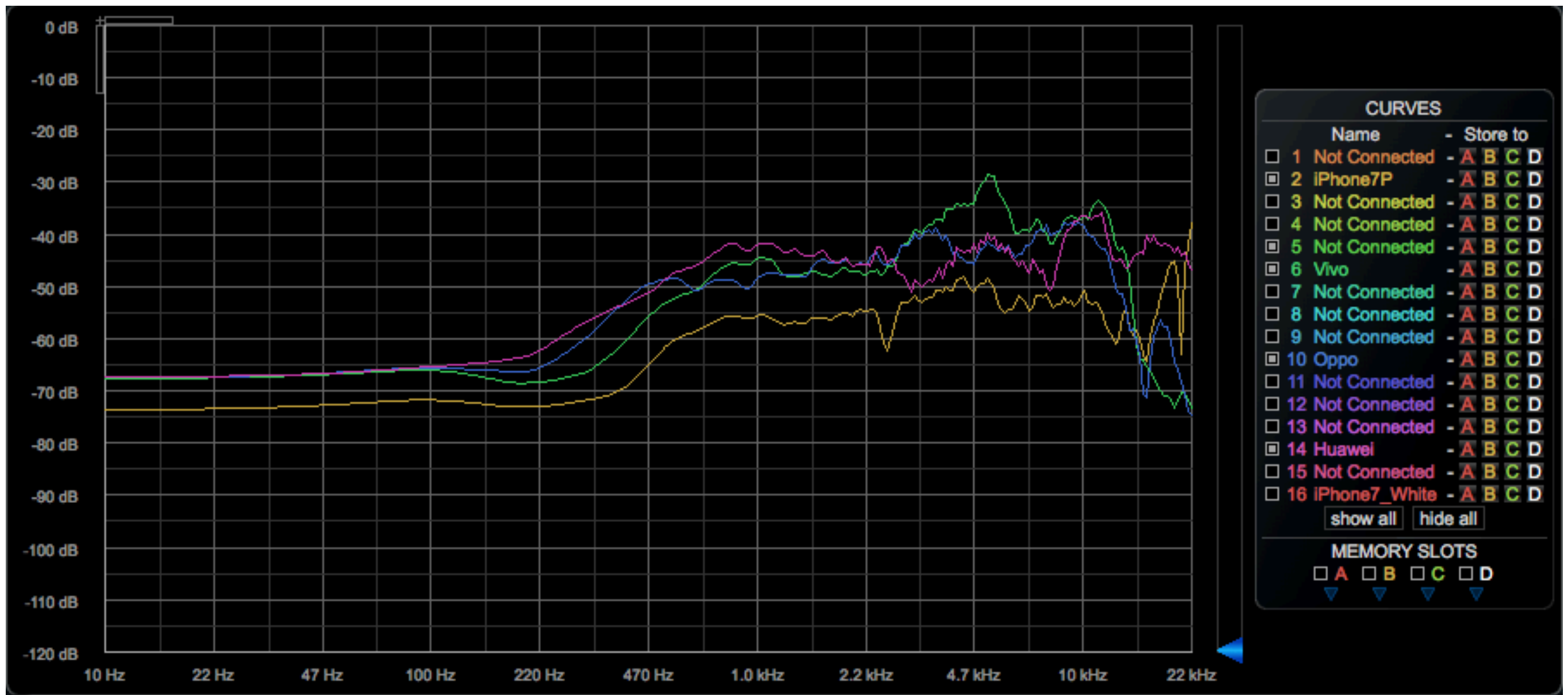


Mobile \$ Games

SPEAKER BOX SPECTRUMS - ANALYSIS

Author: Yang Jie (Digimonk)



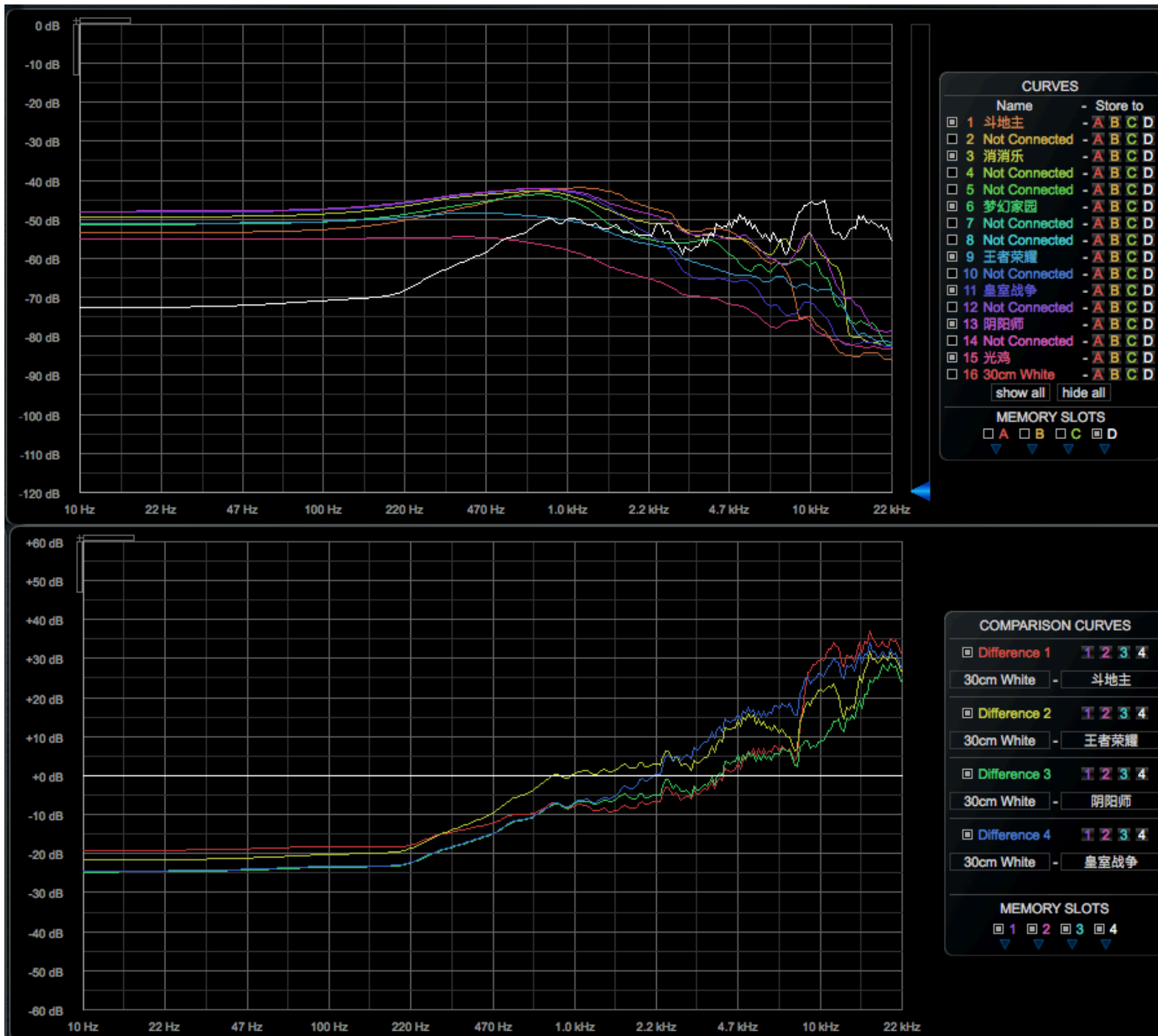
Tencent NEXT Studio

Whitenoise from cells speakers

30CM/-12LKFS REFERENCE

Specification of the spectrums

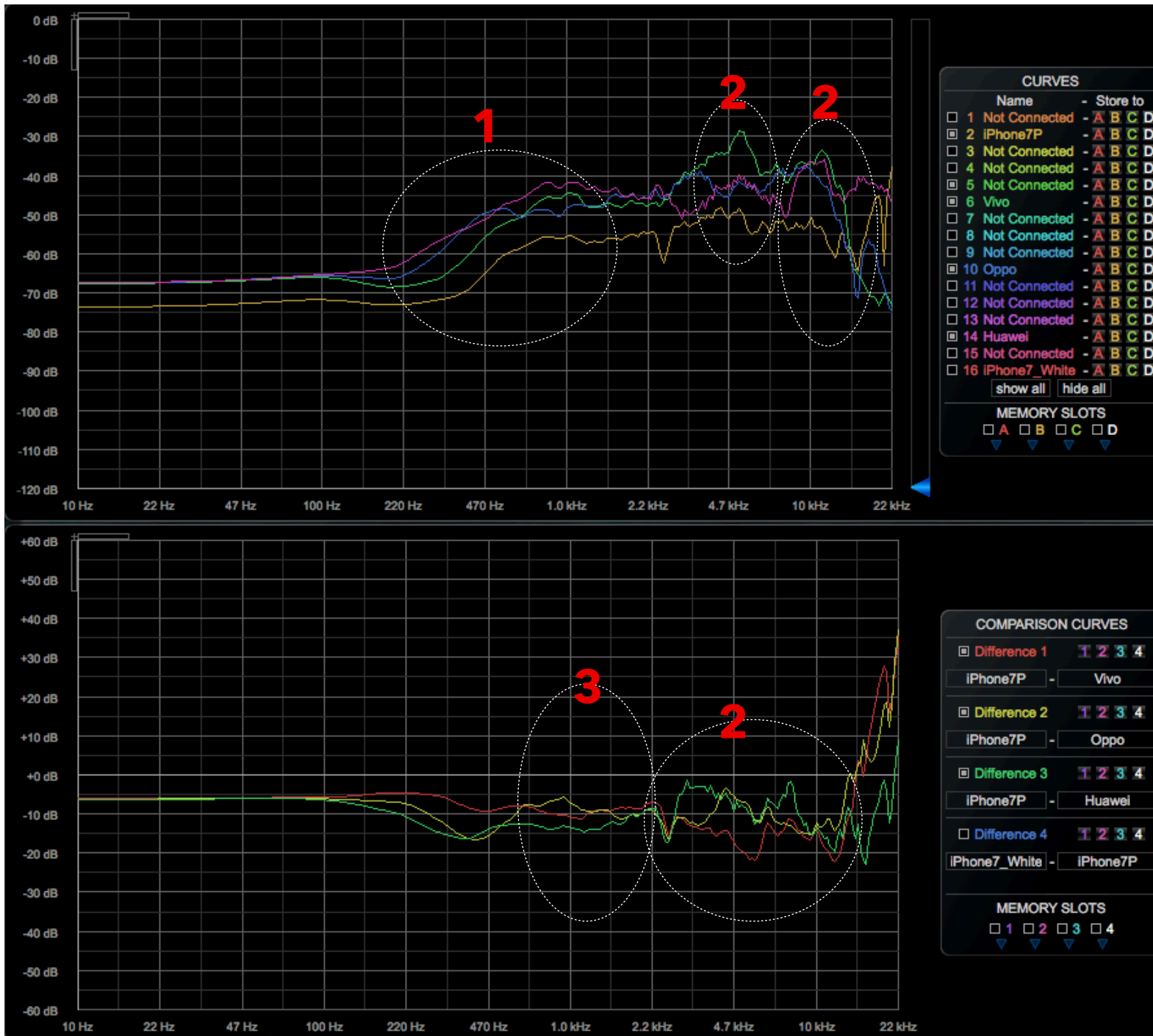
30CM-12LKFS REFERENCE/AVERAGE



1. The above one is the target curves themselves. The below one is the comparison curves, basically using the White noise as the reference to compare with the target curves. That can shows more hidden phenomena.
2. In the comparison curves, the curves below 0dB, means the white noise level is lower than the target curve. The curve above 0dB, means the white noise level is higher than the target one.

Whitenoise on the 4 cells

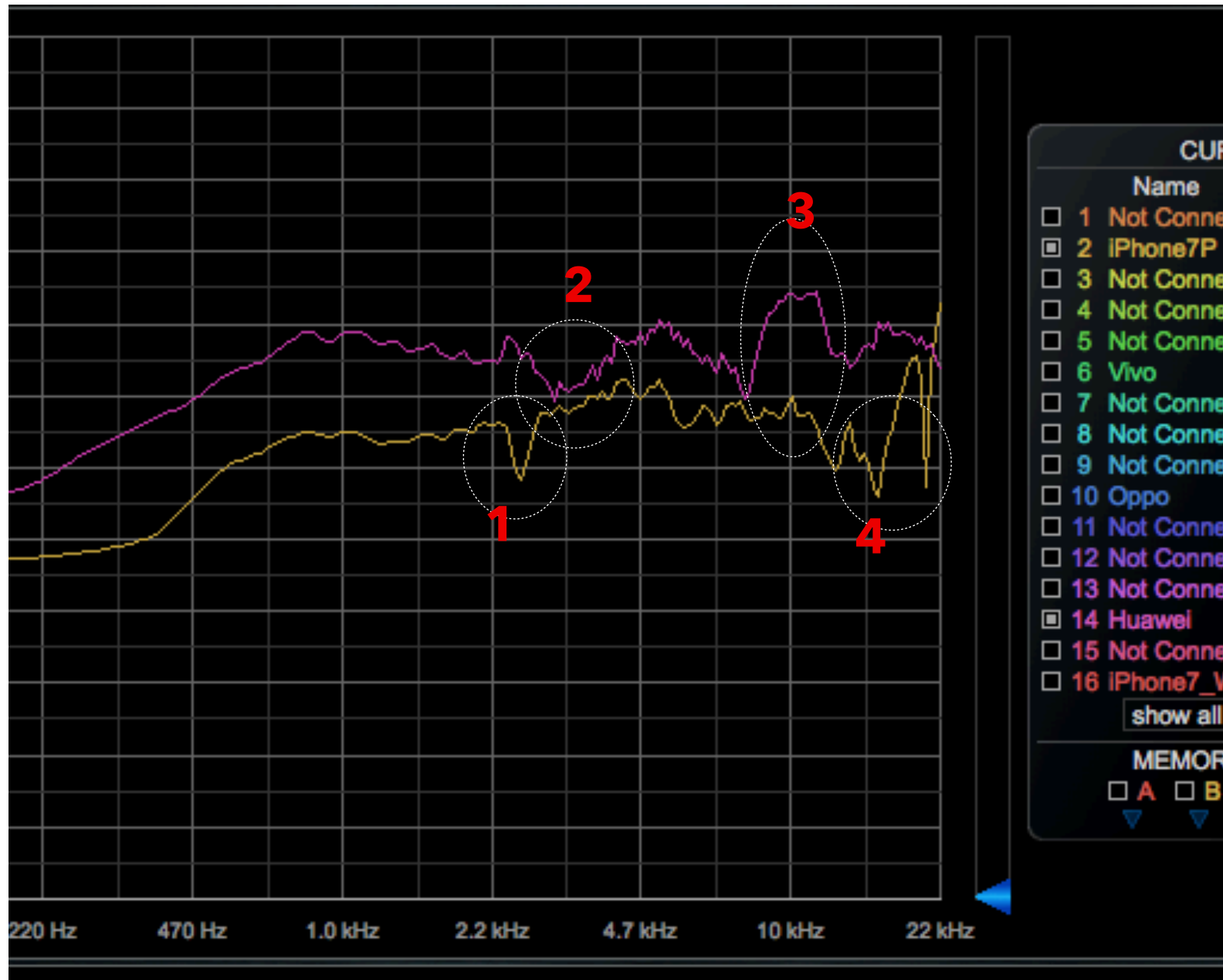
30CM-12LKFS REFERENCE/AVERAGE



1. Roll-off from 1 kHz is general. Even the ratio are quite similar.
2. The biggest difference between them are 2.2 - 15kHz.
 - Vivo is the highest, that's why it not such loud but sharp. And from 12kHz, the hi-freq rolls off very quickly!
 - iPhone 7P is the lowest and flat one. From 12kHz, it goes upper. That's probably the hardware structure design.
 - Huawei is big wave, specially around 10kHz. That's probably the reason why Huawei is very easy to get crap sound. And above 12kHz, it doesn't roll off at all.
3. Between 500-2.2kHz, all of them are quite similar. Vivo and Huawei did a little boost probably for voice.

Whitenoise on iPhone & Huawei

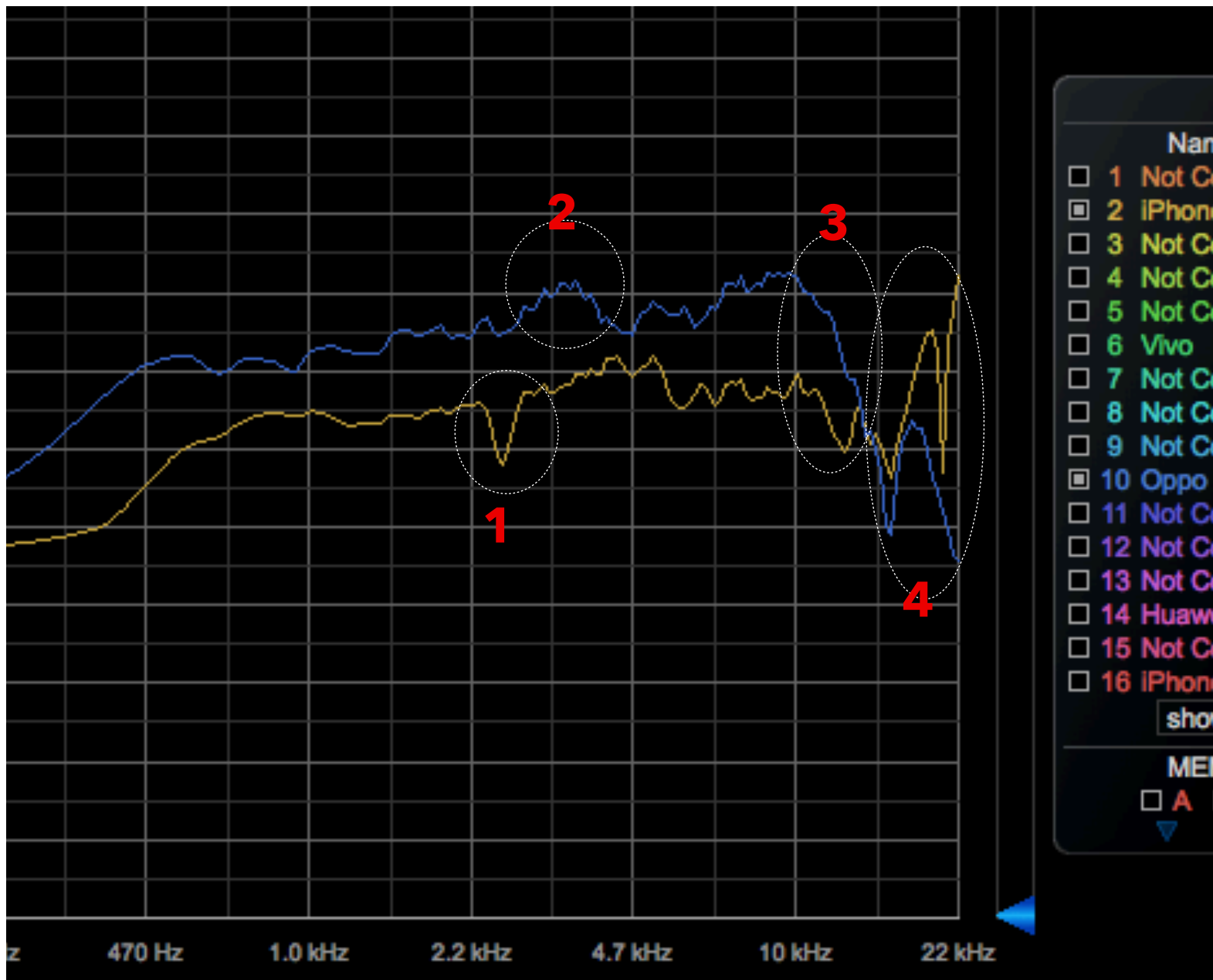
30CM-12LKFS REFERENCE/AVERAGE



1. iPhone7P has an obviously sharp valley around 2.8kHz. Not sure why, it's assumed to keep the a harsh band softer and warmer. (Probably this iPhone7 is damaged. Anyway, this symbolic point can be observed everywhere below.)
2. Because Huawei did the quite similar but softer treatment around 3.1kHz(check #2). This treatment shall be related with the hardware structure response.
3. Huawei has a clear raise around 10kHz. Comparing with the roll-off before that, this huge boost is quite weird. It's probably helpful to older people or noisy street. But that really makes the device very bright and easier to clip.
4. The big cliffy and sharp wave treatment is designed(probably) for getting better stereo hearing experience on iPhone7P.

Whitenoise on iPhone & Oppo

30CM-12LKFS REFERENCE/AVERAGE



1. It's mentioned in the last page.
2. Around 3.45kHz, this raise makes the phone sound harder. Because relatively, the bands around 10kHz is boosted upper very strongly. This curve can cause brighter and harder sound but the loudness is not such big.(check the loudness charts.)
3. Over 30dB fast sliding down from 10kHz to 16.5kHz. This curve shall be related by the hardware structure. And even it's probably adjusted in the later period of the device design.
4. iPhone 7P is the similar design with the Oppo. But for avoiding sharper structure vibrating(caused by raised #2 and #3), the higher band around 20kHz is not boosted. Or another reason is, the engineer thought the freq over 20kHz is meaningless and then it's cut.

Whitenoise on iPhone & Vivo

30CM-12LKFS REFERENCE/AVERAGE



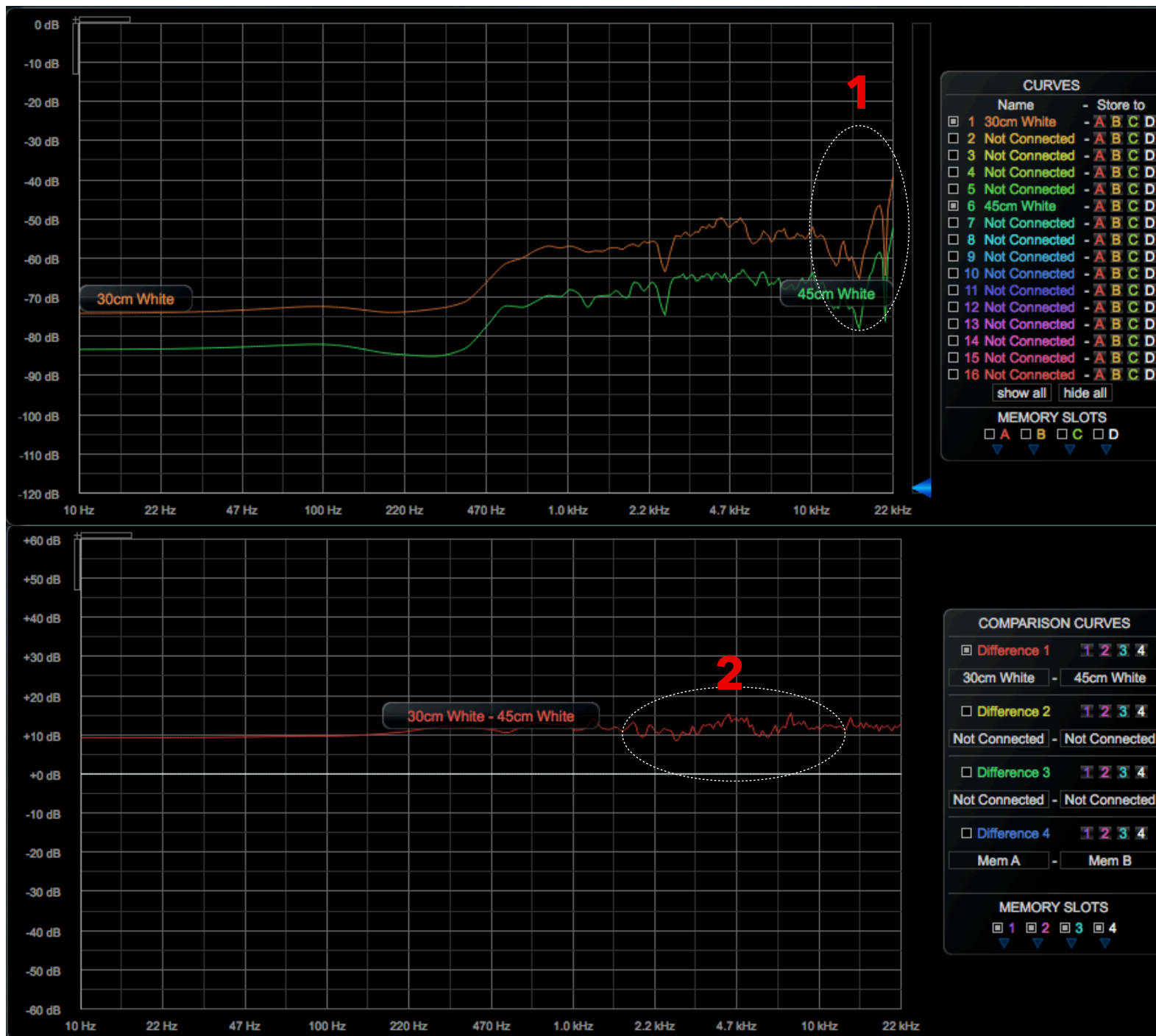
1. Quite similar with Oppo. And the Vivo slides down much deeper than Oppo. (The Huawei device is almost flat around 20kHz.)
2. Oppo has a strong raise around 3.45k. But here the Vivo quickly raises around 5kHz. It looks like the iPhone 7P. But much stronger. That we can hear more percussions or sharp impact. Also helpful for the voice accents.
3. The Vivo slides down deeper than Oppo from 11k to 22kHz, for over 35dB. It doesn't make sense at all. The only reason is probably for less harsh noise(force the device sound "smoother" and "gentler".).

Whitenoise roll-off via distance

30CM/45CM/-12LKFS REFERENCE

Whitenoise roll-off on iPhone 7P

30CM VS 45CM, 12LKFS REFERENCE/AVERAGE



The Orange curve is 30cm and the Green curve is the 45cm. (Below the others in this chapter is the same.)

From the charts of loudness, generally, from 30-45cm, the loudness roll-off on most of the cells are equal and less than 3dB only. From the spectrum, the difference is clearly linear very much. Two curves are almost parallel. Means on most the freq between 20-20kHz, the loss are the same.(about 10dB). It's probably the industrial design, I guess. But further 45cm, the loudness loss is much faster. 10dB off with full scale, but the entire loudness loss is not 10dB because of phase and internal masks between bands.

1. Usually higher freq rolls off faster. But here those 2 curves are totally parallel, even around 20kHz.
2. The slightly difference is above 2.2kHz.

Whitenoise roll-off on Huawei

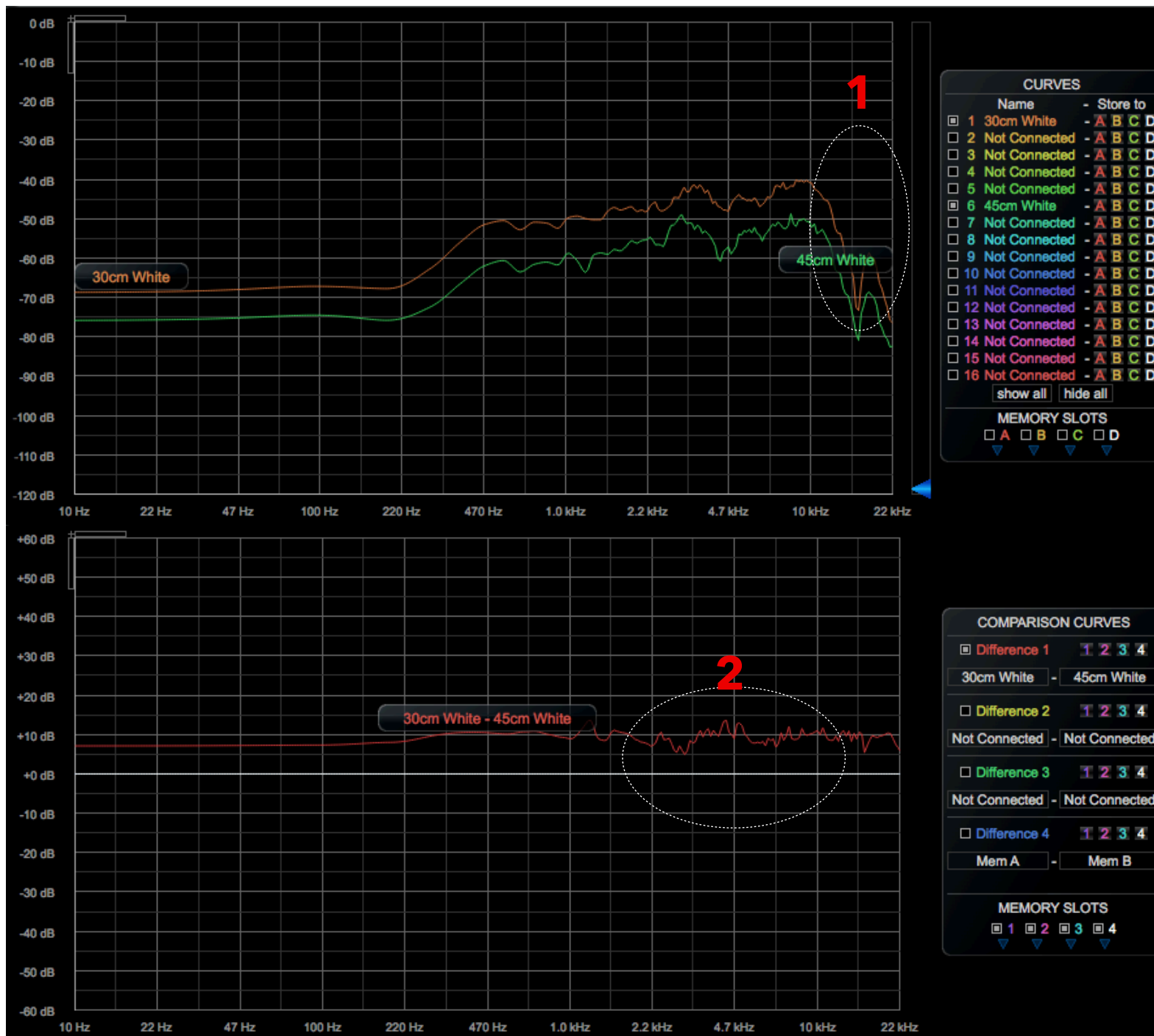
30CM VS 45CM, 12LKFS REFERENCE/AVERAGE



1. The big cliff of both distance are almost the same.
2. The slightly difference between basically around 2.2k - 10kHz. It makes sense since higher freq rolls off faster via distance. For getting this level of parallel curves, the device engineer probably did some boost to the freq between 2.2k and 20kHz.

Whitenoise roll-off on Oppo

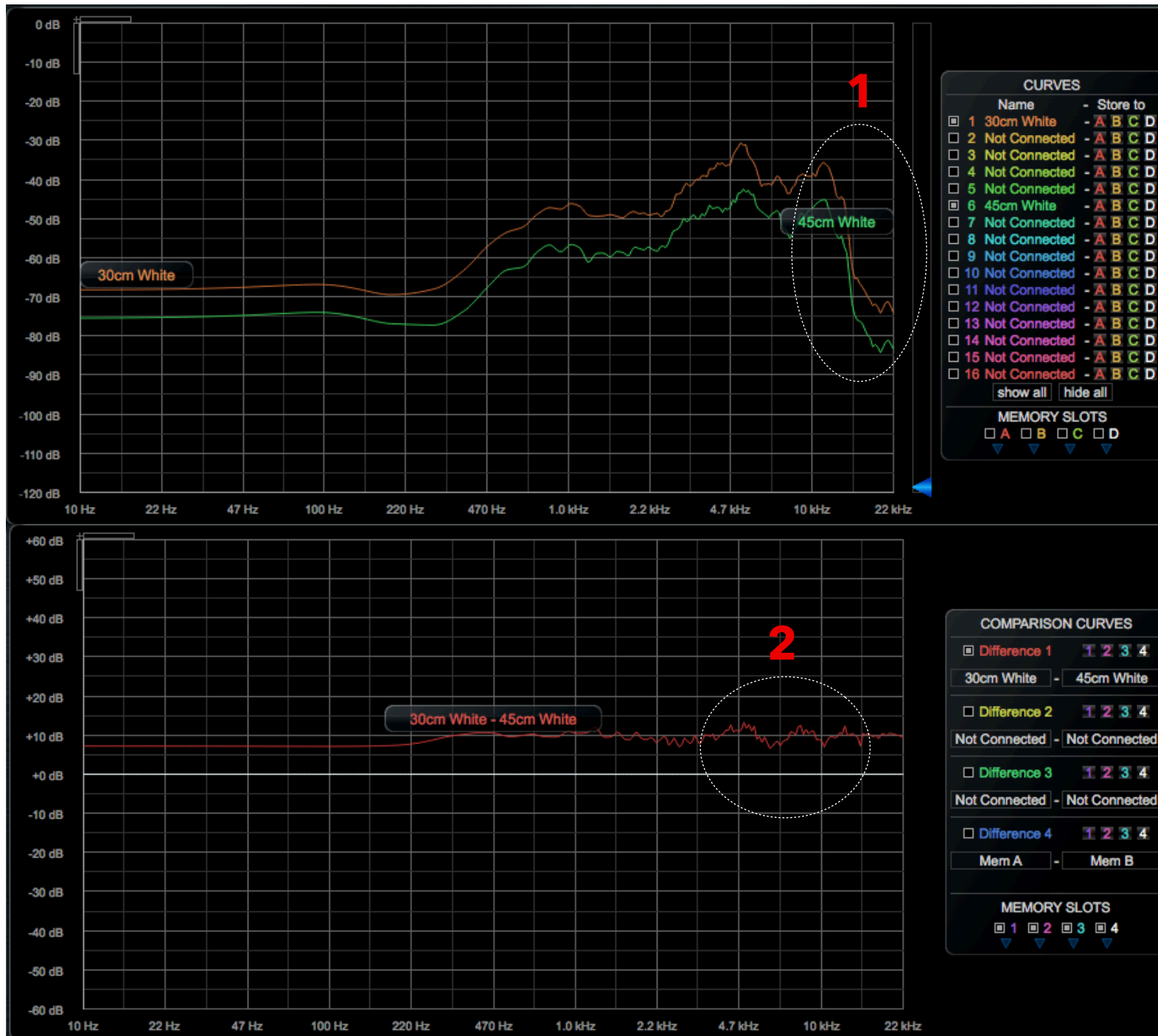
30CM VS 45CM, 12LKFS REFERENCE/AVERAGE



1. The linear roll-off is totally parallel even the clifty part here.
2. The slightly difference between basically around 2.2k - 10kHz. It makes sense since higher freq rolls off faster via distance. For getting this level of parallel curves, the device engineer probably did some boost to the freq between 2.2k and 20kHz.

Whitenoise roll-off on Vivo

30CM VS 45CM, 12LKFS REFERENCE/AVERAGE



1. Here the cliffy roll-off of freq over 11kHz is shown clearly.
2. The difference between the curves is very flat even than flatter than all the other devices. So the difference between 4.7k and 16kHz is noticeable. But this slight level different won't affect much to hearing. It's too small.

Now I have totally forgot all the games' sound from different cells.

Too many sounds, data and spectrums.

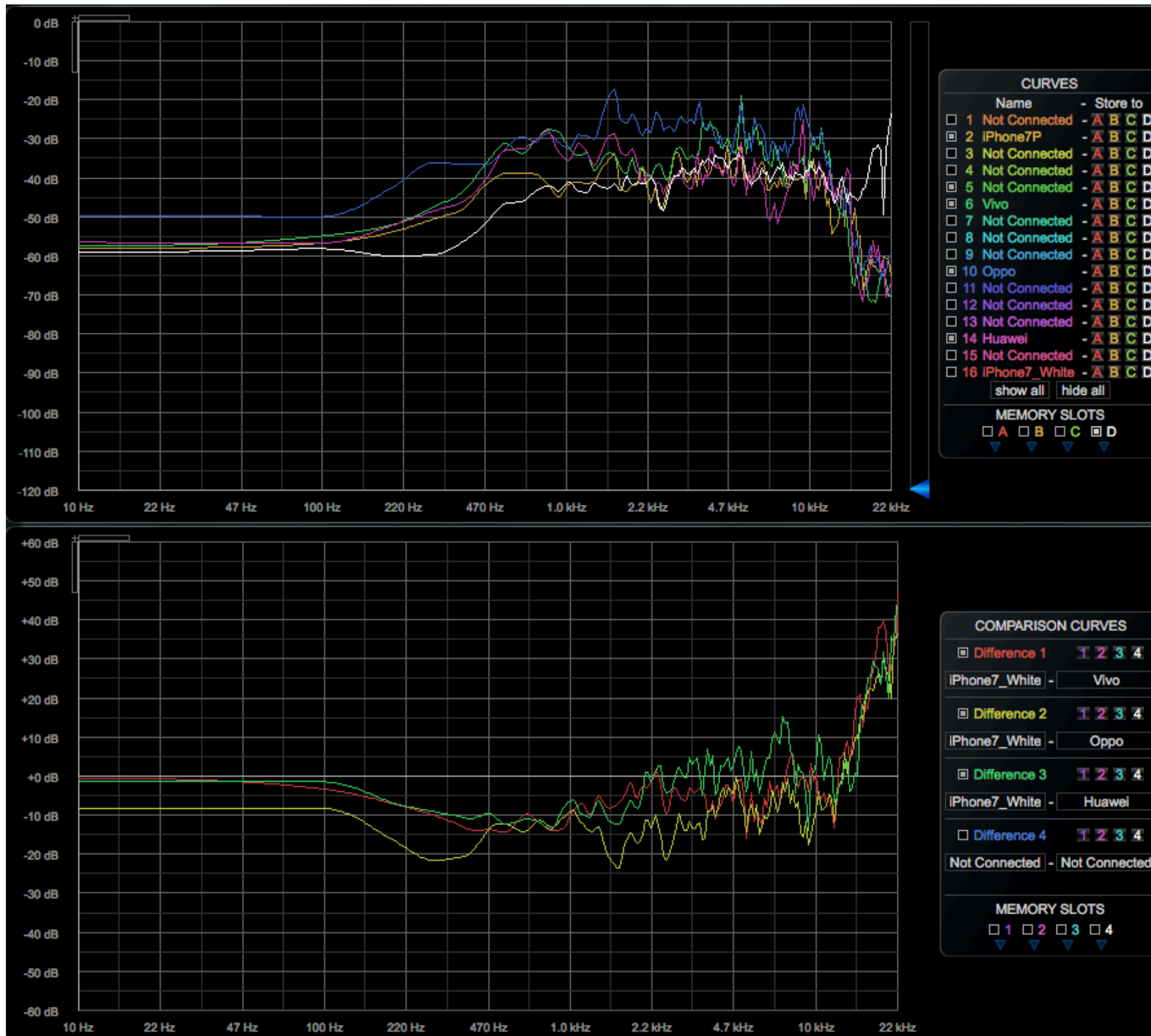
That's good for an objective and technical analysis.

Single 1 game on 4 different cells

7 GAMES/30CM/-12LKFS REFERENCE

1 game on 4 different cells

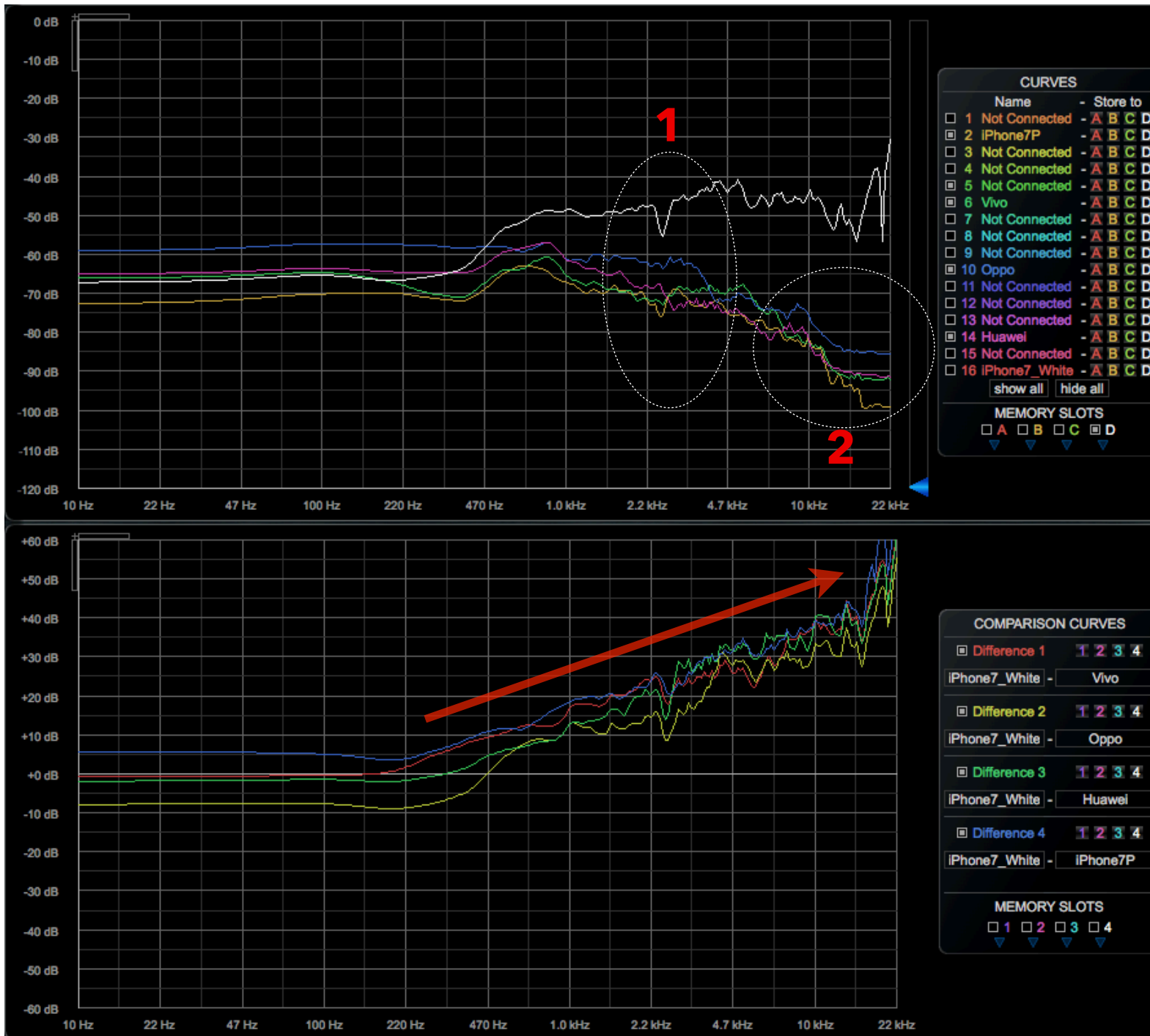
30CM/-12LKFS REFERENCE/PEAK



1. This is PUBG mobile by Tencent Lightning Studios. The curves are from the max peak levels of the game on 4 cells. The bright white curve is the white noise curve from iPhone 7P, as the reference for assuming the difference.
2. As you can see, the curves are too complicated and jamming together. So I tried with the Average peak level in couple minutes of every game playing. Please check the next page.
3. For different game types, the dynamic is different for sure. For example PUBG, as a survival game, most of the gaming time, it's very quiet until shot moment. Stronger hot loudness time, means it probably will goes back to quiet level faster. So, the game recording time are from 5 to 15 minutes depending on the game types. We can see the tendency at least.

PUBG(Lightning studios) on 4 cells

30CM/-12LKFS REFERENCE/AVERAGE

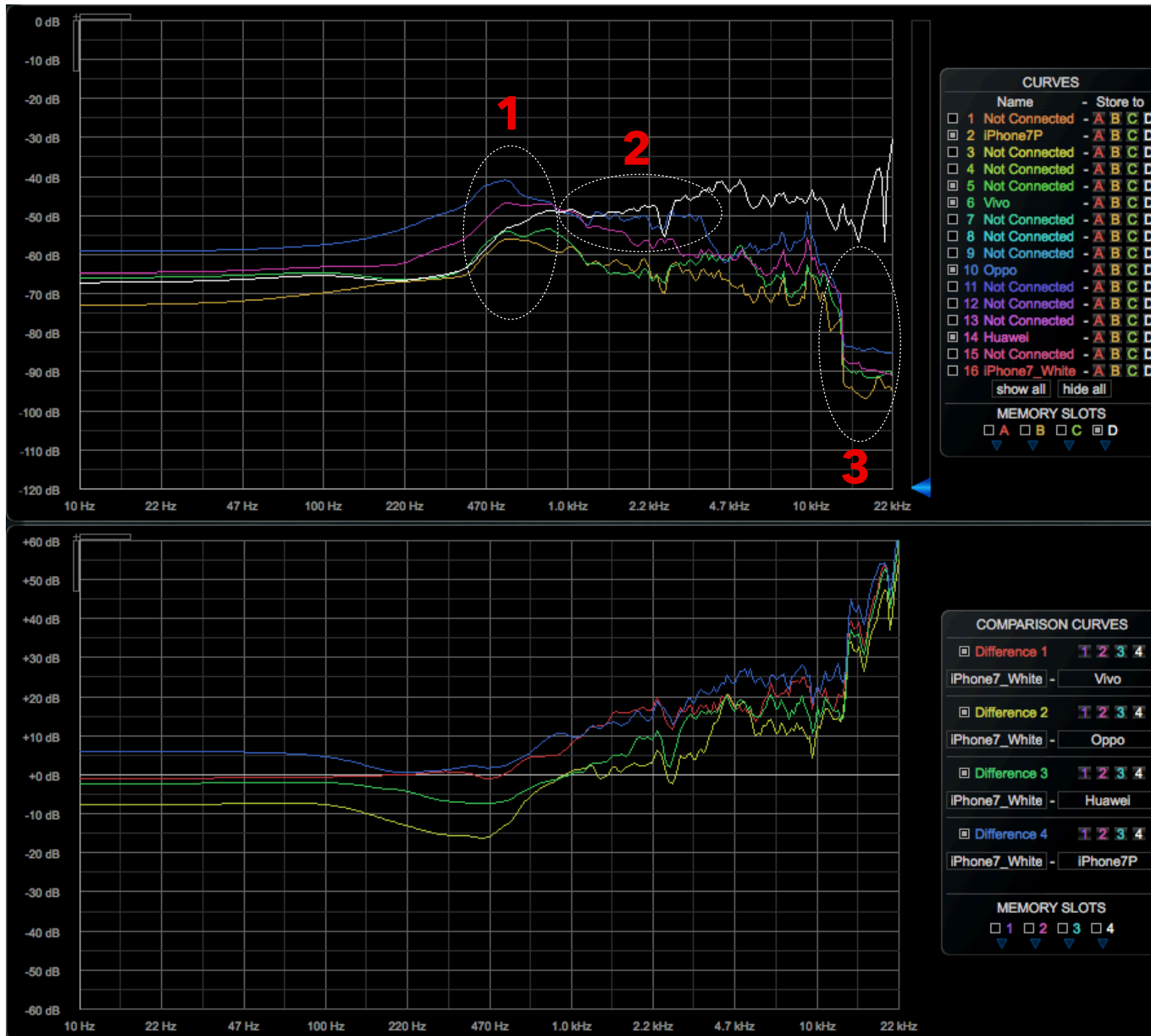


The bright white curve is the -12LKFS white noise from iPhone7P, for the reference. The game on 4 cells are quite similar since the curves dubbing together

1. PUBG on 4 cells are quite similar, generally. Except the notch from iPhone7P, the bigger difference is from Oppo's 1k-4.2kHz. That part of curve is flatter than the other 3 cells.
2. The other part is also from the Oppo. From about 9kHz and higher, the high freq rolls off slower than the others. Even there is about 6dB raise around 10kHz.
3. Obviously, between 100-22kHz, PUBG is generally lighter than the white noise, very much! Certainly this makes sense. And the higher freq, the difference is bigger. But the difference curves are all linear(almost). Is it a regular

开心消消乐 on 4 cells

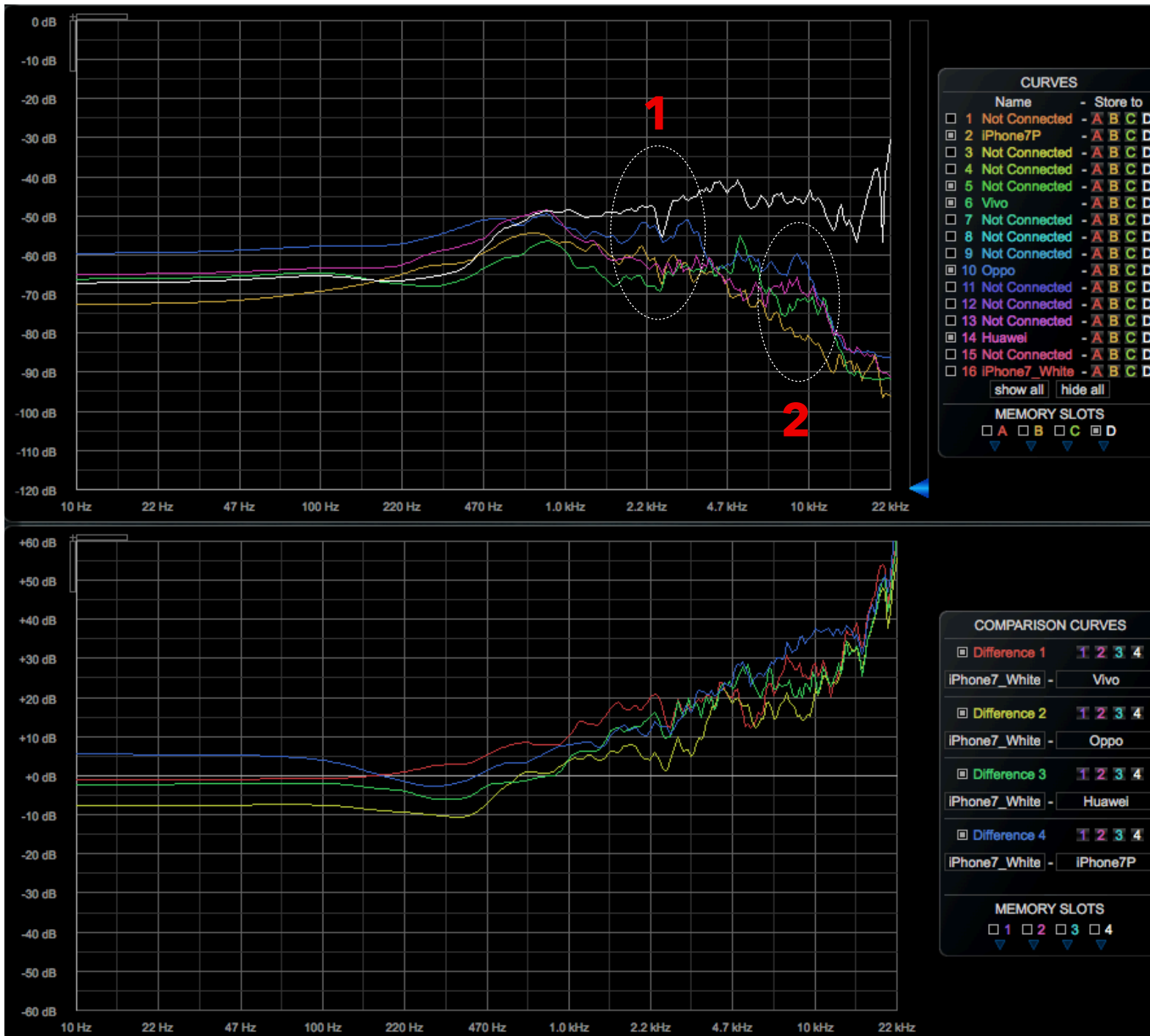
30CM/-12LKFS REFERENCE/AVERAGE



1. This game sounds quite same on 4 cells. But around 600Hz, there is a raise from the game, specially on Oppo and Huawei. iPhone7P and Vivo sound flat just like the white noise.
2. And then all of them roll off slowly. That's different with the hearing experience. But only Oppo is very flat from 1k to 3.5kHz. After this band, there is a long notch until the raise around 10kHz. Means we can hear brighter even sharp sound from the game.
3. All the 4 cells got the same very sharp cliff at 14kHz. It's obviously caused by bigger compression of the audio data. Because, if it's caused by audio sample rates, the cut-off freq shall be around 11kHz.

Homescape on 4 cells

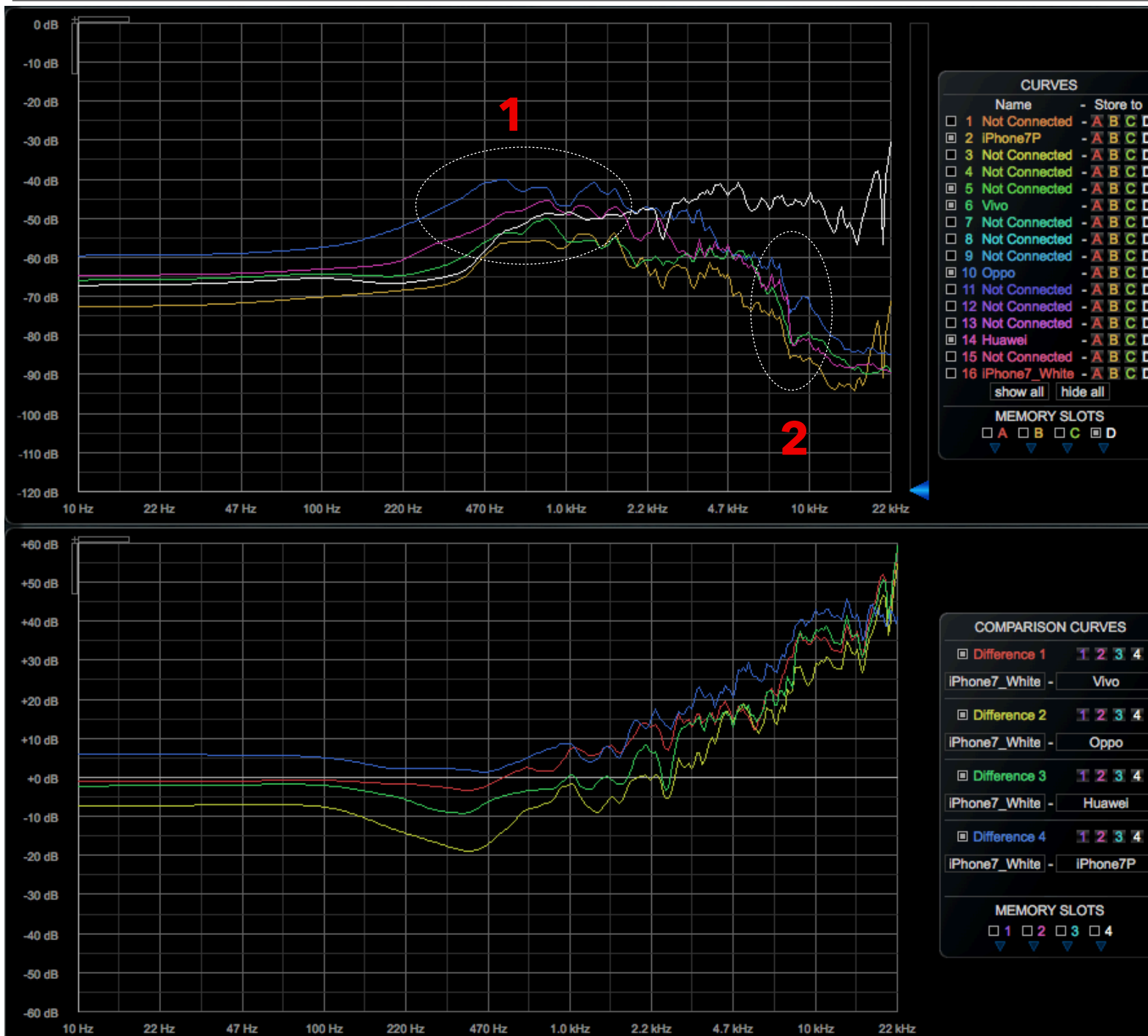
30CM/-12LKFS REFERENCE/AVERAGE



1. Oppo still got boosted between 2.2-3.4kHz. Clearly, it's the phenomenon on Oppo. And more interested thing is, the game on all 4 cells got a sharp notch around 2.5kHz. Clearly it's the result of optimizing from the developer.
2. iPhone 7P is still rolling off here. But on another cells, this game got very strong holding around 10kHz. So it's much bright on those Android devices. And Oppo is still flat around this band, comparing with the other games.
3. Vivo sounds weird(the green curve), it's got a sharp raise around 5kHz. Please check the Comparison Covers. iPhone 7P vs Vivo, the red curve, is standing out at lower bands of 2.2k.

欢乐斗地主 on 4 cells

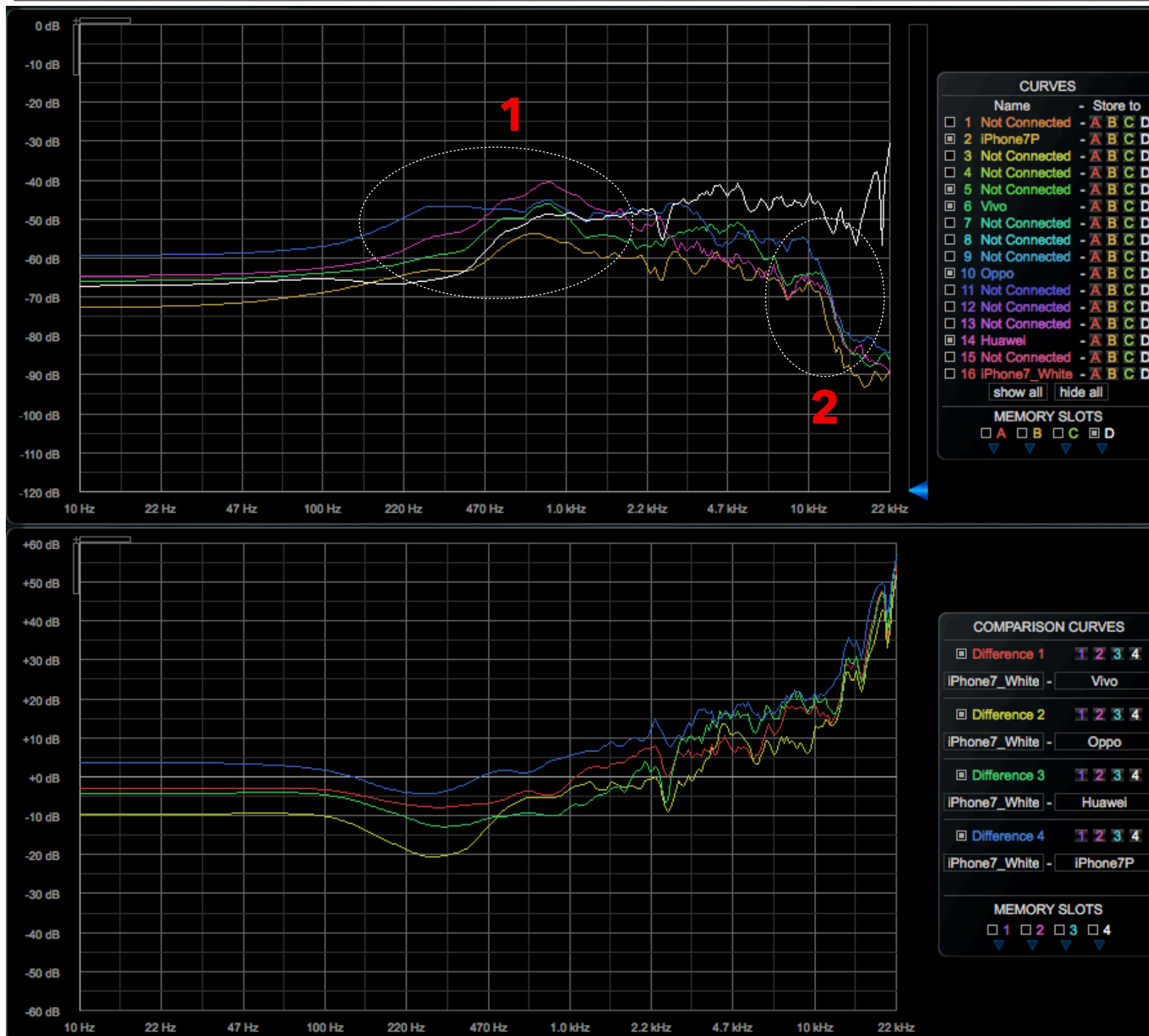
30CM/-12LKFS REFERENCE/AVERAGE



1. From this game, Oppo's lower freq(1kHz and lower) is significantly higher than the cells. But above the 3.5kHz, Oppo doesn't keep the flat curve. It slowly rolls off, until the cliff at about 8kHz.
2. The general cliff at about 8kHz, clearly it's caused by the content compression or the sample rates.
3. This game sounds distortion and extremely clipped. Because of the overdriven samples, specially on Oppo. The band between 1-4.7kHz is higher than the other games. And the general band is narrowed from 500 to 8kHz.

王者荣耀 on 4 cells

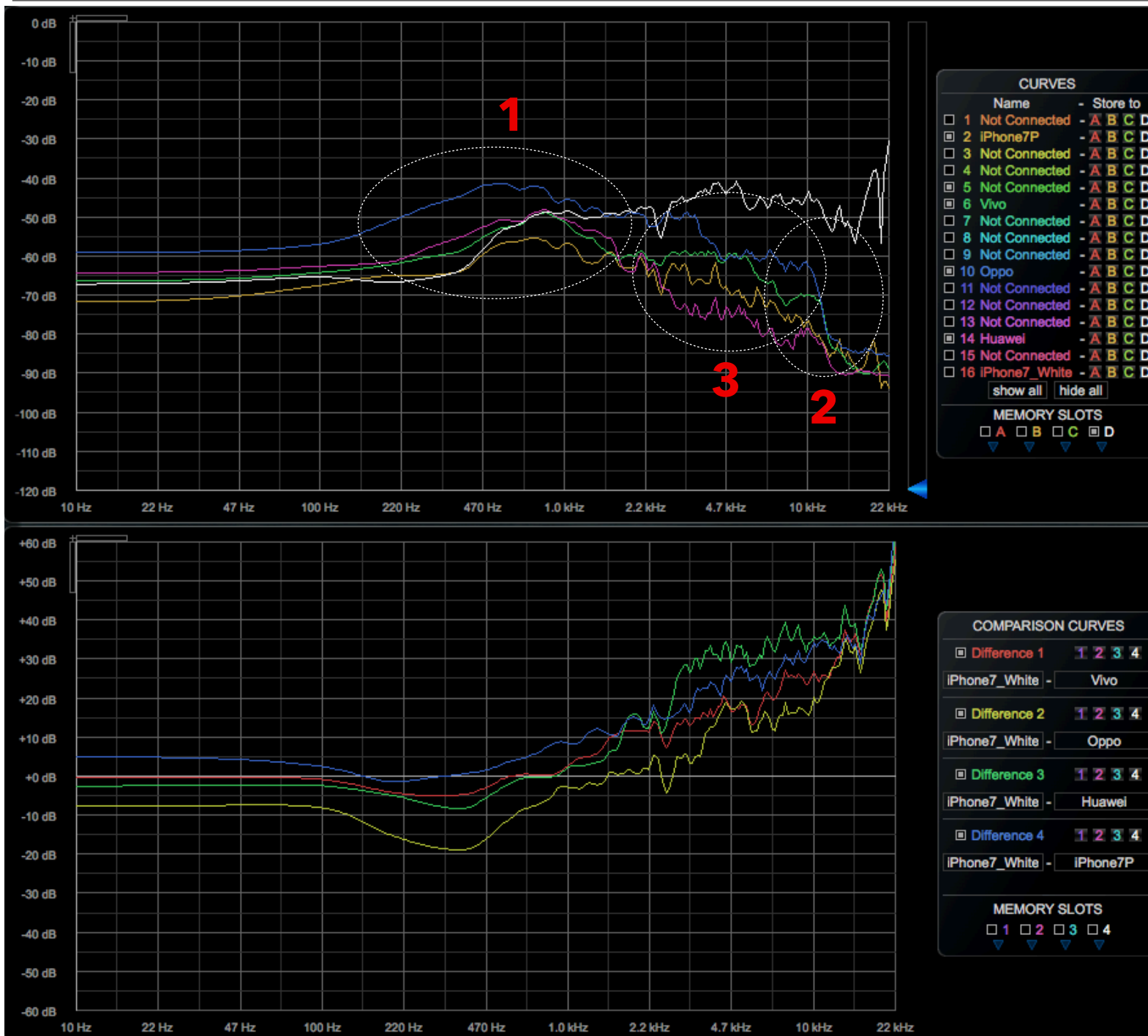
30CM/-12LKFS REFERENCE/AVERAGE



1. This game clearly is wider freq response on all the cells. Specially from 220hz - 2.2kHz. All the other 6 games get faster roll-off from 1kHz or even 500Hz. Oppo is the most significant one on this. And iPhone 7P is still nicely flat except a raise around 700Hz. Actually, except Oppo, all the other 3 cells got a noticeable raise at there. It causes the game sound fatter than the other games.
2. This game got obvious roll-off above 10kHz. It's not such hard cliff caused by lower sample rates or over-compressed data. Clearly it's cause by a heavy compression on sound data, for example the Vorbis rate is less than 96KPS.

皇室战争 on 4 cells

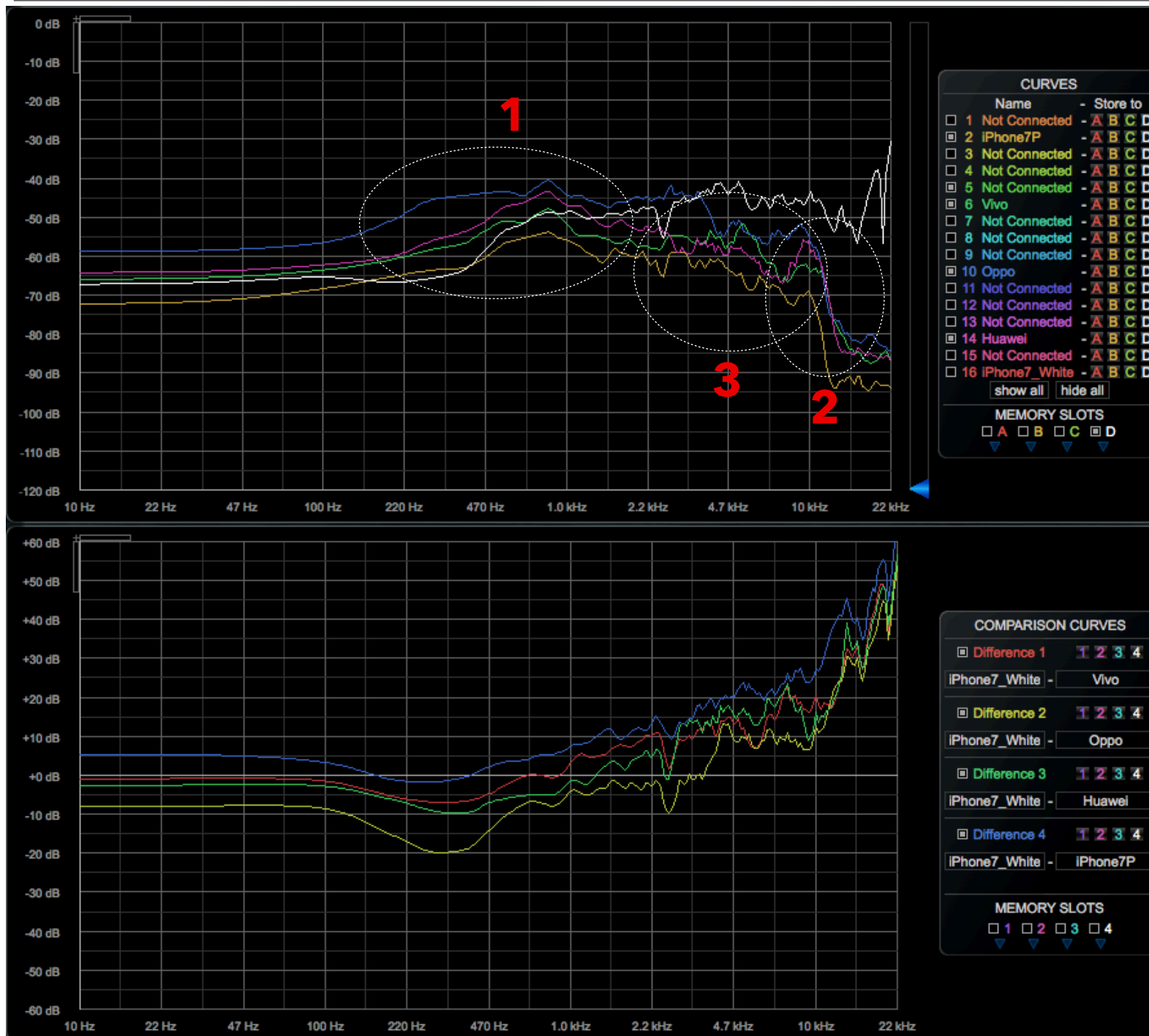
30CM/-12LKFS REFERENCE/AVERAGE



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2. This game got obvious roll-off above 10kHz. It's not such hard cliff caused by lower sample rates or over-compressed data. Clearly it's cause by a heavy compression on sound data.
3. Another part which's worth to be noticed is, the bands between 2.2k-10kHz. 4 cells sound very different.

阴阳师 on 4 cells

30CM/-12LKFS REFERENCE/AVERAGE



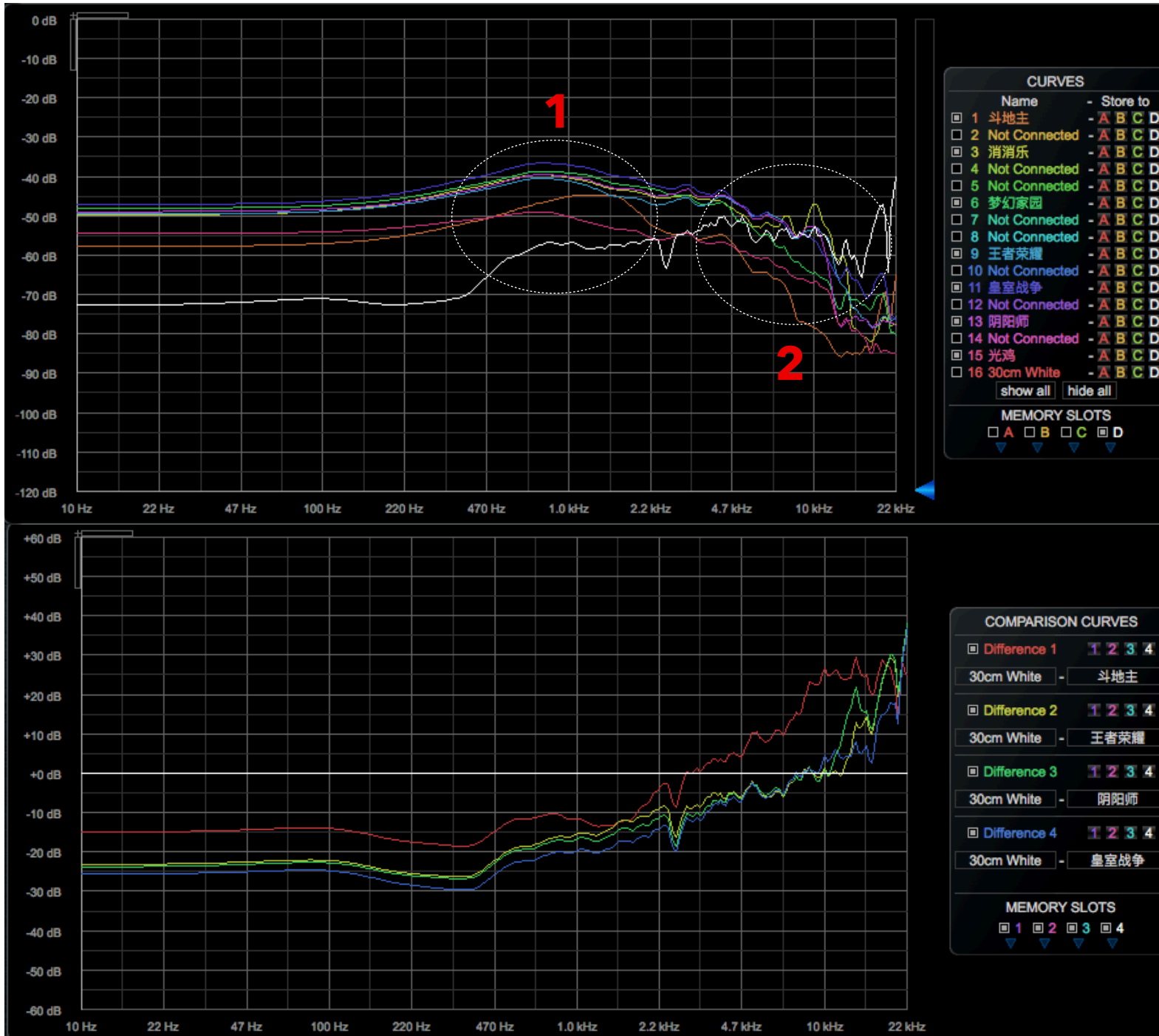
1. 220-1kHz part, this game is similar with the last game above. The roll-off from 1k is harder than that but still strong.
2. The cliff from 10kHz to 13kHz is super big - over 45dB! 3 Android cells got a sharp raise on 10kHz. My guess is that's caused by a heavy sample rates reduction for example 22.5kHz. It's not like a data compression issues. Even the raise on 10kHz is probably a result after tuning.
3. Another part which's worth to be noticed is, the bands between 2.2k-10kHz, just like the last game above. Another games are different in this band. But they are similar tendency. Here the tendencies of them are very different. That causes clearly different hearing experience on the 4 devices.

7 games on 1 cell

7 GAMES/30CM/-12LKFS REFERENCE

7 games on iPhone 7 Plus

30CM/-12LKFS REFERENCE/AVERAGE

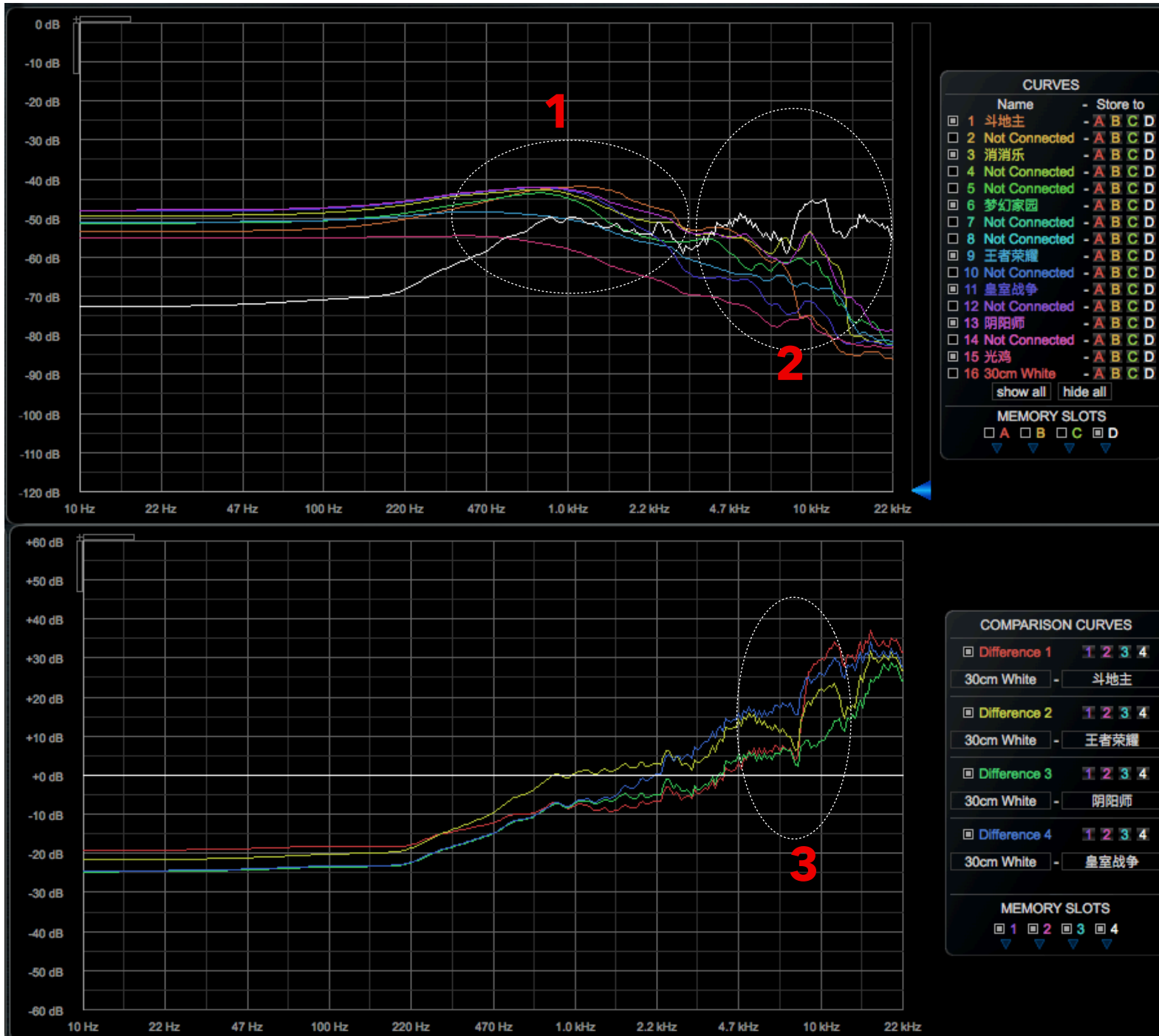


The bright white curve is the white noise from iPhone 7P, for the reference. In fact, dubbing move curves shall be approaching the white noise.

1. All the games are quite similar below 1kHz. But 2 of them are very different between 2-4.7kHz.
2. All the games got cliff when it's higher than 10kHz. But different game's ratio is quite different.
3. 斗地主 is the very different one. The narrow band width is clear among the games. But all the other game got a fast rising from 10kHz.
4. All the games raise from about 400Hz and getting a softer notch between 220 and 470Hz.

7 games on Huawei Mate 7

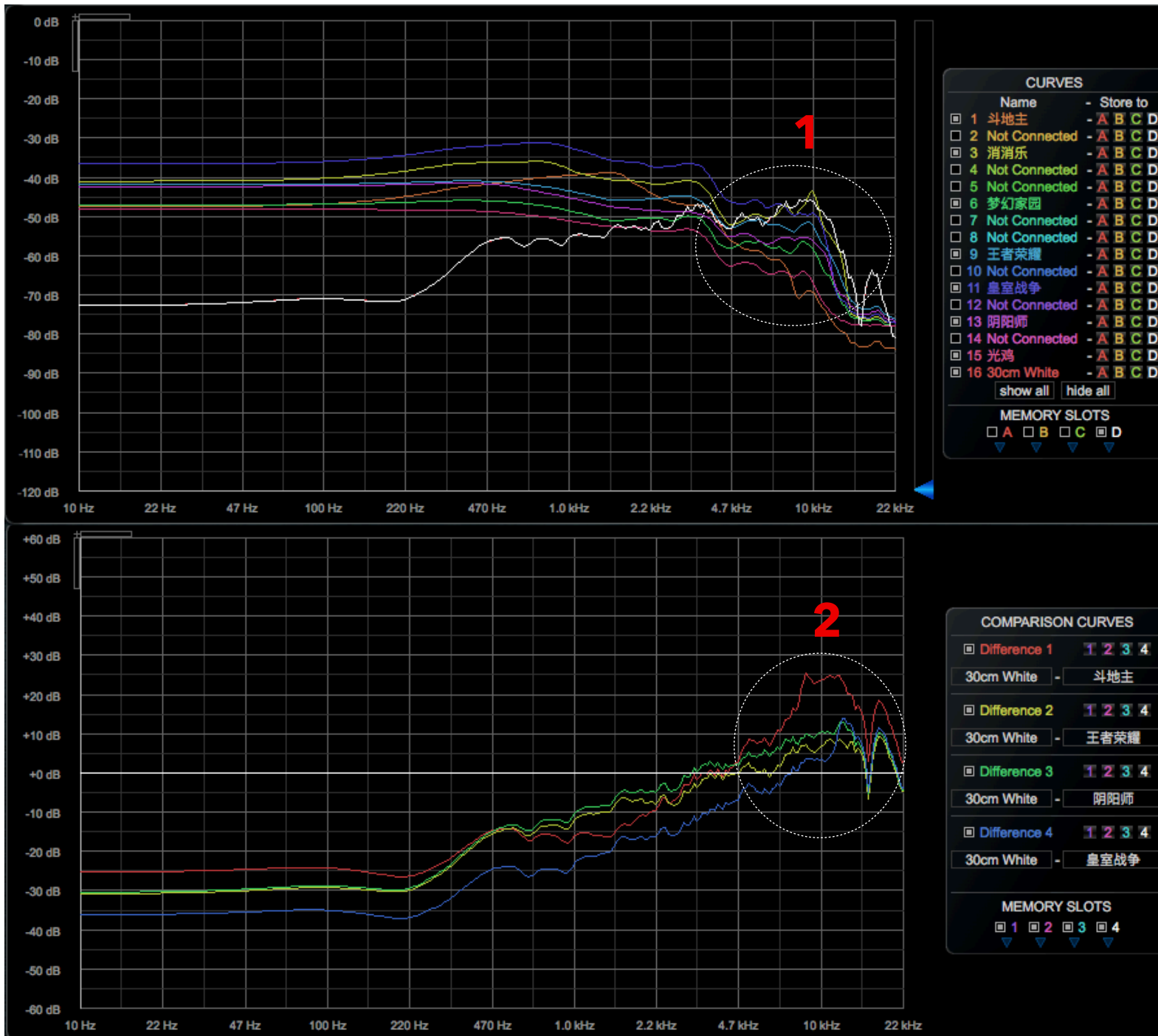
30CM/-12LKFS REFERENCE/AVERAGE



1. All the games are very very similar on the device, even up to 3.5kHz
2. The obvious difference between the games are from 3.5k - 15kHz. PUBG is strongly different at there. The curve is more like the general tendency or the average curve of all the other games.
3. There is heavy and hard notch in the comparison curves. Means all the games on this device, got a very strong notch around 6kHz, comparing with the white noise. In fact, purely watching the white noise curve, you've been able to see the notch(check the #2). And here, when the comparison curves stacking together, this phenomenon got normalized and easier to find. Means something's not such visible but can be found in the comparison curves.
4. All the games raise from 220Hz and almost linear. It's clearly a design.

7 games on Oppo R9 Plus

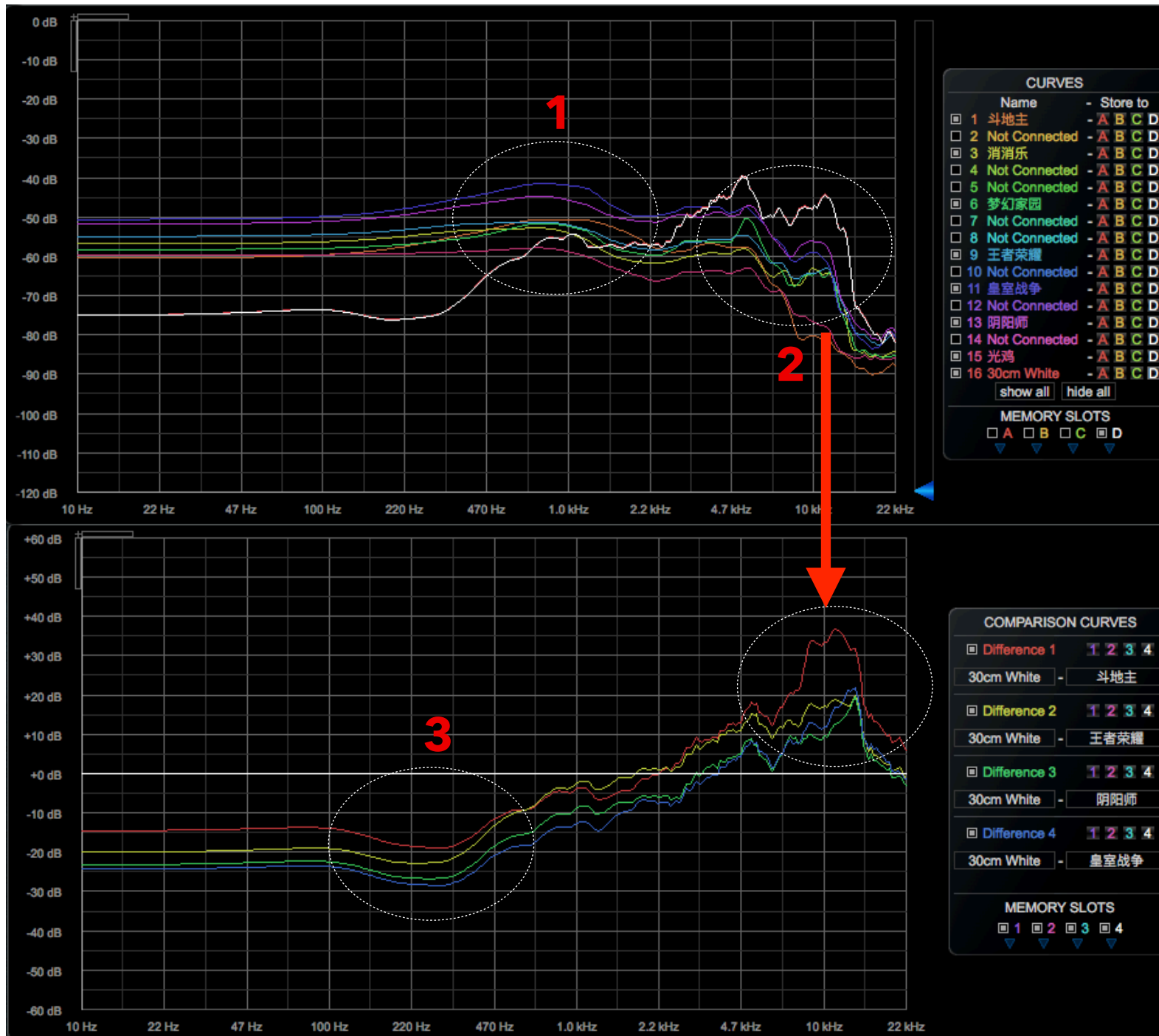
30CM/-12LKFS REFERENCE/AVERAGE



1. All the game sounds very close since the curves are almost parallel in the full scale bands. Generally at 10kHz, all the games got a raise. But 消消乐 got a strongly sharp raise. Really sharp.
2. 斗地主, it gets a big loss comparing with white noise, specially between 4.7k and 22kHz. Because this is much narrow band range.
3. Same as Huawei, all the games raise up from 220Hz, with a straight linear tendency.

7 games on Vivo Y51 A

30CM/-12LKFS REFERENCE/AVERAGE



1. All the games got different ratio of raising around 730-1000Hz. And then they nicely go down and hold until 5kHz.
2. All the games on Vivo goes down from about 5kHz with different ratios. 斗地主 is the strongest one since the its band width is really narrow. They all actually goes down from 5k to 6kHz. And then goes up until 15kHz. Above 15kHz, all the games goes down very fast.
3. Quite similar with iPhone 7P, Vivo got a same softer notch around 220Hz. iPhone 7P is around 350Hz.

My technical summary

7 GAMES/4 CELLS/30CM/-12LKFS REFERENCE

MY SUMMARY, AS A REFERENCE

- On all the devices, the most sensitive frequencies are: 220, 500, 1k, 2.5k, 3.5k, 10k, 11k, 14k
- All the devices, the speakers roll off from 1kHz. All the strong and rich games by hearing, the roll-off between 220-1000Hz are slower.
- All the Android games start raising from 220Hz. But the iPhone 7P starts from 400Hz slowly. That's probably the reason of why iPhone 7P sounds lighter and softer, but more lower frequencies can be felt.
- All the Android game stop high frequencies or roll off from 10kHz. iPhone 7P is quite same. But, it goes upper again from 16kHz to 22kHz.
- Reduction around 11kHz, and the mean time slower roll-off above 11kHz, shall be good for getting smooth brightness. Please check Clash Royale and Homescape. PUBG can be another reference to prove it.
- 4-5kHz shall be very careful band to be controlled and designed on all the devices.

Tencent NEXT Studio

SOUND OF MOBILE GAMES FROM THE SPEAKER BOX



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