Trends in Optical Fibre Metrology and Standards

NATO ASI Series

Advanced Science Institutes Series

A Series presenting the results of activities sponsored by the NATO Science Committee, which aims at the dissemination of advanced scientific and technological knowledge, with a view to strengthening links between scientific communities.

The Series is published by an international board of publishers in conjunction with the NATO Scientific Affairs Division

A Life Sciences	Plenum Publishing Corporation
B Physics	London and New York
C Mathematical and Physical Sciences	Kluwer Academic Publishers
D Behavioural and Social Sciences	Dordrecht, Boston and London
E Applied Sciences	
F Computer and Systems Sciences	Springer-Verlag
G Ecological Sciences	Berlin, Heidelberg, New York, London,
H Cell Biology	Paris and Tokyo
I Global Environmental Change	

PARTNERSHIP SUB-SERIES

1. Disarmament Technologies	Kluwer Academic Publishers
2. Environment	Springer-Verlag
3. High Technology	Kluwer Academic Publishers
4. Science and Technology Policy	Kluwer Academic Publishers
5. Computer Networking	Kluwer Academic Publishers

The Partnership Sub-Series incorporates activities undertaken in collaboration with NATO's Cooperation Partners, the countries of the CIS and Central and Eastern Europe, in Priority Areas of concern to those countries.

NATO-PCO-DATA BASE

The electronic index to the NATO ASI Series provides full bibliographical references (with keywords and/or abstracts) to more than 30000 contributions from international scientists published in all sections of the NATO ASI Series.

Access to the NATO-PCO-DATA BASE is possible in two ways:

- via online FILE 128 (NATO-PCO-DATA BASE) hosted by ESRIN, Via Galileo Galilei, I-00044 Frascati, Italy.
- via CD-ROM "NATO-PCO-DATA BASE" with user-friendly retrieval software in English, French and German (© WTV GmbH and DATAWARE Technologies Inc. 1989).

The CD-ROM can be ordered through any member of the Board of Publishers or through NATO-PCO, Overijse, Belgium.

Trends in Optical Fibre Metrology and Standards

edited by

Olivério D. D. Soares

CETO - Centre de Ciências e Tecnologias Ópticas,
Universidade do Porto,
Porto,
Portugal

Springer-Science+Business Media, B.V.

Proceedings of the NATO Advanced Study Institute on
Trends in Optical Fibre Metrology and Standards
Viana do Castelo, Portugal
June 27–July 8, 1994

Library of Congress Cataloging-in-Publication Data

Trends in optical fibre metrology and standards / edited by O.D.D. Soares.
p. cm. -- (NATO ASI series. Series E, Applied sciences ; vol. 285)
"Published in cooperation with NATO Scientific and Environmental Affairs Division.
Includes index.
ISBN 978-94-010-4020-4 ISBN 978-94-011-0035-9 (eBook)
DOI 10.1007/978-94-011-0035-9
1. Optical fibers--Measurement. 2. Optical fibers--Standards.
I. Soares, O. D. D. (Olivério D. D.) II. North Atlantic Treaty Organization. Scientific and Environmental Affairs Division.
III. Series: NATO ASI series. Series E, Applied sciences ; no. 285.
TA1800.T73 1995
621.36'92'0287--dc20 95-5544

ISBN 978-94-010-4020-4

Printed on acid-free paper

All Rights Reserved

© 1995 Springer Science+Business Media Dordrecht

Originally published by Kluwer Academic Publishers in 1995

Softcover reprint of the hardcover 1st edition 1995

No part of the material protected by this copyright notice may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, recording or by any information storage and retrieval system, without written permission from the copyright owner.

TABLE OF CONTENTS

Preface	XI
Institute Programme	XV
Participants	XIX
Sponsors and Co-sponsors	XXVII
Committees	XXVIII
Opening Message Ministro da Indústria e Energia Engº Luis Mira Amaral	XXIX

I INTRODUCTION

1.1 A Historical Survey of Optical Signals and Optical Fibers Silvério P. Almeida and Olivério D.D. Soares	3
1.2 Trends in Optical Fibre Metrology and Standards Olivério D.D. Soares and Silvério P. Almeida	19

II OPTICAL FIBRES AND MATERIALS

2.1 Polarised Light Evolution in Optical Fibres J. Pelayo, F. Villuendas	47
2.2 Nonlinear Optical Fibres Raman Kashyap	69
2.3 Exotic Fibres F. Gauthier	103
2.4 Fibers and Fiber Lasers for the Mid-Infrared U.B. Unrau	113
2.5 Optical Fibres in Nuclear Radiation Environments F. Berghmans, O. Deparis, S. Coenen, M. Decréton and P. Jucker	131

III OPTICAL FIBRE COMPONENTS

3.1	Connectors and Splices J. Dubard _____	159
3.2	Optical Attenuators and Couplers Characterization C. Le Men _____	175
3.3	Wavelength Division Multiplexers and the Measurement of the Channel Wavelengths J.P. Laude _____	193
3.4	Active Fibre Characterisation with Passive Measurements J.M.S. Anacleto, Modesto Morais, Gaspar Rego, O.D.D. Soares _____	209

IV OPTICAL SOURCES

4.1	Wavelength Tunable Laser Diodes and their Applications M.C. Amann _____	217
4.2	Active Components Characterization C. Le Men _____	241

V OPTICAL FIBRE AMPLIFIERS

5.1	Optical Amplifiers Ivan Andonovic _____	263
5.2	Analysis of Erbium-Doped Silica-Fibre Characterisation Techniques M.A. Rebolledo _____	305
5.3	Optical Fibre Amplifiers Standardisation P. Di Vita _____	327
5.4	Optical Amplification Modelling for Er-Doped Fibre Joaquim M.S. Anacleto and O.D.D. Soares _____	343

VI OPTICAL FIBRE CHARACTERISATION, CALIBRATION AND STANDARDS

6.1	Fibre Characterization and Measurements C. Le Men _____	353
-----	--	-----

6.2	Mechanical and Environmental Testing J. Dubard, P. Fournier, P. Blanchard, F. Gauthier	399
6.3	Fibre Ribbon Measurements Lauri Oksanen	415
6.4	Calibration Artefacts, Traceability and Accuracy A.J. Barlow	429

VII OPTICAL FIBRE INSTRUMENTATION , MEASUREMENT AND METROLOGY

7.1	Photodetector Calibration Antonio Corrons	441
7.2	Power Meter Calibration Pedro Corredera Guillén	453
7.3	OTDR Calibration Francis Gauthier and Lionel Ducos	469
7.4	Optical Spectrum Analyzer Calibration J. Dubard and C. Le Men	489
7.5	EDFA Testing Eric Malzahn	511
7.6	Real-time Heterodyne Fibre Polarimetry by Means of Jones and Stokes Vector Detection R. Calvani, R. Caponi, F. Cisternino	527
7.7	Application of Er-Doped Fiber Amplifiers to Optical Measurement Techniques Haruo Okamura and Katsumi Iwatsuki	541

VIII OPTICAL COMMUNICATION SYSTEMS

8.1	Optical Fiber Communication Technology and System Overview Ira Jacobs	567
8.2	Modern Optical Communication Systems Govind P. Agrawal	593

8.3	An Optical Coherent Transmission System Based on Polarization Modulation and Heterodyne Detection at 155Mbit/s Bitrate and 1.55 μm Wavelength	
	R. Calvani, R. Caponi, F. Delpiano and G. Marone	617

IX OPTICAL SENSORS

9.1	Fiber Sensor Review	
	D.A. Jackson	629
9.2	Fibre Optic Sensors	
	M.R.H. Voet, Y. Verbandt, L. Boschmans, H. Thienpont and F. Berghmans	647
9.3	Fiber Optic Sensors for Environmental Monitoring	
	A.G. Mignani, M. Brenci, A. Mencaglia	691

X FUTURE TRENDS

10.1	Nonlinear Optics: Theory and Applications	
	U. L. Österberg	711
10.2	Advanced Optical Fibre Optoelectronics	
	B. Culshaw	727
10.3	Plastic Optical Fibres (POF)	
	Demetri Kalymnios	747

XI FURTHER POSTERS

11.1	Refractive Index of Planar Microlenses	
	S. Ríos, E. Acosta, M. Oikawa and K. Iga	773
11.2	Fibre Interferometer Set for Phase and Polarisation Measurement of Passive Fibre Elements	
	M. Szustakowski, J.L. Jaroszewicz	781
11.3	FMCW-Lidar with Tunable Twin-Guide Laser Diode	
	A. Dieckman, M.C. Amann	791
11.4	Fibre-Optic White-Light Interferometer Insensitive to Polarization Fading	
	L.A. Ferreira, J.L. Santos, F. Farahi	803

11.5	QND Measurement of the Photon Number using Kerr Effect in Optical Fibres V. Sochor, I. Paulička	809
11.6	Laser Transitions Characterization by Spectral and Thermal Dependences of the Transient Oscillations in the Fiber Lasers Oleg G. Okhotnikov and José R. Salcedo	813
11.7	Nonlinear M-Lines Spectroscopy of DMOP-PPV Polymer Planar Optical Waveguides: Quasi-Permanent and Fast Electronic Refractive Index Changes Francesco Michelotti	825
11.8	Plastic Optical Fibre (POF) Displacement Sensor N. Ioannides, D. Kalymnios and I.W. Rogers	827
11.9	A New Reflective Plastic Optical Fibre Displacement Transducer S. Hadjiloucas, L.S. Karatzas, D.A. Keating and M.J. Usher	829
11.10	White Light Interferometer Using Linear CCD Array with Signal Processing Stephen R. Taplin, Adrian GH. Podoleanu, David J. Webb and David A. Jackson	831
11.11	Radiation-to-guided Field Coupling in Ti:LiNbO ₃ Intensity Modulators M. Marciniak, M. Szustakowski	833
11.12	White Light Fiber Optic Interferometry a Technique for Monitoring Tissue Properties Scott Shukes, Faramarz Farahi, M. Yasin Akhtar Raja and Robert Splinter	833
11.13	Holographic Interferometry of Immersed Systems in Electrochemistry K. Habib	834
11.14	Pressure Effects of Optical Frequency in External Cavity Diode Lasers Hannu Talvitie, Johan Åman, Hanne Ludvigsen, Antti Pietiläinen, Leslie Pendrill and Erkki Ikonen	834
11.15	Methods of Measurement for Angle-Polished Optical Fiber Launching Efficients Darrin P. Clement and Ulf Österberg	835

11.16	The Application of a Fiber Optic Gyroscope for Studies of Extinction Ratio of Fiber Optic Polarizer J.L. Jaroszewicz and M. Szustakowski	835
11.17	Blocks and Architecture for a Multichannel Fibre Optic Correlator Adrian Gh. Podoleanu, Ryan K. Harding, David A. Jackson	836
11.18	Calibration of Fibre Optical Measurement Equipment at SP R. Andersson, M. Holmsten and L. Liedquist	836
11.19	Fibre Application in Absolute Ranging Interferometry with Computer Generated Holograms (CGH) L. Wang, M. Deininger, K. Gerstner, T. Tschudi	837
11.20	Monitoring Through-the-Thickness Behaviour of Composites Using Fiber Optic Sensors W. E. Wolfe and B. C. Foos	837
11.21	Fibre-Optic Fabry-Perot Sensor for Vibration and Profile Measurements I. Paulička, V. Sochor, J. Stulpa	838
11.22	Application of OTDR in the Mining Industry V. Kumar and Dinesh Chandra	838
11.23	Parametric Amplification by Four-Wave Mixing for Distributed Optical Fibre Sensors J. Zhang, V.A. Handerek and A.J. Rogers	839
11.24	Intracavity Laser Diode Pumped and Modulated Er^{3+} Doped Fiber Lasers Oleg G. Okhotnikov and José R. Salcedo	839
11.25	Mode-Locking of A 2.7 μm Erbium-Doped Fluoride Fiber Laser Christian Frerichs	840

AUTHOR INDEX _____

SUBJECT INDEX _____

PREFACE

Fibre Optics has gained prominence in: telecommunications, data transmission and distribution, cable television networks, sensing and control, light probing and instrumentation.

The 1990's shows an increased expansion of optical fibre networks which respond to the rapid growth on a world scale of long distance trunk lines combined with a family of emerging optical based services in which fibre-to-the-home will have the greatest impact. There is already evidence that optical communications are moving toward higher bit-rates, wavelength transparency and irrelevance of signal formats.

The rate of change in fibre optics and the emergence of new services will be a mere consequence of economics. The actual increasing of cost and the demand for high-data-rates or large bandwidth per transmission channels, and the lack of available space in the congested conduits in urban areas, strongly favour the technological change to fibre optics. The recognised advantages of fibre optic technologies and the unchallenged potential to respond to future needs requires the inclusion of fibre optics networking into new installations.

Concomitantly, current progress in the field of optical fibres (optical fibre amplifiers, optical fibre switching, WDM, fibre gratings, etc.) unfold major technical advances and greater flexibility in the designs and engineering of networks, optical fibre components and instrumentation. The explosion of growth in fibre sensors, fibre probes and the myriad of fibre based components shows that we are only using a fraction of optical fibre potential.

The optical fibre market expansion implies a simultaneous accretion of measurement techniques, particularly aimed at the three levels of testing, i.e. laboratory, factory and in the field, to encompass the world character of trade.

The global market and production delocalisation cannot function effectively unless specifications are described by quantities that can be universally measured by common agreed procedures. Interoperability and interconnectivity relies on the development of standards. Standardisation bodies at both national and international levels are active in setting specific standards and reference/alternative testing methods for fibre optics.

The fibre optics world-wide communications market is estimated to reach (USA \$) 8,3 billion by the year 1998. The full exploitation of this projected enormous potential of fibre optics in scientific, engineering and the myriad of applications requires a precise characterisation of optical fibres and their associated systems and components, via effective and accurate measurements supported by reliable measuring standards and good practices in measurements and calibrations. In addition the assurance of universal metrological traceability requests permanent intercomparison practices both at vertical and horizontal level.

The ISO 9000 compliance for adequate quality control of products and services already specifies the requirements for the test, measurement and inspection equipment (ISO 10012-1) which stress the calibration imperatives.

Optical fibre metrology had in recent times a significant evolution to respond to the paradigm shift in telecommunications, to the explosion of applications, with the tightening of specifications and exigencies in performance: automation, portability, real-time surveillance and remote mode testing.

Finally, given that 30% of the investment in fibre optic network installations concerns metrology and related activities, there were sufficient reasons to organise the Advance Study Institute (ASI) on "Trends in Optical Fibre Metrology and Standards".

The paramount importance of providing a progressive and comprehensive presentation of current issues and trends concerning the optical fibre metrology and standards was recognised two years ago within EUROMET (European Federation of Metrological Institutes) where the design of the event was enunciated.

The programme of the ASI considered the science and methodology of optical fibre metrology and standards up to the components and instrumentation level. Equipment was also made available for demonstrations and manipulation by the ASI participants.

Despite the inevitable limitations, a broad and reasonably coherent coverage of the field was achieved, with significant contributions from the attendees some of which presented posters (30 in total) supported with written material of high interest, part of which is included in the proceedings.

The topics covered during the eleven working days include: optical fibres and materials (polarisation, non-linear effects, plastic fibres, fibre lasers); optical fibre components (connectors and splicers, WDM); optical sources (tunable lasers); optical fibre amplifiers (Er-Doped amplifiers, amplifier standardisation); optical fibre characterisation; calibration and standards (fibre characterisation, ribbon fibres, calibration artefacts); instrumentation (photodetectors, power meters, OTDRs, EDFAs, Er-Doped fibres in metrology); optical communications systems (fibre communication technology, modern optical systems, coherent transmission systems); optical sensors (fibre sensors, environmental sensors); future trends (fibre evolution, solitons, non-linear effects, fibre optoelectronics).

Lack of time prevented one from dealing with other crucial aspects of optical fibre metrology such as: automation, remote metrologic systems, software validation, safety and legal aspects of metrology, as well as a family of recently developed fibre components.

The profusivity of material could not be matched by further enlargement of the ASI. The ASI was designed for a lecturers staff of around 10 to 15 lecturers assembled from academia and industry to produce cross-fertilisation and providing views from different backgrounds and orientations. Due to the interest of the topics

and timeliness of the event we obtained 27 world leading experts who expressed their willingness to participate. The number of attendees was programmed for around 60. The actual number of participants was curtailed to 100 who came from four continents. These were selected, from about the 200 requests received.

The organisation of an ASI of these proportions and which was scheduled over a period of two weeks could only be met by laborious efforts of a responsive secretariat which the editor and the organising committee thanks for their dedication and the excellence of a job well done.

Only the financial assistance provided by the Scientific and Environmental Division of NATO, and of the Measurements and Testing Division of the European Commission could make it possible to engineer the ASI to the proportion it reached. Therefore the funding Institutions are thanked profusely for their support and faith in the project.

The indispensable sponsorship endorsed by the FLAD - Fundação Luso Americana para o Desenvolvimento, JNICT - Junta Nacional de Investigação Científica e Tecnológica, IPQ - Instituto Português da Qualidade, NSF - National Science Foundation (USA) is thanked with high appreciation.

The friendship and continued support given by VIEIRA de CASTRO & Filhos, Lda. is also deeply acknowledged.

The valuable cooperation and support of further co-sponsoring companies and organisations is also thanked with gratitude.

The extensive support and engagement by local Institutions, the Governo Civil of Viana do Castelo, the Camara Municipal of Viana do Castelo, Região de Turismo do Alto Minho, and in particular the enrichment brought by an ennobling and charming cultural and social programme, product of the efforts and dedication of the Local Hosting Committee is thanked with great reconnaissance.

The honouring presence of the Minister for Industry and Energy, as a strong sign of encouragement to the fostering of cooperation with Portuguese Industry and academia, is acknowledge with high appreciation.

It is hoped that researchers, production and field engineers concerned with design, manufacturing, installation and maintenance of networks and systems and instrumentation involved in the area of fibre optics whether in measurements, characterisation of materials, devices, systems, networks, standards or oriented R&D will find the proceedings a tool of direct interest to their professional activities and for the development of new directions of industrial and applied research. Furthermore, the book will serve as an excellent up-to-date source of bibliographical material.

The materialisation of the proceedings is of course, the result of considerable efforts by authors for which they deserve the credit and are cordially thanked and acknowledged for the excellence of their contributions.

The editor is also indebted to Mrs. Nel de Boer of KLUWER Academic Publishers for the devoted work to the publication of the proceedings.

The success of the ASI was the direct result of the excellence of the work of all the active members, lecturers and participants but it is the time ahead that shall demonstrate the relevance of the impulse, the benefits of full endeavour and the strength of the outcome toward the traced challenges.

Olivério D.D. Soares

CETO - CENTRO DE CIÊNCIAS E TECNOLOGIAS OPTICAS

Universidade do Porto, Portugal

August 1994

INSTITUTE PROGRAMME

TRENDS in OPTICAL FIBRE METROLOGY and STANDARDS

VIANA DO CASTELO - Hotel do Parque**** - PORTUGAL

Cultural and Congress Center SANTIAGO da BARRA CASTLE

1st Week	27th June-Monday	28th June-Tuesday	29th June-Wednesday	30th June-Thursday	1st July-Friday	2nd July-Saturday	3rd July-Sunday
9-10	REGISTRATION	Fibre Optical Metrology & Standards S.P. Almeida / O. Soares	Fibre Characterisation and Measurement C. le Men	Passive Comp. Characterisation C. le Men	Active Comp. Characterisation C. le Men	PAUSE for INFORMAL GROUP DISCUSSIONS	EXCURSION
10-11		Optical Fibre Communication Technology Ira Jacobs	Fibre Characterisation and Measurement C. le Men	Tunable Lasers and Applications M.C. Amann	WDM Technologies and Applications J.P. Laude		
Coffee Break 11.30 - 12.30							
Lunch		Optical Fibre Communication Technology Ira Jacobs	Ribbon Fibers Measurements L. Oksanen	Tunable Lasers and Applications M.C. Amann	WDM Technologies and Applications J.P. Laude		
Further Activities	16. OPENING CEREMONY					PAUSE for INFORMAL GROUP DISCUSSIONS	EXCURSION
		16. Fibre Characterisation and Measurement C. le Men	15-17 Heterodyne Polarimetric Measurements and Communications R. Calvani		16h30 Optical Amplifiers Ivan Andonovic		
17-18	Modern Optical Communications System G.P. Agrawal	Measurements and Testing Framework Programme 4 P. Sallert (BCR)	Mechanical and Environmental Testing F. Gauthier	Optical Fibre Connectors & Splices F. Gauthier			
Coffee Break							
18½ / 19½	Trends in Optical Fibres S. Mustafa	Fibre Characterisation and Measurement C. le Men	Mechanical and Environmental Testing F. Gauthier	Optical Fibre Connectors & Splices F. Gauthier	19-19h30 Effects Laser RIM on Optical Amplifier Noise Figure I. Jacobs	PAUSE for INFORMAL GROUP DISCUSSIONS	EXCURSION
19½ / 20½							
Dinner	Welcoming Dinner	Posters presentation and discussion	Posters presentation and discussion	Posters presentation and discussion	Posters presentation and discussion	PAUSE for INFORMAL GROUP DISCUSSIONS	EXCURSION

TRENDS in OPTICAL FIBRE METROLOGY and STANDARDS

VIANA DO CASTELO - Hotel do Parque**** - PORTUGAL

Cultural and Congress Center SANTIAGO da BARRA CASTLE

2nd Week	8th Day 4th July - Monday	9th Day 5th July - Tuesday	10th Day 6th July - Wednesday	11th Day 7th July - Thursday	12th Day 8th July - Friday	13th Day 9th July - Saturday
9-10	Optical Fibre Amplifiers Standardisation P. di Vita	Fibre Sensors Metrology Marc Voet	Photodetector Calibration A. Corrons	Er Doped Fibres Characterisation M. Rebolledo	Polarisation in Fibres J. Pelayo	
10-11	Plastic Fibers K. Kalymnios	OTDR Calibration F. Gauthier	Calibration Artifacts, Traceability and Accuracy A. Barlow	Er Doped Fibres Characterisation M. Rebolledo	Application Non-Linear Effects U. Osterberg	
Coffee Break						
11.30 - 12.30	Plastic Fibers K. Kalymnios	OTDR Calibration F. Gauthier	Glass Fibres and Fibre Lasers Mid-IR U.B. Unrau	Polarisation in Fibres J. Pelayo	Application Non-Linear Effects U. Osterberg	
Lunch						
Further Activities						
16	HP EDFA - Testing Eric Malzahn		16h30 Analog Communications on Fibres I. Jacobs	16 Non-linear Fiber Optics R. Kashyap		
17-18	Fibre Sensors Review D. Jackson	Power Meter Calibration P. Corredera	AFA - Instrumentation H. Okamura		Exotic Fibers F. Gauthier	
Coffee Break						
18½ / 19½	Fibre Sensors Metrology Marc Voet	Optical Spectrum Analyser C. le Men	AFA - Instrumentation H. Okamura	Solitons in Optical Fibres G.P. Agrawal	Advanced Fibre Optoelectronics B. Culshaw	
19½ / 20½	Posters presentation and discussion	Posters presentation and discussion	Posters presentation and discussion	Posters presentation and discussion Farwell	CLOSING of SCHOOL	
Dinner				Gala Dinner		

PARTICIPANTS

Lecturers

AGRAWAL, PROF. GOVIND P.
The Institute of Optics
University of Rochester
206 WalmoBuilding
Rochester NY 14627
USA
Telf: 1-716-275-48 46
Fax: 1-716-244 49 36
E-mail: gpa@optics.rochester.edu

ALMEIDA, PROF. SILVÉRIO P.
University of North Carolina
at Charlotte
Charlotte, N.C. 28223
USA
Telf: 704-547 20 40
Fax: 704-547 31 60

AMANN, PROF. MARKUS-CHRISTIAN
Institute of Technical Electronics
University of Kassel
Heinrich-Plett-Str. 40
34109 Kassel
Germany
Telf: 00-49-561-804 44 85
Fax: 00-49-561-804 41 36

ANDONOVIC, PROF. IVAN
Strathclyde University
Dept. Electronic & Electrical
Royal College Building
204 George Street
Glasgow G1 1XW
Scotland
Telf: 44-41-552 44 00
Fax: 44-41-552 24 87
Telex: 7742 UNSLIB G

BARLOW, DR. ARTHUR
EG&G Fiber Optics
Sorbus House
Mulberry Business Park
Wokingham
Berkshire RG11 2GY
United Kingdom
Telf: 44-734-77 30 03
Fax: 44-734-77 34 93
Telex: 847164

CALVANI, DR. RICARDO
CSELT
Via G. Reins Romoldi, 274
10148 Torino
Italy
Telf: 39-11-22 85 111
Fax: 39-11-22 85 085
Telex: 220539 cselte

CORREDERA, DR. PEDRO G.
Instituto de Optica "Daza de Valdés"
Serrano, 121
28006 Madrid
Spain
Telf: 34-1-561 68 00
Fax: 34-1-564 55 57
Telex: 42182 CSICE E

CORRONS, PROF. ANTONIO
Instituto de Optica (CSIC)
c/ Serrano, 121
28006 Madrid
Spain
Telf: 34-1-561 68 00
Fax: 34-1-564 55 57
Telex: 42182 CSICE E

CULSHAW, PROF. BRIAN
Strathclyde University
Optoelectronics Division
Dept. Electronic & Electrical
Royal College Building
204 George Street
Glasgow G1 1XW
Scotland
Telf: 44-41-552 44 00
Fax: 44-41-552 24 87
Telex: 77472 UNSLIB G

DUBARD, DR. J.
LCIE
33, Av. General Leclerc
F 92266 Fotenay-aux-Roses
France
Telf: 33-1-40-95 60 60
Fax: 33-1-40 95 60 50
Telex: labelec 634 147 F

GAUTHIER, DR. F.
LCIE
33, Av. General Leclerc
F 92266 Fotenay-aux-Roses
France
Telf: 33-1-40-95 60 60
Fax: 33-1-40 95 60 50
Telex: labelec 634 147 F

JACKSON, PROF. DAVID A.
Applied Optics Group
University of Kent
Canterbury
Kent CT2 7NR
United Kingdom
Telf: 44-227-475 423
Fax: 44-227-764 000
E-mail: daj1@ukc.ac.uk

JACOBS, PROF. IRA
Virginia Polyt. Inst Bradlex
Elect. Eng. Dept.
Fiber & Elect. Opt. Div.
Blacksburg, VA 24061
USA
Telf: 1-703-231-56 20
Fax: 1-703-231 33 62
E-mail: ijacobs@vtm1.cc.vt.edu

KALYMNIOS, PROF. DEMETRI
School of Electrom
Univ. North London
166 - 220 Holloway Road
London N7 8DB
UK
Telf: 44-71-753 51 26
Fax: 44-71-753 7002

KASHYAP, DR. RAMAN
BT Laboratories
DTN12, B55/131
Marthesham Heath
Ipswich, IP5 7RE
United Kingdom
Telf: 44-473-64 53 63
Fax: 44-473-64 68 85

LAUDE, DR. JEAN PIERRE
ISA / JOBIN - YVON
16-18, Rue du Canal
91163 Longjumeau Cedex
France
Telf: 33-1-64 54 13 00
Fax: 33-1-69 09 07 21
Telex: 602882 F

MALZAHN, DR. ERIC
Hewlett Packard
Herrenberger Strasse 130
71034 Böblingen
Germany
Telf: 49-7031-14 4662
Fax: 49-7031-14 7023
Telex: labelec 634 147 F
E-mail:
Eric_Malzahn@hpgrmy.desk.hp.com

MEN, DR. C. LE
LCIE
33, Av. General Leclerc
F 92266 Fotenay-aux-Roses
France
Telf: 33-1-40-95 62 50
Fax: 33-1-40 95 60 50
Telex: labelec 634 147 F
E-mail: flyer@email.teaser.com

MUSTAFA, DR. SYED AHMED
CORNING
Telecommunication Products
Corning NY 14831
USA
Telf: 1-607-974 48 02
Fax: 1-607-974 70 41
E-mail:

OKAMURA, DR. HARUO
NTT
Transmission Systems Labs
1-2356 Take, Yokosuka-shi
Kanagawa 238-03
Japan
Telf: 81-468 59 32 19
Fax: 81-468 59 33 96
E-mail: okamura@nttsd.ntt.jp

OKSANEN, DR. LAURI
Nokia Cables
PO Box 77, Virkatie 8
01511 Vantaa
Finland
Telf: 358-0-68 251
Fax: 358-0-870 13 59

ÖSTERBERG, PROF. ULF
Thayer School of Engineering
Dartmouth College
8000 Cummings Hall
Hanover
NH 03755-8000
USA
Telf: 1-603-646-34 86
Fax: 1-603-646 38 56
E-mail:
Ulf.Österberg@dartmouth.edu

PELAYO, PROF. J.
University of Zaragoza
Ciudad Universitaria
50009 Zaragoza
Spain
Telf: 34-76-56 07 35
Fax: 34-76-56 52 00

REBOLLEDO, PROF. J.
University of Zaragoza
Ciudad Universitaria
50009 Zaragoza
Spain
Telf: 34-76-56 07 35
Fax: 34-76-56 52 00
E-mail: rebolledo@msf.unizar.es

SOARES, PROF. OLIVÉRIO D.D.
CETO - Centro de Ciências e
Tecnologias Ópticas
Fac. Ciências - Univ. do Porto
Praça Gomes Teixeira
4000 Porto
Portugal
Telf: 351-2-310 290
Fax: 351-2-319 267
E-mail: ceto@fis1.fc.up.pt

UNRAU, PROF. ING. U.
Institut für Hochfrequenztechnik
Technische Universität
Braunschweig
PO Box 3329
D-38023 Braunschweig
Germany
Telf: 49-531-391 24 58
Fax: 49-531-391 58 41
Telex: 952526 tubsw-d

VITA, DR. PIETRO DI
CSELT
Via G. Reins Romoldi, 274
10148 Torino
Italy
Telf: 39-11-22 85 278
Fax: 39-11-22 85 520
Telex: 220539 cselt i

VOET, DR. MARC R.H.
Identity E.E.I.G.
Inspralaan 75
B-2400 Mol
Belgium
Telf: 32-14-58 11 91
Fax: 32-14-59 15 14

Attendees

Anacleto, Dr. Joaquim
CETO
Faculdade de Ciências
Universidade do Porto
Praça Gomes Teixeira
4000 Porto - Portugal
Telf: 351-2-310290
Fax: 351-2-319267
E-mail: ceto@fis1.fc.up.pt

Araújo, Dr. Francisco M.C.
INESC
Rua José Falcão, 110
4000 Porto - Portugal
Telf: 351-2-2094301
Fax: 351-2-2008487
Telex: 23023 INESC P

Bao Varela, Dr. Maria del Carmen
Lab. de Óptica - Dept. Física Aplicada
Faculdade de Física
Campus Universitario
15706 Santiago de Compostela
Spain
Telf: 34-81-521984
Fax: 34-81-21984

Barcelos, Dr. Sérgio
University of Southampton
Optoelectronics Research
Group
Southampton SO17 1BJ
UK
Telf: 44-703-59 31 72
Fax: 44-703-59 31 49
E-mail: s.barcelos@ieee.org

Beguín, Dr. Claude
Swiss Telecom
PTTResearch & Development
Fibre Optic Metrology FE 144
Ostermundigenstrasse 93
CH - 3000 Bern 29
Switzerland
Telf: 41-31-338 31 86
Fax: 41-31-338 57 47
Telex: 911 031 vpttch

Berghmans, Dr. Francis
SCK.CEN, DEPT BR3
Boeretang 200 - B-2400 MOL
Belgium
Telf: 32-14 33 26 37
Fax: 32-14 31 19 93
E-mail: fberghma@vnet3.vub.ac.be

Boccardi, Dr. Pasquale
Via LVII Strada a denominarsi, 6
70059 Trani
Italy
Telf: 39-883 44 969

Brinkmann, Dr. Sven
Hindenburgstr. 14
D-91054 Erlangen
Germany

Cervasio, Dr. Alberto
S.V. Giagumona, 90
07040 (Ottava) - Sassari
Italy
Telf: 39-79-390709

Clement, Dr. Darrin P.
Thayer School of Engineering
Dartmouth College
8000 Cummings Hall
Hanover, New Hampshire 03755
USA
Telf: 1-603-646 1466
Fax: 1-603-646 3856
E-mail: darrin.clement@dartmouth.edu

Cloninger, Dr. Todd L.
1725 Ratchford Drive
Dallas, N.C. 28034-9555
USA
Telf: 1-704-547 25 23
Fax: 1-704-547 31 60

Cortes, Dr. Santiago David Armando Reyes
Universidade da Beira Interior
Departamento de Física
R. Marquês d'Ávila e Bolama
6200 Covilhã - Portugal
Telf: 351-75-25141/4
Fax: 351-75-26198
Telex: 53733 UBI P

Costa, Dr. Manuel Filipe P.C.
Universidade do Minho
Dept. de Física
Largo do Paço
4719 Braga Codex - Portugal
Telf: 351-53-60 43 27
Fax: 351-53-60 43 39

Cui, Dr. Guoqi
AILUN
Via della Resistenza, 39
08-100 Nuoro - Italy
Telf: 39-784-203409
Fax: 39-784-203158

Dias, Dr. Ireneu Manuel Silva
INESC
Rua José Falcão, 110
4000 Porto
Portugal
Telf: 351-2-2094300
Fax: 351-2-2008487
Telex: 23023 INESC P

Dieckmann, Dr. Andreas
SIEMENS AG
ZFE ST KM 42
Oho-Hahn-Ring 6
81739 Munich - Germany
Telf: 49-89-63644486
Fax: 49-89-6363832

Dopazo, Dr. Juan Félix Roman
Begonias 31 - 1º D
La Coruna
Spain
Telf: 34-81-293311 / 256410

Ducos, Dr. Lionel
LCIE
33, Av. General Leclerc
F 92266 Fotenay-aux-Roses
France
Telf: 33-1-40 95 62 50
Fax: 33-1-40 95 60 50

Ferreira, Dr. Ana Cristina Bento
TELECOM
Av. Fontes Pereira de Melo, 40
1089 Lisboa Codex - Portugal
Telf: 351-1-540020
Fax: 351-1-523614

Ferreira, Dr. João M.C.
INESC
Rua José Falcão, 110
4000 Porto - Portugal
Telf: 351-2-209 4000
Fax: 351-2-318 692
Telex: 23023 INESC P

Ferreira, Dr. Luis Alberto
INESC
Rua José Falcão, 110
4000 Porto - Portugal
Telf: 351-2-2094300
Fax: 351-2-2008487
Telex: 230023 INESC P

Figueira, Dr. Ana Rita L. C.
CETO
Faculdade de Ciências
Universidade do Porto
Praça Gomes Teixeira
4000 Porto - Portugal
Telf: 351-2-310290
Fax: 351-2-319267
E-mail: ceto@fis1.fc.up.pt

Fiore, Dr. Marina
C.so L. Kossuth, 71
10132 Torino
Italy

Fonseca, Dr. António Fernando Figueiredo
TELECOM
Av. Fontes Pereira de Melo, 40
1089 Lisboa Codex - Portugal
Telf: 351-1-3504094
Fax: 351-1-523614

Foos, Dr. Bryan C.
Research Scientist
WJ/FIVEC Bldg 45
Wright-Patterson Air Force Base
334 Aberdeen Avenue
Oakwood - OHIO
USA
Telf: 1-513-2553021
Fax: 1-513-2551633
E-mail:
foosbc@fivmailgw.flight.wpafb-af.mil

Frerichs, Dr. Christian
Institut für Hochfrequenztechnik
Technische Universität Braunschweig
PO Box 3329
38023 Braunschweig - Germany
Telf: 49-531-391 24 23
Fax: 49-531-391 58 41
E-mail: C.Frerichs@tu.bs.de

Fuchs, Dr. Richard
European Patent Office
Gitschinerstrasse 103
Berlin D-10958 - Germany
Telf: 49-30-25901-201
Fax: 49-30-25901-845

Gray, Dr. George R.
University of Utah
Dept. of EE
3280 Merrill Eng. Bldg.
Salt Lake City, UT 84112
USA
Telf: 1-801-585 6157
Fax: 1-801-581 5281
E-mail: gray@ee.utah.edu

Guerrero, Dr. Hèctor
Dept. Optica
Facultad de Ciencias Fisicas
Universidad Complutense
Ciudad Universitaria s/n
28040 Madrid - Spain
Telf: 34-1-394 4402/3
Fax: 34-1-394 4683
Telex: 47273 FFUC
E-mail: w653@emducml1

Habib, Dr. Khalid
Materials Application Department
KISR
PO BOX 24885 SAFAT
13109 Kuwait
Kuwait
Telf: 965-4830-432
Fax: 965-57237-19

Ioannides, Dr. Nicos
109 Uxbridge Road
Hanwell, London W7 3ST
United Kingdom
Telf: 44-71-607 27 89 / 607 25 96
Fax: 44-71-753 70 02

Iodice, Dr. Mario
IRECE - CNR
Via Diocleziano, 328
80124 Napoli
Italy
Telf: 39-81-5707999
Fax: 39-81-5705734
E-mail: irece::iodice
E-mail: iodice@dimes.tudelft.nl

Karafolas, Dr. Nikos
University of Strathclyde
Optoelectronics Group
204 George Street
G1 1XW Glasgow
Scotland
Telf: 44-41-5524400
Fax: 44-41-5522487

Karoutis, Dr. Athanase D.
Univ. Crete, School of Health Sciences
Dept. Medicine, Sector Neurology
and Sense Organs
PO BOX 1352
711 10 Heraklion Crete - Greece
Telf: 30-81-54 20 70
Fax: 30-81-54 21 16

Konstantaki, Dr. Maria
Strathclyde University
Dept. E.E. Engineering
Royal College Building
204 George Street
Glasgow G1 1XW
Scotland
Telf: 44-41-552400
Fax: 44-41-5522487
E-mail: m.konstantaki@uk.ac.strath

Kumar, Dr. Virendra
Dept. of Electronics
and Instrumentation
Indian School of Mines
Dhanbad 826 004
India
Telf: 326-822273
Fax: 326-832 040
Telex: 0629-214

Lago, Dr. Maria Elena López
E.U. Optica
Univ. Santiago de Compostela
Campus Sur
15706 Santiago de Compostela
Galicia - Spain
Telf: 34-81-52 19 84 / 56 31 00
Fax: 34-81-52 19 84

Liedquist, Dr. Leif
Physical Measurements
Physics & Electronics
Sveriges Provnings-och
Forskningsinstitut
Statens Provningsanstalt
BOX 857 S-501 15 BORAS
Sweden
Telf: 46-33 16 50 00
Fax: 46 33 13 83 81

Mangia, Dr. Maria
Via Iglesias, n.9
08-100 Nuoro
Italy
Telf: 39-784-204187 / 202024

Marciniak, Dr. Marian
Military Academy of
Telecommunications
05-131 Zegrze 300/11
Poland
Telf: 48-2-6883536
Fax: 48-2-6883413
E-mail: wsowl.frodo.nask.org.pl

Martins, Dr. Maria Raquel V.
CETO
Faculdade de Ciências
Universidade do Porto
Praça Gomes Teixeira
4000 Porto - Portugal
Telf: 351-2-310290
Fax: 351-2-319267
E-mail: ceto@fis1.fc.up.pt

Marttila, Dr. Pekka
Nokia Cables
PO BOX 77
01511 - VANTAA
Finland
Telf: 358-0-68251
Fax: 358-0-8701359
Telex: 123475

Michelotti, Dr. Francesco
Univ. di Roma "La Sapienza"
Dept. di Energetica
Via A. Scarpa, 16
I-00161 Roma - Italy
Telf: 39-6-49 76 65 62
Fax: 39-6-44 24 01 83
E-mail: bertol88@itcaspur.caspur.it

Mignani, Dr. Anna Grazia
IROE - CNR
Via Panciatichi 64
50127 Firenze
Italy
Telf: 39-55-423 1 / 4235262
Fax: 39-55-4379569

Morais, Dr. Modesto Cerqueira
IEP
Rua de S. Gens, 3717
Senhora da Hora
4450 Matosinhos - Portugal
Telf: 351-2-9529675
Fax: 351-2-9530594

Navarrete, Dr. M^a Cruz
Universidade Complutense de Madrid
Dept. Optica - Fac. Ciencias Fisicas
Ciudad Universitaria s/n
28040 Madrid - Spain
Telf: 34-1-39 44403
Fax: 34-13944683

Okhotnikov, Dr. Oleg G.
INESC
Rua José Falcão, 110
4000 Porto - Portugal
Telf: 351-2-2094300
Fax: 351-2-2008487
Telex: 230023 INESC P

Olszak, Dr. Artur
Warsaw University of Technology
Optical Engineering Division
Dept. Precision Mechanics
8 Chodkiewicza St.
02-525 Warsaw
Poland
Telf: 48-22-499871
Fax: 48-22-490 392
E-mail: olszak@mp.pw.edu.pl

Otero, Dr. José Lazaro Gato
E.U. Optica
Dept. Fisica Aplicada
Facultad de Fisica
Univ. Santiago de Compostela
Campus Universitario
15706 Santiago de Compostela
Galicia - Spain
Telf: 34-81-52 19 84
Fax: 34-81-52 19 84

Pervan, Dr. Ogus
Turkish Atomic Energy
Authority
Ankara Nuclear Research and
Training Center
Saray, 06105 - Ankara
Turkey
Telf: 312-8154300/8154390
Fax: 312-8154307

Pieraccini, Dr. Massimiliano
IROE - CNR
Via Panciatichi 64
50127 Firenze - Italy
Telf: 39-55-4235214
Fax: 39-55-4223889
E-mail: brenci@iroe.iroe.fi.cnr.it

Podoleanu, Dr. Adrian
University of Kent
at Canterbury
Physics Laboratory
Kent CT2 7NR
United Kingdom
Telf: 44-227-764000
Fax: 44-227-475423
E-mail: physics-lab@ukc.ac.uk

Pousa, Dr. José Marcelino
CET
Rua Eng^o José Ferreira Pinto Basto
3800 Aveiro - Portugal
Telf: 351-381831
Fax: 351-24723
Telex: 37371

Ravet, Dr. Fabien
Faculte Polytechnique de Mons
Electromagnétisme et
Télécommunications
Boulevard Dolez, 31
7000 Mons
Belgium
Telf: 32-65-374191
Fax: 32-65-37 41 99
E-mail: ravet@fpms.fpms.ac.be

Rego, Dr. Gaspar Mendes do
Fiopos - Barroselas
4905 Barroselas - Portugal
Telf: 058-972215

Ribeiro, Dr. A.B. Lobo
INESC
Rua José Falcão, 110
4000 Porto - Portugal
Telf: 351-2-2094300
Fax: 351-2-2008487
Telex: 230023 INESC P

Rodriguez, Dr. Jorge
U.P.C. ETSI
Campus Nord UPC
Edifici D-3
C/ Sor Eulàlia Anzizu s/n
E - 08034 Barcelona - Spain
Telf: 34-3-401 6795
Fax: 34-3-401 7232

Rodriguez, Dr. Susana Rios
E.U. Optica e Optometria
Dept. Fisica Aplicada
Facultad de Fisica
Univ. Santiago de Compostela
Campus Sur
15706 Santiago de Compostela
Galicia - Spain
Telf: 34-81-52 19 84
Fax: 34-81-52 19 84

Romolini, Dr. Andrea
IROE - CNR
Via Panciatichi 64
50127 Firenze - Italy
Telf: 39-55-4235233
Fax: 39-55-4223889
E-mail: falciai@iroe.iroe.fi.cnr.it

Santos, Dr. Fernando M. Ferreira
INEGI
Fac. Engenharia do Porto
Rua dos Bragas
4099 Porto Codex - Portugal
Telf: 351-2-2007505

Santos, Dr. José Luis C.
INESC
Rua José Falcão, 110
4000 Porto - Portugal
Telf: 351-2-2094300
Fax: 351-2-2008487
Telex: 230023 INESC P

Sartori, Dr. Giovanni
AILUN
Via della Resistenza, 39
08-100 Nuoro - Italy
Telf: 39-784-20 34 09
Fax: 39-784-20 31 58

Seker, Dr. Selim
Bogaziçi University
Dept. of Electrical-Electronic
P.K.2 80815 Bebek
Istanbul - Turkey
Telf: 212-2631540
Fax: 212-2575030

Serra, Dr. Giovanni
Via F.M.Brundu, 1
07040 Codrongianus (SS)
Italy
Telf: 39-79-435203

Sharer, Dr. Deborah
103 South Fork Road
Indian Trail - NC 28079
USA
Telf: 1-704-547 23 02

Shukes, Dr. Scott
1409 Richmond Place
Charlotte, N.C. 28209
USA
Telf: 1-704-527 0821

Sillas, Dr. Hadjiloucas
University of Reading
Dept. Cybernetics - Instrum.
Measurement Research Group
Whiteknights,
PO BOX 225
Reading - Berks RG6 2AY
UK
Telf: 44-734-318219
Fax: 44-734-318220
E-mail: shrhadji@uk.ac.reading

Sochor, Dr. Vaclav
Fac. of Nucl. and Physics Eng.
Czech Techn. Univ.
V Holesovickach 2
180 00 Prague 8
Czech Republic
Telf: 422-85762285
Fax: 422-66414818
E-mail: sochor@troja.fjfi.cvut.cz

Sousa, Dr. Fernando J. Pelicano
Portugal TELECOM
DCRS / RGT
Rua Tomás Ribeiro, 2, 3º DCRS
1000 Lisboa - Portugal
Telf: 351-1-540020
Fax: 351-1-526110
Telex: 60256 DIRS P

Sporea, Dr. Dan G.
Bucharest
P.O. BOX 31-53
Romania
Fax: 40-1-312 11 54
E-mail: sporea@roifa - Bitnet
sporea@ifa.ro - Internet

Szustakowski, Dr. Mieczyslaw
Institut of Technical Physics
2 Kahskiego St.
01-489 Warsaw
Poland
Telf: 48-22-36 93 53
Fax: 48-22-36 22 54
Telex: 812 535 WAT pl

Talvitie, Dr. Hannu
Helsinki Univ. of Technology
Fac. Electrical Engineering
Otakaari 5 A
SF - 02 150 Espoo
Finland
Telf: 358-0-451 23 36
Fax: 358-0-460 224
E-mail: hannu.talvitie@hut.fi

Taplin, Dr. Stephen R.
University of Kent
Room 116 - Physics Dept.
Applied Optics Group
Canterbury - Kent CT2 7NR
United Kingdom
Telf: 44-227-764000
Fax: 44-227-475423
E-mail: srt1@uke.ac.uk

Teixeira, Dr. José Manuel Feliz
CETO
Faculdade de Ciências
Universidade do Porto
Praça Gomes Teixeira
4000 Porto - Portugal
Telf: 351-2-310290
Fax: 351-2-319267
E-mail: ceto@fis1.fc.up.pt

Traian, Dr. Dumitrica
Rudului 129
Ploiesti 2000
Romania
Telf: 40-44-140371

Varga, Dr. Jozsef
PKI Telecommunications Inst.
Budapest IX
Zombori u. 1
H-1456 P.O.B. 2 - Hungary
Telf: 36-1-147 1560
Fax: 36-1-127 5075

Velasco, Dr. Mª Lourdes Pedraza
Escuela Universitaria de
Enfermeria Fisioterapia Y Podologia
3es Piso Fac. De Medicina
Univ. Complutense de Madrid
Ciudad Universitaria
Madrid 28040 - Spain
Telf: 34-1-3941525
Fax: 34-1-3941539

Vinhais, Dr. Carlos Alberto A.
CETO
Faculdade de Ciências
Universidade do Porto
Praça Gomes Teixeira
4000 Porto - Portugal
Telf: 351-2-310290
Fax: 351-2-319267
E-mail: ceto@fis1.fc.up.pt

Vorropoulos, Dr. G.
European Patent Office
Gitschinerstrasse 103
Berlin
D-10958 - Germany
Telf: 49-30-25901614
Fax: 49-30-25901845

Wang, Dr. Lingli
Institute of Applied Physics
Technische Hochschule
Darmstadt, Hochschulstr. 6
D-6100 Darmstadt - Germany
Telf: 49-6151-16 30 17
Fax: 49-6151-16 41 23
E-mail: lingli@trudel.iap.physik.th-darmst

Wolfe, Dr. William
Ohio State University
470 Hitchcock Hall
2070 Neil Avenue
Columbus, OH 43210-1275
USA
Telf: 1-614-292 7338
Fax: 1-614-292 3780
E-mail: wolfe.10@osn.edu

Zhang, Dr. Jian
Dept. Electronic Electrical
Engineering
Kings College of London
Strand
London WC2R 2LS
UK
Telf: 44-71-873 2371
Fax: 44-71-836 4781
E-mail: zdee486@bay.cc.kcl.ac.uk

SPONSORS

Scientific and Environmental Affairs Division - NATO
Commission of the European Union (M & T Division)
CETO - Centro de Ciências e Tecnologias Opticas
The European Institute for Advanced Studies in Optics
FLAD - Fundação Luso-Americana para o Desenvolvimento
JNICT - Junta Nacional de Investigação Científica e Tecnológica
IPQ - Instituto Português da Qualidade
NSF - National Science Foundation
Governo Civil de Viana do Castelo
Câmara Municipal de Viana do Castelo
RTAM - Região de Turismo do Alto Minho
IEP - Instituto Electrotécnico Português
MARCONI - Companhia Portuguesa Rádio Marconi, SA
IVP - Instituto do Vinho do Porto
Vieira de Castro & Filhos, Lda.
CLUB TOUR - Agência de Viagens

CO-SPONSORS

EOS - European Optical Society
HP - Hewlett Packard Portugal
DECADA - Equipamentos de Electrónica e Científicos, S.A.
BA - Fábrica de Vidros Barbosa & Almeida, SA
Comissão de Viticultura da Região dos Vinhos Verdes
CANON - Copicanola
Hotel do Parque - Viana do Castelo
M. T. Brandão, Lda.
Câmara Municipal de Ponte da Barca
PERCON-Computadores
Adega Cooperativa de Monção
BCI - Banco de Comércio e Indústria
SOPETE - Casino da Póvoa de Varzim

COMMITTEES

Organising Committee

PROF. OLIVÉRIO D.D. SOARES (Chairman)

CETO - CENTRO DE CIÊNCIAS E TECNOLOGIAS OPTICAS

Lab. Física - Fac. Ciências - Univ. Porto

Praça Gomes Teixeira

4000 Porto - Portugal

PROF. S. P. ALMEIDA

Department of Physics

University of North Carolina at Charlotte

Charlotte, N.C. 28223

USA

DR. RICARDO CALVANI

CSELT

Via G. Reins Romoldi, 274

10148 Torino

Italy

Local Hosting Committee

Mr. Roleira Meirinho

Governo Civil de Viana do Castelo

Dr. Defensor Moura

Câmara Municipal de Viana do Castelo

Dr. Francisco Sampaio

RTAM - Região de Turismo do Alto Minho

Secretariat and Technical Committee

José Sousa Fernandes

Fernanda Campos

Luis Vilaça

O
MINISTRO da INDÚSTRIA
e
ENERGIA

Excelentíssimo Senhor Governador Civil de Viana do Castelo

Excelentíssimo Senhor Presidente da Câmara Municipal de Viana do Castelo

Excelentíssimo Senhor Presidente da Região de Turismo do Alto Minho

Excelentíssimo Senhor Presidente do CETO - Centro de Ciências e Tecnologias
Ópticas

Ladies and Gentlemen

The time is now upon us to leave the past and join the challenge of the future before it becomes too late. As individuals, as enterprises and as a country, we must continuously upgrade our educational and vocational training, replace obsolete equipment, and develop effective management methods. Portugal is now on the brink of great opportunities to modernise itself and to prepare for the 21st Century. It must not after in its pursuit of the challenges which lie ahead.

Recent advances in telecommunications, information processing and electronic industries represent the driving forces behind the present day industrial revolution. In order to keep abreast of these rapidly developing areas, Portugal must develop new and stronger partnerships between its industries and universities. We must take advantage of the position universities are in to educate and train the much needed students and industrial personnel in areas of research and applications which are vital to the future of the country's development. The Portuguese Ministry for Industry and Energy recognises these needs and has taken a deep interest in the Advanced Institute on "Trends in Optical Fibre Metrology and Standards".

The Advanced Institute on "Trends in Optical Fibre Metrology and Standards" provides a thorough coverage of fibre technology and an insight into opportunities offered to various industries. The theme of the Advanced Institute "Optical Fibre" is central to industries associated with communication, data transfer, sensors, instrumentation; and is a key element in many optoelectronic components.

The telecommunication network represents one of the largest human systems ever developed in the world. It is also one of the most complex in that it handles in excess of 1,000 billion calls each year. This, in addition to, an immense amount of transmitted data. Its very existence represents an important element of personal freedom, progress and economic globalization. Every nations' defence, trade, commerce, industry and social practices are inextricably dependent on the extent and quality of their communication and data transfer networking.

Optical networks, namely, optical fibre based links, offer the potential of gigabit switched bandwidth. Recently developed commercial optical amplifiers provide yet another enormous step forward in transmission and data processing thereby lowering the cost of both terrestrial and submarine transmission. Other important industries which make use of fibre optics include: aerospace, computing, broadcasting, consumer electronics and instrumentation. Also, a diverse range of activities broadly defined as the information technology sector make use of fibre optics.

European market experts project for Portugal, an expanded use of about 100,00 km of fibre optics cabling by the year 1995. The estimated cost for this expansion is of the order of 21 billion dollars. A fraction of 30% of the installation costs goes towards characterisation and metrological uses.

The Portuguese Ministry for Industry and Energy has recognised the need to modernise and support the electronics and information technology industries. In particular, this has recently led to the implementation of an integrated program for information and electronics technologies - PITIE, whose main goal is the setting up of a motivating environment for the development of that industry. Also the strategic program for the dynamic development of the Portuguese industry - PEDIP I was set up to help integrate industrial and entrepreneurship linkages.

The Ministry for Industry and Energy, through PEDIP I, has supported technological innovations in three portuguese optical fibre cable manufacturers. It has provided adequate funding for the instalment of optical fibre metrological facilities both in the manufacturing industries and at related technological centers and laboratories. In addition it has supported, under the supervision of the Portuguese Institute for Quality - IPQ, the Laboratório Primário de Optica - LPO, as part of the Central Laboratory for Metrology - LCM. The LPO which is currently under construction at Vila da Feira, is part of the basic infrastructure for optical metrology. It will provide calibrations, the realisation and dissemination of fibre optical standards. At international level, it will participate in metrological inter-comparisons. In particular, within the Federation of the European National Metrological Institutes - EUROMET and the Bureau Communautaire de Reference - BCR, for adequate traceability. The LCM and CETO - Centro de Ciências e Tecnologias Ópticas will participate in the

scientific and technological programmes of LPO. They will also provide the necessary interface to the industrial users.

Recently, a new strategical program, PEDIP II was formed. PEDIP-II was developed to insure a continued modernisation and strengthening of the portuguese industry. It will lend support to the entrepreneurs' goal to guarantee quality control and sustain its competitiveness within the global economy. In addition, it will support efforts, as those of CETO, to motivate portuguese companies to develop innovative technologies and manufacture of high-tech products and to promote the establishment of foreign companies in Portugal in the field of optoelectronics and related areas.

In conclusion, the Ministry for Industry and Energy welcomes the Advanced Institute on "Trends in Optical Fibre Metrology and Standards" for its foreseeable contribution in promoting contacts and ultimately the internationalisation of related industrial activities, and for stimulating innovating ideas in the latest technologies.

Personally, I would like to welcome all the participants and wish them a very pleasant stay and fruitful outcome.

Eng^o Luis Mira Amaral
VIANA do CASTELO
27 de Junho 1994