The 2 Way Cardioid Array

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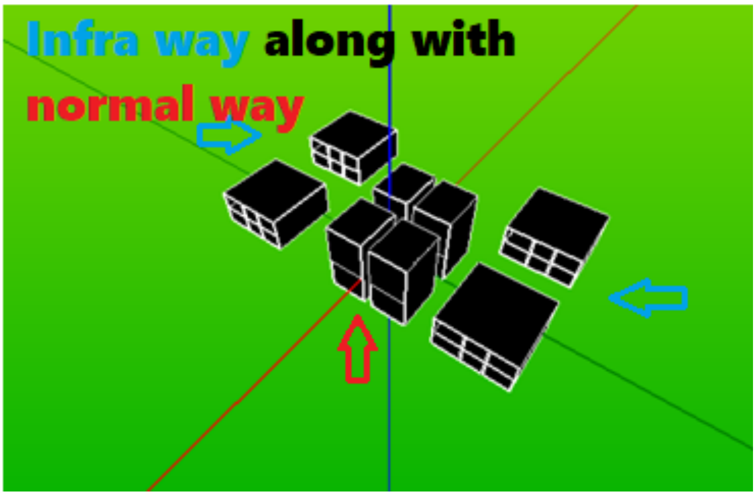
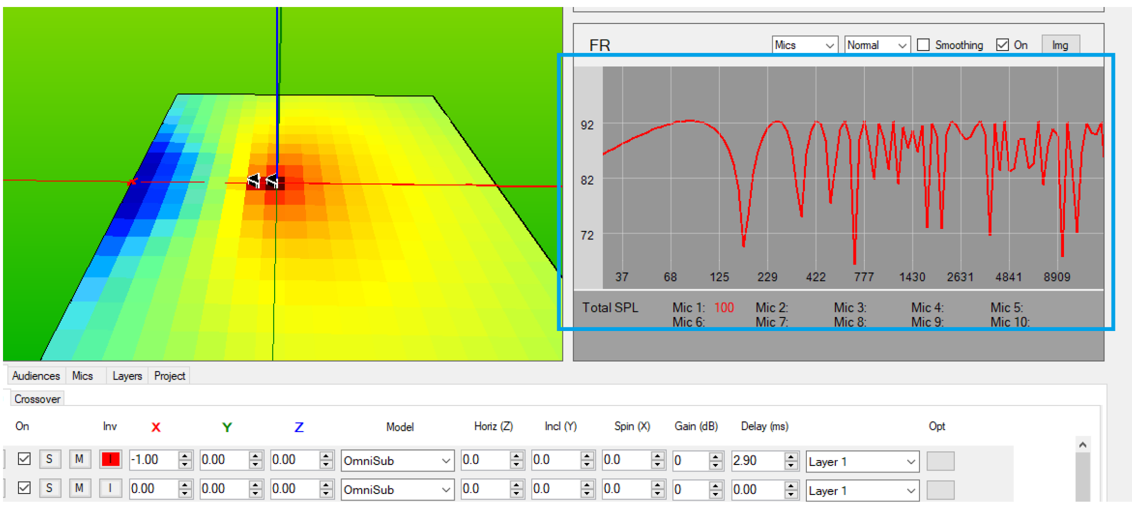


This article originated from my observations of cardioid subwoofer deployments that rely on the **1-meter separation rule of thumb**. While this works for regular subwoofers, I've noticed that some *infra* subs operate at frequencies too low for this spacing to be effective—particularly around the **80 Hz sweet spot**.

It's important to remember the **inherent loss** in very low frequencies and low mids, which occurs simply because the **frontal response of a cardioid system behaves as a comb filter**. This is due to the combination of:

- **Separation delay**
- **Applied delay**
- **Reverse polarity of the rear element**

Frontal response of a **perfect omnidirectional source** in a gradient array… **at the front**.

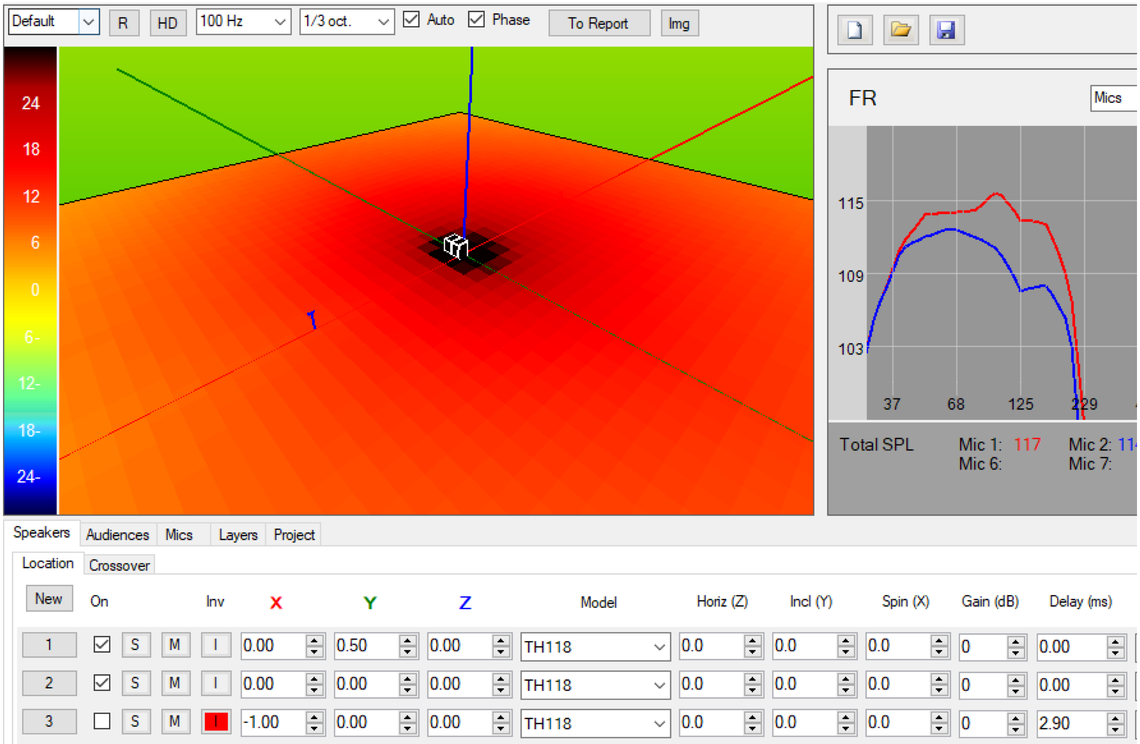


We already explored this topic in the **10-year-old** article on the "Stair Cardioid".

We won't go into **"what is a cardioid"** here, as this should already be well understood. Instead, let's focus on the **frontal response**—not the rear, where we already know cardioid arrays excel at eliminating low frequencies. **Let's talk about the front, where the audience—the people who paid for their tickets—actually hears the sound!**

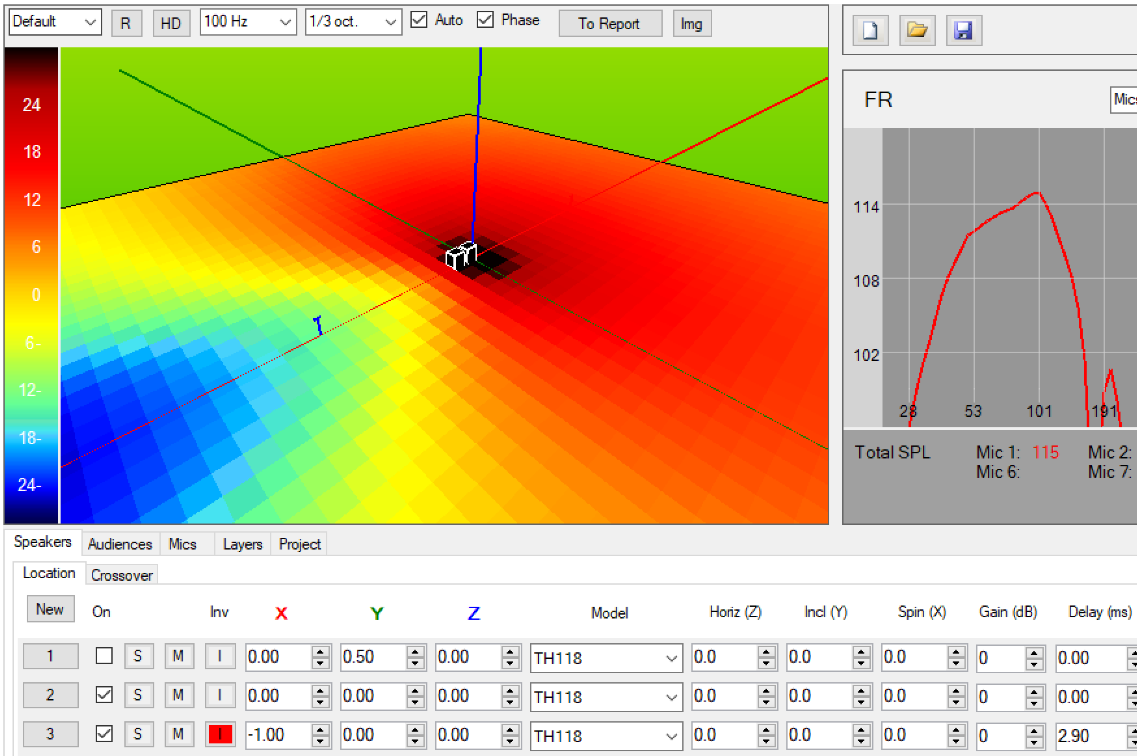
Comparison:

Mono cluster of two real sources:



The **red** measurement is always taken **10 meters in front**, while the **blue** measurement is **10 meters behind**, serving as a reference for this analysis.

Cardioid System with 1m Separation:

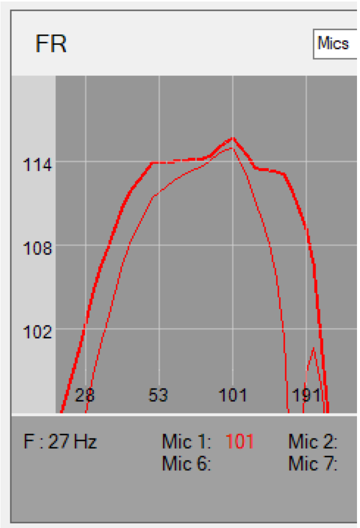


There's no doubt that the **rear cancellation is excellent**. Theoretically, the **blue trace** drops by about **25 dB**, effectively disappearing from the frequency response window. In real-world conditions, the reduction is usually less, but I've measured up to **15 dB of attenuation**. Mathematically, the cancellation is **-infinite dB** (assuming all parameters are perfectly matched and the rear element is in reverse polarity).

However, **we're not here to discuss the rear performance**—we all know it works, and it works well. Given the **long wavelengths** at play, even a **10 cm (half a foot) misalignment** won't significantly affect the cancellation; it will still function properly.

Now, let's **turn off the rear mic** and, as mentioned earlier, focus on the **frontal response**. The **Danley's Direct simulator** allows us to capture a trace just as we do in **Smaart®**.

- The **thicker curve** represents the response of the **mono cluster**.
- The **thinner curve** represents the **cardioid** response.

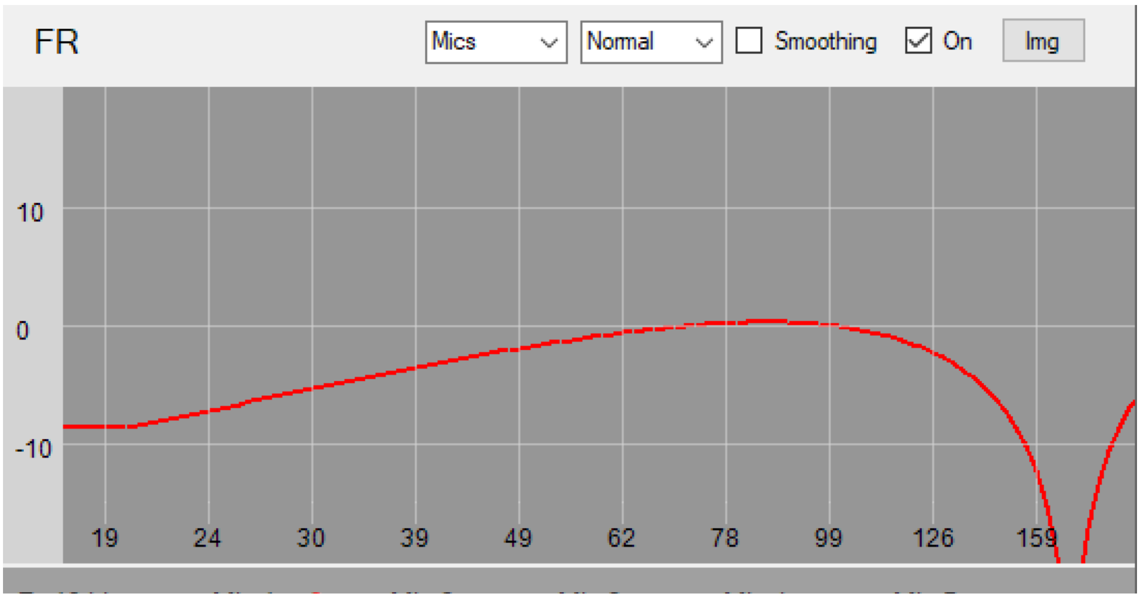


Hey, something happened with the **low frequencies**, huh! There you have it. As it's often said, **there's no free lunch in audio**—or in life, for that matter! At **31 Hz**, we see a loss of more than **6 dB**.

So, if you're using **"infra" subs**, you're essentially **losing your infrasonic range** with this array configuration as it currently stands. And this isn't even an **ultra-infra sub**; it's a **remarkable model**. However, the **subwoofer's inherent response** can be misleading when trying to fully grasp what's actually happening in this setup.

As I've pointed out many times before, the **advantages of a perfectly omni-directional, flat source** are of tremendous value in this kind of analysis.

Now, let's look again using a **perfect theoretical source**... (which, by the way, is an **invaluable tool** for us to see exactly how the acoustical sum plays out, beyond the peculiarities of any specific model).



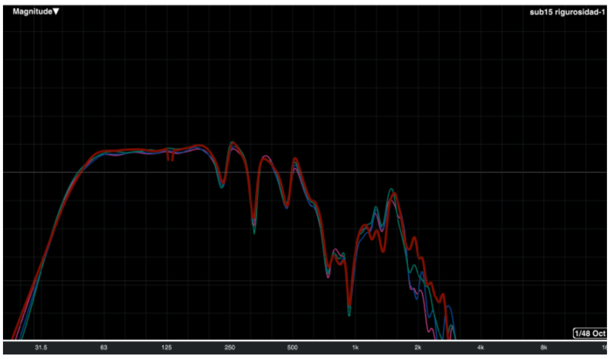
So, you're essentially **throwing away about 6 to 10 dB** between **25 to 31 Hz**.

Now, let’s move on to the **measurements**.

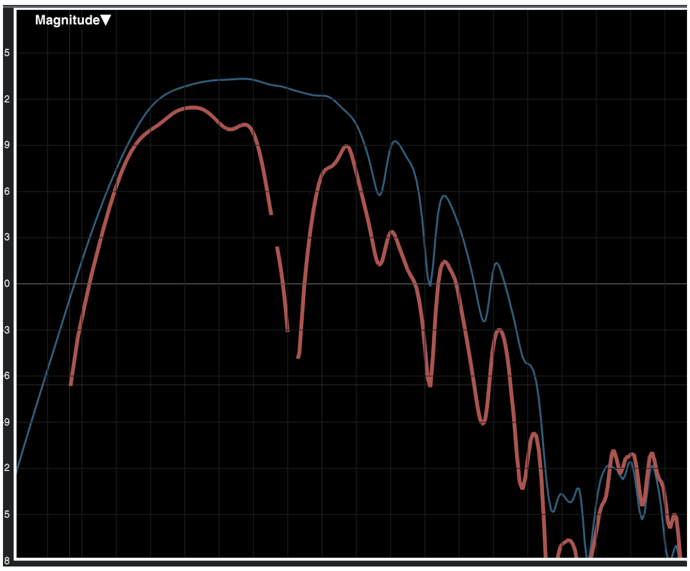
This work was made possible thanks to the help of a few key individuals:

- **Leo Troppa**, Agata Research – Field Engineer and Audio Measurement Expert.
- **José Cofré**, Owner of the perfectly flat space where we conducted the tests.
- **Mr. Gabriel Maban**, for coordinating the logistics.
- **CELESTRE PRODUCCIONES**, for providing all the rig.
- **Rational Acoustics**, for the measurement tools.

Now, let’s take a look at what **SMAART®** told us that beautiful afternoon…

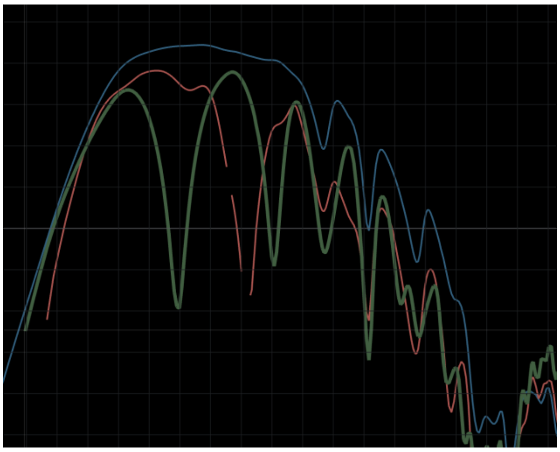


We started with some rigurosity… Each sub equal… All good to start.



This image is important. Blue is simple mono. Orange is Cardioid.

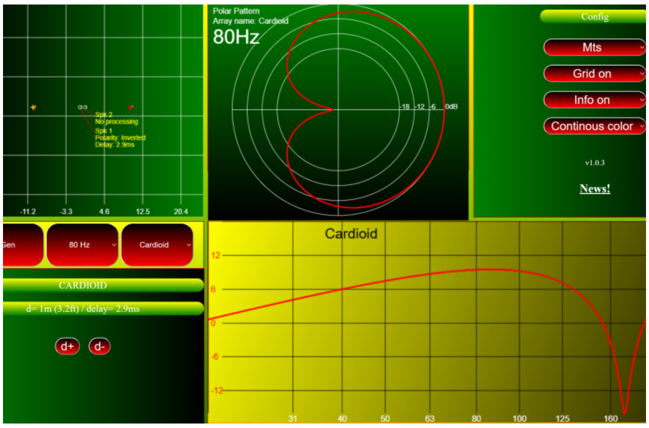
Cluster mono vs Gradient. In **front**… The loss of bass is clear.



Added a 2m separation Gradient…Measured. So, the response is even worst, but, BUT

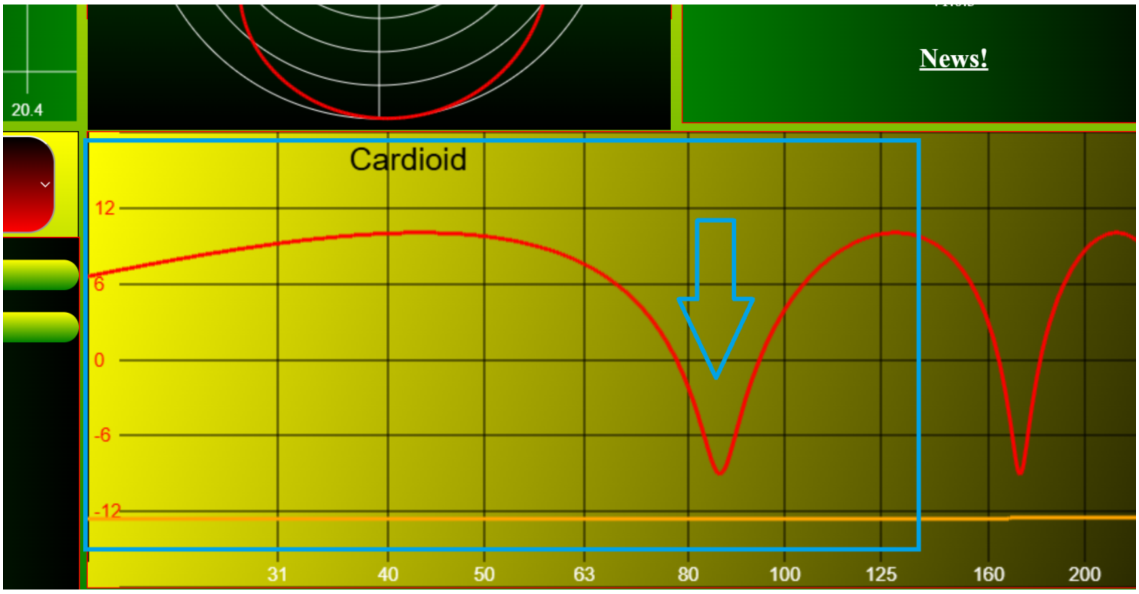
BUT, with the lows is not that bad… eh…. You got the idea, i know.

So if we go back to math, to one of our simulators, we got this:



That´s 1m separation. The loss of infra subs is cristal clear.

Not let´s do a 2m separation one:

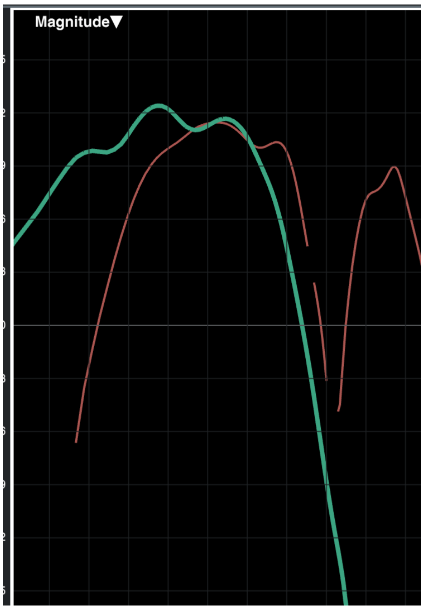


The inherent loss of the gradient in front is greatly reduced at very lows.. But then you have some trouble around 80Hz.

So, the idea here, it´s a 2-way-Gradient array.

A 2 way Cardioid.

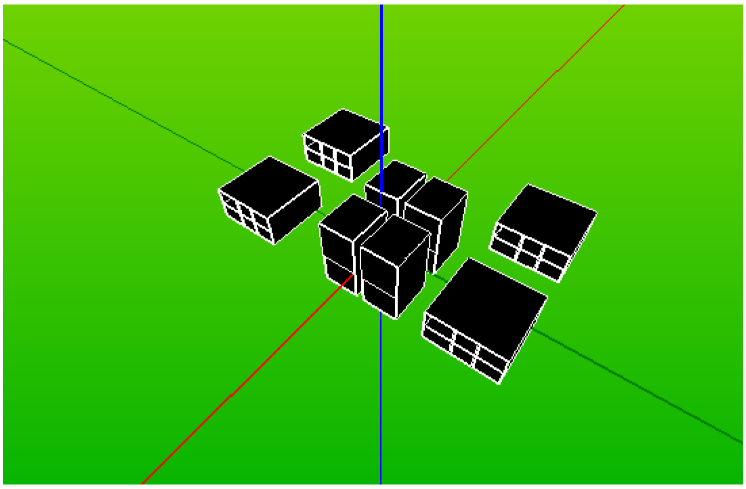
Going back to measurments:



There you go. Infra sub separated 2m. Regular sub separated 1m. Got better.

And the rear cancellation of course is perfect.

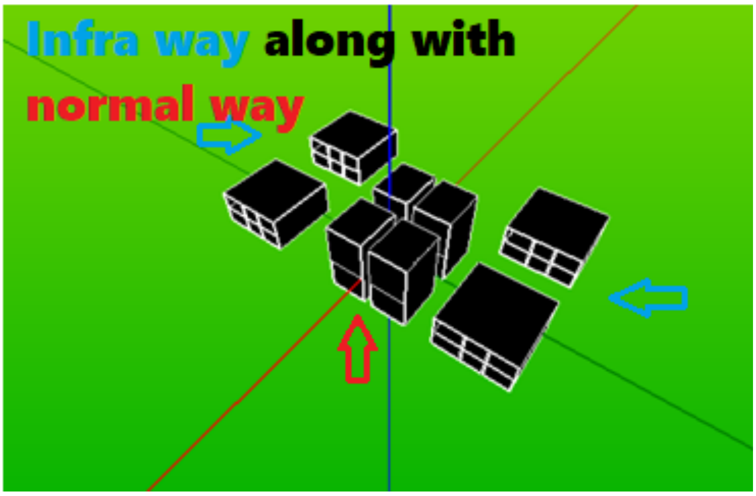
A simple Deployment if you want to try this approach:



Best Regards.

Sebastian R.

Agata Research



We had great time …..

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