General Discussion B

PARZEN: It might be worthwhile to make a comparison between the Ill-Tempered-Five code and the Oak Ridge code. I have some rough figures on the time to do the same sort of calculation that the Oak Ridge code will do. Using, I believe, 16 Runge-Kutta steps, the IT-V will take about 20 sec sompared with the 6 sec Welton mentioned. As for the nonlinear calculations, the IT-V will keep powers up to the 24th, if you wish; it can do nonlinear calculations and investigate all the nonlinear resonances and also coupled resonances. I understand that the Oak Ridge code will handle only one-dimensional resonances, i.e., only radial resonances; of course, it keeps only the linear terms in Z. Also, the IT-V has the feature of allowing you to study acceleration. There is an over-ride that will allow you to change the energy of the particle at certain intervals of time, or of theta.

BLOSSER: The IT-V speed depends on the number of parameters you decide to use. To fit the cyclotron fields you have to use nearly all of the available parameters. In the run we made with the code, we found it was much slower than the writeup would imply, by a factor of about 4 or 5.

PARZEN: That is probably due to the fact that you use 32 Runge-Kutta steps.

BLOSSER: No, we use the same number of steps.

PARZEN: Well, you are quite right, it depends on the number of parameters.

L. SMITH: We find that it takes the IT-V about 20 min for the Oak Ridge code's 6 seconds. I would like to ask Dr. Parzen one question to clarify my point. You showed two curves, one of which was a calculation and the other a numerical curve. I did not understand whether the latter was a measured value or was what the calculating machine gave you.

PARZEN: "Numerical" means that it was done by the computer from magnetic fields which were calculated.

CHAIRMAN JUDD: It is a bit complicated. The two Berkeley dectron model cyclotrons were each built to a prescribed analytical form; we attempted to realize the prescribed fields. But the calculations referred to by Dr. Parzen as numerical were digital computer calculations based on the prescribed analytical form of the field and not on measured fields. So there is room for discrepancies, I believe.

SCHMIDT: As an experimentalist, let me ask if these frequencies were measured experimentally.

BLOSSER: Charles Goodman did these measurements and John Martin repeated them. The measurements agreed, I think it is fair to say, really as well as one could expect at all from the nature of the difficulty of the experiment. From this we concluded that the numerical result was much the better to use.

CHAIRMAN JUDD: Dr. Richardson, do you want to make any remarks about the experimental work on the Berkeley ν_r and ν_z measurements? I remember that you made the measurements.

RICHARDSON: Simply to state that the measurements did agree pretty well with your calculations. (Laughter)

CHAIRMAN JUDD: That is not why I asked you to comment!

BLOSSER: In designing the Oak Ridge Electron model, we did not pick a particular field shape and try to achieve it, but rather used a system in which one worked with particular magnet structures. The field shape as such was essentially ignored; orbit properties were related directly to the magnet structure, and corrections to the magnet were gauged on the basis of their effect on focusing and isochronism. In these computations we did, of course, use the average field and flutter as intermediate steps in the computation of magnet corrections but, except for these important parameters, we never concerned ourselves with detailed features of the fields. Such a system takes advantage of the arbitrary character of most features of the field shape and is, therefore, a more powerful technique than is the preselection of a particular field shape. You work to get the important properties (the average field and flutter) right, and you don't waste effort trying to reproduce minor details of a particular field. The details of the field simply follow whatever form is naturally associated with the magnet structure selected.

The system used at Oak Ridge and at Michigan State to design magnets for medium energy cyclotrons is a direct extension of this method used on the electron model. The one difference is that because of the iron in the magnet, model studies must be substituted for computation in determining the field produced by a particular magnet.

SYMON: We have had some experience at MURA on the comparison of measured values of orbit properties with computed values, not for cyclotrons but for two models of synchrotrons which we have built. For the weak magnet fields that we are using in these models, with a little effort one can make the measured magnetic field agree very closely with the originally desired magnetic field where one computes the magnetic field and then cuts the magnets and winds them according to the computation. Once the measured field agrees with the measurements used in the computer, the orbit properties are almost identical. The frequencies, for example, come out within better than 1/10th of the ν value of the computed field, and the other properties, such as what happens to the orbit when you move the magnet, and so on, all agree in these models, which are perhaps not too different from what one would have in a cyclotron. They agree very well with the computed orbit properties.

CHAIRMAN JUDD: With this very reassuring note--and if the contrary were true I suspect we would not be having a meeting here now--we will adjourn for lunch.