IEEE Inertial Sensors & Systems Symposium 2018 Organizers

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Igor Prikhodko, Analog Devices Inc., United States
Doruk Senkal, InvenSense Inc., United States
Diego Serrano, Panasonic, United States
Ryan Supino, Honeywell, United States
Alessandro Tocchio, ST Microelectronics Inc., Italy
Alexander Trusov, Northrop Grumman, United States
Takahiro Tsukamoto, Tohoku University, Japan
Jae Yoong Cho, University of Michigan, USA
Rong Zhang, Tsinghua University, China

Symposium Management:
Conference Catalysts, LLC, United States
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Media Patron
Exhibitors

Exhibits will be in the Varenna & Cernobbio. Opening at 8:00 AM, Tuesday, March 28 and closing at 4:00 PM, Wednesday, March 29.
Tutorials

Monday, March 26

08:30 - 10:30
System-Level Considerations in Inertial Sensor Performance
Room: Bassanini

Instructor: Professor Michael Braasch, Ohio University

Abstract: Most inertial navigation systems operate at three basic task-rates: high-speed, medium-speed and low-speed. High-speed tasks include formation and compensation of the raw delta-Vs and delta-thetas. Medium-speed tasks include attitude determination and velocity update. Low-speed tasks include position update and gravity calculation. Most inertial sensor designers concentrate their efforts in the high-speed task arena. Once the measurements have been formed and compensated, they are sent off to the systems and software engineers. This tutorial provides an overview of those ‘downstream’ tasks and focuses particularly on the long-term impact of sensor errors on inertial navigation system performance. Key error characteristics such as the Schuler, Foucault and Diurnal oscillations will be discussed. Which is more important? Gyro bias or accel bias? The answer is that it depends on the length of the mission! We will go through the details as well as highlight the criticality of additional performance metrics such as scale factor error, noise, data rate and data latency.

11:00 – 13:00
Non-GPS Aiding of INS
Room: Bassanini

Instructor: Professor Kai Bongs, University of Birmingham

Abstract: This tutorial will introduce atom interferometry for inertial sensing and for timekeeping. Atom interferometers have been first demonstrated 25 years ago and are now being developed in several places worldwide in to mobile systems with potential for real world applications. They offer precision measurements of rotation and acceleration. A key feature is the potential for operation with negligible drift and very linear scale factor. The tutorial will provide an overview of current developments and an outlook into future applications in navigation.
Tutorials

14:15 - 16:15
Modeling of offset and offset drift sources in AM/FM inertial sensors
Room: Bassanini

Instructor: Dr. Alessandro Tocchio, STMicroelectronics

Abstract: This tutorial will focus on the main contributors affecting MEMS inertial sensors performance in terms of accuracy. This parameter is of paramount importance in order to enable new markets and applications such as augmented and mixed reality, pedestrian or indoor navigation, etc. In particular, starting from the basic working principles of MEMS AM gyroscopes and a MEMS AM accelerometer based on capacitive sensing technique, the main phenomena affecting Zero-rate Level (ZRL) and Zero-G offset (ZGO) accuracy will be introduced. The origins of these phenomena and how they influence both the mechanical and the electrical world will be tackled analytically, and the approaches used to simulate them will be described.
Invited Speakers

Tuesday, March 27
09:00 - 09:30
I1: Invited Talk
Room: Bassanini

How high-volume MEMS device manufacturers can meet the requirements of different markets
Dr. Andrea Onetti, STMicroelectronics

Abstract:
ST was at the forefront in bringing MEMS technology to the high volume consumer market. Today the Internet of Things and Smart Driving trends are creating opportunities to make existing and new devices and applications smarter through the use of intelligent connected sensing technologies. This applies to factories and workplaces, cities, homes, vehicles and all the devices that can be found there.

The latest generations of MEMS products and technologies are developed to meet the needs of consumer applications while also targeting emerging automotive and industrial applications. Targeting different markets requires manufacturers to supply sensors with different characteristics but built on the same technology platforms. One key characteristic that differs by market is the accuracy the sensor is required to meet while another key characteristic is the combination of sensing functions that a device needs to have.

This talk will address how MEMS device manufacturers can meet the varied requirements of different markets while building on the high-volume manufacturing capabilities that are already in place for the consumer industry

Wednesday, March 28
09:00 - 09:30
I2: Invited Talk
Room: Bassanini

Sub-femto-g free-fall with LISA Pathfinder
Stefano Vitale, University of Trento, Istituto Nazionale di Fisica Nucleare, and Agenzia Spaziale Italiana, Italy

Abstract:
The talk will briefly review the concept of a space-borne gravitational wave (GW) detector, and of its needs of pure inertial motion (geodesic motion) of reference test-masses. It will discuss then the sub-femto-g performance demonstrated by LISA Pathfinder, ESA’s precursor to the LISA GW detector, and its impact on LISA and on the field of gravitational missions at large.
Invited Speakers

Wednesday, March 28
14:00 – 14:30
I3: Invited Talk
Room: Bassanini

The Machine of Bohnenberger: Inertial Link between Astronomy, Navigation, and Geodesy

Jörg F. Wagner, University of Stuttgart

Abstract:
The “Machine of Bohnenberger” is considered to be the first gyro with cardanics suspension. As this apparatus forms the precursor of Foucault's Gyroscope of 1852, it rates as the ancestor of all gyroscopic instruments. Its inventor, Johann Gottlieb Friedrich Bohnenberger (1765-1831), was a professor of physics, mathematics, and astronomy at the University of Tübingen, Germany, as well as the scientific head-surveying officer of the early Kingdom of Württemberg. Being the direct counterpart of C.F. Gauß in south-west Germany, he made major contributions to introducing modern geodesy in Germany; and besides his Machine, he designed also other various physical instruments. The paper gives an overview over the initial dissemination and the further development of the Machine of Bohnenberger and outlines Bohnenberger's scientific work and life.

Thursday, March 29
09:00 - 09:30
I4: Invited Talk
Room: Bassanini

HRG by SAFRAN, the game-changing technology

Fabrice Delhaye, Safran Electronics & Defense

Abstract:
Whereas the world inertial navigation community was wondering, for decades, if FOG would ultimately replace RLG, Safran is demonstrating with its HRG than technology prospective is not such easy game. With its HRG, Safran is proving that the HRG innovative approach is a real game changer in high end navigation. This paper sums up the overall principles of HRG, how it works and its intrinsic properties. Current applications of HRG are described to illustrate how HRG benefits are capitalized in valued-added products. More prospective aspects of the HRG are also addressed with the latest tests results of performance limits exploration.
### Monday, March 26

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<thead>
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<th>Instructor</th>
<th>Room</th>
<th>Session Chair</th>
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<td>07:00 - 16:00</td>
<td>Tutorial Registration</td>
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<td>Bassanini Foyer</td>
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<tr>
<td>08:30 - 10:30</td>
<td><strong>Tutorial 1: System-Level Considerations in Inertial Sensor Performance</strong>&lt;br&gt;Instructor: Professor Michael Braach, <em>Ohio University</em>&lt;br&gt;Room: Bassanini</td>
<td><strong>Session Chair: Michael Larsen, <em>Northrop Grumman, USA</em></strong></td>
<td>Bassanini</td>
<td><strong>Session Chair: Michael Larsen, <em>Northrop Grumman, USA</em></strong></td>
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<td>10:30 - 11:00</td>
<td>Coffee Break</td>
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<td>Bassanini Foyer</td>
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<tr>
<td>11:00 – 13:00</td>
<td><strong>Tutorial 2: Atom Interferometer Inertial Sensors</strong>&lt;br&gt;Instructor: Professor Kai Bongs, <em>University of Birmingham</em>&lt;br&gt;Room: Bassanini</td>
<td><strong>Session Chair: Michael Larsen, <em>Northrop Grumman, USA</em></strong></td>
<td>Bassanini</td>
<td><strong>Session Chair: Michael Larsen, <em>Northrop Grumman, USA</em></strong></td>
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<td>13:00 - 14:15</td>
<td>Lunch</td>
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<td>Restaurant La Cascata</td>
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<td>14:15 – 16:15</td>
<td><strong>Tutorial 3: Modeling of offset and offset drift sources in AM/FM inertial sensors</strong>&lt;br&gt;Instructor: Dr. Alessandro Tocchio&lt;br&gt;Room: Bassanini</td>
<td><strong>Session Chair: Michael Larsen, <em>Northrop Grumman, USA</em></strong></td>
<td>Bassanini</td>
<td><strong>Session Chair: Michael Larsen, <em>Northrop Grumman, USA</em></strong></td>
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<td>18:00 - 20:00</td>
<td>Welcome Reception</td>
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All attendees are invited to the Welcome Reception for drinks and light hors d'oeuvres.
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<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
<th>Session Chair(s)</th>
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<tbody>
<tr>
<td>08:00 - 18:00</td>
<td>Registration</td>
<td>Room: Bassanini Foyer</td>
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<tr>
<td>08:45 - 09:15</td>
<td>Opening Remarks</td>
<td>Room: Bassanini</td>
<td>Andrei Shkel, 2018 General Chair</td>
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<tr>
<td>09:15 - 09:45</td>
<td>Invited Talk: Dr. Andrea Onetti, STMicroelectronics</td>
<td>Room: Bassanini</td>
<td>Andrei Shkel, University of California, Irvine, USA</td>
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<td>How high-volume MEMS device manufacturers can meet the requirements of different markets</td>
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<td>Dr. Andrea Onetti</td>
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<td>STMicroelectronics</td>
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<tr>
<td>09:45 - 10:45</td>
<td>T1: Instrumentation, Calibration and Testing</td>
<td>Room: Bassanini</td>
<td>Kari Moran, SPAWAR Systems Center Pacific, USA</td>
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<td>Rate table improvements in rate stability using look-up tables</td>
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<td>Rong Zang, Tsinghua University, China</td>
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<td>A Micro Thermal and Stress Isolation Platform for Inertial Sensors</td>
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<td>Calibration and simultaneous measurement of MEMS gyroscope</td>
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<tr>
<td>10:45 - 11:05</td>
<td>Exhibitors’ Highlights</td>
<td>Room: Varenna &amp; Cernobbio</td>
<td>Alessandro Tocchio, STMicroelectronics, Italy</td>
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<tr>
<td>11:05 - 11:30</td>
<td>Coffee Break &amp; Exhibits</td>
<td>Room: Varenna &amp; Cernobbio</td>
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**Tuesday, March 27**

<table>
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<tr>
<th>Time</th>
<th>Session</th>
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<th>Session Chairs</th>
<th>Location</th>
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</table>
| 11:30 - 12:30 | **T2: INS, NAV-grade systems and AHRS**      | Bassanini | **Michael Larsen**, *Northrop Grumman, USA*  
**Julien Auger**, *Safran Electronics & Defense, France* |                                |
|               | **Compact Atomic Magnetometer for Global Navigation (NAV-CAM)**  
Michael Larsen, Michael Bulatowicz, Dennis Bevan, Philip Clark, Robert Griffith, Marta Luengo-Kovac, James Pavell  
*Northrop Grumman, USA* | Bassanini |                                |                                |
|               | **FOG based INS for satellite launcher application**  
Daniele Grifi, Roberto Senatore, Enrico Quatraro, Massimo Verola and Andrea Pizzarulli  
*Civitanavi Systems, Italy* | Bassanini |                                |                                |
|               | **Optimization of Gyroscope and Accelerometer/Magnetometer Portion of Basic Attitude and Heading Reference System**  
Simone Ludwig¹, Antonio R. Jimenez²  
*North Dakota State University, USA¹*; *Jimenez Centre for Automation and Robotics. CSIC-UPM, Spain²* | Bassanini |                                |                                |
| 12:30 - 14:00 | **Lunch**                                    | Restaurant La Cascata |                                |                                |
| 14:00 – 14:40 | **T3: Emerging Applications**                | Bassanini | **Chris Painter**, *Apple Inc., USA*  
**Jae Yoong Cho**, *University of Michigan, USA* |                                |
|               | **Monitoring Earthquake through MEMS Sensors (MEMS project) in the town of Acireale (Italy)**  
Antonino D’Alessandro, Salvatore Scudero, Giovanni Vitale, Roberto D’Anna, Luca Greco, Stefano Speciale, Giuseppe Passafiume  
*Istituto Nazionale di Geofisica e Vulcanologia, Italy* | Bassanini |                                |                                |
|               | **Towards Self-Navigating Cars using MEMS IMU: Challenges and Opportunities**  
Igor Prikhodko, Brock Bearss, Carey Merritt, Charles Blackmer  
*Analog Devices, USA* | Bassanini |                                |                                |
| 14:40 - 15:10 | **Lightning Round Presentations of the following Poster Session** | Bassanini, Bellagio |                                |                                |
Tuesday, March 27

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<th>Chairs</th>
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<tr>
<td>15:10 - 17:00</td>
<td><strong>P1: Gyroscopes and Resonators</strong></td>
<td>Jasmine Foyer</td>
<td>Doruk Senkal, TDK-InvenSense Inc., USA</td>
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<td>Tommi Piirainen, Murata Electronics Oy, Finland</td>
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This session will begin with "Lightning Round" Presentations (2 min X 16 posters) in Bassanini

**P1-1: A dual-mass frequency-modulated (FM) pitch gyroscope: mechanical design and modelling**
Valentina Zega¹, Claudia Comi¹, Patrick Fedeli¹, Attilio Frangi¹, Paolo Minotti¹, Giacomo Langfelder¹, Luca Falorni², Alessandro Tocchio²
Politecnico Milano, Italy¹; STMicroelectronics, Italy²

**P1-2: Quartz Cylindrical Resonators for Mid-Accuracy Coriolis Vibratory Gyroscopes**
Mikhail Basarab¹, Boris Lunin², Evgeniy Chumankin³, Alexey Yurin¹
Bauman Moscow State Technical University, Russia¹; Moscow State University n. a. Lomonosov, Russia²; JSC ANPP TEMP-AVIA, Arzamas, Russia³

**P1-3: Lateral Diffusion Doping of Epitaxial Silicon for Temperature Compensation of MEMS Resonators**
Dongsuk D. Shin¹, David B. Heinz¹, Hyun-Keun Kwon¹, Yunhan Chen², Thomas Kenny¹
Stanford University, USA¹; Apple Incorporated, USA

**P1-4: A control strategy for Coriolis and centrifugal effects reduction in an inertial system test equipment**
Bernard Vau, Damien Ponceau, Mehdi Bussutil
Ixblue, France

**P1-5: A comprehensive model of beams' anisoelasticity in MEMS gyroscopes with focus on the effect of axial non-vertical etching**
Mohammad Izadi¹, Francesco Braghin², Daniele Giannini², Damiano Milani², Ferruccio Resta¹, Matteo Brunetto², Luca Falorni², Gabriele Gatterë², Luca Guerinoni², Carlo Valzasina²
Politecnico Milano, Italy¹; STMicroelectronics, Italy²

**P1-6: Theoretical model and experiments of glass reflow process in TGV for 3D wafer-level packaging**
Yunbin Kuang, Jian Zhou, Wenyin Li, Hongjuan Cui
National University of Defense Technology, P.R. China

**P1-7: Virtually Rotated MEMS Whole Angle Gyroscope using Independently Controlled CW/CCW Oscillations**
Takashiro Tsukamoto, Shuji Tanaka
Tohoku University, Japan

**P1-8: A system-level comparison of amplitude- vs frequency-modulation approaches exploited in low-power MEMS vibratory gyroscopes**
Paolo Minotti¹, Giorgio Mussi¹, Giacomo Langfelder¹, Valentina Zega¹, Stefano Facchinetti², Alessandro Tocchio²
Politecnico Milano, Italy¹; STMicroelectronics, Italy²

**P1-9: Investigating the Impact of Resonant Cavity Design on Surface Acoustic Wave Gyroscope**
Ashraf A Mahmoud, Mohamed Mahmoud, Tamal Mukherjee, Gianluca Piazza
Carnegie Mellon University, USA
Tuesday, March 27

P1-10: The 4th Harmonic Angular Drift Error in MEMS Vibratory Rate Integrating Gyroscopes
Zhongxu Hu, Barry Gallacher
Newcastle University, United Kingdom, Great Britain

P1-11: Resonance Frequency Control and Digital Correction for Capacitive MEMS Gyroscopes within electromechanical Bandpass Delta-Sigma-Modulators
Michael Maurer¹, Stefan Rombach¹, Yiannos Manoli²
Hahn-Schickard, Germany¹; Hahn-Schickard & IMTEK University of Freiburg, Germany²

P1-12: Modeling of temperature frequency-compensation of doped silicon MEMS resonator
Payman Rajai¹, Matthew Straeten¹, Jiewen Liu¹, George Xereas², Mohammed Jalal Ahamed²
University of Windsor, Canada¹; NXTSENS Microsystems Inc, Canada²

P1-13: Decoupled Rate and Quadrature Servos in a MEMS Gyroscope
David Hayner
Coherent Sensors, Inc., USA

P1-14: Predicting Height and Determining Mass of Foaming Agents for Glass Shell Resonators
Bin Luo¹, Jintang Shang¹, Zhaoxi Su¹, Ching-Ping Wong²
Southeast University, P.R. China¹; The Chinese University of Hong Kong, USA²

P1-15: Geometrical compensation of (100) single-crystal silicon mode-matched vibratory ring gyroscope
Shu Yunyi, Yoshikazu Hirai, Toshiyuki Tsuchiya, Osamu Tabata
Kyoto University, Japan

P1-16: Adaptative Feedthrough Cancelation in MEMS Gyroscopes In Reconfigurable IC+FPGA Platform
Joan Giner¹, Kazuo Ono²
GlobalFoundries, Singapore¹; Hitachi, Ltd., Japan²

17:00 - 18:00
Open Posters
Room: Varenna & Cernobbio

All attendees are invited to the Open Poster Session for drinks and light hors d'oeuvres
**Wednesday, March 28**

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<td><strong>Registration</strong></td>
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<td><strong>Room:</strong> Bassanini Foyer</td>
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<tr>
<td>09:00 - 09:10</td>
<td><strong>Welcome Comments, Day 2</strong></td>
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<td><strong>Andrei Shkel, 2018 General Chair</strong></td>
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<td><strong>Room:</strong> Bassanini</td>
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<td><strong>Session Chair:</strong> Giacomo Langfelder, <em>Politecnico di Milano, Italy</em></td>
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<tr>
<td>09:10 - 09:40</td>
<td><strong>I2: Invited Speaker:</strong> Stefano Vitale, <em>University of Trento, Istituto Nazionale di Fisica Nucleare, and Agenzia Spaziale Italiana</em></td>
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<td><strong>Session Chair:</strong> Giacomo Langfelder, <em>Politecnico di Milano, Italy</em></td>
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<td><strong>Sub-femto-g free-fall with LISA Pathfinder</strong></td>
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<td><strong>Stefano Vitale</strong></td>
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<td><strong>University of Trento, Istituto Nazionale di Fisica Nucleare, and Agenzia Spaziale Italiana</strong></td>
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<td>09:40 - 10:40</td>
<td><strong>T4: MEMS Accelerometers</strong></td>
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<td><strong>Room:</strong> Bassanini</td>
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<td><strong>Session Chair:</strong> Diego Serrano, <em>Panasonic, USA</em></td>
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<td><strong>Takashiro Tsukamoto</strong>, <em>Tohoku University, Japan</em></td>
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<td><strong>Single Resonator, Time-switched, low Offset Drift z-axis FM MEMS Accelerometer</strong></td>
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<td><strong>Cristiano Marra</strong>, Filippo Ferrari, Giacomo Langfelder, Francesco Rizzini, Alessandro Tocchio</td>
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<td><strong>ST Microelectronics; Politecnico di Milano, Italy</strong></td>
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<td><strong>High-Density Wide-Range Digital Accelerometer Arrays with High Detection Resolution</strong></td>
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<td><strong>Yemin Tang</strong></td>
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<td><strong>University of Michigan Ann Arbor, USA</strong></td>
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<td><strong>Electro-mechanical Chopping &amp; Modulation of Acceleration: the Geometry-modulated Accelerometer</strong></td>
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<td><strong>Cristiano Marra</strong>, Filippo Ferrari, Giacomo Langfelder, Francesco Rizzini, Alessandro Tocchio</td>
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<td><strong>ST Microelectronics; Politecnico di Milano, Italy</strong></td>
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10:40 - 11:10
Lightning Round Presentations of the following Poster Session
Room: Bassanini

The session will begin "Lightning Round" Presentations (2 min X 12 posters) in Bassanini

11:10 - 13:00
P2: Accelerometers, Magnetometers, IMUs
Room: Bellagio
Session Chair: Igor Prikhodko, Analog Devices Inc., USA
Johannes Classen, Robert Bosch GmbH, Germany

**Session will include Poster Discussion, Coffee Break & Exhibit Inspection**

P2-1: Automated tuning of Kalman Filters
Wojciech Straszewski, Magdalena Drozdz, Hendrik Wouters
Fugro, The Netherlands

P2-2: Combined electronics and algorithm development for offset drift characterization in MEMS accelerometers
Federico Maspero¹, Victor Fernandez López-Rey², Loïc Joët³, Sébastien Hentz⁴, Giacomo Langfelder²
University of Grenoble & CEA-Leti, France; Politecnico di Milano, Italy; CEA-Leti, France

P2-3: Simulation methods for generating reduced order models of MEMS sensors with geometric nonlinear drive motion
Martin Putnik⁵, Stefano Cardanobile⁶, Mateusz Sniegucki⁵, Steven Kehrberg⁵, Matthias Kuehnel⁵, Peter Degenfeld-Schonburg⁵, Cristian Nagel², Jan Mehner³
Robert Bosch GmbH, Germany¹; Robert Bosch GmbH Renningen, Germany²; Technische Universität Chemnitz, Germany³

P2-4: Liquid Package Effects of Piezoresistive MEMS Accelerometer
Liu Xixiang¹, Libo Zhao¹ and Weile Jiang¹, Chen Jia¹,MingZhi Yu¹,², Jiang Zhuangde²
Xi'an Jiaotong University, P.R. China¹; State Key Laboratory for Manufacturing Systems Engineering, P.R. China²

P2-5: A Biologically-inspired Hair Accelerometer Based on Resonant Sensing
Bo Yang
Southeast University, P.R. China

P2-6: A 27μW MEMS Silicon Oscillating Accelerometer with 4-μg Bias Instability and 10-μg/√Hz Noise Density
Xi Wang¹, Guo Ming Xia², Yang Zhao², Jian Zhao², An Ping Qiu², Yan Su², Yong Ping Xu³
China University of Mining and Technology & National University of Singapore, P.R. China¹; Nanjing University of Science and Technology, P.R. China²; National University of Singapore, Singapore³

P2-7: Attitude determination in dead reckoning navigation with reduced inertial support
Yakov Binder
Concern CSRI Elektropribor, Russia

P2-8: High-precision inertial measurement unit IMU-5000
Wednesday, March 28
Yuri Korkishko, Vyacheslav Fedorov, Viktor Prilutskiy, Vladimir Ponomarev, Igor Fedorov, Sergey Kostritskii, Ivan Morev, Dmitriy Obuhovich, Stanislav Prilutskiy, Aleksandr Zuev and Vasiliy Varnakov
RPC Optolink, Russia

P2-9: Experimental investigation of MEMS DRIE etching dimensional loss
Francesco Rizzini, Gabriele Gattere, Lorenzo Corso, Anna Alessandri, Francesco Tripodi, Ilaria Gelmi
ST Microelectronics, Italy

P2-10: In-flight magnetometer calibration in the projectile frame
Ronan Adam
French-German Research Institute of Saint-Louis, France

P2-11: Modeling of a vibrating MEMS magnetometer partially covered with a ferromagnetic thin film
Thomas Perrier¹, ², Raphaël Levy², Patrick Kayser², Béatrice Verlhac², Johan Moulin¹
University Paris Sud, France¹; ONERA, France²

P2-12: Auto-Zero Baseline Correction Circuit for MEMS Accelerometer Based Seismic Sensor
Panagiotis Ioakim, Iasonas Triantis
City University of London, United Kingdom (Great Britain)

13:00 - 14:30
Lunch
Room: Restaurant La Cascata

14:30 – 15:00
I3: Invited Speaker: Joerg F. Wagner, University of Stuttgart, Germany
Room: Bassanini
Session Chair: Joan Griner, GlobalFoundries, Singapore

The Machine of Bohnenberger: Inertial Link between Astronomy, Navigation, and Geodesy
Jörg F. Wagner
University of Stuttgart

15:00- 15:40
T5: IMUs
Room: Bassanini
Session Chair: Joan Griner, GlobalFoundries, Singapore
Ryan Supino, Honeywell, USA

Heteromagnetic Sensors Motion Parameters Of Moving Objects
Aleksandr Skripkin
TU - Saratov, Russia

Human Activity Recognition Method based on Inertial Sensor and Barometer
Lili Xie, Jun Tian, Genming Ding, Qian Zhao
Fujitsu Research & Development Center Co., LTD, P.R. China

15:40 - 16:10
Coffee Break & Exhibits
Room: Varenna & Cernobbio
### Wednesday, March 28

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Location</th>
<th>Chair(s)</th>
</tr>
</thead>
</table>
| 16:10 - 17:10 | **T6: High-precision Gyroscopes and Resonators**  | Room: Bassanini | Alexander Trusov, *Northrop Grumman, USA*  
Randall Jaffe, *L-3 Communications, USA* |

**Symmetric Piezoelectric CVG with Digital Control**  
Glen Sanders, Lee Strandjord, Jianfeng Anthony Challoner  
*InertialWave Inc., USA*

**High quality factor MEMS gyroscope with whole angle mode of operation**  
Mansoor Alam, Sina Askari, Mohammad H. Asadian, Andrei Shkel  
*University of California Irvine, USA*

**Simulation-Based Approach for Fabrication of Micro-Shell Resonators with Controllable Stiffness and Mass Distribution**  
Behrouz Shiari, Tal Nagourney, Sajal Singh, Jae Yoong Cho, Khalil Najafi  
*University of Michigan, USA*

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<thead>
<tr>
<th>Time</th>
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<th>Location</th>
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<tbody>
<tr>
<td>18:00 - 20:00</td>
<td><strong>Banquet Dinner</strong></td>
<td>Room: Restaurant La Cascata</td>
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### Thursday, March 29

<table>
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<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>08:00 - 12:00</td>
<td>Registration</td>
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<tr>
<td>Room: Basanini Foyer</td>
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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>09:00 – 09:30</td>
<td>Welcome Comments &amp; Awards Ceremony, Day 3</td>
</tr>
<tr>
<td>Andrei Shkel, 2018 General Chair</td>
<td>Room: Bassanini</td>
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<tr>
<td>Session Chairs: Michael Larsen, Northrop Grumman, USA</td>
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<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>09:30 – 10:00</td>
<td>I4: Invited Talk: Fabrice Delhaye, Safran Electronics &amp; Defense</td>
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<tr>
<td>Room: Jasmine 2</td>
<td>Session Chair: Andrei Shkel, University of California, Irvine, USA</td>
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<tr>
<td>Session Chair: Andrei Shkel, University of California, Irvine, USA</td>
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**HRG by SAFRAN, the game-changing technology**

Fabrice Delhaye  
*Safran Electronics & Defense*

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<tr>
<td>10:00 - 11:00</td>
<td>T7: Fabrication, Phenomena and Modeling</td>
</tr>
<tr>
<td>Room: Bassanini</td>
<td>Session Chair: Olivier Le Traon, ONERA, France Lyn Coronato, TDK-InvenSense Italy srl, Italy</td>
</tr>
</tbody>
</table>

**Investigation on precise frequency trimming of a micro shell resonator with T-shape masses using low-power femtosecond laser ablation**

Kun Lu, Yan Shi, Dingbang Xiao, Zhanqiang Hou, Wei Li, Xuezhong Wu, Yulie Wu  
*National University of Defense Technology, P.R. China*

**Suppression of the resonance of vacuum-sealed accelerometers: a comparison of two different strategies**

Bruno Fain, Frédéric Souchon, Audrey Berthelot, Romain Anciant, Philippe Robert, Guillaume Jourdan  
*CEA-LETI, France*

**A novel compensation method of damping asymmetry based on piezoelectric electrodes for cylindrical resonators**

Jiangkun Sun, Yulie Wu, Xiang Xi, Yongmeng Zhang, Xuezhong Wu, Luozhen Qu  
*National University of Defense Technology, P.R. China*
### Thursday, March 29

#### 11:30 - 12:45
**Late News 1**  
**Room:** Bassanini  
**Session Chair:** Barry Gallacher, *Newcastle University, UK*  
Andrea Pizzarulli, *Civitanavi Systems srl, Italy*

<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
</tr>
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</table>
| Nuclear Magnetic Resonance Gyroscope (NMRG)                         | Michael Larsen¹, Dennis Bevan¹, James Pavell¹, Marta Luengo-Kovac¹, Michael Bulatowicz¹, Philip Clark¹, Robert Griffith¹, Julia Flicker¹, Ashely Rothballer¹, Daryl Sakaida¹, Gordon Morrison², Juan Campero², Elliot Burke², Steven Estrella², Brian Ehrsam²  
                                                                 | Northrop Grumman, USA¹; Freedom Photonics, USA²                                                                                                                                                          |
| 200mm High Performance Inertial Sensor Manufacturing Process        | Stephane Martel¹, Francois Dion¹, Jeffrey DeNatale²  
                                                                 | Teledyne DALSA Semiconductor, Canada¹; Teledyne Scientific Company, USA²                                                                                                                                  |
| Active Temperature Compensation of Thermal Accelerometer for Improved Stability | Kirsten Kaplan, Martin Winterkorn, Camille Everhart, DongsuK D. Shin, Gary O'Brien, Fritz Prinz, Thomas Kenny  
                                                                 | Stanford University, USA                                                                                                                                                                                |
| Effect of Fabrication Imperfections on Energy Loss through Mechanical Mode Coupling | Daryosh Vatanparvar, Andrei M. Shkel  
                                                                 | University of California, Irvine, United States                                                                                                                                                         |
| Shock behaviour of gyroscope based on gas thermal expansion         | Guillaume Kock, Philippe Combette, Benoit Charlot, Alain Giani  
                                                                 | University of Montpellier & Institute of Electronics & Systems (IES), France                                                                                                                             |

#### 12:45 - 13:00
**Closing Remarks**  
**Andrei Shkel, 2018 General Chair**  
**Room:** Bassanini  
**Session Chair:** Andrei Shkel, *University of California, Irvine, USA*

#### 14:30 – 17:15
**Lake Como Boat Tour**  
**Room:** Bassanini

**More information to be announced**