

# How to read input shaper graphs: a work in progress

Compilation by Reth (the original Reth)

Data taken from:

3D Printers & a whiteboard [How to Read and Analyze Input Shaper Graphs Generated by Klipper – YouTube](#)

Felix Boisselier (Frix\_x): [klippain/docs/input\\_shaper.md at main · Frix-x/klippain · GitHub](#)

Reth's Voron Trident – serial 1190

Lots of members of the Voron Community

Version 8-8-2024

# Introduction

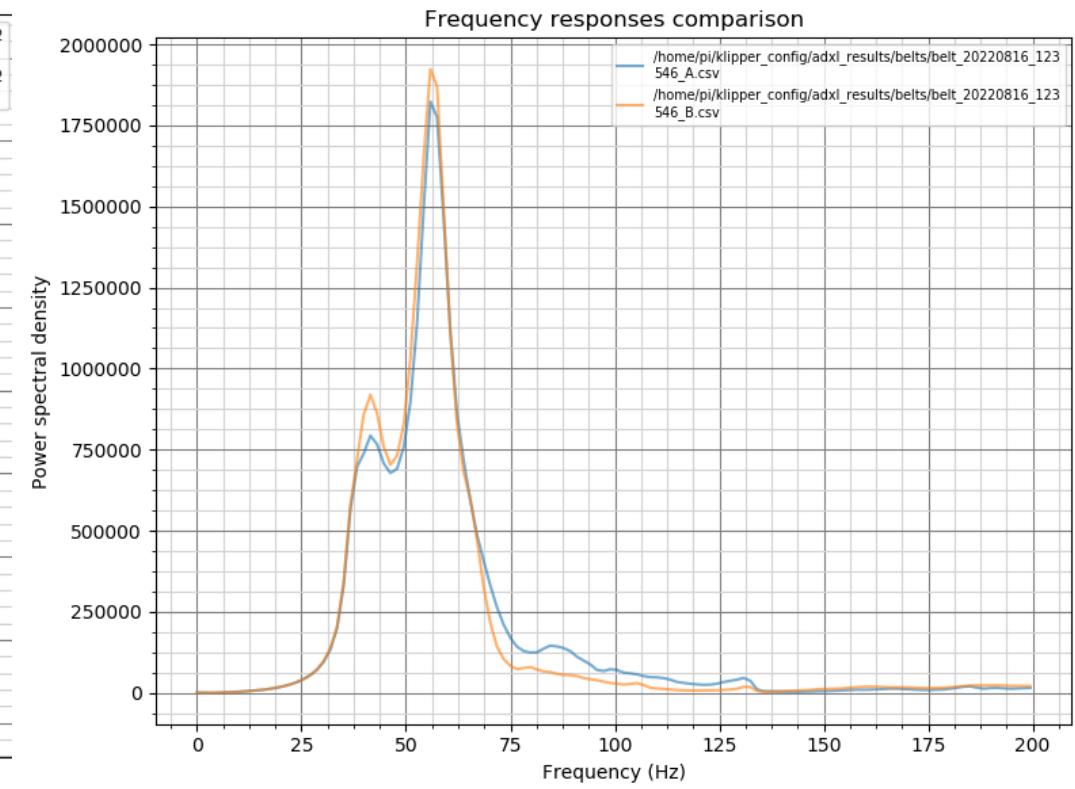
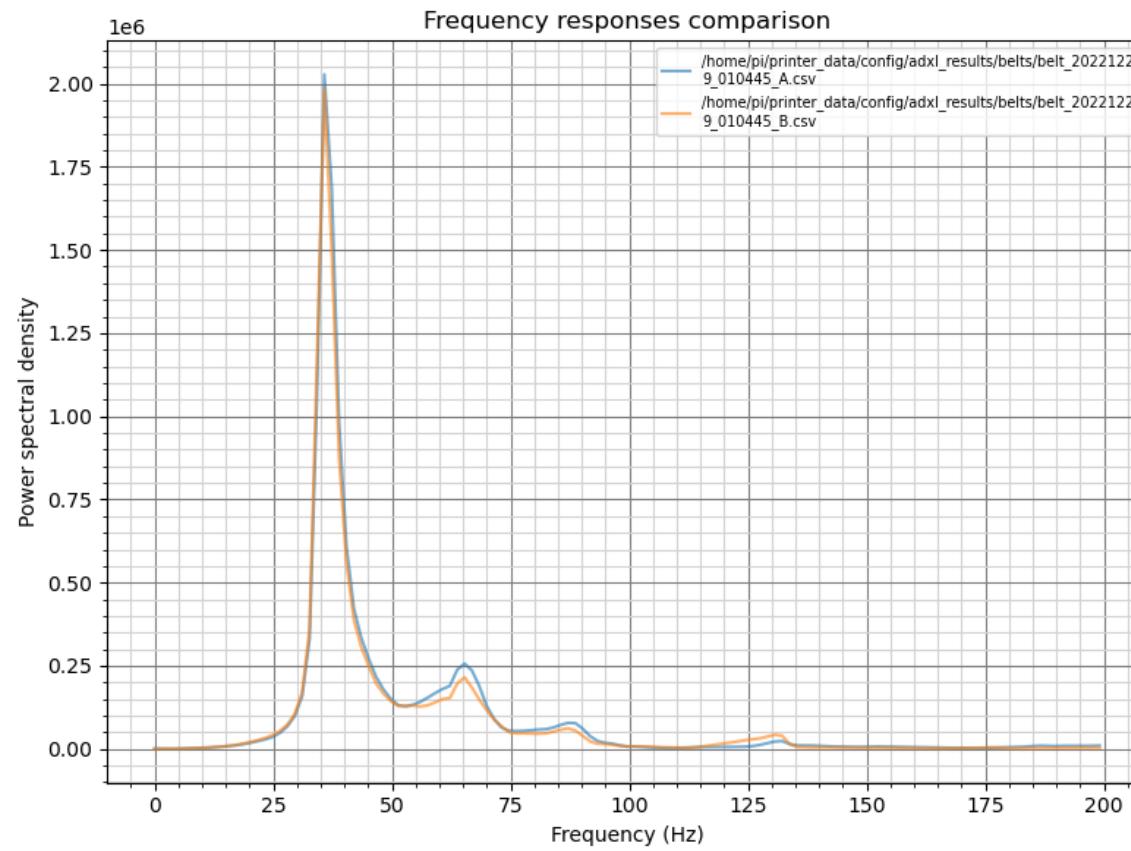
- The following graphs are only applicable to CORE XY printers. Bed slinger, delta, or other style printers will not necessarily be able to match the graphs to mechanical issues as the basic design of the printers are different.
- The purpose of these slides are to present different belt shaper and input shaper graphs with some suggestions on how to go about diagnosing and fixing the issue.
- These graphs were taken from 3D Printers & a whiteboard, Frix\_x, my own Trident 350, and members of the Voron Community with annotations provided for clarity.
- Interpretation of input shaper graphs may not be straight forward and it is possible to have multiple issues happening at the same time
- Note: tighter belt tension is not always the answer. Tightening belts to much can lead to new, and not better, print artifacts.

# Common Issues

- Belts are showing two spikes, three spikes, one spike, etc.
  - “Ideally” you want belt shaper to have a single peak for A and B belts.
  - However, having two spikes, or even three spikes, may not be an issue.
  - Belt shaper is used mainly for determining if the belts have the same relative belt tension, and by itself is not a great troubleshooting tool for anything other than relative belt tension.
  - Need to run input shaper to confirm an issue.
- Belt shaper and/or input shaper shows a problem do I need to do a test print.
  - Begrudgingly yes. Why, sometimes input shaper can just be wrong. This is because input shaper is done by an ADXL and if the ADXL is not mounted correctly/tightly/etc. then it will not be able to produce good graphs. We need a print to verify the accuracy of what input shaper is reporting.
- Input shaper says I can do 1 million accel.
  - You are most likely looking at ZV. It is not recommended to use. This is because it is a really narrow shaper, basically only canceling the main peak. You might be thinking I have really great graphs I only have a main peak. This may not always be the case. Input Shaper only moves in a very small section of the toolheads total movement. There could be vibrations outside of this movement, belts could stretch overtime, the earths magnetic field could collapse. To be better safe than sorry Klipper recommends you use MZV. Further, I have yet to see a ZV shaper return 0% vibr.

# Belt Shaper

# Good belt graphs peaks in freq are aligned



# Belt Tension

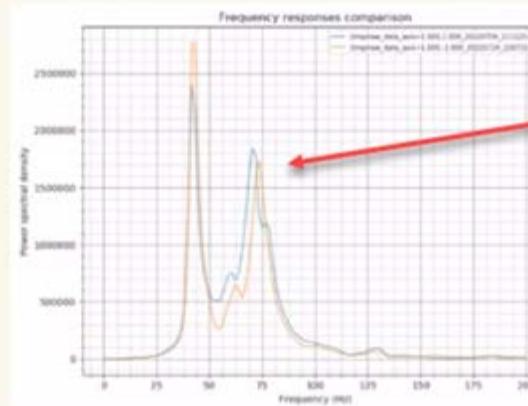
Input Shaper Settings ✓

Absolute Belt Tension ✗

Relative Belt Tension ✓

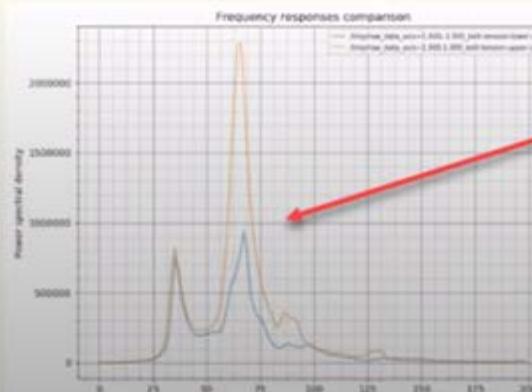
Issues:

- binding
- loose bolts
- over-dampening
- loose belts
- wire loom issues
- printer design issues



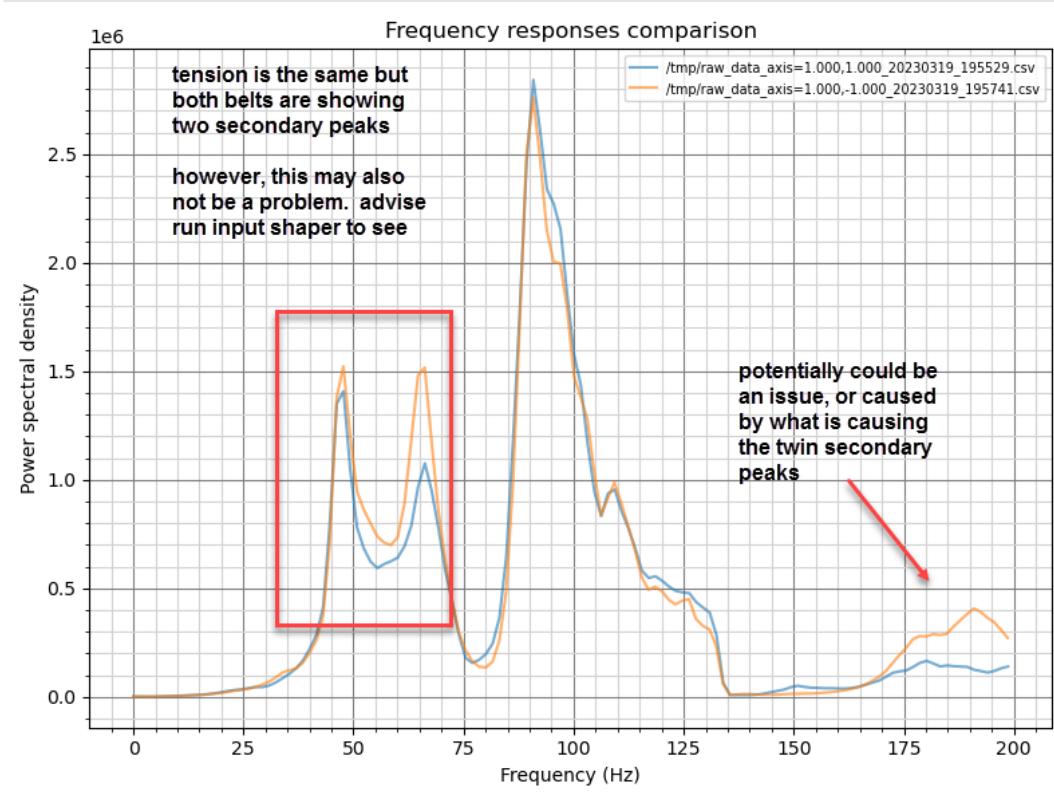
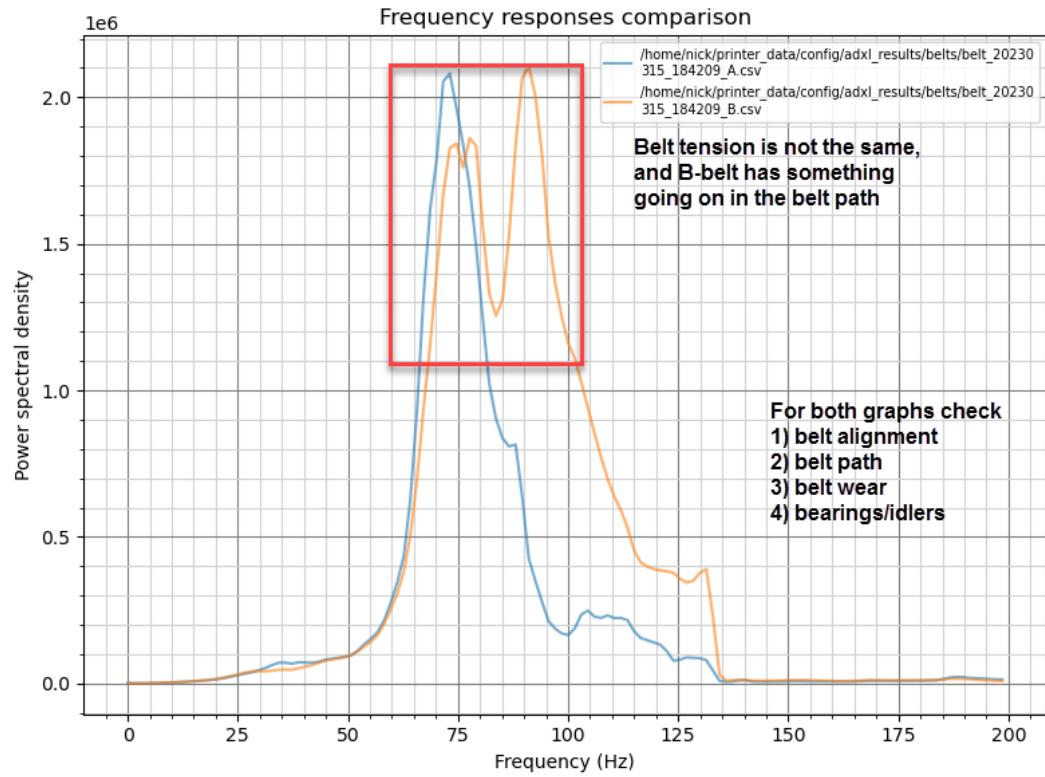
peaks not aligned

bad belt tension



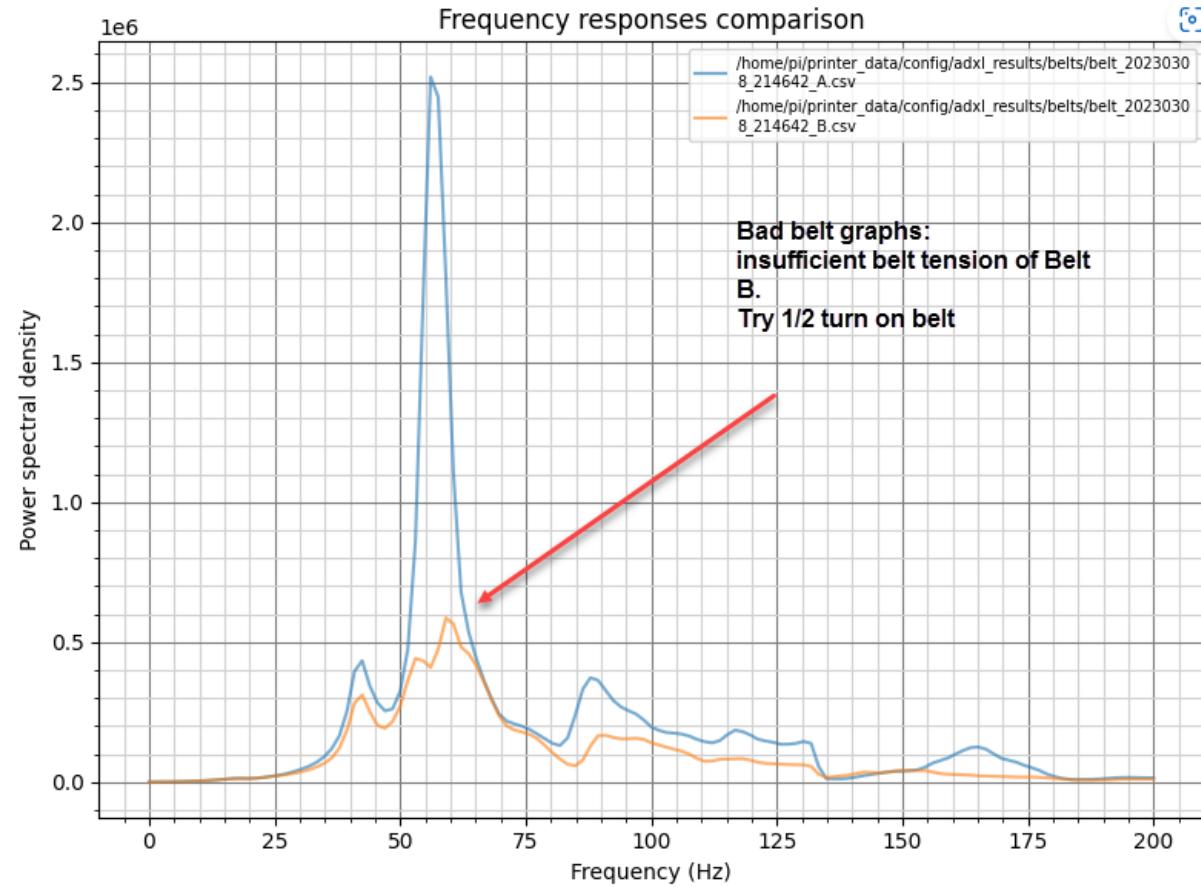
Peaks are aligned, but amplitude is too low. generally indicates  
1) belts were not cut the same length, or  
2) belts length coming our of the x-carriage is not the same, or  
3) something else in belt path

# Belt Path problem

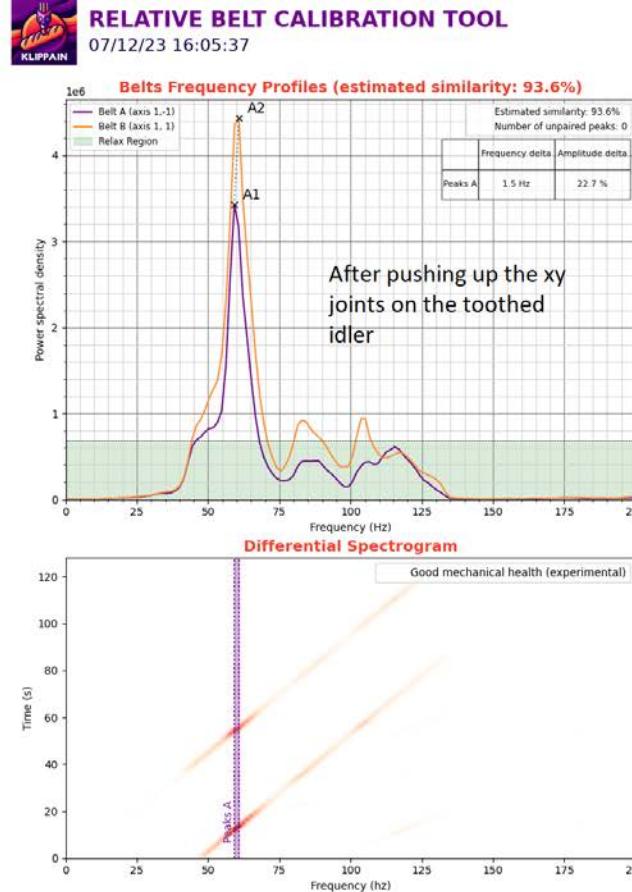
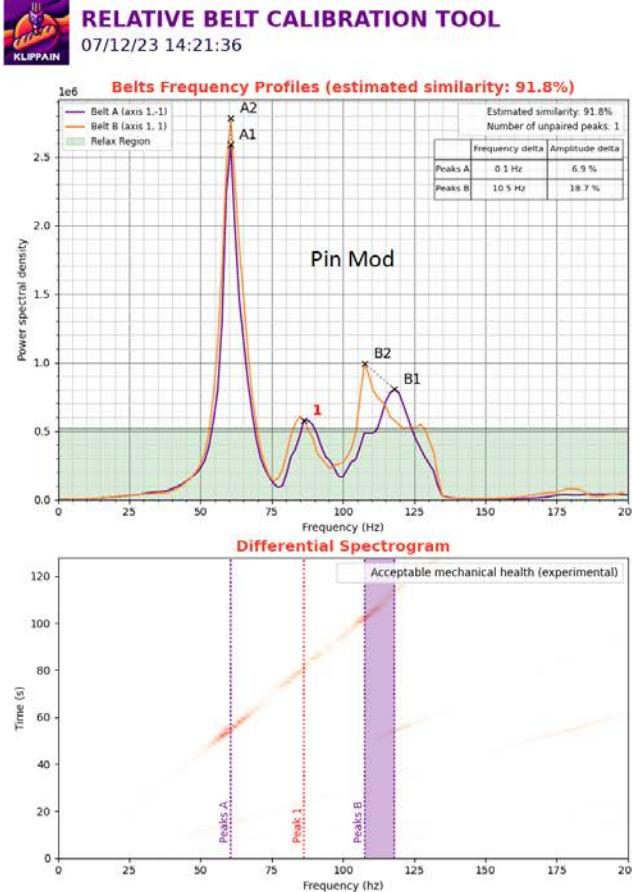


For graphs such as this it is recommended to run input shaper to troubleshoot any issues, and determine if the belt path is a problem

# Belt Tension



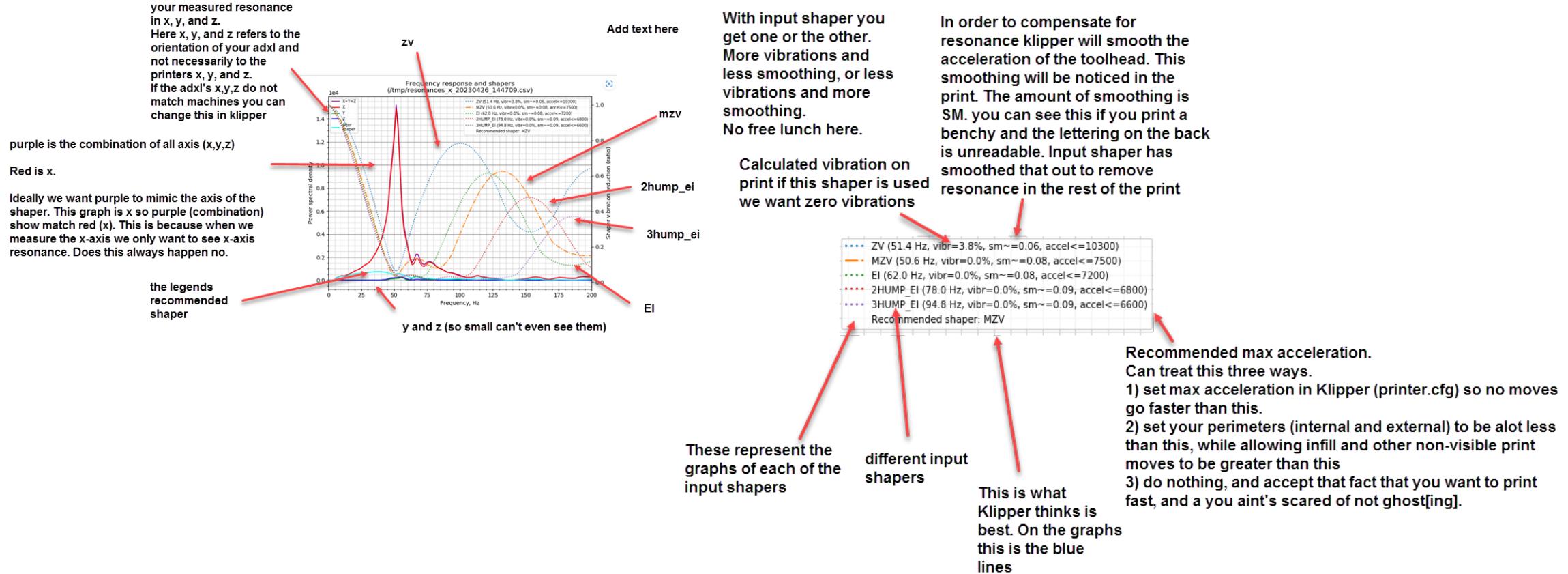
# Pin Mod: may need to push up the xy joint around the idler



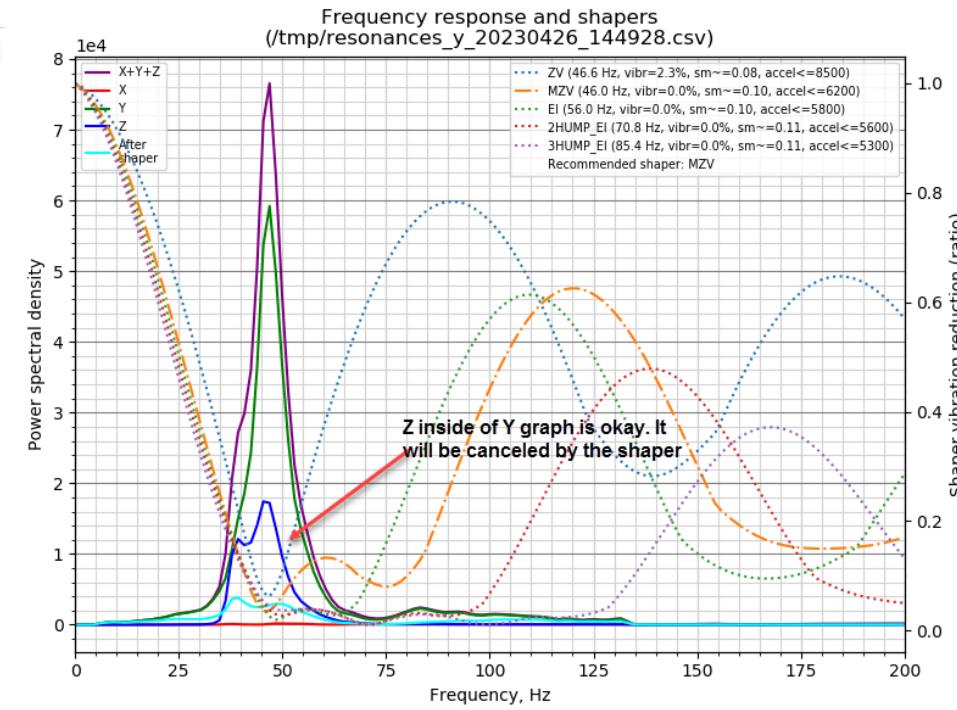
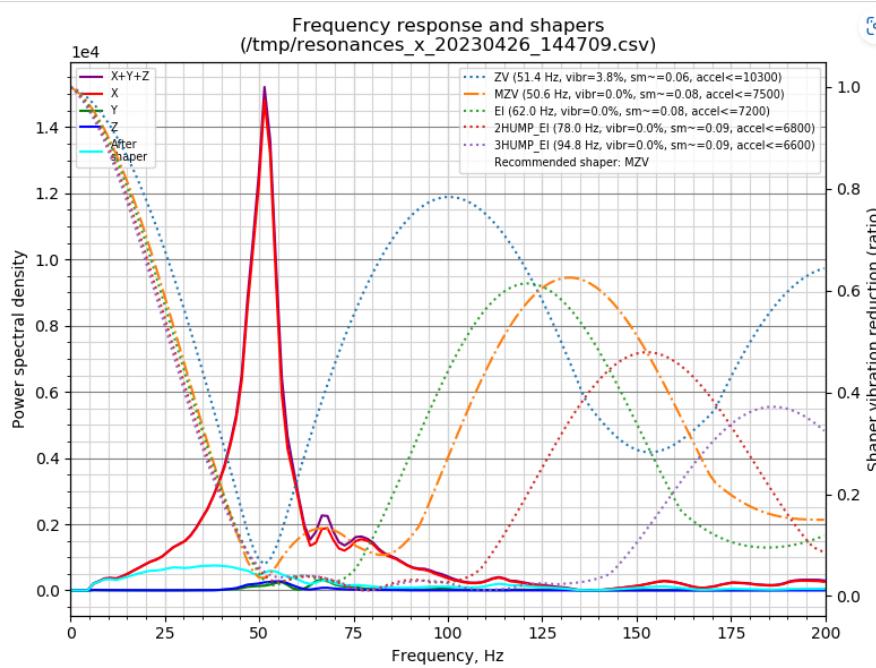
What one can see here is that for the pin mod it is really easy to have the plastic around the toothed idler to contact the flange of the toothed idler thereby dampening is belt shaper

# Input shaper

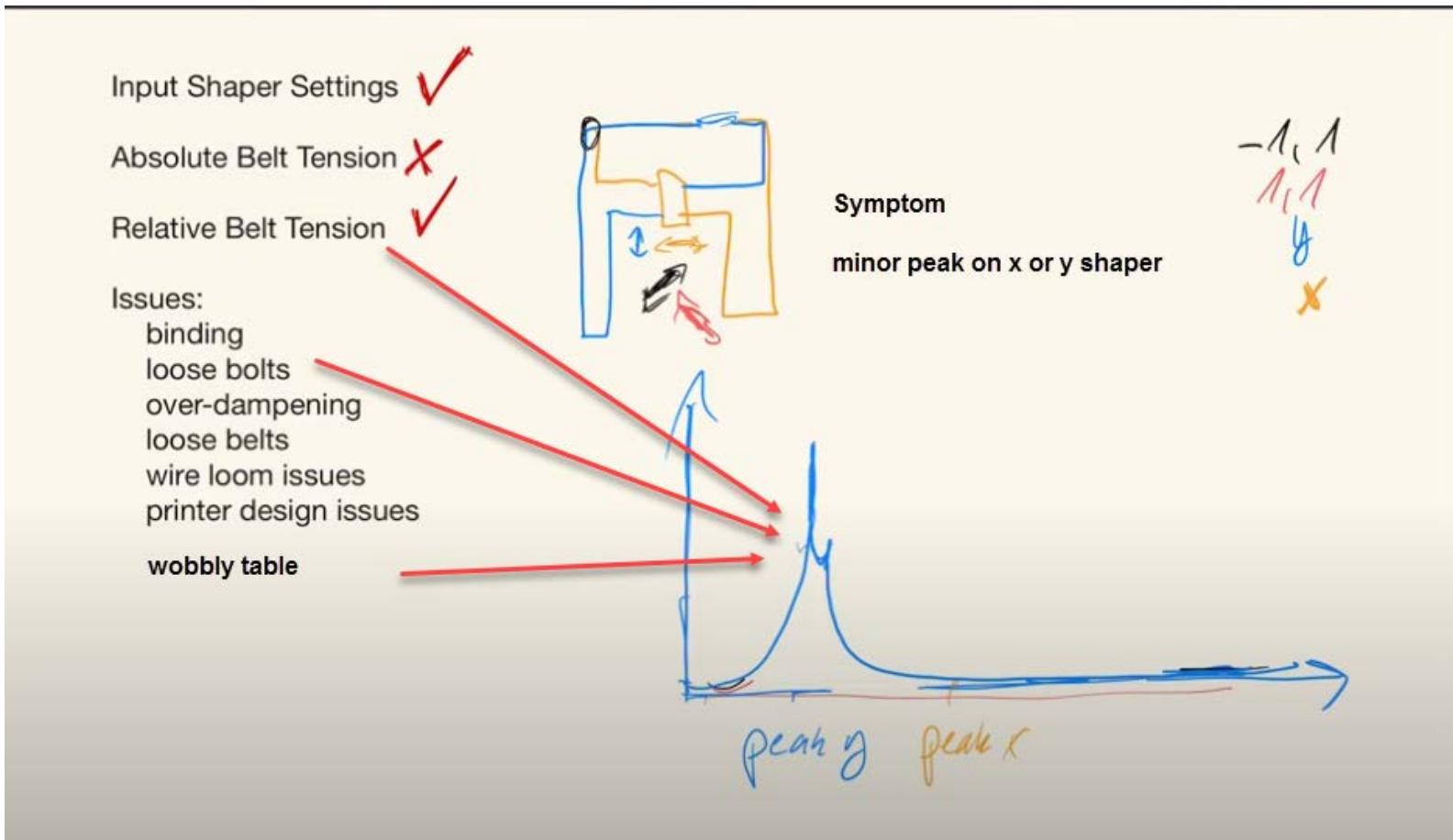
# How to read input shaper graphs



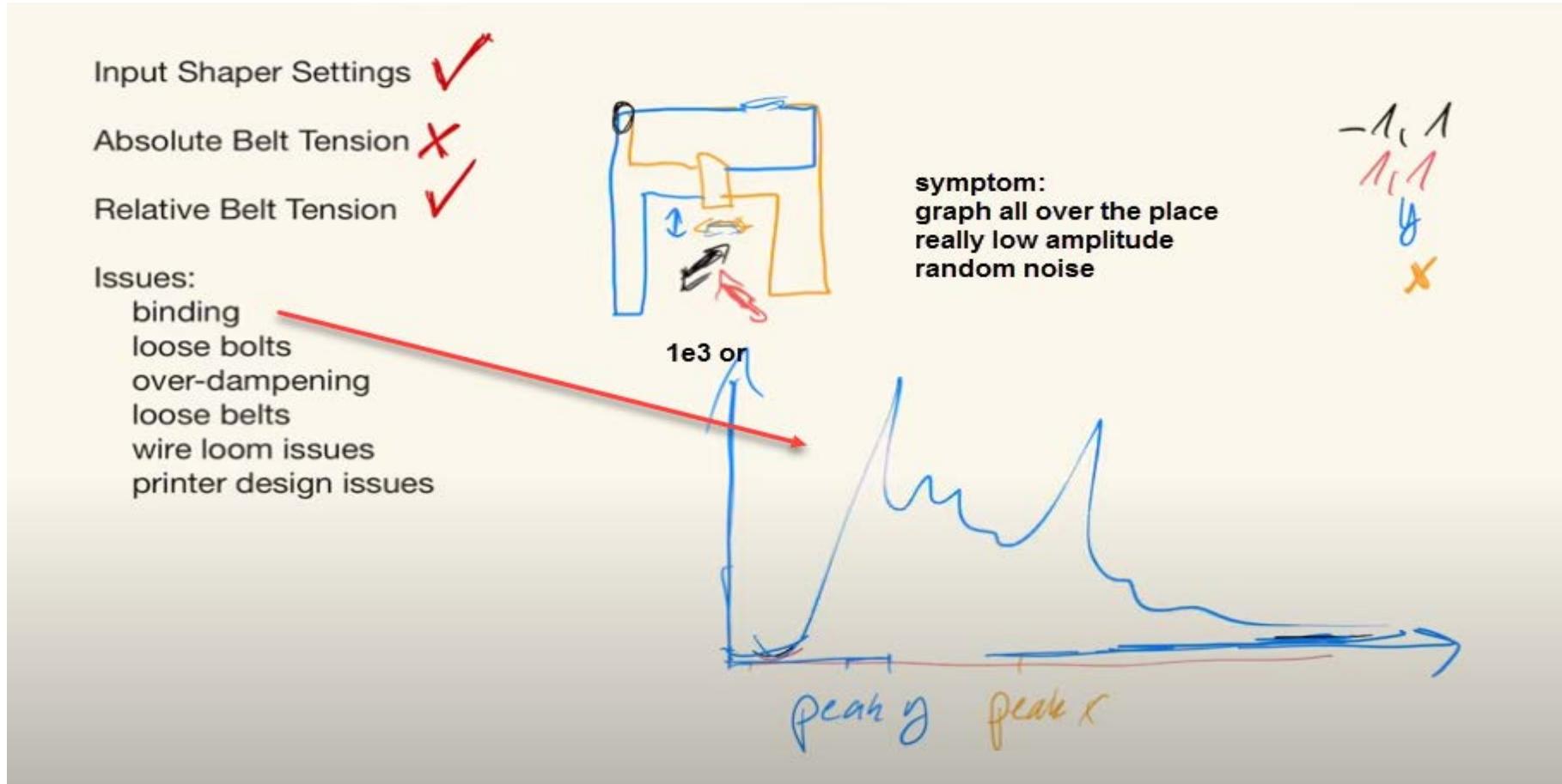
# Good Graphs



# Binding, Relative Belt Tension, Wobbly table



# Binding



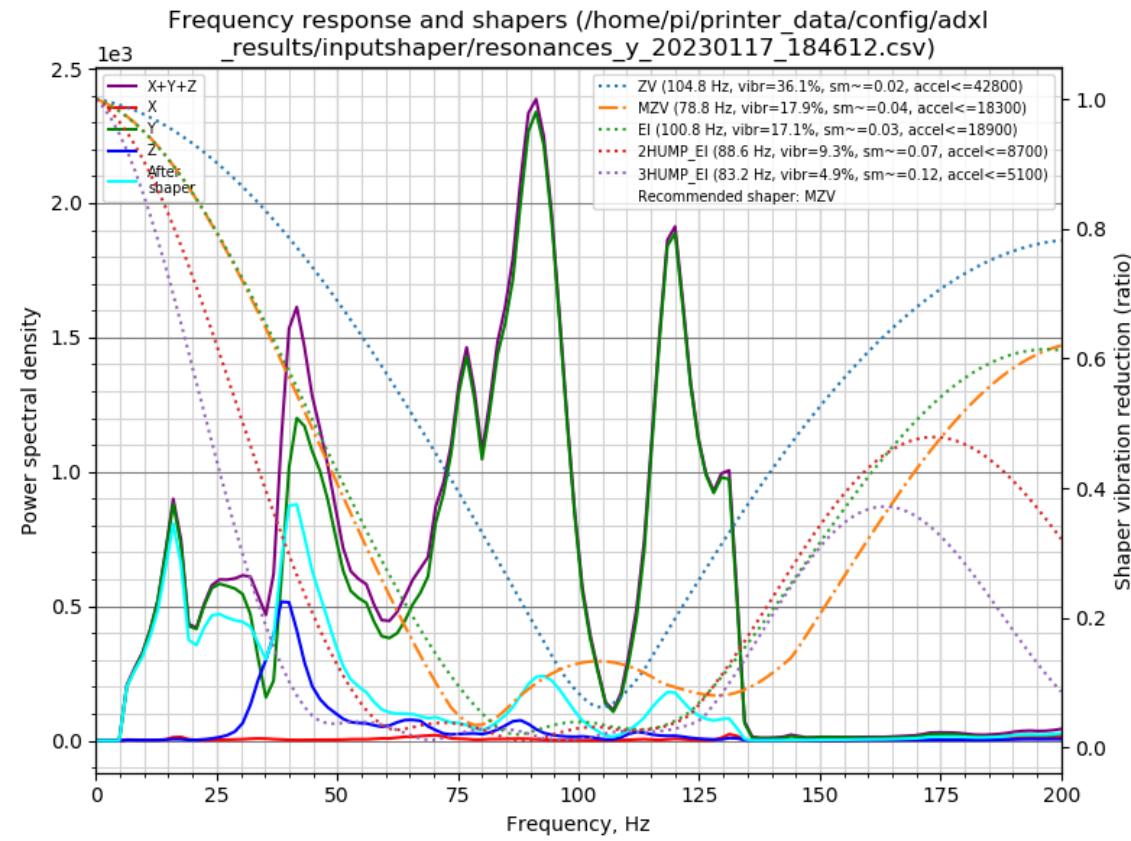
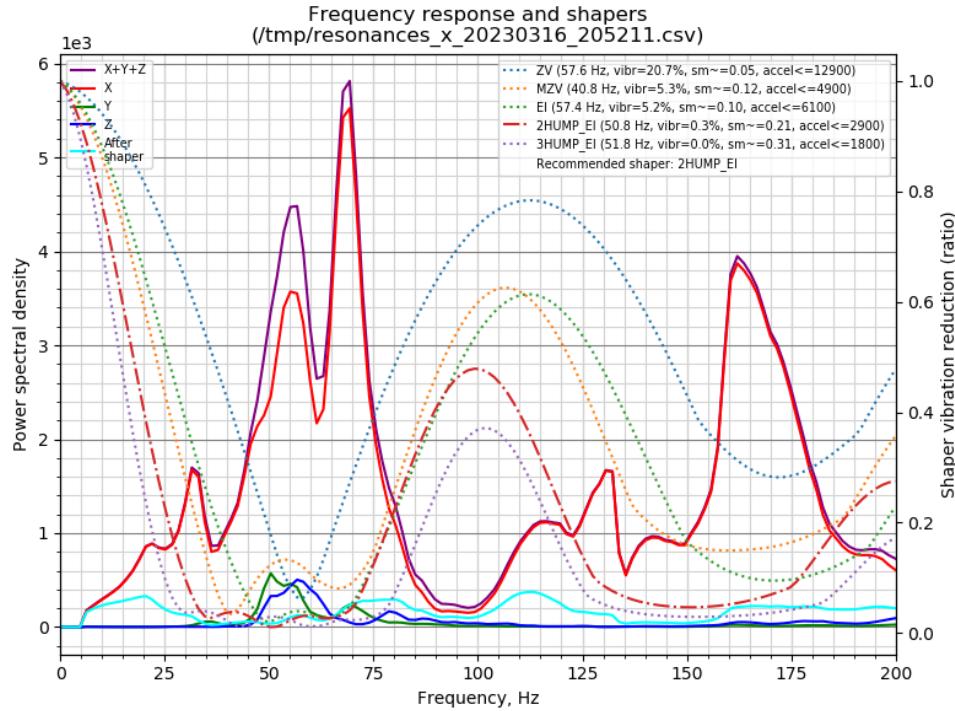
# Binding, racking, wobbly table, etc.

check every moving part

start by placing printer on a stable surface (floor)

then check belt path, then derack, then belt tension.

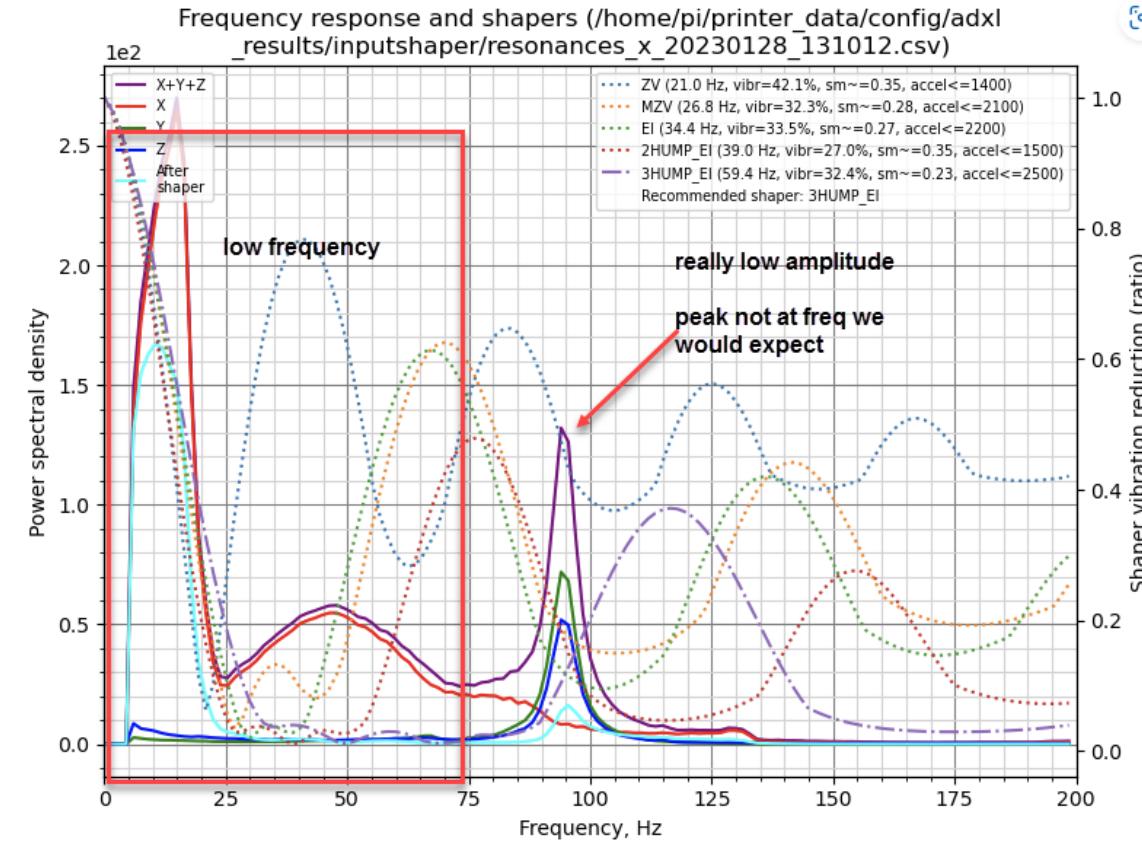
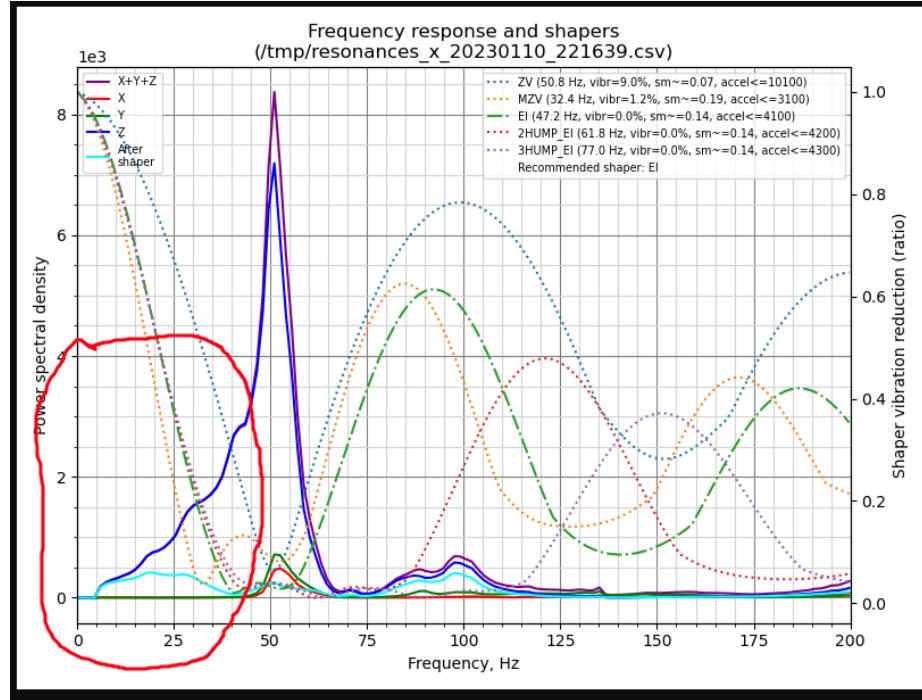
If problem persist consider relubing linear rails, replacing bearings/idlers



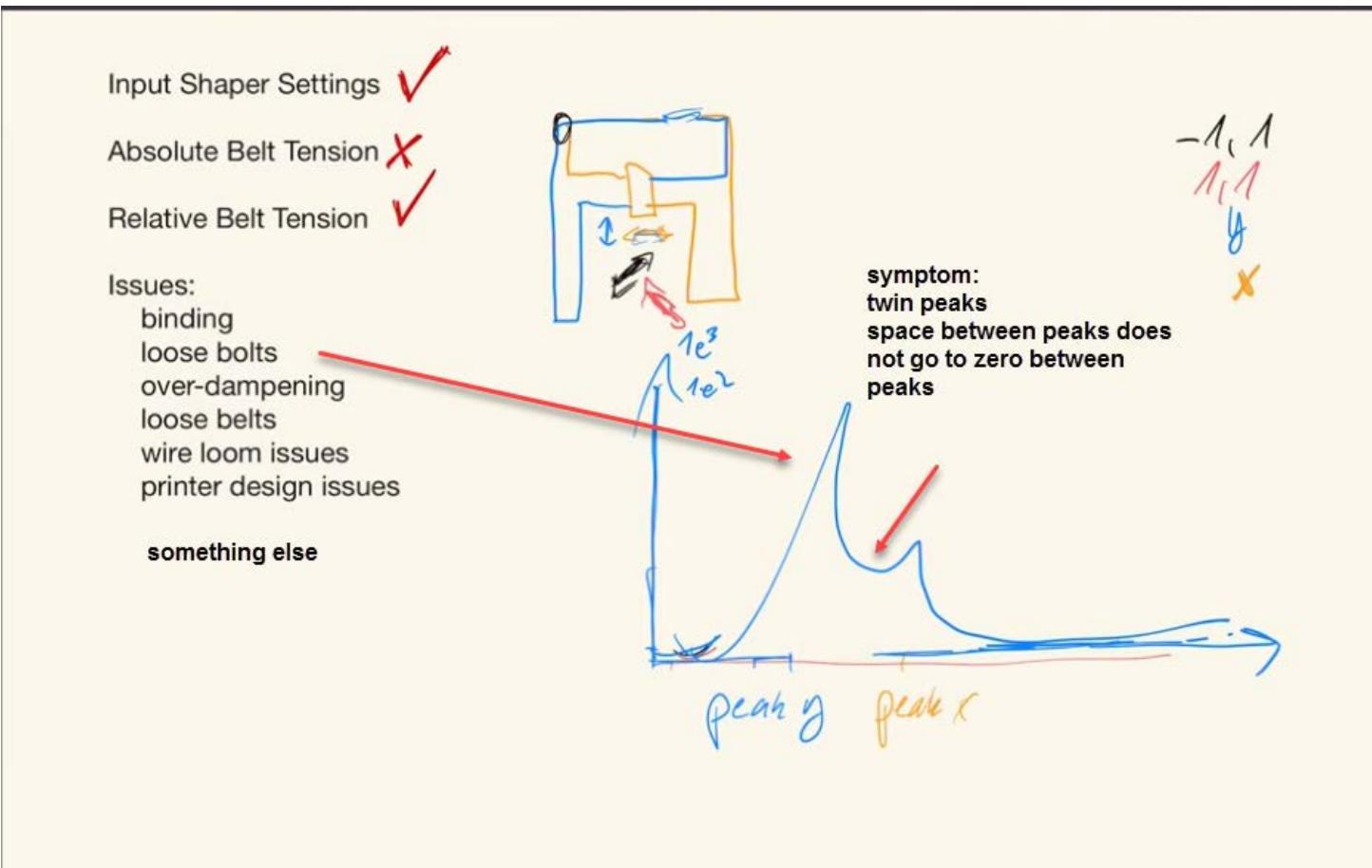
# Low frequency – binding or grinding

## something is not moving freely

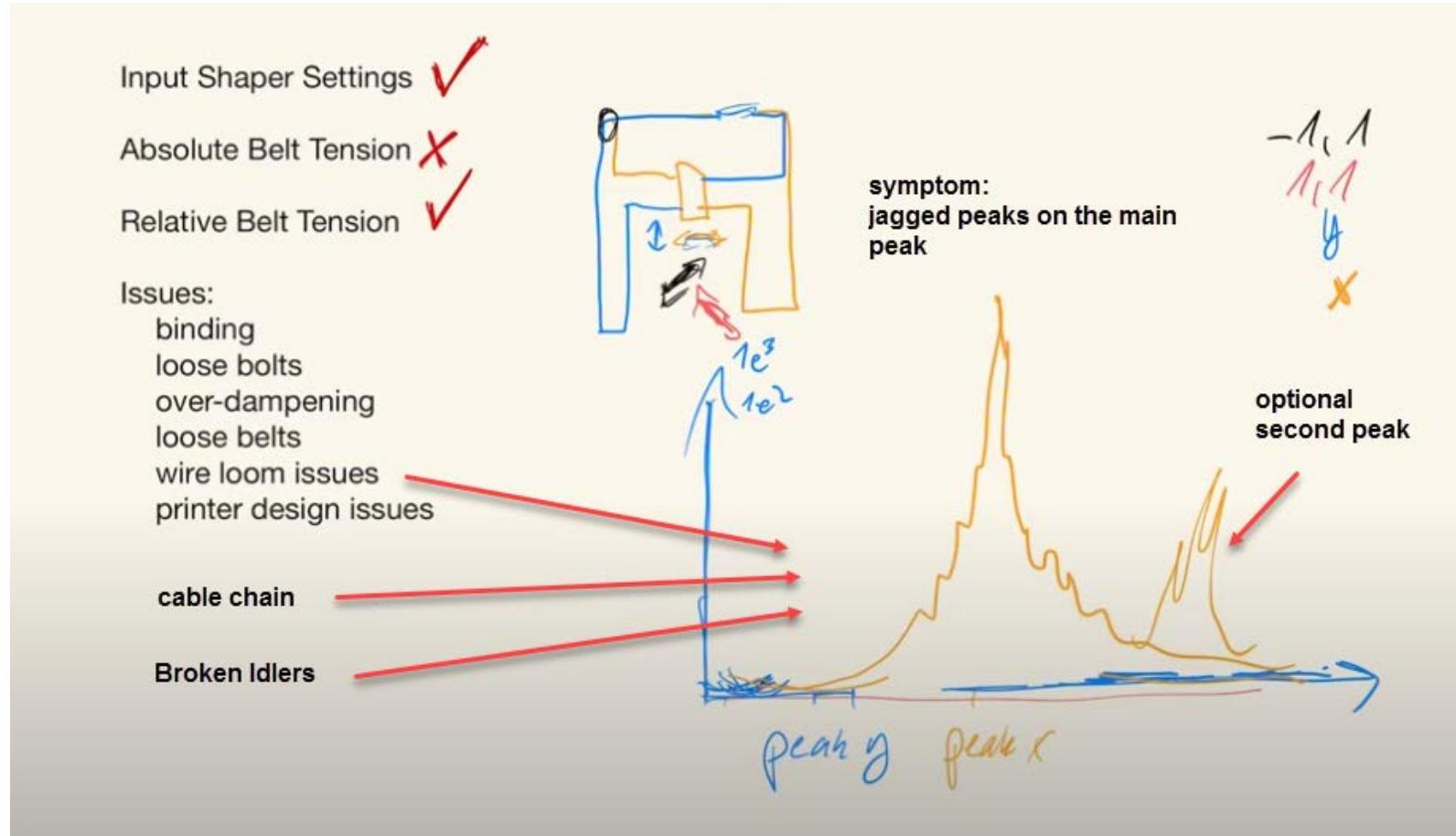
check belt alignment (make sure you have the belt in the middle of the bearings, and not riding on the flange. Make sure bearings have the flange on the outside of the belt bath)  
Check linear rails, bearings, and idlers



# Loose Bolts



# Wireloom/cable chain, Broken Idlers



# Wireloom and loose bolt

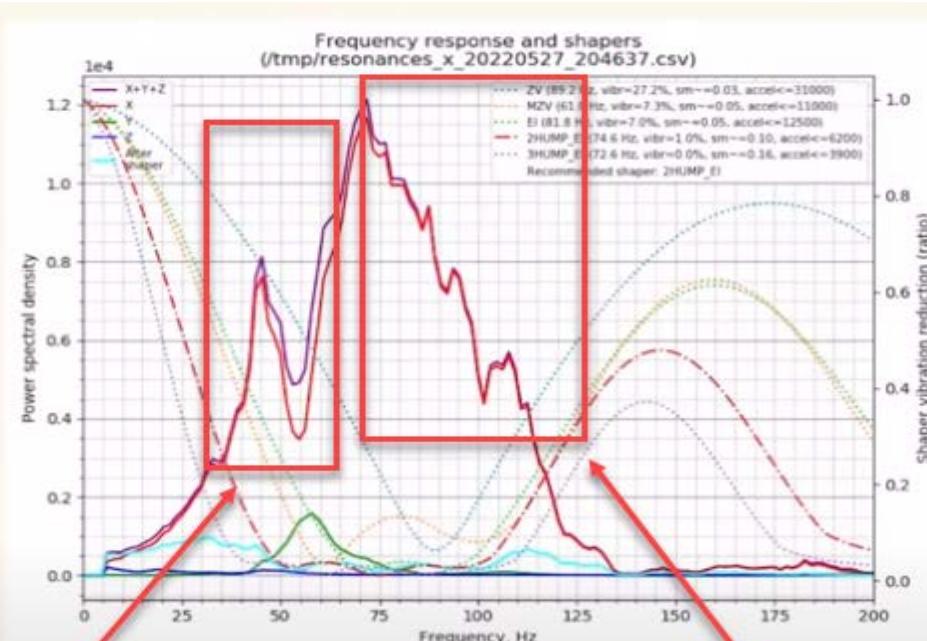
Input Shaper Settings ✓

Absolute Belt Tension ✗

Relative Belt Tension ✓

Issues:

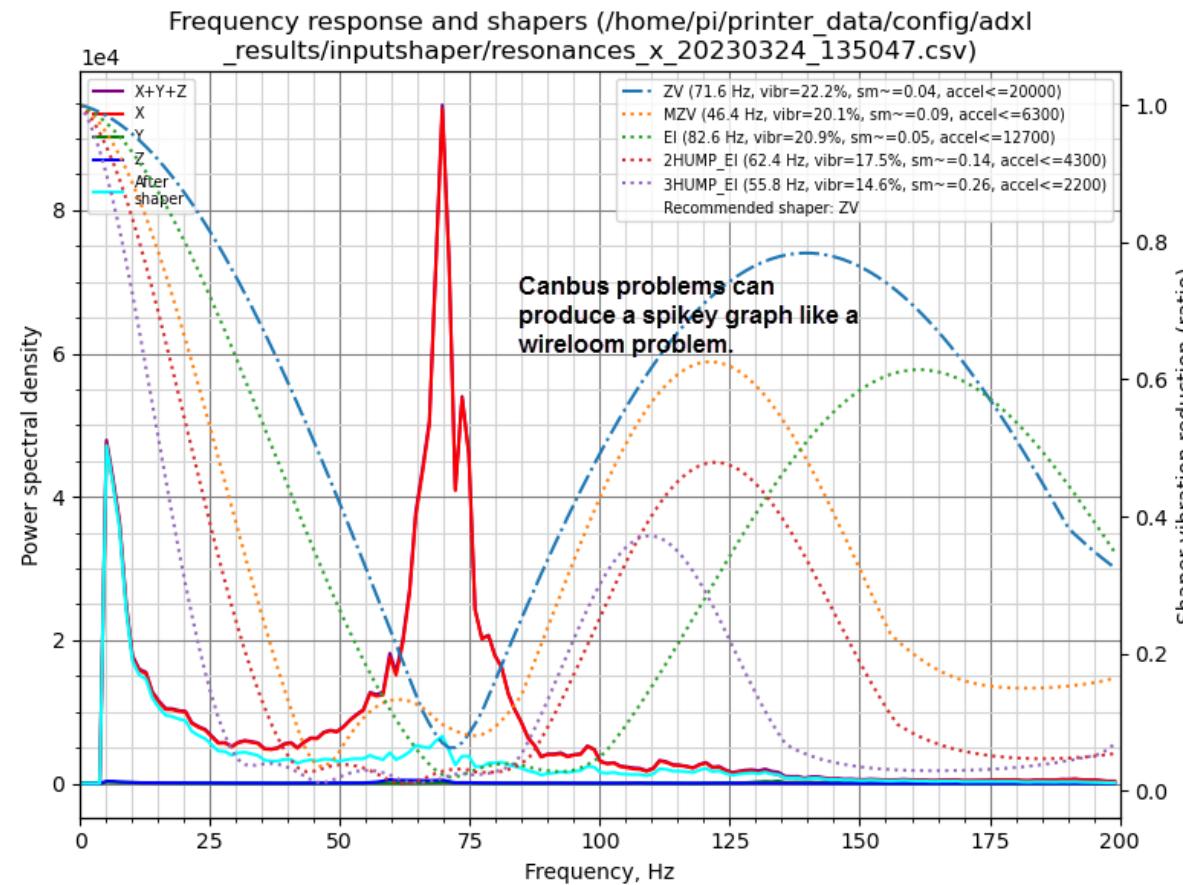
- binding
- loose bolts
- over-dampening
- loose belts
- wire loom issues
- printer design issues



loose bolt:  
second peak

wireloom:  
jagged peaks

# Canbus increase canbus speed to 1M (1 million dollars)

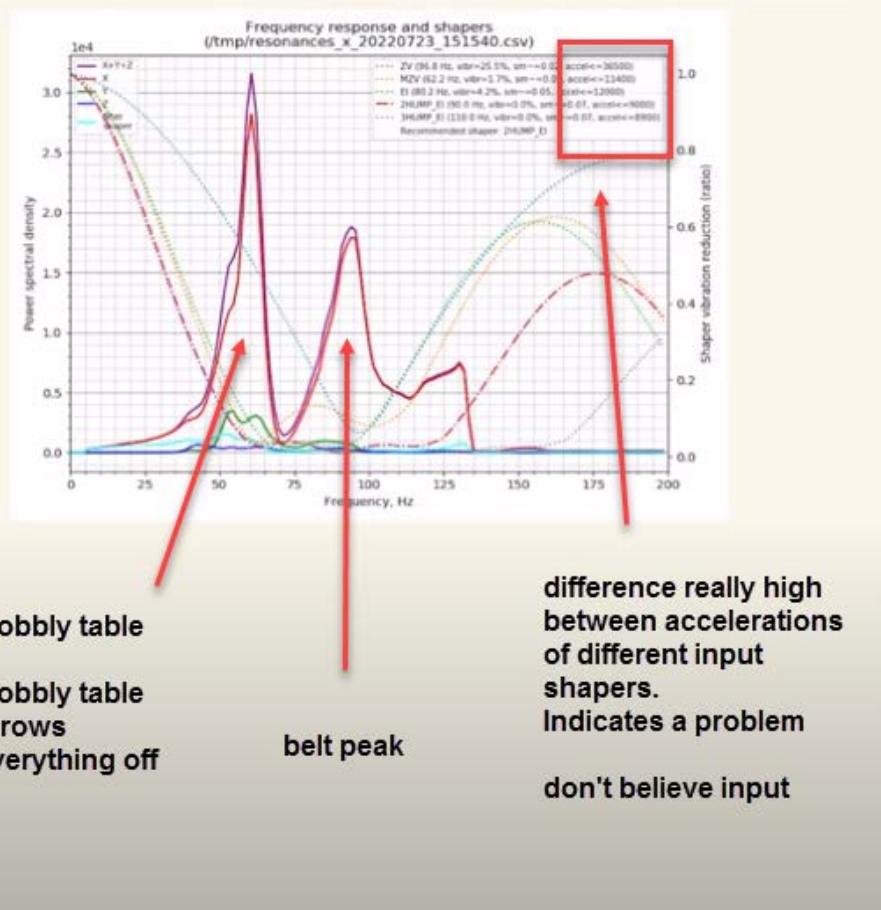


# Wobbly table

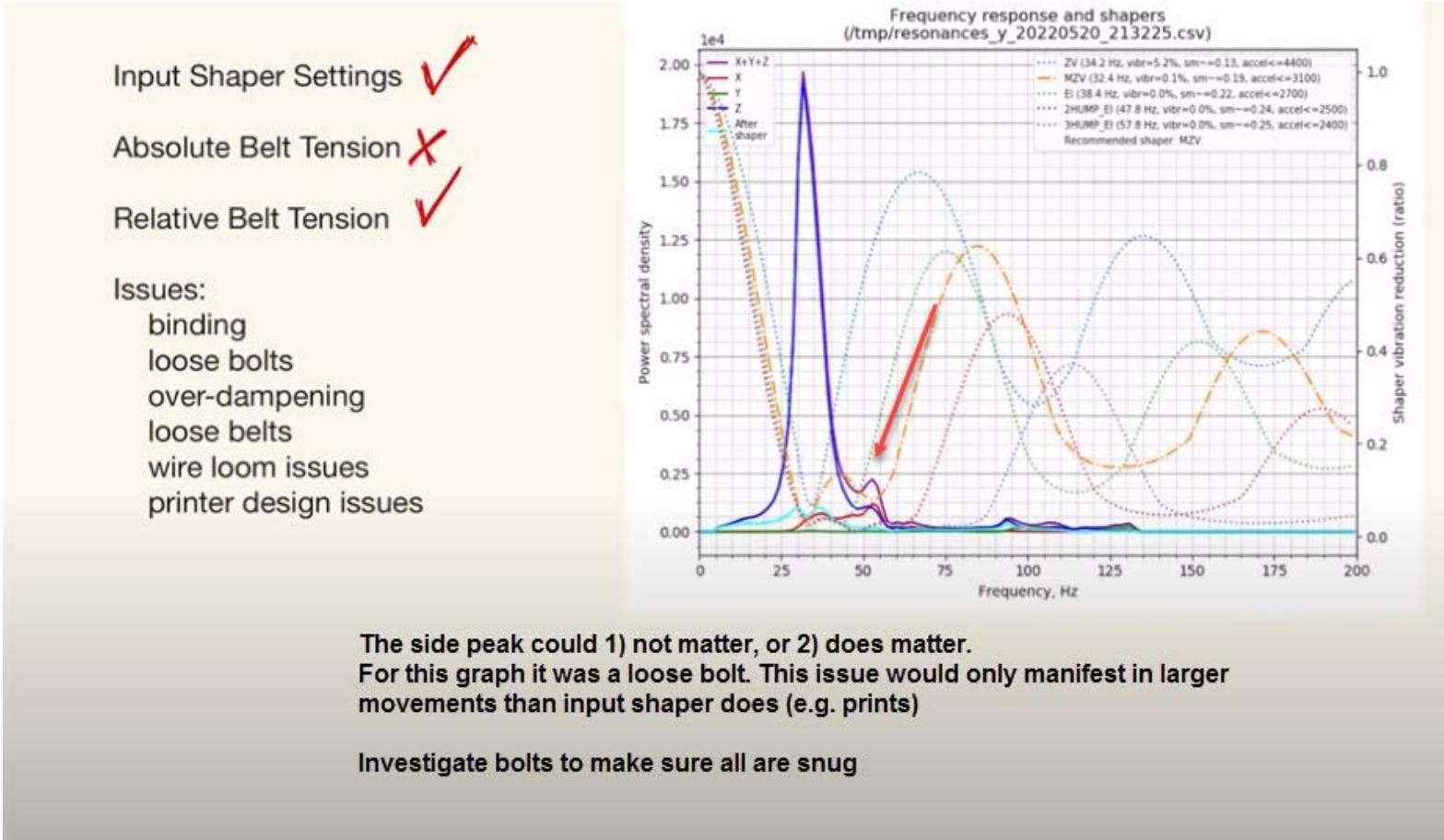
- Input Shaper Settings ✓
- Absolute Belt Tension ✗
- Relative Belt Tension ✓

Issues:

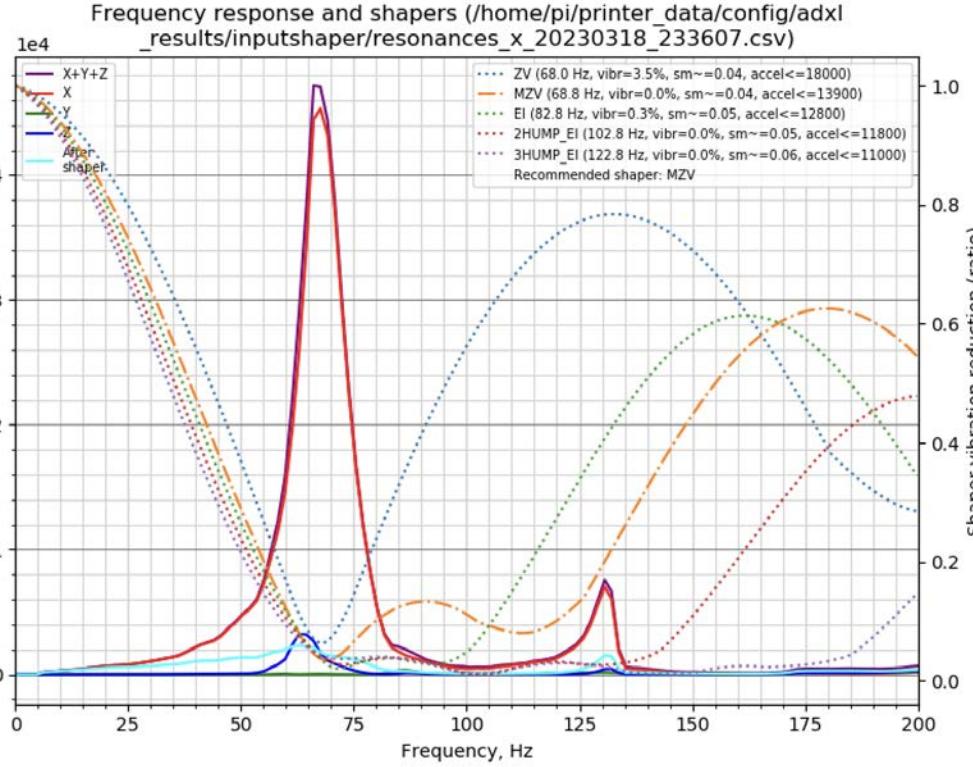
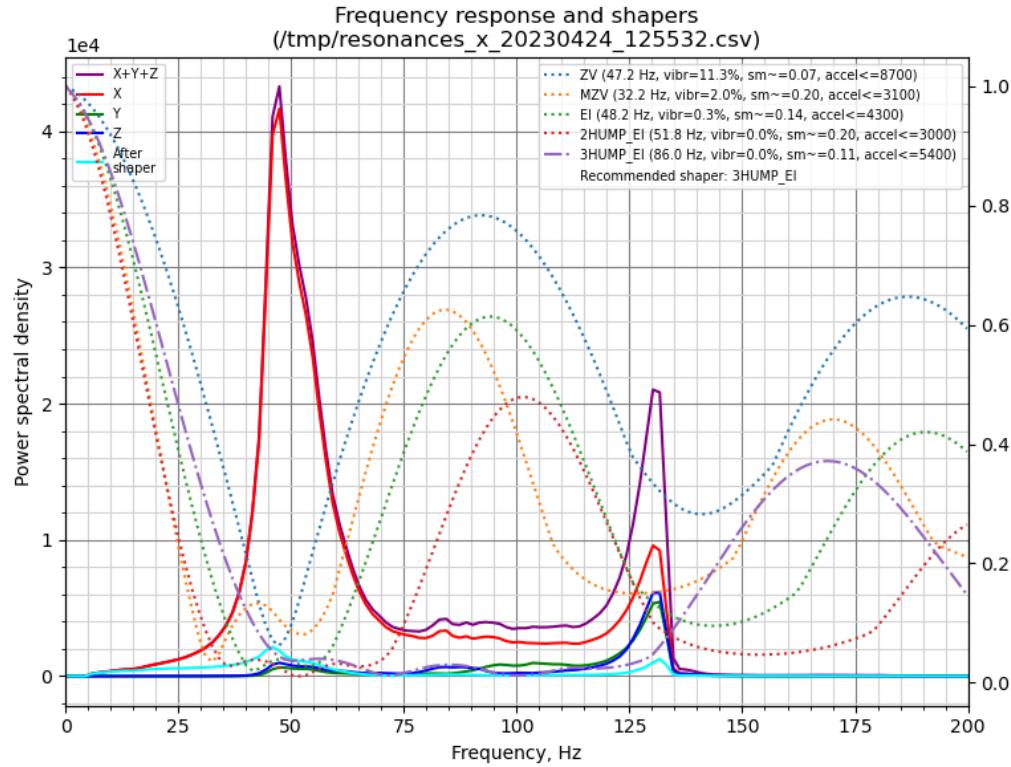
- binding
- loose bolts
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# Potentially loose bolt or nothing at all



# TAP Wobble toolhead in general



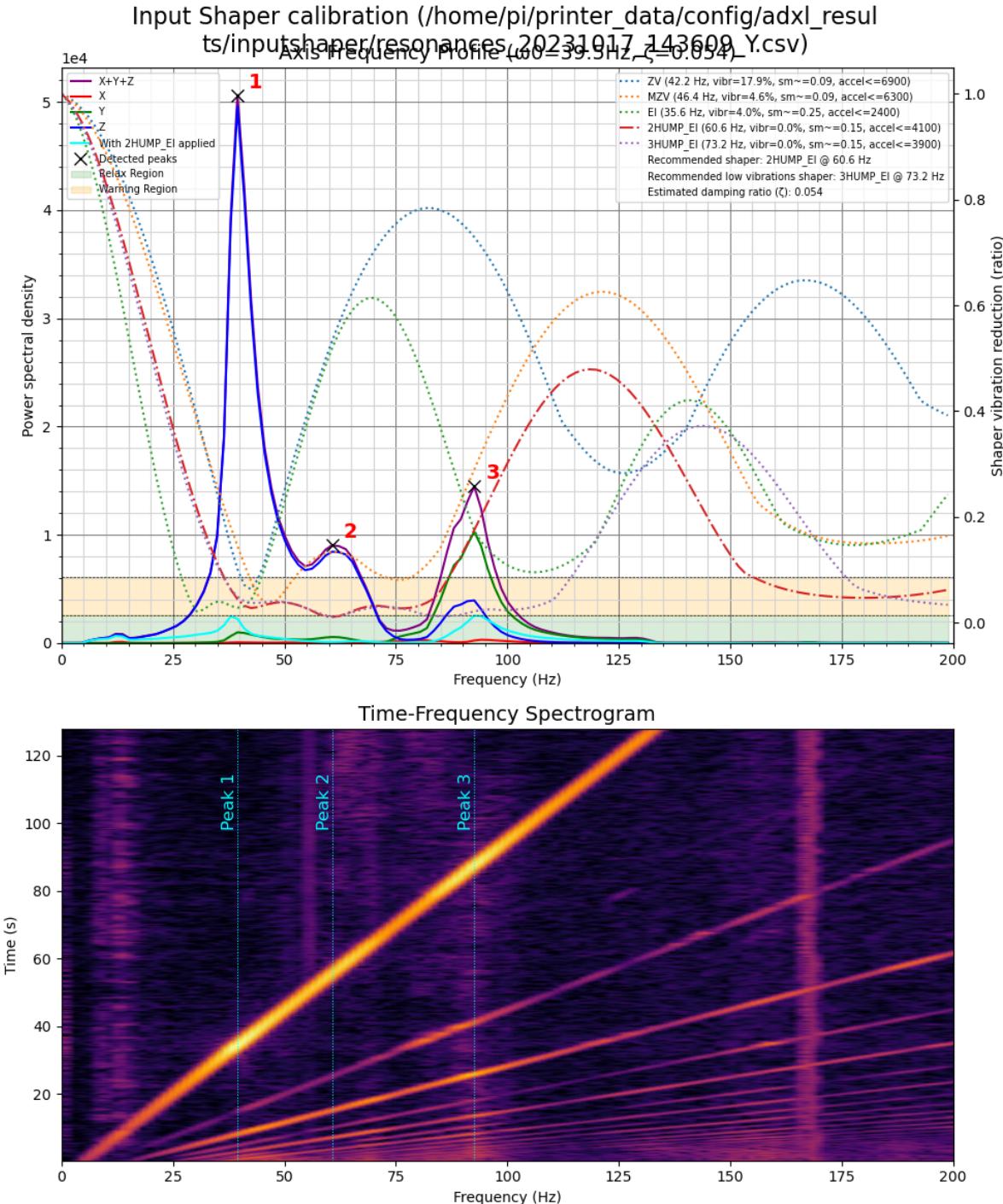
TAP issues are generally around 125hz and have the general shape shown above.

Toolhead issues are also associated with, but not exclusive to, 125hz.

If you see 125hz investigate the toolhead – break it down, and make sure all screws are tight, and your tap magnets are engaged.

Can have 125hz on non-tap machines also

# Canbus cable, or TAP linear rail



peak 3  
this could be the canbus umbilical cable, or this could be the tap linear rail

The effect as seen is that there is a z excitation. This can be interpreted as an RX (rotation on the x axis) or as something pulling up on the tool head.

A canbus umbilical can pull on the toolhead, also the tap rail may not be good enough and allows for Rx rotation

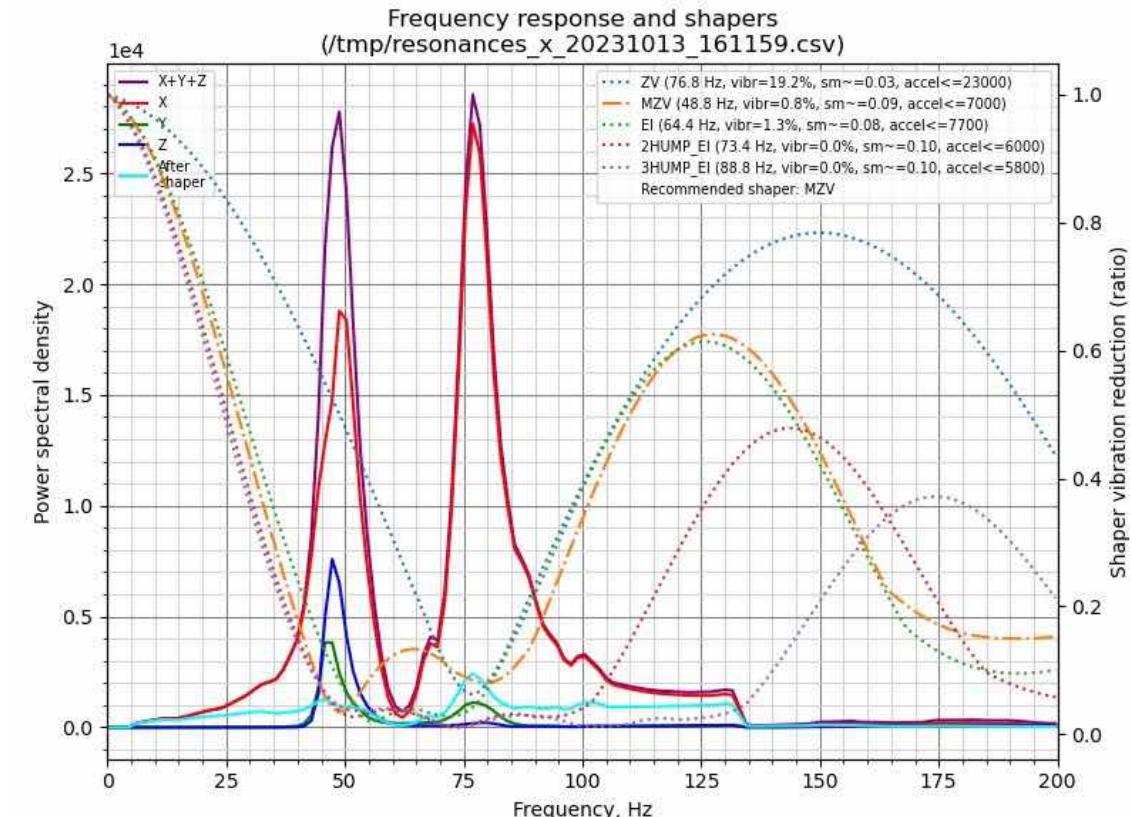
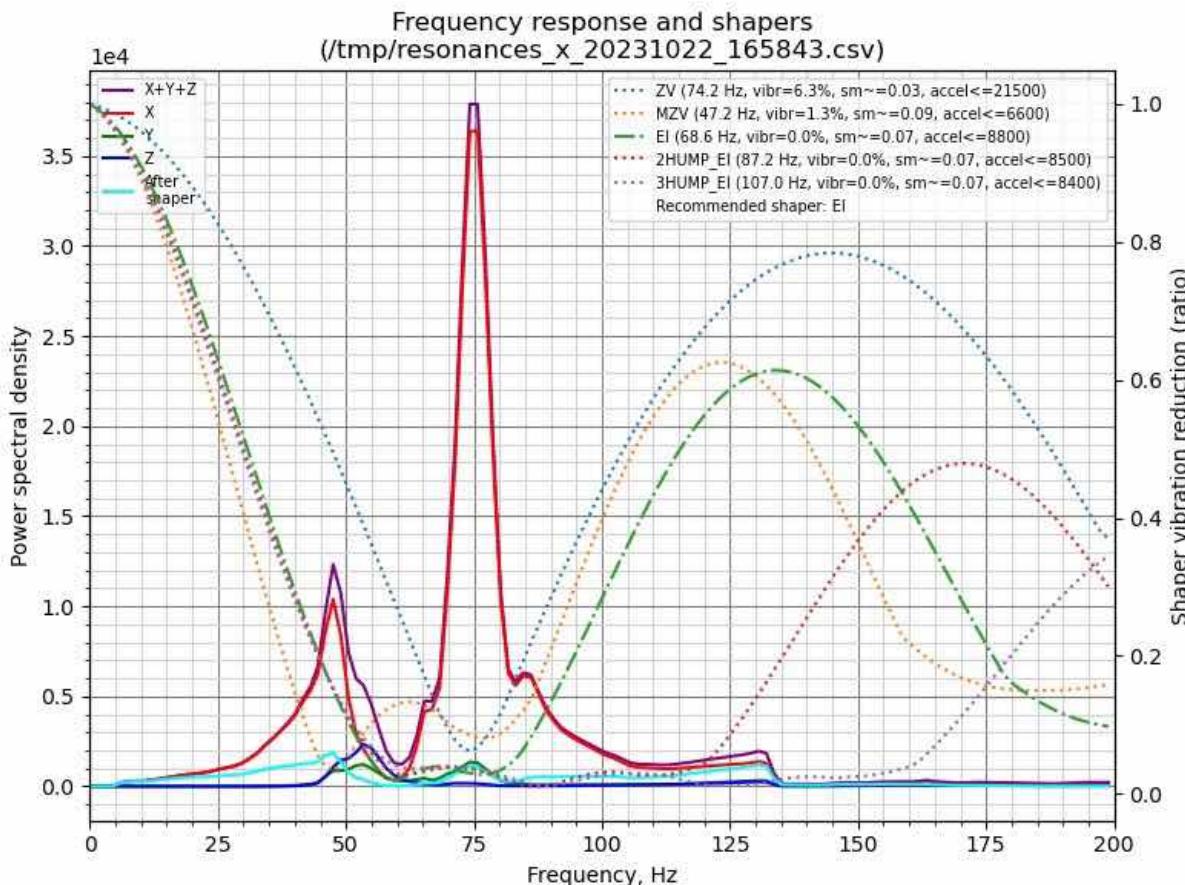
Notice that peak 3 goes to zero on the left and right of it

# Potential Bearing issue

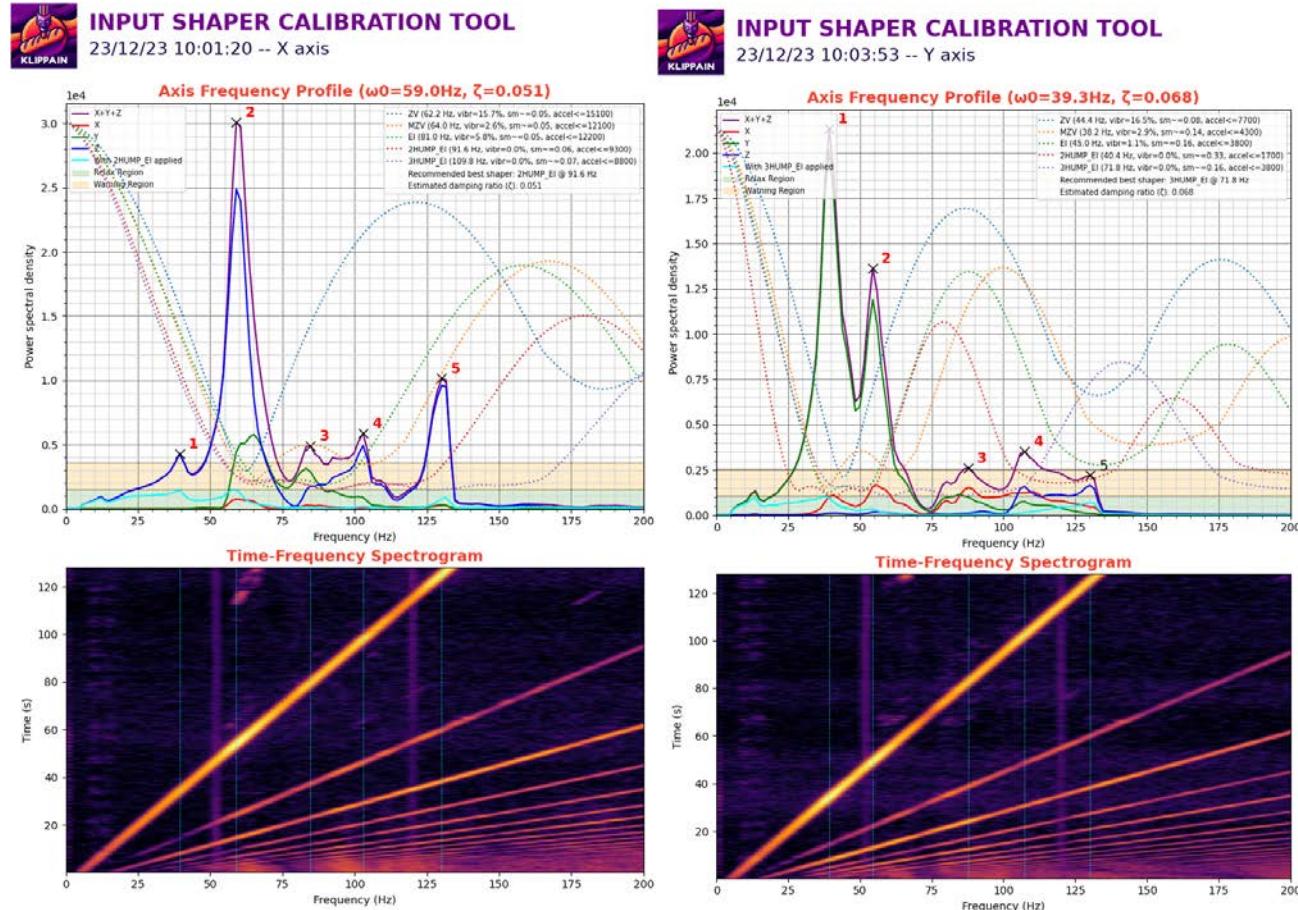
What you see here is two peaks with a valley between them and the valley goes to zero. This is very similar to the canbus, tap, or linear rail.

The difference is the amplitude of the 75 hz spike is equal to or greater than the real freq of around 50hz.

-graphs by rafs2921

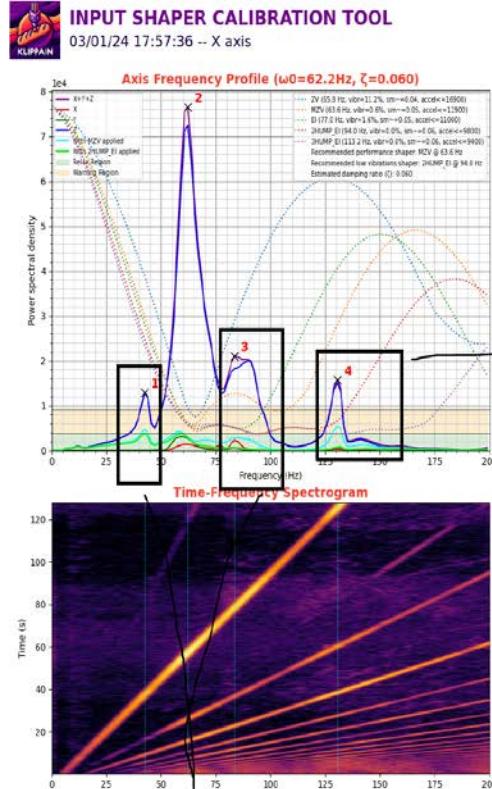


Not using all four screws to secure tap to the x-linear rail – missing two screws.  
Likely similar if screws are loose.

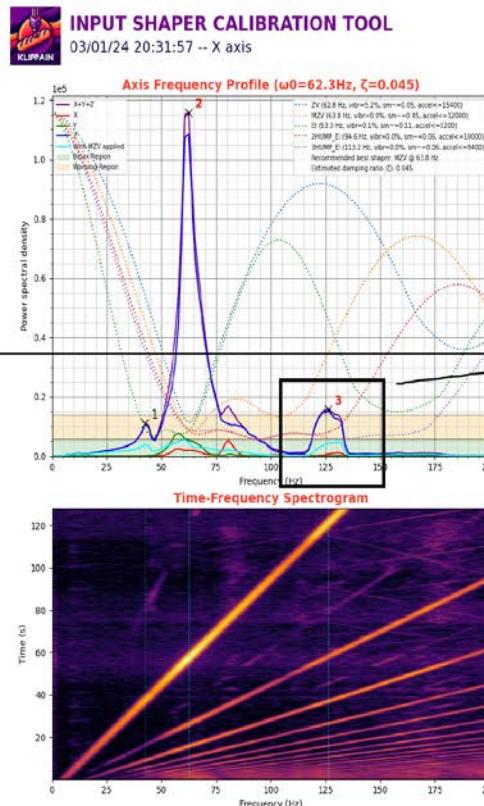


# What a bad x-linear rail looks like.

## Part 1: 125hz is not the x-linear rail

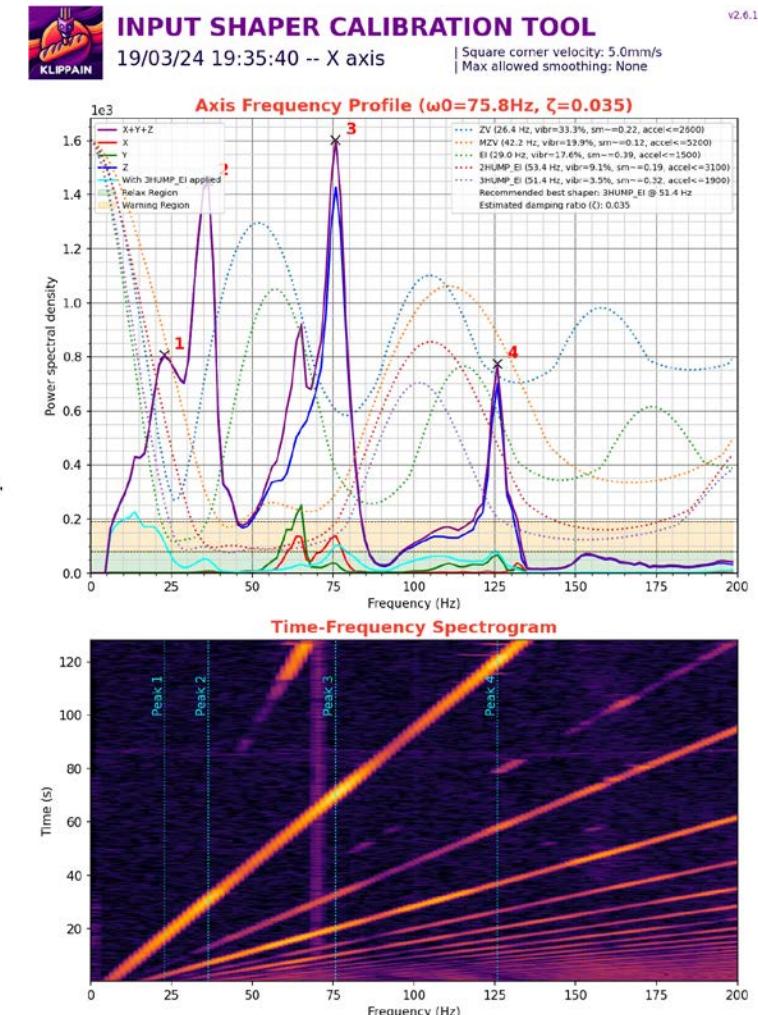


Bad linear rail - missing bearings



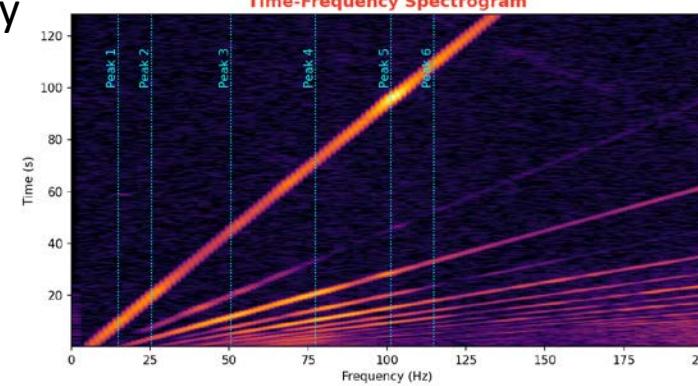
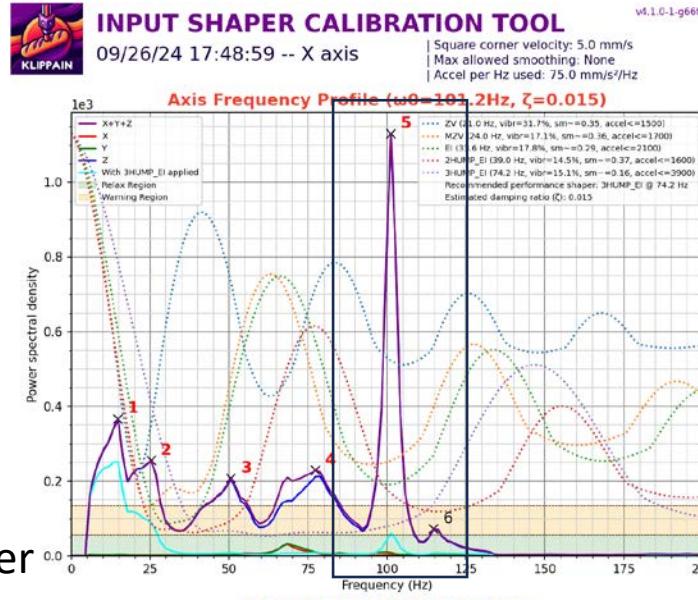
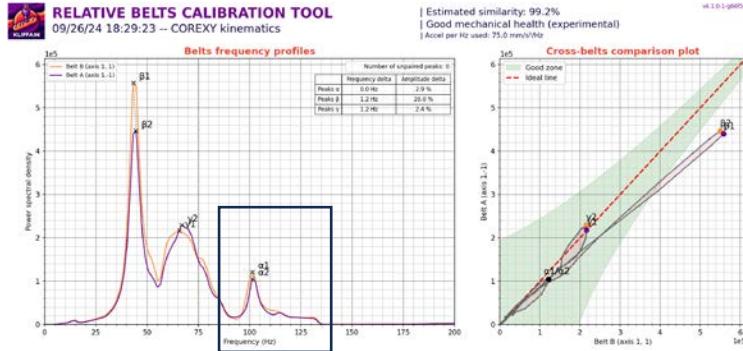
Good linear rail

Tap:  
using mellow tap.  
likely umbilical is causing some of this.

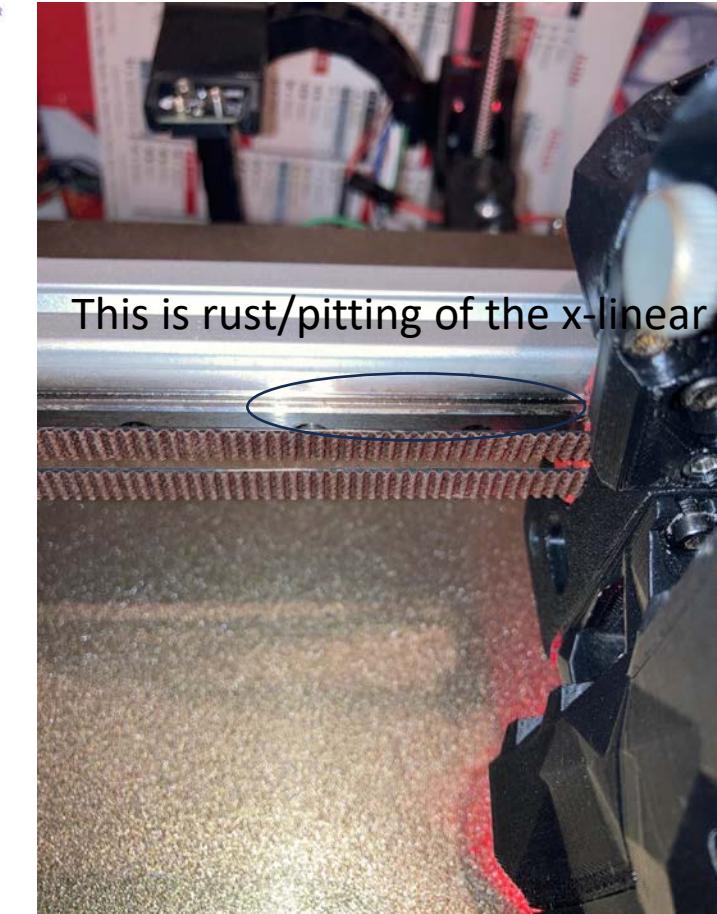


# What a bad x-linear rail looks like.

## Part 2

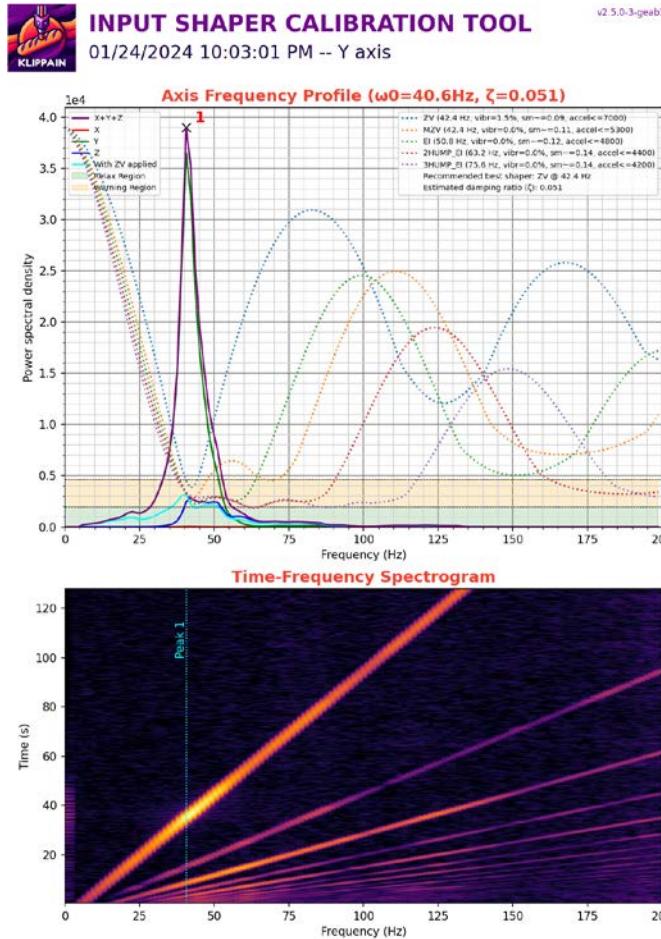
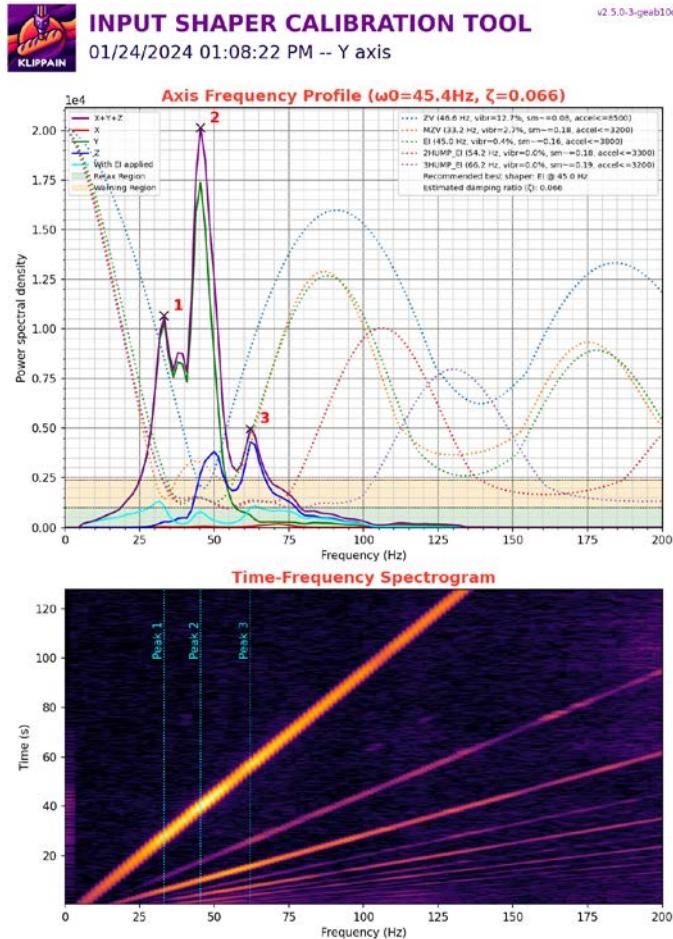


The 100hz spike in belts and x-shaper  
Is due to a rusted (pitted) potentially  
Twisted x-linear rail



This is rust/pitting of the x-linear rail

# Printer wobbled on floor. Added dampers to the printer feet



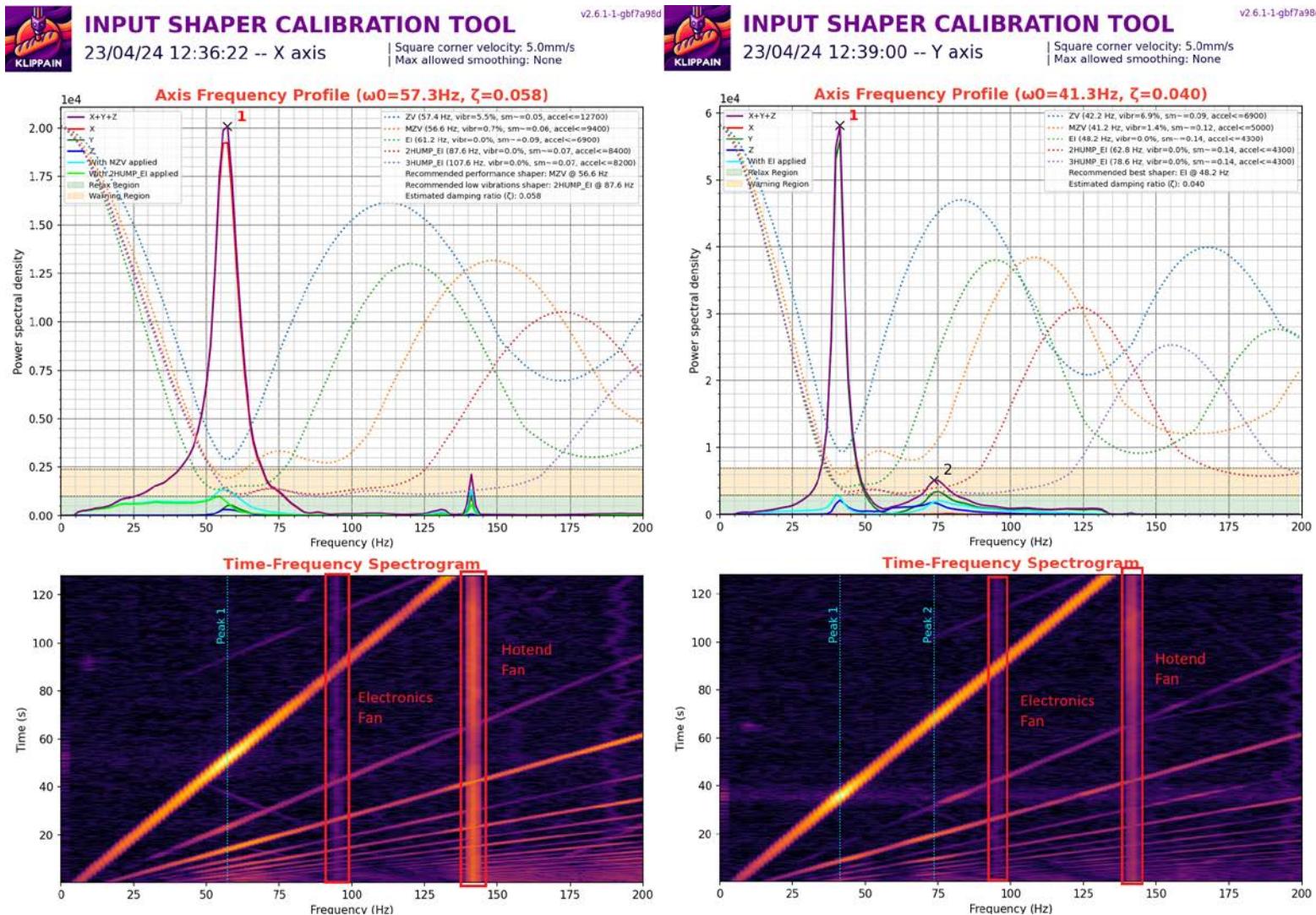
Ioannis\_gi V2.6589  
Used: Raise It Isolation  
Feet for Speaker  
Vibration/Ventilation

As additional vibration  
damper



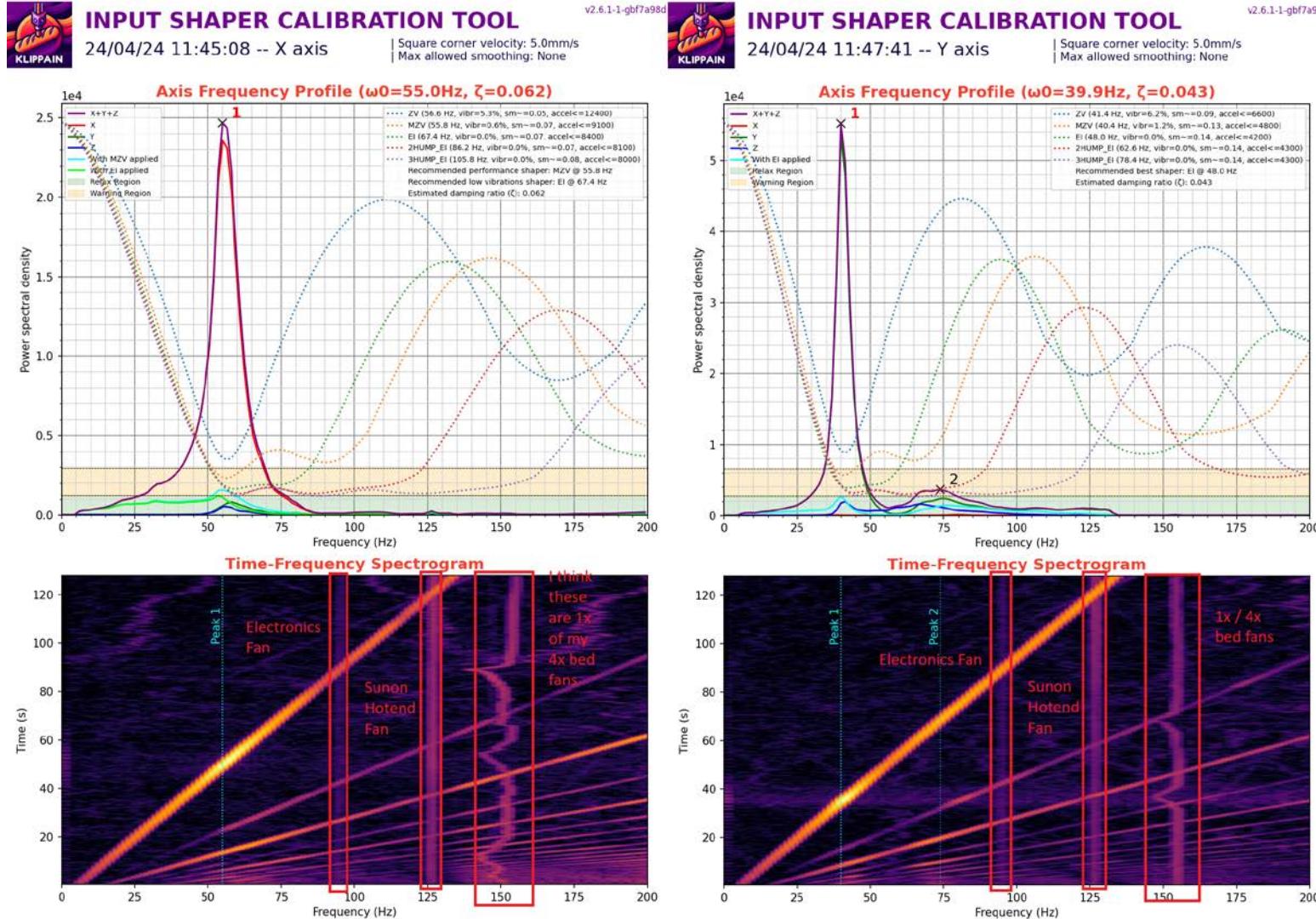
# Fans effects on graphs

by Nick|VS|V0|V2



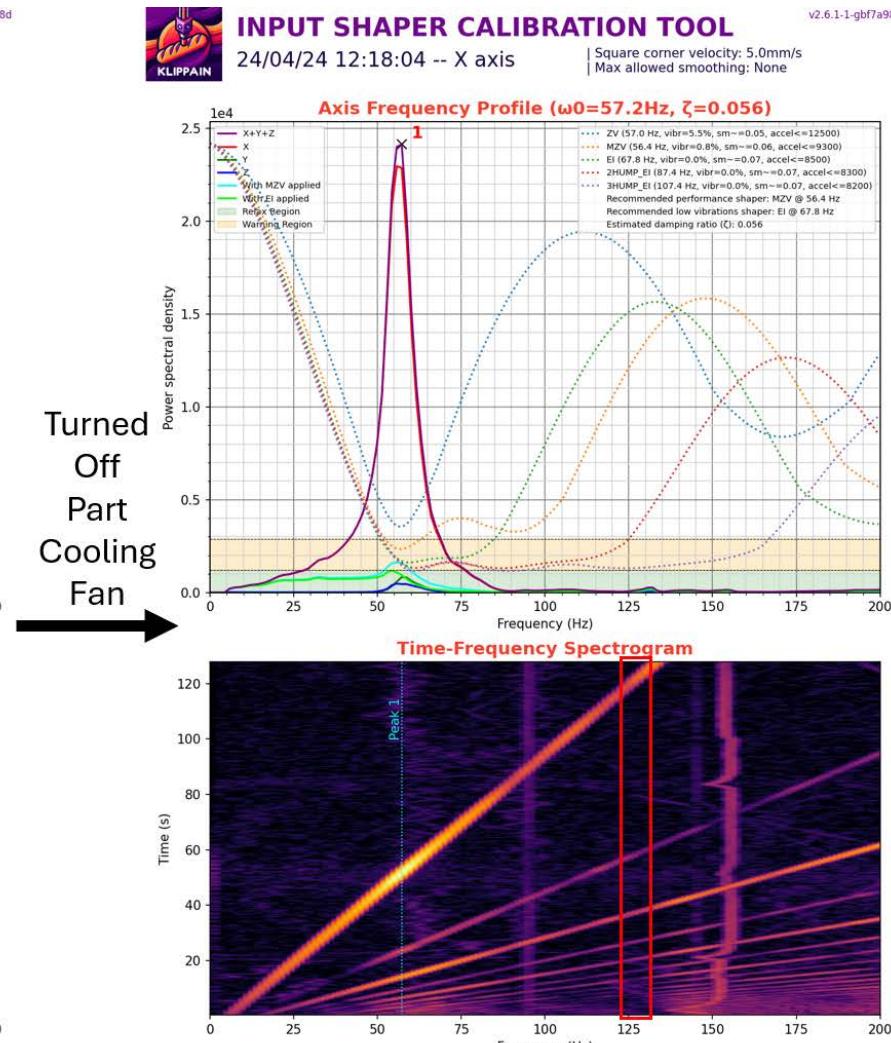
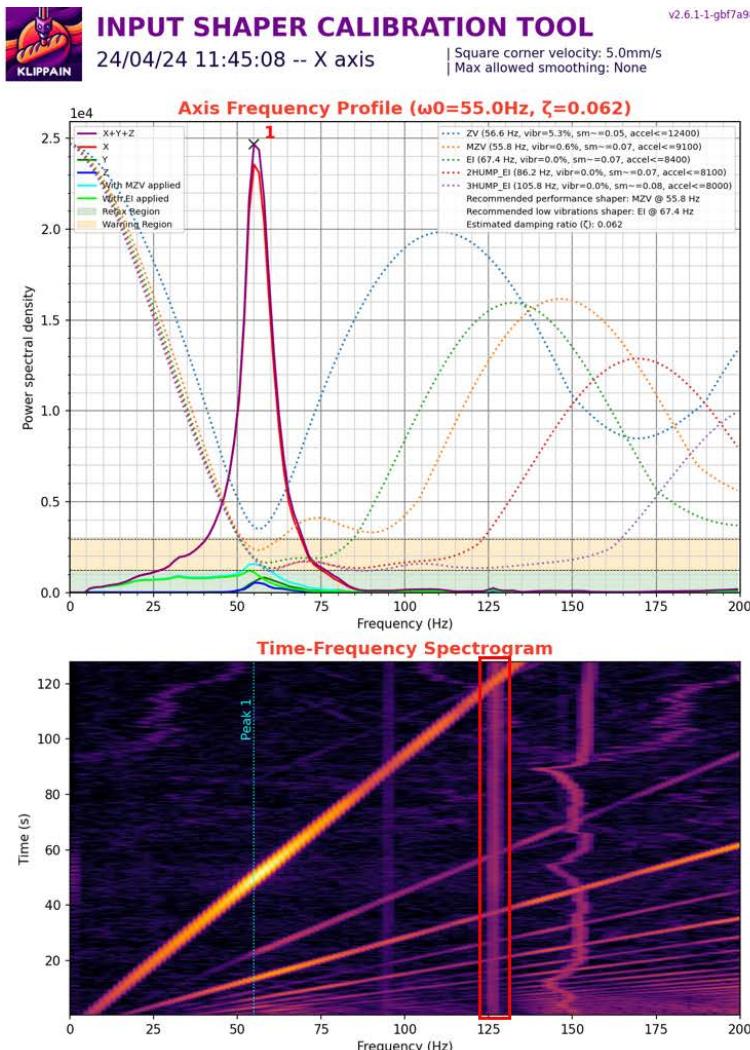
# Fans effects on graphs

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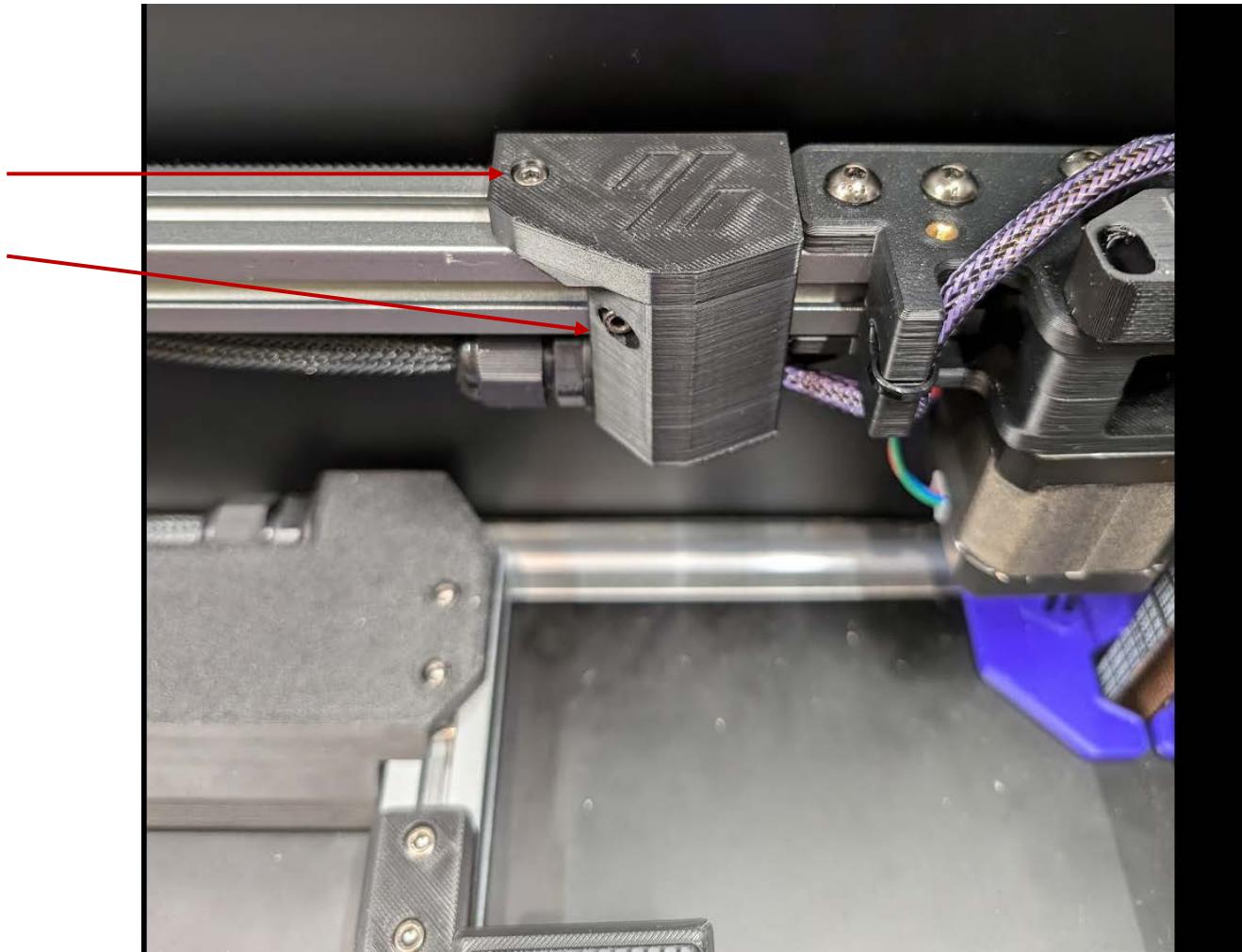
# Fans effects on graphs

by Nick|VS|V0|V2



# Loose Z-mod screw (or missing screw)

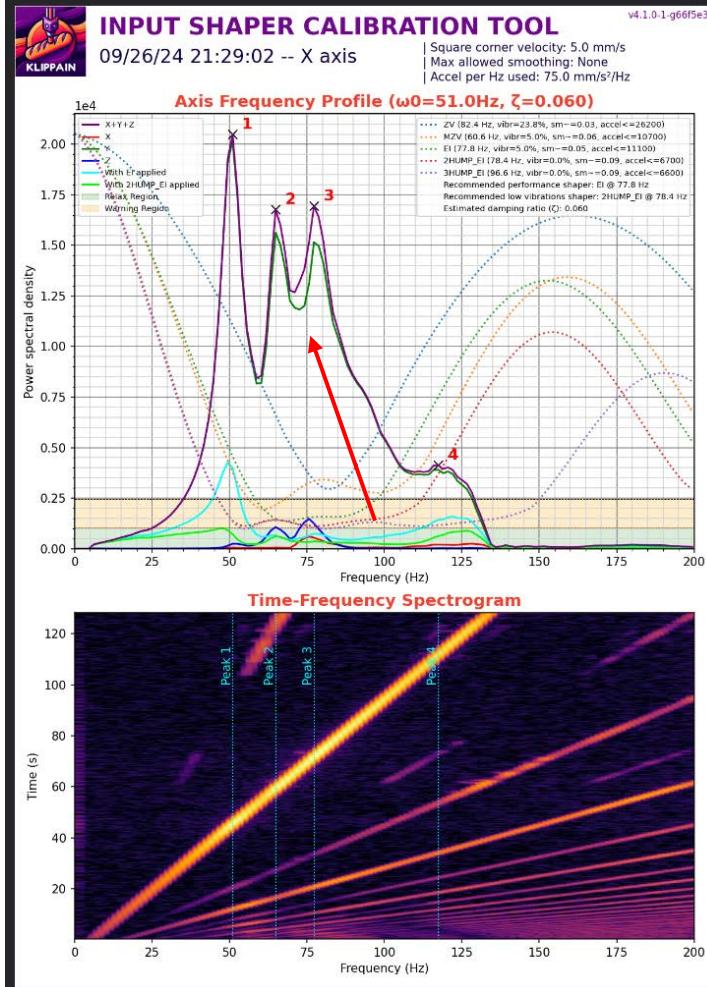
by Maverick



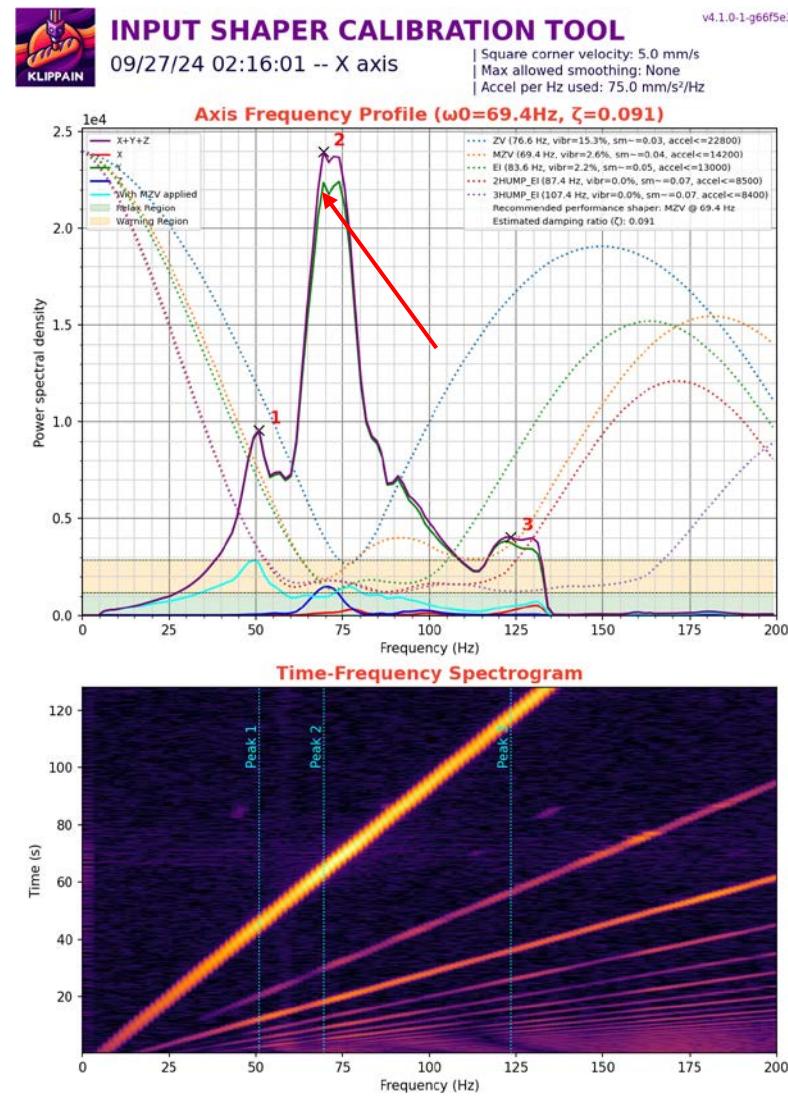
# Loose Z-mod screw (missing screw)

by Maverick

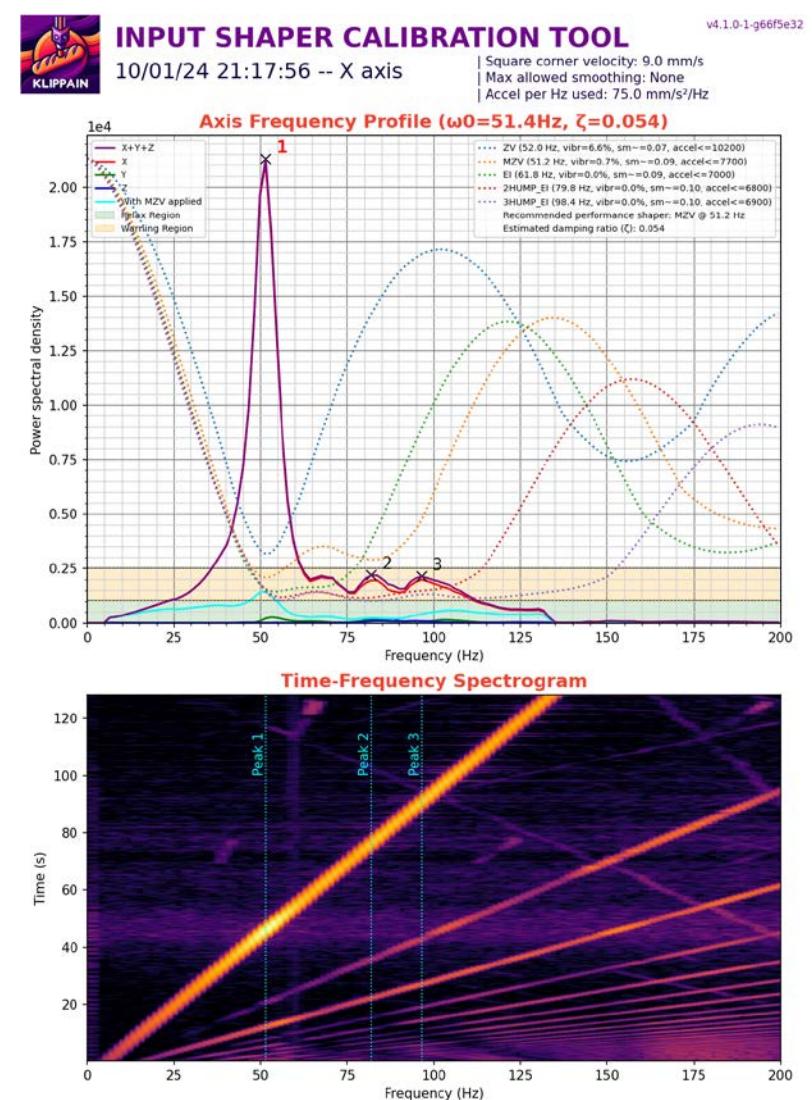
Before



Before

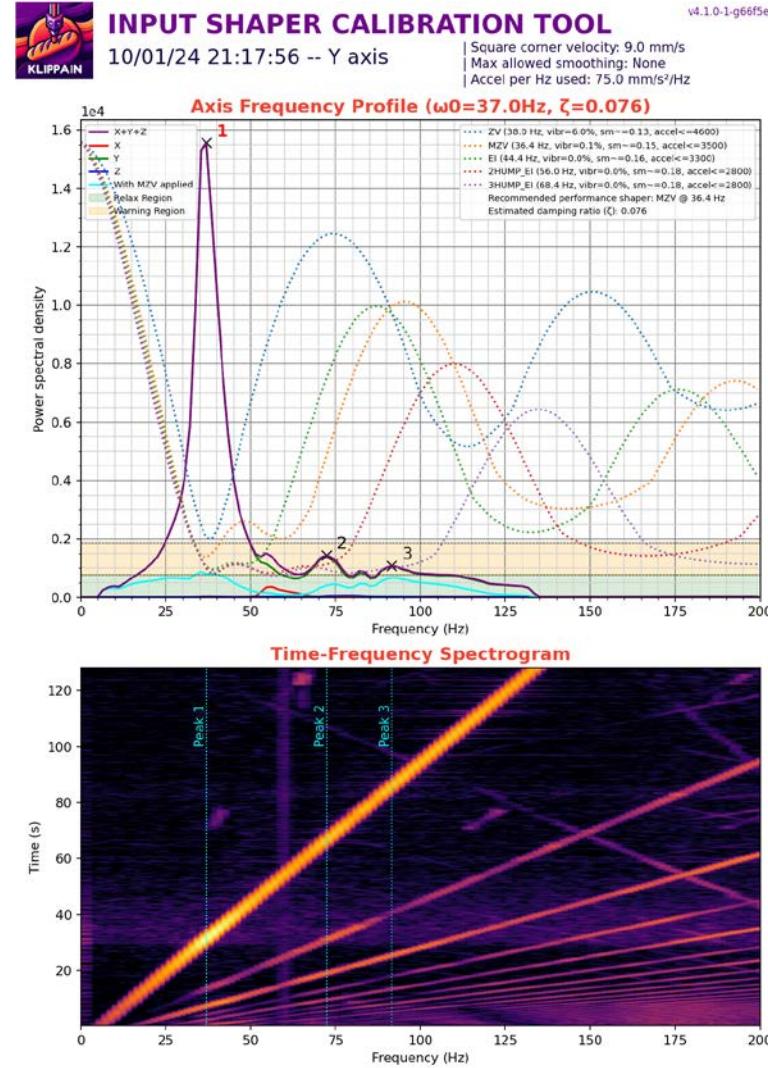
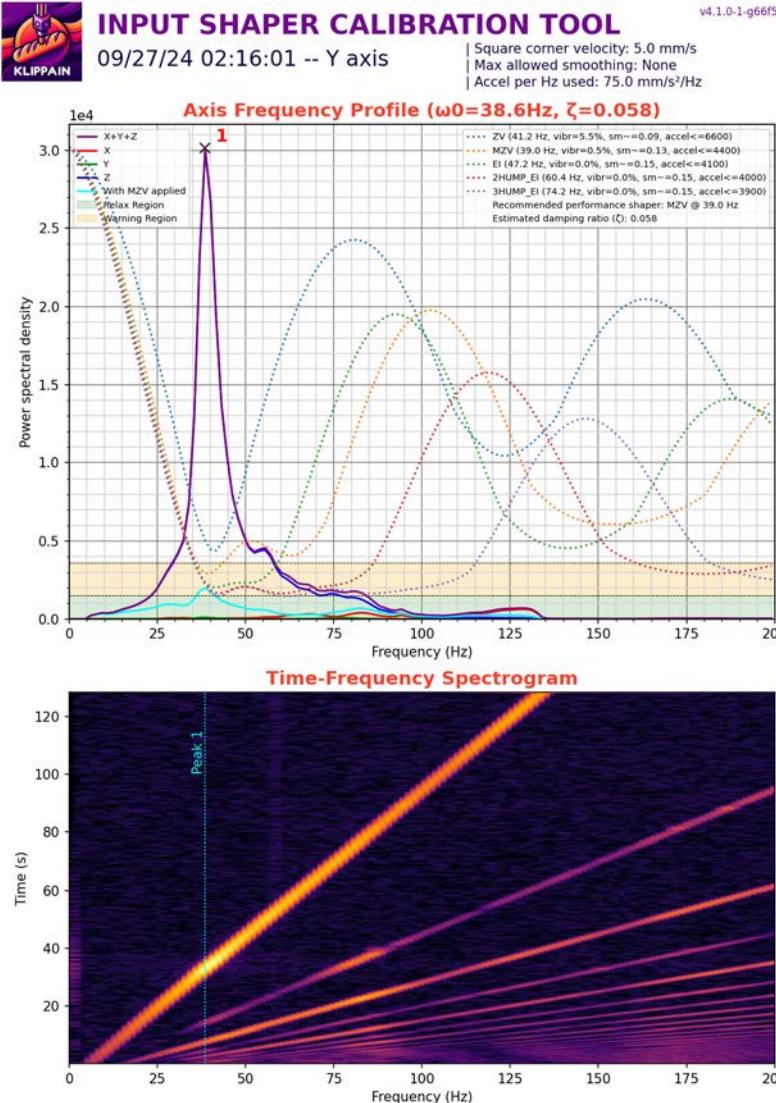


After



# Loose Z-mod screw (missing screw)

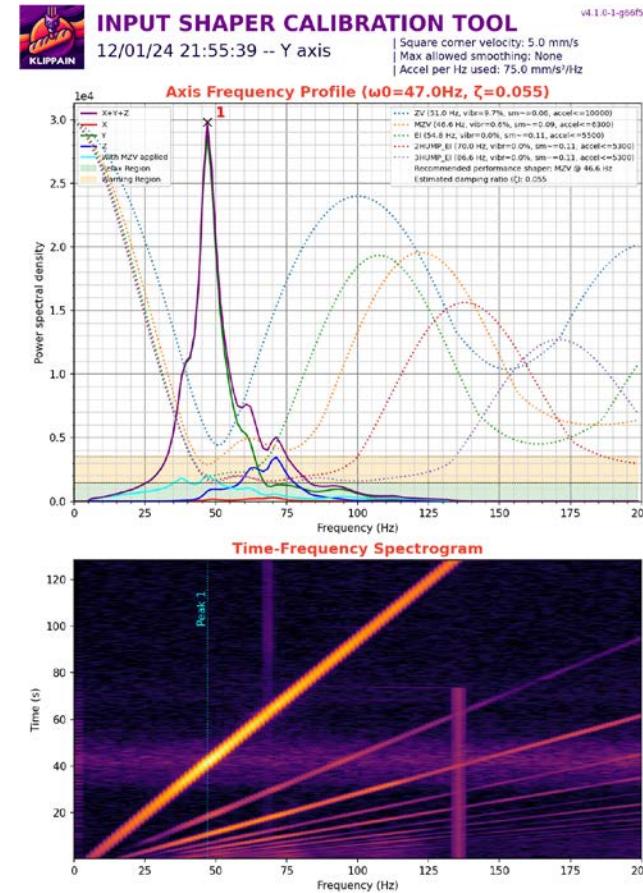
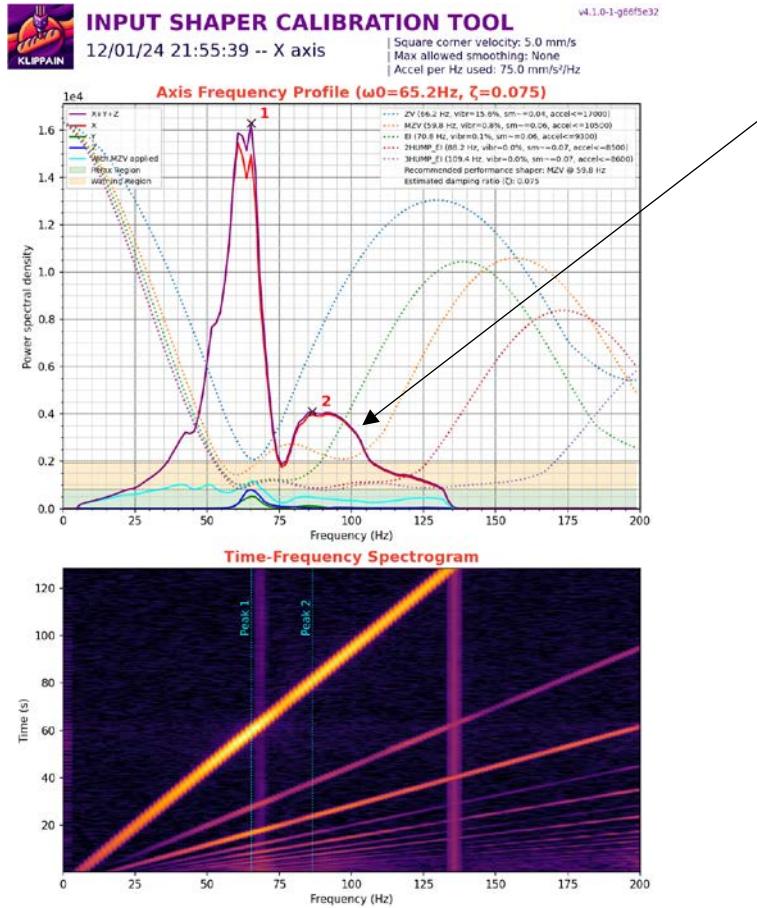
by Maverick



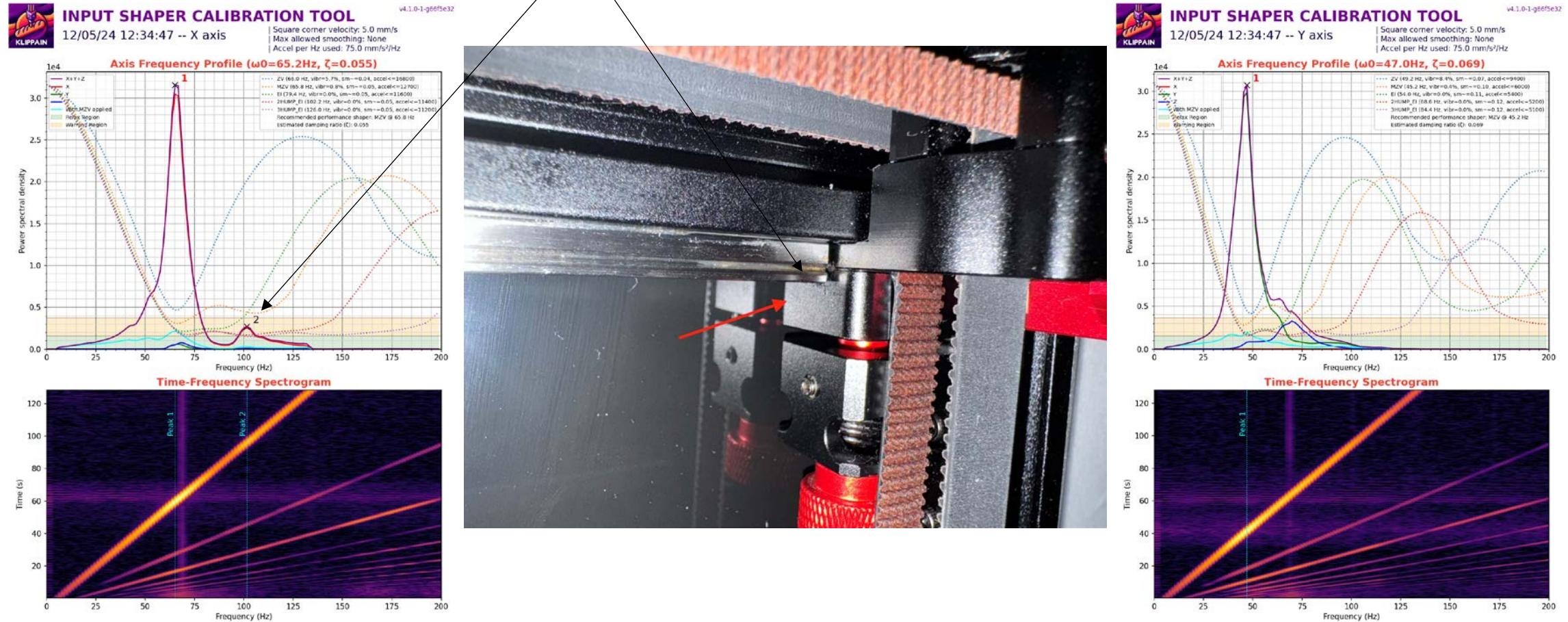
Before

After

# Loose Z-gantry screw (Igiannakas)



# Loose Z-gantry screw (Igiannakas)



# Loose Z-gantry screw (Igiannakas)

## Troubleshooting

### **1. Replaced belt and toothed idlers on the gantry last night.**

I was kind of hoping this would have fixed it, but nope! Absolutely 0 change. Maybe even ever so slightly worse due to the belts not being run in yet. You can imagine my face when i saw those results... (results removed they were not improved)

### **2. Then last night and until 2 in the morning I went down a rabbit hole**

Removed the extruder, replaced its X carriage mount with a new one just in case the old one was worn and was vibrating. Replaced the revo mount with a new one too. Again, absolutely no change whatsoever.

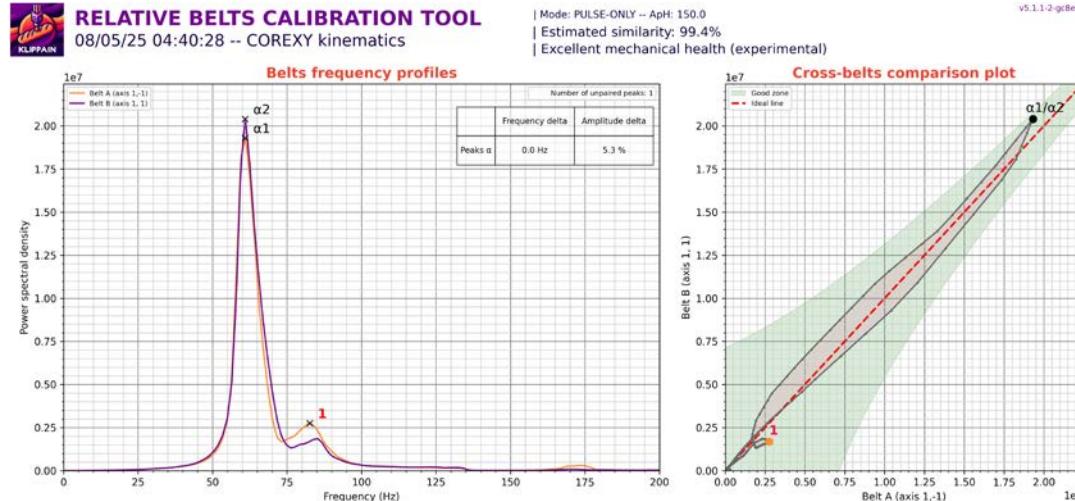
### **3. This morning I decided to re-inspect the motion system.**

I was battling slightly off belt tension with the new belts and thought I had not cut them to exact same size. But that was not the case. I took apart the panels, re-squared the gantry and validated with my machinists square. Then when I was inspecting the Z pins for alignment I noticed that the **bottom belt clamp was not tight on any of the 4 corners.**

# Toolhead screws hitting x-linear rail carriage (MxBnrr)

- During Input Shaping calibration after rebuilding the gantry and toolhead, notice the X-axis graph had an abnormally low PSD value and sporadic graph image.
- Since the low PSD was occurring only in the X-axis, possible causes would have to be potentially exclusive to that axis.
- General visual inspection showed that all belts, gears, and pulleys were properly aligned.
- Tactile investigation found the toolhead being slightly more difficult to move by hand along the X-axis compared to the Y-axis.
- Detailed visual inspection of the toolhead (Dragon Burner) found that the front-facing cowl-to-carriage mount screws were extending through the mount and contacting the rail carriage.
- The screws in use at that time were M3x40mm; they were then changed to M3x35mm.
- No other changes were performed. Hand movement of the toolhead verified equal effort in both X and Y axes, and input Shaper calibration was re-run with drastically improved results.
- Conclusion: the incorrectly sized screws (my own fault) were pinching the X-axis rail carriage and causing slight binding in only that axis.

# Toolhead screws hitting x-linear rail carriage (MxBnrr)

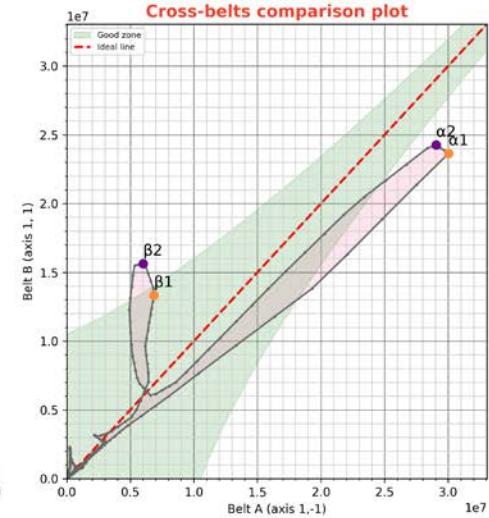
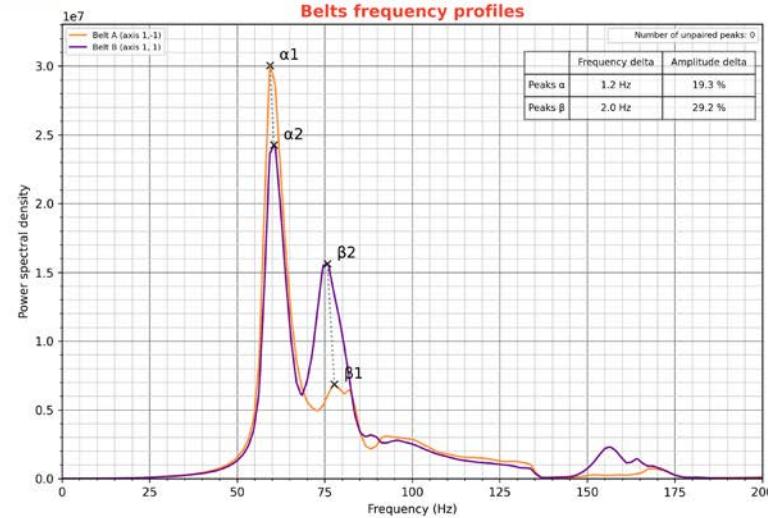


Before

After



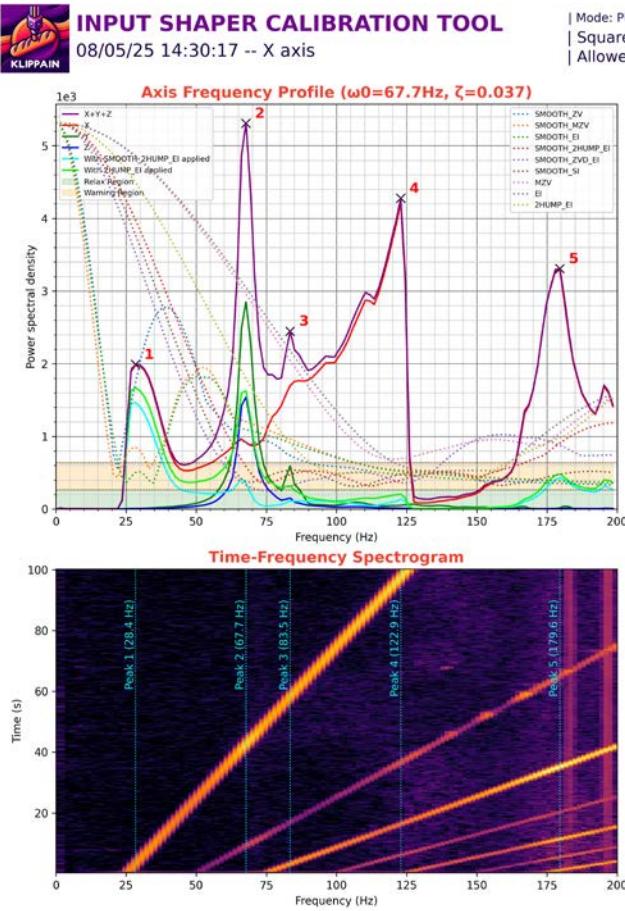
| Mode: PULSE-ONLY -- ApH: 150.0  
| Estimated similarity: 91.9%  
| Excellent mechanical health (experimental)



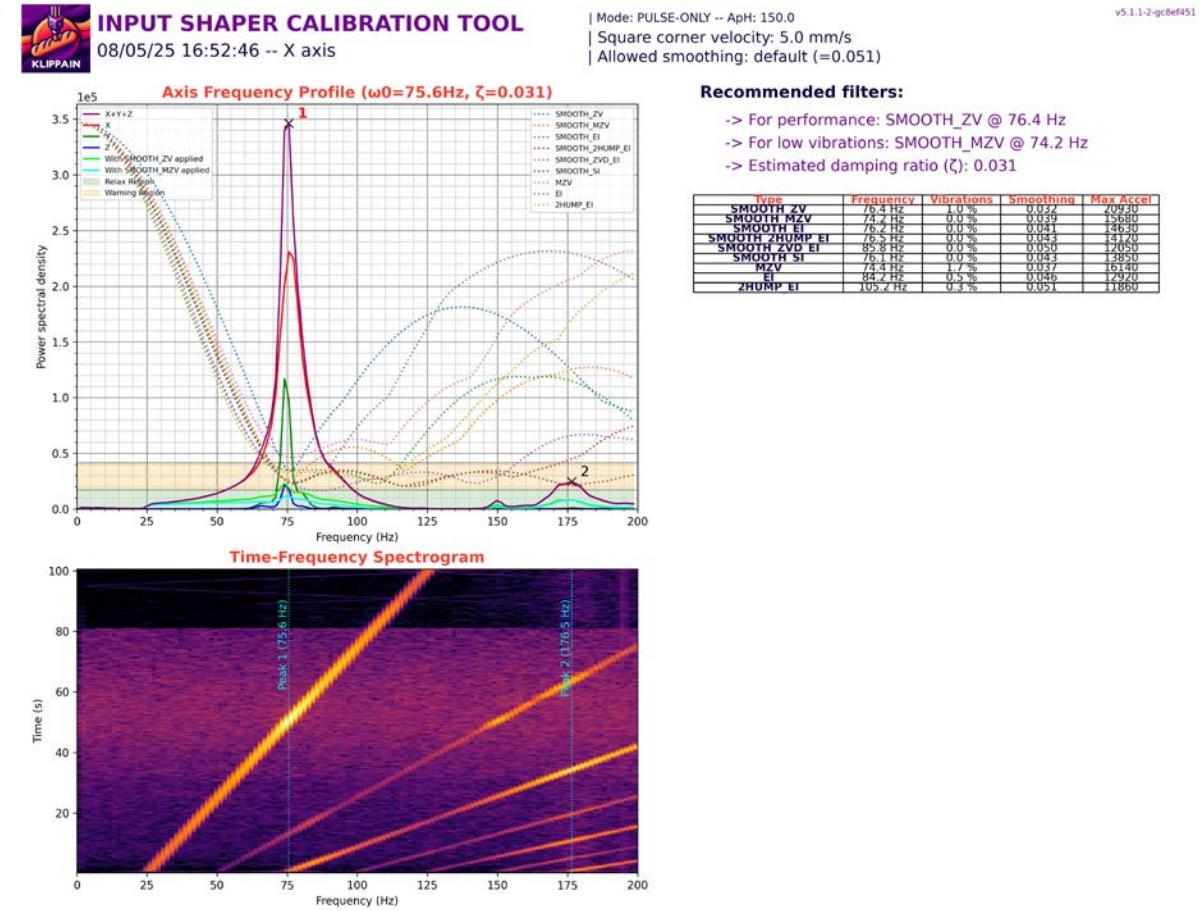
Note: The belts are not showing an issue.  
This is likely due to the fact that the belts test acts upon both the x and y axis (diagonal moves)

# Toolhead screws hitting x-linear rail carriage (MxBnrr)

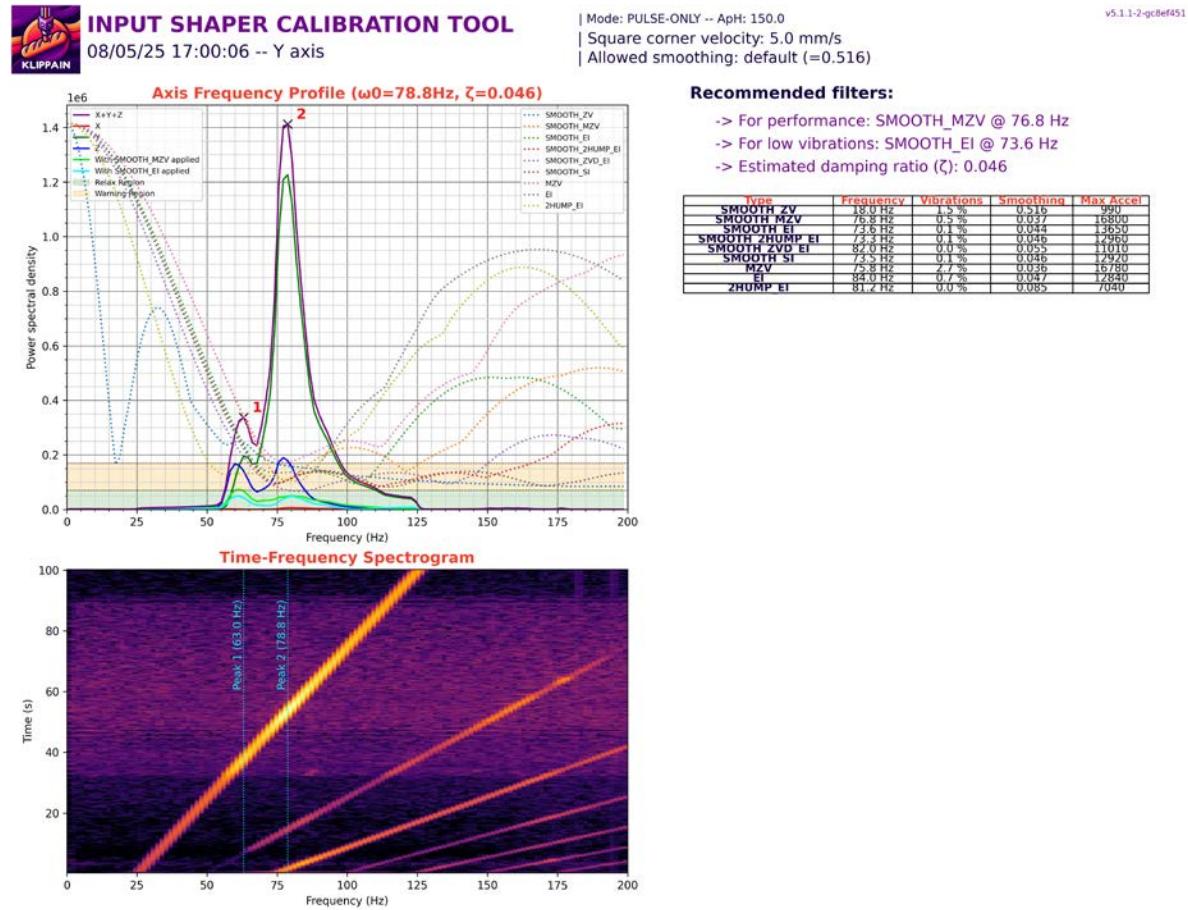
Before replacing screws



After replacing screws



# Toolhead screws hitting x-linear rail carriage (MxBnrr)

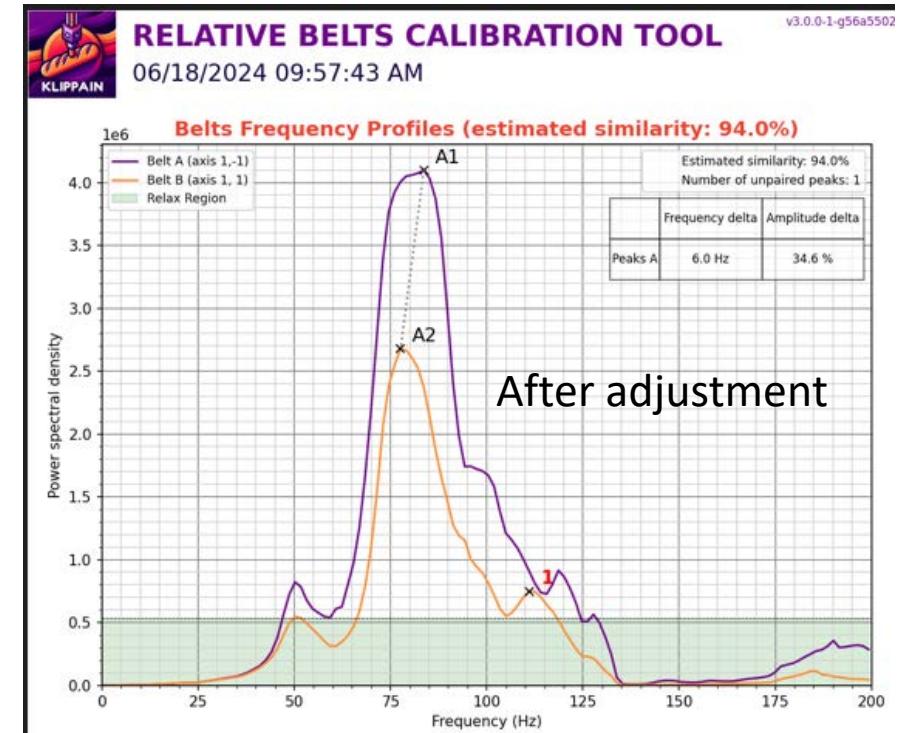
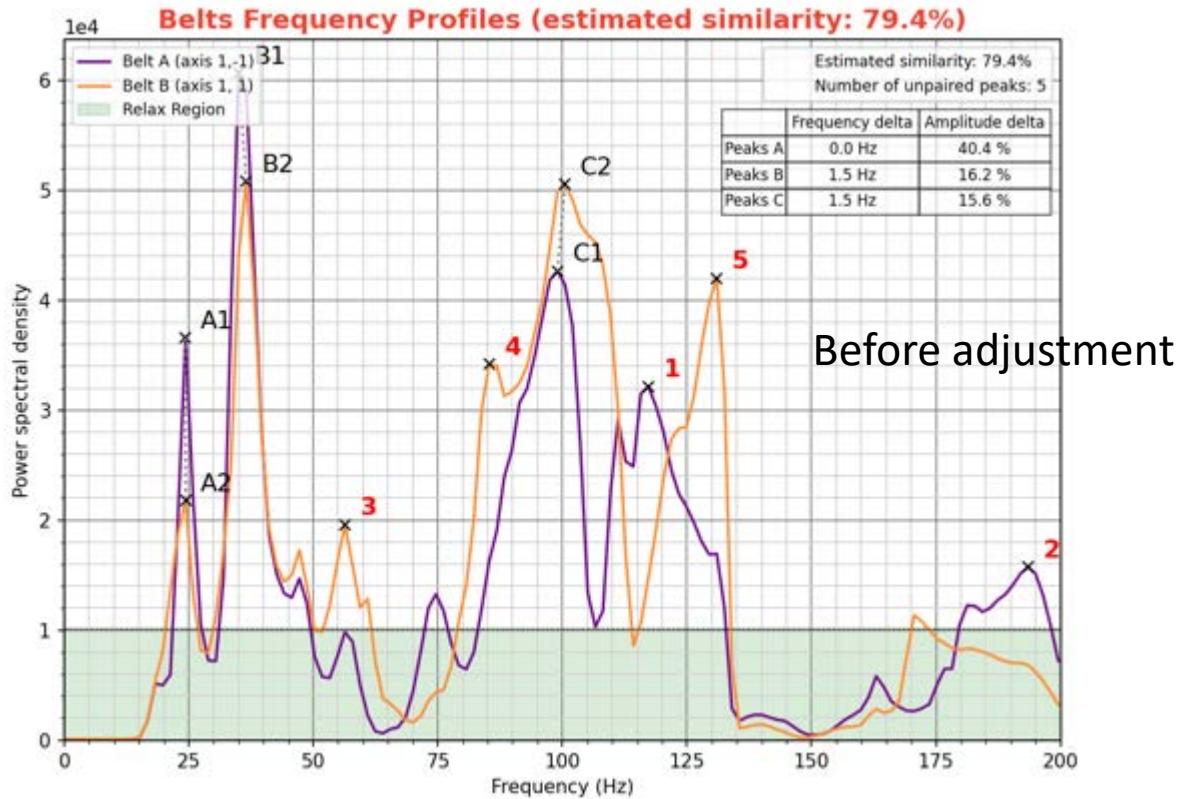


Y-axis after, before it  
looked very similar

# StealthChanger - specific

- Thank you to all the folks at Draft Shift Design (DSD) for their help in bringing this to the communities attention.
- Thank you

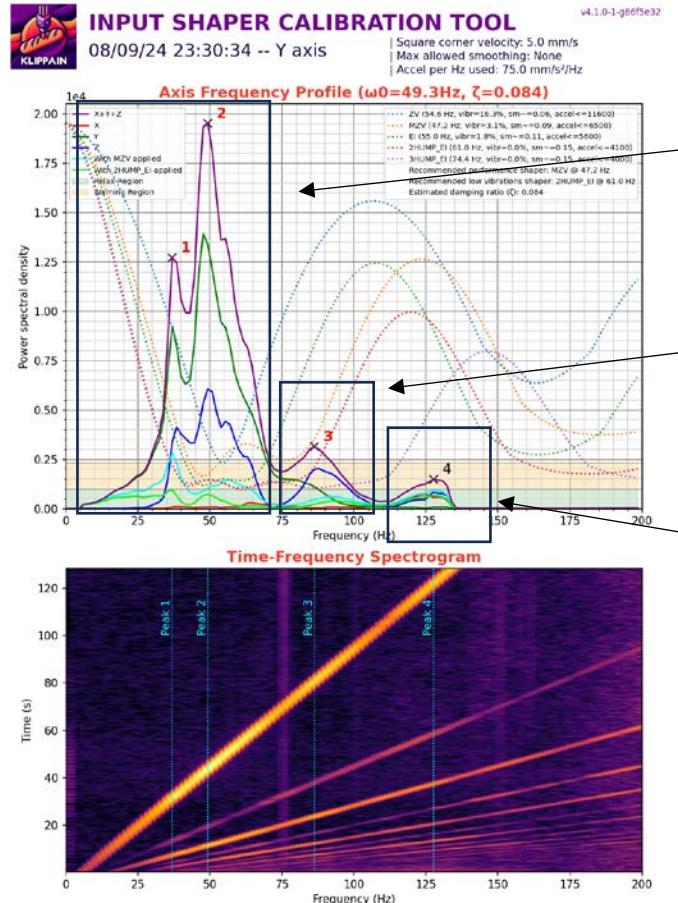
# StealthChanger – Tap Screws



Data by B\*ttSlark:

belts show issue with the tap preload screws (screws connected to tap magnets)  
Use the paper test to adjust preload screws to correct length

# StealthChanger – specific issues

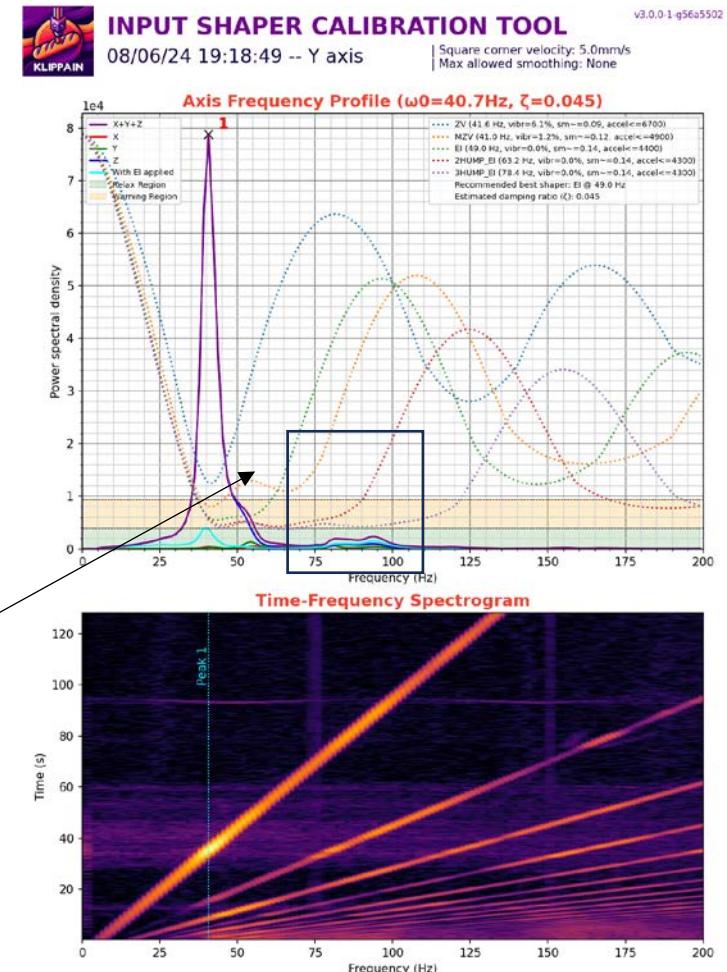


Optional junk you may or may not see with issues with the preload screws

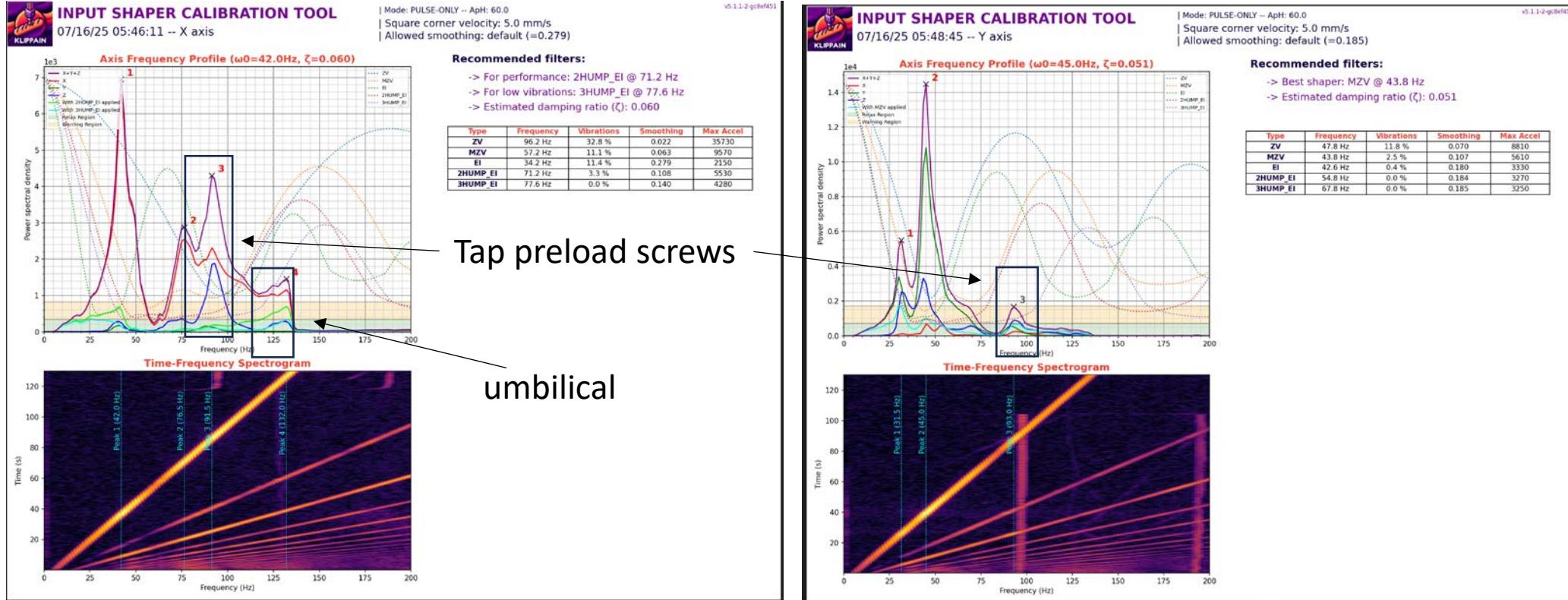
Stealthchanger tap preload screws  
(attach to tap magnets)

Mainly the umbilical

Stealthchanger tap preload screws  
This is tiny and probably should not worry about it



# StealthChanger – specific issues



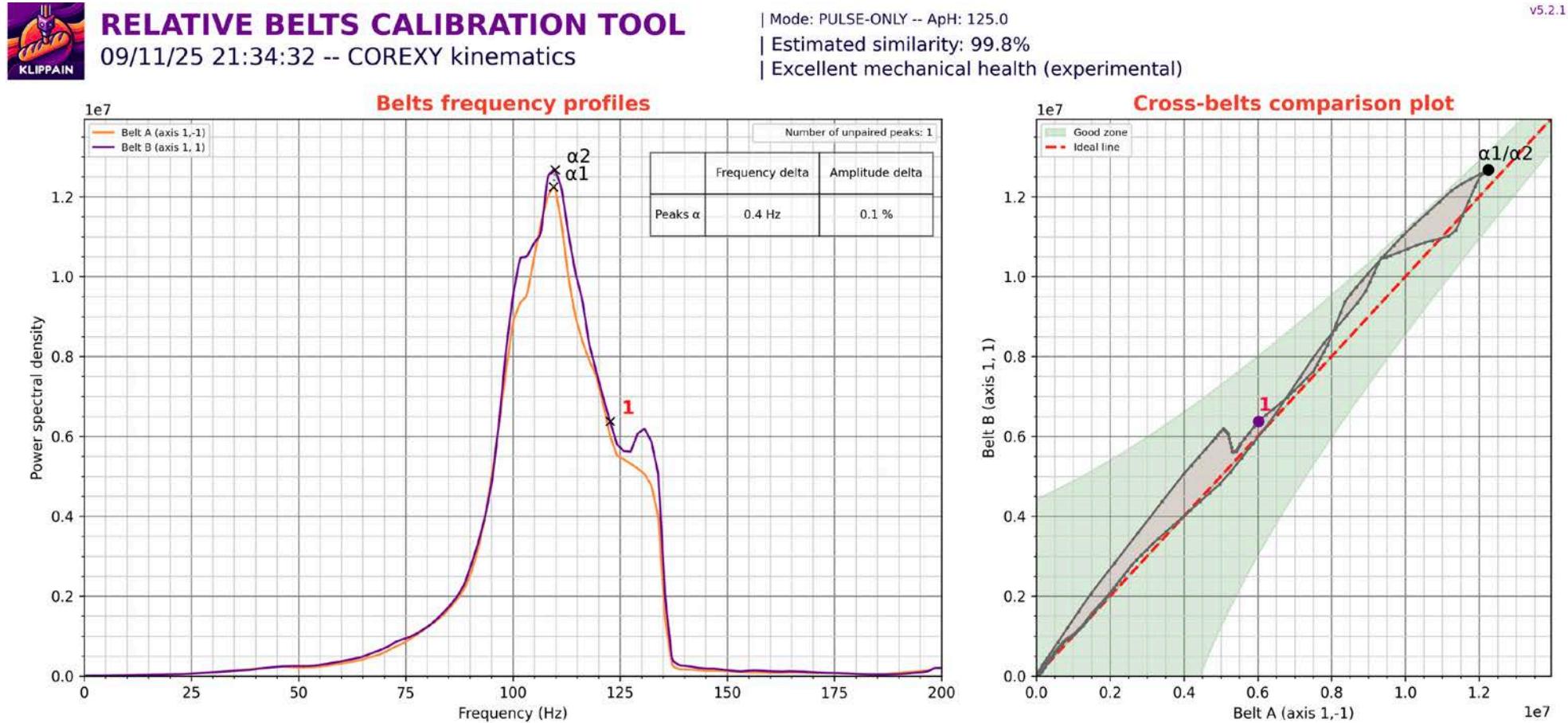
The rest of the junk on the graph is likely/probably due to the tap preload screws not be secured enough to the tap magnets

# AWD

Jango's AWD Trident  
Doom Frame  
mjolnir toolhead

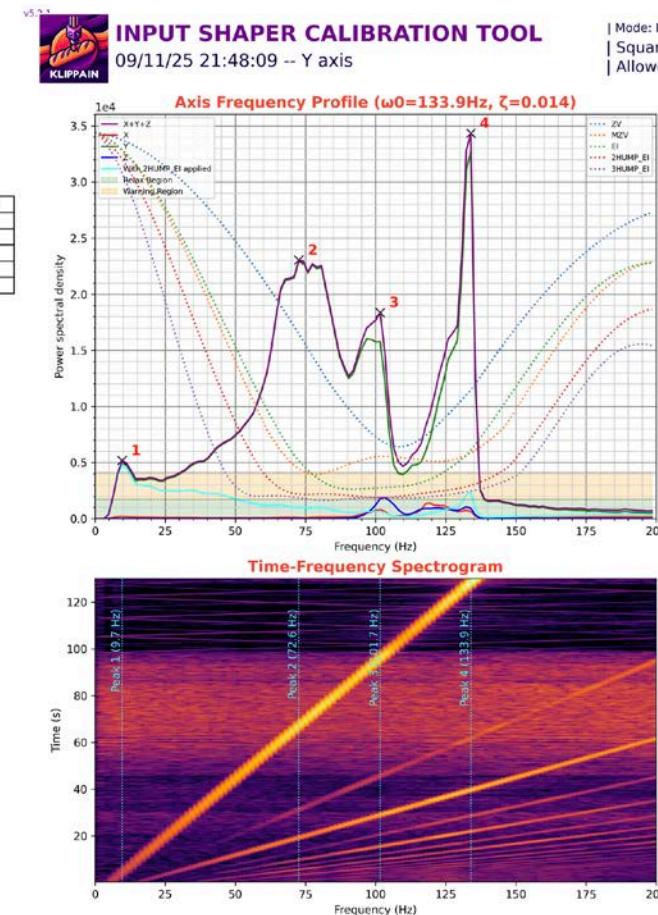
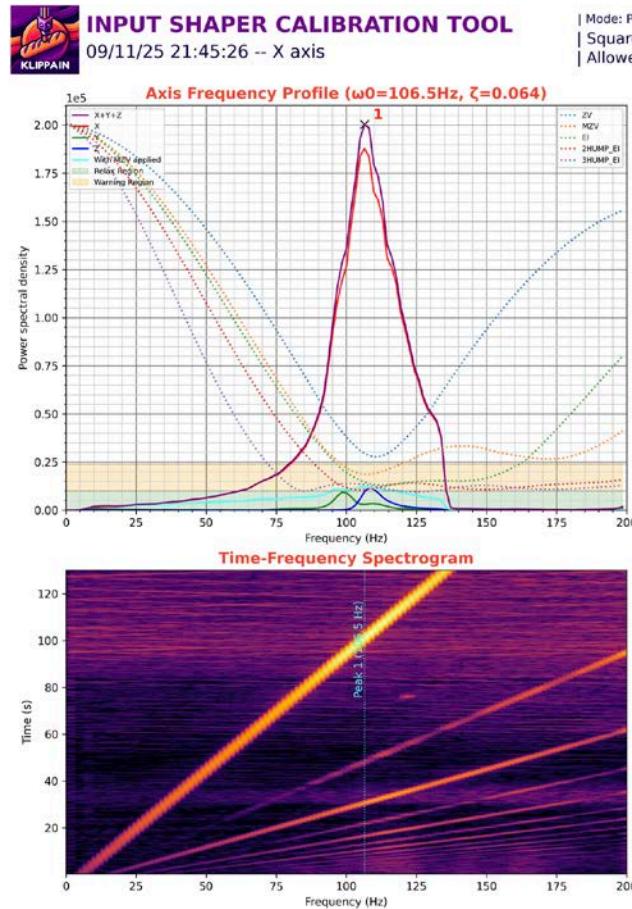


# Belts – look good

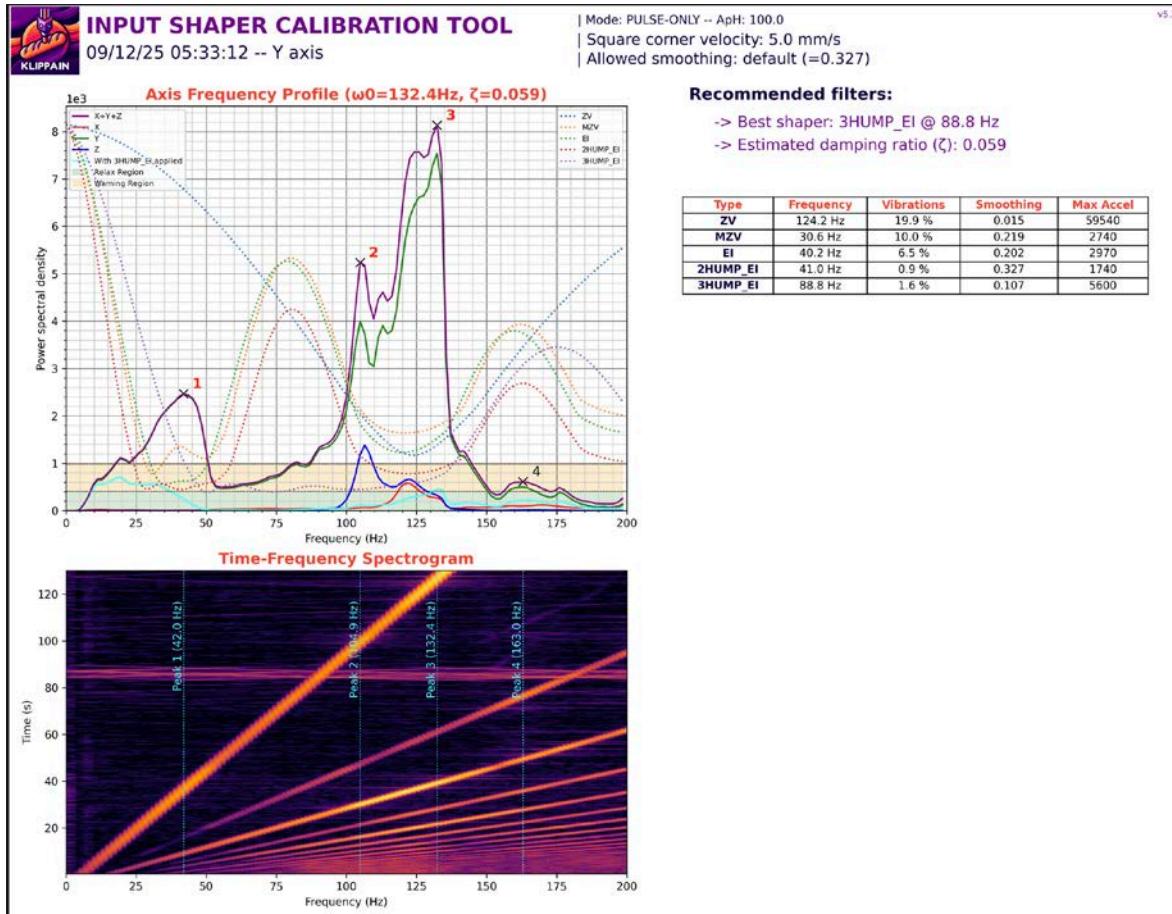


# Input Shaper –

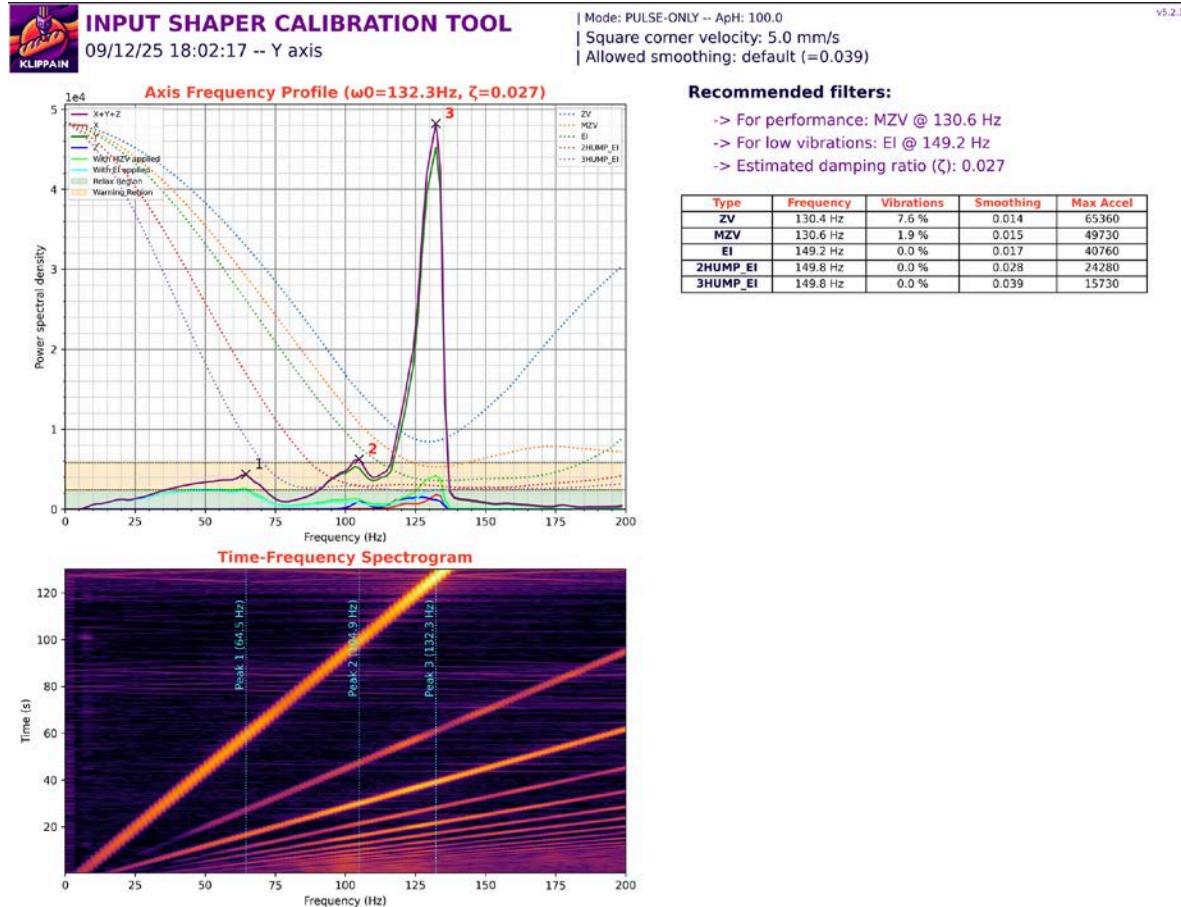
x looks good, y is messed up



# Input shaper – after tightening belts



# Input Shaper – y axis fixed



## Troubleshooting performed

- Loosened all screws for motor mounts to frame (not motors themselves).
- Loosened screws for Y axis extrusions.,
- Loosened screws for rear gantry support extrusion (the top of the rear z rail extrusion part.),
- Moved the toolhead around using the steppers to cause some vibrations in an attempt to cause a natural alignment with the belts at tension.,
- Squared off the rear motor mounts and tightened them starting with one screw on bottom, then one on top, alternating back and forth.,
- More moving the toolhead.,
- Started to tighten up the front motor mounts to the Y extrusion.,
- Tightened Y axis back to frame, measuring distance from upper extrusion to the top of the Y extrusion, making sure they're +/- 0.05mm.,
- Tightened rear gantry support with the upper screws first, then the horizontal screws.