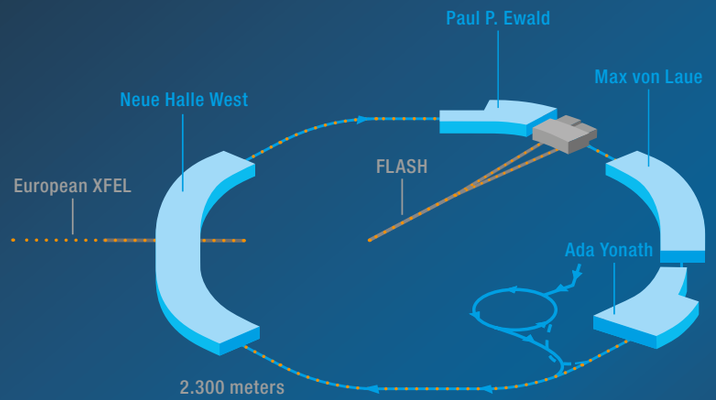
Cutting-edge technology

A unique 3D X-ray microscope is to be built on the DESY campus in Hamburg by 2028: PETRA IV. This accelerator-based X-ray source will provide new insights into the atomic cosmos and uncover scientific phenomena in new dimensions.

The large-scale research facility will help Germany to consolidate its leading position in science and strengthen its status as a business and industrial location in the long term. PETRA IV will offer possibilities for conducting analyses that are unrivalled anywhere in the world, to explore new technologies and materials for a world that is changing.

PETRA IV.



Upgrade:
By 2028
DESY will have completed the 4th generation X-ray source.

Light source:
28+
beamlines can be used in parallel.

Beam time:
5000
hours of beam time per year on each beamline.

Beam quality:
x100
New technologies will lead to a 100-fold improvement.

DESY.

Founded:
1959
and has been continuously modernising its radiation sources ever since.

Employees:
2900

Annual budget:
350 M€

The DESY research centre

DESY is one of the world's leading particle accelerator centres and investigates the structure and function of matter – from the interaction of tiny elementary particles and the behaviour of novel nanomaterials and vital biomolecules to the great mysteries of the universe. The particle accelerators and detectors that DESY develops and builds at its locations in Hamburg and Zeuthen are unique research tools. They generate the most intense X-ray radiation in the world, accelerate particles to record energies and open up new windows onto the universe.

DESY is a member of the Helmholtz Association, Germany's largest scientific association.

HELMHOLTZ

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PETRA IV.
NEW DIMENSIONS

Deutsches Elektronen-Synchrotron DESY
A Research Centre of the Helmholtz Association

Focusing on Brilliance:

- PETRA stands for Positron-Electron Tandem Ring Accelerator. Today, electrons travel around the ring at close to the speed of light, producing **ultra-bright X-rays** that are used to examine materials.

- **Upgrading PETRA III to become PETRA IV by 2028:** The existing 2,300-metre ring is to be modernised, whereby some of it instruments and infrastructure will be recycled.

- Today, some 3,000 researchers use the radiation source every year for their experiments. The demand is far higher, though: in the long run, upgrading the facility will allow **significantly more users from different fields** to carry out research at PETRA IV.

- **The new 3D X-ray microscope** can peer deep inside materials. Focusing the X-rays on the tiniest spot means that the images will be 100x more detailed than before. This will allow natural phenomena in the nanocosmos to be filmed live.

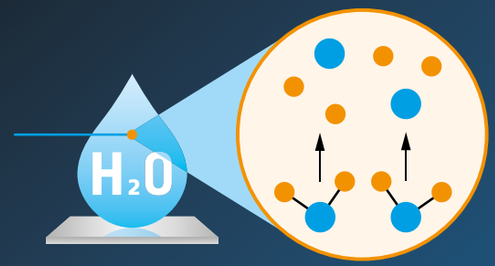
- Similar light sources are currently being set up in the United States and in China. PETRA IV will allow Germany's scientific establishment **to remain competitive**.

- The conversion and subsequent operation will be **extremely energy-efficient and minimise the use of resources**. New accelerator technologies make this possible. In addition, the waste heat will be used to heat buildings on campus and in the neighbourhood.

- The potential discoveries could make **new technologies available in the future and offer solutions** in areas such as the energy industry, aviation, automotive engineering or the healthcare industry.

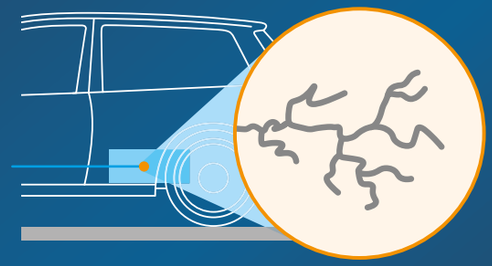
Innovative edge thanks to PETRA IV

Scientific progress often comes about through a precise understanding of atomic structures or the microscopic function of underlying processes.



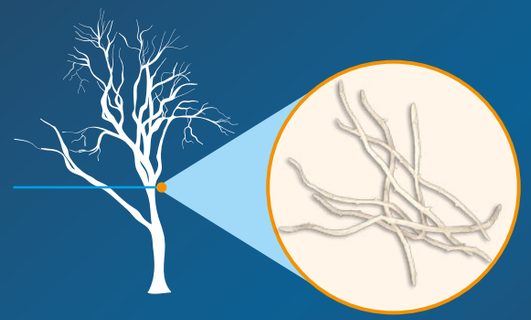
Green hydrogen

Plants use sunlight to split water into hydrogen and oxygen. If this process could be effectively mimicked, hydrogen could be produced in a climate-neutral way. Artificial laboratory leaves are not yet very efficient. X-rays that can be precisely focused down to the nanoscale would allow researchers to observe the functional centres of leaves in operation, in the laboratory and in nature. Such sharp detail is difficult to achieve today, but with PETRA IV it will become routinely available.



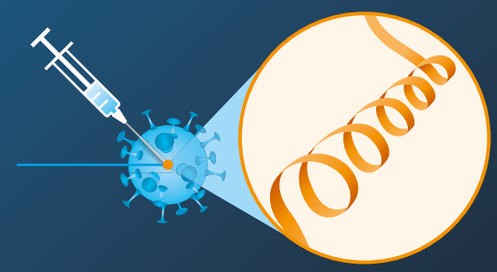
Electric mobility

The X-rays from PETRA IV will reveal how the nanostructures inside batteries change while they are in operation. Tiny metallic deposits form on the electrodes over time, which can grow and lead to defects. At PETRA IV, such fine details can be studied under real-life conditions and used to develop functional materials for better batteries. Research at PETRA IV will therefore support the transition to a climate-neutral society.



Plastic alternative

Plastics are made from petroleum, recycling them is difficult, and they don't easily decompose. A more sustainable alternative are cellulose nanofibres made from wood. In relation to their weight, these fibres are the strongest natural fibres that exist. They could be used for textiles, packaging, or even as a matrix for solar cells. However, their production is complex and time-consuming because the fibres are 10,000 times thinner than a human hair. PETRA IV will change this: thanks to its maximum standardisation and automation both in measuring and in evaluating as well as certification in high-throughput measurement environments, results should reach the market more quickly.



Researching new medications

To develop drugs against new viruses and pathogens, research scientists need to understand in detail the molecular and cellular mechanisms by which the substances work. X-ray sources are a precise tool that can be used to specifically test candidate drugs. Thousands of substances are elaborately screened in this way, which takes a lot of time. The new facility will speed up the search enormously. Compared with today, X-rays from PETRA IV will allow imaging with 100 times greater detail and experiments to be carried out 100 times faster. This means, potential targets for drugs can be identified very quickly.