# THE ACTIVITY ON ACCELERATORS AT THE ENEA FRASCATI CENTER: STATUS AND PERSPECTIVES

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Abstract

The activity on low and medium energy (5 to 100 MeV) accelerators at the ENEA Frascati Center is described. It is devoted to the design and construction of circular and racetrack microtrons for electron beam FEL sources and standing wave linear accelerators for electron beam industrial processing.

## Accelerator Machines Technologies

At the ENEA Frascati Research Center, the knowledge of electron accelerator machines has been increased since the construction of the 1 GeV electron synchrotron. This scientific background has given ENEA the opportunity to transfer its know-how to Italian industry, enabling it to compete in the accelerator machine field.

Electron accelerators have been designed, developed and constructed with the purpose of understanding the machine physics and developing suitable technologies for their implementation.

The following machines are currently in operation at the ENEA Frascati Research Center (see Table 1):

a) A 20 MeV, 120 mA S-band microtron with a 10 μs pulse duration, representing a suitable electron beam source of good optical quality for the free electron laser (FEL) experiments. The use of e-beams generated by microtrons has also been directed towards radiation measurements, and for this purpose a 4-20 MeV variable energy circular microtron was constructed by *Galileo Co.* under an ENEA project (Fig. 1).

b) A 5 MeV, 200 mA S-band microtron with a 4 μs pulse length, for a single pass Cerenkov FEL in the submillimeter wavelength range.

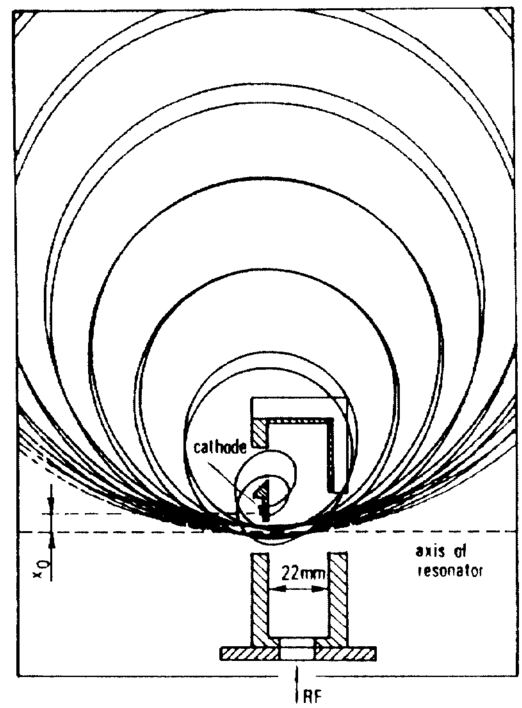


**Fig. 1: Sketch of orbits in a microtron**

c) A 5 MeV, 200 mA S-band linear accelerator delivering 900 W of e-beam average power (Fig. 2).

Linacs are very rugged and reliable devices and have found increasingly wide applications in the fields of industry, agriculture, medicine and environmental protection, in competition with natural sources (e.g., $^{60}$CO). They also represent an alternative to the many

Table 1: Status of the art at the ENEA Frascati Center

| Machine | Energy (MeV) | Peak Current (mA) | Pulse Duration (μs) | Status | Application |
|---|---|---|---|---|---|
| S- band circular microtron | 20 | 120 | 10 | Running | FEL Compton |
| S- band circular microtron | 5 | 200 | 4 | Running | FEL Cerenkov |
| S-band Linac | 5 | 200 | 3.5 | Running | Irradiation tests<br>Industrial radioscopy |
| S- band race-track microtron | 15+85 | 25 | 6 | In construction | FEL-neutron spectroscopy<br>radioisotepe factories |
| S- band circular microtron (Galileo Co) | 4÷20 | 30 | 2.5 | To be installed | Radiation metrology |
| L-band Linac (Irvin Co) | 5 | 600 | 5 | To be assembled | Waste water treatment |
| S-band Linac (Irvin Co) | 3÷5 | 400+200 | 3 | To be assembled | Heatshrinkings materials production |

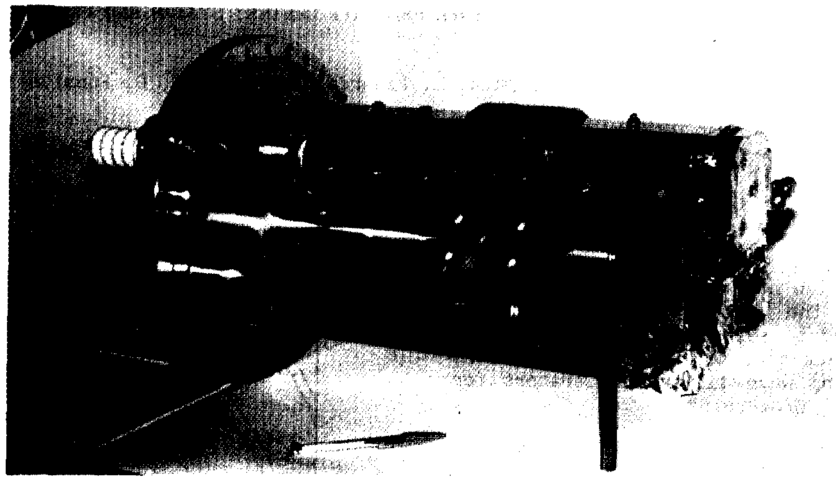

**Fig. 2: 5 MeV, 200 mA S-band on-axis coupled Linac for industrial e-beam processing**

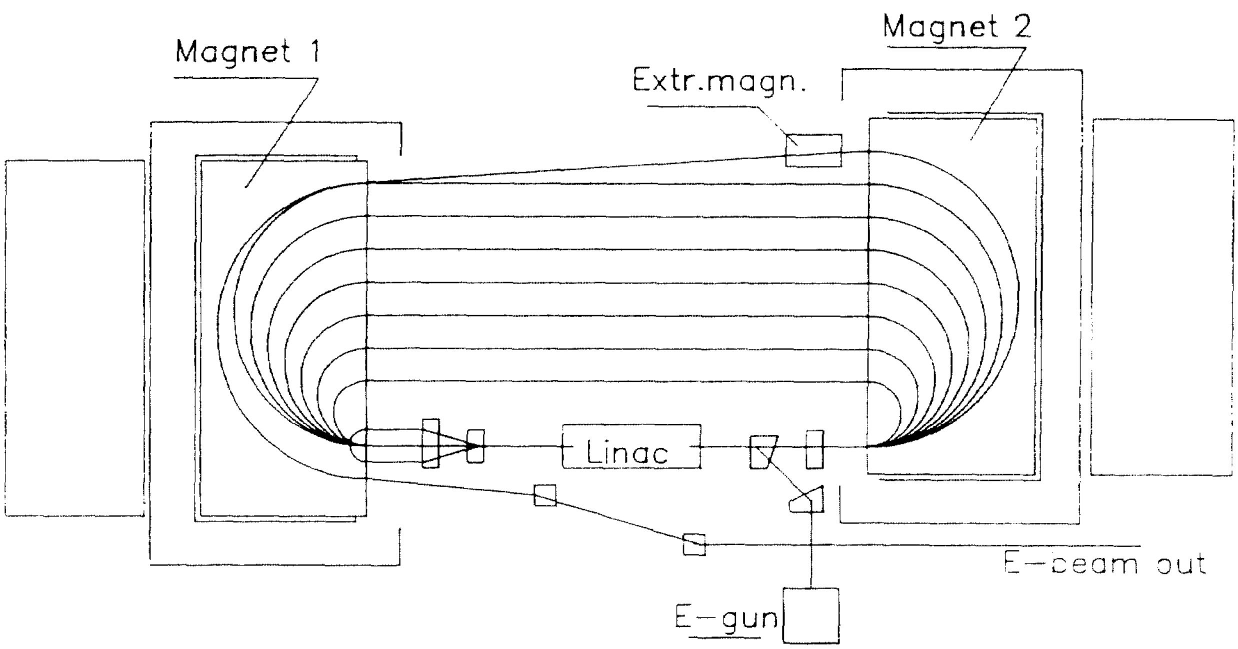


**Fig. 3: Race track microtron**

chemical and thermal processes used for the sterilization of foods and health products, as well as for grain disinfestation, wastewater treatment, vulcanization of rubber products, production of heatshrinking materials and, finally, industrial radiography. The design of the machines has been committed to national industry and electron Linacs in the L- and S-bands in the energy range of 3-5 MeV with an average power of 1-5 kW are presently being constructed by *Irvin Co*.

In order to satisfy most of demands for e-beam energy, a race-track type microtron with a maximum e-beam energy of 85 MeV is in an advanced stage of construction. This type of accelerator is a competitive alternative to linear devices because of its simplicity and compactness. It will find applications in FEL experiments, neutron spectroscopy, high energy $\gamma$-graphy and low mean-life radioisotope manufacturing (Figs. 3, 4, 5).

Another application lies in the use of larger accelerator systems as injectors for storage rings, for scientific or industrial uses.

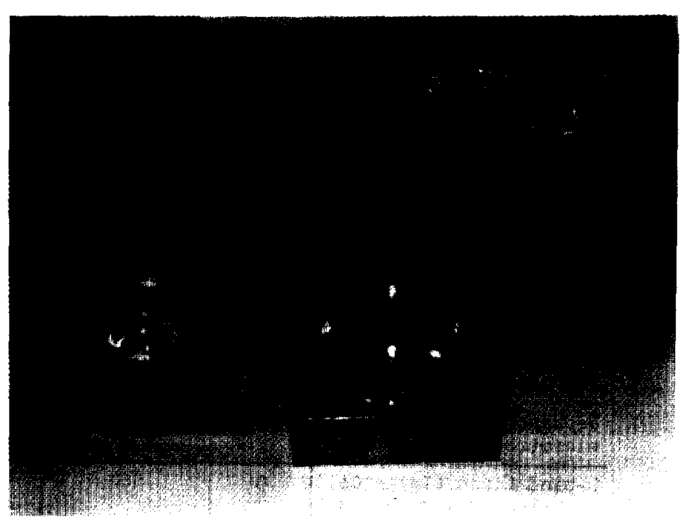

**Fig. 4: Two halves coupling and accelerating cavities of the side coupled S-band Linac for race-track microtron**

**Fig. 5: Side coupled S-band Linac under test**

Manufacturing Techniques

Besides the theoretical development of accelerator physics and the numerical calculation of e-beam dynamics, suitable techniques must be employed in order to successfully construct accelerators. The associated technologies lie in the field of high vacuum systems, brazing of OFHC copper resonators, surface cleaning, machining procedures, etc.

A high accuracy *tuning method* is utilized in testing the whole accelerating linear structure.

In view of satisfying the future demands for accelerator machines, studies are being made on new types of accelerators, e.g., induction or superconducting Linacs. Research is being carried out on new metal glass magnetic materials to be used in magnetic switches, for example.

Other fields of interest are e-beam injection systems, sub-harmonic prebunchers and laser cathodes.