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On behalf of the 2021 IEEE International Workshop on Metrology for Automotive (MetroAutomotive 2021), we warmly welcome you to the first edition of MetroAutomotive 2021 which is taking place as a virtual event.

The goal of this workshop is to bring together researchers from universities, research centers, and industry, to foster sharing and discussion in a common forum where to exchange views about the most recent results of scientific and technological research and, to inspire further developments in the fascinating field of the automotive.

MetroAutomotive 2021 (originally MetroAutomotive 2020) was scheduled to be held in 2020 in the Emilia Romagna region, the heart of the Italian Motorvalley. However, the past year has seen unprecedented issues, with a global lockdown and movement restrictions, which are yet continuing in 2021. It became thus clear that MetroAutomotive 2020 could not be delivered, and that MetroAutomotive 2021 could not be an on-site conference. The Organizing Committee decided that even in a virtual format, MetroAutomotive 2021 would have provided a high standard. The goal is for the virtual workshop to mirror all the features of on-site workshops. It has been therefore decided that all online presentations at the virtual event would be delivered ‘live’. Accordingly, attendees at MetroAutomotive 2021 will experience the following live talks and sessions: Tutorials, Plenaries, and Presentations.

The MetroAutomotive Technical Program consists of 2 Tutorial sessions, 4 plenaries and, 14 oral-presentation sessions scheduled over three days, aiming to cover the several fields of metrology for automotive. MetroAutomotive 2021 also benefits from a panel session organized by the IEEE Women in Engineering (WIE) Italy Section, with the aim of fostering discussion about the impact of gender-diversity in the design methodologies, in the technologies and approaches pursued into the automotive sector.

Plenaries, as well as presentations, will be followed by live Q&A, just like at an on-site event. All accepted papers will be published in the workshop proceedings, while presented papers adhering to the presentation requirements will be uploaded to IEEE Xplore. Authors of the proceedings papers are also eligible to submit an extended version of their work to the MDPI Sensors and MDPI Energies Special Issues dedicated to MetroAutomotive 2021.

Last, and by no means the least, we have to give recognition and special thanks to all the Technical Program Committee members and the reviewers who have contributed to making this possible. We all
did our best so that the live virtual format of MetroAutomotive 2021 will allow attendees to increase their knowledge, meet up online with established friends, and make new contacts from across the world. We wish you all an enjoyable workshop!

**General Chairs**
Lorenzo Peretto, *University of Bologna, Italy*
Luigi Rovati, *University of Modena and Reggio Emilia, Italy*

**Technical Program Chairs**
Roberto Tinarelli, *University of Bologna, Italy*
Stefano Cattini, *University of Modena and Reggio Emilia, Italy*

**Special Session Chairs**
Federico Tramarin, *University of Modena and Reggio Emilia, Italy*
Raffaella Di Sante, *University of Bologna, Italy*
IEEE MetroAutomotive 2021 Committee

GENERAL CHAIRS
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Luigi Rovati, University of Modena and Reggio Emilia, Italy

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Stefano Cattini, University of Modena and Reggio Emilia, Italy

PUBLICATION CHAIR
Ioan Tudosa, University of Sannio, Italy

SPECIAL SESSION CHAIR
Federico Tramarin, University of Modena and Reggio Emilia, Italy
Raffaella Di Sante, University of Bologna, Italy

IEEE WIE ACTIVITIES CHAIRS
Roberta Di Pace, University of Salerno, Italy
Cristina Costa, Fondazione Bruno Kessler, Italy

TREASURY CHAIR
Luca De Vito, University of Sannio, Italy

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Francesco Biral, University of Trento, Italy
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Giorgio Rizzoni, Ohio State University, USA
Harald Scholz, Joint Research Centre (JRC), Italy
Adolfo Senatore, University of Naples Federico II, Italy
Marcello Vanali, University of Parma, Italy
Metrology in Formula 1 - Measuring Fast Cars

Stefano Lovera

FERRARI F1

ABSTRACT

Competitors in the most famous racing series aim to complete laps faster than their adversaries, with reliability being extremely important. Whether measuring displacement, pressure, temperature, torque or a force, over the years sensors have become a vital part of a Formula 1 car. Historically the measurements have been used for onboard control in real time for system optimisation, as well as to provide information for race strategy decisions. During the last decade a significant percentage of transducers are used to help understand the car behaviour and guide future development decisions. Various technologies are used to satisfy the needs to each individual application, whether this is accuracy, speed, ease of installation, robustness to harsh environmental conditions, cost, or all of the above.

SPEAKER BIO

Stefano Lovera, started the collaboration with Ferrari F1 in 1992. He took experience on developing electronic systems that operate in harsh environments. Actually he is managing the Electronic Department being responsible for R&D, Production and Operation (bench and track) of all the Electronic component low voltage.

Christos Karpis graduated from Imperial College London with an MEng in Electrical and Electronics Engineering in 2015. From 2015 onwards he has been a part of the Scuderia Ferrari team, working in the electronics research and development group focusing on sensor systems.
Technical challenging for ADAS/AD sensors evaluation in complex real road scenarios

Mirko Muro

STELLANTIS N.V.

ABSTRACT

The safety and effectiveness of modern ADAS (Advanced Driver Assistance Systems)/AD (Autonomous Driving) strongly depend on the ability of these systems to detect the physical environment in which they operate, represent surrounding objects in a virtual field, extract the main information and respond accordingly in real time. Objects such as roads, vehicles, road signs, pedestrians, animals or simply generic obstacles must be recognized by the functions to create an operational scenario, compute the future states of that scenario and properly maneuver the vehicle, e.g. braking or changing trajectory. The performance is related to the accuracy of the sensors being able to recognize the 3D objects and environment. The assessment of these basic sensors could be evaluated in controlled real scenarios such as test tracks or dedicated test sites, which is very challenging when the tests are performed on public roads where the environment is extremely more complex. Identifying a robust methodologies and ground truth is needed to reach robust evaluation of ADAS and AD sensors and function.

SPEAKER BIO

Mirko Muro, Technical Specialist at FIAT Research Centre within Advanced Technology & Pre-Development Programs, took a degree in Telecommunication Engineering at the University of Trent. Since 2007 he has worked firstly in info-telematics for Intelligent Transportation System, recently he has focused in development methodologies to evaluate performances of Advanced Driving Assistance Systems for Stellantis.
Physical measurements role inside a high performance car virtual development

Giuseppe Raimondi

MASERATI

ABSTRACT

Virtual approach in vehicle development process is even more getting a crucial role; in addition to lower costs and shorter time-to-market process, benefits include also the possibility to explore many more design scenarios and increase the level of design accuracy. The usage of driving simulators has bring the great possibility to include the human perception and the professional drivers' feeling inside the design process before getting into physical prototypes; these permits to almost freeze the entire vehicle's components and related tuning just in virtual way. The success of this kind of innovative approach is obviously related with a high level of correlation between real and virtual world. The aim of the present speech is to describe how the physical measurements criteria, needs and demands have changed through the years inside a high performance car virtual development. Measurement campaigns start from early stages of the development in order to guarantee the complete characterization of all aspects included and is strictly linked to the level of modeling that is required. Progressive measurements with increasing in-deep details during all the development process make virtual models even more realistic and compliant to physical behavior of the vehicle. In the final stages of development measurements are dedicated to a fine tuning of some components or features in order to support the growth of prototypes.
Modelling, Measurements and Control Logic Optimization in a Modular Thermo-management System for e-Buses

Giovanni Bottiglieri
Webasto Group

ABSTRACT
The optimized thermal management of an electric vehicle represents one of the greatest opportunities to increase the mileage range. In addition to cabin conditioning, the energy storage system and power electronics and electric motor also require thermal management. An integration of the different thermal subsystems into a single liquid coolant-based system reduces weight and volume and increase efficiency. A modular approach for each thermal subsystem brings to a concept scalable to different vehicle size and complexity. An advanced thermal control logic integrating a sophisticated valve network is able to switch in between multiple operation modes based on vehicle and environment conditions and modify automatically the thermal energy distribution from source to consumer. Additionally by learning from actual monitoring of performances, the control logic analyses the status and wear information of the components adapting the system configuration to the component diagnostics.

SPEAKER BIO
Giovanni Bottiglieri received the M.S. degree in 2002 and the Ph.D. degree in 2006 from the University of Catania, Italy, both in electrical engineering. From 2006 to 2013 he worked for Trenitalia in the R&D department on the rolling stocks management system. In 2013 he has joined Webasto Group where he is currently active in the development of the thermal management system for electric buses.
Metrology as the basis for accurate and reliable measurements

Alessandro Germak
National Institute of Metrological Research (INRiM), Italy

ABSTRACT
In automotive industry, metrology is involved in all measurements required for the development of a new model, for the performance verification, for safety and during the normal road use when the electronic control units (ECUs) have to manage a variety of measurements coming from the on-board sensors.

Temperature, Speed, Pressure, Frequency, Length, Time, Tension, etc., are examples of the several quantities measured by different sensors that instantaneously must be analysed for providing appropriate instructions to the actuators for the correct operation of the vehicle and, even more important, for providing useful information to the driver for safe driving; it is therefore very important that ECUs and drivers can take correct decisions based on accurate and reliable measurements.

For such purpose, a correct metrological traceability must be ensured: condition required as a basis by the quality standards for proper management of measurements. The traceability, defined as property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty, links the measurement provided by the measuring instrument to the International System of Units.

SPEAKER BIO
Alessandro Germak, first technologist at the National Institute of Metrological Research (INRiM) where he has been carrying out research for over thirty years, is responsible for the primary force and hardness national standards and for the primary method for measuring local acceleration of gravity. He is a technical expert for the accreditation bodies for calibration laboratories and member of the international Technical/Consultative Committees and Working Groups (CIPM, EURAMET) for the quantities of interest. Since twenty years, he is adjunct professor at Polytechnic of Torino for Experimental Statistics and Mechanical Measurements course.
Acoustic array measurements for aeroacoustics in automotive

Gianmarco Battista

Università Politecnica delle Marche, Italy

ABSTRACT

Automotive industry is always focused on the acoustic comfort of its products, ranging from utility vehicles to GT and Sport cars. On one hand, Internal Combustion Engine (ICE), are getting increasingly quieter, on the other hand, new challenges are rising with the diffusion of Electric Vehicles (EV). Moreover, the continuous improvement of internal noise in vehicle cabins requires more and more powerful techniques to reach target performance and improve the quality perceived by customers. Single microphone measurements can only provide information about overall level or spectral content of the noise. Instead, acoustic source mapping with microphone array-based techniques can accomplish source localization, separation of contributions and quick troubleshooting. Given the huge number of techniques, variants and possible classifications, it could be tricky for a newbie user to pick up the best method for a particular application. The knowledge of the basic concepts about different array designs and acoustic mapping techniques enables the user to choose the best combination for each use case. A general overview of acoustic mapping methods will clear up the ideas about pros and cons of beamforming algorithms, deconvolution techniques and inverse methods. Also, general guidelines about the choice of suitable microphone array layout will be provided. Practical examples will show the whole source mapping process and the effect of the most influencing parameters in the application of these powerful measurement techniques.
Measurement of evaporative emissions and canister adsorption/desorption evaluation techniques

Luca Romagnuolo

*University of Naples Federico II, Italy*

**ABSTRACT**

Unburned hydrocarbon evaporation from gasoline vehicle fuel tanks has long been recognized as an important source of pollution. VOCs, that evaporate from gasoline, are very dangerous for both human health and environment. Therefore, international regulations on evaporative emissions are becoming increasingly stringent every year. To deal with these regulations, all modern gasoline vehicles are equipped with an EVAP system, which commonly consists of a carbon canister filter, which stores gasoline vapors that later will be purged by the engine intake manifold and burnt inside the engine cylinder along with the fresh charge.

Unburned hydrocarbon evaporation from gasoline vehicle fuel tanks has long been recognized as an important source of pollution. VOCs, that evaporate from gasoline, are very dangerous for both human health and environment. Therefore, international regulations on evaporative emissions are becoming increasingly stringent every year. To deal with these regulations, all modern gasoline vehicles are equipped with an EVAP system, which commonly consists of a carbon canister filter, which stores gasoline vapors that later will be purged by the engine intake manifold and burnt inside the engine cylinder along with the fresh charge.

A general overview of techniques adopted to study evaporation from gasoline tanks will be provided, with particular attention to the use of a Sealed Housing for Evaporative Determinations. Furthermore, an in-depth analysis of the canister adsorption and desorption behavior will be illustrated, along with useful indirect techniques adopted for analyzing the canister loading and purging phases.
IEEE Women in Engineering Panel  
Thursday, July 1, 2021 - H 14:30 CEST

Exploiting the gender diversity impact in the Automotive sector

The event aims to bring into light the impact of gender diversity in the Automotive sector and encourage discussion around how gender-based differences should be taken into account and can be transformed into a value. During the session, the WIE Commitment Chart "Steering girls to STEM" will be presented. A particular focus will be given to point 8 of the commitment chart: "demonstration of the advantages derived from female presence in working realities", and how it relates to the Automotive Sector. To this aim, two guest speakers from Industry will bring their views on gender diversity impact in the Automotive sector. Technical presentations will be selected to present recent results from scientific and technological research for the automotive industry, which considers gender-related methodologies, approaches and measurements, and their impact on the design of applications and new trends. The Session will close with a round table discussion to collect thoughts around the topics and themes touched during the event. Outputs of the round table will be given back as input to the next edition of the WIE Commitment Chart.

AGENDA

Introduction - Cristina COSTA, FBK CREATE-NET Trento, Secretary of the IEEE WIE AG Italy Section

Overview of the IEEE WIE AG Italy Section - Dajana CASSIOLI, University of L’Aquila, Chair of the IEEE WIE AG Italy Section

Introduction to the WIE Committment Chart "Steering girls to STEM"

GUEST TALK #1 - Lina LONGHITANO, Senior Manager, Mercedes Benz AG
A personal experience on leadership, role models and diversity

GUEST TALK #2 - Bianca Maria Vaglieco & Simona Silvia Merola, CNR-STEMS, Napoli
Project VEDO - Design and Development of EGR Valves with Integrated Digital Diagnostic

GUEST TALK #3 - Eva MILELLA, President of IMAST
Observatory on women from the IMAST high tech district Diagnostic

Scientific Contribution - Roberta DI PACE, Senior Researcher University of Salerno
An alternative approach for the evaluation of the gender impact on vehicle design

Closing round table "Sharing idea with experienced".
Discussion around point 8 of the commitment chart:
"Demonstration of the advantages derived from female presence in working realities"
IEEE MetroAutomotive 2021 - Patronages

- Motor Vehicle University of Emilia-Romagna
- Alma Mater Studiorum Università di Bologna
- Unimorem Universitá degli Studi di Modena e Reggio Emilia
- Università di Parma
- Università degli Studi di Ferrara
- Università degli Studi di Salerno
- INRiM Istituto Nazionale di Ricerca Metrologica
# Program Schedule - June 30, 2021

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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</table>
| 15:30 - 16:20 CEST | Tutorial Session #1  
Metrology as the basis for accurate and reliable measurements  
Alessandro Germak, National Institute of Metrological Research (INRIM), Italy |
| 16:20 - 17:10 CEST | Tutorial Session #2  
Acoustic array measurements for aeroacoustics in automotive  
Gianmarco Battista, Università Politecnica delle Marche, Italy |
| 17:10 - 18:00 CEST | Tutorial Session #3  
Measurement of evaporative emissions and canister adsorption/desorption evaluation techniques  
Luca Romagnuolo, University of Naples Federico II, Italy |

# Program Schedule - July 1, 2021

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tr>
<td>09:00 - 09:30 CEST</td>
<td>Opening Ceremony</td>
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| 09:30 - 10:20 CEST | Plenary Session  
Metrology in Formula 1 - Measuring Fast Cars  
Stefano Lovera, Ferrari F1 |
| 10:30 - 11:50 CEST | Session 1.1 - Enhancing Smart Measurement Systems with Artificial Intelligence for the Automotive Industry of the Future  
Chairs: T. Fedullo, A. Morano, F. Tramarin |
|                 | Session 1.2 - The Smart Battery Paradigm: sensors, modeling, diagnostics and characterization for the next generation batteries  
Chairs: P.A. Traverso, M. Crescentini |
| 12:00 - 13:20 CEST | Session 2.1 - Design, simulation, characterization and communication of measuring and testing systems for ADAS  
Chairs: I. Sobotta, S. Cottini |
|                 | Session 2.2 - Measurements, Meters and Standards in Automotive  
Chairs: C. Landi, P. Iacomussi |
| 14:30 - 16:00 CEST | IEEE Women in Engineering - Italy Section AG - Panel  
Exploiting the gender diversity impact in the Automotive sector |
| 16:10 - 17:30 CEST | Session 3.1 - On-board and off-board vehicle speed meters: design, realization, calibration and diagnosis  
Chairs: M. Laracca, L. Ferrigno, Lei Da |
|                 | Session 3.2 - Measurement for Improving Quality, Reliability and Safety of Hydraulic Systems for Applications in Mobility  
Chairs: E. Frasina, L. Romagnuolo, A. Senatore |
# Program Schedule – July 2, 2021

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Details</th>
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</table>
| 09:00 - 09:50 | **Plenary Session** - Technical challenging for ADAS/AD sensors evaluation in complex real road scenarios  
Mirko Muro, Stellantis N.V. |
| 10:00 - 11:20 | **Session 4.1** - Sensors and Systems for the Measurement of Stress, Attention and Drowsiness Measurement on Drivers  
Chair: A. Affanni   
**Session 4.2** - General Session - Part I  
Chair: M. Pasetti |
| 11:30 - 12:50 | **Session 5.1** - Measurement for Improving Quality, Reliability and Safety in Automotive Applications  
Chairs: L. Ciani, M. Catelani   
**Session 5.2** - General Session - Part II  
Chair: S. Rinaldi |
| 14:00 - 14:50 | **Plenary Session** - Physical measurements role inside a high performance car virtual development  
Giuseppe Raimondi, Maserati |
| 15:00 - 16:20 | **Session 6.1** - IoT Systems and Smart Measurement Architectures for Automotive Performance Evaluation  
Chairs: A. Pozzebon, A. Fort, M. Mugnaini   
**Session 6.2** - General Session - Part III  
Chair: R. Tincarelli |
| 16:30 - 17:20 | **Plenary Session** - Modelling, Measurements and Control Logic Optimization in a Modular Thermomanagement System for e-Buses  
Giuseppe Bottiglieri, Webasto Group |
| 17:20 - 17:50 | CLOSING AND AWARD CEREMONY                                                      |
### Technical Sessions - Wednesday, June 30

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker</th>
<th>Affiliation</th>
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<tbody>
<tr>
<td>15:30 CEST</td>
<td><strong>Metrology as the basis for accurate and reliable measurements</strong>&lt;br&gt;Alessandro Germak, <em>National Institute of Metrological Research (INRiM)</em></td>
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<tr>
<td>16:20 CEST</td>
<td><strong>Acoustic array measurements for aeroacoustics in automotive</strong>&lt;br&gt;Gianmarco Battista, <em>Università Politecnica delle Marche, Italy</em></td>
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<tr>
<td>17:10 CEST</td>
<td><strong>Measurement of evaporative emissions and canister adsorption / desorption evaluation techniques</strong>&lt;br&gt;Luca Romagnuolo, <em>University of Naples Federico II, Italy</em></td>
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Technical Sessions - Thursday, July 1

09:00 - 09:30 CEST
OPENING CEREMONY – WELCOME ADDRESSES
Room: Virtual Room #1

09:30 - 10:20 CEST
PLENARY SESSION
Room: Virtual Room #1
Chair: Lorenzo Peretto, University of Bologna, Italy

Metrology in Formula 1 - Measuring Fast Cars
Stefano Lovera
Ferrari F1

10:30 - 11:50 CEST
SESSION 1.1
Special Session - Enhancing Smart Measurement Systems with Artificial Intelligence for the Automotive Industry of the Future
Room: Virtual Room #1
Chairs: Tommaso Fedullo, University of Modena and Reggio Emilia, Italy
Alberto Morato, CMZ Sistemi Elettronici s.r.L, Italy
Federico Tramarin, University of Modena and Reggio Emilia, Italy

10:30  Estimation of the braking torque for MotoGP class motorcycles with carbon braking systems through machine learning algorithms
Federico Bonini, University of Bologna, Italy
Gionata Manduchi, Ducati Motor Holding S.p.A., Italy
Nicolò Mancinelli, Ducati Motor Holding S.p.A., Italy
Alberto Martini, University of Bologna, Italy
10:50  On-Board Diagnostic of the Motor Vehicle through Smartphone
Pietro V.J.A. Cannistrà, *Università Campus Bio-Medico di Roma, Italy*
Luca Faramondi, *Università Campus Bio-Medico di Roma, Italy*
Giulio Iannello, *Università Campus Bio-Medico di Roma, Italy*
Roberto Setola, *Università Campus Bio-Medico di Roma, Italy*
Luca Vollero, *Università Campus Bio-Medico di Roma, Italy*

11:10  Digital Twins as Electric Motor Soft-Sensors in the Automotive Industry
Francesco Toso, *University of Padova, Italy*
Riccardo Torchio, *University of Padova, Italy*
Andrea Favato, *University of Padova, Italy*
Paolo Gherardo Carlet, *University of Padova, Italy*
Silverio Bolognani, *University of Padova, Italy*
Piergiorgio Alotto, *University of Padova, Italy*

11:30  Developing Safety Metrics for Automatic Vehicle Parking Using Machine Learning
Ronda Easley, *University of West Florida, USA*
S. M. Mizanoor Rahman, *University of West Florida, USA*

10:30 - 11:50 CEST
SESSION 1.2
Special Session - The Smart Battery Paradigm: sensors, modeling, diagnostics and characterization for the next generation batteries
*Room:* Virtual Room #2
*Chairs:* Pier Andrea Traverso, *University of Bologna, Italy*
Marco Crescentini, *University of Bologna, Italy*

10:30  Practical Broadband Measurement of Battery EIS
Alessio De Angelis, *University of Perugia, Italy*
Emanuele Bucchicchio, *University of Perugia, Italy*
Francesco Santoni, *University of Perugia, Italy*
Antonio Moschitta, *University of Perugia, Italy*
Paolo Carbone, *University of Perugia, Italy*

10:50  Sensors for Next-Generation Smart Batteries in Automotive: a Review
Roberta Ramilli, *University of Bologna, Italy*
Marco Crescentini, *University of Bologna, Italy*
Pier Andrea Traverso, *University of Bologna, Italy*
11:10  **Li-Ion Batteries State of Health Analysis via Electro-chemical Impedance Spectroscopy**
Gianluca Caposciutti, *University of Pisa, Italy*
Gabriele Bandini, *University of Pisa, Italy*
Mirko Marracci, *University of Pisa, Italy*
Alice Buffi, *University of Pisa, Italy*
Bernardo Tellini, *University of Pisa, Italy*

11:30  **Smart batteries: requirements of the automotive world**
Mauro Francesco Sgroi, *Centro Ricerche FIAT, Italy*
Matteo Dotoli, *Centro Ricerche FIAT, Italy*
Mattia Giuliano, *Centro Ricerche FIAT, Italy*
Giovanna Nicol, *Centro Ricerche FIAT, Italy*
Flavio Parussa, *Centro Ricerche FIAT, Italy*
Riccardo Rocca, *Centro Ricerche FIAT, Italy*

12:00 - 13:20 CEST
**SESSION 2.1**
Special Session - Design, simulation, characterization and communication of measuring and testing systems for ADAS
Room: Virtual Room #1
Chairs: Jan Sobotka, *Czech Technical University in Prague*
Stefano Cattini, *University of Modena and Reggio Emilia, Italy*

12:00  **Fiber-based Frequency Modulated LiDAR With MEMS Scanning Capability for Long-range Sensing in Automotive Applications**
Sarah Cwalina, *Fraunhofer HHI, Germany*
Christoph Kottke, *Fraunhofer HHI, Germany*
Volker Jungnickel, *Fraunhofer HHI, Germany*
Ronald Freund, *Fraunhofer HHI, Germany*
Patrick Runge, *Fraunhofer HHI, Germany*
Pascal Rustige, *Fraunhofer HHI, Germany*
Thomas Knieling, *Fraunhofer ISIT, Germany*
Shanshan Gu-Stoppel, *Fraunhofer ISIT, Germany*
Jorg Albers, *Fraunhofer ISIT, Germany*
Norman Laske, *Fraunhofer ISIT, Germany*
Frank Senger, *Fraunhofer ISIT, Germany*
Lianzhi Wen, *Fraunhofer ISIT, Germany*
Fabio Giovanneschi, *Fraunhofer FHR, Germany*
Erdem Altuntac, *Fraunhofer FHR, Germany*
Avinash Nittur Ramesh, *Fraunhofer FHR, Germany*
Maria A. Gonzalez-Huici, *Fraunhofer FHR, Germany*
Andries Kuter, *Fraunhofer FHR, Germany*
Sangeeta Reddy, *Fraunhofer FHR, Germany*
12:20  Comparison of VLP-16 and MRS-1000 LiDAR systems with absolute interferometer
Davide Cassanelli, University of Modena and Reggio Emilia, Italy
Stefano Cattini, University of Modena and Reggio Emilia, Italy
Giorgio Di Loro, University of Modena and Reggio Emilia, Italy
Luca Di Cecilia, CNH Industrial, Italy
Luca Ferrari, CNH Industrial, Italy
Luigi Rovati, University of Modena and Reggio Emilia, Italy

12:40  Software Platform for Automotive Radar Target Simulator
Lukáš Krejčí, Czech Technical University in Prague, Czech Republic
Jiří Novák, Czech Technical University in Prague, Czech Republic
Jan Sobotka, Czech Technical University in Prague, Czech Republic

13:00  Generating synthetic radar targets using azimuthal distributed scatterer for automotive applications
Michael Vorderderfler, Graz University of Technology, Austria
Michael E. Gadringer, Graz University of Technology, Austria
Helmut Schreiber, Graz University of Technology, Austria
Wolfgang Bosch, Graz University of Technology, Austria
Herman Jalli Ng, Karlsruhe University of Applied Sciences, Germany

12:00 - 13:20 CEST
SESSION 2.2
Special Session - Measurements, Meters and Standards in Automotive
Room: Virtual Room #2
Chairs: Carmine Landi, University of Campania - Luigi Vanvitelli, Italy
Paola Iacomussi, INRiM, Italy

12:00  A Metrological Fuel Surveillance Application Based on Internet of Intelligent Vehicles
Pedro Andrade, Federal University of Rio Grande do Norte, Brazil
Ivanovitch Silva, Federal University of Rio Grande do Norte, Brazil
Gabriel Signoretti, Federal University of Rio Grande do Norte, Brazil
Marianne Silva, Federal University of Rio Grande do Norte, Brazil
Joao Dias, Federal University of Rio Grande do Norte, Brazil
Lucas Marques, Federal University of Rio Grande do Norte, Brazil
Wilson S. Melo Jr, Instituto Nacional de Metrologia, Qualidade e Tecnologia, Brazil
Carlos Galhardo, Instituto Nacional de Metrologia, Qualidade e Tecnologia, Brazil
12:20  **A Laboratory for Testing E-mobility Power Electronics**
Giuliano Cipolletta, *University of Campania Luigi Vanvitelli, Italy*
Giovanni D’Avanzo, *University of Campania Luigi Vanvitelli, Italy*
Antonio Delle Femine, *University of Campania Luigi Vanvitelli, Italy*
Daniele Gallo, *University of Campania Luigi Vanvitelli, Italy*
Carmine Landi, *University of Campania Luigi Vanvitelli, Italy*
Mario Luiso, *University of Campania Luigi Vanvitelli, Italy*

12:40  **On the trustworthiness of a digital 3D MEMS gyroscope responsiveness to dynamic accelerations for ADAS applications**
Alessandro Schiavi, *INRiM – National Institute of Metrological Research, Italy*
Paola Iacomussi, *INRiM – National Institute of Metrological Research, Italy*
Laura Rossi, *Altran, Italy*
Andrea Prato, *INRiM – National Institute of Metrological Research, Italy*
Fabrizio Mazzeni, *INRiM – National Institute of Metrological Research, Italy*
Alessio Facello, *INRiM – National Institute of Metrological Research, Italy*
Gianfranco Genta, *Politecnico di Torino, Italy*
Raffaele Signoretti, *Politecnico di Torino, Italy*

13:00  **Accurate coil springs axial and transverse stiffness measurements with multicomponent testing machines**
Andrea Prato, *INRiM - National Institute of Metrological Research, Italy*
Gianfranco Genta, *Politecnico di Torino, Italy*
Maurizio Galetto, *Politecnico di Torino, Italy*
Fabrizio Mazzeni, *INRiM - National Institute of Metrological Research, Italy*
Alessio Facello, *INRiM - National Institute of Metrological Research, Italy*
Alessandro Germak, *INRiM - National Institute of Metrological Research, Italy*

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14:30 - 16:00 CEST
**IEEE WIE PANEL**

*Exploiting the gender diversity impact in the Automotive sector*

- **Room:** Virtual Room #1
- **Chairs:** Cristina E. Costa, *SENSE Unit, FBK - Fondazione Bruno Kessler, Italy*
  Roberta di Pace, *University of Salerno, Italy*

  **Introduction** - Cristina COSTA, FBK CREATE-NET Trento, *secretary of the IEEE WIE AG Italy Section*

  **Overview of the IEEE WIE AG Italy Section** - Dajana CASSIOLI, *University of L’Aquila, chair of the IEEE WIE AG Italy Section*

  **Introduction to the WIE Commitment Chart “Steering girls to STEM”**
GUEST TALK #1 - Lina LONGHITANO, Senior Manager, Mercedes Benz AG
A personal experience on leadership, role models and diversity

GUEST TALK #2 - Bianca Maria Vaglieco & Simona Silvia Merola, CNR-STEMS, Napoli
Project VEDO - Design and Development of EGR Valves with Integrated Digital Diagnostic

GUEST TALK #3 - Eva MILELLA, President of IMAST
Observatory on women from the IMAST high tech district Diagnostic
Scientific Contribution - Roberta DI PACE, Senior Researcher University of Salerno
An alternative approach for the evaluation of the gender impact on vehicle design

Closing round table "Sharing idea with experienced". Discussion around point 8 of the commitment chart: "Demonstration of the advantages derived from female presence in working realities"

16:10 - 17:30 CEST
SESSION 3.1
Special Session - On-board and off-board vehicle speed meters: design, realization, calibration and diagnosis
Room: Virtual Room #1
Chairs: Marco Laracca, University of Rome La Sapienza, Italy
        Luigi Ferrigno, University of Cassino and Southern Lazio, Italy
        Lei Du, National Institute of Metrology (NIM), China

16:10 Implementation of national comparison of optical speed meters in China
Qiao Sun, National Institute of Metrology, China
Lei Du, National Institute of Metrology, China
Jie Bai, National Institute of Metrology, China
Jin Cao, Chongqing Academy of Metrology and Quality Inspection, China
Lifang Wang, Chongqing Academy of Metrology and Quality Inspection, China
Yang Su, Chongqing Academy of Metrology and Quality Inspection, China

16:30 An Off-board Reference Facility for Road Vehicle Speed Measurement Based on 3D Tracking Radar
Lei Du, National Institute of Metrology, China
Qiao Sun, National Institute of Metrology, China
Jie Bai, National Institute of Metrology, China
16:50  Calculation of the minimum distance of driving route for average speed control based on three-dimensional modeling
Hao Tang, Hunan Institute of Metrology and Test, China
Jindong Li, Public Security Department of Hunan Province, China
Xubo Chen, Public Security Department of Hunan Province, China
Hongjie Zhou, Public Security Department of Hunan Province, China
Lan Yin, Hunan Institute of Metrology and Test, China
Wenhui Lin, Hunan Institute of Metrology and Test, China
Qiuxi Deng, Hunan Institute of Metrology and Test, China
Jiqiu Deng, Potelissom Company Limited, China
Yihong Xia, Hunan Institute of Metrology and Test, China
Weixian Zeng, Hunan Institute of Metrology and Test, China

17:10  Analysis of the Uncertainty Contributions for on Board Vehicle Speed Meters Calibration Method
Luigi Ferrigno, University of Cassino, Italy
Marco Laracca, Sapienza University of Rome, Italy
Adolfo Martucci, CIRA - Italian Aerospace Center, Italy
Gianfranco Miele, University of Cassino, Italy
Silvia Sangiovanni, Sapienza University of Rome, Italy

16:10 - 17:30 CEST
SESSION 3.2
Special Session - Measurement for Improving Quality, Reliability and Safety of Hydraulic Systems for Applications in Mobility
Room:  Virtual Room #2
Chairs: Emma Frosina, University of Sannio, Italy
        Luca Romagnuolo, University of Naples Federico II, Italy
        Adolfo Senatore, University of Naples Federico II, Italy

16:10  Description of Measurement Techniques for determination of Evaporative Emissions from Gasoline-fueled Vehicles
Luca Romagnuolo, University of Naples Federico II, Italy
Emma Frosina, University of Sannio, Italy
Francesco Fortunato, Stellantis N.V.
Vincenzo Mirante, Stellantis N.V.
Assunta Andreozzi, University of Naples Federico II, Italy
Adolfo Senatore, University of Naples Federico II, Italy
16:30  Experimental analysis of a water spray for the sensors cleaning at different injection pressures
Alessandro Montanaro, STEMS - CNR, Italy
Luigi Allocca, STEMS - CNR, Italy
Giovanni Maccariello, STEMS - CNR, Italy
Emma Frosina, University of Sannio, Italy
Luca Romagnuolo, University of Naples Federico II, Italy
Adolfo Senatore, University of Naples Federico II, Italy

16:50  Experimental Visualization and Lagrangian Simulation of ECN Spray G Injection Process
Alessandro Montanaro, STEMS - CNR, Italy
Francesco Duronio, Università Degli Studi dell’Aquila, Italy
Luigi Allocca, STEMS - CNR, Italy
Angelo De Vita, Università Degli Studi dell’Aquila, Italy
Stefano Ranieri, Università Degli Studi dell’Aquila, Italy

17:10  Conventional and novel measurement systems for sub-23 nm particles emitted by SI engine fueled with low formation particulate fuels
Francesco Catapano, STEMS - CNR, Italy
Silvana Di Iorio, STEMS - CNR, Italy
Agnese Magno, STEMS - CNR, Italy
Bianca Maria Vaglieco, STEMS - CNR, Italy
Technical Sessions - Friday, July 2

09:00 - 09:50 CEST
PLENARY SESSION
Room: Virtual Room #1
Chair: Stefano Cattini, University of Modena and Reggio Emilia, Italy

Technical challenging for ADAS/AD sensors evaluation in complex real road scenarios
Mirko Muro
Stellantis N.V.

10:00 - 11:20 CEST
SESSION 4.1
Special Session - Sensors and Systems for the Measurement of Stress, Attention and Drowsiness Measurement on Drivers
Room: Virtual Room #1
Chair: Antonio Affanni, University of Udina, Italy

10:00  Stress recognition in a simulated city environment using Skin Potential Response (SPR) signals
Pamela Zontone, University of Udine, Italy
Antonio Affanni, University of Udine, Italy
Alessandro Piras, University of Udine, Italy
Roberto Rinaldo, University of Udine, Italy

10:20  Slow-Time mmWave Radar Vibrometry for Drowsiness Detection
Gianluca Ciattaglia, Università Politecnica delle Marche, Italy
Susanna Spinsante, Università Politecnica delle Marche, Italy
Ennio Gambi, Università Politecnica delle Marche, Italy

10:40  Validating Photoplethysmography (PPG) data for driver drowsiness detection
Andrea Amidei, University of Modena and Reggio Emilia, Italy
Piero G. Fallica, University of Messina, Italy
Sabrina Conoci, University of Messina, Italy
Paolo Pavan, University of Modena and Reggio Emilia, Italy
11:00  Design of a low cost EEG sensor for the measurement of stress-related brain activity during driving
Antonio Affanni, University of Udine, Italy
Taraneh Aminosharieh Najafi, University of Udine, Italy
Sonia Guerci, Eurisoft S.P., Italy

10:00 - 11:20 CEST
SESSION 4.2
General Session - Part I
Room: Virtual Room #2
Chair: Marco Pasetti, University of Brescia, Italy

10:00  Intelligent Parking Vehicle Identification and Classification System
Amit K. Kumar, Beijing Institute of Technology, China
Mansour H. Assaf, The University of the South Pacific, Republic of Fiji
Voicu Z. Groza, University of Ottawa, Canada
Emil M. Petriu, University of Ottawa, Canada

10:20  Measurement methods and evaluation techniques of indoor CO2 in a cabin for an electric crane
Luca Muratori, University of Bologna, Italy
Lorenzo Peretto, University of Bologna, Italy
Giovanni Bottiglieri, Webasto Thermo & Comfort Italy Srl, Italy
Federico Coiro, Webasto Thermo & Comfort Italy Srl, Italy
Beatrice Pulvirenti, University of Bologna, Italy
Raffaella Di Sante, University of Bologna, Italy

10:40  Air quality and comfort characterisation within an electric vehicle cabin
Luigi Russi, University of Bologna, Italy
Paolo Guidorzi, University of Bologna, Italy
Beatrice Pulvirenti, University of Bologna, Italy
Giovanni Semprini, University of Bologna, Italy
Davide Aguiari, University of Bologna, Italy
Giovanni Pau, University of Bologna, Italy

11:00  Assessment of energy saving due to a flexible indoor air quality control
Luca Muratori, University of Bologna, Italy
Lorenzo Peretto, University of Bologna, Italy
Giovanni Bottiglieri, Webasto Thermo & Comfort Italy Srl, Italy
Federico Coiro, Webasto Thermo & Comfort Italy Srl, Italy
Beatrice Pulvirenti, University of Bologna, Italy
Raffaella Di Sante, University of Bologna, Italy
11:30 - 12:50 CEST
SESSION 5.1
Special Session - Measurement for Improving Quality, Reliability and Safety in Automotive Applications
Room: Virtual Room #1
Chairs: Lorenzo Ciani, University of Florence, Italy
        Marcantonio Catelani, University of Florence, Italy

11:30 Remote Battery Monitoring System enforcing safety features in Electric Vehicles
Giovanni Gherardi, Energica Motor Company spa, Italy
Ioannis Deligiannis, Energica Motor Company spa, Italy
Eleonora Montanari, Energica Motor Company spa, Italy
Adriana Theodorakopoulou, Energica Motor Company spa, Italy
Valerio Piccini, Energica Motor Company spa, Italy

11:50 Towards a customized vehicular maintenance based on 2-layers data-stream application
Marianne Silva, Federal University of Rio Grande do Norte, Brazil
Gabriel Signoretti, Federal University of Rio Grande do Norte, Brazil
Pedro Andrade, Federal University of Rio Grande do Norte, Brazil
Ivanovitch Silva, Federal University of Rio Grande do Norte, Brazil
Paolo Ferrari, University of Brescia, Italy

12:10 Accelerated Testing and Reliability estimation of electronic boards for automotive applications
Marcantonio Catelani, University of Florence, Italy
Lorenzo Ciani, University of Florence, Italy
Giulia Guidi, University of Florence, Italy
Gabriele Patrizi, University of Florence, Italy

12:30 Strain Modal Testing with Fiber Bragg Grating Sensors of Composite Components for Automotive Applications
Francesco Falcetelli, University of Bologna, Italy
Alberto Martini, University of Bologna, Italy
Alessandro Rivola, University of Bologna, Italy
Raffaella Di Sante, University of Bologna, Italy
Marco Troncossi, University of Bologna, Italy
11:30 - 12:50 CEST
SESSION 5.2
General Session - Part II
Room: Virtual Room #2
Chair: Stefano Rinaldi, University of Brescia, Italy

11:30  Kinematic Parameters Calibration for Automotive Millimeter-Wave Radars
Tianqi Xu, National Institute of Metrology, China
Lei Du, National Institute of Metrology, China
Jie Bai, National Institute of Metrology, China
Qiao Sun, National Institute of Metrology, China
Xiaolei Wang, National Institute of Metrology, China

11:50  A Novel Algorithm for Lane Detection based on Iterative Tree Search
Mario Terlizzi, University of Sannio, Italy
Luigi Russo, University of Sannio, Italy
Enrico Picariello, University of Sannio, Italy
Luigi Glielmo, University of Sannio, Italy

12:10  Vehicle Localisation using Asphalt Embedded Magnetometer Sensors
Giammarco Valenti, University of Trento, Italy
Francesco Biral, University of Trento, Italy
Daniele Fontanelli, University of Trento, Italy

12:30  Development of a flexible test bench for a Hybrid Electric Propulsion System
Massimo Cardone, Università degli Studi di Napoli Federico II, Italy
Bonaventura Gargiulo, Università degli Studi di Napoli Federico II, Italy
Enrico Fornaro, Università degli Studi di Napoli Federico II, Italy

14:00 - 14:50 CEST
PLENARY SESSION
Room: Virtual Room #1
Chair: Roberto Tinarelli, University of Bologna, Italy

Physical measurements role inside a high performance car virtual development
Giuseppe Raimondi
Maserati
15:00 - 16:20 CEST
SESSION 6.1
Special Session - IoT Systems and Smart Measurement Architectures for Automotive Performance Evaluation

Room: Virtual Room #1

Chairs: Alessandro Pozzebon, University of Siena, Italy
        Ada Fort, University of Siena, Italy
        Marco Mugnaini, University of Siena, Italy

15:00  Real Time Car Passengers Comfort Monitoring by means of Environmental and Vibrational Measurements
Ada Fort, University of Siena, Italy
Elia Landi, University of Siena, Italy
Marco Mugnaini, University of Siena, Italy
Lorenzo Parri, University of Siena, Italy
Alessandro Pozzebon, University of Siena, Italy
Valerio Vignoli, University of Siena, Italy

15:20  LoRaWAN in Motion: Preliminary Tests for Real Time Low Power Data Gathering from Vehicles
Gabriele Di Renzone, University of Siena, Italy
Stefano Parrino, University of Siena, Italy
Giacomo Peruzzi, University of Siena, Italy
Alessandro Pozzebon, University of Siena, Italy

15:40  A Wireless Optical Position Sensing and Communications System for a Locking Differential
Audrey M. Cooke, University of Michigan, USA
David Garmire, University of Michigan, USA
Justin Davis, Mechatronics Dana, Incorporated, USA
Michael Creech, Mechatronics Dana, Incorporated, USA
Yogesh Gianchandani, University of Michigan, USA

16:00  Multimodal Electric Vehicle Supply Equipment: Toward a Sustainable and Resilient Mobility
Stefano Rinaldi, University of Brescia, Italy
Marco Pasetti, University of Brescia, Italy
Alessandra Flammini, University of Brescia, Italy
Giulio Maternini, University of Brescia, Italy
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<tr>
<th>Time</th>
<th>Session Title</th>
<th>Presenter(s)</th>
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| 15:00       | A Wireless System for inner Temperature Measurement of High Speed Electric Motors | Igor Valic, *HPE Coxa, Italy*  
Matteo Zauli, *University of Bologna, Italy*  
Nicola Matteazzi, *HPE Coxa, Italy*  
Gianluca Foffano, *HPE Coxa, Italy*  
Luca De Marchi, *University of Bologna, Italy* |
| 15:20       | Cybersecurity Metrics for Human-Robot Collaborative Automotive Manufacturing | S. M. Mizanoor Rahman, *University of West Florida, USA* |
| 15:40       | Performance Metrics for Human-Robot Collaboration: An Automotive Manufacturing Case | S. M. Mizanoor Rahman, *University of West Florida, USA* |

### 16:30 - 17:20 CEST

**PLENARY SESSION**

**Room:** Virtual Room #1  
**Chair:** Federico Tramarin, *University of Modena and Reggio Emilia, Italy*

#### Modelling, Measurements and Control Logic Optimization in a Modular Thermo-management System for e-Buses

Giovanni Bottiglieri  
*Webasto Group*

### 17:20 - 17:15 CEST

**AWARD AND CLOSING CEREMONY**

**Room:** Virtual Room #1