DESY Looks to the Future

A. Wagner

In February 2003 Edelgard Bulmahn, the German federal minister of education and research, decided to support several large-scale facilities for basic scientific research. These included the X-ray free-electron laser (XFEL), which was originally conceived as part of the project proposed by the international TESLA collaboration for a 33 km electron-positron linear collider to be built near DESY, Hamburg. At the same time, the German government decided not to proceed nationally with the linear collider part of the TESLA project and not to propose a German site for such a machine. DESY shall continue work on the project as part of the international research and development effort. These decisions will have important implications for DESY in the coming years.

On June 11, 2003, a “Wissenschaftsforum” on the future scientific activities at DESY (jointly organized by the “Hamburger Abendblatt” and the “Norddeutscher Rundfunk”) took place with participation of Edelgard Bulmahn (rightmost on the photo), Minister of the Federal Ministry for Education and Research, and Jörg Dräger (second from the left), Hamburg Senator for Science and Research. All participants underlined the importance to maintain DESY’s expertise in accelerator physics and high energy physics and to strengthen the research with photons to ensure a successful realisation of the new challenging projects.

The European XFEL Facility and PETRA III

The German government is thus proposing Hamburg as the site for a European XFEL facility, and is prepared to carry half of the investment costs of _684 million. A decision on construction should be possible within two years, and would be followed by a construction period of about six years. Since the announcement in February, the German government has entered into bilateral discussions with other European governments. The first goal is to set up two European working groups, one on scientific and technical issues, and one on organizational and administrative matters. In parallel, the European Strategy Forum on Research Infrastructure (ESFRI) recently initiated a workshop at DESY, on 30-31 October 2003, on the Technical Challenges at the Proposed European XFEL Laboratory. So far discussions have led to the conclusion that only one major facility for research with hard X-rays should be developed in Europe. The XFEL proposed by DESY is the only project proposal in Europe in this field.

In addition, the German research ministry foresees about _120 million for the conversion of the PETRA storage ring - which currently serves as a pre-accelerator for HERA - into a high-performance third-generation synchrotron radiation source (PETRA III). This upgrade is scheduled to start in the middle of 2007 at the latest, after the conclusion of the HERA physics programme, and will strengthen further research with synchrotron radiation. The technical design report for PETRA III will be ready in early 2004.

Testing acceleration structures

For the past 10 years the TESLA collaboration has made decisive progress with the superconducting accelerator technology that forms the basis of the TESLA linear collider and the XFEL. A test accelerator of 250 MeV – the TESLA Test Facility (TTF)– has been built and has been operated at DESY since 1997. The international partners in the project provided about 35% of the investment and personnel funding. At the TTF the collaboration successfully tested the superconducting acceleration structures and made groundbreaking progress on the SASE (Self-Amplified Spontaneous Emission) principle for a free-electron laser at short wavelengths around 100 nm.

The first experiments with this new type of laser provided an impressive demonstration of the high discovery potential of free-electron lasers in the VUV and X-ray region. The TTF is currently being extended to reach an energy of 1 GeV, that is, a length of 260 m. Starting in 2005, it will be available as a user facility for experiments with soft X-ray laser radiation above 6 nm wavelength. As such it will allow researchers to gain important experience in experimentation with free-electron lasers in the X-ray region, and it will provide valuable operating experience for the linear collider.

In co-operation with the other European partners, DESY is actively preparing for the construction of the 20 GeV superconducting linear accelerator for the XFEL laboratory, and is focusing on issues related to the industrialization, mass production, quality assurance and reliability of all the linear accelerator components. A first step in the concrete planning of the XFEL will be the commissioning of the free-electron laser for soft X-ray radiation at the expanded TTF. Since the XFEL is to be realized as a European project, discussions are being held with scientists and politicians in countries that are interested in participating in the effort.

In these discussions a number of issues must be examined and clarified, such as the operational parameters of the laser and the organizational models for the laser laboratory.

Towards a linear collider

At the same time, the TESLA collaboration continues to pursue the high-gradient programme to demonstrate the accelerating field of 35 MV/m that is required to reach 800 GeV for a 33 km TESLA collider. Substantial progress has been made in this area. A first electro-polished nine-cell superconducting cavity has routinely reached gradients above 35 MV/m in long-term testing under typical collider operating conditions (at $Q > 5 \cdot 10^9$ with an RF loading as required for linear collider operation), but without beam. This cavity is complete with all its ancillaries and therefore corresponds to one-eighth of a TESLA cryo-module. At present four nine-cell cavities have shown the required performance of 35 MV/m after electro-polishing. Recently the first nine-cell cavity was electro-polished at DESY and reached a gradient of 39.4 MV/m. This represents a significant step towards the milestones set by the International Linear Collider Technical Review Committee for “Phase II ” of TESLA.

The next major step towards a global collider project concerns the choice of technology. The International Linear Collider Steering Committee is currently setting up an advisory group, which will be charged with performing an analysis of the status of the two competing technologies (“warm ” and “cold ”) and with making a technology recommendation before the end of 2004. If the chosen linear collider technology is “cold ”, a major synergy will exist between the work on the XFEL and the linear collider.

DESY will continue to participate in the international linear collider working groups and once the technology choice has been made, the laboratory will be a partner in a European team within an international linear collider design team. Together with European universities, DESY will play a major role in the design, construction and future operation of the collider detector(s).

The international efforts for the coming years aim at reaching an agreement, in principle, to start the construction of a linear collider in time for commissioning in 2014/15, in accordance with the recommendations of the OECD Global Science Forum.

The future for DESY

The strength of DESY is the result of an in-house synergy in three key areas: accelerator development, particle physics and research with synchrotron radiation. Particle physics has been a driving force behind accelerator development, and this also applies to the TESLA project. The decisions of the research ministry have secured DESY ’s long-term future as one of the world ’s leading centres for research at accelerators.