APPENDIX XIV. COST ESTIMATE AND SCHEDULE

J. E. Finks, Jr.

The cost of the Energy Doubler is determined by a number of factors and definitions. For example, how fast will it be funded, and what part of the experimental facilities will be defined as Doubler?

In our proposal of June 1975 when we anticipated receiving a "new construction" authorization, we estimated the costs on the basis of a definite schedule and on the scope of the Energy Doubler as specified in that proposal. Our estimate, based on a very rapid schedule of building the Doubler largely in FY 77, would still be $35 million, and on a slower schedule to be about $50 million. New data accumulated over the past year show no reason to change that estimate.

At present the Doubler is being funded as an R&D project. At the rate we can anticipate funding, we are on a slow schedule so the total cost probably corresponds to approximately $50 million. On the other hand there is a considerable difference between an effort undertaken with stretched-out funding on an R&D basis and the deliberate development of a totally funded new construction project. There are advantages as well as disadvantages to each method, and the total cost may turn out to be smaller -- or larger. Clearly the Doubler implemented on an R&D basis will advance in stages that are more narrowly designated and the final scope of the project may be different than presently presented in this report because of developmental results.

As one example of how the program might proceed let us assume that $10 million will be available in FY 77 and that about $25 million will be available in FY 78. On that basis we should be able to build all of the magnets, to have installed them in the tunnel and to have sought a coasting beam before the end of FY 78. Expected results by fiscal year are as follows. (See also Schedule Table XIV-I and Fig. XIV-1.)

Table XIV-I. Energy Doubler Cost Estimate*
(to circulating beam)

	FY 77	FY 78
MAGNETS		
Number of 22-ft Dipole Magnets	270	530
Number of Quadrupole Magnets & Correction Elements	0	200
Dipole Magnet Cost	$ 5,400	$11,600
Quadrupole Magnet & Correction Element Cost		1,800
Subtotal - Magnet Cost	$ 5,400	$13,400
OTHER COMPONENTS		
Vacuum	$ 80	$ 300
Controls		300
RF		1,200
Power Supplies		300
Beam Transfer		600
Supports	70	700
Conventional Utilities		1,000
Subtotal - Other Components	$ 150	$ 4,400
ANNUAL R&D	$ 4,000	$ 5,000
SATELLITE REFRIGERATOR SYSTEM	$ 450	$ 2,200
TOTAL - Energy Doubler/Saver (less Central Helium Liquefier, and Contingency)	$10,000	$25,000

*In thousands of dollars

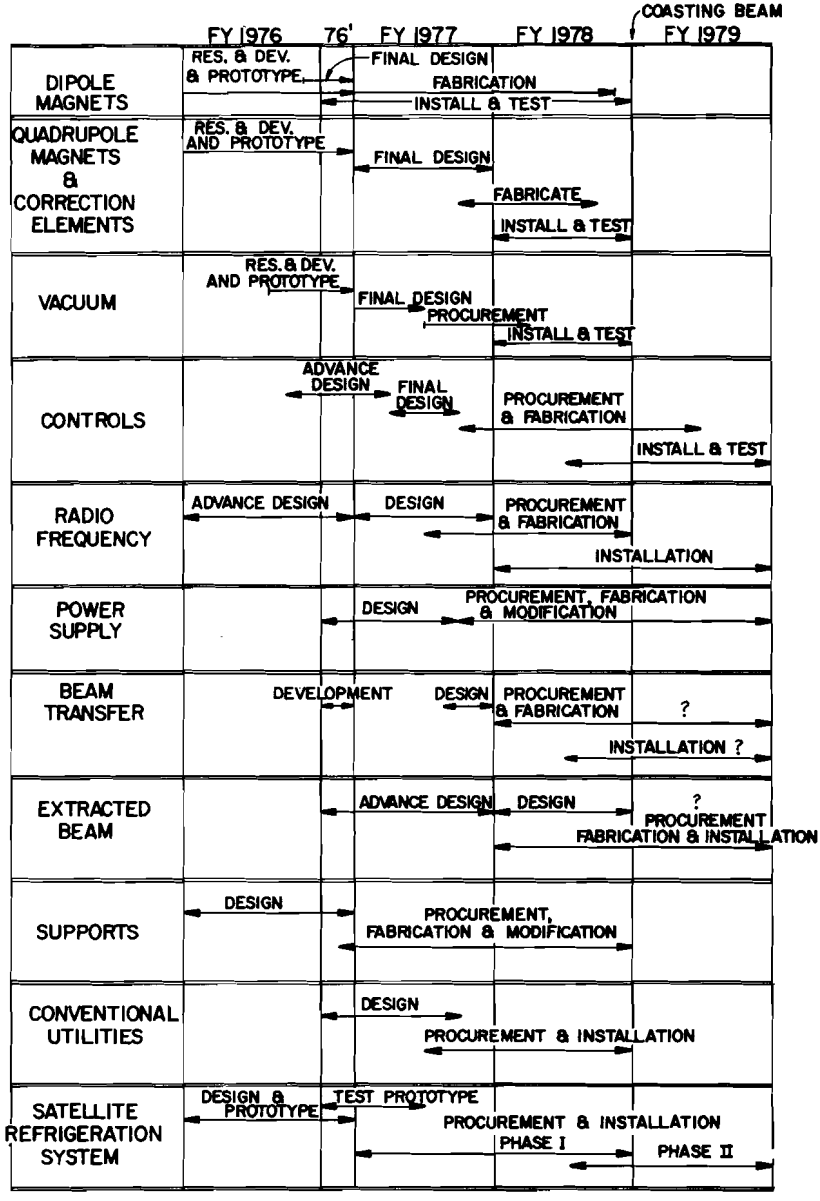

Fig. XIV-1. Proposed schedule for completion of Energy Doubler.

Fiscal Year 1976. During FY 76, extensive progress was made in the development of various models of components for the Energy Doubler. Major accomplishments included perfection of 23-strand, Rutherford-type superconductor cable, fabrication and testing of several 10-ft dipole magnets that reliably achieved the 45-kG design field, installation and operation of model magnets in the Main-Ring tunnel, and design and assembly of the first satellite refrigerator. Production of 22-ft Energy Doubler dipole magnets started on January 20, 1976. We tested the first 22-ft magnet on March 12 and were extremely pleased with this test, because it demonstrated convincingly our ability to produce full-size Energy Doubler magnets that meet performance requirements. By the end of FY 76, we should have fabricated six 22-ft magnets. With the ten magnets planned for the mini-year, this should give us enough dipoles to make up the first string of magnets from Service Building B-1 to the injection line. The first satellite refrigerator is presently being assembled and is scheduled for testing in the Village. Subsequent to testing, it will be moved to Service Building B-1, so that by October 1976 we may expect to have the first magnet string in place and, in addition, to be able to cool it with the satellite refrigerator. We plan to bring 100-GeV beam to B-1 through the Doubler magnets.

The production-magnet field-measurement device for the Energy Doubler development program has been assembled and tested. This includes the necessary magnet stands, a new search-coil system, the existing data-acquisition system, power supplies and junction boxes required by the new cryogenic system. General-purpose search coils, short and long, have been developed for use with the Energy Doubler magnets.

During the mini-year (July-Sept. 1976), we will be severely limited in Energy Doubler production capability by the $11 million provided to the Laboratory by present financial plans. We will be able to finance a maximum of ten magnets during the mini-year. Not only will our in-house production suffer, but we will be forced to delay industry participation to develop magnet-production capability. Efforts on the satellite refrigerator system will be minimal during this time.

Fiscal Year 1977. The budget submitted by the President to the Congress for FY 77 requests $2 million specifically for Doubler R&D. With the funds requested by the President, some 80 Energy Doubler dipole magnets would be fabricated in-house and installed in the Main-Ring tunnel during FY 77. In addition, initial orders would be placed with three commercial firms for the construction of 25 dipole magnets

(eight or nine magnets per firm) to be delivered in FY 78. This would allow qualification of the firms in anticipation of total project funding in FY 78 to allow completion of the Energy Doubler.

We have assumed that an additional $4 million will become available in FY 77, thereby allowing us to increase the production of the Doubler magnets to a total of 270. This corresponds to the example given above and to the entries for FY 77 in Table XIV-I.

The 1500-W helium refrigerator ordered from industry will be delivered and evaluated. Testing of the Fermilab-developed satellite refrigerator system will be completed and final specifications written to allow industry involvement in production of additional systems. Two more satellite refrigerators will be installed during FY 77, making a total of three by year-end.

R&D Efforts will be continued to allow extraction of all possible useful information from the prototype systems and test loops until installation of the final magnets starts.

Fiscal Year 1978. During FY 78, we expect to achieve installation and operation in the Main-Ring tunnel of all Energy Doubler magnets, with the achievement of a coasting beam with acceleration at a slow repetition rate. This will allow the beginning of experiments in the new energy range using the Internal Target area. Attainment of a stored beam in the Doubler opens up the possibility of bringing about collisions between protons in the Main Ring with those in the Doubler. This possibility is being intensely evaluated.

About one-half of the satellite refrigerators will be installed by the end of FY 78. These will be adequate for achieving a circulating beam at a slow repetition rate.

Beyond Fiscal Year 1978. Installation of all components for the Energy Doubler will be completed in FY 79. Full-capacity refrigeration equipment will be installed to allow 10^{12} protons per sec accelerated to 1000 GeV. The 1000-GeV proton beam will be extracted and transported to experimental areas for use in physics experiments. Energy Doubler use will be programmed for electrical-power savings.