Inside the cyclotron

Anno Hellenbroich reports on DESY, one of the world's biggest cyclotron installations, operating in Hamburg, Germany.

During the winter months, maintenance work is carried out at the major research institute called DESY, Deutsches Elektronen-Synchrotron, located in Hamburg, Germany. This offers a favorable opportunity for the visitor to climb down even to the heart of this installation, into the over-6.3 kilometer-long elementary particle accelerator 30 meters below ground.

This part of the cyclotron, which was 90% federally funded, first came on line in 1992. This is the only place in the whole world where electrons and protons are accelerated almost to the speed of light and 30 billion electron volts (BeV) of energy and more, shot against each other and collided. With detectors and complicated methods of evaluation, it is hoped that the subatomic structures of the components of matter as we know it and the interacting forces inside protons and electrons can be better known and better demonstrated.

Above all, it is startling to learn that with one hand, one can almost put one's arms around the electron storage ring; powerful energies are packed into such a small space. The proton storage ring, which runs its course above the circular electron path, is considerably thicker, because a good deal more energy is needed for the acceleration of particles 2,000 times heavier. Superconductivity is used for the sake of economy. If the electromagnets could be cooled down all the way to absolute zero, then current could flow through them without loss, so that one would only need the initial current. Hence, in the only European experiment on this scale, the proton storage rings and the electromagnets have been cooled with helium as the refrigerant to −269°C, or 4° above absolute zero. The electrons are accelerated from 12 to 30 BeV and the protons from 40 to 820 BeV.

So that the electron and proton beams will not be contaminated by air molecules, 2,000 vacuum pumps are in operation to achieve the most disturbance-free possible cycle of the tiny "electron clouds."

This, then, is the "great experimental apparatus," the supermicroscope, with the help of which more than 1,000 scientists from 17 countries are investigating the structure of matter. "After all, what affects the existence of man more than the question of the origin of matter, from which not only the world around him, but also all living things and he himself are constituted? What are the atoms that make up our existence? What are the laws according to which they are formed, change, and then fall apart again?" asks the 1993 DESY annual report. Lines of research with similar experimental objectives are being pursued in six other institutions in the United States, England, Russia, Japan and in the European Center for Nuclear Research (CERN, the European Union's nuclear research center) in Geneva.

Synchrotron light: fascinating 'supermicroscope'

With the development of DESY (founded in 1959), the exploitation of certain properties of an energetic electron led to quite new research results: If an accelerated electron is forced onto a curved path, it radiates energy. Since this light, "synchrotron light," has a very broad spectrum—from infrared, below visible light up to gamma rays—i.e., stretched over 30 octaves of the wave-length spectrum and bunched up like a laser, this light can be employed as a research tool in surface physics, chemistry, molecular biology, crystallography, medicine, and geophysics. For this reason, recently, one of the earlier smaller ring accelerators, DORIS III, has been converted to the production synchrotron light. Thirty-nine workstations have now been set up in this second supporting leg of DESY, the HASYLAB. More than 900 scientists from 23 countries are at work in the most diverse branches of research.

As the DESY annual report impressively documents, new insights have just been gained into cell organelle and cell membrane research. Since the electrons fly around in "cloud packets," the million flashes per second can also be used for slow-motion snapshots, an outstanding means for better grasping processes of change. Thus, a Max Planck group working on ribosome structure under the leadership of Israeli Prof. Ada Yonath is achieving decisive progress in the geometric and functional construction of ribosomes. Here the scientists are seeing paths to knowledge which, for example, can lead to the production of effective antibiotics or to the retarding of undesired protein production in cancer cells.

Since the reunification of Germany, DESY has drawn the High Energy Physics Institute of the former East Germany in

Zeuthen into collaboration. Among the fruits of the growing scientific relations with the former Soviet Union is collaboration on an international research project into cosmic background radiation in Siberia, among others. At the bottom of Lake Baikal, at a depth of 1,300 meters, neutrino detectors (collectively a "neutrino telescope") were installed, with whose help it is hoped to obtain the signatures of neutrinos, which are very difficult to detect in space.

Strengthening basic research

We hope that the public will show more interest in the progress of this basic research. The more so since it is precisely in collaboration and openness of interchange of scientific discoveries (there is *obligatory* publication) with guest scientists of other nations that a model will be created of how mankind should jointly explore the decisive issues for the future that confront man and nature. This is credibly reported, at least, in the DESY annual report. That this no longer can be taken for granted, one can see in the repeated concern in the DESY annual report to justify basic research and the funding it requires (250 million marks a year).

After the enumeration of various possibilities for applications in medicine and technology, under the title "An Essential Element of the Human Quest," the report reads: "All these arguments ought not, however, to conceal from view that the essential motivation for elementary particle research lies in the desire and the curiosity to understand nature. Were one to seek to measure the value of this knowledge-oriented research only by its practical uses, and only orient oneself to that, an essential element of the human quest would be excluded, an essential element of that which ultimately constitutes man. The effort to penetrate the secrets of nature for their own sake is a tradition which, after being cautiously founded in antiquity, has powerfully and continuously advanced, from generation to generation, since the Renaissance. We are confident that even the discoveries which we are today achieving will one day belong to the self-evident wealth of thought and knowledge of mankind, even if today they appear occasionally abstract and not so easily accessible." (DESY Annual Report p. 12.)

One hopes that the newly created technology adviser to the Federal Chancellor will not follow so much the fruitless pragmatist spirit of the times (the ozone hole issue, etc.) or implement downright punitive malthusian obstructionism (the ban on the HTR nuclear reactors, for example), but rather will make it possible for researchers to answer the truly fundamental questions of our future existence. For example, the "cold fusion" phenomena which have been rejected by established science give a totally different insight into the play of forces of atomic and molecular interactions, than the experiments based on the generally accepted standard models can ever show.

It is probably also no accident that the DESY scientists have founded a very successful chamber orchestra.

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