Preface

J.R. Schneider

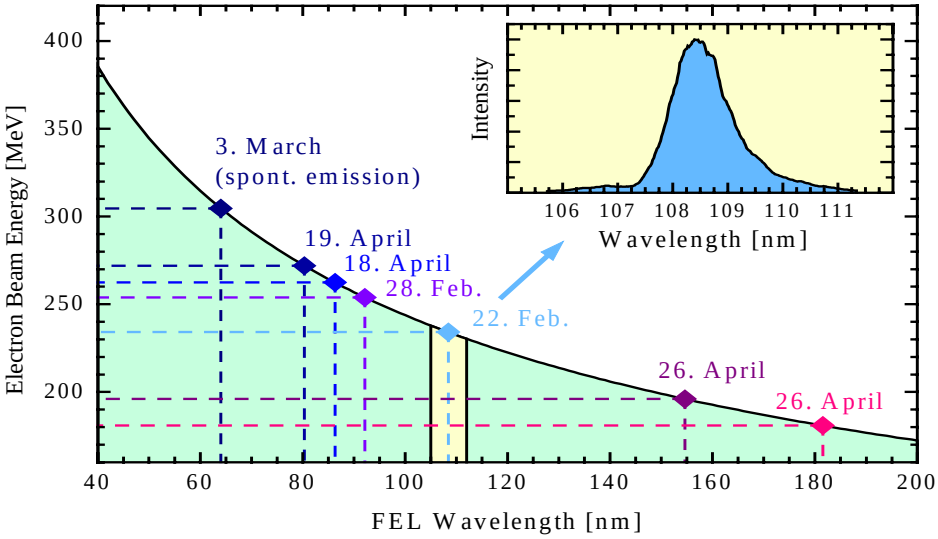
At the Hamburger Synchrotron Radiation Laboratory HASYLAB synchrotron radiation emitted from positrons or electrons in the DORIS III and PETRA II storage ring is used in many different ways in fundamental and applied research in the fields of physics, biology, chemistry and crystallography, in materials and geological sciences as well as in medical applications. This is done by using a wide spectrum of electromagnetic radiation ranging from the visible to the hard X-ray regime and covering an energy domain from about 1 eV to 300 keV. At nine experimental stations the structure of bio-molecules is studied by scientists of the Hamburg Outstation of the European Molecular Biology Laboratory (EMBL) and by three research units for structural molecular biology of the Max Planck Society. HASYLAB contributes to the training of students in physics via a close collaboration with the II. Institut für Experimentalphysik of the University of Hamburg.

DESY 40-years anniversary and opening of the DESY EXPO Exhibition “Light for the New Millenium”, from left to right: Prof. A. Wischnieswky (Polish Minister of Science), Prof. A. Wagner (DESY), Mrs. E. Bulmahn (Federal German Minister for Education and Research), Prof. J.R. Schneider (DESY).

In the time from June 1 to October 31, 2000, the exposition “Light for the New Millennium” took place at DESY in the frame of the world exhibition EXPO 2000. For this purpose the future experimental hall for the VUV Free-Electron Laser and the tunnel housing part of the Linear Accelerator and the undulators were turned into a most exciting, beautiful exhibition area. More than 106000 visitors, among them many pupils from 450 school classes, were attracted. A substantial number of visitors came more than once. The visitors appreciated particularly the explanations given by young physics students from different German universities which matched very well the visitor’s needs. DESY scientists organised a large number of guided tours and introduced the public to DESY’s future plans, i.e. the Linear Collider with integrated Free-Electron Laser laboratory. New brochures describing the science programs at DESY as well as teaching aids for high school physics courses had been prepared and were very well received by the public. A guide through the exhibition with many popular explanations is available as CD (desypr@desy.de) and on the internet: www.desy.de\expo2000. The EXPO exhibition was an exciting and most instructive time for all of us at DESY. Special thanks are due to our public relations department, they did a wonderful job.

Just in time for the EXPO exhibition a successful proof of principle experiment of SASE was achieved on February 22, 2000, at the TESLA Test Facility Free-Electron Laser at a wavelength of 108 nm (Phys. Rev. Lett., 85 (2000) 3825). In the following weeks FEL tunability was demonstrated in the wavelength range between 80 and 180 nm, the gain achieved at a bunch charge of 1 nC varied between 10^3 and 10^4, i.e. saturation of the SASE process with a gain of the order of 10^6 – 10^7 is not yet reached. On the other hand these are the shortest wavelengths ever produced with Free-Electron Lasers. This great success is due to the efforts made by the TESLA collaboration as a whole including scientists and engineers from 39 institutions and 9 countries. At the end of the run period a gain of about 10^5 was observed with a bunch charge of 3 nC. In the second half of the year emphasis at TTF was on machine studies, especially on the production of long bunch trains with high bunch charge for studies of higher order modes in the accelerator cavities.

Starting in 2001 the infrastructure in the tunnel and in the experimental hall of the VUV FEL will be installed. Later the 30 m long undulator and the cryo-modules for the accelerator, as well as connecting beamlines and beam diagnostics will be mounted. All components will be installed in summer 2002 when the current operation of TTF phase I, including about one year for FEL commissioning and operation, will be finished. About one year will be needed for the transition from phase I to phase II, i.e. to the final VUV FEL configuration. First laser light in the experimental hall is expected for December 2003.



Wavelength tunability of the FEL radiation at the TESLA Test Facility (TTF) as a function of electron beam energy. The data points represent the FEL wavelengths at which 'lasing' was achieved. The inset depicts the spectral distribution of the first FEL radiation observed at the TESLA Test Facility on 22. February 2000.

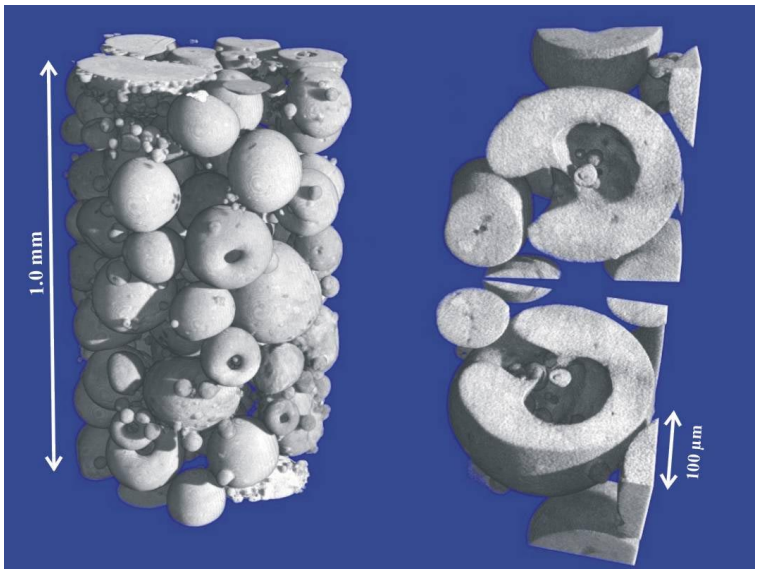
In 2000 the Technical Design Report (TDR) for TESLA has been worked out, which will contain the technical layout of the facilities and the scientific case for both particle physics and synchrotron radiation research, as well as time schedules and cost estimates. At HASYLAB 8 workshops on various aspects of the scientific case for the X-FEL were organised, which were attended by about 190 scientists from 18 different countries. The results will be summarised in the TDR. A lot of effort went into the layout of the beamlines and the FEL laboratory as a whole. The Technical Design Report will be presented to the public at a colloquium on:

Scientific Perspectives and Technical Realisation of TESLA

23/24 March 2001 at DESY in Hamburg

As decided in summer 1999 DESY will provide synchrotron radiation from the DORIS and PETRA storage

rings also during the construction and commissioning phase of TESLA. A first version of the study for a possible upgrade of the DORIS storage ring was finished end of November and will be discussed first with external machine physics experts and then with the users. A study of the implications if the PETRA storage ring would be used as a dedicated synchrotron radiation source providing about 10 undulator beams of similar quality as the ESRF today is under way. It will be presented in April/May 2001 and discussed with machine experts. Both upgrade plans will then be presented to the HASYLAB users in July 2001. A general discussion of the needs of the German synchrotron radiation user community will be organised in the second half of 2001 with the aim to define medium and long term strategies for synchrotron radiation research at DESY.



Microtomography of porous titania hollow speres

Absorption-contrast microtomography using monochromatized synchrotron radiation allows for the 3-dim. non-invasive investigation of samples in the micrometer range. In the figure titania hollow spheres produced by spray drying are presented. On the right only a small part of the total reconstruction volume shown on the left is used to visualize the interior of a single hollow sphere. The tomographical investigation is performed to characterize the shape and porosity of the sample.

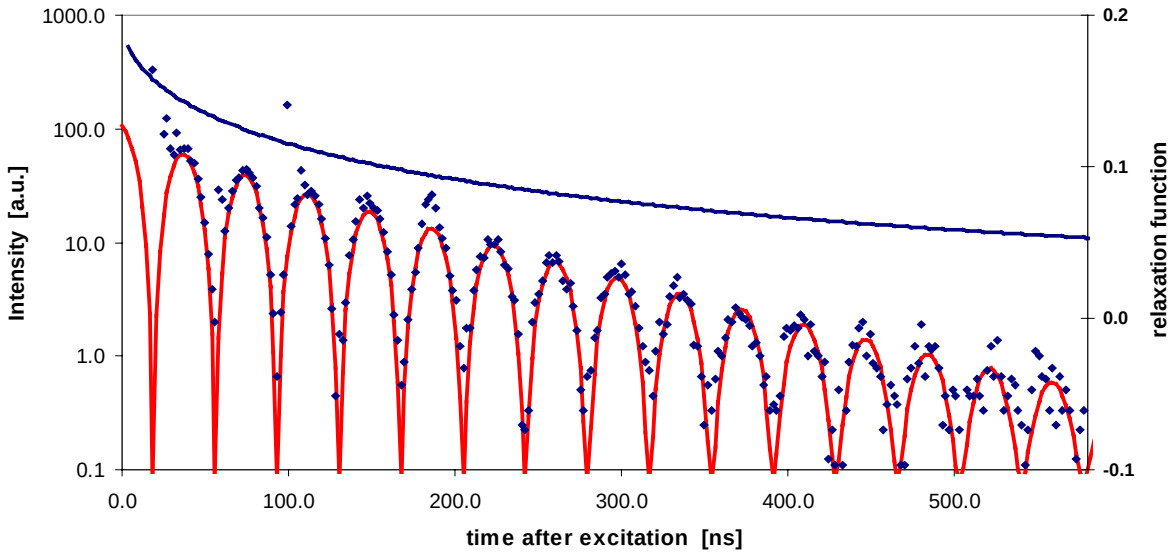
The tomographical scan was performed using 19 keV photon energy at HASYLAB wiggler beamline BW2.

(F. Beckmann, B. Müller, P. Thurner, L. Eckert, S. Buchloh, and E.Wintermantel)

Coming to current synchrotron radiation research at HASYLAB, DORIS III was operated from January 3 to October 2, 2000, with positrons at an energy of 4.5 GeV and initial currents of 150 mA in the 5 bunch mode of operation. Typical lifetimes are 12 hours in the beginning and 22 hours at the end of a 10 hours run period. The 5011 hours of scheduled dedicated user time were grouped in 7 blocks of about 5 weeks each, separated by one week for maintenance. To optimise DORIS operation eight-hour machine shifts were inserted on the second, third and fourth Thursday of each beamtime block. For experiments which need a special time structure, the storage ring was operated in reduced bunch mode for about 20% of its running time. The operation efficiency of DORIS III was further improved to a value of 94.4%. At PETRA about 2200 hours of parasitic beamtime have been provided in 2000.

In a shutdown from October 2, 2000, to February 12, 2001, new vacuum chambers for all quadrupol tripletts will be installed so that the vacuum system is mechanically decoupled from the quadrupoles, which will reduce horizontal movements of the beam observed in the past. In addition all sextupole magnets got new mechanical supports allowing for a more precise alignment of the magnets. The complete water cooling system including pipes, pumps and controls has been renewed. The "bypass" wiggler vacuum chambers got additional titanium sublimation pumps which will lead to an improvement of the vacuum conditions in this area.

This year the successful program on intravenous coronary angiography was completed. Over almost 20 years 14 physicians from the University Hospital Hamburg-Eppendorf and the Heart Center Bad Bevensen as well as 35 physicists, computer scientists and engineers from DESY-HASYLAB, University of Hamburg and the



Relaxation of a ferrocene/dibutyl-phthalate sample measured at 180 K by nuclear resonant forward scattering. Typical for disordered systems (glasses) the relaxation function (solid blue line) follows a stretched exponential behavior. The fit model contains the hyperfine splitting of the ferrocene molecule, the exponential decay with the lifetime of the ^{57}Fe nucleus and the relaxation function.

The relaxation time is 330 ns, the stretching parameter 0.5.

Data were taken at the HASYLAB undulator beamline Petra1 with the storage ring running in 8 bunch mode.

(H. Franz, A. Roth, K. Messel, I. Sergeev and T. Asthalter)

Physics Department of the University of Siegen were involved in this exciting interdisciplinary project called NIKOS. Recently the DESY machine group presented a design study for a small storage ring dedicated to coronary angiography which could be installed next to a hospital. The novel imaging technique NIKOS, which does not need a catheter for injection of the contrast agent, was very well accepted by the patients. All together 379 patients were investigated, 230 of them within the frame of a validation of NIKOS versus conventional selective coronary angiography. The results of this study have been discussed with a high level international group of cardiologists and comparison was made with the other minimal- or non-invasive methods available today, i.e. Magnetic Resonance Imaging (MRI) and Electron Beam Computed

Tomography (EBCT). In conclusion NIKOS provides by far the best images. The pictures are produced within seconds, further technical improvements of the technique are possible. An intrinsic difficulty with NIKOS is due to the superposition of blood-vessels and the limited number of projections. The cardiologists have a lot of hope for further progress with MRI, because it offers the possibility to image not only morphology but also function, and the patient does not receive any radiation dose. In its present stage the cardiologists involved in the discussion did not recommend NIKOS for routine operation in clinical hospitals, instead they recommended further R&D. DESY decided to support further R&D on NIKOS provided a group of cardiologists takes the lead in the very near future.

The HASYLAB Annual Report 2000 is again published as a CD-ROM and an internet version, only a limited number of hard copies will be provided. It contains 700 reports on experiments performed this year at HASYLAB, including structural biology. The list of groups involved in the preparation and performance of experiments at HASYLAB in 2000 contains 232 institutes and about 1450 scientists. In the field of structural biology about 460 scientists from more than 140 institutes, primarily from Europe, used the EMBL beamlines and facilities at DESY. The reports on their experiments were collected in a second section of the Annual Report. As in the preceding years, the authors are fully responsible for the content and the layout of their reports.

In June 2000 Dr. Edgar Weckert joint DESY as Leading Senior Scientist at HASYLAB. His main field of research is physical crystallography with a strong interest in the development of novel diffraction techniques for structural biology. Based on the recommendation of an international search committee for a Leading Senior Scientist in Structural Biology at DESY the position was offered to Professor Janos Hajdu from Uppsala University.

It is a great pleasure to congratulate Professor Giesela Schütz, University of Würzburg, for the prestigious Agilent Technologies Europhysics Award for the year 2000, which she received in conjunction with Drs. P. Carra and G. van der Laan for their pioneering work in establishing the field of X-ray dichroism which was triggered off in 1986 by the first experiment at the HASYLAB RÖMO II station (Phys. Rev. Lett., 58 (1987) 737). Professor Ada Yonath, Weizmann-Institut in Rehovot and Max-Planck-Group “Ribosome-Structur” at DESY, received the inaugural Prize of the European Crystallographic Association for her pioneering achievements in structurial studies on the ribosome. We are very pleased to congratulate Ada Yonath to this prestigious award which recognises her epoch-making contributions to structural biology and to our understanding of nature. This success is an impressive demonstration of the advantage of establishing research groups in structural biology at synchroton radiation facilities, an example which was followed by many other laboratories.

Thanks to the high motivation of the HASYLAB staff and of the external users of the laboratory, HASYLAB is facing promising years ahead, full of exciting synchrotron radiation research. The support of synchrotron radiation research by all colleagues at DESY is very much appreciated.

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Director HASYLAB