REPORT ON CESR, THE CORNELL ELECTRON STORAGE RING

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I wish to take just a few minutes to describe the status and progress of CESR, the Cornell Electron Storage Ring.[1] CESR is an electron-positron storage ring which is designed to operate over the range from 3 to 16 GeV center of mass energy, with capability of eventual extension to 20 GeV in the center of mass. The luminosity will peak at 16 GeV at the design level of $10^{32}/cm^2/sec$.

CESR Description

The storage ring is mounted in the same tunnel with the Cornell synchrotron, and uses the synchrotron as an injector. The configuration of the facility is shown in Fig. 1. Here we see a cutaway of the Wilson Synchrotron Laboratory and tunnel. The tunnel passes through the main experimental hall of the laboratory on the south, and through an underground experimental area on the north side of the ring. The tunnel lies 50 feet below the Cornell campus with the synchrotron hall located on the side of a deep gorge. Figure 2 shows a view of the tunnel with the synchrotron on the right, and the new storage ring installed on the left.

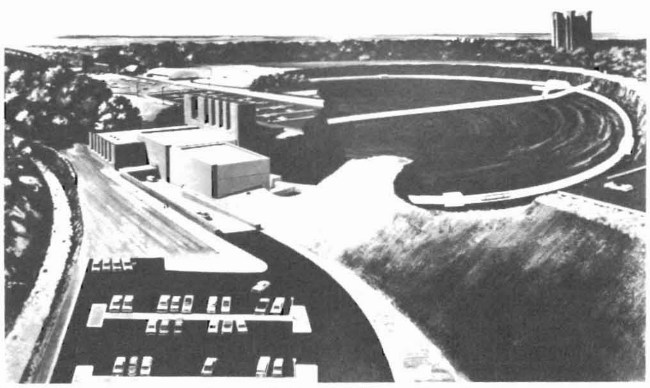

Fig. 1 Cutaway view of the Wilson Synchrotron Laboratory showing the tunnel for CESR and the Synchrotron.

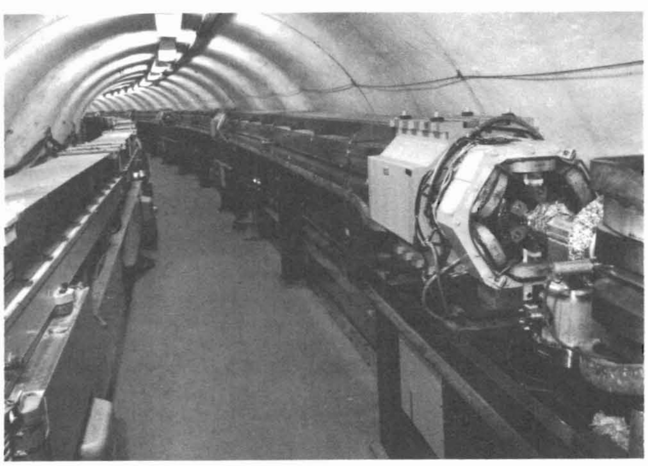

Fig. 2 Tunnel interior with the CESR guidefield magnets shown on the right and the synchrotron magnet ring on the left.

Figure 3 is a schematic diagram of the way in which the injection system works. We have combined some components of the old CEA linac together with those of the Cornell linac to provide positrons by double conversion, as well as electrons. The positrons are injected counterclockwise into the synchrotron and then transferred to the storage ring using the west transfer line. Electrons are similarly accelerated in the clockwise direction and transferred through the east transfer line. In order to increase the effective intensity of the positron source, sixty bunches of positrons are accelerated in the synchrotron at a 30 Hz rate and fast extracted into the storage ring where they are accumulated and stored. To maximize the luminosity we coalesce these sixty bunches into one bunch by making use of the fact that the perimeter of the synchrotron ring is less than that of the storage ring by the amount of one bunch separation. After positron filling is completed, individual bunches are extracted, one at a time, from the storage ring and reinjected into the synchrotron for a predetermined number of revolutions before reinjection into the storage ring. As the bunch circulates in the synchrotron, for every revolution of circulation, the chosen bunch advances in azimuthal phase with respect to the bunches left in the storage ring by one bunch separation, thus one may coalesce each of the bunches into a common bunch by the appropriate programming of the number of revolutions of circulation in the synchrotron before reinjection into the storage ring. When stacking is complete, the machine operates in the single bunch mode with two interaction points, one in the main experimental hall and one in the north experimental area.

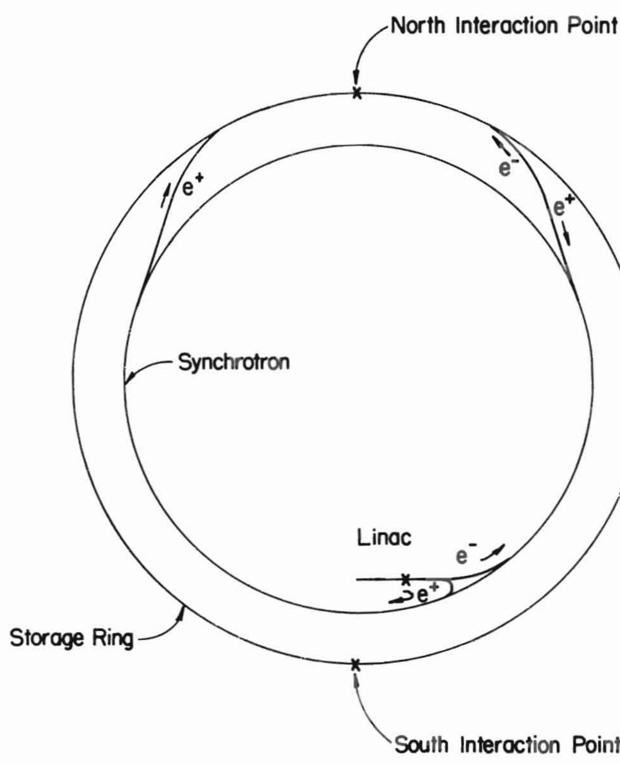

Fig. 3 Schematic layout.

In Fig. 4, we give a few of the basic characteristics of the machine. Figure 5 shows the design luminosity curve as a function of energy for CESR, with corresponding curves given for PEP, PETRA and SPEAR. CESR is ideally suited for the study of the upsilon spectroscopy and other phenomena in this region since we should have an advantage of a factor of 4 in luminosity as well as a lower operating cost.

CESR DESIGN CHARACTERISTICS

PEAK BEAM ENERGY		
	Present program	8 GeV
	Capable of extension to	10 GeV
LUMINOSITY AT 8 GeV		$10^{32}/cm^2/sec$
CIRCULATING CURRENT		
	At 8 GeV	100 ma each beam
	At 5 GeV	60
COST (Storage ring only)		\$ 13 Million

Fig. 4

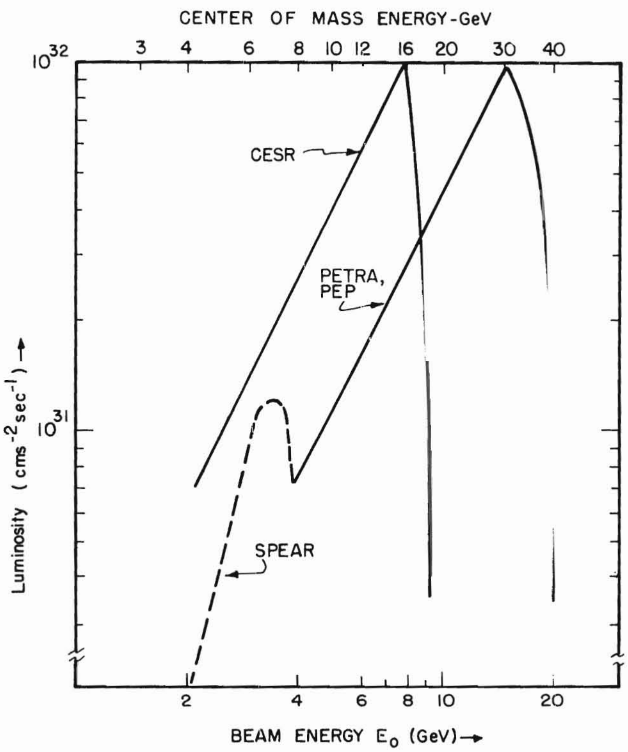

Fig. 5 A comparison of the design luminosity of CESR, PEP, PETRA. The performance of SPEAR is also shown.

In Figs. 6 and 7 is a resume of our rate of progress and performance to date. The program received approval for funding just a little less than two years ago today. First turns were injected into the new ring on April first of this year with stored electron beam following two weeks later. Positrons were first stored May 28 and the demonstration of coalescence was made on June 20. Though coalescence has been accomplished, we have not performed it with high efficiency. Our single bunch intensity gain factor is only 10 instead of the design factor of 30. We have discovered some phase space mismatch in the reinjection process and we are now working to correct this problem. Last week, using the positron coalescence method, we simultaneously stored positron and electron beams of 2 milliamperes each. Electron-positron collisions were detected with our luminosity monitor and a luminosity of about $4 \times 10^{28}/cm^2/sec$ was measured. Within the next few weeks we hope to obtain a luminosity adequate to begin the experimental program.

CESR PROGRESS CHART

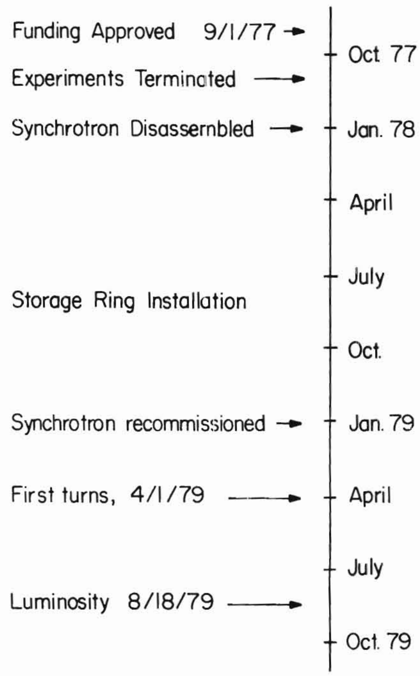

Fig. 6

PERFORMANCE ACHIEVED AT 5.5 GeV per BEAM 8/18/79

- Stored Electron beams to 13 ma.
- Stored Positron beams
  17 ma total in 60 bunches
  2 ma in one coalesced bunch
- Lifetimes up to 3 hours
- Measured luminosity - $4 \times 10^{28} cm^2/sec$

Fig. 7

Experimental Facilities

I would like now to say something about the experimental facilities. As indicated above, there are two interaction points. One of these, the south interaction point, is in the main experimental hall of the laboratory. A large general purpose detector called CLEO[2] is being mounted there. The north experimental area is much more restricted in space so that only smaller apparatus may be mounted there. An experiment proposed by a collaboration from Columbia and Stony Brook has been approved for the North Area. Their apparatus is a large Sodium Iodide and wire chamber system designed for the study of photon and lepton decays of the upsilon and similar processes. Their equipment is designed to obtain high spatial and energy resolution for electrons and photons in the study of the quark spectroscopy. Installation is expected to be completed in the fall of this year.

The CLEO detector of the main experimental hall is being built and installed by a collaboration between five outside university groups together with Cornell. These universities are: Harvard, Rochester, Rutgers, Syracuse, and Vanderbilt. This is a collaboration of about 70 persons. Figure 8 shows a section of the apparatus as viewed along the beam line. The detector has a longitudinal magnetic field provided by the solenoidal coil as shown. Surrounding the thin walled beam pipe, we have first a proportional wire counter which gives accurate longitudinal information on the emerging charged particles.

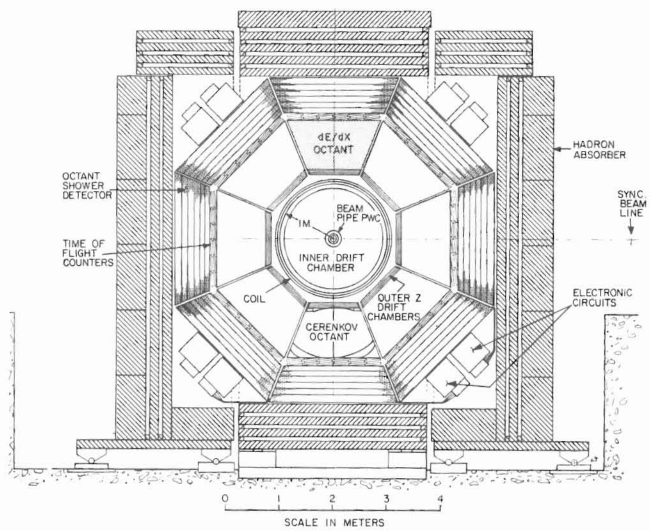

Fig. 8 The CLEO magnetic detector as viewed along the beam line.

Surrounding this, but inside the coil, is a 5,000 cell, 2 meter diameter drift chamber which has 17 layers of wires. Outside the coil are several layers of other detectors which perform various functions. These detectors are assembled in separate octants which surround the coil. Included in these octants are drift chambers next to the coil which provide a precise measure of the z coordinate of emerging particles. Surrounding this is a large space which is provided for devices which measure the velocity of charged particles. The initial assortment of detectors in this space will include two octants of high pressure Cerenkov counters, four octants of atmospheric pressure Cerenkov counters, and two octants of a novel proportional wire system which will measure dE/dx. Eventually, it is planned to provide all octants with dE/dx devices if they prove to be as satisfactory as we believe them to be. Next is a layer of time of flight counters at a distance of about 2 m from the interaction point.

Immediately behind the time of flight counters is a 12 radiation length shower counter made up of an array of crossed proportional counters and lead sheet. Finally, movable iron shields cover the whole system, with muon counters located in two layers on the outside of the shield. Though we are presently working on assembling a thin superconducting coil for the detector, the initial running will be done with a one radiation length aluminum coil operating at 0.5 Tesla. Figure 9 shows a transverse view of the detector. Figure 10 is a view of the drift chamber. Figure 11 shows a partially assembled octant under test. In Fig. 12 we see the first unit of the dE/dx chamber which is to be inserted in an octant.

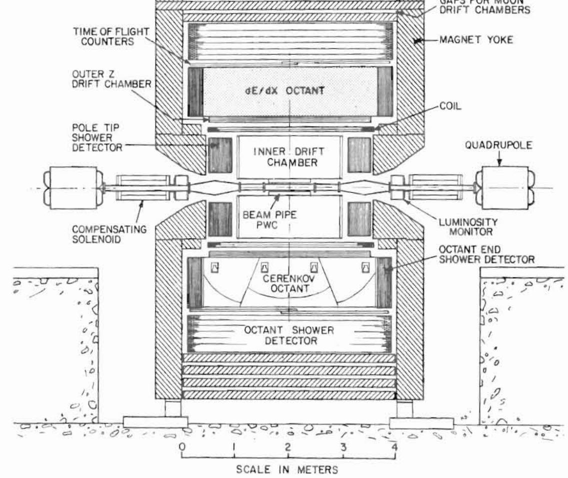

Fig. 9 The CLEO magnetic detector as viewed perpendicular to the beam line.

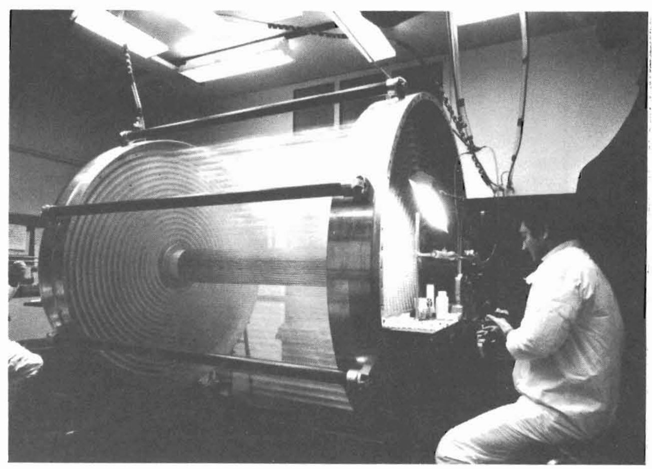

Fig. 10 View of the central drift chamber of CLEO during construction. More than 5,000 cells are provided, arranged in 17 layers.

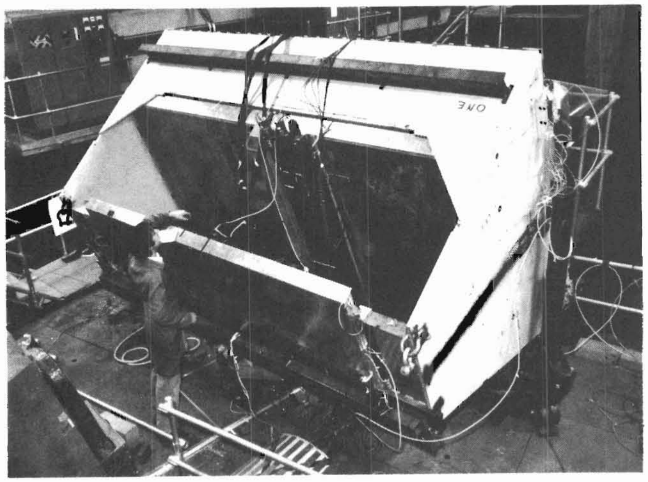

Fig. 11 A view of a partially assembled octant of the CLEO detector.

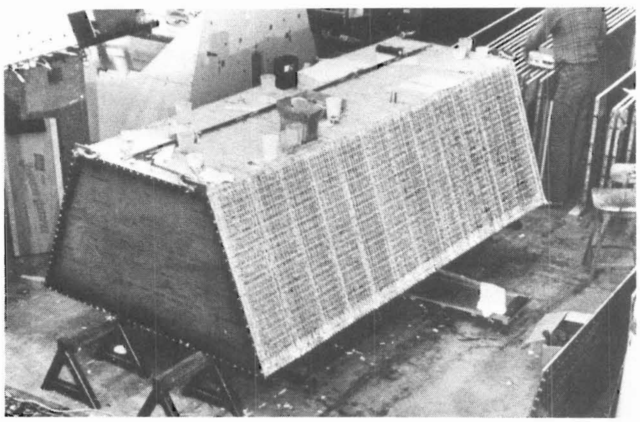

Fig. 12 View of a nearly completed dE/dx chamber.

Presently, the assembly is nearing completion. The magnet and muon shields are in place. All components of the inner detector are installed, and five of the outer octants have been mounted. Two more octants will go into place next month, and the last one will be mounted in November. Figure 13 shows an exterior view of the system with one of the 8 octants in position.

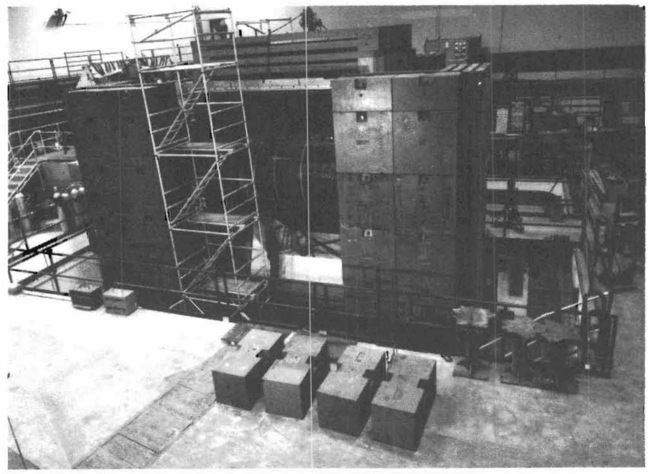

Fig. 13 Exterior view of CLEO. This view shows the solenoid in place together with one of the octants below. The outer muon shields have been parted to provide access.

The various components of the system have all been tested individually in an electron beam, and cosmic ray tests of the assembled system are now being made. We expect to complete the tests and have a working system within about two months. The software systems are well developed and should be able to turn out significant physics results before the end of 1979.

I would like to acknowledge the efforts of all of those physicists who have contributed to this program. Especial recognition should be given to Professor Maury Tigner who has directed the CESR program, Professor Albert Silverman who has served as coordinator of the CLEO effort, and all of our external collaborators. We also wish to recognize the efforts of the Physics Section of the NSF in their strong support of this program.

References

1. CESR Design Report (CLNS-360) April 1977, Laboratory of Nuclear Studies, Cornell University.

2. The CLEO Detector; E. Nordberg and A. Silverman, CBX 79-6, 1979, Laboratory of Nuclear Studies, Cornell University.