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R.F. Note #100

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Contents

1. Dee Voltage Variations

The large size and non-axial symetry about any axis dis-allows exact calculation of Dee Voltages as a function of cyclotron radius and frequency. We can empirically measure these variations using the low power model and a moveable small capacitor. The basic procedure is to insert this capacitor at predetermined logical places along the dee to liner at the median plane. By measuring the change in resonant frequency at each of these places we can judge the relative magnitudes of the peripheral voltages. By normalizing all data to the largest change in frequency point (which corresponds to the largest voltage in the cavity) we can know with good accuracy what the voltage is everywhere. This group of tests should be performed from 14 to 27 MHz as allowed by the LO PO MO. I believe this information would be very useful to F. Marti and others and should be made available. I suggest the LO PO MO be put back in operating condition so that we can acquire this information.

2. Coupling

Bob Rogers has been doing some Poisson studies pertaining to the best shape of the input coupling capacitor. This "best shape" corresponds to one which yields the correct capacitance, while holding the E Field surface gradients down to a minimum. We should repeat these studies here to verify this and implement the results into our mechanical design. Please note the problems encountered with coupling should reduce dramatically if we pursue this approach. See Figure 1 for Bob's results.

3. Transmitter Status

The development of the K800 transmitter has been proceeding well. We first found to operate the 4648 tube without neutralizing we needed to swamp the grid. This was done by inserting a 50 Ohm 1KW resistor in series with a 16000 pf capacitor right at the grid. This solved our instability plus self-excitation problem. At this point we could start producing some power, but alas, our power monitors acted very strange. At some power levels they were telling us we were producing energy from scratch! So we began probing around and noticed the waveform at the output coupler location in the cavity had a great deal more harmonic content then further down the cavity. Since the coupler was right at the top of the cavity next to the final anode; it was unclear whether the capacitor was the cause or whether our proximity to the high harmonic content of the tube was responsible. I, therefore, decided to move the coupler down approximately 9 inches, and we were down for a week to design and fabricate the necessary parts.

Once we got back on line we noticed the transmission line waveform was now much cleaner, but our spectrum analyzer now displays a 1.6 GHz mode popping in and out as a function of Grid drive.

When this 1.6 GHz mode pops in the Bird directional Wattmeter displays a much greater delivered power then we know to be true. So we now placed some eccosorb in logical places to keep this mode off the transmission line and got rid of this problem. Incidentally, various people believe these modes are due to the large radius of the grids, screens, anodes, etc. of these power tubes. They can be calculated approximately from $f_o = C/2\pi r$ and vary around depending on the cavity the tube looks into. Anyway, this mode does not have any appreciable energy in it; so removing it from the transmission line without eliminating it altogether is ok. Since we accomplish this by dampening it with eccosorb, no appreciable energy can build up.

At this point we began changing the bias levels according to some studies I had done and found a pretty good operating point. We are now running the screen at 1600VDC, Grid at -300 VDc, Anode at 20KVDc. With these changes we were able to obtain 220KW delivered into our water cooled 50 Ohm load. This power figure was verified by the Bird directional wattmeter, differential water temperature measurements from the waterload, and D.C. input power to the final anode. Well, finally, everything began to work and agree with a plate efficiency of better then 68%. Now, of course, new problems lurking in the shadows began to emerge.

The main breaker feeding the a.c. to the Energy Systems Power Supply is now calibrated improperly, which causes the breaker to open up when 20KVDC and 15 Amps is delivered. The Energy Systems is rated @ 20KVDC and 20 Amps and I need this much. Also the contact fingers on the final tube socket which contact the D.C. voltage to anode, anode to cavity, and screen to bypass condenser are hardly suitable. If one looks at any commercially built socket for power tubes, one would notice how rigid those fingers are and that they are silver plated. We cannot afford indifferent contact in any of these locations. We are now down again to find some suitable fingers or have some made as this problem has bitten us. Also, during the output coupler relocation, we redesigned the apparatus which couples D.C. power to the tube, the tube to D.C. blocking capacitor, and suspends the anode inductor. We now need to design some small teflon parts to insure all this remains centered to the tube. So, the solutions to these rather trivial problems are in the process of being solved.

In conclusion to this portion of this note, I will say the transmitter is basically sound and working. As previously mentioned we have delivered 220 KW @ 27 MHz with no great problem and have investigated the rest of the operating band. I am guessing when this last group of problems is solved, we will have a design suitable to drive the K800 resonators. The only other problem not previously mentioned is to test the magnetic shielding for the driver tubes. So the main anode box, sliding short drives, etc. are basically finalized. We should start finalizing drawings, machining, procurring, and assembling the other two transmitters from anode box down ASAP.

4. <u>Motion Control</u>

Our motion control consists of basically three types: D.C. Motor, Hydraulic, and Air.

a. D.C. Motor

The majority of our axes of control are of this variety. We have tested an amplifier and power distribution system to accomplish this. This system is supplied by PMI and utilizes an amplifier card for each axis along with transformers and rectifiers to supply the necessary power. We then design and build our own customized controllers which couple all axes directly to the new control system via a 68701 micro-processor board designed by J. Jenkins. Each Dee system, contains a power supply, one half size rack, and up to 12 amplifier cards. Four amplifier cards per each of 3 sliding drawer's in each half sized 19 inch enclosed rack. The main power transformer for each rack would be mounted at the bottom of the rack. Each of these racks could sit in the basement by it's prospective transmitter stem. All power to each dee system to power dee stems, amplifier stems, output couplers, etc. is supplied by equipment contained in this rack. So this rack has 3 varieties of signals entering and leaving.

1. Drive signals originate here and go to each motor.
2. Status signals come from each controlled unit to this rack.
3. Status and control signal paths between this rack and the R.F. local control console.

The controllers at the balcony are housed in single wide Nim modules and are normally totally controlled by the new control system. Each module has a switch, knob & status test points, etc. which disengage the computers totally from performing any control function with the exception of reading status and positions. This capability will be exploited during initial R.F. development and during any control system malfunctions. 1.2 MW is too much power to allow a computer to have control of if it should get fidgity. The motors will be PMI pancake variety for high inertia systems such as Output Couplers and bodine motors in low inertia systems such as transmitter stems and Dee stems. All this would work admirably, is cost effective, and time effective. It is, of course, subject to design review and one will be held shortly.

b. <u>Hydraulic Control</u>

These axes require no power and electronics are already designed and partially fabricated. We add a 68701 board and no problems exist. We will use Atchley servo valves which should be mounted off the cyclotron and in a shielded enclosure. These axes consist of input couplers and dee fine tuners.

c. <u>Air Motor Control</u>

We currently use a bang-bang servo. The control here is lousy at best and the air motors don't tolerate a large magnetic field well. We spoke in the past of removing all hydraulics from the top of the machine and going this way. Our plans need to be discussed and finalized in this regard. During the R.F. motion control design review we should hack this out and make a decision.

MS

K+E 10 X 10 TO THE CENTIMETER 10 X 25 CM KEUFFEL & ESSER CO. MADE IN U.S.A. 46 1512

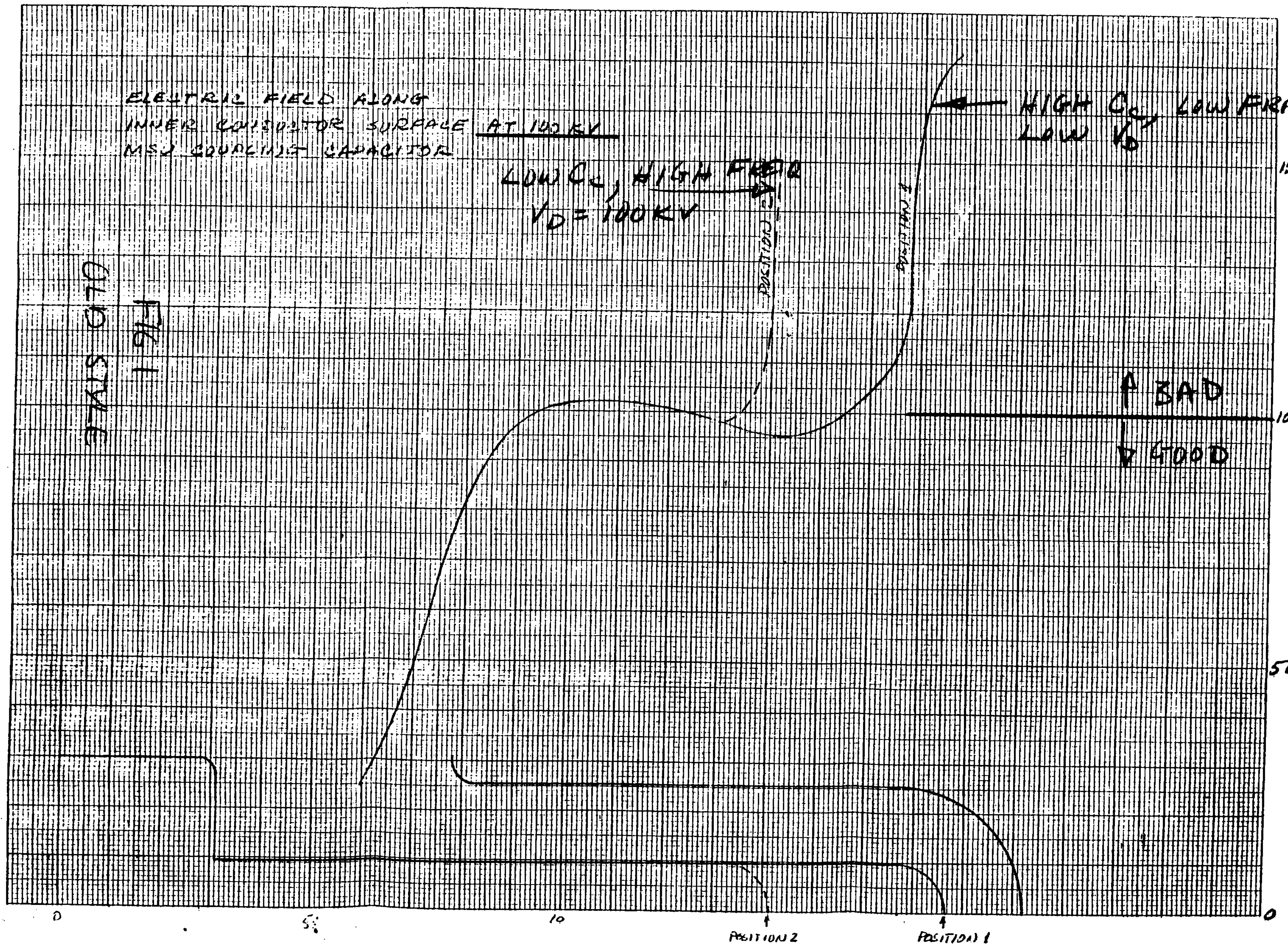

FIG 1
OLD STYLE

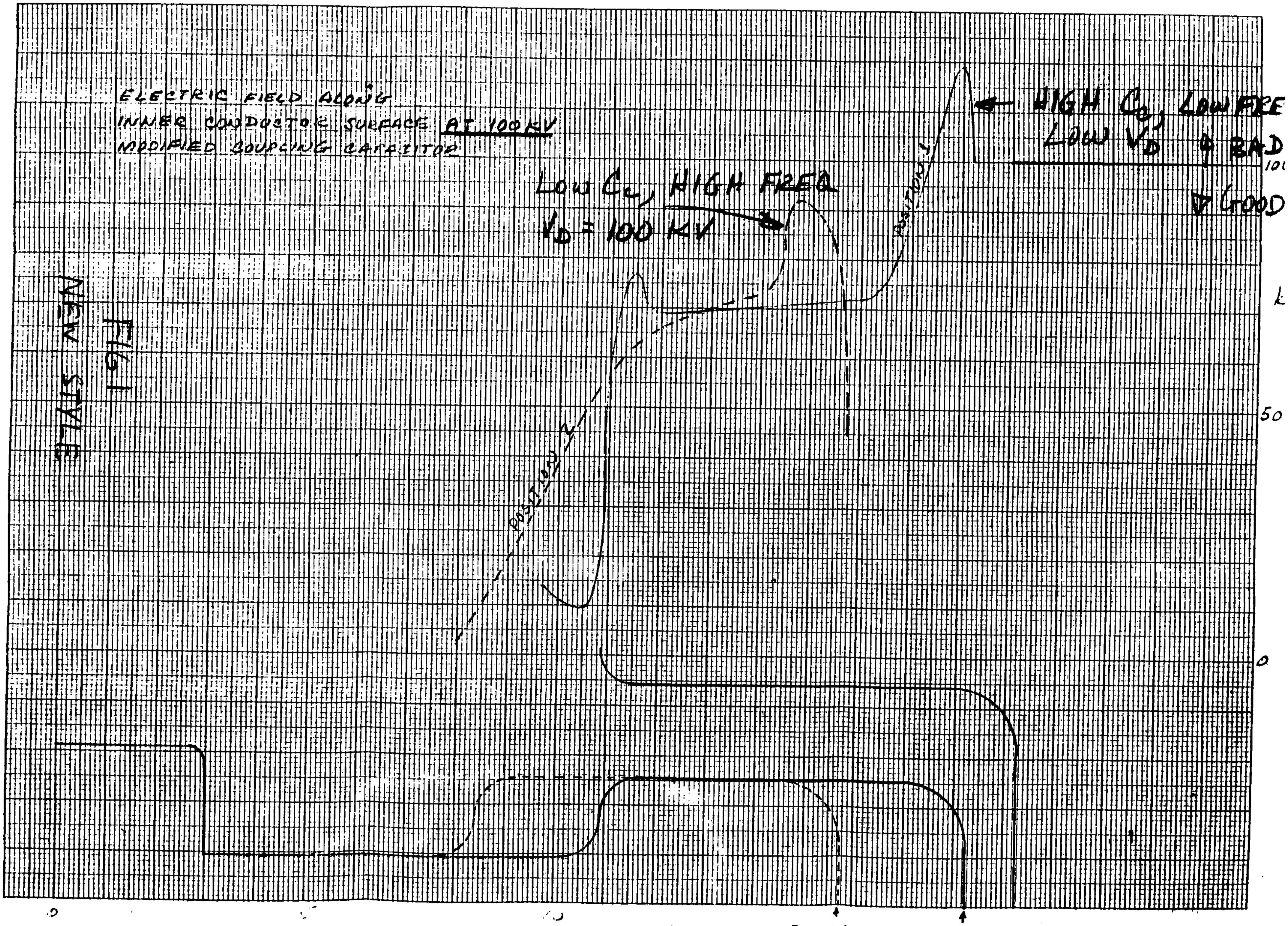

FIG 1
NEW STYLE