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Magnetic shielding tests for the COSINUS experiment

Max Hughes on behalf of the COSINUS Collaboration

20 March 2023

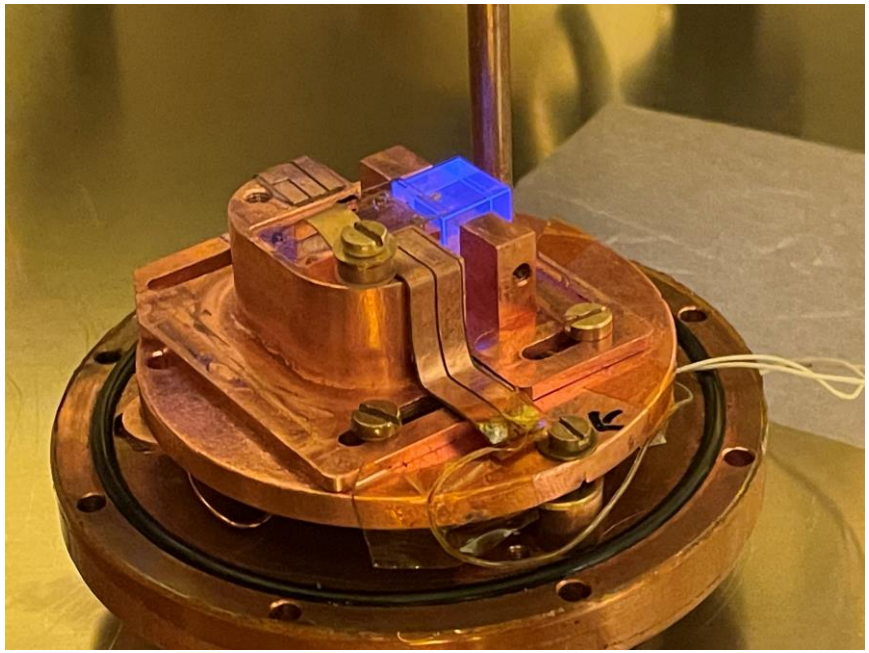
Since 1928 SICCAS · INFN LNGS Istituto Nazionale di Fisica Nucleare Laboratori Nazionali del Gran Sasso · GSSI · HEPHY INSTITUTE OF HIGH ENERGY PHYSICS · HELSINKI INSTITUTE OF PHYSICS · TU WIEN

COSINUS

- Direct dark matter detection experiment with cryogenic sodium iodide

- Transition edge sensors (TES) read heat signal and light signal of events to distinguish nuclear recoils and gamma/electron recoils

- For more info about detector development:
  - T 67.1 by Kumrie Shera
  - T 67.3 by Mukund Bharadwaj



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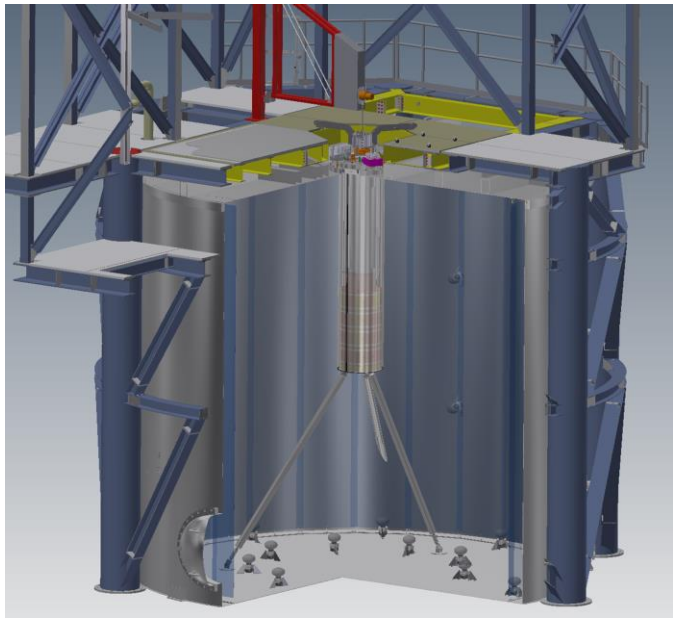
Experimental facility

- In Laboratori Nazionali del Gran Sasso (LNGS)
- Underground cryogenic facility with water shield
- Water shield will be instrumented to serve as muon veto



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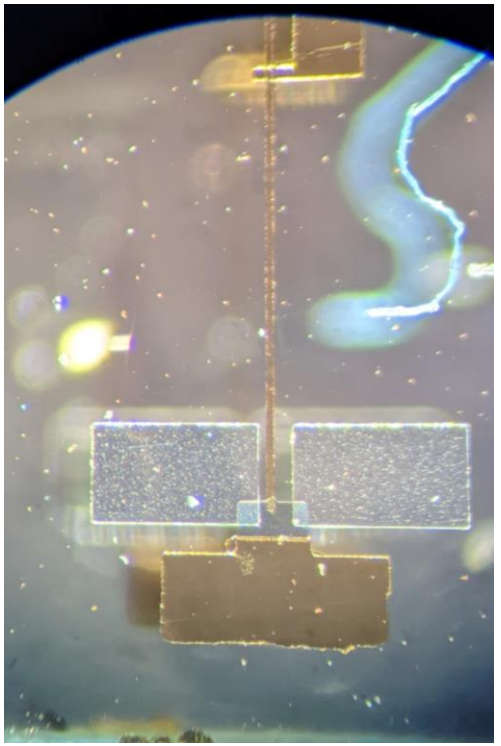
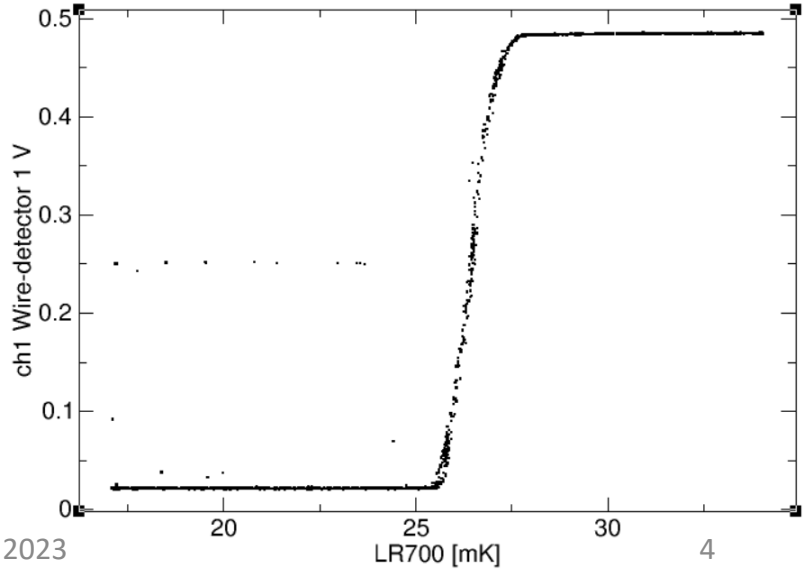
Transition edge sensors

- Consist of a thin film of superconducting material such as tungsten
- The material is held within the transition
- A small change in temperature causes a large change in resistance





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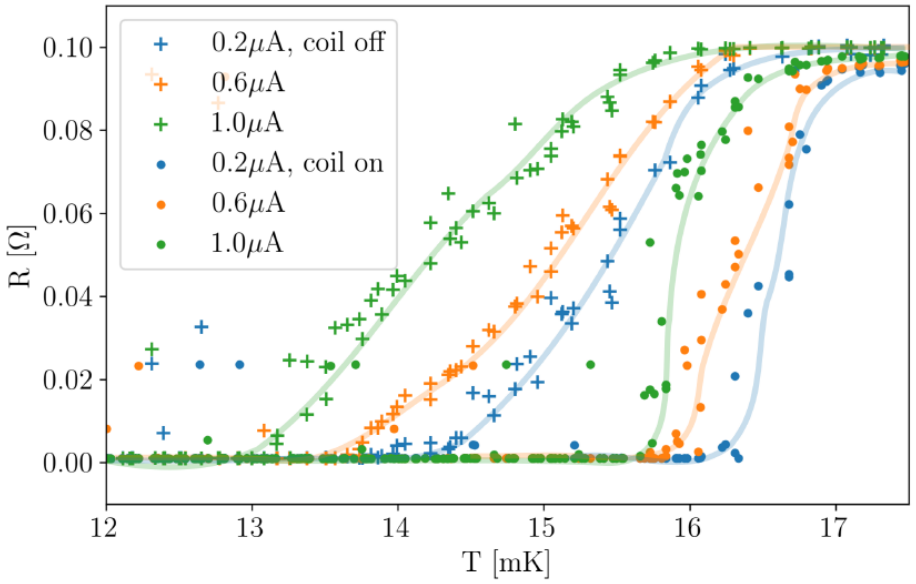
Magnetic fields and TES

- CRESST group has investigated and measure TES with magnetic fields
- Get less sharp transition with increase magnetic fields
- This decreases sensitivity and increases noise



From thesis of J. Rothe. TUM 2021

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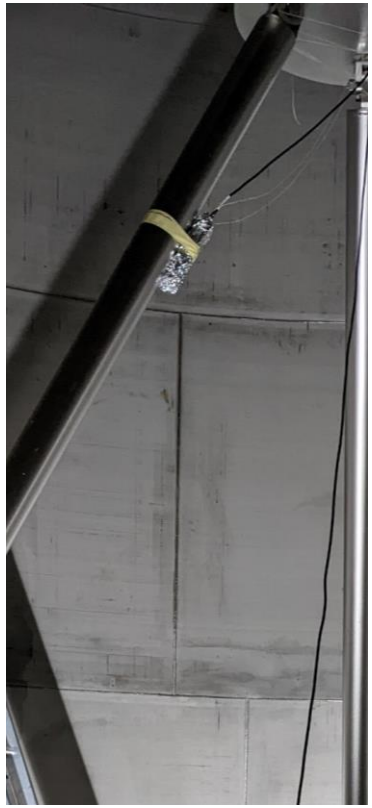
Magnetic fields and facility

- Earth's magnetic field reduces sensitivity
- LNGS cryostat sits in metal drywell
- Collaborators have done measurements of magnetic field at experiment site
- Earth's magnetic field dominates, but heavy machinery moving can induce changes in field



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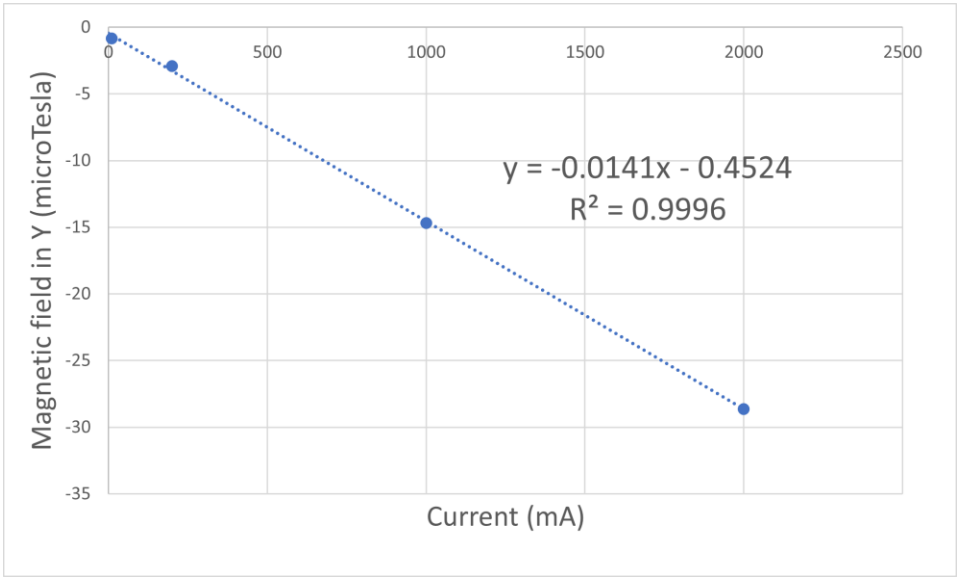
Passive magnetic shielding

- Use aluminum can inside cryostat as thermal shield
- Aluminum goes superconducting at 1.2 K and keeps magnetic field at constant value inside of can
- Freezing of field reduces sensitivity to magnetic changes

Calibrating field coil

- Using a 5 turn coil
- Using magnetic probe in center of coil
- Measured with different currents and with the probe at different heights
- In center, transverse field change of 14 µT per A of current



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Testing current passive shield

- Done at MPP
- Mounted coil to outside of Dewar at cryostat
- After measurement, transverse field without coil was measured to be 32.4 µT
- Ran coil with 0 A, 1.5 A, and 3 A

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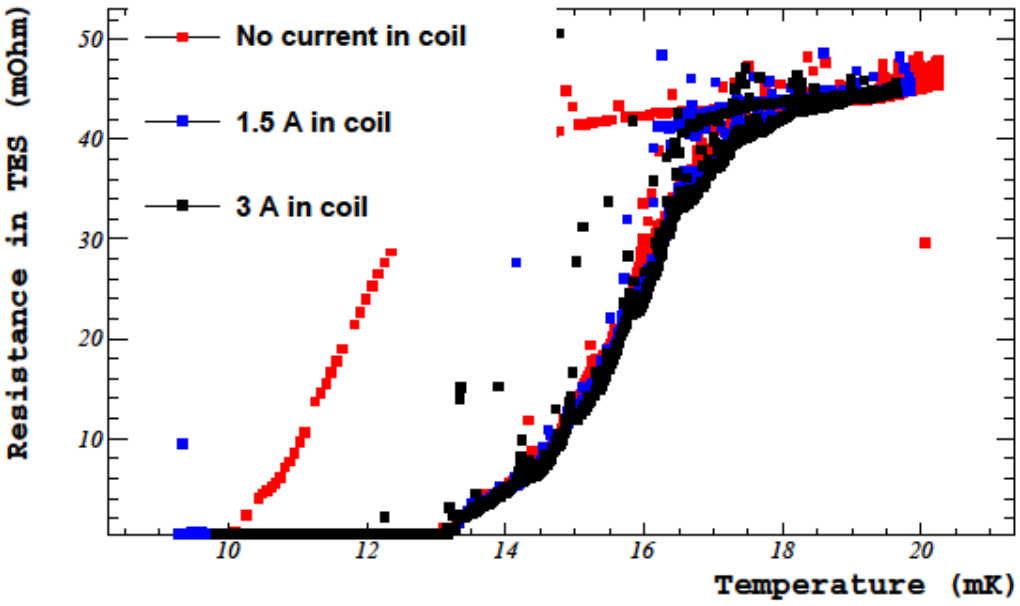
Results with large aluminum can

- With different currents in the coil, heated mixing chamber of cryostat and measured resistance of TES
- The aluminum shields the changes in magnetic field



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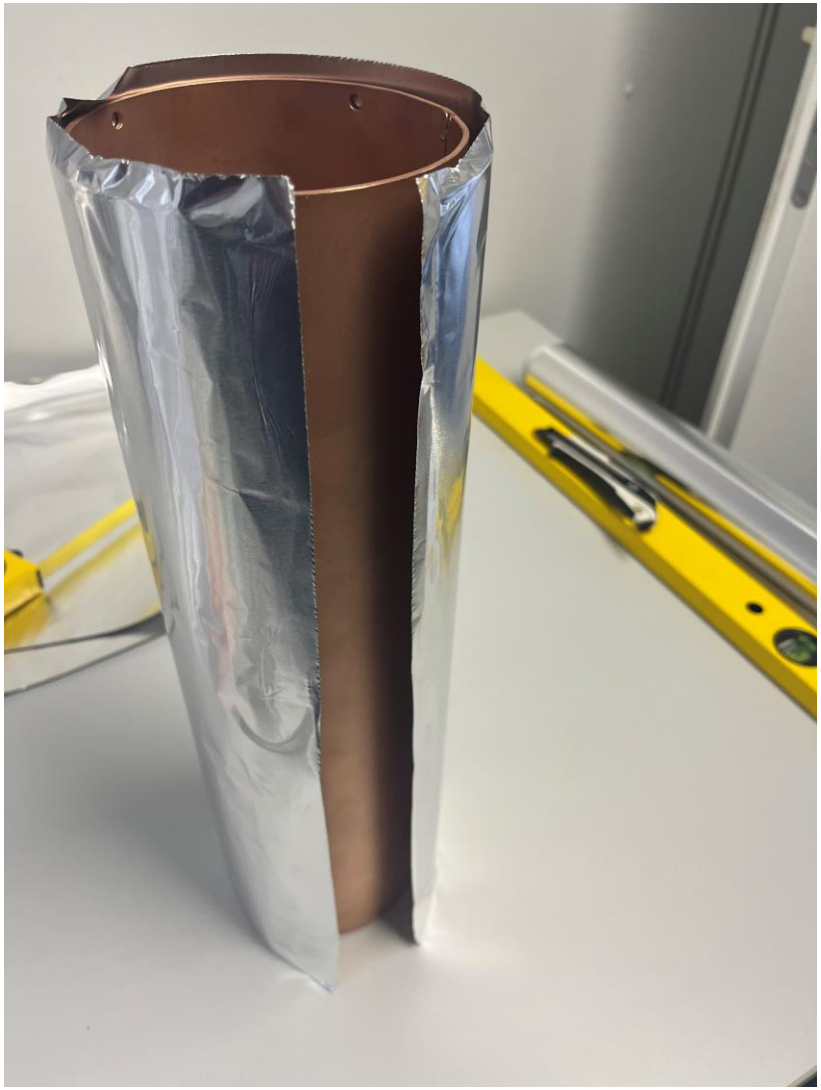
Copper can with aluminum cover

- Using aluminum foil around a copper can would allow for less material near the detectors
- Foil is 20 µm thick
- This is important for radiopurity



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Aluminum foil shield status

- Plan is to laser weld ends of foil together to make a complete sheet
- Welding aluminum foil is difficult
- Sent test pieces of foil to our collaborators in Vienna to work out welding process

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Active magnetic shielding

- Use coils to cancel out earth's magnetic field
- Can cancel out earth's magnetic field before cool down
- Magnetic field will freeze field at low value after cooling completes
- Worried about radiopurity of materials in these coils
- Discussion of location and form of active magnetic shielding is ongoing

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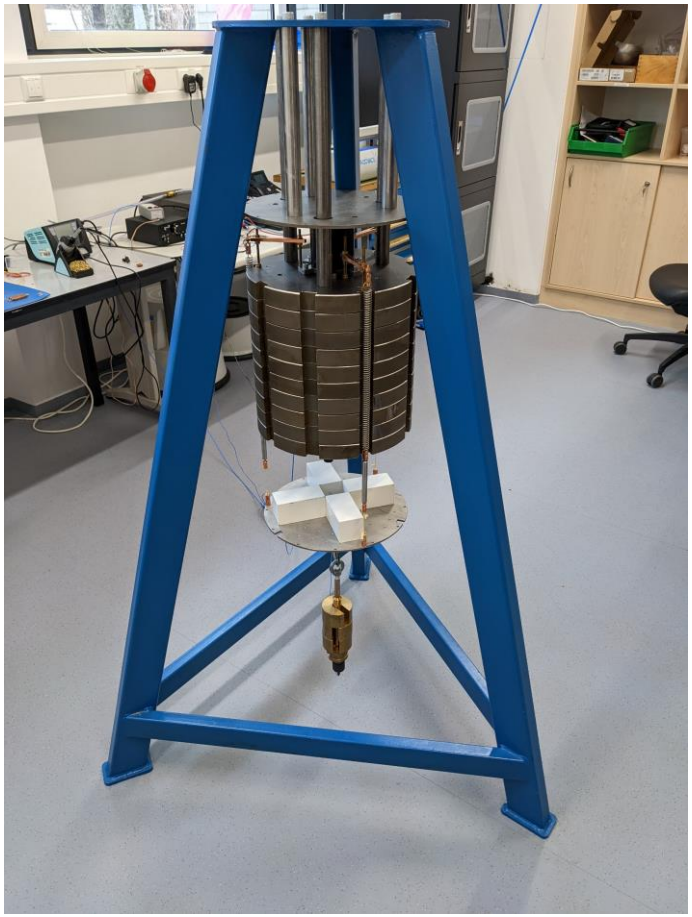
Summary and outlook

- COSINUS is a low background cryogenic NaI experiment
- Magnetic fields interfere with the measurement
- Working on ways to reduce the effect of magnetic fields



T 11.6: Moritz Kellerman

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