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# Dual-mode Auscultation in High-Noise Level Environments

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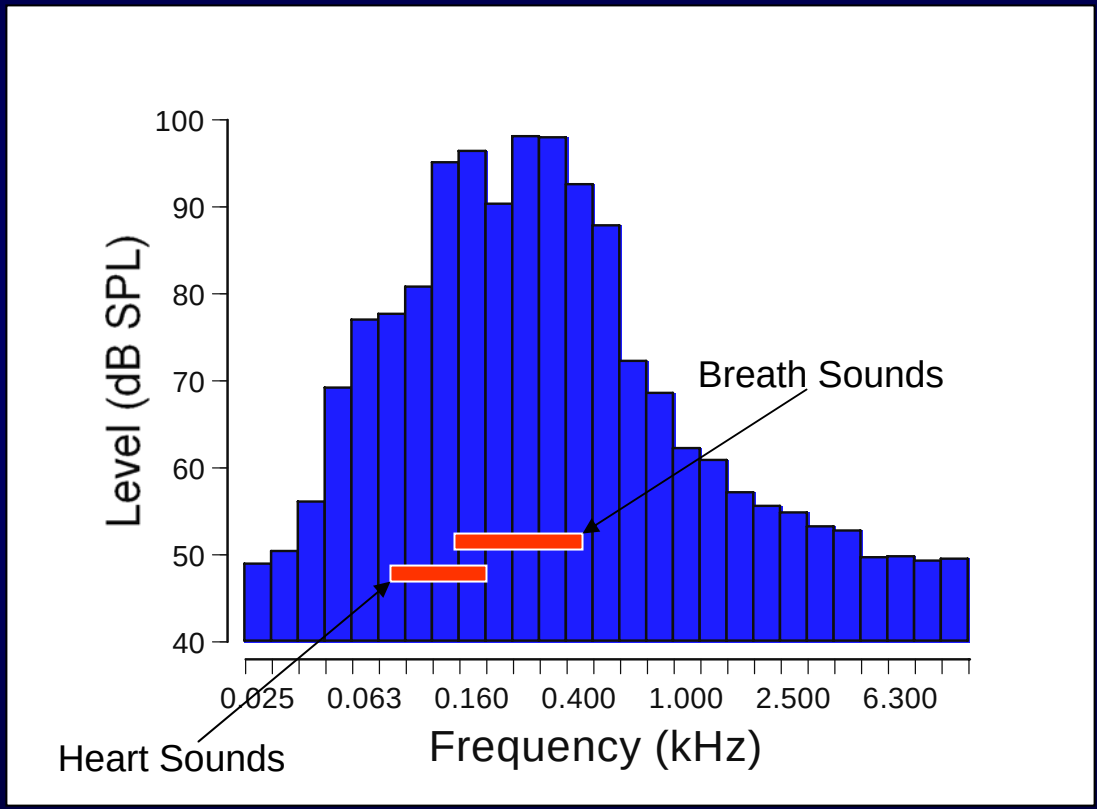
# Performance in Noise Fields

- Classic acoustic stethoscopes function in noise levels up to 90dBC (80 dBA)
- Special electronic stethoscopes can extend functionality range to 95 dB
- Ultrasound/Doppler stethoscopes are unaffected by ambient noise in the frequency range of interest allowing auscultation in noise well over 110 dB!.

# Problem – High Noise Fields
## (Representative UH60)



# Routes of Noise Entry

and possible solutions

**Ear/Stethoscope Interface**
CEP/headset

**Stethoscope Tubing**
shielding/replace by wires

**Stethoscope Head**
ANR/shielding/impedance-matched head transducer

**Wave conduction via skin**
Surround barrier/shield

# Proposed Solutions

- Use of Doppler Ultrasound
- Acoustics mode through Dual Sensor
- Surface noise waves blocked by O-ring barrier(s)
- Electronics integrated into sensor head
- Sound presented via CEP jack on flight helmet

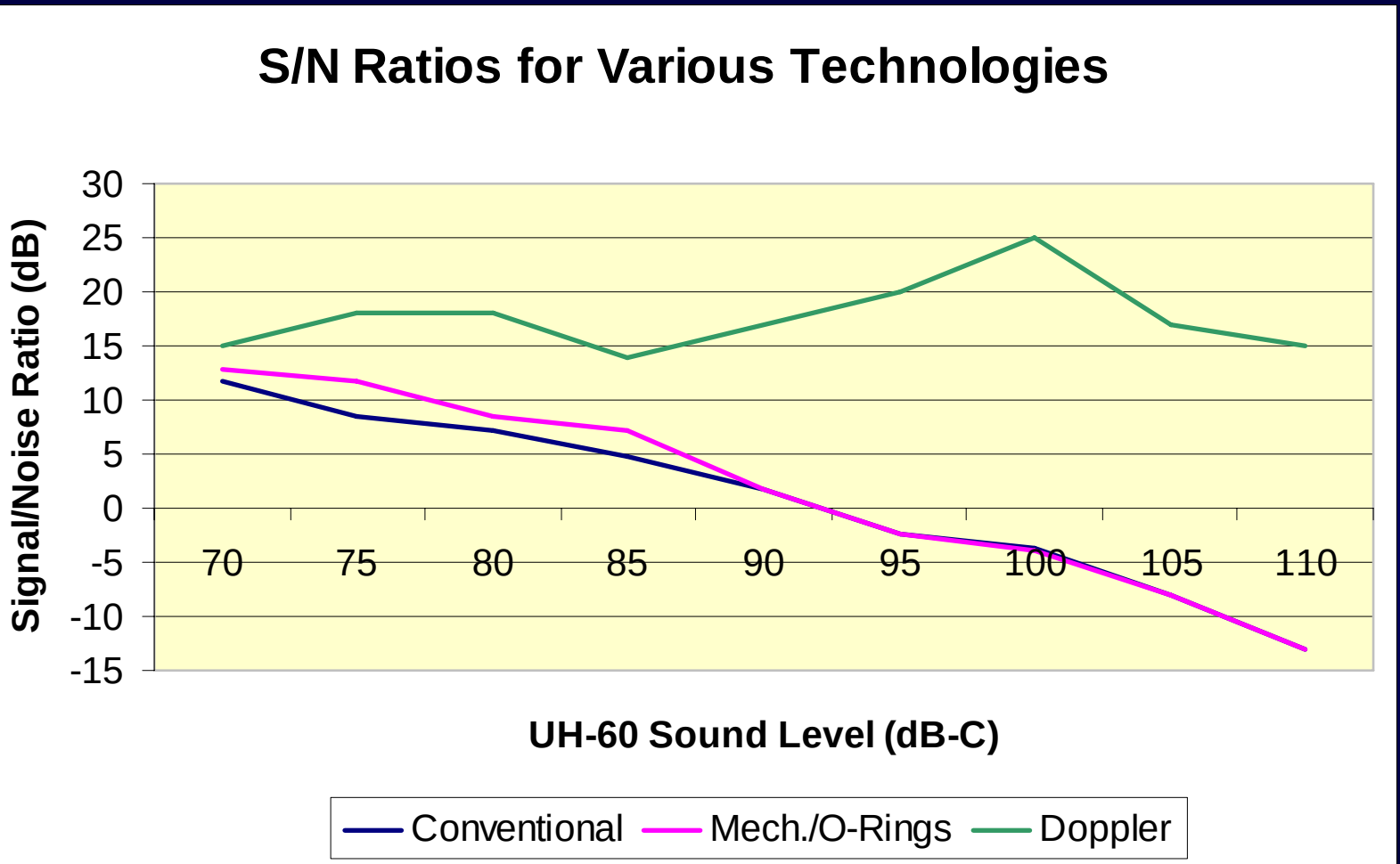
# Dual Sensor Head


# Double O-Ring Noise Barrier

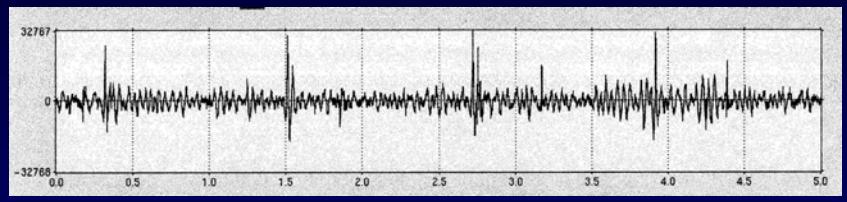
# Signal/Noise Ratio Measurement

- Heart auscultation of ‘’normal’’ patient by trained physician in reverberant sound chamber (diffuse UH60 noise)
- Noise levels incremented from 70-110 dB
- Stethoscopes’ outputs digitally recorded
- Signal/Noise ratios computed from sound levels during heart beat and inter-beat time segments

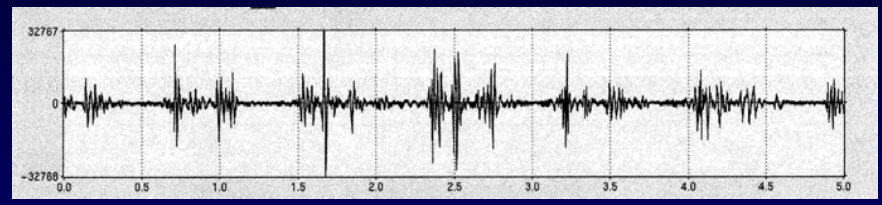
# Summary of Results



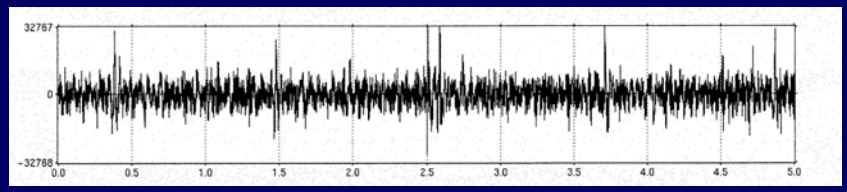
# Some Sound Illustrations



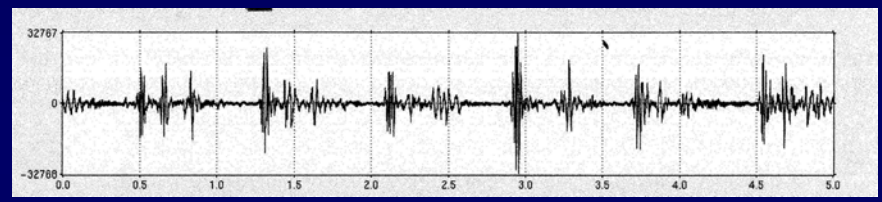

Noise Level = 75 dB



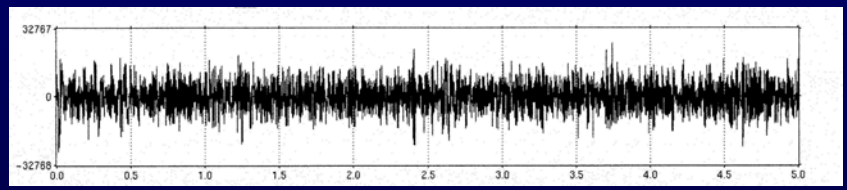

Noise Level = 70 dB



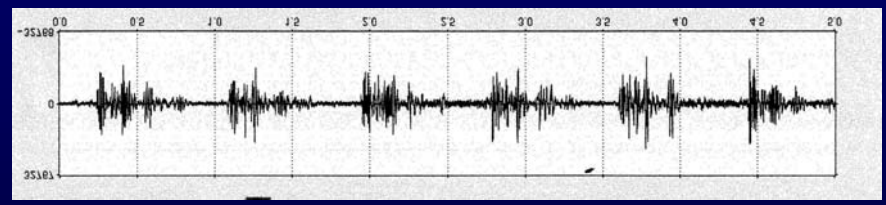

90 dB




90 dB




Littmann Cardiology III 100 dB



AST Doppler 110 dB

# Conclusions

- Increasing the sensitivity (gain) of a traditional acoustic or mechanical transducer stethoscope does **not** increase its signal/noise ratio.
- The Ultrasound/Doppler communication channel (between 2 and 3 MHz) is essentially free of any vehicle noise interference.
- Auscultation is merely limited by the amount of hearing protection worn by the physician.
- Doppler and Acoustic stethoscope sounds are slightly different, and may require some training adaptation and training for physicians.