TESSERACT Experiment

Search for light dark matter using Superfluid Liquid Helium

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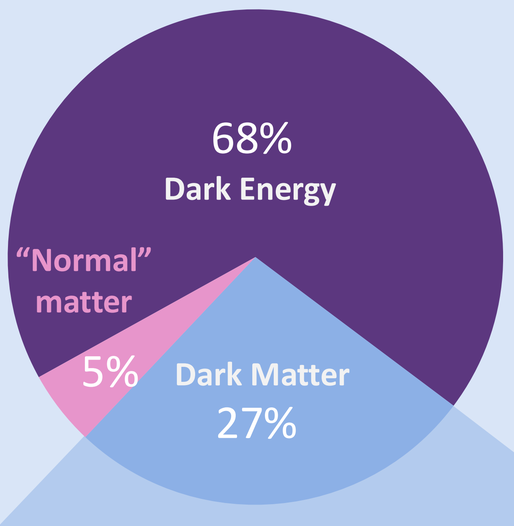
TESSERACT

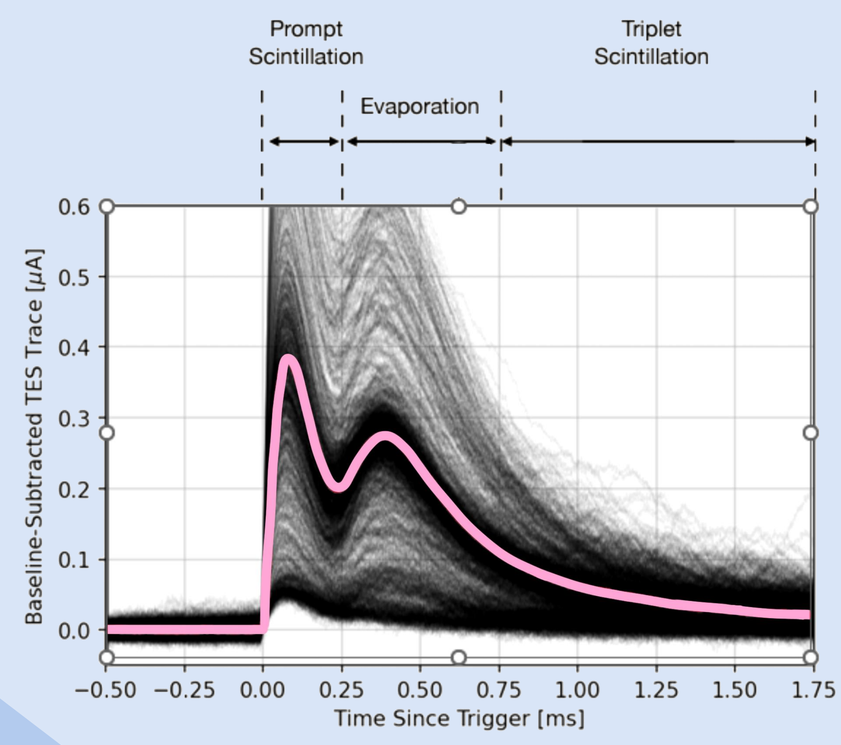


Dark Matter

27% of the **energy density of the Universe**
but its true nature remains **unknown**
Specific Characteristics:

- **Neutral**: no electromagnetic interactions
- **Massive**: interactions through gravity
- **Stable**: over the lifetime of the Universe
- **Cold**: moves slowly

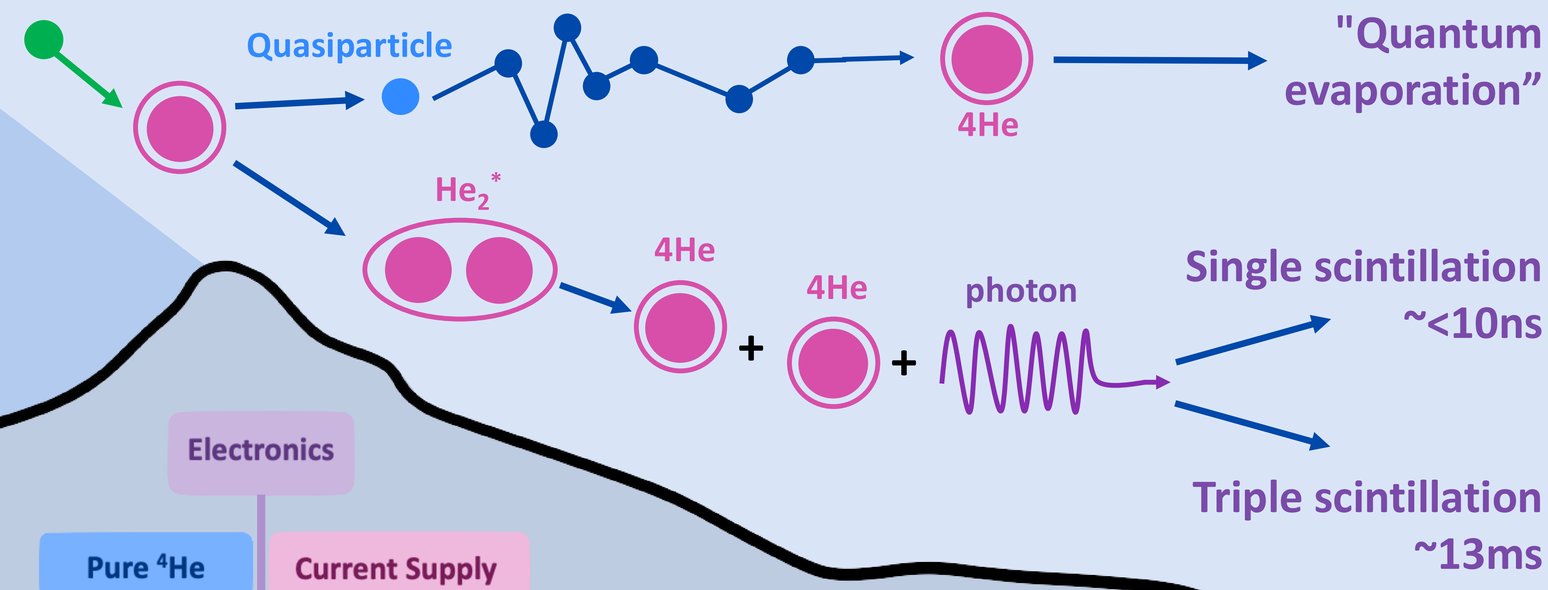
Overlay of many ^{4}He waveforms from the calibration source ^{55}Fe



Superfluid Helium

- Target Temperature: **8mK**
- **Low Noise** in mK temperatures
- Creates unique **signal channels**
- **Scalable** ~kg

Signal Channels

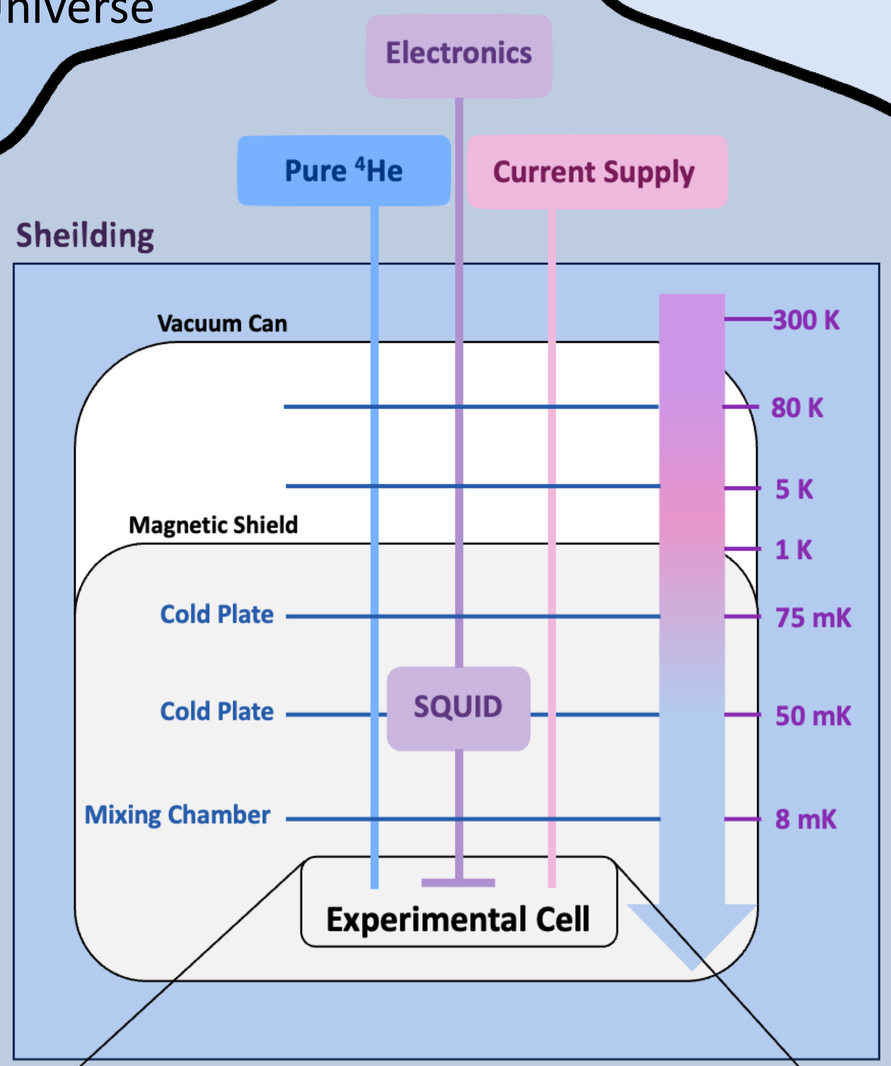


Low Background

- Modane Underground Laboratory (LSM): at **1600m underground**
- **Multiple layers shielding** including Plastic, Stainless Steel, Pb and Cu

Multi-Target Approach

- **Identifies** and **discriminates** backgrounds
- **Different sensitivities** for different types of **DM interactions**
- **Superfluid Helium** to detect phonons and photons
- **Al_2O_3 (sapphire)** to detect athermal phonons
- **GaAs** to detect optical phonons



Dilution Fridge & Experimental Cell

Dilution Fridge:

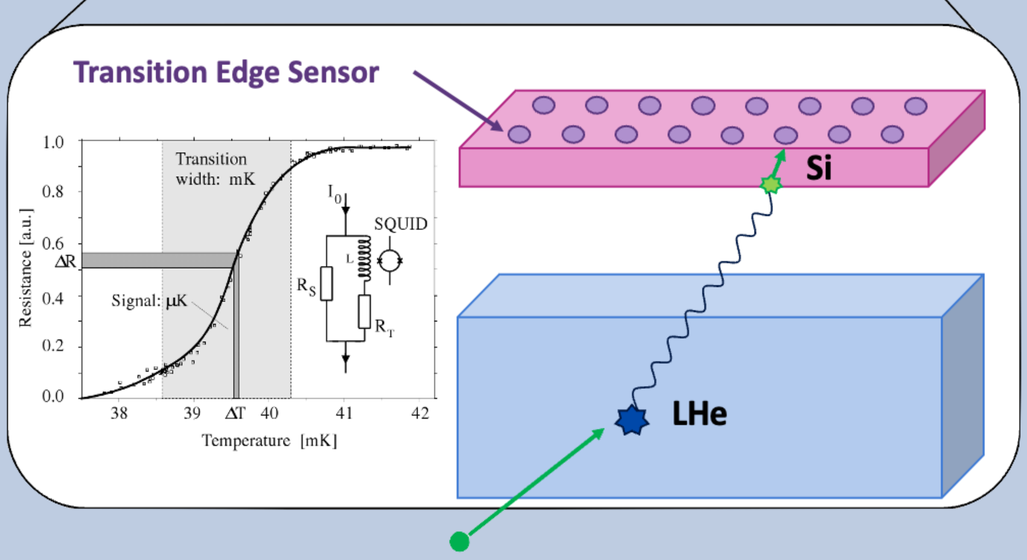
- Cools down to **mK temperatures**
- For developing **quantum sensors**

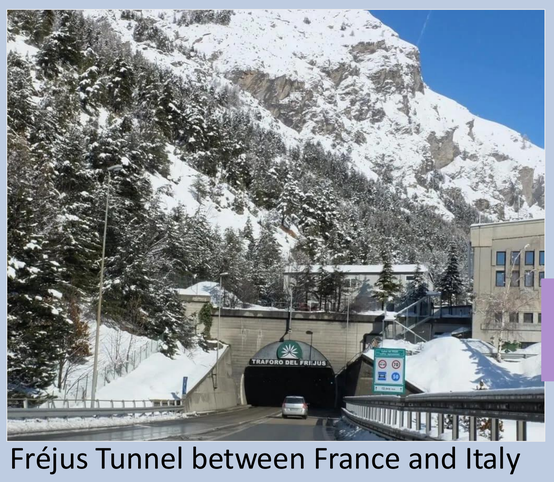
Operating modes:

- Utilizes **phase separation** of **^{3}He/^{4}He** mixture to extract heat
- ^{3}He evaporates**, absorbs heat**, and recondenses

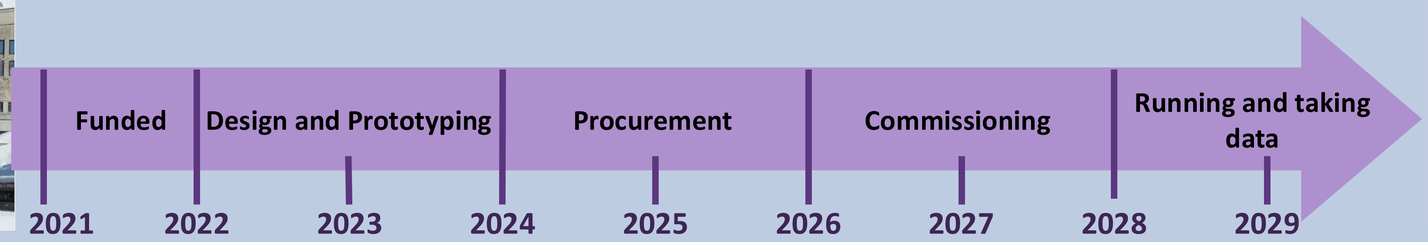
Experimental Cell:

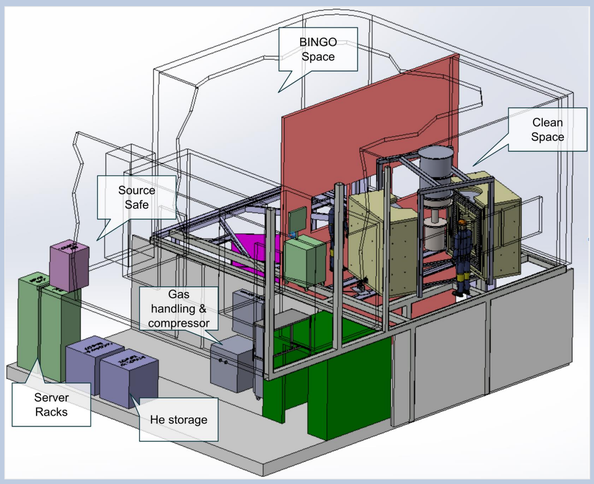
- Helium in the Superfluid state
- **TES** (Transition Edge Sensors) at the top on the cell





Fréjus Tunnel between France and Italy where LSM is located





Scheme of the TESSERACT Experiment laboratory