DEVELOPMENT PROPOSAL OF AN ACCELERATOR NUCLEAR INCINERATION

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Abstract

Development proposal using an accelerator for nuclear incineration is described. For this purpose, a test linac which accelerates electrons up to 10 MeV with duty factor 20 % is planning for the study of high intense beam acceleration. The major items of this year are research of CW(Continuous Wave) accelerating tube the development of high power CW klystron and the analysis of thermal stress induced by high power RF.

Introduction

There are long-lived radioactive nuclides in the spent fuels from nuclear reactors. Recently the incineration disposal has developed in order to transmute these nuclides into short-lived or stable ones by means of a reactor or a accelerator. F.P. products, especially ^{90}Sr and ^{137}Cs which occupy the most part of nuclear waste from spent fuels are not suited for incineration disposal only by reactor because of their smallness of cross section for slow neutrons. There are some methods to incinerate those radioactivities by using accelerator, where the use of photo nuclear reaction high energetic proton spallation, neutron knock-out reaction and so on are candidates. We Power Reactor and Nuclear Fuel Development Corporation (PNC) are now developing the technique around the incineration disposal using method with an accelerator for F. P. product.

Development proposal of an CW accelerator

It is important for the characteristics of an accelerator for incineration disposal to get stable high intensity beam and good efficiency against energy economics. In this disposal, new development is will have to be done because there is no accelerator having such a specification in the world. It is a necessary for that purpose to construct a test linac which accelerates high intensity electron beam. For, in studying above problems, an electron linac is better than others because of its cheap cost. So we are now having a plan of constructing a CW linac accelerating 10 MeV-100mA electrons with duty factor 20 % for basic technical research and development. This R&D will be carried out under the collaboration with National Laboratory for High Energy Physics (KEK).

In Fig. 1, there is presented the state of electron power of accelerators all of the world, where also the position of our test linac which will be made addressed. The basic specification of our accelerator is shown in Tab. 1. The results from this development will be fruitful for the study of the advanced accelerator design. Data from the test linac will be also valuable for new type of light source, positron generator and etc.

At present, it is supposed that the conceptual structure of the test linac is like one shown in Fig. 2, where two klystrons and eight accelerating tubes are seen. The length of the test linac is 16 m. We are planing that this accelerator facility will be constructed in the site of PNC Tokai works.

Subjects of the development

In the case of the test linac, there are many subjects for the development, ___namely beam break up (BBU) problem, CW accelerating tube structure, thermal stress of cavity structure, high power CW klystron with high efficiency, electron gun with good emittance, vacuum technology, control system of linac and so on. In this paper, we mention about the design of CW accelerating tube and high power klystron which are planned to research and develop this fiscal year.

1 CW accelerating tube

Good energy transformation of RF to beam is of vital importance for our lest linac. For this purpose, RF power supply system by not only standing wave but also traveling wave with resonant ring[1] is investigated for good energy-saving. And BBU associated with the periodic structure of accelerating cavity is also important in the case of acceleration of high current beam, so it is necessary to study the problem of induced higher electric field modes caused by beam-RF interaction.

2 High power klystron

There is no CW klystron that output power over 1 MW in the world. So new development especially for electron gun, collector and output window is needed for stable running of accelerator.

High conversion efficiency of electricity into RF is also important. At present, our goal is to get 65% efficiency.

3 Analysis of thermal stress of accelerating tube

The thermal stress by micro-wave that power amount to 300kW per tube is serious for deformation of cavity structure. For this problem, some simulation calculation and model experiments must be achieved in order to search and examine enough cooling structure.

Conclusion

Proposal of constructing 10MeV-100mA test linac for incineration disposal was mentioned. There are many subjects for high intensity beam acceleration and good energy saving.Main design items in this fiscal year is presented for development of the test linac.

Reference

1. I. Sato *et al.* ; to be published in *PARTICLE ACCELERATORS*.

Beam energy	(MeV)	10
Energy resolution		10 X 10^{-4}
Max beam current	(mA)	100
Av. beam current	(mA)	20
Duty factor	(%)	20

Tab. 1. Basic structure of the test linac

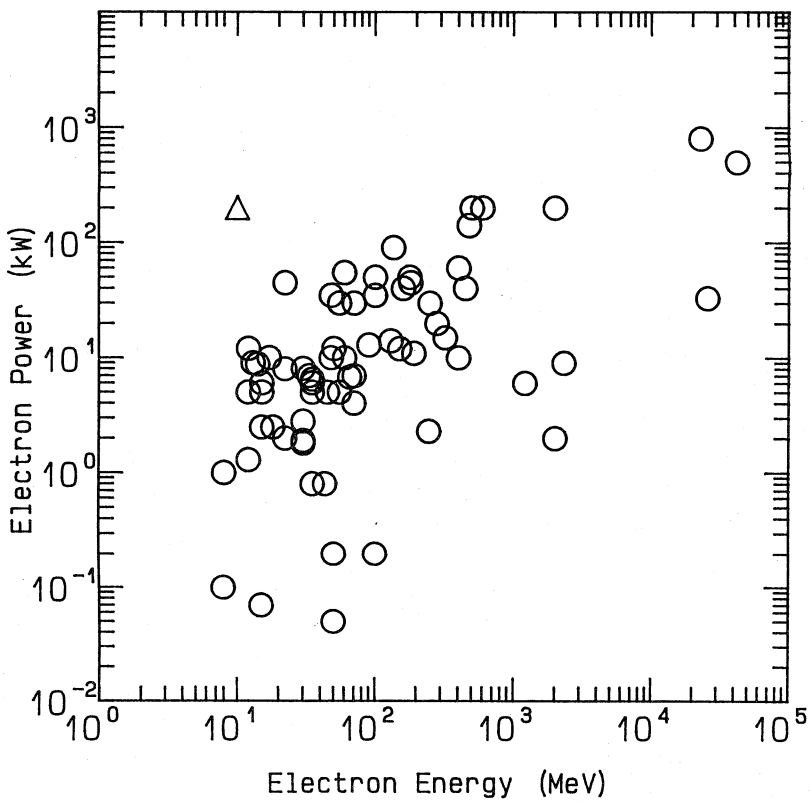

Fig. 1. The status of electron accelerators.
Triangle sign in this figure is a position of the test linac.

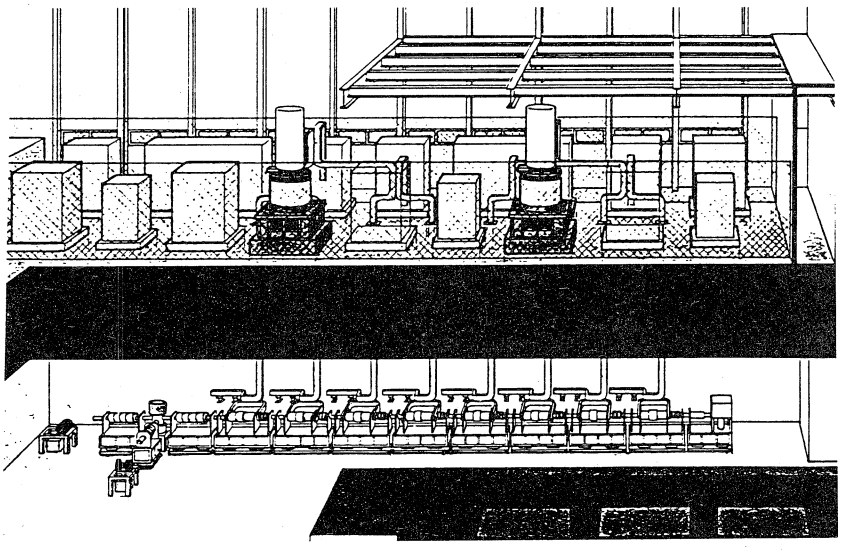

Fig. 2. Conceptual bird view of the test linac facility.