Human Brain Project

"Introduction to HBP" Lessons learned

https://www.humanbrainproject.eu/en/

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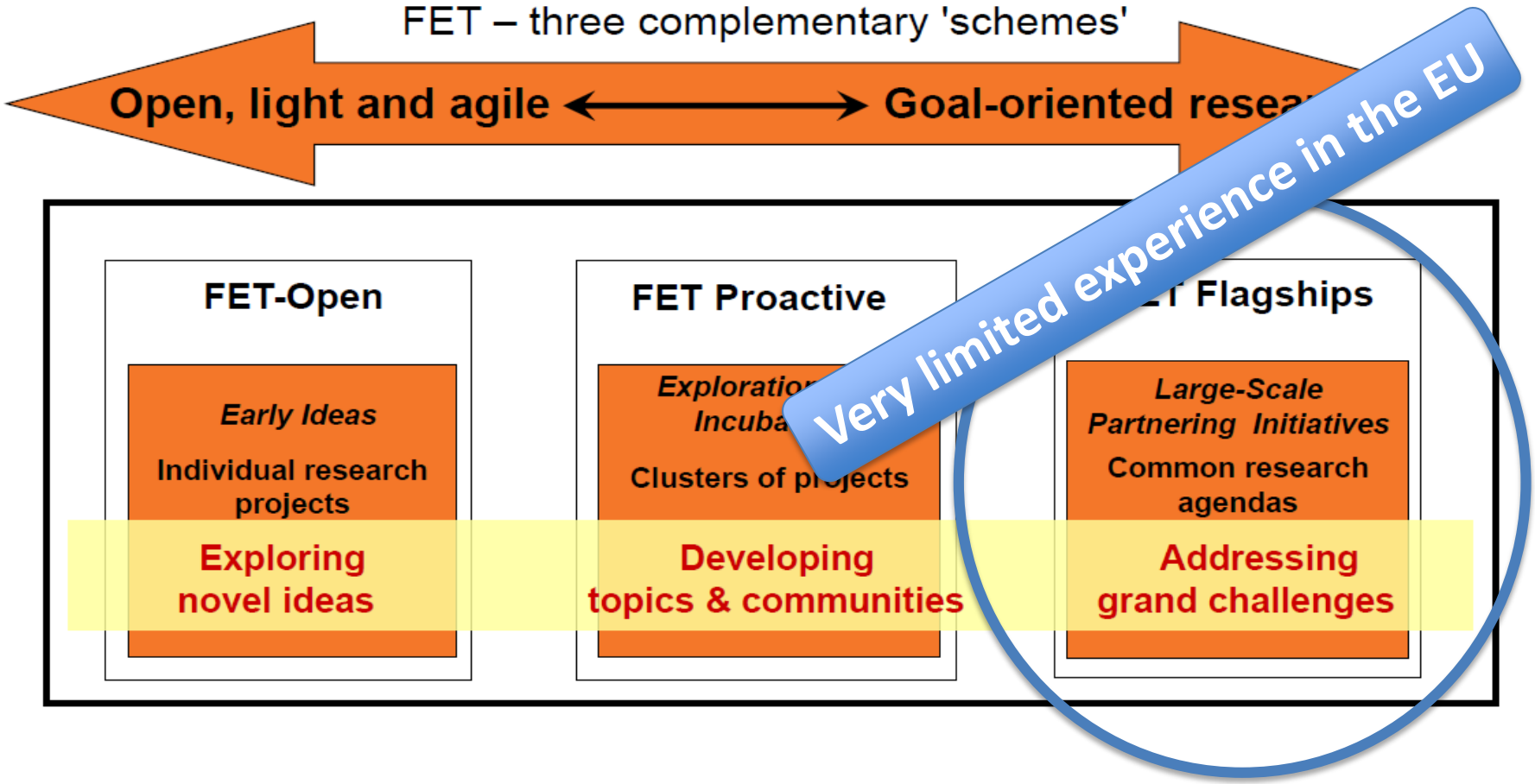
Three FET H2020 modalities



Source: The EU HORIZON 2020 Programme and Teaming for Excellence in the European Research Area H2020-TEERA, Prague, 17-18 October 2013

Selected FET Flagships

After a long selection process the EC selected in 2013 two large Flagship projects

Graphene project

Human Brain Project (HBP)

~ €100 million / year (EC + MS)

during a long period of time (~10 years)

Nobody knew if that amount of money will be available

Big challenge

The ultimate goal of HBP is to make "reverse engineering" of the human brain

Key objectives:

- To obtain detailed simulations of the human brain from the biological perspective, and to develop disruptive high performance computing, modelling techniques and AI algorithms to carry out those simulations.
- **Simulations** should serve as a basis to create:
  - New tools for the diagnostics and treatment of brain diseases
  - Development of advanced prosthesis for brain handicapped persons with "intelligence" close to the human brain
  - Development of new generations of neuromorphic computers and robots

HBP origins (I)

- **Fragmented neuroscience research efforts in all countries**
  - Huge volume of non accessible “brain data” obtained in many labs over the world
    - In formats and conditions difficult to compare
  - Need to address the problem from a multidisciplinary approach
    - Where neuroscientists, computer engineers, computer scientists, etc. should work together
  - Take advantage of all the available and future ICT technology
    - First problem was to understand that this is an ICT project on brain… paid by FP7 ICT area.

HBP origins (II)

- **Spanish position:**

  Take advantage of a privileged position… after participating in the pre-existent international project which incubated the HBP proposal

Microstructure and simulation of cortical columns

International cooperation

International research project Launched by the EPFL (École Polytechnique Fédéral de Lausanne)

UPM-MINECO 2008-2018 (UPM-CSIC 2009-2018) (estimated budget: 12 M€)

Subprojects of HBP

SP1: Multilevel organisation of the mouse brain
SP2: Multilevel organisation of the human brain
SP3: Brain function and cognitive architecture
SP4: Mathematical and theoretical bases
SP5: Platform of neuroinformatics
SP6: Platform of brain simulation
SP7: Platform of high performance computing
SP8: Platform of medical informatics
SP9: Platform of neuromorphic computation
SP10: Platform of neurorobotics

ICT platforms available for the science community

SP11: Applications: neuroscience, medicine and computation
SP12: Ethics and society
SP13: Management

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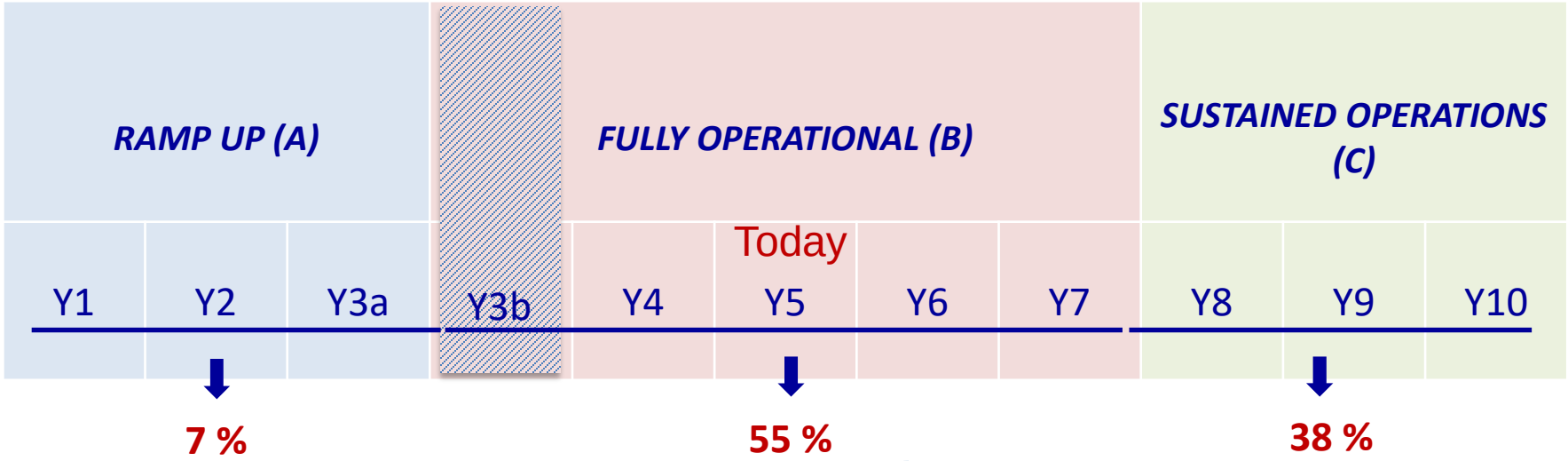
HBP phases



TOTAL COST (10 YEARS): aprox. 1.000 M€

Ramp-up cost: 72.7 M€

EU funding: 54M€ + MS funding: 18,7 M€

EU funding : 56%

MS funding: 44 %

The Spanish participation was very relevant from academia but poor from industry

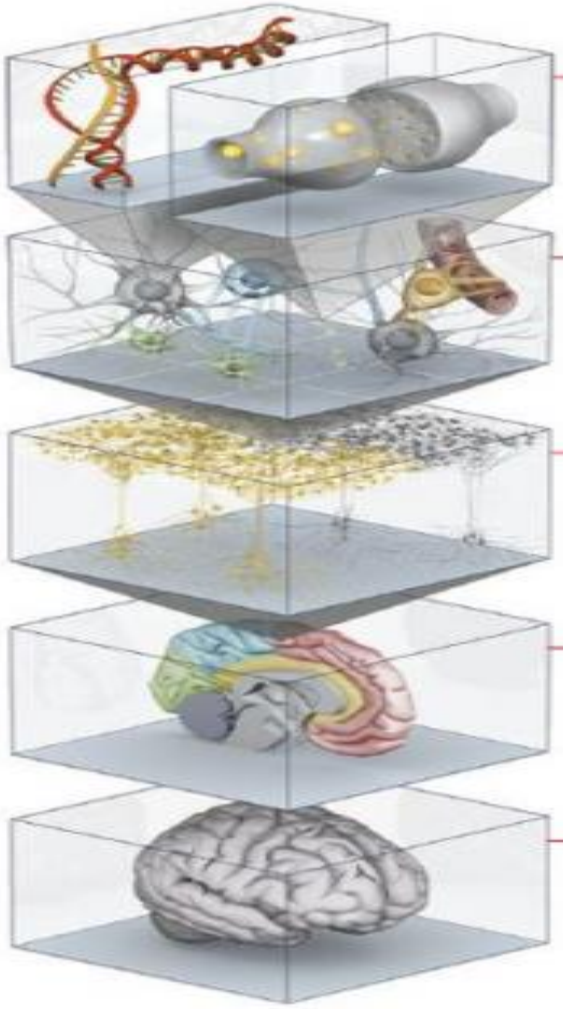
Key role played by Cajal Blue Brain and BSC in the HBP participation

European Brain Research Infrastructure (I)

- The human brain consists of approximately 86 billions of nerve cells that form local and global brain networks
  - ✓ These networks respond in milliseconds, but also change slowly, e.g., during the course of a day, and over the months and years in the lifespan of a person.
  - ✓ They are shaped and re-shaped by genes as well as experience and have several hundred millions of years of evolutionary history
- Understanding the multilevel organization of the brain requires bridging the different scales in time and space
  - ✓ from the molecular to the level of large scale organization and behavior
- **This challenge is so extraordinary that not the even best-funded single research project could claim to provide the full picture**

Human Brain Project

European Brain Research Infrastructure (II)



Molecular
A century of research, beginning with the first inspection of a brain cell under a microscope, would translate into a digital facsimile that combines component molecular parts to assemble a cell that demonstrates the essential properties of a neuron—the transmission of electrical and chemical signals.

Cellular
A brain-in-a-box simulation will have to capture every detail of neurons and nonneuronal glial cells, including the exact geometric shapes of the dendrites and axons that receive and send information.

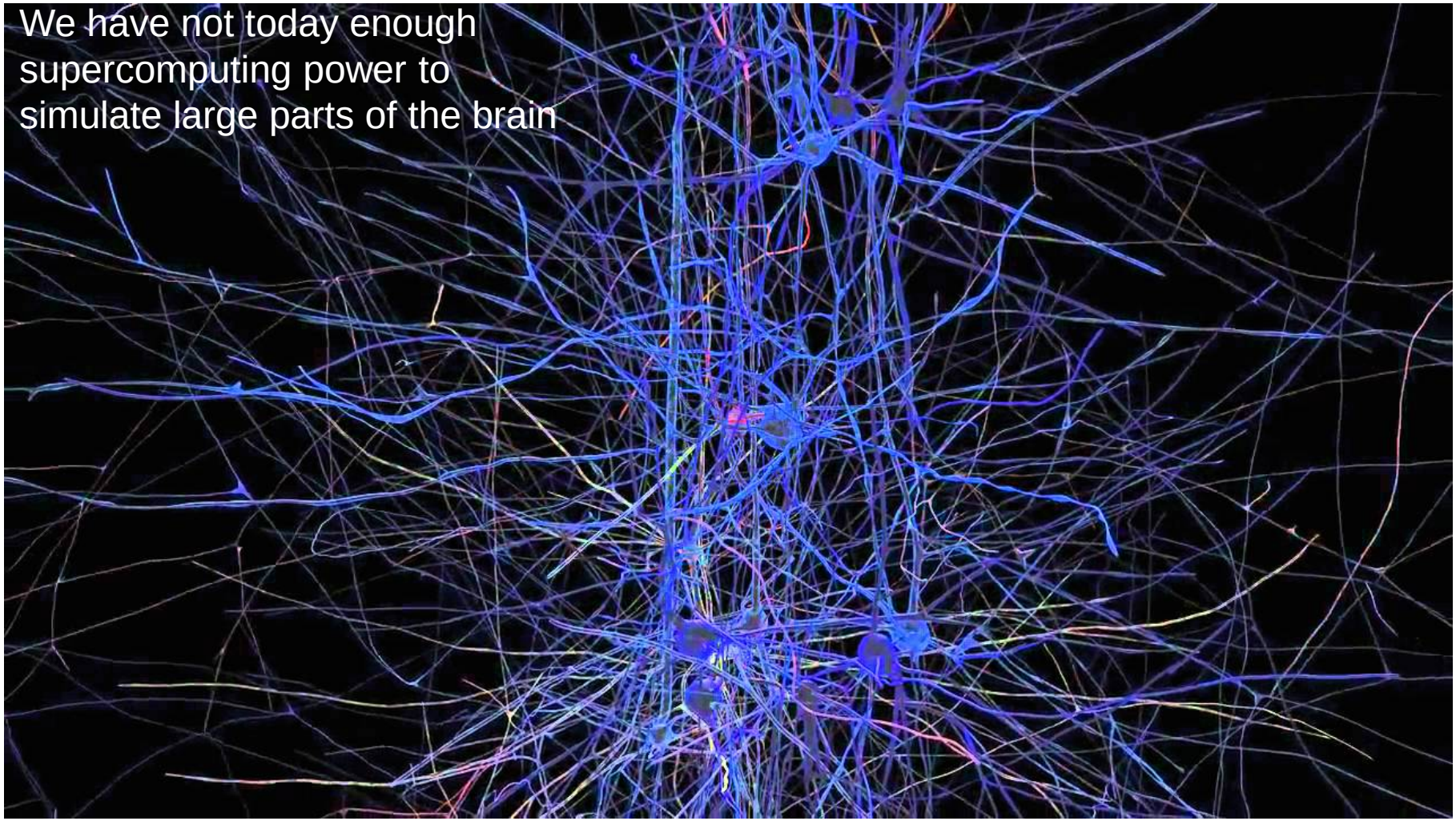
Circuits
A model of the neural connections between different brain areas and among neighboring cells may furnish clues to the origins of complex brain diseases such as autism and schizophrenia.

Regions
Major neural substructures—the amygdala (emotions), the hippocampus (memory), the frontal lobes (executive control)—can be inspected alone or as they interact with one another.

Whole Organ
An in silico brain might substitute for the actual organ. By removing the computer code for a "gene," the virtual system can, for instance, mimic the effects of a mutation, as scientists do today by "knocking out" a gene in mice. The tool would avoid the lengthy breeding process and could simulate a multitude of experimental conditions.

How to manage and process large volume of data at different levels?

European Brain Research Infrastructure (III)



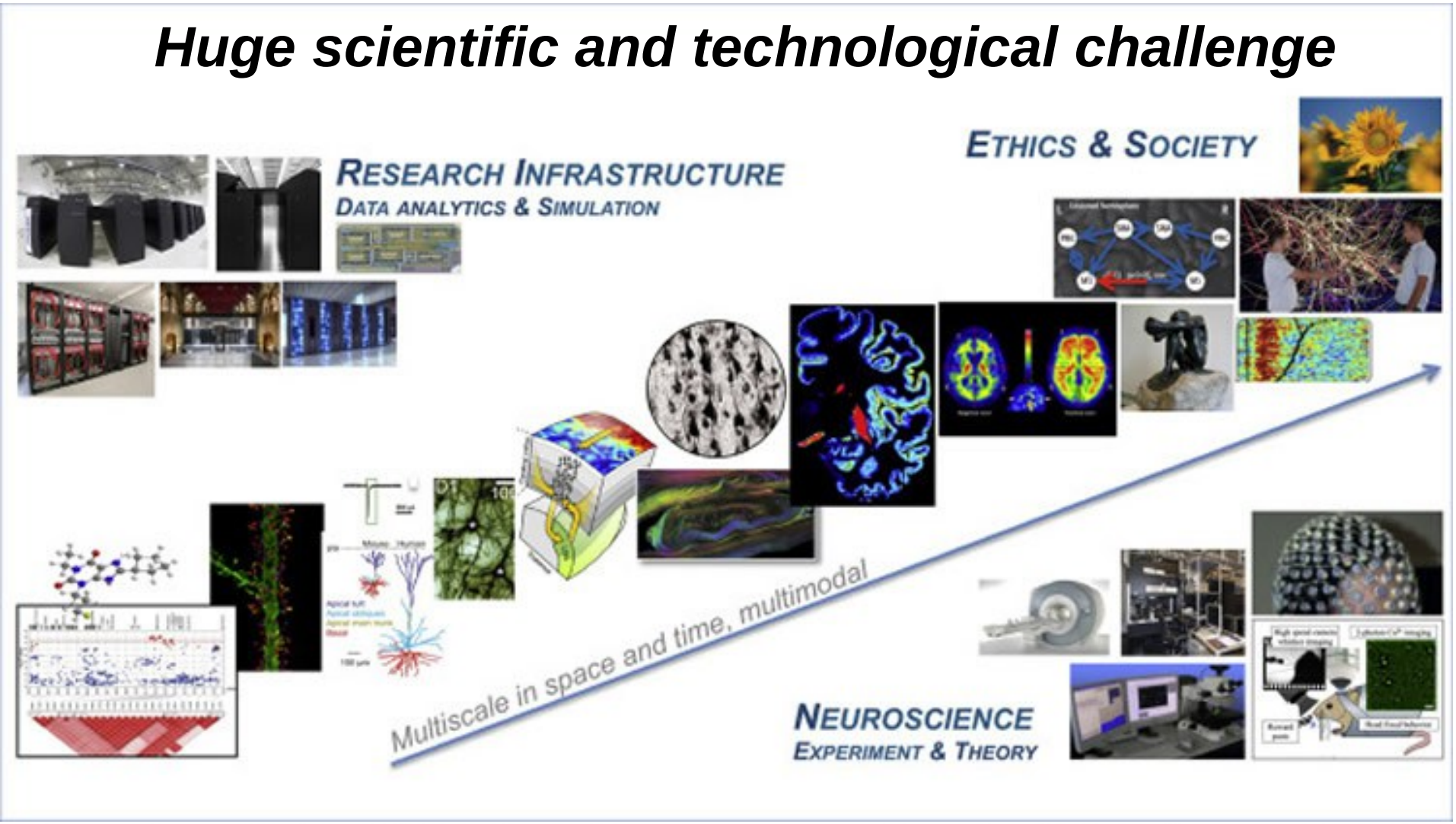
Simulation of a cortical column

European Brain Research Infrastructure (IV)

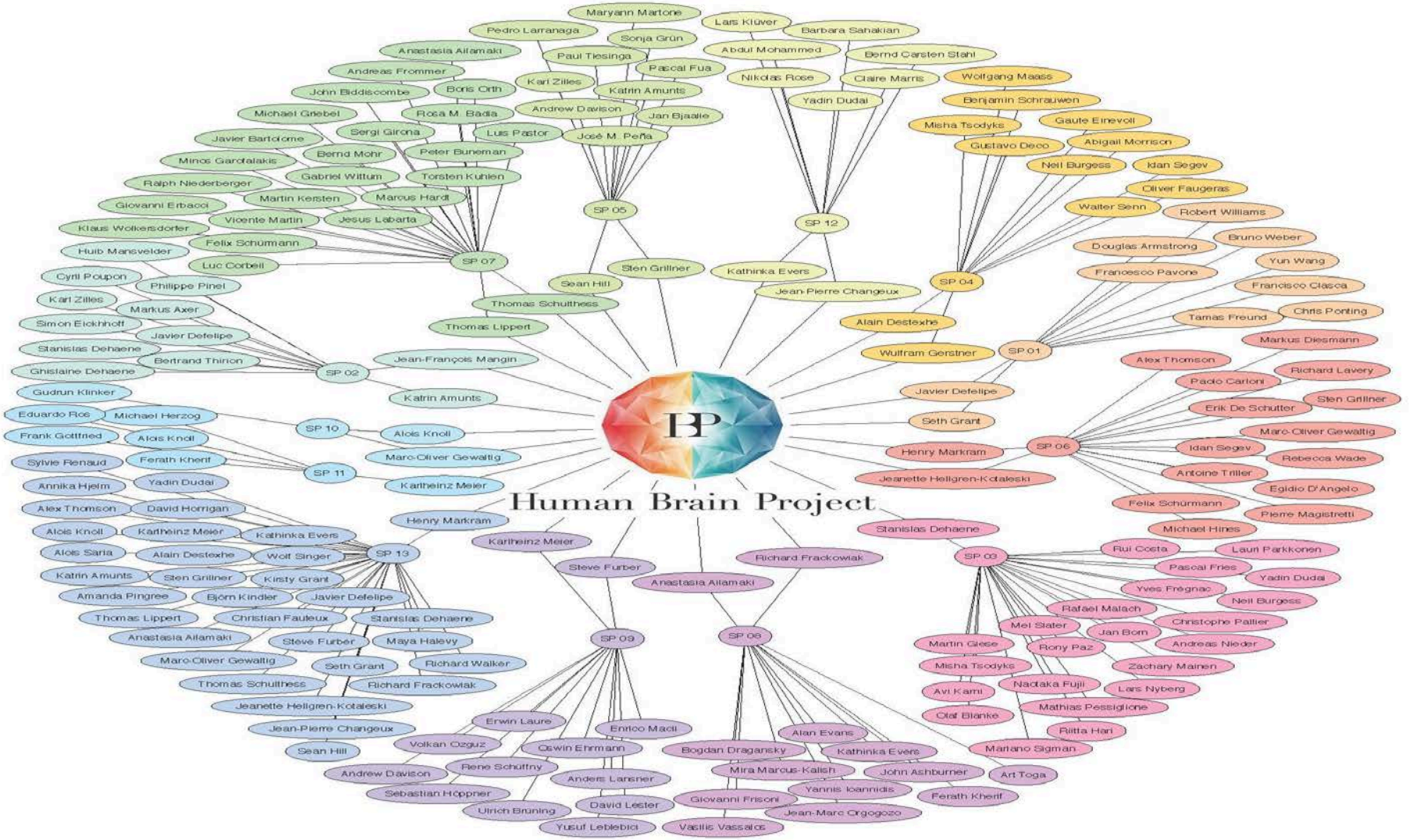
- Therefore, a unique lasting contribution the HBP can make is to integrate and focus precious resources to build a collaborative platform: **a genuine European research infrastructure driven by innovative supercomputing and neuromorphic systems.**
  - ✓ On the platform, experimental and theoretical approaches are combined with models, simulation and data analytics.
- This provides **neuroscience and brain medicine** with a new path to meet the brain's complexity, linking insights, methods and large datasets from many areas of brain research.
  - ✓ This shared platform will serve excellent research groups to leverage and multiply the impact of the available funding, the brightest ideas, and the best scientific talent.

European Brain Research Infrastructure (V)

Huge scientific and technological challenge



Participation (I)



Participation (II)

- Usually, fundamental research is addressed by small groups of researchers with enough freedom to change their minds and to concentrate on frontier research
- R&D projects in the EU FPs priority areas are composed by relatively small groups of partners (usually less than 20 in a single project) where a tight coordination is possible
- In any of these cases it is necessary to integrate the efforts of everybody to provide a single platform for other researchers

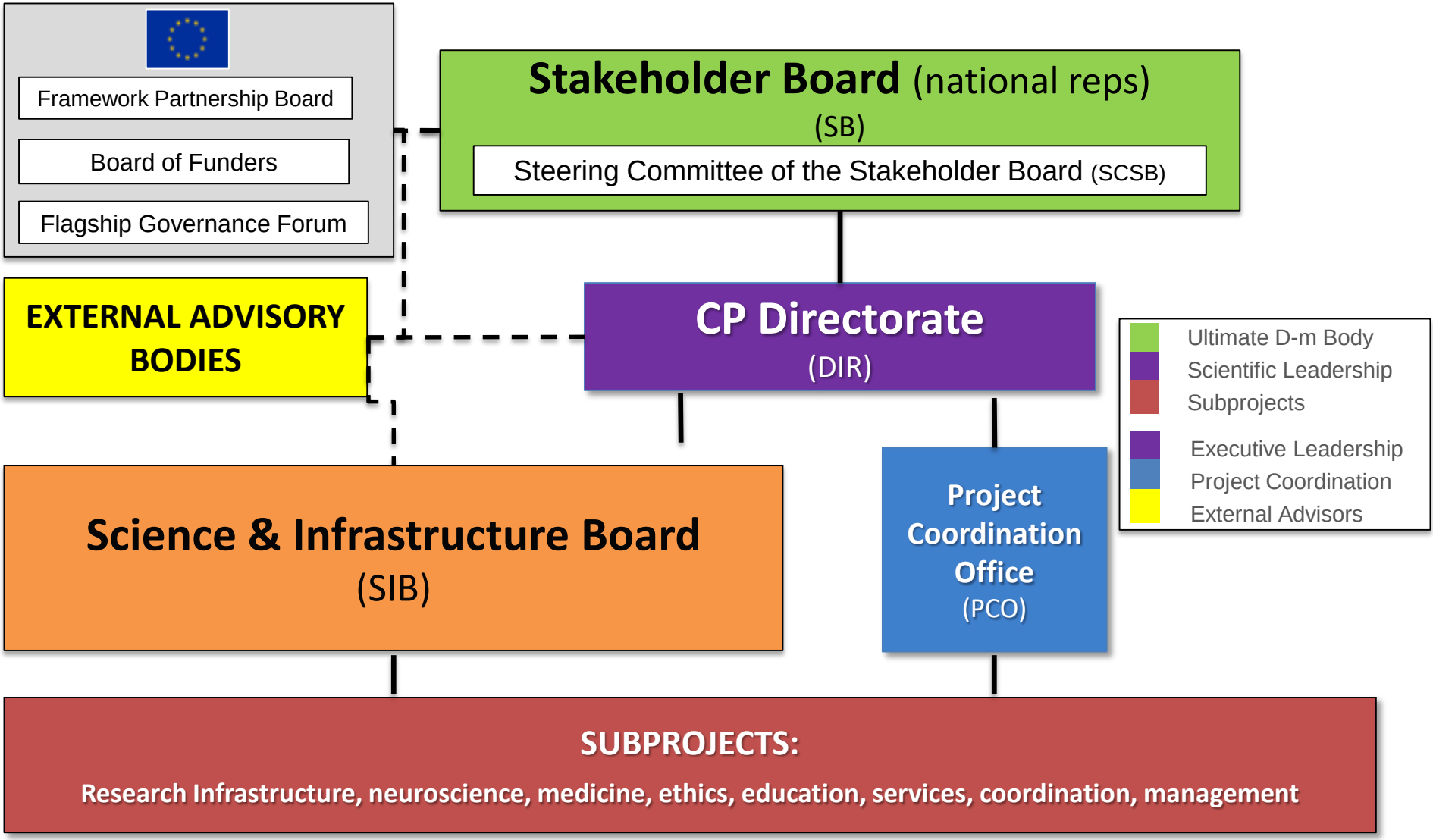
The management challenge

Is it possible to coordinate this type of project with more than 120 institutes (and more than 500 researchers) by using the same approach used by traditional R&D projects?

Governance (I)

- This kind of projects will require to set-up specific governance structures with full-time professionals and to keep close contacts with all stakeholders
- **Governance bodies**
  - **Directorate**
    - coordinated by EPFL
  - **Stakeholder board (SB)**
    - Representatives from MS
  - **Steering committee of the SB (SCSB)**
    - Representatives from the 7 countries with higher participation in order to prepare decisions in the SB
  - **Science and infrastructure Board**
    - Chair + Directors of the subprojects
  - **Ethical committee**
    - Experts nominated by the SB and DIR
  - **Technology transfer committee**
    - Experts nominated by the DIR (pending) and SB

Governance (II)



HBP evolution

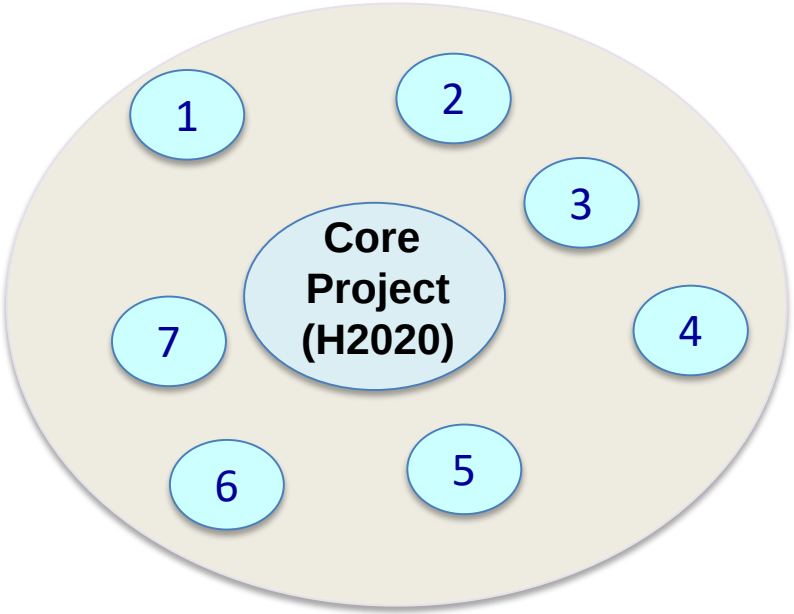
The new phase will start on 1st April 2018 for two years
(€ 90 million from H2020)

Rum-up phase

EC Grant contract FP7

Transition

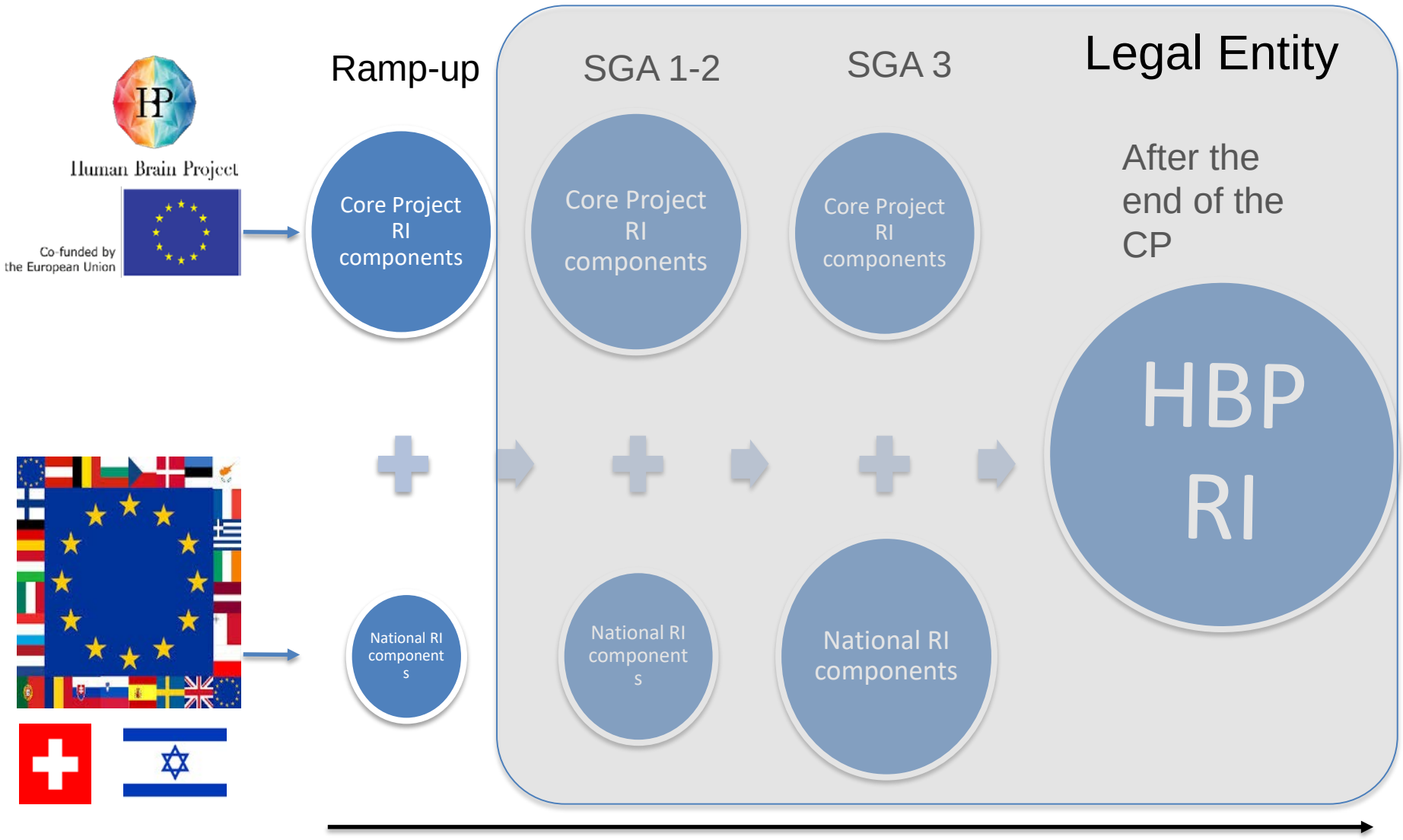
Operational phase



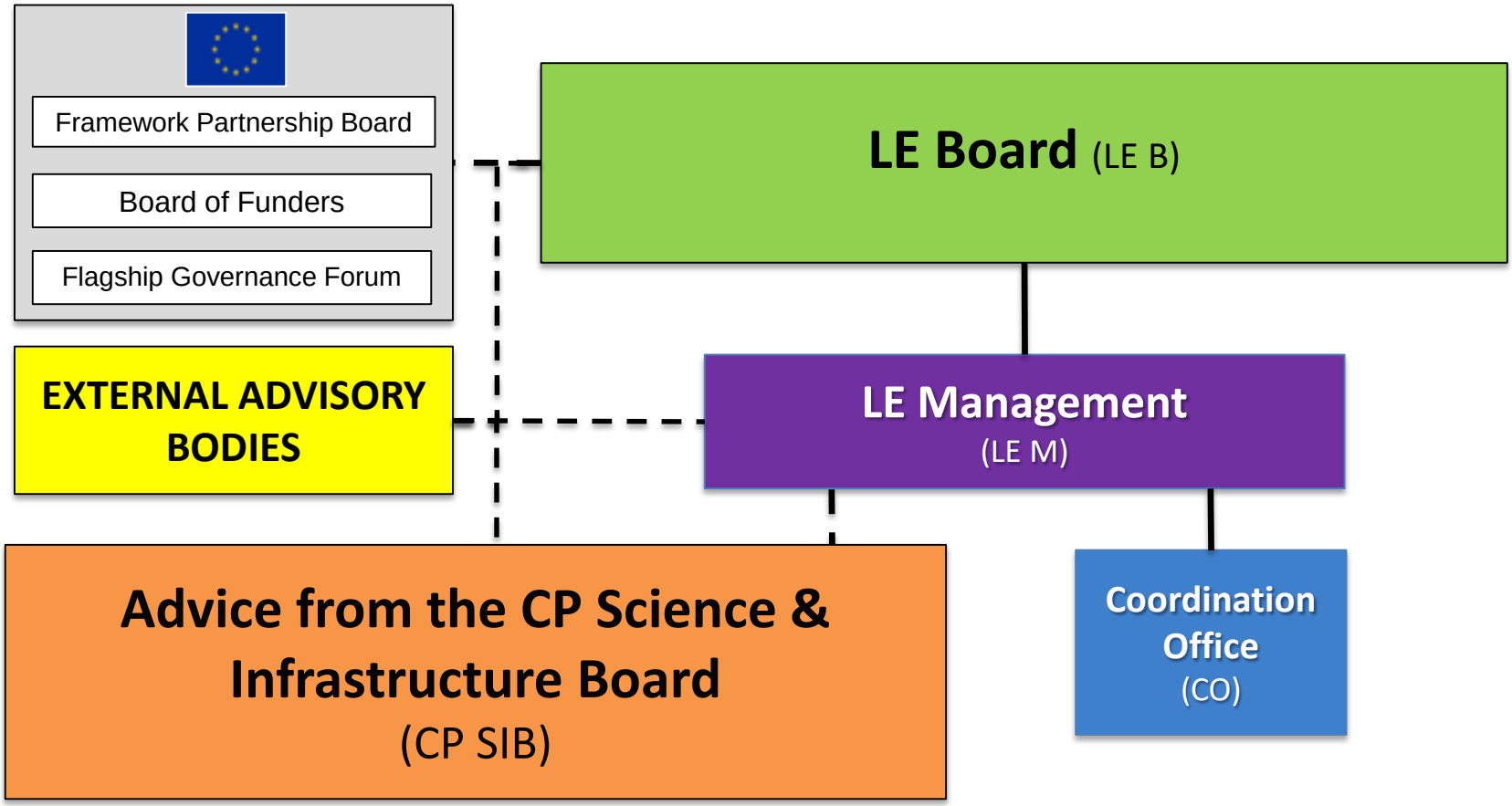
Creation at the beginning of 2018 of a new legal entity (AISBL) to be located in Belgium

Partner Projects funded by HBP, H2020 open calls and member states
Interaction with the core project?

HBP evolution (II)



Governance (III)

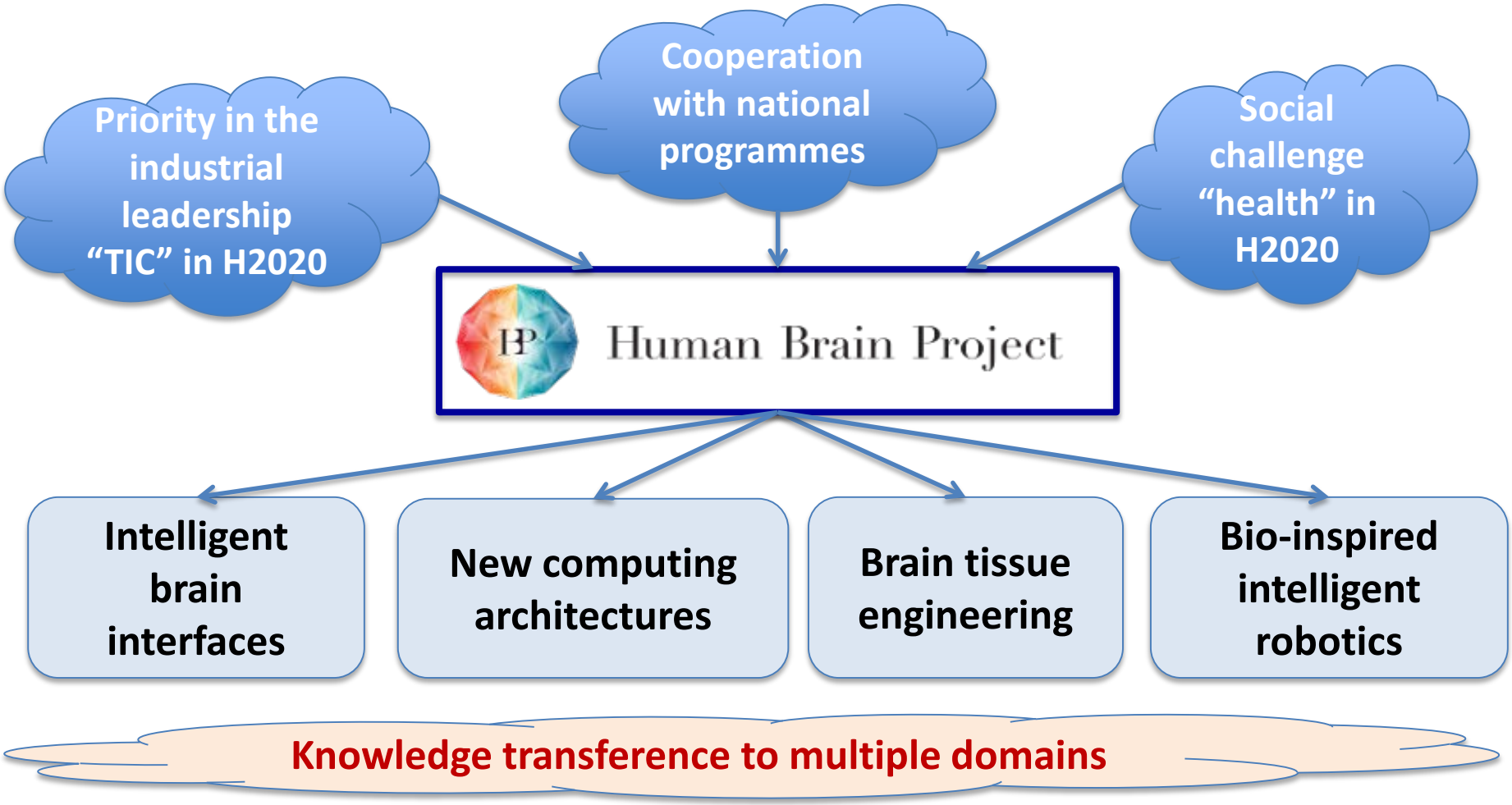


This governance structure should be created in 2018

HBP and industry

Today, the participation of European industry in HBP is very low

Shared perception that HBP research is very far from the market



HBP Technology transfer

After several years of execution, HBP needs to pay attention to the identification, assessing of maturity, and definition of roadmaps in order to move HBP emerging results to the market

- This activity has been incorporated into the new SGA2 phase to start on April 2018
  - Coordinated by the UPM
- **Main activities**
  - ✓ To define a global strategy for the exploitation of results
  - ✓ To identify emerging technologies and to assess their maturity level
  - ✓ To define roadmaps to convert them into products/services
  - ✓ To set-up exploitation agreements with TTOs of participants
  - ✓ To promote global industrial hubs (based n the Spanish one)

Summary of lessons learned

- FET Flagships is a good instrument to coordinate research when the main challenge is quite mature but it still requires long-term efforts
  - ✓ Don't confuse it with a "*very large ERC grant*"!!
- Management procedures for H2020 funded projects are not useful in these cases
  - ✓ Is it necessary to design ad hoc governance structures
  - ✓ Legal entities? why?, what? and how?
- The funding approach between the EC and MS is difficult to implement
  - ✓ Contributions from MS are not guaranteed over time
  - ✓ In-kind vs in-cash contributions flexibility

Conclusions

- The **knowledge of the human brain** structure and functioning is a huge S&T challenge which requires the coordination of research efforts in all the world
  - ✓ HBP is the European effort (in parallel, USA, China, Japan, India and others have launched similar initiatives)
- The project will build up a set of "**distributed platforms**"
  - ✓ researchers could access to structured/open big data and software tools to analyse and simulate the human brain
- Further **technology developments** are expected to accelerate innovation in the ICT and pharma sectors
  - ✓ New computers, new drugs, new robots, new algorithms
- **Governance** became a major issue where current FP procedures are not adequate