Human Brain Project

Co-funded by the European Union

The EBRAINS infrastructure:

integrated services addressing current and future challenges in brain research

Workshop EBRAINS –
a platform for collaboration in digital neuroscience
Centro para el Desarrollo Tecnológico Industrial
Madrid Spain
November 12, 2019

Jan Bjaalie, University of Oslo

Director, HBP Infrastructure Operations
Platform leader, HBP Neuroinformatics
Co-chair, International Brain Initiative (IBI)
Head, Norwegian Neuroinformatics Node (INCF Norway)

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Advancing neuroscience:

Collaborative data sharing, reproducible research, and workflows from data to models of brain function

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«Humans are brains»

- “Understanding the brain”
- “Healing the brain”
- “Modeling the brain”

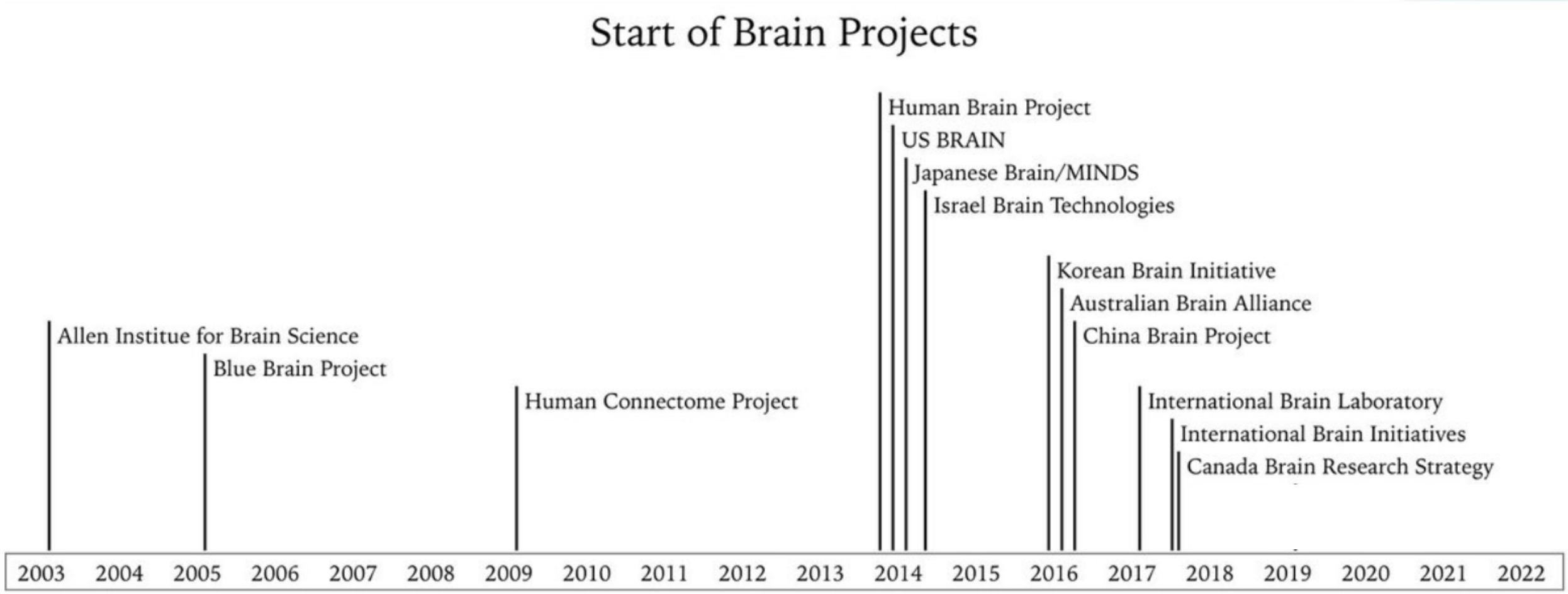
Basic science, Health, Technology

The strongest driving force for neuroscience today is the societal demand for treatments for brain disease

- Cost of dementia alone will surpass cost of all of cancer
- 2015: number of people in age group 60-64 surpassed number in age group 20-24

Human Brain Project (HBP): the first in a wave of large brain projects

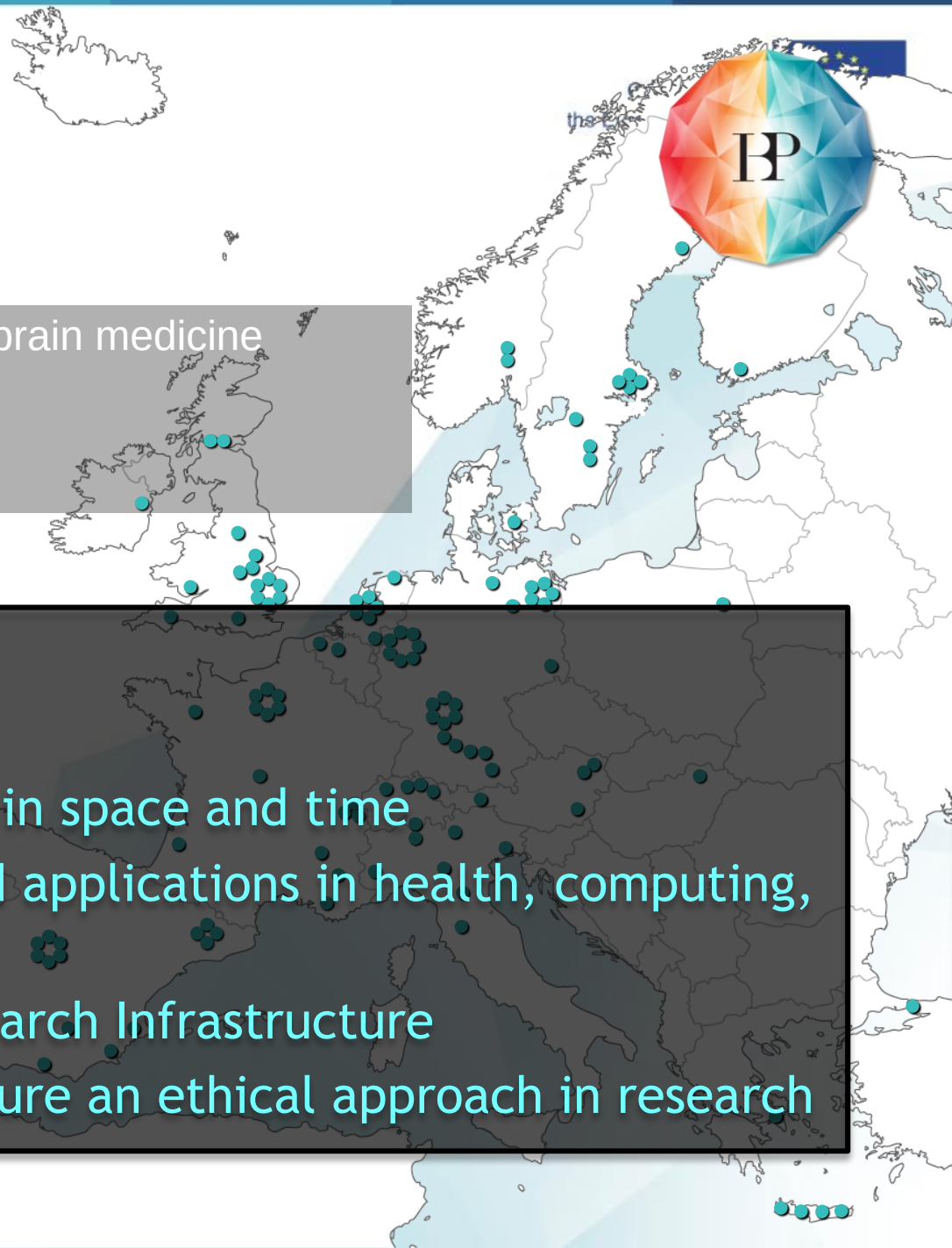
Co-funded by the European Union



The Human Brain Project, 2018

Human Brain Project

HBP at a glance



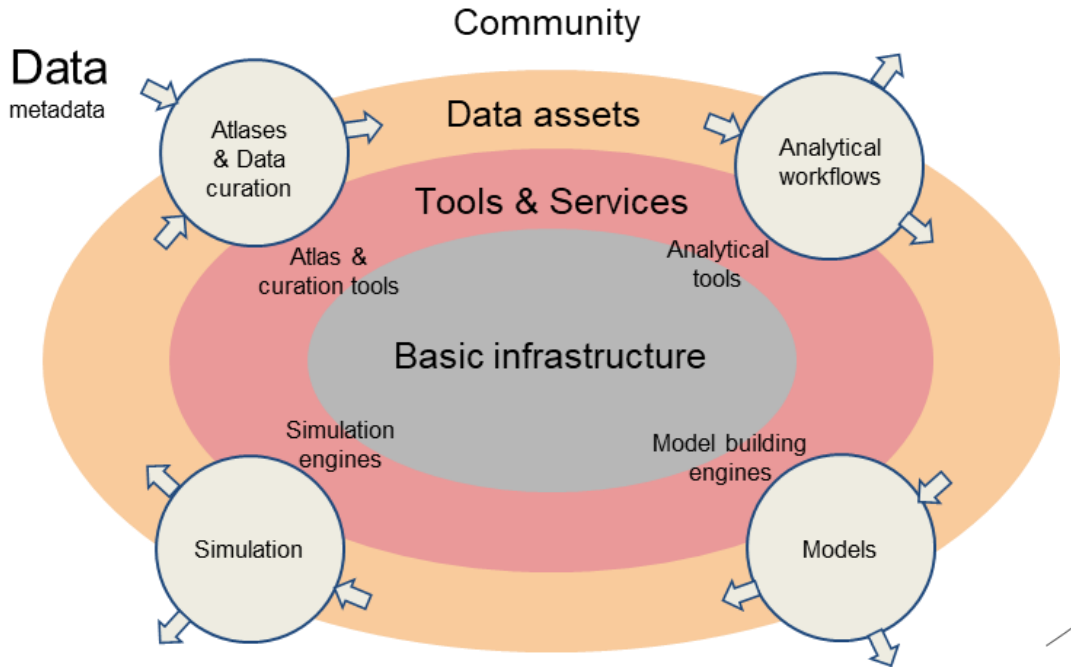
- At the interface of neuroscience, computing, technology and brain medicine
- Research & Infrastructure development
- Driven by “co-design projects“ and “use cases”

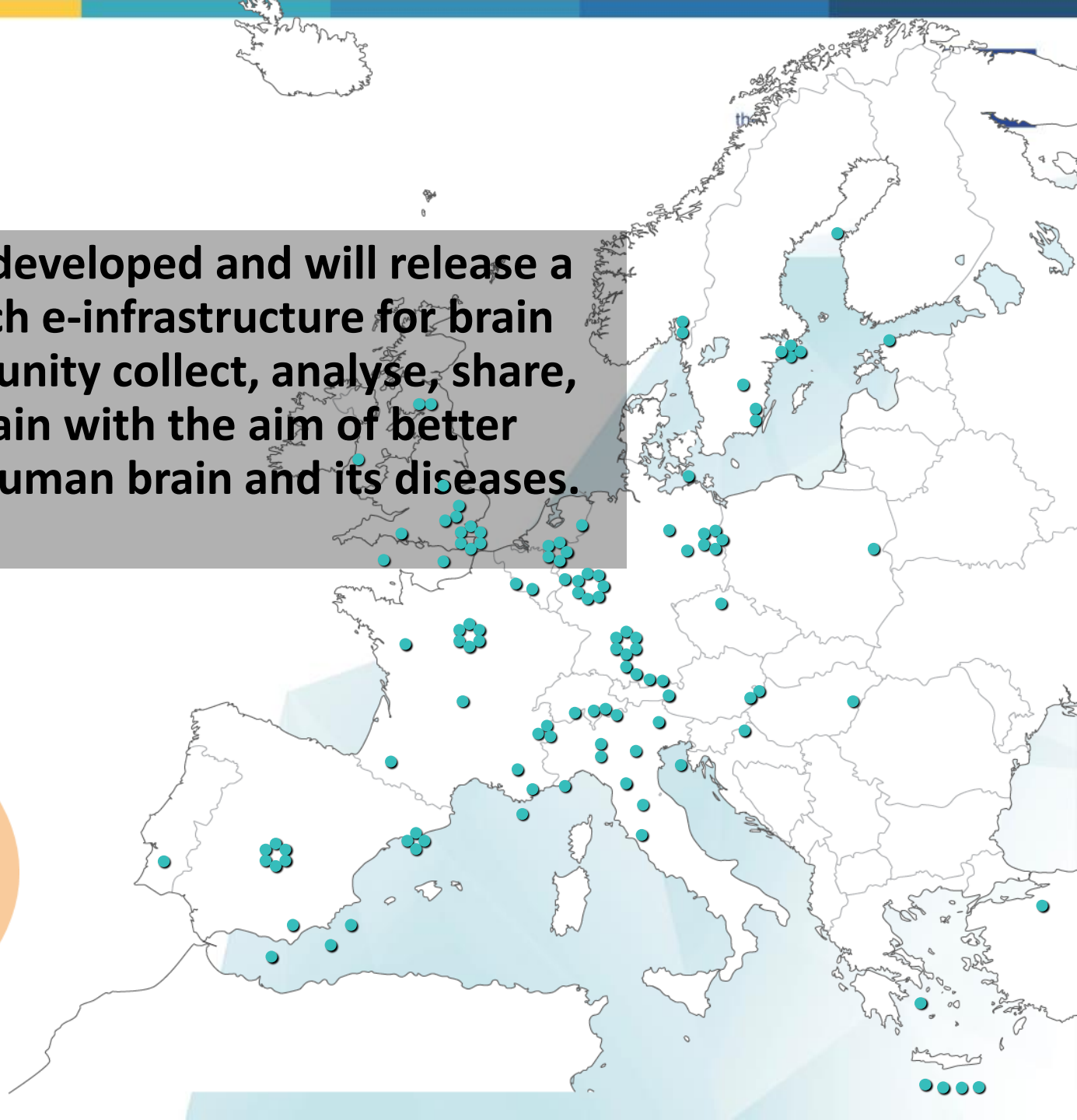
Missions:

- Understanding the multi-level brain organization in space and time
- Transfer the acquired knowledge to brain-derived applications in health, computing, and technology
- Developing and maintaining a European HBP Research Infrastructure
- Create a benefit to the European society and ensure an ethical approach in research

HBP at a glance

The Human Brain Project Flagship has developed and will release a federated ICT infrastructure – a research e-infrastructure for brain research – helping the research community collect, analyse, share, integrate and model data about the brain with the aim of better understanding the functioning of the human brain and its diseases.

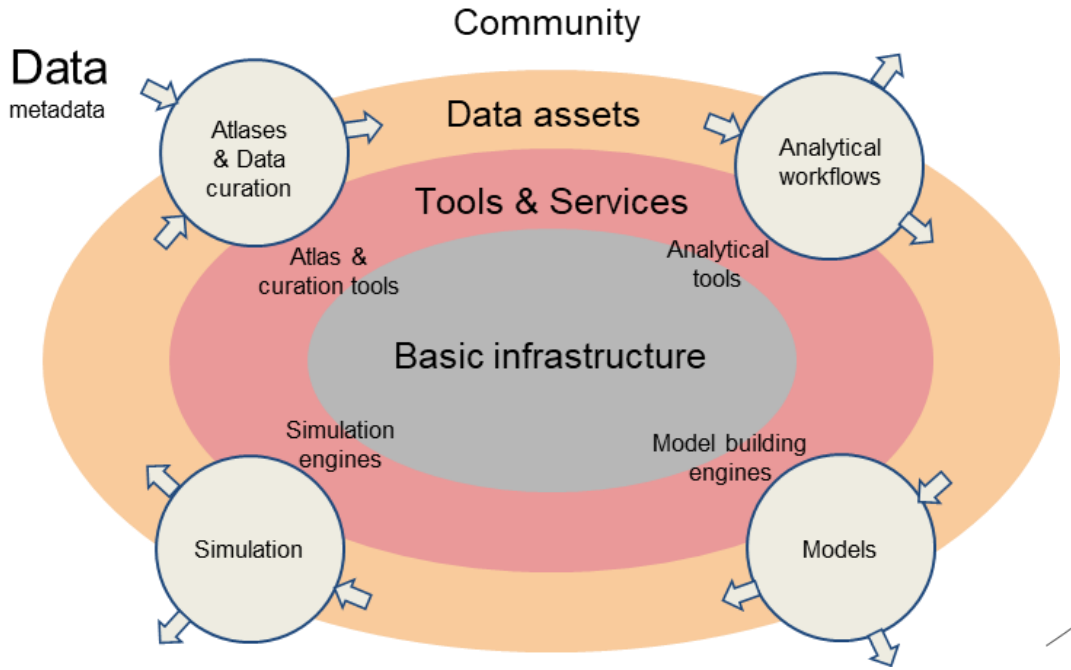




Human Brain Project

HBP at a glance

EBRAINS



The EBRAINS infrastructure will include

- **FAIR data services**
- **Brain atlases for data integration**
- **Brain modeling and simulation**
- **Closed-loop AI and robotics**
- **Medical brain activity data**
- **Interactive High-Performance Computing and Neuromorphic Computing**

EBRAINS

Co-funded by the European Union

European Brain ReseArch INfrastructureS

- supporting a wide range of research methodologies
- facilitating collaborative research and data sharing
- integrating a large variety of ICT services addressing current and future challenges in the neurosciences
- providing working solutions for experimental, computational, and clinical neuroscientists

The Project and work-in-progress
www.humanbrainproject.eu

www.ebrains.eu
Powered by HBP
- Working Solutions
for the scientific community

https://ebrains.eu Pre-launch October 18, 2019

EBRAINS

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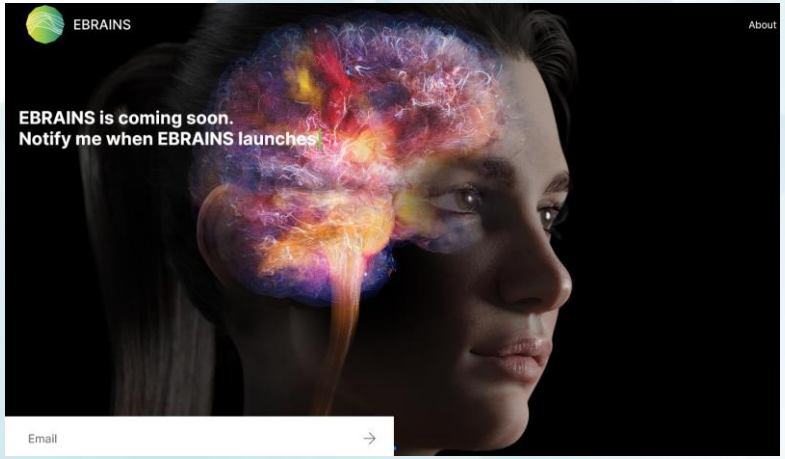

https://ebrains.eu Pre-launch October 18, 2019

Making the infrastructure sustainable

- In the context of preparing for the sustainability of the infrastructure developed by the project, 6 countries participating in HBP have established EBRAINS as a governing Legal Entity / Association internationale sans but lucratif, in Belgium (August 2019)
- Recruitment of EBRAINS CEO just started.

HBP: Decoding the brain

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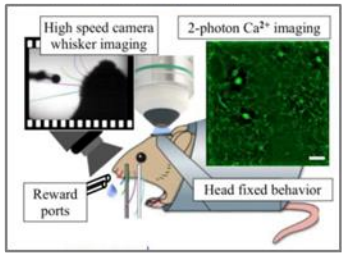
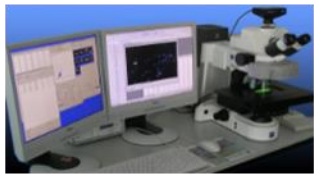
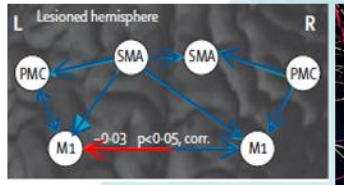
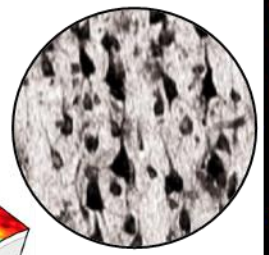
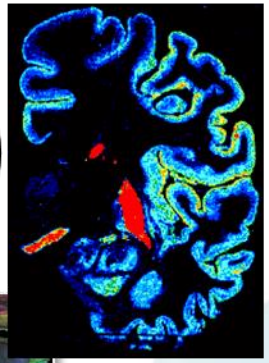
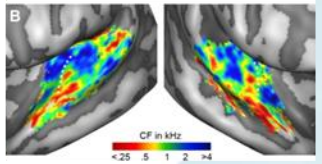


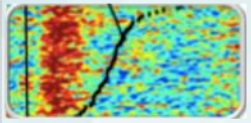
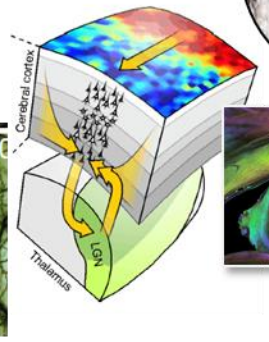


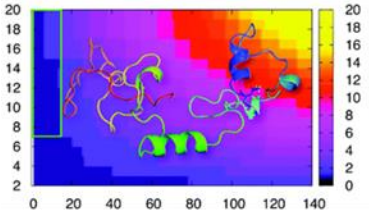
NEUROSCIENCE
EXPERIMENT & THEORY

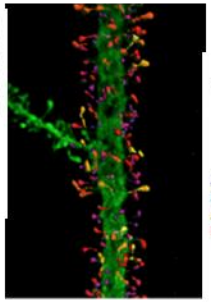
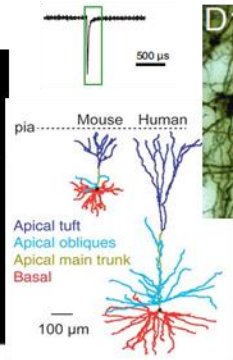
ETHICS & SOCIETY

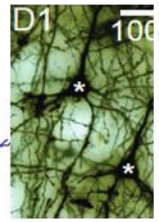


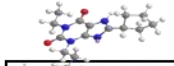
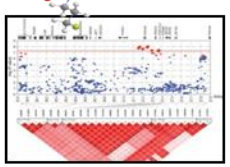







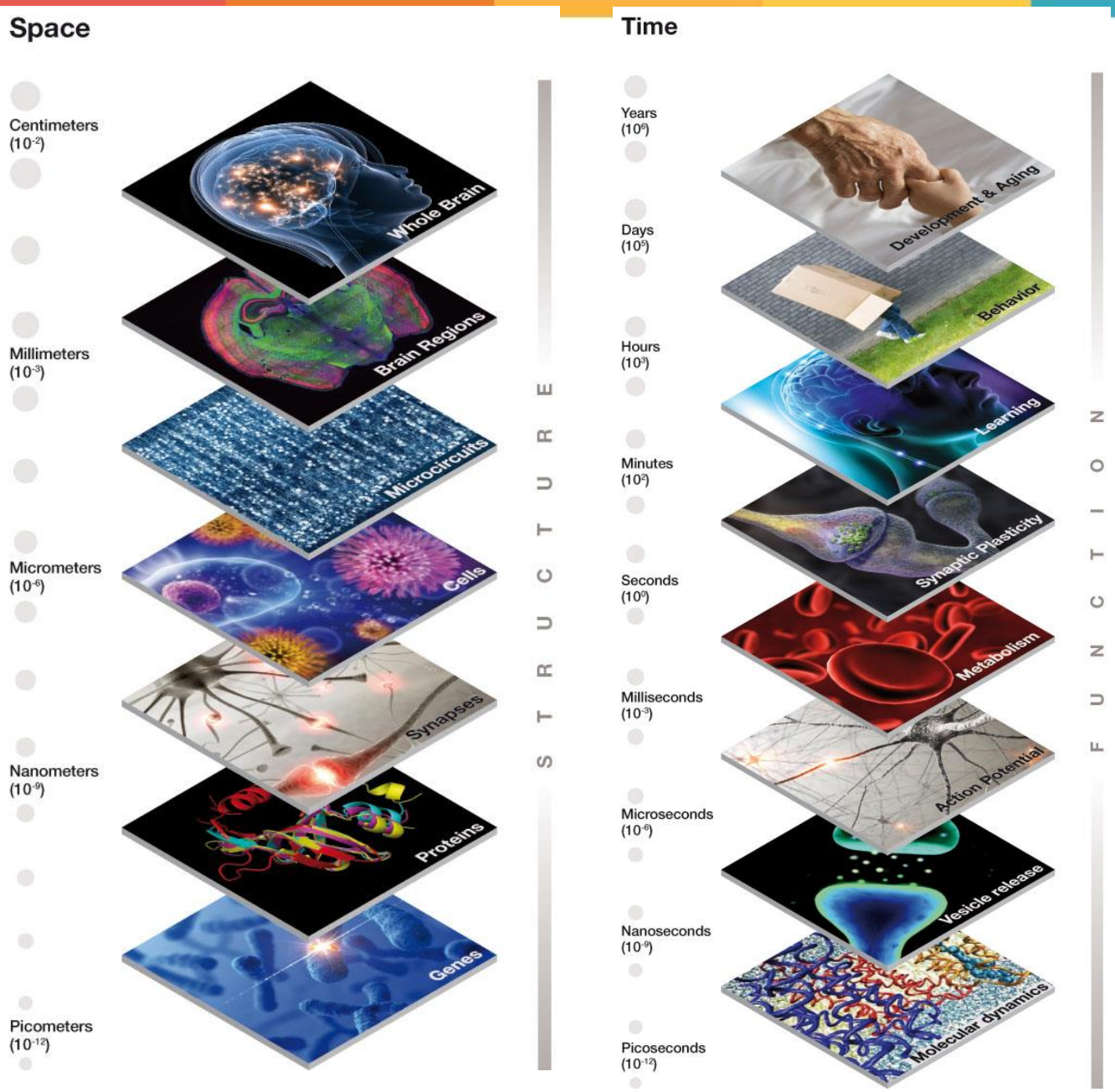
Multiscale in space and time, multimodal






RESEARCH INFRASTRUCTURE
DATA ANALYTICS & SIMULATION

Co-funded by
the European Union



Neuroscience data

- Multiple modalities
- Multiple spatial scales
- Multiple temporal scales

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The Challenge

The Human Brain has astronomical complexity and resilience
DATA INTEGRATION CHALLENGE

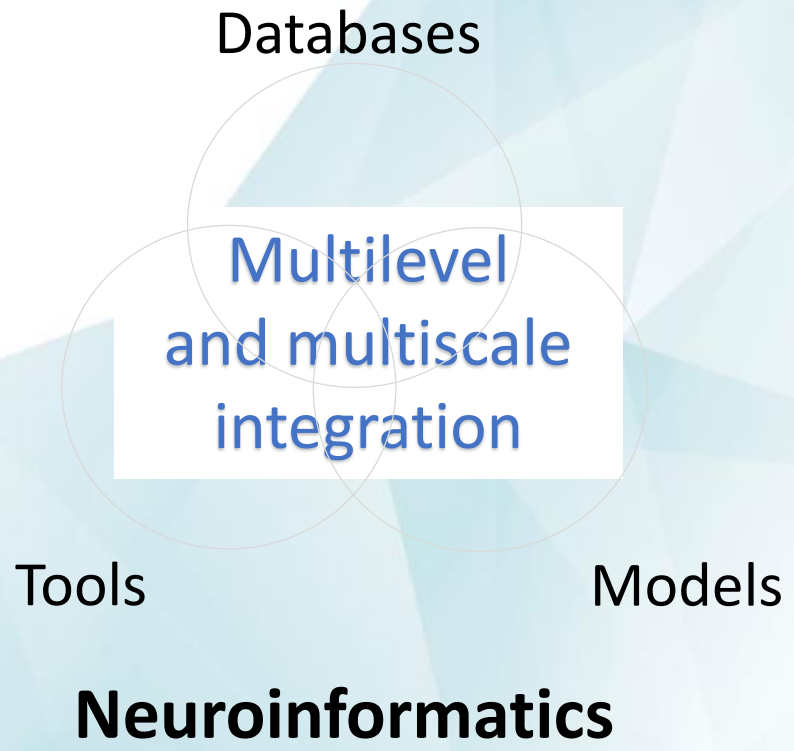
The HBP Answer

EBRAINS: a research e-infrastructure for neuroscience – helping the neuroscience community collect, analyse, share, integrate and model data about the brain with the aim of better understanding the functioning of the human brain and its diseases.

EBRAINS

Data integration

- Combining data residing in different sources and providing users with a unified view of them
- Increasingly important as the volume of data explodes
- Focus in many scientific disciplines and in other sectors of society
- Numerous challenges



Data integration requires data sharing

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- Culture of Knowledge sharing is well developed
- Knowledge builds on data: Culture of Data sharing is lagging behind
- Transformative HBP Neurodata management:
  - Creating a large repository of organized and curated data, unique at the level of containing heterogenous multi-level and multi-modality data
  - Data from HBP and other sources of shared data
  - Accompanied by efficient workflows for organizing, curating, and analysing neuroscience data in the context of brain atlases
- Key aspect: HBP 3-tier curation process for data and models
  1. Basic metadata
  2. Location metadata – registration to reference atlas
  3. Neural activity metadata - deep integration

Topics

- **Data sharing**
- **FAIR data service for neuroscience**
- **Brain atlases as key tools in the FAIR data service**

Topics

- **Data sharing**
  - Why sharing? What are others doing?
- **FAIR data service for neuroscience**
  - What is it? Is it relevant for you?
- **Brain atlases as key tools in the FAIR data service**
  - What would geography be without atlases of the planet Earth?
  - What will future neuroscience be without tools for navigating the brain?

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Questions

- Experiments
  - Data
    - Analysis
      - Interpretation
        - Conclusion

Knowledge sharing through journals

- The history of scientific journals dates from 1665, when the French *Journal des sçavans* and the English *Philosophical Transactions of the Royal Society* first began systematically publishing research results.
- Over a thousand scientific journals were founded in the 18th century, and the number has increased rapidly after that.
- ~ 40.000 journals today
- ~ 60 million articles since 1665
- ~ 2 million new articles per year
- Prior to mid-20th century, peer review was not compulsory. *Nature* instituted formal peer review in 1967.

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Questions

- Experiments
  - Data
    - Analysis
      - Interpretation
        - Conclusion


Journal Example

Example Author Manuscript Title

Where are the research data?

- In Journal articles?
- In Supplementary material provided together with journal articles?
- In Data repositories coupled to journals?
- In other Data repositories?

What do others do?

EUROPEAN COMMISSION

Brussels, 14.3.2018
SWD(2018) 83 final

COMMISSION STAFF WORKING DOCUMENT

Implementation Roadmap for the European Open Science Cloud

… to create a fit for purpose pan-European federation of research data infrastructures, with a view to moving from the current fragmentation to a situation where data is easy to store, find, share and re-use.

EUROPEAN OPEN SCIENCE CLOUD

Launched November 2018

EUROPEAN COMMISSION

The EOSC will offer 1.7 million European researchers and 70 million professionals in science, technology, the humanities and social sciences a virtual environment with open and seamless services for storage, management, analysis and re-use of research data, across borders and scientific disciplines by federating existing scientific data infrastructures, currently dispersed across disciplines and the EU Member States.

The European Open Science Cloud (EOSC) initiative has been proposed in 2016 by the European Commission as part of the European Cloud Initiative to build a competitive data and knowledge economy in Europe.

EUROPEAN OPEN SCIENCE CLOUD

Launched November 2018

Topics

- Data sharing
  - Why sharing? What are others doing?

- **FAIR data service for neuroscience**
  - What is it? Is it relevant for you?

- Brain atlases as key tools in the FAIR data service
  - What would geography be without atlases of the planet Earth?
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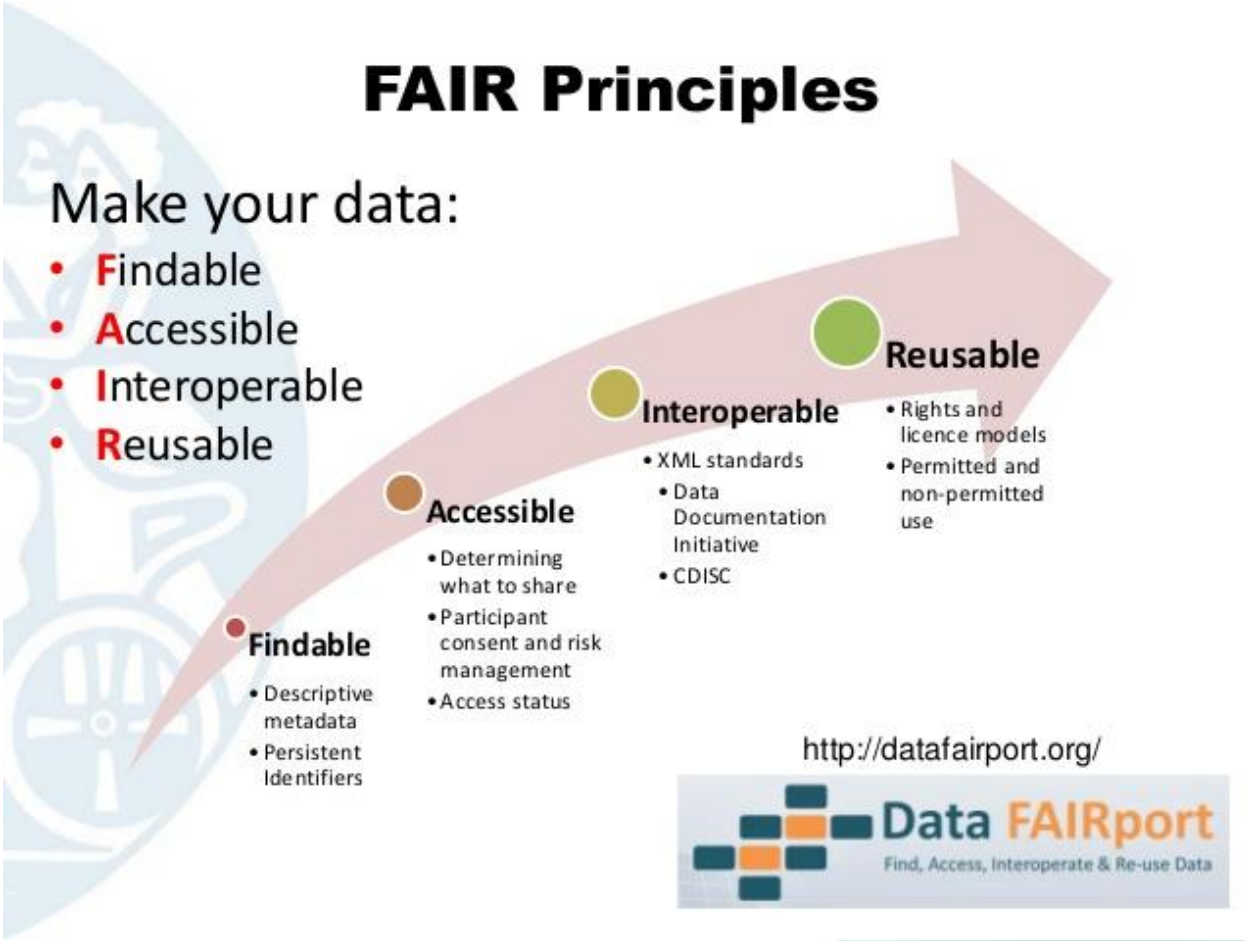
HBP Neurodata management: enabling data sharing

- Computational neuroscientists will benefit from having access to «primary data» or more data from experiments: **extract key features relevant for modeling and simulation**
- Experimental and clinical neuroscientists will benefit from having access to data from other laboratories: **improved analysis, new combinations of data, adding data**
- Groups producing and sharing data will benefit from **future data sharing impact factors**
- By providing well organized and interpretable data, accompanied by well defined conditions for access and use, **HBP Neurodata management will build trust and professionalize the sharing of data**

HBP Neurodata management: Big data, small data, useful data

Co-funded by the European Union

HBP Neuroinformatics Platform



HBP High Performance & Analytics Platform

HBP website

Co-funded by the European Union

Human Brain Project

Science Platforms Collaborate Follow HBP About Education & Training

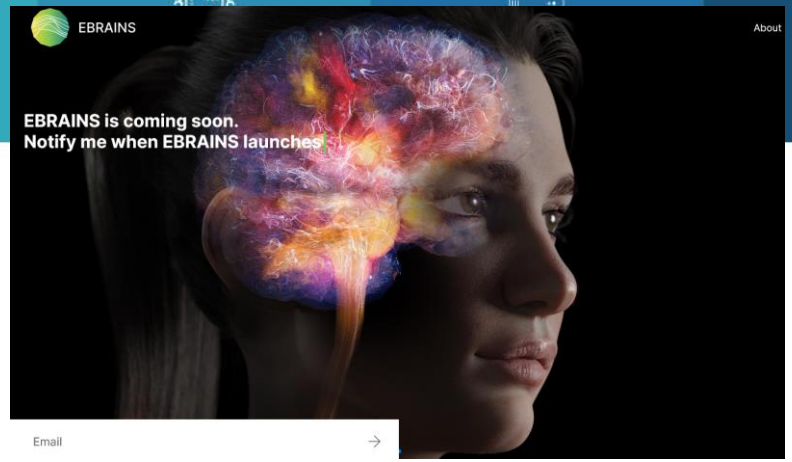
Welcome to the Human Brain Project

The Human Brain Project aims to put in place a cutting-edge research infrastructure that will allow scientific and industrial researchers to advance our knowledge in the fields of neuroscience, computing, and brain-related medicine

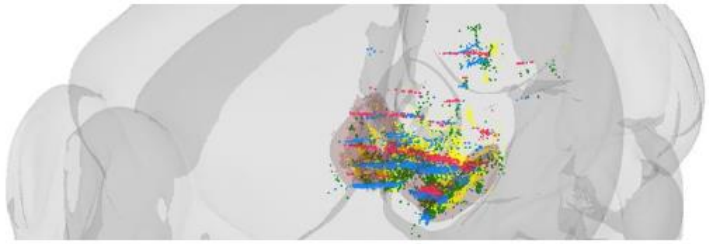
Learn more about the project

3D-Polarized Light Imaging of the human hippocampus. Image: Axer, Amunts and team, Jülich.

Explore the Brain | Brain Simulation | Silicon Brains | Understanding Cognition | Medicine | Social, Ethical, Reflective



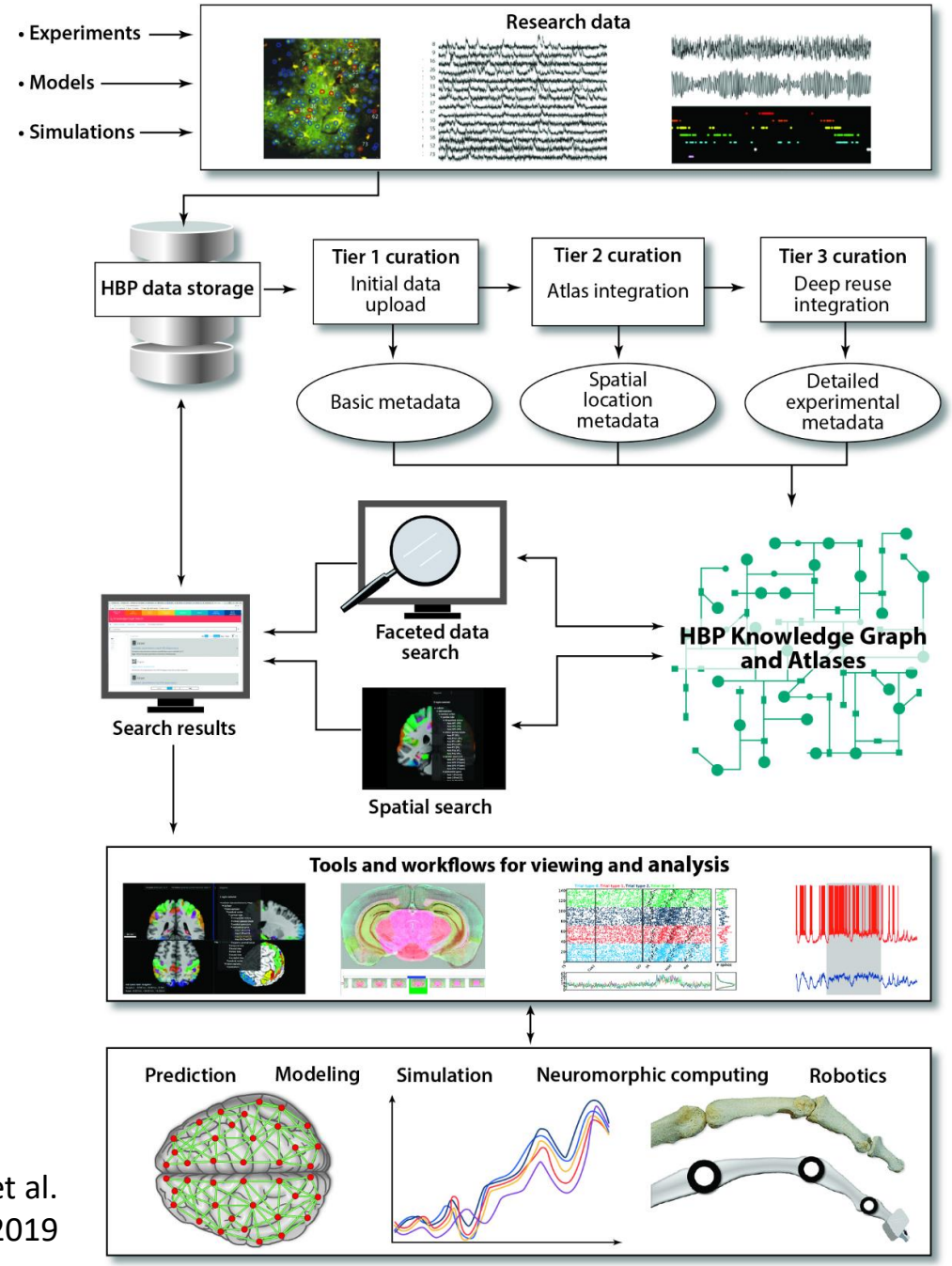
News



FRIDAY, 29 MARCH 2019

New brain atlas of transgenic mouse disease models shared via ...

Events



Amunts et al.
PLOS Biology 2019

Data to knowledge

Co-funded by the European Union

Research data are uploaded to data storage at the HBP High Performance Computing centers

The data are tagged with metadata through a 3-tier curation process, INCLUDING ETHICS CURATION

The data are made accessible through searches for metadata in the online HBP Knowledge Graph and HBP Atlases

Users can analyze data using tools and workflows for visualization and analysis available through the HBP infrastructure

The multiple-scale data are used for informing modeling and simulation, and for extracting principles of relevance for development of brain-inspired technologies

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Explore interactive 3-D anatomical brain atlases

Navigate to your favourite brain region and inspect the structure of the brain in any plane of orientation.

The Big Brain → | JuBrain → | WHS rat brain atlas → | Allen Mouse CCF → | More informations on HBP Atlases →

SHARE data

HBP offers a comprehensive **management and validation** of all data and metadata before it is uploaded and made available in the Knowledge Graph search.

How to share my data

FIND data

Explore neuroscience datasets shared through HBP's Knowledge Graph **data sharing repository**.

Knowledge Graph Search

USE data

Browse through a collection of **HBP supported tools** (reference atlases, elephant, ilastik) to visualise, combine and investigate data.

How to use our data

Share data

Human Brain Project

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1

Fill out request form:

HBP partners: [Contact HBP data curation team]

Non-HBP scientists [Request data sharing service]

Next deadline: March 31st

2

Deliver your data and metadata

1-2 weeks after acceptance

3

View data in the HBP Knowledge Graph

1-2 months after acceptance

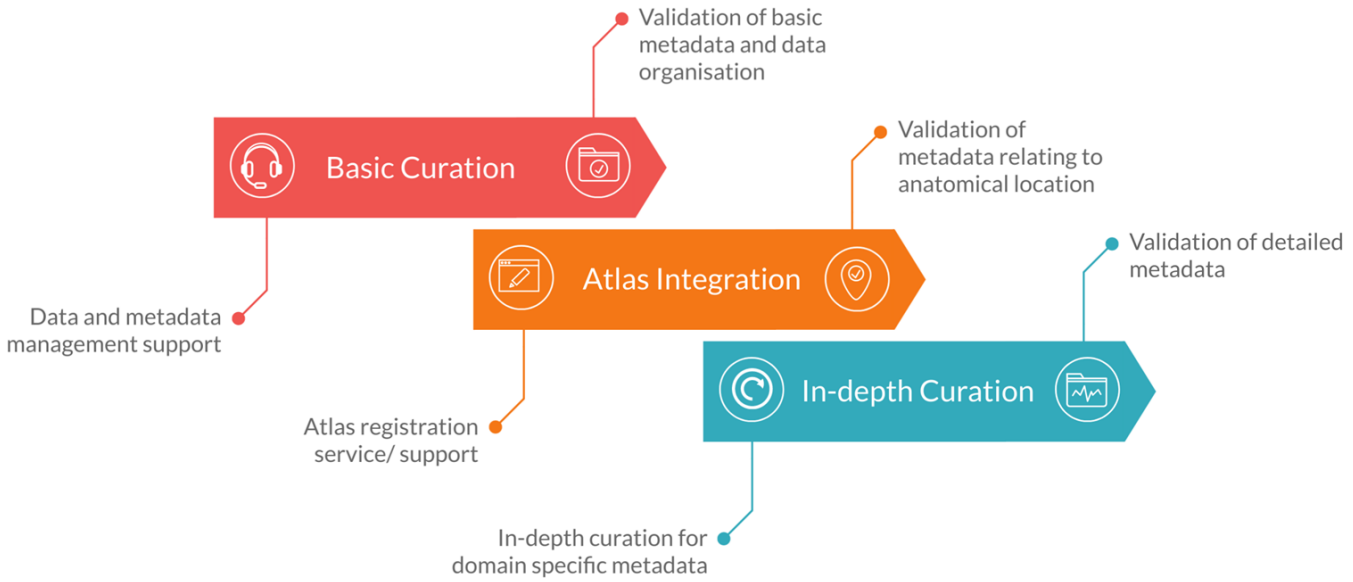
Human Brain Project

Data curation

Co-funded by the European Union

= the organisation and integration of data from various sources into a collection

The HBP's data curation process is organised in three tiers: Basic Curation, Atlas Integration and In-depth Curation.

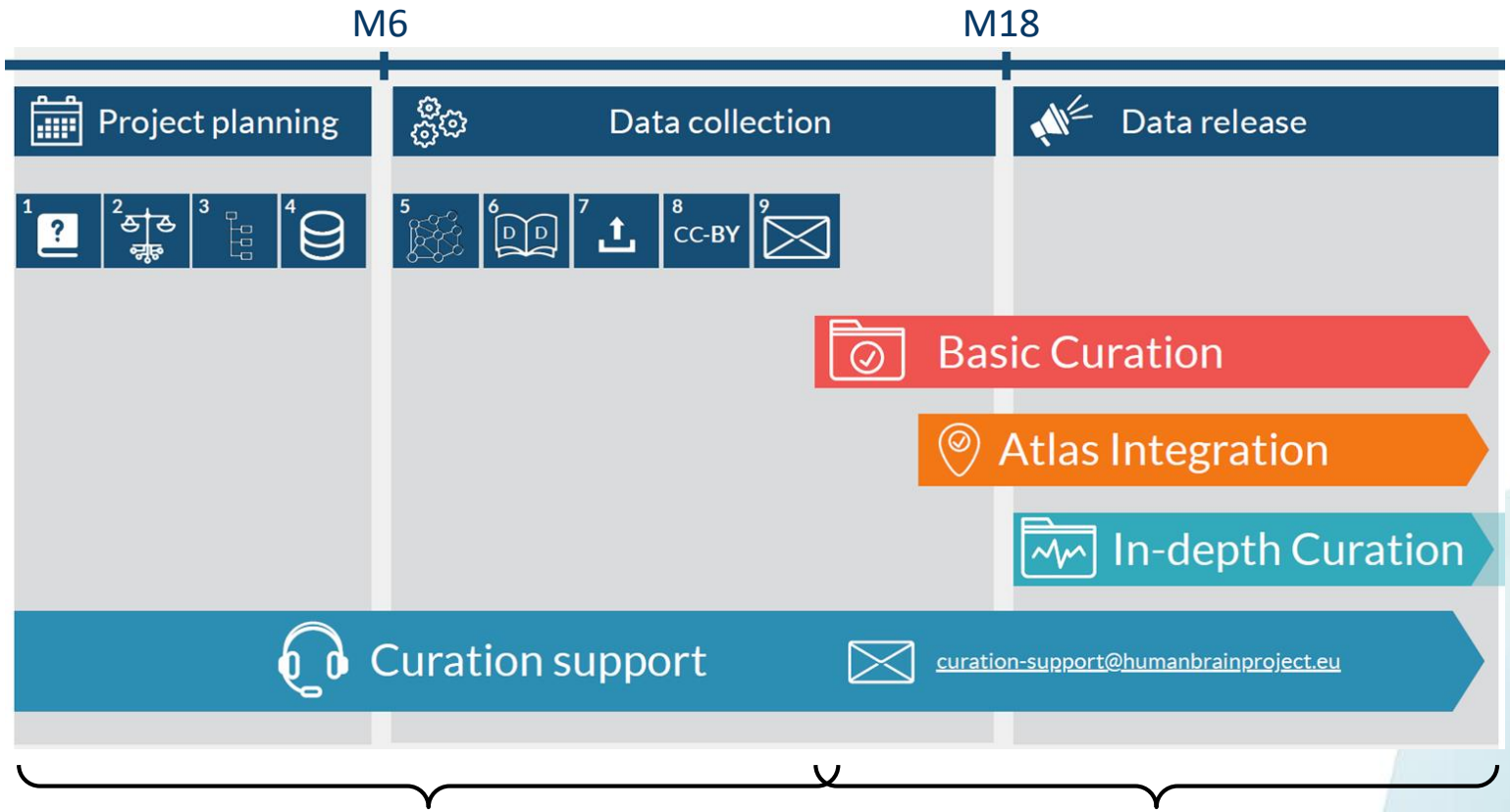


Ensures that…

…data and metadata are organised / managed / stored and integrated in a collection of other neuroscience data

…data are made FAIR

Data curation



Preparatory steps before the curation process starts
(performed by data provider with support from curation team)

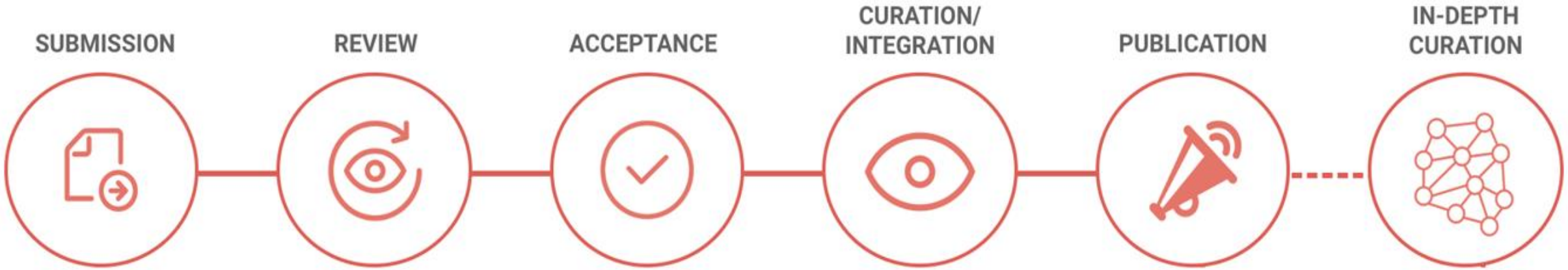
Curation process
(performed by curation team)

1. Download and read the **data integration guide**
2. Complete the **ethics survey**
3. Organise your data **consistently**
4. Create an account for the **HBP storage**
5. Download and fill in the **metadata template** MINDS
6. Download and fill in the **DataDescriptor**
7. **Upload** your data to the HBP storage
8. Choose a **licence** for your dataset(s)
9. Contact the curation support to inform us about your **submission**

Human Brain Project

Data curation

Co-funded by
the European Union



Find data

Human Brain Project

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EBRAINS

Search (e.g. brain or neuroscience)

SEARCH

Project 74 Results | Dataset 569 Results | Subject 825 Results | Sample 1129 Results | Model 32 Results | Contributor 464 Results

FILTERS Reset

Viewing 1-20 of 569 results

View as Grid List

Sort by Relevance

SPECIES

- Homo sapiens 446
- Mus musculus 65
- Rattus norvegicus 57
- Macaca mulatta 4

EMBARGO

- Free 482
- Embargoed 84
- Restricted access 1

Multiunit recordings from visual areas in monkeys performing a detection task

From the The Threshold for Conscious Report: Signal Loss and Response Bias in Visual and Frontal Cortex project

This dataset contains electrophysiological data (Multi-unit activity) from areas V1, V4 and dlPFC of macaque monkey during either a Contrast (visual) or Phosphene (electrical stimulation) detection task. The data is s...

Methods

electrophysiology visual stimulation

Keywords

Automated segmentation of cortical layers of the BigBrain

The cerebral isocortex has six cytoarchitectonic layers that vary depending on cortical area and local morphology. This datasets provides a 3D segmentation of all cortical and laminar surfaces in the BigBrain, a high-...

Methods

magnetic resonance imaging (MRI)

Keywords

analysis technique

brain mapping

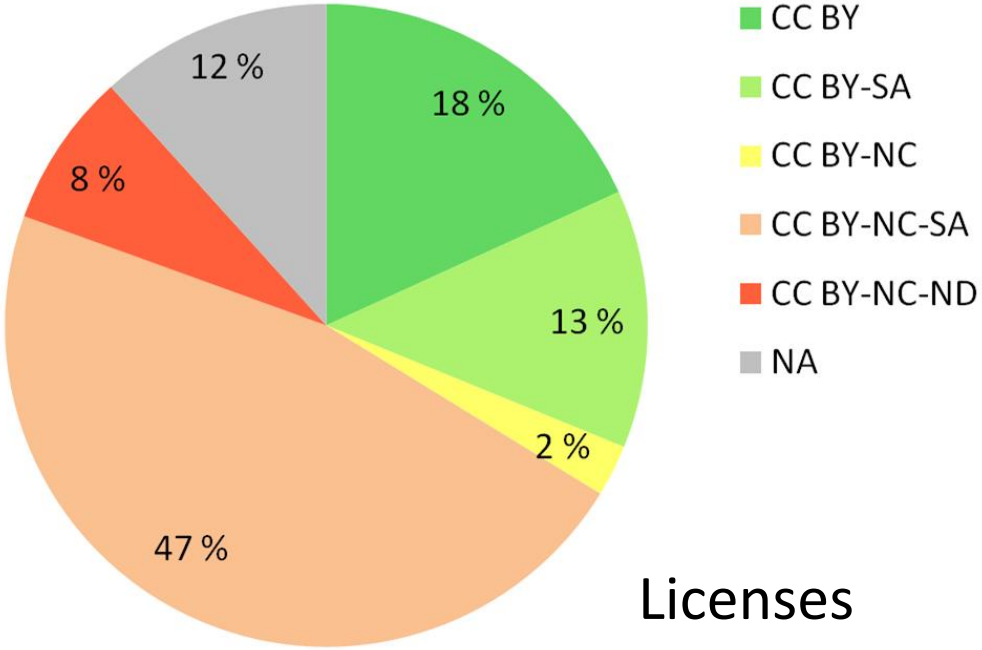
histology

Find data

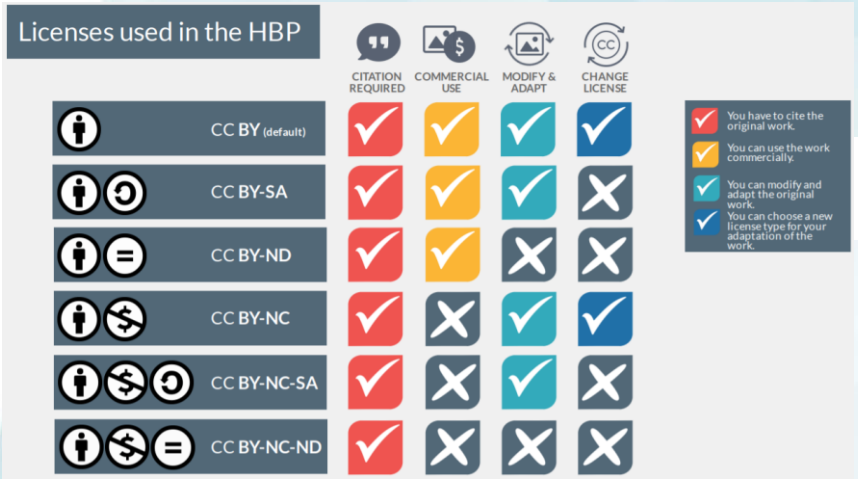
Co-funded by the European Union

HBP Knowledge Graph
Highest FAIRness score

HBP Knowledge Graph
Lowest FAIRness score



Licenses



		Do you allow commercial uses of your work?	
		Yes	No
Do you allow adaptations of your work to be shared?	Yes	Attribution 4.0 International (this is the default) 	Attribution-NonCommercial 4.0 International 
	No	Attribution-NoDerivatives 4.0 International 	Attribution-NonCommercial-NoDerivatives 4.0 International 
	Yes, as long as others share alike	Attribution-ShareAlike 4.0 International 	Selected License Attribution-NonCommercial-ShareAlike 4.0 International 

creative commons

- Helps licensors (creators) retain copyright while allowing others to copy, distribute, and make some uses of their work
- Ensures licensors get the credit for their work they deserve
- Works around the world and lasts as long as applicable copyright lasts (because they are built on copyright)

Human Brain Project

Co-funded by the European Union

EBRAINS

YouTube video: Multiscale Integration of Brain Data
https://www.youtube.com/watch?v=atCdA2H45iU&t=3s

Human Brain Project

Use data

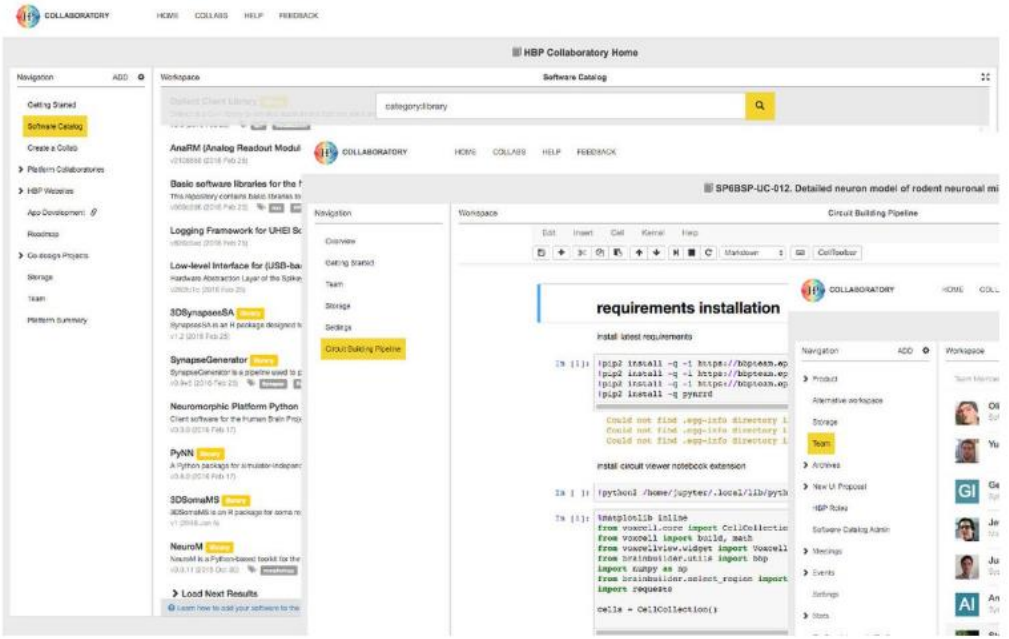
Co-funded by the European Union

HBP Collaboratory

The HBP Collaboratory is divided into collaborative workspaces or *collabs* which helps you share your analyses and collaborate with others on data driven, reproducible scientific workflows.

The collaboratory collects tools from the HBP Platforms in one place.

- Neuroinformatics Platform
- Brain Simulation Platform
- High Performance Analytics and Computing Platform
- Medical Informatics Platform
- Neuromorphic Computing Platform
- Neurorobotics Platform



The Collaboratory Jupyter notebook

Additionally, numerous standard analysis packages are installed by default into the Collaboratory Jupyter notebook, making your scientific work easier. See the growing list of software packages and services registered here.

Getting an HBP account

Visit the HBP Collaboratory →

HBP neurodata infrastructure

Human Brain Project

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Curation and ontologies

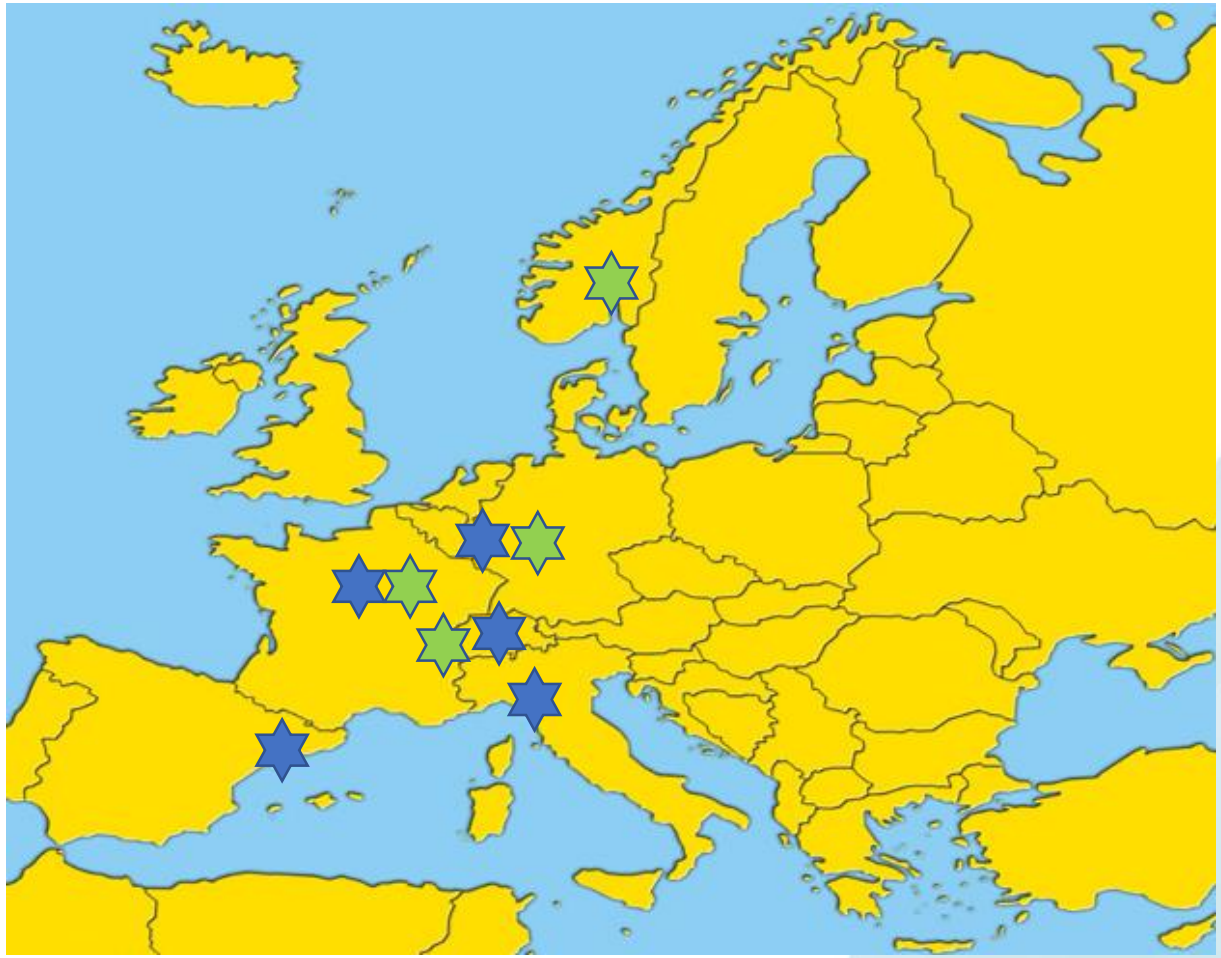
University of Oslo

JÜLICH Forschungszentrum

incf

NeuroPSI PARIS-SACLAY INSTITUTE of NEUROSCIENCE

EPFL



Storage and computing

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CSCS Centro Svizzero di Calcolo Scientifico Swiss National Supercomputing Centre

CINECA

BSC Barcelona Supercomputing Center Centro Nacional de Supercomputación

cea

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UiO : University of Oslo

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BSC Barcelona Supercomputing Center Centro Nacional de Supercomputación

FENIX RESEARCH INFRASTRUCTURE

Publications with HBP Data Citations

Co-funded by the European Union

35. Zu, T. *et al.* Recovery from polyglutamine-induced r
8853–8861 (2004).
36. Sgobio, C. *et al.* Optogenetic measurement of presyn
indicator expression in dopaminergic neurons. *PLoS*
37. Echigo, R., Nakao, K., Fukaya, M., Watanabe, M. &
E272–E278 (2009).

SCI

OPEN

Data Citations

1. Lillehaug, S. *et al. Human Brain Project Neuroinforn*
2. Lillehaug, S. *et al. Human Brain Project Neuroinforn*
3. Lillehaug, S. *et al. Human Brain Project Neuroinforn*
4. Lillehaug, S. *et al. Human Brain Project Neuroinforn*
5. Lillehaug, S. *et al. Human Brain Project Neuroinforn*
6. Lillehaug, S. *et al. Human Brain Project Neuroinforn*
7. Lillehaug, S. *et al. Human Brain Project Neuroinforn*
8. Lillehaug, S. *et al. Human Brain Project Neuroinforn*
9. Yetman, M., Lillehaug, S., Bjaalie, J., Leergaard, T. &
org/10.25493/5H13-1Q0 (2018).
10. Yetman, M., Lillehaug, S., Bjaalie, J., Leergaard, T. &
org/10.25493/WB6K-V72 (2018).
11. Yetman, M., Lillehaug, S., Bjaalie, J., Leergaard, T. &
org/10.25493/AYBB-BXV (2018).
12. Odeh, F. *et al. Human Brain Project Neuroinformati*
13. Boy, J. *et al. Human Brain Project Neuroinformatics*

Received: 20 February 20
Accepted: 19 December 20
Published: 26 February 20

www.nature.com/scientificdata

DATASET

Comparative overview of brain-wide tetracycline-transactivator expression

Description:
Tabular overview (csv format) of brain-wide reporter expression mapped in five commonly used tetracycline-transactivator (tTA) driver lines: neuropsin (Nop); L7/Purkinje cell protein 2 (Pcp2); Pituitary homeobox 3 (Pitx3); cellular prion protein (Prnp), and Ca2+/calmodulin-dependent protein kinase IIa (Camk2a). This analysis is derived from microscopic brain images taken from 12 driver-reporter constructs (DOIs for source data sets are specified in data descriptor file listed below; hbp-00170_Comparative_DataDescriptor_v1p1.txt) in which the different promoters regulate the expression of the E. coli derived LacZ reporter gene encoding β-galactosidase, visualized histologically using X-gal (5-Bromo-4-chloro-3-indolyl β-d-galactopyranoside) as a substrate. Labelling was observed in microscopic images that were spatially registered to the Allen Mouse Common Coordinate Framework (v2; mouse.brain-map.org). The density of labeling was assessed by two independent researchers using a semi-quantitative grading system from 0 – 4, introduced in Yetman et al., Brain Struct Funct 221:2231-49, 2016. Here grade 0 represents absence of labeled cells (less than 1 per 0.01 mm2), grade 1 - low density (few cells, possible to count), grade 2 - medium density (several cells that can be individually discerned, but not readily counted), grade 3 - high density (many labeled cells with large degree of overlap), and grade 4 - very high density (where individual cells cannot be discerned). For each promoter-tTA line one representative case was semi-quantitatively scored and results verified in the other cases. Scores did not vary more than 1 grade between cases or researchers in any regions. The highest numbers were reported. If the density of labeling was found to vary substantially within a region, the highest observed score was recorded.

DOI for these data:
S. Lillehaug, M. Yetman, M. Puchades, M. Checinska, H. Kleven, J. Jankowsky, ... T. Leergaard. (2018). *Comparative overview of brain-wide tetracycline-transactivator expression* [Data set]. Human Brain Project Neuroinformatics Platform. DOI: 10.25493/ARKS-R7H

Contributors: Lillehaug, S.; Yetman, M.; Puchades, M.; Checinska, M.; Kleven, H.; Jankowsky, J.; Bjaalie, J.; Leergaard, T.

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Project: Transgene expression in tetracycline-transactivator driver lines

Custodians: Leergaard, Trygve B.

Preparation: In silico

Methods
Anchoring | Analysis | Density measurment

Keywords
Atlas | B6.Cg-Tg(Camk2a-tTA)1Mmay/DboJ | B6.Cg-Tg(Klk8-tTA)QMmay/MullMmmh | Brain-wide | Ca2+/calmodulin-dependent protein kinase II promoter

view more

Files (3) | Subjects (1)

hbp-00170_Comparative_DataDescriptor_v1p1.txt Terms of use

Table_tTA-distributions.csv Terms of use

Topics

- Data sharing
  - Why sharing? What are others doing?
- FAIR data service for neuroscience
  - What is it? Is it relevant for you?
- **Brain atlases as key tools in the FAIR data service**
  - What would geography be without atlases of the planet Earth?
  - What will future neuroscience be without tools for navigating the brain?

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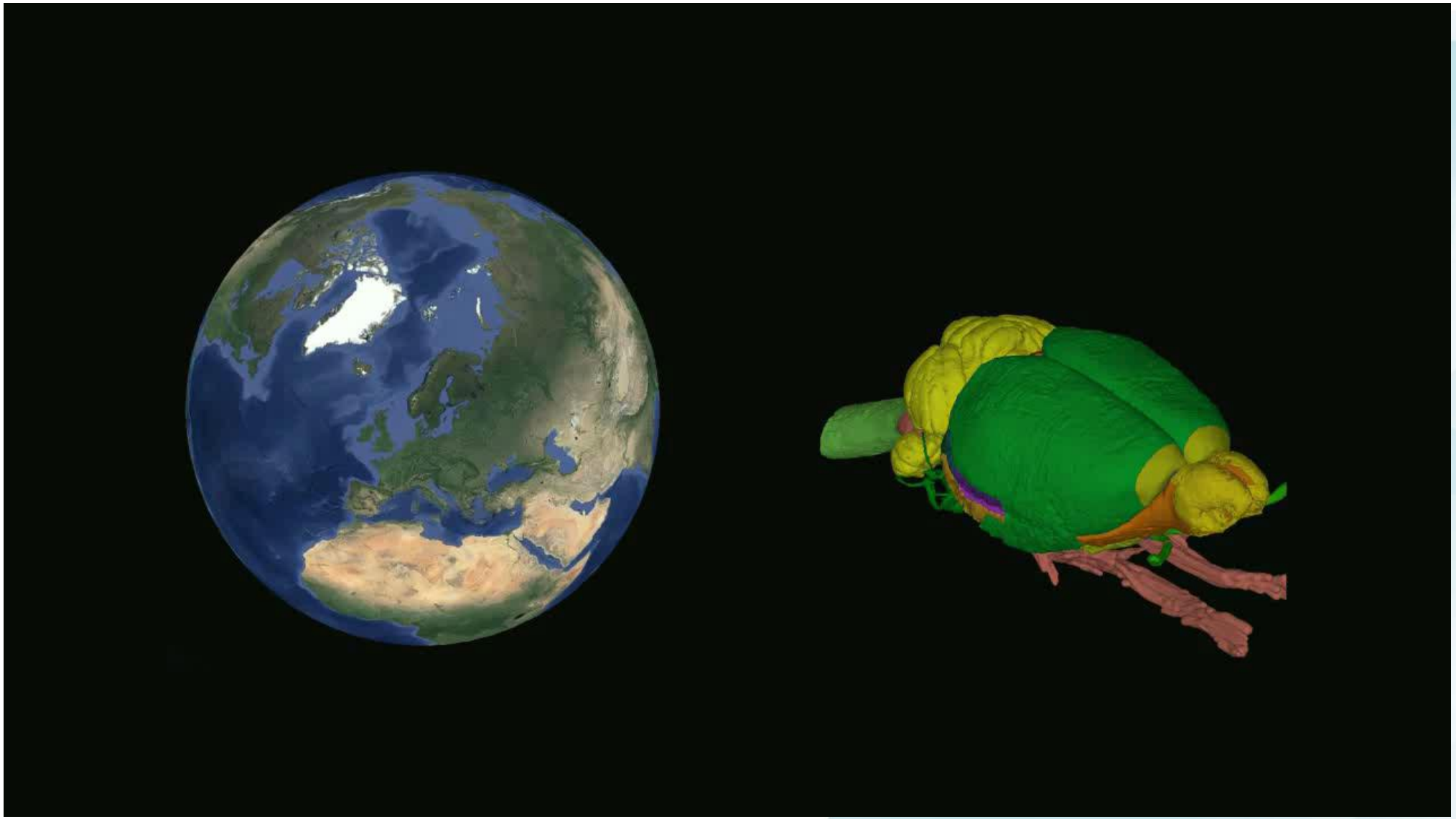
Atlas integration

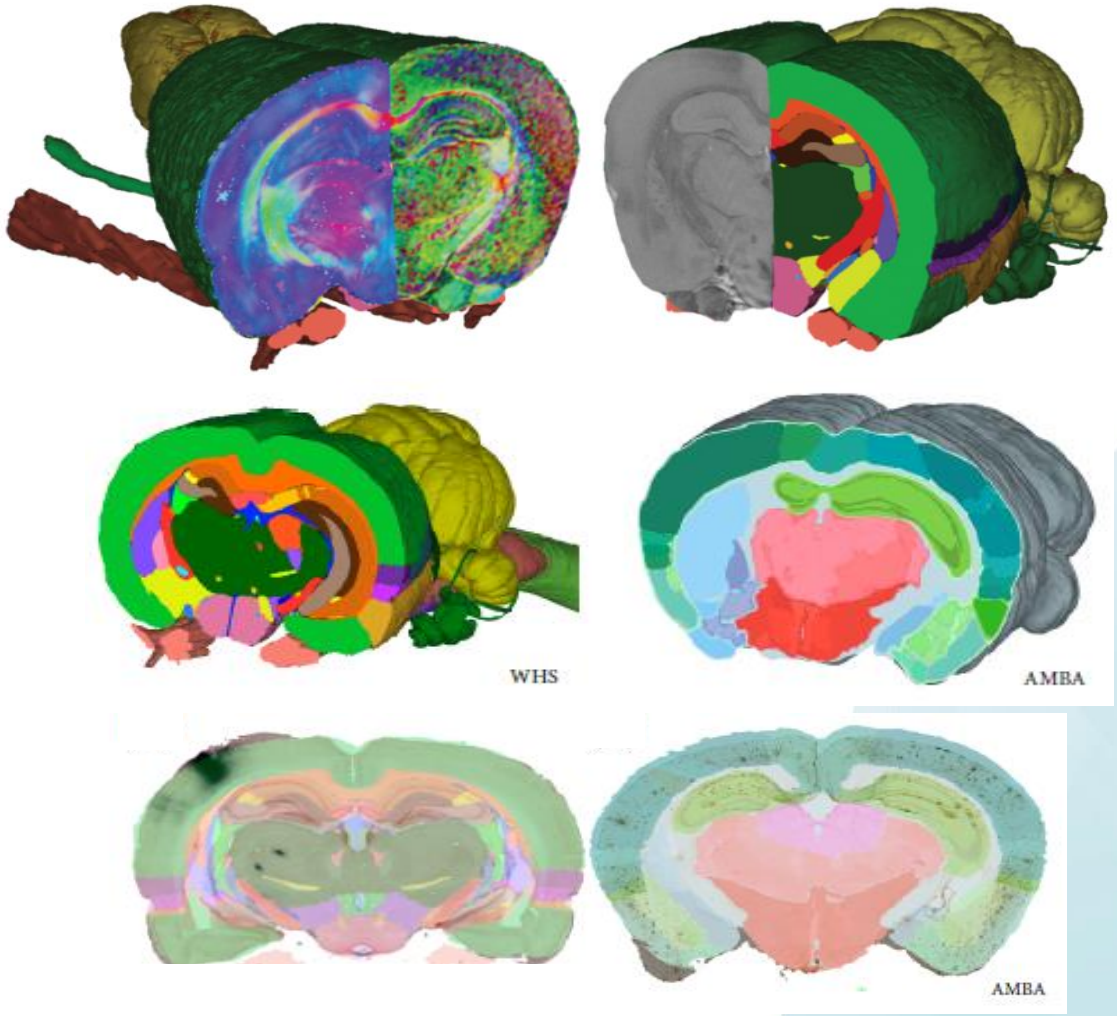
Tier 2 curation: Location in the brain

Co-funded by the European Union



Atlas integration

- 3D **reference atlases**
- **Tools** for viewing and registration
- **Curation service**

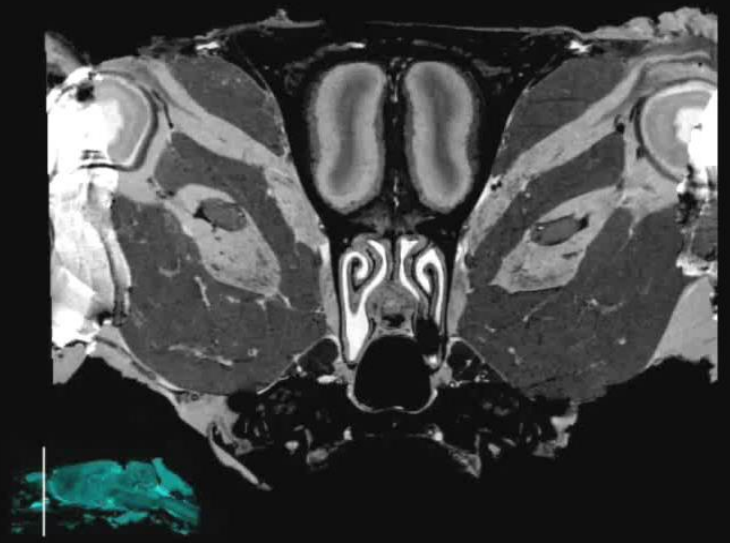


Co-funded by
the European Union

Atlas integration

- 3D **reference atlases**
- **Tools** for viewing and registration
- **Curation service**

YouTube video: Next generation rodent brain atlases
https://www.youtube.com/watch?v=d-FwWfdDR_8



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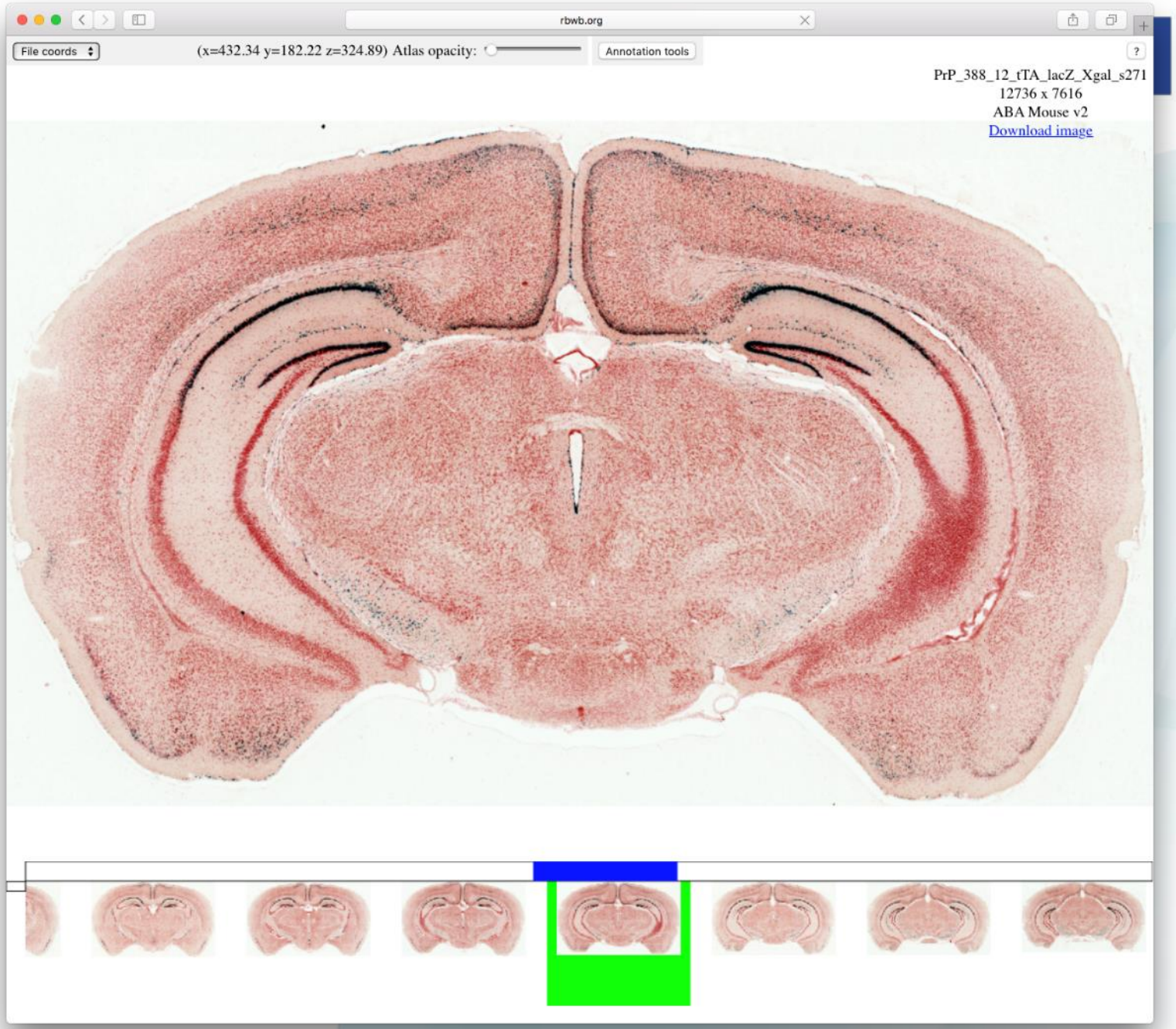
Interactive viewer for series of 2D images

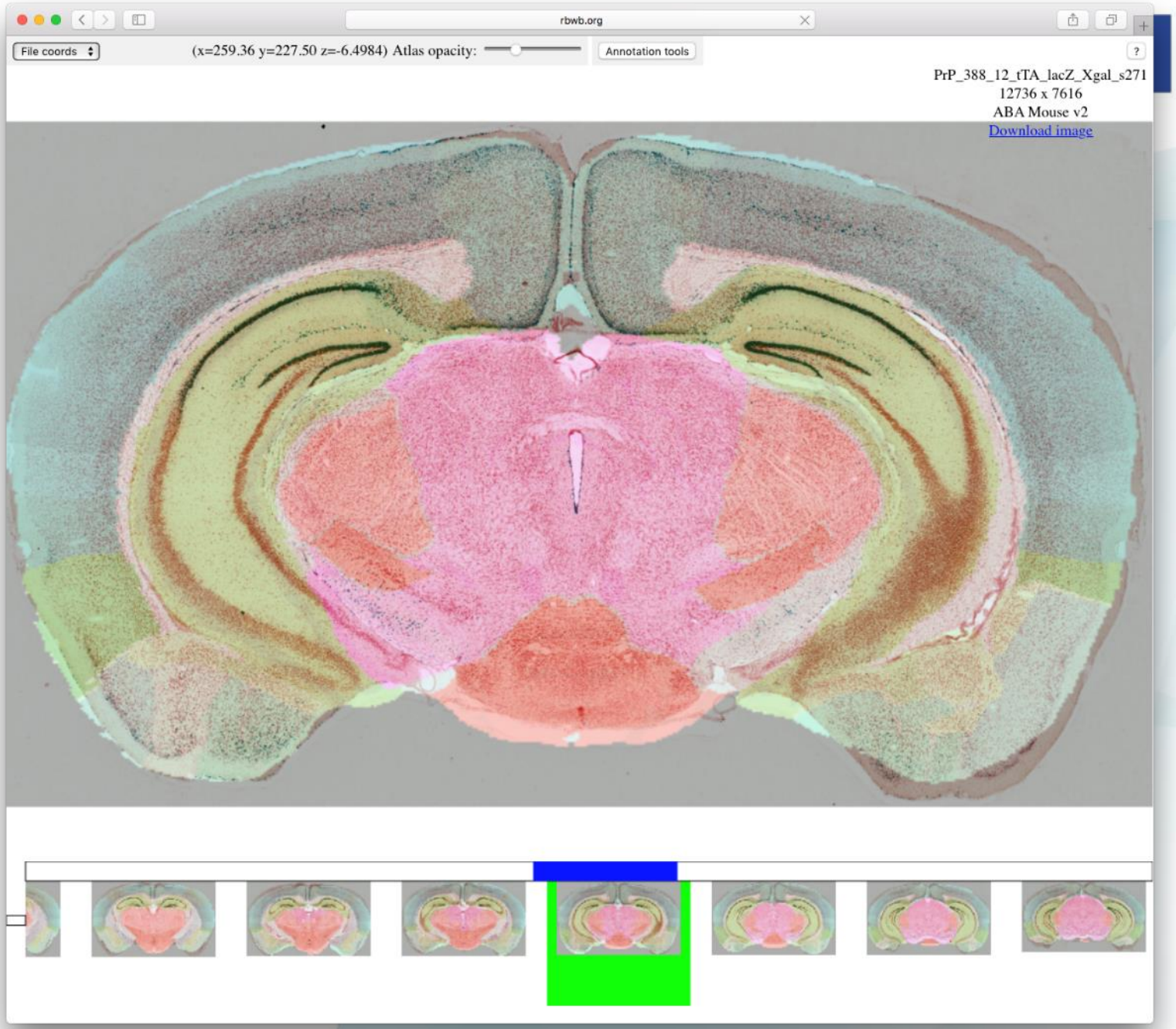


Human Brain Project

Viewer for series of 2D images

The spatial metadata allow viewing of images with overlay of the reference atlas

User chooses image, adjust level of transparancy of atlas overlay, and navigates the image



Human Brain Project

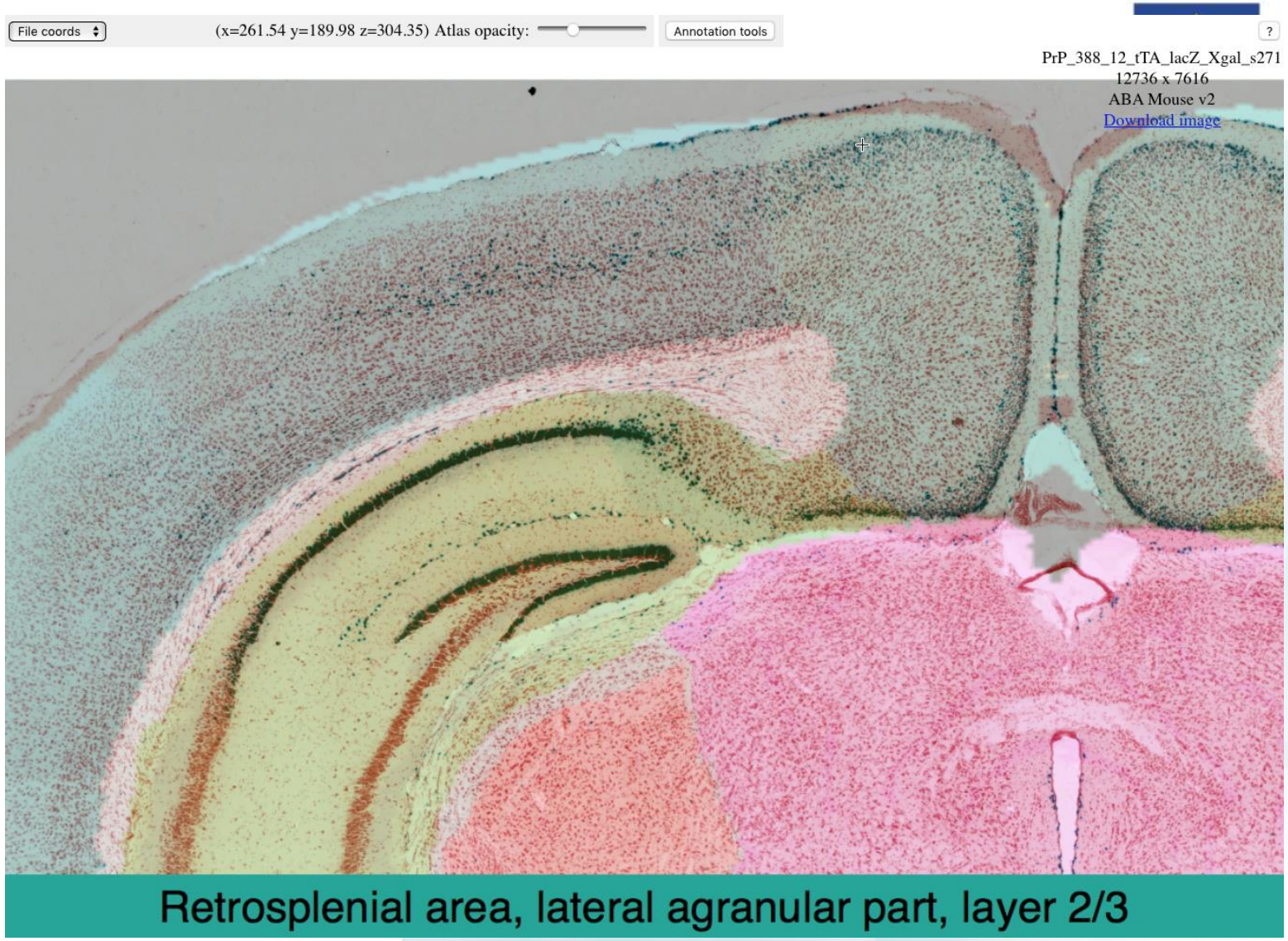
Viewer for series of 2D images

The spatial metadata allow viewing of images with overlay of the reference atlas

User chooses image, adjust level of transparancy of atlas overlay, and navigates the image

Reference atlas coordinates and structure names are available

Spatial information preserved: workflows for feature extraction



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Atlas integration

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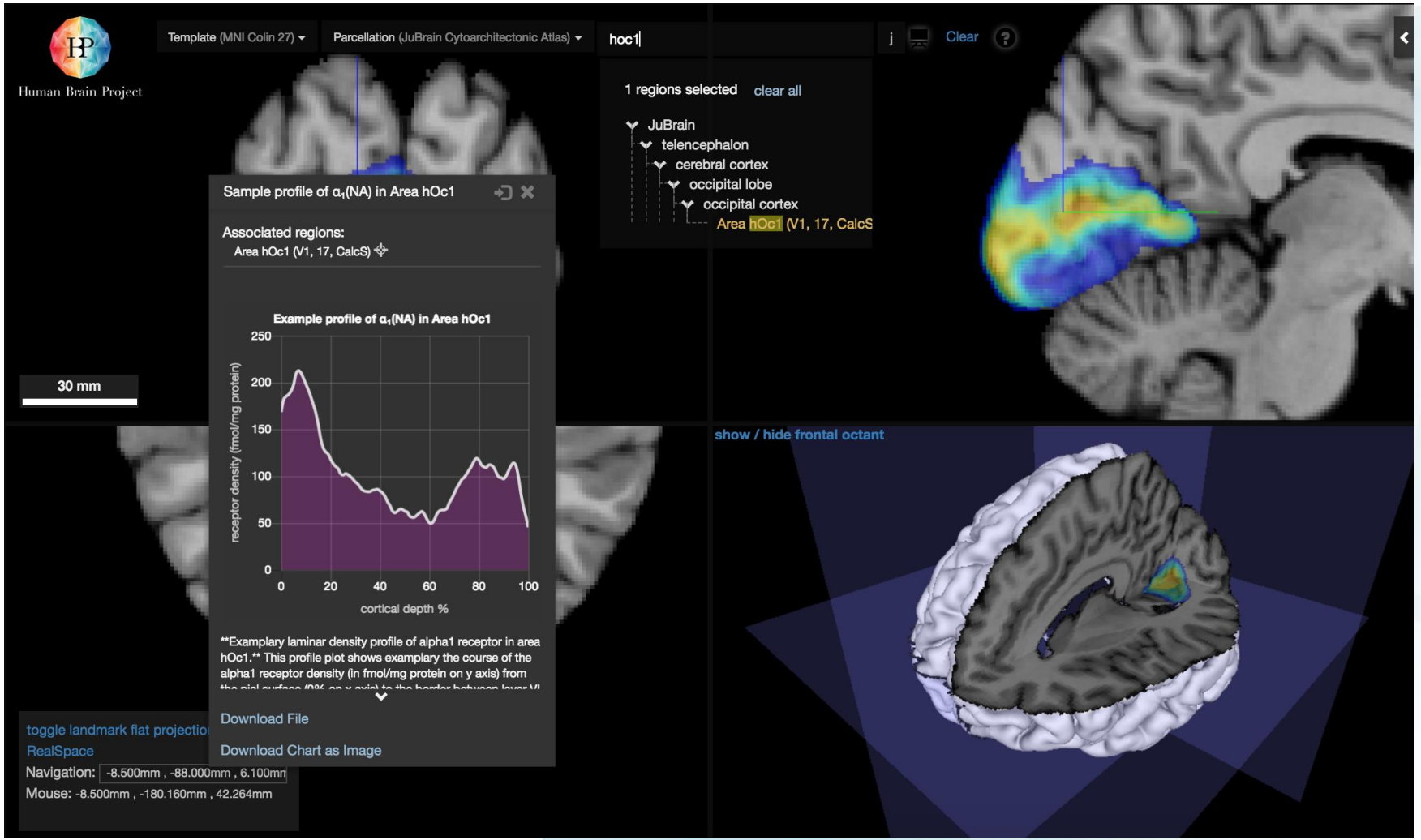
Receptor data linked to brain areas



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Atlas integration

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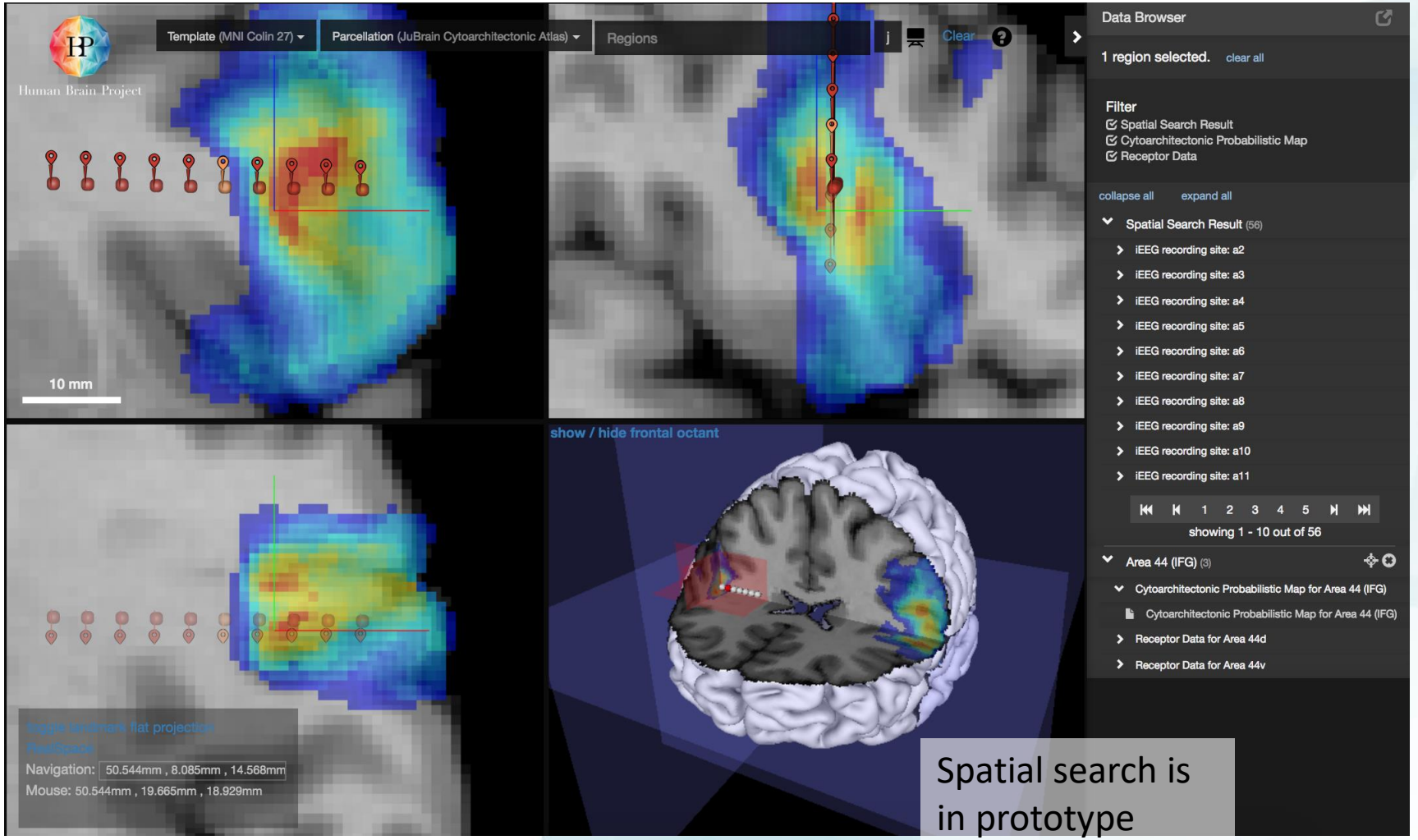
Find iEEG recordings by atlas coordinates



Spatial search is in prototype stage

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EBRAINS Service Categories

SC1: **FAIR data services**: Curated and shared data - neuroscience data publishing

SC2: **Brain atlas services**: navigate the brain in 3D - find, contribute and analyse brain data, based on location

SC3: **Brain modelling and simulation workflows**: integrated tools to create and investigate models of the brain

SC4: **Closed loop AI and robotics workflows**: design, test and implement robotic and AI solutions

SC5: **Medical brain activity data platform**: human intracerebral EEG database and analysis service

SC6: **Interactive workflows on HPC or NMC**: Europe-wide access to scalable and interactive compute services

EBRAINS Service Categories

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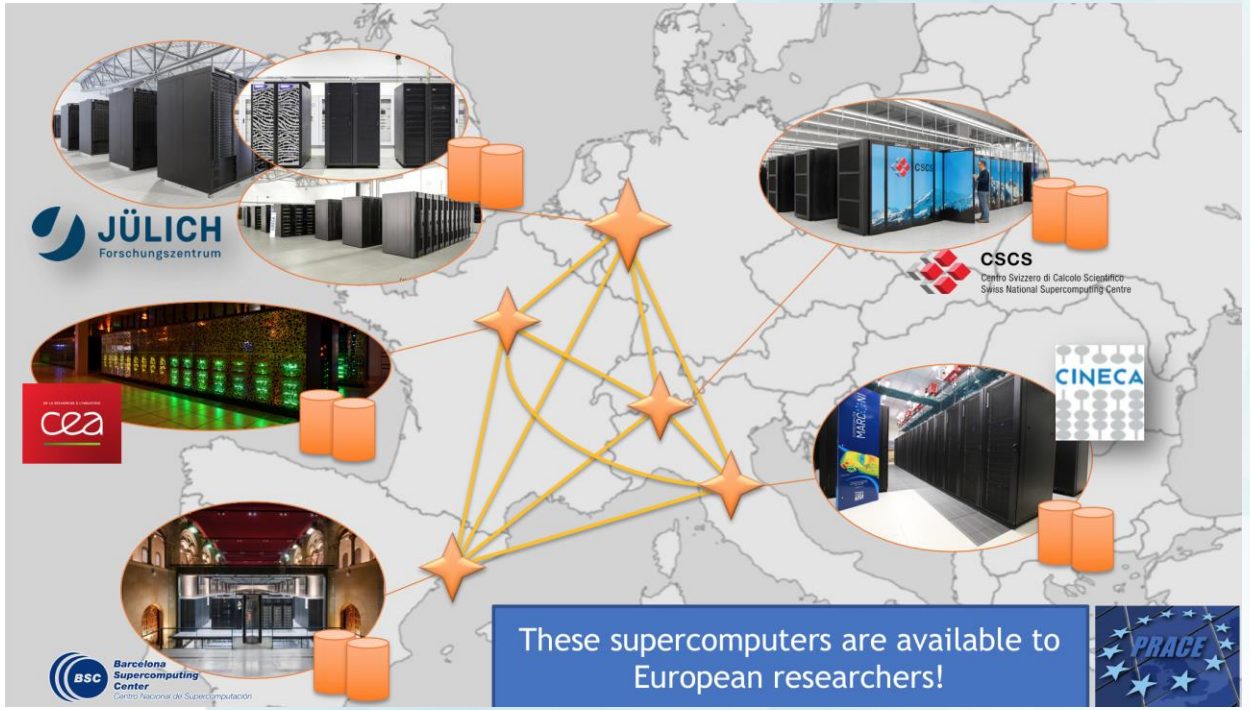
Interactive workflows on HPC or NMC: Europe-wide access to scalable and interactive compute services

- High-performance computing (HPC) has become an important aspect in neuroscience research
  - process and analyse high-resolution data sets
  - simulating large and complex neuronal network models analysing the simulation and/or experimentation results

- Neuromorphic Computing providing access to different kinds of specialized hardware systems, targeting aspects of the emulation of spiking network models difficult to approach by standard simulation methods



HBP Infrastructure Voucher Program

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- **Openness measure** to attract new groups/projects to the HBP IT infrastructure
- **Calls** to invite external researcher to submit ideas and request HBP engineering solutions
- **Target groups**: academic & clinical research, pharma and industry

February 2019: 15 Voucher Projects funded

HBP Partnering Projects

Co-funded by the European Union

- Currently 23 Partnering Projects contributing to the implementation of the HBP roadmap
- Primarily recruited through FLAG-ERA, a new funding mechanism gathering most regional and national funding organisations (NRFOs) in Europe with the goal of supporting the Future and Emerging Technologies (FET) Flagship concept and more specifically, the FET Flagship initiatives Graphene and Human Brain Project (HBP)

High-Level Support Team

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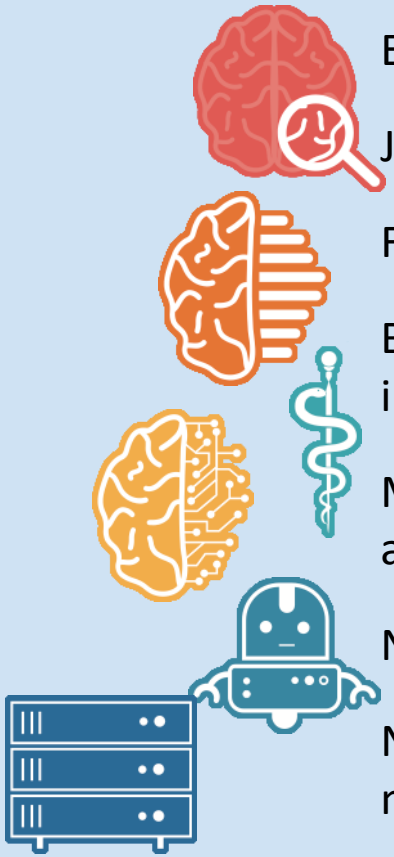
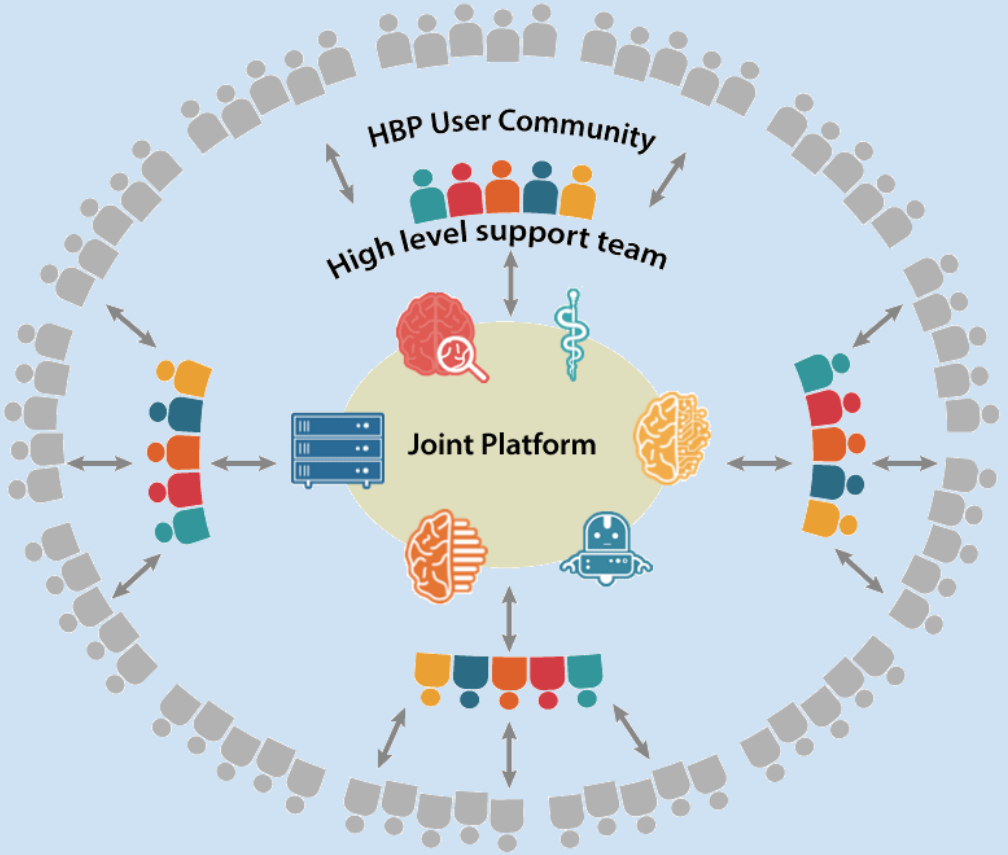


- Extended data curation support
- Jupyter notebook user support
- Functional data analysis workflow support
- Brain simulation functionality and deep integration support
- Medical informatics community management and deep integration support
- Neuromorphic computing advanced user support
- Neurorobotics documenter and community management
- Simulation and data analytics workflow support



Upcoming events

- EBRAINS Open Day, Heidelberg, November 25
- HBP Summit, Athens, February 2020
- Questions: support@ebrains.eu

Human Brain Project

Thank you

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