

# Development of a Continuous Hearing Health Monitoring System

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## Context

30 million workers in North America are susceptible to occupational noise-induced hearing loss (NIHL)[1].

In hearing conservation programs, worker's hearing health status is only updated once a year.

## Problem

Currently, no system is designed to continuously monitor hearing health in a noisy environment.

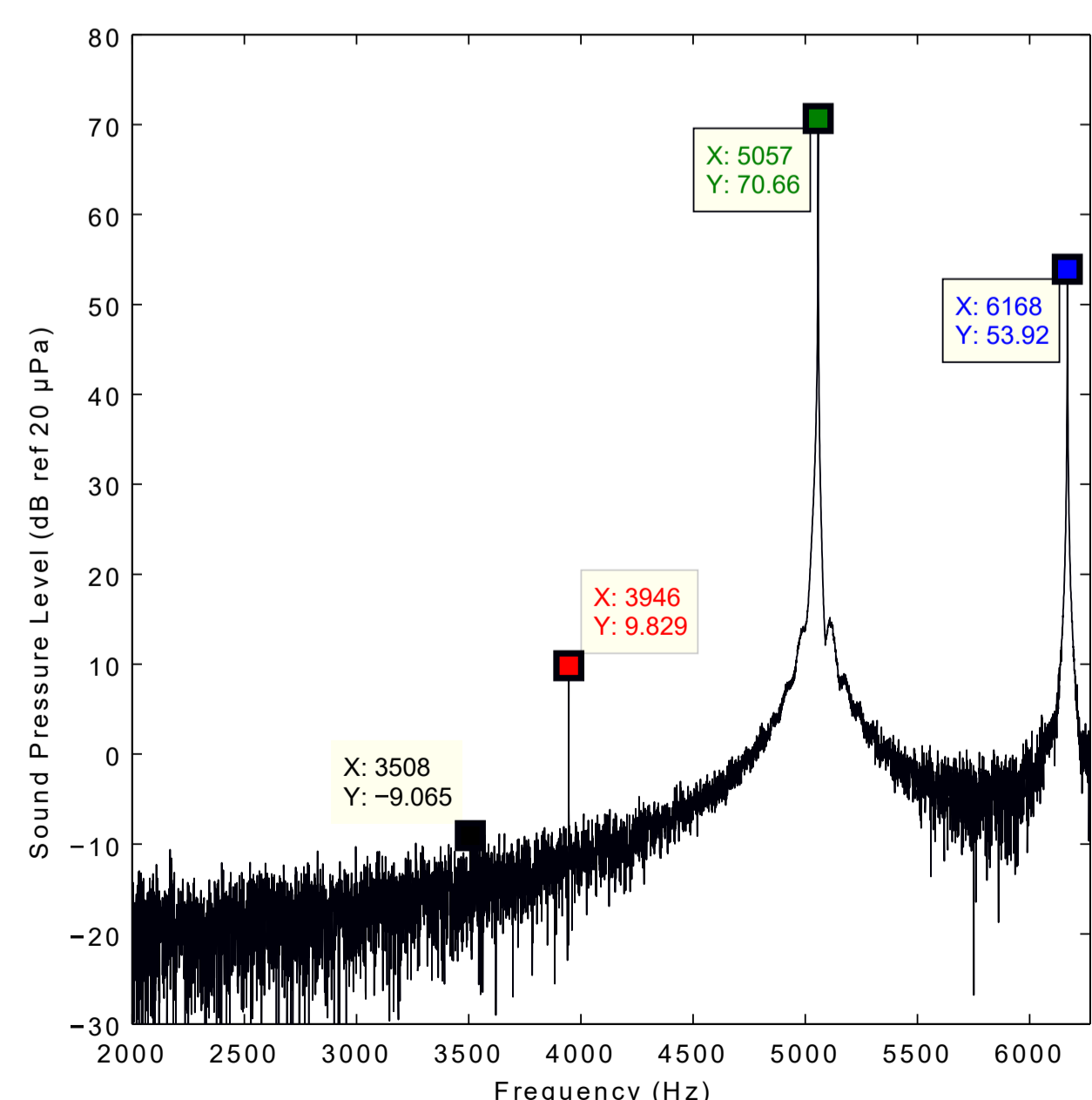
## Objectives

- Develop a device to detect the early onset of hearing fatigue.
- Establish a “noise dose ↔ ear response” relationship.
- Define the individual's susceptibility to noise.
- Prevent hearing loss.

## Proposed Approach : DPOAE

Distortion product otoacoustic emissions (DPOAEs):

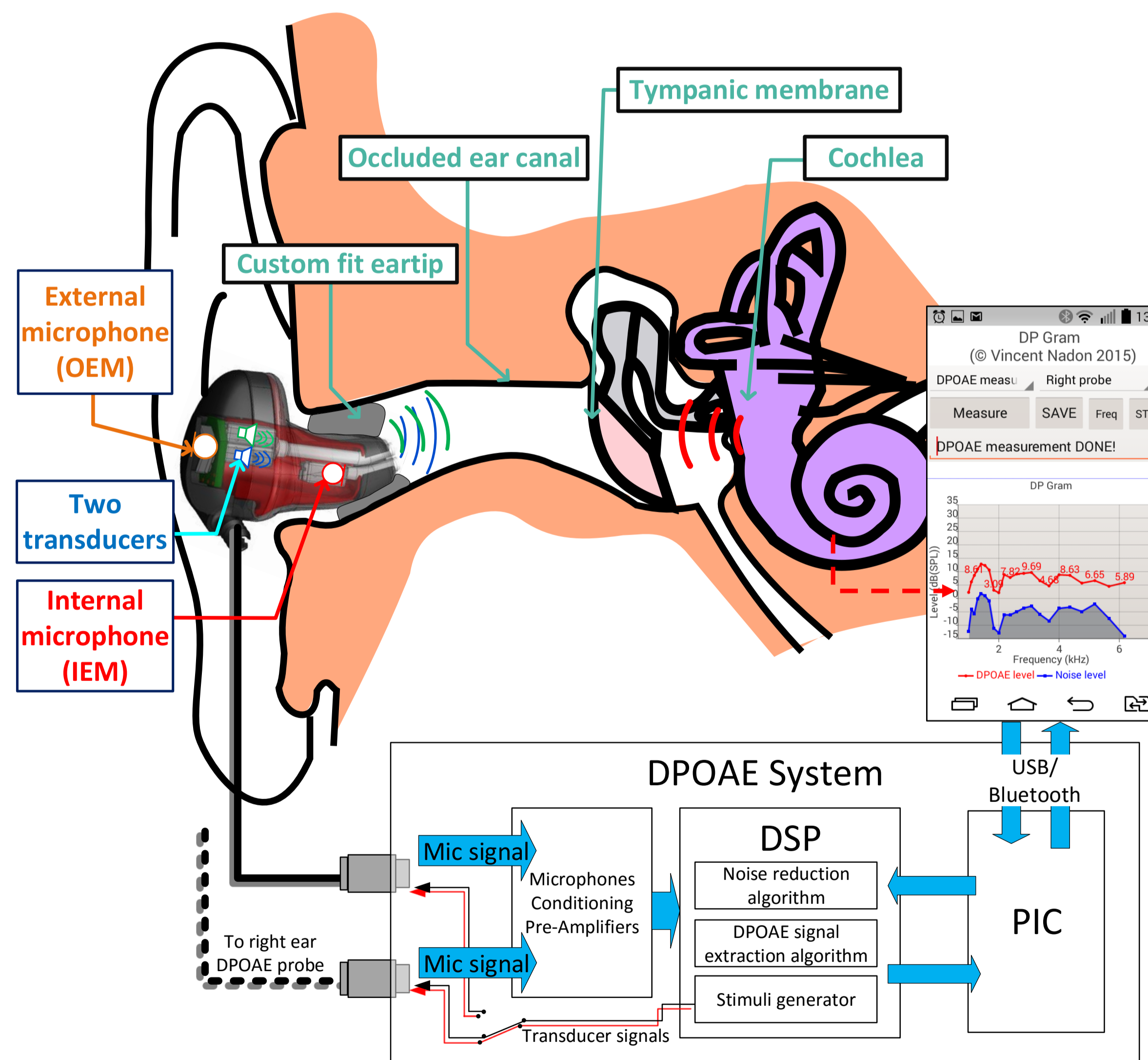
- small acoustical signals generated inside the cochlea ( $f_{dp}$ ) in response to two pure tone stimuli ( $f_1, f_2$ );
- used to detect, at an early stage, the onset of hearing loss.



## Developed System

A portable DPOAE monitoring system using adaptive noise rejection[2] and robust signal extraction algorithms was designed to measure the inner-ear response in noisy environments.

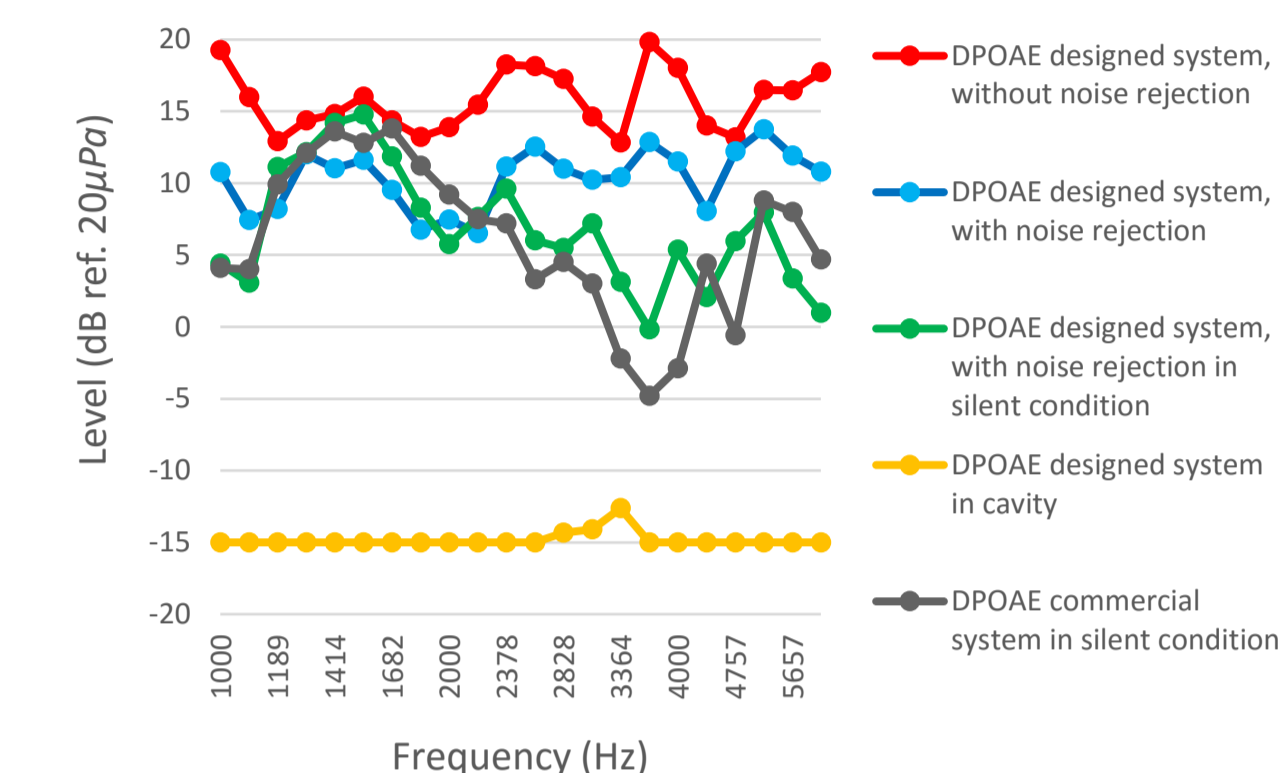
The upcoming version of the system will include **in-ear dosimetry** to automatically establish the **dose-response relationship** and warn the worker when the DPOAE measurement should be done, to prevent hearing damage.



## References

- National Institute for Occupational Safety and Health. 2001. “National Institute for Occupational Safety and Health Website” . Online. <<http://www.cdc.gov/niosh/docs/2001-103/>>.
- Nadon, Vincent, Annelies Bockstael, Dick Botteldooren, Jean-Marc Lina, et Jérémie Voix. 2015. “Individual monitoring of hearing status: Development and validation of advanced techniques to measure otoacoustic emissions in suboptimal test conditions”. In *Applied Acoustics*, March, vol.89, p. 78-87.

## Experimental results



Preliminary measurements showing agreement between the designed system in 70 dB(A) white noise conditions and silent conditions compared to a commercial system in the same human ear. The cavity measurement shows an example of noise floor with the designed system when no DPOAE is present, confirming that a true DPOAE was detected in the human ear previously.

## Benefits

- Provide a reliable tool to scientists to conduct research on hearing recovery mechanisms.
- Warn workers of their hearing fatigue before hearing loss takes place.
- Define appropriate legislation to protect workers against occupational NIHL.
- Reduce indemnity paid to workers due to hearing loss.