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BUNCHER CAVITY RESONANT AT THE FIRST AND SECOND HARMONIC

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Abstract

A buncher is an RF accelerator followed by a drift space. Its purpose is to bunch the dc ion source beam into suitable bunches for acceleration in a linac. The voltage in a simple buncher is a sine wave at the linac frequency. A more elaborate wave form can result in increased capture of ion source beam. The cavities discussed here are resonant at 12.5 and 25 MHz, the first and second harmonic of the Argonne National Laboratory (ANL) low beta linac. They will support a wave form which should give improved bunching. Three designs are given to compare their relative merits.

Discussion

The cavities shown in Fig. 1 are coaxial structures. The inner conductor is grounded at the top and open circuit at the bottom. In a complete design, a drift tube for accelerating the beam would be connected to the bottom end by a stub. All are resonant at 12.5 and 25 MHz and would be suitable for use as a buncher for a 12.5 MHz linac. The cavity on the left is easy to build, the center cavity requires less power, and the cavity on the right is smaller.

These three structures were determined by cut and dry using the program Superfish [1,2,3] Fig. 1 is Superfish output showing the outline of the cavity with the center line on the left. A few electric field lines are also shown.

These resonators are tuned with lumped capacity near the shorted end and at the open end. The large capacity at the drift tube end reduces voltage fluctuations due to beam loading. The charge in an ideal linac bunch is (rf frequency)$^{-1}$ coulombs per ampere of linac beam. In the case of the cavity on the left, Fig. 1.1, if the bunch charge were all in the drift tube then the voltage would change by about 300 V per ampere of beam current. This would be about the same for the cavity on the right, Fig. 1.3, but would be twice as large for the center cavity due to the smaller capacity. A low impedance connection between the drift tube and the bottom of the line is necessary to make the charge on the condenser available to the beam.

The shunt impedance of the cavity on the left, Fig. 1.1, is about ½ M Ω. The center cavity has about half the capacity of the one on the left, and thus requires half the charging current. It has, however, about twice the inductance, thus twice the resistance. The center cavity therefore takes about half the power. The one on the right, Fig. 1.3, has capacity and inductance similar to that in Fig. 1.1. The resistance is slightly greater so the power is slightly greater than that of the resonator in Fig.1.1.

Summary

Three coaxial structures which are resonant at 12.5 and 25 MHz are presented. They could be used as buncher cavities resonant at the first and second harmonic for a 12.5 MHz linac. For simplicity the drift tube, which would be connected to the high voltage end, has been neglected.

In the first example construction would be relatively simple. The other two examples show that reduced power or reduced cavity length can be achieved by using hollow electrodes for capacity loading. Large capacity of the high voltage electrode minimizes beam loading problems in this type of structure.

Acknowledgement

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References

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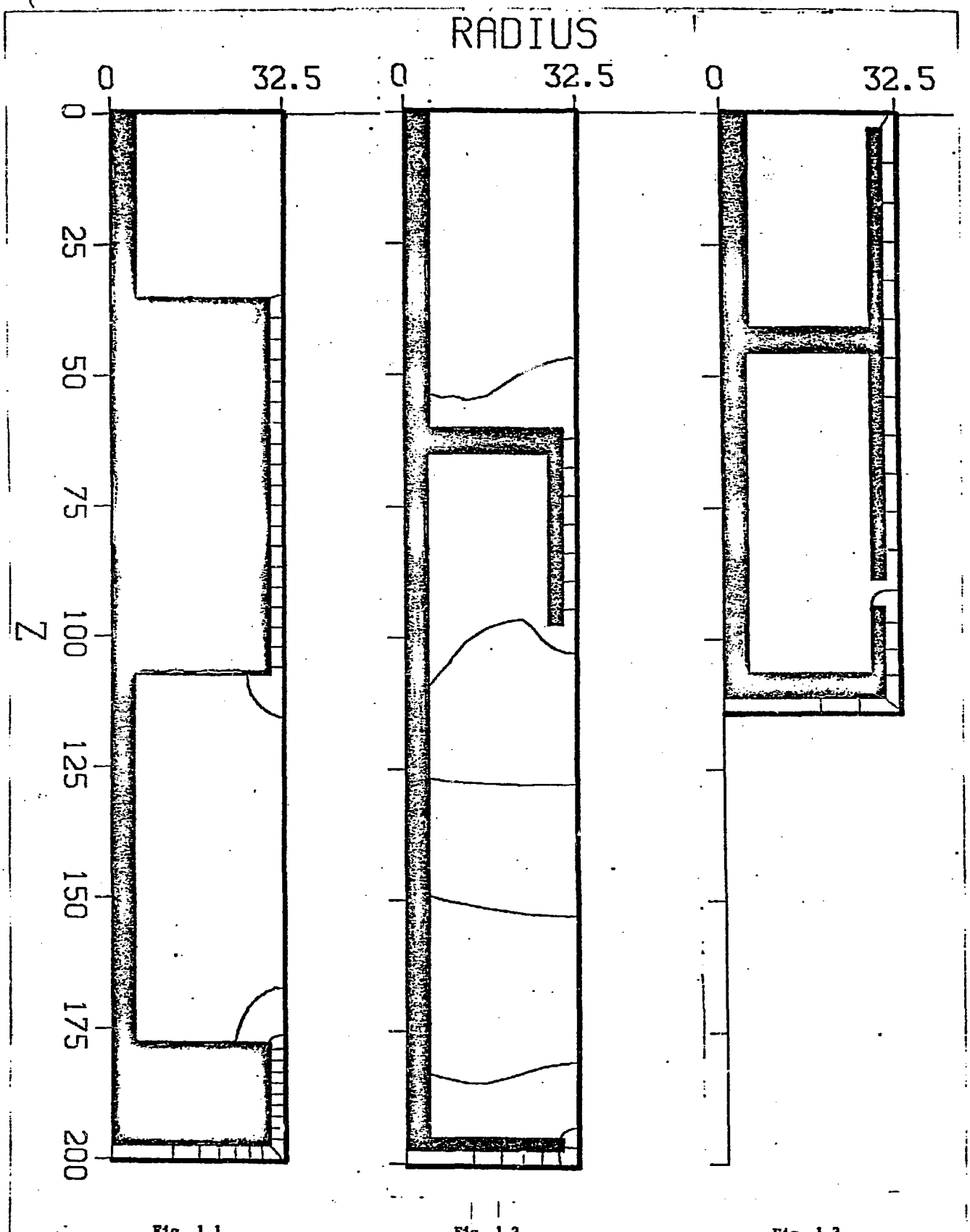

Fig. 1.1 Fig. 1.2 Fig. 1.3

Fig. 1 Cavities Resonant at 12.5 & 25 MHz