

Insta ANR

ACTIVE NOISE REDUCTION EVALUATION IN FINNISH
ARMY NH-90 HELICOPTER



Pekka Lehtonen / SAFE Europe 2022

INSTA – Strategic partner of The Finnish Defence Forces

Family-owned company established in 1960
Industry Automation, Defence & Security, Aviation

INSTA AVIATION ACTIVITIES



AVIONICS MRO

Depot level maintenance for the Finnish Air Force since 1972



AIRCREW SAFETY

Product development
Oxygen systems maintenance



LIFECYCLE MANAGEMENT

Obsolescence
Engineering
Testing



UAS / CUAS

Consulting & Training
Operations
Development

Turnover 140M€, 1100 employees
Certified for military aviation design, maintenance and manufacturing
EASA Part 21, EMAR 21, AQAP-2110, ISO 9001
TRACE Certified

Insta ANR evaluation in Finnish Army NH-90 TTH

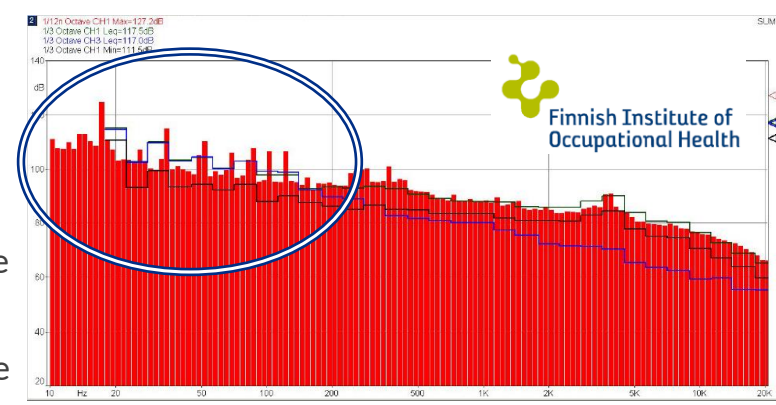
- › Noise issues in NH-90
- › Insta ANR product now
- › Adaptation to the NH-90 platform
- › Test program
- › Results

NH-90 Pilots and Crew exposed to high levels of Low Frequency noise

- > FIOH study in 2021 found that noise exposure is mostly below the required limits
- > Royal Netherlands Air Force study (SAFE Europe, 2015) found the same

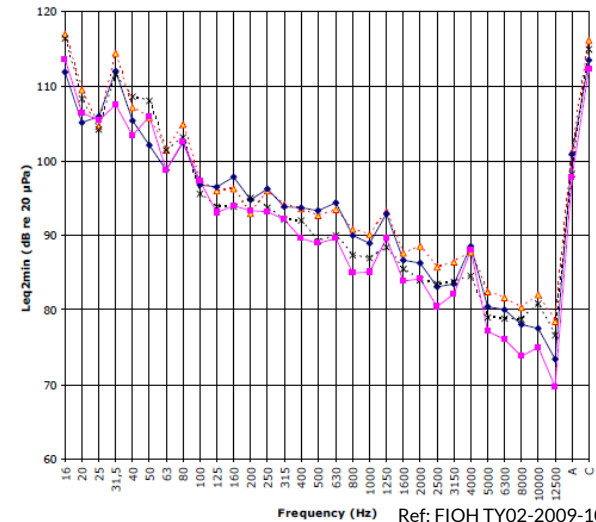
However...

- > Both studies done with **A-weighted** measurements
 - A-weighted measurements **disregard low frequencies** and give “idealistic” results
 - NH-90 Noise emphasized in low frequencies, Rotor frequency and harmonics dominate
- > Complaints from users continue
- > Hearing damage causes high costs in compensations and early retirement
- > Active Noise Reduction effectively removes LF noise



Ref: FIOH TY02-2009-108519

Level Flight 140 knt door open/155 knt door closed, seats 2L and 7R (I)



Ref: FIOH TY02-2009-108519



Finnish Air Force F/A-18 fleet



Saab Gripen E/F

Insta ANR – Active Noise Reduction for Aviation and Demanding Environments

Hybrid algorithm and electronics

- ANR performance exceeds all other products on the market
- High dynamics and high SPL capability
- Combination of passive and active attenuation

Dual speaker driver

- Failsafe intercom
- Intercom driver already approved for the platform
- Easy integration to any intercom system

Comfort

- Internal pressure equalization
- Custom earseal
- Slim earcup

Complete control over ANR algorithm

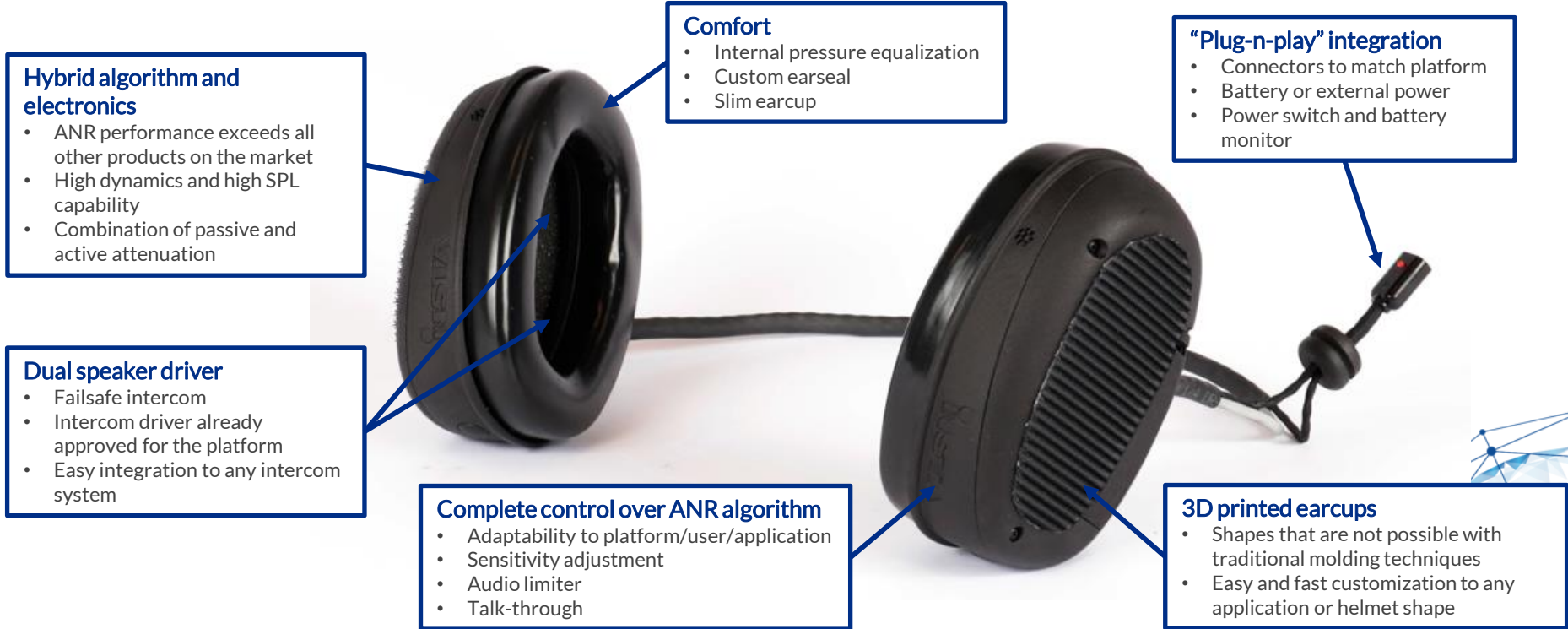
- Adaptability to platform/user/application
- Sensitivity adjustment
- Audio limiter
- Talk-through

“Plug-n-play” integration

- Connectors to match platform
- Battery or external power
- Power switch and battery monitor

3D printed earcups

- Shapes that are not possible with traditional molding techniques
- Easy and fast customization to any application or helmet shape

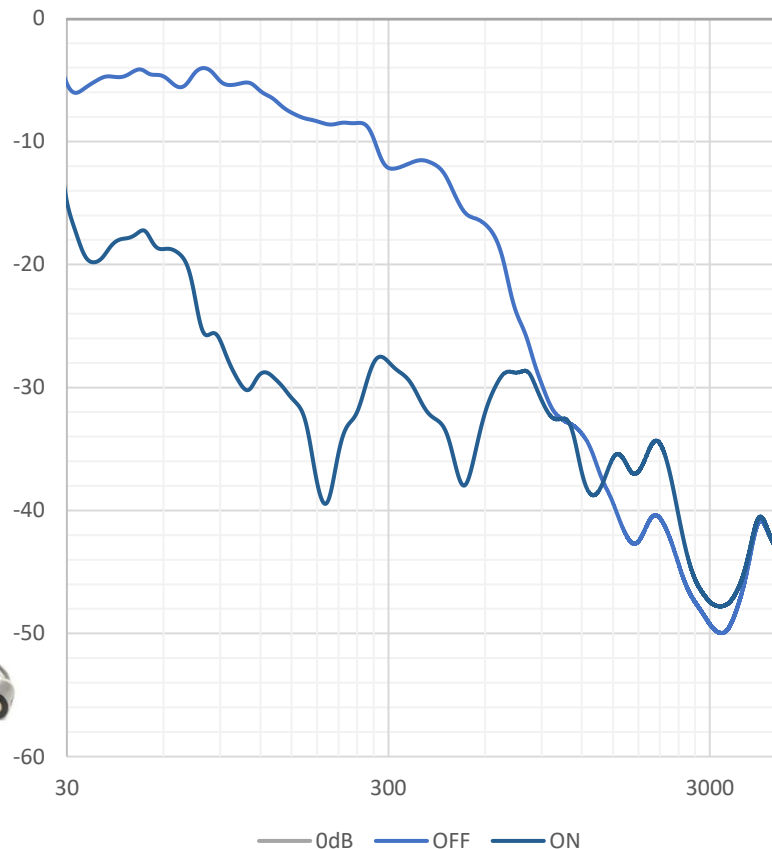


Insta ANR modified for NH-90 and Alpha 900 helmet

- › Intercom speaker driver
- › Algorithm adapted to the speaker and helmet
- › Cabling modified
- › Added Talk Through functionality
- › Earcups mounted to existing helmet earcup webbing



Insta ANR attenuation in Alpha 900 helmet

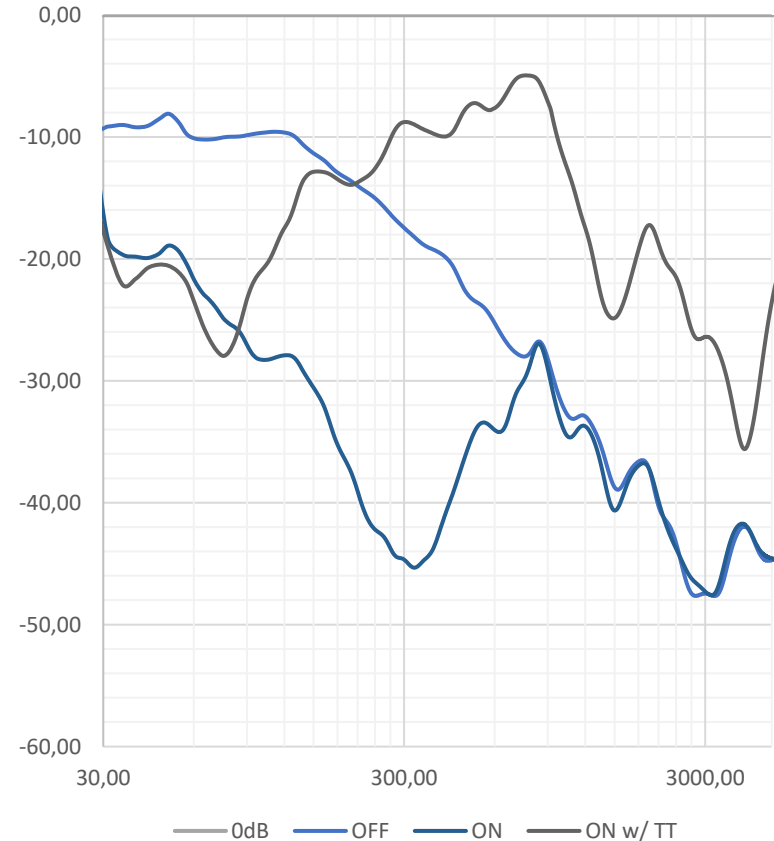


Talk Through for ground operations

- Allow speech frequencies pass through unattenuated
- Switchable
- Attenuate low frequencies
- Limit maximum SPL to 95dB



Insta ANR Talk Through attenuation



Assumed Protection Value (APV) test

- > 8. – 12. November 2021, Utti Helicopter Battalion
- > Goal
 - Establish Assumed Protection Values (APVs) for Insta ANR and current passive earcups
 - Gather user experiences and feedback
- > Method
 - Noise levels during normal operations (7 flights)
 - Each flight with Insta ANR and current earcups as reference
 - Noise levels during gunfire (1 flights)
 - Compare noise exposure of pilot on the same side of the AC as the door gun and pilot on the other side
 - Record audio inside earcup and outside helmet
 - One microphone fixed on shoulder of the pilot
 - Second microphone inserted inside the earmuffs onto the outer auditory canal of the pilot.

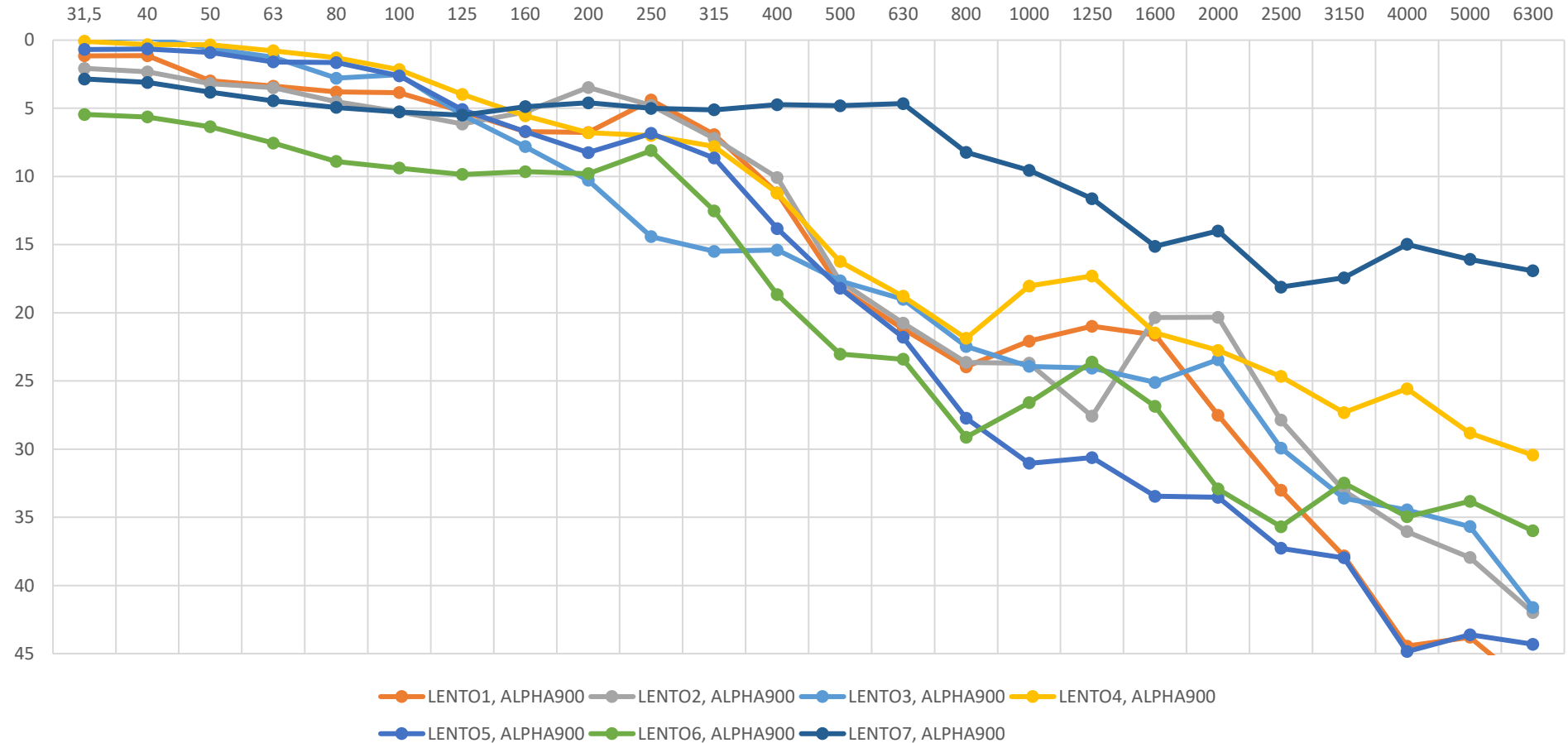


- > Test equipment
 - 2x Zoom F1-LP audio recorder
 - 4x MKE 1-EW microphone
 - Calibrator Nor1256 (Class1)
 - Rion Waveform Analysis AS-70
- > Results
 - Assumed Protection Values (APVs) of subject fit 84 % shall be calculated for each frequency band

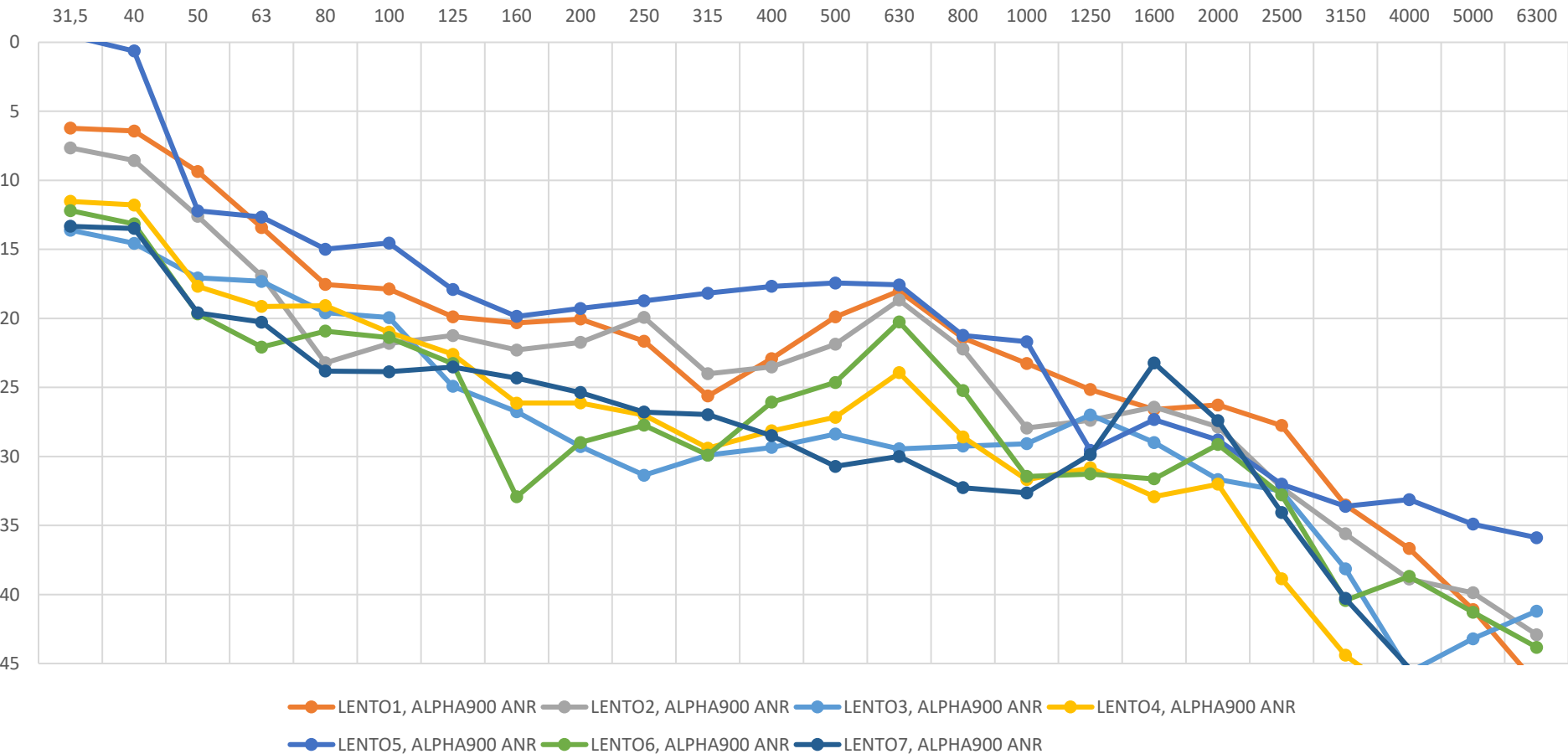
Attenuation performance during normal operation

- › 7 flights in total
- › 2 recordings for each flight: 1 with Insta ANR and 1 with Passive earcups
- › "Clean" noise samples selected from each recording (no intercom)
 - Only few minutes of usable data in each recording
- › Noise samples analysed using Rion Waveform Analysis AS-70
 - Average attenuation and APV (84% subject fit) was calculated
 - Samples with bad earcup fitment removed from analysis
- › Results
 - Significant reduction in low frequency noise exposure when using Insta ANR
 - Low number of samples increases Standard Deviation
 - Fitment is critical in all hearing protection systems
 - Graphs limited to 6300Hz – measurement method is not suitable for high frequencies

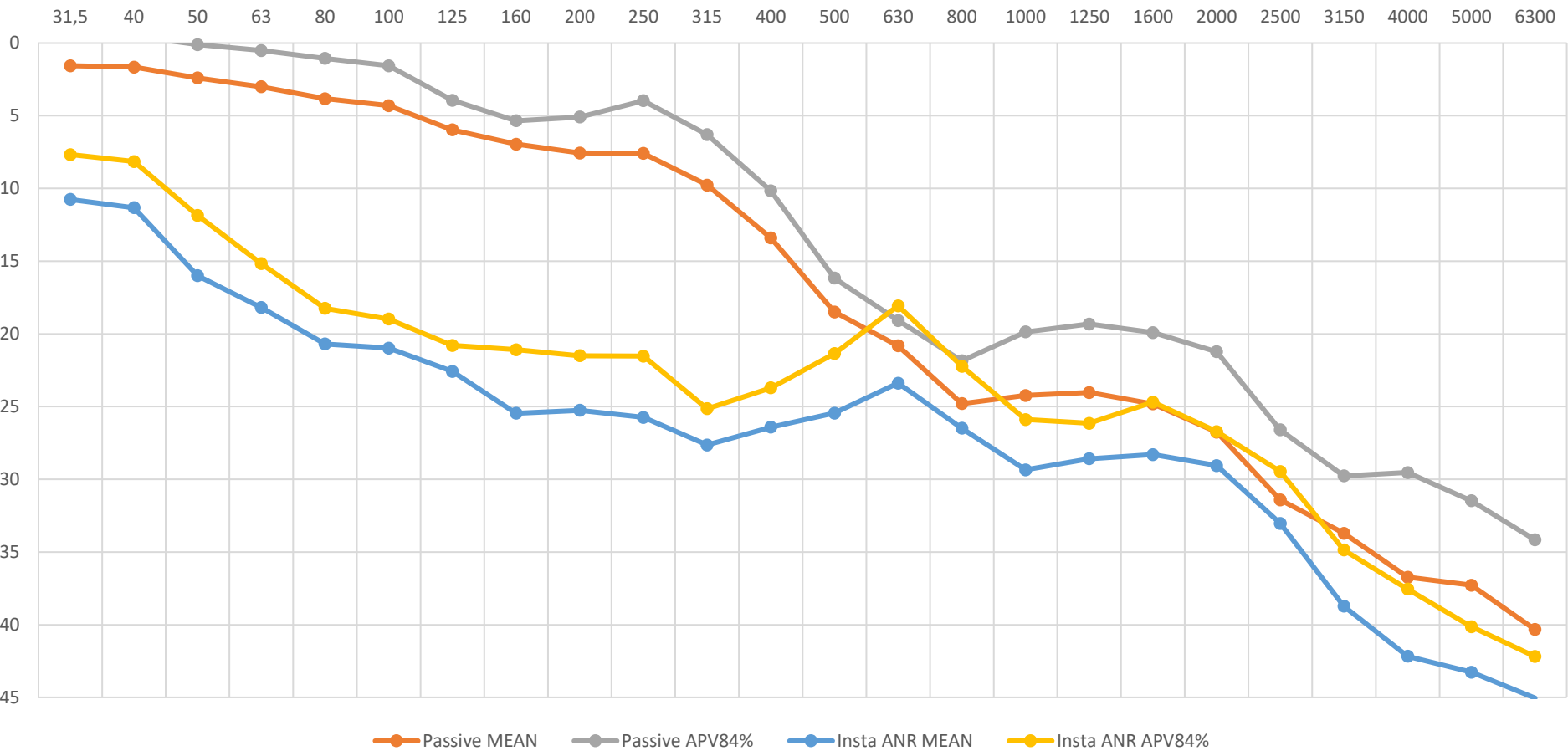
Passive earcups – Average attenuation



Insta ANR – Average attenuation

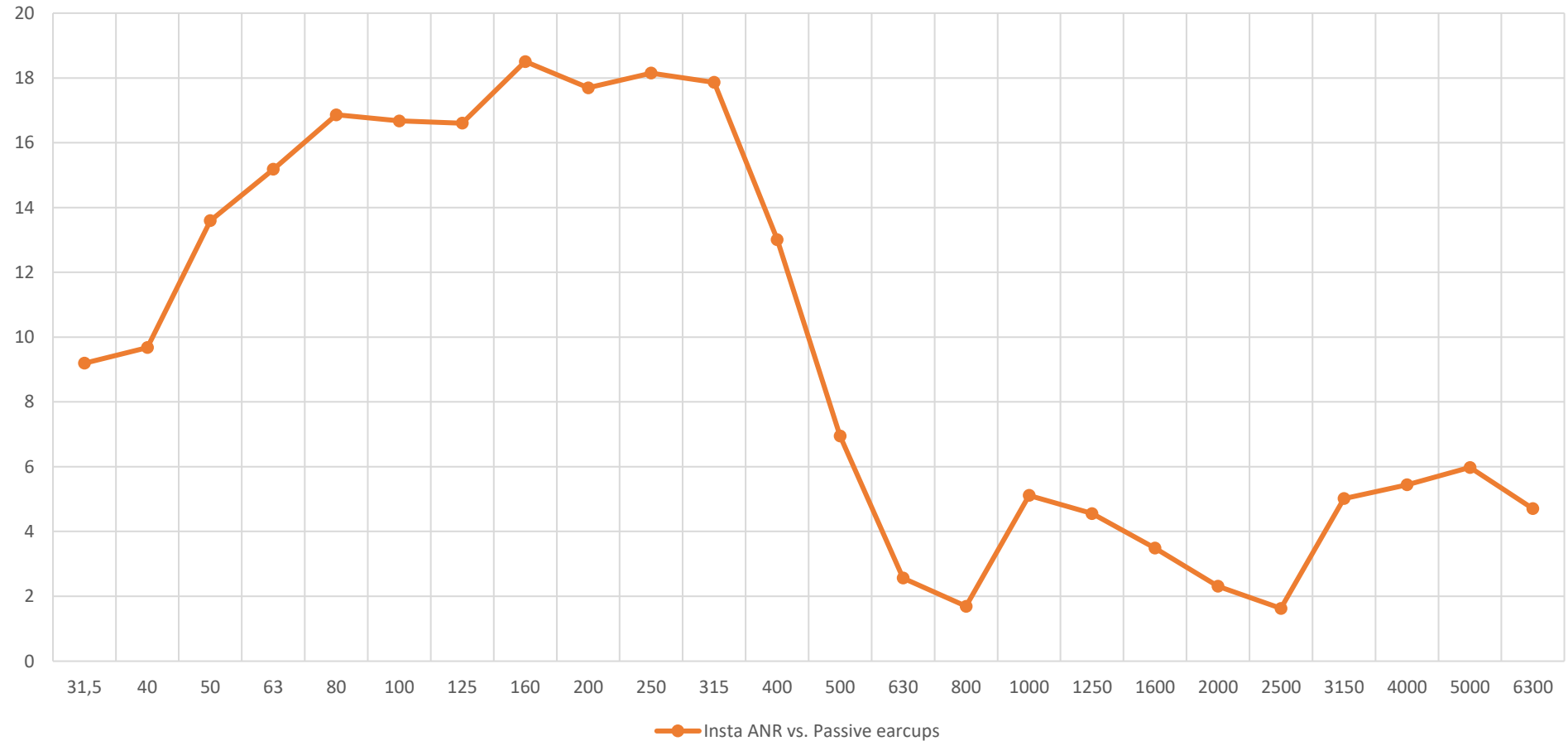


APV84% and Mean attenuation (bad fitment removed)



● Passive MEAN
 ● Passive APV84%
 ● Insta ANR MEAN
 ● Insta ANR APV84%

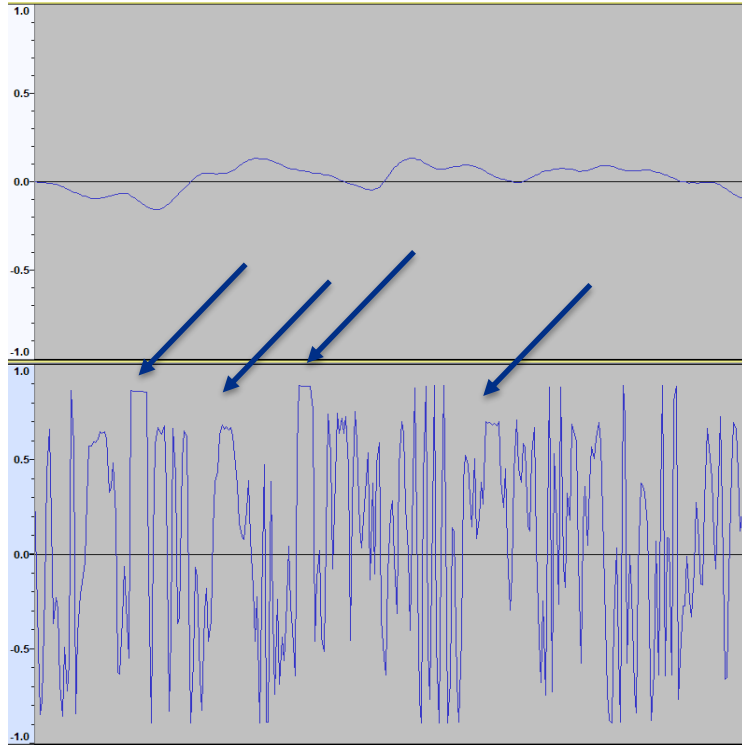
Insta ANR vs. Passive Earcups (dB improvement over passive earcup)



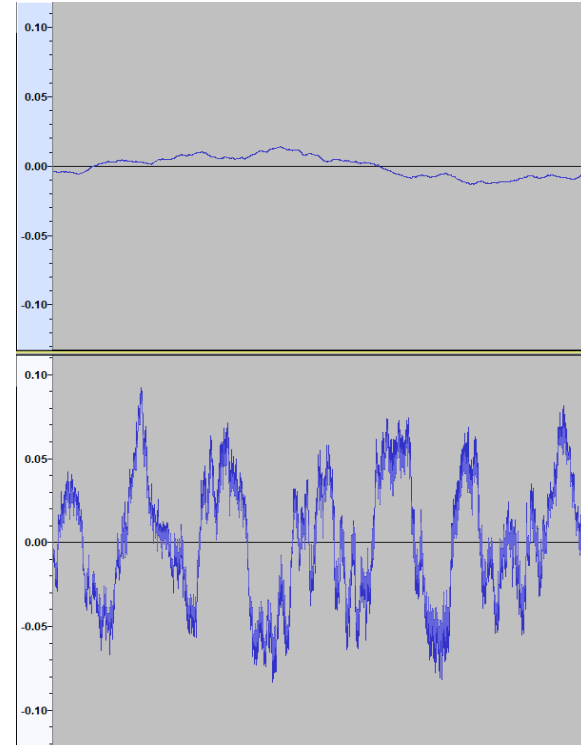
Noise level during gunfire

- › Noise recorded during firing of Dillon Minigun (7.62) onboard NH-90 from the environment and from inside Insta ANR earcup.
- › Determine peak and average noise levels
- › Observe general performance of Insta ANR in extreme noise
- › Results
 - External microphone clipped during firing (Instant peak noise level over 140dB)
 - Unable to calculate absolute attenuation level during gunfire
 - No distortion or other unwanted noises were detected in the Insta ANR earcups during gunfire
 - Noise level inside Insta ANR earcup peaked at 111dB

Recording waveforms – Earcup and Shoulder microphone



Gunfire – Note microphone clipping!



Normal flight – Note vertical scale!

Peak Sound Pressure levels (125ms)

- > SPL levels were analyzed from suitable parts of the recording using Fast Time Weighting (125ms).
- > Instantaneous peak level in shoulder mic during gunfire exceeded the maximum measurement level of 140dB. Actual level is significantly louder.

Condition	SPL	Note
Normal flight, inside earcup	102.7 dB	125ms time weighting
Normal flight, shoulder	110.8 dB	125ms time weighting
Gunfire, inside earcup	111.5 dB	125ms time weighting
Gunfire, shoulder (125ms)	126.5 dB	125ms time weighting
Gunfire, shoulder (instant)	>>141 dB	Instantaneous peak noise level Microphone dynamic range exceeded. Actual SPL is higher!

User feedback

- › *"Best thing ever!"* Pilot
- › *"Works very well. Intercom is really loud now."* Loadmaster
- › *"Works suprisingly well! Needs holding straps to make donning easier."* Loadmaster
- › *"Like sitting on my livingroom couch! The intercom is really loud now."* Pilot

- › *"Not working properly. Needs more attenuation."* Loadmaster
 - Note: This Insta ANR unit had an issue in left earcup. Loadmaster usually wears double protection (earcups+CEP's)
- › *"Low frequency attenuation is great but I would like some additional high frequency attenuation."* Test engineer
 - Note: Test engineers first time aboard NH-90

“Under 630 Hz Insta ANR gives better protection than original ear cups. Above that the Insta ANR works at least as well as passive protector.” *

- › Active Noise Reduction significantly improves low frequency attenuation
- › Reduced low frequency noise emphasizes subjective experience of high frequency noise
- › Fitment is critical in all hearing protection
- › User preference affects subjective results
- › Intercom intelligibility is increased and level can be lowered
- › Talk Through feature improves communication outside aircraft
- › Insta ANR functions properly in extreme noise, additional protection might still be needed

* Ref: FDF Test Report TR20220321-002

“Insta ANR gives clearly better protection than conventional soft earcups”*

Insta ANR Product Family



Insta ANR for F-18

Type certified to the Finnish Air Force F/A-18 C/D

For JHMCS and HGU-55 style helmets

NSN: 5965-58-001-4122 (NMCRL)



NH-90 Alpha 90

Modified intercom speaker and cabling

Talk Through functionality

NH90 evaluation in progress by FDF



Active Noise Reduction Headset

Headband & microphone

EN-352-5

Transport aircraft & ground crew



Other platforms

Army aviation

Civilian rotary wing aircraft

FINAF Hawk jet trainer HGU-55 helmet

*Finnish Institute of Occupational Health Report: TYHYG 2019 393258

Thank you! Questions?

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