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MONTHLY REPORT OF ACTIVITIES*

F. T. Cole

September 1, 1968

Abstract: This report covers the activities of the National Accelerator Laboratory for the month of August.

*This work was done under auspices of the United States Atomic Energy Commission.

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General

1. Status of Appropriation. The fiscal-year 1969 public-works bill containing a $14.574 million appropriation (including carryover funds) with limited construction authorized was signed into law by the President on August 12. We are now awaiting apportionment of funds by the Bureau of the Budget.

2. Construction Schedule. The schedule for construction of the linac building has been moved up in time. It is now planned to solicit construction bids on October 15, at the same time as bid solicitation for the first rough-roads and grading contract.

3. Development of the Campus. All homeowners in the village have accepted offers from the State. Four are planning to move their houses to sites in other municipalities. The village has disposed of practically all its equipment and is expected to complete dissolution soon.

The oft-delayed move of the entire Laboratory to the Campus has still been in some difficulty. Possession of an additional 17 houses was given to the AEC by the State on Friday, August 30. These houses will be readied for occupancy by Laboratory staff during the first week in September. During that same time, we expect further houses to be turned over for our use. We plan to move staff as rapidly as possible and plan to vacate our present quarters completely by October.

The central telephone system was in operation on schedule (August 19). All our existing service at the Campus has been converted to the new number, area code 312, 231-6600. Installation of new service in newly acquired offices and laboratories is proceeding although it is slowed by the telephone strike. Our permanent Campus mailing address, Post Office Box 500, Batavia, Illinois, 60510, is also in operation.

Laboratory Building 3, the RF Building, has been occupied by the rf and booster sections. A contract has been let for plumbing, heating, and ventilating installation. Electrical distribution inside the building is ready to go to Purchasing. It is planned to solicit bids for three new laboratory and shop buildings (Building 4, Research Facilities, Building 5, Main Ring, and Building 7, Machine Shop) early in the second week of September. Building 6, Booster, has undergone a significant design change to reduce the cost of the adjacent booster- enclosure prototype. The booster laboratory and prototype combination is expected to be ready for bid on October 1, at the same time as the main-ring enclosure prototype* to be constructed next to Building 2, the inflatable building. Building 8, Headquarters Quadrangle,

* The prototypes have been infelicitously named "protoboost" and "protomain."

is expected to be ready for bid September 23. The Campus electrical-distribution system is expected to be ready for bid on October 15.

4. Site Acquisition. The State is proceeding toward acquisition of the remainder of the site. At this time, owners of five tracts have signed contracts to sell their properties.

5. Aspen Summer Study. The Summer Study at Aspen has ended,and reports are being collected and prepared for distribution under the direction of Arthur Roberts.

6. Laboratory Staff. On September 1, the Laboratory has 233 employees, including 67 scientists and engineers.

Storage-Ring Summer Study

An intensive and successful two-week working session on the design of storage rings for the NAL accelerator was held during the latter part of August. Over a dozen physicists and engineers from outside NAL participated for various periods during the session. Prior to the working session, discussions were held among experimentalists at Aspen during the last two weeks of that Summer Study concerning experiments using the storage rings and their bearings on the design of the storage rings, especially the interaction regions. The outcome of these discussions forms part of the basis for the design. The design studies were concentrated on two concentric 100-BeV rings with six insertions in the normal lattice. Two of these insertions will be used for injection into the rings and the remaining four will be used for colliding-beam experiments. A triplet lattice and a FODO lattice were investigated. Three types of magnets, conventional copper-iron magnet, cryogenic aluminum-coil magnet, and superconducting magnet were studied. The bypass storage ring concept was abandoned because of the relatively low vacuum of 10^{-7} torr in the main ring of the accelerator, leading to excessively short beam lifetime and severe radiation problems in the main ring, and because it would prevent using the accelerator for other experiments while colliding-beam experiments were being performed. Several reports on the design of various components of the storage rings were written during the study session and are being prepared for distribution.

Another study session during the first week of October is planned. This session will be devoted mainly to experimental use of the storage rings, and its influence on the design of the interaction regions.

Main Ring

1. Model Magnets. Measurements with dc excitation of the 3-foot model B2 magnet have been made with gradient coils. Significant differences at high fields between different kinds of iron have been found. The width of the useful field region appears narrow. A part of this effect is known to be caused by excessive insulation thickness (space between the coil turns and space between the coil conductors and the iron poles). We have decided to order some new coils with insulation thickness corresponding to present

design values. The data could have been influenced by the gradient coils used, which do not have exactly the ideal shape. New coils are being made, with larger effective area, so that the effect of integrator drift will be reduced. Some preliminary data on the end fields indicate an effective extension of about 0.2 in. of the field beyond the physical end of the iron. Pulsed tests will start soon since the first operation of the power supply in the pulsed mode took place at the end of the month. Coils and laminations for the model quadrupole magnet are now on order. As insurance against the difficulties we have had with bending-magnet coils, quadrupole coils were ordered from two vendors, both of whom provided attractive proposals.

2. Fabrication Methods. A core half has been stacked with the side straps notched into the sides of the laminations. The scheme appears to work very well and most probably will be adopted. A TIG weld of the edge of the strap to the adjacent laminations is very successful.

3. Data Computer. The computer for automatic data recording and reduction has been ordered. The computer manufacturer has accepted the responsibility for interfacing the analogue-to-digital equipment to the computer.

4. Vacuum System. The vacuum-chamber model that was built last summer at the Physical Sciences Laboratory of the University of Wisconsin

has been reassembled with welded flanges developed here. Its length exceeds that of the inflatable building where it is installed, so that it extends outside through a hole, as can be seen in the attached photograph. Only ordinary cleaning methods have been used, and the average pressure is 2 to 3 $\times 10^{-8}$ torr.

RF Systems

1. Final Power Amplifier. A comparison of planar triode characteristics is being made with the aim of selecting a particular tube for use in the lower half of the 100 kW cascade power amplifier. The main firms in the U. S. dealing in planar triodes are General Electric, Eimac-Varian, Machlett, and RCA, although we have included all potential suppliers in the present comparison. The planar-triode stage is central to the development because it permits us to minimize rf-envelope delay time in the amplifier chain and thereby achieve effective regulation for beam loading.

2. Booster Cavity. Twelve ferrite cores of Stackpole 2285 material have been tested for low-level Q. Six of these are 5.9 in. O. D., and will be placed in an existing 6-in. TEM-mode test cavity for further evaluation. The ferrite density of 3.98 gm/cm^3 is undesirably low compared with a theoretical (X-ray) density of greater than 5 gm/cm^3; a measurement of incremental permeability vs dc magnetizing force will be made to determine whether the material is useable or not. The deciding factor is the biasing power required. Low-density (excessively porous) ferrite requires a higher biasing

current and generally more costly power supplies.

3. Space Allocation. RF models and related equipment developed during the accelerator design study have been shipped from Berkeley, California to Laboratory Building 3. Some machine tools have been delivered for the rf model shop that will occupy the southeast corner of the building. Temporarily, the booster-magnet stacking fixture is located in the southwest corner and the booster tunnel model in the north end of the building.

4. Future Plans. It is planned to have the developmental booster cavity operating early in 1969. The primary effort this fiscal year is being devoted to the booster high-level system, with less emphasis on the main-ring system.

Booster

1. Buildings and Models. The Pre-Title I review of the layout of the Booster Building is now completed on schedule in preparation for excavation to begin early in 1969. In addition, construction of the prototype enclosure section and laboratory building is to begin in October. A wooden model of the enclosure has been built in Laboratory Building 3. This contains a model support girder together with its power-supply cell. It will be used for studying the layout of components and their interconnections.

2. Magnet. DC magnet measurements are proceeding and efforts are being made to improve the measuring techniques. The magnet design is

now taken to be fixed, so that a complete set of computations and magnetic measurements can be performed. This reference design is that described in last month's report, having external dimensions of 16 in. by 12 in. The coil proposed for this is wound from 0.5-in. sq. copper conductor with a 0.3-in. diameter cooling hole. The stacking fixture is now assembled and stranded-cable coils suitable for 3-ft model magnets have been delivered. Stacking and assembly tests are now beginning using laminations from a previous magnet design (24 in. by 16 in.). Other models expected to arrive this month include a 10-ft magnet with straight pole faces for vacuum tests, and 3-ft magnets for dc measurements. The object of these latter measurements is to determine the available good field width as a function of magnetic field level.

3. Magnet Power Supply. A study has been made of adding a second-harmonic component to the booster magnet current cycle. It appears that considerable cost savings can be realized in the booster rf equipment by the addition of a second harmonic having an amplitude one-eighth of the fundamental.

4. Plans for the Coming Month. Studies of the implications of adding a second-harmonic rf cavity will continue. In addition, the possibility will be examined of initial operation of the booster at reduced repetition rate with a correspondingly reduced rf system.

Linac

1. Campus Facilities. The main power distribution in Building 1 (the Linac Research Building) has been completed. A temporary garage has been constructed north of the building to house dirty grinding and polishing work, mainly on the preaccelerator column, without interference to the high-voltage and rf equipment in the laboratory building. The third linac house (which is shown in an accompanying photograph) is in use, largely as a drafting room. Construction of an entryway connecting the three houses and the laboratory will begin shortly.

2. Modelling Program. The SDS Sigma II computer was delivered and has operated successfully. The interface equipment necessary to allow measurements of rf fields with the computer has been ordered and delivered, and experiments using this equipment will soon be in progress.

Installation of the 200 MHz driver power supply has been completed and the equipment has been operated at full power level, i.e., about 300 kW. This operation of this power supply will now allow full-power tests on the linac model cavities to proceed.

Fabrication of the components for the 10 MeV linac cavity, preaccelerator, and rf system are proceeding. Efforts are now being directed toward the beam-transport system and diagnostic equipment.

3. Building Design. The Title I report on the linac building design was reviewed by the AEC and NAL and approval given by the AEC to proceed to

Title II. The report was sufficiently favorable to consider an acceleration of the schedule (see discussion above) and efforts are now proceeding at the accelerated rate. All equipment layouts and building details are now being finalized preliminary to construction.

4. Plans for the Coming Month. Extensive work will continue on the design of the permanent linac building. Fabrication of the components for the 10 MeV linac prototype will continue. Additional peripheral and interface equipment for the computer, pulsed quadrupole power supplies, and beam-transport elements will be ordered. The design of beam diagnostic equipment will be started.

Radiation

1. Calculations in Progress. Studies are in progress on:

   (i) soil radioactivation around a small iron booster dump.

   (ii) efficiency of a soil gross γ-radiation ionization chamber. This is the start of the environmental surveying and monitoring program.

   (iii) muon shielding.

2. Booster Enclosure. The Pre-Title I booster enclosure drawings have been reviewed.

3. Radiation Equipment. Some equipment has been ordered for the radiation-physics laboratory to be started at the Campus.

Fig. 1. Main-Ring Vacuum System Model

Fig. 2. Linac Houses and Research Building