Enhancing nuclear science education and training using accelerators

Excerption

From

A Report of an IAEA technical meeting
Held in Accra, Ghana, 11-14 September 2007

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EXECUTIVE SUMMARY

A technical meeting on "Enhancing nuclear science education and training using accelerators" was held at Accra, Ghana, from 11 – 14th September 2007. It was organized by the Physics Section of the Division of Physical and Chemical Sciences of the International Atomic Energy Agency in cooperation with the Ghana Atomic Energy Commission.

The overall objective of the meeting was to advise the IAEA of mechanisms that may be developed or promoted to enhance nuclear science education and training using accelerators, and suggest activities in this area that the IAEA could facilitate.

The formal presentations by participants revealed institutional work plans and proposed activities for utilization of accelerators in different parts of the world.

The group showed considerable concern and interest about the improvement and enhancement of worldwide activities related to accelerator-based nuclear and interdisciplinary research in view of its very broad range of relevant applications.

The meeting was attended by twelve international experts, and chaired by Mr. Godsway Banini (Ghana). The major part of the drafting of the report was done by Mr. Andrés Kreiner (Argentina). The IAEA Scientific Secretary was Mr. Nikolai. Dytlewski of the Division of the Physical and Chemical Sciences.

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1. PURPOSE OF THE MEETING

The purpose of this technical meeting is to advise the IAEA of mechanisms that may be developed or promoted to enhance nuclear science education and training using accelerators, and suggest activities in this area that the IAEA could facilitate.

2. BACKGROUND

The enhancement of nuclear science education and training in all Member States, in particular the developing countries, is of interest to the IAEA as many of these countries are building up their scientific infrastructure but are lacking in sufficient numbers of highly educated and qualified persons who could take up the reins of leading and driving activities in applied nuclear science and technology. This may arise from amongst other things, a lack of candidates with sufficient educational backgrounds in nuclear science who would qualify to receive specialized training, or be lacking in institutions available for training nuclear science specialists, i.e. those institutions with an established programme of nuclear science research. A related concern is the potential loss of valuable knowledge, accumulated over many decades, due to ageing workforce.

Recognizing a need to enhance educational and research opportunities for young nuclear professionals, the IAEA in cooperation with the Ghana Atomic Energy Commission convened a technical meeting for the purpose of advising the IAEA on strategies and mechanisms that may be developed or promoted to enhance nuclear science education and training using accelerators. Ion beam accelerators offer a broad range of nuclear applications in environmental management, cultural heritage, natural resources, human health, and industry, as well as manpower development opportunities in areas such as radiation detection, nuclear instrumentation, high voltage, and vacuum systems. In recognition of the potential of ion beam accelerators to build knowledge and expertise, many developing countries are increasing investments in this enabling technology. Such national developments can also support a long-term objective of developing a knowledge base from which to participate in activities at advanced nuclear facilities such as high flux research reactors, synchrotron light sources, spallation neutron sources, and specialized ion beam facilities.

This technical meeting brought together practitioners in the field of accelerators, tertiary institutions, and representatives of national organizations who have, or are intending to acquire accelerators. The presentations covered a range of applications and case studies which discussed or demonstrated approaches to the generic issues involved in this subject area. It was intended that presentations from invited speakers, and round-table discussions, will lead to the formulation of specific conclusions and recommendations on how Member States can best benefit from accelerators, and strategies that may be implemented to achieve this.

3. OBSERVATIONS

The participants presented reviews on their institutional status and work plans, especially with respect to education and training. The abstracts of all the presentations are given at the end of this report together with the agenda of the meeting.

The participants noted that Nuclear Science and Technology can be divided into two main avenues:

1. Science conducted with nuclear reactors (which are based on nuclear fission induced by neutrons) and

2. Science conducted with ion accelerators (based on nuclear reactions induced by charged particles and on collisions with electrons and atoms in matter)

Each of these two technologies is very important in its own right and they may become increasingly interrelated through the development of Accelerator Driven Systems (ADS) for a range of applications in the future from nuclear waste transmutation to energy production.

Accelerators have very important applications in modern society. Electron accelerators form the basis of radiotherapy, while ion accelerators have applications ranging from non-conventional radiotherapies, isotope production for nuclear medicine and environmental sciences through powerful analytical techniques. A partial list of these applications is given below.

- Nuclear medicine-biology: proton therapy, hadron therapy, Boron Neutron Capture Therapy (BNCT), radiobiology, production of radioisotopes, diagnostic imaging

- Environmental sciences: high sensitivity analysis techniques such as: Accelerator Mass Spectrometry (AMS), Particle Induced X-ray Emission (PIXE), Particle Induced Gamma-ray Emission (PIGE), Rutherford Backscattering Spectrometry (RBS)

- Materials science: characterization: RBS, Elastic Recoil Detection Analysis (ERDA), PIXE, Nuclear Reaction Analysis (NRA) and modification of properties (radiation damage, ion implantation, micromachining)

- Explosives detection, cargo inventory verification

- Nuclear waste transmutation and energy production (both through ADS and inertial confinement fusion)

- Studies on structure of matter: sub-nuclear, nuclear, atomic, molecular, solid state

- Geology and mineralogy

- Archaeology and art, cultural heritage

4. CONCLUSIONS AND RECOMMENDATIONS

After four days of in-depth coverage and exchange of ideas on the accelerator-based ongoing research and related educational projects in the home institutions and countries of all the delegates, there was a generalized agreement concerning the importance of these activities for education and training for the future of nuclear science and technology. As a panel of experienced accelerator users and nuclear science educators, we strongly endorse the idea of enhancing nuclear science education and training using particle accelerators. The efforts by IAEA to foster and promote accelerator-based R&D are perceived as very positive and should be strengthened in view of the very wide range of extremely useful applications of these devices.

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