	EUROPEAN COMMISSION Research Executive Agency Marie Curie Actions – International Research Staff Exchange Scheme	SEVENTH FRAMEWORK PROGRAMME

Project No: 269157

Project Acronym: AMISS

Project Full Name: Active and Passive MIcrowaves for Security and Subsurface imaging

Marie Curie Actions

Periodic Report

Period covered: from 01/10/2011 **to** 31/03/2013

Period number: 1st

Start date of project: 01/10/2011

Project coordinator name:
Dr. FRANCESCO SOLDOVIERI

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Duration: 36

Project coordinator organisation name:
CONSIGLIO NAZIONALE DELLE RICERCHE

Periodic Report

PROJECT PERIODIC REPORT

Grant Agreement number:	269157
Project acronym:	AMISS
Project title:	Active and Passive MIcrowaves for Security and Subsurface imaging
Funding Scheme:	FP7-MC-IRSES
Period report:	1st
Period covered - start date:	01/10/2011
Period covered - end date:	31/03/2013
Name, title and organisation of the person in charge of the project for the beneficiary(ies):	Dr. FRANCESCO SOLDOVIERI CONSIGLIO NAZIONALE DELLE RICERCHE
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DECLARATION BY THE PROJECT COORDINATOR

I, Dr. FRANCESCO SOLDOVIERI, as person in charge of the project (269157, AMISS), for the beneficiary(ies), hereby confirm that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;

- The project:

(o) has fully achieved its objectives and technical goals for the period;

( ) has achieved most of its objectives and technical goals for the period with relatively minor deviations;

( ) has failed to achieve critical objectives and/or is not at all on schedule.

- The project Website is up to date (if applicable);

- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project and if applicable with the certificate on financial statement;

- The beneficiary(ies), in particular non-profit public bodies, secondary and higher education establishments, and research organisations, have declared to have verified their legal status. Any changes have been reported under section 3 (Project Management) in accordance with Article II.2.f (Monobeneficiary) or with Article II.3.f (Multibeneficiary) of the Grant Agreement.

SUMMARY OF THE SECONDMENT OF RESEARCHERS DURING THE REPORTING PERIOD

Beneficiary: CONSIGLIO NAZIONALE DELLE RICERCHE

WP n°	First name of the Researcher	Last name of the Researcher	Date of Birth	Gender	Type	Seconded To	Seconded To(Short Name)	Seconded To (Country)	Start date of secondment	End date of secondment	EU Contribution / fellow-month (€)	No. of full-time equivalent months covered by this secondment during this reporting period	Total EU Contribution (€)
2	Francesco	Soldovieri	27/03/1966	Male	ER (4-10 years)	UNIVERSIDADE DE SAO PAULO	USP	BR-Brazil	26/01/2013	07/02/2013	2100	0.44	924.00
2	Ilaria	Catapano	26/08/1977	Female	ER (4-10 years)	UNIVERSIDADE DE SAO PAULO	USP	BR-Brazil	26/01/2013	07/02/2013	2100	0.44	924.00
Total no. of full-time equivalent months covered by this secondment during this reporting period:												0.88	
Total EU Contribution for this Beneficiary in euros (not including the contribution to third countries secondments):													1848.00

Beneficiary: TECHNISCHE UNIVERSITEIT DELFT

WP n°	First name of the Researcher	Last name of the Researcher	Date of Birth	Gender	Type	Seconded To	Seconded To(Short Name)	Seconded To (Country)	Start date of secondment	End date of secondment	EU Contribution / fellow-month (€)	No. of full-time equivalent months covered by this secondment during this reporting period	Total EU Contribution (€)
No secondments for this Beneficiary													

Beneficiary: YILDIZ TECHNICAL UNIVERSITY

WP n°	First name of the Researcher	Last name of the Researcher	Date of Birth	Gender	Type	Seconded To	Seconded To(Short Name)	Seconded To (Country)	Start date of secondment	End date of secondment	EU Contribution / fellow-month (€)	No. of full-time equivalent months	Total EU Contribution (€)

												covered by this secondment during this reporting period	
2	Ahmet Serdar	Turk	05/04/1977	Male	ER (4-10 years)	A. Usikov Institute of Radiophysics and Electronics, National Academy of Sciences of Ukraine	IRE	UA-Ukraine	11/01/2012	25/01/2012	1900	0.48	912.00
2	Ahmet Serdar	Turk	05/04/1977	Male	ER (4-10 years)	A. Usikov Institute of Radiophysics and Electronics, National Academy of Sciences of Ukraine	IRE	UA-Ukraine	06/07/2012	20/07/2012	1900	0.48	912.00
2	Mustafa Dagcan	Senturk	14/02/1983	Male	ESR (<4 years)	A. Usikov Institute of Radiophysics and Electronics, National Academy of Sciences of Ukraine	IRE	UA-Ukraine	18/11/2012	30/11/2012	1900	0.43	817.00
2	Ahmet Serdar	Turk	05/04/1977	Male	ER (4-10 years)	A. Usikov Institute of Radiophysics and Electronics, National Academy of Sciences of Ukraine	IRE	UA-Ukraine	08/02/2013	19/02/2013	1900	0.43	817.00
Total no. of full-time equivalent months covered by this secondment during this reporting period:												1.82	
Total EU Contribution for this Beneficiary in euros (not including the contribution to third countries secondments):													3458.00

Partner: THE BAUMAN MOSCOW STATE TECHNICAL UNIVERSITY

WP n°	First name of the Researcher	Last name of the Researcher	Date of Birth	Gender	Type	Seconded To	Seconded To(Short Name)	Seconded To (Country)	Start date of secondment	End date of secondment	EU Contribution / fellow-month (€)	No. of full-time equivalent months covered by this secondment during this reporting period	Total EU Contribution (€)
3	Sergey	Ivashov	24/08/1947	Male	ER (4-10 years)	CONSIGLIO NAZIONALE DELLE RICERCHE	CNR	IT-Italy	21/10/2012	27/10/2012	1900	0.23	437.00
3	Lesya	Anishchenko	21/01/1982	Female	ER (4-10 years)	CONSIGLIO NAZIONALE DELLE RICERCHE	CNR	IT-Italy	21/10/2012	27/10/2012	1900	0.23	437.00

Partner: A. Usikov Institute of Radiophysics and Electronics, National Academy of Sciences of Ukraine

WP n°	First name of the Researcher	Last name of the Researcher	Date of Birth	Gender	Type	Seconded To	Seconded To(Short Name)	Seconded To (Country)	Start date of secondment	End date of secondment	EU Contribution / fellow-month (€)	No. of full-time equivalent months covered by this secondment during this reporting period	Total EU Contribution (€)

No secondments for this Partner

Partner: STATE RESEARCH CENTER FOR SUPERCONDUCTIVE RADIOELECTRONICS "ICEBERG"

WP n°	First name of the Researcher	Last name of the Researcher	Date of Birth	Gender	Type	Seconded To	Seconded To(Short Name)	Seconded To (Country)	Start date of secondment	End date of secondment	EU Contribution / fellow-month (€)	No. of full-time equivalent months covered by this secondment during this reporting period	Total EU Contribution (€)

No secondments for this Partner

Partner: UNIVERSIDADE DE SAO PAULO

WP n°	First name of the Researcher	Last name of the Researcher	Date of Birth	Gender	Type	Seconded To	Seconded To(Short Name)	Seconded To (Country)	Start date of secondment	End date of secondment	EU Contribution / fellow-month (€)	No. of full-time equivalent months covered by this secondment during this reporting period	Total EU Contribution (€)

No secondments for this Partner

1. PUBLISHABLE SUMMARY

Publishable summary:

Project Objectives

The project aims at fostering the collaboration between the Western and Eastern European Countries and between the European Countries and Brazilian partner, with the aim of sharing knowledge and achieving theoretical and applicative advancements in the scientific areas of the passive and active microwave imaging systems and characterization techniques. Specifically, the research objectives of the proposal are:
1) Development/improvement and characterization of new sensors and systems for active and passive microwave imaging;
2) Set up, analysis and validation of state of art/novel data processing approach for GPR in critical infrastructure and subsurface imaging;
3) Integration of state of art and novel imaging hardware and characterization approaches to tackle realistic situations in security, safety and subsurface prospecting applications;
4) Development and feasibility study of bioradar technology (system and data processing) for vital signs detection and detection/characterization of human beings in complex scenarios

Work performed since the beginning of the project
The activities of the project are organized in four work packages, three regarding technical activities and the last one aimed at the management. The activities are here summarised according to the WP organization of the project.
For “WP1 Microwave and Millimetre wave imaging systems for security”, the first activity has regarded the design of UWB antennas and of the related array, mainly in charge of YTU, with the end of improving the performance of the through wall imaging systems available at the partners. The second activity has regarded the development of an advanced microwave tomographic approach for through-wall-.imaging; the effectiveness of the approach has been demonstrated with real data collected in laboratory conditions. As one of the main outcomes, a holographic radar system has been developed, at BMSTU, for the concealed object detection; the effectiveness of the system was enhanced thanks to the development of a novel data processing based on microwave tomography and first preliminary experiments were successfully performed. As last task of the WP1, the development of waveguide and horn array for parabolic reflector antenna of interest for radiometric passive millimeter wave imaging system has been started; finally, the interpretability of the images collected by the radiometric passive system of SRC has been improved thanks to data processing developed at CNR.
For “WP2 Development of GPR technologies for subsurface sensing and critical infrastructure monitoring”, the first activity has regarded the design of different kind of UWB antennas (mainly, TEM horn antenna) for GPR systems. The second activity has regarded the GPR system, developed at IRE, based on a differential configuration for the clutter mitigation. For this GPR system, the main improvement was concerned with the development of a microwave tomographic approach able to account accurately the differential configuration so to improve the results of the GPR surveys. Another activity has regarded the development and implementation of data processing strategies with the aim to improve the resolution and the interpretability of the data provided by a holographic radar system developed at BMSTU and aimed to subsurface investigation and hidden targets detection. The other main class of activities has regarded the development, analysis and implementation of forward and inverse scattering models in different geometries (1D, 2D, 3D, homogeneous and layered media), mainly in charge of TUDELFT, CNR and USP. In particular, linear and non-linear inverse scattering approaches problem were developed and this activity and will be finalised in the second period of the project.
For “WP3 Radar technologies for remote detection and registration of vital signs”, two main objectives were achieved. A radar system (working in the 1-4 GHz band) based on the holographic principle was realized and validated, at IREA in cooperation with BMSTU, by using two flared horn antennas. About, the data processing, two strategies, were developed at IREA and BMSTU, and compared in a laboratory controlled experiment carried out at BMSTU, thanks to a bioradar system working at 4 GHz. Finally, a comparison between the performances of two radar systems, developed at BMSTU specifically for vital signs detection and working at 4 and 14 GHz, was performed thanks

to the data processing approach developed by IREA.

Main results

WP1 Microwave and Millimetre wave imaging systems for security

• Design of a waveguide array to feed a parabolic reflector so to achieve desired radiation characteristics for air and coastal microwave surveillance radars and radiometric passive millimeter wave imaging system.
• Development, implementation and validation of a microwave tomographic approach for through-wall-imaging.
• Development of a full holographic radar system for concealed object detection.
• Development of data processing strategies for the improvement of the interpretability of the passive radiometric images.

WP2 Development of GPR technologies for subsurface sensing and critical infrastructure monitoring

• Design and implementation of a Ultra Wide Band TEM Horn Antenna Designs for Ground Penetrating Impulse Radar.
• Implementation of the differential GPR system and of the related microwave tomographic approach.
• Development of a linear inversion approach for the processing of data collected by the holographic radar systems
• Development and implementation of a new method for retrieving virtual surface to borehole data from surface reflection data.
• Development and implementation of a new imaging scheme for GPR reflection data collected in multi-offset mode for a layered earth and in multicomponent multi-offset mode for general three-dimensional heterogeneous earth.
• Development of a full waveform inversion scheme to obtain electric permittivity and magnetic permeability from reflection GPR data for a layered earth.
• Development and implementation of an approach for modelling any kind of GPR data for any acquisition configuration in a layered vertical transverse isotropic medium.
• Development of a full 3D microwave tomographic approach.

WP3 Radar technologies for remote detection and registration of vital signs

• Development and performance comparison for the bioradar signal processing approaches.
• Development and validation of a holographic radar system at CNR for vital signs detection and characterization beyond an obstacle.
• Comparison between the performances of the two radar systems developed at BMSTU, specifically realized for vital signs detection and working at 4 GHz and 14 GHz, respectively

As outcome transversal with respect to the technical activities, we stress the dissemination activity of the project, amounting to the 5 papers on international journals and 17 conference presentations. The paper L.N. Anishchenko, S.I. Ivashov, F. Soldovieri, I. Catapano, L. Crocco, “COMPARISON STUDY OF TWO APPROACHES FOR BIORADAR DATA PROCESSING”, has been awarded as the Best Poster at IET International Radar Conference 2013, Xi'an, China, April 2013 .

Expected impact

As stated in the proposal writing and set-up, the technological outcomes of AMISS have a notable and widespread impact in many sectors of the society where there is a huge necessity of reliable and effective tools for non-invasive diagnostics and monitoring , such as: physical security, forensics, civil engineering diagnostics and critical infrastructures monitoring; subsurface prospecting, archaeology and cultural heritage diagnostics.
The first proof of the relevance of the results of AMISS project is stated by the fact that, thanks to the involvement of CNR (as Scientific Coordinator) in the ISTIMES project (www.istimes.eu), a good knowledge/information exchange was performed by ISTIMES and AMISS project. ISTIMES project is concerned with the development of a system able to couple current monitoring and quick damage assessment of critical transport infrastructures thanks to the integration of electromagnetic sensing techniques, where the radar systems are one of the key tools. In addition, AMISS outcomes are relevant to the new COST Action TU1208 “CIVIL ENGINEERING APPLICATIONS OF GROUND PENETRATING RADAR”. AMISS partners as CNR and TUDELFT are fully involved in this COST Action and efforts will be made to include also the other AMISS partners in this COST

Action.

WEBSITE ADDRESS
http://www.irea.cnr.it/index.php?option=com_k2&view=item&id=342:progettoamiss&Itemid=153&lang=it

Contact persons:
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2. GENERAL PROGRESS OF THE PROJECT

Qualitative indicators of progress and success in line with workplan and milestones (description of progress towards milestones and deliverables)

The activities of the project are in line with the expected outcomes in terms of both the expected milestones and the deliverables.

The expected milestones of the first period (18 months) were M4.1, M4.2 and M1.1.

Milestone M4.1 was concerned with "AMISS WEBSITE".
This milestone was concerned with the set-up and availability of the first release of the project website. The milestone has been achieved at month 9 accordingly with what expected by Annex 1. Now, the Website is continuously updated with the news and the scientific outcomes of the project (reports, publications..).
This action is in charge of the coordinator of the project and the website of the project is hosted on the website of IREA-CNR, at the address

http://www.irea.cnr.it/index.php?option=com_k2&view=item&id=342:progetto-amiss&Itemid=153&lang=it

• The AMISS website is organized as follows.
The first page contains the abstract of the project and the links to other pages describing the project's activities, organized as:
• Objectives of the project;
• Partners;
• Plan of work;
• News and achievements;
• Publications ;
• Milestones.

All the sections are continuously updated on the basis of the information provided by the partners.

As other first expected management activity, the Kick-off Meeting (KOM) was held on November 3, 2011 and the main items of the KOM were:
1) The presentation of expertise of the partners, related to AMISS activities, for a first knowledge exchange (few slides were provided and presented from each partner, available on the AMISS website);
2) Description of the scientific/technical activities and expected outcomes for each WP of the AMISS project (the presentation was given by Francesco Soldovieri, AMISS Scientific Coordinator, available on the website);
3) Description of financial aspects (presentation given by Francesca Di Matteo (CNR), appointed by

the Coordinator as the supporting person having in charge the administrative and financial issue of AMISS project);
4) Definition of a procedure to identify the key persons in the project for the roles related to the scientific/technical and administrative management.

The appointment of the key persons was carried out after the Kick-off meeting on the basis of a proposal made by the Scientific Coordinator; this proposal was agreed by all the partners, which also identify from their part the key persons in the Project Management Team. The final appointment of the key persons is detailed in the section 3 regarding the Project Management.

M4.2 was concerned with the first year meeting.
This milestone has been implemented through a phone-conference among YTU, CNR and TUDELFT. The choice of restricting the meeting only to these partners has been due to their direct responsibility in the scientific/technical and administrative/economic aspects of the project towards the EC.
The other main reason at the basis of this choice has been that during the first year of the project, many contacts via e-mail, phone and Skype have been established among all the participants to the project. In addition, a survey of the technical activities of the project's was performed before the meeting with the help and involvement of all the participants and under the coordination of the WP managers (that are all CNR, YTU and TUDELFT members). This survey document has provided the basis for the discussion of the meeting. As outcome of the meeting, several corrective and improving actions were decided and are now under development.

M1.1 "Performance of the through-wall imaging (TWI) approach via measurements"

This milestone has been achieved by means of the delivery of the relative report D1.3 regarding the availability of reconstruction approaches for the through wall imaging developed thanks to the cooperation of CNR and BMSTU. The performance evaluation of the TWI approach has been performed via the processing of both simulated and experimental data collected by means of a time domain GPR system.

About technical activities, the details of the progress towards the achievements of deliverables and milestones are given in detail for each Work-Package.

WP1 Microwave and Millimetre wave imaging systems for security

In the first period, the planned activities in WP1 have been started and performed with the involvement of all the participants to this WP (CNR-YTU-IRE-SRC-BMSTU).

Task 1.1: Horn, parabolic reflector and array antenna preliminary designs in microwave and MMwave bands.
The possibility of using dielectric loaded waveguide and horn antennas, as well as their array configuration for wideband microwave through-wall imaging system (Task 1.2), has been discussed in order to obtain an improvement of the systems performance in terms of the range resolution limits.

Task 1.2: Active microwave tomographic system design for through wall imaging.
Task 1.2 activity has been performed by CNR with BMSTU and had the main aim of the development, and the improvement of a microwave tomographic approach, based on a linear inverse scattering approach, for Through-Wall-Imaging. The TWI approach has been tested in real cases thanks to the processing of measurements collected by a time domain GPR system.

Task 1.3: Active Microwave holographic system design for detection of concealed objects under clothes on human body.
The system is under final development by BMSTU. This system is a holographic radar system exploiting in-phase and quadrature channels and working in the working frequency band around 7 GHz. The data were provided by BMSTU to CNR; this allowed a comparison between the

microwave tomographic approach developed at CNR with the one developed by BMSTU. In aprticular, the comparison was performed by focusing to the interpretability and the resolution of the images achieved by the two data processing strategies. It is planned to write a joint conference contribution on this activity.

Task 1.4: Radiometric passive imaging for concealed weapon detection
YTU has started the development of waveguide and horn array fed parabolic reflector antenna for radiometric passive millimeter wave imaging system, in cooperation with SRC.
Furthermore, radiometric images have been provided by SRC to CNR with the aim to develop and implement signal processing approaches so to achieve radiometric images of the investigated scene more robust to the noise and more easily interpretable by the user. The activity was very important from two point of views; first, researchers of CNR had the possibility to investigate and deepen the analysis of the performance of these passive radiometric systems and, in addition, CNR researcher developed tailored signal processing strategies to improve the interpretability of the radiometric images; this activity has led to the submission of a joint paper (CNR-SRC) to an international journal.

WP2 Development of GPR technologies for subsurface sensing and critical infrastructure monitoring

In the first period of the project, the activities have been started and performed thanks to the involvement of all the participants of the WP (CNR-TUDELFT-YTU-IRE-BMSTU-USP)

Task 2.1: Ultra-wide band (UWB) planar, TEM horn and array antenna designs for GPR systems.
Technical cooperation between YTU and IRE concerning the strictly related Tasks 2.1 and 2.2 was started, according to the planned time line for the delivery of deliverables D2.1 and D2.2, which are due at Month 21. The first activity has been concerned with the design and implementation of a Ultra Wide Band TEM Horn Antenna suitable for Ground Penetrating Impulse Radar. This activity is concerned with different design forms of TEM horn antennas such as, dielectric loaded, Vivaldi shaped and array versions for UWB GPR systems. Technological solutions have been identified to achieve high antenna gain, narrow beam and low input reflection characteristics over an ultra-wide band.

Task 2.2: Wide band impulse generator designs for multi-band GPR.
A technical cooperation has been started between IRE and YTU for the study of signal generators of impulse GPR able to work on a UWB.

Task 2.3: Novel GPR system based on differential configuration for clutter mitigation
With regard to Task 2.3 YTU and IRE have started the development of the novel ultra-wide band TEM horn antenna suitable for the differential GPR system already available at IRE. At present, the differential system of IRE exploits printed bow tie antennas and the activity of this task aims at investigating the possibility to use horn antennas for this system. The differential GPR system is able to erase the direct coupling between receiving and transmitting antenna so that it is suitable to detect and characterize weak scattering targets.
According to the Annex 1, deliverables D2.3 and D2.4, expected at PM 30.
In addition, the other main activity of the task is concerned with the development of an inverse scattering approach able to account for the specific differential configuration. The inverse scattering approach has been developed as result of the cooperation between CNR and IRE. This inverse scattering approach has been implemented and already validated with the real data provided by IRE. Currently, an activity in on-going to evaluate in a complete way the reconstruction performances of the inverse scattering approach and a jpaper on an international journal is going to be submitted.

Task 2.4: Holographic radar for shallower subsurface imaging
CNR in cooperation with BSMTU has developed a linear inversion approach able to deal with the data provided by holographic radar systems so to achieve better performances in terms of resolution and focusing effects for a higher interpretability of the reconstructed images. Results of the inversion approach have been achieved at CNR in controlled conditions, thanks to the data provided by the RASCAN.4/4000 holographic radar developed by BMSTU.
Deliverables D2.5 and D2.6 are expected without delay.

Task 2.5: Application of GPR systems to several domains: geophysical, archeology, NDT
Activities in Tasks from 2.5 to 2.8 are mainly concerned with the development and adaptation of state of art and novel linear and non-linear inversion approaches, have been carried out with the final aim to make experimental validation in Task 2.9.

Task 2.6: Electromagnetic modeling of subsurface wave propagation and scattering from sublayers and buried objects.
The inversion methods of Task 2.8 require the proper modeling of the subsurface wave propagation; accordingly numerical tools to handle the so called forward simulation have to be developed. At the current stage of development, the approaches are able to tackle, without approximation, 1D and 2D propagation of a wave (and its interaction with an obstacle) in a layered medium.
An approach has been developed, which is able to model a horizontally layered earth response for vertical transverse isotropic layers. The fields can be generated by electric or magnetic dipole sources and the magnetic and electric field responses can be computed. Sources and receivers can be located anywhere in the layered model; this allows to compute surface reflection measurements as well as surface to borehole and cross borehole measurements.

Task 2.7 Fast single and multi component linear inversion algorithms using the imaging principle.
A new method has been developed and implemented for imaging GPR reflection data collected in multi-offset mode. The method can work with a minimum of required information about the subsurface and is capable to removing internal multiples. The one-dimensional version has been demonstrated to work and extensions to two- and three-dimensions are under development. The output of this imaging algorithm is the input for full-waveform non-linear inversion, which is the main objective of Task 2.8.
Since the midreport, the method has been extended to 3D and multicomponent multi-offset electromagnetic reflection data can be used to create an electromagnetic wave field, which focuses inside a 3D heterogeneous lossless earth at an arbitrary chosen location. This focusing wave field can be obtained simultaneously in its up-going and down-going components. The focusing wave fields allow constructing a virtual vertical ground penetrating radar (VRP) data set with a virtual source at the focus point and receivers at the receiver locations of the measurements. The up- and down-going VRP data can then be used to create a subsurface image at the focus point by multidimensional deconvolution. This method eliminates all internal multiple effects on the final image and recovers the true reflection amplitude at the image location. This feature allows for using this image in a local inversion scheme for full waveform inversion.

Task 2.8: Full waveform non-linear inversion
It has been shown that full waveform inversion of a layered electromagnetic medium is a two-step linear problem under the following conditions. Sources are located above the receivers and the receivers are located on a plane. Horizontal electric and magnetic field components are measured at the receiver plane and both the fields are properly sampled. Then, the recently developed coupled Marchenko-type equations allow for creating an upgoing and downgoing wave field that is generated by a virtual source at a chosen location in the subsurface without any knowledge of the layered medium. This constructed wave field is used to retrieve the correct reflection amplitude of the interface at the focus point as a function of offset in space domain, or incidence angle in the plane wave domain. From the reflection coefficient as a function of angle the electric permittivity and magnetic permeability can be computed by direct matrix inversion. Both steps are linear operations. The next steps that are under development are including 3D heterogeneities in the inversion part and including losses in the model by assuming non-zero conductivity.
This task will devise inversion strategies based on the forward modeling tools developed in task 2.6 and in which the outcome of the simpler inversion tools developed in task 2.7 are exploited to reduce the overall complexity of the inverse problem underlying the imaging task. At the current stage an architecture of these approaches has been identified and its high level software implementation has begun.

Task 2.9: Experimental validation of the GPR systems at the USP geophysical test site. The experimentation in controlled conditions will aim at identifying, locating and characterizing different types of objects representative of archaeological targets, pipes, drums, and concrete tubes, drainage pipes for agriculture.

During the secondments of IREA researchers to USP, a good information exchange was performed about the features of the USP geophysical tests as well as the working principles of the IREA imaging approaches. This knowledge sharing was performed with the aim to define the experiments to be conducted at USP test site and facilities in order to carry out an experimental validation of model based data processing strategies developed at IREA. In this frame, currently two activities are on-going. The first one is aimed at assessing the reconstruction capabilities of a linear inverse scattering approach against data collected at USP facility and referred to different kind of static, i.e. time invariant, buried objects. The second activity concerns, instead, the imaging of time invariant objects, such as water or oil leakages, and it is specifically devoted to design and test in laboratory controlled conditions an imaging approach for monitoring liquid leakage propagation into a complex subsurface scenario.

WP3 Radar technologies for remote detection and registration of vital signs
In the first period of the project, the technical activities of WP3 are in line with the overall expected outcomes of this WP.

Task 3.1: Analysis of bio-radar technology, achievements, and possible application areas; Design of transmitters, receivers and antennae of the BioRascan radars that operate in the maximum range of 4-15 GHz; Elaboration and adjustment of the radar design in laboratory conditions.
After completing the state of the art review, the institutions involved in Task 3.1 are in the process of tackling the main aspects of the system design. This is fully consistent with the planned timelines. Also, by resorting to solutions identified at BMSTU, a simple radar system based on the holographic principle has been designed and realized at IREA by using two flared horn antennas working in the frequency band 800MHz – 8GHz. An experimental activity involving this simple system has been carried out to investigate the possibility of detecting the vital signs of a subject located behind an obstacle exploiting the 1-4GHz frequency band.
A comparison between the performances of the two radar systems developed at BMSTU, specifically for vital signs detection and working at 4 GHz and 14 GHz, respectively, was performed thanks to the data processing approaches developed at IREA.

Task 3.2: Development of approaches for bio-radar data processing and their integration into the radar system.
As far as Task 3.2 is concerned, the starting period of the project has been already fruitful, since two different processing methodologies, independently developed by CNR and BMSTU, have been applied and compared in a laboratory controlled experiment carried out at BMSTU using a bioradar system developed by BMTSU. This software provide the first basis to build the material required by deliverable D3.2. and D3.3.and has led to a joint publication on an ISI journal.
In particular, the observed results have shown that these two independent processing tool are compatible for an integration as they provide comparable information achieved through different elaborations. As such, their perspective integration, also within a cross-validation framework, is a sound basis for the prosecution of the project’s activities.

Task 3.3: Experiments with the designed radar in controlled conditions for detection of human’s vital signs and his reaction to different stress factors.
This activity is on-going and regards the adoption in realistic conditions of the approaches developed at IREA and BMSTU. This final goal will be the assessment of the ability to detect and identify non only the vital signs but also estimate their variability.

3. PROJECT ACHIEVEMENTS

Scientific highlights and research achievements:

The scientific activity and research achievements are given for each technical WP of the project as reported in the following.

WP1

• Preliminary design discussions on wideband holographic GPR module between YTU and BMSTU, to achieve higher range and resolution for practically useful radar system development.
• Design of a waveguide array to feed a parabolic reflector. The main aim of this design is to obtain desired radiation characteristics for air and coastal microwave surveillance radars and radiometric passive millimeter wave imaging system.
• Understanding of passive radiometric imaging system and its sub-modules such as antennas, receiver and image processing, as cooperation between SRC and YTU. Performance enhancement is aimed at further steps of the project.
• Development of a full holographic radar at BMSTU for concealed objects detection, enhanced by data processing developed at CNR.
• Development, implementation and validation of a microwave tomographic approach, by CNR, for processing data gathered by means of a Through-Wall-Imaging system. This activity was performed according to the support of BMSTU.
• Development of data processing strategies, by CNR, for the improvement of the interpretability of the passive radiometric images collected by the systems available at SRC.

WP2

• Design and implementation of a Ultra Wide Band TEM Horn Antenna Designs for Ground Penetrating Impulse Radar.
• Implementation of the differential GPR system at IRE, also thanks to the cooperation with YTU.
• TUDELFT has developed and implemented a new method for retrieving virtual surface to borehole data from surface reflection data.
• TUDELFT has developed and implemented a new imaging scheme for GPR reflection data collected in multi-offset mode for a layered earth and in multicomponent multi-offset mode for general three-dimensional heterogeneous earth.
• TUDELFT has developed and implemented an full waveform inversion scheme to obtain electric permittivity and magnetic permeability from reflection GPR data for a layered earth.
• TUDELFT has developed and implemented a numerical code for modeling any kind of GPR data for any acquisition configuration in a layered vertical transverse isotropic medium.
• CNR has developed a linear inversion approach able to act in the “differential” GPR configuration. The experimental validation of the approach has been carried out thanks to data provided by the differential GPR system designed and assembled by IRE.
• CNR has developed a full 3D microwave tomographic approach for hidden target detection equipped with a GUI interface.
• CNR in cooperation with BSMTU has developed a linear inversion approach able to process data provided by holographic radar systems; the approach has been validated in controlled conditions, thanks to data provided by the RASCAN.4/4000 holographic radar developed by BMSTU.

WP3

• Development and performance comparison for the bioradar signal processing developed by CNR and BMSTU.
• Development and validation of a holographic radar system at CNR for vital signs detection and characterization beyond an obstacle.
• Comparison between the performances of the two radar systems developed at BMSTU, specifically for vital signs detection and working at 4 GHz and 14 GHz, respectively

Transfer of knowledge and Training activities (workshops):

The transfer of knowledge is below detailed for the technical WPs.
WP1
The first transfer of knowledge activity which has started in this WP is between YTU and BMSTU to

understand the operating principles of holographic GPR for its adaptation and design of a TWI system.
Second transfer of knowledge activity has been started between YTU and SRC concerning the antenna and sub-modules designs for radiometric passive millimetre wave imaging system.
WP2
The transfer has regarded two main points. The first one has concerned the setting up of the most suitable acquisition geometry for measurements at the USP geophysical test-site, where data for testing the developed processing technologies will be gathered. The second one has regarded the use of an imaging approach developed at CNR for processing GPR data. This is the overall goal of WP2 (Task 2.9 and D2.8).
A good knowledge exchange occurred between IRE and YTU in the design of the differential GPR system, with a focus to the design of the antennas exploited in the system.
A good interaction is in course between CNR and IRE for the integration of the software developed by CNR in the differential GPR system.
A good interaction is in course between CNR and BMSTU for the possible integration of the software developed by CNR in the holographic radar systems developed by BMSTU.
Also, as not expected outcome of the project, the appointment of Francesco Soldovieri (CNR) as co-adviser of Dr. Emerson Almeida, PhD student of USP, whose advisor is Prof. Porsani, is at a finalization stage The activity of the PhD student falls within the frame of AMISS action since it is concerned with development of linear and non-linear inversion approaches for GPR data processing in archaeology and forensics.
Another knowledge transfer in view of a future research activity is on-going between CNR and USP and involves the PhD student Vinicius Santos of USP. This activity regards GPR data inversion, where microwave tomographic approaches are combined with artificial neural networks for geometric reconstruction and estimation of physical properties of the subsurface targets

An important event of knowledge transfer from CNR to USP was the XV Summer School of Geophysics 2013 for PhD students, which has been carried out from 28 January to 1 February. In this occasion, Francesco Soldovieri and Ilaria Catapano (CNR experienced researchers) had a course of 30 lesson hours titled "Modeling and inversion of GPR data" devoted not only to the students involved in AMISS project. Aim of the course has been to introduce the basics of the microwave tomography approaches for GPR data processing. In particular, the mathematical relationships describing the scattering phenomenon in homogeneous media have been derived and the main concepts to solve a linear inverse scattering problem have been explained.
At the end of this teaching activity, PhD students and young researchers of USP, which are involved in the AMISS project, have been capable of performing GPR data processing by means of an imaging approach developed at CNR. This represents the major outcome of the secondments arranged from CNR to USP.

WP3
The main transfer has concerned the tailoring of the CNR processing tool to be applied to the BMSTU bioradar. This is a necessary step to foresee the integration of this software tool in the system whose design is the overall goal of the WP (Task 3.3 and D3.3).
During scientific discussions the results of joint activities of BMSTU and IREA-CNR on AMISS project in 2012 were discussed. Also problems which are to be solved during next year were considered and plan of further activities was prepared.
Representatives of BMSTU delivered two talks dedicated to the problems which are under AMISS grant consideration. Below short details of them are given.
1. Sergey Ivashov 'A Review of the Remote Sensing Laboratory's Techniques for Humanitarian Demining'
2. Lesya Anishchenko 'Bioradiolocation and Its Applications'

Dissemination of results (conferences, publications...):

A good dissemination of the results have been performed by means of participation to the conferences and publication of the paper related to the project's scientific outcomes. In the following, we report only the journal papers and conference proceedings/presentation that have explicitly the acknowledgment to AMISS project. Of course, these documents are not fully exhaustive of the dissemination of AMISS activities, which are the subject of many other papers and presentations.

Papers on International ISI Journals

1. F. Soldovieri, E. Utsi, R. Persico, and A.M: Alani "Imaging of Scarce Archaeological Remains using Microwave Tomographic Depictions of Ground Penetrating Radar Data", International Journal of Antennas and Propagation, Volume 2012, Article ID 580454, 8 pages, doi:10.1155/2012/580454
2. F.Soldovieri, I. Catapano, L. Crocco, L. N. Anishchenko, S.I. Ivashov, "A feasibility study for Life Signs monitoring via a continuous wave radar", International Journal of Antennas and Propagation, Volume 2012, Article ID 420178, 5 pages, doi:10.1155/2012/420178.
3. O. M. Yucedag, A.S. Turk, "Parametric Design of Open Ended Waveguide Array Feeder with Reflector Antenna for Switchable Cosecant-Squared Pattern", ACES JOURNAL, VOL. 27, NO. 8, pp. 668-675, AUGUST 2012.
4. Alekhin M.D., Anishchenko L.N., Ivashov S.I., Korostovtseva L.S., Sviryaev Y.V., Konradi A.O., Parashin V.B., Bogomolov A.V., "Estimating Diagnostic Informativeness of Bio-radiolocation Pneumography in Non-contact Screening of Sleep Apnea Syndrome", Biomedical Engineering, 2013, vol. 47., no. 2, (in press).
5. Maksim Alekhin, Lesya Anishchenko, Alexander Tataraidze, Sergey Ivashov, Vladimir Parashin, and Alexander Dyachenko, "Comparison of Bioradiolocation and Respiratory Plethysmography Signals in Time and Frequency Domains on the Base of Cross-Correlation and Spectral Analysis," International Journal of Antennas and Propagation, vol. 2013, Article ID 410692, 6 pages, 2013. doi:10.1155/2013/410692

Conference Proceedings and Abstracts

1. I. Catapano, M. Bavusi, A. Loperte, L. Crocco, and F. Soldovieri, "On the combined use of radar systems for multi-scale imaging of transport infrastructures", European Geophysical Union General Assembly 2012, April 2012, (ORAL PRESENTATION)
2. F. Soldovieri, "AMISS - Active and passive MIcrowaves for Security and Subsurface imaging", in Abstract Booklet of People 2012 Conference, Nicosia, Cyprus, Nov. 2012, ISBN. 978-9963-700-55-4, (POSTER PRESENTATION)
3. L.N. Anishchenko, S.I. Ivashov, F. Soldovieri, I. Catapano, L. Crocco, "COMPARISON STUDY OF TWO APPROACHES FOR BIORADAR DATA PROCESSING", IET Radar Conference 2013, Xi'an, China, April 2013 (POSTER PRESENTATION).
4. L.Crocco, E. Slob, A.S. Turk, I. Catapano, F.Soldovieri, "Active and Passive Microwaves for Security and Subsurface Imaging (AMISS)" in CONFERENCE PROCEEDINGS PEOPLE 2012 Marie Sk#odowska-Curie Actions In Horizon 2020, pp. 56-65, CYPRUS, 5-6 November 2012 (POSTER PRESENTATION).
5. E. Slob and K. Wapenaar, "GPR wavefield decomposition, synthesis, and imaging for lossless layered vertically transverse isotropic media", IN PRINT IN Proceedings of the International Workshop on Ground Penetrating Radar 2013, Nantes, France.
6. M.D. Alekhin, L.N. Anishchenko, A.V. Zhuravlev, A.B. Tataraidze, V.V. Razevig, I.A. Vasilyev, V.B. Parashin, S.I. Ivashov, A.S. Bugaev, "Verification of Bio-radiolocation Method with Respiratory Plethysmography for Non-contact Remote Breathing Monitoring", (Paper #1012 – ORAL PRESENTATION at Session EuMC38) - European Microwave Conference 2013.
7. Alekhin M.D., Anishchenko L.N., Zhuravlev A.V., Ivashov S.I., Korostovtseva L.A., Sviryaev Y.V Evaluation of sleep disordered breathing using non-contact remote bio-radiolocation method(Paper #1458 – ORAL PRESENTATION at Session Technical) - World Congress on Sleep Medicine 2013, which will also be published in a supplement of Sleep Medicine Journal (http://www.journals.elsevier.com/sleep-medicine/)
8. R. Persico, F. Soldovieri, I.Catapano G. Pochanin, V. Ruban, O.Orlenko. "Experimental results of a Microwave Tomography approach applied to a Differential Measurement Configuration", in print in 7th International Workshop on Advanced Ground Penetrating Radar Conference Proceedings, Nantes, France, July 2013.
9. L. Anishchenko, S. Ivashov , I.Catapano. L. Crocco, G. Gennarelli, F. Soldovieri, "Radar for vital signs characterization: a comparison between two different frequency band systems", in print in 7th International Workshop on Advanced Ground Penetrating Radar Conference Proceedings, Nantes, France, July 2013

10. I. Catapano, A. Affinito, Lorenzo Crocco, Gianluca Gennarelli, Francesco Soldovieri, “A Fully 3-D Electromagnetic Subsurface Imaging using Ground Penetrating Radar”, in print in 7th International Workshop on Advanced Ground Penetrating Radar Conference Proceedings, Nantes, France, July 2013.
11. I. Catapano, L. Crocco, F. Di Matteo, A.S. Turk, E. Slob, F. Soldovieri and the AMISS Team, “AMISS - Active and passive MIcrowaves for Security and Subsurface imaging”, abstract in Proceedings of European Geophysical Union General Assembly 2013, Wien, Austria, April 2013 (POSTER PRESENTATION).
12. I.Catapano, L. Crocco, A. Affinito, G. Gennarelli, and F. Soldovieri “Monitoring by holographic radar systems”, abstract in Proceedings of European Geophysical Union General Assembly 2013, Wien, Austria, April 2013 (EGU2013-12450) (POSTER PRESENTATION).
13. I. Catapano, A. Affinito, F. Soldovieri, “A user friendly interface for microwave tomography enhanced GPR surveys”, abstract in Proceedings of European Geophysical Union General Assembly 2013, Wien, Austria, April 2013 (POSTER PRESENTATION).
14. E. Slob, “Non-destructive monitoring of layered infrastructure using GPR data”, abstract in Proceedings of European Geophysical Union General Assembly 2013, Wien, Austria, April 2013 (ORAL PRESENTATION).
15. I. Catapano, L. Crocco, A. Affinito, Gi. Gennarelli, V. Razevig, I. A. Vasiliev, S. I. Ivashov, F. Soldovieri, “On the Holographic Radar as A Tool for structural monitoring”, in print in Proceedings of 4th Workshop on Cultural and Natural Heritage, 6-7 June 2013 - Matera, Italy, (POSTER PRESENTATION).
16. F. Soldovieri, I. Catapano, “Close sensing radar systems enhanced by Microwave Tomography for IED detection and localization”, Proc. of Resilient Threat Management 2013, European Defence Agency, 4-6 March 2013, Brussels, Belgium (POSTER PRESENTATION)
17. Ilaria Catapano, L. Bertolla,, J. L. Porsani and F. Soldovieri,, “PIPELINES MONITORING VIA MICROWAVE TOMOGRAPHY ENHANCED GPR SURVEYS”, SOLICITED for the oral presentation at Seventeenth International Water Technology Conference (IWTC- XVII), 5-7 November 2013, Istanbul, Turkey.

EGU GA is the largest Conference in the fields of the geophysical science and it is a good platform for the dissemination of scientific activities.
IWAGPR is one of the most impotent conferences dealing with GPR scientific technological advances, which is held whit a biennial timeline.
IWTC represents a good dissemination opportunity of the AMISS outcomes in the field of water monitoring and protection at Mediterranean Countries (Egypt, Turkey, Algeria,..)

SESSIONS
In the frame of AMISS activities, Francesco Soldovieri (CNR) has organized and convened the sessions at European Geophysical Union General Assembly 2013
- From Artefact to Historical Site : Geoscience and Non-Invasive Methods for the Study and Conservation of Cultural Heritage, Conveners: Nicola Masini,Monica Alvarez de Buergo , Lev Eppelbaum , and Francesco Soldovieri.
- Electromagnetic sensing techniques and geophysical methods for critical and transport infrastructures monitoring and diagnostics. Conveners: Jean Dumoulin, Francesco Soldovieri, Lorenzo Bigagli, Sven Nordebo.
In these two sessions, the presentations of four works related to AMISS activities were given.

AWARD
The paper L.N. Anishchenko, S.I. Ivashov, F. Soldovieri, I. Catapano, L. Crocco, “COMPARISON STUDY OF TWO APPROACHES FOR BIORADAR DATA PROCESSING”, has been awarded as the Best Poster at IET International Radar Conference 2013, Xi'an, China, April 2013 .

4. PROJECT MANAGEMENT

Overview of the activities carried out by the partnership; Identification of problems encountered and corrective action taken:

As first activity, the Kick-off meeting held on November 3, 2011, was organized by CNR via Skype conference; the meeting was focused on the definition of the main guidelines for the start-up of the project.

Within the meeting were pointed out the objectives of the project, the activity of each work package, the secondments and were reminded the rules for the participating and for the access to the distribution of funds.

Subsequently, the Partnership approved the appointment of the roles proposed by the Coordinator:
- Francesco Soldovieri as scientific responsible of the overall project
- Francesca Di Matteo as Project Administrator, in order to support the activity of the Coordinator and the PMT

and the following work-package managers:
- Ahmet Turk - YTU

WP1 Microwave and Millimetre wave imaging systems for security:
- Evert Slob - TUDELFT

WP2 Development of GPR technologies for subsurface sensing and critical infrastructure monitoring:
- Lorenzo Crocco - CNR

WP3 Radar technologies for remote detection and registration of vital signs.
- Francesca di Matteo, for the administrative aspects and Ilaria Catapano (CNR) for the support to the scientific aspects of the management.

WP4 Project Management

Finally, the Partnership approved the following Project Management Team members:
- Francesco Soldovieri – CNR
- Evert Slob – TUDELFT
- Ahmet Serdar Turk – YTU
- Gennadiy P.Pochanin – IRE
- Alexander Denisov - SRC
- Renato Prado - USP
- Sergey Ivashov - BMSTU

The pre-financing, with the exception of a percentage of 3% that has been retained by the Coordinator for management budget, as decided in the Partnership Agreement and re-defined in the KOM, has been distributed by CNR early after its receiving by the EC among CNR, TUDELFT and YTU, the three UE member or associated countries of the AMISS project.
A continuous flow of information has been activated between the AMISS management and the Project Officer with the main aim to have clear information about mobility modalities in response to the issues raised by the partners.
An updated secondments plan is in course of finalization and will be presented for the approval to the first year meeting.
A flyer depicting the main features and outcomes of AMISS is under development.

Also, as further activity of MGT the continuous updating of the website in ensured according to the information provided by all the partners.

The secondments were performed in the first period in a number smaller compare to the expected ones. This has required a rearrangement of the secondment plan with two aim as: to improve the original secondment plan and to catch the new cooperation opportunities arising for the knowledge/information exchange of the first period. On the basis of the rearrangement of the secondment plan, which is a dynmamic process always driven by the agreement of the PO, we are confident to reach at least the 70% of the originally expected secondments.

5. ADDITIONAL INFORMATION

Additional information, which may be considered useful to assess the work done during the reporting period:

This first part of the project has been characterized by a good interaction and knowledge exchange between the partners. Moreover, a satisfactory subdivision of the work has been reached so to comply with the expected advances in hardware and software development.
About the hardware, the activity concerned not only the preliminary design of the instrumentation but also the first implementation. For modeling and data processing aspects, thanks to the significant expertise of the partners, it was possible to achieve relevant advances for data reconstruction/inversion approaches. These approaches are able to account in an accurate way for the electromagnetic phenomena of scattering and propagation and, accordingly, ensure performances at least comparable with the state of art techniques.
In addition, the knowledge exchange between partners mainly involved in instrumentation design and those mainly focused on data processing is an enabling factor towards the development of systems capable of dealing with realistic situations and providing fast and accurate diagnostics.
As stated in the proposal writing and set-up, the technological outcomes of AMISS have a notable and widespread impact in many sectors of the society where there is a huge necessity of reliable and effective tools for non-invasive diagnostics and monitoring , such as: physical security, forensics, civil engineering diagnostics and critical infrastructures monitoring; subsurface prospecting, archaeology and cultural heritage diagnostics.
The first proof of the relevance of the results of AMISS project is stated by the fact that, thanks to the involvement of CNR (as Scientific Coordinator) in the ISTIMES project (www.istimes.eu), a good knowledge/information exchange was performed by ISTIMES and AMISS project. ISTIMES project is concerned with the development of a system able to couple current monitoring and quick damage assessment of critical transport infrastructures thanks to the integration of electromagnetic sensing techniques, where the radar systems are one of the key tools.
In addition, AMISS outcomes are relevant to the new COST Action TU1208 “CIVIL ENGINEERING APPLICATIONS OF GROUND PENETRATING RADAR”. AMISS partners as CNR and TUDELFT are fully involved in this COST Action and efforts will be made to include also the other AMISS partners in this COST Action.

Attachments	papers_on_journal.zip, Conference_presentations_proceedings.zip, Publishable_summary_ attachment.docx, AWARDS_SCHOOL.zip

Date:

Person in charge of the project for the beneficiary(ies):