ACCELERATION TEST OF DAW STRUCTURE

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Abstract

A test of a disk-and-washer (DAW) acceleration structure has been performed using a pulsed electron beam which has incident energy about 2 MeV. The energy gain 4.5 MeV was obtained when the peak rf power 1.8 MW was provided. From this result, the effective shunt impedance of the DAW tube was found to be about 51 MΩ/m, which is about a half of a calculated value for a DAW tube without end-cavity or rf coupler.

1. A feature of tested DAW tube

The DAW tube consists of five acceleration cavities, which contains a rf coupler and three washers. Total length of the tube is about 30cm. An outline of the DAW tube is illustrated in fig.1. Each washer is supported by two radial stems which have an angle of 90° from each other. The stems are made of copper plated stainless steel pipes so that the cooling water may flow through the stems into the washers. The size of each part of the tube was fitted using a computer code "SUPERFISH" so that the effective shunt impedance of the DAW cavity might be maximized under conditions that the bore of the washers was fixed to 15 mm, and that the acceleration mode lay near 2856 MHz. The optimized values of the effective shunt impedance and the unloaded quality factor were calculated to be 95 MΩ/m and 31200 respectively, where the effects of the end-cavities or the coupler were not taken into account. The frequency of the acceleration mode was tuned by using of tuners which were fitted to cylinders. The measured values of the unloaded quality factor and the frequency of the completed DAW tube are about 20000 and 2857 MHz at room temperature, respectively.

2. Acceleration test

The rf power can be provided from a 5 MW pulse klystron in variable from 0 to 2.5 MW. The rf pulse width is about 7 μs, and the maximum repetition rate is 200pps. The DAW tube was aged over 200 hr at 10 pps, increasing input rf power up to 2.5 MW gradually. The washers and the coupler were cooled by air instead of water because of vacuum leak at the coupler. Therefore, the resonance frequency of the tube was changed several hundred kHz during an experiment, which was matched by varing input rf frequency.

An electron beam of pulse width 2 μs and peak current 100mA was injected in the tube. The incident energy was about 2 MeV. The electron beam accelerated in the DAW tube was momentum analysed in the air using a 30° deflecting magnet. The beam current was monitored at the entrance and the exit of the tube. The beam penetrability was found to be about 70 % when the beam was enough accelerated, where the beam size at the exit of the tube was less than 10 mm wide.

The energy of the accelerated electron beam was obtained by measuring the field strength of the deflecting magnet when the center of the beam profile was seemed to be deflected by an angle of 30°. Fig.2 shows the relation between the electron energy and input rf power. The beam profile monitored using a ZnS plate at the down-stream of the deflecting magnet was several cm wide because of the scattering of electrons by a Ti-foil window at the exit of the tube. Therefore, the electron energies obtained using above method will have large errors because of the uncertainty of the center of beam profile.

The effective shunt impedance of the DAW tube hs been estimated from the energy gain as 51 MΩ/m, which is about a half of the calculated value. If the effects of the end-cavities and the coupler is taken into account, the effective shunt impedance is expected to be about 73 MΩ/m. The measured value is still less than this one, which will be due to existence of stems. However, further discussion will need more detailed and accurate data. We are now preparing for more accurate measurement of the electron energy, and a 1 m long DAW tube is under construction at Mitsbishi Electric Corporation. The effective shunt impedance of the new DAW tube is expected more than that of tested one because of relatively small effects of the end-cavities or the coupler.

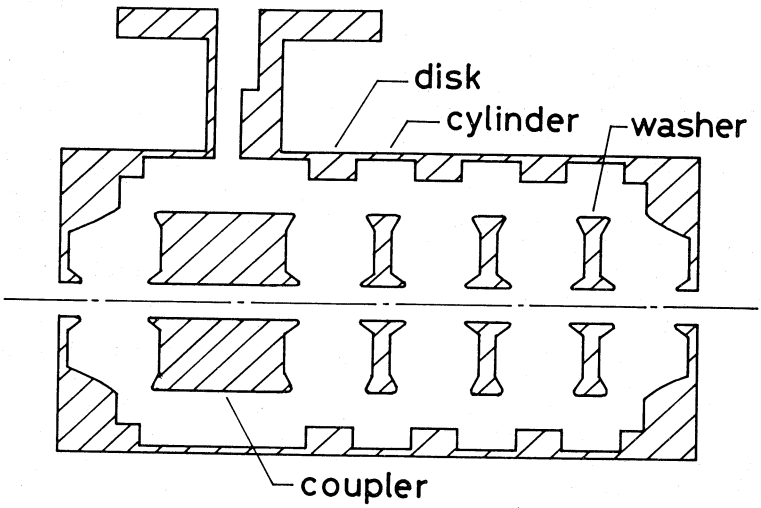

Fig. 1. An outline of the tested DAW tube. The electron beam is injected from left hand side of this figure.

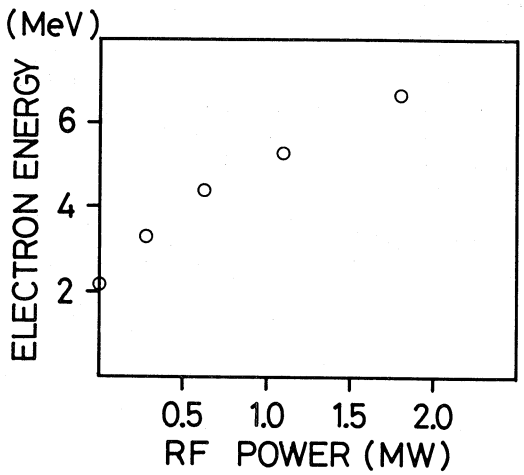

Fig. 2. The result of the measurement of relation between input rf power and the electron energy.