

Chirp stimuli based on cochlear traveling wave delay

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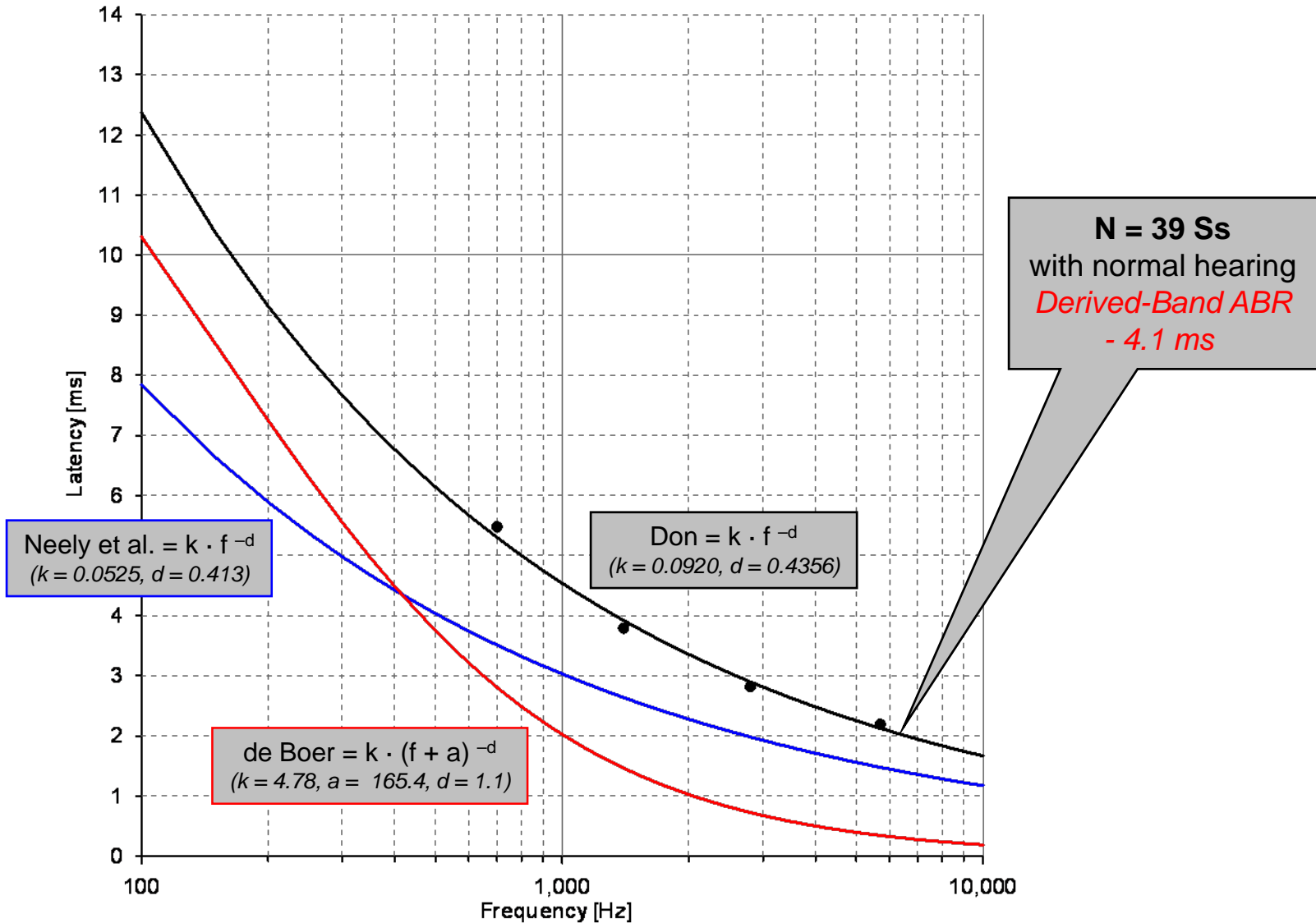
Overview

1. Cochlea traveling wave delay
2. Delay models
3. Chirps
4. Evaluation
5. Summary

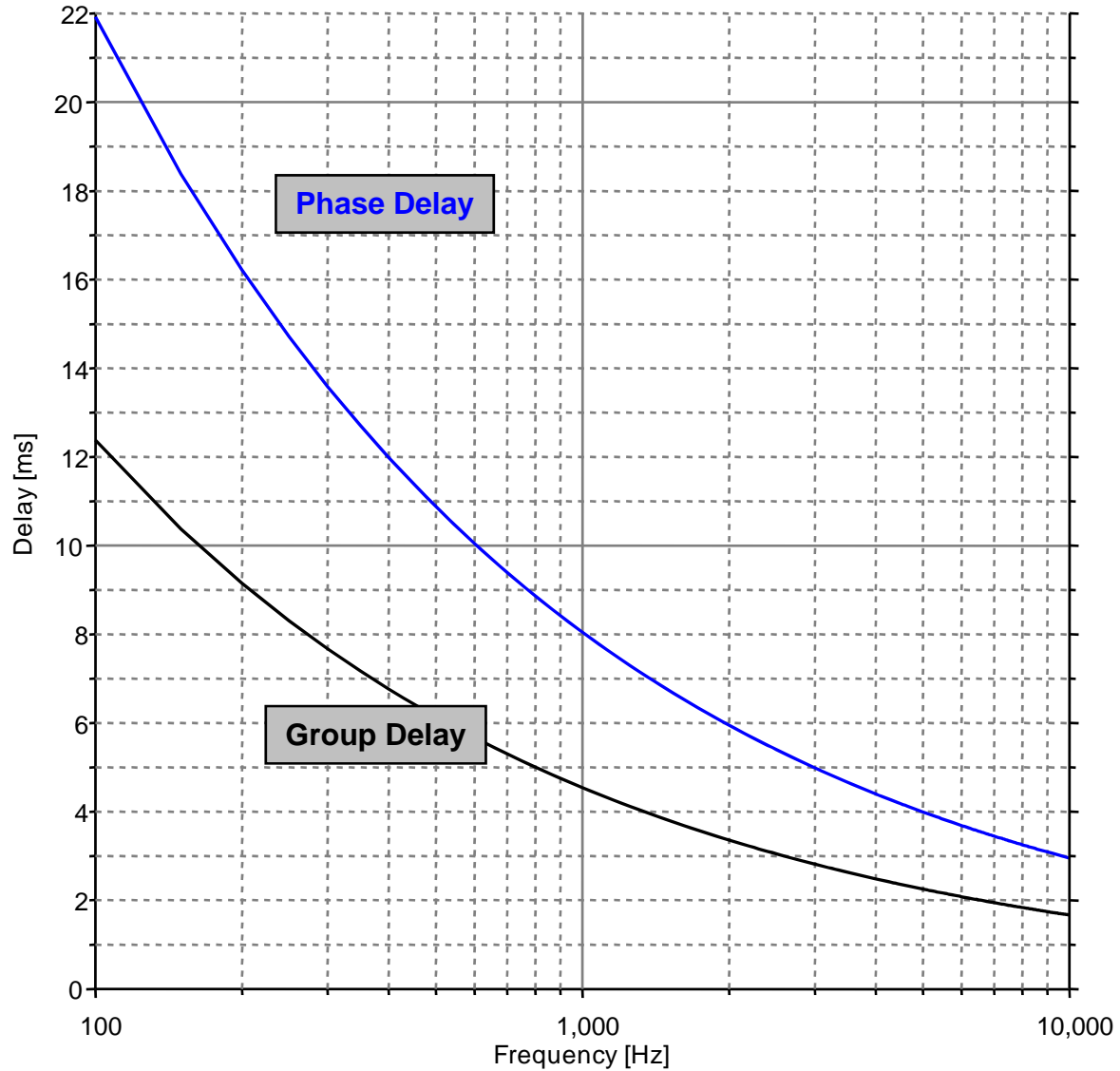
Different models of the cochlear traveling wave delay

- Numerous models exist of the cochlear traveling time in humans
- Here three latency models are used:
 1. based on a cochlear model (de Boer, 1980)
 2. based on tone-burst ABR recordings (Neely et al, 1988)
 3. based on derived-band ABR recordings (Don, 2005)

Latency-frequency functions

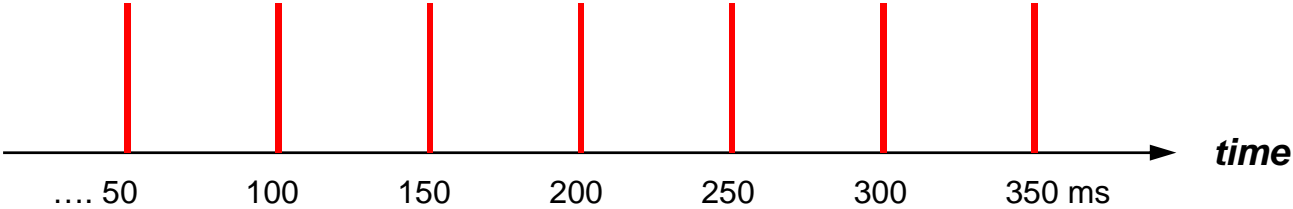


Group delay and Phase delay

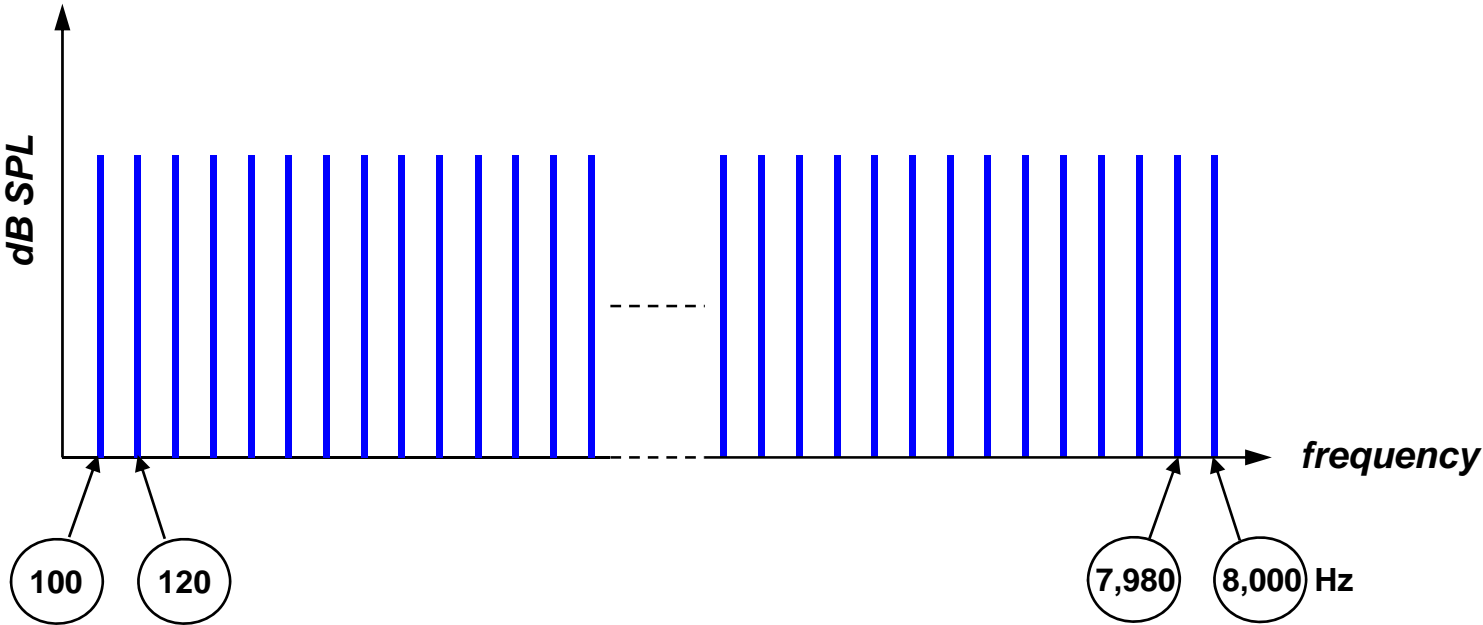


Repetitive Clicks (100 – 8,000 Hz) e.g. 20 clicks per second

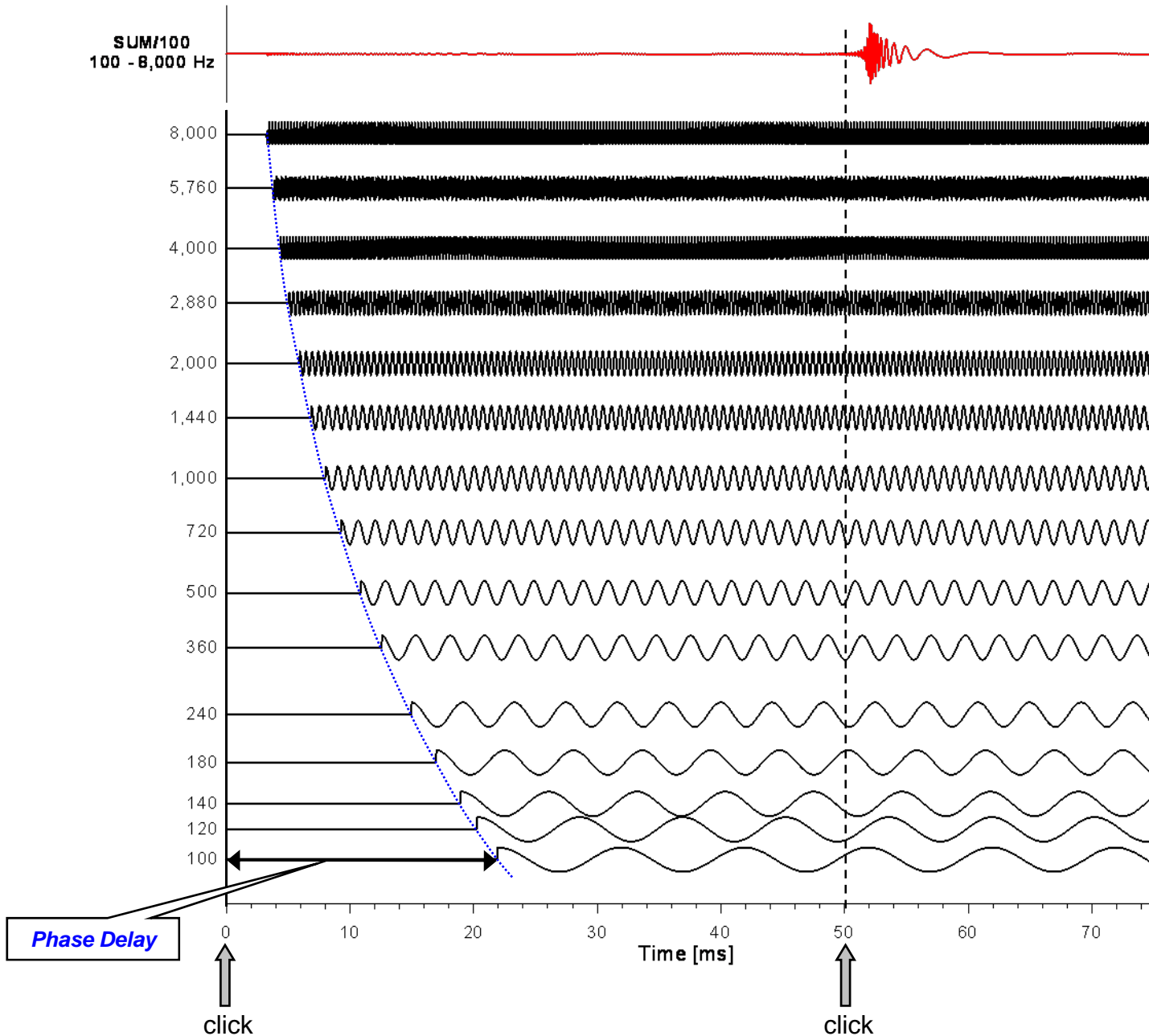
time function



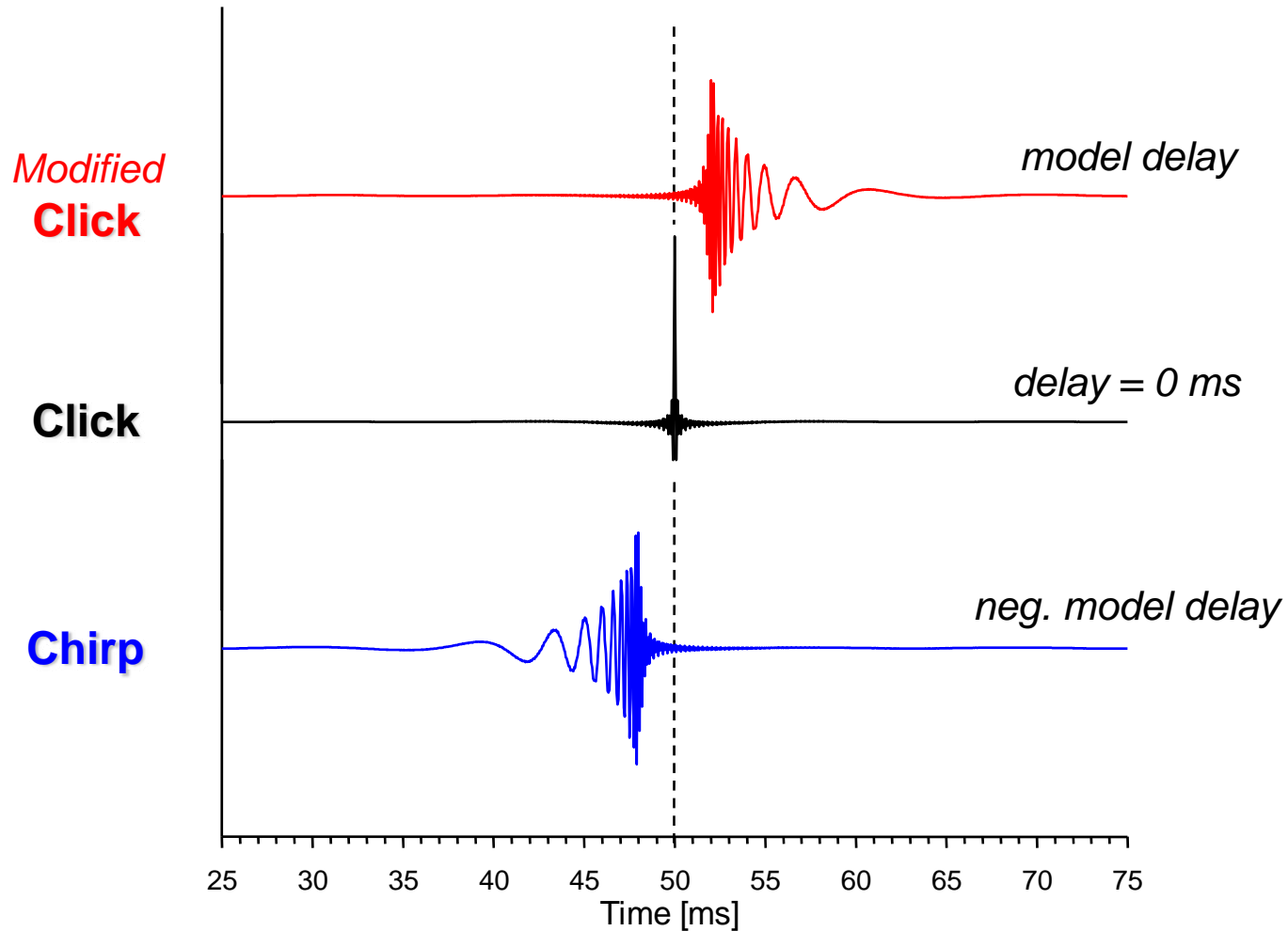
line spectrum



Sum of cosines within a broad band (100 - 8,000 Hz)

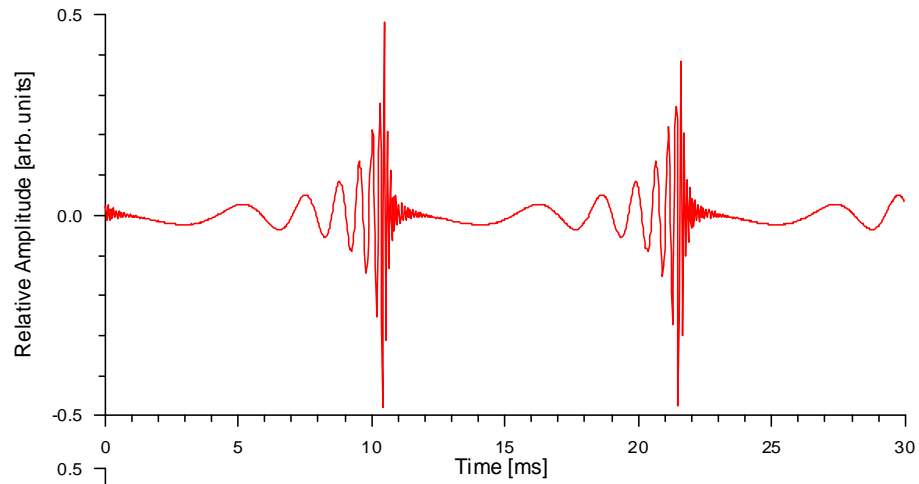


Sum of cosines within a broad band (100 - 8,000 Hz)

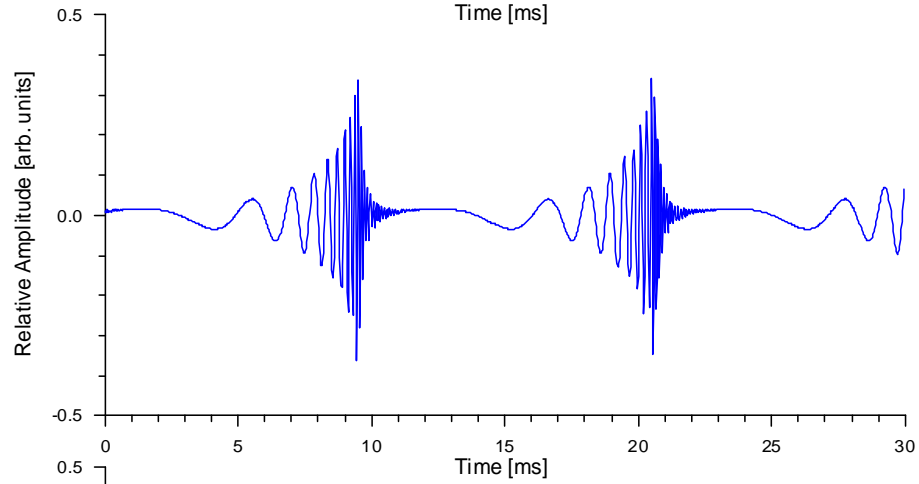


Broad band chirps
Rate: 90/s

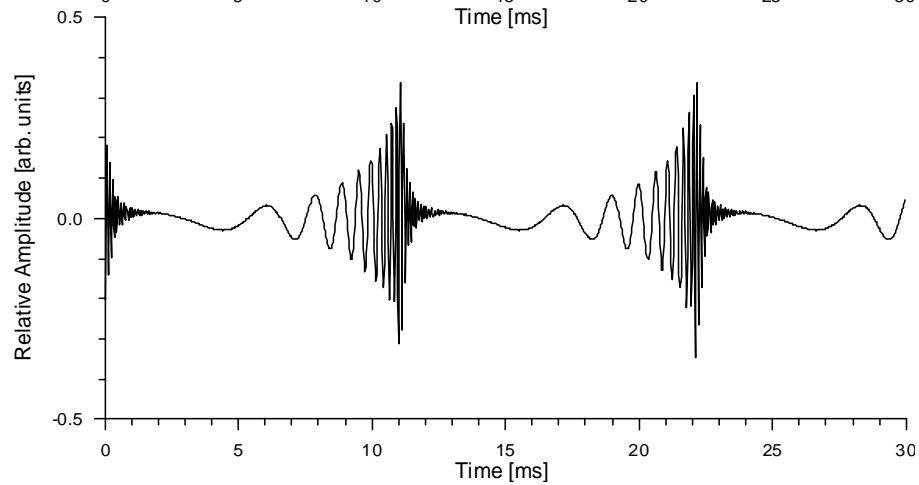
de Boer



Neely



Don



Evaluation: **Adults**

- Testing:
 - Three chirps and a standard click
 - 49 normal-hearing younger adults
- Protocol:
 - Recording time: max 300 s
 - Stimulus rate 90/s
 - Stimulus level: 30 & 50 dBnHL
 - Detection: error rate 0.1%

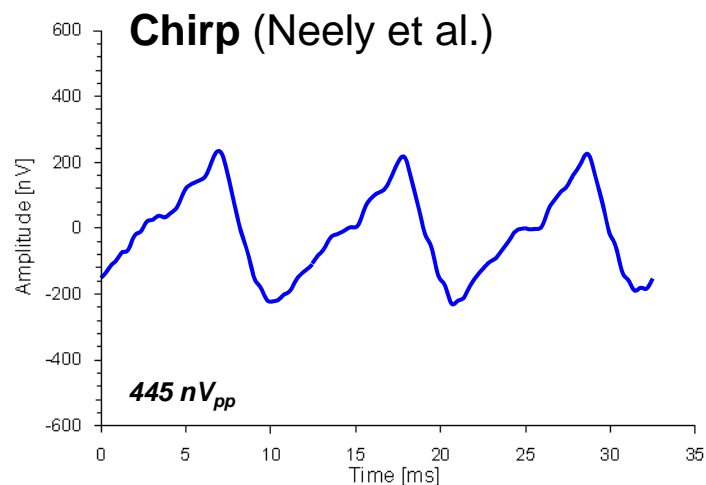
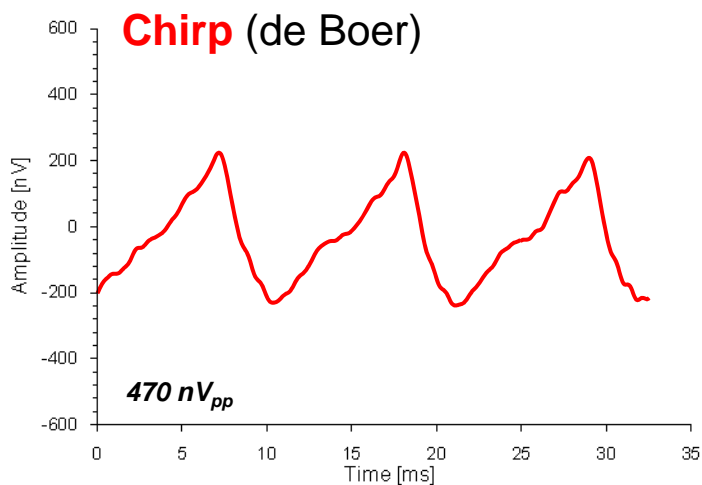
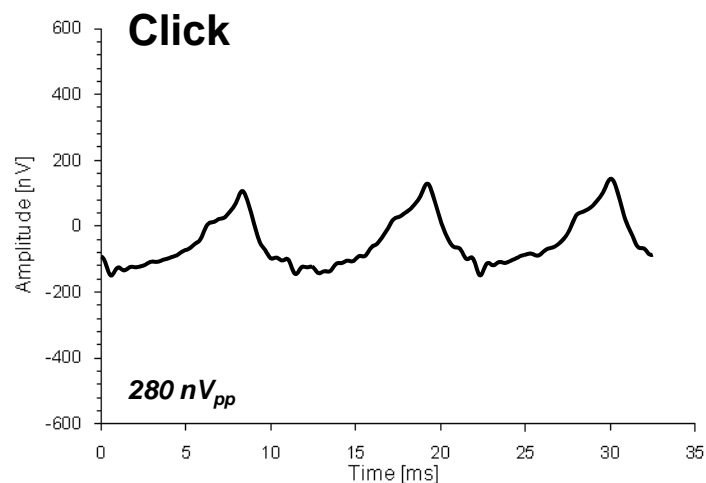
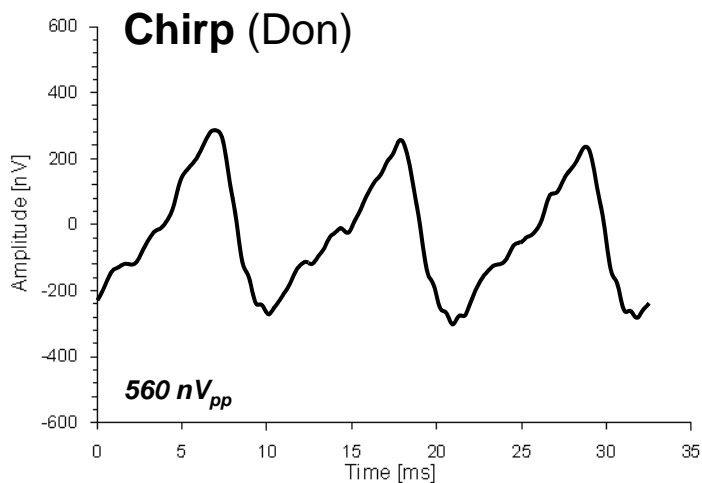
30 dBnHL

	Detection Rate [%]	Detection Time [s]	SNR
Click N = 42	83.3 35/42	72 23 - 230	3.1 0.2 - 8.4
Neely et al. N = 43	95.3 41/43	41 17 - 107	5.0 1.2 - 14.6
de Boer N = 41	97.6 40/41	32 14 - 187	5.2 2.2 - 12.5
Don N = 43	97.7 42/43	30 14 - 127	6.0 1.5 - 17.8

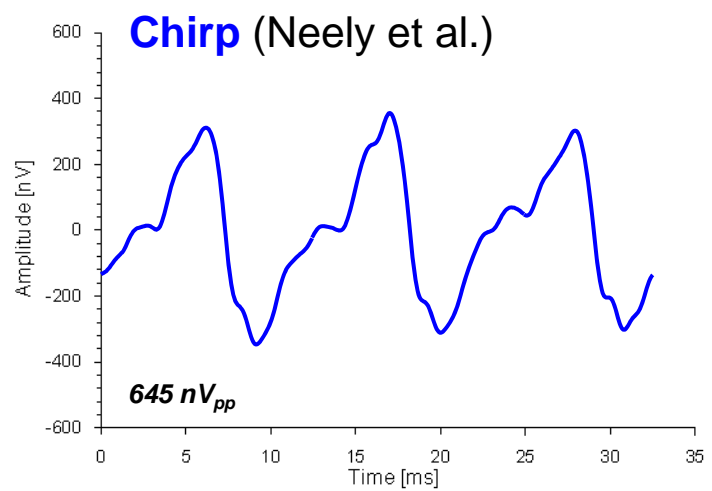
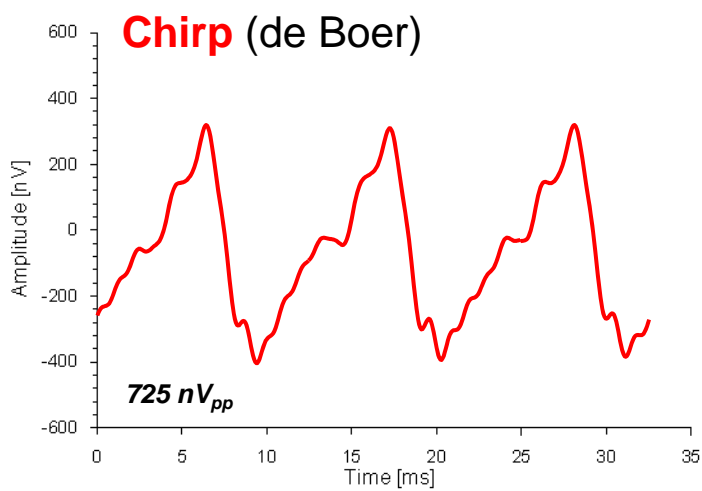
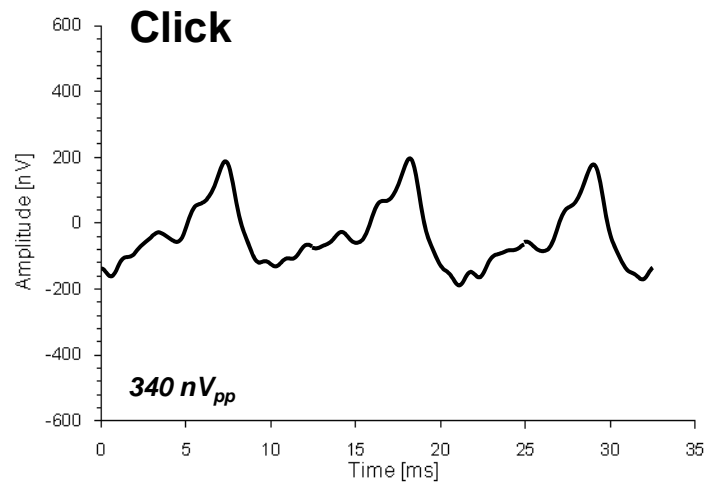
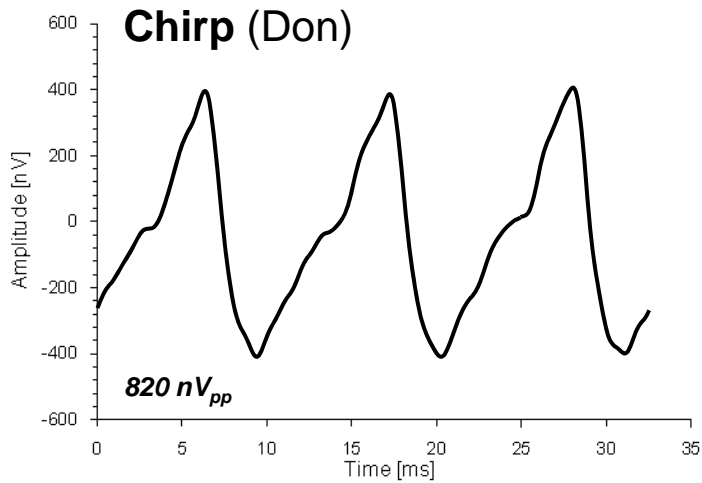
50 dBnHL

	Detection Rate [%]	Detection Time [s]	SNR
Click N = 42	85.7 36/42	40 16 - 207	5.2 0.8 - 10.7
Neely et al. N = 43	97.7 42/43	27 13 - 107	6.6 1.9 - 16.7
de Boer N = 43	100 43/43	27 13 - 69	6.6 3.0 - 15.4
Don N = 43	100 43/43	23 13 - 55	7.4 3.2 - 15.3

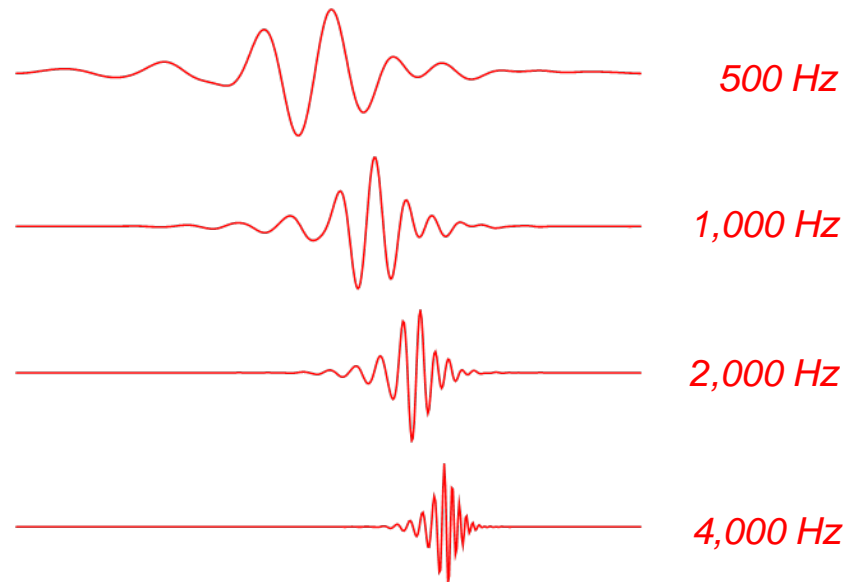
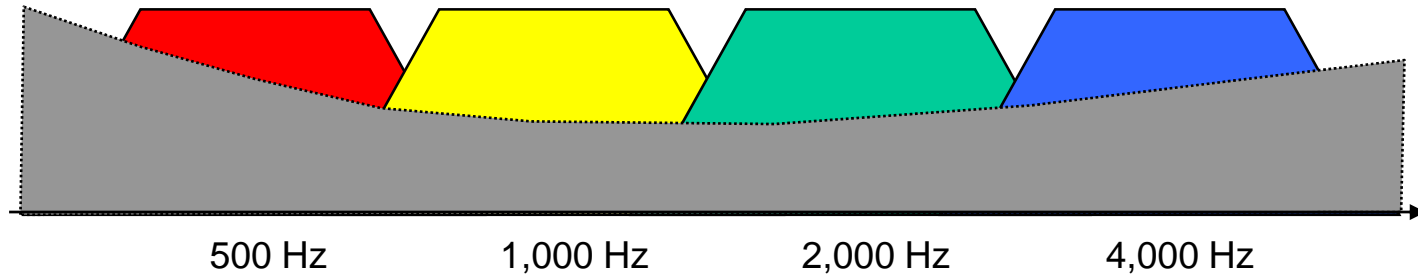
Grand Average ASSR temporal waveforms 30 dBnHL



Grand Average ASSR temporal waveforms 50 dBnHL



Chirp-based frequency-specific stimuli *for example one octave wide*



Summary

- Chirps are constructed from adequate models of the human cochlear traveling time
- In *normal-hearing adults*, the chirps are significantly more efficient than a click
 - this corresponds to more than 20 dB (at low levels)
- There are significant differences between the chirps
- For frequency-specific stimulation band-limited chirps can be constructed

END