

NUCLEAR ELECTRONICS

A CONFERENCE on "Nuclear Electronics" was held at the Institution of Electrical Engineers, London, during November 30–December 1. Nearly 400 scientists and engineers attended, including a fair representation from the near-Continental countries, and the two-day presentation of papers and discussions must be voted one of the most successful conferences of its type ever held.

Radiation Detectors

The first session of the conference was on "Radiation Detectors", and W. Abson (Atomic Energy Research Establishment, Harwell) gave the opening paper. He spoke about the development of spark chambers and image-intensifier/luminescent-chamber systems, which offer the possibility of obtaining pictures or other records of nuclear-particle tracks with a much higher degree of resolution than is possible with existing techniques. Both techniques offer improved time resolution over the cloud-chamber and bubble-chamber methods. Accelerator machine time can be used more efficiently and data on rare nuclear events can be collected more quickly and with less interference from unwanted or spurious events. Image-intensifier developments also offer the possibility of spatial resolution of light from Čerenkov radiations with consequent identification of particles with different velocities.

In his opening address, Mr. Abson also mentioned the development of semi-conductor detectors, providing small detectors capable of improving angular and spatial resolution in particle detection, and capable of measuring the energy of the shorter-range ionizing particles with a very high degree of resolution in particle energy. He also referred to papers, which had been presented at the International Atomic Energy Agency's Conference on Nuclear Electronics held at Belgrade earlier in the year, to illustrate the application of these detection methods in experimental nuclear physics. Measurement of the Čerenkov angle, that is, the angle between a particle path and the direction of its associated Čerenkov radiation, is the only method applicable for accurate measurement of velocity for particles travelling at speeds within 0.1 per cent of the speed of light and reference was made to some of the Belgrade papers to illustrate this technique.

J. Birks (Manchester) presented a paper on "Improved Organic Scintillator Detectors", in which he derived equations for the practical scintillation efficiency (photoelectrons/MeV.) of organic crystals and solutions in terms of molecular parameters and applied them to typical scintillation counter systems. His results suggest several improvements, for example, the use of binary rather than ternary solutions, the use of quartz rather than glass windows and the reconsideration of mixed crystal scintillators based on naphthalene. Improvements by a factor of two in the figure of merit are possible.

R. B. Owen (Harwell) and G. Dearnaley (Harwell) spoke on "Image Intensifiers and Scintillation Track Imaging" and "Semi-Conductor Detectors" respectively. The second paper directed special attention to the problem of neutron detection and gave details of a counter based on the helium-3 (n, p) reaction which he

concluded is the best for neutron spectroscopy and a second system based on the proton-recoil method which he found gives the greatest efficiency for neutron flux monitoring.

Electronic Circuits and Techniques

The second session of the symposium was concerned with "Electronic Circuits and Techniques" and the principal speaker was K. Kandiah (Harwell). He surveyed a wide range of electronic circuit techniques primarily connected with nuclear physics research, and although his contribution was based on papers presented at the International Atomic Energy Agency's Conference he also covered a number of additional topics.

One matter which received special mention was low-noise amplifiers for use with semi-conductors. Since the energy required to produce an ion pair in a semi-conductor is about one-ninth that required in a gas, the statistical fluctuations in the number of ion pairs, for a given particle energy, are reduced to one-third in a semi-conductor. Consequently, the noise-level of the amplifier, when other conditions remain unchanged, should be reduced by a factor of 3 in order to take full advantage of the increased number of ion pairs. Mr. Kandiah referred to American work presented at Belgrade and also new work at Harwell on this problem. The main result is that the minimum in the curve of energy resolution against differentiating and integrating time constants of the amplifier is obtained when the time constant is about 1 or 2 $\mu\text{sec.}$, and the resolution is then about 7–8 keV. In the majority of cases, however, the enhanced noise in the detector, mainly due to leakage, is greater than that due to such low-noise amplifiers.

Pulse-amplitude discriminators for many purposes were discussed at length, including fast discriminators and very sensitive discriminators, coincidence circuits and time-delay analysers; pulse-amplitude analysers and data-handling systems also received mention.

The supporting papers in the session dealt respectively with "Ultra-High Speed Oscillographic Techniques" and "Data-Logging Equipment for Nuclear Physics Experiments".

Radiation Monitors and Instruments

The opening paper in the third session was contributed by D. Taylor (Plessey Nucleonics). He gave a general survey of health-physics instrumentation, directing attention particularly to new developments in contamination monitors (including monitors for specific nuclides), gas and particulate contamination in the atmosphere, liquid effluent monitors, radiation survey meters, and systems for the detection of accidental critical reactor excursions. Some of the special subjects covered by this paper included the use of a scintillation counter system for the determination of the direction of the location of a radioactive source, the transmission of radiation dose-rate level information over the ordinary telephones automatically and the design of a difference integrator for use in dose-sensitive radiation alarm instruments with rate compensation. With this latter system integra-

tion in the normal way is obtained for a certain range of dose-rates, but for less than a certain pre-set limit cancellation is provided. Such a system with an alarm operating on the integrated dose appears to offer many advantages over the conventional systems. In a complete system three identical detector excursion detector units are used operating independently. The output of these units is connected into a two-out-of-three matrix such that at least two units must alarm to give a true excursion signal and initiate personnel evacuation.

D. E. Barnes (Atomic Weapons Research Establishment, Aldermaston) spoke about the important problem of monitoring for airborne plutonium and considered the instrumental systems under three headings: (a) direct, in which the plutonium and background particles are collected and measured

together; (b) selective, in which an attempt is made to collect only the plutonium dust; (c) compensative, in which the background and plutonium dusts are collected together, but the counting system is designed to remove the 'counts' due to background before readout. D. S. Hiorns and G. G. Dale (both of the Central Electricity Generating Board, London) each contributed a specialist paper on "Health Physics Instruments", the latter making it clear that while the majority of instrumentation problems in this field had been satisfactorily solved, two problems still remained for which an improved solution was still wanted. These were: (a) a dose-rate meter capable of monitoring gamma-radiation down to a few times background; (b) a fast neutron monitor capable of measurement in the presence of a large γ -radiation background. DENIS TAYLOR

TRENDS IN DENTAL ANTHROPOLOGY

ANTHROPOLOGICAL interest in teeth until a few years ago lay primarily in using details of dental form to trace phylogenetic relationships among Primates present and past, secondly in describing the frequencies of dental characters in various human populations. How far and in what directions dental anthropology has progressed was well shown by the 1961 symposium of the Society for the Study of Human Biology, held at the British Museum (Natural History) on November 17. In a word, the present approach is much more biological than in the older descriptive studies; for that reason some of the papers will be of interest also to those concerned with human genetics, embryology and growth.

Dr. P. M. Butler directed attention to the difficulties of inferring phylogenetic relationships from dentition. In fossil and living Primates too little is known of variation within a population; of the function of, say, details of cusp pattern, and hence of the adaptive significance of observed variations; of individual development, and particularly the extent of ontogenetic variation; of the genetic basis of dental morphology and development. It was still not possible to say which hypothetical evolutionary progressions could have occurred and which not. Some of his own work on the field theory of dental development provided some relevant indications. The shape of the crown of a mammalian tooth and all its details derive ontogenetically from the folding of a sheet of epithelium, which forms the internal surface of an ectodermal enamel organ. This can first be distinguished as a bud on the dental lamina. Teeth buds appear in a characteristic order for a given species, shown by plotting their appearance against embryo size. The sequence is not from mesial to distal but is determined by pre-existing 'tooth districts'; one such controls the anterior teeth, and within it the bud of the first incisor precedes that of the second, etc.; another the posteriors, so that the graph for the whole primary series shows something approaching a wave form. Comparison of the graphs for some primates with that of an insectivore shows that the latest-appearing buds of the latter have been lost. The graphs show, moreover, that teeth developing at the same time can be morphologically different, while teeth developing at different times may be similar if they are next to each other in the jaw. It seems that in the embryo jaw there is a continuous

morphogenetic field or gradient controlling the development of the teeth germs according to their position within it; this field exists before any teeth buds commence to form, and may be under the influence of one set of genes; another set of genes may be postulated which influence the way in which tooth germs respond at any given point in the field.

Development was also the theme of the paper by Dr. B. S. Kraus (Seattle), who spoke on the morphogenesis of the deciduous molars in man. From an examination of a large number of fetuses it appears that for each molar there is a characteristic pattern of calcification of the crown. In the lower first molar the sequence of appearance of the calcification centres is protoconid, metaconid, hypoconid, entaconid, hypoconulid. Only when all five centres have appeared does bridging between them commence; again this occurs in a regular sequence, linking first the protoconid and hypoconid, then in succession the hypoconid and hypoconulid, the protoconid and metaconid, the hypoconulid and entaconid. In the lower second molar the order of appearance of the centres is similar but the bridging sequence is different. The upper first molar is very different and developmentally is reminiscent of a bicuspid. Not only does each molar have its own characteristic pattern of calcification, but these also are interrelated so that a definite pattern is discernible when all four molars in a single foetus are considered together. The series of foetuses was sufficiently large to demonstrate that there were relatively few other sequences which any variants would follow. Photomicrographs of the undulations of the soft tissue surface of the crown showed how calcification is affected by them. Dr. Kraus concluded by directing attention to the probability that these sequences of calcification were under genetic control, and the possibility of using incidence of variants in radiation effect studies.

Occlusion and malocclusion in the Primates was discussed by Dr. J. R. E. Mills (London). Study of dynamic occlusion (that is, as in normal chewing movements) in the gorilla showed that the large canines do not prevent lateral mandibular movement as formerly thought, but merely limit it. Balanced occlusion, in which on one side of the jaw the lower buccal cusps of the posterior teeth come into relation with the upper lingual cusps, then slide across the crown surface until the lower lingual oppose the