Final Report

IRMMW-THz 2011 - The 36th International Conference on Infrared, Millimeter, and Terahertz Waves

1. Objective

This proposal requested funding for partial support of the 36th Annual International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz 2011), which was held in Houston TX on October 2-7, 2011. This long-running international conference series covers a broad range of technical areas involving long-wavelength electromagnetic radiation. As suggested by the meeting's name, the relevant topical areas are highly interdisciplinary, covering many areas of science and engineering including considerable overlap with many areas of interest to the DOE. The requested funds were used to cover necessary conference expenses, such as the maintenance of the web site and the production of the conference booklet.

2. Background

The [International Society of Infrared, Millimeter, and Terahertz Waves](#) is a non-profit society which oversees the conferences in this ongoing series. Incorporated in 2009, the Society provides a permanent home for the International Organizing Committee (IOC) for IRMMW-THz, formalizes the role of the IOC in maintaining the current conference series, links technically with the *Journal of Infrared, Millimeter, and Terahertz Waves*, and administers the Kenneth J. Button Prize. A copy of the Society's By-Laws are available on request. Under the auspices of the IOC, the 2011 conference was held under the direction of a Local Organizing Committee, chaired by Prof. Mittleman, with participants from Rice University and other local institutions. The LOC oversaw all meeting functions including the web page development, the scheduling of sessions, the venue, and all ancillary events. The LOC was also responsible for the technical exhibit, which has been a growing aspect of this conference in recent years. The exhibit, which featured more than 20 companies within this technology space, provided attendees with the opportunity to see the latest developments from the commercial sector. A second committee, the Program Advisory Committee (PAC), consisted of roughly 30 experts from around the world. The PAC reviewed and rated every submitted abstract, to determine acceptance or rejection. For the first time in the history of the conference series, the rejection rate exceeded 10%. As is customary for conferences in this series, a Memorandum of Understanding was signed by the Society and the IEEE Microwave Theory and Techniques Society. This established technical co-sponsorship of the meeting by the IEEE MTT-S, and provided a mechanism for publication of the conference proceedings by IEEE Press.

3. Scientific content

The topical areas of this meeting are highly relevant to many areas of interest to the DOE, and to DOE-funded researchers. For example, the Major Topic List of the 2011 conference featured a category entitled “IR, millimeter-wave, and THz spectroscopy,” another entitled “Gyro-Oscillators and Amplifiers, Plasma Diagnostics,” and a third called “Free Electron Lasers and Synchrotron Radiation.” Topical areas of interest to meeting participants include millimeter-wave electronics, high-power sources, high-frequency communications systems, and terahertz sensing and imaging, all of which are prominent in the research portfolios of the DOE. The development and study of new materials, components, and systems for use in the IR, THz, and MMW regions of the spectrum are of significant interest as well. The meeting traditionally has featured many DOE-funded researchers from both academia and industry. For example, 2011 plenary speakers included Dr. Gregory Nusinovich, the world’s expert on high-power gyrotrons, Dr. Tatsuo Itoh, the most prominent researcher in the field of MMICs, and Dr. Antoinette Taylor, the leader in the field of terahertz metamaterials. Other technical highlights included plenary presentations from Dr. Ullrich Pfeiffer on the latest results in scaling silicon CMOS processes into the terahertz range, and from Dr. Jerome Faist on the most recent work in terahertz quantum cascade lasers. Other plenary presentations were Dr. Thijs de Graauw (Project Director, ALMA); Stephan Koch (University of Marburg); Daniel Grischkowsky (Oklahoma State University); plus, a Nobel Laureate symposium featuring presentations by Dr. Robert Curl and Dr. Robert Wilson. In addition, a series of technical sessions were organized on the following topics:

- terahertz metamaterials and plasmonics
- imaging techniques and applications
- graphene spectroscopy
- waveguide concepts
- gyrotron science and technology
- ultrafast terahertz measurements
- quantum cascade lasers

Based on the attendance in specific sessions, certain trends in the field can be discerned. Evidently, there are several “hot” areas of research, which are attracting a great deal of attention and are likely to be highlights of future conferences in this series. These include the generation of high intensity terahertz pulses, and the interaction of these high-intensity pulses with materials (i.e., the regime of nonlinear terahertz light-matter interactions), the exploitation of plasmonic effects in the terahertz domain, and the use of terahertz radiation in future wireless communications applications.

4. Conference Attendance

Since the 2004 merger between the International Conference on Infrared and Millimeter Waves and the International Conference on Terahertz Electronics, this meeting has grown rapidly in scope, attendance, and significance for these overlapping communities. This growth is reflective of the recent surge in interest in terahertz systems and applications, as well as continued recognition of the significance of this region for spectroscopic measurements. Terahertz and millimeter-wave technologies are now beginning to impact many more areas of scientific endeavor, and to find their way into broad applications areas in communications, security,

process control, and non-destructive inspection. This conference has become the most important annual meeting for the field of long-wave electromagnetics. By offering a forum for interaction among academic and industrial researchers and companies in this technology space, the conference provides an important service to this burgeoning community. The attached presentation (addendum) includes the attendance figures for 2004-2011, indicating this trend.

Meeting status update

Daniel Mittleman

Technical program

560 abstracts submitted

Final program: 500 abstracts

10 plenary

54 keynote

246 contributed oral

190 posters

North America: 31.4%

Europe: 31.2%

Asia/Pacific Rim: 32.0%

Other: 5.4%

Final program: presenting authors by country

Accepted abstracts by category

IR, MMW, and THz Applications in Biology and Medicine	19	Ultrafast and Nonlinear Measurements	26
IR, MMW, and THz Applications in Astronomy, Atmospheric and Environmental Science	15	Transmission Lines, Waveguides and Antennas	46
IR, MMW, and THz Applications in Security and Defense	11	Gyro-Oscillators and Amplifiers, Plasma Diagnostics	52
IR, MMW, and THz Applications in Industry	11	Free Electron Lasers and Synchrotron Radiation	9
IR, MMW, and THz Spectroscopy and Material Properties	113	Modelling and Analysis Techniques	12
Imaging and Imaging Applications Radar and Communications	42	Novel Devices and Receivers	39
	3	Novel Sources, Devices and Components	102

Attendance by year since 2004

2011: Attendees by country

2011 Conference program

Program Schedule for IRMMW-THz 2011 The 36th Annual International Conference on Infrared, Millimeter, and Terahertz Waves

	Sunday	Monday October 3, 2011	Tuesday October 4, 2011	Wednesday October 5, 2011	Thursday October 6, 2011	Friday October 7, 2011
7:30 - 8:15		Breakfast/Registration - Imperial West	Breakfast/Registration - Imperial West	Breakfast/Registration - Imperial West	Breakfast/Registration - Imperial West	Breakfast/Registration - Imperial West
8:15 - 8:30		Welcome and opening announcements	Announcements	Announcements	Announcements	Announcements
8:30 - 10:00		M1 Plenary Nobel Symposium Imperial East	Tu1 Plenary Imperial East	W1 Plenary Imperial East	Th1 Plenary Button Prize lecture Imperial East	F1 Plenary Imperial East
10:00 - 10:30		Coffee break - Imperial West	Coffee break - Imperial West	Coffee break - Imperial West	Coffee break - Imperial West	Coffee break - Imperial West
10:30 - 11:00		M2A M2B M2C M2D M2E Arboretum 1 Arboretum 4 Cottonwood Dogwood Mesquite	Tu2A Tu2B Tu2C Tu2D Tu2E Arboretum 1 Arboretum 4 Cottonwood Dogwood Mesquite	W2A W2B W2C W2D W2E Arboretum 1 Arboretum 4 Cottonwood Dogwood Mesquite	Th2A Th2B Th2C Th2D Th2E Arboretum 1 Arboretum 4 Cottonwood Dogwood Mesquite	F2A F2B F2C F2D F2E Arboretum 1 Arboretum 4 Cottonwood Dogwood Mesquite
11:00 - 11:30		Lunch	Lunch	Lunch	Lunch	Lunch
11:30 - 12:00		IRMMW-THz society meeting - Redbud	IOC meeting - Redbud	Button Prize committee meeting - Redbud	JIMT editorial board meeting - Redbud	
12:00 - 12:30		M3A M3B M3C M3D Arboretum 1 Arboretum 4 Cottonwood Dogwood	Tu3A Tu3B Tu3C Tu3D Arboretum 1 Arboretum 4 Cottonwood Dogwood	W3A W3B W3C W3D Arboretum 1 Arboretum 4 Cottonwood Dogwood	Th3A Th3B Th3C Th3D Th3E Arboretum 1 Arboretum 4 Cottonwood Dogwood Mesquite	Excursion to NASA Johnson Space Center Buses depart from Hyatt
12:30 - 1:00		Coffee break - Imperial West	Coffee break - Imperial West	Coffee break - Imperial West	Coffee break - Imperial West	
1:00 - 1:30		M4A M4B M4C M4D Arboretum 1 Arboretum 4 Cottonwood Dogwood	Tu4A Tu4B Tu4C Tu4D Arboretum 1 Arboretum 4 Cottonwood Dogwood	W4A W4B W4C W4D Arboretum 1 Arboretum 4 Cottonwood Dogwood	Th4A Th4B Th4C Th4D Th4E Arboretum 1 Arboretum 4 Cottonwood Dogwood Mesquite	
1:30 - 2:00		M5 Poster Imperial West	Tu5 Poster Imperial West	W5 Poster Imperial West	Th5 Poster Imperial West	
2:00 - 2:30		IOC/LOC Dinner - Spindletop	Conference reception - Imperial West / Foyer	Student Prize committee Redbud	Conference banquet Houston Museum of Natural Science	
2:30 - 3:00	Welcome reception and registration					
3:00 - 3:30						
3:30 - 4:00						
4:00 - 4:30						
4:30 - 5:00						
5:00 - 5:30						
5:30 - 6:00						
6:00 - 6:30						
6:30 - 7:00						
7:00 - 9:00						

Full conference program available online at:

<http://www.irmmw-thz2011.org>

(follow the link to “technical program” on the menu at left)

Nobel symposium

Monday, October 3, 2011

Robert W. Wilson

Harvard Smithsonian Center for Astrophysics

B. A. Rice University, 1957

Ph. D. California Institute of Technology, 1962

Nobel Prize in Physics, 1978

“for the discovery of cosmic microwave background radiation”

Robert F. Curl

Rice University

B. A. Rice University, 1954

Ph. D. University of California, Berkeley, 1957

Nobel Prize in Chemistry, 1996

“for the discovery of fullerenes”

Plenary speakers

Tuesday

- **Thijs de Graauw**
Project Director, ALMA
- **Antoinette Taylor**
Los Alamos National Laboratory

Thursday

- **Daniel Grischkowsky**
Oklahoma State University
- **Stephan Koch**
University of Marburg

Wednesday

- **Gregory Nusinovich**
University of Maryland
- **Tatsuo Itoh**
University of California, Los Angeles

Friday

- **Jerome Faist**
ETH Zurich
- **Ullrich Pfeiffer**
University of Wuppertal

Exhibitors / Sponsors

- **25 exhibitors**
- **Funds raised: \$47,000**

External funding obtained

■ **US Government sources**

- US Air Force Office of Scientific Research \$15K ✓
- US Army Research Office \$7.5K ✓
- US Department of Energy \$10K ✓
- US Office of Naval Research \$5K ✓
- US National Science Foundation \$15K ✓

■ **Other sources of funding**

- Rice University, Vice Provost for Research \$10K ✓

Note: Rice University waived all indirect cost charges.

Conference reception

- Hyatt Imperial West Ballroom & Foyer
- drinks and light refreshments
- Tuesday: 7:00-9:00pm

Conference banquet

Houston Museum of Natural Science

- one of the most visited museums in the US
- **TICKET REQUIRED for entry**
- take the light rail, or buses provided
- Date: Thursday October 6, 6:30-10pm

Excursion – NASA Johnson Space Center

- Space Center Houston, plus tram tours of JSC
- 435 tickets for conference participants
- **TICKET REQUIRED for entry**
- Date: Friday October 7
- Buses begin departing at 1:00pm.