Analysis of signal accumulation of avalanche transceivers during multiple burial scenarios

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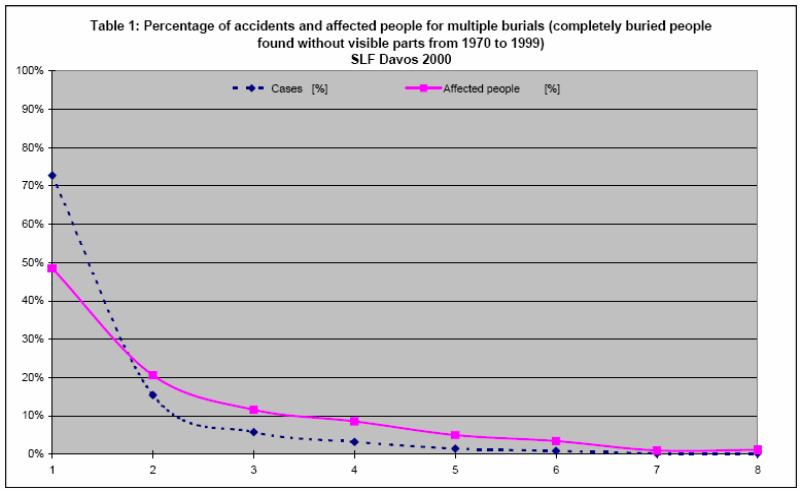
• More and more avalanche transceivers are becoming highly sophisticated signal processing units

• Not least due to the challenge of solving multiple burial scenarios.

• This study analyses the behavior of different transmitting strategies during mixed brand burial situations for the first time ever.

Results of studies by SLF Davos (made in 2000) shows:

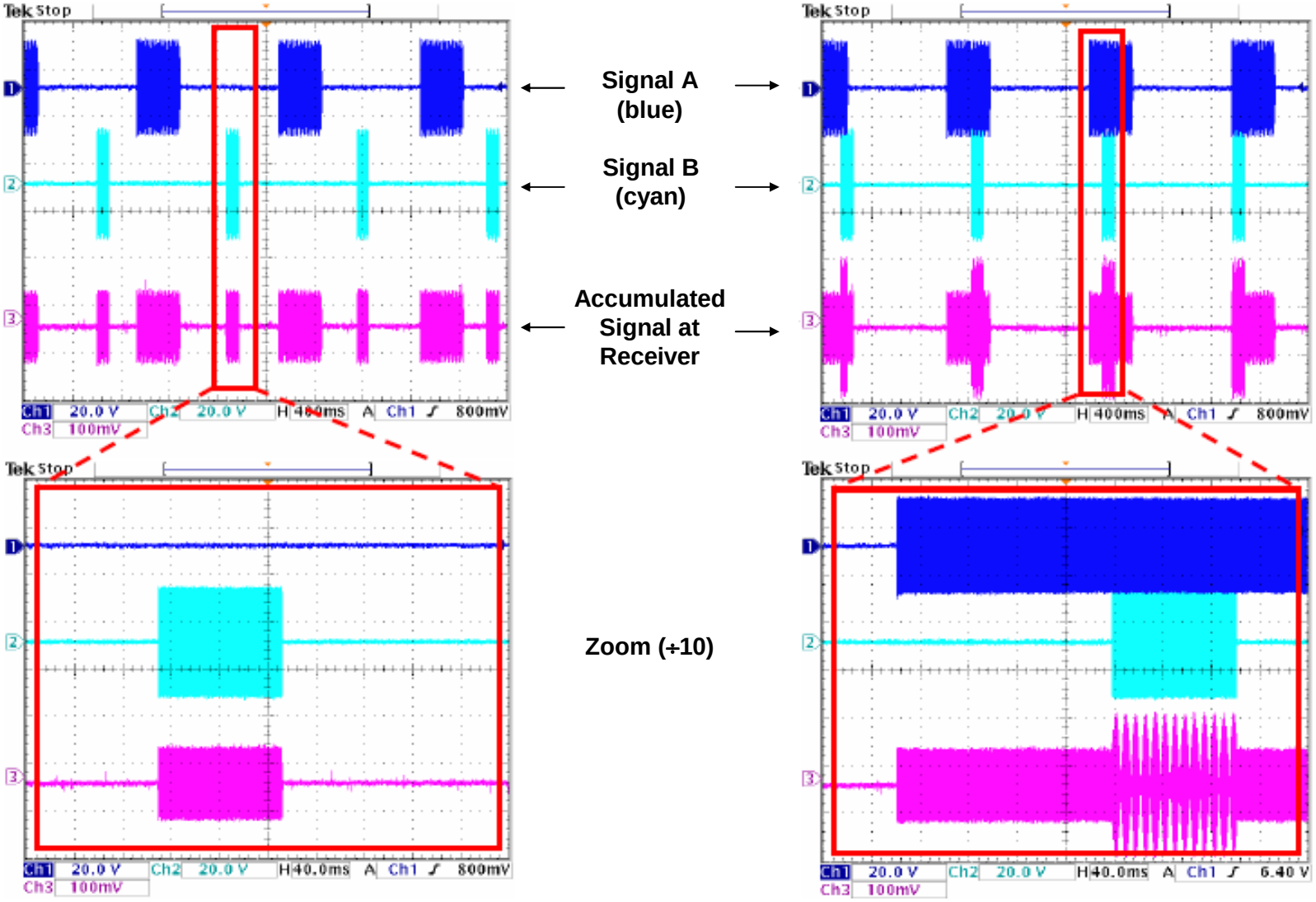
Number of burials	Number of accidents	Number of affected people	Cases [%]	Affected people [%]
1	339	339	72,7%	48,6%
2	72	144	15,5%	20,6%
3	27	81	5,8%	11,6%
4	15	60	3,2%	8,6%
5	7	35	1,5%	5,0%
6	4	24	0,9%	3,4%
7	1	7	0,2%	1,0%
8	1	8	0,2%	1,1%
Gesamt	**466**	**698**	**100,0%**	**100,0%**



- Over 50% of those buried are the victims of multiple burials
- Burials where 2 victims are in close proximity are the big problem!
- In cases with more than 2 victims we can assume that most of these cases will most likely resemble either a step by step single or a double burial search!
- Signal overlapping happens during tranceiving of beacons with different periodic time and/or different impuls duration.

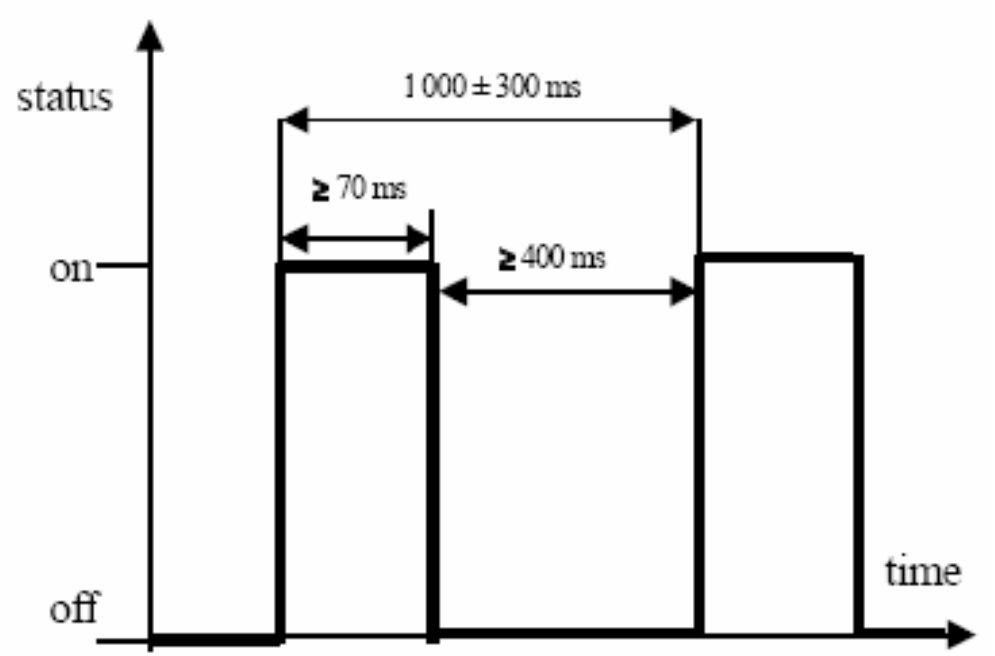
Isolated Signals

Overlapped Signals



- The overlapping of signals is the major source of problems during close multiple burial situations.
- Caused by different Period time overlapping occurs periodical transmitting
- Due to physical beatment and erasement of the two signals, an overlapped signal can no longer be isolated, not even with digital signal processing.

Each manufacturer is in principle free to choose the form in which his signal is transmitted – provided it is within the limits specified by the standard.



Signal according standard EN 300718:

- Signal form: 1A1
  no modulation allowed
- Puls duration: ≥70ms
- Periode time: 1000±300ms
- Pause time: ≥400ms

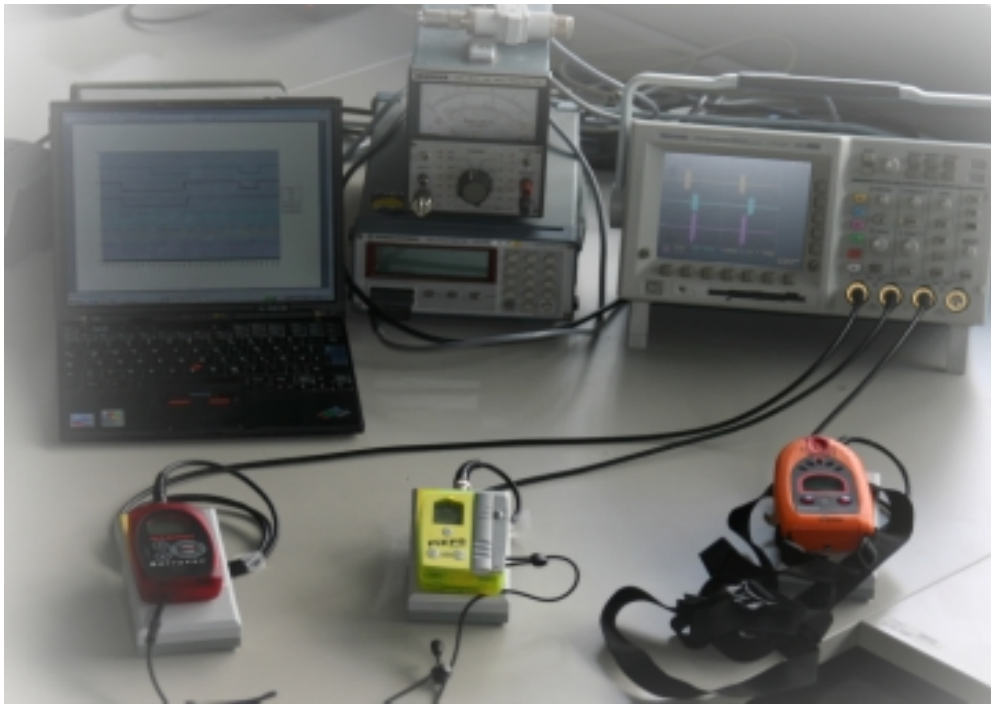
Which transceivers have been tested?

Test Device	Manufacturer / Model	Serial number	Frequency deviation Standard: 457.000 ± 80 Hz	Period duration Standard: 1000 ±300ms	Impulse duration Standard: >=70ms	impulse/pause ratio
A-1	Arva / Advanced	1D-0052-1109	+0 Hz	916 ms	74 ms	8,8%
A-2	Arva / Advanced	E-4604-1210	-2 Hz	890 ms	74 ms	9,1%
A-3	Arva / Evolution	2260	+3 Hz	890 ms	76 ms	9,3%
B-1	Barryvox / Opto3000	M0122375	-3 Hz	996 ms	102 ms	11,4%
B-2	Barryvox / Opto3000	M0122797	-1 Hz	968 ms	102 ms	11,8%
B- 3	Barryvox / Opto3000	M0049664	+7 Hz	1004 ms	102 ms	11,3%
P-1	Pieps / DSP	06048324620321	-5 Hz	960 ms	100 ms	11,6%
P-2	Pieps / DSP	06048324620357	-6 Hz	1020 ms	100 ms	10,9%
P-3	Pieps / DSP	06048324620383	-5 Hz	890 ms	100 ms	12,7%
T-1	Tracker / DTS	98618	+9 Hz	804 ms	96 ms	13,6%
T-2	Tracker / DTS	52279	+23 Hz	792 ms	94 ms	13,5%
T-3	Tracker / DTS	58767	+9 Hz	776 ms	94 ms	13,8%
V-1	Pieps / 457	98 99	-8 Hz	916 ms	100 ms	12,3%
V-2	Pieps / 457	10 06	1 Hz	890 ms	96 ms	12,1%
V-3	Pieps / 457	25 06	-7 Hz	890 ms	94 ms	11,8%
X-1	Ortovox / X1	444404	-7 Hz	868 ms	212 ms	32,3%
X-2	Ortovox / X1	454547	+5 Hz	880 ms	220 ms	33,3%
X-3	Ortovox / X1	347092	+18 Hz	804 ms	196 ms	32,2%
F-1	Ortovox / F1	821072	-40 Hz	1180 ms	366 ms	45,0%
F-2	Ortovox / F1	443745	-91 Hz	1210 ms	370 ms	44,0%
F-3	Ortovox / F1	747747	-79 Hz	1190 ms	388 ms	48,4%
M-1	Ortovox / M2	033201	-54 Hz	704 ms	108 ms	18,1%
M-2	Ortovox / M2	143766	-33 Hz	872 ms	104 ms	13,5%
M-3	Ortovox / M2	132864	-34 Hz	622 ms	112 ms	22,0%

- Representative selections of beacons with significant market share
- All beacons where first measured up and their transmitting parameters determined.
- All tests where carried out with new batteries and at room temperature

How the tests were made:

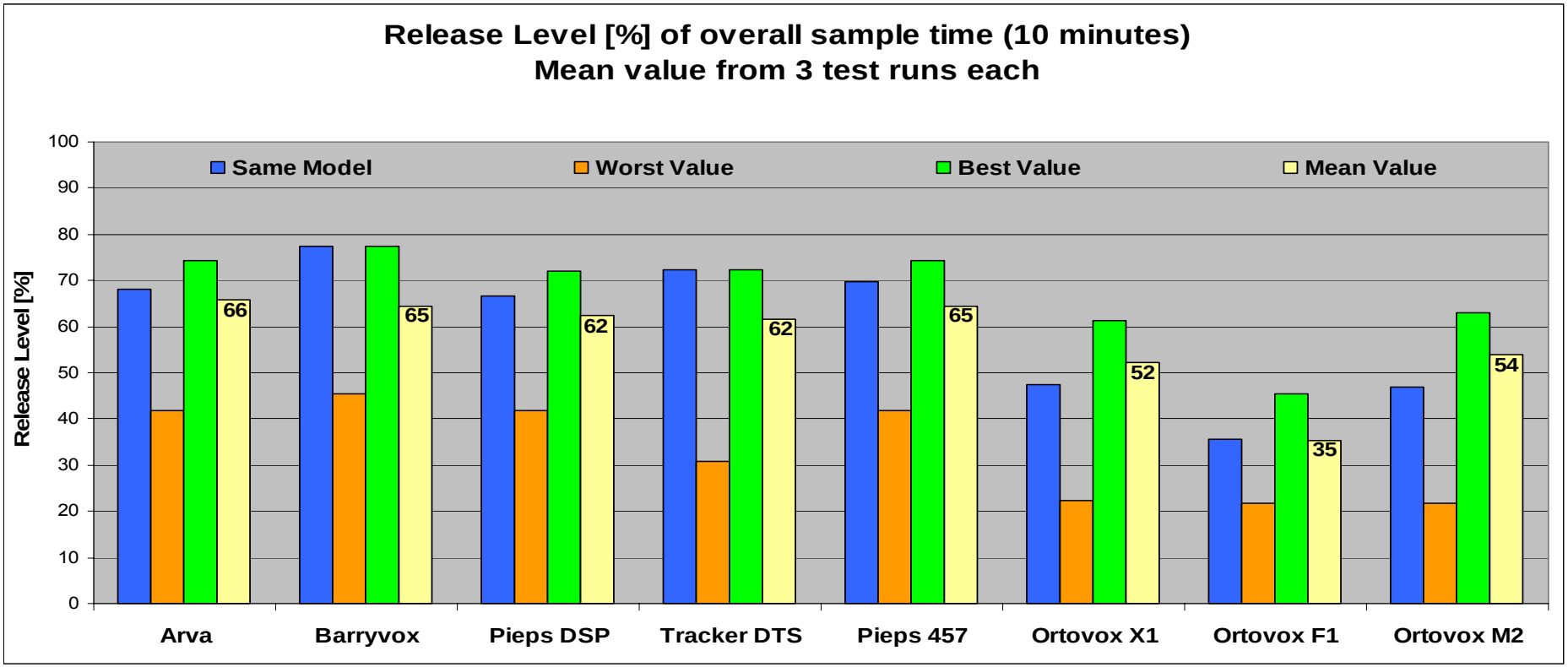
- Simple direct receiver approx. 10cm range
- Connected to Tektronix TDS3014B Oszilloscope
- Connected to digital data logger (10ms sampling rate) linked to a PC via USB
- Recorded data -> Calculation program
- Duration of each test run: 10 min.
- 3 independent series of each constellation (to represent random start-up)
- Calculation rules:
  - When drifting signals start to overlap ➔ “Superposition STARTS”
  - When both signals are fully separated again ➔ “Superposition ENDS”
  - The opposite of this phase in relation to the total test time ➔ “**Release-Level [%]”** – the time share which both signals are isolated and clearly receivable!



Results

Matrix table showing the Release level [%] of a 10 min. test cycle as mean values (3 test runs each) of all possible combination of different beacon brands.

	Arva	Barryvox	Pieps DSP	Tracker DTS	Pieps 457	Ortovox X1	Ortovox F1	Ortovox M2
Arva	*68,15*	*73,62*	*72,17*	*71,90*	*74,40*	*61,25*	*41,93*	*62,50*
Barryvox	*73,62*	*77,34*	*69,77*	*64,44*	*70,49*	*58,10*	*45,58*	*56,97*
Pieps DSP	*72,17*	*69,77*	*66,64*	*63,88*	*70,93*	*54,98*	*41,68*	*58,47*
Tracker DTS	*71,90*	*64,44*	*63,88*	*72,41*	*69,03*	*56,90*	*30,88*	*62,87*
Pieps 457	*74,40*	*70,49*	*70,93*	*69,03*	*69,84*	*57,07*	*41,79*	*62,81*
Ortovox X1	*61,25*	*58,10*	*54,98*	*56,90*	*57,07*	*47,37*	*22,25*	*59,10*
Ortovox F1	*41,93*	*45,58*	*41,68*	*30,88*	*41,79*	*22,25*	*35,60*	*21,84*
Ortovox M2	*62,50*	*56,97*	*58,47*	*62,87*	*62,81*	*59,10*	*21,84*	*47,03*



- Several basic strategies are being followed by the manufacturers, which also have significant influence on the overlap or release level.
- Impulse/pause ratio is the main factor of causing signal superposition

CONCLUSION

Strategy 1: a very short impulse with a period duration as long and constant as possible

- Good impulse/pause ratio results in a good release level!
- Having two beacons of approx. the same periode time could result in ether an excellent release level, or an extremely bad release level. When overlapping occurs it'll last for a while…

Strategy 2: short impulses with period durations that are as long and varied as possible

- High variation of period time, ether by manufacturing dispersion, or by means of a random generation while start-up the beacon.
- A higher chance of overlapping is take into account, to keep the duration of this superpositioning as short as possible.
- Almost the standard of modern digital beacons.

Strategy 3: short period duration

This worsens the impulse/pause ratio and a lower release level must be reckoned with.
But at least it brings the advantage of getting faster readings at the searching device.

Strategy 4: long impulse, long period duration

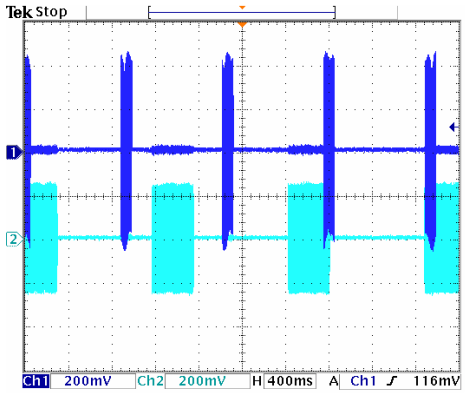
Not taking multiple burials into account at all.
An unfavorable impulse/pause ratio result in a very low release level!

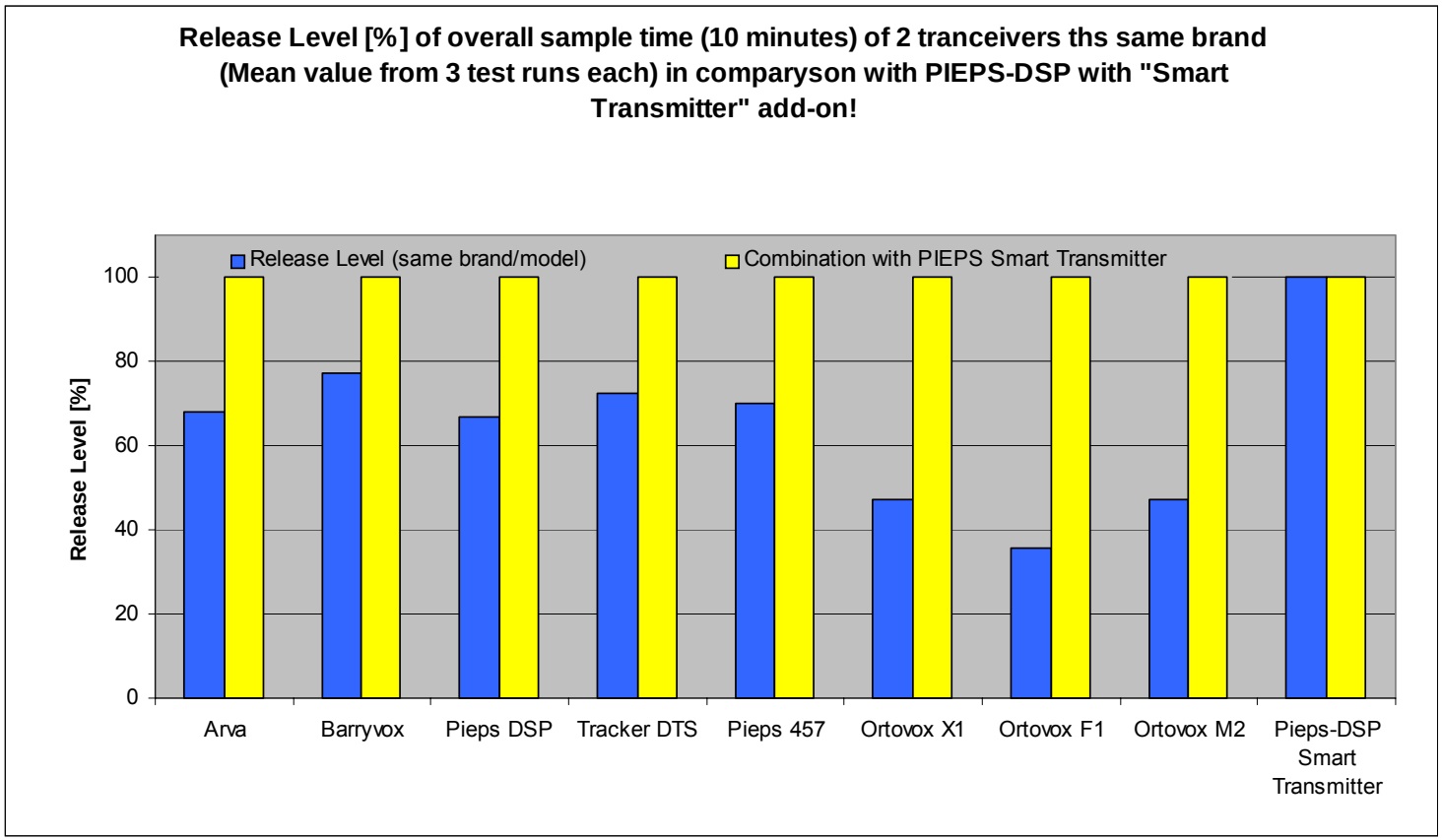
SUMMARY

“Whether an old analog device or a modern digital one is used – both transmit equally well!”

- This notion is a myth that is clearly disproved by this study.
- The all-important issue for the buried person is how her/his device transmits
    - at the correct frequency
    - and uses the right strategy.
- The essential point is that the signals of the different transmitter can clearly be distinguished from each other!
- When the signal can be heard clearly and without interference by the searchers, this has a significant influence on the person being found more easily and faster.
- **Independent of what search technology the rescuers are equipped with!**

FUTURE





“Smart Transmitter” technology is being introduced by PIEPS:

- The transceiver uses all DSP receive capabilities also in standard transmit (SEND) mode
- On reception of a neighbor signal, the **Smart Transmitter** adjusts and moves its signal to a position where overlapping no longer occurs!
- A real advantage for the buried victim – independent of the technology used by the search device

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