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The Frascati Microtron as Synchrotron Injector.

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From the experience gained in the construction of a 5.5 MeV microtron, it was decided in January 1966 to initiate the construction of a $(10 \div 12)$ MeV microtron which could be used as an injector to increase the beam intensity of the Frascati electron synchrotron.

The assembly of the machine began in March 1967. After preliminary tests at 10 MeV and with 10 mA beam current, a new 2 MW radio-frequency system was installed and, in March 1968, operation at 12.4 MeV and 50 mA was realized.

The injector system for the synchrotron was then initiated and in August 1968, after a time of less than one month for installation, the synchrotron was operating stably and at high intensity with the new injector.

The principal advantages that resulted from the replacement of the 2.5 MeV electron Van de Graaf by the 12 MeV microtron are given below.

1) An increase in the maximum beam intensity from $6 \cdot 10^{11}$ e.q./m (or $5 \cdot 10^{9}$ el/pulse) to $6 \cdot 10^{12}$ e.q./m (or $5 \cdot 10^{10}$ el/pulse).

2) A reduction in the number of magnet-correcting coils, which permits a change in beam energy to be more easily made.

3) A very high increase in the stability of the beam intensity.

4) The beam can be accelerated using only one fixed-frequency R.F. system.

5) The operational program for capturing the first few turns was greatly simplified.

6) The maintenance of the new injector is found to be easier and cheaper.

A summary of the characteristics of the microtron is given in Table I.

As regards the injector optics, the coupling between the synchrotron and microtron beams was made through an achromatic beam transport system which was composed of three quadrupole magnets, three bending magnets and an electrostatic inflector.

The magnetic field in the synchrotron at injection time is about 110 G and the spiralization is 1.8 mm/turn. Under optimum conditions, about 15% of all injected particles is accelerated to the maximum energy. It is of interest to note that a cir-

Fig. 1.

TABLE I.

Magnet diameter	106 cm
Magnet gap height	10 cm
R.F. frequency	3000 MHz
R.F. tube	Magnetron Varian TV 1542
Magnetron peak power	2 MW
Injection energy	80 kV
Number of orbits	21
Energy gain per turn	590 kV
Maximum energy	12.4 MeV
Maximum current	50 mA
Maximum pulse rate	300 pulse/s
Operating conditions:	
Peak current	30 mA
Pulse rate	20 pulse/s
Current pulse length	2 μs
Beam energy spread	± 0.5%
Radial emittance	$\pi \times 0.8$ mrad $\times$ cm
Vertical emittance	$\pi \times 0.4$ mrad $\times$ cm

culating current of 70 mA could be accelerated with the existing 6 kW peak power R.F. system.

In Fig. 1 a photograph of the new injector is shown in its operating position at the synchrotron.

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