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NCCAVS 2020 Technical Symposium

The Quantum World

Hosted by: CMPUG, JTG, PAG, and TFUG
Held in conjunction with the 41st Annual NCCAVS Equipment Exhibition and the NCCAVS 9th Annual Student Poster Session

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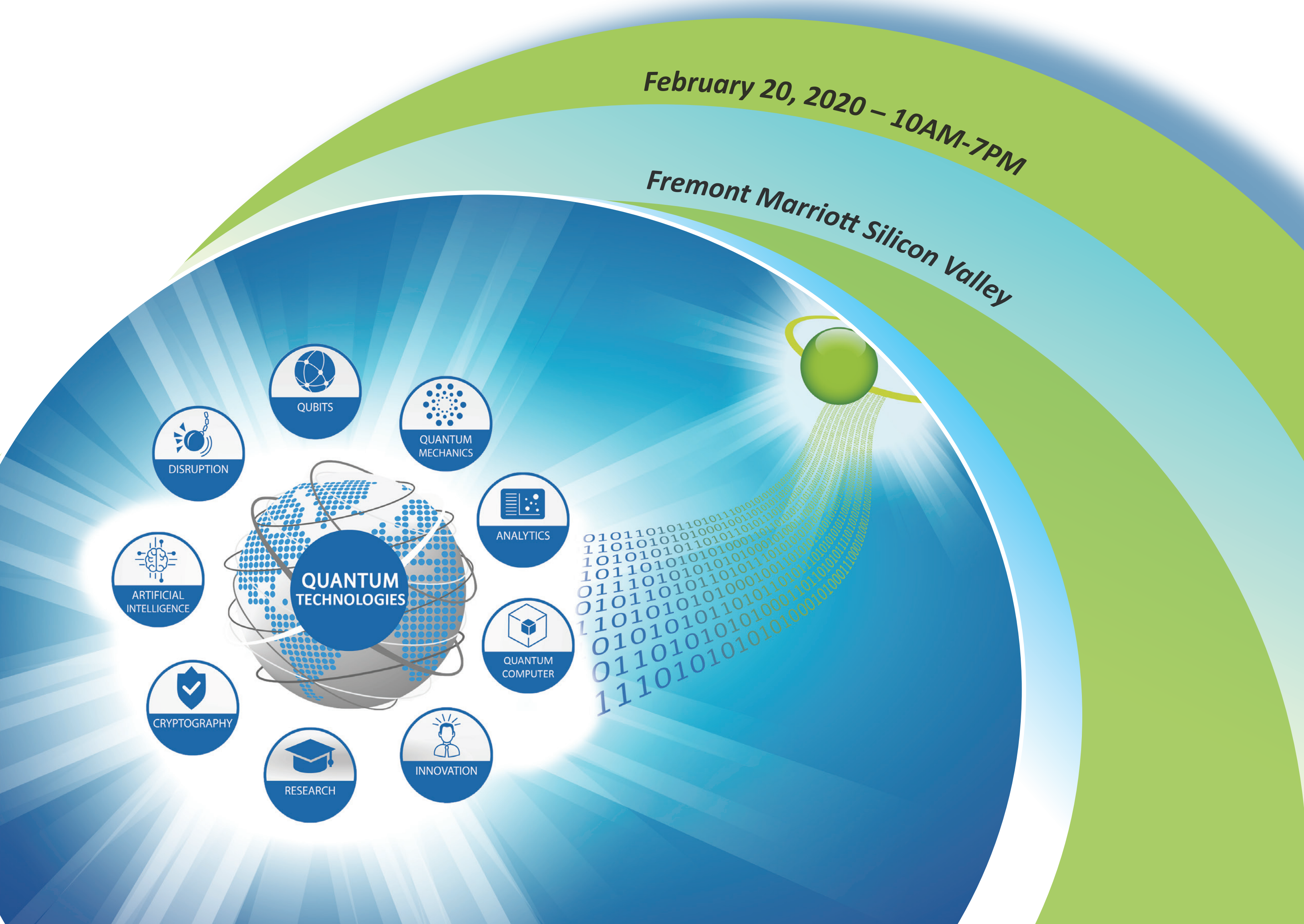
February 20, 2020 – 10AM-7PM

Fremont Marriott Silicon Valley



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Mbar	

Agenda at a Glance

Northern California Chapter of the American Vacuum Society 2020 Technical Symposium

The Quantum World

9:45am	**Welcome and Introductions** Zoran Misetic, Director of Global Business Development, Kurt J. Lesker Company

Session 1: Quantum Computing

Session Co-Chairs: Lucia Feng, Jacques Matteau

10:00am	**Plenary Talk – Modeling Systems with Quantum Computers** Rudy J. Wojtecki, Ph.D., Research Staff Member & IBM Q Ambassador, IBM Research – Almaden
10:45am	**Optimizing Quantum Optimization Algorithms for Noisy Quantum Computers** Davide Venturelli, Ph.D., Associate Director, Quantum Computing at USRA Research Institute for Advanced Computer Science
11:15am	**Enterprise Software to Accelerate the Quantum Revolution** Chris Brown, Ph.D., Director of Quantum Solutions, Zapata Computing, Inc.
12:00pm	**Lunch in the Exhibit Hall (while supplies last)**

Session 2: Quantum Technology

Session Co-Chairs: Mayu Yamamura, Paul Werbaneth

1:30pm	**Plenary Talk – Materials Engineering for Quantum Information Technology** Robert Jan Visser, Ph.D., Vice President CTO Group, Applied Materials
2:15pm	**Introduction of a New Technology Platform to Enable Scalable Fabrication of Single Silicon Vacancy Defect Arrays** Andre Linden, Director of International Business Development, Sales Manager and Applications Scientist, Raith America, Inc.
2:45pm	**Thin Film Fabrication of Quantum Upconverting Sensors for Dark Matter Detection** Dale Li, Ph.D., SLAC National Accelerator Laboratory, Stanford University
3:15pm	**Afternoon Break in the Exhibit Hall**

Session 3: More Quantum Technology

Session Co-Chairs: Daphne Pappas, Paul Werbaneth

3:30pm	**Cryogenic Device Testing and Quantum Protocol Design for Quantum Upconverting Sensors Below 300 MHz** Stephen Kuenstner, SLAC National Accelerator Laboratory, Stanford University
4:00pm	**Superconducting Quantum Coherent Circuits: Introduction, Challenges, and Near-Term Applications** John Mark Kreikebaum, Lawrence Berkeley National Laboratory & Department of Physics, University of California Berkeley
4:30pm	**Student Poster Session**

Agenda

9:45am **Welcome and Introductions**

Zoran Misetic
Director of Global Business Development, Kurt J. Lesker Company

Session 1: Quantum Computing

Session Co-Chairs: Lucia Feng, Jacques Matteau

10:00am **Plenary Talk – Modeling Systems with Quantum Computers**

Rudy J. Wojtecki, Ph.D.
Research Staff Member & IBM Q Ambassador, IBM Research – Almaden

Abstract
The physical realization of multiqubit quantum computers (QCs) are extremely challenging as it requires the ability to control, manipulate and accurately measure an element exhibiting a quantum behavior. Recent work has demonstrated this with superconducting transmon qubits, which behave like artificial atoms capable of accessing properties such as superposition and entanglement but are macroscopic in size and composed of a circuit that can be fabricated using existing semiconductor methods. While efforts to improving the quality of these devices have yielded progress to providing more powerful quantum computers capable of addressing more and more complex problems. While these QCs are a nascent technology, even on a system composed of 6 qubits IBM reported the development of software and uses the unique QC hardware that enabled the accurate modeling quantum systems H_2, LiH and BeH_2. Furthermore, the use of QC in a variety of simulations have been demonstrated that have implications in machine learning as well as artificial intelligence. As QC systems scale, the ability to simulate increasingly complex, and more useful, quantum systems will be realized. This talk will provide an introduction to QC hardware and the ability to exploit these systems in modeling complex systems.

10:45am **Optimizing Quantum Optimization Algorithms for Noisy Quantum Computers**

Davide Venturelli, Ph.D.
Associate Director, Quantum Computing at USRA Research Institute for Advanced Computer Science

Abstract
Noisy, Intermediate-Scale, Quantum (NISQ) Computing Devices are inherently imperfect, resource-constrained machines. As empirical research is becoming a prominent tool to advance the field of quantum optimization, it is of utmost importance to find ways to squeeze the maximum potential out of each device in order to detect signals of quantum speedup and inform future designs. This is particularly important in parametric, variational approaches where there is no strong theoretical guidance, such as in quantum annealing or quantum approximate optimization algorithms. In the talk we introduce and formalize important problems in terms of compilation of quantum algorithms and parameter setting strategies of such algorithms, in both the quantum digital and analog setting. We discuss the relationship between benchmarking and efficient low-level representation of the hybrid quantum-classical computational strategy. These considerations are important for the design of software toolchains. We will present examples from the research of the Quantum AI Laboratory at NASA Ames Research Center.

11:15am **Enterprise Software to Accelerate The Quantum Revolution**

Chris Brown, Ph.D.
Director of Quantum Solutions, Zapata Computing, Inc.

Abstract
Quantum computers, and specifically gate model quantum computers, utilize the quantum properties of matter to allow for massive parallelization of certain calculations. This capability enables these machines to perform calculations that are impossible to do in polynomial (practical) time frames with traditional digital computers. This capability will have profound implications for understanding chemical reactions, the exact nature of physical phenomena and will allow for much more robust machine learning and artificial intelligence than are possible with classical computers. In turn, the implications for national security, energy security, financial markets, human health and other areas are not to be underestimated. Recent legislation and administrative action have underlined the strategic nature of quantum computing to national interests. Recent proof-of-concept demonstrations of quantum algorithms for chemistry, machine learning, finance, cryptography, and other applications represent profound milestones in the quantum computing revolution. The next steps on the pathway towards creating value from quantum computers require a deeper analysis, including rigorous resource assessments for practical use cases, systematic device benchmarks, and apples-to-apples comparisons to

state-of-the-art classical methods. Conventional approaches to such analysis are often time consuming because of the challenges associated with deployment, data management, reproducibility, and framework interoperability. We will discuss how Zapata is addressing these challenges.

12:00pm **Lunch in the Exhibit Hall**

Session 2: Quantum Technology

Session Co-Chairs: Mayu Yamamura, Paul Werbaneth

1:30pm **Plenary Talk – Materials Engineering for Quantum Information Technology**

Robert Jan Visser, Ph.D.
Vice President CTO Group, Applied Materials

Abstract
After a brief introduction into Quantum Information Systems, discussing the opportunities for Quantum based systems for computing, communicating and sensing. We will discuss the different approaches which have been taken in the field. At Applied Materials we do not make complete systems but are working with systems integrators like Quantum Computing Companies to improve the quality of their devices. Of the many approaches we concentrate on solid state devices. Challenges for equipment and processes for quantum devices will be discussed.

2:15pm **Introduction of a New Technology Platform to Enable Scalable Fabrication of Single Silicon Vacancy Defect Arrays**

Andre Linden
Director of International Business Development, Sales Manager and Applications Scientist, Raith America, Inc.

Abstract
Quantum computing holds promise to vastly accelerate computation by using quantum bits (qubits) instead of classical, digital bits. For the realization of the qubit, a fundamental building block of the quantum computer, there are several competing technologies presently garnering significant investments around the world. These technologies include trapped ions, superconducting qubits, silicon quantum dots, topological qubits, as well as vacancy color centers. A vacancy color center is a source of stable and coherent single photons, a key ingredient to realizing a solid-state qubit operating at room temperature. The quantum spin state of this system can be manipulated by electric and magnetic fields and microwaves.

The limited brightness of the nitrogen vacancy center has motivated the

exploration of alternative types of color centers, specifically the Group IV color centers, such as SiV. There are techniques, like electron or neutron irradiation, for generating vacancy color centers, but either the positioning within the device is not well-controlled or patterned resist masks are required. An alternative approach is mask-less ion implantation with focused Silicon ion beams deterministically positions Silicon color centers with nanometer-level accuracy.

In this talk we present a new technology platform that paves the way for scalable fabrication of single silicon vacancy defect arrays. We have developed a stable, focused Silicon ion beam embedded in a true lithography architecture that is complemented by a highly accurate laser interferometer stage and the advanced beam control of Raith's powerful pattern generator and software. We report on the core ingredients required for accurately controlled, mask-less Silicon ion implantation on wafer-scale with positional control in the nanometer range and full support of chip-alignment strategies.

2:45pm **Thin Film Fabrication of Quantum Upconverting Sensors for Dark Matter Detection**

Dale Li, Ph.D.

SLAC National Accelerator Laboratory, Stanford University

Abstract

The coupling of light radiation with a mechanical oscillator has birthed the vibrant field of cavity optomechanics and enabled Nobel Prize winning work such as LIGO. The ability to manipulate and enhance mechanical modes with light through upconversion has been a powerful tool in the advancement of our understanding of quantum mechanics. Using vacuum deposition systems, we can fabricate superconducting circuits and nonlinear Josephson junctions to create an analogous upconverter between a radio frequency electrical resonator and a microwave cavity. The same physics applies but for very different end goals. Dark Matter detection is currently one of the most important scientific objectives. Unfortunately, no direct detection has been made with current detectors and sensors. Building a new class of dark matter detector with these quantum upconverting sensors will enable much higher sensitivity to look for dark matter in unexplored regions.

3:15pm **Afternoon Break in the Exhibit Hall**

Session 3: More Quantum Technology

Session Co-Chairs: Daphne Pappas, Paul Werbaneth

3:30pm **Cryogenic Device Testing and Quantum Protocol Design for Quantum Upconverting Sensors Below 300 MHz**

Stephen Kuenstner

SLAC National Accelerator Laboratory, Stanford University

Abstract

Quantum mechanical measurement protocols such as squeezing and photon counting have revolutionized precision electromagnetic measurements at frequencies above a few GHz. These protocols enhance the science potential of precision fundamental physics experiments, especially the search for QCD axions near 1 μeV. However, at lower frequencies below ~300MHz, relatively little work has been done to demonstrate and develop the sensors and measurement protocols needed for quantum measurement. Developing such sensors would improve the science potential of lower-mass axion searches. One approach to quantum measurements at low frequencies is to upconvert the lower-frequency signal using a carrier at several GHz. We describe the testing and development of thin-film superconducting Josephson junction-based circuits specifically designed to carry out quantum upconversion protocols including SQL-evading electromagnetic measurements, sideband cooling, and two-mode squeezing. Device testing in cryogenic vacuum systems, and development of custom quantum protocols will be discussed.

4:00pm **Superconducting Quantum Coherent Circuits: Introduction, Challenges, and Near-Term Applications**

John Mark Kreikebaum

Lawrence Berkeley National Laboratory & Department of Physics, University of California Berkeley

Abstract

Quantum bits (qubits) are an example of coherent circuits envisioned for next-generation computation. The transmon, one type of superconducting qubit, is a promising architecture for quantum computing due to its high coherence and design flexibility. In this talk, I will describe how to design, fabricate, manipulate, and readout transmons, a field known as circuit quantum electrodynamics (cQED). I will also highlight the status of current experimental implementations and discuss challenges both resolved and open. Last, I will introduce some near-term applications for these circuits such as single microwave photon detection: a difficult task due to the 4-5 orders of

magnitude smaller energies of photons at this frequency compared to optical photons, which can already be individually resolved with commercially available sensors.

4:30pm **Student Poster Session**

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NCCAVS 9th Annual Student Poster Session

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Saba Hussain, Universities Space Research Association
Susan Felch, Susan Felch Consulting
Wenonah Vercoutere, NASA Ames Research Center

Electronics/Sensors (ES)

ES1. **Electro Plasmonic Nanoantenna Array: Label Free Neurophotonics for Ultrahigh Bandwidth Brain Machine Interface**
Ahsan Habib, Xiangchao Zhu, Uryan I. Can, Maverick L. McLanahan, Pinar Zorlutuna, and Ahmet A. Yanik, UCSC

ES2. **Developing Nanopore Technology for Detecting Biomarkers On Ocean World Planets**
Zeal Panchal, Michael Oye, David Deamer, and Wenonah Vercoutere, UCSC, NASA, USRA

ES3. **Stretchable Electrically Conductive Adhesives in Wearable Device Applications**
Nicole Dermenjian and Andrew Nguyen, SJSU

ES4. **3D Nanocarbon Interconnects**
Yu Zheng, Parth Shah, Dongmeng Li, and Cary Y. Yang, SCU

ES5. **Investigating Limitations of Inkjet and Screen Printed Electronic**
Vy Huynh, SJSU

ES6. **Diffusion Rate of Silica Coated Nanodiamonds for Cancer Cell Tracking**
Nedah Basravi, Karen Lopez, Folarin Erogbogbo, and Abraham Wolcott, SJSU

Materials Characterization (MC)

MC1. **Doped Colloidal Germanium Quantum Dots: Structural Disorder and Electronic Properties**
Heather Renee Sully, Katayoon Tabatabaei, Kathryn A. Newton, Logan Knudson, Shayan Zargar, Susan M. Kauzlarich, Frank Bridges, and Sue A. Carter, UCSC

MC2. **Characterizing Surface Chemistry and Bulk Material Properties of Cardiovascular Biomaterials After Sterilization**
Danny Do, Vanessa Aldaz, Brianna Felix, and Patrick Jurney, SJSU

MC3. **Effects of E-beam Sterilization on Implantable Electronic Devices**
Eugenia Mora, Anish Sharma, and Rohan Aurora, SJSU

MC4. **Mathematical Correlation Between Pressure and Centrifugal Forces In a Microfluidic Lab On a Chip**
Nicholas Sosa, SJSU

Processing/Manufacturing (PM)

PM1. **Optimization of Electrolyte Printing and Passivation Method in an All-Printed Supercapacitor**
Ellie Sadatian, UCSD

PM2. **Manufacturing Cylindrical PVA Grafts for Arterial Bypass Surgeries**
Harsimran Hothi, Colby Loop, and Sneha Srinivasan, SJSU

PM3. **Improving the Hemocompatibility of BMHVs with the Application of a Superhydrophobic Coating**
Esther Lopez, Leeya Mengistab, Pourya Bayzaie, and Alessandro Bellofiore, SJSU

PM4. **Characterization of Thin-Film, Flexible Piezoelectric Material in Prosthetic Applications**
Julie Lo and Rabia Shaheen , SJSU

PM5. **Fibrin Droplet Production Using Step Emulsification**
Priyanka Sreeram, Tomas Jimenez , and Melinda Simon, SJSU

PM6. **In-House Pyrolytic Carbon Coating Procedure for Prototyping of Bileaflet Mechanical Heart Valves**
Dhanya Duraivelu, Rafic Roy Hasbini, and Thant Mon Thiri, SJSU

Biomedical Devices (BD)

BD1. **Silicone Infant Hand Prosthesis via 3D Printed Mold**
Andrew Johnson, Navpreet Singh, and Angelina Villa, SJSU

BD2. **Infant Hand Prosthesis with TPE Shell**
Nicole Brown, Bradley Filgas, Stephanie Phan, and Jared Lumauig, SJSU

BD3. **Smart Manufacturing**
Duong Tran, SJSU

BD4. **Novel Load-Bearing Transradial Prosthesis**
Garrett Wiggs, Raychell Ramirez, Antonie Vo, and Matthew Leineweber, SJSU

BD5. **Acoustic Hyperlens**
Julia Son-Bell and Steffi Anaya, SJSU

BD6. **A Novel Improvement in Cardiac Anchor Design for Dilated Cardiomyopathic Patients**
Jasper Mak, Raja H. Khan, and Maritza Fuerte, SJSU

BD7. **Premature Infant Positioning Tool**
Jane Bercilla, Kezia Joy Ugay, and Stanley Wang, SJSU

BD8. **Intelligent Robotics in Medicine**
Ryan Oquendo, Tung Chi Chan, and Nicolai Steifel, SJSU

BD9. **Analyzing the Effect of Test Duration on Energy Expenditure Accuracy of Wearable Devices**
Jonathan Delos Reyes, Quynh Nguyen, and Tanisha Shah, SJSU

Biomedical Electronics (BE)

BE1. **Knee Flexion Sensor and Biofeedback Unit**
John Nguyen, Angelica Polo, and Nam Tran, SJSU

BE2. **Health Intervention for Minority Males (HIMM) App**
Health Intervention for Minority Males (HIMM) App, SJSU

BE3. **Toe Clearance Biofeedback Device**
Karla Markotic, Azita Patel, and Manal Ahmed, SJSU

BE4. **IIoT & Data Sciences in Additive Manufacturing**
Rory Coles, SJSU