

How to Design

How I feel struggle to design

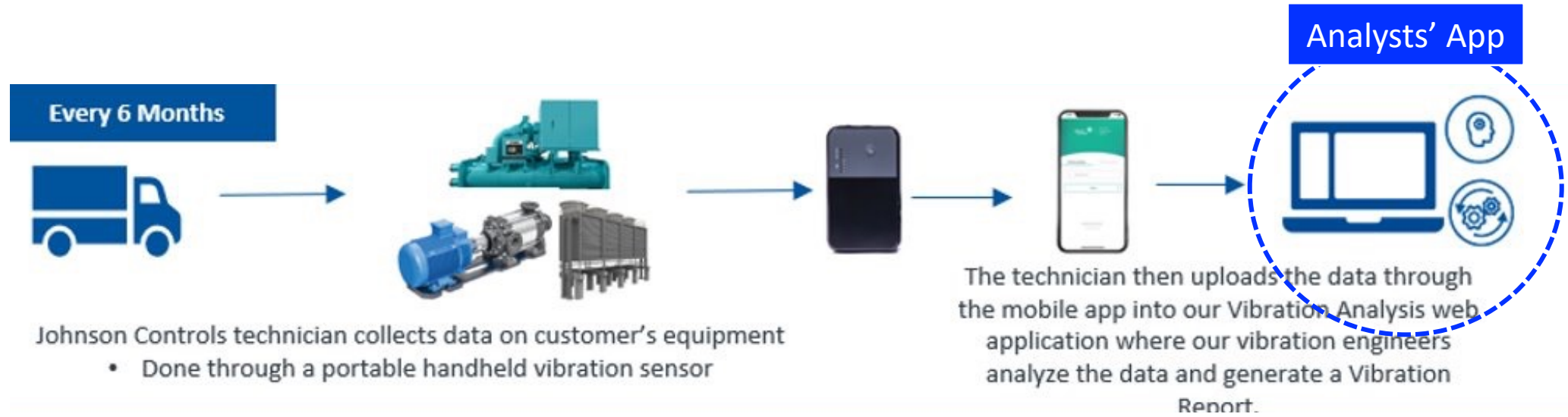
# Complex Graphs

# Agenda

1. OBVA Overview
2. Design Challenges
3. Design Experiment with New Tools
  - Zoom Level Experiment
  - Over-time Plots Experiment
4. Results & Future Works & Other Major Changes


# 1. OBVA Overview


# Overview of Predictive Service





**Gear vibration: Gear eccentricity**


- Eccentric gears produce greater modulation: higher amplitude sidebands.
- The gear centers move relative to each other resulting in higher levels of mesh force during part of the rotation and lower forces in the other part of the rotation.


- 


Imbalances
- 


Electrical motor faults
- 


Bearing failures
- 


Bent shafts
- 

Mechanical looseness
- 

Gearbox failures
- 

Misalignment
- 

Empty space or bubbles (cavitation)
- 

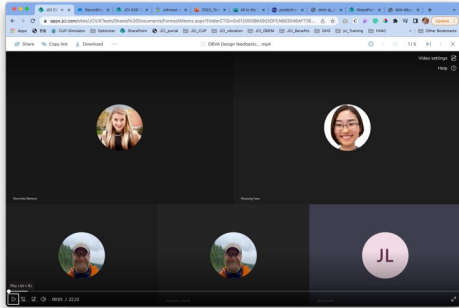
Resonance and natural frequencies
- 

Critical speed issues



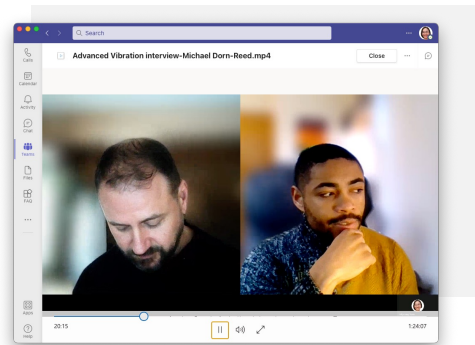
# Work Process – What we have done

## 1 Stakeholder interviews



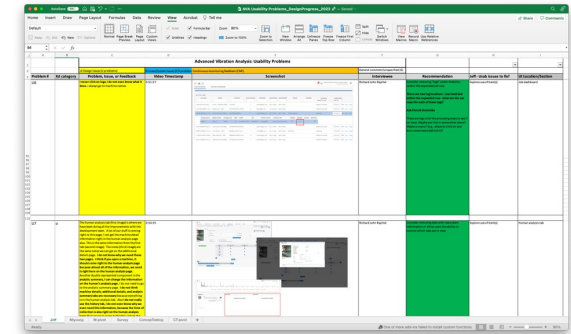
[More videos](#)

## 2 Analyst interviews



[More videos](#)

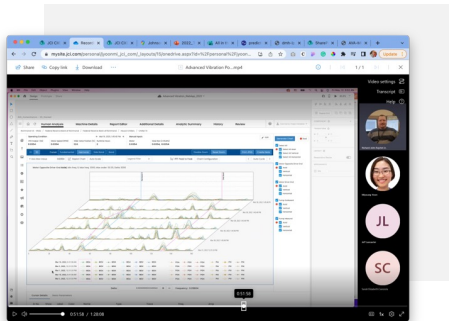
## 3 Usability problem lists



[Excel Lists](#)



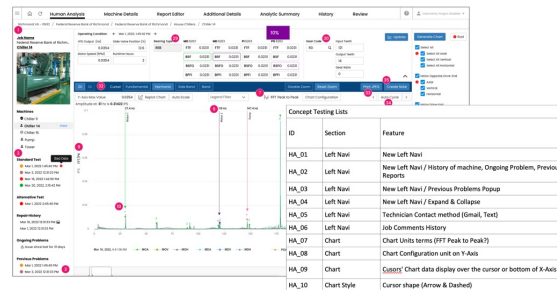
## 6 Concept Feedbacks



[Videos](#)

[Interview Scripts](#)

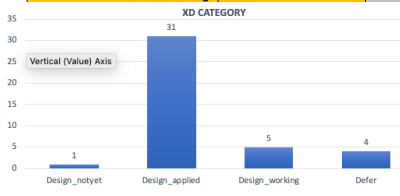
## 5 Design Prototypes



[XD Link](#)

## 4 Categorized by SW and UX issues

Menu/visual element design	21	2	Additional details tab
Explore use of item(s)	1	1	Analytic summary tab
Graph refinement	8	27	Human analysis tab
Singular location	11	11	Job dashboard
User control of defaults	2	2	Machine details tab
Information design	9	7	Report editor tab
		5	Misc
		1	Explore use of items - potential
		56	TOTAL



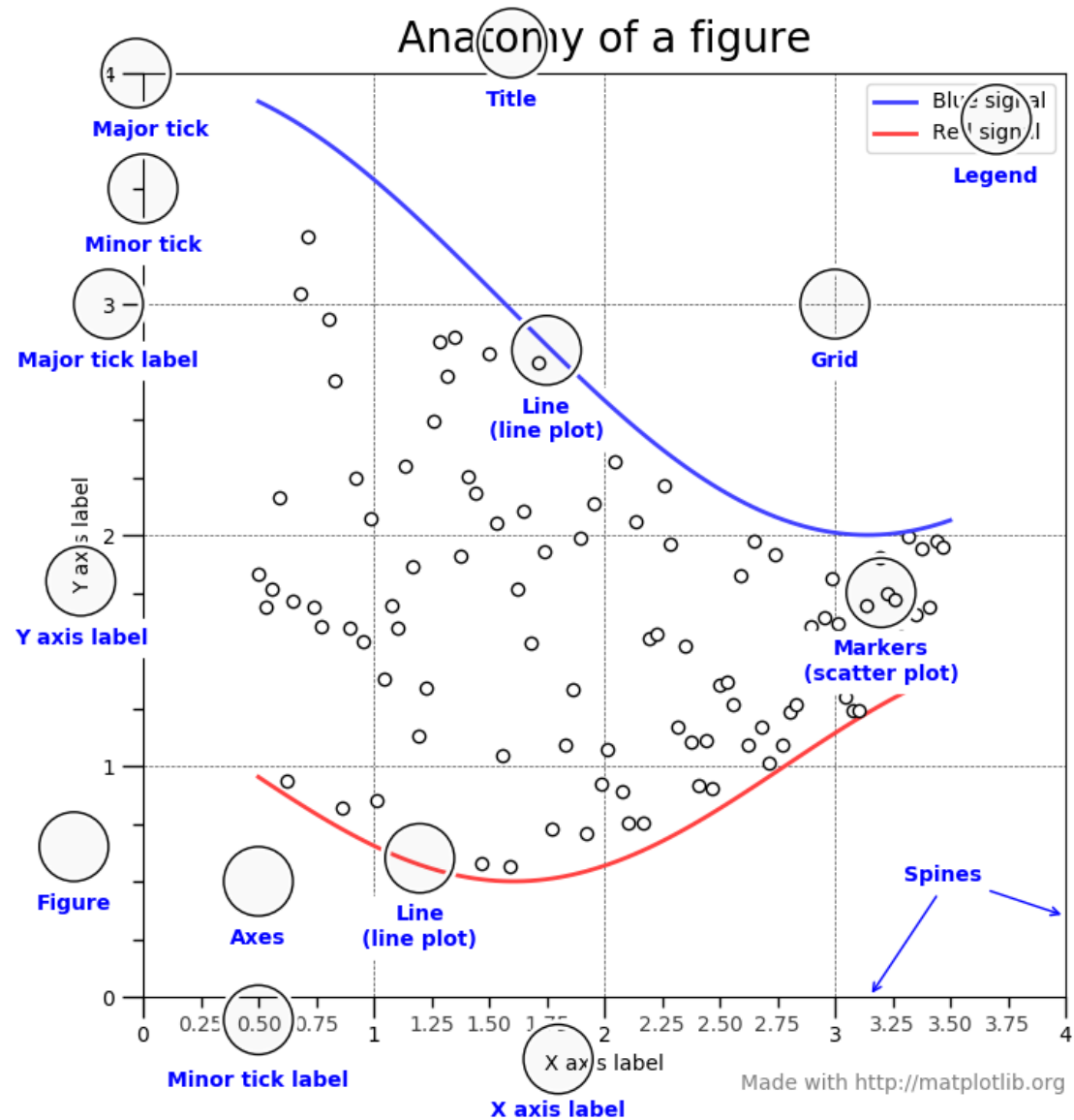
[Categorized Lists with XD id](#)

## 2. Design Challenges

# If you design a chart or plots, how could you start?

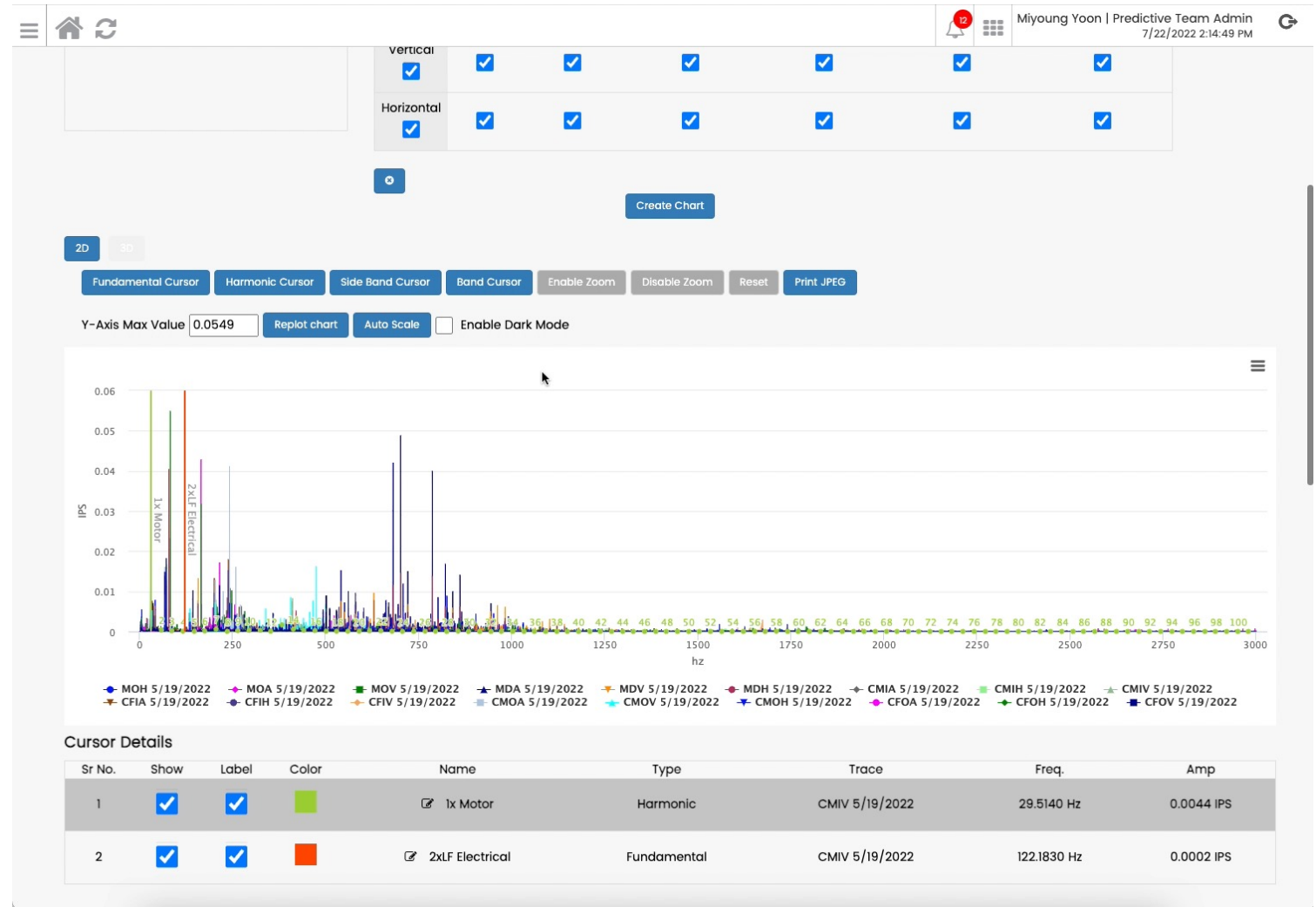
Understand...

1. Data table
2. Graph elements
3. Interactions



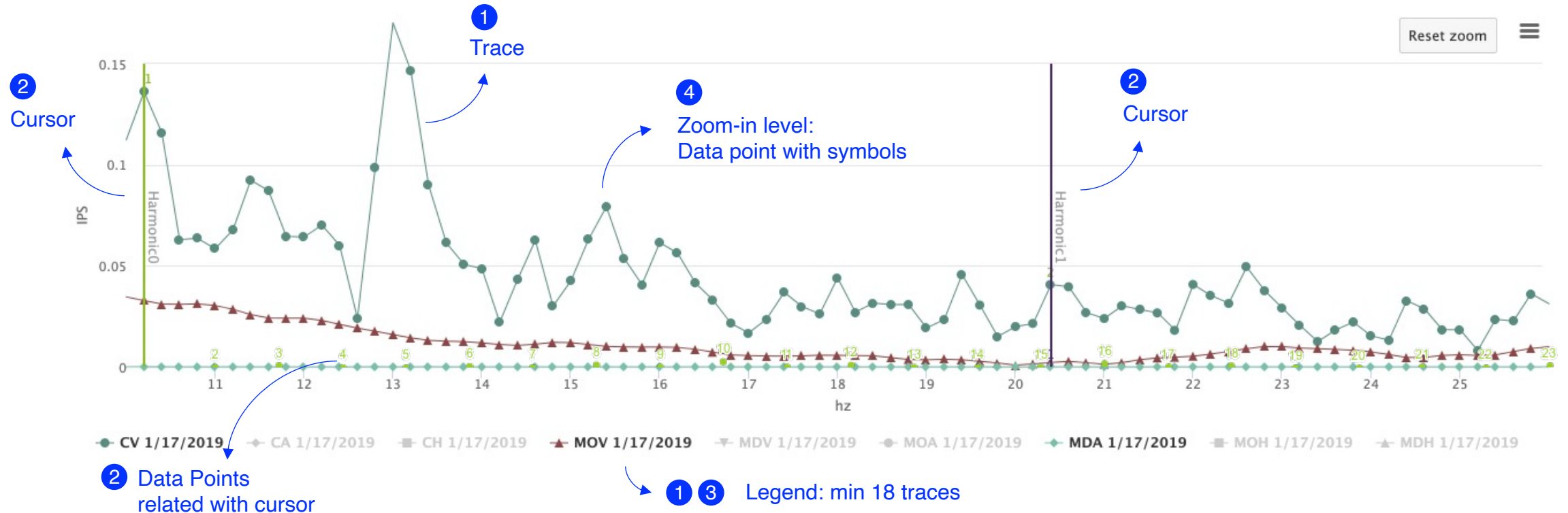
# OBVA Challenges

1. Chart as a **Tool** not the information
2. Many variables
3. Chart types
4. Color accessibility



# Variables Summary

1. At least 9 or >12 Traces
2. 9 Cursors Colors (Harmonic, Side Band, etc.)
3. Compare btw Past vs. Current Data (>18 Traces)
4. Zoom out/in Level
  1. Zoom in Level: Symbols
  2. Zoom out Level: No Symbols



# Variables: Trace Numbers & Cursor Types

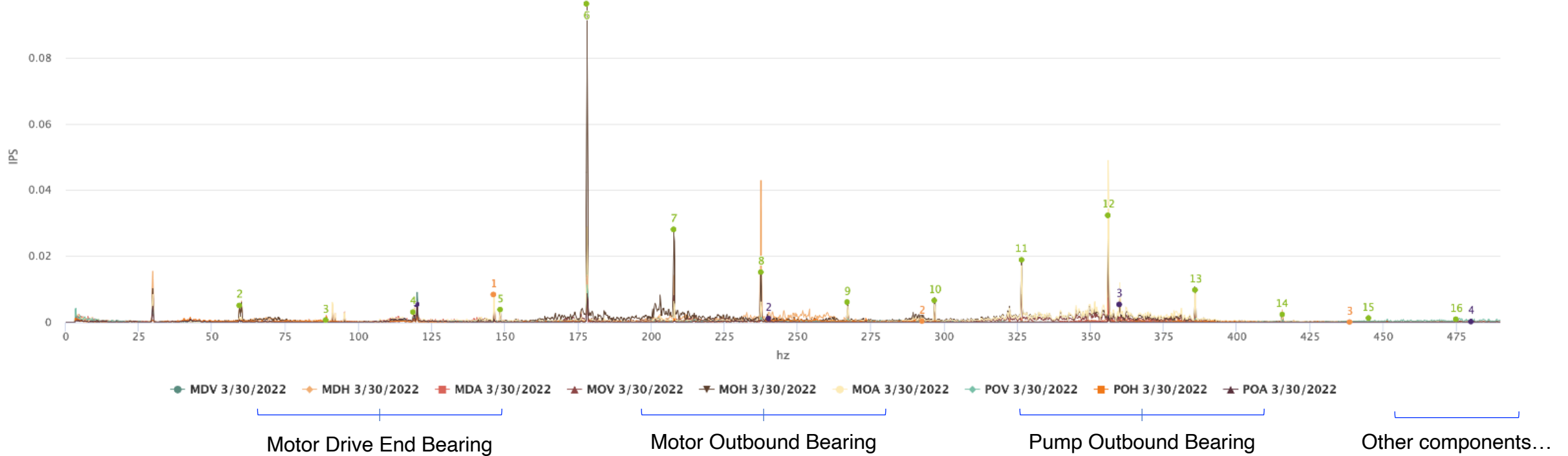
- Traces
  - **Current & Past time** should be distinguishable
  - **Each traces** represent of Machine's components should be distinguishable between lines
  - **Zoom out chart** doesn't have **trace's symbols** only colored lines should be distinguishable
  - **Light & dark** mode (Print version is Light)

Counts	Current	Past time	Total
Normal	9	9	18
Max	12	12	24
Rare 1	6	6	12
Rare 2	More than 12	More than 12	> 24

- Cursor types

Cursor Types	Usages
Harmonic	Most of cursor 90 %
Side Band	Finding pattern of Harmonic
Fundamental	Not use at all
Band Cursor	Specific customer to overall RMS

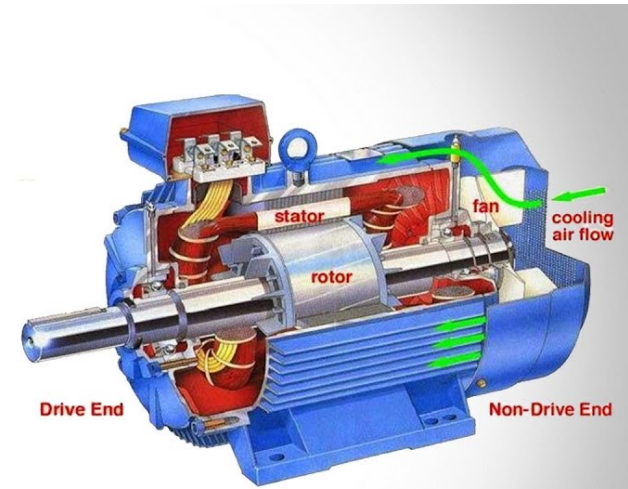
Counts	Current time	Past time	Total
Normal	3-4	Na	Na
Max	6-7	Na	Na



(V: Vertical, H: Horizontal, A: Axial)



Pump



Parts of Motor

# 3. Design Experiment with New Tools

Color choice experiments with R



# Color Choices (RGB & HCL)

## Algorithm; k-mean clustering of HCL

Red Roses

H 330 C 10 L 35

3 colors hard (Force vector)

Sort by diff hue chroma lightness random

Colors

#c90154	201,1,84
#ff6c83	255,108,131
#c596be	197,150,190

JSON

```
["#c90154", "#ff6c83", "#c596be"]
```

RGB json

```
[[[201,1,84],[255,108,131],[197,150,190]]]
```

HCL json

```
[[[10,70.638,42.889],[16.60,0.17,64.668],[330,27.942,67.578]]]
```

LAB json

```
[[42.889,69.497,12.647],
```

<http://medialab.github.io/iwanthue/>

## R Programming

```
263  
264 # data3, blue_scheme  
265 plot_data3_pch +  
266   scale_shape_manual(values=pch_2) +  
267   facet_zoom(xlim = c(0, 20))+  
268   scale_size_identity() +  
269   geom_point(aes(shape=variable, size=2))+  
270   geom_line(aes(linetype = variable)) +  
271   scale_color_manual(values= blue_scheme)  
272  
273 # scale_color_brewer(palette="Set2")  
274  
275 # data3, green_scheme  
276 plot_data3_pch +  
277   scale_shape_manual(values=pch_2) +  
278   facet_zoom(xlim = c(0, 20))+  
279   scale_size_identity() +  
280   geom_point(aes(shape=variable, size=2))+  
281   geom_line(aes(linetype = variable)) +  
282   scale_color_manual(values= green_scheme)  
283  
284 # data3, red_scheme  
285 plot_data3_pch +  
286   scale_shape_manual(values=pch_2) +  
287   facet_zoom(xlim = c(0, 20))+  
288   scale_size_identity() +  
289   geom_point(aes(shape=variable, size=2))+  
290   geom_line(aes(linetype = variable)) +  
291   scale_color_manual(values= red_scheme)  
292  
293  
284.1 (Untitled) R Script  
+ facet_zoom(xlim = c(0, 20))+  
+ scale_size_identity() +  
+ geom_point(aes(shape=variable, size=2))+  
+ geom_line(aes(linetype = variable)) +  
+ scale_color_manual(values= red_scheme)  
> red_scheme <- c("#ac3940", "#d93637", "#e96e6a")  
> # data3, red_scheme  
> plot_data3_pch +  
+ scale_shape_manual(values=pch_2) +  
+ facet_zoom(xlim = c(0, 20))+  
+ scale_size_identity() +  
+ geom_point(aes(shape=variable, size=2))+  
+ geom_line(aes(linetype = variable)) +  
+ scale_color_manual(values= red_scheme)  
> red_scheme <- c("#c90154", "#ff6c83", "#c596be")  
> # data3, red_scheme  
> plot_data3_pch +  
+ scale_shape_manual(values=pch_2) +  
+ facet_zoom(xlim = c(0, 20))+  
+ scale_size_identity() +  
+ geom_point(aes(shape=variable, size=2))+  
+ geom_line(aes(linetype = variable)) +  
+ scale_color_manual(values= red_scheme)
```

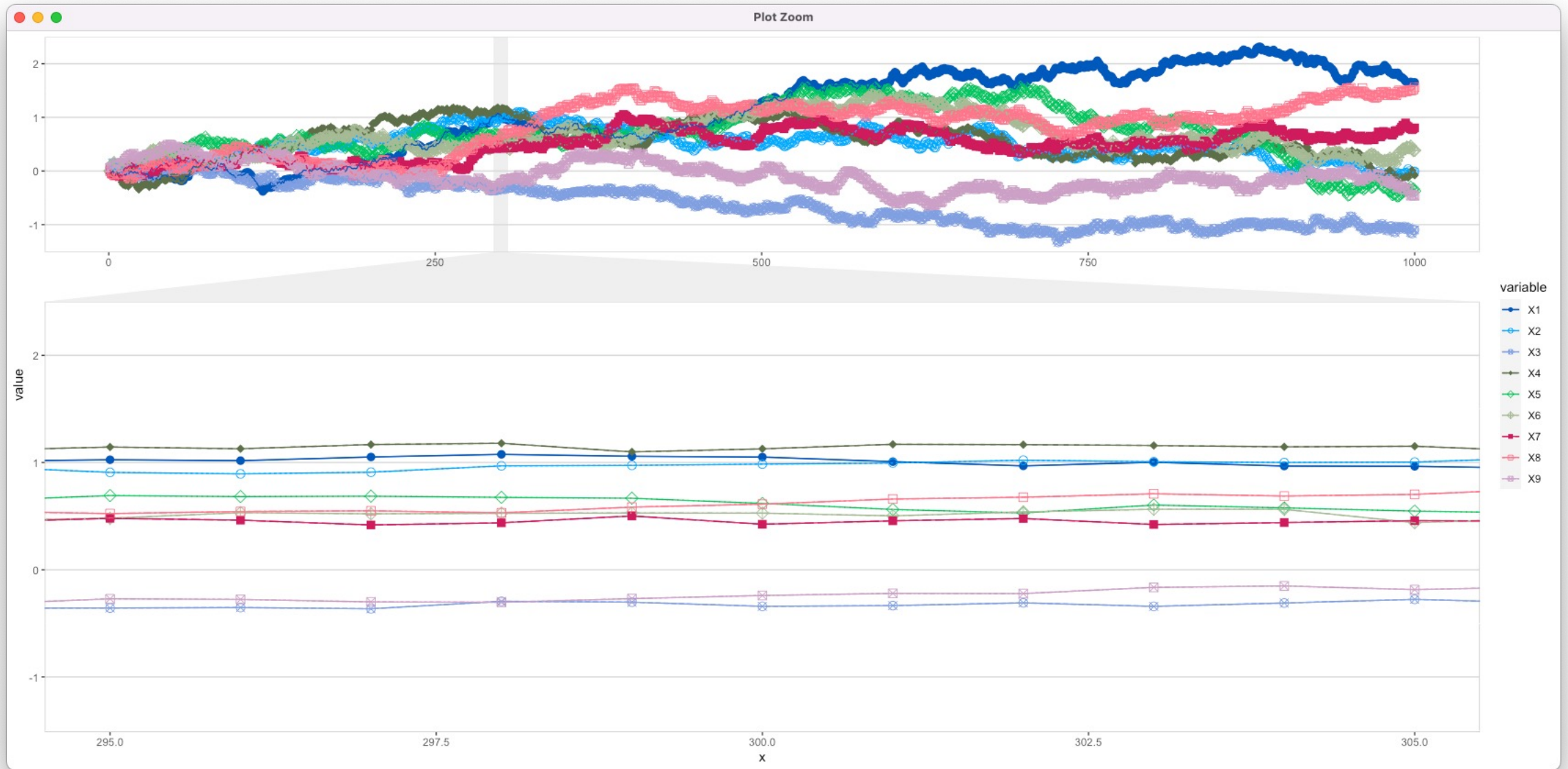
<https://www.rstudio.com/products/rstudio/download/>

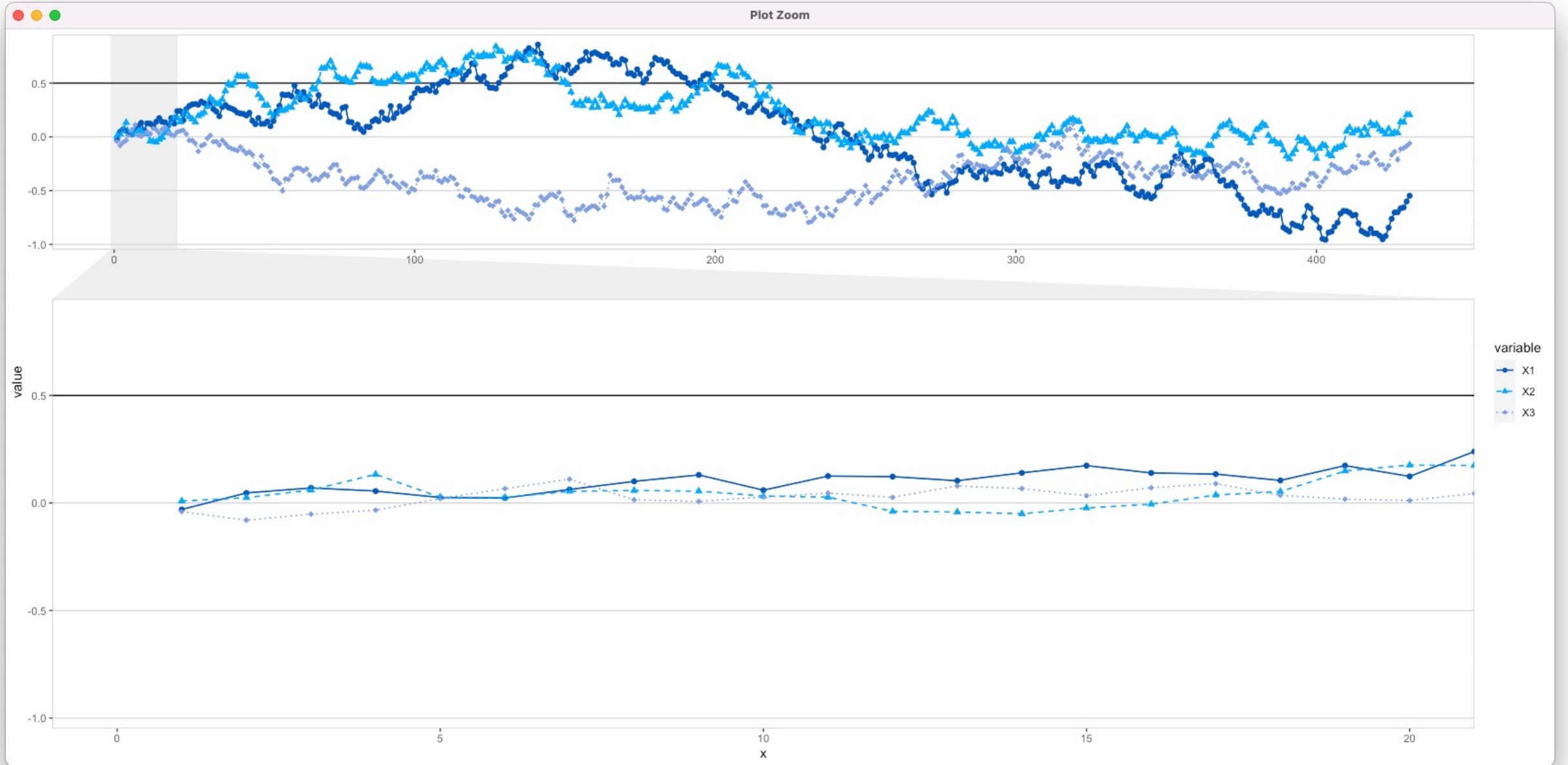
# R Demo (Duration 3:19)

The screenshot displays the RStudio interface with the following components:

- Source Editor:** Contains R code for creating data frames and plots. The code includes comments for 'Long format', 'Brownian motion', and 'Grid'. It uses `data.frame`, `melt`, and `ggplot` functions.
- Environment:** Lists objects in the Global Environment, including `plot_data12`, `plot_data3`, `plot_data3_pch`, `plot_data4`, `plot_data9`, `plot_data9_line`, `plot_data9_line_blank`, and `shapes`.
- Plots:** A line plot titled 'value' vs 'x'. The x-axis ranges from 0 to 1000, and the y-axis ranges from -2 to 2. The plot shows 12 distinct colored lines representing variables X1 through X12. A legend on the right side of the plot identifies each variable by color.

```
82
83
84 df2 <- data.frame(x = seq_along(df2[, 1]),
85                  df2)
86
87 # Long format
88 df2 <- melt(df2, id.vars = "x")
89
90 plot_data12 <- ggplot(df2, aes(x = x, y = value, color = variable)) +
91   geom_line()
92 plot_data12
93
94
95 ### data 3
96 # Brownian motion
97 set.seed(1.234)
98
99 # Grid
100 t <- seq(0, 1, by = 0.002315)
101 p <- length(t) - 1
102
103 # N paths
104 n <- 3
105 I <- matrix(rnorm(n * p, 0, 1 / sqrt(p)), n, p)
106
107 # Data frame
108 df3 <- data.frame(apply(I, 1, cumsum))
109
110
111 df3 <- data.frame(x = seq_along(df3[, 1]),
112                 df3)
113 # Long format
114 df3 <- melt(df3, id.vars = "x")
115
116 plot_data3 <- ggplot(df3, aes(x = x, y = value, color = variable))
```





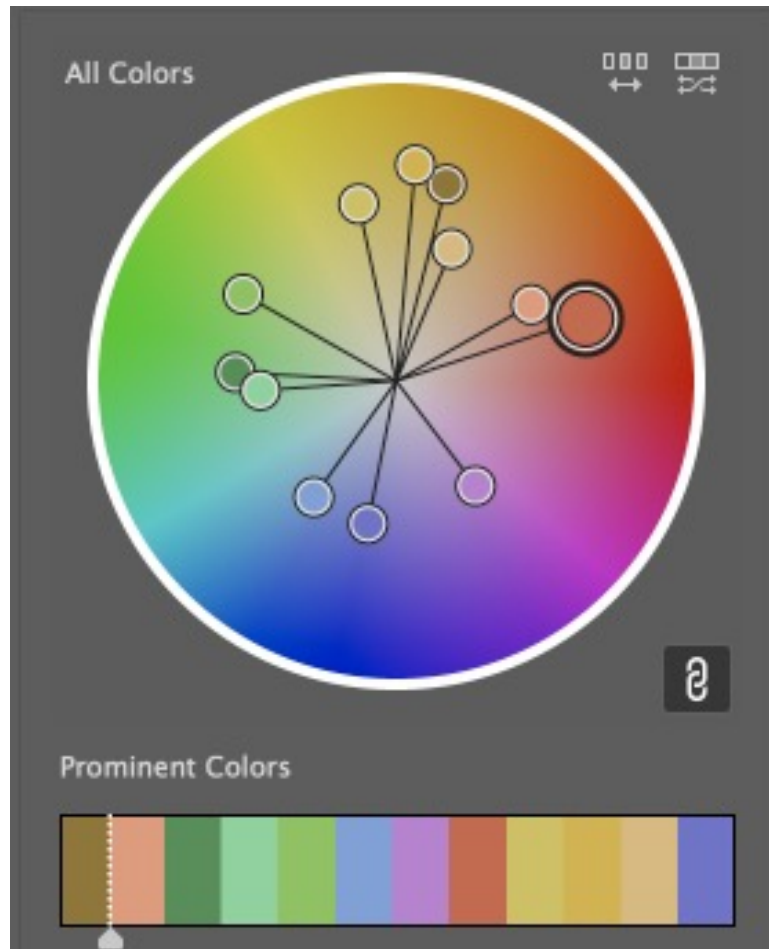
# **Design Reasoning & Color Rules**

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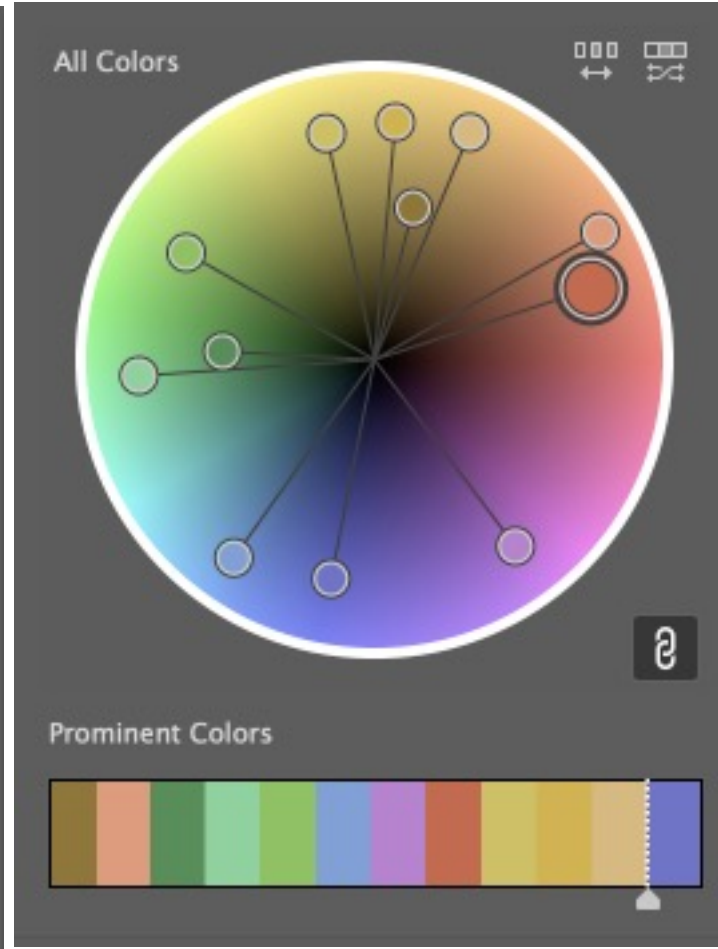


# Color Reasoning

## Traces

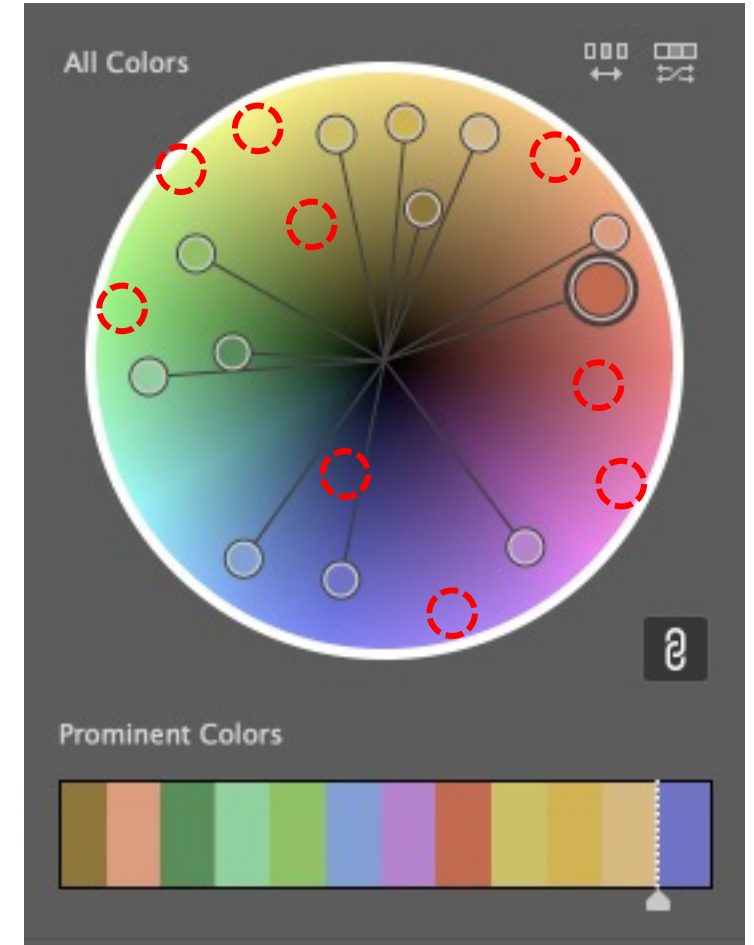


HUE



Saturation

## Cursors







 Potential Cursor colors

# Rule Summary

- 1) Component category color
  - Motor: Cooler color
  - Pump or Compressor: Warmer color
- 2) Work-flow order: MO > MD > PO > PI
- 3) Past data (dashed line+lower saturations)



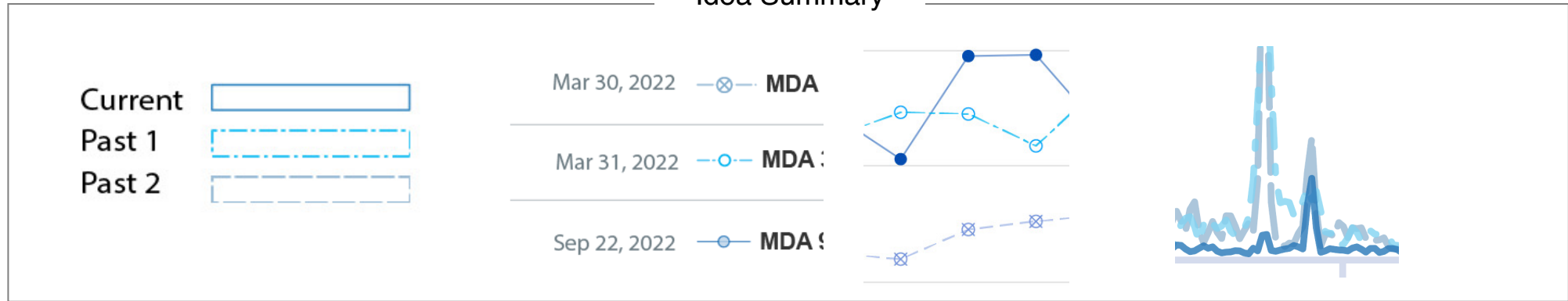
Time	Current measurement
Machine	Motor <span style="float: right;">Pump Or (Compressor)</span>
Component	MO <span style="float: right;">PO PI</span>
Location	A V H <span style="float: right;">A V H A V H</span>
Color	
Symbol	
Line types	Solid

Time	Past measurement
Machine	Motor <span style="float: right;">Pump</span>
Component	MO <span style="float: right;">PO PI</span>
Location	A V H <span style="float: right;">A V H A V H</span>
Color	
Symbol	
Line types	Dashed



# Past Measurement Rules (Line-types & Symbol fill)

## Idea Summary



## Rules

	Motor	MO			MD		
		A	V	H	A	V	H
Past 1							
	Line	Dash 4px, Gap 4px					
	Symbol	Hollow					
Past 2							
	Line	Dash 4px, Gap 2px					
	Symbol	Hollow and X mark					
Past n							
	Line	Dash 6px, Gap 2px					
	Symbol	?					



## Line types

solid		11
dashed		18
dotted		1f
dotdash		81
longdash		88
twodash		8f
		f1
		f8
		ff

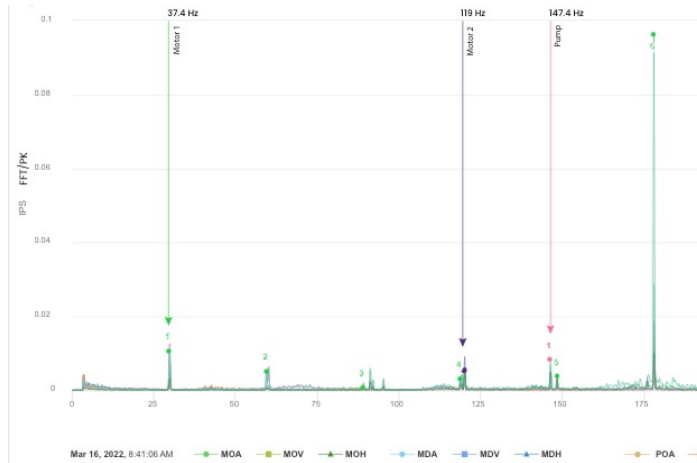
# Graph Types

---

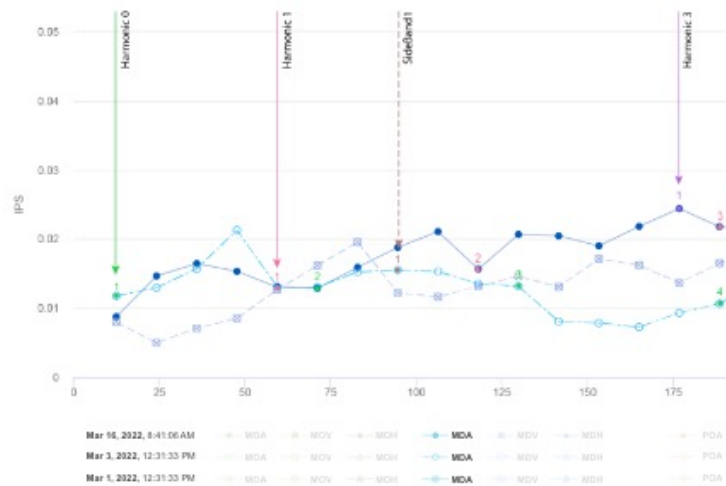
# Graph Types

## 2D

2D-A) Zoom-out

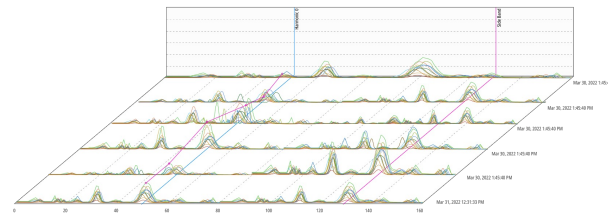


2D-B) Zoom-in

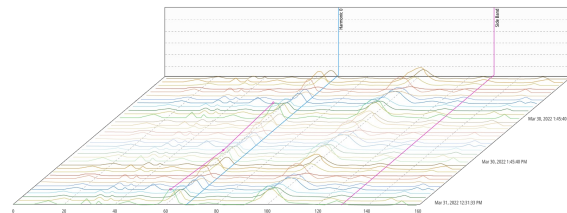


## 3D

3D-A) 45 Skewed & Stacked traces



3D-B) 45 Skewed & Even placed traces

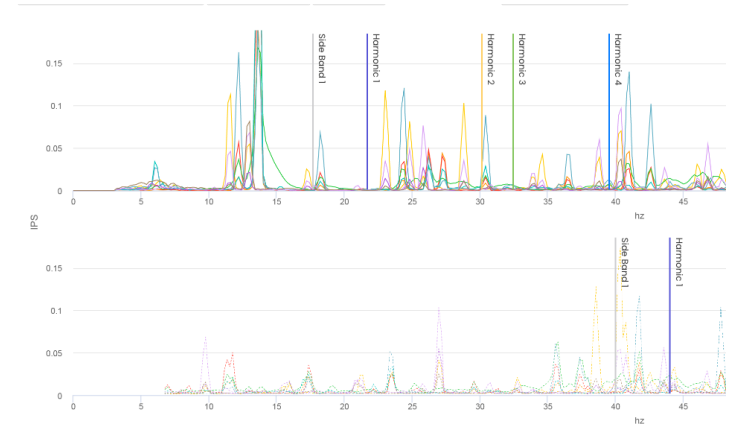


3D-C) 90 Skewed & Even or & Stacked

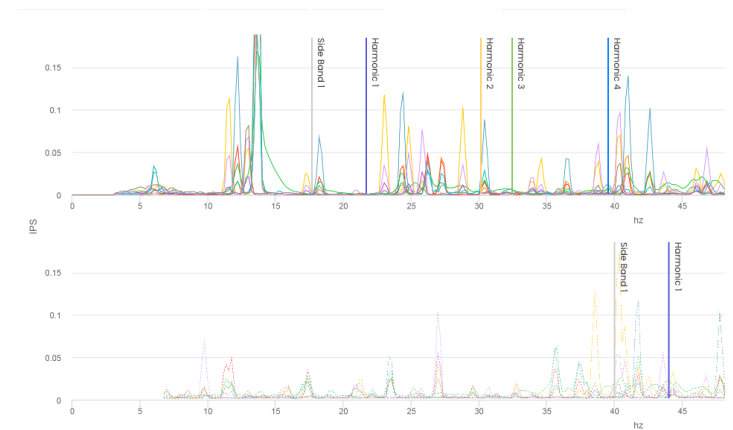


## 2D Multi-plots

Multi-A) Same data with different resolutions



Multi-B) Same data comparing current and past

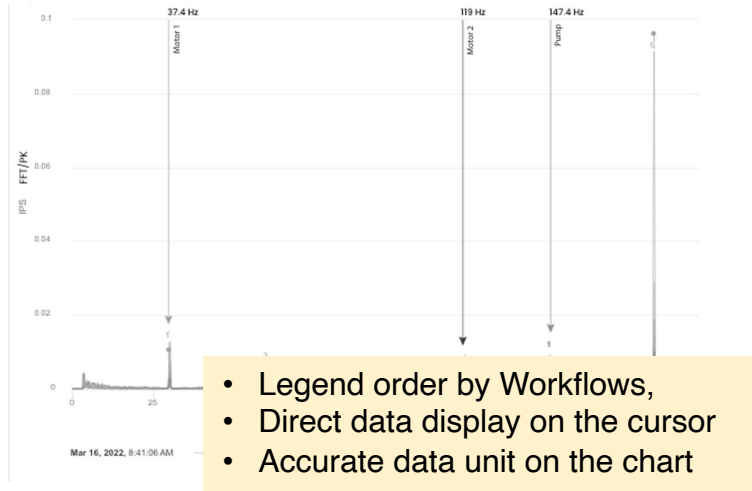


# Potential Outcomes by Graph Types

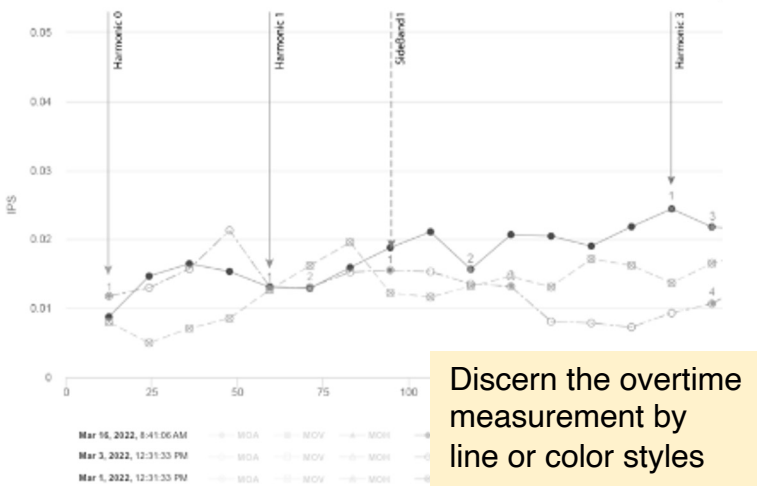
Various chart types:  
Analyze the data in different ways

## 2D

### 2D-A) Zoom-out

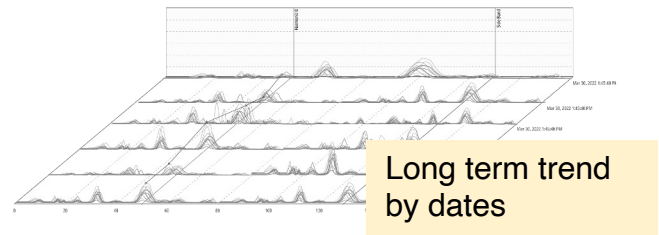


### 2D-B) Zoom-in

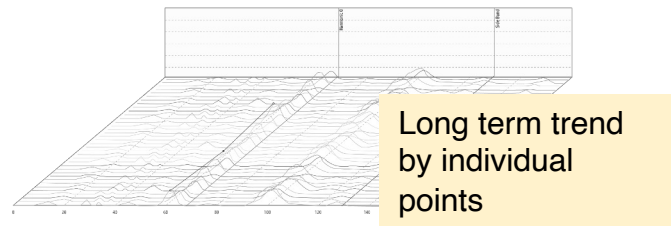


## 3D

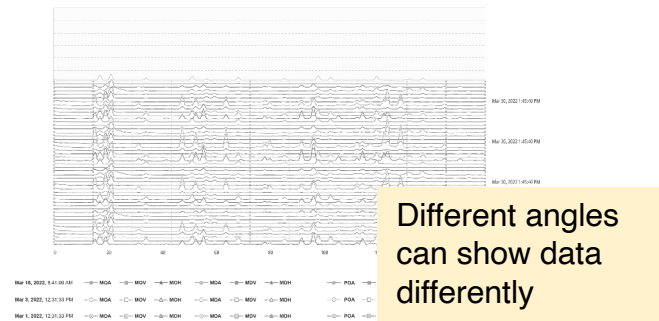
### 3D-A) 45 Skewed & Stacked traces



### 3D-B) 45 Skewed & Even placed traces

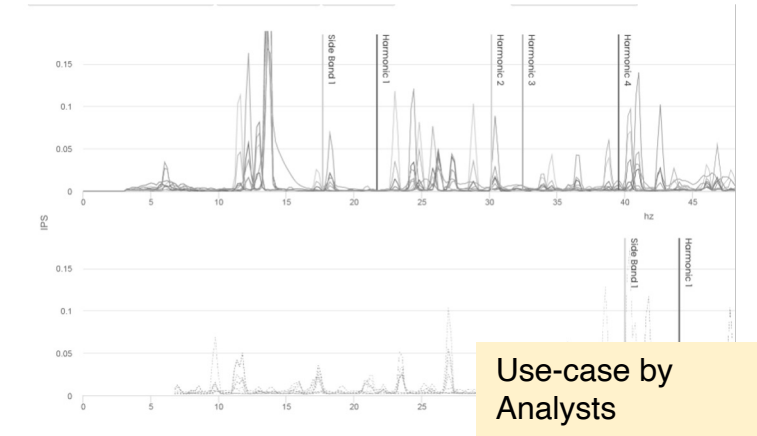


### 3D-C) 90 Skewed & Even or & Stacked

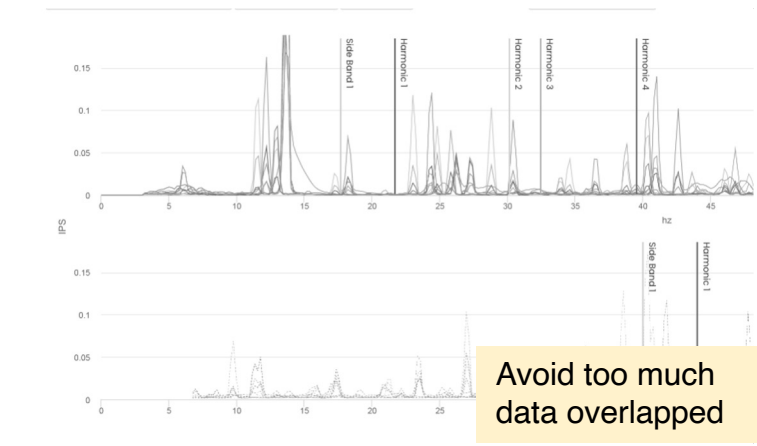


## 2D Multi-plots

### Multi-A) Same data with different resolutions



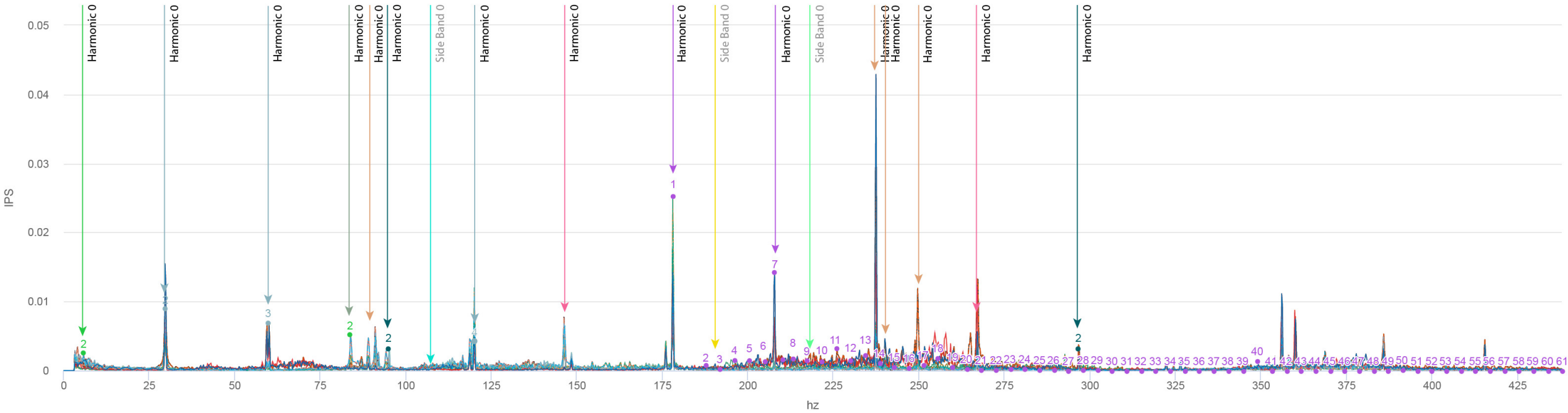
### Multi-B) Same data comparing current and past



# **Zoom Level Experiment**

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# Zoom-Out



Trace colors & Symbols

	MDA	MDH	MDV
Mar 30, 2022	—⊗— MDA 3/30/2022	—⊗— MDH 3/30/2022	—⊗— MDV 3/30/2022
Mar 31, 2022	—○— MDA 3/31/2021	—○— MDH 3/31/2021	—○— MDV 3/31/2021
Sep 22, 2022	—○— MDA 9/22/2021	—○— MDH 9/22/2021	—○— MDV 9/22/2021

Trace line types by timeline

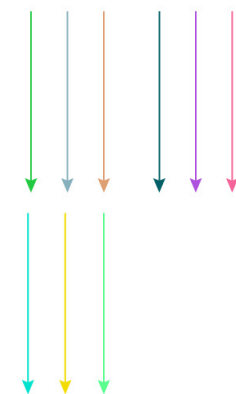
	MDA	MDH	MDV
Current			
Past 1			
Past 2			

Cursor Colors

- Harmonic

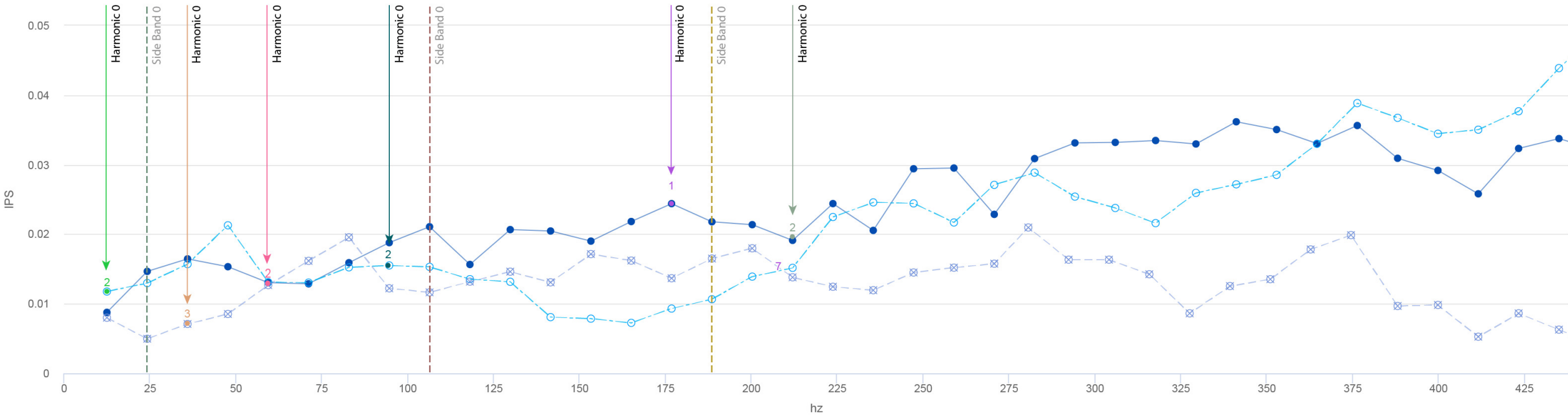


- Side Band



Trial2: Neon color for side band,  
Does the side band need to be an arrow?

# Zoom-in



## Trace colors & Symbols

	MDA	MDH	MDV
Mar 30, 2022	MDA 3/30/2022	MDH 3/30/2022	MDV 3/30/2022
Mar 31, 2022	MDA 3/31/2021	MDH 3/31/2021	MDV 3/31/2021
Sep 22, 2022	MDA 9/22/2021	MDH 9/22/2021	MDV 9/22/2021

## Trace line types by timeline

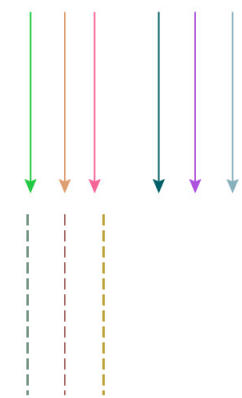
	MDA	MDH	MDV
Current	[Solid Line]	[Solid Line]	[Solid Line]
Past 1	[Dashed Line]	[Dashed Line]	[Dashed Line]
Past 2	[Dotted Line]	[Dotted Line]	[Dotted Line]

## Cursor Colors

- Harmonic



- Side Band

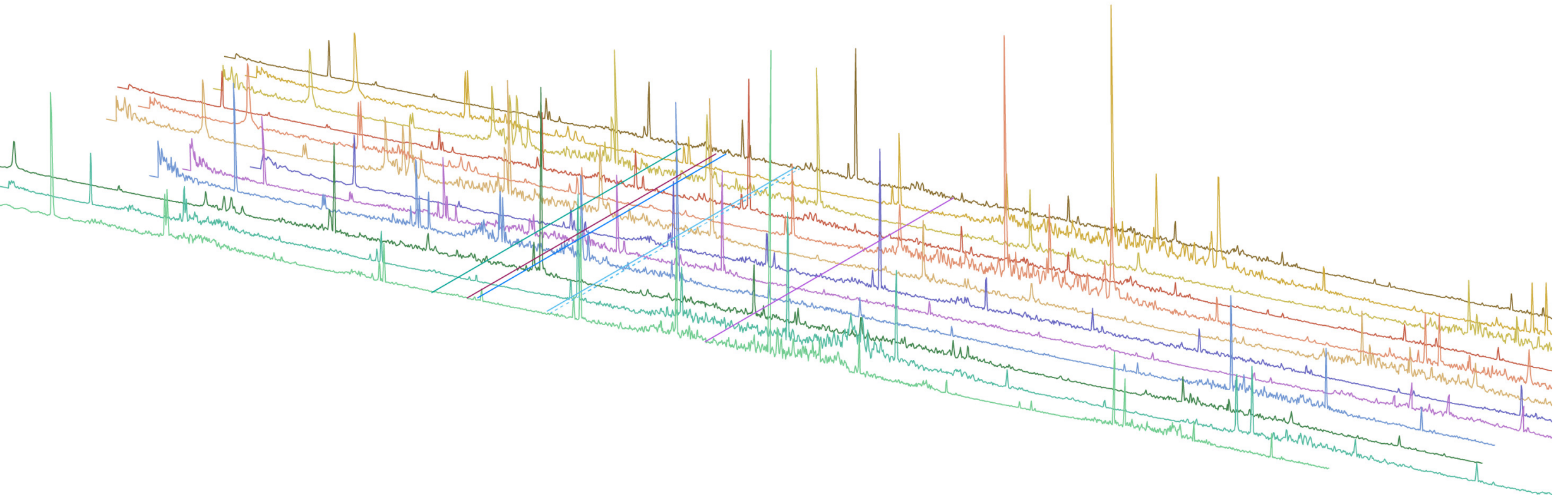


## **Over-time Plots Experiment**

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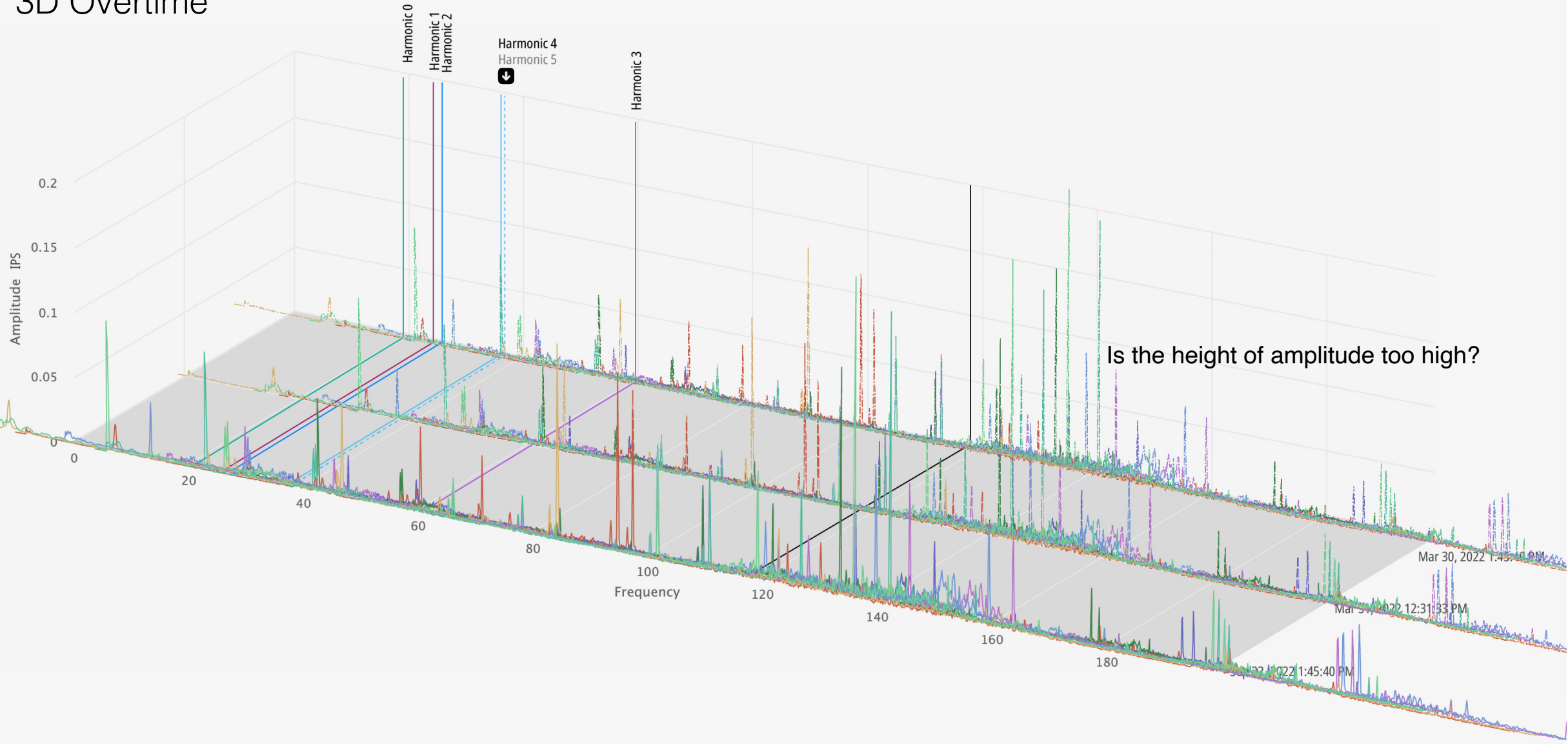
# 3D Current



Sep 22 2022, 8:41:06 AM

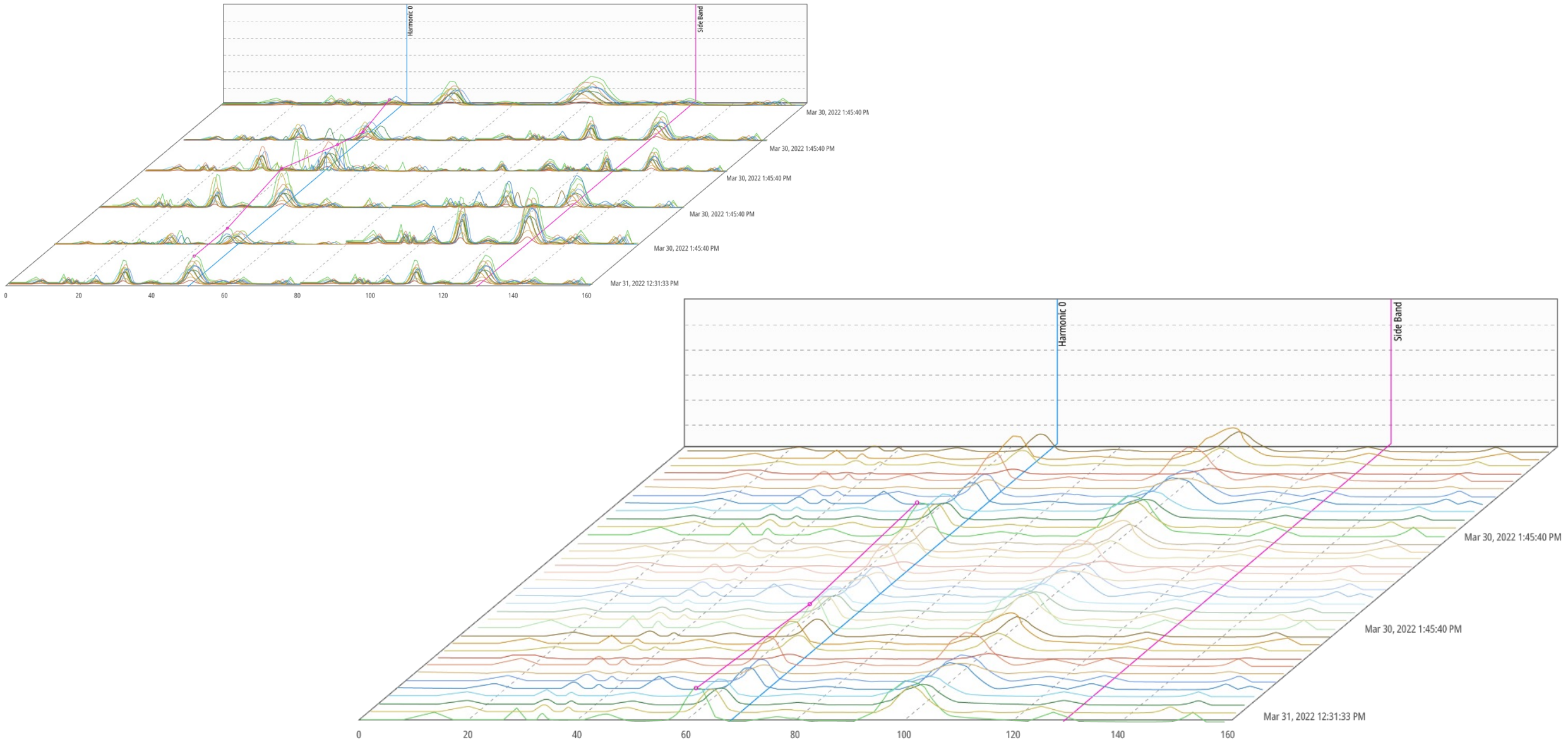
MOA MOV MOH MDA MDV MDH POA POV POH PIA PIV PIH

# 3D Overtime



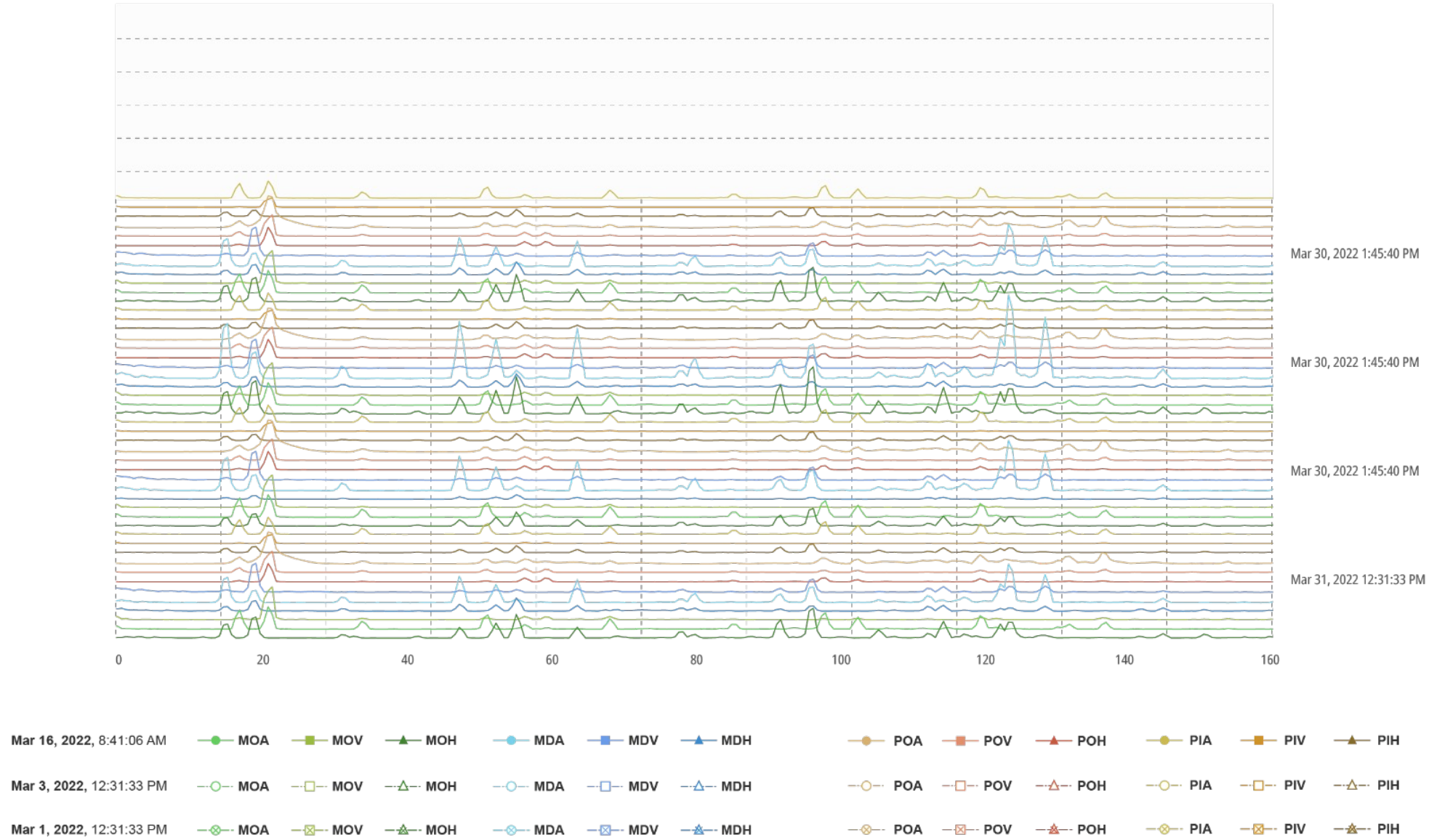
Sep 22 2022, 8:41:06 AM	MOA	MOV	MOH	MDA	MDV	MDH	POA	POV	POH
Mar 31 2022, 8:41:06 AM	MOA	MOV	MOH	MDA	MDV	MDH	POA	POV	POH
Mar 30 2022, 8:41:06 AM	MOA	MOV	MOH	MDA	MDV	MDH	POA	POV	POH

# 3D 90 Skewed & Even or & Stacked



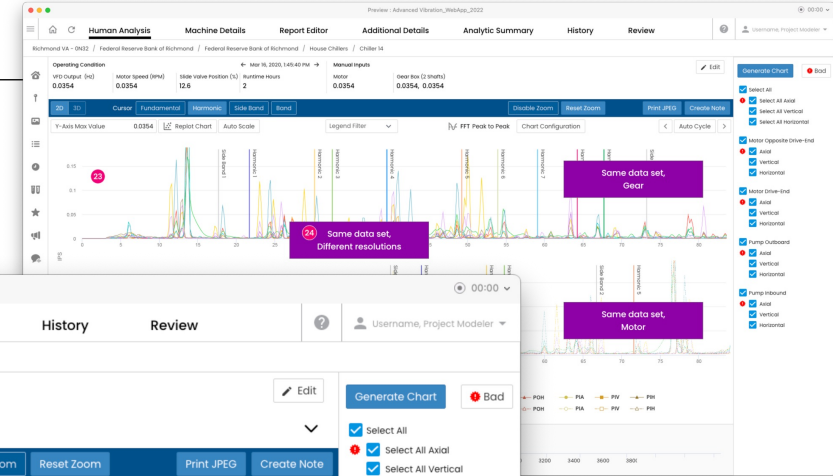
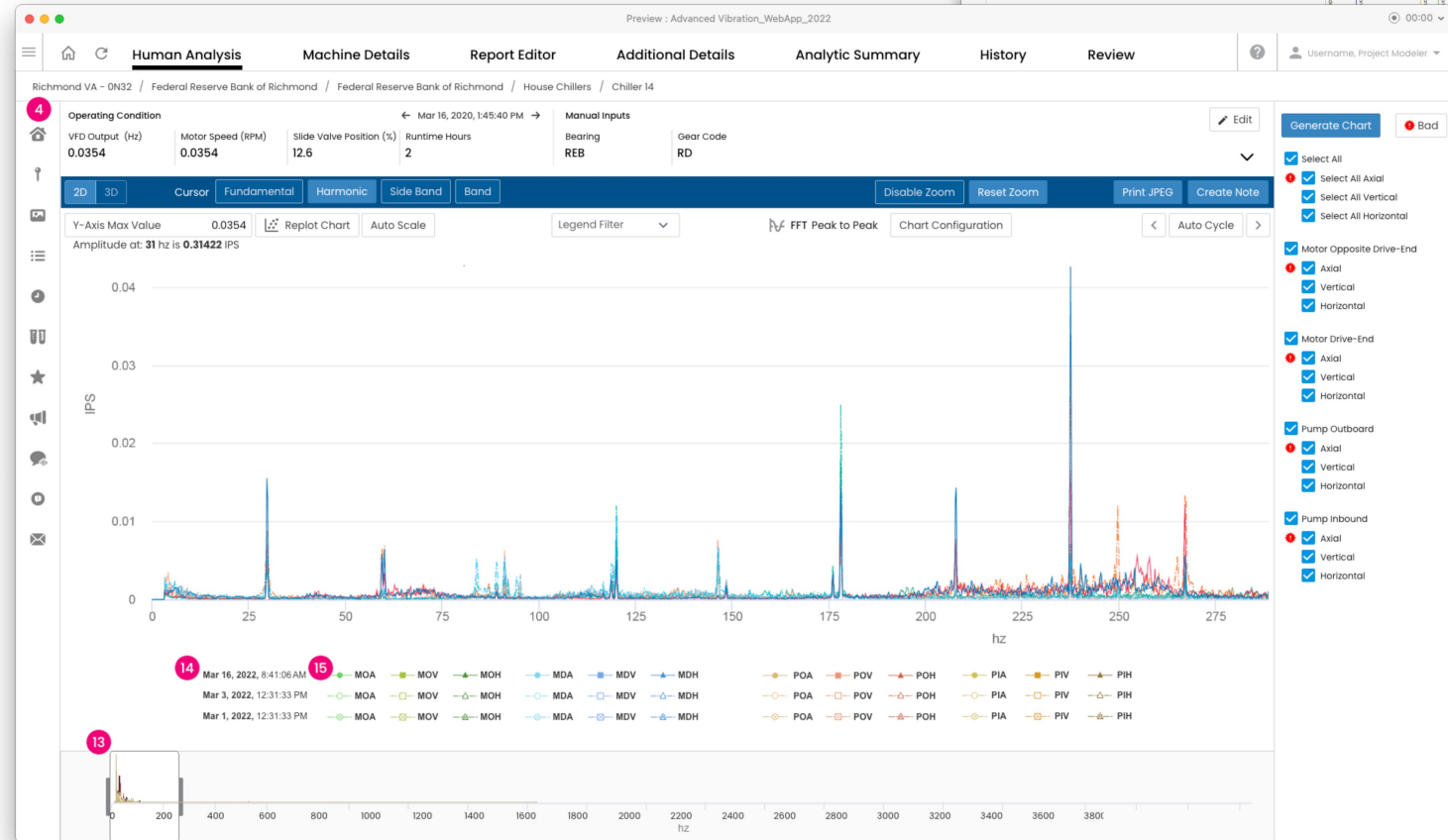
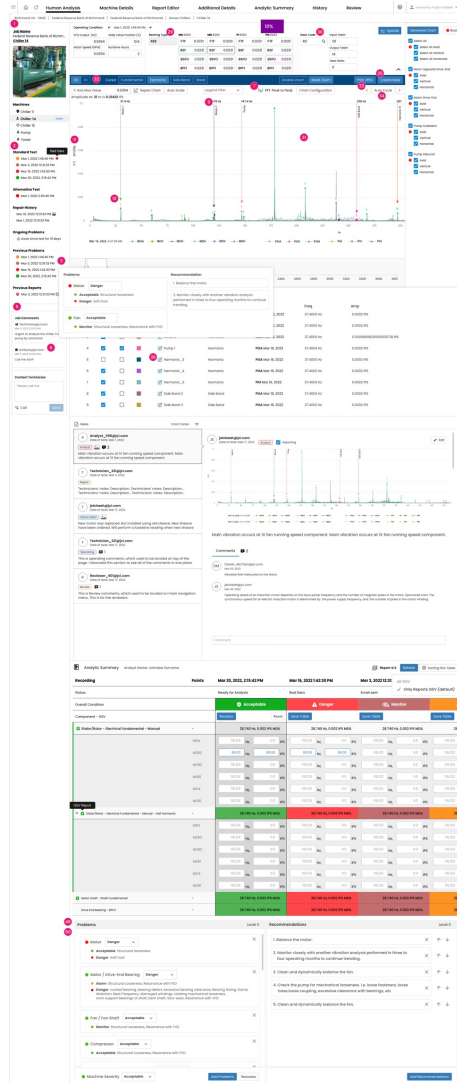


# 3D 90 Skewed & Even placed traces

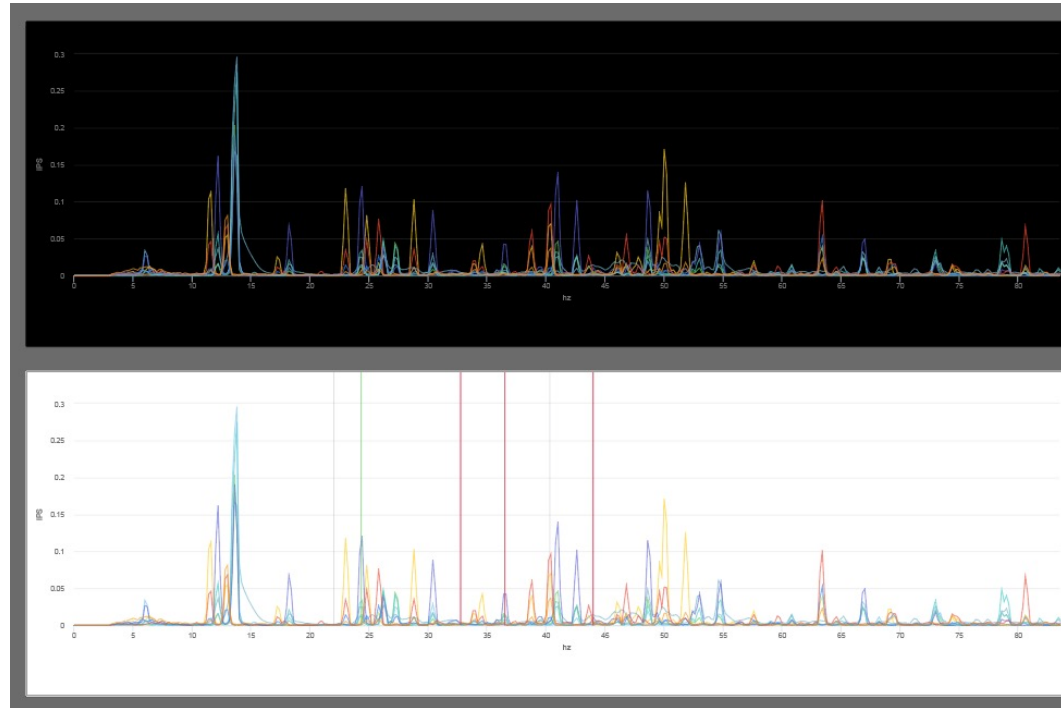


# Results

# Graphs in the web app



Dark mode



Thank you!

If we still have time...

# Web App Other Major Changes

Navigation



Top(Global) navi

Sub navi:  
machines

The dashboard is divided into several sections:

- Top Navigation:** Includes tabs for MACHINE DETAILS, ADDITIONAL DETAILS, ANALYTIC SUMMARY, HISTORY, HUMAN ANALYSIS, REPORT EDITOR, and REVIEW.
- Machine Overview:** Shows details for 'Pkg2.0.0\_package' and 'Pkg2.0.0\_machine', including a photo of the machine, a date selector (Apr 1, 2020), and input fields for '% of Full Load', 'Motor Speed: RPM', and 'VFD Output - Hz'. A 'Update Operating Conditions' button is present.
- Chart Filter / Bad data filter:** A table with columns for 'Motor Drive End Bearing', 'Motor Offend Bearing', and 'Compressor Points'. It has checkboxes for 'Select All', 'Analog', 'Vertical', and 'Horizontal'.
- Chart & Chart controls:** A line chart showing 'V-Axis Max Value' over time. It includes controls for 'Fundamental Cursor', 'Normal Cursor', 'Saw Band Cursor', 'Band Cursor', 'Table Zoom', 'Disable Zoom', 'Reset', and 'Print pdf'. A legend at the bottom identifies various data series like 'MDV 4/1/2020', 'MDH 4/1/2020', etc.
- Cursor detail / Basic Parameter:** A table with columns: 'SI No.', 'Show', 'Label', 'Color', 'Name', 'Type', 'Trace', 'Freq', and 'Amp'. It lists parameters like 'Fundamental'.
- All notes (Analysts, Repair, Observation):** A grid of note cards categorized into 'Analyst Notes', 'Repair Notes', and 'Observations'. Each card shows a date, author, and a small image or icon.
- GSV table:** An 'Analytic summary' table with columns for 'Component - GSV', 'Points', and 'Status'. It lists various machine components like 'Rotor/Stator - Magnetic Field - Auto' and 'Motor Shaft - Shaft Fundamental'.

Chart filter / Bad data filter

Chart & Chart controls

Cursor detail / Basic Parameter

All notes  
(Analysts, Repair, Observation)

GSV table

Top(Global) navi

Sub navi

All about the machine and analysis and test history

The screenshot displays the 'Human Analysis' software interface. At the top, there's a navigation bar with tabs for 'Machine Details', 'Report Editor', 'Additional Details', 'Analytic Summary', 'History', and 'Review'. The left sidebar contains a 'Machines' list, 'Analysis (Fault) History', 'Sweep Test History', 'Repair History', 'Ongoing Issues', 'Operating Conditions', 'Primary Comments', and 'Contact Directly Technicians'. The main area is divided into several sections: a 'Cursor Details' table, a 'Recording' table, and 'Analytic Notes'. The 'Recording' table shows data for four different time points, with columns for status, overall condition, component, and various vibration metrics. The 'Analytic Notes' section at the bottom contains three notes with associated images and text.

Chart filter / Bad data filter

Chart & Chart controls

Cursor detail / Basic Parameter

GSV table

All notes (Analysts, Repair, Observation)

# Major changes (1) Human Analysis/Navigate machines & Filters

## Current

**Navi for machine**

**Bearing Filter**

Select All	Motor Drive End Bearing	Motor Offend Bearing	Compressor Points
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## Prototype

**New**

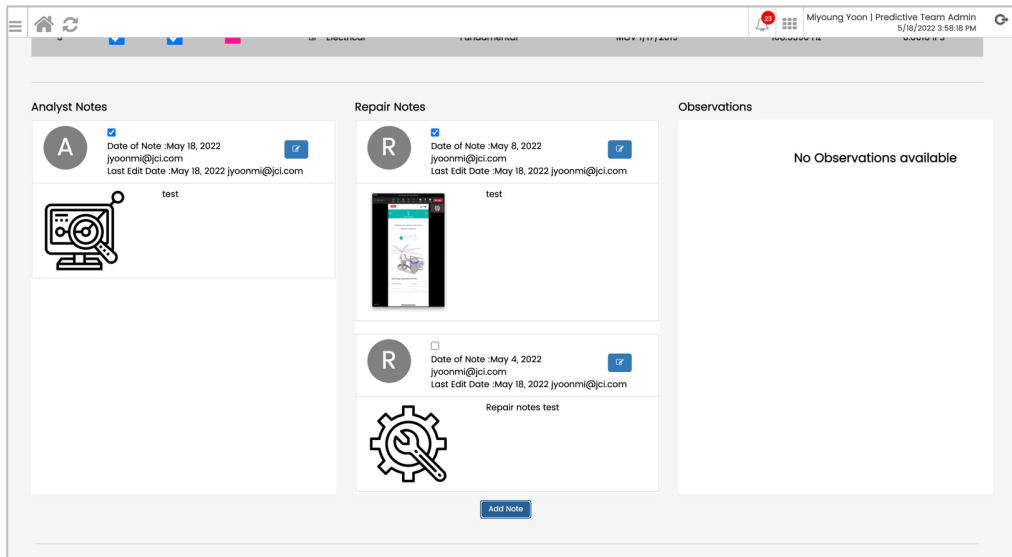
**Bearing Filter**

**Bearing Filter**

Sr No.	Show	Label	Color	Name	Type	Trace	Freq.	Amp
1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Green	Side Band 1	Side Band	MOA Mar 16, 2022	37.4000 Hz	0.0002 IPS
2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Blue	Motor 1	Harmonic	MDA Mar 16, 2022	37.4000 Hz	0.0002 IPS
3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Red	Motor 2	Harmonic	MDA Mar 16, 2022	37.4000 Hz	0.0000890820518302578 IPS
4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Purple	Pump 1	Harmonic	POA Mar 16, 2022	37.4000 Hz	0.0002 IPS
5	<input type="checkbox"/>	<input type="checkbox"/>	Black	Harmonic_3	Harmonic	POA Mar 16, 2022	37.4000 Hz	0.0002 IPS

# Major changes (2) Human Analysis /Notes

## Current



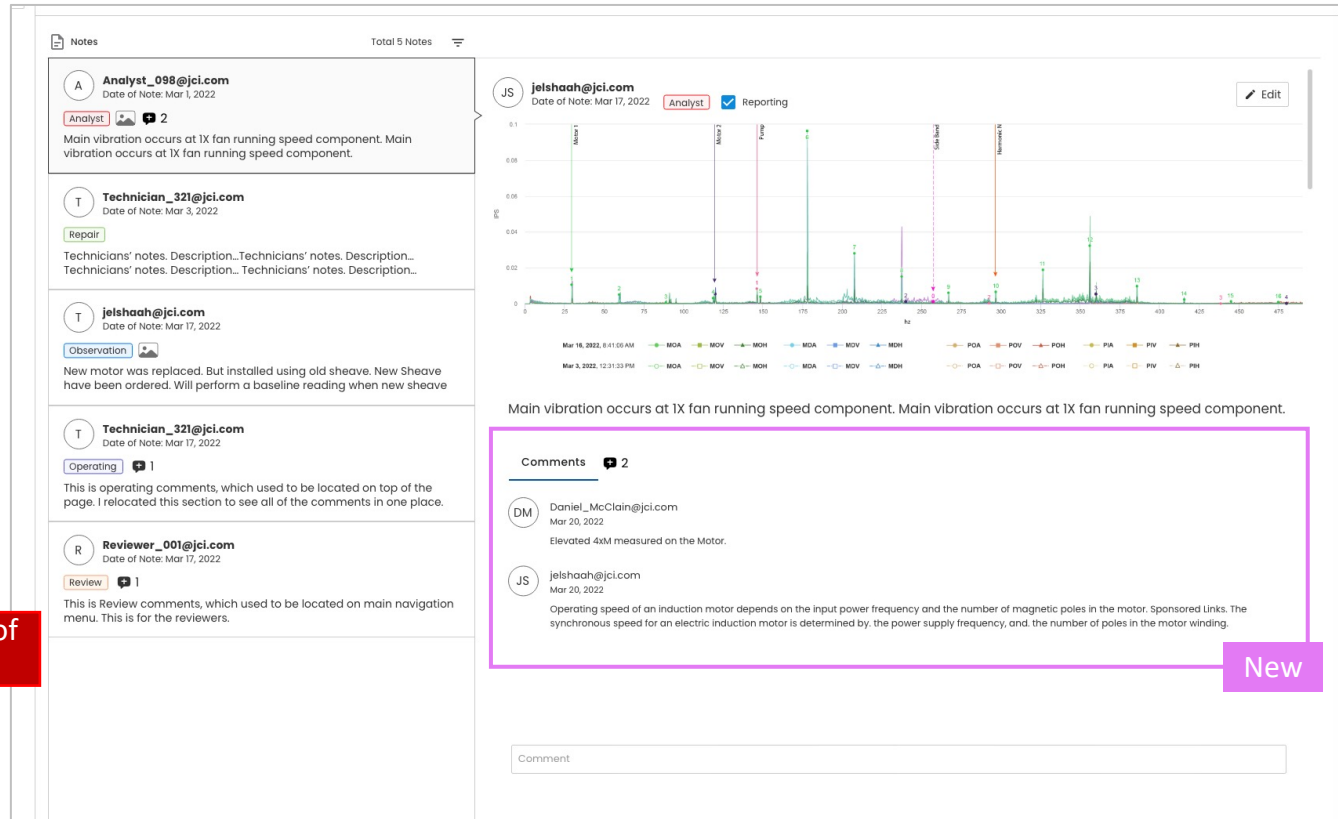
5 types of notes

## Create Note:

- Easy to capture the spectrum images with one click
- Reduce the error of wrong images uploaded to reports



## Prototype

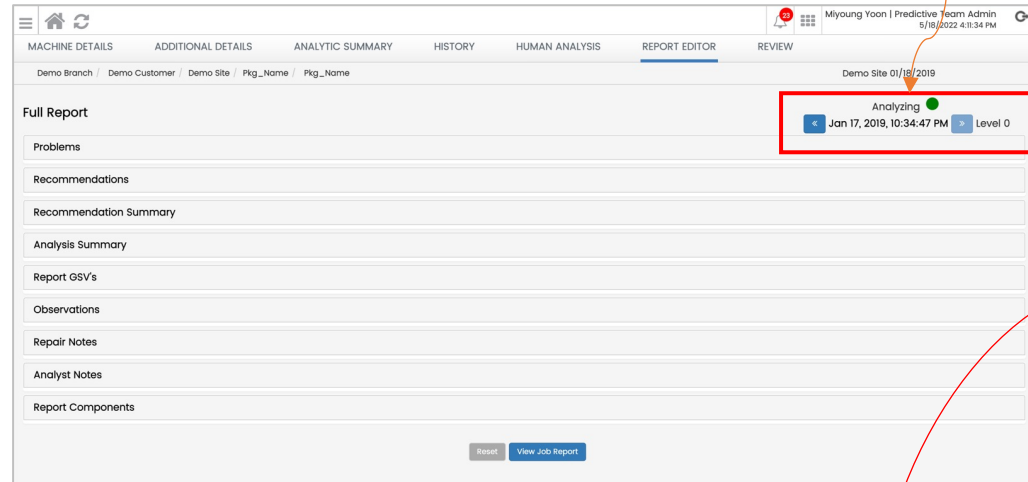


## ✂ Consider:

- Remove the other notes sections, and structures change impacts
- Comments notification

# Major changes (2) Report/Navigation & Sections

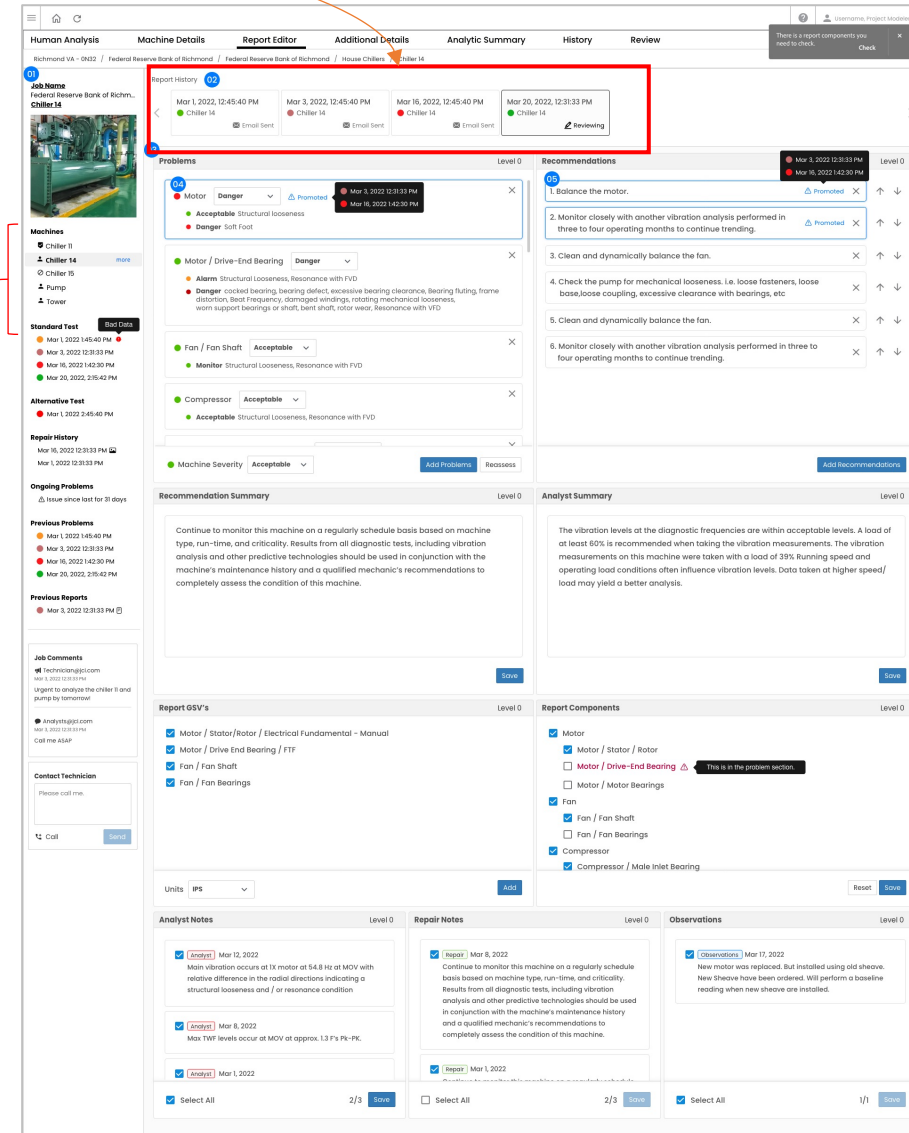
## Current



Navi for Previous reports

Past Reports Navi:  
Move around previous reports and compare the ongoing problems easily

## Prototype



Left Navi / Machine lists:  
Faster to move to different machines report per jobs

**Thank you 😊**

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