

# COLD

S. Di Domizio  
Milano – November 20, 2023

# COLD

## PRIN 2020 – 2020H5L338

- "Thin films and radioactivity mitigation to enhance superconducting quantum processors and low temperature particle detectors"
- 3 years project: May 2022-May 2025
- 4 research units: INFN, GSSI, UniGe, UniMiB

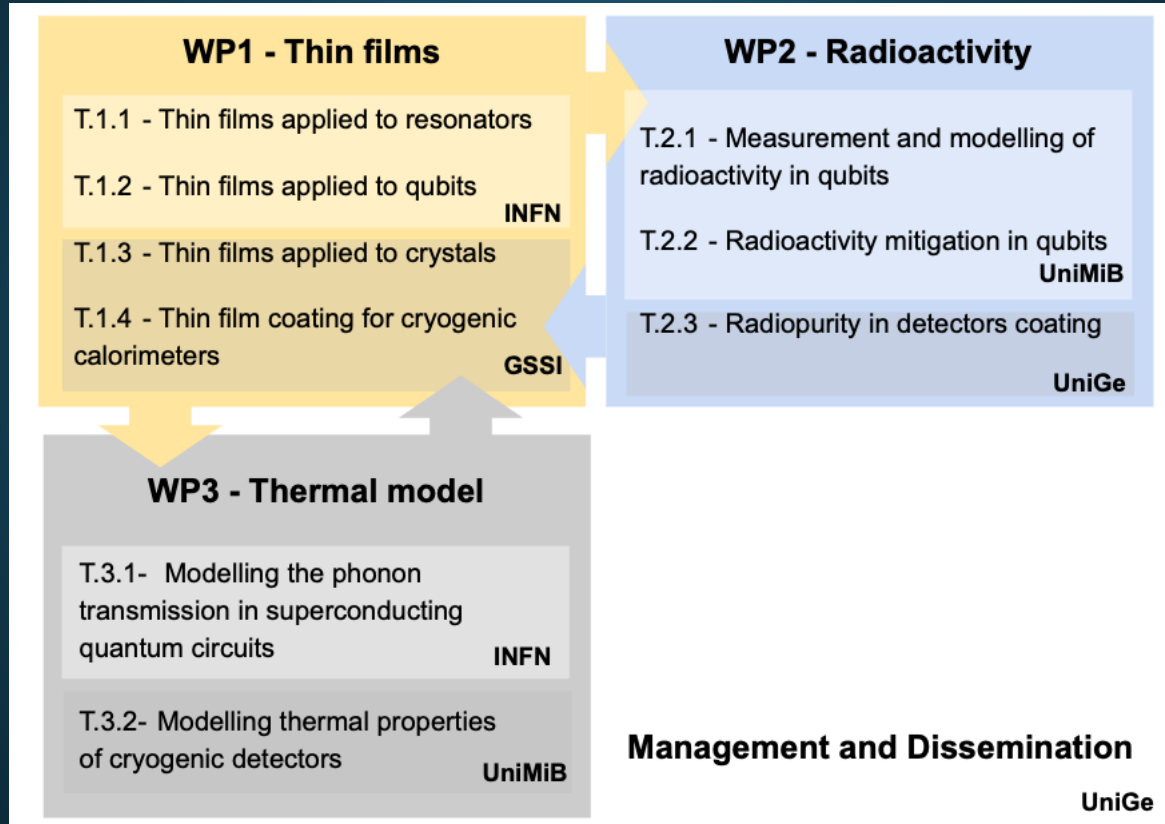
## **COLD: Coatings for Optimized Low temperature Devices**

- Just another name for the same project

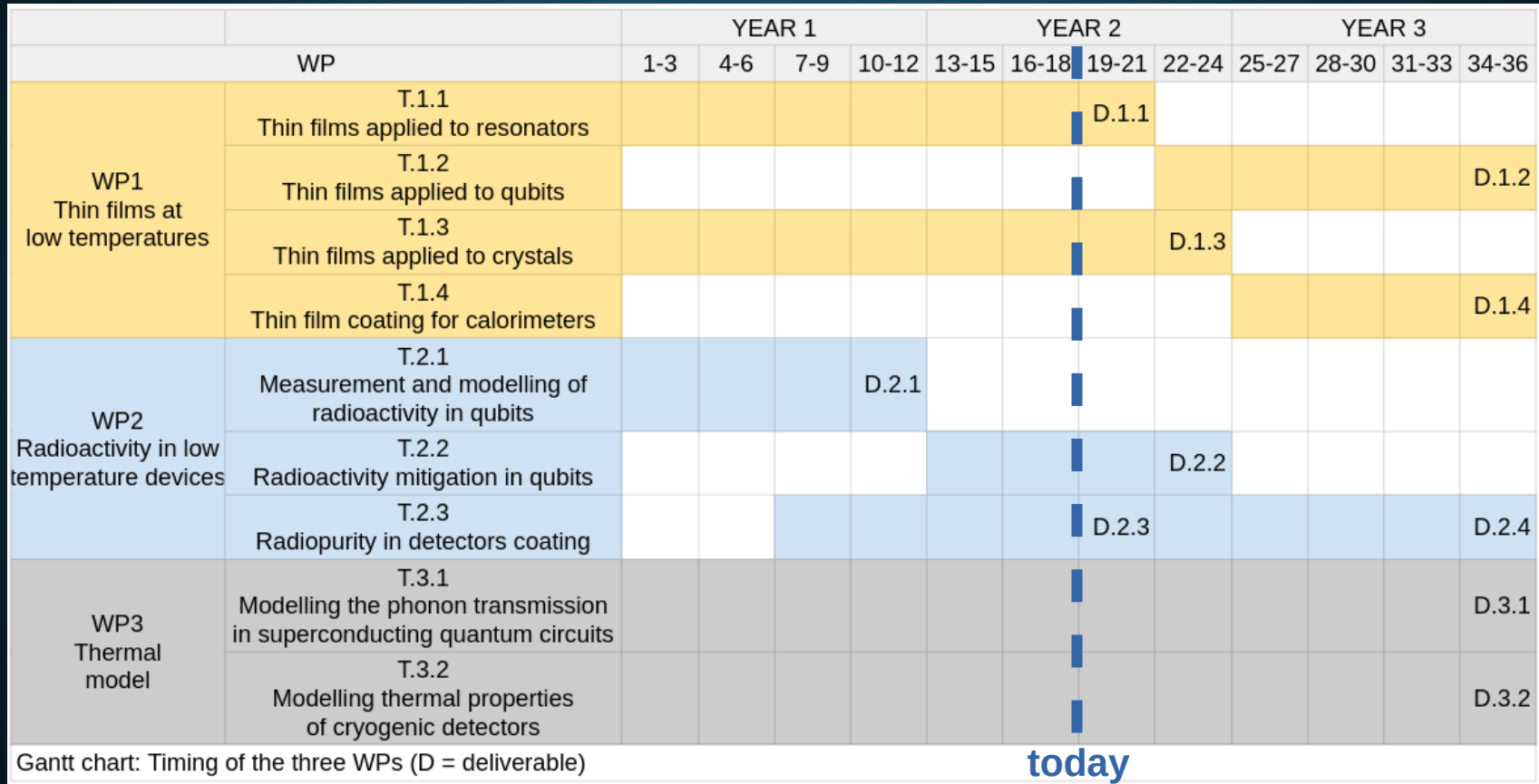
# PROJECT GOALS

1. Enhance the performance of superconducting qubits by suppressing the decoherence and correlated errors induced by radioactivity
2. Propose an innovative design of cryogenic calorimeters for rare events searches, featuring at the same time higher performance and simplified hardware implementation
3. Develop a simulation framework to model and optimize the thermal behavior of qubits and cryogenic detectors

# ORGANIZATION



# PROJECT SCHEDULE



# Deliverables

## **WP1 – Thin films at low temperature**

- D.1.1 (Q7): A superconducting resonator with phonon traps, featuring an internal quality factor an order of magnitude better
- D.1.2 (Q12): A qubit with phonon traps operated in a radiopure environment, featuring a coherence time in the millisecond scale
- D.1.3 (Q8): Definition of a protocol for crystal coating (thin film material and deposition technique)
- D.1.4 (Q12): Low temperature calorimetric test of an array of coated CUPID-like and COSINUS-like crystals

## **WP2 – Radioactivity in low temperature devices**

- D.2.1 (Q4): Model describing how materials constituting the qubit contribute to its radioactive rate
- D.2.2 (Q8): Radiopure qubit prototype
- D.2.3 (Q7): Preliminary selection of the materials for coatings
- D.2.4 (Q12): Background produced in COSINUS/CUPID by contamination in coating materials

## **WP3 – Thermal model**

- D.3.1 (Q12): Model of phonon propagation in qubits including the effect of phonon traps
- D.3.2 (Q12): Model of thermal properties of cryogenic detectors

# COMMUNICATION AND DISSEMINATION

- Website: <https://cold.unimib.it/>
- Internal communication: slack
- Publications
  - L. Cardani et al., “*Disentangling the sources of ionizing radiation in superconducting qubits*”, [Eur.Phys.J.C 83 \(2023\) 1, 94](#)
  - Reference to PRIN 2020H5L338 will appear in future CUPID papers
- Dissemination: towards the scientific community and the general public

# TODAY'S MEETING

## COLD Meeting

Monday Nov 20, 2023, 10:00 AM → 4:00 PM Europe/Rome

U1-14 (INFN-MiB)

### 10:45 AM → 12:30 PM Presentazioni

- 10:45 AM** **COLD** ⌚ 10m  
**Speaker:** Sergio Di Domizio (Istituto Nazionale di Fisica Nucleare)
- 11:00 AM** **Update sulle misure qubit underground** ⌚ 20m  
**Speaker:** Laura Cardani (Istituto Nazionale di Fisica Nucleare)
- 11:25 AM** **Impatto del coating di Al sui calorimetri LMO** ⌚ 20m  
**Speaker:** Massimo Girola (Istituto Nazionale di Fisica Nucleare)
- 11:50 AM** **Titanium phonon traps fabrication** ⌚ 20m  
**Speakers:** Mourad El Idrissi (Istituto Nazionale di Fisica Nucleare), Oscar Azzolini (Istituto Nazionale di Fisica Nucleare)

### 12:30 PM → 2:00 PM

Lunch

⌚ 1h 30m

### 2:00 PM → 3:30 PM Discussione

Pianificazione, deposizioni, misure, AOB