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Twisting your cartridge in the headshell

Posted September 13th, 2009 by JaS

When using a universal 2-point protractor we all know that you should change your stylus overhang by moving the cartridge for and aft in the headshell to align as closely as possible at both alignment points.

But what of the angle of the cartridge in the headshell?

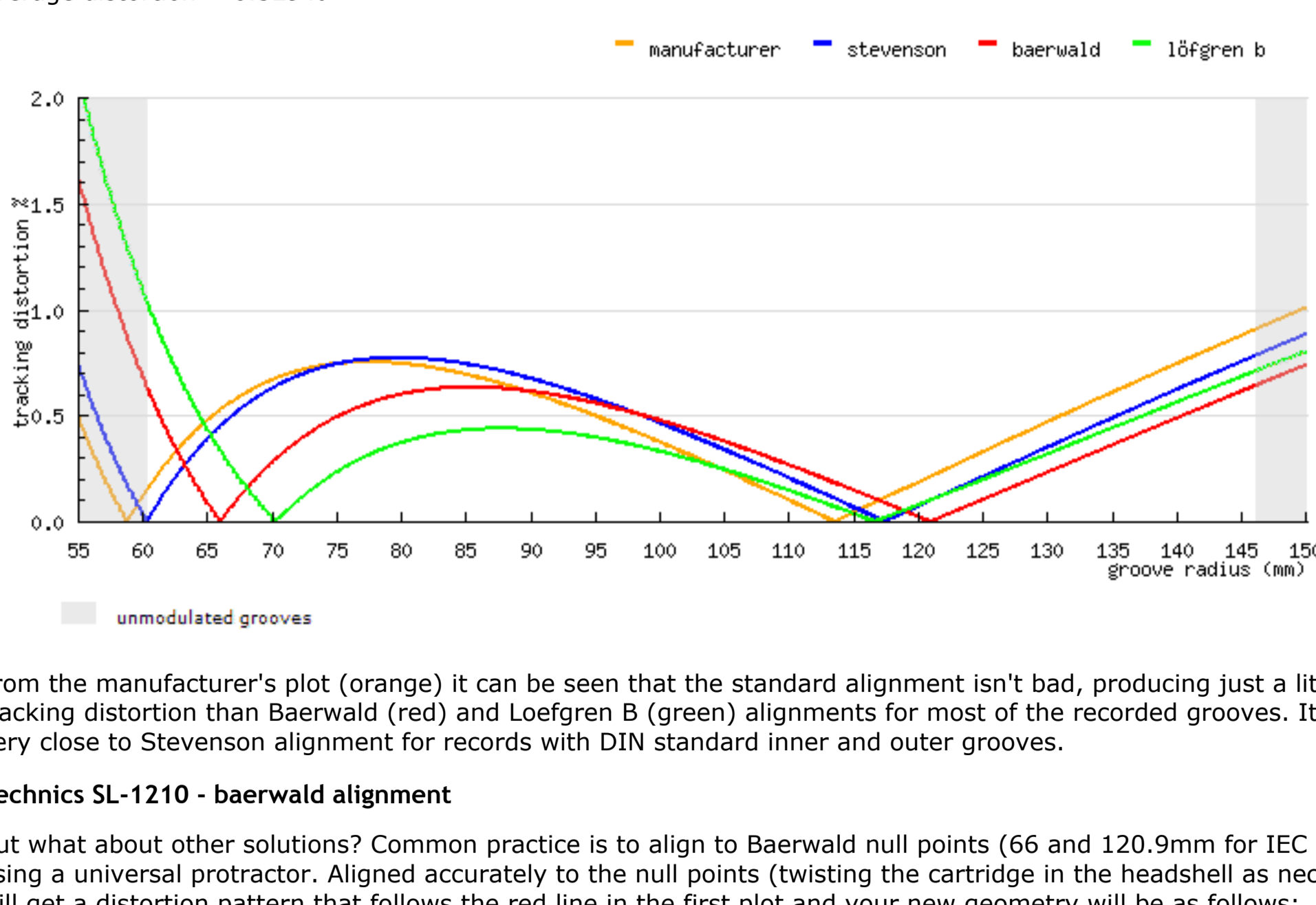
The instructions normally state that you should 'twist' or 'skew' the cartridge in the headshell as required to get perfect alignment at both null points.

However, some people believe it's important to keep the cartridge square in the headshell so only adjust the overhang, even if this means less than perfect alignment at the null points.

So how important is the offset angle and what effect does keeping the original angle in the headshell have on the resulting alignment? To find out I decided to measure the results of the two methods when applied to the Technics SL-1210.

Technics SL-1210 - standard alignment

effective length = 230 mm
 overhang = 15 mm
 offset angle = 22 °
 maximum distortion = 0.904 %
 average distortion = 0.529%



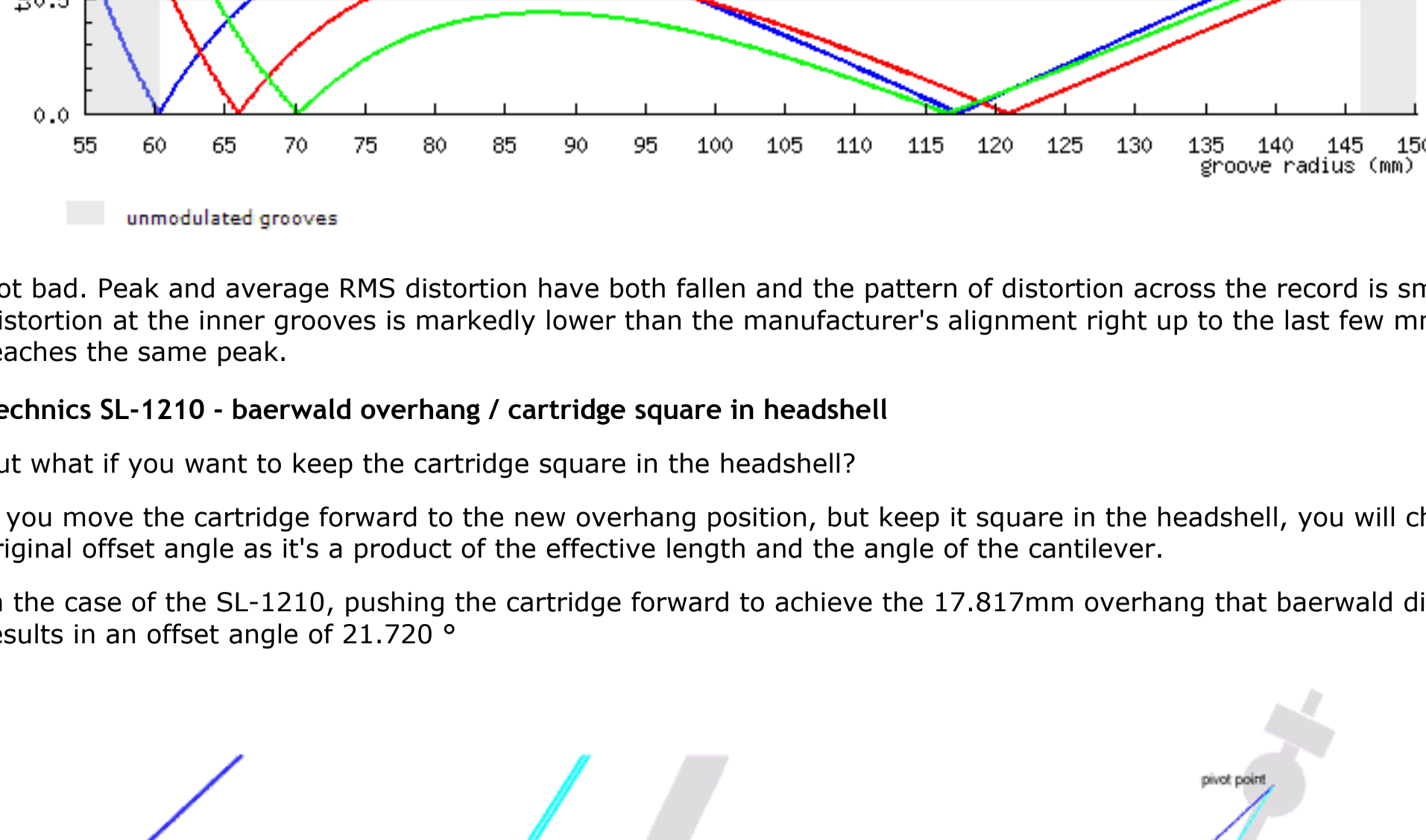
From the manufacturer's plot (orange) it can be seen that the standard alignment isn't bad, producing just a little more tracking distortion than Baerwald (red) and Lofgren B (green) alignments for most of the recorded grooves. It's actually very close to Stevenson alignment for records with DIN standard inner and outer grooves.

Technics SL-1210 - baerwald alignment

But what about other solutions? Common practice is to align to Baerwald null points (66 and 120.9mm for IEC records) using a universal protractor. Aligned accurately to the null points (twisting the cartridge in the headshell as necessary) you will get a distortion pattern that follows the red line in the first plot and your new geometry will be as follows:

new effective length = 232.817 mm
 new overhang = 17.817 mm
 new offset angle = 23.664 °

maximum distortion = 0.64 %
 average distortion = 0.417%



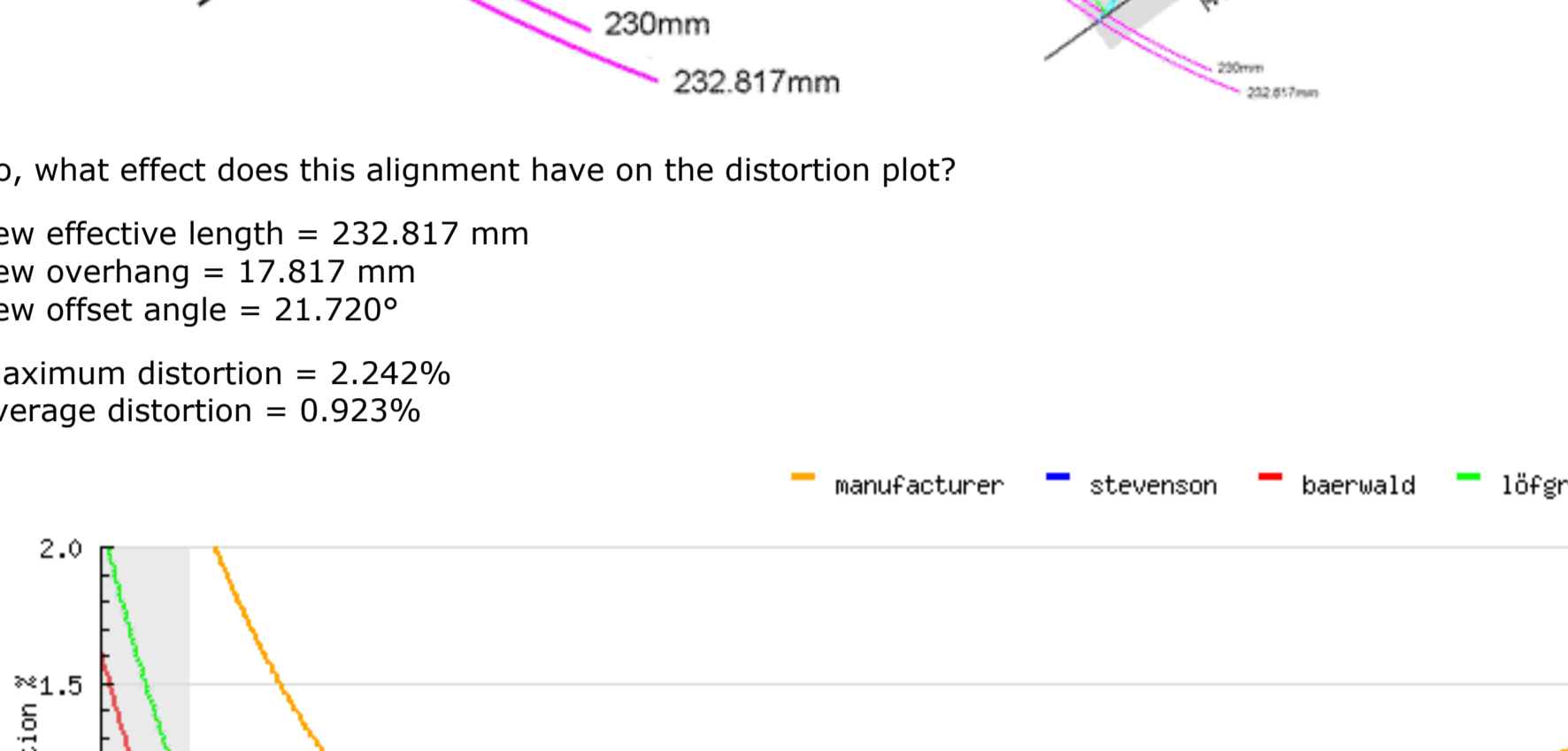
Not bad. Peak and average RMS distortion have both fallen and the pattern of distortion across the record is smoother. Distortion at the inner grooves is markedly lower than the manufacturer's alignment right up to the last few mm and never reaches the same peak.

Technics SL-1210 - baerwald overhang / cartridge square in headshell

But what if you want to keep the cartridge square in the headshell?

If you move the cartridge forward to the new overhang position, but keep it square in the headshell, you will change the original offset angle as it's a product of the effective length and the angle of the cantilever.

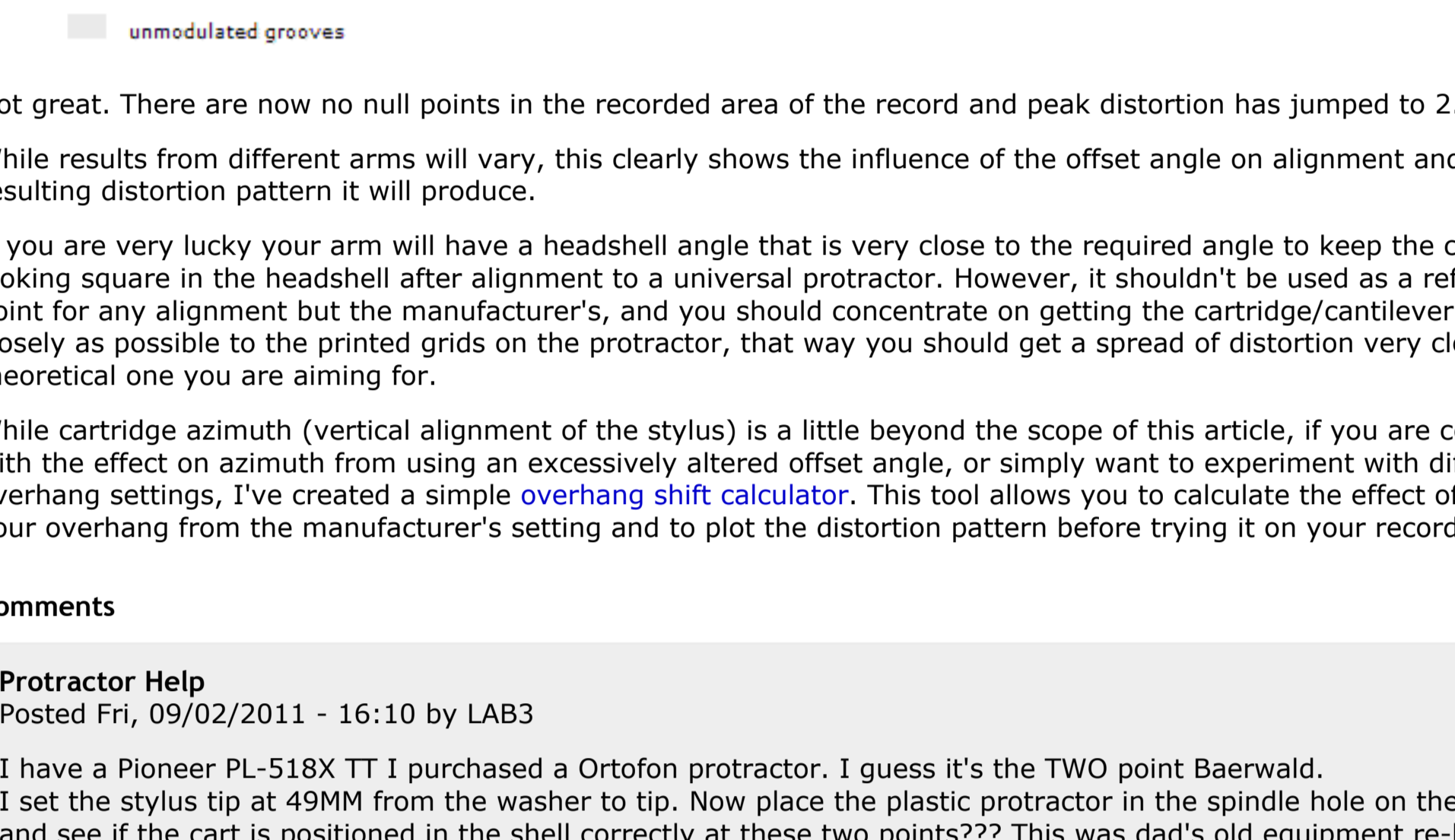
In the case of the SL-1210, pushing the cartridge forward to achieve the 17.817mm overhang that baerwald dictates results in an offset angle of 21.720 °



So, what effect does this alignment have on the distortion plot?

new effective length = 232.817 mm
 new overhang = 17.817 mm
 new offset angle = 21.720°

maximum distortion = 2.242%
 average distortion = 0.923%



Not great. There are now no null points in the cleared area of the record and peak distortion has jumped to 2.242%.

While results from different arms will vary, this clearly shows the influence of the offset angle on alignment and the resulting distortion pattern it will produce.

If you are very lucky your arm will have a headshell angle that is very close to the required angle to keep the cartridge looking square in the headshell after alignment to a universal protractor. However, it shouldn't be used as a reference point for any alignment but the manufacturer's, and you should concentrate on getting the cartridge/cantilever aligned as closely as possible to the printed grids on the protractor, that way you should get a spread of distortion very close to the theoretical one you are aiming for.

While cartridge azimuth (vertical alignment of the stylus) is a little beyond the scope of this article, if you are concerned with the effect on azimuth from using an excessively altered offset angle, or simply want to experiment with different overhang settings, I've created a simple [overhang shift calculator](#). This tool allows you to calculate the effect of shifting your overhang from the manufacturer's setting and to plot the distortion pattern before trying it on your records!

Comments

Protractor Help

Posted Fri, 09/02/2011 - 16:10 by LAB3

I have a Pioneer PL-518X TT I purchased a Otofon protractor. I guess it's the TWO point Baerwald. I set the stylus tip at 49MM from the washer to tip. Now place the plastic protractor in the spindle hole on the platter and see if the cart is positioned in the shell correctly at these two points??? This was dad's old equipment re-learning TT...sigh

Louis

which protractor

Posted Sun, 07/24/2011 - 16:24 by ryk74

Hi,
 at the bottom line, which protractor should we use for technics 1200mk2/mk5? Others suggest Stevenson, other baerwald.....Any method to test the results?
 thanks!

It depends ... either will do

Posted Sun, 07/24/2011 - 19:23 by joey1127

It depends...either will do the job. You have to understand that Technics designed their tonearms to provide the least amount of distortion at the innermost bands of the record. They DID NOT use Stevenson as their design means. They used what was deemed appropriate by, if I remember correctly, EIC standard at that time. Actually, you could use the Technics Baerwald ARC protractor here on the VE and it works GREAT. The cart will be all the way forward and slightly canted inward when set up properly.

To set up the table as Technics intended, just set the stylus tip 52mm from the back of the rubber washer on the headshell. When mounted in the tonearm, this results in an overhang of 15mm.

People will debate over which one is better...but at the end of the day, it depends on your ears. On Theory, Baerwald should sound better as it's goal is to reduce distortion across the entire surface of the record. However, I found on REGA arms that Stevenson sounded better. On DUAL arms, I found that using their own chosen alignment sounded better...

Good Luck

which protractor

Posted Mon, 07/25/2011 - 10:54 by ryk74

Thank you Joey!

Why don't manufacturer specs match Lofgren results

Posted Fri, 09/03/2010 - 19:45 by gmax137

Hello, I recently stumbled into this site and I have been reading up on alignment protractors etc. Last nite I read through the translation of Lofgren's article. Very interesting. I even managed to keep up with the trigonometry. The question I have now is why the difference between the manufacturer's specs on overhang / offset angle and the values calculated using Lofgren's formulas? How do the manufacturer's engineers and designers come up with their specified overhang & offset?

Thanks
 Gregg

Lofgren

Posted Fri, 09/03/2010 - 21:19 by JaS

Hi,
 Even for designers using Lofgren's formulas the final values for overhang and offset angle depend on what formula is used (A or B) and what radii the designer is trying to optimise for?

For example, Japanese tonearms tend to be optimised for smaller inner groove radii, and as they often use overhang gauges for alignment, overhang figures are rounded, presumably to simplify set-up for the end user?

Throw in Stevenson's influence (another variation on Lofgren's formula) and artistic licence (eg VPI, Mayware) and for any given mounting distance there are countless variations to choose from.

Yosh has an excellent page describing the various standards for record specifications - it goes some way to explaining the choices a tonearm designer faces.

<http://www.7a.biglobe.ne.jp/~yosh/recspecs.htm>

Regards,
 JaS

Lofgren

Posted Sat, 09/04/2010 - 13:56 by gmax137

Thanks JaS - there's alot to look at in that link.

I'm glad I found this site. It's an example of the internet at it's best.

Gregg

Proper alignment of the cartridge in the headshell

Posted Mon, 09/28/2009 - 14:18 by rbwinterink

September 28, 2009

This is excellent information and is exactly what I was looking for. I recently purchased a Jelco 750D tone arm and will need easy to understand information that makes more sense to keep the cart square with the headshell so a cartridge aligned for less tracing error may require less bias compensation (I haven't tested this)? To be honest the DV505 skating compensation is a little coarse in adjustment and I found it difficult to achieve perfect results using the original alignment gauge (which I ended up using in preference to a Baerwald purely for ease of alignment).

Regards,
 JaS

Other effects of twisting the cartridge in the headshell

Posted Mon, 04/12/2010 - 21:58 by Lew

First of all, thanks for the careful and detailed analysis.

I recently acquired a Dynavector DV505 tonearm when I align cartridges in that tonearm using a Turntable Basics Protractor, twisting is necessary to align the cartridge body with the grids on the TTB tractor. (Probably due to dissonance between Stevenson geometry and whatever geometry is designed into the TTB.) So far, no problem. But I have noticed that with every cartridge thus situated, there is a tendency for channel imbalance, the R channel sounds consistently "louder" than the L channel. I have puzzled on this, and now I think it is because when I twist the cartridge as needed to align with the TTB, I am in effect increasing the offset angle with respect to a straight line back to the pivot. This results in an increase in skating force over that predicted by the designers of the tonearm. I am now experimenting to see whether increasing anti-skate (above "normal" for a given VTF) will correct this problem. But then I started to think about other issues that may arise to cause distortions when the cartridge body is twisted. For example, when the cartridge encounters a warp or any other surface irregularity, the vector of the force that is applied at the stylus tip will not be in the vertical pivot action of the tonearm. (This is especially obvious if you think of the Dynavector tonearm.) I am wondering whether this also could be an undesirable result of doing "the twist". Any comments would be appreciated.

I too have had channel

Posted Mon, 01/24/2011 - 16:44 by dnlyko

I too have had channel imbalance for years.
 I had been using the HiFi News protractor with my RB250.
 I tried the Rega protractor and it corrected the channel balance.

other effects of twisting the cartridge

Posted Mon, 01/24/2011 - 03:18 by thefringe01

You are correct about record surface irregularities causing the stylus tip vertical motion, not aligning with the vertical motion of the tone arm. When the cartridge is twisted in the headshell, the tone arm geometry will be altered. Now, probably only a slight twist may not cause any difficulty, and ... also keeping in mind that some tonearms are designed with the offset NOT aligned with the pivot point. Good examples are some of the later technics SL series tables, and the original AR deck. The offset pivot point on the Dual turntables were mostly for the purpose of multiple play (which nobody uses) which maintains stylus perpendicularity to the record... In other words the non-offset pivot would begin to cause skewing (ot tilting) of the stylus as perhaps two or three records are stacked on the turntable.

This relates to twisting the cartridge in the headshell, as record warps, and irregularities are encountered. The cartridge misaligns with the pivot. By keeping the cartridge square in the headshell, this does not happen.

I have experimented with twisting the cartridge for the purpose of obtaining less tracking error overall. And I didn't hear any more when I used a DV505, but skating force is a result of groove friction so a cartridge aligned for less tracing error may require less bias compensation (I haven't tested this)? To be honest the DV505 skating compensation is a little coarse in adjustment and I found it difficult to achieve perfect results using the original alignment gauge (which I ended up using in preference to a Baerwald purely for ease of alignment).

Regards,
 JaS

Re your response to my comment on twisting in the DV505

Posted Wed, 04/14/2010 - 02:17 by Lew

Thanks for your comments.

In your first paragraph, I take it that you agree that there may be concerns vis twisting the cartridge in the headshell of the DV505 and related Dynavector tonearms. But I don't quite get the last part where you mention changing the overhang from standard. As far as I can see, when I twist the cartridge to align it with the grids on the TTB protractor, I am not changing overhang at all; I still cite the stylus tip on the cross-hairs engraved on the TTB tractor. What am I missing?

Re your second paragraph, here is what I was trying to say: I think the DV505 was built with Stevenson geometry in mind. If that is incorrect, lets not get hung up on names. All I meant was that the very act of twisting the cartridge so that the body is angled to the spindle side with respect to the long axis of the headshell will result in a relative increase in skating force compared to that which would pertain if the cartridge were instead aligned with the headshell. This slight increase in skating force would or could require a bit more anti-skate to cancel out (a possible R channel imbalance or even R channel distortion). Since I do hear an R channel imbalance with 3 of 3 different cartridges I have thus far auditioned in the DV505, where in each case I did "twist" the cartridge body, I was thinking maybe this is the cause. Maybe a slight increase in anti-skate would cure the problem. If I have time, I may give it a try tonight. If increasing anti-skate does not work, I may do away with the twist, until I can purchase another protractor specifically designed for the DV505 intended geometry. Does this make better sense?

Lew

Geometry

Posted Wed, 04/14/2010 - 07:18 by JaS

"As far as I can see, when I twist the cartridge to align it with the grids on the TTB protractor, I am not changing overhang at all; I still cite the stylus tip on the cross-hairs engraved on the TTB tractor. What am I missing?"

I simply meant that if you are aligning to alignment, or you could get unexpected results. With the DV505 the standard overhang is 15mm and the offset angle 21.5 degrees. To align to the Turntable Basics protractor perfectly you will need to increase the overhang to 17mm and the offset angle to 22.6 degrees. In fact it's not possible to increase overhang without altering the offset angle as the two are related (see my overhang shift calculator).

"All I meant was that the very act of twisting the cartridge so that the body is angled to the spindle side with respect to the long axis of the headshell will result in a relative increase in skating force compared to that which would pertain if the cartridge were instead aligned with the headshell."

The cartridge should only be angled 1.1 degrees further inward when aligned to Baerwald null points so it shouldn't make much difference to skating force? Also the improved tangency with the groove over a larger portion of the playing surface will give lower tracing error (although not necessarily audible). FWIW I used to stick blue tack to the weight of my DV505 to fine tune it as I'd just come from a Zeta and an SME 309 which had continuously adjustable anti-skate and it spoilt me.

"I may do away with the twist, until I can purchase another protractor specifically designed for the DV505 intended geometry."

If you want to keep the original angle in the headshell, the Stevenson two-point protractor or the alignment protractors page will give standard alignment with your arm. I don't know of any commercial protractor that uses Stevenson, although the standard Dynavector overhang gauge was pretty cheap when I bought one (less than £10?)

Regards,
 JaS

Got it, finally.

Posted Wed, 04/14/2010 - 15:58 by Lew

Thanks for staying with me and for your spot-on response. Last night I did the experiment of increasing anti-skate a bit to compensate for the anti-clockwise rotation of my cartridge in its headshell. This maneuver did somewhat ameliorate the channel imbalance. Probably if I had dialed in still more AS, the problem would have been solved by this method. However, I then took the bull by the horns and re-positioned the cartridge so that it is now parallel to the long axis of the headshell. At the same time, I re-set anti-skate back to a lower value. This completely cured the channel imbalance problem even with the lower amount of AS, and the overall presentation benefited as well, with less sense of strain, for want of a better descriptor (at the expense of increased tracing error, I admit). But I have to say the overall presentation is much more enjoyable this way. Then too I independently found the Stevenson protractor here on Vinyl Engine and have downloaded a 1:1 copy. Will re-adjust the cartridge accordingly this evening. I own a very old all-metal version of the Demmesen protractor; I wonder whether that one complies with Stevenson. I will make some measurements, but meantime the paper one from this site should work fine. I guess the moral of the story is that twisting the cartridge in the headshell has some unpleasant consequences, if you are using a Dynavector tonearm.

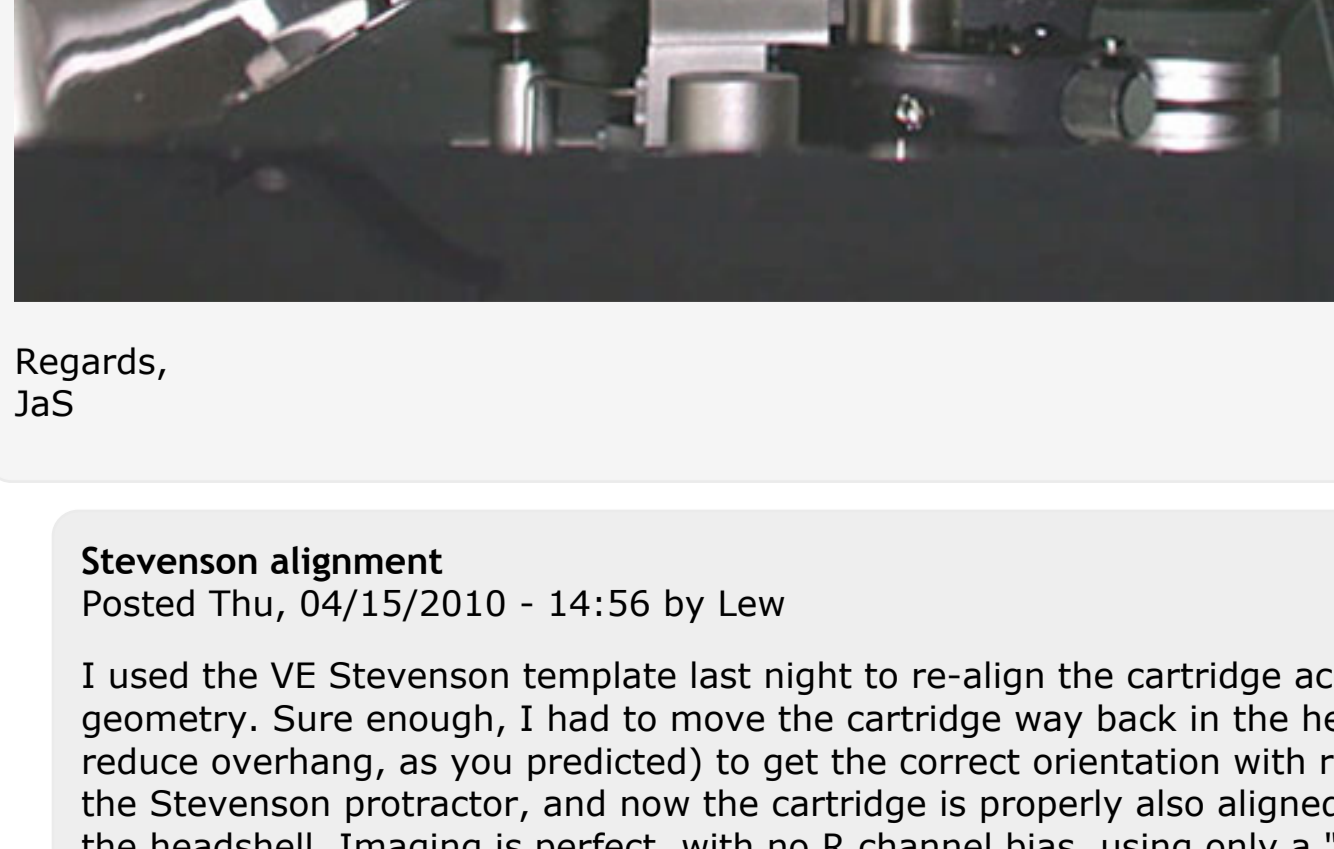
By the way, when I first bought the DV505, I searched the internet in vain for second-hand DV overhang gauge. I never considered that I might actually be able to buy a new one, since it ought to be the same for even the latest DV507 MkII.

DV505

Posted Wed, 04/14/2010 - 18:51 by JaS

Good to hear you got it sorted.

It's 7-8 years since I sold my DV505, but at the time was the UK importer (Pear Audio) sold me a gauge and an anti-skate weight off the shelf! Mine was a great match for my SL1000 :)



Regards,
 JaS

Stevenson alignment

Posted Thu, 04/15/2010 - 14:56 by Lew

I used the VE Stevenson template last night to re-align the cartridge according to its geometry. Sure enough, I had to move the cartridge way back in the headshell (i.e., I had to reduce overhang, as you predicted) to get the correct orientation with respect to the grids on the Stevenson protractor, and now the cartridge is properly also aligned with the long axis of the headshell. Imaging is perfect, with no R channel bias, using only a "normal" or subnormal amount of anti-skate. Without your original post and your responses to my questions, I might never have reached this happy ending. Thanks.