PROGRESS IN NUCLEAR ELECTRONICS

The remarkable advance in recent years in the development of electronic instruments for atomic research and applications, particularly for the detection, measurement and analysis of radiations, was reviewed at a Conference on Nuclear Electronics held by the International Atomic Energy Agency in Belgrade from 15 to 20 May 1961. About 350 scientists from 29 countries and five international organizations participated in the conference. Apart from reviewing radiation detection devices which are already well established, the conference examined problems encountered in developing detection tools of greater speed and sensitivity, such as would meet the needs of nuclear research and applications involving extremely high energy radiations.

Some of the instruments which have recently been developed for such uses were displayed at an exhibition held in Belgrade in conjunction with the conference. The exhibits came from ten of the Agency's Member States: Austria, Czechoslovakia, Denmark, France, Israel, Italy, Japan, Poland, Romania and Yugoslavia.

Opening the exhibition, Mr. Sterling Cole, Director General of IAEA, pointed out that during the past ten years the developments in the field of electronics had been "rapid, fascinating and at times startling in their accomplishments". Judging by present trends, said Mr. Cole, the manufacture and supply of nuclear electronic equipment could be expected to double during the next decade.

At the opening session of the conference Mr. Cole said that a great deal of current research in the nuclear electronics field was directed to developing more sensitive and reliable radiation detection tools, more sophisticated electronic circuits and altogether more advanced electronic systems. The conference, Mr. Cole pointed out, would not deal with the whole field of nuclear electronics, but would concentrate on radiation detectors, electronic circuitry for both classical and fast systems, advanced systems which were still experimental, and some monitoring systems and instruments.

Mr. Aleksandar Rankovič, Vice President of the Yugoslav Federal Executive Council and President of the Federal Nuclear Energy Commission, who also addressed the session, said that electronics had made available the modern means for research in and application and control of nuclear energy.

Role of Nuclear Electronics

Electronic instruments do a variety of jobs in all branches of atomic operations, from prospecting for nuclear materials to reactor control and radiation applications. One of the most important functions is the detection and quantitative and qualitative measurement of nuclear radiation. This again has a variety of uses in atomic energy work; both for basic research and practical measures (such as radiation safety) it is essential to have adequate, effective and prompt means of detecting, measuring and analyzing the radiations emitted by radioactive material or a nuclear facility.

Broadly speaking, there are four types of radiation detectors. In the first category can be grouped all devices based on ionization phenomena. Electrical pulses produced by ionizing events are registered by electronic instruments, and a count of the pulses gives a measurement of the radiation which has caused the ionization. Geiger counters and ionization chambers are well-known examples of this type of detector.

Secondly, the pulses can come from flashes of light produced by radiation in certain materials. Here again, an electronic count of the scintillations is used for the detection and measurement of radiation. The detector based on this principle is known as the scintillation counter.

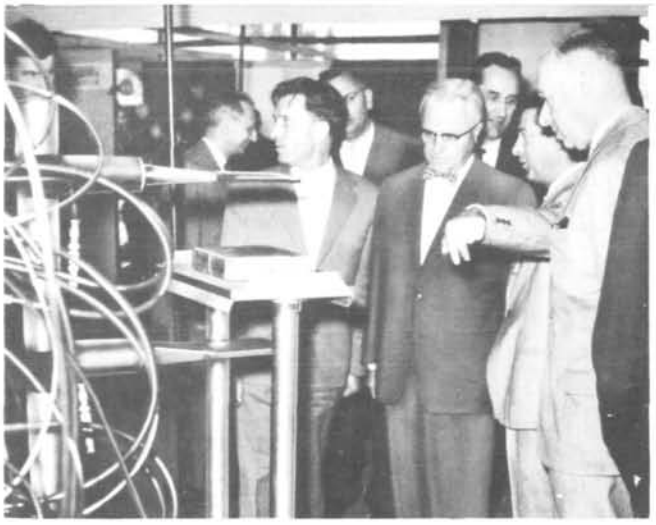
Thirdly, the pulses may be the result of what is known as the Cerenkov effect. Nuclear particles with extremely high speeds can produce light (seen as a faint bluish glow) while passing through a transparent medium, and the pulses produced by this light are registered by Cerenkov detectors.

Fourthly, radiation can also be detected and measured by the damage it causes in solids.

While detection of radiation and measurement of the total amount is relatively easy, a difficult but important task is to determine the type of radiation and the source from which it is emitted. The main objectives of current research and development in this field are, therefore, to evolve more sensitive detector devices with greater power of discrimination between different types of radiation so that they can yield more complete information as to the character of the radiation detected, and secondly, to develop extremely fast electronic circuitry which would be suitable for recording the pulses produced by very high energy nuclear particles.

Detector Types

At the conference in Belgrade, separate sessions were devoted to various types of radiation detectors and electronic systems. The most common type of radiation detector is based on ionization that radiation causes in a gas, as in the Geiger-Mueller tube or the ionization chamber. A new development in ionization detectors is what is known as a spark counter, a device based on the count of electrical sparks produced



An automatic counting system, an exhibit from Italy at the Nuclear Electronics Exhibition in Belgrade, being seen by Mr. Sterling Cole (fourth from right). Behind Mr. Cole is Mr. Slobodan Nakicenovic, Secretary-General of the Yugoslav Federal Nuclear Energy Commission, and at the extreme right is Dr. Bernhard Gross, Director of IAEA's Division of Scientific and Technical Information

as a result of ionization. Scientists from several countries presented papers on the construction of these counters and experiments carried out with them.

Another subject of special interest discussed at the conference was the recent development of radiation detectors using semi-conducting materials. Semiconductors are now well known because of their widespread use in transistors; broadly speaking, they perform the same function as is done in conventional instruments by electronic valves. Semi-conductor detectors are based either on ionization phenomena or damage in solids; even when they are based on ionization phenomena, the ionization is in solids. A large number of papers related to properties of semiconducting materials, construction of detectors, and their applications, especially in high-energy measurements.

For the measurement of high-energy particles, Cerenkov detectors are particularly suitable. Considerable interest was expressed in methods of constructing large radiation detectors based on the Cerenkov effect, in view of the growing demand for such devices for the detection, analysis and measurement of radiations from accelerators (e.g., cyclotrons) and reactors. Scintillation counters and properties of some scintillating materials were also discussed. Papers were also presented on detection devices such as luminescence chambers and intensifier systems. These devices permit the observation and registration of the tracks of particles in scintillation materials; the small flashes of light are so intensified that they can be viewed on a screen or photographed.

At another session the conference discussed electronic methods of analyzing the electrical pulses produced by radiation and handling the information that they yield. Two sessions were on the technical problems of constructing the necessary electronic circuits; one discussed the classical or relatively slow systems, and the other examined the circuitry necessary for very high speed detection and counting. The conference also discussed some highly advanced experimental systems for handling information on many simultaneous events and analyzing and presenting them in a very rapid way. Such systems are used in connection with accelerators.

Monitoring Systems

At the last session of the conference, papers were presented on some monitoring systems and instruments. This is obviously of great practical interest in every type of atomic energy work, particularly in health and safety measures. A paper by P. Desneiges (France) described a whole range of instruments for keeping a permanent check on the radioactive contamination of surfaces, air and liquids; it was stated that these instruments were light, portable and independent and were suitable for carrying out checks at any given moment at a large number of points. Two other French scientists (A. Blanc and J. Lequais) described a device for detecting and measuring contamination of air in laboratories preparing radioactive iodine; the device records the activity in the air and gives an alarm when it reaches a predetermined value or undergoes an abnormally rapid change.

A paper by S. Kobayashi and three other Japanese scientists related to a survey meter which can not only detect the presence of a radioisotope in the neighborhood, but also determine its exact location or direction. E. Clarke and N. Pearce from the United Kingdom gave an account of instruments for the monitoring of plutonium in air and on surfaces.

Two United States scientists, C.J. Borkowski and R.H. Dilworth, described a personal radiation monitor developed at the Oak Ridge National Laboratory, which weighs $3\frac{1}{2}$ ozs. and has the size of an ordinary fountain pen. Worn in the pocket of the user, the device provides immediate audible and visual indication of gamma dose rate; the flashing rate of a neon lamp and the pitch of an audible warning tone increase in proportion to the dose rate. To ensure continuous protection, there is no on-and-off switch; the instrument operates for one month on a 4-volt mercury battery. The radiation detector is based on the Geiger-Mueller principle.

Three scientists from Yugoslavia, B.J. Kovač, S.D. Mučdeka and M.V. Šobajić, described an instrument for radiation control from a distance. The instrument, connected to a normal phone apparatus, gives information on the radiation level in a particular area as an answer to a phone call, without requiring the presence of technical personnel to provide the information on the phone.

The scientific sessions of the conference were presided over by: C.J. Borkowski (USA), E. Djakov (Joint Institute of Nuclear Research, Dubna, USSR), E. Gatti (Italy), G. Gianelli (EURATOM), K. Kandiah (United Kingdom), J. Keller (Poland), B. Lalovic (Yugoslavia), M. Surdin (France), R. Vestergaard (Sweden) and P. Weinzierl (Austria).