Santa Fe Linac Conference

Left to right, John Blewett, Lloyd Smith and Frank Cole together at the recent Santa Fe Linear Accelerator Conference.

The 1981 Linear Accelerator Conference, organized by Los Alamos National Laboratory, was held from 19–23 October in Santa Fe, New Mexico. The surroundings were superb and helped to ensure a successful meeting. There were more than two hundred and twenty participants, with good representation from Japan and Western Europe.

The meeting opened with a remarkable reminiscence by Phil Livdahl on the MTA linac project during the Second World War which was aimed at producing nuclear weapons materials. Although classified for many years, this project, which was terminated after a few years of intense accelerator development, had long-lasting results in the training of a generation of accelerator builders. This was a time when new ideas could be tested — even if it meant the construction of a 12 MHz, 60 foot diameter drift tube linac, incorporating drift tubes weighing forty tons and with bore holes large enough for a man to crawl through. This was a time when things could get done — over a five year period the group, under E.O. Lawrence's direction, built four large accelerator prototypes from the Mark I to the A-48, a 7.5 MeV working deuteron linac. And this was a time when successful machines were built without fancy computer programs.

The Conference was forward-looking. Very few papers dealt with existing operating machines but a number of projects and proposals were presented which push the state of the art in all aspects of machine development.

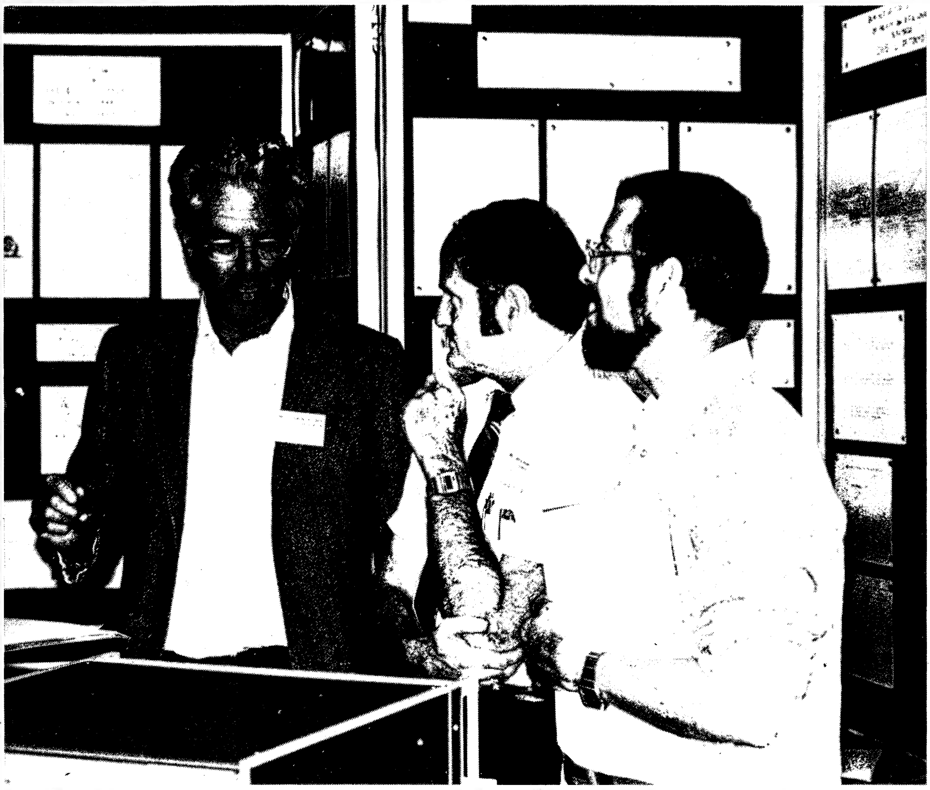
Several papers reported the progress of FMIT (a 35 MeV, 100 mA, 100 per cent duty-factor deuteron linac being developed for Fusion Materials Irradiation Testing). It is the first attempt at c.w. linacs since the MTA project and its development is important to future applications of linacs such as nuclear fuel enrichment which will require GeV beams with hundreds of milliamperes of current.

The major machine development sparked by the FMIT project has been the RFQ (Radio Frequency Quadrupole), for which the first ideas emerged in the Soviet Union. The Los Alamos group enthusiastically pushed RFQ development for application in FMIT and other projects. In principle, it offers enormous advantages over present linac injector schemes, replacing high voltage Cockcroft-Waltons, choppers, and conventional bunchers while offering simplicity and almost 100 per cent bunching efficiency. In three to four years, Laboratories around the world have joined the RFQ development effort. Fourteen papers (out of 110) from seven institutions were presented on the subject. Specific plans are being made to use RFQs in new or retrofitted injectors for several heavy ion and polarized proton accelerator projects.

Another important technological advance is the development of rare earth permanent magnets, which also attracted a number of papers. After a modest beginning (the use of permanent magnet quadrupoles was first proposed at Los Alamos for their PIGMI project) and a fear of losing the ability to adjust quadrupole fields, New England Nuclear Corporation took the bold step of adopting this technology for their 40 MeV proton linac constructed for the production of radiopharmaceuticals. This gave impetus to an entirely new technology of permanent magnet designs — dipoles, quadrupoles, sextupoles and adjustable-field systems. The technology is maturing and will be used extensively on new linac designs. Two commercial com-

Left to right, E.A. Knapp, M.F. Shea and J.D. Hepburn at a poster session.

(Photos Los Alamos)



panies are producing and selling permanent magnets.

Another high point was the advance in understanding beam dynamics. Since the classic work during the late 1960s of L. Smith, R. Gluckstern, R. Chasman and others, theorists were at a loss to explain beam emittance growth phenomena observed in operating linacs. Typically, factors of two to three in emittance growth were measured without obvious explanation.

A number of different approaches are shedding new light. In particular, L. Smith, R. Jameson, I. Hoffman and D. Mittag presented papers on detailed treatment of beam bunch behaviour during acceleration, demonstrating the effect of space charge, mismatching, and tight coupling between transverse and longitudinal phase spaces resulting in the onset of instabilities within the bunch. These mismatches and instabilities lead to emittance growth that appears to be consistent with observation. This work indicates that part of the observed beam emittance growth can be controlled by properly matching the transverse and longitudinal particle temperatures within the bunch or, to use the newly coined term, by 'equipartitioning'. Control of emittance growth will be important as applications of linacs require higher beam currents or current densities.

Frank Cole reviewed 'collective acceleration' which holds the promise of very high field gradients (over 10 MeV/m). However although the physics principles appear sound and the electron ring accelerator (ERA) was pushed fairly hard, this concept has never been thoroughly demonstrated experimentally. Among the many concepts in the USA, the Pulselac at Sandia Laboratory appears to have the best chance for success and interest in this type of linac is sustained, albeit modestly.

Superconducting linacs, promising high gradients and efficiencies also generated much interest ten years ago but their development was plagued by materials problems, contaminants, magnetic field quenches, beam loss quenches and other hazards. Nonetheless, superconducting linac cavities met with some success, particularly as beam separators and heavy ion post-accelerators (for raising the energy of beams in Van de Graaffs) where beam currents are small. It was gratifying to hear two papers from Argonne describing the successful commissioning of their heavy ion superconducting linac booster.

Another paper described first operation of the 40 MeV New England Nuclear proton linac after a four-year construction period. This is noteworthy on two counts — it is the first proton linac built by industry for industrial purposes (production of radiopharmaceuticals) and it is the first using permanent magnet focusing. It is too early to assess success but the linac's performance will be followed with great interest.

A number of proposed linacs are generating good development work. The long-standing Chalk River programme for electronuclear fuel breeding using a 300 mA c.w. 1 GeV proton linac has led to work on high current ion sources, injectors, and the low energy front-end, as well as disc-and-washer (DAW) structures for energies above 150 MeV. C.w. accelerators have to deal with high current densities, multipactoring, thermal effects and the like. A development project called ZEBRA will consist of a 300 mA, 10 MeV front-end linac which eventually might become a demonstration electronuclear breeder.