# Information about the experiments participating in the EXCESS workshop 15-16 June 2021

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# CONNIE/Skipper CCD running at surface

(provided by Guillermo Fernandez Moroni)

## CONNIE

- **Experiment name: CONNIE (Coherent Neutrino-Nucleus interaction experiment)**

**Detector basics**

- Detector concept: Silicon semiconductor ionization detector
- Sensor used: Scientific Charge Coupled Device
- Operating temperature: below 100K
- Location (under/above ground): above ground
- Veto systems/shielding: only passive shield. 60 cm of polyethylene around the sensor. 15 cm of lead around the sensor.
- Calibration source: natural fluorescence X-rays peaks from surrounding materials.

**Target**

- Target material: Silicon
- Target mass: approximately 50 grams
- Target dimensions:8 CCDs each 6 cm x 6 cm x 675 um
- Surroundings (e.g surrounding materials):Silicon, Copper, Kapton, glue, vacuum
- Holdings scheme: CCD is glued to a Silicon (inactive) mechanical substrate. Kapton cable provides the signal path for each sensor glued. Each CCD is attached to a Copper tray. The Copper trays are stacked in a Copper Box.

**Detector performance**

- Energy baseline resolution: around 1.8e- of readout noise per pixel.
- Analysis threshold: 50 eVee
- Measured energy range: 0.05 to 9 keVee.

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable): publication with the presented measurements and data analysis is coming soon. Detector, shield construction and conceptual processing of the data are detailed in previous publications arXiv:1906.02200.

# SKIPPER CCD with passive lead shield running at Surface

- **Experiment name:** Skipper CCD with passive lead shield running at Surface

**Detector basics**

- Detector concept: Silicon with single-electron charge resolution
- Sensor used: Skipper Charge Coupled Device (Skipper CCD)
- Operating temperature: 140K
- Location (under/above ground): above ground
- Veto systems/shielding: 2 inches passive lead shield surrounding the sensor.
- Calibration source: Absolute calibration using charge discretization measurements on the same output data

**Target**

- Target material: Silicon
- Target mass:0.675 grams from two quadrants (hot columns rejected).
- Target dimensions: approximately 4.8 cm x 0.75 cm x 675 um.
- Surroundings (e.g surrounding materials):Silicon, Copper, vacuum.
- Holdings scheme: Package: silicon mechanical substrate glued to the sensor, kapton cable for electrical lines; copper tray holds the sensor package and provides thermal conductivity

**Detector performance**

- Energy baseline resolution: 0.17e- per pixel from readout noise
- Analysis threshold:5 electrons (inclusive) of ionizing energy
- Measured energy range: 5 to 2000 electrons

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable): It will be available on arXiv during the week of the workshop.

# CRESST

(provided by Christian Strandhagen)

- **Experiment name: CRESST-III**

**Detector basics**

- Detector concept: cryogenic particle detector
- Sensor used: tungsten TES (directly evaporated on $CaWO_4$ crystal)
- Operating temperature: ~ 15 mK
- Location (under/above ground): LNGS (undeground 3600 m.w.e.)
- Veto systems/shielding:
    - muon veto (plastic scintillator panels, 98.7% geometric coverage)
    - layered shielding: polyethylene, lead and copper
- Calibration source:
    - $^{57}Co$ source located outside the shielding providing 122 keV gamma rays
    - 63.2 keV tungsten escape peak used for primary calibration
    - 11.27 keV peak from cosmogenically activated tungsten used for fine-adjustment

**Target**

- Target material: $CaWO_4$
- Target mass: 23.6 g
- Target dimensions: (20 x 20 x 10) $mm^3$
- Surroundings (e.g surrounding materials):
    - Silicon-on-Sapphire light detector (20 x 20 x 0.4) $mm^3$
    - copper housing
    - scintillating reflective foil (Vikuiti from 3M)
- Holdings scheme: 3 $CaWO_4$ sticks (diameter 2.5 mm, rounded tip)

**Detector performance**

- Energy baseline resolution: 4.6 eV (1 sigma)
- Analysis threshold: 30.1 eV
- Measured energy range: 30.1 eV - 16 keV (published)

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable):
    - https://arxiv.org/abs/1904.00498
    - https://journals.aps.org/prd/abstract/10.1103/PhysRevD.100.102002
    - https://arxiv.org/abs/1905.07335 (data release)

# DAMIC

(provided by Alvaro Chavarria)

- **Experiment name: DAMIC at SNOLAB**

**Detector basics**

- Detector concept: silicon semiconductor ionization detector
- Sensor used: charge-coupled devices (CCDs)
- Operating temperature: 140 K
- Location (under/above ground): 6000 m water-equivalent depth
- Veto systems/shielding: 20 cm of lead (innermost 5 cm ancient) and 40 cm of polyethylene. No veto.
- Calibration source: Calibrated with muon and Co-60 source on the surface. LED calibration in-situ.

**Target**

- Target material: silicon
- Target mass: 40 g
- Target dimensions: 7 CCDs each 62 mm x 62 mm x 0.68 mm
- Surroundings (e.g surrounding materials): copper box
- Holdings scheme: silicon + flex cable package in copper holder

**Detector performance**

- Pixel white noise: 1.6 e- = 6 eVee
- Leakage current / dark counts: <0.5 e- per pixel
- WIMP search range: 50 eVee – 6 keVee
- Maximum pixel value: 14 keVee

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable):

  Phys. Rev. Lett. 125, 241803 (2020):
  https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.125.241803
  https://arxiv.org/abs/2007.15622

# EDELWEISS

(provided by Jules Gascon)

## EDELWEISS-III

- **Experiment name: EDELWEISS-III**

**Detector basics**

- Detector concept: cryogenic Ge thermal phonon + ionisation
- Sensor used: Phonon: Two Ge-NTD heat sensors (4x4x0.45 mm) glued on detector; Ionisation: Al interleaved electrodes.
- Operating temperature: 18 mK
- Location : Underground (LSM)
- Veto systems/shielding: 15 cm Pb, 60 cm polyethylene, muon veto
- Calibration source: peaks from 68Ge cosmic activation and 71Ge neutron activation (1.3 keV and 10.37 keV uniformly distributed in volume), 133Ba external source (356 keV)

**Target**

- Target material: Ge
- Target mass: 860 g
- Target dimensions: Cylindric; height= 40mm diameter = 70 mm
- Surroundings (e.g surrounding materials): Cu housing covering 4pi
- Holdings scheme: 3 Teflon clamps on each side

**Detector performance**

- Energy baseline resolution: 500 - 1500 eV (150-500 eVee for ER, using 8V bias)
- Analysis threshold: 0.8 keVee
- Measured energy range: 0.8 keVee to 3 MeVee

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable):
    - Detector performance: https://arxiv.org/abs/1706.01070,
    - Electron recoil spectrum: https://arxiv.org/abs/1808.02340,
    - Low-energy background model: https://arxiv.org/abs/1607.03367 and https://arxiv.org/abs/1707.04308,

# EDELWEISS-Surf

- **Experiment name: EDELWEISS-Surf**

**Detector basics**

- Detector concept: cryogenic Ge with thermal phonon sensor
- Sensor used: Phonon: One Ge-NTD heat sensor (2x2x0.5mm$^3$) glued on Ge.
- Operating temperature: 17 mK
- Location : Above ground (IP2I Lyon)
- Veto systems/shielding: 10 cm Pb, with 50$^o$ opening above the detector
- Calibration source: $^{55}$Fe source (5.9 and 6.5 keV)

**Target**

- Target material: Ge
- Target mass: 33.4 g
- Target dimensions: Cylindric; height = 20mm diameter = 20 mm
- Surroundings (e.g surrounding materials): Cu housing covering 4pi
- Holdings scheme: 3 Teflon clamps on each side

**Detector performance**

- Energy baseline resolution: 17.7 eV
- Analysis threshold: 60 eV
- Measured energy range: 60 eV - 10 keV

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable):
    - Detector performance and DM search: https://arxiv.org/abs/1901.03588,

# EDELWEISS-RED30

- **Experiment name: EDELWEISS-RED30**

**Detector basics**

- Detector concept: cryogenic Ge with thermal phonon sensor (with NTL amplification)
- Sensor used: Phonon: One Ge-NTD heat sensor (2x2x0.45mm$^3$) glued on Ge. Ionisation: Aluminum electrodes (= lithographed Al grid (500 mm pitch, 4% coverage to reduce phonon trapping)
- Operating temperature: 20.7 mK
- Location : Underground (LSM)
- Veto systems/shielding: 15 cm Pb, 60 cm polyethylene
- Calibration source: peaks from 71Ge neutron activation (160 eV, 1.3 keV and 10.37 keV uniformly distributed in volume)

**Target**

- Target material: Ge
- Target mass: 33.4 g
- Target dimensions: Cylindric; height = 20mm diameter = 20 mm
- Surroundings (e.g surrounding materials): Cu housing covering 4pi
- Holdings scheme: 3 Teflon clamps on bottom side, 3 Cu clamp + sapphire ball on top side

**Detector performance**

- Energy baseline resolution: 42.7 eV phonon (1.58 eVee with 78V bias)
- Analysis threshold: 6 eV
- Measured energy range: 2 eV - 30 eV (published)

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable):
    - Detector performance and DM search: https://arxiv.org/abs/2003.01046,

# MINER

(provided by Rupak Mahapatra)

- **Experiment name: Mitchell Institute Neutrino Experiment at Reactor (MINER)**

**Detector basics**

- Detector concept: Cryogenic athermal phonon detection
- Sensor used: Transition Edge Sensors (TES) with aluminum fins and tungsten TES
- Operating temperature: base temperature 7 mK, Tc from ~30 mK to 90 mK
- Location (under/above ground): above ground
- Veto systems/shielding: Inner active veto (Ge detector with TES)
- Calibration source: internal (55Fe, 241Am) and external (57Co)

**Target**

- Target material: germanium, silicon, sapphire
- Target mass: Various target masses, ranging from 100-700 gm (3” diameter)
- Target dimensions: 3”x4mm to 3”x1”
- Surroundings (e.g surrounding materials): copper, circlex
- Holdings scheme:Standard SuperCDMS style mounting

**Detector performance**

- Energy baseline resolution: ~15 eV recoil energy (0V)
- Analysis threshold: ~50 eV recoil energy
- Measured energy range: ranges from threshold to 100s of keV, depending on the detector type

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable):

# NEWS-G

(provided by Francisco Vazquez de Sola)

- **Experiment name: New Experiments With Spheres - Gas detectors**

**Detector basics**

- Detector concept: gaseous ionization detector
- Sensor used: Silicon High-Voltage anode / DLC Achinos
- Operating temperature: room temperature
- Location (under/above ground): underground (LSM) [future: SNOLAB]
- Veto systems/shielding: 23 cm VLA Lead plus 3 cm of archeological lead, 40 cm PE. No veto
- Calibration source: Laser (down to single photoelectron), Ar37 (e- & gamma at 2.8keV and 270 eV), AmBe (up to 10 keVnr).

**Target**

- Target material: CH4 [future: Ne + 7% CH4]
- Target mass: 115g
- Target dimensions: 140cm-diameter sphere
- Surroundings (e.g surrounding materials): C10100 copper
- Holdings scheme: N/A, but central anode contains silicon and DLC

**Detector performance**

- Energy baseline resolution:
- Analysis threshold:
- Measured energy range:

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable):

# NUCLEUS

(provided by Johannes Rothe)

- **Experiment name:** NUCLEUS prototype 2017

**Detector basics**

- Detector concept: $Al_2O_3$ cryogenic calorimeter
- Sensor used: tungsten transition edge sensor + Al phonon collectors + Squid readout
- Operating temperature: 15-20mK
- Location (under/above ground): above ground (MPP Munich)
- Veto systems/shielding: none
- Calibration source: $^{55}Fe$ (x-rays 5.9/6.5 keV)

**Target**

- Target material: $Al_2O_3$
- Target mass: 0.49g
- Target dimensions: $(5mm)^3$
- Surroundings (e.g surrounding materials): copper cryostat vessels
- Holding scheme: bronze clamp, $Al_2O_3$ spheres, copper plate

**Detector performance**

- Energy baseline resolution: 3.7 eV
- Analysis threshold: 19.7 eV
- Measured energy range: 19.7 eV – 12 keV

**References** to publications, arXiv pages, or theses where the described measurements are presented (if applicable):

- Detector concept: Physical Review D, 96(2):022009, 2017. https://arxiv.org/abs/1704.04317

- DM search: EPJ C, 77(9):637, 2017. https://arxiv.org/abs/1707.0674
- Prototype measurements: J Low Temp Phys **199,** 433–440 (2020). https://link.springer.com/content/pdf/10.1007/s10909-019-02283-7.pdf
- PhD Thesis, J. Rothe. http://mediatum.ub.tum.de/?id=1576351

# SENSEI

(provided by Sho Uemura)

- **Experiment name: SENSEI**

**Detector basics**

- Detector concept: Silicon with single-electron charge resolution
- Sensor used: Skipper-CCD
- Operating temperature: 135 K
- Location (under/above ground): Shallow underground (MINOS cavern at Fermilab, ~104 m, ~225 m water-equivalent)
- Veto systems/shielding: No veto, thin non-hermetic lead shield
- Calibration source: None (self-calibrating charge measurement)

**Target**

- Target material: Silicon
- Target mass: 1.926 active mass, but not all quadrants functional
- Target dimensions: 9.216 x 1.329 x 0.0675 cm^3 active volume
- Surroundings (e.g surrounding materials): Inactive silicon (pitch adapter and spacers), clear epoxy (Epotek 301-2), vacuum, copper
- Holdings scheme: Detector is epoxied to a silicon “pitch adapter” which is held in place against the copper tray with a copper leaf-spring

**Detector performance**

- Energy baseline resolution: charge resolution of ~0.14 elementary charges
- Analysis threshold: independent analyses for 1e, 2e, 3e, and 4e events
- Measured energy range: determined by ionization energies in Si

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable):
    - Measurements (Phys. Rev. Lett. 125, 171802 (2020)): https://arxiv.org/abs/2004.11378
    - Estimates of radiation-induced backgrounds: https://arxiv.org/abs/2011.13939

# SuperCDMS

(provided by Samuel Watkins and Alexander Zaytsev)

## PD2/CPD

- **Experiment name: SuperCDMS-CPD**

**Detector basics**

- Detector concept: Athermal phonon detector
- Sensor used: Single channel of 1031 QETs
- Operating temperature: $T_c$ = 41.5 mK, Bath Temperature = 8 mK
- Location (under/above ground): Above ground
- Veto systems/shielding: Minimal shielding, 5 cm thick copper box
- Calibration source: Collimated Fe-55 source + 38 um thick Al foil for Al fluorescence facing noninstrumented side of CPD

**Target**

- Target material: Silicon
- Target mass: 10.6 g
- Target dimensions: 45.6 $cm^2$ surface area by 1 mm thick
- Surroundings (e.g surrounding materials): Copper housing, calibration source
- Holdings scheme: six cirlex clamps in a copper housing

**Detector performance**

- Energy baseline resolution: 3.86 eV
- Analysis threshold: 16.2 eV (FPGA Trigger Threshold)
- Measured energy range: up to 240 eV in DM ROI

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable):
- Characterization: https://arxiv.org/abs/2009.14302
- DM Search: https://arxiv.org/abs/2007.14289

# 0VeV/HVeV

- **Experiment name: SuperCDMS HVeV**

**Detector basics**

- Detector concept: HVeV (NTL-gain phonon sensor)
- Sensor used: SuperCDMS QET in NF-C design from HVeV v2. TES-based phonon readout, using NTL effect at 100V to produce quantized charge readout.
- Operating temperature: 50-52mK; 10 mK
- Location (under/above ground): above ground
- Veto systems/shielding: no shielding, no veto
- Calibration source: laser, Fe-55

**Target**

- Target material: Si
- Target mass: 0.93 g
- Target dimensions: 10x10x4 mm^3
- Surroundings (e.g surrounding materials): SiO2 (fiberglass PCB), copper enclosure. Flex PCB (consisting of layered Kapton sheets), and small amounts of tin to produce superconducting traces on interface board. Run at the surface with minimal lead shielding.
- Holdings scheme: Mounted between PCBs (fiberglass) inside of a copper enclosure. Pressure is applied at the corners of the 1cm chip to hold it in place and thermalize through the PCB, force ~10-70 gram on each corner

**Detector performance**

- Energy baseline resolution: 2.7 eV
- Analysis threshold: 9.2 eV (0VeV)
- Measured energy range: 9.2 eV - 120 keV

- References to publications, arXiv pages, or theses where the described measurements are presented (if applicable): https://arxiv.org/abs/2012.12430, https://arxiv.org/abs/2005.14067, https://arxiv.org/abs/1804.10697