THE ALPI PROJECT AT THE LABORATORI NAZIONALI DI LEGNARO

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ABSTRACT

The project of a superconducting linac booster for the LNL-XTU Tandem has been approved and funded by the Istituto Nazionale di Fisica Nucleare. In the future, heavy ion beams up to Uranium will be available in the energy domain from 6 MeV/A up to 20 MeV/A.

The goal of the project is to build a cryogenic linac which in combination with the existing XTU-Tandem will accelerate almost all the stable ion species in the energy domain from 6 up to 20 MeV/A. This machine will preserve the beam quality and the flexibility of the Tandem accelerators even for the very heavy beams permitting to extend nuclear structure and reaction mechanism investigations to an enormous variety of beam-target combinations. In particular, the installation of an ECR Positive Ion Injector (ECR-PII) will overcome the intensity problems, for very heavy beams, which seriously limit the performances of the Tandem - - Linac machine. This will open up the possibility to select with exclusive experiments a wide range of crucial tests of great interest for the comprehension of nuclear physics phenomena.

The lay-out of the Tandem laboratory accelerators complex is shown in fig. 1. The linac itself will consist of ninety-three coaxial Quarter Wave Resonators (QWR) which are accommodated in twenty-five cryostats each containing either three or four units. According to the ion output velocities of the injectors (ECR-PII, XTU- Tandem) and to the beam energy domain fixed by the project, the linac is divided in three sections which resonators characterized by optimum velocities β_{opt}= =0. 055 (24 QWRs), 0.09 (48 QWRs) and 0.15 (21 QWRs) belong to, respectively. To compensate the strong defocusing effect on the beam caused by the resonators, every cryostat pair is followed by a quadrupole triplet focusing lens in an original scheme which minimizes the accelerator length. L and U bends in the Linac machine are designed rigorously isochronous to preserve the very short (100-200 ps) beam bunches.

The cavities (figs. 2 and 3) consist of an OFHC copper base with about 1 μm thick lead coating in the internal surface which acts as a superconductor. Several attempts in the fabrication of the copper base prototypes have been tried in order to remove welds from the short circuit region which often cause additional losses and limit the Q-performances of the resonators. The best solution, thus far, seems to be the one of fig. 3 where all the electron beam welds except that of the outer conductor have been replaced by braze joints. According to the fact that no free gas production has been observed during the lead electrodeposition process, the resonators are plated in the upside-down position with the great advantage of preventing foreign particle deposition in the short circuit region. The whole cycle of plating is completely sealed and so the lead film never comes in contact with air even during the rinsing process.

The best Q-vs E_a (average accelerating field) performances have been obtained with the resonator of fig. 3 which is able to sustain an E_a of 2.5 MV/m with 6-7 W of power losses. Its performances are mainly limited by field emission and we think to improve them by partially reshaping the donut.

The Linac will require a total amount of cryogenic power of 1000 W at 4.5°K and 3000 W at 60°K. This includes the RF power dissipated in the resonators (about 6 W per cavity) and the one coming from static cryogenic losses: transfer lines and valves consume about 2.4 W/m and each cryostat about 2 W.

It is foreseen to use cold helium gas at 60°K for the radiation shields instead of liquid nitrogen.

Regarding the resonator controller, a new project has been started in collaboration with the Weizmann Institute of Science (Israel) aiming at developing a new board which will include a microprocessor with the ADCs, the DACs and digital I/O necessary to control the RF section.

This new board will allow the self-calibration for most of the components and it will sharply reduce the number of links to the host computer by means of a serial line communication channel.

A detailed study of the linac beam dynamics has been started. Particular emphasis is placed on the beam quality and matching of the input beam.

Beam diagnostics along the linac will be positioned between the pairs of cryostats alternating with the quadrupoles. This should facilitate the set- -up of the linac and minimize steering effects.

The project is scheduled to be finished in five years but the installation of the linac will proceed through an intermediate stage (48 β_{opt}=0.09 resonators) that at the beginning of the 1991 will upgrade the present 16 MV XTU-Tandem to an equivalent 35 MV machine.

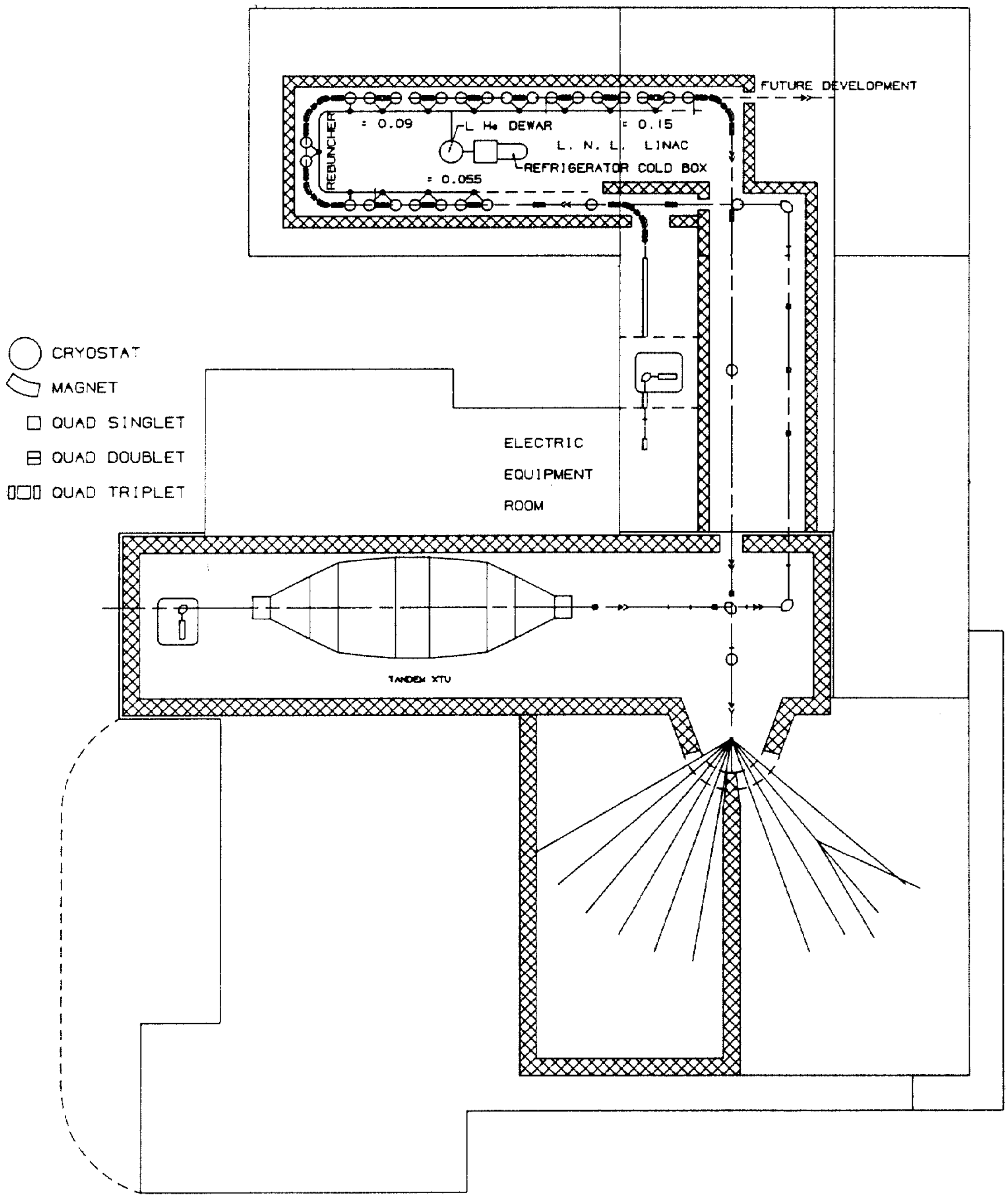

Fig. 1. - Lay-out of the Tandem laboratory accelerator complex.

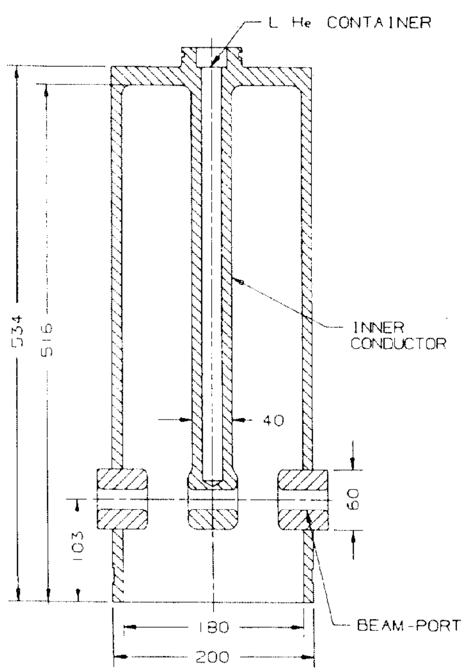

Fig. 2. - The 150 Mhz QWR prototype with straight inner conductor.

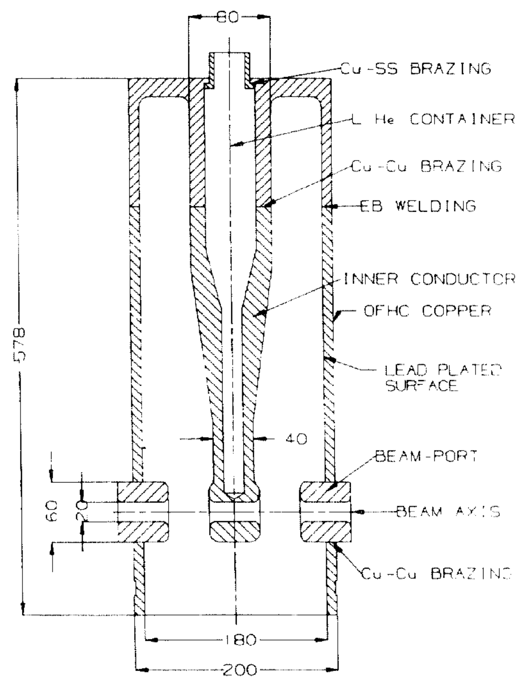

Fig. 3. - The 160 Mhz QWR prototype with tapered inner conductor.