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]

Introduction

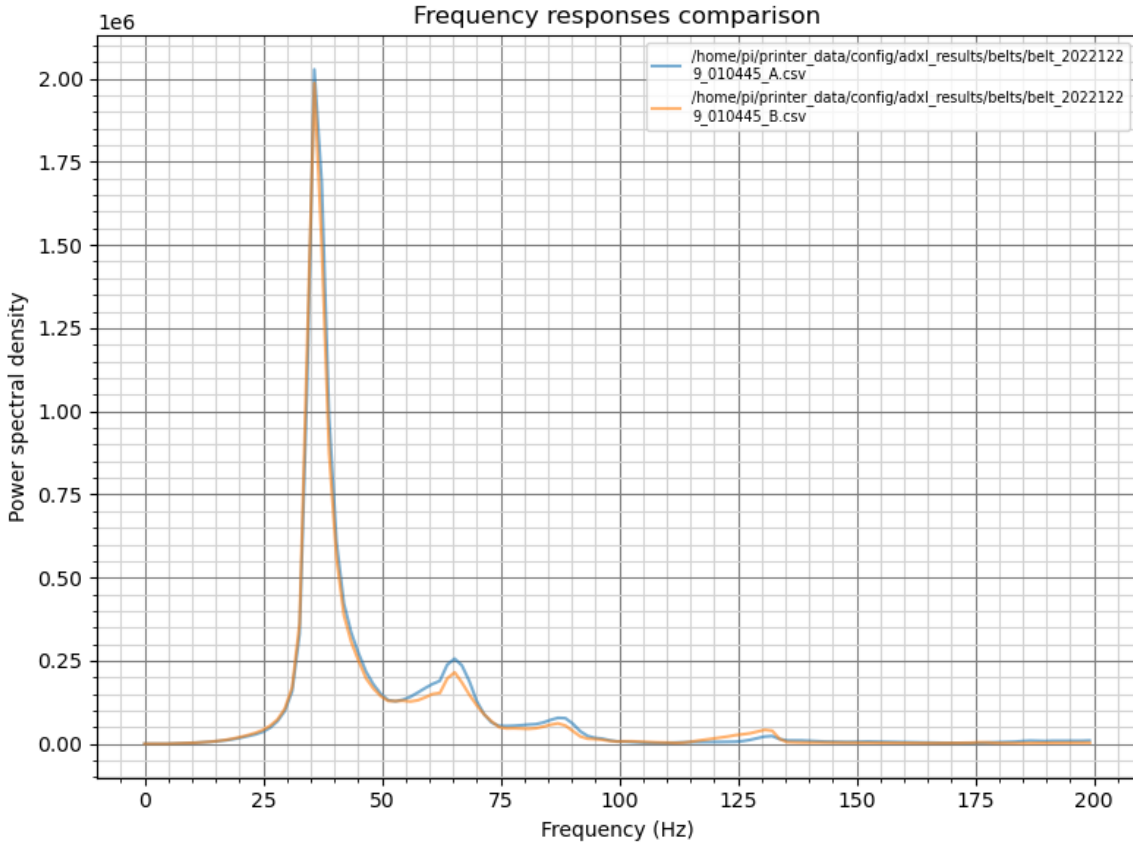
- The purpose of these slides are to present different belt shaper and input shaper graphs with some suggestions on how to go about diagnosing and fixing the issue.
- These graphs were taken from 3D Printers & a whiteboard and Frix_x with annotations provided for clarity.
- Interpretation of input shaper 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.

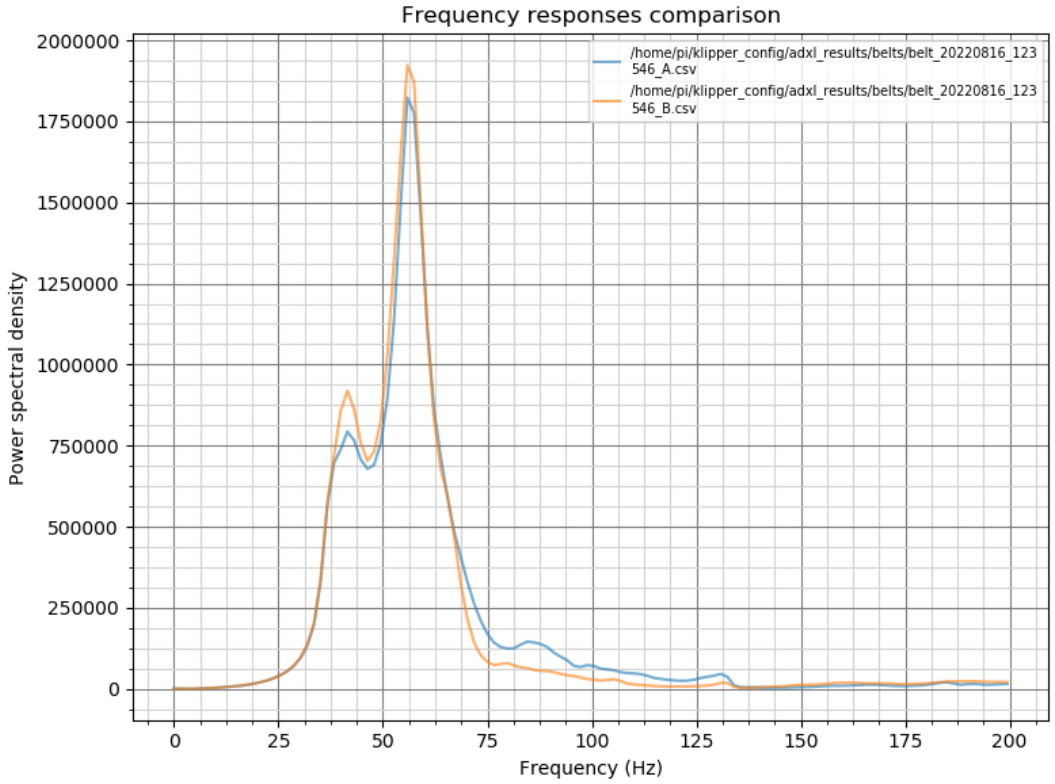
Common Issues

- 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 othe 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/ect. 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





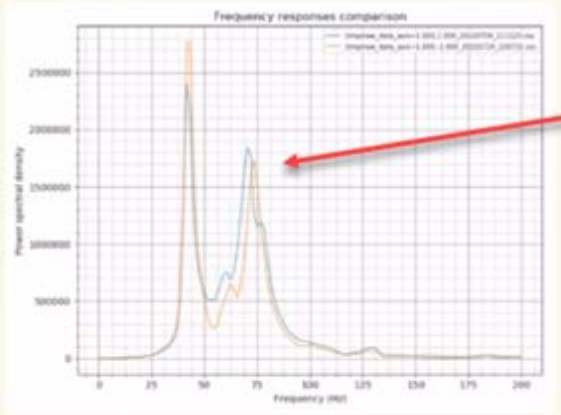
Belt Tension

Input Shaper Settings ✓

Absolute Belt Tension ✗

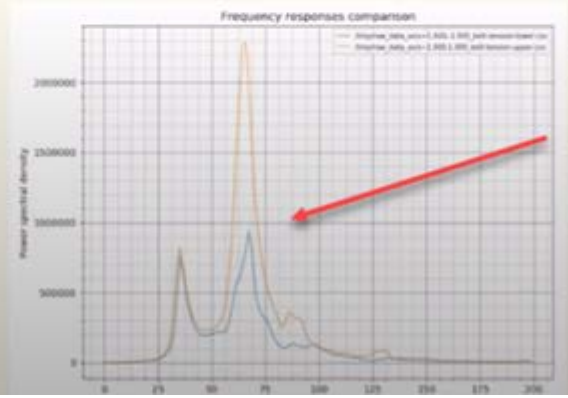
Relative Belt Tension ✓

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



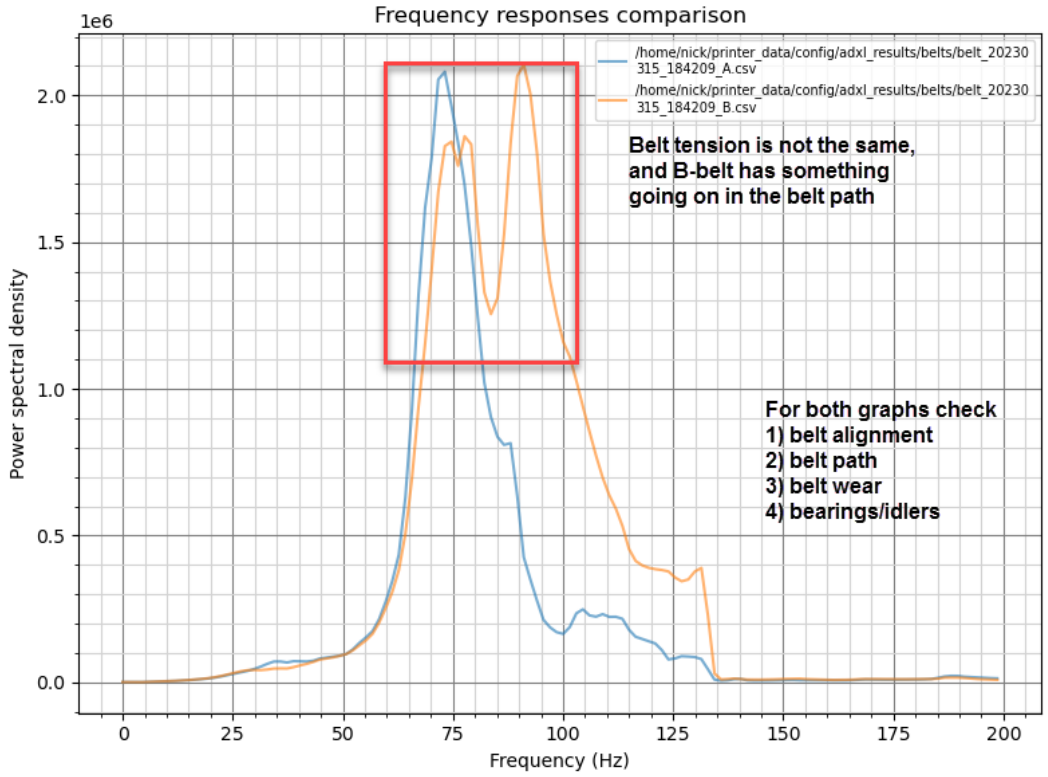
peaks not aligned

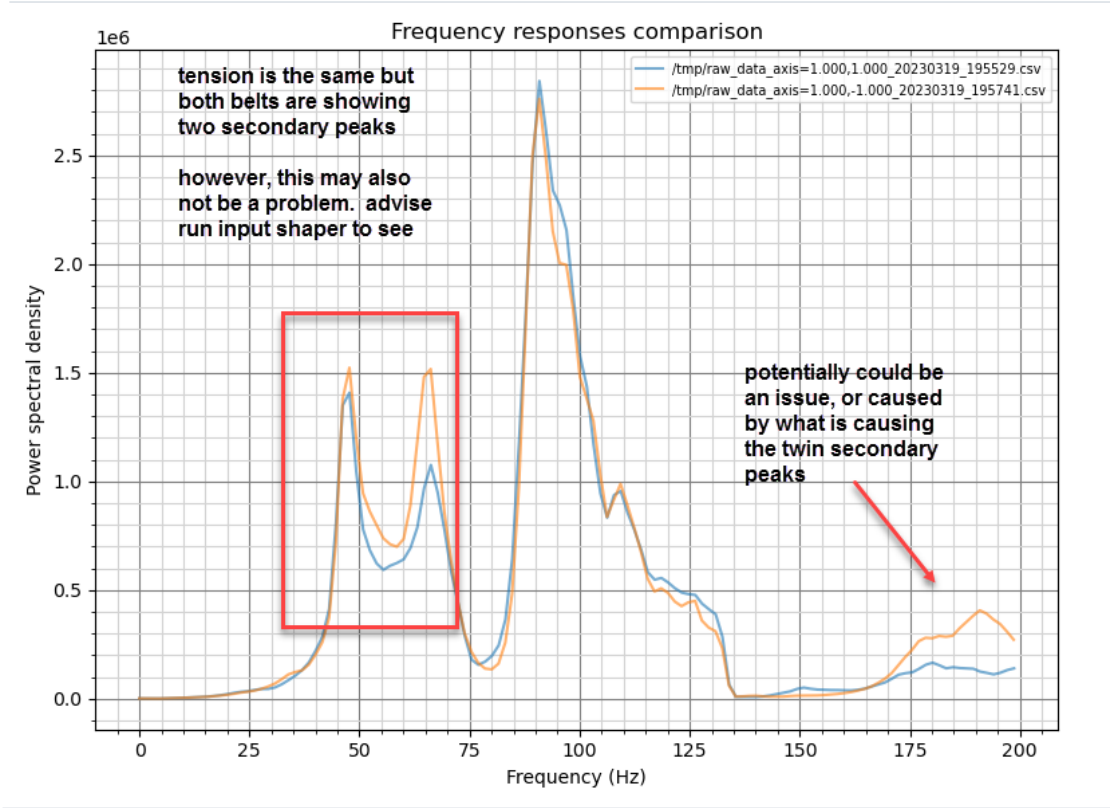
bad belt tension



Peaks are aligned, but amplitude is to 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

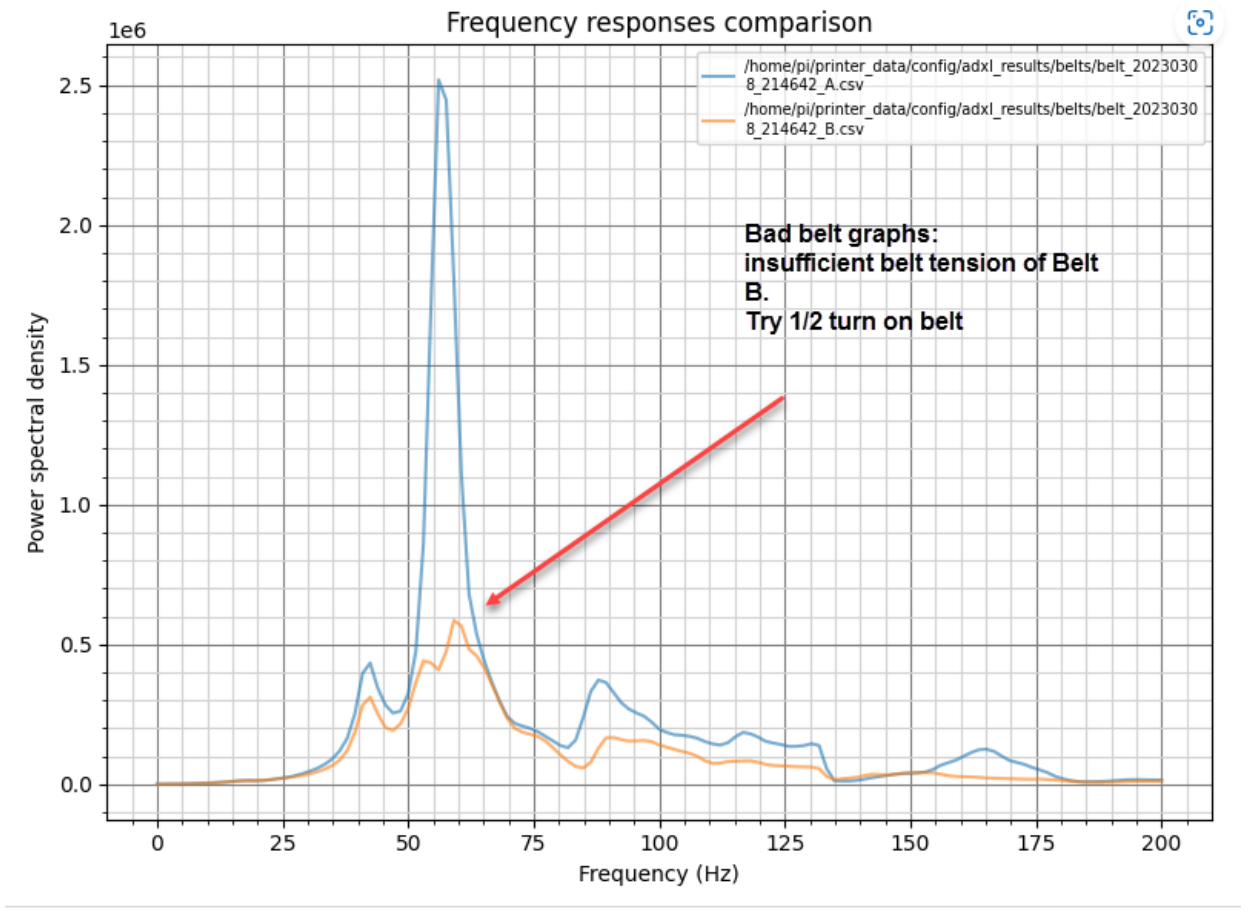
Belt Path problem





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



Input shaper

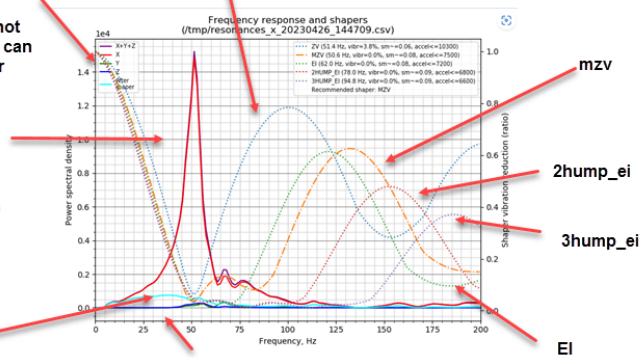
How to read input shaper graphs

your measured resonance in x, y, and z.
Here x, y, and z refers to the orientation of your adxl and not necessarily to the printers x, y, and z.
If the adxl's x,y,z do not match machines you can change this in klipper

purple is the combination of all axis (x,y,z)

Red is x.

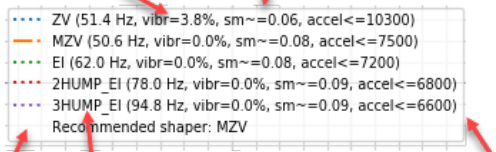
Ideally we want purple to mimic the axis of the shaper. This graph is x so purple (combination) show match red (x). This is because when we measure the x-axis we only want to see x-axis resonance. Does this always happen no.



With input shaper you get one or the other.
More vibrations and less smoothing, or less vibrations and more smoothing.
No free lunch here.

In order to compensate for resonance klipper will smooth the acceleration of the toolhead. This smoothing will be noticed in the print. The amount of smoothing is SM. you can see this if you print a benchy and the lettering on the back is unreadable. Input shaper has smoothed that out to remove resonance in the rest of the print

Calculated vibration on print if this shaper is used we want zero vibrations



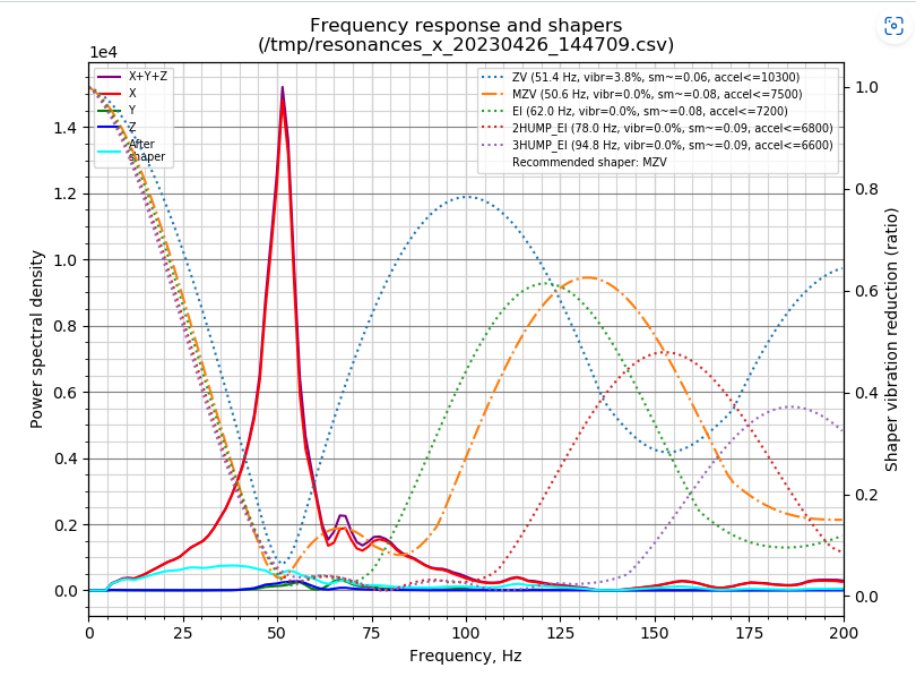
These represent the graphs of each of the input shapers

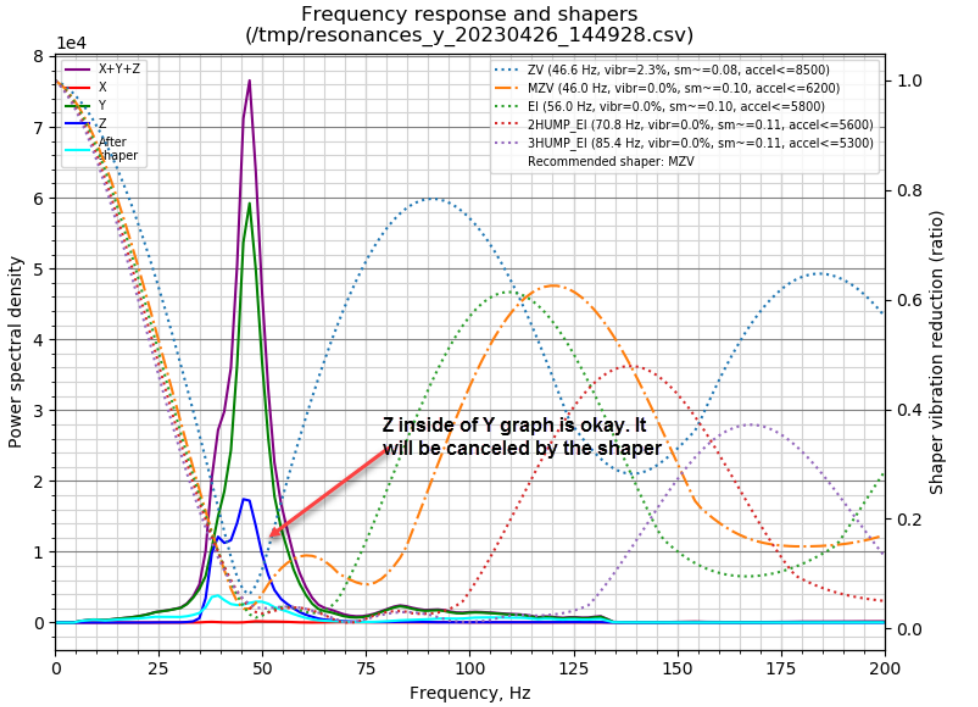
different input shapers

This is what Klipper thinks is best. On the graphs this is the blue lines

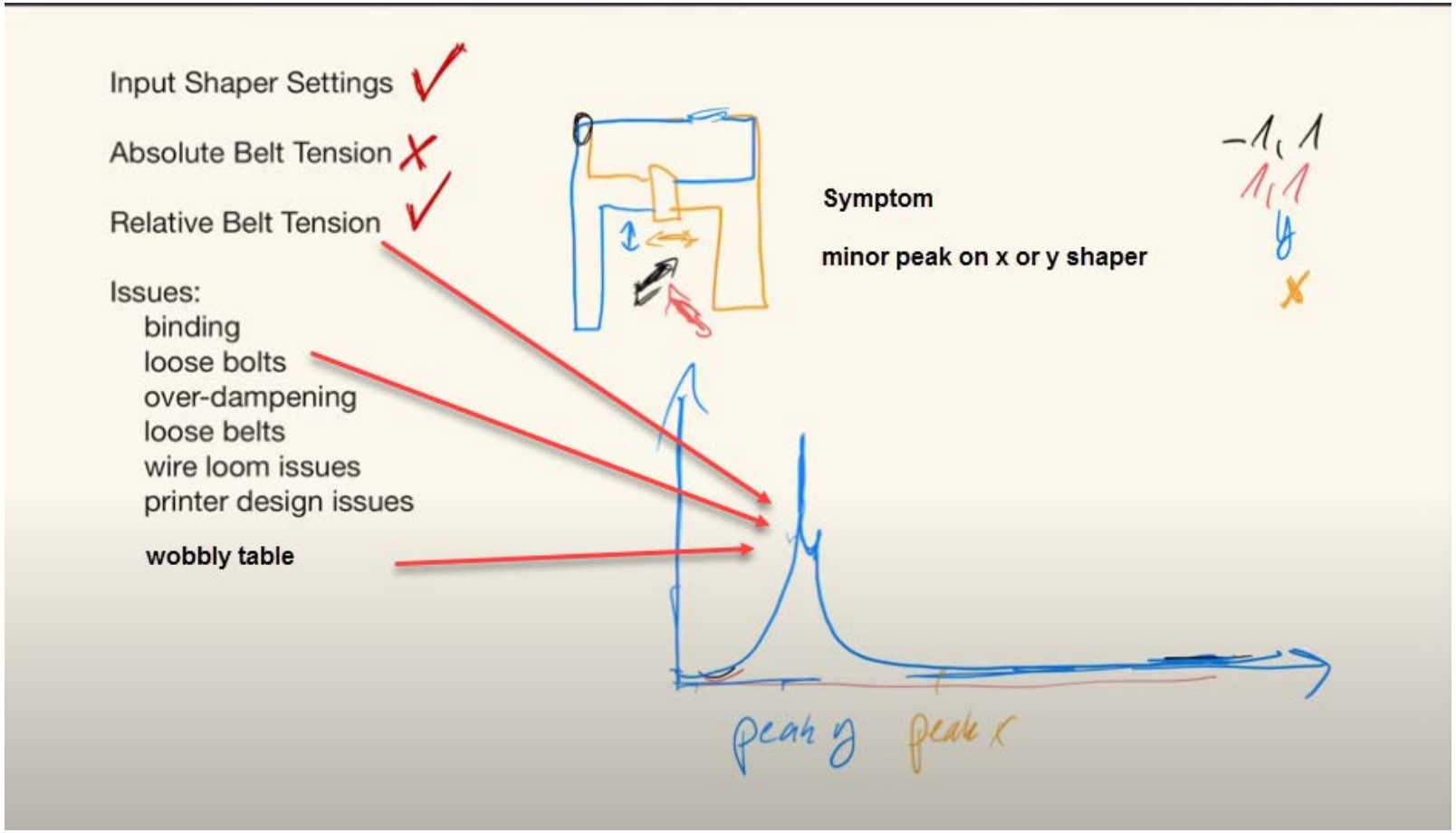
Recommended max acceleration.
Can treat this three ways.
1) set max acceleration in Klipper (printer.cfg) so no moves go faster than this.
2) set your perimeters (internal and external) to be alot less than this, while allowing infill and other non-visible print moves to be greater than this
3) do nothing, and accept that fact that you want to print fast, and a you aint's scared of not ghost[ing].

Good Graphs

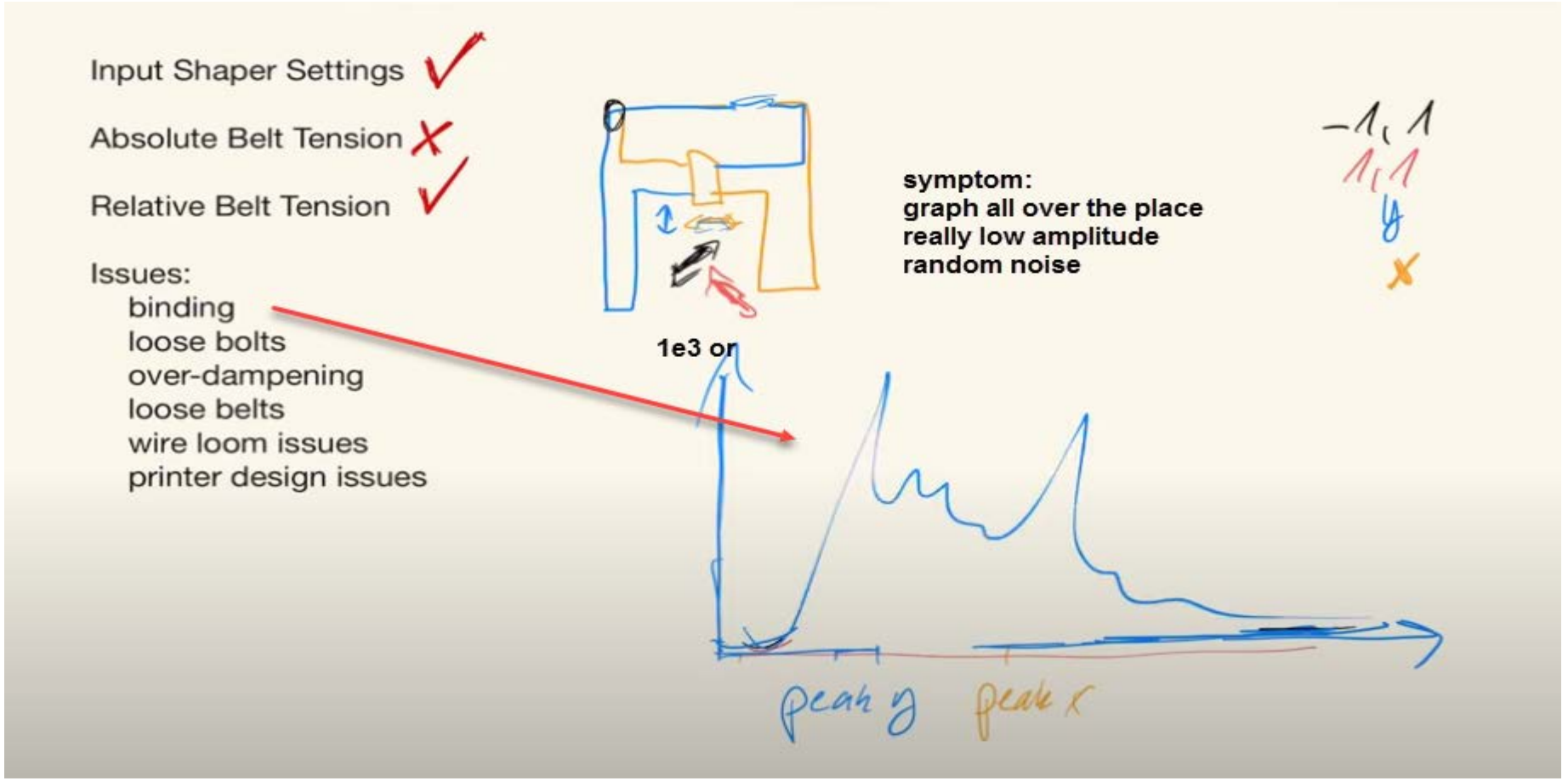

Frequency response and shapers
(/tmp/resonances_x_20230426_144709.csv)
1e4
X+Y+Z
X
Y
Z
After shaper
ZV (51.4 Hz, vibr=3.8%, sm~=0.06, accel<=10300)
MZV (50.6 Hz, vibr=0.0%, sm~=0.08, accel<=7500)
EI (62.0 Hz, vibr=0.0%, sm~=0.08, accel<=7200)
2HUMP_EI (78.0 Hz, vibr=0.0%, sm~=0.09, accel<=6800)
3HUMP_EI (94.8 Hz, vibr=0.0%, sm~=0.09, accel<=6600)
Recommended shaper: MZV
Power spectral density
Shaper vibration reduction (ratio)
Frequency, Hz


Frequency response and shapers
(/tmp/resonances_y_20230426_144928.csv)
1e4
X+Y+Z
X
Y
Z
After shaper
ZV (46.6 Hz, vibr=2.3%, sm~=0.08, accel<=8500)
MZV (46.0 Hz, vibr=0.0%, sm~=0.10, accel<=6200)
EI (56.0 Hz, vibr=0.0%, sm~=0.10, accel<=5800)
2HUMP_EI (70.8 Hz, vibr=0.0%, sm~=0.11, accel<=5600)
3HUMP_EI (85.4 Hz, vibr=0.0%, sm~=0.11, accel<=5300)
Recommended shaper: MZV
Z inside of Y graph is okay. It will be canceled by the shaper
Power spectral density
Shaper vibration reduction (ratio)
Frequency, Hz

Binding, Relative Belt Tension, Wobbly table

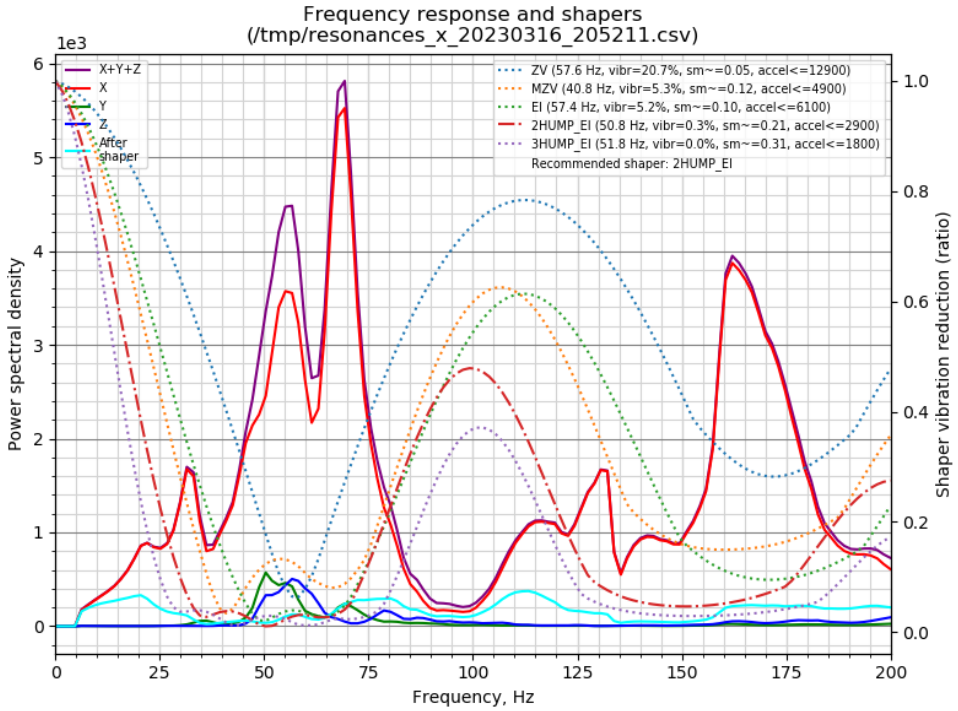


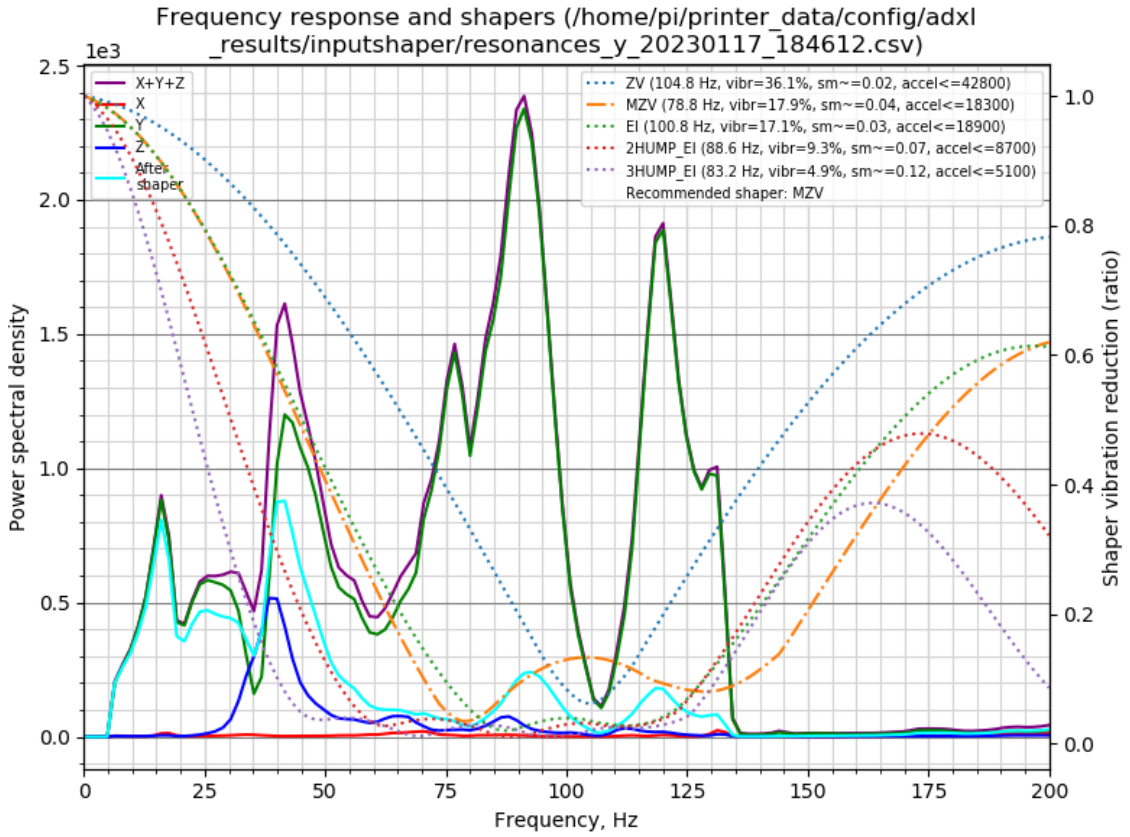
Binding


Input Shaper Settings
Absolute Belt Tension
Relative Belt Tension
Issues:
binding
loose bolts
over-dampening
loose belts
wire loom issues
printer design issues
1e3 or
symptom:
graph all over the place
really low amplitude
random noise
peak y
peak x

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

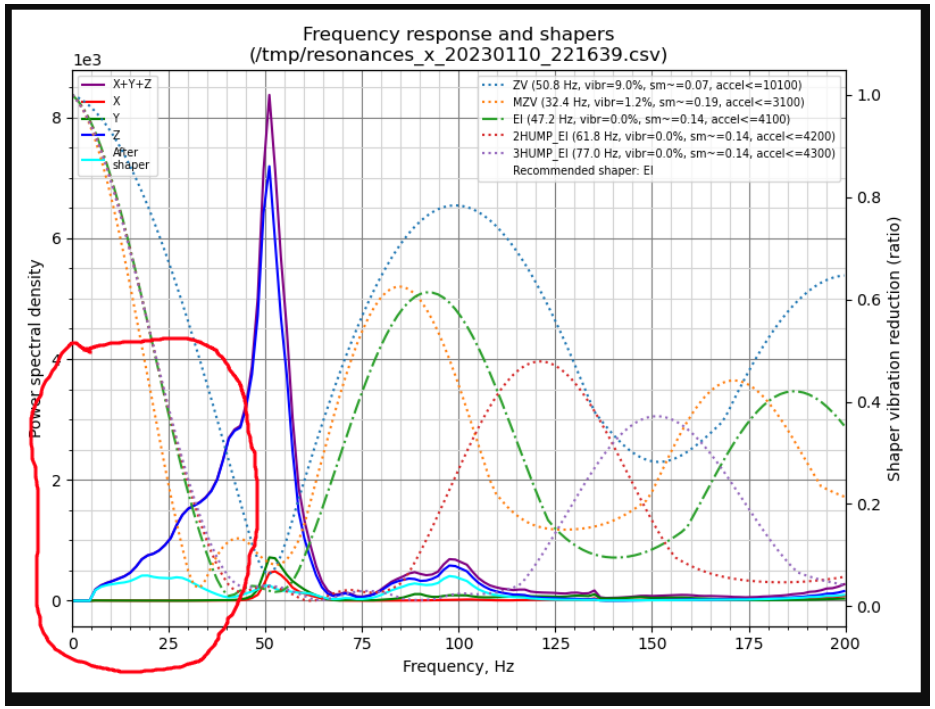


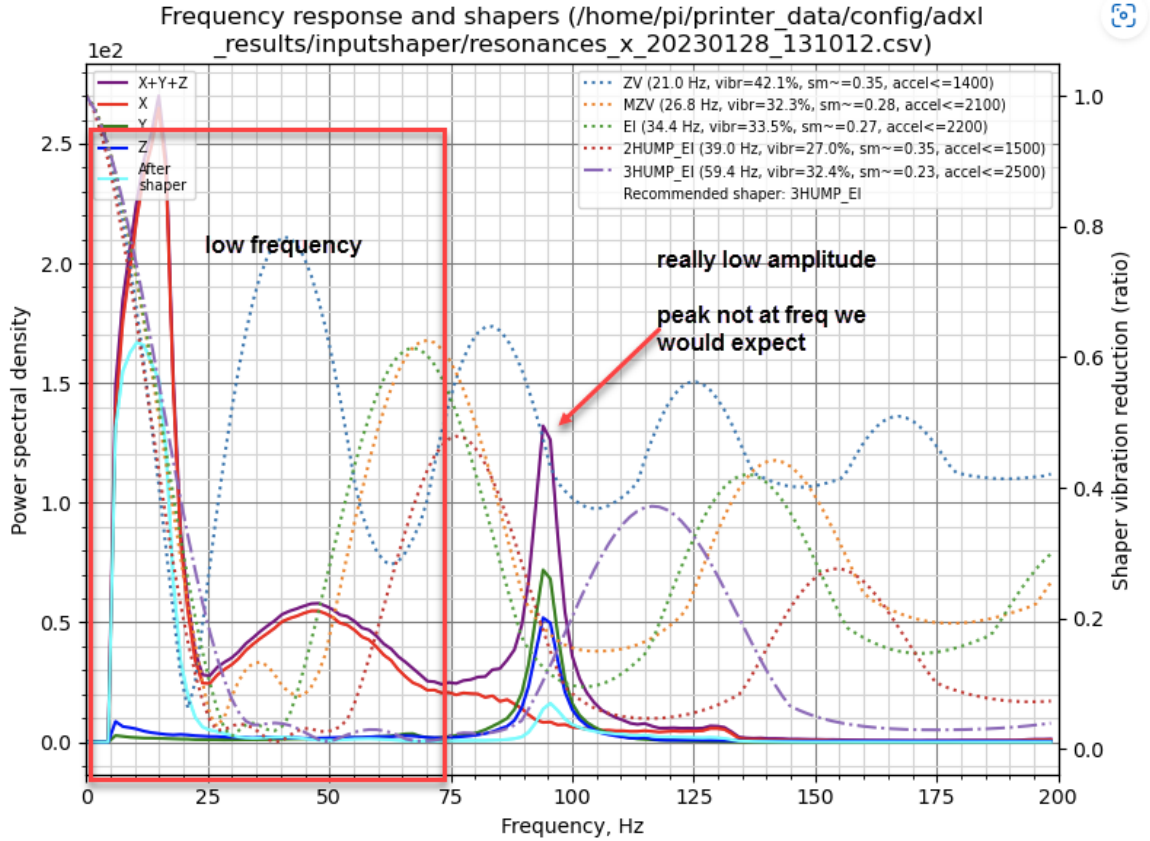


Low frequency – binding or grinding

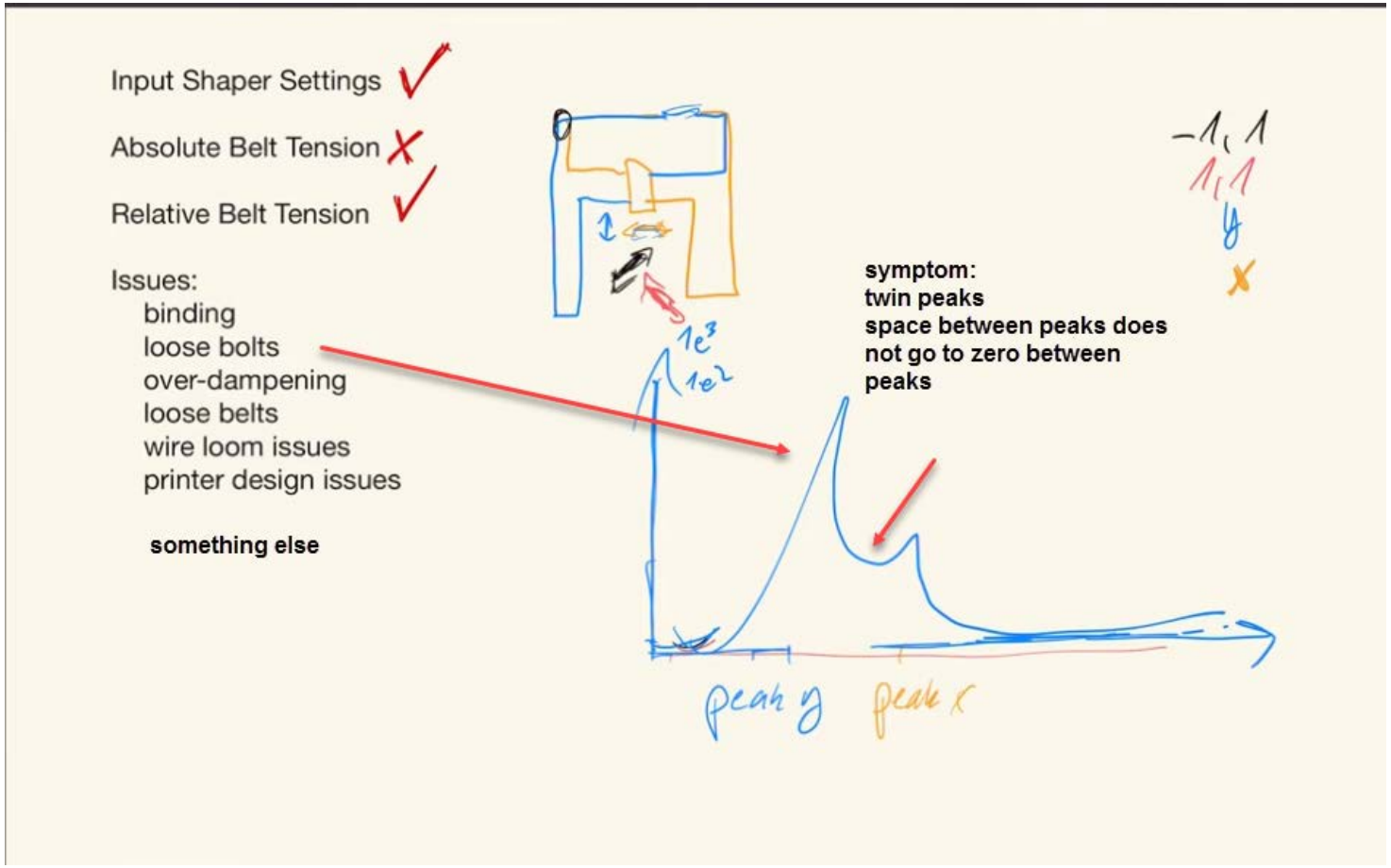
something is not moving freely

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

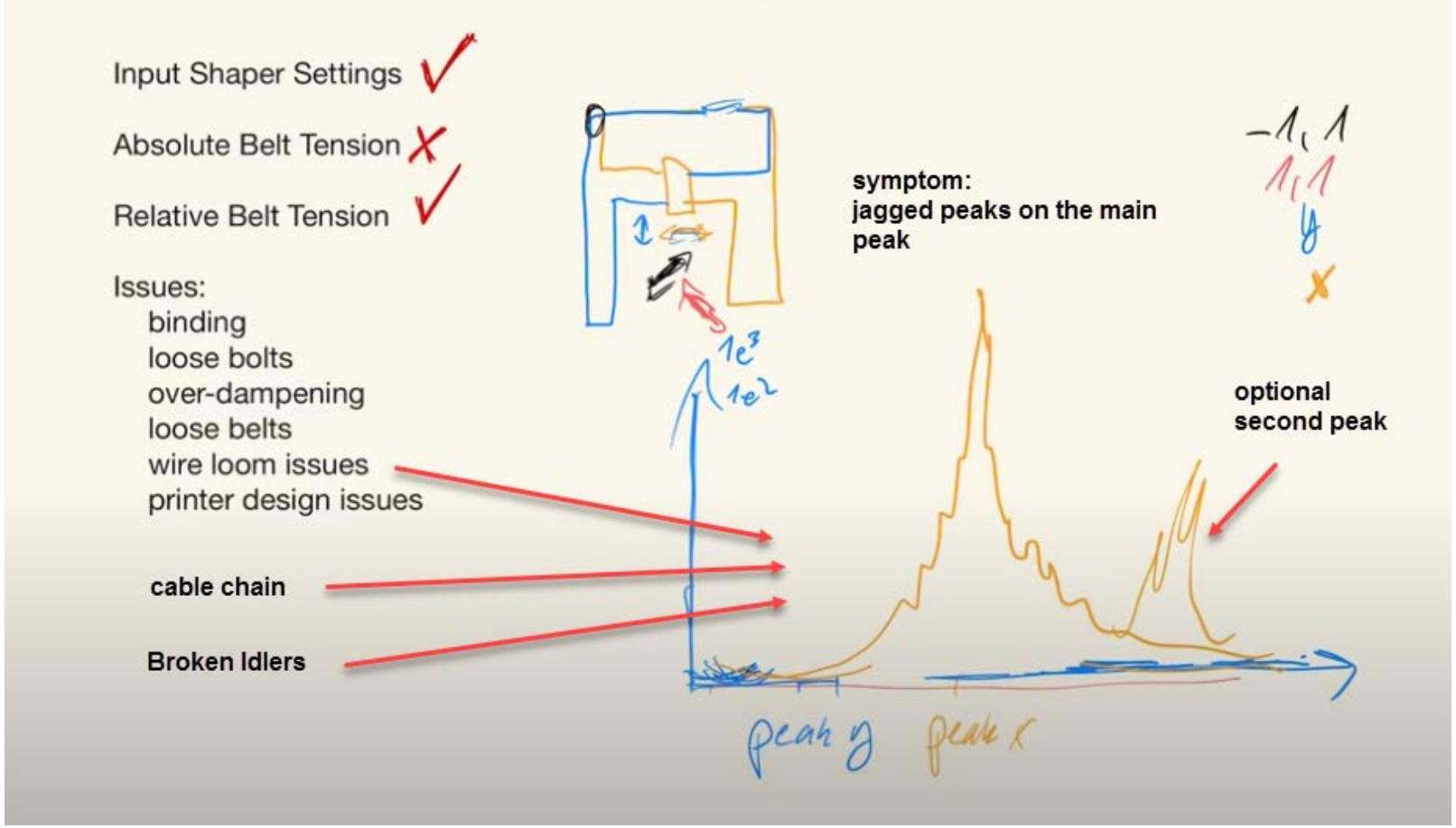




Loose Bolts


Input Shaper Settings
Absolute Belt Tension
Relative Belt Tension
Issues:
binding
loose bolts
over-dampening
loose belts
wire loom issues
printer design issues
something else
symptom:
twin peaks
space between peaks does not go to zero between peaks
peak y
peak x

Wireloom/cable chain, Broken Idlers



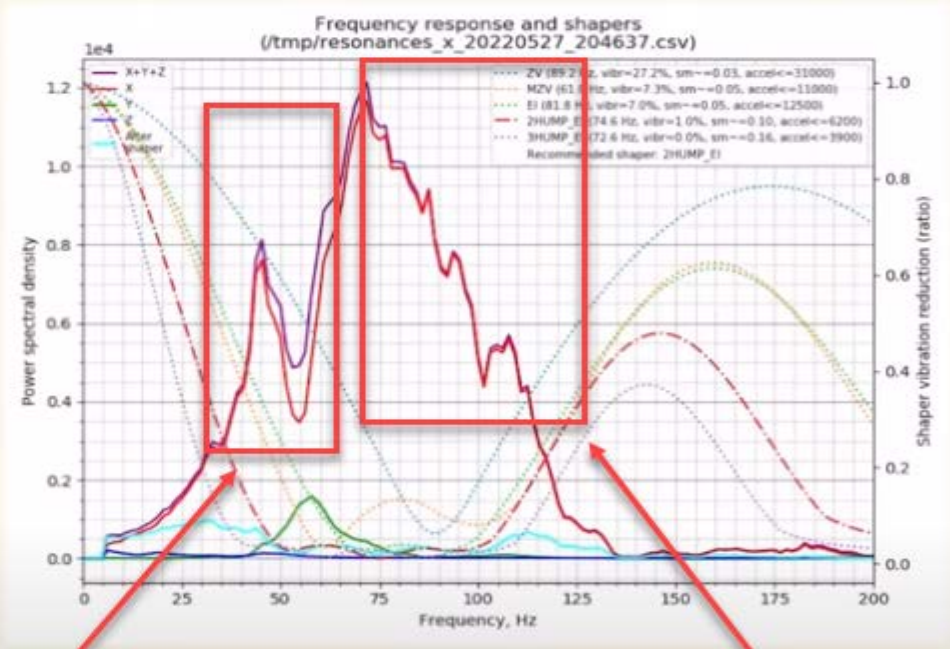
Wireloom and loose bolt

Input Shaper Settings ✓

Absolute Belt Tension ✗

Relative Belt Tension ✓

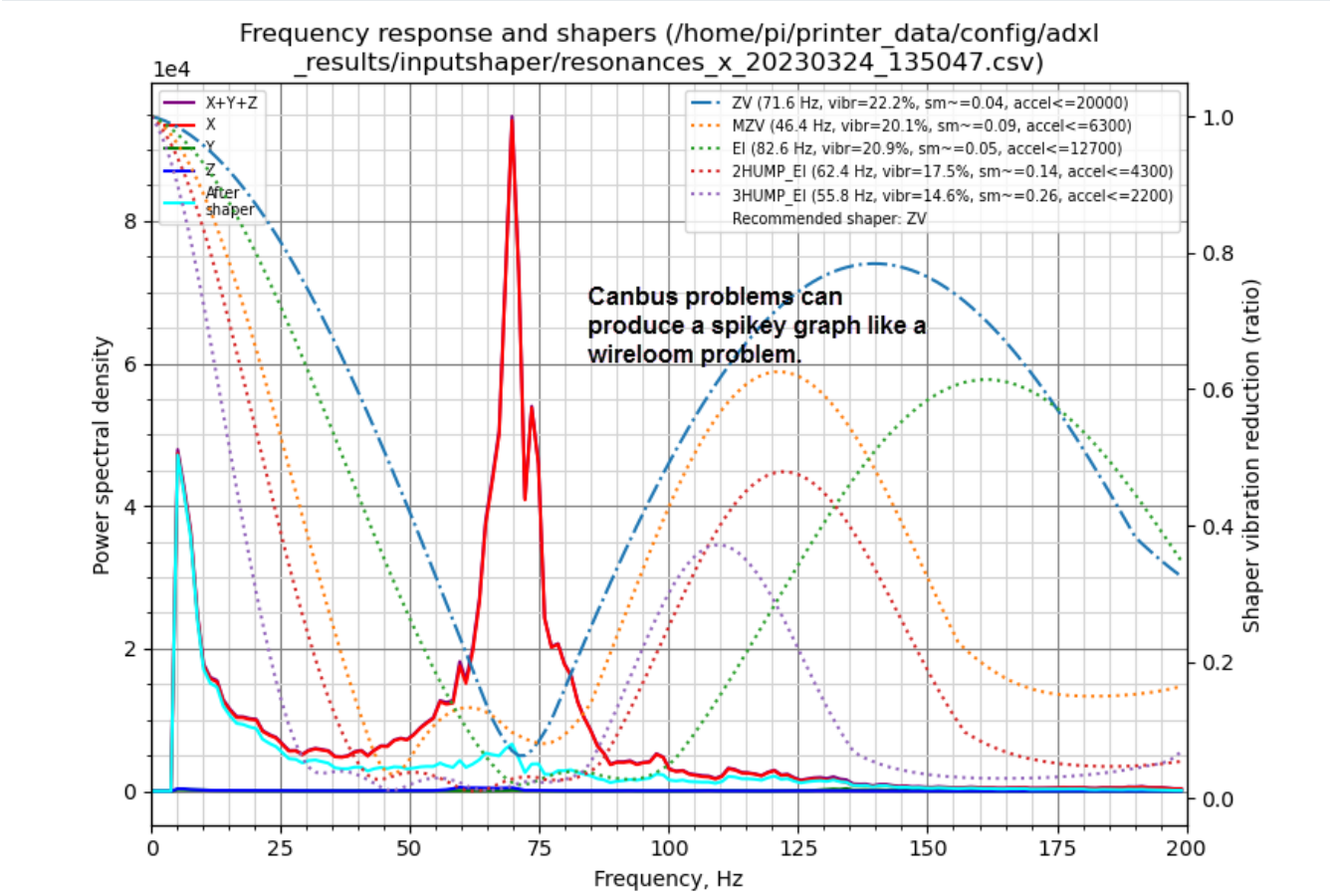
Issues:
- binding
- loose bolts
- over-dampening
- loose belts
- wire loom issues
- printer design issues



loose bolt: second peak

wireloom: jagged peaks

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



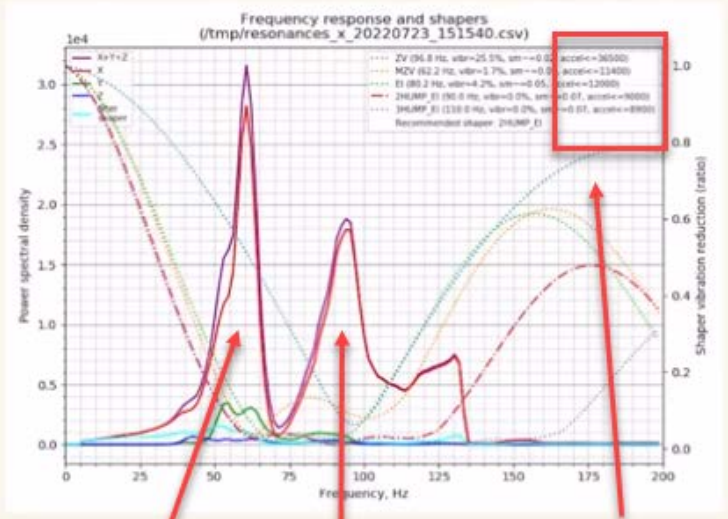
Wobbly table

Input Shaper Settings ✓

Absolute Belt Tension ✗

Relative Belt Tension ✓

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



wobbly table

wobbly table throws everything off

belt peak

difference really high between accelerations of different input shapers. Indicates a problem

don't believe input

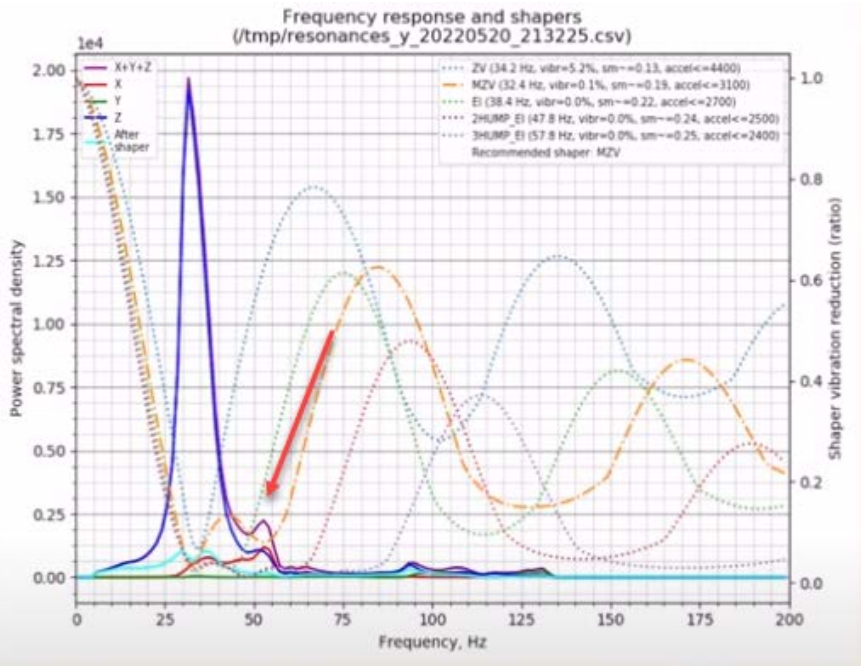
Potentially loose bolt or nothing at all

Input Shaper Settings ✓

Absolute Belt Tension ✗

Relative Belt Tension ✓

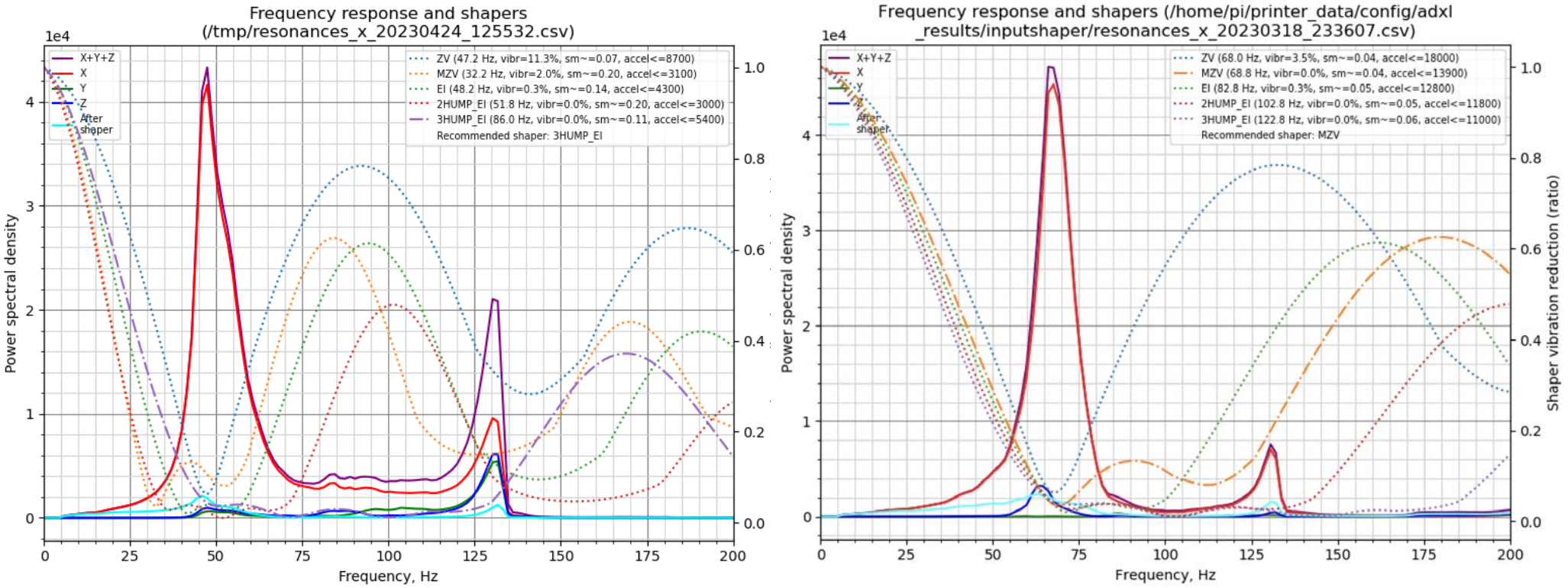
Issues:
- binding
- loose bolts
- over-dampening
- loose belts
- wire loom issues
- printer design issues



The side peak could 1) not matter, or 2) does matter.
For this graph it was a loose bolt. This issue would only manifest in larger movements than input shaper does (e.g. prints)

Investigate bolts to make sure all are snug

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