

# Welcome Message

Dear Colleagues/Friends,

We welcome you at the heart of Southern California – Orange County to present, exhibit, and participate at the inaugural IEEE International Symposium on INERTIAL SENSORS and SYSTEMS (*ISISS'14*). This exclusive symposium is organized this year in the boutique oceanfront *Surf & Sand Resort* in Laguna Beach, California, USA.

This event launches an annual tradition of informal international meetings discussing the latest developments in the area of modern inertial sensors and emerging applications.

The *IEEE ISISS* is sponsored by the IEEE Sensors Council and is the only IEEE event exclusively dedicated to the Inertial Sensors and Systems technology, the industry which is projected to exceed \$4.0B this year.

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 symposium. We hope the breadth and depth of research topics combined with the quality of invited and contributed technical presentations will make the *IEEE ISISS* a 'must attend' event for you every year.

The *IEEE ISISS* has an ambition to establish itself as the premier forum for reporting the latest research, development, and commercialization results in modern Inertial Sensors and Systems. You will hear from world experts the latest in materials and micro-fabrication processes, innovative designs, new physical principals, and a growing number of new applications and business opportunities.

The technical program covers two full days of presentations. By design, this is a single track symposium with high quality oral and poster presentations. Each presentation was selected by our Technical Program Committee after a careful evaluation by at least three independent technical experts.

Our four distinct invited speakers will open the morning and afternoon sessions. The contributed papers will be presented in oral and poster formats, with poster sessions preceded by brief oral sessions introducing the posters. To highlight the informal atmosphere of symposium, we invited all participants to contribute to the "Open Poster" session. This session will encourage participants to discuss informally very recent results, work in progress, and results recently presented elsewhere.

The Digest of Technical Papers for *ISISS'14* contains four-page versions of all oral and poster presentations, and is provided in an USB electronic version. All presented papers will be available in the IEEE Xplore after the symposium.

We would like to express our special thanks to the Advisory Board Committee, the Technical Program Committee, and many experts who contributed their time to evaluate submissions.

We thank the IEEE Sensors Council for sponsoring *ISISS'14*, as well as our Patrons and Exhibitors. Our special thanks to Tom Wehner (Alliance Management Group, LLC) for submission administration and Chris Dyer and the entire staff at Conference Catalysts, LLC.

Finally, we thank all speakers and presenters and you for attending *IS/SS'14*. We hope that you find the Symposium professionally stimulating and enjoyable, and needless to say, we are looking forward to seeing you back next year in Southern California for *IS/SS'15*.

A handwritten signature in black ink, appearing to read 'A. Shkel', written in a cursive style.

Andrei Shkel

Symposium Chair

University of California, Irvine

# ISS 2014 Organizers

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## Exhibitors – GOLD PATRONS

# ACUTRONIC

ACUTRONIC is the world leader in the development, design and manufacture of precision motion simulators for the aeronautics, space, defense, automotive and consumer industries. Motion simulators are used for testing and calibration of inertial sensors (e.g. gyroscopes and accelerometers), Inertial Navigation Systems, stabilized electro-optical systems, Electronic Stability Control systems as well as for simulating flight motion of missiles.

# KVH<sup>®</sup>

KVH Industries, Inc. manufactures precision fiber optic-based sensors & inertial systems for defense and commercial guidance, navigation, and stabilization applications. Based in Middletown, RI, with facilities in Illinois, Europe and Asia, KVH's gyros and inertial

sensors are used in such applications as unmanned navigation, platform stabilization, and autonomous systems' payloads.

## Exhibitors – SILVER PATRONS



Polytec is a world leader in optical measurement systems, featuring the state-of-the-art Micro System Analyzer (MSA-500) system for MEMS characterization. The MSA system incorporates three key technologies: scanning laser Doppler

vibrometry for out-of-plane deflection shape, strobe video microscopy for in-plane motion and white light interferometry for static shape measurements. Our instruments are used throughout the MEMS research community.

# SYSTRON DONNER INERTIAL

Systron Donner Inertial is the world's leading supplier of Quartz MEMS Inertial Sensors & Systems providing reliable precision solutions to aerospace, defense, unmanned aircraft, marine and

land vehicle applications. Our high-performance quartz MEMS products include analog & digital gyros, multi-axis systems, IMUs and INS/GPS navigation systems.

## Exhibitors – MEDIA PATRON

# MEMS JOURNAL

# Invited Speakers

**9:00 AM - 9:25 AM**  
**AOL-A: Invited Talk**  
**Room: Sand Castle**

## **Micro-Technology for Positioning, Navigation and Timing Towards PNT Everywhere and Always**

*Dr. Robert Lutwak – Defense Advanced Research Projects Agency, United States*

### **Abstract:**

The objective of the DARPA Micro-Technology for Position, Navigation, and Timing (micro-PNT) program portfolio is to develop low Cost, Size, Weight, and Power (CSWaP) inertial navigation technology as a backup or "flywheel" PNT solution for GNSS augmentation, validation, and holdover in obfuscated environments. The micro-PNT portfolio comprises programs addressing the development of low-CSWAP inertial sensors and timing sources, integration and co-fabrication of multiple disparate sensors, and algorithms for optimum combinatorial PNT solutions in complex application environments. This presentation will provide an overview of the DARPA micro-PNT program portfolio as well as the objectives and status of the individual programs therein.

### **Bio:**

Dr. Robert Lutwak is a Program Manager in the U.S. Defense Research Projects Agency Microsystems Technology Office (DARPA-MTO). His primary field of interest is the development of compact low-cost components and systems providing "PNT everywhere" for increased battlefield awareness and cooperative engagement. Dr. Lutwak received his Bachelor of Science in Physics from Miami University in 1988 and his Ph.D. in Atomic and Optical Physics from the Massachusetts Institute of Technology in 1997.

**1:30 PM - 1:55 PM**  
**A3L-A: Invited Talk**  
**Room: Sand Castle**

## **A Historical Perspective on Inertial Navigation Systems**

*Dr. Daniel A. Tazartes - Northrop Grumman Corp., United States*

### **Abstract:**

Inertial navigation provides a unique ability to know where one has been, where one is currently, and where one is going, given only a starting position. The laws of physics permit the sensing of dynamic motion without external information, making inertial systems impervious to jamming, masking, or spoofing. Measurements of six degrees of freedom are required – three linear accelerations, and three angular rates – to fully propagate the velocity, position, and orientation of the system. The first inertial sensors are traced to the early 19th century and specialized inertial guidance systems appeared in the 1940s, yet inertial navigation systems did not become commonplace until the 1960s. This is largely due to the fact that requirements for navigation accuracy inertial sensors – accelerometers and gyroscopes – are very challenging. In the past fifty years, significant evolutionary and revolutionary changes have taken place in the designs of inertial sensors and systems. These include the progression from fluid-filled to dry instruments and the transition from mechanically complex stabilized inertial platforms to computationally intensive strapdown systems. Gyroscopes have evolved from large mechanical devices to highly refined precision mechanical sensors. Optical rotation sensors such as the ring laser gyro and the fiber optic gyro have enabled new system designs and capabilities. Coriolis vibratory gyroscopes such as the hemispherical resonator gyro are capable of extreme accuracy and reliability; new opportunities for miniaturizing these types of sensors will lead to new classes of accuracy for inertial navigation systems. Advanced gyroscope technologies such as the nuclear magnetic resonance gyroscope which uses atomic spin to detect rotation have already been demonstrated to achieve navigation accuracy requirements. Cold atom technologies may also provide the opportunity for very high accuracy accelerometers and gyroscopes in the future. Inertial navigation technologies and applications of the past, present, and future are discussed.

### **Bio:**

Daniel Tazartes is Director, Advanced Technology at Northrop Grumman's Woodland Hills campus where he has successfully introduced several generations of new instrument technologies into inertial and integrated navigation systems. Mr. Tazartes holds 62 patents in the fields of inertial sensors, control algorithms, electronics, and signal processing and has published numerous articles and reference texts on inertial sensors and on strapdown navigation technology.

Mr. Tazartes is the 2010 recipient of the IEEE's Aerospace and Electronics Systems Pioneer award for his work in optical gyroscopes and strapdown navigation systems and was recognized as the Engineers' Council 2010 Engineer of the Year. He is the recipient of the Institute of Navigation's 2002 P.V.H. Weems Award, the Engineers' Council 2000 Distinguished Engineering Achievement Award, and the Litton Industries Advanced Technology Awards in 1992, 1995, and 2000.

He is a member of the Institute of Navigation and of the IEEE. He received his M.S.E.E from the California Institute of Technology and his B.S. in Physics from the University of California at Los Angeles.

**9:00 AM - 9:25 AM**  
**B0L-A: Invited Talk**  
**Room: Sand Castle**

### **Inertial Sensors Are Changing the Games**

*Mounir Zok - United States Olympic Committee, United States*

**Abstract:**

Over the past 15 years, inertial sensors have evolved at impressive rates and have contributed greatly to the field of human movement analysis. The Olympic athletes can gain valuable insight into key aspects of their performance through the use of such technology and engineering experts can contribute greatly to their success. This paper sheds some light on the important role that engineering expertise can play in helping athletes achieve their dreams.

**Bio:**

Mounir Zok joined the U.S. Olympic Committee as Senior Sports Technologist in 2012. In his position, he leads the development of innovative technological solutions for the US Olympic and Paralympic sports.

Prior to this, Zok helped grow a sports technology start-up company in Europe into an internationally renowned firm in technology development.

He holds a PhD in Biomedical Engineering and possesses over 10 years of experience in wearable technology.

Zok currently lives with his family in Colorado Springs.



**3:00 PM - 3:25 PM**  
**B3L-A: Invited Talk**  
**Room: Sand Castle**

### **Inertial Measurement Without Inertial, What Could Go Wrong?**

*Dr. William Clark - Analog Devices, United States*

**Abstract:**

MEMS dominates the everyday world of inertial sensors and is gaining ground in inertial navigation applications despite the obvious disadvantage of its small size. A cursory look at performance parameters would lead one to conclude MEMS inertial sensors are, at best, implausible. A typical MEMS sensor uses a proof mass which is measured in micrograms. To accurately measure acceleration or rotation, displacement must be resolved down to the picometer, capacitance resolved in the zeptoFarads, charge detected down to the electron. And yet these devices exist in great profusion displacing incumbent technologies based not only on price but increasingly on performance.

Substantial performance barriers slow MEMS penetration in the navigation realm; gyroscope bias stability is foremost among these. There has been an increasing emphasis on bias stability performance in the published research and yet there is little discussion of the sources of bias instability. This talk seeks to shed some light on this topic in the hope of starting the conversation that will advance the state of the art.

**Bio:**

Bill Clark received his doctorate in electrical engineering from the University of California, Berkeley in 1997 completing a dissertation on MEMS devices with an emphasis on vibratory rate gyroscopes. After graduation, Bill was among the founders of a small start-up company working on precision MEMS inertial sensors that was acquired by Analog Devices. Since acquisition in 2001, Bill has continued to work with Analog Devices designing MEMS optical and inertial devices. Bill's innovations over the years have resulted in over 30 patents in the fields of MEMS fabrication, packaging, power electronics, gyroscope design and architecture.

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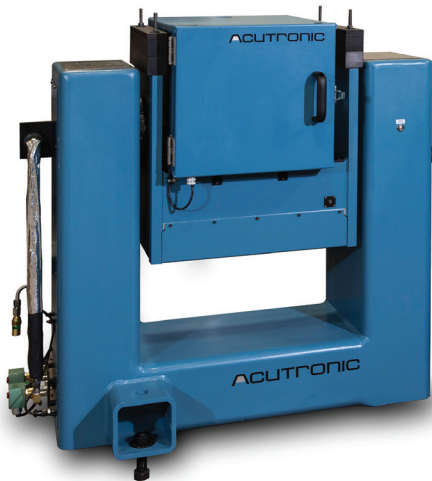
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# Monday, February 24, 2014

6:00 PM - 8:00 PM  
Welcome Reception  
Room: Catalina Deck

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# Tuesday, February 25, 2014

8:00 AM - 5:00 PM  
Registration

8:45 AM - 9:00 AM  
Welcome Comments – Andrei Shkel, ISSS 2014 Chair  
Room: Sand Castle

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9:00 AM - 9:25 AM  
AOL-A: Invited Talk  
Room: Sand Castle  
Session Chair: Andrei Shkel (University of California, Irvine)

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## Micro-Technology for Positioning, Navigation, and Timing Towards PNT Everywhere and Always

Dr. Robert Lutwak  
*Defense Advanced Research Projects Agency, United States*

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9:30 AM - 10:30 AM  
A1L-A: Micro Shell Gyroscopes  
Room: Sand Castle  
Session Chair: David Lynch (Independent Consultant)  
Co-Chair: Chris Painter (Systron Donner)

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## Toroidal Resonators with Small Frequency Mismatch for Rate Integrating Gyroscopes

Burgess Johnson, Chester Boynton, Eugen Cabuz, Steve Chang, Kevin Christ, Sean Moore, John Reinke, Keith Winegar  
*Honeywell International, United States*

## Microscale Three-Dimensional Hemispherical Shell Resonators Fabricated from Metallic Glass

Michael Kanik<sup>3</sup>, Punnathat Bordeenithikasem<sup>3</sup>, Jan Schroers<sup>3</sup>, Nate Selden<sup>1</sup>, Amish Desai<sup>1</sup>, Dennis Kim<sup>2</sup>, Robert M'Closkey<sup>2</sup>  
<sup>1</sup>Tanner Research, United States; <sup>2</sup>University of California, Los Angeles, United States; <sup>3</sup>Yale University, United States

## Design and Modeling of Micro-glassblown Inverted-wineglass Structures

Doruk Senkal, Mohammed Jalal Ahamed, Andrei Shkel  
*University of California, Irvine, United States*

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10:30 AM - 11:00 AM  
Coffee Break  
Room: Catalina Terrace

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**11:00 AM - 12:00 PM**

**A2L-A: Control Challenges**

**Room: Sand Castle**

**Session Chair:** Earl Benser (Honeywell Corporation)

**Co-Chair:** Diego Serrano (Qualtre)

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**Symmetric Gyroscope Frequency Separation by Geometry and Roughness**

Marc Weinberg

*Draper Laboratory, United States*

**MRIG Frequency Mismatch and Quadrature Control**

David Lynch

*Independent Consultant, United States*

**Control Scheme for a rate integrating MEMS gyroscope**

Stephen Bowles<sup>2</sup>, Barry Gallacher<sup>2</sup>, Zhongxu Hu<sup>2</sup>, Chris Gregory<sup>1</sup>, Kevin Townsend<sup>1</sup>

<sup>1</sup>*Atlantic Inertial Systems, United Kingdom;* <sup>2</sup>*Newcastle University, United Kingdom*

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**12:00 PM - 1:30 PM**

**Lunch**

**Room: Catalina Terrace**

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**1:30 PM - 1:55 PM**

**A3L-A: Invited Talk**

**Room: Sand Castle**

**Session Chair:** Andrei Shkel (University of California, Irvine)

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**An Historical Perspective on Inertial Navigation Systems**

Dr. Daniel Tazartes

*Northrop Grumman Corp., United States*

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**2:00 PM - 3:00 PM**

**A4L-A: Atomic Gyroscopes**

**Room: Sand Castle**

**Session Chair:** Doug Meyer (Northrop Grumman Corporation)

**Co-Chair:** David Johnson (Draper Laboratory)

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**Nuclear Magnetic Resonance Gyroscope**

Michael Larsen, Michael Bulatowicz

*Northrop Grumman Corp., United States*

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**Concept of a miniature atomic sensor**

Paul Hamilton<sup>2</sup>, Matt Jaffe<sup>2</sup>, Justin Brown<sup>2</sup>, Brian Estey<sup>2</sup>, Holger Müller<sup>2</sup>, Robert Compton<sup>1</sup>, Karl Nelson<sup>1</sup>

<sup>1</sup>*Honeywell Aerospace, United States;* <sup>2</sup>*University of California, Berkeley, United States*

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**3:00 PM - 3:30 PM**

**A5P-B: POSTER SESSION Lightning Round - Sensors Phenomena and Modeling**

**Room: Sand Castle**

**Session Chair:** Alexander Trusov (Northrop Grumman Corporation)

**Co-chair:** Randall Jaffe (L3-communication)

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**\*\* Session will be "Lightning Round" Presentations (3 min X 10 posters) in Sand Castle**

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**3:30 PM - 4:00 PM**

**Coffee Break**

**Room: Catalina Terrace**

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**4:00 PM - 6:00 PM**

**A5P-B: POSTER SESSION - Sensors Phenomena and Modeling**

**Room: Sand Castle**

**Session Chair:** Alexander Trusov (Northrop Grumman Corporation)

**Co-chair:** Randall Jaffe (L3-communication)

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**CVGs Utilizing Non-Axisymmetric Structures Operating in Whole-Angle Mode**

David Lynch

*Independent Consultant, United States*

**Design of a 1D and 3D Monolithically Integrated Piezoresistive MEMS High-g Accelerometer**

Robert Kuells<sup>1</sup>, Matthias Bruder<sup>1</sup>, Siegfried Nau<sup>1</sup>, Manfred Salk<sup>1</sup>, Klaus Thoma<sup>1</sup>, Walter Hansch<sup>2</sup>

*<sup>1</sup>Fraunhofer EMI, Germany; <sup>2</sup>University of the German Federal Armed Forces, Germany*

**Investigation of Energy Losses in Different Vibrational Modes of Tactical Grade Micro Gyroscope**

Ohad Zohar<sup>1</sup>, Ronen Maimon<sup>1</sup>, Ofir Vashdi<sup>1</sup>, Yuval Gerson<sup>1</sup>, Hanoach Berko<sup>1</sup>, Slava Krylov<sup>2</sup>

*<sup>1</sup>RAFAEL Advanced Defense Systems Ltd., Israel; <sup>2</sup>Tel-Aviv University, Israel*

**Glass-Blown Pyrex Resonator with Compensating Ti Coating for Reduction of TCF**

Joan Giner, Lorenzo Valdevit, Andrei Shkel

*University of California, Irvine, United States*

**Effect of Annealing on Mechanical Quality Factor of Fused Quartz Hemispherical Resonator**

Mohammed Jalal Ahamed, Doruk Senkal, Andrei Shkel

*University of California, Irvine, United States*

**The Method of Averaging Using an Adaptive Notch Filter in Vibratory Gyroscopes**

Fu Zhang, Ehsan Keikha, R. Max Moore, Roberto Horowitz

*University of California, Berkeley, United States*

**Adaptive Mismatch Compensation for Vibratory Gyroscopes**

Fu Zhang, Ehsan Keikha, Behrooz Shahsavari, Roberto Horowitz

*University of California, Berkeley, United States*

**Electrostatic force correction for the imperfections of the MEMS gyroscope structure**

Huilian Cao, Hongsheng Li, Yunfang Ni, Hongyao Pan

*Southeast University, China*

**Optimization of Orbital Trajectory for Frequency Modulated Gyroscope**

Sergei Zotov, Igor Prikhodko, Brenton Simon, Alexander Trusov, Andrei Shkel

*University of California, Irvine, United States*

**Comparative Analysis of Nuclear Magnetic Resonance and Whole Angle Coriolis Vibratory Gyroscopes**

Igor Prikhodko, Alexander Trusov, Andrei Shkel

*University of California, Irvine, United States*

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**8:00 PM**

**Open Poster Session**

**Room: Sand Castle**

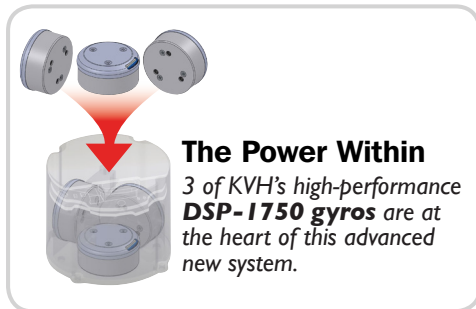
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# Wednesday, February 26, 2014

8:00 AM - 5:00 PM

Registration

8:45 AM - 9:00 AM

Welcome Comments – Andrei Shkel, ISSS 2014 Chair

Room: Sand Castle

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9:00 AM - 9:25 AM

B0L-A: Invited Talk

Room: Sand Castle

Session Chair: Andrei Shkel (University of California, Irvine)

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**Inertial sensors are changing the Games**

Mounir Zok

*United States Olympic Committee, United States*

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9:30 AM - 10:30 AM

B1L-A: Advanced Test and Evaluation

Room: Sand Castle

Session Chair: Kari Moran (Systems Planning Corporation)

Co-Chair: Diego Serrano (Qualtre)

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**A Batch-Mode Assembly and Packaging Technology for 3-Axis Tri-Fold Inertial Measurement Units**

Weibin Zhu, Yafan Zhang, Navid Yazdi

*Evigia Systems Inc., United States*

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**MEMS characterization with Conformal Imaging Vibrometry (CIV)**

James Kilpatrick, Adela Apostol, Vladimir Markov

*Advanced Systems & Technologies Inc., United States*

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10:30 AM - 11:00 AM

B2P-B: POSTER SESSION Lightning Round - Emerging Applications

Room: Sand Castle

Session Chair: David Johnson (Draper Laboratory)

Co-Chair: Chris Painter (Systron Donner)

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**\*\* Session will begin with "Lightning Round" Presentations (3 min X 10 posters) in Sand Castle**

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11:00 AM - 11:30 AM

Coffee Break

Room: Catalina Terrace

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11:30 AM - 1:00 PM

B2P-B: POSTER SESSION - Emerging Applications

Room: Sand Castle

Session Chair: David Johnson (Draper Laboratory)

Co-Chair: Chris Painter (Systron Donner)

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**neMEMSi: One Step Forward in Wireless Attitude and Heading Reference Systems**

Daniele Comotti<sup>2</sup>, Michael Galizzi<sup>2</sup>, Andrea Lorenzo Vitali<sup>1</sup>

<sup>1</sup>STMicroelectronics, United States; <sup>2</sup>Università degli studi di Bergamo, Italy

### **Self-calibration-method for an inertial navigation system with three 3D sensors**

Enrico Köppe<sup>1</sup>, Daniel Augustin<sup>2</sup>, Achim Liers<sup>2</sup>, Jochen Schiller<sup>2</sup>

<sup>1</sup>BAM Federal Institute for Materials Research and Testing, Germany; <sup>2</sup>Freie Universität Berlin, Germany

### **An Open-source Multi Inertial Measurement Unit (MIMU) Platform**

Isaac Skog, John-Olof Nilsson, Peter Händel

*KTH Royal Institute of Technology, Sweden*

### **An Improved Stationary Fine Self-alignment Approach for Strapdown Inertial Navigation Systems using Measurement Augmentation**

Felipe Oliveira E Silva<sup>1</sup>, Waldemar de Castro L Filho<sup>1</sup>, Elder Moreira Hemerly<sup>2</sup>

<sup>1</sup>Ciência e Tecnologia Aeroespacial, Brazil; <sup>2</sup>Instituto Tecnológico de Aeronáutica, Brazil

### **IMU Calibration on a Low Grade Turntable: Embedded Estimation of the Instrument Displacement from the Axis of Rotation**

Alexander Kozlov, Igor Sazonov, Nina Vavilova

*Moscow State University, Russia*

### **Mathematical Modeling of Output Signal for the Correction of the Vestibular System Inertial Biosensors**

Vladimir Aleksandrov<sup>2</sup>, Maribel Reyes Romero<sup>1</sup>, Enrique Soto<sup>1</sup>, Rosario Vega<sup>1</sup>, Tamara

Alexandrova<sup>3</sup>, Dmitriy Bugrov<sup>3</sup>, Anton Lebedev<sup>3</sup>, Stepan Lemak<sup>3</sup>, Katerina Tikhonova<sup>3</sup>

<sup>1</sup>Autonomous University of Puebla, Mexico; <sup>2</sup>Autonomous University of Puebla & Moscow State University, Russia; <sup>3</sup>Moscow State University, Russia

### **A Case Study On Sensors And Techniques for Pedestrian Inertial Navigation**

Alexandre Patarot, Mehdi Boukallel, Sylvie Lamy-Perbal

*Atomic Energy and Alternative Energies Commission, France*

### **A Novel Technique for Extracting Parametric Models from MEM Resonator Test Data**

Thomas Lorentz, Dennis Kim, Robert M'Closkey

*University of California, Los Angeles, United States*

### **Intrinsic Stress of Eutectic Au/Sn Die Attachment and Effect on Mode-Matched MEMS Gyroscopes**

Brenton Simon<sup>2</sup>, Gunjana Sharma<sup>2</sup>, Sergei Zotov<sup>2</sup>, Alexander Trusov<sup>1</sup>, Andrei Shkel<sup>2</sup>

<sup>1</sup>Northrop Grumman Corp., United States; <sup>2</sup>University of California, Irvine, United States

### **Impact of die-attach materials on MEMS Gyro performance**

A. Filipe, Maxime Vincent, V. Volant, C. Kergueris

*TRONICS Group, France*

### **Improvement of Side-wall Roughness in Deep Glass Etched MEMS Vibratory Sensors**

Mohammed Jalal Ahamed, Doruk Senkal, Andrei Shkel

*University of California, Irvine, United States*

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**1:00 PM - 2:30 PM**

**Lunch**

**Room: Catalina Terrace**

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**3:00 PM - 3:25 PM**

**B3L-A: Invited Talk**

**Room: Sand Castle**

**Session Chair:** Andrei Shkel (University of California, Irvine)

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**Inertial Measurement Without Inertial, What Could Go Wrong?**

Dr. William Clark

*Analog Devices, United States*

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**3:00 PM - 4:00 PM**

**B4L-A: Innovative Structural Designs**

**Room: Sand Castle**

**Session Chair:** Barry Gallacher (Newcastle University, UK)

**Co-Chair:** Alexander Trusov (Northrop Grumman Corporation)

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**A 50 Nano-G Resolution Quartz Vibrating Beam Accelerometer**

Raphael Levy, Denis Janiaud, Jean Guerard, Rachid Taïbi, Olivier Le Traon

*ONERA, France*

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**Deformation-robust Gyroscope with 2.0-Hz Frequency Split Variation over Temperature Range of -50 to 150°C**

Daisuke Maeda, Heewon Jeong, Kiyoko Yamanaka, Masahide Hayashi

*Hitachi, Ltd., Japan*

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**Quartz structures for Coriolis Vibrating Gyroscopes**

Jean Guérard, Denis Janiaud, Rachid Taïbi, Raphaël Lévy, Olivier Le Traon

*ONERA, France*

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**4:00 PM - 4:30 PM**

**Coffee Break**

**Room: Catalina Terrace**

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**4:30 PM - 5:10 PM**

**B5L-A: Compensation Techniques**

**Room: Sand Castle**

**Session Chair:** David Lynch (Independent Consultant)

**Co-Chair:** Randall Jaffe (L3-communication)

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**Effect of Stress on Matched-Mode Gyroscope Frequencies**

Erdinc Tatar, Congzhong Guo, Tamal Mukherjee, Gary Fedder

*Carnegie Mellon University, United States*

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**Utilization of Mechanical Quadrature in Silicon MEMS Vibratory Gyroscope to Increase and Expand the Long Term In-Run Bias Stability**

Sergei Zotov, Brenton Simon, Gunjana Sharma, Alexander Trusov, Andrei Shkel

*University of California, Irvine, United States*

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**5:10 PM - 5:50 PM**

**Room: Sand Castle**

**B6L-A: LATE NEWS**

**Session Chair:** Olivier Le Traon (ONERA)

**Co-Chair:** Igor Prikhodko (Analog Devices)

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**Force Rebalance, Whole Angle, and Self-Calibration Mechanization of Silicon MEMS Quad Mass Gyro**

Alexander Trusov<sup>1</sup>, G. Atikyan<sup>1</sup>, D.M. Rozelle<sup>1</sup>, A.D. Meyer<sup>1</sup>, Sergei Zotov<sup>2</sup>, Brenton Simon<sup>2</sup>, Andrei Shkel<sup>2</sup>, <sup>1</sup>*Northrop Grumman Corp., United States;* <sup>2</sup>*University of California, Irvine, United States*

**A Micro Vibratory Stage for On Chip Physical Stimulation and Calibration of MEMS Gyroscopes**

Erkan Aktakka, Jong-Kwan Woo, Daniel Egert, Robert Gordenker, Khalil Najafi  
*University of Michigan, United States*

**Wafer Level Hermetic Encapsulation of MEMS Inertial Sensors using SOI Cap Wafers with Vertical Feedthroughs**

Mustafa Mert Torunbalci, Said Emre Alper, Tayfun Akin  
*Middle East Technical University, Turkey*

**Indoor Positioning Using Wi-Fi Fingerprinting, Pedestrian Dead Reckoning and Aided INS**

Alexey Panyov, Andrey Golovan, Alexey Smirnov  
*Lomonosov Moscow State University, Russia*

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**5:50 PM - 6:00 PM**

**Closing Remarks – Andrei Shkel, ISSS 2014 Chair**

**Room: Sand Castle**