



UGIM 2016 SYMPOSIUM
University of Utah
June 12-15, 2016

University
Government
Industry
Micro/Nano Technology

International Symposium on Research Cleanroom Operations

PROGRAM GUIDE







UGIM 2016

21st UGIM 2016

University • Government • Industry
Micro/Nanotechnology Symposium

Program Guide

University of Utah
Salt Lake City, Utah

June 12th-15th, 2016

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UGIM Mission Statement

The mission of the biennial UGIM Symposium is to bring together leading educators and researchers from university, government and industry around the world to promote the various exciting fields of micro/nanotechnology. Representatives of university micro/nano fabrication facilities, ranging from new labs to nationally recognized facilities, have found this symposium an excellent forum for exchanging information and presenting new research and educational concepts. Government agencies such as NSF, NIH, NIST, SEMATECH, SRC, DoD and ONR have participated with research papers and updates on funding opportunities. Industry interactions with universities, including technology transfer, collaborative research, and training efforts are frequently presented. This is a signature opportunity for those involved in the field of micro/nanotechnology or in the operation of micro/nano cleanroom facilities.

Welcome to UGIM 2016

We appreciate the vendors and exhibitors who not only provide valuable educational and training resources for keeping us on top of developments in the field, but also for their generous sponsorship of our conference that makes it affordable for colleagues to attend from all over the world. Also as a result of sponsorships, we will enjoy multiple social networking opportunities to share best practices with our peers at an IMFT-sponsored dinner and tour at their world-class 300mm wafer fab in Lehi, UT (which will soon be manufacturing the disruptive new XPoint memory technology), an evening canyon train ride, as well as our banquet in the mountains. Thank you for supporting us in our experiment to provide 50-min detailed, non-commercial, educational workshops by topical experts and vendors.

Looking forward to meeting all of you in Salt Lake City!

*Ian R. Harvey, Ph.D.
Associate Director, Utah Nanofab
Chair, UGIM '16, Salt Lake City*



UGIM Steering Committee

Chair: Greg Cibuzar, University of Minnesota
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Ian Harvey
John Shott

A. William Flounders, University of California, Berkeley
Julia Aebersold, University of Louisville
Gary Spinner, Georgia Institute of Technology
John Weaver, Purdue
Vicky Diadiuk, Massachusetts Institute of Technology
David Dickensheets, Montana State University
Phil Himmer, Montana State University
Noah Clay, University of Pennsylvania
Iulian Codreanu, University of Delaware
Aaron Hawkins, Brigham Young University
Dan Christensen, University of Wisconsin

Keynote Speakers



Dr. Lawrence S. Goldberg

Lawrence S. Goldberg was born in St. Louis, Missouri. He received his B.S. degree in Engineering Physics from Washington University in 1961, and his Ph.D. degree in Solid State Physics from Cornell University in 1966. From 1966-67, he spent a postdoctoral year at the Physikalisches Institut, Universität Frankfurt, Germany. From 1967-1985, he was with the Naval Research Laboratory as research physicist in the Optical Sciences Division where his research interests were in ultrashort pulse lasers and nonlinear optics. During 1976-1977, he was on sabbatical leave at Imperial College, London, England. Dr. Goldberg came to the National Science Foundation in 1985, where he

currently is Senior Engineering Advisor in the Division of Electrical, Communications and Cyber Systems, Directorate for Engineering. He served previously as Division Director, and earlier as Program Director in areas of quantum electronics, optics, plasmas, and electromagnetics. In the summer of 1989, he served as Acting Head of the NSF Office in Tokyo, Japan. In 1995, he was appointed by the President's Science Advisor to the interagency management committee for the U.S.-Japan Joint Optoelectronics Project. He served in 2005 as U.S. Embassy Science Fellow in Chisinau, Moldova, where he worked in close cooperation in an advisory role with the President of the Academy of Sciences of Moldova. He has since participated in U.S. government-level science studies in Ukraine, Kazakhstan, and Romania. At NSF, Dr. Goldberg provided oversight for the National Nanotechnology Infrastructure Network (NNIN). He currently is lead program officer and has guided the competition for the newly established National Nanotechnology Coordinated Infrastructure (NNCI), as successor to the NNIN. He has coordinated joint activities on nanoelectronics with the Semiconductor Research Corporation, conducted under NSF's emphasis area on Nanoscale Science and Engineering. He led federal agency funding for the 2012 National Academies study on Optics and Photonics: Essential Technologies for Our Nation. He serves as NSF member of the interagency Wireless Spectrum Research and Development Senior Steering Group, and represents the Engineering Directorate on the NSF program Enhancing Access to the Radio Spectrum (EARS). He also coordinates the Major Research Instrumentation (MRI) program for the Engineering Directorate. Dr. Goldberg is Fellow of the Optical Society of America, and Fellow of the Institute of Electrical and Electronic Engineers.



John Shott

John Shott received three degrees from Stanford University in Electrical Engineering between 1972 and 1978. He then spent the remainder of his career at Stanford in clean room settings in the Integrated Circuits Laboratory, the Center for Integrated Systems, and the Stanford Nanofabrication Facility (SNL).

His focus during much of that time was on the technology, equipment, and facilities required to meet the research needs of a broad community of researchers.

He has recently retired, but is staying active in the university cleanroom community. John is currently the Emeritus Director of Technology at SNL.

Russ Meyer

Russ Meyer has spent 20 years working at Micron Technology supporting advanced development and manufacturing programs. His experience spans many technology nodes across DRAM, NAND, and most recently 3D XPoint. He is currently working as Director of Process Integration for the 3D-XPoint development with the responsibility to manage the Micron side of a joint development program with Intel. Prior to his current role he was the Director of the NAND technology development program, spanning several planar nodes and the startup of Micron's Vertical NAND technology. He has also served as integration manager for Micron's 300mm silicon transition as well as several DRAM technology nodes. He graduated with an M.S. in Engineering Physics from North Dakota State University in 1995.

Historical UGIM Host Institutions

1 st *	1975	University of Cincinnati
2 nd	1977	University of South Florida
3 rd	1979	Texas Tech University
4 th	1981	Mississippi State
5 th	1983	Texas A&M
6 th	1985	Auburn University
7 th	1987	Rochester Institute of Technology
8 th	1989	M2C Marlborough Massachusetts
9 th	1991	Florida Institute of Technology
10 th	1993	Research Triangle Park
11 th	1995	University of Texas Austin
12 th	1997	Rochester Institute of Technology
13 th	1999	University of Minnesota
14 th	2001	Virginia Commonwealth University
15 th	2003	Boise State University
16 th	2006	San Jose State University
17 th	2008	University of Louisville
18 th	2010	Purdue University
19 th	2012	University of California Berkeley
20 th	2014	Harvard University

*Numbering based on extant proceedings. Please notify the host of any earlier meetings.

UGIM Program Sunday, June 12, 2016

Location: Sorenson Molecular Biotechnology Building (SMBB), 2nd floor atrium and James L. Sorenson Auditorium (Room 2650)

Address: 36 S. Wasatch Dr., Salt Lake City, UT, 84112

Time	Room	SUNDAY, JUNE 12, 2016
8:00am - 11:00am	Auditorium	NNCI Coordination Meeting: Oliver Brand – GA Tech, Coordinator
11:00am - 6:00pm	Atrium	UGIM CHECK-IN & Registration
11:00am - 12:00pm	Auditorium	Introduce new facilities and first-time UGIM attendees: A. William Flounders - UCB
12:00pm - 1:00pm	Atrium	Lunch and Mingle
12:00pm - 1:00pm	Boardroom	UGIM Executive Committee meeting
1:00pm - 2:15pm	Auditorium	Bootie Camp - Cleanroom Management: Julia Aebersold - Louisville, Gary Spinner – GA Tech
2:15pm - 2:30pm	Atrium	Break
2:30pm - 3:45pm	Auditorium	Bootie Camp - Safety & Environmental: John Weaver - Purdue (Chair), Greg Cibuzar - UMin, Dennis Schweiger - UMich, Mary Tang - Stanford
3:45pm - 4:00pm	Atrium	Break
4:00pm - 5:00pm	Auditorium	Open Source Cleanroom Management: Ryan Taylor – UofU (Host), Danny Pestal - UCB, Tom Lohman - MIT, Vicky Diadiuk - MIT, Dennis Grimard - MIT
5:00pm - 7:30pm	Atrium & adjacent Utah Nanofab	Reception & Utah Nanofab station-based tours Fab equipment swap meet (SMBB 2660)

UGIM Program Monday, June 13, 2016

Location: Tower at Rice-Eccles Stadium

Address: 451 South 1400 East, Salt Lake City, UT 84112

Time	Room	MONDAY, JUNE 13, 2016
8:00am - 8:15am	Level 6	Opening Remarks
8:15am - 9:15am	Level 6	UGIM survey results: Who are we? Tom Ferraguto - UMass-Lowell Robert Hower - UMich, Susan Anson - KIT
9:15am - 9:45am	Levels 4 & 5	Morning Break
9:45am - 11:15am	Level 6	Keynotes Lawrence Goldberg - National Science Foundation John Shott - SNF Director of Technology Emeritus
11:15am - 12:45pm	Levels 4 & 5	Working Lunch - Topics by table (organized by David Dickensheets and Phil Himmer - MSU)
12:45pm - 1:15pm	Level 6	Debriefing Session David Dickensheets, Phil Himmer - MSU Facilitators discuss topics from tables
1:15pm - 2:15pm	Level 6	Financial Management Panel: Noah Clay - UPenn, Moderator Panelists: Lawrence Goldberg, John Shott, Tom Ferraguto, Robert Hower, Susan Anson, Kevin Walsh - Louisville
2:15pm - 2:45pm	Levels 4 & 5	Afternoon Break
2:45pm - 3:45pm	Level 6	Safety Panel: John Weaver - Purdue, Moderator Greg Cibuzar -UMinn, Dennis Schweiger - UMich, Mary Tang - Stanford
Time	Location	MONDAY EVENING, JUNE 13, 2016
4:00pm - 7:30pm	IM Flash - Lehi, UT	IM Flash Sponsored Dinner Keynote: Russ Meyer - Director of Process Integration Board buses at the front of the stadium by 4:00pm The buses will be at the dinner by 5:30pm
7:30pm - 9:30pm	Heber City, UT	Heber Valley Railroad Ride Board buses at 7:30pm to train at Vivian Park Return to hotel* between 9:30-10:30pm

*Bus will make a circuit to UofU Guest House, Research Park Marriott and Downtown SLC.

UGIM Program

Tuesday, June 14, 2016

Location: Tower at Rice-Eccles Stadium

Address: 451 South 1400 East, Salt Lake City, UT 84112

Time	Room	TUESDAY, JUNE 14, 2016
8:00am - 10:00am	Level 6	Tool Selection: Iulian Codreanu – UDel, Session Chair
10:00am - 10:30am	Levels 4 & 5	Morning Break
10:30am - 11:45am	Level 6	Growing and Adapting to Your User Base: Aaron Hawkins - BYU, Session Chair
11:45am - 1:15pm	Levels 4 & 5	Working Lunch - Roles by table (organized by David Dickensheets and Phil Himmer, MSU)
1:15pm - 2:45pm	Level 6	Managing Exotic Materials: John Shott, Session Chair
2:45pm - 3:15pm	Levels 4 & 5	Afternoon Break
3:15pm - 5:00pm	Level 6	Fab Efficiency & Improvement: Dan Christensen – UWisc, Session Chair
Time	Location	TUESDAY, JUNE 14, 2016
5:00pm - 10:30pm	Red Pine Lodge @ The Canyons	Mountain Banquet Dinner Board buses in front of stadium by 5:15pm Arrive at Mountain Gondola by 6:00pm Return to hotel* by 10:30pm

*Bus will make a circuit to UofU Guest House, Research Park Marriott and Downtown SLC.

Tool Selection - Iulian Codreanu, Session Chair

- 8:00am Acquisition of 17 Fumehoods and Wet Benches, Anders M. Jorgensen, Michael W. Allerup, Jan V. Eriksen, Majken Becker, Flemming Jensen and Karen Birkelund, Technical University of Denmark
- 8:15am Can You Satisfy Every Faculty? Jiangdong Deng, Harvard University Nanofabrication Facility, Center for Nanoscale Systems
- 8:30am Methodologies for Adding Critically Needed PVD Capability to an Already Extensive PVD Tool Suite, Matthew T. Moneck, Norman Gottron and Mark Weiler, Carnegie Mellon University Nanofabrication Facility
- 8:45am How Do You Optimize Tool Selection, Simon Doe, University of South Australia
- 9:00am Building an Academic Cleanroom, Peter Duda, University of Chicago
- 9:15am Acquiring Mission Critical Tools at MIT's Microsystems Technology Labs, Vicky Diadiuk, Massachusetts Institute of Technology
- 9:30am Ion Beam Lithography: Faster Writing Strategies for Features Between 150nm and 1um, B. P. Gila, A. Trucco and D. Hays, University of Florida
- 9:45am Bridging the Gap Between UV and E-beam Lithography with a DUV Stepper, Leif S. Johansen, Matthias Keil, Elena Khomtchenko, Anders M. Jørgensen and Jörg Hübner, Technical University of Denmark

Growing and Adapting to Your User Base - Aaron Hawkins, Chair

- 10:30am The Berkeley Micro/Nanolab High School Intern Program for Young Women, A. William Flounders, Katalin Voros and Tsu-Jae King Liu, UC Berkeley Marvell Nanofabrication Laboratory
- 10:45am Surviving in Today's Federal Funding Climate, J. Aebersold, K. Walsh, S. McNamara, E. Moiseeva, C. McKenna, X. Wang and M. Watson, University of Louisville
- 11:00am Innovative Outreach and Education Programs of the RTNN, Mark Walters, Duke University
- 11:15am Educational Programmes at NNfC, Savitha P. Sunanda Babu, Gopal Hegde and Prabhakara Rao, Indian Institute of Science
- 11:30am The Nordic Nanolab Network - A Best Practice Report, Kay Gastinger, Thomas Swahn, Jörg Hübner and Heini Saloniemi, NTNU NanoLab

Managing Exotic Materials - John Shott, Chair

- 1:15pm Safe Introduction of New Materials and Processes into Existing Open Access Laboratories, Nadia Cour, UNSW Australia
- 1:30pm Mixing Bio- and More Conventional Materials, J. Paul, HDR Architecture, Inc.
- 1:45pm Proper Building Abatement, Exhaust and Waste Handling/Collection Facilities to Accommodate a Broad Range of Materials, Greg Owen, Jacobs
- 2:00pm New Materials Challenges and Solutions for Operating Nanofabs that are Introducing ALD and MOCVD Processes, A. Gregg, Abbie Gregg Inc.
- 2:15pm Cleanroom Design for Hazardous Materials Segregation, Joe Morgan, Wilson Architects
- 2:30pm Panel Session

Fab Efficiency and Improvement - Dan Christensen, Chair

- 3:15pm ISO 9001 Certification for a Research, Development and Prototyping Cleanroom, Craig Hill, Dan Pulver and Marc Brunelle, Massachusetts Institute of Technology Lincoln Laboratory
- 3:30pm Overview of Daily Operation and Management of Multi-User, Gopalkrishna Hedge, Savita P., Y. P. P. Rao, S. A. Shivashankar, P. S. Anilkumar, Rudra Pratap and Navakanta Bhat, Indian Institute of Science
- 3:45pm Leveraging Opportunities for Capital Investment, Karl D. Hirschman and Scott P. Blondell, Rochester Institute of Technology
- 4:00pm Equipment Utilization: Lessons in Equipment Utilization from Queuing Theory, Mary X. Tang, Stanford University
- 4:15pm Merging a Cleanroom and an Analytical Microscopy Facility, Jörg Hübner, Technical University of Denmark
- 4:30pm If You Can't 'See' What You Made, What Good Is It? Tobi Beetz, Stanford University
- 4:45pm Worst Nightmare of a Facility Manager, Burak Birkan and Volkan Öxgüz, Sabanci University

UGIM Program Wednesday, June 15, 2016

Location: Sorenson Molecular Biotechnology Building (SMBB), 2nd floor atrium and James L. Sorenson Auditorium (Room 2650)

Address: 36 S. Wasatch Dr., Salt Lake City, UT, 84112

TRACK A

Time	Room	WEDNESDAY, JUNE 15, 2016
8:00am	SMBB James L. Sorenson	Tom Britton - CSI, Requirements for a CGA Code G13-2015 gas cabinets & VMBs
8:50am	Auditorium	Mingle & Vendor Exhibits
9:00am	RM 2650	Dennis Grimard - MIT, Subatmospheric gas handling
9:25am		Gene Ungvarsky - End Users Consulting, Hazardous exhaust abatement strategies
9:50am		Mingle & Vendor Exhibits
10:00am		James Moody - IM Flash, Life safety monitoring systems for HPM's
10:50am		Mingle & Vendor Exhibits
11:00am		Noah Clay – UPenn, Facilitator; Subsidy benchmarking: The search for sister Schools: Exchange metrics and administrative budget justifications. Bring statistics (from ASEE) on COE faculty size and research expenditures, then roughly classify and associate ourselves by small, midsize, large, then individually compare lists of toolsets, then directly comparing notes with peers on expense, revenue, “ROI” justification metrics and budget request approaches
11:50am		Lunch, Mingle & Vendor Exhibits
1:00pm		Craig Noah – CSI, TEOS and precursor liquid delivery systems
1:50pm		Mingle & Vendor Exhibits
2:00pm		Panel: Issues and concerns integrating the design requirements, and executing construction of a new or retrofitted cleanroom within a research laboratory building. The program will address HPM Handling, optimum facility location within the building, ancillary support services, system delineation, and contracting strategies. Tim Loughran – Cleanroom Construction Associates, Moderator, Jack Paul – HDR, Greg Owen – Jacobs, Abbie Gregg – AGI, Joe Morgan – Wilson Architects
2:50pm		Mingle & Vendor Exhibits

3:00pm	<p>Dave Manko - V.P. Global Engineering, Kurt J. Lesker Company, Engineering design considerations (mechanical and software) for thin film deposition tools in the Nanofab</p> <p>Rob Belan - Technical Director PVD Products, Kurt J. Lesker Company, New and upcoming technologies in PVD and thin films; HIPIMS, pulsed DC, low pressure sputtering</p> <p>Duane Bingaman - V.P. Process Equipment Division, Kurt J. Lesker Company, Atomic layer deposition, beyond the basics- design and use considerations for high performance ALD</p> <p>Joe DeMaio - East Coast Sales Manager, Kurt J. Lesker Company, Educational Outreach, Lesker U</p>
Mingle - End of conference	

UGIM Program Wednesday, June 15, 2016

Location: Sorenson Molecular Biotechnology Building (SMBB), 2nd floor atrium and James L. Sorenson Auditorium (Room 2650)

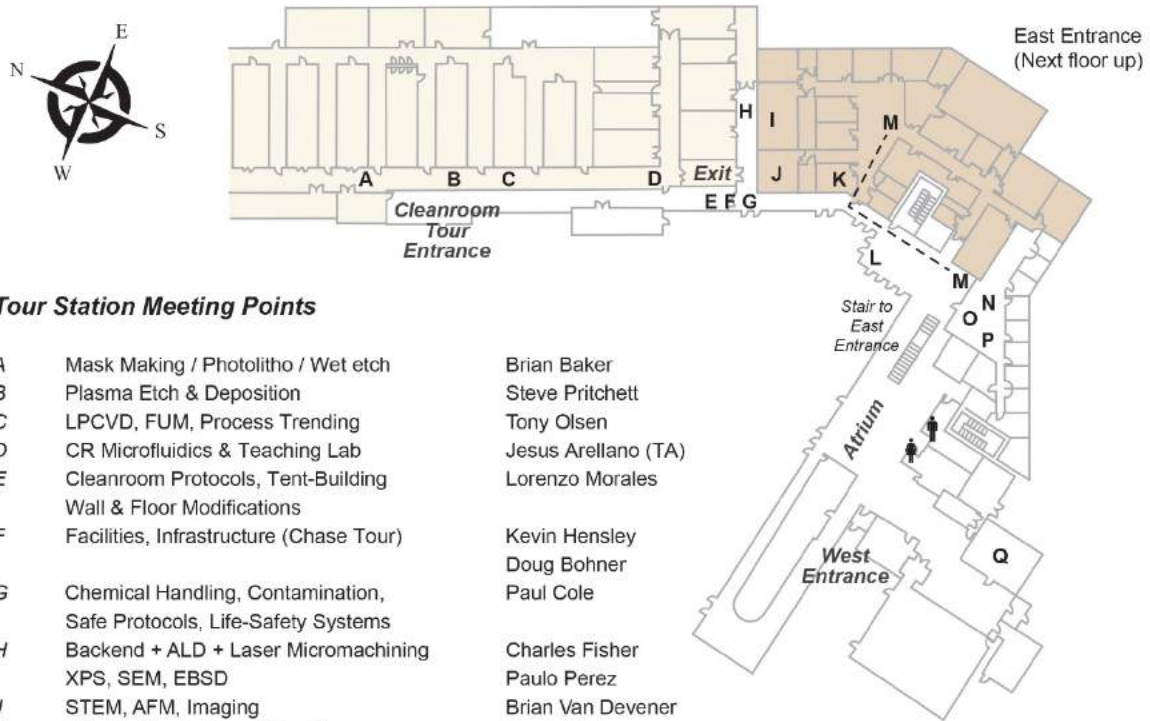
Address: 36 S. Wasatch Dr., Salt Lake City, UT, 84112

TRACK B

Time	Room	WEDNESDAY, JUNE 15, 2016
8:00am	SMBB 2660	Matt Pleil - CNM, Micro/Nano education materials and media
8:25am		Jim Smith – UofU, Community college education nano connection to university
8:50am		Mingle & Vendor Exhibits
9:00am		Brian Van Devenor – UofU, Keeping Afloat: Analytical microscopy facilities co-administrated with cleanrooms
9:15am		Open Discussion: Analytical microscopy facility managers
9:50am		Mingle & Vendor Exhibits
10:00am		Greg Cibuzar – UMinn, External revenue - Considerations for academic Nanofabs
10:25am		Jorg Scholvin – MIT, User behavior on high-demand tools (discrepancies between reservation availability and actual use)
10:50am		Mingle & Vendor Exhibits
11:00am		Niels Wijnaendts van Resandt – Heidelberg Instruments, Direct write LPG and grayscale litho on a desktop
11:50am		Lunch, Mingle & Vendor Exhibits
1:00pm		Rob Pearson - RIT, Incorporating course based formal labs in a research cleanroom
1:50pm		Mingle & Vendor Exhibits
2:00pm		Tony Olsen – UofU, Shared media for safety training Brian Baker – UofU, Shared media library for tool user training
2:25pm		Brian Earl and Bryan Tran – UofU, The cleanroom as the crown jewel of campus STEM outreach: Teaching scaling engineering in campus tours
2:50pm		Mingle & Vendor Exhibits
3:00pm		William M. Harris – Carl Zeiss Microscopy, Mastering the multi-scale challenge: Challenges in correlative microscopy
Mingle – End of conference		



Tour Stations



Tour Station Meeting Points

A	Mask Making / Photolitho / Wet etch	Brian Baker
B	Plasma Etch & Deposition	Steve Pritchett
C	LPCVD, FUM, Process Trending	Tony Olsen
D	CR Microfluidics & Teaching Lab	Jesus Arellano (TA)
E	Cleanroom Protocols, Tent-Building Wall & Floor Modifications	Lorenzo Morales
F	Facilities, Infrastructure (Chase Tour)	Kevin Hensley
G	Chemical Handling, Contamination, Safe Protocols, Life-Safety Systems	Doug Bohner
H	Backend + ALD + Laser Micromachining	Paul Cole
I	XPS, SEM, EBSD	Charles Fisher
J	STEM, AFM, Imaging	Paulo Perez
K	FIB, Multiscale Correlative Microscopy	Brian Van Devener
L	Building Overview	Randy Polson
M	CC Outreach & Scaling Engineering Education (Nanofab "Cool Stuff")	Ken Hart
N	Billing & Invoicing	Jim Smith, Brian Earl, Bryan Tran
O	Executive Administration	Rachel Henderson
P	CORAL, Customization / LMS	Amy VanRoosendaal
Q	Equipment Swap Meet	Ryan Taylor







Tour Entrance: Clean Conference Room

Please bring your new UGIM safety glasses; smock, hairnet, booties and gloves will be provided.

Tour Exit: Gowning Room

Reception food is limited to atrium.

University of Utah Campus Map

	<p>Rice-Eccles Stadium & Tower <i>Monday & Tuesday</i></p>		<p>Walking</p>
	<p>James LeVoy Sorenson Molecular Biotechnology Bldg (SMBB) <i>Sunday & Wednesday</i></p>		<p>Red Line TRAX</p>
	<p>University Guest House</p>		<p>Driving</p>



Upload/Download Instructions for UGIM Speaker Presentations and Notes

SPEAKER PRESENTATIONS

Instructions for **uploading** SPEAKER PRESENTATIONS:

1. Visit the UGIM website <http://ugim.nanofab.utah.edu>, hover over the *Upload/Download* tab at the top of the website and select the *Upload* page <https://ugim.nanofab.utah.edu/participants-upload/upload/>.
2. Select the *SPEAKERS/PRESENTERS-PDF FOR DIST* tab, enter your information and choose your file to upload.

Instructions for **downloading** SPEAKER PRESENTATIONS:

1. Visit the UGIM website <http://ugim.nanofab.utah.edu>, hover over the *Upload/Download* tab at the top of the website and select the *Secure Download* page <https://ugim.nanofab.utah.edu/notes/>.
2. Enter the password "tinystuff".
3. Under *Notes and Presentations* click on *View all Speaker Presentations*.

NOTES

Instructions for **uploading** NOTES taken at the symposium:

1. Visit the UGIM website <http://ugim.nanofab.utah.edu>, hover over the *Upload/Download* tab at the top of the website and select the *Secure Download* page <https://ugim.nanofab.utah.edu/notes/>.
2. Enter the password "tinystuff".
3. Under *To Submit Notes in PDF Format*: you will enter your name, document title, document description and attach your file to upload.

Instructions for **downloading** NOTES taken at the symposium:

1. Visit the UGIM website <http://ugim.nanofab.utah.edu>, hover over the *Upload/Download* tab at the top of the website and select the *Secure Download* page <https://ugim.nanofab.utah.edu/notes/>.
2. Enter the password "tinystuff".
3. Under *Notes and Presentations* click on *View all Note Submissions*.

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1. Open the wireless settings on the device you wish to connect to the network
2. Choose “UGuest” from the list of available networks
3. Open a browser and go to **onboard.utah.edu**
4. Read the Terms & Conditions; if you agree, check the Terms & Conditions checkbox and click “Start”
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6. Follow the on-screen directions, entering an SMS-capable phone number **OR** verification code obtained from a University sponsor

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Cintas Cleanroom Resources is a division of the Cintas Corporation, whose sole specialty is the rental and precision cleaning of apparel for cleanroom and other critical ESD applications along with cleanroom related direct sale and disposable items. Our singular focus on the cleanroom market over many years has allowed us to develop systems and procedures uniquely suited to satisfying the special demands of industry, including the electronics, pharmaceutical, medical device, micro-manufacturing, automotive, medical packaging, and the general manufacturing sectors.

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Lincoln, Nebraska / 68522
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The Film Sense FS-1™ Multi-Wavelength Ellipsometer uses long-life LED's and a no-moving-parts ellipsometric detector to provide fast and reliable thin film measurements in an easy-to-use, compact system. The FS-1 offers the power of Multi-Wavelength Ellipsometry, but at the price point of single wavelength ellipsometer and spectroscopic reflectometer systems. The FS-1 is ideal for measurements in the research lab, classroom, in situ process chambers, industrial quality control, and more.

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Heidelberg Instruments

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310-212-5071
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With an installation base of over 600 systems in more than 50 countries, Heidelberg Instruments Mikrotechnik is a world leader in production of maskless lithography systems and maskless aligners. Our systems are used in some of the most advanced research, development and industrial applications for direct writing and photomask production by some of the most prestigious universities & industry leaders in the areas of MEMS, BioMEMS, nano technology, ASICS, TFT and many other related applications.

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In January 2006, Micron Technology, Inc., one of the worlds leading providers of advanced semiconductor solutions, and Intel Corporation, the world's largest chip maker, came together to form a new company: IM Flash Technologies, LLC. IM Flash marries the technology, assets, and experience of two major corporations to manufacture NAND Flash memory—the fast-growing memory technology used in consumer electronics, removable storage, and hand held communication devices. Manufacturing products exclusively for Micron and Intel, IM Flash combines Micron's expertise in developing NAND technology and operating highly efficient manufacturing facilities with Intel's multi-level cell technology and history of innovation in the Flash memory business. Since we are the child prodigy of two powerful semiconductor companies, our product is distributed through them. However, you don't have to go far to find our product in your life: cell phones, cameras, flash drives, solid state drives, net books, and more. **Our mission:** Be the pre-eminent manufacturer of NAND flash through innovative, low-cost solutions

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Peabody, Massachusetts / 01960
978-535-5900
salesinfo@jeol.com
www.jeolusa.com**

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The Kurt J. Lesker Company is the global leader in vacuum technology specializing in vacuum systems, service and components to support a wide range of nanotechnology research. Lesker provides thin film deposition systems; including Atomic Layer Deposition, Sputtering, E-Beam and Thermal evaporation, as well as sample manipulation and transfer, vacuum pumps, gauges, custom vacuum chambers, and software products all supported by a global network of engineers, scientists, and experienced vacuum practitioners. Lesker offers nanotechnology researchers more than 60 years of experience in the industry as well as technical support channels including the Lesker U series of vacuum technology training classes and the TechInfo service available at Lesker.com

Nanoscribe GmbH

**Hermann-von-Helmholtz-Platz 1
76344 Eggenstein-Leopoldshafen, Germany
+49 721 608-28840
info@nanoscribe.de
www.nanoscribe.de**

Nanoscribe's Photonic Professional *GT* is the world's highest resolution 3D-printer for nano- and microfabrication on the market. It is designed for high-speed fabrication into photosensitive materials and provides additive manufacturing and maskless lithography in one device. The two-photon polymerization driven turnkey systems set new standards in a multitude of applications like photonics, micro-optics, photonic wire bonding, micro-fluidics, and life sciences. Prism Award Winner 2014, category "Advanced Manufacturing", World Technology Network (WTN) Award 2015, category "Materials".

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385 Woodview Avenue #200
Morgan Hill, California / 95037
408-776-5190
sales@neutronixinc.com
www.neutronixinc.com

Neutronix-Quintel (NXQ) is a leading provider of high performance mask alignment systems since 1978. NXQ is comprised of a team of seasoned industry veterans with vast experience in photolithography, providing their customers with the most robust solutions which have been derived from many years of customer driven innovations. NXQ has well over 1000 systems installed around the world used for various technologies such as MEMS, Compound Semi, Biomedical, Microfluidics, HB LED, WLP, 3DIC / TSV, 2.5D Interposer and HCPV.

Prominent high volume manufacturing companies utilize NXQ's equipment for end products such as transceiver chip sets for cell phones and other wireless devices, medical sensors, automobile sensors, LED Lighting, military and defence electronics, IR detectors, optical devices used for communications and discrete devices. The company's products are also used extensively throughout the world at universities and research institutes and are recognized as one of the most versatile and flexible mask aligners in the marketplace.

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enquiries@spts.com
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**6 Executive Park Drive
North Billerica, Massachusetts / 01862
978-528-3209
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STS-Elionix is a partnership between SEMTech Solutions (STS) and Elionix. Together, we sell and support state-of-the-art nanotechnology products throughout the Americas and Europe. The Elionix F-Series systems were derived from customer requests demanding Finer lines and Faster writing speeds. This resulted in the world's only 125 kV Electron Beam Lithography system with a 100 MHz High Speed Beam Deflector.

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Technoparkstrasse 1
CH-8005 Zürich, Switzerland
+41 (0) 44 500 38 00
info@swisslitho.ch
www.swisslitho.com

SwissLitho is a young high-tech company with the vision to change the way nanostructures are commonly made. Our unique nanolithography tools, called *NanoFrazor*, trace their origins to IBM Research Zurich. The NanoFrazor is based on *Thermal Scanning Probe Lithography* and is the first alternative to conventional mask-less lithography technologies. Patterning resolution and speed are similar to high resolution E-beam lithography. However, the novel technique enables direct 3D lithography, in-situ metrology with markerless overlay with sub-5 nm accuracy and the fabrication of sub-20 nm patterns in silicon and metals. The NanoFrazor opens up new and unprecedented possibilities for nanofabrication in order to accelerate scientific and technological progress in all fields of nanotechnology. Since its foundation in 2012, SwissLitho has received many of the most prestigious national and international start-up and technology awards. In 2015 SwissLitho won one of the R&D 100 awards (also titled as "Oscars of Innovation") in the category Process/Prototyping.

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