

26th IEEE Workshop on Signal and Power Integrity Conference Program

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Dear colleagues and friends,

It is a great honor for us to chair the 26th IEEE Workshop on Signal and Power Integrity (SPI 2022) at the University of Siegen, Germany. On behalf of the standing committee, we welcome you all to the beautiful historic city of Siegen in the south of North Rhine-Westphalia.

For the third time we are hosting the workshop. Due to the start of the global COVID-19 pandemic in 2020, SPI had to be canceled at very short notice for well-known reasons. Never-theless, the papers that were positively evaluated in the review process could be published in IEEE Xplore[®] Digital Library. Last year, SPI could only be held as an online-only conference. Thus, we are pleased that this year it is possible again to hold SPI - at least partially - as a face-to-face event. However, since attendance by participants from America and Asia continues to be fraught with difficulties, we have opted for a hybrid format. This means that online participation is also possible.

Over the past two decades SPI has become the leading international conference in the field of signal and power integrity, which is confirmed again this year. Participants from three continents are expected and the program offers a balanced selection of topics ranging from modeling over characterization to AI methods.

The technical program will be topped off with tutorials, keynotes and visits to relevant companies and the Quantum Computing Laboratory of the University of Siegen.

Social events were carefully organized in the long-standing tradition of the workshop. Participants will have the opportunity to greet each other at the welcome reception, discover the



Campus US-C »Lower Castle« in the very heart of Siegen. historic city of Siegen, visit a technical museum and enjoy the local cuisine during the conference dinner.

We would like to express our gratitude to the SPI authors as their work is the basis for this conference. Moreover, we are very grateful to the sponsors who support SPI 2022 and of course to our own university, the University of Siegen: Their generous contribution will ensure a very interesting and certainly successful event.

We wish all of you an enjoyable and successful conference!

Elmar Griese and Thomas Kühler / SPI General Chairs

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Sunday, May 22, 2022 Schedule

Sunday, May 22 - Schedule

12:00 Registration Opens (US-C)

13:00 Tutorials Welcome

13:10 Tutorial

High Speed Circuit Design: Image Sensors and Interconnects in 2.5D technology (1) Speaker: Bhaskar Choubey

14:10 Coffee Break

14:50 Tutorial

High Speed Circuit Design: Image Sensors and Interconnects in 2.5D technology (2) Speaker: Bhaskar Choubey

18:00 Historical City Tour

A walking tour of the historic center of Siegen. The Upper Castle stands for the almost 800-year history of Siegen. You will encounter many more testimonies of the past during a walk through the city center.

19:30 Welcome Reception

Join us at the conference center for a special welcome reception this year. After two year of meeting virtually this year's welcome receptions boasts with a nice view at the castle square, a menu with local specialties and a friendly atmosphere.





Sunday, May 22, 2022 Tutorials

Sunday, May 22 - Tutorials

High Speed Circuit Design: Image Sensors and Interconnects in 2.5D technology

The talk will give an overview on design, build and test issues with high-speed analogue circuit design with particular focus to two application domains. We will first explore the rationale, requirements, designs and solutions for high frame rate, high resolution image sensors. Circuits from high-speed pixels to the readout of large dataset will be explored. A typical solution being proposed for these is to design 3D stack of chips. However, this also significantly increases costs. While this is the only solution in multi-pixels systems, a middle of the road 2.5D solution could be beneficial in several other applications. In the second part of the tutorial, we will cover another case study of high-speed, yet low distance interconnects in such 2.5D systems.



Bhaskar Choubey received the B.Tech. degree from the Regional Engineering College, Warangal, India, in 2002, and the D.Phil. degree from the University of Oxford, Oxford, U.K., in 2007. He was an Associate Professor with the University of Oxford and a Lecturer with the University of Glasgow, Glasgow, U.K. He is currently the Chair of the Department of Analog Circuits and Image Sensors, University of Siegen, Siegen, Germany. He is a Fellow of the Institution of Engineering and Technology. He received the IEEE Sensors Council GOLD Early Career Achieve-

ment Award and the Myril B. Reed Best Paper Award from the IEEE Midwest Symposium of Circuits and Systems. He is currently an Associate Editor of the IEEE Sensors Journal. He is author of several books and numerous published articles and gives lectures about sensorics, image sensing, and entrepreneurship at the University of Siegen.



Monday, May 23, 2022 Schedule

Monday, May 23 - Schedule

- 08:00 Company Tour Thomas Magnete GmbH
- 11:00 Registration Opens (US-C)
- 12:00 Lunch (US-C)

13:00 Keynote

Cooperation Between Industry and Acadamia Bernd Buxbaum (Pmdtechnologies AG, CEO)

- 13:40 Technical Session 1: Measurement and Characterization / Power Distribution Networks
- 15:00 Presentation: Keysight Technologies
- 15:15 Coffee Break
- 15:45 Technical Session 2: High Speed Design and Advanced Interconnect Technologies
- 16:25 Presentation: Rohde & Schwarz
- 16:35 Coffee Break
- 16:55 Technical Session 3: Macro-Modeling
- 17:35 IEEE TC-EDMS Meeting

S. Grivet-Talocia



Monday, May 23, 2022 Keynote

Monday, May 23 - Keynote

Cooperation Between Industry and Acadamia

Collaborations between the industry and universities play a crucial role across many industrial sectors and constantly grow in relevancy every year. In today's society, which is strongly driven by technological disruptions, these collaborations become an important factor for economic growth and academic research.

On the one side, universities thrive to diversify their portfolio to create additional value besides the two traditional core missions of research and teaching. By commercializing academic knowledge with new collaboration concepts or through education programs, patenting, technology transfer mechanisms, or incubators, universities can secure new funding for research projects and can offer attractive connections to the industry to their students.

Companies in exchange profit from access to highly qualified human resources, and gain access to advanced research equipment and the latest academic knowledge. The ongoing shortage of talent will increase the importance of these collaborations even further and will lead to new synergies for both universities and companies.

This talk covers those cooperation topics and trends as well as describes the way we go at University of Siegen.



Bernd Buxbaum, was born in Hachenburg, Germany, in 1970. He studied Electrical Engineering at University of Technology Darmstadt and University of Siegen and received his Dipl.-Ing. degree in 1997 followed by the Dr.-Ing. degree at the Center for Sensor Systems at University of Siegen, in 2002. In 2021 he was appointed as a professor at the University of Siegen.

From 1997 to 2001 he worked at the Center for Sensor Systems (ZESS) on the research of 3D Time-of-Flight technology. Prof. Dr.

Buxbaum is the founding CEO of the pmd group of companies in Siegen, Germany and Executive Board Member at the ifm electronic group of companies in Essen, Germany. He is author of several books and numerous published articles and gives lectures about sensorics, image sensing, and entrepreneurship at the University of Siegen.



Monday, May 23, 2022 Technical Sessions

Monday, May 23 - Technical Sessions

- (1) Measurement and Characterization / Power Distribution Networks Chair: Mihai Telescu, Université de Bretagne Occidentale, Brest (FRA)
- 13:40 EMC Issues and Signal Integrity Analysis of Neutron Diagnostics for Nuclear Fusion Machines

A. Maffucci, D. Capriglione, F. Pompili, B. Esposito, D. Marocco, M. Passeri and M. Riva

14:00 Accurate Characterization of Radiation from Interconnects on Interposer at mmWave Frequencies

M. Huynen, D. Bosman, A. Moerman and D. Vande Ginste

- **14:20** Comparison of coplanar waveguide models at millimetre wave frequencies <u>G. N. Phung</u>, U. Arz and W. Heinrich
- 14:40 Board-Level Power Integrity Analysis for Complex High-Speed Printed Circuit Boards

M. Kamran, S. Gul, M. Rizwan, A. Fayyaz and M. Khan Bilal

- (2) High Speed Design and Advanced Interconnect Technologies Chair: Hubert Harrer, IBM Germany Research & Development GmbH (GER)
- 15:45 Feasibility Analysis of Chip-to-Module Channel Operating at 212 Gbps

F. de Paulis, R. Rabinovich, R. Mellitz and M. Resso

16:05 Development of a 1.35 mm Coaxial Blind Mating Interconnect for ATE mmWave Applications

B. Rosas, D. Lam and J. Moreira

(3) Macro-Modeling

Chair: Joana Catarina Mendes, Universidade de Aveiro, Aveiro (PRT)

- **16:55 Vector Fitting of Noisy Frequency Responses via Smoothing Regularization** <u>A. Carlucci</u>, A. Zanco, R. Trinchero and S. Grivet-Talocia
- 17:15 Low-Frequency Modal Extrapolation and Regularization for Full-Band width Macromodeling of Electromagnetic Structures

M. De Stefano, S. Grivet-Talocia, T. Wendt, C. Yang and C. Schuster



Monday, May 23, 2022 Additional Information

Thomas Magnete GmbH

Our vision is: Fluid Control Solutions for a better Life: Healthy, safe and comfortable - our solutions are supposed to make people's lives healthier, safer and more comfortable.

Employing nearly 900 people, our family-owned company develops and manufactures electromagnetic and fluid actuator systems for the automotive and mobile hydraulics industries as well as medical devices. Our mission to support our customers with the products we develop has allowed us to grow into a leading supplier with four international locations in 2022.

We develop and manufacture our products in line with a zero-defects quality philosophy. Our customers include the top names in the automotive industry, leading international manufacturers of vehicles and mobile machinery as well as system suppliers. They have been benefiting for decades now from the advantages offered by our cutting-edge products and relying on the quality and capabilities of high-end solutions.

Key to our success are highly skilled and motivated employees, who are respected and given responsibility at Thomas. The owner family's corporate code stipulates that the welfare of the company, and thus also of its staff, has top priority – Company First.





Tuesday, May 24, 2022 Schedule

Tuesday, May 24 - Schedule

- 09:00 Laboratory Tour Experimental Quantum Optics Chair (University of Siegen)
- 12:00 Lunch (Brasserie)

13:00 Keynote

Quantum Computing using MAGIC Christof Wunderlich (University of Siegen, Germany)

- 13:40 Technical Session 4: Modeling and Simulation and Design Methodology for SI/PI (1)
- 15:00 Coffee Break
- 15:30 Technical Session 5: Modeling and Simulation and Design Methodology for SI/PI (2)
- 17:00 Social Event





Tuesday, May 24, 2022 Keynote

Tuesday, May 24 - Keynote Quantum Computing using MAGIC

Quantum computation, a new paradigm in information science, has the potential to revolutionize information processing. Front runners for the physical realization of qubits are trapped atomic ions. The properties of atomic ions relevant for quantum computing have been studied for decades and have been measured with highest precision. Nature provides always-identical ions making complex fabrication of qubits superfluous.

The interaction between individual ions required for conditional quantum gates can be provided by MAgnetic Gradient Induced Coupling (MAGIC). In such MAGIC ion traps, all quantum gates are controlled solely by radio frequency fields, thus drastically simplifying the apparatus required for controlling ions. Cross-talk between qubits – that can make large scale error correction impossible – has been demonstrated to be smaller than in any other implementation of qubits when using MAGIC. Full control over conditional MAGIC N-qubit dynamics (N>2) allows for faster quantum algorithms as compared to a breakdown into 2-qubit gates [3].

Using a programmable quantum computer based on MAGIC, we carried out, for example, a proof-of-principle demonstration of the deliberation process in reinforcement learning. In addition to outlining the principles of MAGIC with trapped ions, we will report on new paths towards applications of quantum computing.



Christof Wunderlich holds a chair for Experimental Physics (Quantum Optics) at the University of Siegen where he focuses on research into quantum information processing with trapped atomic ions. In 2020 he co-founded eleQtron GmbH, the first German start-up for quantum computer hardware. He has actively shaped numerous excellently evaluated European and German research projects, for example, one of the first European Integrated Projects in quantum information Science

(Qubit Applications). He received a PhD for his research on light-induced molecular potentials in intense laser fields with T. W. Hänsch (Nobel Prize in 2005, Ludwig-Maximilians-Universität and Max-Planck-Institute for Quantum Optics, Munich, Germany). Later, he joined Serge Haroche's group (Nobel Prize in 2012, Ecole Normale Supérieure, Paris, France) and was privileged to participate in cavity quantum electrodynamics experiments on fundamental questions of quantum physics. He did the Habilitation in 2002 developing novel concepts for groundbreaking experiments with trapped ions with P. E. Toschek and W. Neuhauser at Hamburg University.



Tuesday, May 24, 2022 Technical Sessions

Tuesday, May 24 - Technical Sessions

- (4) Modeling and Simulation and Design Methodology for SI/PI (1) Chair: Stefano Grivet-Talocia, Politecnico di Torino, Torino (ITA)
- 13:40 DDR interface modeling and chip decoupling capacitance optimization through jitter simulation

M. Peyrard, G. Jacquemod, D. Marais, X. Duperthuy and N. Froidevaux

14:00 Signal Integrity Assessment of External ESD Protection for Gbit/s Data Rates on Ceramic Test Fixture

T. Wendt, J. E. Hernandez, J. Schuett, C. Yang and C. Schuster

14:20 PCB Laminate Material Out-of-plane Dielectric Constant Extraction Methodology

H. Zhou , W. Zhang

14:40 Active Expansion Sampling of Magnetic Near-Fields in Unbounded Regions N. Seliger, G. Faltlhauser

- (5) Modeling and Simulation and Design Methodology for SI/PI (2) Chair: Antonio Maffucci, University of Cassino and Southern Lazio, Cassino (ITA)
 15:30 Enhanced Magnetic Field Shielding with Metamaterial Hourglass Lens
- 15:30 Enhanced Magnetic Field Shielding with Metamaterial Hourglass Lens D. Sengupta
- 15:50 Passive Modeling of One-Port Networks Through SOS Orthogonal Rational Functions

F. Coronado, A. Engin

16:10 Random jitter analysis for reference clock network in PCIe Gen3

C. Jonguk, R. JongJae, J. Chanyoung, K. K. Joon, J. Youngwoo, Y. Wonsik, K. Wooseok, <u>K. Dongchul</u>, K. Minseok and M. Sungwook

16:30 Bathtub Extrapolation of IBIS-AMI Timing Jitter

L. Bai



Tuesday, May 24, 2022 Social Event

Tuesday, May 24 - Social Event

Technical Museum and Old Town Hotel in Freudenberg

Come and join us on an adventurous journey to the city of Freudenberg in the west of the Siegerland. Freudenberg is best known for its historic old town with its unique, closed half-timbered ensemble. In the "Alten Flecken", as the historic town center is called, more than 80 black and white half-timbered houses are lined up close together, all of which were rebuilt gable-sided to the street after a city fire in the 17th century.

World-renowned mechanical engineering companies were and are at home in the Siegerland. We will explore the Freudenberg Technology Museum, which certainly pays homage to these pioneers – and yet much more! A lively place for old history and young stories, an extracurricular place of learning and an impressive location of South Westphalian industrial culture!

We will conclude the evening at the Old Town Hotel in Freudenberg where we will be indulged with some specialties of the local cuisine during the conference dinner.

The most beautiful vantage point on Freudenberg and the half-timbered houses is from the spa park. This was already created in 1979, when the city was awarded the title "climatic health resort". From there you can enjoy the impressive view of the old town, which can be perfectly used as a postcard motif.

Social Event - Rendezvous Points

- 17:20 Bus leaves at bus stop "Kölner Tor" (Near Sandstr.1, 57072 Siegen)
- 17:30 Bus leaves at Holiday Inn Express hotel (Koblenzer Str. 115, 57072 Siegen)
- 18:00 Technical Museum Freudenberg (Olper Str. 5, 57258 Freudenberg)

20:00 Diner at "Altstadthotel Freudenberg" (Oranienstr. 41, 57258 Freudenberg)





Wednesday, May 25, 2022 Schedule + Keynote

Wednesday, May 25 - Schedule

12:00 Lunch (Brasserie)

13:00 Keynote

Managing Heat with Diamond: the Example of Diamond/GaN HEMTs Joana Catarina Mendes (University of Aveiro, Portugal)

- 13:40 Technical Session 6: Design Support by Machine Learning and AI / Stochastic Analysis and Uncertainty Quantification (1)
- 14:40 Presentation: Dassault Systèmes
- 14:50 Coffee Break
- 15:20 Technical Session 7: Design Support by Machine Learning and AI / Stochastic Analysis and Uncertainty Quantification (2)
- 16:20 Closing Ceremony

Keynote

Managing Heat with Diamond: the Example of Diamond/GaN HEMTs

The thermal management of electronic components has become a requirement transverse to several applications. Operation at high temperatures impairs the components reliability and may be accompanied by an increase of the electrical resistance, resulting in higher losses. Different techniques can be used to promote the transfer of heat from the active regions in a device to the package, where it can be ultimately dissipated to the heat sink or external environment. One of the possibilities is the use of materials with high thermal conductivity within the package itself, as a substrate material or as a chip-carrier. Due to its breakdown electric field and thermal conductivity, diamond can be considered the ultimate thermal management material; it is available in the form of plates and can be deposited on non-diamond substrates, which allows for different possibilities of integrating it within a package. As an example, the use of diamond to promote the removal of heat from GaN HEMTs will be described and the different integration steps presented. The integration of diamond and GaN HEMTs is a success case; power amplifiers based on GaN-on-diamond wafers are already commercially available, attesting the potential and feasibility of integrating diamond and power components.



Joana Catarina Mendes received her Dipl.-Ing. and Dr.-Phys. degrees from the University of Aveiro, Portugal in 1998 and 2006, respectively. From 2006 to 2012, she was a researcher at the Nanotechnology Research Division in the Mechanical Engineering Department at the same University, where she worked with carbon-based nanostructured material composites and diamond films for tribological applications. Since 2012 Dr. Mendes works as a researcher in the Institute of

Telecommunications. Her current interests are centered in the use of diamond films to improve the thermal management of high-power high temperature electronic components and in sensing applications. Dr. Mendes has participated in several national and international research projects, both as Principal Investigator and team member. She is the author or co-author of more than 50 journal and international conference papers and 6 book chapters. She is a permanent member of WOCSDICE Steering Committee.



Wednesday, May 25, 2022 Technical Sessions

Wednesday, May 25 - Technical Sessions

 Design Support by Machine Learning and AI / Stochastic Analysis and Uncertainty Quantification (1)

Chair: Christian Schuster, Hamburg University of Technology, Hamburg (GER)

13:40 Worst-Case Optimization of a Digital Link for Wearable Electronics in a Stochastic Framework

M. Telescu, R. Trinchero, I. S. Stievano and N. Tanguy

- **14:00 Channel Inverse Design Using Tandem Neural Network** H. Ma, E.-P. Li, Y. Wang, B. Shi, J. Schutt-Ainé and X. Chen
- 14:20 Parametric S-Parameters for PCB based Power Delivery Network Design Using Machine Learning

M. Schierholz, I. Erdin, J. Balachandran, C. Yang and C. Schuster

- ⑦ Design Support by Machine Learning and AI / Stochastic Analysis and Uncertainty Quantification (2)
 Chair: Thomas Kühler, University of Siegen, Siegen (GER)
- 15:20 Estimation of PSIJ in CMOS inverters via Knowledge Based Artificial Neural Networks <u>A. Javaid</u>, R. Achar and J. Tripathi
- 15:40 Application of Neural Network Based Cascade-able Transceiver Model in

 Serial Link Simulation

 Y. Zhao, T. Nguyen and J. Schutt-Ainé
- 16:00 A Machine Learning based Metaheuristic Technique for Decoupling Capacitor Optimization H. Vaghasiya, A. Jain



Thursday, May 26, 2022 IBIS Summit

Thursday, May 26 - IBIS Summit

The IBIS Open Forum is pleased to announce a virtual IBIS Summit meeting following the 26th IEEE Workshop on Signal and Power Integrity on Thursday, May 26, 2022. This is the 24th IBIS Summit associated with events in Europe.

This virtual IBIS Summit is intended to promote exchanges of ideas and methods among user and developers of IBIS models as well as the IEEE EPS and EMC Society members. Those interested in presenting at or in attending the virtual event may register using the information below. We encourage IBIS Summit participants to also attend the 26th IEEE Workshop on Signal and Power Integrity.

The meeting is free and open to everyone. We look forward to seeing you online! Randy Wolff / Chair, IBIS Open Forum People involved in IBIS or related signal integrity and/or power integrity model development or EDA tool development as well as the IEEE EPS and EMC Society members and SPI 2022 attendees are invited to participate.

For further information with respect to registration, participation, presentation or agenda please refer to the according websites: www.ibis.org, www.spi-conference.org