OPTICA

Optical Waveguides: A Key to Socially Acceptable AR Glasses?

11 – 13 October 2023
The Hotel Murano
Tacoma, Washington, USA

optica.org/incubator

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Welcome

Hello and welcome to Tacoma, Washington, and **Optical Waveguides: A Key to Socially Acceptable AR Glasses?** This program has been developed by Kai-Han Chang, General Motors, United States; Ali Özgür Yöntem, University of Cambridge/Jaguar Land Rover, United Kingdom; and Kaan Akşit, University College London, United Kingdom.

The incubator begins on the evening of 11 October with a welcome dinner at 18:00 at Stanford's Steak, located at 1502 Pacific Ave. The following morning, Thursday, 12 October, there will be breakfast at 8:00, with the program beginning at 8:30 in the Torcello/Burano Rooms at the Hotel Murano. We have enclosed a map for your reference.

Incubator Meetings are designed to provide a unique and focused experience, allowing colleagues working in a niche field to meet and engage in discussions of related advances, challenges and opportunities. If you have feedback on the format of the Incubator program or suggestions for future Incubators, please share your thoughts with Hannah Walter-Pilon, Optica Director of Technical Community Engagement at incubators@optica.org.

Sincerely,

Elizabeth A. Rogan

Elizabeth A. Rogan

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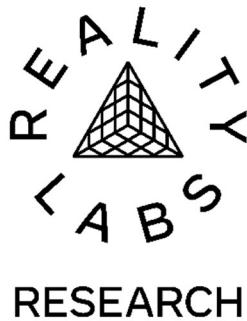As an incubator attendee, you can receive 50% off your first year of Optica membership. Visit optica.org/join and use the code IM-JOIN50.

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Agenda

Afternoon	**Attendees arrive in Tacoma**
18:00 PDT	**Welcome Dinner** Stanford's Steak, 1502 Pacific Ave., Tacoma, WA

Thursday, 12 October 2023

08:00 PDT	**Breakfast at Hotel Murano - Torcello/Burano Rooms** 1320 Broadway, Tacoma, WA
08:30 PDT	**Welcome Remarks** Ryan Strowger, Chief Events and Corporate Engagement Officer, Optica
08:45 PDT	**Program Overview & Goals** Kai-Han Chang, General Motors
09:00 PDT	**What is Socially Acceptable AR?** *Toward Power-Efficient XR: A Perception Perspective* – Qi Sun, New York University *Key Challenges towards Achieving Socially Acceptable Augmented Reality* – Matt Colburn, Meta
10:00 PDT	**Moderated Discussion Period** Kai-Han Chang, General Motors
10:30 PDT	**Coffee Break**
11:00 PDT	**Optical Light Coupling Solutions** *Optical light coupling solutions in AR waveguides: A very brief overview* – Ali Özgür Yöntem, University of Cambridge/Jaguar Land Rover *High-Index Nanocomposite Materials for Waveguide Applications* – Serpil Gonen Williams, Pixelligent *Towards the Ultimate VR Display with Pupil-Steering Waveguides* – Andreas Georgiou, Reality Optics Limited
12:30 PDT	**Moderated Discussion Period** Ali Özgür Yöntem, University of Cambridge/Jaguar Land Rover

13:00 PDT   **Lunch**

14:00 PDT   **Design Tools and Metrology**
   Role of Differentiable Models in Computational Display Research – Kaan Akşit, University College London
   Analyzing the Gratings for Higher Image Quality – Murat Deveci, Optofidelity

15:00 PDT   **Moderated Discussion Period**
   Kaan Akşit, University College London

15:30 PDT   **Coffee Break**

16:00 PDT   **Path to Product**
   The Path to Affordable High-Performance Inorganic Coatings – Omid Sadeghi, Phosio Corp.
   Talk title to be announced – Hiroki Kikuchi, Sony
   Talk title to be announced – Joel Kollin, Holonix LLC

17:00 PDT   **Moderated Discussion Period**
   Kai-Han Chang, General Motors

18:00 PDT   **Networking Dinner**
   Indochine Asian Dining Lounge, 1924 Pacific Ave., Tacoma, WA

Friday, 13 October 2023

08:00 PDT   **Breakfast at Hotel Murano - Torcello/Burano Rooms**
   1320 Broadway, Tacoma, WA

08:30 PDT   **Content and Use Cases**
   Rowing upstream – enterprise insights into mass market AR adoption – Tyler Gibson, Magic Leap
   Enhanced Network Digital Twin Using Augmented Reality (AR) – Haoshuo Chen, Nokia Bell Labs

10:00 PDT   **Moderated Discussion Period**
   Ali Özgür Yöntem, University of Cambridge/Jaguar Land Rover

10:30 PDT   **Coffee Break with Demos**

11:00 PDT   **Discuss Next Steps: Future Technology and Education**
   Leaky-Wave Metasurfaces – Nanfang Yu, Columbia University
   Neural Holography for Next-generation Augmented and Virtual Reality Displays – Suyeon Choi, Stanford University
   Liquid crystals for augmented reality – Kai-Han Chang, General Motors

12:00 PDT   **Moderated Discussion Period**
   Kaan Akşit, University College London

12:30 PDT **Lunch**

13:30 PDT **Group Discussion of Next Steps**

14:30 PDT **Adjourn**

Hosts

Kaan Akşit
Associate Professor, University College London
k.aksit@ucl.ac.uk

Kaan Akşit is an Associate Professor in the Computer Science department at University College London in the United Kingdom, where he leads the Computational Light Laboratory. Kaan received his Ph.D. in electrical engineering at Koç University, Türkiye, in 2014. His M.Sc. degree is in electrical power engineering from RWTH Aachen University, Germany, in 2010. Kaan obtained his B.S. in electrical engineering from Istanbul Technical University, Türkiye, in 2007. Kaan researches the intersection of light and computation, including computational approaches in imaging, graphics, fabrication, and displays. Kaan's research works are widely known among the optics and graphics community for his contributions to display technologies dedicated to 3D, virtual reality, and augmented reality. He worked as a research intern in Philips Research, the Netherlands, and Disney Research, Switzerland, in 2009 and 2013, respectively. In addition, he was a Senior Research Scientist at NVIDIA, the USA, between 2014 and 2020. He received Emerging Technologies Best in Show awards in SIGGRAPH 2018 and SIGGRAPH 2019, DCEXPO special prize in SIGGRAPH 2017, the best papers in IEEE VR 2017 and ISMAR 2018, and the best paper nominee in IEEE VR 2019 and IEEE VR 2021.

Kai-Han Chang

Staff Researcher, General Motors
kchang1@kent.edu

Dr. Kai-Han Chang is a Staff Researcher at General Motors Research and Development. Her research specialty is liquid crystal optics and device development. In this role, she is responsible for developing novel optical solution for both head-up displays and head-down displays. She received her PhD degree from the Chemical Physics Interdisciplinary Program at Kent State University, Ohio in 2018. She received her M. S. degree in electro-optical engineering from the Institute of Electro-Optical Engineering, National Chiao Tung University, Hsinchu, Taiwan in 2012. She has co-authored 1 book chapter, 10 journal papers, 13 conference proceedings, and obtained 38 US patents.

Ali Özgür Yöntem

Visiting Researcher, University of Cambridge
Optical Engineer, Jaguar Land Rover
aoy20@cam.ac.uk

Dr Ozgur Yontem is currently a Visiting Researcher with the Department of Computer Science and Technology, University of Cambridge, UK, focusing on True 3D displays. His research interests include analog and digital holography, light-field/integral imaging, diffractive and reconfigurable optics, 3D image acquisition and display, near-eye displays, waveguides, 3D printed optics with application areas in immersive technologies such AR/VR, automotive HUD, 360-degree 3D interactive displays. He is Senior Member of OPTICA and IEEE. He is currently the Vice Chair of the OPTICA Display Technology Technical Group.

Attendees

Ozan Cakmakci
Staff Optics Hardware Engineer, Google LLC
ozancakmakci@google.com

Ozan Cakmakci is a tech lead/manager focusing on the development of augmented reality optics at Google. He has over 15 years of experience in the field, and he led the next-gen Google Glass optics efforts. He is currently working on a book titled "Optical Design of Eyewear Displays," to be published by SPIE in 2024.

Haoshuo Chen
Researcher, Nokia Bell Labs
haoshuo.chen@nokia-bell-labs.com

Haoshuo Chen received Ph.D degree (Cum Laude) in electrical engineering from Eindhoven University of Technology (TU/E), The Netherlands, in 2014. Supported by the European Union FP7 MODE-GAP Project, he investigated free space and photonic integrated spatial multiplexing solutions and demonstrated large capacity few-mode fiber transmission during his PhD. Since December 2014, he has been working as a member of technical staff at Nokia Bell Labs, NJ, USA. His main research interests include space division multiplexing, photonic integration, digital signal processing, fiber components, wavelength/space switches, machine learning, mixed/virtual reality and robot automation. He has (co-)authored 300+ journal and conference papers, 30+ post deadline papers and holds 13 US patents. He currently servers as an associate editor of IEEE Journal of Quantum Electronics and a strategy representative of IEEE Photonics Society Globalization Committee. He is Program Chair of the 28th Optoelectronics and Communications Conference (OECC). He served as a subcommittee chair/member

and workshop organizer at OFC, ECOC, OECC, ICOCN, IPC, ACP, APC, CLEO/PR, SUM and other conferences. He has also served as a frequent peer reviewer for the Optica and IEEE journals.

Suyeon Choi

PhD Student, Stanford University
suyeon@stanford.edu

Suyeon Choi is a PhD student at Stanford Computational Imaging Lab, advised by Professor Gordon Wetzstein. His research interests are centered on the co-design of optical systems and algorithms, with a focus on developing holographic display systems that incorporate machine learning for next-generation virtual and augmented reality displays. His work is supported by a Meta Research PhD Fellowship, a SPIE Optics and Photonics Education Scholarship, a Kwanjeong Scholarship, a Korean Government Scholarship, and a GPU gift from NVIDIA. Previously, he received his Master's degree in Electrical Engineering from Stanford University, completed his undergraduate studies at Seoul National University as a recipient of The Presidential Science Scholarship.

Matthew Colburn

Research and Development Director, Meta
mcolburn@meta.com

Matthew Colburn is a technology leader with experience delivering innovative solutions at the intersection of materials, optics, and nanofabrication. In 2001, he received his Ph.D. in Chemical Engineering at The University of Texas at Austin developing imprint lithography technology. After graduating, Dr. Colburn joined IBM Research ultimately leading their advanced patterning organization. In 2016, he joined Oculus Research (now Meta Reality Labs Research) and grew the Waveguide product team within Display and Optics. Currently, he is the research and development director focused on driving immersive augmented reality combiner technology within the Optics and Display Research organization.

Murat Deveci
Director of Global Sales and Business Development, OptoFidelity
murat.deveci@optofidelity.com

Murat Deveci oversees the growth of OptoFidelity's business in the emerging and competitive field of Augmented Reality (AR). Also, he serves as the chair of LaSAR Alliance's "IQM3 - Image Quality Metrics, Methods, and Measurements" committee. He supports Big Tech by tackling challenges related to image quality, optical metrology, and other obstacles that hinder the immersive experience of augmented reality smart glasses and head-mounted displays.

Amin Eftekhar
Principal Optical Engineer, Microsoft
Mohammadamin.Eftekhar@microsoft.com

I started my education in Electrical Engineering, and earned my Bachelor of Science degree in 2009, followed by the completion of my Master of Science in the Electromagnetics, Fields, and Waves from the University of Tehran, Iran in 2012. In 2013, fascinated by Physics, Optics and Lasers, I embarked on a research journey at the College of Optics and Photonics (CREOL) at the University of Central Florida, where my focus was on the intricate dynamics of nonlinear-multimode and multicore optical systems. After completing my doctoral studies in 2018, I joined Microsoft's Mixed Reality Team as an optical engineer, contributing to the development of HoloLens 2. My current responsibilities as a Principal Optical System Engineer encompass the exploration and development of cutting-edge technologies integral to the future of mixed reality systems.

Andreas Georgiou

Optics Consultant, Reality Optics Limited
ag245@cantab.net

Andreas Georgiou is an Independent Consultant with Reality Optics Ltd, with a particular interest in computational problems in optics. He worked in diffractive optics for over two decades and over a decade in Mixed Reality optics. Andreas enjoys making new ideas into operating prototypes by combining physics, mathematics, engineering, and software. He particularly enjoys working with head-mounted displays, three-dimensional displays, sensors, and everything odd with lenses and gratings inside. Before his current position, he worked with many product groups at Microsoft (Surface, HoloLens, Azure and Kinect), developed micro-confocal endoscopes for surgery, designed space instruments for Mars, and created the first genuinely holographic display. He obtained his PhD in Optics from the University of Cambridge and is also an Engineering Research Fellow at Robinson College, Cambridge. He has over 30 patents and over 20 peer-reviewed publications on head-mounted displays, data storage, holographic displays, and data transmission.

Tyler Gibson

Director, Product Planning, Magic Leap
tygibson@magicleap.com

Tyler Gibson is an accomplished multi-discipline product development leader in deeply integrated hardware and software systems. During his 15 years at Microsoft, Tyler designed the first agile tools, developer analytics and SaaS ALM services for Microsoft, Azure DevOps and AppInsights. Spent the next 6 years as an engineer and pm coding with hundreds of customer engineers across dozens of industries worldwide. Coding with customers introduced him to HoloLens, leading to the development of the open-source 3D Streaming Toolkit in collaboration with Google and nVidia in 2016, evolving into Azure Remote Rendering and Azure Communication Services. In 2021 Tyler joined Magic

Leap to lead long term product planning and strategy, helping define the next generation of products, services, and markets opportunities for Magic Leap.

Serpil Gonen Williams

CTO, Pixelligent Technologies LLC
sgonen@pixelligent.com

Serpil Gonen Williams, Ph.D., Chief Technology Officer, has over 20 years of experience in developing nanomaterials for various cutting-edge applications where the combination of high refractive index, high transparency, and low haze are essential. She has been instrumental in establishing Pixelligent's PixClear®, PixJet®, and PixNIL® product portfolios. As the technical point of contact in several multi-million dollar JDAs with leading commercial partners, and principal investigator in government grants, she has led the R&D and product development group in creating the highest quality metal oxide nanocrystals and formulations for applications in AR/MR, display, sensor, and optical coatings. She manages Pixelligent's IP portfolio and is an inventor of more than 40 patents and applications. She has also authored or co-authored 16 articles in peer-reviewed journals. She has a PhD in Chemistry from the University of Maryland, College Park, where she studied solid state and inorganic chemistry.

Hiroki Kikuchi

Corporate Distinguished Engineer, Sony Group Corporation
Hiroki.Kikuchi@sony.com

Hiroki Kikuchi is Corporate Distinguished Engineer of Sony Group Corporation and Deputy Senior General Manager of Sony Semiconductor Solutions. He received his M.S. in applied physics from the University of Tokyo. He joined Sony in 1992, where his research fields were solid state laser, electro-optic light modulator, deep-UV laser microscope, MEMS and LCOS-based laser projection display and volumetric light field display. From 1997 to 1998, he studied at Ginzton Laboratory, Stanford University as visiting

researcher.He is currently in charge of nanophotonics research in Sony Semiconductor Solutions. His current major research fields are AR/VR optics, optical metasurfaces and their industrial applications. He is also representing Optics Strategy Committee of Sony Group. In 2003, he received Sony Outstanding Engineer Award for the development of laser projection display.

Joel Kollin

Principal, Holonix LLC
jkollin@live.com

Joel Kollin is an Optical Systems Engineer/Architect specializing in imaging, with special interests in Immersive displays, human perception, and novel HCI.

Greg McIntyre

Manager, Meta Platforms Inc
gregmcintyre@meta.com

Greg McIntyre is Senior Manager of Physical Optics at Meta.

Darran Milne

Co-Founder and CEO, VividQ
Darran.milne@vivid-q.com

Darran Milne is a co-founder and Chief Executive Officer at VividQ. As CEO, he sets the company's long-term vision and oversees the company's investment and commercial strategy, establishing VividQ as the leading provider of holographic display technology. A mathematician and theoretical physicist by training, Darran holds a PhD in quantum information theory and quantum optics from the University of St Andrews and the Max Planck Institute.

Daniel Nikolov

Research Engineer, University of Rochester
daniel.nikolov@rochester.edu

Daniel K. Nikolov was born in Sofia, Bulgaria. He completed his Master's and Ph.D. in Optics from the University of Rochester in 2016 and 2021, respectively.While in the doctoral program at The Institute of Optics, Daniel was co-advised by Professor Jannick P. Rolland and Prof. Nick Vamivakas. Under their supervision, Daniel led the development of metaform optics – a novel optical component for use in near-eye displays. He also created and led the Hyperion project – a cross-platform 3D visualization software for optical design. Daniel is a research engineer at The Institute of Optics, focusing on novel AR and VR display architectures. His broader interest is in enabling the wider adoption of emerging technologies such as freeform optics and metasurfaces via process chains and software tools supporting optical design, manufacture, and metrology.

Jannick Rolland

Brian J. Thompson Professor of Optical Engineering,
University of Rochester
rolland.jannick@gmail.com

Jannick P. Rolland is the Brian J. Thompson Professor of Optical Engineering at the University of Rochester and the Chief Technology Officer of LighTopTech Corp., a startup she co-founded in 2013 in biotechnology. At the University of Rochester, she is the director of the NSF I/UCRC Center for Freeform Optics (CeFO), and the director of the R.E. Hopkins Center for Optical Design and Engineering. She earned an optical engineering diploma from the Institut D'Optique Théorique et Appliquée, France, and MS and PhD degrees in Optical Science from the JCW College of Optical Sciences at the University of Arizona. Professor Rolland is a Fellow of Optica, SPIE, and NAI and an inaugural member of the IEEE VGTC Virtual Reality Academy. She is the recipient of the 2014 David Richardson Medal, and the 2020 Joseph Fraunhofer Medal /Robert M. Burley Prize.

Omid Sadeghi

CEO, Phosio
osadeghi@phosio.com

Omid Sadeghi serves as the CEO and founder of Phosio, bringing over 15 years of experience of Chemistry to the table. His extensive scientific contributions are reflected in more than 75 ISI publications, including a notable feature in Science Magazine. In 2018, Omid founded Phosio, driven by a vision to lead in the development, manufacturing, and commercialization of cost-effective high refractive index inorganic coatings. These innovations are primarily targeted at the high-value optical-device sectors. Phosio's mission is to help optical engineers transition from traditional organic coatings to high-performance, durable inorganic coatings, thereby expanding the design possibilities in this field.

Kazue Shimizu

Optical Engineer, Sony Semiconductor Solutions Corporation
kazue.shimizu@sony.com

Kazue Shimizu is an optical engineer at Sony Semiconductor Solutions. He studied laser physics at RIKEN and received a master's degree in engineering from Keio University. In 2007, she joined Sony to conduct research and development on projector optics, backlight technology for displays, and light-field displays. Several of these were released into production. She was involved in the development of the world's first quantum dot television.In recent years, she has been responsible for the optical design of AR Glass displays, including HOE waveguide and injection-molded SRG waveguide. She is currently the development lead of AR optics and devices at Sony Semiconductor Solutions.

Qi Sun

Assistant Professor, New York University
qisun@nyu.edu

Qi Sun is an assistant professor at New York University. Before joining NYU, he was a research scientist at Adobe Research. He received his PhD at Stony Brook University. His research interests lie in VR/AR, perceptual computer graphics, computational cognition, and behavioral performance. He is a recipient of the IEEE Virtual Reality Best Dissertation Award, with his research recognized as several best paper and honorable mention awards at ACM SIGGRAPH, IEEE ISMAR, and IEEE VIS.

Tuomo von Lerber

Director Optical Design, Microsoft Oy
tvonlerber@microsoft.com

I'm a physicist with over 20 years of experience, deeply passionate about optics, telecommunications, and data science. Currently, I'm with Microsoft, leading a skilled team that is pushing the envelope in optical AR displays. We focus on creating advanced optical waveguides for applications in enterprise and security. Before this role and employer, I led a data science team that developed machine learning algorithms for medical devices compliant with CE-IVD standards. Earlier in my career, I co-founded a startup in optical telecommunications. My professional journey has taken me back and forth between industry and academia, and I have a consistent passion for solving complex problems. Outside of work, I find great joy in exploring the outdoors and appreciating the natural world.

Nanfang Yu

Associate Professor, Columbia University
ny2214@columbia.edu

Nanfang Yu is an Associate Professor of Applied Physics at the Department of Applied Physics and Applied Mathematics, Columbia University. His lab conducts experimental research on "flat optics", which are nanostructured low-dimensional materials that can control light in previously unimaginable ways. Yu and his students work on three research themes related to flat optics: (1) metasurfaces, which are engineered 2D metamaterials that can control light waves propagating in free space in arbitrary ways, (2) integrated photonics, where light propagation and control are confined within networks of waveguides on a chip, and (3) biophotonics and bioinspired optical materials. The vision of Yu's research is to replace conventional bulky optical devices and systems with their "flat" counterparts and to understand the life history of living systems from the point of view of photonics. Yu was a Research Associate in the School of Engineering and Applied

Sciences at Harvard University from 2009 to 2012. He received the Ph.D. degree in Engineering Sciences from Harvard University in 2009, and the B.S. degree in Electronics from the Department of Electronics at Peking University, Beijing, China, in 2004. Yu is the recipient of 2022 Moore Foundation Experimental Physics Investigators (EPI) Award, 2022 OPTICA (formerly Optical Society of America) Fellow, 2017 Defense Advanced Research Projects Agency (DARPA) Director's Fellowship, 2016 Office of Naval Research (ONR) Young Investigator Program Award, and 2015 DARPA Young Faculty Award.

Yiting Zhu
Metrology Manager, Google
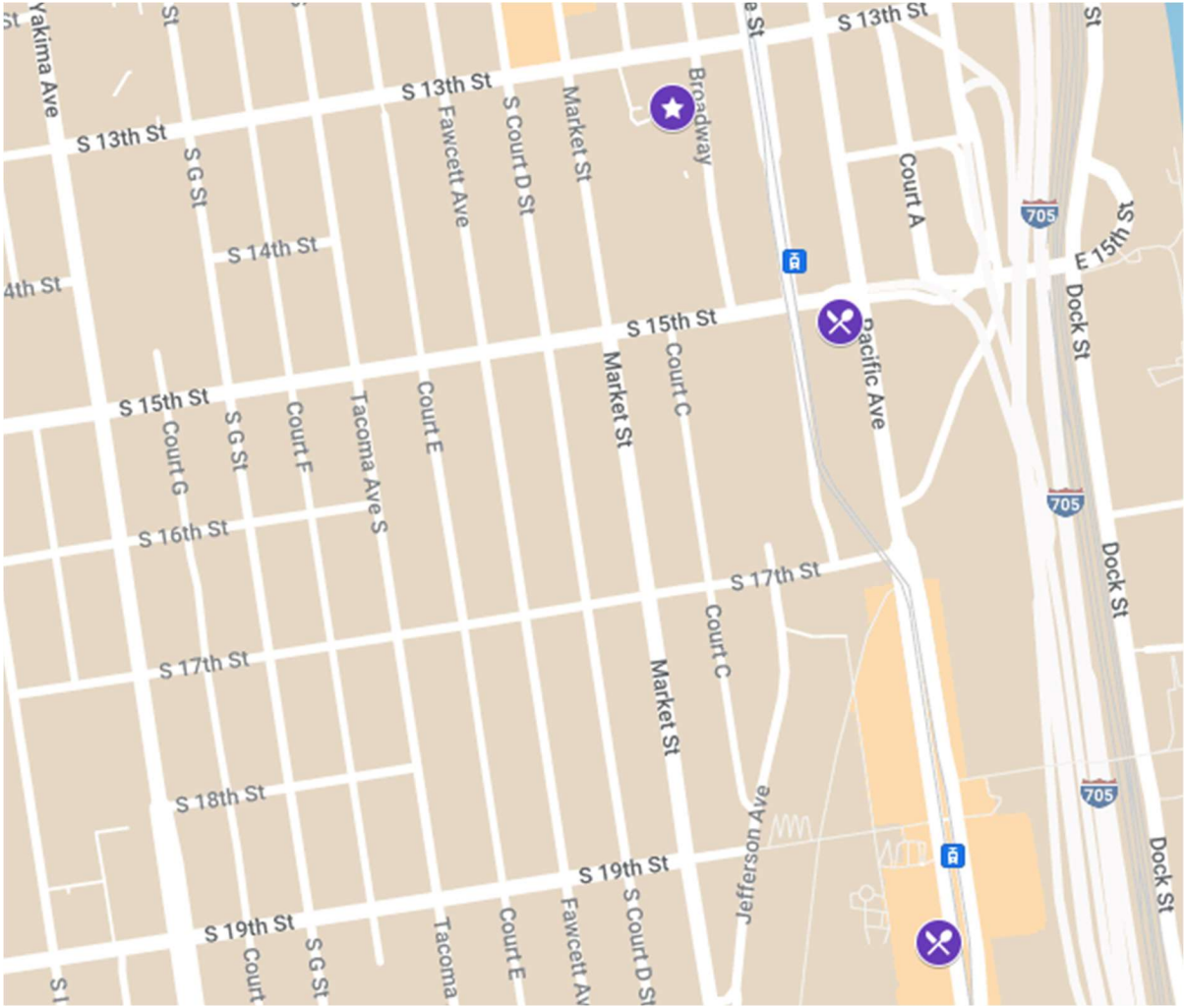*yiting.zhumont@gmail.com*

AR Display Metrology Manager at Google

Map

Hotel Murano: 1320 Broadway, Tacoma WA 98402

Welcome Dinner: Stanford's Steak, 1502 Pacific Ave, Tacoma WA 98402

Networking Dinner: Indochine Asian Dining Lounge, 1924 Pacific Ave, Tacoma WA 98402

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