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A multi path, weather independent avalanche monitoring tool using distributed acoustic fiber optic sensing

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Information on avalanche activity is a paramount parameter in avalanche forecasting. When avalanches are released spontaneously, the risk of avalanches is very high. Triggering avalanches by artificial means, such as explosives launched from helicopter or avalanche towers, can also give information on the stability of the snow pack. Hence, monitoring of avalanches released naturally or artificially, is an important quantity in avalanche forecasting. This information is also needed when deciding whether to close or not endangered ski runs, roads or railway lines. So far monitoring systems lack certain benefits. Either they monitor only large avalanches, can only be used for single avalanche tracks or are weather/sight dependant. Therefore a new tool for avalanche-monitoring, a distributed fiber optic system, is for the first time installed and adapted for the purpose of monitoring snow avalanche activity.

The method is based on an optical time domain reflectometer (OTDR) system, which dates back to the 1970‘s and detects seismic vibrations and acoustic signals on a fiber optic cable that can have a length of up to 30 km. An appropriate test slope for this configuration has been found in the ski area of “Lech am Arlberg”. In this work a detailed description of the theoretical background, the system implementation, the field installation, realization of tests and an investigation of the recorded data is presented. We conducted 100 tests and triggered 41 avalanches so far with a runout distances ranging from a few meters to approximately 250 meters, all of which were detected by the system, as well as the 59 not successful attempts of artificial triggering. Moreover we measured properly if critical infrastructure (in our case a ski run) was reached by the avalanches or not. The spatial distributed sensing approach allowed us to relate the amplitude and spectral content of the signals to avalanche size, avalanche speed and snow properties of the avalanches. In conclusion we summarize that distributed acoustic fiber optic sensing is a precise method to monitor avalanche activity, runout distances and avalanche properties.