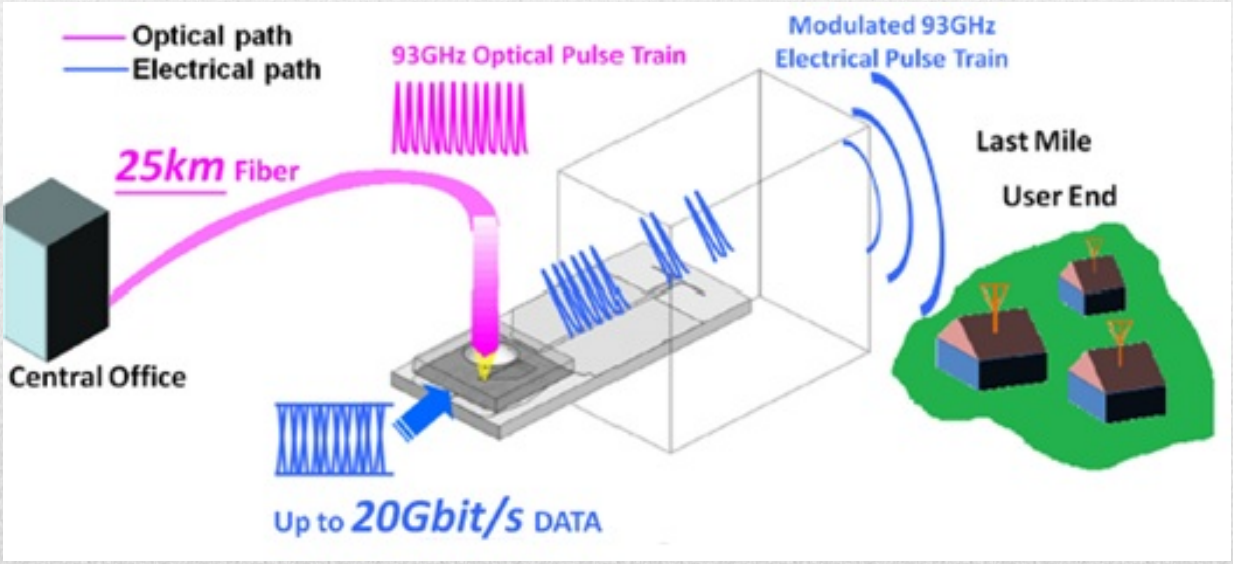
2012 THz Workshop:

Focusing on Radio-over-Fiber Communication

2012 兆赫科技研討會:

探討超高速無線光纖通訊的前景



National Tsing Hua University

Hsinchu, Taiwan

2012/12/3

Sponsored by 前瞻物質基礎與應用科學中心

Frontier Research Center on Fundamental and Applied Science of Matters, NTHU

目錄 Contents

Welcome Message

Greetings, and welcome to the 2nd annual Workshop on THz Science and Technology (2012 THz Workshop), to be held in Hsinchu, Taiwan on Dec. 3rd, 2012.

The information-intensive 21th century is sometimes referred as the Tera-era. Information needs be generated, stored, manipulated and transmitted to the global village at terabit rate, hopefully wirelessly. Unfortunately, such high-volume data transmission over air consumes radio bandwidth—lots of it and a great radio spectrum famine is happening. To meet this demand, the terahertz (1 THz = 10^{12} Hz) wave band of the electromagnetic radiation, which has traditionally only been the domain of astronomers and molecular spectroscopists, must be explored.

Spurred by discovery of new physical principles and innovative technologies in photonics, advanced materials and nanotechnology, novel applications of THz waves in basic science, security, medical diagnostics and treatment, non-destructive inspection, and manufacturing quality-control have recently been demonstrated. THz sensing, in particular, has attracted lots of attention due to its molecular un-ambiguity. Marketing opportunities for security screening in airport, counterfeit prevention in drugs/pharmaceuticals, defect detection in semiconductor manufacturing, and other high-value areas appear promising.

Information and communication technology should also benefit from advances in THz science and technology. The synergy of research areas such as wireless communication, biomedical and environmental sensing, as well as fiber-optic communication with THz science and technology will generate a wealth of applications. A Wireless HD (WiHD) Interest Group (http://www.wirelesshd.org) was recently established to establish a wireless digital interface to broadcast and receive uncompressed high-definition video by exploring the 60 GHz band. The Wireless Gigabit Alliance (http://wirelessgigabitalliance.org/) was created in 2009. IEEE has already set up a THz Interest Group (IGthz for short) in the IEEE 802.15 WPAN Committee (http://www.ieee802.org/15/pub/IGthz.html).

In view of this trend, the 2012 THz workshop focuses on photonic approaches to gigabit wireless communication. We are very pleased and indeed honored to have distinguished guests from Osaka University and local scholars presenting the latest advances in this important field.

The workshop organizers are most grateful to our sponsors, the Frontier Research Center and Applied Sciences of Matters NTHU, established through the academic top university program of the Ministry of Education.

As Conference Chair, I cordially invite all of you to participate and enjoy the excitement and fun of the 2012 THz workshop in Hsinchu.

Ci-Ling Pan 潘犀靈
Conference Chair, 2012 THz Workshop
Professor and Chair, Dept. of Physics
National Tsing Hua University
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Workshop Agenda

Dec 03, Monday **12 月 03 日，星期一** **Venue：Room 019, Physics Building, NTHU**	
09:00 – 09:10	Opening remarks 大會開幕致詞
09:10 – 10:00	Photonic Generation of Terahertz Waves for Communications and Sensing *Invited talk- Prof. Tadao Nagatsuma (Osaka University)* *邀請講演- 永妻忠夫 教授 (大阪大學)*
10:00 – 10:20	Coffee break 茶敘
10:20 – 11:00	NBUTC-PD Based Transmitter-Mixer for Photonic-Network-Compatible High Data Rate Wireless Communication and High-Resolution 3-Diemensional Radar Imaging *Invited talk- Prof. Jin-Wei Shi (Department of Electrical Engineering, NCU)* *邀請講演- 許晉瑋 教授 (中央大學 電機工程學系)*
11:00 – 11:40	Characterization and Modeling of Millimeter-Wave Photonic Transmitter for Wireless-Over-Fiber Applications *Invited talk- Prof. Nan-Wei Chen (Department of Communications Engineering, YZU)* *邀請講演- 陳念偉 教授 (元智大學 通訊工程學系)*
11:40-12:00	Group photo session 與會來賓團體照
12:00 – 13:30	Lunch 午餐
13:30 – 14:10	Applications of Optical Pulse Shaping in the Millimeter-Wave and Sub-THz Regimes *Invited talk- Prof. Chen-Bin Huang (Institute of Photonics Technologies, NTHU)* *邀請講演- 黃承彬 教授 (清華大學 光電工程研究所)*
14:10 – 14:50	Photonic Generation and Characterization of Sub-THz (MMW) Signals by 1550 nm-Based THz Time-Domain Spectroscopic Techniques *Invited talk- Dr. Jim-Wein Lin (Department of Physics, NTHU)* *邀請講演- 林雋文 博士 (清華大學 物理系)*
14:50 – 15:10	Coffee break 茶敘
15:10 – 15:50	RF Power-Fading Mitigation using Optical mm-Wave Signal Generated by Silicon-Ring Modulator in Long-reach Radio-over-Fiber (ROF) Systems *Invited talk- Prof. Chi-Wai Chow (Department of Photonics, NCTU)* *邀請講演- 鄒志偉 教授 (交通大學 光電工程學系)*
15:50 – 16:30	Bidirectional Lightwave Transport Systems Based on Optical Free-Space Transmission Scheme *Invited talk- Prof. Hai-Han Lu (Department of Electric-Optic Engineering ,NTUT)* *邀請講演- 呂海涵 教授 (台北科技大學 光電工程學系)*
16:30 – 17:00	Panel discussion 兆赫科技論壇

About the Invited Speakers

Photonic Generation of Terahertz Waves for Communications and Sensing

Tadao Nagatsuma
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Tadao Nagatsuma received B.S., M.S., and Ph.D. degrees in electronic engineering from Kyushu University, Fukuoka, Japan, in 1981, 1983, and 1986, respectively. In 1986, he joined the Electrical Communications Laboratories, Nippon Telegraph and Telephone Corporation (NTT), Atsugi, Kanagawa, Japan. From 1999 to 2002, he was a Distinguished Technical Member with NTT Telecommunications Energy Laboratories. From 2003 to 2007, he was a Group Leader with NTT Microsystem Integration Laboratories. He is currently a Professor at the Division of Advanced Electronics and Optical Science, Department of Systems Innovation, Graduate School of Engineering Science, Osaka University, Toyonaka, Japan. His research interests include millimeter-wave and terahertz photonics and their application to sensors and wireless communications.

Prof. Nagatsuma is a fellow of the Institute of Electronics, Information and Communication Engineers (IEICE), Japan, a senior member of the IEEE, and a member of the Technical Committee on Microwave Photonics of the IEEE Microwave Theory and Techniques Society, and the Microwave Photonics Steering Committee, and serves as an associate editor of IEEE Photonics Technology Letters. He is the recipient of numerous awards including the 1992 IEEE Andrew R. Chi Best Paper Award, the 1997 Okochi Memorial Award, the 1998 Japan Microwave Prize, the 2000 Minister's Award of the Science and Technology Agency, the 2002 Asia–Pacific Microwave Conference Prize, the 2004 Yokosuka Research Park Award, the 2006 Asia–Pacific Microwave-Photonics Conference Award, the 2006 European Microwave Conference Prize, the 2007 Achievement Award presented by the IEICE, the 2008 Maejima Award presented by the Post and Telecom Association of Japan, the 2011 Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, and the 2011 Asia–Pacific Microwave Conference Prize .

NBUTC-PD Based Transmitter-Mixer for Photonic-Network-Compatible High Data Rate Wireless Communication and High-Resolution 3-Diemensional Radar Imaging

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Jin-Wei Shi was born in Kaohsiung, Taiwan on January 22, 1976. He received the B.S. degree in Electrical Engineering from National Taiwan University, Taipei, Taiwan in 1998 and the Ph.D. in Graduate Institute of Electro-Optical Engineering from National Taiwan University, Taipei, Taiwan in 2002. He was a Visiting Scholar at the University of California, Santa Barbara (UCSB), CA, during 2000 and 2001. In 2002-2003, he served as a post-doc researcher at Electronic Research & Service Organization (ERSO) of Industrial Technology Research Institute (ITRI). In 2003, he joined the Department of Electrical Engineering, National Central University, Taoyuan, Taiwan, where he is now professor. In 2011, he joins the ECE Dept. of UCSB again as a Visiting Scholar. His current research interests include ultra-high speed/power optoelectronic devices, such as photodetectors, electro-absorption modulator, sub-millimeter wave photonic transmitter, and semiconductor laser. He has authored or co-authored more than 90 Journal papers, 150 conference papers and hold 20 patents. He was the invited speaker of 2002 IEEE LEOS, 2005 SPIE Optics East, 2007 Asia-Pacific Microwave Photonic conference (AP-MWP), 2008 Asia Optical Fiber Communication & Optoelectronic Exposition & Conference (AOE), 2011 Optical Fiber Communication (OFC), and 2012 IEEE Photonic Conference (IPC). He served as the technical program committee of OFC 2009-2011, 2012 SSDM, 2012 MWP, and 2013 Asia-Pacific CLEO. He was the recipient of year 2007 Excellence Young Researcher Award from Association of Chinese IEEE and 2010 Da-You Wu Memorial Award

Characterization and Modeling of Millimeter-Wave Photonic Transmitter for Wireless-Over-Fiber Applications

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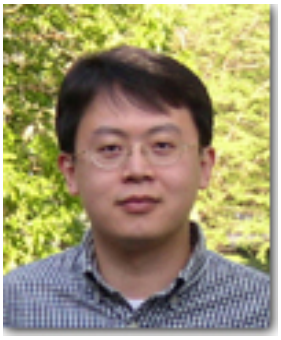

Nan-Wei Chen received the B.S. degree in atmospheric sciences and the M.S. degree in space sciences from National Central University, Jhongli, Taiwan, in 1993 and 1995, respectively. He received the Ph.D. degree in electrical engineering at the University of Illinois at Urbana-Champaign in 2004.

From 1998 to 2004, he was a Research Assistant at the Center for Computational Electromagnetics, University of Illinois, where he worked on time-domain integral equation methods for the solution of scattering and radiation problems. From 2004 to 2009, he was an Assistant Professor of electrical engineering at the National Central University, Taiwan. Since 2010, he has been working as an Associate Professor of communications engineering at Yuan Ze University, Jhongli, Taiwan. His research interests include computational electromagnetics with special emphasis on time-domain integral equations, periodic structures, and millimeter-wave antennas and passive circuits.

Dr. Chen received the Raj Mittra Outstanding Research Award from the University of Illinois in 2004 and the Best Article Award from the Chinese Geoscience Union in 2010.

Applications of Optical Pulse Shaping in the Millimeter-Wave and Sub-THz Regimes

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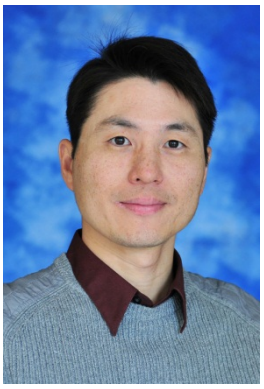

Chen-Bin Huang received his B.S. degree in electrical engineering from National Tsing Hua University, Taiwan, in 1997, his M.S. degree in electro-optical engineering from National Chiao Tung University, Taiwan, in 1999, and his Ph.D. degree from the School of Electrical and Computer Engineering at Purdue University, West Lafayette, IN, USA, in 2008.

He has worked at Bell Laboratories (Alcatel-Lucent) in the USA and the Opto-Electronics & Systems (OES) Laboratories of the Industrial Technology Research Institute (ITRI) in Taiwan. He joined the Institute of Photonics Technologies at National Tsing Hua University in Taiwan as assistant professor in 2008 and was promoted to associate professor in 2012. His current research interests include optical and millimeter-wave arbitrary waveform generations, nanoplasmonic devices, and applications of optical frequency combs.

Photonic Generation and Characterization of Sub-THz (MMW) Signals by 1550 nm-Based THz Time-Domain Spectroscopic Techniques

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Jim-Wein Lin received his B.S. degree in Physics from National Kaohsiung Normal University, Taiwan, in 1994, his M.S. degree in Electrical Engineering from National Tsing Hua University, Taiwan, in 1999, and his Ph.D. degree in Electrical Engineering from National Tsing Hua University, Taiwan, in 2009.
He is currently a postdoctoral research fellow in Department of Physics in National Tsing Hua University. His research interests include terahertz time-domain spectroscopy, electro-optic sampling techniques, and applications of femtosecond fiber lasers.

RF Power-Fading Mitigation using Optical mm-Wave Signal Generated by Silicon-Ring Modulator in Long-reach Radio-over-Fiber (ROF) Systems

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Chi-Wai Chow received the B.Eng. (First-Class Hons) and Ph.D. degrees both from the Department of Electronic Engineering, the Chinese University of Hong Kong in 2001 and 2004 respectively. His Ph.D. focused on photonic packet switched networks. Then, he was a Postdoctoral Fellow at the Chinese University of Hong Kong, working on hybrid integration of photonic devices and silicon photonics.

Between 2005-2007, he was a Postdoctoral Research Scientist in the Tyndall National Institute and Department of Physics, University College Cork (UCC) in Ireland, working mainly on two European Union Projects: PIEMAN and TRIUMPH. In 2007,

He joined the Department of Photonics, National Chiao Tung University in Taiwan, as an Assistant Professor. In 2010, he was promoted to Associate Professor. His research interests are PON, ROF, silicon photonics and advanced modulation formats. He was also the recipient of National Science Council, Dr. Wu Da-You Research Award 2009 and Foundation for the Advancement of Outstanding Scholarship 2009.

Bidirectional Lightwave Transport Systems Based on Optical Free-Space Transmission Scheme

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Hai-Han Lu received the MS and Ph.D. degrees from the Institute of Electro-Optical Engineering, National Central University, Taiwan, in 1991 and 2000, respectively. He joined the Department of Electro-Optical Engineering, National Taipei University of Technology as an Associate Professor in 2001, as well was promoted to Professor and Distinguish Research Professor in 2003 and 2006, respectively. He was the Chair of the Department of Electro-Optical Engineering at NTUT (8/2005-7/2008). He has temporarily transferred to the Tungnan University as a Vice President from 2011 (2011-2014). His research interests include radio-over-fiber (RoF) and fiber optics CATV transport systems.

Professor Lu is currently a Fellow of the IET (Institution of Engineers and Technology), a Senior Member of the IEEE (Institute of Electrical and Electronics Engineers), a Senior and Life Member of the OSA (Optical Society of America), and a Senior Member and Life Member of the SPIE (International Society for Optical Engineers). He was a Membership Committee of the SPIE (2004-2005). He was awarded the ETRI (Electronics and Telecommunications Research Institute) Journal Paper of the Year (SCI, 2007), Outstanding Research Prize of NTUT (2004), and Outstanding Research Prize of EECS in NTUT (2007) for his significant technical contributions to RoF and fiber optics CATV transport systems.

Abstracts

Photonic Generation of Terahertz Waves for Communications and Sensing

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Abstract :

This talk will review our recent progress in the use of photonic technologies for efficient generation of broadband continuous terahertz waves, and their applications to wireless communication, tomographic imaging and spectroscopy.

NBUTC-PD Based Transmitter-Mixer for Photonic-Network-Compatible High Data Rate Wireless Communication and High-Resolution 3-Diemensional Radar Imaging

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Abstract :

In this talk, recent progress in high-speed/power near-ballistic uni-traveling carrier photodiode (NBUTC-PD) with ultra-fast switching speed used for (sub-) millimeter-wave (MMW) photonic Gigabit wireless communication and high resolution radar imaging is reviewed. The photonic technique is attractive for such two applications due to that the (sub-) MMW signal can be easily distributed in the whole system through the use of a low-loss optical fiber and the optical signal processing becomes feasible for the (sub-) MMW signal generation with complex waveform, such as the broadband chirped pulse signal, which is the key for ultra-high resolution radar imaging. Furthermore, the photonic approach can provide an excellent isolation in the short-pulse radar system. Where, the delivery of short-pulse with amazing high peak-power (kW) for long-range (> hundreds of km) object detection is necessary.

A (sub-) MMW photonic transmitter (PT), comprised of high-power photodiodes (PDs) with integrated (sub-) MMW waveguide and antennas for optical-to-electrical (O-E) signal conversion and MMW broadcasting thus play important roles in this kind of photonic-MMW system. The high available power of NBUTC-PD can release the burden imposed on the gain and saturation power performance of sub-THz power amplifier. The development of several different high-power NBUTC-PD based PTs/PDs for MMW/THz pulse generation through MMW waveguide or free space is summarized. The performance of photonic wireless links and radar imaging system developed based on these key components with extremely high data rate (> 25Gbit/sec) and ultra-high range-resolution, respectively, will also be reviewed.

Characterization and Modeling of Millimeter-Wave Photonic Transmitter for Wireless-Over-Fiber Applications

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Abstract :

Efficient and accurate system characterization and modeling of the millimeter-wave (MMW) photonic transmitter are presented. It is shown that the presented system modeling techniques are crucial to the implementation of a photonic transmitter with wide optical-to-electrical (OE) and intermediate-frequency (IF) bandwidth. Specifically, the accurate optical and electrical modeling of the photodiode (PD) along with the microwave network representation of the entire transmitter, including the PD, transmitting antenna, and the front-end passive circuitry, is described. The effectiveness of the proposed modeling techniques for system characterization is experimentally demonstrated through a high-speed (25 Gbits/sec) wireless link developed with the implemented MMW photonic transmitter at W-band.

Applications of Optical Pulse Shaping in the Millimeter-Wave and Sub-THz Regimes

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Abstract :

Optical pulse shaping techniques, in which user-specified ultrashort pulse fields are synthesized via parallel manipulation of optical Fourier components, are now widely adopted. Furthermore, mode-locked lasers producing combs of frequency stabilized spectral lines have resulted in revolutionary advances in frequency metrology. However, until recently pulse shapers addressed spectral lines in groups at low spectral resolution. Line-by-line pulse shaping, in which spectral lines are resolved and manipulated individually, leads to a fundamentally new regime for optical arbitrary waveform generation (OAWG), in which the advantages of pulse shaping and of frequency combs are exploited simultaneously.

In this talk, results on programmable line-by-line shaping of various types will be presented. OAWG promises broad impact both in optical science, allowing for example coherent control generalizations of comb-based time-frequency spectroscopy, and in technology, enabling new truly coherent multi-wavelength processing concepts for spread spectrum lightwave communications and photonically-assisted millimeter-wave (MMW) generations. We will present our recent results on remote generation of high-modulation-depth photonic millimeter-wave (MMW) waveforms by applying line-by-line pulse shaping on a phase-modulated continuous-wave laser frequency comb. Potential applications of such flexible photonic transmitter in sub-THz and even THz regimes will also be discussed.

Photonic Generation and Characterization of Sub-THz (MMW) Signals by 1550 nm-Based THz Time-Domain Spectroscopic Techniques

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Abstract:

Technologies for generating and detecting THz electromagnetic pulse have attracted a lot of interest during the past decades due to the considerable applications such as material inspection, spectroscopy sensing and communications. Among these techniques, the use of THz time domain spectroscopy (THz-TDS) based on a Ti:sapphire laser system has been proven successful and being employed in research nowadays. However, recent trend has suggested using ultrafast fiber laser instead of Ti:sapphire laser due to its compact design. The Er-doped fiber laser (EDFL), in particular, is suitable for the fiber-coupled THz-TDS system in conjunction with the abundant fiber components in optical communication systems.

In this talk, results on a home-made 1550 nm THz-TDS system will be presented. This technique allows both photonically-assisted millimeter-wave (MMW) generations and ultra-fast coherent detections when applying a high-power sub-THz photonic transmitter (PT). We will present our recent results on characterizations of frequency response of the PTs. Besides, potential applications such as the photonic generations of narrow-band MMW pulses and frequency-modulated MMW waveforms by femtosecond pulse shaping on the EDFL will also be discussed.

RF Power-Fading Mitigation using Optical mm-Wave Signal Generated by Silicon-Ring Modulator in Long-reach Radio-over-Fiber (ROF) Systems

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Abstract :

Recently, the merging of passive optical network (PON) and radio-over-fiber (ROF) access network has received more attention, since it is expected to provide broadband and flexible Internet services for both mobile and fixed users in a single platform. Besides, long-reach PON (LR-PON) has been proposed for combining the separate metro and access networks into a single system to reduce network cost and power consumption. It is believed that the integration of the LR-PON and the LR-ROF can further reduce the cost by sharing the same optical components and extending the ROF network coverage. However, the transmission of optical millimeter-wave (mm-wave) signal in the LR-PON is challenging. When the optical mm-wave signal is transmitting in an optical fiber, chromatic dispersion causes a differential delay to be added to the sidebands and the carrier, causing length dependent power fading effect and code time-shifting.

In this work, we propose and demonstrate a LR-ROF signal transmission using single sideband (SSB) optical mm-wave signal generated by a silicon microring modulator. The silicon modulator provides the advantages of low power consumption and compact size. Besides, a unique feature of the silicon microring modulator is that it only modulates the signal wavelength in the resonant null, thus allowing it to encode data on only one of the sidebands of the optical signal in the generation of optical SSB mm-wave signal. Analysis is performed showing the SSB optical mm-wave outperforms the double-sideband (DSB) and optical carrier suppression (OCS) optical mm-wave signals. Error free 100 km single mode fiber (SMF) transmission is achieved experimentally.

Bidirectional Lightwave Transport Systems Based on Optical Free-Space Transmission Scheme

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Abstract :

Wireless communication network is a promising technology to provide broadband service to the end-user. However, due to high attenuation in the wireless band, using wireless communication to connect the head-end and the access point (AP) will place serious limitations on the allowed repeaterless distance. It is expected that fiber transmission link may be a solution to the issue. In optical fiber integration with optical free-space transmission systems, the transmitted signal is converted into the optical one and distributed to the remote APs by fiber link, by which providing broad bandwidth and low attenuation characteristics. Optical free-space transmission scheme is presently developed by researchers and engineers to create high-speed and high security communication networks, in which using optical light to replace modulated and un-modulated signals. It can provide many benefits, like providing communication link in specific areas in which RF communication is prohibited, such as in the hospital or airplane. Optical free-space transmission scheme can be divided into two categories: the divergence scheme and the convergence one. The former uses the divergence beam to provide the mobile service to the end-user. However, it is difficult to obtain good free-space transmission performance due to large service area and low optical power per unit area. On the other hand, the latter uses the convergence beam to provide the mobile service to the end-user. Nevertheless, it is also difficult to obtain good free-space transmission performance due to narrow light beam and laser light misalignment between the transmitter and the receiver.

A novel bidirectional lightwave transport system employing wavelength-division-multiplexing (WDM) and optical add-drop multiplexing techniques, as well as optical free-space transmission scheme is proposed and experimentally demonstrated. Over an 80-km single-mode fiber (SMF) transport and about 2.4 m free-space transmission, impressive and brilliant bit error rate (BER) operation is obtained for long-haul fiber link and finite free-space transmission distance. Such bidirectional lightwave transport system based on optical free-space transmission scheme has been successfully demonstrated, which can not only present its advancement in lightwave application, but also reveal its simplicity and convenience for the real implementation. Our proposed systems are suitably applicable to the lightwave communication systems in wire and wireless transmissions.

Brief Description of the Sponsoring Organizations and the University

國立清華大學物理學系

系所沿革

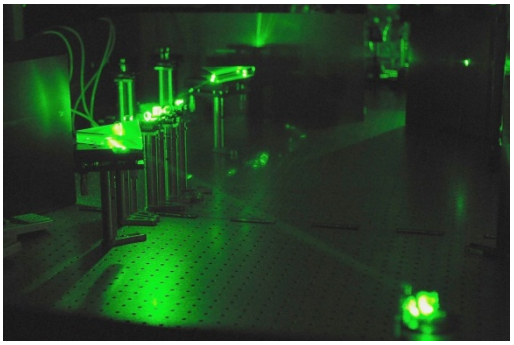
國立清華大學於民國前一年(西元 1910 年)在北平建校，民國 45 年(1956 年)在台灣新竹市復校。首先成立原子科學研究所，物理組為其中一個重要的部門，並開始招收碩士班研究生，為本校日後的物理系及物理研究所奠下良好的基礎。

物理學系則於民國 54 年(1965 年)正式成立，開始招收大學部學生，次年成立物理研究所，招收碩士班研究生；隨即於民國 56 年(1967 年)開始招收博士班研究生。迄今已有約 1500 位學士、850 位碩士及 150 位博士畢業生，歷屆畢業系友於國內外學術界及工業界皆有出色的表現；其中榮任中研院院士共有七位之多，為國內擁有院士榮銜人數最多、密度最高之系所。

民國 90 年(2001 年)於物理系組織內成立天文所，開始招收碩士班研究生，並將於民國 97 年(2008 年)設立天文所博士班。目前全系大學部學生約 290 位、碩士班研究生約 100 位及博士班研究生約 120 位。

師資

本系現有專任教授 34 位(含天文所 5 位)，張石麟、沈元壤、徐遐生、崔章琪、朱經武、朱國瑞等五位院士為本系榮譽講座教授，另有 14 位合聘教授。研究領域遍及統計及數學物理、重力與天文物理、粒子物理與場論、原子核物理、原子分子與光學物理、凝體物理、奈米物理、生物物理、流體與離子體物理等多個學門領域，並有應用科學與跨學門物理。歷年來更有多位教授分別榮獲總統獎、國科會傑出研究獎、教育部學術獎、中山學術獎、教育部國家講座教授、傑出人才基金會講座等等國內重要學術研究獎項。根據國科會統計資料，國科會傑出研究獎自設立以來，三分之一以上的物理獎得主為本系教授。



本系每位教授皆擔任導師，對學生的課業及日常生活給予適當輔導，並幫助解決問題。平均每八名學生即有一位導師，師生接觸及溝通之機會多，關係密切且融洽。

特色

物理系所自成立以來，一直是教學與研究並重，在教學方面，本系的特色是課程領域涵蓋廣泛，使大學部學生及研究生能充分地按照個人興趣學到各重要的課程，老師們授課也多以嚴謹著稱 。在研究方面，從基礎物理到應用物理的各種物理研究領域都有涵括。近年來「遠見」及「天下」雜誌對國內物理系作過一系列教學與研究評鑑，本系均名列榜首。

國科會物理研究推動中心於 1965 年設立於清華大學物理系，主要任務為負責全國物理研究之策劃及推動工作，並成立物理推動中心圖書館，提供完善圖書服務，為全國物理學界利用。

國家理論科學研究中心於民國八十六年成立於清大，許多教授與研究生積極參與並協助中心之學術活動與交流，促進優良研究風氣，主導國內理論物理研究。

國立清華大學光電研究中心

成立宗旨

近年來光電相關產業為政府所推動的另一個重點產業並列為十大新興產業之一，世界各國亦積極地投入大量的財力與人力進行材料與產品的開發，本中心將配合國家光電產業之發展，整合產、學、研界，期許開發具有商業化價值之技術及材料，提供給國內業者應用，並藉由中心之計畫進行人才培育，使光電產業能更加穩固且茁壯。

目標展望

1.整合光電領域相關的資源
2.建立核心設施
3.技術研發、專利申請
4.技術移轉/授權
5.產學研聯盟
6.專業人才培育

光電科技為新興之科技，是台灣成長最快，規模最大的新興高科技產業，又是一個跨足物理、化學、材料、電子、微系統、奈米科技、生醫量測，本中心將整合本校在 光電領域相關的資源，推動整合型的計畫，如 Silicon Photonics 新興的光電應用科技，電射顯示技術，半導體照明，太陽能光電，生醫光電，奈米光電，以爭取更多研發資源，同時加強產學研合作，創造出最 有價值及影響力的研究。

兆赫波光電研究團隊

兆赫波（Terahertz Radiation, 1 THz = 1012 Hz）是頻率從約 0.1 – 10 THz 範圍內的電磁波的簡稱。此一頻率範圍內的電磁波與物質交互作用的相關研究具有豐富的科學內涵和廣泛的應用前景。邁入二十一世紀後，兆赫科技被世界各國視為重要的前沿領域，其進展使遠紅外領域的科學研究豁然開朗；更促進了如國土安全、遙測、生醫、製程控制與材料分析、造影與通訊等跨研究領域課題有了突破性的面貌。

本中心的宗旨是從事兆赫波與物質交互作的基礎研究，並經由掌握兆赫波的產生、偵測與操控而發展各種應用。主要成員包括潘犀靈、黃衍介、張存續、嚴大任等，相關教師有齊正中、施宙聰、黃承彬等。本中心也邀集了國內從事兆赫科技研究的頂尖學者：孫啟光（台大）、許晉瑋（中大，國科會吳大猷獎）、趙如蘋（交大）、鄒志偉（交大，國科會吳大猷獎）等參加，也與多個國際團隊有進行中的合作研究。

團隊成員

物理系潘犀靈教授

過去的五年間，潘犀靈教授研究團隊曾報導了偵測頻寬超越 30 THz 之 GaAs:As+及 InP: H+光導天線，這是迄今利用離子佈植半導體製作之最高頻寬的 THz 偵測器，曾被用以展示第一個直接調制的 THz 通訊系統、傷燙傷偵測系統（台、美專利；與工研院合作）。本團隊也發展了高功率和高效率的次兆赫光子發射器（與中大許晉瑋教授合作），用於超寬帶脈碼無線通信，已可在 W 頻段（0.1 THz）以 20Gb/s 數率傳輸。本團隊也開創了液晶 THz 光子學領域（與交大趙如蘋教授合作），發展多項功能性液晶兆赫光電元件（台、美專利多件）。

光電所黃衍介教授

黃衍介教授研究團隊曾發展最低閥值的兆赫波光參數振盪器。
展示超輻射自由電子雷射概念，並獲得相關之美國專利。

材料系嚴大任教授

嚴大任教授曾於 2004 年時，率先利用人工磁性之超穎材料將磁性響應由微波波段推至 Terahertz 的高頻範圍，成果果發表於國際知名期刊 Science ，該文是兆赫科技領域 2004 年發表之論文中迄今被引用作多的。

物理系張存續教授

張存續教授團隊研究磁旋返波振盪器之物理作用機制，如非線性場收縮特性、非穩態與渾沌行為、線性與時變特性、與軸向模式競爭等。成果曾發表多篇於頂級物理期刊，Phys. Rev. Lett.

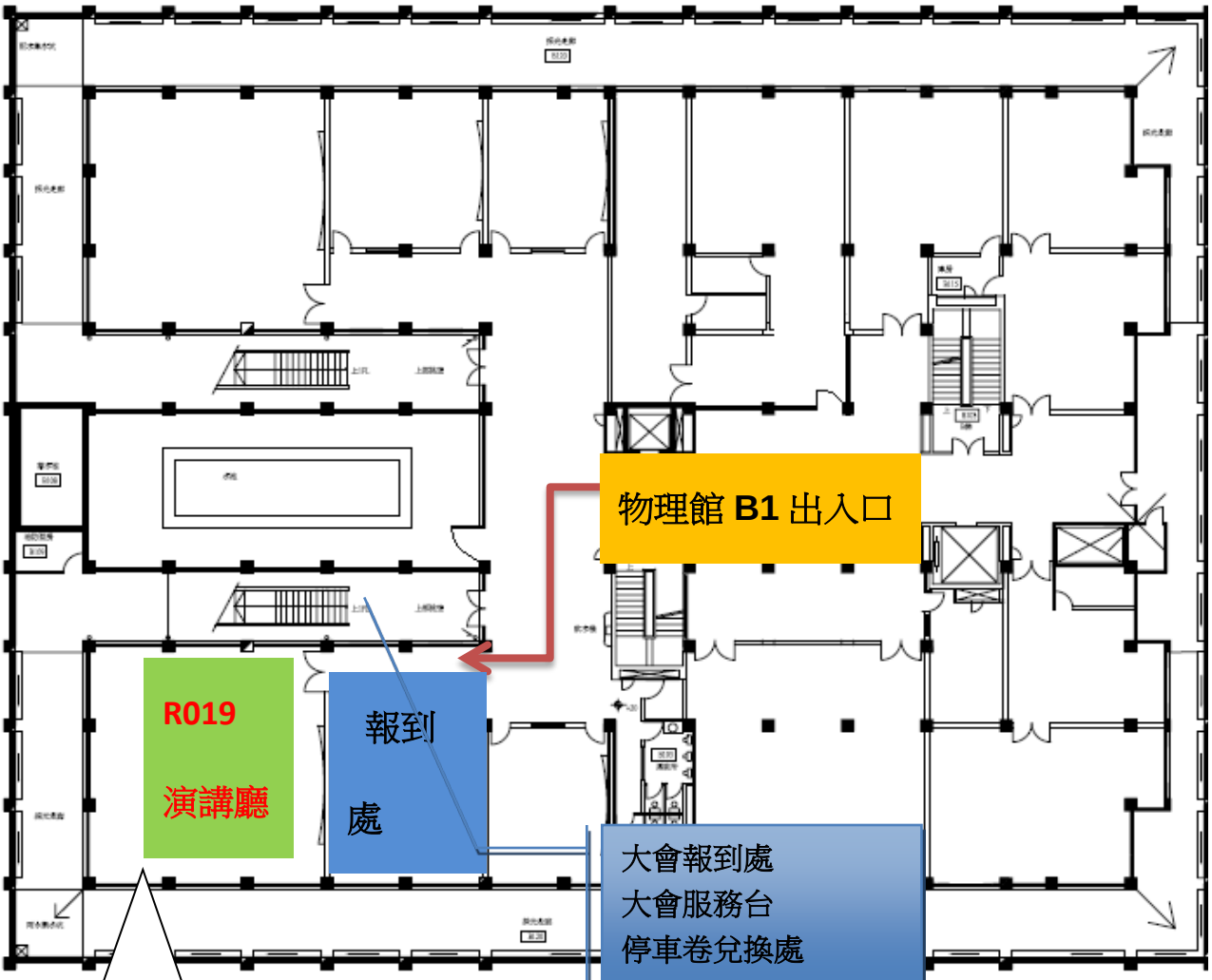
Information on 2012 THz Workshop

大會地點

國立清華大學物理學系

新竹市光復路二段 101 號

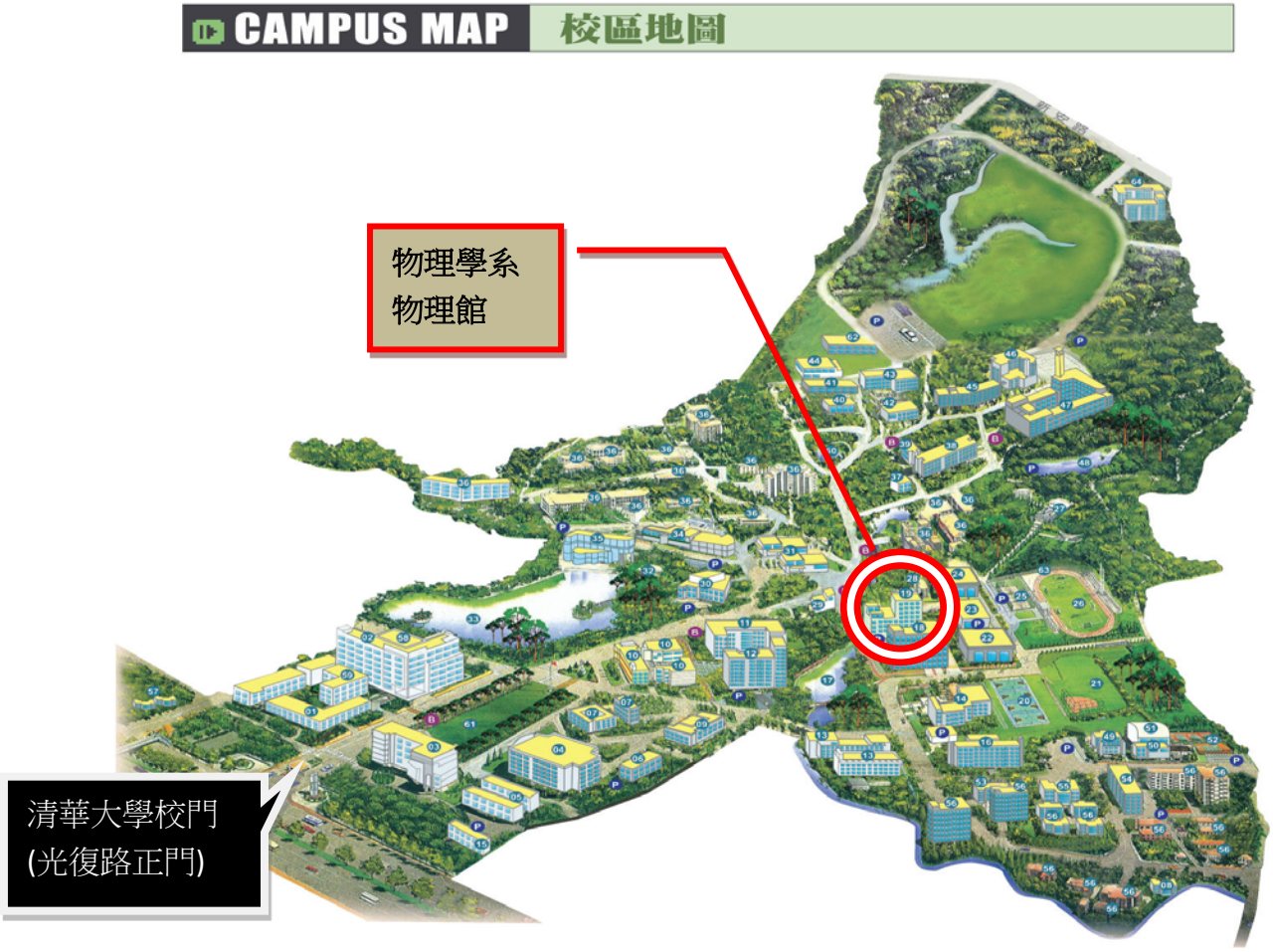
http://www.phys.nthu.edu.tw/index_ch.html



大會場地位置圖

物理館 R019 演講廳

清華大學校園地圖



01. 研發大樓
02. 工程一館
03. 化學館
04. 化工館
05. 動機化學實驗館
06. 醫輔中心
07. 材料中心 (A.B)
08. 清華會館
09. 教育館
10. 第一綜合大樓（行政大樓）
11. 第二綜合大樓
12. 第三綜合大樓
13. 工程三館
14. 資訊材料館
15. 立體機車停車場
16. 材料科技館（工程四館）
17. 昆明湖
18. 資訊電機館
19. 物理館
20. 籃球場
21. 棒球場
22. 游泳池
23. 羽球館
24. 體育館
25. 排球場
26. 田徑場
27. 梅園
28. 蒙民偉樓（學生活動中心）
29. 百齡堂
30. 大禮堂
31. 小吃部
32. 溜冰場
33. 成功湖
34. 水木生活中心
35. 風雲樓（書局、餐廳）
36. 學生宿舍
37. 駐警隊
38. 工科館
39. 原科中心
40. 原子爐
41. 同位素館
42. 生物科技館
43. 生醫工程及環境科學館
44. 加速器館
45. 生命科學一館
46. 生命科學二館
47. 人文社會館
48. 相思湖
49. 材料實驗館
50. 合金實驗館
51. 室內網球場
52. 室外網球場
53. 自強樓
54. 莊敬樓
55. 第二招待所
56. 西院宿舍
57. 東院宿舍
58. 科儀中心
59. 創新育成中心
60. 荷塘
61. 大草坪
62. 相對論光電子實驗室
63. 守德紀念岩場
64. 台積館
P. 停車場
B. 公車站

交通資訊 Travel to NTHU

- 自行開車

國道路線：

※ 中山高二側引道與光復路、公道五路並未直接連結南下欲由光復路下交流道者，請先由公道五出口接引道。

※ **自行開車之來賓請憑停車卷至大會服務台領取免費停車證**。

由中南部北上車輛	路線一	由 95B 竹科交流道下，左轉接園區二路，行至新安路時左轉直行，由本校南門進校園。(本路線適合考場位於人社院、工科館、生科二館、原科院考生)
	路線二	由 95A 新竹交流道下，左轉接光復路後直行，由本校光復路大門進校園。(本路線適合考場位於工一館、化工館、教育館、電資院、綜三館、工四館考生)
由北部南下車輛	路線一	由 95A 公道五匣道下交流道，選擇右方往公道五路出口，沿公道五路直行至建中路口(鄰近中油油庫)左轉，沿建中路直行至底(光復中學)再左轉光復路，可將汽車停放於「赤土崎停車場」，再步行至本校，或由本校光復路大門進入校園。
	路線二	由 95A 公道五匣道出高速公路後直行，經由引道接光復路後右轉直行，由本校光復路正門進入校園。 如果您錯過了上述交流道，請由下一個出口(95B 竹科交流道)下高速公路，右轉接園區新安路後直行，由本校南門進入校園。

- 台灣高鐵

1.請於高鐵新竹站下車，下車後可轉搭其他交通工具，轉乘資訊請見台灣高鐵網站。

2.台灣高鐵公司自 97/1/25 起提供高鐵新竹站快捷專車免費接駁服務，沿途停靠新瓦屋(客家園區)=>交通大學=>清華大學(文教新村 ，於清大光復路大門附近)=>馬偕醫院=>二分局(東光路口)=>文化中心=>東門市場，每班車間隔約 20 分鐘一班 。

高鐵新竹站發車 THSR Hsinchu Station				東門市場發車 Dongmen Market			
07:15	11:50	16:50	21:15	06:05	10:40	15:40	20:15
07:50	12:15	17:15	21:50	06:35	11:15	15:55	20:50
08:15	12:50	17:35	22:15	06:55	11:40	16:15	21:15
08:35	13:15	17:50	22:50	07:10	11:55	16:40	21:40
08:50	13:35	18:15	23:15	07:35	12:15	17:15	22:15
09:15	13:50	18:35	23:50	07:55	12:40	17:30	22:45
09:35	14:15	18:50		08:15	12:55	17:50	
09:50	14:35	19:15		08:40	13:15	18:15	
10:15	14:50	19:35		08:55	13:40	18:30	
10:35	15:15	19:50		09:15	14:15	18:50	
10:50	15:50	20:15		09:40	14:40	19:15	
11:15	16:15	20:35		09:55	14:55	19:30	
11:35	16:35	20:50		10:15	15:15	19:50	

國光客運 0800-010-138 www.kingbus.com.tw

往市區方向，沿途各站均可下車，但不可上客。
往高鐵站方向，於高鐵站前之各站均可上客，但僅可於高鐵站下車。

- 火車
  西部幹線 新竹站下車，下車後需轉搭其他交通工具。
- 新竹市公車
  新竹客運公車號碼：
  1 路（約每 10-15 分鐘一班）
  2 路（約 1 小時一班）
  搭乘地點：民族路，SOGO 百貨旁邊
  下車地點：清華大學站
- 計程車
  火車站→清華大學門口，車資約 150~200 元（若未跳錶，上車前請先與司機議價）

新竹市景點介紹 Famous tourist spots in Hsinchu

資料來源：新竹旅遊網

美食資訊 Eating at Hsinchu

地區 /景點	所在位置	美食小吃
城隍廟夜市	新竹市北區中山里中山路 75 號	汕頭火鍋、摃丸、米粉、肉圓、魷魚羹、肉粽、裸粽、潤餅捲、魚丸、蚵仔煎
花園街夜市	新竹市花園街(東大路橋下)	各式台灣小吃、新加坡美食餐廳
清大夜市	清華大學校門口對面之建功路	小洞天糯米腸、風格傳統豆花、脆皮雞排
新復珍竹塹餅	新竹市北門街六號 (城隍廟邊)	竹塹餅、綠豆椪、麻?、麻糬
黑貓肉包	新竹市北門皆 187 號	黑貓肉包
光復饅頭店	新竹市光復路二段 92 號	各式包子饅頭

緊急聯絡電話 Important Numbers

Office of Department of Physics, NTHU	(03) 574-2306
Prof. C. L. Pan's Lab	(03) 516-2576 (03) 574-2552 (03) 574-2275
Fire & Emergency /火警、緊急事故	119
Police & Traffic Accident /警察報案、交通事故	110
Local Call Directory /市區電話查詢	104
Long Distance Call Directory /長途電話查詢	105
International Information Directory /國際電話查詢或掛發	100
Taiwan Taoyuan International Airport / 臺灣桃園國際機場 The Service Counter of the Departure Hall for 24- hour /Terminal 1 The Service Counter of the Departure Hall for 24- hour /Terminal 2 Website: http://www.taoyuan-airport.com/chinese/index.jsp	(03)398-2143 (03)398-3274
Taiwan High Speed Rail / 台灣高鐵 Website: http://www.tTHSR c.com.tw/en/?lc=en	4066-3000
Kuo-Kuang motor transport / 國光客運 Website: http://www.kingbus.com.tw/index.php	0800-010-138
HsinChu Transportation Co., Ltd. / 新竹客運 Website: http://www.hcbus.com.tw/	(03)522-5151
Inquiry for International Telecommunication Service (free) / 查詢國際電信業務電話（免費）	0800-731-123
Department of Tourism Hsinchu City Government / 新竹市政府觀光處 Website: http://dep-tourism.hccg.gov.tw/	(03)521-6121

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Conference Organizer

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http://www.phys.nthu.edu.tw/~clpanlab/workshops/2012THz/Homepage.htm