



Engineer/scientist position at CEA/NeuroSpin (2020-22) in RF electronics for MRI at Ultra-High-Field

Background

About NeuroSpin: NeuroSpin is a world-class research platform specialized in **brain imaging** with a strong emphasis on high-field MRI facilities. **Ultra high field (UHF) MRI** leads to high spatial resolution, thereby allowing to investigate the in-vivo brain in greater details than at the hospital. NeuroSpin is located in Saclay (France) and is affiliated with **CEA, Paris-Saclay University, CNRS** and INSERM. For human brain observation, NeuroSpin hosts Siemens Magnetom scanners: a 3-Tesla Prisma-Fit, a first-generation prototype 7T system, and soon a unique world-record 11.7T scanner whose magnet and multi-transmit RF coil were designed by CEA.

On one hand, methodologists from the **BAOBAB unit** develop hardware and software technologies to make the most of the prototype equipment and provide the tools for individual & cohort image processing. On the other hand, end users from the UNICOG and UNIACT units exploit the high field scanners towards neuroscience applications: cognition, normal and pathological brain development, psychiatry, the early detection and follow-up of neuro-degenerative diseases... NeuroSpin is thus a rich mix of engineers, physicists, mathematicians, data scientists, psychologists and medical doctors with a fair amount of international representatives. Between 150 and 200 people work there under Stanislas Dehaene's leadership.

Inside the BAOBAB unit, the **METRIC lab**, led by Alexandre Vignaud, is in charge of bringing the best-quality images from the UHF clinical scanners, in acquisition times made as short as possible. A small team there, led by Alexis Amadon, conducts R&D in **MRI instrumentation** to address both B0 and B1 field inhomogeneities that arise at UHF. Thus, parallel-transmit RF coils as well as a brain-dedicated B0-shim insert are under development for both 7T and 11.7T scanners... Recently, the METRIC lab obtained a participation in a new European project called M-One.

About the M-One project: To tackle B1-inhomogeneities in the human brain at 7T without an expensive multi-transmit array, recent advances from the now-ending European M-Cube project have yielded promising results towards a single-transmit birdcage coil based on meta-materials. This technology is now targeted by startup Multiwave, leader of the M-One project, to come out with a commercial RF coil at 7T within **2 years, starting October 1, 2020**. One work-package consists in building a 32-channel receive array to be inserted in the birdcage. Another one, led by NeuroSpin, will be to validate the whole coil set in-vivo at 7T, implying the fulfillment of the regulatory SAR limitations. The two other partners in M-One include « Université catholique de Louvain » and « Université Aix-Marseille ».

Description of the position

Open in the METRIC lab, the offered position will primarily consist in fulfilling the tasks of the M-One project, centered around the **development of a head coil at 7T** :

1. Take active part in the design of a **32-channel receive coil insert** with the support of a PhD student. The foreseen solution is a tight loop array based on preamplifier-decoupling, but coaxial high-impedance resonators could also be studied to allow for flexibility in a wearable hood or cap. Novel initiatives are welcome, especially if they can also apply at 11.7T. Moreover, the

candidate is expected to **miniaturize the electronics** into a single $\sim 1\text{-cm}^2$ chip encompassing the following functions:

- **Transmit/Receive switch:** during transmission, the resonator must be detuned, whereas at reception, the NMR signal must be pre-amplified
- **Pre-amplification** of the NMR signal by field effect transistor
- Impedance **matching circuit** between coil and transistor. Ideally, one would like to integrate the possibility of automatic adjustment of the resonant frequency and impedance matching, perhaps by means of DTCs (Digitally Tunable Capacitors).

The challenge is to achieve a non-magnetic RF component that supports very high fields and fast gradient switching (which can induce eddy currents). In particular, it is important to consider the disturbance of the Hall effect linked to the static field on the transistor. A packaging of the integrated component in a shielded “cage” will be studied. The targeted frequency is 300 MHz at 7T, but the design of yet another chip working at 500 MHz should also be considered for 11.7T. Consulting with electronic experts from CEA/LETI will be expected from the candidate.

2. Take part in the validation of the final prototype with the help of NeuroSpin MRI experts. Essential steps will include:

- B1-field mappings of a phantom with known electric properties in the 7T-MRI, to be compared with electromagnetic simulations performed in the design stage.
- Prediction of global and maximum local SAR from such simulations + matching of such predictions with PRF-based temperature mappings.
- In-vivo performance measurement: noise correlation matrices, Signal-to-Noise Ratio and g-factor mappings.
- Benchmarking : comparing performance with other commercial coils.

Moreover, the successful candidate will be encouraged to participate in the development of related projects in the MRI instrumentation team.

Required qualifications

- M.Sc. or Ph.D. in physics or electrical engineering, with a major/minor in microelectronics and Radio-Frequency electronics.
- Experience in MRI RF coil development, or in electronic integration and packaging.
- Excellent skills in analog electronics, including proficient programming with EDA software such as Proteus.
- Some knowledge in MATLAB, Scilab or Python scientific programming is expected.
- Knowledge in CAD software such as Solidworks is a plus.
- Excellent communication, teamwork and organizational skills.
- Excellent knowledge of English is a must. French is appreciated.

Application

The position is open at CEA for 2 years as early as possible **from October 1, 2020**.

We look forward to receiving your online application **before June 30, 2020**, with 1/ a cover/motivation letter (*one page*) that demonstrates your suitability for the offered position, 2/ a curriculum vitae including a list of publications and academic records, 3/ names and contact information of two references. Please send all documents to alexis.amadon@cea.fr, and alexandre.vignaud@cea.fr .