Searching for light Dark Matter with the CRESST Experiment

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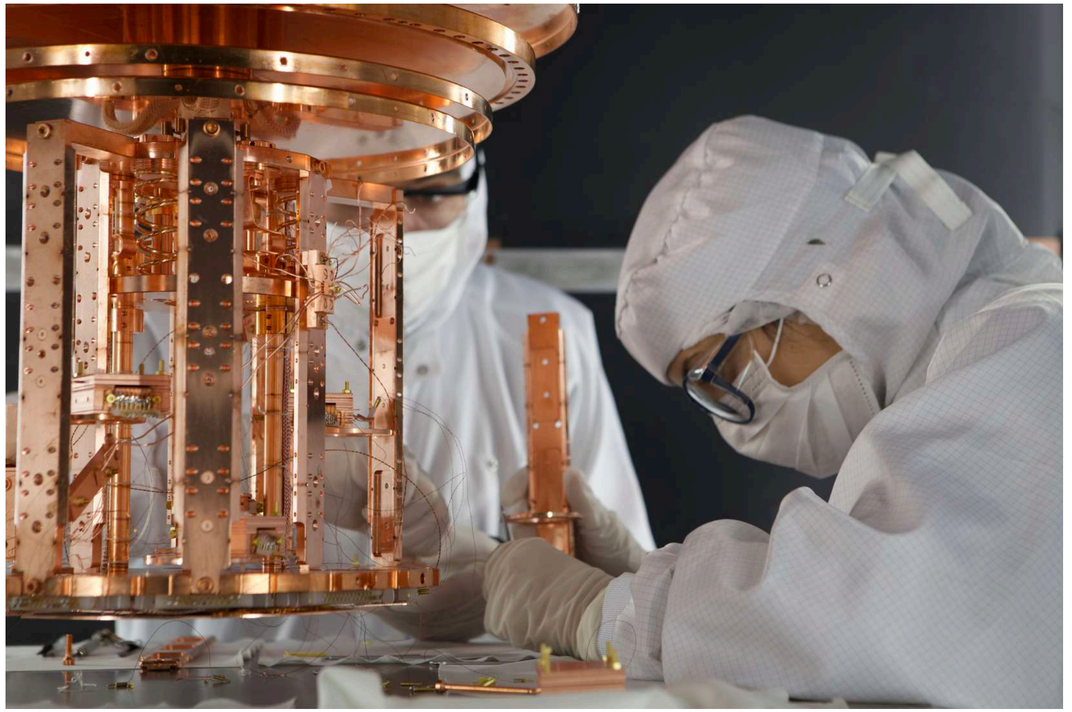
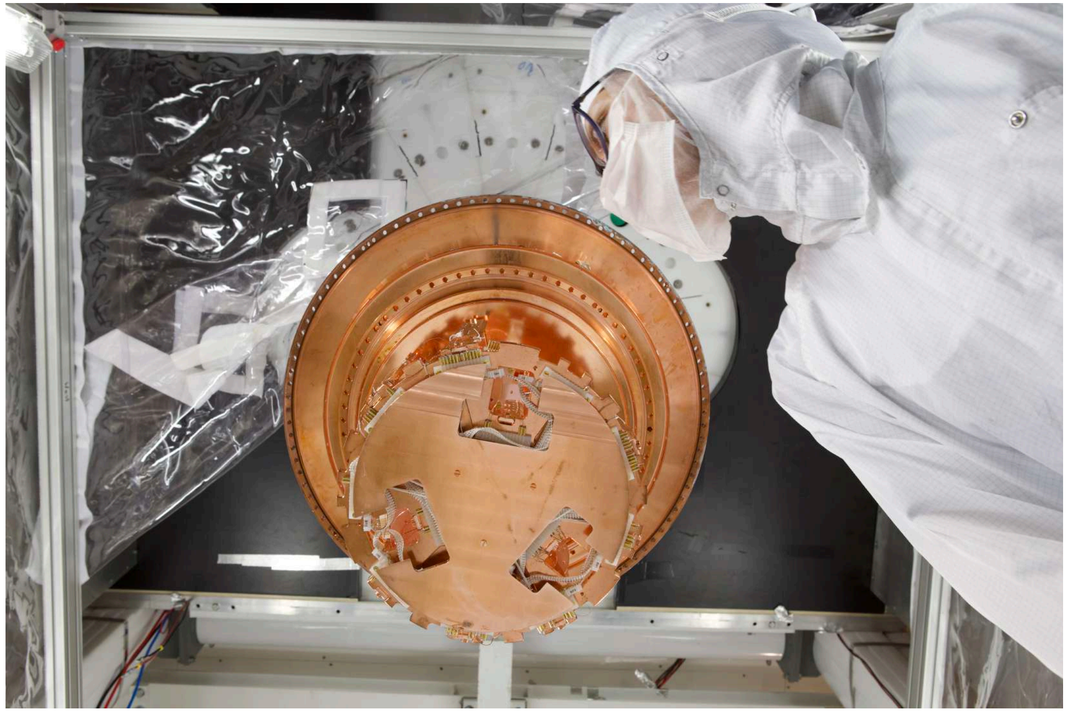
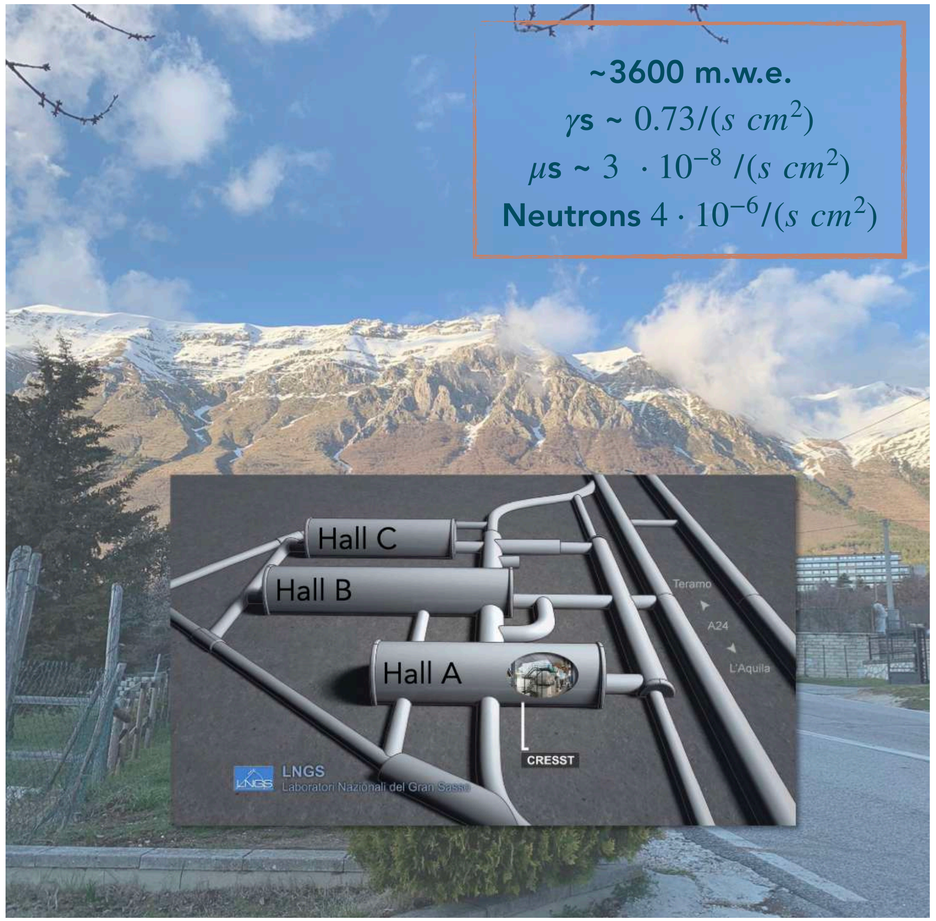


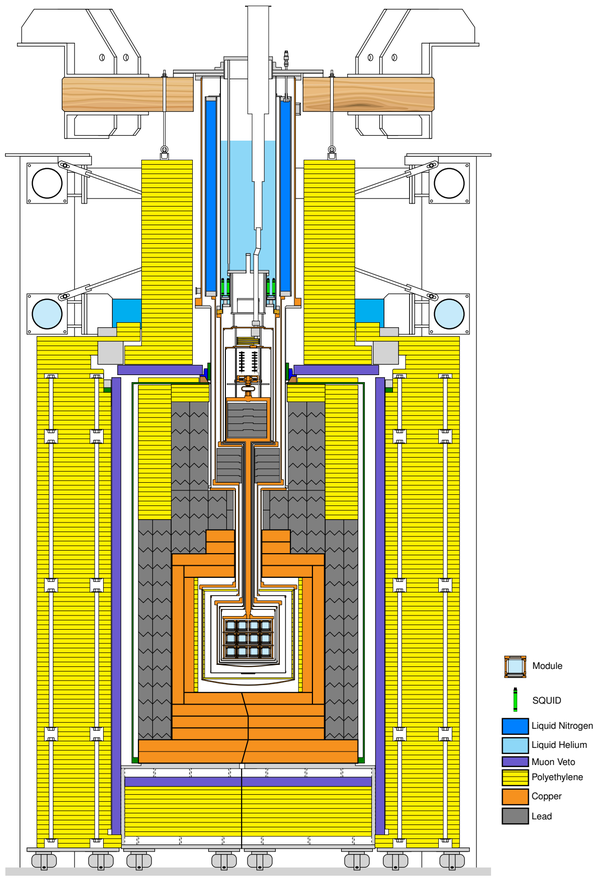


The CRESST Experiment

Cryogenic Rare Event Search with Superconducting Thermometers

- CRESST aims at directly detecting dark matter particles via their scattering off target nuclei in cryogenic detectors operated at ~15 mK
- Situated at the Laboratori Nazionali del Gran Sasso



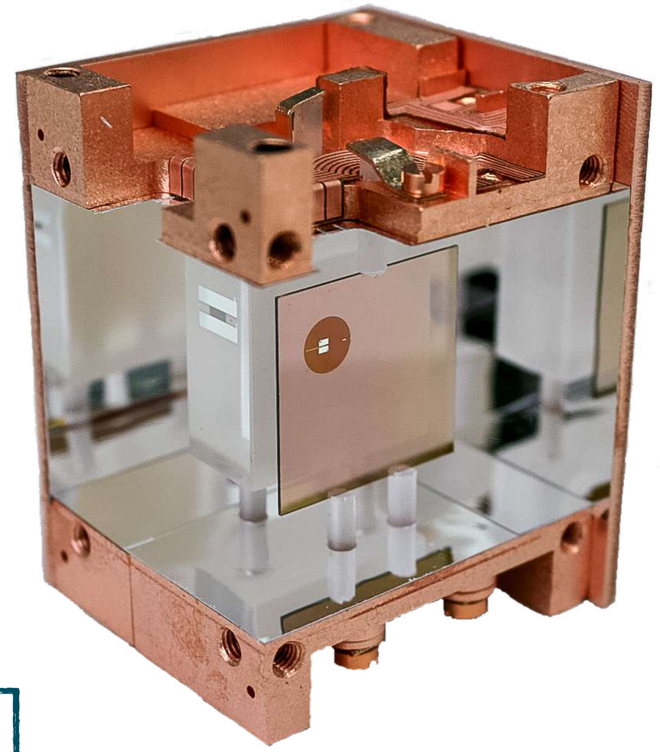


Multiple passive shielding layers

Detector Modules

Cryogenic Rare Event Search with Superconducting Thermometers

- Main target crystals of different materials
- Operated as cryogenics calorimeters
- Separate cryogenic light detector to detect the scintillation signal
  - Phonon signal (~ 90%) precise measurement of the deposited energy, independently of the type of particle
  - Light signal (few %) depends on the particle and on the type of recoil

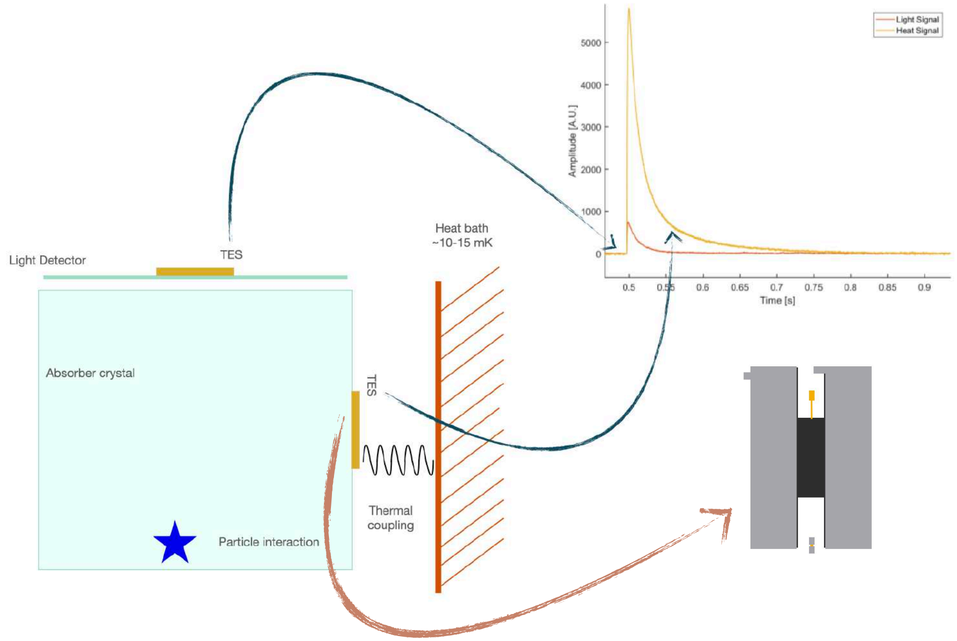


CRESST-III detectors are optimised for low mass (< few GeV) DM searches

Transition Edge Sensors

Cryogenic Rare Event Search with Superconducting Thermometers

- Tungsten thin films operated in their superconducting transitions
- Energy deposits measured as variations in the sensor's temperature
- $\Delta T \sim \Delta E/C$ → Low temperatures → Low heat capacity → High sensitivity



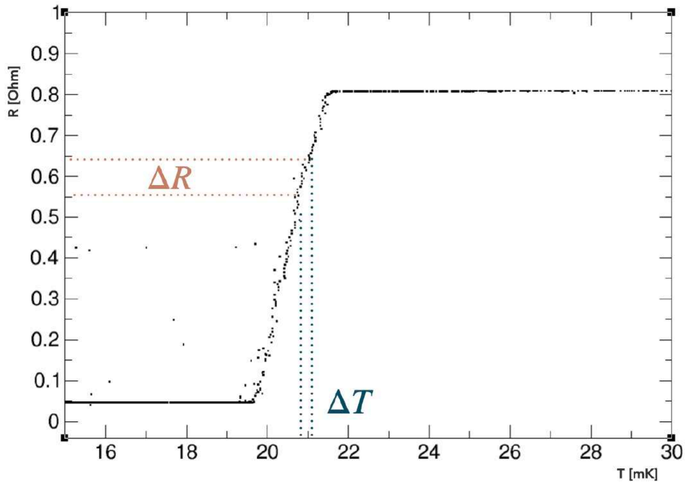
Energy Deposition $\sim keV$

↓

Temperature Rise $\sim \mu K$

↓

Resistance change $\sim m\Omega$



CRESST Results: first LEE observation

Cryogenic Rare Event Search with Superconducting Thermometers

Spin independent limit with Detector A

Crystal: 23.6 g $CaWO_4$

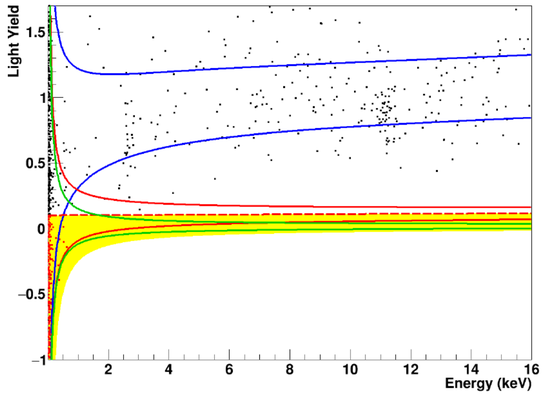
Data Taking period: Oct. 2016 - Jan 2018

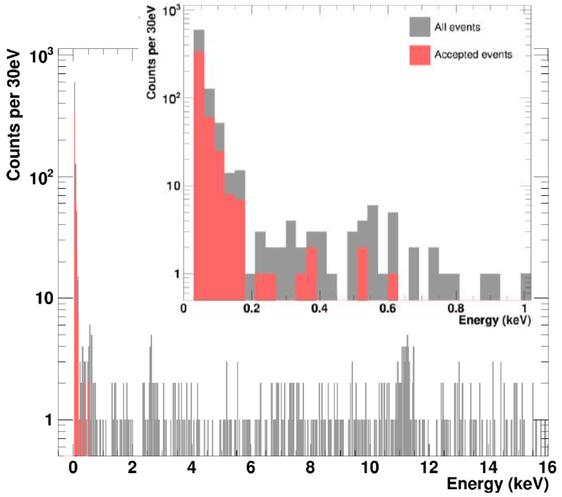
Exposure: 5.698 kg·days

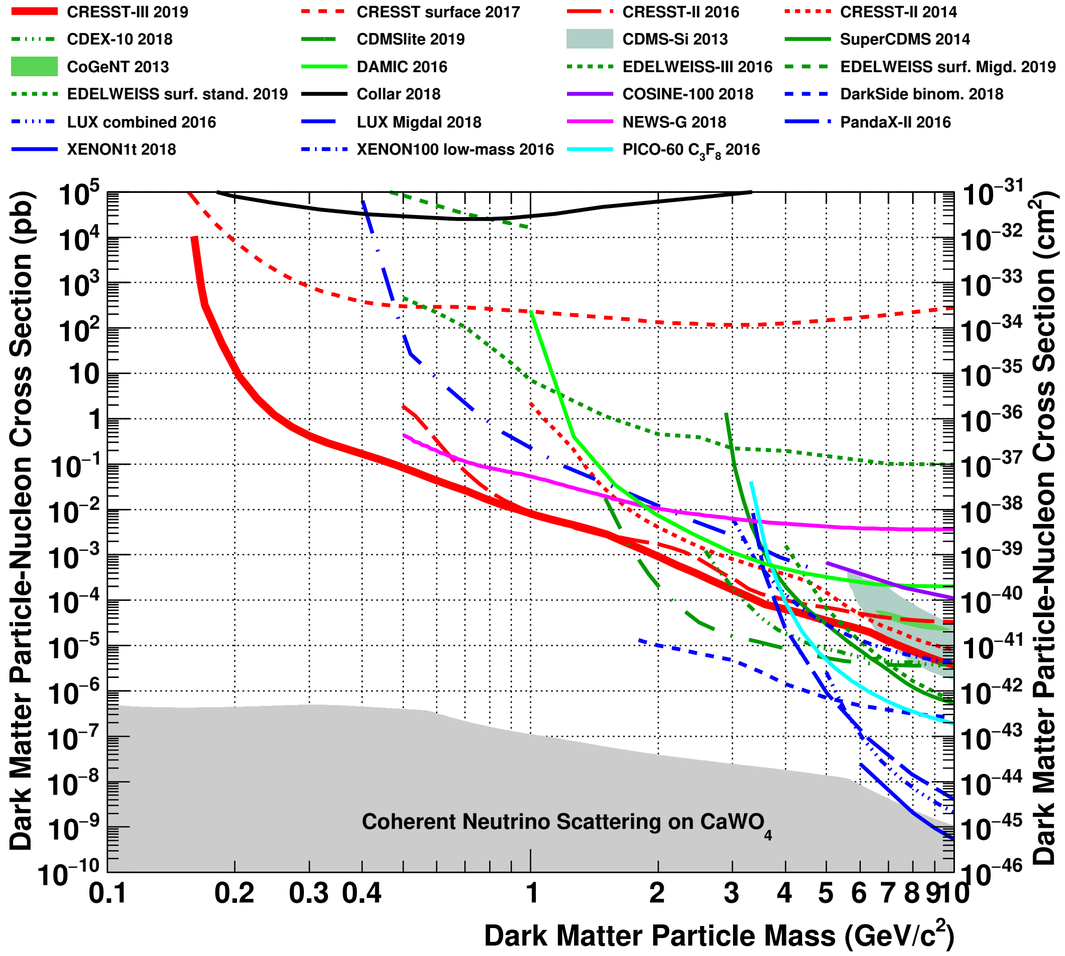
Baseline Resolution: 4.6 eV

Nuclear recoil threshold: 30.1 eV

First Observation of a Low Energy Excess







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The CRESST Collaboration

Cryogenic Rare Event Search with Superconducting Thermometers

~60 people from 9 different institutes in Europe

Opportunities

Cryogenic Rare Event Search with Superconducting Thermometers

In the next few years, the CRESST experiment will further push its sensitivity to dark matter, increasing its sensitivity (with R&D studies) and exposure (with the upcoming CRESST upgrade).

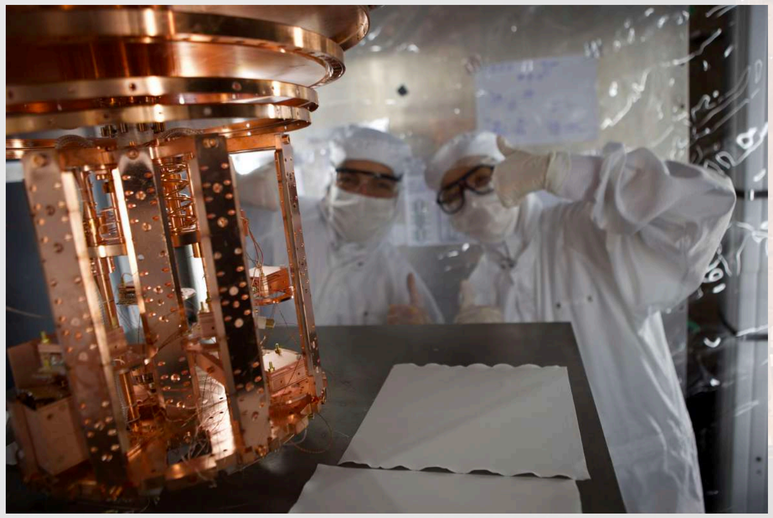
Hardware:

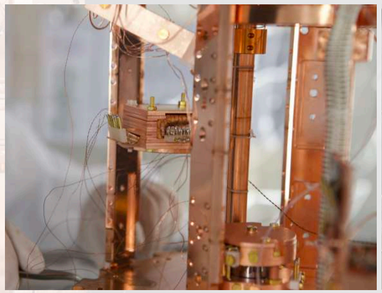
- Development and test of innovative dark matter detectors
- Studies of the TES design to improve performance and increase sensitivity
- Identification of the Low Energy Excess
- Upgrade of the cryogenic facility

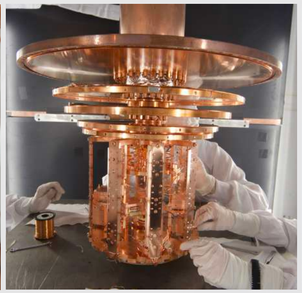
Software:

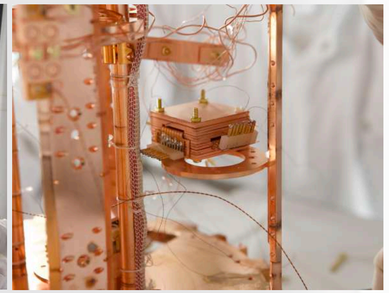
- Dark matter analysis (standard & non-standard)
- Other rare events analysis
- Studies of the LEE
- Upgrade of the analysis framework

Thank you for your attention









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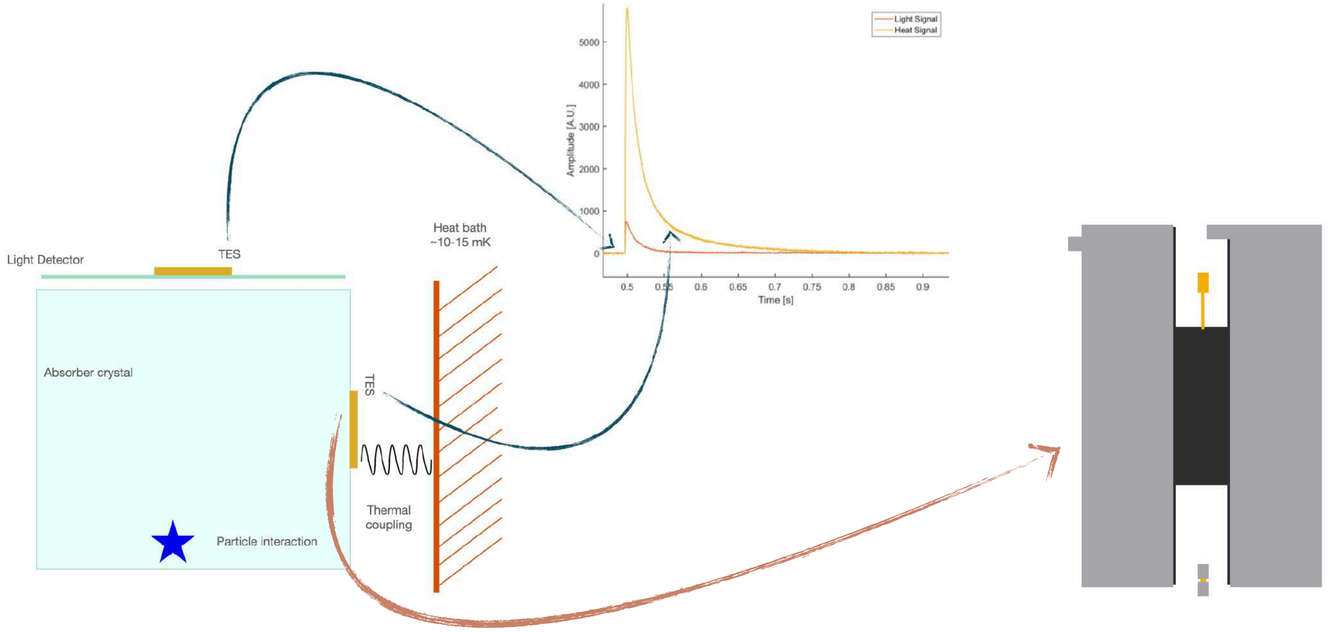
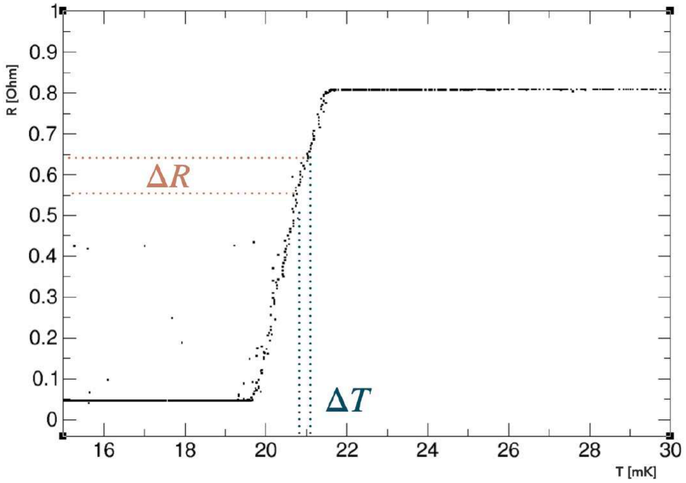
Backup slides

Transition Edge Sensors

Cryogenic Rare Event Search with Superconducting Thermometers

- Tungsten thin films operated in their superconducting transitions
- Gold thermal link for thermally connecting the sensor to the heat bath
- Aluminium phonon collectors to increase the collection area, enhancing the signal

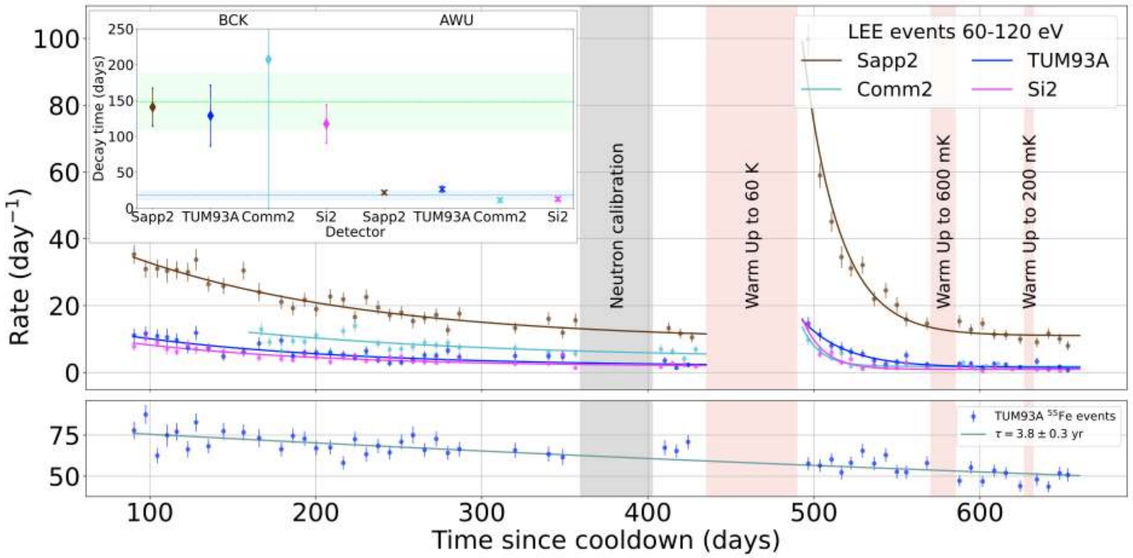




The Low Energy Excess (LEE)

Cryogenic Rare Event Search with Superconducting Thermometers

- Rise of particle events at energies below 200 eV
  - Present in all absorber materials with different holding schemes
  - Decays with time
  - Cannot be due to radioactive background
  - Counting rate not affected by neutron calibration
  - Can be repopulated with thermal cycles



The origin is still unclear

A new generation of detectors is needed to reach a better understanding of this signal