214-0077-01-01_00

RF BOOK

R.F. Note 76

October 5, 1981
J. Riedel

CLOSE!

Contents

1. Present Status of Resonator Tests

On 9/25/81 the "A" dee was installed without provision for water cooling and with a sufficient leak in B & C stems so that only air tests could be made. The frequency limits were measured to be 8.3 MHz and 29.66 MHz, in fair agreement with the calculated values. (The shorts are 2.75" from the corona rings so that it is possible, with short modifications, to reach 32 MHz.) The Q values were 1900 at the upper and 2250 at the lower frequency.

The dees were removed to add the water cooling and at the same time the center holes, which permitted RF to look at iron, were closed over with copper disks. On 9/30 we were on again and at 29.75 MHz measured Q values of 3000. The calculated value is 5500, but measuring Q accurately is a tricky business so we plunged on, got a vacuum of 1.5×10^{-5} and on 10/1/81 came on with 30 amps in each magnet coil. It took only about 10 minutes to break through multipactoring.

We shut down to tune up the rf system in air (principally to set the dee coupling capacitor for minimum reflected power).

At 8 a.m Saturday October 3, 1981, the vacuum was at 1.5×10^{-5} and we came on with no magnetic field. There was no multipactoring. Quickly (10 min.) we were limited by sparking, but were able to have the sparking limit raise rapidly. By 10:30 P. Miller had his X ray monitor working and we got a calibration for our loops. We were at 74 kV! Horray! It seemed like we would quickly get to our goal of 85 kV.

Than things changed. The vacuum would increase to 4×10^{-5} and a glow discharge would result. H.B. could visibly see this through the small window we have that looks at the center of the cyclotron. We turned 30 amps on to the magnet coils but this had no effect on the vacuum problem. However, with the field on we could no longer get an X ray spectrum.

After a hiatus due to interlock problems we settled into a mode of operation where we adjusted the dee voltage at a level where the vacuum pressure was less than 4×10^{-4} T. Between noon and 3 p.m. we could only raise the voltage from 55 to 60 kV and found ourselves stuck there.

Tim Antaya finally, in the wee hours of Sunday morning, found the source of the problem. The valve to the water cooling of the bell, the outer conductor penetrating the magnet, and the liner, was shut off. Immediately upon opening this valve, conditions got better, so that by 8 a.m. Sunday we were operating at 80 kV.

But at 10 a.m. we were off and found a pitifully drooping propeller from the output coupler capacitor blower draped over the hole in the transmitter stem outer conductor. How sad! Enough detail. We fixed these things, including replacing the damaged output coupling capacitor, and fighting various interlock problems. Then we upped the voltage and finally achieved 100 kV. We were delighted.

Although our test was successful, it revealed that there was a great deal of work to be done before reliable operation could occur. The loop monitors picked up 2.5 times what they were supposed to, which caused a problem with excessive power in our terminators. The voltage regulator had an oscillation at 10 kHz. There were three circuits that worked perfectly. The $-\frac{dV}{dt}$ kicked us off when a spark occurred, the excessive final screen current override circuit limited the amplitude so that we never got kicked off because of excessive screen current, and the spark detectors recorded a few sparks at the upper insulator and the transmitter. The transmitter sparks were solved by H.B. and at 100 kV no more insulator sparks occurred, so we assumed that that fly that was in there got zapped. Everyone knows what being zapped is.

So, after 30 hours of sometimes frustrating endeavors we shut down, when, at that time, we were running at 80 kV with no sparks and a pressure of 1.00×10^{-5} Torr. In spite of the various frustrations, it was a very successful test.

2. Transrex Power Supply

A very fine young man has added various baffles to the rectifier transformer of the 450 kW Transrex power supply, which is the final anode power supply for the K500 transmitters. The adequacy of this solution to the heating problem of this transformer has not been tested as yet, but we hope and, in fact, presume, that this modification will solve the overheating problem.

3. Mixers & Phase Detectors

W. Gress's mixers and phase detector modules left much to be desired. T. Miyanaga's modifications to these modules to make them properly operational left them in an excessively cluged state. So Toshi is redesigning a combined double NIM module containing 4 mixers + 2 phase detectors. No doubt this will be a great improvement, but it is not on the main stream, as we will have to make out with what we now have for the first beam.

4. Fast Trip Circuits

The fast trip circuits do not work, and we have had to disconnect them to get on. Apparently extraneous voltages are countermanding the proper signals. This needs to be debugged.

5. Toshi has conpleted the fast phase shifter modules and the manual phase shifters. Kudos to him. It is very nice when somebody does something completely.

6. And Hiroshi has completed the 3ϕ meter. God, what would we do without these Japanese engineering aides?

7. Miscellany

W. Worsham had installed one beam phase probe in the upper dee so that we could see how much of the dee rf would be picked up on it. We are happy to announce that at 100 kV this probe picks up only 2 volts. Difficult to explain is that, using a spectrum analyzer, the 2nd harmonic is down by only 13 db and the fourth by only 20 db.

I suspect that most of the observed signal is stray pickup from the transmitter, not from the dee, which should be a pure fundamental signal.

Worsham has also built a rf surface resistance measuring probe which permits us to get a relative measure of, for example, the difference between copper, aluminum, brass, ss etc.

We have a bid for about 25K$ for making the aluminum extrusions for the K800 stem panels. Unfortunately the quoted dimensional tolerances are inadequate.

8. Plans.

During the week of October 5 we will assemble all three dees, get all the water and hydraulics hooked up and be ready by October 12 to come on with rf in vacuum. During this time we will also close the following servo loops on all three stations.

1. amplitude regulator
2. driver grid servo
3. final grid servo
4. anode fine tuner
5. dee fine tuners
6. fast phase shifters

RF Memo 7/20/81

Cooling the Stem Outer Conductors

at 27 MHz, I = 4800 amps and for the Hex of 16" a surface the current density is approximatly 75 amps/in resulting in a dissipation of 11.5 watts/in^2

Thermal conductivity of Al is about .5 of Cu making it 4.97 Watts/°C in (#63 of Rad Lab Design Data Book).

$$\Delta T = \frac{11.5}{\sigma A}\int_0^X x\,dx = \frac{1.16\,X^2}{t} \text{ for al.}$$

where X is ½ the distance to a water cooled point and t is the thickness.

Thus, with only cooling at the corners of the Hex T = 296°C for t = .25"

with cooling also at the panel centers

T = 74°C

If we have an extrusion, I would recommend having three tubes, one in the center, the other 2 at 2 2/3 in from the edges.

T = 32°

With 2 tubes only spaced 8" apart, T = 74°C

with 3/16" al as drawn ΔT = 30°C