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Abstract:	The Human Brain Project (HBP) Consortium developed more than 100 research collaborations and more than 20 collaborations with industries in M12-30. These collaborations have generated numerous publications, new code, and in some cases prototypes. Going forward, the Project Coordination Office (PCO) will work with the Consortium to better align collaborations with the Flagship Objectives to help drive the overall progress of the Project. Strong and fruitful relations with FLAG-ERA have been developed, and the first Partnering Projects (PPs) are joining the HBP in SGA1 M01. The association mechanisms and application process for PPs in general were developed and approved. The HBP Education Programme formed an Education Committee, developed and released a curriculum, developed guidelines and calls for schools and workshops, and released its first version of online educational services.
Keywords:	Collaborations, partnerships, industry relations, HBP education programme, funding agencies
Available at:	www.humanbrainproject.eu/ec-deliverables

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1. Introduction

1.1 The European Research Programme Office

One of the HBP's strategic goals is to collaborate with national funding agencies, research programmes and initiatives, and industrial partners, to obtain the best possible access to research, data sources, technologies, platforms and infrastructures offered by other organisations, and to enable organisations outside the HBP to use the tools and results developed by the Project to pursue their own research and innovation activities.

As outlined in the Description of Work (DoW) and expressed in the Commission Staff Working Document *FET Flagships: A novel partnering approach to address grand scientific challenges and to boost innovation in Europe*[1] it is essential that the HBP coordinates its activities with those of other organisations, programmes, initiatives and projects whose activities are related in some way to the goals of the Project.

A primary aim of the European Research Programme (ERP) Office has been to support the HBP achieve its objectives in regards to partnerships and innovation by working with the Consortium, and mapping efforts by the Consortium to:

1) Identify relevant stakeholders in the following target groups:
    a) European and international research institutions, initiatives and infrastructures
    b) EU member states and regions
    c) European industry including SMEs and large industry
    d) International organisations including IGOs
    e) Civil society including NGOs and interest groups
    f) Funders (FLAG-ERA, EU research funding instruments, Venture Capital Firms, Early Stage funding mechanisms, philanthropy, HNW individuals, business incubators etc.).
2) Develop and pilot partnership categories and options for each of the target groups
3) Develop and pilot business development scenarios for the HBP
4) Develop technology portfolio
5) Develop and test an outreach approach and supporting materials for internal and external audiences
6) Identify and build relationships with other relevant Departments (DGs) of the European Commission to identify other EU policies, programs and instruments that could add value to the HBP
7) Monitor progress, assessing outcomes and outputs, reporting, identify key lessons.
8) Develop strategy for Legal Entity Phase including KPIs.

1.2 Purpose of this Document

This document reports progress in the implementation of the ERP. It includes chapters describing contacts with national funding agencies and with other research programmes and initiatives, contacts with industry, and the HBP Education Programme.

1.3 Structure of this Document

The document is structured to highlight the main accomplishments and issues encountered in the period M12–30 in building relations with National Funding Agencies, Research programmes and initiatives and industry relations.

2. Relationships with National Funding Agencies

2.1 Overall Goals

The primary goal in the Ramp-Up Phase was to develop a strong working relationship with FLAG-ERA, which brings together Regional and National Funding Organisations (NRFOs) in Europe, to coordinate opportunities to bring regional and national research activities together with the Flagship.

2.2 Main Achievements

The strong and trustful relationship with FLAG-ERA continued in M12-M30. A key achievement was the Joint Transnational Call (JTC) 2015 and the successful identification of the first six Partnering Projects (PP). These PPs are being brought on board in an official Kick-Off meeting in April 2016.

The ERP also worked closely with FLAG-ERA to define the association mechanisms for integrating the PPs into the HBP. The association mechanism would include a Welcome Letter, a Memorandum of Understanding on being an HBP PP, a Memorandum of Understanding (MoU) on being an HBP Associated Member, Confidentiality Terms and Conditions, and a videoconference call to welcome the PPs and introduce them to the HBP (including an HBP overview presentation), and connect them with the Subproject Leader and Manager with whom they will be working closest.

This experience is being expanded into the development of a general Partnering Package for any research group wishing to join the HBP as a PP. See figure 1 below.

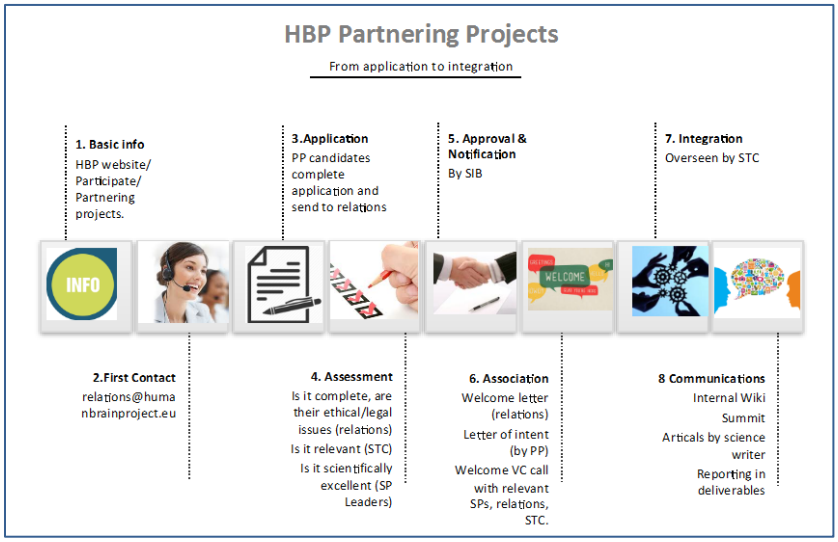

Figure 1: HBP Partnering Projects, from application to integration

The ERP has worked closely with the Science and Technology Coordination and FLAG-ERA to define the call topics for the 2017 JTC call. HBP is supporting FLAG-ERA where possible

with communications efforts about the HBP to encourage NRFOs to participate in the 2017 Call, which will also include innovation.

HBP supported FLAG-ERA in the development of the FLAG-ERA 2 proposal, based on our experiences working together in the Ramp-Up Phase and expectations in regards to HBP needs in the Operational Phase of the Project.

Together with GRAPHENE, HBP participated in developing a proposal for the CSA on Support and Coordination of the Partnering Environment (SCOPE), which, if successful, foresees the development of relations with funding organisations outside FLAG-ERA. To ensure synergies, FLAG-ERA is a member of the proposed SCOPE Steering Committee.

HBP Consortium members also submitted research proposals for National and European funding on diverse topics. These successful proposals have benefited the work of the HBP.

UNIPV received a grant from Regione Lombardia, a National Research Funding Agency in Italy, to expand HBP efforts to include research groups in the region in work to improve strategic data sampling and potentiate modelling to transfer it into robotic applications for neurorehabilitation. Non-HBP partners funded through the grant and involved in this effort include the University of Milano, University of Milano Bicocca, Politecnico di Milano, IRCCS Neurological Institute C. Mondino Pavia. The total grant was EUR 100,000. Four publications were produced in 2015.

UNIPV received a grant from IRCCS C.Mondino, a private, National Neurological Research Institute, to extend HBP research towards neurology and in particular in the MRI and TMS field. Five publications were produced in 2015 thanks to this grant, which totalled EUR 50,000.

EPFL/Blue Brain Project was awarded a grant from the King Abdullah University of Science and Technology (KAUST), a National Research Funding Agency, to undertake research on integrative modelling of brain energy metabolism. Publications were produced.

TUM was awarded EUR 140,000 from BMBF, Germany, a National Research Agency to undertake research on on “Motor Control and Timing in the Cerebellum: Spatio-Temporal Integration in Complex Neuronal Networks”. Several presentations, conference abstracts and a paper were produced.

The HBP PCO collaborated with GRAPHENE to submit a proposal for the SCOPE project, a CSA action to support the partnering environment. If successful, the project will help HBP to promote the partnering project concept with funding organisations not participating in FLAG-ERA, and will enhance HBP’s ability to successfully integrate the PPs into the Flagship. This would increase chances for mutual benefits between the CP and PPs. The outcome of the proposal will be known in Fall 2016.

2.3 Main Problems

There have been a few challenges that have created delays in finalising the association mechanisms for Partnering Projects:

- The Memorandum of Understanding
- The approval process for PPs
- Defining call topics
- IPR

Memorandum of Understanding: the challenge is to outline a set of principles to associate the PPs/AMs to the HBP that would meet the needs of the AMs on the on hand, and those of the Core Project members on the other hand. As the HBP does not have a legal entity that can centralise these questions, the drafting of the MoU needs careful thinking. Going

forward, a simple solution needs to be found that will help resolve, in particular, issues relating to IP because the Partnering Projects are not bound by the HBP Consortium Agreement (CA).

Approval Process for the PPs: outside of FLAG-ERA JTC calls, the approval process for the PPs also needs further discussion as the PPs are expected to propose very specific independent research. A lengthy and multistep approval process may discourage research groups and researchers from submitting proposals. Currently the Science and Infrastructure Board (SIB) is final approving body, but the diversity of the HBP means that the SIB may not be able to judge the relevance of the proposal. Also, PPs are expected to be an important user group for the HBP Platforms. The Platform teams are keen on having an efficient approval process so that groups can become approved as quickly as possible without too many hurdles. This will be resolved in the first months of SGA1.

Defining call topics: as the HBP is an extremely diverse project and FLAG-ERA funding is so far limited, defining a small set of relevant call topics has been challenging. The approach taken by the SPs, described in section three, is an efficient way for collaborating with non-HBP research groups as it foresees collaboration on a topic of mutual interest between the CP partner and other research groups. These groups could possibly submit applications to be "recognised" as Partnering Projects afterwards. This will be explored early in SGA1.

IPR: An ongoing challenge related to the PPs is IPR. The Platforms involve diverse IP from many partners and identifying which IP is needed/implicated for the work of the PPs needs to be addressed.

2.4 The Next Six Months

For the Project Coordination Office, efforts in the next six months focus on defining the 2017 JTC call topics, continuing to foster the relationship with FLAG-ERA, and ensuring the successful integration of the first PPs starting with the kick-off meeting with FLAG-ERA in April 2016. HBP recognises the importance of ensuring the PPs are integrated smoothly and that their experience is mutually beneficial. We would like to be able to communicate about the experience of the first PPs to encourage other groups to seek to join the HBP as a PP.

3. Relationships with Other Research Programmes and Initiatives

3.1 Overall Goals

FET Flagships are expected to achieve transformational impacts on science and technology and bring substantial benefits for European competitiveness and society. As such, Flagships have been built and designed around an innovative concept of science-driven initiatives involving a large number of stakeholders. The broader scientific community, composed of hundreds of researchers and institutions, is one of these stakeholders as they are able to "bring new knowledge, competencies, ideas and resources to the Flagship and will reinforce its scientific directions and leverage its innovation and exploitation potential. By connecting to the Flagships, researchers will benefit from outstanding scientific collaborations and participating countries will reinforce their own technological excellence and expertise over time".[1]

Even without the association mechanisms for the Partnering Projects yet in place, HBP Consortium members participated in more than 100 research collaborations with universities, public institutions and industrial partners that brought new ideas into the HBP

and resulted in a cross-fertilisation with research groups outside the HBP. The research results including prototypes are already benefiting the HBP and helping the HBP move closer to achieving its objectives.

3.2 Main Achievements

The HBP pursued a two-pronged approach to developing collaborations with ongoing research programmes and initiatives, which resulted in diverse collaborations aimed at supporting HBP achieve its core objectives.

- At the SP level, more than 100 collaborations with research groups were established leading to publications and in some cases the development of prototypes
- The PCO and Consortium members continued dialogue with research programmes and initiatives in Europe and third countries in areas including developing the research infrastructure, data collaborations, innovation, key performance indicators.

3.2.1 SP level research collaborations

3.2.1.1 SP1

UNOXF (Chris PONTING) collaborated with VIB, Belgium, a publically funded research institute, to investigate astrocyte heterogeneity. The Research activities undertaken focused on an analysis of single cell astrocyte data from a variety of sources. The results are expected by the end of 2016.

UNOXF also worked with the Max-Planck-Institut, a publicly funded research institute in Germany as part of a research collaboration to validate predictions of surface receptor proteins. The Research activities undertaken included an analysis of single cell data from a variety of sources. Results are expected by mid-2017.

SNS Scuola Normale Superiore, Laboratory of biology Bio@SNS developed a research collaboration with IIT Istituto Italiano di Tecnologia - Center for Nanotechnology Innovation CNI@NEST Pisa, a public research institute, to i) set up an all-in-one inducible expression lentiviral vector in neurons, and ii) engineer short tags for the direct chemical labeling of antibody domains, for advanced imaging purposes. The Research activities undertaken included construction of plasmids, inducible viral vectors, tagged antibody domains. A pipeline of scientific publications is expected in 2016/2017.

EBRI worked with Sapienza University to investigate functional aspects of neuroligins in the brain. Research activities undertaken included *in vivo* injection of GFP lentivirus in mice and patch-clamp recordings from brain slices. Publications are expected in 2016.

IST (Ryuichi SHIGEMOTO) worked with Osaka University to develop new probes for freeze-fracture replica double labelling. This will be useful for T1.1.3, elucidation of principles of receptor and ion channel co-localization. Activities included discussions and collaboration among postdocs at both universities on the synthesis of new probes. The first results of double labeling using the new probes are expected by the end of 2016.

UCLM (Rafael LUJÁN) established a collaboration with Fukui University to perform experiments using freeze-fracture replica single and double labelling. This will be useful for the 2D and 3D mapping of receptors and ion channels, as well as for the elucidation of principles of receptor and ion channel co-localization. Research activities to-date focus on subcellular localization of receptors and ion channels using SDS-FRL technique. Two articles are under preparation.

The Swiss Institute of Bioinformatics worked with Temple University and with Weill Medical College of Cornell University on a research collaboration to elucidate elementary mechanisms underlying K channel functions. Research activities undertaken focused on Ion

channel mutagenesis, electrophysiology measurements. A publication is expected in the coming year.

LENS undertook several research collaborations with external groups that resulted in benefits to the HBP, such as:

- The Department of Information Engineering, University of Florence on the development of automated analysis tools for teravoxel-sized images Research activities undertaken focused on the development of deep learning methods for cell soma detection.

  Publications:

  P. Frasconi, L. Silvestri, P. Soda, R. Cortini, F. S. Pavone and G. Iannello, "Large-scale automated identification of mouse brain cells in confocal light sheet microscopy images", *Bioinformatics* **30**(17), i587-i593 (2014).

  L. Silvestri, M. Paciscopi, P. Soda, F. Biamonte, G. Iannello, P. Frasconi and F. S. Pavone, "Quantitative neuroanatomy of all Purkinje cells with light sheet microscopy and high-throughput image analysis", *Front. Neuroanat.* **9**, 68 (2015).

  New code:

  http://bcfind.dinfo.unifi.it/

- The Integrated Research Centre, University Campus Bio-medico of Rome to develop tools to manage teravoxel-sized images Research activities undertaken focused on the development of stitching tool (TeraStitcher) and of visualization tool (TeraFly).

  Publications:

  P. Frasconi, L. Silvestri, P. Soda, R. Cortini, F. S. Pavone and G. Iannello, "Large-scale automated identification of mouse brain cells in confocal light sheet microscopy images", *Bioinformatics* **30**(17), i587-i593 (2014).

  I. Costantini, J.-P. Ghobril, A. P. Di Giovanna, A. L. Allegra Mascaro, L. Silvestri, M. C. Müllenbroich, L. Onofri, V. Conti, F. Vanzi, L. Sacconi, R. Guerrini, H. Markram, G. Iannello, and F. S. Pavone, "A versatile clearing agent for multi-modal brain imaging", *Sci. Rep.* **5**, 9808 (2015).

  New code:

  http://abria.github.io/TeraStitcher/

- Meyer Pediatric Hospital, Florence on the Analysis of human brain samples with cutting-edge optical methods. The research activities undertaken focused on optimisation of clearing and staining of human brain biopsies.

  Publication:

  I. Costantini, J.-P. Ghobril, A. P. Di Giovanna, A. L. Allegra Mascaro, L. Silvestri, M. C. Müllenbroich, L. Onofri, V. Conti, F. Vanzi, L. Sacconi, R. Guerrini, H. Markram, G. Iannello, and F. S. Pavone, "A versatile clearing agent for multi-modal brain imaging", *Sci. Rep.* **5**, 9808 (2015).

- Harvard University on mapping whole-brain activity with cellular resolution using immediate early genes. The specific research activities undertaken focused on light-sheet analysis of Arc-dVenus mice. They will publish a paper early in SGA1.

  Conference proceeding:

  L. Silvestri, N. Rudinskiy, M. Paciscopi, M. C. Müllenbroich, I. Costantini, L. Sacconi, P. Frasconi, B. T. hyman, and F. S. Pavone, "Brain-wide charting of neuronal activation maps with cellular resolution," in Optics in the Life Sciences, OSA Technical Digest (online) (Optical Society of America, 2015), paper BrM3B.6.

UPM worked with Instituto Cajal, Consejo Superior de Investigaciones Científicas, a public Research Organisation, to development a new tool to explore and reveal the detailed organization of the microanatomy of pyramidal neurons with functionally related models. The specific research activities undertaken focused on visual analysis and 3D cell reconstructions.

The result of the collaboration was the development of the *PyramidalExplorer*: A New Interactive Tool to Explore Morpho-Functional Relations of Human Pyramidal Neurons. Pablo TOHARIA, Oscar D. ROBLES, Isabel FERNAUD-ESPINOSA, Julia MAKAROVA, Sergio E. GALINDO, Angel RODRIGUEZ, Luis PASTOR, Oscar HERRERAS, Javier DEFELIPE and Ruth BENAVIDES-PICCIONE.

Article: http://journal.frontiersin.org/article/10.3389/fnana.2015.00159/abstract

PyramidalExplorer: http:// gmrv.es/pyramidalexplorer.

Neurospin, CEA cooperated with University of Concepcion, Concepcion, Chile on the inference of a U-fiber bundle atlas. Research activities undertaken focused on an experiment with different strategies to align brains before comparing their bundle for atlas inference. The outcome of was a first prototype of U-fiber bundle atlas. **Neurospin** also collaborated with Université de Tour - Inserm U 930 - CNRS ERL 3106, a university and Public Research Organisation on the Validation of the DMRI-based tractography using Dissection (Klingler s method). In the near future, this collaboration will be expanded to include high resolution *post mortem* Diffusion MRI. The research activities undertaken aimed 1) to build up a database containing, for the same subjects, *in vivo* (3D and DWI-MRI, neuropsychological evaluation) and *ex vivo* data (DWI-MRI and tracts reconstructions from dissection), 2) to qualitatively and quantitatively compare *in* and *ex vivo* MR-tractography to dissection, considered as a ground truth, 3) To develop a website giving free access to data and to this comparison method for research and teaching. Results of the collaboration can be found under https://sites.google.com/site/fibratlas.

JUELICH worked with McGill University, Montreal Neurological Institute (MNI), Montreal, Canada, a University and Public Research Organisation to provide tools and data for the BigBrain. Research activities undertaken aimed to provide a tissue classification of the BigBrain. Tools were developed to extract the laminar structure of the cerebral cortex in 3D. Publications:

Amunts K, Lepage C, Borgeat L, Mohlberg H, Dickscheid T, Rousseau ME, Bludau S, Bazin PL, Lewis LB, Oros-Peusquens AM, Shah NJ, Lippert T, Zilles K, Evans AC (2013) BigBrain: An ultrahigh-resolution 3D human brain model. Science, 340(6139): 1472-1475.

Wagstyl K, Lepage C, Zilles K, Amunts K, Fletcher P, Evans A (2016) BigBrain. Automated analysis of laminar structure in the cerebral cortex. Abstract submitted to OHBM, 2016.

INRIA collaborated with the University of Stanford, Departments of Psychology, Poldrack's lab as part of a formal, “associate team” programme of INRIA to develop meta-analyses of brain activation data. Research activities undertaken included Machine learning models to probe the occurrence of cognitive concepts in a large corpus of experiments and improved modelling of the cognitive concepts related to functional activation experiments. A publication is being written and code is regularly produced (joint Coding sprints in Berkeley in May 2016 and in Paris in June 2016).

INRIA collaborated with UC Berkeley, Gallant's lab as part of a formal collaboration on France-Berkeley Funding to develop advanced computational models of vision. Research activities undertaken include experiments with high resolution fMRI at 7T and a comparison of activity models for videos encoding. A publication submitted to NeuroImage.

JUELICH collaborated with the Department of Radiology, Stanford University, USA on Fibre tracts in human hippocampus. Research activities undertaken included a joint analysis together with Michael ZEINEH in Juelich.

Publication:

Zeineh, M.M., Palomero-Gallagher, N., Axer, M., Gräßel, D., Goubran, M., Wree, A., Woods, R., Amunts, K., Zilles, K.: Direct visualization and mapping of the spatial course of fiber tracts at microscopic resolution in the human hippocampus. Cerebral Cortex (2016, in press)

JUELICH collaborated with the Department of Psychology, Stanford University, Stanford, CA, USA on the identification of the face recognition area by cyto- and receptorarchitecture combined with functional imaging. The main research activities undertaken were brain mapping.

Publications:

Weiner, K.S. and Zilles, K.: The anatomical and functional specialization of the fusiform gyrus. Neuropsychologia http://dx.doi.org/10.1016/j.neuropsychologia.2015.06.033 (2015)

Weiner, K., Golarai, G., Caspers, J., Mohlberg, H., Zilles, K., Amunts, K., Grill-Spector, K.: The mid-fusiform sulcus: A landmark identifying both cytoarchitectonic and functional divisions of the human fusiform gyrus. Neuroimage 84: 453-465 (2014)

JUELICH collaborated with Helmholtz Center Munich, Institute of Developmental Genetics (IDG), Neuherberg, Germany, a public research organization to explore the role of transmitter receptors in Parkinson's disease. Research activities undertaken focused on multireceptor measurements inKO animal models of Parkinson's disease.

Publication:

Cremer, J.N., Amunts, K., Graw, J., Piel, M., Rösch, F., Zilles, K.: Neurotransmitter receptor density changes in Pitx3ak mice – a model relevant to Parkinson's disease. Neuroscience 285: 11–23 (2015)

A further collaboration between JUELICH and Max-Planck Institute for Human Cognitive and Brain Sciences, Department of Neuropsychology, Leipzig, Germany focused on the characterization of language related cortical areas by their receptor expression. Research activities focused on Receptor mapping and one publication was produced.

Publication:

Zilles, K., Bacha-Trams, M., Palomero-Gallagher, N., Amunts, K., Friederici, A.D.: Common molecular basis of the sentence comprehension network revealed by neurotransmitter receptor fingerprints. Cortex 63: 79-89 (2015)

Julich was part of a large collaboration on Atlasing that included Allen Institute for Brain Science, Seattle, WA, USA; Department of Anatomy and Neurobiology, Washington University School of Medicine, St. Louis, MO, USA; The Institute for Neuroimaging and Informatics (INI) and Laboratory for Neuro Imaging (LONI), Keck School of Medicine, University of Southern California, Los Angeles, CA, USA; Center for Magnetic Resonance Research, Departments of Radiology & Neurosurgery, University of Minnesota School of Medicine, Minneapolis, MN, USA; Hellen Wills Neuroscience Institute, Brain Imaging Center, University of California at Berkeley, CA, USA; Department of Cognitive Neuroscience, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands; Institute of Basic Medical Sciences, University of Oslo, Oslo, Norway; INSERM, U992, Cognitive Neuroimaging Unit, F-91191 Gif/Yvette, France; Cuban Neuroscience Center, Havana, Cuba; Key Laboratory for Neuroinformation, Chengudu, China; Parietal Research Team, French Institute for Research in Computer Science and Automation (INRIA), Gif sur Yvette, France; Department of Psychiatry, Psychotherapy and Psychosomatics, RWTH University Aachen, Aachen, Germany; International Neuroinformatics Coordinating Facility Secretariat (INCF), Stockholm, Sweden; Department of Neuromodulation, University of Cologne, Cologne, Germany; Department of Neurosurgery, Stanford University, Stanford, USA; Department of Neurosciences, KU Leuven, Leuven, Belgium; Montreal Neurological Institute, McGill University, Montreal,

Canada; Institute for Clinical Neuroscience and Medical Psychology, Heinrich-Heine University, Düsseldorf, Germany. The aim of the collaboration was to undertake a critical review of interoperability of atlasing approaches. Publication:

Amunts, K., Hawrylycz, M.J., Van Essen, D.C., Van Horn, J.D., Harel, N., Poline, J-B., De Martino, F., Bjaalie, J.G., Dehaene-Lambertz, G., Dehaene, S., Valdes-Sosa, P., Thirion, B., Zilles, K., Hill, S.L., Abrams, M.B., Tass, P.A., Vanduffel, W., Evans, A.C., Eickhoff, S.B.: Interoperable Atlases of the Human Brain. Neuroimage 99: 525-532 (2014).

A further collaboration by **JUELICH** was with the Department of Anatomy and Neurobiology, Boston University School of Medicine, Boston, MA 02118, USA. This collaboration focused on Receptor- and cytoarchitecture in human and rodent cingulate cortex. The Research activities undertaken focused on Receptor and fibre tract mapping as well as cytoarchitectonic parcellation. Two publications were produced:

Vogt, B,A., Hof, P.R., Zilles, K., Vogt, L.J., Herold, C., Palomero-Gallagher, N.: Cingulate area 32 homologies in mouse, rat, macaque and human: Cytoarchitecture and receptor architecture. J. Comp. Neurol. 521:4189-4204 (2013).

Palomero-Gallagher, N., Zilles, K., Schleicher, A., Vogt, B.A.: Cyto- and receptor architecture of area 32 in human and macaque brains. J. Comp. Neurol. 521: 3272-3286 (2013).

JUELICH collaborated with the Ahmanson-Lovelace Brain Mapping Center, and David Geffen School of Medicine UCLA, Los Angeles, USA to write a Common grant application on the Transmitter receptor mapping, fibre tracts and cytoarchitecture in vervet monkey brains during postnatal ontogeny. Research activities undertaken included Receptor and fibre tract mapping in adult vervet monkey brains. The collaboration resulted in a publication:

Zilles, K., Palomero-Gallagher, N., Gräßel, D., Schlömer, P., Cremer, M., Woods, R., Amunts, K., Axer, M.: High-resolution fiber and fiber tract imaging using polarized light microscopy in the human, monkey, rat and mouse brain. In: Rockland K.S. (Ed.), Axons and Brain Architecture, pp. 369-389. Elsevier Academic Press, San Diego (2016)

JUELICH continued a collaboration with the Research Imaging Institute, University of Texas Health Science Center at San Antonio in a formal collaboration through the BrainMap Consortium and supported by an NIH grant. The Goal of the collaboration was to develop and implement methods for neuroimaging meta-analyses and database-driven functional mapping of the human brain. The Research activities undertaken focused on revised methods for neuroimaging meta-analyses, implemented and refined co-activation mapping including correction for activation baserates, developed approaches for co-activation based parcellation, improved methods for functional inference. A result was the development of new versions of the GingerALE software, ~50 joint publications since 2013

JUELICH also collaborated with the Chinese Academy of Sciences, Institute of Automation, a Public Research Organisation as part of a formal, MoU between the CAS and the FZJ. The goal of the collaboration was to advance multi-modal human brain atlasing, multi-scale neuroanatomy, imaging genetics and pathophysiology of neurological and psychiatric disorders, large-scale integration of neuroimaging data. Research activities undertaken focused mainly on the Brainnetome atlas and the comparison to JuBrain, connectivity-based parcellation, structure function relationships. The Brainnetome atlas is about to be publically released, 8 joint publications on multi-modal brain mapping were produced.

JUELICH collaborated with the Div. Theoretical Bioinformatics, B080, Biomedical Computer Vision Group, DKFZ Heidelberg and University of Heidelberg, BioQuant, IPMB as part of the portfolio “Supercomputing and Modeling for the Human Brain”, funded by the Helmhotz Association. The collaboration focused on image registration and research activities undertaken To use sophisticated tools for image analysis for aligning series of

images to create a 3D-reconstruction of the human brain. Protoptypes of software tools already established.

3.2.2 SP4/EITN

In the Ramp-Up Phase, the EITN hosted several visitors including Michael Berry (Princeton University, two weeks), Diego CONTRERAS (University of Pennsylvania, two weeks), Sergey KOROGOD (University of Kiev, two weeks), Valentina GLIOZZI (University of Torino, two weeks), Marco BRIGHAM (University of Lisbon, two weeks), Fabian CHERSI (UCL SP3-SP4, two weeks), Several collaborations emerged from the hosting of these visitors.

Michael BERRY is collaborating with Olivier MARRE and Ulisse FERRARI (SP4), and his stay at EITN was used to draft this collaboration.

Diego CONTRERAS is collaborating with Alain DESTEXHE, and in this particular case, his stay at the EITN was very productive in reviving previous collaborations between the two labs. They have plans to submit together a joint application to the BRAIN initiative in the US, based on large-scale multi-electrode recordings and analysis. Diego Contreras plans to return to the EITN as a speakers of the Vision Workshop in May 2016.

Marco BRIGHAM is collaborating now with Alain DESTEXHE, and a paper is currently being written. His stay at the EITN was essential in this collaboration.

Mathieu GALTIER's work was important in starting a collaboration with a PME start-up company ("RYTHM"), specialized in fabricating devices to interface the human EEG with appropriate stimulation. Together with RYTHM, CNRS submitted and obtained a FLAG-ERA grant, called SLOWDYN, and which consists in the study of slow-wave dynamics using models, animal experiments (mice) and human subjects, in parallel.

3.2.3 SP5

UiO (Jan G. BJAALIE / Trygve B. LEERGAARD) worked with Professor Menno P. WITTER, The Kavli Institute for Systems Neuroscience, Norwegian University of Science and Technology, Trondheim, Norway to Establish open access atlas of the rat hippocampal region with expert-validated delineation criteria. Research activities undertaken included:

1) Generation of comprehensive collection of histological material cut in coronal, sagittal, horizontal planes, stained to reveal different aspects of the hippocampal neuroarchitecture.
2) Systematic histological delineation based on updated cyto- and chemo-architectonic criteria in three principal histological planes.
3) Analysis of structural and diffusion MRI contrast in the rat hippocampal region, followed by delineation of the high-resolution ex vivo MRI/DTI Waxholm Space Atlas template for the Sprague Dawley brain.

The collaboration produced interactive online atlas application for the rat hippocampal region (Kjønigsen *et al.*, 2011), resource available via www.rbwb.org (Rat Hippocampal Atlas) and publication of detailed descriptions of histological criteria used for delineation of the hippocampal region in multiple planes (Boccara *et al.*, 2015) and Sharing of 3-D delineations of the rat hippocampal region (Waxholm Space Atlas, version 2.0), via the INCF software center, with publication of delineation criteria (Kjønigsen *et al.*, 2015).

UiO (Jan G. BJAALIE) worked with Professor Steffen Roßner, University of Leipzig, Germany through the EU JPND programme, project "CrossSeeds" to combine experimental approaches from fundamental, pre-clinical and clinical neuroscience with computational approaches to identify cross-disease pathways leading to pathogenic protein aggregation. Research activities included the production and digitalization of of preliminary series for antibody testing. The series are currently being registered to the mouse brain atlas using

Navigator3 registration platform and tool QuickNII. Pilot experiments were conducted, first results are expected by the end of 2016.

UiO (Jan G. BJAALIE) collaborated with Professor Stephan VON HÖRSTEN, University of Erlangen, Germany as part of a collaboration through EU JPND program, project "CrossSeeds" to combine experimental approaches from fundamental, pre-clinical and clinical neuroscience with computational approaches to identify cross-disease pathways leading to pathogenic protein aggregation. Research activities undertaken included a visit to the laboratory in Erlangen in order to coordinate some experimental parts. Disease models, i.e. mouse and rat brain series will be labelled to show specific protein aggregates and sent to us for digitalization. Pilot experiments were conducted, first results are expected by the end of 2016.

UPM (Pedro LARRAÑAGA and Concha BIELZA) worked with:

- Columbia University to study the random positions of dendritic spines in human cerebral cortex. The result was the publication of a paper in the Journal of Neuroscience.
- the University of California San Francisco To develop individualized progonostic for temporal lobe epilepsy. A journal paper will be published in 2016.
- the Centro de Alzheimer Fundación Reina Sofia to analyze data from a longitudinal study on Alzheimer's patients for early diagnosis. The main Research activities undertaken was Data analysis. A paper was published in Frontiers in Aging Neuroscience.
- the Instituto de Salud Carlos III to analyze data of non motor symptoms in Parkinson's patients with the aim of discovering new subtypes of patients. A journal paper wil be published.
- Bioef to analyze data extracted from the human brain bank of Bioef. A journal paper will be published.

KI (Sten GRILLNER), **EPFL** (Sean HILL) and **UCSD** (Terry SEJNOWSKY) fostered the relationship with the US Brain initiative Chines and Japanese Brain initiatives by participating in several conferences.

Neurospin, CEA worked with the University of Concepcion, Chile, on an Inference of a U-fiber bundle atlas. Research activities undertaken focused on an experiment with different strategies to align brains before comparing their bundle for atlas inference. Results consisted of the first prototype of U-fiber bundle atlas. **Neurospin** also worked with Université de Tour - Inserm U 930 - CNRS ERL 3106 to validate the DMRI-based tractography using Dissection (Klingler s method), and in the near future, high-resolution *post mortem* Diffusion MRI. Specific aims were:

1) To build up a database containing, for the same subjects, *in vivo* (3D and DWI-MRI, neuropsychological evaluation) and *ex vivo* data (DWI-MRI and tracts reconstructions from dissection),

2) To qualitatively and quantitatively compare *in* and *ex vivo* MR-tractography to dissection, considered as a ground truth,

3) To develop a website giving free access to data and to this comparison method for research and teaching.

Results of the collaboration can be viewed on: https://sites.google.com/site/fibratlas/.

JUELICH worked with McGill University, Montreal Neurological Institute (MNI), Montreal, Canada to develop tools and data for the BigBrain. Research activities were undertaken in order to provide a tissue classification of the BigBrain. In addition, tools are being developed to extract the laminar structure of the cerebral cortex in 3D.

Two publications were produced:

Amunts K, Lepage C, Borgeat L, Mohlberg H, Dickscheid T, Rousseau ME, Bludau S, Bazin PL, Lewis LB, Oros-Peusquens AM, Shah NJ, Lippert T, Zilles K, Evans AC (2013) BigBrain: An ultrahigh-resolution 3D human brain model. Science, 340(6139): 1472-1475.

Wagstyl K, Lepage C, Zilles K, Amunts K, Fletcher P, Evans A (2016) BigBrain. Automated analysis of laminar structure in the cerebral cortex. Abstract submitted to OHBM, 2016.

INRIA worked with University of Stanford, Departments of Psychology, POLDRACK's lab to develop meta-anlyses of brain activation data. Research activities undertaken were:

- Machine learning models to probe the occurrence of cognitive concepts in a large corpus of experiments.
- Improved modelling of the cognitive concepts related to functional activation experiments.

A publication is being written and code is regularly produced (joint Coding sprints in Berkeley in May and in Paris in June).

INRIA worked with UC Berkeley, Gallant's lab to develop advanced computational models of vision. Research activities undertaken focused on experiments with high resolution fMRI at 7T and a Comparison of activity models for videos encoding a publication was submitted to NeuroImage.

JUELICH worked with the Department of Radiology, Stanford University, USA to research Fibre tracts in human hippocampus. A publication was produced:

Zeineh, M.M., Palomero-Gallagher, N., Axer, M., Gräßel, D., Goubran, M., Wree, A., Woods, R., Amunts, K., Zilles, K.: Direct visualization and mapping of the spatial course of fiber tracts at microscopic resolution in the human hippocampus. Cerebral Cortex (2016, in press).

JUELICH worked with the Department of Psychology, Stanford University, Stanford, CA, USA to identify the face recognition area by cyto- and receptorarchitecture combined with functional imaging. Research activities undertaken focused on grain mapping. Publications produced:

Weiner, K.S. and Zilles, K.: The anatomical and functional specialization of the fusiform gyrus. Neuropsychologia http://dx.doi.org/10.1016/j.neuropsychologia.2015.06.033 (2015).

Weiner, K., Golarai, G., Caspers, J., Mohlberg, H., Zilles, K., Amunts, K., Grill-Spector, K.: The mid-fusiform sulcus: A landmark identifying both cytoarchitectonic and functional divisions of the human fusiform gyrus. Neuroimage 84: 453-465 (2014).

JUELICH worked with Helmholtz Center Munich, Institute of Developmental Genetics (IDG), Neuherberg, Germany, a Public Research Organization on the role of transmitter receptors in Parkinson's disease. Research activities undertaken focused on Multireceptor measurements inKO animal models of Parkinson's disease. A publication was produced:

Cremer, J.N., Amunts, K., Graw, J., Piel, M., Rösch, F., Zilles, K.: Neurotransmitter receptor density changes in Pitx3ak mice – a model relevant to Parkinson's disease. Neuroscience 285: 11–23 (2015).

JUELICH worked with Max-Planck Institute for Human Cognitive and Brain Sciences, Department of Neuropsychology, Leipzig, Germany on the Characterization of language related cortical areas by their receptor expression. The main research activity undertaken was receptor mapping. A publication was produced:

Zilles, K., Bacha-Trams, M., Palomero-Gallagher, N., Amunts, K., Friederici, A.D.: Common molecular basis of the sentence comprehension network revealed by neurotransmitter receptor fingerprints. Cortex 63: 79-89 (2015).

JUELICH worked with a large Consortium of research institutes on atlasing. The main research activities undertaken were a critical review of interoperability of atlasing approaches. The Consortium included: Allen Institute for Brain Science, Seattle, WA, USA; Department of Anatomy and Neurobiology, Washington University School of Medicine, St. Louis, MO, USA; The Institute for Neuroimaging and Informatics (INI) and Laboratory for Neuro Imaging (LONI), Keck School of Medicine, University of Southern California, Los Angeles, CA, USA; Center for Magnetic Resonance Research, Departments of Radiology & Neurosurgery, University of Minnesota School of Medicine, Minneapolis, MN, USA; Hellen Wills Neuroscience Institute, Brain Imaging Center, University of California at Berkeley, CA, USA; Department of Cognitive Neuroscience, Faculty of Psychology and Neuroscience, Maastricht University, Maastricht, The Netherlands; Institute of Basic Medical Sciences, University of Oslo, Oslo, Norway; INSERM, U992, Cognitive Neuroimaging Unit, F-91191 Gif/Yvette, France; Cuban Neuroscience Center, Havana, Cuba; Key Laboratory for Neuroinformation, Chengudu, China; Parietal Research Team, French Institute for Research in Computer Science and Automation (INRIA), Gif sur Yvette, France; Department of Psychiatry, Psychotherapy and Psychosomatics, RWTH University Aachen, Aachen, Germany; International Neuroinformatics Coordinating Facility Secretariat (INCF), Stockholm, Sweden; Department of Neuromodulation, University of Cologne, Cologne, Germany; Department of Neurosurgery, Stanford University, Stanford, USA; Department of Neurosciences, KU Leuven, Leuven, Belgium; Montreal Neurological Institute, McGill University, Montreal, Canada; Institute for Clinical Neuroscience and Medical Psychology, Heinrich-Heine University, Düsseldorf, Germany. Publication:

Amunts, K., Hawrylycz, M.J., Van Essen, D.C., Van Horn, J.D., Harel, N., Poline, J-B., De Martino, F., Bjaalie, J.G., Dehaene-Lambertz, G., Dehaene, S., Valdes-Sosa, P., Thirion, B., Zilles, K., Hill, S.L., Abrams, M.B., Tass, P.A., Vanduffel, W., Evans, A.C., Eickhoff, S.B.: Interoperable Atlases of the Human Brain. Neuroimage 99: 525-532 (2014)

JUELICH collaborated with the Department of Anatomy and Neurobiology, Boston University School of Medicine, Boston, MA 02118, USA on Receptor- and cytoarchitecture in human and rodent cingulate cortex. The main research activities undertaken were receptor and fibre tract mapping as well as cytoarchitectonic parcellation. Two publications were produced:

Vogt, B,A., Hof, P.R., Zilles, K., Vogt, L.J., Herold, C., Palomero-Gallagher, N.: Cingulate area 32 homologies in mouse, rat, macaque and human: Cytoarchitecture and receptor architecture. J. Comp. Neurol. 521:4189-4204 (2013).

Palomero-Gallagher, N., Zilles, K., Schleicher, A., Vogt, B.A.: Cyto- and receptor architecture of area 32 in human and macaque brains. J. Comp. Neurol. 521: 3272-3286 (2013).

JUELICH worked with Ahmanson-Lovelace Brain Mapping Center, and David Geffen School of Medicine UCLA, Los Angeles, USA on the transmitter receptor mapping, fibre tracts and cytoarchitecture in vervet monkey brains during postnatal ontogeny. The main research activities undertaken were receptor and fibre tract mapping in adult vervet monkey brains. A publication was produced:

Zilles, K., Palomero-Gallagher, N., Gräßel, D., Schlömer, P., Cremer, M., Woods, R., Amunts, K., Axer, M.: High-resolution fiber and fiber tract imaging using polarized light microscopy in the human, monkey, rat and mouse brain. In: Rockland K.S. (Ed.), Axons and Brain Architecture, pp. 369-389. Elsevier Academic Press, San Diego (2016).

JUELICH worked with the Research Imaging Institute, University of Texas Health Science Center at San Antonio through the BrainMap Consortium supported by an NIH grant to implement methods for neuroimaging meta-analyses and database-driven functional mapping of the human brain. The main Research activities undertaken were revised methods for neuroimaging meta-analyses, implemented and refined co-activation mapping including correction for activation baserates, developed approaches for co-activation

based parcellation, improved methods for functional inference. The collaboration resulted in new versions of the GingerALE software, ~50 joint publications since 2013.

JUELICH worked with the Chinese Academy of Sciences, Institute of Automation, a Public Research Organisation, as part of a formal collaboration with a MoU between the CAS and the FZJ, to advance multi-modal human brain atlasing, multi-scale neuroanatomy, imaging genetics and pathophysiology of neurological and psychiatric disorders, large-scale integration of neuroimaging data. Specific research activities undertaken focused on the Brainnetome atlas and the comparison to JuBrain, connectivity-based parcellation, structure function relationships. The Brainnetome atlas is about to be publically released and they produced eight joint publications on multi-modal brain mapping.

JUELICH worked with the Div. Theoretical Bioinformatics, B080, Biomedical Computer Vision Group, DKFZ Heidelberg and University of Heidelberg, BioQuant, IPMB as part of the portfolio "Supercomputing and Modeling for the Human Brain", funded by the Helmhotz Association on image registration. Research activities undertaken focused on using sophisticated tools for image analysis for aligning series of images to create a 3D-reconstruction of the human brain. Prototypes of software tools were developed.

SKU (Paul TIESINGA/Rembrandt BAKKER) worked with Radboud University Nijmegen (SKU) — Researcher: Marcel VAN GERVEN — to develop missing data strategies based on mouse connectome data from Zingg et al paper. Specific research activities undertaken were the Co-supervision of master student working on the collaborative project — building a latent variable model to account for connectivity structure. A publication is in preparation.

UPM (WP5.2) entered diverse collaborations to further refine the EspINA toolkit, including with:

- New York University, New York, NY, USA
- Universidad Autónoma de Madrid, Madrid, Spain t
- Janelia Farm Research Campus, Howard Hughes Medical Institute, Ashburn, VI, USA. Usage reference (http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0087351)
- University Medical Center Freiburg, Freiburg, Germany)Usage reference (http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0066191)
- Institute of Neuroanatomy, Hannover Medical School, Hannover, Germany (Usage reference (http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0066191)
- University of Barcelona, Barcelona, Spain (Usage reference (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4440362/)
- Institut de Recerca de l'Hospital Universitari de la Vall d'Hebron (VHIR), Barcelona, Spain (Usage reference (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4440362/)
- NTNU, Norwegian University of Science and Technology, Trondheim, Norway (Usage reference (http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A740261&dswid=-2414)
- University of Yamanashi, Chuo-city, Japan (Usage reference (http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A740261&dswid=-2414).

Members of WP5.3 (Andrew DAVISON, Sonja GRÜN, Michael DENKER, Alper YEGENOGLU, Detlef HOLSTEIN) and Dr Rick GERKIN (ASU), Dr Todd JENNINGS (LMU), worked with Mr Robert PRÖPPER (TUB) a) Arizona State University b) Ludwig-Maximilians-University of Munich c) Technische Universität Berlin on the Community development of the Elephant electrophysiology data analysis toolkit. Elephant is developed as an open-source, open-community project on Github. The aim was to contribute code to the project and performed code review. The results were fully integrated into the Elephant code base.

An additional collaboration on Elephant was with Thomas WACHTLER (LMU) and Daniel WOJCIK (Nencki) on the Integration of tools developed in the lab of Daniel Wojcik. With Thomas WACHTLER, metadata management using odML was driven by employing the software in use cases based on odML, Neo, and Elephant. This took place as part of the Community development of the Elephant electrophysiology data analysis toolkit and interfacing of Elephant with the Neo and odML software packages The code contributions are in the process of being integrated into the Elephant code base.

3.2.4 SP6

Eilif MULLER (EPFL-BBP), Costas ANASTASSIOU (Allen), Sergey GRATIY (Allen), Padraig GLEESON (UCL), Andrew DAVISON (SP9; UNIC-CNRS), Werner VAN GEIT (EPFL-BBP) and others worked together on the convergence on performance data models for large-scale simulations and analysis. The collaboration is ongoing to explore and disseminate a proposed standard performance data-model format for large-scale simulations, around which an ecosystem can be built for the benefit of HBP, Allen and community use-cases, and for which bridges can be developed with NeuroML where appropriate. Results are expected Q3-Q4 of 2016.

Giorgio ASCOLI (Krasnow Institute), Frances SKINNER (UToronto), Padraig GLEESON (UCL), Szabolcs KALI (SP1-HBP, IEM-HAS), Alex THOMSON (UCL), Audrey MERCER (UCL), Michele MIGLIORE (CNR), Marianne BEZAIRE (Boston U), and others worked together to define a community roadmap for the development of open and unifying models of hippocampus. Several meetings were organized: Hippocamp (http://neuralensemble.org/meetings/HippocampCA1/), and an informal dinner meeting at SfN2015 in Chicago. A community roadmap opinion piece is in preparation. Student exchange between IEM-HAS, EPFL-BBP and UCL on hippocampal single neuron modeling. Work towards the M30 delivery of a scaffold model of hippocampus. Several collaborators contributed “pro bono”. The collaboration has the following results to date:

- M30 delivery of scaffold model of hippocampus including models for primary neuron types.
- Community roadmap opinion piece is in final stages of preparation, but to include sufficient time for feedback from the many community partners, this may not be submitted to a journal by M30. In that case, an option would be to put a first version of the paper on arxiv.org.
- A student exchange between EPFL-BBP and IEM-HAS resulted in contributions to the open source testing framework SciUnit/NeuroUnit (https://github.com/BlueBrain/neuronunit).

EPFL/BBP collaborated with The Victorian Research Laboratory (VRL) of the National Information and Communication Technology Australia and the University of Melbourne in the context of HBP-CIBF (http://www.cibf.edu.au/) collaboration on the evaluation of predictive-coding hypothesis in the BBP cortical microcircuit model. Two grant proposals to the Australian Research Council have been submitted to support this collaboration in a more formal way. Hamish MEFFIN is PI, Eilif MULLER is co-PI. One of the proposals was unsuccesful. The decision on the other is still pending. Assuming the ARC grant applications are successful, first results/outputs should come out in 2017.

EPFL/ BBP worked with King Abdullah University of Science and Technology (KAUST) as part of a formal collaboration that predates the HBP. The current CRG3 collaboration was concluded during the Ramp-Up Phase. It represents a complementary effort to activities of SP6 and intends to develop into a partnering project.

Goals of the collaboration are on Integrative Modeling of Brain Energy Metabolism. Research activities undertaken focus on EM reconstruction of rat neuropil, visualization and modelling of astrocytes. Results of the collaboration are publications:

- Marwan Abdellah, Ahmet Bilgili, Stefan Eilemann, Henry Markram, and Felix Schurmann. Physically-based In Silico Light Sheet Microscopy for Visualizing Fluorescent Brain Models. *BioVis* 2015, 2015.
- Ahmet Bilgili, Stefan Eilemann, Grigori Chevtchenko, Renato Pajarola, and Felix Schürmann. Large-scale Interactive Volume Rendering Engine. *Eurographics Symposium on Parallel Graphics and Visualization*, 2015.
- Corrado Cali, Jumana Baghabra, Daniya Boges, Glendon Holst, Anna Kreshuk, Fred Hamprecht, Madhusudhanan Srinivasan, Heikki Lehvslaiho, and Pierre Magistretti. Three-dimensional immersive virtual reality for studying cellular compartments in 3D models from EM preparations of neural tissues. *J Comp Neurol*. 2016 524(1).
- Jay S Coggan, Daniel Keller, James G King, Corrado Cali, Heikki Lehvaslaiho, Henry Markram, Felix Schürmann, and Pierre J Magistretti. Model of electrometabolic coupling of the neuro-glia-vasculature in the cerebral cortex explores role of the glycogen shunt. In *Annual Meeting of Society for Neurosciences*, October 17-21, Chicago, 2015.
- Stefan Eilemann and Madhusudhanan Srinivasan. Interactive Supercomputing for Large-Scale Brain Simulations. *Technical report, EPFL and KAUST*, 2013.
- Renaud Jolivet, Jay S Coggan, Igor Allaman, and Pierre J Magistretti. Multitimescale Modeling of Activity-Dependent Metabolic Coupling in the Neuron- Glia-Vasculature Ensemble. *PLoS Computational Biology*, 11(2), 2015.
- Daniel Nachbaur, Raphael Dumusc, Ahmet Bilgili, Juan Hernando, and Stefan Eilemann. Remote parallel rendering for high-resolution tiled display walls. In *Large Data Analysis and Visualization (LDAV), 2014 IEEE 4th Symposium* pp. 117-118. IEEE, 2014.

EPFL/BBP (Julian SHILLCOCK, Lida KANARI, Eleftherios ZISIS, Juan PALACIOS) collaborated with Allen Institute for Brain Science (ABI), Washington, USA a Private Research Organization as part of the BBP-ABI collaboration led by Prof. Sean HILL (EPFL/BBP) to use software developed within the Blue Brain Project to assess and improve the quality of automatically reconstructed neurons produced by the ABI's Big Neuron initiative. Activities undertaken were the presentation of BBP's neuron analysis software NeuroM at the Brain Informatics and Health meeting, London 2015 and at the Human Brain Project summit, Madrid 2015; participation in two hackathons organized by the ABI to help them measure quantitative features of their neuron reconstructions; we gave input to their pipeline development plans; co-writing a paper on extending the ABI automated neuron reconstruction pipeline towards neuron synthesis; application for funding to organize a workshop on neuron synthesis and morphology analysis at EPFL. A position paper was submitted that has been accepted in Brain Informatics entitled "Reconstructing the Brain: from Image Stacks to Neuron Synthesis" which describes the Big Neuron automatic reconstruction pipeline and the BBP extension to it that will allow cell analysis, classification and synthesis.

EPFL/BBP (Eilif MULLER, Werner VAN GEIT, Christian ROESSERT, Felix SCHUERMANN, Lida KANARI, Guy ATENEKENG); HUJI (Idan SEGEV); Allen (Costas ANASTASSIOU, Christof KOCH) worked with the Allen Institute for Brain Science (ABI), Washington, USA, a private Research Organization as part of the BBP-ABI collaboration led by Prof. Sean HILL. The **Goals of the collaboration** were to develop models of mouse visual neocortex neurons and jointly release models to the public. Specific research activities undertaken were Specification of the data gathering, feature extraction, model fitting techniques by EPFL/BBP and as used in SP6. A Joint release tool place in March 2016.

HBP Education and SP5 & SP6 are working with Allen Institute for Brain Science (ABI), Washington, USA. A Private Research Organization as part of the BBP-ABI collaboration led

by Prof. Sean HILL on the Joint training course "Cells, Circuits and Computation: expanding the horizon of Big Data Analysis" (official satellite of FENS 2016, Copenhagen). Activities focus on the preparation of the course material using HBP SP5 & SP6 data, tools and workflows. There will be a workshop in July 2016 prior to FENS

3.2.5 SP7

BSC worked with the Institut de Recerca Biomèdica (IRB), a Public Research Organisation to prepare a project proposal to take advantage of the PyCOMPSs Programming Model when developing applications at IRB. Several meetings took place to understand better each other's expertise, and to try to figure out how we can achieve a mutual benefit.

Results will be expected under the umbrella of a new project.

BSC worked with Edinburgh Parallel Computing Centre (EPCC). A Public Research Organisation as part of the Project Intertwine to to improve the interoperability of different programming APIs (OpenMP, OmpSs, MPI, GASPI, StarPU, etc). Research activities undertaken included gathering of requirements and known issues of the different APIs regarding interoperability (the project started four months ago). There are no results yet. They are expected as part of the project Deliverables (both documentation and prototypes).

BSC, CINECA, CSCS, JUELICH collaborated with the Partnership for Advanced Computing in Europe (PRACE, www.prace-project.eu), the EU funded project PRACE as part of an MoU signed on Jan 25th 2015 to use the PRACE network for HBP infrastructure. Results of the collaboration for HBP are financial savings, personal staff savings, knowhow transfer

JUELICH worked with WISE Community (www.wise-community.org) as part of a collaboration of security experts from different organizations and EU Projects, e.g. PRACE, EUDAT, EGI, GÉANT, LIGO Scientific Collaboration (LSC) to share information and work together, creating collaboration among different e-infrastructures. WISE provides a framework of standards, guidelines, and practices to promote the protection of critical infrastructure. Results of the collaboration are permanent improvement of the IT security of the collaborating partners' infrastructures.

EPFL/ BBP is working with KAUST as part of a formal collaboration, the KAUST-EPFL Alliance for Integrative Modeling of Brain Energy Metabolism to undertake *in-silico* Imaging. Results of the collaboration are: Physically-based In Silico Light Sheet Microscopy for Visualizing Fluorescent Brain Models. BMC Bioinformatics, (16), 2015.

3.2.6 SP8

LUMC is working with the Allen Institute for Brain Science (USA) on tSNE development for the Allen Brain atlases Research activities undertaken are joint research, leading to code and one joint journal paper:

A. Mahfouz, M. van de Giessen, S. Huisman, M.J.T. Reinders, M.Hawrylycz, B.P.F. Lelieveldt, "Visualizing the spatial gene expression organization in the brain through non-linear similarity embeddings", Methods, vol 15(2), pp 79-89, 2015.

LUMC worked with Delft University of Technology (Netherlands) as part of a faculty exchange to mine the Allen Brain atlas. Joint research activities were undertaken. The collaboration resulted in six joint journal papers:

- A. Mahfouz, B.P.F. Lelieveldt, A. Grefhorst, L.T.C.M. van Weert, I.M. Mol, H.C.M. Sips, J.K. van den Heuvel, N.A. Datson, J.A. Visser, M.J.T. Reinders, O.C. Meijer, "Genome-wide co-expression of steroid receptors in the mouse brain: identifying signaling pathways and functionally coordinated regions", Proceedings North American Academy of Sciences doi:10.1073/pnas.1520376113, 2016.

- E.Eising*, S.M.H. Huisman*, Ahmed Mahfouz, Lisanne Vijfhuizen, [the International Headache Genetics Consortium], Dale Nyholt, Boukje de Vries, Boudewijn P.F. Lelieveldt#, Arn M.J.M. van den Maagdenberg#, Marcel J.T. Reinders#, "Gene co-expression analysis identifies brain regions and cell types involved in migraine pathophysiology: a GWAS-based study using the Allen Human Brain Atlas", Human Genetics, in press.
- L. van der Maaten, "Accelerating t-SNE using Tree-Based Algorithms", The Journal of Machine Learning Research 15 (1), 3221-3245, 2014.
- W. Abdelmoula, K. Škrášková, B. Benjamin, R. Carreira, E. Tolner, B.P.F. Lelieveldt, L.J.P. van der Maaten, H. Morreau, A. van den Maagdenberg, R. Heeren, L. McDonnell, J. Dijkstra, "Automatic Generic Registration of Mass Spectrometry Imaging Data to Histology using Nonlinear Stochastic Embedding", Analytical Chemistry, vol 86(18), pp 9204-9211, 2014.
- S. Babei, A. Mahfouz, M. Hulsman, B.P.F. Lelieveldt, M.J.T. Reinders, J. de Ridder, "Hi-C chromatin interaction networks predict co-expression in the mouse cortex", Plos Computational Biology, vol. 11(5), e1004221, 2015 (Cover paper).
- G. Saygili, E.A. Hendriks, M. Staring, "Confidence Estimation for Medical Image Registration Based On Stereo Confidences", IEEE Transactions on Medical Imaging vol. 35(2), pp 539 – 549, 2015.

LUMC worked with NIH, NICHD (USA), a Research Institute also to mine the Allen Brain atlas. A Joint publication resulted:

- A. Mahfouz, M.N. Ziats, O.M. Rennert, B.P.F. Lelieveldt and M. J.T. Reinders, "Shared Pathways among Autism Candidate Genes determined by Co-expression Network Analysis of the Developing Human Brain Transcriptome", Journal of Molecular Neuroscience, vol. 57(4), pp 580-594, 2015.

HUG worked with Utrecht University (Netherlands) to develop a cross link between MoBrain (https://mobrain.egi.eu/)and the MIP platform with MoBrain portal.

JSI worked with University of Ljubljana, Medical Faculty (Slovenia) on:

- The analysis of brain imaging data. Research activities undertaken were Initial analysis performed, first results acquired. In addition, introductory lectures on data mining in neuroscience for undergraduate students was given. The study is still in progress.
- The analysis of brain connectivity data an Initial analysis performed. The study still in progress.

AUEB worked with the National Technical University of Athens (Greece)to conduct research regarding Ontology Based Data Access. A paper was submitted for publication in ESWC 2016.

EPFL signed a LoI in Feb 2016 with Ospedale Niguarda Milano (Italy), a Hospital to Integrate the hospital's data into MIP. The collaboration focused on the analysis of available data sources and integration architecture. Results are expected in the second half of 2016.

EPFL and CHUV signed a LoI signed on 31.07.2015 with Universitätsklinikum Freiburg (Germany), a Hospital (Public Research Organisation) to Integrate hospital's data into MIP. Research activities focus on tests for anonymization, prepared VM for tests, and data exploration. Results are expected in the second semester 2016

CHUV signed a data use agreement with ADNI (North America) a Public Research Initiative to Integrate Alzheimer research data into MIP. A proof-of-concept study for biological signatures of disease (SP8 and SP11) was undertaken. Two publications were produced:

- Dukart J, Mueller K, Villringer A, Kherif F, Draganski B, Frackowiak R, Schroeter ML; Alzheimer's Disease Neuroimaging Initiative. Relationship between imaging biomarkers, age, progression and symptom severity in Alzheimer's disease. Neuroimage (Amst). 2013 Jul 26;3:84-94. doi: 10.1016/j.nicl.2013.07.005.
- Dukart J, Kherif F, Mueller K, Adaszewski S, Schroeter ML, Frackowiak RS, Draganski B; Alzheimer's Disease Neuroimaging Initiative. Generative FDG-PET and MRI Model of Aging and Disease Progression in Alzheimer's Disease. PLoS Comput Biol. 2013 Apr;9(4):e1002987.

One paper was submitted to New England Journal of Medicine end 2015.

CHUV signed a data use agreement with 3C Study - Bordeaux (France), a hospital (Epidemiological Institute) and university to integrate Alzheimer research data into the MIP. A proof-of-concept study for biological signatures of disease (SP8 and SP11) was undertaken. One paper was submitted to New England Journal of Medicine end 2015.

CHUV worked with MNI (Canada), a University Research Institute on preparation for the uploading and pre-processing of image data on the MIP. Activities focused on using and testing components from their C-Brain platform. Results are expected during SGA1.

CHUV and EPFL (HBP PCO) initated a dialogue with IMI (Belgium) to share knowledge on data management, databasing, and data analysis. A Joint workshop took place in January 2015 followed by a meeting in January 2016. A workshop with several IMI partners is planned for June 2016.

3.2.7 SP9

Nicholas CAIN (ABI)/Andrew ROWLEY (UMAN) collaborated with the Allen Brain Institute on xhibiting the execution of their models (mean-field Potjans-Diesmann micro-circuit) into the platform (SpiNNaker/NM-MC-1). Research activities undertaken focused on the implementation and were undertaken in January 2016. A paper will be forthcoming during SGA-1

Andrew MUNDY (UMAN) collaborated with Chris ELIASMITH (University of Waterloo) on Nengo-Spaun on SpiNNaker. Research activities undertaken focused on jointly developing code. A paper was produced and will be confirmed.

The Heidelberg Group collaborated with the University of California Los Angeles, EE Department, prof. Khang WANG to use single chip neuromorphic system. Research activities undertaken focused on experiments on single chip system. A PhD thesis and joint publication are in progress.

3.2.8 SP10

TUM collaborated with the Department of Cognitive Sciences, UCI, U.S.A. as part of a cooperation funded by BaCaTech) for a project on “Brain-based navigation for real and virtual in-silico robotic experiments”, see http://www.bacatec.de/cgi-bin/details/en/981. The collaboration has just started (1.1.2016).

TUM worked with the Department of Electrical Engineering, Technical University of Denmark as part of a project on Modular Playware Bodies. Results are forthcoming.

TUM worked with INSA Lyon, France, a public Research Organisatio, as part of a collaboration funded by BFHZ, see http://www.bayern-france.org) to develop and implement a neuro-inspired control method for an anthropomimetic robotic arm. The result was a completed student project.

TUM, FZI, EPFL worked with the Department of Mechano-Informatics, University of Tokyo, Japan to initiate collaborative project in SGA1. Workshops were organized in Tokio and there were several short visits from members of Japanese lab to TUM, see

http://www6.in.tum.de/japan-eu-neurorobotics-2015. A second workshop is planned for first months of SGA1.

3.2.9 SP11

UHEI worked with Purdue University to define benchmarks for visual processing; creation of a cortex model including simulations. Research activities undertaken were computer simulations. The result was a publication:

Clarke, A. M., Herzog, M. H., Francis, G. (2014). Visual crowding illustrates the inadequacy of local versus global and feedforward versus feedback distinctions in modelling visual perception. Frontiers in Psychology, 5(1193): 1-12.

3.2.10 SP12

KCL organized a three-day workshop (11-13 June 2015) with Fondation Brocher to support cross-SP and external stakeholder engagement on the future of Neuroscience.

3.2.11 SP13

The PCO has continued to foster the relationship with the international brain initiatives and most notably the US BRAIN initiative. Greg FARBER of the NIH spoke at the HBP 2015 Summit in Madrid. Since that time, there have been a series of meetings between HBP and NIH representatives involved in the Brain Initiative. A number of concrete steps have been taken already in the run-up to the Platform release and 2016 will continue to build a broad framework for direct engagement of HBP and BI scientists and alignment of the respective roadmaps of the two projects.

The PCO has supported SP8 in building relations with IMI (workshop January 2015, meeting 2016) The PCO is supporting SP8 to organize a follow-up workshop in June 2016. The aim of the workshop is to enable sharing and learning between HBP and the IMI projects EMIF and AETIONOMY and possibly others on issues of common interest relating to technology and data. Opportunities for collaboration will also be explored. Day 1 – deep dive presentations and discussions on technologies and data. Day 2 – moving forward. The HBP is also supporting CDP6 develop a dialogue with IMI industry partners.

The PCO developed a strong relationship with the Coordination and Support Action TAIPI - Tools and Actions for Impact Assessment and Policy makers Information, launched in January 2015. The project aims at supporting and strengthening HBP and Graphene by undertaking impact assessment and collection information need for policy making. The key achievements have been the development of indicators for the impact assessment, the launch of a survey to understand the information needs of members of the HBP Consortium and the development of a contact database with relevant stakeholders to disseminate information about TAIPI's results. IMI disseminated information to their partners about the HBP Platform release to encourage them to participate in the web-streamed event.

The PCO fostered dialogue with several larger research programmes including FENS, INCF, Keystone, the Brain Council and others about the Platform Release. Discussions are underway with the outreach groups of these organizations to explore synergies. Dialogue was maintained with innovation groups including EEN and EUREKA. These groups could be important "business introducers" (see 4.2) in SGA1.

The PCO is organizing a science market session as part of the ESFRI delegation meeting in Geneva on 2-3 June 2016 as part of building a dialogue and relations with ESFRI. The session will include an HBP presentation and three hands on sessions.

3.3 Main Problems

Difficulties experienced by HBP Consortium members and lessons learned from building collaborations in M12-30 are as follows:

- It is difficult to build collaborations without associated funding (specially with public centers), so maybe a small part of budget could be saved from the total in order to engage partners to build these external collaborations.
- In order to establish a successful long-term collaboration with potential user of the technology, an additional effort in terms of resources is needed. Giving support a network of user requires to have dedicated personnel to attend user messages, reported bugs and feature requests. These objectives are out of the scope of the project but are needed to give the produced technology a roadmap to follow.
- Research collaborations with partners from Non-European countries are vital to the project. **Ways should be identified to include such partners on a more formal basis**. This is also true for American efforts, such as the BRAIN Initative, and the Human Connectome Project.
- The hippocampus community effort had many lessons learned for the overall user engagement strategy for SP6. The forthcoming opinion piece will document those in detail. They will inspire the community engagement strategy followed by SP6 in the SGA1 phase. Already, the SGA1 planning includes several points to support these community engagement efforts:
  - Strong support for seed partners for the hippocampus community effort in SGA1: 4 FTES
  - Much more budget allocated for (community) meetings like the Hippocamp (http://neuralensemble.org/meetings/HippocampCA1/)
  - New task on data-model standards, as this was under-prioritized in the Ramp-Up Phase
  - New task on validation suites, as this was identified as a key driver or community model refinement and transparency thereof.

The PCO has difficulties keeping informed about these collaborations and how they are benefiting the HBP specifically as well as their alignment with HBP's strategic objectives. Going forward a more concerted effort will be made to draw a link between research collaborations, HBP strategic objectives (the flagship objectives per the FPA), and efforts will be made to foster collaborations that help HBP achieve its strategic objectives. This is described in the SGA1 proposal on Partnerships.

3.4 The Next Six Months

In SGA1 a working group on collaborations will be set up with members of the newly elected SIB and other interested PIs to produce a road-map document on collaborations that is aligned with the Flagship Objectives. This includes a more strategic approach to fostering relations with the international brain initiatives.

The PCO will continue to collect information on research collaborations being established by HBP's partner institutions. Where possible these collaborations may become more formal partnering projects.

4. Relationships with Industry

4.1 Overall Goals

Business development models will be designed and piloted to the degree possible during the Ramp-Up Phase. Goals of the business development efforts are to bring in funding to the HBP project to enhance the scope and depth of activities and to build a funding model that will sustain and expand the HBP after the Flagship funding ends.

A pilot will be initiated establishing a thematic HBP Innovation Hub to create a sustainable and enduring "lab-to-market" innovation chain and in a deliberate policy effort to deliver value across Europe. The mechanism for establishing the hub will be designed and tested beginning in year 2.

4.2 Main Achievements

The main achievements in regards to industry relations have been:

- The development of diverse collaborations between HBP Consortium members and large enterprises (LE) and as small and medium size enterprises (SME) and
- The development of HBP's approach to innovation that defines mechanisms for collaboration with industry in the Operational Phase.

Industry collaborations with HBP Consortium members

The SPs reported diverse interactions including concrete collaborations, meetings and workshops with industrial partners. These collaborations are concentrated primarily in SPs 5–10. SP 1 and 2 also reported one industrial collaboration each.

In two cases, the collaboration resulted in the development of a prototype system. For example, partners from SP2 in JUELICH developed a prototype *Optical bank* as a result of an analysis of birefringence in human brain sections. This work is part of a broader research collaboration on polarizing microscope development with Taorad GmbH from Aachen, Germany, a highly specialized SME. SP8 partner CHUV collaborated with Denodo, a highly specialized data virtualization company (SME) with offices in the US and Europe, to develop the prototype of MIP federated architecture.

4.2.1 SP6

The **Institute of Neuroscience and Medicine** (INM-9, Prof. Paolo CARLONI, HBP-WP6.3) undertook research activities with Grünenthal GmbH (Aachen, Germany) on molecular dynamics simulations, which provided the binding modes and affinities of prototypical opioid analgesics for the pain-mediating human μ-opioid receptor. The calculations, validated by experiments, showed ligand-induced conformational changes towards the receptor activation. A joint publication was produced. X. Cong et al. (2015), Structural Determinants for the Binding of Morphinan Agonists to the μ-Opioid Receptor. PLoS ONE 10(8): e0135998. doi: 10.1371/journal.pone.0135998

EPFL/ BBP collaborated with 3BRAIN – Switzerland, a SME, to develop a new high-density MEA for slice recordings and its application software for spike-train analysis. Preliminary data were obtained and one publication was produced. Further results are expected in SGA1.

UNIPV (Egidio D'ANGELO) collaborated with HABILITA (Italy), a private Hospital – private, to submit a project proposal to the EU on the development of a new robotic neuro-rehabilitation system based on neural network modelling. As part of the proposal

development, preliminary studies using simulated robots with Politecnico di Milano (Italy). Results are expected in SGA1 as part of CDP2.

4.2.2 SP7

BSE explored collaboration with Endor Nanotechnologies, an SME, through a series of workshops on using the PyCOMPSs Programming Model and BSC Life Sciences experience in molecular dynamics to build models that describe the *in-vitro* processes of Endor Nanotechnologies. Results are expected in SGA1 under the umbrella of a new collaboration. Similarly BSE also implemented workshops with Intelligent Pharama, an SME in Spain, to develop ideas on how to exploit the PyCOMPSs Programming Model for Intelligent Pharma processes.

BSE also collaborated with Lenovo in several countries to define a common project aimed at investigating Dynamic Resource Management techniques more closely with Lenovo technologies. In the Ramp-Up the project was defined and a kick-off meeting took place. A two-year cooperation agreement was signed in January 2016 and results are expected in SGA1.

KIT purchased cloud storage for HBP users from DataDirect Networks (DDN), headquartered in USA. The purchase agreement for storage solution, included:

- Hardware: 2 Web Object Storage (WOS) Archive nodes and SAS drives summing up to 480 TB.
- Software: WOS S3 software and license.
- Support: WOS Core and WOS S3 installation, configuration and basic support.

KIT undertook preliminary testing of the storage solution before signing the purchase agreement. Following the purchase, DDN set-up the WOS storage solution, as well as the S3 gateway software solution. During the initial installation and configuration, KIT provided support with networking set-up, supplied the hardware and the operating system set-up of the S3 servers.

Further collaboration activities ensued during firmware and software upgrades, with DDN remotely performing the upgrades and KIT providing on-site support. The DDN WOS-based S3 cloud storage is now available for use by the Human Brain Project.

JUELICH worked with two consortia as part of the Pre-Commercial Procurement (PCP) contract concerning R&D services for the Whole System Design for Interactive Supercomputing. Consortium 1: IBM Research GmbH, Switzerland and NVIDIA GmbH, Germany. Consortium 2: Cray Computer Deutschland GmbH, Germany and Cray Computer GmbH, Switzerland.

During the execution of the contract, which will run until January 2017, the contractor performed R&D on topics relevant for the realization of future HPC systems that feature interactivity. This includes integration of dense memory, scalable visualization as well as dynamic resource management. The collaboration will result during 2016 in the delivery of a pilot HPC system.

4.2.3 SP8

EPFL collaborated with Gnúbila (France), an SME as part of a subcontract (service agreement) to develop the anonymisation software for the MIP. Activities undertaken included software development, testing, deployment, support. The collaboration resulted in the successful development of tools for anonymisation (of DICOM, text, and genomics files) and Query filter including their documentation.

CHUV explored opportunities for a collaboration with IBM Research Zurich (Switzerland) on analytics and big data solutions. Activities undertaken included common workshops on

future medicine including a joint workshop at 2nd HBP Education Workshop "Future Medicine. Medical Intelligence for Brain Diseases" in CHUV (March 2015).

CHUV also signed a data use agreement with Sanofi (France) to integrate research data (MRIs) into MIP. Activities undertaken include a proof-of-concept study for biological signatures of disease (SP8 and SP11). Results are expected in the course of SGA1.

CHUV signed an evaluation license agreement with Bearing Point (BP) to evaluate a BP tool, HyperCube, as a potential analytical tool for the Evaluating new tools for the MIP. Results are expected at the end 2016.

4.2.4 SP9

UHEI had several meeting with IBM Germany and USA to explore joint technology development. The meetings will continue in SGA1.

UHEI and UMAN jointly organized a workshop series entitled "NICE Workshop" involving academia, industry and funding agencies to develop a strategy document for neuromorphic computing.

UHEI signed a manufacturing contract with Fritsch GMBH, a German SME, and Würth, on the development and production/test of a 50cm x 50cm, 14 Layer, fine pics PCB. The collaboration resulted in the production of 30 working PCB boards for use in the SP9 platform. They are fully assembled and an integral part of platform launch. Next steps in SGA1 include collaboration on wafer embedding technology jointly developed with HBP partner Fraunhofer.

4.2.5 SP10

TUM organized a workshop with Siemens, Germany, to explore joint initiatives (see http://www.cki-tum.de)

TUM also jointly supervised a master thesis with Panasonic R&D: Panasonic Silicon Valley Lab, focusing on the investigation of deep reinforcement learning for autonomous systems

4.2.6 Lessons learned by the HBP Consortium members from developing industry collaborations in the Ramp-up Phase

- HBP is acting as a catalyst for a large range of technological developments and applications. These range from the biological to the neurorobotic and neurological field. Continuity of funding and support is needed for full exploitation of these initial projects.
- HBP has developed technologies that are of interest for future hardware developments even at large companies like IBM.
- Successful community building among groups working in neuromorphic computing. High visibility of neuromorphic computing in Europe through the Human Brain Project.
- It is difficult to build collaborations without associated funding (although not so difficult with large private companies). Perhaps a small part of the budget could be saved from the total in order to engage partners to build these external collaborations. We believe that collaborating with a leading storage company to purchase both hardware and software solutions enabled the KIT to provide mature cloud storage with a high Technology Readiness Level. Compared to the initial idea of using commodity hardware and open-source software (e.g. Ceph), the current solution also decreases the complexity of maintenance and administration. On the other hand, we found that such a solution lacks the dynamism of open source community, with a longer waiting time for adoption of new software features. We believe that during the Operational Phase communication could be intensified in order to get access to such new features

earlier. This increased communication might also lead the industry partner to consider HBP needs in the process of developing and releasing new software.

In the Ramp-Up Phase, the PCO collaborated with the HBP Consortium to develop the project's approach to innovation, which will be implemented in SGA1 and includes diverse approaches to working with industry, such as:

Fostering relations with industry at the SP level through workshops, research collaborations and collaboration on technology development (similar to the activities described above).

Collaboration on the development of HBP's **innovation road-maps** for future neuroscience, future medicine and future computing to help ensure exchange and foster opportunities for join efforts in these areas

Innovation hubs – the concept is to explore possibilities to setup something new when no relevant "hub" already exists in a given member state, or to partner with existing organisations when possible. (Task 11.7.2) The hubs will naturally include the identification of relevant industrial partners.

"Business introducers" - In the second half of SGA1, when the Technology Map has been prepared, HBP will build a network of "business introducers" to leverage the "distribution channels" of the science and technology, in addition to working through the HBP and TTO networks described above. These business introducers will include groups identified in the Ramp-Up Phase including thematic clusters, professional associations, scientific societies, backing and interface Co-funded by the European Union structures (e.g. the members of the Enterprise Europe Network), chambers of commerce and industry.

The HBP Consortium endorsed the concept of the Engagement funnel as an approach to fostering relations with potential users and contributors to the HBP infrastructure, including industry (FPA Appendix 4, Figure 14). The concept will be implemented in collaboration with the communications, innovation and platform teams in SGA1.

4.3 Main Problems

The on-going development of the prototype Platforms slowed progress in developing business development models during the Ramp-Up Phase. A costing of the emerging RI is being undertaken and will be part of the business plan and concept for the HBP RI, delivered in M03 of SGA1. In addition, IP issues are being clarified.

It was not possible to develop a concept and pilot a thematic innovation hub in the Ramp-Up as the HBP technologies did not have a high enough TRL level. The TRL tracking will be expanded in SGA1 into a full technology map and together with the ITTC opportunities for technology maturation and the development of thematic innovation hubs will be further developed. A full concept for the hubs will be developed as part of task 11.7.2.

4.4 The Next Six Months

The HBP will work to implement the SGA1 proposal. In regards to industry collaborations, the work is described in the Work Package on Partnerships & Innovation.

Area	Activity
Business plan for RI	Develop the business plan for the Research Infrastructure including cost model, services, training needs (SGA1 M03)
Innovation coordinators	Training and continue/ scale-up industry outreach at SP level to explore R&D collaborations (SGA1 M03)
Technology Map	Develop database mapping tool and scale-up mapping (SGA1 M12)
ITTC	Expand ITTC and initiate dialogue on HBP IP policy (SGA1 M12)
Industry	Identify industries and plan industry workshops on future computing, neuroscience, medicine (SGA1 M18)
Innovation incentive scheme	Develop incentive scheme (SGA1 M9)

5. HBP Education Programme

5.1 Overall Goals

The HBP Education Programme offers various training opportunities, including Workshops and an annual School, as well as a trans-disciplinary Curriculum taught via a mixture of online and other methods. According to D13.4.2 HBP Education Programme: Curriculum v1, Guidelines for Workshops & Schools, it was originally open only to PhD students working in the HBP, but participation has since been expanded to include:

- MSc/MA students already carrying out research
- PhD students
- Researchers who have received their doctoral degree within the past three years at the time of their application

These categories define the target audience, not only for the Curriculum, but also for all HBP educational events, such as Workshops and annual Schools. With regard to the target groups, the HBP Education Programme does not differentiate whether they are affiliated with the HBP or not, as the objective is to broaden the impact of the HBP Education Programme and increase the visibility of the HBP as a whole.

The Curriculum includes training in disciplines outside students' areas of specialisation (e.g. neuroscience for computer scientists), as well as training in transversal competencies relevant to the Project's goals (e.g. research ethics, broader ethical issues raised by scientific research, IPR management, legal and organisational solutions for exploiting project results, etc.).

The HBP's Education Programme plays a major role in building awareness of the Project's work and results, delivering courses to students and providing young European scientists with trans-disciplinary knowledge and skills.

The HBP Education Programme is implemented in the following steps:

The first step is the formation of an Education Programme Committee made up of representatives of the different Subprojects. The Committee evaluates sites for Schools in terms of available infrastructure, accessibility, etc., selects topics for Schools and Workshops, invites scientists to act as tutors or organisers, and defines the selection of participants. The Committee also defines guidelines for the duration, the student/tutor ratio, etc.

The Committee defines a trans-disciplinary Curriculum for students and other researchers working within and outside the HBP. This includes training in the disciplines outside students' areas of specialisation (e.g. neuroscience for computer scientists) as well as training in 'transversal' competencies, relevant to the Project's goals. The Curriculum is used by the HBP Partners in defining teaching content for their students, as well as in the organisation of the first HBP Workshops and Schools.

The HBP Education Programme Website will provide online education services for the HBP Education Programme's target audience. The content supplements teaching at the Partner institutions, offering trans-disciplinary learning materials that are not available locally. Content is collected from the Subprojects, the HBP Schools and Workshops and used to produce slides, videos, tutorials and other media, which are made available online.

HBP Schools

HBP Schools are advanced courses that take place once a year. The Schools provide training by experienced scientists from within and outside the HBP, and are lecture-based, modelled on high-profile schools provided by scientific societies like SfN, FENS, EMBO and IBRO. Additional training (e.g. in software use and soft skills) is also part of the School's activities.

Application to the HBP Schools is competitive. Students eligible to apply include:

- MSc/MA students already carrying out research
- PhD students
- Researchers who have received their doctoral degree within the past three years at the time of their application

5.2 Main Achievements

To meet the objectives of the HBP Education Programme in the Ramp-Up Phase, and to prepare operations for the following period, the Month 6 Deliverable was produced as a planning document. It has been closely followed according to all 41 Key Performance Indicators (KPIs, EP-001 – EP-041 in Deliverable D13.4.2). The actions carried out for each KPI have been recorded and reported.

The major activities were defined as Milestones in the work programme and all Milestones were reached at the times originally planned, as follows:

- MS239a (M6): "Education Committee formed"

  The Education Programme Committee was formed by recruiting one member from each Subproject, who volunteers for advising the HBP Education Programme Office on scientific matters and contents of the Programme. This Committee met three times during the Ramp-Up Phase (May 2014, October 2014 and February 2016) and discussed and/or approved documents and specific actions or decisions periodically through email correspondence.

- MS239b (M6) "First release HBP Curriculum"

A first draft of the courses and topics that should be included in such a programme were included in D13.4.2, with a view to developing an interdisciplinary Curriculum applied through a "blended learning" method, i.e. online lectures combined with an online discussion forum and a final wrap-up Workshop and exam to educate "non-experts" from various disciplines in HBP. Thereafter, the strategy was followed according to the planning document throughout the Ramp-Up Phase, and finally, a complete set of five courses, each with at least eight lectures or more, was established. The five course directors are affiliated with four HBP Partner universities: Tel Aviv University, Israel; The University of Manchester, UK; Linnaeus University, Sweden; and Medical University Innsbruck, Austria. A total of 42 teachers from 16 universities or organisations in 7 countries have been recruited and instructed for the first full teaching cycle in the SGA1 period. All teachers and course directors teach on a volunteer basis without fees or honoraria. Clusters and a plan for the recording of the lectures have been determined to ensure the production of all online material between April and December 2016, for operating the first full teaching cycle of all courses in the first semester of 2017.

- MS239c (M6) "Guidelines and calls for Schools and Workshops"

  To establish and complete three Workshops and two (summer) Schools during the Ramp-Up Phase, as foreseen in the Work Plan, appropriate guidelines and calls were drafted and approved by the Education Programme Committee. This enabled a structured preparation and operation as well as a fair and transparent application and selection process of young researchers participating.

- MS239d (M6) "First release online education services"

  By M6, a fully functional website for information on the HBP Education Programme had been established. This website was continuously developed, including new functionalities implemented by the HBP IT department at EPFL and contents managed through a content management system (Liferay) by the HBP Education Programme Office at Medical University Innsbruck, Austria. The HBP Education Website at this time includes the following major components:

  - Information and an application option for Schools and Workshops
  - Information on Platform user training offered on different Platform-related sites
  - A career support page with links to sites offering vacant positions of the 112 HBP Partners in 24 countries
  - A link to the open HBP community forum
  - A closed forum page for young female researchers in HBP
  - Information about the Student Representatives in the Education Programme Committee
  - A repository of 156 recorded lectures on various topics related to HBP Subprojects, of which 98 were recorded during HBP Schools and Workshops, can be found at https://education.humanbrainproject.eu/web/hbp-education-portal/documents

  Descriptive figures of the HBP Education Programme Website (January 2016):

  - 191 registered HBP students
  - >52 000 page views
  - 156 online recordings of lectures.

- MS241/243/244 (M12/18/30) Schools and Workshops

As foreseen in the original work plan, three Workshops with more focus on hands-on training, and two advanced summer Schools with lectures and some hands-on tutorials were completed as follows:

- 1st HBP Education Workshop: New Frontiers in Neuroscience and Methods of Transdisciplinary Education, 18 – 20 June 2014, Tel Aviv, Israel.
- 1st HBP School: State-of-the-Art of the HBP subprojects, 8 – 14 September 2014, Alpbach, Austria.
- 2nd HBP Education Workshop: Future Medicine – Medical intelligence for Brain Diseases, 15-18 March 2015, CHUV Lausanne, Switzerland (M18).
- 2nd HBP School: Future Computing, 3 -9 August 2015, Obergurgl, Austria (M23).
- 3rd HBP Education Workshop: Future Computing, 11-15 January 2016, Manchester, UK (M28).

The descriptive statistical figures of Schools, Workshops and the use of the Website are summarised in the table below.

- MS244 Evaluation results

  All events have been individually evaluated by an online survey and feedback has been mostly positive. Individual suggestions and criticism are considered for future training events.

Table 1: Descriptive figures of HBP Education Programme events

School / Workshop	1st Workshop	1st School	2nd Workshop	2nd School	3rd Workshop	RUP
Date	18-20 Jun 2014	8-14 Sep 2014	15-18 Mar 2015	3-9 Aug 2015	11-15 Jan 2016	
Venue	Tel Aviv, Israel	Alpbach, Austria	Lausanne, Switzerland	Obergurgl, Austria	Manchester, UK	
Participants[1] (n)	90	48	55	46	45	284
Students (n)	49	27	31	20	30	157
HBP students (n)	9	17	20	11	20	77
External students (n)	40	10	11	9	10	80
Faculty (n)	33	16	20	22	8	99
Student presentations (n)	21	24	31	21	60	157
Recorded lectures (n)	33	12	13	24	8	90

[1] Students, faculty, scientific & local organizers

Training sessions (n)	0	3	6	4	4	17
Female students (n)	22	10	16	6	7	61
Female students (%)	45%	37%	52%	30%	23%	39%
Female faculty (n)	9	2	3	2	0	16
Female faculty (%)	27%	13%	15%	9%	0%	13%
Participating nations (n)	12	12	15	9	14	24*
Participating nations, students (n)	8	9	11	6	11	22*
Participating nations, faculty (n)	8	6	9	5	4	17*

* Total number of nations participating in at least one event (each participating nation counted once only, even if represented at more than one event)

5.3 Main Problems

The number of students or young investigators participating in the HBP Education Programme is key for success and the cost-effectiveness of the Programme. Therefore, a range of measures were undertaken or will be considered to aim for as large a number as possible.

1) Initially, we set up a registration and log-in system for HBP students to access the Education Website and extract information or apply for parts of the Programme. This was required to identify and build a database of PhD students working in HBP. However, it was soon realised that this represented an obstacle for users. Therefore, content that was not considered confidential or with copyright for the HBP Consortium was gradually moved to a public space. During the Operational Phase, we will aim for all content to be offered in a public space. A simple registration system will be used to monitor the user numbers or the participants in the online courses.

2) The number of applicants for individual Schools and Workshops varied. This number did not correlate with the downloads of information or flyers for individual events. Thus, we do not consider this a result of varying general interest in the offered topics or training. Countries where visa are required for many participants such as UK or Israel (e.g. non-European nationals working in a Schengen country) were reported as being problematic, since visas are very expensive from the students' point of view and sometimes difficult to obtain at all. Therefore, we will attempt to run Programme events preferentially in Schengen countries and the Course Directors of the HBP Curriculum – though 3 of 5 are from outside the Schengen area – have agreed to hold their final Workshops and exams in Schengen countries only. The dates for the second

HBP School in August may not have been ideal. Though any time of year may be problematic for some, it has been decided to move the third annual HBP School to end of November – early December 2016.

3) At least seed funding for mobility of students to participate in the Programmes is required. The Education Programme Committee members unanimously concluded that funds for students to participate in Education Programmes through grants of their PIs are limited and decreasing. Therefore, the budget of the Education Programme includes a substantial portion designed to partially fund European students to participate in the Programme.

4) Increasing visibility and facilitating access of training is helpful. The strategy to foster these aspects will include the search for collaborations with external partners - potentially with co-funding opportunities – and align some activities with large international meetings that many participants may attend anyway and so use their expenses more efficiently. In this context, a satellite Workshop entitled “Cells, Circuits and Computation: Expanding the Horizons of Big Data Analysis” has been approved by the organisers of the Forum of European Neuroscience Societies in Copenhagen (6000+ attendees) on July 1st and will be co-organized and co-funded by the HBP Education Programme and the Allen Institute for Brain Research in the US. Both partners have in addition applied to organise a professional development Workshop at the Society for Neuroscience Meeting (30 000+ attendees) in November in San Diego, USA.

5) Teaching the HBP interdisciplinary Curriculum through open online courses will reach a large number of students. However, at present no tools for online exams, which clearly identify the individuals taking exams and avoid cheating, are available. Thus, exams are planned at final Workshops that individuals attend in person. If demand exceeds supply of slots, and since teachers of the courses are located at 16 organisations in 7 countries, exams may be organised in additional places in Europe.

References

[1] https://ec.europa.eu/digital-single-market/en/news/fet-flagships-novel-partnering-approach-address-grand-scientific-challenges-boost-innovation