HBP At The Halfway Point

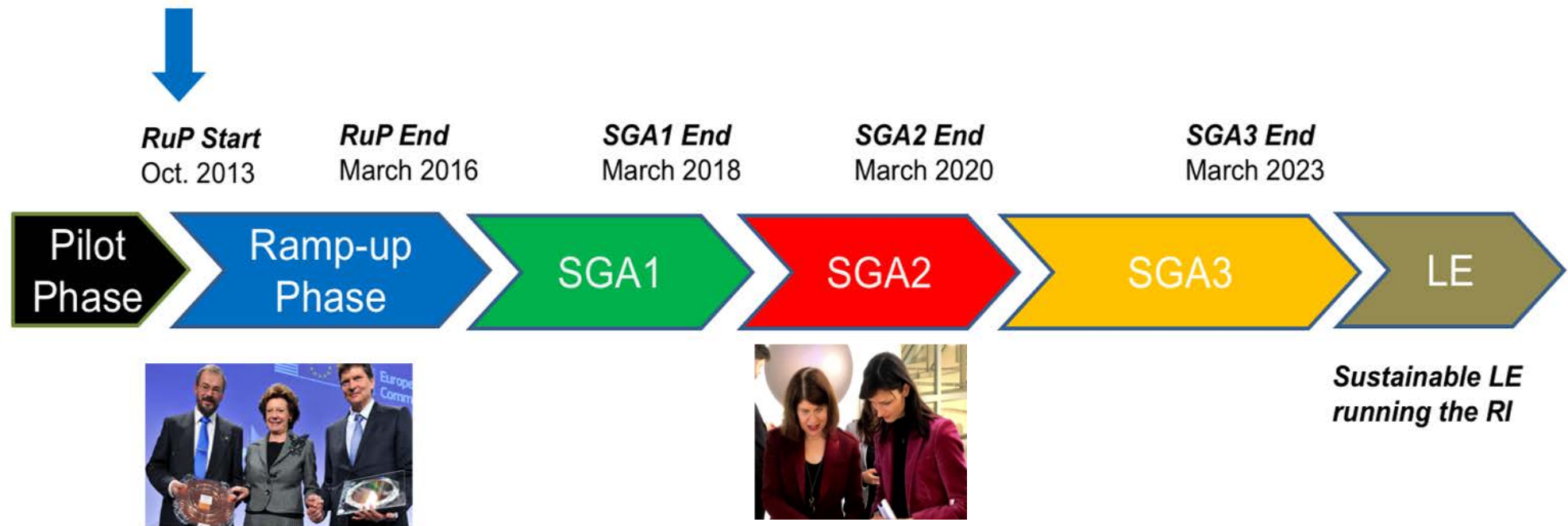## Andreas Mortensen

Director General – Human Brain Project

Flagships' Board of Funders   Brussels - 16 Nov. 2018

The HBP At Half-Way

RuP Start
Oct. 2013

RuP End
March 2016

SGA1 End
March 2018

SGA2 End
March 2020

SGA3 End
March 2023

Pilot Phase | Ramp-up Phase | SGA1 | SGA2 | SGA3 | LE

Sustainable LE running the RI

FP 7 2007-2013	Horizon 2020 2014-2020 Flagship initiatives in the centre of the programme	Horizon Europe, 2021-2027 Pursuing a mission-oriented policy approach

HBP Vision and Mission
(revised as of Oct. 2018)

Vision

Deepen understanding of the human brain structure and function by building a European infrastructure that harnesses multiple disciplines and computing, and advances science, ICT and medicine to the benefit of society.

Mission

- Explore the multi-level complexity of the brain in space and time.
- Transfer the acquired knowledge to brain-derived applications in health, computing, and technology.
- Provide shared, open computing tools, models and data through the HBP Joint Platform as a European Research Infrastructure that serves to integrate brain science across disciplines.
- Create a trans-disciplinary community of researchers united by the quest to understand the brain and thus derive societal benefits.

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Human Brain Project Milestones 2013-2023

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Oct. 2013 – Mar. 2016	HBP Ramp-up Phase (54 M€)
Oct. 2015	Horizon 2020 Framework Partnership Agreement signed
Apr. 2016 – Mar 2018	Specific Grant Agreement 1 (SGA1) (89 M€)
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The Stakeholder Board: Improvements

COUNTRY	MEMBER	INSTITUTION
Austria	Christine BRANDTLOW	Medical University of Innsbruck
Belgium	Sigrid STROBANTS	University of Antwerp
Denmark	tba	
Finland	tba	
France	Andre SYROTA (*)	Institut nationale de la santé et de la recherche médicale
Germany	Wolfgang MARQUARDT (*)	Forschungszentrum Jülich
Greece	Michael HATZOPOULOS	University of Athens
Hungary	tbc	
Israel	Joseph KLAFTER (*)	Tel Aviv University
Italy	Eugenio GUGLIELMELLI (*)	University of Rome
Netherlands	Rob HEINSBROEK	Netherlands Organisation for Scientific Research
Norway	Frode VARTDAL	University of Oslo
Portugal	Antonio DAMASIO	University of Southern California
Slovenia	Bernard ZENKO	Jozef Stefan Institute
Spain	Gonzalo LEÓN	Technical University of Madrid (UPM)
Sweden	Gunnar LANDGREN	Royal Institute of Technology
Switzerland	Martin VETTERLI (*)	Ecole Polytechnique Fédérale de Lausanne
United Kingdom	Matthew LAMBON RALPH (*)	University of Cambridge
Turkey	Serkan UCER	TÜBİTAK's Research Infrastructures

(*) Steering committee of the Stakeholder Board (SCSB)

SB Chair: Matt Lambon-Ralph

AISBL-ESFRI-ERIC

- Creation of an association with the double objective of acting as coordinator of HBP and of preparing a lasting research infrastructure for brain research in Europe. The association takes the form of an AISBL (*Association sans but lucratif*) = "not-for-profit association" in Belgium. Foundation ≈ April 2019

- Will support HBP's application to the ESFRI (European Strategy Forum on Research Infrastructures) roadmap (submission of proposal in August 2019)

- Possible next step: ERIC (European Research Infrastructure Consortium) = a specific legal form to facilitate the establishment and operation of research infrastructures with European interest.

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HBP Consortium At A Glance

Core project:

121 institutions

(+5 since May 2018)

in 19 countries
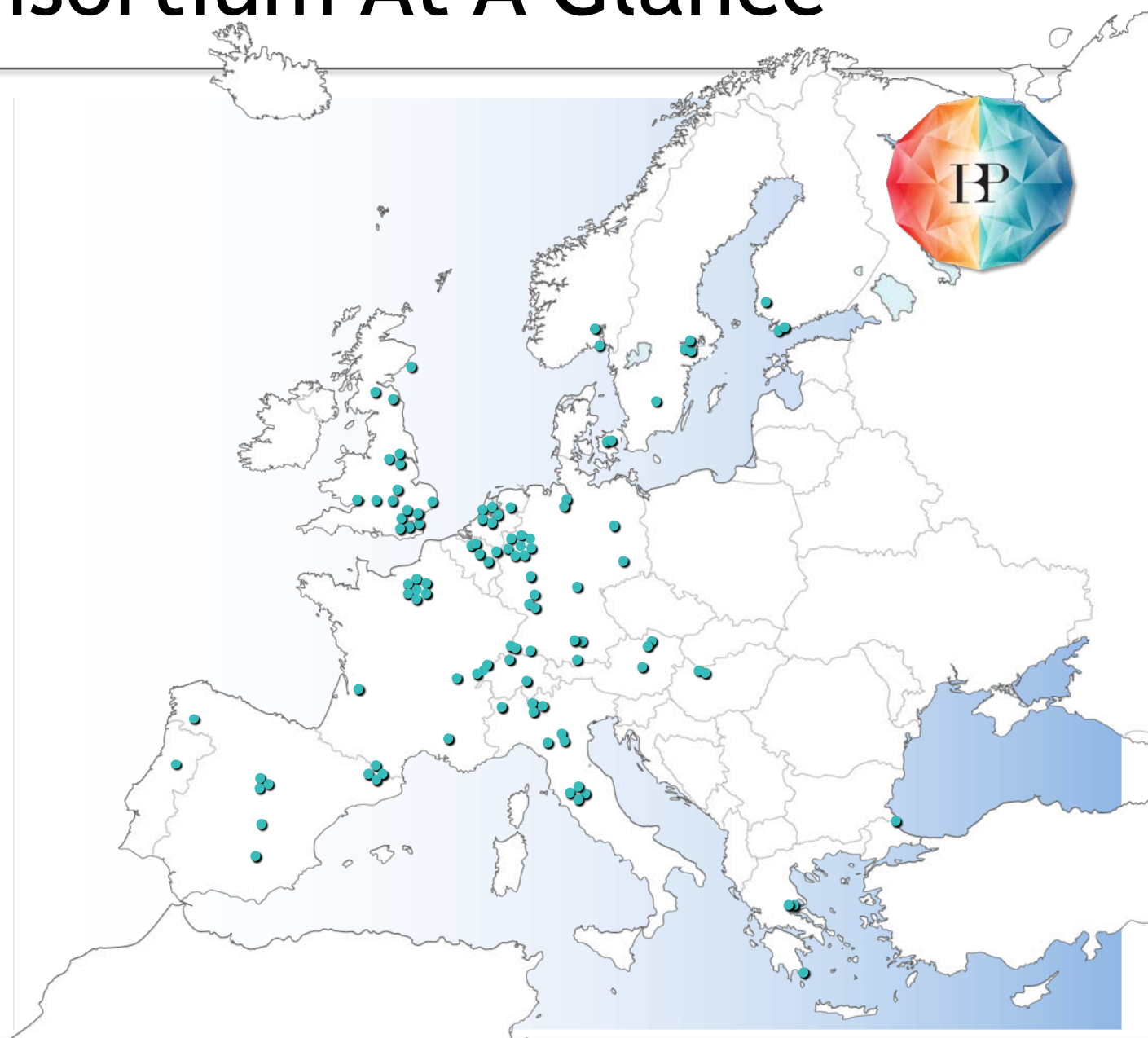
HBP Update I

- Election of the Science & Infrastructure Board (SIB) and its leaders (Katrin Amunts, Karlheinz Meier, Alois Knoll)

- Christian Fauteux appointed Executive Director of Project Coordination Office (PCO). Andreas Mortensen appointed Director General of HBP.

- Co-Design Projects (CDPs) now directly represented in the SIB (Rainer Goebel)

- High Level Support Team (HLST) of the collaboratory established, call for vouchers launched

- International Cooperation Group (INCO) renewed (led by Cyriel Pennartz)

HBP Update II

- Fenix started to establish High Performance Computing (HPC) and data infrastructure services for multiple research communities

- Interactive Computing e-Infrastructure (ICEI) started within the HBP-FPA

- External calls resulting in new partners: Sub Project (SP) joint calls SP1/SP2, SP8 calls, 2 new CDPs

SGA1 Review; June 2018

- "Great science and platform and technology development are shown"

- "Strong commitment to collaboration from PIs and other project members"

- "Strong improvement compared to the ramp-up phase with respect to results and integration"

- "Focus on integration beyond the science..."

- "Platforms: increase usability and accessibility"

- "Clear goal-driven HBP roadmap with timeline and with clear and verifiable targets"

- "Gender balance at all levels to reflect the respective research communities"

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Actions In Response To SGA1 Review

- Update of the vision and mission statements for HBP

- Update of the HBP Roadmap for the second half of HBP

  - Introduction of results chain to clarify outputs, outcomes and impacts

  - Detailed planning for the HBP Joint Platform

- Planned change of project structure for SGA3 to focus on vertically-integrated interdisciplinary scientific projects and use cases

- Platform user engagement and user support activities launched

- Implementation of a Gender Action Plan

The HBP Joint Platform
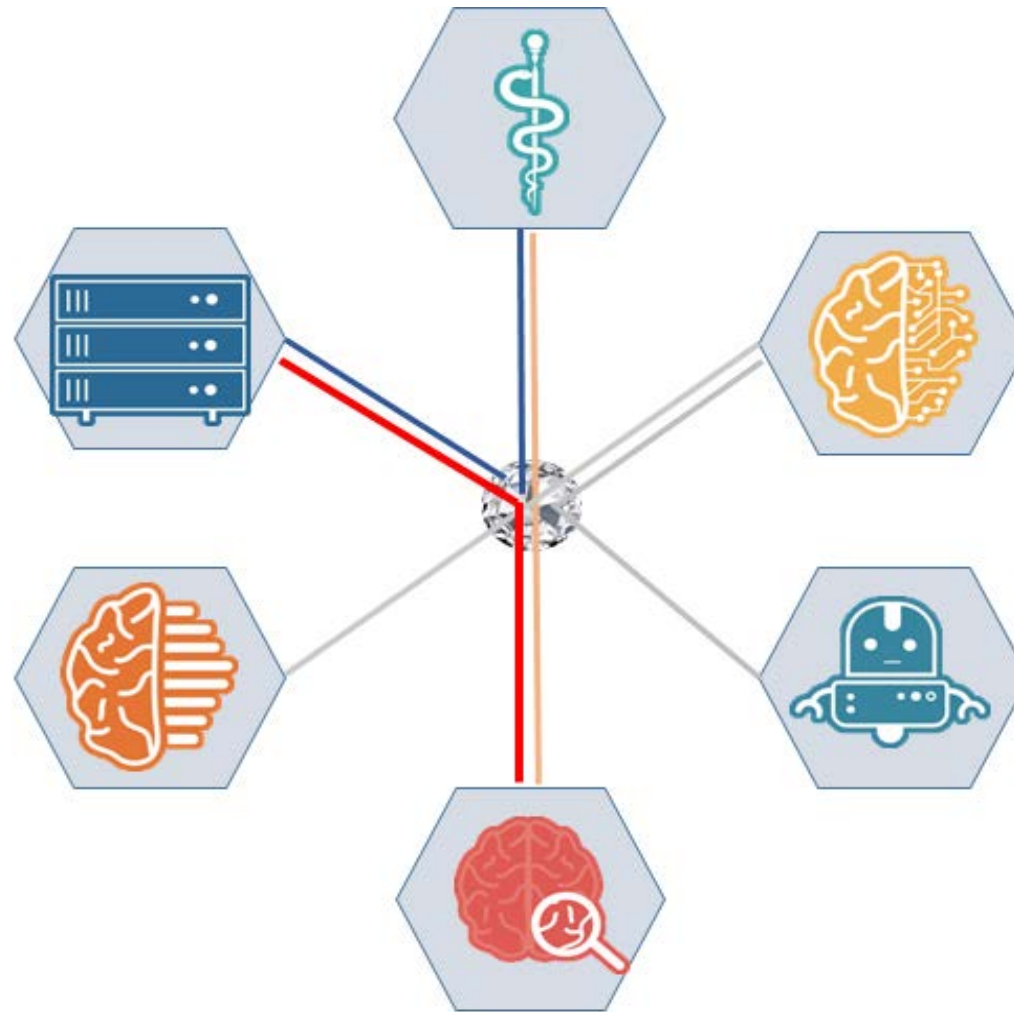
The HBP Joint Platform

Neuroinformatics Platform: delivers data curation and management of all data and models, makes data and models discoverable and usable, provides analysis tools

Brain Simulation Platform: develops and provides brain models and necessary simulation engines

HPAC Platform: provides high-performance computing, analytics services, and data services

Medical Informatics Platform: collects, curates, and federates clinical data

Neuromorphic Computing Platform: develops and operates neuromorphic computing systems

Neurorobotics Platform: develops and operates virtual and physical neurorobotics laboratories
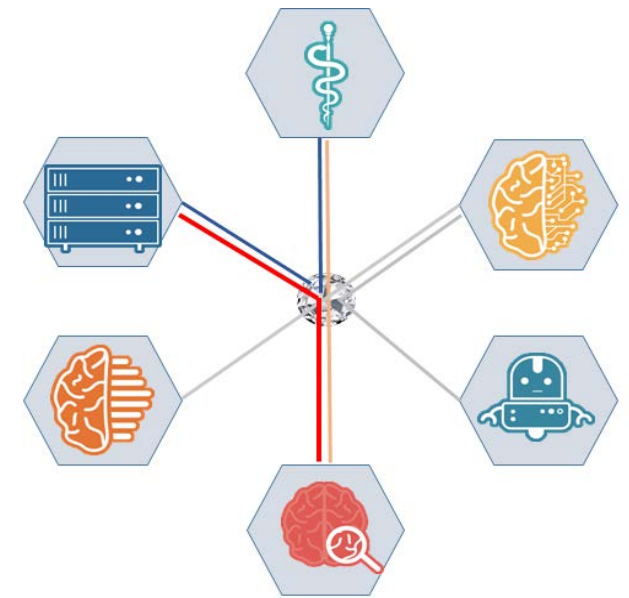
Growth and impact of HBP platforms

SP5 **Neuroinformatics Platform**
Number of files uploaded: 181387
Reference atlas: 11.3 Mio server hits,
40548 visitors (Since December 2017)

SP6 **Brain Simulation Platform**
- 502 unique active users (+29% since May 2018)
- 75073 page views (+80% since May 2018)
- 11081 use cases executed (+89% since May 2018)

SP7 **High Performance Analytics and Computing Platfrom**
400 accounts on HPC and Cloud infrastructure of the HPAC Platform

SP8 **Medical Informatics Platform**
- MIP installed in 9 hospitals (+29% since May 2018)
- 3 hospitals contributed
data from 6619 patients (+5% since May 2018)

SP9 **Neuromorphic Computing Platform**
5000 SpiNNaker jobs executed (+100% since May 2018)
619500 external user jobs (+30% since May 2018)

SP10 **Neurorobotics Platform**
503 registered users (+26% since May 2018)
72220 views of the NRP forums (+93% since May 2018)
875 Twitter followers (+12% since May 2018)

# Updated Organisation of Joint Platform

- **Horizontal service layers** (the underlying infrastructure)
  - HBP platform tools and services
  - Infrastructure services

- **Vertical Solutions** (tools which are used by customers/users)
  - Provide specific solutions for end-users that leverage the horizontal services - e.g. running a simulation on the Neurobotics Platform.
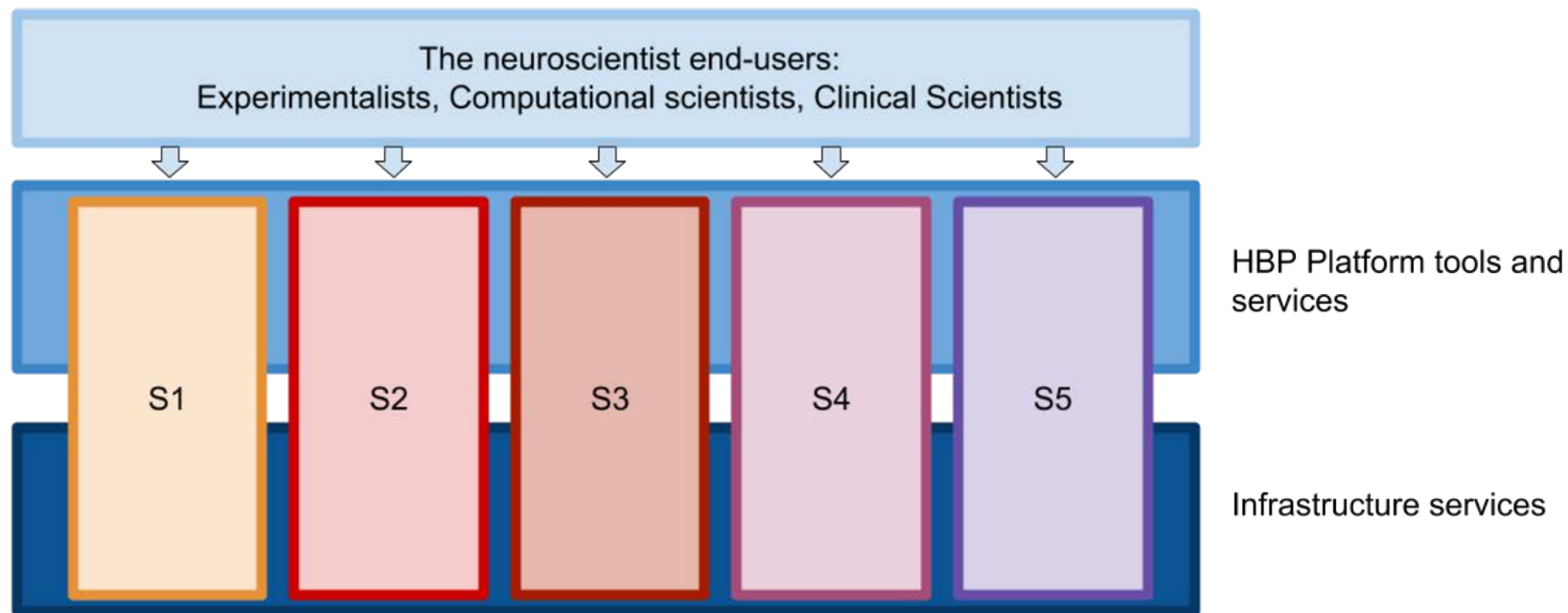
Community Services Under Implementation

Starting set of Solutions:

- HBP Brain Atlasing - multi-level and multi-species

- HBP Multi-scale Brain Simulation

- HBP Complex workflows for linking multi-level neuroscience data

- HBP Neurorobotics Simulation

- HBP Medical Data Analytics

- HBP Neuromorphic solutions for
  Neuroscience

Solution

HBP Brain Atlasing

https://www.humanbrainproject.eu/en/explore-the-brain/
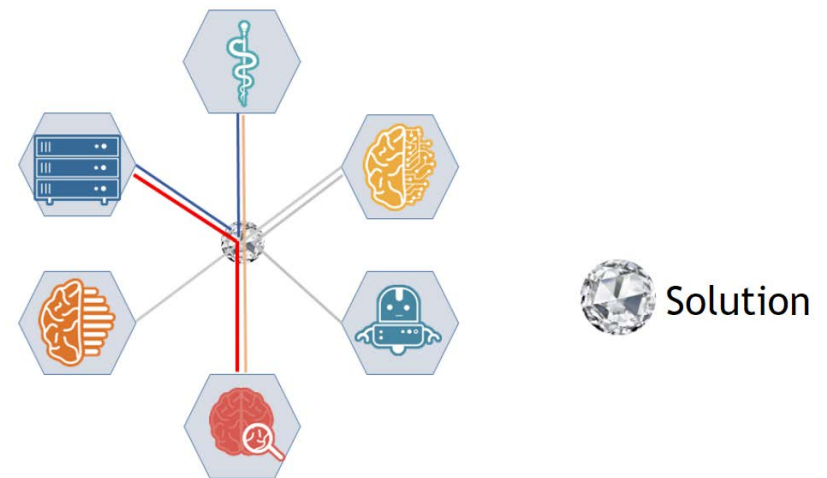
- **Features and capabilities**
  - Providing multi-level brain data in topographically organized framework to the community accessed through atlas search and navigation
  - Modeling creates links across scales and species including ontologies, semantics and statistics

- Horizontal services
  - Curation services and Knowledge Graph (KG)
  - Visualisation services
  - Ontologies, provenance, and versioning
  - Software deployment services
  - Data storage and transfer services
  - Scalable and interactive compute services
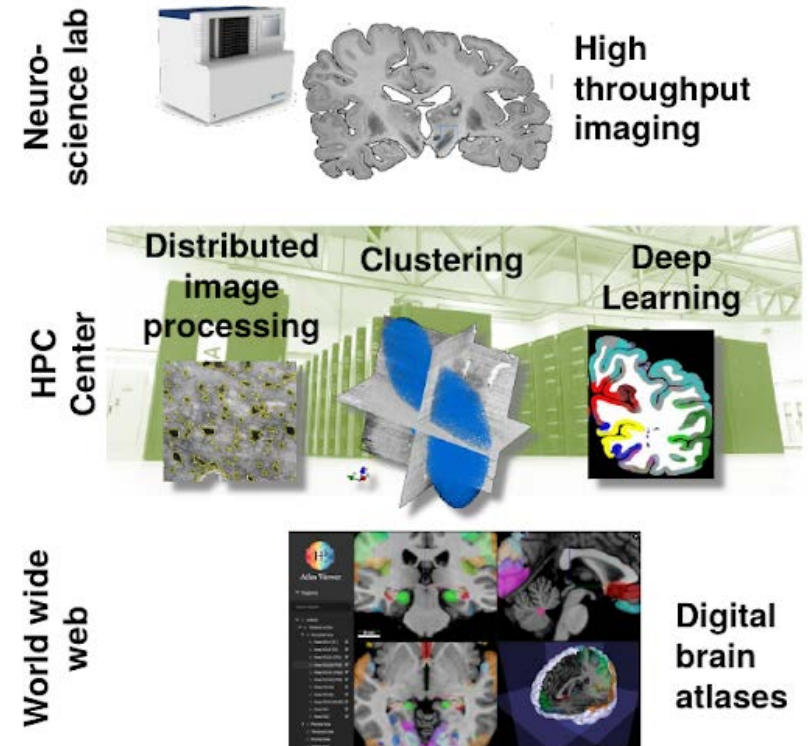
Additional Services

ICEI infrastructure services

- Scalable compute, interactive compute, virtual machine (VM) services

- Archival and active data repositories

- Data location and transfer/mover services

- Authentication and Authorization Infrastructure (AAAI), Fenix User and Resource Management Services

Neuromorphic computing systems

Patient data infrastructure

- Data stores in hospitals, patient data management services, patient data query and analysis services

HBP Summit Maastricht 2018

15 OCTOBER 2018 MAASTRICHT

HUMAN BRAIN PROJECT OPEN DAY

ENHANCING OUR UNDERSTANDING OF THE BRAIN

TALKS | DEMOS | ROBOTS | VIRTUAL REALITY

16-18 OCTOBER 2018 MAASTRICHT

HUMAN BRAIN PROJECT SUMMIT

670 attendees
incl. 359 from the public

494 registrations for the Summit
incl. 88 PhD students

15 OCTOBER 2018 MAASTRICHT

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Keynotes

Dick Swaab
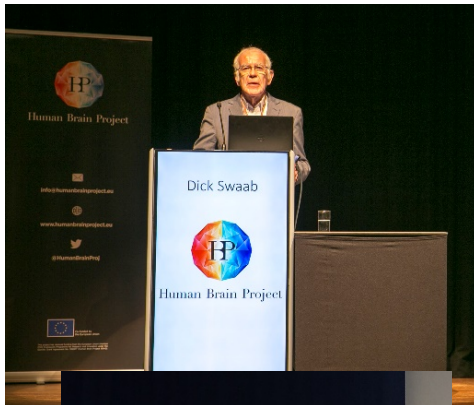
Rector Magnificus Maastricht
University Rianne Letschert

**Science Market
record visitor number**

Jeff Hawkins

Local host Rainer
Goebel
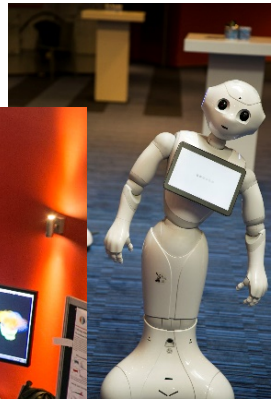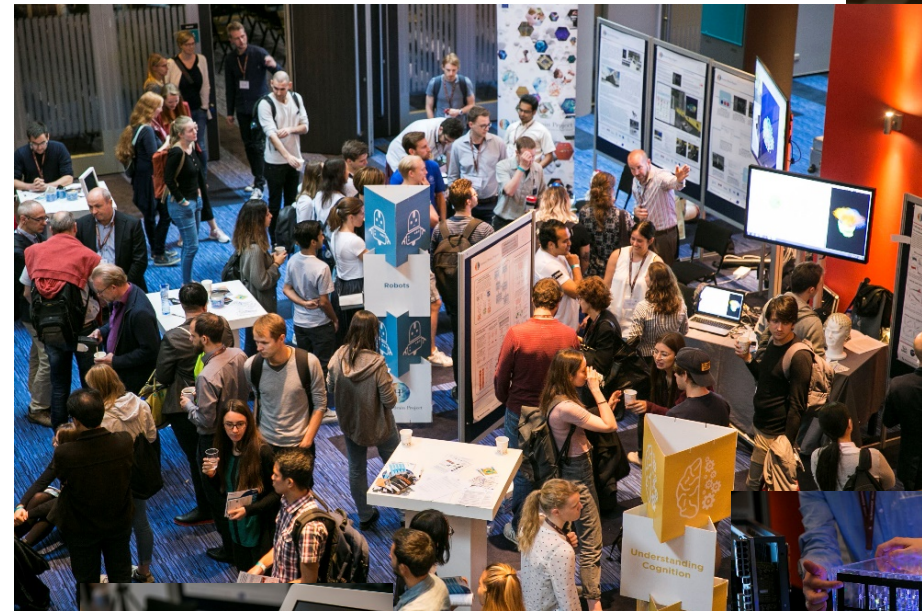
Summit Highlights

Commissioner Mariya Gabriel

28 Plenary Sessions
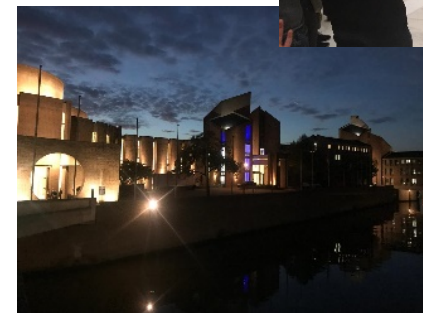39 parallel Sessions

Focus On Clinical IMPACT

Town Hall meeting

Linda Richards Keynote

Welcome Reception and Summit Dinner

Poster Sessions

Young Researchers Event

HBP Success Stories

1. Enabling the paralysed to walk

   (EPFL and CHUV/Unil Courtine SP10)

2. A clinical trial for computer modelled epilepsy treatment

   (Victor Jirsa – SP4)

3. Writing directly from a camera to the visual cortex

   (Pieter Roelfsema SP2)

4. SpiNNaker - a super-computer capable of simulating 1 billion point neurons

   (University Of Manchester – Furber/Lester SP9)
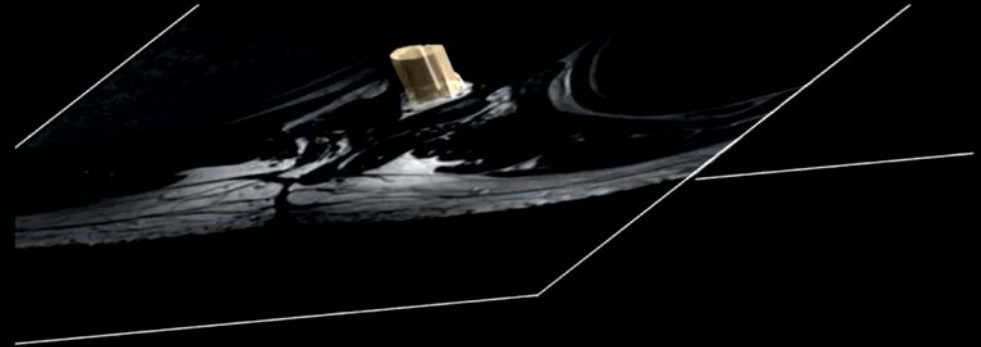
Personalized computational models HBP

1

HIGH RESOLUTION MRI SEQUENCE
FOR IMAGING THE ENTIRE EXTENT
OF DORSAL AND VENTRAL ROOTS

2

PERSONALIZED COMPUTATIONAL
MODEL TO PREDICT THE SURGICAL
PLACEMENT OF THE LEAD

https://youtu.be/yNAqu-h9Kuw

How The Technique Enables Walking

- A personalised computer model is used to optimize the placement of electrodes for each patient

- Computing fiber activation using a model developed in the framework of the HBP.

- Stimulation is delivered as a sequence of pulse trains that cycle through phases of locomotion for both legs

- The time sequence was defined through optimization with a spinal network model developed during the HBP that predicts efficacy of the stimulation during movement

- After 6 months training the patient shows improvement in the control of her/his legs with and without stimulation

- The brain learns to use the stimulation to move the legs voluntarily to the point that the patients are able to walk using the stimulation and minimal body weight support systems outside the laboratory environment!
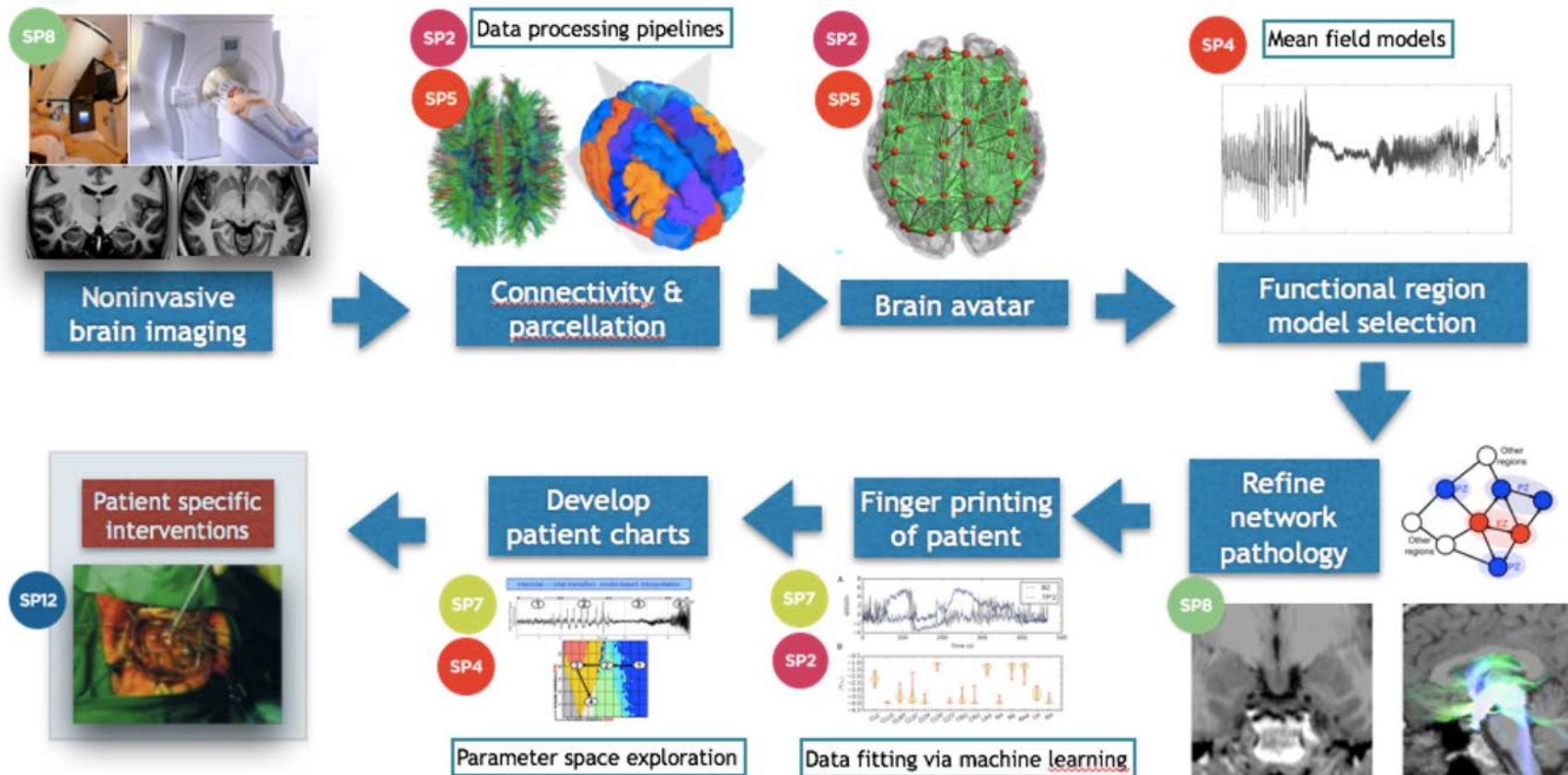
Nature volume 563, pages 65–71 Oct. 2018

https://youtu.be/2Sq6TVBj4Ow

https://youtu.be/MguSl43aRM0

Wagner et al. Nature 2018
Formento et al. Nature Neuroscience 2018

Improving Epilepsy Treatment (SP4)

THEVIRTUALBRAIN.

Patient-specific large-scale brain networks
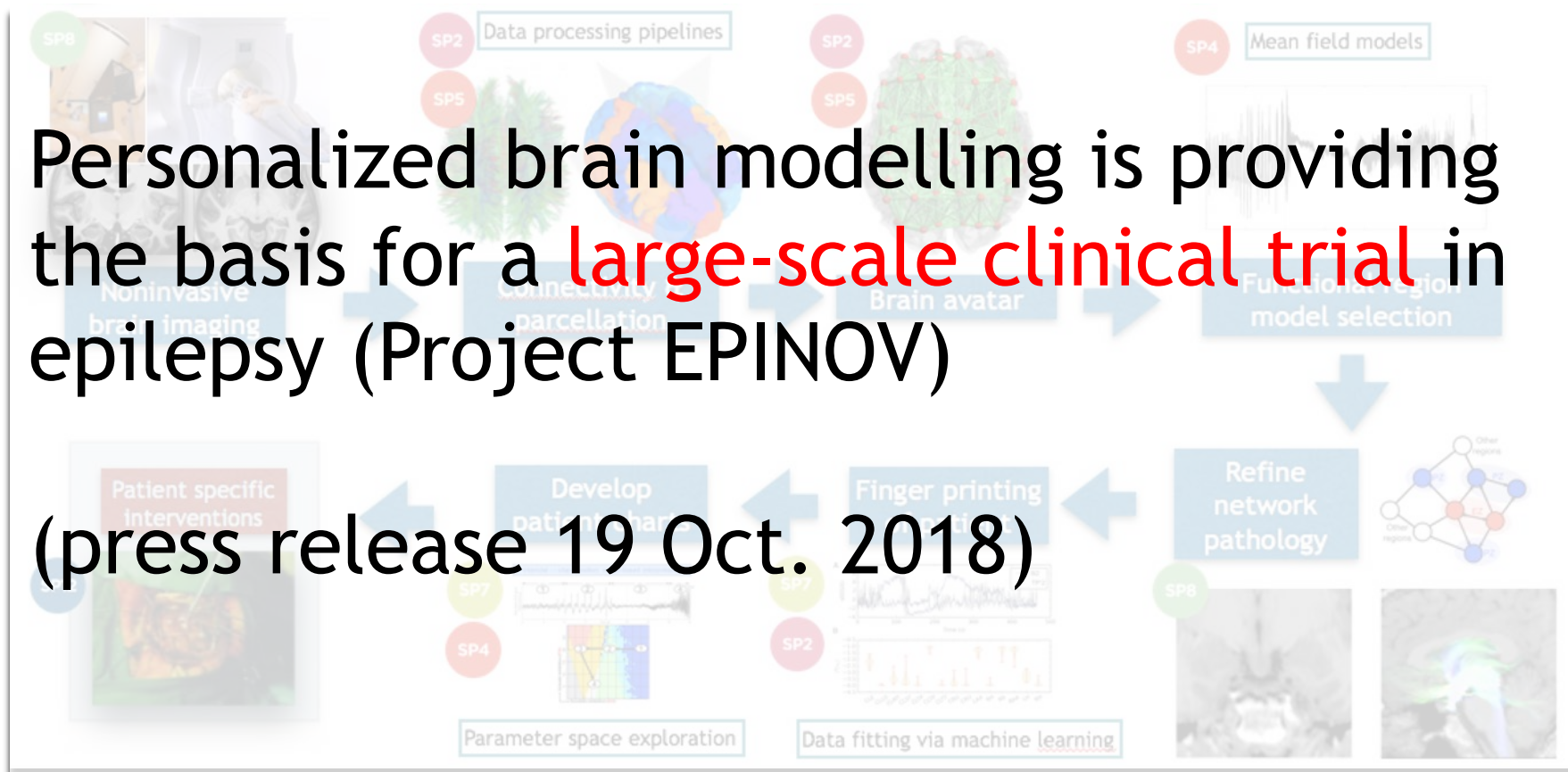

Proix, Jirsa, Bartolomei, Guye, Truccolo. *Nature Communications*, 9, Date 2018-03-14

Patient-specific large-scale brain networks

Personalized brain modelling is providing the basis for a large-scale clinical trial in epilepsy (Project EPINOV)

(press release 19 Oct. 2018)

Proix, Jirsa, Bartolomei, Guye, Truccolo. *Nature Communications*, 9, Date 2018-03-14

Visual Prothesis For Blindness (SP2)

High-resolution neuroimaging

Neuroanatomy

Electrode technology
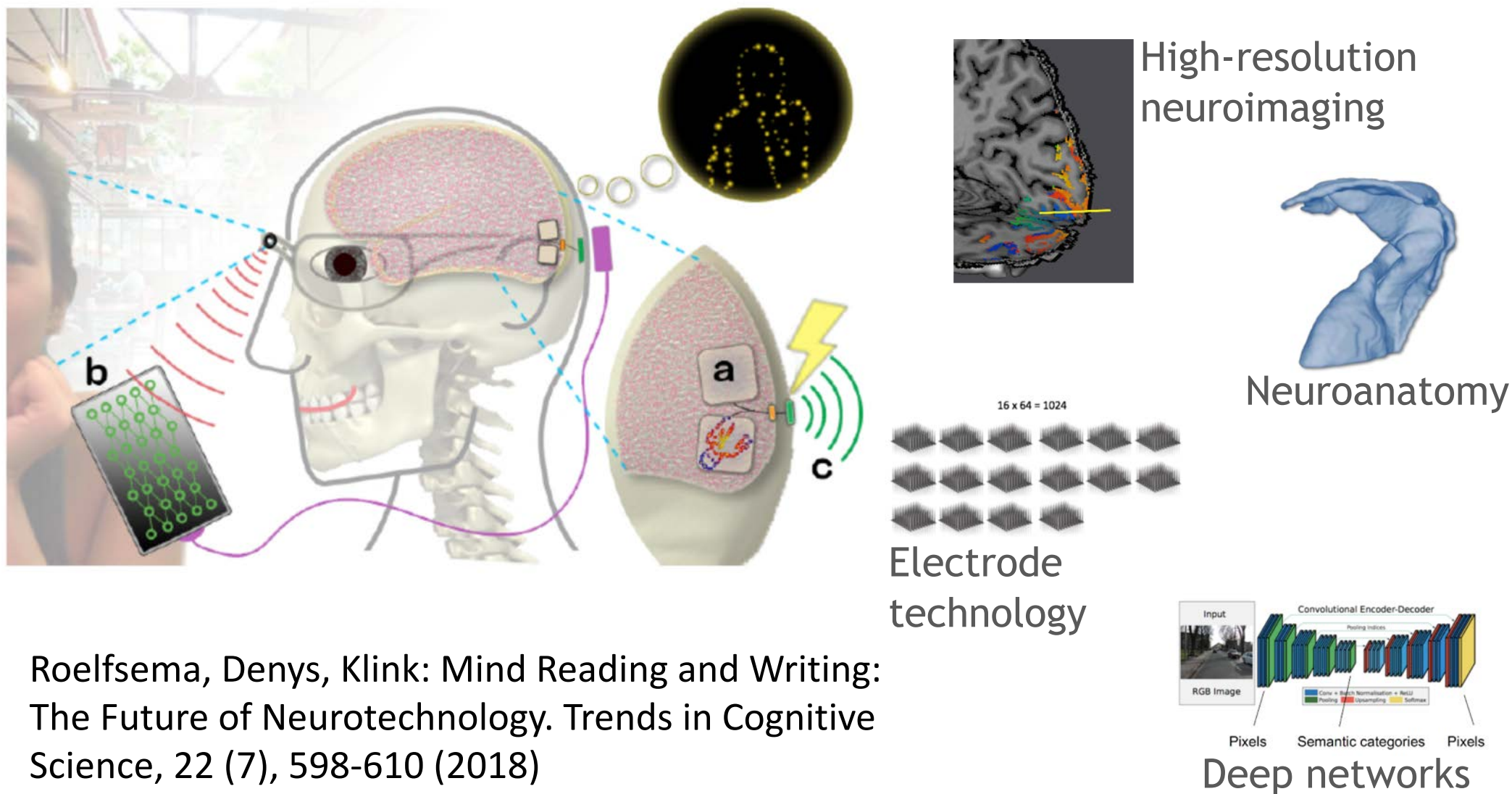
Roelfsema, Denys, Klink: Mind Reading and Writing: The Future of Neurotechnology. Trends in Cognitive Science, 22 (7), 598-610 (2018)
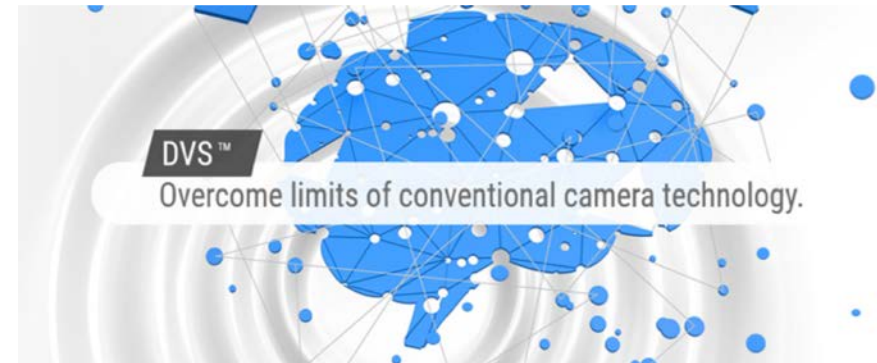
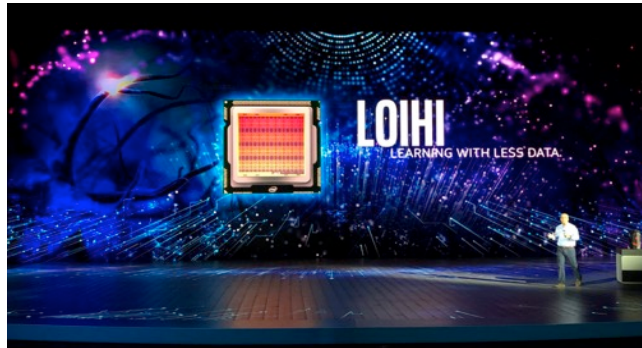Deep networks

SpiNNaker project (SP9)

- A million **arm** (neuromorphic) processors (used in mobile phones) united in one computer

- able to model about 1% of the human brain capacity...

- ...or 10 mice brains

Asynchronous Interconnect

Ethernet Link

● SpiNNaker CMP

Host System
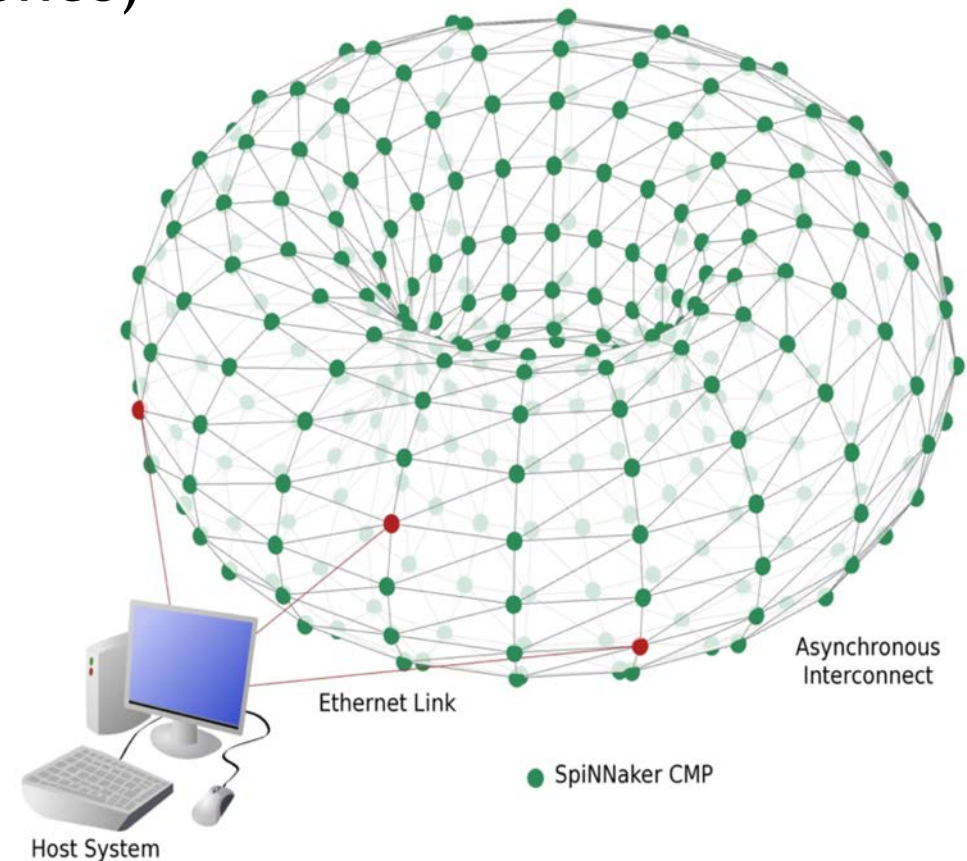
SpiNNaker project (SP9)

Start-ups and industry interest

High-level scientific publications
Examples of 2018 Publications*

Among 261 Registered For 2018 In HBP PLUS

PLOS COMPUTATIONAL BIOLOGY

RESEARCH ARTICLE
The physiological variability of channel density in hippocampal CA1 pyramidal cells and interneurons explored using a unified data-driven modeling workflow

Rosanna Migliore[1]*, Carmen A. Lupascu[1], Luca L. Bologna[1], Armando Romani[2], Jean-Denis Courcol[2], Stefano Antonel[2], Werner A. H. Van Geit[2], Alex M. Thomson[3], Audrey Mercer[3], Sigrun Lange[3,4], Joanne Falck[3], Christian A. Rössert[2], Ying Shi[2], Olivier Hagens[5], Maurizio Pezzoli[5], Tamas F. Freund[6,7], Szabolcs Kali[6,7], Eilif B. Muller[2], Felix Schürmann[2], Henry Markram[2], Michele Migliore[1]

Science NEUROSCIENCE

The threshold for conscious report: Signal loss and response bias in visual and frontal cortex

Bram van Vugt,[1]* Bruno Dagnino,[1]* Devavrat Vartak,[1]* Houman Safaai,[2,3]† Stefano Panzeri,[3] Stanislas Dehaene,[4,5] Pieter R. Roelfsema[1,6,7]†

nature COMMUNICATIONS

ARTICLE
DOI: 10.1038/s41467-018-02973-y   OPEN
Predicting the spatiotemporal diversity of seizure propagation and termination in human focal epilepsy

Timothée Proix[1,2,3], Viktor K. Jirsa[4], Fabrice Bartolomei[4], Maxime Guye[5] & Wilson Truccolo[1,2,3]

nature COMMUNICATIONS

ARTICLE
DOI: 10.1038/s41467-018-06628-w   OPEN
Lateral inhibition by Martinotti interneurons is facilitated by cholinergic inputs in human and mouse neocortex

Joshua Obermayer[1], Tim S. Heistek[1], Amber Kerkhofs[1], Natalia A. Goriounova[1], Tim Kroon[1,3], Johannes C. Baayen[2], Sander Idema[2], Guilherme Testa-Silva[1,4], Jonathan J. Couey[1,5] & Huibert D. Mansvelder[1]

Trends in Cognitive Sciences

CellPress REVIEWS

Opinion
Mind Reading and Writing: The Future of Neurotechnology

Pieter R. Roelfsema,[1,2,3,*] Damiaan Denys,[2,4] and P. Christiaan Klink[1,2,4]

Nature REVIEWS

Imaging-based parcellations of the human brain

Simon B. Eickhoff[1,2]*, B. T. Thomas Yeo[3,4,5,6] and Sarah Genon[1,2]

Systems/Circuits
h-Type Membrane Current Shapes the Local Field Potential from Populations of Pyramidal Neurons

Torbjørn V. Ness,[1] Michiel W.H. Remme,[2] and Gaute T. Einevoll[1,3]
[1]Faculty of Science and Technology, Norwegian University of Life Sciences, 1432 Ås, Norway, [2]Institute for Theoretical Biology, Humboldt University Berlin, 10115 Berlin, Germany, and [3]Department of Physics, University of Oslo, 0316 Oslo, Norway

Karlheinz Meier 1955-2018

A week after this year's HBP Summit, HBP Infrastructure Operations Director and Karlheinz Meier, a co-founder and driving force within the HBP passed away suddenly.

Karlheinz Meier embodied the spirit of encouragement and collaboration that is a hallmark of the HBP.
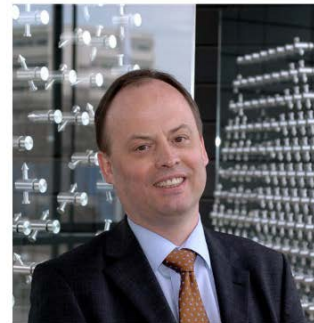
Thank You

www.humanbrainproject.eu   @HumanBrainProj   Human Brain Project