2009 IEEE TA/MGA Visits Program –
Czechoslovakia Section: Technical Lectures in Prague

AGENDA

Saturday 18 July 2009

Prague Marriott Hotel
Meeting Room: Bohemia II
Prague, Czech Republic

NOTE: The Panel of Conference Organizers (POCO) is scheduled to adjourn at 3:30pm

Time	Lectures
3:30 p.m.	**Introduction & Welcome** Harold Flescher (Vice President, IEEE Technical Activities) Jan Sistek (Vice Chair, IEEE Czechoslovakia Section)
3:35 p.m.	Ivan Wilhelm (Governmental coordinator of European R&D programs in the Czech Republic) **Research and Science from the Czech Republic in the frame of EU and OECD**
4:00 p.m.	Jan Dobeš (Director of the Nuclear Physics Institute ASCR) **Nuclear Physics in the Czech Republic**
4:45 p.m.	Break – Heavy hors d'oeuvres with wine and beer served at break and during rest of lectures
5:00 p.m.	Bill Moses (IEEE Nuclear and Plasma Sciences Society) **Nuclear Medical Imaging Instrumentation: Present Status and Future Directions**
6:00 p.m.	Rolf Aschenbrenner (IEEE Components Packaging, and Manufacturing Technology Society) **In the field of Microelectronic Packaging: Heterogeneous Integration**
7:00 p.m.	Open discussion with continuation of heavy hors d'oeuvres with wine and beer
~8:30 p.m.	Adjourn

Nuclear Physics in the Czech Republic

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Research activities of the nuclear physics community in the Czech Republic are summarized. Both the basic nuclear physics research and interdisciplinary and oriented studies at the national level are discussed. The home-based important facilities are introduced and examples of their exploitation are given. The research facilities and the scientific programs of the Nuclear Physics Institute (NPI) of the Academy of Sciences of the Czech Republic are presented. The facilities include an Isochronous Cyclotron, a Microtron, a Van de Graaff accelerator and a new Tandetron accelerator. The institute has also access and operates instrumental experiments at the research nuclear reactor of the neighboring Nuclear Research Institute. The scientific program includes basic research where projects are carried out mostly within international collaborations, in the thematic fields of collisions of heavy nuclei, nuclei far from the stability line, nuclear astrophysics, neutrino mass from electron spectroscopy, theoretical physics, and mathematical physics. In interdisciplinary and oriented research, the NPI carries out activities in thematic fields having its own natural connections and social requirements such as nuclear analytical methods, neutron diffraction, nuclear physics for future energy-production technologies, radiation dosimetry, and radiopharmaceuticals.

Curriculum vitae

Born: 1944 in Zlín (Czechoslovakia)
1966 : MSc. in nuclear physics, Czech Technical University, Prague,
1973 : Ph.D. in nuclear physics, Charles University, Prague
1973 - present : researcher in the Nuclear Physics Institute, Academy of Sciences of the Czech Republic, active in the theory of nuclear reactions and nuclear structure
1991 - present : lecturer at the Charles University, Prague
1998 - present : director of the Nuclear Physics Institute ASCR

Research and Science
from the Czech Republic in the frame of EU and OECD

Ivan Wilhelm
Governmental plenipotentiary person for coordination of European R&D programs in the Czech Republic

The results and status of research and science in the Czech Republic are summarized. The comparison with neighboring countries in the region as well as with EU and OECD countries is shown. Evolution of indicators for the Czech Republic is given such as the Author Citation Index.

Curriculum vitae

Graduated in 1964 at the Faculty of Technical and Nuclear Physics of the Czech Technical University in Prague. Professional carrier started on the same faculty. The period 1967 – 1970 he spent in the Joint Institute for Nuclear Research in Dubna. On his return from Dubna, he continued to work on Faculty of Mathematics and Physics of Charles University in Prague in different positions up to now. In 1972 he received the PhD level equivalent in nuclear physics. In the end of seventies he devoted himself to intensive work in the newly founded van de Graff Ion Accelerator Laboratory at the Faculty of Mathematics and Physics, Charles University Prague. The research program of this laboratory was oriented to physical experiments in nuclear physics and to the testing procedures for particle physics and cosmic program experiments. All those activities are highly internationally completed. He had published more than 100 articles and reports on nuclear and particle physics.

Prof. Wilhelm is the former Vice-rector (1994 – 2000) and Rector (2000 – 2006) of the Charles University in Prague. He is the elected Chairperson of the Scientific Committee of JINR in Dubna. Since 2007 is appointed member of the UN University Coucil. Since 2006 is appointed as the governmental plenipotentiary person for coordination of European R&D programs in the Czech Republic.

Nuclear Medical Imaging Instrumentation: Present Status and Future Directions

Bill Moses

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Positron emission tomography (PET) is a nuclear medical imaging technique that is commonly used to image cancer, heart disease, and brain function. Recent years have seen many advances in PET instrumentation. The fraction of the body that is imaged has expanded by an order of magnitude and x-ray CT scanners are now mounted in the same gantry as the PET camera so that anatomical images from CT can be fused with the functional information from PET (*i.e.,* the PET image shows which tissue is cancerous, while the CT image shows where this cancer is located in the patient's body). The efficiency for detecting the injected radiation has been increased dramatically, but this greatly increases the flux of radiation that the detectors must process, and so new scintillator materials capable of higher speed operation have been developed. PET cameras dedicated to imaging specific forms of cancer, such as breast cancer or prostate cancer, have also been developed. In the research arena, PET has been found to be extremely valuable for studying biological function in animals, especially mice. This has spurred the development of PET cameras optimized for imaging mice that boast spatial resolutions approaching 1 mm fwhm. Time-of-flight PET, which reduces the statistical noise in the images, is experiencing a major rebirth.

Despite these impressive advances, the instrumentation still limits the performance of PET in many ways. In a typical PET study, only about 25% of the detected coincidences are "true" events—the other 75% are background event either from events that have undergone Compton scatter in the patient (roughly 25% of the events) or random coincidences (up to 50% of the events). The 511 keV gamma rays from positron annihilation can penetrate a significant distance into the scintillator crystals before they interact and are detected, which degrades the spatial resolution. The amount of radiotracer that can be injected into the patient is limited by safety concerns (radiation dose), so statistical noise (due to detecting fewer events than desired) limits the image quality. For animal PET, it is very desirable to image awake (rather than anesthetized) animals, as the anesthesia can significantly alter biological function. Finally, work needs to be done on how to evaluate how improvements in instrumentation translate into improvements in clinical practice and patient care. This presentation will describe these recent advances in more detail, list the needs that are presently unmet, and illustrate how some evolving technologies may help to meet these needs.

Heterogeneous Integration

Rolf Aschenbrenner

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Advanced silicon technologies offer the possibility of integrating hundreds of millions of transistors in a single electronic component such as a microprocessor. Experts predict that the increase of components per chip will follow the well known “Moore’s law” in the next decade, too. “Microelectronics” will become “Nanoelectronics”. This trend can be characterized by “More Moore”. If electronic signal and data processing systems are focussed, nanoelectronic components will be very cost efficient due to larger wafer sizes and a high degree of miniaturization (System-on-Chip). But future multifunctional systems require not only more signal and data processing power but also require interfaces to the human sensory organs and altogether functions for an interaction with the environment. Besides these, antennas, components for optical signals and data transmission as well as functions for energy conversion and storage are also needed.

However, for these future multifunctional technologies in most cases the cost efficient nanoelectronic standard technologies cannot be applied. Non-electronic and often radiofrequency functions require alternative materials and special processes. This additional process steps often reduce the yield or require special process developments which result in a tremendous cost increase. Therefore pure “System on Chip (SoC)” solutions will be supplemented by “More than Moore” solutions. “More than Moore” uses standard technologies for the realisation of multifunctional system technologies.

The present status of system integration is still dominated by single-chip packaging, with the few stacked-die SiP solutions being implemented mainly using wire bonding. The most advanced substrate boards are High Density Interconnect (HDI) multi-layer boards. Unlike the integrated circuit industry, where electrical, thermal and mechanical characterisation is allocated to the complete design, the chips, package and board in SiP solutions are still designed separately.

This approach will not be sufficient to meet the future integration requirements of advanced SiP solutions. The very high level of miniaturisation and extreme reliability required in future SiPs will mean that issues such as thermal and mechanical stress management will need to take into account everything between the point at which heat is generated and the outside of the package. It will be further complicated by integration of special functions into the package, such as sensors, actuators, RF interfaces or power supply components, which may be especially sensitive to heat, stress etc. In addition the application environment in which the SiP will ultimately be used will also need to be taken into account.

To meet these challenges, new architectures will have to be developed. To reach the required level of miniaturisation, it will also be necessary to develop advanced assembly and handling technologies for thin wafers and chips. The integration of nano-ICs, sensor chips, actuator components, passives and displays into 3-D architectures will require the development of new design methodologies as well as reliable ultra-thin metallic interconnect technologies.