

Tank 1 of the new 70 MeV linac at the Rutherford Laboratory in its raw state after delivery from Morfax Ltd. Water cooling, electrical connections, vacuum pumps, r.f. feeds have since been added and the tank has done its bit in achieving design energy in May.

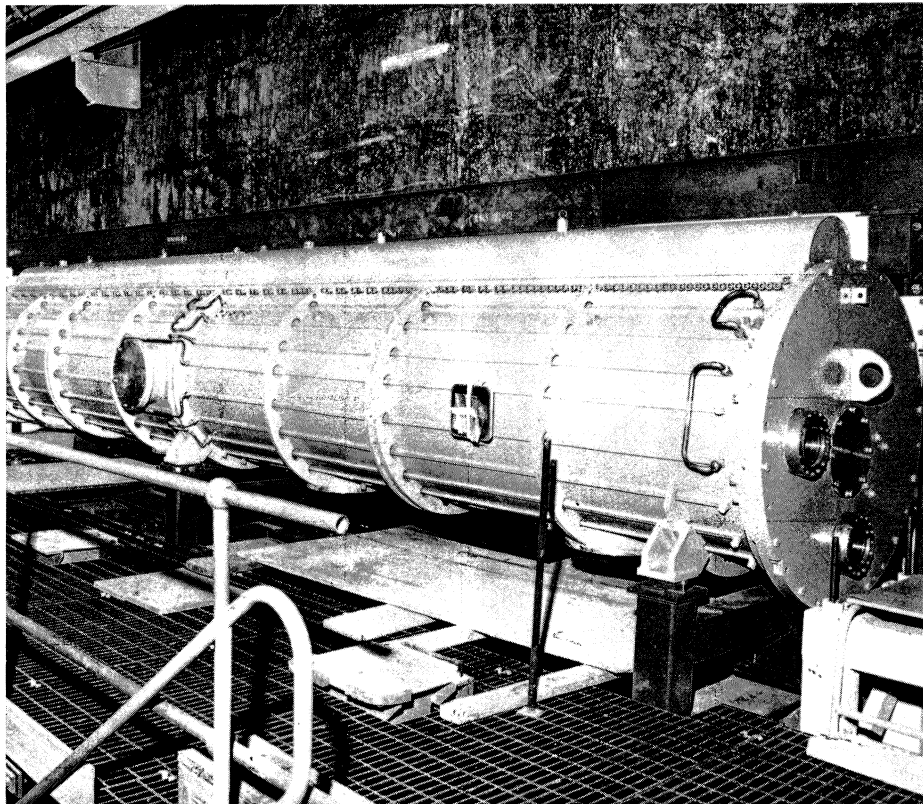
(Photo Rutherford)

RUTHERFORD Commissioning of new linac

Construction of a 70 MeV proton linear accelerator at the Rutherford Laboratory, originally designed as a new injector to increase the intensity of the 8 GeV Nimrod proton synchrotron, is now complete and a 70 MeV beam has been obtained. The injector, sited alongside the existing 15 MeV linac, figures prominently in the Laboratory's plans to adapt the Nimrod complex into a high intensity neutron source (see May COURIER).

The design specification for the new linac calls for an output beam intensity of 75 mA with a pulse duration of 500 μ s and a maximum repetition rate of 1 pulse per second. It has four tanks, the second and third being from the 50 MeV proton linear accelerator (PLA) closed down at the Rutherford Laboratory in 1969. The first and fourth tanks are new and are based on the design of the Brookhaven and Fermilab 200 MeV injectors.

The pre-injector is designed for a 200 mA beam intensity of 500 μ s pulse length. Protons from a small duoplasmatron source (outer dimensions 130 mm long by 100 mm diameter) are focused into a medium gradient column (16 kV/cm) and accelerated to an energy of 665 keV. The effect of beam loading on the output voltage of the Haekeley Cockcroft-Walton EHT generator is reduced by means of a 0.01 μ F reservoir capacitor. A drop of about 10 kV would still occur, but is stabilised by means of an electronic stabiliser (the 'bouncer') which applies a compensating signal to the earthy plate of the reservoir capacitor. In October, the pre-injector was working to specification with stable, repeatable characteristics. The bouncer worked at almost the



first attempt and held the accelerating potential steady to within 200 V.

In parallel with the commissioning of the pre-injector, installation of the four radio-frequency power systems was proceeding. A common low power drive chain, from the old Rutherford Laboratory PLA, supplies a 202.5 MHz drive signal at a power level of 20 kW, which is divided between the four r.f. power amplifiers. Each of these has a peak power output capability of 4.25 MW and produces a 700 μ s pulse which is loop-coupled to the tank. The first system to be completed was that of tank 2, which was operated at its design field in the autumn of 1975.

Installation of the remainder of the machine was completed early in 1976 and a beam was accelerated through the first tank to 10 MeV in February. Tuning runs gave 28 mA of 10 MeV beam within the first week without the buncher. Subsequently, with the buncher powered and with improved tuning, more than 80 mA of 10 MeV beam was measured at tank 1 output. By the end of April beam was allowed through the machine to an external beam-stop. Working with short pulses, tanks 2, 3 and 4 have been progressively commissioned and 70 MeV protons were first seen on 19 May. Efforts now turn to minimising beam losses and achieving high reliability. Commissioning will probably be completed by the end of 1976.

DESY On-line

One of the VIT's (very important things) at a high energy physics Laboratory is the computer centre — frequently used but comparatively rarely mentioned. It is well known that today it would be impossible to do high energy physics without big and fast computers, handling the large quantity of data produced by the experiments. In most Laboratories the normal way of doing physics is to take data at the experiment, assisted by a small computer and to go afterwards to a big computer to sort out the results. At DESY (and a few other Laboratories such as Daresbury) the concept is different — the big computer is part of the experiment from the beginning.

24 'assistant' computers at the experiments, including an HPD automatic film measuring machine, are connected on-line with two IBM 370/168s at the computer centre. The small computers are checking the experimental set-up and collecting data, but the data go directly to one of the 168s. The primary data will be written on a tape and also used to calculate some first physical results. DASP and PLUTO for example — the two big detection systems situated at the interaction regions of the DORIS storage rings — are sending ten kilo-

bytes per second to the IBM filling a magnetic tape with 36 megabytes per hour. Performing this job and doing calculations on this on-line data absorbs about 10 % of the IBM's capacity.

The argument of the not-on-line specialist that he would never dare to be dependent with his experiment on a computer centre is countered by the DASP group's experience — only four days within the last 17 months lost because of the on-line connection.

Each on-line computer is supported by a separate on-line job in the central computer. To avoid overloading the store and unnecessary scans of supervisory programs through mainly inactive queues, every job which is idle for more than an hour is automatically thrown out but can be reinvoked through an interrupt within 20 s. Thus the number of on-line jobs living in the computer at any one time has been reduced to about 5 to 6.

Another important facility is the data-set migration scheme. Every user's request for allocation of a permanent data-set on disc is satisfied out of a pool of discs which now extends to 500 megabytes. Whenever a certain upper threshold is reached, this disc pool is emptied, to a certain amount on a least-recently-used basis, by copying data-sets to tape. This can be done because the user identifies his data by a unique name only, not specifying the name of the volume his data resides on. Once this data is emigrated, the user is free to process his data off tape or to immigrate it first. By this method it was possible to extend the effective disc space to 3 gigabytes at the cost of some data movement which is mainly done during night shifts.

The following figures show that most of the users are wanting their data-sets frequently: More than 1000 jobs are calculated each weekday. Each week in recent months 5.2 to

6.7 kilojobs were passing through the computers. During 325 days in 1975 263 kilojobs were calculated. Within these 7800 hours for each '168', 7005 hours CPU-time was used — an average CPU time per job of about 1.6 min. At the end of this year the capacity of the DESY computer centre will be saturated.

Starting a job on the machine is possible by feeding cards into the reader or by using one of 16 terminals of the TSO time sharing system located at different places on the DESY site. An interactive plotting system, IPS, enables users to look at their data in a graphic form or even to produce a graph of their experimental setup. Most of these special services are programmed and handled by the DESY computer staff. The centre is run by 6 system programmers, 4 programmers and 18 operators.

New particles

Reports about new particles continue coming in. Those people who favoured charm theory already at the end of 1974, when the J/ψ and ψ' were found, seem now to be the final winners over their colleagues who preferred other models. At the same time when SPEAR announced a spectrum of particles near 2 GeV as good candidates for charmed mesons (see June COURIER 1976, p. 211) DORIS, the electron positron storage ring at Hamburg, presented results on the semi-leptonic decay of those particles.

As the members of the J/ψ family are bound states of a charmed quark and an anticharm quark they have no visible charm. Charmed mesons are however combinations between a charmed quark and one of the three old quarks. As charm is not violated in strong and electromagnetic interactions a charmed meson can only decay by weak interaction. The charm theory predicts that charm quarks

couple preferentially to strange quarks, which means that the decay into a K and a lepton must be visible besides the decay into a kaon and one or more pions seen at SPEAR.

Since the beginning of 1976 DORIS experiments have concentrated on these channels and found an extraordinary electron production starting at energies above 4.0 GeV. The spectrometer PLUTO (run by a collaboration of DESY, University of Hamburg, Siegen and Wuppertal) and the DASP collaboration (Aachen, DESY, Hamburg University, Max-Planck-Institute Munich, and Tokyo) are able to see electrons and positrons down to an energy of only 300 resp. 200 MeV/c. DASP people, for example, used a Cherenkov counter in front of the magnet to identify electrons. Asking for at least three other particles in the inner detector led to 22 events which can only be due to a weakly decaying particle. A high multiplicity of pions, which peaked at 5 to 6, excluded heavy lepton decay for these events.

Since the charm theory predicts a strong relation between charm quarks and strange quarks both experiments looked for events with the appearance of a kaon and a single lepton. Both spectrometers were successful: at PLUTO a sample of simultaneous production of K_s^0 and electrons was found and DASP people are sure that they have observed events with charged kaons and electrons, both together with a high multiplicity of pions. It is interesting to know that PLUTO saw this correlation at a centre of mass energy of 4.1 GeV but not at 4.4 GeV though a good K-signal there has also been observed. Measuring at 3.6 GeV showed that there is no eK correlation below the threshold. All these events cannot be interpreted without the existence of new hadrons with a new quantum number and all properties of these new particles are consistent with charm.