Human Brain Project

Co-funded by
the European Union

THE HUMAN BRAIN PROJECT AND ITS MISSION

The HBP's quest to understand the human brain is advancing well. Detailed online brain atlases and models are being created. New insights are emerging from a broad spectrum of experiments, supercomputing-based analysis of large, complex data sets and simulations of molecules, cells and networks of cells. Progress is being made in the area of neurorobotics, where brain models are tested by connecting them to physical or virtual robots. HBP neuroscientists, computer and robotics experts are working together to build a unique Information and Communications Technology (ICT)-based infrastructure for brain research, which will be a lasting contribution to the science community worldwide. This should deliver major benefits: accelerating the scientific process of understanding the brain; speeding up development of targeted new treatments and diagnostics for patients with brain diseases and inspiring future computing, including neuromorphic systems and modular supercomputing.

Prof. Katrin Amunts
Scientific Research Director

Christoph Ebell
Executive Director

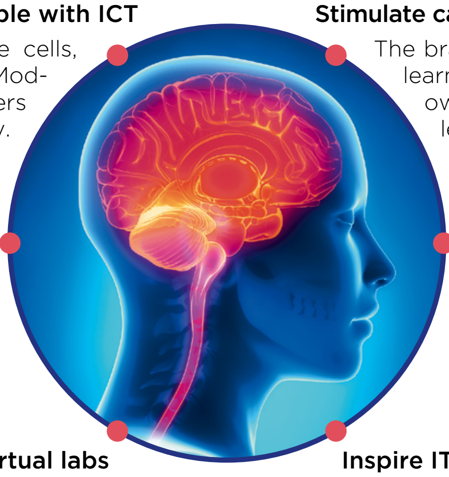
The HBP is a 10-year European Flagship project, aiming at a comprehensive understanding of the human brain. To achieve this, the HBP combines excellent neuroscience research with the development of a joint platform for research and brain-inspired technology development.

The HBP is following a unique, multi-disciplinary approach to accelerate brain research, brain medicine and brain-inspired technology. The infrastructure makes available a growing range of data, models, software tools and hardware capabilities to scientists, and industry.

The HBP draws on the academic prowess of Europe's leading universities and research institutions, backed by the computing and data-analytics power of four major supercomputing centres in the EU.

The HBP also looks at the social and ethical implications of its work; this includes reflection on our understanding of consciousness, animal research, patient anonymity, etc., and engages with the public on these issues. It also runs a comprehensive education programme to increase scientists' and engineers' ability to work in cross-disciplinary teams.

Brain science and computing: a productive loop



Only possible with ICT

The human brain has 86 billion nerve cells, each with up to 10,000 connections. Modern supercomputers will help researchers handle this complexity.

Stimulate capabilities

The brain has many unique features: children learn their mother tongue, largely on their own, in three years. Advanced machine learning systems have to be fed many examples and still perform far less well.

Advancing brain related medicine

ICT can help us to analyse data from thousands of patients, facilitating diagnosis and opening the way to better treatments.

Boost ICT efficiency

Most modern ICT is programmed slowly, at huge cost. The brain learns quickly and spontaneously, with no need for programming.

Virtual labs

Simulations of the brain allow us to perform experiments that would be impossible in humans or in animals, and help to accelerate the development of new therapies.

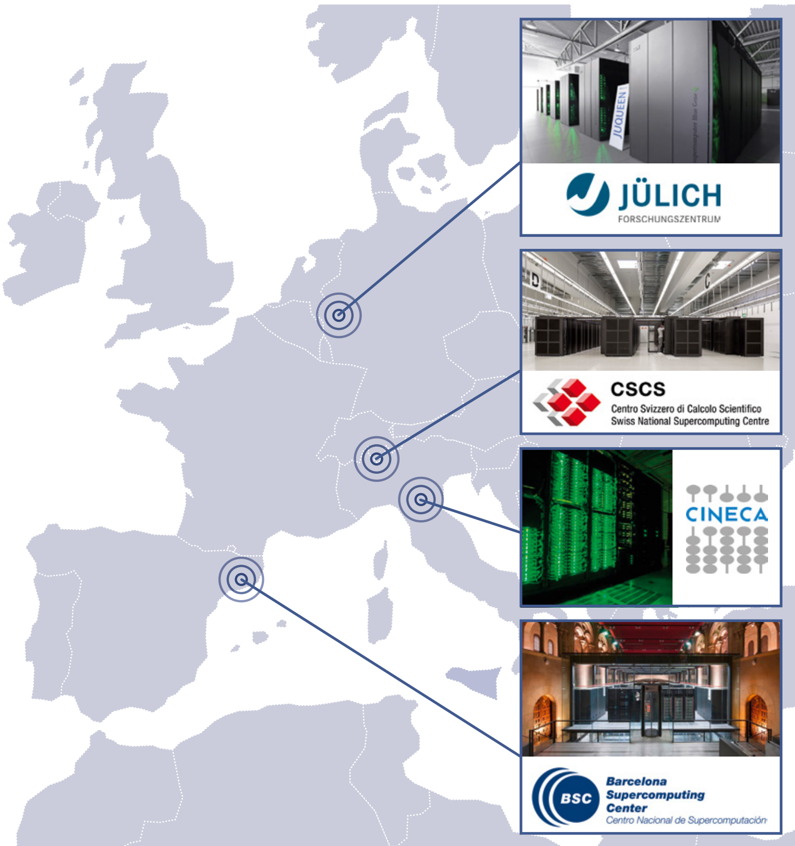
Inspire IT flexibility

The brain uses different strategies to solve a problem and learns quickly. Future supercomputing will become modular and more flexible to handle complex workflows.

THE HBP IS HARNESSING ICT TO EXPLORE THE BRAIN
AND USING THE BRAIN TO INSPIRE NEW ITC CAPABILITIES

The HBP's world-leading ICT-based research infrastructure

The HBP is creating an advanced ICT platform to support researchers studying the brain and its diseases, empower brain-inspired computing and drive technological development. It includes cloud-based collaborative virtual experiments, data analytics, and compute services and databases that enable meta-data handling and provenance tracking. Leading-edge supercomputers, brain-inspired neuromorphic computers, and neurorobotic systems combining simulated brains with robotic bodies, are being provided to scientists. The HBP is developing advanced software for big data analytics, modelling and simulation at all levels of brain organisation – from the level of single molecules to the whole brain – to understand how the different levels of brain organization interact and generate complex behaviour. Researchers can access all these from their own laboratories and collaborate with other labs.



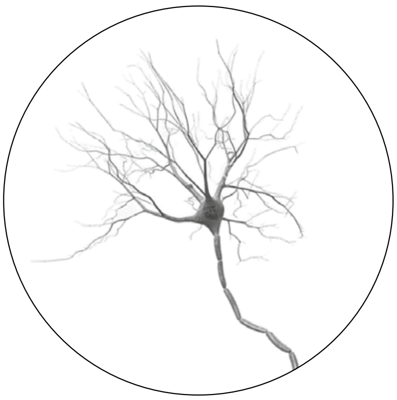
The HBP scientific research infrastructure is powered by the most powerful supercomputers in Europe

The HBP's cutting-edge scientific research

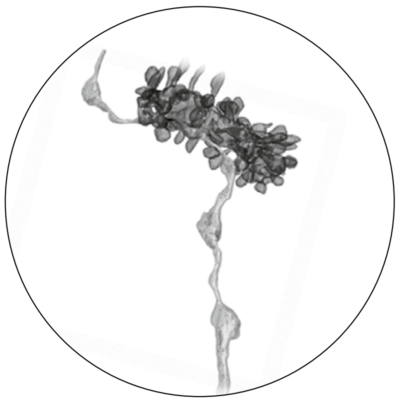
The biggest challenge in understanding the brain is the bridging of different scales in space and time. This means identifying how genetic, molecular and cellular organisation is translated into brain functions such as cognition and intelligence. It also means deciphering how behaviour, disease and environment may influence what happens at the molecular, genetic or cellular levels – and all of this over time, from millisecond responses to the whole lifespan. The datasets generated at these levels of description are so large that neuroscience needs high-performance computing to connect the scales into a comprehensive picture. The ability to combine simulation and "Big Data" analytics with experiments is key to making brain complexity scientifically tractable.

Whole brain
cm scale

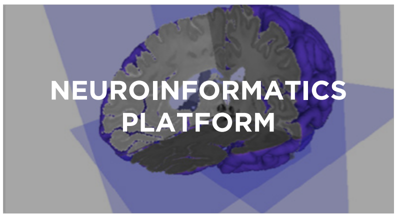
Neuron
µm to mm scale



Synapse
nm to µm scale

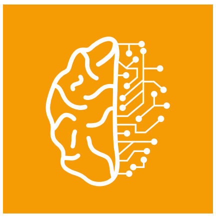


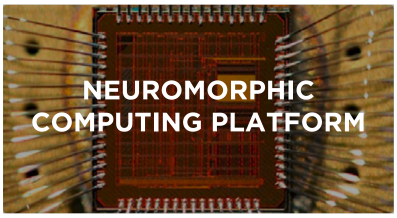
HBP ACHIEVEMENTS



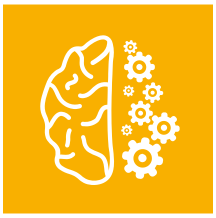
The Neuroinformatics Platform represents the HBP's search engine for distributed data, curated data repositories, brain atlases and knowledge about the brain, making it available for research use worldwide.

The Brain Simulation Platform's suite of software tools allow extrapolation of highly representative static models and simulations of brain activities, within brain regions or whole brains, using sparse data sets.

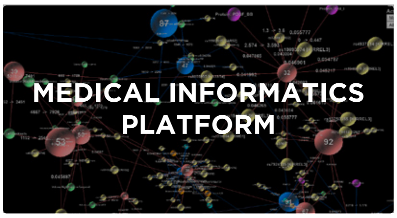




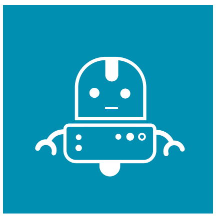
Researchers can use the most advanced, brain-inspired computing hardware to accelerate their work; for example, to simulate learning processes faster than real time. This provides unique insight into neural information processing and anticipates devices that mimic unique strengths of the brain.

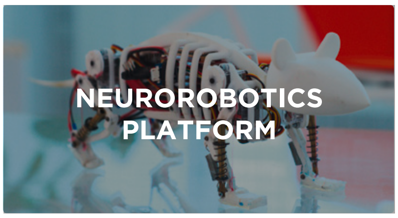


Scientists inside and outside the HBP are starting to use techniques, models and software tools developed by the Project. Examples include different models, such as protein-protein interactions in synapses, simulation engines and the HBP human and rodent brain atlases.



The Medical Informatics Platform aims to allow researchers to look for patterns in data from patients while preserving patient confidentiality. Big Data techniques are being employed to identify signatures of brain diseases.





Researchers can test their brain simulations by connecting them to virtual or real robots. They can check, whether the robot's "behaviour" in a given situation matches that of its real-life counterpart and learn from that to improve simulations and robots.

Computer scientists build, integrate and operate the hardware and software components of the supercomputing, data and visualization infrastructure to run extensive, large-scale simulations and manage large amounts of data and complex workflows.

The HBP uniquely combines microscale approaches with larger scale methods like whole brain imaging. As well as high-profile publications and collaborations, the HBP undertakes clinically relevant research; for example, helping to measure consciousness in unresponsive patients, and use of brain modelling tools to develop a new disease intervention.

Key figures

116 Partners (●) in 19 countries, of which 87 universities, 26 research institutes and 2 companies

9 Associated Members (●) in 7 countries, including Canada and the USA

7 Partnering Projects active, 6 more in the approval process

856 full-time research and staff positions, of which 31% filled by women

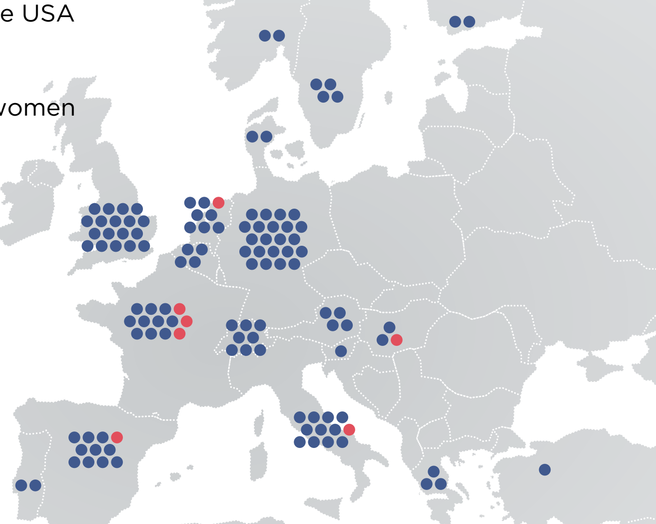
Estimated EU funding, 2013-2023: EUR 406 million

Estimated national funding, 2013–2023: EUR 600 million

More than 700 scientific publications to date

2 patent applications to date

Platform users October 2017: 2,335 accounts (1,412 external)
October 2016: 1,443 accounts (734 external)



The value of being a FET Flagship

With a longer timeframe and more funding than most EU research initiatives, the FET Flagships allow scientists and engineers to take a longer-term approach, address bigger challenges and deliver more advanced technologies, with greater transformational potential. Only this larger scope can enable the HBPs ambitious transformative endeavour of providing the basis for a new kind of 21st century science of the brain.

By selecting the HBP as a FET Flagship, Europe has staked out a leading position in brain-related research worldwide. The EU's decision also encouraged a number of other countries around the world to set up national brain research initiatives. The HBP's leadership has been particularly active in reaching out and collaborating with other brain initiatives, notably the US BRAIN initiative. The objective is to combine complementary forces and to minimise duplication of efforts.

Major brain initiatives and years of launch

- **EU**: The Human Brain Project, 2013
- **USA**: The BRAIN Initiative, 2014
- **Australia**: The Australian Brain Alliance, 2016
- **China**: The China Brain Project, 2016
- **Japan**: Brain/MINDS project, 2016
- **Canada**: Government/Brain Canada joint funding, 2017

Priorities for 2018–2020

Creation of an **HBP Legal Entity** to manage this scientific research infrastructure and ensure its long-term sustainability after the FET Flagship ends.

Fusion of the six ICT Platforms developed 2013-16 into an integrated **HBP Joint Platform**, with a common service level.

Improved User Support & Integration: Creation of High-Level Support Teams and a Voucher scheme, to make expertise and resources available to support external users in exploiting and enriching the research infrastructure for specific, cutting-edge applications.

To identify rules by which bottom-up and top-down **brain organisation on a given spatial or temporal scale** are translated to the next higher or lower level.

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FETFlagships

Contact
Human Brain Project
Project Coordination Office
Campus Biotech
Chemin des Mines 9
1202 Geneva
Switzerland

Info@humanbrainproject.eu