PE 0000023 NQSTI – Cascade Funding - Proposal Template

GENERAL INFORMATION

Project acronym:	QBETTER
Project title (extended name):	**AI-based strategies to tame decoherence in complex environments**
Spoke:	1
Topic:	*3. Development of efficient AI-based strategies against decoherence for quantum technology development*
Duration (months*): (the duration cannot exceed 18 months)*	18
Project location*: (specify region)*	Milano, Lombardia, Italia
Total project budget (€):	180000
Total grant requested (€):	180000
Project Coordinator:	*Matteo PARIS, University of MILAN, matteo.paris@unimi.it, +390250317662*

Abstract *(max 1500 characters including spaces):*

Quantum devices are physical systems operating in complex and noisy environments, making it essential to find effective strategies that, while simplifying the description of the environment, keep unchanged the predictions concerning the quantum system of interest. This project QBETTER aims to advance AI-based methodologies to mitigate decoherence stemming from interactions with complex and diversified sources of noise. The main goals are: 1. the effective characterization of complex quantum systems, extracting the relevant features, classifying the kind and the strength of noise, and quantifying complexity; 2. the integration of state-of-the-art methods for general quantum dynamics with AI-driven strategies to explore the highly dimensional parameter space and tame decoherence through both active and passive strategies; 3. the combination of deep reinforcement learning with a comprehensive characterization of the environment to devise optimal control strategies for the transport of quantum states. Building upon methodologies developed by the Milano group, such as ML-based classification schemes for channel estimation, T-TEDOPA and pseudo-mode techniques, the project involves a strategic planning with milestones and an ongoing review. Ultimately, our main goal is to reshape the description of complex noisy environments, providing innovative tools to combat decoherence in quantum systems of key relevance for quantum technology advancement.

Keywords*:* Open quantum systems, machine learning in quantum information, non-Markovian dynamics, quantum probing .

DNSH Principle: In the context of the National Recovery and Resilience Plan (PNRR), our project aims to harness the transformative potential of quantum technologies while adhering strictly to the principle of 'Do No Significant Harm' (DNSH). In particular, we aim at advancing quantum sensing by addressing complex challenges with an eye on environmental, ethical, and societal well-being. We pledge to minimize environmental impacts, ensuring our quantum initiatives are energy-efficient and utilize sustainable materials. Socially, we're dedicated to inclusivity, making quantum advancements accessible to all, fostering societal progress. Ethically, we adhere to stringent guidelines to protect individual rights and data privacy, ensuring technologies serve the public good. Economically, we aim to integrate quantum innovations harmoniously, supporting existing industries and preparing the workforce for future challenges. Our commitment extends globally, emphasizing collaboration and transparency to share the quantum leap's benefits and navigate its risks together. This project is about scientific breakthroughs but about moving forward responsibly, with every action guided by a commitment to do no significant harm, ensuring quantum technology's benefits are realized sustainably and equitably.