Transceiver performance when searching for multiple burials

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International Snow Science Workshop
ISSW 2012

WSL Institute for Snow and Avalanche Research SLF

Objective

Testing the performance of transceivers in multiple burial accident situations by the three main user groups “novice/average”, “advanced recreational“ and “professional” users…

… by ***measuring time*** for locating the first, second and third search target.

Multiple burial situations

- Not testing “Blue sky”- situation, but challenging set-up.
- Multiple burial situations are not rare:
  - 18% of accidents with more than 1 completely buried person (1999-2000 to 2008-09)
  - The probabilities for two or more, three or more and four buried subjects are about 35%, 17% and 5%, respectively.

Test characteristics

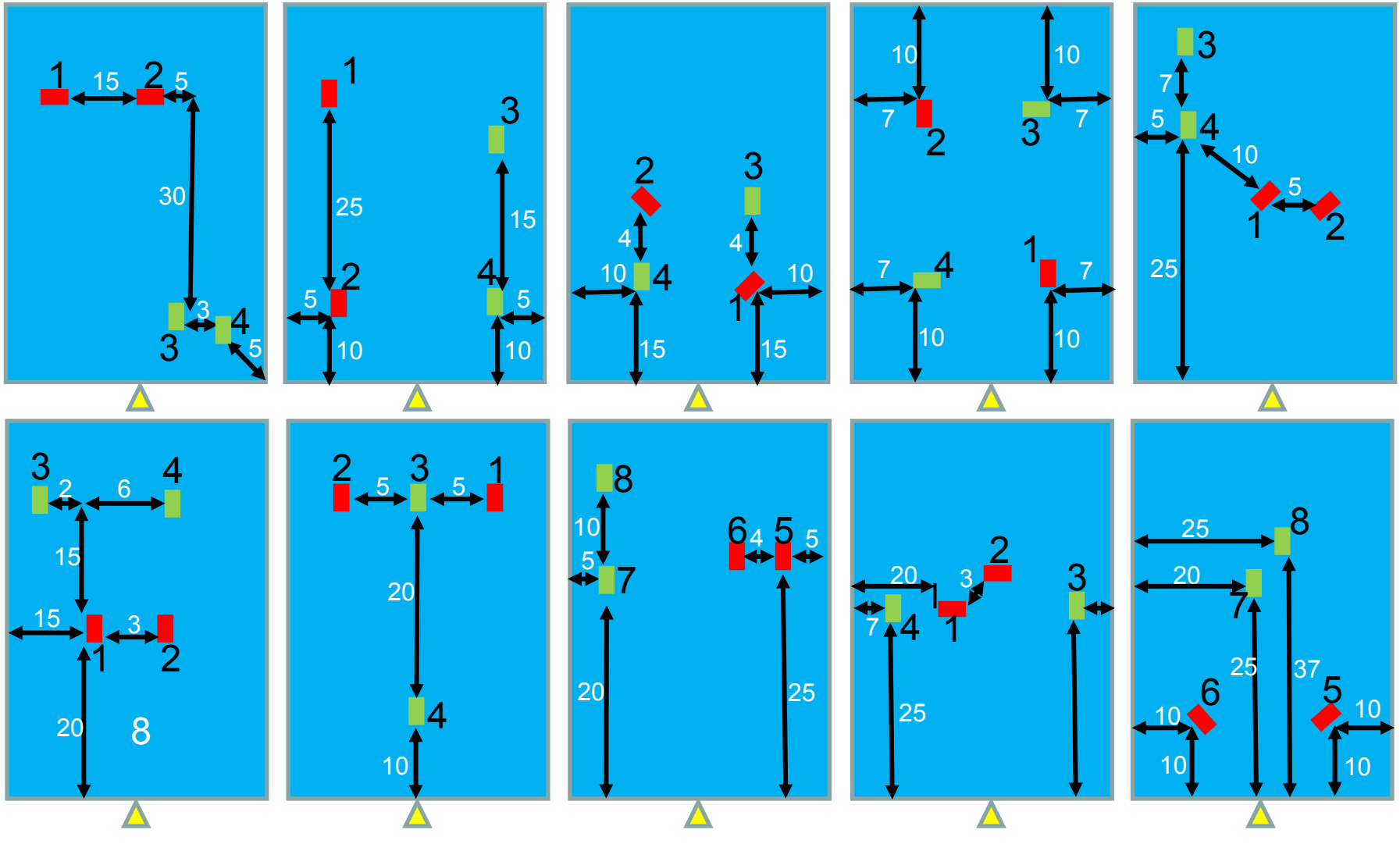
Location	Davos Sertig SUI	Col du Lautaret FRA
Date	12-13 Jan 2012	12-16 May 2012
User groups	Novice/average	Advanced recreational and professional
Number of test participants	20 (on 1 full day)	10 per day (on 3 full days), in total: 30
Training	2 hrs (20 min per brand of beacon by representative of manufacturer)	3 hrs (45 min per brand by mountain rescue instructors with specific training)
Brands and models of beacons tested	ARVA Axis Mammut Element Barryvox Ortovox 3+ Pieps DSP Tour Tracker 2	ARVA Link Mammut Pulse Barryvox Ortovox S1+ Pieps DSP

FR: 4 Training Modules, 45min each

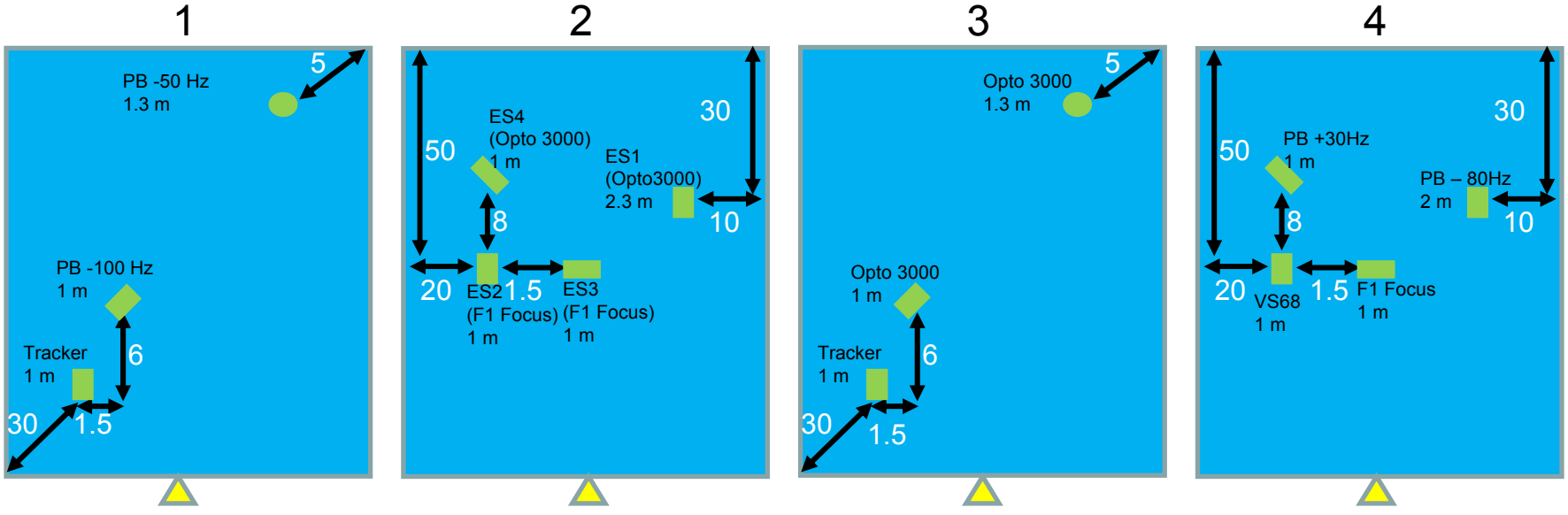
Test characteristics

Location	Davos Sertig SUI	Col du Lautaret FRA
Size of square test fields	40-50 m	100 m
Number of test fields	10	4
Burial depth	1 m	1 m, occasionally 2 m
Number of search targets per field	3	3, occasionally 4
Search targets	remotely controlled transmitter at exactly 457 kHz simulating a modern beacon with a short lasting transmit time	remotely controlled transmitters and standard transceivers with different transmit times and frequency deviations

Search scenarios (Davos)



Search scenarios (Col du Lautaret)



Search times (Davos)

	ARVA Axis	Element Barryvox	Ortovox 3+	Pieps DSP Tour	Tracker 2
First target (min:sec)	2:00	1:45	2:00	2:00	1:30
Second target (min:sec)	5:45	3:45	4:30	6:00	4:00
Third target (min:sec)	10:00	6:00	6:15	10:00	7:00
# of cases where the First, second or third target was not found within the time limit.	0 / 5 / 18	0 / 0 / 1	0 / 1 / 12	0 / 5 / 23	2 / 2 / 1

* median values, rounded to quarter minutes.

Search times (Col du Lautaret)

	ARVA Link	Pulse Barryvox	Ortovox S1+	Pieps DSP
First target (min:sec)	3:15	3:00	3:30	3:00
Second target (min:sec)	5:30	5:15	6:15	5:15
Third target (min:sec)	10:30	8:45	9:45	9:30
Fourth target (min:sec)	14:00	12:15	15:30	17:30
# of cases where the first, second or third target was not found within the time limit.	0 / 0 / 1 / 2	0 / 0 / 1 / 0	0 / 1 / 2 / 0	0 / 0 / 3 / 1

* median values, rounded to quarter minutes.

Summary of test results

Test at Davos:

- Novices easily located first target in ~2 minutes.
- With 4 out 5 brands of beacons novices were unable to locate the third target in about 1/3 of the cases.

Test on Col du Lautaret:

- Experienced and professional users in most cases found third or fourth target.
- Successfully applied backup search strategies to overcome deficiencies of devices, e.g. not reliably working marking functions.

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Discussion

Why were the second and third search targets often not found?

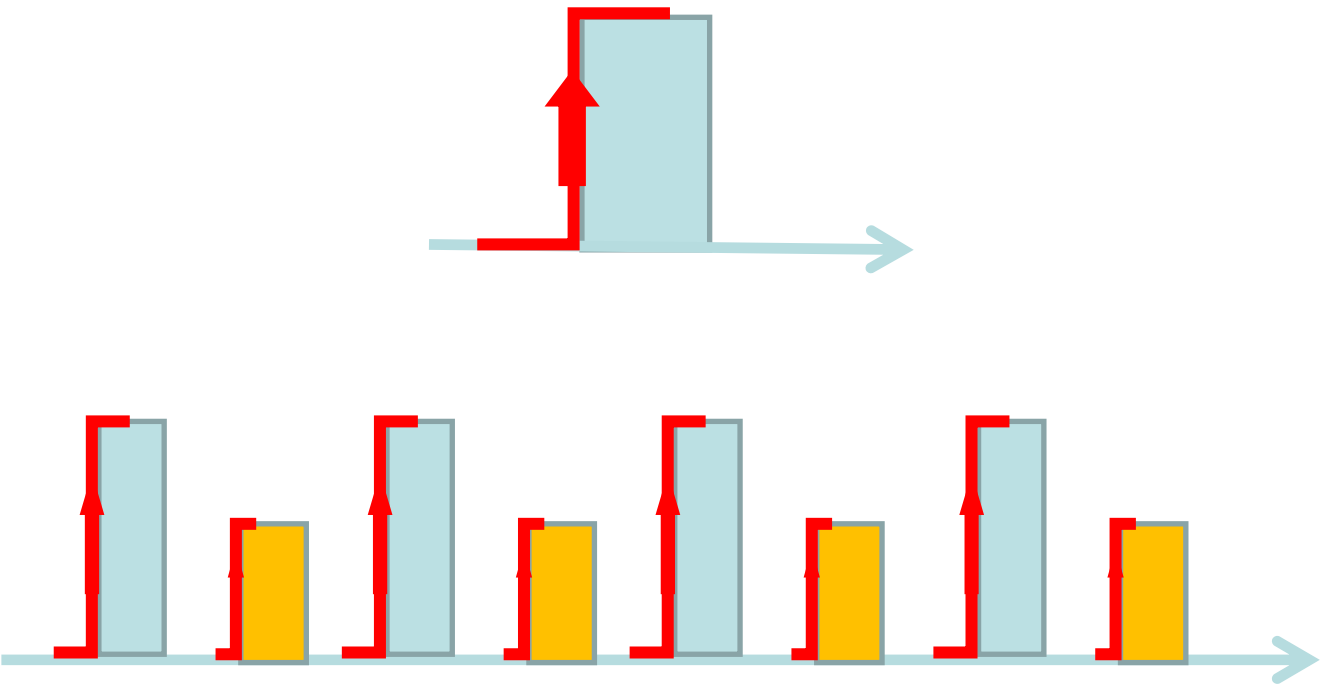
→ Problems with signal separation

Signal separation criteria

- Difference in start position on the time axis
- Differences in transmit frequency
- Differences in signal strength
- Relative phase

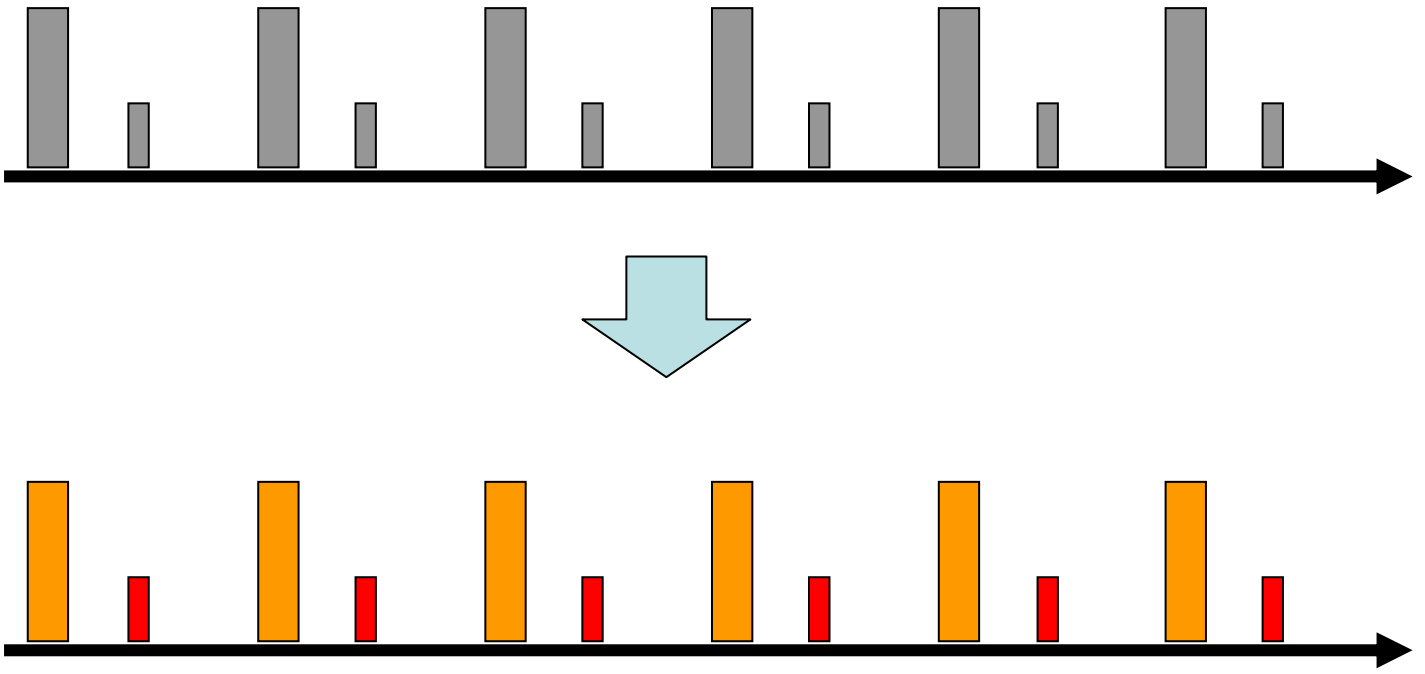
- Additional search information

Positive edge detection and pattern recognition



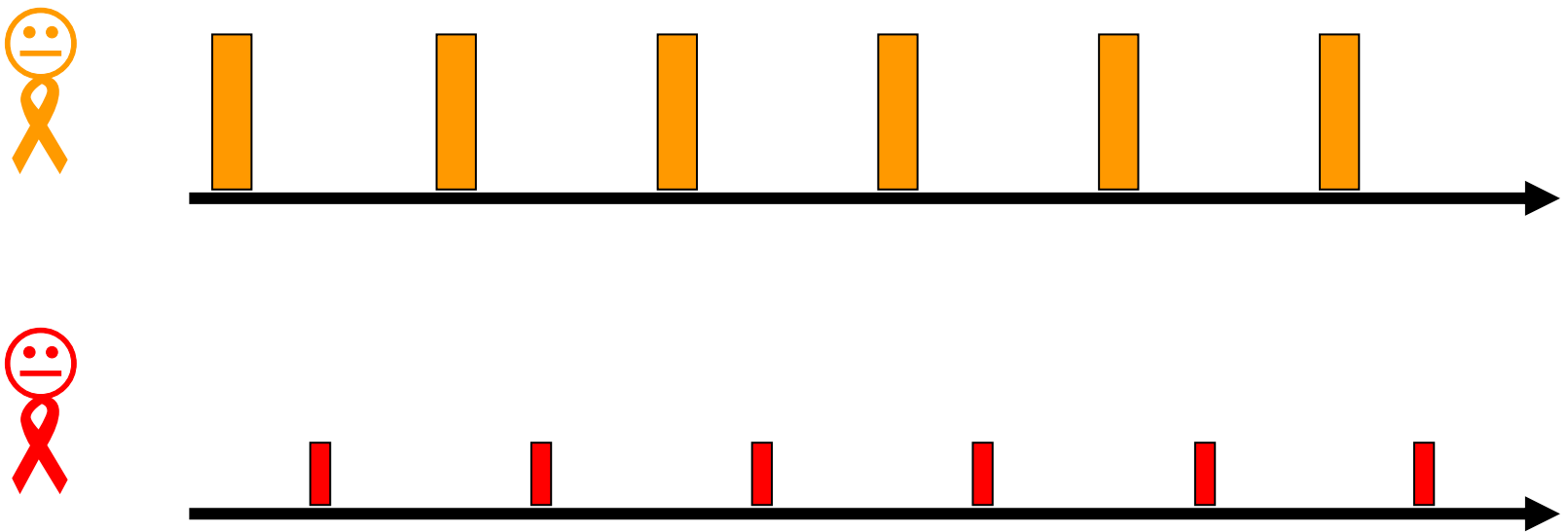
Positive edge detection and pattern recognition

Signals that repeat themselves in the same pattern belong to the same buried subject.



Successful signal separation

- Entry in list of buried subjects or on maps.
- Buried subjects may be located without applying specialized search strategies.
- Buried subjects previously found can be ignored for the future search based on marking features.



Reasons for lack of reliability

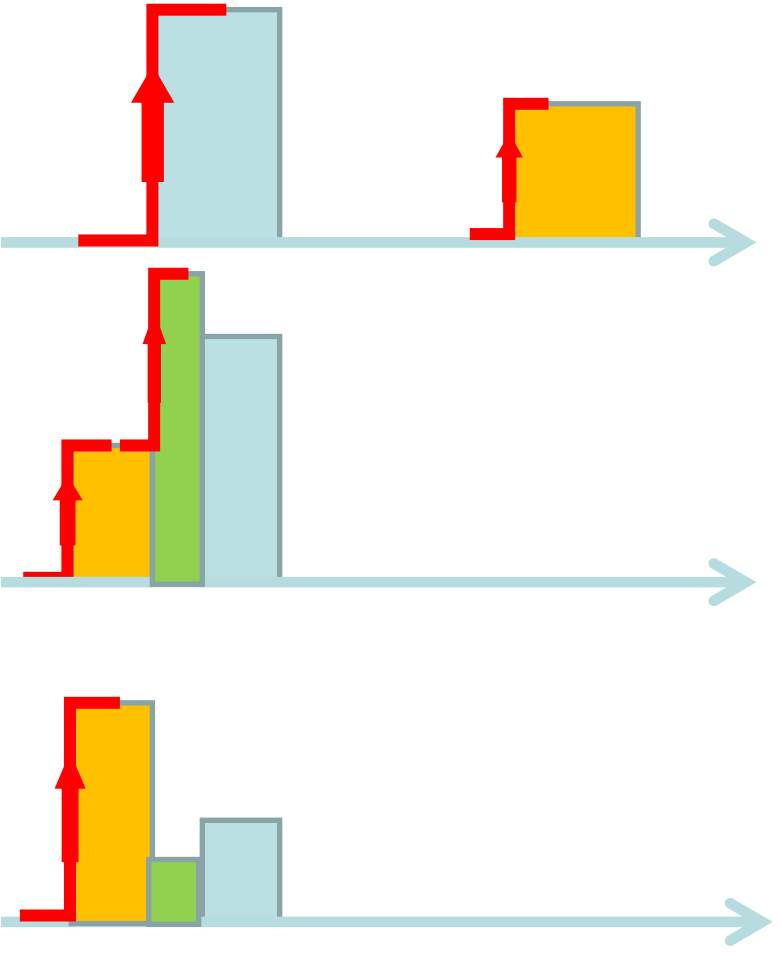
- Long lasting or persistent signal overlap
- Lack of difference in signal strength
- Phase relation between signals during overlap
- Failure of positive edge detection

Signal overlap and positive edge detection

No Overlap

Overlap ascending

Overlap descending



Conclusions

- Even the most advanced digital search modes still are not 100% reliable.
- The higher the training level of the rescuer, the better he was able to detect deficiencies of the device and apply a search tactical workaround so that most buried subjects were found.
- Backup search strategies are essential and need to be taught.

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