

## AVYX® AVALANCHE RADAR



Automatic avalanche detection with radar technology in all-weather and at any time of the day. Real-time detection with alarm option for automatic traffic control.





## WHY RADAR?

AVYX® avalanche radar is a Doppler radar that makes use of the Doppler effect of a moving mass, such as snow or ice in an avalanche. It offers the following benefits:

- **Real-time detection** of avalanches at safe distance.
- **All-weather application** (snowfall, fog or rain) and day and night.
- Monitoring of **large areas** at a distance of up to **5 km**.
- Coverage of **multiple avalanche tracks** simultaneously.
- Opening angles of up to **90° horizontally and 20° vertically** (other opening angles on request).
- Dedicated **GEOPREVENT algorithms** for reliable detection of avalanche events of varying sizes independent of visibility conditions.
- **Differentiation** of single avalanche tracks.
- **Mapping** of avalanches on GRAVX data portal.
- Combination of radars for even larger coverage, redundancy or different functionality e.g. people detection.

Our statistics of more than 15,000 recorded avalanche events revealed that most avalanches occur in poor weather conditions with no visibility (storms). Radar functions even in these conditions and offers reliable technology for the area-wide detection of avalanches.

## AUTOMATIC AVALANCHE DETECTION

Automatic avalanche detection and notification is a valuable tool for avalanche experts, transportation operators, communities and ski resorts, offering an unprecedented level of opportunities:

- **Enhance avalanche situation assessment and forecast verification** through knowledge of avalanche activity for avalanche sizes 1–5, including avalanche characteristics (e.g., size, length, duration, frontal velocity).
- **Improve road and railroad management** and reduce closure times.
- **Verify avalanche control work** in any weather and at any time of day with simultaneous coverage of multiple avalanche tracks and remote avalanche control systems (RACS) with one single device.
- **Immediately alert areas at risk** at roads or railways with an alarm system and **automatically reopen** the transportway if the event does not reach the road or railway.
- **Integration with avalanche databases** or other third-party systems possible and automatic transmission of avalanche events and characteristics.
- **Avalanche statistics and trajectories** for avalanche consultants, planners and researchers.



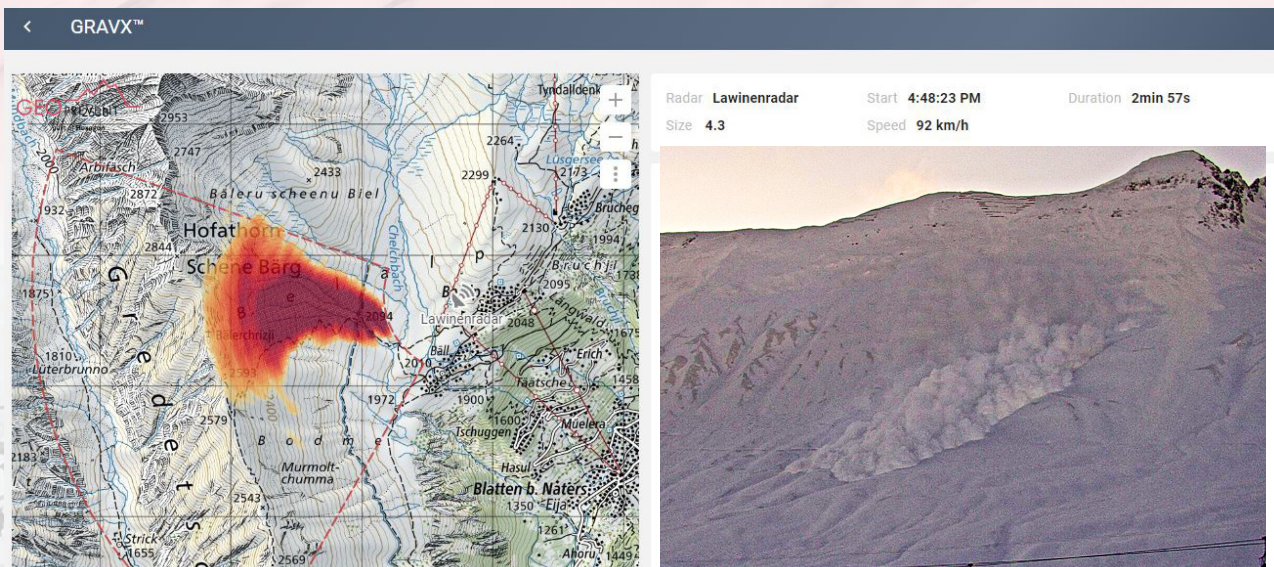
## MAXIMUM COVERAGE AND AVAILABILITY

The avalanche radar allows to monitor large areas and several avalanche tracks simultaneously.

- Opening angles: 90° horizontal, 20° vertical.
- Opening angles for very long-range: 30° horizontal, 30° vertical.
- Other opening angles on request.
- Maximum range (in operation): 5 km.
- Coverage of several avalanche tracks.
- Integrated, patented anti-snow system to keep the radar radome snow-free even under the harshest conditions.
- Differentiation of different avalanche tracks.
- Combination of radars for even larger coverage, redundancy and different application e.g. people detection.

## AVALANCHE MAP AND NOTIFICATIONS

Once the avalanche radar detects an avalanche event, it triggers the system-integrated camera to take a series of pictures or record a video of the event. The radar tracks the event until it comes to a stop or leaves the field of view. All event data is then transmitted to GRAVX data portal for online display. Avalanche parameters such as start time, duration, size and average front speed are also provided. SMS and email notifications allow for immediate awareness when an avalanche occurs, either at event start, event completion, or when predefined zones are reached. Let the radar do the work and notify you of what's happening.



## COMPREHENSIVE SOLUTIONS

Avalanche radar systems come as a complete system and include the radar hardware, cameras, communication devices and a self-sufficient power supply, if required. We tailor our systems to local requirements and design for long-term fully automated operation. For this, we use high-quality components that are suitable for harsh winter conditions and provide an energy-efficient solution.

### INTEGRATED CAMERAS

The AVYX system includes an integrated camera for event images and videos. We use remote-controlled cameras with pan-tilt-zoom functionality (PTZ) or high-resolution, very energy-efficient camera systems. Thermal imaging cameras or other models may also be added. Besides event images, the camera generates regular status images and if desired, closeups of predefined zones (e.g. avalanche release areas). The user can control PTZ cameras directly via the data portal and gain a live view of the situation on-site through smartphone, tablet or PC.

### POWER SUPPLY

As a power source, we use grid power or, if not available, a sophisticated combination of solar panels and a methanol fuel cell. The solar array is dimensioned based on solar simulations at the radar site and the station's power consumption. Solar power is used when available, whereas the fuel cell takes over during periods of poor weather or when the station is in the shadow. The fuel cell and methanol tanks are integrated in the electronics cabinet and the setup is designed for one service visit per year to replenish the tanks, usually in spring/summer.

### COMMUNICATION

All avalanche data and images are transmitted to the GEOPREVENT cloud for storage and display. In addition, the system sends status and health data for functionality monitoring and the GEOPREVENT operations team can access the system remotely to troubleshoot, if necessary. Data communication is possible through different channels, either through existing networks such as GSM, ethernet, or fiber, or we set up dedicated radio links with repeater stations or satellite communication.

### 24/7 MONITORING INCLUDED

We continuously monitor all our systems around the world to ensure they are functioning properly. Automated health checks verify critical system parameters and notify the GEOPREVENT team in case of irregularities. Our operations team can access all systems and verify settings, fine-tune radar, and perform upgrades.

## ADDITIONAL OPTIONS

The avalanche radar can be combined with various additional options. In the following, a number of such options are described. However, this list is not exclusive and we are always happy to discuss other requirements and solutions.

### AUTOMATIC ALERTING

The avalanche radar system can be upgraded to an alarm system that triggers automatic actions, such as the closure of a road or railway or the evacuation of a construction site. Common alerting devices are traffic signs, automated gates, or audio-visual sirens. We usually also implement automatic reopening in case the avalanche did not reach the road. By doing so, the closure times remain short and road users can continue their journey a few minutes after the alarm.

### PERYX PEOPLE RADAR

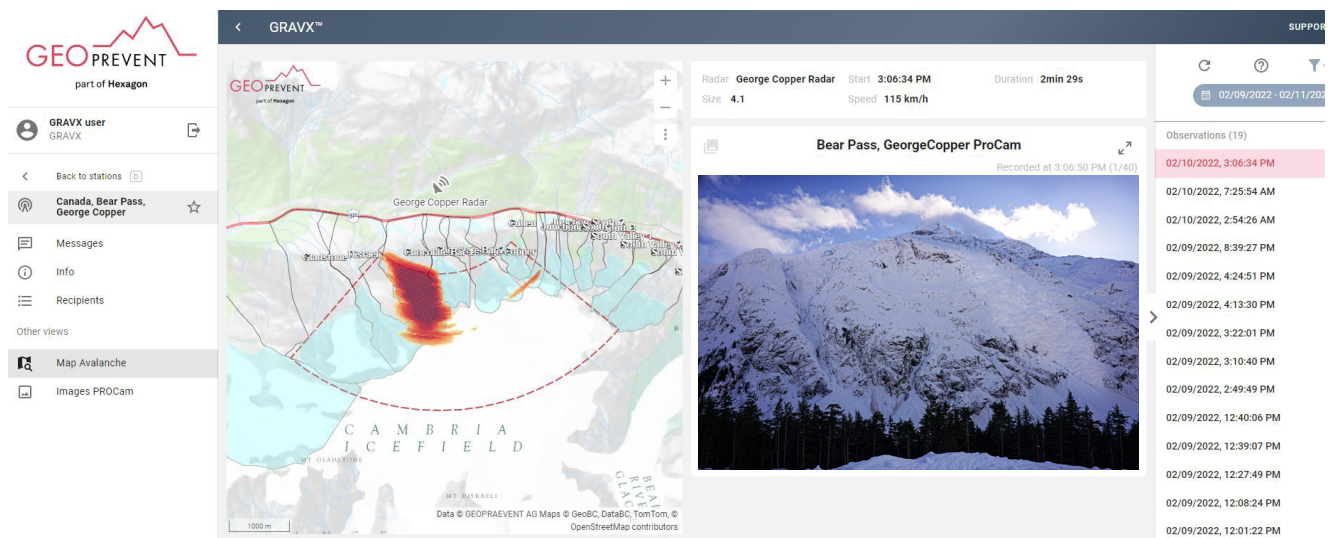
The people detection radar is a convenient add-on to the avalanche radar system, particularly if avalanche control work is carried out. This type of radar detects moving people, vehicles or other objects within a range of 1500 m and tracks them in real-time. The people detection radar also operates in all weather and at any time of the day.



# GRAVX® ONLINE DATA PORTAL

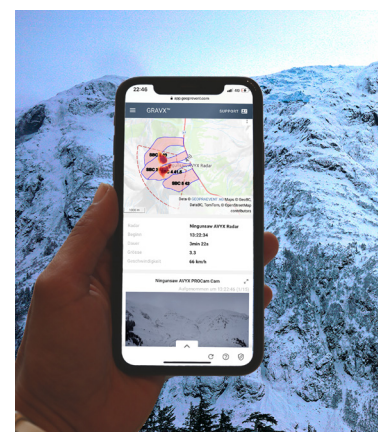
GRAVX online data portal connects, visualises and archives avalanche and status data and provides you with the relevant information conveniently via your preferred devices, i.e. smartphone, tablet or PC. GRAVX online data portal is based on state-of-the-art technology and offers secure storage of your measurement data with password-protected user access. The user only needs to log on to the browser-based portal, there is no need to install any software on any devices.

GRAVX allows for easy navigation and provides an overview of all system data. Avalanche events are displayed georeferenced on a map with an intensity heatmap or event trajectories. According event imagery and avalanche characteristics are shown in the same view. All lists can be filtered by time or image type. The image viewer function is a convenient tool to inspect and compare image details, such as avalanche release zones or crevasses. Other features include remote camera control or the alarm system control center for reopening transport ways.



## ANYTIME – ANYWHERE

GRAVX online data portal can be accessed anytime from anywhere, be it by smartphone, tablet or PC. Avalanche data is available already in the field. SMS and emails can be sent at event start, end or upon reaching certain areas. Different user levels allow the delimitation of certain functions, such as traffic light control. GRAVX also offers a message board to communicate with the project team and the GEOPREVENT staff.





# AVALANCHE AND PEOPLE TRACKS

The avalanche radar tracks the avalanche event and maps it accordingly on the data portal. Our algorithms allow to distinguish individual avalanche paths and to plot the event in the corresponding path. The images below show an avalanche event at a distance of 4,6 km from the radar location with the event image taken from there. The lower plot shows data of a people radar with the tracks of individual ski tourists. People radar systems are often equipped with thermal imaging cameras to verify people in the terrain in addition to the visual image.

The screenshot displays the GRAVX™ data portal interface, divided into two main sections. The top section shows an 'Avyx Radar' track for an avalanche event. It includes a map of the Saas-Grunde area with a red dashed line indicating the avalanche path. The radar data shows a start time of 3:03:41 PM, a duration of 3 min 9 s, and a speed of 50 km/h. A PTZ camera image shows the avalanche event recorded at 3:04:54 PM. The bottom section shows a 'Personenradar' track for ski tourists. It includes a map of the Belalp area with red and orange tracks. The radar data shows a length of 1824m, a speed of 5.3 km/h, and a start time of 7:19:15 AM. Two camera images are shown: a 'Belalp Thermal Cam' image recorded at 7:19:41 AM and a 'Belalp PTZ Cam' image recorded at 7:19:21 AM. A list of observations on the right side of the interface shows the selected event highlighted in pink.



## REFERENCE PROJECTS

### AADS BEAR PASS, CANADA

The automatic avalanche detection system (AADS) at Bear Pass consists of 3 self-sufficient stations; two avalanche radars cover 9 avalanche tracks at up to 4km in distance. The third station is a repeater station that ensures data communication from the radar stations via radio to the town of Stewart, 30km away. The avalanche data assists the ministry's avalanche program in forecasting and road management of Highway 37A.



### AADS NINGUNSAW, CANADA

Also in northern BC, the AADS Ningunsaw is located on Highway 37 and monitors 4 avalanche tracks simultaneously. The system is self-sufficient, powered by solar power and a fuel cell. Avalanche data and high-resolution images are transmitted via satellite communication. The system provides the Avalanche Programme with important data on avalanche activity and assists in planning their operations.



### ADN ROGERS PASS, CANADA

The avalanche detection network (ADN) at Rogers Pass includes 4 avalanche radars located at 3 sites and covers more than 15 avalanche tracks at up to 3.5 km. One station is located close to the pass summit, two self-sufficient stations are on the opposite side of the avalanche slope. One station is a dual radar system with two radars facing in different directions. The data is transmitted via mobile network.



### AVYX® ZERMATT, SWITZERLAND

The avalanche radar system in Zermatt was put into operation in 2015 and consists of 2 avalanche radars for complete coverage of the two notorious avalanche tracks at the village entrance. Radar detection of an avalanche triggers automatic closure of two road sections and notifies the Avalanche Commission. The experts check the condition of the road via webcams and can rapidly arrange clearing operations.



### AVYX® HOLMBUKTURA, NORWAY

The road along Holmbuktura fjord runs below a large avalanche slope and is the only access to the village. The road was frequently closed in the past and a tunnel would cost more than 40 million EUR. Since 2017, an avalanche radar system with traffic lights has been in place to protect the exposed road stretch. Two avalanche radars cover the whole slope at a distance of up to 3.6 km and 5 avalanche tracks.



### AVYX® AOSTA VALLEY, ITALY

Val Ferret is a steep valley with several glaciers located near Mont Blanc and popular with tourists. The settlement of Planpincieux and the road are exposed to snow and ice avalanches due to glacier break-offs. An avalanche radar monitors the glacier tongue and automatically closes the road in case of an event. If the avalanche does not reach the road, it is automatically reopened after 2 minutes.



## TECHNICAL DATA AVYX® AVALANCHE RADAR

<b>Range:</b>	600 m to 5 km
<b>Coverage:</b>	0,3 km <sup>2</sup> to 10 km <sup>2</sup>
<b>Frequency:</b>	10–10.6 GHz
<b>Bandwidth:</b>	10–50 MHz
<b>Antenna opening angle:</b>	15°–90°
<b>Weight (without mast):</b>	Approx. 50 kg
<b>Power consumption:</b>	Approx. 50 W
<b>Power supply:</b>	Grid power, solar panel, fuel cell
<b>Software:</b>	Avalanche-detection-algorithm, online data portal
<b>Integration:</b>	Online data portal, smartphone, tablet
<b>Alarm:</b>	Automatic alert option, other alarm-functions
<b>Installation:</b>	Quick, few hours

## ALARM AND MONITORING SYSTEMS FOR NATURAL HAZARDS

GEOPREVENT provides alarm and monitoring solutions for a wide range of natural hazards. We either monitor the hazard zone to measure precursors of an event or we detect the event itself and automatically trigger alarms.

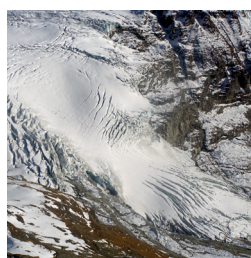
GEOPREVENT also provides technology to detect people in the hazard zone (e.g. prior to avalanche blastings).



ROCKFALL



FLOODS



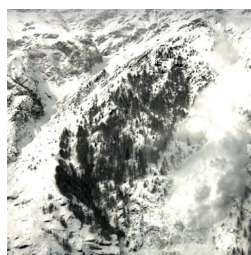
GLACIERS



LANDSLIDES



GLACIAL LAKES



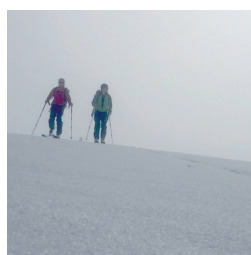
AVALANCHES



DEBRIS FLOWS



SAFETY NETS



PEOPLE

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