Searches for NLDBD into Normal Hierarchy with Quantum Calorimetry

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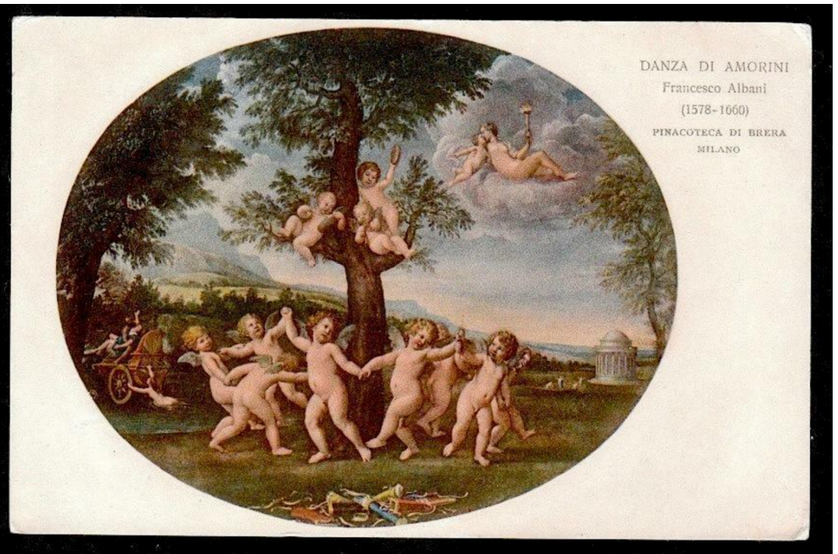
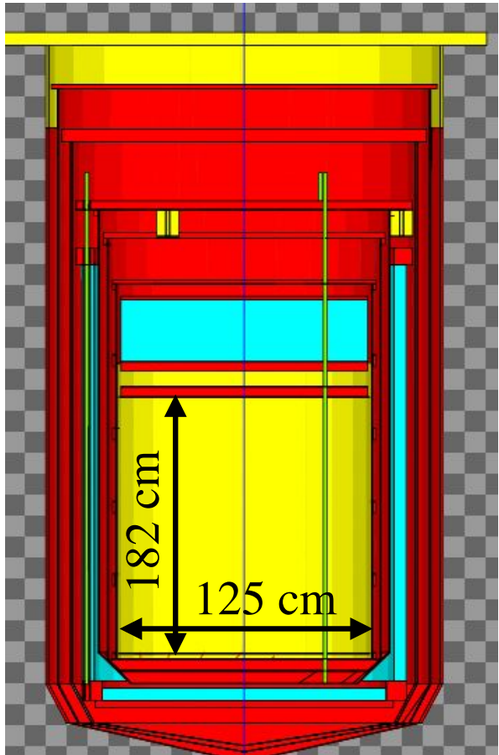




CUPID-1T Concept

CUPID-Baseline

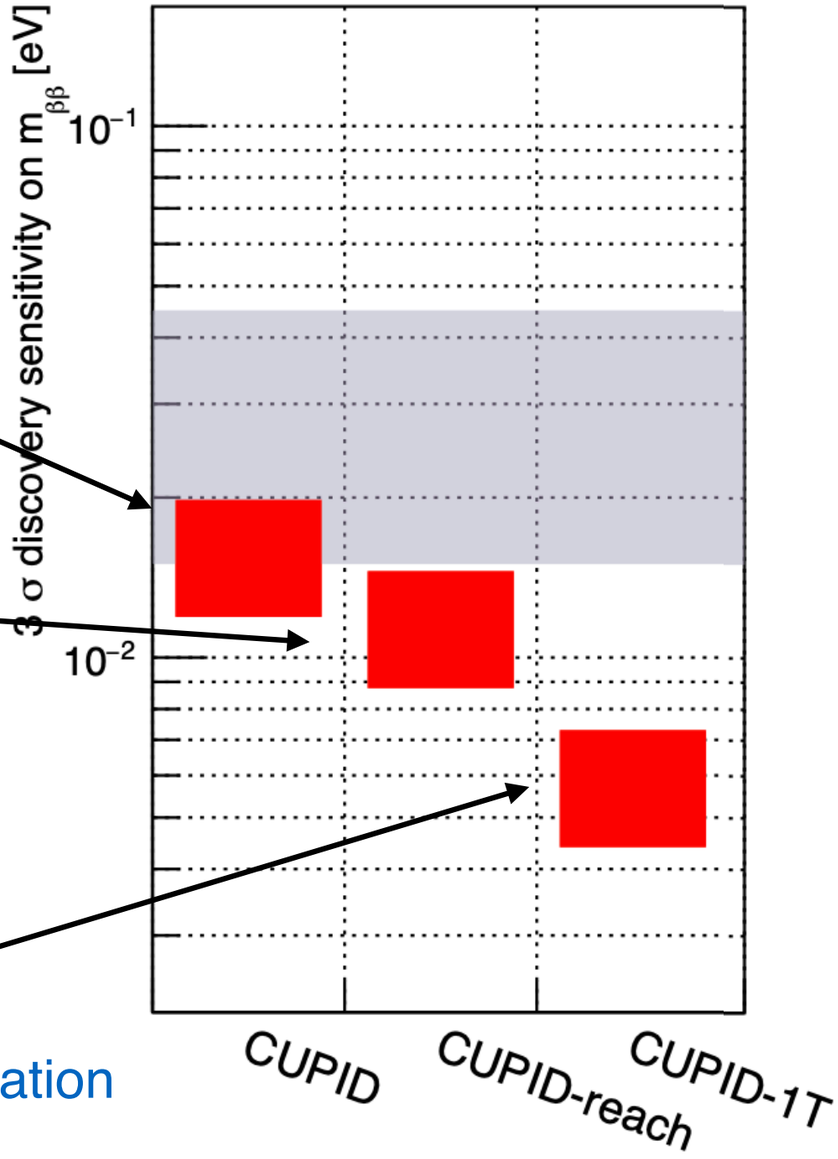
- Mass: 450 kg (**240 Kg**) of $Li_2{}^{100}MoO_4$(^{100}Mo) for **10** yrs
- Energy resolution: **5 keV** FWHM
- Background: **10^{-4}** cts/keV.kg.yr
- Discovery sensitivity **$T_{1/2} > 1.1\times10^{27}$ yr (3σ)**

CUPID-Reach

- R&D for further background reduction by radio purity and reduce pileup background
- Discovery sensitivity **$T_{1/2} > 2\times10^{27}$ yr (3σ)**

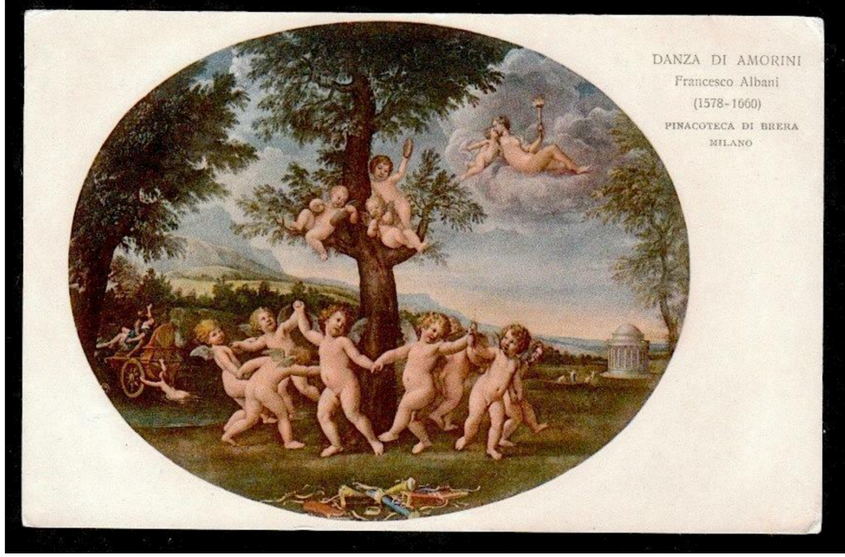
1-Ton

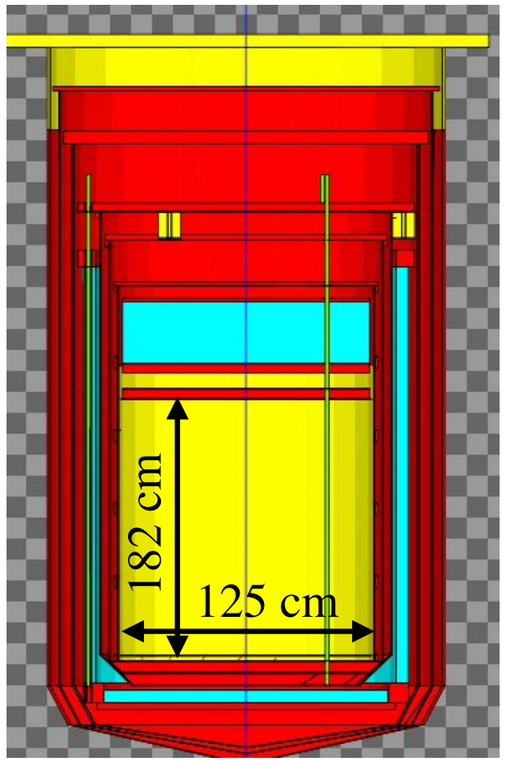
- Concept of a next-next generation detector
- 1000 kg of ^{100}Mo
- "Zero" background limit BI<**5×10^{-6}** cts/keV.kg.yr
- Discovery sensitivity in NH region **$T_{1/2} > 8\times10^{27}$ yr (3σ)**



Technology complementarity with DM, CMB, quantum information

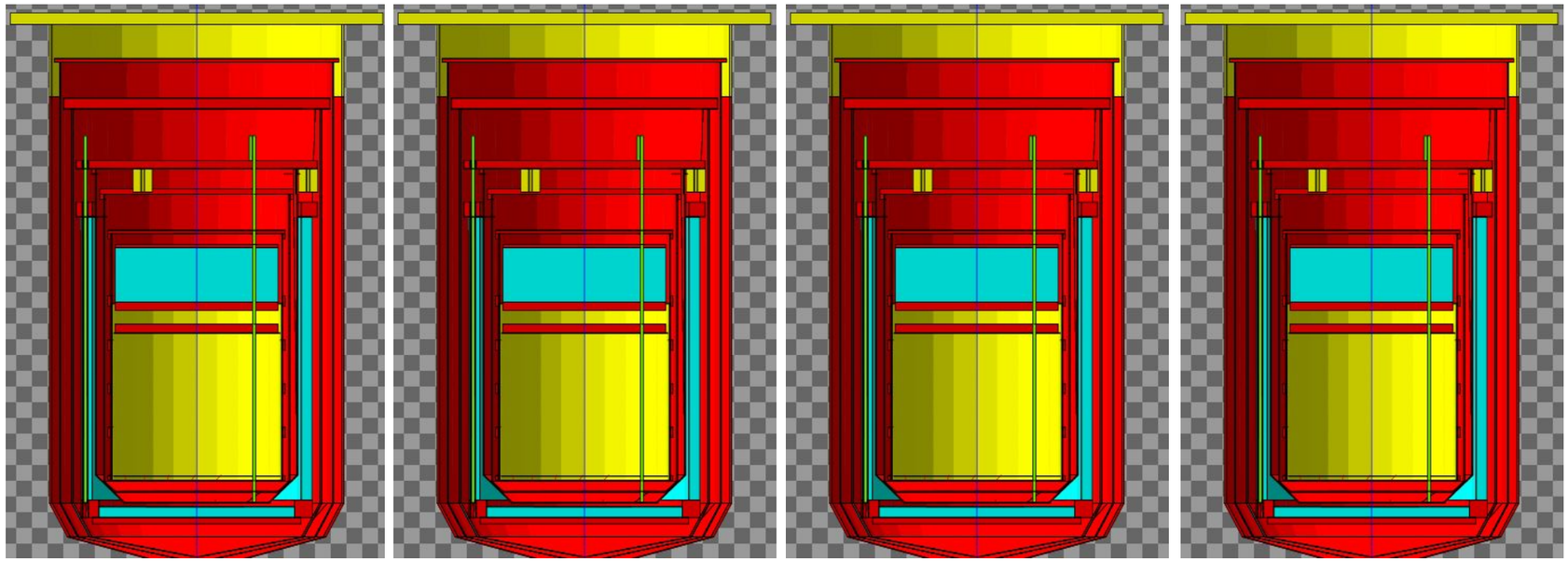
Two deployment options





1000 kg of ^{100}Mo

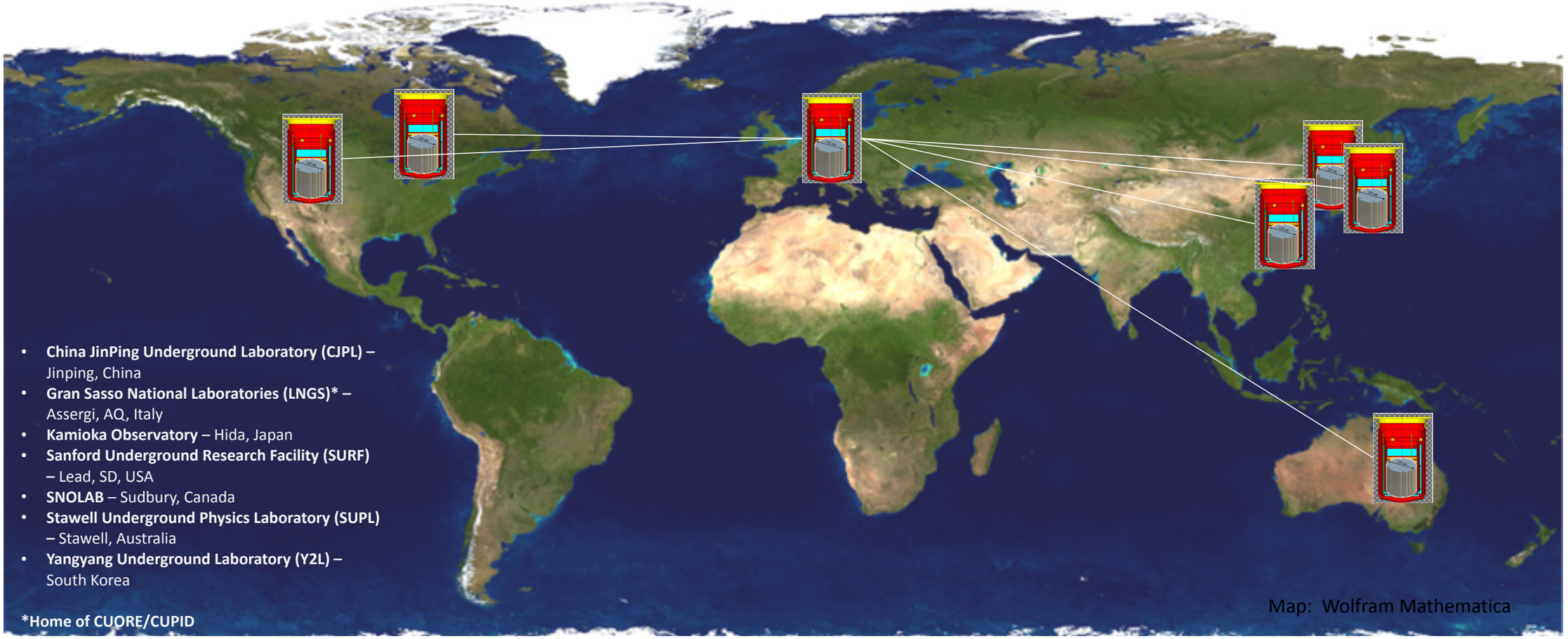
Single large cryostat



4x250 kg of ^{100}Mo

A “flock” of CUPIDs around the world

From CUPID to CUPID-1T: Multi-Site Possibilities



- **China JinPing Underground Laboratory (CJPL) –** Jinping, China
- **Gran Sasso National Laboratories (LNGS)* –** Assergi, AQ, Italy
- **Kamioka Observatory** – Hida, Japan
- **Sanford Underground Research Facility (SURF) –** Lead, SD, USA
- **SNOLAB** – Sudbury, Canada
- **Stawell Underground Physics Laboratory (SUPL) –** Stawell, Australia
- **Yangyang Underground Laboratory (Y2L) –** South Korea

***Home of CUORE/CUPID**

Map: Wolfram Mathematica

Joint Efforts, Common Datasets, and Desired Outcomes

Key Joint R&D Efforts & Joint Datasets:

- Active γ veto and event topology (synergy with low-mass DM experiments – CF1)
- Development of high-speed superconducting sensors (TES, MKID) – DM experiments, QIS (IF1, IF2)
- Multiplexed readout systems (IF1, IF7)
- Cryogenic CMOS ASIC developments (synergy with QIS); support for ~10K channels in one (or more) cryostat(s) (IF1, IF2, IF7, UF03)
- Radiopurity and shielding efforts (UF03)
- Physics/Sensitivity Simulations (NF5, NF3)
- Common frameworks for matrix elements (NF5, NF3)
- Common event generators (NF5, NF3)

NF5: Neutrino Properties
NF3: BSM Neutrinos
RF4: B-L Violating Processes
CF1: Particle-like DM
IF1: Quantum Sensors
IF2: Photon Detectors
UF03: Underground Detectors
IF7: Electronics/ASICS

Desired outcomes for Snowmass 2021:

- ***Strengthened collaboration between NP and HEP***
- ***Focus on the development of scalability of quantum sensor arrays with robust multiplexing techniques***

Science and Technology Complementarity

- Recognition within the community and the funding agencies of a need for NLDBD experiments “beyond ton scale” (i.e. beyond IH)
- As experiments get larger and most expensive, it becomes crucial to explore complementarity in science and technology
  - Technology complementarity with developments in DM, CMB, QIS
  - Science complementarity with DM
- Snowmass process in the US will consider NLDBD “beyond the ton scale”
- R&D component is essential to maintain technological expertise and train future workforce
- Coordinating various R&D opportunities into a coherent and vibrant program is beneficial for funding.
- LBNL is at the forefront in multiple areas: collaborative approaches ?
- There will be a CUPID-1T White Paper