

# *Chirp stimuli based on cochlear traveling wave delay*

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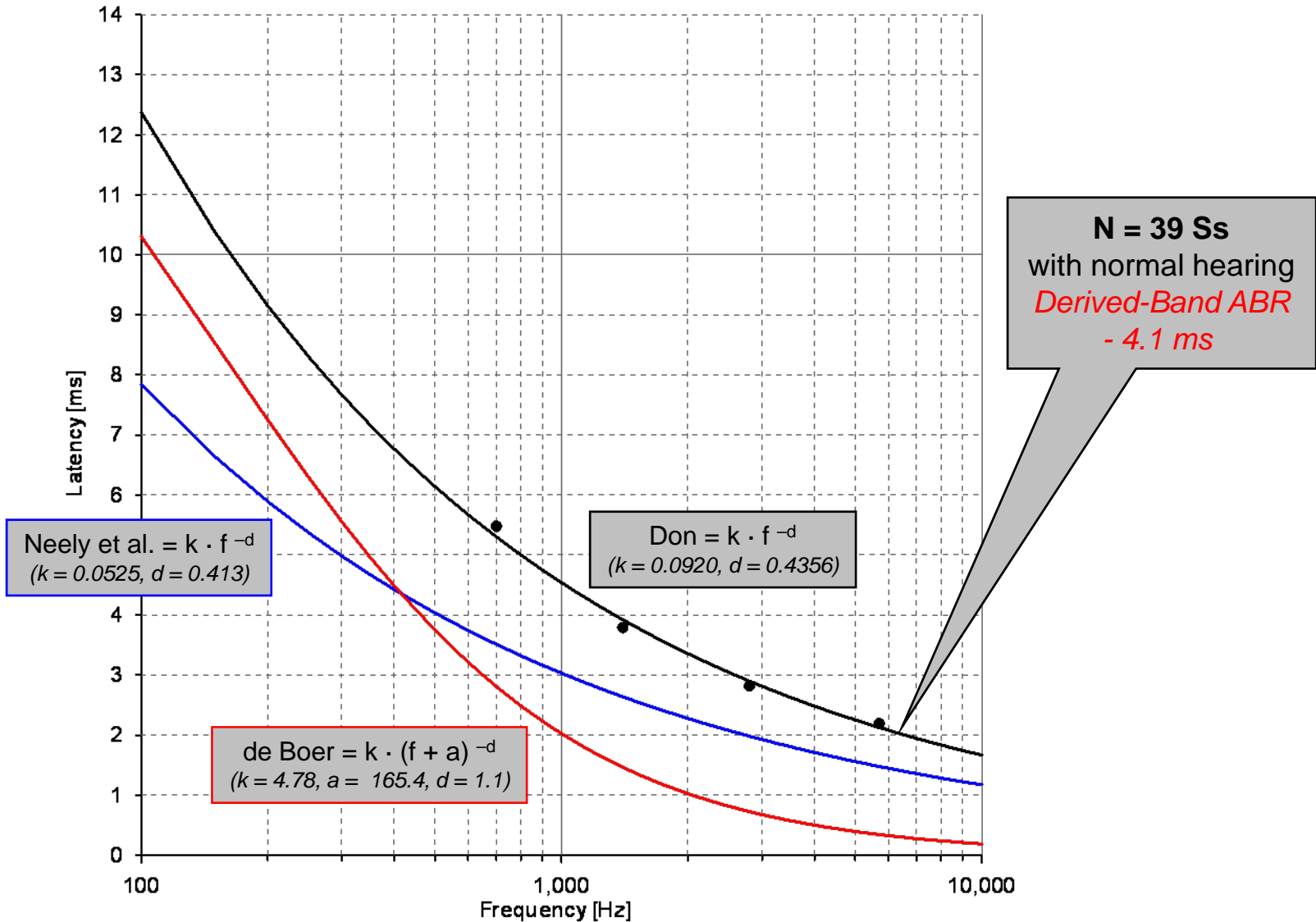
# Overview

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

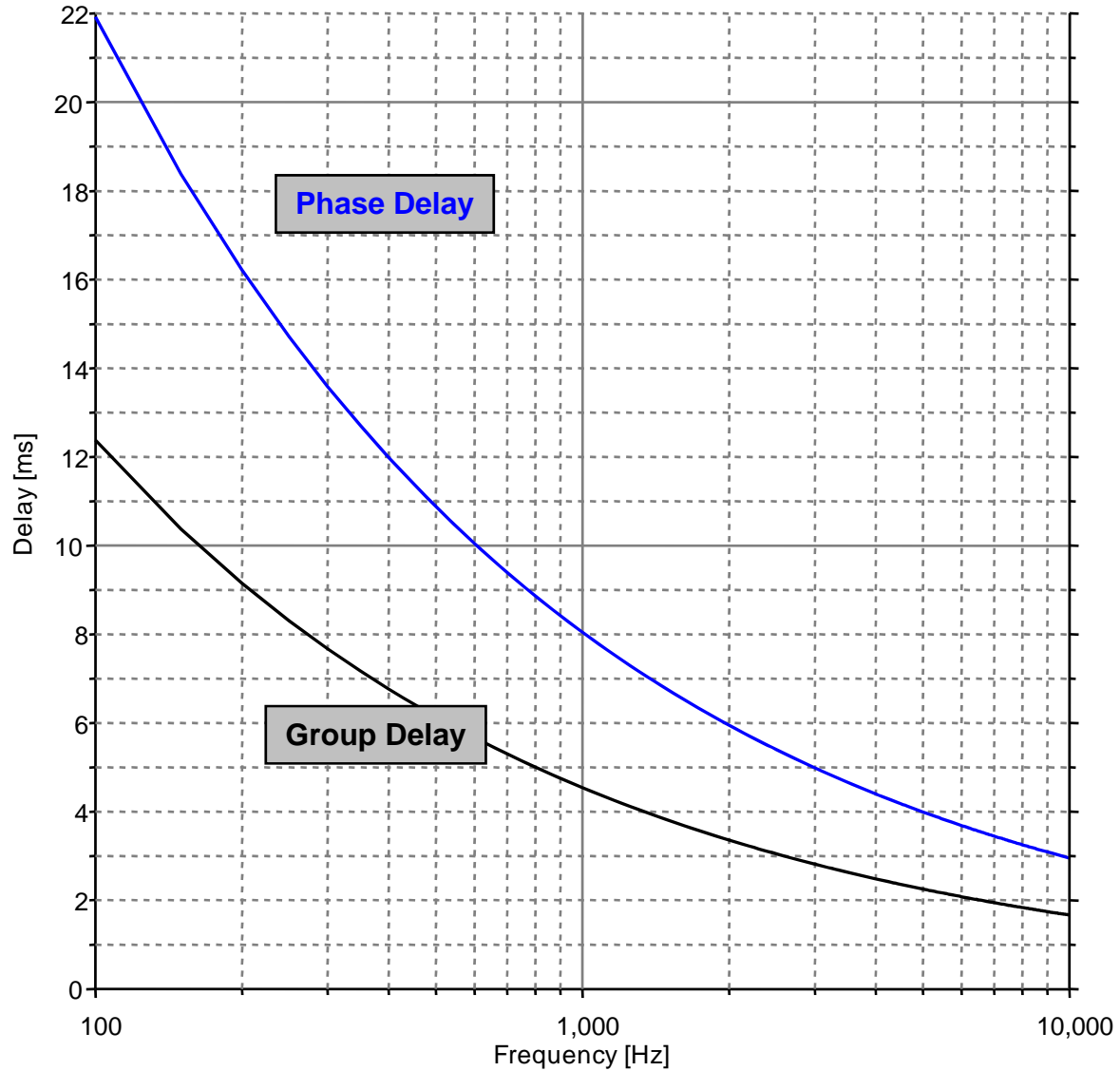
# Different models of the cochlear traveling wave delay

- 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

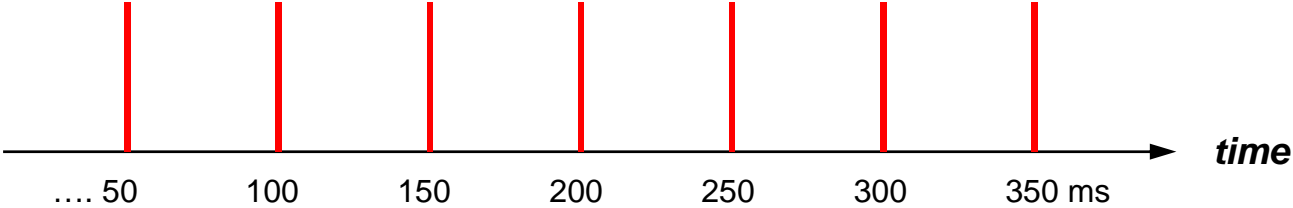


# Group delay and Phase delay

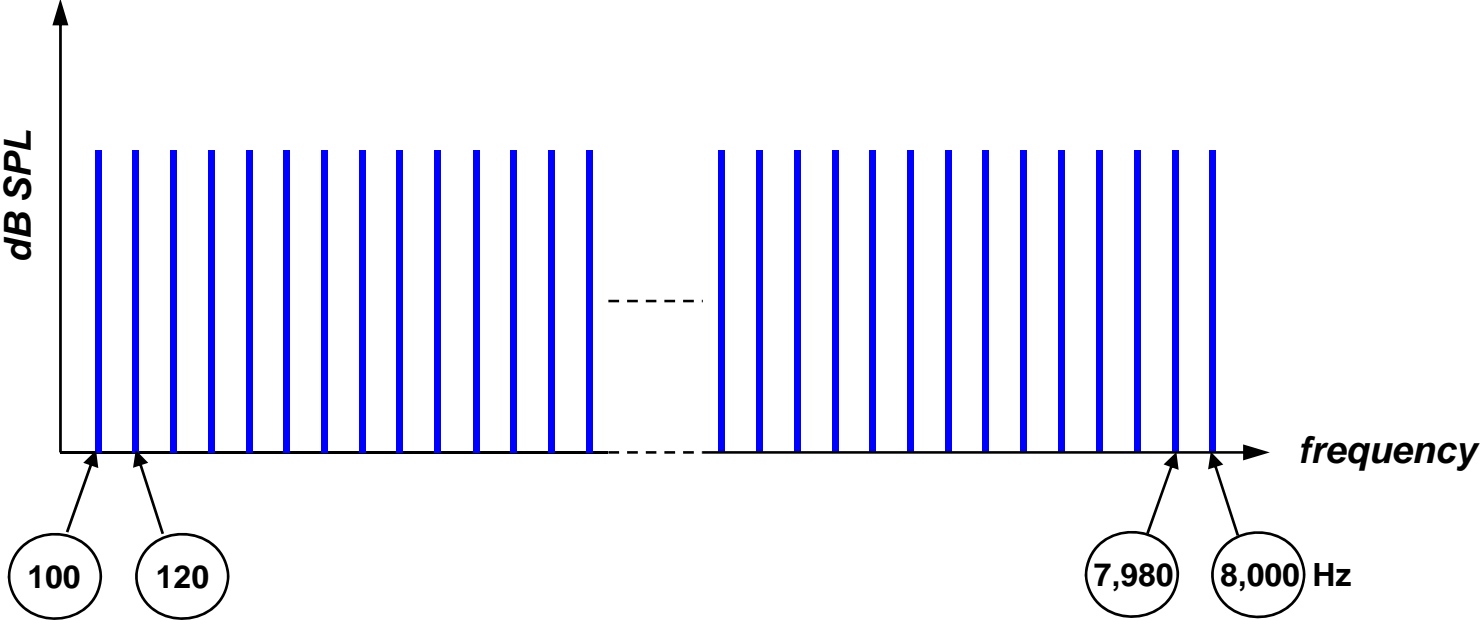


*Repetitive Clicks (100 – 8,000 Hz) e.g. 20 clicks per second*

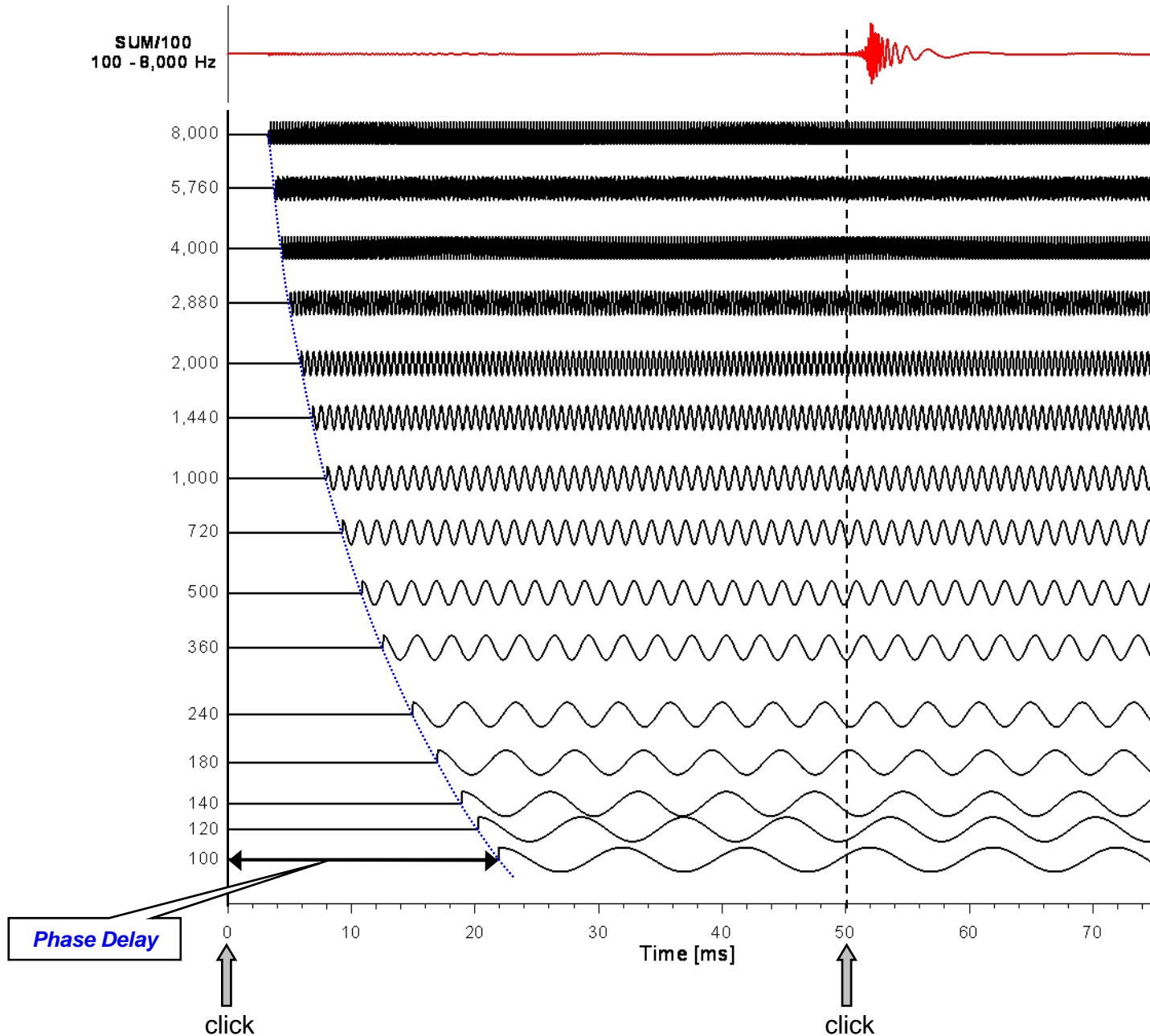
**time function**



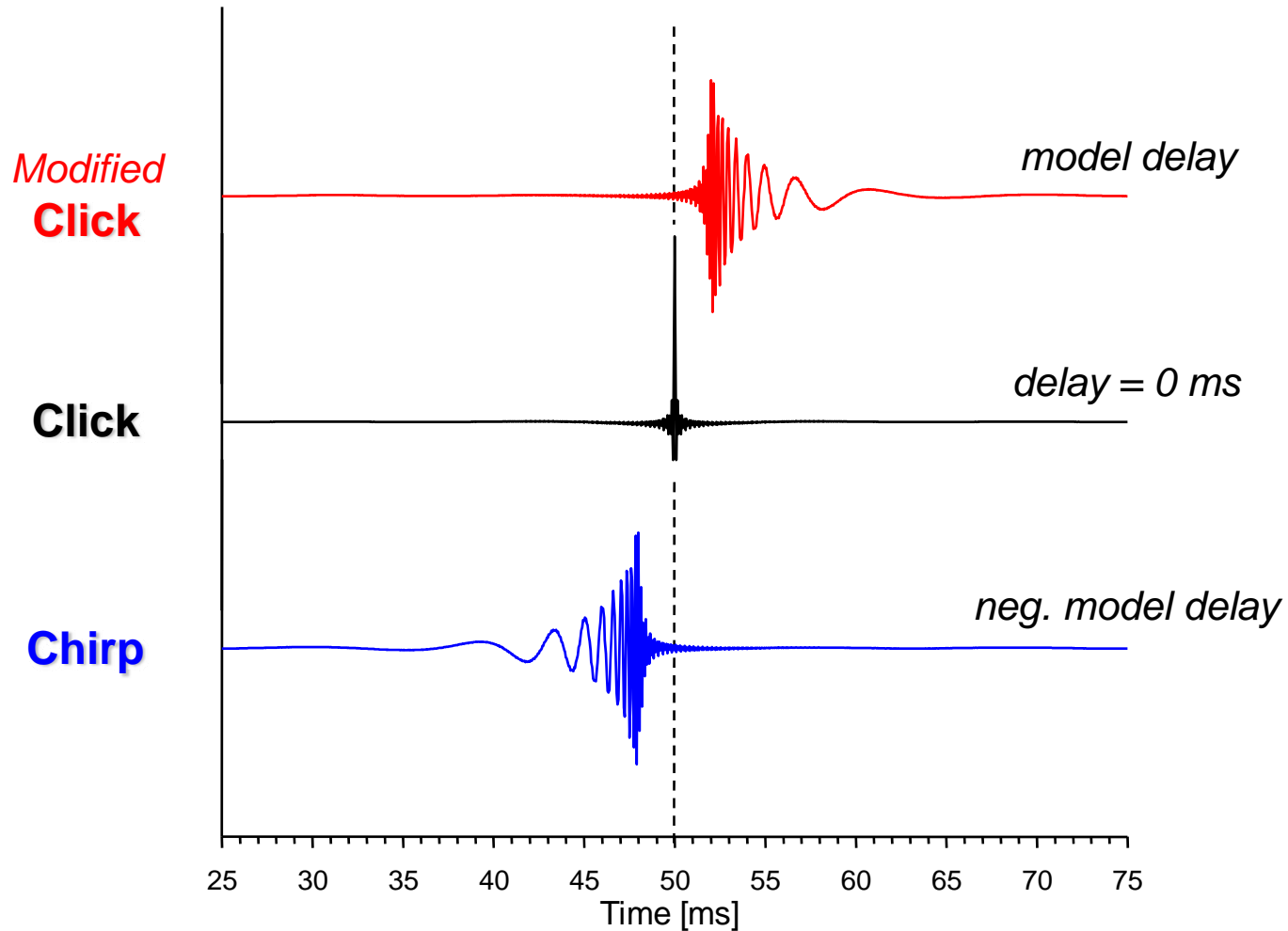
**line spectrum**



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



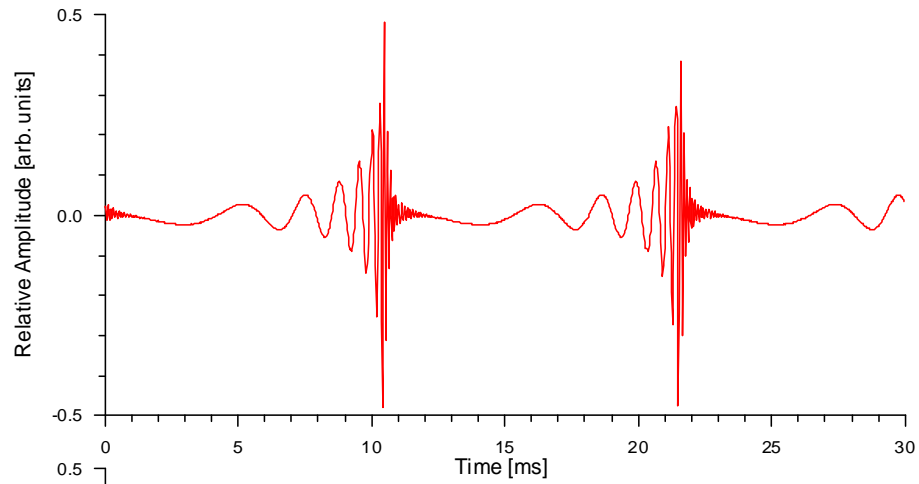
# Sum of cosines within a broad band (100 - 8,000 Hz)



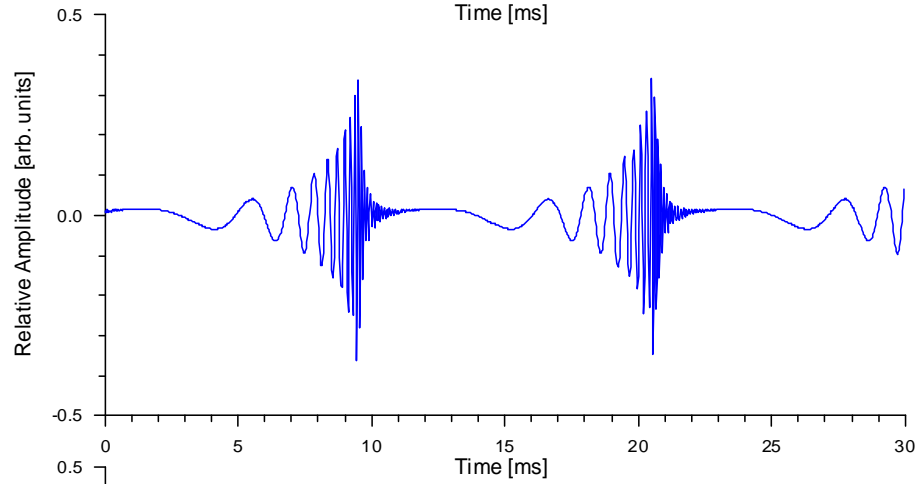


**Broad band chirps**  
**Rate: 90/s**

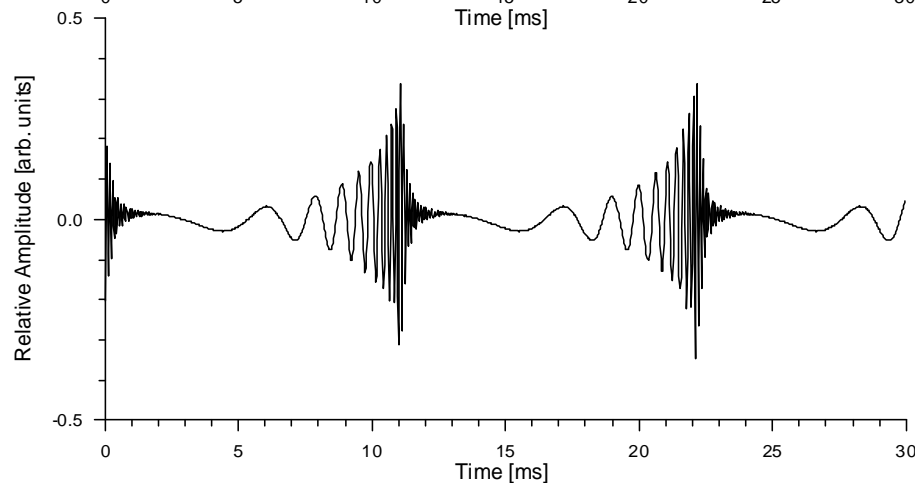
de Boer



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%

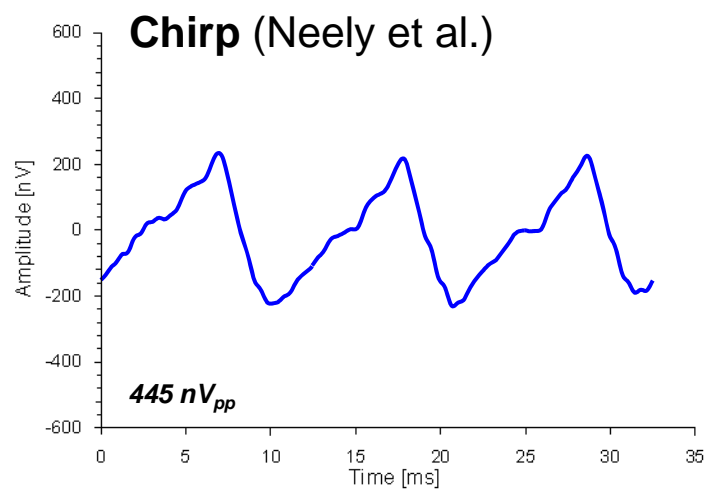
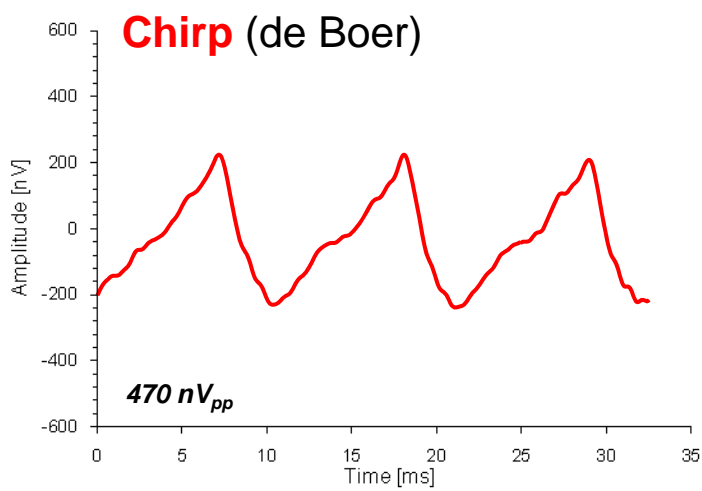
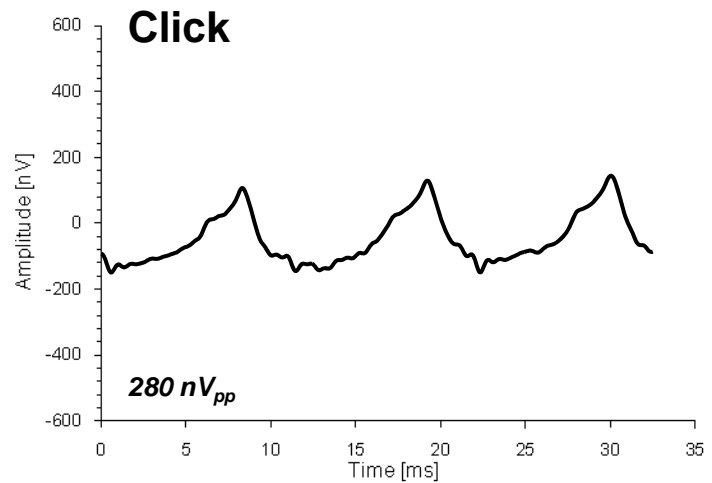
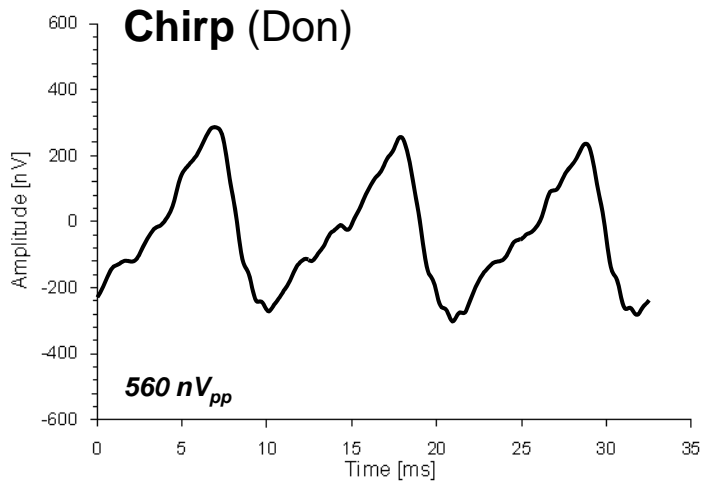
## 30 dBnHL

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

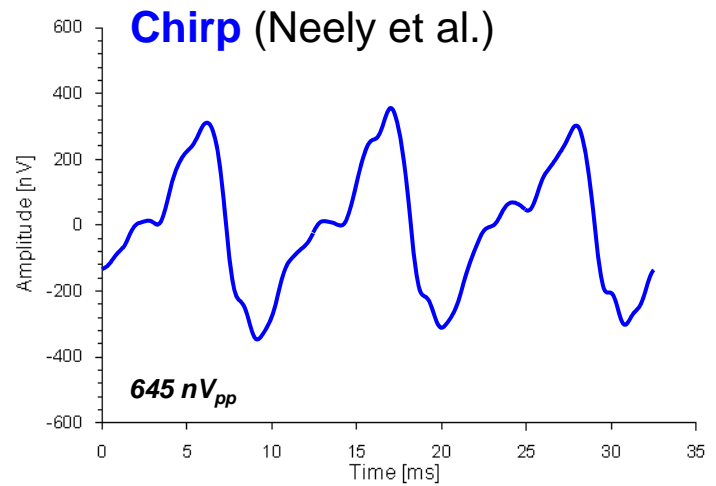
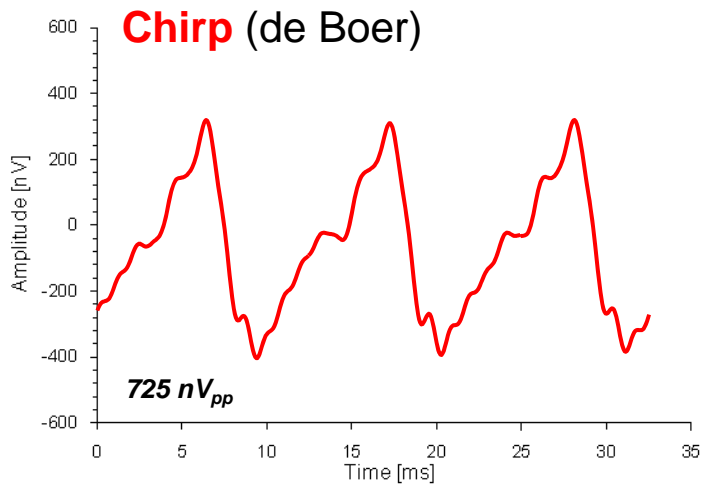
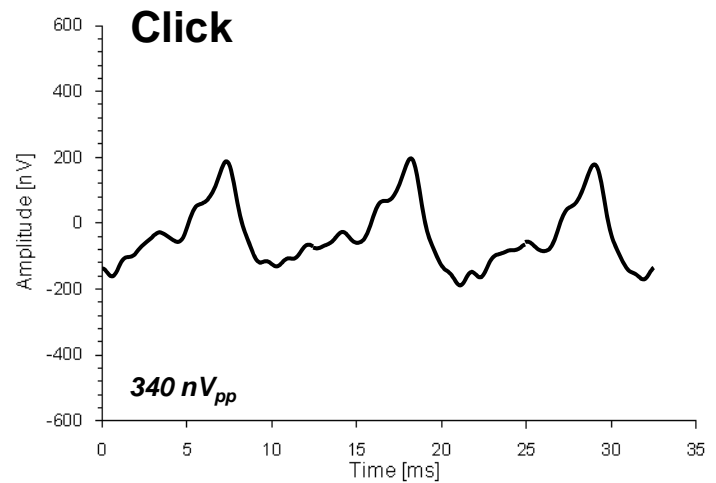
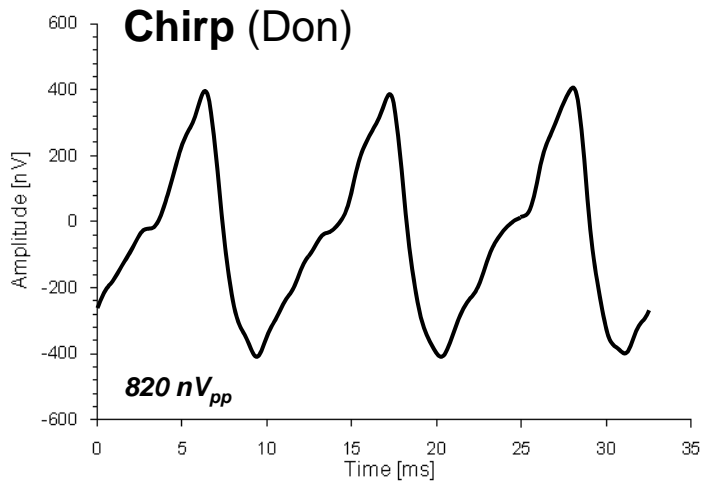
## 50 dBnHL

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

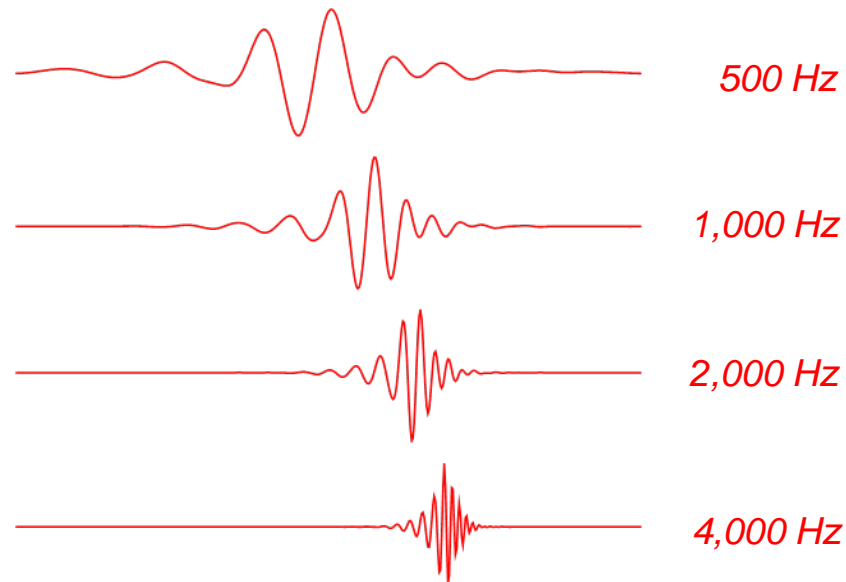
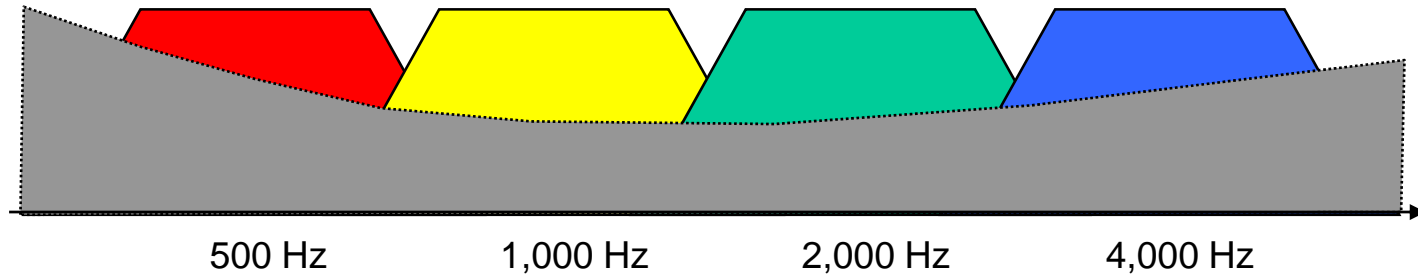
# Grand Average ASSR temporal waveforms 30 dBnHL



# 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***