# Experience using the PI System for Vibration Monitoring at PGE

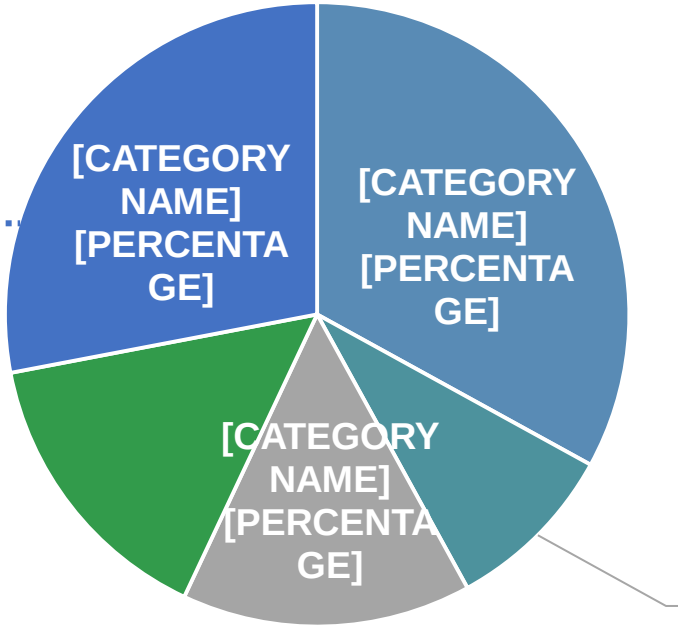
Austin Curtis, PGE | Steve Sabin, B&K Vibro


Brüel & Kjær Vibro
a spectris company

# About Portland General Electric

- Serves ~885 thousand customers in Portland, Salem, and surrounding Oregon communities (51 cities total)
- 2900 employees
- Five Natural Gas-Fired Plants

| Plant | Capacity |
|---|---|
| Beaver | 509 MW |
| Carty | 437 MW |
| Coyote Springs | 249 MW |
| Port Westward 1 | 411 MW |
| Port Westward 2 | 225 MW |



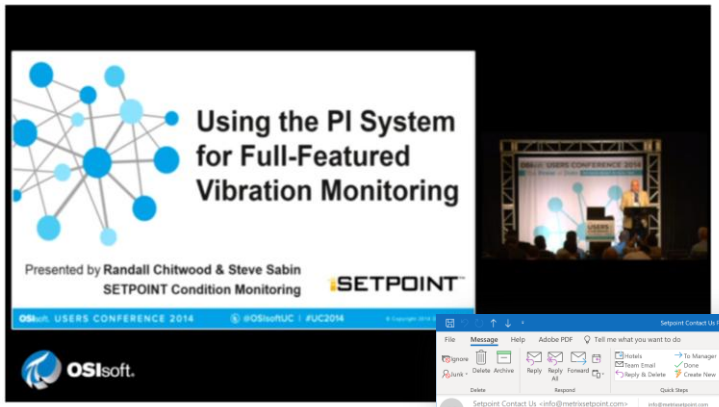
# About PGE's Beaver Plant

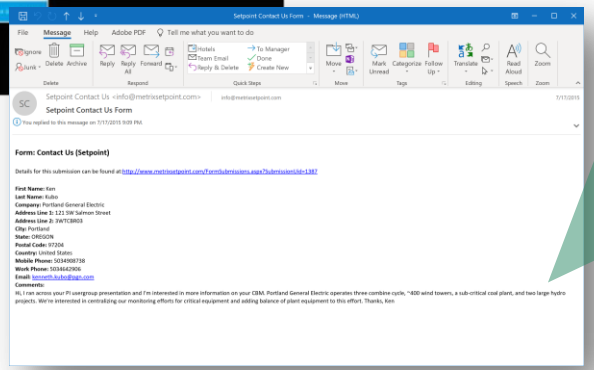
- Operating since 1974
- 6-on-1 combined cycle
  - Units 1-6: 6 x GE 7B combustion turbines
  - Unit 7: 1 x 155MW GE steam turbine
  - Unit 8: 1 x 25 Alstom simple-cycle combustion turbine

# How our journey began…

**2014 - Users Conference - San Francisco**

***Using the PI System for Full-Featured Vibration Monitoring***




**July 17, 2015**

***Hi, I ran across your PI usergroup presentation and I'm interested in more information on your CBM. Portland General Electric operates three combined cycle, ~400 wind towers, a sub-critical coal plant, and two large hydro projects. We're interested in centralizing our monitoring efforts for critical equipment and adding balance of plant equipment to this effort.***

***Thanks,***
***Ken Kubo***

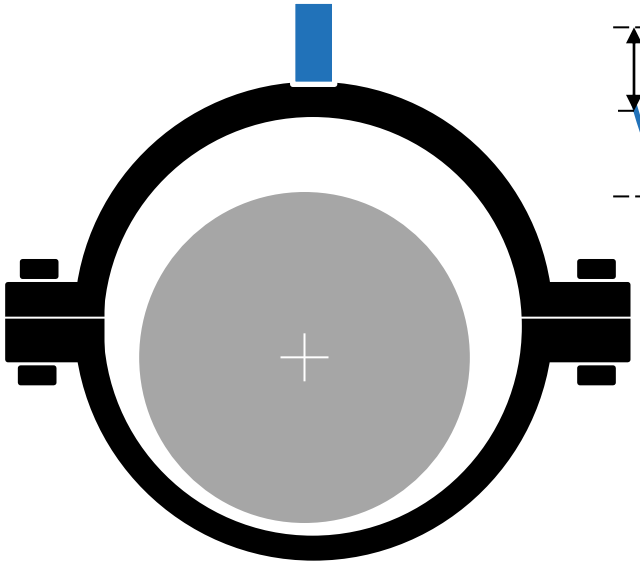
# Vibration Monitoring Systems (As-Found)

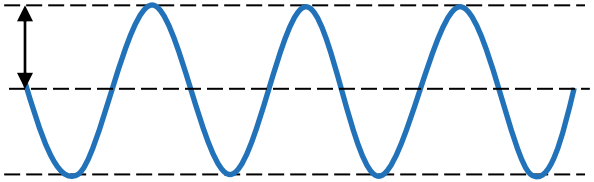
| Unit | Machine | Size | Sensors | MPS | CMS |
|---|---|---|---|---|---|
| 1 | GE Frame 7B* | 60MW | Velocity | GE Speedtronic | None |
| 2 | GE Frame 7B* | 60MW | Proximity | GE Speedtronic | None |
| 3 | GE Frame 7B* | 60MW | Velocity | GE Speedtronic | None |
| 4 | GE Frame 7B* | 60MW | Velocity | GE Speedtronic | None |
| 5 | GE Frame 7B* | 60MW | Velocity | GE Speedtronic | None |
| 6 | GE Frame 7B* | 60MW | Proximity | BN3500 | None |
| 7 | GE steam turbine | 155MW | Proximity | BN3500 | None |
| 8 | Alstom GT10B2* | 25MW | Proximity | BN3500 | None |


Typical as-found monitoring system (Bently Nevada 3500 Series on Beaver Unit 8)

* Combustion turbines

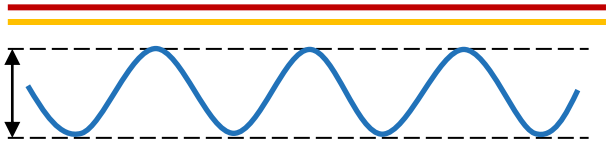
# Velocity Vibration Measurements

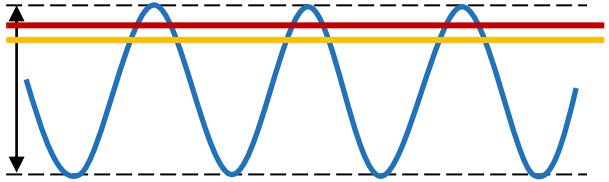


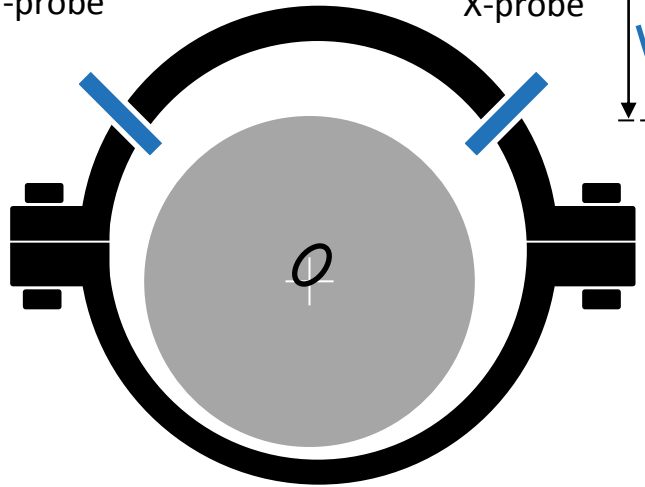


Velocity
(in/sec 0-pk)

# Proximity Vibration Measurements








Displacement
(mils pk-pk)

# Problems

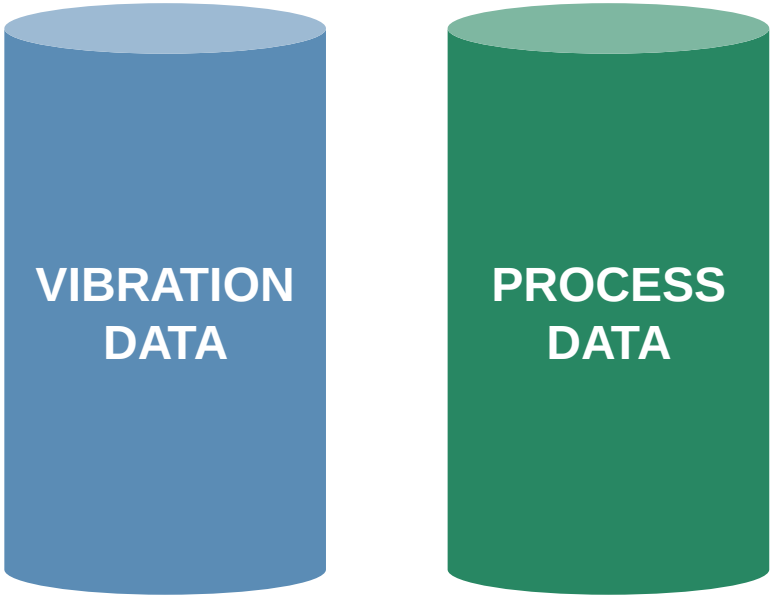
1. No online ConMon = no data when needed
   - Reactive – not there when problems occur
   - Gather data “after the fact” (problem may no longer be present); scene of the crime may be devoid of evidence.
   - Often **MISS** critical data – no means to forecast and model

# Problems

2. No remote access
   - Specialist flies to site to collect data manually
   - Requires moving people, not data; involves plane tickets and 5-hour travel times
   - SLOW

# Problems

3. Siloed data
   - Incumbent provider's CM software entails a separate "silo" just for vibration data
   - Integration effort to combine and determine cause/effect
   - Additional IT burden (2 systems)
   - Not in PI = Not accessible to other analytic tools such as APR



# Problems

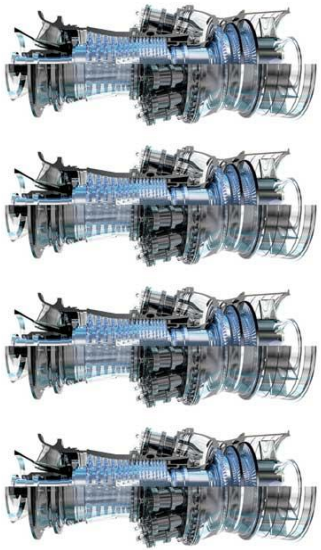
4. “Closed” data
   - Special viewer software and licensing required
   - Hard to share data when/where needed
     - FTP sites required to share large files
   - Impedes collaboration to solve problems

# Problems

5. Can’t easily build/share “asset health” dashboards with plant management
   - Extra integration effort to do in PI
   - Extra software licensing and training to do in native CM environment

# Solution: ***PUT THE DATA INTO PI!***

*Machines* → *SETPOINT® Edge Device and Machinery Protection System* → *PI System*



**Vibration Sensors**


**ALL* Vibration Data**

**Includes high-speed waveform data*

# Vibration Monitoring Systems (As-Left)

| Unit | Machine | Size | Sensors | MPS | CMS |
|---|---|---|---|---|---|
| 1 | GE Frame 7B* | 60MW | Proximity | SETPOINT | SETPOINT |
| 2 | GE Frame 7B* | 60MW | Proximity | SETPOINT | SETPOINT |
| 3 | GE Frame 7B* | 60MW | Proximity | SETPOINT | SETPOINT |
| 4 | GE Frame 7B* | 60MW | Proximity | SETPOINT | SETPOINT |
| 5 | GE Frame 7B* | 60MW | Proximity | SETPOINT | SETPOINT |
| 6 | GE Frame 7B* | 60MW | Proximity | SETPOINT | SETPOINT |
| 7 | GE steam turbine | 155MW | Proximity | BN3500 | SETPOINT |
| 8 | Alstom GT10B2* | 25MW | Proximity | BN3500 | None |


**Integrates machinery protection and condition monitoring functions**

* Combustion turbines

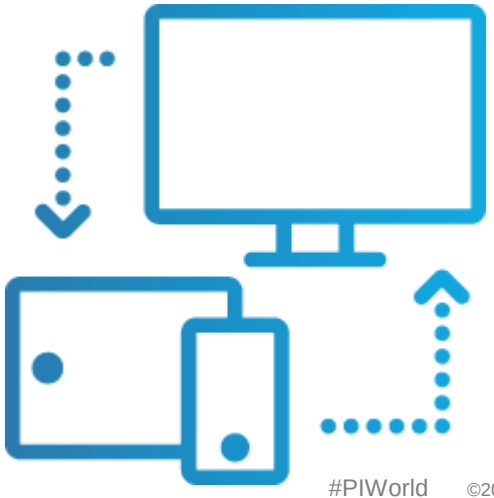
# Enables

1. Online ConMon = never miss important data
   - Specialist analyzes data, rather than collects data
   - Proactive – doesn't matter if not there when problems occur
   - i-factor technology detects change automatically and does not rely on human-intensive alarm setting/management

**ALL DATA PRESENT AND ACCOUNTED FOR!**

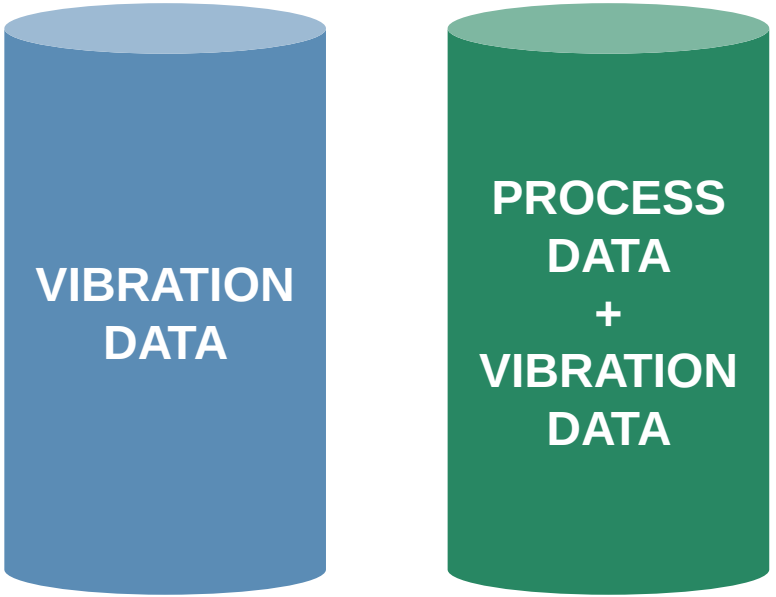
# Enables

2. Remote access
   - Data is accessible remotely and securely to offsite specialist
   - Can access in minutes instead of hours
   - Move data, not people



# Enables

3. Integrated data
   - Uses PI as repository for all data
   - Process and vibration is in one place; correlation and cause/effect more easily ascertained
   - Reduced IT burden (1 system)
   - In PI = Accessible to other analytic tools such as APR



# Enables

4. Viewer software is PI and special free download
   - Open (.cms) file format similar in concept to PDF
   - Easy to share data when/where needed
   - No extra licenses or fees
   - Enhances collaboration to solve problems

# Enables

5. Easily build/share “asset health” dashboards with plant management
   - No special integration effort to do in PI
   - Can drill down to special visualization tool when required to do deep diagnostic analysis

# DEMO

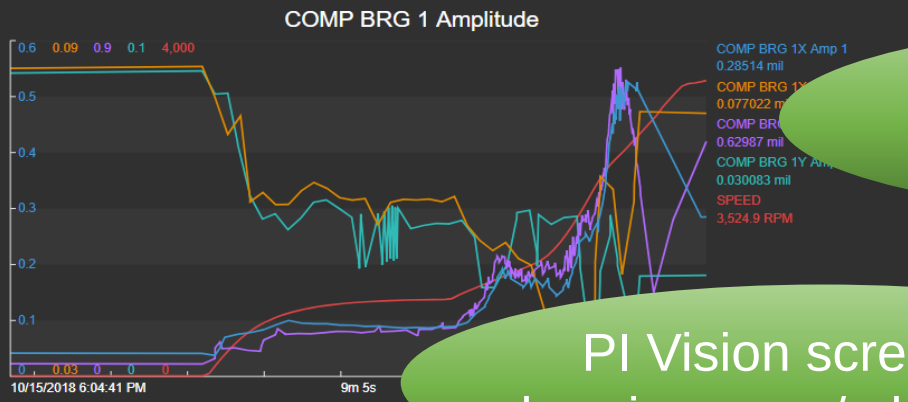
## Sample Screens for Anomaly Detection

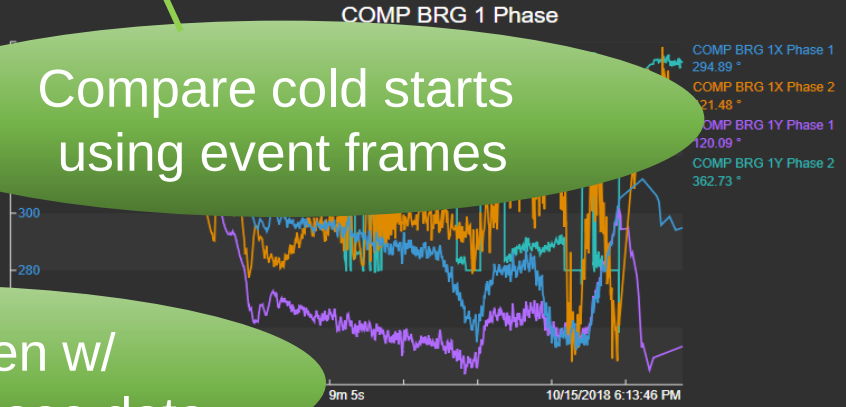
# 2GT Bearing Vibrations and Phase

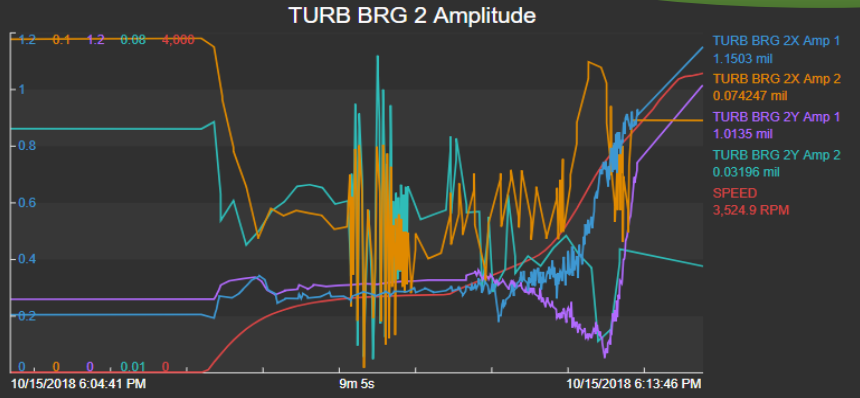
Go to comparisons for: (all Bearings) Cold Starts Warm Starts Hot Starts

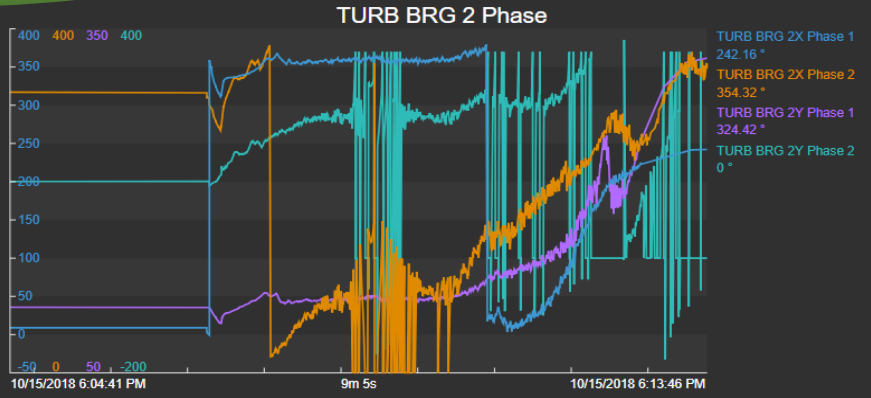
Compare cold starts using event frames

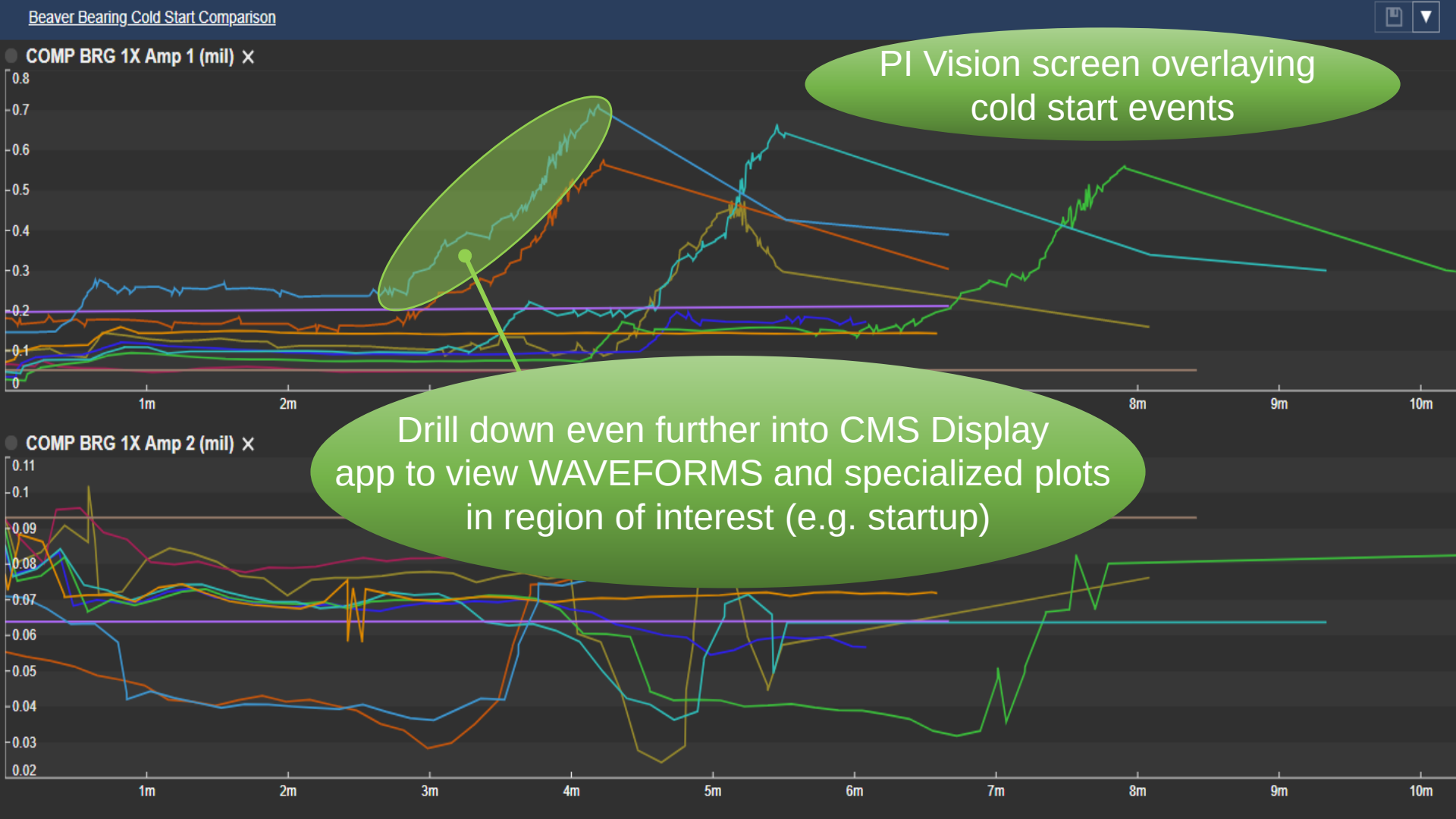
PI Vision screen w/ bearing amp / phase data

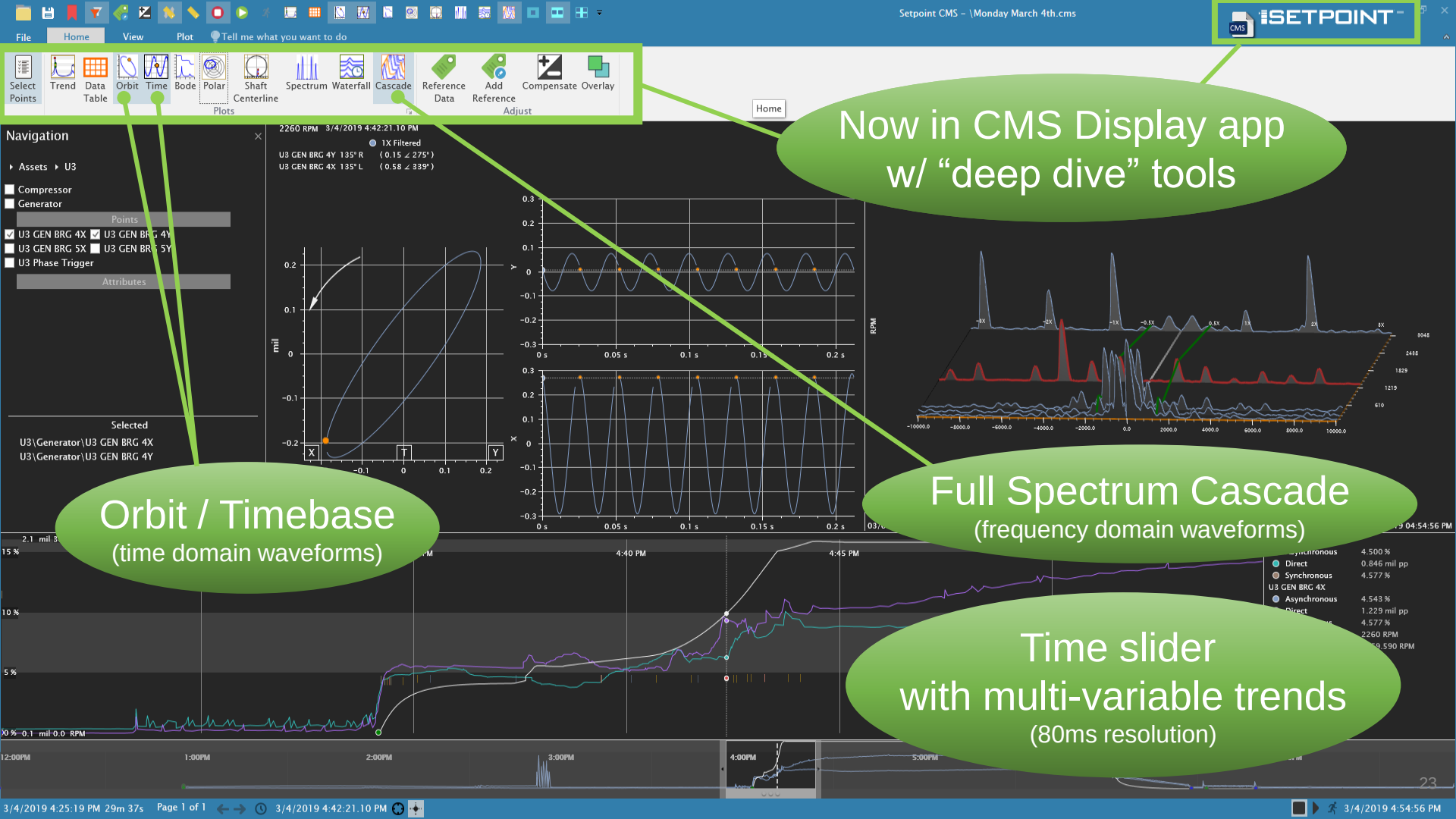


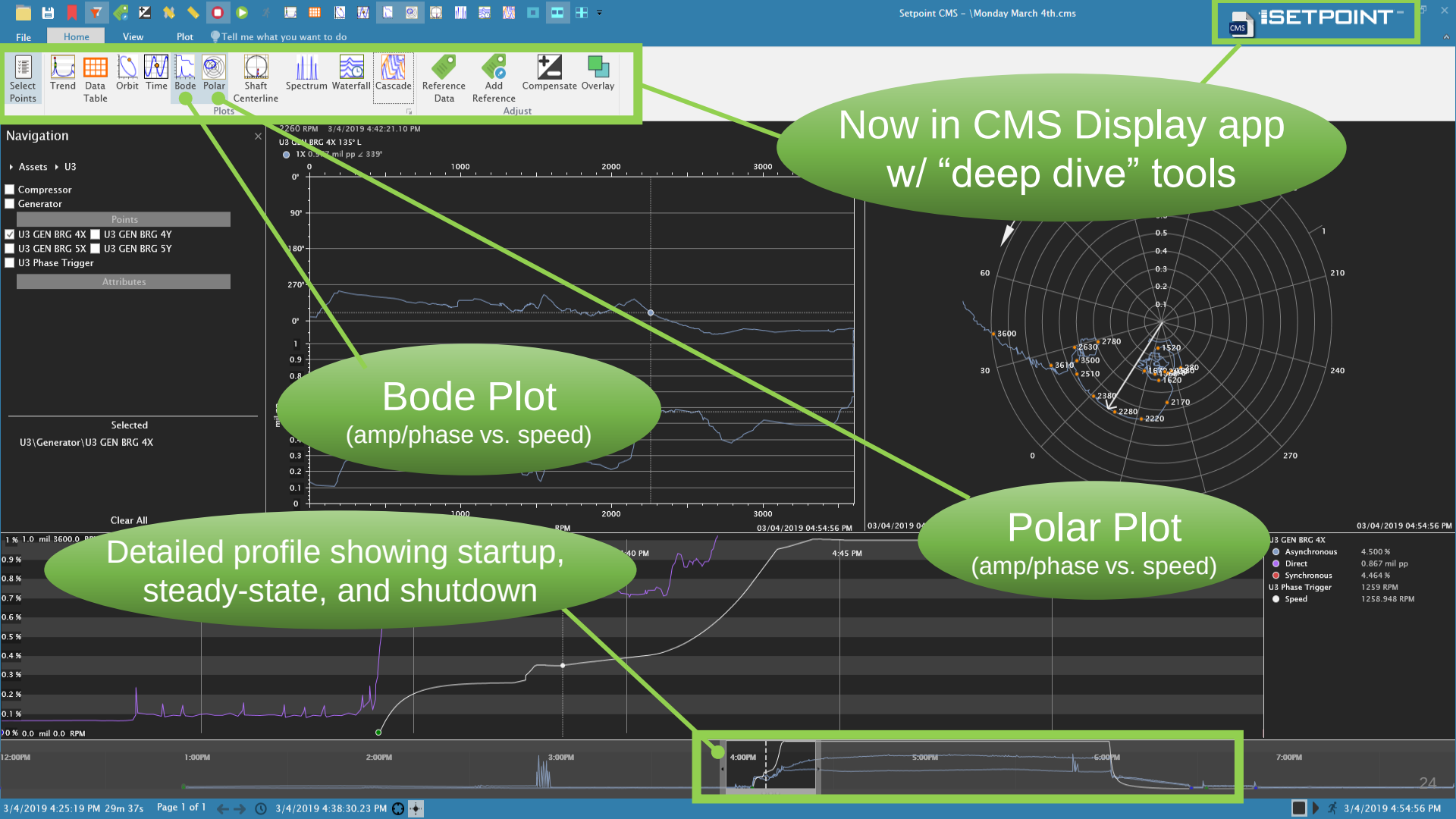




Beaver Bearing Cold Start Comparison
COMP BRG 1X Amp 1 (mil)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1m
2m
8m
9m
10m
PI Vision screen overlaying cold start events
COMP BRG 1X Amp 2 (mil)
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
1m
2m
3m
4m
5m
6m
7m
8m
9m
10m
Drill down even further into CMS Display app to view WAVEFORMS and specialized plots in region of interest (e.g. startup)


Setpoint CMS – \Monday March 4th.cms
SETPOINT
File
Home
View
Plot
Tell me what you want to do
Select Points
Trend
Data Table
Orbit
Time
Bode
Polar
Shaft Centerline
Spectrum
Waterfall
Cascade
Reference Data
Add Reference
Compensate
Overlay
Plots
Adjust
Navigation
Assets ▸ U3
Compressor
Generator
Points
U3 GEN BRG 4X
U3 GEN BRG 4Y
U3 GEN BRG 5X
U3 GEN BRG 5Y
U3 Phase Trigger
Attributes
Selected
U3\Generator\U3 GEN BRG 4X
U3\Generator\U3 GEN BRG 4Y
2260 RPM 3/4/2019 4:42:21.10 PM
1X Filtered
U3 GEN BRG 4Y 135° R ( 0.15 ∠ 275° )
U3 GEN BRG 4X 135° L ( 0.58 ∠ 339° )
mil
RPM
Home
Now in CMS Display app
w/ “deep dive” tools
Orbit / Timebase
(time domain waveforms)
Full Spectrum Cascade
(frequency domain waveforms)
Time slider
with multi-variable trends
(80ms resolution)
4:40 PM
4:45 PM
Synchronous 4.500 %
Direct 0.846 mil pp
Synchronous 4.577 %
U3 GEN BRG 4X
Asynchronous 4.543 %
Direct 1.229 mil pp
4.577 %
2260 RPM
12:00PM
1:00PM
2:00PM
3:00PM
4:00PM
5:00PM
3/4/2019 4:25:19 PM 29m 37s
Page 1 of 1
3/4/2019 4:42:21.10 PM
3/4/2019 4:54:56 PM


Setpoint CMS – \Monday March 4th.cms
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U3 GEN BRG 4X
U3 GEN BRG 4Y
U3 GEN BRG 5X
U3 GEN BRG 5Y
U3 Phase Trigger
Attributes
Selected
U3\Generator\U3 GEN BRG 4X
Clear All
Now in CMS Display app w/ “deep dive” tools
Bode Plot
(amp/phase vs. speed)
Polar Plot
(amp/phase vs. speed)
Detailed profile showing startup, steady-state, and shutdown
U3 GEN BRG 4X
Asynchronous 4.500 %
Direct 0.867 mil pp
Synchronous 4.464 %
U3 Phase Trigger 1259 RPM
Speed 1258.948 RPM
3/4/2019 4:25:19 PM 29m 37s
Page 1 of 1
3/4/2019 4:38:30.23 PM
3/4/2019 4:54:56 PM

# Portland General Electric

## Putting comprehensive vibration data into the PI System


### CHALLENGE

No online condition monitoring data when machinery decisions needed to be made.

- Incumbent system required expensive additional infrastructure
- Offline approach was too reactive and involved 10-hour roundtrip travel to/from site

### SOLUTION

SETPOINT® Edge Device streamed all vibration data into existing PI System

- Eliminated separate infrastructure; used PI System already installed
- All data in same “system of record” for ease of correlation
- Accessible to everyone in the plant
- WAVEFORMS IN PI!
(the key to accurate analysis)

### RESULTS

Overall company risk significantly reduced.

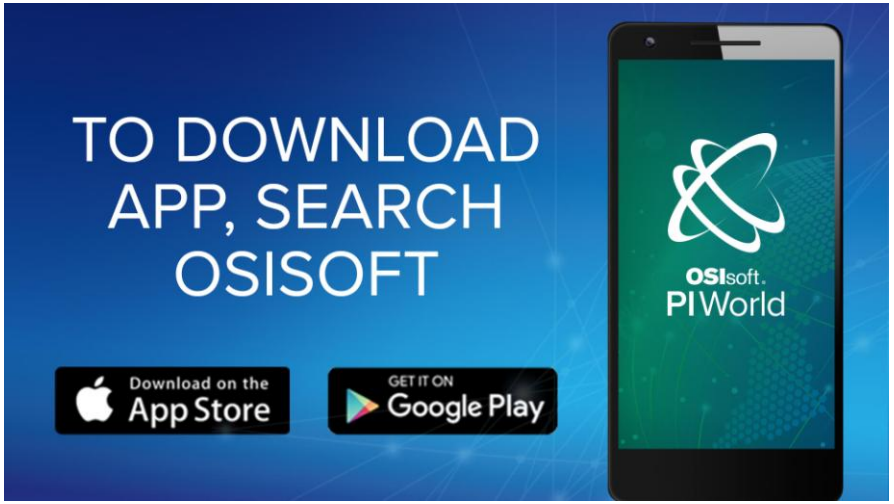
- Can now identify critical asset health accurately
- We know when we’re healthy (and when we’re sick)
- Data analysis done in 1 hour instead of 15+ hours

# Questions?

Please wait for the **microphone**

State your **name & company**

# Please remember



# Your presenters

- **Austin Curtis**
- Maintenance Manager
- Portland General Electric
- austin.curtis@pgn.com

- **Steve Sabin**
- VP – Marketing & Product Management
- Brüel & Kjær Vibro
- steve.sabin@bkvibro.com