IEEE

INERTIAL 2022

The 9th IEEE International Symposium on Inertial Sensors & Systems

Avignon, France | May 8-11, 2022

INERTIAL 2022 SYMPOSIUM **PROGRAM**

Please visit website for more information!

2022.ieee-inertial.org

SPONSORS AND ORGANIZERS

IEEE Sensors Council


Shape tomorrow‘s future and be part of **innovative sensing solutions** in Consumer Electronics.
BOSCH
Invented for life
bosch-sensortec.com

Table of Contents

Welcome Message 4

2022 Organizing Committee 8

Technical Reviewers 9

Patrons & Exhibitors 10

Tutorials 14

Keynotes 17

Invited Speakers 20

Technical Program 22

IEEE INERTIAL 2022

Welcome Message

Dear Colleagues, dear Friends,

After two years of successful virtual Symposia, it is time to turn our dreams into reality! We warmly welcome you to the 9th **in person IEEE International Symposium on Inertial Sensors and Systems**, INERTIAL'22, which will be held in the city of **Avignon, France, Palais des Papes**, an outstanding place with over 7 centuries of history.

This year's event continues our established tradition, started in 2014 in Laguna Beach, CA, USA of informal international meetings discussing the latest developments in the area of modern inertial sensors and emerging applications enabled by inertial sensors.

IEEE INERTIAL is sponsored by the IEEE Sensors Council and is the only IEEE event exclusively dedicated to Inertial Sensors and Systems technology.

This symposium offers a rare opportunity to meet and network with leaders in the field of inertial sensors and systems through the informal atmosphere of a focused international technical gathering. After two years of virtual conferences, the time has come to meet again; to rediscover the remarkable atmosphere of our symposium: conviviality and high-quality exchanges. We hope the atmosphere, breadth and depth of research topics, combined with the quality of invited and contributed technical presentations, will continue to make INERTIAL a 'must attend' event for you every year.

IEEE INERTIAL aspires to establish itself as the premier forum for reporting the latest research, development, and commercialization results in modern inertial sensors technology. You will hear from world experts about the latest in materials and micro-fabrication processes, innovative designs, new physical principles, increased performance, and a growing number of new applications and business opportunities.

This year, our program will begin on **Sunday, May 8th**, with three **tutorials** offered in the areas of i: fiber optic gyroscopes, ii: quantum sensors, iii: inertial MEMS, given respectively by **Dr. Enrico Quatraro, Dr. Malo Cadoret and Dr. Dusan Radovic**.

The **technical program** covers three days of technical presentations, **May 9th to 11th**. By design, this is a single-track symposium with high quality oral presentations and exhibitions. Each presentation was carefully reviewed and selected by our Technical Program Committee, after a careful evaluation by at least three independent reviewers – the technical experts in the field.

Our **three keynote speakers, Dr. Valérie Renaudin, Dr. Udo-Martin Gomez and Dr. Manuel Rodrigues** will open each day with stimulating topics, including innovative solutions for pedestrian indoor navigation, an overview of Inertial MEMS technologies and market, and, finally, the success story of Microscope mission, the first satellite to test the equivalence principle in space.

Our **two invited speakers, Dr. Philippe Bouyer and Dr. Carlo Valzasina** will open the corresponding sessions throughout the meeting with focused talks on quantum sensors, and new dual-mode applications of 6-axis low-power IMUs.

The contributed papers will be presented in oral and poster formats, with poster sessions preceded by a brief oral session introducing the posters.

Several exhibitors will bring their latest industrial products and achievements, available for interaction during the coffee breaks and lunches from May 9th on, introduced by a lightning round session on the first exhibition day.

The Digest of Technical Papers for the 2022 IEEE Inertial Sensors contains four-page versions of both the "regular technical papers" and "late news" presentations", all provided to attendees in an electronic form. Most presented papers will be available through IEEE Xplore after the symposium.

Continuing the long-standing IEEE Inertial tradition, the Technical Program Committee will select one Best Student Paper, as well as first and second runner up papers. The Awards will be announced Thursday during the Gala Dinner.

We would like to express our special thanks to the Oversight Committee, the Technical Program Committee, and many experts who contributed their time to evaluate over 90 paper submissions representing 17 countries.

We thank the IEEE Sensors Council for sponsoring the 2022 IEEE Inertial Sensors Symposium as well as our **Patrons and Exhibitors**. Our special thanks to Caroline Foster, at the beginning of this story..., now **Caroline Kravec**; Brianna Orr, and the entire staff at Conference Catalysts, LLC for administrative support.

Finally, we thank all speakers, presenters, and attendees for making the 2022 IEEE Inertial Sensors Symposium such a unique event. We hope that you find the INERTIAL'22 Symposium professionally stimulating and enjoyable, and of course, we are looking forward to seeing you back next year for the INERTIAL'23.

In this so particular time, we are convinced that we will live an exceptional event, **together in Avignon, Palais des Papes**, France!

Olivier Le Traon

IEEE INERTIAL 2022
General Chair

Giacomo Langfelder

IEEE INERTIAL 2022
Technical Program
Committee Chair

General Chair:

Olivier Le Traon
ONERA, France

TPC Chair:

Giacomo Langfelder
Politecnico di Milano, Italy

Treasurer:

Joan Giner
Bosch Sensortec, Germany

Oversight Committee:

Andrei Shkel
University of California, Irvine, USA

Mike Larsen
Northrop Grumman, USA

Toshiyuki Tsuchiya
Kyoto University, Japan

Symposium Management:

Conference Catalysts, LLC

Technical Program Committee:

Ahmed Jalal
University of Windsor, Canada

Andrei Shkel
University of California, Irvine, USA

Caroline Coutier
CEA Leti, France

Diego Serrano
Panasonic, USA

Dingbang Xiao
National University of Defense Technology, China

Gando Ryunosuke
Toshiba, Japan

Igor Prikhodko
Analog Devices Inc., USA

Jae Yoong Cho
Enertia Microsystem inc., USA

Jenna Chan
U.S. Army Research Laboratory, USA

Johannes Classen
Bosch Sensortec, Germany

Julien Auger
Safran Electronics & Defense, France

Kaji Shiori
Toshiba, Japan

Kari Moran
Naval Information Warfare Center Pacific, USA

Marra Cristiano
TDK-InvenSense Italy srl, Italy

Mike Larsen
Northrop Grumman, USA

Paola Carulli
ST Microelectronics, Italy

Paolo Minotti
Bosch Sensortec, Germany

Philippe Bouyer
CNRS- Institut d'Optique Graduate School, France

Raphaël Levy
Onera, France

Ron Polkawich
U.S. Army Research Laboratory, USA

Ryuta Araki
Sumitomo Precision Products Co., LTD, Japan

Shuji Tanaka
Tohoku University, Japan

Slava Krylov
Tel Aviv University, Israel

Takshiro Tsukamoto
Tohoku University, Japan

Tommi Piirainen
Murata Electronics Oy, Finland

Technical Reviewers

Jim Adleman
Majed Alghamdi
Filipe Alves
Fabio Alves
Ryuta Araki
Sina Askari
Julien Auger
Eyal Baruch
Edoardo Belloni
Marco Bestetti
Eric Bozeman
Justin Brown
Andrea Buffoli
Michael Bulatowicz
Luigi Casacanditella
Fabrizio Cerini
Jenna Chan
Jae-Yoong Cho
Jennifer Choy
Johannes Classen
Francesco Coppo
Florenc Demrozi
Jeffrey Denatale
Bianca Di Diodoro
Rosana Dias
Andrea Donadel
Daniel Donavanik
Luca Giuseppe Falorni
Patrick Fedeli
Antti Finne
Paolo Frigerio
Marco Gadola
Leonardo Gaffuri Pagani
Ryunosuke Gando
Gabriele Gattere
Matteo Gianollo
Joan Giner
Jeffrey Gregory
Yohei Hatakeyama
Ryan Hennessy
Joshua Hill
Jonathan Hoffman
Tamio Ikehashi
Eric Imhof
Steven Jefferts
Yaesuk Jeong
Burgess Johnson
Jerome Juillard
Shiori Kaji
Christophe Kergueris
Imran Khan
Mario Kiuchi
Ryan Knight
Akira Konno
Naftaly Krakover
Vinaya Kumar
Juha Lahdenperä
Giacomo Langfelder
Michael Larsen
Olivier Le Traon
Kuo Lu
Robert Lutwak
Jean-Sébastien Macé
Ashraf Mahmoud
Cristiano Rocco Marra
Kevin Meier
Douglas Meyer
Damiano Milani
Paolo Minotti
Radwan Mohammednoor
Kari Moran
Eurico Moreira
Dr Saeed Mozaffari
Tal Nagourney
Frank Narducci
Christian Padovani
Mikko Partanen
Ujjval N. Patel
Ullah Philippe
Tommi Piirainen
Ronald Polcawich
Christophe Poulain
Igor Prikhodko
Dušan Radović
Vincent Ragot
Payman Rajai
John Reinke
Michele Ricci
Francesco Rizzini
Andrew Sabater
Kim Sandvik
Arthur Savchenko
Dennis Schlippert
Frank Schmid
Anton Selivanov
Diego Serrano
Andrei Shkel
Avishai Sintov
Neal Solmeyer
Alberto Sposito
Andrew Stewart
Matthew Straeten
Jiangkun Sun
Shuji Tanaka
Toshiyuki Tsuchiya
Takashiro Tsukamoto
Yusheng Wang
Danmeng Wang
Haoran Wen
Dingbang Xiao
Sheng Yu

PLATINUM PATRONS

BOSCH

SAFRAN

GOLD PATRONS

life.augmented

FIBERPRO

IDEAL AEROSMITH

ACTIDYN ACTIVE DYNAMICS

CIVITANAVI SYSTEMS®

FOS FIBER OPTICAL SOLUTION

FIZOPTIKA

SILVER PATRONS

asygn

emcore®

tronics microsystems

AWARD PATRON

iXblue

WELCOME RECEPTION PATRONS

tronics microsystems

LANYARD PATRON

ONERA
THE FRENCH AEROSPACE LAB

LUNCH PATRON

LITEF

COFFEE BREAK PATRON

CIELO
PRECISELY ON YOUR TARGET

ColdQuanta

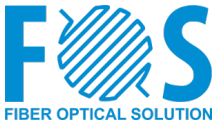
EXHIBITORS


BOSCH


SAFRAN


Physical Logic


tronics
microsystems


FOS
FIBER OPTICAL SOLUTION


asygn


CIVITANAVI
SYSTEMS®


IDEAL
AEROSMITH


SILICON
SENSING


FIZOPTIKA


LITEF


emcore


ACTIDYN
ACTIVE DYNAMICS


iXblue


lyncée tec


ACUTRONIC
Simulation & Test


LUNA


SMG
SILICONMICROGRAVITY


EXALOS
The bright light source company

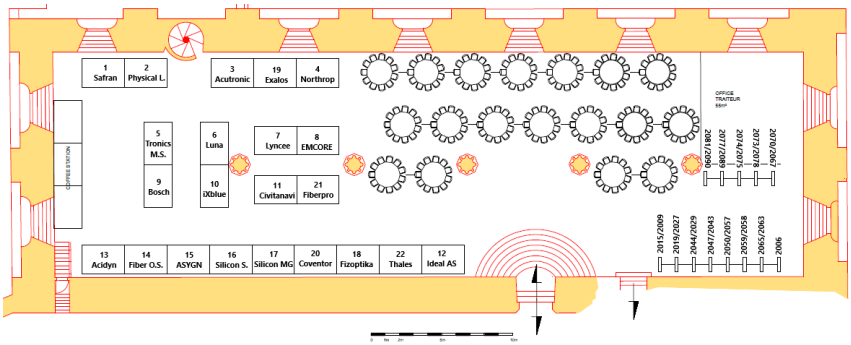

FIBERPRO


COVENTOR
A Lam Research Company


THALES
Building a future we can all trust

Exhibits will be in the Grande Audience

Exhibits open at 10:45, Monday, May 9th and close at 14:10, Wednesday, May 11th



ACTIDYN
ACTIVE DYNAMICS

MOTION SIMULATORS CENTRIFUGES

ACTIDYN SYSTEMES designs and offers a full range of high-end motion simulators and laboratory centrifuges.

High precision mechanics engineering
- For production line
- For defense grade application
- For R&D
- For IMUs and accelerometers calibration

Advanced real time axis controller for centrifuges and motion simulators
- inertial grade system
- up to 5 axis,
- HWIL
- high accuracy positioning and stability

All-in-one solutions with combined configurations
- Temperature chamber
- On-board chambers, thermal or/and vacuum
- High speed data transmission with optical fiber line

Worldwide support
- Calibration and maintenance
- Replacement parts
- Upgrades and refurbishment

Actidyn Systemes (Elancourt, France)
contact@actidyn.com +33 1 30 16 05 30 www.actidyn.com

Sunday, May 8th Tutorials

Time Zone is CEST

09:00 - 10:45

FIBER OPTIC GYROSCOPES – LIGHTING UP THE NAVIGATION

Room: **Chambre du Trésorier**

Instructor: **Enrico Quatraro,** Civitanavi Systems

Abstract: With his first experiments, in 1913, Georges Sagnac laid the groundwork for a new category of inertial sensors, capable of measuring rotation rates by means of light.

Over one century of experiments and development attempts, pushed by the increasing interest of the Inertial Navigation community in a reliable and completely strap-down class of sensors, the optical gyros gained a dominant position in a wide range of applications and grades, from tactical to high end navigation.

The first uses of Sagnac effect sensors, that subsequently gained wide usage was represented by the Ring Laser Gyro, RLG;.

Later on, by taking advantage of the advancements in optical fiber technology, pushed by the fast growth of the Telecom market, the efforts in the development of Fiber Optic Gyroscopes, FOGs; led these highly versatile and easily scalable sensors to overcome the RLG. Thus, FOGs have recently dominated most of the rotation rate sensor technologies, especially in high performance navigation grade applications.

This result by the FOG was achieved thanks primarily to its flexibility and highly advantageous, difficult to compete with, size to performance ratio.

The purpose of this tutorial is to provide a basic overview of FOG technology, from the working principles to the most common implementation techniques, going through the description of the building blocks of the sensor and addressing the main design challenges and the physical effects behind them.

Finally, we will discuss some of the advantages of FOGs compared to other gyro technologies.

Sunday, May 8th Tutorials

Time Zone is CEST

11:15 – 13:00

PRECISION INERTIAL MEASUREMENTS USING COLD-ATOM INTERFEROMETRY

Room: **Chambre du Trésorier**

Instructors: **Malo Cadoret,** French Aerospace Lab, ONERA;

Abstract: Atom interferometry exploits the fact that matter, like light, exhibits wave-like properties. In optical interferometry, light waves are recombined after propagating along different paths. Depending on the difference in the waves' phase accumulated along the two paths, the light may interfere constructively and appear bright or it may interfere destructively and appear dark.

Similar to an optical interferometer, an atom interferometer splits matter waves into different paths and recombines them in a coherent manner [1]. Cold-atom interferometry use atoms that are laser-cooled to millionths of a degree above absolute zero. The atom interferometer is then realized thanks to sequences of laser pulses used to split, deflect and recombine matter waves along different trajectories, acting as beam splitters and mirrors. Through measuring the resulting interference fringes, it is possible to extract the phase difference accumulated between the waves on the paths. Since these paths are influenced by inertial effects, inertial quantities that enter this phase difference can then be accurately determined, making atom interferometry a leading precision measurement technology with applications in both applied and basic science.

Atom interferometers today are the most sensitive instruments for measuring gravity or accelerations, and probing fundamental physical phenomena. Future applications of cold-atom interferometry include inertial navigation, satellite gravimetry and space-based experiments to test gravity. These applications require a new generation of cold-atom interferometers capable of highly precise and stable measurements within compact configurations, and able to operate in real-world field conditions which represent a significant challenge for the community.

This tutorial is designed to introduce those with a vague understanding of optical interferometers to cold-atom interferometry. We will outline the basic theory needed to calculate the observed phase shift, and indicate how this phase shift is experimentally determined. We illustrate the presentation with a description of some realizations of laboratory-based cold-atom sensors dedicated to fundamental tests of physics.

Additionally, in the scope of both field and mobile applications, we will make a review of the progress made towards the development of such instruments for measuring gravitational and inertial signals and the possible benefits that cold-atom quantum sensing may offer in navigation.

[1] Mark Kasevich and Steven Chu, Phys. Rev. Lett. 67, 1991;, pp. 181–184.

Sunday, May 8th Tutorials

Time Zone is CEST

14:30 – 17:00

CONSUMER INERTIAL MEMS – HIGH TECH IN YOUR HANDS

Room: **Chambre du Trésorier**
Instructor: **Dušan Radović**

Abstract: Consumer inertial MEMS sensors or inertial measurement units, IMU; are tiny devices with typical package size of 2.5mm x 3mm which contain three axes accelerometer and gyroscope sensors. They can be found in many products we get in touch almost every day as smart phone, fitness tracker, smart watch, gaming controller, toy… Two of those high tech IMU devices named BMI160 are inside NASA helicopter Ingenuity which did fly many times on Mars surface in 2021.

The tutorial provides explanation what is inside tiny consumer inertial MEMS sensors and give each participant opportunity to put hands-on them by using hardware that will be provided. After looking what is inside, technology and application overview we continue with how to start using consumer inertial MEMS sensor by explaining basic electrical connections and communication protocols. Based on the datasheet information we show how to write simple scripts to obtain sensor data – motion information. Each participant will have opportunity to use its own hardware to configure sensor, read out data, do evaluation of parameters like accelerometer or gyroscope offset and noise. We conclude with some more experiments and proposals for further measurements with the provided hardware.

Monday, May 9th Keynote

Time Zone is CEST

09:05 – 09:45

THE GENERAL RELATIVITY TESTED IN SPACE BY THE MICROSCOPE SATELLITE

Room: **Salle du Conclave**

Instructor: **Manuel Rodrigues,** MICROSCOPE, Department of Physics, Instrumentation, Environment and Space

Abstract: MICROSCOPE is a French space mission aiming at testing the equivalence principle developed by CNES, the Observatory of Cote d'Azur and ONERA from 1999. At the foundation of the Einstein's general relativity, the equivalence principle, EP; stipulates that all bodies are falling at the same rate in a uniform gravity field regardless of their mass or composition. Testing general relativity to its foundations is nothing more than finding the Grail of physics: the ultimate unification theory.

MICROSCOPE objective was to improve by two orders of magnitude the best current laboratory tests reaching barely 10-13. Launch in 2016, MICROSCOPE has delivered useful information for two and a half years. At the heart of the satellite, the scientific instrument developed by ONERA measured signals with a resolution better than 10-14m/s² at the particular frequency of the EP test. Apart from the scientific role, the instrument was also to feed the Drag-Free and Attitude Control System of the satellite to limit the environment accelerations to 10-13m/s² and the angular accelerations to 10-12rd/s². A first publication in 2017 confirmed at 10-14 the Einstein's principle of equivalence with only 7% of the data available at that time. All the relevant data has been analysed and now provides the most accurate test of the equivalence principle: probably setting the test limit for the next decade.

Pending final results, the presentation will focus on the outstanding preliminary results of the MICROSCOPE mission, the first test in space of EP and will present the implications of these results for physics.

Tuesday, May 10th Keynote

Time Zone is CEST

09:05 – 09:45 CEST

MEMS INERTIAL SENSORS – EVOLUTION OF MARKETS, SENSORS AND TECHNOLOGIES.

Room: **Salle du Conclave**

Instructor: **Markus Ulm,** Robert Bosch GmbH

Abstract: Since the first acceleration sensors in the mid-80s, the market and technology of MEMS-based inertial sensors have developed enormously in just a few decades. Starting from first applications for automotive airbag systems, MEMS and especially inertial sensors have become key components in almost all aspects of modern life.

Safety and comfort functions in our cars, modern user interfaces in our cell phones, intelligent power management in wireless headphones, independent recognition of gymnastic exercises in fitness trackers, or the various monitor functions in robots, smart homes, or industry – all functions that would be inconceivable without MEMS inertial sensors.

This progress has been made possible by an impressively high speed of innovation – even compared to Moore´s Law for semiconductors.

The combined figure of merit, cFOM; of MEMS inertial sensors has steadily improved by several orders of magnitude in just a few years, illustrating that performance of those sensors is increasing drastically despite power consumption and footprint being significantly reduced.

Cross-domain innovation is a key success factor here. New approaches in manufacturing, design or the integration of intelligent software / AI enable leaps in innovation and continually enabling completely new use-cases.

The presentation gives an overview of the development of MEMS inertial sensors from the beginning until today and explains the progress in their development with recent examples.

Wednesday, May 11th Keynote

Time Zone is CEST

09:05 – 09:45

FROM INERTIAL SIGNALS TO PRECISE PEDESTRIAN INDOOR POSITIONING: ASSESSING HUMAN GAIT

Room: **Salle du Conclave**

Instructor: **Valérie Renaudin,** Gustave Eiffel University

Abstract: Indoor positioning and navigation have become a prerequisite for many applications and services. Currently available solutions are mainly based on radio beacon networks deployed in the infrastructure or a-priori mapping of signal characteristics. The first approach is costly and requires numerous calibrations, and the second assumes that the signals are stable over time, which is rarely true.

Given these limitations, the use of inertial signals offers the promise of a solution that requires no infrastructure deployment, no knowledge of the map, is functional without mobile cellular networks coverage and therefore accessible to a larger population. It has become the backbone of pedestrian localization systems but must be fused with other measures to compensate for its measurement errors. The inertial sensors embedded in wearable devices are first of low quality and they require continuous calibration "tricks". Second, they measure many human motions, which are not those we are trying to estimate to track the human gait. In this context, what accuracy is achieved by the recent inertial signals processing methods? Can we measure complex human movements even when the wearable device is worn by the pedestrian on different parts of the body? Is the hybridization of inertial signals with other data still needed to ensure high accuracy? What is the best strategy to label time series of inertial data for learning human gait features with artificial intelligence: physics or human interpretation?

I will talk about recent developments in indoor pedestrian localization with inertial measurements, including artificial intelligence approaches, whether for professional applications where a 6.8m after 2'500m 3D accuracy on 3 indoor levels, ANR/DGA MALIN competition; was recently achieved or for the general public with wearables where learning issues to gain robustness in everyday life will be presented."

Monday, May 9th Invited Speaker (Time Zone is CEST)

14:00 – 14:30

Quantum Sensors for GPS-Denied Navigation

Room: **Chambre du Trésorier**

Instructor: **Philippe Bouyer,** CNRS- Institut d'Optique Graduate School, France

Abstract: Inertial sensors based on cold atoms and light-pulse interferometry exhibit state-of-the-art sensitivity and ultra-low measurement bias that could revolutionize a variety of fields including geophysics and seismology, gravitational wave detection and fundamental tests of gravity, and inertial navigation. We will present in this talk the progress towards a full, 3D, Quantum inertial Navigation System.

Wednesday, May 11th Invited Speaker

11:10 – 11:40

A Compact 6-Axis IMU Combining Low-Power Operation with High Stability and Low Noise

Room: **Chambre du Trésorier**

Instructor: **Carlo Valzasina,** STMicroelectronics

Abstract: Consumer-grade inertial measurement units (IMU) have traditionally fallen into either the low-power sensor category suitable for wearable and IoT applications or consumer high-end sensors for AR/VR applications with improved stability but higher power consumption. ST disrupts this compromise between power and performance with a low-current 6-axis MEMS IMU that demonstrates excellent stability and noise performance. Join me as we discover the architecture, design choices, and test results of this remarkable sensor.

Technical Program: Sunday, May 8th

Time Zone is CEST

08:00 - 09:00

Tutorial Registration

Room: **Salle des Gardes**

09:00 – 10:45

Tutorial: Fiber Optic Gyroscopes – Lighting Up the Navigation

Enrico Quatraro, Civitanavi Systems

Room: **Chambre du Trésorier**
Session Chair: **Gabriele Gattere,** ST Microelectronics

10:45 – 11:15

ColdQuanta Coffee Break

Room: **Salle des Gardes**

11:15 – 13:00

Tutorial: Precision Inertial Measurements Using Cold-Atom Interferometry

Malo Cadoret, French Aerospace Lab, ONERA;

Room: **Chambre du Trésorier**
Session Chair: **Gabriele Gattere,** ST Microelectronics

13:00 – 14:30

Lunch

Room: **Espace Jeanne Laurent**

14:30 – 17:00

Tutorial: Consumer Inertial MEMS – High Tech in Your Hands

Dušan Radović, Bosch Sensortec
Room: **Chambre du Trésorier**
Session Chair: **Gabriele Gattere,** ST Microelectronics

18:30 – 20:00

Tronics Microsystems Welcome Reception

Room: **Espace Jeanne Laurent + Pont St Bénezet**

All attendees are invited to the Welcome Reception for drinks and light hors d'oeuvres.

Technical Program: Monday, May 9th

Time Zone is CEST

08:00 - 08:45

Registration

Room: **Salle des Gardes**

08:45 – 09:05

Opening Remarks

Olivier Le Traon, 2022 General Chair
Room: **Salle du Conclave**

09:05 – 09:45

Keynote: The General Relativity Tested in Space by the Microscope Satellite

Manuel Rodrigues, MICROSCOPE, Department of Physics, Instrumentation, Environment and Space
Room: **Salle du Conclave**
Session Chair: **Olivier Le Traon**, ONERA

09:45 – 10:25

Session - RIG and FM MEMS Gyroscopes

Room: **Salle du Conclave**
Session Chairs: **Andrei Shkel,** University of California, Irvine; **Tobias Hiller,** Robert Bosch GmbH

09:45

Real Time Q-Factor Mismatch Detection for Rate Integrating Gyroscope Using Amplitude Modulated Driving Signal

Takashiro Tsukamoto, Tohoku University, Japan
Shuji Tanaka, Tohoku University, Japan

10:05

Frequency Modulated Operation in a Silicon MEMS Gyroscope with Quatrefoil Suspension System

Madan Parajuli, University of Cambridge, United Kingdom
Guillermo Sobreviela, Silicon Microgravity, United Kingdom
Ashwin A. Seshia, University of Cambridge, United Kingdom

10:25 – 11:00

Cielo Coffee Break/Exhibits

Room: **Grande Audience**

Technical Program: Monday, May 9th

Time Zone is CEST

11:00- 11:30

Exhibitors Lightning Round

Room: **Salle du Conclave**

11:30 – 12:30

Session - Emerging Applications

Room: **Salle du Conclave**
Session Chairs: **Jenna Chan,** U.S. Army Research Laboratory
Diego Serrano, Panasonic

11:30
Cots MEMS Gyros for Space

Guillaume Delavoipiere, CNES, France; **Kateryna Kiryukhina,** CNES, France; **Francoise Bezerra,** CNES, France; **Djemel Lellouchi,** ELEMCA, France; **Olivier Gigan,** TRONICS TDK, France; **Yann David,** TRONICS TDK, France; **Antoine Filipe,** TRONICS TDK, France; **Guillaume Papin,** TRONICS TDK, France

11:50
Monitoring Cardiac Activity by Detecting Subtle Head Movements Using MEMS Technology

Sarah Solbiati, Department of Electronics, Information and Bioengineering, Politecnico di Milano, Italy; **Andrea Buffoli,** Department of Electronics, Information and Bioengineering, Politecnico di Milano, Italy; **Valentino Megale,** Softcare Studios Srls, Italy; **Gianfranco Damato,** Softcare Studios Srls, Italy; **Bruno Lenzi,** Softcare Studios Srls, Italy; **Giacomo Langfelder,** Department of Electronics, Information and Bioengineering, Politecnico di Milano, Italy; **Enrico Caiani,** Department of Electronics, Information and Bioengineering, Politecnico di Milano, Italy

12:10
A Neural Network Approach to Mitigate Thermal-Induced Errors in ZUPT-aided INS

Chi-Shih Jao, University of California, Irvine, United States; **Danmeng Wang,** University of California, Irvine, United States; **Austin Parrish,** University of California, Irvine, United States; **Andrei Shkel,** University of California, Irvine, United State

Technical Program: Monday, May 9th

Time Zone is CEST

12:30 – 14:00

LITEF Lunch/Exhibits

Room: **Grande Audience**

14:00 – 15:30

Session - Quantum Inertial Sensors

Room: **Salle du Conclave**
Session Chairs: **Kari Moran,** Naval Information Warfare Center Pacific; **Mike Larsen,** Northrop Grumman

14:00
Invited Speaker: Quantum Sensors for GPS-Denied Navigation

Philippe Bouyer, CNRS- Institut d'Optique Graduate School, France

14:30
Marine and Airborne Gravimetry with an Absolute Cold Atom Sensor

Alexis Bonnin, ONERA, France; **Yannick Bidel,** ONERA, France; **Cédric Blanchard,** ONERA, France; **Jeanne Bernard,** ONERA, LCM-CNAM, France; **Malo Cadoret,** ONERA, LCM-CNAM, France; **Nassim Zahzam,** ONERA, France; **Sylvain Schwartz,** ONERA, France; **Alexandre Bresson,** ONERA, France

14:50
Diamond NMR Gyroscope

Andrey Jarmola, UC Berkeley, United States; **Sean Lourette,** UC Berkeley, United States; **Victor Acosta,** University of New Mexico, United States; **Glen Birdwell,** U.S. Army Research Laboratory, United States; **Peter Blümler,** Johannes Gutenberg-Universität Mainz, Germany; **Dmitry Budker,** Johannes Gutenberg-Universität Mainz, Germany; **Tony Ivanov,** U.S. Army Research Laboratory, United States; **Vladimir Malinovsky,** U.S. Army Research Laboratory, United States

15:10
Progress Towards the Development of a cold-Atom Inertial Measurement Unit for Onboard Applications

Jeanne Bernard, CNAM and ONERA, France; **Malo Cadoret,** CNAM and ONERA, France; **Yannick Bidel,** ONERA, France; **Clément Salducci,** ONERA, France; **Nassim Zahzam,** ONERA, France; **Sylvain Schwartz,** ONERA, France; **Alexis Bonnin,** ONERA, France; **Cédric Blanchard,** ONERA, France; **Alexandre Bresson,** ONERA, France

Technical Program: Monday, May 9th

Time Zone is CEST

15:30 - 16:00

Posters Lightning Round

Room: **Salle du Conclave**

16:00 – 16:30

Cielo Coffee Break/Exhibits

Room: **Grande Audience**

16:15 – 17:30

Poster Session/Coffee Break

Room: **Grande Audience**
Session Chairs: **Slava Krylov,** Tel Aviv University; **Joan Giner,** Bosch Sensortec

A Novel Modeling Method Based on 3D CT Images for Dynamics Analysis of the micro-Hemispherical Resonator Gyroscope, μ-HRG

Min Meng, Microsystem & Terahertz Research Center, China Academy of Engineering Physics, China; **Kai Yang,** Microsystem & Terahertz Research Center, China Academy of Engineering Physics, China; **Wei Su,** Institute of Electronic Engineering, China Academy of Engineering Physics, China; **Shengwei Dong,** Microsystem & Terahertz Research Center, China Academy of Engineering Physics, China; **Hao Zhang,** Microsystem & Terahertz Research Center, China Academy of Engineering Physics, China; **Jie Zhang,** Microsystem & Terahertz Research Center, China Academy of Engineering Physics, China; **He Li,** Microsystem & Terahertz Research Center, China Academy of Engineering Physics, China; **Xi Wang,** Microsystem & Terahertz Research Center, China Academy of Engineering Physics, China

Temperature Drift Self-Calibration for Honeycomb Like Disk Resonator Gyroscope

Tongqiao Miao, National University of Defense Technology, China; **Yi Xu,** National University of Defense Technology, China; **Qingsong Li,** National University of Defense Technology, China; **Xiaoping Hu,** National University of Defense Technology, China; **Xuezhong Wu,** National University of Defense Technology, China; **Dingbang Xiao,** National University of Defense Technology, China

Inertial Navigation Compensation with Machine Learning

Eric Bozeman, NIWC Pacific, United States; **Minhdao Nguyen,** NIWC Pacific, United States; **Mohammad Alam,** NIWC Pacific, United States; **Jeffrey Onners,** NIWC Pacific, United States

Technical Program: Monday, May 9th
Time Zone is CEST

Poster Session/Coffee Break (cont.)

SAR Imaging Challenges on UAV Trajectory Restitution / Study Case with SAR-Light Prototype at X-Band

Jean-Francois Nouvel, ONERA, France; **Nicolas Castet,** ONERA, France; **Jerome Henrion,** ONERA, France

A Transfer Model of HIGH-G Shock for MEMS in Real Working Conditions

Tianfang Peng, Tsinghua University, China;
Zheng You, Tsinghua University, China

ULTRA-Fast Characterization of Detection Electrode Errors Under WHOLE-Angle Mode in 10 Seconds

Jiangkun Sun, National University of Defense Technology, China; **Kui Liu,** Xi'an Institute of Modern Control Technology, China; **Sheng Yu,** National University of Defense Technology, China; **Xiang Xi,** National University of Defense Technology, China; **Xuezhong Wu,** National University of Defense Technology, China; **Yongmeng Zhang,** National University of Defense Technology, China; **Dingbang Xiao,** National University of Defense Technology, China;

Effect of Geometry on Energy Losses in Fused Silica Dual-Shell Gyroscopes

Wei Guan, University of California, Irvine, United States; **Danmeng Wang,** University of California, Irvine, United States; **Mohammad Asadian,** University of California, Irvine, United States; **Andrei Shkel,** University of California, Irvine, United States

Q-Learning BASED-Noise Covariance Adaptation in Kalman Filter for MARG Sensors Attitude Estimation

Xiang Dai, University Grenoble Alpes, France; **Vahid Nateghi,** University Grenoble Alpes, France; **Hassen Fourati,** University Grenoble Alpes, France; **Christope Prieur,** University Grenoble Alpes, France

Compact Cold Atom Accelerometer Payload for LOW-Earth Orbit Atmospheric Drag Measurement

Michael Trigatzis, Teledyne e2v, United Kingdom; **Marton Kiss-Toth,** Teledyne e2v, United Kingdom; **Stephen Maddox,** Teledyne e2v, United Kingdom; **Isabelle Riou,** Teledyne e2v, United Kingdom

Technical Program: Monday, May 9th

Time Zone is CEST

Poster Session/Coffee Break (cont.)

A Cooperation Positioning Algorithm Based on Time Delay Square Root Cubature Kalman Filter for AUVs

Mingye Tong, Harbin Institute of Technology, China; **Ya Zhang,** Harbin Institute of Technology, China; **Qingxin Wang,** Harbin Institute of Technology, China; **Jianbo Shao,** Harbin Institute of Technology, China

A Simulation Study of the Temperature Sensitivity and Impact of Fabrication Tolerances on the Performance of a Geometric Anti-Spring Based MEMS Gravimeter

Vinod Belwanshi, University of Glasgow, United Kingdom; **Abhinav Prasad,** University of Glasgow, United Kingdom; **Karl Toland,** University of Glasgow, United Kingdom; **Kristian Anastasiou,** University of Glasgow, United Kingdom; **Steven Bramsiepe,** University of Glasgow, United Kingdom; **Richard Middlemiss,** University of Glasgow, United Kingdom; **Douglas Paul,** University of Glasgow, United Kingdom; **Giles Hammond,** University of Glasgow, United Kingdom

An Analytical Model for Vibration Analysis of Disk Resonator Gyroscopes

Mehran Hosseini Pishrobat, Bilkent University, Turkey; **Baha Erim Uzunoglu,** Bilkent University, Turkey; **Derin Erkan,** Bilkent University, Turkey; **Erdinc Tatar,** Bilkent University, Turkey

UmiX Series - How to Miniaturize Fog Technology

Sébastien Ferrand, IXBLUE, France; **Maxime Rattier,** IXBLUE, France; **Cédric Moluçon,** IXBLUE, France; **Emmanuelle Peter,** IXBLUE, France; **Marco Mancini,** IXBLUE, Italy; **Kévin Gautier,** IXBLUE, France; **Pierrick Cheiney,** IXBLUE, France

17:30 – 17:45

Wrap Up

Room: **Grande Audience**

17:45 – 18:30

Sponsor Appreciation/Open Posters Social Event

Room: **Grande Audience**

fizoptika.com

VG191AD

VG221

VG1703SPE

VG1703

MINIATURE
FIBER OPTIC GYROSCOPES

3-Axis G181

VG2103S

VG103SD

Technical Program: Tuesday, May 10th

Time Zone is CEST

08:00 – 09:00

Registration

Room: **Salle des Gardes**

09:00 – 09:05

Opening Remarks

Olivier Le Traon, 2022 General Chair
Room: **Salle du Conclave**

09:05 – 09:45

Keynote: MEMS Inertial Sensors – Evolution of Markets, Sensors and Technologies

Markus Ulm, Robert Bosch GmbH
Room: **Salle du Conclave**
Session Chair: **Olivier Le Traon,** ONERA

09:45 – 10:45

Session - Fiber Optic Gyroscopes

Room: **Salle du Conclave**
Session Chairs: **Raphaël Levy,** ONERA; **Roberto Senatore,** Civitanavi Systems

09:45

CMOS-Enabled Silicon Photonics Driver Chip for Interferometric Fiber Optics Gyroscope

Yen-Chieh Wang, National Sun Yat-sen University, Taiwan; **Sin-Yun Lu,** National Sun Yat-sen University, Taiwan; **Min-Chi Chan,** National Sun Yat-sen University, Taiwan; **Yin-Hsuan Lee,** National Sun Yat-sen University, Taiwan; **Tzu-Hsiang Yen,** National Sun Yat-sen University, Taiwan; **Chia-Chien Wei,** National Sun Yat-sen University, Taiwan; **Yi-Jen Chiu,** National Sun Yat-sen University, Taiwan; **Ren-Young Liu,** National Sun Yat-sen University, Taiwan; **Yung-Jr Hung,** National Sun Yat-sen University, Taiwan

10:05

Original Technique for Residual Amplitude Modulation Reduction in RFOG

Maxime Descampeaux, THALES AVS, THALES RESEARCH AND TECHNOLOGY, LUMIN CNRS ENS Paris-Saclay, France; **Gilles Feugnet,** THALES Research and Technology France, France; **Fabien Bretenaker,** LUMIN CNRS ENS Paris-Saclay, France

Technical Program: Tuesday, May 10th

Time Zone is CEST

Session - Fiber Optic Gyroscopes (cont.)

10:25

Impact of Photonic Bandgap HOLLOW-Core Fiber Loss Wavelength Dependence on the Performance of RFOG

Maxime Descampeaux, THALES AVIONICS, France; **Gilles Feugnet,** THALES RESEARCH AND TECHNOLOGY, France; **Benoit Debord,** GPPMM group, XLIM, CNRS, Université de Limoges, Limoges, France; **Fetah Benabid,** GPPMM group, XLIM, CNRS, Université de Limoges, Limoges, France; **Fabien Bretenaker,** LUMIN CNRS ENS Paris-Saclay, France; **Foued Amrani,** GPPMM group, XLIM, CNRS, Université de Limoges, Limoges, France; **Frédéric Gérôme,** GPPMM group, XLIM, CNRS, Université de Limoges, Limoges, France

10:45 – 11:15

Cielo Coffee Break/Exhibits

Room: **Grande Audience**

11:15 – 11:30

INERTIAL 2023 Presentation

Room: **Salle du Conclave**

11:30 – 12:50

Session - Solid-State Gyroscopes

Room: **Salle du Conclave**

Session Chairs: **Paola Carulli,** ST Microelectronics; **Andrei Shkel,** University of California, Irvine

11:30

Si-MEMS Gyro by Safran – Towards the Navigation Grade

Jean-Sebastien Mace, Safran Electronics and Defense, France; **Christophe Kergueris,** Safran Colibrys, Switzerland; **Frederic Fretouly,** Safran Electronics and Defense, France; **Julien Auger,** Safran Electronics and Defense, France; **Yan Lenoir,** Safran Electronics and Defense, France; **Fabrice Delhaye,** Safran Electronics and Defense, France; **Jean-Daniel Emerard,** Safran Electronics and Defense, France

11:50

GYTRIX, a Novel Axisymmetric Quartz Gyroscope for Navigation Purpose

Thomas Perrier, ONERA - The French Aerospace Lab, France; **Olivier Le Traon,** ONERA - The French Aerospace Lab, France; **Raphaël Levy,** ONERA - The French Aerospace Lab, France; **Jean Guérard,** ONERA - The French Aerospace Lab, France; **Amandine Andrieus Ledier,** ONERA - The French Aerospace Lab, France; **Pierre Lavenus,** ONERA - The French Aerospace Lab, France

Technical Program: Tuesday, May 10th

Time Zone is CEST

Session - Solid-State Gyroscopes (cont.)

12:10

Effect of Metallization on Fused Silica Dual-Shell Gyroscopes

Danmeng Wang, UCI MicroSystems Laboratory, United States; **Wei Guan,** UCI MicroSystems Laboratory, United States; **Mohammad Asadian,** UCI MicroSystems Laboratory, United States; **Andrei Shkel,** UCI MicroSystems Laboratory, United States

12:30

Investigating the Effects of Silicon Etching Imperfections on the Quadrature Error in MEMS Gyroscopes

Alexandre Azier, THALES, France; **Bertrand Leverrier,** THALES, France; **Najib Kacem,** Univ. Bourgogne Franche-Comte, FEMTO-ST Institute, CNRS/UFC/ENSMM/UTBM, France; **Bernard Chaumet,** THALES, France; **Noureddine Bouhaddi,** Univ. Bourgogne Franche-Comte, FEMTO-ST Institute, CNRS/UFC/ENSMM/UTBM, France

12:50 – 14:10

Lunch/Exhibits

Room: **Grande Audience**

14:10 – 15:30

Session - Aiding Technologies and Navigation

Room: **Salle du Conclave**

Session Chairs: **Cristiano Marra,** TDK-InvenSense Italy srl; **Ron Polkawich,** U.S. Army Research Laboratory

14:10

Inertial and Imaging Sensor Fusion for an Autonomous Tomorrow

Igor Prikhodko, Analog Devices, United States

14:30

Gyroscope-Aided Odometry Navigation Using a Highly-Precise Automotive MEMS IMU Complemented by a Low-Cost Sensor Array

Lukas Blocher, Robert Bosch GmbH, Germany; **Wolfram Mayer,** Robert Bosch GmbH, Germany; **Miloš Vujadinović,** Robert Bosch GmbH, Germany; **Jonas Haack**, Robert Bosch GmbH, Germany; **Johannes Hoefele,** Robert Bosch GmbH, Germany; **Dušan Radović,** Robert Bosch GmbH, Germany; **Tobias Hiller,** Robert Bosch GmbH, Germany; **Joachim Gerlach,** Albstadt-Sigmaringen University, Germany; **Oliver Bringmann,** University of Tuebingen, Germany

14:50

Magnetometer Based on a Quartz MEMS Resonator with Two DETFs and a Stack of Magnetic Materials

Charles Mauc, ONERA, France; **Thomas Perrier,** ONERA, France; **Raphaël Levy,** ONERA, France; **Johan Moulin,** C2N, France; **Patrick Kayser,** ONERA - The French Aerospace Lab, France

Technical Program: Tuesday, May 10th

Time Zone is CEST

Session - Aiding Technologies and Navigation (cont.)

15:10

Frequency Modulated MEMS Lorentz Force Magnetometer Using CW/CCW Modes

Linxin Zhang, Tohoku University, Japan; **Takashiro Tsukamoto,** Tohoku University, Japan; **Shuji Tanaka,** Tohoku University, Japan

15:30 - 16:00

Posters Lightning Round

Room: **Salle du Conclave**

16:00 – 16:30

Cielo Coffee Break/Exhibits

Room: **Grande Audience**

16:15 – 17:30

Poster Session/Coffee Break

Room: Grand Audience

Session Chairs: **Julien Auger,** Safran Electronics & Defense; **Igor Prikhodko,** Analog Devices

Rayleigh-OFDR Strain Distribution Measurement on a Self-Standing Fiber-Gyro Coil

Hugo Boiron, Laboratoire Hubert Curien, UJM-CNRS-IOGS / iXblue, France; **Jérémie Pillon,** Université Paris-Saclay, ENS Paris-Saclay, CNRS, LMT / iXblue, France; **Emmanuelle Peter,** iXblue, France; **Emmanuel Marin,** Laboratoire Hubert Curien, UJM-CNRS-IOGS, France; **Matthieu Collignon,** iXblue, France; **Adriana Morana,** Laboratoire Hubert Curien, UJM-CNRS-IOGS, France; **Sylvain Girard,** Laboratoire Hubert Curien, UJM-CNRS-IOGS, France; **Hervé Lefevre,** Laboratoire Hubert Curien, UJM-CNRS-IOGS / iXblue, France

Design Methodology and Model Order Reduction for Resonant Accelerometers

Omer Halevy, Tel Aviv University, Israel; **Slava Krylov,** Tel Aviv University, Israel

Towards Real-Time Frequency Modulated Accelerometer Bias Calibration

Andrew Sabater, Naval Information Warfare Center, NIWC; Pacific, United States; **Eric Bozeman,** Naval Information Warfare Center, NIWC; Pacific, United States; **Stephen Hobbs,** Naval Information Warfare Center, NIWC; Pacific, United States

Wobble Estimation of a Turntable Axis by Using an Inertial Measurement Unit

Mehdi Bussutil, iXblue, France; **Bernard Vau,** iXblue, France; **Damien Ponceau,** Scalian, France; **Clément Pinzio,** iXblue, France

Technical Program: Tuesday, May 10th

Time Zone is CEST

16:15 – 17:30

Poster Session/Coffee Break (cont.)

Miniaturized Navigation Grade Quartz VBA Accelerometer for Space Applications

Olivier Jolly, Ixblue, France; **Pierrick Cheiney,** Ixblue, France; **Thomas Kerrien,** Ixblue, France; **Stéphanie Michel,** Ixblue, France; **Steven Fosset,** Ixblue, France; **Alexandre Cadu,** Isae Supaero, France

Modular Probecard-Measurement Equipment for Automated Wafer-Level Characterization of High Precision MEMS Gyroscopes

Sebastian Weidlich, Chemnitz University of Technology; **Roman Forke,** Fraunhofer ENAS, Germany; **Karla Hiller,** Fraunhofer ENAS, Germany; **Daniel Bülz,** Fraunhofer ENAS, Germany; **Alexey Shaporin,** Fraunhofer Institute for Electronic Nano Systems ENAS; **Harald Kuhn,** Fraunhofer ENAS, Germany

Characterization of Mass-Loaded Silicon Nitride On-Chip Resonators for Traceable Sensing of Low Amplitude Acceleration

Timothy Hodges, The University of Ottawa, Canada; **Lixue Wu,** National Research Council Canada, Canada; **Gengyang Mu,** The University of Ottawa, Canada; **Nikaya Snell,** The University of Ottawa, Canada; **Alexandre Bouchard,** The University of Ottawa, Canada; **Michel Stephan,** The University of Ottawa, Canada; **Triantafillos Koukoulas,** National Research Council Canada, Canada; **Richard Green,** National Research Council Canada, Canada; **Raphael St-Gelais,** The University of Ottawa, Canada

High Stability Two Axis cold-Atom Gyroscope

Mohamed Guessoum, SYRTE, France; **Romain Gautier,** SYRTE, France; **Quentin Bouton,** SYRTE, France; **Leonid Sidorenkov,** SYRTE, France; **Arnaud Landragin,** SYRTE, France; **Remi Geiger,** SYRTE, France

Noise Reduction by Data Fusion in a Multisensor System of Replicated MEMS Inclinometers

Alessandro Nastro, University of Brescia, Italy; **Marco Ferrari,** University of Brescia, Italy; **Camilla-Irine Mura,** STMicroelectronics, Italy; **Andrea Labombarda,** STMicroelectronics, Italy; **Marco Viti,** STMicroelectronics, Italy; **Sandro Dalle-Feste,** STMicroelectronics, Italy; **Vittorio Ferrari,** University of Brescia, Italy

A MEMS Gravimeter with multi-Axis Gravitational Sensitivity

Richard Middlemiss, University of Glasgow, United Kingdom; **Paul Campsie,** University of Strathclyde, United Kingdom; **William Cunningham,** University of Glasgow, United Kingdom; **Rebecca Douglas,** University of Glasgow, United Kingdom; **Victoria McIvor,** University of Glasgow, United Kingdom; **Vinod Belwanshi,** University of Glasgow, United Kingdom; **James Hough,** University of Glasgow, United Kingdom; **Sheila Rowan,** University of Glasgow, United Kingdom; **Douglas Paul,** University of Glasgow, United Kingdom; **Abhinav Prasad,** University of Glasgow, United Kingdom; **Giles D. Hammond,** University of Glasgow, United Kingdom

Poster Session/Coffee Break (cont.)

Indirectly-Coupled Optical Resonators for Anti-Parity-Time-Symmetric Gyroscopes

Martino De Carlo, Photonics Research Group, Department of Electrical and Information Engineering, Politecnico di Bari, Italy; **Francesco De Leonardis,** Photonics Research Group, Department of Electrical and Information Engineering, Politecnico di Bari, Italy; **Francesco Dell'Olio,** Department of Electrical and Information Engineering Politecnico di Bari, Italy; **Pietro Peliti,** Northrop Grumman Italia, Pomezia, Italy; **Fabrizio Berton,** Northrop Grumman Italia, Pomezia, Italy; **Mario Lucchesini,** Northrop Grumman Italia, Pomezia, Italy; **Vittorio M. N. Passaro,** Photonics Research Group, Department of Electrical and Information Engineering, Politecnico di Bari, Italy

Planar Foucault Pendulum Silicon Gyro

Lucas Hudeley, ONERA - The French Aerospace Lab, France; **Alain Bosseboeuf,** C2N, CNRS, University Paris-Saclay, France; **Olivier Le Traon,** ONERA - The French Aerospace Lab, France; **Thomas Perrier,** ONERA - The French Aerospace Lab, **France; Raphaël Levy,** ONERA - The French Aerospace Lab, France; **Jean Guérard,** ONERA - The French Aerospace Lab, France

17:30 – 17:45
Wrap Up

Room: **Grande Audience**

19:30 – 21:30
Gala Dinner and Awards Ceremony

Room: **Grand Tinel**

Technical Program: Wednesday, May 11th

Time Zone is CEST

08:00 – 09:10

Registration

Room: **Salle des Gardes**

09:10 – 09:20

Opening Remarks

Olivier Le Traon, 2022 General Chair
Room: **Salle du Conclave**

09:20 – 10:00

Keynote: From Inertial Signals to Precise Pedestrian Indoor Positioning: Assessing Human Gait

Valérie Renaudin, Gustave Eiffel University
Room: **Salle du Conclave**
Session Chair: **Olivier Le Traon, ONERA**

10:00 – 10:45

Session - Late News

Room: **Salle du Conclave**
Session Chair: **Giacomo Langfelder,** Politecnico di Milano

10:00

Glass Molding for Microstructures

Bin Luo, Southeast University, China; **Zhaoxi Su,** Southeast University, China; **Jintang Shang,** Southeast University, China

10:15

Open Source Bio-Logger for Monitoring and Recording Inertial Movement

Stéphane Viollet, CNRS, France; **Nicolas Huloux,** Aflokkat, France; **Julien Diperi,** CNRS, France; **Jean-Marc Ingargiola,** Aix-Marseill University, France; **Akiko Kato,** CNRS, France; **Yan Roppert-Coudert,** CNRS, France

10:30

ULTRA-Low Resonance Frequency MEMS Gravimeter with Off-Resonance Closed-Loop Control

Chengzhi Yi, Waseda University, China; **Jun Wu,** Waseda University, China; **Hideyuki Maekoba**, Coventor, A Lam Research Company, Japan; **Arnaud Parent,** Coventor, A Lam Research Company, France; **Tamio Ikehashi,** Waseda University, Japan

Technical Program: Wednesday, May 11th

Time Zone is CEST

10:45 – 11:10

Coffee Break/Exhibits

Room: **Grande Audience**

11:10 – 12:40

Session - Technologies for MEMS Inertial Sensors and IMUs

Room: **Salle du Conclave**

Session Chairs: **Caroline Coutier,** CEA Leti; **Shuji Tanaka,** Tohoku University

11:10

Invited Speaker: A Compact 6-Axis IMU Combining Low-Power Operation with High Stability and Low Noise

Carlo Valzasina, STMicroelectronics, Italy; **Luca Giuseppe Falorni,** STMicroelectronics, Italy; **Francesco Rizzini,** STMicroelectronics, Italy; **Luca Guerinoni,** STMicroelectronics, Italy; **Marco Milani,** STMicroelectronics, Italy; **Marco Garbarino,** STMicroelectronics, Italy; **Stefano Polesel,** STMicroelectronics, Italy; **Matteo Quartiroli,** STMicroelectronics, Italy; **Alessandro Mecchia,** STMicroelectronics, Italy; **Alessandra Maria Rizzo Piazza Roncoroni,** STMicroelectronics, Italy

11:40

0.25 deg/h Closed-Loop Bulk Acoustic Wave Gyroscope

Diego Emilio Serrano, Panasonic Device Solutions Laboratory of Massachusetts, USA; **Amir Rahafrooz,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **Ronald Lipka,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **Duane Younkin,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **Kieran Nunan,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **John English,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **Chihchuan Chen,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **Ryan Hennessy,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **Yaesuk Jeong,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **Eugene Ivanov,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **Dan Sullivan,** Panasonic Device Solutions Laboratory of Massachusetts, USA; **Ijaz Jafri,** Panasonic Device Solutions Laboratory of Massachusetts, USA

12:00

The BDRIE-HS* Technology Approach for Tiny Motion Detection with Improved Sensitivity and Noise Performance

Roman Forke, Fraunhofer ENAS; **Karla Hiller,** Fraunhofer ENAS; **Susann Hahn,** TU Chemnitz; **Alexey Shaporin,** Fraunhofer ENAS; **Sebastian Weidlich,** TU Chemnitz; **Daniel Buelz,** Fraunhofer ENAS; **Matthias Kuechler,** Fraunhofer ENAS; **Danny Reuter,** Fraunhofer Institute for Electronic Nano Systems ENAS / Chemnitz University of Technology, Germany; **Christian Helke,** Chemnitz University of Technology, Germany; **Dirk Wuensch,** Fraunhofer ENAS; **Knut Gottfried**, Fraunhofer Institute for Electronic Nano Systems ENAS, Germany; **Harald Kuhn,** Fraunhofer ENAS

Technical Program: Wednesday, May 11th
Time Zone is CEST

Session - Technologies for MEMS Inertial Sensors and IMUs (cont)

12:20
High Performance MEMS IMU with ThELMA-Double Technology

Gabriele Gattere, STMicroelectronics, Italy; **Francesco Rizzini,** STMicroelectronics, Italy; **Luca Guerinoni,** STMicroelectronics, Italy; **Luca Falorni,** STMicroelectronics, Italy; **Carlo Valzasina,** STMicroelectronics, Italy; **Federico Vercesi,** STMicroelectronics, Italy; **Lorenzo Corso,** STMicroelectronics, Italy; **Giorgio Allegato,** STMicroelectronics, Italy

12:40 – 14:10
Lunch/Exhibits
Room: **Grande Audience**

14:10 – 15:10
Session - MEMS Accelerometers
Room: **Salle du Conclave**
Session Chairs: **Tommi Piirainen,** Murata Electronics Oy; **Philippe Robert,** CEA-Leti for the session MEMS Accelerometers

14:10
Nanoresonator-Based Accelerometer with Large Bandwidth and Improved Bias Stability
Theo Miani, cea leti, France; **Thierry Verdot,** cea leti, France; **Audrey Berthelot,** cea leti, France; **Federico Maspero,** cnr, Italy; **Alexandra Koumela,** cea leti, France; **Philippe Robert,** cea leti, France; **Giacomo Langfelder,** deib politecnico, Italy; **Julien Arcamone,** cea leti, France; **Marc Sansa,** cea leti, France

14:30
A low-Noise Mixed Signal ASIC for Navigation-Grade Resonant MEMS Accelerometer
Rémy Dejaeger, Thales, France; **Olivier Lefort,** Thales, France; **Mathieu Jeanneteau,** Thales, France; **Jean-Michel Muguet,** Thales, France

14:50
Active Shock/Vibes Rejection in FM MEMS Accelerometers
Leonardo Gaffuri Pagani, Politecnico di Milano, Italy; **Paolo Frigerio,** Politecnico di Milano, Italy; **Dario Falato,** Politecnico di Milano, Italy; **Christian Padovani,** Politecnico di Milano, Italy; **Francesco Rizzini,** STMicroelectronics, Italy; **Giacomo Langfelder,** Politecnico di Milano, Italy

15:10 – 15:40
Closing Remarks
Room: **Salle du Conclave**

Notes:

Notes:

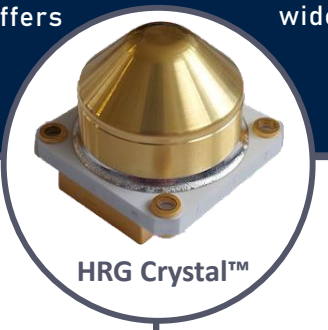
SAFRAN ELECTRONICS & DEFENSE

European leader in inertial navigation

Our high-tech solutions in optronics, avionics, electronics and critical software for both civil and military markets spans land, naval, aeronautical and space applications. Every day, our know-how allows operational to observe, decide and guide, all over the world.

Safran Electronics & Defense is the European leader in inertial navigation. The HRG Crystal™ hemispherical resonator gyro, patented by Safran, was developed in recent years, and more than **30,000 HRG** have been delivered to date. The HRG Crystal™ offers the highest performance in its market segment.

Because of its simple design and mature technologies, the HRG Crystal™ allows Safran to develop inertial navigation systems featuring ultra-high reliability for both civil and military applications, and offering a wide choice of performance specifications.



HRG Crystal™

Aeronautical & Spatial applications

Naval application

Land application

Submarine application

SAFRAN

www.safran-group.com
contact-defense@safrangroup.com