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CARE
Coordinating the Antenna Research in Europe

Funding Scheme: Coordination Action

Deliverable D2.1
Secondments start-up and results in ABPGs

Due date of deliverable: M03
Actual submission date: M06

Start date of project: 1/1/2010 Duration: 28 months

Revision 1.1

Abstract

The CARE activities about secondments in WP2 are detailed at Initial, Intermediate and Final stages. In detail, 3 releases of this document will be provided according to the abovementioned deadlines.

Keyword List

Secondments, researchers mobility, antenna

Document Evolution

Revision	Date	Reason of change
Rev. 1.0	30 June 2010	First Edition
Rev. 1.1	30 September 2010	First Edition - update

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1. Initial status of the Secondment activities in ABPGs

1.1. Secondments topics proposed by the Partners

The Antenna Best Practices group contributes in two parts – the Antenna Software Best Practices Group (led by Katholieke Universiteit Leuven - ABPG1) – and the Antenna Measurement Best Practices Group (led by Politechnika Wroclawska).

The Software Best Practises group copes with one strategic main objective: to facilitate and stimulate the interaction between antenna software developing research groups in Europe. This is done in cooperation with the EurAAP software Working group. Several activities within the European School of Antennas involve antenna modeling and software. Although they are within the scope also of this ABPG, they will be reported in deliverable D5.1. Two software activities are actually discussed in this deliverable.

The list of the secondments topics and activities proposed by the Partners, both for software and measurements, is reported in the following paragraphs. These secondments involve stays with longer duration, typically in the order of weeks or months.

At the end, a very specific activity is reported, the Electromagnetic Data Exchange Language Developer's Short Course. It is being organized by ESA in cooperation with the EuRAAP Software Working Group. Since it is in the core of what the software activities within CARE are about, there is a perfect opportunity to announce it as an activity within the framework of the CARE "secondments".

1.1.1. Katholieke Universiteit Leuven (ABPG1 Leader)

Proposal for a secondment from KUL to UPC

TOPIC – Integration of fast matrix solvers in MoM tools (ABPG1 leader)

It is widely recognized within the computational Electromagnetics community that fast matrix solvers are able to level the performance of MoM tools with those of the well-known commercial finite element and FDTD solvers. These fast matrix solvers will allow MoM tools to handle both complex and large topologies in a reasonable computation time.

On the one hand, UPC (Universitat Polytecnica de Catalunya, Spain) is a well- known expert in the development of fast matrix solvers for MoM tools. Within the context of ACE, it developed several generations of these solvers. On the other hand, KUL has been developing its own MAGMAS software framework since the 80's. This framework is a global framework, heavily used for new research lines, where commercial solvers did not yet penetrate. However, essentially it still uses straightforward LU-decomposition techniques.

The goal of this secondment is to combine the expertise of UPC with that one of KUL in order to integrate the fast matrix algorithms of UPC within the MAGMAS code. For that a KUL researcher is planned to work with the UPC group for a month at the UPC premises.

Work description

- Study of the present state-of-the-art at UPC
- Selection of the most appropriate fast matrix solvers
- Implementation in the souce code of the MAGMAS framework
- Testing and comparison with literature

Duration

1 month, in 2011-2012 **Proposal for a secondment at KUL**

TOPIC – Development of fast Green's function calculation algorithms

Within the antenna software development community, the concept of Green's functions in a multilayered structure is well-known and widely used. However, still today, there is a considerable activity on the further development of more efficient and faster calculation techniques for Green's functions. Fast Green's function calculation in some cases indeed forms part of the computational bottle neck for Method of Moment codes (next to the matrix solvers, see previous secondment). The purpose of this secondment is to allow a researcher, involved in the study of Green's functions, to come to Leuven in order to study the algorithms used at K.U. Leuven, in combination with the algorithms used at the home university, and to set up a road map for a more performant technique, making use of the best of both.

Duration

1 month, in 2011 - 2012, financed by CARE.

Contact

Prof. Guy Vandenbosch
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1.1.1.1 EDX short course (4 October, 2010, ESTEC, Noordwijk, The Netherlands)

EDX is an advanced language designed to facilitate the exchange of data among electromagnetic modelling tools. EDX has already been adopted by several professional software developers. Two large industrial corporations and a number of universities are evaluating the standard for integration in their software and the use of the language is strongly recommended by ESA and EURAP, who promote EDX as a reference for data exchange among antenna and EM software tools. Developers of such software from both industry and universities are encouraged to learn about its advantages and young researchers and engineers should give EDX attention as a way to improve their effectiveness in antenna developments.

The short course will enable researchers to understand the structure and details of EDX and to use it within your own electromagnetic modelling tools.

The course covers the following topics:

- *Introduction to EDX*
- *Overview of Data Dictionaries*
- *The Electromagnetic Markup Language*
- *The Electromagnetic Data Interface library*
  - *Structure*
  - *Usage*
- *Validating your implementation*

The course also includes hands-on sessions to familiarise with the practical side of programming with the Electromagnetic Data Interface library.

Taking into account that exchange of information and data is one of the key issues in the software ABPG, it is strongly suggested that interested researchers can attend this short course within the framework of the CARE activities.

Contact:

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1.1.2. Czech Technical University in Prague

Proposal for a secondment at CTU FEE

TOPIC – Antenna noise calculation

Design objectives for Cosmic-to-Earth radio communication systems mandate a very low receiver noise budget to permit reception of extremely weak signals. In this respect, antenna-temperature interaction plays a critical role in the receiving chain's noise performance. The antenna temperature performance calculation is conceptually described as multiplying the spatial function of antenna gain by the temperature distribution of the space surrounding the antenna, integrated over all space.

Our in-house developed Antenna Noise Temperature Calculator program (ANTC) computes antenna noise using antenna radiation patterns input from CST Microwave Studio Software, FEKO Software or from an actual antenna measurement. Antenna noise temperature is calculated for elevation angles from 0 to 90 degrees in single degree increments. ANTC also enables the calculation of system noise and average noise temperatures.

ANTC software was developer mainly for parabolic dish antenna optimization. With the current one degree radiation pattern digitization, the program is able to calculate noise temperature for antennas with gains up to 34 dB. To deal with very fine digitization and immense data volume requirements associated with higher gain antennas, the noise analysis should be modified by dividing it into two tasks: an analysis of the antenna main beam only with very fine digitization followed by an analysis of the remaining radiation pattern with the current 1 degree digitization. This proposed future modification of ANTC software would be necessary for calculation of absolute noise parameters.

Work description

The objective of the work is to improve the ANTC for operation with high-gain antennas (up to 50 dBi). This means to employ adaptive algorithm and/or further tricks to deal with integration of very directive radiation patterns.

The work of the trainee can involve the following aspects:

- Introduction of our work on ANTC
- Literature research
- Improvement of the current ANTC software (adaptive integration coding)
- Testing against real-world measurements of high-gain antenna noise temperature parameters

Duration

The time frame is flexible, but will be at least 1 month

Place

CTU-FEE, Prague, Czech Republic

Profile of the candidates

The candidate should have must be well motivated, communicative, and able to work independently as well as in team, and have an open mind for ideas and comments. A good background in antenna theory (reflector antennas, antenna noise temperature) is recommended. Good MATLAB / C++ knowledge and programming skills required. He/she should be fluent in English.

Contact

To apply for the position, or for more detailed information, please contact:

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1.1.3. IMST GmbH

Secondment from IMST to University of Nice Sophia-Antipolis (related to AEG1 & ABPG2)

TOPIC – Design and measurement of integrated mm-wave antennas on LTCC

A very promising but also challenging technology for the integration and/or miniaturisation of mm-wave antennas is found in the use of LTCC (Low Temperature Co-fired Ceramic) as a substrate. Using LTCC allows complex antenna structures or electrical circuits to be placed in the most area-effective way, yielding in very small modules. However, characterising the behaviour of antennas integrated in monolithic LTCC modules is a complex issue. Test structures can be defined, but the results may differ from those of the actual system, due to the interfaces required.

The goal of this secondment is to combine the expertise of IMST in the design of integrated mm-wave antennas on LTCC with the know-how of the University of Nice Sophia-Antipolis regarding measurement of mm-wave antennas. For that an IMST researcher (Christos Oikonomopoulos-Zachos) will visit the University of Nice Sophia-Antipolis for a week, to perform the measurements on the existing prototypes.

Work description

- Fabrication of antennas at 60GHz on LTCC
- Craracterisation of the antennas (matching, radiation)
- Optimisation of the designs
- Optimisation of the manufacturing procedure
- Benchmarking of the measurement facilities

Duration
1 week, in December 2010

These are the expected secondments from IMST:

- Markus Krengel. Early Stage Researcher. He attended ICECOM 2010 in Dubrovnik, Croatia, from 20/9/9010 to 22/09/2010.
- Christos Oikonomopoulos-Zachos. Early Stage Researcher. He is planning a short mission to the University of Nice Sophia-Antipolis to exchange know-how regarding the design of millimetre-wave antennas on LTCC (on IMST side) and their characterisation (on U. Nice side). The stay should take place in December 2010.
- Further secondments will consist in hosting young researchers for a duration of 6 months or more. IMST has prepared an offer and a requirement profile that will be published shortly.

1.1.4. Karlsruher Institut fuer Technologie

Secondment concerning the UWB antenna simulation and channel measurement techniques within the framework of the activities specified in D 1.1. To be further detailed.

1.1.5. Universidad Politécnica de Madrid

Proposal of secondments from Radiation group

UMP plan secondments to:

- **Secondment at DTU from 6/9/9010 to 17/12/2010.**

  Supervisor: Prof. Sergey Pivnenko from the Department of Electrical Engineering at DTU.

  The secondment goal is the collaboration in an antenna measurement field project and specifically in the antenna measurement post-processing. Particularly the work is planned on the error compensation in microwave and millimeter wave antenna measurement processes due to noise, reflections and antenna misalignment.

  The profile of the candidate was a Phd student in the general area of antenna design and measurement.

  The secondment has been published in the internal web page of the UPM and the selection has been already done to Mr Francisco Cano Facila.
- **Seciondmente at ESA - ESTEC from 10/1/2011 to 30/6/2011**.

  Supervisor: Cyril Mangenot.

  UMP has published the grant in the UPM web page and the PhD student Mr. Alfonso Muñoz has been selected and his stay has to be approved by ESTEC-ESA.

  He will work in the characterization of compact range for millimeter and sub-millimeter antenna measurement.

- **Secondment at UNIZAG from 1/2/9011 to 30/4/2011**

  Supervisor: Prof. Zvonimir Sipus.

  The secondment has the objective to learn about electromagnetic numerical methods and to work in specific techniques for antenna modeling and numerical methods applied to printed antenna design.

  After its publication in the UPM web page, the selected student has been Mr Andres García-Aguilar, PhD student in the Department of Signal, Systems and Radiocommunication of UPM.

- **Secondment at Toronto University from 1/4/2011 to 30/6/2011**.

  Supervisro Prof. Sean Victor Hum.

  This secondment has been selected to work in the field of active antenna design and reconfigurable antenna design, either on frequency band modification or in pattern configuration trough active circuit controll.

  A first selection has been done between several PhD students at UPM and Mr Javier Garcia Gasco has passed the first selection and presented to the UPM final approval.

1.1.6. RUAG Space AB

Proposal for a secondment at RUAG Space

Wide-Band Assessment of Anechoic Chamber

Modern anechoic chambers are typically shielded and equipped with wedge or pyramidal absorbers. The absorbers are tailored to achieve a "quite zone" around the antenna under test (AUT). However, size constraints and other parameters will limit the frequency band over which low reflections can be achieved.

Traditionally, the frequency of the bands of interest has increased with time. However, recently this trend has also been towards expanding into lower frequencies as well. Previously it was common to relegate such measurements to outdoor ranges, but both interference issues and the use of fragile designs rule out this option, especially in the case of space antennas.

The RUAG Space "A6" anechoic chamber is primarily used for frequencies between 0.8 and 40 GHz. The cross-section is 5 m x 5 m x 9 m, with a probe to AUT distance of 6 m. The reflection properties of the absorbers deteriorate for lower frequencies, but 0.8 GHz is no abrupt cut-off. Recently, antenna projects in the UHF range (400-470 MHz) have necessitated an assessment of the possible use of this chamber at these low frequencies. The goal of this assessment is then to provide viable figures for the measurement accuracy of this chamber in terms of disturbance levels and frequency dependence.

Some measurements have been made with reference antennas to obtain a picture of what can be achieved, but a simplistic numerical or analytical model of the properties would enhance the understanding of important parameters.

The numerical modeling is foreseen to involve FDTD or FEM software, and approaches could range from brute force to equivalent reflectivity absorber modeling.

The analytical model would typically involve Matlab code, and could range from simplistic to semi-numerical approaches.

The assessment project is expected to involve two man-months of work, and should comprise:

- A literature study
- Theory
- Matlab model
- FDTD/FEM model

- Comparison with previous measurements
- Conclusions and recommendations

Duration
The time frame is ca. 2 months

Place
RUAG Space, AB, Sweden

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Politechnika Wroclawska (ABP2 Leader)

Proposals for secondments at WUP

Proposals for secondments at WUT should be within described interests and laboratory capabilities.
WUT areas of current interests in the field of antenna measurements:

(i) dual-polarized and circularly antenna elements

(ii) spacecraft TTC antennas and lightweight arrays

(iii) airplane SAR antenna arrays

(iv) wearable antennas

(v) small and wireless terminal antennas

(vi) medical imaging for surgery robotics

(vii) inflatable antenna arrays

(viii) antenna diagnosis with microwave holography.

Measurement facility at WUT:

The 344 x 370 cm and 295 cm high anechoic chamber is designed to measure relatively large objects and is laid with 18'' or 12'' pyramidal broadband absorbers. The system is to measure 3D radiation pattern of tin spacecraft. The system is to deal with all small spacecraft that are held within a sphere of 1.5 m diameter or 1x1.2x2.4 mm when solar panels are deployed.

The scanner is capable to run near-field sample acquisition in (i) planar bi-polar regular and thinned, (ii) planar spiral, (iii) cylindrical conventional, (iv) cylindrical-helical, (v) spherical formats. Planar bi-polar and cylindrical scanning can be run for the same antenna under test. The system is equipped with four-port vector network analyzer operating up to 50 GHz (ZVA50) and a real-time computer (PXI-8146RT) for scanning

control with LabView of National Instruments. ZVA50 is able to operate with external mixers. The laboratory is equipped with a line of rectangular waveguide probes covering 1 to 50 GHz. The control and the ZVA50 network analyzer can acquire results at a few dozen frequencies during a single scan (usually we measure on 14 to 25 frequencies). Results are presented with LabView modules developed under one of M.Sc. Thesis at our lab.

The software package makes possible to compute interpolation between grids with Optimum Sampling Interpolation (OSI), near-to-far-field transform in planar rectangular format and to compute backward projection onto antenna aperture plane. With the latter software module, amplitude and phase distribution between elements in arrays can be determined.

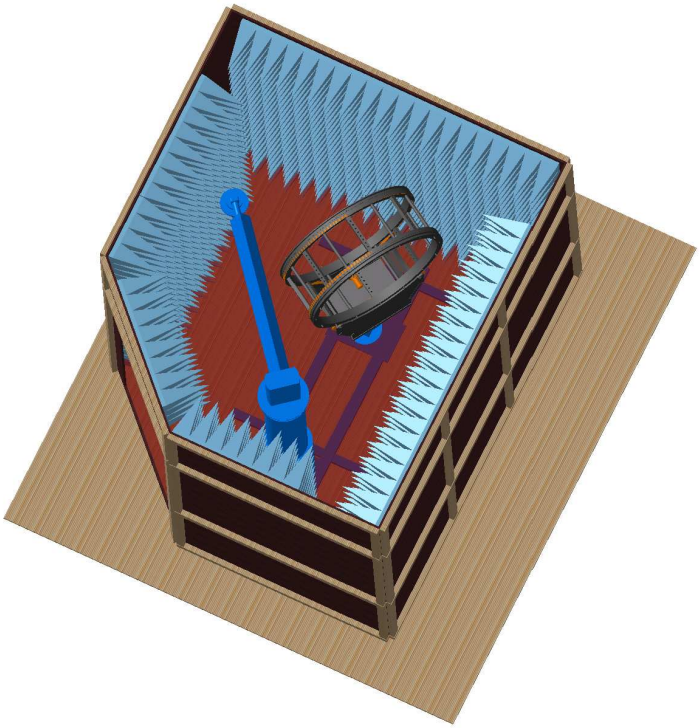

Figure. 1. Computer rendition of the anechoic chamber and a three-system scanner implemented at the WUT. Absorbers are to be installed in July and August 2010. Other system components and control software are ready, but only US supplier of open-ended waveguide probes for mm-wave range has got back delivered 12 items out of 16 in total due to unsatisfactory properties in January 2010. The probes of the acceptable quality are expected to be delivered any time presently.

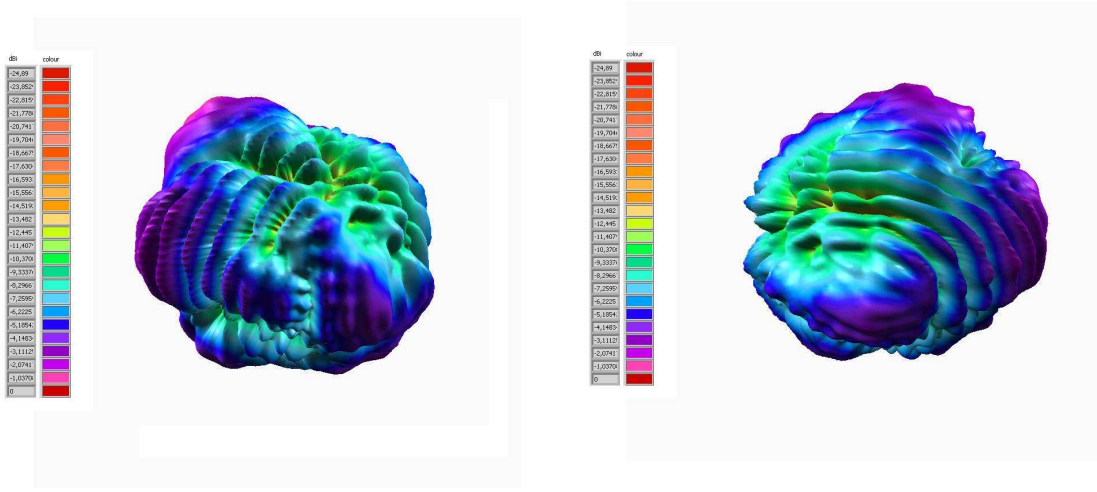

Figure 2. Example of results visualization with our software.

Measurements of antenna properties at highly elevated temperatures (after summer 2011):
(i) input impedance measurements
(ii) radiation pattern and polarization with the near-field scanner

Proposals for secondments from WUP

1. Measurements of patch antenna elements generating circular polarization in the full spherical angle.
2. Measurements of radiation pattern for inflatable antennas (300 x 300 mm size)
3. Evaluation of radio link properties when use is made of wearable antennas on one persons and on two persons.
4. Measurements of combined radiation pattern of a network of several patch antennas mounted on a small spacecraft antennas (20 x 20 x 20 cm or 1 x 1 x 1.2 meters).
5. Measurements of antennas making use of metamaterials
6. Medical imaging with mm-wave systems (particularly 20 to 50 GHz).

Contact

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1.2. Advertisements, Identification of candidates and Appointment procedure

According to the planned secondments listed in the previous paragraph, a set of advertisements of the CARE opportunities, together with the scientific topics related, are distributed in the main international conferences in Antennas and Propagation (i.e. at the EuCAP010 conference in Barcelona or URSI/APS2010 in Toronto).

In addition, the open positions will be published in the CARE Virtual Centre, published in a dedicated section of the EurAAP portal at www.antennasVCE.org .

An initial list of candidates is planned to be extracted from the applications, received by email.

According to the procedure detailed in the CARE Description of the Work, the local teams will proceed with the selection of candidates and will inform Prof. Mazanez (the Secondments Responsible) about the names and expertise of the young researchers involved in the CARE secondments.

1.2.1. Secondments Forms

In order to reach an uniform and controlled approach to the management of the CARE secondments, both from the applicants and hosting sides, 4 Forms have been produced:

1) the CARE Host Application Form; this form, available on the CARE website, must be filled by the Institutions that would like to host a CARE secondment (these are the Open Positions)
2) the CARE Secondment Application Form; this form, available on the CARE website, must be filled by the researchers that would like to apply for a CARE secondment
3) the CARE Grant Officialisation Form; this form has to be sent to the selected applicant in order to inform him/her about the successful result of his/her application
4) the CARE Secondment Report Form; this form must be filled by the seconded researcher at the end of the secondment period, in order to present the results of the hosted activity.

The Forms are available on the CARE Virtual Centre, in the Secondment section.