Vibration Sensor

VS Series:
VS-1 VS-1^{R} VS-2^{SI}

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Dedicated to

Operation Safety

Improving Production Yield

Reducing Downtime

Cost Savings

Reliability of Fault Prediction

Our sensors have been greatly relied on to accurately monitor conditions of the machines in the *global* semiconductor industry.

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Capabilities of VS

The VS sensors are powerful diagnostic tools
that will:

- ***Provide advanced warning***
  When machine conditions are deteriorating, a vibration sensor will be able to diagnose the problem, allowing engineers to take pre-emptive action and avoid catastrophic failure and loses

- ***Monitor trends conditions by vibration***
  Any problems arising from shaft imbalance or mechanical installation, can be seen when monitoring vibration feedback.

- ***Detect dynamic problems***
  Debris build-up, mechanical failure, bearing deterioration and wearing out of mechanism can all be determined and measured.

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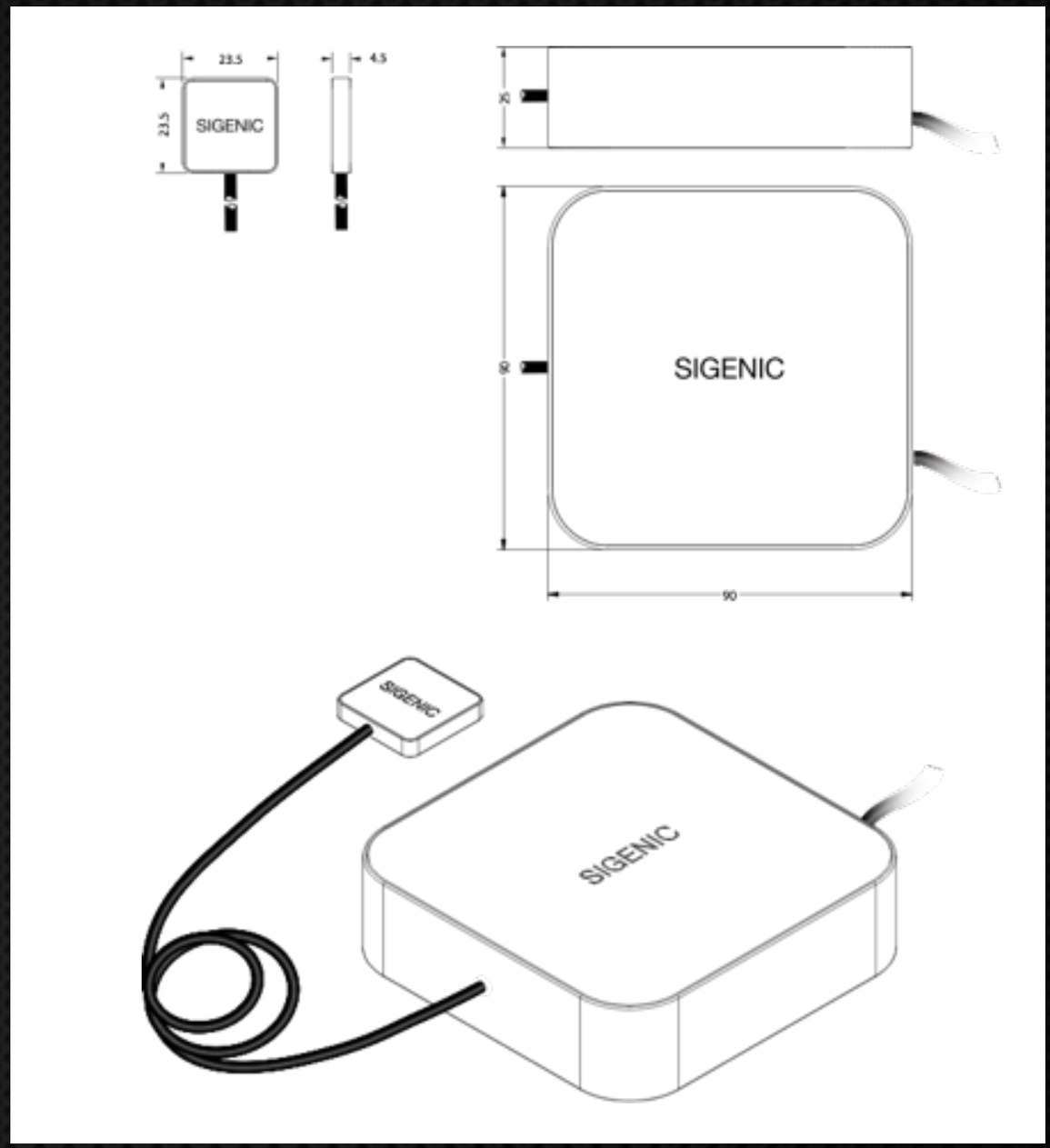
VS-1 Sensor Specification

Measurement of Acceleration	3 Directions (i.e. X, Y, Z)
Measurement Range	+ / -2g, 4g, 8g, 16g
Non-Linearity	0.5%
Sensitivity Change Due to Temperature	0.01% per 1 degree celsius
Resolution	0.01g
Output Data Rate	0.1 to 3200Hz
Operating Temperature	-20 to 80 degree celsius
Shock Resistance	10000g



Features:

- *Compact* design with user-friendly interface
- Generates a *high output data rate*
- *Simple and convenient* plug-n-read USB operation
- Supplied in sturdy lightweight carry cases for *portability*

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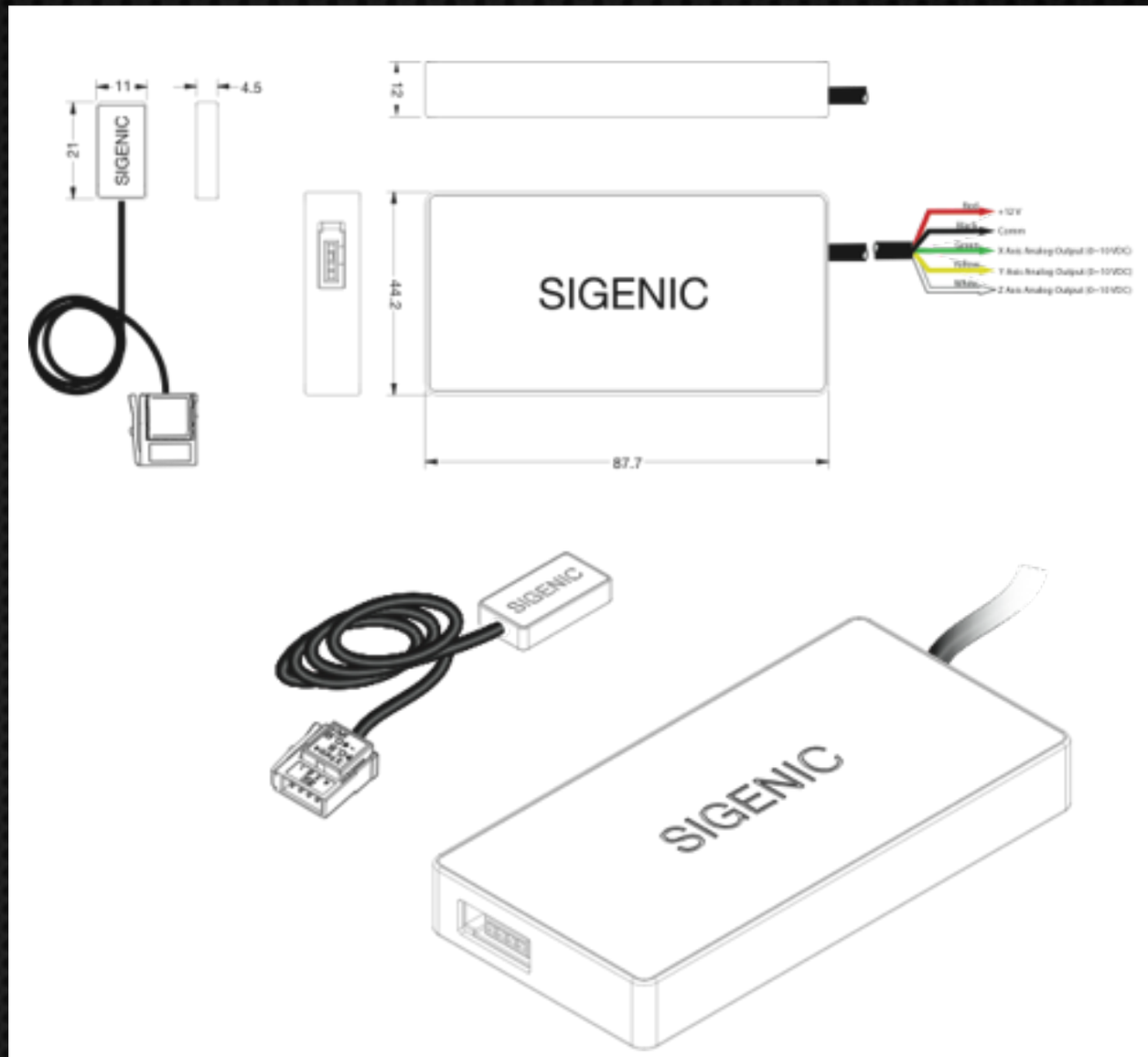
VS-1^{R} Sensor Specification

Measurement of Acceleration	3 Directions (i.e. X, Y, Z)
Measurement Range	+ / -2g, 4g, 8g, 16g
Non-Linearity	0.5%
Sensitivity Change Due to Temperature	0.02% per 1 degree celsius
Output Data Rate	200Hz / 1000Hz
Operating Temperature	-20 to 80 degree celsius
Shock Resistance	10000g
Analog Output (X, Y, Z)	0 ~ 10 VDC



Features:

- *Slim, light weight* design allowing great ease during installation on machines
- *Real time monitoring* capability of machine health condition

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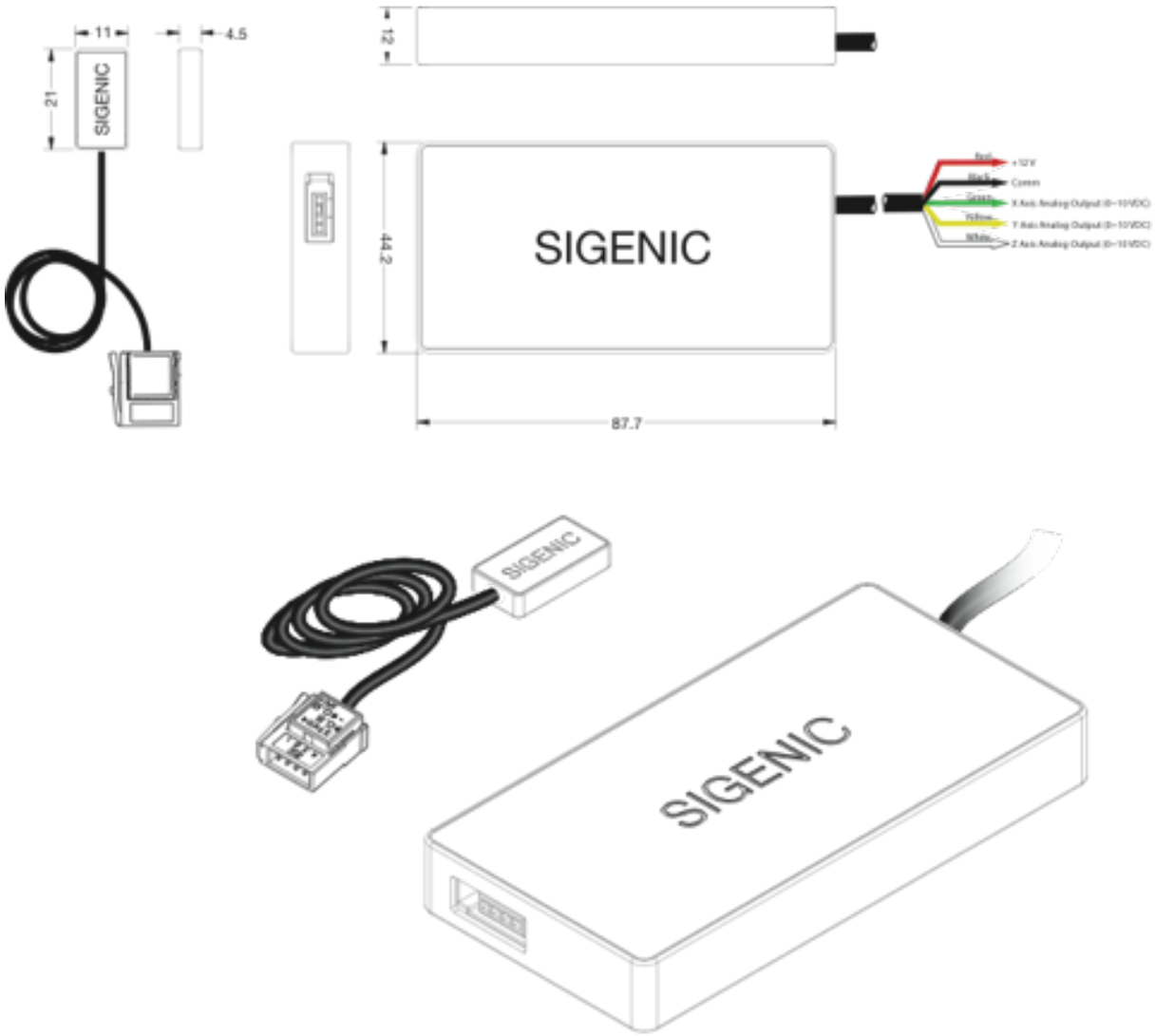
VS-2SI Sensor Specification

Measurement of Acceleration	3 Directions (i.e. X, Y, Z)
Measurement Range	+ / -2g, 4g, 8g, 16g
Non-Linearity	0.5%
Sensitivity Change Due to Temperature	0.02% per 1 degree celsius
Output Data Rate	200Hz / 1000Hz
Operating Temperature	-20 to 80 degree celsius
Shock Resistance	10000g
Analog Output (X, Y, Z)	0 ~ 10 VDC



Features:

- *Slim and light weight*
- *Real time monitoring* capability
- *Vibration Stability Index*, capturing the overall stability of a complete work cycle

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VS-2SI

The Real-time Cost Saving Device

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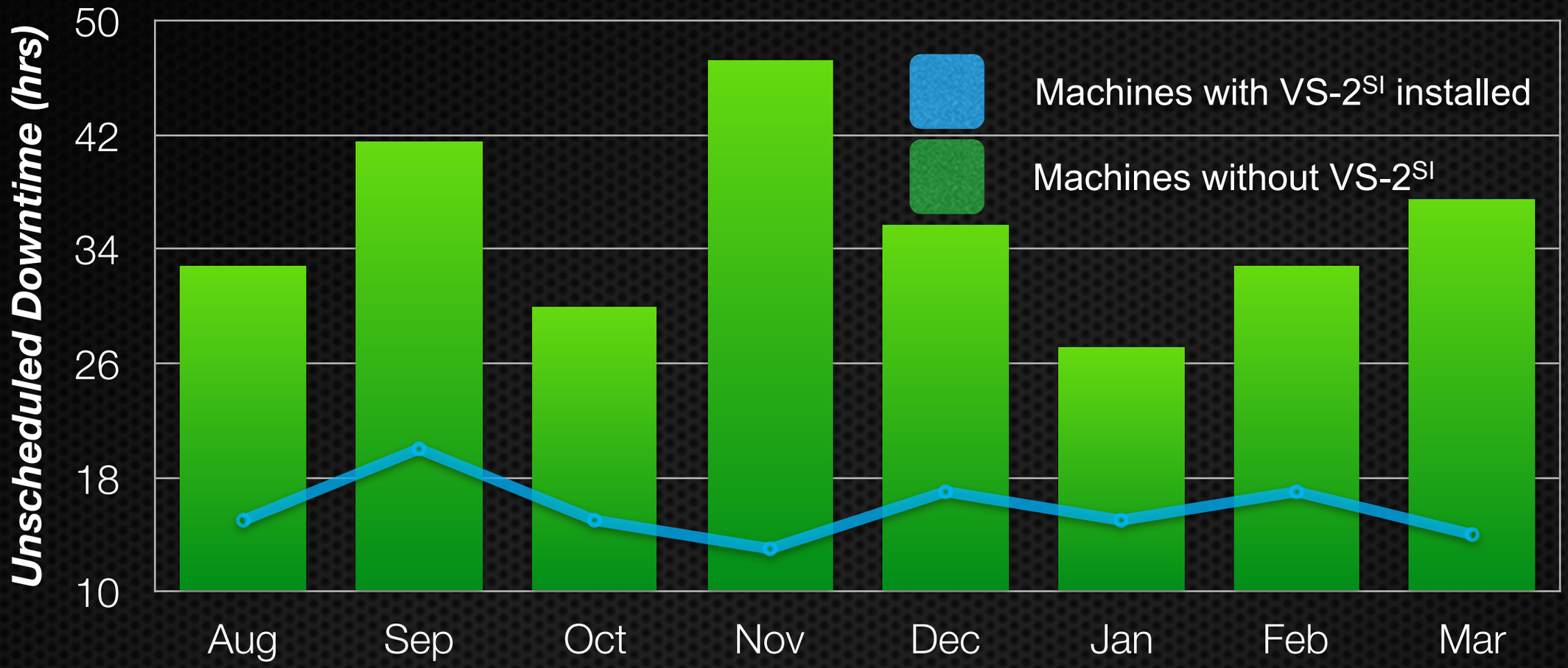
Average Unscheduled DownTime Comparision



Reduced UDT translates into:

- Lesser Manpower Costs in fault finding
- Higher Yield Rates
- Higher Profit Margin

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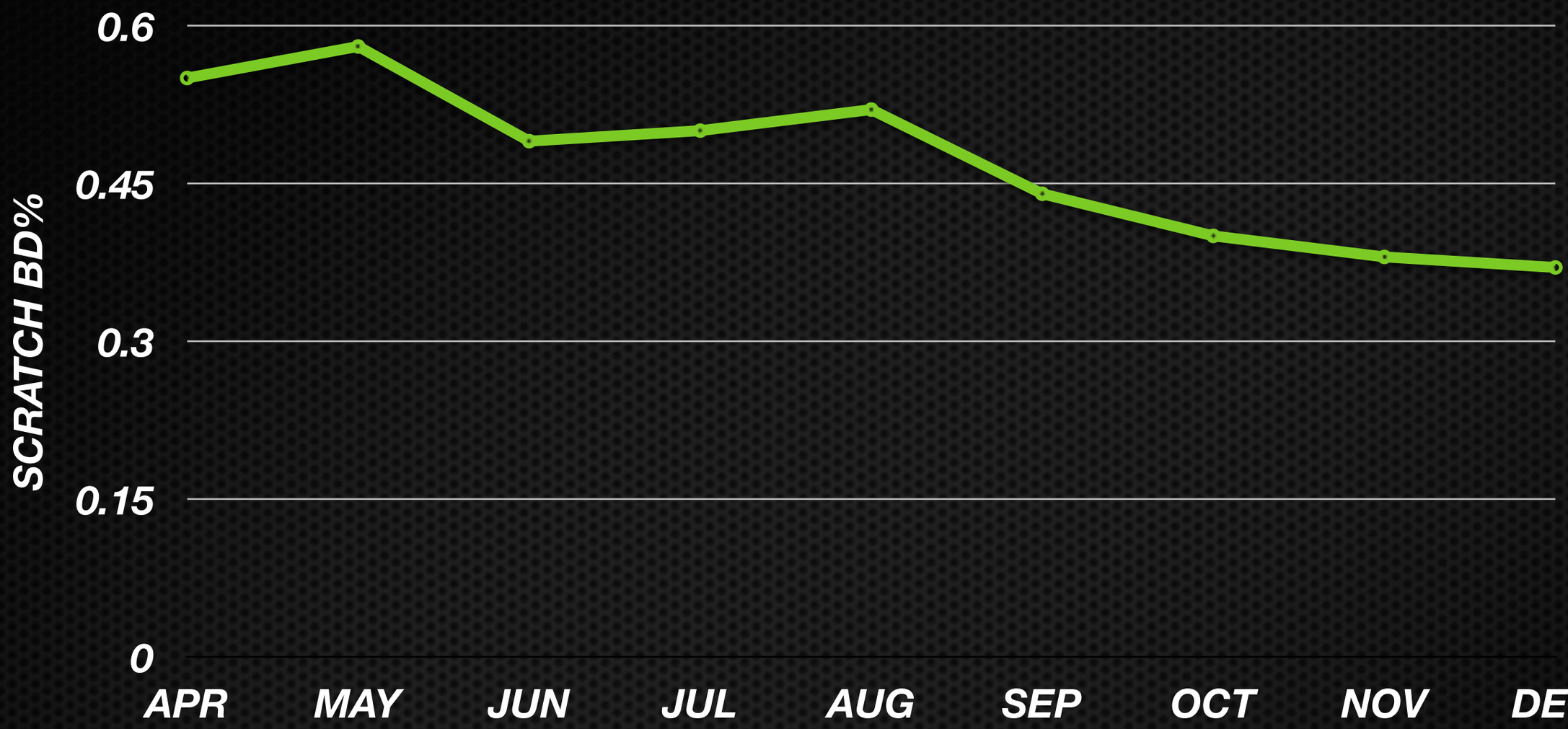
Micro Scratches Bad Die % (FEOL CMP STI/ILD)



- Micro-Scratch BD% improves by 0.131%.(From 0.528% to 0.397%)
- Fab Line Yield improved by 0.131%
- Translates into ***monthly cost saving of USD 230K*** from micro-scratches baseline improvement for a 50,000 output wafer fab

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CMP Excursion Case

PC arm collision against polishing head

- Total wafer scraped : 280pcs
- Estimated total cost impact : USD 980,000**

Robot Arm Excursion Case- Lithography Dept.

Robot position drift causing wafer collision against flange

- Total wafer scraped : 120pcs (broken)
- Estimated total cost impact : USD 1,500,000**

With the VS-2 installed, early / immediate detection of collision issue could translate into huge cost savings.

***Cost calculated includes man-power cost, up-time lost and cost of wafer and parts.*

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CASE STUDIES

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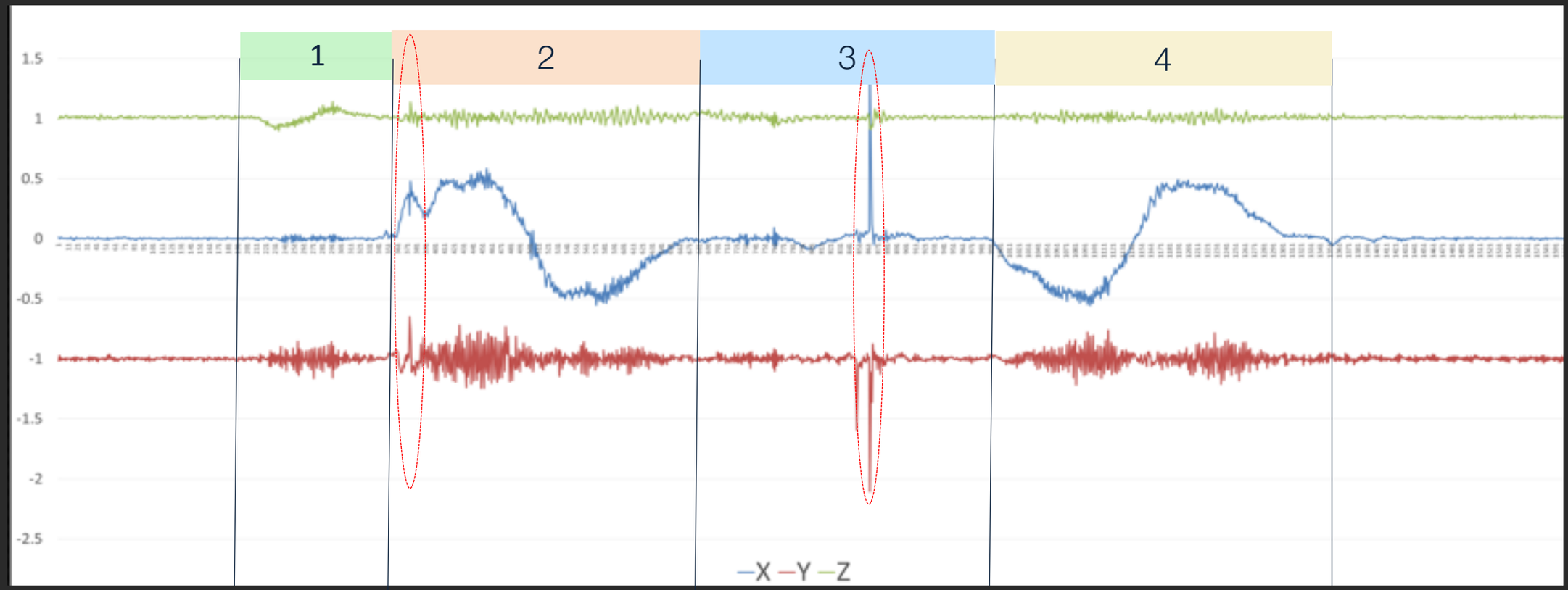
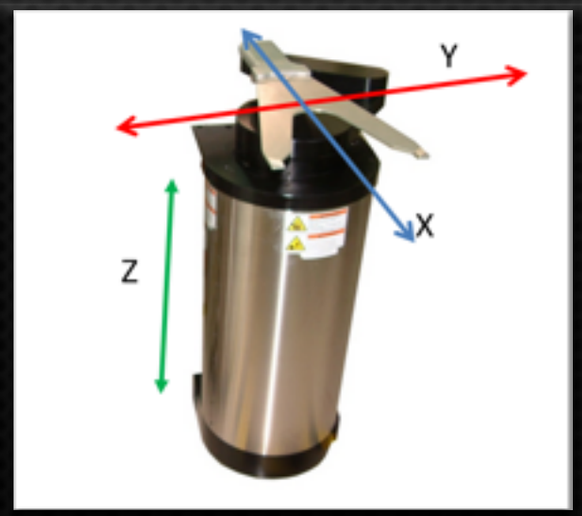
Data logged by VS-1:

FI Robot Wafer Retrieval Motion



Four main steps of the retrieval motion:

1. FI robot to ready position (pick up slot position) (Z-axis motion)
2. Robot blade extend into FOUP (X-axis motion. Plunger will retract during start of this step)
3. Robot blade pick up wafer (Z-axis motion, wafer lifted up from slot and plunger extend to hold the wafer)
4. Robot blade retract from FOUP (X-axis motion, wafer retrieval action completed)



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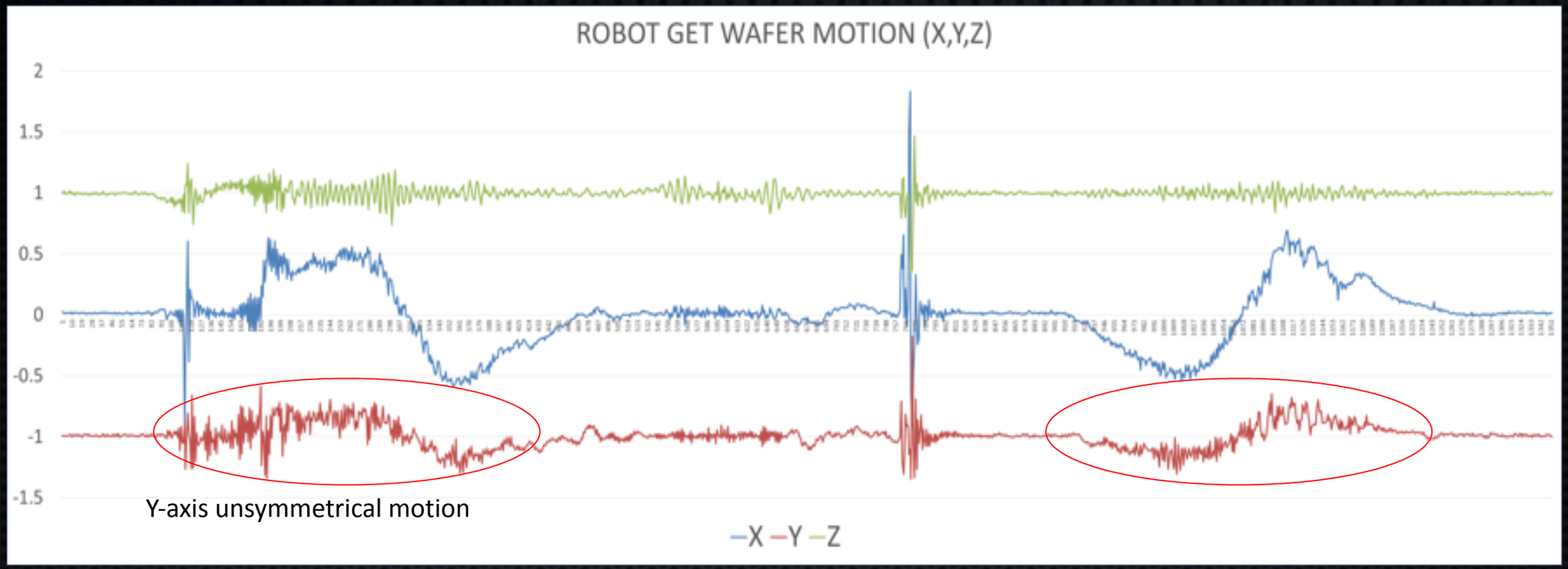
VS-1 SubCase Study 1:

Y-axis unsymmetrical motion captured during wafer retrieval action



Observation:

Y-axis unsymmetrical motion

Risk:

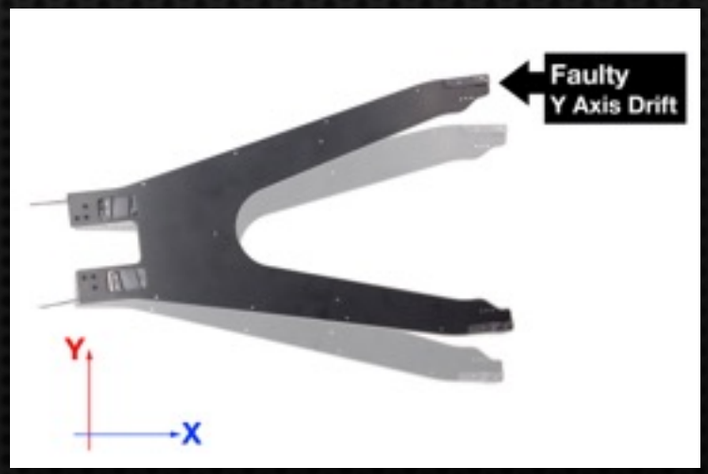
Wafer may rubbing against transfer station (FOUP or pathway)

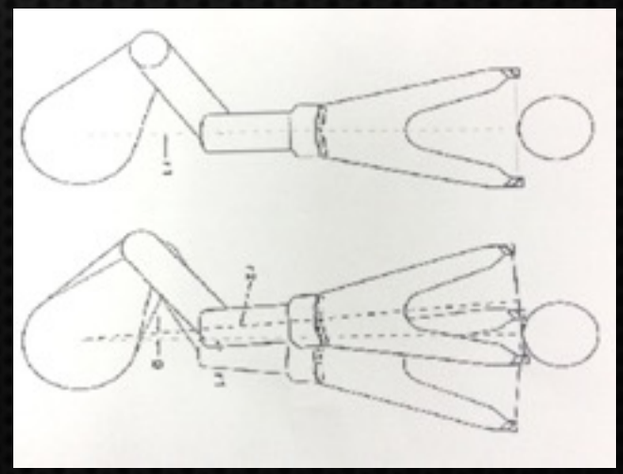
Possible Root Cause:

Robot arm bearing loosen

Corrective action:

Down for servicing/ repair





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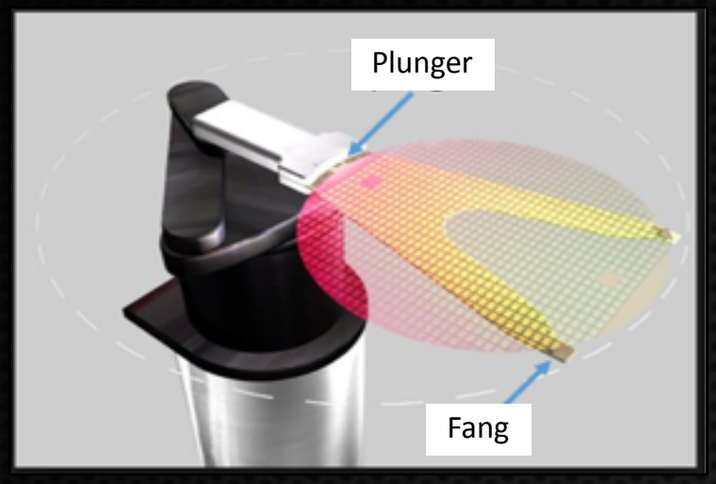
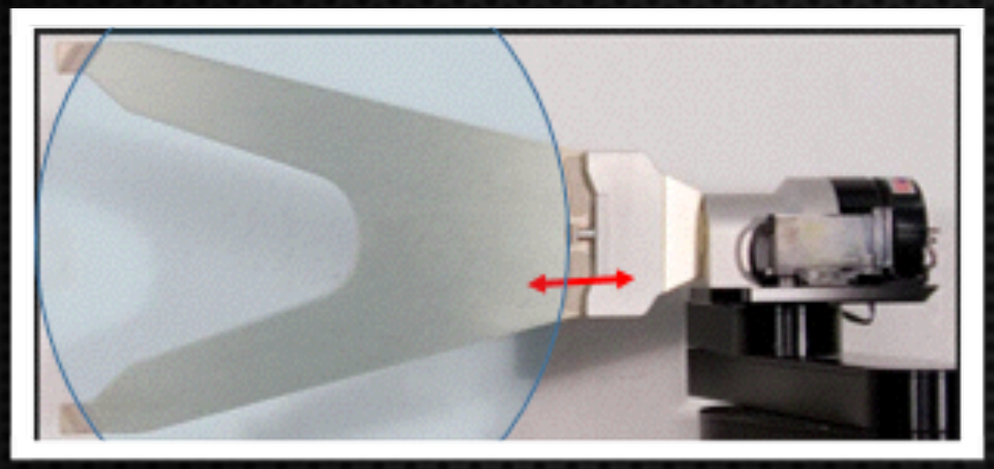
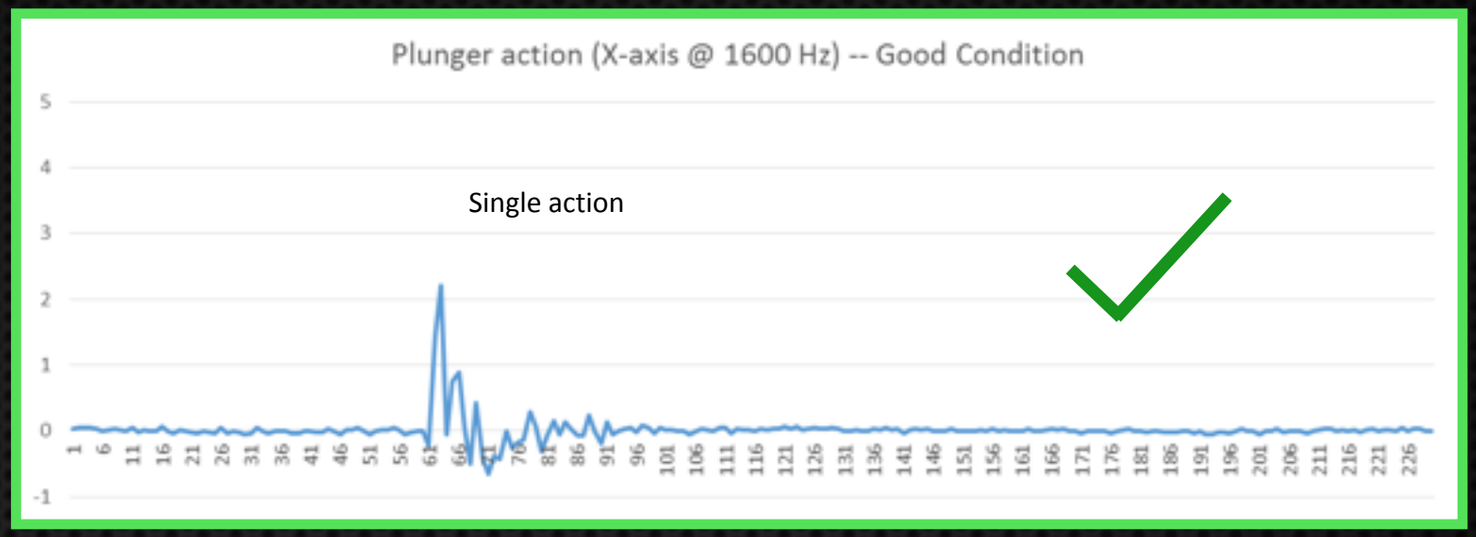
VS-1 SubCase study 2:

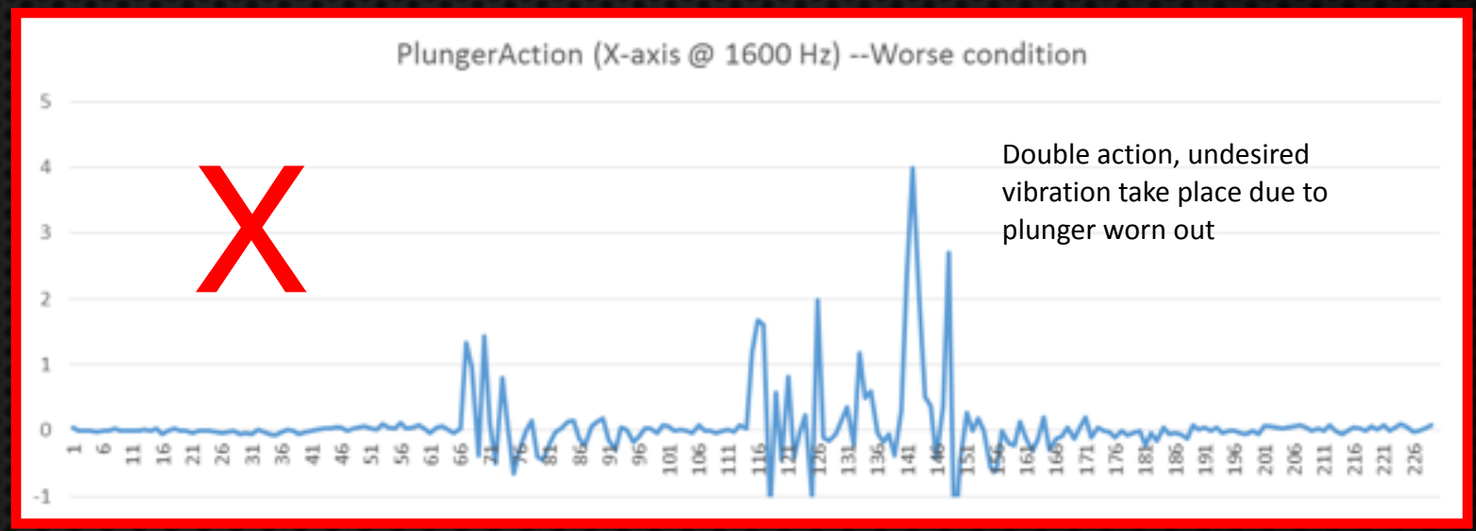
Worn out plunger induce double actions during holding a wafer





Worn out plunger induce double action during holding a wafer





1. Robot plunger hold/ grip wafer during wafer transfer
2. Plunger force applied directly to the wafer edge (too high will cause wafer to break, too low might cause wafer drop during supinator)
3. ***Vibration behaviour*** during wafer gripping process can use to monitor plunger and robot fang condition

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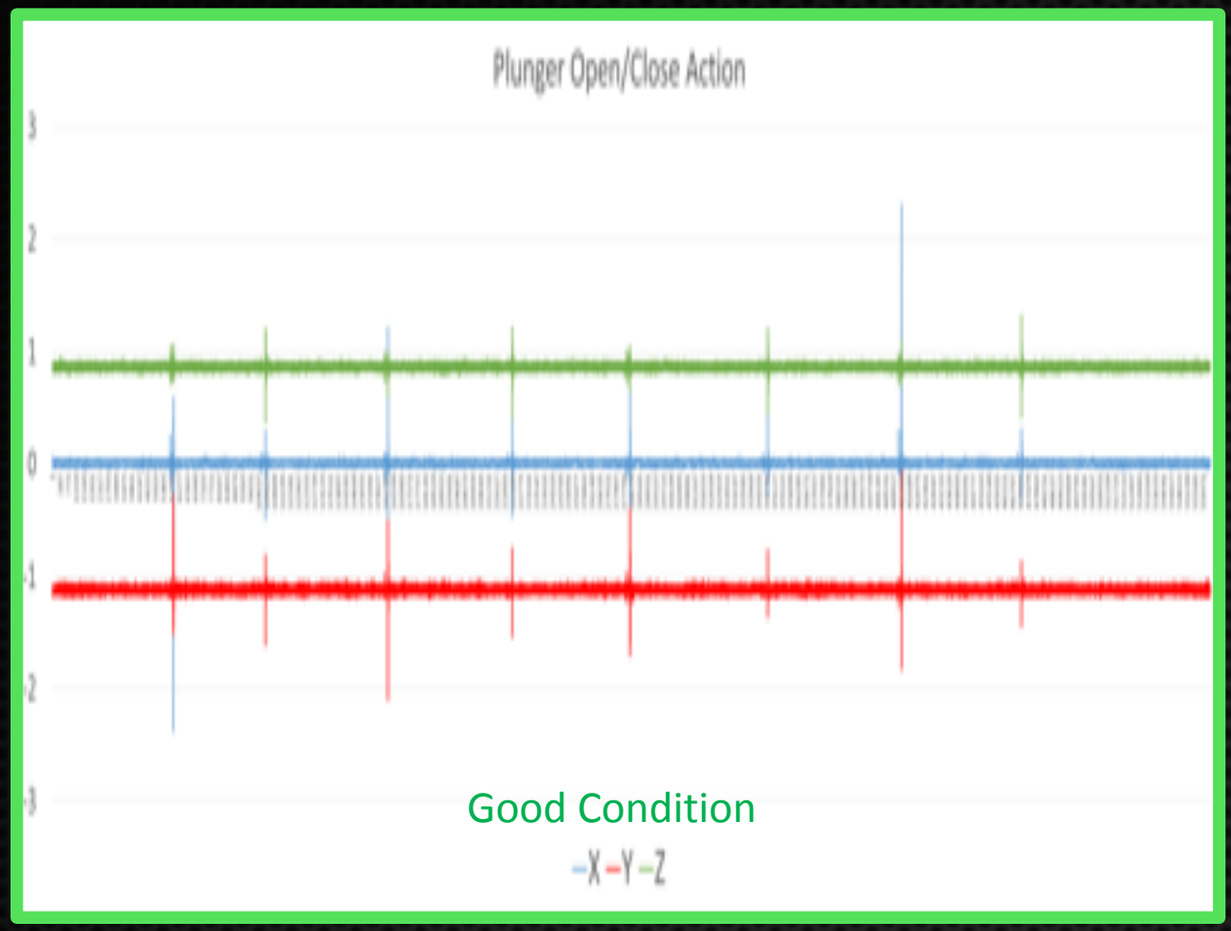
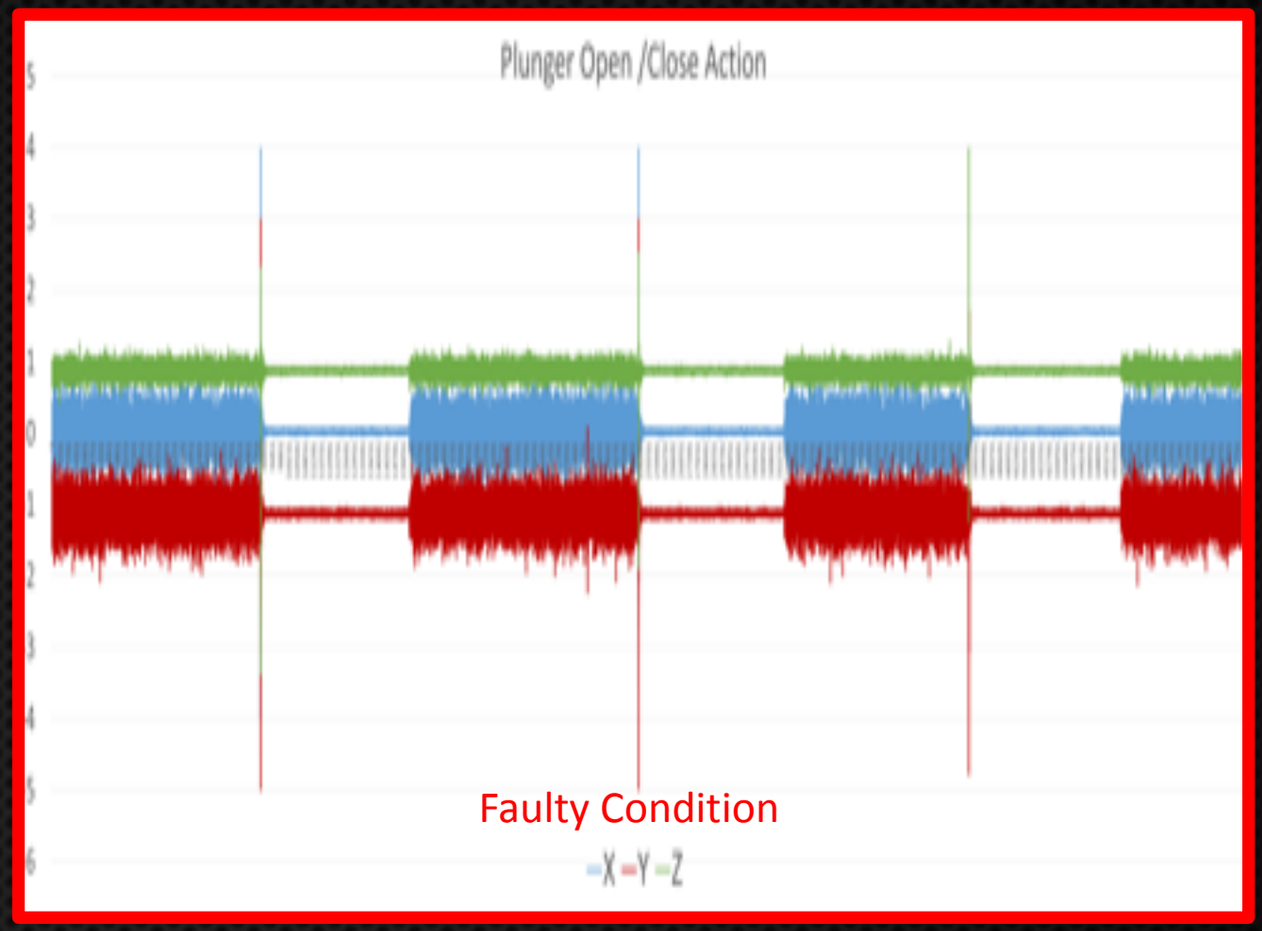
VS-1 SubCase study 3:

Plunger actuator's fitting broken cause abnormal vibration during wafer gripping





Observation:

Abnormal vibration detected when plunger was gripping a wafer

Risk:

Wafer drop off during transfer (supinator) due to lower gripping force

Root Cause:

Plunger actuator's fitting broken

Corrective action:

Replace actuator fitting. Vibration behaviour back to normal

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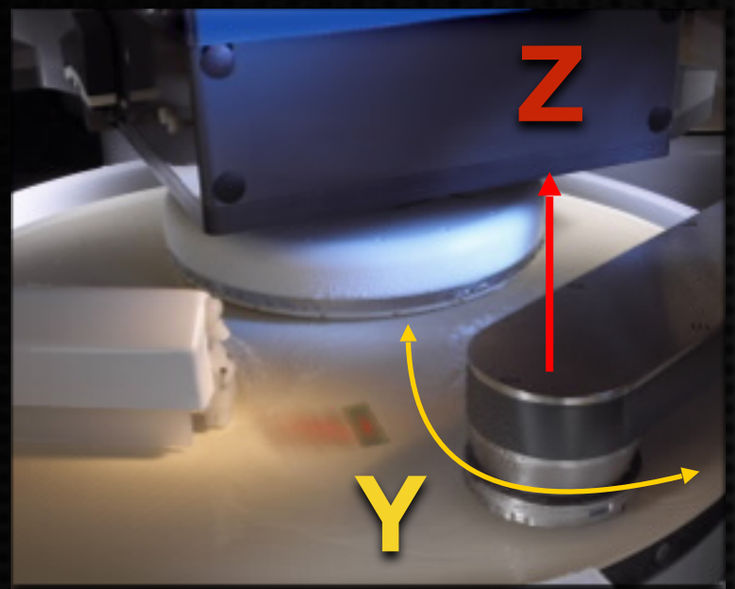
Data logged by VS-1 @ 800Hz :

Pad Conditioner (PC) Arm Vibration Behaviour

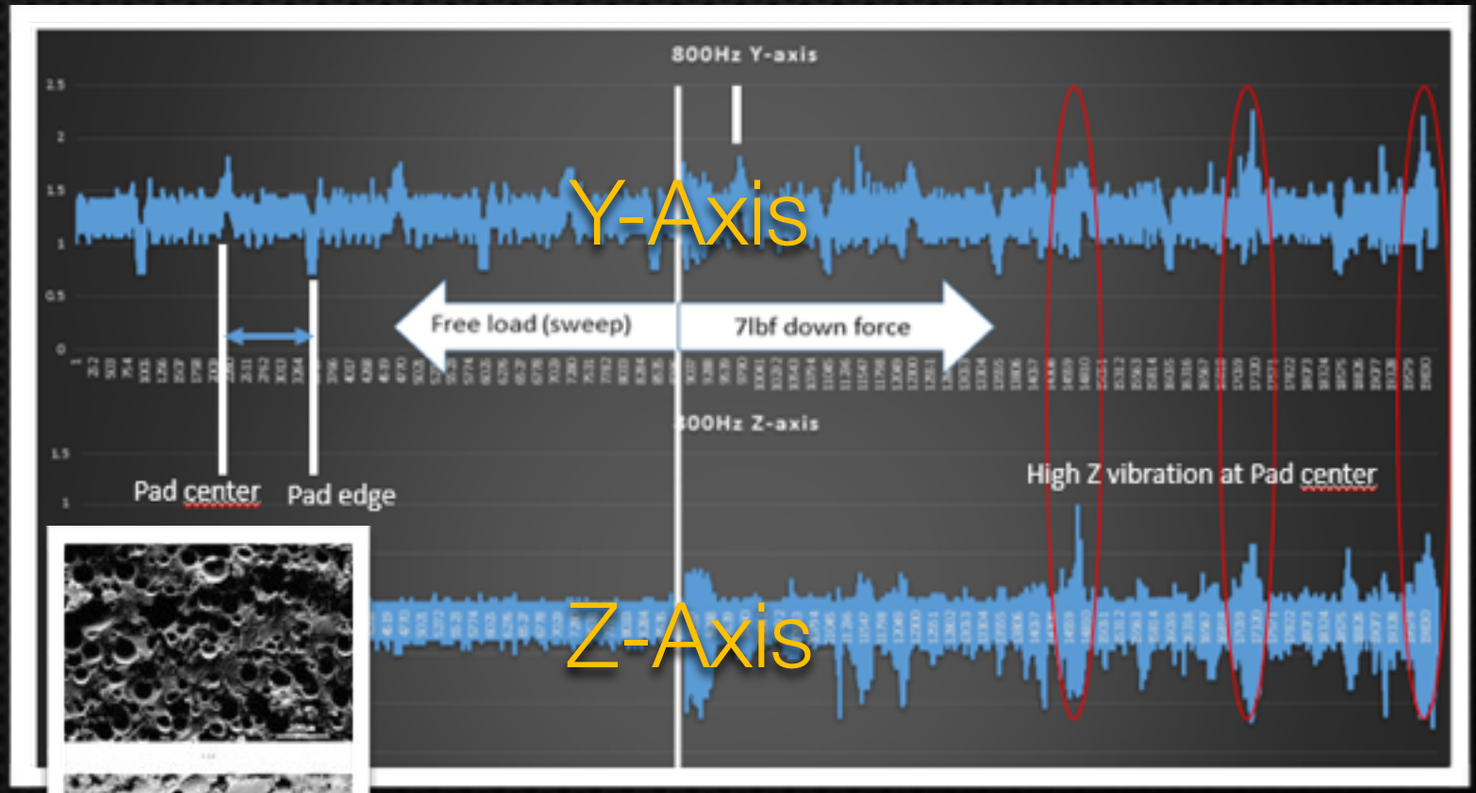


The ***VS-1*** was deployed to detect the vibration of the PC Arm. The yellow arrow Y indicates the sweeping movement of the PC Arm

Observation:

Logged data showed Z-axis vibration to be high at the centre of the pad. Follow-up investigation found that the High Pressure Rinse DIW nozzle spray was weak at pad centre area (insufficient water) and increased the friction.

This will result in low cleaning efficiency at pad centre area and induce pad glazing and micro-scratch issues.



SEM images of pore-type pad surface and glazed surface of the same pad.

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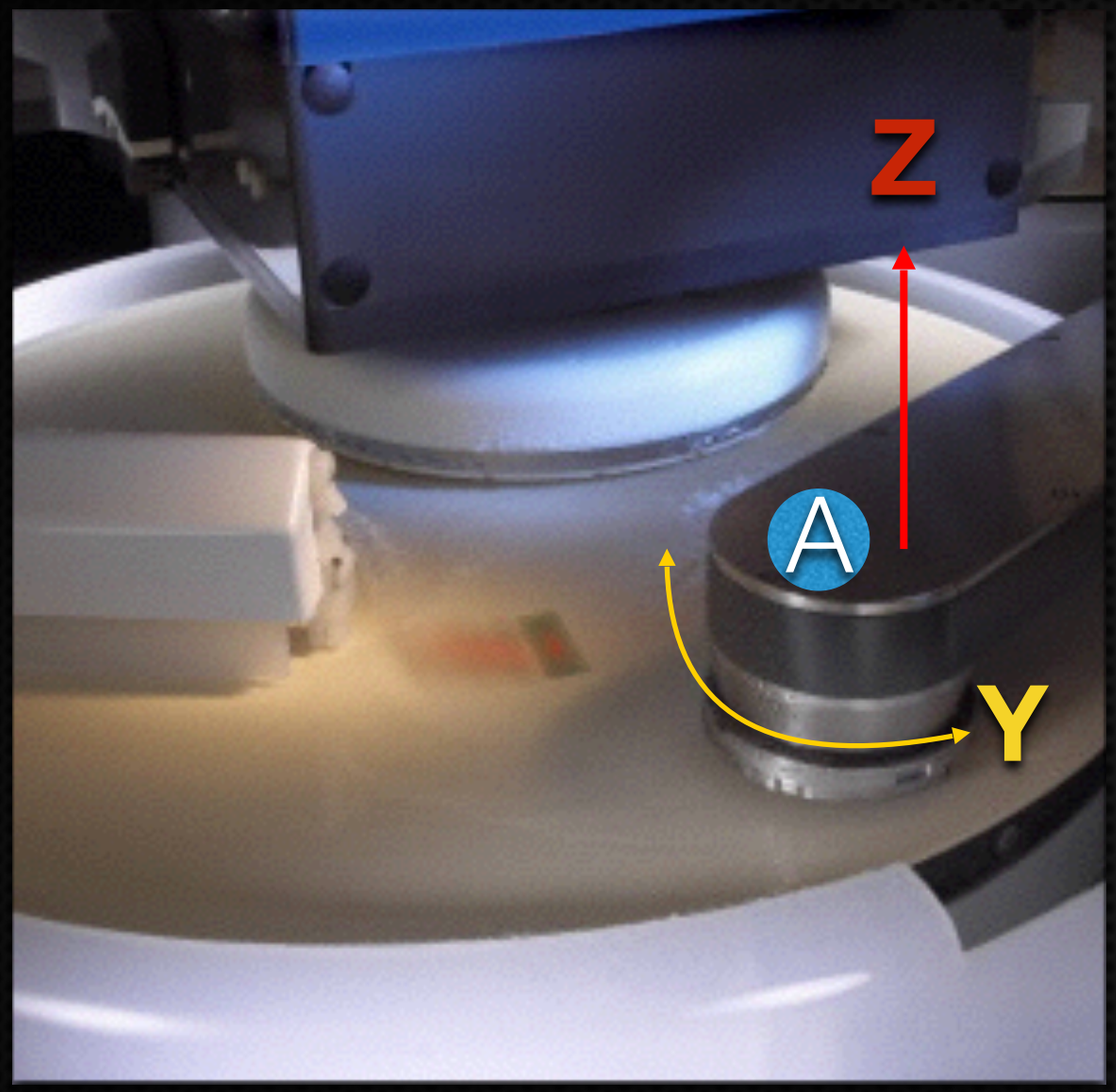
VS-1^{R} Real Time Detection:



- ***VS-1^{R}*** was installed at PC Arm head, indicated A.
- The Z axis, which to measure the ***vertical vibration behaviour***, as indicated by the red arrow.
- The Y axis, measures the left/ right sweeping movement ***(horizontal vibration behaviour)***, as indicated by the yellow arrow.

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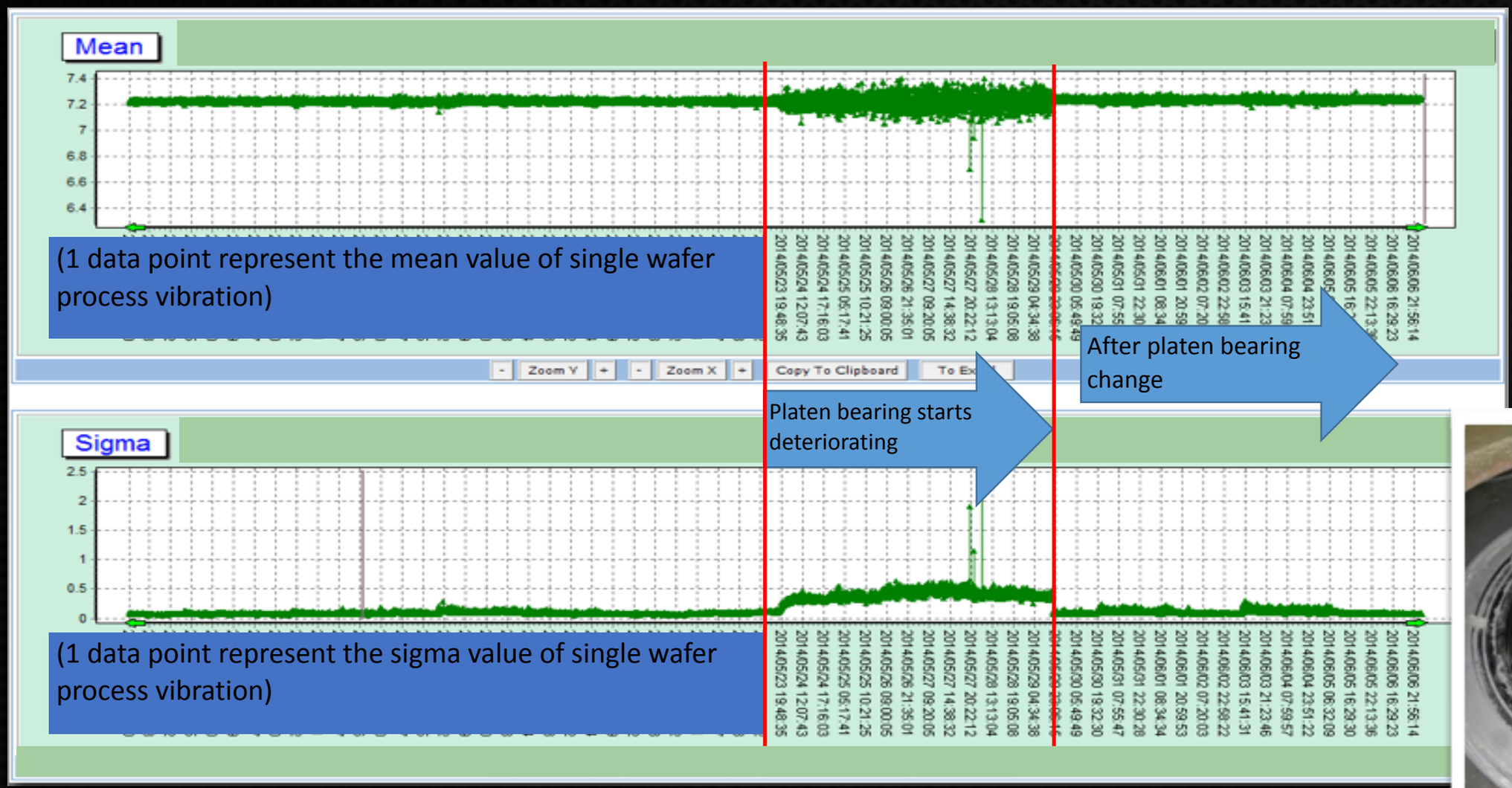
VS-1^R SubCase study 1:

Polisher platen bearing abnormality was detected
Motor torque endpoint failure issue was resolved



Rusty bearings caused the unstable torque, which incurred abnormal vibration

Observation:

Z-axis experienced **high working vibration** and unstable wafer polish endpoint (motor torque)

Root cause:

Platen bearing worn out and caused high vibration on Pad Conditioner Arm Z-axis

Corrective Action:

Replaced new platen bearing, vibration level back to normal baseline

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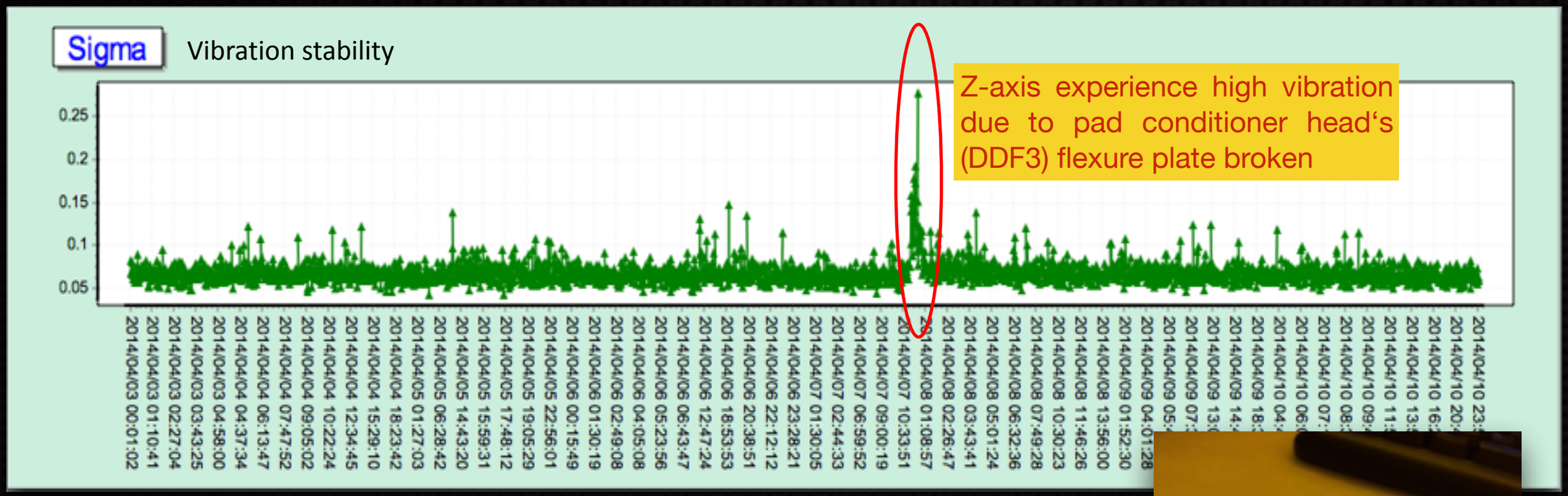
VS-1^R SubCase study 2:

Early detection of broken PC Arm's flexure plate



Observation:

Z-axis vibration sigma abnormal

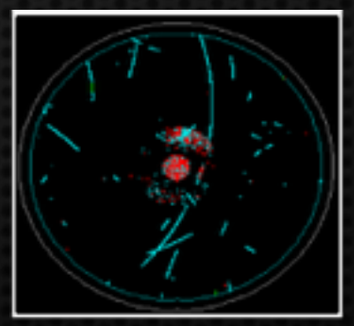
Root cause:

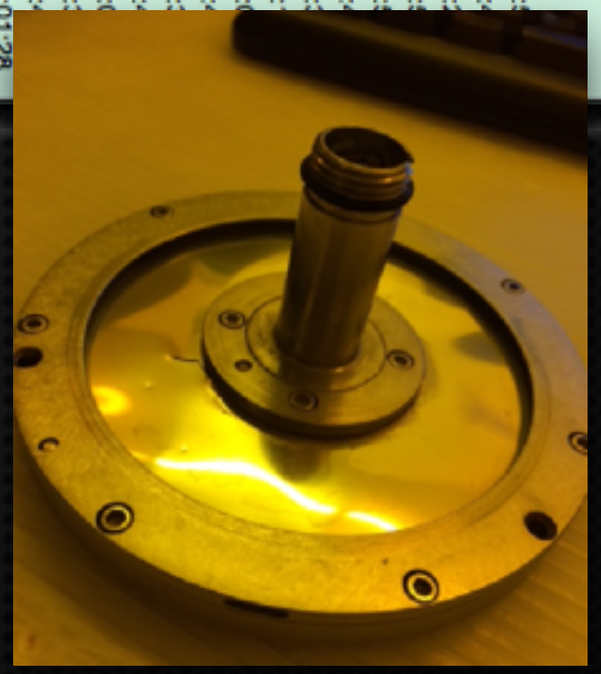
DDF3 flexure plate broken

Corrective Action:

Replaced new flexure plate, Z-axis vibration sigma back to normal baseline

Fail to detect this issue may causes pad glazing and result in wafer scrap due over polish and micro-scratch issues.





Broken DDF3 flexure plate

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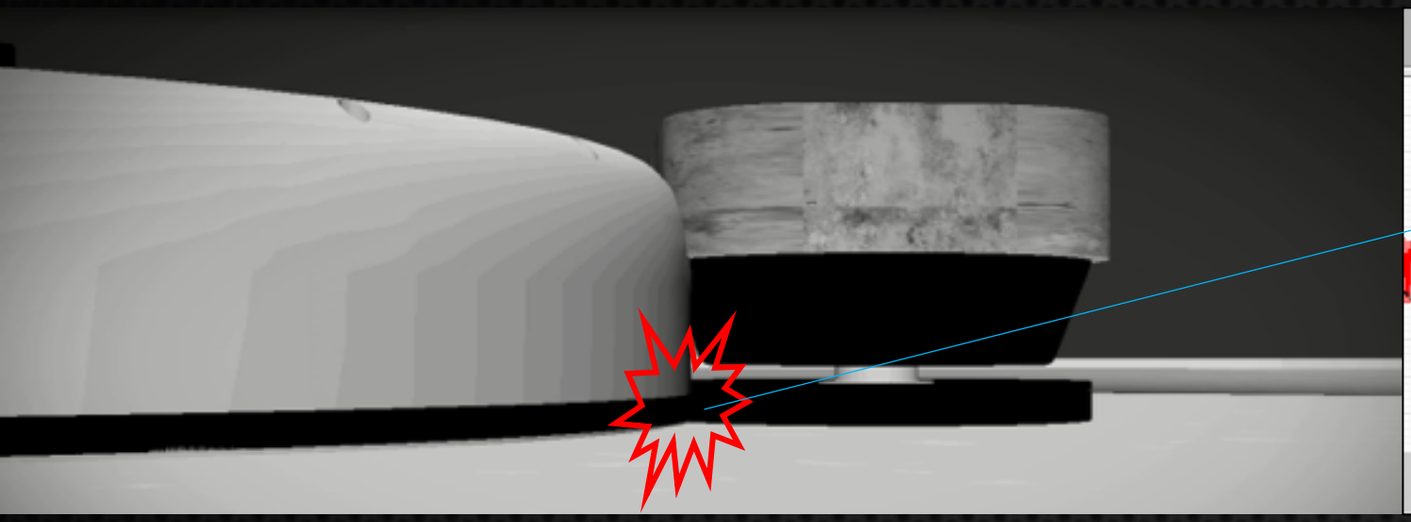
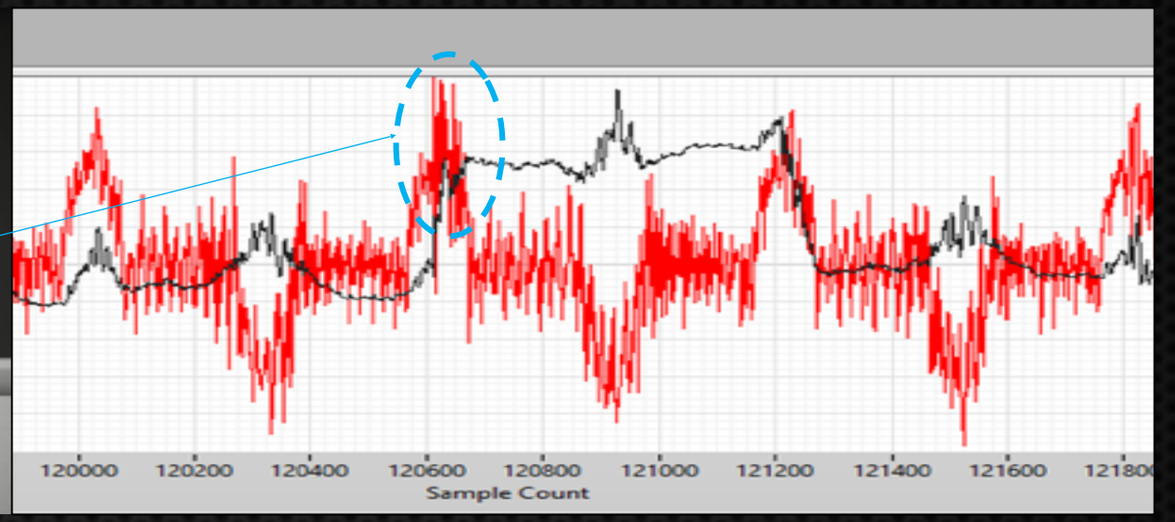
VS-2^{SI} SubCase study 1:

STI PC DDF3 Colliding against Polishing Head





Observation:

PC DDF3 colliding against polishing head during process

Detection Method:

When PC arm collide against Polishing Head, abnormal vibration will take place. The vibration *Stability Index*** (black) will experience a upward spike due to abnormal vibration being introduced into the sweep cycle.

**Vibration *Stability Index* (SI) – an index representing the overall stability of a complete work cycle. Any abnormalities taking place during the process will be clearly captured in this index.

Suspected root cause:

- PC home position drift
- Faulty PC sweep mechanism cause over-sweeping motion, leading to the collision of PC DDF3 and polishing head.

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