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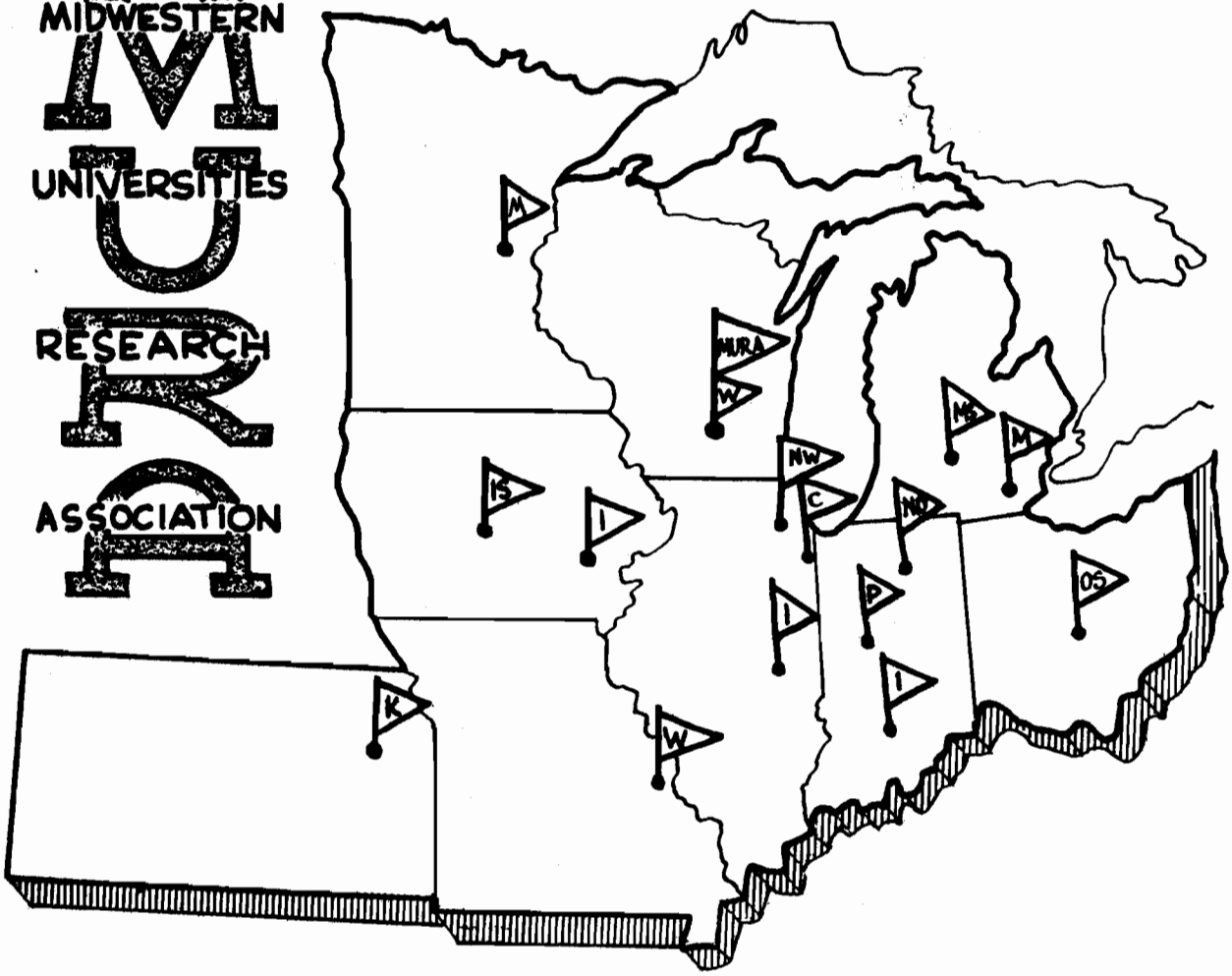

INTERNATIONAL CONFERENCE ON HIGH ENERGY ACCELERATORS AND INSTRUMENTATION AT CERN

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INTERNATIONAL CONFERENCE ON HIGH ENERGY ACCELERATORS AND INSTRUMENTATION AT CERN

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Inasmuch as the full conference proceedings will appear shortly, we will present first merely our general impressions of the conference. We next present a few bits of information gleaned in private conversations which may not appear in the proceedings. Finally we present a somewhat more detailed discussion of what we have learned regarding the FFAG development programs at CERN and at the Lebedev Institute in Moscow.

General Impressions at the Conference

In contrast with the 1956 CERN conference at which ideas for FFAG, colliding beams, and plasma accelerators were presented, the most striking thing about the 1959 conference seems to be that there is very little really new in the accelerator field to report. The only really novel idea presented in the 1959 Conference that comes to mind is the suggestion of cryogenically cooled, air-core guide-field magnets and this idea has received so little development thus far that it is difficult to evaluate its importance. In spite of the paucity of new ideas the conference program was quite crowded with papers. There has been a great deal of theoretical and experimental development work since 1956 both on conventional accelerators and on the new accelerator ideas presented at the 1956 conference. The major theoretical and experimental developments have run strikingly parallel in the United States, in Europe and in the Soviet Union.

Developmental work on FFAG accelerators and particularly on electron models is being carried on primarily at MURA, at the CERN accelerator development group and at the Lebedev Physical Institute in Moscow. The latter

two groups are engaged in designing two-way electron machines, but have no operating machines yet, nor did they report any studies on high energy proton accelerators. In addition there are of course many groups in the United States, in Europe, and in the Soviet Union working on Thomas cyclotrons and spiral sector cyclotrons. A spiral sector cyclotron is now operating at Dubna in the Soviet Union and a Thomas cyclotron at Delft in Holland.

Several papers reported theoretical and some experimental work on stochastic acceleration processes which were suggested at the 1956 CERN conference. More work is needed before the merits of stochastic acceleration methods can be properly evaluated.

There were surprisingly few papers presented regarding the proposal in 1956 by Budker to utilize a relativistic plasma to generate the guide field for an accelerator. In spite of the considerable amount of interest which has been generated by this suggestion, there has been relatively little experimental and theoretical progress and it is still not possible to evaluate the practicality of this proposal. Two papers were presented by Veksler concerning shock coherent acceleration, that is, the acceleration of particles by elastic or inelastic collisions of plasma bunches. Veksler's work was predicated on the assumption that a small stable relativisitic plasma ring of the type envisioned by Budker can be generated and that one such ring can be propelled into collision with a second one. If the e/m ratio of the first ring is small and the e/m ratio of the second ring is large, and if the mass of

the first ring is larger than the mass of the second ring, then acceleration of the first ring to particle energies of a few million volts followed by a collision with the second ring will result in energies of the particles in the second ring of many billions of volts. However, almost nothing is yet known about whether such collisions will actually occur in the manner envisioned by Veksler and whether the rings will be sufficiently stable during the collision.

In view of the fact that during the latter half of the week of the conference a number of separate informal sessions on plasma accelerators and on FFAG accelerators were organized, our attendance at the regular sessions during the latter half of the week was somewhat spotty. These sessions were concerned with experimental techniques for utilizing high energy accelerators. A number of papers were presented on electronic techniques for use with counter arrays, on bubble chambers, on techniques for analyzing bubble chamber pictures, and on electromagnetic beam separators which have now reached a rather satisfactory state of development. Perhaps the newest addition to the experimental tools available in high energy physics is the scintillation chamber. A number of groups mostly in the United States are working on fiber bundle and solid scintillation chambers. The few pictures attained to date are still of rather primitive quality but are beginning to approach a resolution which will be useful in performing experiments. Much better chambers are anticipated in the near future. Jones already has a scintillation chamber experiment in progress at Berkeley. Bridge of MIT reported that his group expects to have a rather large fiber bundle scintillation chamber

in operation at the Cosmotron by the end of the year with which they hope to measure the g factor for the lambda particle.

Special Items of Information

The 50 Gev alternating gradient synchrotron planned by the Russians was originally designed to contain a number of reversed field magnets whose purpose was to push the transition energy above 50 Gev. It was learned that, if it turns out, as now seems likely, that the transition energy is not a serious problem, this accelerator may be built without reversed magnets in which case, due to the improved circumference factor, it will be able to reach an energy around 70 Gev, with the same number of magnets.

The 7 Gev AGS model reported by the Russians in 1956 is expected to be in operation next year. Injection is at 3.6 Mev by a Van de Graaff. Work is in progress to inject at higher energy with a linac. The machine will be used for high energy physics experiments, regardless of the appelation "model."

Rodionov presented a paper on relativistic plasmas. The Russians are experimenting with a high current betatron developed for the purpose of trying to approach the Budker regime, but Rodionov was unwilling to state for publication the currents which had been achieved. He did say however in private conversation that currents of 100 amperes of 10 Mev electrons had been achieved but that the measurements were preliminary and that they were not ready to state for publication that currents this high had been reached. If true, this represents a tenfold increase over the currents reported at the

1956 conference. It is still a factor of ten or so below the currents necessary to reach the Budker self-focusing conditions.

During the last days of the conference, the CERN proton synchrotron group succeeded in getting an injected beam into the AGS and around one turn. The output current from the 50 Mev linac is 5 milliamperes and appears to be reasonably well collimated. Once the inflection fields had been adjusted, there was no difficulty in attaining a beam for one turn around the accelerator. The beam was well centered in the vacuum chamber. By varying the injection time, it was possible to move the beam back and forth as much as 5 centimeters on a fluorescent screen at the end of the first turn. This indicates that the beam is comfortably clearing the walls of the vacuum chamber all the way around. If no further difficulties are encountered, accelerated beam may be expected very soon and in any case, the group at CERN expects to have an accelerated beam by the end of this year.

The CERN accelerator development group have a Pfeiffer ultrahigh vacuum mechanical pump under test. There seem to have been some difficulties with leaks in their test system which were not associated with the Pfeiffer pump. In any case under blanked-off conditions, the Pfeiffer pump has run continuously for a period of time with a vacuum of 10^{-8} mm Hg.

CERN FFAG Development Group

The CERN advanced accelerator development group is under the direction of A. Schoch. A subgroup under the direction of M. Pentz is working on a 100 Mev two-way electron accelerator. The group consists, in addition to Pentz, of N. Vogt-Nilsen and P. Kirstein (Theory), E. Fischer (Vacuum)

and Suzini (RF). They hope to complete this accelerator in 1962. Injection will be at 2 Mev from a Van de Graaff generator in order to be able to inject above the transition energy. The repetition rate will be several hundred cycles per second and the voltage per turn required will therefore be several times higher than in the MURA accelerator. It is planned to use two rf accelerating cavities, each very similar to the MURA cavities, properly phased with respect to each other. The CERN group have developed a new concept in the construction of FFAG magnets which they hope will prove feasible. Their present concept envisages a magnet consisting of a contoured pole similar to the MURA magnet in the high field region, terminating in flat parallel polefaces in the low and medium field regions. A series of flat coils will be prefabricated and laid over the flat pole area in such a way as to achieve the desired k value in the low and medium field regions entirely by means of properly arranged backwound coils. This design has the advantage of simplifying the machining of the magnets and the winding and placing of the coils. It has the disadvantage over the MURA design of losing the automatic scaling feature in the low and medium field regions and of replacing the precision machining which is required in the MURA magnets with equally high precision winding which is required in the CERN design. A model magnet of this type has been built with only three layer coils. The measured k values showed considerable variation with radius as may be expected but the variation is in accord with theoretical calculations and therefore affords some confidence in the possibility of designing such coils theoretically. Another novel feature of the CERN design which is possible in a two-way accelerator is the elimina-

tion of the back legs on the magnets. The flux through any given magnet is returned through its adjacent neighbors in which the field is in the reversed direction. In this way both the outer and inner perimeters of the accelerator are free of iron and the vacuum tank is accessible throughout the entire circumference.

FFAG Development at Lebedev Physical Institute

A group including A. A. Kolomenski and A. N. Lebedev are working on the development of a 30 Mev two-way electron accelerator which they hope to complete in 1962. Present plans call for a k of 16 with injection at 60 kev. There will be a preliminary betatron stage of acceleration to avoid an excessive fm modulation range. The revolution frequency at 60 kev will be 16.8 megacycles and will increase to 34 megacycles at the transition energy, then fall to 29 megacycles at 30 Mev. A peak voltage of one kilovolt per turn will be required in order to achieve a 200 cycle repetition rate. They are considering the possibility of utilizing a stochastic acceleration method across the transition energy. Studies of the possibility of utilizing a dee system for rf acceleration were discouraging because of the likelihood of many resonant modes. As a result, they plan to use a low Q rf cavity similar to the cavity in the MURA 40 Mev two-way accelerator. A number of magnet models have been constructed very similar in concept to those in the MURA 40 Mev two-way design. Like MURA, they are concerned to hold flutters in k with radius to a minimum and have made studies regarding the optimum arrangement of slots for this purpose. These studies are reported in a paper by Kolomenski which will shortly be available in translation at MURA and which should also appear in the proceedings of the CERN conference.