



# AUTOMATIC RF TECHNIQUES GROUP

## NEWSLETTER

WINTER 2018/2019

NUMBER 60

### Important deadlines:

**Feb. 15, 2019:** 93<sup>rd</sup> conference (Jun. 2019) paper submission deadline

**Sep. 27, 2019:** 94<sup>th</sup> conference (Jan. 2020) paper submission AND student sponsorship application deadlines

**Oct. 1, 2019:** Student fellowship applications due

**Feb. 14, 2020:** 95<sup>th</sup> conference (Jun. 2020) paper submission deadline

## *92<sup>nd</sup> ARFTG Microwave Measurement Symposium: Next Generation Microwave and Millimeter-Wave Measurement Techniques and Systems*

### OVERVIEW

The January 2019 ARFTG Microwave Measurement Symposium took place at the Rosen Plaza Hotel in Orlando, FL. The event was held over four days: Sunday, January 20, 2019 to Wednesday, January 23, 2019 and, for the first time, was co-located with Radio Wireless Week (RWW). The Symposium consisted of the ARFTG/NIST measurements short course, an on-wafer measurement users' forum, an NVNA users' forum, a workshop on high frequency and high bandwidth measurements for 5G and related applications, and the main conference. The theme of this symposium was "Next Generation Microwave and Millimeter-Wave Measurement Techniques and Systems". The main event was the 92<sup>nd</sup> ARFTG Microwave Measurement Conference, which took place on Monday and Tuesday. In addition to these technical events, there was an awards luncheon on Tuesday and a vendor exhibition during the conference. In total, this amounted to four days of exciting activities for engineers, scientists, and technologists.



*The Rosen Plaza Hotel, Orlando was the site of the 92<sup>nd</sup> (January 2019) ARFTG Symposium.*

### CONFERENCE TECHNICAL SESSIONS

The 92<sup>nd</sup> ARFTG Microwave Measurement Conference began on Monday, January 21<sup>st</sup> with introductions by ARFTG President, Dominique Schreurs, and Conference Co-Chairs, Joe Gering and Jon Martens. On this occasion, about 58 people attended, between ARFTG-only and RWW+ARFTG superpass registrants. The conference consisted of five oral sessions (with 15 papers), an interactive forum (with 5 papers), and a panel session on microwave measurement needs for 5G and was planned by Technical Program Co-Chairs, Patrick Roblin and Andrej Rumiantsev. The oral sessions included a keynote talk by Dr. Michael O'Neal (Qorvo) and three invited papers by Dr. Mauro Marchetti (Anteverta-MW), Prof. Kuby Sertel (The Ohio State University), and Dr. Kate Remley (NIST) [presented by

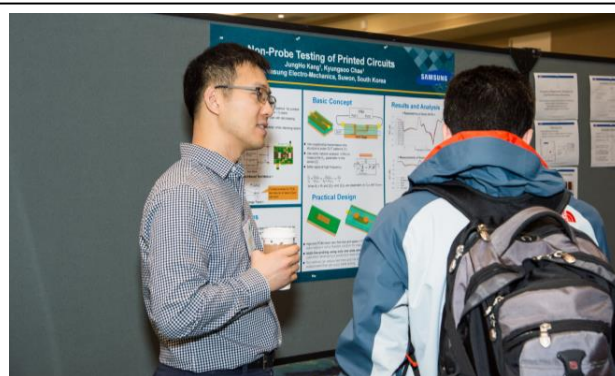


*Attendees view the keynote talk by Michael O'Neal (Qorvo).  
(Photo by LylePhotos, Atlanta)*

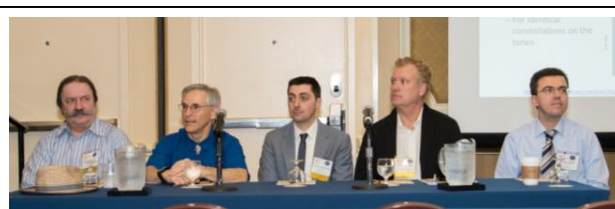
Ron Ginley (NIST)]. The technical program can be found at [www.arftg.org](http://www.arftg.org) under the Past Conferences tab. Also, all ARFTG oral and interactive papers are archived in the IEEE Xplore Digital Library.

For the 92<sup>nd</sup> conference, the best oral paper, as voted on by the conference attendees, was “A 3D printed TE10 rectangular to TE01 circular waveguide transition for polymer waveguide characterization,” by M. del Mastro<sup>1</sup>, M. Alonso del Pino<sup>2</sup>, and M. Spirito<sup>1</sup> (<sup>1</sup>ELCA, Delft University of Technology and <sup>2</sup>NASA-Jet Propulsion Laboratory). The best interactive forum paper was selected to be “Non-probe probing of printed circuits,” by JungHo Kang and Kyungsoo Chae (Samsung Electro-Mechanics). Also, new for this conference, the conference attendees selected a best student paper, “Transient and steady-state thermal measurements of GaN-on-SiC HEMT transistors under realistic microwave drive conditions,” by Jonas Urbonas, Cristian Matei, and Peter H. Aaen (University of Surrey). Congratulations to our best paper awardees.

As a change from recent conferences, this conference also held a panel session with our invited speakers, Michael O’Neal (Qorvo), Mauro Marchetti (Anteverta-MW), Kuby Sertel (The Ohio State University), and Ron Ginley (NIST) and Earl McCune (Eridan Communications) from the ARFTG workshop.



*ARFTG attendees discuss with interactive forum presenters. (Photo by LylePhotos, Atlanta)*



*The ARFTG panel session featured our invited speakers. (Photo by LylePhotos, Atlanta)*

## CONFERENCE SPONSORS AND EXHIBITS

The ARFTG conference wouldn’t be possible without the support of our corporate sponsors. ARFTG is pleased to thank the sponsors of this conference:

- Gold sponsors: Qorvo.
- Silver sponsors: Anritsu Company, Copper Mountain Technologies, Keysight Technologies, and Maury Microwave.

For future sponsorship opportunities, contact the Sponsorship Chair, at [sponsorship@arftg.org](mailto:sponsorship@arftg.org).

The exhibition provides an excellent opportunity to see the latest range of products available from 18 of the leading suppliers in microwave measurement industry. As part of the co-location, the exhibition was a joint RWW/ARFTG event. This conference’s exhibiting companies were: Advanced Test Equipment Rentals, AMCAD Engineering, Anatech Electronics, Anritsu, Copper Mountain Technologies, Gowanda Components Group, HSIO Technologies, Junkosha, Inc., Keysight Technologies, Maury Microwave Corp., Modelithics, National Instruments, Pickering Interfaces Inc., SemiDice, Inc., SGS North America, SPINNER GmbH, Teledyne Storm Microwave, and Virginia Diodes. The best exhibitor as voted by conference attendees was Maury Microwave. To exhibit at a future conference, please contact the Exhibits Chair, at [exhibits@arftg.org](mailto:exhibits@arftg.org).



*The joint ARFTG/RWW exhibition provided access to a with range of exhibitors. (Photo by LylePhotos, Atlanta)*

## ARFTG/NIST SHORT COURSE

A 1 ½ day, short course on microwave measurements, organized by Jim Booth (NIST), was held on January 20<sup>th</sup> and 21<sup>st</sup>. The short course was chaired by Ron Ginley (NIST) and Aric Sanders (NIST). About 13 people attended this course, which included these presentations and instructors:

- Microwave Power and Traceability – Ron Ginley (NIST/ARFTG)

- Modern Network Analyzer Calibration Techniques – Rusty Myers (Keysight Technologies)
- New Methods for Data Analysis and Management – Aric Sanders (NIST/University of Colorado)
- Everything You Can Do With Vector Nonlinear Microwave Measurements – Patrick Roblin (The Ohio State University)
- Correlated Uncertainty Analyses for Microwave Measurements – Ron Ginley, Aric Sanders, Dylan Williams (NIST)
- Over-the-Air Testing of Wireless Devices – Aric Sanders, Kate Remley (NIST)
- Uncertainties in mm-Wave On-Wafer Measurements – Uwe Arz (PTB)
- Connectorized Millimeter-Wave S-Parameter Measurements – Jon Martens (Anritsu)
- Design, Characterization and Evaluation of TRL Calibration Kits Integrated Using Silicon Based Technologies – Marco Spirito (Delft University of Technology)
- On-Wafer Materials Measurements – Aric Sanders, James C. Booth (NIST)
- RF GaN Device Models and Extraction Techniques – Raj Sodhi (Keysight Technologies)
- Vector Large Signal Measurements – Dominique Schreurs (K.U. Leuven)

We greatly appreciate the instructors who made this short course successful, and we especially thank Aric Sanders and Ron Ginley for stepping in for NIST colleagues who were unable to attend due to the US government shutdown.



*The ARFTG/NIST short course is an excellent, educational opportunity. (Photo by LylePhotos, Atlanta)*

## WORKSHOP

As part of the ARFTG symposium, a workshop was held on the morning of Wednesday, January 23<sup>rd</sup>. The theme was *High frequency and high bandwidth measurements for 5G and related applications*, and it was organized by Jon Martens (Anritsu), Marco Spirito (T.U. Delft), and Patrick Roblin (OSU). Approximately 23 people attended and heard these lectures:

- Challenges review and testing options to help success in the implementation of 5G-NR systems - Earl McCune (Eridan Communications)
- Uncertainties in mm-wave on-wafer measurements - Uwe Arz (PTB)
- Measurement solutions for circuits at microwave and millimeter-wave frequency - Masahiro Horibe (AIST)
- Calibration and large-signal challenges and solutions for mm-wave and sub-mm-wave VNA based setups - Luca Galatro (Vertigo technologies)
- Wideband load-pull measurement techniques: architecture, accuracy, and applications - Mauro Marchetti and Gustavo Avolio (Anteverta-MW)



*A workshop on measurements for 5G was presented at the fall/winter symposium. (Photo by LylePhotos, Atlanta)*

## ANNUAL BUSINESS MEETING

The annual ARFTG Business Meeting was held on Tuesday, January 22, 2019. A significant part consisted of electing five members to the ARFTG Executive Committee. Biographies for the candidates were distributed prior to voting, and the candidates were given an opportunity to speak to introduce themselves to the membership. The outcome of the voting was the election (or re-election) of five members to ExCom: Dominique Schreurs, Ron Ginley, Joel Dunsmore, Patrick Roblin, and Andrej Rumiantsev. Additionally, the membership was asked to vote “for” or “against” an amendment to the ARFTG Bylaws. The proposed amendment was distributed prior to the meeting, and Jon Martens gave brief review of the proposed changes. The proposal to amend the ARFTG Bylaws was approved. There was also a report from the ARFTG Treasurer indicating that ARFTG’s finances are strong.



## CONFERENCE AWARDS

ARFTG President, Dominique Schreurs, presided over the conference awards ceremony, which took place during the awards luncheon on Tuesday, January 22<sup>nd</sup>. Certificates of appreciation were presented to the organizers of the 92<sup>nd</sup> conference, namely Joe Gering and Jon Martens as Conference Co-Chairs and Patrick Roblin and Andrej Rumiantsev as Technical Program Co-Chairs.

Awards were also given for best papers and exhibitor from the previous (91<sup>st</sup>) conference held in Philadelphia, PA. The best oral paper award went to “Electro-optic near field imaging of high-power RF/microwave transistors in plastic packages,” by Jonas Urbonas<sup>1</sup>, Frederik Vanaverbeke<sup>2</sup>, Kevin Kim<sup>2</sup>, and Peter Aaen<sup>1</sup> (<sup>1</sup>University of Surrey and <sup>2</sup>NXP Semiconductors). The best interactive forum presentation was awarded to “Active antenna array characterization for massive MIMO 5G scenarios,” by Marina Jordao, Daniel Belo, and Nuno Borges Carvalho (Universidade de Aveiro). The Best Exhibitor was awarded to Keysight Technologies.



*ARFTG President Dominique Schreurs presents the ARFTG Life Membership Award to Jon Martens.  
(Photo by LylePhotos, Atlanta)*

Two additional awards were conferred at this conference. Jon Martens (Anritsu) was elevated to Life Member status, and Aric Sanders (NIST) was presented with a Certificate of Appreciation for impromptu services as a surrogate short course chair and conference speaker. If you feel you may qualify for ARFTG life member status, information can be found at <http://www.arftg.org/membership/lifemember.html>.

## USERS FORUMS AND STANDARDS MEETINGS

The ARFTG Symposium hosted two users' forums on the morning of Monday, January 21<sup>st</sup>: the NVNA Users' Forum and the On-Wafer Measurement Users' Forum. Information on the both forums can be found under the Forums tab at [www.arftg.org](http://www.arftg.org).

The NVNA Users' Forum is organized by Patrick Roblin (OSU), Dominique Schreurs (KU Leuven), Jean-Pierre Teyssier (Keysight), J. Apolinar Reynoso Hernandez (CICESE), Tibault Reveyrand (XLIM), and Karun Rawat (IIT Roorkee). This meeting was led by Patrick Roblin and had about 20 participants with this agenda:

- Welcome Patrick Roblin, The Ohio State University
- Presentation: Tony Gasseling, AMCAD-Engineering – Use of IVCAD 3.8 with NVNA and de-embedding of time domain measurements to the intrinsic reference planes
- Proposed Discussions
  - Use of NVNA in device modeling and verification
  - Sharing of data acquisition codes for NVNA
- Presentation: Dominique Schreurs, KU Leuven – Non-linear verification device developed in cooperation with Keysight & NPL.
- Farewell

In addition to the meeting at the fall/winter ARFTG, the NVNA Users' Forum also held a meeting on July 5, 2018 at the 2018 International Workshop on Integrated Nonlinear Microwave and Millimeter-Wave Circuits (INMMiC) at Brive-La\_Gaillarde, France. That meeting had approximately 30 participants with this agenda:

- Welcome Tibault Reveyrand, XLIM
- Tony Gasseling, AMCAD Engineering – A robust and reliable behavioral model of high power GaN HEMTS for RF Doherty Amplifier Application
- Tibault Reveyrand, XLIM – Unknown Thru Calibration Algorithm
- Farewell

The January 2019 On-Wafer Measurement Users' Forum was organized by Marco Spirito (TU Delft) and Jon Martens (Anritsu) and had approximately 19 participants. This was the agenda for this meeting:

- Introduction and Opening – Marco Spirito, TU Delft, Jon Martens, Anritsu
- Investigation of Line Length Effects in Multiline TRL Calibrations at 1.1 THz – Matt Bauwens, DM Probes
- How to effectively include DRC fills effect in EM simulations – Marco Spirito, TU Delft
- Debate mm-wave probing Contact less vs. Contact – Sertel Kubilay and Marco Spirito with moderator: Jon Martens
- Wrap up – Marco Spirito, TU Delft, Jon Martens, Anritsu

In addition to the meeting at fall/winter ARFTG, the On-Wafer Measurement Users' Forum also held a meeting on September 27, 2018 at the 2018 European Microwave Conference. That meeting was organized by Andrej Rumiantsev (MPI Corporation) and had approximately 20 participants with this agenda:

- Introduction and Opening – Andrej Rumiantsev, MPI Corporation, Taiwan
- What did we learn about wafer-level calibration from PlanarCal project? – Gia Ngoc Phung, FBH Berlin, Germany
- On the location of the on-wafer calibration reference plane – Andrej Rumiantsev, MPI Corporation, Taiwan
- Repeatable multiline-TRL calibration by super-beginner operators – Ryo Sakamaki, AIST, Japan
- What is the reference impedance of the lumped-standard based calibration? – J. Apolinar Reynoso Hernandez, CICESE, Mexico
- Wrap up – Andrej Rumiantsev, MPI Corporation, Taiwan

As is often the case at ARFTG conferences, standards committees hold in-person meetings. At the January 2019 ARFTG conference, there was a committee meeting for IEEE P287, Recommended Practice for Precision Coaxial Connectors at RF, Microwave and Millimeter-wave Frequencies.

## FUTURE EVENTS

### Spring 2019 ARFTG Conference

The 93<sup>rd</sup> ARFTG Microwave Measurement Conference will be held on June 7, 2019 in Boston, Massachusetts, as part of Microwave Week 2019, in conjunction with IMS ([ims-ieee.org](http://ims-ieee.org)) and the RFIC symposium ([rfic-ieee.org](http://rfic-ieee.org)). The ARFTG conference theme is “*Measurement Challenges for the Upcoming RF and Millimeter-wave Communications and Sensing Systems*”. **The deadline for submission of paper abstracts (with supporting data and figures) is Feb. 15, 2019.** For up-to-date information, visit [www.arftg.org](http://www.arftg.org) or contact the Conference Co-Chairs, Mohammad Sayed ([mmsayed@sbcglobal.net](mailto:mmsayed@sbcglobal.net)) and Dave Blackham ([dave.blackham@keysight.com](mailto:dave.blackham@keysight.com)) or the TPC Co-Chairs, Marco Spirito ([m.spirito@tudelft.nl](mailto:m.spirito@tudelft.nl)) and Patrick Roblin ([roblin.1@osu.edu](mailto:roblin.1@osu.edu)).

As part of the 93<sup>rd</sup> ARFTG conference activities, it is also planned to have joint IMS/ARFTG technical sessions, to hold users' forums, and to co-sponsor two workshops that will be taking place during Microwave Week 2019:

- WMD: Measurement and Design Techniques for Next-Generation Communication Systems (organized by Antonio Raffo and Patrick Roblin)
- WMF: Measurement Challenges in Over-The-Air Testing (organized by Jon Martens and Nuno Borges Carvalho)

Students interested in obtaining financial assistance to attend the conference should contact the Conference Chairs. Any awards will be discretionary, and preference will be given to authors of accepted papers.

### January 2020 ARFTG Symposium

The Fall/Winter 2019/20 ARFTG Microwave Measurement Symposium will be held in San Antonio, TX, on January 26-29, 2020 and will once again be co-located with Radio Wireless Week ([radiowirelessweek.org](http://radiowirelessweek.org)). The conference theme is “*RF to Millimeter-Wave Measurement Techniques for 5G and Beyond*”. It is planned to hold the 94<sup>th</sup> ARFTG Conference, a short



*The Westin Boston Waterfront Hotel is the site for the 93<sup>rd</sup> ARFTG Microwave Measurement Conference*

course, a workshop, a joint RWW/ARFTG exhibit, and the users' forums. **The paper submission deadline is September 27, 2019.** For more information, contact the Conference Co-Chairs, Andrej Rumiantsev ([a.rumiantsev@ieee.org](mailto:a.rumiantsev@ieee.org)) and Joe Gering ([joe.gering@qorvo.com](mailto:joe.gering@qorvo.com)) or the TPC Co-Chairs, Joel Dunsmore ([joel\\_dunsmore@keysight.com](mailto:joel_dunsmore@keysight.com)) and Marco Spirito ([M.Spirito@tudelft.nl](mailto:M.Spirito@tudelft.nl)). More information will be available at [www.arftg.org](http://www.arftg.org).

### Users' Forums

An NVNA Users' Forum occurs at all ARFTG conferences. Please send your ideas for the meeting at the spring ARFTG with IMS in Boston (June 6-7, 2019), fall/winter ARFTG with RWW in San Antonio, TX (January 26-29, 2020), or any future meetings to the forum organizers: Patrick Roblin ([roblin.1@osu.edu](mailto:roblin.1@osu.edu)), Dominique Schreurs ([dominique.schreurs@kuleuven.be](mailto:dominique.schreurs@kuleuven.be)), Jean-Pierre Teyssier ([jean-pierre.teyssier@keysight.com](mailto:jean-pierre.teyssier@keysight.com)), J. Apolinar Reynoso Hernandez ([apolinar@cicese.mx](mailto:apolinar@cicese.mx)), Tibault Reveyrand ([reveyrand@gmail.com](mailto:reveyrand@gmail.com)), and Karun Rawat ([karunrawat@gmail.com](mailto:karunrawat@gmail.com)). In addition, the next European meeting will be during INMMiC at Cardiff University in Cardiff, UK on April 16-17, 2020. More information on the latest activities and schedules can be found at the ARFTG web site, [www.arftg.org](http://www.arftg.org) under the Forums tab.

Additionally, an On-Wafer Measurements Users' Forum occurs at all ARFTG conferences. Please send your ideas for the meeting at the spring ARFTG with IMS in Boston (June 6-7, 2019), fall/winter ARFTG with RWW in San Antonio, TX (January 26-29, 2020), or any future meetings to the forum organizer: Andrej Rumiantsev ([a.rumiantsev@ieee.org](mailto:a.rumiantsev@ieee.org)). In addition to the ARFTG meetings, the On-Wafer Measurements Users' Forum is planning meetings in Europe at EuMW-2019 (Paris, October 3, 2019) and Asia at APMC-2019 (Singapore, December 2019). More information on the latest activities and schedules can be found at the ARFTG web site, [www.arftg.org](http://www.arftg.org) under the Forums tab.

## ARFTG STUDENT PROGRAMS

ARFTG typically awards one or more *ARFTG Roger Pollard Memorial Student Fellowships in Microwave Measurement* to recognize and provide financial assistance to graduate students who show promise and interest in pursuing research related to microwave measurement techniques. The next application deadline is October 1, 2019. The application instructions and criteria for the next award cycle are published at [www.arftg.org](http://www.arftg.org), or you may contact the education chair, Jim Booth, at [studentfellowship@arftg.org](mailto:studentfellowship@arftg.org).

ARFTG may also grant ARFTG Student Sponsorships to help M.S. and Ph.D. students defray the expense of attending the fall/winter conference. Students are required to present a paper and provide volunteer service at the conference. The application deadline is September 27, 2019. For information on sponsorships at future conferences, see [www.arftg.org](http://www.arftg.org) or contact the sponsorship chair, Joe Gering, at [sponsorship@arftg.org](mailto:sponsorship@arftg.org).

## ADDENDUM

Every effort has been made to publish correct information in this newsletter. Significant errors should be reported to the ARFTG Secretary, Joe Gering ([joe.gering@qorvo.com](mailto:joe.gering@qorvo.com)), so that corrections can be reported in the next issue.

