

NORTH ATLANTIC TREATY ORGANISATION



RESEARCH AND TECHNOLOGY ORGANISATION

BP 25, 7 RUE ANCELLE, F-92201 NEUILLY-SUR-SEINE CEDEX, FRANCE

RTO LECTURE SERIES 229

Optics Microwave Interactions

(Interactions entre optique et micro-ondes)

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Sensors and Electronics Technology Panel (SET) and the Consultant and Exchange Programme of RTO presented on 2-3 September 2002 in Jouy en Josas, France, on 5-6 September 2002 in Duisburg, Germany and on 9-10 September 2002 in Budapest, Hungary.



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RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote cooperative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective coordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also coordinates RTO's cooperation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of initial cooperation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS Studies, Analysis and Simulation Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier cooperation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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Optics Microwave Interactions

(RTO EN-028 / SET-058)

Executive Summary

The field of optics-microwave covered by this 2 day lecture series can generally be defined as the study of high speed devices and systems operating at microwave, millimeter wave and even THz frequencies. The benefits drawn by the introduction of optics in microwave techniques are illustrated through numerous examples.

This two-day lecture series covers the main applications of opto-microwaves to the defence area with a broad approach stretching from devices to systems.

The first day starts with a general overview and state of the art of the field. Then, the hybrid integration of opto-electronic components and associated technology are reviewed. The optoelectronic transducers from electronics to optics and optics to electronics are presented in detail. Then, a wide variety of applications is presented: recent developments in fiber-fed radio systems, optical distribution of broadband RF and MMW signals for mobile and wireless systems of RF signals to phased array antennas, beamforming, beam control and antenna remoting.

The second day presents the applications to optical processing of microwave signals and to optical control of microwave devices as well. Optical networks for radar and electronics warfare systems, for broadband applications (1-20 GHz) are also discussed. Finally, novel techniques of microwave photonics applied to optical Analogue to Digital Converters (ADC) and for medical imaging are also presented.

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Sensors and Electronics Technology Panel (SET) and the Consultant and Exchange Programme of RTO presented on 2-3 September 2002 in Jouy en Josas, France, on 5-6 September 2002 in Duisburg, Germany and on 9-10 September 2002 in Budapest, Hungary.

Interactions entre optique et micro-ondes

(RTO EN-028 / SET-058)

Synthèse

Ce cours concerne toutes les interactions entre l'optique et les micro-ondes et vice-versa et les bénéfices liés à l'introduction de l'optique dans les techniques micro-ondes par rapport à une approche conventionnelle purement électrique sont illustrés par de nombreux exemples. Le domaine de fréquence exploré va des micro-ondes (GHz) au THz en passant par la gamme millimétrique.

Le cours est réparti sur deux journées, et les principales applications de l'optomicro-onde dans le domaine de la défense sont traitées, du dispositif au système applicatif.

La première journée est consacrée en partie à une introduction générale sur les domaines avec un rappel de l'état de l'art. Ensuite, l'intégration hybride de composants optique et micro-ondes, et la technologie associée seront présentées. Les composants optoélectroniques servant d'interface électrique/optique et optique/électrique seront revus en détail. La journée s'ouvre ensuite sur un vaste champ d'applications : les récentes avancées sur les systèmes radio sur fibre, la distribution optique de signaux RF large bande ou millimétrique pour les antennes à balayage de phase, les mobiles et les réseaux sans fils, la distribution radar, la formation et le contrôle de faisceaux, les antennes déportées.

La deuxième journée présente les applications au traitement optique du signal micro-ondes, le contrôle optique de dispositifs micro-ondes, la conversion analogique/numérique, la distribution optique dans les systèmes radars très large bande (1-20 GHz). Des récentes applications en plein essor telles que l'imagerie médicale sont aussi présentées.

Cette publication a été rédigée pour servir de support de cours pour le Cycle de conférences 229, organisé par la Commission de la technologie des capteurs et des dispositifs électroniques (SET) dans le cadre du programme des consultants et des échanges de la RTO du 2-3 septembre 2002 à Jouy en Josas, France, du 5-6 septembre 2002 à Duisburg, Allemagne et du 9-10 septembre 2002 à Budapest, Hongrie.

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