

A Future “View” of Digital Data from Wearable Devices

Dan Schramek, GSK
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Agenda

Data Visualization Concepts for Digital Wearable Devices



Background

Time-Series Plots

Bar Charts

Summary Figures – Heat Maps

Background

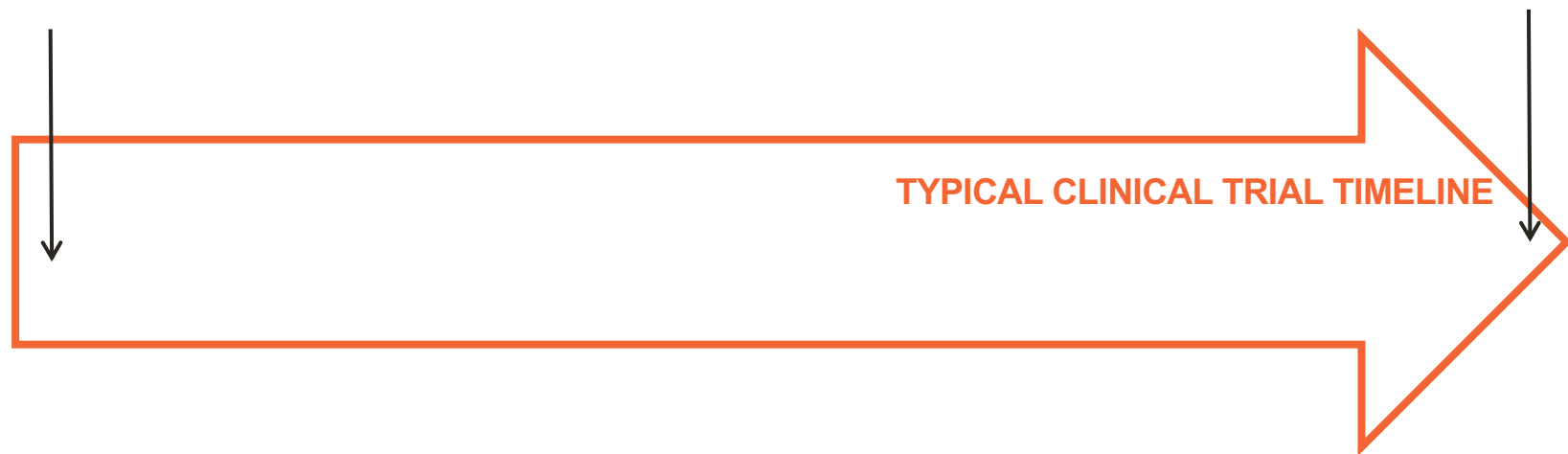
Background

Traditional Trial Study Designs



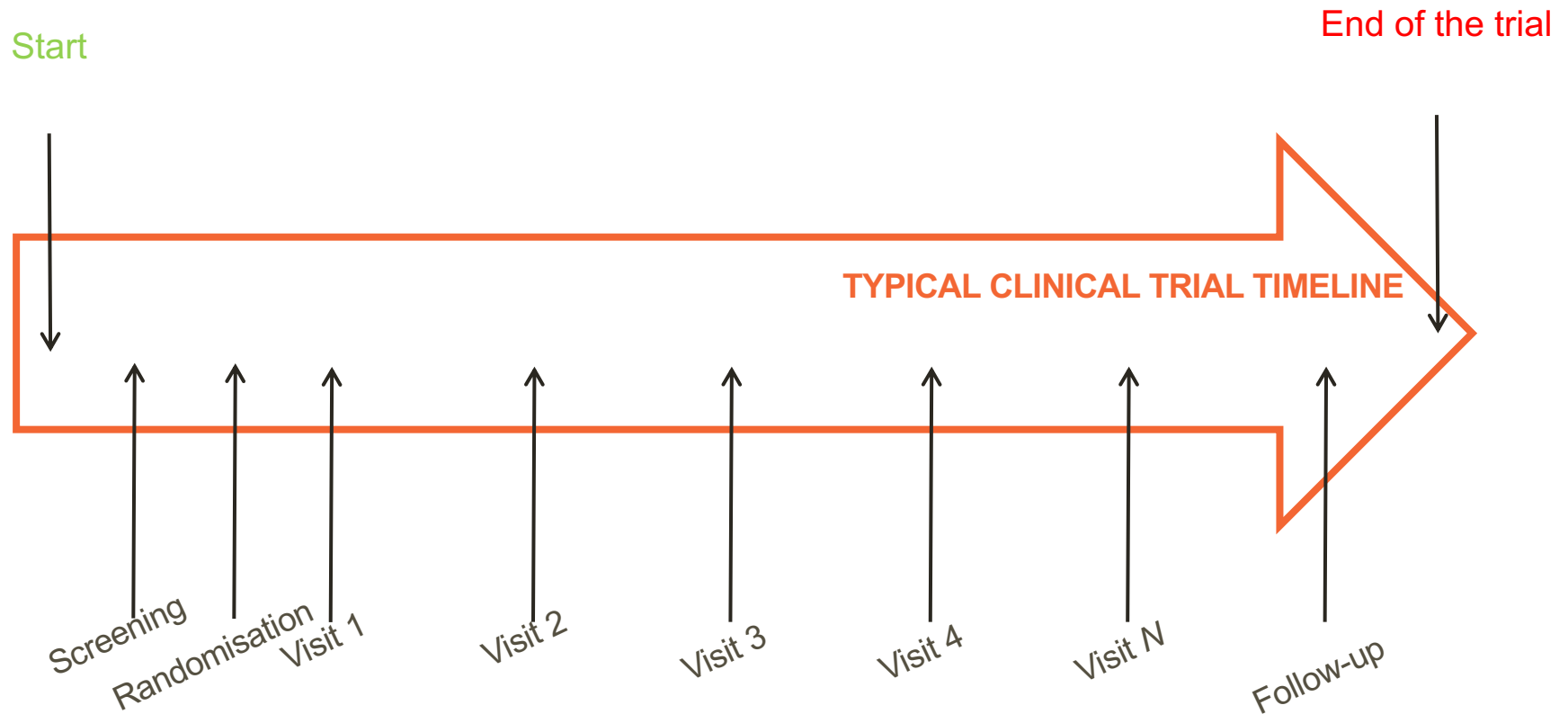
Start

End of the trial



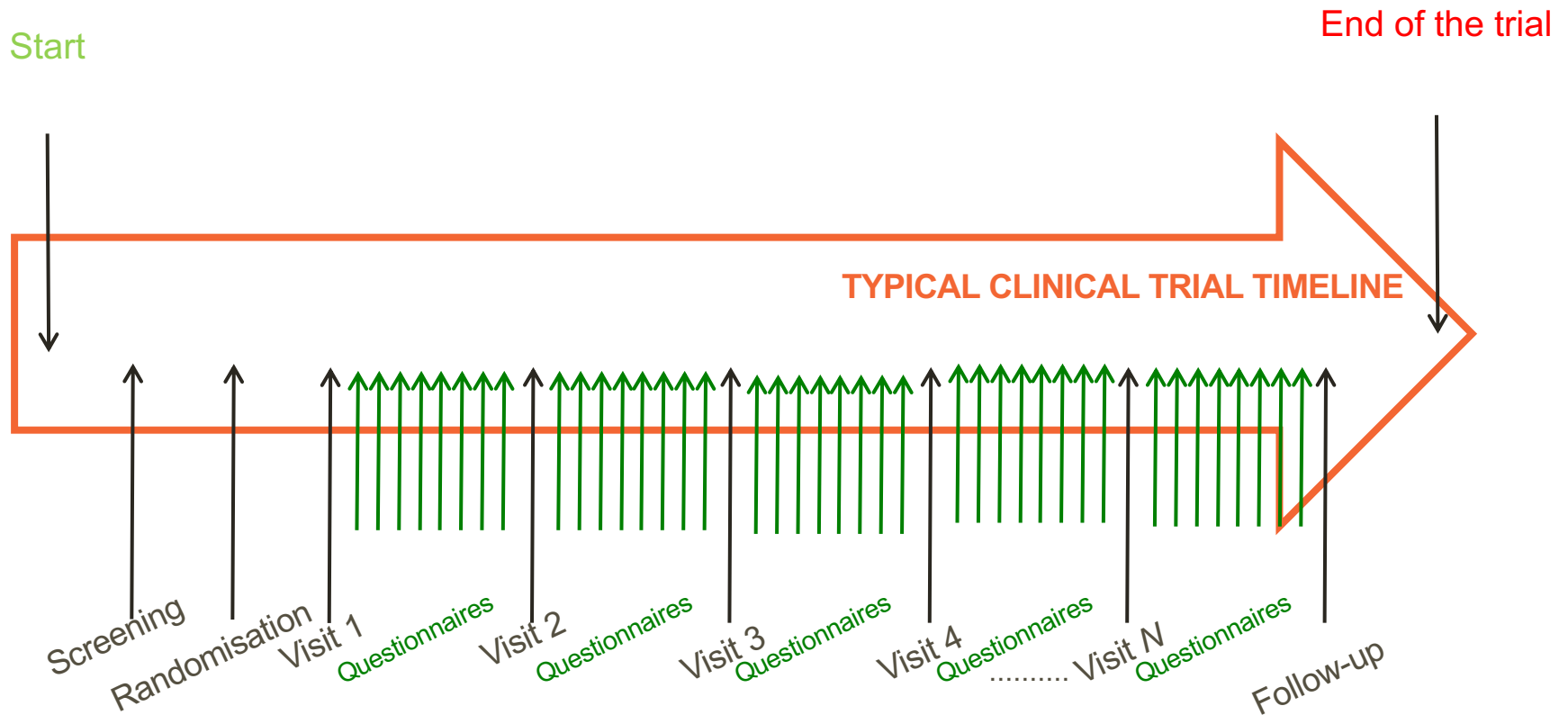
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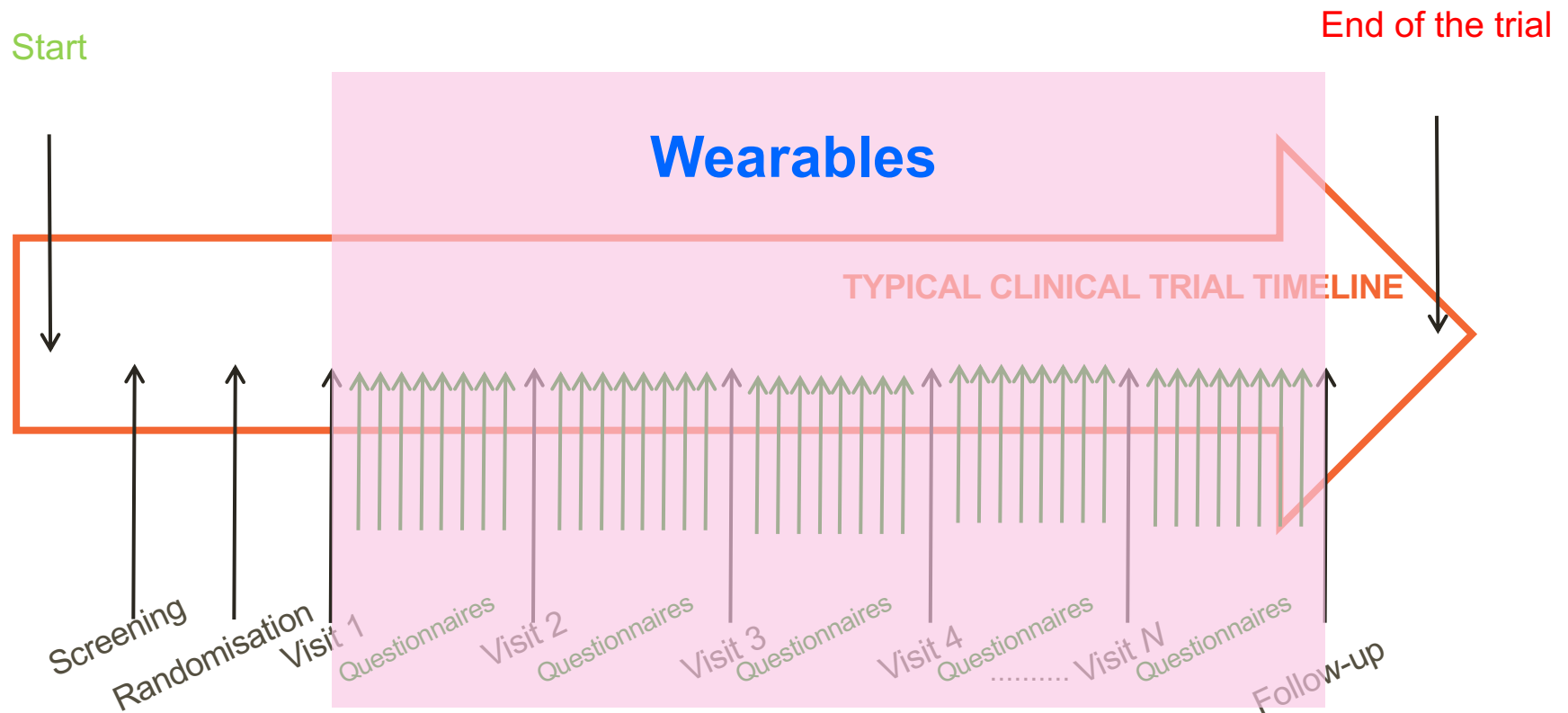
Background

Traditional Trial Study Designs



Background

Traditional Trial Study Designs



Benefits

Continuous, Objective measurement

Potential to discover novel endpoints

Potential for real-time data capture

'Real-World' data

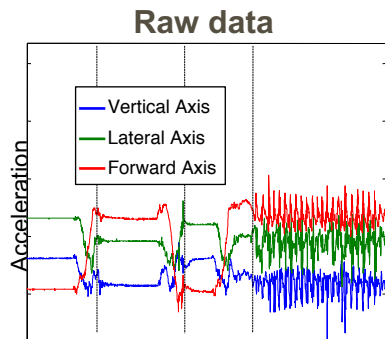
Challenges

Regulatory requirements – devices & endpoints

Clinical acceptability and subject burden

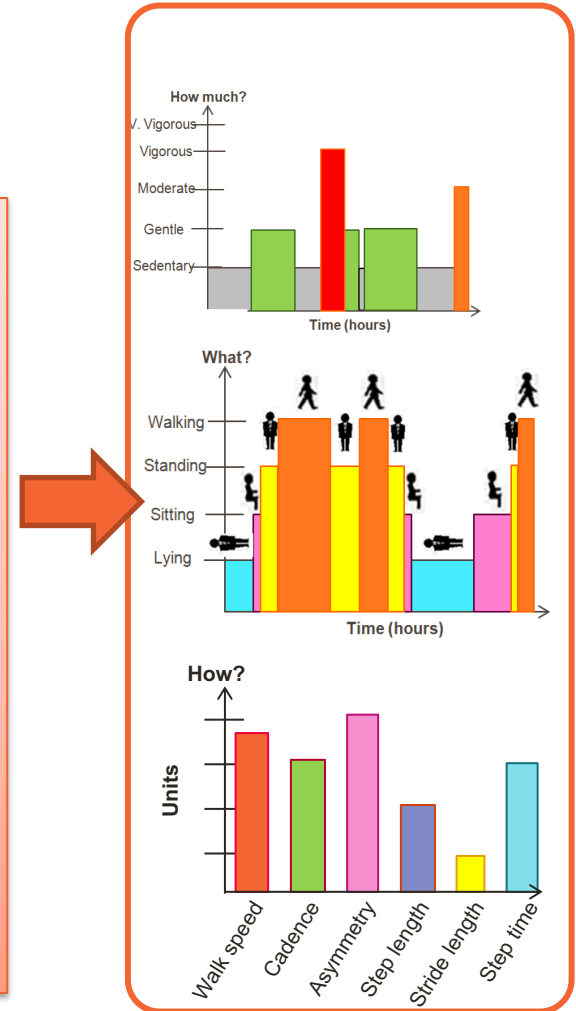
Data transmission, handling and Analytics

Initial operating costs and increased trial complexity



Minute-by-minute data include:

- **METs**: rate of energy expenditure ($1 \text{ MET} = 1 \text{ Kcal Kg}^{-1} \text{ h}^{-1}$)
- **Total energy expenditure** (Kcal)
- **Number of steps**
- **Type of activity**: lying, standing, sitting, walking, running
- **Intensity of activity**: sedentary, moderate, vigorous, very vigorous
- **Skin temperature**
- **Speed, distance, sleep...**



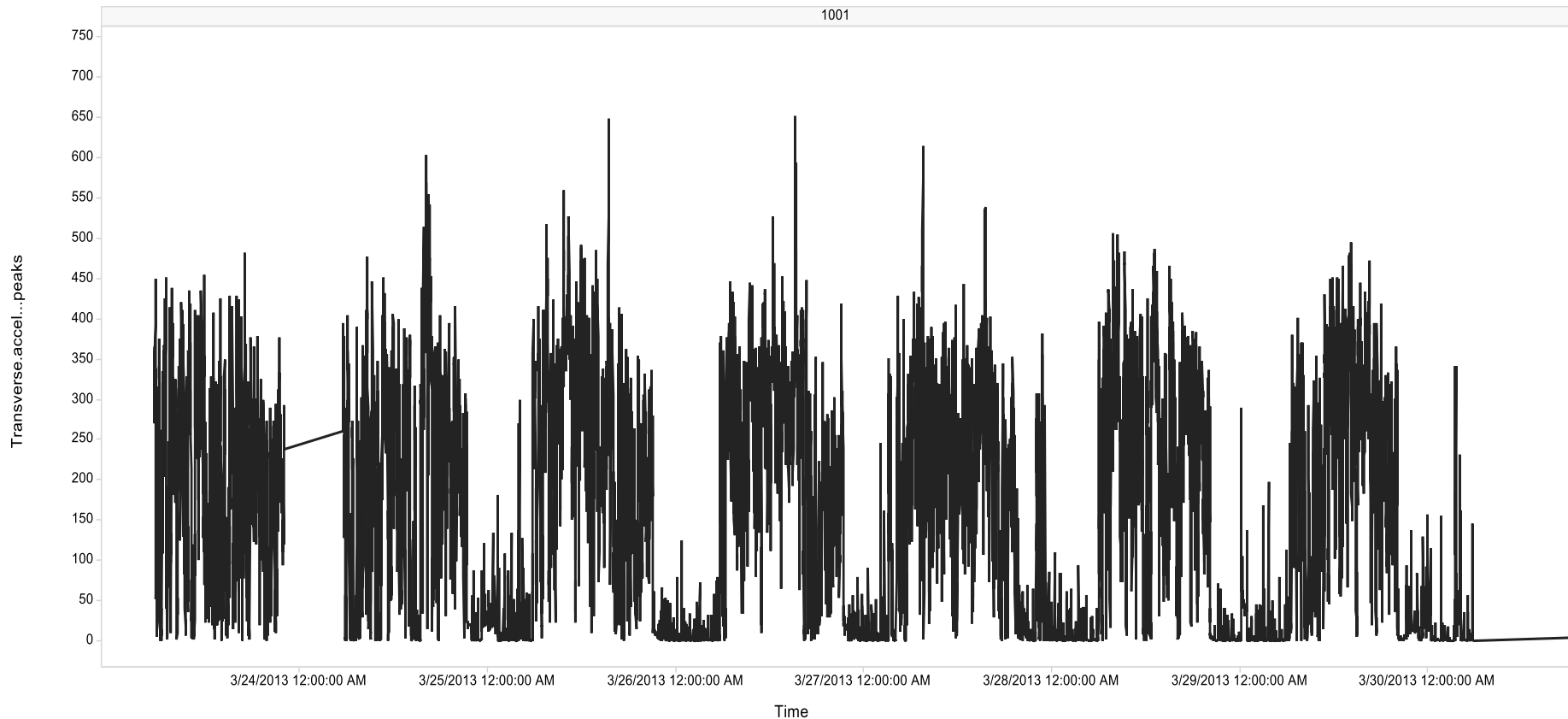
Time-Series Plots

Time-Series Plots



Digital Data from Wearable Devices is Complex!

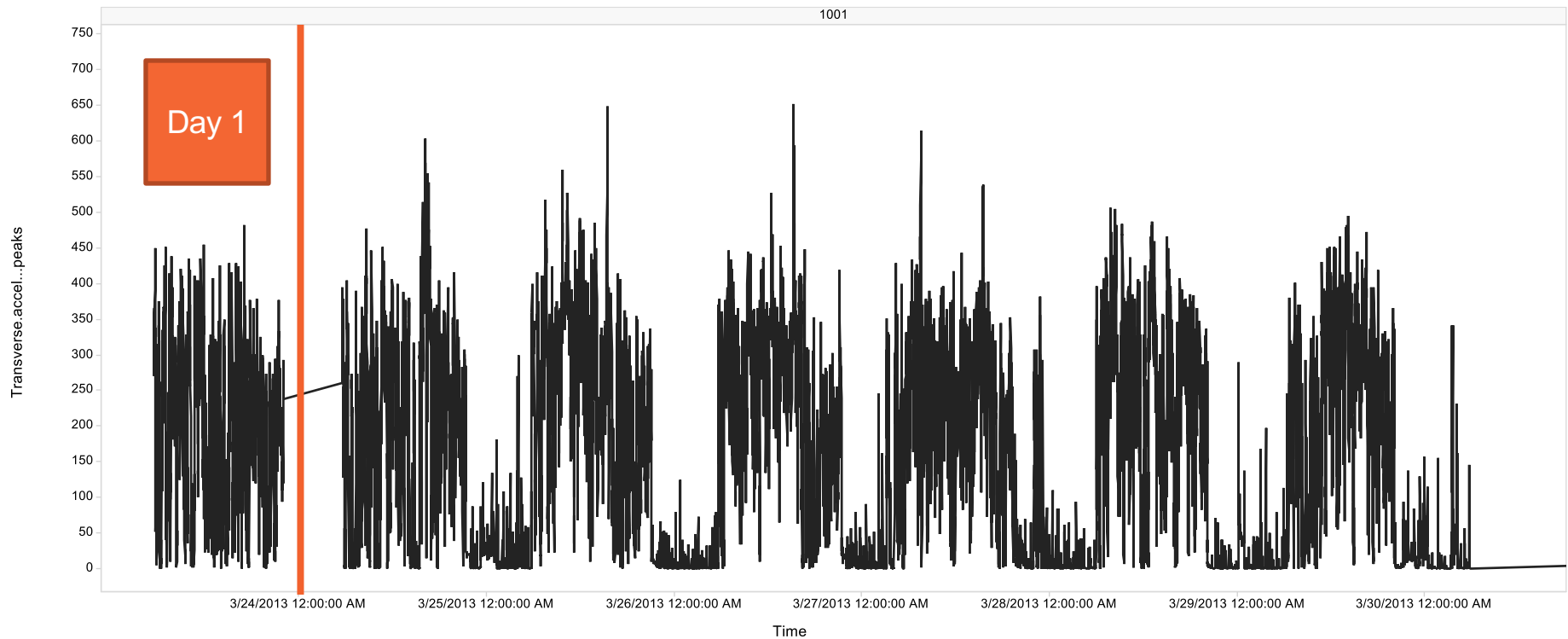
- 1 week Data Collection - 300 data points per second $\times$ 3600 seconds per hour $\times$ 24 hours per day $\times$ 7 days per week = **181.44 million** data points
- Minute-by-minute means below:



Time-Series Plots



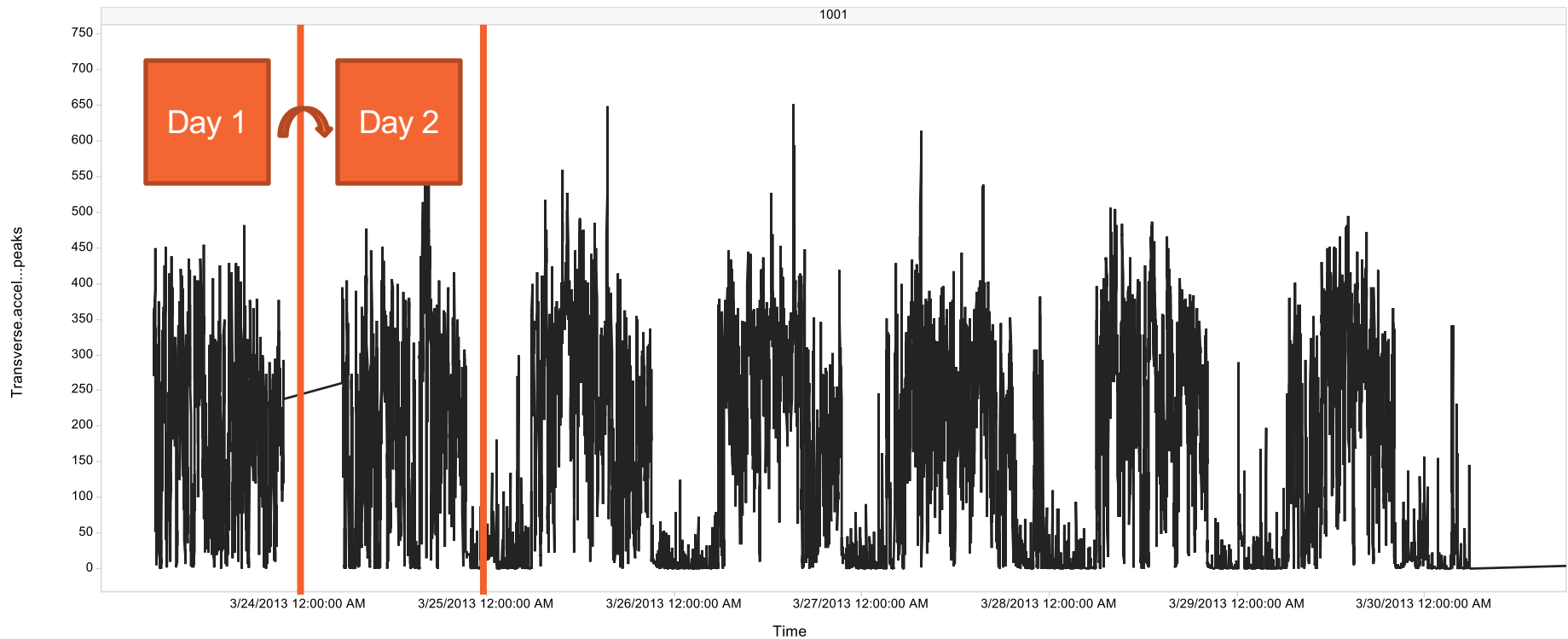
You can learn much about the quality and quantity of the data collection



Time-Series Plots



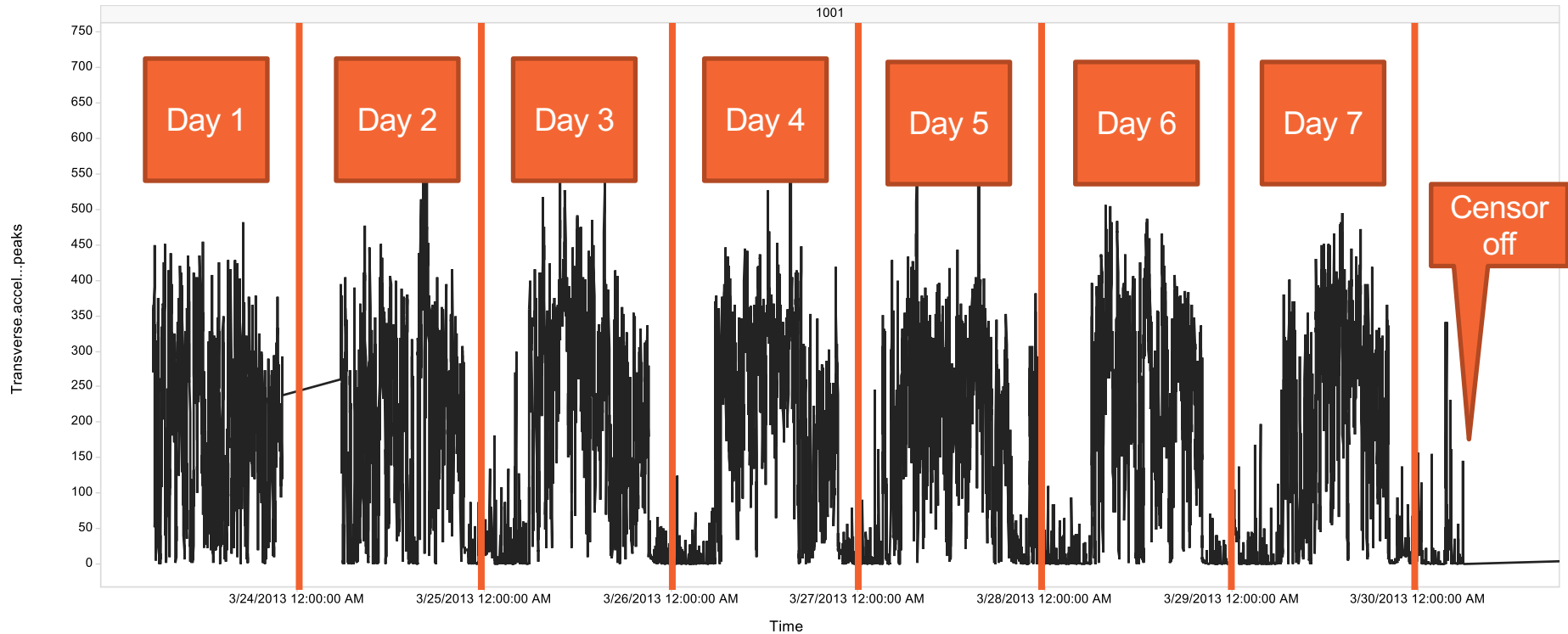
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Time-Series Plots



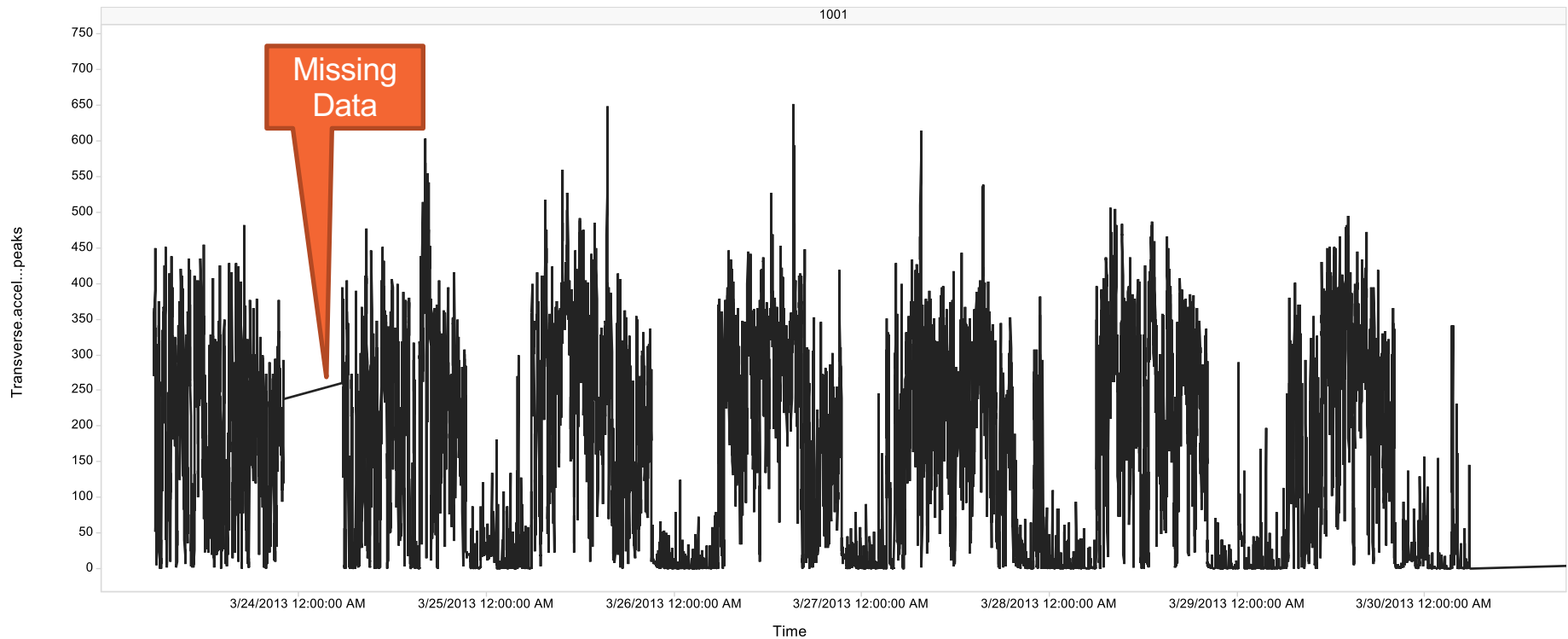
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Time-Series Plots



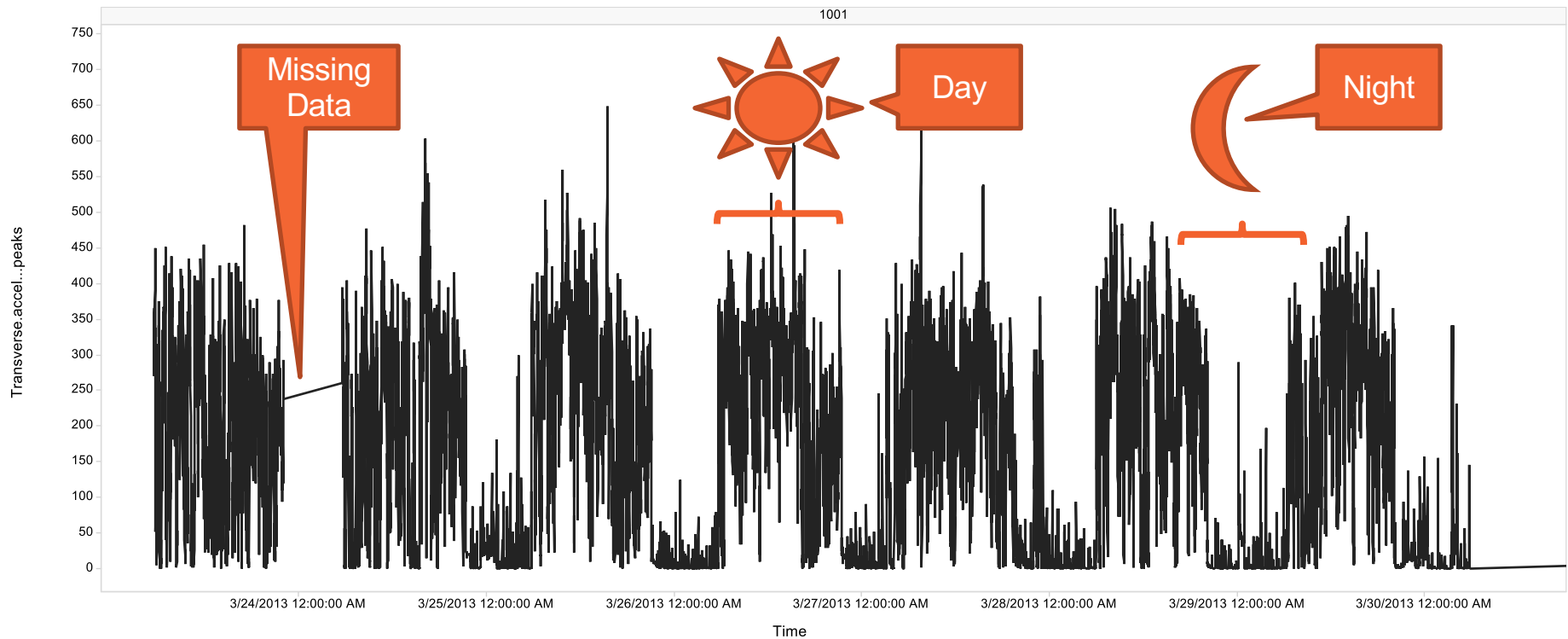
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Time-Series Plots



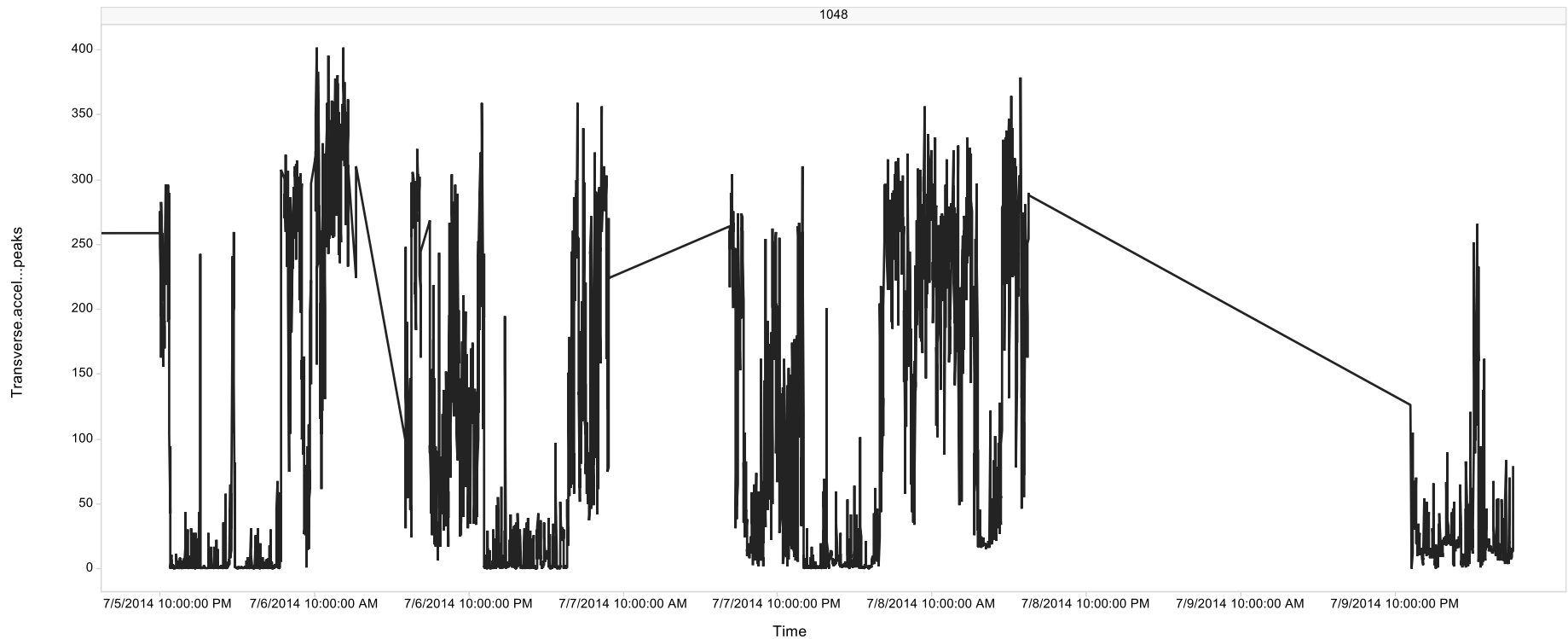
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Time-Series Plots



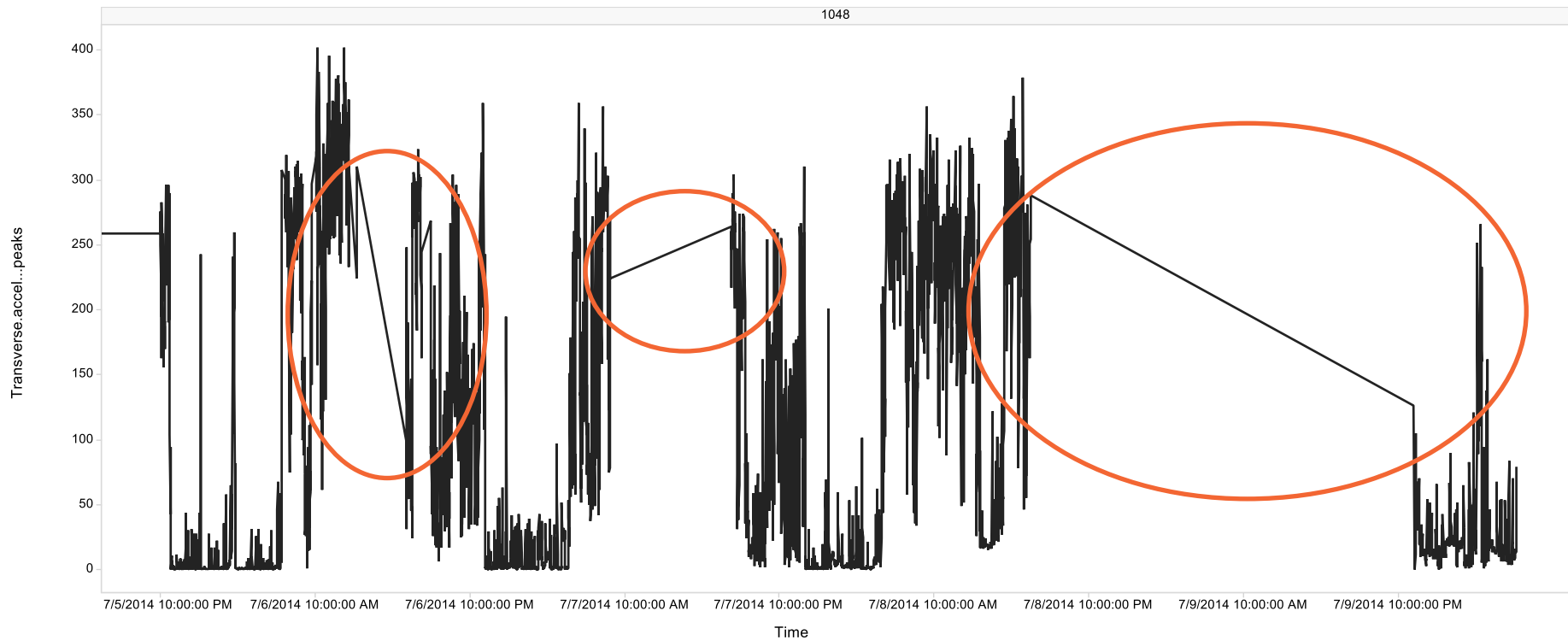
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Time-Series Plots



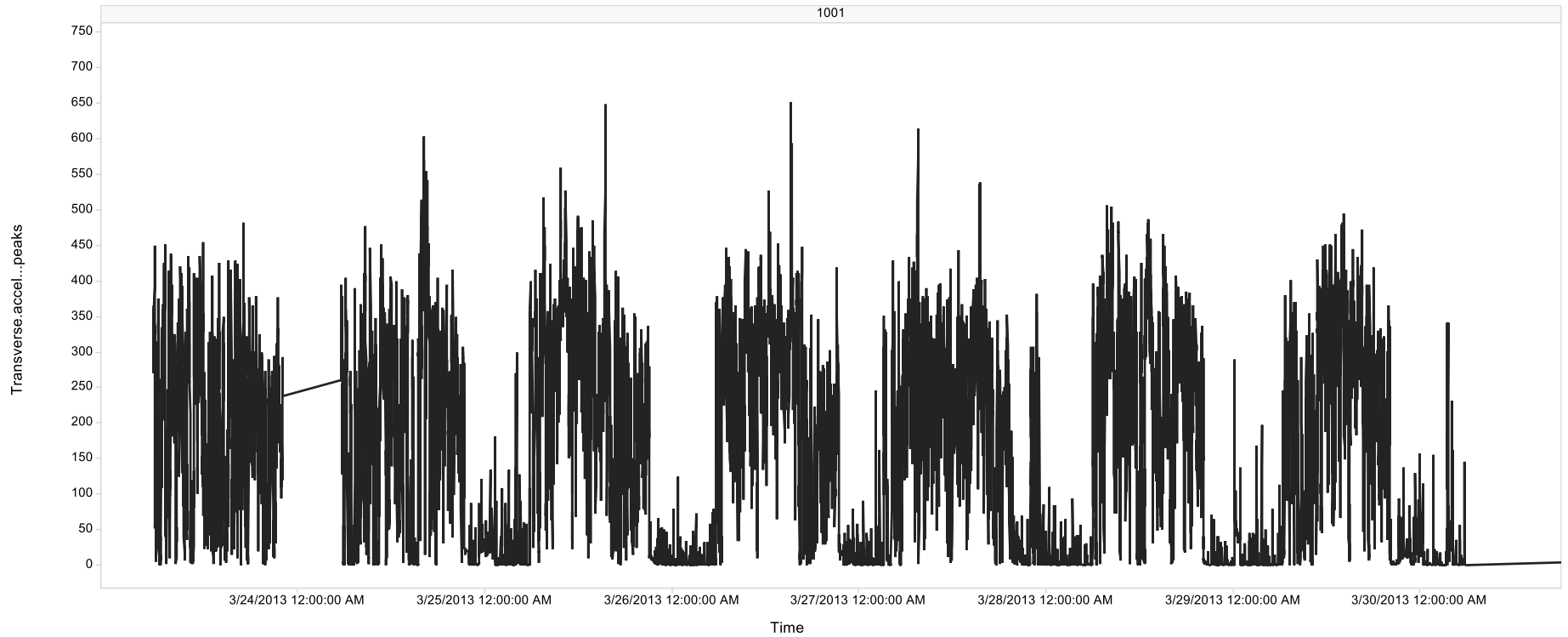
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Time-Series Plots



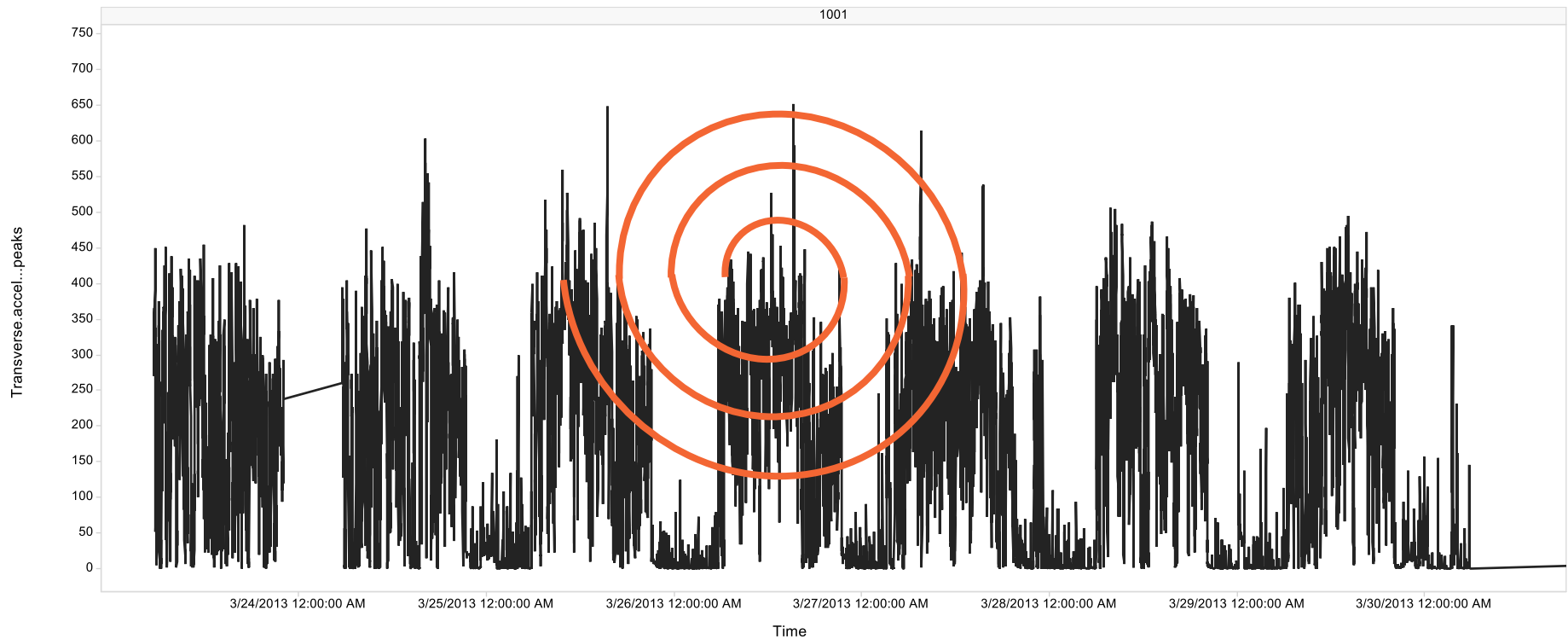
Spiral Plots



Time-Series Plots

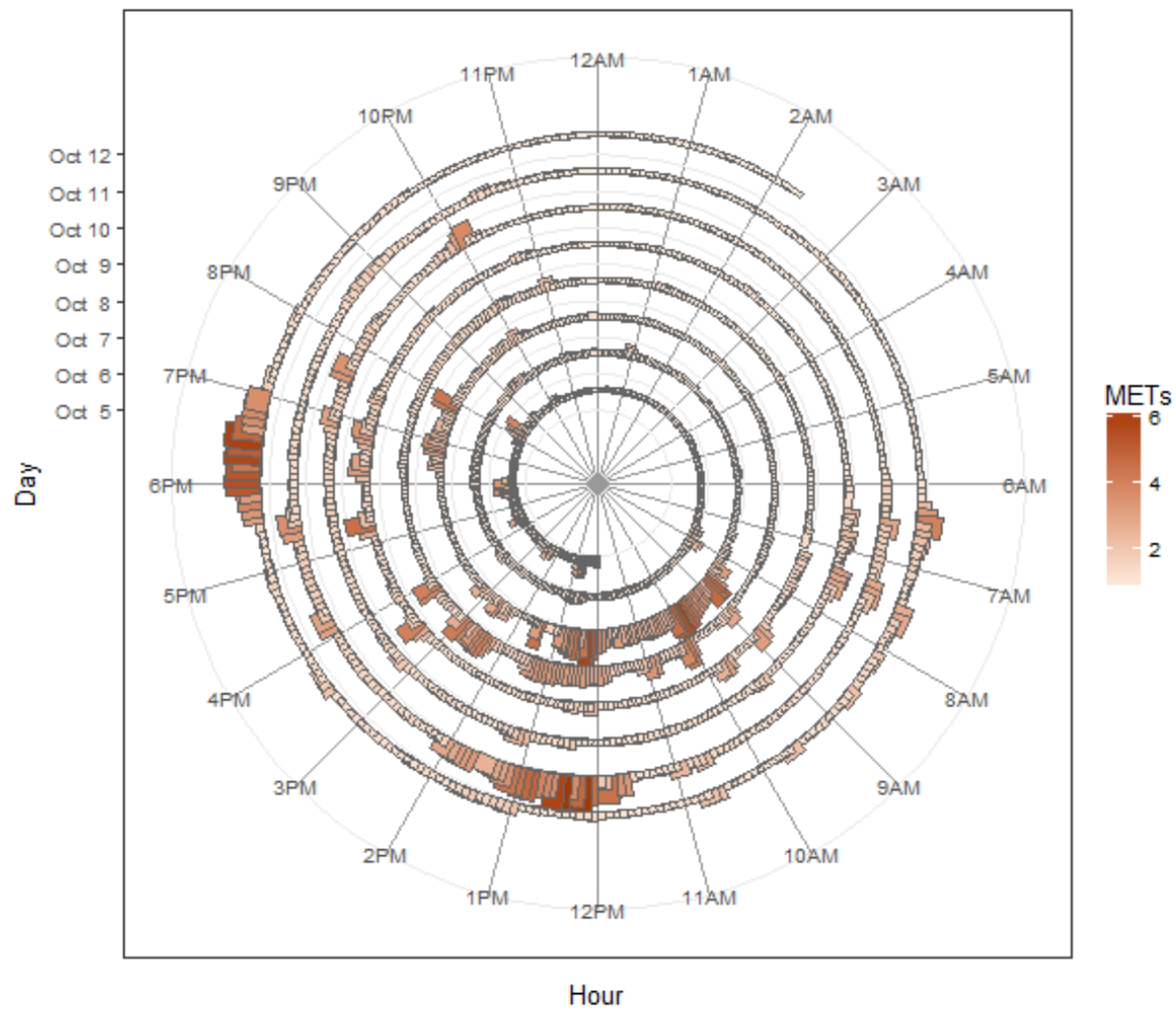


Spiral Plots



Time-Series Plots

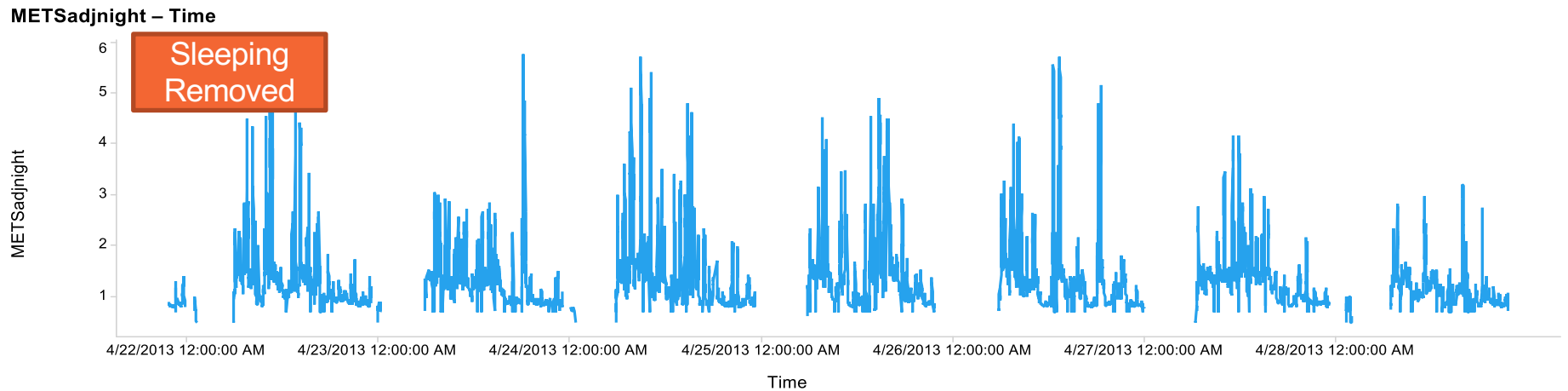
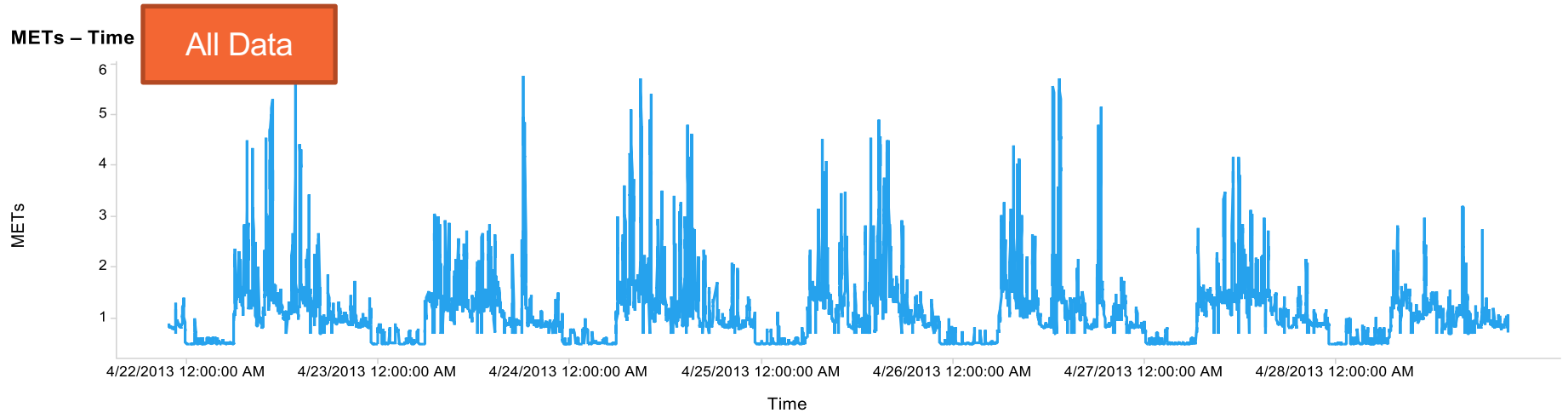
Spiral Plot



Time-Series Plots



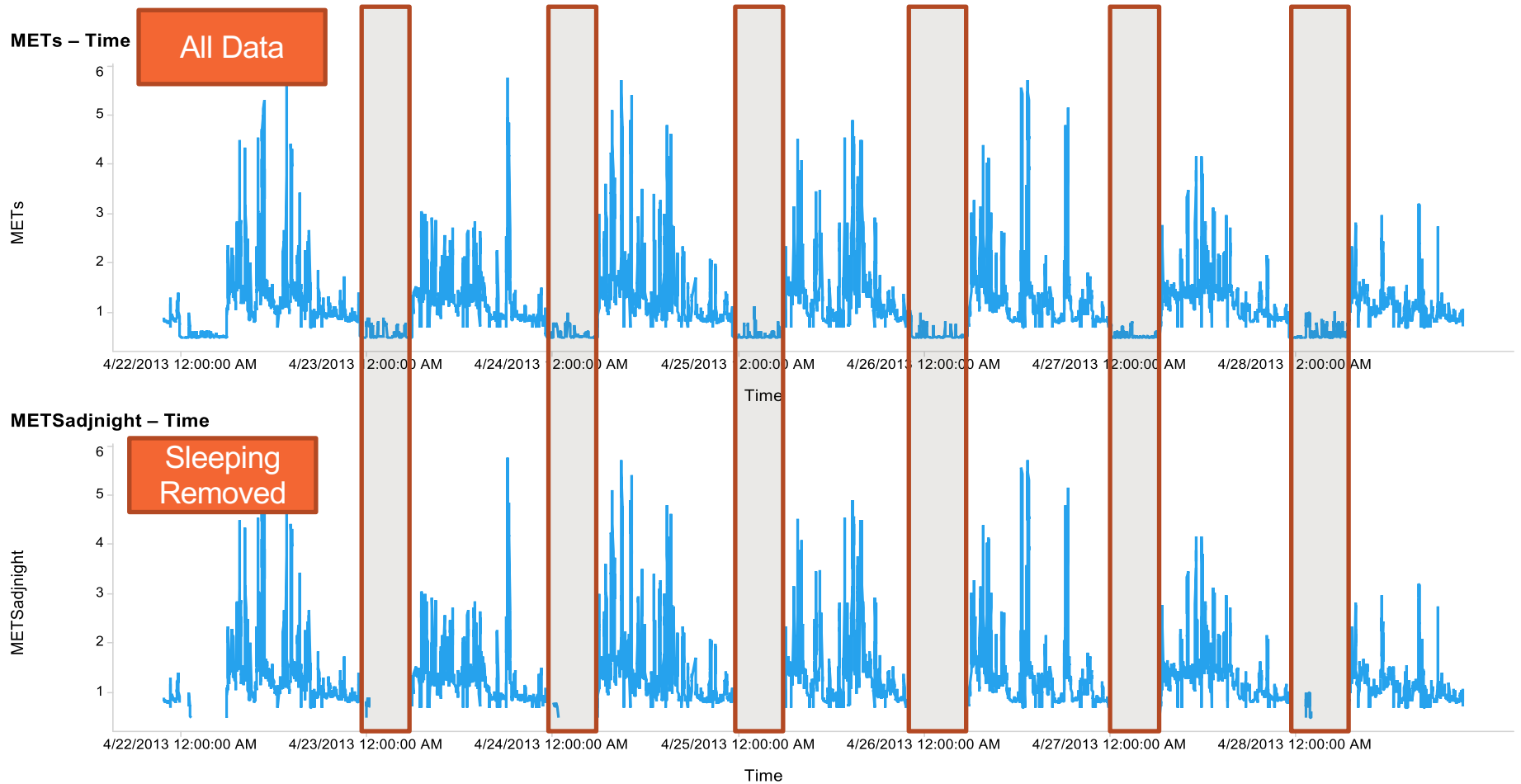
Time Spent Sleeping



Time-Series Plots



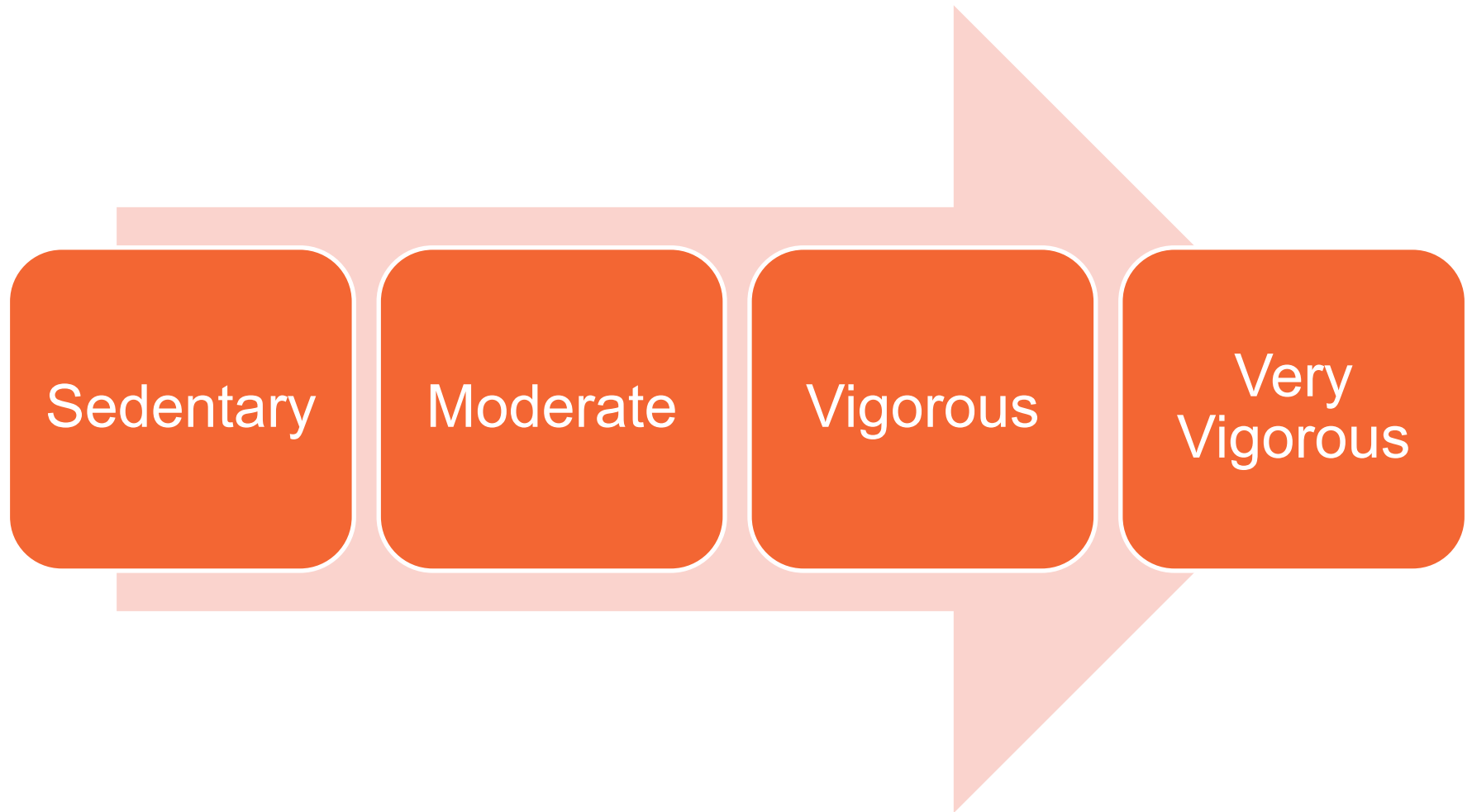
Time Spent Sleeping



Bar Charts

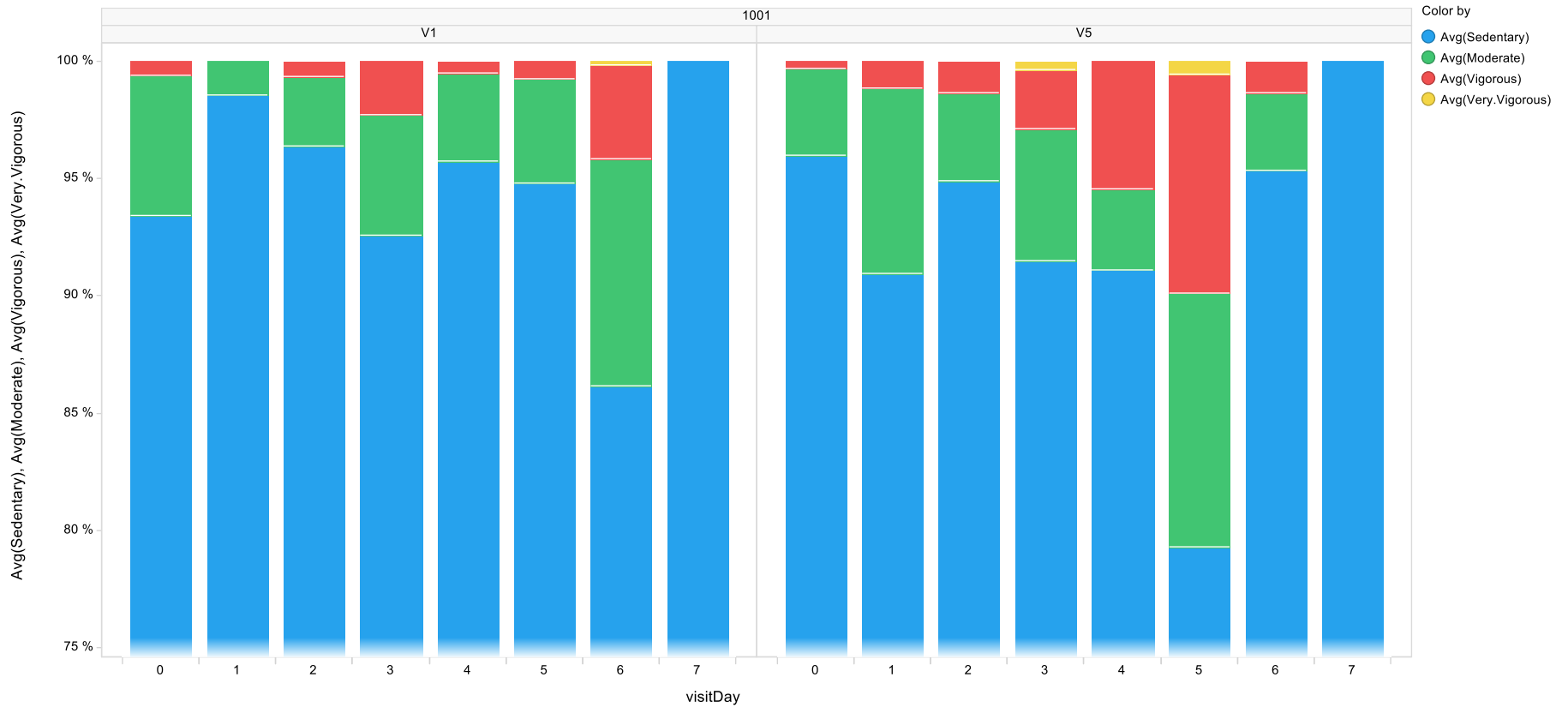
Time-Series Plots

Activity Categories



Bar Charts

100% Stacked Bar Chart

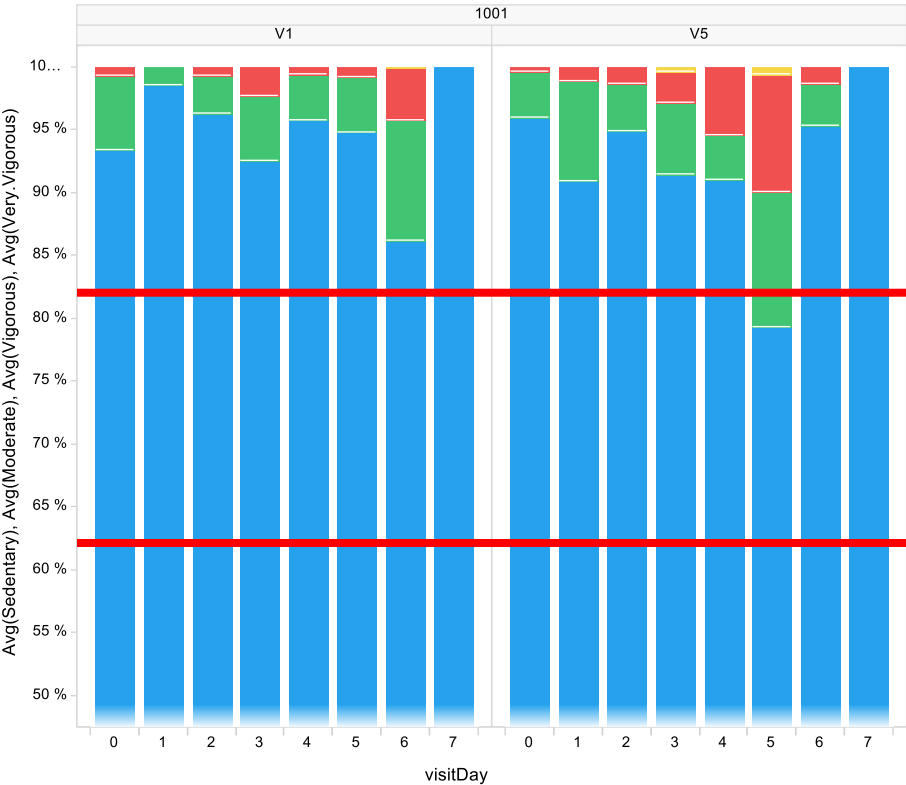


Bar Charts

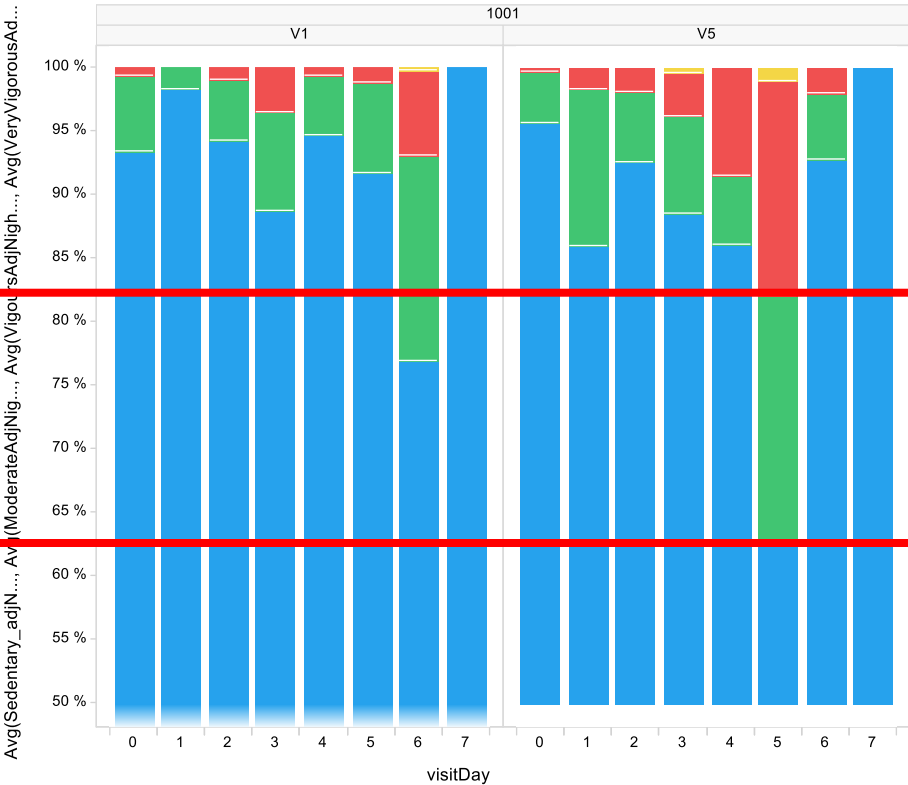
Time Spent Sleeping



Sedentary, Moderate, Vigorous, Very.Vigorous per visitDay

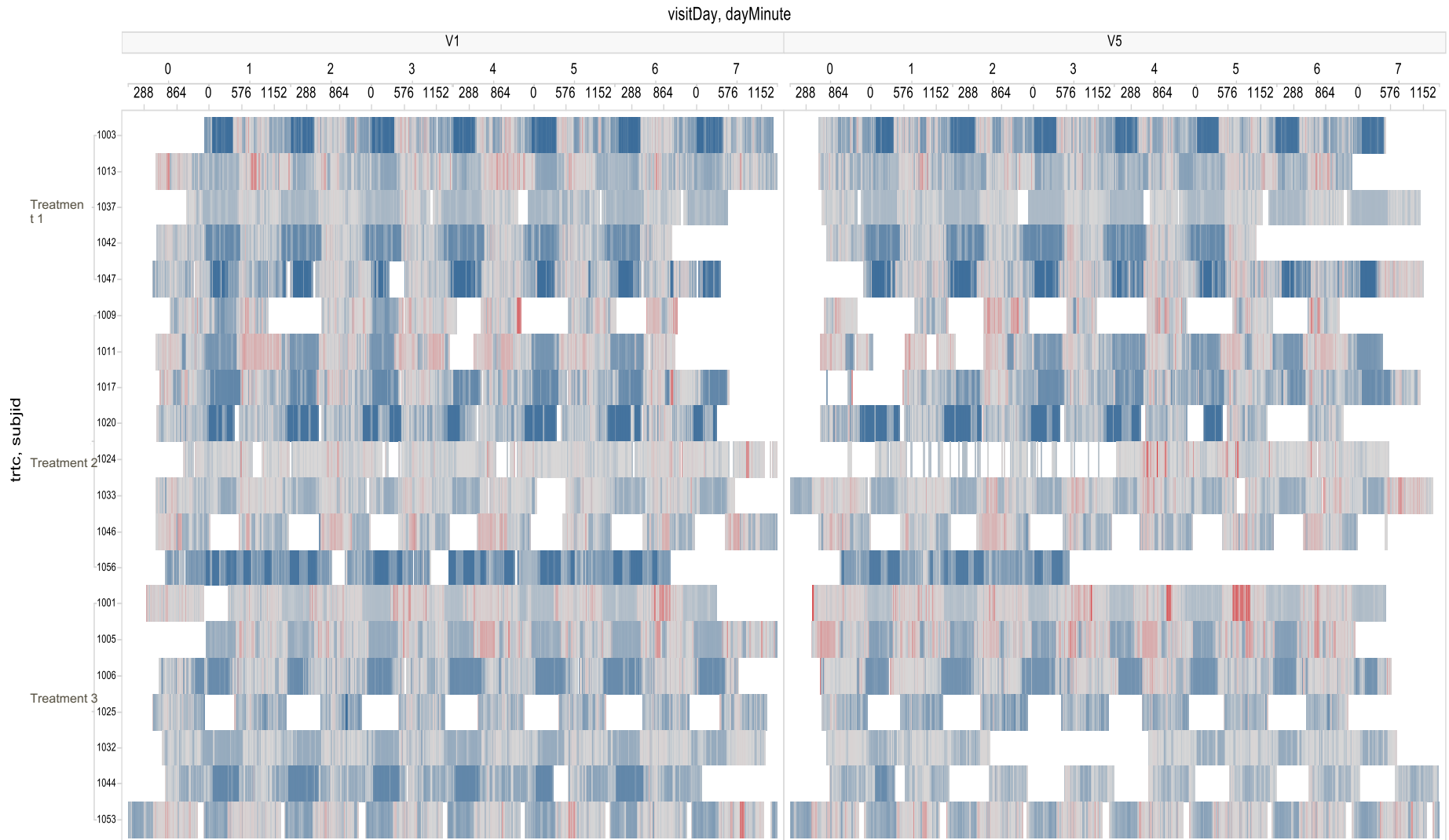


Sedentary_adjNight, ModerateAdjNight, VigoursAdjNight, VeryVigorousAdjNight per visitDay



Summary Figures – Heat Maps

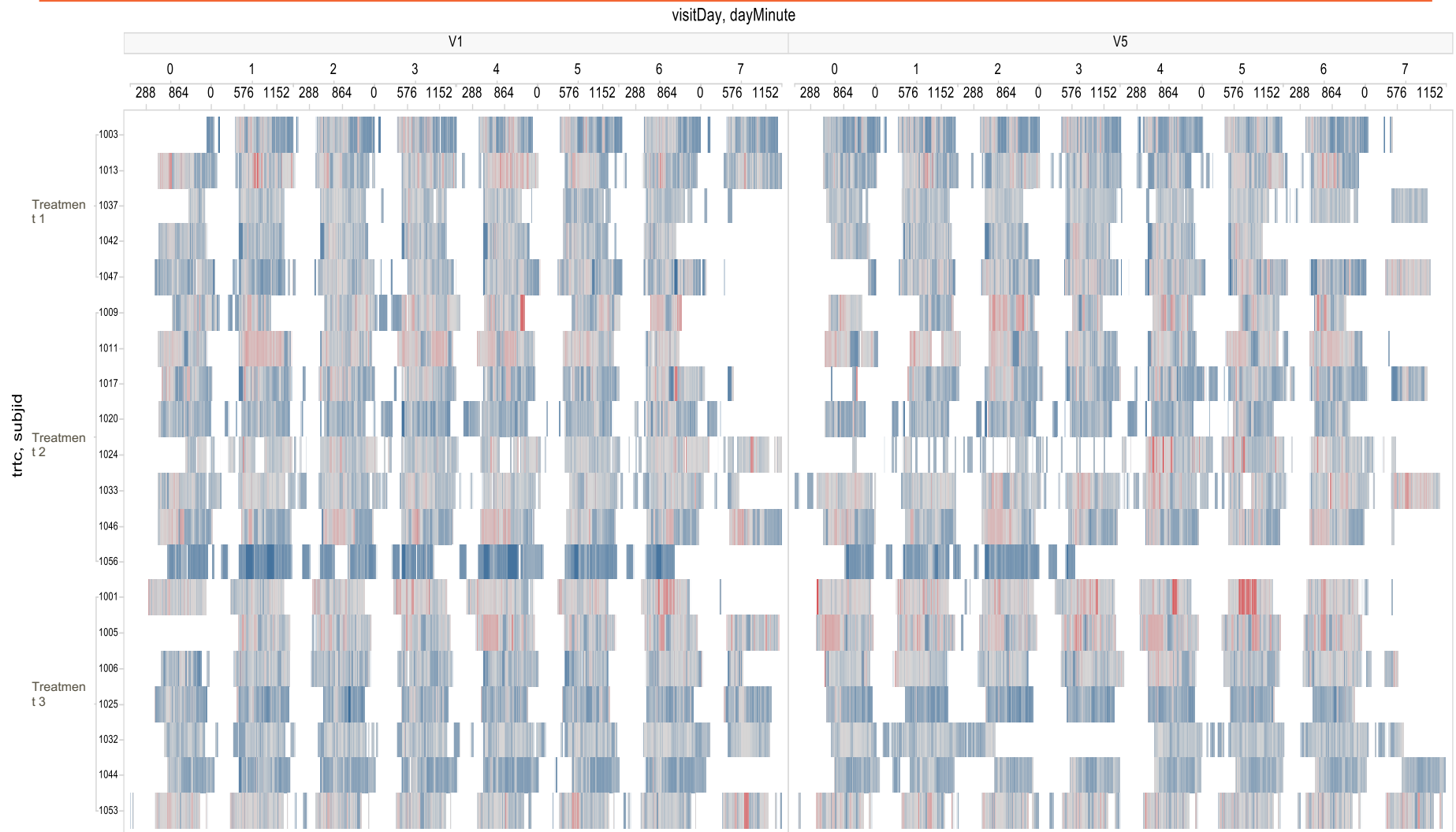
Summary Figures – Heat Maps



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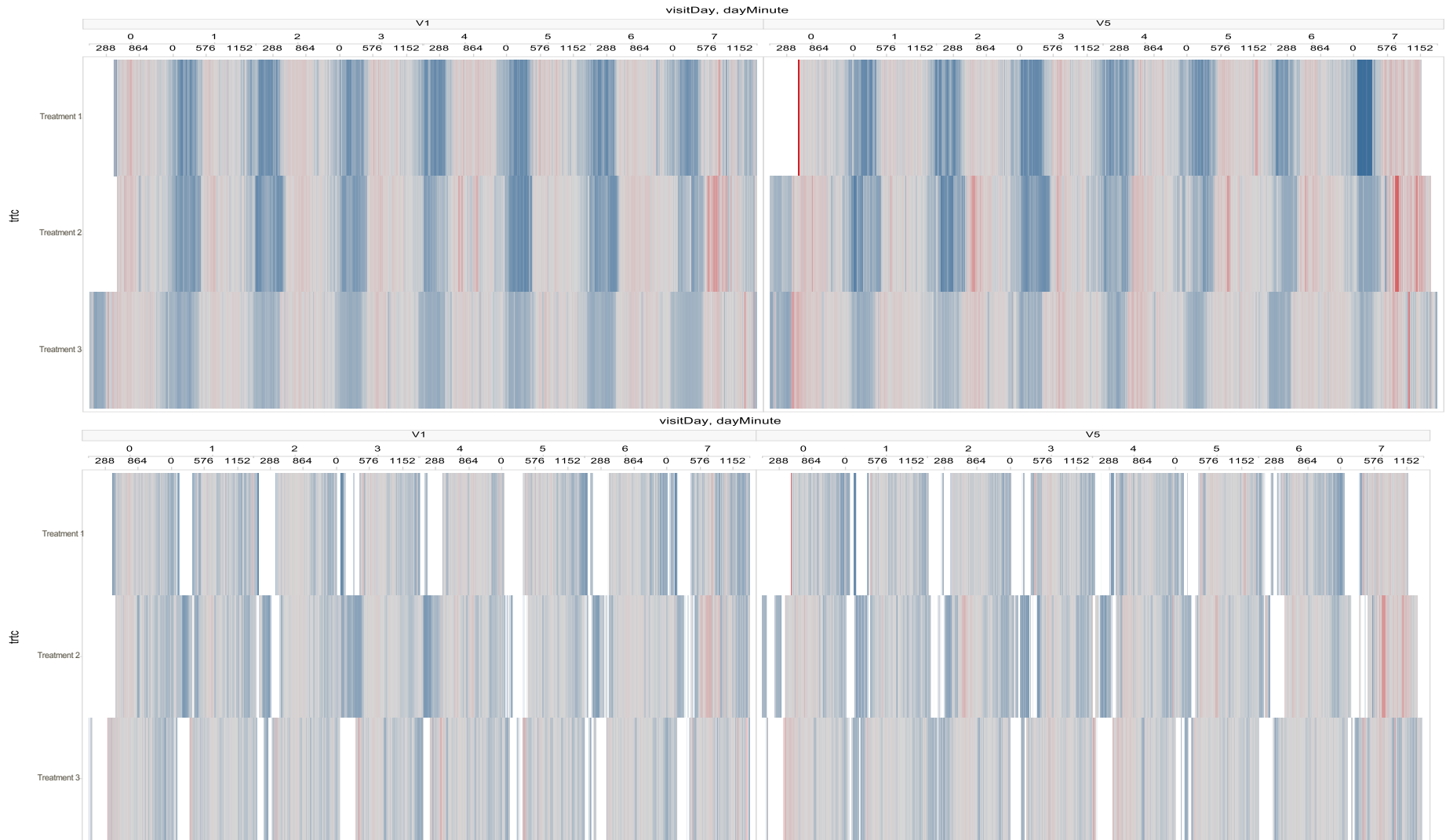
Time Spent Sleeping Data Removed



Summary Figures – Heat Maps



Summary



Summary

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- Digital data from wearable devices may be utilized on clinical trials in the future
 - Benefits
 - Objective and patient focused
 - Yields more complete information than discrete data collection
 - Better ‘real-world’ evidence
 - Challenges
 - Meaningful and validated endpoints need to be identified
 - Investigator and regulatory agency buy-in
 - Complexity, size and cost of the data and transfer issues
 - Time-Series, Bar charts and Heat Maps are key visualizations
 - Innovation opportunity for Clinical statisticians, quantitative data scientists and programmers
-

Acknowledgement



GSK AADD Team and Analysis and Visualization Sub-team

- Special thanks to the members of the GSK Advanced Analytics for Digital Data group and especially the Analysis and Visualization sub-team for the tremendous amount of work done to date and for the input into this presentation.
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Thank you!

Any Questions?