SuperCDMS:
New Payload Operation at Soudan Mine

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Experiment Overview

Deep underground site significantly reduces cosmogenic background

Detectors reside in the "icebox"

Cryogenic system cools detectors to ~50 mK, needed for phonon detection

Lead, poly and scintillator provide additional shielding
**CDMS Hardware Vocab**

- **Stripline** = flexible copper + kapton cables, carry detector signals out to room temp.

- **SQUET** = FET + SQUID

- **iZIP** = 1-inch Ge crystal, ~0.6 kg each, interleaved charge and phonon sensor design

- **Cold end** connects to SQUET card

- **Warm end** breaks out at the **EBox**

- **9.5 kg total**

- **15 detectors arranged in 5 towers**

- **Cold Electronics**

- **Side coaxial cable**

- **Ge Detector stack**

- **Tower assembly**

- **Tower** = 4 temperature stages (4K, 600 mK, 50 mK and 10 mK) heat sunk to different stages of the fridge via nested layers of the icebox
What has CDMS been up to recently?

Dec. '09: Final CDMS II dataset analyzed, 2 events seen, consistent w/ surface event bg

Spring '09 – Spring '11: Two separate “engineering” installations to test 1-inch thick detector designs: mZIP and iZIP

March '11: Fire in Soudan shaft prematurely ends Spring engineering run, CDMS survives sudden warmup from base temp (thankfully) without incident

Summer '11: iZIP design wins out, fabrication of full payload completed at the end of the summer, at least 10X better surface event rejection expected from SuperCDMS
Major Milestones Since Spring Shutdown

- **September:** Fabrication and testing of SuperCDMS payload completed
- **October:** Best-performing detectors selected and assembled into 5 towers (total ~10 kg Ge, 15 detectors)
- **October 25:** Safe delivery of detectors to Soudan after cross-country ground transport (driver condition not as good as the detectors upon arrival)
- **November 8:** Tower installation complete, icebox closed
- **November 29:** Hit base temperature (60 mK), confirmed at detector thermal stage, 3 days ahead of schedule (!)
Other Activities

• Ongoing repair and reinforcement to mine shaft restricts access more than usual
• Backup diesel generator for CDMS was a casualty of the fire, replaced with a new generator that can supply power to the whole experiment (48+ hrs) in the event of a blackout.
• Working out ongoing teething problems with new He and N liquefiers (used to recycle exhaust and reduce overall consumption of cryogens)
• Development of new automated data quality system
• Minor upgrades to data acquisition hardware - several computers replaced or decommissioned, digitization reconfiguration, trigger logic updates
SuperCDMS 5-Tower Installation

- Only detectors were replaced in current installation, other components, including cold hardware reused from CDMS II

- An opportunity to train new people (significant changes in personnel taking place this year)

- First CDMS installation to undergo thorough documentation in the form of videos and photos

Set a new record for fewest problems during an installation!

View overlooking icebox, Nov. 1 2011
Photo-log of SuperCDMS Installation
Delivery and Transport Underground

Tuesday October 25

Loading 2 Towers onto the cage

Polyethylene transport cases

High density foam pads

Underground (just outside CDMS RF room)
Unpacking

Nitrogen pressurized transport canisters

Tower 1
Tower 2
Tower 3
Tower 4
Tower 5

Dan unpacking Tower 1

Tuesday
October 25
Inserting Tower 3 into the Icebox

Thursday October 27
10 and 50 mK Thermal Connections In Place

Friday October 28
Rebuilding the IR Shielding

Tuesday November 1

600 mk shielding took 3 attempts and 3 days, but finally done on November 1 (!)

On to the 4 mK stage....
Cold Hardware Installation

**Tuesday – Thursday**  
**November 1-3**

*Aligning tool helps guide SQUET pins into place*

- Attaching SQUET to stripline
- Attaching SQUET to thermal staging

- 13 SQUET cards installed only  
  17 more to go…
Thermometry and Final Adjustments at the 4K Stage

Friday – Tuesday November 3-8

Copper tape over small cracks helps to block IR

4K thermometry is stubborn to install
Cabling and Continuity Checks

“Christmas Vacation”
Chevy Chase

Somewhat like this...

It’s a tight fit inside the Ebox...

but with more automation

and underneath it too!
Installation Complete!

Tuesday November 8
Closing the Icebox

Sealing the inner vacuum chamber

Sealing the outer vacuum chamber

Tuesday November 8
Pump Out and Cool Down

Remember to crack that valve SLOWLY!
Rebuilding the Shielding

November 16-17

Hanging muon veto (scintillator) panels
First Phonon Pulses from Physics Event!

Last Friday (Dec. 9)

Showing 7 of 8 phonon channels on a single iZIP (still tuning settings on 8th)

Continuity checked out ok on > 99% of channels
Minor Installation Snags

Very smooth installation when considering aging infrastructure and re-use of cold hardware

- Chassis short on tower thermometry, found and fixed

- Installation of cold hardware results in one broken stripline. Solved by last minute swap with thermometry stripline

Closeup of “surgical repair”

Some striplines have a very tight fit between SQUET cards

Closeup of “surgical repair”
Base Temperature

Smoothest cool-down in recent memory, no incidents

• Base temperature slightly higher than past operation (~60 mK compared to ~50 mK)

• All detectors expected to be operational

• Thought to be due to slight thermal touch between two temperature stages or poor thermal contact at the 50 mK stage
Next Steps

• Turn on remaining detectors
• Determine operating conditions (optimize for detector stability and noise)
• Data Quality system commissioning
• Repair He liquefier (one of two failed and returned to manufacturer for repair)

Search for WIMPs (!)
Backup
Where things stand

So far, no clear evidence for WIMPs, but much progress made in probing interesting theoretical regions

Spin-Independent scattering above 10 GeV/c² WIMP masses

Spin-Independent scattering below 10 GeV/c² WIMP masses
Make Sure the Thermal Contact Points are Clean!