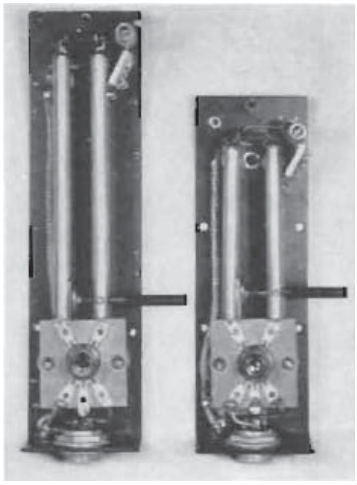
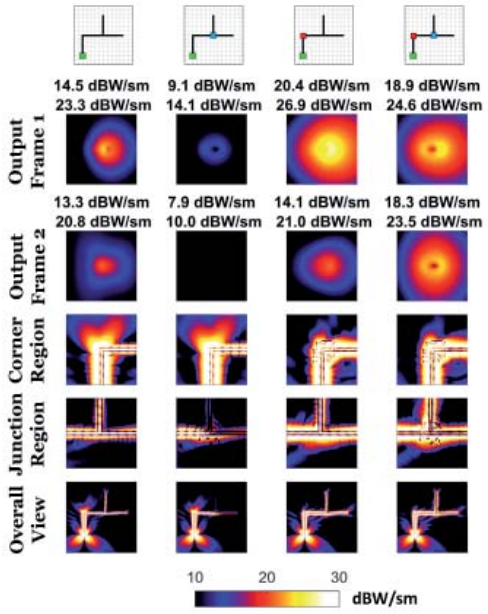
Radio Science Bulletin

ISSN 1024-4530

INTERNATIONAL
UNION OF
RADIO SCIENCE

UNION
RADIO-SCIENTIFIQUE
INTERNATIONALE





Vol. 2018, No. 369
June 2019

URSI, c/o Ghent University (INTEC)
Technologiepark - Zwijnaarde 126, B-9052 Gent (Belgium)

Contents

Cover: (upper figure) Lecher lines for UHF from 1938. Both were one-eighth-wavelength long. (l) A 200 MHz (19 cm) line; (r) a 300 MHz (12.5 cm) line (public domain). See the historical paper by Stefano Maddio and Stefano Selleri. (lower figure) The power density (dBW/sm) in different frames and regions for a nano-link system and its variations. The mean and maximum power-density values in the output frames are also provided. See the paper in the Solution Box column by Aşkın Altınoklu and Özgür Ergül.

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Almost anyone who has worked with analog UHF or higher-frequency circuits has used a version of the Lecher line: a resonant-stub two-wire balanced transmission line. Such lines are used for demonstrating standing waves, measuring the wavelength of the electromagnetic waves on the transmission line, and for tuning circuits attached to the transmission line. In the Historical Corner, Guiseppe Pelosi has brought us a paper by Stefano Maddio and Stefano Selleri on Ernst Lecher and his major contributions to electromagnetics. It traces the invention, development, and use of Lecher lines. It is both fascinating reading, and is illustrated with wonderful original figures, as well.

In his Solution Box column, Özgür Ergül brings us a paper that revisits a type of problem first introduced in the September 2017 issue of the *Radio Science Bulletin*. This deals with nano-link systems involving different arrangements of nanowires and nano-couplers. The nano-couplers were optimized using arrangements of nano-cubes, computed with the use of genetic algorithms and the Multilevel Fast Multipole Algorithm. The problems examined in the current paper analyzed the electromagnetic responses of five different such systems in operation, observing the power-transmission performance. Typical dimensions were 90 nm, the nano-cubes were made of Ag, and a frequency of 250 THz was used. The computational challenges were significant, and the physics and electromagnetics illustrated by the results are fascinating.

Our Other Contributions

Be sure to take a look at the Et Cetera column. I think you will definitely enjoy Tayfun Akgül's perspective on a couple of current topics in radio science.

In his ECR column, Stefan Wijnholds presents a report on the Young Scientists Awards and Student Paper Competition from the URSI AP-RASC2019 (Asia-Pacific Radio Science Conference). This was a great success, with a large number of participants in both activities.

Mahmoud T. El-Hadidi and Elsayed M. Saad have provided us with a nice report on the 2019 Egyptian National Radio Science Conference. It is clear this was a most interesting meeting.

In their Ethically Speaking column, Randy Haupt and Amy Shockley deal with "whataboutery." You will need to read the column to understand what whataboutery is about. I urge you to do so.

The call for the URSI Young Scientist Awards to assist Young Scientists in attending the 2020 URSI General Assembly and Scientific Symposium (GASS) in Rome, Italy, appears in this issue. If you are going to be less than 35 years old on September 1, 2020, I urge you to consider applying for this award. While it is a financial help (available to those both from developing and developed countries), it is also a substantial scientific recognition. Many of our most distinguished radio scientists began as URSI Young Scientist Awardees.

The GASS2020 Web Site is Open!

The Web site for the URSI GASS2020 is now open at www.ursi2020.org. The GASS2020 will be held August 29 - September 5, 2020, at the Sapienza University campus, Rome, Italy. Session, workshop, and short course proposals are due by August 31, 2019. Paper submission will start October 15, 2019, and the final submission deadline is January 31, 2020. There is a tremendous amount of information already available on the Web site: I urge you to visit it, and start making plans to attend now!

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Foreword

This issue presents a paper by Stefano Maddio and Stefano Selleri, both of the University of Florence, on Ernst Lecher (Vienna, Austria, June 1, 1856 – Vienna, Austria, July 19, 1926; Figure 1) and his main contribution to electromagnetism. This was the technique for measuring and hence fixing the wavelength of an oscillator. He used a spark generator in the beginning, but soon *Lecher lines*, so named in his honor, were used to tune audion-based oscillators, such as the one shown in Figure 1. Indeed, Lecher lines were the key tuning mechanism in UHF for decades. They could be found in every house in the tuner section of the TV sets up to the 1970s and beyond. Lecher lines are also still effectively used as an educational tool.

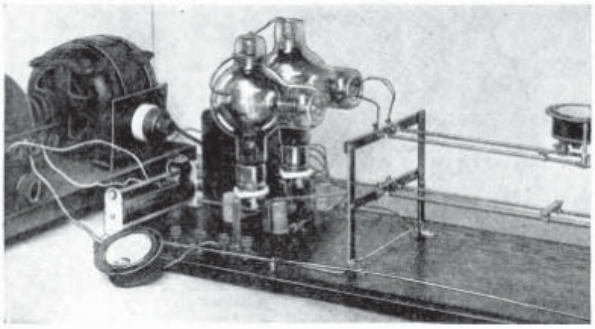

Figure 1. An experimental UHF radio transmitter using two type 932 tubes in a push-pull Barkhausen-Kurz oscillator (1933).

As a curiosity, Ernst Lecher was one of seven sons. Among his siblings, one of his sisters, Emma, is worth mentioning. Emma Lecher married Adolf Lorenz, and the two were parents to Konrad Lorenz (Vienna, Austria, November 7, 1903 – Vienna, Austria, February 27, 1989; Figure 2). The renowned ethologist, zoologist, and ornithologist, Nobel Prize for Physiology and Medicine in 1973, was hence Ernst Lecher's nephew. Konrad Lorentz is famous worldwide, and one of his books, *King Solomon's Ring* (1849), is also so pleasant to read for non-ethologists that it has been translated into many languages and is still reprinted, often with Figure 2 or a similar picture on its cover.

Figure 2. One of the most famous pictures of Konrad Lorenz, swimming with his ducks.

Ernst Lecher and His Wires

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Abstract

This paper focuses on Ernst Lecher, Austrian physicist, who studied guided electromagnetic propagation on two parallel wires, with the aim of measuring the relative wavelength. He perfected this device up to the point that "Lecher lines" become a synonym for a two-wire transmission line. His findings were used throughout all of the XXth century to tune UHF receivers, and are still used as an educational tool.

1. Life

Ernst Lecher (Vienna, Austria, June 1, 1856 -Vienna, Austria, July 19, 1926; Figure 1) was an Austrian physicist. He was the son of Zacharias Konrad Lecher (Dornbirn, Austria, December 12, 1829 – Vienna, Austria, April 28, 1905), a writer and a journalist, Chief Editor of the Wiener Zeitung Neue Freie Presse. Ernst was one of the seven children of Zacharias; among the others, the most notable were Otto and Emma.

Otto Lecher (Vienna, Austria, January 6, 1861 – Leopoldsdorf, Austria, January 20, 1939), was a lawyer, and Secretary of the Chamber of Commerce in Brno (Czech Republic). At the end of World War I, Otto Lecher was a Member of the *Provisional Nationalversammlung* (National Assembly), which established the Republic of Austria, serving from October 21, 1918 to February 16, 1919.

Emma Lecher married Adolf Lorenz (Weidenau, Czech Republic, April 21, 1854 – Altenberg, near Vienna, Austria, February 12, 1946), an orthopedic surgeon remembered for his work with bone deformities. He was known for treating patients without cutting into skin or tissue, which earned him the title of "The Bloodless Surgeon of Vienna." He was renowned for his treatment of congenital dislocation of the hip in children. He created a manipulative treatment for clubfoot and, through the use of traction and pulleys, he developed a mechanism for the treatment of scoliosis. Emma and Adolph Lorenz were parents to Konrad Lorenz (Vienna, Austria, November 7, 1903 – Vienna, Austria, February 27, 1989), the founder of modern ethology, who received the Nobel Prize for Physiology and Medicine in 1973.

Ernst Lecher (Figure 1) attended the *Akademischen Gymnasiums* (high school) in Vienna, and later studied physics at the University of Vienna. He obtained the PhD in 1879 at Innsbruck University. He married Helene von Rosthorn (Vienna, Austria, September 8, 1865 – Vienna, Austria, October 2, 1929). Helene was herself quite famous for her great services in nursing during the First World War, where she applied her knowledge of nutrition, leading the diet kitchen of the war hospital of the American Red Cross in Vienna-Meidling. Another such dietary kitchen was set up at the War-Barackenspital in Grinzing, which was headed by physiologist Arnold Durig (Innsbruck, Austria, November 12, 1872 – Schruns, Austria, October 18, 1961). This war hospital had 6,000 beds. Many of the patients suffered from dysentery. After the dissolution of the war hospital in 1919, she led two private barracks as a day care center for children at risk of poor health. She was acquainted with Hermine Wittgenstein (Teplice, Czech Republic, December 1, 1874 – Vienna, Austria, February 11, 1950), who ran a similar center for children, and who was sister to the philosopher Ludwing Wittgenstein (Vienna, Austria, April 26, 1889 – Cambridge, UK, April 29 1951), a philosopher much appreciated by one of the authors [1].

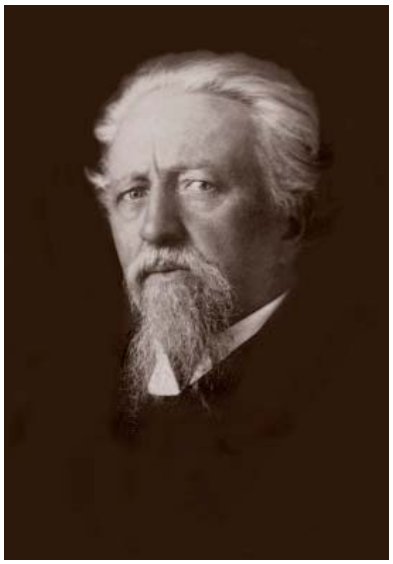

Figure 1. A photo of Ernst Lecher in 1919, by an unknown photographer (public domain).

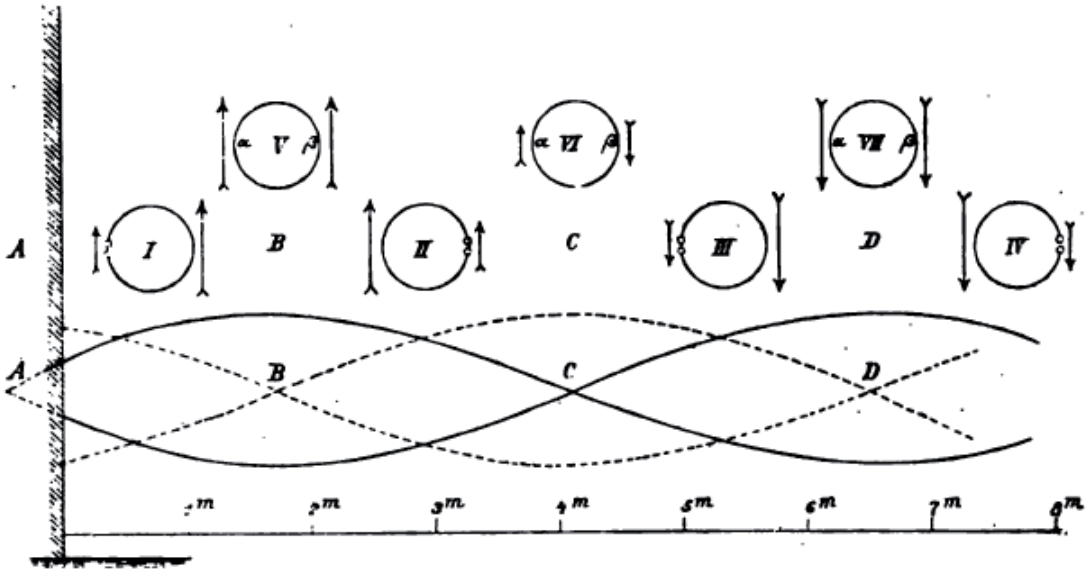

Figure 2. A figure from Hertz's 1888 paper [2], showing standing waves and the spark loop he used to find nodes (copyright expired).

Ernst Lecher become *Privatdozent* in Physics and went back to Vienna in 1882, where he become an assistant at the Department of Physics of the University, and gained the habilitation for Experimental Physics. He was back in Innsbruck as a Professor from 1891 to 1895. He then took the Chair of Experimental Physics in Prague of Ernst Mach (Brno, Czech Republic, February 18, 1838 – Munich, Germany, February 19, 1916), pioneer of supersonic fluid mechanics as well as a philosopher and physiologist. In 1892, Ernst Lecher was elected a member of the *Deutsche Akademie der Naturforscher Leopoldina – Nationale Akademie der Wissenschaften*, the German Academy of Sciences.

Lecher was back in Vienna in 1909. In recognition of his research results, the University of Lech in Vienna appointed him head of the first Physics Institute in 1909, and the Vienna Academy of Sciences accepted him in 1914 as a member.

In October 1925, a serious illness forced him to retire. Lecher died in Vienna half a year later. He rests in an honorary grave in the Döblingermonumental cemetery in Vienna. In Vienna, there is a street named after him, *Lecherweg*, parallel to the street *Marconiweg*, dedicated to Guglielmo Marconi (Bologna, Italy, April 25, 1874 - Rome, Italy, July 20, 1937). Both streets cross Oppenheimweg, dedicated to Samuel Oppenheim, astronomer (Braunsberg, Czech Republic, November 19, 1857 - Vienna, Austria, August 15, 1928).

However, we shall go back later to Lecher's connection with Marconi, writing about Lecher's wires.

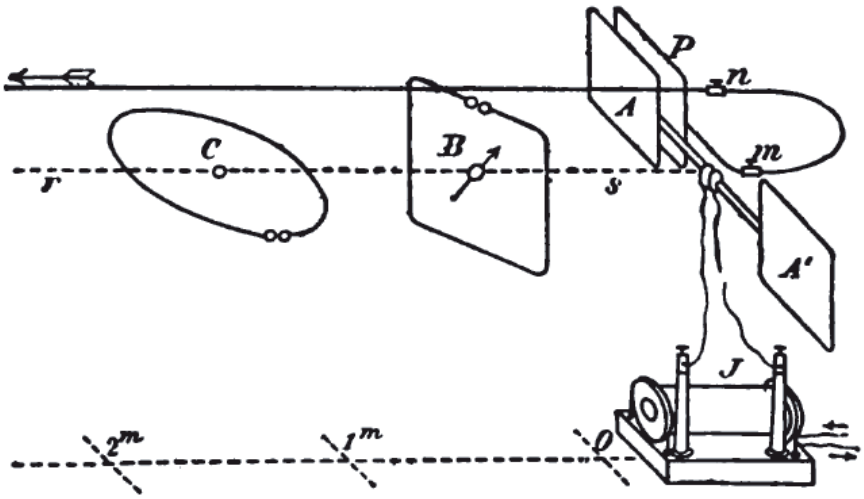

Figure 3. Hertz's 1888 apparatus [4] as it appeared in the 1893 English translation of his book [5] (copyright expired).

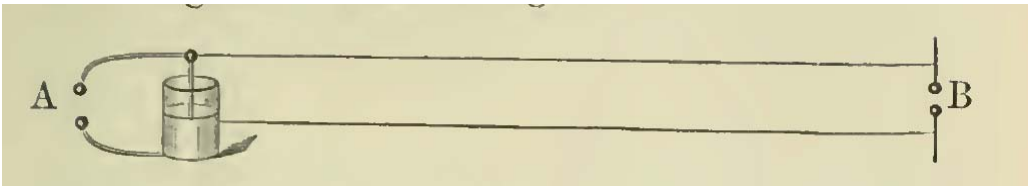

Figure 4. A figure from Lodge's 1888 paper [6] showing an apparatus for producing standing waves along a line (copyright expired).

2. Two Wires to Measure a Wave (and Its Speed)

A Lecher line is a pair of parallel wires or rods used to measure the wavelength of radio waves, mainly in the range of meters to centimeters (UHF to microwave frequencies). These are also called Lecher wires. In modern terminology, they are a resonant stub of a balanced transmission line. When connected to a source of radio-frequency power, a standing wave forms along the length of the wires.

By sliding a bar bridging the two wires along their length with some sort of voltage meter on the bar, the length of the waves can be physically measured by finding the standing wave nodes.

Heinrich Hertz was certainly the first to use standing waves to measure wavelength. Indeed, he demonstrated the existence of standing waves (Figure 2), and hence of electromagnetic waves, in his fundamental 1888 paper [2]. A recent paper in English clearly shows this experiment in modern terms [3].

Hertz also studied conducted waves [4, 5], but his apparatus was unbalanced (Figure 4) and meant to devise a difference in propagation velocity between the free-space wave and the wire-bound wave. Curiously enough, Hertz declared to have found such a difference, stating that the free-space and conducted propagation velocities were in a ratio of 45:28 [5, p. 108]. Of course, this is false, and was probably due to the very low sensitivity of Hertz's spark detectors.

Oliver Lodge (Penkhull, UK, June 12, 1851 – Wilsford, UK, August 22, 1950) was indeed probably the first to use parallel lines for this task. He published an early paper in that same 1888 (manuscript July 7, published in [6]), acknowledging in an end note to the paper (added July 24, while Lodge was in Tyrol at Cortina d'Ampezzo, now in Italy) that Hertz had made the same discovery earlier and for aether, not conducted, waves.

Figure 4 shows Lodge's apparatus. It was rather primeval: electromagnetic waves were powered by the discharge of a Leyden jar, with its capacity – thanks to a spark gap in a coil – providing an inductive behavior. The frequency was determined by their resonance. A second spark could be observed in B, much stronger if wires were a half-wavelength or multiples thereof. Of course, this was quite impractical for what concerned tuning, and poor in sensitivity

Swiss researchers Edouard Sarasin (Geneva, Switzerland, Grand-Saconnex, Switzerland, May 20, 1843 – July 22, 1917) and Lucien de la Rive (Choulex, Switzerland, April 3, 1834 – Geneva, Switzerland, May 4, 1924) also used a balanced line [7], with spark detectors similar to Hertz's (Figure 5).

Ernst Lecher made a fundamental step forward. He started from a setup similar to that used by Sarasin and de la Rive [7], providing a very detailed description of the apparatus [8] (Figure 6):

> A and A′ are square sheet metal plates with 40 cm sides; they are connected by means of a 100 cm long wire segment, which is cut in the middle and at F two brass balls of 3 cm in diameter are added (in Figure 1, only the cross-section of the square plates is drawn). The two brass balls are at a distance of 0.75 cm from each other and are connected using thin

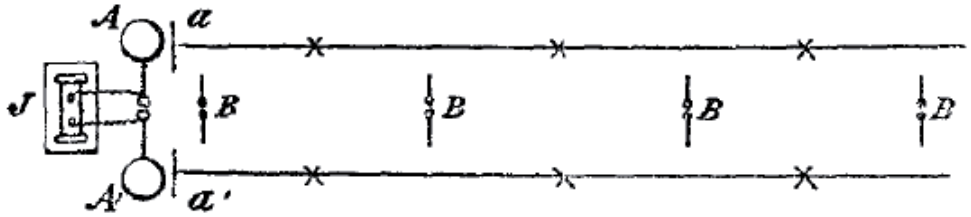

Figure 5. A figure from Sarasin's and De la Rive's 1890 paper [7], showing an apparatus for producing standing waves along a line (copyright expired).

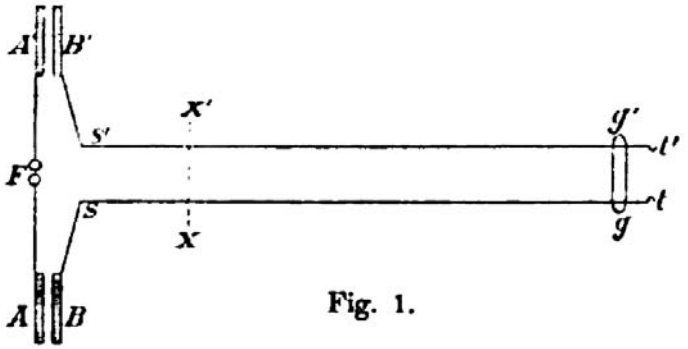

Fig. 1.

Figure 6. A figure from Lecher's 1890 paper [8] (copyright expired).

wires to the poles of a very strong inductor, whose coil has a length of 35 cm and a diameter of 18 cm; the inductor is fed by four powerful accumulators [batteries], and in some cases by a dynamo.

A Foucault mercury interrupter serves as electric break. Across from the plates A and A′ are two plates B and B′ of identical size at a distance of around 4 cm. From these plates B, B′ run two wires against s and s′ and from there parallel until t and t′. The distance between the parallel wires (s to s′) is 10-50 cm; the length st (s′t′), on the other hand, should be at least 400 cm. The diameter of these parallel wires is here and for all experiments in this publication 1 mm. For this first experiment we assume the length to be about 600 cm (drawn too short in the figure), and the distance of the parallel wires from each other 30 cm.

At the end of the parallel wires (t and t′) a cord is connected to each, which extends the length of the wires by about 100 cm, and allows for a gentle and comfortable tensioning thereof.

The paper by Lecher was dated 1890, in the last issue of the *Annalen* for that year. In its introduction, there are a few lines possibly referring to an oral presentation in April 1890 to the Academy of Science in Vienna. Lecher explicitly cited [7]. However, many references – for example [9, p. 265] – give the incorrect date of 1888 for the Lecher paper. Wikipedia [10], follows [9] in this mistake.

However, what differs from previous work is the method of detecting nodes and antinodes in the wires:

Over the wire ends t and t′ I now lay an exhausted glass tube without electrodes g g′, ideally filled with nitrogen and a trace of turpentine vapor; this glass tube starts to light up due to the electrical vibrations in the wires.

Now, while the tube is shining brightly, place a crossbar over the parallel wires, so it will connect them together metallically (the direction of the wire hanger is perpendicular to the wires and through the dotted line x x′ shown in Figure 1); then the light of the tube disappears for the moment. Now move the crossbar xx′ along the wires, until one arrives at a certain, strangely sharply defined place, where the tube suddenly lights up again. The search for these places and the circumstances surrounding their position constitute the main content of this work.

This is the key point. Previous researchers were seeking for maximums or zeros in the standing wave via a low-sensitivity spark-gap on a wire with arbitrary length, hence providing a reactive impedance to the oscillating circuit difficult to know *a priori* (at least in those early days). By placing a short in xx′, Lecher effectively created a resonator extending from ss′ to xx′. This loaded the oscillating circuit in a much more efficient manner (Lecher stated that he could hear the difference in the spark crackling [8, p. 853]). The key proof was in Figure 3 of Lecher's paper [8] (Figure 6, here).

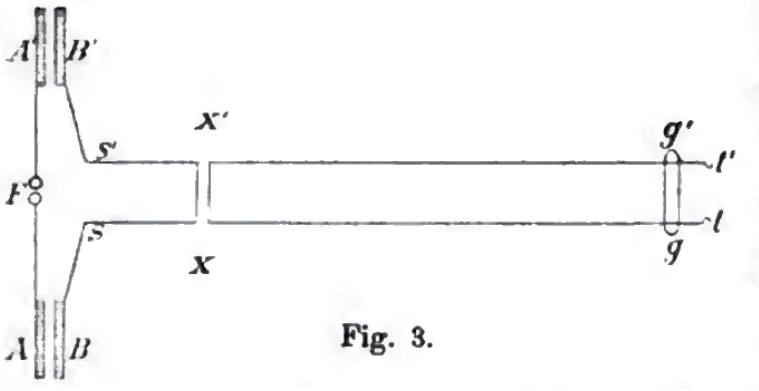

Fig. 3.

Figure 7. A figure from Lecher's 1890 paper [8], showing the apparatus with disconnected wires (copyright expired).

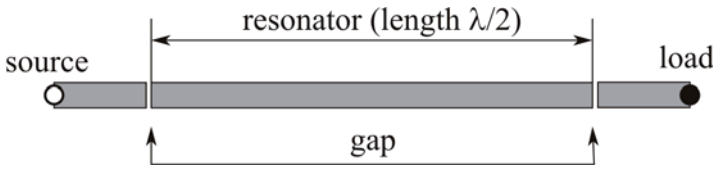

Figure 8. The simplest microstrip gap-coupled bandpass filter.

Lecher placed two isolated shorts across xx′ and then cut the wires in between. This produced a short-circuit stub loading the oscillator, and a disconnected line shortened at one end and loaded by the tube at the other. The tube still shed light. If a further short was placed across the wire between xx′ and the tube, then the tube turned off unless such a short was again in a very precise position. What Lecher was creating was analogous to a microstrip bandpass filter with just one resonator (Figure 8). The resonant part, a half-wavelength long, was determined by the two shorts and, at the resonance, the signal passed up to the glowing tube.

In his paper, Lecher also noted that the length of the resonant part delimited by the two shorts was also somewhat dependent on its absolute position along the line. He correctly commented that this was due to the load of the line sections on the left and the right of the resonator, which were themselves length-dependent.

In the last part of the paper, Lecher evaluated the speed of the signal along the wires. The setup was that reported in Figure 9. The left part was unchanged from the previous experiment. At the right end, a capacitor was added, and the glowing tube was placed on it. Shorts were placed in dd′ and cc′ so as to have a nice bright response from the tube.

Lecher measured a half wavelength of 982 cm as an average over 20 repetitions of the experiment. However, the frequency of the oscillation was determined by the *LC* circuit at the far right, comprised of an (inductive) wire loop and the capacitor. This circuit was estimated by Lecher computing the inductance via the Neumann formula [11, 12],

$$L = 2l\left[\ln\left(\frac{4l}{d}\right) - 0.75\right], \tag{1}$$

and the capacitance via its simplified formula,

$$C = \frac{R^2}{4\delta}. \tag{2}$$

The corrective term due to fringing fields was neglected; it was already known (Kirchhoff [3]) on the basis of some considerations of the dimensions of the disk and of the point where the wires were connected.

With his geometrical parameters (the length of the wire in the secondary oscillator, $l = 303.2$ cm; the wire diameter, $d = 0.1$ cm; the radius of the capacitor plates, $R = 8.96$ cm; and the distance between the plates, $\delta = 0.99$ cm, Lecher obtained

$$L = 5248 \text{ cm}, \tag{3}$$

$$C = 20 \text{ cm}.$$

Yes, inductances and capacitances are in centimeters. This is due to the odd system of units used in Lecher's times, the *electrostatic system of units*. The interested reader might refer to [14] for further details. Due to this choice, Lecher also wrote

$$T = \frac{\pi\sqrt{LC}}{c}, \tag{4}$$

with *T* being the oscillation period and *c* being the speed of light in a vacuum, a universal constant quantity that appears as a scale factor between the *electrostatic* and *electromagnetic* systems of units [14]. From Equation (4),

$$\lambda = Tc = \pi\sqrt{LC} = 1017 \text{ cm}$$

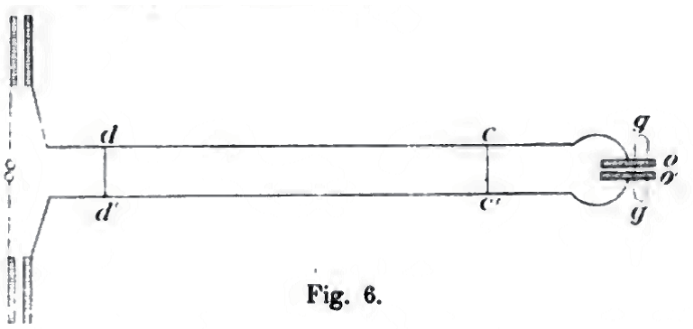

Figure 9. The Lecher apparatus modified to measure the speed of propagation, from Lecher's 1890 paper [8] (copyright expired).

Figure 10. A photo of Prosper-René Blondlot by an unknown photographer (public domain).

can immediately be obtained. The free-space wavelength and the wavelength on Lecher's wires were hence the same (within a 3.5% error that Lecher reasonably neglected and ascribed to the very delicate measurement setup). Since the period was necessarily the same and the wavelength was the same, Lecher correctly derived that also the speed of propagation was the same for both free-space and conducted waves.

Indeed, it was possible that Lecher somewhat got the result he was expecting. The formula to determine the inductance, Equation (1), is too approximate, since it is for a straight wire and not a loop. For the capacitor, he neglected fringing, and hence took a smaller value. However, the key point was the length of the wire in the rightmost part of the circuit. A subsequent investigation [15] showed that it was too long with respect to wavelength to assume that Equation (1) was valid, which was derived based on the hypothesis of a constant current along the wire. As a result, Lecher's results were obtained by chance.

Soon after Lecher, Prosper-René Blondlot (Nancy, France, July 3, 1849 – Nancy, France, November 24, 1930; Figure 10) published a more-accurate experiment [16] with several different lengths for the secondary circuit, obtaining reliable values ranging from 291400 to 304100 km/s^2. Blondlot is actually more (in)famous for his "discovery" in 1903 of the non-existent N-rays [17]. This was a case unequalled in the number of scientists involved and the number of papers published by qualified scientists of high reputation belonging to the community of scholars. Some 120 scientists published almost 300 articles on the topic

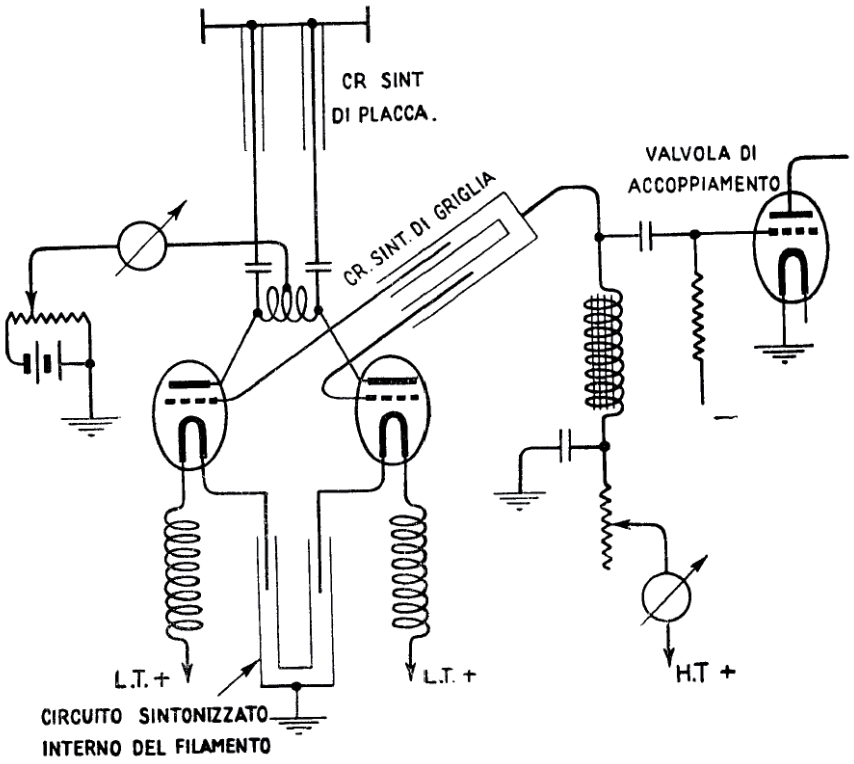

Figure 11. A receiver by G. Marconi (about 1931), with three Lecher lines of adjustable length for syntonization: on the anode (*placca*), on the grid (*griglia*), and on the cathode (*filamento*) (public domain).

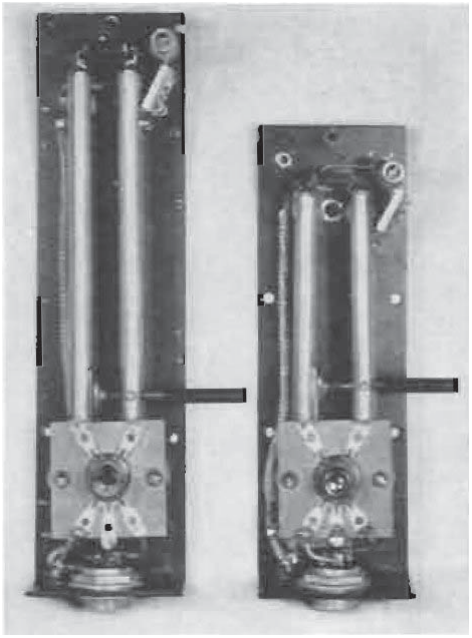

Figure 12. Lecher lines for UHF (1938). Both were one-eighth-wavelength long. (l) A 200 MHz (19 cm) line; (r) a 300 MHz (12.5 cm) line (public domain).

during the years 1903-1906. Blondlot himself published 26 articles and a book [18] before stopping, all of them on "rays" that had never been observed. Indeed, this was a paradigmatic case on the dangers of error introduced by experimenter bias [19].

3. Later, Widespread Use

Since the time described above, Lecher lines have become synonymous with two-wire transmission lines, especially if used to determine wavelength rather than as a transmission line. This remained the main instrument for determining the frequency of an oscillator up to the advent of frequency counters, just after World War II.

Indeed, when, later in his life, Guglielmo Marconi (Bologna, Italy, April 25, 1874 – Rome, Italy, July 20, 1937) started to investigate high-frequency radio communications he used Lecher lines, also in a tunable-length version, to fix the frequency of his valve oscillators [20] (Figure 11). In addition, Nello Carrara, who minted the word "Microwaves," used Lecher lines to generate them [21]. Figure 12 shows a later (1938) pair of Lecher lines used to tune a UHF receiver at 200 MHz and 300 MHz. They are used at frequencies between HF/VHF and UHF/SHF. At lower frequencies, lumped components can be used, and at higher frequencies, resonant cavities are more practical. In particular, they were used in TV tuners up to the advent of digital electronics (Figure 13).

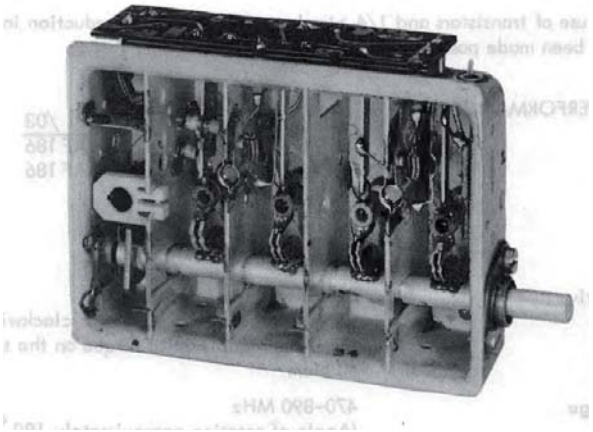

Figure 13. A 1969 UHF TV tuner (Philips Model AT6381/01). Four Lecher lines, vertically placed and loaded with variable capacitors for tuning, are visible in the four rightmost compartments (from [22]).

Lecher lines are often cited in the later literature as the easiest way to set the frequency of an oscillator, and in particular, for educational purposes [23-26].

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XXXIII General Assembly and Scientific Symposium of the International Union of Radio Science

Union Radio Scientifique Internationale

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Preliminary Call for Papers and Sessions

The **XXXIII General Assembly and Scientific Symposium** (GASS) of the International Union of Radio Science (URSI, www.ursi.org) will take place in Rome, Italy from August 29 to September 5, 2020. The scientific programme will be organized around the ten URSI Commissions (see below) and will comprise oral sessions, poster sessions, plenary and public lectures, and tutorials, with both invited and contributed papers. In addition, there will be **workshops, short courses, special programmes for young scientists, a student paper competition, programmes for accompanying persons, and an industrial exhibition**. More than 1,500 scientists from more than 50 countries are expected to participate.

Scientists and researchers are invited to submit papers **as well as proposals for sessions** (that may include both invited and contributed papers), workshops and short courses. Detailed information will be posted on the GASS 2020 web site.
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Workshops are expected to promote interactive exchanges, with enhanced organization flexibility.

Paper Submission

All papers should be submitted electronically via the link provided on the GASS 2020 web site, to be checked prior to submission regarding latest instructions, templates, and sample formats. Accepted papers presented at the GASS 2020 may be submitted for posting on IEEE Xplore, if the author chooses so.

Important Deadlines:

Session, workshop and short course proposals: **August 31, 2019**
Paper submission opening: **October 15, 2019**
Paper submission closing: **January 31, 2020**
Notification of acceptance: **March 15, 2020**

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The application needs to be done electronically by going to the same Web site used for the submission of abstracts/papers via http://www.ursi2020.org/. After entering the author and submission details, authors will be asked if they want to apply for the Young Scientist Award. If they check the box "Yes," additional questions will pop up for them to answer. Submissions must use the following file-naming convention, where "Lastnameauthor" text is replaced by the student's surname:

- YSASummaryLastnameauthor.pdf
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The deadline for paper submission is **31 January 2020**.

Applications will be assessed by the URSI Young Scientist Committee, taking account of the national ranking of the application and the technical evaluation of the Summary Paper by the relevant URSI Commission. Awards will be announced on 1 May 2020 on the URSI Web site.

For more information about URSI, the General Assembly and Scientific Symposium, and the activities of URSI Commissions, please look at the URSI Web site at: http://www.ursi.org/ and the GASS 2020 Web site at http://www.ursi2020.org/. Updates will also be posted on our Twitter account @URSI_Radio (https://twitter.com/URSI_Radio) and on our Facebook page @internationalunionofradioscience (https://www.facebook.com/internationalunionofradioscience/).

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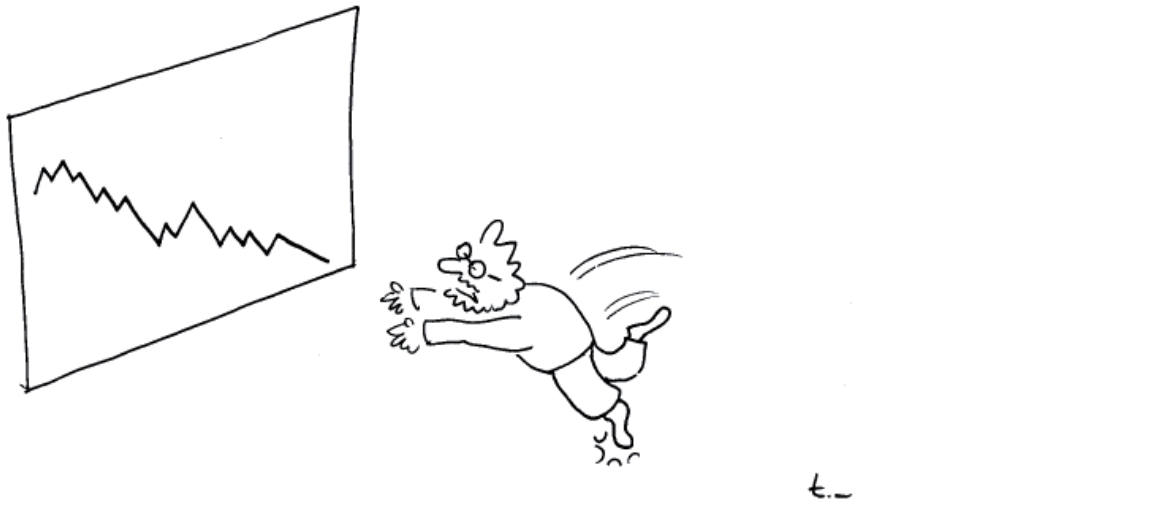

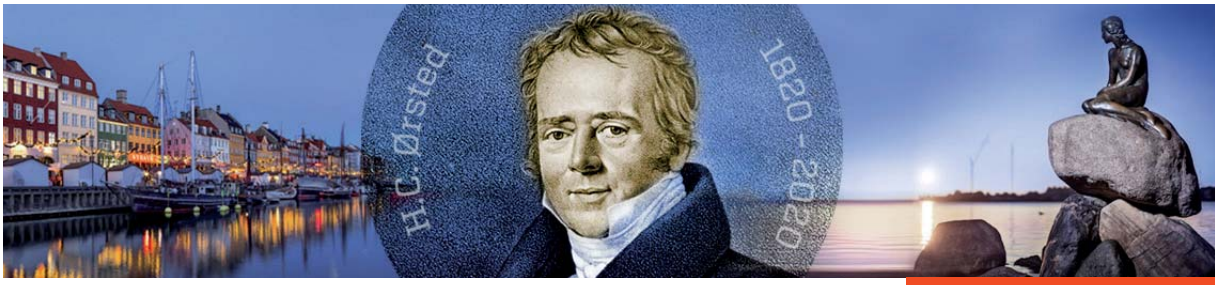

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SOLBOX-16: Nano-Link Systems

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1. Introduction

The topic of SOLBOX-08 in the September 2017 issue of the URSI *Radio Science Bulletin* designed effective nano-couplers that consisted of nanoparticles to improve electromagnetic power transmission along bent nanowire systems [1]. It was shown that by finding optimal nanoparticle configurations and arrangements it was possible to significantly improve transmission, even for nanowires with sharp corners. For this purpose, genetic algorithms were employed to perform on/off (1/0) optimization on given nanoparticle grids. Even though they were compact, the designed nano-couplers could be so effective that they mitigated the need for smoothly curved bends that often wasted the available physical space. We note that nano-couplers also reduce cross-talk between different nanowire transmission lines, as they suppress diffracted waves at the bending locations [2].

In this issue of Solution Box (SOLBOX-16), five different nano-link systems that involve different arrangements of nanowires and well-designed nano-couplers are presented. Similar to the case in SOLBOX-08, the nano-couplers used consisted of optimized arrangements of nano-cubes, which were obtained by using genetic algorithms combined with the Multilevel Fast Multipole Algorithm (MLFMA) [3] for full-wave simulations. However, instead of the design of these nano-couplers, the purpose of the problems in SOLBOX-16 was to analyze their electromagnetic responses when they were in action. Specifically, these nano-coupler designs as well as their usage at different corners and junctions to construct different nano-link systems were considered, while the aim was to accurately and efficiently simulate these systems to observe power-transmission performance. The sensitive nature of nanoparticles and nanowires require full-wave solutions, where the plasmonic properties of metals are fully considered without resorting to fundamental assumptions. At the same time, nanowires are relatively long in terms of the wavelength, making the overall structures electrically large. Therefore, acceleration algorithms, such as MLFMA, are required for efficient solutions. The sample solutions presented in this issue were obtained with such a solver, which can be a reference for interested readers who would like to apply their solvers to analyze this interesting set of problems.

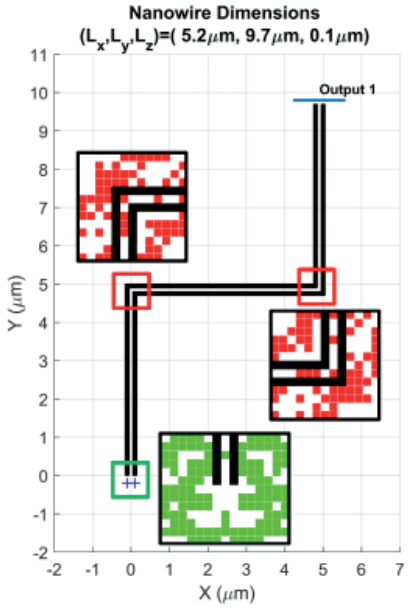

Figure 1. Nano-link System 1, which involved two corner couplers at sharp bends and an input coupler enclosing the input source (dipole pair).

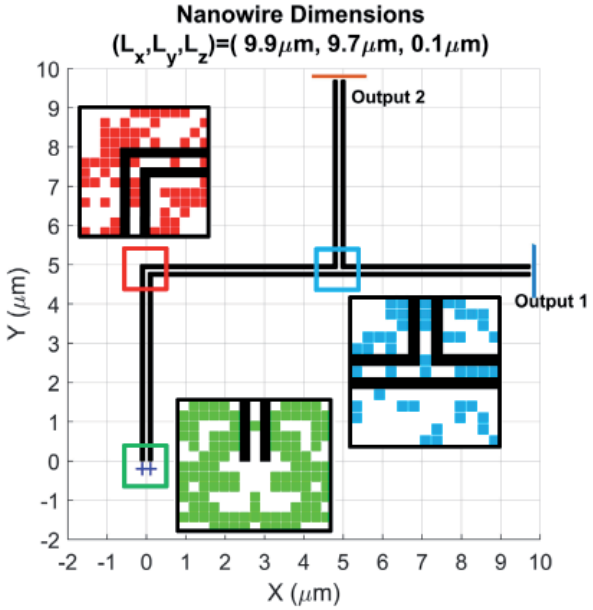

Figure 2. Nano-link System 2, which involved a corner coupler at a sharp bend, a junction coupler at a three-way junction, and an input coupler enclosing the input source (dipole pair). There were two outputs of the system.

2. Problems

2.1 Problem SOLBOX-16 (*Aşkın Altınoklu and Özgür Ergül*)

In SOLBOX-16, we considered five different nano-link systems, depicted in Figures 1-5, each involving nanowires, nano-couplers, an input, and output(s), as well as corners and junctions. In all cases, pairs of nanowires were used to transmit power from the input to the output(s). Similarly to those in SOLBOX-08, the nanowires had 0.1 μm × 0.1 μm square cross sections, while the distances between them were also fixed at 0.1 μm. For excitation, a pair of Hertzian dipoles with opposite directions was placed at a distance of 0.2 μm from the nanowires. Nano-couplers were designed by using 90 nm × 90 nm × 90 nm nano-cubes that were located on grids with 0.1 μm intervals between grid points. In Figures 1-5, the coupler designs are described by showing the nano-cubes that were kept as obtained via optimization. Optimization trials were performed in various scenarios to improve the power transmission through sharp corners, three-way junctions, and four-way junctions. In each nano-link system, an input coupler was also used to improve the coupling from the source to the nanowires. Specific properties of the considered systems were as follows.

- Nano-Link System 1 (Figure 1): This system involved a combination of three 5 μm segments that were connected to each other with sharp corners. In addition to the input coupler, two corner couplers were used to maximize the power transmission from the input to the single output.
- Nano-Link System 2 (Figure 2): This system involved a combination of four 5 μm segments leading to two outputs. A corner coupler and a three-way junction coupler were used to simultaneously increase the power transmission to both outputs.

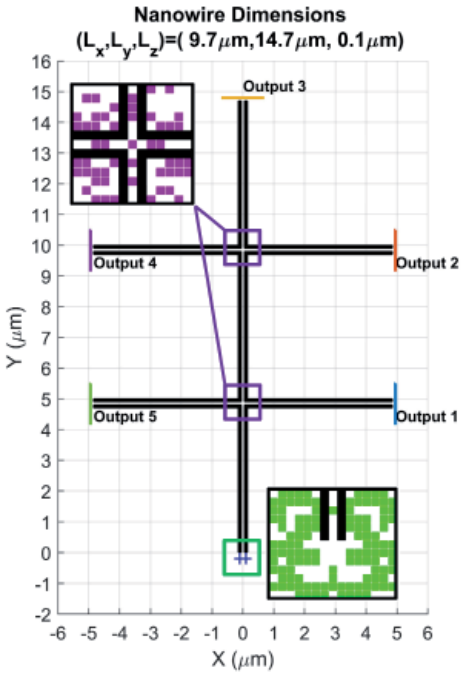

Figure 3. Nano-link System 3, which involved junction couplers at two four-way junctions and an input coupler enclosing the input source (dipole pair). There were five outputs of the system.

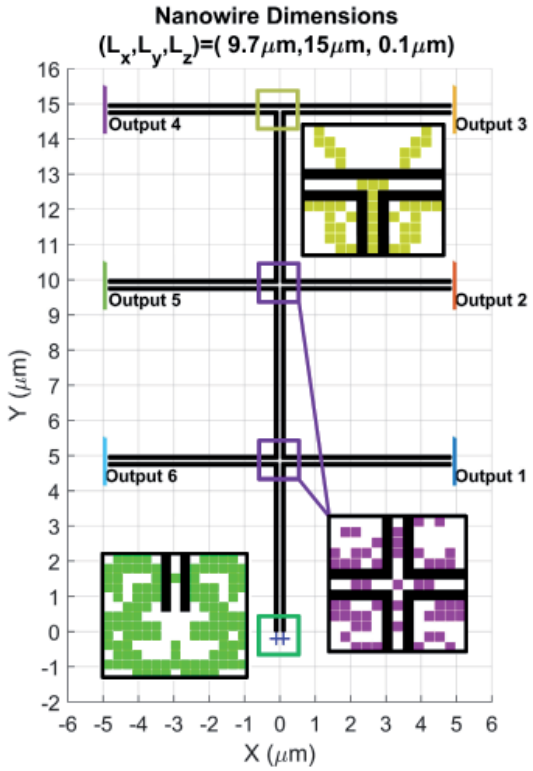

Figure 4. Nano-link System 4, which involved two four-way junctions and one three-way junction, all supported by nano-couplers, as well as an input coupler enclosing the input source (dipole pair). There were six outputs of the system.

- Nano-Link System 3 (Figure 3): This was a larger nano-link system, which covered an area of 9.7 μm × 14.7 μm. There were five outputs and two four-way junction couplers to improve the transmission to these outputs.

- Nano-Link System 4 (Figure 4): This was an extended version of System 3, which was obtained by including two extra 5 μm segments and increasing the total number of outputs to six. To maintain power transmission, a three-way junction coupler was consequently added to the system. We noted that this nano-coupler was different from the one used in System 2 (which was another three-way junction coupler), due to the different orientations of the junction's input/output.

- Nano-Link System 5 (Figure 5): This system could be seen to be a modified version of System 3 by asymmetrically placing the input, while the original input became an output. Four-way junction couplers were oriented accordingly to improve the power transmission towards all outputs.

Simulations could be performed at any optical frequency, but the nano-couplers were designed to be particularly effective at 250 THz and when the nanowire and nano-cube materials were Ag. It was therefore suggested

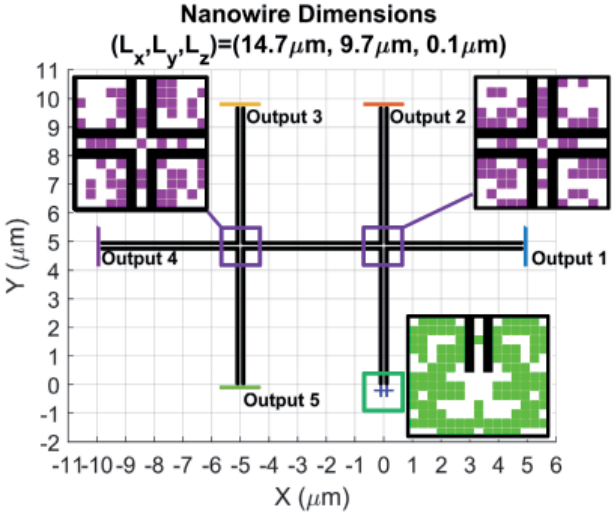

Figure 5. Nano-link System 5, which involved two four-way junctions with junction couplers and an input coupler enclosing the input source (dipole pair). There were five outputs of the system

to keep the frequencies close to 250 THz and to use Ag, if good power transmission was desired to be observed. In the frequency domain, the complex relative permittivity of Ag at this frequency is approximately $-60.76 + 4.31i$, based on measurement data. The transmission properties of the nano-link systems could be visualized by considering their near-zone characteristics, e.g., by inspecting the near-zone power density distributions as in the example solutions.

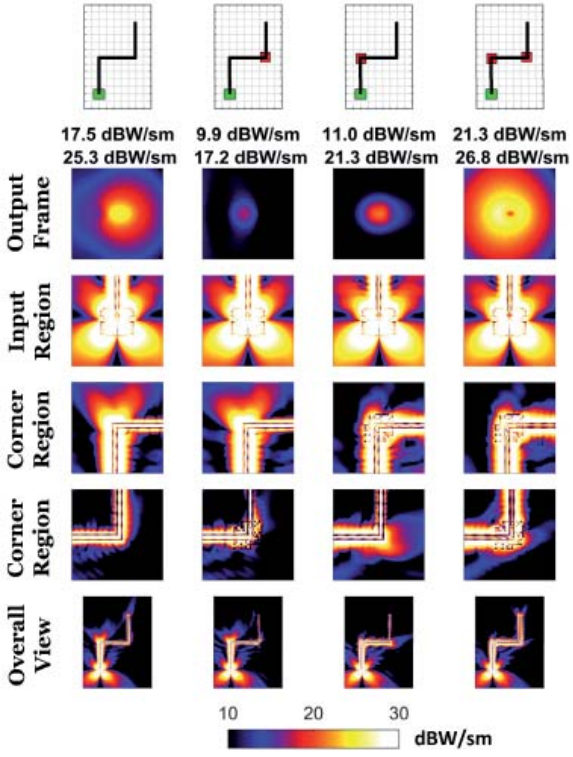

Figure 6. The power density (dBW/sm) in different frames and regions for nano-link System 1 and its variations. The mean and maximum power-density values in the output frame are also provided.

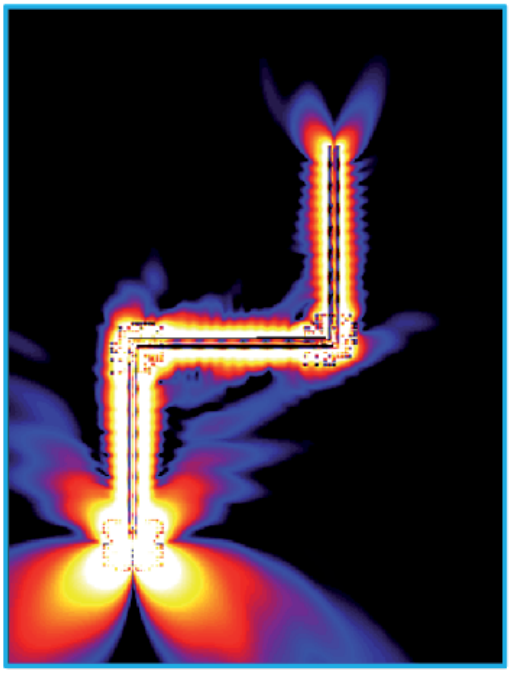

Figure 7. The power-density (dBW/sm) distribution for nano-link System 1. The color values are the same as those in Figure 6.

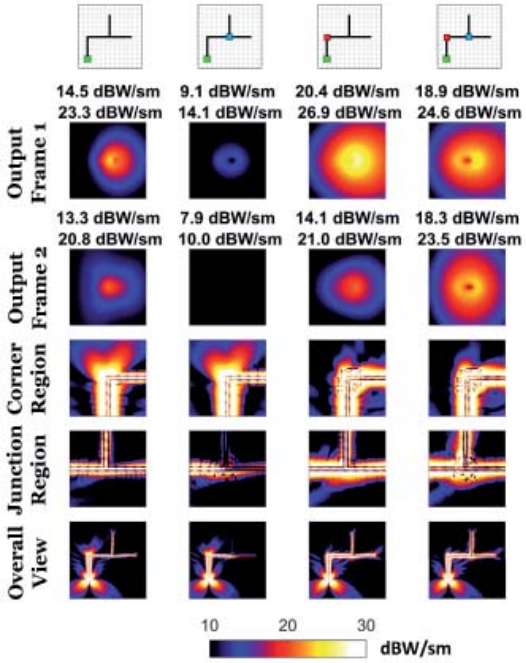

Figure 8. The power density (dBW/sm) in different frames and regions for nano-link System 2 and its variations. The mean and maximum power-density values in the output frames are also provided.

Additionally, the power-density values at the output(s) could be sampled to evaluate transmission abilities.

3. Solution to Problem SOLBOX-16

3.1 Solution Summary

Solver type (e.g., Noncommercial, commercial):
Noncommercial research-based code developed at CEMMETU, Ankara, Turkey
Solution core algorithm or method: Frequency-domain MLFMA
Programming language or environment (if applicable): *MATLAB + MEX*
Computer properties and resources used: 2.5 GHz Intel Xeon E5-2680v3 processors (using 1 core)
Total time required to produce the results shown (categories: < 1 sec, < 10 sec, < 1 min, < 10 min, < 1 hour, < 10 hours, < 1 day, < 10 days, > 10 days) < 1 hour for the solution of each problem; < 10 hours for each near-zone power-density computation

3.2 Short Description of the Numerical Solutions

A frequency-domain MLFMA solver was used in order to analyze the nano-link systems listed under SOLBOX-16. Each nano-link was investigated at 250 THz, while the nanowire and nano-cube materials were considered to be Ag, as suggested. Hertzian dipoles that were used for excitations were assumed to have 1 Am dipole moments. Problems were formulated with the Modified Combined Tangential Formulation (MCTF) [4], which was discretized by using the Rao-Wilton-Glisson functions on triangulated surfaces. Using sufficiently small triangles, the total number of unknowns changed from 21,654 to 40,182. In order to accelerate iterative solutions, robust preconditioners based on approximate forms of the MLFMA were employed [5]. For this purpose, the main solutions were performed by using a flexible variant of the Generalized Minimal Residual (GMRES) algorithm. From System 1 to System 5, the iteration counts were 79, 85, 88, 91, and 87, respectively, to reach 0.0001 residual error. Once equivalent current coefficients were obtained, they were used to compute the power density in different frames and regions around the nano-link systems. Among these, output frames were defined as 1.3 μm × 1.3 μm square areas that were located at a distance of 0.1 μm from the nanowire surfaces. In an overall plot showing the whole structure, the number of locations to compute power density was in the range from 103,041 (System 2) to 514,884 (System 4) for sufficiently good resolution.

3.3 Results

We start with the results for the first nano-link system (see Figure 1) presented in Figure 6. In addition to the full system with all three nano-couplers, we included results for three more cases, i.e., when one of the corner couplers was missing or when both were missing. Figure 6 presents

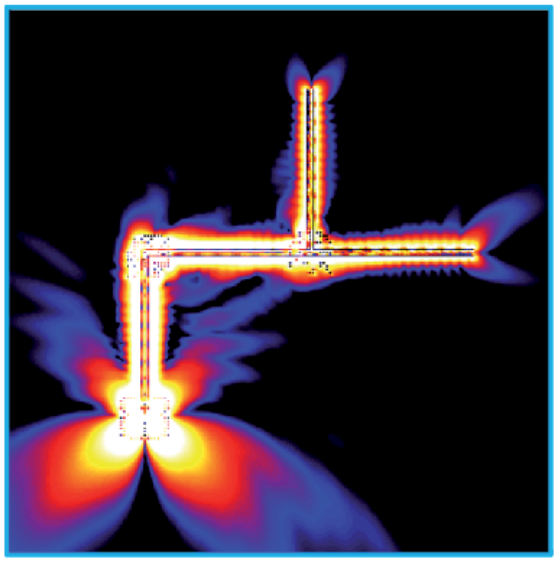

Figure 9. The power-density (dBW/sm) distribution for nano-link System 2. The color values are the same as those in Figure 8.

the power-density distributions in the output frame, in the input region, and in the two corner regions, in addition to the overall view. We observed significant effects of corner couplers and their effectiveness in reducing diffractions and improving power transmission. It was remarkable that in terms of output values, using only one corner coupler was even worse than using no corner coupler. When all three couplers existed, the mean and maximum power-

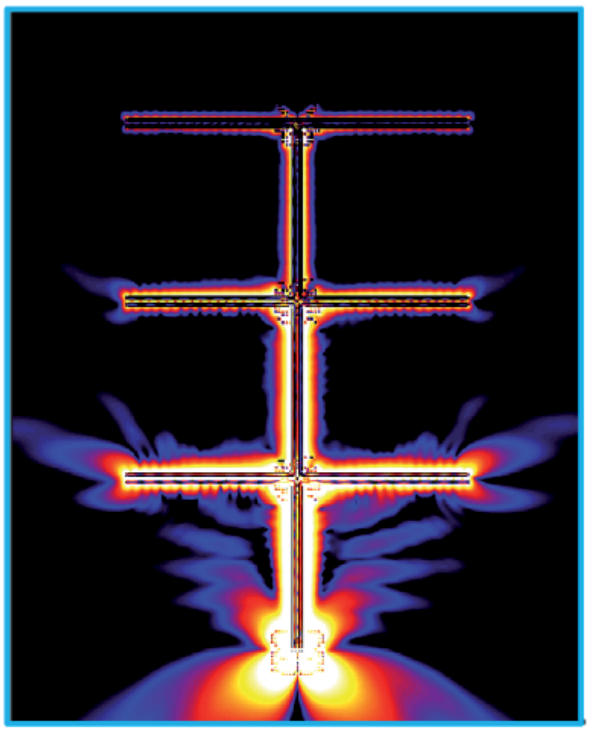

Figure 11. The power-density (dBW/sm) distribution for nano-link System 4. The color values are the same as those in Figure 6.

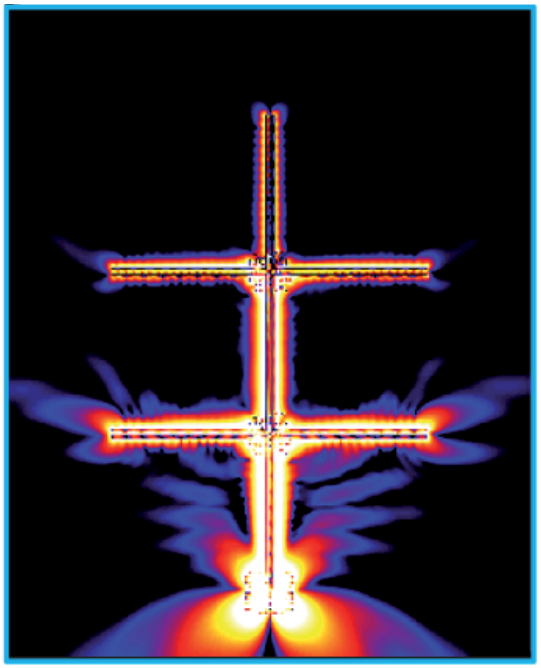

Figure 10. The power-density (dBW/sm) distribution for nano-link System 3. The color values are the same as those in Figure 6.

density values in the output frame reached 21.3 dBW/sm and 26.8 dBW/sm, respectively. Figure 7 presents an enlarged view of the overall picture, where efficient power transmission was clearly observed.

Results for nano-link System 2 (see Figure 2) are next presented in Figures 8 and 9. Similarly to the previous results, three different cases were considered, in addition to the overall nano-link system. Comparing the results in Figure 8, we observed that the junction coupler was not very effective if the corner coupler was absent. This was due to the phase difference between transmitted waves along the nanowire pairs introduced by the corner. On the

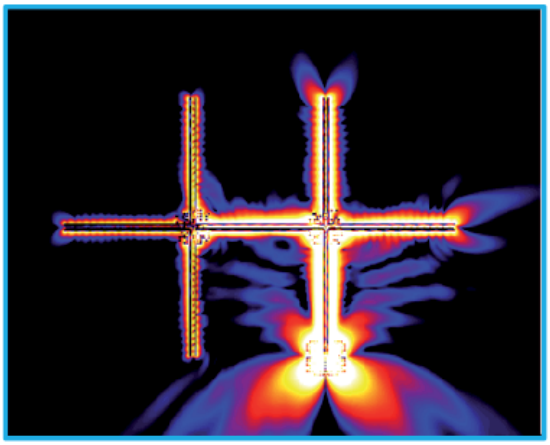

Figure 12. The power-density (dBW/sm) distribution for nano-link System 5. The color values are the same as those in Figure 6.

other hand, when the junction coupler was missing (but the corner coupler existed), transmission to the outputs became imbalanced. The best results were obtained when both junction and corner couplers were used (in addition to the input coupler that was always used). For this case, the maximum power-density values measured in the output frames reached 24.6 dBW/sm (at Output 1) and 23.5 dBW/sm (at Output 2). Effective transmission from the input to both outputs was also evident in the zoomed overall view in Figure 9.

For nano-link Systems 3-5 (see Figures 3-5), we present only the overall performance of the complete structures, i.e., when all nano-couplers existed. Figure 10 depicts the result for System 3 that involved two four-way couplers, in addition to the input coupler, and five outputs. We observed that the power density naturally dropped from the bottom (input region) to the top (output region). Nevertheless, the junction couplers operated as desired, and they maintained the transmission as well as equal power distribution to their outputs. We noted that these couplers were designed to simultaneously improve power transmission to their three outputs. After the first coupler achieved this, the power transmitted to the second coupler was further divided into three. Considering the overall system, the power density was therefore not intended to be equally distributed among five outputs. The result in Figure 11 showed what happened if two more segments and a suitable coupler were added to System 3, leading to System 4. We observed that since the transmitted power to the three-way junction was relatively weak, the top two outputs received lower electromagnetic power in comparison to the other four outputs. Finally, the result for System 5 is shown in Figure 12, where the effectiveness of the couplers was also clearly visible in this configuration. The first (right) four-way coupler equally distributed the power among three outputs, one of which was further divided into three by the second coupler (left).

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IMST, Kamp-Lintfort, May 13- 17
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ANTENNA SYSTEM FOR 5G COMMUNICATION
CHALMERS, Gothenburg, May 20-24
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Coordinator: Y. Vardaxoglou, A. Alexandridis

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Coordinators: , V. Degli Esposti, C. Oestges,T. Kürner

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Coordinators: A. Freni, J. Mosig

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Coordinators: L.Crocco, G. Vecchi

METASURFACES FOR ANTENNAS
UNIZG, Zagreb, September 23-27
Coordinators: S. Maci, Z. Sipus

FUNDAMENTALS ON ANTENNAS
UC3M, Madrid, October 14-18
Coordinator: D. Segovia

BODY AREA NETWORK
QMUL, London, October 21–25
Coordinator: Y. Hao

ANTENNA AND RECTENNAS FOR IOT APPLICATIONS
UCA, Nice, November 4-8
Coordinator: L. Lizzi

DISRUPTIVE ANTENNAS BASED ON EMERGING TECHNOLOGIES FOR NOVEL SATELLITE TELECOMMUNICATION SCHEME (REVOLVE)
TAS, Rennes, November 11-15
Coordinators: M. Ettorre, H. Legay

ESOA off-shore

ANTENNAS FOR RADIOTELESCOPES
SU-CSR, Stellen, November 18-22
Coordinator: D. de Villiers

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Whataboutery

Several years ago, I was returning home from the airport at midnight and was stopped by the police for speeding. I almost never speed. The streets were empty of cars and people, and I wanted to get home, so I made an exception. Needless to say, I was not happy. Many justifications for my speeding went through my head, but when the policeman said, "You were going 10 miles per hour over the speed limit," I simply responded, "Yes, I know that I was speeding." I had a number of other responses going through my head, such as, "Why aren't you chasing the real criminals that are committing real crimes at this time of night?" and "What about the fact that there is nobody out right now, so I was not endangering anyone or anything!" I kept these thoughts to myself and begrudgingly paid my $100 fine the next day.

When accused of something, people often respond with a counter accusation or change the subject. For instance, if you see me eating a cookie at a reception, you might say, "You are a diabetic, you should not be eating a cookie." My rebuttal might be, "What about you? You are eating a cookie, and it looks like you could lose a few pounds," or "You have cookie crumbs on your lips." Either of these responses deflects the accusation away from me and puts you on the defensive, with no acknowledgement of whether your statement was fair.

This reaction is known as "whataboutery" or "whataboutism," which refer to responding to a hard question or accusation by making a different accusation or changing the subject. The name is derived from a typical response to an accusation: "What about when you..." or "What about that person...." Sometimes, the accusation is totally invalid. For instance, in the cookie scenario, I may have low blood sugar and need to eat the cookie to avoid an insulin reaction, and possibly pass out. Your accusation would have been based on a false premise. On the other hand, your cookie accusation may be dead on. If that were the case, it would be to my benefit to take your accusation to heart. However, often our pride keeps us from admitting when we are wrong. After all, they do say that "The best defense is a good offense."

We all encounter whataboutism on a daily basis: either on the giving or receiving end. Whataboutery destroys effective communication. It is an emotional response to a comment. The following steps can help to diffuse inappropriate responses to whataboutery:

1. Recognize whataboutism and approach it analytically.

2. Isolate and resolve whataboutery by recognizing a person, phrase, or subject that acts as a trigger.

3. Strip away the emotion, and evaluate the simple facts of the scenario in order to give an appropriate response. The two facts in the diabetic example were 1) I am Type I diabetic, and 2) I am eating a cookie. The inquirer does not know my blood-sugar levels, may not understand how diabetes impacts the body, could be well-intended and might have had a loved one who did not properly manage their diabetes, might be simply curious, or may be trying to goad me. My interpretation of their intent depends on previous interactions with the individual, completely unrelated interactions with other people that day (i.e., a fight with a spouse or a difficult conversation with a boss), or their specific phrasing.

4. A defensive response can be countered with curiosity. For instance, in the cookie scenario, I could ask "What is your intent with this question?" or "How much do you know about diabetes?" Another approach is to simply respond by letting the individual know which part of their question or statement did not land well with you, and calmly ask if that was their intent, or if it could be discussed in another scenario.

5. Evaluate your perception of the person making the statement. Try to remove the emotion in your relationship with the person when considering what they said.

Taking these steps with no expectation of reciprocity drastically reduces the whataboutery in your life, and leads to much more effective relationships and communication.

My coauthor said that she was shocked that I received a speeding ticket that cost $100. I retorted with, "What about the time in 12th grade when you got the speeding ticket on the way to skiing?" Our discussion ended at that point. I think we need to re-read our column.

James Clerk Maxwell Newsletter Available

The summer 2019 issue of the James Clerk Maxwell Newsletter is available for downloading from the Clerk Maxwell Foundation's Web site. The PDF can be downloaded from http://www.clerkmaxwellfoundation.org/Newsletter_2019_Summer.pdf. The issue contains an article on the results from the Cassini probe to Saturn, and an article on the house built for Albert Einstein in which he wrote his tribute to Maxwell.

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Young Scientist and Student Paper Competition Awards at AP-RASC 2019

At each of its flagship meetings (AT-RASC, AP-RASC, and GASS), URSI runs a Young Scientist program to promote participation by Young Scientists (YS): early-career researchers under the age of 35. The Young Scientist program usually consists of Young Scientist awards and a Student Paper Competition (SPC). For the Asia-Pacific Radio Science Conference (AP-RASC), held in New Delhi, India, in March 2019, I was co-chair of the Young Scientist Program Committee. In this ECR column, I look back on the Young Scientist Awards and the Student Paper Competition of this very successful and enjoyable meeting.

Young Scientist Awards at the AP-RASC 2019

The Young Scientist Awards aimed to assist young scientists from both developed and developing countries to attend the AP-RASC 2019. To qualify, applicants for a Young Scientist Award had to be under 35 years of age on March 1, 2019, and had to be the principal author of a paper submitted to the conference and accepted for oral or poster presentation in a regular session during the conference. After the call for the Young Scientist Award, 129 eligible applications were received from 23 different countries. The second row in Table 1 shows the distribution of applicants across the 10 Commissions of URSI.

The applicants had to submit a full-length conference paper and a CV, including a list of publications. The Young Scientist Program Committee collected the review scores from the paper-submission system after the reviews of all contributions submitted to the conference were completed. In this manner, the papers submitted by the Young Scientist Award applicants were judged by the same pool of reviewers as the other contributions. The CVs were scored by the Commission representatives in the Young Scientist Program Committee, and checked for consistency and balance by the Young Scientist Program Committee co-chairs. The two scores were averaged, with weights of 60% (paper score) and 40% (CV score). Based on the resulting ranking, the 20 Young Scientist awardees were selected. In a few cases, preference was given to a lower-ranked candidate above a candidate who had already received a Young Scientist Award at an earlier URSI flagship meeting to maximize the number of individuals receiving a Young Scientist Award from URSI in their career. This was preferably done when this improved the balance among Commissions, the geographic distribution, or the gender balance of the awardees.

Table 1. The distribution of Young Scientist Award applicants and awards across the URSI Commissions.

	Commission									
	A	B	C	D	E	F	G	H	J	K
YSA applications	4	32	19	10	3	24	18	5	3	11
YSAs awarded	0	5	2	2	1	2	2	2	0	4

Figure 1. A group picture of the Young Scientist Awardees along with key URSI and AP-RASC officials after receiving their certificates at the conference banquet.

The third row in Table 1 shows the distribution of Young Scientist Awardees across URSI's scientific Commissions. The 20 awardees came from nine different countries; six of them were female. The Young Scientist Awardees received free registration and free accommodation for the duration of the conference. It could be concluded that the Young Scientist Program was very successful, given the high number of applications and the quality of the submissions. The oversubscription by a factor of more than six made the Young Scientist Award a very competitive award, so congratulations to the Young Scientist Awardees!

To further encourage radio science research in India, the Indian Radio Science Society (InRaSS) decided to give away 10 awards, named "URSI – InRaSS Young Indian Radio Scientist (IYRS) Awards." The funding for this year's IYRS Awards was kindly provided by the National Atmospheric Research Laboratory (NARL) in Tirupati, India. The rules for this award were identical to the YSA award. The awardees were selected by the Young Scientist Program Committee. The IYRS awardees also received free registration and free accommodation for the duration of the conference.

Student Paper Competition at the AP-RASC 2019

Any student from any country, who was the principal author and the presenter of a paper (oral or poster) at a regular session of the AP-RASC 2019, could apply for the Student Paper Competition. Every Student Paper Competition applicant had to be a full-time university student at the time of application, and had to submit a full-length conference paper and a certification letter by his/her advisor. The certification letter had to clearly state that the applicant was a full-time university student for a degree at the time of application. For a paper with multiple authors, the letter also had to state that the role of authors other than the applicant was primarily advisory in nature.

The Young Scientist Program Committee reviewed the applications. Originally, the plan was to select five candidates for the Student Paper Competition final during the conference. However, ultimately seven finalists (out of 34 applicants) were selected, as their review scores were very close. Unfortunately, one of the selected candidates could not come to the conference and therefore could not take part in the final Student Paper Competition. All Student Paper Competition finalists were offered free registration and free accommodation for the duration of the conference.

The top three prize winners were:

Pooja Munjal (Indian Institute of Science Education and Research Mohali, India), "Optically Probing Sub-Nanometer Photo-Dynamics of Solid Surfaces"

Figure 2. Pooja Munjal (l) receiving the first prize in the Student Paper Competition from URSI President Prof. Makoto Ando.

Shuang Liu (University of Tokyo, Japan) "Development of a Method for Estimating Field Map in an Object Containing Magnetic Materials from View Line Sequence in MRI"

Krushna Chandra Barik (Indian Institute of Geomagnetism, India) "A Theoretical Model for the Generation of Kinetic Alfvén Waves (KAWs) in the Earth's Magnetosphere by Ion Beam and Velocity Shear"

Honorable mentions were given to:

Mia Filic (independent scientist, Croatia) "On Correlation Between SID Monitor and GPS-Derived TEC Observations During a Massive Ionospheric Storm Development"

Shuto Takahashi (University of Electro-Communications, Japan) "Incorporation Algorithm with RPM and DBIM in Bayesian Framework for Microwave Non-Destructive Testing"

Sreenath Reddy Thummaluru (Indian Institute of Technology – Indian School of Mines, India) "Reducing the RCS of MIMO Antenna Using Angularly Stable FSS"

Report on 2019 Egyptian National Radio Science Conference (NRSC2019)

1. Event Organizers

The National Radio Science Committee, an affiliate of the Academy of Scientific Research and Technology of Egypt (which acts as the national representative of URSI) organized its 36th annual national radio science conference in Port Said, Egypt, during the period of April 16-18, 2019. The co-organizer was the Arab Academy for Science and Technology (AAS&T), which is an affiliate of the Arab League, with six branches in Egypt, one branch in Syria, and another branch in UAE. The Institute of Electrical and Electronics Engineers (IEEE) acted as the technical cosponsor of the conference, following a tradition that is more than twenty years old.

2. Venue

Historically, the city of Port Said is known for the role it played during the Suez Crisis in 1956. Since then, many developments have taken place in this vibrant city. It recently has been selected by the Egyptian Government to be the role model for a number of its digital transformation projects, notably in the medical insurance sector. In addition, a number of "mega" projects have been implemented in Port Said, including the eastern extension of the Port Said seaport, and the digging of two new tunnels underneath the Suez Canal that span 3.92 km each. With these facts in mind, NRSC2019 was hosted in the city's new cultural center, thanks to a generous offer from the Governor of Port Said, General Adel El-Ghadban (Figure 1).

Figure 1. NRSC2019 was hosted in the Cultural Center of Port Said City.

3. Conference Highlights

3.1 Paper Statistics

NRSC conferences follow a tradition that has been established over the years. Prospective authors (national and international) were encouraged to submit their contributions to the conference portal. Submissions were solicited in two versions: a `.doc` version (containing details for the authors and their affiliation), and a `.pdf` version (without authors' names or their affiliation, for blind reviewing). Cross checking by an IEEE plagiarism checker was carried out to determine the eligibility of each submitted paper before evaluation. Three separate referees from institutions other than the affiliations of the submitting authors were selected and their evaluations, supported by any constructive remarks, were solicited. Subsequently, the Technical Program Committee reviewed the papers' evaluations and determined the candidate papers for presentation at the conference. Another cross checking for plagiarism was carried out before a candidate paper was finally accepted.

NRSC2019 received 109 papers, but only 51 were accepted for presentation, corresponding to an acceptance ratio of 46.78%. The accepted papers for NRSC2019 were distributed among the 10 URSI tracks as follows: Commission B (11 papers), Commission C (23 papers),

Figure 2. The NRSC2019 opening ceremony was attended by (l-r) Dr. Khaled Shehata (NRSC2019 co-Chair), Dr. Mostafa Saad (NRSC2019 Chair), Dr. Mahmoud Sakr (President of Academy of Scientific Research and Technology), General Adel El-Ghadban (Governor of Port Said), Dr. Alaa Abd-El-Bary (Vice-President of Arab Academy for Science and Technology), and Dr. Mahmoud El-Hadidi (NRSC2019 Vice Chair).

Figure 3. (l-r) Dr. Mahmoud Sakr, Dr. Alaa Abd-El-Bary, and Dr. Abd-El-Halim Shousha (honored radio science pioneer).

Commission D (13 papers) and Commission K (four papers). Except for one paper, all accepted papers were presented during the event, and therefore 50 papers were submitted to appear in IEEE Xplore.

3.2 Opening Ceremony

The conference was inaugurated by speeches from the Governor of Port Said, General Adel El-Ghadban; the President of the Academy for Scientific Research and Technology, Dr. Mahmoud Sakr; the Vice President for the Arab Academy of Science and Technology, Dr. Alaa Abd-El-Bary; and the NRSC2019 Chair, Dr. Elsayed Saad (Figure 2).

3.3 Honoring Radio Science Pioneers

Three radio science pioneers were honored during the opening ceremony of NRSC2019: Prof. Abd-El-Halim Shousha (Cairo University), Prof. Esmat Abd-El-Fattah

Figure 5. (l-r) Dr. Mahmoud Sakr and Dr. Hamdy El-Mikati (husband of honored radio science pioneer the late Dr. Fatma Abou-Chadi).

Figure 4. (l-r) Dr. Khaled Shehata, Dr. Mahmoud Sakr, Dr. Alaa Abd-El-Bary, and Dr. Esmat Abd-El-Fattah (honored radio science pioneer).

(Electronic Research Institute), and the late Prof. Fatma Abou-Chadi (Mansoura University). In addition, Prof. Said El-Khamy (former Chair of the Egyptian National Radio Science Committee) was honored for his distinctive efforts and extensive years of leadership while heading the Egyptian National Radio Science Committee. Figures 3-6 depict the honoring ceremony for these leading scientists.

4. Invited Talks and Keynote Speeches

4.1 Invited Talks

NRSC2019 invited two former Egyptian government officials to present their visions concerning current trends in communication and information technology. The first invited talk (Figure 7) was "ICT: Does it Dominate the World? The Top Tech. 2019 Trends," delivered by Dr. Mohamed Salem (former Minister of Communication and

Figure 6. (l-r) Dr. Mahmoud El-Hadidi, Dr. Khaled Shehata, Dr. Mahmoud Sakr, Dr. Alaa Abd-El-Bary, Dr. Said El-Khamy (Past President of National Radio Science Committee), and Dr. Elsayed Saad (NRSC2019 Chair and current President of National Radio Science Committee).

Figure 7. Dr. Mohamed Salem delivering his invited talk on "ICT: Does it Dominate the World? The Top Tech. 2019 Trends."

Figure 8. Dr. Ashraf Abd-El-Wahab delivering his invited talk on "The Digital Transformation Challenges and Opportunities."

Information Technology, and currently Senior Advisor to the President of the Arab Academy of Science and Technology). The second invited talk (Figure 8) was "The Digital Transformation Challenges and Opportunities," delivered by Dr. Ashraf Abd-El-Wahab (former Minister of Administrative Development, and currently SAP Digital Transformation Director, Public Sector, Egypt). These talks aimed at emphasizing the interactions between academic research and real-world applications.

4.2 Keynote Speeches

Three keynote speeches were presented during the three days of the NRSC2019 conference. The first keynote speech was delivered by Dr. Ahmed Kishk (IEEE Fellow, Tier I Canada Research Chair, and Professor in the Electrical and Computer Engineering Department of Concordia University, Canada). Its title was "Beams Number Extension and Two-Dimensional Beam Scanning by Enhanced Butler Matrices" (Figure 9).

The second keynote speech was delivered by Dr. Abbas Omar (IEEE Fellow and Professor at the University of Magdeburg, Germany). Its title was "Overview on the Concepts of MIMO, Multiuser MIMO, and Massive MIMO" (Figure 10).

Figure 9. Dr. Ahmed Kishk delivering his keynote speech on "Beams Number Extension and Two-Dimensional Beam Scanning by Enhanced Butler Matrices."

Figure 10. Dr. Abbas Omar delivering his keynote speech on "Overview on the Concepts of MIMO, Multiuser MIMO, and Massive MIMO."

Figure 11. Dr. Hassan Aboushady delivering his keynote speech on "RF Sigma-Delta ADC: Realizing the Cognitive Radio Dream."

The last keynote speech was delivered by Dr. Hassan Aboushady (Associate Professor at the Sorbonne University, Campus Pierre and Marie Curie, UPMC, France). Its title was "RF Sigma-Delta ADC: Realizing the Cognitive Radio Dream" (Figure 11).

5. Special Sessions

A number of special sessions were scheduled during the three days of the NRSC2019 event. These included:

- "Mermistors: New Innovation Trends in Future of Electronics," Sherif Nafea and Ahmed Dessouki (Port Said University)

Figure 13. Dr. Elsayed Saad honoring Dr. Aida El-Saban (Arab Organization for Industrialization) with the participation of Dr. Rowayda Sadek (Helwan University) (l) and Dr. Hadia El-Hennawy (Ain-Shams University) (second from the left).

Figure 12a. Dr. Elsayed Saad (l) honoring Dr. Ahmed El-Dessouki from Port Said University his contribution to the special session on mermistors.

Figure 12b. Dr. Elsayed Saad (l) honoring Dr. Sherif Nafea from Port Said University for his contribution to the special session on mermistors.

- "Wireless Communication Channels: The Backbone of the Global Maritime Distress and Safety System (GMDSS)," Mohamed Aboul-Dahab (Arab Academy for Science and Technology)
- "*COMSOL Multiphysics*: A Powerful Tool for Electromagnetic Devices Modeling," Ahmed Heikal (Zewail City of Science and Technology)
- "Women in Radio Science," Hadia El-Hennawy (Ain Shams University), Aida El-Saban (Arab Organization for Industrialization), and Rowayda Sadek (Helwan University).

Figure 14. Students who received NRSC2019 Poster Awards and Certificates of Appreciation posing for a photo with members of the NRSC2019 Organizing Committee.

The intent of these sessions was to provide the attendees of NRSC2019 with in-depth information regarding a hot research area (mermistors), a life-saving wireless technology (GMDSS), a powerful analysis and design tool that is very effective in URSI-related research (*COMSOL*), and the significant role currently played by Egyptian women in the areas of radio science including education, research, and industrialization. Figures 12 and 13 depict the honoring of some lead speakers in these special sessions.

6. Poster Sessions

Keeping with a long-established tradition, NRSC2019 encouraged undergraduate students from all Egyptian universities to submit their graduation projects for possible exhibition as posters during the conference days. A rigorous screening process was adopted to select the candidate projects, and the authors of the accepted projects were instructed to produce posters according to a standardized

Figure 15. Winners of best paper and best student paper awards posing for a photo with members of the NRSC2019 Organizing Committee.

Figure 16. Touring the Suez Canal onboard a passenger vessel.

Figure 18. Participants of NRSC2019 touring Port Said City's National Museum.

format. A total of 21 posters were accepted for display from the following institutes: Ain Shams University, Alexandria University, Arab Academy for Science and Technology, and Menoufia University. A committee from the NRSC2019 Organizing Committee evaluated the presented posters and selected ten of them to receive awards and appreciation certificates. Figure 14 depicts a group photo of the students receiving NRSC2019 Poster Awards.

7. Best Paper and Best Student Paper Awards

The NRSC conference organizers were keen to encourage both academic staff and young researchers (graduate students) to present high-quality research. Towards this objective, two best paper awards and three best student paper awards were offered at the closing ceremony of the conference. The winning papers were based on the initial reviewers' evaluation, the session chairs evaluation of the authors' presentations, and the evaluation provided by a special NRSC subcommittee that attended the various sessions and listened to presentations. The pool for the best paper awards consisted of all submitted papers, while the pool for the best student paper awards was limited to papers that were authored/coauthored by graduate students. The URSI Secretariat generously offered 500 euros as a financial contribution towards the student awards. This year, all five winning papers were coauthored by graduate students. The winning papers were:

First Best Paper: "Ultra-High Bit Rate All-Optical Half Subtractor Based on Photonic Crystal," Tamer S. Mostafa (Egyptian Russian University, Egypt), Nazmi Mohammed (Shaqra University, Saudi Arabia), and El-Sayed El-Rabie (Menoufia University, Egypt)

Second Best Paper: "Linearly Polarized SIW Horn Antenna Integrated with MM for Gain Enhancement and Polarization Conversion," Noha El-Shalaby (Kafer

Figure 17. Participants of NRSC2019 visiting the Memorial of the Unknown Soldier.

Figure 19. The participants of NRSC2019 attended a folklore show presented by the Port Said Dancing Company on the eve of the conference.

El-Shekh University, Egypt), Mona Badawy (Badr University, Egypt), Hend Malhat (Menoufia University, Egypt), and Saber Zainud-Dean (Menoufia University, Egypt)

First Best Student Paper: "Dual-Input Single-Inductor Dual-Output Power Management Unit Using Energy-Recycling/Backup and SAR-Based ZCS," Mohamed El-Hakim (Ain Shams University, Egypt), Hesham Omran (Ain Shams University, Egypt), and Sameh Ibrahim (Ain Shams University, Egypt)

Second Best Student Paper: "High Efficiency Modulation Technique for Visible Light Communication (VLC)," Amgad Aziz (Assiut University, Egypt), Omar Aly (Assiut University, Egypt), and Usama Mohammed (Assiut University, Egypt)

Third Best Student Paper: "Pilot Contamination Mitigation in Massive MIMO Systems Over Laplacian Local Scattering Spatial Correlation Channels," Waleed Ali (El-Shorouk Academy, Egypt), Wagdy Anis (Ain Shams University, Egypt), and Hamed El-Shenawy (El-Shorouk Academy, Egypt)

The winners of the best paper award and the best student paper awards received a financial incentive and a certificate of appreciation (Figure 15).

8. Social Events

8.1 Touring the Suez Canal

The Governor of Port Said kindly arranged for the participants of NRSC2019 to have a tour in the Suez Canal onboard a passenger vessel. Figure 16 depicts a view of the Suez Canal during the tour.

8.2 Visiting the Unknown Soldier Memorial and Port Said Museum

Another sightseeing activity of Port Said City in which the NRSC2019 participants joined was a visit to the memorial of the Unknown Soldier and the nearby National Museum. Figures 17 and 18 give a glimpse of this activity.

8.3 Attending a Folklore Show in the Cultural Center

On the eve of NRSC2019, the Governor of Port Said invited the NRSC2019 participants to attend a special show presented by the Port Said Dancing Company. The show took place in the Cultural Center and the audience enjoyed a very lively evening. Figure 19 captures one of the scenes during the show.

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URSI Conference Calendar

July 2019

IconSpace2019
6th International Conference on Space Science and Communication
Pulai Springs Resort, Johor, Malaysia 28-30 July 2019
Contact: Prof. Mardina Abdullah, Chair of IconSpace2019 Space Science Centre (ANGKASA), Institute of Climate Change Universiti Kebangsaan Malaysia 43600 UKM Bangi, Selangor Malaysia Tel: +603 8911 8033/8482/8497 Fax: +603 8911 8490

September 2019

ICEAA - IEEE APWC 2019
Granada, Spain, 9-13 September 2019
Contact: iceaa19@iceaa.polito.it

Metamaterials 2019
Rome, Italy, 16-19 September 2019
Contact: http://congress2019.metamorphose-vi.org/

RFI 2019 Workshop
Toulouse, France, 23 - 26 September 2019
Contact: http://www.cesbio.ups-tlse.fr/SMOS_blog/?p=6069

IEEE RADIO 2019
IEEE Radio and Antenna Days of the Indian Ocean 2019
Reunion Island, 23-26 September 2019
Contact: http://www.radiosociety.org/radio2019/

IEEE RFID-TA 2019
10th IEEE International Conference on RFID Technology and Applications
Pisa, Italy, 25-27 September 2019
Contact: http://www.elettromagnetismo.it/10th-ieee-international-conference-on-rfid-call-for-papers/

November 2019

COSPAR 2019
4th Symposium of the Committee on Space Research (COSPAR): Small Satellites for Sustainable Science and Development
Herzliya, Israel, 4-8 November 2019
Contact : COSPAR Secretariat, 2 place Maurice Quentin, 75039 Paris Cedex 01, France, Tel: +33 1 44 76 75 10, Fax: +33 1 44 76 74 37, E-mail: cospar@cosparhq.cnes.fr
http://www.cospar2019.org

March 2020

EUCAP 2020
Copenhagen, Denmark 19-20 March 2020
Contact: www.eucap2020.org

August 2020

COSPAR 2020
43rd Scientific Assembly of the Committee on Space Research (COSPAR) and Associated Events
Sydney, Australia, 15-23 August 2020
Contact : COSPAR Secretariat, 2 place Maurice Quentin, 75039 Paris Cedex 01, France, Tel: +33 1 44 76 75 10, Fax: +33 1 44 76 74 37, E-mail: cospar@cosparhq.cnes.fr
http://www.cospar2020.org

URSI GASS 2020
Rome, Italy, 29 August - 5 September 2020
Contact: URSI Secretariat, c/o INTEC, Tech Lane Ghent Science Park - Campus A, Technologiepark-Zwijnaarde 15, B-9052 Gent, Belgium, E-mail gass@ursi.org, http://www.ursi2020.org

May 2021

AT-RASC 2021
Third URSI Atlantic Radio Science Conference
Gran Canaria, Spain, 23-28 May 2021
Contact: Prof. Peter Van Daele, URSI Secretariat, Ghent University – INTEC, Technologiepark-Zwijnaarde 15, B-9052 Gent, Belgium, Fax: +32 9-264 4288, E-mail: peter.vandaele@ugent.be, http://www.at-rasc.com

August 2022

AP-RASC 2022
Asia-Pacific Radio Science Conference 2022
Sydney, Australia, 21-25 August 2022
Contact: URSI Secretariat, Ghent University – INTEC, Technologiepark-Zwijnaarde 126, B-9052 Gent, Belgium, E-mail: info@ursi.org

A detailed list of meetings is available on the URSI website at http://www.ursi.org/events.php

Information for Authors

Content

The *Radio Science Bulletin* is published four times per year by the Radio Science Press on behalf of URSI, the International Union of Radio Science. The content of the *Bulletin* falls into three categories: peer-reviewed scientific papers, correspondence items (short technical notes, letters to the editor, reports on meetings, and reviews), and general and administrative information issued by the URSI Secretariat. Scientific papers may be invited (such as papers in the *Reviews of Radio Science* series, from the Commissions of URSI) or contributed. Papers may include original contributions, but should preferably also be of a sufficiently tutorial or review nature to be of interest to a wide range of radio scientists. The *Radio Science Bulletin* is indexed and abstracted by INSPEC.

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