Loudspeakers have been a hobby of mine for three decades.

Through these years I have been annoyed by their missing ability to reproduce sound equally to how it is experienced "live".

Having tried all the known and some unknown solutions and learning by reading and by doing, change one part, doing again, and again and again I at last concluded that it could not be done by use of scientifically accepted techniques used by engineers around the world.

Being not an engineer but autodidact I had not learnt to obey the rules and to obey the scientific methods.

What I learnt instead was to focus on the results and not the method. To check the found result in all imaginable situations.
If all these checks gave a common result, then and first then a theory or an explanation was search for by a lot of reading of scientific literature, if it was to find there.

Also I had the advantage of not knowing the degree of thought and commonly accepted audibility. If I heard it it was persuaded as all other faults or qualities.

I was lucky not to be forced to make money on this hobby of mine, just to seek the expenses on the parts used on given project covered. I worked for free regarding the time spent as learning hours for myself.

All these around 100 different projects changed and based on the still growing experiences from former constructions took a course of its own, ending at a final point from where I speak and write.

Looking back from this point, it amazes me that so many years of experiments was necessary to reach the very simple and straight forward solution I have reached to.

It also puzzles me, that reading these audio groups shows, that what I have focused on and fought so hard to achieve, is denied to be audible at all.

Well! They are to me. Not because my hearing is special in any other aspect, than I do have a well trained acoustic memory. As also others do have.

But because my solution is different in its inner working mainly but also in appearance, as paint and veneer are forbidden as covering material.

It can be argued, that my solution is only suitable for my ears.
I can see and understand this argument but also I will reject it - it cannot differ to anybody.

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xxxxxxxxxxxxxxxxxxxxxxx
x    It act equally to air.     x
xxxxxxxxxxxxxxxxxxxxxxx
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We all experience sound transported through air and only adjustments for distance to the source of sound and humidity of air is needed.

Further anything done by a loudspeaker to sound not also done by the air is faulty behaviour of the loudspeaker.

The reference of sound reproduction is therefore given as ISO-standard 9613.
No more no less

It is the deviancies from that, which divide us.

Sound transported through air has resulted in the rules found from ISO standard 9613.

Sound is perceived by humans also following rules.
These rules are learnt without any teaching. But developed through confirmation from our other senses.

An experience of sound from a natural source is normally connected to the sight of the sound-source, of which we find the direction by the time-delay of sound between the right/left ear and the difference of intensity if any.

Our hearing needs a delay as short as 6-10 us and two working ears to do that finding.
This capacity serves our survival and therefore must be detected to react on very quickly. (it is also the cause to the fog thrown onto the phantom centre speaker)

Basically it rises an important question:
How high in frequency must the loudspeaker reproduce correctly, if a 6 us delay between the right/left ear still should be clearly detected from sound of the set of loudspeakers?

The behaviour of sound transported through air is described by ISO standard 9613.

Sound is perceived by humans binaurally. Which is the cause of the ability to find the direction to a source of sound.
This ability is crucial for our survival. Therefor the area in which it is working optimally must be in the near and dangerous field where also the difference in intensity plays a role.
Therefore also the distance to the sound-source is determined by the binaural hearing.
To detect these two parameters all needed it two holes on either side of our head.
With two holes only the problem is to differ between sounds from the front and from the back horizontally but also vertically.

To perform that crucial detection the outer ear is brought in individually shaped as it is.

Normally - talking with engineers - the influence on sound to distance/humidity described in ISO 9613 is ignored as not important. Well! that is an opinion of theirs.
I simply cannot rule that out.
Our hearing is trained with sound transported through air, contaminated by specific reflections from the outer ear, the head and also shoulders.

These "contamination" is known to be, learnt in a way, that very important information on the position in all three dimension and further as reflections separated in time all in all to give the result "there it is".

When the high Q's on the basilar membrane and the smearing effect of that is taken into account, the important information for survival MUST be placed at very high frequencies before they are dampened by the transport through air.
Detection of transients is maybe not important for listening to music, where we have lots of time to predict what is coming, but for speech and survival it is as also for High Fidelity reproduction of music and not just a recognisable one.

"How high in frequency must the loudspeaker reproduce correctly, if a 6 us delay between the right/left ear still should be clearly detected from sound of the set of loudspeakers?"

The answer must be - "So high that the transients, from which we extract this information of position will come through correctly phased in accordance with ISO 9613."

The outer ear tells an important story as also do the whole mechanical construction of the human ear.
It seems as if the eardrum is seen as our hearing organ, copied as it is -.idealised to a point of sound to develop from, when microphones and loudspeakers are developed.
For me to see the eardrums are placed in the bottom of a strangely formed little horn consisting of the ear canal and the outer ear at first and spaced by the head itself.

Every one who has built horns, should know how catastrophic a not smooth and irregularly shaped construction is to the smoothness and linearity of the reproduced sound.

The outer ear is individually shaped, which indicate differences in our hearing for frequencies of which the wavelengths are equal with or smaller than the distances from the opening of the ear canal.

The outer ear is apparently well understood as forming resonances influencing the frequency responses and from these variations gain information of direction to the source of sound.

Resonances are steady state situations and are, as far I can see, NOT a common factor for sounds of danger for which the directive ability serves basically.

No! the acoustic world of transients is for me the interesting area and there the importance of correct phase comes forward as also the outer ears role as a reflector.

It is my opinion that the binaural hearing in the horizontal plane and the reflections from the outer ear vertically and between front and back provide the clues for pointing out the precise direction to the source of sound.

This interpretation demands an extremely quick and a not so quick registration in the cochlea organ, which I do see present there.

You should read about Dr. Leonhards ideas http://www.leonhard.dk

I wrote:

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The cochlea circuit - how complicated it may look - do register both the temporal as the pitch dependant properties of sound.
The way it does it, is developed from millions of years experiences by survival of the fittest. In this long span of time the temporal hearing is developed first and the pitch sensitive part is a build on or an extension of that.
Our focus on frequencies is guided by the importance of this aspect of sound in the for us so important speech.
The Fletcher Munson curve and its consequences e.g. the idea of sensitivity from 20 to 20000 Hz and that there should be, what can be called - a common human hearing - drawn as a thin lined curvature on a graph is simply unbelievably idiotic.
There are crucial differences between Asians and Europeans. The individual differences cannot be cooked down to a thin line but should be shown as a broad line of a thickness of at least +/- 6 dB, probably thicker.
All measurements - I have seen by studying our hearing - do not go beyond the mentioned limit of frequencies - more often less - despite the curves stop at a level far away form 0 dB.
There is a world of sound beyond both limits. Ignoring them is like reading

a text consisting of only consonants.
It CAN be read with a rather high precision, but an area of interpretations will always be the consequence.
You could try to do the same with vowels, and you will feel brought back in time - millions of years.
Consonants have spectra reaching beyond the limits - far beyond.
We hear them so often - these sounds beyond the limits - but we do not notice.

Sounds with spectra reaching beyond the limits - far beyond - we do hear all the time.
That people here still cling to the idea that all sounds can be divided into a sum of sinusoidal tones, that we only can hear from 20 Hz to 20 kHz and not beyond these limits has contaminated and placed obstacles for a sound and advancing research.
There are lots of questions to be answered in order to lift the fog thrown on recording and reproducing sound by this belief.
There are no sinusoidal tones in nature, Therefore our hearing system do have trouble with them.
There are no limits to the frequency-area other than those created by the source of sound and the absorption done by the air transporting this sound.

We are placed in this space of changes and experiencing them by our senses - all of them at once.
To place limits governed by ignorance or generalisations on them as single senses in order to be able to handle them are illogical and very wrong.

There should be no limits created, others than those set by our skill to produce the thing.
Our dexterity improves all the time the more we learn, do not let that be stopped by anything - especially not the closed minds highly educated persons seem to hide behind.

In the following writings, I will present a possible way of how our hearing sense is capable to expand the known limits of the detected frequencies registered by the hair-cells.

Sounds with spectra reaching far beyond the limits set by the Fletcher Munson curve surround us constantly with no limits to the wideness of frequencies but those created by the source of sounds and the absorption done by the air transporting these sounds.

Sounds can principally be grouped into sounds dissolvable into a number of sinusoidal tones and transients/others, dissolvable into spectra-bands.

The idea of an abrupt filter-function within our ear seems logical as the

limitations of the inner hair-cells seen as resonators is well-known.
Seen in that light the limitations should be around 50 Hz to 15.5 kHz.
It is obviously a wrong interpretation, as it is easy to demonstrate such limits to be very different from them - especially in the lower end.
The idea, that all sound we as humans can hear, consists of sinusoidal tones (based on the resonator idea) led to the test-result of equal loudness of sinusoidal tones giving the Fletcher Munson curve and the limitations 20 Hz to 20 kHz.
The scientific world rested satisfied and still do, it seems, if this group is representative for the state of knowledge.

A consequence have been the focus on linearity of amplitude alone.
It has served the development well - so well that it has been able to hide the importance of phase, when audible sound is in speak, but not when its electrical replica is.

It is obviously the task for a loudspeaker to reproduce and transform the electrical signal into an acoustical ditto.
It is likewise obvious for me at least, that the reproduction/recreation of the source of sound to be accurate in amplitude as also in phase, in order to create a clear window through which to hear .

To get hold of what is needed for achieving maximum transparency, we must ask our hearing for help.

The problem is much the same as asking a working neural network. how it does its tricks. It will be a message not understandable to us.

We know a lot more about sound transported through air.
We know much about the mechanical parts of the cochlea organ in general but not much, when it comes to the individual use of that apparatus.

It is therefore clear, that the experience of sound is happening in every single hearing persons own head and normally the education of the neural network for every single person is based on the individual lifelong experience of sound transported through air

Our hearing is extremely sensitive covering a dynamic range of around 140 dB.
It is further binaural in its working manner.

Right/left is heavily connected between the many centres at the two afferent neural pathways.
That these centres are placed near the cochlea organ and not, where they probably rightly belong (in the brain), do indicate a need of high speed not involving the conscious mind.
The neurones from and to the haircells is kept in a very stringent order the whole pathway to the Auditory Cortex, indicating some kind of virtual picturing of the heard sound.
We all like this 3D perspective and picturing of sound, and the continued

work on this matter will give important cues to, how our perception of sound works.

I do believe that our sense of hearing likewise our sense of sight is not that dependant of where on the retina or the basilar membrane the pattern is placed, but **the pattern itself**, that is used as the actual content of the sound.

The interesting issue to focus on is the importance of the transients as pointed out by the Danish Scientist Dr. Frank Uldall Leonhard.

His patent application is open to read EP0737351 or US5884260
It can be found at:
http://l2.espacenet.com/dips/viewer?PN=EP0737351&CY=dk&LG=dk&DB=EPD

http://l2.espacenet.com/espacenet/bnsviewer?CY=dk&LG=dk&DB=EPD&PN=EP0737351&ID=WO+++9425958A2+I+

We must enter the world of FFT - spectra-band and find the most widely possibilities the physiology of our hearing organs pressure sensitive part *the cochlea organ* can deliver monaurally as well as binaurally.

It can be postulated just to be speculation. Despite that it explains and point out properties not explained elsewhere.

Sound transported by air has no low frequency limitation, which is the case for the reproducing part - The loudspeaker.
The real world is filled with infrasonic sounds and are dealt with as LF-noise from highways, air bases, transport centres and more. Some are annoyed by these low frequencies and others are not.
To find these limits I have searched the literature and have found that our sensitivity towards LF-modulation as well as Virtual Pitch as also Beat frequency, fluctuation strength and the spectrum of the human speech, all to support a drastic widening
downwards of the frequency band for the human hearing (what ever is include into that).

Our hearing has developed a special listening technique involving the ear surrounds (head, shoulder, body) and also by intense use of the stable outer ear. All these parts. how alike they may seem, are individually shaped and play their role individually for frequencies comparable in length. This is beyond discussion.

In the development of our brain, nature must have found a different solution supporting our survival. We as human beings do not seem that well equipped for that in any way. Our reproduction rate, time for pregnancy and long time childcare do show us to be a not hunted animal.
Putting it all together and looking at all of it with an open mind, It is my opinion
that it is within reason to say, that the human hearing can detect from 0.2

Hz to 40 or 50 or even 100 kHz heard and not heard, but detected and used unwittenly.

The mechanism used is INTER-MODULATION.

It must be emphasised here, that our hearing organ is far from linear. This seems to create consequences, which can be seen as negative in some technical views, but despite that it is factual for our hearing mechanism and is used positively as a source of information.
It is likewise important here at start to point out that even at absolute silence, there is a reasonable constant firing frequency from the outer haircells. This firing is not by the brain treated as noise but as absolute silence and it is by a local variation on the basilar membrane a specific pitch is registered. It is important here to point out, that the idea of a narrow locality must be taken with a grain of salt. A haircell with a specific CF can very well be forced to oscillate at an other frequency nearby. This happens when the stimuli is a single sinusoidal tone of higher level.

An overpressure lowers this firing frequency of silence and an underpressure increases it.

In total silence infra-sonic sound can be registered, at least there is a mechanism to do it , and I would be surprised if our hearing wouldn't use it. (alarm-signal?)
The big question is how we react on its presence - we feel it, if the level is high - but what if the level is low? An anechoic chamber has an almost scarring sound of silence.

I'm sure, that there is an audio world near silence, which we fight by making noise.

The input to the hearing organ (Auditory Cortex) connected to the basilar membrane with its row of inner and outer hair- cells connected by the afferent but also the efferent pathways and communicating by neural coding forth and back by strictly ordered neurones, must be seen as slightly separated in time from, what is served from our conscious mind as heard. The cochlea organ is therefore placed in a very near future delivering data to predict on.
These inventions of possibilities are naturally built on the first registered signals from the haircells and must unavoidably be of high frequencies.

The sensed input from the cochlea organ is filtered, treated, sorted, sent back for confirmation/amplificatioen, and put together for relevance, before it is sent to the Auditory Cortex and there brought in a larger context, before it is sent to our conscious mind.,
We can see an enormous "neural network" present but how it works in detail we only can hope one day to be able to understand in broad lines.
Some cues can be found by examination of the construction itself.

The mentioned order **is** strange and worth examining closer. The inverse order of connection inner/outer haircells to the afferent/efferent pathway is - I'm sure - the key to a deeper understanding but, why this need of a stringent order?

Our hearing as a whole **can** be rather instantaneous (danger) but will normally
extract information for a moment (30 us) and simultaneously compare it with a longer moment (at least 5 sec) as a whole. Here you must think at our capacity to interprete sentences especially the longer ones. It so to say deals simultaneously with what was, what is and what (based on these information) can be expected.
A bio-feedback/forward takes place here.
Our cochlea organ is the sensitive part of vibration in a tonotopical organised circuit to and from a memory bank.
The tonotopicity and the length of time the neural coding is combined with earlier coding will, together with the binaurally (3D) method of hearing, form the basis of understanding.
For the more technical minded it is much like a delay-crossed stereo feed-forward mechanism with a limited power source.

We hear sound. Identify parts of it as basic patterns, whereto the rest - in accordance to learnt rules - is connected in full or partly. The "pattern" can be recognised almost every where on the basilar membrane.
If a LF signal is added, then the pattern will be doubled (side-bands) as if there are two sources and not one. (the pattern is not place-dependant),
How should the brain differentiate these if there was not a mechanism to establish the double to one. The modulating tone is the one - it is sensed/heard and used.
If it wasn't so our hearing would break down - it does not.

I have met this minor problem several times by listening to stereo loudspeakers, where a centreplaced instrument miraculously was divided into two yes sometimes into three separate instruments (Left, right and centre).
Most surprisingly this could be cured by change to a different powercable at the only part changed.
Strange - yes really strange!

I do not know the reason for this. I just want to point out, that the mechanisms used by our hearing sense must be extremely delicate, and maybe most important - not that well understood.
I think I understand it now – on that, later in another article aboout cleaning the main power.

Our hair-cells are frequency sensitive elements with an individual centre frequency CF, though the single hair-cell only at extremely low level works alone.
Together they form a not countable row of bandpass filters within the CF's range from around 50 Hz to 16 kHz and further complicated by the fact that the firing frequency from an individual hair cell has an absolute maximum

around 4000 Hz. These limits divide our way of hearing into a rather precise part below 1500-2000? and a more accidental part beyond.

Despite these limitations we seem to be able to hear far more than accounted for.(20 Hz to 20 kHz sinusoidal tones)
I would go even further from around 0.2 to at least 50 kHz (maybe even further to 100 kHz or more)
Research from Psychoacoustics do point out that sound up/down to these limits somehow can be registered directly or indirectly. No matter which way - it is my opinion that the whole spectraband we know from measurements to be, must be reproduced correctly.
Hypersonic Effect.
http://www.icad.org/websiteV2.0/Conferences/ICAD2002/proceedings/Oohashi.pdf

It is totally illogical to me to sanctify some limits based on only sounds dissolvable into a sum of sinusoidal tones.
Sounds from the real world have not chosen side, they are as they are - not periodic and not continuous.
These sounds recorded using a microphone with limitations in frequency band forbids their real nature to come through. Such microphones are hard to make but not impossible - far from impossible. A loudspeaker and a microphone is the same thing - the only difference is the size and use of them.

To reach a true natural recording and reproduction no limitations are allowed within the limits created by the full capacity of the human hearing.

The question is - where are the limits?

These must be extracted out from the limited haircell registration of the basilar membrane's travelling waves.

We know this is done already, as there is no known mechanism to detect sinusoidal tones below the lowest haircell CF at around 50 Hz.

I have been told so often, to leave and go study - among other things - our hearing.
Well! I have done that, left with more questions than answers.

A very basic and simple question is, "how do we hear below 50 Hz?"

If anybody knows - please come forward.

Inspired by this until now unanswered question and good deal of others, I have come up with an idea, which seems to explain a lot.

Double haircell information

Bark #1 deals with the frequency area from 0 to 100 Hz. It contains 150 hair

cells covering only the frequency area from 50 Hz to 100 Hz.
A doubling distributed on 150 individual haircells probably distributed exponentially
will give a CF difference to the neighbouring haircells.
(the numbers must not be taken too accurate, they do vary individually)

Frequency	CF difference (2 cells)	CF difference (3 cells)	(four cells)
	150th root of (100/50) time 50 -50		
50	0.23 Hz		

Continued for the other Barks

Frequency	CF difference (2 cells)	CF difference (3 cells)	(four cells)
100	0.46		
200	0.54		
300	0.57		
400	0.65		
510	0,71		
630	0.84		
770	0.91		
920	0.98		
1080	1.17		
1270	1.3		
1480	1.5	3	
1720	1.73	3.46	
2000	1.98	3.96	6
2320	2.35	4.7	7
2700	2.78	5.56	8.4
3150	3.38	6.76	10,1
3700	4.27	8.54	12.8
4400	5.46	10.92	16.4
5300	6.67	13.34	20
6400	7.89	15.78	23.7
7700	10.8	21.6	32.4
9500	14.8	29.6	44.
12000	20.5	41	61
15500	26.5	53	

THERE is the possibility to detect INFRA LOW FREQUENCIES.

Two neighbouring haircells firing simultaneously or with a shift of a very low frequency I'm sure will be detected as an specific order in an almost chaotic movement and possibly be interpreted as a low frequency tone present.
The firing from a single haircell tells the story of a narrow frequency band active but a low frequency periodicity in firing sequences from more cells tell the story of another and modulating frequency present.

The masking effects dependency of the Barks do imply an internal working togetherness between 150 haircells as a group. The dividing frequencies are selected ones for practical reasons, meaning not tied to any specific frequency but to the number of neighbouring haircells only.

This is what my indirect data supported and intuitive understanding of the cochlear organ tells me of how the detection of low frequencies below the direct firing limit of around 50 Hz **can** take place.

It points out the lowest frequency for detection of modulation to be 0.2-0.3 Hz (fact)
It places the higher bandpass sensitive of the fluctuation strength at the most sensible frequency area. (interesting)
It places the sensing of bass (below 50 Hz) directly at the treble area and do therefore explain also the strange fact, known by all serious loudspeaker builders, that bass and treble are influencing and strangely dependant of each other. (fact)

If my explanation is correct in a scientific view, or is probable or provable does not count that much for me. It explains, what I want to be explained, so at least I can come forward and test the ideas.

That these theoretical considerations are coincident with the exaggeration of bass, if a hearing aid is corrected solely to compensate for the age dependant treble loss, can be seen as a sort of proof. The known loss of sensibility towards bass on a later stage, can be explained differently, though it also can be explained as a epiphenomenon of lost treblesensitivity for sinusoidal pure tones.
When it comes to detection of ultra-sonics I'm sure a quite different mechanism takes place - probably involving a higher number of haircells; the row of outer hair-cells, so well suited for an instantaneous and direct detection of a transients forefront, which plays an important role for Dr. Leonhards theory, as it also do for my hearing of the synchronousness between loudspeaker units by reproduction of sound from a loudspeaker using dividing networks.

The placing of both HF and ILF at the start of the basilar membrane logically points at detection and interpretation of transient signals.

A transient signal is characterised by the shape of its forefront and the duration of time for the ILF to fall at rest, which will give information on the size of the source of the transient.
Transients and the correct reproduction of them demand much of the system regarding synchronous behaviour of all units in the system - a problem still not solved
The goal for reproduction of sound are two:
1. The reproduction of an event of sound as it happened.
2. To serve this to the individual human hearing ruling out all differences between our individually trained sense of hearing.

Claim 2 luckily places limits onto claim 1. but which are the limits.

We know that the brain is bombarded with around 11 million bits pr. sec. from the different sensing nerves. This high number is reduced drastically leaving important tracks of which we are not aware, but instinctively react on. Served to the conscious mind are a low numbered bitstream of cues indicating only changes to the individual picture of the world - sensed as sensed by the individual person.

It is my opinion that we register far more, than we actually hear as heard. These "not heard" parts create pathways for the heard part, and thereby factually are heard.
An example is the influence of high Q resonances far beyond 20 kHz.
As audible every part of sound influencing on what IS heard must be defined as indirect audible. This include room influence, standing waves, missing fundamental, LF modulation, detection of phase and more.
The reality of the sound from a loudspeaker is NOT the one heard/measured in an anechoic chamber - far from.
The reality of the sound from a given loudspeaker is the one heard in the individual room for listening, driven by a given set and listened to by a set of ears and every part of the body influencing that too.

What we can hear is not only what our conscious mind tells us, but what can be shown possible to detect, and verified through measurements at the place of registering and the neural centres before it is delivered to the conscious mind.

Let's look at our hearing organs possibilities of detecting ultrasonic sounds - called so for now.
The first fact of importance is the locked position of our ears. We have lost the ability to direct our single ear towards the sound, this indicating that we do not hear solely with one ear but with two. The human binaural hearing so well equipped with neural connections between the two. Delays between the two as short as 6 us is detectable.
The next fact of importance is the outer ear. Despite their shape are rather different some characteristic similarities are present.
First - the forefront of the outer ear forms a line perpendicular to a line towards the eye confirming the fact that ear and eye work together. You hear better if what you hear is confirmed by sight. You also hear better if you

stop stimulation of sight.
Said differently - if you see a loudspeaker you'll hear a loudspeaker, except when the sound doesn’t seem to be sent from them.

Back to the line. It means a lot for soundwaves with wavelengths comparable in length with the distances to every reflecting cartilage structure.
The literature focus on variation of level and standing waves, when the directivity of the outer ear is discussed. I see these parameters as not that relevant when the forefront from a transient is heard.
One does not know the characteristics of the sound beforehand and it takes time to build up resonances.

The only constant influence the outer ear will have is the role as a reflector.
A transient and its immediate reflections from the outer ear will tell the story from which any vertical direction as well as in some respect the horizontal too can be determined.

The forefront of the transient is described by it content of high frequencies, it is those first registered from the basilar membrane, though it takes time to create the wandering wave itself. Therefore an even quicker way MUST be present in the cochlea organ, to serve our survival best possible.

The inner haircells ARE of great importance as they use around 95 % of the 50000 afferent neurones and organised as spokes in a wheel.(2½ time around) formed by the circular bending of the cochlea organ.

Also the outer haircells are there and are assumed playing a minor role.
The number of neurone from the 12000 outer haircells is only around 2700, therefore 4 to 5 cells share the same neurone, which are assembled as the outer circle of a wheel. (one round)

The outer haircells are the old ones in the time-span of evolution, and therefore must serve our survival - they still are there.

Their working manner as extremely small balloons blown up by polarisation and easily punctuated and firing by their constant contact to the techtorial membrane, which cover the organ of Corti towards the first sound-wave transported through the fluid of scala media and scala vestibulis though separated by Reisners membrane.
A transient will have enough energy to be registered directly by the outer hair cells as it passes through SM before the basilar membrane starts moving. I will leave the calculation on frequencies for this to happen to you.

The fact that the brain is connected to the outer haircells by the efferent pathway and the inner haircells are not - together with the fact that the

neurons from IHC/OHC are not of the same type and speed of signals - do clearly tell, that the OHCs play a quite different role in detection of sound and purpose of this detection too.
A lot of research on the influence of the OHCs has been done, but still the fog hasn't been lifted.
You have all heard the effect of OHC's working and stop working.properly.
Listen to how the sound from a soloist, duo, trio, quartet and so on to a full orchestra changes from a clear detection to a rather unclear ditto.
The amount of transients exeeds the capacity of our hearing.

"There is a world below 20 Hz and beyond 20 kHz and we detect both.

The religious sanctification of Mr. Fletchers work from the thirties by his high priest and other disciple has as all religions created a stop for development.

It is time to open for a far more trustworthy limitation of "0.2 Hz to 0.2 MHz".
(chosen here for its beauty)
No human despite race and learning of his/hers neural network will reach beyond that, and therefore is will be impossible to differ between natural and artificial sound when what will be between is done in full accordance with our hearing.
It will involve lots of tests by listening to confirm the correctness of what theory says.

It is possible to come sufficiently close to both by use of present or soon coming digital technologies.
The major problems are placed at the transducers - microphone and loudspeaker.