



The 7<sup>th</sup> International Conference **MEASUREMENT 2009** is organized by the Institute of Measurement Science of the Slovak Academy of Sciences, Bratislava, Slovakia. 7<sup>th</sup> International Conference on Measurement

# MEASUREMENT 2009

Proceedings

Congress Centre of SAS, Smolenice Castle, Slovakia May 20 -23, 2009

## MEASUREMENT 2009

Copyright © 2009 by Institute of Measurement Science, SAS

Editors: Milan Tyšler, Ján Maňka and Viktor Witkovský Publisher: Institute of Measurement Science Slovak Academy of Sciences Dúbravská cesta 9, 841 04 Bratislava

#### ISBN 978 - 80 - 969672 - 1 - 6

Printed in Slovakia by Komprint s.r.o., Bratislava

#### ORGANIZERS OF THE CONFERENCE

#### Organizer

Institute of Measurement Science, Slovak Academy of Sciences, Bratislava

#### **Co-organizers**

Institut für Fertigungstechnik, Technische Universität Wien, Austria Faculty of Electrical Engineering, Czech Technical University in Prague, Czech Republic Faculty of Biomedical Engineering, Czech Technical University in Prague, Kladno, Czech Republic Faculty of Mechatronics and Machine Building, Kielce University of Technology, Poland Faculty of Mechanical Engineering, Technical University Košice, Slovakia Faculty of Electrical Engineering and Information Technology, STU Bratislava, Slovakia Slovak Institute of Metrology, Bratislava, Slovakia

#### **Technical sponsorship:**

IEEE, Czechoslovakia section Slovak Metrological Society Slovak National Committee U.R.S.I. Slovak National Committee IMEKO Association of Slovak Scientific and Technological Societies

#### **Conference Chairman**

Milan Tyšler, Slovakia

#### **Steering Committee**

- S. Adamczak, Poland S. Ďuriš, Slovakia I. Frollo, Slovakia V. Havlíček, Czech Republic H. Osanna, Austria J. Vajda, Slovakia
- J. Živčák, Slovakia

#### Local Organizing Committee

M. Tyšler J. Maňka V. Witkovský P. Andris M. Hain E. Bukovenová K. Cimermanová V. Juráš S. Karas M. Škrátek S. Štolc M. Teplan

### **International Program Committee**

J. Maňka, Slovakia, Chairman J. Bartl, Slovakia V. Boháč, Slovakia Z. Domotor, USA D. Eidukas, Lithuania Y. Gao, Hong Kong, China D. Hofmann, Germany J. Hozman, Czech Republic R. Hudák, Slovakia Y. V. Chugui, Russia E. Kawate, Japan G. Kozmann, Hungary L. Lhotská, Czech Republic R. Maniewski, Poland K. Meigas, Estonia L. Michaeli, Slovakia P.P.L. Regtien, The Netherlands K. Roubík, Czech Republic V. Smieško, Slovakia D. Šimšík, Slovakia S. Takayama, Japan M. Tarata, Romania L.I. Titomir, Russia E. Tkacz, Poland G. Wimmer, Slovakia V. Witkovský, Slovakia E.G. Woschni, Germany J. Zakrzewski, Poland

# Preface

The international conferences MEASUREMENT have always fostered intensive knowledge interchange among various disciplines within the broad field of measurement science and technology. Traditionally, participants are scientists dealing with theoretical problems of measurement as well as engineers applying new measuring methods and systems in research, industry, or medicine.

This book contains Proceedings of the 7<sup>th</sup> International Conference MEASUREMENT 2009 that was organized as a continuation of successful events in the years 1997 to 2007. It covers topics from theoretical problems of measurement, measurement in biomedicine, measurement of physical quantities and specific measuring systems. The aim of the Conference was not only to continue in the exchange of information among experienced specialists in the disciplines of measurement science, metrology, and selected application areas but also to attract young students and specialists and to challenge them by the competition for the Young Investigator Award sponsored by the Czechoslovak section of the IEEE.

The conference was developed to its current form thanks to Professor Ivan Frollo, founder and chairman of the previous MESUREMENT conferences who started the meetings of the international community more than 12 years ago and converted the former local workshops to international conferences. Since then, every two years, the attractive conference center in the Smolenice Castle offers the participants the possibility to meet and exchange their ideas form effective co-operations and build new professional and friendly contacts.

The conference was traditionally organized by the Institute of Measurement Science of the Slovak Academy of Sciences with substantial and inspiring support of all co-organizers and technical sponsors. Representatives of them were involved in preparation of the conference program and proceedings, what gives a guarantee that the conference would maintain its high scientific level.

We hope that this year's conference will become again both, a memorable scientific meeting and an enjoyable social event. The organizers also believe that the proceedings reflect the professional enthusiasm during the conference and the book will be a quoted reference in the field of Measurement Science.

Milan Tyšler, Ján Maňka and Viktor Witkovský editors