The Quest for Ultra-high Fields in Brain MRI: The Iseult 11.7 T Whole Body Magnet and its Expected Impact on MRI Research

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***Abstract*— Understanding the human brain is one of the major scientific challenge of this century. Magnetic resonance imaging (MRI) is one of the most powerful tools for exploring the brain. Increasing sensitivity and spatial, temporal and spectral resolution through higher magnetic fields will help develop new tools in health care to detect and monitor psychiatric and neurodegenerative diseases. It will also contribute to expanding our knowledge in neuroscience by providing information on the structures and functions of the human brain. To this end, a new 11.7 T whole-body MRI magnet reached its nominal field in July 2019 at the CEA Paris-Saclay Neurospin Centre. This magnet, the largest MRI magnet in the world to date, is part of the Iseult/Inumac project, a French-German initiative focusing on very high field molecular imaging. It is an actively shielded magnet made from an NbTi superconductor with a homogeneous field level of 11.75 T in a 90 cm warm bore. It operates at a current of 1483 A in a pressurized bath of superfluid LHe at 1.8 K. The stored energy is 338 MJ and the inductance 308 H. The size is about 5 m in diameter and 5 m in length for a total weight of the magnet of 132 tons. The complete MRI system, including gradient and RF coils, will be commissioned in spring 2020. Here we will describe the technical challenges and breakthroughs made over the past 15 years to power the Iseult magnet, including a comparison with existing systems and future projects at higher fields. We will also briefly describe the scientific prospects for brain MRI research, as well as the possible long-term impact envisioned by the use of the Iseult MRI system.**