Efthinis Epe, Greece
- Center for Security Studies, Greece
- University of Strasbourg, France
- University of Coimbra, Portugal

### COORDINATOR

University of Rome, Italy

### CONTACT

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### PROJECT INFORMATION

Space-based Information Support for Prevention and REcovery of Forest Fires Emergency in the MediteRanean Area (PREFER)

Contract N°: 312931  
Starting Date: 01/12/2012  
Duration: 36 months  
EU Contribution: € 1.906.357,88  
Estimated total cost: € 2.844.994,08

# SENSUM

Framework to integrate Space-based and in-situ sENSing for dynamic vUlnerability and recovery Monitoring



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General scheme of the SENSUM project, involving the use of space- and ground-based observing platforms and images of different scales and resolutions.

## ABSTRACT

*The SENSUM goals involve developing methods for continuous urban vulnerability assessment and analysis involving remote sensing and ground-based methods for multi-type risk analysis, the application of space technologies to disaster recovery, applying the developed tools to the specific hazards of earthquakes and landslides, including their temporal and spatial relationships, and the enhancement of the scientific and technical capacities of the Central Asian partner countries for disaster risk management and mitigation.*

## GROUND- AND SPACE-BASED METHODOLOGIES FOR URBAN VULNERABILITY ASSESSMENT

The SENSUM project is a response to the fact that human society is becoming increasingly exposed to natural hazards through urbanisation, greater dependency on technological infrastructures and environmental change. It is therefore essential to understand the changes in society's vulnerability, and to integrate this into robust estimates of risk and of losses that follow an extreme natural event. This is especially important in countries such as those in Central Asia, where area-wide knowledge of the existing building stock is lacking, and the urban environment is rapidly changing.

It is this lack of information about an urban area's vulnerability, in fact even the extent and makeup of a given town or city, which is the fundamental problem confronted by SENSUM. It is for this reason that innovative methods of integrating observations and data from Earth Observing satellites and ground based methods such as omni-directional camera surveys will be a primary focus.

However, the availability of the necessary data and information is not uniformly distributed. Hence, SENSUM will consider both "data poor" areas, such as the Isfara-Batken region between Kyrgyzstan and Tajikistan which is prone to earthquakes and landslides, and "data rich" areas such as Cologne, Germany, which is prone to seismic events.



Massimiliano PITTORE  
Project Coordinator

## QUESTIONS & ANSWERS

### **What is the project designed to achieve ?**

SENSUM is setting out to develop tools for the exploitation of remote sensing and ground-based imaging to assess the vulnerability of the urban environment. While the project's focus is on landslides and earthquakes, the methods are being designed to be utilised when considering other natural and anthropogenic disasters. These tools will be tuned towards the needs of end-users and practitioners.

### **Why is this project important for Europe and how does it benefit European citizens ?**

Despite having some of the most complete records of urban development in the world, civil protection and disaster response and mitigation planners still lack sufficient information about the vulnerability of the urban environment for truly efficient response measures. The development of cost effective methods by SENSUM will help to remedy this problem, leading to the enhancement of European society's resilience.

### **How does the project exceed the current state of knowledge?**

SENSUM will contribute to a better understanding of how risk can be estimated in rapidly changing urban environments prone to multiple types of disasters. This will be achieved by advancing methods for integrating ground- and space-borne observations, with the resulting software tools developed on a Free and Open Source basis, allowing their wider dissemination to the disaster management and mitigation communities.

# SENSUM

Framework to integrate Space-based and in-situ sENSing for dynamic vUlnerability and recovery Monitoring

## LIST OF PARTNERS

- Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum, Germany
- Centro Europeo di Formazione e Ricerca in Ingegneria Sismica, Italy
- Deutsches Zentrum für Luft und Raumfahrt, Germany
- Stiftelsen Norges Geotekniske Institutt, Norway
- University of Cambridge, England
- Institute of Geology, Earthquake Engineering and Seismology of the Academy of Sciences of the Republic of Tajikistan, Tajikistan
- Central Asian Institute of Applied Geosciences, Kyrgyzstan
- ImageCat Ltd., England

## COORDINATOR

Helmholtz-Zentrum Potsdam Deutsches  
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## PROJECT INFORMATION

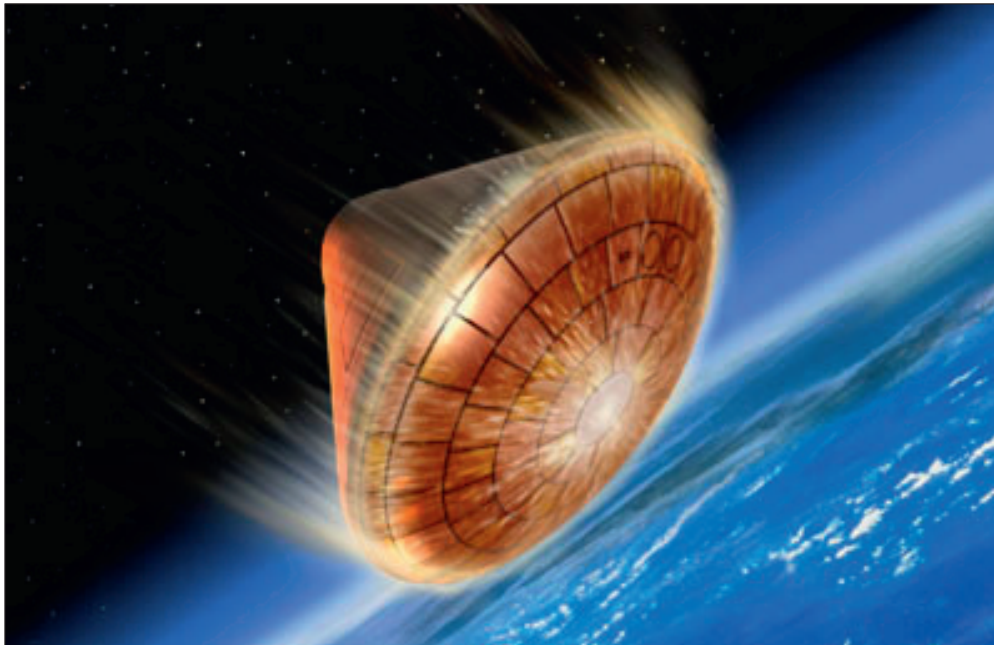
Framework to integrate Space-based and in-situ sENSing for dynamic vUlnerability and recovery Monitoring (SENSUM)

Contract N°:312972  
Starting Date: 01/01/2013  
Duration: 24 months  
EU Contribution: €1.931.683,00  
Estimated total cost: €2.439.074,00



# ABLAMOD

## Advanced Ablation Characterization and Modelling



© ESA

ESA ARD re-entry capsule.



Ali Gülhan

Project Coordinator

### ABSTRACT

*The overall objective of ABLAMOD is the improvement of the characterization and modelling of the ablation materials in flight relevant high temperature environments. The new physical models will be integrated in a modular code. For the validation advanced measurement techniques will be used to measure the ablator and flow properties during testing in most powerful European facilities.*

### DEVELOPMENT OF A NEW EUROPEAN TOOL FOR RELIABLE DESIGN OF ABLATIVE THERMAL PROTECTION SYSTEMS

Ablative thermal protection materials are a key technology for current and future space exploration missions. However, today the mission feasibility is determined by the materials available, and the development of new materials is performed, essentially, by an iterative trial-and-error process. This is due to the absence of validated predictive models for ablative material behaviour – models are tuned to bulk material properties from tests. For each new material, this tuning has to be redone because the models are not of sufficiently high fidelity to be able to make even small extrapolations. This means that materials cannot be designed to a specification to fulfil the needs of a particular mission.

Therefore the main aim of this project is to make a substantial progress for the design of an ablative thermal protection system by incorporating aspects of high fidelity mesoscale ablator physics within a modular framework.

The new model will be validated by applying advanced and sophisticated measurement techniques for the characterization of an ablator's behaviour inside a severe thermo-mechanical environment in most powerful European facilities. After its validation with experimental data the new modelling code will be used to estimate the performance of the ablative thermal protection system for realistic flight configurations.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

Development of reliable prediction tools to assess the performance of ablative thermal protection materials for severe aerothermal environments.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Improvement of the European non-dependent access to space ability by developing a high fidelity simulation tool for the design of ablative thermal protection systems.

#### **How does the project exceed the current state of knowledge ?**

- A European team with excellent skills in modelling, instrumentation and characterization of materials, with validation experiments in most powerful facilities using novel diagnostic techniques will be formed,
- The European dependency on ITAR restricted space components will be reduced,
- Consideration of system requirements for space vehicles due to the involvement of four industrial teams, who are strongly involved in on-going European projects and creation of an industrial use plan,
- Dissemination activities beyond the consortium, of the numerical tools and technology produced, including publications, conferences and exploitation of the results produced by the team,
- Education of young European scientists due to the use of the results for Ph. D, M.Sc and B.Sc theses.

### LIST OF PARTNERS

- Deutsches Zentrum für Luft- und Raumfahrt, Germany
- Astrium, France
- Avio, Italy
- Centro Italiano Ricerche Aerospaziali, Italy
- Fluid Gravity Engineering, United Kingdom
- University of Strathclyde, United Kingdom
- VKI, Belgium
- AMORIM CORK COMPOSITES, Portugal
- Austrian Institute of Technology, Austria
- Österreichisches Gießerei-Institut, Austria

### COORDINATOR

German Aerospace Center (DLR)

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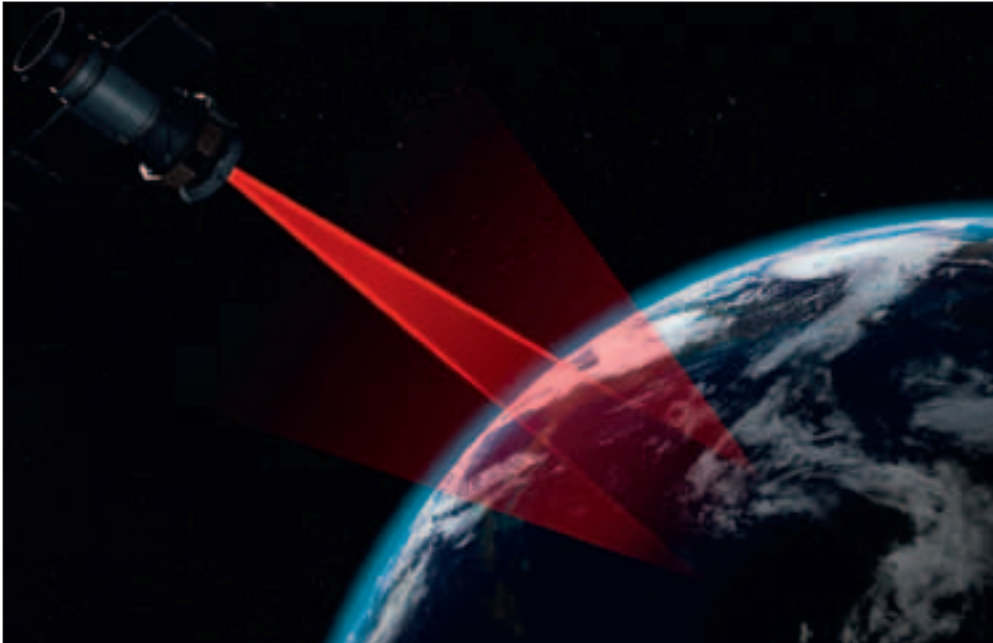
### PROJECT INFORMATION

Advanced Ablation Characterization and Modelling (ABLAMOD)

Contract N°: 312987  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.981.906,00  
Estimated total cost: € 2.735.124,20

# BRITESPACE

## High Brightness Semiconductor Laser Sources for Space Applications in Earth Observation



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Artist view of spaceborne LIDAR for earth observation.

### ABSTRACT

The BRITESPACE objective is the design, realization and validation of a semiconductor laser transmitter for monitoring greenhouse gases in future earth observation space missions. The transmitter, based on a fully integrated Master Oscillator Power Amplifier, will be a component of a LIDAR system. The project aims to demonstrate that semiconductor lasers can be used as optical sources in space applications requiring simultaneously high power, beam quality and spectral purity.

### SEMICONDUCTOR LASERS FOR EARTH OBSERVATION FROM SPACE

The availability of suitable laser sources is one of the key issues for the development of active optical instruments in future earth observation space missions. The new generation of high brightness semiconductor lasers brings advantages over other sources due to their compact size, reduced mass, high reliability and high conversion efficiency. The main objective of this project is to demonstrate the feasibility of a semiconductor based laser source to be used as a laser transmitter in a Differential-Absorption LIDAR system for the observation and monitoring of greenhouse gases in the atmosphere.

The basic building block of the project is a monolithic Master Oscillator Power Amplifier consisting of a frequency stabilized single-mode laser diode and a multi-section tapered semiconductor amplifier emitting at two wavelengths in the 1500-1600 nm region. It will be mounted in a space-compatible laser module with the beam forming optics and completed with the stabilization and control electronics.

The entire laser source will be designed to be used as the transmitter unit of a Random Modulated CW LIDAR system enabling the integrated-path measurements of atmospheric CO<sub>2</sub> concentration. The receiver unit will be also developed in order to validate the approach by performing CO<sub>2</sub> concentration measurements on ground.

In a more general context the project will pave the way for using high brightness semiconductor lasers in space applications requiring simultaneously high power, beam quality and spectral purity.



Ignacio ESQUIVIAS  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The objective of BRITESPACE is the realization and testing of a laser source based on a fully integrated semiconductor Master Oscillator Power Amplifier to be used for CO<sub>2</sub> monitoring. This includes the design of the complete system, at chip, module and transmitter level, its realization and the final testing on the field in a complete LIDAR system.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

BRITESPACE will be a step forward in the development of space borne laser sources for Earth observation from space. It will contribute to strengthening of the European leadership position in photonics technologies, focusing on relevant issues in our daily lives, such as greenhouse gas emissions in the atmosphere and its impact on climate and global warming.

#### **How does the project exceed the current state of knowledge ?**

Laser sources used in space missions have been traditionally based on solid state lasers. BRITESPACE aims to demonstrate the suitability of semiconductor lasers for their use in space, thus improving the current state of the art technologies, with smaller, more efficient and more reliable devices based on semiconductor materials.

# BRITESPACE

## High Brightness Semiconductor Laser Sources for Space Applications in Earth Observation

### LIST OF PARTNERS

- Universidad Politécnica de Madrid, Spain
- III-V Lab GIE, France
- Fraunhofer Institute for Laser Technology ILT, Germany
- Alter Technology TUV Nord SA, Spain
- University of Bristol, United Kingdom
- Deutsches Zentrum für Luft- und Raumfahrt, Germany

### COORDINATOR

Universidad Politécnica de Madrid

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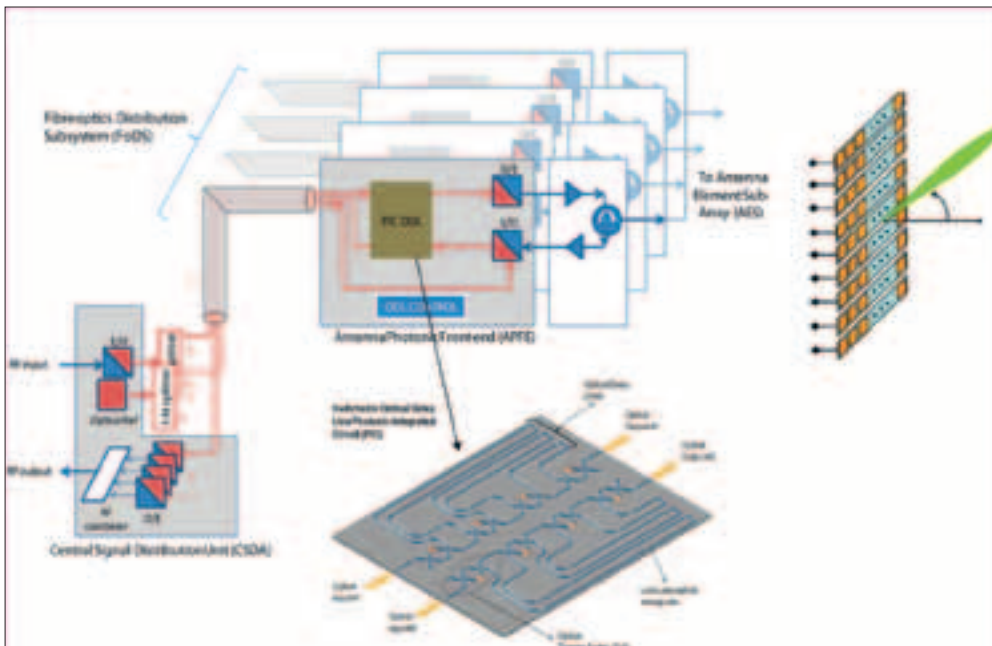
### PROJECT INFORMATION

High Brightness Semiconductor Laser Sources for Space Applications in Earth Observation (BRITESPACE)

Contract N°: 313200  
Starting Date: 01/12/2012  
Duration: 36 months  
EU Contribution: € 1.995.040,00  
Estimated total cost: € 3.086.352,00

# GAIA

## Gaia-Photonics Front-End For Next-Generation SAR Applications



GAIA Technical approach.

### ABSTRACT

The objective of GAIA is the development of the photonic technology required in future array antenna systems for SAR applications. It will provide new true-time-delay control of the signal for each antenna element by using integrated photonics in both transmission and reception, the design of the optical harness suitable for large, deployable antennas and the development of an antenna array module in the X band.

### COMPACT RADAR / SAR TECHNOLOGY FOR FUTURE EARTH OBSERVATION MISSIONS

The evolution of future generation of Synthetic-aperture radar (SAR) has shown a clear trend towards systems with better performance resulting in higher complexity (larger antennas, operating bandwidth and/or different frequencies) at lower cost as well as less mass, size and power consumption. This trend imposes strong requirements on today's technology of antennas and Radio Frequency (RF) components.

Satellite systems with larger antennas will require more complex, bulky and difficult-to-route harness to transport the RF signals from the processing unit of the satellite to the antenna. It could also impose strong mechanical and thermal requirements, especially when the antennas should be deployed in-orbit. On the other hand, larger bandwidths associated with larger antennas and scanning angles require True-Time-Delay (TTD) beamforming, resulting in bulky and complex solutions (and very limited for lower frequencies – larger delays) impacting directly the size, mass and integration cost.

In this scenario, the implementation of the TTD beamforming network of the antenna by photonic integrated circuits (PIC) technology could potentially provide an order-of-magnitude reduction in both size and mass when compared with the traditional implementation with RF technology. This photonic approach opens the door for the use of optical fibre in the antenna harness, which is more lightweight than RF harness and with very low attenuation with distance, which could reduce the risks associated to the in-orbit antenna deployment.

Additionally, the broadband nature of the photonic technology related to the transport and processing of RF signals enormously simplifies the beamforming network. Moreover, unlike the traditional RF implementation in which different substrates, waveguides and technologies must be used for different frequencies, applications or even missions, a unique common medium is used in the GAIA's approach, which also contributes to the reduction in cost and complexity of the whole system.



Alejandro MARTÍNEZ  
Project Coordinator

### QUESTIONS & ANSWERS

#### What is the project designed to achieve ?

This project aims at developing new concepts and technologies for deployable SAR antenna. The final design will be a complete modular antenna system with TTD characteristics photonically controlled which will be the base of a large, deployable SAR antenna with a net gain in bandwidth/ resolution size, mass, complexity and cost when compared with traditional implementations.

#### Why is this project important for Europe and how does it benefit European citizens ?

The achievement of GAIA goals will strengthen the European leading position in Copernicus (former GMES - Global Monitoring for Environment and Security) by developing state-of-the-art antenna systems improving the capabilities of the European SAR instrumentation applicable for Earth observation missions, which are useful for areas such as environment, security, agriculture, forestry and meteorology, civil protection and risk management.

#### How does the project exceed the current state of knowledge?

For the first time, this kind of TTD antenna system (complete modular with a net gain in bandwidth/ resolution size, mass, complexity and cost) will be developed. Moreover, the underlying photonic monolithic technology required for this application represents a clear and disruptive step ahead in the state-of-the-art of the photonic technology with a very wide range of applications in fields such as space, telecom or sensing.

### LIST OF PARTNERS

- Universitat Politècnica De València, Spain
- Das Photonics S.L., Spain
- Space Engineering, S.P.A., Italy
- Gesellschaft Fuer Angewandte Mikro Und Optoelektronik Mit Beschränkterhaftung Amo GmbH, Germany
- Science And Technology Facilities Council, United Kingdom

### COORDINATOR

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### PROJECT INFORMATION

Photonics Front-End For Next-Generation SAR Applications (GAIA)

Contract N°: 313290  
Starting Date: 01/10/2012  
Duration: 36 months  
EU Contribution: € 1.434.432,75  
Estimated total cost: € 1.961.317,41

# GAMALINK

## Generic SDR-based Multifunctional space Link



© GAMALINK - TEKEVER

Artist's impression of the GAMALINK concept.

### ABSTRACT

*The objective of GAMALINK is to develop an Inter Satellite Link (ISL) based on Software-Defined Radio (SDR) technology capable of supporting mobile ad hoc networking, GPS, and attitude determination using the VOR (VHF Omni directional Radio) concept, for nano- and pico-satellite platforms. The end result will be a prototype ready for integration in a Cubesat launch opportunity.*

### A SOFTWARE-DEFINED RADIO (SDR) INTER SATELLITE LINK (ISL) WITH NETWORKING AND ATTITUDE DETERMINATION CAPABILITIES

In the field of communications, terrestrial technologies are far more advanced than those applied in space. Spin-in of terrestrial technologies can be pursued to provide the technology push that will lead space markets beyond the current state of the art.

GAMALINK will combine satellite navigation, ad hoc networking, attitude determination, antenna design and beam forming into a compact common technological platform, suitable for small satellite LEO missions. This platform will be based on Software-Defined Radio (SDR), an innovative terrestrial concept that enables the development of various waveforms using a common hardware platform.

A set of different techniques will be implemented on top of this: mobile ad hoc networking, an enabler for ISLs, attitude determination of one station relative to another, through the measurement of carrier phase delays between signals, transmitted from multiple antennas, GPS waveform reading and signal decoding and ranging between different satellites, based solely on the transmission of radio signals. GAMALINK will also focus on innovative antenna, RF front-end design and beam forming techniques.

On the one hand, it proposes to bring SDR to space, a breakthrough terrestrial technology acting as basis for laying several other state of the art techniques on top. On the other hand, it offers an integrated solution for communications and attitude and orbit control purposes, targeting the increasingly popular small satellites' market. Nevertheless, GAMALINK's ultimate goal is to prove the applicability of a wide range of technologies in space, in an attempt to increase their technology maturity level both in terrestrial and in space applications.



André OLIVEIRA  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

GAMALINK is designed to develop a prototype of an Inter Satellite Link (ISL) based on Software-Defined Radio (SDR) technology capable of supporting mobile ad hoc networking, GPS, and attitude determination using the VOR (VHF Omni directional Radio) concept, for nano- and pico-satellite platforms. This prototype will be prepared for integration in a subsequent Cubesat launch opportunity after project conclusion.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Faster validation of innovative technologies for space use is key in opening opportunities for new space players and fostering space technology progress. GAMALINK will improve small satellite technology, accelerate technology maturing and enable high impact, high risk missions (like formation flying, in-orbit servicing or networked science) with benefits to citizens (e.g. better satellite communications or deeper understanding of space and our solar system).

#### **How does the project exceed the current state of knowledge?**

The use of multiple waveform SDR in space to support multiple applications is innovative in the small satellite world. The concurrent application of VOR for attitude determination, ad hoc networking using inter-satellite links in LEO constellations, and precise ranging with differential GPS are beyond the state of knowledge. This progress will be demonstrated in a prototype capable of all the above.

### LIST OF PARTNERS

- TEKEVER, Portugal
- DVLX, Turkey
- TTI Norte, Spain
- Universidade do Porto, Portugal
- Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung, Germany
- TUBITAK Uzay, Turkey

### COORDINATOR

TEKEVER, Portugal

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### PROJECT INFORMATION

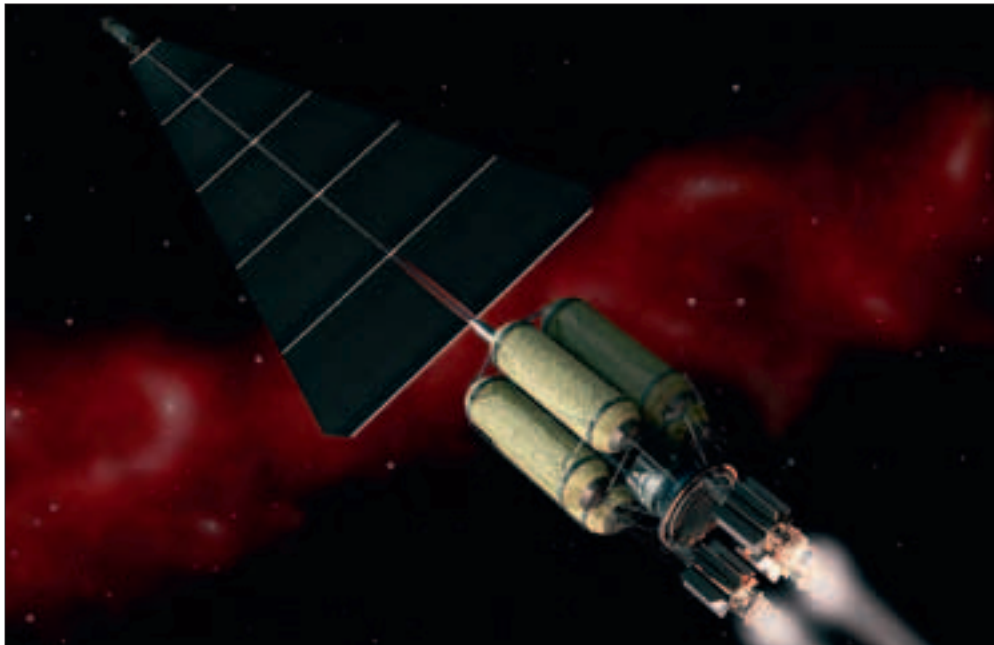
Generic SDR-based Multifunctional Space Link (GAMALINK)

Contract N°: 312830  
Starting Date: 01/01/2013  
Duration: 24 months  
EU Contribution: € 1.484.973,20  
Estimated total cost: € 1.914.826,17



# MEGAHIT

## Megawatt Highly Efficient Technologies for Space Power and Propulsion Systems for Long-duration Exploration Missions



© CNES/ILSZAMES Alexandre, 2006

Artistic impression of a spacecraft with nuclear-electric propulsion.



Jean-Claude WORMS  
Project Coordinator

### ABSTRACT

*MEGAHIT will address the European development plan for high-power nuclear electric propulsion technology, preparing a potential future international cooperation through coordination action with potential partners, leading to the establishment of a common European roadmap involving all stakeholders. The roadmap will be driven by technological choices that suit the long term objectives of space exploration. It should be the supporting tool in defining common research objectives and initiating research alliances.*

### DEVELOPMENT PLAN FOR HIGH-POWER NUCLEAR ELECTRIC PROPULSION TECHNOLOGY

Space exploration is one of Europe's priorities. Numerous successful missions (Mars Express, Cassini-Huygens, SOHO...) have proved that this field is often a privileged ground for intra-European and international cooperation. Advanced propulsion and energy sources are at the core of solar system exploration efforts. Indeed, very ambitious missions to the outer solar system, like sample return from moons of giant planets or manned Mars exploration, are challenges that are difficult, if not impossible, to undertake with current propulsion means. Conventional propulsion modes for such missions also have other important drawbacks: transfer times to Mars cannot be reasonably lowered below a minimum of 6 months and launch windows are scarce and tight.

This can be generalized to all exploration missions, either robotic or manned, to other celestial bodies. Several solutions are being studied to overcome the limits of classical propulsion.

Among them high power electric propulsion seems to be one of the most promising candidates.

The objective of MEGAHT is to address the development plan for high-power nuclear electric propulsion technology that has been recognised internationally as a key enabling technology for the future, preparing a potential future international cooperation through adequate coordination action with potential partners, leading to the establishment of a common roadmap involving all stakeholders. The roadmap will be driven by technological choices that suit the long term objectives of space exploration. It should be the supporting tool for defining common research objectives, drawing-up research agendas and initiating research alliances.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

MEGAHIT aims to develop a roadmap for high-power nuclear electric propulsion technology and prepare the ground for future international cooperation between the partners. It should be the supporting tool for defining common research objectives, drawing-up research agendas and initiating research alliances.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

High power nuclear electric propulsion is probably the most viable candidate for enabling ambitious missions and human exploration to the solar system. MEGAHT will help guide Europe to a leadership position in Solar System exploration and enhance international cooperation within and outside the European Union.

#### **How does the project exceed the current state of knowledge ?**

European expertise exists in this field but it is neither consolidated nor focused. MEGAHT will connect European experts in the field of advanced nuclear propulsion and will set the basis for future collaborations. The final roadmap will provide Europe with the first consolidated plan for developing high-power propulsion for solar system exploration.

# MEGAHIT

Megawatt Highly Efficient Technologies for Space Power and Propulsion  
Systems for Long-duration Exploration Missions

## LIST OF PARTNERS

- European Science Foundation, France
- Deutsches Zentrum für Luft- und Raumfahrt, Germany
- Centre national d'études spatiales, France
- Thales Alenia Space Italia, Italy
- Keldysh Research Center, Russia
- National Nuclear Laboratory, United Kingdom

## COORDINATOR

European Science Foundation, France

## CONTACT

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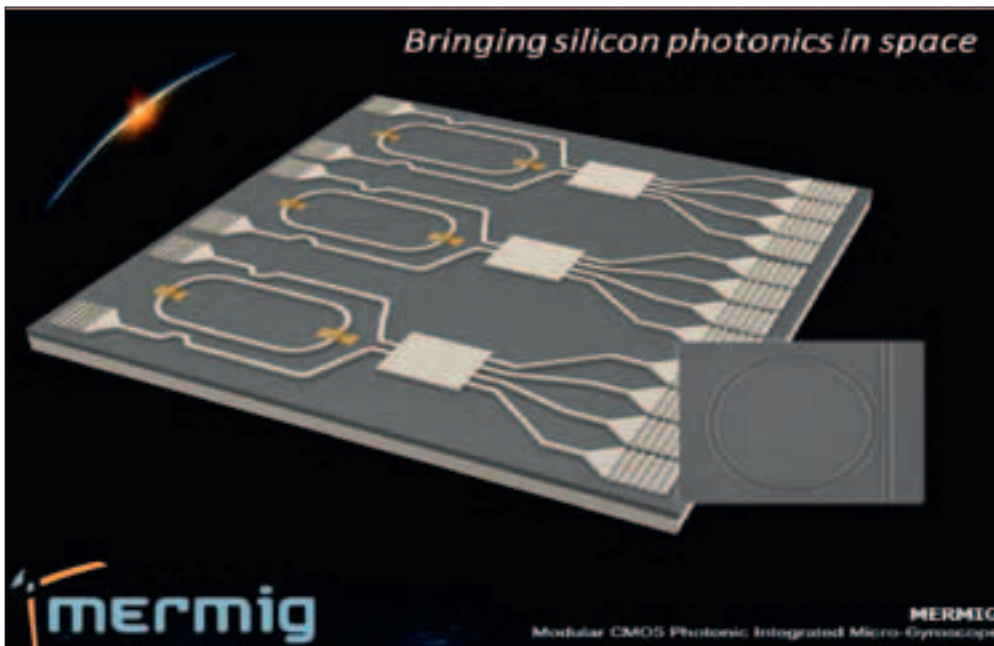
## PROJECT INFORMATION

Megawatt Highly Efficient Technologies for Space Power and Propulsion Systems for Long-duration  
Exploration Missions (MEGAHIT)

Contract N°: 313096  
Starting Date: 01/01/2013  
Duration: 18 months  
EU Contribution: € 495.382,83  
Estimated total cost: € 565.903,60

# MERMIG

## Modular CMOS Photonic Integrated Micro-Gyroscope



The figure shows the artistic view of the MERMIG chip-scale gyroscope incorporating splitters, gratings, cavities and interferometers in integrated on a silicon substrate. The inset shows an optical resonator component integrated using the silicon nano-phonic platform.

### ABSTRACT

MERMIG is focused on five main objectives related to the development of a silicon micro-gyroscope photonic integrated circuit (SGPIC): Ultra compactness by building a optical gyroscope on a photonic chip; Low cost and reliable CMOS-compatible fabrication using SOI nano-phonic platform; Fibre-coupled 1.55 micron high-power gyroscope laser module; Compact, power efficient and modular gyroscope system; SGPIC system evaluation and exploitation.

### DEVELOPMENT OF A NEW GENERATION PHOTONIC GYROSCOPE-ON-A-CHIP FOR SPACE

Space system vendors seek solutions to deliver small-size and cost-effective sensor systems to “de-congest” satellite payloads, drastically reduce the equipment cost and open the possibility for new generation of micro-payload systems. MERMIG aims to provide this technology replacing current expensive, bulky, heavy and power-consuming fibre optic gyroscopes (FOGs).

To address these key challenges, MERMIG invests in the right mix of silicon photonic CMOS-compatible component fabrication and nano-imprint lithography laser fabrication. Both technologies are being adopted by the terrestrial telecom market and MERMIG will develop them for bringing their unique advantages into space sensor systems. MERMIG will squeeze the bulky FOG into a couple of cm<sup>2</sup>, integrating a cavity, pin junctions and a phase decoder into compact sub-micron waveguides. The MERMIG “smart” packaging technique will allow power-efficient optical pumping and hermetic packaging of the gyro-photonic chip.

MERMIG will develop the first 1550nm high-power laser with a fiber-coupled power of 150mW using an integrated laser MOPA, fabricated with advanced nano-imprint lithography. The 150mW delivered will enable a modular architecture for 3-axis sensing. The single-step NIL process ensures low-cost and high-volume laser production.

MERMIG will bring together photonics and electronics on a fully-functional opto-electronic gyroscope system prototype. MERMIG will deliver to ASTRUM a new generation gyroscope that will weigh <1kg, consume <5W electrical power in a few cm<sup>3</sup> footprint. The angle random walk range that will be feasible within MERMIG is 0.1–0.01 deg/sqrt(hr) suitable for telecommunications and scientific satellites. The technology fully allows for future integration of photonic “gyroscopes-on-a-chip”.



Leontios Stampoulidis  
Project Coordinator

### QUESTIONS & ANSWERS

#### What is the project designed to achieve ?

MERMIG is a technology-intensive project that aims to exploit silicon photonic integration on CMOS and Nano-Imprint Lithography used in telecoms. It provides a modular, compact and low cost optical gyroscope that meets the requirements of new generation micro-sensors for space robotics, micro-payloads and power/cost-efficient satellite systems.

#### Why is this project important for Europe and how does it benefit European citizens ?

European citizens will be able to benefit from the new MERMIG space technology, enabling more efficient and lighter space components. The introduction of photonics in space is directly linked with the prospect of reducing the mass, volume and power consumption of satellite systems with the associated performance improvement and cost reduction

#### How does the project exceed the current state of knowledge?

CMOS compatible fabrication and nano-imprint lithography will play a key role in advancing the current state-of-the-art. The photonic gyroscope circuit can be fabricated in high volumes and at a very low cost with the strong potential of electronics optics co-integration on CMOS that will bring about even smaller and more functional sensor chipsets. Cost-effective nano-imprint lithography for fabrication of high performance gyroscope laser module (GLM). It is technically possible to fabricate GLM modules in high volumes and at low-cost with the ability to couple >100 mW into a fibre.

### LIST OF PARTNERS

- Universitat Politecnica de Valencia, Spain
- Astrium S.A.S, France
- Constelex Technology Enablers LTD, Greece
- Modulight OY, Finland
- IHP GMBH – Innovations for High Performance Microelectronics / Leibniz-Institut fuer Innovative Mikroelektronik, Germany
- DAS Photonics SL, Spain
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### COORDINATOR

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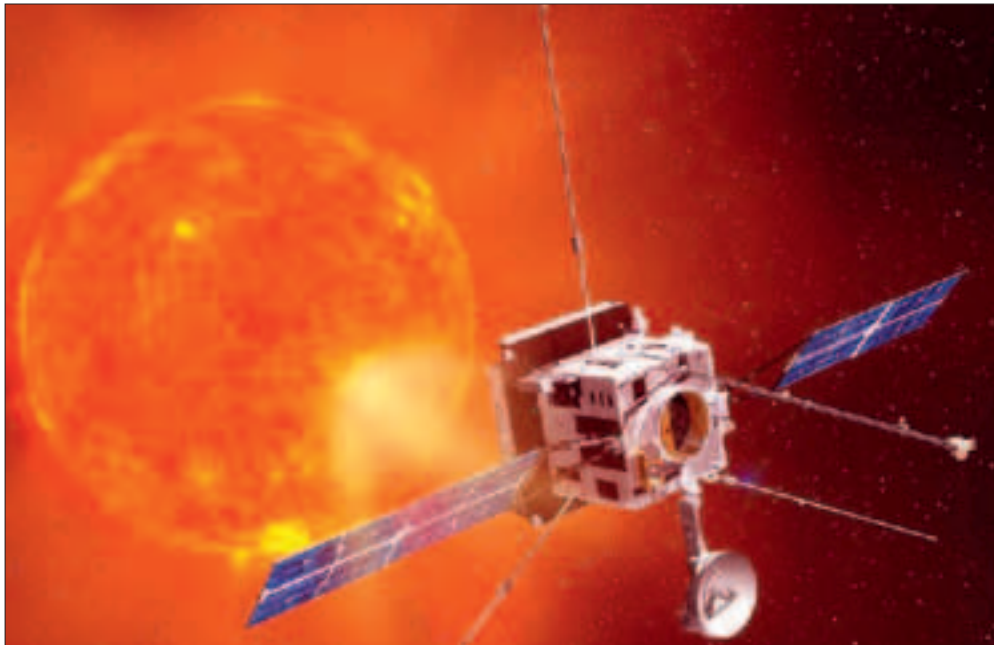
### PROJECT INFORMATION

Modular CMOS Photonic Integrated Micro-Gyroscope (MERMIG)

Contract N°: 313037  
Starting Date: 01/10/2012  
Duration: 36 months  
EU Contribution: € 1.495.364,00  
Estimated total cost: € 1.1951.103,20

# MISSION

Methodology and assessment for the applicability of ARINC-664 (AFDX) in Satellite/Spacecraft on-board communication networks



© European Union Satellite Centre (EUSatCen)

Example of Satellite Overflight.

## ABSTRACT

*MISSION aims: (a) to define the methodology for applying ARINC-664 (AFDX) in on-board spacecraft/satellite communication networks; (b) to define the interfaces/modifications to existing on-board I/O subsystems and (c) to implement and validate an experimental prototype ARINC-664 (AFDX) network for spacecraft on-board communications.*

## APPLICABILITY OF ARINC-664 (AFDX) IN SATELLITE/SPACECRAFT ON-BOARD COMMUNICATION NETWORKS

ARINC-664 Part 7 specification (AFDX) provides the enabling technology for network I/O in Integrated Modular Avionics (IMA) architectures, since it is designed based on the IMA concepts and requirements (ARINC 653 specification), already an ESA roadmap (i.e. IMA4Space project). In order to avoid the lack of flexibility, scalability, reliability and to improve security and qualification process in spacecraft on-board data networks, ARINC-664 (AFDX) could be the solution by offering hardware assisted service, determinism and standardisation as a minimum. Additionally AFDX has been validated and is in use today in the European avionics industry, which has, in some areas, quite similar requirements with the space domain, and could be more easily adopted (over SpW, or directly Ethernet for space).

MISSION aims are following: to define the methodology for applying ARINC-664 (AFDX) in on-board spacecraft/satellite communication networks; to define the interfaces/modifications to existing on-board I/O subsystems and to implement and validate an experimental prototype ARINC-664 (AFDX) network for spacecraft on-board communications.

The MISSION project aims to apply the IMA avionics concept on spacecrafts, together with highly deterministic interconnected on-board network (ARINC-664, AFDX). It will constitute an enabling technology harmonization and standardization action, together with an intrinsic improvement of systems performance, product assurance and reliability. It is expected to provide multiple benefits at all industrial levels, such as standardized and configurable systems, products and technology elements, easier and faster integration of complex systems, larger procurement basis, easier sub-contracting scheme.



Vangelis KOLLIAS  
Project Coordinator

## QUESTIONS & ANSWERS

### **What is the project designed to achieve ?**

MISSION aims to apply the IMA avionics concept on spacecraft, together with highly deterministic interconnected on-board network (ARINC-664, AFDX). The objective of this project is to implement and validate an experimental prototype ARINC-664 (AFDX) network for spacecraft on-board communications (based on the operational spacecraft bus profile).

### **Why is this project important for Europe and how does it benefit European citizens ?**

MISSION will pave the way for the entire European ARINC-664 (AFDX) community to exploit its know-how in the space market, thus providing them with significant competitive advantages and offering new business opportunities in the space sector. It will allow the development of new SW, HW subsystems, solutions and products to be developed for the space market, thus its impact on the European Hi-Tech industry is expected to be high.

### **How does the project exceed the current state of knowledge?**

MISSION will constitute an enabling technology harmonization and standardization action, together with an intrinsic improvement of systems performance, product assurance and reliability. It is expected to provide multiple benefits at all industrial levels, such as standardized and configurable systems, products and technology elements, easier and faster integration of complex systems, larger procurement basis, easier sub-contracting scheme.

# MISSION

Methodology and assessment for the applicability of ARINC-664 (AFDX) in Satellite/Spacecraft on-board communication networks

## LIST OF PARTNERS

- TELETEL S.A. – Telecommunications and Information Technology, Greece
- Creative Electronic Systems, Switzerland
- GTD Sistemas de Informacion, Spain
- Astrium S.A.S., France
- University of Surrey, United Kingdom

## COORDINATOR

TELETEL S.A., Greece

## CONTACT

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## PROJECT INFORMATION

Methodology and assessment for the applicability of ARINC-664 (AFDX) in Satellite/Spacecraft on-board communication networks (MISSION)

Contract N°: 312746  
Starting Date: 01/01/2013  
Duration: 24 months  
EU Contribution: € 1.332.674,25  
Estimated total cost: € 1.800.037,00

# NANOSAT

Utilizing the potential of NANOSATellites for the implementation of European Space Policy and space innovation



© ESA/ESTEC

ESTCube-1 - a new addition to the European nanosatellites. Pushing the limits of nanosatellite technology, ESTCube-1 sets out to demonstrate the Electric Solar Wind Sail technology for the first time in space.

## ABSTRACT

*The main objective of the NANOSAT project is to contribute to a roadmap for space and innovation in Europe through studies and events and support highly capable small satellites and thereby innovative space applications and new business models for space missions in Europe.*

## NANOSATELLITES IN SUPPORT OF EUROPEAN SPACE POLICY

Nanosatellites serve to be a cost-effective science and technology platform to make a sustainable contribution to a roadmap for space and innovation in Europe, which includes realising the potential of new and innovative space applications and stimulating the evolution of new business models for space missions. NANOSAT project brings together partners from nanosatellite development networks in Europe:

- to create opportunities for continuous collaboration between nanosatellite players;
- further the advancement of a nanosatellite platform;
- to speed up development of innovative space applications and share the best practice amongst space community.

The main objective of the NANOSAT project is to contribute to a roadmap for space and innovation in Europe through studies and events in support of highly capable small satellites and thereby innovative space applications and new business models for space missions in Europe. In order to reach to desired impact, the NANOSAT project aims to: consolidate the main actors in the

European nanosatellites landscape by creating a functional network, showcasing best practices and potential markets thereby serving the objectives of the European Space Policy; demonstrate the potential of nanosatellites in Europe by proposing innovative services, which will complement and create synergy with Copernicus (formerly GMES) services by addressing information needs faster and more flexibly; draw "proof of concept" missions that will realise the ability of nanosatellites to perform missions like communications and Earth observation in support of the European Space Policy.



Kristo REINSALU  
Project Coordinator

## QUESTIONS & ANSWERS

### **What is the project designed to achieve ?**

NANOSAT project focuses on the consolidation of the main European actors in the field of nanosatellites by creating a functional network and by showcasing best practices and potential markets. The project also demonstrates the potential of nanosatellites in Europe by proposing innovative services and roadmap for nanosatellites missions.

### **Why is this project important for Europe and how does it benefit European citizens ?**

Although the size of nanosatellites constrains their capability, they are still viable science platforms and the fidelity and range of applications will continue to grow. This will be supported by the integration of advances in miniature, micro-, and nanotechnologies, which will enable ever more sophisticated nanosatellite applications for the citizens of Europe in coming years.

### **How does the project exceed the current state of knowledge ?**

Mapping the current status and analysing the potential of nanosatellites versus needs and costs would provide an important input to decision makers at the European and international levels. Furthermore, NANOSAT project is expected to give valuable insights to EC and ESA in areas such as technological competitiveness, autonomous access to space, cost-effective S&T platform, adding value to Copernicus.

# NANOSAT

Utilizing the potential of NANOSATellites for the implementation of European Space Policy and space innovation

## LIST OF PARTNERS

- Invent Baltics, Estonia
- Orbitale Hochtechnologie Bremen-System AG – OHB, Germany
- Nanospace AB, Sweden
- Tartu Observatory, Estonia
- Aalborg University, Denmark

## COORDINATOR

Invent Baltics (Estonia)

## CONTACT

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## PROJECT INFORMATION

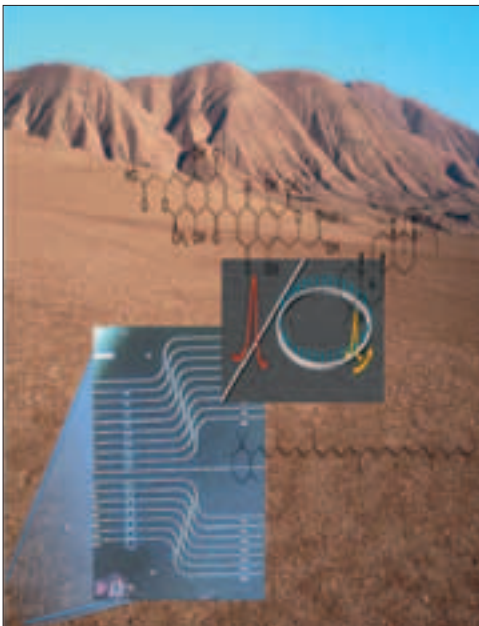
Utilizing the potential of NANOSATellites for the implementation of European Space Policy and space innovation (NANOSAT)

Contract N°: 313116  
Starting Date: 01/01/2013  
Duration: 24 months  
EU Contribution: € 498.216,00  
Estimated total cost: € 498.216,00



# PBSA

## Photonic Biosensor for Space Application



© Victor Parro

Photonic microrings and waveguides functionalized with antibodies (blue Y form in the small insert) to detect molecular biomarkers.

### ABSTRACT

*The objective of the PBSA project is the implementation of a photonic, label-free and real time immunosensor for the detection of microbial life markers for space and planetary exploration. A compact PBSA device with integrated microfluidics, photonic components and biosensing elements (antibodies or other capturing molecules) will be constructed and tested. The subsystems and the whole device will be tested under space-relevant conditions: high energy radiation or Martian conditions.*

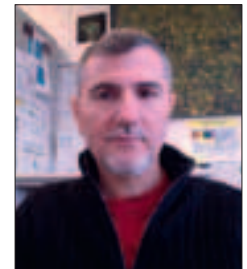
### INSTRUMENT TO DETECT MOLECULAR BIOMARKERS BY PHOTONIC INTEGRATED IMMUNOSENSOR FOR SPACE AND PLANETARY EXPLORATION

There are a number of applications in space that require rapid, robust, light and automatic biosensing techniques. For example, for checking the microbial contamination in space stations or to search for life in planetary exploration. The PBSA proposal aims to implement a Lab-on-a-chip (LoC) device with a photonic immunosensor and to demonstrate its use for microbial monitoring and life detection missions. Advanced terrestrial technologies in the field of biosensors are combined for the development of a novel solution ready and tested for the space environment. This approach employs recent advances in antibody microarray-based immunosensors with two powerful technologies, photonic integrated circuits (PICs) and microfluidics.

The use of PIC enables the implementation of highly integrated solutions for the implementation of a LoC. Multiple detection can be integrated into a single chip for multiple parallel analyses.

That is, multiple microbial targets or biomolecules can be detected simultaneously. This technology has shown to be very sensitive and improves the protocol simplicity compared to other techniques such as the fluorescent approach that requires labelling steps. The PIC based solution permits direct and real time measurement of the target analytes (molecules or whole microbes) in just a few minutes. This feature, together with microfluidics, makes PBSA suitable for remote sensing in space applications, where savings in reagents are very valuable.

Both photonic and microfluidic systems optimize critical parameters in space applications (volume and mass), enabling new opportunities. These benefits apply also to terrestrial markets, such as veterinary or biomedical purposes.



Victor Parro  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The project target is to develop and build a prototype instrument capable of analyzing complex liquid samples by means of a photonic integrated circuit immunosensor. Antibodies will be immobilized onto a photonic ring chip allocated in a microfluidic chamber and connected to microfluidic conduits. Analytes will be detected in a real time and label-free mode by recording the resonant signal produced by the bound analyte to antibody after a laser beam light passes next to the rings.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Developing quick, robust and light biosensors capable of working under space relevant conditions would put Europe in the lead in the development of biosensing technology for space applications, such as monitoring space station or for the search for life in planetary exploration. Additionally, it would strength the capacity of the European industry, and particularly of the aerospace industry. New biosensing technology can be applied to environmental, veterinary or biomedical monitoring.

#### **How does the project exceed the current state of knowledge ?**

The aim of the call was to bring terrestrial sensors to space applications. So, the current knowledge will be exceed by

- Adapting integrated photonic circuits, including the sensor, light source and light detector for space applications. For example by developing a high sensitive, label-free and real time biosensor for biomolecules or microbes for planetary exploration or to monitor the contamination of space satiations.
- Testing a compact and light microfluidic system (deposits, pumping and valves) under space relevant conditions. E.g. in a Mars simulation chamber. This will allow new portable devices for space and planetary exploration.

### LIST OF PARTNERS

- Instituto Nacional de Técnica Aeroespacial (INTA), Spain
- DAS Photonics, Spain
- Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung, Germany
- EVOLEO Technologies LDA, Portugal

### COORDINATOR

Instituto Nacional de Técnica Aeroespacial  
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### CONTACT

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### PROJECT INFORMATION

Photonic Biosensor for Space Application (PBSA)

Contract N°: 312942  
Starting Date: 01/12/2012  
Duration: 24 months  
EU Contribution: € 1.469.847,49  
Estimated total cost: € 1.879.851,00

# PEASSS

## PiezoElectric Assisted Smart Satellite Structure



© ISIS

Conceptual view of PEASSS CubeSat.

### ABSTRACT

*The objective of the PEASSS project is to develop, manufacture, test and qualify “smart structures” which combine composite panels, piezoelectric materials, and next generation sensors, for autonomously improved pointing accuracy and power generation in space. Smart structures will enable fine angle control, thermal and vibration compensation, improving all types of future Earth observations, such as environmental and planetary mapping, border and regional imaging.*

### COMPOSITE STRUCTURES WITH EMBEDDED SENSORS, PIEZOELECTRIC ACTUATORS AND POWER GENERATION FOR SPACE

The objective of the PEASSS project is to develop, manufacture, test and qualify “smart structures” which combine composite panels, piezoelectric materials, and next generation sensors, for autonomously improved pointing accuracy and power generation in space. Smart structures will enable fine angle control, thermal and vibration compensation, improving all types of future Earth observations, such as environmental and planetary mapping, border and regional imaging.

This new technology will help keep Europe on the cutting edge of space research, potentially improving the cost and development time for more accurate future sensor platforms, including synthetic aperture optics, moving target detection and identification, and compact radars.

The system components include new nanosatellite electronics, a piezo power generation system, a piezo actuated smart structure, and a fiber-optic sensor and interrogator system. The designs will be prototyped into breadboard models for functional development and testing.

Following completion of operational breadboards, components will evolve to flight-test ready hardware and related software, ready to be integrated into a working satellite. Once the nanosatellite is assembled, on-ground tests will be performed. Finally, the satellite will be launched and tested in space.

Results of the program will be disseminated to industry through a project website, papers, courses, and presentations. Actuated “smart structure” technology will take the first steps toward space qualification in the PEASSS project, making it a proven viable technology, with a high TRL available to improve future European space missions. PEASSS technologies will give European space, aviation, and other industries a new tool in their design repertoire.



Matthew  
MANISCALCO  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The main objective of the PEASSS project is the development, manufacturing, testing and qualification in a space environment of “smart structures” which combine composite panels, piezoelectric actuators/generators, and next generation sensors for accurate pointing and power generation.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

The project directly enables European space observation and in-space activities, by improving power, accuracy and stability of Earth Observation sensor platforms, to monitor the health and impacts of human activities, including industrialisation, farming, mining, smuggling, terrorism and immigration. This new “smart structure” technology may also provide positive economic impacts on other industries, such as automotive, aviation and consumer products.

#### **How does the project exceed the current state of knowledge?**

Piezoelectric actuators embedded in a composite structure is a new technology for space, which aims to increase pointing accuracy and stability, while decreasing mass and power consumption. Embedded fiber optic sensors are also cutting edge, allowing structural monitoring without wiring and related electromagnetic interference. Piezo power generation can be incorporated into structures, allowing power for distributed sensor networks.

### LIST OF PARTNERS

- TNO, the Netherlands
- ISIS, the Netherlands
- NSL Satellites, Israel
- Active Space Technologies, Germany
- Technion, Israel
- SONACA, Belgium

### COORDINATOR

TNO, Netherlands

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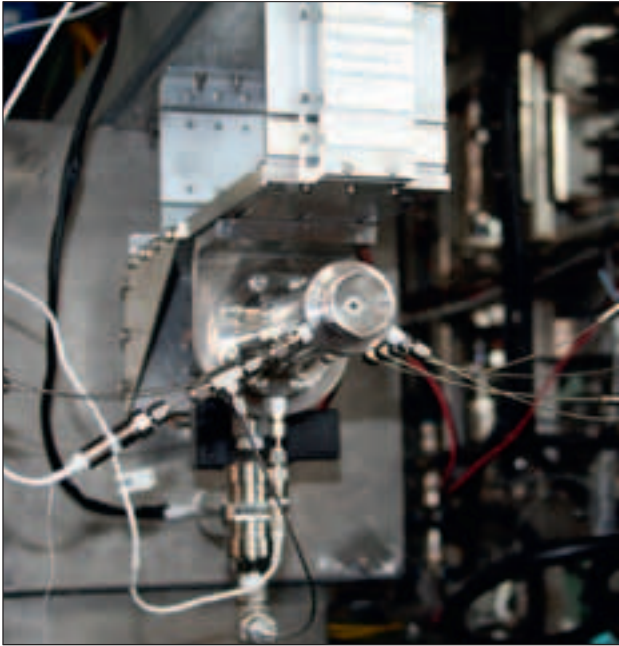
### PROJECT INFORMATION

PiezoElectric Assisted Smart Satellite Structure (PEASSS)

Contract N°: 312216  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.994.537,00  
Estimated total cost: € 2.667.403,80

# PulCheR

## Pulsed Chemical Rocket with Green High Performance Propellants



© Alta S.p.A.

A picture of the "green" monopropellant set-up at Alta S.p.A.

### ABSTRACT

*The PulCheR project aims at demonstrating the feasibility of a new propulsion concept that can substitute today's propulsion system in particular for satellite applications. The feasibility of the new propulsion concept will be investigated using "green" propellants, both in mono and bipropellant configurations, at breadboard level through the design, realization, assembly and testing of a platform of the overall propulsion system that will include all its main components.*

### A NEW PROPULSION CONCEPT USING "GREEN" PROPELLANTS

PulCheR is a new propulsion concept in which the propellants are fed in the combustion chamber at low pressure and the thrust is generated by means of high frequency pulses, reproducing the defence mechanism of a notable insect: the bombardier beetle.

The radical innovation introduced by PulCheR is the elimination of any external pressurizing system even if the thruster works at high pressure inside the combustion chamber. At each pulse, pressurization of the combustion chamber gases takes place due to the decomposition or combustion reaction, and the final pressure is much higher than the one at which the propellants are stored. The weight of the feeding system is significantly reduced because the propellants are fed at low pressure, and there is no need for turbopumps, high pressure propellant tanks or gas vessels. The feed pressure becomes independent on the chamber pressure and the performance degradation typical of the blow down mode in monopropellant thrusters can be avoided.

The PulCheR concept is able to substitute many currently used propulsion systems for satellite applications.

The feasibility of this new propulsion concept will be investigated at breadboard level in both mono and bipropellant configurations through the design, realization and testing of a platform of the overall propulsion system, including all its main components. In addition, the concept will be investigated using green propellants with potential similar performance to the current state-of-the-art for monopropellant and bipropellant thrusters. The test campaign will experimentally investigate the propulsive performance of the system.



Lucio TORRE  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The project aims at demonstrating the feasibility of the new propulsion concept at a breadboard level through the design, realization, and testing of the overall propulsion system including: One monopropellant thruster (5-10 N); One bipropellant thruster (20-100 N); Tanks, valves and lines.

As an additional challenge, the project will employ "green" high performance storable propellants.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Nowadays, European aerospace industry is strongly interested in finding different chemicals (possibly "green") for substituting hydrazine. New frontiers of research will be opened for virtually all the propulsion system components, due to the new concepts developed for the thrust generation (pulsed operation). All the European space community could benefit from the new technology that will come out of the project.

#### **How does the project exceed the current state of knowledge?**

The PulCheR concept considerably simplifies the propulsion subsystem. Its main advantages are: Low feeding pressure; Feeding/chamber pressures independency; Feeding system weight reduction (almost halving the dry-mass) and cost savings; Reduced "blow down" performance degradation; Increased reliability; Fine control of Minimum Impulse Bit; Thrust modulation; High propulsive performance with "green" propellants.

### LIST OF PARTNERS

- Alta S.p.A., Italy
- Thales Alenia Space France, France
- Moog Inc Cooperation, USA
- Japan Aerospace Exploration Agency, Japan
- Bradford Engineering B.V., the Netherlands
- National Center for Scientific Research "Demokritos", Greece
- Institute of Aviation, Poland
- Universität Bremen (ZARM), Germany
- Università di Pisa (DCCI), Italy

### COORDINATOR

Alta S.p.A., Italy

### CONTACT

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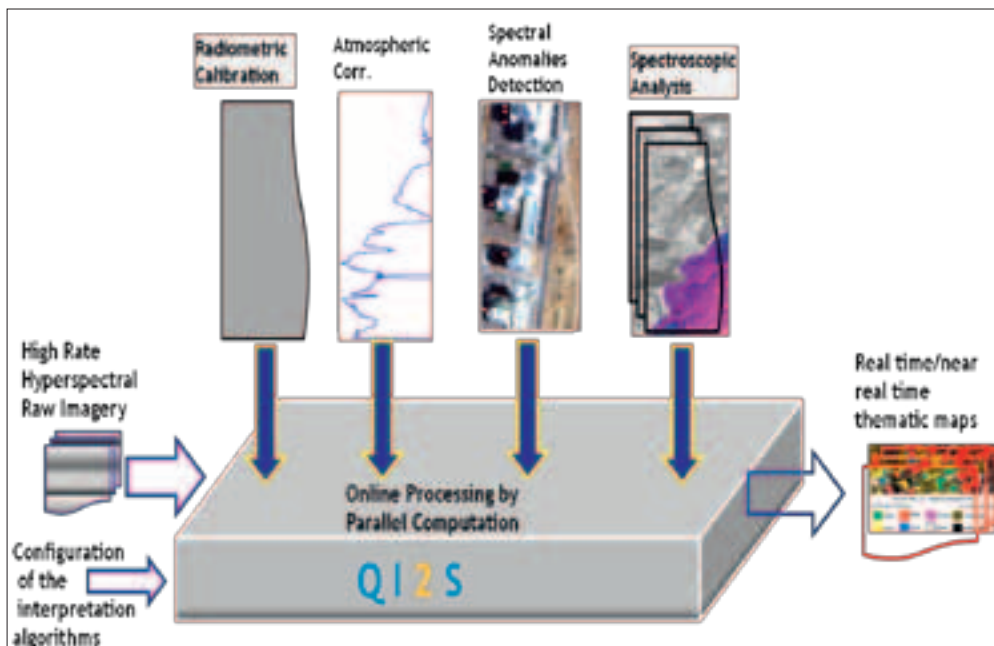
### PROJECT INFORMATION

Pulsed Chemical Rocket with Green High Performance Propellants (PulCheR)

Contract N°: 313271  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.853.667,15  
Estimated total cost: € 2.600.592,60

# QI2S

## Quick Image Interpretation System



Overview of QI2S solution – input, process and outcome.

### ABSTRACT

QI2S will enable dramatic reductions of delay in the delivery of Earth Observation (EO) Hyperspectral (HS) data from image capture to receipt by the end-user of end product on the ground, from days or weeks to real-time or near-real-time which represents an improvement factor of 100x in delay and 420x in effective bandwidth.

### SPACE BORNE HYPERSPECTRAL (HS) EARTH OBSERVATION (EO)

Hyperspectral (HS) Earth Observation (EO) is used by applications such as environmental protection, farming, ocean monitoring, observing climate changes, mining, etc. Information is collected across the optical electromagnetic spectrum which enables identification of the various materials. However HS imaging did not reach its full potential due to long delays in response time resulting from the complex interpretation process to produce the useful information from the raw HS data.

QI2S will usher in dramatic reductions of delay in the delivery of EO HS interpreted data to the end user, from days or weeks to real-time or near-real-time by designing, developing, integrating and validating a highly innovative and comprehensive ITAR-free technology platform with a many-core computing engine, software building blocks and a mission definition language, all adapted to onboard processing and interpretation of HS or spectral EO data, and integrated with standard satellite HS payload.

So finally when target data is collected and analysed by QI2S, it will be in tens to hundreds of hyperspectral bands and at higher spatial resolution, for example 10 m / pixel or higher, in contrast to SOTA typical limitations to a smaller number of bands and lower spatial resolution, e.g. ca. 36 spectral bands and/or 30 meters / pixel.

This will help realise the tremendous potential of hyperspectral imaging, dramatically reduce the delay in delivery of its interpreted data to end-users, increase viability of evolving incident interpretation (natural disaster information processing, etc.) and make accessible to a wider public applications, which under the present limitations, often require weeks or months and carry prohibitive costs.



Ron NADLER  
Project Coordinator

### QUESTIONS & ANSWERS

#### What is the project designed to achieve ?

The QI2S solution can be represented along three main axes:

- The downlink communication bandwidth requirements needed for QI2S drops dramatically to Mbits/Sec from Gbits/Sec
- The response time from when a user submits an EO information request until they are served with the response will be hours instead of weeks.
- In QI2S the interpretation reconfiguration will take minutes.

#### Why is this project important for Europe and how does it benefit European citizens ?

Europe is not able to provide competitive onboard processing solutions which would exploit the full capabilities of modern hyperspectral technology. QI2S' impact will enable future discoveries with regard to the environment we live in, by opening the door to rapid hyperspectral interpretation of images, whether looking inward to our own planet (weather, science, ocean, etc.) or outward onto the universe.

#### How does the project exceed the current state of knowledge ?

QI2S will offer a substantial advance beyond the SOTA of HS imaging. QI2S HS processing will be performed onboard, requiring a thin slice of the satellite's downlink communication bandwidth, estimated in Mbits/Sec, the delay in responding to an end-user's request will drop to hours and the interpretation reconfiguration will take minutes.

### LIST OF PARTNERS

- Digital Signalprocessing & Information Technology DSI GmbH, Germany
- Compagnia Generale per lo Spazio, Italy
- Ramon Chips, Israel
- ARTTIC SAS, France
- Technical University Braunschweig, Germany

### COORDINATOR

Elbit Systems Electro-optics ELOP Ltd, Israel

### CONTACT

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### PROJECT INFORMATION

Quick Image Interpretation System (QI2S)

Contract N°: 313102  
Starting Date: 01/01/2013  
Duration 30 month  
EU Contribution : € 1.883.170,00  
Estimated total cost: € 2.789.588,00



# SHEE

## Self-deployable Habitat for Extreme Environments



© Space Innovations, v.o.s.

Mars Base 10 analogue base.



Angelia P. BUKLEY  
Project Coordinator

### ABSTRACT

*The objective of the SHEE project is the development and the design of a robotically, self-deployable habitat architecture in the form of a physical habitat test-bed. The habitat will serve for terrestrial analogue simulations and further research and development of emergency habitats on Earth and planetary bases on Moon and Mars. Due to its compact self-folding capability, the habitat will be used on simulation sites in Europe and worldwide.*

### DEVELOP AN AUTONOMOUSLY DEPLOYABLE ARCHITECTURE TECHNOLOGY TEST BED FOR TERRESTRIAL ANALOGUE SIMULATIONS IN EXTREME ENVIRONMENTS

Self-deployable autonomous habitats are needed, in particular, in extreme environments where there is no infrastructure and heavy machinery available. Self-deployable habitats will mitigate construction safety risks and reduce costs due to their subsystems coupling and compact transportation size. Robotic construction integrated into architecture is currently at a very low level of technology readiness. SHEE will address significant gaps in this area to progress the research of extra-terrestrial habitats and provide a feasible solution for near term human space exploration.

The understanding of self-constructible and fully self-sustainable habitats for space also provides a knowledge base for terrestrial applications. The potential of SHEE in terrestrial applications lies in the support and protection of humans exposed to natural disasters.

The utilisation of rapidly self-deployable habitats that do not require any infrastructure for their operation may become an essential part of a post-disaster management.

The SHEE habitat test-bed will be composed of a deployable (flexible) structure of approximately 5 m in diameter surrounding a 1.5 - 2.5m diameter rigid core structure. The habitat will be up to 4m tall including robotic deployment of subsystems and an external power generation system. The habitat test bed will be conceived as a temporary living module for two people. The folding capability of the habitat will allow interdisciplinary research and tests of various technologies in different locations in Europe and worldwide.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

SHEE will provide major advancement in habitat technology research through identification of design principles for self-deployable robotics integrated into architecture for remote and harsh environments without connection to basic technical infrastructure.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Self-deployable and self-sustainable emergency habitats may significantly help during and after natural disaster scenarios. The SHEE compact architecture will point out how aspects of self-sustainability and autonomy providing subsystems may be leveraged in future buildings in daily life. The SHEE will significantly contribute to human spaceflight research in Europe and world wide by providing an innovative habitat analogue test bed.

#### **How does the project exceed the current state of knowledge ?**

Robotics integrated in architecture is a novel topic that has not yet been thoroughly explored. Robotics may significantly mitigate human risks during construction, decrease cost and construction time. The integration of flexible, deployable and rigid structures represents a base for a hybrid structure habitat that has not been developed and tested before. Full autonomy of a compact habitat is another important and still underdeveloped topic the SHEE project aims to address.

### LIST OF PARTNERS

- International Space University, France
- LIQUIFER Systems Group GmbH, Austria
- Space Applications Services N.V., Belgium
- Institute of Technology, University of Tartu, Estonia
- Compagnie Maritime D Expertises S.A., France
- Sobriety s.r.o., Czech Republic
- Space Innovations, v.o.s., Czech Republic

### COORDINATOR

International Space University, France

### CONTACT

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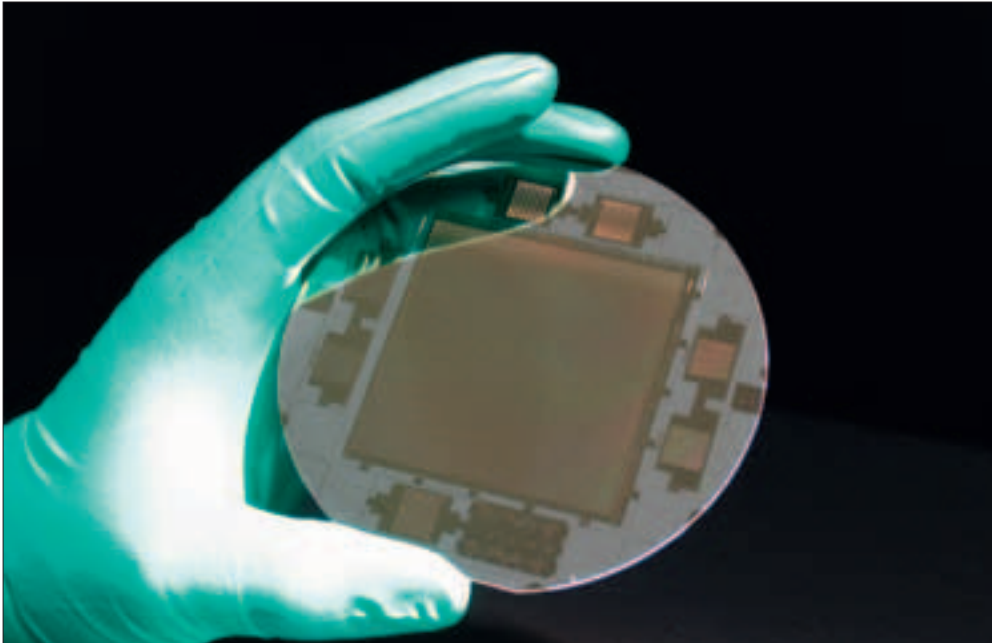
### PROJECT INFORMATION

Self-deployable Habitat for Extreme Environments (SHEE)

Contract N°: 312747  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.984.972,00  
Estimated total cost: € 2.281.210,28

# SPACEKIDS

## Kinetic Inductance Detectors: A New Imaging Technology for Observations In and From Space



© SRON / Jochem Baselmans

An array of KID detectors manufactured at SRON. The large chip in the centre has 5400 KID pixels.

### ABSTRACT

*The Kinetic Inductance Detector (KID) is a new superconducting detector technology suitable for detection of electromagnetic radiation at far infrared to millimetre wavelengths. It offers the promise of excellent sensitivity combined with ease of operation in space. The SPACEKIDS project will focus on developments needed to enable this technology for space. Two demonstrator systems will be built and evaluated, representative of both astronomy and Earth observing applications.*

### A NEW DETECTOR TECHNOLOGY FOR SPACE

Space satellites for astronomy, solar system exploration, and Earth observation need sensitive, robust, and versatile detectors covering a large part of the electromagnetic spectrum. Current detector technology in the far infrared - millimetre wavelength range (30 micrometres - 3 mm) is inadequate in several respects. For the shorter wavelengths there is currently no high-performance technology with space heritage, and for longer wavelengths, detectors are complex and difficult to manufacture and operate.

The Kinetic Inductance Detector (KID) is a new superconducting detector sensor technology offering the promise of excellent sensitivity and ease of operation in space. Only a few simple metal deposition and patterning processing steps are needed in the manufacture, and many pixels can be read out simultaneously and very simply. These features make KID detectors very attractive for future space missions.

KIDs have already been demonstrated to give state-of-the-art performance in ground-based instruments.

SPACEKIDS will focus on developments needed to enable this technology for space. This will include optimisation of the design to improve imaging performance and uniformity and ability to cope with the presence of cosmic rays in a space environment, and the demonstration of specialised digital electronics suitable for operating them in a satellite.

Two demonstrator systems will be built and evaluated, one representative of space astronomy observations, which require detection of very faint light levels, and one representative of Earth observing applications, for which the detectors must be able to cope with a much more intense signal level and to respond very rapidly to changing illumination.



**Matt GRIFFIN**  
Project Coordinator

### QUESTIONS & ANSWERS

#### ***What is the project designed to achieve ?***

The purpose of this project is to develop and demonstrate the capabilities and the suitability of Kinetic Inductance Detectors for use in future space science and Earth observing missions working at far infrared to millimetre wavelengths.

#### ***Why is this project important for Europe and how does it benefit European citizens ?***

The project brings together world-leading groups from several European countries, and will consolidate and extend Europe's expertise and capabilities in state-of-the-art far infrared detectors and instrumentation. Besides opening up new scientific possibilities for future space satellites, this will help to establish European capability and independence in key technologies and sustain a technically advanced economy in Europe.

#### ***How does the project exceed the current state of knowledge ?***

Kinetic Inductance Detectors are relatively new. So far, basic manufacturing and operating techniques, and excellent scientific performance have been demonstrated for ground-based applications. SPACEKIDS will advance this to the next stage, in which complete systems, representative of space instruments will be built and evaluated - bringing it to the level of maturity and credibility needed for implementation in space missions.

# SPACEKIDS

## Kinetic Inductance Detectors: A New Imaging Technology for Observations In and From Space

### LIST OF PARTNERS

- Cardiff University, United Kingdom
- Space Research Organisation of the Netherlands, the Netherlands
- Technische Universiteit, Delft, the Netherlands
- CNRS-NEEL, France
- Consejo Superior de Investigaciones Científicas (CSIC), Spain
- AimSys BV, the Netherlands
- QMC Instruments Ltd., United Kingdom

### COORDINATOR

Cardiff University, UK

### CONTACT

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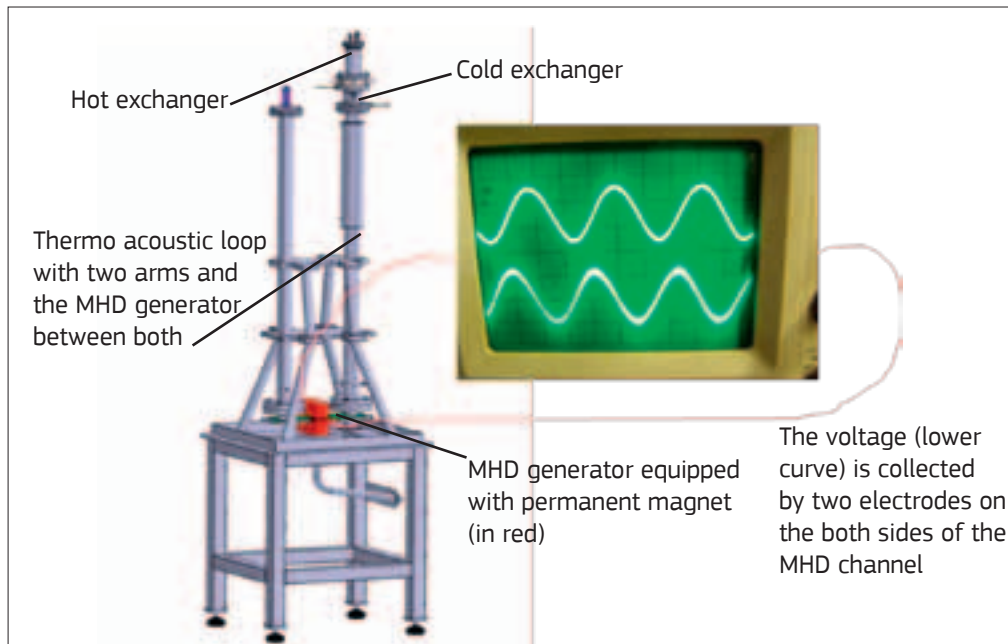
### PROJECT INFORMATION

Kinetic Inductance Detectors: A New Imaging Technology for Observations In and From Space (SPACEKIDS)

Contract N°: 313320  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.995.286,55  
Estimated total cost: € 2.462.026,60

# Space TRIPS

## Space Thermo acoustic Radio-Isotopic Power System



The facility tested at the CNRS (Grenoble) concerns the production of electricity by combination of thermo acoustic loop and MHD generator. The photograph of the two signals represents the pressure wave (upper) and the resulting voltage (lower).



Antoine ALEMANY  
Project Coordinator

### ABSTRACT

The project aims to demonstrate the feasibility of an advanced radioisotopic power system for space exploration, with high efficiency and free of moving parts. The concept relies on thermo acoustic engine, coupled with an MHD electrical generator. The project involves four main tasks: theoretical modelling, design and construction of the engine, experimentation, and design for assessment of a space system.

### DEMONSTRATION OF AN ADVANCED GENERATOR, RADIO-ISOTOPIC TYPE, FOR ON-BOARD ELECTRICITY PRODUCTION FOR SPACECRAFT OR PLANETARY ROVERS

On-board energy is key for exploration of the solar system. Beyond Jupiter radio-isotopic power systems (RPSs) are really necessary as the solar power is very low. Space Trips is focused on the feasibility of an electrical generator for the energy production in space, with high efficiency and free of moving parts.

The project is based on the use of two elements: A Thermo Acoustic engine (TAC) to convert thermal power of a hot source, in mechanical energy produced in closed loop by a gas on the form of a pressure and velocity waves; This mechanical energy will be transformed in AC current by a liquid metal Magneto hydrodynamic (MHD) electrical generator. It will use the induced AC magnetic field produced by thermo acoustic oscillations to produce an induced magnetic flux inside a coil delivering an AC current.

The best choice of the two fluids seems to be Helium as the gas to produce TAc mechanical energy and sodium as liquid metal to produce electricity by MHD.

The heat source will be radio isotopic elements and the cold source a radiative cooler. The energy transfer from the heat source and cold source will use either conducting elements or high pipes. One of the best advantages of the combination of the two engines is due to the fact that it does not use any moving mechanical part.

The objective of the project is to assess the performances of the process in terms of efficiency, volume and mass.

### QUESTIONS & ANSWERS

#### What is the project designed to achieve ?

This project aims at demonstrating the feasibility of a highly efficient and reliable electrical generator for space, using radio isotopic heat source. The project is based on the modelling, design, construction and experimentation of a prototype of MHD electrical generator driven by a thermo acoustic engine. A design implementing this technology will be completed to assess the performance of a space system.

#### Why is this project important for Europe and how does it benefit European citizens ?

Space exploration will improve the knowledge of our environment and our origins and improve our understanding of the Earth's climate.

The system object of the project is adaptable to renewable energies as for example solar energy, waste recovering etc.

In the framework of the project, a summer school and an international conference are planned.

#### How does the project exceed the current state of knowledge ?

Existing technologies are either of low efficiency, or with moving parts, i.e. with potential reliability concerns. The Space Trips concept will allow a high efficiency and no moving parts. Thermo acoustic engine is a very new concept. It constitutes a rupture technology being a quasi static engine. It is under development in many countries: USA, Mexico, Japan, China, France, Germany, Austria, the Netherlands and England.

# Space TRIPS

## Space Thermo acoustic Radio-Isotopic Power System

### LIST OF PARTNERS

- HEKYOM France
- CNRS, France
- IPUL, Latvia
- AREVA TA, France
- Thales Alenia Space, Italy
- HZDR Germany

### COORDINATOR

Hekyom Company, France

### CONTACT

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### PROJECT INFORMATION

Space Thermoacoustic Radio-Isotopic Power System (Space TRIPS)

Contract N°: 312639  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.877.981,75  
Estimated total cost: € 2.603.350,40

# SPAMUS

Smart technology for artificial muscle applications in space



© ARQUIMEA INGENIERIA

Conceptual design of the suit, upper and lower limb.



Ramiro CABÁS  
Project Coordinator

## ABSTRACT

The objective of the project is to develop a new type of astronaut's suit, so called smart suit, with at least two functionalities: biofeedback monitoring and musculoskeletal degradation countermeasures based on feedback forces. To address this goal, the consortium considers taking advantage of the promising benefits offered by smart technologies to make the electromechanical actuators developed for biofeedback suits more efficient, safer, smaller and lighter.

## BRINGING TERRESTRIAL SME-RESEARCH INTO THE SPACE DOMAIN

In the context of European Space Policy and its requirements regarding achieving solid technological base and competitive space industry, the SME relevant research, is a key point to develop key generic technologies.

Within this framework the consortium involved in SPAMUS project, led by ARQUIMEA, has identified the need for developing a new type of astronaut's suit, so called intelligent. Thus, the overall objective of the project is to analyse the suitability and gain information on the Shape Memory Alloys (SMA) and Electroactive Polymer (EAP) based actuation technologies, terrestrial applications, in order to research new concepts of artificial muscles for biofeedback suits for astronauts, as an alternative to currently used technologies.

To address this goal, the consortium will take advantage of the promising benefits offered by the smart technology to make the electromechanical actuators of the artificial muscles developed for biofeedback suits more efficient, safer, smaller and lighter, in order to adapt the technology to the on board requirements for space. The key elements of smart actuators are the SMA and the EAP.

The SPAMUS project will entail, amongst other specific objectives, the contribution of the existing experience on SMA/EAP technologies to the space domain, adapting consolidated terrestrial technologies to the space domain. It will also contribute to the substitution of the conventional hydraulic actuators by taking into account control and biometric sensors related aspects.

## QUESTIONS & ANSWERS

### What is the project designed to achieve ?

The aim of the project is to improve the actual technology and make it more efficient, safer, smaller and lighter, which resists space conditions. This technology will be used to obtain a smart suit for astronauts, which will mitigate the pernicious effect of microgravity and motor inactivity. In the future, it will be possible to use it for commercial purposes.

### Why is this project important for Europe and how does it benefit European citizens ?

As a response to the user demands, the smart suit will automatically adjust its mechanical resistance, in order to fine-tune the intensity of the user exercise when working in its resistive configuration. The suit will also be able to assist the user in his work when working in a collaborative configuration. It will turn into an improvement of freedom degrees, a higher flexibility and a reduction of weight and volume with respect to existing options.

### How does the project exceed the current state of knowledge?

SMA's and EAP's are different from other electromechanical technologies and are immune to electromagnetic interferences and do not produce noise. Furthermore, these technologies will favour the substitution of traditional exoskeleton functionalities by introducing a new concept of suit, lighter and less bulky than current exoskeletons, which will be capable of moving and exerting forces opposite to the support and limited joint movements.

### LIST OF PARTNERS

- Arquimea Ingenieria S.L.U., Spain
- Deutsches Zentrum für Luft- und Raumfahrt, Germany
- Eidgenössische Technische Hochschule Zürich (ETH), Switzerland
- University of Pisa, Italy
- Sensodrive GmbH, Germany
- Universidad Carlos III de Madrid, Spain

### COORDINATOR

Arquimea Ingenieria S.L.U., Spain

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### PROJECT INFORMATION

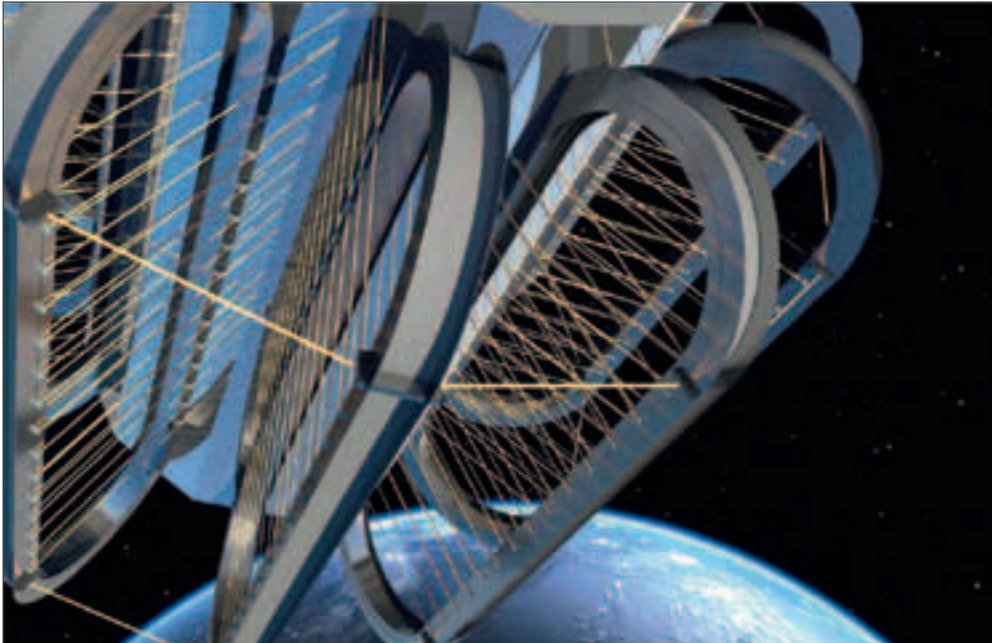
Technology for artificial muscle applications in space (SPAMUS)

Contract N°: 312815  
Starting Date: 13/12/2012  
Duration: 36 months  
EU Contribution: € 1.460.287,35  
Estimated total cost: € 2.073.415,00



# SR2S

## Space Radiation Superconductive Shield



© Valerio Calvelli

Front view of a spacecraft equipped with a set of superconducting magnetic coils creating a torodial field shielding the habitat from the galactic cosmic ray to protect the astronauts.

### ABSTRACT

*SR2S will assess active radiation shield requirements, key technologies for development of an active, space bor magnetic shield, identify solutions for magnetic/coil configurations. It will also design a configuration for demonstration units of active shields, provide a roadmap to develop active shield technologies, review radiation doses for exploration travel and compute shield effectiveness, design cables for active shield applications, study/compare coils configurations for assembly in space and improve superconducting cables.*

### TO DEVELOP, VALIDATE AND INCREASE THE TECHNOLOGY READINESS LEVEL (TRL) OF THE CRITICAL TECHNOLOGIES RELATED TO A MAGNETIC SHIELDING SYSTEM

An astronaut's survivability in space, especially on long duration missions such as the ones targeted to Mars or to Near Earth Asteroids (NEA), is currently based on the use of passive radiation protection techniques which are based on ionisation energy loss through a thin amount of material.

Shelters using specified materials based on criteria accepted by the scientific community can provide acceptable protection from particles produced by Solar-Particle Events (SPE).

As a result of energetic Galactic Cosmic Rays (GCR), exploration missions will, however, expose crews to levels far exceeding doses received during any mission currently being carried on at the International Space Station (ISS) or in the past Apollo, Low Earth Orbit (LEO), and ISS missions.

GCR have an energy spectrum which cannot be stopped by the relatively thin passive shields which can be used in space. In addition, GCR produce secondary particles interacting with the spacecraft and shield materials that increase significantly the dose delivered after the shield. It follows, therefore, that in space, where only a limited amount of passive shields can be considered, that passive protection is totally ineffective in reducing the dose due to GCR.

From a health perspective it is clear that the relationship between radiation exposure and risk is both age and gender specific, due to latency effects and differences in tissue types, sensitivities, and life spans between genders.



**Roberto Battiston**  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

Develop, validate and increase the Technology Readiness Level of the most critical technologies related to a magnetic shielding system for protecting astronauts' lives during long duration space missions.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

The next generation of radiation protection systems for astronauts will require technical, managerial and financial resources that national programs cannot meet. Developing these technologies, as in SR2S, will ensure astronaut survivability during deep space missions. Developing the technology will enable Europe to be a strategic partner in cooperative exploration missions and to set-up bartering agreements with other space faring nations.

#### **How does the project exceed the current state of knowledge ?**

SR2S will provide the rationale for new assessments of dose exposure, evaluate shielding efficiency for different mission scenarios and develop the concept for new magnetic configurations.

It will also develop superconducting cables, improve the engineering value of density of superconducting cables, develop/test a new coil configuration and provide results on the cryogenic operation.

### LIST OF PARTNERS

- Istituto Nazionale di Fisica Nucleare, Italy
- Compagnia Generale per lo Spazio, Italy
- Columbus Superconductors, Italy
- Thales Alenia Space – Italia, Italy
- Commissariat à l'énergie atomique et aux énergies alternatives, France
- European Organisation for Nuclear Research (CERN), Switzerland
- Carr Communications Ltd, Ireland

### COORDINATOR

Istituto Nazionale di Fisica Nucleare, Italy

### CONTACT

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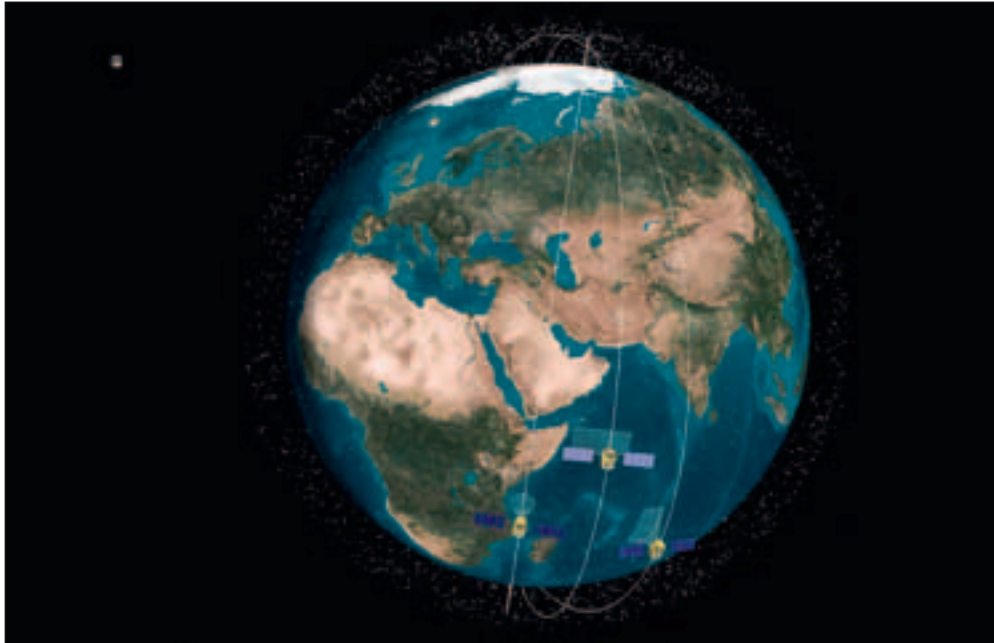
### PROJECT INFORMATION

Space Radiation Superconductive Shield (SR2S)

Contract N°: 313224  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.996.102,00  
Estimated total cost: € 2.711.180,00

# STEP

## Support to the development of a European SSA capability



© European Union Satellite Centre (EUSatCen)

Example of Satellite Overflight.



Juan-Luis VALERO  
Project Coordinator

### ABSTRACT

The STEP support action contributes from a technical perspective to the development of a Data Policy for a future European SSA capability. The EU SatCen offers a unique environment to discuss SSA's challenging issues, covering simultaneously institutional, national, civilian, military and technical actors, which contribute infrastructure elements to develop an SSA capability. STEP aims also to bring the gap between technical and decision-making actors on SSA matters.

### SUPPORTING GOVERNANCE AND DATA POLICY FOR THE DEVELOPMENT OF A EUROPEAN SSA CAPABILITY

Space is a key strategic sector for European competitiveness and economic growth. Space-based applications are essential for a wide range of activities in modern societies. The European Space Policy, in line with the Europe 2020 Flagship Initiative Innovation Union, has highlighted the importance to improve the knowledge of the space object population and space environment also known as Space Situational Awareness (SSA).

SSA capabilities support the protection of European space infrastructure and guarantee safe operations by providing alerts of potential hazards (e.g. space debris, near-earth objects and space weather) in a sufficient time to allow preventive actions to be taken.

The STEP support action is striving to provide a technical perspective for the development of SSA data policy.

In this regard, actions are addressed to facilitate the elaboration of coordinated information exchanges, data handling processes, operational interfaces and best practices for the implementation of an SSA capability in Europe. STEP facilitates the dialogue among key SSA Stakeholders, contributing infrastructure elements in Europe, by catalysing a common understanding of organisational and governance issues.

To support the said dialogue with efficient and hands-on appreciation of organisational and data policy issues, in a multi-national and complex environment, indicative SSA services are being simulated using an experimental platform to perform scenario-based assessments.

To achieve these goals, the STEP support action benefits from the fruitful cooperation already established with key SSA Stakeholders. STEP capitalises on the existing EU SatCen assets and unique expertise in data security policies.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The STEP support action is striving to catalyse a common understanding of technical challenges to SSA through an organised dialogue among key SSA stakeholders. STEP pays special attention to specific pressing issues related to the development of Data Policy to support a European SSA development.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

STEP gives benefit to diverse European arenas where SSA is a key element and the EU SatCen is participating directly or indirectly. STEP provides a forum, enabling a technical dialogue to bridge the gap between decision makers and technical audiences. European citizens will benefit from the proper protection of strategic assets and space-based applications that translates into important economic savings and security preservation.

#### **How does the project exceed the current state of knowledge ?**

There is a need to define a common technical ground on SSA in order to facilitate the decision making process in policy areas. The STEP project address issues on SSA Governance and Data Policy in Europe, like the elaboration of coordinated information exchanges among different SSA stakeholders, data handling processes or operational interfaces.

### LIST OF PARTNERS

- European Union Satellite Centre, Spain

### COORDINATOR

European Union Satellite Centre, Spain

### CONTACT

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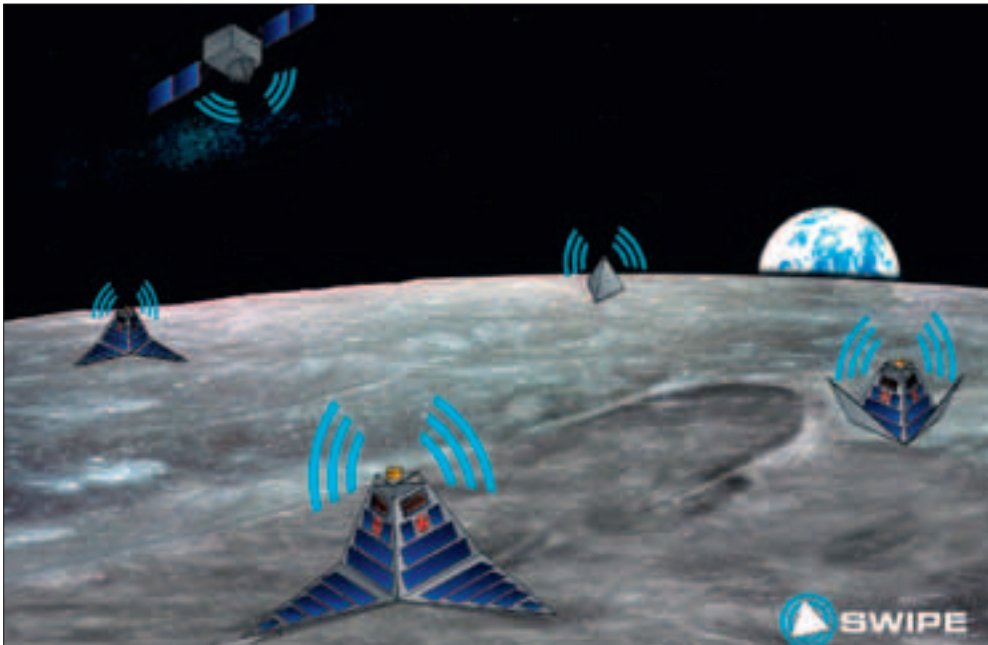
### PROJECT INFORMATION

Support to the development of a European SSA capability (STEP)

Contract N°: 312249  
Starting Date: 01/11/2013  
Duration: 18 months  
EU Contribution: € 500.000,00  
Estimated total cost: € 622.310,00

# SWIPE

## Space Wireless sensor networks for Planetary Exploration



© SWIPE - TEKEVER

Artist's impression of the SWIPE concept.



André OLIVEIRA  
Project Coordinator

### ABSTRACT

SWIPE's main goal is to prove the applicability of ad hoc networking in space and particularly on a planetary exploration scenario, based on a Wireless Sensor Network. Even though the main target of the project will be the network and the associated communications, the project will complement this with the development of a set of sensors that will allow the project to show the scientific benefit of the SWIPE concept.

### A MANET WIRELESS SENSOR NETWORKS (WSNS) FOR PLANETARY EXPLORATION

In order to prepare for manned missions to other planets, it is necessary to monitor permanently the surface environment and have a clear notion of its conditions. Hundreds or thousands of small wireless sensors could be dropped from a satellite orbiting the planet onto the surface to assure a uniform and sufficient coverage. These autonomous sensors would then create their own ad hoc network, while some of them, equipped with satellite communication capabilities, would establish a link between the sensor network and the satellite or directly to Earth.

SWIPE will define this mission scenario in detail and will also perform system level design of the different communication segments. However, SWIPE's main effort is put on designing and developing several functional node prototypes, focused on three main areas: communications, sensors and data processing techniques. These nodes will be used to validate and evaluate the concept under controlled conditions and later in a field test on a terrestrial environment with similar characteristics as those in other neighbouring planets.

SWIPE's philosophy relies on terrestrial technology. The communications concept for instance is based on a terrestrial networking technology, not yet validated in space. The hardware communications platform will be based on Software-Defined Radio, another promising terrestrial technology already deserving the attention of the major space players. By combining these concepts, SWIPE intends to take a leap forward in bringing innovative terrestrial research and technology to the demanding space environment.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

SWIPE intends to prove the applicability and benefits of using two innovative and promising terrestrial technologies, Wireless Sensor Networks and Ad hoc Networks, in future planetary exploration missions. It will prepare a reference mission, design and develop ad hoc sensors and data processing algorithms and finally validate the concept in a relevant environment on Earth.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

The concept proposed in SWIPE can be used in the future to support astronauts or robotic missions in better understanding the environment around them. It will contribute to faster and cheaper missions and increase substantially the knowledge about other planets. The technology can also be used back in terrestrial applications for early detection and monitoring of forest fires for instance.

#### **How does the project exceed the current state of knowledge ?**

The two terrestrial technologies addressed in SWIPE have not yet been applied in space, which will mean a major step for Europe to take the lead in terms of space networking technologies. The mission concept of using a network of sensors to map and monitor planetary surfaces is also innovative and can be crucial in long term manned endeavours.

### LIST OF PARTNERS

- Tekever, Portugal
- Arquimea Ingenieria S.L, Spain
- Astrium SAS, France
- University of Leicester, United Kingdom
- Consorzio per la Ricerca nell' Automatica e nelle Telecomunicazioni C.R.A.T., Italy

### COORDINATOR

TEKEVER, Portugal

### CONTACT

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### PROJECT INFORMATION

Space Wireless sensor networks for Planetary Exploration (SWIPE)

Contract N°: 312826  
Starting Date: 01/04/2013  
Duration: 31 months  
EU Contribution: € 1.495.852,00  
Estimated total cost: € 2.056.245,36

# THOR

## Innovative Thermal Management Concepts for Thermal Protection of Future Space Vehicles



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Atmospheric Entry of the Sharp-Edge Flight Experiment SHEFEX.



Burkard ESSER  
Project Coordinator

### ABSTRACT

*The main objective of THOR is to design, develop, implement, test and validate new thermal management concepts for future re-usable space vehicles that can meet the flight performance requirements during atmospheric entry. Four different concepts are considered that are based on recent progress in material development, e.g. SiC based ceramic foams and carbon-based fibres with a huge thermal conductivity. All concepts will be verified by ground tests under realistic entry conditions.*

### NEW CONCEPTS FOR THERMAL MANAGEMENT OF RE-USABLE SPACE VEHICLES

When entering a planetary atmosphere space vehicles are exposed to extreme thermal loads. To protect the vehicle's interior, a thermal protection system (TPS) is required for manned missions, as well as for unmanned missions. For state-of-the-art re-usable vehicles, e.g. the Space Shuttle orbiter, the thermal management concept is mainly based on the fact that heat loads can be controlled by choosing a blunt shape for highly loaded vehicle components, e.g. the nose and the wings' leading edges.

Future space vehicles, in particular next generation orbiters, will need improved flight performance for efficient operation, a requirement that cannot be met with extremely blunted components. Considerable reduction of bluntness, however, causes significantly higher heat loads far beyond the capabilities of conventional thermal management.

THOR is focussing on the development of new disruptive thermal management concepts for future re-usable space vehicles.

Four different concepts are considered in detail. Two concepts are aiming at an equilibration of thermal loading by transferring heat efficiently from highly loaded surface areas to less loaded regions, in particular by using innovative composite materials with integrated highly conductive fibres and TPS structures with intensive radiative heat exchange.

Active cooling is the key element of the other THOR concepts which are based on a ceramic sandwich TPS, including ceramic foams, and transpiration cooling of an external vehicle surface.

For each concept, models will be designed and manufactured to qualify the thermal management approach under realistic entry conditions in DLR's arc heated facilities LBK and JAXA's shock tunnel HIEST.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The objective of THOR is to design, develop, implement, test and validate new thermal management concepts for future re-usable space vehicles. Four concepts are considered that are based on recent progress in material development, e.g. SiC based ceramic foams and carbon-based fibres with a huge thermal conductivity. All concepts will be verified by ground tests under realistic entry conditions.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

THOR will help to maintain Europe's leadership in thermal protection. With the integral thermal management approach European industry will be able to significantly improve safety during atmospheric re-entry from orbital flight. The same technologies are beneficial for planetary exploitation missions, as well by reducing system mass and enhancing scientific capabilities correspondingly.

#### **How does the project exceed the current state of knowledge ?**

Currently, thermal management of re-usable space vehicles, e.g. the Space Shuttle orbiter, is based on local control of heat loads by choosing a blunt shape for highly loaded vehicle components, e.g. the wings' leading edges. THOR will introduce non-local aspects into thermal management concepts by considering an equilibration of thermal loads as well as active cooling.

### LIST OF PARTNERS

- Deutsches Zentrum für Luft- und Raumfahrt, Germany
- Fundación Tecnalia Research & Innovation, Spain
- TUBITAK UZAY, Turkey
- Fluid Gravity Engineering, United Kingdom
- Erbicol, Switzerland
- Scuola Universitaria Professionale della Svizzera Italiana, Switzerland
- Aerospace & Advanced Composites, Austria
- Thales Alenia Space - Italia , Italy
- Japan Aerospace Exploration Agency (JAXA), Japan

### COORDINATOR

DLR, Germany

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### PROJECT INFORMATION

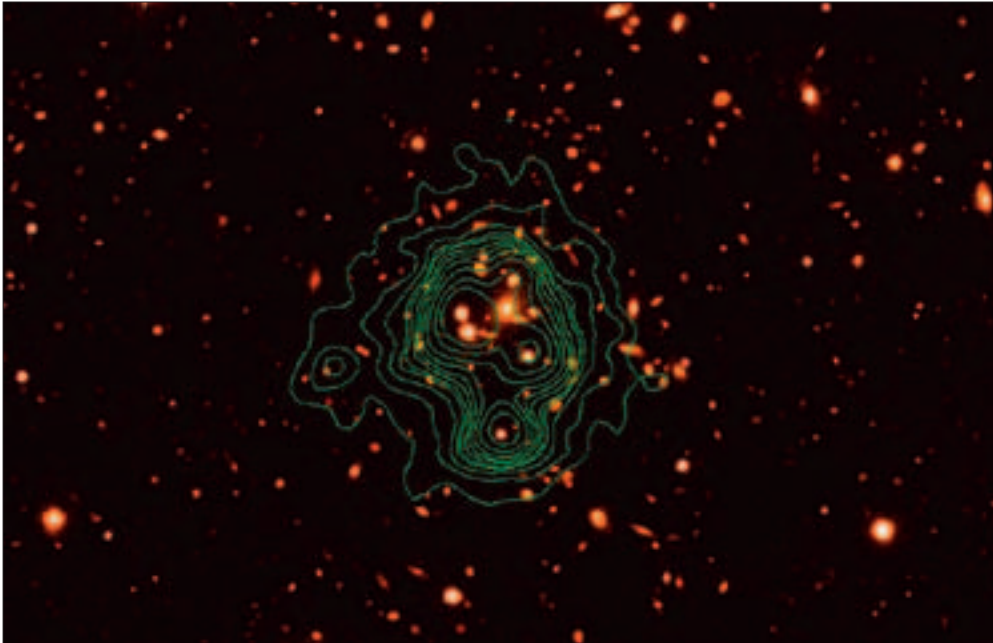
Innovative Thermal Management Concepts for Thermal Protection of Future Space Vehicles (THOR)

Contract N°: 312807  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.967.767,75  
Estimated total cost: € 2.715.741,40



# ARCHES

## Astronomical Resource Cross-matching for High Energy Studies



© Leibniz-Institut für Astrophysik Potsdam

Optical red image of the cluster of galaxies RBS825 with X-ray intensity contours overlaid in green.



Christian Motch  
Project Coordinator

### ABSTRACT

*ARCHES will focus on the X-ray survey catalogue data from the XMM-Newton mission. New tools will be developed for cross-correlation with extensive archival resources, producing well-characterised multi-wavelength data in the form of spectral energy distributions for large sets of objects. These enhanced resources will significantly broaden the effective exploitation of the data by the scientific community in the exploration of a wide range of forefront astrophysical questions.*

### BUILDING AN ENHANCED MULTI-WAVELENGTH VIEW OF THE XMM-NEWTON CATALOGUE OF COSMIC X-RAY EMITTERS

Observational astronomy has dramatically evolved over the last few decades as a result of the opening up of new observing windows in the electromagnetic spectrum and the development of efficient and large area detectors. Ground-based and space-borne all-sky surveys have provided an essential astrometric and photometric reference frame and the first true maps of the entire sky.

This ever-increasing wealth of multi-wavelength data has fundamentally changed the way astronomers now tackle scientific problems. The previous paradigm, typically focusing on a single wavelength range, has now evolved towards a systematic fully multi-wavelength approach.

In fact, our understanding of the physics of stars and galaxies now essentially rests on the modelling of their electromagnetic spectra over the widest range of frequencies, spanning from radio to the highest energy gamma-rays.

Despite the paramount scientific importance of large-scale multi-wavelength observational studies, obstacles still remain for their efficient utilisation by a large majority of astronomers.

The high-energy window to the Universe has strongly benefited from the recent availability of the European Space Agency (ESA) XMM-Newton space observatory. This large X-ray telescope routinely observes the sky with an image quality approaching that of ground-based optical telescopes, generating one of the key ESA astrophysical databases, the XMM-Newton X-ray catalogue, now extending to a half million entries.

ARCHES will considerably increase the usability and research potential of the XMM-Newton X-ray catalogue, enhancing it with key multi-wavelength resources and distributing these results to the international community.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The objective of ARCHES is to build scientifically-validated spectral distributions for the many stars, galaxies and clusters of galaxies detected by the ESA X-ray space observatory XMM-Newton. These multi-wavelength enhanced data sets will open new avenues of investigation and will be distributed to the international community through Virtual Observatory tools in order to ensure the largest audience.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

The XMM-Newton satellite is the most scientifically productive European X-ray observatory ever flown and is currently one of the flagships of the European Space Agency's astronomical programme. By bringing together expertise from leading institutes in the field of multi-wavelength analysis, ARCHES will investigate new, exciting domains of research, which will significantly increase the overall scientific return of this highly successful European space observatory at a modest cost.

#### **How does the project exceed the current state of knowledge?**

Identifying the properties of a given star or galaxy in collections of astronomical catalogues with billions of entries and heterogeneous spatial resolutions is a complex process which requires the development of sophisticated software tools. Searching for new clusters of galaxies will also rely on novel tools that will associate potentially extended XMM-Newton objects to groups of faint optical galaxies.

### LIST OF PARTNERS

- Université de Strasbourg, France
- Leibniz-Institut für Astrophysik Potsdam, Germany
- University of Leicester, United Kingdom
- Universidad de Cantabria, Spain
- Instituto Nacional de Técnica Aeroespacial (INTA), Spain

### COORDINATOR

Université de Strasbourg, France

### CONTACT

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### PROJECT INFORMATION

Astronomical Resource Cross-matching for High Energy Studies (ARCHES)

Contract N°: 313146  
Starting Date: 01/01/2013  
Duration: 32 months  
EU Contribution: € 1.720.367,30  
Estimated total cost: € 2.228.233,46

# ASTRODEEP

Unveiling the power of the deepest images of the Universe



© NASA, ESA, R. Ellis (Caltech), and the HUDF 2012 Team

Recent image from the Hubble Ultra Deep Field 2012, showing many galaxies caught as they appeared billions of years ago.

## ABSTRACT

*ASTRODEEP is a coordinated and comprehensive programme of i) algorithm/software development and testing; ii) data reduction/release, and iii) scientific analysis aimed at making Europe the world leader in the exploitation of the deepest astronomical data. It will develop new, revolutionary tools for image analysis and – at the same time – address fundamental questions related to the early life of galaxies.*

## BIRTH AND EVOLUTION OF GALAXIES; COSMOLOGY; ADVANCED TOOLS FOR IMAGE ANALYSIS

The ultimate goal of modern cosmology is to answer fundamental questions such as how galaxies and super-massive black holes assembled from the very earliest times, or when the universe was re-ionized. For this purpose, the most advanced telescopes from ground and space have been extensively used in recent years to observe a few, selected regions of the sky, where the faintest and farthest objects in the Universe can be observed with minimal obstruction from our Galaxy.

However, it is abundantly clear that the full potential of the data will not be unlocked unless they can be properly and robustly combined and analysed.

The conceptual and technological challenges that must be overcome relate to the varying depth and, most importantly, widely varying angular resolution of the data delivered by various observatories.

ASTRODEEP aims to achieve this. The focus of our project is to develop, refine and combine advanced algorithms for image analysis, test and properly validate their effectiveness on the deepest multi-frequency data, and apply them to produce uniquely powerful homogenized data products. We will deliver to the worldwide astronomical community the final data as well as the software specifically developed for our analysis.

We ourselves plan to use this unrivalled database to address several of the key outstanding issues in present-day extragalactic astronomy, related to how galaxies formed and evolved in the post-Big Bang Universe.

Finally, we will use the gained experience to maximize the scientific return from the next generation of space surveys, especially ESA's planned EUCLID Deep survey.



**Adriano FONTANA**  
Project Coordinator

## QUESTIONS & ANSWERS

### ***What is the project designed to achieve ?***

We will make crucial progress in two fields. First, we will develop new, advanced algorithms and tools for image analysis, which we will apply to a unique set of astronomical data. This unrivalled database will be fundamental to address several key outstanding issues in present-day cosmology, related to how galaxies formed and evolved in the post-Big Bang Universe.

### ***Why is this project important for Europe and how does it benefit European citizens ?***

Astronomy and cosmology are among the most popular sciences, as witnessed by the huge media coverage of recent discoveries. They also provide an ideal arena for the development of the most advanced technologies. As such they receive significant funding from European agencies. Our program aims at extracting their full potential, and disseminating their results to all European citizens.

### ***How does the project exceed the current state of knowledge ?***

Our new algorithms and tools for image analysis will enable scientists to extract the whole information from the astronomical data, and will also be adopted in other research fields. Applying these techniques to the wealth of data coming from the most modern telescopes and satellites, we will explore the history of the first galaxies in the Universe with unprecedented accuracy.

# ASTRODEEP

Unveiling the power of the deepest images of the Universe

## LIST OF PARTNERS

- INAF – Rome Astronomical Observatory, Italy
- University of Edinburgh, Institute for Astronomy, United Kingdom
- CEA-Saclay, France
- CNRS, CDS, Strasbourg, France

## COORDINATOR

Istituto Nazionale di Astro Fisica, Italy

## CONTACT

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## PROJECT INFORMATION

Unveiling the power of the deepest images of the Universe (ASTRODEEP)

Contract N°: 312725  
Starting Date: 01-01-2013  
Duration: 48 months  
EU Contribution: € 1.968.710,00  
Estimated total cost: € 2.579.646,00

# AstRoMap

## Astrobiology and Space Missions Road Mapping



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M16 Eagle Nebula: new technologies will allow us to tackle important unresolved scientific questions.

### ABSTRACT

*AstRoMap (Astrobiology Road Mapping activity) is a coordination action that aims at providing the European Planetary Science Community with a road map in space science and astrobiology. Goals of the project are following: (i) to pose big scientific questions that could be answered with the help of space missions, and (ii) to identify according space missions to be developed in future programs. Project work includes the organisation of expert panels and international workshops.*

### TACKLING OF KNOWLEDGE GAPS IN THE FIELD OF ASTROBIOLOGY AND DEPICTION OF FUTURE SPACE MISSIONS TO ANSWER THOSE GAPS

AstRoMap tackles the issue of definition of future scientific priorities and recommendation of research activities in the field of astrobiology and the improvement of the knowledge of this field in Europe and beyond. It will also provide new networking tools.

AstRoMap will span over *four areas* of activities:  
*Community consultation*

The aim is to: perform a wide consultation on current and future research perspectives and priorities in astrobiology; map the astrobiology and planetary sciences landscape in Europe and beyond; develop modern tools for networking and exchange of information.

*Foresight*

On the basis of the feedback from the community consultation, expert workshops will be organised to discuss and reach consensus on research priorities in the field of astrobiology. Four workshops will be organised, each with a different topic: Origin of organic compounds, steps to life;

Physico-chemical boundary conditions for habitability; Biosignatures as facilitating life detection; Origin of Solar system. Each workshop will be structured according to the following steps: definition of the science goals; identification of knowledge gaps - science and technology; suggested missions/instrumentation and experiments to reach the goals. Three cross-cutting activities will be discussed during the workshops: Earth analogues in the context of astrobiology, planetary protection and planetary ethics, new technologies for space missions.

*Astrobiology road-mapping*

Based on the results and conclusions elaborated during the workshops, an astrobiology roadmap will be defined, taking into account the European needs and competences.

*Education and public outreach*

AstRoMap will provide a comprehensive education and outreach program and disseminate the results through its website.



Felipe GÓMEZ GÓMEZ  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The main deliverable would be a road map which will include, at least, the following aspects: the identification of a minimum number of missions, ordered by priority, which could shed light over the questions identified as the big challenges for the next decades of space exploration; the identification of Earth Analogues to test scientific hypothesis and instrumentation for future space missions.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

AstRoMap will provide the ideal scientific and technical environment to fully analyse the new technological developments and instruments for preparing the next generation of space missions. AstRoMap will play a vital role in establishing the European Community as a leading player in planetary and space exploration.

#### **How does the project exceed the current state of knowledge ?**

AstRoMap exceeds the current state of knowledge due to its focus on the identification of cutting-edge questions and knowledge gaps in the field of astrobiology. The project will try to answer those questions and gaps, proposing new techniques and tools for space missions to be developed in the next decades.

### LIST OF PARTNERS

- Instituto Nacional de Técnica Aeroespacial (INTA), Spain
- European Science Foundation, France
- Association pour un Réseau Européen d'Exo/Astrobiology, France
- Belgian User Support and Operations Centre, Belgium
- Deutsches Zentrum für Luft- und Raumfahrt, Germany
- National Institute for Astrophysics, Italy

### COORDINATOR

Centro de Astrobiologica (INTA-CSIC), Torrejón de Ardoz, Madrid, Spain

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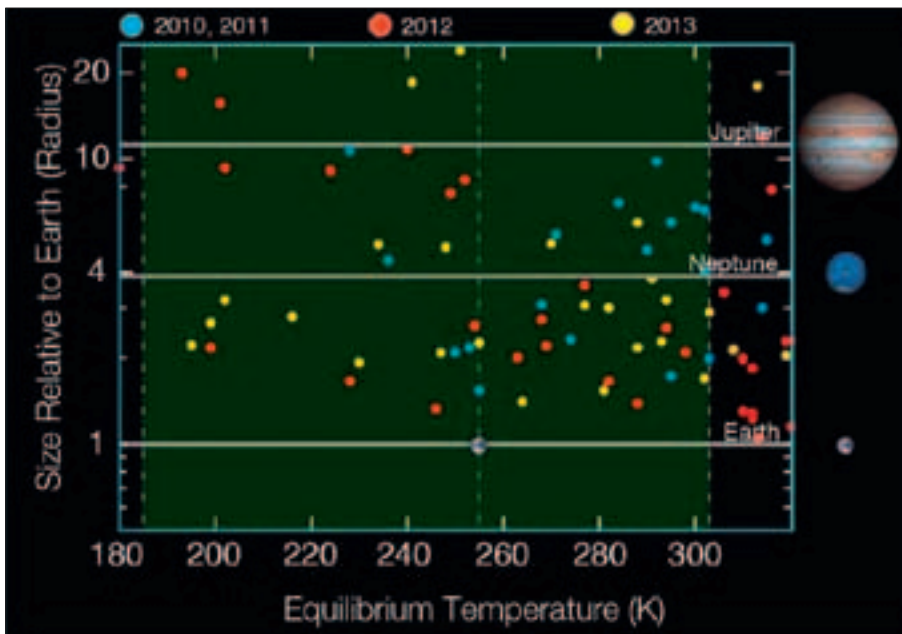
### PROJECT INFORMATION

Astrobiology and Space Missions Road Mapping (AstRoMap)

Contract N°: 313102  
Starting Date: 01/10/2012  
Duration: 36 months  
EU Contribution: € 499.575,44  
Estimated total cost: € 665.585,50

# ETA-EARTH

## Measuring $\eta_{\oplus}$ : Characterization of Terrestrial Planetary Systems with Kepler, HARPS-N and Gaia



Candidate planets in the Habitable Zone detected by Kepler.



Alessandro SOZZETTI  
Project Coordinator

### ABSTRACT

ETA-EARTH will provide the first ever quantitative answer to an age-old question of mankind: ‘How common are Earth analogs in our Galaxy?’. This goal will be achieved by combining the unprecedented photometric precision of NASA’s Kepler mission, the unrivalled precision of ground-based radial-velocities from the HARPS-N spectrograph, and ESA’s Gaia mission’s exquisitely accurate parallaxes, which underpin the physical properties and occurrence rates of terrestrial extrasolar planets with unprecedented accuracy.

### CHARACTERIZATION OF EARTH ANALOGS

The ETA-EARTH project is a transnational collaboration between European countries and the United States setup to optimize the synergy between space- and ground-based data whose scientific potential for the characterization of extrasolar planets can only be fully exploited when analyzed together.

We will use the HARPS-N spectrograph for 5 years to measure dynamical masses of terrestrial planet candidates identified by the Kepler mission. With the unique combination of Kepler photometric and HARPS-N spectroscopic data we will learn for the first time about the physics of their interiors. Some of these planets will have characteristics (masses, radii) similar to Earth, and they might be orbiting within the habitable zone of stars much like our Sun. We will carry out selected experiments in the Kepler field (mass measurements of multiple-planet systems and circumbinary planets) to probe models of planet formation, orbital migration, and long-term dynamical evolution.

We will search for planets similar to Earth orbiting a carefully selected sample of nearby bright solar-type stars, providing suitable candidates for spectroscopic characterization of their atmospheres with next-generation space observatories. We will combine Kepler, HARPS-N and Gaia data products of stars in the Kepler field to underpin the occurrence rates of terrestrial planets ( $\eta_{\oplus}$ ) as a function of stellar properties with unprecedented accuracy. ETA-EARTH will finally provide the first ever quantitative answer to an age-old question of mankind: ‘How common are Earth analogs in our Galaxy?’.

Our unique team expertise in observations and modelling of exoplanetary systems will allow us to fully exploit the potential for breakthrough science intrinsic to this cutting-edge, multi-techniques, interdisciplinary project, making the best use of data of the highest quality gathered from NASA and ESA space missions and ground-based instrumentation.

### QUESTIONS & ANSWERS

#### What is the project designed to achieve ?

ETA-EARTH will make the best use of data collection techniques of the highest quality gathered from NASA and ESA space missions and ground-based instrumentation: Kepler photometry; HARPS-N spectroscopy; Gaia astrometry. Within the 5 years of the project, ETA-EARTH will determine physical properties and occurrence rates of terrestrial planets ( $\eta_{\oplus}$ ) as a function of stellar characteristics with unprecedented accuracy.

#### Why is this project important for Europe and how does it benefit European citizens ?

The ETA-EARTH project will help place the European community in the future of planetary science, and it will provide inspiration for younger scientists in cross-disciplinary fields. ETA-EARTH will allow transferring the scientist’s curiosity towards some of the most fundamental questions of modern astronomy (is the Earth unique? How varied is the class of potentially habitable terrestrial planets?) across European society.

#### How does the project exceed the current state of knowledge ?

The ETA-EARTH project will, for the first time, combine the highest-precision datasets available to the scientific community working on exoplanets, gathered with three different ground-based, as well as space-borne techniques. ETA-EARTH will ultimately bring us closer to finding answers to age-old questions concerning the uniqueness of the Earth as a habitat.

# ETA-EARTH

## Measuring $\eta_{\oplus}$ : Characterization of Terrestrial Planetary Systems with Kepler, HARPS-N and Gaia

### LIST OF PARTNERS

- Istituto Nazionale di Astrofisica, Italy
- Università degli Studi di Padova, Italy
- Université de Genève, Switzerland
- The University Court of the University of St. Andrews, United Kingdom
- The Queen's University of Belfast, United Kingdom
- The University of Edinburgh, United Kingdom
- Smithsonian Institution, United States
- The Warwick University, United Kingdom

### COORDINATOR

Istituto Nazionale di Astrofisica, Italy

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### PROJECT INFORMATION

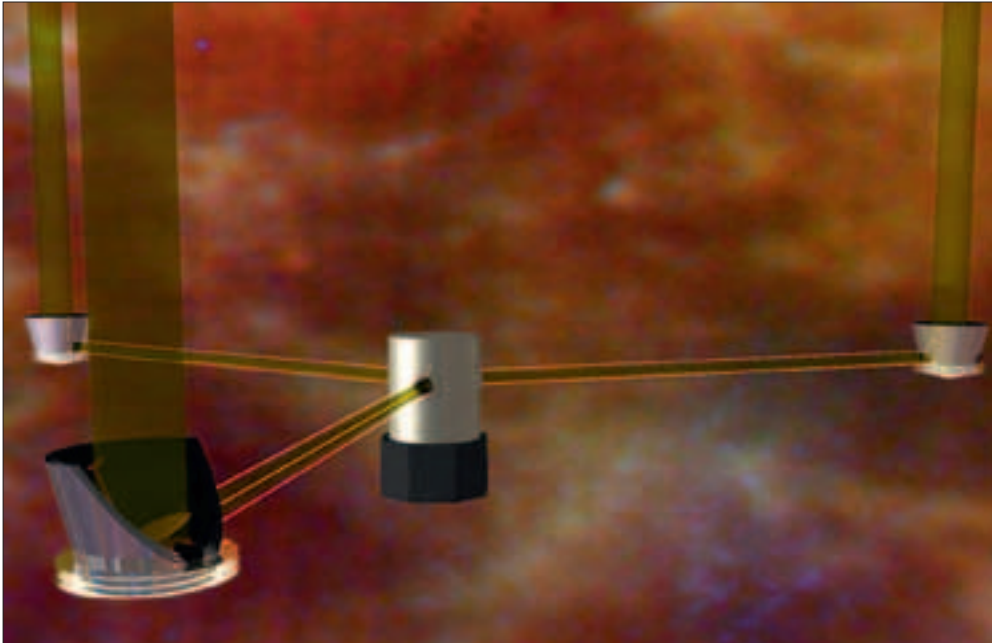
Measuring  $\eta_{\oplus}$ : Characterization of Terrestrial Planetary Systems with Kepler, HARPS-N, and Gaia (ETA-EARTH)

Contract N°: 313014  
Starting Date: 01/01/2013  
Duration: 60 months  
EU Contribution: € 1.994.359,00  
Estimated total cost: € 2.957.200,00



# FISICA

## Far Infrared Space Interferometer Critical Assessment



© FISICA

Concept figure of a free flying Far Infrared Space Interferometer. Single telescopes receiving light from weak distant object relay the light to a central hub satellite which combines these beams accounting for the small positional variations of these satellites. FISICA will investigate many of the technology aspects required.

### ABSTRACT

*The objective of FISICA is to provide the foundations of the technology development required for a far-infrared interferometer mission. We will develop far infrared optical and mechanical components, construct an end-to-end instrument simulator, and assess the feasibility of launching and operating a broadband far infrared interferometer in space.*

### STUDY OF FEASIBILITY OF A FAR INFRARED SPACE INTERFEROMETER AND ADVANCEMENT IN THE REQUIRED KEY TECHNOLOGIES

Impressive advancements in our understanding of the environments in our own (Milky Way) and other galaxies have been made by the Herschel space observatory with its unprecedented combination of spectral coverage and sensitivity, and its high angular resolution compared to previous facilities. But its angular resolution, which struggles to match the spatial detail which Newton had with his optical telescopes, is poor compared to that currently achieved in the optical and radio regions. This is problematic since the Far Infrared (FIR) is precisely the spectral region where most of the energy from star and exoplanetary systems and from galaxy clusters deep in space is radiated. To understand the nature of these objects it is thus crucial to get the clearest view by enhancing the spatial fidelity.

The FISICA team have proposed a novel instrument which is similar to the large ground based radio interferometers but which is designed to be placed outside the Earth's atmosphere to overcome absorption at these wavelengths.

A key difference to the radio system is that the proposed interferometer will be able to provide both the spectral and spatial detail necessary to understand the physical nature of the astronomical sources.

Performing interferometry in space will be challenging as individual telescopes will be large (3m diameter) and we need several of them linked together. Options to consider for the interferometer telescope system include formation flying, large booms or tethered satellites. The FISICA team will study these and many other technical requirements to pave the way for such a pioneering mission.



Giorgio SAVINI  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The project will define the science requirements for a FIR space interferometer and outline a feasible design while advancing some of the required key technologies such as beam combining, optical delay lines and calibration sources.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

This project takes good advantage of existing facilities and expertise throughout Europe to develop and test key technologies. It will position Europe at the forefront of high-angular resolution FIR astronomy and thus enable to lead the way in understanding the nature of star and exo-planet formation and the evolution of galactic clusters in the universe.

#### **How does the project exceed the current state of knowledge ?**

It is not currently conceivable to launch telescopes with dishes much greater than the Herschel Space Telescope into space. The instrument concept proposed by the FISICA team is novel and represents a credible solution to providing the detailed maps necessary to explore our universe. Each of the relevant technology development activities will be pushing the boundaries of what has been achieved so far in this field.

### LIST OF PARTNERS

- University College London, United Kingdom
- Cardiff University, United Kingdom
- Science Technology and Facilities Council, United Kingdom
- Glyndwr University, United Kingdom
- National University of Ireland Maynooth, Ireland
- University of Lethbridge, Canada
- Istituto Nazionale di Astro-Fisica, Italy
- Laboratoire d'Astrophysique de Marseille, CNRS, France
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### COORDINATOR

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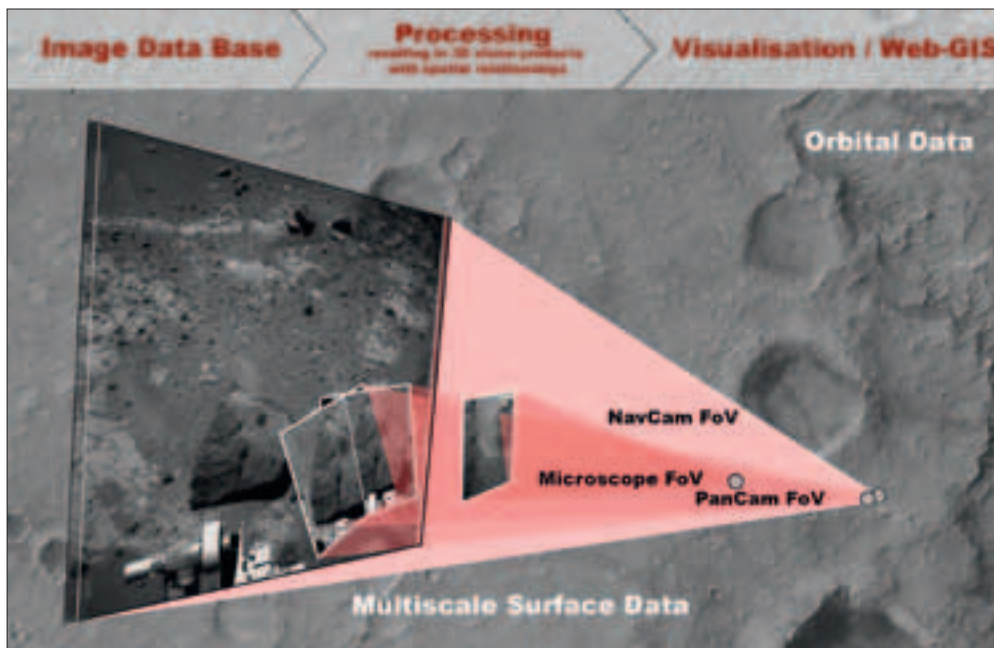
### PROJECT INFORMATION

Far Infrared Space Interferometer Critical Assessment (FISICA)

Contract N°: 312818  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.996.585,85  
Estimated total cost: € 2.607.612,00

# PRoViDE

## Planetary Robotics Vision Data Exploitation



Rover Bridget on its way through the desert in the caldera of Tenerife.

### ABSTRACT

*PRoViDE will assemble a major portion of the imaging data gathered so far from vehicles and probes on planetary surfaces into a unique database. It processes a complete set of 3D vision products, brings them into spatial context and provides seamless and immersive real-time access to them by a multi-resolution visualization engine that combines various levels of detail for a dynamically rendered 3D scene representation.*

PROVIDE PLANETARY ROBOTICS VISION DATA AND A COMPLETE SET OF 3D VISION PRODUCTS BROUGHT INTO A SPATIAL CONTEXT. DEVELOP A MULTI-RESOLUTION VISUALIZATION ENGINE AND A WEB-BASED GEOGRAPHIC INFORMATION SYSTEM (GIS)

The international community of planetary science and exploration has launched, landed and operated dozens of human and robotic missions to the planets and the Moon. They have collected various surface imagery that has only been partially utilized for further scientific application purposes. Few attempts have been made so far to bring these data into a unified spatial context, or to exploit spatial relationships implicit in these images, including orbiter data.

PRoViDE will assemble a major portion of the imaging data gathered so far from vehicles and probes on planetary surfaces into a unique database, bringing them into a spatial context and providing access to a complete set of 3D vision products. Processing is complemented by a multi-resolution visualization engine that combines various levels of detail for a seamless and immersive real-time access to dynamically rendered 3D scene representations.

PRoViDE aims to: complete relevant 3D vision processing of planetary surface missions; provide highest resolution orbital vision data processing results for these sites to embed the robotic imagery and its products into spatial planetary context; collect 3D vision processing and remote sensing products within a single coherent spatial data base; realize seamless fusion between orbital and ground vision data; demonstrate the potential of planetary surface vision data by maximising image quality visualisation in a 3D publishing platform; collect and formulate use cases for novel scientific application scenarios; realize on-line dissemination of key data and its presentation by means of a web-based Geographic Information System and rendering tool.



Gerhard PAAR  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

Within PRoViDE all available (usable) images taken on the surface of celestial bodies in the Solar System are embedded into the spatial context of orbiter imagery and fully processed into 3D vision products. A real-time rendering tool for seamlessly accessing all available (3D) image data resolutions is established for expert visualisation. A web-based geographic information system provides online data presentation and access.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

The PRoViDE initiative will boost the efficiency of information extraction about planetary environments from the raw science and engineering data returned to Earth. The ultimate impact will help lower the costs of operation and improve the quality and quantity of the scientific return from space missions. The provided www front-end for data visualisation ensures public access to selected project results.

#### **How does the project exceed the current state of knowledge?**

PRoViDE presents the first comprehensive 3D vision processing of all surface image data sets available from planetary missions on Mars, the Moon and other planetary bodies. The resulting 3D surface data are supplemented by spatial information, which allow mapping these planets by the superimposition of orbiter images, surface images and the gained 3D vision products. A novel real-time rendering tool allows immersive data visualisation similar to Google Earth, but with much higher data richness.

### LIST OF PARTNERS

- Joanneum Research, Austria
- University College London, United Kingdom
- Czech Technical University, Czech Republic
- The University of Nottingham, United Kingdom
- Technical University Berlin, Germany
- Federal State Educational Budget Institution of Higher Vocational Training Moscow State University of Geodesy and Cartography (MIIGAiK), Russia
- VRVis Centre for Virtual Reality & Visualisation, Austria
- Aberystwyth University, United Kingdom
- Imperial College of Science, Technology and Medicine, United Kingdom

### COORDINATOR

Joanneum Research, Austria

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### PROJECT INFORMATION

Planetary Robotics Vision Data Exploitation (PRoViDE)

Contract N°: 312377  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.999.954,00  
Estimated total cost: € 2.498.562,00

# SOLID

## First European comprehensive SOLar Irradiance Data exploitation



© ESA

Artist's impression of the ESA PROBA2 satellite in space.



Margit HABERREITER  
Project Coordinator

### ABSTRACT

*SOLID will concentrate on providing a complete and consistent time series of solar spectral radiation incident on the Earth's atmosphere from the XUV/EUV to the radio wavelength regions. This will be achieved by combining all existing European space observations of the solar spectral irradiance and complement them through state-of-the-art irradiance modelling.*

### PROVIDE A COMPREHENSIVE SOLAR SPECTRAL IRRADIANCE DATA SET BASED ON SPACE OBSERVATIONS ALONG WITH STATE-OF-THE-ART IRRADIANCE MODELLING

Variations of the solar radiation incident on the Earth's atmosphere are the most important natural factor in the terrestrial climate. Therefore, the time dependent spectral solar irradiance (SSI) is a crucial input to any climate model. The main difficulty, however, is that the observations of the spectral radiation incident at the top of the Earth's atmosphere to date only exist in numerous diverse data sets. SOLID will make an important contribution to this field, as the major objective of the project is to analyse and merge existing European irradiance observations, complemented by non-European space data.

In addition, modelling results will be used to bridge observational gaps in wavelength and time. This will allow the SOLID team to reduce the uncertainties in the irradiance time series and to provide a consistent data set focusing on the period from the beginning of the space era to the present but also including the pre-space era.

Most importantly, the irradiance product will contain a detailed error analysis, which is an essential requirement by the user communities. Besides the climate community, further users of the SSI data product will be the stellar, planetary, and lunar communities, as well as modellers of the Earth's ionosphere. The SOLID-consortium includes representatives from all European solar space experiments; European teams specialized in multi-wavelength solar image processing, as well as European experts in irradiance modelling.

Finally, representatives from the climate community, who will accompany the project with wide dissemination activities, complement the SOLID team.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The objective of SOLID is to provide the first comprehensive solar spectral irradiance data set based on European space observations along with state-of-the-art image processing and irradiance modelling. The data product will be tailored to the specific needs of user communities, in particular the climate modelling community, via interaction throughout the course of the project.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

SOLID is important for Europe as it brings added value to the already existing data obtained through European space experiments. As a consequence, the impact of European space research with all its national contributions from the space agencies will be increased. Climate models will benefit from more precise descriptions of the natural forcing of climate change, thereby allowing scientists to characterise past climate changes and also assess future climate scenarios more precisely. This timely issue has important societal implications in and outside Europe.

#### **How does the project exceed the current state of knowledge ?**

To date the solar spectral irradiance time series only existed as scattered data sets with considerable gaps in wavelength and time. As a consequence there are still numerous open questions as to how much the SSI varies over time scales from days to decades and longer. By combining all existing data series and complementing them with state-of-the-art models, SOLID will increase our knowledge about variations in solar irradiance.

# SOLID

## First European comprehensive SOLar Irradiance Data exploitation

### LIST OF PARTNERS

- Centre National de la Recherche Scientifique, France
- Royal Observatory Belgium, Belgium
- University of Bradford, United Kingdom
- Universität Bremen, Germany
- Imperial College London, United Kingdom
- Max Planck Institut für Sonnensystemforschung, Germany
- Istituto Nazionale di Astrofisica, Italy
- Aristotle University, Thessaloniki, Greece

### COORDINATOR

Physikalisch-Meteorologisches Observatorium  
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### CONTACT

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### PROJECT INFORMATION

First European Comprehensive SOLar Irradiance Data exploitation (SOLID)

Contract N°: 313188  
Starting Date: 01/12/2012  
Duration: 36 months  
EU Contribution: € 1.994.373,60  
Estimated total cost: € 2.579.598,40

# SPACEINN

## Exploitation of Space Data for Innovative Helio- and Asteroseismology



© NASA, CNES, ESA

Space missions: Kepler (top left), CoRoT (top right), SOHO (lower left), and SDO (lower right).

### ABSTRACT

*The main goal of SPACEINN is the full exploitation of space data and complementary ground-based data to allow for innovative approaches in helio- and asteroseismology. Therefore, the overall strategy of the project to accomplish this, focuses on developing innovative approaches for handling, archiving, processing, and the analysis of helio- and asteroseismic data. The work plan includes new developments in seismic analysis, namely, in signal processing, data analysis and stellar modelling.*

### THE INTERIORS OF THE SUN AND THE STARS

Observations of oscillations on the solar and stellar surfaces are a unique and powerful tool to gain information on the processes in the Sun and stars.

Through helio- and asteroseismology we can obtain detailed inferences of the conditions inside the Sun, and extensive information on the properties of a broad range of stars. Knowledge about the solar interior increases the understanding of structure and evolution for our central star. Also, it gives insight into the operation of the solar magnetic activity which has an important impact on our technological society through the potentially harmful solar eruptions, and which may play a significant role in the Earth's climate variations. The stellar results put the Sun into a broader context and provide an extensive possibility for testing and understanding the physical processes in stars. The resulting improvements in stellar characterization and modelling are crucial for broad areas of astrophysics, including the investigation of the structure and evolution of the Galaxy and the understanding of the formation of elements in the Universe.

With the organization of the large and increasing volume of space- and ground-based data for helio- and asteroseismology, it will become possible to study in depth the interiors of the Sun and the stars. This project will strengthen the cooperation of the major groups working in this important discipline, where Europe plays a leading role.



Markus ROTH  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

To contribute towards the best-optimised impacts in terms of international scope and synergies in the fields of helio- and asteroseismology. This will be done through improved access and use of data and data products from the Solar Heliospheric Observatory (SOHO), the Solar Dynamics Observatory (SDO), CoRoT and Kepler combined with ground-based data from GONG, BiSON, and follow-up observations of stars.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

SPACEINN will enhance the effectiveness of the European scientific community by promoting the use of space assets to increase the knowledge in helio- and asteroseismology.

This will create new insights in the generation of the Sun's magnetic field with its influences on near-Earth space and Earth's climate, and on stellar activity, stellar evolution, and the material cycle in the universe.

#### **How does the project exceed the current state of knowledge ?**

Space missions such as SOHO, CoRoT, SDO, and Kepler have provided new insights in the structure and dynamics of the solar and stellar interiors. This project will allow the community to go far beyond the present scientific accomplishments by extending the usage of available space data, and developing better tools to process and interpret data obtained from various assets.

### LIST OF PARTNERS

- Kiepenheuer-Institut für Sonnenphysik, Germany
- Instituto de Astrofísica de Canarias, Spain
- Commissariat à l'Énergie Atomique et aux Énergies Alternatives, France
- Max-Planck-Gesellschaft zur Förderung der Wissenschaften, Germany
- Istituto Nazionale di Astrofisica, Italy
- Katholieke Universiteit Leuven, Belgium
- Observatoire de Paris, France
- Centro de Astrofísica da Universidade do Porto, Portugal
- University of Birmingham, United Kingdom
- Aarhus Universitet, Denmark
- Université Paris-Sud / Institute Astrophysique Spatial, France
- Consejo Superior de Investigaciones Científicas (CSIC), Spain
- Det Kongelige Bibliotek – Nationalbibliotek og Kobenhavns Universitetsbibliotek / Royal Library, Denmark
- Magyar Tudományos Akademia Csillagászati Es Foldtudományi Kutatóközpont / Konkoly Observatory, Hungary
- National Solar Observatory, United States of America
- University Corporation for Atmospheric Research / High Altitude Observatory, United States of America
- Université Paul Sabatier Toulouse III, France

### COORDINATOR

Kiepenheuer-Institut für Sonnenphysik, Germany

### CONTACT

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### PROJECT INFORMATION

Exploitation of Space Data for Innovative Helio- and Asteroseismology (SPACEINN)

Contract N°: 312844

Starting Date: 01/01/2013

Duration: 48 months

EU Contribution: € 1.994.615,00

Estimated total cost: € 3.218.568,53



# SpacePLAN-2020

Space technology road-mapping and planning for Europe



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SpacePLAN 2020: Pushing Space Technology Forward.



Vaios LAPPAS  
Project Coordinator

## ABSTRACT

*The SpacePLAN 2020 project will focus on: Analysis of existing space technology roadmaps in Europe and internationally on the areas of space technology such as: guidance, navigation and control, propulsion, launch vehicle technology, small satellite and space exploration; Foster dialogue between European and international space technology stakeholders, to identify areas of possible collaboration in space technology and missions; Identify and prioritise future developments in space technology, according to technology readiness, mission needs and implementation readiness levels.*

## DEVELOPING A COMPREHENSIVE AND INTERNATIONAL TECHNOLOGY ROADMAP FOR THE EU ON KEY AREAS OF SPACE TECHNOLOGY

Space is part of our everyday life. Space applications, missions, space exploration, with or without humans, are fully dependant on the technology we develop. Technology, which needs to be robust, reliable, low cost, effective, should lead to the successful and sustainable exploitation of the benefits, we get from space and from our planet.

SpacePLAN 2020 promises to develop one of the first independent, comprehensive and international technology roadmaps for the EU on key areas of space technology such as: guidance, navigation and control, propulsion, launch vehicle technology, small satellite and space exploration.

SpacePLAN will fill in a gap which exists in the European community, by providing a long-term (up to 2020) research and technology roadmap for key space technologies, while using inputs from all stakeholders in Europe and internationally by fostering dialogue and collaboration.

The SpacePLAN 2020 project will answer various questions towards the EU mandate to develop a robust and sustainable space research capability in Europe such as:

*What space technologies need to be further developed and how?*

*What should be the space technology agenda in Europe towards 2020?*

*In which areas and how can Europe collaborate with international partners and for what type of space missions and space applications?*

*Can a comprehensive technology roadmap be drawn with strong European and complimentary international inputs?*

## QUESTIONS & ANSWERS

### **What is the project designed to achieve ?**

SpacePLAN 2020 aims to develop one of the first independent, comprehensive and international technology roadmaps for the EU on key areas of space technology such as: guidance, navigation and control, propulsion, launch vehicle technology, small satellite and space exploration.

### **Why is this project important for Europe and how does it benefit European citizens ?**

The global financial crisis forces more collaboration to fulfil space missions; the EU and ESA are expanding and adapting to new emerging needs for providing higher quality of life to its citizens through space. There is a need for a comprehensive roadmap for space technologies to identify gaps, needs, synergies and areas where Europe can take the lead while forging new alliances. For example joining efforts on common goals (e.g Mars) on space exploration can maximise mission success while reducing costs.

### **How does the project exceed the current state of knowledge ?**

Currently Europe and its international partners have various technologies and mission roadmaps which are not necessarily interlinked. This non-coordinated situation often leads to duplication of technologies and space missions, and reduces benefit from technology efforts and developments taking place in other parts of Europe or internationally. The project will analyse current space technology roadmaps, foster dialogue within Europe and internationally and identify areas where joint activities, developments and missions can take place.

# SpacePLAN-2020

Space technology road-mapping and planning for Europe

## LIST OF PARTNERS

- University of Surrey, United Kingdom
- Astrium S.A.S, France
- Athena - Space Programmes Unit (SPU), Greece

## COORDINATOR

University of Surrey, United Kingdom

## CONTACT

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## PROJECT INFORMATION

Space Research Road-mapping and Planning for Europe (SpacePLAN 2020)

Contract N°: 312768  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 486.129,63  
Estimated total cost: € 674.573,00

# STORM

## Solar system plasma Turbulence: Observations, intermittency and Multifractals



Satellites investigate turbulence within the solar system, from the Sun, into the solar wind and the planetary magnetospheres of the inner and outer planets.

### ABSTRACT

*The objective of STORM is to develop and apply a full package of advanced analysis methods on plasma data acquired by European satellites in key-regions of the solar system, like the solar wind, the magnetospheres of Venus, Earth, Mars and Saturn, as well as comets, e.g. Halley. STORM will advance the understanding of turbulence in an astrophysical context and reveal the impact of the solar cycle on plasma turbulent properties.*

### EXPLORATION OF THE SOLAR SYSTEM, SATELLITE DATABASES, ENERGY TRANSFER AND TURBULENCE IN SPACE, SOLAR VARIABILITY AND PLANETARY MAGNETOSPHERES

Turbulence is one of the unsolved fundamental processes that is found in many physical systems. The solar system plasmas exhibit turbulence in various different environments (the interplanetary medium, the planetary magnetospheres) and can be seen as a cosmic scale plasma laboratory, the only one where we can study turbulence in an astrophysical context. The data acquired by the fleet of spacecraft launched during the last decade provide a rich reservoir of knowledge not yet fully exploited.

Developing advanced data analysis techniques is one of the keys to advance knowledge of turbulence from the existing satellite databases. In STORM we will apply on data from European spacecraft a package of analysis methods, like the Fourier analysis or the statistical methods able to reveal hidden tendencies and correlations. Thus, STORM will provide unprecedented views on the variability of turbulent plasmas in the solar system, on the probability of extreme events and the topology of the energy transfer.

In STORM we analyse data from European missions launched to study the solar wind (Ulysses), the planetary plasma environment of Venus (Venus Express) and the Earth's magnetosphere (Cluster). STORM will provide data products that will be available for the space science community and also provide new insight on turbulent processes in key-regions of the solar system and how the turbulence varies with the solar cycle.



Marius ECHIM  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

STORM joins a team of world class specialists from nine European space science institutes and universities, who will build on their mutual expertise as well as on the high quality of data provided by European satellites, launched to explore the solar system. The project adds value to existing databases and advances the understanding on fundamental processes like turbulence and intermittency.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

Europe has made important investments in solar system exploration that lead to the accumulation of an important quantity of data. The analysis of these data by advanced, modern algorithms and methods will increase the return value of this investment and will contribute to scientific breakthroughs that will consolidate Europe's major position in space exploration.

#### **How does the project exceed the current state of knowledge ?**

STORM makes a systematic survey of the existing databases on which it applies for the first time an integrated package of advanced analysis methods. It investigates turbulence in various key-regions of the solar system and during different phases of the solar cycle.

# STORM

## Solar system plasma Turbulence: Observations, inteRmittency and Multifractals

### LIST OF PARTNERS

- The Belgian Institute for Space Aeronomy, Belgium
- Technical University Braunschweig, Germany
- Space Physics Institute Kiruna, Sweden
- Center for Space Science of the Polish Academy of Sciences, Poland
- Institute for Space Sciences, Romania
- University of Oulu, Finland
- Hungarian Institute for Geophysics, Hungary
- National Institute for Astrophysics, Italy
- Space Research Institute Graz of the Austrian Academy of Sciences, Austria

### COORDINATOR

Belgian Institute for Space Aeronomy, Belgium

### CONTACT

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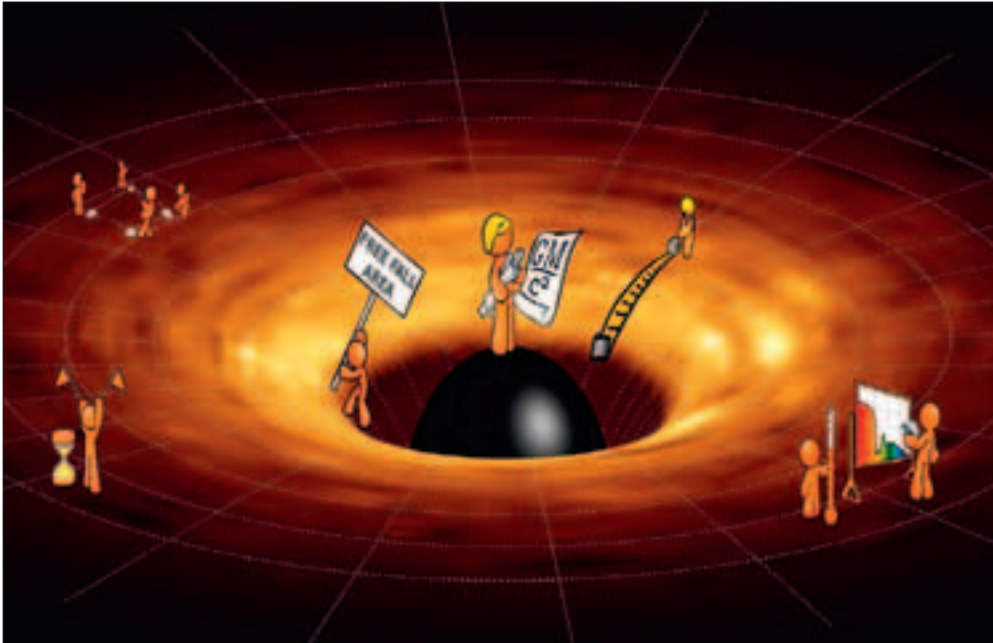
### PROJECT INFORMATION

Solar system plasma Turbulence: Observations, inteRmittency and Multifractals (STORM)

Contract N°: 313038  
Starting Date: 01/01/2013  
Duration: 36 months  
EU Contribution: € 1.998.200,00  
Estimated total cost: € 2.450.280,00

# STRONGGRAVITY

Probing Strong Gravity by Black Holes Across the Range of Masses



© Michal Bursa, Astronomical Institute AS CR, Prague

The artistic view of a black hole and its inner accretion disc.

## ABSTRACT

*The objective of STRONGGRAVITY is to develop analytical tools to study processes occurring near astrophysical black holes, acquire observational data on the Galactic solar-mass black holes in binary systems, super-massive black holes in the centres of galaxies and our central black hole of the Milky Way, and use the created tools together with the new and archival data for better understanding the properties of black holes and their immediate neighbourhood.*

## ASTROPHYSICS OF BLACK HOLES THROUGH DEVELOPMENT OF ANALYTICAL TOOLS AND USE OF OBSERVATIONAL DATA

Black holes provide a crucial link between Einstein's theory of gravity and real cosmic objects which astronomers can observe and study in the Universe. This project is oriented towards legacy of the cornerstone XMM-Newton X-ray satellite mission of European Space Agency in synergy with relevant data in other spectral domains that are covered by ground-based infrared and radio interferometric techniques at European Southern Observatory and elsewhere. Information in different wavelengths will be gathered and explored in order to understand radiation processes in places of strong gravity, near black holes.

It is almost impossible to see black holes directly, therefore it is the observation of the matter moving in close vicinity of these objects, either orbiting them, falling down upon them or being ejected from their neighbourhood that can reveal their properties.

In this project we will analyse and interpret multi-wavelength spectral and fast timing observations of systems containing different kinds of black holes, according to their mass – the solar-mass black holes in the binary systems in our Galaxy and the supermassive black holes in the centres of galaxies with masses of more than billion suns.

We will include valuable data from archives and complement them by performing new observations where needed. Our main objective is to use and enhance computational tools that the participating groups have been developing over two decades, and to join our effort in a dedicated program of data analysis and science interpretation of the most bizarre cosmic objects – black holes.



Michal DOVČIAK  
Project Coordinator

## QUESTIONS & ANSWERS

### **What is the project designed to achieve ?**

The objective of this project is to enhance our understanding of astrophysical black holes and to determine their properties. In this regard, we will develop new analytical tools, to be used freely by the astronomical community, carry out new observations and utilise the archival data.

### **Why is this project important for Europe and how does it benefit European citizens ?**

Black holes are fascinating astronomical objects that catch the imagination of the humanity since their discovery last century. The project will get together a group of leading European experts in the field of black-hole astrophysics to push our knowledge further and to create new analytical tools for use by the world-wide astronomical community.

### **How does the project exceed the current state of knowledge ?**

We will develop new tools for the computation of the spectral, timing and polarization properties of the radiation emitted close to the black hole and apply them to data, either from the public archives or obtained via dedicated proposals, mainly but not exclusively from current and near-future X-ray satellites.

# STRONGGRAVITY

## Probing Strong Gravity by Black Holes Across the Range of Masses

### LIST OF PARTNERS

- Astronomický ústav AV ČR v.v.i., Czech Republic
- Centre National De La Recherche Scientifique, France
- Università Degli Studi Roma Tre, Italy
- The Chancellor, Masters and Scholars of the University of Cambridge, United Kingdom
- Consejo Superior de Investigaciones Científicas (CSIC), Spain
- Universität zu Köln, Germany
- Centrum Astronomiczne Im. Mikołaja Kopernika Polskiej Akademii Nauk, Poland

### COORDINATOR

Astronomický ústav AV ČR v.v.i., Czech Republic

### CONTACT

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### PROJECT INFORMATION

Probing Strong Gravity by Black Holes Across the Range of Masses (STRONGGRAVITY)

Contract N°: 312789  
Starting Date: 01/01/2013  
Duration: 60 months  
EU Contribution: € 1.989.320,00  
Estimated total cost: € 2.644.556,40

# G-SEXTANT

## Service Provision of Geospatial Intelligence in EU External Actions Support



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Marino PALACIOS MORERA  
Project Coordinator

G-SEXTANT will benefit the development of services in support of EU External Action by addressing several selected scenarios.

### ABSTRACT

*G-SEXTANT aims to develop a portfolio of Earth Observation products and services to support the geo-spatial information needs of EU External Action stakeholders, such as the European External Action Service, building on the lessons learned in previous projects.*

### DEVELOPING EARTH OBSERVATION PRODUCTS AND SERVICES TO SUPPORT GEOSPATIAL INFORMATION NEEDS OF EU EXTERNAL ACTION

G-SEXTANT aims to develop a portfolio of Earth Observation (EO) products and services to support the geo-spatial information needs of EU External Action users and stakeholders, such as the European External Action Service.

Building on the lessons learned in previous projects (such as G-MOSAIC), G-SEXTANT will enhance existing services through continued R&D and on the basis of user needs, identified during the course of the project. Horizontal issues, such as the implementation of an appropriate governance model, will also be examined.

The main goals of the project are: The preparation and delivery of pre-operational services in user-driven Support to External Action (SEA) scenarios; The enhancement of mature products and services, as requested by users; The development of a standardised portfolio of products and services.

G-SEXTANT addresses the following proposed scenarios in the context of support to EU External Action: intelligence for humanitarian aid and civil protection operations, exploitation of natural resources, monitoring of land use, treaty compliance and nuclear non-proliferation monitoring, monitoring of illicit crops, and border monitoring outside the EU.

The G-SEXTANT project will take into account the skills and experience of the various stakeholders involved: industry (in terms of production and implementation capacity), academic and research organisations (in terms of scientific expertise), and EU bodies and institutions (in terms of coherence with existing policies and operations, and access to intelligence data).

Finally, users will be involved in the validation of products and services, so that the impact of the project on the Security user community can be measured.

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The G-SEXTANT project will develop EO services and products in support of EU External Action. Currently, the services considered in G-SEXTANT have not proven mature enough to enter the operational phase. The project will address the corresponding areas of research and development in order to bring the services closer to operational deployment. The goal is to develop a standardised portfolio of pre-operational services.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

The project is important for Europe as the extraction of intelligence information from EO data and other sources provides support to EU decision makers. European citizens will benefit from the development of operational Copernicus services in support to External Action, in particular from services such as the support to treaty compliance and nuclear non-proliferation monitoring, or monitoring of illicit crops.

#### **How does the project exceed the current state of knowledge?**

The G-SEXTANT project specifically addresses services for Security applications that are not yet 'mature' and therefore need further research and analysis in order to become operational. The project will develop both technological tools and thematic studies in selected scenarios, whilst building on the results already achieved by other projects. All results will be subject to external validation and user verification.

# G-SEXTANT

## Service Provision of Geospatial Intelligence in EU External Actions Support

### LIST OF PARTNERS

- Indra Sistemas S.A., Spain
- Deutsches Zentrum für Luft – und Raumfahrt, Germany
- European Union Satellite Centre, Spain
- Joint Research Centre – European Commission, Belgium
- Paris – Lodron – Universität Salzburg, Austria
- e-Geos SPA, Italy
- SpaceTec Partners SPRL, Belgium
- Eurosense Belfotop N.V., Belgium
- Centrum Badan Kosmicznych Polskiej Akedemii Nauk, Poland
- Forschungszentrum Juelich GmbH, Germany
- Internationales Konversionszentrum Bonn GmbH, Germany
- Università degli Studi di Pavia, Italy
- Istituto Affari Internazionali, Italy
- Commissariat à l’Energie Atomique et aux Energies Alternatives, France

### COORDINATOR

INDRA SISTEMAS S.A. (Spain)

### CONTACT

Dr Marino PALACIOS MORERA  
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### PROJECT INFORMATION

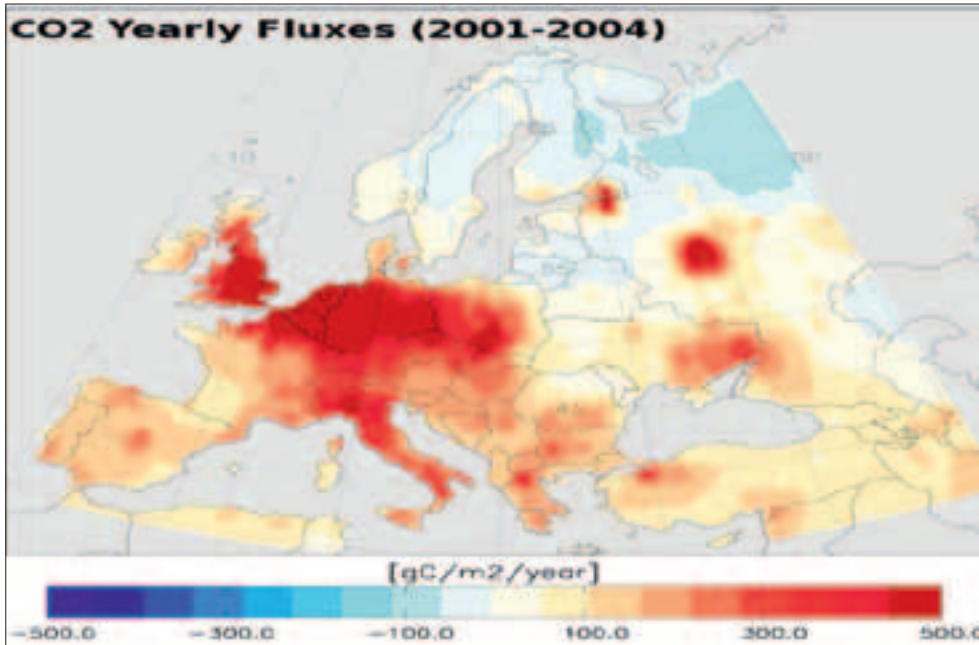
Service Provision of Geospatial Intelligence in EU External Actions Support (G-SEXTANT)

Contract N°: 312912  
Starting Date: 01/01/2013  
Duration: 24 months  
EU Contribution: € 4.000.000,00  
Estimated total cost: € 5.699.911,26



# ICOS

## Integrated Carbon Observation System



Map of the flow of carbon over Europe from 2001-2004 using 5 independent atmospheric models. Graph depicts how the models ICOS uses within its partnership can be used to show an overall picture of CO<sub>2</sub> distribution.

### ABSTRACT

*The ICOS project will build an infrastructure for co-ordinated, integrated, long-term high quality observation data of the greenhouse balance of Europe and of adjacent key regions of Siberia and Africa. Consisting of a centre for co-ordination, calibration and data in conjunction with networks of atmospheric, ecosystem and oceanic observations, ICOS is designed to create the scientific backbone for a better understanding and quantification of greenhouse gas sources and sinks and their feedback with climate change.*

### ENABLING MORE ACCURATE CLIMATE CHANGE PREDICTIONS

ICOS will provide the long-term observations required to understand the present state and predict future behaviour of the global carbon cycle and greenhouse gas emissions. ICOS will additionally monitor and assess the effectiveness of greenhouse gas mitigation activities on atmospheric composition levels, including attribution of sources and sinks by region and sector. The ICOS measurements will be combined using advanced carbon cycle models in an operational information system which permit: the detection of systematic changes in regional greenhouse gas fluxes despite their high level of internal variability; the reduction of uncertainties in Earth system models; early warning of negative developments; the timely introduction of mitigation and adaptation measures and the evaluation of their successes.

This system will establish a world class standard for understanding the exchange processes between the atmosphere, the terrestrial surface and the ocean.

The routine flux diagnostics will be generated both by research institutes, members of ICOS, and by other institutes that will benefit from free access to the observations provided by the infrastructure. Regular assessment and synthesis of the different flux products, and interaction with policy will be organized by ICOS.

ICOS will strengthen the position of Europe as a global player for in situ observations of greenhouse gases, data processing and user-friendly access to data products for validation of remote sensing products, scientific assessments, modeling and data assimilation.



Philippe CIAIS  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The overarching goal of ICOS is to provide the future research infrastructure with the data required to understand the greenhouse gas budgets and perturbations. As such, ICOS will provide long-term observations required to understand the present state and predict future behaviour of the global carbon cycle and greenhouse gas emissions. ICOS will provide the link necessary to join together research, education and innovation to promote technological development related to greenhouse gas quantification.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

ICOS will provide the necessary high-precision continuous and harmonized data for the global climate modelling community to understand the European and global greenhouse gas budgets and their potential fluctuations under changing climatic and economic conditions. It will secure the availability of these important data for the next decades.

#### **How does the project exceed the current state of knowledge?**

Research efforts to deduce the best possible estimate of the greenhouse gasses of Europe and their uncertainties has not been homogenous across Europe. With ICOS and its data assimilation and data fusion techniques as well as the continuous development of realistic model development, we are now reaching a stage in which accurate, homogenous and reliable GHG measurements can be quantified.

### LIST OF PARTNERS

- Commissariat à l'Energie Atomique, France
- Max-Planck-Gesellschaft, Germany
- University of Tuscia, Italy
- University of Heidelberg, Germany
- Vrije University Amsterdam, the Netherlands
- University of Helsinki, Finland
- University of Edinburgh, United Kingdom
- Centre National de la Recherche Scientifique-Institut National des Sciences de l'Univers, France
- Lunds universitet, Sweden
- Forskningscenter Riso, Danmarks Tekniske Universitet, Denmark
- SJ Berwin LLP, Belgium
- Universiteit Antwerpen, Belgium
- Fundacion Centro de Estudios Ambientales del Mediterraneo, Spain
- Centrum vyzkumu globalni změny AV ČR, vvi, Czech Republic
- Eidgenoessische Technische Hochschule, Switzerland
- Institut National de Recherche Agronomique, France
- UniResearch, Norway
- Weizmann Institute of Sciences, Israel
- Future Partner: Poznan University, Poland

### COORDINATOR

Commissariat à l'Energie Atomique, France

### CONTACT

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### PROJECT INFORMATION

Integrated Carbon Observation System (ICOS)

Contract N°: 211574

Starting Date: 01/04/2008

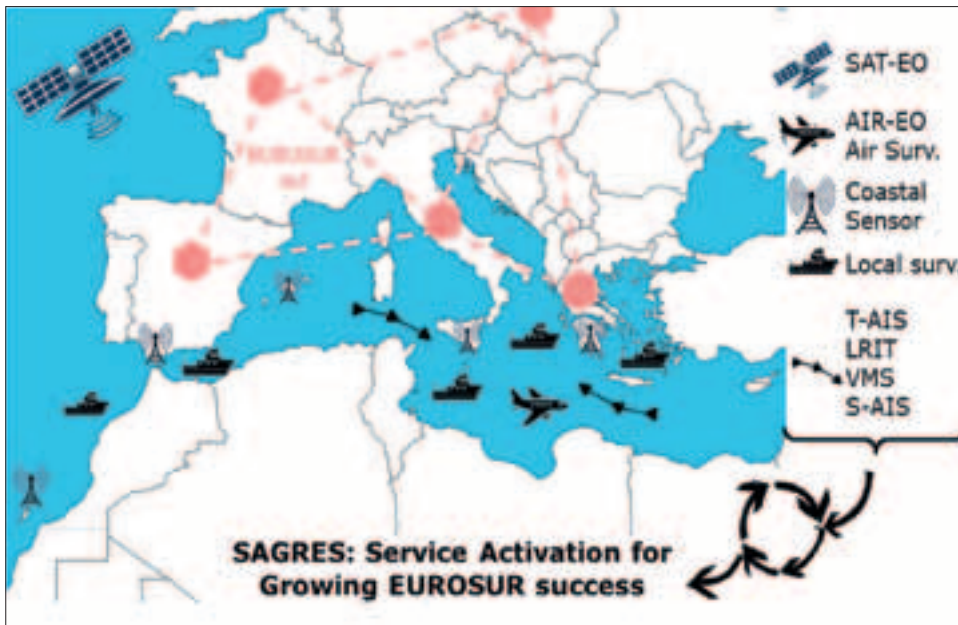
Duration: 60 months

EU Contribution: € 4.300.000,00

Estimated total cost: € 5.700.000,00

# SAGRES

## Service Activations for GRowing Eurosur's Success



SAGRES: providing a multi-source data processing approach.

### ABSTRACT

The project pursues a fourfold goal: To test the reliability of the CONOPS services in support of operational border surveillance; To run campaigns where the main key actors are involved; To bridge the gap between research and the operational set-up by drafting a system design; To provide answers to key technical drawbacks that currently limit the involvement of EO technology in operational missions.

### PRE-OPERATIONAL TEST OF THE HIGH-TIME CRITICAL BORDER SURVEILLANCE SERVICES: FRONTEX'S CONCEPT OF OPERATIONS (CONOPS)

SAGRES will support the pre-operational deployment of the high-time critical Concept of Operations (CONOPS) components via the EUROSUR network. CONOPS refers to a document defined by key EU agencies that describes the set of services foreseen by the Member States to cover a set of operational needs in the field of border surveillance. The reference scenarios are: 1) tracking vessels on the high seas and 2) punctual monitoring of third-country port and coasts.

The pre-operational services that will be managed by SAGRES are:

- S3: probability of departure of a target within a 3rd country port
- S4: probability of departure of a target within a 3rd country shore
- S5: track targets of interest at open seas > 40NM from EU coast
- S6: monitor targets with anomalous behaviour at open seas > 40NM from EU coast
- S7: monitor a buffer area at open seas > 40NM from EU coast

S8: maritime environmental assessment to label areas of interest

S12: land environmental assessment to label areas of interest

The services will be delivered to FRONTEX via EUSC and EMSA, which will complement the end-product with confidential reports. The work will not start from scratch as SAGRES will re-use the technological resources available at EU agencies. The principle of "use, comment, upgrade, use" applies, which will result in a cyclic development of five service versions.



Gerard MARGARIT  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The project is designed to show the importance of EO technology, combined with cooperative reporting streams, to support border surveillance operational missions. It aims at confirming that an increased efficiency in tracking/avoiding specific scenarios can be achieved with an improved resource management.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

This project would provide European citizens with a system that would increase the security and safety levels that are currently deployed at maritime EU borders. The main drivers are to fight against the losses of life at EU borders and to increase law verification efficiency.

#### **How does the project exceed the current state of knowledge ?**

The project will provide the means to understand how two different technological approaches would work together in the field of border surveillance. Certainly, the times and methods of local deployable means and of remote sensing devices are completely different. Trying to integrate all of them together into the same scenario is the challenge of SAGRES.

### LIST OF PARTNERS

- GMV Aerospace and Defence S.A.U., Spain
- European Satellite Centre, Spain
- GMV Skysoft, Portugal
- Deutsches Zentrum für Luft- und Raumfahrt, Germany
- Spot Image S.A., France
- Fraunhofer FKIE, Germany
- Guarda Nacional Republicana, Portugal
- National Space Centre, Ireland
- NATO's Centre for Maritime Research and Experimentation, Italy
- European Space Imaging, Germany
- Spot Image Hellas, Greece
- Infoterra GmbH, Germany
- Engineering, Italy
- Hisdesat, Spain
- KEMEA- Centre for Security Studies, Greece
- CNR, Italy
- Guardia Civil, Spain

### COORDINATOR

GMV Aerospace and Defence S.A.U., Spain

### CONTACT

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### PROJECT INFORMATION

Service Activation for Growing EUROSUR's Success (SAGRES)

Contract N°: 313305  
Starting Date: 01/01/2013  
Duration: 24 months  
EU Contribution: € 3.400.000,00  
Estimated total cost: € 5.600.000,00

# SENSYF

## Sentinels Synergy Framework



SENSYF will explore Copernicus (formerly GMES) synergistic services using cloud computing infrastructure.

### ABSTRACT

*The SNSYF operational objectives are twofold: Develop and operate an acquisition and processing framework allowing easy access to Sentinel datasets, in which the novel Services for exploitation of Synergetic Sentinel data can be built; Develop a set of pre-selected Services that address both the system capabilities and provide feedback on it, and at the same time assess the coverage of each Service's driving needs.*

### CLOUD BASED INFRASTRUCTURE FOR EXPLOITATION OF SENTINEL SYNERGETIC SERVICES

Earth Observation (EO) satellites generate huge amounts of data that are not easily integrated into processing chains outside space agencies ground segments, which is particularly true for the Sentinel missions. Very often, scientists or small/medium enterprises (SME) do not have access to the computing and storage capacity required to handle the amount of data needed to implement, test and deliver end-user services based on EO data, or will need to re-size their infrastructure in view of the increased volume of Sentinel data.

SENSYF project shall establish a complete system for fully automated data acquisition and processing, including a specialized Sandbox Service with tools and development/validation platforms where Service developers are able to implement and test their applications, and then tap into a distributed pool of cloud resources when ready for the exploitation phase.

This project will allow for the development and testing of new Services and Applications for Sentinel and Copernicus (former) GMES contributing mission data, as well as assisting in the delivery of higher-level products and services complementing the information provided by the (pre-) operational services. SNSYF shall be based on a dynamic parallel processing infrastructure, where the capabilities of grid computing applied to Sentinel data processing can be exploited and demonstrated.

On top of the Synergy Framework proposed, a selected set of demonstrative services were also selected, which will: demonstrate the system's potential; provide valuable development feedback for the framework improvement, and prove the overall concept by addressing specific services needs within the European and global settings.



Antonio GUTIERREZ PEÑA  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

SENSYF aims to furnish a framework similar to space agencies operational environments, where applications are run against large EO datasets, and where the "time-to-market" or the applications readiness for production can be streamlined. The distributed processing services will bridge the exploitation gap by offering access to EO data and processing power, bringing processors and applications closer to the data.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

By using the same model behind the European Space Agency (ESA) Grid Processing on-Demand environment, SNSYF will enable the collaborative sharing of data and processing power from commercial or/and private clouds. SNSYF will provide an infrastructure where SME and scientists can develop and deploy Earth Science applications with a lower overall cost of data, infrastructure setup and maintenance.

#### **How does the project exceed the current state of knowledge ?**

SENSYF framework will allow, for the first time in EO domain, any interested scientific and/or commercial partners to take advantage of distributed computational and storage resources without any particular technological investments and a clear cost model.

SENSYF will go beyond state-of-the-art by achieving a common infrastructure with large EO data series, high performance/throughput computing solutions and near-real-time satellite data ingestion.

### LIST OF PARTNERS

- DEIMOS Engenharia, Portugal
- DEIMOS Space, Spain
- Terradue SRL, Italy
- Centro Nacional de Información Geográfica, Spain
- ACRI-ST SAS, France
- Northern Research Institute Tromsø AS, Norway
- ARGANS Limited, United Kingdom
- Instituto Superior Técnico, Portugal
- Universitat de Valencia, Spain

### COORDINATOR

DEIMOS Engenharia, Portugal

### CONTACT

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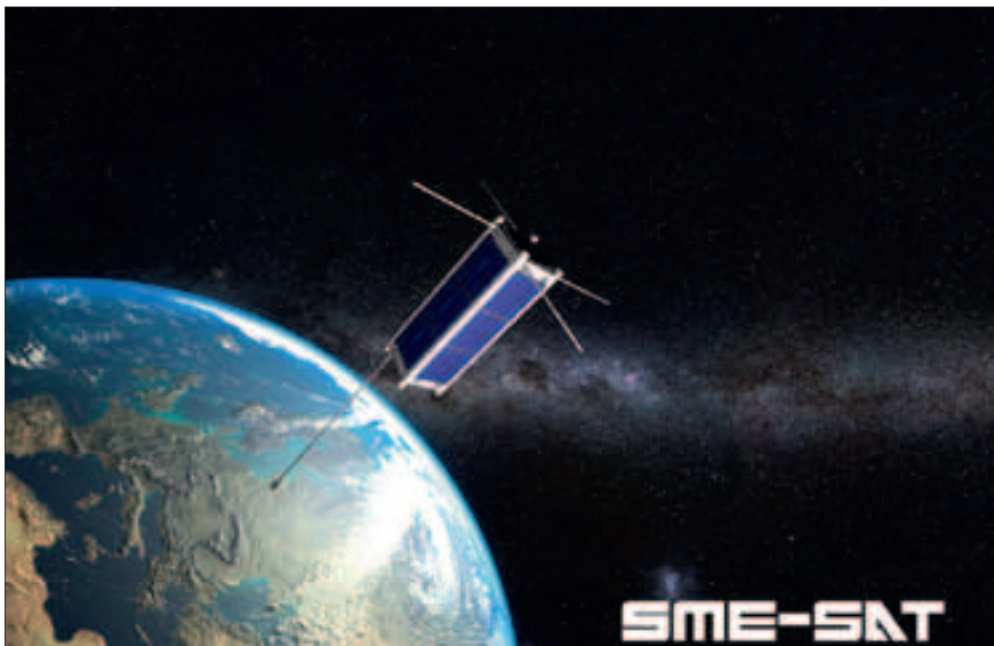
### PROJECT INFORMATION

Sentinels Synergy Framework (SENSYF)

Contract N°: 313117  
Starting Date: 01/11/2012  
Duration: 36 months  
EU Contribution: € 1.992.967,00  
Estimated total cost: € 2.545.421,90

# SME-SAT

## Small and Medium Enterprise Satellite



© University of Surrey-Tom Harle

SME-SAT Nanosatellite in Low Earth Orbit.

### ABSTRACT

The primary purpose of this spacecraft is as a technology demonstrator. Each SME in the consortium will be responsible for contributing a particular spacecraft subsystem. These systems/subsystems will be integrated into a nanosatellite forming SME-SAT and allow Small to Medium Enterprises to space qualify and characterise their technologies in the environment of space.

### FLIGHT QUALIFYING OF SME DEVELOPED TECHNOLOGIES IN A NANO-SATELLITE DEMONSTRATION MISSION

Fuelled by mass market demand, terrestrial consumer electronics continue to drive technology advancement in the field of microelectronics devices. Many of these technologies are spearheaded by the contributions of Small and Medium Enterprises (SME). There is a clear opportunity to revolutionize space technologies by leveraging advancement in the commercial electronics market. However, despite the benefits to the space industry, it remains difficult for SMEs to get involved due to the significant cost, effort, time, and paper work to qualify parts for space applications.

A trend toward smaller and cheaper satellites allows for a novel approach to space qualification and testing. Nanosatellites (1kg to 10kg) can be launched at a relatively low cost as piggy back payloads for larger satellite missions. Since the cost of failure is significantly lower, nanosatellites offer an ideal platform for high risk demonstration missions.

The primary purpose of this spacecraft is as a technology demonstrator. Each SME in the consortium will be responsible for contributing a particular spacecraft subsystem. Systems that will be demonstrated in this project include: High precision ADCS (Nano-Control Moment Gyros for agility, Gyros, Accelerometers, Star sensor, Failure Detection, Isolation and Recovery); Power system, Structures, Magnetometer, GPS.

The primary objective of this project is to involve SMEs from the terrestrial sector on a space project and allow them to space qualify their technology. SME-SAT brings together one of the largest SME based consortiums ever to develop advanced space technologies based on terrestrial applications.



Vaios LAPPAS  
Project Coordinator

### QUESTIONS & ANSWERS

#### **What is the project designed to achieve ?**

The aim of this project is develop and space qualify technologies developed by SME's and universities in a low cost nanosatellite demonstration mission. This provides low cost access to space and will demonstrate the performance and viability of commercially available off the shelf terrestrial components for use in space.

#### **Why is this project important for Europe and how does it benefit European citizens ?**

This project represents a unique, unprecedented space mission, fostering a new alliance between European SME's, universities and a large scale space prime/integrator, in which high risk technologies will be developed and fully tested in space using a 3U Cubesat.

#### **How does the project exceed the current state of knowledge ?**

SME-SAT will demonstrate a low cost startracker compatible with nanosatellite markets and technical constraints, reduced magnetometer noise to the level of  $\sim 20$  pT/Hz-1/2 at 1 Hz; a target previously achievable only by ground-based flux-gate magnetometers. It will also demonstrate the performance of a number of COTS devices.

### LIST OF PARTNERS

- University of Surrey, United Kingdom
- Sensoror, Norway
- Innovative Solutions in Space (ISIS), the Netherlands
- Astrium, France
- THEON SENSORS, Greece
- Hellenic Space Systems, Greece
- Systematic Design, the Netherlands
- SSBV Space & Ground Systems, United Kingdom
- MPB Communications, Canada
- Laboratory of Electro-Magnetic Innovations, Ukraine

### COORDINATOR

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### PROJECT INFORMATION

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