In the framework of the harmonization of Slovak legislation witch European Directives there is nowadays prepared a new law on "Public Health" containing the part dealing with regulation of exposure of natural radioactivity concentration in building materials. Application of this law in the practice of radiation protection is supposed in the end of this year.

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Education of medical radiation physicists in the Czech Republic

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Medical physics as an interdisciplinary branch involving physics, engineering and medicine has become increasingly important in connection with the development and implementation of new sophisticated methods and technologies utilizing ionising radiation in medicine. In accordance with new legislation reflecting the relevant EC directives, the Czech Technical University has prepared a new master degree programme in medical physics, which is based on a profound background in mathematics and physics. This program is organized in cooperation with partner institutions, including departments of radiotherapy, nuclear medicine and radiodiagnostics in hospitals. This project is important with respect to general problems of health care treated by the new legislation, and is directly linked to the future fields of interest of the new national professional organization of medical physicists, which is currently being set up.

"A medical physicist (MP) is a person qualified with a University degree, or equivalent, majoring in physics with specialist education and training in the concepts and techniques of applying physics in medicine, who, using scientific physics principles, methods and techniques works in alliance with medical staff in medical institutions (general or university hospitals, research institutes or laboratories) employing and/or developing medical technology for the prevention, diagnosis and treatment of human diseases, and/or runs courses in medical physics and allied sciences for physicists, engineers, technicians and medical doctors." [Definition of MP profession, IOMP 2003]. The position of medical physicists in the health care system of the Czech Republic has not been well recognized. Although staff members have worked in the position of a "medical physicist" for many years, their educational background has not been treated carefully. More or less anybody who graduated in natural sciences or engineering at master's level was accepted for training in medical physics (officially: "Technical collaboration in nuclear medicine, radiodiagnostics and radiotherapy") organized by the Institute of Postgraduate Education in Health Care under the Ministry of Health. Even worse, this specialized postgraduate education was not mandatory. The training has been based on (not very intensive) theoretical lectures and on-the-job training dealing with physics in radiotherapy, nuclear medicine

or radiodiagnostics, and with associated general health disciplines. Medical physics was exclusively a field of postgraduate education.

The "Atomic Act", governing peaceful utilization of nuclear energy and ionising radiation, has been valid in the country since 1997. The act requires, among other things, that a medical physicist should be in charge of every significant ionizing radiation source, including therapeutic Co60 based treatment machines, clinical linear accelerators, etc.. This is required above all for radiation protection reasons and, of course, it is in agreement with the directive EC 97/43 EURATOM, which treats the profession of a medical physicist. Lack of MPs in health care, due to their unacceptably low salaries and their low professional status, has been an ongoing problem. A related problem has been that the MP profession has not been recognized as a "health" profession, which has pushed MPs to the outer edge of the spectrum of people working in health care, even when they were university educated and highly specialized.

Currently, an Act on non-clinician Health Professions is being issued, and this will include MPs. One of its contributions is that MPs ("radiological physicists" according to the terminology of the Ministry of Health) are recognized as members of a health profession, which is immediately reflected, e.g., in a significantly higher salary. Moreover, according to the Act, an MP needs to be a graduate from a master degree university programme in radiological physics certified by the Ministry of Health. Alternatively, an MP may be a graduate from a university master degree programme based on mathematics and/or physics. In the latter case, graduation from a special course in medical physics, again certified by the Ministry of Health, is required. For a certain period (2-3 years), MPs will undergo on-the-job training in a hospital under the supervision of a Qualified Medical Physicist (QMP). Then, after fulfilling all requirements of postgraduate education and training (organized by an institution certified by the Ministry of Health), he/she becomes a QMP specialized in radiotherapy, nuclear medicine or radiodiagnostics. After a subsequent period of practice and after fulfilling the requirements of the credit point system quantifying life-long education, the QMP can become a Medical Physicist Expert (MPE). This qualification is checked periodically using the previously-mentioned credit point system.

The Czech Technical University in Prague (CTU) has many years of experience with education in dosimetry and application of ionising radiation, including medical applications. Since problems of radiation protection and medical application of ionising radiation are the a major aspect of all medical physics, current MP staff in hospitals in the Czech Republic have been recruited mostly from CTU graduates. About 6 years ago, CTU opened a new specialization in Medical Radiation Physics, now renamed as Radiological Physics. The programme of this specialization has gradually been separated from the original Dosimetry and Ionising Radiation Application programme by implementing further medicine and medical physics-related courses instead of some of the original non-medically oriented courses. From the beginning, courses such as Basic Human Anatomy and Physiology, Human Biology, Biochemistry, Basic Radiotherapy, Clinical Dosimetry, Basics of Nuclear Medicine and some others were added to or replaced some courses from the programme in Dosimetry and Ionising Radiation Application. In addition to these, courses such as Biological Effects of Ionising Radiation and Radiation Protection" were accepted from this programme also to the Radiological Physics programme. Subsequently, new courses in Physics of non-ionising Radiation, including medical applications of nuclear magnetic resonance, lasers and ultrasound, Radiodiagnostics, Advanced Radiotherapy, Radiobiology, and Image Registration and Processing have been implemented. Radiological physicists study the interactions of radiation in matter, with special interest in the quantitative determination of the energy absorbed. Also of interest are the analyses of the nature of radiation environments and the effect of radiation and radioactivity on life processes. Applications of this knowledge can range from the design of radiation detection instrumentation, to the establishment of radiation protection standards. All the courses are, of course, built on a profound mathematical and physical background and further focused on nuclear and radiation physics, including detection and dosimetry of ionising radiation. Applications of modern Monte Carlo simulation methods, which play an increasing role in problems of ionising radiation, also receive considerable attention. New course of application of MCNP was prepared last year. MCNP is a general-purpose Monte Carlo N-Particle code that can be used for neutron, photon, electron, or coupled neutron/photon/electron transport. Specific areas of application include, but are not limited to, radiation protection and dosimetry, radiation shielding, radiography and medical physics. The code treats an arbitrary three-dimensional configuration of materials in geometric cells bounded by first- and second-degree surfaces and is very useful for solving the problems of radiological physics.

In accordance with modern requirements, great attention is paid to practical work. In the framework of two one-semester courses, students are familiarized with basic radiation dosimetry and measurements using various detectors of ionising radiation. Additionally, some courses are organized in close collaboration with partner institutions such as the State Office for Nuclear Safety, the State Institute for Radiation Protection,

the Czech Metrology Institute, the Institute of Nuclear Physics of the Czech Academy of Sciences and a number of hospital departments. This ensures that students are well informed about the function and tasks of these organizations. Moreover, a number of departments of radiodiagnostics, nuclear medicine and radiotherapy in hospitals have now promised to facilitate intensive two-week per department "on-the-job" training sessions for students under the supervision of experienced medical physicists to prepare them for the work they will undertake after graduating.

Since the preparation of this university programme according to the new legislation is a matter of public interest, the Ministry of Education and also the Ministry of Health have provided significant support for this project. Due to the EC directive cited above and the "Atomic Act", the Czech Republic has to assure adequate education for medical physicists. It is anticipated that this educational model will be acceptable to the relevant organizations in the EU. The European Federation of Organizations for Medical Physics (EFOMP), which groups national medical physics organizations, is probably the most important. The problem of the Czech Republic is that there has been no national representative in EFOMP since 1992, when former Czechoslovakia was split into the Czech Republic and Slovakia. It is of great importance to establish a national organization of MP, which will be registered by EFOMP. Pre-graduate education is also a matter of great interest for such an organization, so CTU is involved in these activities, as a significant part of the MP community in the country consists of CTU graduates.

The Department of Dosimetry and Application of Ionizing Radiation offers graduate study leading to the Ing. degree (M. S.) in Radiological Physics, bachelor study leading to the Bachelor in Radiological Technique. The Department offers furthermore graduate study leading to the Ing. degree (M. S.) in Dosimetry and Application of Ionizing Radiation and bachelor study leading to the Bachelor in Radiation Protection and Environment, traditionally.

The curriculum of the Radiological Physics combines theoretical, experimental and applied radiological science courses. After graduation, students are prepared for employment as radiological physics in the departments of radiotherapy, radiodiagnostics and nuclear medicine or many continues studies leading to the PhD.

In addition to pre-graduate education, CTU also intends to apply for Ministry of Health certification for special courses in medical physics aimed at graduates from other mathematics- and physics-based programs who wish to be employed as MPs in hospitals. This will be possible in the near future, when the new legislation becomes valid and the Institute for Postgraduate Education loses its monopoly on postgraduate education in health care.

All the CTU activities mentioned above may be viewed as a good implementation of a new university education program in close connection with the requirements of practice and legislation, and as a good model for a 21st century interdisciplinary branch of university studies. No uniform model exists for the education of MPs in the EU: they are usually recruited from the field of general physicists, and medical physics-oriented education often consists of postgraduate courses and on-the-job training in hospitals. Based on tradition and on relatively good experience, the Czech Republic allows medical physics to be taught at pre-graduate level, followed by postgraduate on-the-job training leading to registration as a QMP.