Canadian scientists plan high energy electron ring

Richard Dubinsky

Scientists from York, as well as the University of Toronto, Carleton, and McGill may soon be embarking on a project that some have called "A Window on the dawn of time".

The task before them is an enormous one—involving nearly a hundred scientists, and more than 83 million dollars, but if it's successful, it may help scientists to understand the very origins of our universe.

The project is the construction of a massive experimental apparatus called CHEER, the Canadian High Energy Electron Ring.

York Physics professor Bill Frisken, along with many other scientists from all over the country, is working to make it a reality.

Long Term Project

CHEER is a product of the Institute of Particle Physics, a consortium of approximately 200 physicists who have organized to prepare for future physics projects. Their cooperation is important because physics experiments in the '80s and '90s will be extremely large, costing many millions of dollars, and will require the attention of large numbers of scientists over long periods of time.

Frisken was relieved of his normal fall term teaching duties to allow him to devote his full attention to the CHEER project as chairman of the CHEER Steering Committee. It is asking for an initial two and a quarter million dollars in order to allow a basic study for CHEER to be carried out during the coming fiscal year. It will take an estimated five years more for its final design and construction.

The Electron Storage Ring

Once constructed, CHEER would be a storage device for very rapidly moving electrons. As planned the ring has a circumference of 1350 meters and serves as a racetrack around which the high energy electrons race at the speed of light. Their trajectories are beat into this curved path by high precision electromagnets placed at regular intervals around the ring.

Their actual path around the racetrack goes through a long curved aluminum tube, about 20 centimeters in diameter from virtually all the air has been removed.

The electrons make one circuit of the 1350 meter track in four and a half micro seconds. If this vacuum is good enough and if the magnets are precise enough, CHEER will able to store an electron "beam" for about half a day, by which time they will have gone around the track 19 billion times.

Electrons are pumped into the CHEER ring in three stages. An electron "gun" similar to that found in a television picture tube, provides bursts of electrons. These particles are accelerated to the speed of light in a LINAC (linear accelerator), a long tunnel that uses very short radio waves to push the electrons to the desired speed.

After leaving the LINAC, the electrons enter a booster synchrotron which increases their energy further, and then shoots them into the final electron ring.

The technology is highly complex, requiring very specialized skills. These talents are presently available in Canada but may not remain so if they are not used. Frisken states that "we must have exciting projects in Canada if we wish to keep our scientists from emigrating. It is much easier for good scientists to go to the U.S. or Europe rather than to stay in Canada to develop a new project."

Key to the First Moments of the Universe

All high school science students know that the "atom" in their chemistry course is not the "Greek atom", the ultimate indivisible elementary building block of matter.

They all know that the atom of chemistry consists of a nucleus and peripheral electrons, and they know that the nucleus consists of neutrons and protons. Some of them have heard that the protons and neutrons are not elementary either, but consist of groups of "quarks".

Physicists are working on a theory of the Universe based on the idea that quarks and electrons are the Greek atoms of which all matter is made. This theory is crucially tested by collisions between quarks and electrons at very high energies, that is, during energies high enough to simulate conditions during the "Big Bang", the first second of the history of the universe.

Canada's Technological Bank—A CHEER for Canada

Dr. Frisken believes that new knowledge is extremely important to the human spirit, but as well its pursuit is essential for Canada's economic development.

"To break away from a resource based economy we will need highly trained people such as scientists engineers and technologists," he says. Dr. Frisken believes that they key to more better-trained people lies in getting their attention at the grade 9 level. "Students must be motivated to take science and math at an early age or they will never be able to pursue technical careers."

Another important issue for Canada's development involves raising the technological competence level of industry. For the CHEER project, 80 per cent of the high technology money will be spent in Canada, which will push industries into development. A similar organization in Europe has discovered that for each $1 investment, $6 worth of business is generated. It was found that spin offs from high technology research can be applied in many unrelated areas. Dr. Frisken used the example of a sophisticated mechanism designed for moving magnets, which resulted in applications to tasks in steel yards.

In addition to strengthening Canada's technological Bank, CHEER will be exposed to an international traffic of scientists, engineers and diplomats. Its operation will promote exportation of Canada's technological abilities. Dr. Frisken believes that "There is no reason why Canada cannot become an exporter of high technology. If Canada is to grow intellectually and economically, projects such as CHEER require strong support from both the population and the government."

Dr. Bill Frisken and York honours physics student Paul Padley examine a computer simulation of an electron-proton collision event in a CHEER prototype design.

John Cox, President of Exploranium, gave the first talk in a series sponsored by the York Geoscience Society. For information on the Society's up-coming speakers, contact Rick Keehn in Room 101 Petrie.