Vad vet vi om bullerreduktion i hörapparater? Mätningar på 12 moderna hörapparater

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Method

- Programming
  - default prescription
- Hearing aid
  - Mic, OMNI
  - MPO, MAXIMAL
  - Expansion, OFF
  - VC, OFF
  - Feedback reduction, OFF
  - Other sig. proc., OFF
- Equipment
  - Equinox HIT440, IA
  - TBS25 test box, IA
  - 711 coupler, GRAS
  - Mic (ref./meas.), GRAS
- Measurements
  - Pre-conditioning 30 seconds
  - Long-term average 30 seconds

”Classification of steady state gain reduction produced by amplitude modulation based noise reduction in digital hearing aids" by Hoetink AE, Körössy L, and Dreschler WA. Int J Audiol, 48, 2009, 444-455.

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Method

- Measurement signals
  - ISTS (ISMADHA draft)
  - ICRA1 (stationary speech-weighted noise)

- Variables
  - **SNR** in the input singal (8 different)
    - ”Speech”, +6 dB, +3 dB, 0 dB, -3 dB, -6 dB, -9 dB, -12 dB
  - **Sound pressure level** (fixed speech level)
    - 62 and 75 dB SPL (ANSI S3.5)
  - **Audiogram** (3 different)
    - KS100, Flat50, N4

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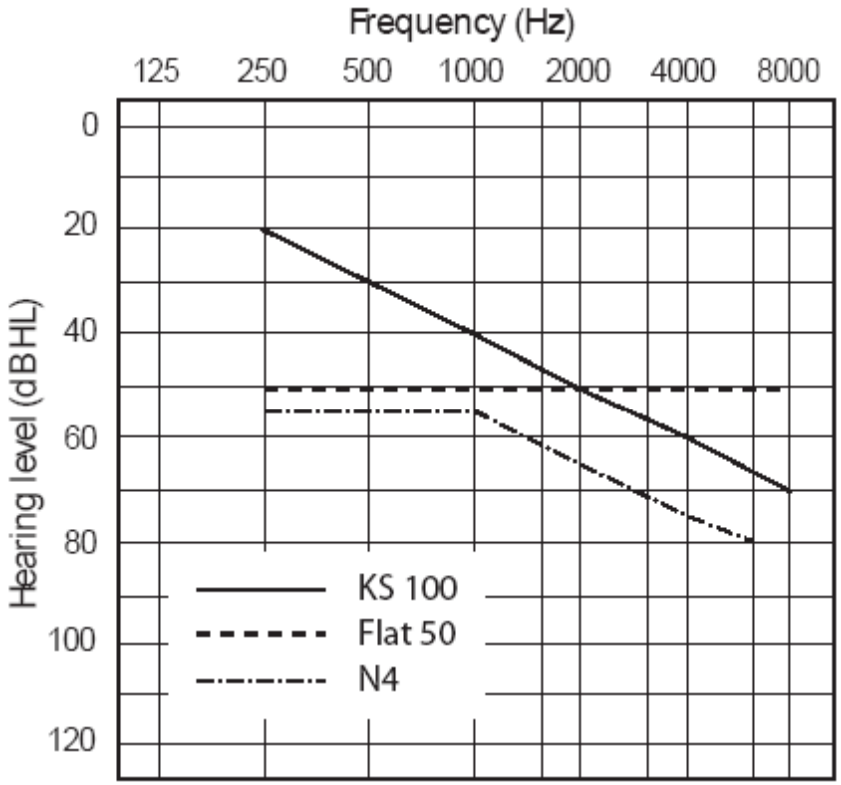
Audiogram



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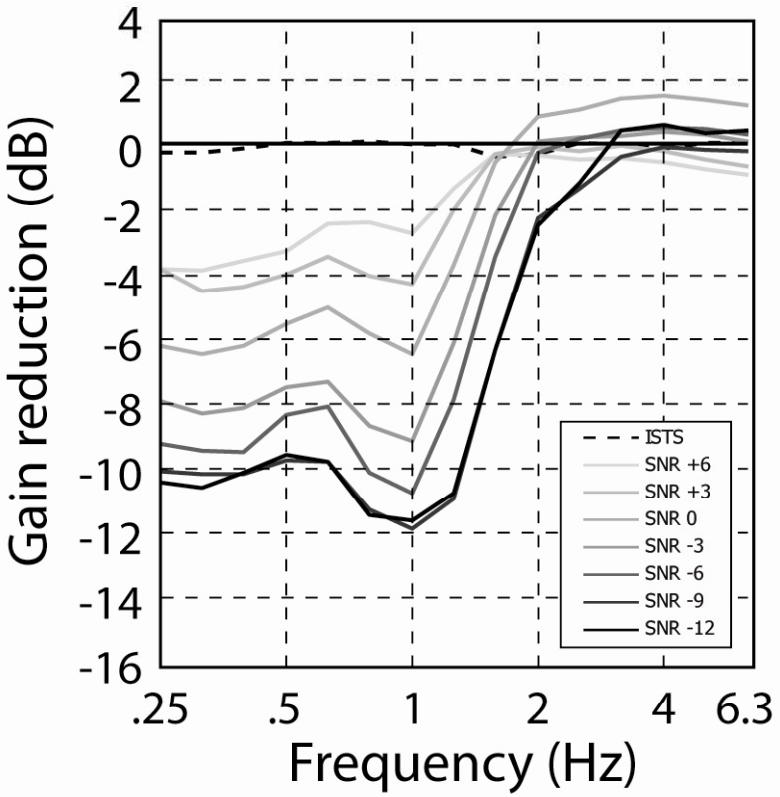
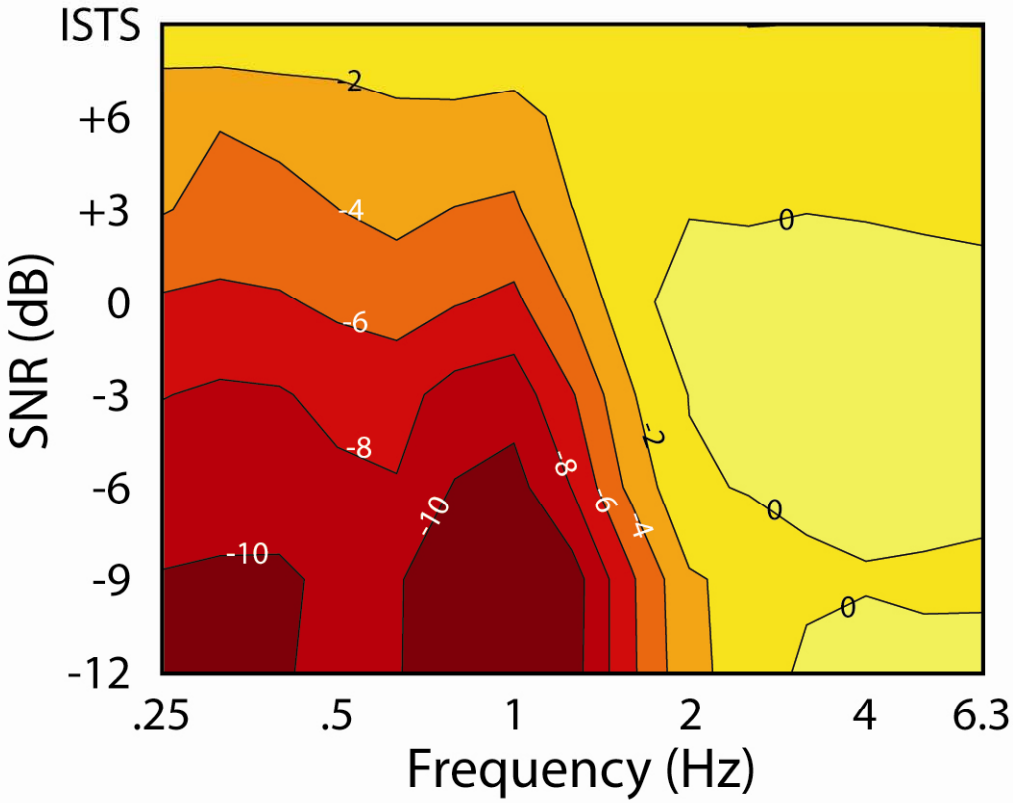
Gain reduction

Gain reduction = ON - OFF



Reduction contours



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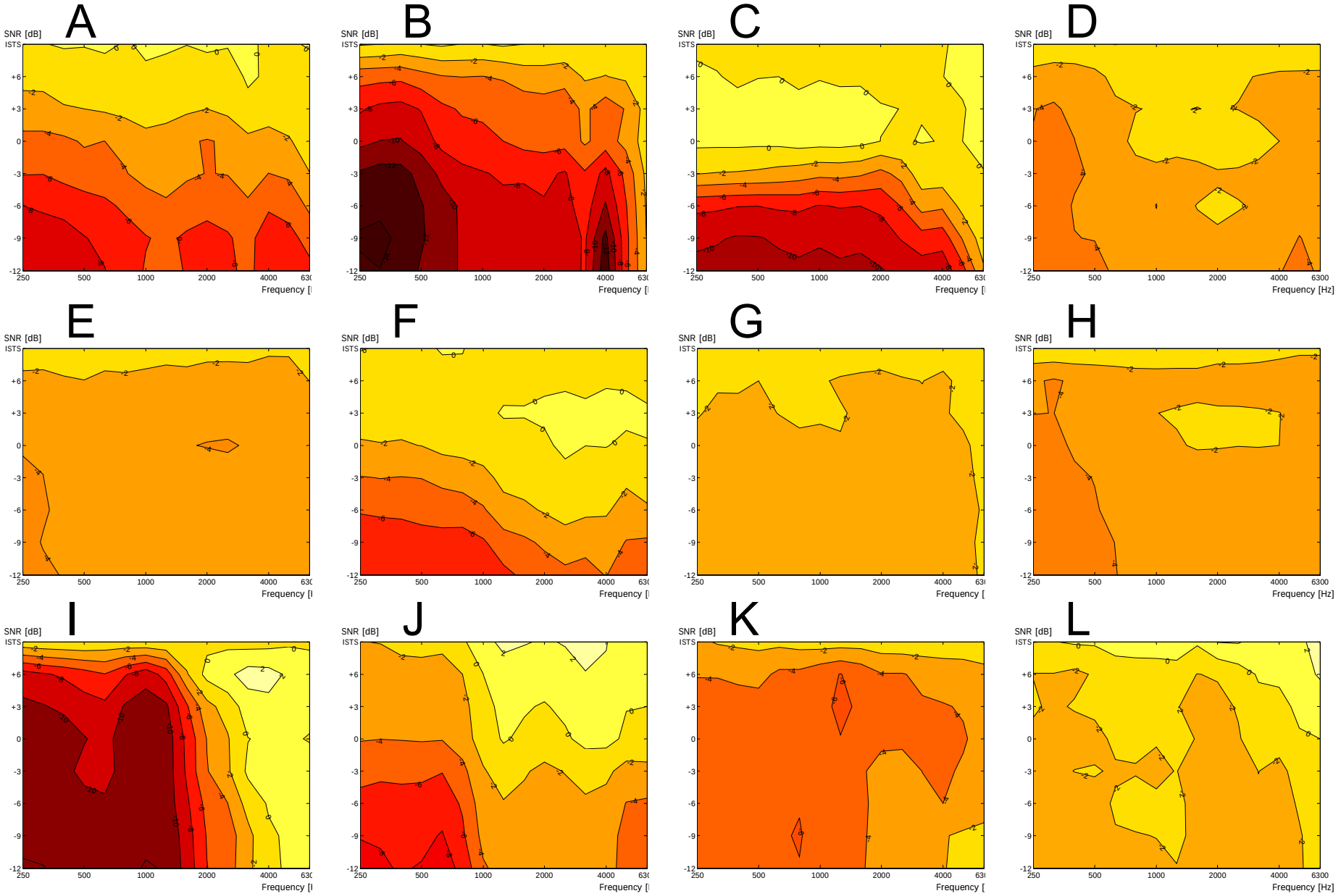
KS100, 75 dB SPL speech



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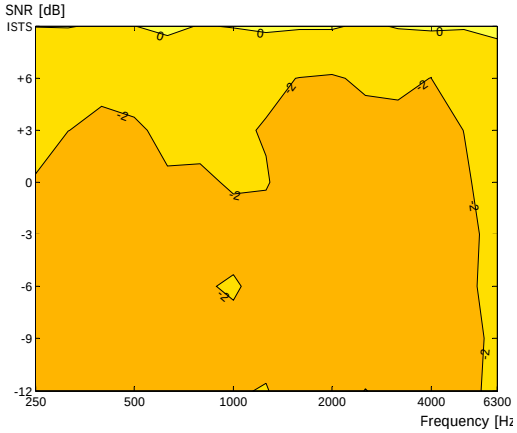
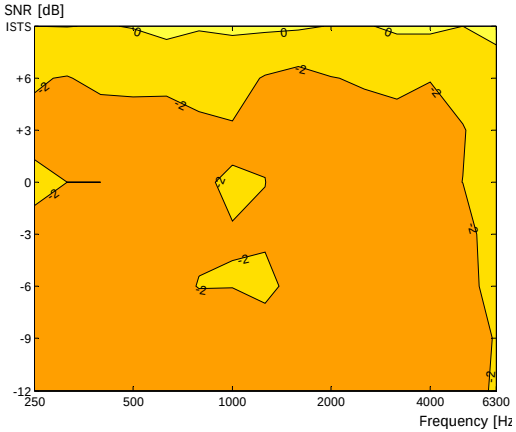
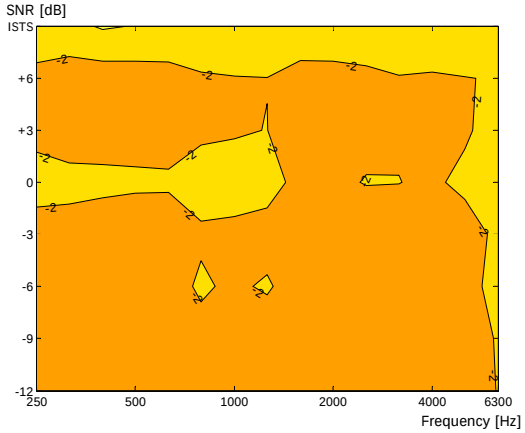
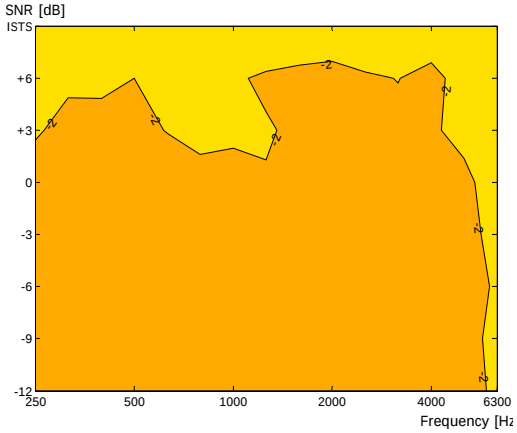
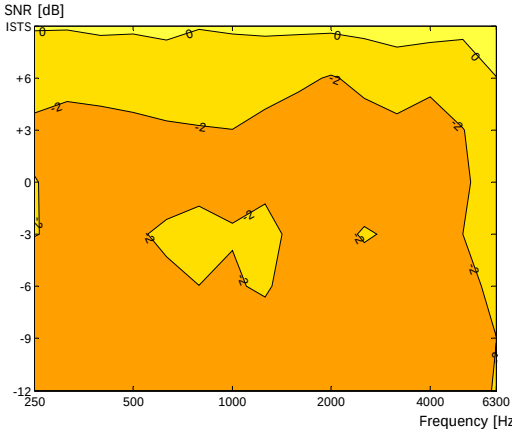
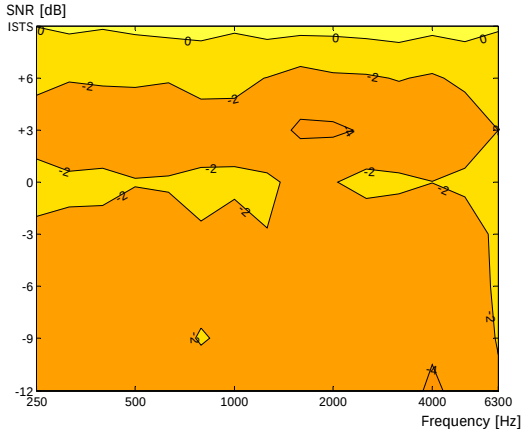
Least reduction and ”least difference”: G

	KS100	Flat50	N4
62 dB SPL			
75 dB SPL			

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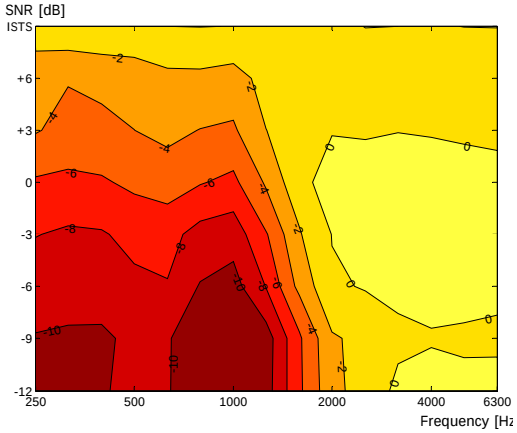
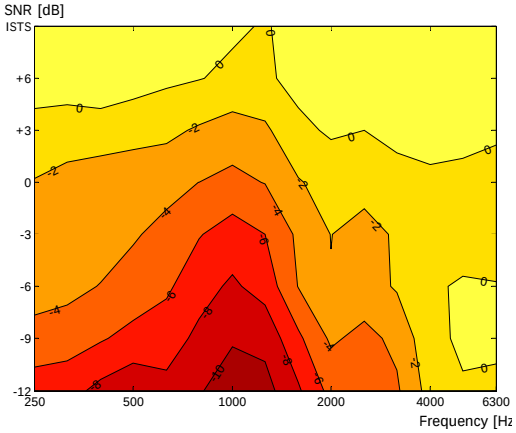
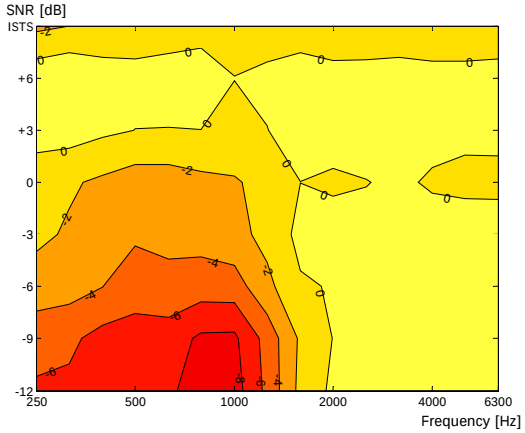
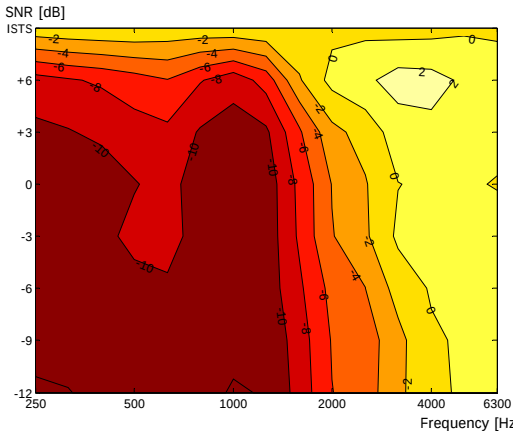
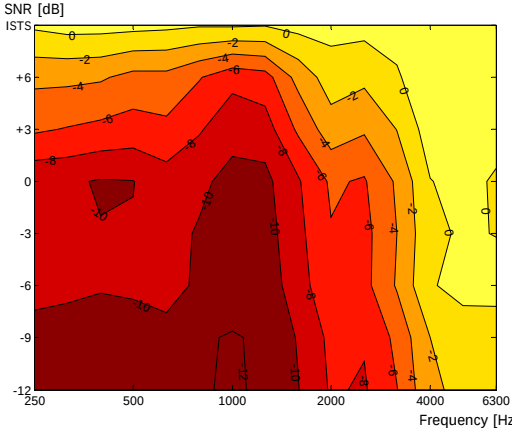
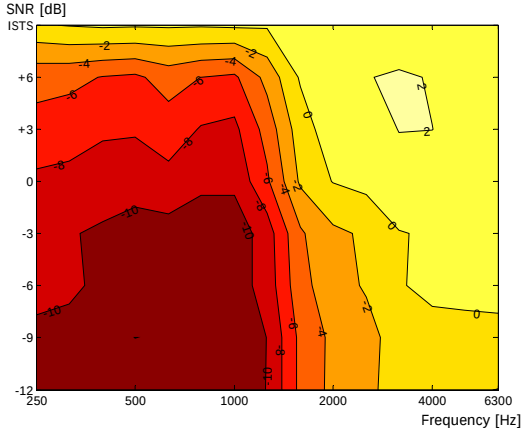
Largest reduction and ”largest difference”: I

	KS100	Flat50	N4
62 dB SPL			
75 dB SPL			

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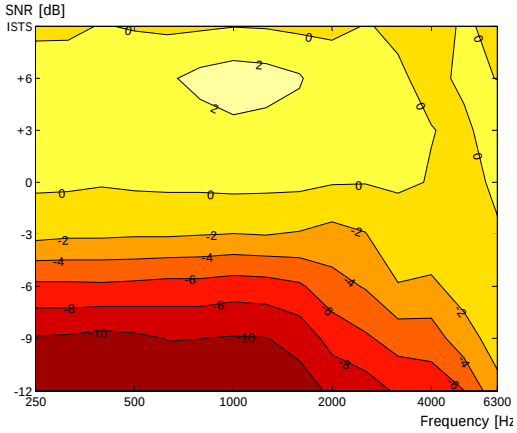
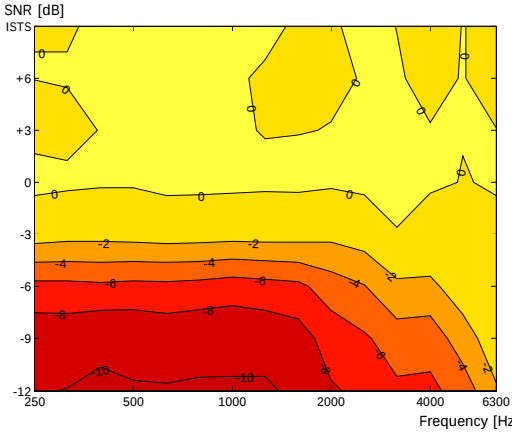
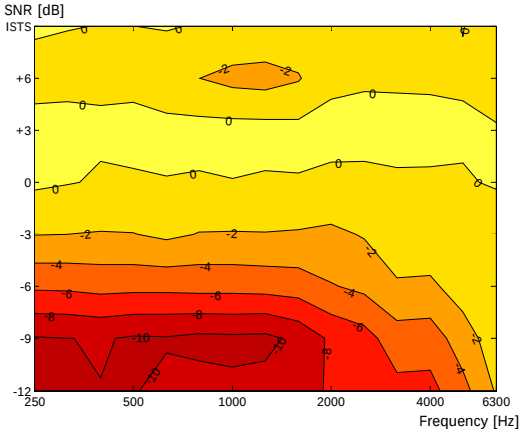
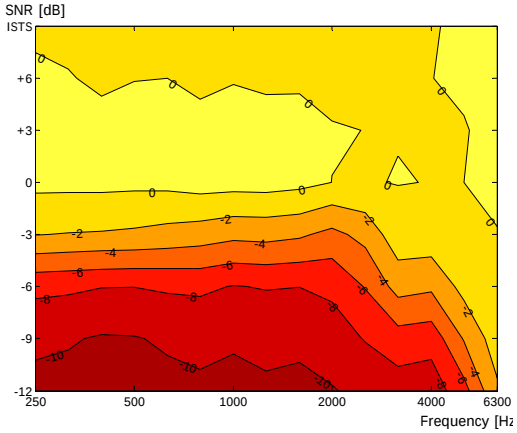
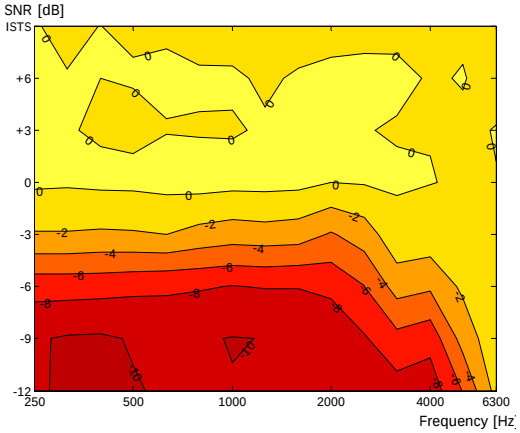
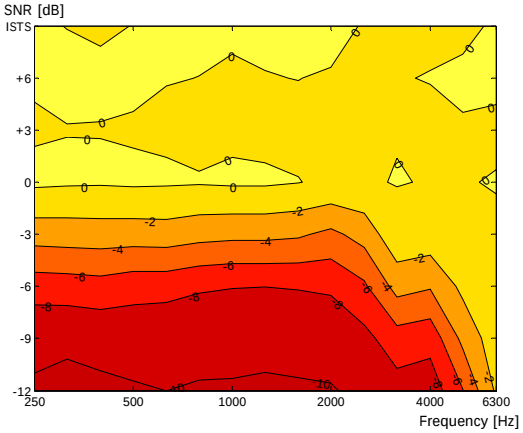
Large reduction and ”small difference”: C

	KS100	Flat50	N4
62 dB SPL			
75 dB SPL			

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Summary

- Large differences!
- Limitations
  - Long-term average reductions
  - We do not know how hearing-aid users perform with the various NR systems
- Next step: Short-term average reductions

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Method

- Programming
  - default prescription
- Hearing aid
  - Mic, OMNI
  - MPO, MAXIMAL
  - Expansion, OFF
  - VC, OFF
  - Feedback reduction, OFF
  - Other sig. proc., OFF
- Equipment
  - Recordings sound card
  - MATLAB processing
  - TBS25 mätbox, IA
  - 711 coupler, GRAS
  - Mic (ref./meas.), GRAS
- Measurements
  - Pre-conditioning: 30 s
  - Short-term average (1/3-oct): 125 ms
  - Updated every 40 ms
  - Hagerman sentences in ICRA1 noise
  - KS100 audiogram

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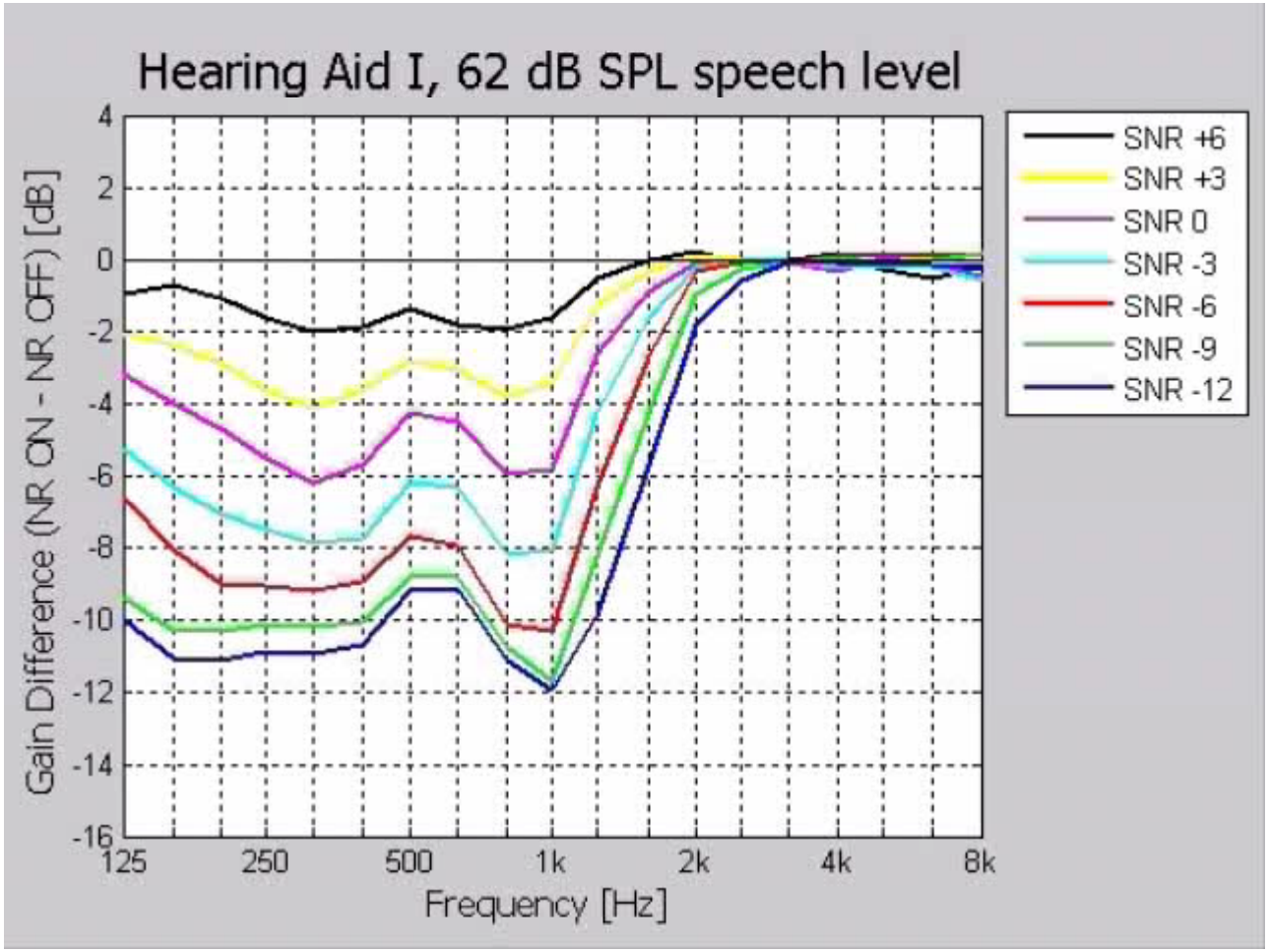

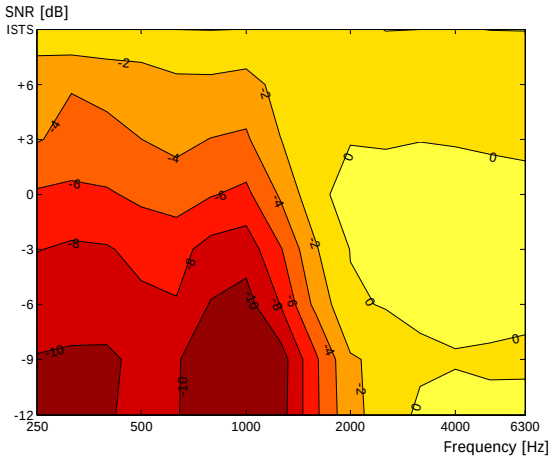

14 measurements (7 SNR, NR on/off) in the same figure.

We will listen to the speech signal without noise.

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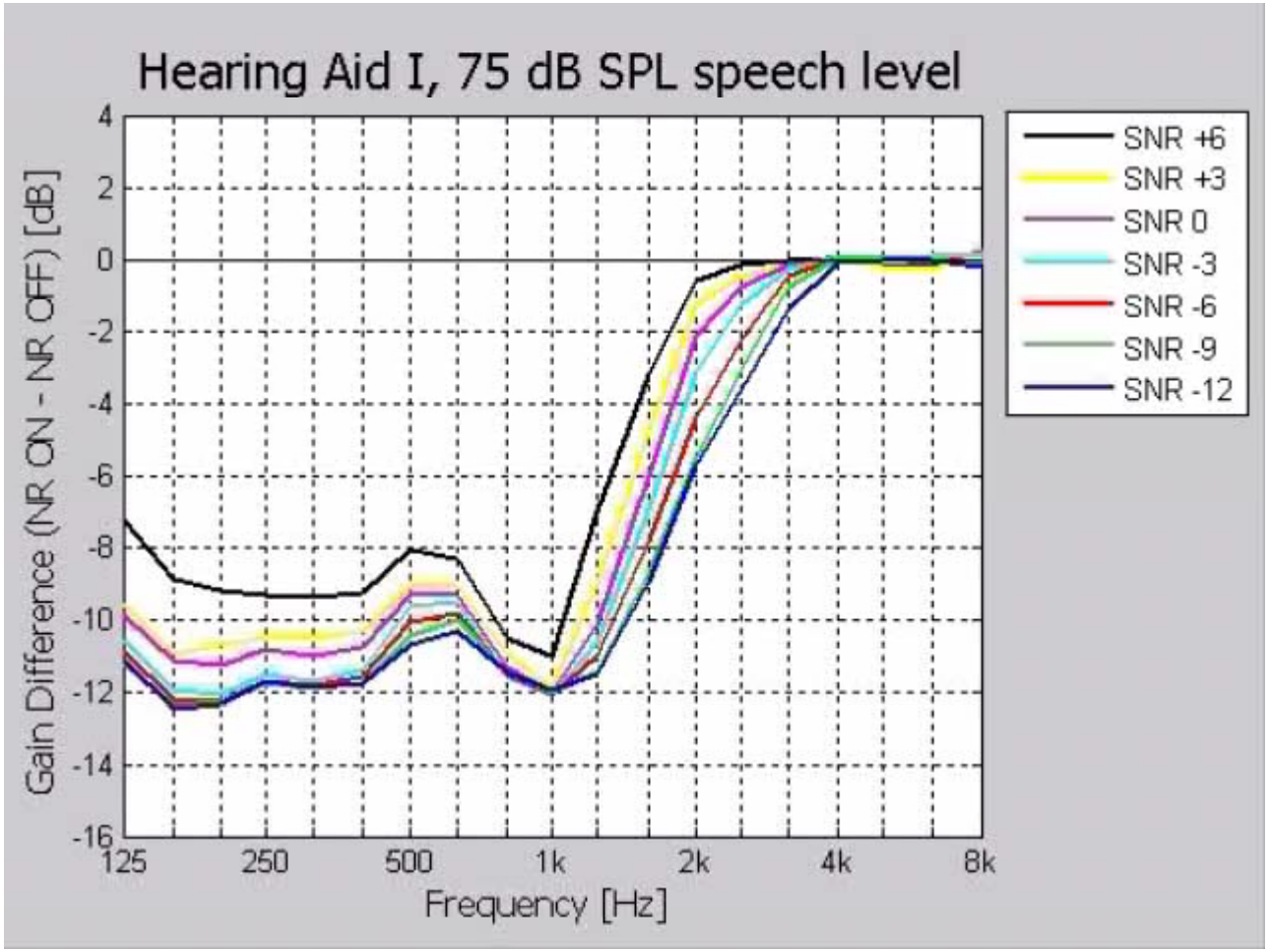
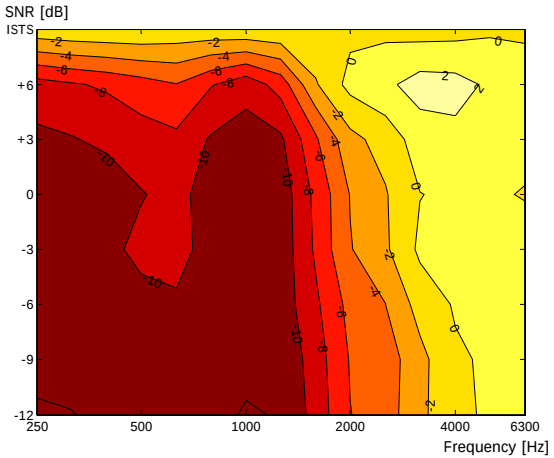

Hearing Aid I, 75 dB SPL speech level
Gain Difference (NR ON - NR OFF) [dB]
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
125
250
500
1k
2k
4k
8k
Frequency [Hz]
SNR +6
SNR +3
SNR 0
SNR -3
SNR -6
SNR -9
SNR -12


SNR [dB]
ISTS
+6
+3
0
-3
-6
-9
-12
250
500
1000
2000
4000
6300
Frequency [Hz]

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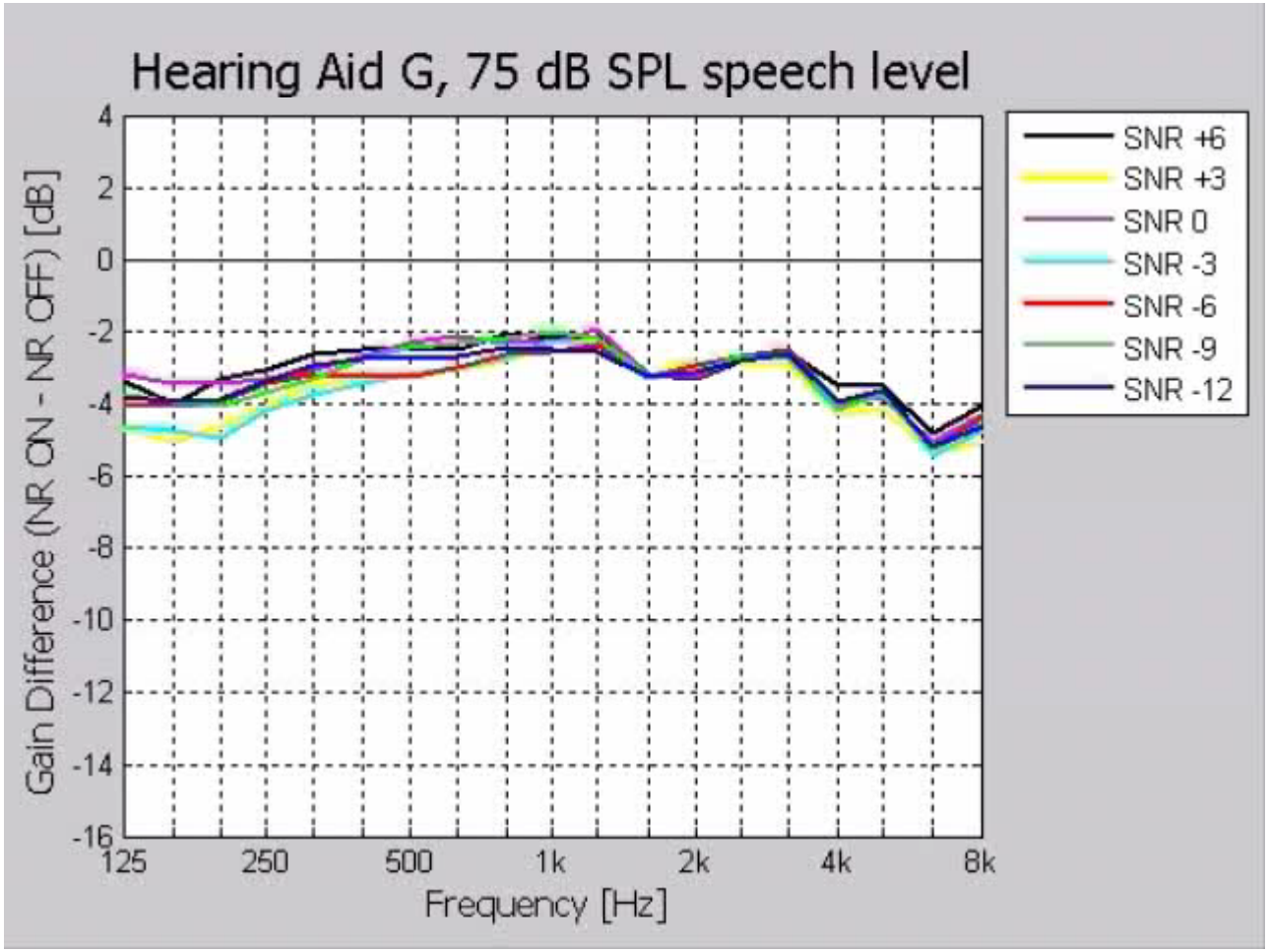
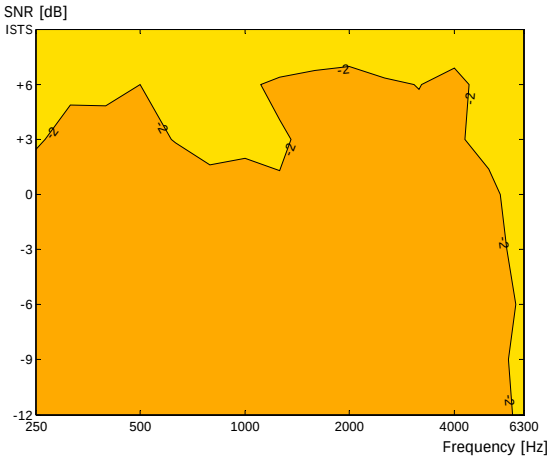

Hearing Aid G, 75 dB SPL speech level
Gain Difference (NR ON - NR OFF) [dB]
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
125
250
500
1k
2k
4k
8k
Frequency [Hz]
SNR +6
SNR +3
SNR 0
SNR -3
SNR -6
SNR -9
SNR -12


SNR [dB]
ISTS
+6
+3
0
-3
-6
-9
-12
250
500
1000
2000
4000
6300
Frequency [Hz]

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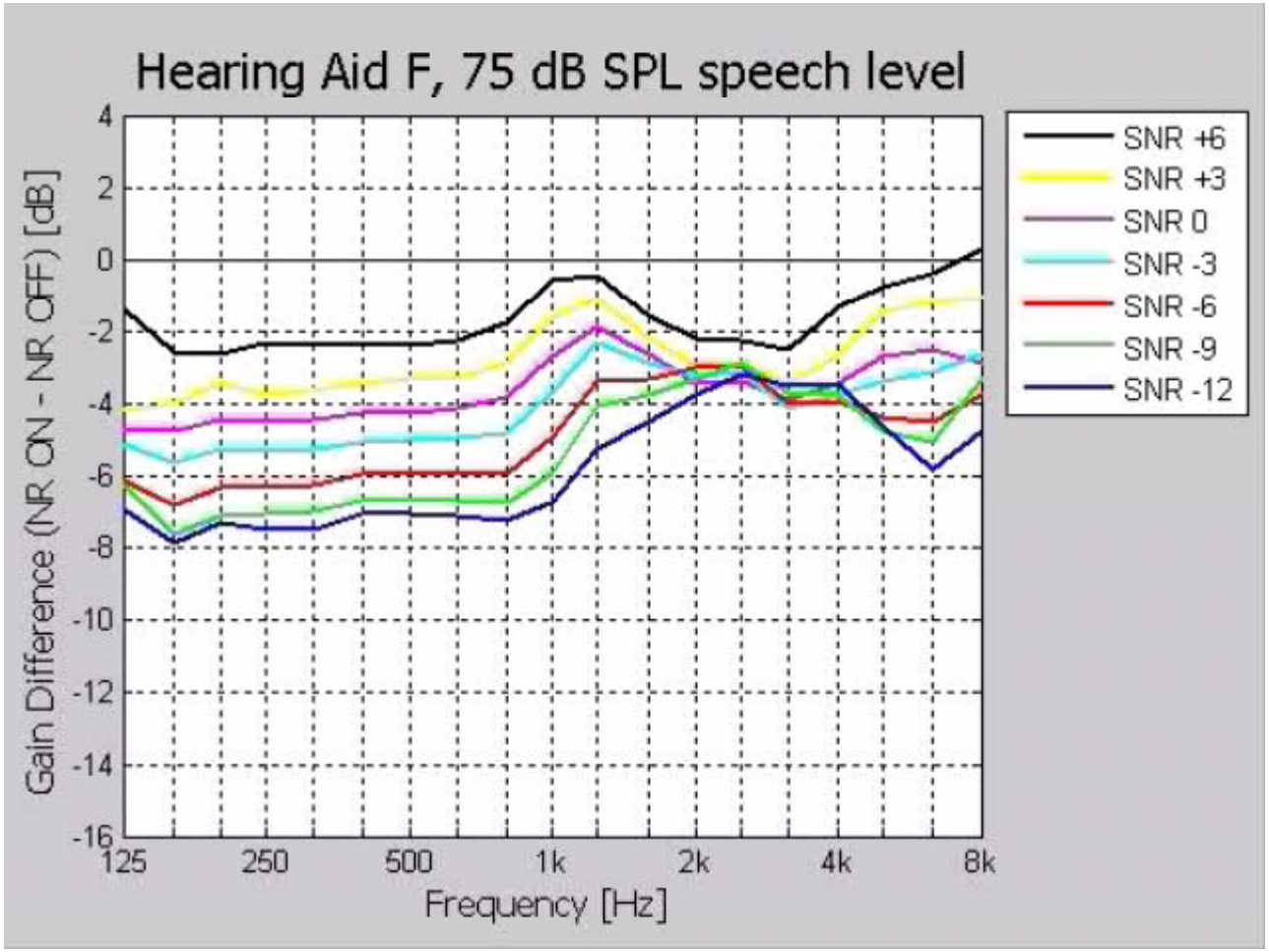
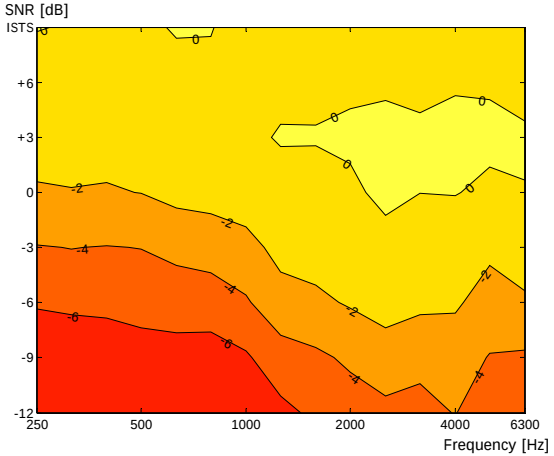

Hearing Aid F, 75 dB SPL speech level
Gain Difference (NR ON - NR OFF) [dB]
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
125
250
500
1k
2k
4k
8k
Frequency [Hz]
SNR +6
SNR +3
SNR 0
SNR -3
SNR -6
SNR -9
SNR -12


SNR [dB]
ISTS
+6
+3
0
-3
-6
-9
-12
250
500
1000
2000
4000
6300
Frequency [Hz]

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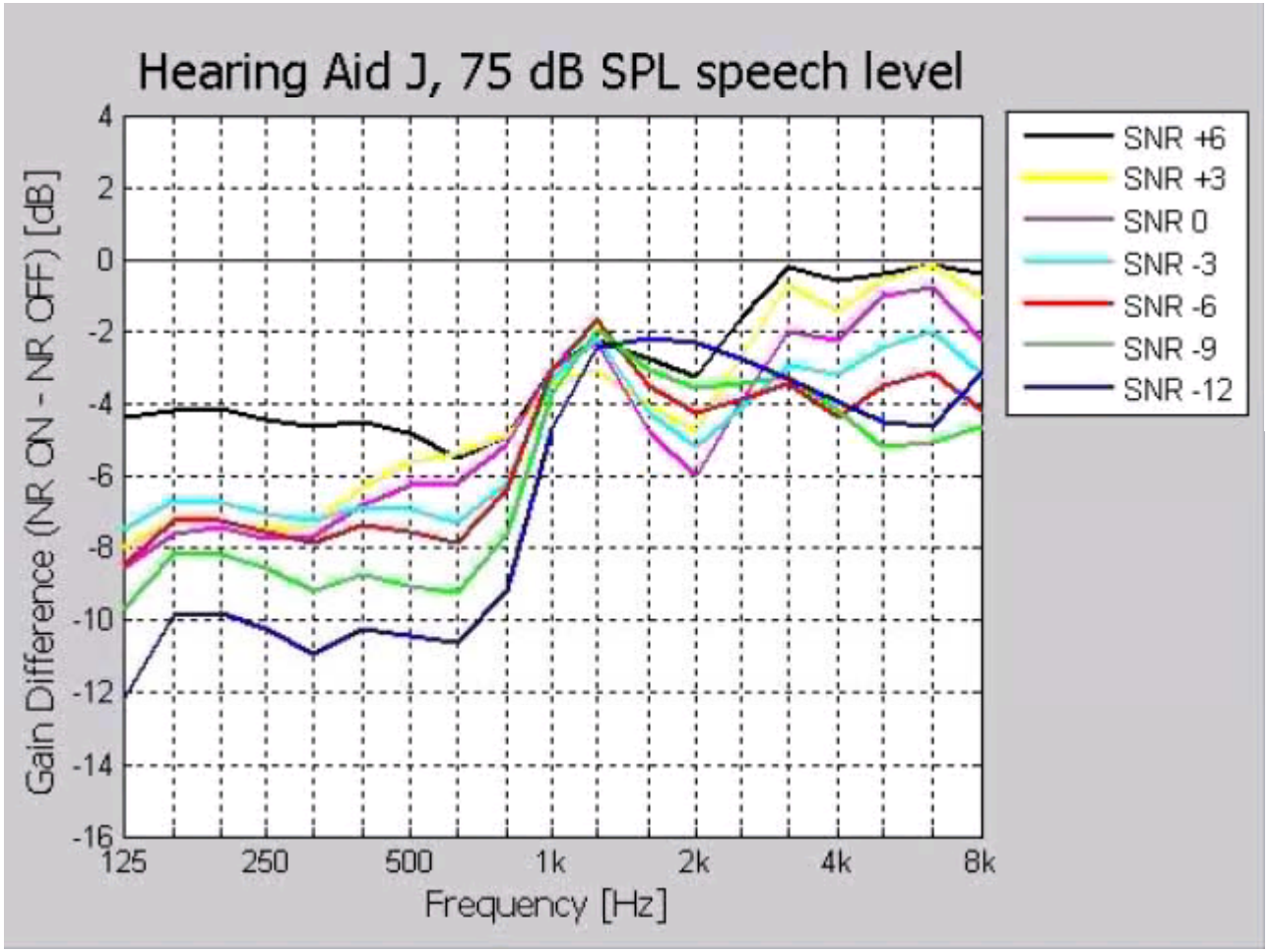
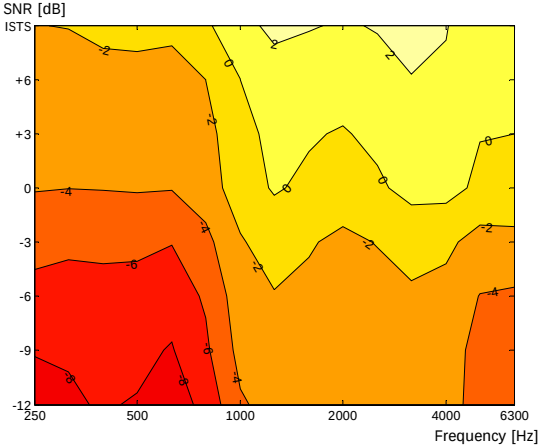

Hearing Aid J, 75 dB SPL speech level
Gain Difference (NR ON - NR OFF) [dB]
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
125
250
500
1k
2k
4k
8k
Frequency [Hz]
SNR +6
SNR +3
SNR 0
SNR -3
SNR -6
SNR -9
SNR -12


SNR [dB]
ISTS
+6
+3
0
-3
-6
-9
-12
250
500
1000
2000
4000
6300
Frequency [Hz]

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Summary

- Large differences in how the various NR systems work!
- The short-term aspects are needed to describe the noise reduction systems (and they most likely have perceptual relevance)
- Clinical relevance?
- Future work
  - Evaluate the systems with hearing-impaired listeners…

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Thank you for your attention!

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