

Proceedings of the 31<sup>st</sup> Symposium on Space  
Terahertz Technology:



# ISSTT 2020

8-11 March 2020

Tempe, Arizona

Hosted by:



The 2020 31st IEEE International Symposium on Space Terahertz Technology (ISSTT 2020) took place in Tempe, Arizona, USA on March 8–11, 2020. It was held on the grounds of Arizona State University and organized by the local committee consisting of engineers and scientists from ASU.

Held just before COVID–19 began to severely restrict travel to and from the USA, attendance at this conference was impacted. But nonetheless, the conference successfully and safely hosted 88 registered participants from 8 countries, with 80 papers spread over 8 oral sessions and 1 poster session presented. The option to both present papers and attend the conference remotely by zoom was available to all who could not attend in person. Of all the papers, four invited talks were given by prominent scientists, with some of them leading new large missions. The Symposium presentations covered a broad range of topics including instruments, receivers, THz mixers and local oscillators, large detector array, optics, calibration techniques, and some new ideas related to device physics. A full symposium agenda and list of presentations can be found at the Symposium website: <http://www.isstt2020.com>.

Special thanks to:



Virginia Diodes, Inc.



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# The Best PhD Student ISSTT2020 Contribution Award Committee

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## Winner of the best PhD Student ISSTT2020 Contribution

*Development of a Dual-Band Metamaterial Lens for Cubesat Water Observation,*  
Cassandra Whitton

# Conference Schedule

## SUNDAY, MARCH 9 2020

5pm - 7:30pm - **Reception**, Four Peaks Wilson tasting room

## MONDAY, MARCH 9 2020

8:00 - **Coffee and Registration**

8:45 - **Welcome**, Nancy Gonzales - Dean of Natural Sciences, The College of Liberal Arts and Sciences, Arizona State University

9:00 - **Invited Talk** - *The Gal/Xgal Ultra-Long Duration Balloon-borne Spectroscopic THz Observatory (GUSTO)*, Christopher Walker, Craig Kulesa, and Paul Goldsmith

### Session I: Suborbital

Chair: Chris Groppi

9:30 - *First Flight of an Almost All-CMOS 183 GHz Limb-Sounding Spectrometer System Aboard the ReckTangLE Ballooncraft*, Adrian Tang, Deacon Nemchick, Maria Alonso, Goutam Chattopadhyay, Theodore Reck, Yan Zhang, Yanghyo Kim and Mau-Chung Frank Chang

9:50 - *The Terahertz Intensity Mapper (TIM): Far-infrared Balloon Mission for Spectroscopic Galaxy Evolution Studies*, Reinier Janssen, James Aguirre, Peter Barry, Justin Bracks, Matt Bradford, Bruce Bumble, Anthony Corso, Jeff Filippini, Chris Groppi, Dan Marrone, Matthieu Bethermin, Tzu-Ching Chang, Mark Devlin, Olivier Dore, Jianyang Fu, Steve Hailey-Dunsheath, Jonathan Hoh, Gilbert Holder, Garrett Keating, Rick LeDuc, Ryan Keenan, Ely Kovetz, Guilaine Lagache, Lunjun Liu, Hamdi Mani, Justin Mathewson, Rong Nie, Phil Mauskopf, Desika Narayanan, Gergo Popping, Joseph Redford, Erik Shirokoff, Adrian Sinclair, Rachel Somerville, Isaac Trumper, Matt Underhill, Bade Uzgil, Joaquin Vieira and Jonas Zmuidzinas

10:10 - *In-flight Performance of the BLAST-TNG Kinetic Inductance Detector Arrays and Readout Electronics*, Philip Mauskopf and Christopher Groppi

10:30 - **Coffee Break**

11:00 - *ASTHROS - Astrophysics Stratospheric Telescope for High-Spectral Resolution Observations at Submillimeter-waves: Mission Overview and Development Status*, Jose V. Siles, Jorge Pineda, Jonathan Kawamura, Christopher Groppi, Pietro Bernasconi, Joshua Gundersen and Paul Goldsmith

### Session II: Missions and Concepts

Chair: Jose Siles

11:20 - *THz Space Mission to Probe the Trail of Water*, Paul Goldsmith, Dariusz Lis, Jon Kawamura, Jose Siles and Youngmin Seo

11:40 - *The SAFARI far-IR Spectrometer for SPICA*, Willem Jellema, Pieter Dieleman and Peter Roelfsema

12:00 - *Submillimeter Wave Differential Absorption Radar For Water Vapor Sounding In The Martial Atmosphere*, Omkar Pradhan, Ken Cooper, Leslie Tampari, Brian Drouin, Raquel Monje, Richard Roy, Jose Siles and Corey Cochrane

12:20 - *Millimetron Space Observatory Mission Development*, Andrey Baryshev, Andrey Smirnov, Evgeny Golubev, Mikhail Arkhipov, Elena Filina, Victor Pyshnov, Nelly Myshonkova, Sergey Fedorchuk, Igor Vinogradov, Thijs Graauw De and Sergey Likhachev

12:40 - Lunch Break

2:00 - Invited Talk - *Submillimeter Wave Power Generation with InP HEMT Technology*, Bill Deal

Session III: Schottky Diode and CMOS receivers

Chair: Imran Mehdi

2:30 - *Technology Roadmap for the Heterodyne Receiver for Origins (HERO)*, Martina Wiedner

2:50 - *High-Sensitivity Terahertz Detection Module (HSTDM) onboard China's Space Station*, Sheng-Cai Shi

3:10 - *A Single Sideband 530-600 GHz Integrated Receiver Utilizing Tunable Waveguide Filters*, Theodore Reck, Daniel Koller, Jeffrey Hesler and Eric Bryerton

3:30 - Coffee Break

3:50 - *MetOp-SG Ice Cloud Imager 183-664 GHz Front-End Engineering and Qualification Model Test Results*, Patrick Pütz, Bertrand Thomas, Michael Brandt, Guido Sonnabend, Tobias Stangier, Pia Krause, Ralf Henneberger, Monica Trasatti, Martin Philipp, Andreas Kilian, Hugh Gibson, Simon Rea, Hui Wang, Manu Henry, Chris Howe, Kai Parow-Souchon, Brian Moyna, Brian Ellison, Ana Andrés-Beivide, Marc Bergada, Noelia Alcaraz, Jaione Martinez, Michael Gotsmann and Ulf Klein

4:10 - *180 GHz CMOS Pulsed Transmitter and Heterodyne Receiver Pair for in-situ Chemical Detections*, Deacon Nemchick, Brian Drouin, Adrian Tang, Yanghyo Kim, Maria Alonso and M.C. Frank Chang

4:30-4:50 - *Integrated Silicon Platform for Co-planar Design of Vertically Stacked 2.06 THz Mixer Module*, Christine Chen

5:45 - Buses Leave ISTB4 to Botanical Garden - Banquet

6:00 - Reception Banquet, Desert Botanical Garden

TUESDAY, MARCH 10 2020

8:00 - Coffee and Registration

8:45 - Invited Talk - *FIR Astrophysics in the US*, Kartik Sheth

Session IV: Novel Devices

Chair: Boris Karasik

9:15 - *Heterodyne receiving with frequency combs: towards simultaneous ultrabroadband spectroscopy*, David Burghoff

9:35 - *Wideband Superconducting Parametric Amplifiers for Millimeter-wave Instruments*, Peter Day, Nikita Klimovich, Byeongho Eom and Henry Leduc

9:55 - *Mixing with Y-Ba-Cu-O Josephson Junctions Fabricated with Focused Helium Ion Beam Irradiation*, Anthony Cortez, Ethan Cho, Hao Li, Daniel Cunnane, Boris Karasik and Shane Cybart

10:15 - *Low-power consumption THz quantum-cascade VECSEL using patch-based metasurface*, Christopher Curwen, John Reno and Benjamin Williams

10:35 - **Coffee Break**

11:00 - *Design Study for Optimal Performance of Tunable Antenna-Coupled Intersubband Terahertz (TACIT) Mixer*, Changyun Yoo, Jonathan Kawamura, Kenneth West, Loren Pfeiffer, Boris Karasik and Mark Sherwin

11:20 - *NOEMA heterodyne receivers performance and tuning optimization*, Christophe Risacher

## Session V: THz sources

Chair: H.W. Huebers

11:40 - *Development and Testing of the 1.46 THz and 1.9 THz GUSTO Flight-Model Local Oscillator Arrays*, Jeffrey Hesler, Thomas Crowe, Cliff Rowland, Stephen Retzliff, Corey Gardner, Silvio Mancone and Ben Swartz

12:00 - *Compact Multi-Pixel Frequency Multiplied Local Oscillator Sources for Wideband Array Receivers in the 200-600 GHz & 1.4-2.7 THz Ranges*, Jose V. Siles, Jonathan Kawamura, Robert Lin, Choonsup Lee, Alain Maestrini, Darren Hayton, Ken Cooper, Maria Alonso del Pino and Imran Mehdi

12:20 - *Stabilization of terahertz quantum-cascade lasers by near-infrared optical excitation*, Martin Wienold, Tasmim Alam, Xiang Lü, Klaus Biermann, Lutz Schrottke, Holger T. Grahn and Heinz-Wilhelm Hübers

12:40 - **Lunch Break**

2:00 - *Advances in High-Power THz Sources*, Thomas Crowe, Steven Retzliff, Eric Bryerton and Jeffrey Hesler

## Session IV: Spectrometers, Readouts, and IF electronics

Chair: Patricio Mena

2:20 - *Advancements in Millimeter-Wave Filter Bank Spectrometers*, Kyle Massingill, Sean Bryan, Christopher Groppi, Philip Mausekopf, Bianca Pina, Philip Rybak and Peter Wullen

2:40 - *Development of a Tone-Tracking Algorithm for Maximizing Dynamic Range of Kinetic Inductance Detectors*, Jonathan Hoh, Adrian Sinclair and Ryan Stephenson

3:00 - *Ultra-high Gain, Low Distortion Cryogenic Low-noise Amplifier for Astronomical Purposes*, Justin Mathewson, Jonathan Hoh and Hamdi Mani

3:20 - *Characterization of Cryogenic Flexible Transmission Lines Designed for the GUSTO IF Harness*, Marko Neric, Thomas Mozdzen, Hamdi Mani and Christopher Groppi

3:40 - **Coffee Break**

4:10-5:50 - **Poster Session**



WEDNESDAY, MARCH 11 2020

8:00 - Coffee and Registration

8:45 - Invited Talk - *Steward Observatory's Radio Telescopes: Recent Advancements and Future Developments*, Alyson Ford

## Session VII: Optics and Waveguide Components

Chair: Andrey Baryshev

9:15 - *4 THz beam filter based on a back to back Si-lens system*, Yuner Gan, Behnam Mirzaei, Sebastiaan van der Poel, Jose Silva, Matvey Finkel, Martin Eggens, Marcel Ridder, Ali Khalatpour, Qing Hu, Floris van der Tak and Jian Rong Gao

9:35 - *Silicon micromachined receiver calibration switch for THz frequencies*, Adrian Gomez Torrent, Umer Shah and Joachim Oberhammer.

9:55 - *Characterization of Dielectric Material at 300 GHz for Vacuum Window Applications*, C. Edward Tong, Keara Carter and Jake Connors

10:15 - *Contactless rotating MEMS waveguide switch for water detection at 557 GHz*, Sofia Rahiminejad, Cecile Jung-Kubiak, Mina Rais-Zadeh and Goutam Chattopadhyay

10:35 - Coffee Break

11:10 - *Receivers for the wideband Submillimeter Array*, Paul Grimes, Raymond Blundell, Scott Paine, Edward Tong and Lingzhen Zeng

## Session VIII: SIS Mixers and Receivers

Chair: Edward Tong

11:30 - *A Horn-coupled 4-beam Dual-polarization Balanced SIS Mixer Based on Planar-integrated Circuits*, Wenlei Shan, Shohei Ezaki, Keiko Kaneko, Akihira Miyachi, Takafumi Kojima and Yoshinori Uzawa

11:50 - *Advanced Tuning Algorithms for High-Frequency SIS Mixers*, Ronald Hesper, Jan Barkhof, Andrey Baryshev, Tobias Vos, Giorgio Siringo, Neil Phillips and Pavel Yagoubov

12:10 - *Optics and Feed Design for the wSMA Receiver System*, Paul Grimes, Scott Paine, Lingzhen Zeng and Edward Tong

12:30 - Lunch Break

2:00 - Invited Talk - *The Evolution of Antenna Technology: Past, Present and Future*, Constantine Balanis

2:30 - *Terahertz MgB<sub>2</sub> HEB mixers with a 13GHz gain bandwidth*, Narendra Acharya, Evgenii Novoselov and Sergey Cherednichenko

2:50 - *Experimental Characterization of the LO Heating Effect in THz SIS mixers*, Alessandro Traini, Boon-Kok Tan, Ghassan Yassin, John Garrett, Andrey Khudchenko, Ronald Hesper, Andrey Baryshev and Valery Koshelets

3:40-4:40 - Meteorite Vault and lab Tours - ISTB4

# Poster Presentations

*A Novel WR1.0 Full Band Terahertz Frequency Quadrupler*, Fei Yang

*Thermal Transport in Graphene-based Hot Electron Bolometers with Different Electrode Contacts*, Wei Miao, Feiming Li, Hao Gao, Zheng Wang, Wen Zhang, Yuan Ren, Kangmin Zhou, Shengcai Shi, Cui Yu, Zezhao He, Qingbin Liu and Zhihong Feng

*Development of a 350-GHz Dual-Polarization On-Chip Spectrometer*, Jing Li

*Follow-up experiments of the gain and noise IF bandwidth for a Ni-NbN HEBM*, Yoshihisa Irimajiri and Akira Kawakami

*A Full Octave-Band OMT for Millimetre-Wave Receivers*, Doug Henke

*A balloon-borne heterodyne receiver for atmospheric studies of atomic oxygen*, Martin Wienold, Alexey Semenov, Heiko Richter and Heinz-Wilhelm Hübers

*Research on High Precision Carbon Fiber Reinforced Plastics Reflector Panels for Dome A 5m Terahertz Explorer*, Yuan Qian, Xufeng Hao and Hongtao Xu

*Suppressing cavity resonances in high-frequency amplifiers with metamaterial structures*, David Monasterio, Nelson Castro, Francisco Pizarro and Patricio Mena

*Modelling of Travelling-Wave Kinetic-Inductance Parametric Amplifiers Implemented with Artificial Transmission Lines*, Patricio Mena and Daniel Valenzuela

*High Dynamic Range Josephson Travelling Wave Parametric Amplifier*, Kitti Ratter and Boon-Kok Tan

*High Reflectance of Roughened Surface for the Integrating Sphere of SAFARI Calibration Source*, Ming-Jye Wang, Chun-Lun Wang, Chuang-Ping Chiu and Ting-Hang Pei

*Mid-infrared multi-beam local oscillator source based on a fiber coupled quantum cascade laser*, Yuan Ren, Daixi Zhang, Zheng Wang, Kangmin Zhou, Jiaqiang Zhong, Dong Liu, Wei Miao, Wen Zhang and Shengcai Shi

*Characterization System for SIS Frequency Converters based on Scalar Mixer Calibration Technique*, Takafumi Kojima, Yoshinori Uzawa, Wenlei Shan and Yuto Kozuki

*Planar silicon metamaterial lenses with integrated anti-reflection coatings for frequencies around 150 GHz*, Julie Jauk, Guoliang Wang, Victor Moreno, Magali Parioleau, Anne-Laure Fontana, Samuel Leclercq and Eduard Driessen

*Development of wideband circular polarizer in 70-118 GHz band*, Sho Masui, Yutaka Hasegawa, Toshikazu Onishi, Hideo Ogawa, Satoshi Ochiai and Issei Watanabe

*Preliminary Design of a Multibeam Receiver for the SMA*, John Garrett, Paul Grimes and Edward Tong

*Performance of the SIS terahertz photon detector*, Hajime Ezawa, Hiroshi Matsuo, Masahiro Ukibe, Go Fujii and Shigetomo Shiki

*Waveguide Components for wSMA Frontends*, Lingzhen Zeng, C Edward Tong and Paul Grimes

***Development of a Dual-Band Metamaterial Lens for Cubesat Water Observation***, Cassandra Whitton, Christopher Groppi, Philip Mauskopf, Jose Siles and Adrian Tang

***Development of readout electronics for SIS photon counting detectors***, Hiroshi Matsuo, Hajime Ezawa, Ryohei Noji and Saho Kawahara

***Development of 109-pixel NbTiN-Al MKID array for the 100-GHz band astronomical observations***, Yosuke Murayama, Tom Nitta, Makoto Nagai, Ryotaro Hikawa, Ryuji Suzuki, Wenlei Shan, Hiroshi Matsuo, Akihira Miyachi, Matthias Kroug, Shohei Ezaki, Yutaro Sekimoto, Takashi Noguchi, Masato Naruse, Nario Kuno and Naomasa Nakai

***High Power Amplifier Modules from 110 to 200 GHz***, Theodore Reck, Zach Griffith and Eric Bryerton

***Reliability study of THz Schottky mixers and HBV frequency multipliers for space applications***, Vladimir Drakinskiy, Jospik Vukusic, Daniel Heinerås, Peter Sobis, Vaclav Valenta, Marie-Genevieve Perichaud, Fernando Martinez Martin and Jan Stake

***Performance Comparison of Fabricated 90 Degree Waveguide Twists using Direct Milling***, Usman Shehryar

***Tuning of superconducting Ti and Ti/Au bilayer films for transition-edge sensors***, Wen Zhang, Zheng Wang, Pei Zhan Li, Yue Gen, Jia Qiang Zhong, Wei Miao, Yuan Ren, Kang Ming Zhou, Qi Jun Yao and Sheng Cai Shi

***A 200 GHz cloud radar multiplexing antenna***, Richard Wylde, Stuart Froud, Manju Henry, Peter Huggard, Duncan Robertson, Soe Min Tun and Hui Wang

***1 to 8 beam distributor at 4.7 THz for GUSTO***, Behnam Mirzaei, Matvey Finkel, Jose Silva, Wouter Laauwen, Christopher Groppi, Ali Khalatpour, Qing Hu, Abram Young, Christopher Walker and Jian Rong Gao

***Design, Fabrication and Characterization of Waveguide to Substrate Transition Based on Unilateral Substrateless Finline Structures***, Cristian Lopez, Vincent Desmaris, Denis Meledin, Alexey Pavolotsky and Victor Belitsky

***Spline-Profile Diagonal Horn Transmitter at 104 GHz Suitable for LLAMA Observatory Holography Measurements***, Daniele Ronso Lima, Rocio Molina, Catalina Medina, Danilo Zanella, Ricardo Finger, Jacques Lepine and Andrey Baryshev

***Design, Construction and Characterization of a Dichroic Filter for Dual-Band Observation with ALMA***, Daniel Montofre, Fausto Patricio Mena and Andrey Baryshev

***Development of THz Superconducting HEB Receiver Systems for Balloons, Aircraft, SmallSats and Future Large Missions***, Jonathan Kawamura

***Photo-Induced Coded-Aperture Terahertz Imaging using Mesa-Array Structures for Approaching Subwavelength Resolution***, Yijing Deng, Yu Shi, Jun Ren, Patrick Fay and Lei Liu

***A 1.37 THz Waveguide-based 2 X 2 Beam Divider Fabricated by Two Microfabrication Technologies***, Haotian Zhu, Jerome Valentin, Thibaut Vacelet, Sylwester Bargiel, Samuel Queste, Laurent Robert, Djaffar Belharet, Etienne Herth, Yan Delorme and Martina Wiedner

***Absorber Optimization Study for the Terahertz Intensity Mapper (TIM)***, Rong Nie, Reinier Janssen, Matt Bradford, Jeff Filippini and Steve Hailey-Dunsheath

***Meissner Effect Transistor***, Siddhartha Sirsi and Christopher Walker

***Design concept of the W-Band multibeam receiver for the SRT***, Alessandro Navarrini, Luca Olmi, Renzo Nesti, Pasqualino Marongiu, Pierluigi Ortu, Luca Cresci, Andrea Orlati, Alessandro Scalambra and Alessandro Orfei

***Developing High-Sensitivity Graphene Terahertz Detectors Through A High-Yield Nanofabrication Process***, Panagiotis Theofanopoulos and Georgios Trichopoulos

***A small satellite with a dual-frequency heterodyne spectrometer for the detection of atomic oxygen in the atmosphere of Earth***, H Richter, J Hildebrandt, T Roth, M Lengowski, C Philpot, A Braukhane, T Delovski, M Wienold, S Klinkner and Heinz-Wilhelm Hübers

***SuperSpec: On-Chip Direct-Detection Spectroscopy, Preparing for LMT Campaign***, Joe Redford, Steve Hailey-Dunsheath, H.G. (Rick) LeDuc, Reinier Janssen, C.M. (Matt) Bradford, Ryan McGeehan, Kirit Karkare, Erik Shirokoff, Pete Barry, Jordan Wheeler, Jason Glenn, Phil Mausekopf, Carole Tucker, Ryley Hill, and Scott Chapman