Job Title	COAX - Complex Coaxial Microwave Resonators
Main Research Field	Information Science and Engineering (ENG)
Sub Research Field	Microwave
Key words	Microwave passive volumic devices, resonators, filters, systems, tuneability, reconfigurability
Job Summary	*There is a continually growing need for small-sized microwave filters with good electrical performances (insertion losses, amplitude flatness and sufficient phase linearity in the passband, wide band rejection, power handling, and a wide tunability dynamic if the structure is a tunable one), low sensitivity and, if possible, genericity and low cost. For low frequencies, notably in UHF, lumped-element filters are presently the most frequently used. They offer the advantage of extremely small size, but suffer from poor quality factors, between 10 and 50, leading notably to very high insertion losses. Volumic filters, made using air cavities, offer quality factors of several thousand that make very good electrical performances possible, but really take up too much space. They are used over a wide range of frequencies, from the L-band to the millimeter domain, and withstand high power levels. In between, the air filled coaxial resonator offers another compromise. It has quality factors around 3000, but is less bulky than traditional waveguides.* *The aim of the work is to explore new concepts of volumic resonators built on original association of coaxial sections. The final objectives is to bring new alternatives in the design of new generations of: filters, duplexers, multiplexers ... fixed or reconfigurable.*
Job Description	*Project context ?* *In 2015, the Lab-STICC laboratory and Elliptika company describe a new concept of microwave SIR (Stepped Impedance Resonators) resonator built from coaxial structures fitted inside one another. The novelty of this work was the construction of a resonator out of a succession of coaxial sections in cascade, where the ground conductor of one becomes the central core of the next, or vice-versa. An advantageous property of SIR is that they allow a substantial reduction in size, while maintaining an acceptable quality factor and a significant distance from the first harmonic. The specific properties of this particular resonator were fully mathematically described. Through circuit and line theory analyses, verified by electromagnetic simulations, we gave for simplified resonators with two and three sections, the theoretical expressions of the frequency behavior. Second order and sixth order filters, were then conceived and realized in the UHF band, to validate the concept and to show the numerous advantages of these resonators. These preliminary results show that the behavior of the resonator is not conventional and could be applied in many microwave systems, where tunability is needed for instance.*

Objectives?

The aim of the work would be to extend, the work initially carried out on a limited number of section (2 and 3), to a large number (n) of sections. The goal is to be able to propose multifunctional resonators, integrated in high performance filters, diplexers and multiplexers. In terms of tunability, the target is one decade, the choice of the accordability element (MEMs, diodes ...) being to be defined..

Relevant approaches include ? (but are not limited to) ? …

A coaxial structure supports a TEM mode, which is define from DC on a very wide frequency band. This a great advantage when the aim is to obtain tunability on a very large frequency dynamic. Another great advantage is that, TEM modes allow to use a circuit approach to design efficiently complex architectures. Compared to an electromagnetic approach, it is possible with a circuit analysis, to establish easily the theoretical expression of the resonant frequency, of the first spurious frequencies, of the transmission zeros and of the quality factor.

When the number of the sections is high (> 4 or 5), we already know that the extraction of the the different frequencies will pass through the resolution of polynomial equations, for which the roots are not not evident. So, a mathematical effort to solve the problem is needed. However the obtained solutions can be verified through electromagnetic simulations, carried on a software like HFSS.

Once the structure is fully electrically defined, it can be used to build a complex filtering function. For this step we will use expressions of need from industrials like Thales or agencies like CNES or ESA.

+ 2/3 most relevant references

"UHF second order bandpass filters based on miniature two-section SIR coaxial resonators". H. Aouidad, E. Rius, J. F. Favennec, Y. Clavet, A. Manchec, International Journal of Microwave and Wireless Technologies, Volume 8, Issue 8, December 2016, pp. 1187-1196, Published online: 02 September 2015

"Filtre accordable à résonateurs coaxiaux Matriochka à deux sections." A. Aouidad, E. Rius, J-F. Favennec, A. Manchec, Y. Clavet, JNM Bordeaux, Juin 2015. ***Best EuMA paper award***

"A Tunable Filter Based on Miniature SIR Coaxial Resonators"
H. Aouidad, J. F. Favennec, E. Rius, A. Manchec, Y. Clavet,
European Microwave Conference, septembre 2015, Paris, France

Supervisor(s)	*Short CV (5/10 lines) detailing Supervisor(s) description / experience / expertise Professor Eric Rius is the vice head of the Lab-STICC UMR CNRS 6285. His research, concerns the design of microwave passives devices for centimetric and millimetric wave applications. During 2014-2016, he was one of the leader TEAM of the Lab-STICC, DIM for « Multiphysic Interfaces and devices ». In 2010, he was the TPC chair of the 40th edition of the European Microwave Conference. He supervised more than 22 PhD Students and several post-docs. He spent several months at Singapore as visiting Professor at Nanyang Technological University (NTU). He participated to more 90 PhD jury defenses and 10 HDR jury defenses. h-number 20, more than 1770 citations.* *+ 2/3 most significant publications/productions* *"Theoretical and experimental study of various types of compensated dielectric bridges for millimeter-wave coplanar applications" E. Rius, J. P. Coupez, S. Toutain, C. Person, P. Legaud* *IEEE Transactions on Microwave Theory and Techniques, Vol. 48, n°1, Janvier 2000, p. 152-155.* *"Narrow Bandpass Filters Using Dual Behavior Resonators (DBRs)." C. Quendo, E. Rius, C. Person, IEEE Transactions on Microwave Theory and Techniques, Vol. 51, n°3, Mars 2003.* *"Wide- and Narrow-Band Band-Pass Coplanar Filters in the W-Frequency Band ". E. Rius, G. Prigent, H. Happy, G. Dambrine, S. Boret, A. Cappy, IEEE Transactions on Microwave Theory and Techniques, Vol. 51, n°3, Mars 2003.* *+ web page (or ResearchGate page)* *https://www.labsticc.fr/en/teams-members/498-rius-eric.htm* *https://orcid.org/0000-0002-8081-3460*
Department/Research:	*Laboratory ? MOM Hub: Microwaves, Optoelectronics and Materials of the Lab-Sticc (Research laboratory in information and communication science and technology). University of Brest (France)* *Thematic ? Microwave passive devices* *Infrastructure available & Website ? https://www.labsticc.fr/en/index/* *National/international projects ? Thales, CNES, DGA…*
Suggestion for interdisciplinary / intersectoral secondments	*Mathematic*
Skills Requirements (optional) :	*Skill Specific Requirements? Electronic, Electromagnetism, Microwave, Circuit theory, mathematic …* *Required Languages? English (French would be appreciated)* *Tools? CAD (HFSS, ADS …, microwave measurements*

	Publications? at least 1 per year since the PhD in 1st author