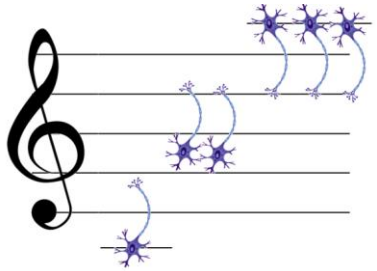
SCALES

« **S**tudying **C**ognitive **A**ctivity at several **LE**vels with **S**imultaneous depth and surface recordings”



Christian Bénar, Aix-Marseille University

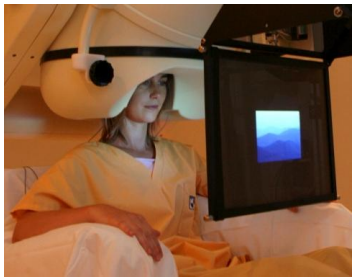
FLAG-ERA JTC 2017 Project Kick-off Seminar

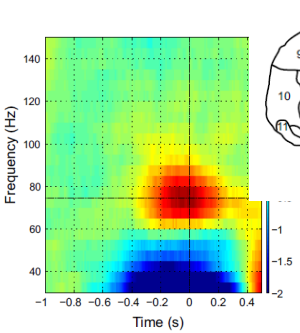
Madrid, March 22nd 2018

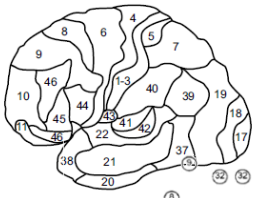
FLAG-ERA

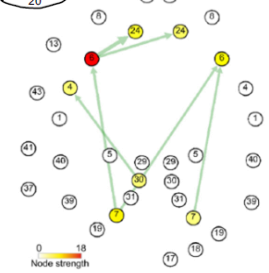
Mapping brain networks: different measurement scales

MEG/EEG





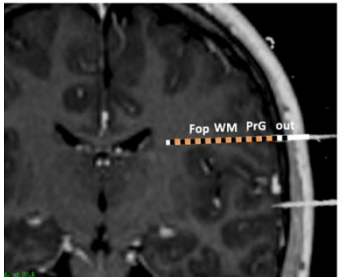


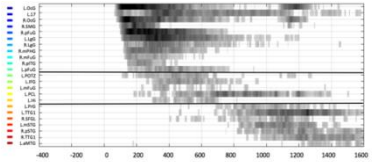


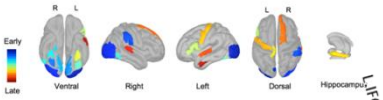
Brovelli et al J Neurosci 2015

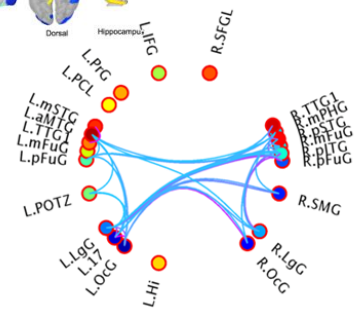
+ time (and time-frequency)
+ large-scale networks
- low spatial precision

Intracerebral EEG (SEEG)
(presurgical evaluation of epilepsy)



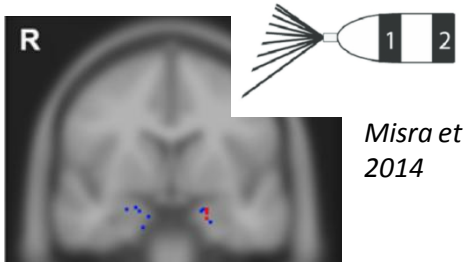




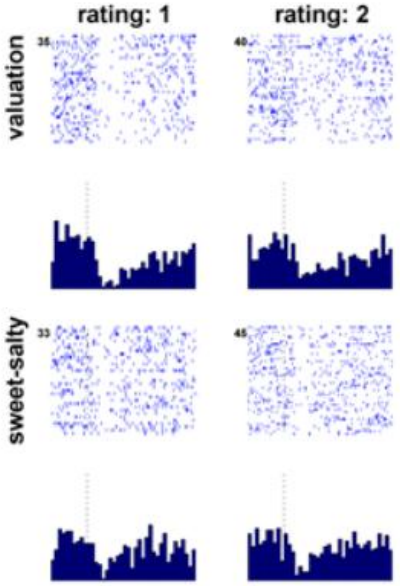


Dubarry et al Psychol Sci 2017
See also Trébuchon et al 2009

Unit activity



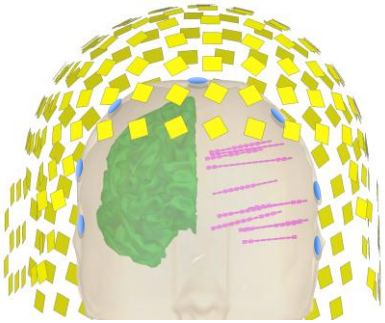
Misra et al 2014



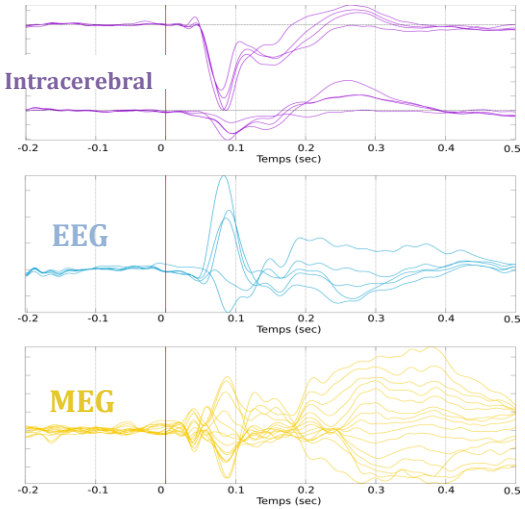
Mormann et al Cereb Cortex 2017

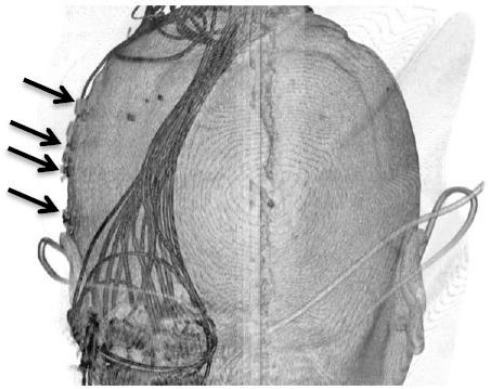
Macro-scale ⟷ *Meso-scale* ⟷ *Micro-scale*

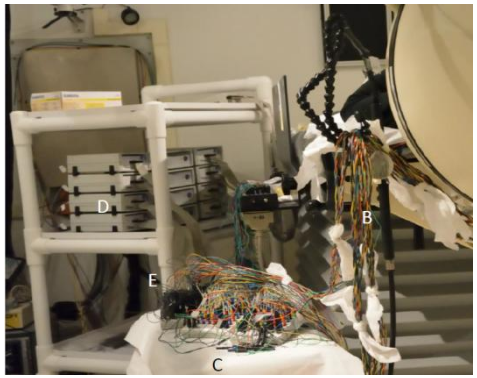
Simultaneous recordings can bridge the gap between scales



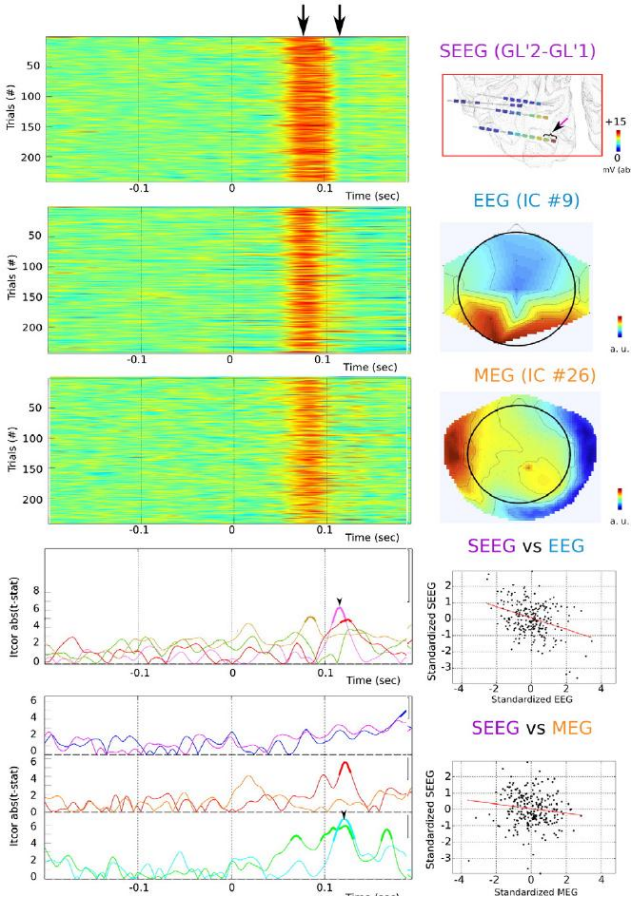
A.S. Dubarry







Badier et al Phys Meas 2017

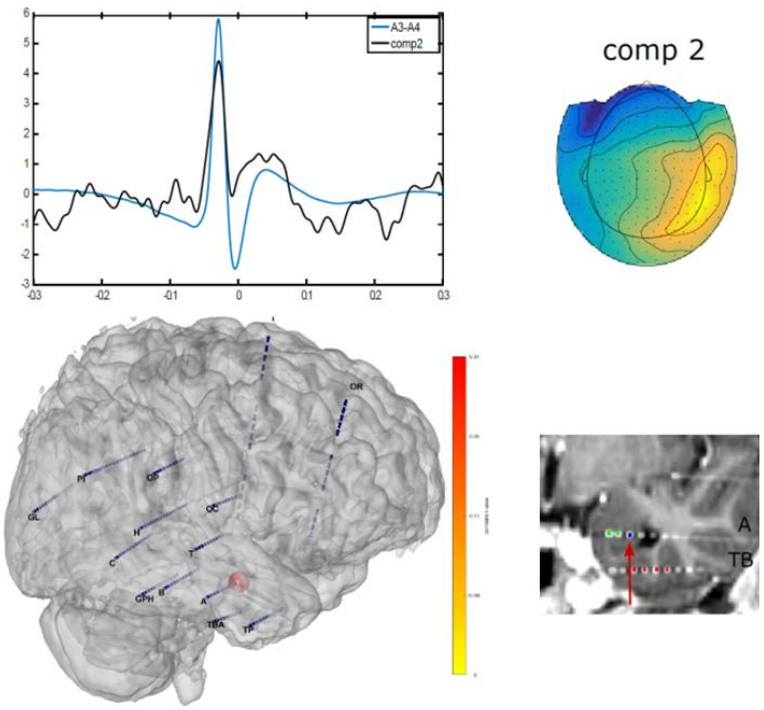


Dubarry et al Neuroimage 2014

Aplications of simultaneous recordings

- Methodological:

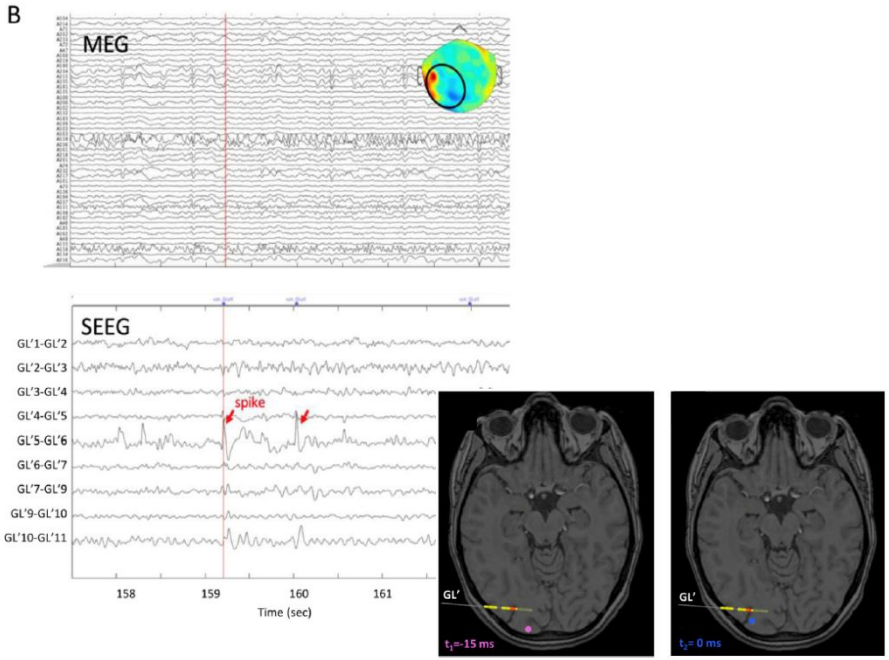
Depth/surface relationships



Visibility of hippocampus/amygdala on MEG signals

Pizzo et al under review

- Multi-level « meta-modality »



SEEG-informed MEG analysis

Gavaret et al Epilepsy Res 2016

Objectives of the SCALES project

Our goal is to **better define the spatio-temporal signature of the brain networks** involved in simple cognitive tasks using simultaneous surface and depth recordings

- Understand links between modalities, improve non-invasive tools
- Investigate cognitive networks in language and memory
- Provide unique reference datasets for methodologists and computational neuroscientists

Consortium

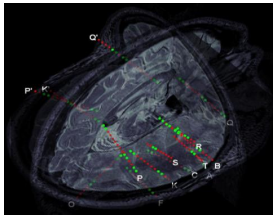
Andrei Barborica, Physicist
Ioana Mindruta, Neurologist
Cristi Donos, Engineer

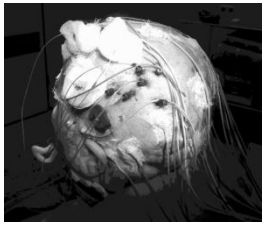
Serge Vulliemoz, Neurologist
Pierre Megevand, Neurologist
Renaud Marquis, Engineer

Xavier Alario, Neuroscientist
Agnès Trébuchon, Neurologist
JM Badier, Engineer
Christian Bénar, Engineer

Data types

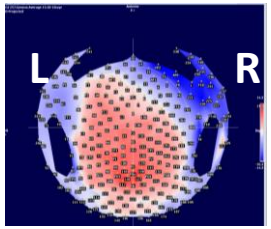
EEG-SEEG
20 EEG channels
Up to 256 SEEG channels
One week recording

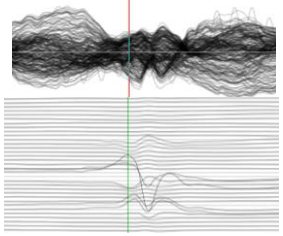




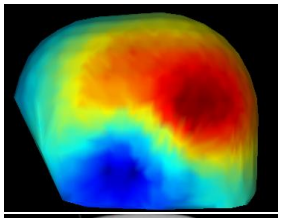
EEG

High density EEG-SEEG
256 EEG channels
Up to 256 SEEG channels
1 hour recording



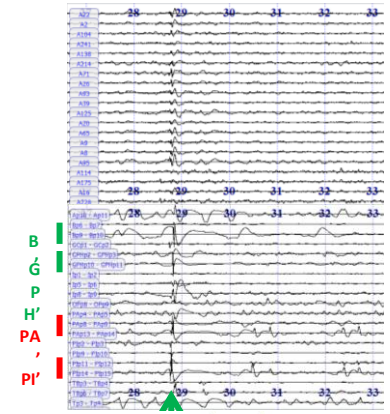


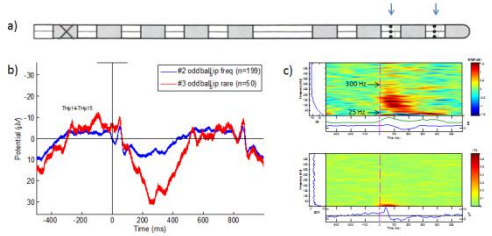
Simultaneous MEG-EEG-SEEG
248 MEG channels
23 EEG channels
~ 200 SEEG channels
1 hour recording



MEG

SEEG



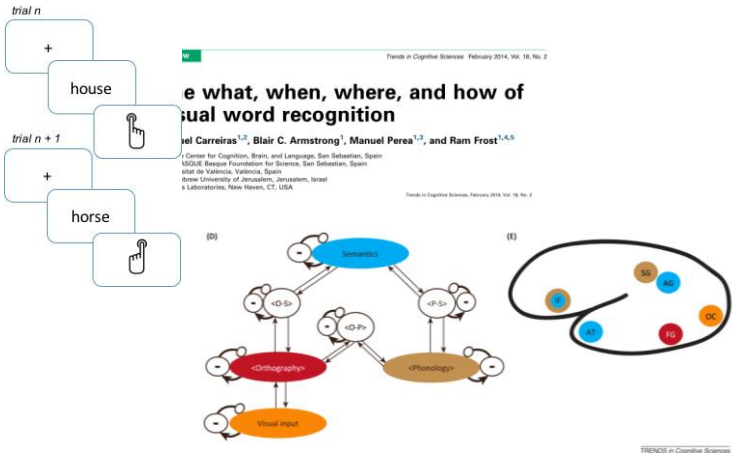


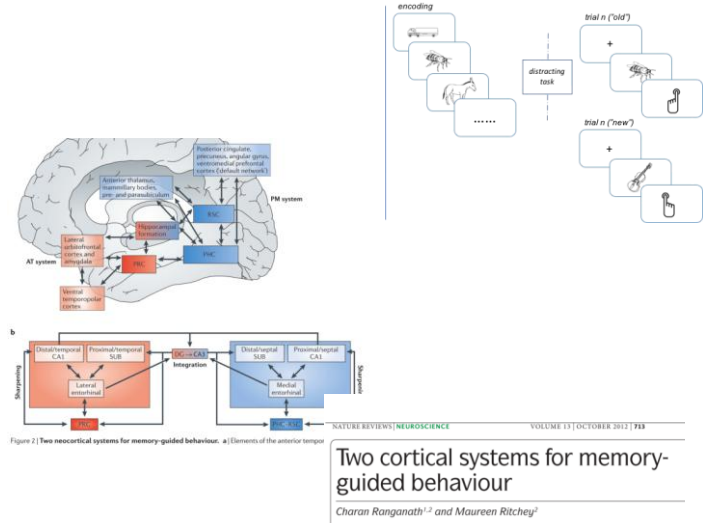
+ feasibility study of recording additionally micro electrodes

Protocols and data analysis

1) Resting state (includes pathological activity), simple stimulation (sounds, checkerboards)

2) Language and memory tasks





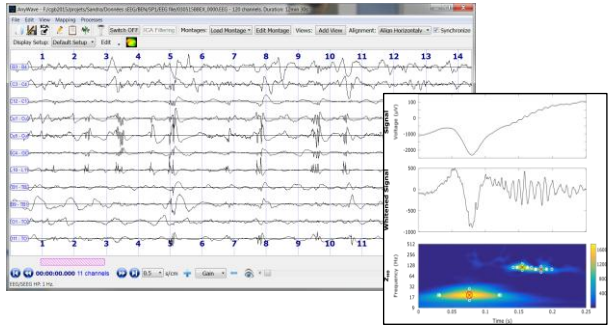
3) Analysis: - source localization

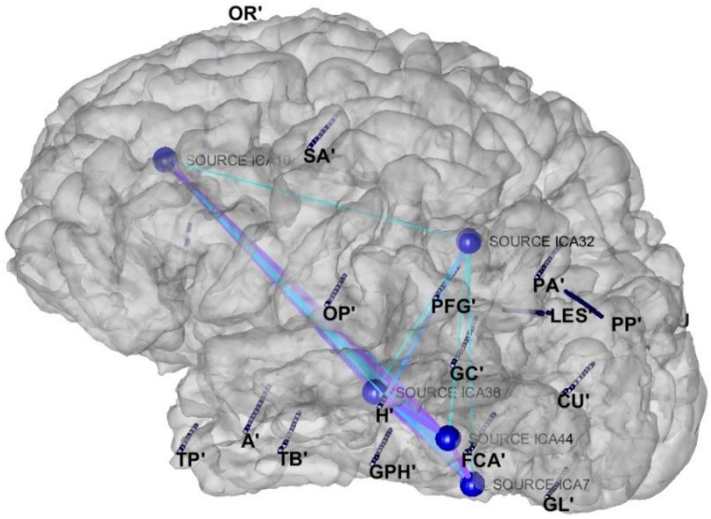
- network analysis: within and across scales (SEEG vs EEG/MEG)

Visibility of deep structures, sensitivity f modalities to different frequency bands

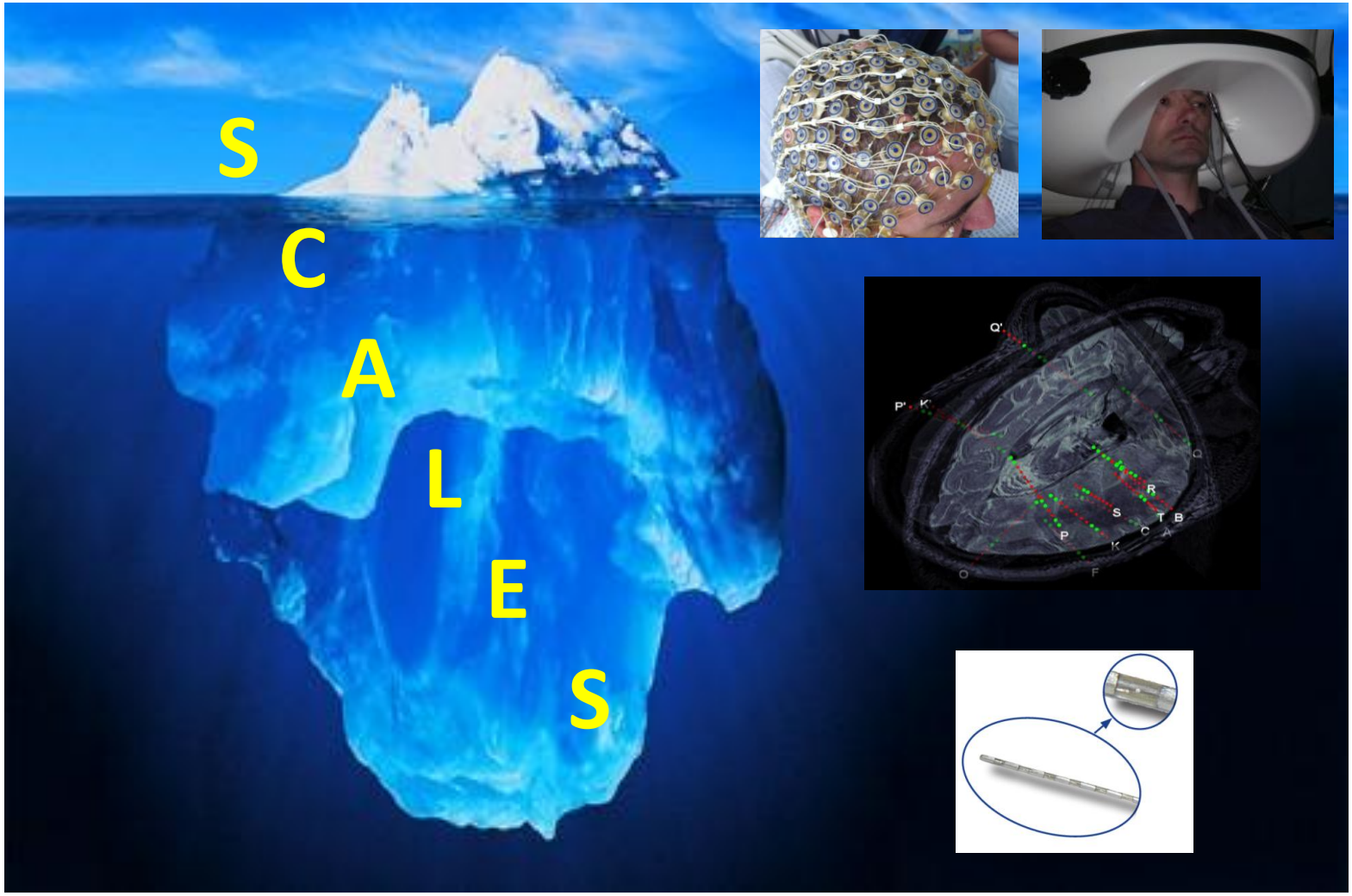
Summary: expected output

- Simultaneous data at different scales
  - Long term scalp EEG/SEEG
  - High density scalp EEG/SEEG
  - MEG/SEEG
  - Preliminary data on micro LFP recordings
- Software: Signal processing pipelines
- Methods: Validation of non-invasive EEG/MEG imaging
- Neuroscience: Multi-level characterization of brain networks





Thank you for your attention !



For further information: christian.benar@univ-amu.fr