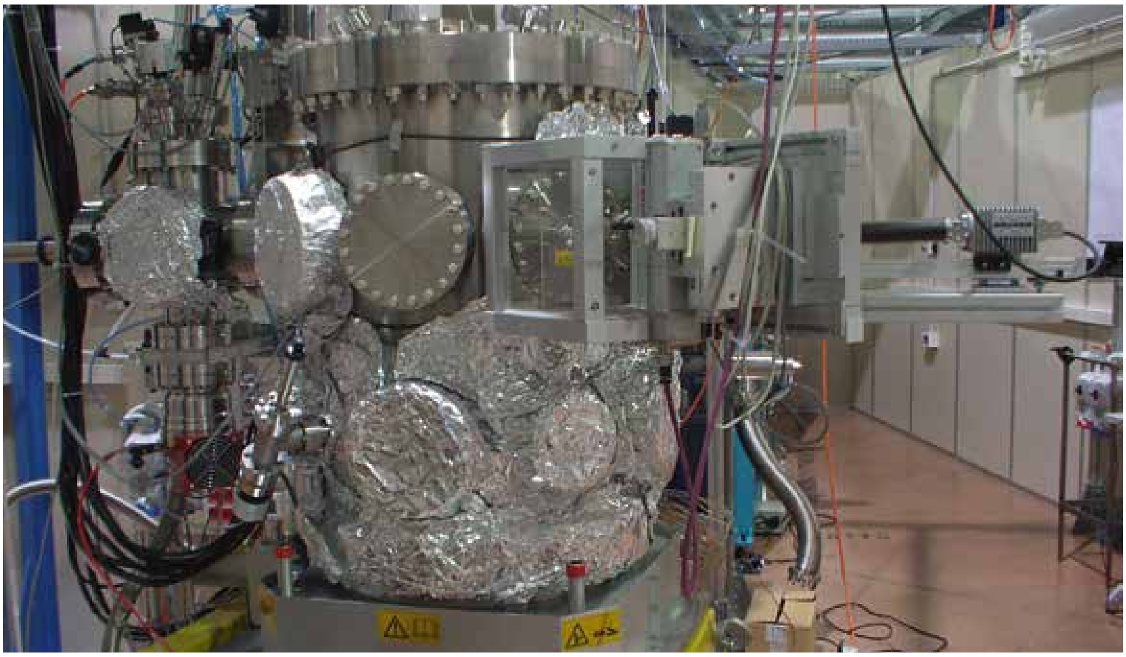
ACCELERATOR APPLICATIONS SUPPORT NUCLEAR SCIENCE AND TECHNOLOGY

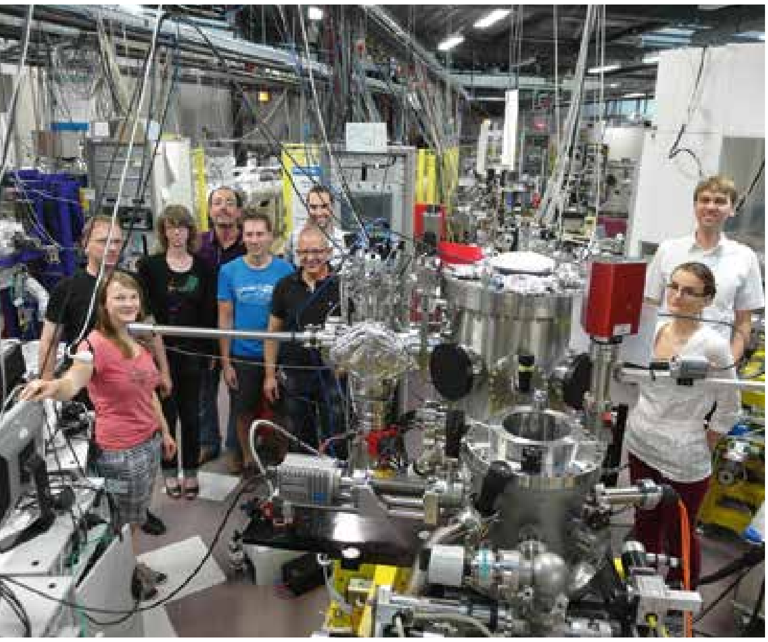
Accelerators are machines that use high voltages to produce artificial radiation in the form of beams of energetic particles. They are more versatile and safer than radioactive sources because the energy can be varied, and when the accelerator is turned off, so is the radiation. Accelerators are used for diverse applications such as to treat cancer, analyse artwork and old artefacts, clean up waste effluent gases, produce computer chips and map the structure of proteins. Accelerator technology makes a valuable contribution to the technological progress of a country, which in turn can also contribute to a country's economic development.

Accelerators have been around for more than 80 years. In 1929, Dr Robert Jemison Van de Graaff, an American physicist, successfully demonstrated how a high voltage machine could accelerate particles. There are currently about 30 000 accelerators operating globally. About 99% of them are used for industrial and medical applications and only about 1% are used for basic research in science and technology. The production of industrial accelerators is a worldwide business with an annual revenue of over US $2 billion and the products processed by them have annual sales valued at about US $500 billion.

As part of the IAEA Division of Physical and Chemical Sciences, the Nuclear Science and Instrumentation Laboratory (NSIL) supports Member States in the development of a broad range of nuclear applications and in the effective use of related instrumentation. The IAEA Physics Section and the NSIL currently support 17 national and regional technical cooperation (TC) projects in 56 Member States in accelerator applications, as well as coordinate seven coordinated research projects with institutes from 40 Member States. To support these programmes, the IAEA Physics Section cooperates with external institutions through mutual agreements. Elettra in Trieste, Italy and the Ruđer Bošković Institute in Zagreb, Croatia are two such partners.

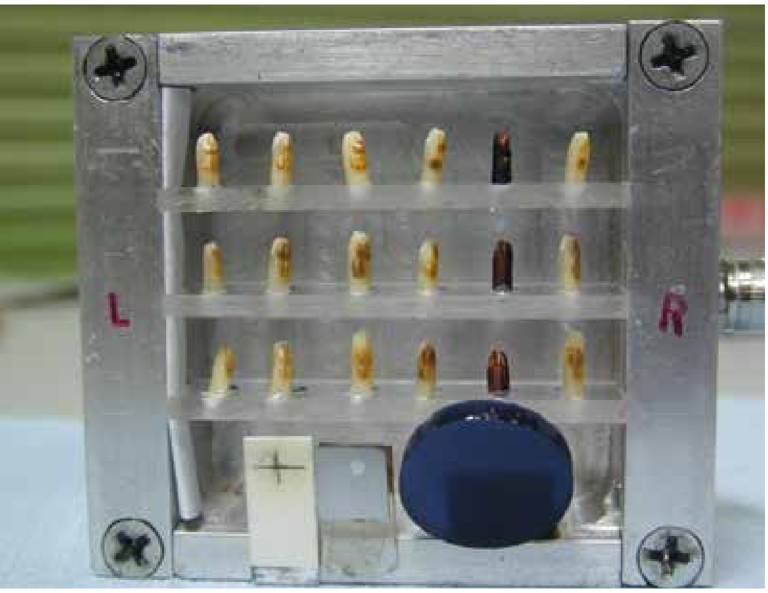


1 The ultra-high vacuum chamber (UHVC) end station at the new IAEA beam line at the Elettra synchrotron in Trieste, Italy. This state-of-the-art X-ray fluorescence beam line can be used to analyse which chemical elements are found in a material. One of the results of this advanced technology is its ability to produce 2D and 3D maps of the chemical analysis of the material being tested. The machine was shipped from Berlin to Trieste and is in the process of being commissioned for Member States' use by July 2014. (Photo: IAEA)

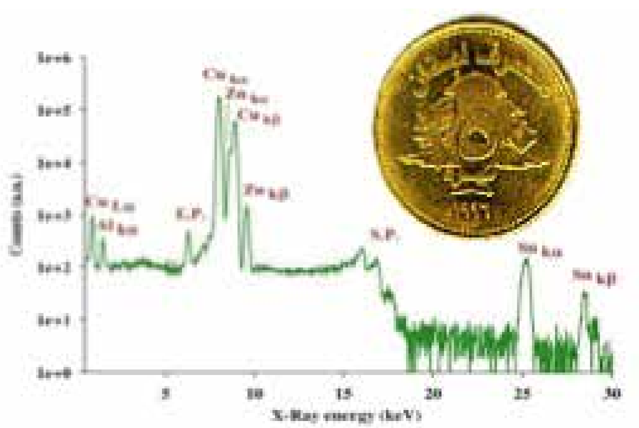


2 Staff from the IAEA NSIL, the German Institute for Standardization in Berlin, as well as Elettra in Trieste came together in August 2013 for the joint beam test of the UHVC at the BESSY II synchrotron radiation source in Berlin. The test of the X-ray fluorescence beam line was successful in analysing which chemical elements are found in a material and confirmed that the chamber performed the technical task as intended. The test was conducted prior to shipping the accelerator to Trieste, Italy. (Photo: IAEA)

3 Installation of an ion beam accelerator that was donated by the Netherlands to the new accelerator centre in Accra, Ghana. The accelerator will offer training opportunities for students in nuclear research and applications in material sciences, environmental topics and cultural heritage analysis, such as determining age and authenticity of artwork and artefacts. This is the subject of a TC project for Ghana supported by the IAEA Physics Section. (Photo: IAEA)



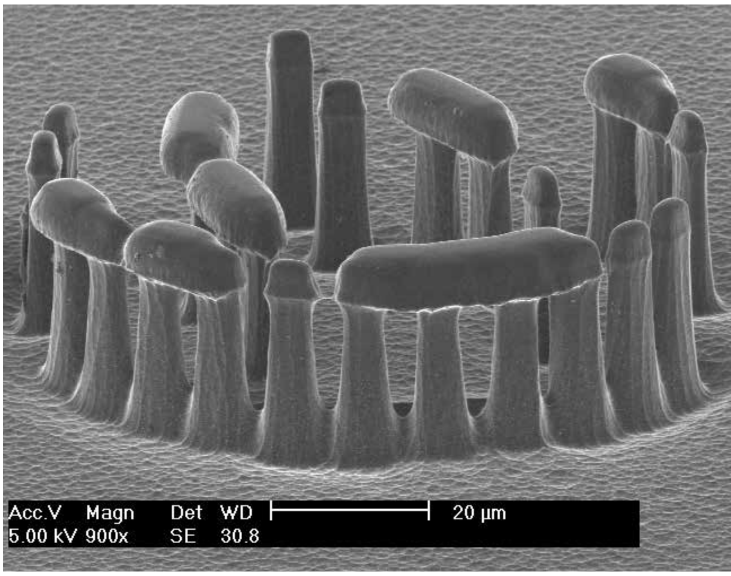
4 Ion beam irradiation can be used to initiate mutations which can lead to plant varieties with better properties. This is an example of rice that has received ion beam irradiation at Chiang Mai University, Thailand. This type of work is carried out as part of TC projects supported by the IAEA Physics Section. (Photo: Chiang Mai University, Thailand)



5 A graph of an ion beam analysis of a 250 Lebanese Lira coin to determine its layer composition and thickness. This kind of analysis through nuclear technology can be used to assess and authenticate coins or other ancient artefacts. This analysis was part of a TC project in Lebanon supported by the IAEA Physics Section. (Photo: Lebanese Atomic Energy Commission)

6 A panoramic view of the IAEA beam line at the Elettra Synchroton Chamber in Trieste, Italy. The synchrotron radiation beam line enters from the right side of the chamber and finally reaches the UHVC, which is the end station seen just left of centre. Synchrotron beam light facilities produce X-rays that are millions of times brighter than medical X-rays. Scientists use these highly focused, intense beams of X-rays to reveal the identity and arrangement of atoms in a wide range of materials, including metals, semiconductors, ceramics, polymers, catalysts, plastics and biological molecules. The IAEA beam line has been working since April 2014. This beam line is especially suited to material science applications. (Photo: IAEA)

7 Ion beam accelerator at the Ruđer Bošković Institute (RBI) in Zagreb, Croatia. The IAEA NSIL has been operating a beam line at this accelerator since 1996. The accelerator uses a voltage of six million volts to accelerate protons that are used for a wide variety of applications, such as material analysis. (Photo: RBI, Zagreb)



8 A 3D nanostructure 'Silicon Henge' produced by focused proton beam irradiation of silicon at the Centre for Ion Beam Applications (CIBA), Department of Physics, National University of Singapore. This illustrates how ion beams can be used to produce complicated nanostructures, a key requirement for nanotechnology. (Photo: Professor Martin Breese, CIBA)

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