RIEDEL

R.F. Note #58

January 10, 1980
J. Riedel

K=800 RF System, 2nd Look

In RF Note #27 we presented the results of a calculation of the dee-stem resonator for the K=800 cyclotron, mainly to show that a feasible design could exist. It is now time to make a more detailed study, because we must soon order the power supply, and also decide whether or not our architectural design provides enough vertical space for stems and push rods.

Program MV800 was modified to print out results for 9 and 27.5 MHz and data for different geometrys (lines 2000-3000) were stored in several data files which could be weaved into MV800. The pertinent data and results are presented in Table I. Before studying this table, perhaps it is best to say something about the computer model. It is exactly the same as used in MSUDS and described in RF Note #17, but to avoid having to refer to it, I herein include a copy of FIG 3 which, I hope, adequately describes the model. After going into a huddle with myself, consulting Resmini and Burleigh's drawings of the dee, I settled on values for the parameters up to point 9, where the stem starts. Table II presents these parameters. Note that although the dee is larger than the K=500 dee, I have kept the same values for $C\phi$ and C6 because we will have twice the gap spacing (at least). I have reduced C3 because we will have no capacity to an ion source.

Lengths 9, 10, and 11 will have 12 inch diam outer conductors and are the penetration through the iron, which unless recessed, add up to 17x3 = 51 in. The moving short is confined to 46.

Now for Table I. First, the peak dee voltage is 200 KV and at 27.5 MHz the middle of the dee is 190 KV (because of properly centering the stem, the inner and outer voltages are the same).

Run 1 This is a possible design using the insulator. This requires a 27" diam recess into the iron about 12 inches deep.

Run 2 is an improvement on run 1 by changing only B9 and B10. This design requires the least power.

Run 3 The recess in iron uses a uniform 6 inch inner conductor and a 12 inch outer conductor. Simplest design, but the short is 23 ft from the M/P. Power is o.k.

Run 4 Uniform line - 8 in inside 24 in. Power too high.

Run 5 Uniform 12 in outer conductor, but modified B 9, 10, 11. Satisfactory, but L16 a little long.

Run 6 Modified to reduce L16. Power too high.

Run 7 Better modification, satisfactory design, but short current excessive.

Run 8 Uniform 6 in. in 24 in. design looks good.

Run 9 Here we feel we have, for the time being, found a good compromise; the short current density is low, W27.5 and L-reasonable.

Run 10 Attempt to improve 9. It reduced L-by32 inches, otherwise it is about the same.

Run 11 For relativity consideration, I put the data from MSUDS into MV 800 and ran. This is the geometry for the K=500 machine running at 200 KV. As you see the power is the same as for run 10 and except for the high sort current density and the high voltage at the insulator would run. This means that the K=500 stem + insulator will run the K=800 dees at 100 KV.

The computer printouts show the detailed calculations and data for run 9.

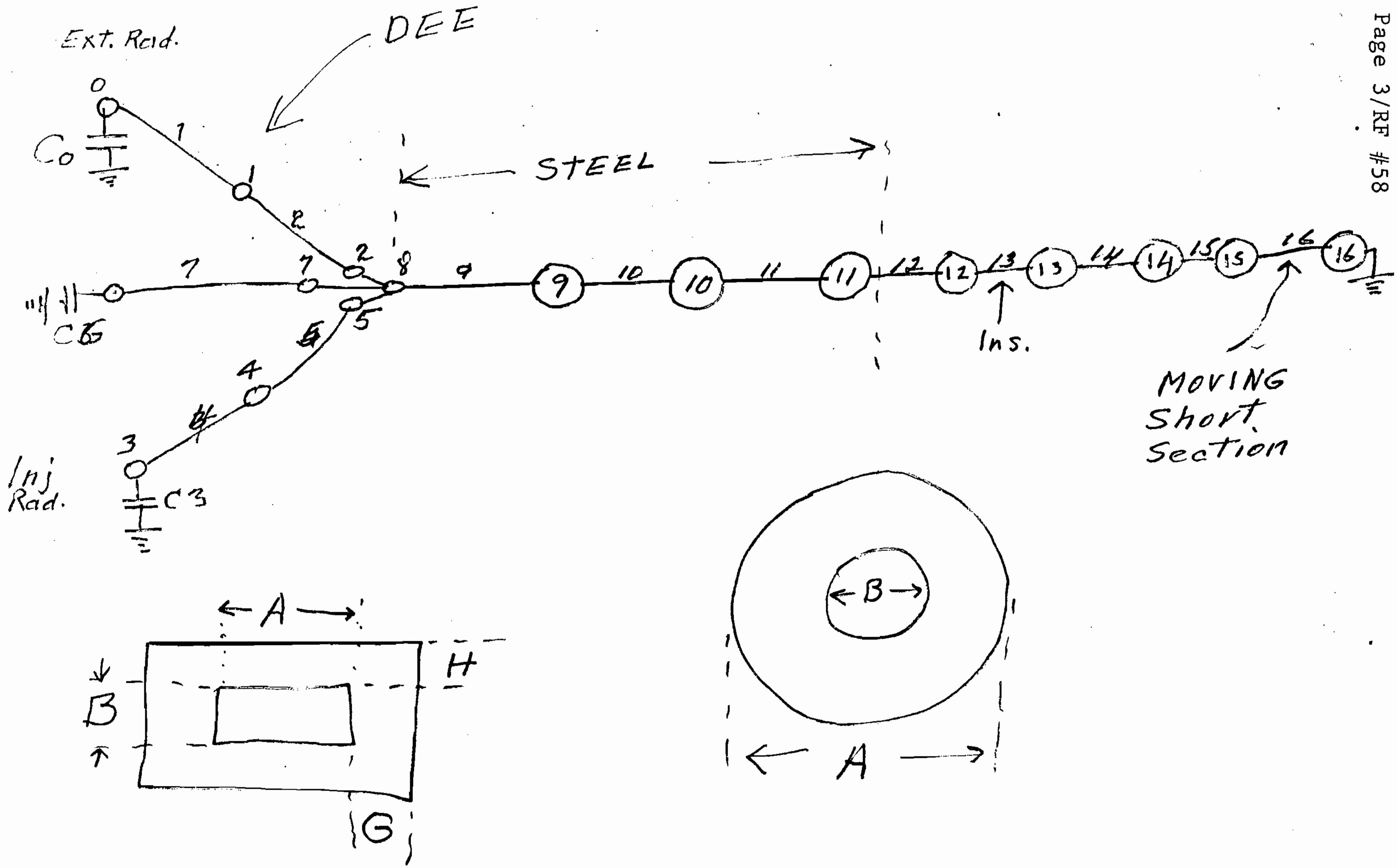

FIG 3. (from RF Note #17)

RUN #	W 27.5	W 9	L+	L-	ΔL	B9	B10	B11	A13	B13	A16	B16	I Short
1	212	121	66	191	125	6	10	8	26	14	24	8	6300
2	156	94	65	224	159	6	6	8	26	14	24	8	4500
3	191	253	66	278	212	6	6	6	12	6	12	6	4300
4	271	119	72	205	133	8	8	8	24	8	24	8	5900
5	191	125	67	248	181	6	6	6	12	8	12	8	4300
7	232	127	73	193	160	6	7	10	12	10	24	8	5900
6	321	189	72	193	121	10	10	8	20	8	20	8	4100
8	190	88	66	206	140	6	6	6	12	8	24	6	4300
9	190	95	66	230	154	6	6	6	12	8	24	8	4300
10	195	95	69	198	129	6	6	8	12	8	24	6	4600
11	195	140	66	192	126	4.12	4.12	7.25	21.7	12	16	4.12	5100

W 27.5 & W 9 is the power in KW for the frequency extremes.

L+ & L- are the distances from short to M/R in inches.

ΔL = L- - L+ the short range.

A13, B13 are 10 in. long for runs 1 & 2 to accomodate the insulator. for the rest of the runs L13 is only 1" long.

TABLE I

09:31 JAN 10 TEST4...

PROGRAM MV800---- MODIFIED HFRF

FOR 9.00 MHZ THE RESULTS ARE

N	Z	L	A	B	G	H	K	D	C
0	0.0	0	0.00	0.00	0.00	0.00	0.00	0.00	14.4
1	54.5	11	6.00	4.00	2.00	6.00	1.53	3.02	0.0
2	41.7	11	10.00	6.00	4.00	3.00	1.24	3.02	0.0
3	0.0	0	0.00	0.00	0.00	0.00	0.00	0.00	3.0
4	40.0	11	10.00	6.00	2.00	6.00	1.34	3.02	0.0
5	42.9	11	11.00	4.00	4.00	3.00	1.25	3.02	0.0
6	0.0	0	0.00	0.00	0.00	0.00	0.00	0.00	4.8
7	43.3	10	8.00	6.00	3.00	3.00	1.24	2.74	0.0
8	0.0	10	0.00	0.00	0.00	0.00	0.00	0.00	0.0
9	41.5	27	12.00	6.00	0.00	0.00	1.00	4.66	0.0
10	41.5	44	12.00	6.00	0.00	0.00	1.00	4.66	0.0
11	24.3	61	12.00	8.00	0.00	0.00	1.00	4.66	0.0
12	24.3	62	12.00	8.00	0.00	0.00	1.00	0.27	0.0
13	24.3	63	12.00	8.00	0.00	0.00	1.00	0.27	0.0
14	24.3	64	12.00	8.00	0.00	0.00	1.00	0.27	0.0
15	24.3	65	12.00	8.00	0.00	0.00	1.00	0.27	0.0
16	83.1	198	24.00	6.00	0.00	0.00	1.00	36.43	0.0

TABLE II

Dee parameters

N	Z	L	DEG	DEG	R/M	V	I	W	E
0	0.0	0	0	0	0.0	2.0E+05	1.2E+02	0.0	
1	54.5	11	3	6	8.2E-03	2.0E+05	2.5E+02	81.	
2	41.7	11	4	7	3.3E-03	2.0E+05	4.3E+02	1.1E+02	
3	0.0	0	0	0	0.0	2.0E+05	24.	0.0	
4	40.0	11	0	3	4.5E-03	2.0E+05	2.1E+02	21.	
5	42.9	11	4	7	3.5E-03	2.0E+05	3.8E+02	88.	
6	0.0	0	0	0	0.0	2.0E+05	38.	0.0	
7	43.3	10	1	3	3.7E-03	2.0E+05	1.9E+02	14.	
8	0.0	10	0	0	0.0	2.0E+05	1.0E+03	0.0	
9	41.5	27	17	21	2.5E-03	1.9E+05	1.3E+03	1.4E+03	
10	41.5	44	21	26	2.5E-03	1.9E+05	1.5E+03	2.1E+03	
11	24.3	61	16	21	2.1E-03	1.8E+05	2.0E+03	2.8E+03	
12	24.3	62	21	21	2.1E-03	1.8E+05	2.0E+03	2.1E+02	
13	24.3	63	21	21	2.1E-03	1.8E+05	2.0E+03	2.1E+02	
14	24.3	64	21	21	2.1E-03	1.8E+05	2.0E+03	2.2E+02	
15	24.3	65	21	22	2.1E-03	1.8E+05	2.1E+03	2.2E+02	
16	83.1	198	54	90	2.1E-03	1.4E-03	2.6E+03	4.0E+04	

W/DEE KW	E/DEE MVA	Q	R SH	C EQ PF	C COUP 3 DEES
95	653	6834	209	578	5

FOR 27.50 Z THE RESULTS ARE

N	Z	L	DEG	DEG	R/M	V	I	W	E
0	0.0	0	0	0	0.0	2.0E+05	3.5E+02	0.0	
1	54.5	11	8	17	1.4E-02	1.9E+05	7.6E+02	1.3E+03	
2	41.7	11	13	22	5.7E-03	1.8E+05	1.3E+03	1.7E+03	
3	0.0	0	0	0	0.0	2.0E+05	71.	0.0	
4	40.0	11	1	10	7.9E-03	1.9E+05	6.2E+02	3.2E+02	
5	42.9	11	11	20	6.1E-03	1.8E+05	1.1E+03	1.3E+03	
6	0.0	0	0	0	0.0	1.9E+05	1.1E+02	0.0	
7	43.3	10	2	10	6.4E-03	1.8E+05	5.5E+02	2.0E+02	
8	0.0	10	0	0	0.0	1.8E+05	3.0E+03	0.0	
9	41.5	27	43	58	4.3E-03	1.4E+05	3.6E+03	2.0E+04	
10	41.5	44	58	72	4.3E-03	7.8E+04	4.1E+03	2.8E+04	
11	24.3	61	61	75	3.6E-03	4.1E+04	4.5E+03	2.9E+04	
12	24.3	62	75	76	3.6E-03	3.9E+04	4.5E+03	1.9E+03	
13	24.3	63	76	77	3.6E-03	3.7E+04	4.6E+03	1.9E+03	
14	24.3	64	77	78	3.6E-03	3.5E+04	4.6E+03	1.9E+03	
15	24.3	65	78	78	3.6E-03	3.2E+04	4.6E+03	1.9E+03	
16	83.1	69	87	90	3.6E-03	1.4E-03	4.6E+03	7.9E+03	

W/DEE KW	E/DEE MVA	Q	R SH	C EQ PF	C COUP 3 DEES
195	1066	5443	102	308	2

10000 HALT

>

Conclusions

1. Power. I believe we should provide for 200 KW per dee which, at 50% efficiency, mean a power supply of 1.2 MW.

2. The short will be about 200 inches from the center line and the movement will be about 160 inches. So the push rods are about 14 ft long. So the absolute minimum length (no Bellows) is 360 in = 30 ft. To accomodate bellows over the push rods we probably ought to allow another 4 ft, making the distance to the bottom of the pit be 34 ft. minimum. The K=500 pit is 31 ft below the M/P!

3. We should build a 1/2 scale model of the dee to verify the computer model.