Status Report on JAERI Activities

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There are three kinds of activities related to rf superconductivity in JAERI; a construction project of a superconducting heavy ion booster, a research program of metal-oxide superconducting cavities and a research project of a free electron laser. This paper describes the outline of these activities.

1. Superconducting heavy ion booster

A project of a superconducting heavy-ion booster is in progress at JAERI[1]. The design goals are to be able to accelerate heavy ions of carbon to a vicinity of gold from the JAERI 20UR tandem accelerator. Desired energy gains are twice for lighter ions and four times for heavier ions. Even the gold ions from the tandem are to be boosted up to the Coulomb barrier energy in the interaction with similarly heavy target nuclei.

For the heavy ion tandem-booster, JAERI has been developing superconducting quarter-wave resonators made of niobium and copper since 1984. The development has been progressing satisfactorily. A maximum accelerating field level of 5 MV/m was obtained with the prototype resonator, as was shown in the previous workshop at Argonne[2]. Four more resonators have been made and tested[1,3]. Their accelerating field levels at a moderate rf input of 4 watts were 5 to 6 MV/m. The details of the resonator development work is reported elsewhere in this workshop. The resonator fabrication was well established for the construction of the booster. Two of the four resonators are to be used for the buncher and the other two for the debuncher of the booster.

JAERI, then, started the fabrication of the booster linac. The linac will be composed of 40 quarter-wave resonators of $\beta_o = 0.1$. The resonators will be housed in ten cryostats; four in one cryostat. Sixteen of them with four cryostats will be completed by the beginning of 1991 and the rest 24 with 6 cryostats by the beginning of 1992. The schematic diagram of the booster is shown in fig. 1. The cryostats are vertically cylindrical as are illustrated in fig. 2. The heat radiation shields will be cooled with cold helium gas from the refrigerators. The up-stream half and down-stream half of the booster are to be separately refrigerated with two refrigerators.

The booster building will be completed by the end of 1991 and the refrigeration system and some beam line components will be installed in the beginning of 1992 according to the present plan. The floor plan of the booster is shown in fig. 3.

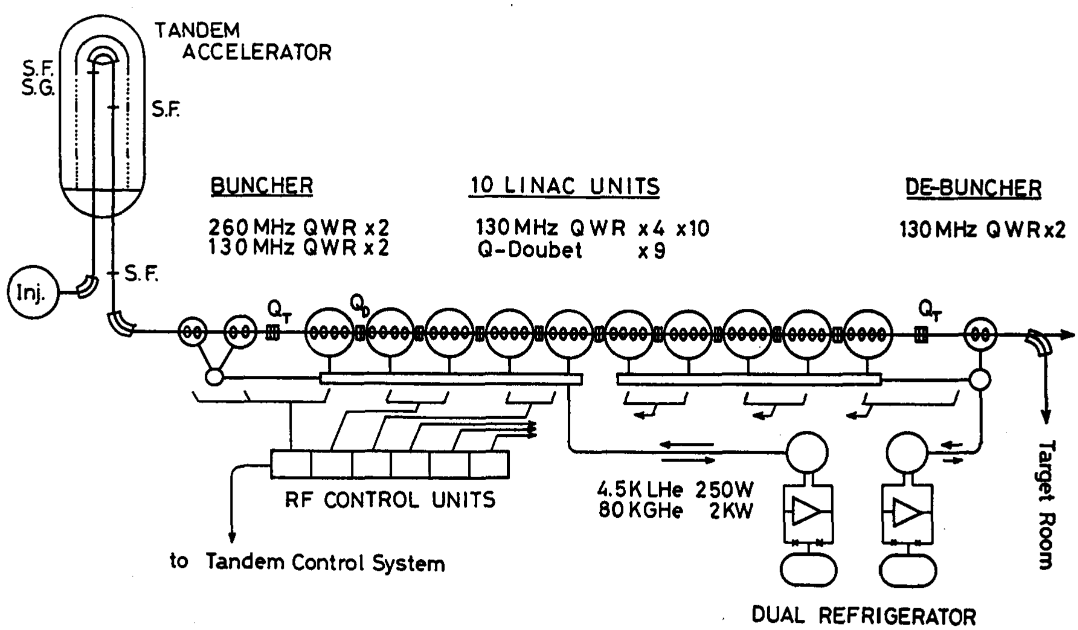

Fig. 1. Schematic diagram of the JAERI superconducting heavy ion booster.

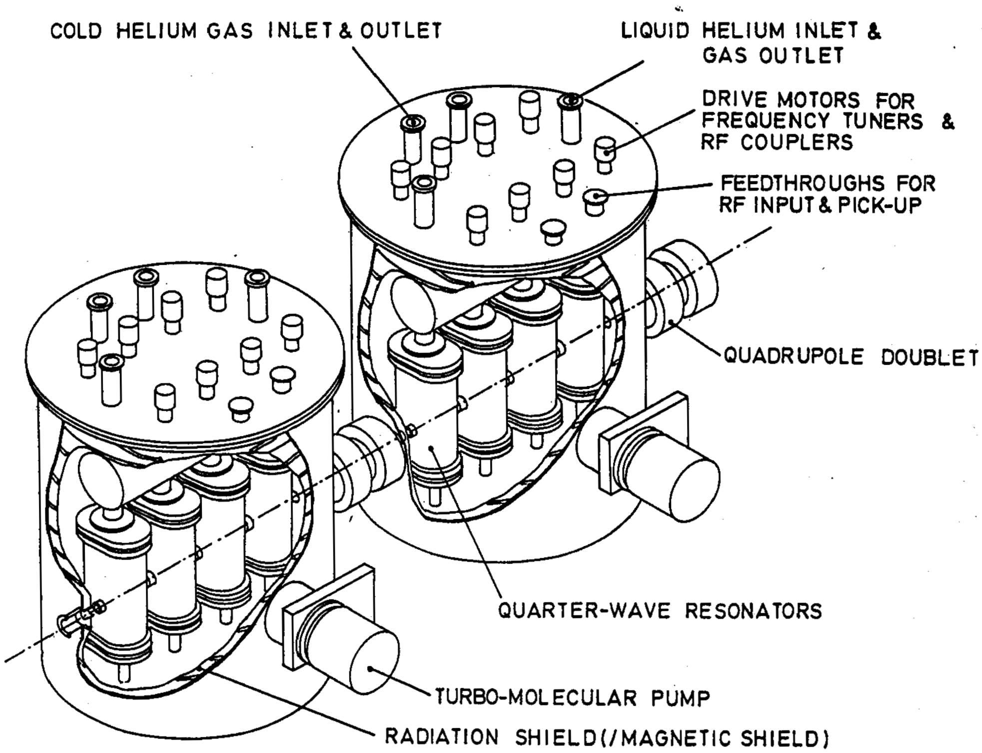

Fig. 2. Schematic view of linac units of the booster.

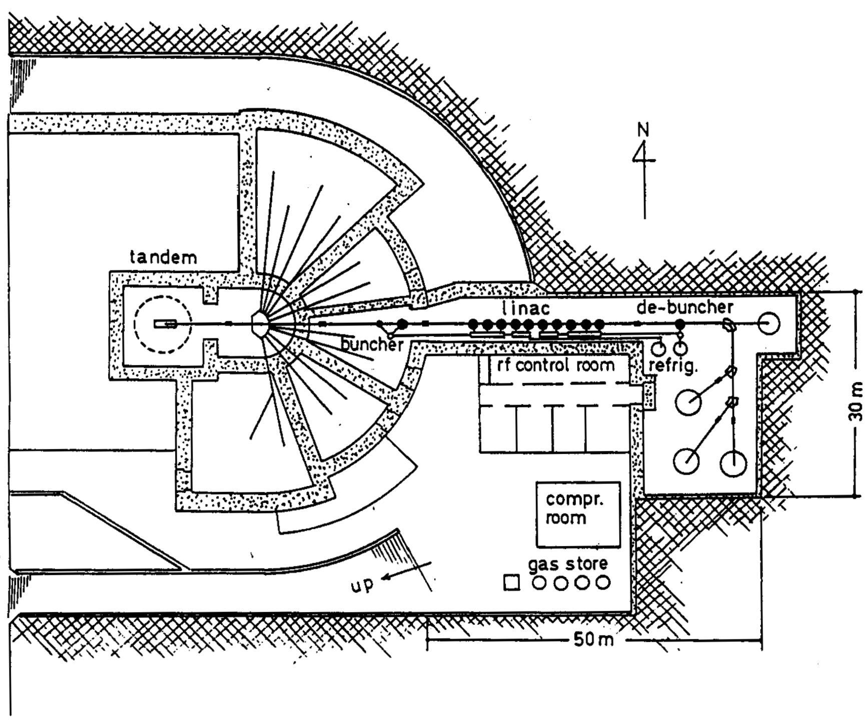

Fig. 3. Layout plan of the booster.

2. Metal-oxide superconducting cavities

RF superconductivity in metal-oxide superconductors is being investigated by E. Minehara et al. as a research program of JAERI on high temperature superconductors.

The details are reported elsewhere in this workshop. The outline of thier results obtained up to now is the following. They tried many ways of making microwave cavities; machining of bulk sintered superconductors, plasma splay printing of metal-oxide superconductor onto copper cavity surface and so on. Different superconductors were surveyed also. As a result, cavities made of bulk YBaCuO and cut by machining presented good results[4]. With 3 GHz and 7 GHz TM_{010} cavities shown in fig. 4, Q factors of 10^5 - 10^6 were obtained in 1988. With a 20 GHz TE011 cavity, those of 10^6 - 10^7 were obtained in 1989. These cavities were composed of two disks and a ring of machined YBaCuO and their contacts were welded by a low temperature brazing agent.

The Q measurements were done with very low rf input. The investigation with higher rf power input is the subject hereafter.

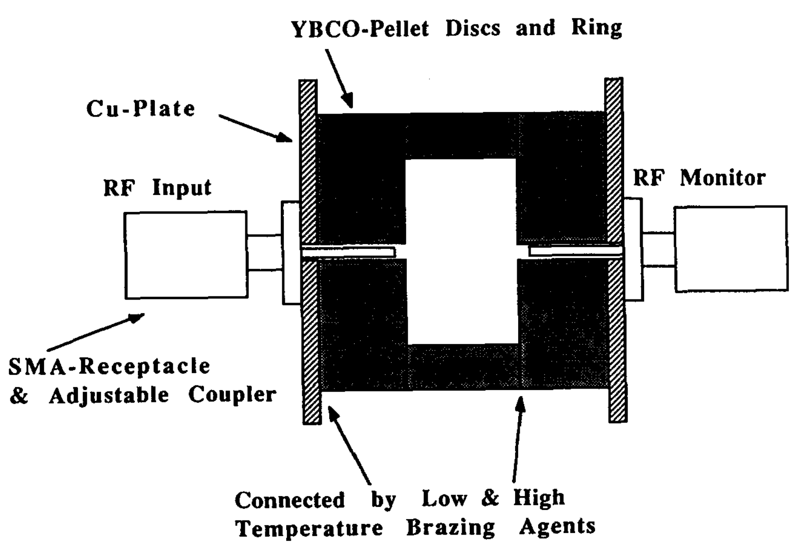

Fig. 4. TM_{010} $YBa_2Cu_3O_7$ cavity.

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3. Free elecrtron laser

Rf superconductivity will be applied to the free electron laser(FEL) being developed at JAERI. As extraordinarily high quality electron beams are required for the FEL, use of superconducting cavities is advantageous to obtain constant field cw or long pulses at high field levels with very low rf power consumption.

JAERI's final purpose of the FEL development is to obtain the laser light for uranium-isotope separation. In the first phase of the developement, infrared FEL oscilation of 10.6 um is pursued.

The JAERI FEL system will be composed of a grid-pulsed thermoionic electron gun with acceleration of 250 KeV, a sub-harmonic buncher of 84.7 MHz, a 508 MHz buncher, two single cell superconducting cavities of β_o = 0.9 and f = 508 MHz for the preacceleration, a momentum filter, two five-cell superconducting cavity units for the main acceleration, an undulator and so on[5]. The conceptional view of the system is shown in fig. 5.

The five-cell superconducting cavity units will be duplicates of the KEK five-cell cavities in the TRISTAN main ring. Acceleration of more than 20 MeV is expected from the results at KEK[6]. For the β_o = 0.9 superconducting cavities, design work is being done. At present, the electron gun, bunchers and rf components are being prepered. The superconducting cavities will be manufactured in the period from 1990 to 1992.

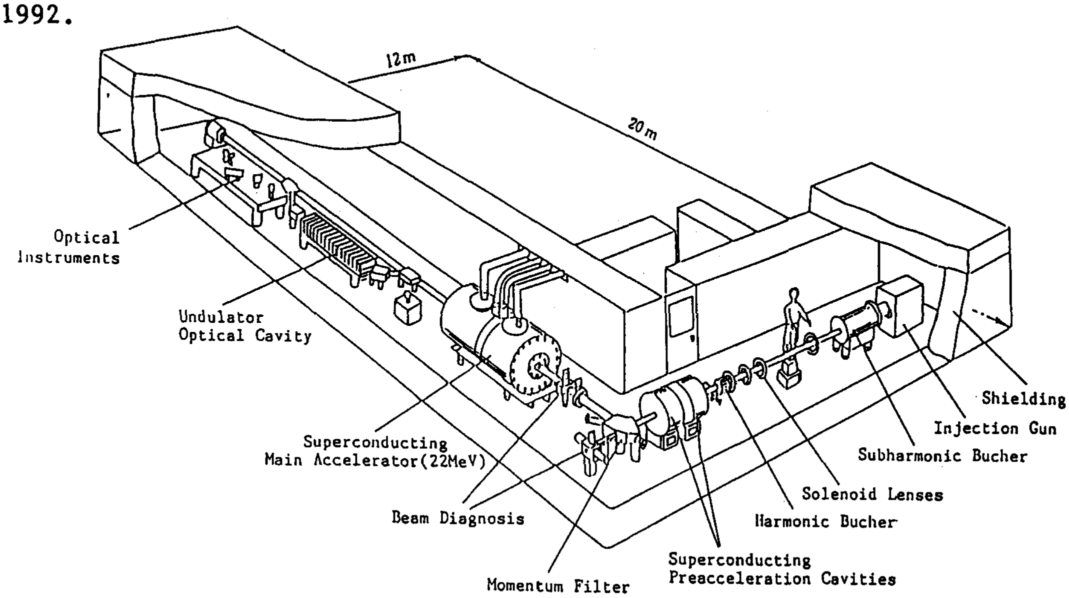

Fig. 5. Experimental set-up of a free electron laser at JAERI(phase-1).

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