

HELMHOLTZ Information

From Insights to Impact:
Advancing Digital Sovereignty



MISSION AND FOCUS TOPICS

SHAPING SOLUTIONS FOR GRAND CHALLENGES



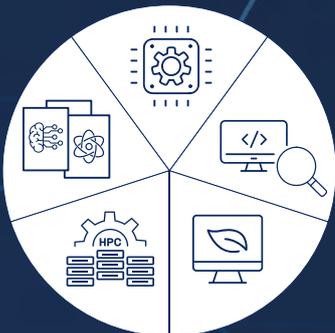
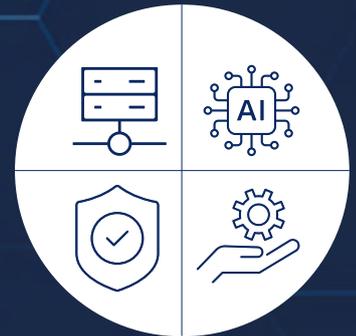
“We drive the future of computing, material and life sciences by identifying and developing new key technologies through interdisciplinary research and the development and utilization of unique infrastructures. Our mission is to make significant contributions to Germany's and Europe's digital and technological sovereignty.”

Astrid Lambrecht

Vice-President of Helmholtz Information

Artificial Intelligence

We develop and operate computing capacities and offer a wide range of competences for large-scale and generative AI approaches through to everyday laboratory applications with digital twins, electronic lab notebooks, automated laboratories or AI-supported quality control. The trustworthiness and security of the models and systems are an important aspect of our work.

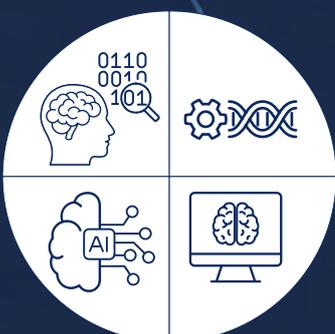


Future Computing

We operate energy-efficient high-performance computers and drive the further development of our modular computer systems by integrating new energy-saving architectures such as quantum and neuromorphic computer components in a software-hardware co-design. We foster research software engineering and the visibility of software codes as scientific reputation markers.

Digitalized Material Science

We create and utilize digital tools, including digital twins and electronic lab notebooks, to enhance the development of material systems through targeted and application-specific design. By automating our laboratories and integrating AI into our results evaluations and quality controls, we significantly accelerate our development and manufacturing processes. At the same time, we prioritize a sustainable circular economy by employing simulations and conducting comprehensive life cycle analyses of material systems.



Digitalized Life Sciences & Brain Research

We use supercomputers to decode natural information processes and intelligence in living organisms, ranging from single cells to complex systems such as the human brain. We will use the understanding of neural computation to reveal fundamental ingredients of intelligence and catalyze the next generation AI. By understanding these processes, we also advance the development and use of functionalized biomaterials and biohybrids to advance biotechnology and medical technology, for example in the field of implant research or brain-machine interfaces.

OUR RESEARCH INFRASTRUCTURES

ENABLING GLOBAL RESEARCH COLLABORATION

OVERVIEW

Large-scale research infrastructures are a cornerstone of cutting-edge research and technological progress. As part of its mission, the Helmholtz Association provides and maintains national research infrastructures, ensuring long-term scientific excellence.

Within this framework, Helmholtz Information develops and operates diverse research infrastructures that form a cohesive ecosystem for digital and computational research. They form the foundation for next-generation computing architectures, AI-driven simulations, and secure digital technologies, while also enabling data-centric innovation in materials science and biological information processing. These infrastructures support Germany's leadership in research and strengthen international collaboration across diverse disciplines.

MATERIAL CHARACTERIZATION AND SYNTHESIS

Advancing Micro- & Nanotechnologies



Helmholtz Nano Facility // cutting-edge facility for research, fabrication & characterization // nanoelectronics & bioelectronics

Accelerated Materials Research with Automation & AI



Auto.MAP // self-driving labs for materials discovery // ML, automated synthesis & simulation // materials & devices

Photon & Neutron Research for Materials Science



GEMS // complementary research with photons & neutrons // central user platform // applications in batteries, nanotechnology, & pharma // operated by Helmholtz Matter

Materials Discovery Facility



BESSY II // brilliant source of soft X-rays // in situ and operando characterization // quantum and energy materials // operated by Helmholtz Matter

Information-driven Materials Science



KNMFI // correlated multiscale manufacturing and high-end characterization // automated advanced materials synthesis // RDM // driving innovation in academia & industry

Pioneering Cutting-Edge Electron Microscopy



Ernst-Ruska Centre // BMBF roadmap project ER-C 2.0 // aberration-corrected instruments advanced cryo-electron // atomistic structure of phases, interfaces, defects // materials science // life science // advanced cryo-electron microscopy // cellular structures





Europe's First Exascale Supercomputer

JUPITER // > 1 ExaFLOP/s (10¹⁸ calculations/s) // modular architecture // optimized for extreme-scale simulations & AI // highest energy efficiency



Energy-Efficient Supercomputing

HoreKa // 23 PetaFLOP/s // award-winning warm-water cooling // heat re-usage // optimized for AI & data-intensive computing



Jülich UNified Infrastructure for Quantum computing

JUNIQ // quantum computers, annealer and simulator // hybrid computing: integration with HPC // cloud-based access // for science and industry



Integrated Security for Smart & Connected Systems

KASTEL Security Labs // explainable cyber security for critical infrastructures // security research labs for energy, mobility and production systems



Europe's Largest Repository for Fish Lines

European Zebrafish Resource Center // Zebrafish & Medaka research // supports data-driven biomedical research // training courses



Atomic Resolution Structures and Dynamics

Biomolecular NMR Center // ultra-high-field liquid & solid-state NMR spectrometers // advancing structural biology



Europe's Infrastructure for Brain Research

EBRAINS // neuroscience // Human Brain Atlas // FAIR data // AI // digital tools // medical analytics // simulation // computing



RESEARCH PROGRAMS

BUILDING BLOCKS OF OUR CUTTING-EDGE RESEARCH

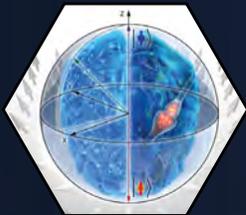
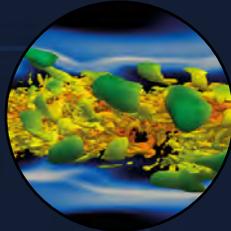


ENGINEERING DIGITAL FUTURES

We contribute to solving the methodological, technical, organizational, and societal challenges faced by science, engineering, industry, and society in the age of digital transformation.

Key Research Areas

- Enabling computational- & data-intensive science and engineering
- Modular exascale, data, & AI infrastructure with quantum & neuromorphic systems
- Secure and dependable cyber-physical systems in critical infrastructures
- Technology assessment & ethics for shaping the digital change

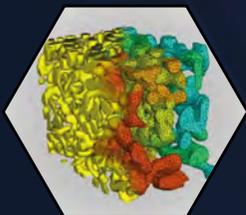
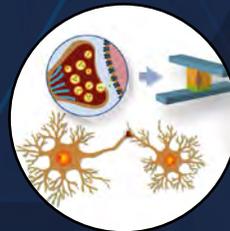
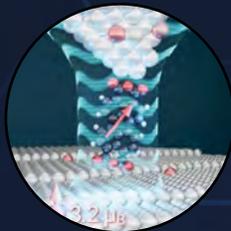


NATURAL, ARTIFICIAL AND COGNITIVE INFORMATION PROCESSING

We explore the fundamental principles of information processing in natural, artificial, & cognitive systems, driving advances in AI, computing, & biomedicine.

Key Research Areas

- Quantum Materials: Topology, emergence, nanostructures, & dynamics for computing
- Concepts, devices, and systems for neuromorphic, & quantum computing
- Living cells and the brain for novel concepts in information technology
- Understanding human intelligence for future AI systems

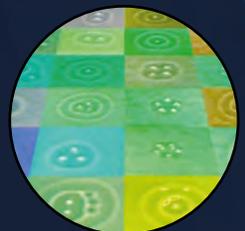
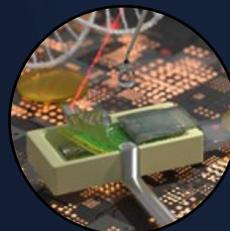
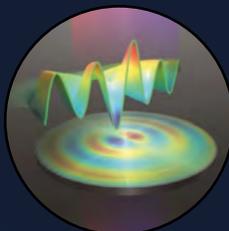
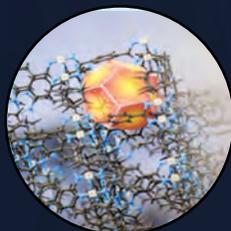


MATERIALS SYSTEMS ENGINEERING

We research and integrate data-driven methods into materials science to accelerate efficient and digitalized discovery of sustainable, cost-effective materials systems.

Key Research Areas

- AI & digital twins to optimize material design, development, & applications
- Robotics & correlative characterization to boost efficiency of knowledge gain
- Big data analyses & machine learning for predictive modeling
- Accelerated discovery of smart materials for healthcare, electronics, & photonics



ABOUT HELMHOLTZ INFORMATION IN A NUTSHELL

At Helmholtz Information, researchers from Forschungszentrum Jülich, Karlsruher Institut für Technologie, Helmholtz-Zentrum Hereon, and Helmholtz-Zentrum Berlin combine expertise in computing, data, material, and life sciences to develop groundbreaking solutions for next-generation information systems that drive data-driven processes in science, industry, and society. Our interdisciplinary approach fosters technological innovation by addressing critical challenges in artificial intelligence, quantum and neuromorphic computing, neuroinspired systems, and autonomous materials design.

As a hub for cutting-edge research, we integrate state-of-the-art methods and unique infrastructures to bridge fundamental science and real-world applications. From advancing digitalized materials science and life sciences to pioneering new computing paradigms, our mission is to empower Germany's and Europe's digital and technological sovereignty and shape the digital transformation.



FACTS AND FIGURES



Scientists

1600



PhD Graduates

183



Budget

€344 million



**Third-Party
Funding**

€195 million



**Industry &
Partners**

286

*reference year 2023

CONTACT INFORMATION

Helmholtz-Gemeinschaft Deutscher Forschungszentren e. V.
Astrid Lambrecht, Vice President Helmholtz Information
Christine Mieck, Chief Research Manager Helmholtz Information
Coordination Office Helmholtz Information
E-Mail: helmholtz-information@fz-juelich.de
More Information: information.helmholtz.de
Version as of March 2025

