

## Exploring the Human Brain with Ultra-high Field MRI: Perspective from the Iseult Project

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***Abstract***—The understanding of the human brain is one of the main scientific challenges of the 21<sup>st</sup> century. In the early 2000s the French Atomic Energy Commission (CEA) launched a program to conceive and build a “human brain explorer”, the first human MRI scanner operating at 11.7T. This scanner was envisioned to be part of the ambitious Iseult project, bridging together industrial and academic partners from France and Germany to push the limits of molecular neuroimaging using Ultra-High Field (UHF) MRI. The actively shielded 5.2mx5m magnet (90cm in bore) consisting in a stack of 170 wetted double pancakes of a Niobium-Titanium multifilament wire was delivered at NeuroSpin, CEA-Saclay University campus in June 2017, cooled down to 1.8K from a suprafluid helium cryoplant installed onsite, and progressively energized, reaching in July 2019 the field of 11.72T, which is the world record for an MRI magnet. Images of an ex-vivo brain were first acquired in October 2021, as a demonstration. After approval of the regulatory agencies scanning on normal volunteers is now in progress. In this lecture a summary of Iseult MRI system specifications, the technological challenges, in terms of magnet design, winding technology, cryogenics, quench protection, stability control, which have been overcome to build this outstanding instrument are outlined, as well as the current status of UHF MRI in the world. The unprecedented resolution and the new contrasts allowed by such UHF magnets, in combination with innovative concepts in physics and neurobiology, will allow to explore the human brain at a mesoscale at which everything remains to discover and certainly open a new window of opportunities to better understand our brain and some of its illnesses, such as neurodegenerative diseases and psychiatric disorders.

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