

In its continual round of CERN Member States the European Committee for Future Accelerators (ECFA) recently visited Sweden, where it met at the University of Lund. Left to right, ECFA Chairman Günter Flügge, Head of Lund Physics Department Bengt Lörstad and ECFA Secretary Denis Linglin pose under the stern gaze of spectroscopy pioneer Johannes Rydberg (1854-1919), who spent his entire career at Lund.

detector is able to operate unattended in the harsh conditions of outer space. Three levels of triggering are foreseen before passing the data to the on-board computer prior to transmission to earth.

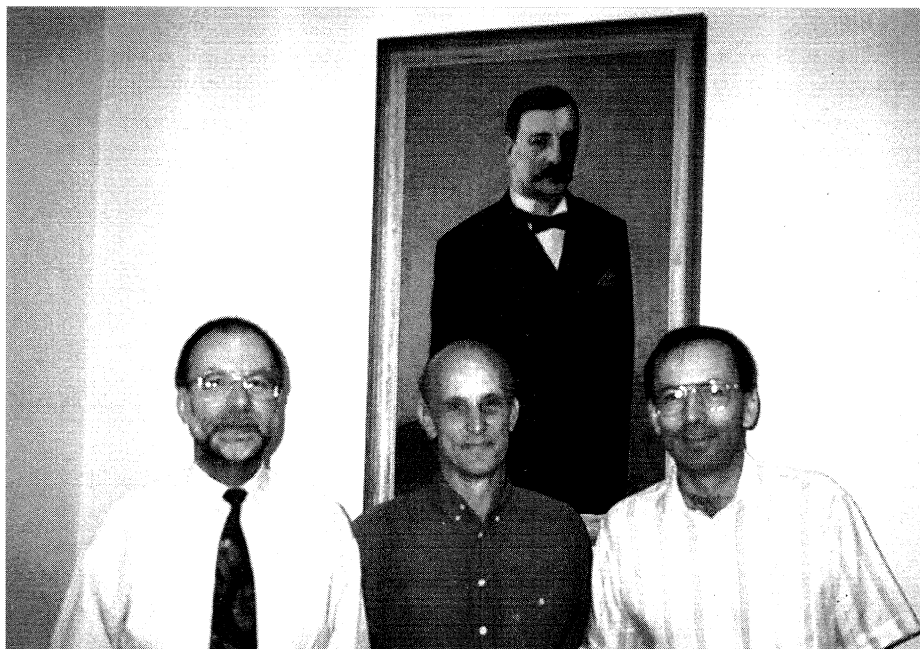
The magnetic material, a special alloy of rare-earth (neodymium), iron and boron, will be supplied by China. Additional space is reserved for a 1-tonne astrophysics detector underneath the magnet for accurate measurements of positrons, antiprotons, nuclei, etc.

A major physics objective is the search for nuclei of antimatter, which will show up as oppositely curved tracks.

With naturally-occurring antimatter almost unknown in our narrow experience, conventional Big Bang theories naturally incorporate an 'arrow of time' which ensures that antimatter has long been annihilated and that the resultant Universe is composed of matter alone. However on the intergalactic scale, there could be room for a different picture.

The plan is to fly AMS initially as a Space Shuttle payload on the STS-90 mission in April 1998. The detector will operate for approximately 100 hours during this mission. This flight will provide data on background sources and verify performance under actual space flight conditions, as well as testing ground control and data communications. Providing a substantial sample of cosmic antiprotons, positrons and high energy gamma rays, this exposure could already provide interesting new cosmic ray and astrophysics data.

The second space flight is scheduled for Space Shuttle mission STS-110 in 2001 for installation on the international Space Station as an attached payload. The detector will operate for three years before being



returned to Earth on the Shuttle. The first element of the international Space Station is scheduled for launching in November 1997.

As well as considerably increasing our understanding of known intergalactic physics, these new windows on cosmic particles in their natural environment could lead to totally unexpected new insights.

Sweden

In its continual monitoring of physics in its Member States, the European Committee for Future Accelerators (ECFA) recently visited Sweden, where it met at the University of Lund in September.

Physics in Sweden is flourishing, with both a long CERN tradition and excellent prospects for future collaboration. On the experimental side, about 80 researchers, including

about 30 graduate students, out of a total of 110 (including 50 graduate students), concentrate on CERN for their work. The main centres of experimental activity are: Chalmers-Göteborg; Lund (particle physics and relativistic heavy ion groups), the Royal Institute of Technology - KTH - Stockholm, the University of Stockholm, and Uppsala. Engineering support staff in particle and high-energy nuclear physics number about 25.

There is a strong Swedish participation (34 researchers from Lund, Stockholm, and Uppsala) in the Delphi experiment at LEP with a full commitment to higher energy running at LEP2, in the CP-LEAR experiment, JETSET studies at the LEAR low energy antiproton ring and in a LEAR hyperon experiment. Sweden is also well represented in CERN's extensive programme of nuclear and heavy ion physics, with 12 researchers active in the heavy ion programme, and a contingent in the SMC muon beam experiment.

The strong Swedish interest in CERN's heavy ion programme was underlined by a special national contribution of 1.5M Swiss francs to the new lead ion injector. At lower energies, there is also good Swedish participation (mainly from the Chalmers Institute) in the Isolde on-line isotope separator. The national physics community has always appreciated CERN's diversified programmes and has greatly benefited as a result.

For the future, there is an important involvement (some 40 physicists) in the ATLAS experiment at CERN's LHC collider. Swedish groups have been active in 11 research and development project for LHC physics.

Sweden's heavy ion activity will continue at the RHIC heavy ion collider being built at Brookhaven and later at the ALICE heavy ion experiment at the LHC. For ALICE, a Nordic collaboration of about 50 experimentalists has been set up, together with a collaboration on related theoretical questions.

In addition to CERN-related research, there are national particle physics activities, but the senior people are in most cases also associated with work at CERN. In medium-energy physics, there is the WASA study at Uppsala's CELSIUS ion cooler ring, with 11 researchers. CERN assisted in the construction of CELSIUS, which uses magnets from the old 'g-2' experiment (which measured the anomalous magnetic moment of the muon and subsequently adapted for the ICE beam cooling experiment).

There is also Swedish participation (5 physicists) in the H1 and HERA-B experiments at the HERA electron-proton collider, DESY, Hamburg.

Swedish physicists are active in astroparticle physics projects - the AMANDA neutrino experiment at the South Pole (10 physicists), and the Caprice balloon-borne antimatter experiment.

Accelerator physics is particularly strong in Sweden and activities illustrate how accelerators have become useful tools in other branches of science. As well as Uppsala's CELSIUS storage and cooler ring (mainly used for nuclear and medium energy physics), Stockholm's CRYRING is used for in atomic physics and Lund's MAX rings supply soft synchrotron radiation. A new machine, MAX-2, was inaugurated this year. Sweden also has a dedicated accelerator company, Scanditronix, supplying systems for medical and industrial applications as well as pure research.

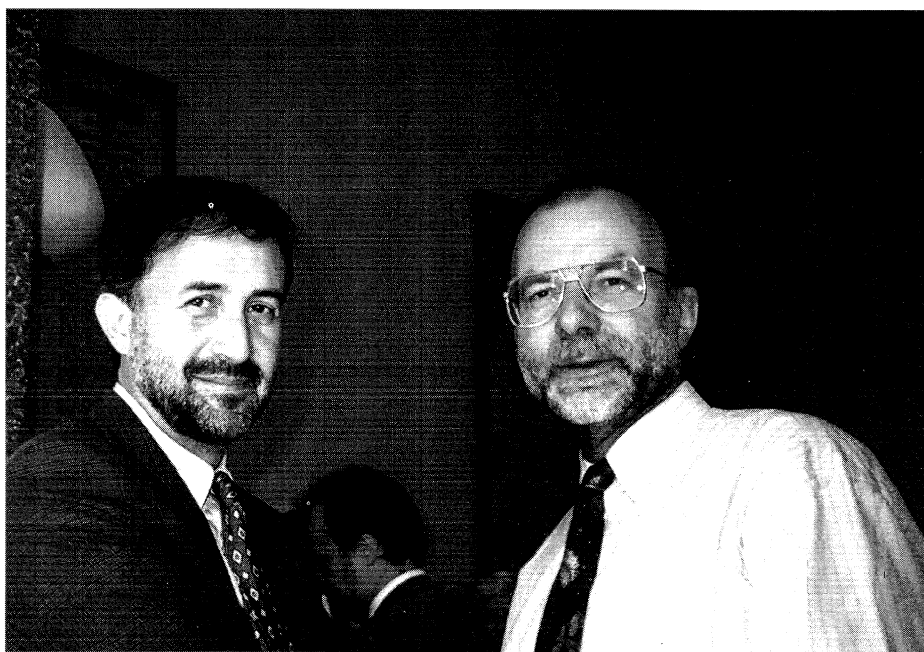
On the theoretical side, Sweden

counts many well-known figures, 24 of whom are on tenure positions and are interested in CERN physics, together with some 40 graduate students. There are altogether five important theory groups - Göteborg, Lund, Stockholm (2) and Uppsala. Main interests cover field and string theory, phenomenology, model simulation and neural networks. The "Lund model" of particle production in narrow 'jets' is particularly famous.

Sweden is also a traditional partner in Nordita, the Copenhagen theory centre for Nordic physics, which provides a stimulating research setting for young theorists and senior visitors.

It is the Swedish Ministry of Education and Science which pays the Swedish contribution to CERN (of the order of 25M Swiss francs) and provides practically all resources for particle physics research in Sweden, whether through the universities or through specialized funding boards. It covers the material cost of experiments, research and development

ECFA Chairman Günter Flügge (right) of Aachen, and Enrique Fernandez of Barcelona, who takes over as ECFA Chairman next year.



Physics monitor

work, half the technical support, positions not covered by the universities (about 20%) and travel. This additional particle physics budget is of the order of 4 M Swiss francs per year. Nuclear physics has its own separate budget.

Prospects appear good. The numbers of high energy experimentalists and theorists are increasing, while former students and young researchers are finding interesting employment in industry.

Research and development work for major new projects, including particle physics, is handled by a new funding source providing strategic long range support to industry. The Swedish-CERN Committee (Chairman Goran Jarlskog) is seeking support for R&D, with fellowships and studentships for improving technology transfer.

For CERN, special funding for ATLAS and ALICE will be available. The present goal is 16M Swiss francs. Funding at the level of 1.2M Swiss francs per year is planned by the Swedish Natural Science Research Council (Naturvetenskapliga Forskningsradet, or NFR), which uses a three-year rolling plan. A significant contribution will also be sought from the Wallenberg Foundation.

Funding for large-scale experimental and computer equipment is channeled through the Swedish Council for Planning and Coordination of Research (Forskningsradsnämnden - FRN), under priorities set by the NFR. Basically NFR finances running expenses and plans investment opportunities, which are financed by FRN.

The average amount granted per year for particle physics is at present at the level of 2.5 M Swiss francs. The Swedish contribution to the LEP

detectors (DELPHI) was 2.8 M Swiss francs for the period up to 1986, continuing subsequently for infrastructure and for computing hardware.

Two research boards, the Swedish Research Council for Engineering Sciences, TFR, and the Swedish National Board for Industrial and Technical Development, NUTEK, provide funding for applied research in direct collaboration with industry at the level of 0.2 M Swiss francs per year.

A special liaison company (Technotransfer AB) has been set up to promote relations between industry, technical universities and international Research organizations.

Recent noteworthy contributions to arrive at CERN from Sweden include the DELPHI RHIC mirrors and cryogenics for LEP2. Ongoing research and development work covers transition radiation detectors, radiation-hard semiconductor detectors, front-end electronics, and a model LHC magnet. This latter development resulted from a joint Swedish and Finnish initiative with financing provided both by Sweden (NUTEK) and Finland.

ASTROPHYSICS

The oldest galaxy yet

The most remote galaxy ever seen directly has been detected by astronomers using the ESO (European Southern Observatory's) 3.5 metre New Technology Telescope (NTT) at La Silla, Chile, and the 10-metre Keck telescope in Hawaii. It shows that stellar evolution was already well underway some 10 billion years ago, when the Universe was 'only' a few billion years old.

Due to the continual expansion of the Universe in the wake of the Big Bang, visible light emitted a long time ago becomes 'stretched', and appears redder. This 'redshift' is a measure of how long ago the radiation was emitted.

Until this new sighting, the oldest known objects were quasars, huge concentrations of matter at the fringe of the Universe blasting energy out into space. Looking hard at such a quasar, ESO astronomers noticed that light of one particular wavelength was strongly absorbed, indicating an intervening cloud of hydrogen. (In intergalactic space, such absorption spectra are not seen - September, page 34.)

The redshift of the absorption line showed that the cloud itself was almost (90%) as old as the Universe. Further study revealed other absorption lines, showing that the cloud also contained carbon, oxygen, aluminium and sulphur.

So much indirect evidence for stellar-like material suggested that stars might be around. Earlier this year the ESO astronomers embarked on a search for directly visible material. Their CCD SUSI (SUperb Seeing Instrument) picked up a faint signal