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ACE

Antenna Centre of Excellence

Instrument: Network of Excellence

Thematic Priority: IST - Information Society Technologies
Mobile and wireless systems beyond 3G

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Abstract

Keyword List

Document Evolution

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1.0	2005-12-29	

Table of contents

1 Introduction

This report is a summary of the work done in the activity 3.1 Training and Education during the full 24 months of the project. The details of the work are described in full in the 5 previous deliverables:

3.1.D1
3.1.D2 v.2
3.1.D3
3.1.D4
3.1.D5

This report will therefore only provide an overview of this work and focus on future work and the conclusions to be drawn from ACE. Note that deliverable 3.1.D2 has been updated with information on the courses held after the original delivery date M18.

1.1 Participants

The complete list of contribution to this task is as follows:

Partic. Number	Participant name	Participant short name	Country
2	KATHOLIEKE UNIVERSITEIT LEUVEN	KUL	Belgium
3	DANMARKS TEKNISKE UNIVERSITET	DTU	Denmark
4	TICRA FOUNDATION	TICRA	Denmark
5	TEKNILLINEN KORKEAKOULU	HUT	Finland
11	UNIVERSITE DE MARNEE LA VALLEE	UMLV	France
13	INSTITUT NATIONAL DES SCIENCES APPLIQUEES DE RENNES	IETR	France
16	IMST GMBH	IMST	Germany
19	UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA"	SAPIENZA	Italy
20	POLITECNICO DI TORINO	POLITO	Italy
21	UNIVERSITA DEGLI STUDI DELLA CALABRIA	UNICAL	Italy
22	UNIVERSITA DEGLI STUDI DI FIRENZE (3)	UNIFI	Italy
23	UNIVERSITA DEGLI STUDI DI SIENA	UNISI	Italy
26	UNIVERSITAT POLITECNICA DE CATALUNYA	UPC	Spain
27	UNIVERSIDAD POLITECNICA DE MADRID	UPM	Spain
28	UNIVERSIDAD POLITECNICA DE VALENCIA	UPV	Spain
29	CHALMERS TEKNISKA HÖGSKOLA AB	CHALMERS	Sweden
32	KUNGLIGA TEKNISKA HOEGSKOLAN	KTH	Sweden
35	ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE	EPFL	Switzerland
36	NETHERLAND ORGABISATION FOR APPLIED CCIENTIFIC RESEARCH	TNO	Netherlands

Note that the level of participation varies quite a bit between the participants in the list above. Some took part of the teaching of a course, whereas some were responsible for a complete deliverable.

1.2 Meetings held

Joint activity meeting were held

- Noordwijk, 2004-01-29
- Gothenburg 2004-06-10
- Florence, 2004-10-01
- Nice, 2004-11-11
- Lausanne, 2005-01-24
- Den Haag, 2005-04-14
- Noordwijk, 2005-05-30
- Paris, 2005-10-03
- Noordwijk, 2005-12-02

The participation at the meetings has been very good with an attendance typically between 15 and 20 persons

1.3 Joint papers

The work of the activity has been presented at a number of joint papers at conferences as well as in an IEEE Magazine:

- IEEE Antennas and Propagation Symposium, Washington D.C., July 2005.
- European Microwave Conference (EuMC), Paris, October 2005.
- URSI meeting, New Dehli, 2005
- IEEE Antennas and Propagation Magazine, in press 2005-2006.

2 WP 3.1-1

The European School of Antennas (EsoA) ESoA, is a new model of geographically distributed PhD school which aims to improve the antenna advanced training and research in Europe. The school is organized in the framework of the Antenna Center of Excellence (ACE), a "Network of Excellence" financed by the sixth framework program of the European Union. The school is constituted by a highly qualified integrated set of advanced courses at PhD level, distributed in the most accredited European research centres on antennas. The general objectives of the School are: i) strengthening the European excellence on antennas; ii) completing the individual PhD curricula of students in Electrical and Information Engineering by offering interaction with the best trainers in Europe; iii) increasing the link between european Universities and Industries in antenna research and development; iv) facilitating the interchange of ideas among early stage researchers and teachers, thus increasing the future mobility and synergy. The school is furnished with a centralized WEB support and it is coordinated so that the courses have the same format and apply common basic rules for exams and credits.The details on the courses held are included in full in the recently updated 3.1.D2 v.2. The total geographical picture is shown in Fig.1.

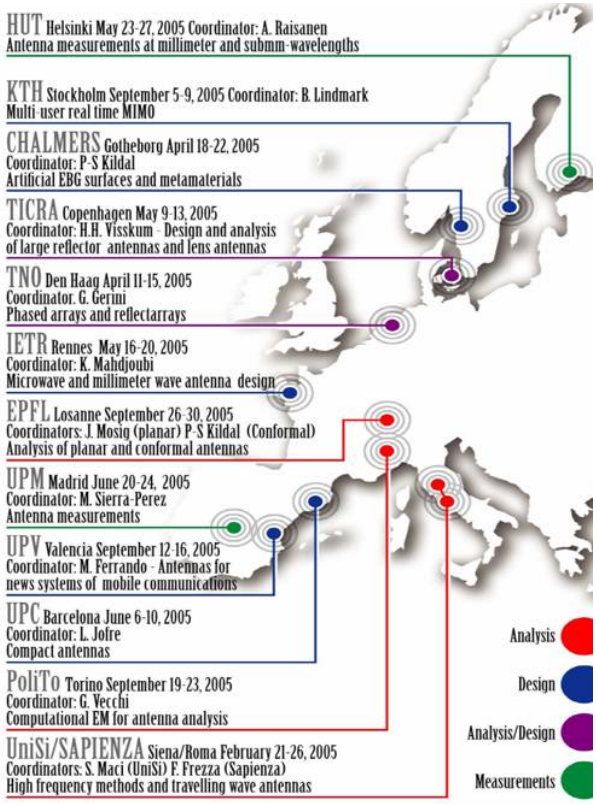

Fig. 1: Map of the courses in the European School of Antennas.

The output of the evaluation form and the enthusiasm we have seen among of the students confirm the effectiveness of our model. The overall number of students registered to the courses was 240, with an average of 22 students per course. The major part of the students have followed one course, some students have followed more than one up to four courses. Due to the economic facility of the institutions belonging to ACE, about the 80% of the students came from the ACE institutions. However, European students external to ACE have had exclusive access to 60 grants offered by ACE (5 for each course) to cover entirely their mobility and fee expenses. An average of 50% of the students came from the host country. The data concernied with the number and the origin of the trainers are very interesting: we had 99 among teachers and assistants). Only 40% of these were belonging to the institution hosting the course. This confirms the international character of the school.

	INPUT (Registration fees)	OUPUT (eligible expenses)	Balance	Output for grants	Total Balance
UNISI	3360	-7400	-4040	-4750	-8790
TNO	5700	-6497	-797	-5000	-5797
CHALMERS	3000	-3000	0	-4800	-4800
TICRA	1980	-1943	37	0	37
IETR	1900	-2040	-140	-800	-940
HUT	1350	-3754	-2404	0	-2404
UPC	7.000	-8975	-1.975	-7000	-8.975
UPM	2200	-6036	-3836	-5100	-8936
KTH	3200	-3459	-259	-1000	-1259
UPV	4838	-4508	330	-5000	-4670
POLITO	6450	-5110	1340	-3000	-1660
Total			**-11744**	**-36450**	**-48194**

Table. 1: The budget of the courses held during 2005 in the EuSA.

The financial situation for the EuSA is summarized in Table 1, for details please see 3.1.D2 v.2. The income consisted of registration fees and this was balance by the eligible expenses and the cost of the travel grants of the students. We can see that the deficit is 11744 Euro, if we neglect the grants. The average registration fee for the courses was 150 Euro for ACE-participants and 400 Euro for non-ACE participants. With 240 students participating, it is clear the even a modest increase of say 50 Euro per participant is enough to cover this deficit.

3 WP 3.1-2

In WP 3.1-2, there were two main actions during ACE: first, an inventory of the the available Ph.D. courses was made. The result is summarized in 3.1.D2 and in Fig. 2 below.

name	partner	kind	language	prere	contactem	weblink
name of the course		Intended partecip	language	prerequisites to follow the course	contact e-mail	Web link
Time-Harmonic Electromagnetic Fields with Spectral...	CHALMERS	phd	English	Introductory course in fundamental	simon@elmagn.chalmers.se	http://www.elmagn.chalmers.se/elmagn/antenna/c
Integral Equations and Moment Methods	CHALMERS	phd	English	An introductory course in basic	simon@elmagn.chalmers.se	www.elmagn.chalmers.se/elmagn/antennas
Antennas	UPM	master	Spanish	General Antenna and Propagation studies.	leandro@gr.ssr.upm.es; m.sierra.perez@gr.ssr.upm.	http://www.gr.ssr.upm.es/antenas/antenas.htm
Electromagnetismo Avanzado (Advanced Electromagnet...	UPV	phd	spanish	Electromagnetics, Antennas, Microwaves	mferrand@dcom.upv.es	http://www.upv.es/antennas
Electromagnetics Engineering	UPC	phd	English	- Basic electromagnetics theory	rius@tsc.upc.es	
Antennas and Propagation	UNISI	und5	Italian	Basic knoweledge of electromagnetic fields	macis@dii.unisi.it	http://www.ing.unisi.it/insegnamento.php?id=5147
Functional Analysis	SAPIENZA	phd	Italian	Real and complex analysis, as taught in	lovat@die.uniroma1.it	www.die.uniroma1.it/personale/frezza
Electromagnetic Fields II (first module)	SAPIENZA	phd	Italian	Basic concepts of Electromagnetics:	fabrizio.frezza@uniroma1.it	www.die.uniroma1.it/personale/frezza
Electromagnetic Fields II (second module)	SAPIENZA	phd	Italian	Basic and more advanced concepts of	fabrizio.frezza@uniroma1.it	www.die.uniroma1.it/personale/frezza
Metodos Numericos en Electromagnetismo (Numerica...	UPV	phd	Spanish and English	-Antennas	avalero@dcom.upv.es	http://www.upv.es/antenas
Antenas	UPV	und4	Spanish	-Electromagnetic Theory	mferrand@dcom.upv.es	http://www.upv.es
Microwaves	UPV	und4	Spanish	-Electromagnetic Theory	mbaquero@dcom.upv.es	http://www.upv.es
Foundations of Radio Engineering	HUT	und3	Finnish/English			www.hut.fi
EMC-design and Testing	HUT	und4	Finnish and English			www.hut.fi
Analytical Modelling in Radio Engineering	HUT	phd	English			www.hut.fi
Advanced Field Theory	HUT	phd	Finnish and English			www.hut.fi
Antenna Theory	HUT	master	Finnish			www.hut.fi
Millimetre Wave Engineering	HUT	master	Finnish			www.hut.fi
Radar Engineering	HUT	master	Finnish			www.hut.fi
Antenna Techniques in Telecommunication	HUT	master	Finnish			www.hut.fi
Antenna Theory	KTH	und4	English	Electromagnetic Theory and must be well	bjorn.lindmark@s3.kth.se	www.s3.kth.se/kurser/2H1260/
Sensor Array Signal Processing	KTH	phd	English	Graduate level Estimation Theory , for	bjorn.ottersten@s3.kth.se	http://www.s3.kth.se/signal/grad/sap/
Matrix Algebra	KTH	phd	English		magnus.jansson@s3.kth.se	http://www.s3.kth.se/signal/grad/matrix/
Project Course in Smart Antenna Implementation	KTH	phd	English	Primarily for students in the Graduate School of	perz@s3.kth.se	http://www.s3.kth.se/signal/grad/smart_impl/
Applied Antenna Theory	KTH	und4	Swedish/ In English on	Electromagnetic Theory must be well	2a1830@alfvenlab.kth.se	http://www.alfvenlab.kth.se/edu/2A1830.html
Electromagnetic Wave Propagation	KTH	phd	Swedish/ In English on	The basic courses in Electromagnetic Theory	2h1255@alfvenlab.kth.se	http://www.alfvenlab.kth.se/edu/2H1255.html
Design of passive arrays and smart antennas	UPM	phd	Spanish	Telecommunication engineer specialized in	m.sierra.perez@gr.ssr.upm.es	
Electromagnetic Compatibility	UNISI	und3	Italian / English	Electromagnetic Fields, Basic.	capolino@dii.unisi.it	http://www.ing.unisi.it/insegnamento.php?id=5151
Antennas	UNISI	und5	Italian	Basic knowledge of electromagnetic field.	macis@dii.unisi.it	http://www.ing.unisi.it/insegnamento.php?id=5150
Advanced Electromagnetic Field	UNISI	und5	Italian	Basic knowledge of electromagnetic field	tiberior@dii.unisi.it	http://www.ing.unisi.it/insegnamento.php?id=5151
Directive EBG Antennas	IETR	phd	French or English	Fundamental Notions on antennas and arrays	mahdjoubi@univ-rennes1.fr	
Antenna Measurements in Radio Anechoic Chamb...	DTU				ob@oersted.dtu.dk	http://www.kurser.dtu.dk/presentation/presentation

Fig. 2: Result of the Ph.D. course inventory of WP 3.1-2.

Second, a survey of the existing undergraduate education in electromagenitcs and antennas was made. This work, referred to as XUNTA; was reported in 3.1.D3.

4 WP 3.1-3

4.1 Overview of the activity and its objective

For a high quality education in antenna design the availability of numerical tools is extremely helpful, since it provides an increased understanding of the physics behind an antenna problem and also reduces the need for expensive and bulky antenna measurement equipment.Therefore, ideally a comprehensive antenna education, which includes different tools that today are being developed with little coordination among different institutions and research centers, should be of great value. Since the software is proprietary to the universities or companies that have developed them, sharing it directly is a problem. The key feature of the VALab working package is to develop something more than a regular website where the student or/and the researcher can download only static pages, despite the fact that they can move from one to the other using hyperlinks. Moreover, the idea is to provide them the possibility of integrating some executable modules, already available among the ACE network, into their own codes. In the virtual laboratory all the material that the partners have decided to share with the other participants should be available for the researchers, according to the restrictions that the owners have indicated. Moreover, the virtual laboratory would also include educational material and examples of different antennas design.

4.2 First tests on VALab prototype

The first tests on the VALab prototype has been focused on the pages related to the remote execution. In particular, we performed several tests to develop a code which allows each partner the remote execution of shared routines. This code is particularly descripted in the section “remote execution service”. It was reported in 3.1.D1 and 3.1.D5.

4.3 Description of VALab services

4.3.1 Educational material

This section is aimed at all users interested in using computer-based/web-based educational materials. Most ACE partners have developed more or less extensive amounts of educational material such as notes, slides and videos. However, most of this data is not made available to other partners and, even more often, partners in different entities are not aware of what other colleagues have produced.

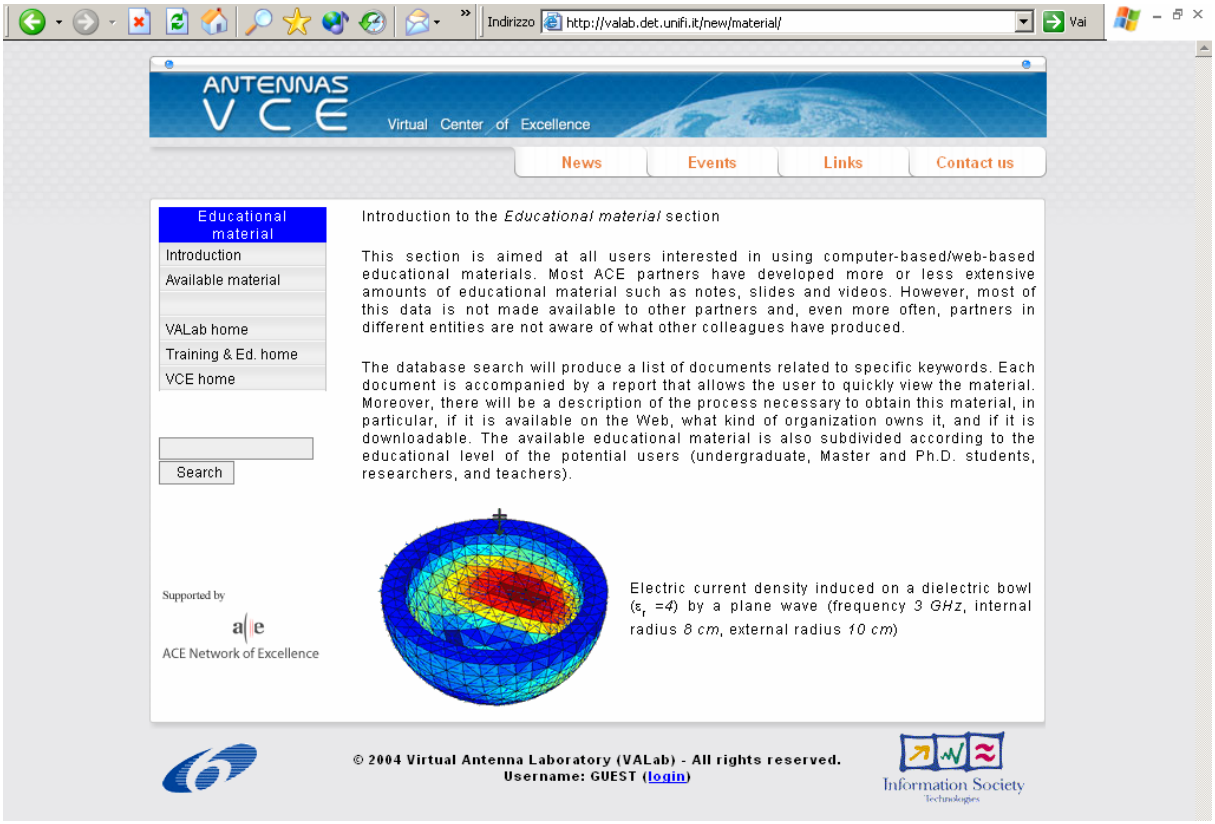

Figure 3 - Educational material - Introduction page

The introduction page (see Fig. 3) contains a brief description of the aim of this section and on the left there is a menu which introduces the user to the available material page or where the user can perform a keyword search.

An example of the output of the database search is the following. If we search in the database for the string “array” we obtain output shown in Fig. 4.

Figure 4 - Educational material - Database search example

4.3.2 Canonical solution

The aim of this section is to offer a set of solutions that the users could compare to the ones they have generated, in order to test the accuracy of their own code.Moreover, for each canonical problem, a link to the theory is also available; it provides a theoretical background on the formulation used to achieve the specific result. As an example of the available material we developed a typical antennas problem that is the design of a pyramidal horn. A brief description of this is shown in Figs. 5.

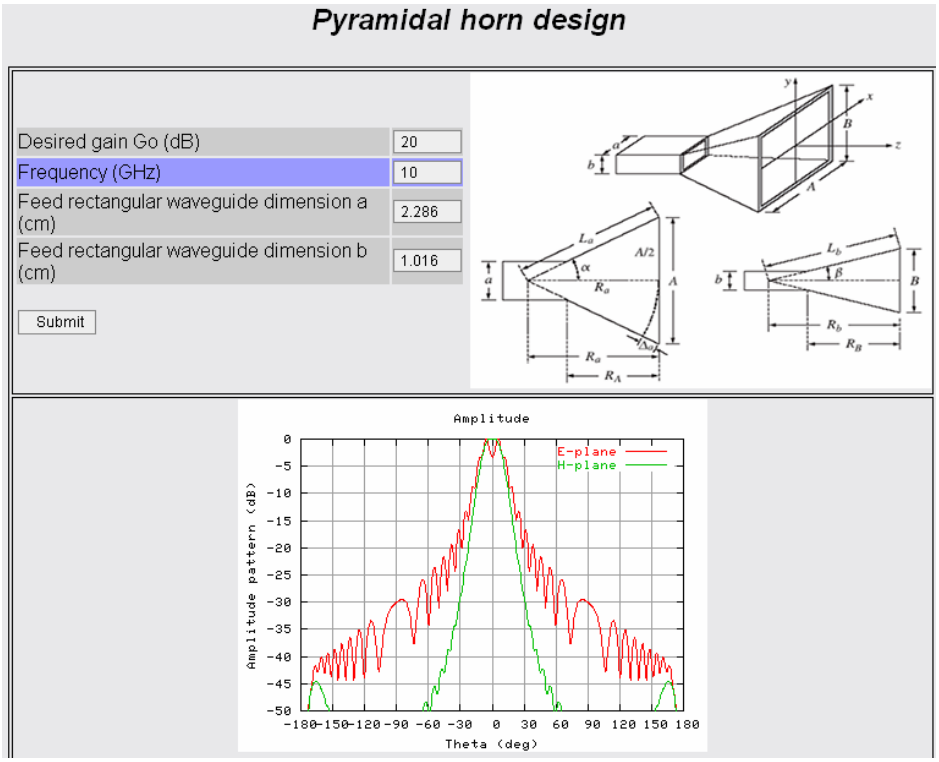

Figure 5 - Horn antennas design –Results

4.3.3 Remote execution service

The aim of the remote execution is to provide users with a set of executable routines, which we will call *modules*, which can be used as a base for easily building and testing their numerical algorithms. It's a distinctiveness of this service to allow the users to execute all the modules available on the server, without having to resort to executables or source codes. This can be achieved by executing the routines by remote access on the VALab server. The fundamentals of this service is shown in Fig. 6 below.

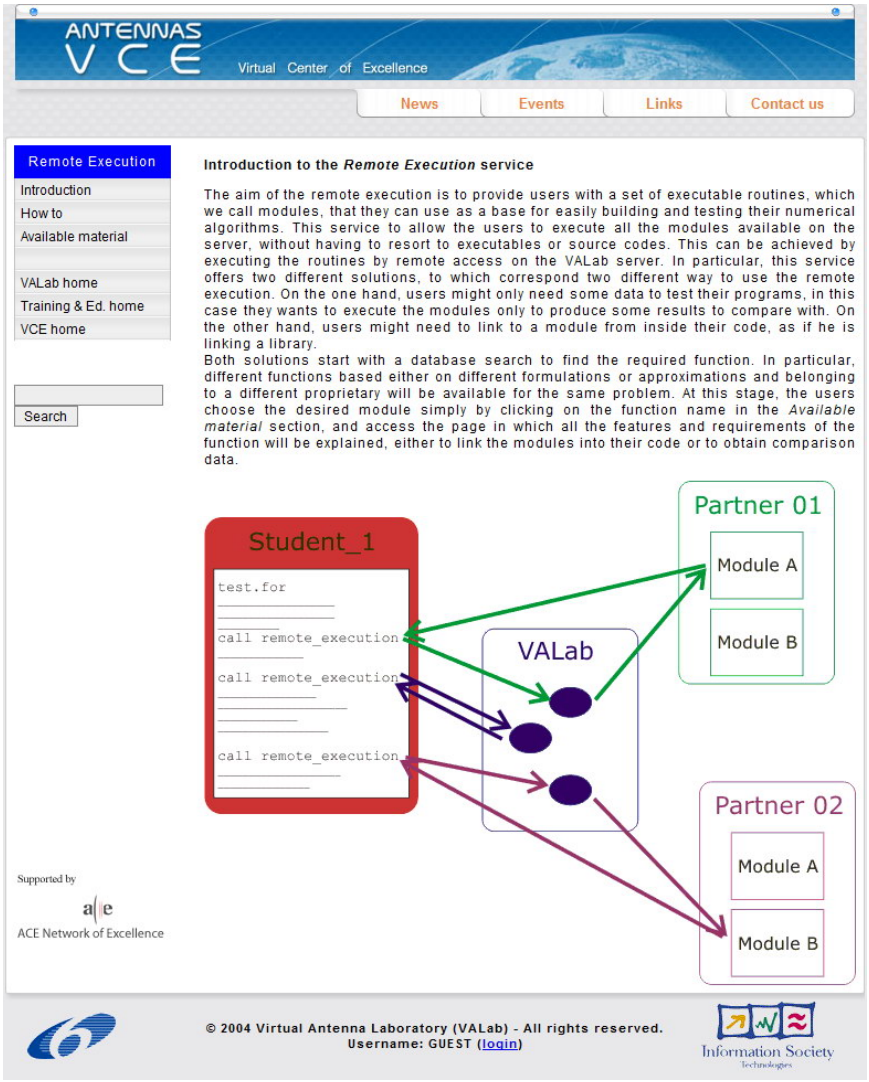

Figure 1 - Web homepage of Remote Execution service.

4.3.4 European School support

As support to the European School of Antennas, for each course of the school is also available on VALab a page where the students can download the course material (transparences, notes, software, etc.). Each page is protected and only the teachers and the registered students can access the course page. Figure 7 shows, as an example, the page relevant to the "Computational EM for Antenna Analysis" course held in Turin on 19-23 September 2005.

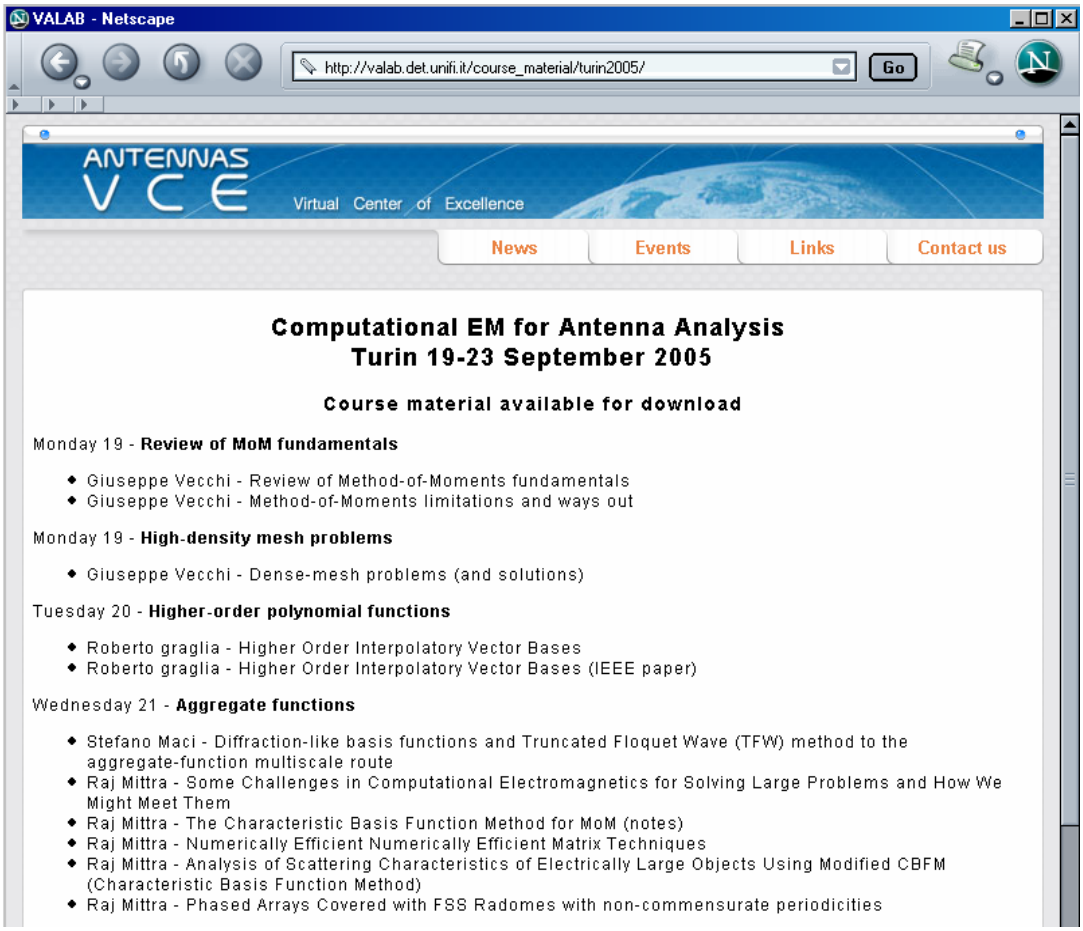

Figure 7 – Course material of the Computational EM for Antenna Analysis, Turin 19-23 September 2005

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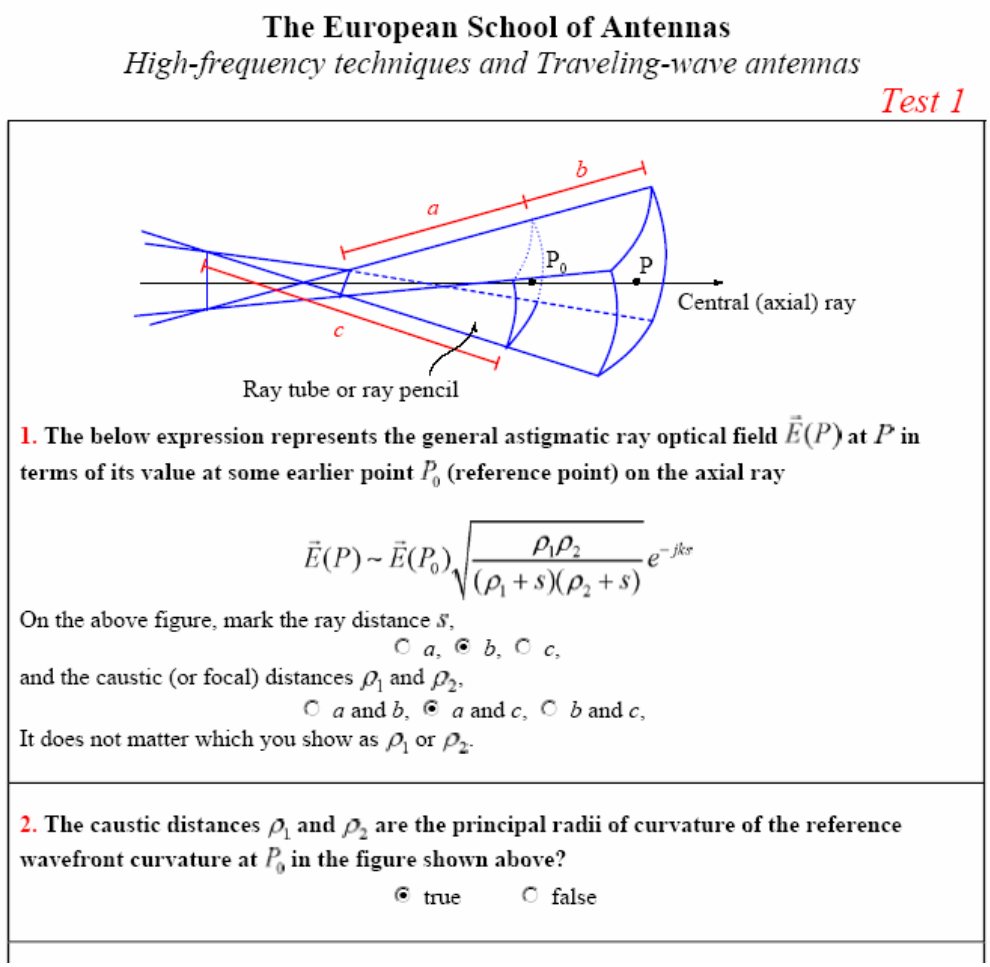
4.4 Training

In this section we describe how a teacher can easily create a training page that the students can use to check their background before to join a course, and/or verify their knowledge before to undertake the course final exam. A training page is essentially a web page containing a list of multiple-answers questions. The student marks the answers that he thinks correct and submits the page. As a result, he obtains back the same web page where for each choice is specified if the answer is correct or not. In case, a simple message can appear around the answer in order to suggest to the student how to solve the question. The idea is illustrated in Fig. 8 below.



The European School of Antennas

High-frequency techniques and Traveling-wave antennas

Test 1

1. The below expression represents the general astigmatic ray optical field $\vec{E}(P)$ at P in terms of its value at some earlier point P_0 (reference point) on the axial ray

$$\vec{E}(P) \sim \vec{E}(P_0)\sqrt{\frac{\rho_1\rho_2}{(\rho_1+s)(\rho_2+s)}}\,e^{-jks}$$

On the above figure, mark the ray distance s,

○ a, ◉ b, ○ c,

and the caustic (or focal) distances ρ_1 and ρ_2,

○ a and b, ◉ a and c, ○ b and c,

It does not matter which you show as ρ_1 or ρ_2.

2. The caustic distances ρ_1 and ρ_2 are the principal radii of curvature of the reference wavefront curvature at P_0 in the figure shown above?

◉ true ○ false

Figure 8 – Example of training page.

The VALab website contains the sections necessary to start or improve the study of the antenna systems, as the acronyms suggests the Virtual Antenna Laboratory is aimed to guide the users as though they were in a real laboratory. To arrive to a final antenna project we have figured out a series of steps which have been identified with the different sections of the website.

First of all a user has to study or improve the theoretical basis of the antenna system to develop, so he/she has to look for a specific topic in the educational section. Then, according to the available material a problem can be formulated with the help of the canonical solutions. The last stage is to help the users to develop themselves numerical algorithms in order to solve more complex problems. This can be done using the modules shared by the partners in the remote execution section.

The first VALab website has been successfully developed. Now we need to fill it with more antenna materials. Concerning this, we discover that a small number of ACE partners have developed a multimedia material on antennas and from these a few in English. Furthermore, a search on the web showed that these remarks can be extended to all the European universities.

During the European School of Antenna (ESoA) progress, we discovered that several students need to check their background before to join a course in order to know if they have to perform some preliminary work. As a matter of fact, the education is not uniform in Europe and same basic topics are treated with a different depth. This suggested to develop a web page containing a list of multiple-answers questions where the

student can check his preparation and discover which topics have to study more in depth. At the present, a few free programs are available on the web to build a page containing multiple-answers questions. However, they do not expect any formulas, or treat these as images, resulting in a very complicated and time consuming task for the teacher. To overcome this problem, we developed a simple program that builds the appropriate web page by starting from a simple Word or LaTeX document. To the teacher we only ask to insert a few simple key words in the document to indicate which the questions are and which are the right or wrong answers.

As support to the ESoA, for each course of the school we created a web page where course students and ACE partners can download the course material (transparences, notes, software, etc.). We protected the page so only the teachers, the student and the ACE partners can access the course material. We scheduled only one undifferentiated level of access. However, during the last meeting came out that, especially for those courses organized by the industry, several parts of a course cannot be spread in an electronic form for copyright problems, and at least four different levels of access are required: registered students, ACE partner, course teachers, and course supervisors. Furthermore, could be convenient to give free access to a small fraction of the course material, just for publicity.

5 Conclusions and recommendations

- Training & Education gives integration of teachers AND students over Europe. This is true for the courses arranged, the inventory actions, and the virtual laboratory.
- It is relatively easy to get participants host courses and teach. We have thus seen a great willingness to spread excellence!
- The average cost of the courses is somewhat above the income. However, a increase of the course fees to around 200 Euro and 450 Euro for members and non-members, respectively, would thus make the school break even. Assuming that the teachers are reimbursed for their work, we could thus have a continuation of the school after
- The work on course inventories has been concluded, but we are still lacking an effective dissemination of the results through the VCE. This work will continue in ACE-2.
- It has been difficult to improve the Industry-University interaction through Ph.D. student exchange. One reason for this is the lack of industry partners in an activity which by its nature engages primarily university partners.
- For the VaLAB, a functioning virtual environment has been created and demonstrated.