Welcome Message

Dear Colleagues/Friends,

We welcome you back to Hawaii – this time to the Island of Kauai – to present, exhibit, and participate in the 4th IEEE International Symposium on Inertial Sensors and Systems (INERTIAL’17). This year event continues our recently established tradition, started in 2014 in Laguna Beach, CA, of informal international meetings discussing the latest developments in the area of modern inertial sensors and emerging applications enabled by inertial sensors. The IEEE INERTIAL is sponsored by the IEEE Sensors Council and is the only IEEE event exclusively dedicated to the Inertial Sensors and Systems technology. The acceptance of technology is growing fast, with the MEMS Inertial Sensors market alone projected to exceed $2.0B by 2020.

The event offers a rare opportunity to meet and network with leaders in the field of Inertial Sensors and Systems in an informal atmosphere of a focused, international, technical gathering. We hope the atmosphere, research topics, and the quality of invited and contributed technical presentations will make the INERTIAL a ‘must attend’ event for you every year. The INERTIAL has an ambition to establish itself as the premier forum for the latest research, development, and commercialization results in modern Inertial Sensors technology. You will hear from the world experts the latest in materials and micro-fabrication processes, innovative designs, and new physical principles.

The technical program this year covers two and a half days of technical presentations. By design, this is a single track symposium with high quality oral and poster presentations. Each presentation was carefully reviewed and selected by our Technical Program Committee, after a careful evaluation by at least three independent reviewers. Our three distinct invited speakers will open the morning session every day. The contributed papers will be presented in oral and poster formats, with poster sessions preceded by brief oral sessions introducing the posters. Following the success of last year, we expanded our program by a day of tutorials. On Monday, there will be three tutorials offered, this year in the area of Atomic Sensors for Inertial Navigation, Non-GPS Aiding of Inertial Navigation Systems (INS), and the Fiber Optic Gyroscopes. The tutorials are organized and chaired by Dr. Michael Larsen.

The Digest of Technical Papers for the 2017 IEEE Inertial Sensors contains four-page versions of regular oral and poster presentations and 2-pagers of “late news” presentations, all provided to attendees in an electronic form. Most (but not all) presented papers will be available in the IEEE Xplore after the symposium. This Year we added a few new events – the “Lighting Round” by Exhibitors and “Open Posters” by Participants. On Tuesday morning, our exhibitors will be invited to briefly introduce their companies, products, and services, stimulating interactions with attendees throughout the meeting. The “Open Posters” session on Tuesday night will offer an opportunity for all attendees to discuss informally the latest and greatest from the labs.

On Wednesday morning, Dr. Kari Moran will be hosting a breakfast for “Women in Inertial Sensors”. This event is sponsored by IEEE Sensors Council and will promote the discussion on the role of women engineers in the modern work force.

This year, for the first time, the Technical Program Committee will select two Best Student Papers, one from the oral track and another from the poster track. Dr. Giacomo Langfelder will be chairing the Award Committee this year. Good luck to all presenting students!

We would like to express our special thanks to the Advisory Board Committee and the Technical Program Committee who contributed their time to evaluate submissions. We thank the IEEE Sensors Council for sponsoring the 2017 IEEE Inertial Sensors as well as our Patrons and Exhibitors. Our special thanks to Tom Wehner (Alliance Management Group, LLC) for submission administration and Cynda Covert, Chris Dyer, and the entire staff at Conference Catalysts, LLC for administrative support.

Finally, we thank all speakers, presenters, and attendees for making the 2017 IEEE Inertial Sensors such a unique event. We hope that you find the INERTIAL’17 Symposium professionally stimulating and enjoyable, and of course, we are looking forward to seeing you back next year for the INERTIAL’18.

Andrei M. Shkel
Symposium Chair
Professor, University of California, Irvine
IEEE Inertial Sensors & Systems Symposium 2017
Organizers

Symposium Chair:
Andrei Shkel, University of California, Irvine, United States

Symposium Treasurer:
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Ryan Lu, SPAWAR Systems Center Pacific, United States
Kari Moran, SPAWAR Systems Center Pacific, United States
Chris Painter, Apple Inc., United States
Igor Prikhodko, Analog Devices Inc., United States
Adam R. Schofield, US Army CERDEC, United States
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Alessandro Tocchio, ST Microelectronics Inc., Italy
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Rong Zhang, Tsinghua University, China
Sergey Zotov, GE, United States

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Alexander Trusov
Arantxa Uranga
Larry Vallot
Marc Weinberg
Ahmed Zaki
Sam Zhang
Sergei Zotov
Exhibits will be in the Jasmine Room 1. Opening at 8:00 AM, Tuesday, March 28 and closing at 4:00 PM, Wednesday, March 29.
Tutorials

Monday, March 27

08:00 - 10:00
Atomic Sensors for Inertial Navigation
Room: Jasmine 1

Instructor: Dr. John Kitching, NSIT

Abstract: We will discuss the physics, design, operation and performance of sensors for inertial navigation based on atomic spectroscopy, with a focus on atom interferometers and gyroscopes based on nuclear magnetic resonance. These instruments have been under development for some time, as just now being released into the commercial marketplace, and are poised to bring new capabilities to the inertial sensors arena, such as exceptional bias and scale factor stability. We will review the atomic physics that underlies each of these instruments, present several example instrument designs, discuss the performance of each instrument in the context of the broader inertial sensors technology area, and present the prospects for commercialization, miniaturization and ultimate use in a variety of application spaces.

10:30 - 12:30
Non-GPS Aiding of INS
Room: Jasmine 1

Instructor: Dr. John Raquet, AFIT

Abstract: Most inertial navigation systems are integrated with other sensors in order to remove long-term drift. While GPS is an ideal aiding sensor for inertial systems, there is increasing interest in non-GPS aiding sources to be used in situations where GPS is not available. This tutorial will provide a survey of several different non-GNSS navigation techniques. A variety of non-GNSS alternatives will be covered at the phenomenology level, describing the overall characteristics of each of the possible phenomenologies that can be used to navigate, including the limits of performance that result from use of these phenomenologies (where they can be used, when they can be used, expected accuracies, etc.). Then, for some of the more common approaches, we will describe some of the practical implementation issues that are faced when implementing a real-world system. Examples of phenomenologies useful for navigation to be covered include vision, signals of opportunity, lidar, pseudolites/beacons, magnetic field variations, and star trackers.
The Fiber Optic Gyroscope: From Principles to Future Prospects
Room: Jasmine 1

Instructor: Professor Michel Digonnet, Stanford Photonics Research Center

Abstract: This short course will review the basic principles of the fiber optic gyroscope (FOG), starting from the fundamental Sagnac effect and the Sagnac interferometer and building up to the closed-loop gyroscope developed for commercial applications. This will include biasing techniques, sources of noise and drift, and the means that have been developed over the years to overcome them. It will then discuss the more recent research developments in laser-driven FOGs, which now exhibit for the first time the low noise and low drift required to navigate an aircraft. The course will conclude with a discussion of future prospects for further improving the performance and reducing the cost of the FOG, including the use of optical resonators and a discussion of the impact of slow light on sensitivity.
Invited Speakers

Tuesday, March 28
09:00 - 09:30
A1-L-A: Invited Talk
Room: Jasmine 2

Precise Robust Inertial Guidance for Munitions (PRIGM)

Robert Lutwak, Defense Advanced Research Projects Agency, United States

Abstract:
The DARPA Precise Robust Inertial Guidance for Munitions (PRIGM) program is developing next-generation inertial sensors with sufficiently low size, weight, and power to enable precision-guided munitions in GPS-degraded or –denied environments. The PRIGM program comprises two main thrusts: a near-term transition effort to develop a MEMS-based Navigation-Grade Inertial Measurement Unit (PRIGM:NGIMU) and fundamental research on Advanced Inertial Micro-Sensors (PRIGM:AIMS). PRIGM:NGIMU performers are developing an interface-compatible drop-in replacement for currently deployed tactical-grade MEMS IMUs, while PRIGM:AIMS performers are investigating novel architectures, materials, and operating modalities for future inertial sensors that are capable of providing extraordinary navigation performance under extreme operating conditions.

This presentation will outline the PRIGM:NGIMU and PRIGM:AIMS goals as well as provide an overview of the technical approaches under investigation in these programs.

Wednesday, March 29
09:00 - 09:30
B1-L-A: Invited Talk
Room: Jasmine 2

Where are We Heading: A Brief History and Future of Navigation

Douglas Meyer, Northrop Grumman, United States

Abstract:
For at least the past 200,000 years modern humans have been exploring the world around them. These explorations were driven by the need for food, water, better shelter, and in some cases possibly just for curiosity… ‘what is over that next mountain ridge or on the other side of the valley…’ The earliest explorations were most likely tied to changing of the seasons, animal migration paths and were done without the aid of navigation tools. As the sphere of human exploration increased beyond the known realm, the need for navigation tools became paramount to provide a means for charting where they went, allow a means of returning home, and provide a method of return to the newly discovered lands. Over the course of time more sophisticated navigation tools, such as the sextant and naval chronometer, where developed to allow one’s present position to be determined relative to a starting location or a destination. A significant turning point occurred in the 17th Century with Sir Isaac Newton’s development of the laws of motion. While not obvious at the time, these are the foundation of modern inertial navigation. This paper will discuss some of the methods; evolution of navigation tools used by early navigators and will conclude with the current state of the art and what future technologies and sensing modalities hold for the art of navigation.
3D RF Localization within an LTE Network: Challenges and Opportunities

David A. Howe, Group Leader, Time and Frequency Division, NIST, United States

Abstract:
NIST’s Communications Technology Laboratory and its Public Safety Communications Research (PSCR) Division is leading a first-of-its-kind nationwide cell-phone network that will enable improved interoperable broadband communications and new functionalities. As this network becomes a reality, public safety stakeholders have set unprecedented metrics for Location Based Services (LBS) as one of its primary goals. This presentation will provide an overview of these criteria for 3D indoor localization (vertical and horizontal local positioning) necessary for servicing large numbers of first responders in emergencies that have especially challenging, unique operations in a dense, urban environment. Cell phone modulation protocols and 4G LTE standards use RF spectra that does not include precise 3D positioning at this time but is primarily focused on spectrum-shared, robust communications. I will discuss PSCR research that directs 5G LTE formats and RF modulation protocols that potentially achieves 0.1m 3D uncertainty in real-time position and velocity dynamics for hours-long durations. Lastly, I will present the significant benefits of small, low-phase noise atomic oscillators that can be introduced into future cell phone networks to obtain high precision 3D RF localization and improved data capacity.
Everyday millions of critical decisions are made in safety and security, Thales is at the heart of these. Thales has more than 62,000 talented people across 56 countries. Together, we innovate with our customers to build smarter solutions. Our intelligent technologies are dedicated to protecting people, property and information worldwide in Space, Aerospace, Security, Ground Transportation, Defence and Cyberspace markets. Every moment of every day, wherever safety and security are critical, Thales delivers.

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TopAxyz IMU
High-performance Inertial Measurement Unit
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RING LASER GYRO TECHNOLOGY IMU

NAVIGATION GRADE IMU

OUTSTANDING STABILITY

2 CHANNELS FOR NAVIGATION AND STABILIZATION

Everyday millions of critical decisions are made in safety and security, Thales is at the heart of these. Thales has more than 62,000 talented people across 56 countries. Together, we innovate with our customers to build smarter solutions. Our intelligent technologies are dedicated to protecting people, property and information worldwide in Space, Aerospace, Security, Ground Transportation, Defence and Cyberspace markets. Every moment of every day, wherever safety and security are critical, Thales delivers.

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It Knows Where You’re Headed

Systron Donner’s SDN500 INS/GPS delivers a highly accurate, tightly coupled navigation, stabilization and geolocation solution featuring < 1.0°/ hr. in-run gyro bias. The SDN500 is environmentally robust and maintains tactical-grade performance during GPS outages.

for specifications and a quote see us at ISISS or visit www.systron.com
### Monday, March 27

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<th>Event</th>
<th>Instructor/Speaker</th>
<th>Room</th>
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<td>07:00 - 16:00</td>
<td>Tutorial Registration</td>
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<td>Jasmine Foyer</td>
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<tr>
<td>08:00 - 10:00</td>
<td><strong>Tutorial 1: Atomic Sensors for Inertial Navigation</strong></td>
<td>Dr. John Kitching, NIST</td>
<td>Jasmine 1</td>
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<td>10:00 - 10:30</td>
<td><strong>Coffee Break</strong></td>
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<td>Jasmine Foyer</td>
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<td>10:30 - 12:30</td>
<td><strong>Tutorial 2: Non-GPS Aiding of INS</strong></td>
<td>Dr. John Raquet, AFIT</td>
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<td>12:30 - 14:00</td>
<td><strong>Lunch</strong></td>
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<td>14:00 – 16:00</td>
<td><strong>Tutorial 3: The Fiber Optic Gyroscope: From Principles to Future Prospects</strong></td>
<td>Prof. Michel Digonnet, Stanford Photonics Research Center</td>
<td>Jasmine 1</td>
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<tr>
<td>18:00 - 20:00</td>
<td><strong>Welcome Reception</strong></td>
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All attendees are invited to the Welcome Reception for drinks and light hors d'oeuvres.
## Tuesday, March 28

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<tr>
<th>Time</th>
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| 08:00 - 18:00 | Registration  
Room: Jasmine Foyer                             |
| 08:45 - 09:00 | Opening Remarks  
Andrei Shkel, 2017 General Chair  
Room: Jasmine 2 |
| 09:00 - 09:30 | A1L-A: Invited Talk: Robert Lutwak, DARPA  
Room: Jasmine 2  
Session Chair: Andrei Shkel, University of California, Irvine, USA |
|           | Precise Robust Inertial Guidance for Munitions (PRIGM)  
Robert Lutwak  
DARPA, United States |
| 09:30 - 10:30 | A2L-A: Special Session: Advances in Precision Inertial Sensors - I  
Room: Jasmine 2  
Session Chair: Michael Larsen, Northrop Grumman, USA  
Co-Chair: Kari Moran, SPAWAR SCP, USA |
|           | Effect of Direct PRBS Modulation on Laser Driven Fiber Optic Gyroscope  
Sarat Gundavarapu, Tin Komljenovic, Minh Tran, Michael Belt, John Bowers, Daniel Blumenthal  
University of California, Santa Barbara, United States |
|           | Trade-Offs in Size and Performance for a Point Source Interferometer Gyroscope  
Gregory Hoth, Bruno Pelle, John Kitching, Elizabeth Donley  
National Institute of Standards and Technology, United States |
|           | On a Feasibility of a Resonant Stimulated RAMAN Scattering Gyroscope  
Wei Liang, Vladimir Ilchenko, Danny Eliyahu, Anatoliy Savchenkov, Andrey Matsko, Lute Maleki  
OEwaves Inc., United States |
| 10:30 - 11:00 | Exhibitors’ Highlights  
Room: Jasmine 2 |
| 11:00 - 11:30 | Coffee Break & Exhibits  
Room: Jasmine 1 |
## Tuesday, March 28

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<tr>
<th>Time</th>
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<th>Room</th>
<th>Session Chair</th>
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<td>11:30 - 12:30</td>
<td>A3L-A: Sensors Phenomena and Modeling - I</td>
<td>Jasmine 2</td>
<td>Jenna Chan, ECS Federal, USA</td>
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<td></td>
<td>FM/Rate Integrating MEMS Gyroscope Using Independently Controlled CW/CCW Mode Oscillations on a Single Resonator</td>
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<td>Takahiro Tsukamoto, Shuji Tanaka</td>
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<td><em>Tohoku University, Japan</em></td>
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<td>Half-a-Month 0.2 Degree-Per-Hour Stable Mode-Matched MEMS Gyroscope</td>
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<td>Igor Prikhodko, Jeffrey Gregory, William Clark, Michael Judy</td>
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<td><em>Analog Devices, Inc., United States</em></td>
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<td>Controlled Capacitive Gaps for Electrostatic Actuation and Tuning of 3D Fused Silica Micro-Wineglass Resonator Gyroscope</td>
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<td>Mohammad Asadian, Yusheng Wang, Sina Askari, Andrei Shkel</td>
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<td><em>University of California, Irvine, United States</em></td>
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<td>12:30 - 14:00</td>
<td>Lunch</td>
<td>Jasmine 3</td>
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<td>14:00 – 15:00</td>
<td>A4L-A: Inertial Microsystems</td>
<td>Jasmine 2</td>
<td>Shuji Tanaka, Tohoku University, Japan</td>
<td>Alexander Trusov, Northrop Grumman, USA</td>
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<td>Tactical-Grade Dual-Chip Inertial Sensor Assembly</td>
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<td>Daniel Endean, Xiao Zhu Fan, Max Glenn, Robert Horning, John Reinke, Barry Roberts</td>
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<td><em>Honeywell International, United States</em></td>
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<td>Electrostatic Compensation of Structural Imperfections in Dynamically Amplified Dual-Mass Gyroscope</td>
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<td>Alexandra Efimovskaya, Yu-Wei Lin, Danmeng Wang, Andrei Shkel</td>
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<td><em>University of California Irvine, United States</em></td>
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<td>On-Chip Characterization of Scale Factor of a MEMS Gyroscope via a Micro Calibration Platform</td>
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<td>Ethem Erkan Aktakka, Jong-Kwan Woo, Khalil Najafi</td>
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<td><em>University of Michigan, Ann Arbor, United States</em></td>
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<td>15:00 - 15:30</td>
<td>Coffee Break &amp; Exhibits</td>
<td>Jasmine 1</td>
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Tuesday, March 28

15:30 - 17:00
A5P-B: Sensors Phenomena and Modeling
Room: Jasmine Foyer
Session Chair: Ryan Lu, SPAWAR SPC, USA
Co-Chair: Giacomo Langfelder, Politecnico di Milano, Italy

**Session will be "Lightning Round" Presentations (2 min X 13 posters) in Jasmine 2**

A5P-1: Miniature Accelerometer for High Dynamic Precision Guided Systems
Jose Beitia, Pierre Loisel, Chris Fell
InnaLabs Ltd, Ireland

A5P-2: Drift Modeling and Compensation for MEMS-Based Gyroscope Using a Wiener-Type Recurrent Neural Network
Yu-Liang Hsu¹, Po-Huan Chou², Yu-Chen Kou¹
¹Feng Chia University, Taiwan; ²Industrial Technology Research Institute, Taiwan

A5P-3: Incorporating Geometric Nonlinearities in Reduced Order Models for MEMS Gyroscopes
Martin Putnik¹, Mateusz Sniegucki¹, Stefano Cardanobile¹, Steven Kehrberg¹, Matthias Kuehnel¹, Peter Degenfeld-Schonburg¹, Cristian Nagel¹, Jan Mehner²
¹Robert Bosch GmbH, Germany; ²Technische Universitaet Chemnitz, Germany

A5P-4: The First Integrated Optical Driver Chip for Fiber Optic Gyroscopes
Minh Tran, Jared Hulme, Tin Komljenovic, Mj Kennedy, Daniel Blumenthal, John Bowers
University of California Santa Barbara, United States

A5P-5: A Catch-and-Release Drive MEMS Gyroscope with Enhanced Sensitivity by Mode-Matching
Ryunosuke Gando, Kubo Haruka, Kei Masunishi, Tamio Ikehashi, Yasushi Tomizawa, Etsuji Ogawa, Shunta Maeda, Yohei Hatakeyama, Tetsuro Itakura
Toshiba Corporation, Japan

A5P-6: A Novel Dual-Threshold MEMS Accelerations Latching Switch
Weirong Nie, Zhijian Zhou, Zhanwen Xi, Chao Bu, Qiao Luo
Nanjing University of Science and Technology, China

A5P-7: Nonlinear Vibration and its Influence on the Vibratory Cylinder Gyroscope
Yongmeng Zhang, Xuezhong Wu, Yulie Wu, Xiang Xi, Dingbang Xiao
National University of Defense Technology, China

A5P-8: Noise Contributions in a Closed-Loop MEMS Gyroscope for Automotive Applications
Tobias Hiller¹, Burkhard Kuhlmann¹, Alexander Buhmann¹, Hubert Roth²
¹Robert Bosch GmbH, Germany; ²University of Siegen, Germany

A5P-9: Optical Self-Excitation and Detection for Inertial MEMS Sensors
Ansas Kasten, William Challener, Mengli Wang, Yizhen Lin, Loucas Tsakalakos, Todd Miller, Sergey Zotov
GE Global Research, United States

A5P-10: Parametric Drive of a Micro Rate Integrating Gyroscope Using Discrete Electrodes
Mingliang Song, Bin Zhou, Tian Zhang, Bo Hou, Rong Zhang
Tsinghua University, China
Tuesday, March 28

A5P-11: Numerical Study of Impact of Surface Roughness on THERMOELASTIC Loss of Micro-Resonators
Behrouz Shiari, Tal Nagourney, Ali Darvishian, Jaeyoong Cho, Khalil Najafi
University of Michigan, United States

A5P-12: Frequency Split Reduction by Directional Lapping of Fused Quartz Micro Wineglass Resonators
Yusheng Wang, Mohammad Asadian, Andrei Shkel
University of California, Irvine, United States

Danmeng Wang, Mohammad Asadian, Alexandra Efimovskaya, Andrei Shkel
University of California, Irvine, United States

17:00 - 18:00
Open Posters
Room: Jasmine Foyer
Session Chair: Ryan Lu, SPAWAR SPC, USA
Co-Chair: Giacomo Langfelder, Politecnico di Milano, Italy

1: Body Frame Calibration without Known Stimuli for 3-AXIS Accelerometers Used in Directional Drilling
M. V. Gheorghe
Ideal Aerosmith. Inc., United States

2: High Flux Atom Beam Gyroscopes
Li Chao, Chandra Raman
Georgia Institute of Technology, United States

3: 3D High Aspect-Ratio Glass Axisymmetric Shell Resonators
Bin Luo¹, Chenyue Lu², Ming-ai Zhang¹, Jintang Zhang¹, Ching-Ping Wong³
¹Southeast University, China; ²Nanyang Technological University, Singapore; ³The Chinese University of Hong Kong, Hong Kong

4: Ultra-Stable μTorr-Level Vacuum Packaging for High Performance MEMS Inertial Sensors
Mohammad H. Asadian, Sina Askari, Andrei M. Shkel
University of California, Irvine, United States

5: 3D MEMS for Inertial Navigation
Alexandra Efimovskaya, Yu-Wei Lin, Mohammad H. Asadian, Yusheng Wang, Danmeng Wang, Bahram Seifi, Radwan Mohammednoor
University of California, Irvine, United States

All attendees are invited to the Open Poster Session for drinks and light hors d'oeuvres
Wednesday, March 29

07:00 - 08:30
Women in Inertial Sensors Breakfast
Room: Ginger Room

08:00 - 17:00
Registration
Room: Jasmine Foyer

08:45 - 09:00
Welcome Comments, Day 2
Andrei Shkel, 2017 General Chair
Room: Jasmine 2

09:00 - 09:30
B1L-A: Invited Speaker: Doug Meyer, Northrop Grumman
Room: Jasmine 2
Session Chair: Andrei Shkel, University of California, Irvine, USA

Where are We Heading: A Brief History and Future of Navigation
Doug Meyer
Northrop Grumman, United States

09:30 - 10:30
B2L-A: Emerging Applications
Room: Jasmine 2
Session Chair: Chris Painter, Apple, USA
Co-Chair: Adam Schofield, CERDEC Army, USA

A Comprehensive Study of NEMS-Based Piezoresistive Gyroscopes for Vestibular Implant Systems
Stefano Dellea¹, Antonio Longoni², Giulia Mantini³, Raimund Naschberger³, Antonios Nikas², Olivier Leman², Johann Hauer², Patrice Rey¹, Giacomo Langfelder⁴
¹CEA Leti, France; ²Fraunhofer Institut, Germany; ³MEDEL, Austria; ⁴Politecnico di Milano, Italy

Accurate Indoor Localization and Tracking Using Mobile Phone Inertial Sensor, WiFi and iBeacon
Han Zou², Zhenghua Chen², Hao Jiang¹, Lihua Xie²
¹Fuzhou University, China; ²Nanyang Technological University, Singapore

Quantifying Important Differences in Athlete Movement During Collision-Based Team Sports: Accelerometers Outperform Global Positioning Systems
Samuel Howe¹, William Hopkins¹, Andrew Stewart¹, Bryce Cavanagh², Robert Aughey¹
¹Institute of Sport, Exercise and Active Living, Victoria University, Australia; ²Melbourne Rebels Rugby Union Team, Australia

10:30 - 11:00
Coffee Break & Exhibits
Room: Jasmine 1
Wednesday, March 29

11:00 - 12:30
B3P-B: Emerging Systems & Late News
Room: Jasmine Foyer
Session Chair: Igor Prikhodko, Analog Devices, USA
Co-Chair: Rong Zhang, Tsinghua University, China

**Session will be "Lightning Round" Presentations (2 min X 18 posters) in Jasmine 2**

**B3P-1: Inertial Sensor for an Autonomous Data Acquisition of a Novel Automotive Acoustic Measurement System**
Johannes Masino, Matthias Luh, Michael Frey, Frank Gauterin
Karlsruhe Institute of Technology, Germany

**B3P-2: Micro Shell Resonator with T-Shape Masses Fabricated by Improved Process Using Whirling Platform and Femtosecond Laser Ablation**
Kun Lu, Wei Li, Dingbang Xiao, Zhanqiang Hou, Yan Shi, Xuezhong Wu, Yulie Wu
National University of Defense Technology, China

**B3P-3: A New Approach to Vacuum Packaging of Getter-Less and Gettered Ceramic Chip Carriers**
Ryan Knight, Ronald Polcawich
US Army Research Lab, United States

**B3P-4: Inertial Navigation System with Acoustic Obstacle Detection for Pedestrian Applications**
Joshua Jaekel, Mohammed Jalal Ahamed
University of Windsor, Canada

**B3P-5: Fabrication of Wide and Deep Cavities for Silicon MEMS Devices Without Wafer Bonding**
Yunhan Chen², Ian Flader², Dongsuk Shin², Chae Ahn¹, Thomas Kenny²
¹InvenSense Inc., United States; ²Stanford University, United States

**B3P-6: Iteratively reweighted Kalman Filter for NLOS Mitigation and Sensor Data Fusion**
Joan Bordoy, Rui Zhang, Fabian Höflinger, Christian Schindelhauer, Leonhard Reindl
University of Freiburg, Germany

**B3P-7: What Is the Best Displacement Transducer for a Seismic Sensor?**
Peter Novotny¹, Benjamin Aimard², Gael Balik², Laurent Brunetti², Bernard Caron³, Andrea Gaddi¹
¹CERN, Switzerland; ²LAPP-IN2P3-CNRS Université Savoie Mont-Blanc, France; ³Université Savoie Mont-Blanc, France

**B3P-8: Development of a Complete Model to Evaluate the Zero Rate Level Drift Over Temperature in MEMS Coriolis Vibrating Gyrosopes**
Stefano Facchinetti, Luca Guerinoni, Luca Giuseppe Falorni, Andrea Donadel, Carlo Valzasina
STMicroelectronics, Italy

**B3P-9: A Universal Electronics Approach for Rate Integrating Gyrosopes**
Anthony Challoner, Jeremy Popp, Peter Bond
InertialWave Inc, United States

**B3P-10: Study of Environmental Survivability and Stability of Folded MEMS IMU**
Yu-Wei Lin, Alexandra Efimovskaya, Andrei Shkel
University of California Irvine, United States
Wednesday, March 29

B3P-11: 3-Axis MEMS Gyroscope Calibration Stage: Magnetic Actuation Enabled Out of Plane Dither for Piezoelectric in-Plane Calibration
Visarute Pinrod, Sachin Nadig, Benyamin Davaji, Amit Lal
Cornell University, United States

B3P-12: Study on the Thermoforming Process of Hemispherical Resonator Gyro (HRGs)
Tian Zhang, Zhihui Lin, Mingliang Song, Bin Zhou, Rong Zhang
Tsinghua University, Beijing

B3P-13: A Programmable Emulator of MEMS Inertial Sensors
Leonardo Gaffuri Pagani, Giacomo Langfelder, Paolo Minotti, Nicola Aresi,
Politecnico di Milano, Italy

B3P-14: A Static Approach for the Frequency Shift of Parasitic Excitations in MEMS Gyroscopes with Geometric Nonlinear Drive Mode
Martin Putnik¹, Stefano Cardanobile¹, Steven Kehrberg¹, Cristian Nagel¹, Peter Degenfeld-Schonburg¹, Matthias Kuehnel¹, Jan Mehner²
¹Robert Bosch GmbH, Germany; ²Technische Universitaet Chemnitz, Germany

B3P-15: A 160 μA, 8 mdps/√Hz Frequency-Modulated MEMS Gyroscope
Paolo Minotti¹, Giorgio Mussi¹, Stefano DELLEA¹, Claudia Comi¹, Valentina Zega¹, Stefano Facchinetti², Alessandro Tocchio², Andrea Bonfanti³, Andrea Leonardo Lacaita¹, Giacomo Langfelder¹
¹Politecnico di Milano, Italy; ²STMicroelectronics, Italy

B3P-16: Thermally Induced Bias Errors for a Fiber Coil with Practical Quadruple Winding
Berk Osunluk, Serdar Oğut, Ekmel Ozbay
Bilkent University, Turkey

B3P-17: A Status on Components Development for Folded Micro NMR Gyro
Radwan M. Noor, Venu Gundeti, Andrei M. Shkel
University of California, Irvine, United States

B3P-18: Atom Interferometer Gyroscope Based on Continuous Cold Atomic Beam
Tae Hyun Kim, Sangkyung Lee, Kyu Min Shim, Sin Hyuk Yim
Agency for Defense Development, Korea

12:30 - 14:30
Lunch
Room: Jasmine 3

14:30 - 15:10
B4L-A: Sensors Phenomena and Modeling - II
Room: Jasmine 2
Session Chair: Doug Meyer, Northrop Grumman, USA
Co-Chair: Alessandro Tocchio, ST Microelectronics, Italy

Dual-Resonator MEMS LORENTZ Force Magnetometer Based on Differential Frequency Modulation
Soner Sonmezoglu², Ian B. Flader¹, Yunhan Chen¹, Dongsuk D. Shin¹, Thomas W. Kenny¹, David A. Horsley²
¹Stanford University, United States; ²University of California, Davis, United States
Wednesday, March 29

**Electrostatic Tuning of Temperature Coefficient of Frequency of Anisotropic Disk-Shaped Resonators**
Dongsuk Shin\(^3\), Chae Ahn\(^2\), Yunhan Chen\(^3\), Vu Hong\(^1\), Eldwin Ng\(^2\), Yushi Yang\(^2\), Thomas Kenny\(^3\)
\(^1\)Apple Incorporated, United States; \(^2\)InvenSense Incorporated, United States; \(^3\)Stanford University, United States

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<td>Coffee Break &amp; Exhibits</td>
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<td>16:00 - 17:00</td>
<td><strong>B5L-A: Special Session: Advances in Precision Inertial Sensors - II</strong></td>
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<td><strong>Session Chair:</strong> Earl Benser, Honeywell, USA</td>
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<td><strong>Co-Chair:</strong> Ryuta Araki, Sumitomo, Japan</td>
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<td>Development of Compact Resonator Fiber Optic Gyroscopes</td>
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<td>Glen Sanders, Lee Strandjord, Jianfeng Wu, Marc Smiciklas, Mary Salit, Tiequn Qiu, Wes Willaims, Chellappan Narayanan</td>
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<td><em>Honeywell International, United States</em></td>
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<td>Coil and Gyro-Level Performance of Sagnac Coils</td>
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<td>Mansoor Alam, Jan Khan, Lilja Gudmundsdottir, Amanda Robinson</td>
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<td>A Test Bed for High-Order Inertial Phase Shifts in Time-Domain Atom Interferometers</td>
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<td><em>Sandia National Laboratories, Albuquerque, New Mexico</em></td>
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<td>18:00 - 20:00</td>
<td>Banquet Dinner</td>
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<td>08:00 - 12:00</td>
<td>Registration</td>
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<td>08:45 - 09:00</td>
<td>Welcome Comments, Day 3</td>
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<td>09:00 - 09:30</td>
<td>C1L-A: Invited Talk: David A. Howe, NIST</td>
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<td><strong>3D RF Localization within an LTE Network: Challenges and Opportunities</strong></td>
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<td>David A. Howe, NIST</td>
<td>National Institute of Standards and Technology, United States</td>
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<td>Late News 1</td>
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<td><strong>Effect of Drive-Axis Displacement on MEMS Birdbath Resonator Gyroscope Performance</strong></td>
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<td>Christopher Boyd, Jong-Kwan Woo, Jaeyoong Cho, Tal Nagourney, Ali Darvishian, Behrouz Shiari, Khalil Najafi</td>
<td>University of Michigan, United States</td>
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<td><strong>Theoretical Foundations for Scale Factor Improvement of the Disk Resonant Gyroscope</strong></td>
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<td>Andrew Sabater, Paul Swanson, Kari Moran</td>
<td>SPAWAR Systems Center Pacific, United States</td>
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<td><strong>Localization System Based on Handheld Inertial Sensors and UWB</strong></td>
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<td>Fabian Höflinger, Rui Zhang, Patrick Fehrenbach, Joan Bordoy, Leonhard Reindl, Christian Schindelhauer</td>
<td>Albert-Ludwigs-Universität Freiburg, Germany</td>
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<td><strong>Compact Roll-Pitch-Yaw Gyroscope Implemented in Wafer-Level Epitaxial Silicon Encapsulation Process</strong></td>
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<td>Alexandra Efimovskaya, Yushi Yang, Eldwin Ng, Yunhan Chen, Ian B. Flader, Thomas W. Kenny, Andrei M. Shkel</td>
<td>University of California, Irvine, United States</td>
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<td>10:30 - 11:00</td>
<td>Closing Remarks</td>
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<td>Andrei Shkel, 2017 General Chair</td>
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