R.F. Note #98

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Topics: 1. Final K800 resonator design
2. Phase probe project
3. Beam centering monitor project
4. Miscellany re the K500.

1. LO-PO-MO Project

This means low power model. About 8/1/84 the LO-PO-MO was ready for testing. Initial measurements showed that vast improvements were necessary for any meaningful results to be achieved. When these improvements were made the measurements showed that there was considerable disparity between the results and the results from our computer model entitled MV800D. By this time J. Vincent had acquired superfish. Superfish is great when there is an axis of symmetry, so to test MV 800D, a fast running basic program. we modified the LO-PO-MO by removing the dees and measuring the frequencies that occur for the $\lambda/4$ & $\lambda/4$ modes for a line from the short to an open at the entrance to the valley, where everything is coaxial.

This produced good results. Superfish results agreed with the model measurements quite well; but MV 800D had to be modified to get equally good agreement. The main alteration to MV 800D was to include a Δ C each time there was a discontinuity in Zo. The LO-PO-MO was then restored to its initial condition and improvements were made to the moving short and a new set of measurements were made.

MV 800D calculations now showed a consistent .5 MHz offset downwards from the measured results. This was corrected for by increasing the dee Zo's by 5% and then the measured and calculated results agreed to within 1/2% in short length vs. frequency. It is disappointing to find that the computed and measured values for the 3/4 & 5/4 λ modes did not agree at all. Being tired we choose to ignore this and hope that later this matter won't haunt us.

Fig. 1 shows the measured and calculated values for the LO-PO-MO including a calculation for 9Mhz. Note that the short length for 9Mhz is only 96 inches, and at 27.6 Mhz the power is 270 KW and the short current 5400 amps. The linear current density at the short is 286 amps/inch.

The K500 current density is about 200 amps/inch and since the problems probably go as the square of this number it seems desirable to reduce it, since we have plenty of real estate to work with. We ran for 6, 8, 10 and 12 inches and the results are summarized below:

TABLE I

Stem Diam	L 26	I/inch	I/Ringer
6	96.4	286	57
8	111.7	215	43
10	128.2	172	34.4
12	145.2	143	28

As you can see, using a 10" stem reduces the current density to less than we have with the K-500, and the stem length is comfortable. Therefore, I opt for a 10" stem. Table II below summarizes the results for a 10" stem. Since there no longer is any reason for these odd choices of frequency I include Table III for more reasonable choices.

TABLE II

	F	Wmax	VDEE	Imax	L26	Ccoup
1	27.6	267	200	5400	.7	2.98
2	25.9	252	200	5300	3.3	3.09
3	23.92	226	197	5100	7.0	3.21
4	21.02	165	180	4400	14.1	3.42
5	18.87	124	165	3800	21.4	3.61
6	17.26	96	152	3400	28.5	3.77
7	15.95	77	141	3000	35.8	3.92
8	14.90	63	132	2700	42.6	4.07
9	14.06	53	124	2400	49.3	4.21
10	9	25	100	1500	128.2	5.65

Assume W = 300 KW - or 900 KW total. Thus with a 1.2 MW supply we are allowed to dissipate 300 KW total or 100 KW per Xmitter the efficiency, which is input power must therefore be $\frac{300}{400}$ = 75%

This should be no problem.

TABLE III

	F	Wmax	VDEE	Imax	L26	Ccoup
1	27.5	266	200	5400	.7	3 pf
2	25	244	200	5300	4.8	3.15
3	22	185	186	4600	11.4	3.35
4	19	126	166	3900	20.8	3.6
5	15	64	133	2700	42.1	4.06
6	9	25	100	1500	129.7	5.6

The only disturbing thing is the power at 27.5 MHz. The power in the dee itself is only 10 KW. Superfish, which isn't very accurate where the dees are concerned, gives 320 KW as the power required. Let us assume this number is correct. This means that, to limit the total power consumption to 400 KW per transmitter, the transmitter efficiency must be 320/400 = 80%. My calculations using TUBE show that this is achievable. Besides, we can undoubtedly draw 10% more power out of the power supply than it is rated for,

in which case 73% efficiency is adequate and this is a snap.

I recommend that we use the door spring finger design ala K500 for the inner short, and 12 pistons seems ok. For the outer fingers I recommend we use the new silver graphite fingers with no pistons.

Figure II is a sketch showing the dee + stem configuration and is supposed to help people interpret the computed results. Then I include Tables IV, V and VI, computer printouts of the entered data and the calculated results for 27.5 and 9 MHz. Note that N can stand for a point or a line length.

Amen to the K800 resonator design. Still to be decided is the input coupler design.

Phase Probe Project

Bob Worsham's first assignment on arriving here was to build a phase probe to be mounted in the upper dee. When we got our first beam this phase probe, mounted at a small radius in "A" dee clearly showed that, although about .1 volts of dee rf was present in the signal, the existence or non-existence of beam was clearly discernable and its phase could be measured. Recently we installed this probe, and by bucking out the $F\phi$ signal using a bridging technique could get a nice beam signal for a 300 NA e beam (N^{5+}).

This is encouraging, as it clearly shows that with 10 or 11 of these at various radii and alot of electronics we could present to the computer data permittingit to present information on radial oscillations and non destructive beam current amplitude. It is possible that it can even show vertical oscillations. Thus it would be valuable diagnostic apparatus.

The probes themselves can probably be built for $200 each, but the cables (SiO2 insulated with encapsulated terminations at each end) would be $5000 for 11. Then the electronics would probably total 6 man months. So it is a matter for the powers that be to determine whether the results justify the time and expense to achieve them.

Beam Centering Monitor Project

It has been demonstrated by P. Miller that the beam can be modulated in intensity at 20KHz by putting symmetrical square waves into the new ion source power supply. At an earlier time it had also been demonstrated that feeding the main probe current to the lock-in amplifier resulted in our being able to get a reading of the phase and amplitude of the modulated beam current as a function of radius.

So now it is a straightforward thing to process this information, send it digitally to the computer where it will subtract a signal proportioned to r^2 and display the radial oscillations of the beam so that the operator can minimize them. I recommend that we proceed with this effort since very little effort or expense is involved and only requires that the probe work properly.

Miscellany re the K500 rf system.

The K500 rf system has performed very well lately, although the voltages have been less than 70KV. The "B" dee has the new (disk) coupler in it, but there is anamolous behavior and it is too early to decide that it is superior to the original coupler. We recently lost out second 4CW100000E trasmitter tube due to emission limiting. Perhaps later, it can be revived. It had it's allotted 10000 hours of running on it. Amazingly, we haven't lost a single 4CW2000 driver tube yet.

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