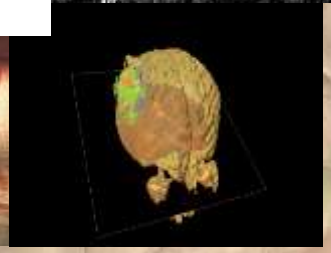
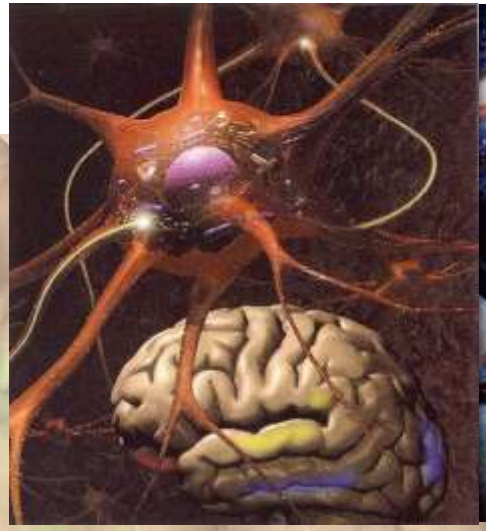
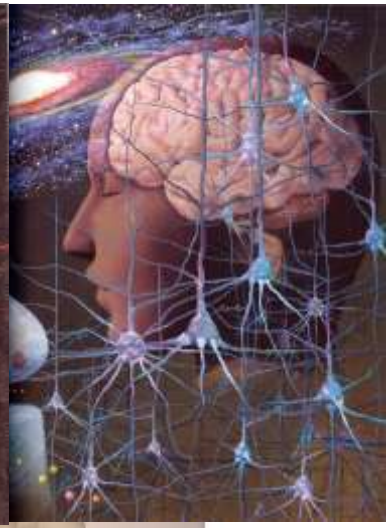
•NEUROSPIN

A Translational Research Infrastructure for brain imaging using Ultra High Field MRI

Investigating the Human Brain



✓*Neurosciences…*

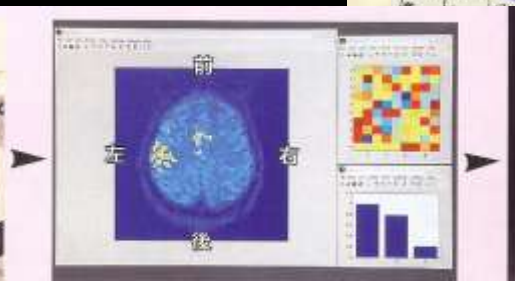
Brain (organ) structure & function

✓*Neurology/neurosurgery*
✓*Development, aging, rehabilitation*
✓*Psychiatry, mind disorders*

Person level (health care)

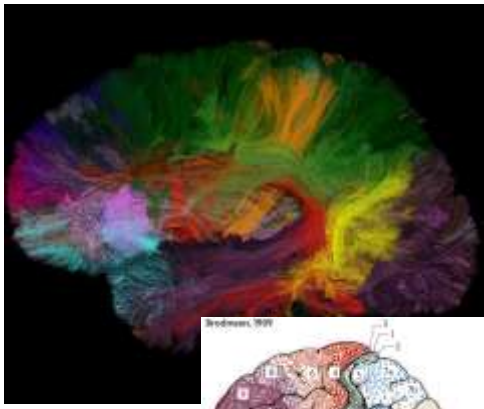
✓*Social/cultural behaviors, art…*
✓*Human-machine interfaces*
✓*Learning, education*

Interaction, society level

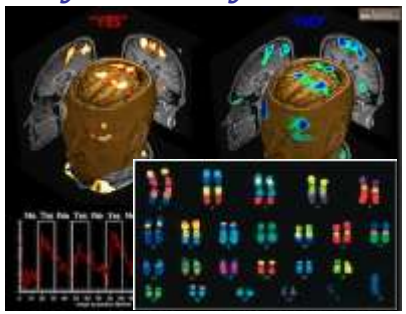
Neuroimaging: A multiscale approach

➢ *Yesterday & today: macroscopic functional architecture of the brain:*



1000 millimeters

MACRO



-Functional MRI: Cognitive codes

-Diffusion MRI: Connections

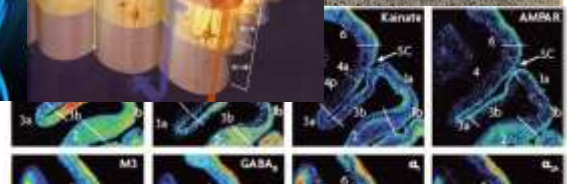
➢ *Today & tomorrow: Genes and brain, environment*

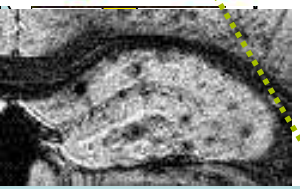
20-25 10^3 genes (10^{10} bits), but 10^{11} neurons & 10^{15} synapses

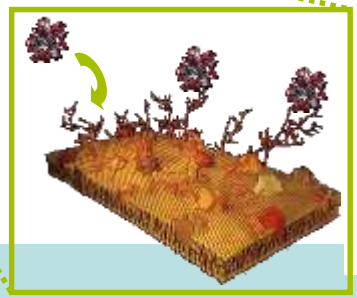
MESO

➢ *Tomorrow, the « neural code»?*

Mesoscopic structure-function relationship







➢ *« Health » aims:*

→ *Early detection of diseases (ALZ, psychiatry)*

→ *Rehabilitation/reprogramming (« stroke », injuries)*

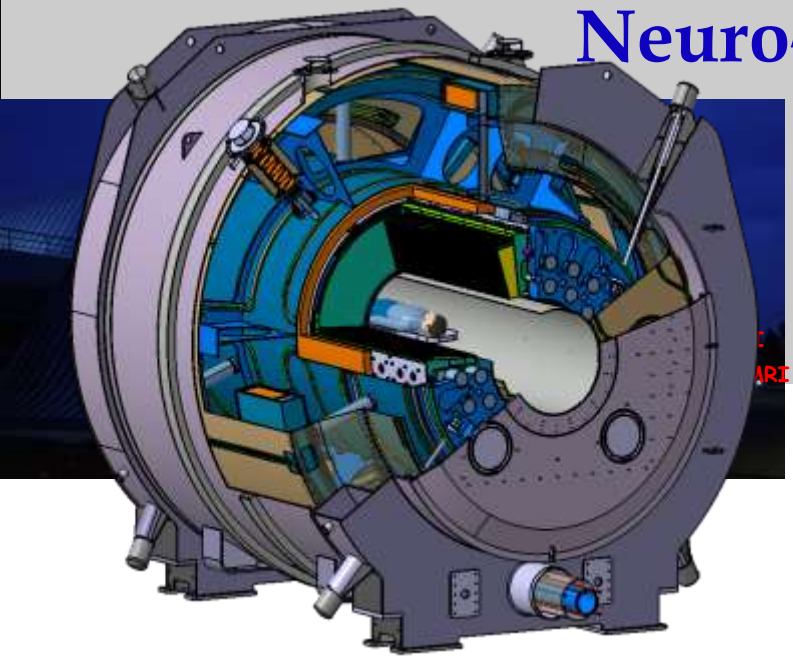
Mesoscale & MRI(~100μm): Structure & Function

Instruments are key to groundbreaking science:

Pushing the limits of MRI

Large Instruments concept

- **High energy, particles physics**
  → CERN, RIKEN, etc.
- **Astronomy and astrophysics**
  → Hubble telescope, Huygens-Cassini probe

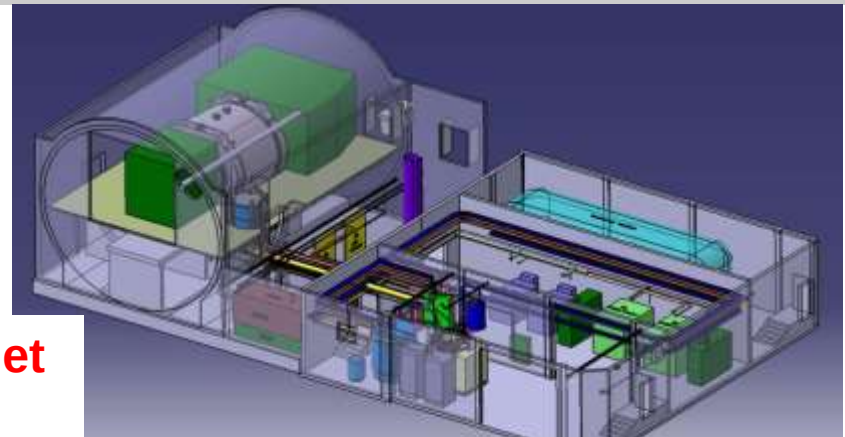


Neuro-physics → NeuroSpin (2001→2007)

- **Aimed at *ultra-high field* MRI systems:**

- 3T, 7T, *11.74T* wide-bore for human studies

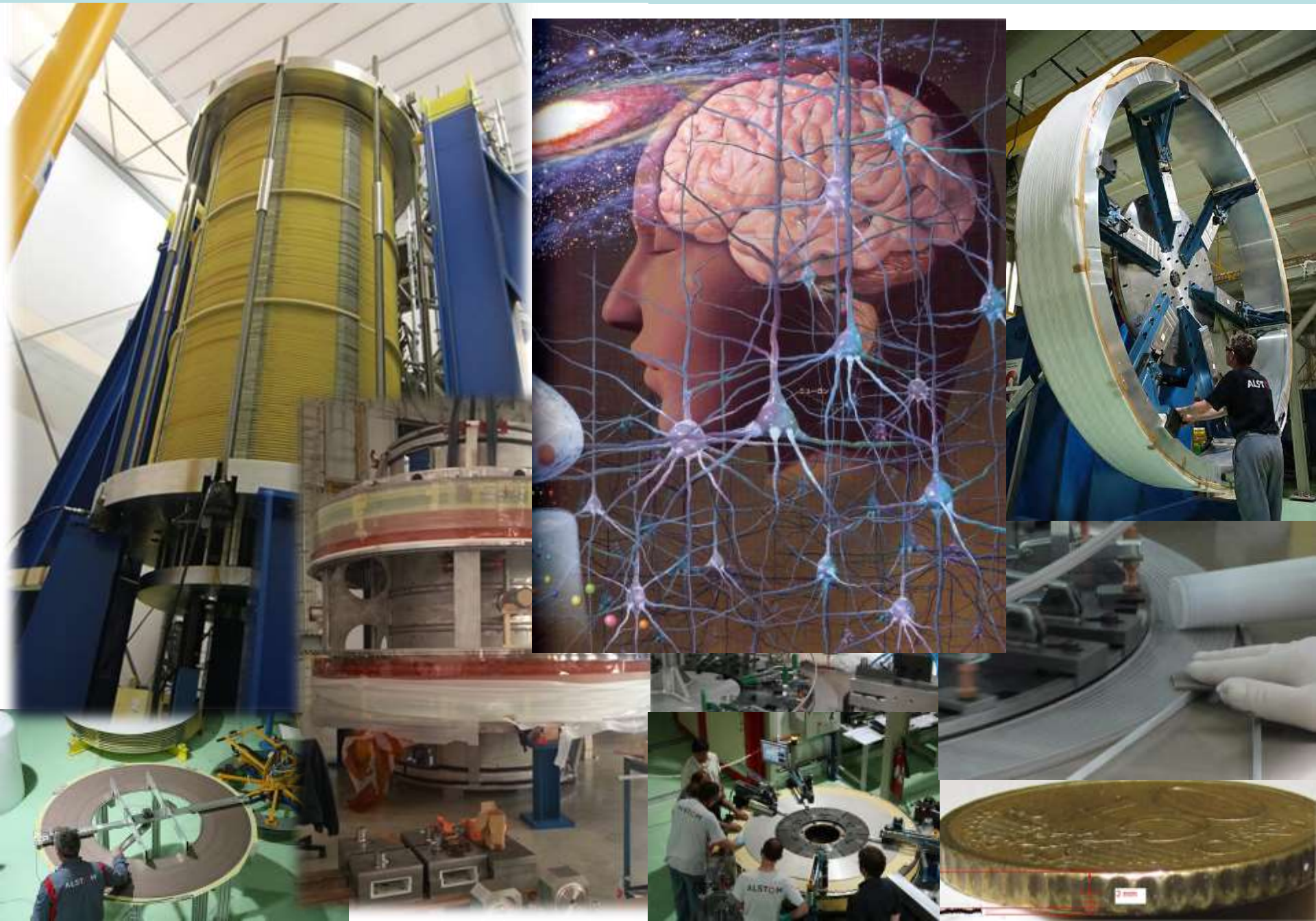
- 11.7T (primates) and *17.6T* (rodents)

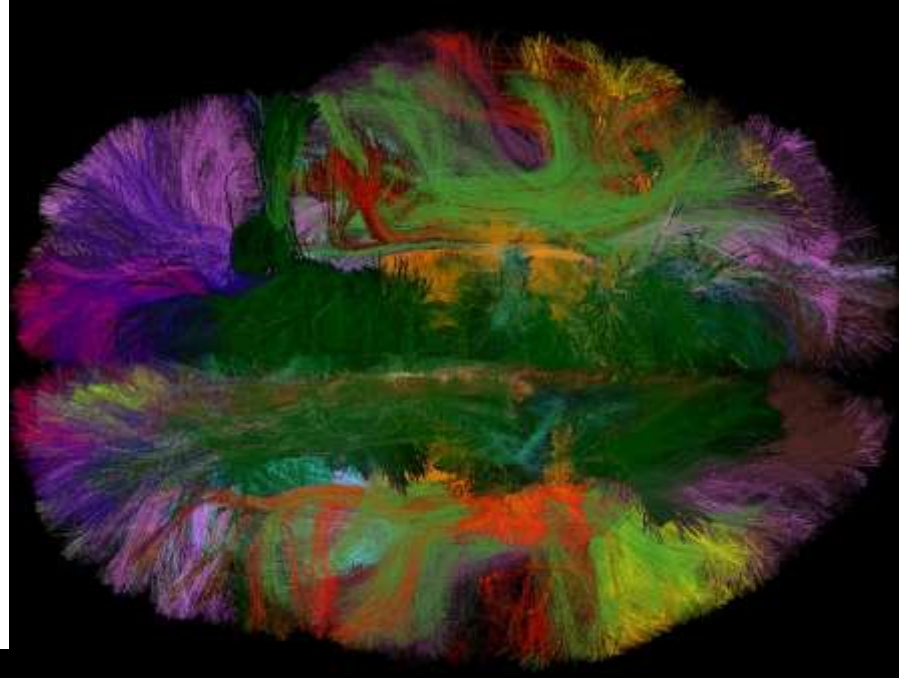


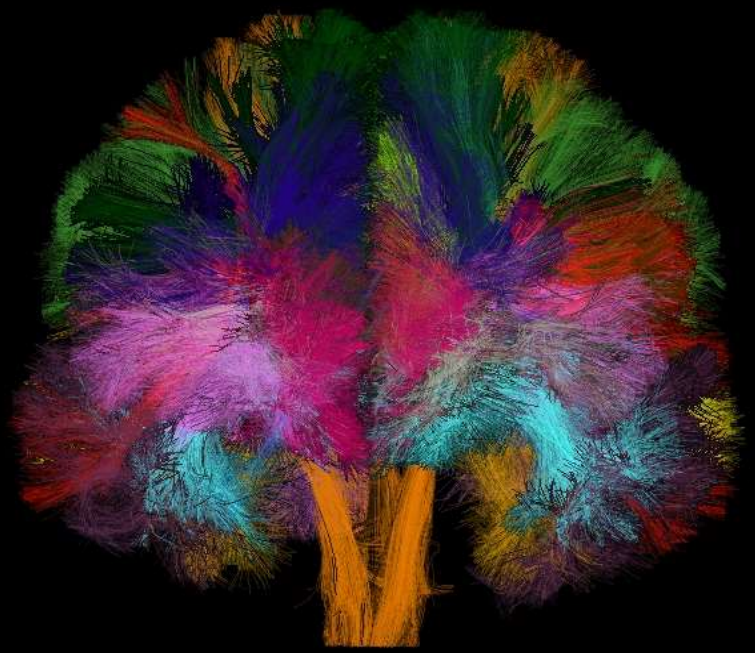
NeuroSpin/CEA 90cm bore 11.74TMRI magnet
(world 1st, France-German Iseult Project)

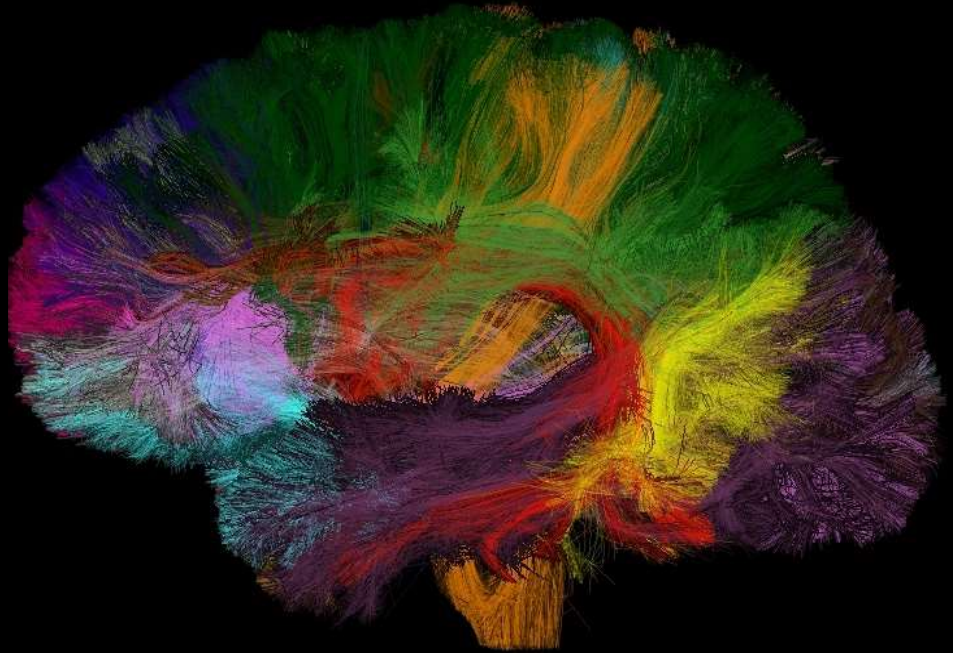
Human brain explorer

11.7T Human MRI magnet





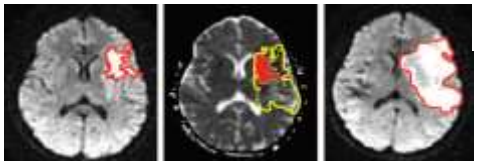




Poupon et al. (Connectomist/NeuroSpin)

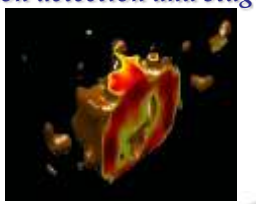
1984: CONCEPTION OF WATER DIFFUSION MRI

→Infering microstructure from macroscopic resolution *(virtual biopsy)*

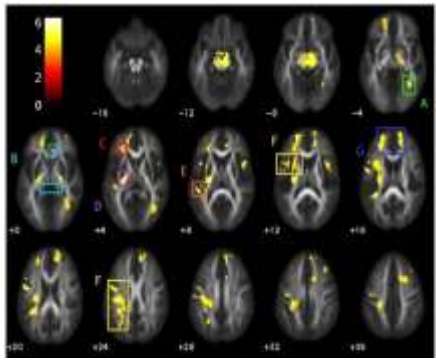


Prediction of infact growth and clinical outcome based on water diffusion
Rosso et al. Radiology 2009

Breast cancer:
Lesion detection and staging



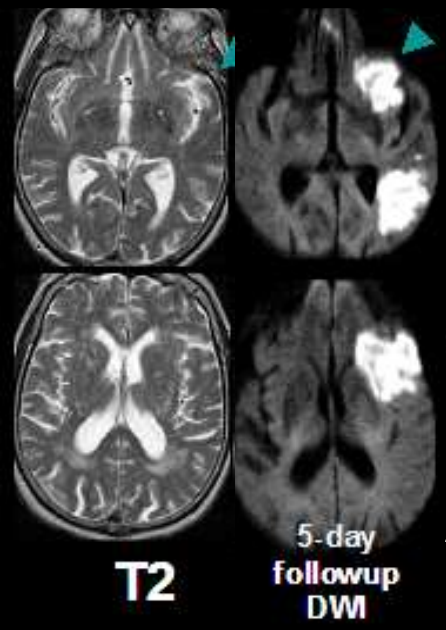
Brain development
Maturation of language networks in 2-4 ùonths babies
Dubois J et al., Cerebral Cortex2008

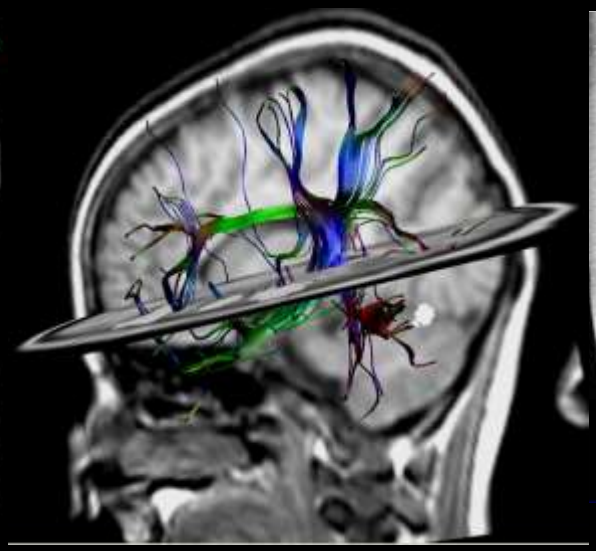


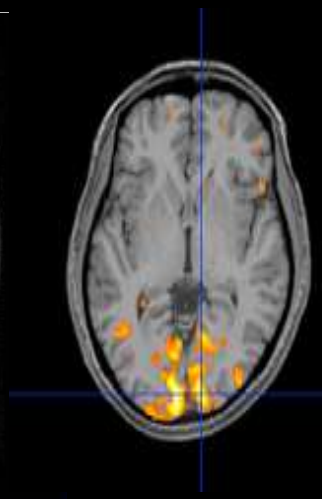
Mind disorders: Schizophrenia
Skelly, et al. Schizo. Res. 2008

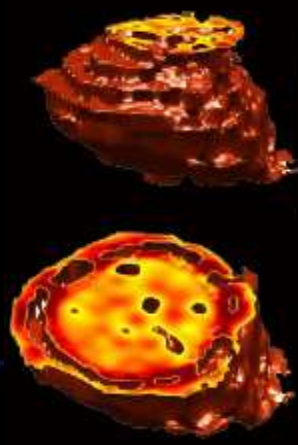
1985...1989... 1991...1992...1994...1998....2004... ...2001....2006...2013...2016...

Stroke **Brain connectivity** **Cancer** **Brain fMRI** **Elastography**









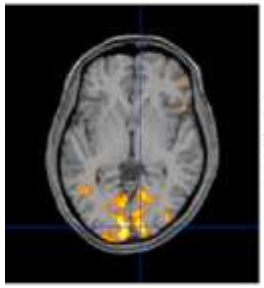
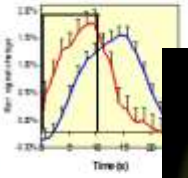
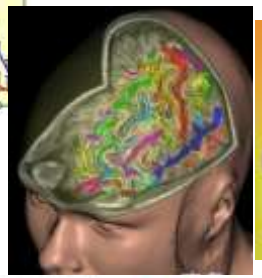
Neurospin research programs

From basic research to clinical applications








- **MRI « without limits »**
  - spatial & temporal resolution, contrast
  - non water MRI (metabolism, neurotransmission)
- **Brain development and plasticity**
  - anatomy and function (cognition)
- **Genetics, neuroimaging, bioinformatics**
  - Bio-statistics, big databases, population imaging
- **Brain architecture**
  - Functional and multiscale features (WM/GM, macro/meso/micro)
- **Translational research (diagnostic/treatment)**
  - Animal models of brain disorders
  - Clinical applications (NDD (alz), epi pediatrics, psychiatry…)
  - Molecular imaging (Iseult)
- **Higher order cognitive functions (language/music, calculus, consciousness)**
  - Spatio-temporal features
  - Cognitive code (and decoding, « mind reading »)