

Somewhat like Terry Wogan and his listener, I feel my first article secured one noble reader. My hope now is to double that number in this follow-up.

In my last piece, I suggested the audio industry was populated by three distinct stereotypes, these being gods, gurus and mystics; the first two I've covered adequately but omitted a definition of those I call the gurus. These are a class of enthusiasts who are blessed with golden ears – as a professional audio engineer I regard myself as having fairly well-tuned hearing but confess I could never match the aural sensitivities of these (largely self-appointed) god-like creatures.

My first encounter with the species occurred shortly after launching Heliuss when I was invited to visit a dealer and demonstrate Heliuss tonearms.

I turned up at the appointed hour and was greeted by the shop manager who introduced me, with considerable reverence, to his key salesman – whereafter, **he** disappeared with disconcerting alacrity.

The rather surly individual I'd been left with glared at me in a manner worthy of someone who had spent too long in the services of one of those three-lettered American agencies – he came with no known sense of humour.

"I have a cod id by brain so I'b 6dB down in my left hand channel," he announced with a degree of emphasis intended to stamp his authority on the meeting.

Though sympathetic to the circumstances of his nasal congestion, my head filled with the image of large fish up this bloke's nose. Simultaneously the most pathetic play on words sprung into mind; had this head-cold rendered my opponent sinus-oidally challenged rather than sinusoidally?

"Sorry to hear it," I replied, struggling to suppress any sign of a smirk having decided he was, indeed, the sort of person who would have actually measured his own hearing.

Clearly not a chatty chap, he raised a solitary eyebrow that would have done justice to Roger Moore at the height of his acting career...I was being brow-beaten into accepting that he was the final arbiter of my products here.

Still hoping that I was misreading the situation, I asked, half in humour, half with full blown sarcasm.

"Is that a broadband spectral issue, or is your one-eared attenuation frequency specific?"

The stand-off (I admit largely self-inflicted) was rapidly descending into an audio equivalent of a spaghetti Western - I raised him a matching eyebrow as an act of defiance. However, no sooner had I uttered the words, than I remembered my Confucius,

'Before you embark on a journey of revenge – dig two graves.'

"I'b 6dB down at 6KHz, 9dB down at 10K and I roll off 24dB per octave after 15KHz" came the gruff response.

With Henry Mancini's theme to 'The Good, the Bad and the Ugly' running through my head, I came to my senses and re-evaluated the situation.

I was ultimately there to try and sell him something, so there was no other solution - I immediately raised both eyebrows in a gesture of unconditional surrender and prayed we could move on before that tenuously suppressed smirk erupted finally onto my face.

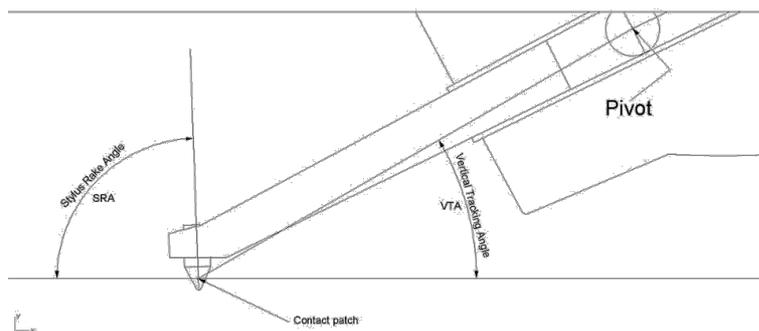
Apart from sucking all the fun out of hi-fi, such people often maintain their reputations by hearing things that aren't actually there or by misinterpreting the differences they can.

A good example is tonearm VTA – Vertical Tracking Angle.

Some say, (to use the famous Top Gear phrase) that small misalignments of your stylus will result in audible distortion or mistracking. Whether generated from incorrect tonearm height adjustment or inaccurate cartridge angle, the gurus believe that angular errors can be heard.

Personally, I question the audibility of modest inexactitudes. This is not to say inaccuracies can't be heard, it's just that I attribute them to the other factors.

As a starting point, when people refer to Vertical Tracking Angle, VTA -they usually mean Stylus Rake Angle, SRA – in other words, the perpendicularity of the stylus with respect to the groove.

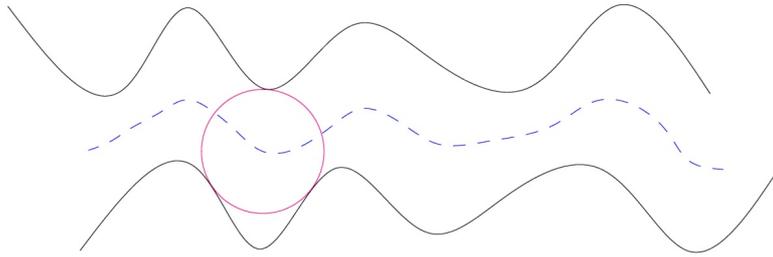


Note that VTA is referenced to the cantilever pivot point and NOT the height of the arm where it is mounted to the turntable.

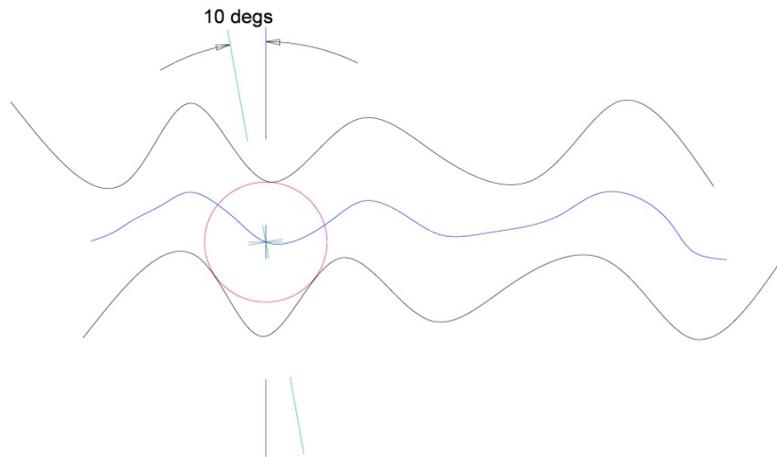
More significantly, the mechanical characteristics of the cantilever suspension is where all reaction energy is transferred into the

The vast majority of styli are spherical – not elliptical, fine-line or Shibata; (we'll come to these soon) given also that a slice taken through a sphere will produce a circle, the diagrams below are valid and describe how a spherical stylus sits in the groove.

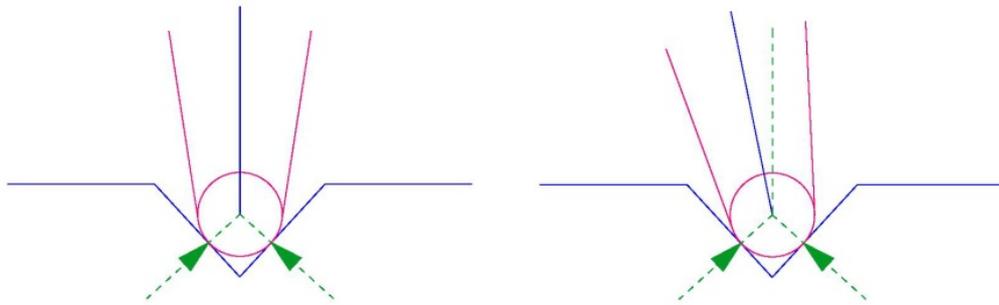
There are three geometric planes we need to align when setting up a cartridge; VTA, Azimuth and tracking angle. At any point on a record, the contact points might look like this.



If we emulate a ten degree angular error of the cartridge in its headshell, the same image changes to this.



Can you see any difference? ... I sure can't and nor can the stylus. Furthermore, this same visual scenario applies to VTA and Azimuth. For instance, if we consider the azimuth scenario, it looks like this.



As you can see – the contact points remain the same despite this exaggerated 10 degree error.

Whichever geometric plane you observe from, the result (for a spherical stylus) is the same – the contact points are always based on a sphere/circle lodged in a groove.

At this point some of you will be asking why can I still hear a difference? ...well, the answers are more complex for non spherical styli, so I'll finish this part of the article by answering only in respect of spherical styli.

Experience divides my feet into two camps. The easiest being 'worn record/new stylus syndrome' – the second but, by far the more important aspect of the set-up is the stylus-overhang/arm geometry.

In respect of record wear, if you've upgraded from a spherical stylus to an elliptical, or your record has frequently been play with a variety of cartridges with different levels of downforce – expect some degree of wear in the grooves and, usually, this wear focuses on one side often groove more than the other.

If you really want to test the audibility of angular errors use a brand new, unworn record to draw your conclusions. If you're planning to use your favourite Led Zep album you bought as a teenager – and that you played to death on your first hi-fi, **don't** deem it to be a suitable record for this purpose!

If you want to visualise the system, put yourself inside the cartridge. What generates the music is the relative movement between magnets and coils. In order to hear a correct rendition of what's happening in the groove it is imperative that the cantilever/coil assembly is properly centralised. If the stylus overhang or pivot geometry are not optimised, bias forces multiply with very small errors.

This corrective force should be linear, in other words, pretty much the unchanged as the arm traverses the record. Unfortunately, relatively small errors can have disproportionately large adverse effects on the cartridge.

The centrality of the coils in relation to the magnets IS the singular most important issue – if not optimised, the harmonics will be emphasised in one channel and mistracking is more likely to occur. It's a scenario usually ameliorated by increasing downforce which, in turn means the cartridge will be fighting further 'unnatural' influences.

What you may hear is the illusion of 'more detail' in some areas or differences in bass performance - indeed you may well *like* what you hear, but it's not musically neutral...for purists, it's a recipe for paranoia – 'I might be technically wrong, but I think it sounds better.'

So...my conclusion, based on the use of a spherical stylus, is that you can't hear modest cartridge misalignment errors provided the arm is accurately set up on the turntable. The question is how to test this assertion.

The start with, buy yourself a new test record and listen to a 3KHz tone (or somewhere thereabouts) - then alter the arm height and try again, twist the cartridge in the headshell, play with azimuth settings. Listen for 'impurities' – added harmonics that shouldn't be present in a pure tone, or an emphasis in one channel. My guess is that you won't hear any difference, my caveat being that the errors aren't extreme; the cantilever needs to be close to tangential to the groove if we want to maintain an optimal coil/magnet relationship. Whilst the cartridge suspension will accommodate reasonable errors, other the mechanical forces in play will ultimately reveal themselves.

Modest angular errors are inherent in a design where the cantilever is intended to vibrate through a range of about 5 degrees; fortunately, the spherical stylus is very forgiving and errors are inaudible.

In the beginning of this article, I implied the position for a non-spherical stylus was a little more complicated. In part 2 of this, I'll go one stage further.

Part 2:-

In the first part of this I described the geometry of a spherical stylus in a groove and the non-consequences of minor errors in angular alignment. Pictured as a ball in a channel, misalignments of the cartridge don't change the contact area – however, extreme errors will skew the cantilever in relation to the groove and impose mechanical loads that you will be able to hear.

I also intimated that the position for elliptical styli is more complicated, and that when you advance using profiles like the Shibata stylus, things are not quite so simple.

In the context of tonearm and turntable geometry, the same basic geometric rules apply regardless of the stylus shape but, like high performance automotive engines, accurate set-up is more critical if using more sensitive components. Small changes begin to become audible.

As this article is supposed to be about the audibility of angular errors in cartridge alignment, we have to consider how heavily 'shaped' styli are more sensitive to adjustments...so to begin with, we need to look at how a record is cut in the first place.

It will come as no surprise to you that the cutter stylus is very different from that you use in playback.

The following website shows not only the shape of the cutting diamonds but also the shanks in which they are mounted.

<http://www.myshank.com/de/12-neumann-vinylium-caruso>

In particular, if you read their FAQ section, <http://www.myshank.com/de/content/6-faq>

You will see the recommendation that the cutting angle is set 'around' 8 degree (+/- 2 degrees)

Here's your first hint as to why you might be able to hear differences in height setting of the arm, but can't find a singular 'sweet spot' that suits every record. Like all mechanical things, there are tolerances associated with the angular alignment of the diamond tip and further limits to how accurately it's glued onto the shank. Errors can be cumulative, but usually fall within the limits of less than 5 degrees.

Put in the context that raising your 10" tonearm by 5mm at the rear, will alter SRA by barely 1 degree, it becomes obvious that you can't tell if your height adjust is improving things or making them worse.

What the cutting stylus image shows very clearly is how sharp the edges are – this is needed to imprint 20KHz into the disk where the radial velocity of the inner grooves is much lower.

What this implies is that the profile of the playback styli is crucial; having said that, this article is not about stylus design, so again, I'm going to refer you to 2 websites that cover various designs quite well...and keep in mind that you need a 'sharper' shape to reveal finer inner-groove detail.

http://www.ortofon.com/media/14912/everything_you_need_to_know_about_styli_types.pdf

If you're interested, a more detailed description can be found on the vinylengine website.

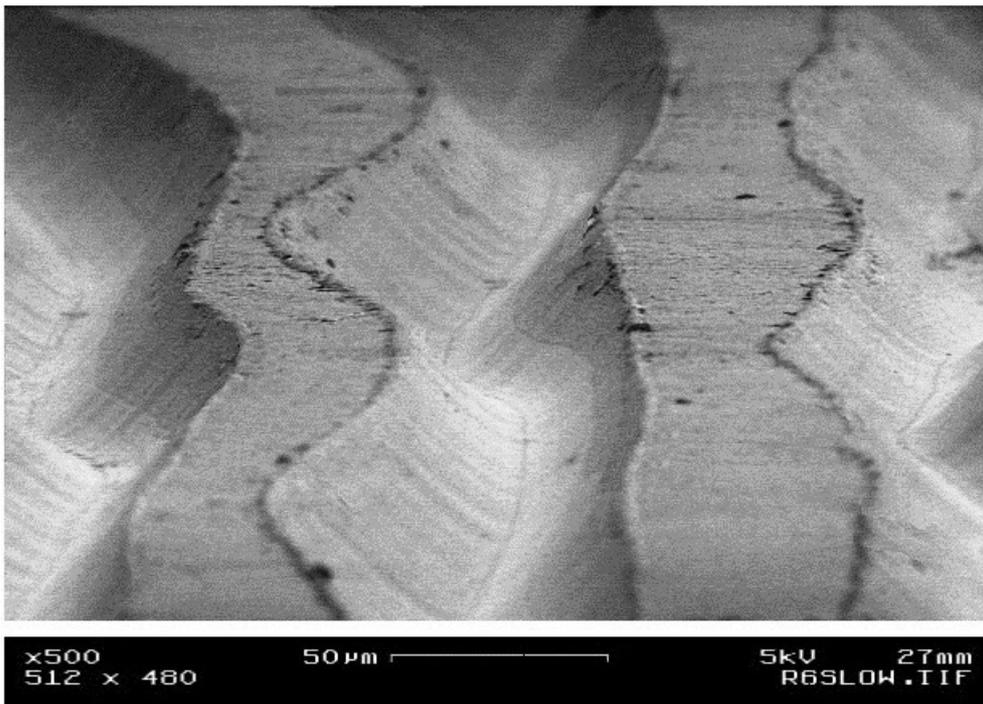
http://www.vinylengine.com/turntable_forum/viewtopic.php?t=22894

The importance of a good stylus can't be overestimated. Just as (no matter how sophisticated) a formula 1 car is ultimately dependant on the contact areas of 4 tyres on asphalt, that little tiny diamond in your cartridge is the thing performing at the coal face – it's the tortured bit that does the actual work of following and retrieving the musical waveform.

So, how different is the experience of hyper-elliptical stylus and how do angular/geometric errors compared to the spherical stylus?

We'll answer this by looking at each of the 3 planes – azimuth, VTA (SRA really) and tracking angle. My starting point is to look at some real grooves.

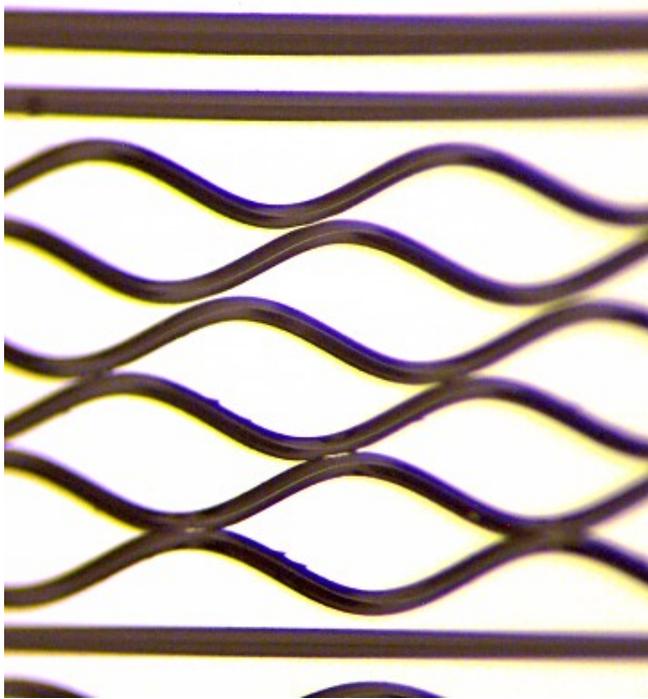
This first image shows the difference between left and right channel and some of the exceptionally fine high frequency (HF) detail.



From this you can see that hearing the finer HF detail is dependent on having the sharpest stylus edges. If you look at the groove to the right you can see the rapid changes required by the stylus.

In transcribing this, the total cantilever displacement is only about 80 microns – or 0.08mm; the finest detail measures around 5 microns – hence my preference for a Shibata stylus as it's more likely to register the finest detail.

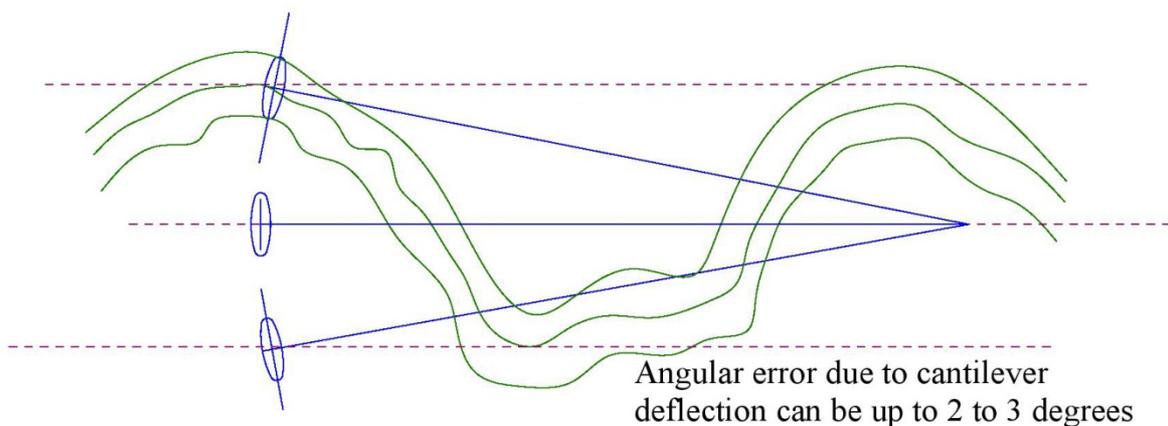
In contrast, this image shows a 300Hz pure sine tone.]



Given the actual groove width is still about 50 microns, the total deflection here is about 400 microns or 0.4mm.

Given that cantilevers are generally 8mm to 10mm long, the deflection here amounts to about 3 degrees, the fulcrum of this movement being the cartridge suspension.

Demonstrating this diagrammatically, the change in stylus angle simply due to cantilever deflection looks like this.



Whichever way you look at it, around 3 degrees of angular displacement is innate within the physiology of the vinyl record – it's just how cartridges work.

Coupled with this is the physical limitation of fixing tiny diamonds to the cantilever. (in both the recording and playback phase) Errors encountered simply gluing a stylus in place can amount to 2 or 3 degrees and this could be compounded between recording and playback - you simply have no way of knowing how to compensate. Using a microscope to set up the cartridge might help but consider that records have different thicknesses and platter mats can vary in thickness in accordance with ambient temperature (soft rubber/silicone/cork/felt etc. will expand or contract according to temp.)

There is absolutely no point in driving yourself mad trying to achieve geometric perfection. I reckon every system will have cumulative errors of around 5 degrees – and that could mean raising the tonearm by 25mm if it were all SRA.

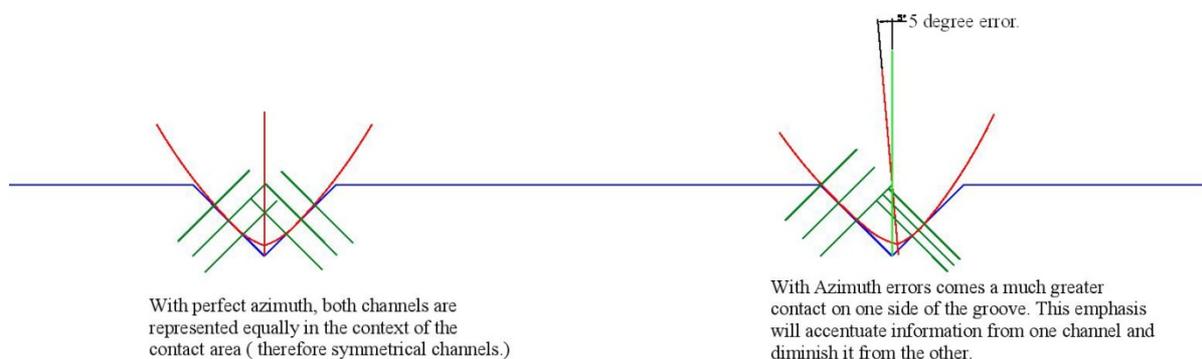
Despite the views of golden eared, I do not believe that anyone can hear adjustments of a millimetre or two in the weight of the tonearm. There is a rule in engineering that is universally true of life in general – you can achieve 80% of the results in 20% of the time, but trying to achieve the last 20% will cost you 80% of the time.

By all means play with the system and explore the effects of adjustments – but don't obsess – it's not worth it because what is right for one record will be wrong for another.

To conclude the geometric part of this discussion, let's just say there is no 'one-perfect' VTA/SRA setting – no singular 'sweet-spot' that applies to every record. The nature of the beast is that these angles change constantly.

However, there is one error that does warrant additional attention in conjunction with non-spherical styli – and that is Azimuth.

The following diagram of a Shibata stylus shows how a small error in the tube angle can lead to a dramatic degradation in performance.



Small azimuth errors exaggerate discrepancies in the contact area. For both channels to be represented equally in respect of coil/ magnet alignment, the groove must be able to 'push' the stylus with symmetrical force.

Working with the azimuth condition shown in the right-hand image, the stylus has little contact with the right wall of the groove and excessive contact in the left...now suppose you're playing some piece of stereo music that has an emphasis in the right channel at some point in time. Less of the music will come through, and if there's less music in the left channel that moment, the overall sound will be lacklustre. It will be devoid of dynamics and possibly very sibilant – certainly very prone to surface noise in the left channel.

Similarly, if there is a musical emphasis on the left, you may feel inclined to adjust the balance control on the amp. Poor azimuth alignment will accentuate wear record wear as well as distort information.

Having said that, those familiar with Helius arms will point out that I have always sworn by fixed headshells. The reason, quite simply, is that I don't think customers can adjust the tube angle within a degree or two and it's better to start from a known position. Anyway, after you've played with tube angles for an hour or two, you forget where the original setting was. Putting alignment marks on the arm is not practical when the adjustments needed are likely to be barely one of two degrees and adding micro-adjusters just adds to effective mass.

Considering all these factors, I sometimes think it's a miracle the system works at all – however, I'm pleased to say it does.

Although misalignment errors can be cumulative, the vinyl industry is run by dedicated enthusiasts who bring one quality to the process that digital audio misses - we bring 'art' to the process.

Many of you will say that's one good reason to avoid vinyl – but as an engineer, I can promise you that you're just swapping one set of technological problems for another.

To conclude – learn to live with the fact that the geometry will never be perfect. You have no idea what settings the record was cut to - much less do you have control over parameters like record thickness.

For those wanting to explore the VTA issue in more detail I'm going to finish with one final web reference. – here is someone (Geoff Husband) who has driven himself mad trying everything – I thoroughly recommend the read.

http://www.tnt-audio.com/sorgenti/vta_e.html

Auf Wiedersehen – until next time.