BOEING TRAVELLING WAVE STRUCTURE ELECTRICAL PERFORMANCE

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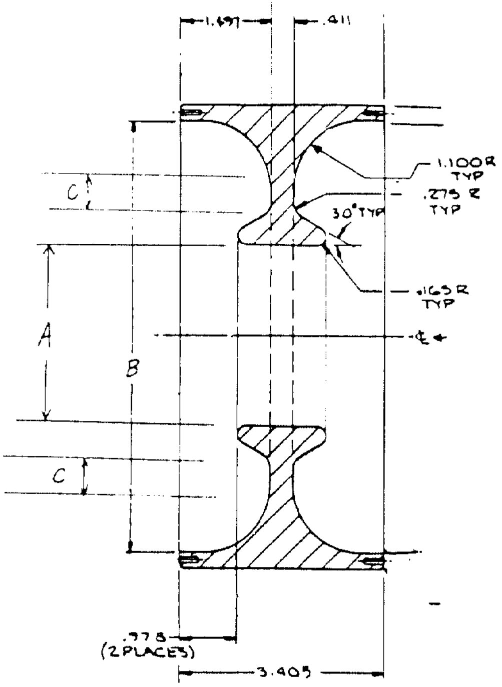
We have over several years accumulated a lot of data on electrical parameters on our travelling wave electron linac structure. The cavity geometry is shown below. The shape is azimuthally symmetric. All dimensions are in inches (1300 MHz). Note that the dimension C is the only dimension that changes with beam hole A and the major diameter B.



In particular, in designing the High Average Power Linear Accelerator[1] (130 MeV, 0.29 A, 2.5% duty factor) we found it necessary to go to bigger holes (higher group velocity) and expanded our data base accordingly.

We have a numerically controlled shop, with which we make four identical cells (just like above). By stacking these between shorting plates, we can excite discrete normal modes which lie on the dispersion diagram. By using various combinations a Brillioun diagram can be constructed.

*Work supported by USASDC/BMD under contract DASG60-87-C-0011

A metal bead is pulled through the stack longitudinally, and a fourier analysis of the frequency response gives us the fraction of the energy in the synchronous spatial harmonic. A sapphire rod inserted through same path ties the integrated square of the longitudinal electric field to the stored energy in the stack. From this r/Q is deduced.[2] Q_0 is much harder to measure, and after repeated attempts it was concluded that the RF cavity codes Urmel and Superfish probably do a very good job in this respect, although they cannot account for imperfect finish, braze joints, etc. Aside from Q, all values are measured.

We present values for our mode (3pi/4 phase shift per period) but have data for 0, pi/4, pi/3, pi/2, 2pi/3 and pi also. In particular, we tabulate r(Mohms/m), Vg/c, I(nepers/m), fraction of power in the spatial harmonic of interest (see figure 1).

Q_0 is believed to be about 20,000. The highest we have ever measured is 20,200 (A=2.15 in.). The cavity codes Urmel and Superfish agree very well on the cavity losses (see figure 2)

We average these values and interpolate. From this, we get the shunt impedance directly. With knowledge of the group velocity we get the attenuation (see figure 3).

References:

1. T. Buller, "Design of High Average Power Linear Electron Accelerator Sections" proceedings this conference.
2. W. Gallagher, "Periodic Transmission-Line Mode Measurements", Particle Accelerators, 16, p.113, 1984

CH2669-0/89/0000-0229$01.00©1989 IEEE

Figure 1

A (in.)	B (in.)	v_g/c	R/Q (ohm/cm)	percent of power in fundamental spatial harmonic
2.0	6.665	.0023	23.2	65
2.1	6.675	.0028	22.5	66
2.2	6.695	.0035	21.9	68
2.3	6.715	.0046	21.2	69
2.4	6.740	.0056	20.6	70
2.5	6.770	.0070	19.9	71
2.6	6.795	.0086	19.3	72
2.7	6.830	.0098	18.6	74
2.8	6.860	.0124	18.0	75
2.9	6.900	.0140	17.4	76
3.0	6.645	.0166	16.7	77
3.1	6.989	.0192	16.1	79
3.2	7.033	.0218	15.4	80

Figure 2

A (in.)	Urmel	Superfish
2.0	20,000	21,000
3.2	19,000	20,000

Figure 3

A(in.)	R(Mohms/m)	I(nepers/m)	Q_0
2.0	47.6	.289	20,500
2.1	45.9	.238	20,420
2.2	44.5	.191	20,330
2.3	42.9	.146	20,250
2.4	41.5	.121	20,170
2.5	40.0	.097	20,080
2.6	38.6	.079	20,000
2.7	37.0	.070	19,920
2.8	35.7	.055	19,830
2.9	34.4	.049	19,750
3.0	32.8	.042	19,670
3.1	31.5	.036	19,580
3.2	30.0	.032	19,500