RECENT STATUS OF A C-BAND 2MEV ACCELERATOR

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Abstract

In order to carry out engineering research on miniaturization of accelerator, We performs an effort to develop c-band 2MeV standing wave accelerator. At present, the important progress has been achieved on the accelerator development. The accelerating tube has been fully sealed, and the hot test platform of the accelerator has been built. In condition of repetition rate of 200Hz, preliminary power test has been got through. Using ionization chamber dose monitor, we tested the dose rate of X-ray at 1m before the target. And by means of steel absorption method, we tested the energy of the electron beam. The preliminary test results show that, the beam energy is about 2.0MeV and the dose rate about 200 rad /min·m.

INTRODUCTION

Minitype linac is of preferable long term potential. It can be used of portable X - ray source for nondestructive examination, as well as used of beam injection for compact free - electron laser. Regarding to accelerator, because its whole dimension can be decreased along with its working frequency increased, now high frequency accelerator development has been becoming a popular choice for small type accelerator manufacturing. C - band accelerator has been developed for medical radiotherapy and Self - Amplified Spontaneous Emission Free - Electron Laser internationally[1-2]. As to China, the first start time of c - band accelerator development is relatively quite late. Up to now, still some progress has been achieved. The design of a c - band 1.5 MeV standing wave accelerating tube for nondestructive inspection was reported by China Atomic Energy Research Institute in 1999[3]. A standing wave accelerator of c - band 6 ~ 9 MeV development status is given by Tsinghua University in 2008[4]. We have made an effort on c - band standing wave accelerator development since 2003[5]. An important progress on the accelerator development has been achieved in 2012. The development of the accelerating tube has been completed. At the same time, the x - ray source prototype of 2 MeV c - band accelerator is set up. And power test is performed. And anticipative result is gotten. This paper introduces newly progress on development work of the C - band accelerator. Also gives the experimental results of the c - band accelerator.

ACCELERATING TUBE DEVELOPMENT

Accelerating tube is an important component of the accelerator. We have completed the design, processing, and tune work of the c - band 2 MeV standing wave accelerating tube. The accelerating tube consists of 7 accelerating cavities. In which the first 3 cavities are in the bunching section and the last 4 cavities are in the accelerating section. Figure 1 and figure 2 are the sketch design of the c - band standing wave (SW) accelerating tube and the photo of the accelerating tube after welding respectively. The weight of the fully sealed accelerating tube is less than 7 kilogram.

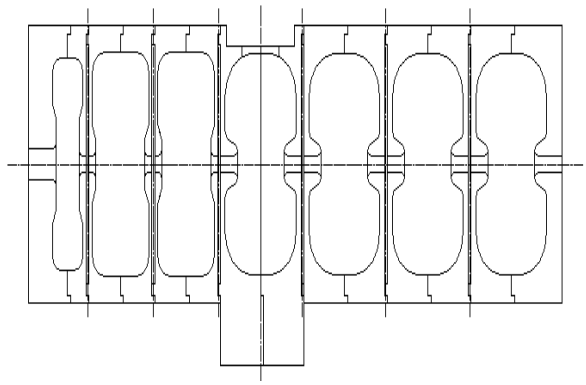

Figure 1: Sketch design of c-band SW accelerating tube.

Figure 2: Photo of the fully sealed accelerating tube after Welding.

PROTOTYPE OF THE ACCELERATOR

In order to set up the accelerator experimental facility, we made some change on power supply module such as modulator and pulse transformer available in our laboratory. And we used a homemade 1.5MW magnetron as the microwave power source. The power test experimental facility for x - ray source of 2 MeV c - band accelerator is set up, as shown by figure 3.

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ISBN 978-3-95450-122-9

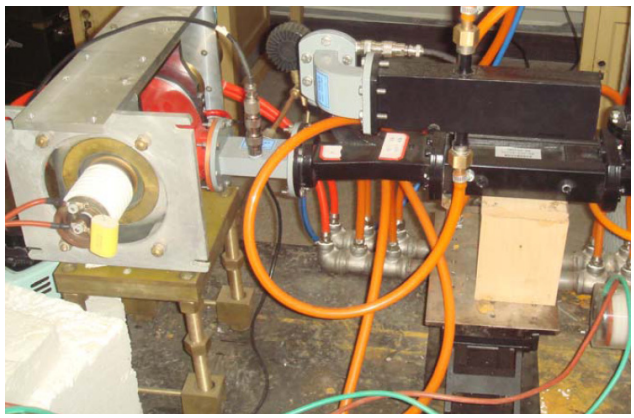

Figure 3: Experiment prototype of the 2MeV accelerator.

TEST RESULT

Maximum dose rate measurement. Using ionization chamber dose monitor, we tested the maximum dose rate of x-ray at 1 meter before the target. In the dose rate test, through increase the repetition rate of accelerator step-by-step, we tested the maximum dose rate of x-ray at 1 meter before the target. Experimental results are shown by Figure 4. It can be seen in the picture that, the maximal dose rate of the accelerator is over 200 rad /min·m when its repetition rate is 250 Hz.

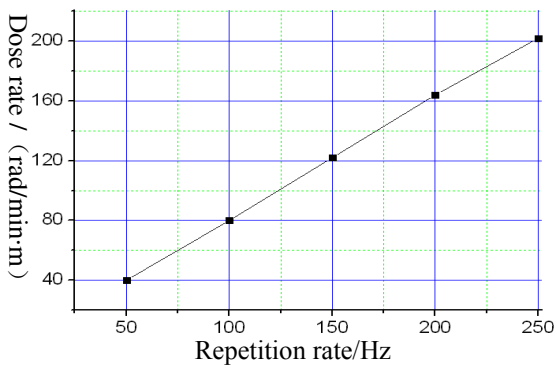

Figure 4: Test on repetition rate and maximal dose rate of the c - band accelerator.

Energy of electron beam measurement. By means of steel absorption method, we tested the energy of the electron beam. We place different thickness steel mass 1m right ahead the x-ray source, then we measured the radiant intensity value behind the steel masse respectively. Through experiment, we measured the steel plate's thickness which made the intensity of incidence x-ray damping to half of that of incidence x-ray. Table 1 gave the test results about half value layer of steel. It can be seen from the table, that the half value layer(HVL) of steel is about 20 mm. According to the relationship between the half value layer and the correspond energy of electron beam, it can be gotten that the energy of the electron beam is about 2MeV.

Table 1: Results of Half Value Layer Tested on C - Band Sccelerator X-ray Source

Order number	Steel plate thickness mm	Intensity of incidence x-ray rad/min·m	Intensity of x-ray damped rad/min·m
1	20	410	204
2	20	420	210

Focus spot size measurement of the accelerator. By means of "sandwich" stack piece, we measured the focus spot size. "sandwich" stack piece is built up by lead sheets with certain thickness and plastic sheets with certain thickness interlacing. We place Stack piece at 300 mm, 500 mm, 800 mm away from the target on central axis of the x-ray respectively, and then measure the focus spot size on each location, finally we find out the focus spot size through the method of least squares fitting. By this means, we get the focus spot size of the accelerator no more than 1.4 mm in the end.

CONCLUSION

We have developed a miniaturization prototype of c - band 2MeV accelerator. In condition of repetition rate of 250Hz, The preliminary power test is complete, and the test results are: beam energy about 2.0MeV, dose rate about 200rad /min•m.

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