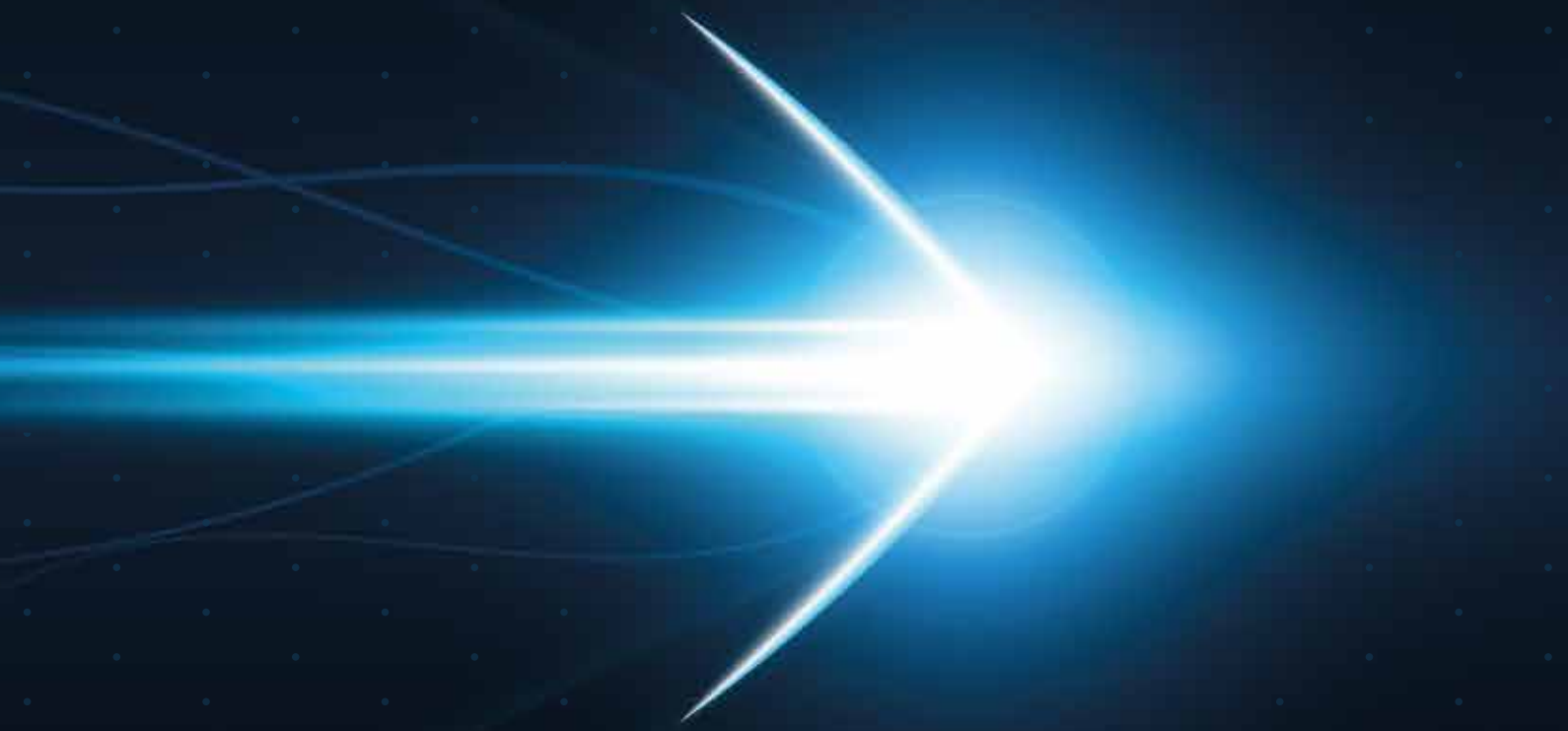
DESY 2030.

Our Strategy for the Future



Brochure for the DESY 2030 Strategy Kick-off Event
on 20th March 2018.

“A goal without a plan is only a wish.”

Antoine de Saint-Exupéry,
French writer and pilot

Contents

Preface

DESY on the move

For DESY, 2018 is all about setting the course for the future of our research centre.

That is why we DESY staff asked ourselves: are we still on the right track? Are we prepared for the future? What developments do we expect to see in the coming decades? What developments do we want to contribute to? Which research aspects are particularly important for us? Are we prepared for this? If not, what to do?

Together with about 400 colleagues from all areas, we have addressed these questions in a lively, honest and fruitful discussion process. We systematically defined the current situation, discussed challenges and developed a strategy for the coming years. We would now like to share the results with you.

Please join us as we take DESY into the future.

Yours

Helmut Dosch
Chairman of the DESY Board of Directors

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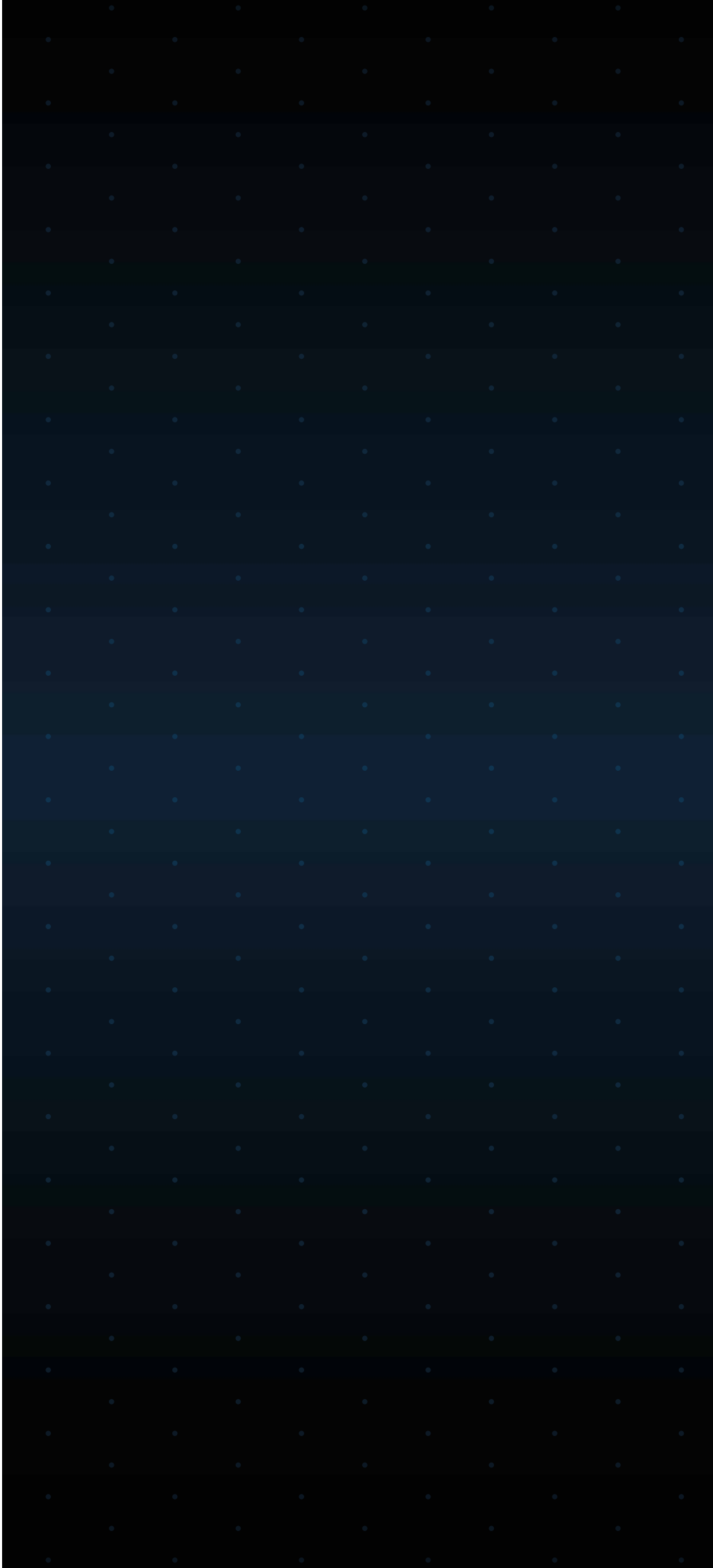


The Decoding of Matter

DESY is committed to fundamental research into the structure and functioning of matter, preparing the knowledge base necessary for the world of tomorrow. The research centre is thus making a unique and important contribution to the future of our society.

Who we are

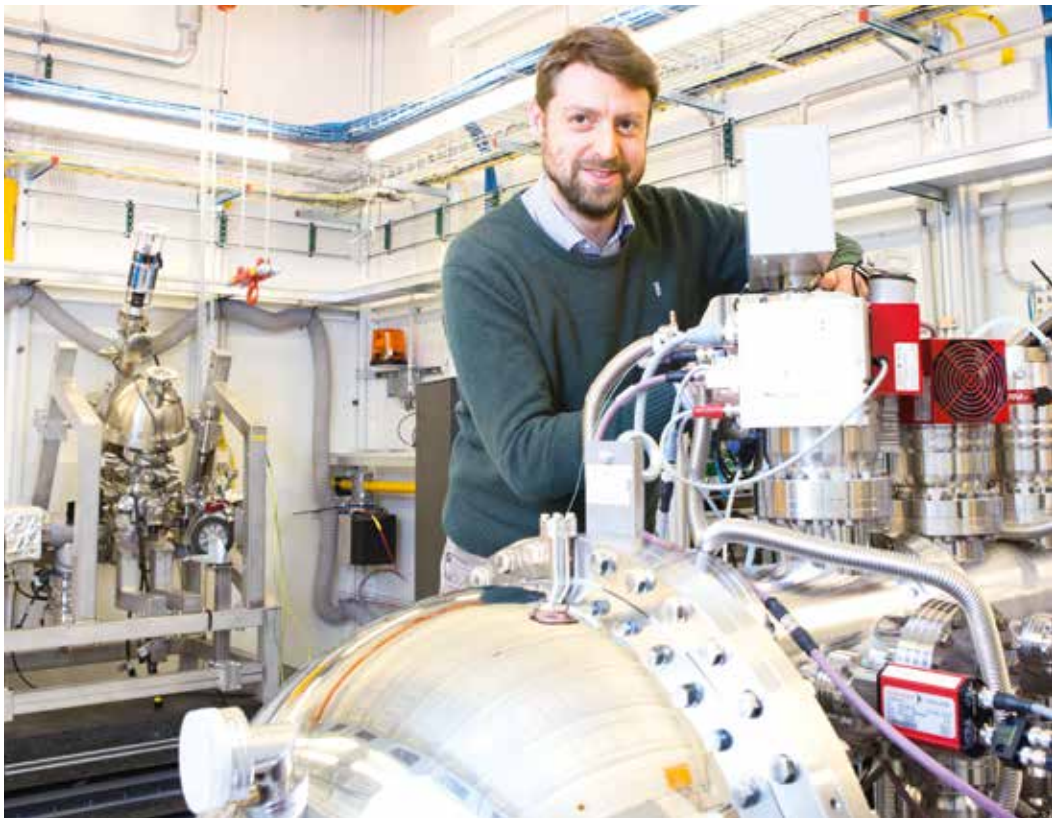
DESY is not only an employer of over 2,000 people and a magnet for more than 3,000 guest researchers from over 40 nations every year, but also a sought-after partner in national and international cooperation. Committed young researchers find an exciting, interdisciplinary environment at DESY.

Scientists can only be truly successful if the framework is right and the infrastructure works. This infrastructure includes a great deal: from administration, workshops and computer centres to libraries and canteens. Hundreds of experts ensure that we are able to conduct top-notch research successfully.

Young talents matter to us. In addition to exciting perspectives for students, the research centre also offers attractive training opportunities for a variety of professions. The diversity of the people at DESY is our strength.

"DESY is a great place for my research with excellent colleagues."

Elisa Pueschel
Astroparticle Physics



"The DESY campus offers a first-class environment for scientific research. What's so special about this place is the extensive knowledge and the strong passion that people here have for their work."

Christoph Schlüter
Photon Science

"I find the research at DESY thrilling and exciting – it is a great pleasure for me to support it and also to report on DESY to the outside world."

Nele Müller
Photon Science

"My work on one of the most modern accelerator systems is both challenging and fascinating for me."

Anne Oppelt
Accelerator Physics

"I appreciate DESY's excellent networking with other laboratories in Europe and the growing interest in EU-funded projects, especially among young scientists."

Ute Krell
EU office

"I would like to be at DESY when we discover fundamentally new physics with our large experiments in particle physics at the LHC or a future accelerator."

Thomas Schörner-Sadenius
Particle Physics

Our Mission

We conduct top-level international research into the fundamental relationships of matter – its structure and function. We are creating the knowledge base that is needed in order to solve the huge and urgent challenges that society, science and the economy are facing. The research facilities we develop and operate for this purpose are open to scientists from all over the world.

"Sharing my work and my fascination for science with people outside of science is what makes DESY so special for me."

Marc Wenskat
Particle Physics

"I search for the sources of cosmic neutrinos, and for that DESY is the best place in the world."

Timo Karg
Astroparticle Physics

"I search for dark matter – one of the greatest mysteries of the universe. DESY is an experimental place – not only in the field of research, but also when it comes to looking beyond one's own nose with other disciplines."

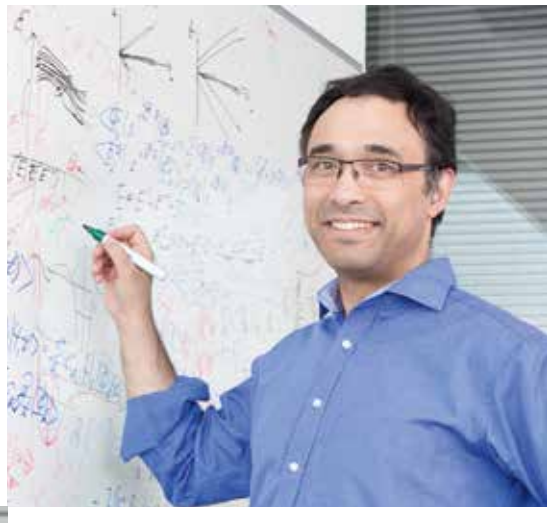
Christian Schwanenberger
Particle Physics

"Our DESY groups investigate ultrafast and ultra-precise laser technologies that enable novel accelerator, free-electron laser and spectroscopy concepts."

Ingmar Hartl
Photon Science

"For 20 years FLASH has stood for ground-breaking superconducting accelerator technology and free-electron laser developments. With the upcoming upgrades, FLASH will be even more versatile and maintain its place in cutting-edge research."

Katja Honkavaara
Accelerator Physics



"The exciting thing about working at DESY is that we are constantly pushing the boundaries of what is technically feasible in the development of our accelerator systems and instruments."

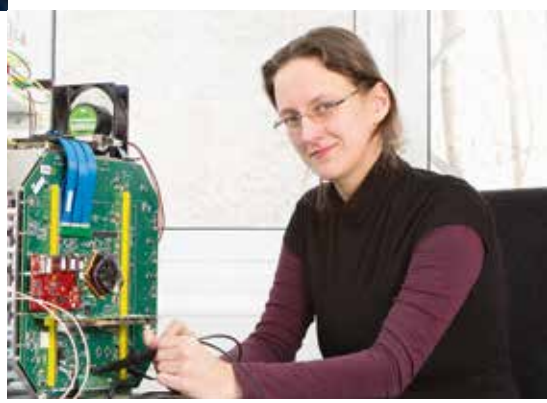
Lutz Lilje
Accelerator Physics

"My research topic is ultrafast dynamics of light-induced processes, and I am proud of our cutting-edge research, which holds its own in international competition."

Robin Santra
Photon Science

"I want to decipher the spatial structure of the molecular machines that drive everything so that we better understand the fundamental mechanisms of life."

Henry Chapman
Photon Science



"I want to unravel some of the secrets of the universe."

Heike Prokoph
Astroparticle Physics

Our Mission

We are expanding knowledge in the research fields of photon science, particle and astroparticle physics, and accelerator physics. We gain our results from synchrotron radiation sources, X-ray lasers, particle accelerators, detectors, and observatories, and we conduct related research and development work.

"DESY's versatility offers us trainees many opportunities to think outside the box and experience research at first hand."

Isabelle Masuch
Mechanics Workshop

"I chose DESY for my PhD because it has a great reputation. Now that I'm here, it turns out to be even better than I imagined."

Afiq Anuar
Particle Physics

"Here I can do everything from the development of modern telescopes to the exploration of cosmic accelerators."

Gianluca Giavitto
Astroparticle Physics

"After my PhD thesis in Hamburg, I decided to take a postdoctoral position at DESY because the atmosphere in the CFEL inspires me and I have fantastic research conditions here."

Dongfang Zhang
Photon Science

"As a PhD student at DESY, I'm involved in many recent discoveries in the field of neutrino astronomy."

Thomas Kintscher
Astroparticle Physics

"I want to develop new technologies for the accelerators of tomorrow."

Gregor Loisch
Accelerator Physics

"As an international research centre, DESY has for me an interesting mix of ideas and cultures."

Nur Zulaiha Jomhari
Particle Physics

"With my infrastructure groups, I would like to develop the Campus in Zeuthen as part of DESY into a widely active research location."

Stefan Klepser
Site management Zeuthen

"In the mechanical engineering training at DESY, I learn the most diverse manufacturing techniques and am therefore excellently prepared for future tasks."

Willi Herhold
Mechanics Workshop

Our Mission

We offer young researchers an international and interdisciplinary setting for ambitious scientific projects, and we provide the appropriate training and working environment for a variety of technical and administrative professions.

"As a purchaser at DESY, I face exciting and challenging procurement projects every day."

Stefan Frank
Purchasing and Materials Administration

"In the DESY school lab, I look forward to seeing children and young people enthusiastic about the unbelievably exciting world of research every day."

Karen Ong
School Lab

"It's exciting to work with people from all over the world at DESY."

Sandra List
Secretariat

"In the Photon Science User Office, we organize access to DESY's light sources for our more than 2,000 guest scientists each year. The wide variety of scientific questions, the international environment and the friendly and collegial working atmosphere contribute to the fact that I enjoy working for DESY."

Daniela Unger
Photon Science

"I am fascinated by the enormous versatility in the here and now of DESY and look forward to making contributions as an engineer to our ambitious future projects."

Birte van der Horst
Accelerator Physics

“My goal at DESY is to make the smallest things visible and to understand them. To do this, my team and I develop techniques to focus X-rays on tiny little spots.”

Christian Schroer
Photon Science

“I develop modern computing infrastructures for research at DESY.”

Rico Lindemann
Data Centre

“Excellent research needs technology, and we´ve got plenty of that at DESY. Most of all, however, it needs talented and dedicated people doing this excellent research. We at PR are excited to “translate” our research world to the world out there.”

Barbara Warmbein
Press and Public Relations

“DESY puts a lot of emphasis on the health of its employees. I ensure it stays that way.”

Natascha Peleikis
Health Management

What we are good at

Our core competencies

Research projects at the limits of what is technically feasible have made DESY a vibrant, internationally renowned research centre. This success is based on the openness of all those involved to learn constantly – not only in a strictly scientific sense, but also by evaluating and adapting processes, structures, cooperation, the infrastructure and much more. This has created a good breeding ground for cutting-edge research.

A strategy for the future begins with an assessment of the current situation. What are we good at? What are our core competencies? They are fundamental to DESY's future development.

Team spirit

We work together as partners, inspire each other and cooperate with others. That's why we work on complex research projects so successfully.

Project management

We have set standards with successful large-scale projects (most recently the European XFEL). We organise international research collaborations and live an effective, professional and reliable management culture.

User orientation

We care for users. In partnership, we make our large-scale facilities available to scientists from all over the world. Our well-established and well-structured processes are a solid basis for their research success.

Technological competence

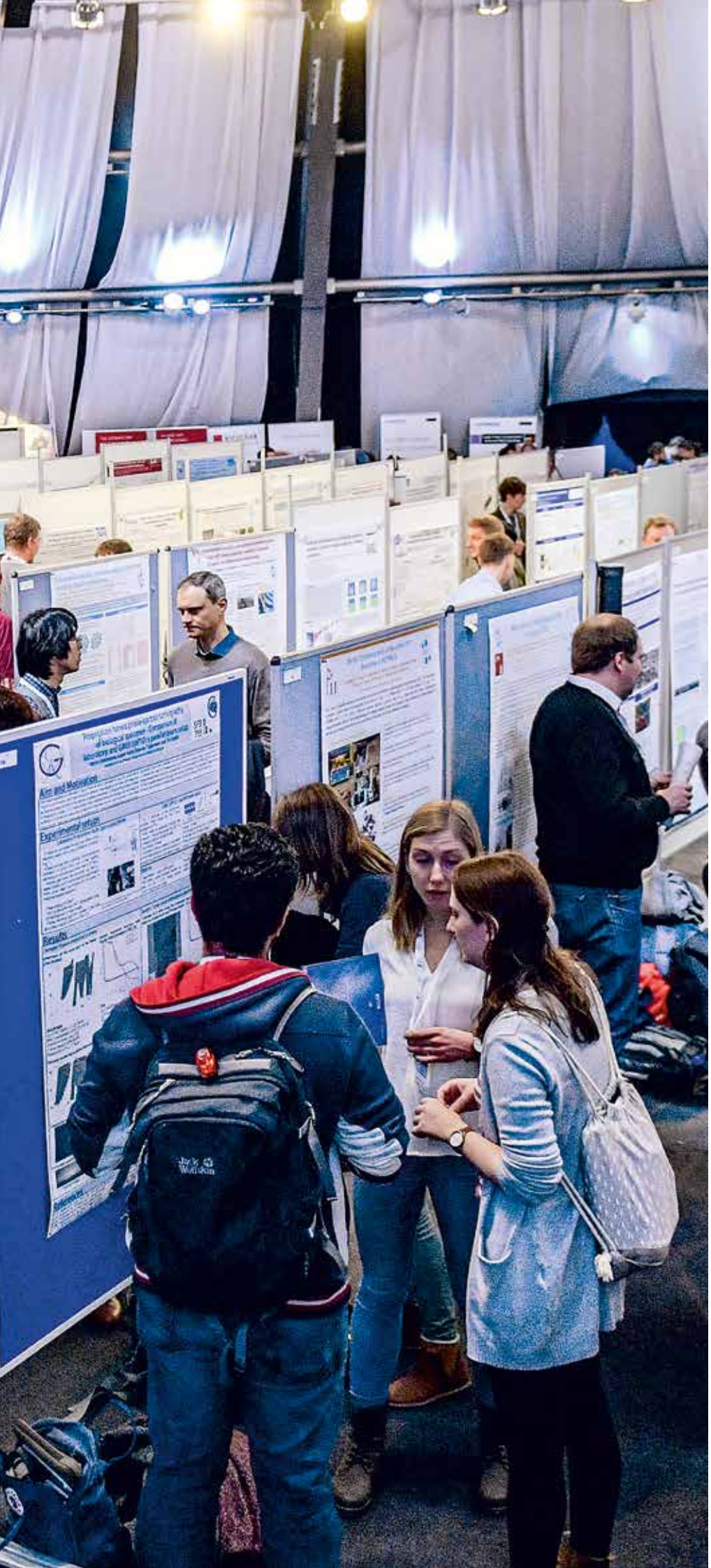
We have a world-leading expertise in accelerator and photon science systems as well as detectors for particle and astroparticle physics. This applies to all levels from research and development to the planning and implementation of large-scale projects and the operation of such facilities.

Strategic cooperation design

We actively participate in shaping research strategies and agendas on the nation and international level. As a partner we continually invest in the further development of our networks. We know from experience that this contributes decisively to successful research results.

Scientific competence

DESY is an institution of cutting-edge research. Due to the broad acceptance of our partners and our scientific expertise, we can make a significant contribution to defining promising research topics and also putting them into practice.


Aim and Motivation
Experimental setup
Results

What we have achieved

More than 50 years ago, the first research projects began at the DESY synchrotron. Since then, we have systematically expanded our expertise and become a world-class research centre.

Over the course of time, we have dynamically adapted our research profile and our research facilities to current and future scientific questions and technological challenges. Today, DESY is one of the world's leading centres for research with synchro-

DESY

1959

DORIS

1971

PETRA

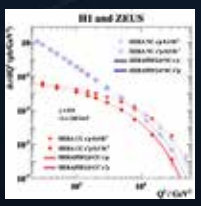
1974

DORIS-SR

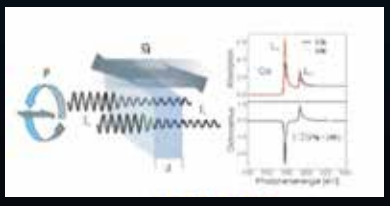
1981

1984

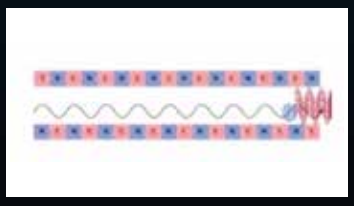
Gluon



Electroweak Unification



X-Ray Magnetic Circular Dichroism Effect



Single Path X-Ray Laser

Examples of discoveries and technological breakthroughs at the accelerator facilities at DESY.

tron radiation and free-electron lasers, particle and astroparticle physics as well as for the development of state-of-the-art accelerators.

HERA

FLASH

PETRA III-SR

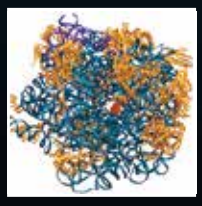
XFEL

1993 2000 2009 2018

Proton Structure

TESLA Technology

XFEL LINAC



Ribosome Structure

Serial Femtosecond Crystallography (SFX)

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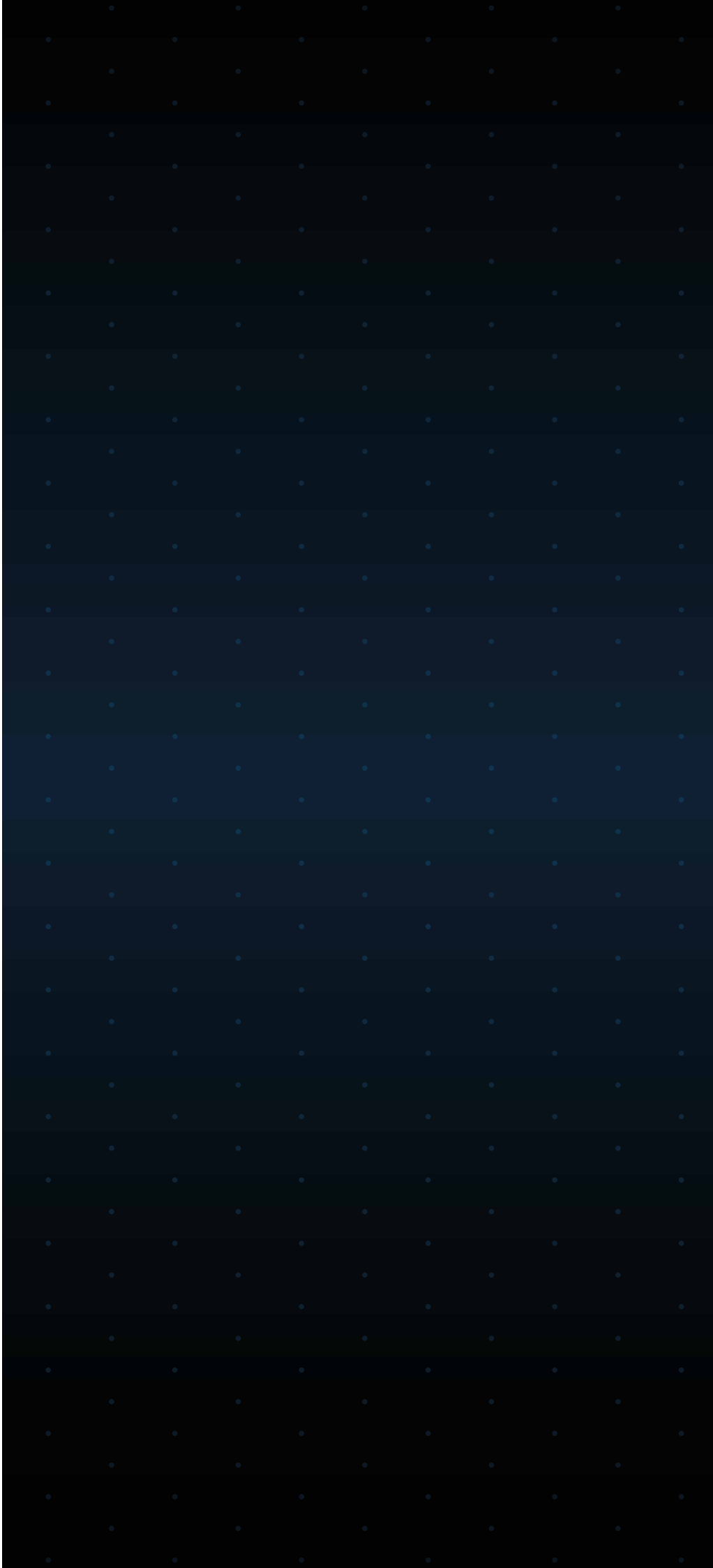


Challenging Future

Cutting-edge research is about exploring unknown territory, finding fundamentally new things – answers to questions that decisively determine our future.

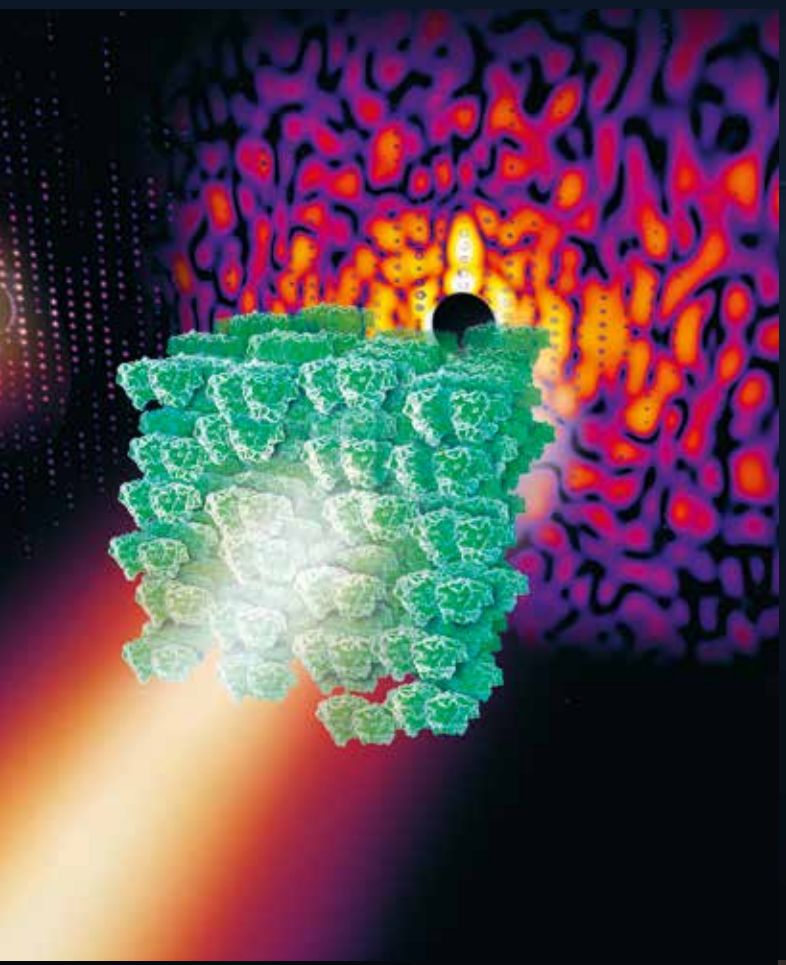
We are currently facing revolutionary opportunities and challenges in all our research areas. Our goal is to handle this responsibly.

In this way, we will continue to create new knowledge and new ways of thinking and contribute to addressing the pressing global challenges.

Our challenges

Decoding molecular structures

We have decoded the atomic structure of many materials and biological structures. But how do these molecular systems work? How can they be controlled in order to develop new compounds and active ingredients? For obtaining precise information for these challenges, we need to further develop our research facilities and push the limits of what is feasible with innovative technologies. For this we need technology transfer and cooperation.



Understanding the origins of mass

With the discovery of the Higgs particle, the last building block of the standard model of elementary particles was found. But we are still facing great mysteries: What is the precise mechanism that gives particles its mass? What is dark matter? Why has all the anti-matter gone? Is there a common origin of all fundamental forces? We expect answers from particle and astroparticle physics experiments.

Understanding cosmic evolution

In astroparticle physics, we have discovered all the messengers of the universe in recent years. But what role do these high-energy particles play in cosmic evolution? We are at the threshold of a “golden age”: neutrino astronomy and gamma astronomy, together with gravitational wave astronomy, can provide us with completely new insights into the origins of our universe. That is why we must now set up clear and targeted research programmes.

With the DESY 2030 strategy we meet these challenges.

Building the machines of the future

With the start-up of operation of the European XFEL X-ray laser a new era has begun for us. The successful construction and successful operation within the time and cost limits is another major triumph for the DESY accelerator team and a seal of approval for the competence of the research centre. But what will the accelerators of the future look like? This is where completely new concepts are on our agenda, and we need to further expand our global leadership.

Creating inspiration for cutting-edge research

We all know that good research results are not only produced in the laboratory or in isolation. Inspiration and interdisciplinary exchange are important. How do we create the framework conditions for cutting-edge research? Together with our partners, we want to build a more interdisciplinary research campus with an international reach.

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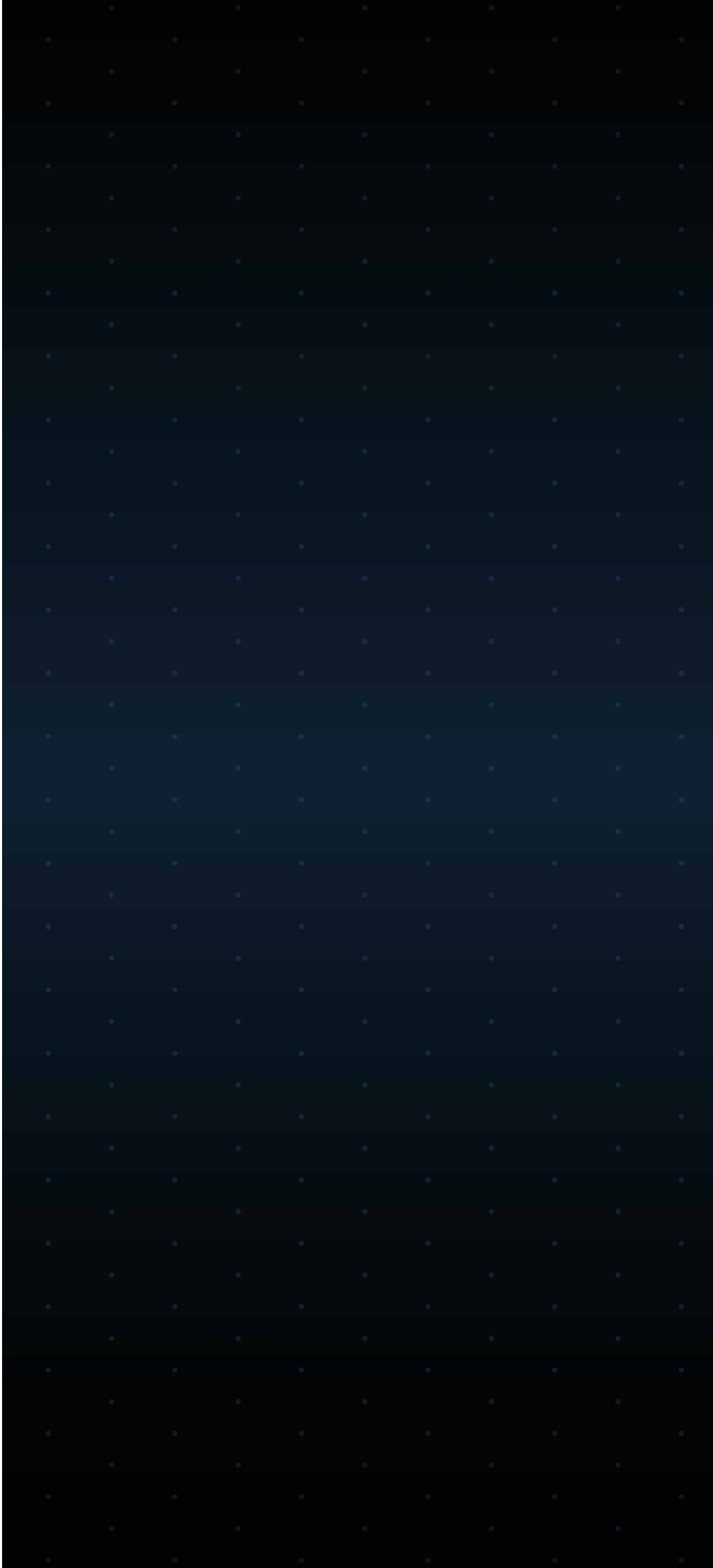


Defining coordinates

Over a period of around 16 months, more than 400 DESY staff have been working on the future of our research centre.

Organised in 19 competence teams from the fields of science, large-scale facilities and supporting infrastructure as well as a strategy group, we defined the starting point, discussed challenges and goals, developed strategic options for the future and gradually developed a detailed strategy. The process was supported by the consulting company osb international.

Strategy process

The competence teams

- Accelerator research and development
- Detector development
- Data management and analysis
- European XFEL accelerator
- PETRA III
- Data processing TIER-2
- Free-electron laser FLASH
- Matter – dynamics, mechanism and control (MatDMC)
- Nano and materials science (NanoMat)
- Biological and soft matter (BioSoft)
- Experimental particle physics
- Theoretical particle physics
- Astroparticle physics
- Campus development
- Talent management
- Sustainability
- Outreach
- Innovation and technology transfer
- Internationalisation and cooperation

Together, a strategy group consisting of the board of directors, deputy directors and selected representatives of the competence teams worked out the details of the strategy.

Strategy process

Step 1
Strategic analysis: December 2016 to April 2017

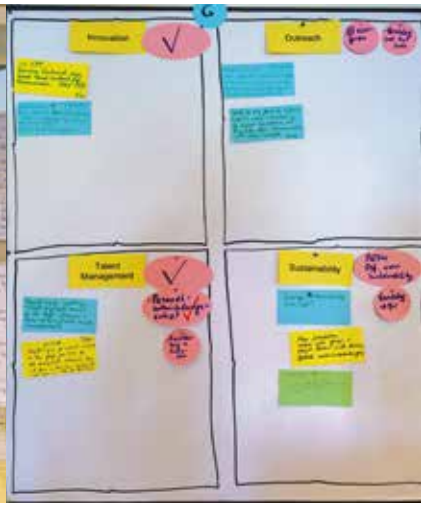
The aim of this phase was to outline the most important opportunities and risks that DESY will face in the future. The aim was to obtain a common realistic picture of internal resources and the external framework conditions – a central working basis for the strategy process. The meeting of the strategy group with the spokespersons of all competence teams at the end of the first phase was a milestone. Due to its spirit of optimism, it was called the “Woodstock” meeting and established a format for the DESY strategy development, which will take place once per year in the future.

Step 2
Inventing the future / Developing strategic options

In this step, specific future visions for DESY were first developed. The teams then worked out various realistic strategic options, some of which differed significantly from the status quo. The consequences of the respective options for DESY were discussed in detail. At the end of this phase, all parties involved agreed on the options to be worked out in the following weeks.

Step 3
Taking decisions

In the course of the intensive examination of the individual options, an ever-sharper picture of DESY’s future developed. In this way, it was possible to agree on an option that DESY will most likely offer the best opportunities for the future.



Step 4
Drawing a picture of the future

After the direction was agreed upon, the strategy was concretised, strategic programmes were formulated and the respective key measures, milestones and intermediate goals were defined in a second Woodstock meeting.

Step 5
Adjusting organization and processes

In preparation for the concrete implementation of the strategy, DESY's structures and processes were rethought and the distribution of resources discussed in the fifth phase of strategy development.

Step 6
Critical monitoring of developments

This phase was all about bridging the gap between theory and practice. It was defined how the strategic decision can be implemented, its impact monitored and adjusted.

Step 7
Implementing the strategy

The implementation of the strategy begins with this phase: the process and its results are communicated comprehensively, the agreed packages of measures are consistently worked on, and the development process is coordinated internally at regular intervals, as well as with external advisory bodies and funding agencies.

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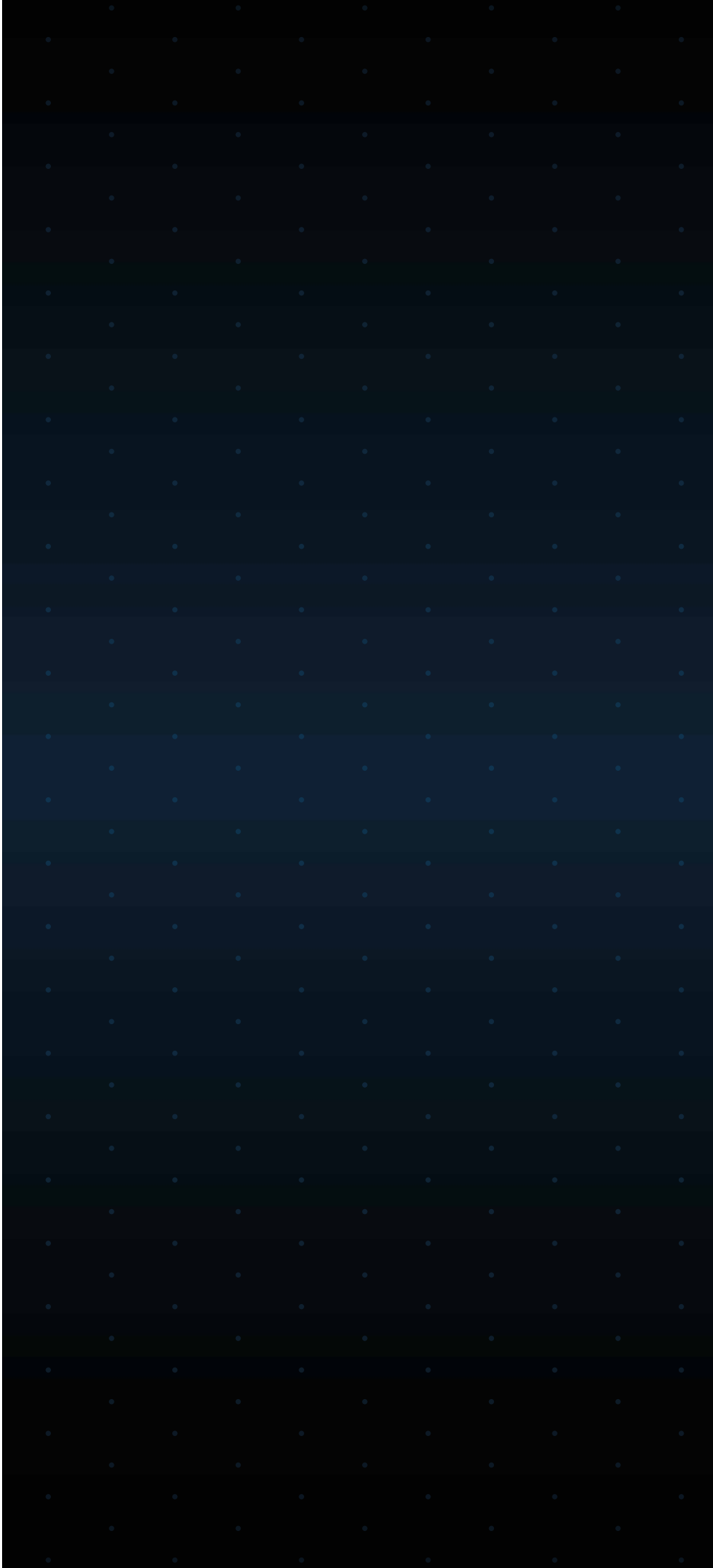

Setting goals

DESY is one of the world's largest accelerator centres and a leading partner in international research collaborations. We want to strengthen and expand this position.

Mission-critical for a successful future for DESY:

- PETRA IV as the next major project for DESY
- A substantial participation of DESY in the expansion of the European XFEL within the framework of a joint FLASH@XFEL strategy
- Dealing with enormous amounts of data and the topic of scientific computing
- Contributions to the LHC, in particular to the upgrade of the LHC experiments
- The expansion of astroparticle physics in Zeuthen
- The development of cross-departmental platforms
- Adaptation of supporting infrastructures and administration

Our goals

The accelerator lab – We build the machines of the future.

Accelerators are among the most important research tools. A wide variety of research areas benefit from them. The development of machines with which we can decipher the structure of matter is therefore a separate research discipline. We are constantly developing our systems, exploring new possibilities and building the machines of tomorrow.

- **We build the ultimate X-ray microscope.**
  With PETRA IV, DESY realises an X-ray microscope with a resolution 100 times higher than possible today.
- **We are making the European X-ray laser even better.**
  Together with European XFEL GmbH, DESY is completely expanding the European X-ray laser.
- **We develop novel accelerator concepts.**
  DESY designs innovative and compact accelerators and builds first test facilities.

The technology driver – We make insight possible.

The experiments at our accelerators generate enormous amounts of events and produce large amounts of data. Accelerator systems, detectors and scientific computing are therefore an indispensable basis for DESY's scientific success. We further develop our detector systems and our competence in scientific computing. In this way we create the conditions for discovering, measuring and analysing the so far unknown. This is how we make insight possible.

- **We are expanding our leading role in detector development.**
  DESY is investigating and developing new high-resolution detector systems.
- **We are establishing an interdisciplinary centre for scientific computing.**
  DESY is developing a "Center for Data and Computing Science" (CDCS) to meet the increasing demands on data-intensive applications in research.
- **We promote innovation and share our know-how.**
  DESY expands technology transfer. DESY is going to be the starting point for further start-ups in the Hamburg and Brandenburg regions.

The lab for the decoding of matter – We create the knowledge of tomorrow.

We ask nature the right questions. DESY investigates the microcosm in all its diversity - from the interaction of the smallest elementary particles to the behaviour of novel nanomaterials, to vital processes that take place between biomolecules and to particles from far away corners of the universe. In our research areas of particle physics, photon science and astroparticle physics we want to explore what holds the world together at its core and understand the evolution of the cosmos.

- **We decode molecular structures.**
  DESY is the world's leading centre for photon science. We want it to stay that way. Together with partners on the campus in Hamburg, we are strengthening our role as a centre for research into the structure, dynamics and function of matter and developing state-of-the-art light sources.

- **We hunt the tiniest building blocks of matter.**
  DESY secures its position as the national centre for particle physics. We expand our leading position as a key partner in international projects and by setting up an attractive research and development programme.

- **We open new windows to the universe.**
  In the coming years, DESY will drive its activities in astroparticle physics towards a separate research department and expand its location in Zeuthen to become an international centre for astroparticle physics with a focus on gamma ray and neutrino astronomy.

Centre for cutting-edge science – We create places for exchange and ideas.

DESY operates in tightly linked national, international and interdisciplinary networks. More and more institutions are settling on the campus to use the DESY facilities and to cooperate as closely as possible with us. We want to further improve our set-up and remain a magnet for cutting-edge research.

- **We create inspiration for world-class research.**
  DESY further expands its national and international networks and develops its locations in Hamburg and Zeuthen into attractive locations for interdisciplinary exchange, science and innovation.

- **We create new networks.**
  All research fields at DESY benefit greatly from the strengthening of regional and national partnerships. This opens up completely new perspectives for cooperation and interdisciplinary research. We want to take advantage of this.

DESY.

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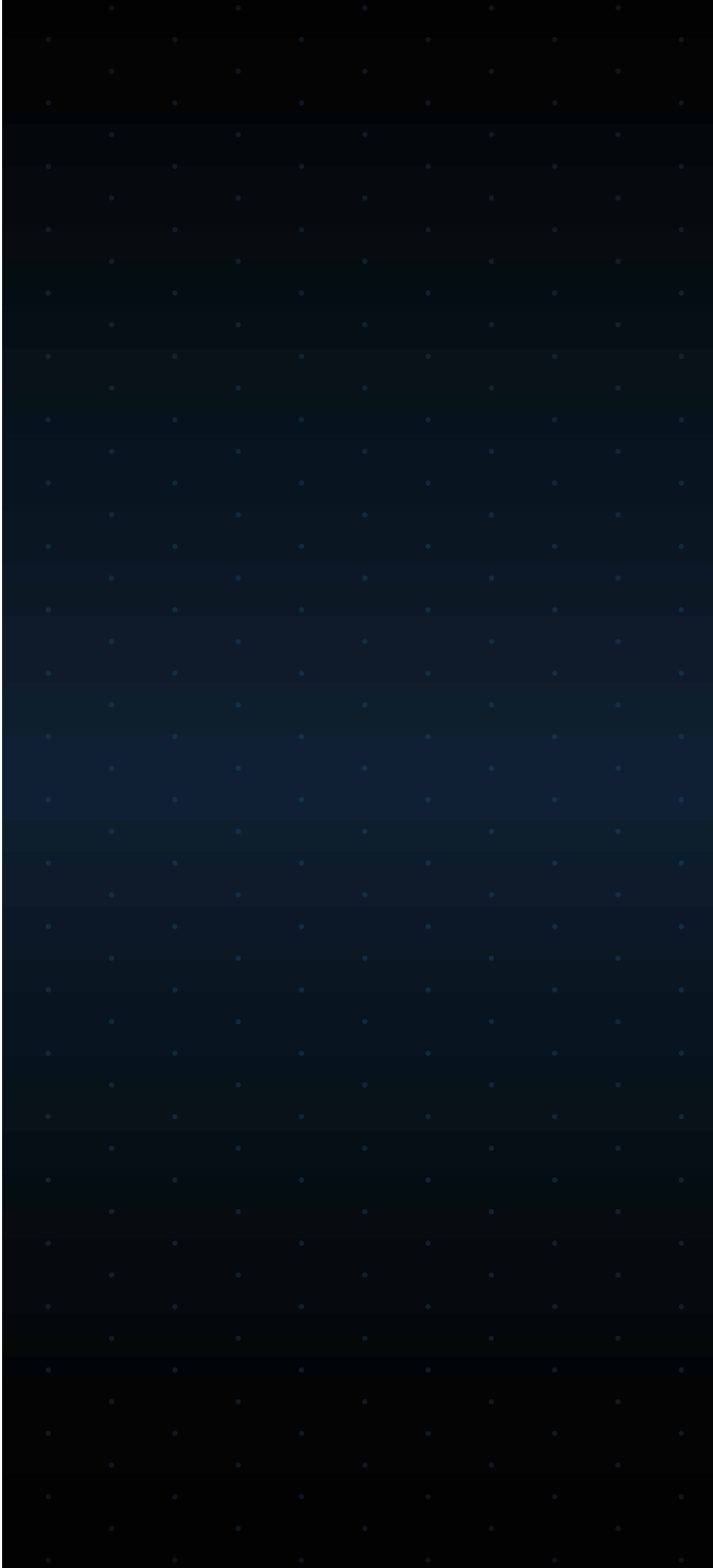


Setting the course

Research at DESY is extremely versatile. We search for the smallest building blocks of matter in the world, develop innovative high-tech materials and look for active components for future drugs. As one of Germany's largest research centres, DESY contributes with its fundamental research to the creation of new knowledge and new approaches. This is the basis for mastering the challenges of the future and requires long-term thinking, sustainable solutions and new technologies.

In line with our goals, 19 competence teams from the fields of research, large-scale facilities and supporting infrastructure (cross-sectional themes) worked together with the board of directors and deputy directors to develop the details of the strategy and concrete measures. The results of the individual competence fields are listed in detail below.

Light sources – tools of research

DESY operates the unique photon sources PETRA III and FLASH and is a key partner of the European XFEL. These facilities are the basis for leading international research groups at DESY and must be further developed and expanded in order to maintain our international leadership role.

Field of competence: PETRA

PETRA III – further expansion

PETRA III is currently the synchrotron radiation source with the highest brilliance in the world. When extended, PETRA III will consist of 25 fully equipped beamlines with state-of-the-art experimental stations.

The extension of PETRA III, which has already begun, will take a few years. Until then, six more beam lines will be put into operation. We aim to cooperate with universities for two of the remaining undulator stations. A collaboration with the FAU Erlangen-Nuremberg is in preparation for an experimental station for small-angle scattering at PETRA III for joint material science research. All beamlines and experiments at PETRA III are continuously kept up to date with the **latest technology**. In this way, we ensure that instrumentation can continue to be used on PETRA IV in the future.

Many experiments at PETRA III are currently undergoing a paradigm shift: until now, users evaluated their data at their home institute after their trip to DESY. In the future, this will become increasingly difficult due to the complexity of modern measurement methods and rapidly increasing data volume. Instead, data analysis will take place at DESY as part of the experiment. As part of DESY's strategy for scientific computing, DESY provides the necessary resources and support for data analysis.

PETRA IV – the next major project

In the long term, the plan is to upgrade PETRA into a **synchrotron radiation source with ultra-small emittance** (PETRA IV), whereby the brilliance in the hard X-ray range can be increased by a factor of 100. PETRA IV will be the only source in the world to provide beam conditions that will make it possible to offer all X-ray techniques with a highly focused X-ray beam. PETRA IV becomes the **ultimate 3D microscope** for the investigation of complex chemical, biological and physical processes on all length and time scales from atomic to macroscopic dimensions and under realistic conditions. PETRA IV thus provides the basis for understanding complex processes in nature and the function of new materials and agents.

PETRA's upgrade is made possible by a new storage ring technology, the so-called multi-bend achromat technology, which significantly improves the performance of modern synchrotron radiation sources (by one to two orders of magnitude). Since PETRA is the world's largest storage ring used to generate synchrotron radiation and the maximum achievable brilliance depends heavily on its size, PETRA IV will be by far the most brilliant source after the upgrade and will hold a **worldwide leading position**.

The current schedule of the PETRA IV project schedules the preparation of a design proposal for 2018 and a technical design report by the end of 2019. After a preparatory phase in which the necessary components will be developed and manufactured, the upgrade could begin in early 2025. Towards the end of 2026, it is planned to start user operation.

An X-ray examination at DESY can improve the quality of chocolate.

The free-electron lasers European XFEL and FLASH

DESY is one of the pioneers in the design, construction and operation of free-electron lasers in the wavelength range from extreme ultraviolet (XUV) to hard X-rays. The unique feature of the technology developed at DESY for the superconducting, linear electron accelerators in FLASH and in the European XFEL is the very high repetition rate in the range of 100 kHz compared to the rates possible with conventional linacs in the range of 100 Hz. This high repetition rate has advantages for all experiments with extremely diluted samples, such as gas phase reactions or low signal strength, as well as for experiments that combine different information channels.

Field of competence: XFEL

DESY is the largest shareholder of European XFEL GmbH, operates the accelerator complex for the company, develops it further and will be one of the main scientific users of the outstanding research opportunities at this facility.

Operation of the accelerator of the European XFEL

DESY carries out the technical operation of the accelerator complex for European XFEL GmbH as part of the operating agreement concluded between the two organisations. The XFEL accelerator team at DESY is committed to guaranteeing efficient and high-quality operation of the accelerator system. The aim is to provide the "**best beam for the best users**", i. e. to make the XFEL accelerator an outstanding example of the efficient, flexible and challenging operation of a large research facility by combining decades of extensive experience with new information technology concepts.

DESY is committed to continuously working on improvements and possible expansions of the accelerator. DESY will develop new concepts and technologies for electron-beam-based X-ray generation and thus contribute to the innovation of photon science. DESY will consolidate its worldwide leading role in superconducting high-frequency technology with the demonstration of maximum availability, stability and beam quality of the XFEL linear accelerator.

DESY staff works closely with their colleagues and the management of European XFEL GmbH. The commitment and ambition for excellent work at the highest level goes far beyond being just a "service provider".

Extension of the European XFEL

In order to fully exploit the system's potential, the pulse mode currently used in the European X-ray laser needs to be converted into continuous wave operation (also known as "CW"). The advantage of continuous wave operation is that the distance between the pulses can be freely selected according to experimental requirements and enables even higher repetition rates.

The further optimisation of the XFEL system, including the extension of the accelerator to higher continuous beam power (CW operation), has high priority on the list of DESY's far-reaching strategic plans for the future. In cooperation with European XFEL GmbH, DESY intends to concentrate on the development of **CW operation for the European XFEL**.

DESY is also proposing to realise **the planned second fan of beamlines of the European XFEL**, which will enable another five FEL beamlines. DESY also proposes to transfer its FLASH FEL activities to the second fan of the European XFEL and to operate two FEL lines with a particle energy of approximately 2.5 GeV under its own responsibility as FLASH@XFEL. In the meantime, DESY will make every effort to keep the FLASH operation up to date with the latest scientific and technical developments and thus be prepared for FLASH@XFEL. After the transition of the FLASH activities to FLASH@XFEL, the operation of FLASH will be cease.

The resources released by the end of FLASH operation will then be used to **strengthen the user programme** of FLASH@XFEL, PETRA III/IV and for the targeted further development of detectors, accelerators and laser components. This plan requires close cooperation with XFEL GmbH and the other shareholders.

Processing a cavity in the clean room

Field of competence: FLASH

FLASH is the world's only X-ray laser based on superconducting accelerator technology for the wavelength range of extreme ultraviolet (XUV) to soft X-rays. The scientific questions that can be dealt with in this wavelength range at FLASH today and in the future are complementary to the European XFEL.

DESY is planning an **ambitious development programme called "FLASH2020+"** to ensure a high-level research programme in the wavelength range of FLASH and the smooth transition from FLASH to FLASH@XFEL. This ensures that FLASH retains its position as the best X-ray laser with a high repetition rate for the XUV and soft X-ray range, offers excellent experimental facilities for users and enables excellent science.

The "FLASH2020+" development programme of the two FEL lines and the accelerator includes

- the operation of two independent FEL lines (FLASH1 and FLASH2) with **variable magnet structures** (undulators) for trend-setting new lasing concepts and "seeding" with a high repetition rate,
- the **extension of the wavelength range** from the fundamental to the oxygen K-edge, in order to reach the important elements for energy research and to cover the water window for biological questions,
- **flexible excitation/query schemes** for time-resolved experiments,
- **variable polarisation** for the investigation of the light-induced switching of magnetic storage media; and
- **shortest pulses** up to the attosecond range.

In order to achieve these goals, it is planned to establish a **joint research and development programme with the X-ray laser European XFEL**. The plans perfectly fit the requirements for excellent science in such diverse fields as fundamental questions of atomic and molecular physics and chemistry, catalysis, atmospheric and astrochemistry, nanoscience, life sciences and materials science. The "dream FLASH facility" of the community of FLASH users would also run with a repetition rate of 100kHz in continuous-wave operation, which could be realised in the long term with the X-ray laser European XFEL.

Photon science

Investigation with photons allows to decipher the structure and dynamics of matter on all relevant length and time scales. This requires modern photon sources.

The **focus of physics with photons** ranges from the investigation of the interaction of extremely intense and short light pulses with matter to the decoding and control of the properties and functions of biological molecules and complex materials from the atomic to the macroscopic scale. Scientists who operate the experiments at PETRA III and FLASH work closely together with the DESY research groups in the three research fields “Matter – Dynamics, Mechanism and Control” (Mat-DMC),”Nanosciences and Materials Sciences” (Nano-MAT) and “Biological and Soft Condensed Matter” (Bio-Soft).

External partners are involved in photon science via joint research centres.

In the **CFEL** (Center for Free Electron Laser Physics), DESY cooperates with groups from the Max Planck Institute for Structure and Dynamics and the University of Hamburg. This successful cooperation is the basis for the success in the past German Excellence Initiative and is the excellent basis for the upcoming one.

DESY will participate in the **CSSB** (Center for Structural System Biology) with a working group. The CSSB is an alliance of ten university and non-university research partners, mainly from northern Germany. The common goal is to decipher molecular processes during the infection process. The centre combines the biological competence of the CSSB with the methodological competence of DESY. Together, we are in an excellent position to investigate and understand molecular biological processes with the highest precision.

Together with the **Helmholtz Zentrum Geesthacht and the Christian-Albrechts-University of Kiel**, the new **CXNS (Center for X-ray and Nano Science)** with integrated nano-laboratory (**NanoLab**) will be realised in the next few years.

In the longer term, the aim is to establish an interdisciplinary centre for water research (Center for Water Science, CWS) with various partners from Germany and abroad. In this context, DESY’s expertise in the use of advanced investigation methods at ultra-modern photon sources will be used as a basis for the project.

In order to further develop medical imaging with synchrotron radiation, it is planned to establish a **Helmholtz Institute for Advanced X-ray Medicine** (HIMaX) at the **Otto-von-Guericke-University Magdeburg**. For this purpose, a dedicated measuring station is to be set up and operated as part of the PETRA III extension.

Field of competence: Matter – Dynamics, Mechanism and Control (Mat-DMC)

The research focus Mat-DMC aims to decipher **the fundamental mechanisms** of the interaction between electromagnetic radiation (light) and matter at extreme intensities and in short pulses at free-electron lasers. The scientists are developing the basis for the applications of radiation sources in the various scientific disciplines. Theoretical and experimental groups work hand in hand.

Mat-DMC's goals for the next ten to 15 years include the following points:

- **Non-linear optics:** measurement and application of nonlinear optical procedures in the X-ray range in solids, gases, plasmas and nano objects. This requires for example the development of a suitable theoretical framework and the implementation of the corresponding software.
- **Planetary and highly compressed matter:** creating and characterising matter at high pressure and/or high temperature. This is relevant for geophysics, planetary and astronomical physics.
- **Single imaging of macromolecular systems:** an important aspect will be the development, construction and operation of beam guidance systems for FLASH, PETRA III/IV and the European XFEL (HIB).
- **Chemistry under extreme conditions:** astrochemistry in the laboratory is characterised by low densities, low temperatures, high radiation levels, questions of molecular chirality (handiness) and the evolution of life.
- **Quantum Molecular Movie:** The simultaneous detection of the molecular structure (atomic compositions) and the electronic structure along molecular reaction pathways. This requires greater control at the molecular level (including in more complex systems), increased sensitivity of imaging techniques and international cooperation with detector developers and theory groups.
- **Non-equilibrium dynamics:** development of extended simulations for liquids, surfaces and solids. We are pursuing a hybrid approach, combining some of the capabilities of our existing software toolkits. In particular, in order to be able to describe systems with increasing complexity, we will push ahead with multi-scale modelling.
- **Control of electron dynamics:** the adaptation of laser beams to control the electronic behaviour in matter. In order to meet this challenge, a strong experimental group with broadly diversified competencies ranging from the generation and formation of ultra-short light pulses to molecular science is being built up. This group will work closely with other DESY groups.
- In the **area of theory**, the aim is to join forces with other theoretical groups on the campus as part of the planned "Wolfgang Pauli Centre".

With these topics, Mat-DMC is very well positioned for future challenges in this field in order to continue to achieve outstanding research results.

Field of competence: Nano sciences and Materials Sciences (Nano-Mat)

One of the greatest scientific challenges of today is to **decipher the properties of complex functional materials** on all length scales from atomic dimensions to the macrocosm. It is equally indispensable to understand the behaviour of matter far from equilibrium on all relevant time scales in order to monitor and control the processes taking place in these materials. DESY's research focus on nano sciences and materials science (Nano-Mat) is dedicated to answering these central question. A particular focus is on the study of **material properties under real process conditions (in-situ and operando)** with state-of-the-art analytical X-ray techniques at the local X-ray sources PETRA III, FLASH and the European XFEL. The investigations are prepared, accompanied and supplemented by the DESY NanoLab, which provides complementary microscopy, spectroscopy and nanoproduction methods.

In addition, **cooperation** with the newly founded Center for Hybrid Nanostructures (ChyN, University of Hamburg) and the Max Planck Institute for Structure and Dynamics (MPSD) will be established on the campus in Hamburg. The aim is to create an interdisciplinary, inter-institutional **Hamburg Centre for Nanosciences**. Then it will be possible to achieve a fundamental understanding of functional and structural materials from the nanometre scale to macroscopic dimensions, which will allow a **complete picture from material synthesis to its function**.

Research priorities and milestones particularly relevant for Nano-Mat are:

- To understand the development of novel magnetic materials and their **magnetic dynamics on ultra-short time scales**. This makes it possible to adapt their properties to desired functionalities, as required in the development of novel materials for information technology (data storage and processing) and magnetic sensors.
- An in-depth understanding of **catalysts and chemically active materials** under real process conditions: closing the gap between model systems and real catalysts, combined with nanometre-accurate imaging methods and the depiction of ultra-short temporal dynamics, will make it possible to answer key questions in heterogeneous catalysis. These consist primarily in the search for catalytically highly active phases and their optimisation with regard to selectivity and catalyst lifetime.
- The main focus of research on novel thin-film systems is on the **synthesis of functional nanomaterials**, e. g. for flexible electronics and photovoltaics. In-situ studies correlate nanostructural properties with optical and electronic properties in real time and under realistic and industrially relevant conditions.

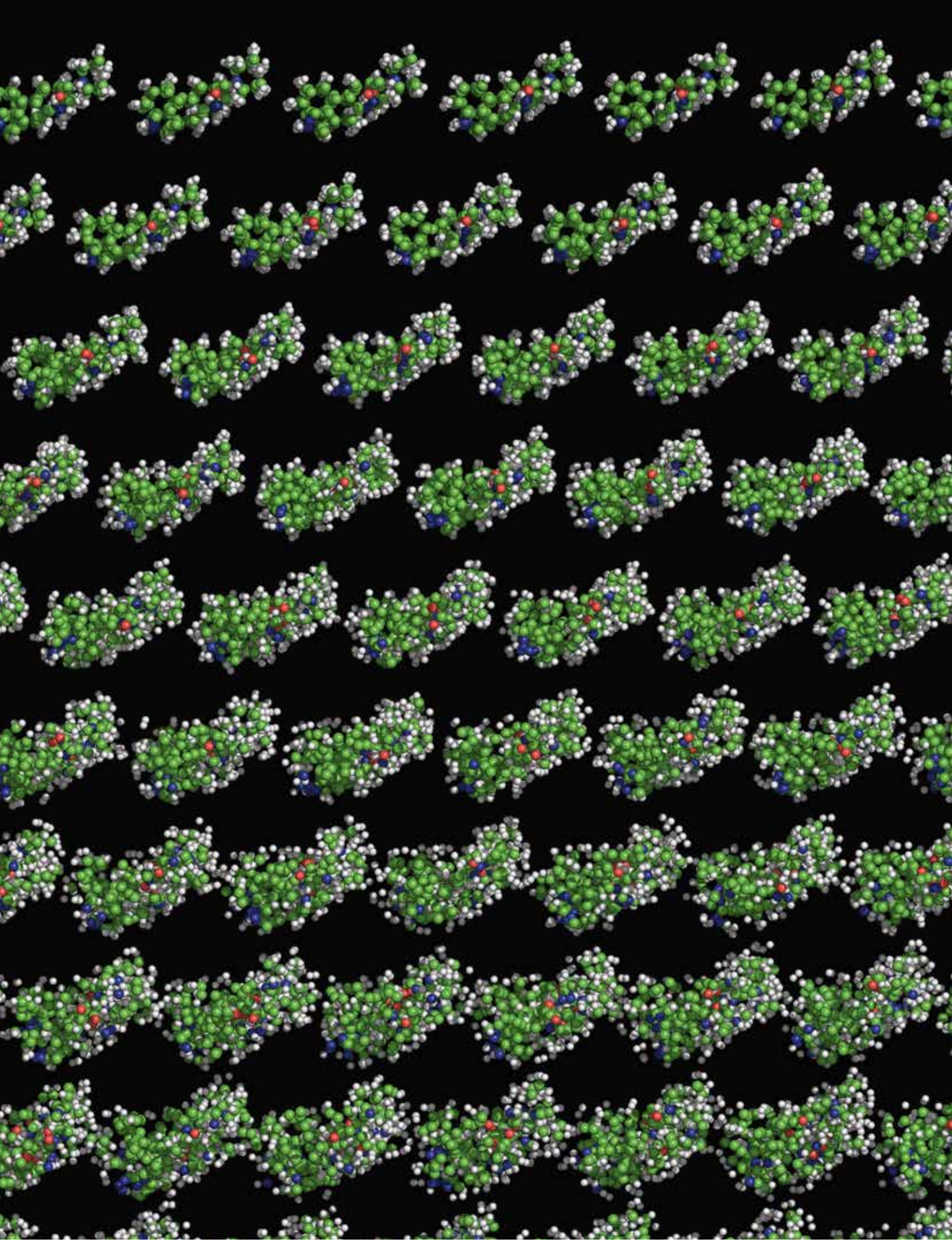
The development of high-resolution X-ray optics up to their physical limits is the strong methodological backbone of these research activities. The aim is to provide ultra-fast X-ray imaging (ptychography, coherent diffraction imaging) with atomic and chemical resolution.

Field of competence: Biological and soft condensed matter (Bio-Soft)

The overall goal of the Bio-Soft research unit is to understand the function of biological molecules and macromolecular complexes as well as the properties of soft matter on a structural and dynamic level. The aim is to use this understanding for controlling functions or generating new functionalities in biological or synthetic systems. To this end, the following research priorities are set:

- Investigation of the **structure and dynamics of macromolecules** under physiological conditions.
- Investigation of dynamically and spatially **heterogeneous systems**.
- Determination of the structure of complete **biological cells** with one-nanometre resolution.
- Real-time studies of **energy conversion** and structural dynamics processes.
- Increased use of measurement methods using **coherent X-ray radiation** to investigate the structure and dynamics of non-crystalline soft matter.
- Establishment of an **interdisciplinary water institute** with the aim of gaining a detailed, molecular understanding of water. This includes the exploration of dynamic processes in bulk water and at the interfaces, which are of highest relevance for biology, earth and environment as well as technology.
- Development of innovative, new techniques and methods based on existing expertise in photon research, diffraction physics, imaging, spectroscopy, X-ray interaction and molecular filming methods.
- Close cooperation in the development of imaging techniques for cryo-electron microscopy and single-particle X-ray diffraction.
- Strengthening scientific cooperation to define the development of the experimental facilities at FLASH2020, PETRA IV and European XFEL and thus the development of a leading role in the XFEL user consortia.
- Collaboration with the detector group and the proposed Centre for Data and Scientific Computing to develop hardware and software solutions for the increasing flood of data.

In addition, close cooperation with all research institutions on campus and in the greater Hamburg area is being sought. Collaboration with the CSSB (Center for Structural System Biology), the new Max Planck Institute for Structure and Dynamics and the Centers of the University of Hamburg CHyN (Center for Hybrid Nanostructures) and HARBOR (Hamburg Advanced Research Centre for Bioorganic Chemistry) are of particular importance.



A protein crystal consists of a regular pattern of protein molecules.

Particle Physics

Three central scientific questions form the cornerstones of the future portfolio of particle physics at DESY: the Higgs particle and fundamental interactions in high-precision physics, the search for new particles and phenomena as well as cosmology and the dark sector of the universe.

These questions cover the essential points that are of fundamental experimental and theoretical interest today. Experiment and theory are closely interlinked in these topics. The close collaboration between theoretical and experimental particle physics is one of DESY's particular strengths in particle physics.

The research topics offer excellent opportunities to connect with other fields of research, in particular astroparticle physics, and research programmes in the field of detector development and computing at DESY and other Helmholtz Centres (KIT, GSI/FAIR).

Strong voice in European particle physics

Due to its strengths, DESY is an important player in the development of particle physics as a whole. The process of updating the European strategy of particle physics, which is just beginning, will be concluded in the spring of 2020 with the publication of an update of the strategy. DESY has a strong voice in this process.

In particle physics, DESY has built up its "lifecycle expertise" over decades, which ranges from the conception and design of experiments, their construction and operation to data analysis and the theoretical interpretation of the data. This expertise and DESY's excellent infrastructure justify the laboratory's high reputation and its position as a national laboratory for particle physics ("hub" for the German community). DESY collaborates closely with the German university groups and supports them in ongoing and new research activities. With the increasing size and complexity of particle physics projects, this role will gain in importance.

Our portfolio will focus on some major experimental projects and the further development of our theoretical activities.

All particle physics activities are highly dependent on scientific computing. The expansion of the NAF to IAF and the establishment of a CDCS will provide new scientific impetus that will go beyond the important operation of the Tier-2 computing infrastructure.

Field of competence: Experimental Particle Physics

Our LHC activities, including our contributions to the global flagship project in particle physics - the upgrade of the LHC to the high luminosity LHC (HL-LHC) - continue to form the backbone of our experimental work. DESY has assumed special responsibilities in the upgrade process, in particular for the punctual and technically perfect completion of the tracking detector endcaps for ATLAS and CMS. The detectors are being built at DESY in close cooperation with numerous German university groups. DESY must make this success possible by contributing hardware and other resources appropriate for a laboratory of its size.

The upgrades are expected to be completed by around 2025 and the experimental programme is expected to extend well into the 2030s. DESY offers German university partners significant support and infrastructure for upgrade projects.

The Belle II project also demonstrates DESY's importance as a national hub for particle physics. We will make essential contributions to the successful commissioning and the rich physics programme of Belle II over the next ten years.

As a national laboratory, DESY will support international particle physics projects with strong German participation.

For the International Linear Collider (ILC), we expect the Japanese government to reach a decision by the end of 2018. In the event of a positive outcome, we will strive to expand our leadership role in accelerator and detector development and lepton collider physics.

In the event that the ILC is not implemented, DESY will be involved in deciding which alternative project to implement as part of the European strategy process: CLIC, FCC, HE-LHC, CEPC, SppC - there are many ideas and studies, and we will invest our expertise and leadership in the most promising project.

DESY's role includes the expansion of an attractive research and development programme on campus. These activities increase the attractiveness of the laboratory for cooperation partners and scientists at all stages of their careers and strengthen our influence on the design of the field.

We will have a very attractive "on site" programme from around 2020 onwards: ALPS II will then be operational and MADMAX will be in preparation, as may be the IAXO and LUXE experiments.

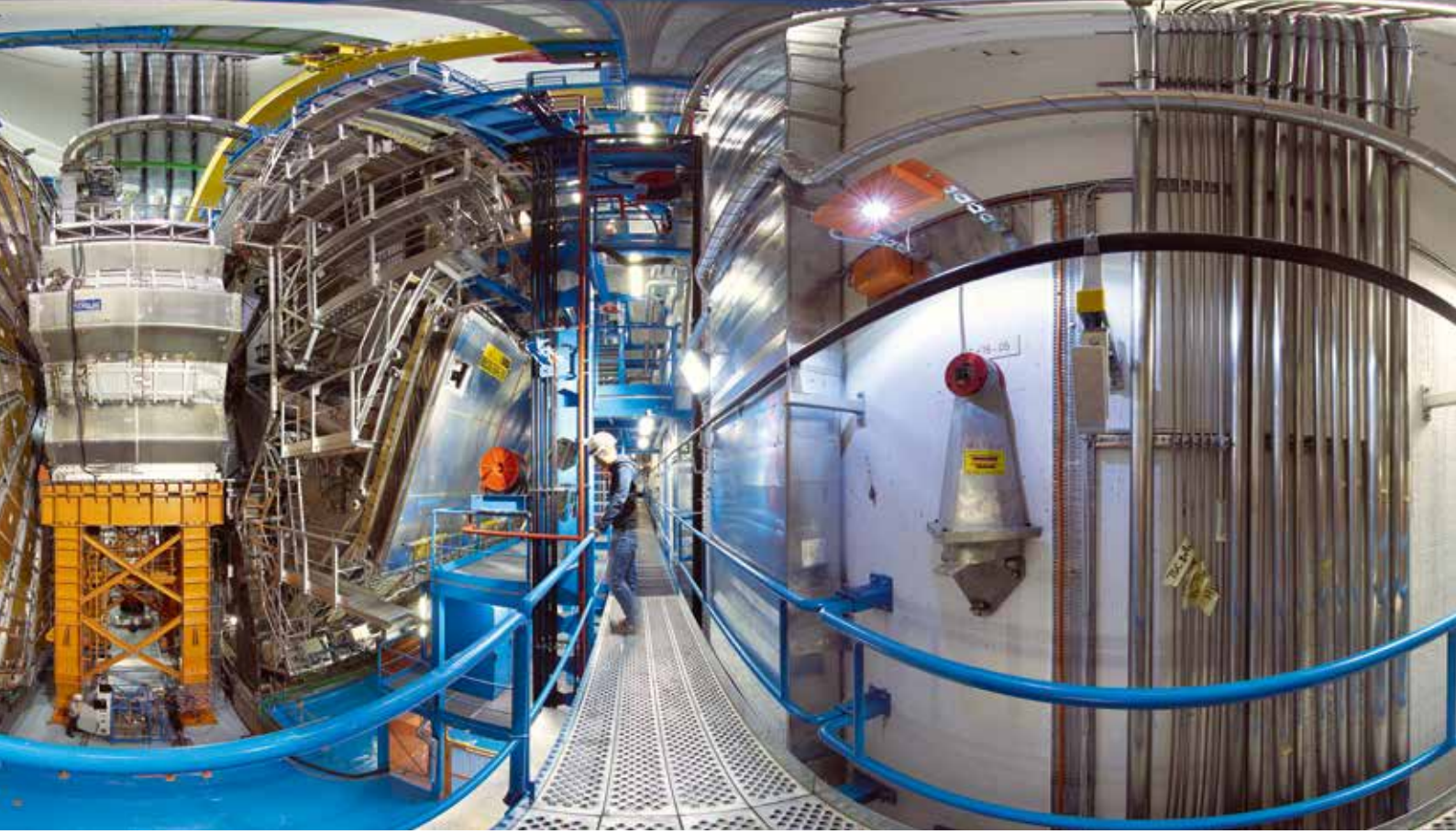
The "Detector Assembly Facility" will be fully utilised with the construction of the HL-LHC end caps until 2025. This important infrastructure will afterwards be available for other projects. Just as important as this facility is the test beam facility at DESY II, which is to be expanded.

Field of competence: Theoretical Particle Physics

The DESY Theory Group is unique in Germany in size, breadth and degree of networking and enjoys the highest reputation on a European and global level. It plays a central role in particle physics in Germany and beyond. Their work will be increasingly important in interpreting the results of the experimental activities and in initiating new experimental developments.

The theory will link its four pillars – collider phenomenology, string theory, particle cosmology, lattice gauge theory – even more strongly than before. The cross-fertilisation of different fields with methods and tools will be crucial to achieve breakthroughs in answering central questions: What is the origin of mass? What is the structure of the vacuum? What is dark matter and energy? Where does the asymmetry between matter and antimatter come from?

In answering these and other fundamental questions, **interdisciplinary cooperation** will also be decisive, as it is to be developed further in the **Wolfgang Pauli Centre (WPC)**. For this centre, we aim to build our own building, which will house all theoretical activities on the campus. We see the WPC as Germany's leading and internationally outstanding institute for theoretical physics.



360-degree view of the ATLAS cavern

Theoretical particle physics

Field of competence: Astroparticle Physics

In astroparticle physics we investigate our universe at high energies with gamma rays and neutrinos. Our goal is a fundamental understanding of the **role of high-energy particles and processes in the development of our universe**. This is the pre-re-quisite for the search for dark matter or physics beyond the standard model of particle physics using cosmic messengers. Our challenges are:

- Identification and investigation of sources of high-energy neutrinos.
- Thorough searches for galactic and extragalactic gamma-ray sources combined with detailed investigations of the different types of these sources.
- The identification and understanding of the relevant processes of relativistic matter in magnetised plasmas and radiation fields.

DESY has extensive experience and expertise in experimental **gamma-ray and neutrino astronomy** as well as in **theoretical astroparticle physics**. We are rigorously developing our activities in astroparticle physics owards a separate research department. In this way, we are taking into account the successful development of this growing research field at DESY and exploiting the great scientific potential of astroparticle physics, especially with gamma rays and neutrinos. The aim is to develop the location in **Zeuthen into an international centre and contact point for astroparticle physics**.

The CTA project (Cherenkov Telescope Array), an international observatory for gamma-ray astronomy, is of outstanding importance. The partnership with CTA will be strengthened at several levels:

- The **CTA Science Data Management Centre** will be located on the DESY Campus in Zeuthen. Researchers from all over the world will come to us as guests.
- We are a key partner in the **development, construction and operation** of essential components both in the construction phase and during future expansion of **the observatory**.

In the coming years, substantial resources will be used to build the CTA Observatory:

- Construction and commissioning of the medium telescopes at the observatory sites in Chile and on the Canary Island of La Palma.
- Development and implementation of the entire software system for both control and data taking.
- Development of software pipelines for calibration, reconstruction and analysis of observation data.

In addition, we are shifting our activities for the current experiments H.E.S.S., MAGIC and VERITAS to CTA in the coming years in order to prepare the “physics harvest” with CTA.

Another core project of astroparticle physics at DESY is IceCube. We are a **leading institute in the IceCube collaboration**. To ensure that this remains so, we are driving the **design, development and expansion of IceCube**. In this way, the IceCube detector will retain its unique sensitivity to cosmic neutrinos in the coming years. Through the development of better analysis algorithms and the expansion of a **multi-messenger programme** together with gamma-ray and optical observatories, we are working to identify the sources of cosmic neutrinos.

In addition to the two core scientific projects CTA and IceCube, we continue to pursue small, strategically selected and expandable experimental projects. They complete **a robust and foward-looking research programme** and increase independence from international partners and schedules. Special attention is paid to the **radio detection of cosmic neutrinos**. DESY will develop the proposal for a dedicated experiment in the coming years. In addition, we are continuing the development of a satellite for gamma radiation astronomy and studies on astrophysics in the laboratory.

In theoretical astroparticle physics, we are continuing to expand our research into **acceleration and transport processes of cosmic radiation**. Emphasis is placed on the development of a deeper understanding of diffusive shockwave acceleration and the role of turbulence in the transport of cosmic rays.

The **close link between gamma-ray and neutrino astronomy and theoretical astroparticle physics** creates a scientific area, which will develop a high scientific impact through close cooperation and many synergies.

Prototype of the medium-size telescope for the Cherenkov Telescope Array CTA

Field of competence: Accelerator research

A **strong accelerator research programme** is indispensable for DESY's future. The laboratory has played a leading role in the successful implementation of the research topic "Accelerator Research and Development" (ARD) in Helmholtz, thus significantly improving the visibility of this research discipline. The ARD activities take place in a close cooperation of the M, FH and FS departments and with the University of Hamburg as a strategic partner; they are a successful example of **laboratory-wide cooperation.** ARD is an activity on the research front in which new ideas and concepts can develop and change quickly. **Flexibility in the strategic direction** is therefore important and the strategy is subjected to an analysis of any necessary changes at appropriate intervals.

DESY's undisputed leading role in **superconducting high-frequency technology** will ensure the best possible further development of the XFEL accelerator system. The ARD activities will focus on the continuous wave mode of the linear accelerator, in particular the essential development of a **CW high-frequency cannon** as a beam source and the optimisation of the accelerator modules. The implementation of this programme is carried out in close cooperation with the XFEL accelerator team of DESY and the European XFEL GmbH. The test programme for the conventional high-frequency cannon at PITZ in Zeuthen will be completed in the course of the 2020s. Until then, PITZ activities will remain an important element in our strategy.

The activities in **novel accelerator concepts and ultrafast technologies** are coordinated by a scientific steering team of the "**Hamburg Alliance for Novel Radiation and Concepts**" led by the Accelerator Division. Its members include leading scientists from all DESY departments in Hamburg and Zeuthen and the University of Hamburg. The committee's tasks include discussing and defining the medium- and long-term strategy for research work on ARD. The Board does not make decisions on the distribution of resources.

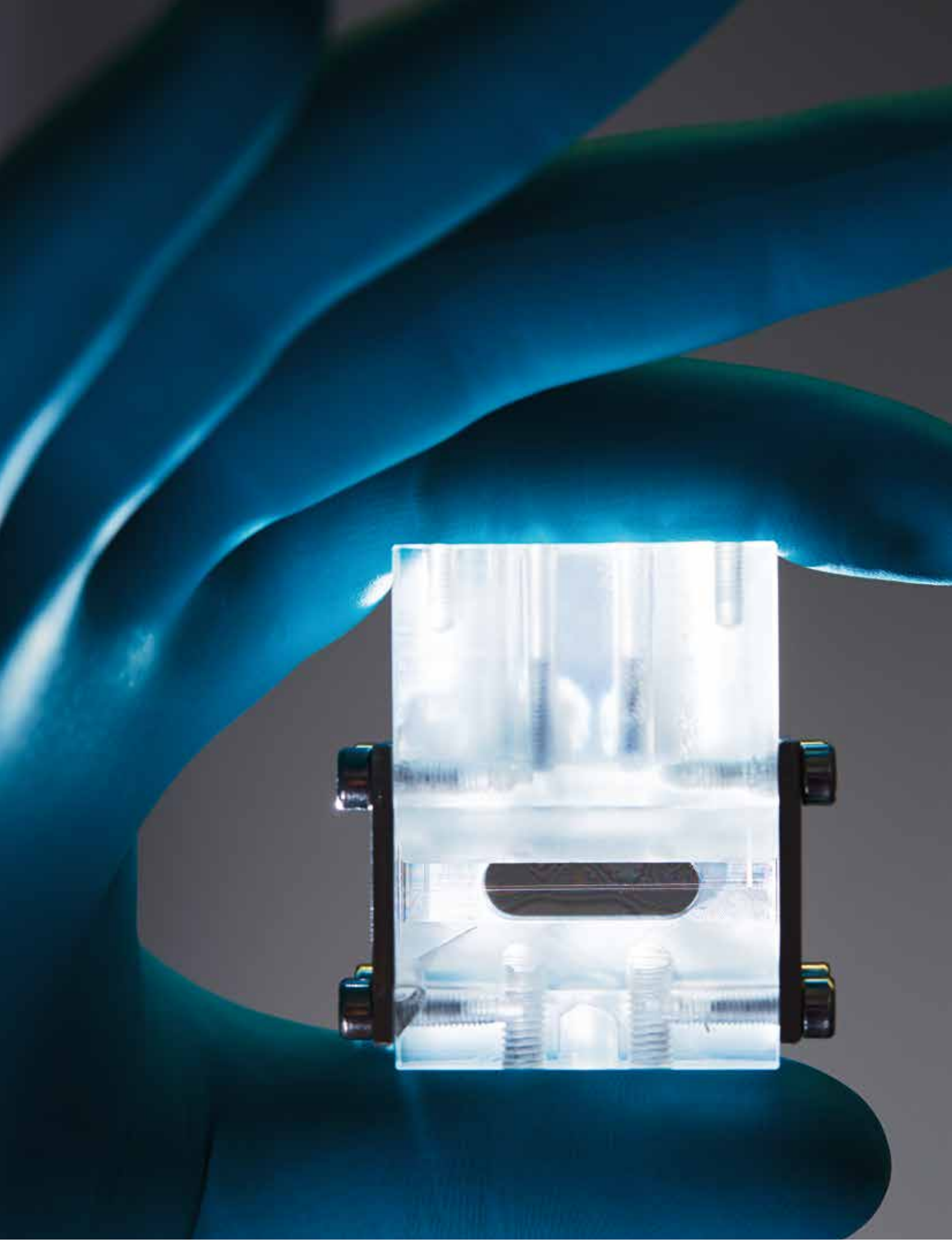
The new **SINBAD/ATHENA** infrastructure will bundle work on (sub) femtosecond electron beams, laser plasma acceleration and optical accelerators with THz or infrared laser beams.
The strategic objective is to demonstrate the usability of these innovative concepts of extremely compact accelerators in initial pilot facilities, e. g. a soft X-ray FEL. The infrastructure strengthens DESY's position in the European and international context, e. g. as a possible location for a future **EuPRAXIA plasma accelerator facility**.

The FLASHforward experiment for **electron-beam-driven plasma acceleration** is carried out at the FLASH accelerator and represents the second pillar of the development of novel concepts for compact accelerators of the future. The experiment aims to demonstrate the efficient acceleration of a high-energy and high-quality secondary beam.

The FLASH strategy creates possibilities for new concepts and solutions (e. g. seeding or sub-femtosecond beams). We are ready to support such developments. A sustainable R&D programme for new FEL concepts should, in cooperation with the European XFEL, also be continued after the end of FLASH's operation.

In order to improve contact with users and colleagues at the user facilities, ARD is proposing to organise satellite events at the user meetings of the photon science department at which potentially relevant developments on ARD can be presented and discussed.

ARD experiments at the REGAE facility, which is operated primarily for a Max Planck Group, will be completed at the beginning of the POF IV period; REGAE will no longer be operated thereafter. A strong ARD programme will expand and improve the possibilities of research on user facilities. It will generate innovation potential in a wide range of applications and attract **young talent**. And it will increase DESY's attractiveness for international cooperation partners in the field of accelerator physics and technology. Thus, ARD will consolidate and expand DESY's role as a leading designer in this field - for example in EU projects.



Plasma cell for acceleration experiments

Field of competence: Detector development

Detector development plays a central role in DESY´s strategy. Detectors are one of the pillars that enable scientific progress at DESY. We aim to further expand and develop our position as a world-leading laboratory in the development and construction of detectors and to play a leading role worldwide, particularly in the field of **highly pixelated** and **high-granular systems**.

We are convinced that with the strong groups we already have in the field of photon science and particle and astroparticle physics, there is an excellent basis for further increasing our visibility in this area. Our highly efficient central groups in the area of electronics development, but also efficient workshops, play an important role in this. As part of the MT programme, we are closely networked with the other Helmholtz centres. We want to further expand and intensify our cooperation with universities.

In recent years, we have made decisive progress in a number of areas:

- We have successfully equipped the first experiments on the XFEL with mega-pixel detectors (AGIPD).
- With the foundation of X Spectrum GmbH we have successfully commercialised the Lambda detector type.
- We have built a substantial part of the new CMS pixel detector at DESY and put it into operation at CERN.
- We have made key contributions to establishing highly granular calorimeters, revolutionising the construction and operation of calorimeters along the way.
- We have successfully built several pixel cameras for the H.E.S.S. experiment and established DESY as a competence centre in this area.

We have developed a technology and detector roadmap that reflects these ambitions. The common goal of our activities is to develop detectors that are capable of delivering the ultimate spatial resolution in the micrometre range, time resolution in the nanosecond range and excellent energy resolution in one system at the same time. One of our strengths is our technological expertise, especially in the field of highly-pixelised semiconductor detectors, chip development and connection technology. CMOS systems will be a special focus in this context. We want to develop these strengths further in a targeted manner.

DESY is known all over the world for its system competence with regard to the construction of complex detector systems. Especially in recent years, we have massively strengthened our competence in the field of innovative non-active detector materials. Over the next few years, there will be a strong focus on detectors for the European XFEL, PETRA, high-luminosity LHC and CTA. In addition, however, we will also push ahead with fundamental development work on new systems, such as those that have already been carried out very successfully in recent years, for example in the development of highly granular calorimeter systems.

Our detector systems generate more and more larger amounts of data that have to be transported and processed. We therefore aim to work closely with the new research area “Data Management and Analysis” in the Helmholtz research field Matter and will continue to expand our expertise in the field of fast data transfer, but also in rapid data processing and the development of algorithms.

Ambitious detectors on the edge of what is technically feasible need highly qualified scientists who have access to suitable and high-quality infrastructure. However, there is also a need for close involvement of detector scientists in the science for which the detectors are to be developed. We have learned that this close involvement is ideally suited to generate creative and innovative ideas. We will continue to encourage this close involvement and at the same time expand a strong central coordination group in order to better coordinate the detector activities of DESY throughout.

Scientific Computing

As part of the DESY strategy process, the key role of scientific computing for all research areas at DESY has become very clear. There is an increasing need for data processing and analysis through the infrastructure provided by the large Tier-2 infrastructure for large amounts of data. It is therefore planned to strengthen the various computing activities and link them to an interdisciplinary Center for Data and Computing Science (CDCS).

Field of competence: Tier-2

The large Tier-2 instrument and the connected National Analysis Facility (NAF) is currently operated for the experiments of particle physics ATLAS, CMS, LHCb and Belle II. With the rapid increase in the data volumes of all large instruments operated by DESY or in which DESY is involved, completely new challenges arise: PETRA III, FLASH and the European XFEL, as well as the gamma-ray observatory CTA require an **extension of this concept** and the provision of analysis facilities for external users.

The following measures are planned for the large Tier-2 instrument:

- The expansion of the current Tier-2 instrument and the NAF into an "**Interdisciplinary Analysis Facility**" (IAF) through the expansion of software and hardware.
- Linking the Interdisciplinary Analysis Facility (IAF) to the Center for Data and Computing Science (CDCS), which is currently being planned, as a specialised resource.
- Changing computing models, extended user groups and increasing data volumes require the optimisation and further development of software in the area of data management. As the main developer of dCache, this poses a particular challenge to DESY. This is of specific importance for the further expansion of DESY's strong position in the "World-wide LHC Computing Grid" (WLCG) for the LHC components ATLAS and CMS.
- The **expansion of the user group**, in particular by scientists from the field of photon research or astroparticle physics.
- Positioning as one of the **central data centres** within the framework of newly formed international federations for DESY's relevant research areas.
- The development, optimisation and methodical advancement of software, especially in the field of data management and changing computing models.
- Connection of the Science Data Management Centre and the computing infrastructure of the CTA Observatory.
- Active participation and management in Helmholtz-wide, **national and international activities** such as the European Open Science Cloud (EOSC) of the Research Data Alliance (RDA) and others.

Field of competence: Data processing and analysis

The importance of data processing and analysis has risen sharply in all scientific areas and in the operation of DESY's machines. Central challenges are:

- Development of **modern analytical methods** geared to the **future needs of users**, e. g. "Imaging" through the use of methods such as machine learning, big data analytics, quantum computing etc. for the analysis of very large amounts of data from experiments and for the analysis of sensor data from the accelerator sector and for the further development of control systems.
- Development and optimisation of high-performance **simulations** for parallel computers (HPC systems) and modern add-on components such as GPUs, in the areas of plasma simulation, Lattice QCD, accelerator physics and others.
- Development of **data management systems**, including metadata systems, which enable fast storage of e. g. beamline data as well as their retrieval in compliance with modern principles such as Open Access and FAIR principles (findable, accessible, interoperable, reusable).
- Professionalisation of the **software lifecycle** by expanding software development competence at DESY.
- Professionalisation of the scientific evaluation of data, e. g. at the beamlines, by introducing and training of **data scientists** at DESY.

The following measures are planned to achieve these objectives:

- Establishment of a **virtual group at DESY across the DESY areas** that bundles the competencies and human resources of the central IT groups with the competence and needs of the end users in the various scientific areas.
- Building up additional specific competence, e. g. for machine learning.
- Improving IT competence by **increasing the number of staff on the beamlines**, improving scientific use and competitiveness with other similar infrastructures.
- In the POF IV structure of the **topic "Data Management and Analysis"** (DMA) in the programme "Matter & Technology" of the research area "Matter".
- Participation in Helmholtz-wide, national and international initiatives and application for **third-party funded projects**.
- Collaboration with the **Helmholtz Research Unit Information** and other university and non-university research groups.

Center for Data and Computing Science (CDCS)

The interdisciplinary Centre for Data and Computing Science (CDCS) at DESY is the answer to the huge and growing challenges in data-intensive scientific computing. In order to fully exploit the scientific potential of DESY's outstanding, globally unique large-scale equipment in the future, it is necessary to strengthen and further professionalise scientific computing.

The **work programme** of the innovative interdisciplinary centre focuses on topics that are decisive for solving the challenges in the main fields of application at DESY. Central features of the CDCS are:

- **Interdisciplinary integration and inter-university cooperation with computer science and applied mathematics** create the necessary new skills. The partners such as the University of Hamburg, the Technical University of Hamburg and the University of Applied Sciences have shown great interest in and broad support for the plans.
- The focus is on knowledge and training (software and brainware).
- The establishment of a **Helmholtz "Data and Computing Science" graduate school** is therefore one of the first major activities with a very high structural importance. To that effect, an application for a Helmholtz call for proposals is submitted March 2018.
- As a truly **interdisciplinary research and development centre** in the field of applied computer science, the CDCS is also a key resource in the "International Science Park" in Bahrenfeld.
- **Planning and development of an effective IT infrastructure** (needs forecasts, benchmarks, etc.) - are integrated into the project but the procurement and operation of hardware is not integrated.

As a virtual centre, CDCS will begin its work in 2018. A **first working group with scientific leadership** is to be set up in 2018 and six groups, three of them funded by DESY, are to be set up by 2025. The approximately one hundred employees then work in a modern CDCS laboratory building on the former premises of the horse race track (Trabrennbahn Bahrenfeld). Essential steps for a successful implementation and focal points of the work in the first years are:

- Establishment of an **internal steering and external advisory board**.
- Intensification of **exchange** and clarification of needs and **cooperation** with partners: workshops, pilot projects, data science seminars and courses for students, workshops in 2018, conference and summer school in 2019.
- **Flexibility** in work planning, topics and methods – **sustainability** in the maintenance of key software components and career prospects.
- Formal **management structures and cooperation models**, anchoring in POF IV.

Computer equipment for the operation of the National Analysis Facility NAF and the Tier-2 facility

Cross-sectional Issues

Field of competence: Innovation and technology transfer

DESY assumes responsibility as a Helmholtz Centre and will significantly increase the importance of innovation and technology transfer in the future. The fundamental research carried out by DESY forms the foundation of the innovation activities. DESY has formulated the following **global goals and fields** of action for its innovation strategy:

1. **Exploitation of science-driven technologies**: DESY develops new ideas, excellent and practicable applications and products based on fundamental research. In addition to the scientific communities, society and the economy should benefit from these developments in the short and medium term.
2. **Innovation services on the basis of DESY know-how and the research infrastructure**: DESY wants to be a reliable and interesting partner for industry and offers the entire DESY ecosystem to support industrial issues.
3. **Starting point for start-ups**: DESY enables the **creation of new high-tech start-ups** based on DESY technology and DESY personnel in the Hamburg and Brandenburg region.

The mission and the three global objectives form the basis for a series of **measures** coordinated by the newly created position of **Chief Technology Officer** (CTO).

In order to establish the DESY brand in the direction of industry and to achieve all global goals, a professional communication and outreach strategy in the area of innovation is crucial. The aim is to make DESY known in the **industrial environment**. To this end, DESY becomes a **member of industrial associations** and business clusters such as LifeScience Nord e. V. A further step is a continuous presence at strategically important **trade fairs and congresses**.

In order to strengthen DESY's position as a centre of technology and innovation, an **ecosystem** is to be created in Hamburg and Brandenburg together with the local partners. In Hamburg, the Bahrenfeld research campus with its local partners is the first choice. In Brandenburg, networking with the TH Wildau as an "Innovative University" is of great interest.

The following measures are envisaged in the fields of action:

Innovation services:
- Optimisation and professionalisation of the innovation services, an appearance according to the principle "**one face to the customer**", which ensures all-round support for industrial customers and partners. The aim here is to combine the problem-oriented orientation of the economy and the method-focusing of science.
- Development of a **service portfolio** of DESY.
- Foundation of a **DESY Innovation GmbH** to outsource purely service-oriented business.
- Development of an industrial case for large investments in expansion to consider future industrial use from the very beginning.

Exploitation and cooperation:
- Introduction of a "**DESY Generator Programme**" to promote innovative technology projects and industrial cooperation outside of day-to-day business.
- Establishment of a network of **technology scouts** at DESY.
- Close integration with the instruments for **innovation promotion** in the regions.

Business start-ups:
- Establishment of an **innovation centre** together with the City of Hamburg and the University of Hamburg on the research campus Bahrenfeld.
- Participation in **regional programmes** to promote start-ups (such as "be your pilot" in Hamburg)
- Establishment of DESY as an **actor in the start-up scenes of the Hamburg and Berlin-Brandenburg regions**.

In order to ensure that DESY is always up to date with its innovation strategy, the establishment of an **Innovation Advisory Committee** (IAC) is planned. The IAC is conceived as an advisory body and supports DESY in an annual cycle with regard to the **continuous further development, reflection and evaluation of the innovation strategy**.

Field of competence: Talent management and personnel development

In order to attract the best talents to DESY in the future, a new staff unit for strategic personnel development will be set up at DESY. The task of a future strategically oriented personnel development at DESY is to prepare the employees for the current and future requirements of DESY derived from the centre´s goals and, if necessary, to qualify them beyond a previous field of competence. In addition, DESY supports employees in their professional and personal development and in developing their potential (talent management). The aim is also to bind key players in performance and core competence to the centre on a long-term basis. Offers of individual further training and career development are an important plus in the decision-making process of potential applicants.

Personnel development encompasses all measures that serve to select, qualify, promote and develop employees and managers and ensure a high degree of employee loyalty.

In the future, the **Human Resources Development** department for DESY will comprise the following fields of activity:

- Carrying out a needs assessment
- Analysis of existing personnel development offers as well as expansion, networking and adaptation of the offers
- Development of management tools and leadership tools
- Development (e. g. advanced training with compulsory and elective modules) to support managers as personnel developers “on site” as part of an overall strategy.
- Development of career paths for different occupational groups and career phases.

Personnel development is not limited to the development of individual persons, but also includes instruments for the development of teams and organisational units. In line with a holistic strategic orientation, recruitment at DESY is also to be expanded and further professionalised, in particular through new ways of recruiting personnel. In addition, goals resulting from gender equality and diversity management are taken into account in all personnel development fields of activity. This makes personnel development the central point of contact for employees and managers in matters of career planning and concrete development opportunities.

Since personnel development is a far-reaching, cross-divisional task, a so-called steering board is to be set up to coordinate cooperation with all areas and to accompany the merging of personnel development, Recruitment and EDU. The success of the measures developed is regularly evaluated against the background of the strategic goals.

Field of competence: Outreach at DESY – Building bridges between science and society

DESY's diverse communication activities can be assigned to four thematic focal points, each of which includes defined target groups and communication goals. The responsible communicators at DESY have the expertise to effectively reach the target groups and must jointly ensure a coherent image following the course of DESY's strategy and mission.

Focus: Politics

Objective: To jointly secure future perspectives and the development of DESY

→Continuous and coherent communication with strategic priorities, especially PETRA IV

Focus: Cooperation

Objective: Strengthening and expansion of strategically relevant cooperation

→Communication of DESY as a centre for excellence and cutting-edge research, well known far beyond the current user community; strategic priorities: innovation, PETRA IV.

Focus: Personnel

Objective: To win and develop the best brains and hands for DESY

→Communication of DESY as a talent pool and inspiring community, development of an employer brand, active recruitment, strengthening of internal communication, also between research areas and locations.

Focus: Society

Objectives: Creating acceptance for DESY and DESY's future projects

→Transparent and credible communication of DESY as a centre for cutting-edge research with high social relevance, strategic priorities: PETRA IV, campus development.

Key factors for successful communication

The following measures form the basis for effective and sustainable communication with all relevant target groups:

- **Ensure consistent communication**: close cooperation and coordination between all communicators at DESY, joint editorial board, common guidelines, corporate identity, training programme.
- **Strengthen digital communication** (web, social Media, mailings …): development of a concept for digital communication with a user-centred approach, continuous web development, more multimedia, content management with a high degree of automation.
- **Create more visualisation**: Develop in-house competence for visual media (videos, animations, graphics, photos).

Open Day at the DESY Campus Zeuthen

Field of competence: Campus development in Hamburg and Zeuthen

The campus, with its diverse possibilities and professional workplaces, is a place for excellent top-class research. The DESY sites in Hamburg and Zeuthen both perform a flagship role for scientific reseach reaching far beyond any regional context. Both serve as a centre for scientific and technological innovation, and cooperating with industry, the aspect of innovation becomes ever more important as future technologies need to be developed to address the scientific challenges facing society while keeping in mind local policy guidelines.

During the strategy process, it has become clear that campus development **involves two areas of action**. It is difficult to look at them individually, as they are closely interdependent and must be driven forward at the same time:

1. The campus as a workplace

In this first field of action, the focus is on soft factors such as improving service and communication at and between the locations and the external impact in the respective regional context. The working environment for employees and guests must be carefully considered and adapted to future quantitative and qualitative requirements.

“Best Host” and “Work & Life @ DESY”

In the context of the user communities in particular, the aim is to achieve the status of “Best Host” for the service around research operations at both locations in an international comparison. For this purpose, the relevant areas must be continuously checked for improvements and living and working conditions must be adapted to the campus site. Other important aspects for the development are the campus and laboratory-safety aspects. We provide adequate and modern laboratory and office spaces and take care of the social and family needs of employees and guests. This applies at both locations in Hamburg and in Zeuthen.

Supported by a survey and extensive feedback from the divisions, the following fields of action were identified in the strategy process:

- The exchange of information between the scientific users of the research facilities on the one hand and the providers of infrastructural services on the other is becoming more important. One aspect of this is that selected services and facilities at the Hamburg location are available **24/7** or at least longer than before, i. e. even beyond the usual working hours.
- Due to the **growing number of campus partners** and guests as well as the increasing complexity of the collaborations, the need for coordination in cross-campus collaborations and activities is increasing. This requires a certain degree of control and limitation to as few interfaces as possible.
- In order to be able to better assess the performance of the infrastructure and the services offered, an **internal evaluation system** for quality assurance is to be introduced.
- In addition to the goal of providing first-class service, the campus infrastructure at both locations must also be improved as a place to stay in line with the “**Work & Life @ DESY**” approach. Intelligent and sustainable green management, the creation of communication sites and a pleasant working environment should enable outstanding science.
- A modern **childcare** provided by an external provider must be adapted to the number of employees.
- An integrated and flexible **security and access concept** is needed for a campus that is growing and increasingly perceived by scientists and citizens as a public space, which has to be developed and put into practice with the participation of all campus partners.

2. Strategic campus development

In the second area of campus development, the aim is to create an opportunity to be able to implement the future requirements of science in terms of construction. This results in interactions with the urban planning context, the settlement of scientific cooperation partners and, last but not least, the technical dependencies that are inseparably linked to the infrastructure. In contrast to the first part, the structural and planning factors are considered here, i. e. ”hard” factors.

Facing the organically grown campuses in Hamburg and Zeuthen and the lack of space at both locations, DESY must work out a development strategy with urban planning principles and communicate these to multipliers and decision-makers. The initiated **master planning process** provides a fundamental and flexible framework for the future campus development of both locations.

The process identifies the needs in the fields of building infrastructure, quality of living, mobility and green aspects, taking into account scientific developments. The focus here is on DESY's "**One Lab – One Campus**" approach. The aim of the process must be understood as an evolving working paper – **the master plan** – with a long-term part of ideas and adaptable goals for action, which should be orientation and decision support.

The first part of the master plan, which is descriptive and geared to the determination of the status quo, finished in spring 2018, provides a substantive basis and presents the urban planning structures with detailed information. Based on these data, recommendations for action and principles of order will be developed. The master plan is based on the ideas of the urban planning framework of 2012 and 2014 and thus underlines the continuity of a long-term urban planning process.

The second – future-oriented - part of the master plan focuses on the results of the competence field campus development from the DESY strategy process and puts them into a long-term urban development context. It translates ideas, goals and messages from the strategy process with the given abstraction into an urban planning process. In Hamburg, the master plan follows the vision of the International Science Park Hamburg, which already takes into account industrial cooperation with the necessary provision of space in the Vorhornweg R&D Park. The scientific projects such as PETRA IV and CDCS are described and, together with the comprehensive concepts of innovation transfer, Green DESY and mobility, are highlighted.

Field of competence: Sustainability

As part of the strategy process, DESY has opted for a broad concept of sustainability. In its activities, the centre is guided by social, ecological and ethical standards and is committed to sustainable development in its mission statement. The **responsible use of material and immaterial resources** is recognised as a natural element of organisational culture and the basic principles of **good governance** (transparency, consideration of stakeholder interests) are anchored in organisational management.

DESY assumes responsibility through a **voluntary commitment** as a widely visible sign of the intended implementation of self-imposed goals and measures along five functional areas according to the "Guidelines for Sustainability Management in Non-University Research Organisations" (LeNa) of 2016, which was developed by the Fraunhofer-Gesellschaft, the Helmholtz Association and the Leibniz Association in cooperation with the BMBF: (1) Organisational management, (2) Research, (3) Personnel, (4) Buildings and infrastructures and (5) Supporting processes (procurement, mobility).

This commitment is supported by the following measures:

- **Integration of sustainability** into existing organisational structures and processes. Sustainability aspects are mandatory in project proposals and are monitored by the Project Commission.
- In order to support and coordinate sustainability management, a **Sustainability Office** will be set up at DESY. Substantial capacities for decentralised sustainability measures (e. g. energy monitoring, portfolio analysis of buildings) are made available and in many cases also acquired through corresponding support programmes.
- DESY is to be measured against high standards for sustainable development. For this purpose, **reporting on sustainability indicators** is implemented as a tool for monitoring, controlling and communicating sustainable development.
- Organisation of **advanced training** for DESY employees to raise awareness of sustainability aspects in their specific field of activity.
- Organisation of regular **workshops and conferences with internal and external stakeholders** to initiate new sustainability activties (e. g. improvement of public transport) and to emphasise DESY's role as an important actor for the sustainable development of the region.
- Creation of **incentives for scientists, technicians and administrators** to increase DESY's contribution to solving societal challenges (e. g. by supporting projects within the framework of the DESY Strategy Fund or by appreciating its commitment to internal events).

Field of competence: Internationalisation and Collaboration

Collaboration with regional, national and international partners guarantees DESY's cutting-edge research. The centre is closely integrated into a rich and widely networked collaboration landscape, which includes knowledge and personnel exchange with numerous partners, active participation in research networks and consortia, as well as strategic partnerships and research participations. Collaboration at DESY will focus on cooperation and excellent research infrastructures that provide top-class research either at DESY or elsewhere in the world. The centre's multifaceted cooperative relationships ensure the long-term scientific excellence of research at DESY, create new scientific opportunities and make better use of DESY's potential for innovation and research. In addition, cooperation with national and international partners increases the pool of talents, resources and know-how to which the laboratory has access. This highly successful approach must be continued at various levels.

Cooperation with universities

All research fields at DESY benefit greatly from the strengthening of regional and national partnerships. In recent years, DESY has considerably fostered its cooperation with the universities, particularly through joint appointments. This applies in particular to cooperation with the universities in Hamburg, Potsdam and Berlin, with which DESY maintains close cooperation. In the future, the instrument of cooperative professorships in particular is to be expanded further. Cooperation with local campus partners and universities (in Hamburg: UHH/PIER, European XFEL, EMBL, MPG, TUHH; in Zeuthen: HU Berlin, U Potsdam) must be further strengthened and structurally expanded.

For DESY, these cooperations play an essential role in recruiting young scientists and in the implementation of new research topics in the university curriculum (example XFEL research).

Development of the University of Hamburg

DESY supports the plan of the University of Hamburg to relocate the physics, chemistry and parts of the biology faculty to the Bahrenfeld research campus. This opens up completely new perspectives for cooperation and interdisciplinary research. We want to take advantage of this.

International collaborations

DESY has extensive experience in **international collaborations and consortia** and is a driving force in the initiation and further development of scientific cooperation on a European and international level in many fields of research and technology. In the context of research infrastructures, this active role of DESY must be further consolidated in order to better orchestrate research activities in the European or international context and to contribute to shaping future projects, as in the case of LEAPS, for example.

Increased internationalisation should also include intensified efforts to expand **scientific diplomacy** in order to build bridges through scientific cooperation in politically uneasy times and to demonstrate greater commitment in less developed research communities and regions (e. g. EU-13). In addition, the international mobility of researchers, especially young scientists, must be further promoted in order to contribute to the individual networking and profiling of researchers. This requires special framework programmes with selected cooperation partners for **mobility and exchange programmes** (including joint doctoral programmes) as well as appropriate support structures (such as DESY's international office) to provide housing, relocation and advice to international researchers.

Finally, an optimal combination of **centralised and decentralised support services** must be found within the centre in order to organise the establishment, maintenance and further development of the cooperative activities at DESY efficiently and effectively. This includes, among other things, more **internal exchange on "best practice" examples** regarding the cooperation formats, better coordination of cooperation initiatives and a strengthening of legal expertise and processes in contract management.

Organisational changes at DESY

Cross-divisional platforms

Thanks to the strategy process, DESY's comprehensive information on the various organisational units is currently at an exceptionally high level. This spirit of cooperation and exchange will continue to be maintained and promoted after the end of the current strategy process. On this basis, a number of organisational measures are to be initiated.

Strengthening of cross-divisional activities and topics

If necessary, DESY will supplement its organisational structure with cross-divisional platforms. The establishment of the CDCS is an example of this, in order to bundle and substantially improve capacities in the context of scientific data management.

In addition to strengthening cross-divisional cooperation in scientific questions of data management or accelerator and detector development, administrative and technical services should also be anchored in the form of platforms across divisions. The topic of talent management and its optimisation was acknowledged as critical for the success of DESY and the strategy process. In addition to a new staff unit for personnel development, a steering board is to be set up in the sense of a steering committee for these platforms, which is composed of members from all areas of DESY and reports to the Executive Board. The function and rules for the cooperation of this strategic platform are defined in rules of procedure. Similar to a project-related organisation, the platform pursues a clear mission. The representatives delegated by the divisions act as a steering committee for strategic issues of the units cooperating in the platform. This includes strategic budget planning. The disciplinary authority to issue instructions as well as the operative provision of resources and capacities will continue to be carried out within the framework of the organisational structure by the responsible departments. Unlike a project, the platform is anchored in DESY's organisation for an unlimited period of time.

The idea of bundling responsibility and competence in cross-divisional and strategic issues should also be applied to technical services. The plan is to introduce strategic platforms for facility management, data processing, electronics and mechanics. Here, too, cross-divisional steering committees are to coordinate the strategic orientation of these critical issues. A library commission has already been set up to represent the interests of the departments in matters concerning libraries, literature, information and publications.

Demand-oriented adaptation of infrastructural services

In the impressive history of the research centre, progress and growth have always been determined by scientific needs. As an internal service provider, DESY's infrastructural services in the sense of supporting services and resources make an important contribution to the success of science. They are responsible for critical processes such as hiring personnel, purchasing goods or constructing and managing buildings. Their task is to provide demand- and solution-oriented services smoothly and efficiently for the scientific tasks of DESY and its international users. These indispensable services are provided in the administrative and technical units of the FH, FS, M and especially V divisions.

In view of DESY's steady growth and the increasing complexity of the environment in which the research centre operates, the challenge has arisen in recent years to implement a number of new generic tasks such as innovation, tax and legal issues, sustainability, international cooperation or human resources development in organisational terms and to expand them considerably in some cases.

All of DESY's infrastructural and scientific units are required to continuously improve their effectiveness. In order to cope with the increasing demand and demands on the services of the infrastructure, DESY as a whole will need increased monitoring and, where necessary, follow-up of the appropriate provision of infrastructure services.

The RTD-related overheads approach will also provide valuable guidance in this respect for appropriate growth rates over a specific programming period, which is mainly determined by scientific developments. In this consideration, organisational management must distinguish between the infrastructural needs caused by the existing core processes of research and those demands on the infrastructure caused by completely new task complexes. The forecasting and planning horizon of scientific projects and corresponding infrastructural services should be as uniform as possible in the future.

In order to meet the requirements of modern support for core scientific processes as well as the associated tasks and statutory provisions, DESY is striving to establish a suitable system of key performance indicators for its supporting processes. A corresponding system of key performance indicators provides information on the quantity and quality of administrative and technical services. It encompasses both classic business management indicators and the recording of the satisfaction of users and employees and is the basis for a target-oriented control of business processes and their use of resources.

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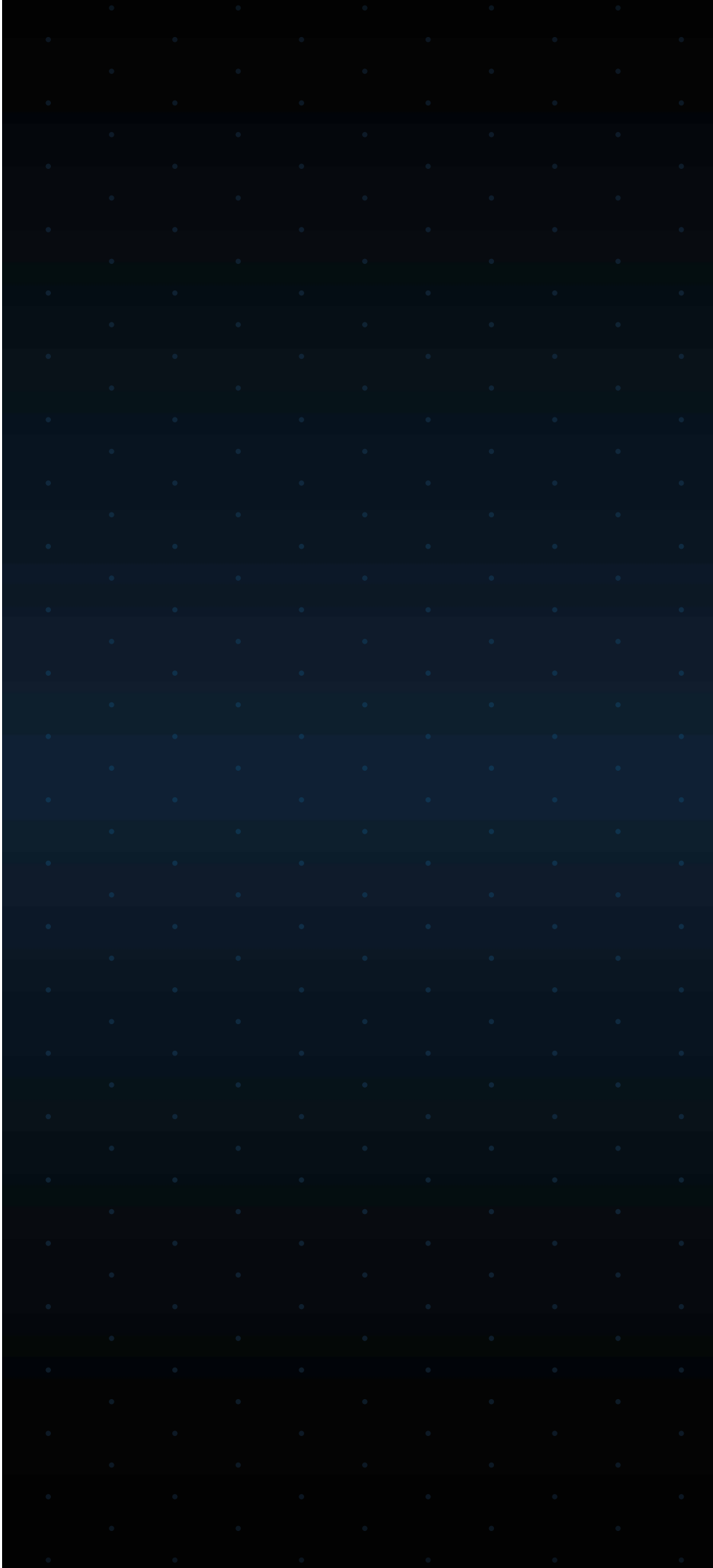


Gaining momentum

Designing and changing a research facility of DESY's size is an exciting, complex and challenging task. We have a sustainable plan for this.

Gaining momentum

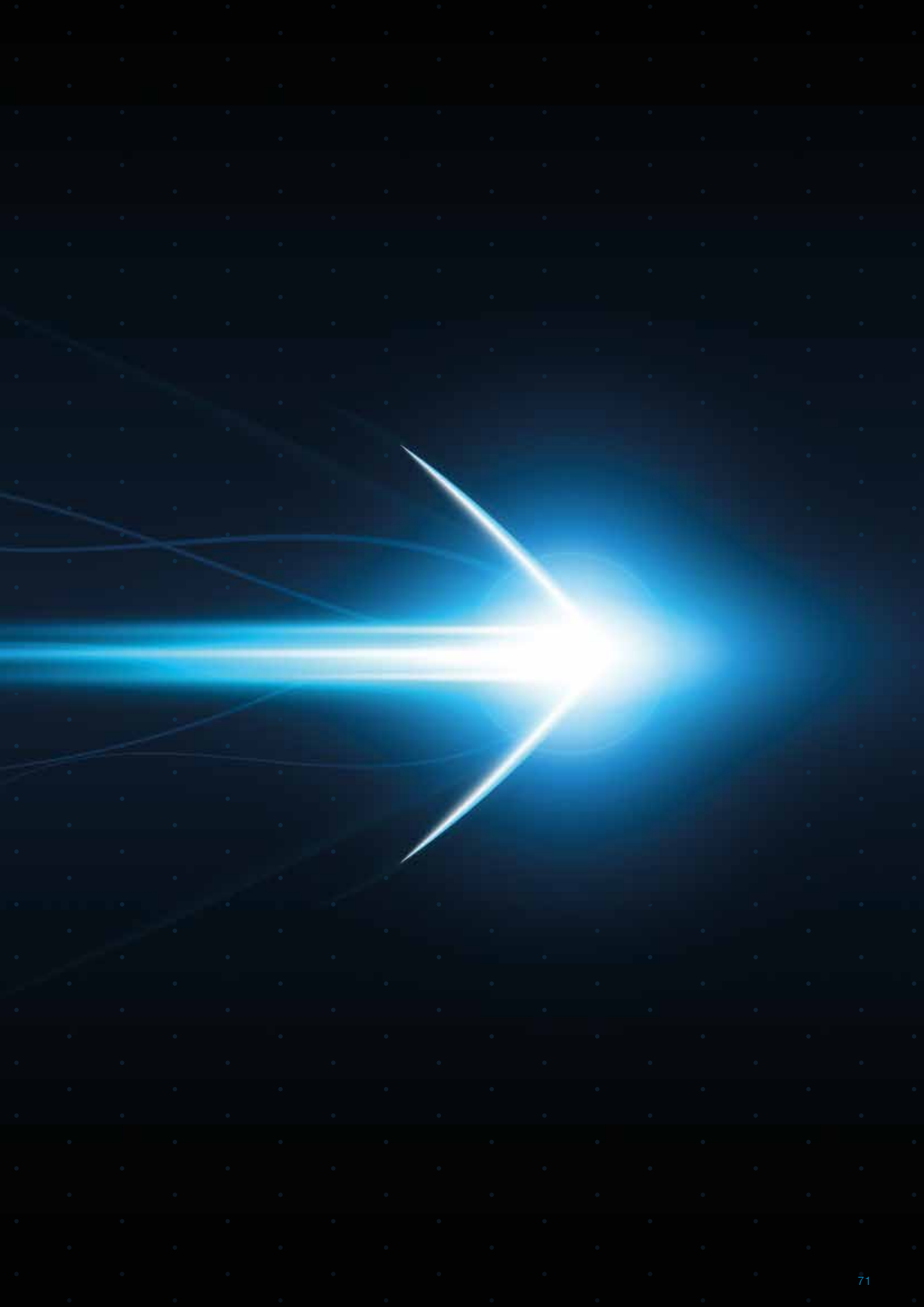
Full speed ahead

With the DESY 2030 strategy, we have created a detailed picture of our future together. This brochure presents you with an overview of our competencies, challenges, opportunities and goals, as well as the way in which we will implement them.

The past strategy process has led to a very fruitful exchange both within and between the competence teams. The overall level of information across the various organisational units has thus reached an exceptionally high level at DESY. Our goal is to maintain this network and strengthen our “one-lab spirit” in the long term. It is therefore planned to actively involve the competence teams in the implementation and regular monitoring of the strategy.

DESY is well positioned for the future. Based on our strategy, we can now secure our strengths, tackle challenges and break new ground. I would like to thank all those who have contributed their expertise and perspectives to the process.

Yours
Helmut Dosch



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A Research Centre
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Hamburg Location
Notkestraße 85, 22607 Hamburg
Tel.: +49 40 8998-0
Fax: +49 40 8998-3282
desyinfo@desy.de

Zeuthen Location
Platanenallee 6, 15738 Zeuthen
Tel.: +49 33762 7-70
Fax: +49 33762 7-7413
desyinfo-zeuthen@desy.de

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The Helmholtz Association pursues the long-term research goals of state and society to maintain and improve the livelihoods of the population. To do this, the Helmholtz Association conducts top-level research to identify and explore the major challenges facing society, science and the economy. Its work is divided into six research fields. The Helmholtz Association brings together 18 scientific-technical and biological-medical research centres. With more than 38,700 employees and an annual budget of over € 4,5 billion, the Helmholtz Association is Germany's largest scientific organisation. The Association's work follows in the tradition of its namesake, the natural scientist Hermann von Helmholtz (1821-1894).

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