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The Early History of Radio Communications Through the Photos of the Italian Navy Archives

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Abstract

In June 2005, a special selection of images concerning the development of telecommunications, kept in the archives of the Italian Navy, were collected, selected, and organized in a panel exhibition held at the Italian Navy Academy. A selection of the rarest of these images is presented here.

Keywords: History

I. Introduction

The Italian Navy Academy, Leghorn (Figure 1), hosted the photographic exhibition "The Early History of Radiocommunications Through the Photos of the Italian Navy Archives" [La Storia delle Telecomunicazioni Attraverso le Immagini dell'Archivio Storico della Marina Militare Italiana] on June 15-16, 2005. The exhibition was created thanks to the efforts of the Institute for Radar and Telecommunications of the Italian Navy "Giancaro Vallauri" [Istituto Radar e delle Telecomunicazioni della Marina Militare «Giancarlo Vallauri» (MARITELERADAR)], in Leghorn; of the Historical Department of the Italian Navy, in Rome; of the University of Florence; and of the University of Pisa. It had the patronage of the IEEE Central and South Italy Sections, of Italian National Committee of URSI, and of the Italian Society on Electromagnetics (SIEm), a nonprofit organization for the development of activities in electromagnetic engineering in Italy [1].

The exhibition followed the main steps of telecommunication developments in Italy since the very beginning up to World War II by means of the photographic records, many of which had never been published before, having been kept in the Italian Navy

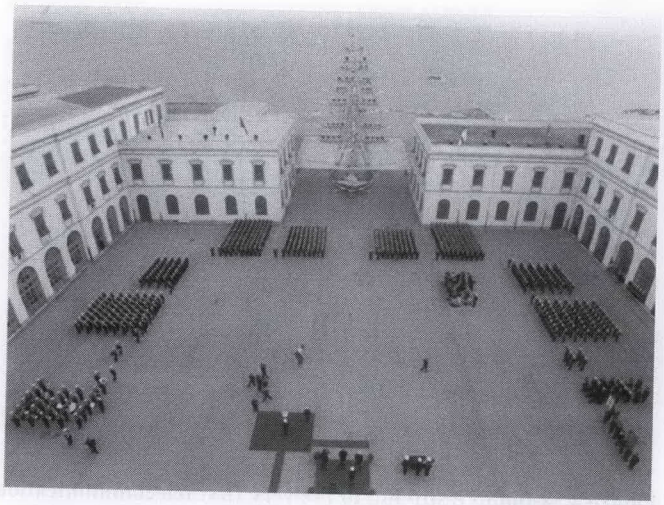

Figure 1. A panorama view of the Navy Academy, Leghorn, Italy, from the clock tower during cadets oath-giving.

Figure 2. Part of the panel exhibition in the gallery of the Navy Academy, Leghorn, Italy.

Archives. Of course, the exhibition was not a complete overview of the history of telecommunications in Italy, but nevertheless showed many of the very fundamental events in the first pioneering years. Indeed, it is very worth noticing how many of the prominent researchers in telecommunications in Italy in those years were Navy officers, and how much important research was supported by the Navy.

The images, over one hundred, were carefully selected and organized from the thousands stored in the archives. They were then reproduced on large panels and organized in thematic paths to form the exhibition, as partially shown in Figure 2.

Both the central archives of the Navy in Rome and the MARITELERADAR Institute itself host large quantities of photographs and technical drawings of the first years of telecommunications in Italy, and this wealth of material originated the idea of a photographic exhibition. The images were arranged into thematic paths, grouping photos by topics, rather than in a strict chronological order. Seven of these paths are presented here. The following section reports, after a brief summary of the paths themselves, a few important, annotated, photographs. The full range of the photos presented at the exhibition was recently published in a special issue of the Italian Navy Journal *Rivista Marittima* [2]. A further selection of the most interesting images is here presented, most of them are actually published for the first time outside Italy, the absolute first time being the June 2005 show.

This paper is organized as follows. In the following paragraph a brief history of the MARITELERADAR Institute is presented, highlighting its contributions to the development of telecommunications in Italy. The third section contains the photographic material, organized in topical paths.

2. The Institute of the Italian Navy Committed to Telecommunications

The Italian Navy showed very early (1897) interest in telecommunications, thanks to its close links with Marconi himself. In the following years, the Navy created the constitution (1916) of an Institute specifically devoted to electric and telegraphic devices and instruments, namely the Electrical Techniques and Telegraphic Institute of the Royal Navy [Istituto Elettrotecnico e Radiotelegrafico della Regia Marina (IERT)]. This Institute was hosted in a new building within the area of the Navy Academy, in Leghorn. The first task of this institute was to contribute to the industrial production of vacuum tubes. The first director of the institute was Giancarlo Vallauri (1882-1957), at that time among the leading experts of radio in Italy. As will be shown in the following, the institute gave a great impulse to the development of vacuum tubes in Italy.

In 1928, the institute changed its name to the Royal Institute for Electrical Techniques and Radiocommunications [Regio Istituto Elettrotecnico e delle Comunicazioni della Marina (RIEC)], with expanded and extended competencies (Figure 3). In the following years, many people worked at the institute. Among them, it is worth mentioning M. Boella, F. Vecchiacci, N. Carrara [3], U. Tiberio [4], who performed important studies on measurement techniques, microwaves, and radio detection and ranging (radar).

[Mario Boella (Genova, Italy, January 31, 1905 – Loranzè Canavese (TO), Italy, February 16, 1989) developed new devices and performed research in the fields of time and frequency meas-

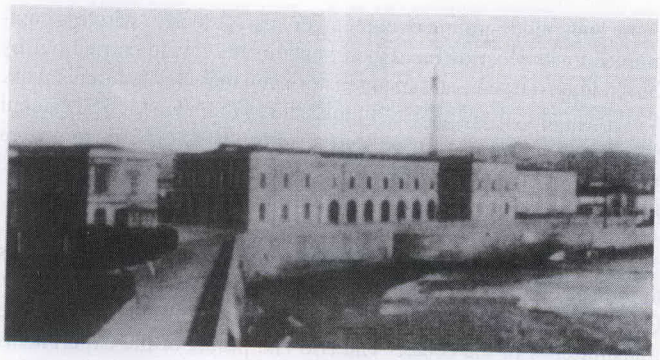

Figure 3. The Royal Institute for Electrical Techniques and Communications [Regio Istituto Elettrotecnico e delle Comunicazioni della Marina (RIEC)], in the twenties.

urements. He is also known for having discovered the effect (the BOella effect) of parasitic capacitances in a resistor, which causes a decay of resistance with frequency. If properly combined with the skin effect, which causes a resistance increase with frequency, it leads to resistors with a value that is very stable with frequency. Francesco Vecchiacci (Filicaia (LU), Italy, October 9, 1902 – November 20, 1955) worked in the Italian industry Magneti Marelli, in which he realized several radio links across Italy. He also worked on a radio locator, which eventually lead to the Italian radar (see also U. Tiberio, below). In 1947, Nello Carrara (1900-1993) founded the Institute of Research on Electromagnetic Waves in Florence. In a paper dating back to 1932 [2], he used the word "microwaves" for the first time in history. He was very active in the microwave measurements field. Ugo Tiberio (Campobasso, Italy, August 19, 1904 – Leghorn, Italy, May 17, 1980) was a Navy officer during World War II. He developed the basic ideas of a "Radiotelemeter," which later on developed into the Italian radar devices [3].]

Since 1957, the institute has been named Istituto Radar e delle Telecomunicazioni della Marina Militare, [Institute for Radar and Telecommunications of the Italian Navy], and referred to in brief as MARITELERADAR. Since 1960, the institute has also been titled to Giancarlo Vallauri.

3. The Photographic Exhibition

This section is organized into seven subsections, according to the subject paths chosen in the original exhibition:

1. First Experiences
2. The *Carlo Alberto*
3. Vacuum Tubes
4. Coltano
5. *Elettra*
6. Torre Chiaruccia
7. The Italian radar

3.1 First Experiences

This photo group covers the very early steps in wireless communications. Most of the experiments in Italy were carried out by Guglielmo Marconi, and many historical papers related to his work have been already published in this same *Magazine* [5, 6]. Marconi was a Navy officer. Consequently, some of his experiments were actually carried out in the Navy arsenals, and their records were stored in the Navy archives.

The photo in Figure 4 dates back to July 15, 1897. It testifies to the very first telecommunication experiment of the Italian Navy. G. Marconi, without uniform, is surrounded by Navy officers. The transmitter is in the center. The two end points of the experiments were the Navy headquarters in La Spezia, Italy, and the facing island of La Palmaria (see Figure 7 for a map). Figure 5 shows the receiver, aboard tugboat No. 8, in the gulf of La Spezia. Figure 6 again shows the transmitter in San Bartolomeo (La Spezia, Italy),

Figure 4. A photo testifying to the very first telecommunication experiment of the Italian Navy (La Spezia, Italy).

Figure 5. G. Marconi, at the center of the photo, operating his receiver (La Spezia, Italy).

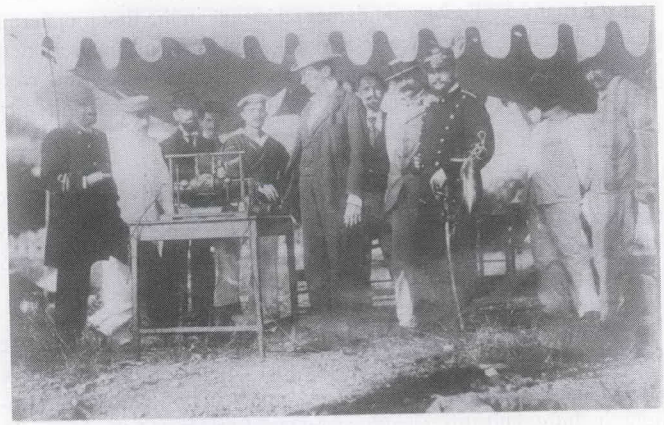

Figure 6. G. Marconi, at the center of the photo, operating his transmitter (La Spezia, Italy).

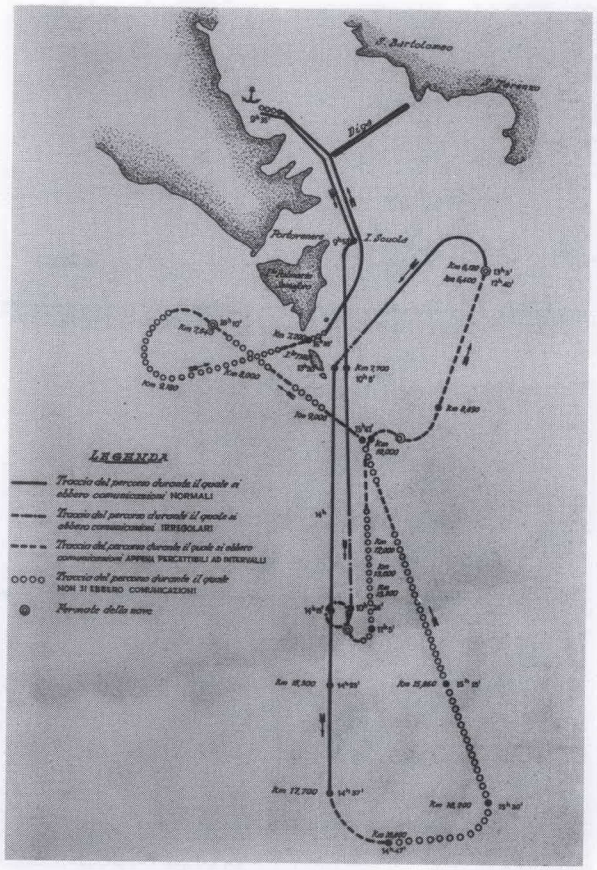

Figure 7. A map from 1897, showing the routes of Marconi's sea experiment in La Spezia Gulf.

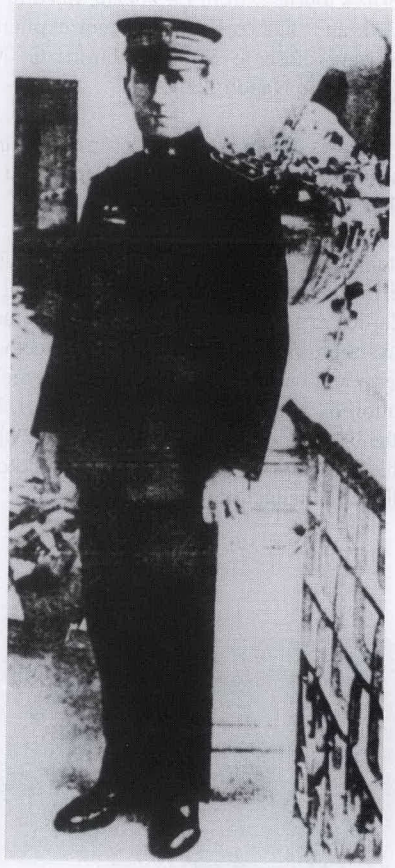

Figure 8b. Marconi wearing his uniform.

Figure 8a. A photo of Marconi's Navy registry sheet.

for that same series of experiments, which went on for the rest of July 1897.

Figure 7 shows a map dating back to 1897, showing the routes of Marconi's sea experiment in La Spezia gulf. La Spezia itself is off the map, on the top. San Bartolomeo, the site of land-based experiments, is marked on the top right; La Palmaria is the larger of the two islands on the left.

As mentioned earlier, G. Marconi was a Navy officer. Figure 8a shows his registry sheet, and Figure 8b shows Marconi himself, wearing his Lieutenant Commander's uniform. The last annotation that can be read on the sheet dates to November, 1, 1901.

3.2 The *Carlo Alberto*

As a follow on to Marconi's first experiments in Italy and Great Britain, the Italian Navy provided the battleship *Carlo Alberto*. This was committed on a diplomatic voyage to St. Petersburg to Marconi as a moving laboratory. Marconi made important long-distance experiments aboard. Some iconographic material was already presented in [6]. Here, new pictures from the Navy archives are shown.

Figure 9 shows the *Carlo Alberto* in Kronstadt harbor (July 1902), where a special telecommunication demonstration was performed from Poole Station (UK) to the *Carlo Alberto*. It was witnessed by the King of Italy and the Tsar of Russia. Figure 10 shows

the *Carlo Alberto*'s journey, from La Spezia, Italy, to Poole, where Marconi boarded, and then to Kronstadt (not explicitly shown on the map: it is very close to St. Petersburg). G. Marconi then continued his journey to Napoli, Italy.

Figure 11 shows blueprints of the *Carlo Alberto*, showing Marconi's antenna. The picture was taken from the *Italian Navy Journal* (October 1902).

Most notable in the *Carlo Alberto* experiments was the introduction of the magnetic detector, and the successful transmission across land. Earlier experiments always took place across the sea. Figure 12 shows a prototype of the magnetic detector used aboard the *Carlo Alberto* and built inside a cigar box. On the lid, there is a written annotation by Marconi to Lieutenant Solari, his coworker. On the lid at the bottom left, the date "Luglio 1902" [July 1902] is clearly readable. Finally, Figure 13 shows a photo of Admiral Carlo Mirabello, commander of the *Carlo Alberto*.

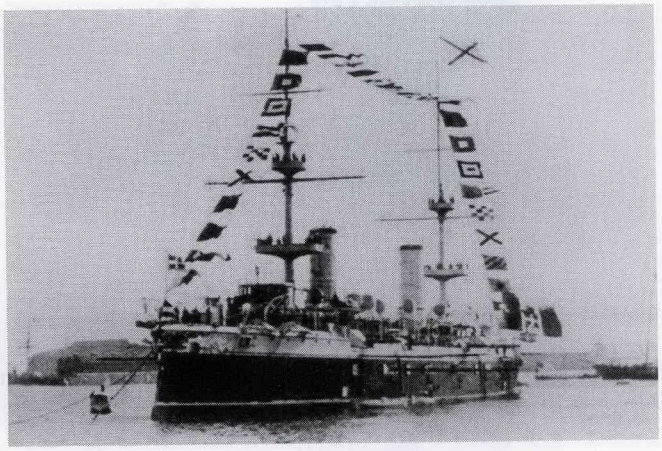

Figure 9. The *Carlo Alberto* in Kronstadt harbor, Russia, July 1902.

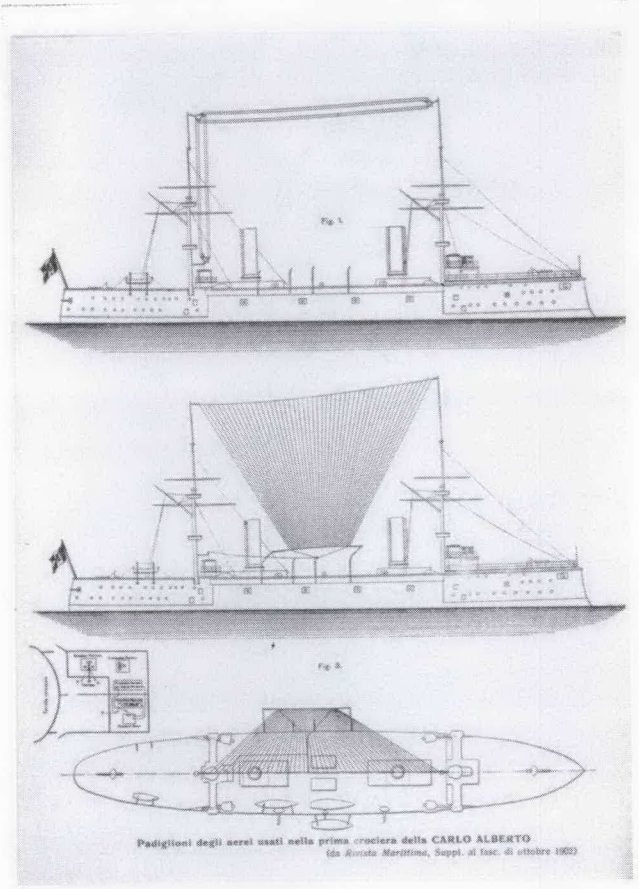

Figure 11. A blueprint of the *Carlo Alberto*, with Marconi's antenna.

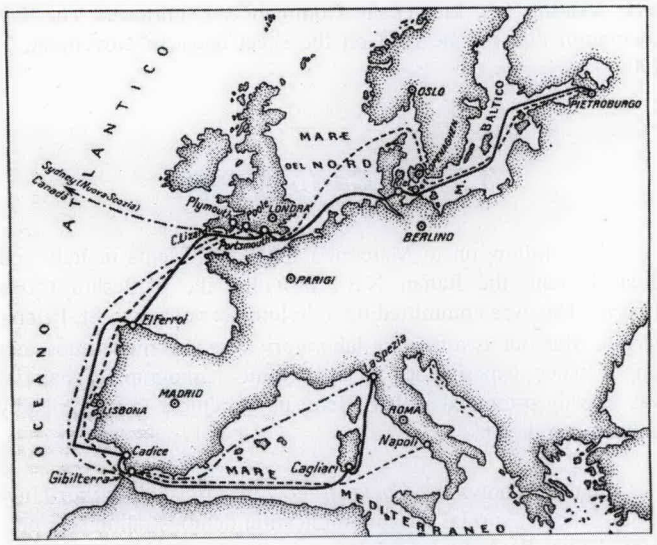

Figure 10. The journey of the *Carlo Alberto*.

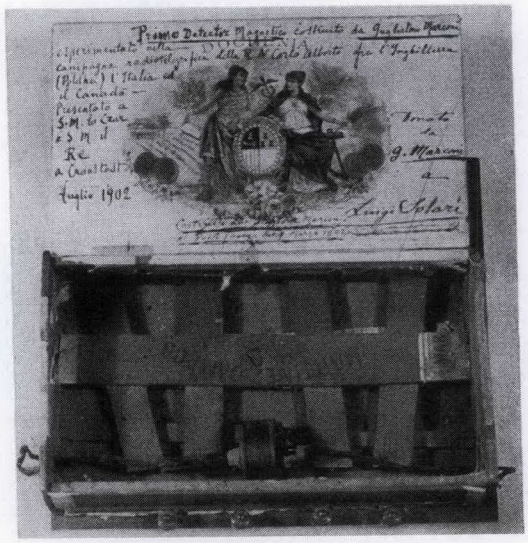

Figure 12. The prototype of the "magnetic detector" used aboard the *Carlo Alberto*.

Figure 13. Admiral Carlo Mirabello (1847-1910), commander of the *Carlo Alberto* during Marconi's experiments.

Figure 14. Admiral and Professor Giancarlo Vallauri (1882-1957), first Director of the IERT.

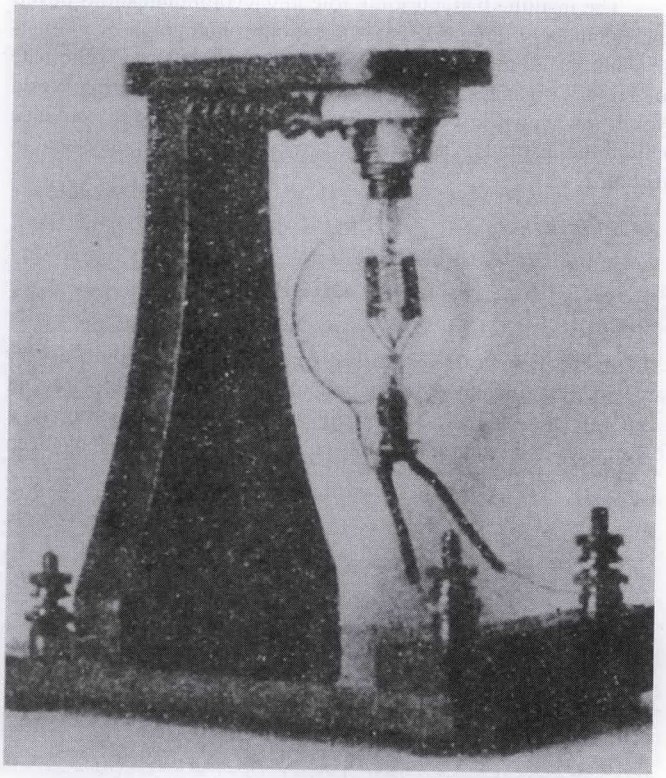

Figure 15. A photo of one of the first vacuum tubes built at the IERT (1916).

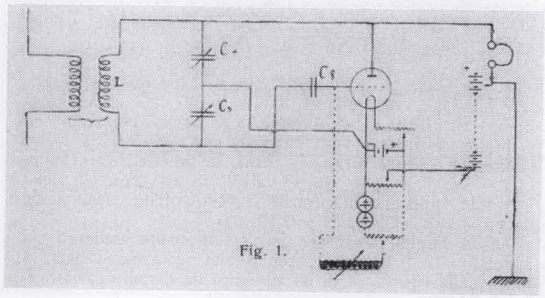

Figure 16. A schematic of one of the first vacuum-tube receivers, from the IERT archives.

3.3 Vacuum Tubes

A very important impulse to the development of radio communications in Italy was again given by the Navy in 1916, when the Electrical Techniques and Telegraphic Institute of the Royal Navy [Istituto Elettrotecnico e Radiotelegrafico della Regia Marina (IERT)] was founded and placed under the direction of G. Vallauri (Figure 14). This institute was the technical electrical and telegraphic institution of the Navy, where the first series production of vacuum tubes in Italy was performed (Figure 15).

Figure 16 shows the very first vacuum-tube receiver. Figure 17 shows the curves characterizing a triode from Vallauri's paper of those years. The equation providing the curves, $\Delta i_a = (1/r_u)(\Delta v_a + \mu \Delta v_g)$ is also known in Italy as the Vallauri equation.

The institute had a leading role in telecommunications development in Italy. Figure 18 shows a group photograph of the participants in the international symposium "Triods Days" [Giornate sui Triodi], organized by the institute in 1924. Later, during World War II (as shown in below in Path 7), radar prototypes were also built at the institute. The institute is now called RIEC, as stated in Section 2.

3.4 Coltano

In the first years of the last century, the Navy built a very large intercontinental radio station in Coltano, between Pisa and Leghorn. The station was also built with Marconi's support, and a few images and blueprints of this communication center have been

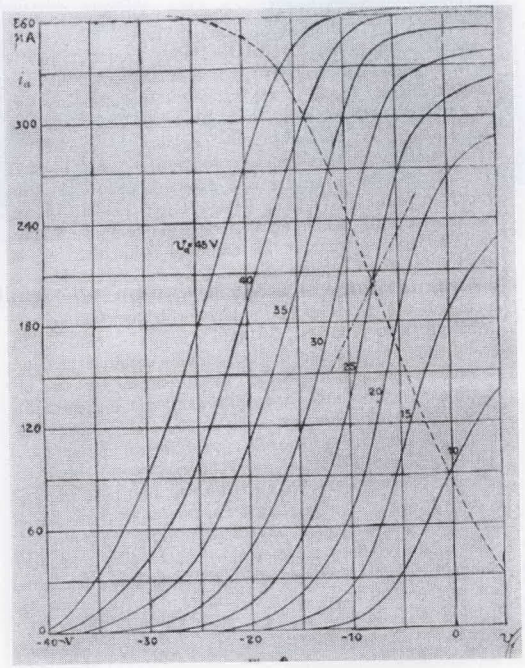

Figure 17. A figure showing the triode's characteristic curves, from the original Vallauri paper.

Figure 18. A group photograph of the participants in the International Symposium "Triods days" [Giornate sui Triodi], organized by the RIEC in 1924 (Vallauri is in the front row, second from the left).

Figure 19a. The relative positions of Coltano and Massawa (Eritrea).

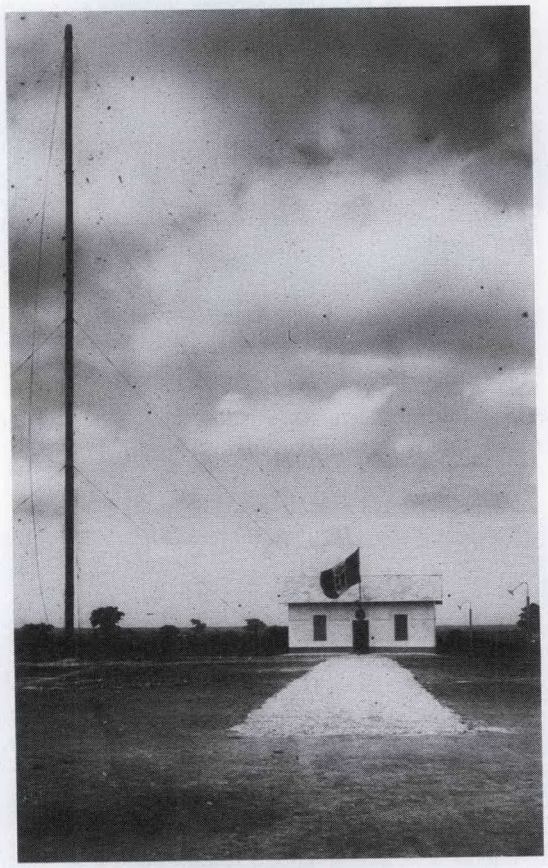

Figure 19b. A receiving station at Afgoi.

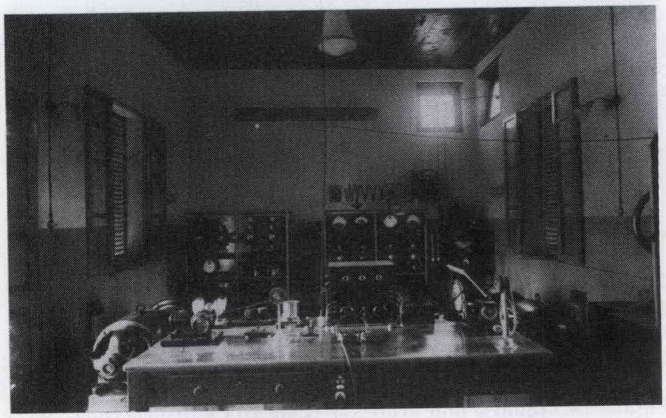

Figure 19c. The inside of the receiving station at Afgoi.

Figure 20a. The location of the Italian base in Tientsin, China (in the center shaded area).

Figure 20b. A square in the shaded area of Figure 20a.

Figure 21. The ship *Conte Rosso* as it left Shanghai harbor, sailing into the China Sea.

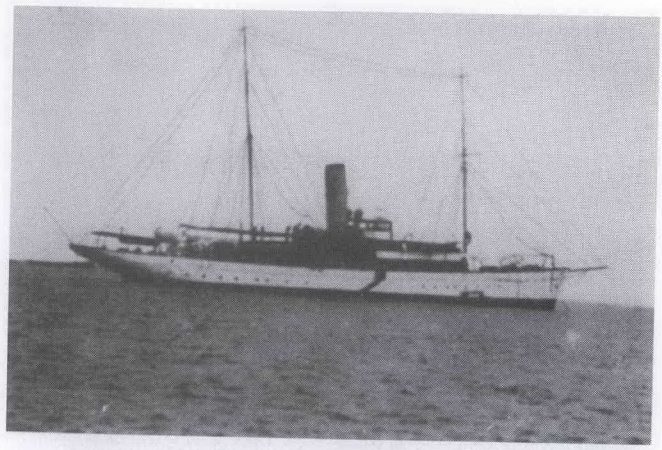

Figure 22. The *Elettra* (67.40 m long, 632.81 tons).

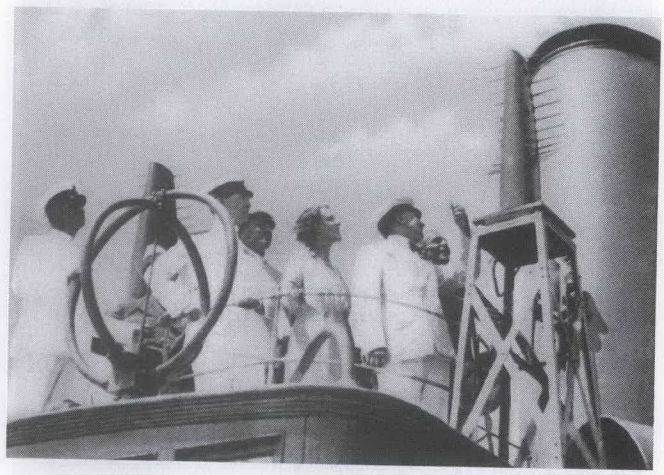

Figure 23. Marconi with his wife and several Navy officers on the deck of the *Elettra* during microwave-link experiments. The parabolic cylindrical reflector can be seen on the right (1930).

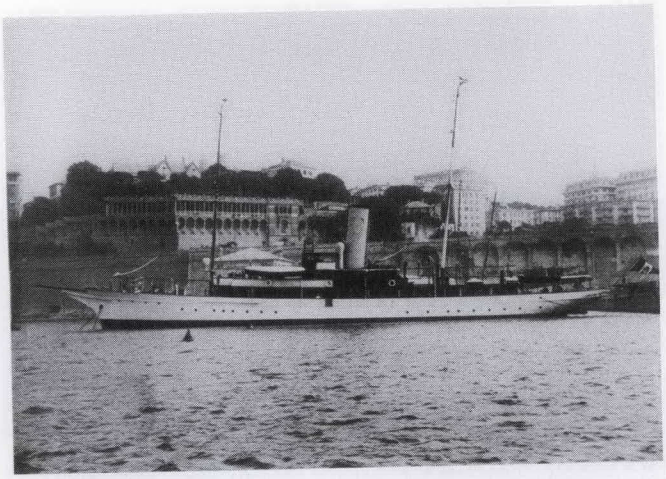

Figure 24a. The *Elettra* anchored in front of the Duca degli Abruzzi harbor, Genova, Italy, March 26, 1930.

Figure 25a. Admiral Alberto Bottini, commander of the Torre Chiaruccia Navy station, where Marconi performed his first experiments on radio detection and ranging (radiotelemetry, as he called it).

Figure 24b. Marconi, on the same day as shown in Figure 24a, ready to switch the button and send a signal to Sidney, Australia, which switched on the town-hall lights in that city.

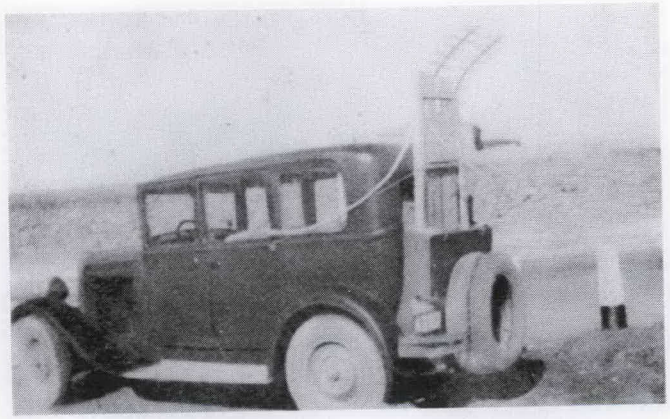

Figure 25b. The car, belonging to Admiral Bottini, on which Marconi mounted a couple of parabolic reflectors to perform ranging experiments. The photos in Figures 25a and 25b were not dated, but should refer to 1930-1935.

recently published [6]. Coltano Station was comparable to Clifden Station, in Ireland, and remained the key Italian long-range station for a long time. In this path, the focus is hence given to Coltano's partners: the stations that received its transmissions.

The chart in Figure 19a shows the relative positions of Coltano and Massawa (Eritrea). Figure 19b shows the receiving station at Afgoi, in the Italian colonies of eastern Africa, with its antenna. The inside of this same station is also shown, in Figure 19c. Afgoi was located near Massaua, Eritrea. The photos are from about 1910. Coltano remained Italy's most powerful station in the twenties and thirties. Since 1932, regular public connections were held with the Italian base in Tientsin, China. The map in Figure 20a shows the Italian area of Tientsin in the shaded area in the center. The photo in Figure 20b (November, 4, 1928) shows a square in that area.

Coltano Station's longest connection was to the ship *Conte Rosso*, shown in Figure 21. Dating back to 1932, the photo shows the ship as it left Shanghai harbor, sailing in the China Sea much further than 10,000 miles from Coltano itself.

3.5 *Elettra*

Marconi owned a sailing ship, the *Elettra*, which he bought in 1920 (Figure 22). On the *Elettra*, he carried out some important experiments in the twenties and thirties. Most notable were his studies on microwaves, made aboard the ship (Figure 23) [7]. In these, Marconi tested microwave links between a land-based transmitting station and his ship, sailing away from the transmitter. The most notable experiment that took place aboard the *Elettra* was probably the link between the ship in the Genova harbor and the Sydney, Australia, City Hall (Figure 24a). It is worth noting the wealth of photographs of the *Elettra* in the Navy archives, due to the strict collaboration with Navy officers (Figure 24b), and their consequent continuous presence aboard.

3.6 Torre Chiaruccia

The Navy base at Torre Chiaruccia, next to Rome, hosted the very first Italian studies on radar systems. Marconi noticed a fluctuation in the received signal over a microwave link between Vatican City, Villa Mondragone, and Castel Gandolfo, while setting up his first land-based microwave link. These fluctuations were correlated by him with the presence of vehicles in the antennas' line of sight. This led Marconi (Figure 25a) to devise the possibility of detecting objects via radio waves [7]. These experiments, held at the Navy laboratories of Torre Chiaruccia, had a large impact on the press, which speculated over "death rays" and rays able to jam engines at a distance (Figure 25b).

3.7 The Italian Radar

Italian radar studies were continued at the Royal Institute for Electrical Techniques and Radiocommunications [*Regio Istituto Elettrotecnico e delle Comunicazioni della Marina* (RIEC)], where prototypes were built (Figures 26 to 29) and mounted on ships (Figure 30) [4]. In these studies, the main contribution was due to the Navy officer (and later on, Professor at the University of Pisa) Ugo Tiberio [8]. The Italian radar prototypes were still in a too-early stage of development during World War II, and did not have the impact on the war that the English radar had.

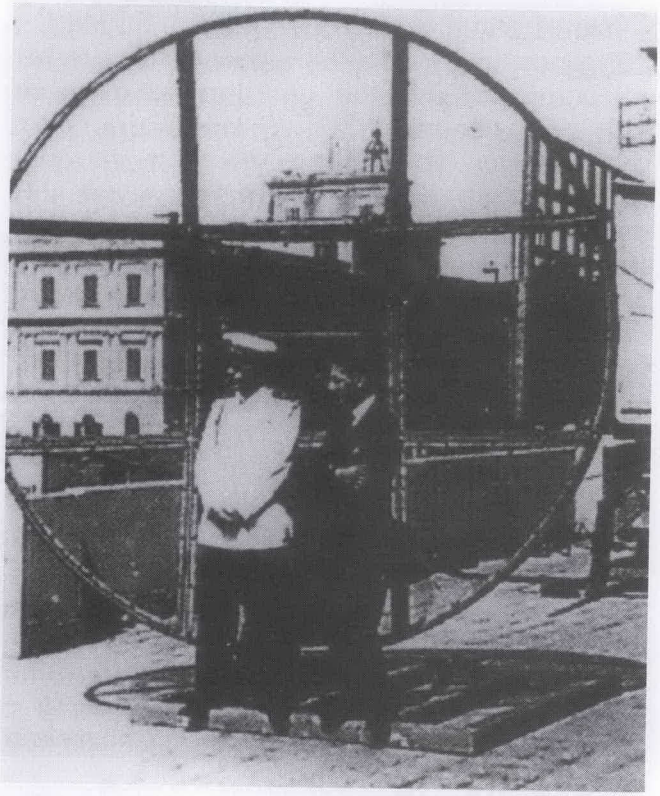

Figure 26. Prototypes of radar antennas on the RIEC roof (about 1936).

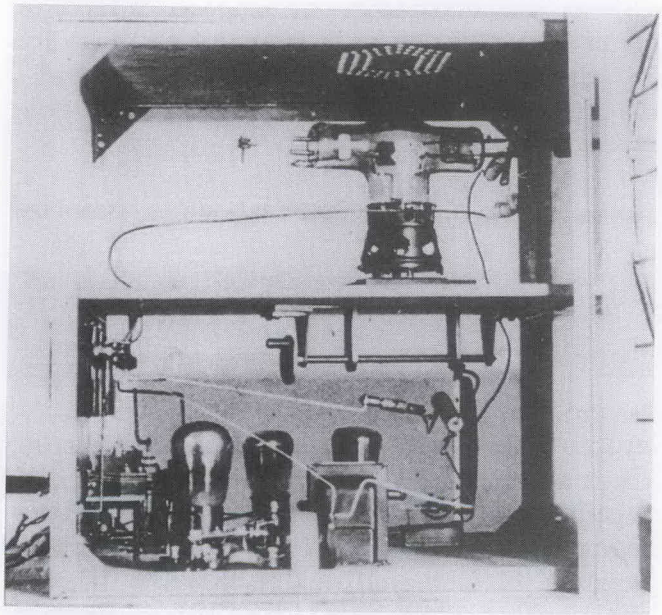

Figure 27. The transmitting-receiving section of the EC2 prototype (1937).

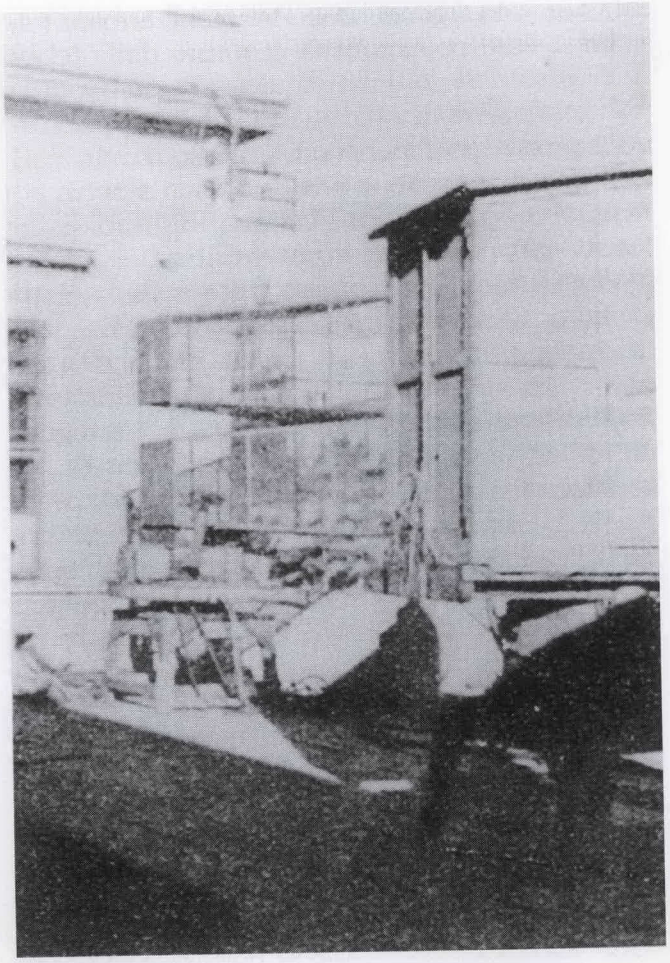

Figure 28. Antennas, in the form of a pair of horns, one transmitting, one receiving, for the EC3 and EC3bis radars. The wavelength was 60 cm (1937).

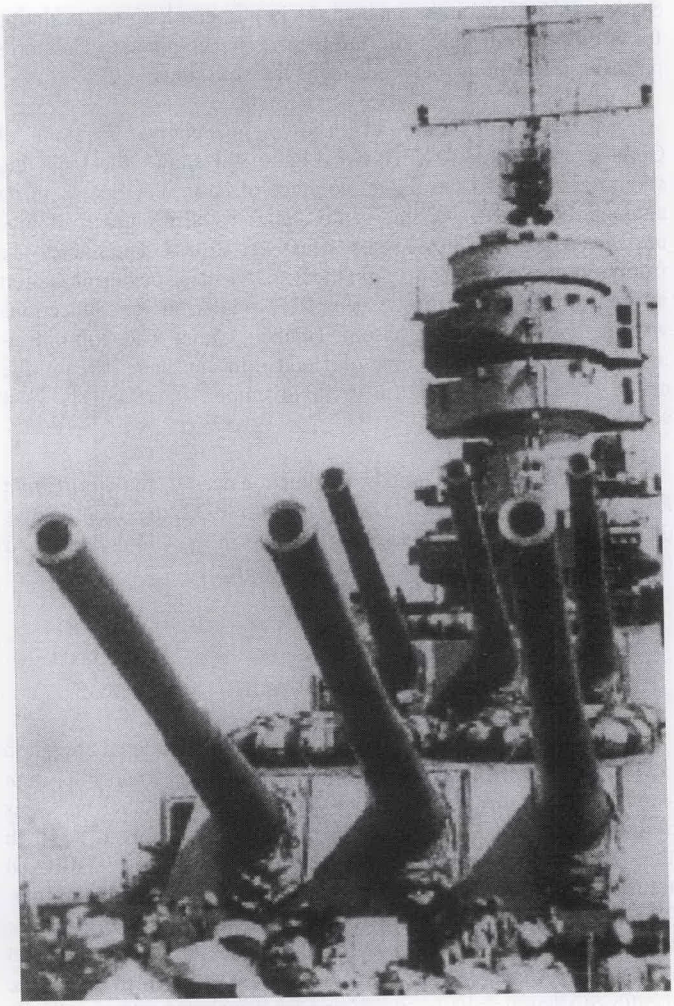

Figure 30. The radar "Howl" [Gufo], among the very first working Italian radars, mounted on the mast of the battleship *Littorio* (1943).

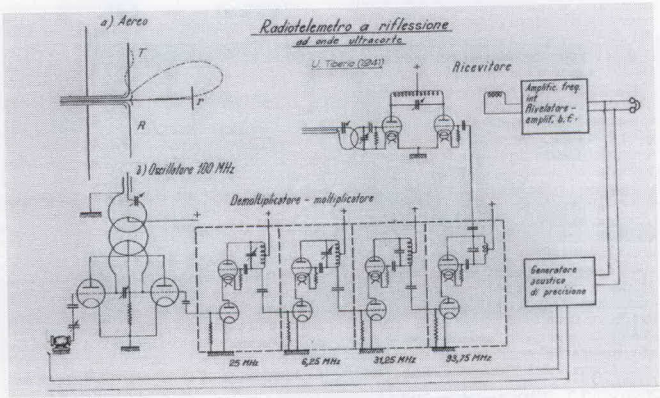

Figure 29. The electrical schematic of the EC3bis radar.

4. Acknowledgments

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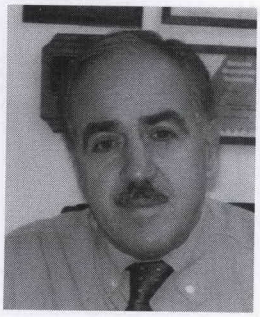
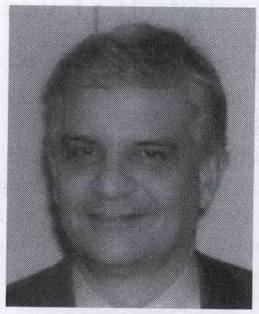
Introducing the Authors

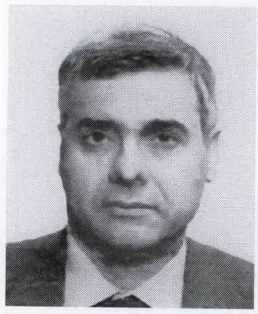


Giovanni Abbatangelo was born in Montichiari (Brescia), Italy, on April 5, 1955. He is a Navy officer, and participated in several Navy operations in the 1970s-1980s. In the 1990s, he was subsequently Head of the 11th Combat System Department in La Spezia, Italy; Head of the Command and Control Department; and Head of the Warfare Systems Department, Rome. He was subsequently Technical Director of the NATO Improvement Link Eleven in Washington (1997) and San Diego (1998-1999). From 2003 to 2006, he was Director of the Istituto Radar e delle Telecomunicazioni della Marina Militare "Giancarlo Vallauri" [Institute for Radar and Telecommunications of the Italian Navy "Giancaro Vallauri"], (MARITELERADAR), Leghorn, Italy. He is currently Head of the Italian Commission ITALSWIP (Software Integration Platform for Combat Management System, "Orizzonte" Class Units) in Rome.

Miranda Cavicchi was born in Leghorn, Italy, on December 17, 1944. He received the laurea (Doctor) degree and the PhD in Nuclear Engineering from the University of Pisa, Italy, in 1970 and 1972, respectively. In 1971, he was with the Department of Defense. He is currently at the Institute for Telecommunications and Electronic "Giancarlo Vallauri," Leghorn, where is Technical Consultant.



Giuliano Manara was born in Florence, Italy, on October 30, 1954. He received the Laurea (Doctor) degree in Electronics Engineering (summa cum laude) from the University of Florence, Italy, in 1979. He was first with the Department of Electronics Engineering, University of Florence, as a Postdoctoral Research Fellow. In 1987, he joined the Department of Information Engineering, University of Pisa, where he is currently a Professor. Since 1980, he has been collaborating with the Department of Electrical Engineering, The Ohio State University, Columbus, where in the summer and fall of 1987 he was involved in research at the ElectroScience Laboratory. His interests have centered mainly on the asymptotic solution of radiation and scattering problems to improve and extend the Uniform Geometrical Theory of Diffraction. He has also been engaged in research on numerical and asymptotic techniques (in both the frequency and time domains), scattering from rough surfaces, frequency-selective surfaces (FSS), and electromagnetic compatibility. Prof. Manara is a member of the IEEE Central and South Italy Section Executive Committee, and Secretary and Treasurer of the Italian Society on Electromagnetics (SIEm).

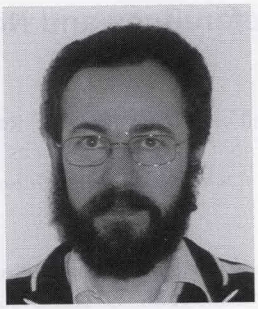


Giuseppe Pelosi was born in Pisa, Italy, on December 25, 1952. He received the Laurea (Doctor) degree in Physics (summa cum laude) from the University of Florence in 1976. Since 1979, he has been with the Department of Electronics and Telecommunications of the same University, where he is currently Professor of Electromagnetic Fields. Prof. Pelosi was a Visiting Scientist at McGill University, Montreal, Quebec (Canada) from 1993 to 1995, and Professor at the University of Nice-Sophie Antipolis (France) in 2001. He is mainly involved in research in the field of numerical and asymptotic techniques for electromagnetic engineering, with particular interest in antennas, circuits, microwave and millimeter-

wave devices, and scattering problems. He is also very active in the study of electromagnetic engineering and telecommunications history.

He is coauthor of over 300 scientific publications on the aforementioned topics, appeared in international referred journals and in national/international conferences. He has been Guest Editor of several special issues of international journals (*IEEE Transactions on Antennas and Propagation*, 2001, with V. Grikunov and J. L. Volakis; *International Journal of Numerical Modelling: Electronic Networks, Devices and Fields*, 2000, with P. Guillon and T. Itoh; *Electromagnetics*, 1998, with J. L. Volakis; *Annales des Telecommunications*, with J. L. Bernard and P. Y. Ufimtsev, 1995; *COMPEL*, 1994, with P. P. Silvester; *COMPEL*, 2002; *Alta Frequenza – Rivista di Elettronica*, 1992. He is also coauthor of three books: *Finite Elements for Wave Electromagnetics* (with P. P. Silvester, IEEE Press, 1994); *Finite Element Software for Microwave Engineering* (with T. Itoh and P. P. Silvester, Wiley, 1996); and *Quick Finite Elements for Electromagnetic Fields* (with R. Coccioli and S. Selleri, Artech House, 1998).

G. Pelosi is a Fellow of the IEEE. He has been a member of the Board of Directors of the Applied Computational Electromagnetics Society (ACES) (1999-2001), the Board of Directors of the IEEE Central and South Italy Section (1992-1995 and 1995-1998), and Chair of the IEEE Magnetics Chapter of the same Section (1996-1999).



Stefano Selleri was born in Viareggio, Italy, on December 9, 1968. He obtained his degree (Laurea), cum laude, in Electronic Engineering, and the PhD in Computer Science and Telecommunications from the University of Florence in 1992 and 1997, respectively. In 1992, he was a Visiting Scholar at the University of Michigan, Ann Arbor, MI; in 1994, at McGill University, Montreal, Canada; and in 1997, at the Laboratoire d'Electronique of the University of Nice – Sophia Antipolis. From February to July, 1998, he was a Research Engineer at the Centre National d'Etudes Telecommunications (CNET) France Telecom. He is currently an Assistant Professor at the University of Florence, where he conducts research on numerical modeling of microwave devices and circuits, with particular attention to numerical optimization.