



Proceedings of the 14th International Symposium on Space Terahertz Technology

Chris Walker[†] and John Payne[‡], Editors

[†] Steward Observatory, University of Arizona

*[‡] National Radio Astronomy Observatory
Tucson, Arizona*

April 22-24, 2003

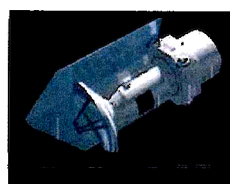
*Loews Ventana Canyon Resort
Tucson, Arizona*



SOFIA



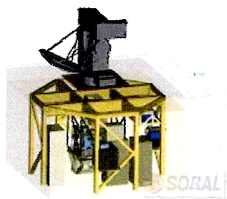
SAFIR



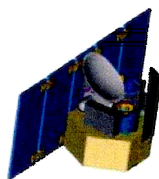
Herschel



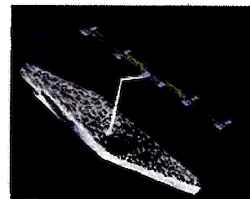
ALMA



AST/RO



GTO



TPF

**Steward Observatory Radio Astronomy Lab
University of Arizona
Tucson, Arizona**

**National Radio Astronomy Observatory
Tucson, Arizona**

**Georgia Institute of Technology
Atlanta, Georgia**

April, 2004

PREFACE

The fields of THz science and technology are now experiencing tremendous growth, both in the public and private sectors. Recent advances in theory, fabrication, and analytical tools permit for the first time the realization of devices, components, and systems that were only imagined just a short time ago. Much of this accelerated growth can be traced directly to the instrument requirements of space missions (*e.g. Herschel*). We will be benefiting from this work for years to come, both in future missions (*e.g. SOFIA* and *SAFIR*) and in enumerable remote sensing applications (spaceborne and terrestrial). THz science and technology is still in its infancy. The next decade should prove to be even more exciting and productive than the last!

The 14th International Symposium on Space TeraHertz Technology was held at the Loews Ventana Canyon Resort in Tucson, Arizona from April 22-24, 2004. There were a total of ~125 engineers and scientists in attendance from around the world. There were 12 oral sessions and a 3-day long poster session. A total of 55 papers were presented in the oral sessions and 35 in the poster session, for a combined total of 90 papers. The number of contributions in each subject area were roughly as follows:

Hot Electron Bolometers	15
SIS Mixers	18
Sources	18
Devices	8
Incoherent/Bolometers	2
Waveguide	9
Spectrometers	5
Systems	10
Optics	5

The Symposium would not have been possible without the support of the NRAO Tucson staff (in particular Jennifer Neighbours) and the students of the Steward Observatory Radio Astronomy Laboratory (Chris Groppi, Dathon Golish, and Abby Hedden). We also wish to thank Dr. John Papapolymerou and Peter Kirby of the Georgia Institute of Technology for their help in organizing the conference and the IEEE MTT Society for their support. Finally, the Chairs thank the SOC, session chairs, presenters, and all participants for making the 14th International Symposium on Space TeraHertz Technology an enjoyable and rewarding experience. We look forward to seeing you all in the future.

Christopher K. Walker
John M. Payne

14th International Symposium on Space Terahertz Technology

Session 1: HEB MIXERS I

Chair: Sigfrid Yngvesson

University of Massachusetts at Amherst

- 1.1. Review of HEB Heterodyne Detectors and Receiver Systems for the THz** 1
Range: Present and Future
Sigfrid Yngvesson
 University of Massachusetts at Amherst
- 1.2. Noise performance of NbN Hot Electron Bolometer mixers at 2.5 THz and its dependence on the contact resistance** 11
J. J. A. Baselmans¹, M. Hajenius^{1,2}, J. R. Gao^{1,2}, T. M. Klapwijk², P. A. J. de Korte¹, B. Voronov³, G. Gol'tsman³
¹Space Research Organisation of the Netherlands (SRON), Groningen, The Netherlands
²Faculty of Applied Sciences, Delft University of Technology, The Netherlands
³Moscow State Pedagogical University, Russia
- 1.3. Fabrication and Noise Measurement of NbTiN Hot Electron Bolometer Heterodyne Mixers at THz Frequencies** 20
Pourya Khosropanah¹, Sven Bedorf², Sergey Cherednichenko¹, V. Drakinskiy¹, Karl Jacobs², Harald Merkel¹, Erik Kollberg¹
¹Department of Microtechnology and Nanoscience, Microwave Electronics Laboratory, Chalmers University of Technology, Sweden
²KOSMA, I. Physikalisches Institut, University of Cologne, Germany
- 1.4. Comparison of the Noise Performance of NbTiN and NbN Hot Electron Bolometer Heterodyne Mixers at THz Frequencies** 31
Harald F. Merkel, Pourya Khosropanah, Sergey Cherednichenko, Erik Kollberg
 Microelectronics Department, Microwave Electronics Laboratory, Chalmers University of Technology, Sweden

Session 2: SIS MIXERS I

Chair: Tony Kerr

National Radio Astronomy Observatory

- 2.1. Superconducting Hot-Electron Bolometer Mixer for Terahertz Heterodyne Receivers** 33
Alexei D. Semenov¹, Heinz-Wilhelm Hübers¹, Heiko Richter¹, Konstantin Smirnov², Gregory N. Gol'tsman², Natalia Kaurova², Boris M. Vornov²
¹DLR Institute of Space Sensor Technology and Planetary Exploration, Germany
²Moscow State Pedagogical University, Russia
- 2.2. Sideband-Separating SIS Mixer For ALMA Band 7, 275-370 GHz** 41
Stéphane Claude
 Institut de Radio Astronomie Millimetrique, France
- 2.3. Design Accuracy of the Resonance Frequency for the PCTJ SIS Mixer** 52
Yasunori Fujii^{1,2}, Ken'ichi Kikuchi¹, Junji Inatani¹
¹National Space Development Agency of Japan, Japan
²Nihon Tsushinki Co., Ltd., Japan

- 2.4. Low noise SIS mixer for the band 1.1-1.25 THz of the Herschel space radio telescope** 54
A. Karpov¹, D. Miller¹, F. Rice¹, J. Zmuidzinas¹, J. A. Stern², B. Bumble², H. G. LeDuc²

¹California Institute of Technology

²Jet Propulsion Laboratory

- 2.5. Influence of Junction-Quality and Current Density on HIFI Band 2 Mixer Performance** 55

*R. Teipen¹, M. Justen¹, T. Tils¹, S. Glenz¹, C. E. Honingh¹, K. Jacobs¹, B. D. Jackson²,
T. Zijlstra³, M. Kroug³*

¹KOSMA, I. Physikalisches Institut, Universität zu Köln, Germany

²National Institute for Space Research (SRON), The Netherlands

³Dept. of Nanoscience, Faculty of Applied Sciences, Delft Univ. of Technology, The Netherlands

- 2.6. All-NbN SIS Mixers Using a Tuning Circuit with Two Half-Wavelength Distributed Junctions** 63

Y. Uzawa, A. Kawakami, M. Takeda, Z. Wang

Kansai Advanced Research Center, Communications Research Laboratory, Japan

Session 3: SOURCES I

Chair: John Payne

National Radio Astronomy Observatory

- 3.1. A 1600-1900 GHz Tunable Source** 64
Neal Erickson, Ron Grosslein, John Wielgus, Vern Fath, I. Mehdi, J. Gill

¹Department of Astronomy, University of Massachusetts

²Jet Propulsion Laboratory

- 3.2. W Band MMIC Power Amplifiers for the Herschel HIFI Instrument** 73
*Robert R. Ferber¹, Todd C. Gaier¹, John C. Pearson¹, Lorene A. Samoska¹,
Mary Wells¹, April Campbell¹, Gerald Swift², Paul Yocom², K. T. Liao²*

¹Jet Propulsion Laboratory, California Institute of Technology

²Northrop Grumman Space Technology (NGST)

- 3.3. Broadband Submillimeter Receiver and Source Development** 83
J. L. Hesler, D. W. Porterfield, W. L. Bishop, D. S. Kurtz, T. W. Crowe
Virginia Diodes Inc.

- 3.4. Design and Analysis of 500 GHz Hetero-structure Barrier Varactor Quintuplers** 84

Mattias Ingvarson, Arne Øistein Olsen, Jan Stake

Microwave Electronics Laboratory, Chalmers University of Technology, Sweden

- 3.5. 1400-1900 GHz Local Oscillators for the Herschel Space Observatory** 94
*John Ward, Frank Maiwald, Goutam Chattopadhyay, Erich Schlecht,
Alain Maestrini*, John Gill, Imran Mehdi*

California Institute of Technology, Jet Propulsion Laboratory

*Now at the Observatoire de Paris

Session 4: DEVICES

Chair: Art Lichtenberger

University of Virginia

- 4.1. HgCdTe Photoconductive Mixers for 3- 15 Terahertz** 102
Albert Betz¹, Rita Boreiko¹, Yongdong Zhou², Jun Zhao², Yusuf Selamet², Yong Chang², Renganathan Ashokan², Charlie Bucker^{2,3}, Sivalingam Sivananthan²
¹Center for Astrophysics & Space Astronomy, University of Colorado
²Microphysics Laboratory and Department of Physics, The University of Illinois at Chicago
³Physics Institute of Wuerzburg, Germany
- 4.2. Transferred Substrated Heterojunction Bipolar Transistors for Submillimeter Wave Applications** 112
Andy Fung¹, Lorene Samoska¹, Peter Siegel¹, M. Rodwell², M. Urteaga², V. Paidi², Roger Malik³
¹California Institute of Technology, Jet Propulsion Laboratory
²Department of Electrical and Computer Engineering, University of California at Santa Barbara
³RJM Semiconductor
- 4.3. Novel Designs for Submillimeter Subharmonic and Fundamental Schottky Mixers** 118
Erich Schlecht, John Gill, Peter Siegel, John Oswald, Imran Mehdi
 Jet Propulsion Laboratory
- 4.4. Design, Fabrication and Testing of Semi-conductor Tunable Antenna-coupled Intersubband Terahertz (TACIT) Detectors** 119
M. S. Sherwin^{1,3}, G. B. Serapiglia¹, Y. Dora^{1,2}, M. Hanson⁴, A. C. Gossard^{2,4}, W. R. McGrath⁵
¹Institute for Quantum Engineering Science and Technology (iQUEST), University of California at Santa Barbara (UCSB)
²Department of Electrical and Computer Engineering, UCSB
³Department of Physics, UCSB
⁴Department of Materials, UCSB
⁵Submillimeter-wave superconductive sensors group, Jet Propulsion Laboratory
- 4.5. SIR Chip for TELIS** 121
S. V. Shitov^{1,2}, V.P. Koshelets^{1,2}, P.A. Yagoubov, L. V. Filippenko¹, P.N. Dmitriev¹, O.V. Koryukin¹, An. B. Ermakov^{1,2}, R. W. M. Hoogeveen².
¹Institute of Radio Engineering and Electronics (IREE), Russian Academy of Sciences, Russia
²National Institute for Space Research (SRON), The Netherlands
- 4.6. Large RF Bandwidth Waveguide to Thinfilm Microstrip Transitions on Suspended Membrane for Use in Silicon Micromachined Mixer Blocks at THz Frequencies** 127
J. W. Kooi¹, Christian Drouet d'Aubigny², Chris Walker², Arthur W. Lichtenberger³
¹California Institute of Technology
²Department of Astronomy and Steward Observatory, University of Arizona
³University of Virginia

Session 5: INCOHERENT/BOLOMETRIC DETECTORS

Chair: Harvey Moseley

NASA - Goddard Space Flight Center

5.1. Photon Counting vs Photon Integration at SubMM Waves 128

Boris S. Karasik¹, Andrew V. Sergeev²

¹Jet Propulsion Laboratory, California Institute of Technology

²Wayne State University

Session 6: WAVEGUIDE

Chair: John Papapolymerou

Georgia Institute of Technology

6.1. Single Chip, Beam Combining, Interferometric Detector for Submillimetre-wave Astronomy 129

E. Campbell¹, S. Withington¹, G. Yassin¹, C. Y. Tham¹, S. Wolfe², K. Jacobs²

¹Department of Physics, University of Cambridge, UK

²Department of Physics, University of Cologne, Germany

6.2. Measurements and Simulations of Overmoded Waveguide Components at 70-118 GHz, 220-330 GHz, and 610-720 GHz 138

G. A. Ediss

National Radio Astronomy Observatory

6.3. A Broadband Waveguide Thermal Isolator 148

J. L. Hesler¹, A. R. Kerr², N. Horner²

¹University of Virginia, Department of ECE

²National Radio Astronomy Observatory

6.4. Silicon Laser Micromachining for the Development of Planar Waveguide-Based THz Structures 155

Peter Kirby¹, John Papapolymerou¹, Christian D'Aubigny², Chris Walker²

¹School of Electrical & Computer Engineering, Georgia Institute of Technology

²Department of Astronomy, University of Arizona

6.5. Design of a Dual Polarization SIS Sideband Separating Receiver Based on Waveguide OMT for the 275-370 GHz Frequency Band 159

A. Navarrini, M. Carter

Institut de Radioastronomie Millimétrique (IRAM), France

6.6. Symmetric Waveguide Orthomode Junctions 169

E. J. Wollack¹, W. Grammer²

¹Laboratory for Astronomy and Astrophysics, NASA/Goddard Space Flight Center

²National Radio Astronomy Observatory

Session 7: SPECTROMETERS

Chair: Rudolf Schieder

Physics Institute, University of Cologne

- 7.1. Optical Methods for Spectral Analysis of Future Heterodyne Instruments** 177
R. Schieder
 Physics Institute, University of Cologne, Germany
- 7.2. A Correlator Chip for Spaceborne Radiometry** 178
Constantin Timoc
 Spaceborne Inc., La Canada, California

Session 8: SYSTEMS

Chair: Chris Walker

University of Arizona

- 8.1. Deployment of TREND – A Low Noise Receiver User Instrument at 1.25 THz to 1.5 THz for AST/RO at the South Pole** 179
Eyal Gerecht¹, Sigfrid Yngvesson¹, John Nicholson¹, Yan Zhuang¹, Fernando Rodriguez Morales¹, Xin Zhao¹, Dazhen Gu¹, Richard Zannoni¹, Michael Coulombe², Jason Dickinson², Thomas Goyette², Bill Gorveatt², Jerry Waldman², Pourya Khosropanah³, Christopher Groppi⁴, Abigail Hedden⁴, Dathon Golish⁴, Christopher Walker⁴, Jacob Kooi⁵, Richard Chamberlin⁵, Antony Stark⁶, Christopher Martin⁶, Robert Stupak⁶, Nicholas Tothill⁶, Adair Lane⁶
¹University of Massachusetts at Amherst
²Submillimeter Wave Technology Laboratory, University of Massachusetts at Lowell
³Chalmers University of Technology, Sweden
⁴Department of Astronomy and Steward Observatory, University of Arizona
⁵California Institute of Technology
⁶Smithsonian Astrophysical Observatory
- 8.2. Heterodyne Array Development at the University of Arizona** 189
C. Groppi¹, C. Walker¹, C. Kulesa¹, G. Narayanan², K. Jacobs³, U. Graf³, R. Schieder³, J. Kooi⁴
¹SORAL, University of Arizona
²University of Massachusetts at Amherst
³University of Cologne, Germany
⁴California Institute of Technology
- 8.3. TELIS – Development of a New Balloon-Borne THZ/Submm Heterodyne Limb Sounder** 204
R. W. M. Hoogeveen¹, P. A. Yagoubov¹, A. M. Maurellis¹, U. Mair², M. Krocka², G. Wagner², M. Birk², H.-W. Hübers³, H. Richter³, A. Semenov³, G. Gol'tsman⁴, B. Voronov⁴, V. Koshelets⁵, S. Shitov⁵, B. Ellison⁶, B. Kerridge⁶, D. Matheson⁶, M. Harman⁶, R. Siddans⁶, J. Reburn⁶
¹National Institute for Space Research (SRON), The Netherlands
²Remote Sensing Technology Institute, DLR, Germany
³Institute for Space Sensor Technology and Planetary Exploration, DLR, Germany
⁴Moscow State Pedagogical University, Russia
⁵Institute of Radio Engineering and Electronics (IREE), Russia
⁶Rutherford Appleton Laboratory (RAL), UK

8.4. Heterodyne Instrumentation Development for the Caltech Submillimeter Observatory	215
<i>Jacob W. Kooi, Attila Kovacs, T. G. Phillips, J. Zmuidzinas</i> California Institute of Technology	
8.5. CO(9-8) in Orion	216
<i>Simon J. E. Radford¹, Ray Blundell², Scott Paine², Hugh Gibson², Dan Marrone²</i> ¹ National Radio Astronomy Observatory ² Smithsonian Astrophysical Observatory	
8.6. Quasi-Optics for 640 GHz SIS Receiver of International-Space-Station-Borne Limb-Emission Sounder SMILES	217
<i>Masumichi Seta¹, Axel Murk², Takeshi Manabe¹, Junji Inatani³, Richard Wylde⁴, Takeshi Miura³, Toshiyuki Nishibori³</i> ¹ Communications Research Laboratory ² Institute of Applied Physics, University of Bern, Switzerland ³ National Space Development Agency, Japan ⁴ Thomas Keating Ltd., UK	
8.7. Meeting the Optical Requirements of Large Focal-Plane Arrays	227
<i>Antony A. Stark</i> Smithsonian Astrophysical Observatory	

Session 9: SIS MIXERS II

Chair: Karl Jacobs
University of Cologne

9.1. Influence of Temperature Variations on the Stability of a Submm Wave Receiver	237
<i>Baryshev, A.^{1,2,3}, R. Hesper^{1,2,3}, G. Gerlofsma^{1,2,3}, M. Kroug⁴, W. Wild^{2,3}</i> ¹ Netherlands Research School for Astronomy (NOVA), The Netherlands ² Space Research Organization Netherlands (SRON), The Netherlands ³ University of Groningen (RuG), The Netherlands ⁴ DIMES, Delft University of Technology, The Netherlands	
9.2. Quasiparticle Mixing and Josephson Electrodynamics in Non-uniform Parallel Junction Arrays	246
<i>F. Boussaha, M. Salez, Y. Delorme, F. Dauplay, A. Feret, K. Westerberg, B. Lecomte</i> LERMA, Observatoire de Paris, France	
9.3. Investigation of the Performance of 700 GHz Finline Mixers	247
<i>P. Grimes¹, P. Kittara¹, G. Yassin¹, S. Withington¹, K. Jacobs²</i> ¹ Cavendish Laboratory, UK ² KOSMA, I. Physikalisches Institut, University of Cologne, Germany	
9.4. Measurement of Gain Compression in SIS Mixer Receivers	257
<i>A. R. Kerr¹, J. Effland¹, S.-K. Pan¹, G. Lauria¹, A. W. Lichtenberger², and R. Groves¹</i> ¹ National Radio Astronomy Observatory ² University of Virginia	
9.5. Investigations into the Effect of Reflections at the RF and LO Ports of an SIS Mixer	265
<i>Nicholas D. Whyborn</i> National Institute for Space Research (SRON), The Netherlands	

Session 10: HEB MIXERS II

Chair: Johathan Kawamura

Jet Propulsion Laboratory

-
- | | |
|---|-----|
| <p>10.1. Development of NbN Terahertz HEB Mixer Devices and Films
 <i>Eyal Gerecht¹, Ashok K. Bhupathiraju¹, John Nicholson², Dazhen Gu², Yan Zhuang²,
 Fernando Rodriguez Morales², Xin Zhao², Richard Zannoni², Sigfrid Yngvesson²</i>
 ¹National Institute of Standards and Technology
 ²Department of Electrical and Computer Engineering, University of Massachusetts at Amherst</p> | 266 |
| <p>10.2. Gain Bandwidth and Noise Temperature of NbTiN HEB Mixer
 <i>Gregory Gol'tsman, Matvey Finkel, Yuriy Vachtomin, Sergey Antipov,
 Vladimir Drakinski, Natalia Kaurova, Boris Voronov</i>
 Moscow State Pedagogical University, Russia</p> | 276 |
| <p>10.3. A 1.5 THz Hot-Electron Bolometer Mixer Operated by a Planar Diode-Based Local Oscillator
 <i>Jonathan Kawamura¹, C.-Y. Edward Tong², Denis Meledin², Raymond Blundell²,
 Neal Erickson³, Imran Mehdi¹, Gregory Gol'tsman⁴</i>
 ¹Jet Propulsion Laboratory, California Institute of Technology
 ²Harvard-Smithsonian Center for Astrophysics
 ³Department of Astronomy, University of Massachusetts
 ⁴Physics Department, Moscow State Pedagogical University, Russia</p> | 286 |
| <p>10.4. Broadband Millimeter-Wave Bolometric Mixers Based on Ballistic Cooling in a Two-Dimensional Electron Gas
 <i>Mark Lee, L. N. Pfeifer, K. W. West</i>
 Bell Laboratories, Lucent Technologies</p> | 287 |
| <p>10.5. Bistability in NbN HEB Mixer Devices
 <i>Yan Zhuang, Dazhen Gu, Sigfrid Yngvesson</i>
 Department of Electrical and Computer Engineering, University of Massachusetts at Amherst</p> | 289 |

Session 11: SOURCES II

Chair: Imran Mehdi

Jet Propulsion Laboratory

-
- | | |
|---|-----|
| <p>11.1. Heterostructure Barrier Varactor Frequency Triplers to 220 – 325 GHz
 <i>Yiwei Duan, Qun Xiao, Jeffrey L. Hesler, Thomas W. Crowe</i>
 Department of Electrical and Computer Engineering, University of Virginia</p> | 299 |
| <p>11.2. THz-range Unipolar Ballistic Tunnel-Emission Transit-Time Oscillators
 <i>J. East, Z. S. Gribnikov, N. Z. Vagidov, V. V. Mitin, G. I. Haddad</i>
 ¹Department of ECE, Wayne State University
 ²Department of EECS, University of Michigan</p> | 307 |

11.3. F-Band (90-140 GHz) Uni-Traveling-Carrier Photodiode Module for a Photonic Local Oscillator 318

H. Ito¹, T. Ito¹, Y. Muramoto¹, T. Furuta¹, T. Ishibashi²

¹NTT Photonics Laboratories, NTT Corporation, Japan

²NTT Electronics Corporation, Japan

11.4. Optical Far-IR Wave Generation – An ESA Review Study 328

*B. Leone¹, V. Krozer², M. Feiginov³, H. Roskos⁴, H. Quast⁴, T. Löffler⁴, G. Loata⁴,
G. Döhler⁵, P. Kiesel⁵, M. Eckardt⁵, A. Schwanhäuser⁵, T. O. Klaassen⁶, P. Lugli⁷*

¹ESA Directorate of Technical and Operational Support, ESTEC, The Netherlands

²Denmark Technical University, Denmark

³Technical University of Darmstadt, Germany

⁴University of Frankfurt, Germany

⁵University of Erlangen, Germany

⁶Delft University of Technology, The Netherlands

⁷University of Rome, Italy

11.5. Amplitude Noise in a Photomixer Using a UTC-PD in the 100 GHz Band 344

*T. Noguchi¹, A. Ueda¹, H. Iwashita¹, S. Takano¹, Y. Sekimoto¹, M. Ishiguro¹,
T. Ishibashi^{2*}, H. Ito², T. Nagatsuma³*

¹Nobeyama Radio Observatory, Japan

²NTT Photonics Laboratory, NTT Corporation, Japan

³NTT Microsystem Integration Laboratories, NTT Corporation, Japan

*Present Affiliation: NTT Electronics Corporation

Session 12: OPTICS

Chair: Eric Mueller

Coherent Inc.

12.1. Propagating Partially Coherent THz Fields Using Non-Orthogonal Over-Complete Basis Sets 353

R. H. Berry, S. Withington, M. P. Hobson, G. Yassin

Cavendish Laboratory, University of Cambridge, UK

12.2. Experimental Verification of Electromagnetic Simulations of a HIFI Mixer Sub-Assembly 371

Willem Jellema¹, Paul Wesselius¹, Stafford Withington², Ghassan Yassin², J. A. Murphy³, C. O'Sullivan³, N. Trappe³, T. Peacocke⁴, Bruno Leone⁵

¹National Institute for Space Research (SRON), The Netherlands

²Cavendish Laboratory, University of Cambridge, UK

³National University of Ireland Maynooth (NUIM), Ireland

⁴UK Astronomy Technology Center (UKATC), UK

⁵European Space Agency (ESA/ESTEC), The Netherlands

12.3. A Novel Procedure for Designing Band-pass Filters using FSS Structures 383

Ge Wu¹, Volkert Hansen¹, Ernst Kreysa², Hans-Peter Gmuend²

¹Chair of Electromagnetic Theory, University Wuppertal, Germany

²Max Planck Institute for Radioastronomy, Germany

Session 13: POSTERS

Chair: Tom Crowe
University of Virginia

HEB MIXERS

- 13.1. A Hot-Spot Model for Membrane-Based HEB Mixer** 393
Jean Baubert^{1,2}, H. Merkel², M. Salez¹, P. Khosropanah²
¹LERMA, Observatoire de Paris, France
²MC2, Chalmers University, Sweden
- 13.2. Noise Performance of Spiral Antenna Coupled HEB Mixers at 0.7 THz and 2.5 THz** 405
*K. V. Smirnov¹, Yu. B. Vachtomin¹, S. V. Antipov¹, S. N. Maslennikov¹, N. S. Kaurova¹,
V. N. Drakinsky¹, B. M. Voronov¹, G. N. Gol'tsman¹, A.D. Semenov²,
H. Richter², H.-W. Hubers²*
¹Moscow State Pedagogical University, Russia
²DLR Institute of Space Sensor Technology, Germany
- 13.3. Improved NbN phonon cooled hot electron bolometer mixers** 413
*M. Hajenius^{1,2}, J. J. A. Baselmans², J. R. Gao^{1,2}, T. M. Klapwijk¹, P. A. J. de Korte²,
B. Voronov³, and G. Gol'tsman³*
¹Department of Nanoscience, Delft University of Technology, The Netherlands
²Space Research Organization Netherlands, The Netherlands
³Moscow State Pedagogical University, Russia.
- 13.4. NbAu Bilayer Diffusion Cooled HEB** 424
Harald F. Merkel, P. Khosropanah, S. Cherednichenko, T. Ottoson, J. Baubert, E. Kollberg
Department of Microtechnology & Nanoscience, Chalmers University of Technology, Sweden
- 13.5. Transition-Edge Operation of Tantalum Diffusion-Cooled Hot-Electron Bolometers** 427
Anders Skalare, William R. McGrath, Bruce Bumble, Henry G. LeDuc
Jet Propulsion Laboratory, California Institute of Technology
- 13.6. Impedance and Bandwidth Characterization of NbN Hot Electron Bolometric Mixers** 431
F. Rodriguez-Morales, Sigfrid Yngvesson
Department of Electrical and Computer Engineering, University of Massachusetts

SIS MIXERS

- 13.7. Sideband-Separating SIS Mixer at 110 GHz for the Measurement of Atmospheric Ozone** 439
Shin'ichiro Asayama¹, Takashi Noguchi², and Hideo Ogawa¹
¹Department of Earth and Life Sciences, College of Integrated Arts and Sciences, Japan
²Nobeyama Radio Observatory, Japan

13.8. Repeatability and Reliability of the 640 GHz SIS Mixer for JEM/SMILES	442
<i>K. Kikuchi, Y. Fujii, W.-L. Shan and J. Inatani</i>	
¹ National Space Development Agency of Japan, Japan	
² Nihon Tsushinki Co., Ltd., Japan	
³ Communications Research Laboratory, Japan	
13.9. Observation of an Anomalous IF Peak at High Bias Voltage in 660-GHz SIS Mixers	444
<i>M. J. Wang¹, W. L. Shan², W. Zhang², H. W. Cheng¹, T. Noguchi³, S. C. Shi², Y. Irimajiri⁴, T. Manabe⁴</i>	
¹ Institute of Astronomy and Astrophysics, Academia Sinica, Taiwan	
² Purple Mountain Observatory, China	
³ Nobeyama Radio Observatory, NAOJ, Japan	
⁴ Communications Research Laboratory, Japan	
13.10. SuperMix Aided Design of SIS Tunnel Junction Heterodyne Mixers	---
<i>Attila Kovács, Jacob W. Kooi, T. G. Phillips, J. Zmuidzinas</i>	
California Institute of Technology	
13.11. Development of the HIFI Band 3 and 4 Mixer Units	447
<i>G. de Lange¹, B. D. Jackson¹, M. Eggens¹, H. Golstein¹, W. M. Laauwen¹, L. de Jong¹, S. Kikken¹, C. Pieters¹, H. Smit¹, and D. Van Nguyen¹, M. Kroug², T. Zijlstra², and T. M. Klapwijk²</i>	
¹ SRON National Institute for Space Research, The Netherlands	
² Department of Nanoscience, Faculty of Applied Science, Delft University of Technology, The Netherlands	
13.12. Design of 129-174 GHz SSB SIS Mixer for Band 2 of New Generation Receiver of IRAM PdB Interferometer	450
<i>A. Navarrini* and B. Lazareff</i>	
Institut de Radio Astronomie Millimetrique, France	
*Present Address: Radio Astronomy Lab, University of California	
13.13. Scaled Model Measurement of the Embedding Impedance of a 660-GHz Waveguide SIS Mixer with a 3-Standard De-embedding Method	453
<i>W. Zhang¹, C.-Y. Edward Tong² and S.C. Shi¹</i>	
¹ Purple Mountain Observatory, Chinese Academy of Sciences, China	
² Harvard-Smithsonian Center for Astrophysics	
13.14. Superconducting Microstrip Line Models at Millimeter and Sub-millimeter Waves and Their Comparison	456
<i>V. Belitsky, C. Risacher, M. Pantaleev, V. Vassilev</i>	
Group for Advanced Receiver Development, Onsala Space Observatory, Chalmers University of Technology, Sweden	

SOURCES

13.15. Local Oscillator Systems for (Sub)millimeter Spectroscopy	476
<i>A. Emrich, S. Andersson, J. Embretsen</i>	
Omnisys Instruments AB, Sweden	

- 13.16. Equivalent Circuit for Photomixing in Resonant Laser-Assisted Field Emission** 478
M. J. Hagmann¹, M. S. Mousa², M. Brugar³, E. P. Sheshin⁴, A. S. Baturin⁴
¹Deseret Electronics Research Corporation,
²Department of Physics, Mu'tah University, Jordan
³Image Instrumentation Inc.,
⁴Moscow Institute of Physics and Technology, Russia
- 13.17. Effect of Finite Spectral Width on Photomixing in Resonant Laser-Assisted Field Emission** 481
M. J. Hagmann
 Deseret Electronics Research Corporation
- 13.18. TeraHertz Quantum Cascade Laser Based on LO-Phonon-Scattering Assisted Depopulation** 484
Qing Hu¹, Benjamin S. Williams¹, Hans Callebaut¹, Sushil Kumar¹, John L. Reno²
¹Department of Electrical Engineering and Computer Science and Research Laboratory of Electronics, Massachusetts Institute of Technology
²Sandia National Laboratories, Dept 1123, MS 0601
- 13.19. Terahertz Backward Wave Oscillator Development** 486
Lawrence Ives¹, David Marsden¹, Malcom Caplan¹, Carol Kory¹, Jeff Neilson¹, S. Schwartzkopf²
¹Calabazas Creek Research, Inc.
²RWI, Inc.
- 13.20. Design and Operational Considerations for Robust Planar GaAs Varactors: A Reliability Study** 488
Frank Maiwald, Erich Schlecht, John Ward, Robert Lin, Rosa Leon, John Pearson, Imran Mehdi
 Jet Propulsion Laboratory, MS 168-314
- 13.21. A Design Theory for a Terahertz-Frequency Quantum Oscillator that Operates in the Positive Differential Resistance Region** 492
Dwight Woolard¹, Peiji Zhao², H. L. Cui³
¹US Army Research Lab., ARO
²Department of Electrical and Computer Engineering, NCSU
³Department of Physics and Engineering Physics, Stevens Institute of Tech
- 13.22. A Multi-Subband Design Theory for a Terahertz-Frequency Double Barrier Quantum Well Oscillator** 495
Peiji Zhao¹, D. L. Woolard²
¹North Carolina State University
²Army Research Laboratory, Army Research Office

DEVICES

- 13.23. Beam Lead Fabrication for Submillimeter-wave Circuits Using Vacuum Planarization** 499

R. B. Bass¹, J. C. Schultz¹, A. W. Lichtenberger¹, J. W. Koo², C. K. Walker³

¹Department of Electrical and Computer Engineering, University of Virginia

²Division of Physics, Mathematics, and Astronomy, California Institute of Technology

³Department of Astronomy, University of Arizona

- 13.24. Wide Band Cryogenic IF Amplifiers for ALMA and Herschel Receivers** 502

Isaac López-Fernández, Carmen Diez, Juan Daniel Gallego, Alberto Barcia

Centro Astronómico de Yebes, OAN-IGN, Spain

INCOHERENT/BOLOMETER DETECTORS

- 13.25. Investigation of Superconducting Transition in the Molybdenum-Copper** 505

Thin Film Structure Showing the Proximity Phenomenon with the Purpose of Constructing TES Bolometer

S. A. Kovtonyuk, A. G. Kovalenko, A. A. Chebotarev, A. N. Vystavkin

Institute of Radioengineering and Electronics of RAS, Russia

WAVEGUIDE

- 13.26. Full-Waveguide Band Orthomode Transducer for the 3mm and 1mm Bands** 508

Gopal Narayanan, Neal R. Erickson

Department of Astronomy, University of Massachusetts

- 13.27. Precision Measurements of the Properties of Thin-film Superconducting** 513

Microstrip Lines at 100-500 GHz

Anastasios Vayonakis¹, Alexey Goldin², Henry Leduc², Chiyan Luo³, Jonas Zmuidzinas¹

¹California Institute of Technology

²Jet Propulsion Laboratory

³Massachusetts Institute of Technology

- 13.28. Propagation in Lossy and Superconducting Cylindrical Waveguides** 516

Ghassan Yassin, Choy Yoong Tham, Stafford Withington

Cavendish Laboratory, University of Cambridge, UK

SPECTROMETERS

- 13.29. Autocorrelation Spectrometers for (Sub)millimetre Spectroscopy** 520

A. Emrich, S. Andersson, J. Embretsén, J. Dahlberg, L. Landén, C. Tegnander

Omnisys Instruments AB, Sweden

- 13.30. Chip Set for Autocorrelation Spectrometer Applications** 522
L. Landén^{1,2}, J. Dahlberg¹, A. Emrich¹

¹Omnisys Instruments AB, Sweden

²Chalmers University of Technology, MEL, Sweden

- 13.31. THIS – A Quantum-Cascade-Laser Pumped Mid-Infrared Heterodyne Receiver** 525
Daniel Wirtz¹, G. Sonnabend², V. Vetterle¹, M. Olbrich¹, R. Schieder¹

¹I. Physikalisches Institut, Universität zu Köln, Germany

²NASA Goddard Space Flight Center

SYSTEMS

- 13.32. Heterodyne Receiver Requirements for the Single Aperture Far-Infrared (SAFIR) Observatory** 529

D. J. Benford¹, Jacob Kooi²

¹NASA – Goddard Flight Center, Code 685

²Caltech, MC 320-47

- 13.33. Cartridge-type receiver system on ASTE** 535

**Masahiro Sugimoto¹, Yutaro Sekimoto¹, Sozo Yokogawa¹, Takeshi Okuda¹,
 Ken'ichi Tatematsu¹, Takashi Noguchi¹, Kotaro Kohno², Hideo Ogawa³,
 Kimihiro Kimura³**

¹National Astronomical Observatory of Japan, Japan

²Institute of Astronomy, The University of Tokyo, Japan

³Department of Earth and Life Sciences, College of Integrated Arts and Sciences, Japan

- 13.34. Current Status of the Antarctic Submillimeter Telescope and Remote Observatory** 538

**Kecheng Xiao¹, Antony A. Stark¹, Adair P. Lane¹, Christopher L. Martin¹,
 Wilfred M. Walsh¹, Christopher K. Walker², Jacob W. Kooi³**

¹Smithsonian Astrophysical Observatory

²University of Arizona

³California Institute of Technology

OPTICS

- 13.35. Efficient Side-band Ratio Measurement of a Submm Wave Mixer Using a Fourier Transform Spectrometer** 542

A. Baryshev^{1,2,3}, R. Hesper^{1,2,3}, G. Gerlofsma^{1,2,3}, M. Kroug⁴, W. Wild^{2,3}

¹Netherlands Research School for Astronomy (NOVA), The Netherlands

²Space Research Organization Netherlands (SRON), The Netherlands

³University of Groningen (RuG), The Netherlands

⁴DIMES, Delft University of Technology, The Netherlands

- 13.36. Transmission and Reflection Characteristics of Slightly Irregular Wire-Grids for Arbitrary Angles of Incidence and Grid Rotation** 543

Takeshi Manabe¹, Axel Murk²

¹Communications Research Laboratory, Japan

²Institute of Applied Physics, University of Berne, Switzerland