IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

YQAR3D: hYbrid Quantum system: spin waves & microwave cAvities pRinted in 3D

Postdoctoral fellow (2 years)

Microwave Department, Brest, France

IMT Atlantique

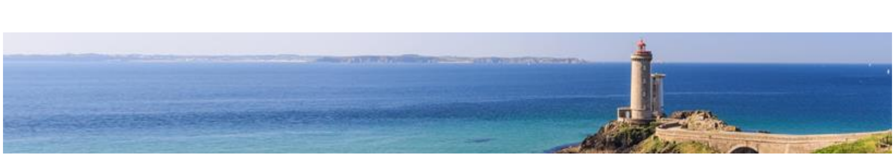
IMT Atlantique is an **institute of higher education and research**, born through the fusion of École des Mines Nantes and Telecom Bretagne in January 2017. Research and innovation constitute one of the school's primary missions in its fields of excellence which are digital technology, and energy and environment. Research is carried out in one of our six research laboratories linked to national research organisations (**CNRS -** French National Centre for Scientific Research and Inserm - French National Institute of Health and Medical Research), and is managed internally by 13 teaching and research departments. With over 800 publications per year (including 400 top tier), approximately 90 researchers and lecturers authorised to supervise research, and on average 80 theses presented each year, IMT Atlantique is ranked among the top ten engineering schools in France, when it comes to research. **The main campus of IMT Atlantique is situated in the Brest-Iroise Science and Technology Park**. Overlooking **the ocean, this** campus is undeniably one of the most beautiful in Europe. Created in 1990, the Brest-Iroise Science and Technology Park gathers more than 5,000 people including 2,000 students and 1,000 research-lecturers in higher education institutions and research centres and over 2,500 people working in different companies. It is also a dynamic partner in the economic development of Brittany. It develops links between companies, research and teaching partners in the Brest area and the whole Brittany.

CONTEXT

The two years contract is funded at 75% by the **Région Bretagne** and 25% from **industrial partners**: ELLIPTIKA and THALES DMS. The project, **YQAR3D**, aims to develop a hybrid system composed of a magnetic resonator and a resonant micro-cavity produced by 3D printing for the development of a new class of tunable filters. The innovative tuning function (in addition to conventional tuning elements) will be achieved by the control of a specific coupling regime between these two resonators, called **"strong coupling"**. This regime is characterized by a coupling strength which is greater than the average energy loss in both resonators. These considerations are universal and apply to all types of resonances. A strong coupling regime has been already observed between **photons** and various excitations of condensed matter, such as electrons, phonons, plasmons, superconducting qubits, and **magnons**.

In recent years, a new light-matter interaction platform [1-2] has been developed by combining microwave photons residing in a resonant cavity with magnons from a magnetic material like Yttrium Iron Garnet (YIG). The use of a standard 3D cavity for microwave applications purpose, based on this specific platform, seems difficult to combine with concepts of integration, compactness, and miniaturization. In **YQAR3D** project, we propose to take advantage of the geometric configuration of **re-entrant microwave cavity** to counterbalance this problem, which is becoming more and more critical by reducing the working frequency. Microwave re-entrant cavities offer many advantages in terms of frequency tunability, volume reduction, control of the microwave magnetic field distribution, while keeping a high Q factor.

IMT Atlantique
655, avenue du Technopôle
29280 Plouzané
FRANCE



The postdoctoral fellow will have to improve and optimize this very first prototype of metallized plastic micro-cavity to meet the objective set:

- ✓ Proof of concept of 3D printed tunable filter based on re-entrant cavities, adjustable inner posts, iris aperture, and magnon-photon coupling control.

3D printing prototyping offers new degrees of freedom compared to conventional manufacturing technologies. It is possible to produce complex, more compact, and lighter objects. In addition, it offers the opportunity of integrating tunable devices such as magnetic field generation and mechanical elements. Nevertheless, the most attractive features of **YQAR3D** are listed below:

- ✓ Ability to quickly adjust and produce new re-entrant cavities taking into account the simulation and measurement data. All the data gathered around the 3D prototyping will make it possible to build precise specifications, thus promoting a transfer to larger scale production
- ✓ Overview of the coupling regime dependencies as function of the volume of YIG, volume of the cavity, electric and magnetic losses and frequency in an original cavity design
- ✓ The strong coupling between photons and magnons emerged as a potential candidate for implementing quantum transducers and memories [1]-[3]
- ✓ Opens a new world of solutions for 3D tunable filters

[1] D. Zhang, X. Luo, Y. Wang, T. Li, and J. Q. You, Observation of the exceptional point in cavity magnon-polaritons, Nature Communications, 8, 1368 (2017)
[2] Y. Tabuchi, S. Ishino, T. Ishikawa, R. Yamazaki, K. Usami, and Y. Nakamura, Hybridizing Ferromagnetic Magnons and Microwave Photons in the Quantum Limit, Phys. Rev. Lett. 113, 083603 (2014)
[3] Y. Tabuchi1, S. Ishino, A. Noguchi, T. Ishikawa, R. Yamazaki, K. Usami, Y. Nakamura, Coherent coupling between a ferromagnetic magnon and a superconducting qubit, Science, 349, 405 (2015)
Talks – SPICE Spin Cavitronics 2018

PROFIL

- ✓ PhD in Physics or RF engineering
- ✓ Experimental skills requested
- ✓ Ability to work with new equipment and simulation software
- ✓ Ability to communicate and disseminate his/her results
- ✓ Good social skills

ELIGIBILITY CRITERIA FOR APPLICATIONS

- ✓ The candidate must have spent a **maximum of 18 months in France** in the **last 3 years** (from January 2019)
- ✓ Starting date: From January 2019 to June 2019

ADDITIONAL INFORMATION

CV and motivation letter to:
Vincent CASTEL
Microwave Department, Brest
vincent.castel@imt-atlantique.fr
+33 646 575 237
+33 229 001 281