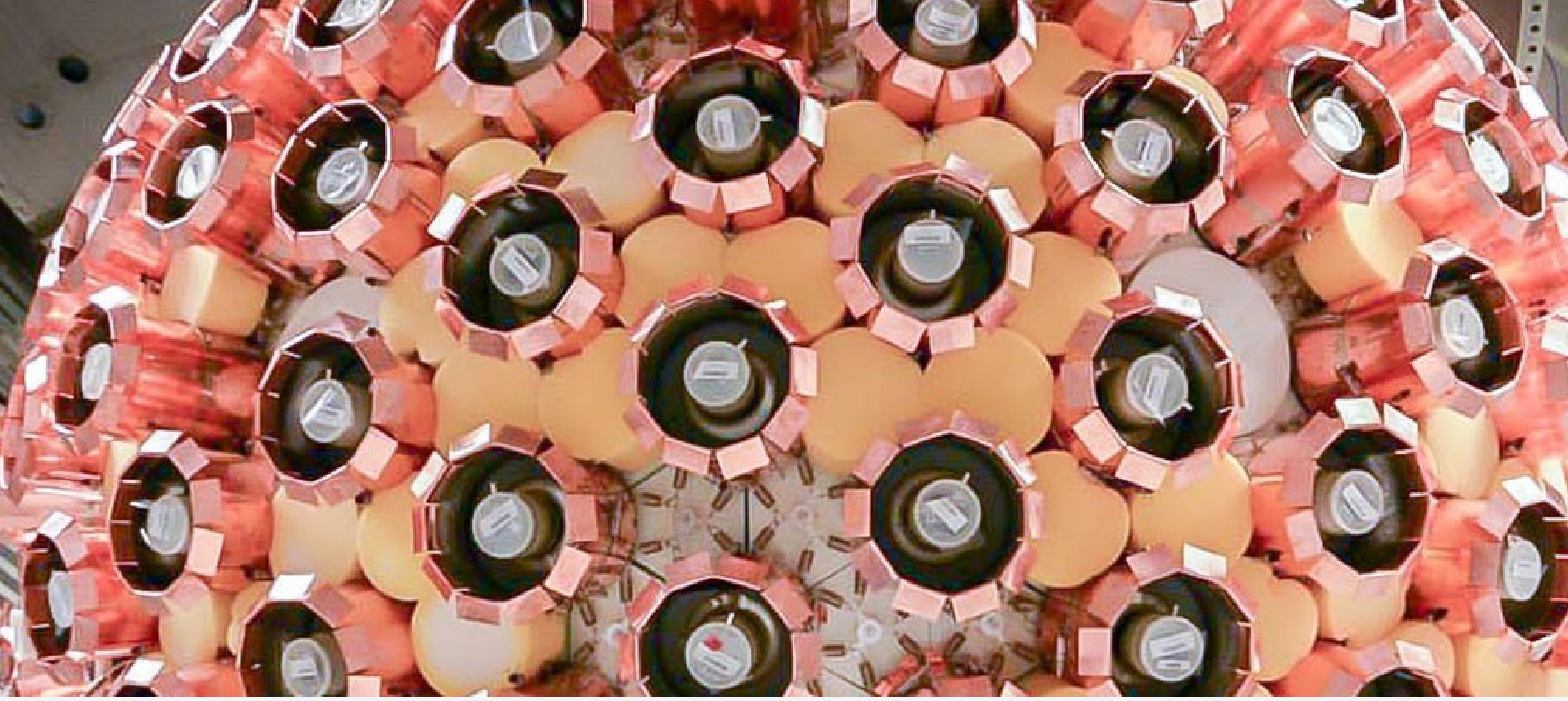

CUSTOMER CASE STUDY

SNOLAB: Hunting dark matter with a central data platform

SNOLAB - www.snolab.ca
Industry - Life sciences, education, infrastructure

Challenges

- Lack of visibility into operational data, which limited root-cause investigations of process upsets
- Multiple data lakes prevented efforts to identify maintenance needs, avoid equipment failure, and reconstruct events
- Highly sensitive experiments that require uninterrupted power and other controlled conditions

Solution

- Deployed AVEVA™ PI System™ to collate and structure data and AVEVA™ PI Vision™ to give operators and engineers better visibility into critical operations.

Results

- Reduced infrastructure costs by 66% and freed up more space in the facility
- Provided the tools to complete root cause investigations, ensuring experiments keep running and systems are designed as efficiently as possible
- Enabled scientists to monitor experiments autonomously and remotely

AVEVA

Two kilometers underground, in an active nickel mine in Canada's Sudbury Basin, scientists conduct groundbreaking experiments in astroparticle physics. SNOLAB is the deepest, cleanest lab in the world. Its depth provides a low-radiation environment ideal to study dark matter and neutrinos, where scientists explore our most pressing questions about the universe. The lab hosts over one thousand academic collaborators from over twenty-four countries. It's where Dr. Art McDonald proved neutrinos have mass, a discovery for which he won the Nobel Prize in physics.

Why does SNOLAB need to be two kilometers underground? "Imagine," Steven Back, Operations Manager at SNOLAB says, "You're sitting in an orchestra. There's violinists, there's flutes, there's trumpets. Now I ask you to listen for a pin drop—and you can't. There's so much noise around you that you can't hear the pin drop. So this is why we go two kilometers underground. The noise—the orchestra—is the millions of particles that are coming through us every single second from places like the sun, the universe, objects around us that emit radiation."

To eliminate that noise and maintain conditions necessary for scientific discovery, the SNOLAB team turned to AVEVA, a longtime partner of Vale, the mine that hosts SNOLAB. AVEVA solutions enabled the team to turn their millions of data points into insights about maintenance needs, equipment failure, and event reconstruction—and enabled world-renowned scientists to listen to the pin drop that is dark matter.

"AVEVA PI System allowed us to bring [the data] into a central database, structure it, eliminate the noise, make the data visible, and produce insights."

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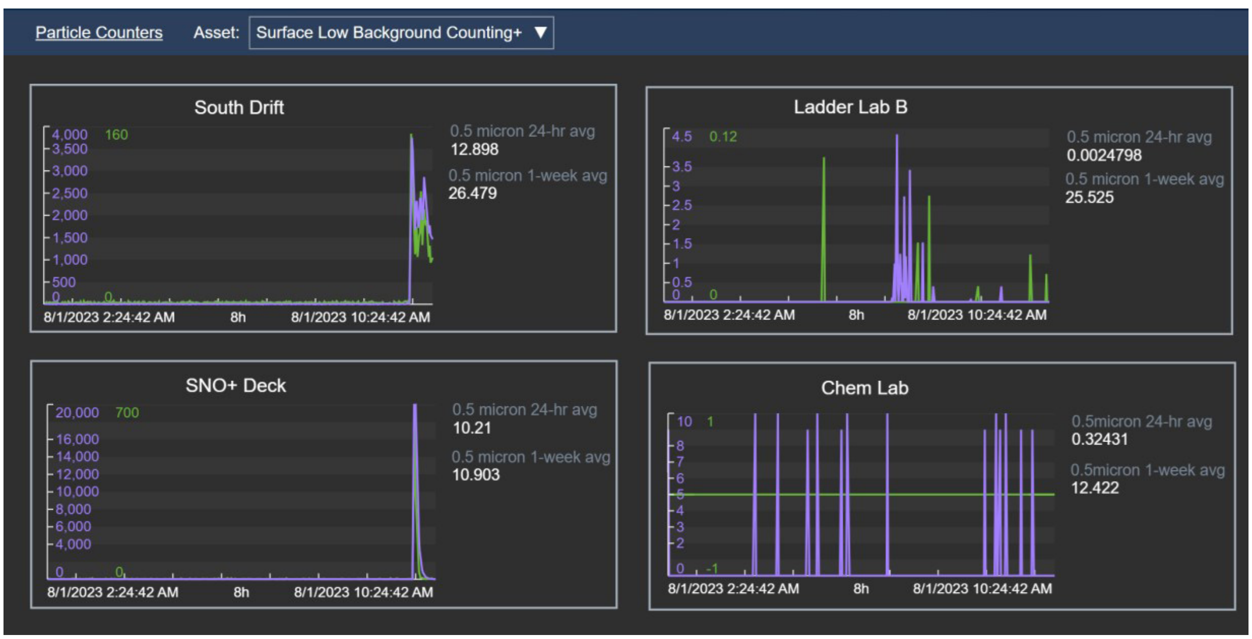
Steven Back

Operations Manager, SNOLAB



Screens show sensitive particle counters to ensure the underground lab remains experiment-ready

Eliminating the noise with a central data platform

SNOLAB had data lakes upon data lakes: a collection of programmable logic controllers (PLCs), distributed control systems (DCSs), and standard operating procedures (SOPs). Three megawatt generators provided backup power to the lab, each run on different PLCs. There were dozens of platforms, each collecting information. The SNOLAB team had no central way to collate and analyze data to complete root cause investigations. When something went wrong, they had to go to different DCSs and PLCs to try and reconstruct the event.

The lab deployed AVEVA PI System to collate and structure its data, and used AVEVA PI Vision to provide the visibility to reconstruct events and solve operational issues. This data platform helps the SNOLAB team keep the lab clean, powered, and running efficiently. The platform also enables over 1000 scientists at 164 institutions to create their own displays, alarms, analysis, and trends based on both experiment and operations data. Scientists can track different project logistics, monitor project schedules, and discover when something goes wrong what exactly happened—and they don't have to be physically in the lab to do so.

Tracking project details, reconstructing events, and keeping the lab clean

Having the data to reconstruct events—reliable, centralized, visible data—gives SNOLAB teams the ability to maintain control over the conditions of the lab and the viability of projects.

For example, scientists use a pharmaceutical-grade petrochemical distillation system for their SNO+ experiments to discover neutrinos. They brought 800 tons of mineral oil two kilometers underground, distilled it, stripped it, and put it inside the vessel of the SNO+ experiment. AVEVA PI System serves as a bridge between the vessel and the detector, giving scientists the ability to easily track details of the project and conduct root cause analysis when something goes wrong with the distillation system.

SNO+ experiment scientists can monitor these kinds of details even when they're not in the lab. Screens developed by the SNO+ team in Oxford, England allow them to monitor their own infrastructure that's happening two kilometers underground in Sudbury from the comfort of their home base. They can see exactly what's going on with equipment and processes without having to waste time traveling or sending someone out to investigate when an alert occurs.

This centralized platform also allows the operations team to monitor the conditions of the lab to ensure they remain optimal for the science being conducted. SNOLAB is an ISO 6 clean space, one of the highest levels of the cleanroom categories set by the International Organization for Standardization (ISO). Even the tiniest bit of dust is enough to impact experiments. It introduces too much radiation and makes them almost useless. Using AVEVA PI Vision displays and an array of sensitive particle counters allow SNOLAB to monitor and trend lab cleanliness. Screens alert the team if levels approach alarm limits so they can bring in the cleaners to stop dirt before it reaches the experiments.

Screens allow scientists to monitor the SNO+ experiment in Sudbury from their home in England

Data-driven design: Keeping the power on

As Steven Back says, "Power is the lifeblood of the lab." Power keeps all SNOLAB's critical infrastructure running—chillers, compressed air, HVAC systems—so that the experiments can keep running. Using AVEVA PI System, teams can see exactly when the power is interrupted. For instance, SNOLAB's Underground Ultra-Pure Water plant, which re-circulates ultra-pure water to the SNO+ experiment. If the power is interrupted, it triggers an alarm and a notification is sent to the on-call managers that this piece of critical infrastructure has gone down.

Much of the equipment scientists use at SNOLAB is on a local uninterruptible power supply (UPS), so when the power goes out, systems automatically switch over to battery power until the generators kick on. Historically, SNOLAB had to make an educated guess when it came to deciding how much backup power systems needed. Now, the team can reconstruct power outages to see exactly how much backup power was needed, which allows them to design appropriate bridging power.

When the lab's Helium and Lead Observatory (HALO), a supernova neutrino detector, switched to backup power, the team was able to reconstruct the event and see that the bridging power required was about seven minutes, as opposed to the 30 minutes they'd previously hypothesized. This information ultimately saved them 66% in UPS costs and saved valuable space in the lab. It also allowed operations to validate the system designs and collect trends to address future potential problems before they occur.

> "AVEVA PI System allows us to look at event reconstructions like this, and say: Okay, we're meeting seven minutes. If this becomes eight minutes, or nine minutes, it prompts us to look at the infrastructure and see what might happening that we might need to address before it impacts the experiments."
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> **Steven Back**
> Operations Manager, SNOLAB

Supernovas and dark matter: Don't hit that snooze button

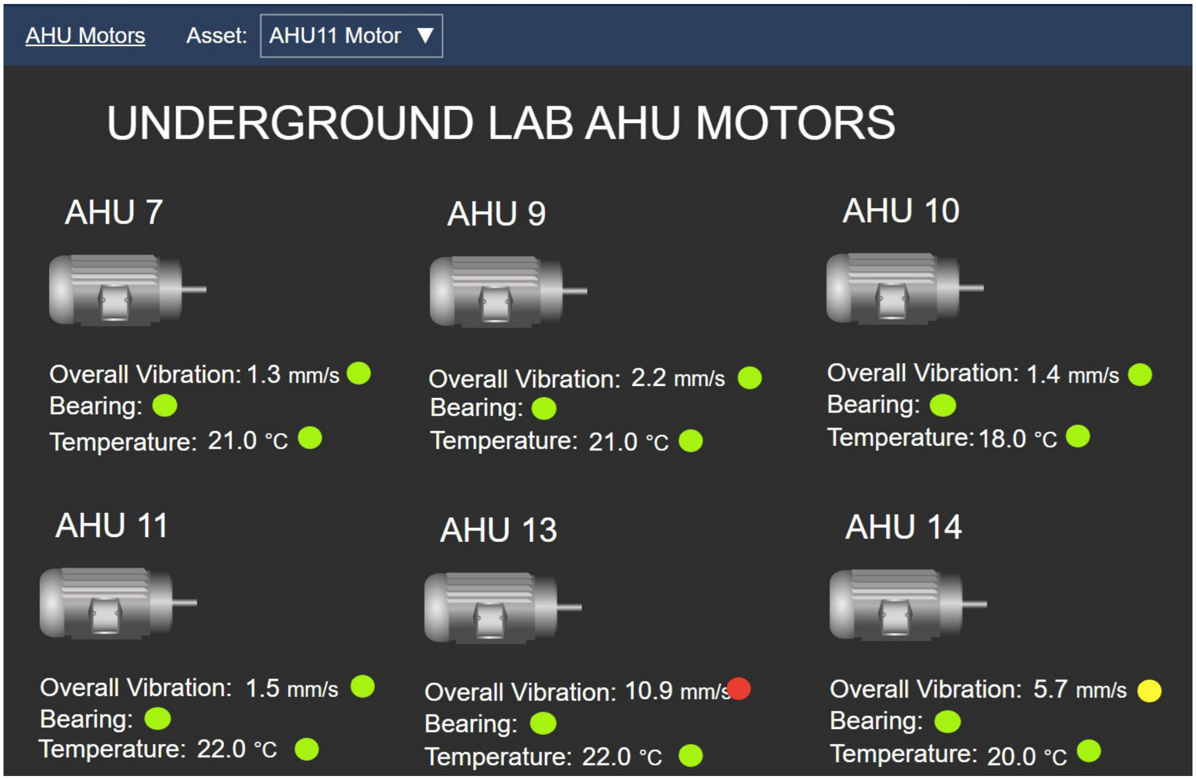
A supernova is predicted to occur every few decades, and the last one occurred in 1987—so scientists are on the lookout for the next one. When a star explodes, it sends out a wave of neutrinos, followed by visible light. International scientists have developed a system of highly sensitive neutrino detectors spread across the world called the SNEWS network.

When scientists detect this wave of neutrinos, they sound an alarm that directs the world's largest telescopes to that region of the sky. Scientists can then look at the visible light of this exploding star and gain insights around how the universe works.

HALO and SNO+ are part of this SNEWS network. In the scientific community, it's important to be at the forefront of these types of events. "You don't want to hit snooze on the alarm clock," as Steven Back says. "You want to be the first alarm that sounds." Experiment uptime is crucial for capturing the moment that wave of neutrinos is released. Uninterrupted power could mean the difference between being a major player in the next supernova event or missing the party altogether.

Another example of how important uninterrupted power is for SNOLAB is the SuperCDMS. Astronomers and astrophysicists predict that about 95% of all matter in the universe is dark matter that we haven't discovered yet. The SuperCDMS is an innovative dark matter detector. It operates at a fraction of a degree above absolute zero using liquid helium.

If there's an interruption in power, it takes time to get the detector back to that fraction of a degree above absolute zero. Every time there's a slight bump in power, several weeks of scientific data can be lost. And just like with the supernova detection, the Nobel Prize doesn't go to the scientist who discovered it second.



SNOLAB is beginning to incorporate predictive analytics into its equipment monitoring, using vibration monitors on its largest motors

Predictive analytics: Doing more with less

The next frontier for the lab is using advanced analytics to be able to spot deviations well in advance. Recently, SNOLAB deployed AVEVA Predictive Analytics to prompt maintenance long before an issue occurs using an array of vibration monitors across its largest motors. This allows maintenance teams to address the issue before it impacts the work at the lab. Long-term, the lab plans to use more predictive analytics to reduce unplanned downtime and maximize equipment reliability.

Using AVEVA PI System, SNOLAB has been able to provide visibility of reliable data to scientists, operations teams, and engineers. The data platform gives scientists the tools and autonomy they need to listen to the pin drop that is dark matter, to detect the next supernova's wave of neutrinos— ensuring SNOLAB is the location of choice for deep underground science.

Watch the full presentation

References:

Back, Steven. "SNOLAB: The world leading deep underground laboratory, leading with AVEVA PI System" - view the presentation