A PREPARATORY STUDY OF LINAC FOR THE FEL PROJECT AT JAERI

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Abstract

Preliminary consideration on the linac for a free electron laser (FEL) project proposed by Japan Atomic Energy Research Institute (JAERI) will be briefly described.

1. Introduction

The first success[1] of an FEL experiment at HEPL, Stanford University in 1976 and 1977 gave a great impetus to R&D activities on FEL. The FEL has characteristics superior to ordinary lasers such as gas and glass lasers in its abilities to change the wave length and to produce high power output. Wider applications are thus expected in various future uses. However, only a few experiments have succeeded so far in the FEL oscillations, because extremely high quality of the electron beam is required.

The aim of our project is to produce infrared through visible FEL lasers, because these lasers can be possibly used for practical purposes such as uranium enrichment and isotope separation. Though the laser wave length depends on the design of the undulator magnet, the electron beam energy, ranging from a few of tens of MeV to several hundred MeV, is considered to be suitable for those purposes. This requirement lead us to adopt the linear accelerator as the first stage machine of our project.

The required beam quality, however, cannot be easily achieved from the simple modification of the present linac. It is necessary to design a completely new machine dedicated only to the FEL project. At present, we are not yet ready to fix our specifications. This study will discuss only preliminary matters such as how we can choose the suitable type for the dedicated machine.

2. Considerations on linac types

For last several years, serious considerations have been given and some promising results have been already obtained in the development of superconducting linacs operated in a liquid He temperature. An successful

operation of superconducting cavities was carried out at Tristan Accumulator Ring[2] and a new proposal has been made[3] for the CEBAF (Continuous Electron Beam Accelerator Facility). At JAERI, a project of a heavy ion boosting linac for the Tandem accelerator is now in progress using a niobium quarter half line resonator[4]. The various techniques of the cryogenics and high Q cavities developed there will be adoptable. When superconducting linacs are chosen, standing wave cavities rather than traveling wave will have to be newly built due to the requirement of the high Q value. But, the most difficult problem will still remain in the electron current intensity that superconducting linacs can accelerate.

Several normal conducting linacs operated at room temperature and with standing wave mode have been built and used for the FEL projects at several laboratories such as LANL, U.S.A. and Kelvin Laboratory, U.K. A new linac with travelling wave mode at Boeing Aerospace Company[5] was also designed for only FEL experiments. This linac will produce a long pulsed beam with more than 100 μs for FEL oscillations. Klystrons designed for these specific purposes will be supplied from Thomson CSF[6]. They have carried out experiments using the 20 MeV S-band linac in the past, but they decided to change it to the L-band linac. Although the L-band linac is expected to be more efficient in electron current and quality, various technical problems will still have to be solved in future.

In addition to all of these conditions, the availability and familiarity with our present S-band linac may also be one of the essential factors to be considered. Thus the problems are rather complicated, and we have to compromise between these conflicting choices.

3. Schedule

The first step will hopefully start next fiscal year 1987, with 4 or 6 year project's period. In the first year, the surveys of the existing FEL programs and technical feasibility studies for the various possible choices will be carried out. In parallel with those works, the design studies for the injector, RF power supply and beam diagnostics will be started, because these parts, especially an electron gun, can be separately designed, fabricated and tested.

In the next year, we will start the detailed design works for the main accelerator parts, after the decision about main specifications has been made. A bench test of the injector will be performed in this stage.

The design and fabrication of the RF power supply with high stability will be started at the same time.

In the third year, the fabrication of the main accelerator parts will be started, and the building and new shielding facility for the new accelerator will be constructed. The design and fabrications of undulator and laser optical instrumentations will be also started.

The fourth year will be used for the assembly of the whole system and test experiments to check the performances for the FEL will be started.

4. Conclusion

Various kinds of electron accelerators are now used for the FEL experiments in the world. We are now at the starting point of this project. One of main parts of this project is thus to choose the most suited linac in the most successful manner.

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