

CURRICULUM VITAE

MICHELE NORGIA

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 - **78 international journals** (75 indexed ISI Web Of Science), with 7 invited papers
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Citations number (January 2022):

1975 ISI WEB OF SCIENCE

2435 SCOPUS

3250 GOOGLE SCHOLAR

Hirsch Index (June 2021):

22 ISI WEB OF SCIENCE

23 SCOPUS

29 GOOGLE SCHOLAR

Curriculum vitae

Michele Norgia was born in Omegna on October 1st, 1972, he obtained his diploma in 1991 at the Liceo Scientifico Statale "G. Ferrari" Borgosesia (VC), vote 60/60 with letter of laude from the Committee. On October 18th 1996 he graduated with honors in Electrical Engineering from the University of Pavia, with the thesis: "A new formulation of the noise in the optical amplifier", supervisor Prof. Silvano Donati.

Since December 1996, he held an internship for a period of five months at CSELT S.p.A., Turin, working on optical and electronic measurements for the characterization of Bragg gratings in optical fiber.

He then carried out his military service as an officer in the Army Corps of Engineers.

In 1997 he won the competition (ranked first) for the XIII cycle of the PhD in Electrical Engineering and Computer Science at the University of Pavia, undertaking a research in the field of optoelectronic measurement instrumentation. On December 21, 2000, he received the Ph.D. title defending a thesis entitled "Injection detection and applications to interferometry", supervisor Prof. Silvano Donati.

During the PhD course he attended the School of Advanced Integrated Training, organized by the University Institute of Advanced Studies of the University of Pavia, earning his diploma degree.

From 1999 to 2004 he was the web manager for the Italian section of the IEEE Lasers and Electrooptic Society (LEOS), and collaborated in organizing several scientific and educational activities sponsored by the group, nationally and internationally.

From November 2000 to June 2001 he had a collaboration contract with the Department of Electronics, University of Pavia, with subject: "Development and engineering of a measuring interferometer for contactless movement detection, even on diffusing surfaces".

From July 2001 to September 2004 he worked in the Electro-Optics Laboratory of the University of Pavia, under a contract of Research Fellowship (having won a place in the field: Mathematical, Computer, Electrical, Electronic and Mechanical Engineering).

Since 2003 Michele Norgia collaborates with the Electronic Measurements Group, Department of Electronics and Information of Politecnico di Milano, both on scientific and educational activities.

From October 2004 to December 2005, he was Research Fellow at the Department of Electronics and Information of Politecnico di Milano, working on laser spectroscopy and optical measurements.

In January 2006, he joined the Department of Electronics, Information and Bioengineering of Politecnico di Milano, as Assistant Professor in Electrical and Electronic Measurements (ING-INF/07). He was confirmed in that role in 2009.

In October 2014, he became Associate Professor in Electrical and Electronic Measurements at the same Department.

In December 2014, he attained the national qualification (*Abilitazione Scientifica Nazionale*) for Full Professor in Electrical and Electronic Measurements (ING-INF/07).

Since December 2016, he is Full Professor in Electrical and Electronic Measurements at the Department of Electronics, Information and Bioengineering of Politecnico di Milano.

Organizing of Scientific Activity

Michele Norgia contributed to different organizing activities for international conferences and meetings, and also contributes to the scientific community as reviewer and associate editor.

He was part of the organizing committee for the following International conferences of the IEEE:

WFOPC '98 - Workshop on Fiber Optic Passive Components, Pavia, September 18-19, 1998, organized by the IEEE LEOS Italian Chapter;

ODIMAP II - 2nd Topical Meeting on Optoelectronic Distance/Displacement Measurement and Applications, Pavia, May 20-22, 1999, organized by the IEEE LEOS Italian Chapter;

WFOPC 2000 - 2nd Workshop on Fibers and Optical Passive Components, Pavia, June 8-9, 2000, organized by the IEEE LEOS Italian Chapter.

He was secretary of the International Meeting:

ODIMAP III - 3rd Topical Meeting on Optoelectronic Distance/Displacement Measurement and Applications, Pavia, September 20-22, 2001, organized by the IEEE LEOS Italian Chapter.

He was also part of the organizing committee of the following national conferences:

Reti ottiche di nuova generazione: architetture e tecnologie, Roma, June 18, 2001.

Elettroottica 2004, 8° Convegno Nazionale "Strumentazione e Metodi di Misura Elettroottici", Pavia, June 14 – 16, 2004.

He is member of the Electric and Electronics Measurement Group (GMEE), unit of Milano, and he is *senior member* IEEE, I&MS and LEOS since 2009.

He was *distinguished lectures* for IEEE (Photonics Society, Italian Chapter).

Michele Norgia acts as reviewer for different international journals: IEEE Transactions on Instrumentation & Measurement, IEEE Photonics Technology Letters, IEEE Journal of Microelectromechanical Systems, IEEE Journal of Quantum Electronics, IEEE Sensors Journal, IEE Electronics Letters, IEEE Journal of Selected Topics in Quantum Electronics, Optics Express, Optics Communications, Journal of the Optical Society of America A, Optics Letters, Mechatronics, IEEE Science, Chinese Optics Letters, IEEE Robotics and Automation Letters, Optics & Laser Technology, Measurement & Technology, Measurement.

He was a member of the Editorial Board for the international journal *Advances in OptoElectronics* from 2012 to 2017, he is member of the Editorial Board for the international journal *ACTA IMEKO* since 2016 and he is member of the Editorial Board for the international journal *SENSORS* since 2018.

He was guest editor of the special section “Self-Mixing Interferometry for Industrial Applications” for the journal *Optical Engineering* (2018).

Since 2010, he is member of the *I²MTC Technical Program Committee* (IEEE International Instrumentation and Measurement Technology Conference) and he was chairman of the session “Optical measurements” in *I²MTC* 2010.

He was also member of the IEEE SSD *Technical Program Committee* (International Multi Conference on Systems, Signals & Devices).

Technology Transfer Activity

The Research activity of Michele Norgia has led to different results in terms of technology transfer, especially for industrial applications. He was also involved in some national and international Research projects.

He co-wrote the proposal for the PRIN 2007, “Picosecond laser source with synchronization of the repetition rate of the pulses for applications in high resolution telemetry”, which was funded under the National Research Program. He was also involved for 8 months in PRIN 2002 “Micromirrors design and optical characterization”.

He was involved in four European Projects:

ACTS: PHOTOS AC046 (1994-1998)

SELMIX Brite-Euram (1999-2003)

OCCULT (2001-2004)

MEGAFRAME (2006-2010)

He participated as Unit responsible to the call Metadistrict Regional Unit 2007, which won the financing, but was unfortunately canceled due to the waiver of one of the firm (Accent S.p.A.).

He participated as Unit responsible to the call Metadistrict Regional Unit 2008.

He participated as Unit responsible to the call Made in Italy 2015.

He participated as a national coordinator to the call FIRB 2009 in Future Research.

He participated as Unit responsible to the calls FIRB 2010, FIRB 2012, PRIN 2013, overcoming the local selections, but not getting to the national financing.

Michele Norgia was responsible or co-responsible for different Research & Development Contracts with the following companies: Datamed S.r.l, Doteco S.p.A, Balance-System S.r.l., IMA Flavour, M3i Technology GmbH, NET S.r.l., Tenaris Dalmine S.p.A., Sidel S.p.A., CEA S.r.l., Redcap S.r.l., Ducati Corse S.r.l, Yamaha Motor Italia, Ansaldo Energia S.p.A, EMIT-LAS, Cemb S.p.A., Caccialanza S.p.A., TEA Elettronica, AMA S.p.A., Micropto S.r.l., MWM Schmieranlagen S.r.l., BTSR International S.p.A., Travaglini S.p.A..

The research contracts with industry, stipulated by Michele Norgia at Politecnico di Milano since 2006, have a total financing amount exceeding 1000 k€. This activity strongly contributed to the development of the Measurement Laboratory of the Department of Electronics, Information and Bioengineering.

He is co-founder and member of the Board of Directors of the interdepartmental laboratory POLINDT, devoted to Diagnosis and Structural Monitoring (financed by Politecnico in 2015).

Regarding the direct technology transfer, Michele Norgia collaborates to the building of REDCAP S.r.l., a start-up of the Politecnico di Milano working on safety devices for chainsaws, and Julight S.r.l., a spin off of the University of Pavia working on optoelectronic instruments. Since 2012 he is also a member of the Board of Directors of Julight S.r.l. company.

Research Activity

His main research interests deal with electronic measurements and optoelectronics, regarding the study, design and development of new sensors and instrumentation, for scientific and also industrial applications.

The main subjects of his scientific activity are:

1. Self-mixing interferometry
2. Optical measurements
3. Biomedical measurements and instrumentation
4. Micro-electro-mechanical sensors
5. Laser spectroscopy and stabilization
6. Cryptography and chaos in lasers
7. Bragg gratings characterization
8. Noise in optical amplifiers
9. Industrial measurements

For each subject M. Norgia provided different original contributions, which lead to more than 200 papers published in international journals or conference proceedings, altogether reaching more than 1000 citations in scientific journals.

1. Self-mixing interferometry

Since its Doctoral Thesis, Michele Norgia worked on the development of self-mixing laser interferometry, for different measurement applications. The initial research framework was the European Project SELMIX BRITE-EURAM, in collaboration with a Group of the *Ecole des Mines*, Nantes, headed by Prof. Thierry Bosch. The developed research included a deep experimental activity concerning design and measurements, together with the theoretical study of the optical back-injection in laser diodes. The self-mixing interferometer is based on the amplitude modulation exhibited by a laser diode when subjected to back-reflections from a remote target. The amplitude modulation contribution turns into a variation of the optical power emitted by the laser, resulting in an interferometric signal depending on the phase of the back-reflected optical field, and hence on the distance of the remote target. The amplitude modulation signal can be easily detected by the monitor photodiode, typically mounted into the laser package. For very-low back-injection, the power modulation is a nearly sinusoidal function of the target distance, while in the moderate back-injection regime it shows a distortion, becoming sawtooth-like. For this particular regime, it is possible to measure the target displacement and discriminate the motion direction, by counting the fringes of the interferometric signal, corresponding to a displacement of half a wavelength. Thanks to its simple optical setup, there are many other applications of this kind of interferometry to mechanical measurements and beyond. The main developments realized by Michele Norgia, are measurement systems for: displacement, velocity, absolute distance, vibrations and liquid flow. This technique was also applied to the measurement of some physical parameters of laser diodes.

With the study and development of self-mixing interferometry, Michele Norgia gained an international visibility confirmed by hundreds of citations, an international patent, and several review requests for international paper on that subject. Furthermore, paper **P45** was one of the most Accessed Articles in 2013 for the journal *Review of Scientific Instruments*, with about 1000 full-text views.

Related publications: **P4, P6, P11, P13, P19, P24, P28, P31, P39, P40, P42, P43, P45, P46, P49, P50, P52, N7, I5, I8, I12, I14, I20, I22, I23, I27, I30, I34, I35, I36, I53, I56, I57, I60,**

I61, I63, I64, I65, I66, I68, I69, I70, I73, I74, I76, I77, I78, I79, I84, I86, I87, C5, C7, C18, C22, C26, C32, C36, C39, C44, C48, C49, C52, C60, C62, C63, C66, C69, C71, C74, C76, C78, C83, C84, C85, V4, B2, BI1.

2. Optical measurements

In addition to the self-mixing applications, Michele Norgia studied innovative optical measurement methods, and designed different optical instruments and sensors for specific measurement applications. In the following, a resume is reported of the main results, in chronological order.

In a framework with Telecom Italy Lab (TiLab, Turin, Italy), Eng. Norgia dealt with frequency characterization of broadband photodiode, developing new techniques and photo-mixing measurement methods, using the beat of two low cost Fabry-Perot lasers. The purpose of the activity was the generation with optical techniques, of a 60 GHz carrier for transmission of information in indoor environments.

In collaboration with the Department of Mechanical Engineering of the Politecnico di Milano, Michele Norgia developed a custom laser Doppler velocity measurement system, for waterjet cutting machines. The system was designed to allow the measurement of water flow velocities up to 1000 m/s, in harsh optical conditions, because of the abrasive powders used in such machines. Through some improvements of the opto-electronic measuring system, it was also possible to measure the Lorentzian velocity distribution inside the jet.

Also in collaboration with the Department of Mechanical Engineering, Michele Norgia developed a sensor for the characterization of ultrasound welding machines. The novel sensor is based on optical triangulation, with high resolution ($< 1\mu\text{m}$) and bandwidth capabilities (400 kHz).

Within the European project "Million Frames per Second, Time-Correlated Single Photon Camera", in collaboration with the University of Pavia, Dr. Norgia studied innovative systems for light concentration, to be applied to three-dimensional cameras, based on arrays of rangefinders.

A further activity, in collaboration with colleagues from the Automation Section of the Politecnico di Milano, was the design of optical distance sensors, used for measuring the roll angle in racing motorbikes. The measurement on asphalt at high speeds has brought to a strong light interference, which has been deeply investigated. Finally, a robust solution was found in the ultimate realization of the sensors. The system was tested and used also by Ducati for moto GP and by Yamaha for superbike races.

As part of the national research project PRIN 2007 Dr. Norgia collaborated on the design and implementation of an innovative tool for distance measurement, based on the phase shift measurement of the upper harmonics of a femtosecond pulsed laser. The new technique exhibits excellent performance, being able resolving 10 μm of absolute distance, with an optical rangefinder substantially based on the measurement of time-of-flight.

Related publications: P27, P34, P35, P36, P37, P44, P51, I16, I29, I40, I45, I46, I48, I50, I54, I67, I71, I72, I80, I81, C10, C12, C19, C38, C43, C50, C51, C72, C73.

3. Biomedical measurements and instrumentation

During his scientific activity, Michele Norgia developed several novel sensors and measurement systems for biomedical applications.

As part of a collaboration with Glaxo-Smith-Kline Dr. Norgia designed and developed an electronic device for the "in vivo" amperometric polarimetry on guinea pigs. The device allows to measure, with great sensitivity, the concentration of chemical species (such as serotonin and dopamine) through the application of electrical potentials and the subsequent measurement of the currents generated within the cerebral cortex of the animal. The possibility of applying this technique to free subjects is due to the small size of the measuring device (about 1 cm per side) and the optical transmission of infrared signals to a receiving station.

Further activities for biomedical applications have been carried out in collaboration with the Institute of Biomedical Engineering of the National Research Council (CNR) in Milan. The first of these activities involved the study and the experimental characterization of cochlear implants. The achieved results were compared with finite element simulation of the system, obtaining a good description of the entire process, through a very good marching between measured data and theoretically simulated ones.

Also in collaboration with the Institute of Biomedical Engineering CNR in Milan, Michele Norgia studied different measurement techniques for 3D laser scanning and image reconstruction, aimed at creating mandibular and maxillofacial prosthesis.

Through a consortium of three small- and medium-sized enterprises, Dr. Norgia participated and won the funding of a contract Metadistrict for SMEs in 2007 (total funding € 950,000) in order to achieve a multi-sensor catheter for applications in urology. Unfortunately, the project was canceled due to the waiver of one of the firms (Accent S.p.A.).

As part of a national Metaframe, in cooperation with the company Datamed Srl (MI), Michele Norgia carried out various activities for biomedical optoelectronics measurement applications. An innovative extracorporeal blood flow meter was realized, through a laser technique, which has been patented. The sensor consists of a simple laser diode, which measures the backscattering induced by the scattering of red blood cells, through a lens-less self-mixing interferometer. Another result was an optical volumetric flow-meter for infusion, which measures in real time the drops volume, through the integration of their shadow on a photodetector.

A collaboration with the Regional Centre of Lecco (Sensibilab) led to the study and implementation of a sensitized mat, to be used in innovative incubators. The mattress is manufactured in a special gel, with a matrix of pressure and temperature sensors, which allows obtaining real-time map of the location and medical condition of the newborn, very useful for avoiding problems due to premature births.

Concerning optoelectronic biomedical applications, there is an ongoing collaboration with the Department of Bioengineering at the Politecnico of Milan, to study pulmonary impedance. Through the realization of custom micro-interferometers, a high-sensitivity monitoring system for forced respiratory oscillations has been realized. The work has shown excellent results, providing important information about the pulmonary impedance.

Related publications: **P16, P18, P25, P26, P30, P39, P42, P43, P50, N1, I10, I13, I19, I25, I31, I32, I40, I42, I43, I56, I61, I63, I64, I65, I73, I74, I82, I86, I87, C14, C15, C23, C29, C30, C33, C34, C40, C42, C59, C60, C62, C69, B2, B11.**

4. Micro-electro-mechanical sensors

As part of the project MADESS II of CNR, in collaboration with ST Microelectronics, Dr. Norgia worked on the study and characterization of devices made by silicon micromachining technology (MEMS). The well-established production techniques of integrated circuits are

used, in this case, to produce low-cost sensors, with the possibility of integrating in the same component the sensitive device and the measurement electronics: gyroscopes, accelerometers and linear resonators. In the case of the gyroscopes, a thin silicon mass suspended by springs vibrates along an axis by the application of an electrostatic force; in the presence of rotation, the Coriolis force couples a vibration along the perpendicular axis.

With regard to the characterization of the devices, it is necessary to retrieve the resonance curve, which describes the amplitude of vibration as a function of the applied force, the pacing rate and the pressure. For this purpose, we used the technique of self-mixing interferometry, described in Section 1, which allows measurement of the resonance curves in a non-electrically-invasive way, even placing the device in a vacuum bell. Note that the classic interferometric techniques are hardly usable in this case: in fact, the vertical side of the mass is not optically accessible because of the case, and also the upper surface of the mass behaves as a diffuser. The characterization has revealed non-linear aspects of the movement of the masses, such as the hysteresis in the frequency response. Different techniques were carried out, based also on a white-noise excitation. This technique allows, with a single acquisition, to acquire the entire frequency response of the device. In this way it is possible a fast and easy measurement also on prototypes, of which the resonance frequency is not known a priori. In order to characterize devices not optically reachable, Michele Norgia also implemented a technique of electrical measurement, which consists in the measurement of the capacity variation of the device combs. This technique has been studied and its limits were highlighted using the comparison with optical measurements described above.

The realization of a new micro-interferometer allowed to perform measurements under vacuum conditions also on a rotating platform, in order to directly measure the displacement due to the Coriolis force. To this purpose, it was developed a feedback system for keeping the interferometer locked to a half fringe, for calibrating the measurement, even when the MEMS is excited by white noise. This system is capable of maintaining the interferometer in quadrature, through a control signal at low frequency fed to the supply current of the laser. That optical technique has also allowed the simultaneous characterization of multiple vibration modes of the same structure.

Along with this characterization work, a new configuration has been proposed and studied for a hybrid gyroscope, with micromachined structure but optically readable. This structure has excellent potential performances, with respect to the simple electrical reading.

The work on micro-electro-mechanical systems led Michele Norgia to be invited to national and international conferences.

The characterization work was also carried out for micro-electro-mechanical devices realized for optical applications (MOEMS), used for the fast switching of optical signals or for fast images scanning. The measurements, both static and dynamic, were realized through interferometers and optical techniques based on position sensing detectors (PSD). In the context of a PRIN project, new structures of micromirrors were also characterized, named "Venetian-blind", composed of many reflective stripes. For these measurements a fiber-optic interferometer was set up, which allowed the complete static and dynamic characterization of the devices.

Some of the described works are reported in a chapter of an international scientific book.

Related publications: **P5, P7, P8, P10, P12, P17, P21, P29, I3, I6, I9, I17, C4, C6, C8, C13, C20, C21, C24, V3.**

5. Laser spectroscopy and stabilization

Michele Norgia participated and provided significant contributions to a further activity, developed in the Department of Electronics and Information of Politecnico di Milano, which concerns the laser spectroscopy of atomic and molecular species. Spectroscopy is performed with direct techniques or frequency modulation, in order to determine new frequency standards in the near infrared region, realized through the stabilization of appropriate laser sources. Michele Norgia collaborated to the measurement of the absorption curves of molecule CH₃D and the relative coefficient of collisional broadening. Spectroscopy measurements were then performed on the molecule of HI, at different pressures, with the aim of achieving a stabilized source locked to this reference. For the realization of a robust stabilization, a double control loop was employed for the laser: a first feedback loop acting on a piezoceramic actuator, for frequencies up to 100 Hz; a second loop acting on the laser current supply for frequencies up to 100 kHz. Through a Pound-Drever-type control, using an electro-optical modulator, a frequency stability of 10⁻¹⁰ was achieved at 1541.06 nm.

In order to characterize the piezoceramic actuator of the employed laser, Dr. Norgia has studied and realized a new method for measuring laser frequency tunability, based on the back-injection effect. The proposed method allowed a significant simplification of the calibration phase of the laser source.

As part of the PRIN project "Devices for Frequency Metrology and Near Infrared Spectroscopy", in collaboration with the Department of Physics, innovative solid-state laser sources were developed and characterized for metrology applications in the optical region of 1 μm, using crystals of Yb:KYF and Yb:YLF.

Related publications: **P20, P28, P32, P33, I24, I28, I30, I33, I38, I39, I47, I51, I52, C17, C25, C31, C37, C45, C55, C57, C58, V2.**

6. Cryptography and chaos in lasers

A semiconductor laser subject to strong back-injection can evolve into a chaotic regime. A typical feature of this regime is an optical spectrum broadened by a few GHz. This effect can be used to hide information in a sort of chaotic encryption. To extract the signal is mandatory to reproduce a chaos identical to the masking one, which may be induced on the receiver laser, still by optical injection using a technique of master-slave. The work, done within the European project OCCULT, consisted in the implementation of the experimental setup of a master-slave scheme, based on two semiconductor lasers with external cavity directly realized by the input face of an optical fiber, and measurements of the different chaos regimes generated at radiofrequency. It was studied in detail the dependence of the chaotic regimes on the length of the optical cavity, demonstrated the chaos locking of the slave laser through a correlation and spectral analysis. Particular attention was paid to the study of systems in open- or closed-loop, which differs in the status of the slave system: in the first case it is unperturbed while in the second one it is already chaotic even in the absence of injection by the master.

Michele Norgia was also involved in the study and development of an active control system of the external cavity length, in order to compensate the thermal drifts. This system allowed keeping master and slave locked in the closed loop scheme, where the request is a stability of the cavity length down to tens of nanometers, well below the laser wavelength.

The activity evolution concerned the encrypted transmission of signal, realized through the technique of chaos masking, which was demonstrated for an amplitude modulation on a few GHz carrier. In addition to the realization of the optical system, Dr. Norgia was involved in

the design and development of measuring equipment dedicated such as radio-frequency preamps (10 GHz), mixers, detectors, RF power-meter (up to 6 GHz) and demodulators.

The work was concluded with the transmission of audio and video signals on a chaotic carrier, which demonstrated, for the first time, the feasibility of a whole chaotic cryptography optical communication channel. The relevance of the obtained results was confirmed by invited publications in journals and conferences and by the publication of a paper in the journal Nature (Vol 437, November 2005 pag. 343-346). In this article, Dr. Norgia was merely indicated in the acknowledgements, as it was decided to indicate as authors only one responsible coordinator for each research group involved in the European project.

Related publications: **P9, P14, P22, I11, C9, C27, C35.**

7. Bragg gratings characterization

During the period of internship at CSELT, Turin, Dr. Norgia worked on the study and characterization of the properties of Bragg gratings in optical fiber.

The aim of the research consisted in modeling and measurement of the Bragg grating, in order to predict the spectral behavior as a function of the physical characteristics. Through a numerical simulator, functional dependencies on the project parameters have been described, for gratings with both constant and variable lattice pitch. An original physical interpretation was also given for the properties of lattices for the chromatic dispersion compensation.

Michele Norgia has developed a bench for measuring the polarization properties of the lattices, which has allowed the identification of the polarization mode dispersion (PMD) of the device, due to the birefringence induced by the lattice writing process. The latter has proved to be one of the greatest limitations for such dispersion compensators. In order to improve the measurement accuracy, Michele Norgia studied a novel theoretical approach to the problem, which has allowed defining special noise subtraction procedures, allowing reliable measurements, otherwise not possible.

This research and the corresponding results were included in the European project ACTS 046 PHOTOS.

Related publications: **P1, P2, I1, I2, R1, R2, R3, R4, R5.**

8. Noise in optical amplifiers

Starting from his diploma thesis, Dr. Norgia dealt with the theoretical study of a new theoretical model for noise estimation in optical amplifiers. The proposed model is realized by a semiclassical treatment of the electromagnetic radiation physical properties, and is able to correctly describe the transmission, amplification and detection of the signal at optical frequency. The semiclassical implementation of some principles of quantum mechanics (it is of fundamental importance to the fluctuation of the vacuum electromagnetic field) combines the simplicity of a formal treatment based on conventional analysis methods of the electronic noise, to the rigor of a quantum treatment. Through an appropriate mathematical method the evolution of the noise figure of a cascade of optical amplifiers was then analyzed. To complete the model, non-linear effects of the radiation propagation were considered, developing simulations able to calculate the signal evolution, and the noise associated, along a transmission line. The importance of the results obtained is demonstrated by the recovery of a figure of [P3] in a textbook internationally renowned and widely distributed (Application of Nonlinear Fiber Optics, GP Agrawal 2001 Academic Press). With a deep investigation of

nonlinear interactions between the signal and the vacuum field, it was possible, for the first time, to give a theoretical explanation of phenomena already observed experimentally, such as the self-generated modulation instability.

Related publications: **P3, I4, C1, C2, C3.**

9. Industrial measurements

Over the last decade in Politecnico di Milano, Dr. Norgia has dealt with various measurement issues for industrial applications. The following is a summary of the main R&D activities concerning industrial collaborations and research contracts.

On commission of the firm Tessitura Tele Metalliche Rossi S.r.l., in a project funded by the province of Como, Michele Norgia designed and realized an electronic circuit for proximity measurement that allows safeguarding of the chainsaw user. The principle of operation consists in a capacitive detection of the distance between the blade and the operator. Given the good functionality and high reliability, combined with compactness and low cost, the system developed has been patented and is now being tested by the most important manufacturers of chainsaws (Emak, Active, Husquarna and Stihl), with the goal to greatly improve the current safety standards. On this project, the Politecnico di Milano is collaborating with the National Institute for insurance against accidents at work (INAIL).

For the company Ansaldo Energia, Michele Norgia realized an optical system for measuring the radial dimensions of blades mounted on turbines, based on an innovative system of laser fork, which has allowed reaching an accuracy better than 10 μm in the measurement of turbine with diameter up to 4 meters in diameter. Given the excellent result achieved, the cooperation is still in progress, for other optical measurements on turbine stages.

On commission of the company Caccialanza & C., in a project funded by the province of Milan, Eng. Norgia studied an innovative system for locating fires, using common cameras with silicon sensors, for detecting the position of possible outbreaks of fires in enclosed spaces. The possibility of a fire is detected by a special image processing algorithm, which assesses the spatial and temporal evolution of the light sources in the near infrared. The fire location is estimated using triangulation techniques between two cameras. As an evolution of the previous work has been designed and implemented a tracking system for fire based on arrays of thermopile.

For the company CEA S.r.l. Materials for Lifts, as part of a regional funded project, Eng. Norgia explored innovative measurement and control of the cabin level of an elevator in order to replace obsolete systems, magnetic relays.

In collaboration with the company ALSTOM, an advanced system for measuring the temperature of dimmer switches has been designed and implemented.

On commission of the firm BALANCE SYSTEM, Michele Norgia developed and tested new interferometric systems for vibration measurement, for the balancing of electric motors rotors. In cooperation with the firm DATAMED, as described in section 3, there are several ongoing researches in the biomedical field.

For the company DOTECA, Michele Norgia worked on the design and implementation of an optical thickness meter for plastic film, based on low-coherence interferometry, and the design and implementation of a capacitive thickness measuring of plastic film. It was also carried out the study of systems for measuring the surface treatment of plastic film (corona treatment).

In collaboration with Prof. Savaresi, Michele Norgia carried out the following activities for companies YAMAHA, DUCATI and APRILIA: research and development of optical sensors away from asphalt, to measure roll angle of racing motorcycle.

On commission of the IMA-FLAVOUR company, Eng. Norgia has designed and built prototypes of optical triangulator for measuring vibration, dedicated to the characterization of ultrasonic welders (vibration of 50 um to 35 kHz). The sensor was also reproduced for the company CAVANNA.

In cooperation with the firm EMIT-LAS (SIT calibration center), was created an automated system for temperature sensors calibration.

On commission of the company M3i Technologies GmbH, has been designed and built a prototype of a guitar with optical reading of the fingers positions, made with 6 laser triangulators for the direct generation of MIDI signal.

For the company CEMB, Eng. Norgia has designed and built an optical sensor for distance measuring, optimized for the detection of the profile of a tire during the balancing process.

In collaboration with the Department of Mechanics, commissioned by the company CAVANNA, has been studied and sensorized a system of ultrasonic welding machines for flow-pack.

For the company NET, a miniaturized mass spectrometer was studied, operating with the corona discharge, for the realization of an extremely sensitive gas sensor.

On order of the TEA-electronics company, has been designed and developed a moisture meter for clay (for installation in a furnace), created through an innovative optical system for measuring absorption in multi wavelength.

For the company TENARIS-DALMINE, Michele Norgia developed a technique for the characterization of magneto-elastic load cells, for the measurement of forces in rolling mills. The collaboration with TENARIS continued into the context of non-invasive analysis techniques, in particular magnetic flux leakage. The aim of our work was to improve the inspection system of seamless steel pipes currently in use in the company. An additional research theme, still in progress, is the automatic characterization of the tube geometry through optical sensors.

For the company MWM, Michele Norgia invented and developed new measurements techniques for minimal lubrication monitoring, giving rise to two patents (BI3, BI4).

Related publications: P36, P37, P38, P47, P48, I37, I46, I48, I49, I50, I58, I62, I75, I80, I81, I83, I85, C41, C46, C50, C53, C54, C56, C61, C64, C68, C77, C79, C80, C81, C82, C86, V5, V6, V7, B1, B3, B4, BI2, BI3, BI4.

Teaching

Michele Norgia was the academic supervisor of four Ph.D students in Information Engineering, at Politecnico di Milano:

Alessandro Magnani, cycle XXVI

Dario Melchionni, cycle XXVIII

Parisa Esmaili, cycle XXXII

Federico Bandi, cycle XXXIV

He was also the thesis supervisor for about 100 students taking the first-level degree (Bachelor degree), and some other 150 students taking the second-level degree (MS degree). Their thesis works were developed at the Measurement Laboratory of Politecnico di Milano.

Michele Norgia was the lecturer for the following courses at the Politecnico di Milano, getting always very good students' evaluations (sometimes he was the best-rated in his course of study):

Academic year 2021-2022 [total of about 360 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 280 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 80 students).

Academic year 2020-2021 [total of about 400 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 302 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 97 students).

Academic year 2019-2020 [total of about 330 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 247 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 87 students).

Academic year 2018-2019 [total of about 300 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 211 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 83 students).

Academic year 2017-2018 [total of about 340 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 244 studenti).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 75 studenti).

- “Radiofrequency Measurements”, for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 28 studenti).

Academic year 2016-2017 [total of about 330 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 195 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 101 students).
- “Radiofrequency Measurements”, for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 41 students).

Academic year 2015-2016 [total of 361 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 185 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 98 students).
- “Radiofrequency Measurements”, for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 78 students).

Academic year 2014-2015 [total of 343 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 169 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 99 students).
- “Radiofrequency Measurements”, for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 75 students).

Academic year 2013-2014 [total of 249 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 114 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 82 students).
- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 53 students).

Academic year 2012-2013 [total of 281 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 113 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 127 students).
- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 41 students).

Academic year 2011-2012 [total of 231 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 94 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 106 students).

- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 31 students).

Academic year 2010-2011 [total of 205 students]

- “Misure e Strumentazione” (Instrumentation and Measurements), for students in Automation Engineering, (8 CFU, 99 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 75 students).
- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 31 students).

Academic year 2009-2010 [total of 205 students]

- “Misure per l’Automazione” (Measurements for Automation), for students in Automation Engineering, (7.5 CFU, 87 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 64 students).
- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 54 students).

Academic year 2008-2009 [total of 218 students]

- “Misure per l’Automazione” (Measurements for Automation), for students in Automation Engineering, (7.5 CFU, 84 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 62 students).
- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 72 students).

Academic year 2007-2008 [total of 338 students]

- “Misure per l’Automazione” (Measurements for Automation), for students in Automation Engineering, (7.5 CFU, 98 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 123 students).
- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 78 students).
- “Laboratorio di Acquisizione Dati” (Laboratory of Data Acquisition), for students in Engineering of Computing Systems, Como, (2.5 CFU, 39 students)

Academic year 2006-2007 [total of 415 students]

- “Misure per l’Automazione” (Measurements for Automation), for students in Automation Engineering, (7.5 CFU, 93 students).
- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 237 students).
- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 85 students).

Academic year 2005-2006 [total of 482 students]

- “Misure per l’Automazione” (Measurements for Automation), for students in Automation Engineering, (7.5 CFU, 98 students).

- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 171 students).
- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 172 students).
- “Laboratorio di Acquisizione Dati” (Laboratory of Data Acquisition), for students in Engineering of Computing Systems, Como, (2.5 CFU, 41 students)

Academic year 2004-2005 [total of 420 students]

- “Fondamenti della Misurazione” (Fundamentals of Measurement), for students in Electronics Engineering (5 CFU, 227 students).
- “Misure a Radiofrequenza” (Radiofrequency Measurements), for students in Master of Science Electronics Engineering and Telecom Engineering (5 CFU, 126 students).
- “Progetto di Acquisizione Dati” (Data Acquisition Project), for students in Engineering of Computing Systems, Como, (2.5 CFU, 67 students)

At the Politecnico di Milano he has also carried out the following integrative teaching activities.

Academic years 2008-09, 2007-08, 2006-07, 2005-06, 2004-05, 2003-04:

- Teaching assistant for “Statistica e Misurazione” (Measurement and Statistics)

Academic year 2004-05:

- Teaching assistant for “Misure per l’Automazione” (Measurements for Automation)
- Teaching assistant for “Analisi Statistica dei Dati e Affidabilità” (Reliability and Statistics)
- Teaching assistant for “Misure Elettroniche” (Electronics Measurements)
- Laboratory teacher for “Misure per l’Automazione” (Measurements for Automation)
- Laboratory teacher for “Misure per Telecomunicazioni” (Telecommunication Measurements)
- Laboratory teacher for “Misure Elettroniche” (Electronics Measurements)

Anno accademico 2003-04:

- Teaching assistant for “Misure per l’Automazione” (Measurements for Automation)
- Laboratory teacher for “Misure per l’Automazione” (Measurements for Automation)
- Laboratory teacher for “Misure per Telecomunicazioni” (Telecommunication Measurements)
- Laboratory teacher for “Misure Elettroniche” (Electronics Measurements)
- Teaching assistant for “Misure a Radiofrequenza”, (Radiofrequency Measurements).
- Teaching assistant for “Fondamenti della Misurazione” (Measurement Fundamentals)
- Laboratory teacher for “Fondamenti della Misurazione” (Fundamentals of Measurement)
- Teaching assistant for “Progetto di Acquisizione Dati” (Data Acquisition Project)

Anno accademico 2002-03:

- Teaching assistant for “Misure Elettroniche” (Electronics Measurements)
- Laboratory teacher for “Fondamenti della Misurazione” (Fundamentals of Measurement)
- Laboratory teacher for “Misure Elettroniche” (Electronics Measurements)

At the University of Pavia, he held the following educational seminars, as teaching assistant:

- Anno accademico 2000-01: Electronics for Diploma.
- Anno accademico 2001-02: Electronics.
- Anno accademico 2002-03: Electronics.

He also gave the following courses, aimed at students of doctorate courses.

- Academic year 2002-03: 2 lessons for the course “Misure Ottiche ed Optoelettroniche” (Optical and Optoelectronic Measurements) within the school to PhD in Electrical Engineering and Telecommunications at the Politecnico di Milano.
- Academic year 2003-04: lesson on “Low-jitter Optical Sampling Techniques” at the National School of Excellence "Italo Gorini" for PhD students”, September 1-5 2003

He was a member of the examination boards at the University of Pavia for the courses: Electronics, Electronics for Diploma, Optoelectronics + Optics, Optoelectronics II, for the academic years from 1998-1999 to 2003-2004.

Eng. Norgia helped to supervise the work of graduate theses, as supervisor or co-supervisor, carried out at the Electrooptics Laboratory of the University of Pavia in the academic years 1998-99 to 2003-2004.

With regard to the organization of didactic activity, Dr. Norgia participated in the Commission for Tutoring (2009-2013) and in the Joint Commission of the School of Engineering (2011-2013). He is also responsible for the management of didactic laboratories for all the courses belonging to the Department of Electronics and Information of Politecnico di Milano (since 2006).

Summary of Publications

Publications in international journals: 78 (75 ISI +1 Scopus), with 7 invited papers

25 IEEE Transactions on instrumentation and Measurement

5 IEEE Journal of Quantum Electronics

5 IEEE Photonics Technology Letters

3 IEEE Journal of Microelectromechanical Systems

3 Review of Scientific Instruments

3 Applied Optics

3 Optical Engineering

2 Measurement

2 Journal of Optics A: Pure and Applied Optics

2 IEEE Journal of Selected topics in Quantum Electronics

2 Optics and Lasers in Engineering

2 Optics Letters

2 CSELT Technical Reports (not-ISI)

1 Measurement Science and Technology,

1 Sensors & Actuators: A. Physical

1 IEEE Sensors

1 Sensors (MDPI)

1 IEEE/OSA Journal of Lightwave Technology

1 Optics Express

1 Optics Communications

1 Photonics (MDPI)

1 Chinese Optics Letters

1 Electronics Letters

1 IEEE/ASME Transactions on Mechatronics

1 C. R. Physique

1 ACTA IMEKO

1 Journal of Neuroscience Methods

1 Journal of Laser Applications

1 Acta Imeko (not-ISI, Scopus)

1 Sensor & Transducers (not-ISI)

1 ST Journal of System Research (not-ISI)

1 Audio Infos (not-ISI)

P1. S. Bonino, **M. Norgia**, E. Riccardi, M. Schiano, "Measurement of polarisation properties of chirped fibre gratings", 1998 CSELT Technical Reports 26 (1), pp. 49-55.

- P2. S. Bonino, **M. Norgia**, E. Riccardi, "Spectral behaviour analysis of chirped fibre Bragg gratings for optical dispersion compensation", 1998 CSELT Technical Reports 26 (1), pp. 137-145.
- P3. **M. Norgia**, G. Giuliani, S. Donati, "Noise Evolution along Optically Amplified Links in presence of Non-Linear Parametric Gain", IEEE/OSA J. of Lightwave Technol., vol. 17, n. 10, October 1999, pp. 1750-1757.
- P4. G. Giuliani, **M. Norgia**, "Laser diode linewidth measurement by means of self-mixing interferometry", IEEE Photonics Technology Letters, vol. 12, n. 8, August 2000, pp. 1028-1030.
- P5. V. Annovazzi-Lodi, S. Merlo, **M. Norgia**, "Measurement on a Micromachined Silicon Gyroscope by Feedback Interferometry", IEEE/ASME Transactions on Mechatronics, vol. 6, n. 1, March 2001, pp. 1-6.
- P6. **M. Norgia**, S. Donati, D. D'Alessandro, "Interferometric Measurements of Displacement on Diffusing Target by a Speckle Tracking Technique", IEEE J. of Quantum Electronics, vol. 37, n. 6, June 2001, pp. 800-806.
- P7. **M. Norgia**, S. Donati, "Hybrid opto-mechanical gyroscope with injection-interferometer readout", Electronics Letters, vol. 37, no. 12, 7 June 2001, pp. 756-758.
- P8. V. Annovazzi-Lodi, S. Merlo, **M. Norgia**, "Comparison of Capacitive and Feedback-Interferometric Measurements on MEMS", IEEE Journal of Microelectromechanical Systems, vol. 10, no. 3, September 2001, pp. 327-335.
- P9. (INVITED PAPER) V. Annovazzi-Lodi, S. Merlo, **M. Norgia**, A. Scirè "Characterization of a Chaotic Telecommunication Laser for Different Fiber Cavity Lengths", IEEE J. of Quantum Electronics, vol. 38, n. 9, September 2002, pp. 1171-1177.
- P10. V. Annovazzi-Lodi, S. Merlo, **M. Norgia**, "Characterization of Silicon Microstructures by Feedback Interferometry", Journal of Optics A, vol. 4, November 2002, pp. S311-S317.
- P11. (INVITED PAPER) G. Giuliani, **M. Norgia**, S. Donati, T. Bosch, "Laser Diode Self-Mixing Technique for Sensing Applications", Journal of Optics A, vol. 4, November 2002, pp. S283-S294.
- P12. V. Annovazzi-Lodi, S. Merlo, **M. Norgia**, G. Spinola, B. Vigna, S. Zerbini "Optical Detection of the Coriolis Force on a Silicon Micromachined Gyroscope" IEEE Journal of Microelectromechanical Systems, vol. 12, no. 5, October 2003, pp. 540-549.
- P13. **M. Norgia**, S. Donati, "A Displacement-Measuring Instrument Utilizing Self-Mixing Interferometry", IEEE Trans. on Instrumentation and Measurement, vol. 52, no.6, December 2003, pp. 1765-1770.
- P14. (INVITED PAPER) V. Annovazzi-Lodi, M. Benedetti, S. Merlo, **M. Norgia**, "Fiber optics setup for chaotic cryptographic communications", C. R. Physique, vol. 5, August 2004, pp. 623-631.
- P15. V. Annovazzi-Lodi, M. Benedetti, S. Merlo, **M. Norgia**, "Spot Optical Measurements on Micromachined Mirrors for Photonic Switching", IEEE Journal of Selected topics in Quantum Electronics, Vol. 10, No. 3, May/June 2004, pp. 536-544.
- P16. F. Crespi, D. D'Alessandro, V. Annovazzi-Lodi, C. Heidbreder, **M. Norgia**, "In vivo voltammetry: from wire to wireless measurements", Journal of Neuroscience Methods, Vol. 140, Issue: 1-2, 30 December 2004, pp. 153-161.
- P17. V. Annovazzi-Lodi, M. Benedetti, S. Merlo, **M. Norgia**, "Optical detection of multiple modes on resonant micromachined structures", IEEE Photonics Technology Letters, vol. 16, n. 7, July 2004, pp. 1703-1705.
- P18. G. Tognola, S. Burdo, M. Caponio, **M. Norgia**, M. Parazzini, P. Ravazzani, F. Grandori, C. Svelto, "Measurement of Electrode Current Pulses from Cochlear Implants", IEEE Trans. on Instrumentation and Measurement, vol. 54, no. 5, October 2005, pp. 2105 - 2112.
- P19. **M. Norgia**, G. Giuliani, S. Donati, "Absolute Distance Measurement with Improved Accuracy using Laser Diode Self-Mixing Interferometry in a Closed Loop", IEEE Trans. on Instrumentation and Measurement, Vol. 56, n. 5, October 2007, pp. 1894 -1900.
- P20. C. Svelto, **M. Norgia**, E. Bava, G. Galzerano, "FM Spectroscopy of Monodeuterated Methane as a Frequency Standard at 1.54 μm ", IEEE Trans. on Instrumentation and Measurement, vol. 54, no. 4, August 2005, pp. 1630 - 1633.

- P21. S. Merlo, V. Annovazzi-Lodi, M. Benedetti, F. Carli, **M. Norgia**, "Testing of "Venetian Blind" Silicon Microstructures with Optical Methods", IEEE Journal of Microelectromechanical Systems, vol. 15, no.3, June 2006, pp. 588-596.
- P22. V. Annovazzi-Lodi, M. Benedetti, S. Merlo, **M. Norgia**, B. Provinzano, "Optical Chaos Masking of Video Signals", IEEE Photonics Technology Letters, vol. 17, n. 9, September 2005, pp. 1995 – 1997.
- P23. G. Tognola, M. Parazzini, **M. Norgia**, A. Pesatori, L. Di Rienzo, S. Burdo, C. Svelto, P. Ravazzani, F. Grandori, "Experimental measurement of current excitation and numerical estimation of electrical fields generated by cochlear implants," Audio Infos, Special ENT, pp. 20-23, 2005.
- P24. S. Donati, **M. Norgia**, G. Giuliani, "Self-mixing differential vibrometer based on electronic channel subtraction", Applied Optics, vol. 45, n. 28, October 2006, pp. 7264-7268.
- P25. G. Tognola, M. Parazzini, G. Pedretti, P. Ravazzani, C. Svelto, **M. Norgia**, F. Grandori, "Three-dimensional reconstruction and image processing in mandibular distraction planning", IEEE Trans. on Instrumentation and Measurement, Vol. 55, n. 6, December 2006, pp. 1959 - 1964.
- P26. G. Tognola, A. Pesatori, **M. Norgia**, M. Parazzini, L. Di Rienzo, P. Ravazzani, S. Burdo, F. Grandori, and C. Svelto, "Numerical modeling and experimental measurements of the electric potential generated by cochlear implants in physiological tissues", IEEE Trans. on Instrumentation and Measurement, Vol. 56, n. 1, February 2007, pp. 187-193.
- P27. M. Annoni, L. Cristaldi, **M. Norgia**, C. Svelto "Efficiency Measurement of Waterjet Orifices by a Novel Electrooptical Technique", IEEE Trans. on Instrumentation and Measurement, Vol. 57, n. 1, January 2008, pp. 48-54.
- P28. **M. Norgia**, A. Pesatori, C. Svelto "Novel Interferometric Method for the Measurement of Laser Wavelength/Frequency-Modulation Sensitivity", IEEE Trans. on Instrumentation and Measurement, Vol. 56, n. 4, August 2007, pp. 1373-1376.
- P29. V. Annovazzi-Lodi, S. Merlo, **M. Norgia**, G. Spinola, B. Vigna, S. Zerbini "Optical Detection of the Coriolis Force on a Silicon Micromachined Gyroscope", ST Journal of System Research, vol. 3, n. 1, July 2006, pp. 63-73.
- P30. G. Tognola, M. Parazzini, G. Pedretti, P. Ravazzani, F. Grandori, A. Pesatori, **M. Norgia**, C. Svelto, "Gradient-vector-flow snake method for quantitative image reconstruction applied to mandibular distraction surgery", IEEE Trans. on Instrumentation and Measurement. Volume 58, n. 7, July 2009, pp.2087- 2093.
- P31. **M. Norgia**, C. Svelto "Novel Measurement Method for Signal Recovery in Optical Vibrometer", IEEE Trans. on Instrumentation and Measurement, Vol. 57, n. 8, August 2008, pp. 1703-1707.
- P32. A. Pesatori, **M. Norgia**, V. Calabrese, G. Galzerano, E. Bava, C. Svelto "Optical Frequency Standard by HI Doppler-Broadened Absorption and External-Cavity Laser Diode at 1.541 μm ", IEEE Trans. on Instrumentation and Measurement, Vol. 57, n. 8, August 2008, pp. 1708-1712.
- P33. G. Galzerano, P. Laporta, E. Sani, G. Bonelli, A. Toncelli, M. Tonelli, **M. Norgia**, A. Pesatori, C. Svelto, "Characterization of Single-Frequency Yb:KYF₄ Lasers at 1.03 μm for Optical Frequency Metrology", IEEE Trans. on Instrumentation and Measurement, Vol. 57, n. 8, August 2008, pp. 1713-1717.
- P34. M. Annoni, L. Cristaldi, **M. Norgia**, C. Svelto, "Measurement of Water Jet Velocity Distribution Using Laser Velocimetry", IEEE Trans. on Instrumentation and Measurement, Vol. 57, n. 8, August 2008, pp. 1524-1528.
- P35. S. Donati, G. Martini, **M. Norgia**, "Microconcentrators to Recover Fill-Factor in Image Photodetectors with Pixel On-board Processing Circuits", Optics Express, vol. 15, n. 26, December 2007, pp.18066-18075.
- P36. **M. Norgia**, I. Boniolo, M. Tanelli, S. M. Savaresi, C. Svelto, "Optical Sensors for Real-Time Measurement of Motorcycle Tilt Angle", IEEE Trans. on Instrumentation and Measurement. Vol. 58, n. 5, May 2009, pp.1640- 1649.
- P37. **M. Norgia**, M. Annoni, A. Pesatori, C. Svelto, "Dedicated Optical Instruments for Ultrasonic Welder Inspection and Control", Measurement, Vol. 43, n. 1, January 2010, pp. 39-45.

- P38 A. Pesatori, **M. Norgia**, C. Svelto, "Optical sensor for online turbine edge measurement", *Measurement Science and Technology*. Volume 20, n. 10, 2009, 104006 (7pp).
- P39 **M. Norgia**, A. Pesatori, L. Rovati, "Low-Cost Optical Flowmeter With Analog Front-End Electronics for Blood Extracorporeal Circulators", *IEEE Trans. on Instrumentation and Measurement*, Vol. 59, n. 5, May 2010, pp. 1233-1239.
- P40 **M. Norgia**, A. Pesatori, M. Tanelli, M. Lovera, "Frequency Compensation for a Self-Mixing Interferometer", *IEEE Trans. on Instrumentation and Measurement*, Vol. 59, n. 5, May 2010, pp.1368-1374.
- P41 B. Paroli, G. Bettega, G.Maero, M. Romè, **M. Norgia**, A. Pesatori, C. Svelto, "Electrostatic diagnostics of nanosecond pulsed electron beams in a Malmberg-Penning trap", *Review of Scientific Instruments*, Vol. 81, n. 6, June 2010, pp. 063503 (5 pages).
- P42 **M. Norgia**, A. Pesatori, L. Rovati, "Self-Mixing Laser Doppler Spectra of Extracorporeal Blood Flow: A Theoretical and Experimental Study", *IEEE Sensors*, Vol. 12, n. 3, March 2012, pp. 552-557.
- P43 I. Milesi, **M. Norgia**, P. P. Pompilio, C. Svelto, R. Dellacà, "Measurement of Local Chest Wall Displacement by a Custom Self-Mixing Laser Interferometer", *IEEE Trans. on Instrumentation and Measurement*, Vol. 60, n. 8, August 2011, pp. 2894-2901.
- P44 A. Pesatori, **M. Norgia**, C. Svelto, M. Zucco, M. Stupka, A. De Marchi, "High Resolution Time of Flight Telemeter with High Harmonics Pulses Locking", *IEEE Trans. on Instrumentation and Measurement*, Vol. 61, n. 5, May 2012, pp. 1536-1542. Digital Object Identifier: [10.1109/TIM.2012.2183437](https://doi.org/10.1109/TIM.2012.2183437)
- P45 M. Norgia, A. Magnani, A. Pesatori, "High Resolution Self-Mixing Laser Rangefinder", *Review of Scientific Instruments*, Vol. 83, n. 4, April 2012, pp. 045113 (6 pages). Digital Object Identifier: <http://dx.doi.org/10.1063/1.3703311>
- P46 A. Magnani, A. Pesatori, **M. Norgia**, "Self-Mixing Vibrometer with Real-Time Digital Signal Elaboration", *Applied Optics* Vol. 51, n. 21, July 2012, pp. 5318–5325.
- P47 **M. Norgia**, A. Pesatori, "Dual Wavelength Moisture Meter for Clay", *Optical Engineering*, Vol. 51, n. 10, October 2012, pp. 104402 (4 pages). doi:10.1117/1.OE.51.10.104402
- P48 A. Pesatori, **M. Norgia**, "Infrared image system for fire location", *Measurement*. Vol. 46, December 2013, pp. 4172-4178, Digital Object Identifier: <http://dx.doi.org/10.1016/j.measurement.2013.07.040>
- P49 A. Magnani, **M. Norgia**, "Spectral Analysis for Velocity Measurement through Self-Mixing Interferometry", *IEEE J. Of Quantum Electronics*, Vol. 49, n. 9, September 2013, pp. 765-769 Digital Object Identifier: [10.1109/JQE.2013.2273562](https://doi.org/10.1109/JQE.2013.2273562)
- P50 (INVITED PAPER) S. Donati, **M. Norgia**, "Self-mixing Interferometry for Biomedical Signals Sensing", *IEEE Journal of Selected topics in Quantum Electronics*, Vol. 20, n. 2, March 2014, pp. 6900108 (8 pages). Digital Object Identifier: [10.1109/JSTQE.2013.2270279](https://doi.org/10.1109/JSTQE.2013.2270279)
- P51 **M. Norgia**, A. Pesatori, "Optical flow sensor through near-field grating diffraction", *Sensors and Actuators A*, Vol. 203, 1 December 2013, pp. 382–385 DOI: 10.1016/j.sna.2013.09.029.
- P52 A. Magnani, A. Pesatori, **M. Norgia**, "Real-Time Self-Mixing Interferometer for Long Distances" *IEEE Trans. on Instrumentation and Measurement*, Vol. 63, n. 7, July 2014, pp. 1804-1809. Digital Object Identifier: 10.1109/TIM.2013.2297816.
- P53 D. Melchionni, **M. Norgia**, "Optical System for Liquid Level Measurements", *Review of Scientific Instruments*, Vol. 85, n. 7, July 2014, pp. 075113 (7 pages). Digital Object Identifier: <http://dx.doi.org/10.1063/1.4890437>
- P54 **M. Norgia**, A. Magnani, D. Melchionni, A. Pesatori, "Drop Measurement System for Biomedical Application" *IEEE Trans. on Instrumentation and Measurement*, Vol. 64, n. 9, September 2015, pp. 2513-2517. DOI: [10.1109/TIM.2015.2398972](https://doi.org/10.1109/TIM.2015.2398972)
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Milano, January, 2022

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