ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

Leonardo - Atomic Clocks building blocks and full system design

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Context of the research activity	The research area is Quantum Physics with a focus on Cold Atoms and Laser cooling technologies for sensors, also including experimental Optics, Photonics and Plasma Physics
Objectives	The objective of the research is to develop compact atomic clocks based on cold atoms for Position, Navigation, and Timing (PNT) applications. The aim is to create highly precise and stable timekeeping devices that can significantly enhance the accuracy and reliability of PNT systems. Cold atom clocks are quantum devices that exploit laser cooling and trapping techniques to reduce the thermal motion of the atomic sample, thereby improving the accuracy and stability of the clock. The activity focuses on integration and miniaturization solutions that reduce the Size, Weight, and Power (SWAP) of these devices, enabling new practical deployments in various environments, including space, terrestrial, and avionic applications. The building blocks of such devices encompass many different technology areas, such as low-noise RF sources, lasers and photonics, control electronics, FPGAs, automation of experiments, vacuum technology, programming, and data analysis. This type of research activity allows the candidate to gain a unique and broad set of competencies in many different aspects of engineering and quantum physics by addressing challenging problems. The PhD candidate will carry out the research activity within the context of Leonardo Labs – Quantum Technology Unit and is expected to actively contribute to the development and realization of the project with new ideas and solutions, combining analytical and numerical approaches with a strong laboratory attitude.
Skills and competencies	It will be helpful to possess prior, even partial, knowledge in one or more of following fields: laser systems, optical components, electronic circuits, control systems. Proficiency in programming languages like Python or MATLAB for automating

competencies for the development of the activity	experiments and data analysis is beneficial. Hands-on experience in experimental techniques in atomic and laser physics, such as spectroscopy and cooling and trapping of atoms, is an advantage. Analytical skills for troubleshooting and interpreting complex data are essential. Even if the candidate does not possess all these skills, most of them will be developed during the research activity.