

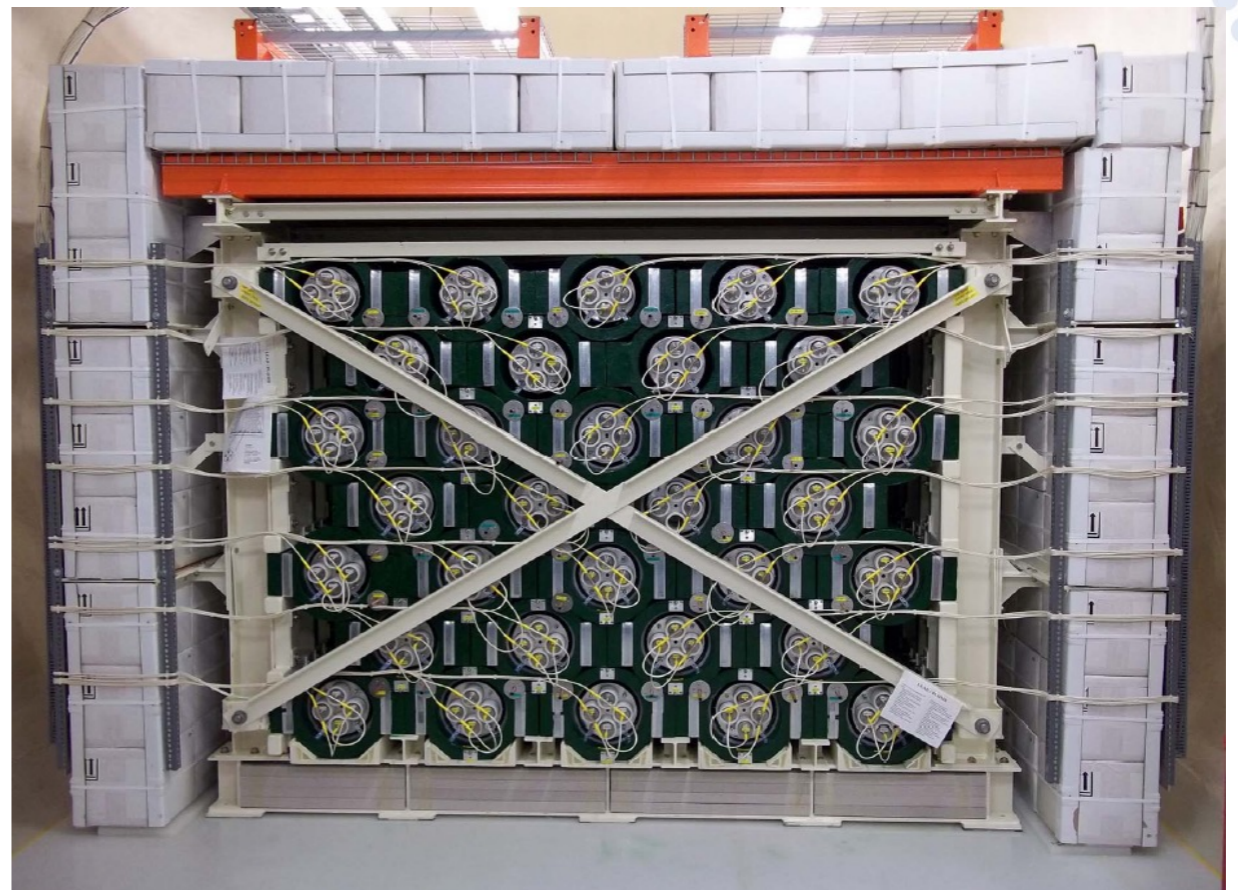
The Helium and Lead Observatory (HALO) is SNOLAB's longest continuously running experiment, currently in its 12th year of operation

HALO

Clarence Virtue

Spokesperson

Thursday, February 8th, 2024



Experiment Overview

The Helium and Lead Observatory (HALO) is a lead-based supernova neutrino detector employing 79 tonnes of lead and 128 ^3He neutron detectors from the third phase of SNO.

Neutrino detection is via neutron detection following one or two neutron emission from lead nuclei excited by NC or CC neutrino interactions. The CC electron is not detected.

Neutron thermalization and capture takes place with a characteristic time of $\sim 200 \mu\text{s}$ so timing information is slightly degraded and directional information is lost.

Several aspects make lead-based SN detectors compelling:

- Insensitivity to the anti- ν_e flux resulting in complimentary sensitivity water and liquid scintillator based detectors
- Robustness of the technology
- Low maintenance and operating cost

New science developments

Analysis

- Focus is currently on the spallation neutron multiplicity analysis
- Of interest to the NEMESIS Collaboration looking for exotic DM signatures in lead targets; muon spallation is a background...
- Are the background rates observed by HALO fully consistent with conventional muon spallation expectations
- HALO completed a run selection and presented 2054 days (445 tonne.years) of data in a poster session at TAUP 2023

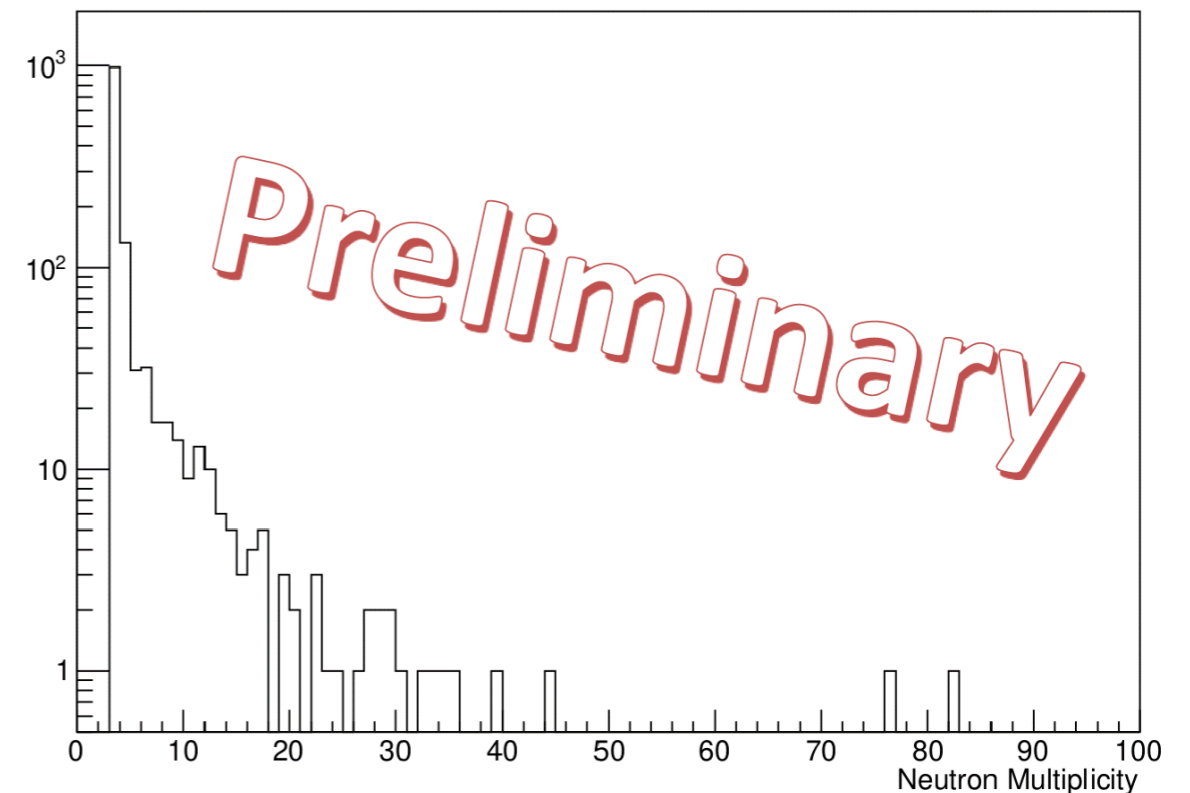


Figure 13: Preliminary neutron burst multiplicity spectrum from 5.6 years of HALO livetime. This dataset contains 192 bursts with 5 or more events.

New science developments

Current students (MSc)

- Esther Weima ([defended February 9th](#))
 - Alpha backgrounds in HALO-1kT prototype ^3He neutron detectors
- Remington Hill ([defended September 25th](#))
 - T_{zero} extraction for SNEWS 2.0 triangulation inputs for HALO-1kT, HALO, SNO+
- Ben Nichol (defending March 2024)
 - Isotope content and age of HALO " ^{252}Cf " neutron source
- Shayaan Sajid (URegina – Barbi & Kolev) ([defended August 29th](#))
 - Muon veto design for mini-HALO

Talks

- Tom Sonley, The HALO Experiment at SNOLAB, Workshop on Neutrino Interaction Measurements for Supernova Neutrino Detection, ORNL, March 6-10, 2023
- Clarence Virtue, Lead-based Supernova Neutrino Detectors, SNvD 2023@LNGS, LNGS, May 29 – June 1, 2023.
- Clarence Virtue, HALO Update, 2023 Canadian Astroparticle Physics Community Meeting, Kingston, Aug 8-10, 2023

New science developments - SNEWS

The SuperNova Early Warning System, SNEWS, is undergoing a complete upgrade, introducing new multi-messenger astronomy capabilities.

- HALO has been the first detector to connect to SNEWS 2.0 (while remaining connected to SNEWS “1.0”) and will be the first to sign an MOU with SNEWS 2.0
- The transition to SNEWS 2.0 is not far away; HALO continues with an over-sized role in its development as one SNEWS 2.0 co-spokesperson is a HALO member
- a HALO MSc student has been deeply involved in developing algorithms to extract time-zeroes from relatively low statistic bursts to be used in pointing triangulation to be performed within the SNEWS 2.0 machinery.

Experiment Status – 2023

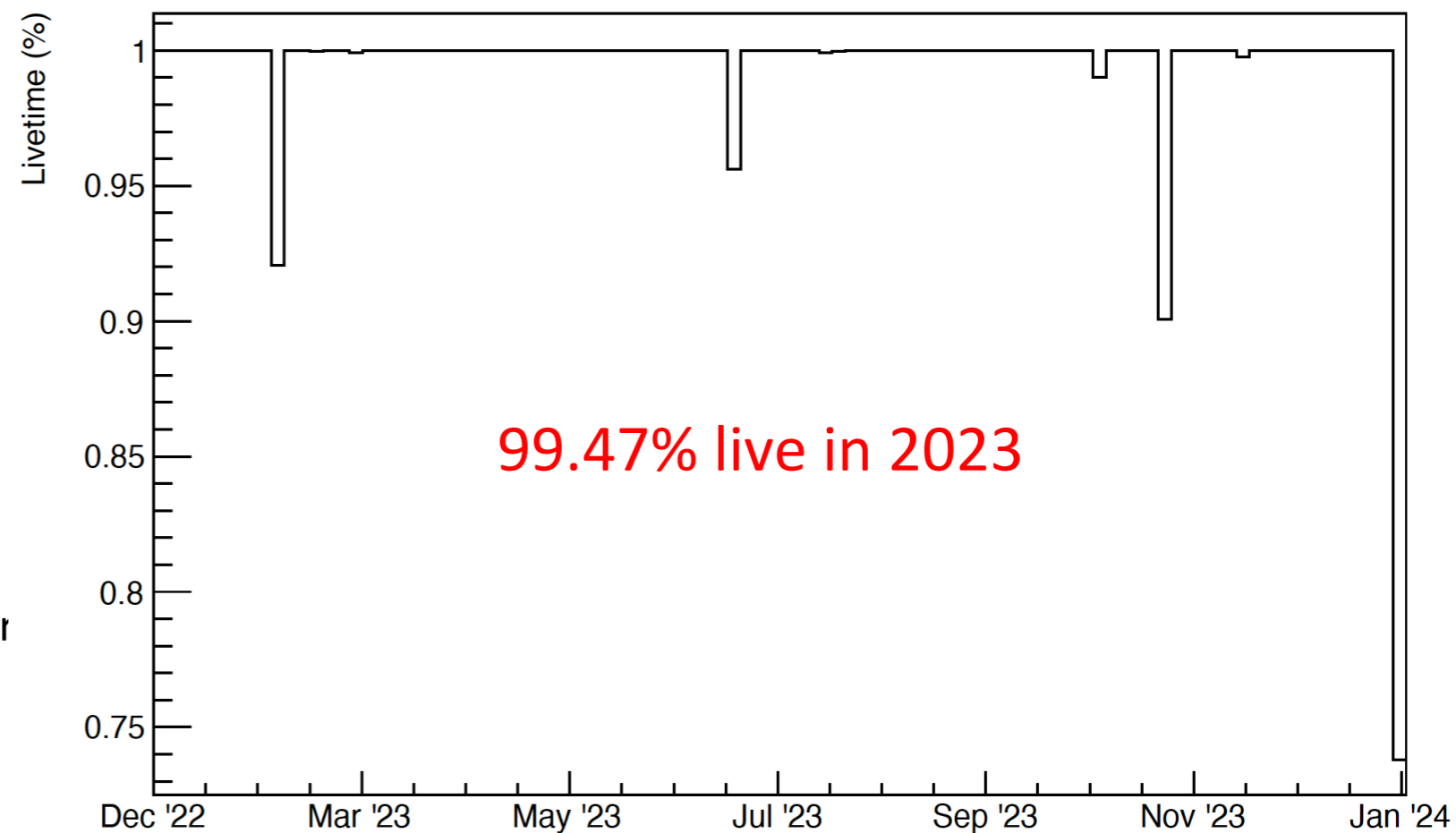
HALO continues to operate with impressive livetime with assistance from 15 HALO shifters.

In 2022 several DAQ hardware upgrades addressing a backlog of issues were completed.

No further hardware upgrades in reporting period but we have had available effort and are chasing minor software and monitoring improvements.

Core Local Group: Steve Sekula, Tom Sonley, Anita Masaskapoe, cjv

HALO Livetime



99.47% live in 2023

Experiencing some orca instability / Mac OS issues, and SNOLAB network issues

Experimental Status - 2023

HALO Remote Monitoring System

- MAIN
- HALO Dashboard
- Machines
- VME
- High Voltage
- Low Voltage
- UPS
- PDU
- GPS
- Hardware Map
- Pulser
- Bursts
- CouchDB
- Assets
- Development Site
- EXTERNAL LINKS
- Data Viewing
- Shift Schedule
- Shift Reports (Twiki)
- Monitoring Wishlist

Version 1.1.0

Current Run Progress — 08:51:12 Elapsed

Detector Overview

Info Status Log

Run 8158 is in progress on HALOdaq2...

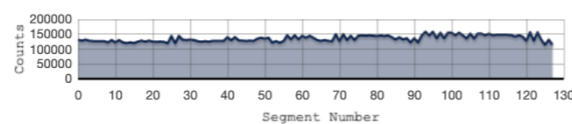
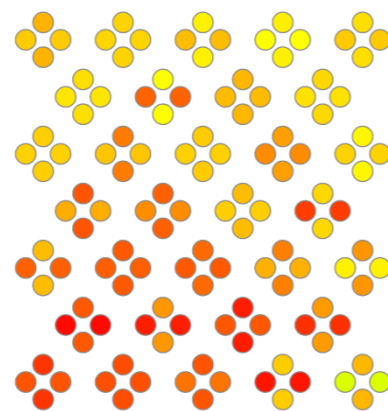
Last Updated: 3 seconds ago (2022-04-21 21:52:16 EDT)

Time Started: 2022-04-21 13:01:03 EDT
Time Remaining: 15:08:48

Run Type: Source in Storage; Pulser; SNEWS; Front Shielding; Supernova;

Total Counts: 17,336,144
Total Rates: 4.60

HALO Live View [Clear](#)



Segment Counts Threshold Gain

Hardware Overview

GREEN HALOdaq1

CPU: 1.20%
RAM: 30.20%
IP: 142.51.71.221

GREEN HALOdaq2

CPU: 11.70%
RAM: 47.00%
IP: 142.51.71.222

GREEN Halo Shift

CPU: 32.70%
RAM: 20.10%
IP: 10.0.3.1

GREEN Halo User

CPU: 45.10%
RAM: 11.50%
IP: 10.0.3.2

GREEN SBC 1

CPU: 25.10%
RAM: 7.89%
IP: 10.0.4.1

GREEN SBC 2

CPU: 25.60%
RAM: 6.14%
IP: 10.0.4.2

GREEN LV 1

IP: 10.0.5.1

GREEN LV 2

IP: 10.0.5.2

GREEN HV 1

IP: 10.0.6.1

GREEN HV 2

IP: 10.0.6.2

GREEN VME Crate 1

IP: 10.0.7.1

GREEN VME Crate 2

IP: 10.0.7.2

GREEN Pulser

IP: 10.0.8.0

GREEN UPS

IP: 10.0.9.0

GREEN Upper PDU 1

IP: 10.0.10.1

GREEN Upper PDU 2

IP: 10.0.10.2

GREEN Lower PDU 1

IP: 10.0.11.1

GREEN Lower PDU 2

IP: 10.0.11.2

GREEN Non-UPS PDU

IP: 142.51.71.224

GREEN GPS

IP: 142.51.71.9 (UG), 142.51.70.9 (AG)

Alarms

No active alarms.

ORCA / Sentry (Documentation)

DAQ 1

Sentry Status: **GREEN**

Last Updated: 0 minutes ago (2022-04-21 21:51:27 EDT)

Colour Status Alarms: None

[Click for Sentry Data](#)

DAQ 2

Sentry Status: **GREEN**

Last Updated: 0 minutes ago (2022-04-21 21:51:18 EDT)

Colour Status Alarms: None

[Click for Sentry Data](#)

High-Voltage

Crate 2 is ON

Last Polled: 0 minutes ago (2022-04-21 21:51:48 EDT)

IP: 10.0.6.2

Number of channels on: 32

Number of channels ramping: 0

Nominal Fan Speed: 3200 RPM

Crate 1 is ON

Last Polled: 0 minutes ago (2022-04-21 21:51:48 EDT)

IP: 10.0.6.1

Number of channels on: 32

Number of channels ramping: 0

Nominal Fan Speed: 3200 RPM

Challenges

I am relocating from Sudbury to Edmonton and taking a step back in day-to-day issues...

- Expertise rests with a small number of local individuals with much of the collaboration no longer having hands on, onsite experience in addressing the occasional issues that do arise.
- Significant effort went into “housekeeping”, documenting the hardware, software and configuration to be well positioned for ongoing operation
- About to ask the Collaboration to ratify some succession / transition plans where leadership responsibility will be shared with a co-spokesperson and a Detector Manager will be designated

The decommissioning of ~ 70 $^{10}\text{BF}_3$ neutron detectors, inherited by HALO along with HALO's lead from the decommissioning of a cosmic ray monitoring station in Deep River, was started as a project for the 2023 PMP. Momentum was lost but we are in a position to complete the project by the end of March 2024.

Questions?
