ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

INRiM - Advanced Metrology for Electrical, Electronics and Communications Engineering

Funded By	I.N.RI.M. - ISTITUTO NAZIONALE DI RICERCA METROLOGICA [P.iva/CF:09261710017]

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Context of the research activity	This Thematic Grant includes 8 research Topics (listed below), with a specific title and proponent Supervisor/s. The applicants have the possibility to identify the specific topic they are interested in. The research activity will be carried out in Turin. Topic 1: Electric Properties Tomography based on Magnetic Resonance Imaging Topic 2: Leveraging synthetic data and performance metrics to validate AI models in diagnostic imaging Topic 3: Laser interferometry on optical data networks: from integrated fiber sensing to quantum communication Topic 4: Analysis, modelling and characterization of supercapacitors Topic 5: A vapor cell atomic clock for space applications Topic 6: Programmable Josephson junction series arrays for coherent sub-sampling measurement of time-varying waveforms Topic 7: Microwave measurements for 6G and quantum technologies Topic 8: Bayesian statistical methods for metrological applications in the field of sensor calibration and conformity assessment.

	For more details about the Topics, visit: https://www.inrim.it/en/services/training/early-career-metrology/phd-scholarships

Objectives	Topic 1: Development and validation of algorithms for Electric Properties Tomography based on Magnetic Resonance Imaging, able to self-evaluate the pixel-wise uncertainty of their results. Topic 2: The proposed research activity focuses on the assessment of AI models for diagnostic imaging, particularly for disease detection in breast cancer screening, using both synthetic and clinical data. Topic 3: Develop opto-electronic techniques to measure deformations of optical fibers, exploitable for improving the network resilience and enable environmental sensing and real-world quantum communication. Topic 4: The objective of the PhD is to develop techniques for the determination of SoC/SoH of supercapacitors, for the assessment of equivalent circuit models (ECMs) and their verification in real conditions. Topic 5: The candidate should contribute to design, implement and characterize a compact Rb clock with high frequency stability performances. Topic 6: To provide step change from conventional to quantum methods in the metrology of time-varying waveforms, using coherent subsampling strategy based on programmable Josephson arrays and machine learning. Topic 7: The research advances metrology for 6G and quantum technologies by developing SI-traceable RF&MW measurements at cryogenic temperatures and improving VNA calibration at room temperature. Topic 8: Development of statistical (Bayesian) methods for characterization of certified reference materials, virtual calibration of large batches of sensors, conformity assessment of samples of items.

Skills and competencies for the development of the activity	Topic 1: Master's degree in mathematics, Physics or Engineering. Some specific background in either electromagnetism, computer science, or statistics may be useful (but it is not a binding requirement). Topic 2: Data analysis and data preparation, fundamentals of statistics, machine learning models; Basic knowledge of machine learning frameworks (PyTorch, TensorFlow) and computer programming (Python). Topic 3: Background in signal processing and optical transmission can be useful, but the candidate will have the chance to fill initial gaps during the activity. Topic 4: Good knowledge of electrical engineering, circuit modeling, electrical measurements, Matlab programming. Topic 5: Basic knowledge of electronics signal processing and some experience with optical measurements are welcome. Topic 6: Experience in solid state physics, electronic properties of materials -

	superconductors and semiconductors – multi-physic modelling and signal theory; Knowledge of Josephson effect; Programming. Topic 7: Appreciated Skills: microwave design and measurements (active and passive devices, S-parameters, power, noise, spectrum analysis), data acquisition and analysis, Python programming, cryogenics. Topic 8: Solid background in Probability and Statistics, good programming skills (R, Python, Matlab, ...).