

## **List of the Republic of Poland activities**

The activities accepted to be undertaken by the Government of the Republic of Poland under the PECS decided in the year 2008 which, pursuant to the terms of the ECS Agreement, have been approved by the Agency's Programmes Boards and Committees and the PECS Committee, are the following

### **A. Space Science**

#### **1. *BepiColombo – Calibration and modelling of the Italian Spring Accelerometer (ISA) errors***

The main goal of this project is to cooperate in the preparation of software for investigating an error budget of the Italian Spring Accelerometer (ISA) for the BepiColombo ESA cornerstone mission. The role of the ISA is to remove from the list of unknowns the non-gravitational accelerations that perturb the gravitational trajectory followed by the Mercury Planetary Orbiter (MPO).

The main cooperation tasks are in the following points:

1. cooperating with the ISA PI Team in the development of a concept for ISA in-flight calibration;
2. preparing parts of algorithms for in-flight calibration;
3. verifying/testing of the prepared algorithms by adequate modelling cases;
4. documenting and providing the related software.

The strict cooperation with IFSI (Istituto di Fisica dello Spazio Interplanetario) enables the Polish Space Research Centre to get knowledge about inertial techniques. It will be very useful for the future projects related to inertial navigation systems. The precise terms of this cooperation will be subject to further iterations between the PI and the Polish partner, before the PECS contract will be placed.

#### **2. *BepiColombo – Design, production and tests of the MERTIS POInting Unit (MPOI) flight and spare flight models***

One of BepiColombo experiments is the imaging spectrometer MERTIS (Mercury Radiometer and Thermal Infrared Spectrometer). Main scientific objectives of the experiment are:

- Study of Mercury's surface composition,
- Identification of rock-forming minerals,

- Mapping of the surface mineralogy,
- Study of surface temperature and thermal inertia.

The MERTIS instrument is an IR-imaging spectrometer based on the push-broom principle. It is based on an un-cooled micro-bolometer array providing spectral separation and spatial resolution according to its 2 dimensional shape. The operation concept principle is characterized by intermediate scanning of the planet surface and 3 different calibration targets free space and on-board black body sources. Sharing the same optical path, a push-broom radiometer is implemented according an in-plane separation arrangement.

The Space Research Centre (SRC) has been involved in this experiment since 2003 and is responsible for the MERTIS Pointing Unit (MPOI). At the current stage, the engineering model of the MPOI is under development through national funding. Since the beginning of the project it was assumed that phase C/D and E would be funded by PECS. The production of the mechanical parts of the unit will be made by Przemysłowe Centrum Optyki SA in Warsaw.

## **B. Earth Observation**

### **1. Participation to Soil, Water and Energy Exchange / Research (SWEX/R)**

The project SWEX/R is the support program to the wider program SMOS Validation and Retrieval Team (SVRT) AO3275. It requires conducting several field campaigns, defined in the SVRT agreement for the purpose of gathering the ground truth data on SM (Soil Moisture) by tests, and assessing environmental conditions in the test places, beyond the local scale of tests.

Since December 1, 2005, the Space Research Centre of the Polish Academy of Sciences, and the partners associated in the national Consortium SWEX (Soil, Water and Energy Exchange), are included to the Cal-Val plan, and conduct the preparatory activities for AO3275. The general goal of this project is to include the ground based research in selected test areas in Poland to the global SMOS Cal-Val program and keep that ground activities scientifically valuable through the life time of the SMOS mission, three years since SMOS commissioning in the mid of 2008 and beyond if the extended SMOS operation is decided. Particular research goals are the subject of individual research programs, funded by national grants and other European funds. For the moment, the time slot for the SWEX/R is limited, from January 1, 2009 till December 31, 2011.

The project SWEX/R will be performed by Space Research Centre PAS, who will engage the following partners associated in the national Consortium SWEX:

- 1) Institute of Geodesy and Cartography (IGiK), Warsaw,

- 2) Institute of Agrophysics Polish Academy of Sciences (IA PAN), Lublin,
- 3) Institute of Geography and Spatial Organization (IGiPZ PAN), Warsaw, Observational Station, Szymbark,
- 4) Institute for Land Reclamation and Grassland Farming (IMUZ), Bydgoszcz Division,
- 5) Department of Management and Protection of Environment, Świętokrzyska Academy (SZOiKŚ AŚ), Kielce,
- 6) Institute of Tele-Radiotechniques (ITR), Warsaw.

The said partners are committed to the goals of project AO3275, as expressed officially in the agreement on the Consortium SWEX. The project respects the SVRT agreement on AO3275 and comprises a new test region (Beskid Niski, Szymbark) for forest research.

## **2. GSE-FM Forest Monitoring Inputs for National Greenhouse Gas (GHG) Reporting**

Service is planned to be provided by the GSE-FM (GMES Service Element Forest Monitoring) international consortium, led by GAF AG (a German company specialized in the field of Earth observation applications). GEOSYSTEMS Polska Ltd., an EO and GIS specialized company, will play the role of service provider in the project. It has experience as a service provider in GSE-FM activities gained in a pilot project in 2005. The end-user of products to be delivered during the project is the Ministry of the Environment (ME), institution responsible for national Greenhouse Gas (GHG) reporting.

The service will provide critical environmental information that is currently unavailable in Poland for the effective implementation of the UNFCCC/KP reporting.

The main elements of greenhouse gas reporting include national summary statistics of forest area, forest area changes within a land use change matrix, totals and changes in stem volumes, biomass and carbon.

The information provided is supplemented by an uncertainty analysis that quantifies the level of error and thereby allows a reliable estimate.

The combination of EO and in-situ data within the GSE-FM approach allows users responsible for reporting under the Kyoto-Protocol to achieve the highest levels of reporting confidence. In situations where no national forest inventory is available, the GSE-FM services promote the design of an inventory at low cost.

The main target group for GSE-FM greenhouse gas reporting includes national forestry and environmental agencies with a mandate to deliver national reporting and accounting under the Kyoto Protocol.

Specific Service features:

- Spatially explicit information for Land Use, Land Use Change and Forestry (LULUCF), delivered as maps and statistics
- Consistent and cost effective 1990 base year assessment
- Documentation in accordance with Good Practice Guidelines (GPG) and Conference of Parties of the conventions (COP) decisions.
- Accuracy and uncertainty information in accordance with UNFCCC/KP reporting requirements.
- Service coverage: the entire area of Poland; Update frequency: Annually or on client specifications

### **3. Geo-spatial analysis for development processes of Metropolitan areas of Poland**

The main goal of this project is to implement and apply in practical manner know-how available within other European Projects, namely GEOLAND (Land Monitoring), MOLAND, MURBANDY, GSE Land Activities, being in disposal of either European Space Agency, or Infoterra or European Commission, and to disseminate this existing experience within Warsaw Metropolitan Area Institutions. It is also aiming at applying in a practical way technologies such as VHR satellite photos, newest imagery from TerraSAR radar satellite, detection change methodology for the purpose of establishing Earth observation satellite based permanent monitoring of Warsaw Metropolitan Area, and at later stages (beyond project cycle) at disseminating and replicating the experience gained by this project for other 16 metropolitan areas in Poland as well as for other 45 cities which have more than 100, 000 inhabitants.

This project will be realized by TECHMEX Ltd., founder of the Satellite Centre for Regional Operations, the only satellite Earth observation ground station company in Poland. This company has a long term experience in creation and dissemination of VHR EO applications. Its experience will be shared with GEOLAND and GSE consortia members. This project is meant to be integrated into Infoterra activities.

### **4. Assessment of carbon balances for different biomasses and soil moistures within various ecosystems**

The objective of the project is the assessment of the level of carbon balance with regard to land use, the amount of biomass, the soil moisture and meteorological conditions. The project will also assess the influence of the land use cover on carbon release.

The changes in carbon flow will be analyzed for the chosen areas used in the study. Since soil moisture influences the carbon balance, and in order to establish how much of the carbon is absorbed and how much is discharged, the following tasks will be carried out:

- land use will be mapped with special attention to forest area changes, bio-energy plants and wetland areas;
- the soil moisture will be measured for different areas by applying the spectro-radiometer L band;
- variations of carbon fluxes will be measured for each chosen area;
- spatial emphasis will also be put to the wetland areas in terms of changes of soil moisture (source of methane).

This project will be executed in close co-operation with InfoTerra for GeoLand.

## **5. Transboundary water resource management**

More than 20 % of European ground waters are charged with high nitrate loads and more than 40 % of European rivers and lakes show eutrophication symptoms and / or are delivering high nutrient loads to the sea. Thus, water resources are under a constant pressure. One of the main contributors for nutrient inputs into the water cycle is intensification of agriculture usage. The European Water Directive (WFD), including the Nitrate Directive was set into law to overcome this burden and to ensure the good status of water bodies by 2015. One main requirement set by the WFD is the transboundary holistic management of river basins including spatially explicit, topical reporting.

The aim of the proposed project is to support the management of water bodies by integrating Earth Observation derived land cover / land use information into specialized water quality and agri-economical models. The water quality models aim at delivering spatially explicit (geo-located) information on the potential matter input into the water cycle, the predicted environmental concentration of these matters in the water bodies. Additionally scenarios can be calculated which depict the potential influence of changing agricultural / environmental conditions resulting from dedicated management measures. The next step is to estimate the economic viability of these management measures to ensure acceptable and sustainable program of measures, as it is required by the WFD.

The added value of high and medium resolution cross-border (transboundary) and topical information derived from remote sensing data has been very successfully demonstrated by GMES Land and parallel activities, within for example projects like EU FP 6 IP Geoland, but also ESA's GSE Land. The projects have shown that GMES Water Quality services strengthen the ability of legally mandated organizations to respond to the demanding requirements of the WFD and to manage their water more efficiently.

This project will be executed in close co-operation with InfoTerra, especially with regard to transboundary / international catchment implementation and GSE Land methods.

## **C. Human Spaceflight, Microgravity and Exploration**

### **1. ExoMars – Development of the support system for the Heat Flow and Physical Properties Package (HP3) instrument**

The “Heat Flow and Physical Properties Package” (HP<sup>3</sup> in short) was selected by ESA as an instrument to fly on the ExoMars mission to the planet Mars, planned for launch in 2013. The HP<sup>3</sup> instrument consists of four parts:

- A package of thermal and electrical sensors is carried to depth by a tractor Mole (HP<sup>3</sup>/Mole) which will for the first time access a depth of up to 5 m in the regolith of Mars to measure the physical properties and the planetary heat flow.
- The mole pulls behind a Payload Compartment (HP<sup>3</sup>/PC) that houses several sensors and electronics.
- The payload compartment is linked to the Support System (HP<sup>3</sup>/SP) on the surface via an instrumented tether.
- The support system houses the instrument in flight configuration and the Back End Electronics (HP<sup>3</sup>/BEE). The support system has to secure hold the instrument items (mole and payload compartment)

The release mechanism is a critical item and thus will be especially designed (to fulfil mass and volume restriction) and developed in very reliable technology. Also the structure of the support system has to be designed more lightweight, what is possible in a new design (some new concept, FEM analysis and a special technology). The first prototype is too massive and quite large in dimensions.

In conclusion, this project will cover two main tasks:

1. Design and analysis of the HP3 support system in order to develop a lightweight and reliable space device.
2. Manufacturing, integration and tests of several HP3 support system models.

### **2. ASIM – Design, manufacturing and tests of EM, PFM and FS models of the Power Supply Unit for Miniature X and Gamma-ray Sensor (MSGX PSU)**

The Atmosphere-Space Interactions Monitor (ASIM) is proposed for the International Space Station (ISS) external facilities on the Columbus module, for the study of high-altitude optical emissions from the stratosphere and mesosphere related to thunderstorms. One of the two main ASIM instruments is Miniature-X and Gamma-ray Sensor (MXGS) designed by University of Bergen and University of Valencia, in co-operation with Polish Space Research Centre in Warsaw.

The funding of this project through the PECS will be the financial basis for further Polish participation as Co-Investigator in ASIM/MXGS project.

In order to fulfill the Polish commitment in this project, a consortium of commercial companies together with the Polish Space Research Centre will be established. The continuation of design and manufacturing of the Power Supply Unit (PSU) for the MXGS will be the main goal of the project. Three models will be built: Engineering Model, Proto-Flight Model and Flight Spare. This activity will cover the following tasks:

- Design, manufacturing and testing of PSU Engineering Model, delivery of the model to Bergen and integration with MXGS EM, participation at MXGS EM tests.
- Preparation of flight model documentation according to ESA and industry rules and specifications.
- Manufacturing and testing of PSU Proto-Flight Model, delivery of this model to Bergen, integration with MXGS PFM, participation at MXGS PFM tests, participation at ASIM PFM integration and test.
- Manufacturing and test of PSU Flight Spare Model.
- Preparation of required documentation, in particular PA/QA and safety analysis, EIDP and User Manual.

## **D. Satellite Navigation**

### **1. Design, development, testing and demonstration of innovative SISNeT-based software and applications**

Augmentation signals provided by the geostationary EGNOS satellites are intended to improve the accuracy of the calculated user coordinates. But due to obstructions preventing the reception of the SIS (Signal In Space), especially in so-called urban canyons and also in mountainous or forested regions the usage of EGNOS augmentations is restricted. In order to overcome this problem, ESA has developed and constantly improves the SISNeT (Signal in Space through the Internet) service, which allows retrieving the EGNOS messages across the Internet in real-time, usually employing wireless networks like GSM or GPRS.

In the framework of studies performed by ESA, several new application fields based on SISNeT have been identified and confirmed to have either clear commercial prospects for exploitation (e.g. enhanced car navigation, fleet management, tourism) or advantages for public services (monitoring of dangerous goods, road tolling, helping disabled people).

The overall objective of the proposed project is to design, develop, test and demonstrate innovative SISNeT-based software and applications in Poland with a view to further dynamic exploitation of acquired know-how for the benefit of Polish consumers and public administration, and with a useful contribution to the R&D activities of the ESA-GNSS-1 project office.

2. **Formal model valuation of EGNOS measurements availability with defined level of accuracy**

For many years, the main feature of positioning system seems to be error border which the system does not cross, with the defined level of probability. This means that during some time the system can reach higher or lower accuracy than declared by the provider. For this reason, it is important to have a tool forecasting the probability of specified level of accuracy during a given time period.

The goal of this project is to elaborate a mathematical model and, consequently, the software which gives the possibility to forecast and estimate in probabilistic categories the accuracy of EGNOS service during a specified time.

3. **EGNOS – EUPOS integration**

The main purpose of this project is to improve the effectiveness and range of applications of the EGNOS system, by achieving the full compatibility and integration with the EUPOS system. The last one is now installed in a number of countries of Central Europe including Poland and will be the basis of the official legal geodetic reference system in these countries. Both systems are designed for very similar tasks: positioning and navigation and they are serving the same territory, both are based on satellite technology but with different conceptual and technical assumptions and with different technical infrastructure. However, from the point of view of the user it is very important to have the possibility to use both systems interchangeably, with seamless and homogeneous measurements. At the same time the features of both systems should be used which are complementary to each other and permit to get the added value in terms of the effectiveness of the measurement and improvement in accuracy. The accuracy and availability of corrections in the Eastern part of Europe are degraded because some GPS satellites are observed but they have no EGNOS corrections. The EEI (EGNOS-EUPOS Integration) will allow reaching these aims.

More specifically, the EGNOS system is based on dissemination of the corrections to the GPS signals and Galileo signals in the future. These corrections are generated by the network of the 34 monitoring stations in Europe. The EUPOS will be based on hundreds of reference stations deployed in Germany, Poland, Czech Republic and other countries

of the Central Europe. In Poland only the network will consist of more than 80 stations. In the frame of the project the following problems will be solved:

1. Preparation of the algorithm transforming one reference system to another, enabling to use both systems at the same time.
2. Modelling of the state of ionosphere and troposphere for the improvement of the accuracy of the corrections.
3. Local improvement of the EGNOS corrections, by improvement of the spatial and temporal resolution by a factor 10, using EUPOS reference stations as complementary EGNOS monitoring stations;
4. Preparation of the data transmission channels used in EGNOS for the transmission of data with enhanced resolution;
5. Performing of the field tests of the EEI method in static and kinematical mode in land, maritime and aviation applications.

## **E. Technology**

### **1. *Incorporating Poland into ESA Space Technology Transfer Activities with special emphasis on SME's***

Space Technology Transfer in ESA is a well-developed activity conducted by a network of technology brokers (the ESA Technology Transfer Network) which allows the matching of technology requests from the non-space industry to technologies developed through European space programmes (Technology Pull) and looking for opportunities to commercialise space technologies (Technology Push). It aims to provide a general service to all industries, especially SME and acts as an umbrella for technology transfer activities. The objective of the National Technology Transfer Initiative (NTTI) is to provide the opportunity for an individual State to tailor specific technology transfer activities according to local industry and competencies. The initiative focuses on local goals whilst maintaining opportunities for international collaboration on technology transfer activities. It acts as an extension to the existing general technology transfer service provided by the ESA Technology Transfer Programme Office (TTPO).

The aim of this project is to allow Poland as a new European Co-operating State to be incorporated into technology transfer activities as early as possible, i.e. from the beginning of its PECS participation, in order for Polish space and non space industry (especially SME) to make the most out of the technology transfer supported by ESA.

## **2. Participation of Warsaw University of Technology in ESA parabolic flight campaigns and ESEO spacecraft**

The main goal of the project is the development and increase of quality of space technology education at different faculties of Warsaw University of Technology, in close cooperation with the Space Research Centre of the Polish Academy of Sciences.

Education of engineers in area of space technologies is very important for the development of Polish space industry. The best way to achieve this goal is the participation of students in practical realization of space missions in both international education projects and own internal projects (i.e. project of cubesats and their usage in investigation of space environment).

The project will include the following tasks:

- Participation in ESA parabolic flight campaigns:

Subject to the availability of flight opportunities, the aim of this part is to create a practical opportunity to obtain some scientific results on pursued theoretical projects. A competition of student conceptions for each campaign shall be organized. The most utilizable and sensible projects to be pursued in microgravity environment would be undertaken as a result of a selection. This would give a possibility to test space technology related solutions, invented by students, which could be utilized in future scientific or commercial missions.

- Participation in ESEO project:

Subject to the positive outcome of the next ITT process including the baseline design consolidation.

## **3. Communication subsystems to the ESMO spacecraft**

Phase A of the European Student Moon Orbiter (ESMO) mission is underway.

Subject to the positive outcome of the next ITT process, the University of Technology could be considered for the development of certain communication subsystems comprising antennas, transceivers, microwave units and software needed to operate the spacecraft. Flight models (incl. redundant units) and backup hardware/software are to be delivered to ESA. Furthermore, Data Acceptance Package to each subsystem, user manual, simulation software and results of tests are part of this project.