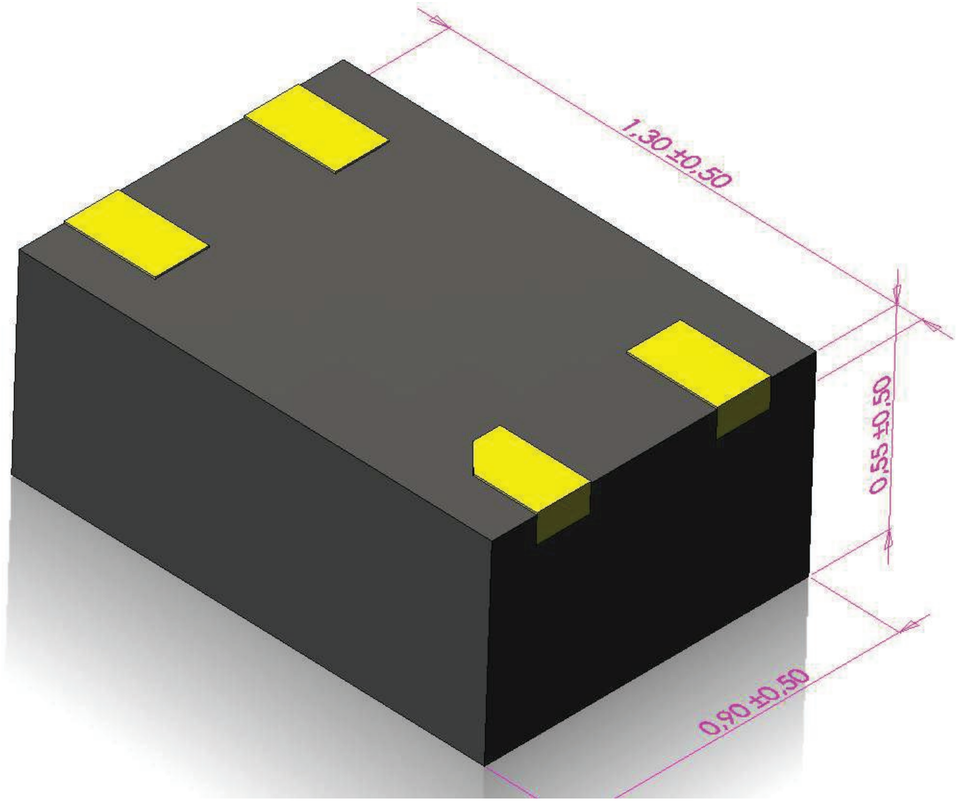
MSc

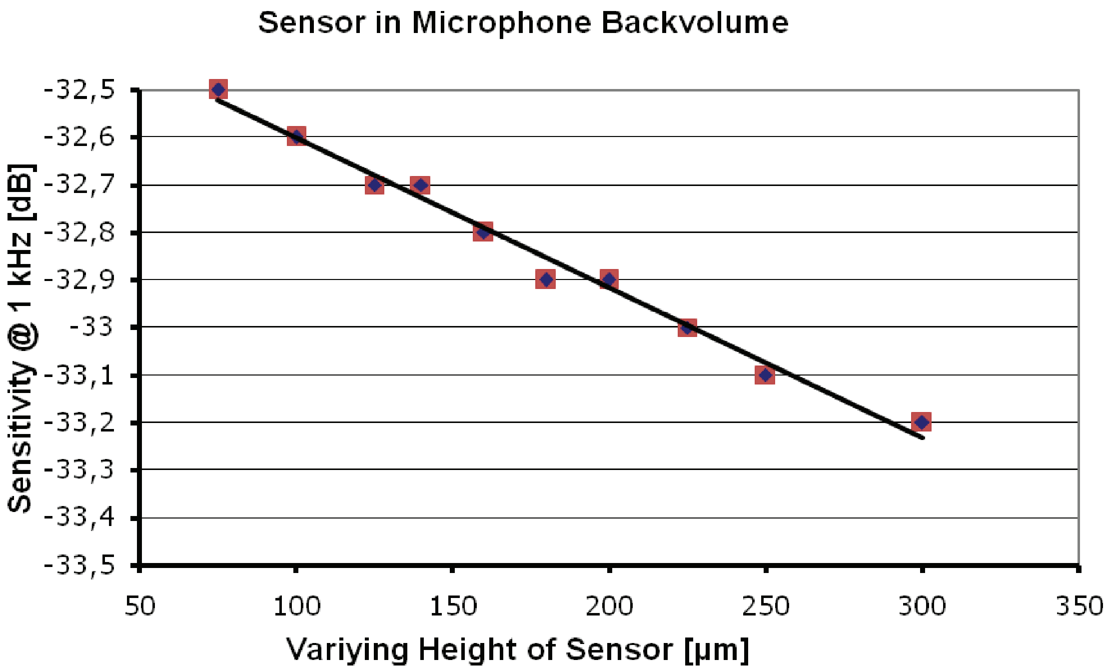
Van Halteren, Aart
Sonion Nederland B.V.
Zekeringstraat 9, 1014 BM Amsterdam

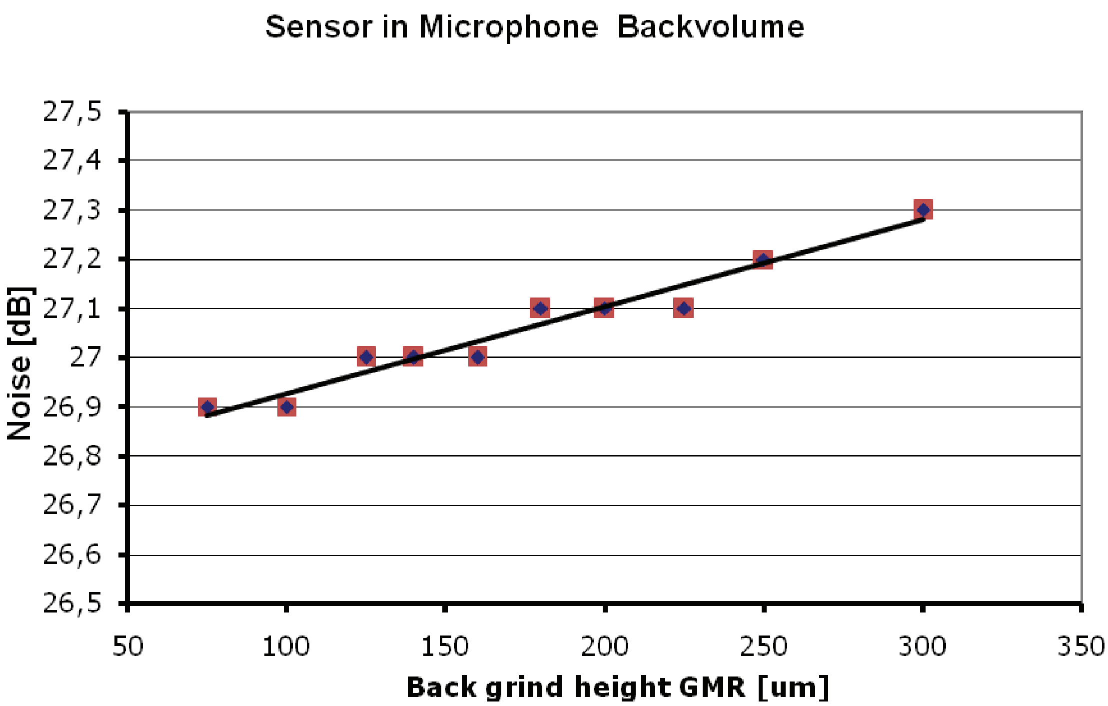
The most significant challenge in Hearing Aid design is to get the requiredm, very high performance in the smallest possible instrument that also looks nice. People are vain and would like the hearing aid to be invisible, or at least as small as possible. One other challenge is to make the Hearing Aid as user friendly as possible. One aspect of that user-friendlyness is that the Hearing Aid automatically switches to picking up the AC-magnetic field of a phone when a (cell) phone comes near the Hearing Aid. In the past people had to flip a switch. You can imagine that was not a nice thing to do, every time you get a phone call. Picking up the magnetic field from the speaker instead of the sound means that the hearing aid user is not disturbed by sounds from the environment, which is a big advantage.
Unfortunately there is a drawback : to do this switching automatically, you need a sensor that picks up the DC-field of the phone. (very often the DC-field of the speaker is not strong enough, so you need to put a strong magnet on the phone). This sensor is not very big, but you also need to make contacts somehow and all in all this means that the hearing aid gets bigger, and that is definitely not what you want.



Example of a Magnetic Sensor packaged as an SMD component.

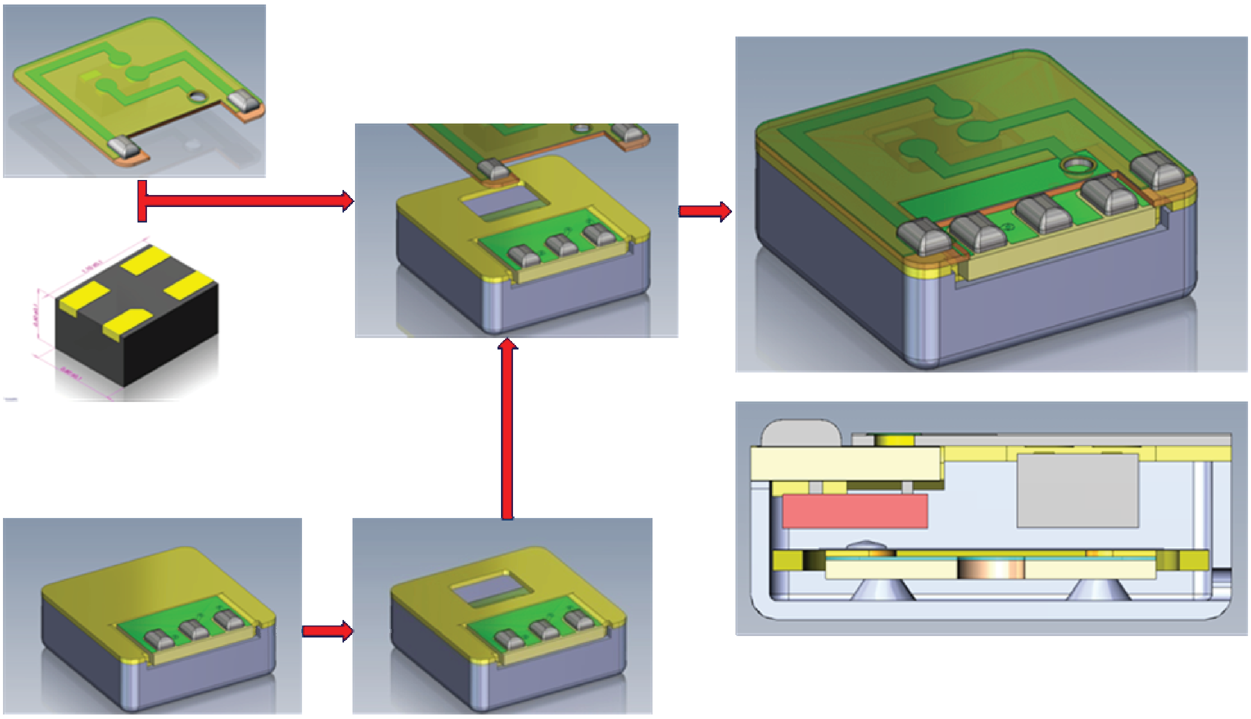
So a logical idea would be to integrate this in the microphone of the hearing aid. In the microphone there is always an electronic circuit for the buffer you need for a typical electret microphone that is standard for hearing aids.
Here we find a new challenge : adding something to the microphone will reduce the internal volume of the microphone, and that will directly influence two of the most important parameters negatively : the sensitivity will go down and the noise performance will deteriorate. (See figures below) One way to reduce the volume is to use and unpackaged die and lap that down as much as possible.





Although using a naked die would give the best performance of the microphone, it definitely had drawbacks in the reliability of the whole device, so we chose to use a packaged die.

We made microphones with the sensor integrated and found as a next issue that – much to our surprise – the sensor was latched up when we did some tests and subjected the microphones to a high DC magnetic field. We were surprised since we thought we used stainless steel that would be difficult to magnetize. It soon became apparent that we used some hard versions (to be able to stamp the material) and softer versions. The hard versions were quite easy to magnetize, so we had to change the hardness that meant we had to change a lot of our productions processes. We had to anneal the material after stamping to make it really difficult to magnetize.
Then another design challenge turned up: the market requires an enormous amount of variations of this microphone, also based on different electronics in the microphone. So if we would integrate the sensor on the same hybrid we had to define new hybrids for all these variations. This led to the following design :



In this design,the sensor is on a separate Flex print which can be combined with many different standard hybrids in different microphones, where we have the flexibility to make a choice between a microphone with and without a sensor in a late stage of the production process.
Overall, we lost less than 1 dB in sensitivity and noise and we got the same reliability as for the standard microphones without sensor. The costprice of such a microphone with integrated sensor is of course significantly higher, but this has to be outweighed by the fact that the Hearing Aid can be made much smaller.
In this project integration of two completely different sensors seemed to be the right way to go.

-