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UNIVERSITÀ
DEGLI STUDI
DI PADOVA

PhD course of National Interest in Technologies for
Fundamental Research in Physics and Astrophysics

Annual report

Name and surname: Raja Yasir Mehmood Khan

Cycle and a.a.: 40 (2024/2025)

Supervisors: Lorenzo Pagnanini (GSSI) and Laura Cardani (INFN)

- Research activity carried out during the year

Aim:

The project aims are:

- Study the effect of ionizing radiations on multiple qubits simultaneously.
- Fabricate phonon traps on a qubit chip and characterize them.
- Analyze how ionizing radiations affect qubits in the presence of these phonon traps.

The ultimate objective is to understand radiation-induced decoherence mechanisms and developing phonon traps for mitigating them in multi-qubit systems.

Research Activities (Year-1):

Durring my first year I focused on:

- literature review.**
- Training through courses and Schools.**
- Establishing the qubit setup**, including assembling, operating, and characterizing the system. Initial work also involved a preliminary assessment of radiation impact.

Difficulties encountered:

The main challenges we faced was operating multi-qubit system simultaneously and preventing qubit state leakage problem.

Potential Solutions:

- Reviewing literature for better understanding of state leakage problems and its potential causes.
- Optimizing drive, readout and pump pulses.



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iii. Fabricating a new qubit chip featuring a longer coherence time.

- **List of attended courses and passed exams**

- i. Cryogenics sensors for astroparticle physics
- ii. Vacuum Technologies
- iii. Laboratory of low-energy radiation measurement
- iv. Quantum technologies

- **List of attended conferences, workshops and schools, with mention of the presented talks:**

- i. Benasque spring school on superconducting qubits (May 21 to May 30, 2025).

- **List of published papers/proceedings:**

N/A

- **Thesis title:**

Mitigating effect of Ionizing Radiations on Transmon Qubits by Phonon Traps.

Date: September 15, 2025

Signature...

Seen, the supervisor