HUMAN BRAIN PROJECT

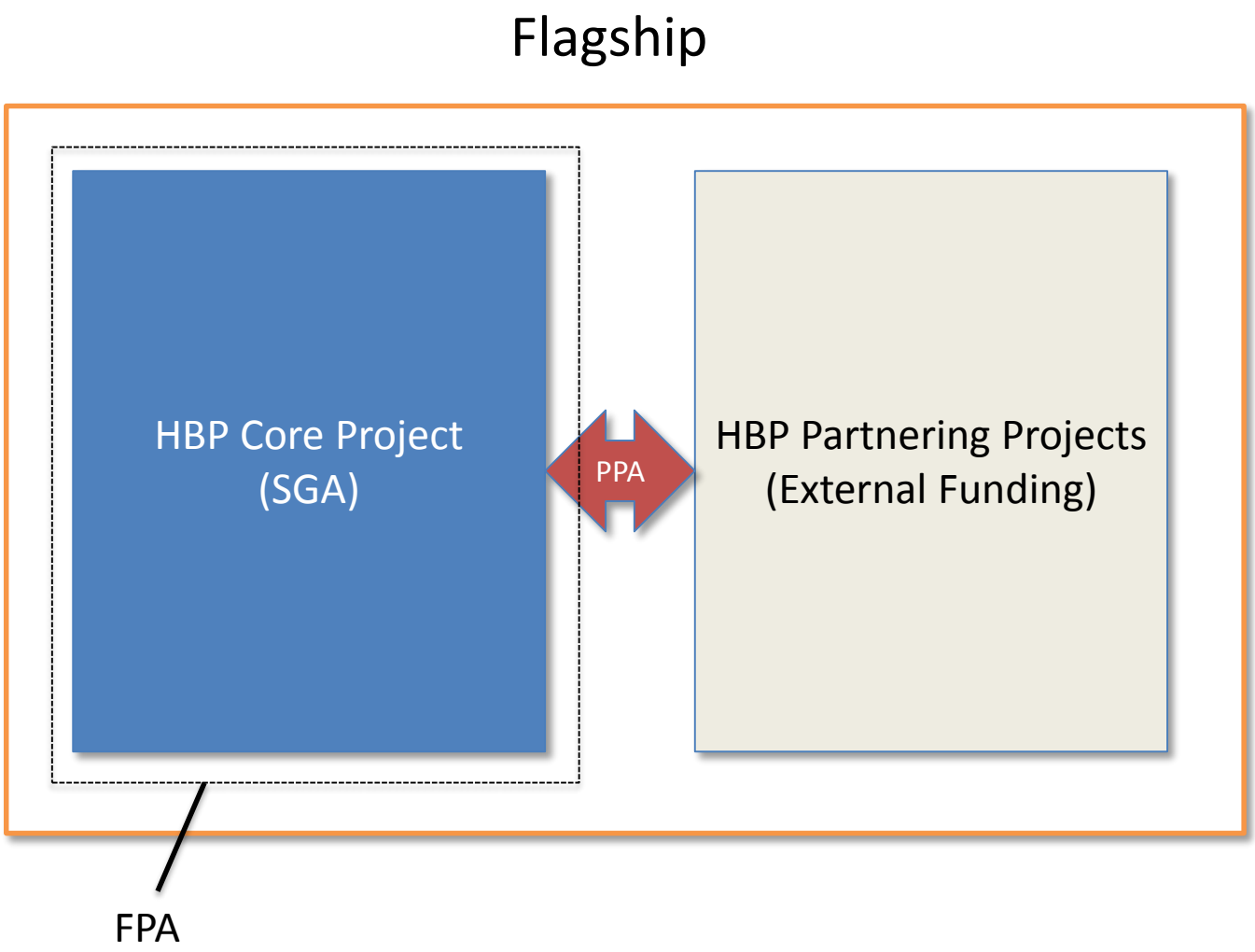
Workshop FET-FLAGSHIPS

Lisbon, 10 July 2014

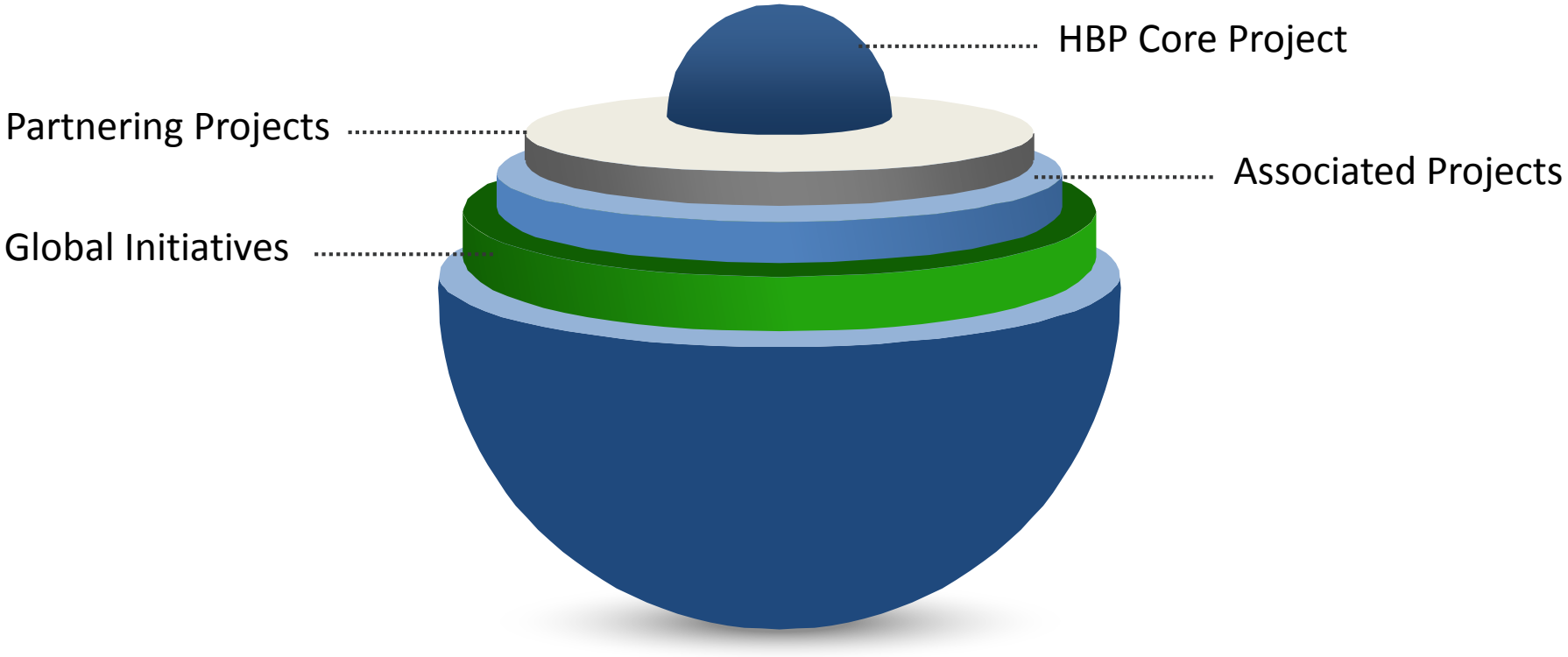
Main Points

- FPA submitted 10 June 2014
- FLAG-ERA meeting in Toulouse
- FLAG-ERA JTC workshop in Lausanne
- HBP Topic Input Process
- Overview Suggested Topics
- Integration Process
- Timeline
- Q&A

The Basic Flagship Structure in the Operational Phase (FPA governed)



The Larger Picture



FPA Progress

- Submitted 10 June 2014
- In evaluation

Joint Transnational Call Development

- Set up by FLAG-ERA
- Constant exchange with HBP-FLAG-ERA Liaison Group (phone conferences, email)
- Presented process and Strategic Research Objectives at FLAG-ERA Workshop in Toulouse, 5-6 May
- JTC Workshop in Lausanne, 17 June

Topic Input Process

- Presented general Objectives at Workshops
- Solicited topic suggestions from SP leaders
- Asked SP leaders to make specific topic recommendations
- Formatted content, got ExCo approval
- Sent topics to FLAG-ERA
- Next week: clarification of FLAG-ERA questions

Scope of JTC Call

- Call will cover all SPs foreseen in the FPA (projects will run from CA to FPA)
- FLAG-ERA decided to pick one topic per area to control the volume of the submissions (latest information from this morning)
- Challenge: specificity vs. openness

The Flagship Specific Project Objectives (SPO)

- Simulating the Human Brain
- Mapping brain diseases
- Brain-inspired computing
- Neurorobotics
- Interactive supercomputing
- Targeted brain mapping
- Theoretical foundations
- Collaboration Platforms
- Complementary Strategic Research
- European and international collaboration
- Innovation and Industry engagement
- Knowledge management and education
- Communication and Societal Engagement
- Responsible Research Innovation

Subproject Themes

NOTE – FOR INFORMATION PURPOSES ONLY – FPA UNDER REVIEW

- **Subproject 1: Targeted Mapping of the Mouse Brain**
- **Subproject 2: Targeted Mapping of the Human Brain**
- **Subproject 3: Theoretical and Mathematical Foundations of Neuroscience**
- **Subproject 4: Neuroinformatics**
- **Subproject 5: Brain Simulation**
- **Subproject 6: High Performance Computing**
- **Subproject 7: Medical informatics**
- **Subproject 8: Neuromorphic Computing**
- **Subproject 9: Neurorobotics**
- **Subproject 10: Ethics and Society**

SP1

- **WP1.7 Physiological data:** collect targeted physiological data going beyond the data sets collected in the Core Project; candidate data sets include but are not limited to data on whole brain dynamics neuroendocrinology and neuroimmunology, metabolism and energetics, microcircuit dynamics and information processing, the physiology of neurons and synapses, receptor and channel biophysics, and gene expression.
- **WP1.8 From genes to cognition:** perform experimental and informatics studies on the link between genes and cognition and the impact of normal genetic variations and mutations; develop links to human brain disease signatures established in SP7 and to human work in SP2.
- **WP1.9 Functional architectures of cognition:** collect data on functional architectures of cognition in mouse; possible themes include but are not limited to multi-modal perception and action, motivation, reward and decision making, synaptic plasticity, learning, memory and goal-oriented behaviour, representations of space time and quality in planning and navigation, and the architecture of gene-behaviour-environment interactions.
- **WP1.10 Comparative studies:** perform research comparing structural and physiological data in mouse, humans and other animals (research performed in conjunction with SP2).

SP2

- **WP2.7 Physiological data:** collect targeted physiological data going beyond the data sets collected in the Core Project; possible data sets include but are not limited to data on whole brain dynamics neuroendocrinology and neuroimmunology, metabolism and energetics, microcircuit dynamics and information processing, the physiology of neurons and synapses, receptor and channel biophysics, and gene expression.
- **WP2.8 From genes to cognition:** perform experimental and informatics studies on the link between genes and cognition and the impact of normal genetic variations and mutations; develop links to human brain disease signatures established in SP7 and to human-related work in SP1.
- **WP2.9 Functional architectures of cognition:** collect data on functional architectures of cognition in human; possible themes include but are not limited to multi-modal perception and action; motivation, reward and decision making; synaptic plasticity, learning, memory and goal-oriented behaviour; representations of space time and quality in planning and navigation; the architecture of gene-behaviour-environment interactions.
- **WP2.10 Comparative studies:** perform research comparing structural and physiological data in mouse, humans and other animals (research performed in conjunction with SP1).

SP3

- **WP3.7 Model development:** develop theory-driven models of brain function suitable for implementation on the Brain Simulation, Neuromorphic Computing or Neurorobotics Platforms; use the Platforms for *in silico* experiments validating and refining the models; possible themes include but will not be restricted to perception-action, surprise, novelty, multi-sensory integration, decision making, goal-oriented behaviour, reward, wakefulness, sleep, dreams and the wake-sleep cycle, learning and memory, working memory, declarative memory, skills and habits, symbols and language (development in conjunction with SP8 and SP9).
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- **WP3.8 Brain-inspired architectures for HPC:** develop HPC architectures inspired by theoretical and experimental insights into the structure and function of the brain (development in conjunction with WP6 and WP7).
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- **WP3.9 Disease modelling:** develop theory-driven models of disease from the biological signatures of disease and the disease classifications identified by researchers using the Medical Informatics Platform (development in conjunction with SP5 and SP7).
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SP4

- **WP4.7 Methods and tools:** develop methods and tools expanding the functionality of the Neuroinformatics Platform and integrate them into the Platform; possible tools include but are not limited to tools and methods for the analysis of large volumes of structural brain data (e.g., image stacks) and for the analysis of large volumes of functional data.
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- **WP4.8 Sensory organs, the spinal cord and the peripheral nervous system:** expand the mouse and the human brain atlases to accommodate data on sensory organs, the spinal cord and the peripheral nervous system in mouse and in humans; generate initial data sets to populate the expanded atlases.
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- **WP4.9 Atlases for other species:** create multi-level atlases for the brains of species not covered by the HBP Mouse Brain and Human Brain Atlases on the Neuroinformatics Platform; integrate the atlases with the HBP Mouse Brain and Human Brain atlases, enabling cross-species comparisons.

SP5

- **WP5.9**: **Tools, methods and workflows**: develop tools, methods and workflows expanding the functional capabilities of the Brain Simulation Platform; possible topics include but are not limited to new techniques for multi-scale simulation, new simulation engines and enhancements to existing engines, new tools for data analysis and visualisation, and virtual instruments (*in silico* molecular imaging, large-scale synaptic imaging, whole-brain *in silico* electrical recording, *in silico* optogenetics, virtual MRI, DTI, and PET).
- **WP5.10 Brain modelling**: develop high-fidelity reconstructions of specific regions of the mouse or human brain, or of specific levels of biological organisation not fully covered by HBP models; create high-fidelity reconstructions of the brains of species not covered by the HBP; create data-driven models of sensory organs or the spinal cord.
- **WP5.11 In silico neuroscience**: use the Brain Simulation Platform (where necessary, in combination with the Neuromorphic Computing or Neurorobotics Platforms) for *in silico* experiments in basic neuroscience, cognition and behaviour.
- WP5.12 Disease and drug simulation: use data from the Medical Informatics Platform and simulation capabilities from the Brain Simulation Platform to gain new clinical insight; possible themes include but are not limited to mechanisms of disease causation, mechanisms of action of known therapeutic agents, and screening of drug candidates (development in conjunction with SP7).
- **WP5.13 Other Applications of Brain Simulation**: Develop other applications of brain simulation of commercial and/or clinical value; examples include fast prototyping of new experimental methods; fast prototyping of neuroprosthetic devices, etc.

SP6

- **WP6.8 Technologies and architectures:** develop supercomputing technologies and architectures meeting the specific requirements of brain simulation and expanding the capabilities of the High Performance Computing Platform; possible themes for research include but are not limited to novel solutions for multi-scale simulation, novel solutions for resiliency, fault tolerance and self repair; new hardware/software solutions for memory and I/O hierarchies, new interconnect architectures.
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- **WP6.9 Software, algorithms and numerical methods:** develop software, algorithms and numerical methods that meet the specific requirements of brain simulation and expand the capabilities of the High Performance Computing Platform.
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- **WP6.10 Hybrid HBP-neuromorphic architectures:** develop conceptual designs for hybrid HPC-neuromorphic computing systems for energy efficient, accelerated simulations in neuroscience; demonstrate feasibility using the Neuromorphic Computing Platform and the HBP Platform; possible architectures include but are not limited to hybrid systems linked across networks, on-board hybrids, on-chip hybrids (Neuromorphic cores) (development in conjunction with SP8).
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- **WP6.11 Brain-inspired architectures for HPC:** develop HPC architectures inspired by theoretical and experimental insights into the structure and function of the brain (development in conjunction with SP3 and SP6).

SP7

- **WP7.8 Clinical data infrastructure:** develop tools to harmonize heterogeneous clinical databases, and for data anonymisation; develop interfaces for ontology-based querying. Develop methods for federated search and intensive distributed analysis of clinical data. Coordinate implementation of above tools in HBP Unified Portal.
- **WP7.9 Clinical studies:** use the data and analysis tools provided by the Platforms to gain new insights into the diagnosis, and classification of brain disorders and to identify potential targets for treatment; studies may include but are not limited to cluster analysis of data from retrospective studies, analysis of changes in disease signatures during disease progression, re-analysis of data from clinical trials and epidemiological studies (e.g., studies of nutrition as a protective or a risk factor).
- **WP7.10 Disease and drug simulation:** use data from the Medical Informatics Platform and simulation capabilities from the Brain Simulation Platform to gain new clinical insights; possible themes for research include but are not limited to mechanisms of disease causation, mechanisms of action of known therapeutic agents, screening of drug candidates (development in conjunction with SP5).
- **WP7.11 Services for personalised medicine:** use the capabilities of the Medical Informatics Platform to develop and trial new services for personalised medicine: personalised diagnosis and prognosis, personalised treatment, etc.
- **WP7.12 Methods and tools:** develop and integrate new tools and methods contributing to the capabilities of the Medical Informatics Platform; possible tools and methods include but need not be limited to tools and methods for the identification of clusters in large volumes of data; and tools and methods to protect patient privacy.

SP8

- **WP8.7 Applications for neuromorphic computing:** use the NM-PM and NM-MC systems to demonstrate applications of Neuromorphic Computing Systems; potential application areas include but are not limited to pattern detection in spatio-temporal data streams, finding causal relations in big data, data mining, temporal sequence learning, approximate computing; feed back the results for further development and feature upgrades of the Neuromorphic Platform systems.
- **WP8.8 Portable hardware systems for neuromorphic computing:** use the NM-PM and NM-MC systems to derive specialised and resource efficient neuromorphic circuit architectures for custom, special purpose low-power, compact, low-cost hardware implementations as neuromorphic cores or complete stand-alone systems; application areas include but are not limited to robotics, automotive, manufacturing, telecommunication.
- **WP8.9 Devices for neuromorphic computing:** develop and evaluate new device technologies for neuromorphic computing; simulate, construct and evaluate small- scale demonstrator systems; evaluate integration into the HBP Neuromorphic Platform systems; possible themes for development work include but are not limited to resistive memories, magnetic memories, organic devices, 3D Integration, and distributed powering.
- **WP8.10 Hybrid HBP-neuromorphic architectures:** develop conceptual designs for hybrid HPC-neuromorphic computing systems for energy efficient, accelerated simulations in neuroscience; demonstrate feasibility using the Neuromorphic Computing Platform and the HBP Platform; possible architectures include but are not limited to hybrid systems linked across networks, on-board hybrids with Neuromorpic cores.

SP9

- **WP9.10 Software, tools and technologies:** develop software, tools and technologies that expand the capabilities of the Neurorobotics Platform; possible themes include the high-performance, high-fidelity simulation technologies for robots and their environments.
- **WP9.11 Embodied neurorobotics:** perform research on the physics and function of bodies (bones, muscles, tissue), sensors (vision, audition, touch, balance) and peripheral nervous system (spinal cord) and integrate the results into the Neurorobotics Platform.
- **WP9.12 Social neurorobotics:** expand the Neurorobotics Platform to enable experiments involving interactions among multiple neurorobotic systems.
- **WP9.13 Neurorobotics as a tool for *in silico* neuroscience:** use neurorobotic systems to perform *in silico* experiments investigating fundamental issues in basic neuroscience, cognition and behaviour.
- **WP9.14 Applications:** use the Neurorobotics Platform to develop applications of commercial or clinical value; possible applications include but are not limited to applications in manufacturing and mechanical engineering, personalised neuro-prosthetics and neuro-muscular controllers, robots for healthcare, robotic vehicles, and robots for domestic applications.

SP10

- **WP10.7 Ethical, conceptual and philosophical issues:** perform research on ethical, conceptual and philosophical issues, going beyond the research already planned within the Core Project.
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- **WP10.8 Public outreach:** organise outreach activities to promote public debate and participation on issues related to HBP research.

Specific Topic Example (SP2, Targeted Mapping of Mouse Brain)

- **Identification of genotype/phenotype relationships - from genes to brain structure and cognition** (identify genes influencing cognitive performance and/or connectivity in elderly subjects. GWAS or candidate genes would be analyzed. Structural phenotypes are from MRI and include, e.g., pattern of sulci, cortical volume/thickness, fiber tracts, etc. This project would support tasks 2.1.1 and 2.1.2, and also the collaboration with the Allen Institute.

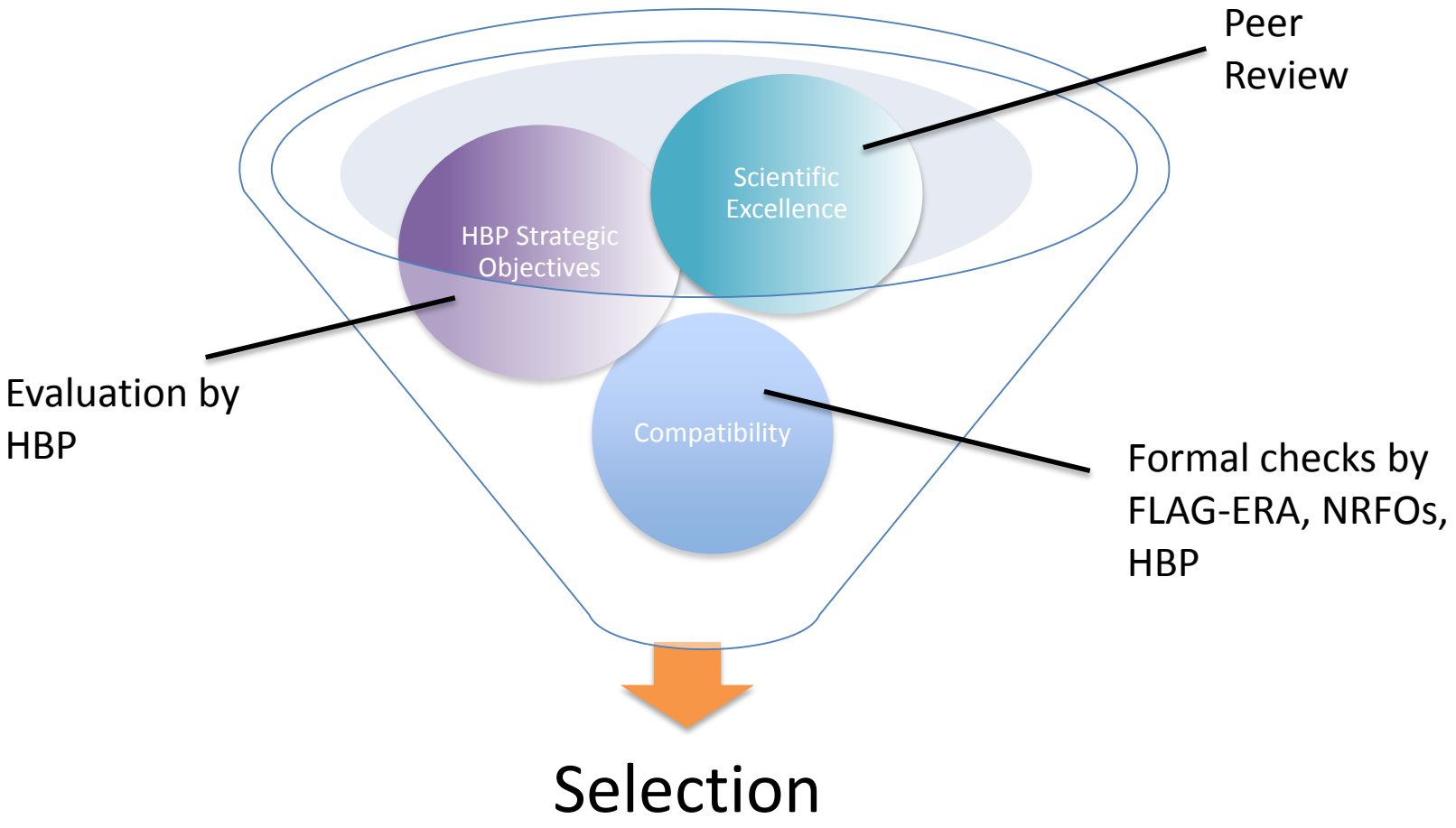
- **Mapping of brain metabolism - receptors, glial-neuronal and neurovascular coupling** (this project would contribute to task 2.1.5, but also provide a link to the cellular level of orgnization (neuron-glia coupling), and to simulation (SP6). putative targets include the lactate and adenosine receptors. The topic is not only relevant for SP2, but also for SP1.

NOTE – FOR INFORMATION PURPOSES ONLY – FPA UNDER REVIEW / FLAG-ERA DEFINES FINAL CALL TEXT

Integration Process

- FLAG-ERA Transnational Call (TNC) will be a first for the project integration process.
- Additional challenge: projects will run from CA governance to FPA governance
- Project integration is defined in the CA and FPA
- Scientific excellence to be evaluated by peer review (national).
- HBP compatibility and contribution evaluated through HBP process.

Evaluation and Partnering Criteria



Questions & Discussion