A grayscale microscopic image of neurons, showing their cell bodies and long, thin processes extending across the field of view. The neurons are interconnected, forming a complex network. The background is dark, making the lighter-colored neurons stand out.

Starlab Neuroscience

LUMINOUS H2020 FET project

Aureli Soria-Frisch (PhD)

**Neuroscience
BU Director**

Starlab
Living Science

Starlab – a brief introduction

A private R&D company
based in Barcelona (since
2000)

Transforming **Science** into
Technologies

Developing new products
and services with profound
and **positive social impact**



HIVE project: vision and focus

hiVE

HYPER
INTERACTION
VIABILITY
EXPERIMENTS

Could computers someday interact directly with the human brain? The vision of this four-year project is that in the next 50 years we will witness the coming of age of technologies for fluent brain-computer and computer-mediated brain-to-brain interaction. While recent EEG research has delivered important breakthroughs in brain-to-computer transmission, little has been achieved in the other direction—computer-controlled brain stimulation. Our goal is to research stimulation paradigms to design, develop and test a new generation of more powerful and controllable non-invasive brain stimulation technologies. Starting from current distributed and multi-scale neuron-current interaction modelling and stimulation experiments using tDCS, TMS, EEG and tMRSt in different scenarios, the project will develop multi-scale transcranial current stimulation technologies implementing real time EEG monitoring and feedback. We will explore high-level communication using stimulation, stimulation during different states of consciousness, stimulation and therapy, as well as sense synthesis, that is, the construction of new perceptions deriving from sensors interacting directly with brains through stimulation systems—all with the goal of probing the limits of non-invasive computer-to-brain interfaces. WP1 will focus on biophysical modelling aspects, WP2 and WP3 will carry out stimulation experiments with animals and humans, and WP4 will integrate the results to develop and test new multiple technologies for interaction—both hardware and software. WP5 will organise two workshops and carry out dissemination and socio-ethical impact analysis tasks, while WP6 will cover technical and administrative management aspects. Given the fundamental role of interaction in human experience, advances in this area can deliver breakthrough information society technologies of great value in addition to advancing the state-of-the-art in fundamental neuroscience research, neurology diagnosis and therapy.

Vision: in the next 50 years we will witness the coming of age of technologies for fluent brain-computer and computer-mediated brain-to-brain interaction—which we call *hyper-interaction*.

Our question: are non-invasive brain stimulation technologies a viable option for hyper-interaction?

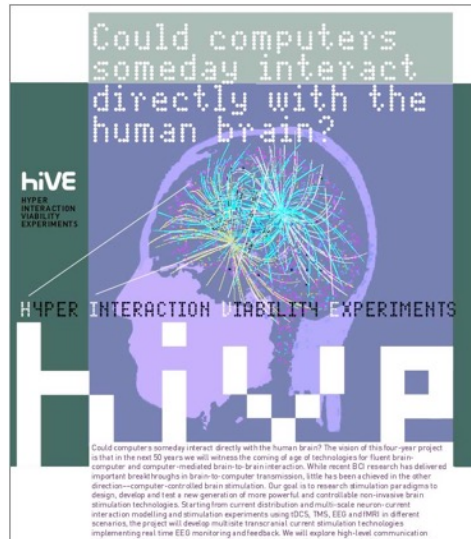
hiVE
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OPEN ACCESS Freely available online

PLOS ONE

Conscious Brain-to-Brain Communication in Humans Using Non-Invasive Technologies



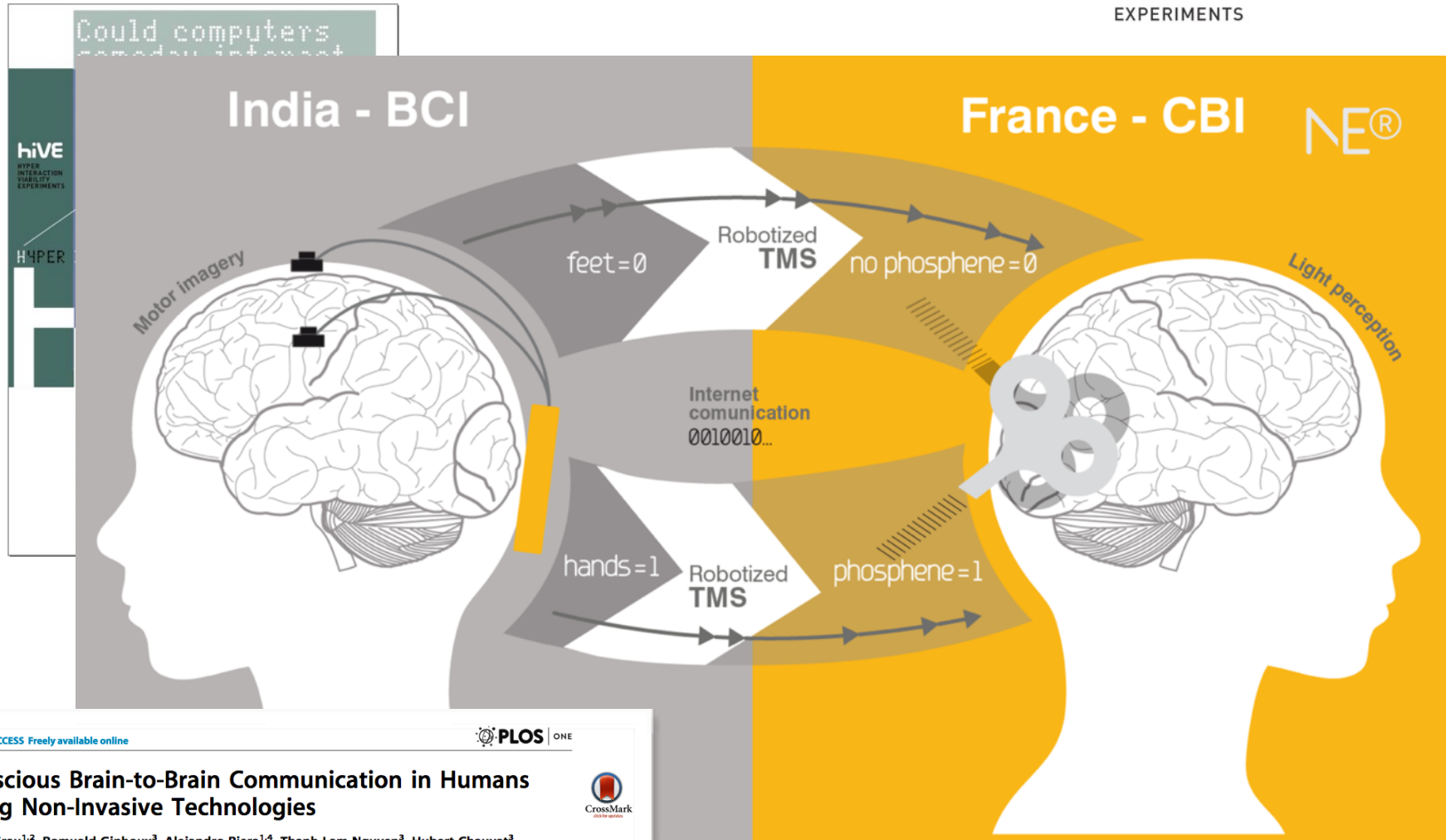
Carles Grau^{1,2}, Romuald Ginhoux³, Alejandro Riera^{1,4}, Thanh Lam Nguyen³, Hubert Chauvat³, Michel Berg³, Julià L. Amengual⁵, Alvaro Pascual-Leone⁶, Giulio Ruffini^{1,4*}

1 Starlab Barcelona, Barcelona, Spain, **2** Neurodynamics Laboratory, Department of Psychiatry and Clinical Psychobiology, Psychology and Medicine Faculties, University of Barcelona, Barcelona, Spain, **3** Axilum Robotics, Strasbourg, France, **4** Neuroelectrics Barcelona, Barcelona, Spain, **5** Cognition and Brain Plasticity Unit, Department of Basic Psychology, University of Barcelona, Barcelona, Spain, **6** Berenson Allen Center for Noninvasive Brain Stimulation, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, United States of America

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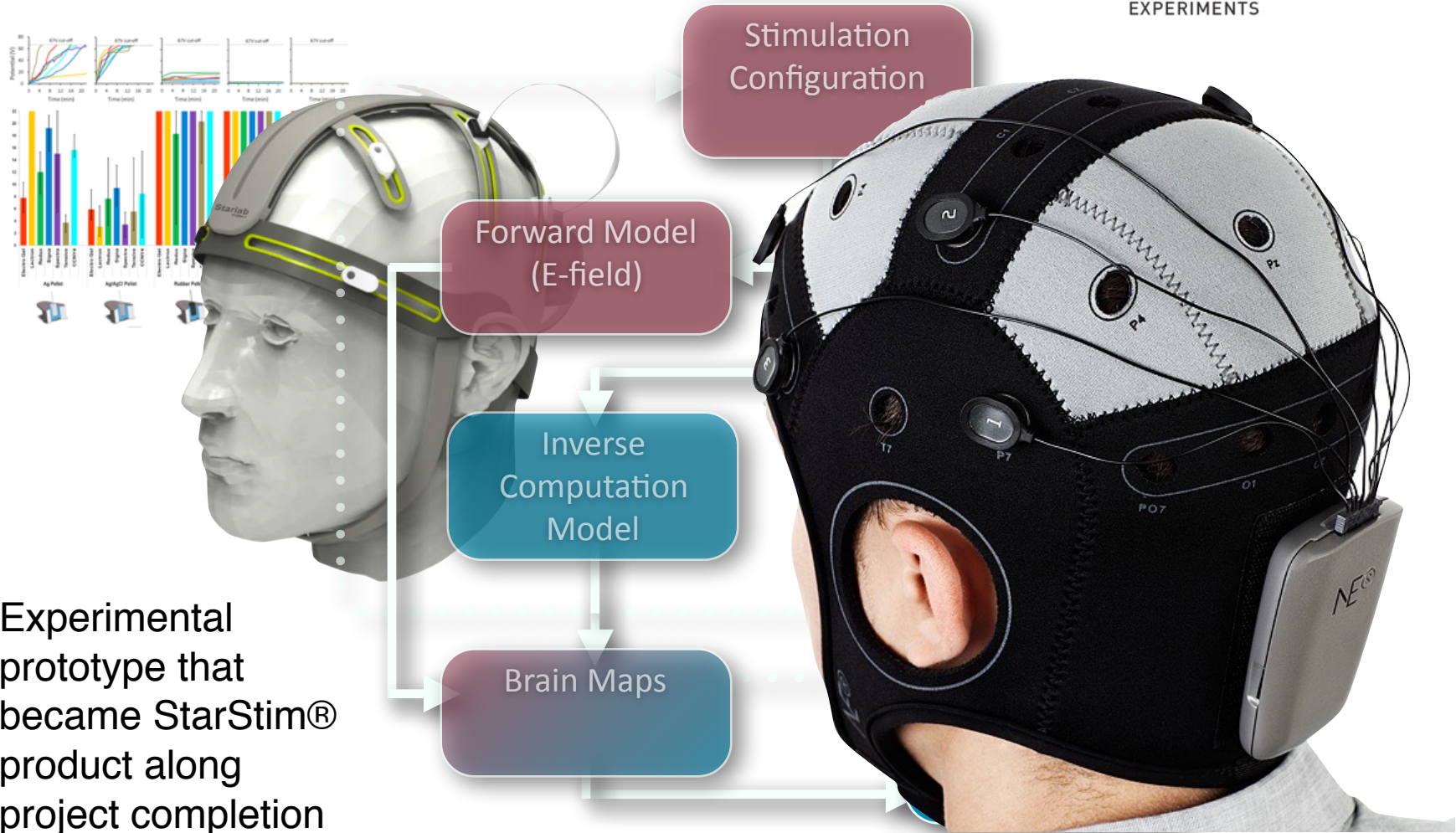
¹ Starlab Barcelona, Barcelona, Spain, ² Neurodynamics Laboratory, Department of Psychiatry and Clinical Psychobiology, Psychology and Medicine Faculties, University of Barcelona, Barcelona, Spain, ³ Axilum Robotics, Strasbourg, France, ⁴ Neuroelectrics Barcelona, Barcelona, Spain, ⁵ Cognition and Brain Plasticity Unit, Department of Basic Psychology, University of Barcelona, Barcelona, Spain, ⁶ Berenson Allen Center for Noninvasive Brain Stimulation, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, United States of America



HIVE Achievements - StarStim

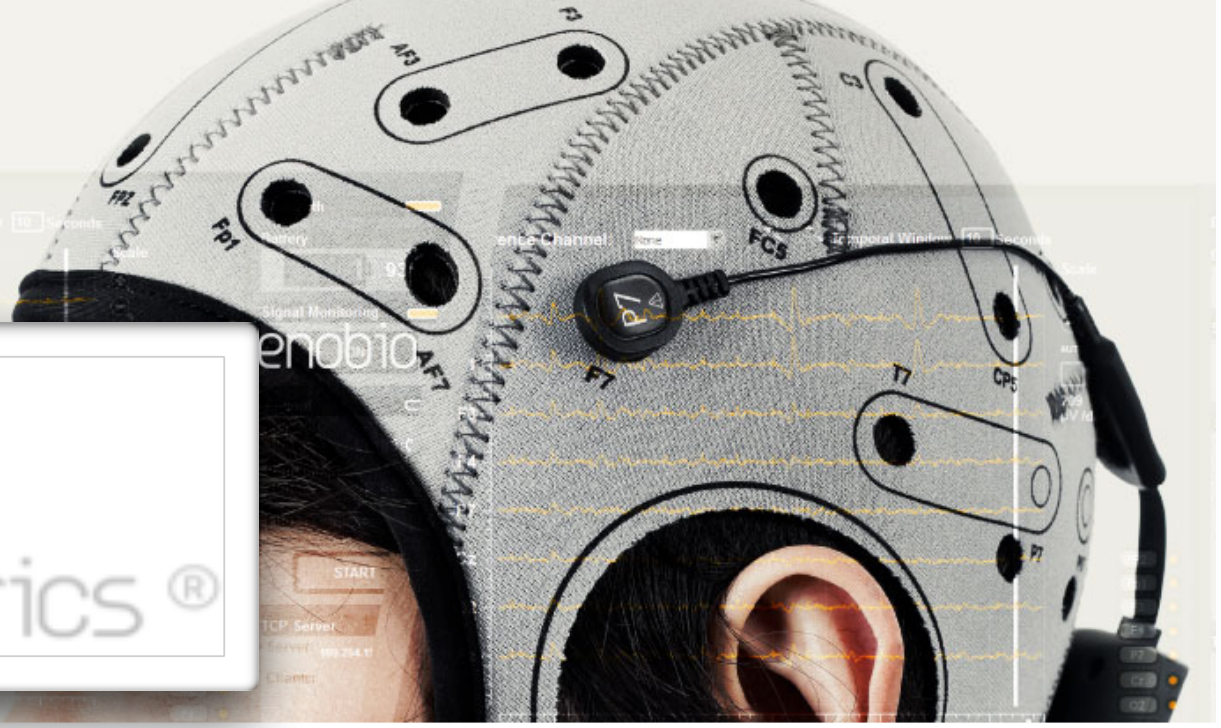
hive

HYPER
INTERACTION
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Experimental prototype that became StarStim® product along project completion

A new paradigm
to monitor and
stimulate the
brain



Mobile brain
signal sensing
and stimulation
systems

Enobio

Starstim

Digital Brain Health



Neuroelectrics

The Digital Brain
Health Company



NE-20161017-01

Funded Research

DIGITAL HEALTH



THE MICHAEL J. FOX FOUNDATION
FOR PARKINSON'S RESEARCH

Comunitats
RIS3CAT

Research and
Innovation
Strategies for
Smart Specialisation



NE
neuroelectrics®

biomarker discovery



Studying Consciousness
in the electrical brain

Starlab®

LUMINOUS

brain
stimulation

hiVE

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Starlab Neuroscience

LUMINOUS[®]

THE LUMINOUS PROJECT

Studying consciousness in the electrical brain

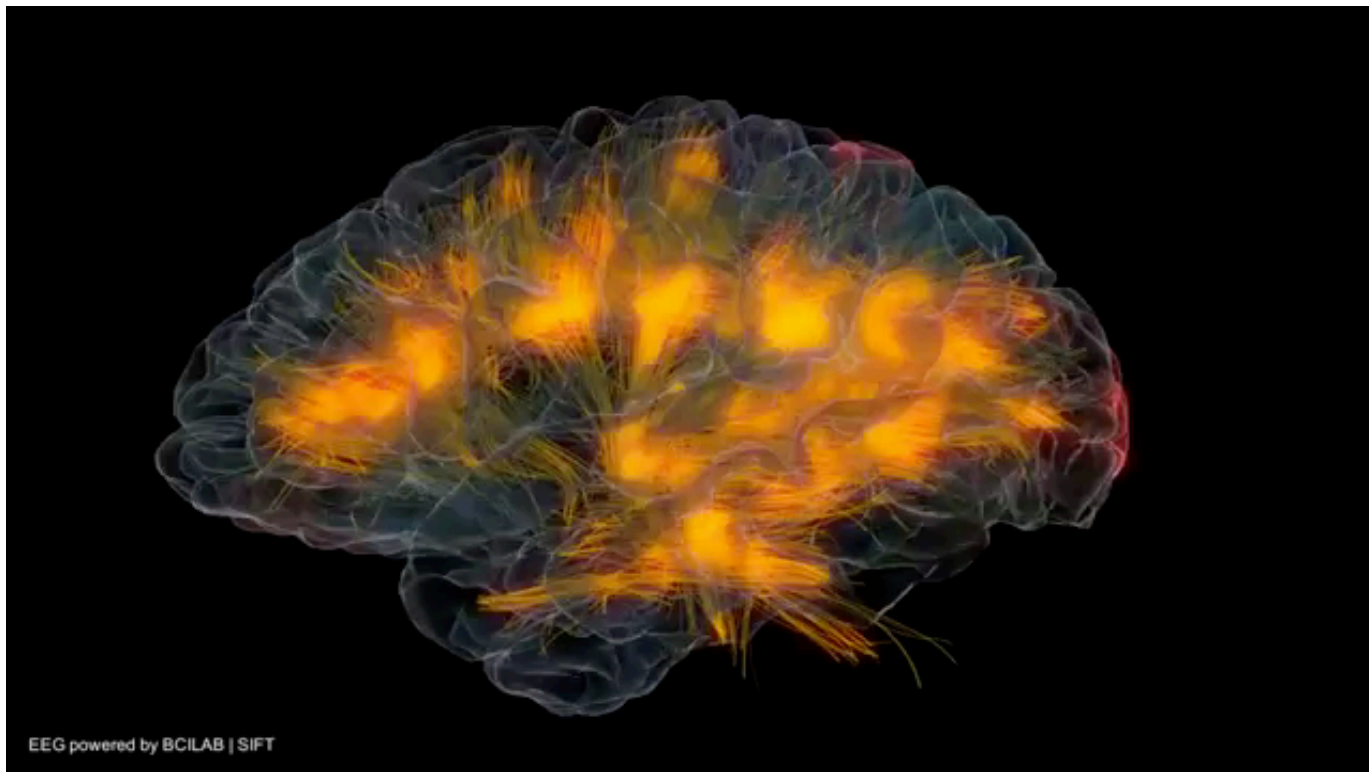
EU H2020 FET Open Project



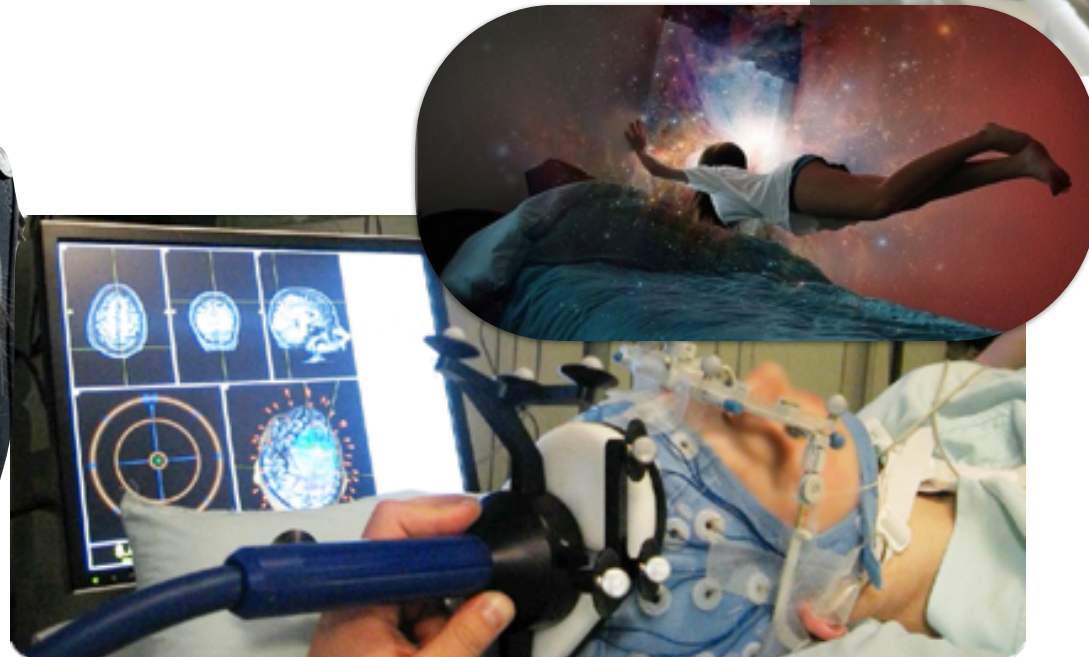
Horizon 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme Euratom research and training programme 2014-2018 under grant agreement Number 686764

The Electrical Brain



Consciousness will someday be electromagnetically measured and altered, and that the associated needed insights will prove crucial to the development cognitive sciences.



Luminous project

vision

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our
questions

What is consciousness?

Can it be measured?

Can it be altered through electromagnetic brain stimulation?

Luminous project

vision

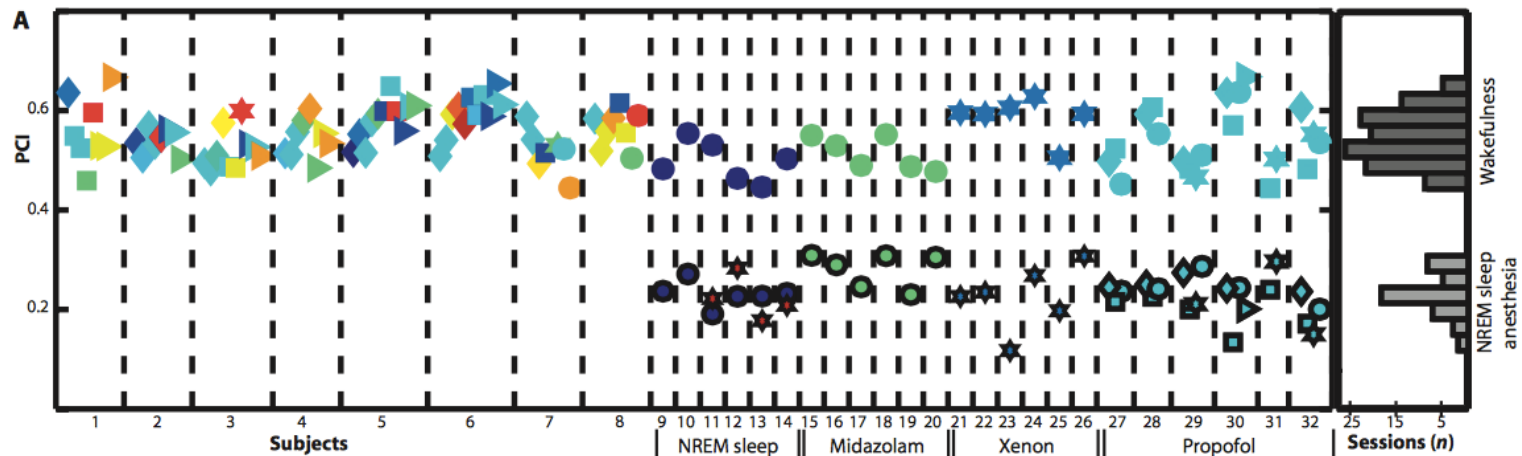
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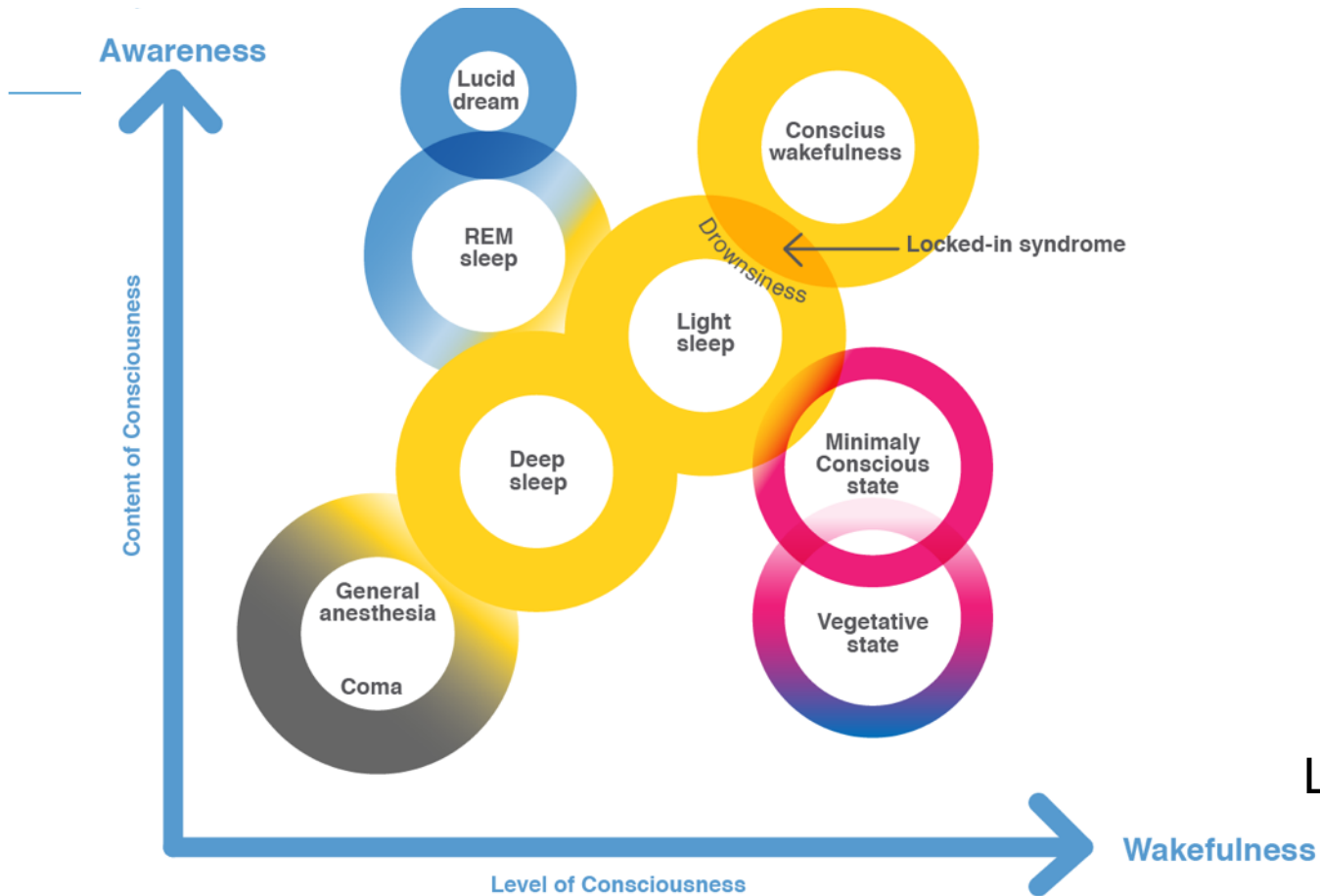
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Cassini et al 2013

Luminous project

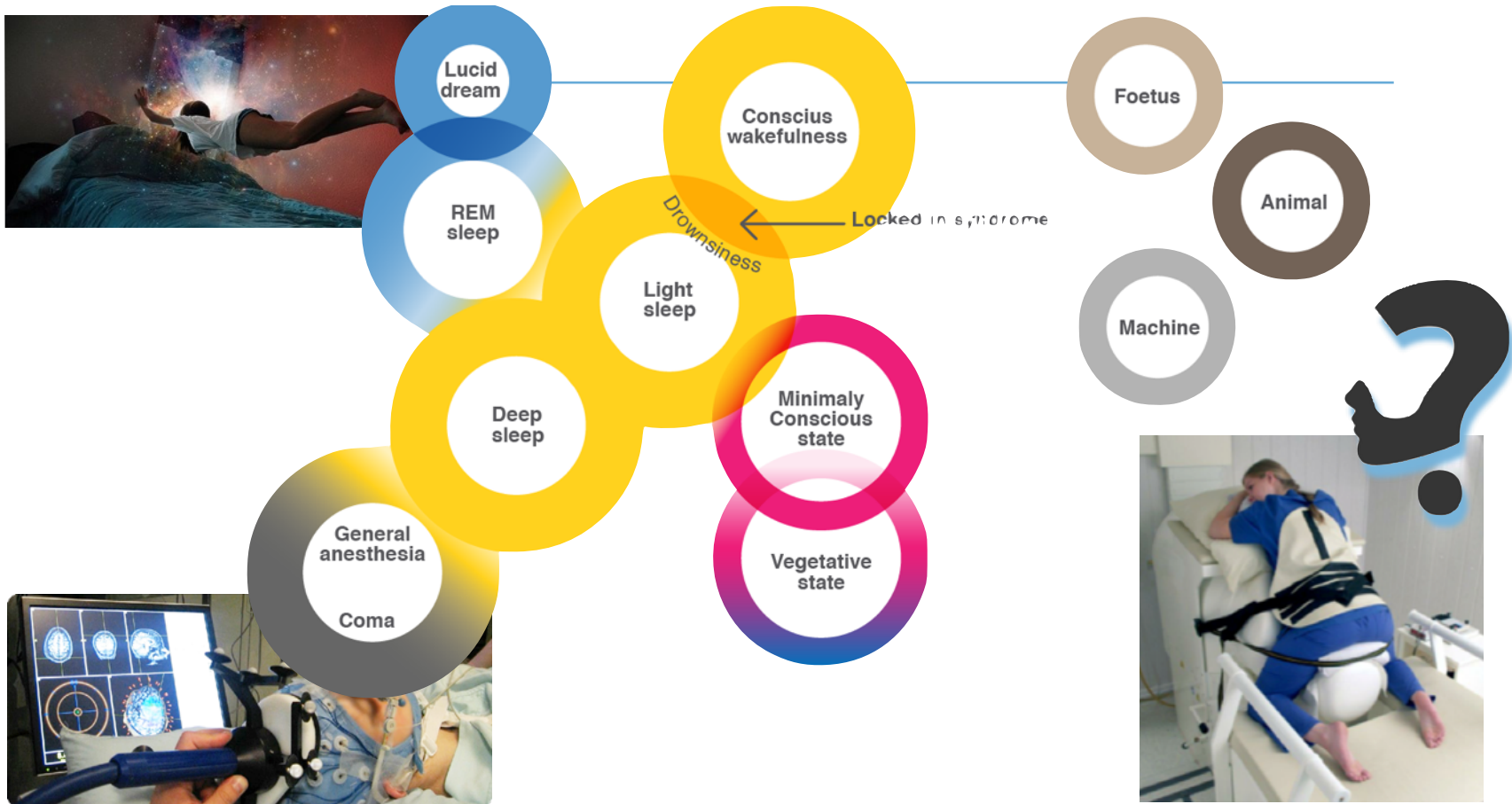
Studying Consciousness in the Electrical Brain



Laureys 2005

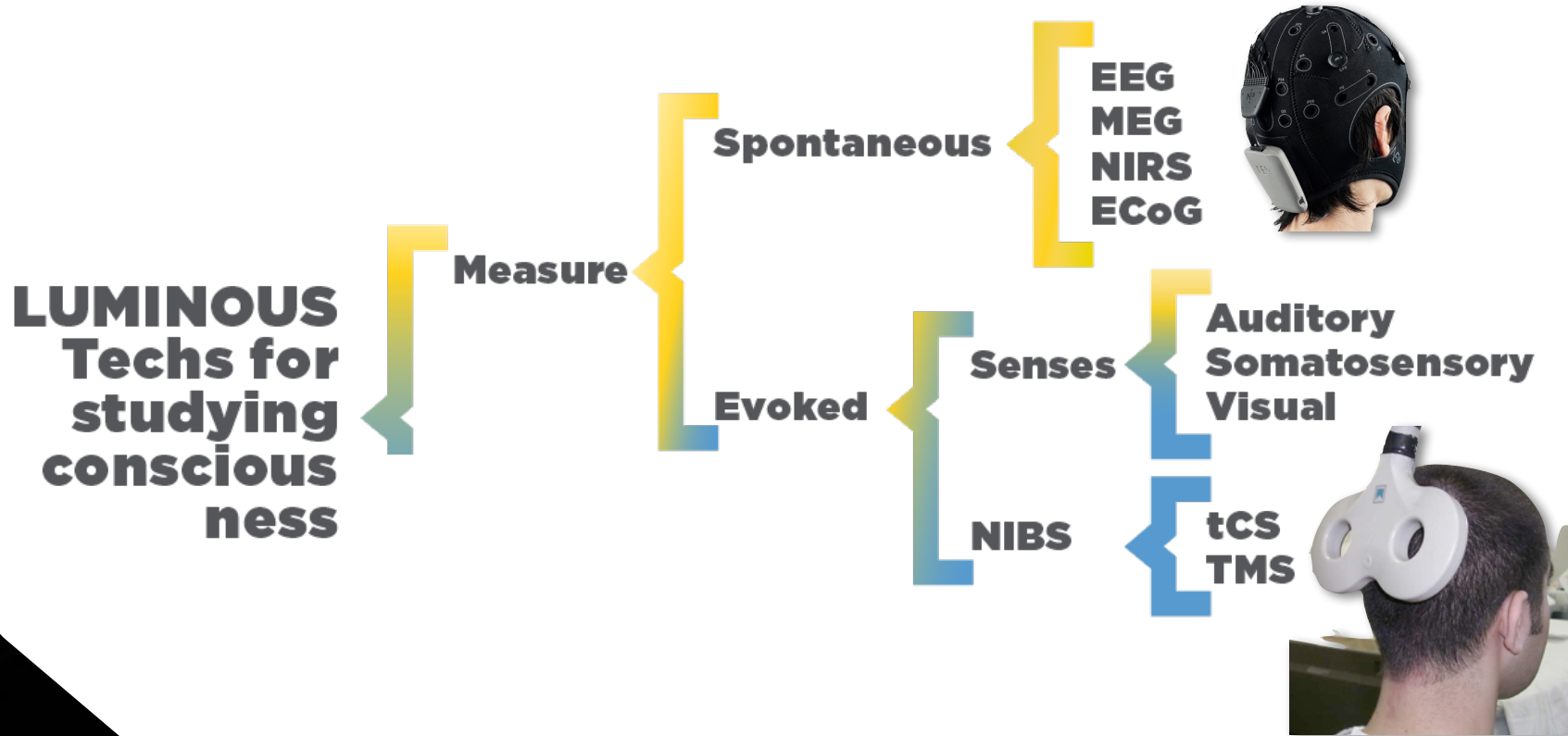
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Measuring Consciousness in the Electrical Brain



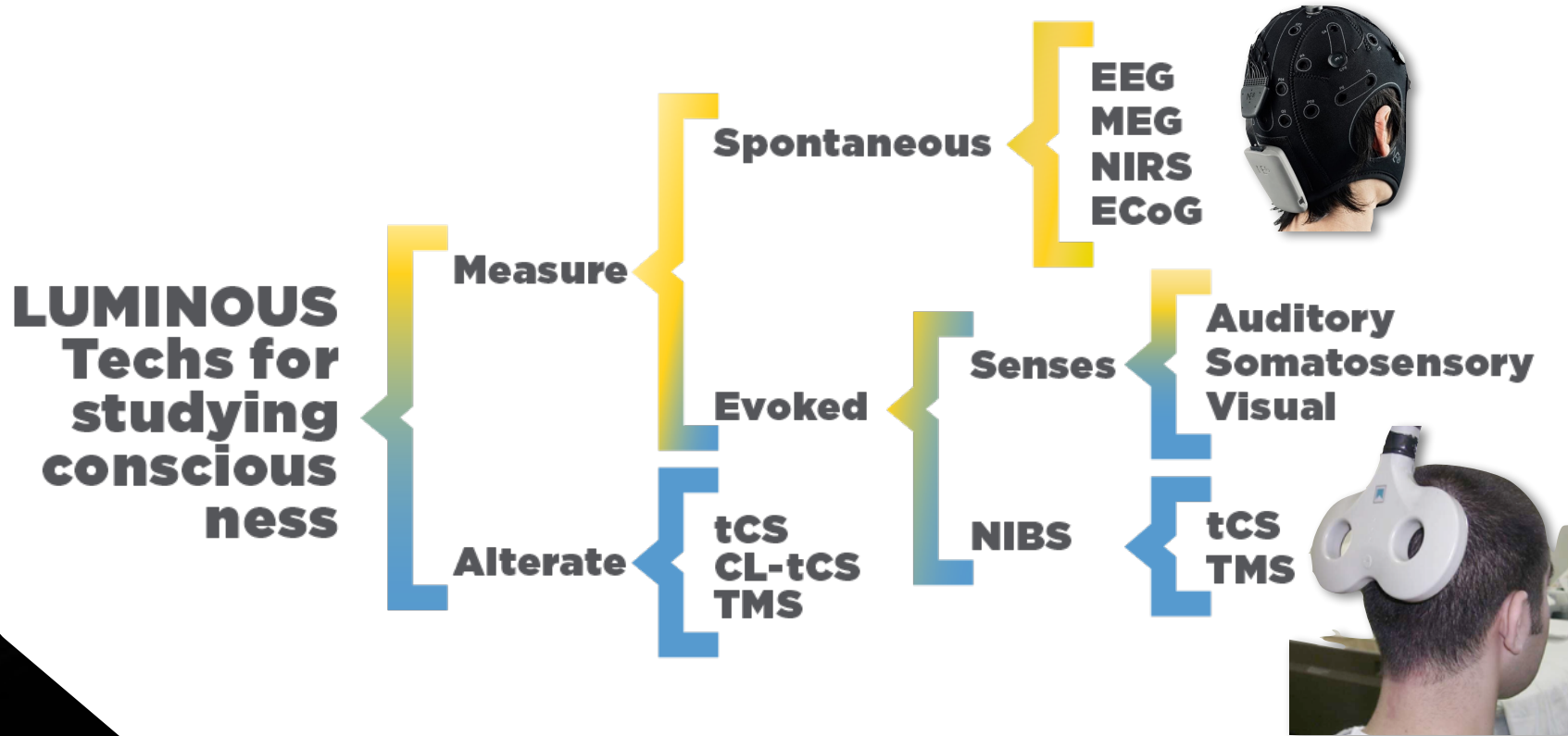
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Advancing Consciousness Technologies



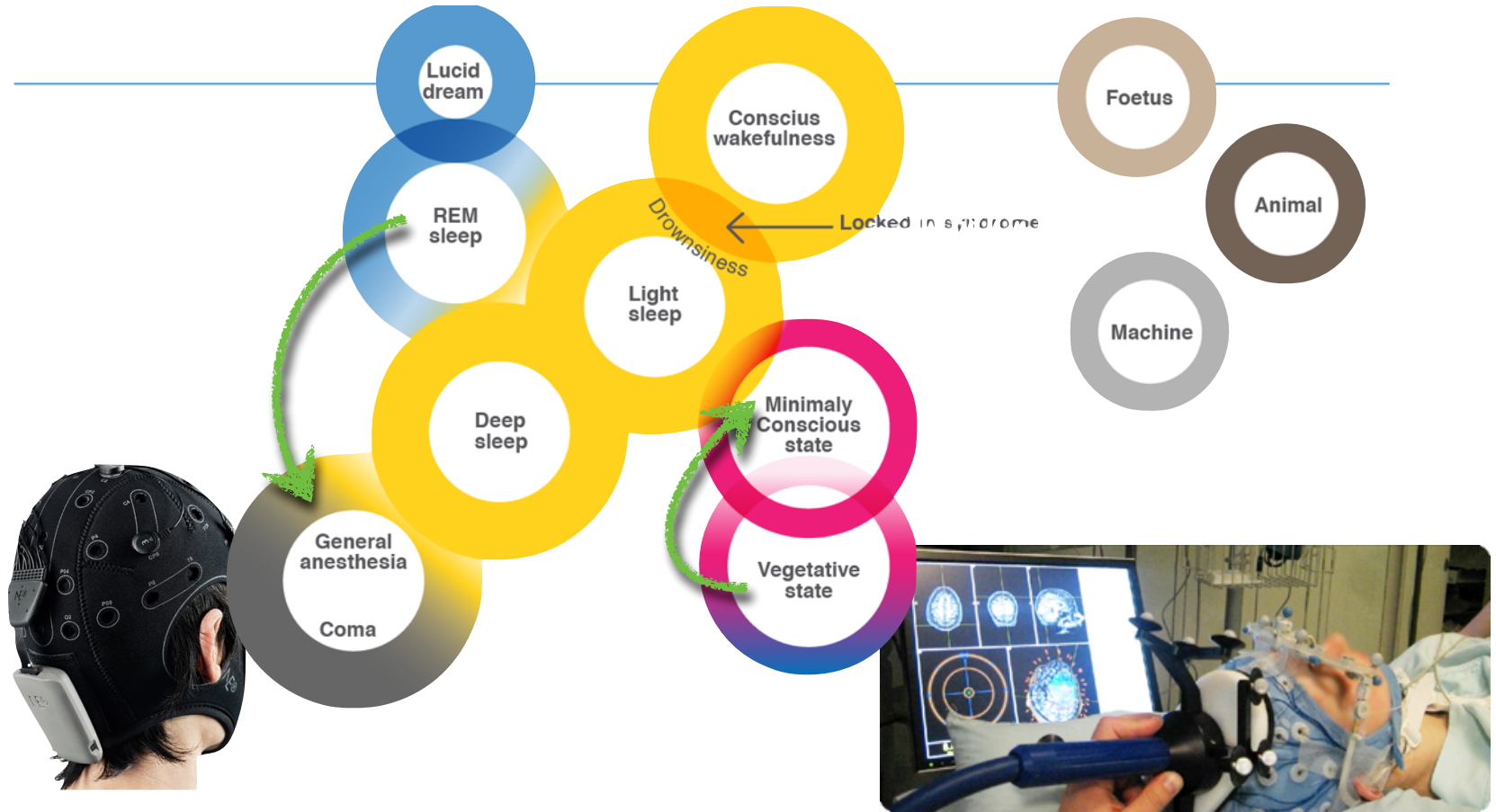
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Advancing Consciousness Technologies



Luminous project

Changing Consciousness in the Electrical Brain?



LUMINOUS project: consortium



Helmholtz Zentrum
münchen

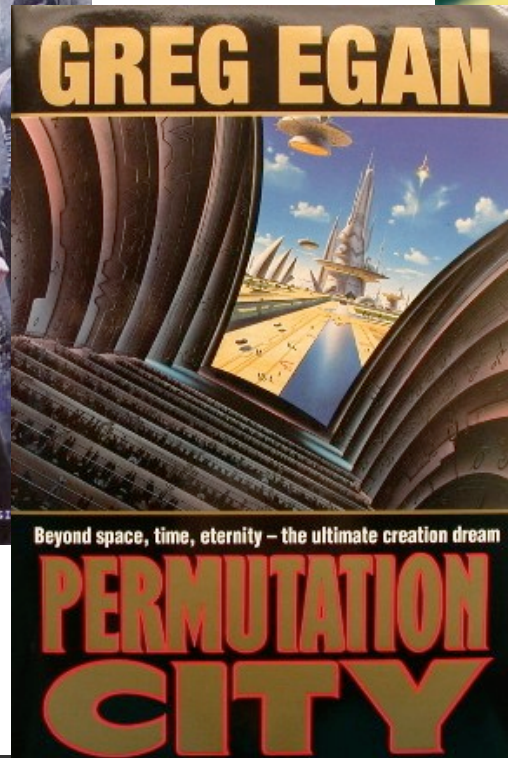


LUMINOUS project: lessons

- ✦ Clear and challenging long-term vision
- ✦ No incremental improvement, but radically new, and high risk

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Project consortium



Project **Advisory board**: G. Tononi (theory of consciousness, ITh, neurophilosophy), A. Pascual-Leone (neuroscience, brain stimulation), D. Wolpert (AI, mathematics), I. Aleksander (Machine consciousness, robotics)

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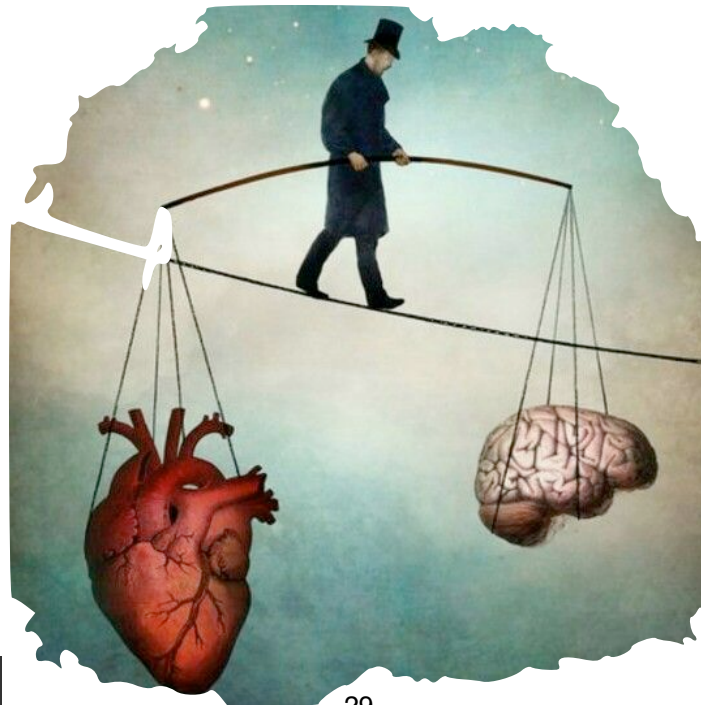
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exploration
serendipity
blue sky



feasibility
exploitation
down to earth

Christian Schloe
Digital Artwork
<https://www.artflakes.com/en/products/the-balance-3>

A grayscale microscopic image of a neural network, showing numerous interconnected neurons with long, thin dendrites and axons. A semi-transparent rectangular box is overlaid on the left side of the image, containing text.

**Thank you for
your attention!**

aureli.soria-frisch@starlab.es

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