IMPROVING WORKER SAFETY AND ACCESS TIMING WITH AVALANCHE RADAR IN A COMPLEX SKI RESORT: CRANS-MONTANA-AMINONA, SWITZERLAND

Fabrice Meyer[1,2], Severin Stähly[3]*, and Susanne Wahlen[3]

1 Remontées mécaniques de Crans Montana Aminona (CMA) SA, Valais, Switzerland
2 Commune de Crans-Montana, Valais, Switzerland
3 Gravimon AG, Zurich, Switzerland

ABSTRACT: The Crans-Montana-Aminona (CMA) ski resort lies on the southern side of the Alpine main ridge in Valais, Switzerland, on predominantly south-facing terrain strongly influenced by solar radiation, while storms from the west and northwest can rapidly deposit large amounts of snow. The resort's three interconnected sectors are affected by recurring avalanche problems from early winter through spring, managed with hand charges, helicopter-deployed explosives, tramway charge-delivery systems, and fixed remote avalanche control installations (RACS). The eastern sector has no direct lift access from the valley and is reached only via a cat road from the central sector that passes beneath several avalanche-prone slopes; following heavy snowfall, patrollers have had to remain on-site overnight or delay access until control work in the central sector secured the route. To improve worker safety and operational efficiency, the resort deployed a Gravimon Doppler radar system in February 2026 to monitor the start zones above this access corridor.

Installed on an existing lift station, the radar covers more than a dozen start zones at distances of 1 to 2.5 km, operates continuously and independent of visibility, and automatically maps detected events to a user interface with synchronized camera imagery for visual verification and post-event review. Deployment occurred just before a two-week storm cycle that brought more than 270 cm of new snow at 2400 m elevation; over the 2025/26 season the system recorded 104 avalanches between February 10 and April 1. 26 of them released naturally and 78 triggered by control work, with event durations ranging from 13 to 166 seconds.

Operationally, the radar proved particularly valuable during nighttime tramway and RACS control work, when visibility is often limited: real-time confirmation of slope response gives patrollers greater confidence in determining when the access road can safely be opened, enabling earlier and more informed deployment of teams to the eastern sector. This case demonstrates how targeted radar monitoring can support safer operations and more efficient access management in complex ski resort terrain.

KEYWORDS: avalanche radar, Doppler detection, remote avalanche control, worker safety, ski resort access management

1. INTRODUCTION

The Crans-Montana-Aminona ski resort occupies sunny, south-facing terrain above the Rhône valley in Valais, Switzerland, at the southern edge of the Alpine main ridge. Because the terrain is predominantly south- to southeast-facing, solar radiation strongly influences snowpack evolution, while storms tracking in from the west and northwest can deposit large amounts of snow within short periods. The resort is organized into three interconnected sectors: a central sector around Crans-Montana and Cry d'Er, and an eastern sector at Aminona. All three are affected by recurring avalanche activity from early winter through spring. Hazard management relies on a combination of hand charges, helicopter-deployed explosives, tramway charge-delivery systems, and fixed remote avalanche control installations (RACS).

The consequences of underestimating avalanche activity on maintained resort terrain are well documented in the region. On 19 February 2019, an avalanche released onto a marked, regularly groomed slope at Crans-Montana at danger level 2, resulting in the death of a ski patroller who was on duty at the time (BBC News, 2019). The incident illustrates that avalanche risk to resort staff is not confined to extreme-danger days or to unmaintained backcountry terrain, and that patrollers and other on-slope workers carry a disproportionate share of residual avalanche exposure during and after control work.

The eastern sector at Aminona has no direct lift access from the valley floor and can only be reached via a cat road departing from the central sector. This access route runs beneath several avalanche-

* *Corresponding author address:*
Severin Stähly, Gravimon AG,
Technoparkstrasse 1, 8005 Zurich, Switzerland
tel: +41 77 222 55 25
email: severin.staehly@gravimon.com

prone slopes, most notably the Tubang start zones (2600–2800 m, south- to southeast-facing, prone to northwest wind loading) and the Mont Bonvin start zones (2600–2800 m, south- to southwest-facing), which also affect access to the tramway station near Petit Mont Bonvin and the Plaine-Morte piste. Large avalanches released from the Tubang start zones can travel through the Bovèreche valley, crossing ski runs between roughly 2200 and 1950 m, a communal road at 1700, and cantonal roads at 1500 and 1200 m a.s.l.. Following snowfall, eastern-sector patrollers have historically had to either remain on-site overnight or delay their crossing of this corridor until avalanche control work in the central sector confirmed the start zones had been sufficiently unloaded – a judgment that, prior to 2026, relied on RACS/tramway triggering records and visual inspection, both of limited use whenever cloud, darkness, or continuing snowfall prevent direct observation of the upper slopes (Figure 1).

This operational challenge played out against a broader pattern of avalanche activity across the Swiss Alps in the 2025/26 season. By the end of March, 244 people had been caught in 171 avalanches nationwide, compared with a ten-year average of 182 people in 127 events. Most of the season's fatal accidents involved avalanches triggered in weak layers of old snow that had formed after early-season snowfall was followed by a dry, sunny period in January (SLF, 2026). Conditions in Valais deteriorated sharply from 11 February 2026, when the WSL Institute for Snow and Avalanche Research SLF raised the danger rating to level 4 of 5 as an approaching storm was expected to deposit large amounts of fresh and wind-drifted snow over a weak old-snow layer (swissinfo.ch, 2026). To close the observation gap on the eastern-sector access corridor, the town of Crans-Montana and CMA deployed a Gravimon avalanche radar combined with a PTZ camera at an abandoned lift station (the "Granzettes" site) on 10 February 2026, monitoring the Tubang and Mont Bonvin start zones and more than a dozen further paths at distances of 1 to 2.5 km. This paper presents the deployment as a case study in radar-supported access management, describing the operational challenge, the detection results from the first season, and the resulting gains in worker safety and morning-opening efficiency.

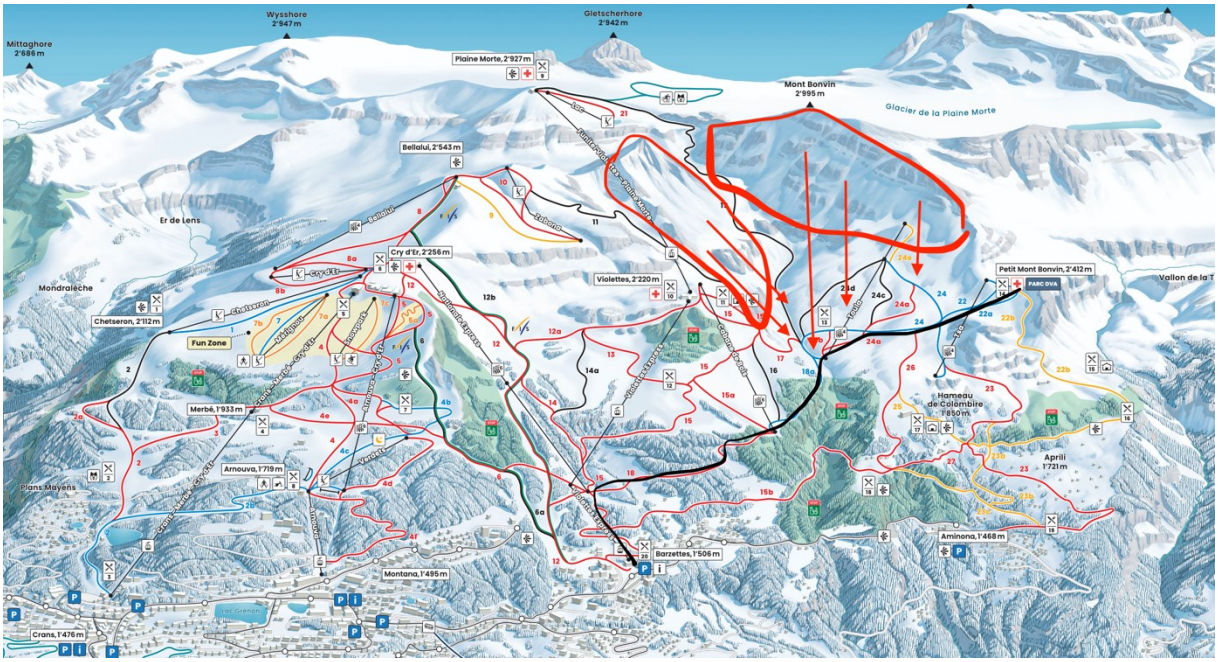

Figure 1: Ski resort of Crans-Montana-Aminona, showing the cat road beneath the Tubang and Mont Bonvin avalanche start zones (red circles). Below the cat road, there is a hiking trail and further down a cantonal road.

2. AVALANCHE RADAR DEPLOYMENT

The Gravimon system is an industrial-grade, all-weather Doppler radar purpose-built for avalanche detection. Installed on an existing lift station at the Granzettes site above Aminona, it covers more than a dozen start zones above the eastern-sector access corridor at distances of 1 to 2.5 km, operating continuously and independent of visibility. Detected events are automatically located and mapped, and each detection is synchronized with imagery from an integrated camera, allowing visual verification when conditions permit and supporting post-event review through the cross-platform GraviApp interface (Figure 2). The application also supports push notifications and can integrate readings from connected weather sensors.

Radar-based verification of remote-control-system triggering is an established application of this technology: similar long-range Doppler radars have previously been used to confirm avalanche release and RACS blasting performance at other Swiss resorts (Stähly et al., 2024). At CMA, the radar was installed just ahead of the season's most significant storm cycle. Over the following weeks CMA and Gravimon used the resulting trajectory data to refine the system's detection algorithm for the specific terrain of the Tubang and Grand-Bonvin paths.

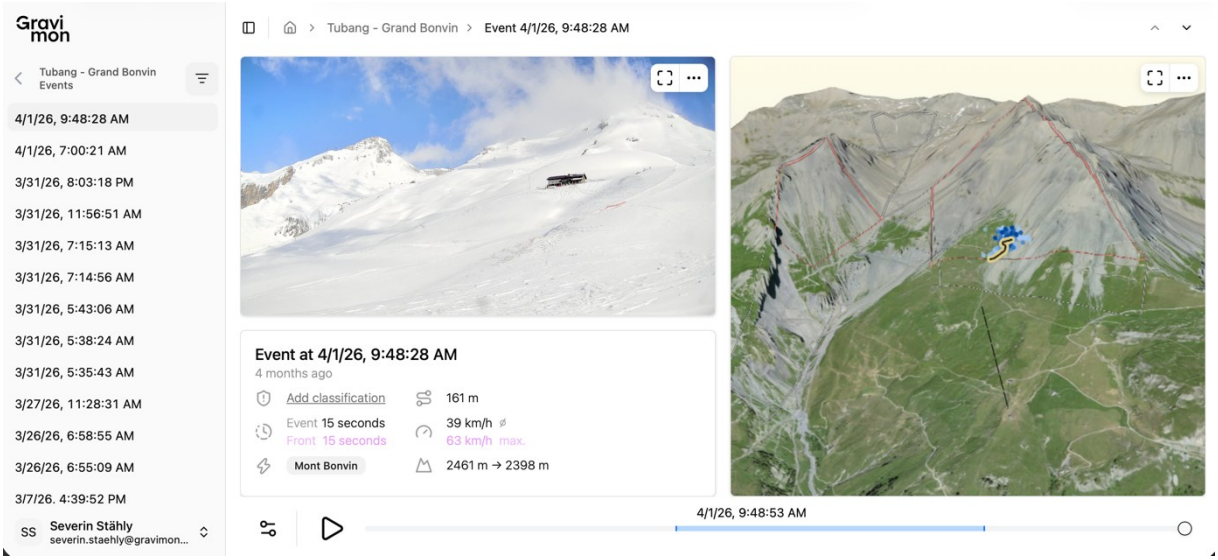

Figure 2: Avalanche visualization in the GraviApp: event list on the left. Event video, 3D visualized radar data and event characteristics are displayed for the selected event. Event video and 3D map are animated with the time slider at the bottom.

3. DETECTION RESULTS DURING THE 2025/26 SEASON

The radar was installed on 10 February 2026, just prior to a two-week storm cycle that deposited more than 270 cm of new snow at 2400 m and produced more than 70 avalanches on the monitored paths between 10 and 22 February alone. Over the full 2025/26 season, from installation through 1 April, the system automatically detected and recorded 104 avalanches (Figure 3). Of these, 26 were natural releases and 78 were triggered by control work: 32 by fixed RACS installations, 31 by tramway, 9 by hand charge, and 6 by helicopter. 58 detections occurred on the Tubang paths and 38 on the Grand-Bonvin/Mont Bonvin paths, with the remainder on the Toula and Barmaz paths. 25 detections included synchronized video as the other events occurred during nighttime or bad visibility. Signal durations ranged from 13 seconds, for a small dry-slab avalanche released by a hand charge, to 166 seconds, for a wet-slab avalanche released by the tramway on the Tubang path in early March.

Detection activity closely tracked the SLF's high danger rating and the storm timing: more than half of the season's avalanches were recorded in the ten days following installation, before activity decreased through March and early April as the snowpack stabilized (Figure 3).

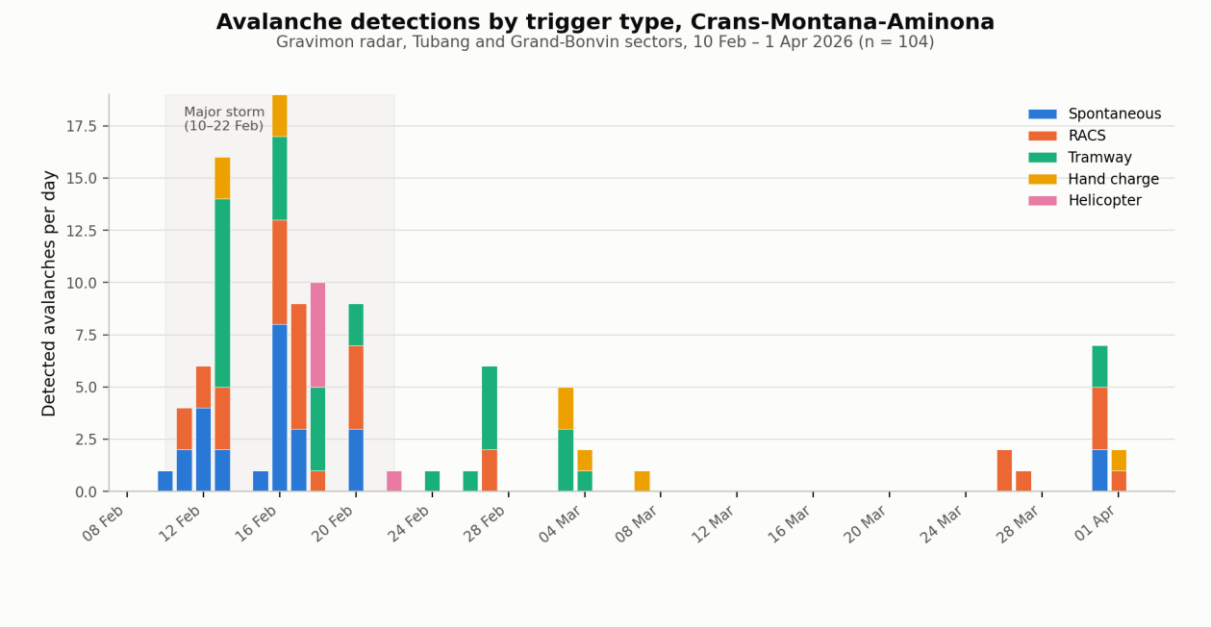

Figure 3: Avalanche detections by trigger type at Crans-Montana-Aminona, 10 February to 1 April 2026 (n = 104). Data: Gravimon radar detection log, Tubang and Grand-Bonvin sectors.

4. OPERATIONAL VALUE FOR NIGHTTIME CONTROL AND MORNING ACCESS

For CMA's patrol team, the radar's practical value has been most apparent during nighttime tramway and RACS control work, when visibility is frequently limited by darkness, blowing snow, or clouds. Prior to the radar's installation, patrollers could not always confirm from the base that a triggered charge had produced the expected release or that a hazardous start zone had, in fact, been purged – which, as described above, often meant staying at Aminona overnight or delaying the corridor's reopening pending a visual inspection. With continuous, weather-independent detection, patrollers can now cross-check control-work records against the radar's automatic event log and camera imagery in real time, providing considerably greater confidence in assessing slope response before deciding to open the access road.

This earlier, more confident decision-making has allowed teams to be deployed into the eastern sector sooner after storms, improving both worker safety and the efficiency of morning opening procedures. The season's data also point to a recurring pattern that CMA's patrol team had suspected but could not previously confirm: natural avalanches frequently release within hours of the onset of snowfall, often before scheduled control work begins, underscoring the value of continuous monitoring rather than periodic visual checks alone. Building on this first season of detections, CMA and Gravimon continued to refine the radar's trajectory algorithm over the course of the winter, and CMA anticipates that a longer detection record will support further reductions in road-closure duration as forecasting and control-timing decisions are increasingly informed by radar data – a direction consistent with recent work combining model predictions with radar detections for operational avalanche forecasting (Trachsel et al., 2024).

5. CONCLUSION

This case study demonstrates that continuous, all-weather Doppler radar monitoring can meaningfully improve both worker safety and operational efficiency in complex, multi-sector ski resort terrain, where access corridors pass beneath avalanche-prone slopes that conventional visual observation cannot reliably assess during storms, darkness, or low cloud. Deployed at Crans-Montana-Aminona just ahead of a major mid-February storm cycle, the Gravimon radar provided CMA's patrol team with continuous coverage of the Tubang and Mont Bonvin start zones above the eastern-sector access corridor, automatically detecting and recording 104 avalanches between 10 February and 1 April.

For CMA, the practical value of this capability was most apparent during nighttime control work, when tramway and RACS triggering is common but visual confirmation of slope response is rarely possible. Real-time, camera-synchronized detection gave patrollers a level of confidence in assessing start-zone status that had not previously been available, shortening the periods of uncertainty that, in past seasons, kept the eastern-sector access road closed longer than strictly necessary and required patrollers to remain on-site overnight.

The same radar coverage extends benefits beyond the patrol team responsible for the eastern-sector corridor. The Commune de Crans-Montana's road avalanche safety services, which manage the communal and cantonal roads in the Bovèreche valley below the Tubang start zones, gain earlier and better-substantiated warning of avalanche activity that could reach these roads, supporting their own closure and reopening decisions. CMA's lift operations near Petit Mont Bonvin and the Plaine-Morte piste – terrain directly adjacent to the Mont Bonvin start zones – likewise benefit from continuous monitoring of slopes that affect both patroller access and piste safety on skier-facing terrain immediately next to the site of the 2019 fatal on-piste avalanche. Based on this first season's results, CMA plans to continue and expand its use of the radar system as a standing part of eastern-sector avalanche management, with the expectation that a growing detection record will further reduce access delays in future winters.

ACKNOWLEDGEMENTS

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