A HEAVY ION SUPERCONDUCTING LINEAR POST-ACCELERATOR CALLED ALPI

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The stage reached in the construction of the superconducting Linac which will boost the ions accelerated by the LNL-XTU Tandem will be reported on. The final design together with recent progress in resonator performance will be discussed.

Introduction

The main features of the superconducting Linac known as ALPI have been extensively discussed in reference [1]. It will consist of quarter wave resonators (93 in total) made out of copper, lead plated on their inner surface, cooled down to 4.2 K and independently phased. Ions, from silicon to uranium, accelerated by the 16 MV XTU Tandem, already operating at the Laboratori Nazionali di Legnaro, will be further stripped of electrons and injected into the Linac in such a way as to achieve an energy from 6 up to 20 MeV/amu. The final part of the construction will include the installation of a positive ion source of the type ECR followed by a superconducting RFQ system of the equivalent voltage of 9- to 12 MeV.

The construction of the Linac

The building which will house the accelerator has been started on and will be completed by the end of 1990. The whole Linac will be at a level of 4 metres

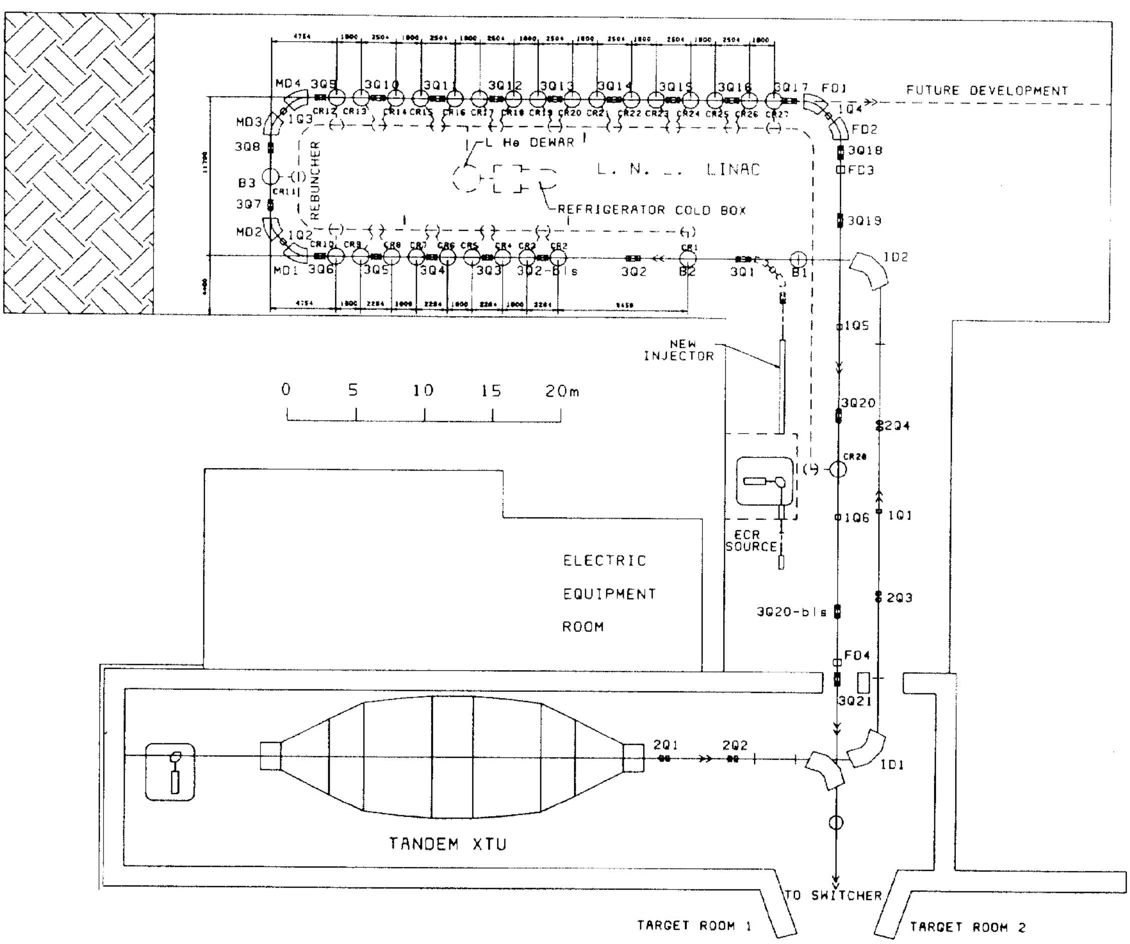

Fig. 1. - Lay-out of the ALPI Linac.

underground, and the lines connecting it from the XTU-Tandem will be tilted about 6°.

Detailed calculations of the beam optics have been performed [2] in order to enable the system to maintain intact the characteristics of the emittances at the exit of the Tandem for the ions up to the heavy ones. It is worthwhile mentioning that the basic module of the Linac consists of two cryostats, each one with four cavities, separated by a triplet of quadrupoles. This unique feature takes advantage of the fact that the quarter wave resonators inside a cryostat give rise to an only slightly diverted beam. The magnetic elements for the final phase have already been ordered and will be delivered at the beginning of 1991 when the assembling of the machine will start. The main characteristics are listed in Table 1.

Table 1. - Magnetic elements

	Units	Deflection angle	Magnet product
DIPOLES	2	90°	524 MeV·a.m.u.
	6	45°	446 MeV·a.m.u.
	2	7°	435 MeV·a.m.u.
QUADRUPOLES	Type	Aperture	Gradient
	5 singlet	53 mm	20 T/m
	1 singlet	103 mm	10 T/m
	4 doublets	103 mm	10 T/m
	15 triplets (long)	53 mm	20 T/m
	8 triplets (short)	53 mm	20 T/m

The cryogenic system has already been ordered and will be delivered at the beginning of 1991. It consists of a cold box scaled to the size of the comp-plete Linac, a system of transfer lines relating to phase one and the necessary gas recovery system. All the pipelines have been scaled for the final phase (see Table 2).

Recent Improvements

The main improvements achieved in resonator construction and assembly have been extensively reported in ref. [1] and [3]. The main feature which distinguishes the QW resonators constructed at Legnaro is the use of vacuum brazing to join the copper pieces both in the high current region (in the central conductor) and in the outer cylinder where high thermal conductivity is needed. We have now also constructed two resonators with the geometry of Fig. 2 with no welding at any point except for the beam ports.

This was achieved by machining the central and outer conductor from a bulk copper base. The final results of the quarter wave resonator with the straight central conductor are shown in Fig. 3 where they are

Table 2. - Cryogenic plant (ordered)

	Type	Refrigeration capacity	
COLD BOX	Turbine	PHASE 1	PHASE 2
		500 W at 4 K	1000 W at 4 K (1300)
		1500 W at 70 K	3000 W at 70 K
TRANSFER LINES	Multi-pipes	Shield	Distribution boxes
		He gas at 70 K	10
GAS RECOVERY SYSTEM	150 m^3/h (pistons)	Pressure	Bottles
		200 bar	20×1 m^3

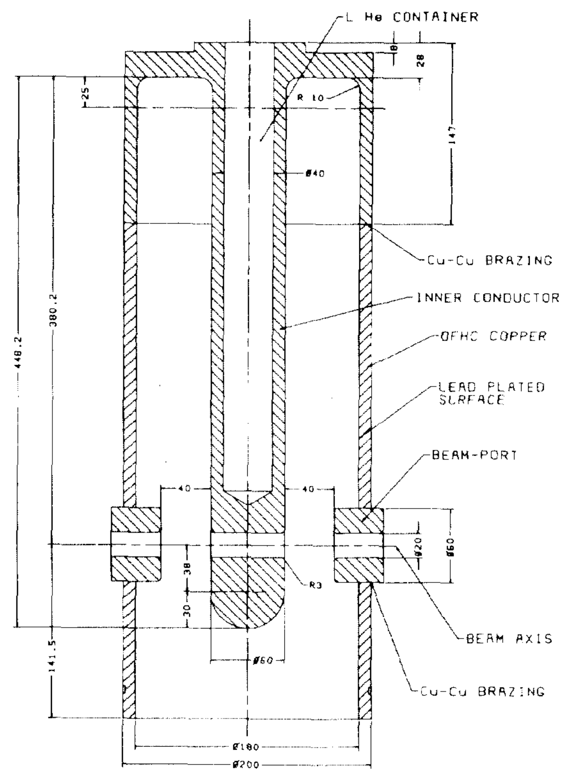

Fig. 2. - Cross section of the quarter wave resonator. [7]

also compared with the previous ones. The production of 48 equal resonators with β=0.11 has begun whilst we are also preparing an experiment with four cavities in a cryostat boosting the beam of the XTU-Tandem on a beam line. The experiment, which will take place in July 1990, will include the use of a superconducting buncher at 160 MHz, a diagnostic box and an electronic controller partially developed at Legnaro [1,4].

The cryostat containing four cavities has also been modified. Starting from the Weizmann Institute design [5], the scheme has been changed in order to enable the use of helium gas, at around 60 K from the

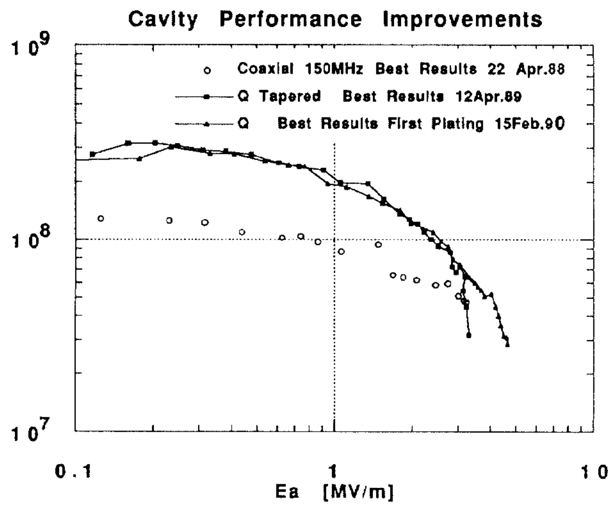

Fig. 3

cold box, for the shield of the 4 K region [6]. In order to meet this requirement a reservoir with thin double walls has been used for the gas circulation, capable of shielding both the cavities and the liquid helium reservoir from room temperature. The tender for the 15 cryostats of the first phase has just come out and the order should be placed within the first half of the current year.

References

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