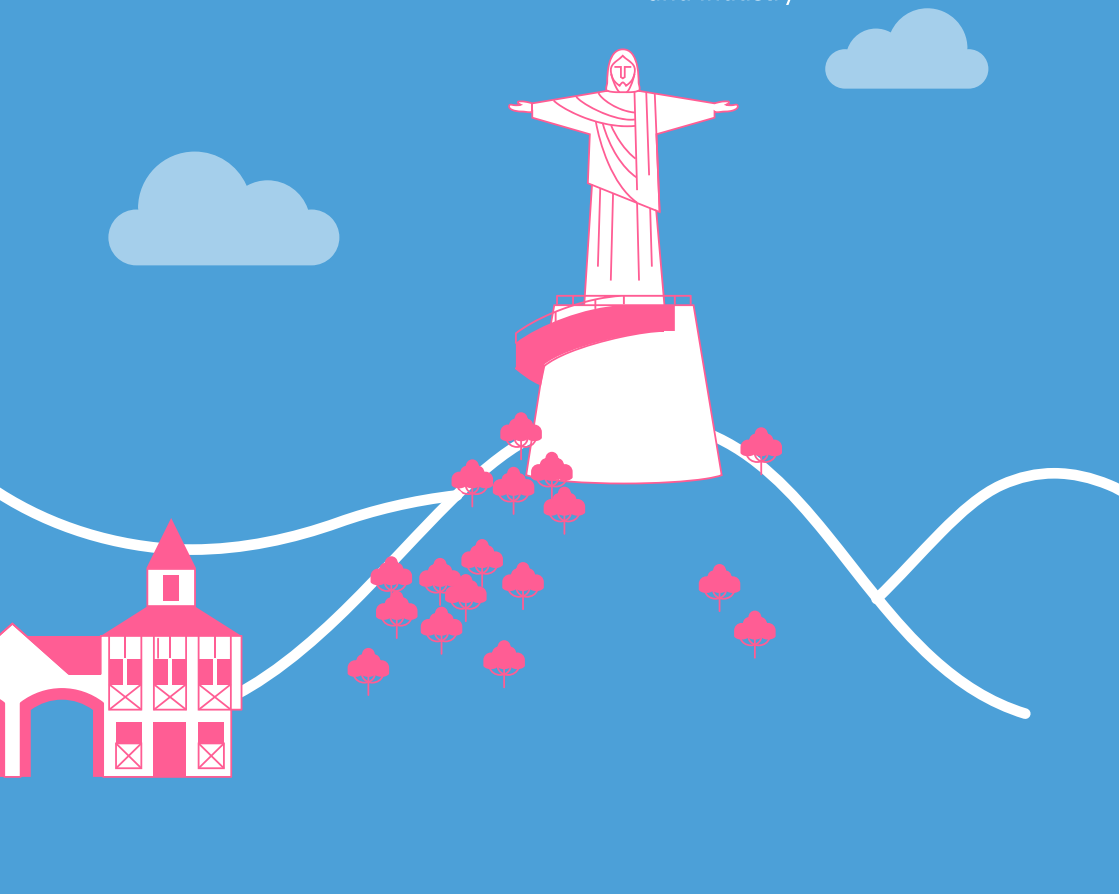
IMOC 2017
águas de lindóia

# Conference Programme

**SBMO/IEEE MTT-S International Microwave and Optoelectronics Conference**

Águas de Lindoia, Brazil
August 27th—30th

Bridging Academia,
Research Centers,
and Industry



# Table of Contents

It is a great pleasure for me to welcome you to the 17th edition of the SBMO/IEEE MTT-S International Microwave and Optoelectronics Conference, IMOC 2017, this time in Águas de Lindoia, state of São Paulo, Brazil. I wish to extend to you the greetings from the Organizing and Technical Program Committees and Support Team, who have been working for over 1 year to make this event possible.

Sponsored by the Brazilian Microwave and Optoelectronics Society (SBMO) and the Microwave Theory and Technique Society of the Institute of Electrical and Electronics Engineers (IEEE MTT-S), IMOC is a biennial event aimed at the exchange and dissemination of scientific and technological knowledge on microwave, antenna, optical communication, sensors and their applications. It gathers national and international representatives of universities, research institutions, manufacturers of equipment and devices, telecommunication operators and government bodies.

IMOC 2017

The technical activities of this Edition start with 6 Short Courses given by renowned researchers and specialists. They cover important topics within the conference scope. The Technical Program has been organized with 8 Plenary Sessions, presented by distinguished guests, 14 Oral Sessions for Regular Papers, with 12 Invited Papers, 4 Poster Sessions and 1 Oral Session for Post Deadline Papers – in a total of 159 peer-reviewed papers. To provide graduate and undergraduate students attending the conference with an engaging challenge to embrace, a Student Paper Competition has also been organized, in partnership with IEEE Photonics Society (IPS).

IMOC 2017 is themed "Bridging Academia, Research Centers, and Industry". In this context, we have organized a Workshop to discuss the challenges, technology trends and product development processes aiming at innovative and cooperative initiatives not only between university and research center groups but, also, with the industry segment. The Workshop comprises 3 Plenary Sessions and 8 Invited Talks.

I would like to thank SBMO and IEEE MTT-S and the other Sponsors – many of them can be met at the Exhibit Hall – for their financial and technical support. I would also like to thank our guest speakers and all professionals, researchers, academics and students authoring the papers and/or attending the conference. Without our joint effort IMOC 2017 would not become a reality. On behalf of IMOC 2017 Organizing and Technical Program Committees, I hope everybody enjoy this opportunity to share information, to meet people and, also, the social events.

Daniel Moutinho Pataca
IMOC 2017 General Chair

IMOC2017
águas de lindóia

# General Information

## Badge

Please note that badges must be worn during the whole conference, except during welcome and conference dinners.

## Oral Presentation

Authors must deliver their presentation files at the room of the session at least 20 minutes prior to the session start time or, if possible, on the day before, at the registration desk. We ask the presenters to be at the session room 15 minutes before the session starts.

Time slot for each oral presentation: 30′ (25′ for presentation + 5′ for discussion), for Invited Papers, and 15′ (12′ for presentation + 3′ for discussion), for Regular Papers.

Session Chairs are instructed to strictly limit the length of a presentation. We kindly ask the presenters their cooperation in keeping the schedule

## Posters

Poster sessions provide an opportunity for selected papers to be presented in greater visual detail and the posters should be prepared to facilitate the discussions with attendees. Authors must remain in the vicinity of the bulletin board for the duration of the session to answer questions and are required to use only the boards corresponding to their posters.

Note that poster presenters are not supplied with any audiovisual equipment.

Members of the local staff will assist the authors in poster set up. Each poster board is marked with a poster ID-number and posters shall be fixed with some stick tape or other non-perforating material.





Posters not removed by the end of the teardown will be removed and the organization will not take any responsibility for it.

The Poster Sessions will be displayed on August 29 (Tuesday) and 30 (Wednesday) from 11:20 until 13:00.

**Set up**, in both days: 9:00 to 11:00

**Teardown**: 13:30

## Student Paper Competition

Registration will be open at the reception desk up to at least 1 hour prior to the beginning of the technical session where the paper will be presented. Each competition entry must be authored by one student only – neither supervisor(s) nor other student(s) are allowed as co-authors.

## Venue

**Hotel Majestic**
Praça Dr. Vicente Rizzo, 160 (for GPS use Av. das Esmeraldas, 200)
Águas de Lindóia – SP, Brazil
**Contact**: contato@hotelmajestic.com.br
**Phone**: +55 11 3217 9800 and +55 11 3672 2955

## Shuttle Service

The Shedule for Departure from Águas de Lindoia to Campinas will be displayed at the Registration Desk.

## Lunch & Coffee Break

The registration fee does not include lunch. If the attendant is staying in Hotel Majestic, the lunch is included in the package. The coffee break is free for all attendees.

## Insurance

Brazil has a public health service system, but it is recommended that all participants carry the proper travel and health insurance. The Organizers of the Conference do not provide insurance for the attendees and do not take responsibility for any loss, accident or illness that might occur during the Conference or in the course of travel to or from the meeting site.

## Climate

In Águas de Lindoia, the month of August is characterized by gradually rising daily high temperatures, with daily highs increasing from 24.4°C to 26.6°C (76°F to 80°F) over the course of the month, and rarely exceeding 31.1°C (88°F) or dropping below 19.4°C (67°F). Daily low temperatures increase from 11.6°C to 13.3°C (from 53°F to 56°F), rarely falling below 7.7°C (46°F) or exceeding 16.6°C (61°F).

The month of August in Águas de Lindóia experiences essentially constant cloud cover, with the percentage of time that the sky is overcast or mostly cloudy remaining about 28% throughout the month.

Unlike temperature, which typically varies significantly between night and day, dew point tends to change more slowly, so while the temperature may drop at night, a muggy day is typically followed by a muggy night.

## Currency

Brazilian Real (BRL R$)

International credit cards (American Express, Master Card, Visa) are accepted at most hotels, restaurants and shops. ATMs are available at Águas de Lindoia city.





## Electricity

Voltage: 110 V, generated at 60 Hz. It is advised to bring an adapter type B (also works with type C) electrical outlets. For additional details, please visit http://www.worldstandards. eu/electricity/plugs-and-sockets/n/

## Useful Telephone Numbers

**Police**: +55 19 3824 1661
**Ambulance**: +55 19 3824 2074
**Pharmacy (24h)**: +55 19 3824 4629
**Taxi**: +55 19 3824-1404 / 3824-1847 / 3824-1557

**Bus Station**
Rápido Serrano: +55 19 3824 1128
Auto Viação Bragançal: +55 19 3824 1682
MKZ: +55 19 3824 1574

# Social Events

## Welcome Cocktail

Pentagono Room

19:00 – 21:00 Sunday, August 27

Cocktail is free for all conference attendees.

## Conference Dinner

Pentagono Room

21:00 – 23:00 Tuesday, August 29

Featuring a Musical Show with Paulo Freire and Ana Salvagni (http://www.paulofreirevioleiro.com.br/index.htm and http://www.anasalvagni.com.br/)

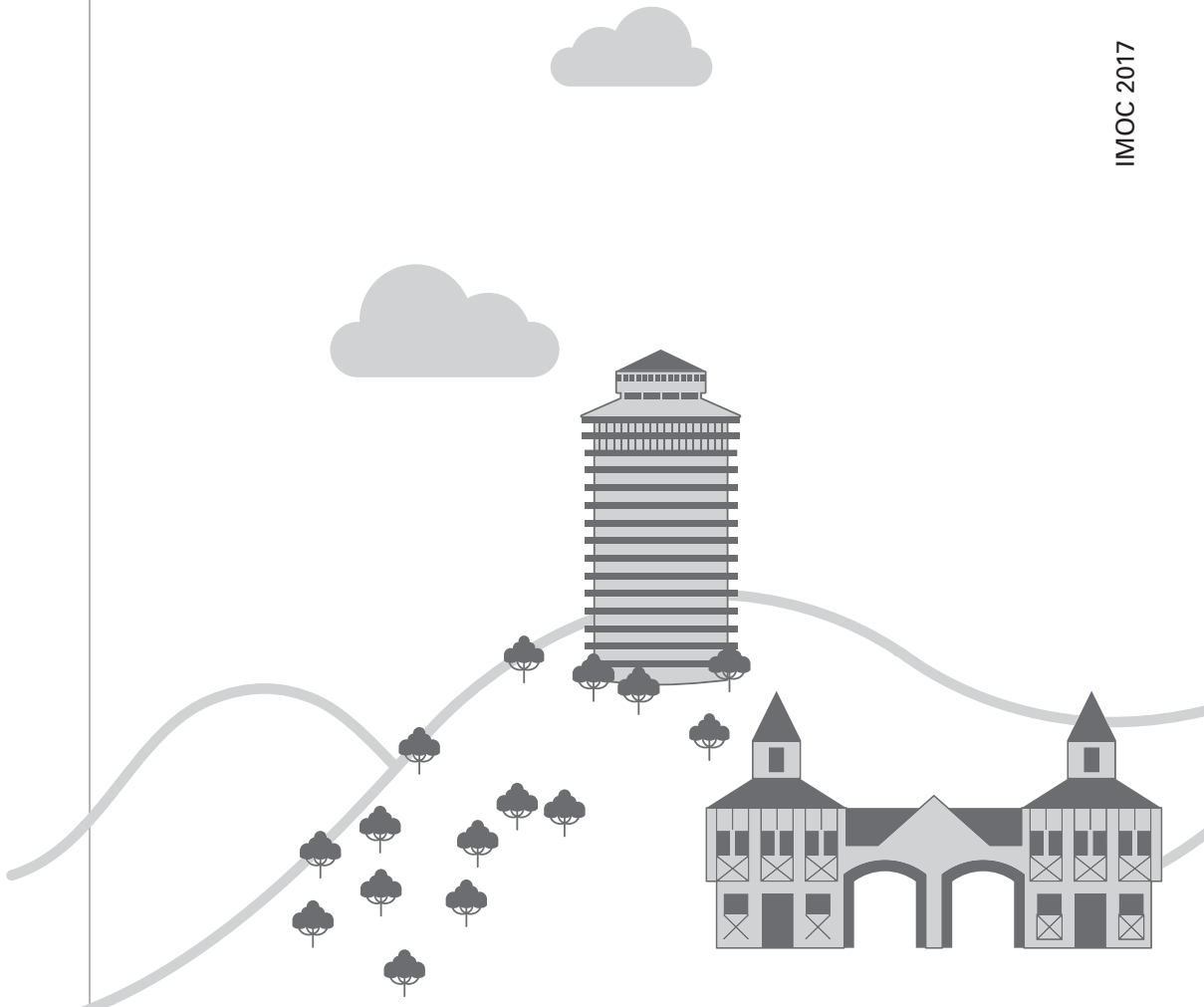
Conference dinner is included for all full-registration attendees. Invitations can be purchased at the reception desk for students and companions.

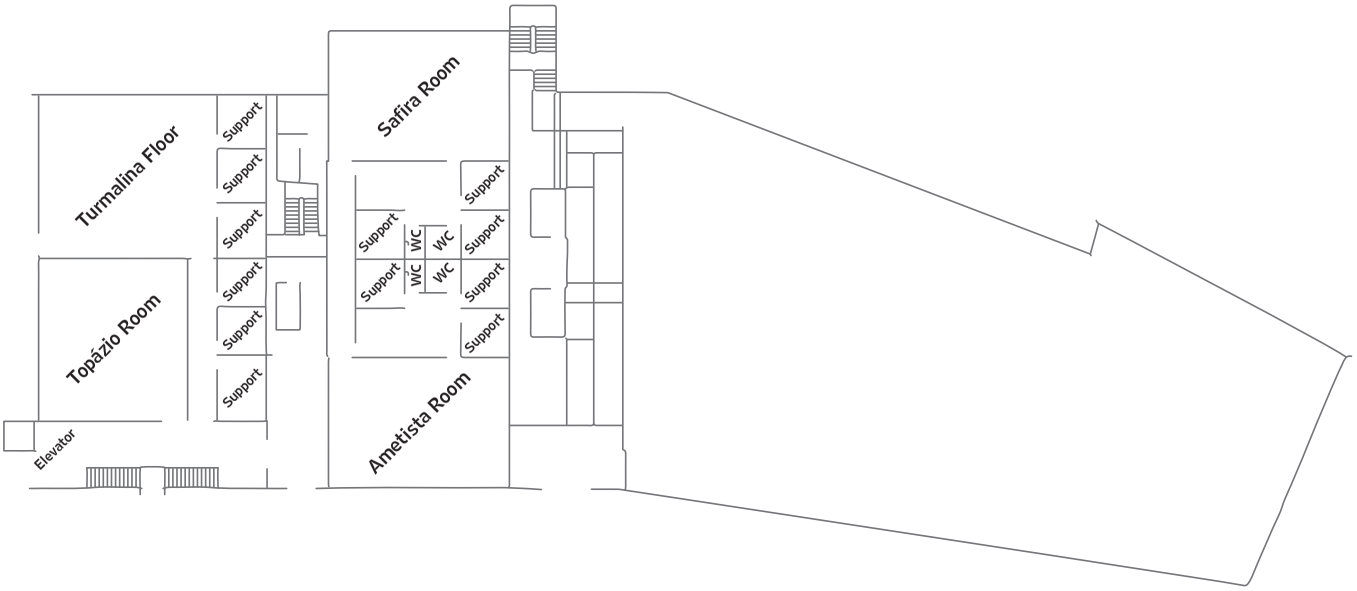
Further information will be provided at the reception desk.



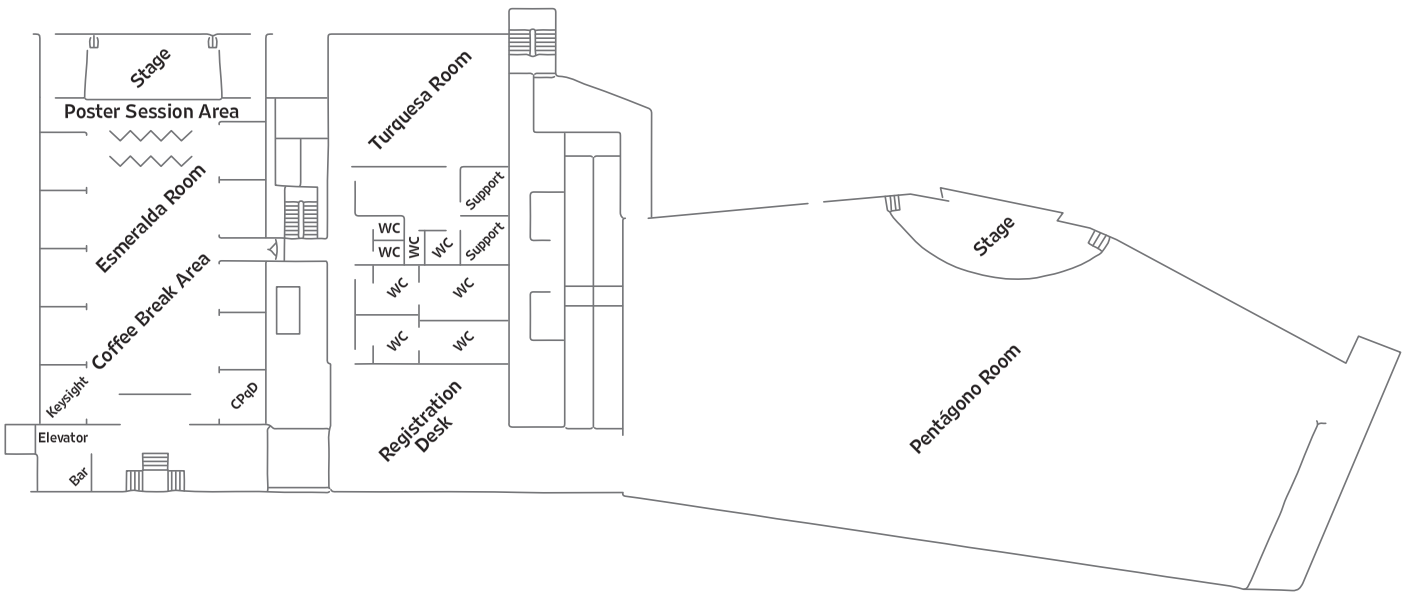


IMOC 2017

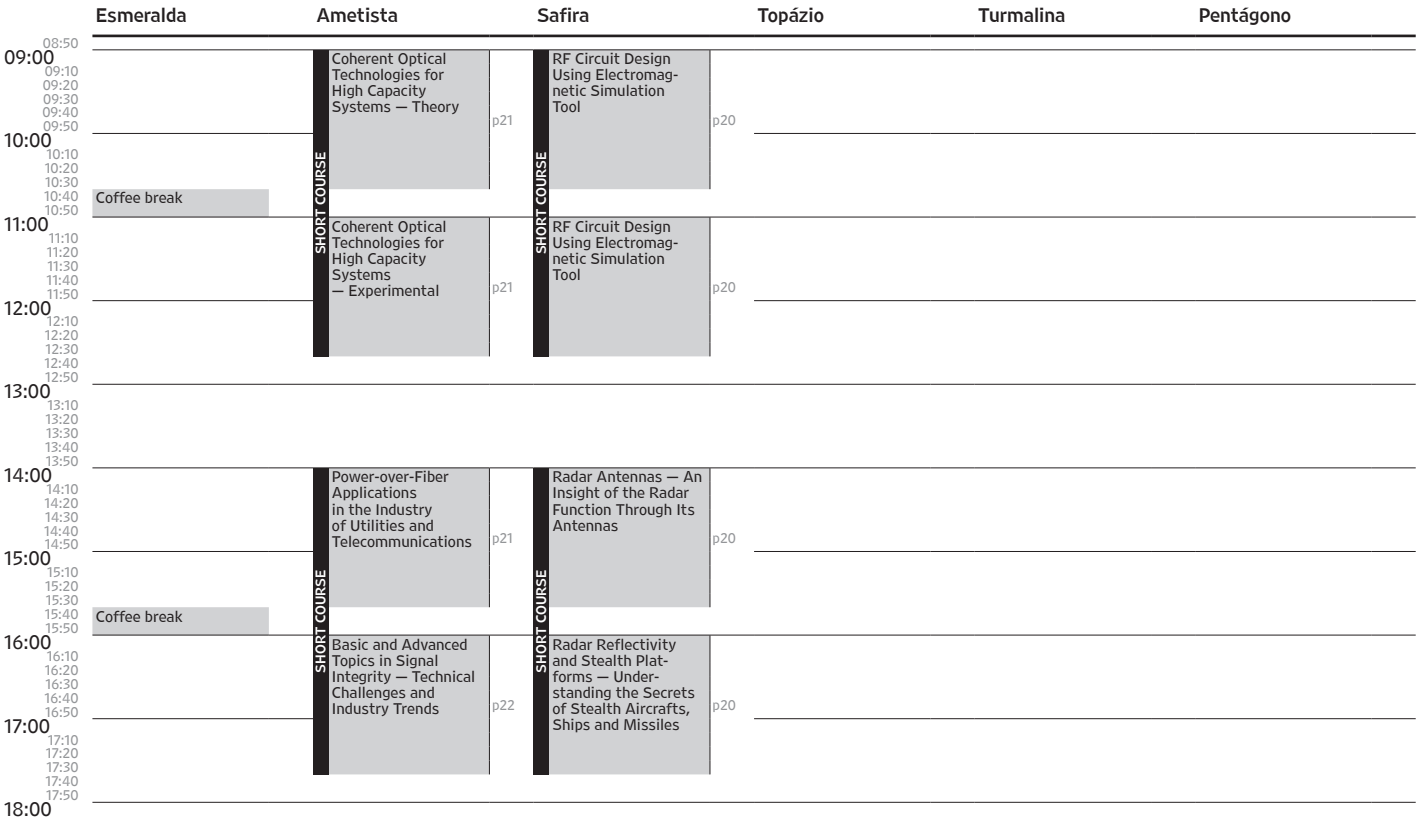




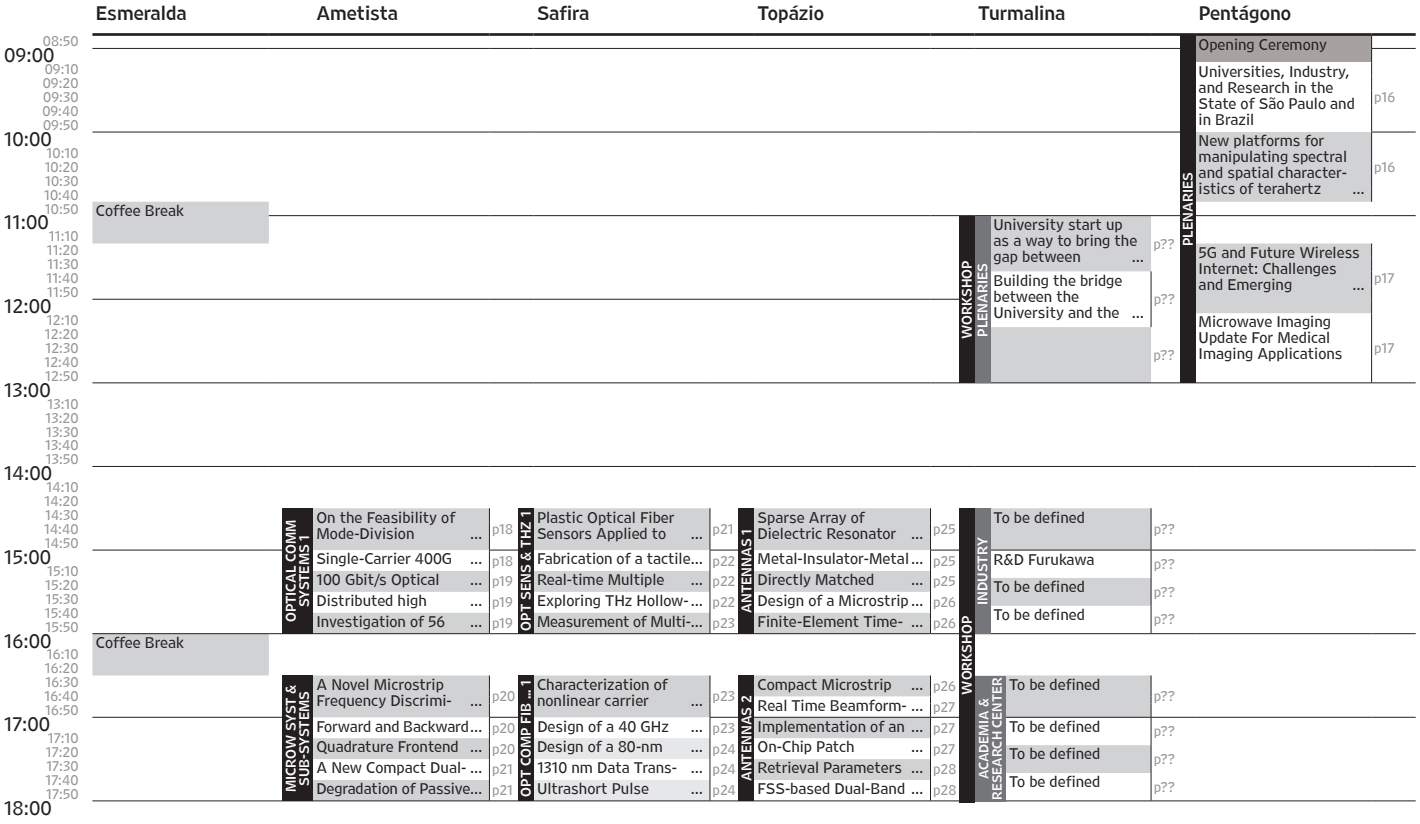

# Ground floor

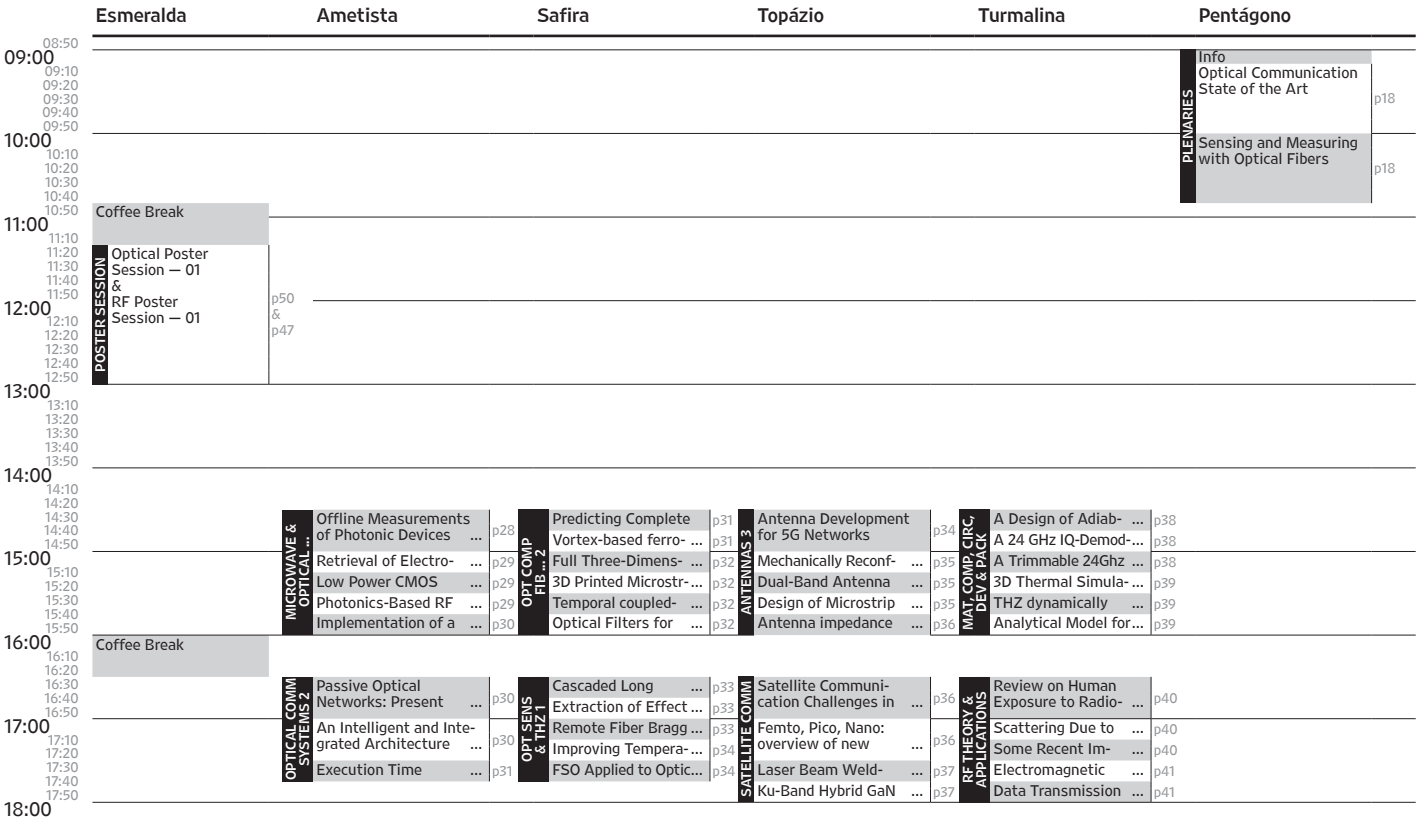


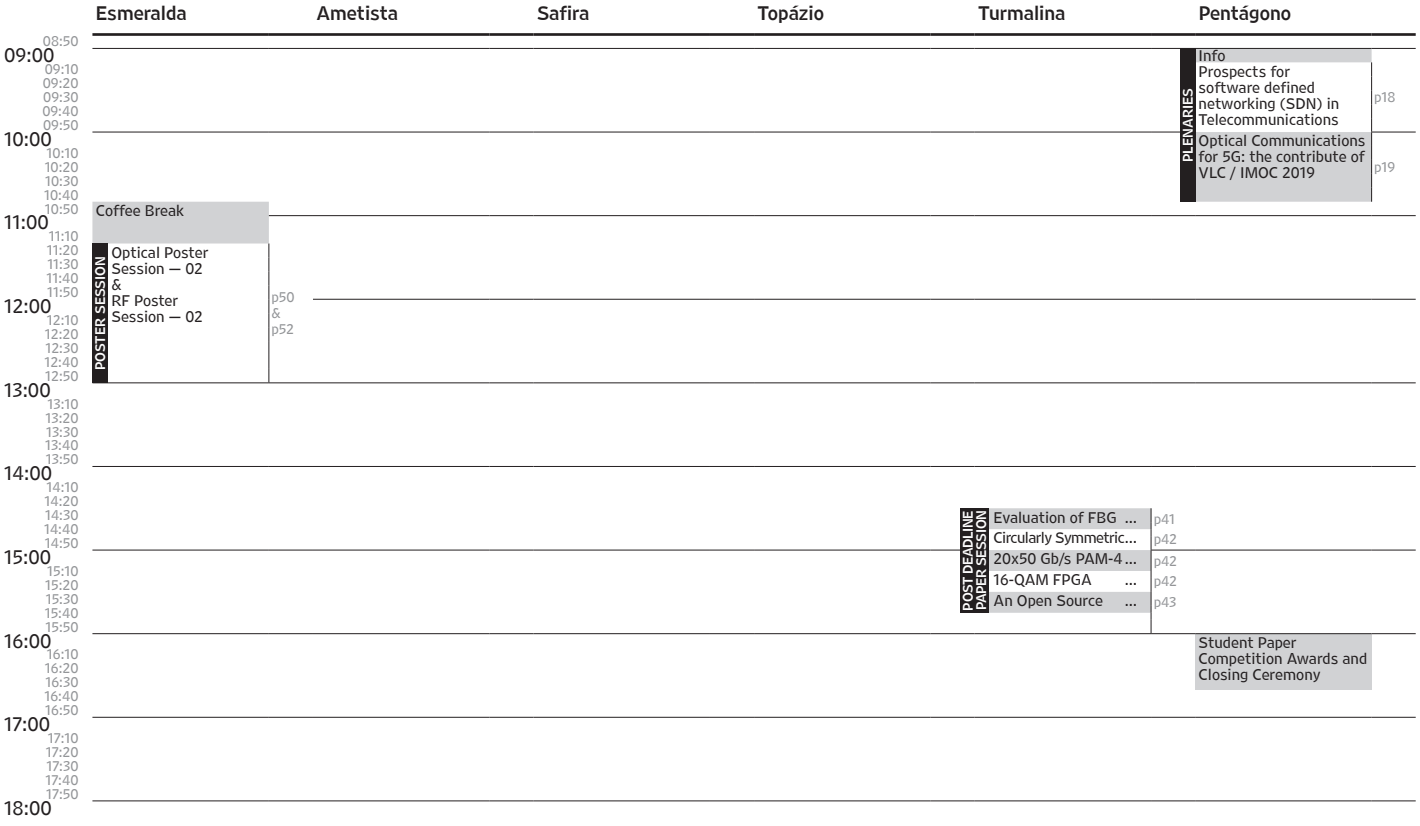

# Upper Floor


Esmeralda
Ametista
Safira
Topázio
Turmalina
Pentágono
Coffee break
Coffee break
SHORT COURSE
Coherent Optical Technologies for High Capacity Systems — Theory p21
Coherent Optical Technologies for High Capacity Systems — Experimental p21
Power-over-Fiber Applications in the Industry of Utilities and Telecommunications p21
Basic and Advanced Topics in Signal Integrity — Technical Challenges and Industry Trends p22
RF Circuit Design Using Electromagnetic Simulation Tool p20
RF Circuit Design Using Electromagnetic Simulation Tool p20
Radar Antennas — An Insight of the Radar Function Through Its Antennas p20
Radar Reflectivity and Stealth Platforms — Understanding the Secrets of Stealth Aircrafts, Ships and Missiles p20




Esmeralda
Ametista
Safira
Topázio
Turmalina
Pentágono
Coffee Break
Coffee Break
PLENARIES
Opening Ceremony
Universities, Industry, and Research in the State of São Paulo and in Brazil p16
New platforms for manipulating spectral and spatial characteristics of terahertz ... p16
5G and Future Wireless Internet: Challenges and Emerging ... p17
Microwave Imaging Update For Medical Imaging Applications p17
WORKSHOP PLENARIES
University start up as a way to bring the gap between ... p??
Building the bridge between the University and the ... p??
p??
OPTICAL COMM SYSTEMS 1
On the Feasibility of Mode-Division ... p18
Single-Carrier 400G ... p18
100 Gbit/s Optical ... p19
Distributed high ... p19
Investigation of 56 ... p19
OPT SENS & THZ 1
Plastic Optical Fiber Sensors Applied to ... p21
Fabrication of a tactile... p22
Real-time Multiple ... p22
Exploring THz Hollow-... p22
Measurement of Multi-... p23
ANTENNAS 1
Sparse Array of Dielectric Resonator ... p25
Metal-Insulator-Metal ... p25
Directly Matched ... p25
Design of a Microstrip ... p26
Finite-Element Time- ... p26
WORKSHOP INDUSTRY
To be defined p??
R&D Furukawa p??
To be defined p??
To be defined p??
MICROW SYST & SUB-SYSTEMS
A Novel Microstrip Frequency Discrimi- ... p20
Forward and Backward... p20
Quadrature Frontend ... p20
A New Compact Dual- ... p21
Degradation of Passive... p21
OPT COMP FIB ... 1
Characterization of nonlinear carrier ... p23
Design of a 40 GHz ... p23
Design of a 80-nm ... p24
1310 nm Data Trans- ... p24
Ultrashort Pulse ... p24
ANTENNAS 2
Compact Microstrip ... p26
Real Time Beamform- ... p27
Implementation of an ... p27
On-Chip Patch ... p27
Retrieval Parameters ... p28
FSS-based Dual-Band ... p28
WORKSHOP ACADEMIA & RESEARCH CENTER
To be defined p??
To be defined p??
To be defined p??
To be defined p??


Esmeralda
Ametista
Safira
Topázio
Turmalina
Pentágono
PLENARIES
Info
Optical Communication State of the Art p18
Sensing and Measuring with Optical Fibers p18
Coffee Break
POSTER SESSION
Optical Poster Session — 01 & RF Poster Session — 01 p50 & p47
MICROWAVE & OPTICAL ...
Offline Measurements of Photonic Devices ... p28
Retrieval of Electro- ... p29
Low Power CMOS ... p29
Photonics-Based RF ... p29
Implementation of a ... p30
OPT COMP FIB ... 2
Predicting Complete p31
Vortex-based ferro- ... p31
Full Three-Dimens- ... p32
3D Printed Microstr-... p32
Temporal coupled- ... p32
Optical Filters for ... p32
ANTENNAS 3
Antenna Development for 5G Networks p34
Mechanically Reconf- ... p35
Dual-Band Antenna ... p35
Design of Microstrip ... p35
Antenna impedance ... p36
MAT, COMP, CIRC, DEV & PACK
A Design of Adiab- ... p38
A 24 GHz IQ-Demod-... p38
A Trimmable 24Ghz ... p38
3D Thermal Simula- ... p39
THZ dynamically ... p39
Analytical Model for... p39
Coffee Break
OPTICAL COMM SYSTEMS 2
Passive Optical Networks: Present ... p30
An Intelligent and Integrated Architecture ... p30
Execution Time ... p31
OPT SENS & THZ 1
Cascaded Long ... p33
Extraction of Effect ... p33
Remote Fiber Bragg ... p33
Improving Tempera-... p34
FSO Applied to Optic... p34
SATELLITE COMM
Satellite Communication Challenges in ... p36
Femto, Pico, Nano: overview of new ... p36
Laser Beam Weld- ... p37
Ku-Band Hybrid GaN ... p37
RF THEORY & APPLICATIONS
Review on Human Exposure to Radio- ... p40
Scattering Due to ... p40
Some Recent Im- ... p40
Electromagnetic ... p41
Data Transmission ... p41


Esmeralda
Ametista
Safira
Topázio
Turmalina
Pentágono
PLENARIES
Info
Prospects for software defined networking (SDN) in Telecommunications p18
Optical Communications for 5G: the contribute of VLC / IMOC 2019 p19
Coffee Break
POSTER SESSION
Optical Poster Session — 02 & RF Poster Session — 02 p50 & p52
POST DEADLINE PAPER SESSION
Evaluation of FBG ... p41
Circularly Symmetric... p42
20x50 Gb/s PAM-4 ... p42
16-QAM FPGA ... p42
An Open Source ... p43
Student Paper Competition Awards and Closing Ceremony

# Plenaries

## ■ Monday, August 28th

09:10—10:00 Pentágono Room Public

### ↘ Universities, Industry, and Research in the State of São Paulo and in Brazil

Carlos Henrique de Brito Cruz

10:00—10:50 Pentágono Room Microwave

### ↘ New platforms for manipulating spectral and spatial characteristics of terahertz waves

Mona Jarrahi

Although unique potentials of terahertz waves for chemical identification, material characterization, biological sensing, and medical imaging have been recognized for quite a while, the relatively poor performance, higher costs, and bulky nature of current terahertz systems continue to impede their deployment in field settings. In this talk, I will describe some of our recent results on developing fundamentally new terahertz electronic/optoelectronic components and imaging/spectrometry architectures to mitigate performance limitations of existing terahertz systems. In specific, I will introduce new designs of high-performance photoconductive terahertz sources that utilize plasmonic antennas to offer terahertz radiation at record-high power levels of several milliwatts – demonstrating more than three orders of magnitude increase compared to the state of the art. I will describe that the unique capabilities of these plasmonic antennas can be further extended to develop terahertz detectors and heterodyne spectrometers with single-photon detection sensitivities over a broad terahertz bandwidth at room temperatures, which has not been possible through existing technologies. To achieve this significant performance improvement, plasmonic antennas and device architectures are optimized for operation at telecommunication wavelengths, where very high power, narrow linewidth, wavelength tunable, compact and cost-effective optical sources are commercially available. Therefore, our results pave the way to compact and low-cost terahertz sources, detectors, and spectrometers that could offer numerous opportunities for e.g., medical imaging and diagnostics, atmospheric sensing, pharmaceutical quality control, and security screening systems. And finally, I will briefly highlight our research activities on development of new types of high-performance terahertz passive components (e.g., modulators, tunable filters, and beam deflectors) based on novel reconfigurable meta-films.







11:20—12:10 Pentágono Room Microwave

### ↘ 5G and Future Wireless Internet: Challenges and Emerging Technologies

H Anthony Chan

Wireless devices are becoming more diverse with not just over 6 billion wireless phones but also possibly a much larger number of sensors, machines contributing to machine to machine communication, and practical everything in the so called Internet of Things (IoT). With an anticipated growth to 100 billion IoT devices by year 2025, more dense radio networks are emerging. Both data and signaling from mobile devices are expected to grow exponentially over the next five or more years. The cellular networks serving cellular phones and mobile devices globally have employed centralized control with different network functions arranged in a hierarchy. On the other hand, the Internet which is originally built for fixed users is making perhaps the biggest changes to serve the wireless users. Meanwhile networks are being transformed with software defined networking as well as network function virtualization and cloudification as the technologies in communication technologies and information technologies are merging. Standards to define 5G technologies are underway.

12:10—13:00 Pentágono Room Microwave

### ↘ Microwave Imaging Update for Medical Imaging Applications

Roger Stancliff

This talk will provide an update on the progress of Keysight and various partners on Microwave Medical Imaging products, systems, and their commercialization. It will approach the physical basis for this imaging modality and then provide an update on the progress to date of a number of product trials and commercialization activities from Dune Medical, Micrima, Medfield Diagnostics, EMTensor, and MiWa technologies. Extensive references are included. These are not comprehensive but representative of the research ongoing in Microwave Medical Imaging.

## ■ Tuesday, August 29th

09:10—10:00 Pentágono Room

### ↘ Optical Communication State of the Art

Andrew Ellis

From the first recorded use of optical communications using fire beacons, there have been many turning points in the development of optical communications over history. Innovations have included semaphore networks, single mode optical fibres, and optically amplified wavelength division multiplexed networks. Each turning point has fundamentally altered the way we view communications as a whole, with the deployment of optically amplified networks underpinning the internet, social media, e-commerce, indeed our modern way of life. Whilst there is still a long way to go in terms of deployment, especially in the last mile, there is a feeling that the next turning point is around the corner. Technologies contending to become the next turning point include all-optical nonlinearity compensation, novel new fibres such as hollow-core or advanced multi-mode, optical networking for short range (e.g. data centre) applications, converged fixed wireless networks and massive spatial diversity. In this presentation, we will review the most recent research in optical communications, examine the impact on energy consumption and speculate on the societal changes that may be enabled by the next generation of communication technology.



10:00—10:50 Pentágono Room

### ↘ Sensing and Measuring with Optical Fibers

Walter Margulis

Optical fibers have been used for sensing and measurement for decades. Recently, however, the use of fibers in industrial environments became much more accepted. Some of the driving forces behind this development include the concept that machines must also tell us how they are doing, the introduction of new classes of materials, and the need for increased efficiency in industrial processes, for example at high temperature or under the sea. All these open new opportunities for the use of fibers. Likewise, the needs for monitoring the environment, for safety and for human health are examples of challenges that require advanced sensing. The known advantages of optical fibers are then increasingly explored in monitoring temperature, pressure, movement, distance, acceleration, electric and magnetic fields and current and many other parameters. In this talk, we will discuss possibilities opened by the use of advanced fibers and techniques for sensing and measurement, and give some examples of recent work in the area.

09:10—10:00 Pentágono Room

### ↘ Prospects for software defined networking (SDN) in Telecommunications

Paul Gunning

This last decade has witnessed the emergence, growth and consolidation of software defined networking, underpinned by merchant silicon hardware and open source software, in warehouse scale datacenters across the globe. Attention is turning to how SDN might be adapted, re-purposed and deployed in telecommunications networks. This talk will consider the prospects (and highlight some of the pitfalls) for SDN in the coming decade to transform telecommunications networks across the globe.





10:00—10:50 Pentágono Room

### ↘ Optical Communications for 5G: the contribute of VLC / IMOC 2019

Paulo Sérgio de Brito André

In the near future, optical fiber access transport needs to be scalable to support the projected 5G deployment goals. When the topic of 5G wireless is discussed, the first though isn't optical communications. However, this architecture more than just a radio access technology, encompasses the entire network infrastructure, from optical core to radio access network. Besides the obvious implications for the core transport, that can only be achieved by exploring new and advanced technologies, like SDM along with energy efficient coherent detection based modulation formats, the improvement of coverage, capacity, and overall Quality of Experience in datacenter and downtowns, can rely in free-space links, which are a low cost and a flexible solution. By introducing additional orthogonal multiplexing dimensions, like the space and the orbital angular momentum, along with advanced modulation formats we are proposing optical backhaul solutions with very-high capacity, spectral efficiency, and energy efficiency, and low cost per bit for visible light communication links. The concept of wavefront spatial-phase modulation VLC transmission and the generation of OAM carrying beams are robust and suitable solutions to overcome some obstacles of today's networks, such as the improvement of spectral efficiency. Such kind of solution will reveals of most importance to face the increasing bandwidth demand and challenging requirements arising from new applications in very high capacity future 5G networks.

# Short Courses

## ■ Sunday, August 27th

09:00—12:40 Safira Room SC-M-SUN-01

### ↘ RF Circuit Design Using Electromagnetic Simulation Tool

Mauricio Kobayashi

Effective Operation of ADS User's Interface; Circuit Design Using Schematic and Layout environments; S-Parameters Concepts Review; EM Simulation Technologies MoM, FEM and FDTD; Filter Design using simulators "S-Parameter" and "Momentum"

14:00—15:40 Safira Room SC-M-SUN-02

### ↘ Radar Antennas — An Insight of the Radar Function Through Its Antennas

Antonio Dias de Macedo Filho

Radars are used in a large variety of applications and their main architecture main change somewhat from case to case. However, for intelligence gathering purpose, the main feature that a technical observer can distinguish is its antennas. Moreover, the technical status of the radar may also be inferred and any technological breakthrough may be investigated. This course will deal with two main subjects: The first one is to describe the several kinds of radar and their main applications. The second one is how these radars must spread into space the energy provided by their transmitters. The analysis of such feature is crucial to pinpoint the possible use of the radar.

16:00—17:40 Safira Room SC-M-SUN-03

### ↘ Radar Reflectivity and Stealth Platforms – Understanding the Secrets of Stealth Aircrafts, Ships and Missiles

Antonio Dias de Macedo Filho

Modern radars face the challenge of low Radar Cross Section (RCS) targets. These targets are designed with the intention to reflect the least possible energy back in the direction of the incident radar signals. These studies are conducted since the radar early days at II World War and today there are plenty of examples of aircrafts and ships of very low RCS. This Short Course intents to present radar signal propagation and to describe the Radar Cross Section of specific targets. It will show how the use of special materials and proper shaping of the target superstructure can reduce this parameter. It will also be discussed how radars can overcome such measures and be able to detect the so-called stealth platforms. The course will first describe the basics of radar signal propagation and how the RCS will limit the target detection. After the main techniques used to reduce the platform's RCS will be described. In sequence, several examples of stealth aircrafts, ships, missiles and land vehicles will be shown and commented. Finally, some techniques used by radar designers to provide them with low RCS detection capability are discussed. This course will also be useful to introduce graduate engineers and students to the radar science which is a field closely related to telecommunications engineering.







09:00—10:40 Ametista Room SC-O-SUN-01a

### ↘ Coherent Optical Technologies for High Capacity Systems — Theory

Andrea Chiuchiarelli, Eduardo Rosa

In an era where the demand for IP traffic from users and enterprises is constantly increasing, coherent optical communications are widely established as the most effective solution to ensure high capacity per bandwidth over distances that range from a few kilometers to thousands of kilometers. Today, coherent optical technologies represent the core of metro and long-haul transmission systems, enabling transmission of a tremendous amount of data with the highest spectral efficiency. More recently, coherent optics also gained wide interest for shorter reach applications, such as data center interconnect, due to its technological maturity and increasing cost effectiveness compared to direct detection systems. This short course will give an overview on digital coherent optical technologies, both from a system and signal processing point of view. In the first part of the course, the building blocks of a coherent optical system will be reviewed, along with the main transmission scenarios. The second part will focus on digital signal processing techniques for signal generation and detection, highlighting its benefits and pointing out the main challenges to be overcome for each of the proposed transmission scenarios.

11:00—12:40 Ametista Room SC-O-SUN-01b

### ↘ Coherent Optical Technologies for High Capacity Systems — Experimental

Rodrigo Vicentini

14:00—15:40 Ametista Room SC-O-SUN-02

### ↘ Power-over-Fiber Applications in the Industry of Utilities and Telecommunications

João Batista Rosolem

Beyond telecommunications optical fibers can also transport optical energy to powering electric or electronic devices remotely. This technique is called power over fiber (PoF). Besides the advantages of optical fiber (immunity to electromagnetic interferences and electrical isolation) the employment of a PoF scheme can eliminate the energy supply by metallic cable and batteries located at remote sites, improving the reliability and the security of the system. PoF is very interesting technique to be applied in Smart Grid. Smart Grid is seen by experts as the output to a new technological level seeks to incorporate extensively technologies for sensing, monitoring, information technology and telecommunications for the best performance electrical network. On the other hand in passive optical networks (PON) PoF can make PON extenders virtually passives. This short course describes the PoF principle, its main elements, technologies and the applications focusing in access networks and in smart grid developed by the author. Objectives:

We will present in this course not only a comprehensive review of PoF since the 70's when it was published the first paper for telecommunication application, but a complete explanation about how it works and how it has been applied in real field applications.

16:00—17:40 Ametista Room SC-0-SUN-03

**Basic and Advanced Topics in Signal Integrity — Technical Challenges and Industry Trends.**

Davi Correia

This short course will give the student the overall understanding of what signal integrity is, the main technical challenges, and the common solutions. It will address how the microwave/electromagnetic community can contribute in the signal integrity development. The industry trends, state-of-the art solutions and advanced techniques will also be discussed. At the end, the student should be able to identify critical technical challenges in the design phase of high-speed circuits. He should also be able to recognize the industry leaders, what the trends are, and some of the new products and technologies that are coming to the market.





IMOC 2017

Short Courses

# Technical Sessions
# Oral Sessions

■ TS-O-MON-01 **Optical Communications Systems – 01**
Monday, August 28th 14:30-16:00 Ametista Room

↘ **TS-O-MON-01-01 On the Feasibility of Mode-Division Multiplexed Transmission over Few-Mode Fibres (Invited Paper)**
Filipe M. Ferreira, Christian Sanchez, Stylianos Sygletos, Andrew Ellis

This paper reviews our most recent results on mode-division multiplexing systems based on few-mode fibres with low differential mode delay, spanning from the fibre design optimization to the receiver memory dimensioning. First, the fibre refractive-index profile is optimized for low differential mode delay and low macro-bend losses. Afterwards, we present a semi-analytical model of the linear mode coupling induced by fibre imperfections and stress. Finally, the interplay between the linear mode coupling and the differential mode delay is studied numerically and analytically, allowing to quantify the receiver memory required for a given fibre span.

↘ **TS-O-MON-01-02 Single-Carrier 400G Unrepeatered WDM Transmission using Nonlinear Compensation and DD-LMS with FEC Feedback**
José Hélio da Cruz Júnior, André Souza, João Januário, Sandro M Rossi, Andrea Chiuchiarelli, Jacklyn Reis, Sergejs Makovejs, Darli Mello

In this paper, we investigate the performance of unrepeatered optical transmission using nonlinear compensation, and dynamic equalization enhanced by forward error correction (FEC) feedback. The digital back-propagation (DBP) algorithm is used for nonlinear compensation, while error correction is provided by spatially-coupled low-density parity-check (SC-LDPC) codes. The technique is experimentally evaluated by the unrepeatered WDM transmission of 16x400 Gb/s single-carrier channels (66 GBd DP-16QAM) within a 75 GHz grid over 403 km (64.7 dB span loss), achieving 2.58 Pb/s.km. The results indicated Q2 margins to the FEC limit of up to 0.4 and 0.5 dB for 3 and 6-dBm average launch powers, respectively, exhibiting a tangible improvement compared with previous works.







↘ **TS-O-MON-01-03 100 Gbit/s Optical Transport Network 40 nm Test Chip Design and Prototyping**
Eduardo Mobilon, Rodrigo Bernardo, Luis Monte

This work reports the design and prototyping of a 100 Gbit/s OTN 40 nm test chip, manufactured as a test vehicle strategy for an OTN processor device under development at CPqD for the Brazilian telecom industry. The main issues related to the integration of third-party silicon intellectual property solutions are covered, together with the evaluation environment where the test chip was successfully validated.

↘ **TS-O-MON-01-04 Distributed high birefringent localization based in polarization OTDR converter: a field demonstration**
Claudio Floridia, João Batista Rosolem

We present a field demonstration of a distributed high birefringent localization based in POTDR-C (Polarization Optical Time Domain Reflectometer Converter). In such conception, a low cost converter is used after a commercial OTDR (Optical Time Domain Reflectometer) to reduce spectral line width of OTDR laser. This ensures high sensitivity to SOP (State of Polarization) changes due to local birefringence of optical signal keeping high reach of hundreds kilometers of present OTDR technology. The proposed system was tested in a real installed system in one route of 106.70 km with accumulated polarization mode dispersion (PMD) of 31.46 ps. It successfully determined three segments of high PMD in the route of 8.1 km, 4.0 km and 4.1 km. Replacement of identified high PMD sections resulted in PMD reduction to 1.354 ps, very close to predicted value of 1.314 ps.

↘ **TS-O-MON-01-05 Investigation of 56-GBd PAM4 Bandwidth and Chromatic Dispersion Limitations for Data Center Applications**
Rafael C. Figueiredo, André Souza, Stenio Ranzini, Luis Henrique Hecker de Carvalho, Jacklyn Reis

We investigate some key requirements for PAM4 operation at 56 Gbaud focusing on short-reach intra-data center interconnect. We report simulated results of bandwidth limitations for transmitter and receiver sides components with and without pulse shaping, presenting the penalties imposed in each scenario. We also evaluate chromatic dispersion tolerance for different values of bandwidth limitations, presenting the maximum possible reach without dispersion compensation. These analyses are important for an appropriated design of optical transmission systems employing 100G per wavelength.

## ■ TS-O-MON-02 **Microwave Systems and Subsystems**

Monday, August 28th 16:30-18:00 Ametista Room

### ↘ TS-O-MON-02-01 A Novel Microstrip Frequency Discriminator for IFM Based on Balanced Gray-code (Invited Paper)

Marcos Mello, Sérgio Souza, Elias Marques Ferreira de Oliveira, Túlio Pedrosa, Bruno G. M. de Oliveira, Ignacio Llamas-Garro, Lauro Lourenço, Novo

This work presents the design, simulation, fabrication and measurement of a novel set of microstrip filters to perform the task of frequency discriminators. These filters' frequency responses are based on the balanced Gray-code. Results show that the use of the balanced Gray-code, as opposed to the traditional Gray-code, allowed 20% circuit size reduction by using 60% less resonators due to a change in the resonators' orientation.

### ↘ TS-O-MON-02-02 Forward and Backward Waves Propagation in an Array of Split-Ring Resonators

Joaquim Leite Neto, Joaquim J Barroso, Pedro de Castro, Ugur Hasar, José Edimar Oliveria

Simulation studies of resonator split-ring resonators inserted in a rectangular waveguide WR-90 are conducted to determine the nature of wave propagation linked to the electric and magnetic responses of a metamaterial array inserted in a WR-90 waveguide. As expected, magnetic transmission band (around 3.6 GHz) is of backward-wave character. However, to the right of the isolated magnetic-resonance mini-band, there appears a wider transmission band (4-8 GHz) with multiple ripples which are identified as being of forward and backward types alternately. Unlike previous works on SRR-loaded waveguides, in which all the transmission resonances in the second band have been classified as of the forward-type, the occurrence of backward-wave transmission peaks in the second transmission band, as it is demonstrated here, has never been reported.

### ↘ TS-O-MON-02-03 Quadrature Frontend with Directional Coupler for RF Reflection Coefficient Measurements

Volker Kible, Karolinne Brito, Robson Lima

A Cartesian approach reflection coefficient measurement block based on a directional coupler and four quadrature mixers is presented in this work. The block was designed for use in an automatic impedance matching system in the ultra-high frequency range. Simulations, including parasitics, resulted in an average error of 3.4% full-scale and indicate a high potential of the approach for an implementation in integrated circuit technology. Measurements on a discrete setup demonstrate a maximum error of 28% full-scale and prove the usefulness of the approach.







### ↘ TS-O-MON-02-04 A New Compact Dual-band FSS with Angular and Polarization Stability for Wireless Applications

Valdemir Neto, Samuel Paiva, Adaildo G D'Assunção

This paper presents a compact dual-band dual polarized frequency selective surface (FSS) with angular stability for wireless communication applications. The proposed FSS element geometry is composed of a slotted cross dipole combined with four annular rings which are placed to provide symmetry along the conducting patch main axes. Simulation is performed using Ansoft HFSS software to ensure dual band and dual polarized performances which are suitable for modern wireless communication systems. The FSS angular stability is investigated considering the incidence of waves at different angles. Additionally, an investigation is performed for different polarized wave incidence. Simulation results are compared to measurements ones for validation purpose. Good agreement is observed between simulated and measured results.

### ↘ TS-O-MON-02-05 Degradation of Passive Microwave Components due to Metalstack Deviations in CMOS Technology

Soenke Vehring, Yaoshun Ding, Philipp Scholz, Friedel Gerfers, Georg Boeck, Ing Berger, Dominic Maurath, Silvio Ernesto Barbin

In this paper, performance degradations of passive microwave components induced by deviations of metalstack dimensions in a 65nm CMOS technology are presented. Customarily, on-chip passive microwave components use special technology options which evacuate large areas from metal fillers in order to decrease eddy-current losses. An issue of interest is the influence of metal filler absence on the dimensions of the fabricated passive component. As a case study, intensive investigations are done on an on-chip transformer which is employed for impedance matching, noise cancellation, and bias-T diplexing in an inputstage of a multi-stage 24GHz low-noise amplifier. Performance of the low-noise amplifier's input-stage is shown and discussed. The investigations start with electro-magnetic field-simulation of the transformer with metalstack dimensions provided by the CMOS foundry. With a fabricated testchip the transformer is measured and compared to the simulated performance. Since significant deviations are observed a focused ion-beam analysis is done in order to extract precise dimensions for the transformer. With the gained information more accurate electro-magnetic simulations can be performed for future designs.

## ■ TS-S-MON-03 **Optical Sensors and TeraHertz – 01**

Monday, August 28th 14:30-16:00 Safira Room

### ↘ TS-S-MON-03-01 Plastic Optical Fiber Sensors Applied to Electric Energy Industry (Invited Paper)

Marcelo Martins Werneck, Cesar Carvalho, Regina Allil

The Photonics and Instrumentation Laboratory (LIF) at the Universidade Federal do Rio de Janeiro is a R&D laboratory mainly involved in optical sensors applied to Energy, Oil & Gas and Biotechnology areas. This paper demonstrates some techniques used by LIF to measure,

detect and monitor several physical parameters applying plastic optical fiber (POF) either as sensor or as a communication channel for telemetry. The applications to be presented include measurement of electrical current in high voltage, temperature and leakage currents over insulators. We take advantage of the POF for its high insulation property, applying them to measure electrical parameters in high voltage environment. For each example presented, it will be shown the measurement principle, laboratory tests and field application.

### ↘ TS-S-MON-03-02 Fabrication of a tactile sensor array with fiber Bragg gratings using a 3D printed mold

Marcelo Pedroso, Lucas H Negri, Marcos Kamizi, José L Fabris, Marcia Muller

This work describes the fabrication of a tactile sensing array instrumented with six optical fiber Bragg gratings. Bragg gratings were housed in silicone elastomer with the aid of a mold manufactured with a 3D printer using filament of acrylonitrile butadiene styrene, 1.75 mm diameter. The sensor array was tested by measuring the FBGs wavelength shifts for different loads applied in the central position of the array. FBGs have shown linear responses with correlation coefficients better than 0.99. Additionally, the six FBGs have coupled responses, allowing the application of the sensor array in quasi-distributed tactile sensing.

### ↘ TS-S-MON-03-03 Real-time Multiple Machines Sound Listening Using a phase-OTDR Based Distributed Microphone

Carolina Franciscangelis, Walter Margulis, Leif Kjellberg, Claudio Floridia, Fabiano Fruet

We proposed and experimentally demonstrated a multiple machines sound listening using a spatially tunable phase-OTDR based distributed microphone. The distributed acoustic sensing capability, allied with the real-time spatial tuning, enabled this method to listen to a drill and a cooling water system pump placed in two different sections along a single optical fiber, one at a time. The recorded acoustic waveform profile of both machines agreed with their operating cycles. Moreover, the sounds generated by both engines were successfully distinguished through the proposed method besides both machines were operating simultaneously.

### ↘ TS-S-MON-03-04 Exploring THz Hollow-Core Fiber Designs Manufactured by 3D Printing

Alice Lima da Souza da Cruz, Cristiano MB Cordeiro, Gildo Rodrigues, Jonas Osorio, Luiz da Silva, Marcos Antonio Ruggieri Franco

In this paper we demonstrate the terahertz propagation characteristics of 3D printed hollow core fibers with inner capillaries. The fibers were numerically characterized using a beam propagation method software. The guidance is supported by antiresonant effect and the spectral transmission







was evaluated until 1.6THz. Special designs were proposed exploring the versatility of 3D printing technique. The potential application of these THz waveguides as a refractometer is presented.

### ↘ TS-S-MON-03-05 Measurement of Multi-point Displacements by Optical Fiber Specklegram Sensor

Eric Fujiwara, Murilo dos Santos, Carlos Suzuki

The evaluation of an optical fiber specklegram sensor on the assessment of multi-point displacements is reported. The light emitted by a 663 nm laser source is launched into the multimode fiber, resulting in an output speckle field that is detect by a CCD. The fiber is attached to 3 microbending transducers for specklegram modulation, being the intensity distribution referenced to the possible fiber statuses in order to calculate the relative speckle field changes. Finally, the obtained data is processed by artificial neural networks for retrieving the magnitude of each input displacement. The methodology was tested on the interrogation of 2 or 3 transducers, yielding maximum errors of 0.29 μm and 0.5 μm, respectively, regarding a 30 μm range. Although the specklegram sensitivity is reduced for a large number of attached devices, the methodology can be applied on the monitoring of small sensor arrays, providing a reliable alternative for time and wavelength-based multiplexing schemes.

## ■ TS-O-MON-04 Optical Components, Fibers and Devices – 01

Monday, August 28th 16:30-18:00 Safira Room

### ↘ TS-O-MON-04-01 Characterization of nonlinear carrier dynamics in silicon strip nanowaveguides (Invited Paper)

Paulo Fernandes da Silva Júnior, Ivan A Aldaya, Andrés Gil-Molina, Julián Pita, Hugo L. Fragnito

Nonlinear carrier recombination dynamics is characterized in a 450 nm × 220 nm silicon nanowire by employing a time-resolved pump-and-probe experiment. Our results show that the recombination rate is faster at the early stages of the decay as compared to the final stages, in agreement with trapassisted mechanism. We have also demonstrated that by operating at high carrier density, faster excess carrier generation and recombination can be obtained, which we have used to improve the speed of an all-optical FCA based silicon switch from about 7 to 1 ns.

### ↘ TS-O-MON-04-02 Design of a 40 GHz Bandwidth Slow-Wave Silicon Modulator

Diogo de Azevedo Motta, Yesica Rumaldo Bustamante, Alexandre Passos Freita, Giovanni Beninca de Farias, Uiara de Moura, Lucas Heitzmann Gabrielli

We present the design of a carrier depletion silicon modulator with series push-pull diode configuration and slow-wave transmission line for the 1550 nm wavelength range. The electro-optical

bandwidth is 40 GHz at -2.5 V diode bias and 35 ohms termination resistance in a 3.15 mm long device. The modulation efficiency VpiLpi is 2.2 V.cm and optical loss 12.8 dB/cm for the same bias. The steps in the design process is detailed and simulation results are presented.

### ↘ TS-O-MON-04-03 Design of a 80-nm tunable hybrid III/V-on-silicon laser

Henrique Freire, Giovanni Beninca de Farias, Alexandre Passos Freita, Diogo de Azevedo Motta

We present the concept of a hybrid integrated widely tunable III-V-on-silicon ring laser with 80 nm tuning range. Laser spontaneous emission is provided by two gain chips, one for the C band and the other for the L bands. Gain chip sections are duplexed into the SiP passive cavity using a lattice filter. Ring tunability is obtained using the Vernier effect between two ring resonators incorporated in the SiP cavity. We present numerical results of modeled laser cavity using a time-domain circuit simulator optimizing the choice of the output mirror reflectivity. The simulated performance shows a waveguide output power higher than 50mW with a high SMSR (>45dB) over the entire range.

### ↘ TS-O-MON-04-04 1310 nm Data Transmission using Silicon Photonic Integrated Circuit comprising Directly Modulated DFB Laser and SOA

Robert N Sheehan, Antonin Gallet, Ines Ghorbel, Cormac Eason, Lee Carroll, Peter O'Brien, Alexandre Shen, Guang-Hua Duan, Fatima C Garcia-Gunning

A directly modulated silicon photonic DFB laser integrated with a SOA was used to validate error-free transmission over 25 km of standard single mode fiber at 1310 nm. Data in NRZ format at a rate of 10 Gbps with PRBS of length 2^{31}-1 were used in the experiment.

### ↘ TS-O-MON-04-05 Ultrashort Pulse Generation Using Mechanically Exfoliated Graphite onto D-shaped Optical Fiber in Erbium Doped Fiber Laser

David Steinberg, Juan Zapata, Eunézio Thoroh de Souza, Lúcia Saito

We present the ultrashort pulse generation of 250 fs from a mode-locked Erbium doped fiber laser by using mechanically exfoliated graphite saturable absorbers deposited onto side-polished surface of a D-shaped optical fiber.



## ■ TS-M-MON-05 Antenas – 02

Monday, August 28th 14:30-16:00 Topazio Room





### ↘ TS-M-MON-05-01 Sparse Array of Dielectric Resonator Antennas for Ultra-Wide Band Applications (Invited Paper)

Lucas Heitzmann Gabrielli, Luciano Prado, Gilliard N. Malheiros-Silveira, Julián Pita, Hugo Enrique Hernandez Figueroa

We present our latest advances in antenna miniaturization using dielectric resonators and design of sparse arrays for ultra-wide band applications without the need for non-linear numerical optimization. We experimentally demonstrate a dual-feed, low-profile, stacked dielectric resonator antenna for the C band with wide bandwidth and high gain, as well as a bio-inspired sparse array design for ultra-wide band applications. We show that the results presented can be successfully extended to other frequency windows, in particular the near-infrared range, where specific issues prevent the use of more conventional antenna and antenna array designs.

### ↘ TS-M-MON-05-02 Metal-Insulator-Metal Tunnel Diodes on Micro/Nano Antennas for Energy Harvesting and Detector Applications

Liangrid Silva, Newton Gomes, Vilson Almeida

There are open issues related to efficient rectifying device (diode) for effective applications on energy harvesting and detectors based on micro/nano antennas. Some technological approaches have been developed to improve diode performance at Terahertz (THz) and optical frequency regimes. Diodes based on Metal-Insulator-Metal (MIM) structure is one of the best candidates for this task, mainly due to its relative simple architecture, as well as its capability to achieve high frequency operations. The tunneling current mechanism is the main effect that allows fast diode performances. However, there are challenges related to the fabrication process, due to very low thickness of its insulator barrier, usually below 3 nm. Motivated by this, in this theoretical study we design MIM diodes based on very promising insulator for THz and optical frequency operations based on Zinc Oxide (ZnO), combining with Aluminum (Al), Zinc (Zn) and Copper (Cu) metals; we analyze some basic performance features, assuming variations of the insulator thickness. Results show a critical dependence of MIM diode performance on small variations of this parameter. Therefore, this study indicates the necessity of a strict control of the manufacturing parameters.

### ↘ TS-M-MON-05-03 Directly Matched Active Integrated Antenna for GPS receiver

Diego Moná, Eduardo Sakomura, Daniel Nascimento

The design of an active integrated antenna (AIA) front-end circuit using the ATF 34143 field effect transistor (FET) in a minimum noise figure (NF) condition for GPS frequencies is presented. Both RF and DC bias circuits are calculated for a co-designed probe fed circularly polarized rectangular microstrip antenna (CPRMA). To optimize performance a source inductance was added and tuned using a procedure that involves feedback from experimental to joint circuit/full-wave simulated

results, achieving stability up to 13GHz. A prototype was implemented and tested; noise figure and gain measurements were performed following a detailed step-by-step process shown in this paper.

### ↘ TS-M-MON-05-04 Design of a Microstrip Antenna Array with Polarization Diversity for DoA Application

Tarcisio Gripp, Bernardo Fabiani, Eduardo Silveira, Daniel Nascimento

This paper presents the design, manufacture and tests of a microstrip antenna array with polarization diversity for radiofrequency sources tracking. The designed array is a composite part of a system based on the MUSIC (Multiple Signal Classification) algorithm, showing the importance of considering the use of polarization diversity in order to obtain a reliable solution of Direction of Arrival (DoA) of the incoming RF signal. The array performance is verified by means of some tests using a manufactured prototype.

### ↘ TS-M-MON-05-05 Finite-Element Time-Domain Solver for Axisymmetric Devices Based on Discrete Exterior Calculus and Transformation Optics

Dong-Yeop Na, Fernando Teixeira, Ben-Hur V Borges

We present a new finite-element time-domain (FETD) solver for analysis of axisymmetric devices based on discrete exterior calculus (DEC) and transformation optics (TO) concepts. The proposed FETD solver decomposes the fields into TE^{\phi} and TM^{\phi} modes, which are expanded by using appropriate set of (vector or scalar) basis functions. Utilizing DEC, trigonometric orthogonality, and a leap-frog time-integrator, we obtain energy-conserving fully discrete Maxwell's equations. We explore TO principles to map the original problem from a cylindrical system to an equivalent problem on a Cartesian mesh embedded on an effective (artificial) inhomogeneous medium with radial variation. The new FETD solver is illustrated for the efficient solution of a backward-wave oscillator (BWO) encompassing a slow-wave waveguide with sinusoidal corrugations.

## ■ TS-M-MON-06 Antenas – 02

Monday, August 28th 16:30-18:00 Topazio Room

### ↘ TS-M-MON-06-01 Compact Microstrip UHF-RFID Tag Antenna on Metamaterial Loaded with Complementary Split-Ring Resonators

João Dias, Fernando Moreira, Glaucio L. Ramos

This paper presents the design of a compact UHF RFID tag antenna with a bent and rectangular microstrip patch. Additionally, it utilizes Complementary Split-Ring Resonators(CSSRs) in the ground plane in order to reduce the size of the antenna. The RFID tag is composed by a RO3003 Rogers Substrate with the electric permittivity of 3.0 and an UCODE7 SL3S1204 chip from NXP Semiconductor. The size of the is RFID tag is 36.5 x 22.5 x 0.795 mm designed to operate with a frequency of 915 MHz. The performance of the proposed antenna was analyzed in terms of







antenna gain and return loss through simulations in CST Microwave Studio software. The results show that the use of complementary split ring resonator with the RFID tag reduce the size of the antenna in 30 percent.

### ↘ TS-M-MON-06-02 Real Time Beamforming Algorithms: Experimental Validation

Cynthia Junqueira, Adilson W Chinatto, Jr.

In this paper, a custom software defined radio that implements a smart antenna array is used in the task of real-time beamforming. Specific beamforming algorithms are implemented in FPGA, remotely controlled by a computer host. The antenna array is mounted in a metallic cylinder and tested in anechoic chamber. Experimental measurements highlight the efficiency of the algorithms implementation. Moreover, the performance differences between the algorithms allow a better comprehension of the challenges of such real-time implementation regarding the hardware, software, and firmware developments.

### ↘ TS-M-MON-06-03 Implementation of an Optically-Controlled Antenna in a dual-band Communications System

Andreia Aparecida Castro Alves, Danilo Henrique Spadoti, Sergio Pinna, Antonella Bogoni, Filippo Scotti, Arismar Cerqueira S. Jr.

This work presents the development of an optically controlled slot antenna capable of operating at two different resonant frequencies, 2.5 and 5.1 GHz. A silicon switch controls the frequency operation. The proposed antenna design was analyzed in terms of S-parameters and gain. Measured results shows a difference of 20 dB for the reflection coefficient and 3 dB in the antenna gain, between the switch "on" and "off" state. The prototype was also tested under a data transmission in a multi band photonic down conversion system. Measurements results show the antenna performance in the reception compared to a fixed broadband antenna.

### ↘ TS-M-MON-06-04 On-Chip Patch Antenna on InP Substrate for Short-Range Wireless Communication at 140 GHz

Yunfeng Dong, Tom Johansen, Vitaliy Zhurbenko

This paper presents the design of an on-chip patch antenna on indium phosphide (InP) substrate for short-range wireless communication at 140 GHz. The antenna shows a simulated gain of 5.3 dBi with 23% bandwidth at 140 GHz and it can be used for either direct chip-to-chip communication or chip-level integration and packaging. In the transmission frequency band from 130 GHz to 150 GHz the estimated in-band gain variation is 0.5 dBi which guarantees gain uniformity. The antenna with optimized dimension is implemented for a transition between elevated coplanar waveguide (ECPW) and rectangular waveguide. The chip-to-waveguide transition in back-to-back configuration exhibits a simulated return loss of 10 dB and insertion loss of 3 dB from 128 GHz to 153 GHz. For higher directivity, a horn antenna is used together with the chip-to-waveguide transition forming an extended packaging structure that is suitable for the transceiver (Tx and Rx)

chips. The simulated gain of the extended packaging structure is 11.9 dBi with 21.4% bandwidth at 140 GHz and the in-band gain variation is 2 dBi.

### ↘ TS-M-MON-06-05 Retrieval Parameters of Chiral Metamaterials With Proposed Crescent Shaped Split Ring Resonators

Musa Bute, Ugur Hasar, Joaquim J Barroso

We propose a new uniaxial chiral metamaterial which is composed of four crescent shaped split-ring resonators mutually twisted by 90° and patterned on opposite sides of a dielectric substrate. It illustrates a strong optical activity and circular dichroism in the range from 5 GHz to 10 GHz. The presented design can be fabricated more easily due to its efficient metallic structures. Furthermore, chirality value of this proposed chiral metamaterial is large enough the optical applications. This study also shows that the proposed crescent shaped chiral metamaterials have good responses when compared with other studied samples in literature. All validations are performed by computer simulation program CST Microwave Studio in the 5-10 GHz frequency range.

### ↘ TS-M-MON-06-06 FSS-based Dual-Band Cassegrain Parabolic Antenna for RadarCom Applications

Tiago Brandão, Hugo Filgueiras, Juliano Mologni, Antonella Bogoni, Arismar Cerqueira S. Jr.

Radar systems typically have one antenna for each particular radar. This paper presents the design of a Cassegrain parabolic antenna based on a frequency selective surface able to simultaneously operate in two distant frequency ranges, namely S-band and X-band, for dual-use radars. Numerical results, obtained using ANSYS HFSS, demonstrate the proposed antenna provides 30 dBi gain for 2.45 and 9.9 GHz, which are the frequencies of a photonics-based dual-band radar, previously developed by our research group. The new antenna can be efficiently applied for the development of radar/communication (RadarCom) systems that can be interchangeably used as a radar sensor and communications device.

## ■ TS-O-TUE-01 Microwave and Optical Measurements / Industrial Applications

Tuesday, August 29th 14:30-16:00 Ametista Room

### ↘ TS-O-TUE-01-01 Offline Measurements of Photonic Devices (Invited Paper)

Evandro Conforti, Tiago Sutili

Performances of microwave photonics devices are evaluated using offline techniques following the appropriate experiments. First, the harmonic distortion and the half-wave voltage of an electro-optical modulator are obtained for the entire bandwidth using opposite phase sinusoidal signals. Then, phase noise, electromagnetic emission behavior, and linewidth of several semiconductor lasers are characterized using heterodyne reception. Both offline analyses employ fast digital signal acquisition and processing.







### ↘ TS-O-TUE-01-02 Retrieval of Electromagnetic Properties of Metamaterials with Weak-Coupling

Ugur Hasar, Gul Buldu, Joaquim J Barroso

Metamaterials (MMs) are engineered material with electromagnetic properties not commonly seen by natural materials such as negative refraction and near-zero permittivity. These materials have interesting applications ranging from perfect lens and electromagnetic cloaks to leaky-wave antennas and shifters. For such applications, electromagnetic properties of MMs are needed to be known. In this study, we propose a waveguide method for accurate electromagnetic parameter retrieval of weakly-coupled MM slabs (the wavevector is normal to the plane of the metallic inclusions). To achieve our goal, new expressions for effective permittivity and permeability as well as the magnetoelectric coupling coefficient are derived. For validation of our waveguide method, we used the simulated scattering parameters of a MM slab composed of split-ring-resonator unit cells by using a commercial 3D electromagnetic simulation program.

### ↘ TS-O-TUE-01-03 Low Power CMOS Temperature Protection Sensor for Smart Cards

Luis Antonio Quispe Cartagena, Silvio Ernesto Barbin

In this paper, it is presented the design of a low power temperature sensor for the protection of smart cards from attacks at the corners of their operating temperature range. The attacks usually use failure generation techniques for abnormal environmental conditions. They normally result in malfunctions in the smart card processor, allowing additional access to information to happen. The purpose of this design is to effectively protect the chip of smart cards from this art of security tampering for the temperature range -20C to 120C with a small area and low power consumption circuit. The sensor is designed in Cadence and TSMC using the System on a Chip (SoC) concept employing a standard 0.065um CMOS technology and operates for a power supply voltage of 1.2V. It is based on a circuit with two MOS transistors and only one PNP bipolar transistor for producing a Complementary to Absolute Temperature voltage (CTAT). The obtained results for the temperature protection at the corners of a -40C to 140C temperature range and Vdd = 1.2 V +- 10%, show an excellent performance for the sensor; The PSRR -62dB in the worst case and a hysteresis corner 5 millivolts. This new circuit design can effectively work as an excellent protector against security tampering to smart cards.

### ↘ TS-O-TUE-01-04 Photonics-Based RF Phase Shifter for Ultra-Broadband Communications

Matheus Sêda, Arismar Cerqueira S. Jr., Regivan N Da Silva, Ramon Maia Borges

This paper presents a simple and reconfigurable photonics-based radiofrequency phase shifter (PBPS) for ultra-broadband communications. The proposed approach makes use of a single DC

voltage control to manage the RF signal phase. It employs a single-drive Mach-Zehnder modulator, an optical filter and optical phase shifter for performing a continuous (from 0 to 360° )RF phase shift over an ultra-wide frequency range. Numerical results demonstrate a flatness phase shift of RF signals up to 100 GHz, with low amplitude and phase deviations of 0.002 dB and 0.050°, respectively. The proposed device can be applied to future wireless networks, including 5G systems operating in the millimeter-waves.

### TS-O-TUE-01-05 Implementation of a Broadband Photonics-assisted RF Amplifier Toward 5G Networks

Ramon Maia Borges, Andre Marques Muniz, Dionisio Noque, Leandro Manera, Antonella Bogoni, Arismar Cerqueira S. Jr.

We report the implementation of a photonics-assisted RF amplifier for broadband and multiband 5G networks. A 2 Gsymb/s signal with different digital modulation formats at 20 GHz and a 100 Msymb/s high-order digital modulated signal at 6 GHz have been used for characterizing the proposed technology as a function of the RF gain, signal-to-noise ratio and error vector magnitude. Experimental results demonstrate RF amplification, reconfigurability, distortion absence and low phase noise levels through 6, 20 and 38 GHz frequency bands, which have been considered potential for the future 5G networks.

## TS-O-TUE-02 Optical Communications Systems – 02

Tuesday, August 29th 16:30-17:45 Ametista Room

### TS-O-TUE-02-01 Passive Optical Networks: Present Status and Future Outlook (Invited Paper)

Murilo Araujo Romero

This invited paper discusses the present status and evolution trends for passive optical networks (PONs). A brief historical overview is provided, leading to the recent NGPON2 (T-WDM) standard. Next, the main technological contenders for the future PON generations are discussed. Emphasis is given on the WDM-PON self-seeded configuration.

### TS-O-TUE-02-02 An Intelligent and Integrated Architecture for Data Centers with Distributed Photonic Switching (Invited Paper)

Moises Renato Nunes Ribeiro, Gilmar Vassoler

A novel architecture dealing with the coupling between cloud orchestration and network control is here proposed. TRIIIAD – TRIple-Layered Intelligent and Integrated Architecture for Data Centers consists of three horizontal layers and a vertical control, management and orchestration plane. The top layer offers the IaaS (Infrastructure as a Service). The middle layer provides a lightweight routing/forwarding mechanism. The bottom layer works as a distributed photonic switching plane. Finally, the vertical plane is responsible for coordinating the interoperation of those three layers and keeping them agnostic to each other. The vertical plane brings a new concept for server-centric



designs: an Augmented Software-Defined Networking, in which a SDN controller can integrate network control with orchestration, so that consistency between decisions taken at network and virtualization layers can be ensured.

### TS-O-TUE-02-03 Execution Time Improvement for Optical Amplifier Cognitive Methodology in Dynamic WDM Networks

Uiara de Moura, Miquel Garrich, Amilcar Careli César, Juliano Oliveira, Evandro Conforti

Optical networks are facing complexity and management challenges because a multi-technology infrastructure is required to support an ever-increasing traffic volume and dynamicity. In this heterogeneous context, we recently proposed a Cognitive Methodology to adjust the gain operating point of optical amplifiers using case-based reasoning. In this paper, we evaluate the execution time and introduce a modification on the original Cognitive Methodology to improve this critical parameter without degradation on the optical performance. The obtained results show an execution time reduction of around 92\%, with the same (or even better) optical performance.

## TS-M-TUE-03 Optical Components, Fibers and Devices – 02

Tuesday, August 29th 14:30-16:00 Safira Room

### TS-M-TUE-03-01 Predicting Complete Band-Gaps of 2D Photonic Crystals by Using Artificial Neural Networks

Adriano da Silva Ferreira, Gilliard N. Malheiros-Silveira, Hugo Enrique Hernandez Figueroa

In this paper, artificial neural networks are modeled to predict complete band-gaps of bi-dimensional photonic crystals. The available data-set has been generated by an integrated artificial immune network and MPB (MIT Photonic Bands) optimization procedure. Two case studies were carried out, considering square lattice photonic crystals composed of two and three silicon round rods embedded in air. Results from tests showed the modeled artificial neural networks are capable of estimating complete band-gaps across the proposed range of rods.

### TS-M-TUE-03-02 Vortex-based ferromagnetic resonance isolator in 2D photonic crystal waveguide

Daimam Zimmer, Victor Dmitriev

We suggest and numerically analyze a new type of THz isolator possessing a very compact structure. It is based on a 2D photonic crystal with square unit cell. The forward incident wave in the photonic crystal waveguide with a magnetized ferrite rod is transmitted while the backward wave is blocked due to ferromagnetic resonance losses in the rod. The necessary structure of the AC magnetic field in the ferrite rod with circular rotation in the plane normal to the DC magnetic field is provided by two stubs in the waveguide. The electromagnetic field in the rod has a vortex-like profile. Numerical simulations show that, at the central frequency 0.1066 THz,

the proposed isolator has insertion losses lower than -0.8 dB and isolation level better than -15 dB in the operating bandwidth of 0.8 GHz.

### TS-M-TUE-03-03 Full Three-Dimensional Broadband and Isotropic Carpet Cloak

Daniely Silva, Poliane Teixeira, Lucas Heitzmann Gabrielli, Mateus Junqueira, Danilo Henrique Spadoti

This paper presents a full three-dimensional carpet cloak design, whose invisibility is independent of the incident wave direction. The device is developed with transformation optics and three-dimensional quasi-conformal coordinate transformation, which is obtained through parametrization and numerical optimization. The anisotropy reduction was sufficient to consider the medium as isotropic and to achieve the invisibility effect. The used technique enables to design the carpet cloak in broadband range and independently of light polarization.

### TS-M-TUE-03-04 3D Printed Microstructured Optical Fibers

Thiago Marques, Beatriz Lima, Jonas Osorio, Luiz da Silva, Cristiano MB Cordeiro

In this investigation we report, to the best of our knowledge, the first realization of air-core optical fibers obtained by drawing a 3D printed preform. Two different optical fibers are presented. Descriptions on the preform preparation and fiber drawing are provided, and our preliminary results are presented.

### TS-M-TUE-03-05 Temporal coupled-mode theory of electromagnetic components with magnetic symmetry

Victor Dmitriev, Gianni Portela, Leno Martins, Daimam Zimmer

The utilization of the temporal coupled-mode theory in the analysis of a photonic crystal based circulator is presented. This method is widely used in the cases where reciprocal components (with symmetrical scattering matrices) are considered, since it provides useful insights about the functioning of these devices. However, the nonreciprocity and the low symmetry of some components, like the concerned circulator, imposes several difficulties on their analysis by means of the temporal coupled-mode theory. Through the calculation of expressions for the scattering matrix entries and the comparison between theoretical and numerical results, we show that it is possible to describe such nonreciprocal structures with low symmetry by means of a temporal coupled-mode theory approach.







### TS-M-TUE-03-06 Optical Filters for Narrow-Band Imaging on Medical Devices

Manuel Fernando da Silva, Talita Granado, Rodrigo Gounella, João Paulo Costa, Yuri Assagra, José H Correia, João Carmo

This paper presents optical filters for narrow-band imaging on medical devices. Two optical filters were designed to provide an extremely narrow passband around the 415 nm (blue) and 540 nm (green) wavelengths using the Fabry-Perot phenomenon. Each filter is composed by successive thin-film layers of dielectric materials of titanium dioxide (TiO2) and silicon dioxide (SiO2). The TiO2 and SiO2 that compose the thin-films were fully characterized by ellipsometry applied within the 250-1700 nm wavelength range. The optical performance of the blue NBI optical filter (415 nm) was also measured. These filters were developed to integrate with light emitting diodes (LED) to provide the desired narrow-band imaging (NBI) bands on medical devices.

## TS-O-TUE-04 Optical Sensors and TeraHertz – 02

Tuesday, August 29th 16:30-17:45 Safira Room

### TS-O-TUE-04-01 Cascaded Long Period Grating Coated with Polymethyl methacrylate

Jean Kuhne, Juliana Thaler, Rafael Nadas, Jeferson de Deus, Ilda Abe, Ricardo Kamikawachi

Experimental results of refractive index response of cascaded long period grating (CLPG) coated with polymethyl methacrylate (PMMA) are presented in this work. The response of the grating to environmental refractive index changes is investigated by grating immersion into glycerin-water blends with several concentrations. The results indicate that CLPG refractometers with PMMA nanocoating allow refractive index measurement beyond the limit imposed by the cladding refractive index.

### TS-O-TUE-04-02 Extraction of Effective Parameters in Terahertz Time-Domain Spectroscopy

Paloma Pellegrini, Lucas Heitzmann Gabrielli, Livia dos Santos, Rafael Ribessi

Formerly known as the gap in the electromagnetic spectrum, the terahertz technology is being developed in several fields of science. A terahertz time-domain spectroscopy system will be presented and used to obtain transmission spectra of organic samples. This work proposes the implementation of an algorithm able to extract effective optical parameters of the analyzed samples in terahertz and also their thickness, using only the transmittance as experimental data. Lactose samples were characterized using the proposed method.

### TS-O-TUE-04-03 Remote Fiber Bragg Grating-Based Sensor Characterization with Ultra-High-Resolution Tunable Photon Counting OTDR

Luis Ernesto Ynoquio Herrera, Gustavo Amaral, Jean Pierrre von der Weid

We report on the possibility of remotely characterizing Bragg gratings using an ultra-high-resolution tunable photon-counting OTDR. The achievable 2.8 cm resolution as well as the tunability of the technique permit the determination of the dispersion induced by the grating and its length inside the fiber. We believe that this characterization technique can be employed in long distance monitoring for different Bragg-grating fiber sensors.

### TS-O-TUE-04-04 Improving Temperature Resolution of Distributed Temperature Sensor Using Artificial Neural Network

Luis Silva, Helder Rocha, Carlos Castellani, Marcelo Eduardo Vieira Segatto, Maria José Pontes

Temperature resolution is a key factor for the performance of a Distributed Temperature Sensor (DTS). One can define the resolution as the degree of uncertainty in the temperature information. Thus, the temperature measured in a steady-state condition at a given point in the fiber will vary between successive measurements and between adjacent points that are at the same temperature. Temperature resolution of the system becomes worse as return signal level decreases, as in the case of measurements in longer fibers or as a result of increased loss due to bends or connectors. Besides, recent studies show temperature resolution becomes worse for high measurement temperatures. In this context, this paper discusses the use of an Artificial Neural Network (ANN) algorithm to improve the temperature resolution in a DTS by correctly reconstructing hot regions in the fiber without new extra information of the system, such as: impulsive response, attenuation of the signal of interest, local losses due to fiber curvatures and connectors. Therefore, the use of ANN has a strong application in the calibration of DTS systems.

### TS-O-TUE-04-05 FSO Applied to Optical Fiber Sensing: a Field Test Demonstration

João Batista Rosolem, Rivael S Penze, Claudio Floridia, Danilo C Dini, Rodrigo Peres, Carlos Alexandre Meireles Nascimento, Julio Eduardo Valadares

In this work we described the use of free-space-optics (FSO) for sensing applications in a field test demonstration. The test evaluation was performed in an overhead transmission line during around eight months. We also described the main factors that influence the coupling loss of the FSO devices and the proposed mitigation to turn this application practical in real systems.



## TS-M-TUE-05 Antennas – 03

Tuesday, August 29th 14:30-16:00 Topazio Room





### TS-M-TUE-05-01 Antenna Development for 5G Networks (Invited Paper)

Arismar Cerqueira S. Jr.

This work reports the development of antennas and antenna arrays for the future 5G cellular networks, which have been realized at the Brazilian Institute of Telecommunications (Inatel) in the last four years. Diverse reconfigurable antenna types based on printed and milled structures have been designed, fabricated and proper characterized from microwaves to mm-waves, with the aim of fulfilling the requirements of 5G networks. Numerical simulations and experimental investigations for frequencies up to 40 GHz demonstrate the applicability of the proposed and innovative antenna for the 5G lower/higher frequency bands.

### TS-M-TUE-05-02 Mechanically Reconfigurable Slotted-Waveguide Antenna Array for 5G Networks

Hugo Filgueiras, Igor da Costa, James Kelly, Arismar Cerqueira S. Jr.

This paper proposes a high-gain mechanically reconfigurable antenna array based on a ring-shaped slotted-waveguide antenna for mm-wave applications. A full scanning range in the azimuthal plane is ensured by proper mechanically rotating a metallic jacket, which partially covers the array radiating structure. The technique provides a beamwidth of 37° in the azimuth plane and gain of 17.41 dBi at the operating frequency of 27.3 GHz. Significantly, unlike a conventional phased array, this approach does not suffer from: scan loss, beam broadening or SLL degradation. Experimental results of the array element and numerical results of the antenna array demonstrate its applicability in 5G cellular networks.

### TS-M-TUE-05-03 Dual-Band Antenna Array with Beam Steering for mm-waves 5G Networks

Igor da Costa, Danilo Henrique Spadoti, Arismar Cerqueira S. Jr.

This work reports an innovative structure and preliminary results of a four-elements antenna array with beam steering for 5G access cellular networks, operating in the underutilized millimetre wave (mm-wave) frequency spectrum. Its structure is based on four slotted-waveguide antenna arrays, which enables to simultaneously perform radiation pattern reconfiguration in the 28 GHz and 38 GHz bands, providing scanning range of 75° and 55° for the lower and higher frequency bands, respectively. The bandwidth varies from 24.19 GHz to 31.42GHz and from 36.61 GHz to 39.22GHz.

### TS-M-TUE-05-04 Design of Microstrip Monopoles for Broadband Systems Using an Iterative Wave Formulation

Valdemir Neto, Mychael Duarte, Jurgen Azevedo Nogueira, Adaildo G D'Assunção

This paper presents the analysis of microstrip monopoles for applications in ultra wideband systems (UWB). Antenna structures using circular and semi annular ring patches are considered. The antennas are printed on a FR4 dielectric substrate and present truncated ground planes with a small cut beneath the microstrip line feeder to improve the antenna impedance matching. Results for return loss, resonant frequency, and impedance bandwidth are calculated using an iterative fullwave formulation based on the concept of electromagnetic waves (WCIP Method) and simulated using Ansoft HFSS software. Prototypes are fabricated and measured for validation purpose. Agreement is observed between WCIP calculated, HFSS simulated and measured results, confirming the WCIP method accuracy. The performance of the developed antennas are suitable for UWB and broadband systems. UWB and broadband systems.

### TS-M-TUE-05-05 Antenna impedance correction for low power energy harvesting device

Polyanna Mara Pereira, Ricardo Luiz Adriano, Ursula Resende, Guilherme Brandão, Ravel Pimenta

In this paper, a two-step methodology is presented to design a low power wireless energy harvesting device. The rectenna system, consisting of an half-wave rectifier circuit and a non-50 ohms antenna, is designed to archive maximal power transfer at some specified frequency and power level. The main idea of this work is to obtain maximum efficiency avoiding complex impedance matching circuits. First, the rectifier circuit is designed and its input impedance is measured under the desired operating conditions (frequency range and input power levels). Then, the antenna geometry is optimized to match the complex impedance of the rectifier. Results are presented for a 2.45 GHz rectenna. The performance of the non-50 ohms antenna is compared to a conventional one.

## TS-M-TUE-06 Satellite Communication

Tuesday, August 29th 16:30-18:00 Topazio Room

### TS-M-TUE-06-01 Satellite Communication Challenges in a Fully Interconnected World (Invited Paper)

Marcos G. Castello Branco, Augusto Gomes

This paper discusses the most critical challenges to be faced by satellite communication networks in a near future fully interconnected world which becomes a reality with the emergence of next generation mobile and fixed services to transfer information data among human beings and their distributed devices and or machines.







### TS-M-TUE-06-02 Femto, Pico, Nano: overview of new small satellite standards and applications (Invited Paper)

Chantal Cappellatti

With the beginning of the "CubeSat Era" at the end of the 1990s, a revolution started in the field of satellites. When prof. Twiggs and prof. Puig Suari introduced the CubeSat specifications, nano-satellites were considered only as toys, unable to accomplish interesting mission goals. In the last two decades, CubeSat have became attractive not only for the academic world but also for small companies, industries and governmental institutions, showing that is possible to perform ambitious missions tasks using modern and easy-to-access solutions. The introduction of the CubeSat standard allowed also establishing a new market and the birth of small-sat companies that, starting from successful university projects based on CubeSat, have based their business on the design and manufacturing of CubeSat components. Without the introduction of the Cubesat standard this would have been impossible because there would not have been a market ready to receive these technologies. Furthermore, CubeSats allowed access to space to emerging countries and young generations, such as medium and high school students. The success of this platform encouraged other players to introduce and try to divulgate their own platforms, always trying to reduce weight and costs. Recently, new standards based on nano, pico and femto satellite platforms are becoming more popular and are showing their potentialities for future missions and applications. This paper gives an overview of Cubesats and other small satellites platforms, showing details of some recent missions. Limitations and benefits of every platform will be introduced and discussed.

### TS-M-TUE-06-03 Laser Beam Welding of Ku Band Waveguides for Communication Satellites

Sirko Pamin, Divya Ratnasami, Jörg Hermsdorf, Stefan Kaierle

Delivery time of products for satellite payloads is increasingly becoming a key competitive factor for companies in the relevant industry sector. This paper discusses a new approach of joining standard waveguide segments such as flanges, bends and straight segments. With the combination of using both a pulsed laser system and wire freed drive along with a special holding mechanism, a complex aluminum waveguide for the Ku band was welded. Measurement showed that the electrical performance exceeds the requirements.

### TS-M-TUE-06-04 Ku-Band Hybrid GaN Block Upconverter for Very Small Aperture Terminals

Daniel Maassen, Felix Rautschke, Silvio Ernesto Barbin, Georg Boeck

Within this paper the development and design of a hybrid Ku-band block upconverter (BUC) with a GaN-HEMT amplifier is shown. The BUC is supposed to work within a very small aperture terminal (VSAT) where more often higher output power levels are required. Therefore the authors already developed GaN-HEMT power amplifiers up to Pout= 70 W. In here an integration of a 10 W amplifier within a newly developed BUC is shown that comes along with a small size and

low weight paired with a low amount of dissipated power. Additionally the BUC is equipped with a linearization technique that automatically improves the spectral regrowth for common modulation schemes (QPSK, 8PSK), as well as for future high order modulation (DVBS2X, 5G). Finally the BUC is tested with a VSAT in a satellite link and demonstrates its function with up to data rates of 1 Mbit/s.

## ■ TS-M-TUE-07 **Materials, Components, Circuits, Devices and Packaging**

Tuesday, August 29th 14:30-16:00 Turmalina Room

### ↘ TS-M-TUE-07-01 A Design of Adiabatic Digital Circuits for Micro, Nano and Cube Satellites: Four Stage JK-FF Binary Counter Using Four-Phase AC-clocked Power-Supply

Valério Salles, Silvio Ernesto Barbin, Luiz Carlos Kretly

There is a growing interest among universities and industry in the field of nano, micro and cube Satellites. These are very small satellites, about the size of a shoebox, which can be launched into space at a much lower cost than typical large satellites. CubeSats are generally low earth orbit -LEO-satellites, which mean they orbit are from 200 to 1200 km above earth surface. Due to the small nature of these satellites on of the concerns is the energy consumption. This paper presents a design strategy of adiabatic digital circuit for this purpose. The adiabatic digital circuits are a kind of design technique where the energy is treated so that the dissipation loss in the circuitry can be minimizing. The design is focused on a four stage JK-FF binary counter using four phase sinusoidal Ac-clocked power supply.

### ↘ TS-M-TUE-07-02 A 24 GHz IQ-Demodulator with Ultra-Low Amplitude and Phase Imbalance

Yaoshun Ding, Soenke Vehring, Dominic Maurath, Silvio Ernesto Barbin, Friedel Gerfers, Georg Boeck

This paper describes a 24 GHz quadrature demodu- lator (IQ-demodulator) using 65 nm bulk CMOS technology. The proposed IQ-demodulator consists of two direct down conversion mixers and a polyphase filter for 90° phase shifting. The two mixers are matched to 50 ohm by an on-chip bias-tee matching network with ESD protection. The parasitic inductance com- pensation technique is used to minimize the IQ imbalance. The proposed IQ-demodulator is measured with 5 dBm LO power. Measurement results show a peak conversion gain of 7.3 dB with IQ phase and amplitude imbalances of 0.1 dB and 6 degree, respectively. The total power consumption of the demodulator is 16 mW. The active chip area is 0.42 mm2 .







### ↘ TS-M-TUE-07-03 A Trimmable 24 GHz Low-Noise Amplifier with 20 dB Gain and 3.7 dB Noise Figure in 65 nm Bulk CMOS

Soenke Vehring, Yaoshun Ding, Philipp Scholz, Dominic Maurath, Silvio Ernesto Barbin, Friedel Gerfers, Georg Boeck

A 24 GHz low-noise amplifier (LNA) with trimming capability is presented. It is demonstrated, that with the proposed trimming concept, frequency shifts due to model uncertainties, process variations, and underestimated parasitic capacitances can be compensated. The realized LNA showed a shift in peak gain of 2.5 GHz towards lower frequencies in the non-trimmed state. After trimming to the specified operating frequency of 24 GHz, a gain degradation of only 0.3 dB is observed. The trimmed LNA achieves a peak gain of 20 dB at 24 GHz with a 3 dB-bandwidth from 21 to 28 GHz, a noise figure of 3.7 dB, and an OIP3 of 15 dBm. Furthermore, it is equipped with ESD protection and can be supplied with a single voltage. The active die size and the power consumption are 0.13 mm 2 and 17 mW, respectively.

### ↘ TS-M-TUE-07-04 3D Thermal Simulations and Modeling of Multi-Finger InP DHBTs for Millimeter-Wave Power Amplifiers

Virginio Midili, Virginie Nodjiadjim, Tom Johansen, Michele Squartecchia, Muriel Riet, Agnieszka Konczykowska

This paper presents the comparison between the simulated and measured thermal resistance of InP Double Heterojunction Bipolar Transistors (DHBT). 3D thermal simulations were carried out in order to compute the temperature distribution across the full structure due to a constant power excitation of devices with up to 8 emitter fingers. The surface temperature profile was then used to compute the average thermal resistance of the multi-finger devices. The comparison with the corresponding results obtained by electrical measurements show a good agreement. The temperature profiles from several simulations are used to extract the thermal resistance matrix used in the electro-thermal coupling network of a compact large-signal model.

### ↘ TS-M-TUE-07-05 THZ dynamically controllable graphene Y-circulator

Wagner Castro, Victor Dmitriev, Clerisson Nascimento

A new type of the graphene-based three-port circulator is suggested and analysed. The cross-section of the component presents a three-layer structure consisting of graphene, silica and silicon. The in-plane figure of the circulator presents a circular graphene resonator and three waveguides symmetrically connected to it. The graphene is magnetized normally to its plane by a DC magnetic field. The physical principle of the device is based on the dipole resonance of the magnetized graphene resonator. We investigate the influence of different parameters on characteristics of the circulator. Numerical simulations demonstrate the isolation of -15 dB in 9.4% bandwidth with the central frequency 5.38 THz. The biasing DC magnetic field is 0.57 T.

### TS-M-TUE-07-06 Analytical Model for Magnetoopic Five-layered Planar Waveguides

Licinius Alcantara, Carlos Alberto De Francisco, Ben-Hur V Borges

This work presents an analytical formalism for magnetoopic five-layered planar waveguides, which can be used as a fast resource to assist in the design of nonreciprocal optical couplers. The methodology was implemented in a GNU Octave program code and results are shown for both forward and backward guided propagation.

## ■ TS-M-TUE-08 RF Theory and Applications

Tuesday, August 29th 16:30-18:00 Turmalina Room

### TS-M-TUE-08-01 Review on Human Exposure to Radiofrequency Electromagnetic Field (Invited Paper)

Agostinho Linhares de Souza Filho

This paper reviews many important aspects of human exposure to RF-EMF, considering exposure limits and its rationale; the electromagnetic environment, where people are exposed in indoor and outdoor places; international standards and possible health effects. It shows examples of exposure levels for different radiocommunication services and ongoing work related to EMF Exposure from Brazilian and International Bodies.

### TS-M-TUE-08-02 Scattering Due to Rain in Brazil for Millimeter Waves

Teddy Surco

Wireless telecommunications systems operating in the millimeters waveband are heavily affected by rain, signal attenuations occur due to absorption and scattering caused by hydrometeors. Scattering by raindrops can cause interference between wireless systems operating in the millimeter wave range. This paper presents a method of calculating the scattering cross section of raindrop in the millimeter wave range using the Mie theory in some regions of Brazil. The calculations will be based on measurements of the precipitation rate measured in different regions of Brazil and will be compared with the precipitation rates provided by Recommendation ITU-R P.837-6

### TS-M-TUE-08-03 Some Recent Improvements in Modeling of Electromagnetic Well-Logging Sensors via Numerical Mode-Matching

Maiquel S Canabarro, Guilherme Rosa, José Ricardo Bergmann, Fernando Teixeira

The numerical mode-matching (NMM) technique is a very efficient method to solve the electromagnetic problem of logging-while-drilling (LWD) sensors for geophysical prospecting. In this paper we present recent trends that have improved the numerical efficiency of the traditional NMM. Two NMM formulations are discussed here, with focus on its main relevant upgrades compared to previous approaches. We present numerical results for three case scenarios that demonstrate the accuracy of these new proposals to modeling typical well-logging tools used for oil and gas exploration.







### TS-M-TUE-08-04 Electromagnetic Modeling of Wave Propagation in Curved Boreholes for Geophysical Exploration

Guilherme Rosa, José Ricardo Bergmann, Fernando Teixeira

Logging-while-drilling (LWD) tools are routinely used to guide well placement during exploration of hydrocarbons reservoirs. Recent advances in the drilling technologies have allowed real-time proactive geosteering of the drilling direction to steer to a precise target zone. Electromagnetic modeling of LWD sensors in complex geometries is a challenging task to conventional computational electromagnetics~(CEM). In particular, several complications arise due the non-conformal boundaries present in this problem. In this paper we present a pseudoanalytical formulation to handle the electromagnetic wave propagation inside radially-stratified and axially-toroidal structures that could be used as an efficient CEM method for modeling LWD tools inside directional boreholes. Preliminary results demonstrate that our method can accurately analyze LWD sensors in typical directional wells.

### TS-M-TUE-08-05 Data Transmission in the EHF band with QPSK modulation

Andy Alvarez Arellano, Andrew Cordes, Luis Ernesto Ynoquio Herrera, Jean Pierrre von der Weid

We use the photomixing technique to generate a continuous-wave signal in the EHF (Extremely High Frequency) band and modulate it with a Vector Signal Generator (VSG) programmed with E-TM 1.1 (E-UTRAN Test Model) standard in Quadrature Phase-Shift Keying (QPSK). To receive the EHF signal, we use a Schottky diode receiver which is in turn connected to a Vector Signal Analyzer (VSA) which determines the Error Vector Magnitude (EVM).

## ■ PD-M0-WED-01 Post Deadline

Wednesday, August 30th 14:30-15:45 Topazio Room

### PD-M0-WED-01-01 Evaluation of FBG sensors to measure ultrasonic guided waves in rail transport monitoring

Wagner Cano, João Batista Rosolem, Claudio Floridia, Paulo Lopes, Danilo C Dini, Rivael S Penze, Eduardo Costa, João Fracarolli

Long range ultrasonic testing approach is strategic due to its capability to inspect long distances and to detect incipient damage in rail transportation. The present work aims to verify the ability of a FBG sensor to measure ultrasonic guided waves in a subway rail sample. The results were compared with conventional acoustic detection using lead zirconate titanate (PZT) sensor in a 5-m rail sample at 40 kHz.

### PD-MO-WED-01-02 Circularly Symmetric Frozen Waves and their Optical Forces in Optical Tweezers Using a Ray Optics Approach

Amélia Santos, Pedro Arantes, Leonardo Ambrosio

In this work we analyze, in the ray optics regime, the optical forces exerted on micro-sized dielectric spheres due to optical beams created as suitable discrete superpositions of scalar and vector Bessel beams - also known as frozen waves, thus envisioning applications in optical tweezers. Scalar frozen waves have been recently and theoretically introduced as auxiliary optical fields in the trapping and manipulation of neutral particles paper in both the Rayleigh (dipole) and the Mie regimes, the latter demanding a full electromagnetic treatment. Here, the extension of previous studies is twofold in the sense that we perform investigations both in the ray optics regime, which has only been previously considered in terms of simplistic models, and in terms of a vector approach which allows us to go beyond the paraxial approximation.

### PD-MO-WED-01-03 20x50 Gb/s PAM-4 transmission over 80 km of Uncompensated SSMF Link with Direct Detection and Reduced Complexity DSP

Stenio Ranzini, Sandro M Rossi, Rafael C. Figueiredo, Matheus Rodrigues, Andrea Chiuchiarelli

We experimentally demonstrate transmission of 20x50-Gb/s WDM PAM-4 channels over an 80-km uncompensated fiber link, based on reduced complexity DSP and hardware. BER values below pre-FEC limit of 3.8x10^-3 are reported, validating the proposed architecture for low-cost, high-capacity short-reach connectivity.

### PD-MO-WED-01-04 16-QAM FPGA Digital Modulator and a Tool to Evaluate Bit Error Rate

Luiz Antônio Côrrea-Jr, Marco Aurélio Jucá, Alvaro Augusto M de Medeiros, Alexandre dos Santos Bessa, Thiago Coelho, Daniel D. Silveira

This article discusses the implementation of a wide band vectorial digital modulator and a tool to evaluate the Bit Error Rate. This modulator is capable of generate a wide band (up to 6.3 MHz) 16-QAM modulation in baseband. A second functionality programmed in the tool and reported in this article evaluates the Bit Error rate in order to measure the received signal quality. Results are reported using a Signal Analyzer.



### PD-MO-WED-01-05 An Open Source Simulation Tool for Sharing and Compatibility Studies between 5G and Other Radiocommunication Systems

Edgar Souza, Agostinho Linhares de Souza Filho, Calil Queiroz, Letícia Valle, Ugo Dias, Andre Barreto

This paper presents an open source simulation tool called SHARC. This software is designed to support sharing and compatibility studies between IMT systems (including 5G) and other radiocommunication systems according to the framework proposed by Recommendation ITU-R M.2101. In order to show some of the simulator capabilities, this paper also presents a preliminary sharing study between 5G systems and Fixed Satellite Service (FSS) that operate in the same frequency band.

# Technical Sessions
# Poster Sessions

■ PS-O-TUE-01 **Optical Poster – 01**
Tuesday, August 29th 11:20—13:00 Esmeralda Room

↘ PS-O-TUE-01-01 **Extended-Reach Transmission of Single-Wavelength 112-Gbps PAM4 Channel Enabled by MLSE for Intra Data Center Applications**
André Souza, Rafael C. Figueiredo, José Hélio da Cruz Júnior, Sandro M Rossi, Andrea Chiuchiarelli

↘ PS-O-TUE-01-02 **All-optical fast Fourier transform for processing an optical OFDM superchannel**
Rafael Ferreira, Diego M Dourado, Matheus Rodrigues, Sandro M Rossi, Daniel Moutinho Pataca, Mônica de Lacerda Rocha

↘ PS-O-TUE-01-03 **Impact of the Fiber Type Arrangement on Bidirectional Mixed-Fiber Optical Links**
Marcionilo José da Silva, Mozart Correia-Filho, Leonardo Didier Coelho, Joaquim F. Martins-Filho

↘ PS-O-TUE-01-04 **Impact of the Phase Modulation Index in the Performance of CO-OFDM Systems based on Electrical Domain Constant-Envelope Signals**
Jair Adriano Lima Silva, Marcelo Eduardo Vieira Segatto, Helder Rocha, Esequiel Pereira, Vinícius Dias

↘ PS-O-TUE-01-05 **Design of a DAC-less PAM-4 Integrated Optical Modulator Based on Silicon Photonics with Graphene**
Israel Marques, Rafael Oliveira

↘ PS-O-TUE-01-06 **Double-Lock Strategy Applied to Optical Spectral Phase and Delay Encoding**
Marcelo Abbade, Leonardo Bobadilla, Vanessa Martão, Daniel Carvalho, André A. Ferreira, Luiz H Bonani







↘ PS-O-TUE-01-07 **Sub-300 fs Mode-locked Erbium Doped Fiber Laser Using Graphene Oxide and Reduced Graphene Oxide onto D-Shaped Optical Fibers**
David Steinberg, Rodrigo Gerosa, Fernanda Niemann, Sérgio Domingues, Eunézio Thoroh de Souza, Lúcia Saito

↘ PS-O-TUE-01-08 **3D numerical investigation of double-core optical fiber properties modulated by flexural acoustic waves**
Isabela Javorsky, Ricardo da Silva, Alexandre Pohl, Marcos Antonio Ruggieri Franco

↘ PS-O-TUE-01-09 **Arbitrary Geometry Polarization Splitter Designed with Quasi-Conformal Transformation Optics**
Poliane Teixeira, Daniely Silva, Mateus Junqueira, Danilo Henrique Spadoti, Lucas Heitzmann Gabrielli

↘ PS-O-TUE-01-10 **Design of Optimized Integrated Optical Phase Modulators with Graphene**
Fabiana Casallas, Rafael Oliveira

↘ PS-O-TUE-01-11 **Computational Modeling of Transducer Elements of Temperature Sensors using Surface Plasmon Resonance in a D-Shaped Optical Fiber**
Valdemir Da Silva, Jr, Joaquim F. Martins-Filho, Jehan Nascimento

↘ PS-O-TUE-01-12 **Guard Time Requirements for SOA-based Electro-Optical Space Switches and AM Signals**
Tiago Sutili, Bruno Taglietti, Rafael C. Figueiredo, Cristiano M Gallep, Evandro Conforti

↘ PS-O-TUE-01-13 **Vortex Polymer Optical fiber operating at a visible wavelength of 633 nm**
José Borda-Hernández, Claudia Serpa-Imbett, Hugo Enrique Hernandez Figueroa

↘ PS-O-TUE-01-14 **Magnetic group analysis of electromagnetic modes in C2v(C2)-symmetric graphene array**
Victor Dmitriev, Luis Matos

- PS-O-TUE-01-15 **Algorithm for Shared Path Protection in Elastic Optical Network Based on Spectrum Partition**
  Andre Luiz Lourenço, Amilcar Careli César
- PS-O-TUE-01-16 **OSNR-based Backup Path Protection Algorithm with Sharing Limits**
  Rodrigo de Freitas, Joaquim F. Martins-Filho, Carmelo Bastos-Filho, Etzel Santos, Helder A. Pereira, Daniel Chaves
- PS-O-TUE-01-17 **Low-Cost Embedded OTDR Monitoring for Direct Modulation Analog Radio over Fiber**
  Diego Villafani Caballero, Luis Ernesto Ynoquio Herrera, Patryk Urban, Jean Pierrre von der Weid
- PS-O-TUE-01-18 **Discrete Hopf Fibration in the Design of Four-Dimensional Modulations**
  Fernando Alves Rodrigues, Guilherme Temporão, Jean Pierrre von der Weid
- PS-O-TUE-01-19 **Separation of Temperature and Strain in a Single Fiber BOTDA System by Pseudo-inverse Approach**
  Felipe L. R. Marques, Claudio Floridia, Fabiano Fruet

■ PS-M-TUE-01 **RF Poster – 01**
Tuesday, August 29th 11:20—13:00 Esmeralda Room

- PS-M-TUE-01-01 **Frequency Selective Surface Based on Open Trapezoidal Rings Geometry**
  Alfrêdo Gomes Neto, Jefferson Costa Silva, Deisy Mamedes, Juliete Souza, Thamyris da Silva Evangelista Evangelista
- PS-M-TUE-01-02 **Design of a Novel Single-Layer Dual-Band FSS with Angular Stability Using Multifractal Geometry**
  Erico Braz, Sergio Dantas, Antonio Campos, Alfrêdo Gomes Neto
- PS-M-TUE-01-03 **Negative Group Delay in Lumped-Element C-L Transmission Lines**
  Joaquim J Barroso, José Edimar Oliveria, Olympio Coutinho, Ugur Hasar





- PS-M-TUE-01-04 **A Novel Complementary Frequency Selective Surface for Satellite Communication**
  Bruno Sátiro da Silva, Antonio Campos
- PS-M-TUE-01-05 **Proposal of a Microwave Absorber Using FSS with Square Loops**
  José Peixoto Neto, Antonio Campos
- PS-M-TUE-01-06 **Modeling Lossy Boundaries in TLM-SCN Time Domain**
  Plínio Ganime
- PS-M-TUE-01-07 **A Passive Capacitive Soil Moisture and Environment Temperature UHF RFID Based Sensor for Low Cost Agricultural Applications**
  Newton Fonsêca, Raimundo Freire, Smail Tedjini, Adriano Batista, Glauco Fontgalland
- PS-M-TUE-01-08 **Performance Comparison of Metallic and Graphene Buckypaper Microstrip Transmission Lines**
  Juan Pablo Pantoja, Raluca Savu, Mara Canesqui, Stanislav Moshkalev, Hugo Enrique Hernandez Figueroa
- PS-M-TUE-01-09 **Investigation on the Deployment of FSS as Electromagnetic Shielding for 5G Devices**
  Juliano Mologni, Jefferson Costa Silva, Arismar Cerqueira S. Jr., Marco Alves
- PS-M-TUE-01-10 **A Low-Cost Modular Transmit Front-End with Analog Beamforming Capability**
  Daniel Lemes, Marcos V. T. Heckler, Andreas Winterstein
- PS-M-TUE-01-11 **Operation Analysis of a Novel Concept of RF Source Known as Gyromagnetic Line**
  Jose O Rossi, Fernanda Sayuri Yamasaki, Joaquim J Barroso, Edl Schamiloglu, Ugur Hasar
- PS-M-TUE-01-12 **Optimization of the Parameters of a Microstrip Line for the Construction of a Hydrogen Sensor**
  Keila dos Santos, Eduardo Fontana, Gustavo Cavalcanti

- PS-M-TUE-01-13 **A Simple Reduced Size and Reconfigurable Element for Multiband and Angular Stable Frequency Selective Surface**
  Valdemir Neto, Mychael Duarte, Francinete de Lima, Adaildo G D'Assunção
- PS-M-TUE-01-14 **Compact Antenna based on Fractal for IoT Sub-GHz Wireless Communications**
  Euclides L Chuma, Yuzo Iano, Leonardo Bravo Roger
- PS-M-TUE-01-15 **Controlled Directivity and Gain of Antenna Using Square Loop RFSS Based on PIN Diode**
  Francisco Ariaildo Costa Sá, Manuelle Oliveira, Crislane Silva, Túlio Pedrosa, Marcos Mello
- PS-M-TUE-01-16 **Microstrip Feeding for the Excitation of a Higher-Order Resonant Mode in Cylindrical Dielectric Resonator Antennas**
  Murilo Seko, Fatima Correra, A. Long, David R. Jackson
- PS-M-TUE-01-17 **Measurement Campaign on the Electromagnetic Environment in the Central Region of the City of Mossoro**
  Talles Santana, Humberto Andrade, Idalmir Junior, Glauco Fontgalland, Samanta de Holanda, José Lucas Silva, José Magno
- PS-M-TUE-01-18 **A Terahertz Graphene Antenna with Dynamical Control of its Radiation Pattern**
  Nilton Rodrigues, Rodrigo M. S. de Oliveira, Victor Dmitriev
- PS-M-TUE-01-19 **Study of the Effects of a Metasurface on the Performance of a Microstrip Antenna**
  Rafael dos Santos, Antonio Campos
- PS-M-TUE-01-20 **Analysis of Impedance Matching Techniques in Tapered Microstrip Patch Antenna**
  Deisy Mamedes, João Paulo Fernandes da Silva, Thamyris da Silva Evangelista Evangelista, Thayuan Rolim de Sousa, Juliete Souza, Paulo Silva
- PS-M-TUE-01-21 **Parameters Optimization for Rectangular and Circular Microstrip Antennas Using the Taguchi Method**
  Ruann Lira, Antonio Campos







- PS-M-TUE-01-22 **H-Shaped Fractal Antennas for Dual-Band Applications**
  Deisy Mamedes, Gabriela Luciani, Jens Bornemann, Alfrêdo Gomes Neto
- PS-M-TUE-01-23 **Wearable Koch Pre-Fractal Antennas**
  Paulo Fernandes da Silva Júnior, Raimundo Freire, Alexandre Serres, Maciel Oliveira, Paulo Silva

■ PS-O-WED-01 **Optical Poster – 02**
Wednesday, August 30th 11:20—13:00 Esmeralda Room

- PS-O-WED-01-01 **CMOS developments for photonic modules on endoscopic capsules**
  Rodrigo Gounella, João Paulo Costa, Talita Granado, João Carmo, Yuri Assagra
- PS-O-WED-01-02 **Holographic Techniques using Spatial Light Modulators applied to Maskless Photolithography**
  Ricardo Marinheiro, Marcos Gesualdi
- PS-O-WED-01-03 **Analysis of Grounding Problems using Interpolation Element-Free Galerkin Method with Reduction of Computational Domain**
  Maisa Oliveira, Rafael Barroso, Ursula Resende, Rafael Alipio
- PS-O-WED-01-04 **Optical Constant and Thickness Determination Using THz Time-Domain Reflection-Only Signals**
  Salah Haffar, Ugur Hasar, Joaquim J Barroso
- PS-O-WED-01-05 **Optical measurements of vibration waves: analysis of point-scanning and full-field interferometric methods**
  Carolina Goloni, Vadim Girardeau, Olivier Jacquin, Guilherme Temporão, Eric Lacot
- PS-O-WED-01-06 **Performance Evaluation of a real time OFDM Radio Over Fiber System at 2.5 GHz using Software Defined Radio SDR**
  Juan David Cepeda, Santiago Isaac Rodriguez, Monica Rico, Christian Daniel Muñoz, Gloria Margarita Varón Durán, Idelfonso Tafur Monroy

- PS-O-WED-01-07 **Fiber Bragg Grating Interrogation Using FBG Filters and Artificial Neural Network**
  Marco Aurélio Jucá, Alexandre dos Santos Bessa

- PS-O-WED-01-08 **Mode characteristics of a D-shaped porous fiber with a thin gold layer in THz regime**
  Markos Cardoso, Patrick Gaia, Joao Crisostomo Weyl-Costa, Anderson Silva

- PS-O-WED-01-09 **Modeling of magnetostrictive optical modulator for application as a magnetic field sensor**
  Bruno Lima, Josemir Coelho Santos, Marcos Antonio Ruggieri Franco

- PS-O-WED-01-10 **Graphene 3-port circulator based on edge-guide mode propagation**
  Victor Dmitriev, Samara Matos, Clerisson Nascimento

- PS-O-WED-01-11 **Vibration Analysis of a Cantilever Beam with Visco-elastic Neutralizers Using Fiber Bragg Gratings**
  Rafael Linessio, Jean Carlos Cardozo da Silva, Carlos Bavastri, Lucas Tavares, Thiago Silva

- PS-O-WED-01-12 **Fabrication and characterization of fiber Bragg grating based sensors for force measurements**
  Marcos Kamizi, Marcelo Pedroso, José L Fabris, Marcia Muller

- PS-O-WED-01-13 **High-quality phase-shifted Bragg grating sensor inscribed with only one laser pulse in a polymer optical fiber**
  Carlos A.F. Marques, Andreas Pospori, Luis Pereira, S. Marques, Ole Bang, Paulo André

- PS-O-WED-01-14 **Voltage-Controlled Gain Amplifier Applied for Temperature Compensation in FBG Dynamical Sensing**
  Eduardo Costa, Felipe L. R. Marques, Fabio R Bassan, João Batista Rosolem







- PS-O-WED-01-15 **Curvature Sensitivity Enhancement of Fused Fiber Taper**
  Clenilson Rodrigues, Joao Crisostomo Weyl-Costa, Maria Thereza Rocco Giraldi, Marcos Antonio Ruggieri Franco, Ricardo da Silva, Pedro Jorge, Orlando Frazão

- PS-O-WED-01-16 **Properties of bulk dental composites using fiber Bragg grating sensors**
  Ana Franco, Leandro Z Karam, Camila Moura, Hypolito J. Kalinowski

- PS-O-WED-01-17 **GPON-based Front-End Architecture for 5G Networks**
  Regivan N Da Silva, Matheus Sêda, Igor da Costa, Arismar Cerqueira S. Jr.

- PS-O-WED-01-18 **Linearization Techniques for Electro-Optical Modulation in Analog Radio over Fiber**
  Luis Ernesto Ynoquio Herrera, Renata Leibel, Gustavo Amaral, Jean Pierrre von der Weid, Patryk Urban

- PS-O-WED-01-19 **Longitudinal Forces on a Spherical Dielectric Particle Exerted by a Truncated Bessel Beam in the Ray Optics Regime**
  Pedro Arantes, Leonardo Ambrosio

- PS-O-WED-01-20 **Characterization of the Occlusal Splints using Optical Fiber Sensors**
  Ilda Abe, Paula Nascimento, Ana Franco, Leonardo Primon, Rodrigo Fiorin, Valmir de Oliveira, Hypolito J. Kalinowski

■ PS-M-WED-02 **RF Poster – 02**
Wednesday, August 30th 11:20—13:00 Esmeralda Room

- PS-M-WED-02-01 **The Radar Cross Section of a Military Transport Helicopter in the X-Band**
  Mauro Alves, Luiza Folgueras, Inacio Malmonge, Ricardo da Silva, Alessandro de Abreu

- PS-M-WED-02-02 **A New Planar Sensor Based on the Matryoshka Microstrip Resonator**
  Alfrêdo Gomes Neto, Ademar G. Costa Junior, Cleumar da Silva Moreira, Thayuan Rolim de Sousa, Ianes Coutinho
- PS-M-WED-02-03 **Thirty Years of Fast-tracking Chemical Reactions with Microwaves**
  Luiz Alberto Jermolovicius, Eduardo V. S. Pouzada, Ailton Renato Stefanelli, Renata Nascimento, Edmilson Renato de Castro, José Senise
- PS-M-WED-02-04 **Measurement of RF Field Strength in Home Environments from a Nearby Base Station and Wireless Devices**
  Agostinho Linhares de Souza Filho, Antonio Martins Soares, Alex Azevedo
- PS-M-WED-02-05 **On Analytical Descriptions of Finite-Energy Bessel Beams in the Generalized Lorenz-Mie Theory**
  Leonardo Ambrosio
- PS-M-WED-02-06 **On the accuracy of approximate descriptions of discrete superpositions of Bessel beams in the generalized Lorenz-Mie theory**
  Leonardo Ambrosio, Carlos Henrique da Silva Santos, Ivan Eduardo Rodrigues
- PS-M-WED-02-07 **On Analytical Descriptions of Finite-Energy Paraxial Frozen Waves in Generalized Lorenz-Mie Theory**
  Nereida Llerena Valdivia, Leonardo Ambrosio
- PS-M-WED-02-08 **Analysis of azimuthal variation of rain attenuation**
  Luciano M Tomaz, Carlo Capsoni
- PS-M-WED-02-09 **Beam Selection in Multiuser Millimeter-Wave Sytems with Sub-Array User Terminal Architectures**
  Carlos Viteri-Mera, Fernando Teixeira





- PS-M-WED-02-10 **SDR-Based Radar-Detectors Embedded on Tablet Devices**
  Rafael G. Licursi de Mello, Fernando Rangel de Sousa, Cynthia Junqueira
- PS-M-WED-02-11 **A Behaviour Model for Power Amplifiers based on Sum of Products between One-dimensional Polynomials and Finite Impulse Response Filters**
  Carolina Machado, Eduardo Lima
- PS-M-WED-02-12 **Data-aided power estimation for a multiuser noncoherent MFSK fast Rayleigh fading system**
  Manish Sharma
- PS-M-WED-02-13 **Patch Antenna Bio-inspired on Wayfaring-tree (Viburnum lantana) for Applications in 2.4 GHz**
  Andrécia Pereira da Costa, Maciel Oliveira, José Magno, Glauco Fontgalland, Gustavo Forte, Galba F. Aragão, Paulo Silva
- PS-M-WED-02-14 **Analysis of Dual-Band Non-Uniformly Spaced Arrays for Mobile Communications**
  Daniel Lemes, Marcos V. T. Heckler, Lukasz A Greda, Roger Farias
- PS-M-WED-02-15 **Methodologies for Path Loss Prediction in LTE – 1.8 GHz Networks Using Neuro-Fuzzy and ANN**
  Hugo Cruz, Regina de Nasaré Nascimento, Jasmine Priscyla Leite de Araújo, Evaldo Pelaes, Gervásio Cavalcante
- PS-M-WED-02-16 **Harmonic Suppression in Microstrip Patch Antenna Using Spur-Line Filter**
  Fabricio Batista, Maciel Oliveira, Glauco Fontgalland, Paulo Silva, Laio Souza, João Paulo Fernandes da Silva
- PS-M-WED-02-17 **3D CUDA Based FDTD Method for Analysis of Microstrip Antennas**
  Ravel Pimenta, Ricardo Luiz Adriano, Maria Africano Contreras, Ursula Resende

- PS-M-WED-02-18 **Dissimilar Circular Patch Size Antenna Array With Enhanced Bandwidth and Broadside Gain**
  Maciel Oliveira, Glauco Fontgalland, Paulo Fernandes da Silva Júnior, Raimundo Freire, Paulo Silva, Elder Eldervitch Oliveira, João Paulo Fernandes da Silva, Fabricio Batista

- PS-M-WED-02-19 **Refining Worst-Case Crosstalk Models for the Next Generation Broadband Over Copper**
  Diogo Acatauassu, Joao Crisostomo Weyl-Costa

- PS-M-WED-02-20 **Horn Antenna Covered with an Artificial Dielectric Structure**
  Antonio Tomaz, Joaquim J Barroso, Pedro de Castro

- PS-M-WED-02-21 **Measurements of Extremely Low Frequency Waves (1-12 Hz) Produced by Ionospheric High-Frequency Waves**
  Mauro Alves, Inacio Malmonge, Marcelo Gomes, Alessandro de Abreu, Luiza Folgueras

- PS-M-WED-02-22 **Radar Cross Section Computation of Aircraft with Detailed Engine Inlets**
  Martin Vogel, Cynthia Junqueira

# About IMOC
# Organizing Committee

## General Chairs

= Daniel Moutinho Pataca (CPqD)
= Amilcar Careli César (USP São Carlos)
= Hugo Enrique Hernandez Figueroa (Unicamp)
= Maria Thereza Rocco Giraldi (IME)




## Technical Program Chairs

= Darli Augusto de Arruda Mello (Unicamp)
= Mônica de Lacerda Rocha (USP São Carlos)
= João Batista Rosolem (CPqD)



## MTT-S Chapter Chair – South Brazil section

= Luiz Carlos Kretly (Unicamp)

## International Liaison

= Silvio Ernesto Barbin (USP São Paulo)



# Technical Program Committee



Adaildo Gomes D'Assunção (UFRN / BR)
Adolfo Cartaxo (Instituto de Telecomunicações / PT)
Agostinho Linhares de Souza Filho (Anatel / BR)
Alfrêdo Gomes Neto (IFPB / BR)
Andrea Chiuchiarelli (CPqD / BR)
António Luis Jesus Teixeira (University of Aveiro / PT)
Arismar Cerqueira Sodre Junior (Inatel / BR)
Claudio Enrique Fernández Rodríguez (IFRS / BR)
Claudio Floridia (CPqD / BR)
Danilo Henrique Spadoti (UNIFEI / BR)
Fatima Gunning (Tyndall National Institute / IE)
Filipe M. Ferreira (Aston University / UK)
Giovanni Beninca de Farias (CPqD / BR)
Ivan T. Lima Jr. (NDS University / USA)
Jean Carlos Cardozo da Silva (UTFPR / BR)
Joaquim Ferreira Martins Filho (UFPE / BR)
José Antônio Justino Ribeiro (Inatel / BR)
José Luís Campos Oliveira Santos (University of Porto / PT)
José Ricardo Bergmann (PUC Rio / BR)
João Crisóstomo Weyl Albuquerque Costa (UFPA / BR)
Juliano João Bazzo (CPqD / BR)
Leonardo Ambrosio (USP São Carlos / BR)
Leonardo Rodrigues Araújo X.de Menezes (UnB / BR)
Lucas Heitzmann Gabrielli (Unicamp / BR)
Luis Henrique Hecker de Carvalho (BrPhotonics / BR)
Luiz Carlos Kretly (Unicamp / BR)
Marcelo Eduardo Vieira Segatto (UFES / BR)
Marcos Antonio Ruggieri Franco (IEAv / BR)
Maria Thereza Rocco Giraldi (IME / BR)
Maria Valéria Marquezini (Ericsson / BR)
Michel Daoud Yacoub (Unicamp / BR)
Miquel Garrich Alabarce (Politecnico di Torino / IT)
Nuno Borges Carvalho (University of Aveiro / PT)
Odilon Maroja da Costa Pereira Filho (UFPE / BR)
Paulo Sérgio de Brito André (Instituto Superior Técnico / PT)
Rashaunda Henderson (University of Texas at Dallas / US)
Roberto Pannepucci (CTI / BR)
Ulysses Rondina Duarte (IFMG / BR)
Valery Rozental (Monash University / Australia)

# Organizers

sbmo MTT-S CPqD USP UNICAMP

# Sponsors

## Diamond

KEYSIGHT TECHNOLOGIES CPqD

## Gold

Anritsu

# Support

IEEE Photonics Society FAPESP CAPES

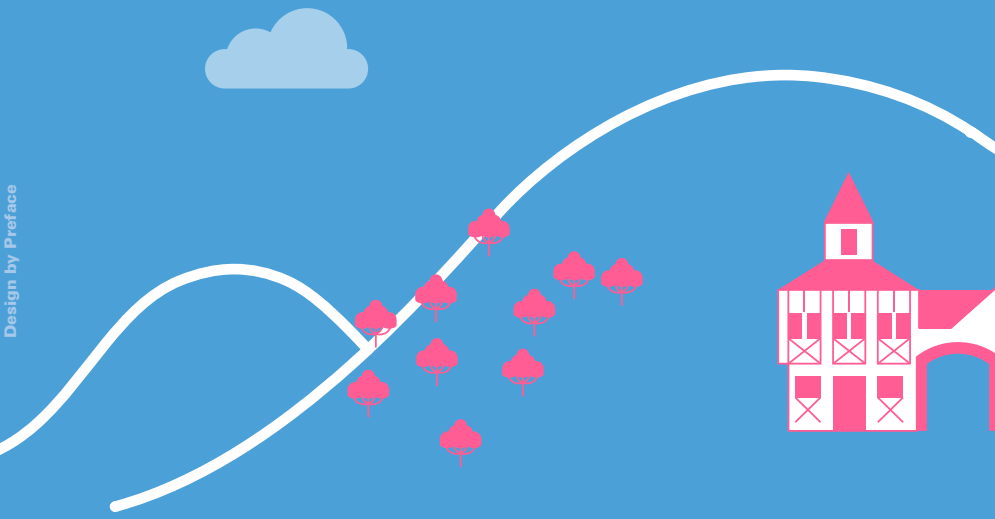
## ORGANIZERS

## SPONSORS

Diamond

Gold

## SUPPORT



Design by Preface