# RP201: Acoustic Consequences of an Adaptive Directional Microphone, Noise Reduction, and Split Processing

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Thursday March 31, 2022
11:45 AM – 12:15 PM

AAA 2022 + HearTECH EXPO

# DISCLOSURE

Relevant Financial Relationship:

- All contributors are employees of ORCA-USA, WS Audiology.

# STUDY OBJECTIVE

- **Compare** traditional **single stream** hearing aid processing to **new split processing** via acoustic measurements.
- Examine the output level and the output SNR when using **split processing** (SP) technology, and single stream based **digital noise reduction** (DNR), and **adaptive directional microphone** (ADIR).

# NOISE TOLERANCE

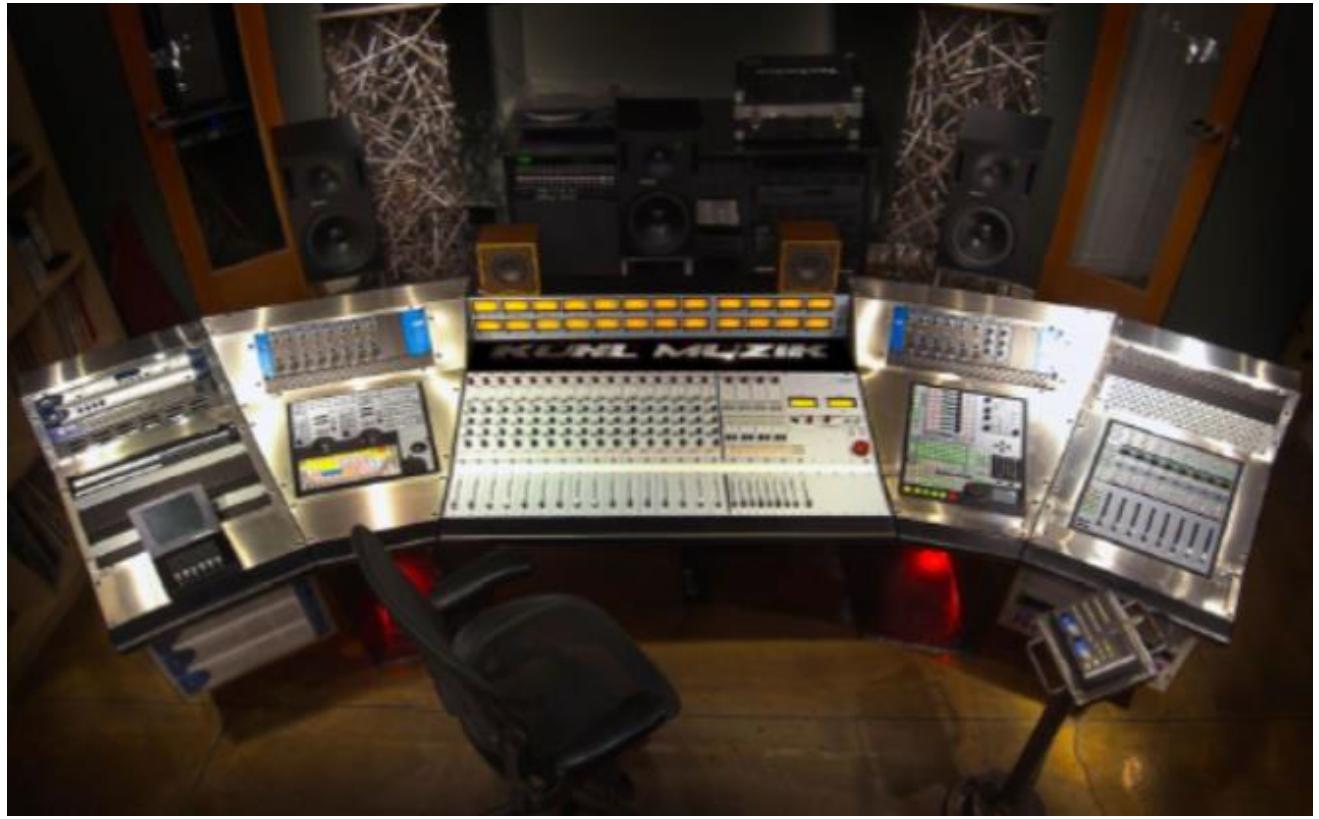
- Communication in noise is a major challenge.
  - Noise masks speech cues.
  - Adds to annoyance of the listening situations.
  - Compromises ease of communication.
- Traditional HA technologies addressing speech in noise problem include.
  - Directional microphones.
  - Noise reduction algorithms.

# **TRADITIONAL** HEARING AID APPROACH

WSAudiology

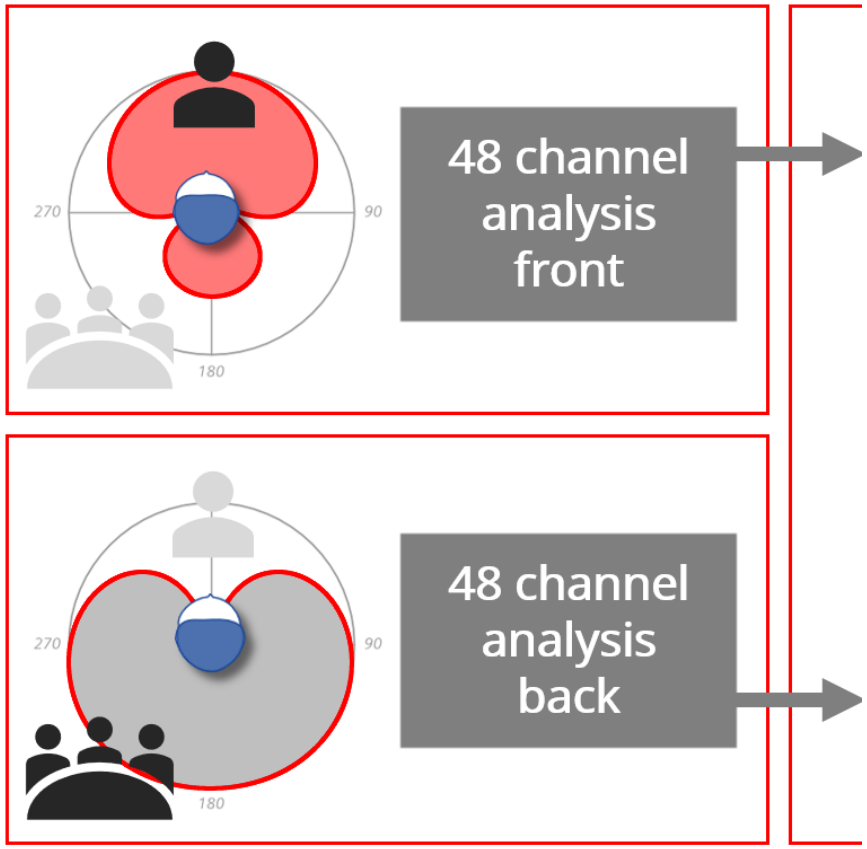
ORCA USA

# INSPIRATION FOR SPLIT PROCESSING

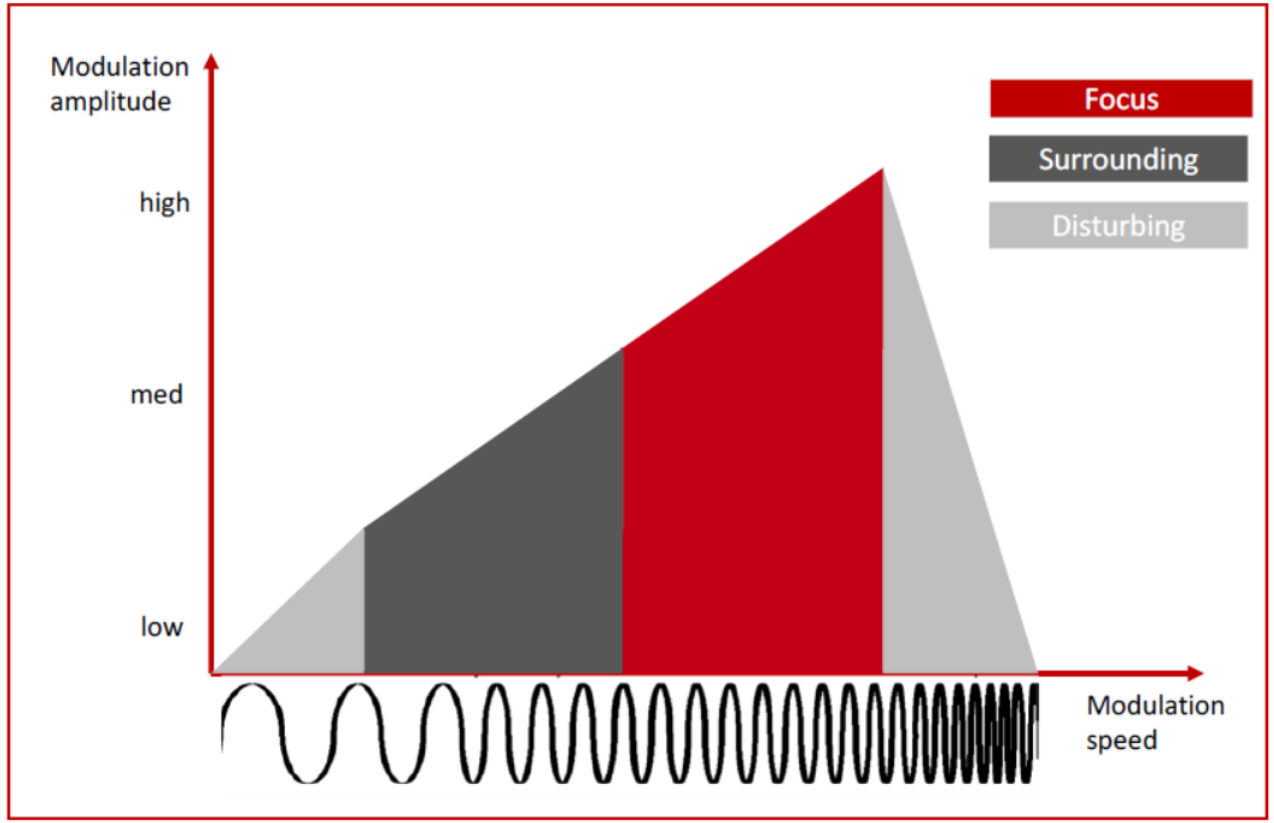


**Could we adjust different sound sources separately?**

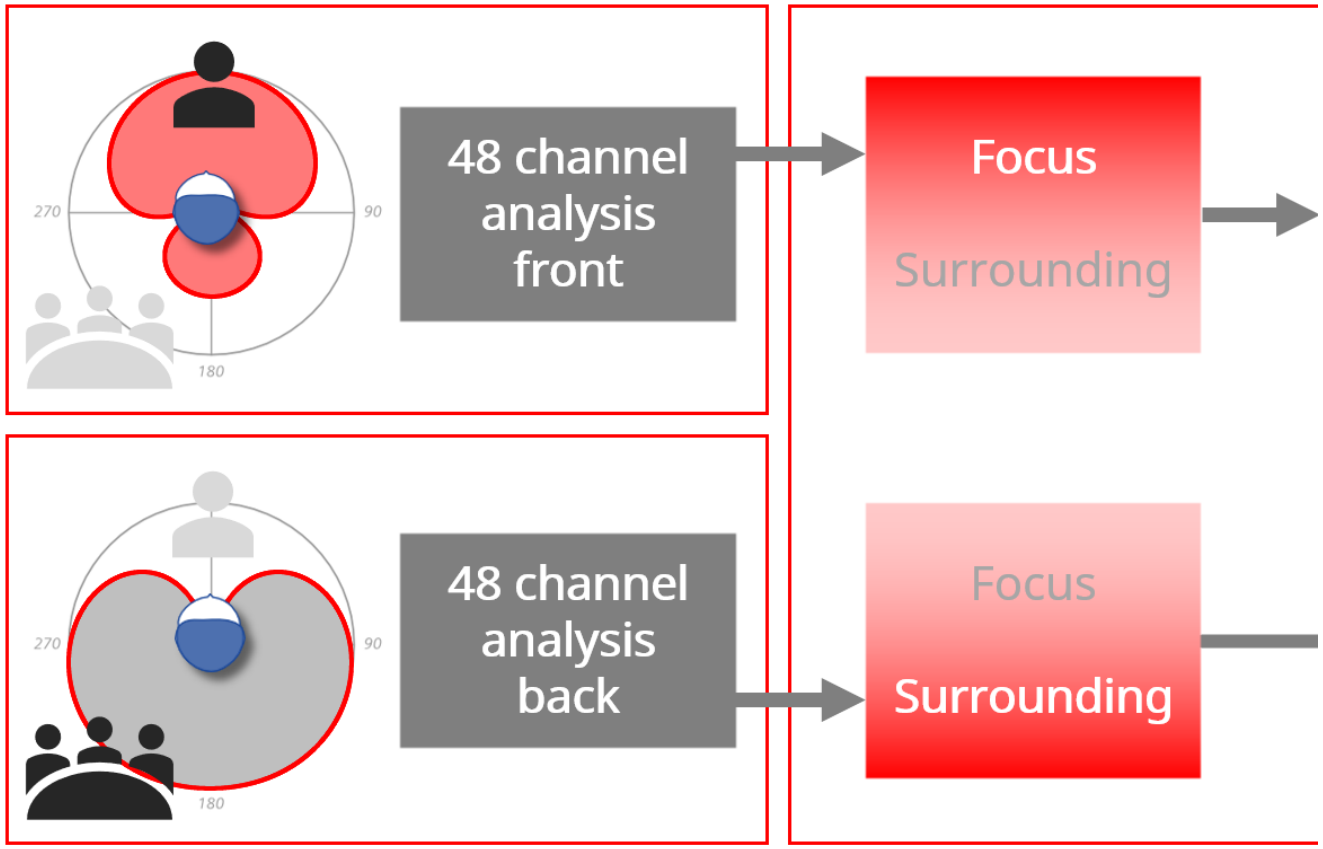
# SPLIT PROCESSING

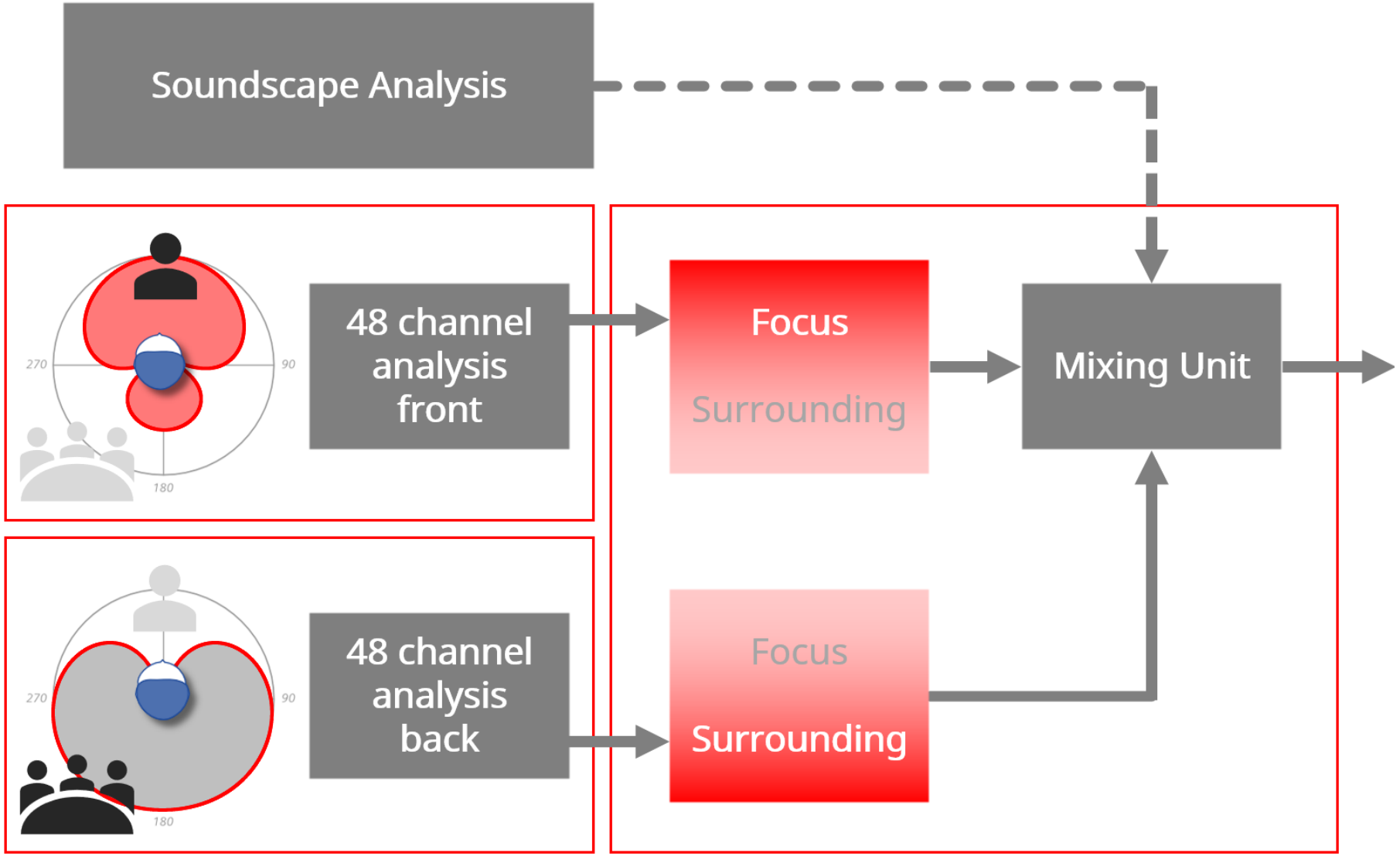


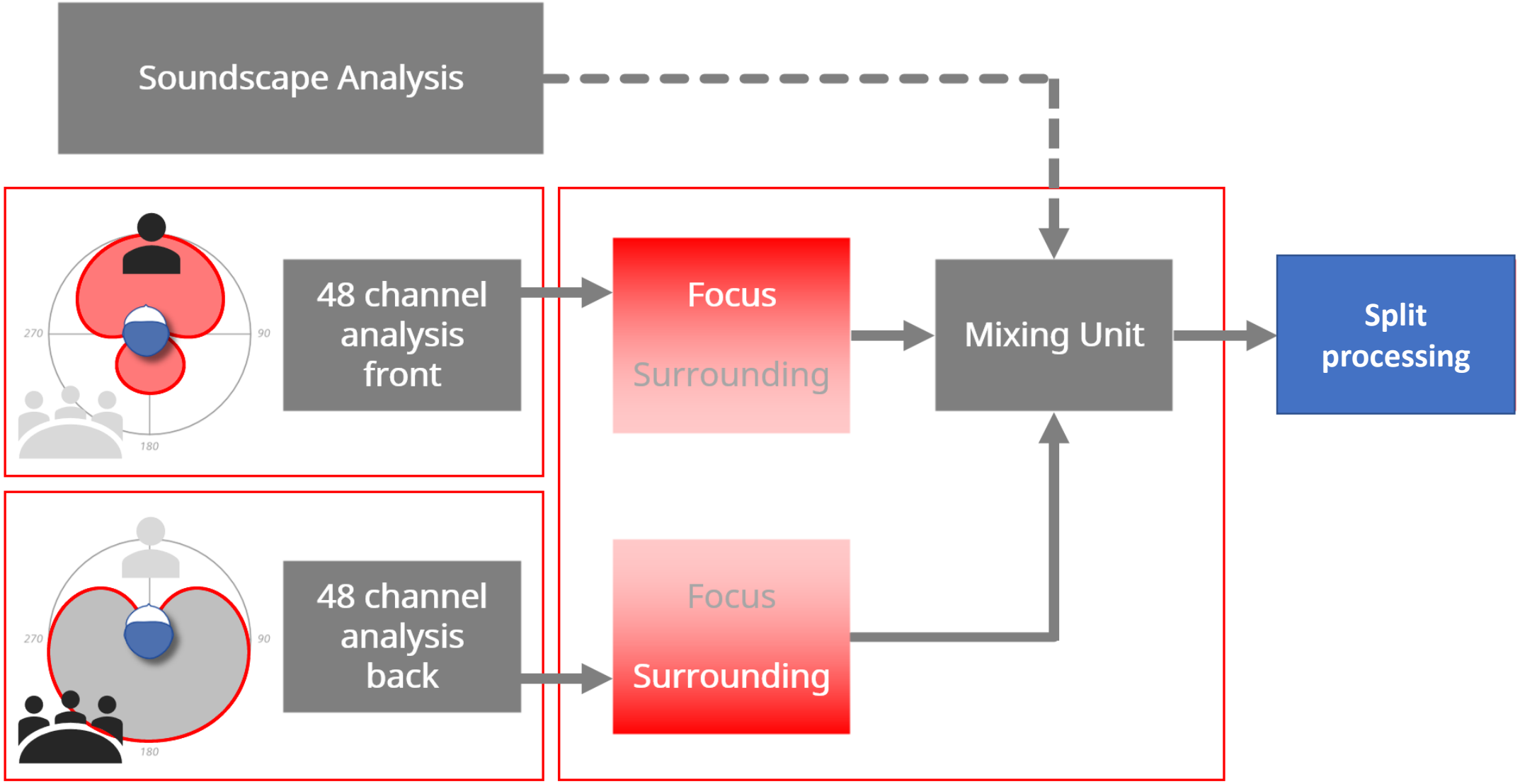
# SPLIT PROCESSING



# SPLIT PROCESSING




Soundscape Analysis
270
90
180
48 channel analysis front
Focus
Surrounding
Mixing Unit
270
90
180
48 channel analysis back
Focus
Surrounding


Soundscape Analysis
270
90
180
48 channel analysis front
Focus
Surrounding
Mixing Unit
Split processing
270
90
180
48 channel analysis back
Focus
Surrounding

# SPLIT PROCESSING

- Focus sounds processed more linearly.
- Distractor sounds more attenuated and compressed.

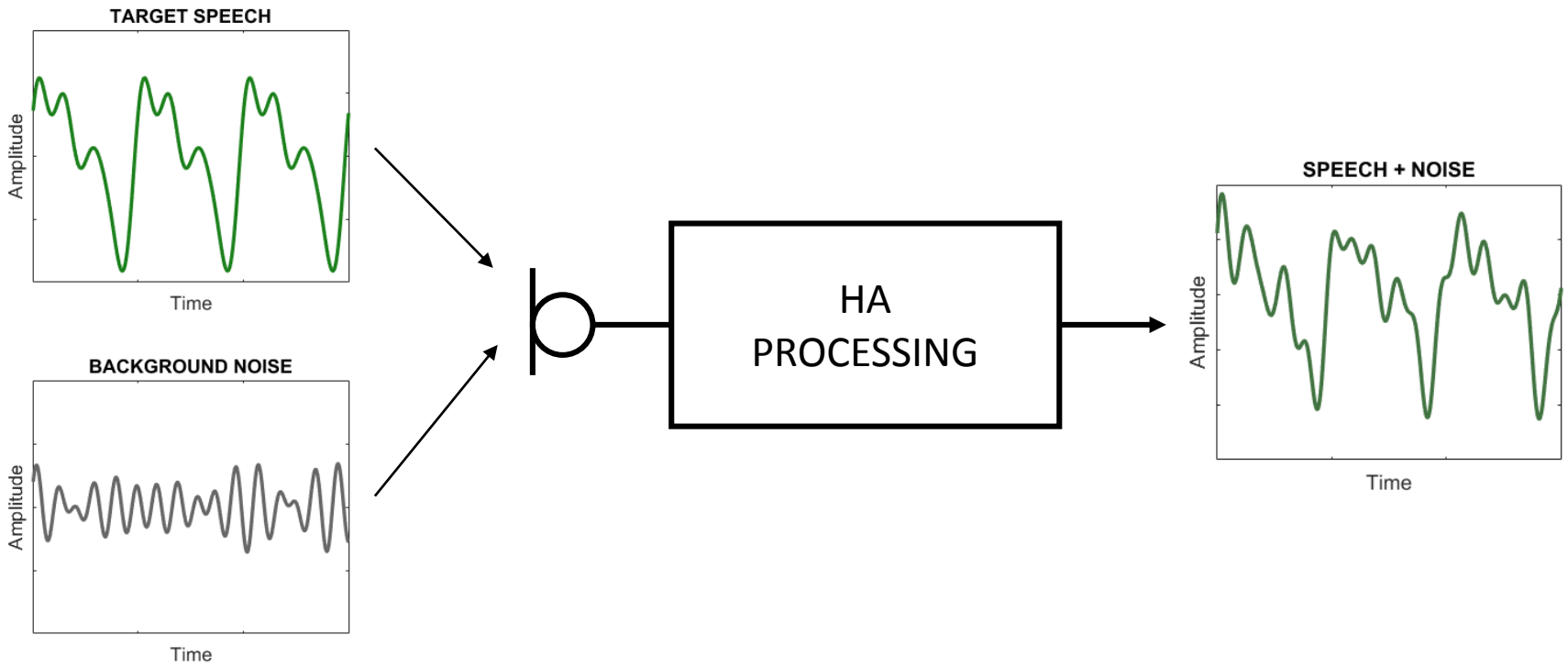
- Increases the contrast between focus and surrounding

  → Speech stands out as being clearer and easier to understand.

# SPLIT PROCESSING BEHAVIORAL EVIDENCE

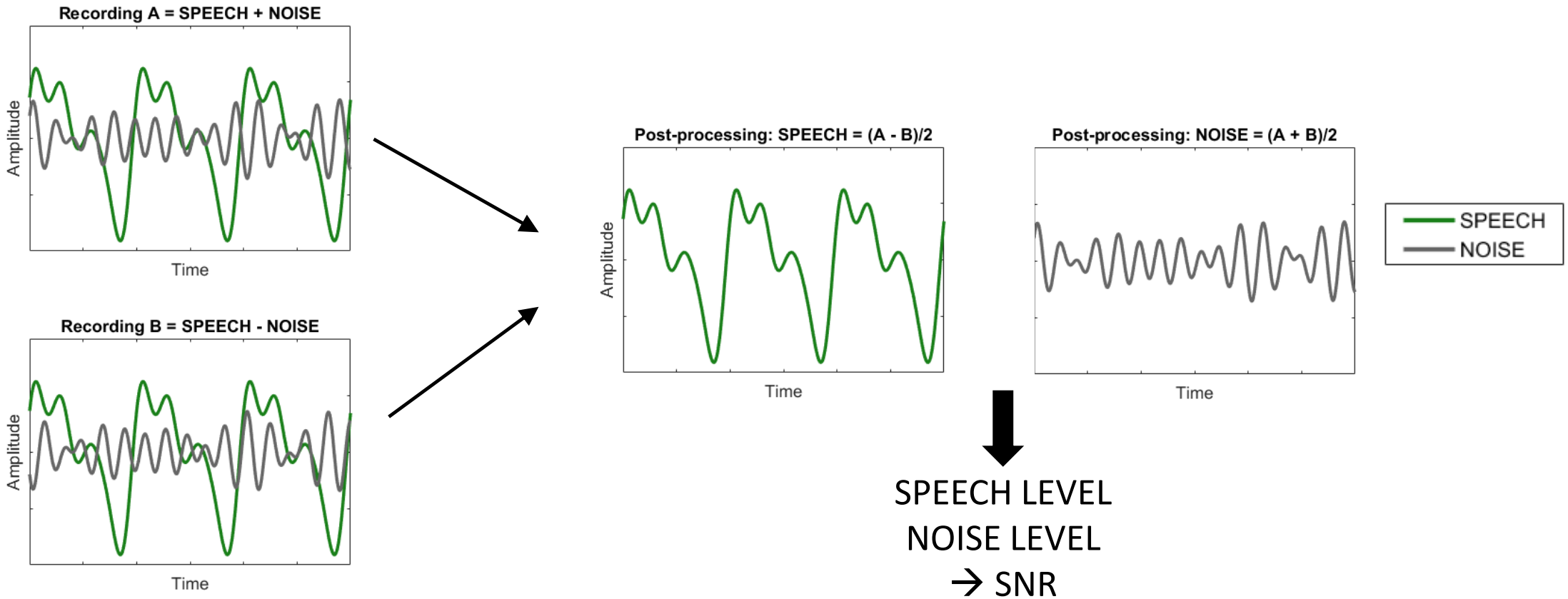
- Split processing has been demonstrated to improve
  - Speech recognition performance (Jensen et al., 2021).
    - 3.9 dB improvement in the speech reception thresholds (SRT80).
  - Noise tolerance (Kuk et al., 2021)
    - 3 dB improvement in noise tolerance over single-stream based processing ADIR+DNR.
    - 8 dB improvement over unaided and aided single-stream processing in omnidirectional mode (with DNR).
- Would the acoustic analysis reveal in detail why?
  - Overall output? Speech output? Noise output?

# PROBLEM



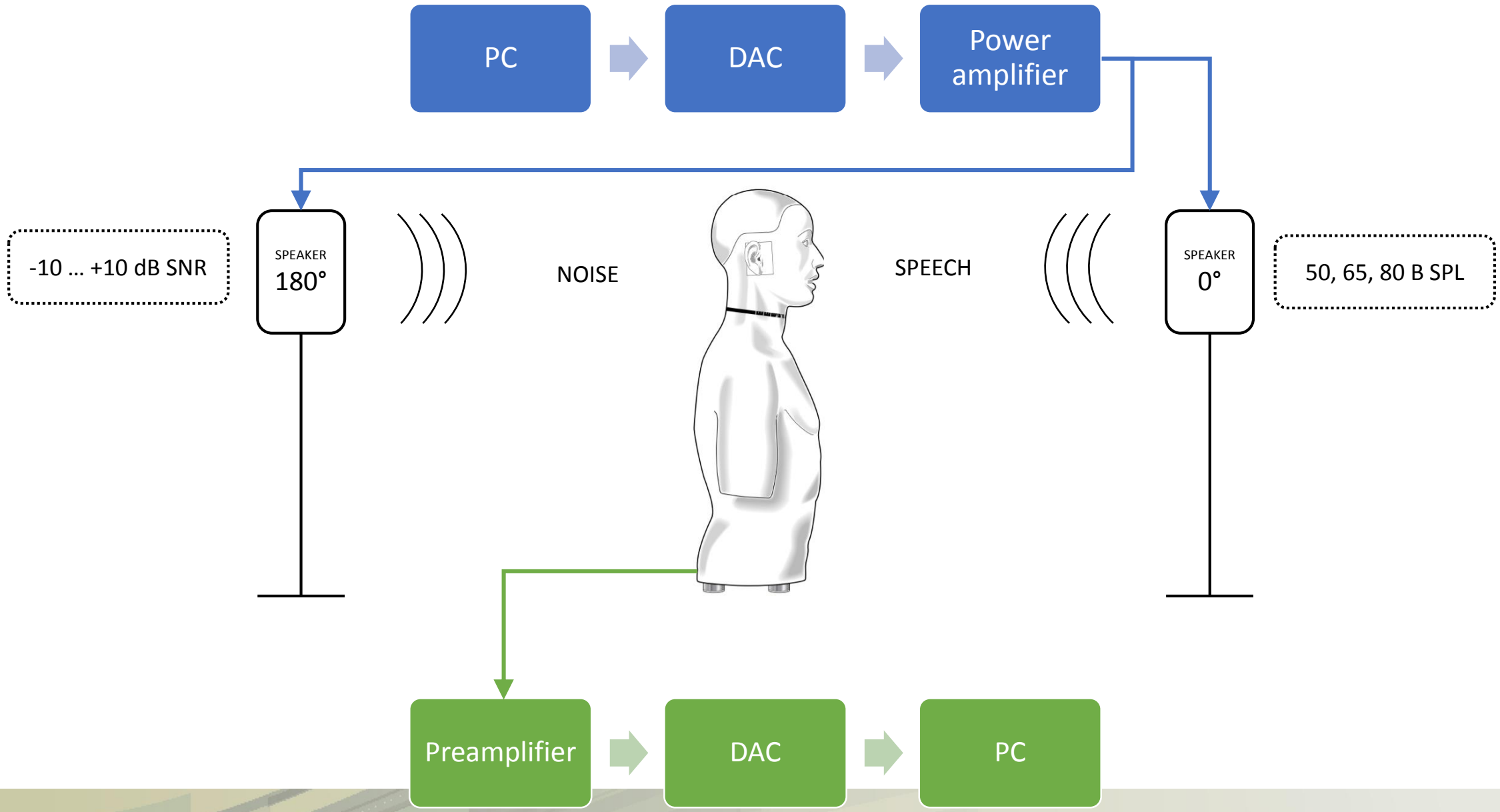

What happened to the speech?
What happened to the noise?
What is the SNR?

# SOLUTION:
# HAGERMAN PHASE INVERSION



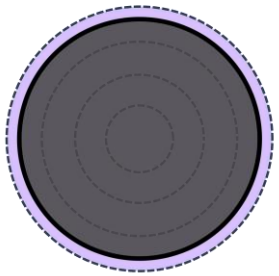

SPEECH LEVEL
NOISE LEVEL
→ SNR

# THE STUDY

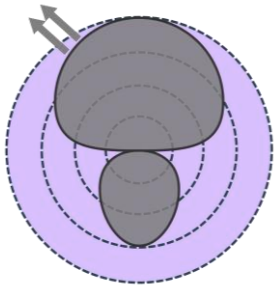

PC
DAC
Power amplifier
-10 … +10 dB SNR
SPEAKER
180°
NOISE
SPEECH
SPEAKER
0°
50, 65, 80 B SPL
Preamplifier
DAC
PC

# METHODS: HEARING AIDS

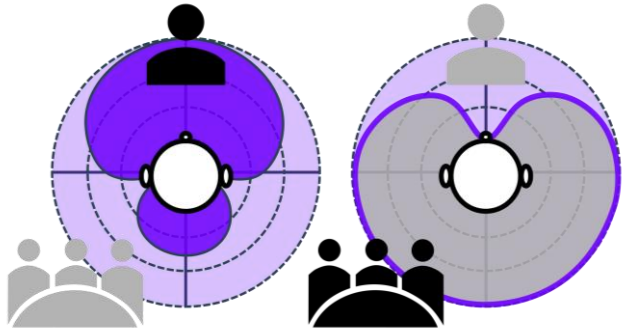
- HA with and without split processing (Signia AX).
- N3 standard audiogram (NAL-NL2 gain prescription).
- Fully occluded.
- HA conditions:
  - Single stream based:
    - Omnidirectional microphone (no DNR)
    - Adaptive directional microphone mode (with DNR).
  - Split processing:
    - Adaptive directionality and DNR.



OMN



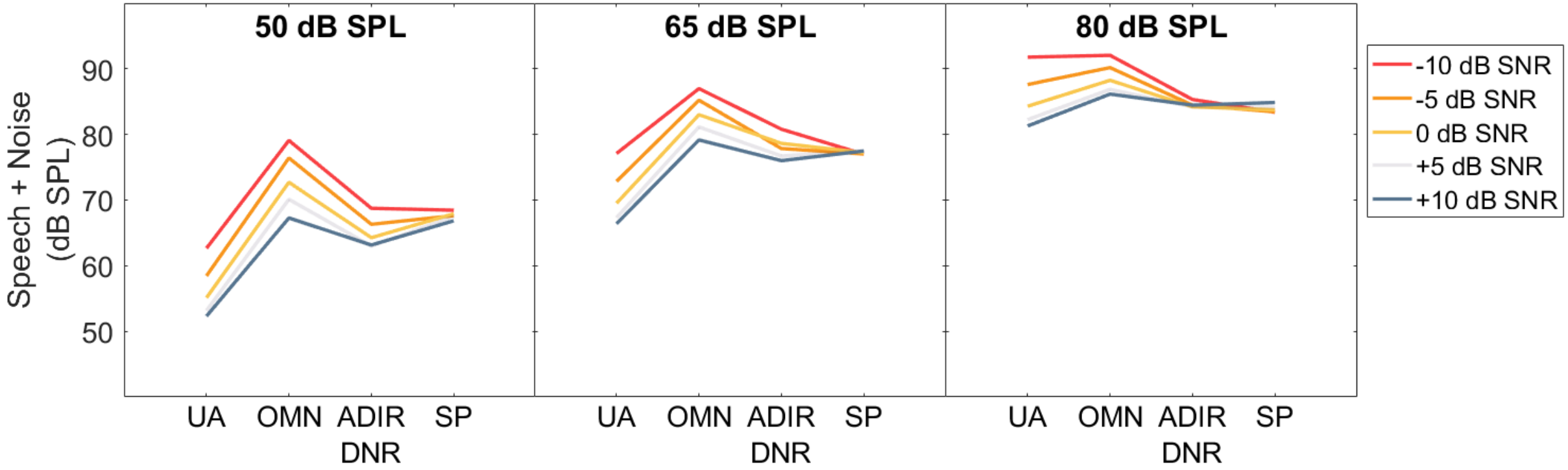
ADIR-DNR

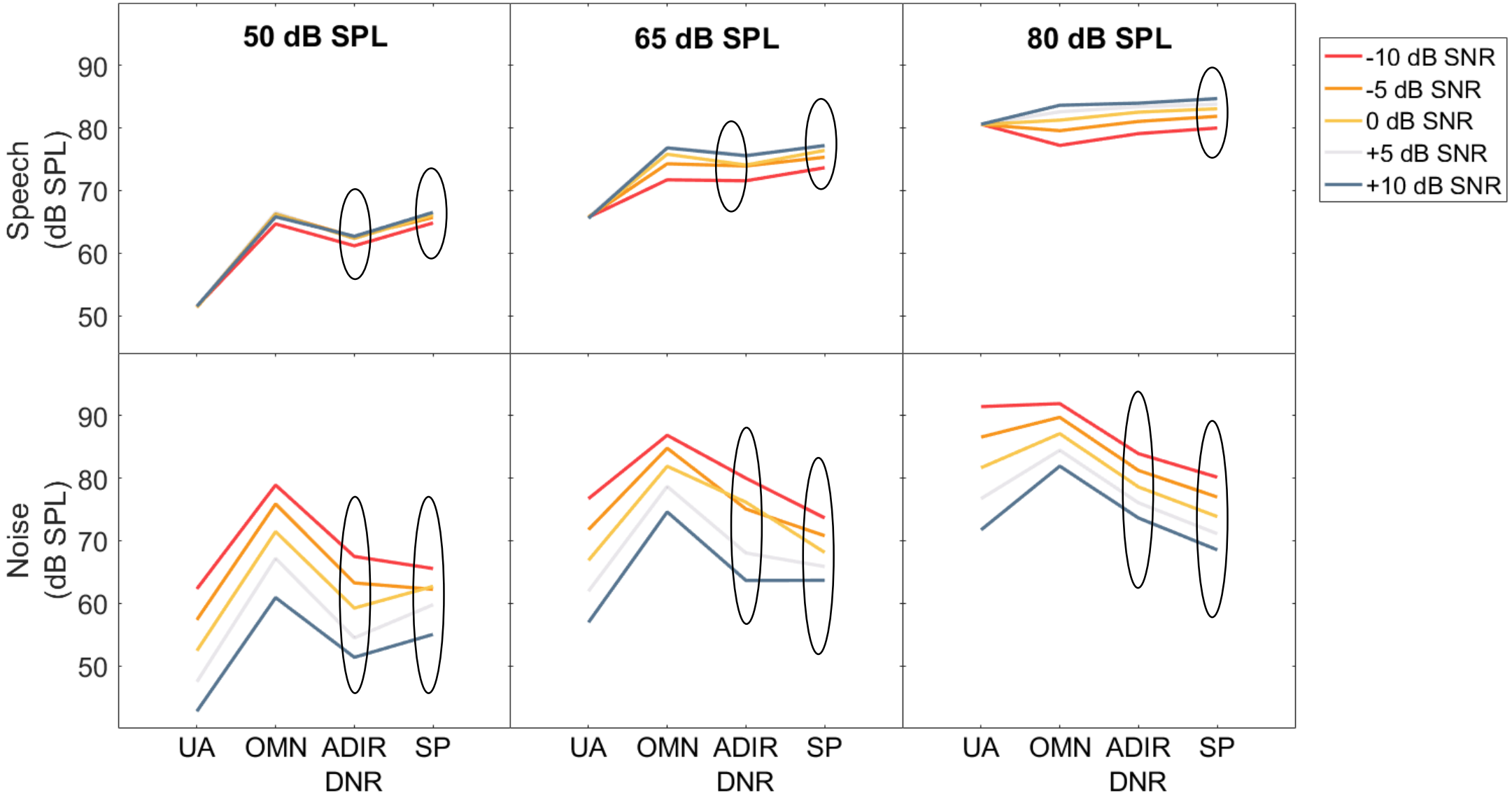


SP

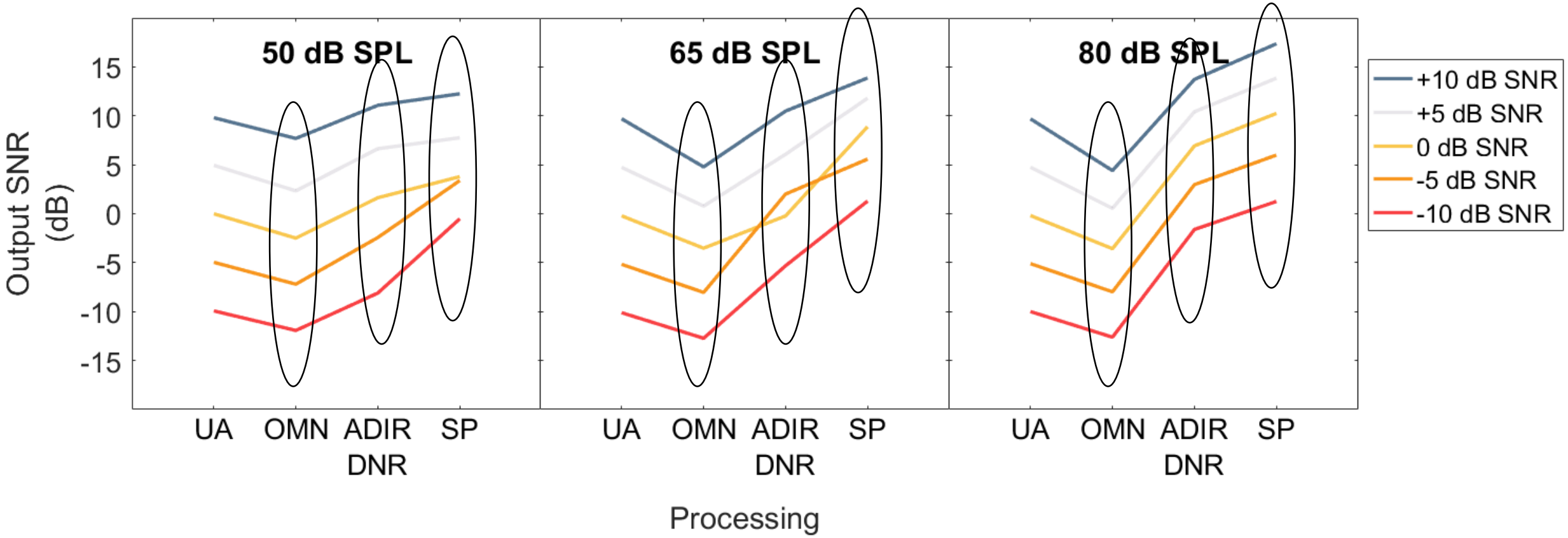
# RESULTS

# TOTAL OUTPUT

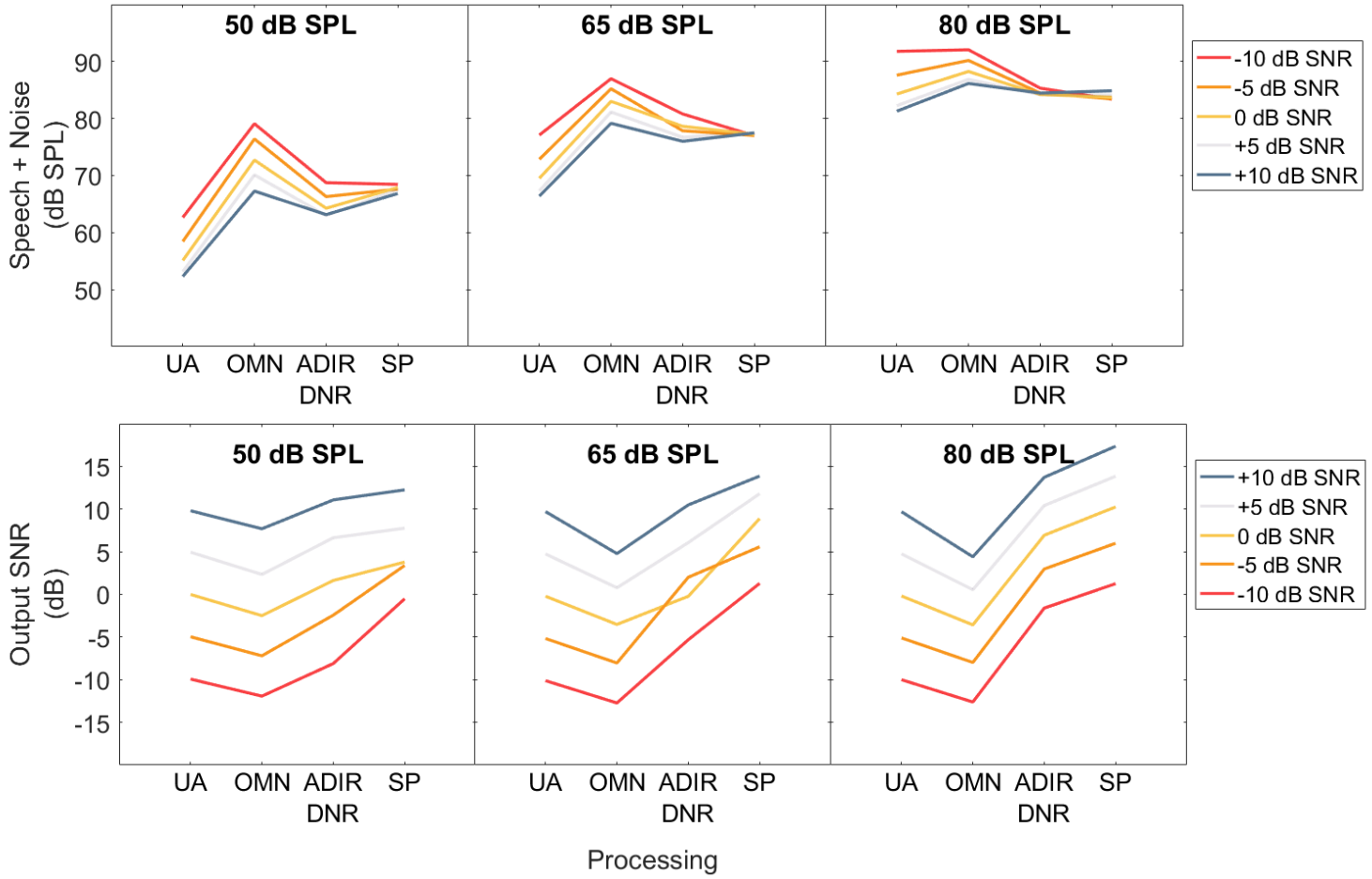



50 dB SPL
65 dB SPL
80 dB SPL
Speech (dB SPL)
Noise (dB SPL)
90
80
70
60
50
UA
OMN
ADIR
DNR
SP
-10 dB SNR
-5 dB SNR
0 dB SNR
+5 dB SNR
+10 dB SNR

# OUTPUT SNR


50 dB SPL
65 dB SPL
80 dB SPL
Output SNR (dB)
15
10
5
0
-5
-10
-15
UA
OMN
ADIR DNR
SP
Processing
+10 dB SNR
+5 dB SNR
0 dB SNR
-5 dB SNR
-10 dB SNR

# OUTPUT LEVEL, OUTPUT SNR



# SUMMARY

- Phase inversion technique allows **analysis of speech and noise separately**.
- SP improved the output SNR over traditional single-stream processing across all input levels and SNR conditions.
- Average SNR improvement with split processing:
  - 7.9 dB re: unaided.
  - 11.1 dB re: single-stream omni.
  - 4.2 dB re: single-stream processing with advanced features.
- The improvement in output SNR was achieved without compromising the speech output level across all input levels.

# POTENTIAL CLINICAL IMPLICATIONS OF SPLIT PROCESSING

- Overall level was reduced while improving the output SNR
  - Less sound – better SNR.
- Speech stand out as being clearer and easier to understand.
- Focus sound being perceived as being closer than the surrounding sounds.
- Separate and fast adjustment for surround sounds improves stability of the sounds.

# MORE RESEARCH ON SPLIT PROCESSING AT AAA

- **Using Tracking of Noise Tolerance to Measure the Efficacy of Split Processing**
  - Friday: 3:45 PM – 4:15 PM CTRP313 - Location: 224
- **Using Electroencephalography to Evaluate the Benefit of Split-processing in Hearing Aids**
  - Friday: 4:30 PM – 5:00 PM CTRP314 - Location: 224