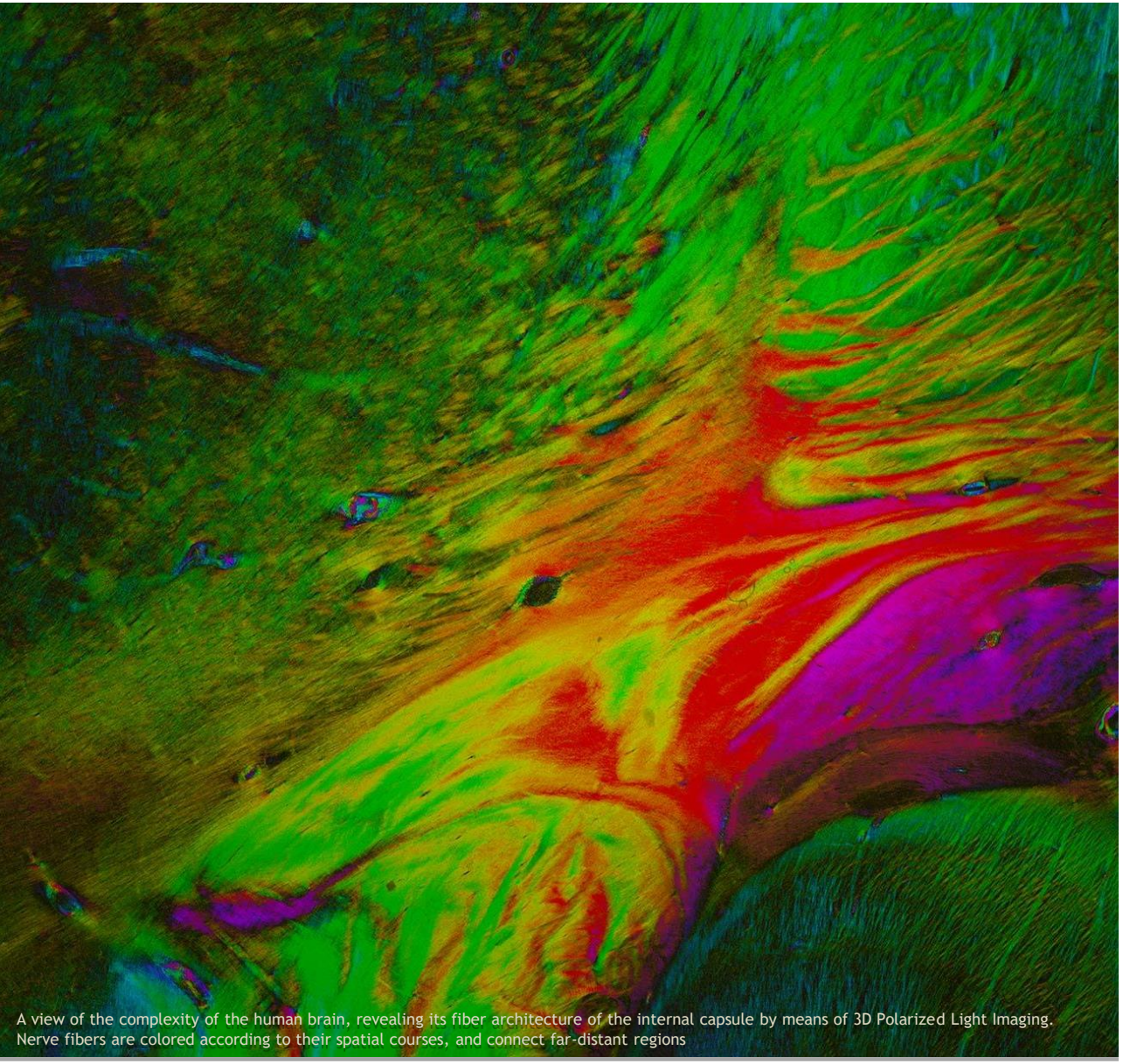
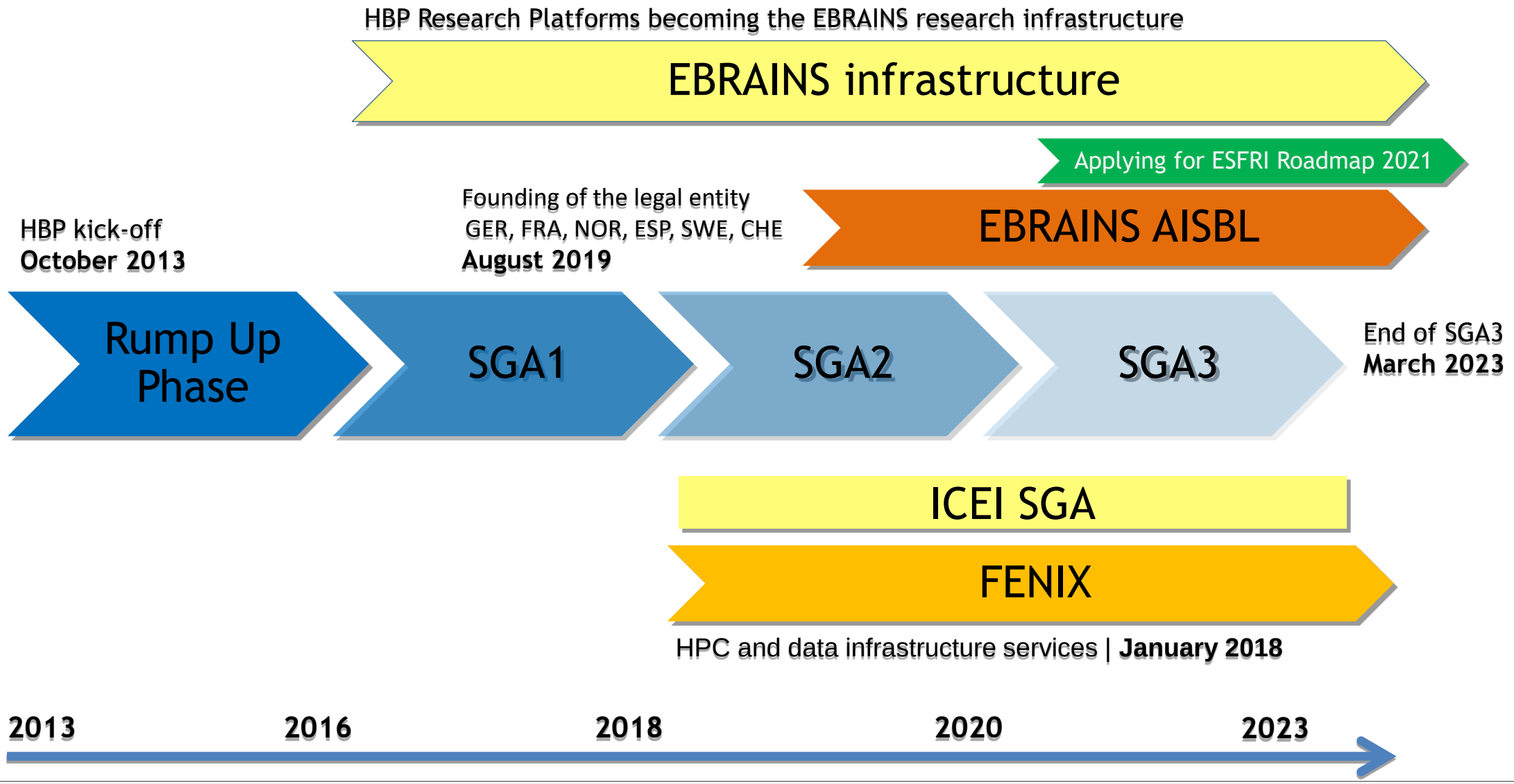


A view of the complexity of the human brain, revealing its fiber architecture of the internal capsule by means of 3D Polarized Light Imaging. Nerve fibers are colored according to their spatial courses, and connect far-distant regions

The Human Brain Project

Katrin Amunts
Chair of the Science and Infrastructure Board
Scientific Research Director

Human Brain Project Timeline



Research Strategy

Scientific focus in SGA3: **Decoding Brain Connectivity**

- The human multiscale brain connectome and its variability (WP1)
- Networks for cognition and consciousness (WP2)
- Networks for adaptive architectures of cognitive functions (WP3)

Science WPs 1-3: driven by research, they co-design the infrastructure, test it and benefit from its development

Research infrastructure WP 4-6: implement tools, integrate data, provide it to users through 6 *Service Categories* and learn from their experience (*High-Level Support Team*)

Our approach: **Building and providing access to EBRAINS (WP4-6)**

Lead Scientist Voucher Programme

Concept: attract lead scientist and invite them to set up a collaborative project with the HBP

Total budget: EUR 1.25 Mio (250.000EUR / project)

- **Jean-Pierre Changeux**, Collège de France and Institut Pasteur: *Allosteric Modulation of pentameric ligand-gated ion channels: relevance to COVID-19 (M7-M36)*
- **Stanislas Dehaene**, Inserm-CEA Cognitive Neuroimaging Unit: *Singularity of the human brain (M7-M36)*
- **Karl Friston**, University College London: *Dysconnection syndromes and dynamic causal modelling (M10-M34)*
- **Talma Hendler**, Tel Aviv University: *Multi-scale Neural Depiction of Learning from Failure in Humans (M7-M36)*

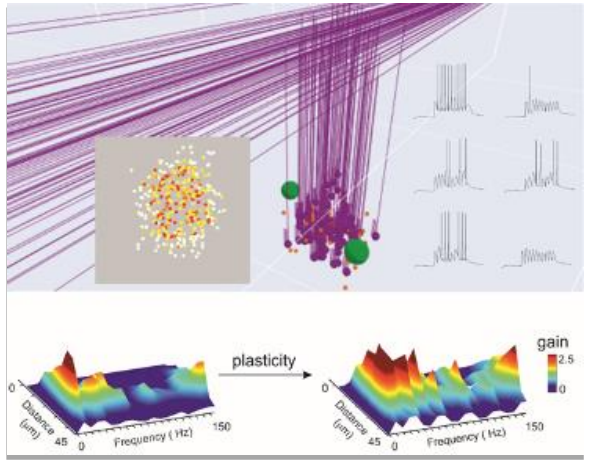



- ➢ Projects have been integrated in the work plan (SGA3 Amendment1)
- ➢ The search for a 5th candidate is in the very final stage.

Success stories: Science

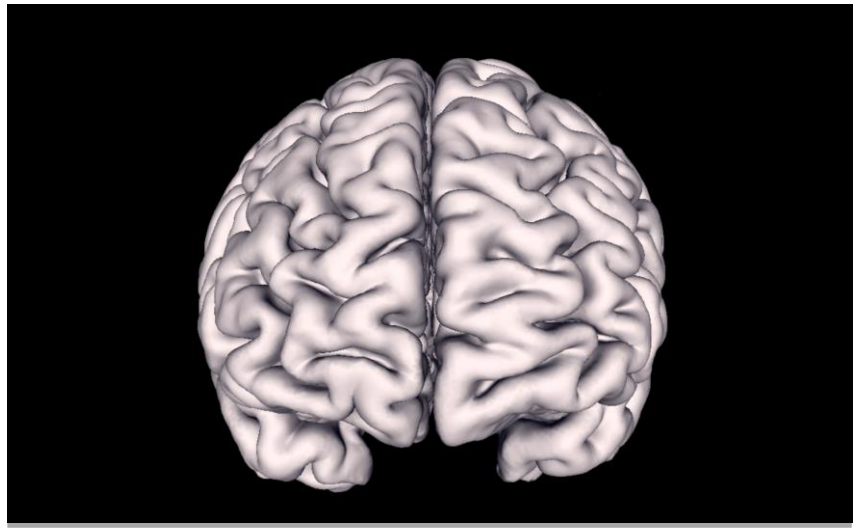
Computational modeling predicts the basis of local computation in brain microcircuits:

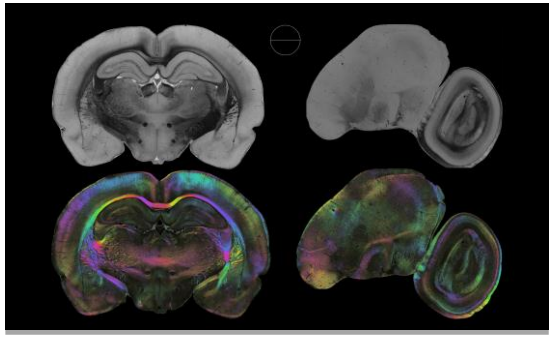
In «Nature Communications Biology», the team at the Neurophysiology Laboratory of the University of Pavia has revealed how the microcircuit of the cerebellum transforms internal signals implementing *de facto* computational algorithms that can be modified through learning.



A centerpiece of EBRAINS' human brain atlas is presented in "Science"

"Julich-Brain" is the name of the first 3D-atlas of the human brain that reflects the variability of the brain's structure with microscopic resolution



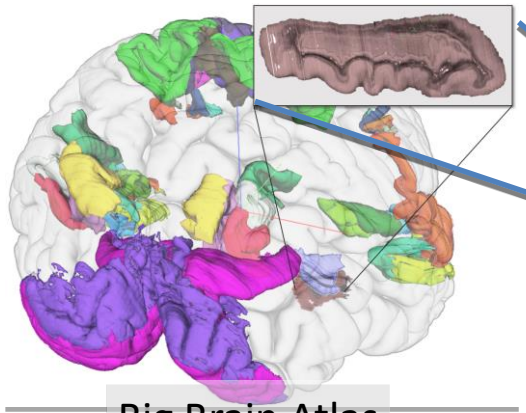


EBRAINS-powered study reveals unknown complexity in avian brains

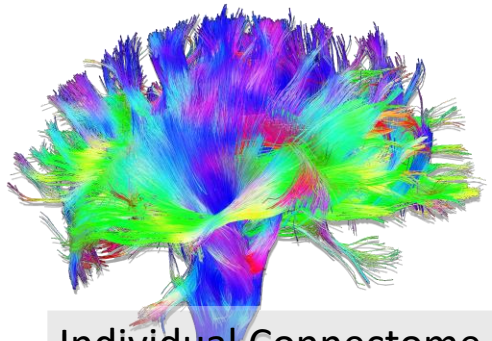
An innovative microscopy method shows surprising similarities between mammals and birds was published in "Science"

Success stories: Science

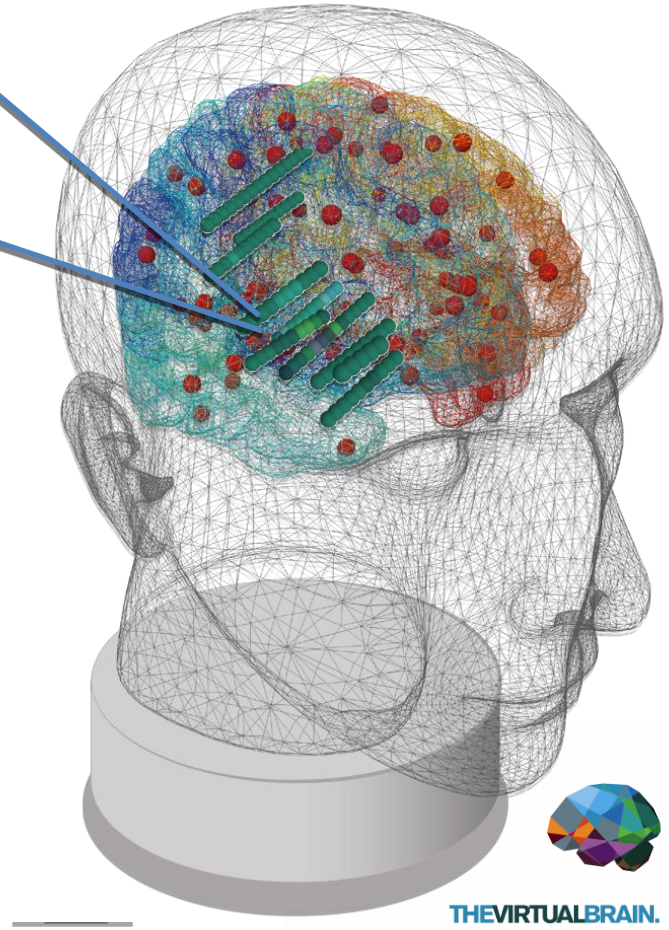
From mathematical descriptions, neuroimaging experiments and atlas data to personalized brain models



Big Brain Atlas



Individual Connectome

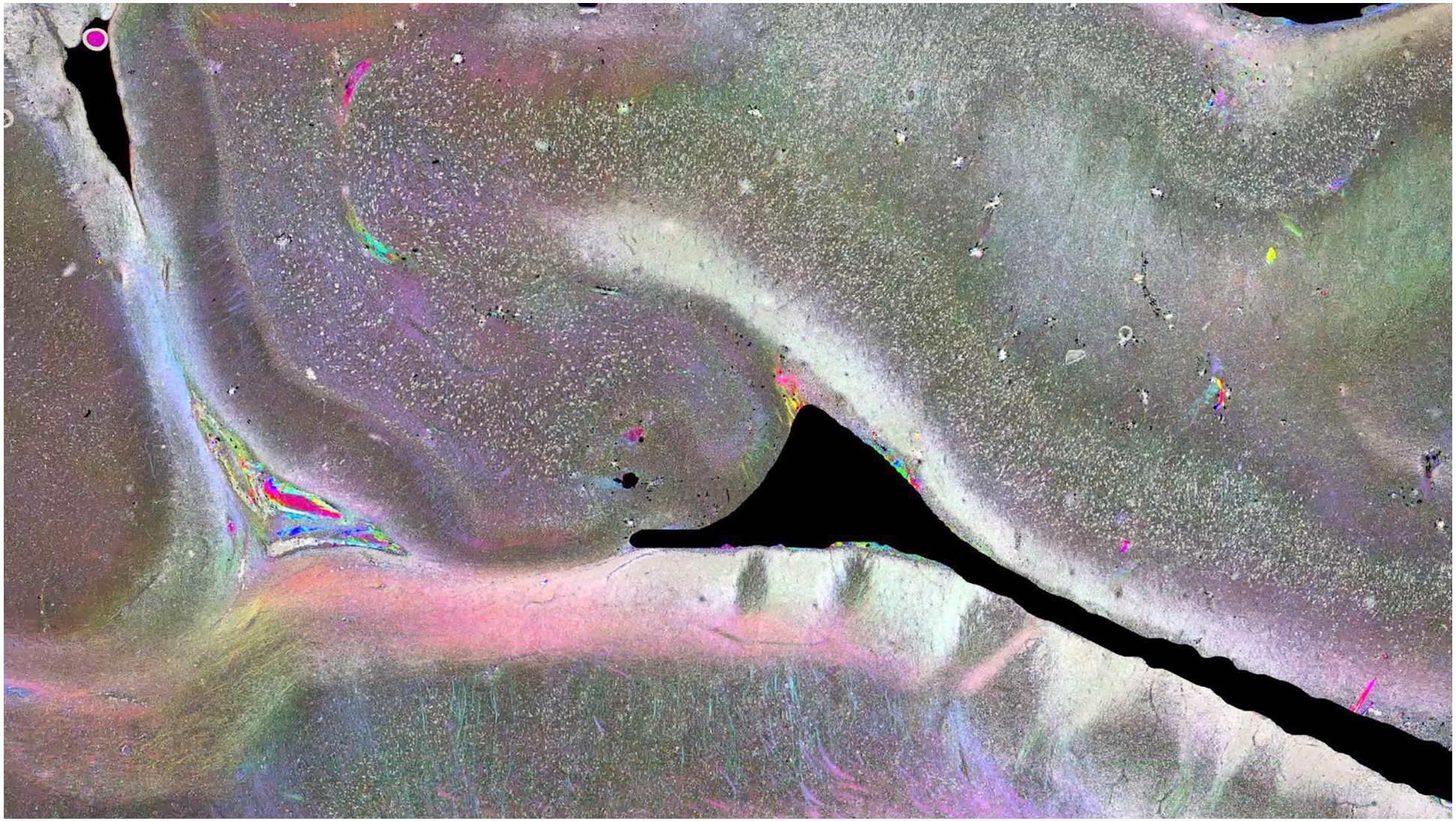


functional MRI

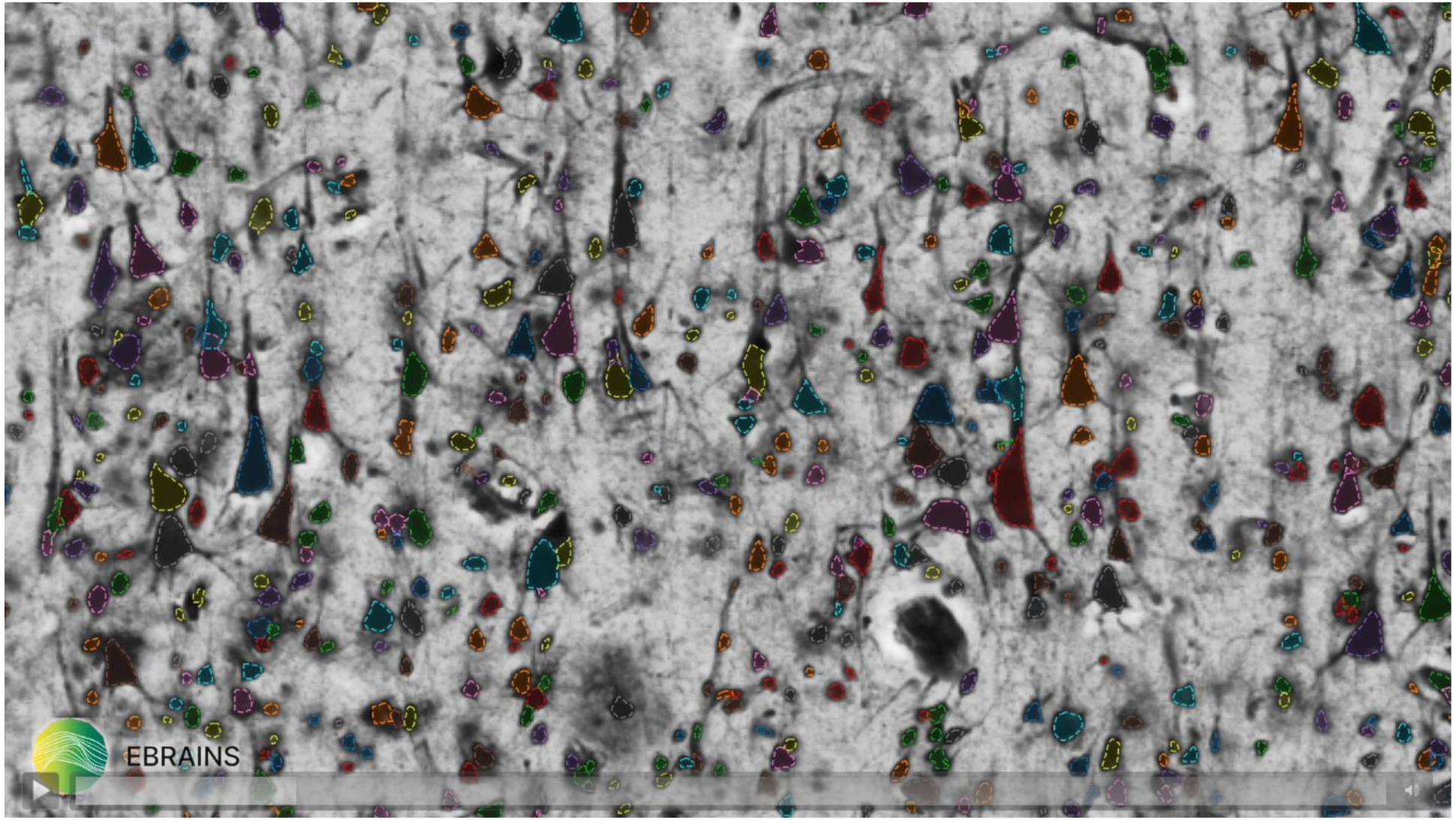
stereotactic EEG

First clinical trial started in FRANCE

Success stories : Bridging the Scales

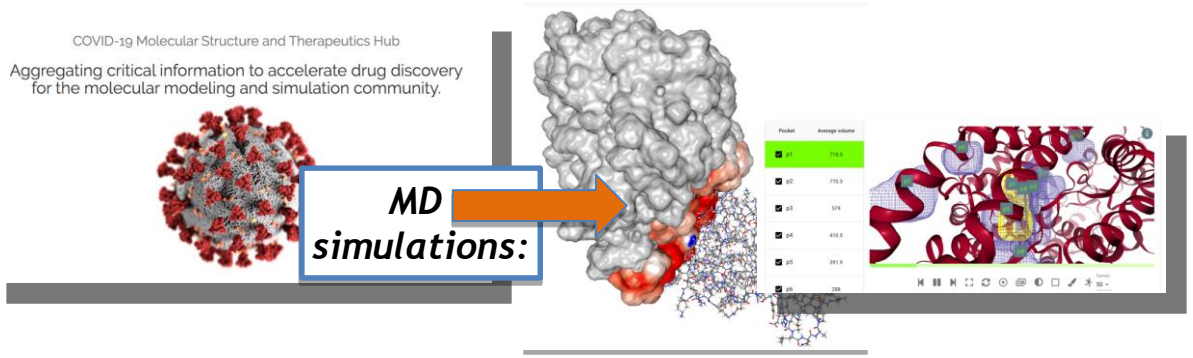


Success stories : The Human Brain Atlas



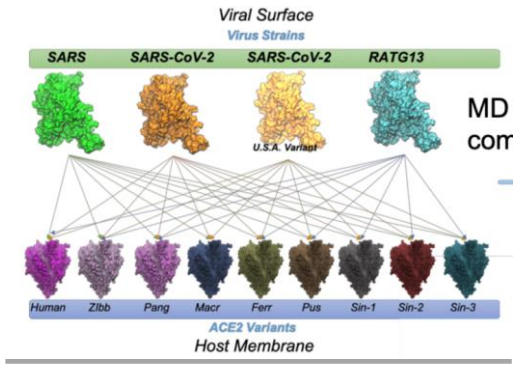
Status SGA3: Fostering SARS-CoV-2 Research

HBP* collaborating with *BioExcel



BioExcel simulation workflows

Big Data Study:
ICEI/FENIX
computational power
Massive amount of data



Composability of services:
- HPC resources
- Long-term storage & data sharing
- Cloud services (e.g. VMs)

Federation across large European HPC centers

Scientific co-design by key users in different disciplines

Key players in the field talking about FENIX:

„… **Fenix** is a distributed e-infrastructure providing different types of compute and storage resources. It is being used by several different projects performing COVID-19 related research. Some of them are using the HPC resources for simulations. The infrastructure is also being used for sharing data through a publicly accessible object store.“ Amaro and Mulholland, "Computing in Science and Eng. 22(6), 2020

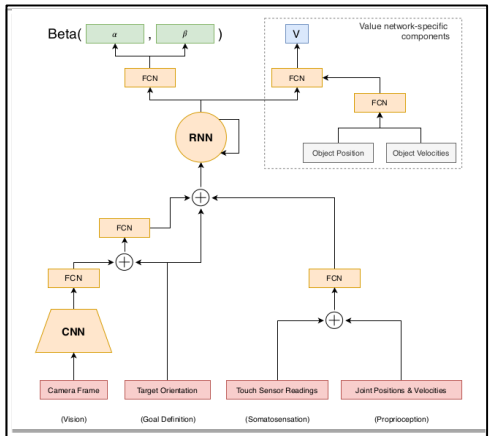
Status SGA3: Showcases (reviewed in I/2021)

To demonstrate progress in SGA3 @ Months 9 and to empower EBRAINS

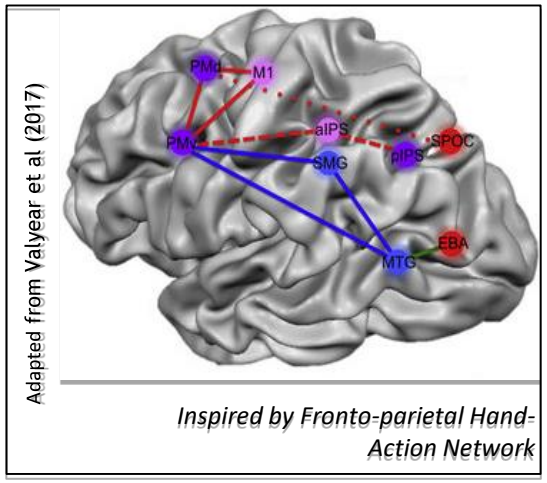
	Title	Description
WP1	Showcase 1. Degeneracy in neuroscience - when is Big Data big enough?	Early prototype software interface with atlas services based on initial versions of data models including DEMO1 of Showcases 1 and 2
WP1	Showcase 2. Improving epilepsy surgery with the Virtual BigBrain	
WP2	Showcase 3.Brain Complexity and consciousness	Proof of concept demos of large scale, full brain simulation corresponding to (Showcase 3) different brain states and consciousness levels and (Showcase 4) robot demonstration and simulation of object and scene recognition
WP2	Showcase 4. Object perception and memory	
WP3	Showcase 5. Dextrous manipulation - how the brain coordinates hand movements	Proof of Concept, performing human-like digit configurations by robotic hand

Showcase 5: In-hand dexterous manipulation

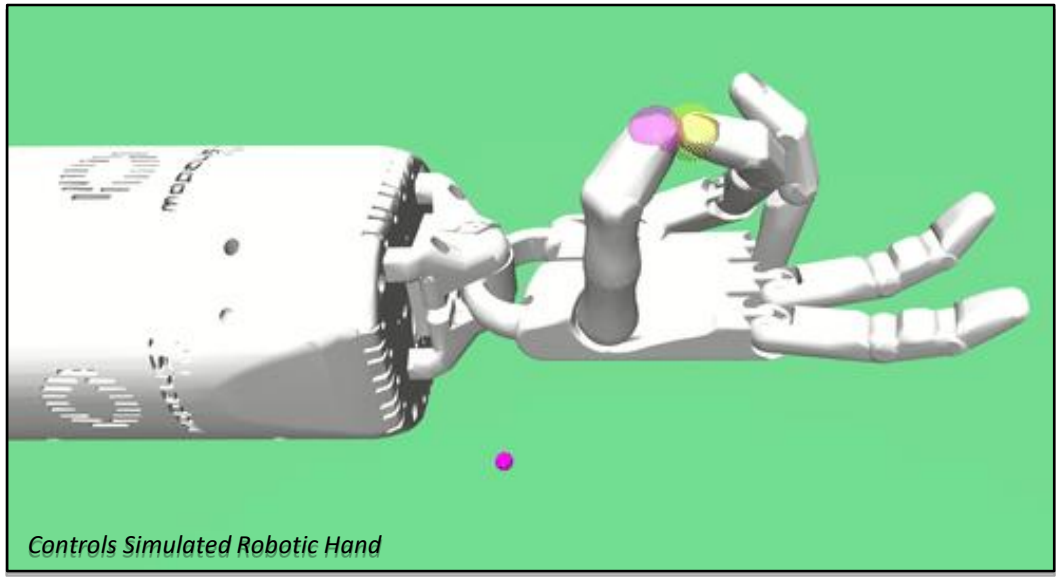
- **Objective**: developing neuro-inspired artificial network architecture capable of performing in-hand object manipulation with a robotic hand.
- **Relevance for brain science**: better understanding the fronto-parietal network involved in control of arm and hand movements.
- **Only on EBRAINS**: training on Fenix HPC, embodiment & simulation with EBRAINS Simulation services, models to be constrained with EBRAINS Data and Atlas services.
- **Applications:** Computational & cognitive neuroscience, modules & services w/ relevance to robotics, unmanned systems, automation & AI, intelligent logistics, Quality Control, Industry 4.0, circular economy.



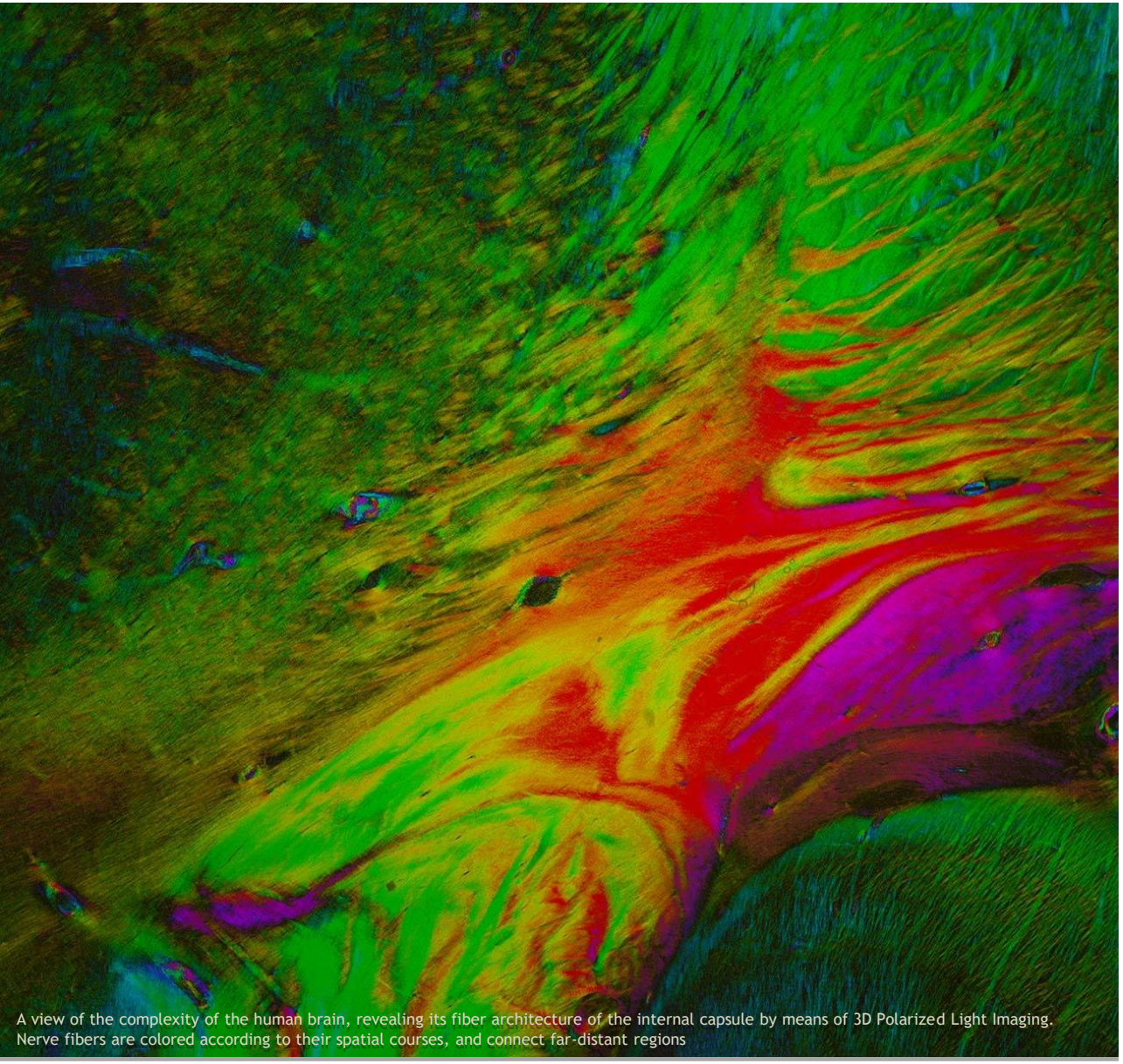
Deep Recurrent Neural Network



Inspired by Fronto-parietal Hand-Action Network



Controls Simulated Robotic Hand



A view of the complexity of the human brain, revealing its fiber architecture of the internal capsule by means of 3D Polarized Light Imaging. Nerve fibers are colored according to their spatial courses, and connect far-distant regions

EBRAINS

Paweł Świeboda
CEO EBRAINS AISBL
Director General, Human Brain Project

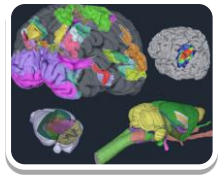
What EBRAINS brings to the scientific community

EBRAINS aims at **accelerating collaborative brain research** with a comprehensive package of data, tools and facilities.

EBRAINS is capitalizing on the HBP tremendous efforts performed throughout the Flagship era

Data and Knowledge

- Online solutions to facilitate sharing of and access to research data, computational models and software

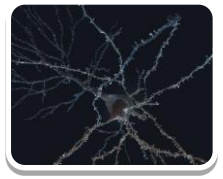


Atlases

- Navigate, characterise and analyse information on the basis of anatomical location

Simulation

- Solutions for brain researchers to conduct sustainable simulation studies and share their results



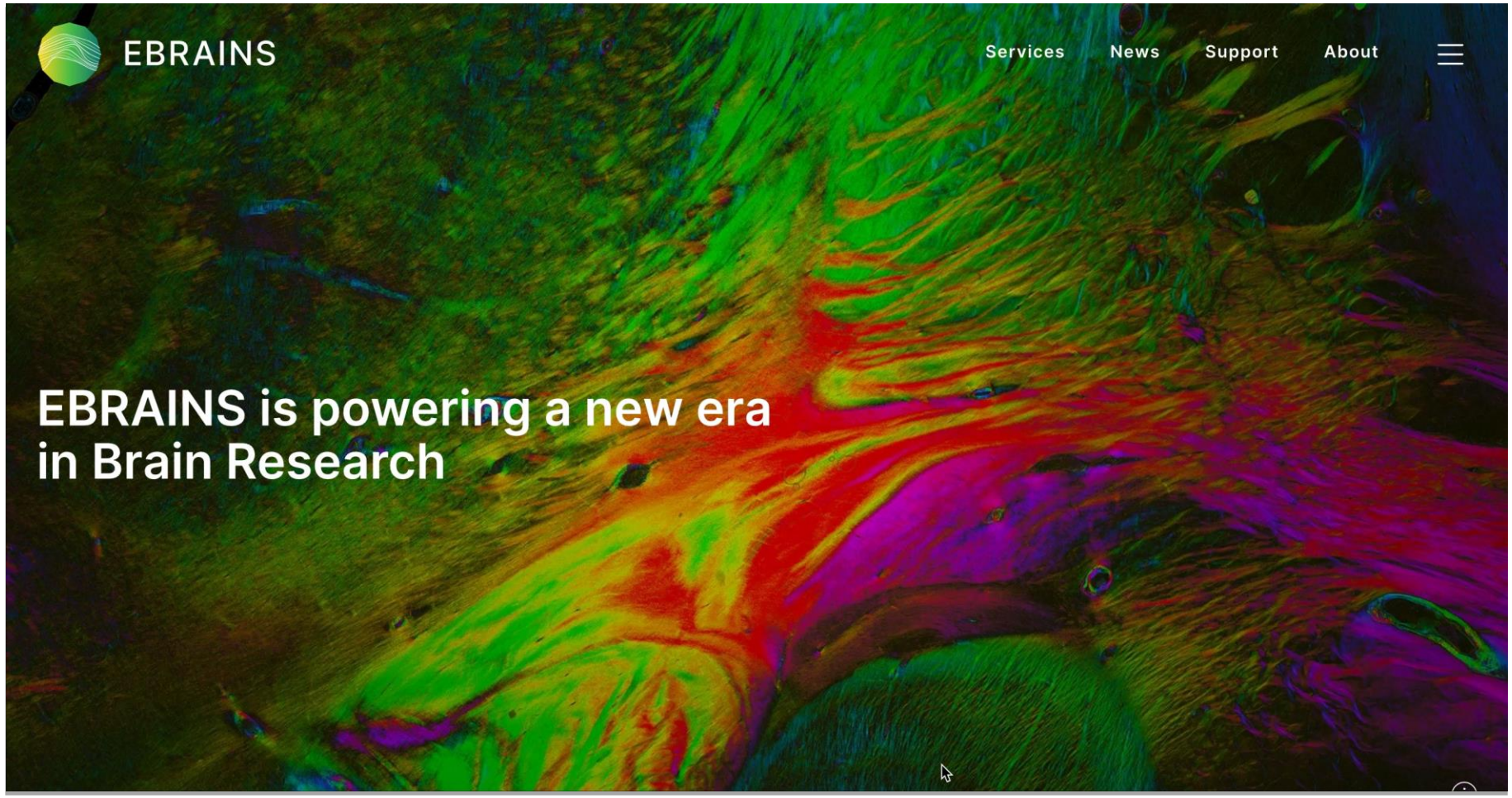
Brain-Inspired Technologies

- Understand and leverage the computational capabilities of spiking neural networks

Medical Data Analytics

- The Medical Data Analytics service provides two unique EBRAINS platforms, covering key areas in clinical neuroscience research

A user-friendly portal to access services



www.ebrains.eu

EBRAINS strives for inclusivity and co-creation

EBRAINS Community:

- Lasting
- Large
- Diverse
- Highly collaborative

The EBRAINS Community will build bridges between the technical users of the RI services.

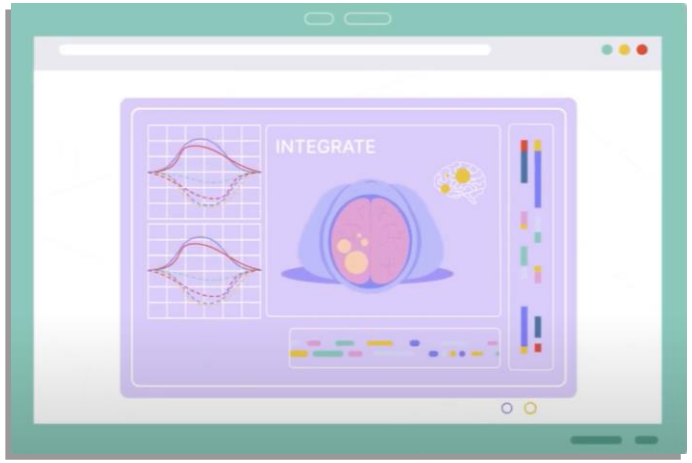
EBRAINS will foster collaboration across disciplinary and professional practices, institutes, nations, stakeholders, funders, policymakers and societal actors, in order to expand the scale of use of the RI.

The co-design of EBRAINS is an integral aspect of the responsibility by design approach pioneered by EBRAINS, which can serve as an example for other infrastructures and research fields.

Actively engaging into multidisciplinary collaborations

The SGA3 Calls for Expression of Interest (CEOIs) aim to directly contribute to the development of the research Infrastructure (EBRAINS) and increase the scope of its application in terms of innovation, neuroscience and clinical research.

Call Name	Opening	Closing
Brain atlas and simulation engine adapter construction	5 August 2020	26 October 2020
Application of functional architectures supporting advanced cognitive functions to address AI and automation problems of industrial and commercial relevance	5 August 2020	26 October 2020
High-level neuro-symbolic processing for guidance of goal-directed behaviour	5 August 2020	26 October 2020
Engagement of Industry, SMEs and start-ups	5 August 2020	26 October 2020
EBRAINS Research Infrastructure Voucher Programme Call 2020	18 September 2020	30 November 2020

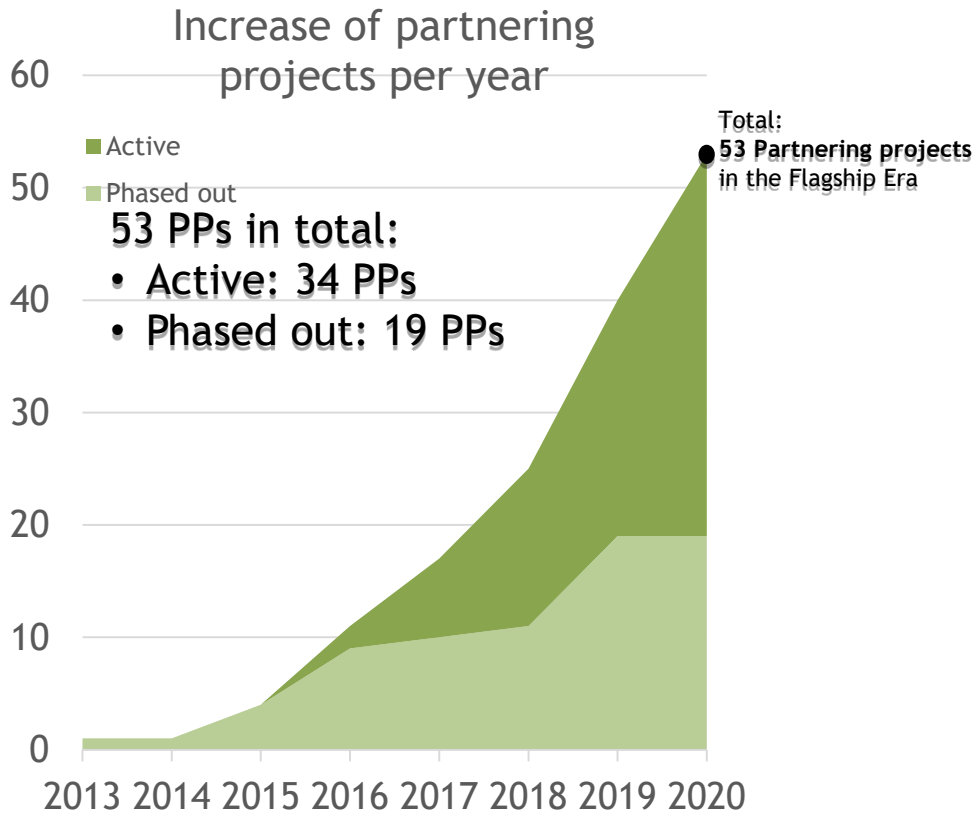


Partnering for growth

The goal of the Partnering Environment is to increase the number of consortia and organisations with formal collaboration agreements with HBP/EBRAINS, either as Partnering Projects (PPs), or under new legal instruments.

- International Relationships
  The HBP consortium's efforts in the International Coordination Working Group are actively supported, developing concrete international collaborations.

- Strategic Alliances
  The HBP scientific leadership will be assisted to turn personal relationships and shared interests with fellow EU brain research institutions into active alliances and collaborations.



Origin of 53 PPs:
- Flag-Era: 20
- Spontaneous application:
  - 13 National
  - 5 EU
- Voucher: 15

Total Budget: 71 million €
- Active: 56.88 million €
- Phased out: 14.13 million €

EBRAINS AISBL: Central Hub @ Belgium

EBRAINS is an AISBL (Association Internationale Sans But Lucratif) under Belgian Law.

Our mission is to

- **coordinate the Human Brain Project** *(HBP) in SGA3* (2020 - 2023)
- foster **close coordination with Science and participating countries**
- **build the future of the EBRAINS Research Infrastructure beyond 2023**

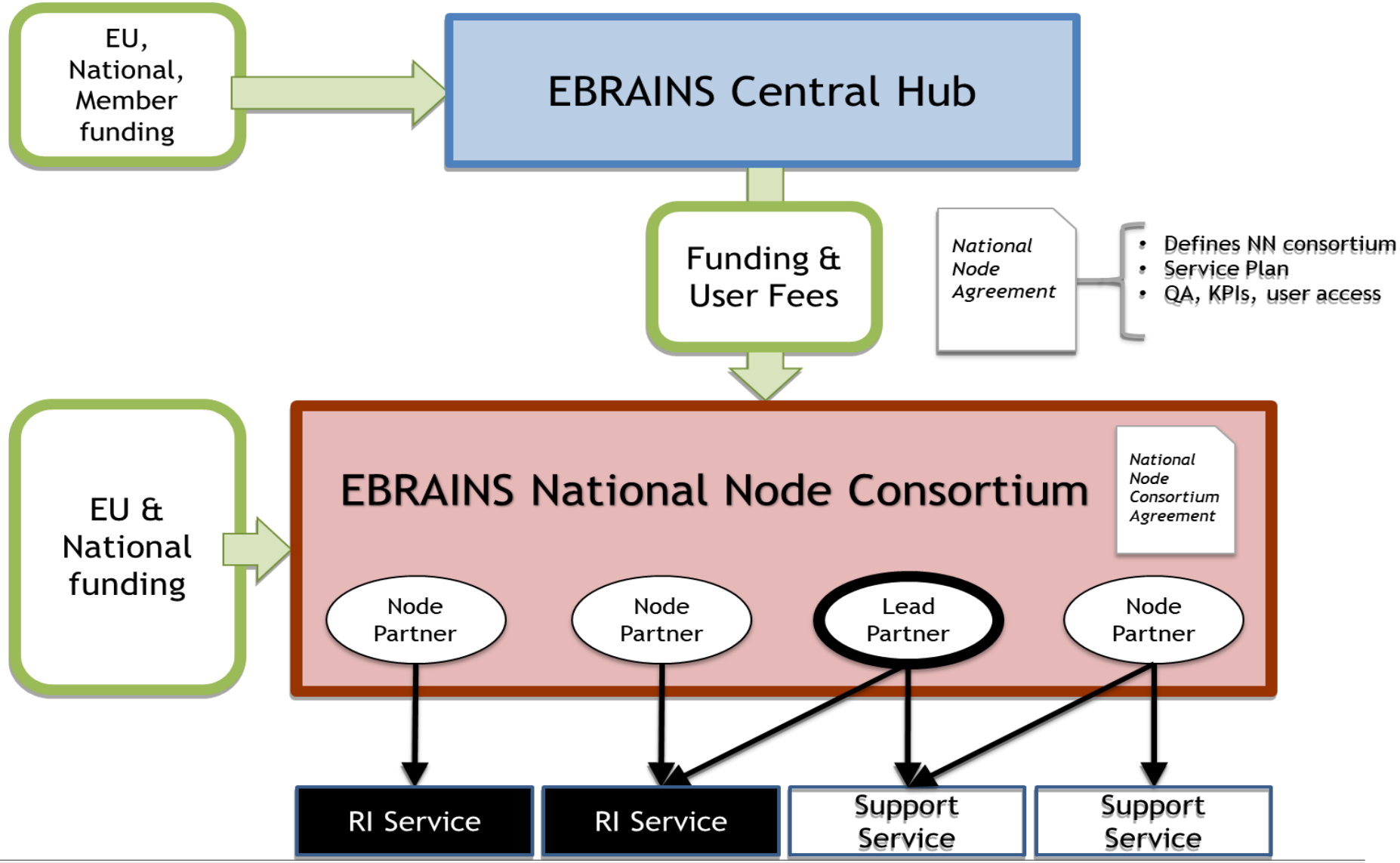
By joining the EBRAINS AISBL, ***members get the opportunity to participate in the co-development of the research infrastructure and be involved in the co-shaping of our future service offering***.

Our current members:

- Commissariat à l'énergie atomique et aux énergies alternatives (France)
- Forschungszentrum Jülich (Germany)
- the Consiglio Nazionale delle Ricerche (Italy)
- the Universitetet i Oslo (Norway)
- the Universidad Politécnica de Madrid (Spain)
- the Kungliga Tekniska Högskolan (Sweden)
- the Ecole Polytechnique Fédérale de Lausanne (Switzerland).

Geographically distributed, albeit unified structure

EBRAINS aims to be truly pan-European, and to integrate "best-in-class" resources, creating synergy and building upon scientific developments nationally.



An integrated transparent governance structure

- EBRAINS governance is currently being implemented
- Close collaboration between EBRAINS Governance and HBP Governance (SB - BoD ; DIR – MB ; SIB – MB…)
- Advisory role is currently provided by HBP Advisory Board and will be independent by the end of SGA3

Learning from others, an on-going exercise:

The governance of 13 RIs on the ESFRI Research Infrastructures list has been benchmarked

The importance of ESFRI inclusion

Seeking recognition as part of the ESFRI Roadmap is an important milestone in transitioning to an enduring, sustainable European research infrastructure beyond 2023, **making EBRAINS a permanent part of the European science landscape.**

ESFRI Roadmap 2021: building up support

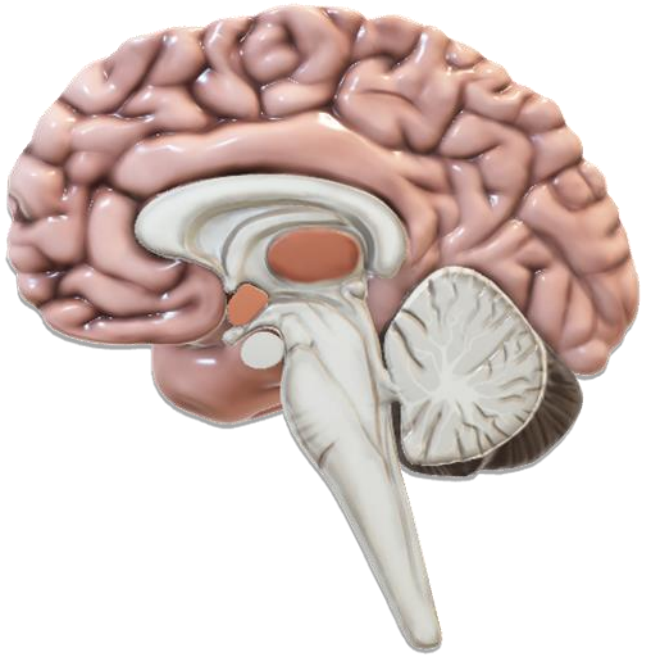
EBRAINS officially submitted the application in September 2020.

France is the Lead Country + support of **9 additional countries** and more getting engaged.

Strengthened with **94 letters of support** from institutions across Europe.

Application confirmed as eligible by the EC in November 2020.

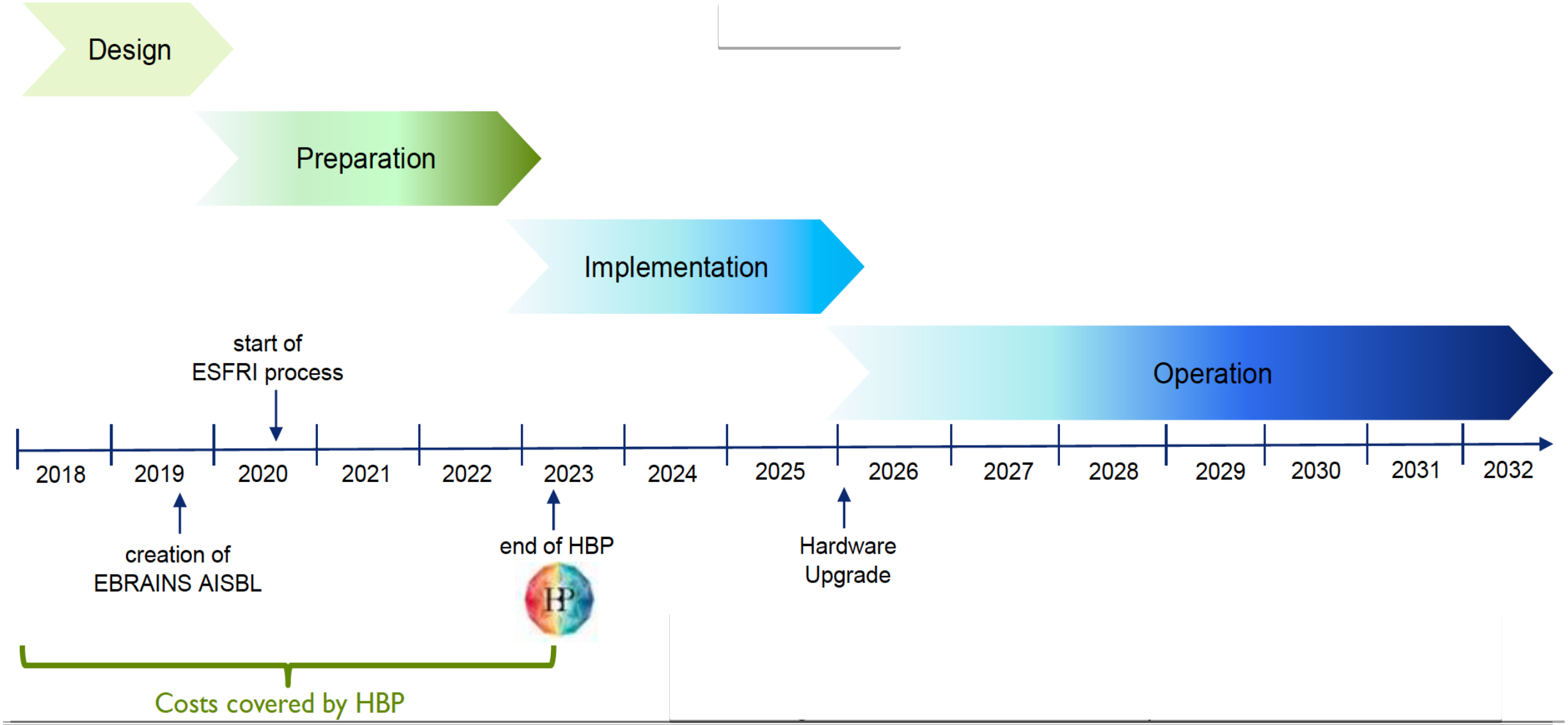
EBRAINS is now preparing and looking forward to the hearing in **April-May 2021.**

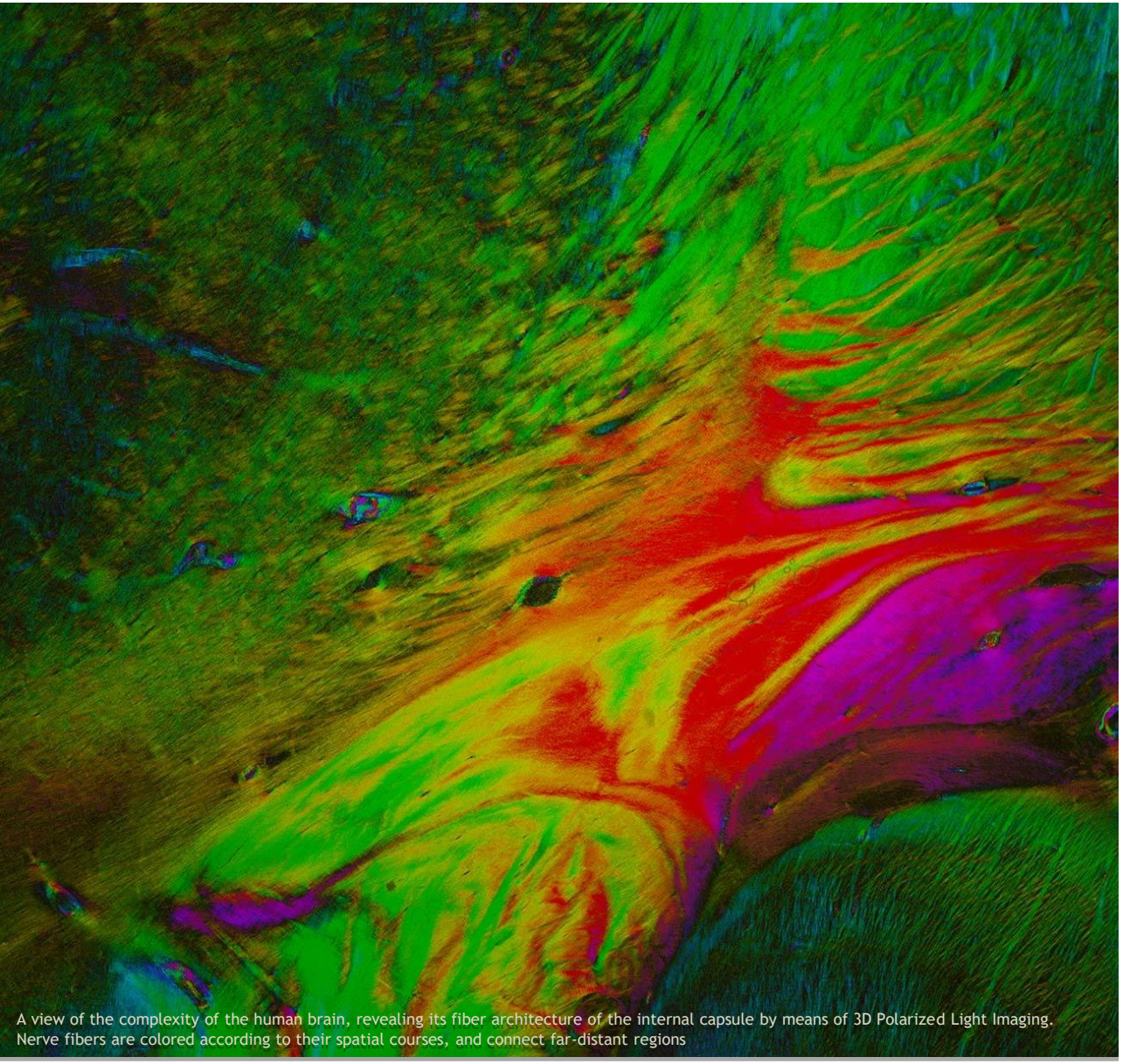


EBRAINS' supporters
Bulgaria
Denmark
France (Leading country)
Greece
Italy
Netherlands
Norway
Spain
Sweden
Switzerland

Country	Number of support letters
Austria	5
Belgium	1
Denmark	1
France	8
Germany	25
Netherlands	14
Norway	2
Spain	30
Sweden	3
UK	5
Grand Total	**94**

EBRAINS' Lifecycle





A view of the complexity of the human brain, revealing its fiber architecture of the internal capsule by means of 3D Polarized Light Imaging. Nerve fibers are colored according to their spatial courses, and connect far-distant regions

EBRAINS

Thank you for your attention