



## Avalanche measurements by the radar-based monitoring system Grimming-Multereck

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The steep north-eastern slope of Mt. Grimming (Upper Styria, Austria) is the location of a reoccurring large avalanche endangering the "Salzkammergut-" federal road below. Although part of the road has been secured by means of a tunnel there is still an unprotected bridge section at the southern end of the tunnel. To reduce the remaining risk an avalanche monitoring and warning system has been developed with a Pulsed-Doppler-radar as its central element.

The avalanche's starting zone lies in the vicinity of the Multereck peak at 2150 m asl. and reaches the valley base (700 m asl.) after a runlength of about 2.2 km. Large avalanches had occurred in the years 1924, 1948, 1988 and 1999. The event in 1988 led to the construction of the tunnel which, together with a quarry a short way above the road, eliminated the danger of wet-snow avalanches but powder avalanches represent still a residual risk. The requirement to reduce this risk further without the need of extended road closure led to the development and installation of an active avalanche detection and information system, based on the avalanche radar of the Institute of Broadband Communication (former Institute of Communication and Wave Propagation) of Graz University of Technology (TU-Graz, Austria). This radar application has been in use for avalanche measurements in the areas of research and road maintenance since 1989. The installation of the radar at the Multereck site was in 2004, with extensive testing and necessary adjustments in the following years. Since then several large avalanches - going down the whole slope till the quarry - together with a large number of small snow slabs in the upper part of the slope have been detected and the associated radar echo data recorded.

Because the radar measures range resolved velocity spectra it is able to give insight into the spatial and temporal evolution of the avalanche's velocity and dynamics making it also a valuable tool for avalanche researchers.

This contribution is the first presentation of the measurements at Grimming-Multereck. It summarizes the available data from the radar together with information about the weather- and snow-situation from some of the larger and more interesting events. Furthermore starting with the raw echo Doppler spectra it shows the derivation of different display formats (dependency on time and/or range) and presents some results. To compare these measurements with computer calculations an existing 3-D simulation (SAMOS and ELBA models) of a large powder-avalanche will also be presented. This simulation has been the base of the hazard-analysis.