UPDATING AND EXPANSION OF A FIELD STUDY TO OPTIMIZE THE SEARCH STRIP WIDTH OF AVALANCHE BEACONS

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ABSTRACT

The range of an avalanche beacon depends on certain technical characteristics of the device and the position of the transmitter (or victim) relative to the receiver (or rescuer). To correct the effects of different coupling positions, some beacon manufacturers require various moving activities during a search, such as turning, rotating, and swinging. However, the methodology is uncleardy defined by the manufacturer and makes it difficult for the search team to follow. Additionally, search strip widths are defined differently by different manufacturers of avalanche beacons and thus it is difficult for users to know which width to use. As a result, the devices are often used incorrectly.

The ranges of all commercially available multi-antenna beacons in different coupling positions were determined in an extensive field study. The different runs were executed without moving any of the beacons in order to avoid changes in the coupling positions. The search paths, given by the direction and distance indicators of the beacons, were recorded with a differential global position system in sub-decimetre resolution. The results define useful ranges of beacons, independent from personal management of these beacons. The results differ from the manufacturer manuals and suggest that further discussion is necessary for the determination of the search strip width.

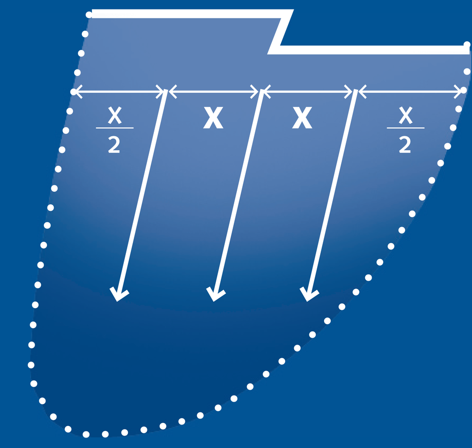
BACKGROUND

The worst case scenario is when the victim is completely buried and the rescuer has to start the search without receiving any signal from the victim's avalanche beacon. In order to search for the first signal as a single rescuer, the rescuer must cover the avalanche field with meandering shape tracks until the first signal is received. If there is more than one rescuer available, then a parallel search array is possible in order to save time. In both situations, the rescuer(s) must know the useful range of the avalanche beacon. Using a smaller search strip width increases the probability of detecting the victim, but requires more time to cross the avalanche terrain. A larger search strip width reduces the search time, but the rescuer risks not receiving a signal from the victim. Theoretically, the search strip width is two times the useful range of a beacon. The useful range depends on three conditions: signal properties, beacon characteristics, and the coupling position of the beacons. Assuming the theoretical case that the rescuer is holding his or her beacon correctly, three different coupling positions are possible.

METHODOLOGY

A square of 50 x 50 m was used for the field study. The square was divided into 5 m wide strips and a transceiver was positioned at the bottom left corner (coordinates x=0, y=0 at Fig. 3 to Fig. 5) in three different antenna orientations (coaxial, perpendicular and vertical). The rescuer, with a receiver, walked along the predefined 5 m strips directly followed by a second person with a Differential Global-Positioning-System (DGPS). This made it possible to record the accurate track (to the nearest 5 cm) of each search path. The rescuer started at a distance of at least 50 m from the transmitter, always using the same receiver orientation. Until the rescuer received the first signal, the 5 m strips were used as his or her path. After receiving the first signal, the path was determined according to the displayed signal on the beacon. The only change for the three different trials was the orientation of the transmitter.

Multiple rescuers



Single rescuer

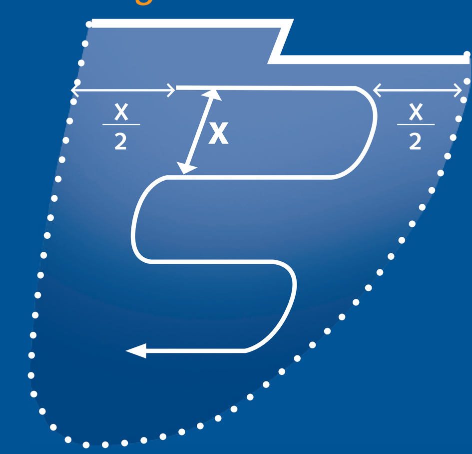


Fig 1. Scenarios with single rescuer (left) and multiple rescuers (right).
X → search strip width

Trajectories in good coupling position

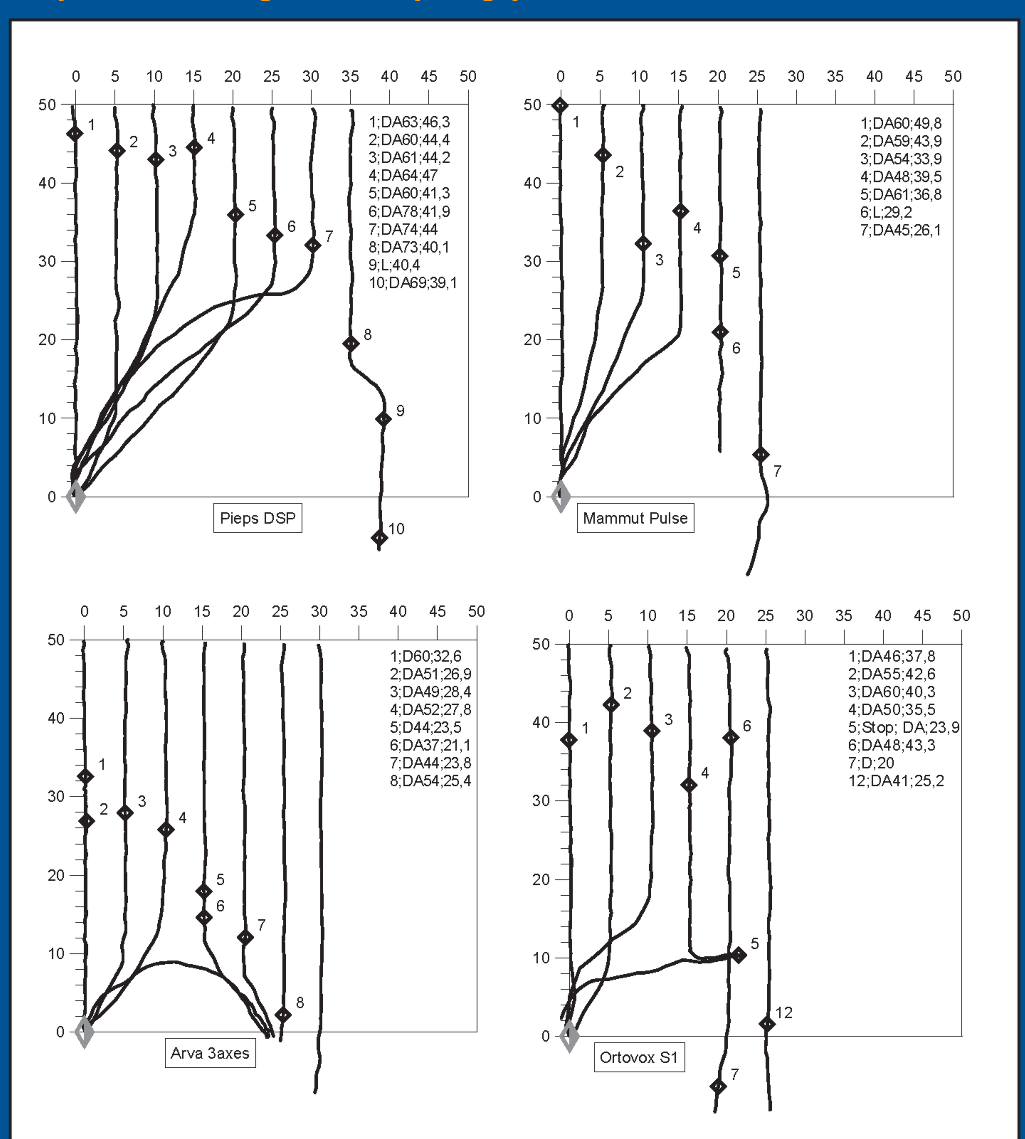


Fig 3. Trajectories of four different 3-antenna beacons in good coupling position. The numbered rhombi indicate the first signal and are discussed in the text. The useful range of the beacons, clock-wise from the top left are 30 m, 15 m, 20 m, and 15 m.

Trajectories in bad coupling position

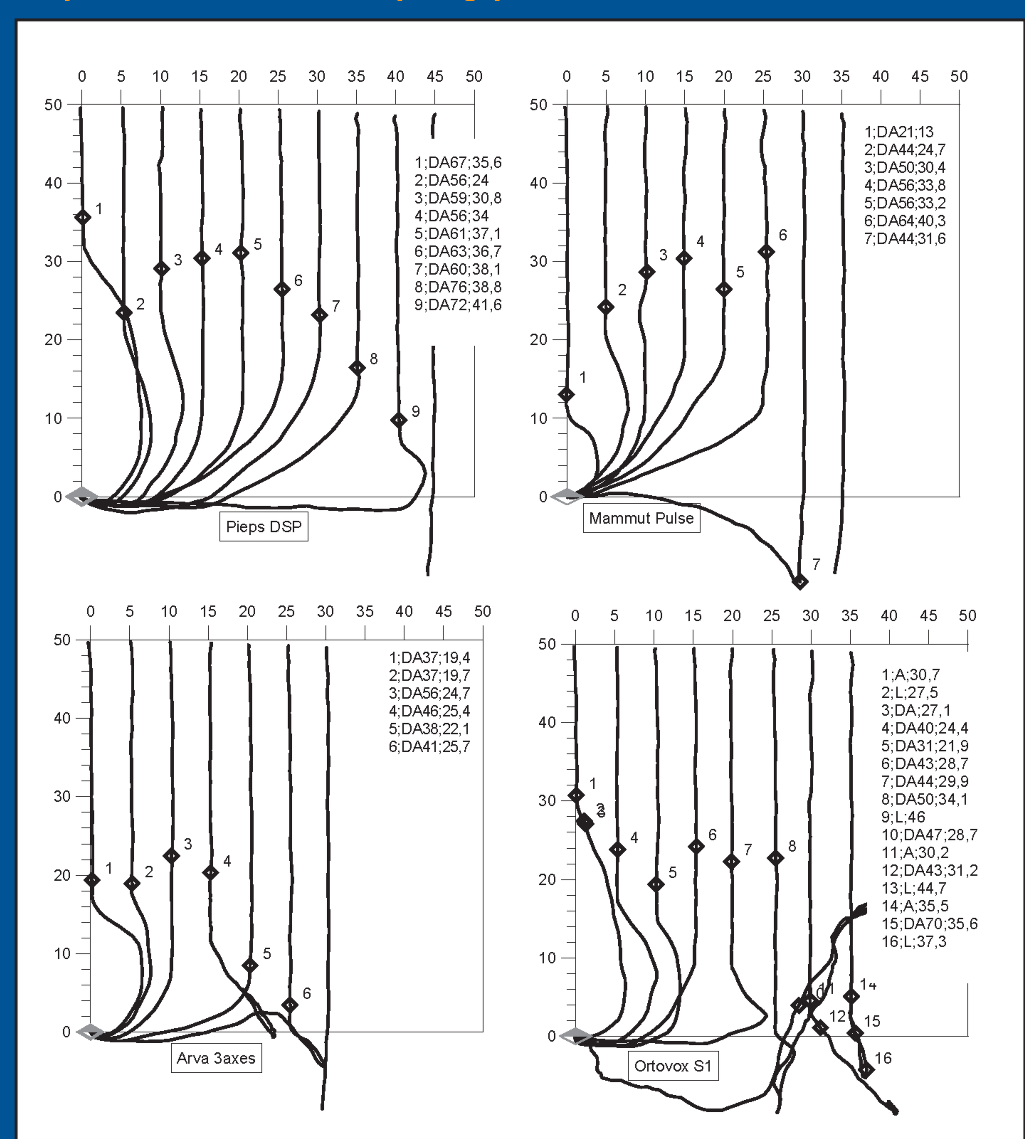


Fig 4. Trajectories of four different 3-antenna beacons in bad coupling position. The numbered rhombi indicate the first signal and are discussed in the text. The useful range of the beacons, clockwise from the top left are 40 m, 30 m, 25 m, and 25 m.

Trajectories with a vertical transmitter

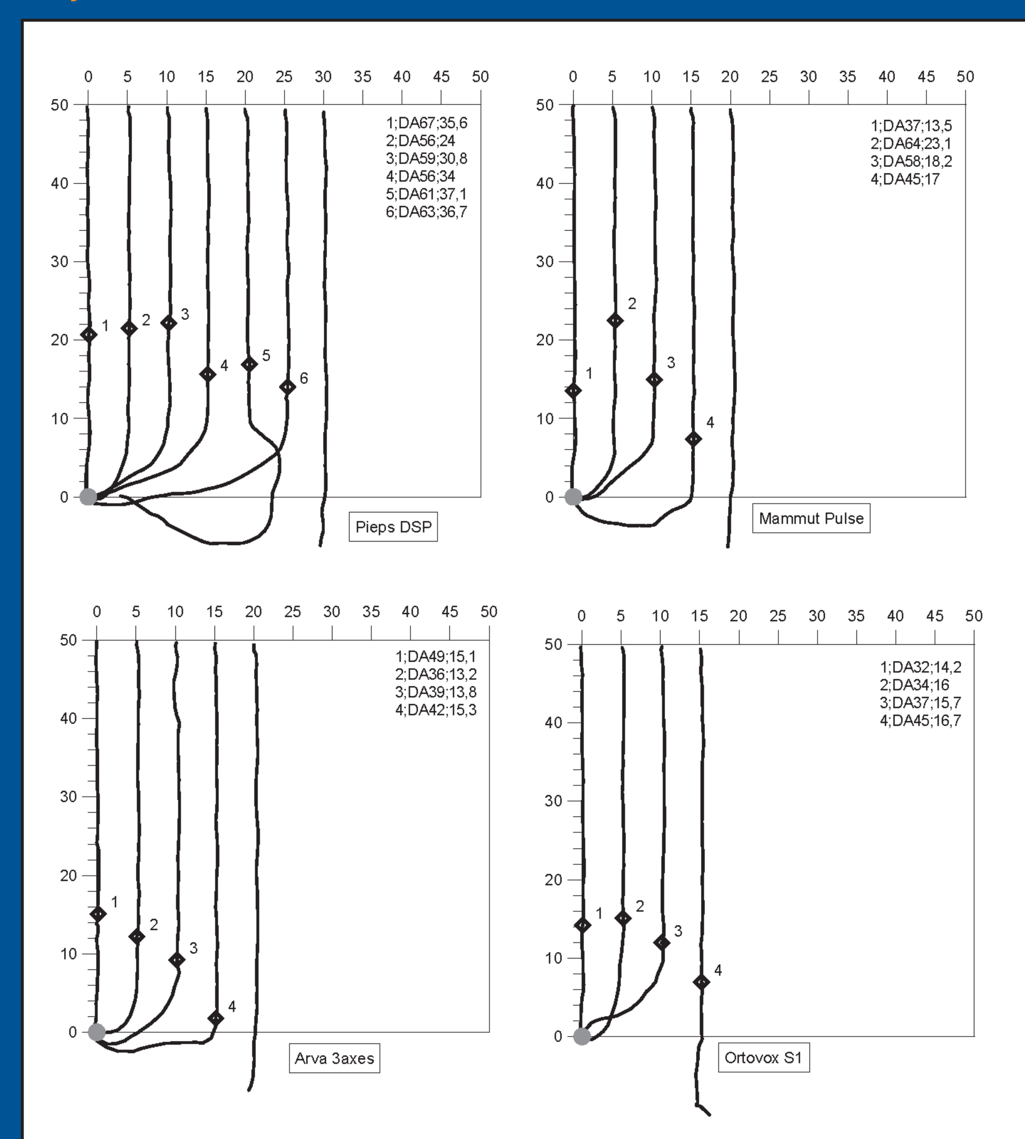


Fig 5. Trajectories of four different 3-antenna beacons with a vertical transmitter antenna. The numbered rhombi indicate the first signal and are discussed in the text. The useful range of the beacons, clockwise from the top left are 25 m, 15 m, 15 m, and 10 m.

RESULTS

	Pieps DSP	Mammut Pulse	Arva 3axes	Ortovox S1
gc	30	20	20	15
bc	40	30	25	25
vc	**25**	**15**	**15**	**10**
rs	50	50	40	50
es	**50**	**30**	**30**	**20**
r_{max}	*46.3*	*49.8*	*32.6*	*37.8*
w	*58.3*	*62.8*	*41*	*47.6*

Tab 1. Comparison of the useful ranges of the tested beacons in metres.

gc → good coupling position = parallel/coaxial
bc → bad coupling postion = perpendicular
vc → vertical coupling position = perpendicular in 3D
rs → recommended search strip width from manufacturer
es → search strip width derived from this study
r_{max} → maximum range from coaxial antenna configuration
w → search strip width using modified Meier´s equation $w = 1{,}26\ r_{max}$

The bold values are the minimal ranges in respect to each beacon and give the effective search strip width as the double of the DGPS-derived useful range.

INTERPRETATION & DISCUSSION

Different manufacturers are using different approaches to define the search strip width for their own products, thus making the recommended search strip widths incomparable. Therefore, it is important to establish how the three antennas work together within their internal processing system and to determine how the result is shown as a distance and azimuth display. In the presented field study, the search strip width is determined using data from all three-antenna positions for each individual beacon. A statistical approach is generally acceptable if the same values with the same sources are compared. But in our case, with three antenna beacons, the interaction of the three antenna positions is different. As a result, the previously calculated values from Meier's statistical approach were much higher than the values determined in the presented study.

SUMMARY & CONCLUSIONS

The presented study shows a method to determine the search strip width in based on the interaction of all three antennas and the range of a reliable azimuth and distance indication on the display. Only three-antenna beacons were considered. These results should provoke further discussion on how to determine the search strip width. Since the characteristics of several multi-antenna receivers are different, it is not acceptable to calculate a realistic search strip width based on a single equation. It is necessary to run field tests with different antenna configurations in order to determine the realistic search strip width.

REFERENCES

Eck, M., Schober, M. and Schreilechner, M., 2008. New definition of the useful range using a reliable, accurate, and reproducible test procedure with practical relevance – running a field test tracked by a DGPS. Proceedings ISSW 2008. International Snow Science Workshop, Whistler, BC, Canada.. **Genswein, M. and Schweizer, J.,** 2008. Numerical stimulation of the survival chance optimized search strip width. Genswein, Meilen, Schweiz and WSL Institute for Snow and Avalanche Reserach SLF, Davod, Switzerland. **Meier, F.,** 2001. Determining the Width of a Search Strip for Avalanche Beacons. Eglisau, Switzerland. **Schweizer, J.,** 2007. Determining the search strip width based on range measurements. SLF Davos, Switzerland. **Schweizer, J. & Krüsi, G.,** 2003. Testing the performance of avalanche transceivers. Cold Regions Science and Technology 37, 429-438. Semmel, C., 2007. Stellungnahme der DAV-Sicherheitsforschung zur Bestimmung der optimalen Suchstreifenbreite.