OCTOBER 25, 2023

Economies of scale with AVEVA™ PI System™ and AI: the world's top Lithium producer shares its journey

Jonathan Alexander

© 2023 AVEVA Group plc and its subsidiaries. All rights reserved.

Albemarle Intelligence

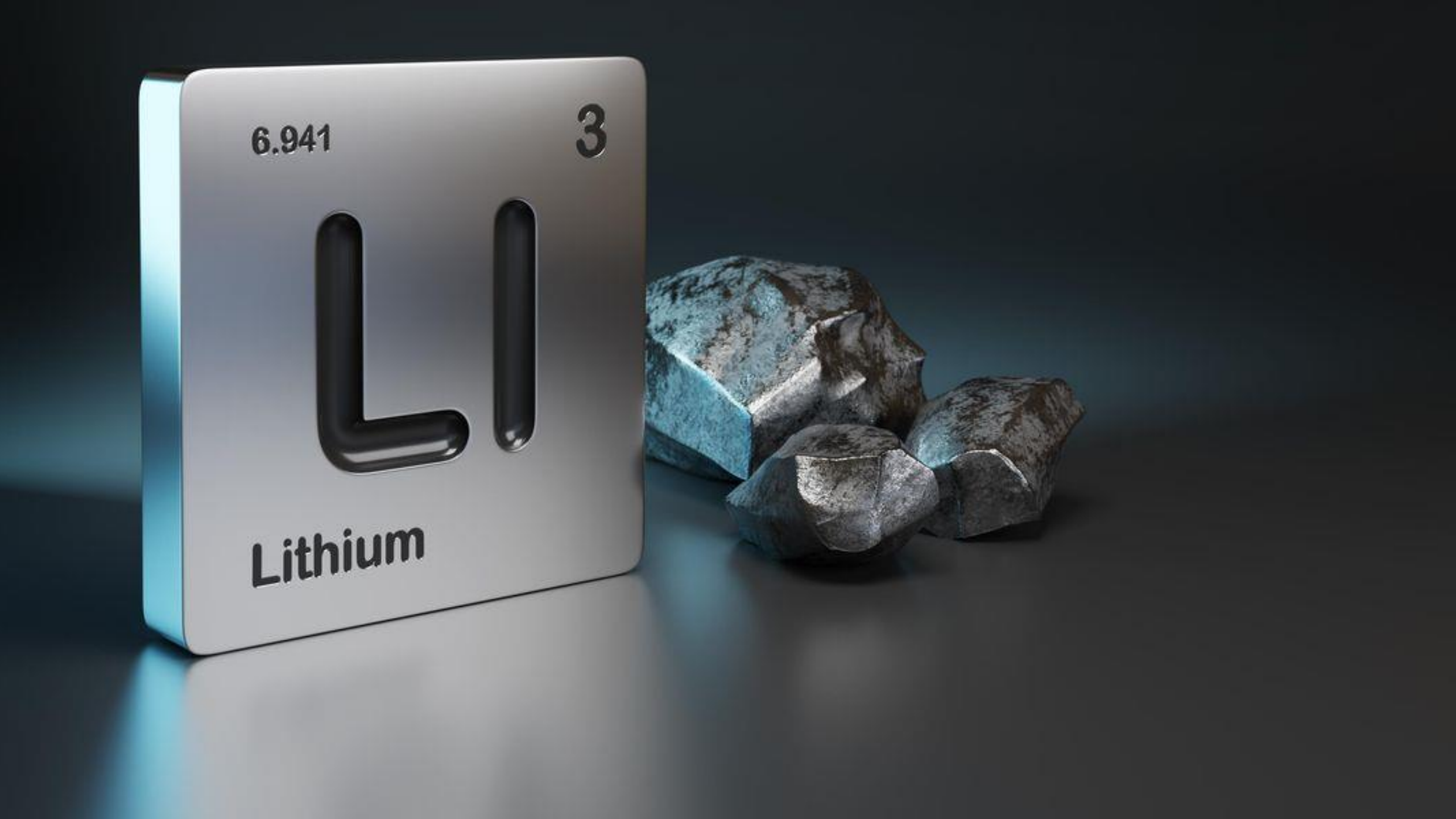
Economies of Scale with AVEVA PI System and AI
The World's Top Lithium Producer Shares its Journey

Presented by: Jonathan Alexander

ALBEMARLE®

Global Emissions
reduced 45%
by 2030
net zero
by 2050

EVs sold globally:
2019
2.5 million
2023
15.7 million
2030
46.9 million


6.941
3
Li
Lithium

Lithium Demand expected to grow 30% annually from 2023 to 2030

ALBEMARLE®

Providing Critical Ingredients for Mobility, Energy, Connectivity and Health

MOBILITY Advancing the future of movement by being the leading provider of materials that make mobility better and cleaner.

ENERGY Powering the energy transition to meet the rising needs so we can ensure the world has critical resources for years to come.

CONNECTIVITY Enabling an always-on world to make technology more consistent and reliable, so we can continue to innovate more efficient.

HEALTH Improving quality of life by making health safer and more attainable today, so the planet and future generations can continue to thrive.

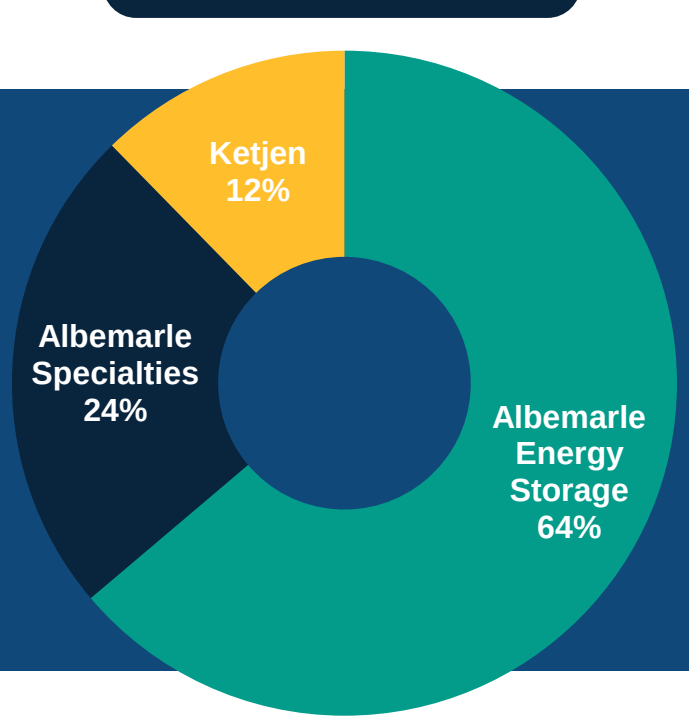
Leading the World in Transforming Essential Resources

Albemarle by the Numbers[1]

Employees[2]	~7,400
Customers	~1,900
Countries	~70
Active Patents	>2,100

FY 2022 Financial Highlights

Net Sales	$7.3B
Net Income[3]	$2.7B
Adj. EBITDA[4]	$3.5B
Adj. EBITDA Margin[4]	47%



- Clear strategy to **achieve profitable growth** and **enhance sustainability**
- **A global leader** with durable competitive advantages
- Track record of **strong financial and operating performance**
- Growth expected to continue in 2023 – **+40-55% net sales** Y/Y
- Capitalizing on growth opportunities in **electric vehicles and beyond** — mobility, energy, connectivity, health

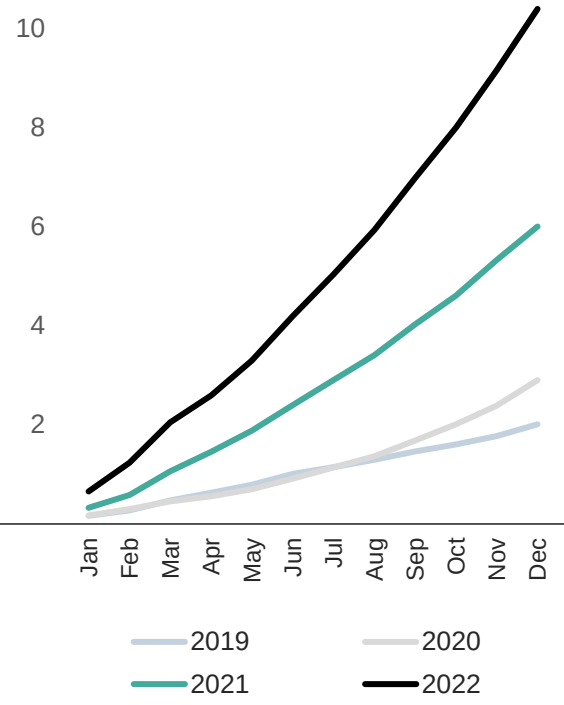
[1] As of December 31, 2022 [2] Includes employees of consolidated JVs [3] Attributable to Albemarle Corporation [4] Non-GAAP measure; see Appendix for definition and reconciliations of historical measures to most directly comparable GAAP measure

Increasing Our Lithium Market Demand Outlook: 5x Growth by 2030

Global EV

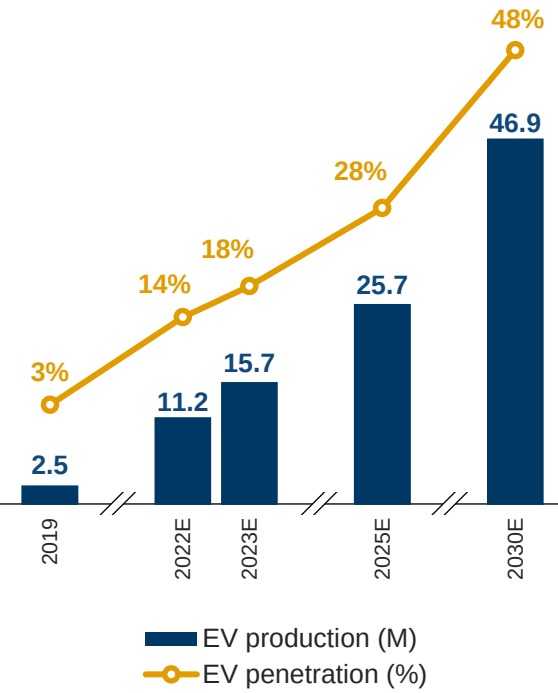
Cumulative Sales by Year[1]
(M units)

2022 vs. 2021:
+64%



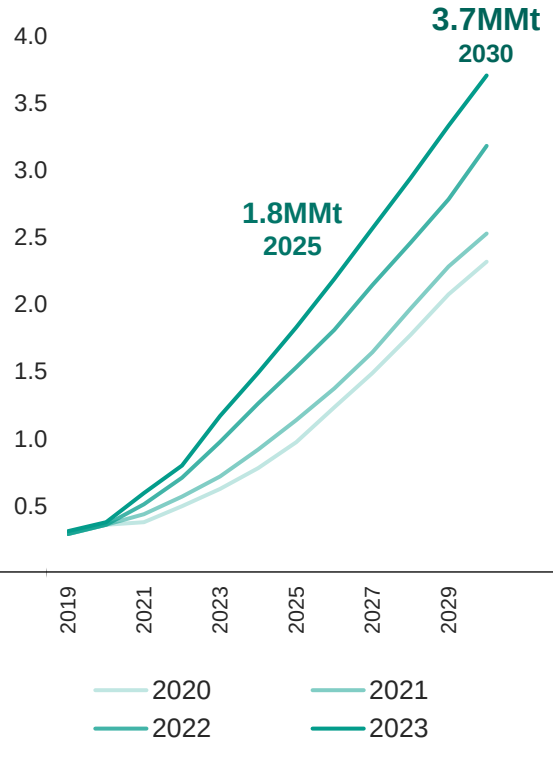
Production / Market Penetration[2]

2022-2027
CAGR: 25-30%



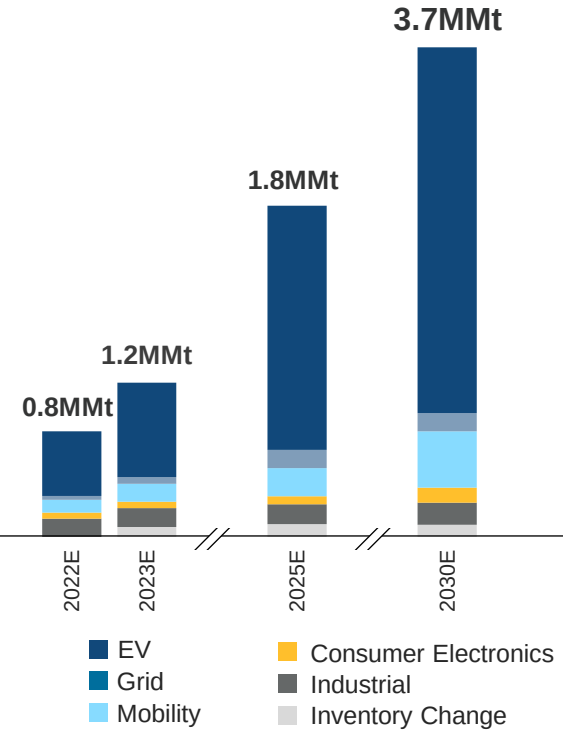
Lithium Demand

ALB Projections[3]
(MMt LCE)



by Application[3]
(MMt LCE)

2022-2027
CAGR: 25-30%



2030E lithium demand of 3.7MMt LCE +15% from previous forecast due to IRA and strong EV demand

[1] Marklines data as of 01/25/2023 [2] S&P Global Mobility, Global Production based Alternative Propulsion Forecast, November 2022 [3] Albemarle analysis

Source: Albemarle Sustainability Report 2022

Established Processes for Conventional Resources

Continuous improvement through optimization, efficiency, technology advancements

Resource Extraction

Lithium Conversion

Lithium Products

Hard Rock

0.5- 2.5% Li_2O

Mines

Greenbushes, Wodgina, Kings Mountain*

6% Li_2O Concentrate

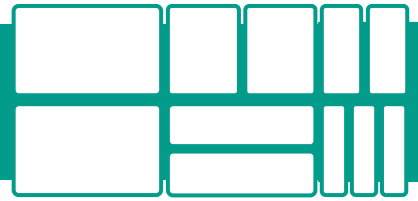
Xinyu, Chengdu, Qinzhou, Kemerton

Option to convert to lithium carbonate via 3rd party tolling

Battery and Technical Grade Lithium Hydroxide

Brine

0.01- 0.30% Li



Ponds

Salar de Atacama, Silver Peak, Antofalla*, Magnolia*

6% Li Concentrate

La Negra, Silver Peak

Optional further processing to produce hydroxide

Kings Mountain

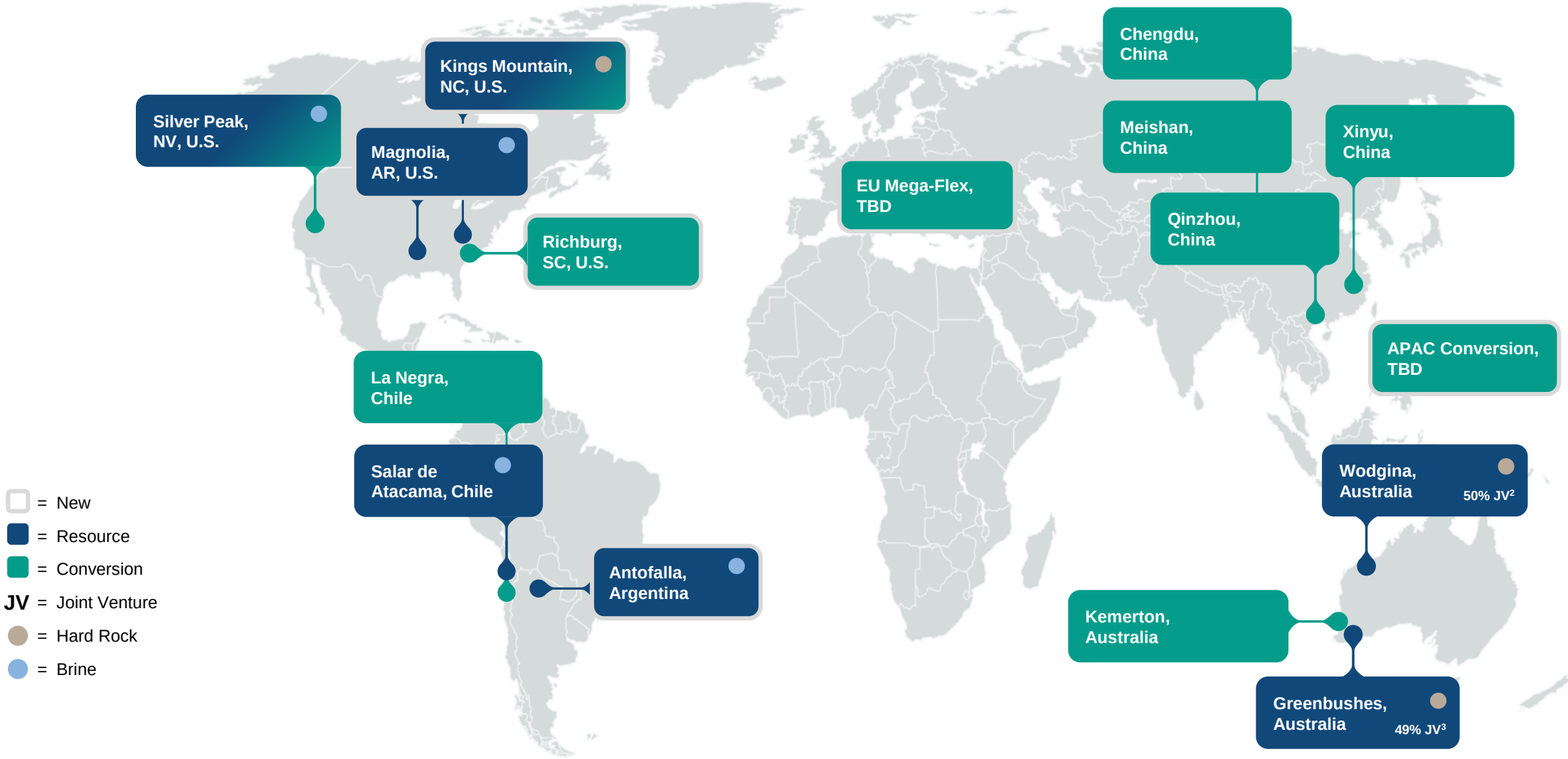
Battery and Technical Grade Lithium Carbonate

Battery and Technical Grade Lithium Hydroxide

Battery Grade Metal

*Not currently in operation

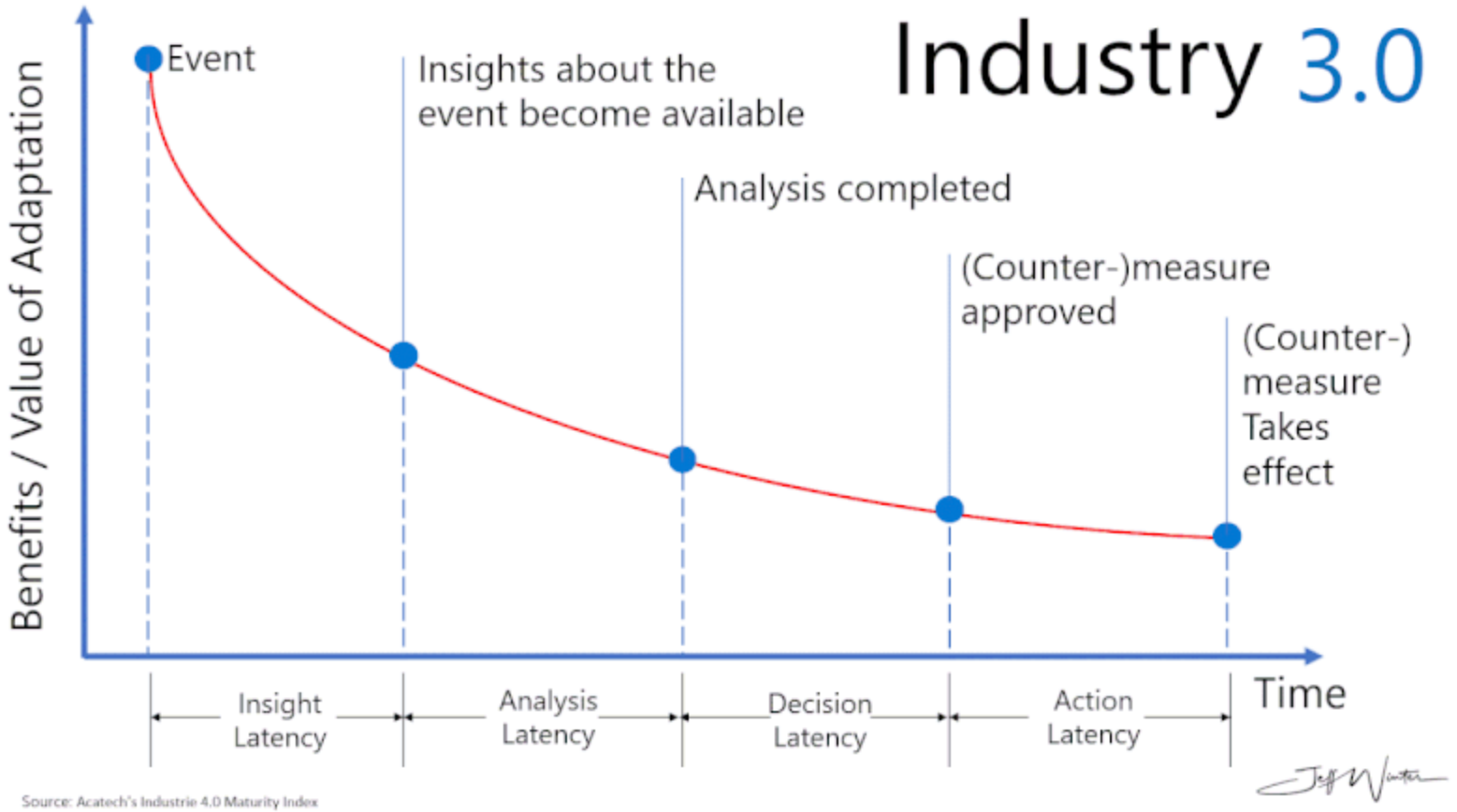
Expanding Global Footprint – Strong Presence in Major Markets[1]



[1] Map is representative of Albemarle's global reach; not inclusive of all the company's sites [2] Expected joint venture ownership interest, pending regulatory approvals
[3] Joint venture ownership interest, with right to 50% of the offtake

25,000
minutes
annually

AI
0101

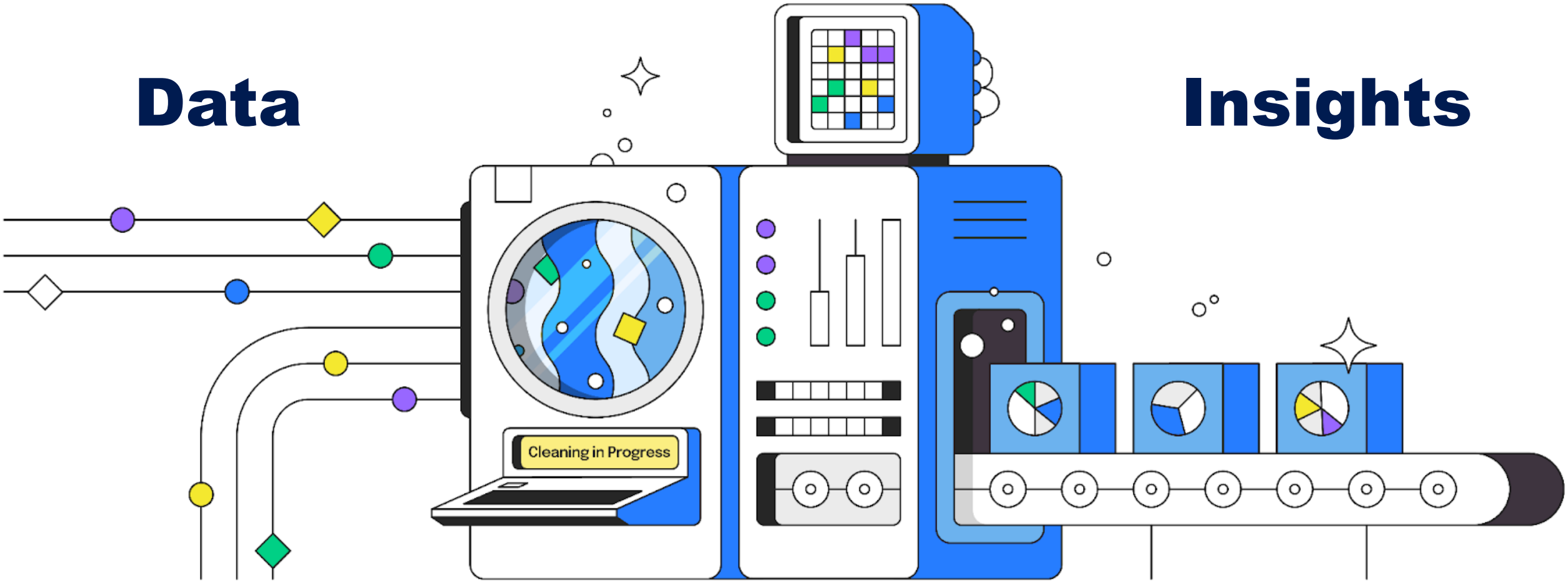


Proprietary information – all rights reserved.

ALBEMARLE INTELLIGENCE

Data

Insights



Proprietary information – all rights reserved.

ALBEMARLE INTELLIGENCE

DATA SOURCES

SAP

DCS

LIMS

Wireless Edge

Manual Data

SHIFTCONNECTOR® OEE

Mobile Devices

AVEVA PI SYSTEM ASSET FRAMEWORK

Templates

PI Analytics

Event Frames

PI SQL

ROVISYS Automation & Information Solutions

DATA ANALYTICS SUITE

PI Builder - Excel

PI Vision

SQL Query - PI RTQP

Northwest Analytics

NWA Quality Analyst Automatic Datasets

NWA Focus EMI Real Time SPC & SQC

SARTORIUS Machine Learning Algorithms

SIMCA®

PI Central Server

SAP

PI Notifications for WO generation Production and Inventory Tracking

USER ROLES

TRANSACTIONAL - OPERATIONS

Email & Text Notifications

Daily Troubleshooting

Analytics & Data Driven Decision Making

Alarms Specs SPC Rule

Real Time Machine Learning

TACTICAL - ENGINEERS

Customer Spec Capability Product Quality

OEE Downtime Analysis

STRATEGIC - LEADERSHIP

Global Perspective

Power Generation Fleet Status

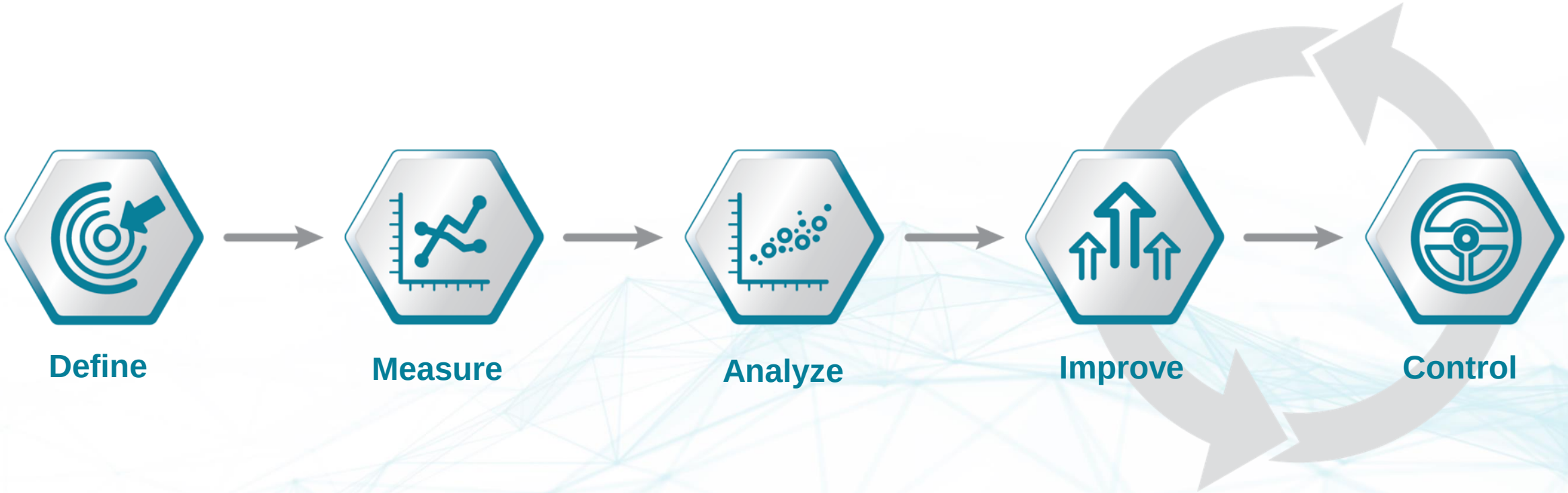
Power BI

Executive Reporting

ALBEMARLE INTELLIGENCE

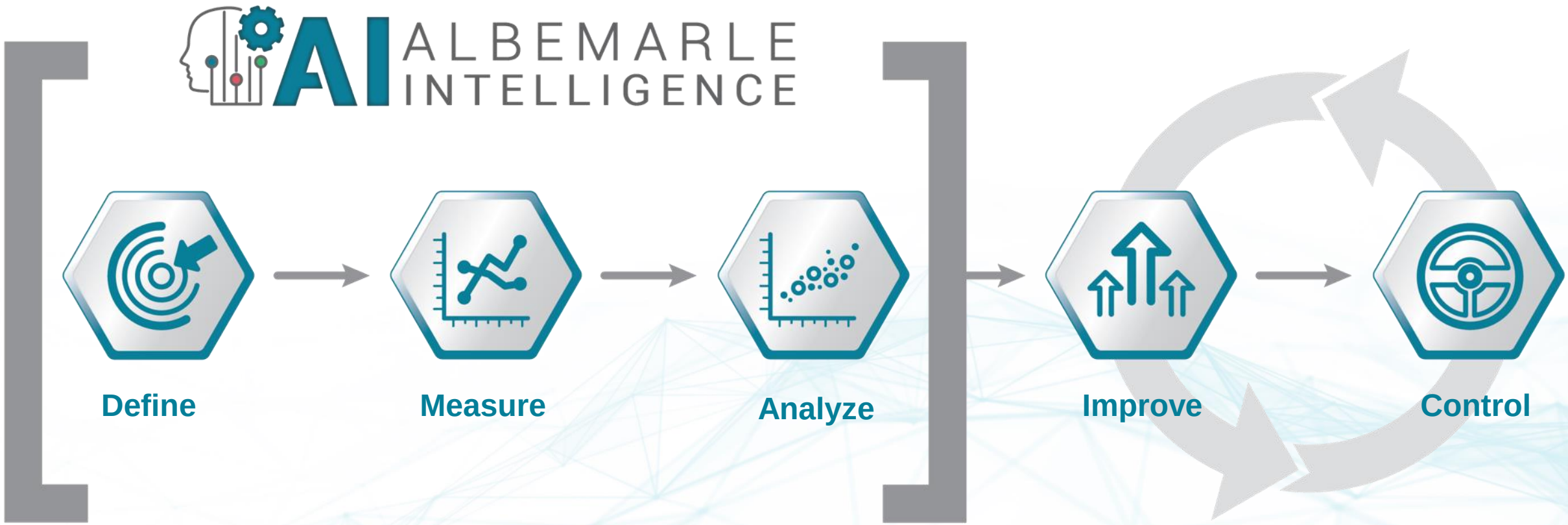
Proprietary information – all rights reserved.

Six Sigma: Manual Version



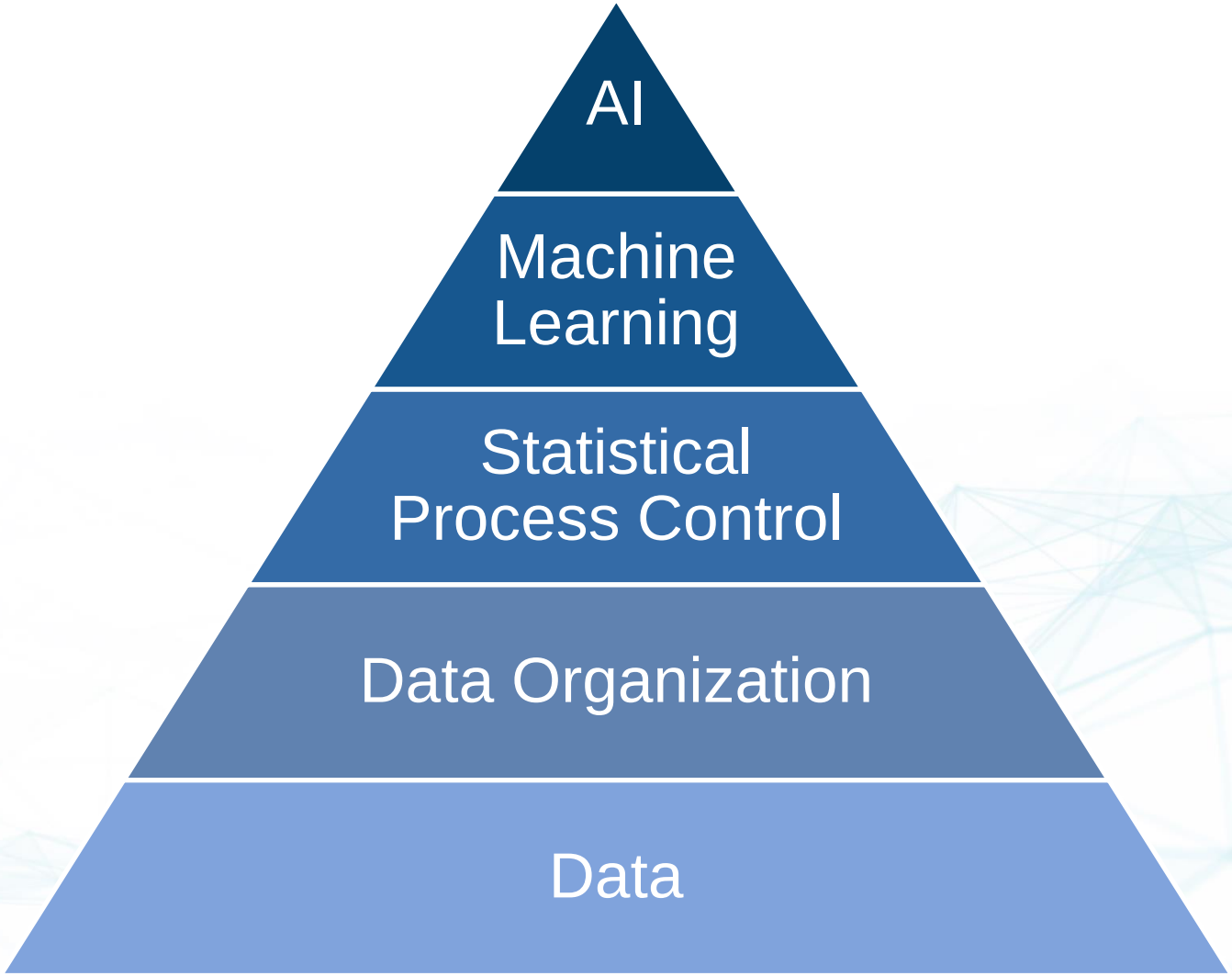
Proprietary information – all rights reserved.

Six Sigma: Automated



Proprietary information – all rights reserved.

AI Strategy



Automation

- Key Process Variables Monitored Automatically
- Standardized Global Data Structure
- Supports Global Growth & Economies of Scale

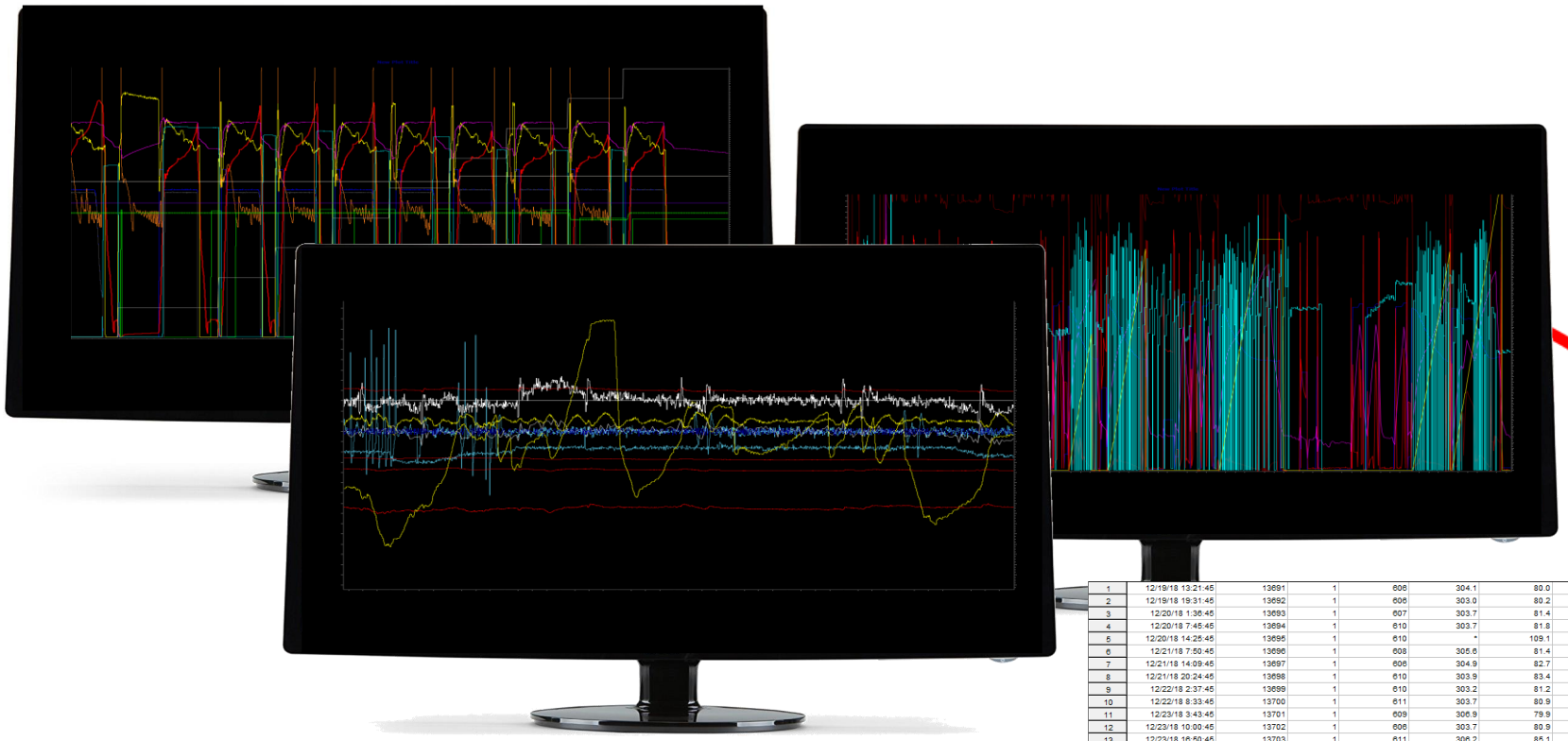
Stabilization

- Statistical Actionboards enable Engineers & Operations to minimize Firefighting
- Improved Process Control
- Improved Equipment Reliability

Innovation

- “Data at your fingertips” enables Engineers to do more Engineering
- Advanced Analytics & Machine Learning techniques unlock unknown correlations and pre
- Positions Albemarle as a global leader in Digital Manufacturing & Industry 4.0

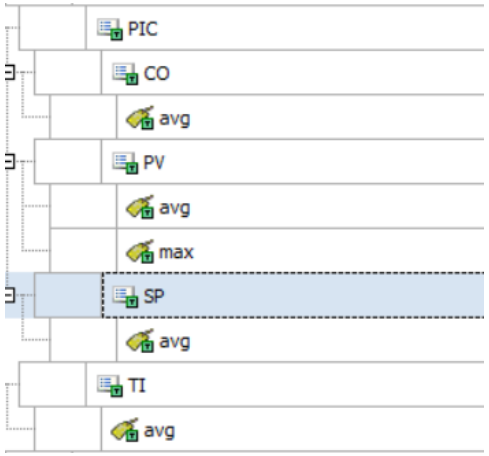
Proprietary information – all rights reserved.



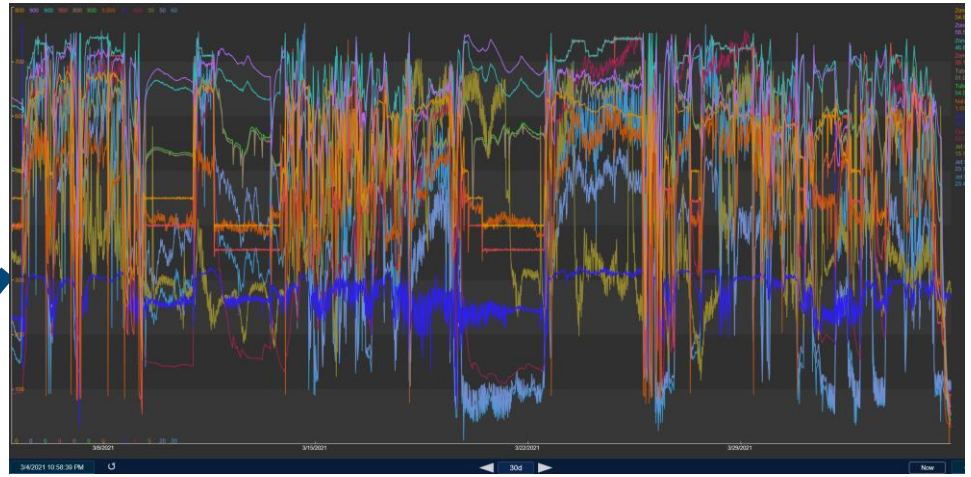
1	12/19/18 13:21:45	13691	1	606	304.1	80.0	2098	44.5	22	104	107	77	164.46	7149	6419.3	2.3	8847.334
2	12/19/18 19:31:45	13692	1	606	303.0	80.2	2048	44.5	23	101	136	77	164.01	7148	6360.6	2.3	8409.153
3	12/20/18 1:36:45	13693	1	607	303.7	81.4	2226	44.5	24	101	125	77	164.13	7149	6386.1	2.3	8478.928
4	12/20/18 7:45:45	13694	1	610	303.7	81.8	2316	44.5	25	98	132	77	164.01	7151	6327.4	2.3	8499.395
5	12/20/18 14:25:45	13695	1	610	*	109.1	2060	44.5	26	98	160	79	162.23	7150	6338.3	2.3	8611.963
6	12/21/18 7:50:45	13696	1	608	305.6	81.4	1227	45	27	108	148	80	162.42	7149	6447.5	2.3	8683.598
7	12/21/18 14:09:45	13697	1	606	304.9	82.7	2054	45	28	98	146	79	162.27	7151	6362.6	2.3	8832.448
8	12/21/18 20:24:45	13698	1	610	303.9	83.4	2061	45	29	97	144	80	162.08	7150	6406.9	2.2	7730.021
9	12/22/18 2:37:45	13699	1	610	303.2	81.2	*	45	30	97	67	80	162.21	7150	6440.3	2.2	8021.211
10	12/22/18 8:33:45	13700	1	611	303.7	80.9	2013	45	31	97	117	78	162.12	7150	6323.9	2.3	8285.421
11	12/23/18 3:43:45	13701	1	609	306.9	79.9	2140	45	32	107	67	80	162.38	7148	6525.2	2.3	7762.582
12	12/23/18 10:00:45	13702	1	606	303.7	80.9	2176	45	33	98	137	81	162.26	7149	6197.5	2.2	6291.748
13	12/23/18 16:50:45	13703	1	611	306.2	85.1	2064	45	34	98	137	82	162.29	7151	6414.4	2.2	7566.285
14	12/23/18 22:54:45	13704	1	*	311.6	81.9	2048	45	35	102	125	74	162.70	7152	6028.4	2.3	10093.03
15	12/24/18 7:31:45	13705	1	602	309.4	81.4	2090	45	36	94	286	71	162.48	7155	5982.3	2.4	11320.12
16	12/24/18 14:37:45	13706	1	545	309.5	84.2	2043	45	37	95	183	74	161.79	7157	5706.0	2.3	11832.73
17	12/24/18 20:33:45	13707	1	603	312.2	85.8	2068	45	38	99	105	79	162.27	7153	6245.2	2.2	9536.7
18	12/25/18 2:45:45	13708	1	603	309.8	82.2	2050	45	39	94	119	70	162.32	7156	5818.0	2.2	11451.3
19	12/25/18 10:40:45	13709	1	603	310.2	81.5	1877	45	40	96	244	72	162.21	7153	6043.8	3.0	11545.26
20	12/25/18 17:26:45	13710	1	602	312.4	85.1	2055	45	41	96	167	77	162.22	7154	6183.0	2.9	10347.01
21	12/26/18 0:00:45	13711	1	609	309.1	84.7	2022	45	42	96	168	80	158.78	7151	6091.4	2.8	8602.66
22	12/26/18 6:03:45	13712	1	569	309.7	83.9	2146	46	43	94	139	72	158.57	7158	5812.0	2.8	11360.13
23	12/26/18 12:55:45	13713	1	603	312.7	83.9	2022	46	44	99	173	79	162.28	7153	6170.2	2.8	9911.619
24	12/26/18 19:22:45	13714	1	605	307.8	85.4	2051	45	45	98	137	81	162.18	7150	6102.3	2.9	7056.47
25	12/27/18 1:04:45	13715	1	606	308.3	84.7	1971	45	46	100	111	81	162.26	7150	6211.3	2.9	7109.498
26	12/27/18 6:48:45	13716	1	606	308.8	83.8	2158	45	47	101	109	80	162.03	7149	6233.1	2.9	8123.546
27	12/27/18 12:44:45	13717	1	609	313.8	84.4	2019	45	48	106	112	80	161.58	7147	6333.8	2.9	8759.883
28	12/27/18 18:53:45	13718	1	603	307.8	84.7	1897	45	49	104	130	78	161.39	7149	6197.8	2.8	8932.923
29	12/28/18 0:59:45	13719	1	602	307.0	85.2	2097	45	50	104	128	79	161.53	7150	6237.0	2.9	9011.07
30	12/28/18 7:06:45	13720	1	602	309.8	85.0	2012	45	51	103	130	78	161.62	7151	6163.3	2.7	9939.528
31	12/28/18 16:17:45	13721	1	598	308.8	85.6	1937	45	52	118	288	85	161.21	7151	6504.8	2.7	9986.975
32	12/28/18 22:40:45	13722	1	597	312.8	86.3	1953	45	53	120	120	85	161.08	7151	6600.9	2.9	10469.81
33	12/29/18 5:20:45	13723	1	596	307.0	85.0	1852	45	54	117	130	83	161.17	7151	6356.3	2.7	9537.63
34	1/11/19 19:03:45	13725	3	565	307.9	86.4	2031	45	55	108	438	56	160.93	7148	6567.6	2.9	10104.2
35	1/12/19 2:10:45	13726	1	569	300.7	87.9	1967	45	57	118	166	86	160.92	7150	6329.3	2.8	7185.784
36	1/12/19 8:16:45	13727	1	577	305.3	85.4	1966	45	58	117	109	84	160.97	7151	6336.5	2.8	10049.31
37	1/12/19 15:02:45	13728	1	602	303.1	83.5	1944	45	59	117	152	82	160.99	7148	6277.2	2.8	8655.688
38	1/12/19 21:23:45	13729	1	602	306.0	84.0	1797	45	60	118	125	85	160.93	7148	6433.7	2.9	9941.389
39	1/13/19 4:11:45	13730	1	605	302.9	82.6	1735	45	61	119	156	83	160.85	7144	6283.6	2.9	8946.879
40	1/13/19 10:39:45	13731	1	602	303.4	83.5	2096	45	62	118	132	83	160.97	7147	6282.8	2.7	9694.854
41	1/13/19 17:18:45	13732	1	603	302.9	82.5	1946	45	63	116	124	80	160.97	7147	6046.4	2.9	9181.318
42	1/13/19 23:45:45	13733	1	602	304.9	83.1	2076	45	64	119	122	81	160.89	7145	6235.5	2.9	9758.116
43	1/14/19 6:23:45	13734	1	602	303.3	83.5	2041	45	65	117	140	80	160.99	7147	6148.1	2.9	9389.709
44	1/14/19 12:50:45	13735	1	602	303.7	83.9	2025	45	66	117	136	81	161.01	7147	6171.1	2.9	9540.422
45	1/14/19 19:23:45	13736	1	602	304.3	83.9	2013	45	67	118	135	82	161.83	7147	6187.4	3.0	9524.605
46	1/15/19 1:47:45	13737	1	602	305.9	83.6	2004	45	68	120	120	82	161.73	7146	6279.8	2.9	9932.086
47	1/15/19 8:09:45	13738	1	603	309.9	83.7	1977	45	69	121	121	82	161.88	7146	6287.2	2.9	9844.636
48	1/15/19 14:26:45	13739	1	602	312.1	83.6	1990	45	70	119	124	81	161.91	7147	6095.9	2.4	10440.04

Scaling Event Frames as an Analytics Engine

PI System Event Frames Capture Key Process Indicators



PI Vision – Time Series Trend

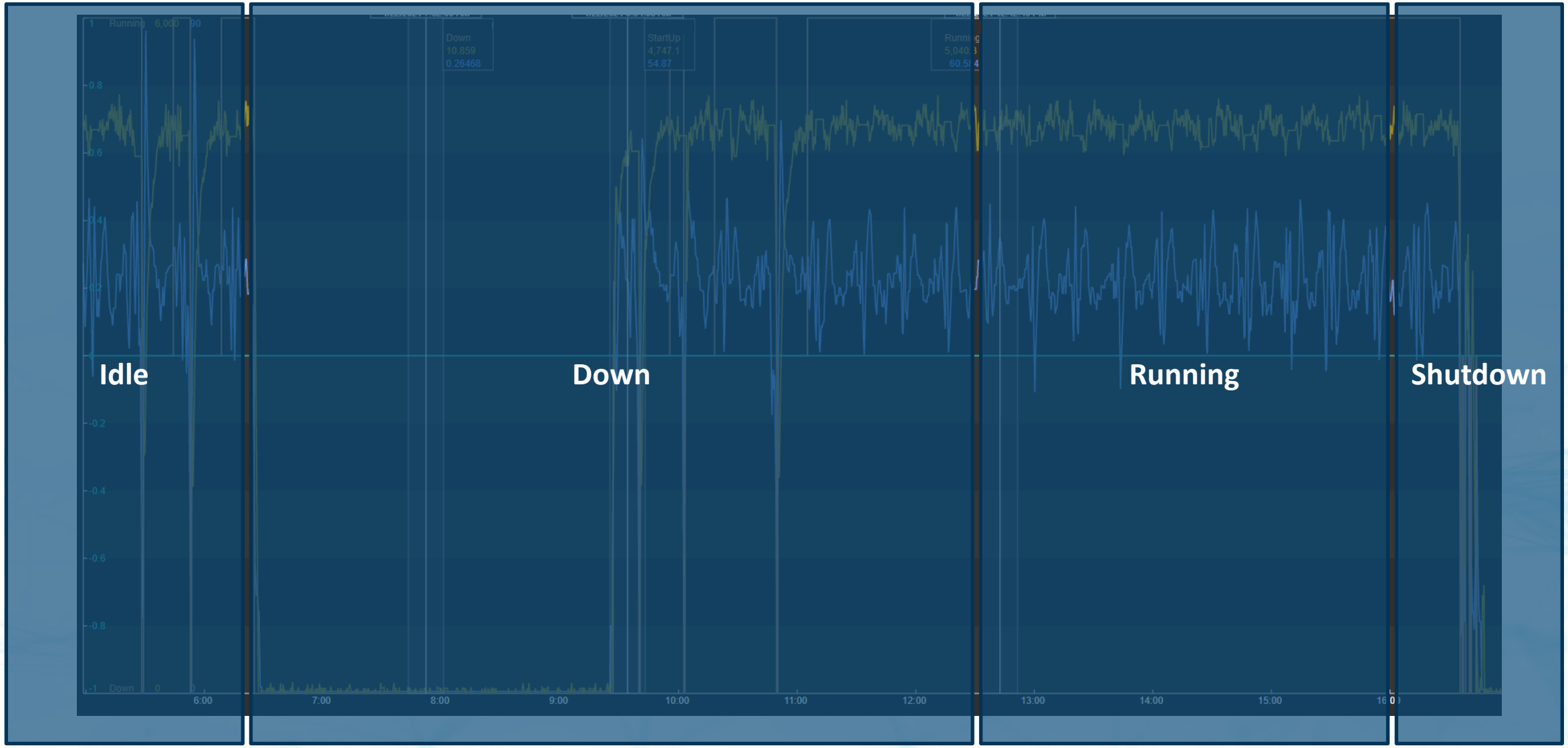


Time Series Data converted to NWA Automated Dataset

Running	0.3718942	2.909119	216.495739360325	-0.1321941	383.8147
StartUp	-0.4279914	-0.2840576	322.860671633938	0.1736194	63.82583
Running	-0.4223962	-0.3425598	305.745576461575	0.1763347	62.66646
Shutdown	-0.4734771	-0.324707	298.052300682118	0.1772715	61.86706
Running	0.2159671	0.4127502	220.930605507834	-0.1006555	313.9682
Down	-0.5094602	-0.2527466	284.357069405793	0.1859251	60.79785
StartUp	-0.5613872	-0.3156433	278.476235698077	0.2133375	68.21075
Running	-0.5736619	-0.4169922	284.672640178253	0.2123941	73.50066
Running	-1.567335	0.441864	137.47848763637	-0.1426007	371.2763
Running	-0.5626348	8.453369E-03	302.569833874868	0.2008539	71.44946
Running	-1.412884	0.4262085	102.067914653533	-0.1506102	391.2102
Running	-0.5321657	-0.1895752	360.878072766825	0.2073481	70.59
Running	0.4135617	0.4399414	93.1583761218025	-0.1381288	359.4965
Running	-0.539593	-0.2280273	405.759095291282	0.2009507	73.90455
Running	0.4200543	0.4533997	88.5530691171817	-0.1277233	384.5705
Running	-0.5278784	-0.1741943	414.219982169718	0.196907	75.8298
Running	0.4203337	0.4443359	86.7404389693375	-0.1268579	388.081
Running	-0.5972258	-0.2887268	408.247929732666	0.1513973	124.4997
Running	0.4149729	0.4399414	84.805173803336	-0.1262336	389.712
Running	-0.5588144	-0.2571411	414.147331062345	0.213384	71.81898
Running	0.4115643	0.441864	84.9106852121235	-0.1293062	392.6315
Running	-0.5406891	-0.131073	435.808046336968	0.2040336	69.80434
Running	-0.174948	0.419342	86.0640458073636	-0.1368737	400.9058
Running	-0.5188184	-0.2796631	400.768687646535	0.237986	80.87172
Running	0.2648312	0.9035645	142.866938346426	-0.133588	368.343
Running	-0.5269991	-0.2887268	425.40655445341	0.2053514	80.04122
Running	0.4027434	0.6423645	171.854726951685	-0.1557973	370.0322
Running	-0.5193281	-0.2077026	443.191644130461	0.2043966	81.53143
Running	0.5225884	1.459473	212.481242306819	-0.1425536	389.6417
Running	-0.5414297	-0.3021851	456.241302642243	0.1967892	83.35027
Running	0.5620538	1.268311	258.128296187667	-0.1338389	391.7454

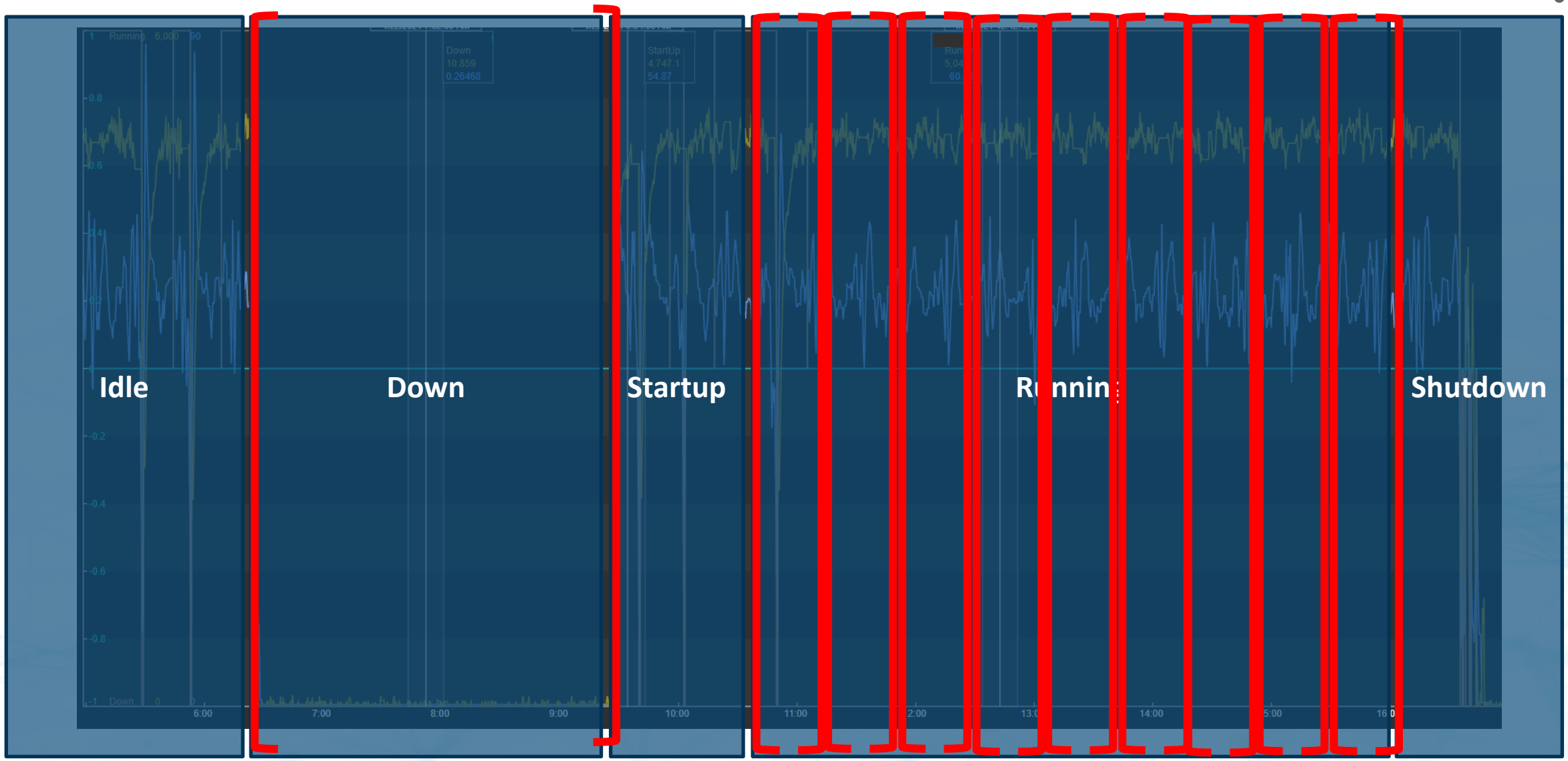
Proprietary information – all rights reserved.

Dataset Theory – Continuous Unit Operation - Status Flag



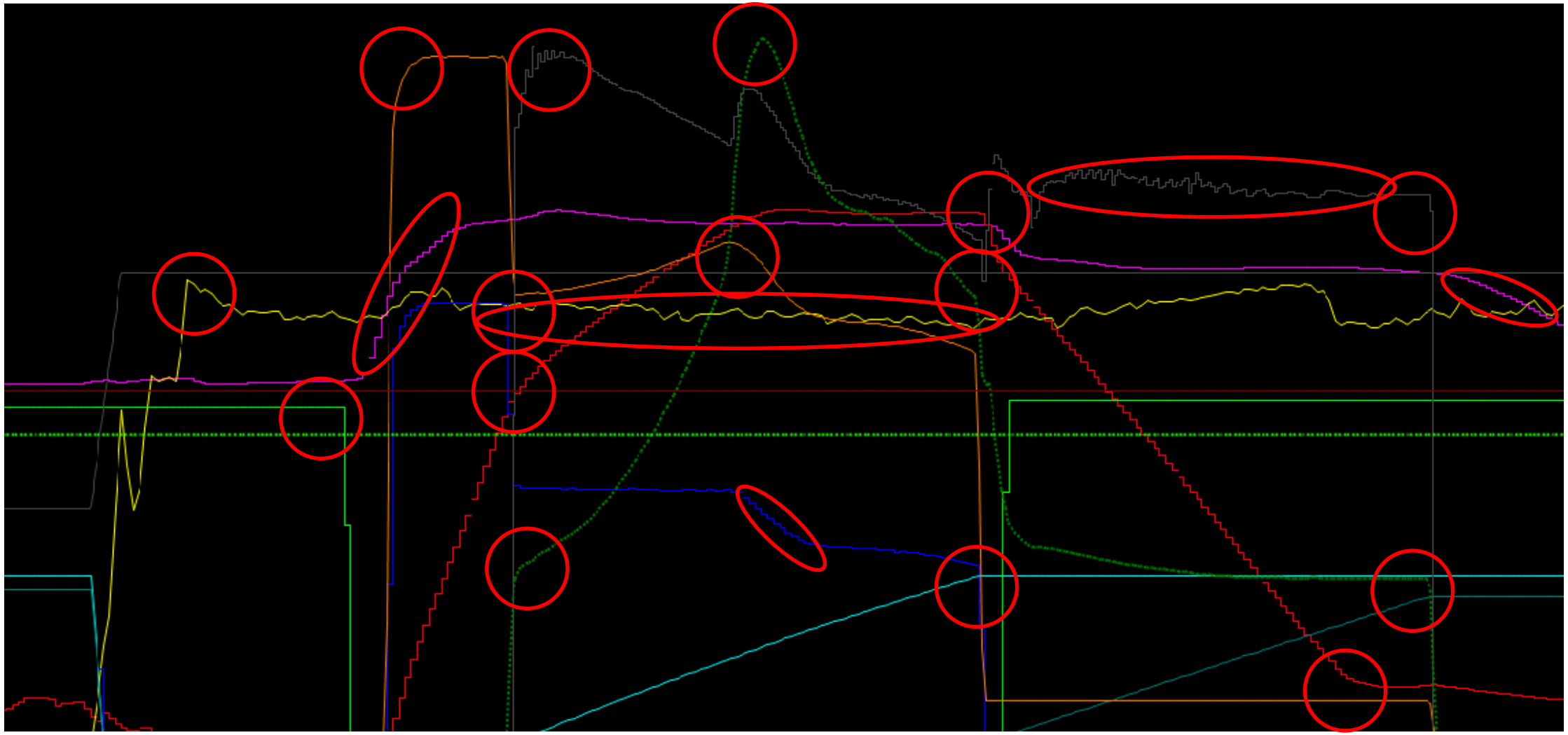
Proprietary information – all rights reserved.

Dataset Theory – Continuous Unit Operation - Status Flag



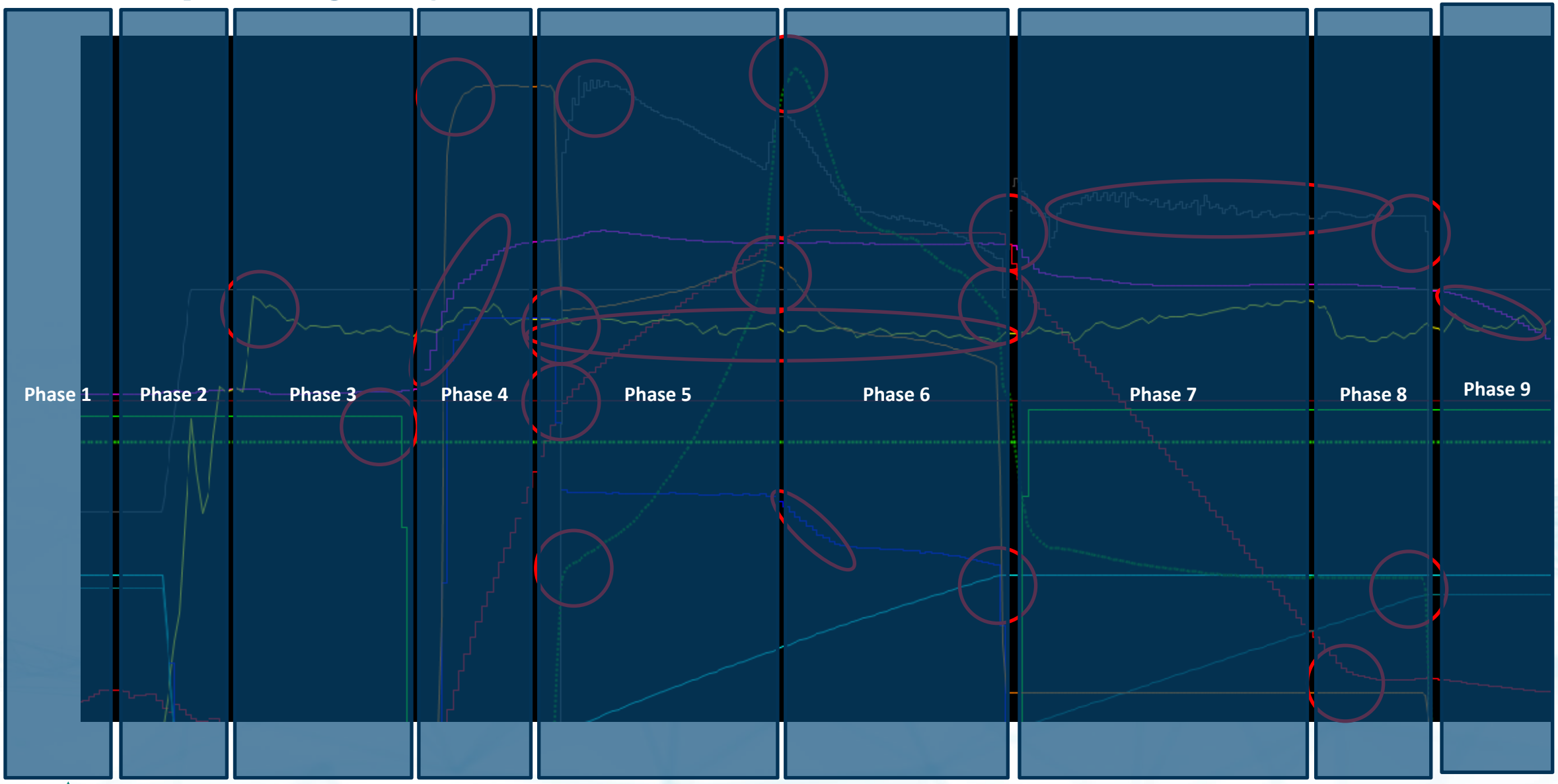
Proprietary information – all rights reserved.

Finding the Key Process Indicators & Inflection Points



Proprietary information – all rights reserved.

PI Asset Framework Event Frames - Capturing Key Process Indicators



Proprietary information – all rights reserved.

1/8/20 12:06 PM	10001	1	8,000	x	x	x	x	x	x	x	x	x	x
1/8/20 12:07 PM	10001	2	x	200	x	x	x	x	x	x	x	x	x
1/8/20 12:12 PM	10001	3	x	x	5000	x	x	x	x	x	x	x	x
1/8/20 12:19 PM	10001	3	x	x	x	315	x	x	x	x	x	x	x
1/8/20 2:20 PM	10001	5	x	x	x	x	120	x	x	x	x	x	x
1/8/20 2:56 PM	10001	5	x	x	x	x	x	600	x	x	x	x	x
1/8/20 3:06 PM	10001	5	x	x	x	x	x	x	12,000	x	x	x	x
1/8/20 3:11 PM	10001	6	x	x	x	x	x	x	x	2.13	x	x	x
1/8/20 3:14 PM	10001	8	x	x	x	x	x	x	x	x	25	x	x
1/8/20 3:19 PM	10001	9	x	x	x	x	x	x	x	x	x	12	x
1/8/20 3:20 PM	10002	1	8,000	x	x	x	x	x	x	x	x	x	x
1/8/20 3:21 PM	10002	2	x	200	x	x	x	x	x	x	x	x	x
1/8/20 3:26 PM	10002	3	x	x	5000	x	x	x	x	x	x	x	x
1/8/20 3:33 PM	10002	3	x	x	x	315	x	x	x	x	x	x	x
1/8/20 5:34 PM	10002	5	x	x	x	x	120	x	x	x	x	x	x
1/8/20 6:10 PM	10002	5	x	x	x	x	x	600	x	x	x	x	x
1/8/20 6:20 PM	10002	5	x	x	x	x	x	x	12,000	x	x	x	x
1/8/20 6:25 PM	10002	6	x	x	x	x	x	x	x	2.13	x	x	x
1/8/20 6:28 PM	10002	8	x	x	x	x	x	x	x	x	25	x	x
1/8/20 6:33 PM	10002	9	x	x	x	x	x	x	x	x	x	12	x
1/8/20 6:34 PM	10003	1	8,000	x	x	x	x	x	x	x	x	x	x
1/8/20 6:35 PM	10003	2	x	200	x	x	x	x	x	x	x	x	x
1/8/20 6:40 PM	10003	3	x	x	5000	x	x	x	x	x	x	x	x
1/8/20 6:47 PM	10003	3	x	x	x	315	x	x	x	x	x	x	x
1/8/20 8:48 PM	10003	5	x	x	x	x	120	x	x	x	x	x	x
1/8/20 9:24 PM	10003	5	x	x	x	x	x	600	x	x	x	x	x
1/8/20 9:34 PM	10003	5	x	x	x	x	x	x	12,000	x	x	x	x
1/8/20 9:39 PM	10003	6	x	x	x	x	x	x	x	2.13	x	x	x
1/8/20 9:42 PM	10003	8	x	x	x	x	x	x	x	x	25	x	x
1/8/20 9:47 PM	10003	9	x	x	x	x	x	x	x	x	x	12	x

Proprietary information – all rights reserved.

1/8/20 12:06 PM	10001	1	8,000	x	x	x	x	x	x	x	x	x
1/8/20 12:07 PM	10001	2	x	200	x	x	x	x	x	x	x	x
1/8/20 12:12 PM	10001	3	x	x	5000	x	x	x	x	x	x	x
1/8/20 12:19 PM	10001	3	x	x	x	315	x	x	x	x	x	x
1/8/20 2:20 PM	10001	5	x	x	x	x	120	x	x	x	x	x
1/8/20 2:56 PM	10001	5	x	x	x	x	x	600	x	x	x	x
1/8/20 3:06 PM	10001	5	x	x	x	x	x	x	12,000	x	x	x
1/8/20 3:11 PM	10001	6	x	x	x	x	x	x	x	2.13	x	x
1/8/20 3:14 PM	10001	8	x	x	x	x	x	x	x	x	25	x
1/8/20 3:19 PM	10001	9	x	x	x	x	x	x	x	x	x	12
1/8/20 3:24 PM	10001		8,000	200	5000	315	120	600	12,000	2.13	25	12
1/8/20 3:20 PM	10002	1	8,000	x	x	x	x	x	x	x	x	x
1/8/20 3:21 PM	10002	2	x	200	x	x	x	x	x	x	x	x
1/8/20 3:26 PM	10002	3	x	x	5000	x	x	x	x	x	x	x
1/8/20 3:33 PM	10002	3	x	x	x	315	x	x	x	x	x	x
1/8/20 5:34 PM	10002	5	x	x	x	x	120	x	x	x	x	x
1/8/20 6:10 PM	10002	5	x	x	x	x	x	600	x	x	x	x
1/8/20 6:20 PM	10002	5	x	x	x	x	x	x	12,000	x	x	x
1/8/20 6:25 PM	10002	6	x	x	x	x	x	x	x	2.13	x	x
1/8/20 6:28 PM	10002	8	x	x	x	x	x	x	x	x	25	x
1/8/20 6:33 PM	10002	9	x	x	x	x	x	x	x	x	x	12
1/8/20 6:38 PM	10002		8,006	203	5005	315.2	121.3	600	12,002	2.15	24	12.2
1/8/20 6:34 PM	10003	1	8,000	x	x	x	x	x	x	x	x	x
1/8/20 6:35 PM	10003	2	x	200	x	x	x	x	x	x	x	x
1/8/20 6:40 PM	10003	3	x	x	5000	x	x	x	x	x	x	x
1/8/20 6:47 PM	10003	3	x	x	x	315	x	x	x	x	x	x
1/8/20 8:48 PM	10003	5	x	x	x	x	120	x	x	x	x	x
1/8/20 9:24 PM	10003	5	x	x	x	x	x	600	x	x	x	x
1/8/20 9:34 PM	10003	5	x	x	x	x	x	x	12,000	x	x	x
1/8/20 9:39 PM	10003	6	x	x	x	x	x	x	x	2.13	x	x
1/8/20 9:42 PM	10003	8	x	x	x	x	x	x	x	x	25	x
1/8/20 9:47 PM	10003	9	x	x	x	x	x	x	x	x	x	12
1/8/20 9:52 PM	10003		8,003	201	5004	315.7	119	599	12,024	2.17	25.5	12.5

Proprietary information – all rights reserved.

1/8/20 12:06 PM	10001	1										
1/8/20 12:07 PM	10001	2										
1/8/20 12:12 PM	10001	3										
1/8/20 12:19 PM	10001	3										
1/8/20 2:20 PM	10001	5										
1/8/20 2:56 PM	10001	5										
1/8/20 3:06 PM	10001	5										
1/8/20 3:11 PM	10001	6										
1/8/20 3:14 PM	10001	8										
1/8/20 3:19 PM	10001	9										
1/8/20 3:24 PM	10001		8,000	200	5000	315	120	600	12,000	2.13	25	12
1/8/20 3:20 PM	10002	1										
1/8/20 3:21 PM	10002	2										
1/8/20 3:26 PM	10002	3										
1/8/20 3:33 PM	10002	3										
1/8/20 5:34 PM	10002	5										
1/8/20 6:10 PM	10002	5										
1/8/20 6:20 PM	10002	5										
1/8/20 6:25 PM	10002	6										
1/8/20 6:28 PM	10002	8										
1/8/20 6:33 PM	10002	9										
1/8/20 6:38 PM	10002		8,006	203	5005	315.2	121.3	600	12,002	2.15	24	12.2
1/8/20 6:34 PM	10003	1										
1/8/20 6:35 PM	10003	2										
1/8/20 6:40 PM	10003	3										
1/8/20 6:47 PM	10003	3										
1/8/20 8:48 PM	10003	5										
1/8/20 9:24 PM	10003	5										
1/8/20 9:34 PM	10003	5										
1/8/20 9:39 PM	10003	6										
1/8/20 9:42 PM	10003	8										
1/8/20 9:47 PM	10003	9										
1/8/20 9:52 PM	10003		8,003	201	5004	315.7	119	599	12,024	2.17	25.5	12.5

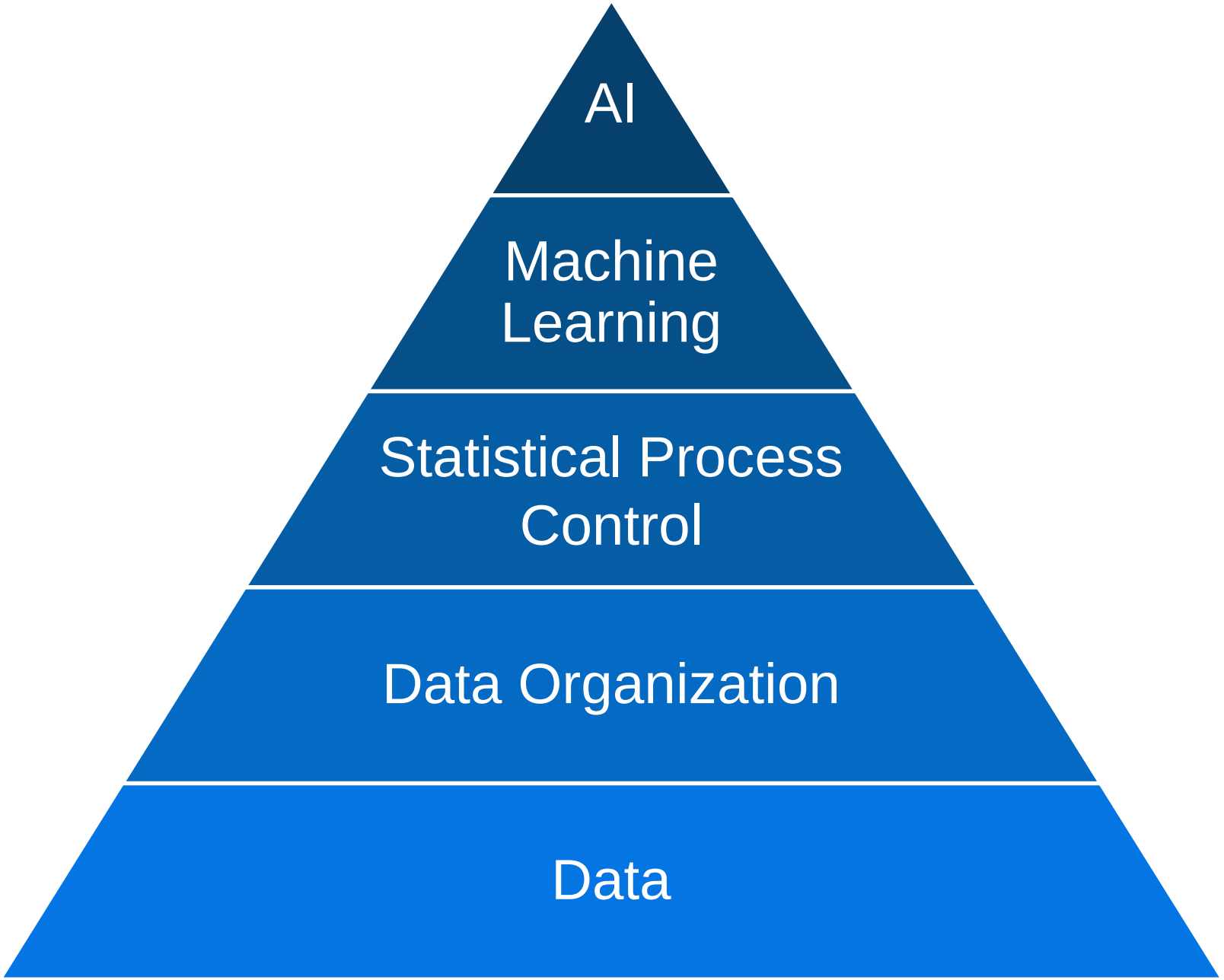
Proprietary information – all rights reserved.

1/8/20 3:24 PM	10001		8,000	200	5000	315	120	600	12,000	2.13	25	12
1/8/20 6:38 PM	10002		8,006	203	5005	315.2	121.3	600	12,002	2.15	24	12.2
1/8/20 9:52 PM	10003		8,003	201	5004	315.7	119	599	12,024	2.17	25.5	12.5

Proprietary information – all rights reserved.

1	12/19/18 13:21:45	13691	1	606	304.1	80.0	2098	44.5	22	104	107	77	164.46	7149	6419.3	2.3	8847.334
2	12/19/18 19:31:45	13692	1	606	303.0	80.2	2048	44.5	23	101	136	77	164.01	7148	6360.6	2.3	8409.153
3	12/20/18 1:36:45	13693	1	607	303.7	81.4	2226	44.5	24	101	125	77	164.13	7149	6386.1	2.3	8478.928
4	12/20/18 7:45:45	13694	1	610	303.7	81.8	2316	44.5	25	98	132	77	164.01	7151	6327.4	2.3	8499.395
5	12/20/18 14:25:45	13695	1	610	*	109.1	2060	44.5	26	98	160	79	162.23	7150	6338.3	2.3	8611.963
6	12/21/18 7:50:45	13696	1	608	305.6	81.4	1227	45	27	108	148	80	162.42	7149	6447.5	2.3	8683.598
7	12/21/18 14:09:45	13697	1	606	304.9	82.7	2054	45	28	98	146	79	162.27	7151	6362.6	2.3	8832.448
8	12/21/18 20:24:45	13698	1	610	303.9	83.4	2061	45	29	97	144	80	162.08	7150	6406.9	2.2	7730.021
9	12/22/18 2:37:45	13699	1	610	303.2	81.2	*	45	30	97	67	80	162.21	7150	6440.3	2.2	8021.211
10	12/22/18 8:33:45	13700	1	611	303.7	80.9	2013	45	31	97	117	78	162.12	7150	6323.9	2.3	8285.421
11	12/23/18 3:43:45	13701	1	609	306.9	79.9	2140	45	32	107	67	80	162.38	7148	6525.2	2.3	7762.582
12	12/23/18 10:00:45	13702	1	606	303.7	80.9	2176	45	33	98	137	81	162.26	7149	6197.5	2.2	6291.748
13	12/23/18 16:50:45	13703	1	611	306.2	85.1	2064	45	34	96	137	82	162.29	7151	6414.4	2.2	7566.285
14	12/23/18 22:54:45	13704	1	*	311.6	81.9	2048	45	35	102	125	74	162.70	7152	6028.4	2.3	10093.03
15	12/24/18 7:31:45	13705	1	602	309.4	81.4	2090	45	36	94	286	71	162.48	7155	5982.3	2.4	11320.12
16	12/24/18 14:37:45	13706	1	545	309.5	84.2	2043	45	37	95	183	74	161.79	7157	5706.0	2.3	11832.73
17	12/24/18 20:33:45	13707	1	603	312.2	85.8	2068	45	38	99	105	79	162.27	7153	6245.2	2.2	9536.7
18	12/25/18 2:45:45	13708	1	603	309.8	82.2	2050	45	39	94	119	70	162.32	7156	5818.0	2.2	11451.3
19	12/25/18 10:40:45	13709	1	603	310.2	81.5	1877	45	40	96	244	72	162.21	7153	6043.8	3.0	11545.26
20	12/25/18 17:26:45	13710	1	602	312.4	85.1	2055	45	41	96	167	77	162.22	7154	6183.0	2.9	10347.01
21	12/26/18 0:00:45	13711	1	609	309.1	84.7	2022	45	42	96	168	80	158.78	7151	6091.4	2.8	8602.66
22	12/26/18 6:03:45	13712	1	569	309.7	83.9	2146	46	43	94	139	72	158.57	7158	5812.0	2.8	11360.13
23	12/26/18 12:55:45	13713	1	603	312.7	83.9	2022	46	44	99	173	79	162.28	7153	6170.2	2.8	9911.619
24	12/26/18 19:22:45	13714	1	605	307.8	85.4	2051	45	45	98	137	81	162.18	7150	6102.3	2.9	7056.47
25	12/27/18 1:04:45	13715	1	606	308.3	84.7	1971	45	46	100	111	81	162.26	7150	6211.3	2.9	7109.498
26	12/27/18 6:48:45	13716	1	606	308.8	83.8	2158	45	47	101	109	80	162.03	7149	6233.1	2.9	8123.546
27	12/27/18 12:44:45	13717	1	609	313.8	84.4	2019	45	48	106	112	80	161.58	7147	6333.8	2.9	8759.883
28	12/27/18 18:53:45	13718	1	603	307.8	84.7	1897	45	49	104	130	78	161.39	7149	6197.8	2.8	8932.923
29	12/28/18 0:59:45	13719	1	602	307.0	85.2	2097	45	50	104	128	79	161.53	7150	6237.0	2.9	9011.07
30	12/28/18 7:06:45	13720	1	602	309.8	85.0	2012	45	51	103	130	78	161.62	7151	6163.3	2.7	9939.528
31	12/28/18 16:17:45	13721	1	598	308.8	85.6	1937	45	52	118	288	85	161.21	7151	6504.8	2.7	9986.975
32	12/28/18 22:40:45	13722	1	597	312.8	86.3	1953	45	53	120	120	85	161.08	7151	6600.9	2.9	10469.81
33	12/29/18 5:20:45	13723	1	596	307.0	85.0	1852	45	54	117	130	83	161.17	7151	6356.3	2.7	9537.63
34	1/11/19 19:03:45	13725	3	565	307.9	86.4	2031	45	56	108	438	56	160.93	7148	6567.6	2.9	10104.2
35	1/12/19 2:10:45	13726	1	569	300.7	87.9	1967	45	57	118	166	86	160.92	7150	6329.3	2.8	7185.784
36	1/12/19 8:16:45	13727	1	577	305.3	85.4	1966	45	58	117	109	84	160.97	7151	6336.5	2.8	10049.31
37	1/12/19 15:02:45	13728	1	602	303.1	83.5	1944	45	59	117	152	82	160.99	7148	6277.2	2.8	8655.688
38	1/12/19 21:23:45	13729	1	602	306.0	84.0	1797	45	60	118	125	85	160.93	7148	6433.7	2.9	9941.389
39	1/13/19 4:11:45	13730	1	605	302.9	82.6	1735	45	61	119	156	83	160.85	7144	6283.6	2.9	8946.879
40	1/13/19 10:39:45	13731	1	602	303.4	83.5	2006	45	62	118	132	83	160.97	7147	6282.8	2.7	9694.854
41	1/13/19 17:18:45	13732	1	603	302.9	82.5	1946	45	63	116	124	80	160.97	7147	6046.4	2.9	9181.318
42	1/13/19 23:45:45	13733	1	602	304.9	83.1	2076	45	64	119	122	81	160.89	7145	6235.5	2.9	9758.116
43	1/14/19 6:23:45	13734	1	602	303.3	83.5	2041	45	65	117	140	80	160.99	7147	6148.1	2.9	9389.709
44	1/14/19 12:50:45	13735	1	602	303.7	83.9	2025	45	66	117	136	81	161.01	7147	6171.1	2.9	9540.422
45	1/14/19 19:23:45	13736	1	602	304.3	83.9	2013	45	67	118	135	82	161.83	7147	6187.4	3.0	9524.605
46	1/15/19 1:47:45	13737	1	602	305.9	83.6	2004	45	68	120	120	82	161.73	7146	6279.8	2.9	9932.086
47	1/15/19 8:09:45	13738	1	603	309.9	83.7	1977	45	69	121	121	82	161.88	7146	6287.2	2.9	9844.636
48	1/15/19 14:26:45	13739	1	602	312.1	83.6	1990	45	70	119	124	81	161.91	7147	6095.9	2.4	10440.04

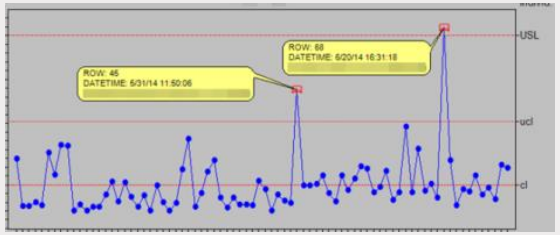
Proprietary information – all rights reserved.



Statistical Process Control

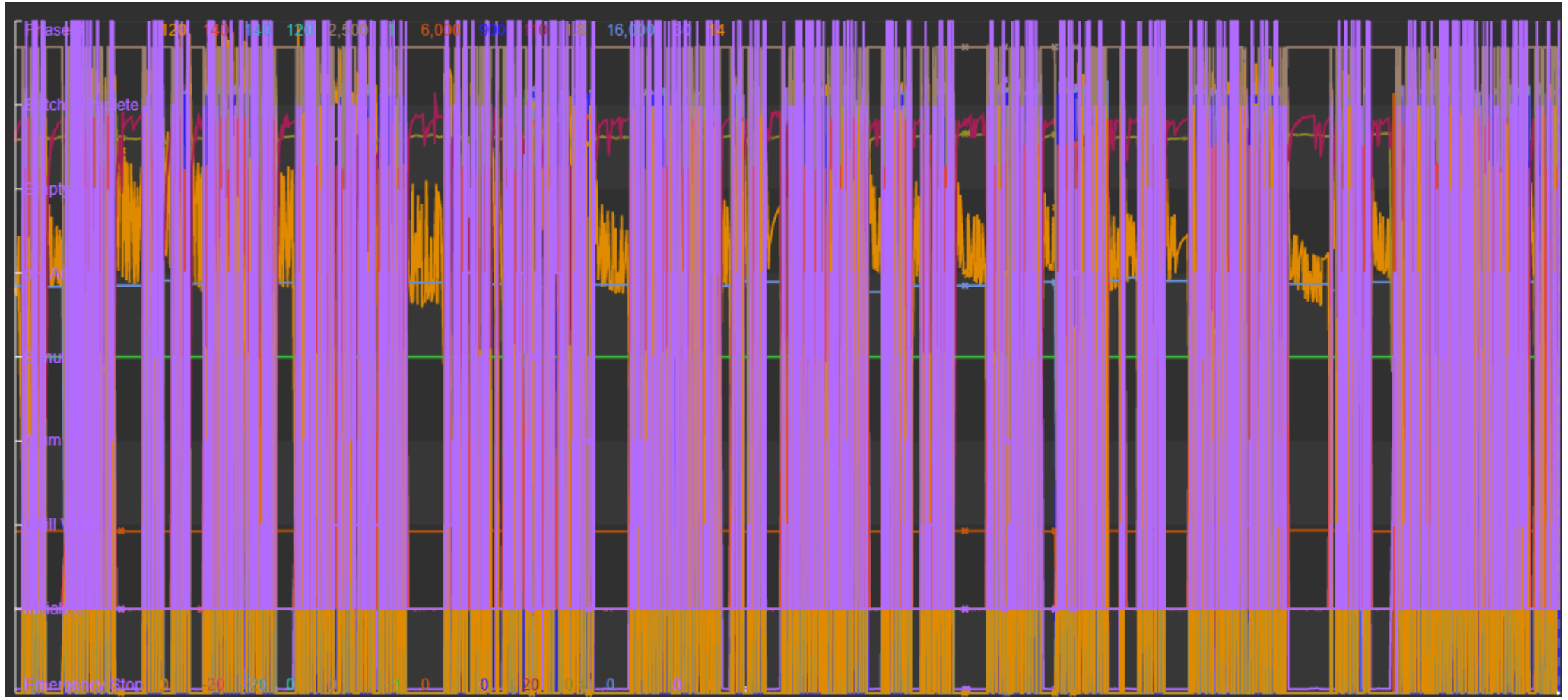
- SPC
- Eliminating Noise
- Focus on What Matters

Northwest Analytics



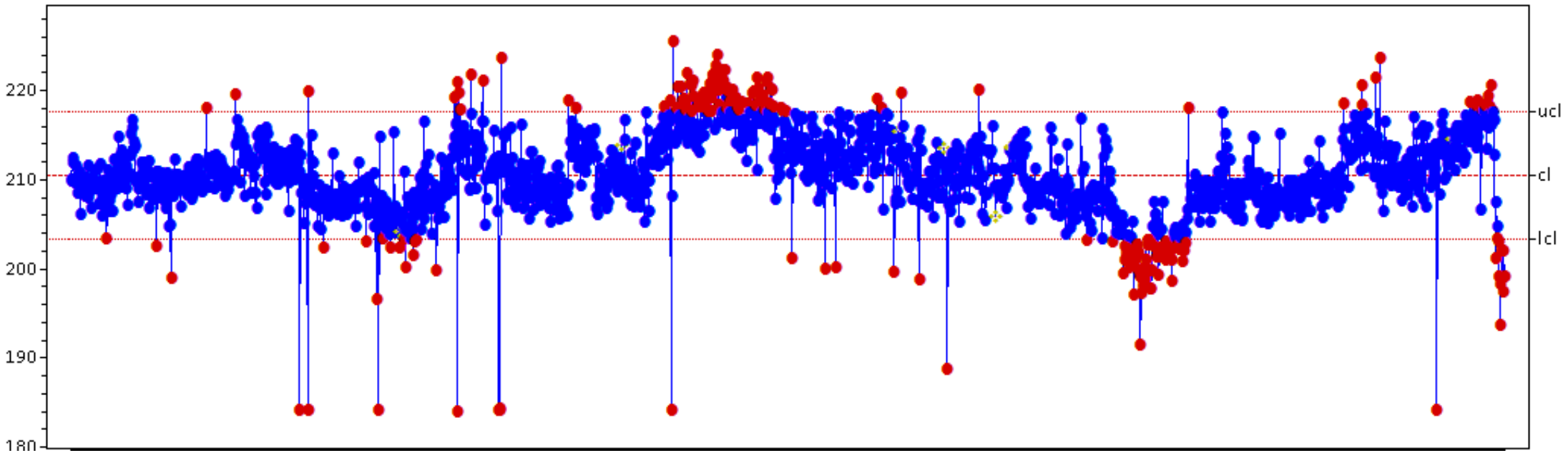
Proprietary information – all rights reserved.

3 Month PI Vision Trend – No Event Frames



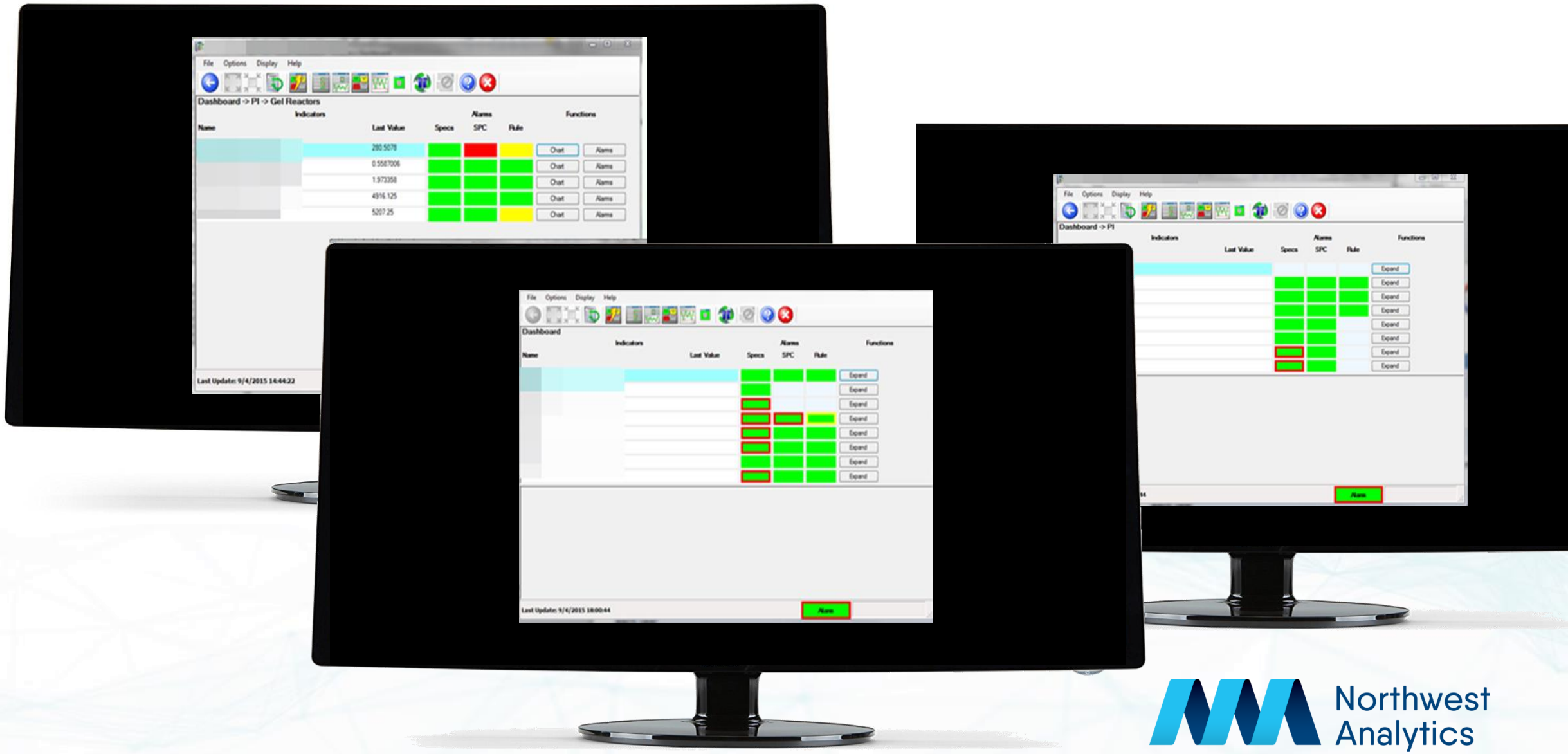
Proprietary information – all rights reserved.

3 Month Statistical Analysis – w/ Event Frames



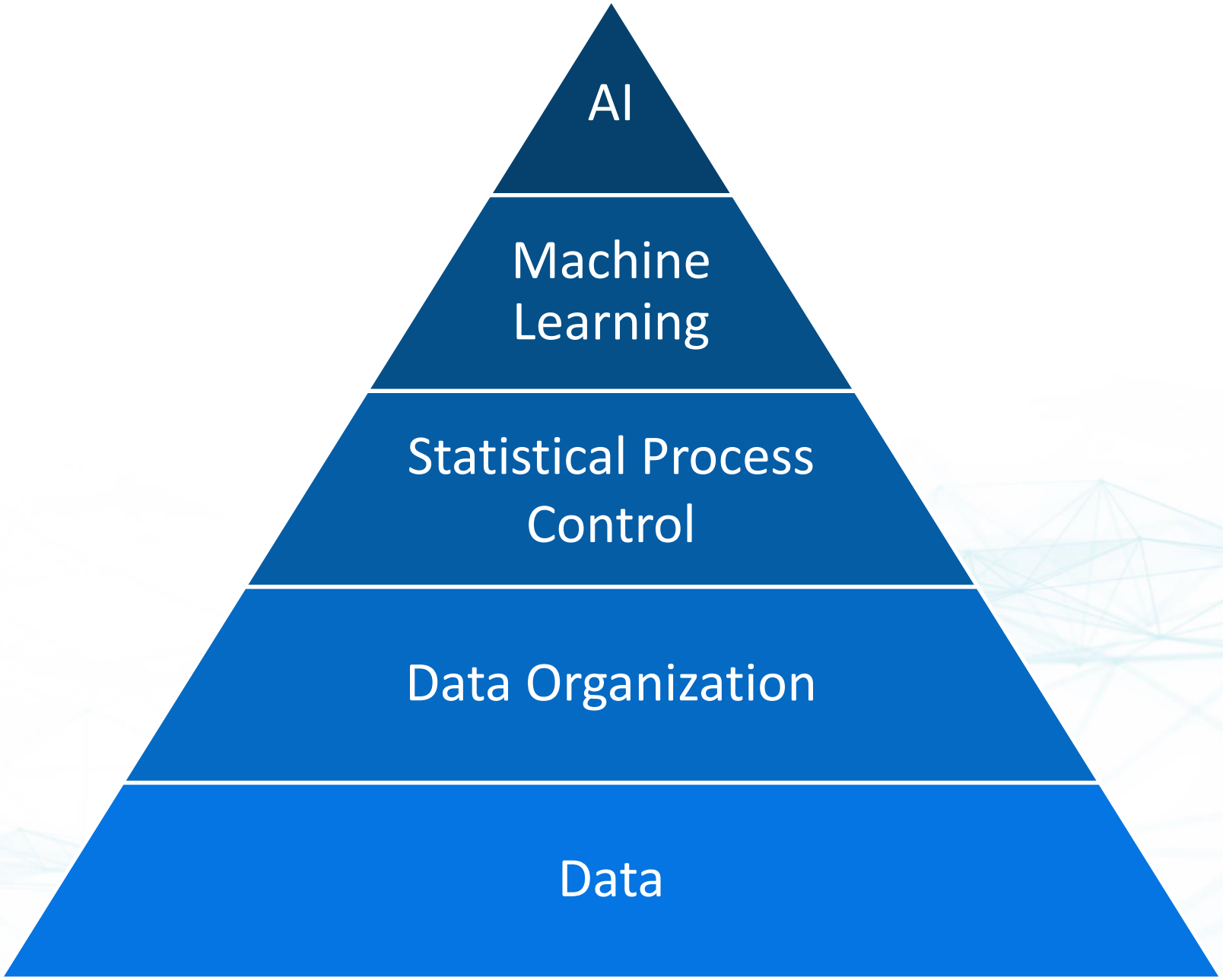
Northwest Analytics

Proprietary information – all rights reserved.



Northwest Analytics

Proprietary information – all rights reserved.

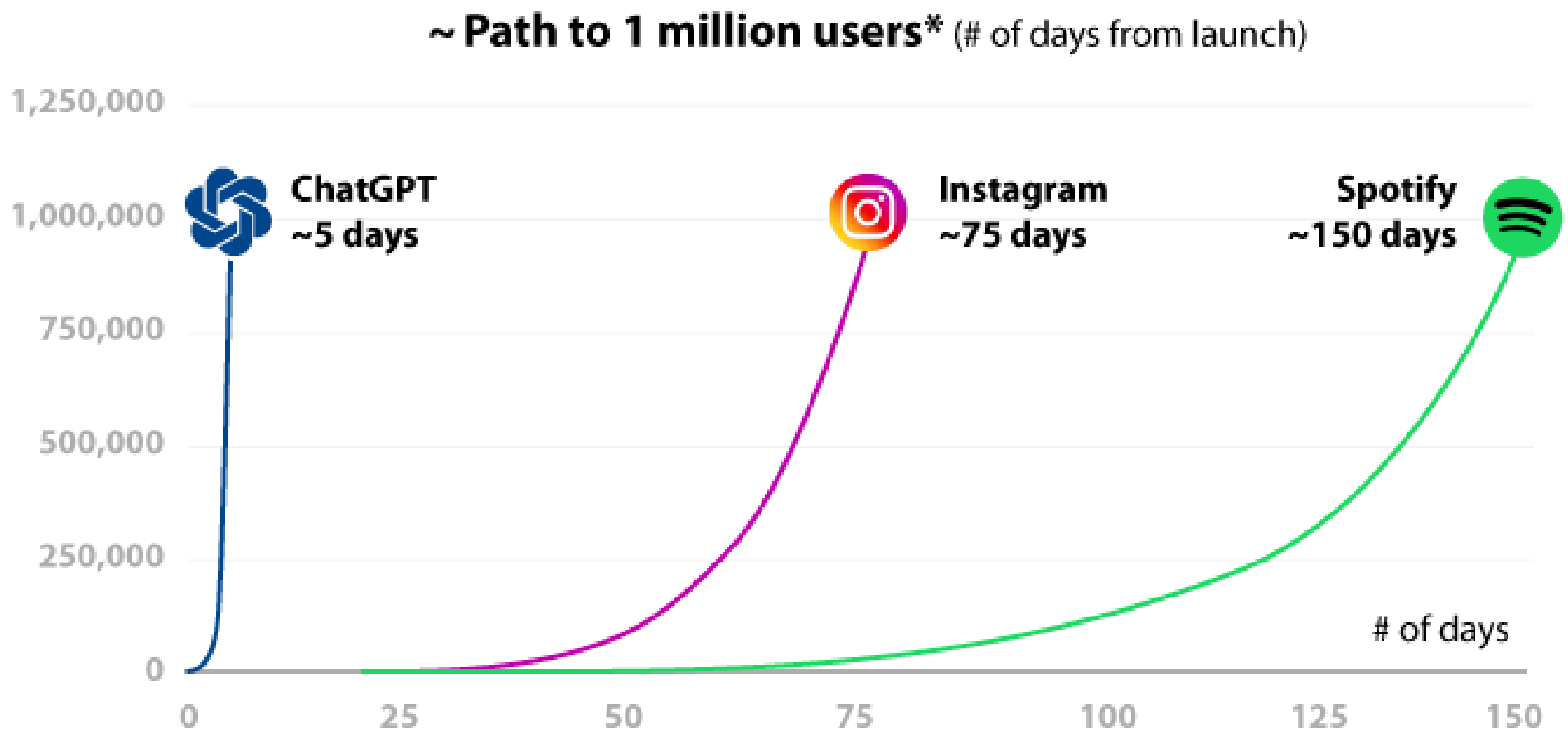


AI

- Complete Automation
- Self Learning

Proprietary information – all rights reserved.

OpenAI



Sources: Google, Subredditstats, Media Reports

Proprietary information – all rights reserved.

ChatGPT

chat.openai.com

GPT-3.5 GPT-4

ChatGPT PLUS

Make a content strategy
for a newsletter featuring free local weekend events

Help me pick
a gift for my dad who loves fishing

Suggest some codenames
for a project introducing flexible work arrangements

Create a personal webpage for me
after asking me three questions

Send a message

ChatGPT may produce inaccurate information about people, places, or facts. ChatGPT September 25 Version

Hey Chat GPT,
finish this building...
Hey Chat GPT,
finish this building...
Your skills are irreplaceable.
IMPACT
Satisfying jobs in construction
Quick to open

ALBEMARLE INTELLIGENCE

Data Sources

AVEVA PI Asset Framework

Data Analytics Suite

User Roles

49,719
Tags Mapped

3,834
AF Templates

9,001
PI Analytics

20,496,053
PI Event Frames

1000+
PI Vision Displays

586
Automated Datasets

20,000+
Statistical Analysis

586
Multivariate Models

1,000+
Operators

300+
Engineers

200+
Improvement Projects

SAP

LIMS

Manual Data

Mobile Devices

SHIFTCONNECTOR®
OEE

PI SQL

PI Central Server

ROVISYS
Automation & Information Solutions

PI Builder - Excel

PI Vision

SIMCA®

Transactional - Operations

Daily Troubleshooting

Email & Text

Real Time Machine Learning

Tactical - Engineers

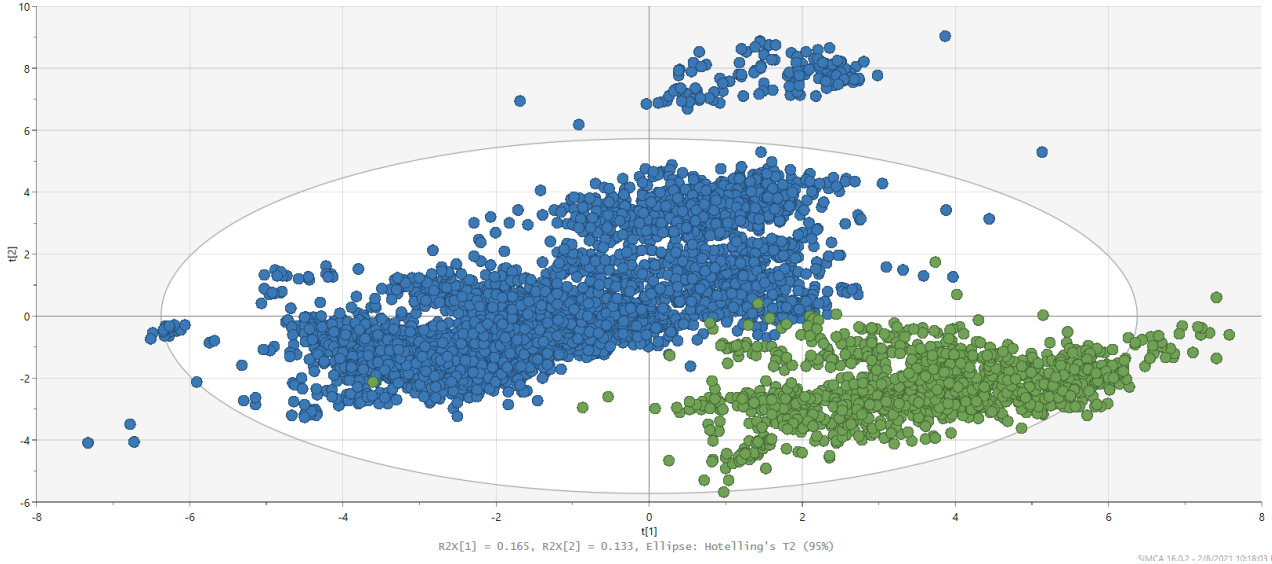
Strategic - Leadership

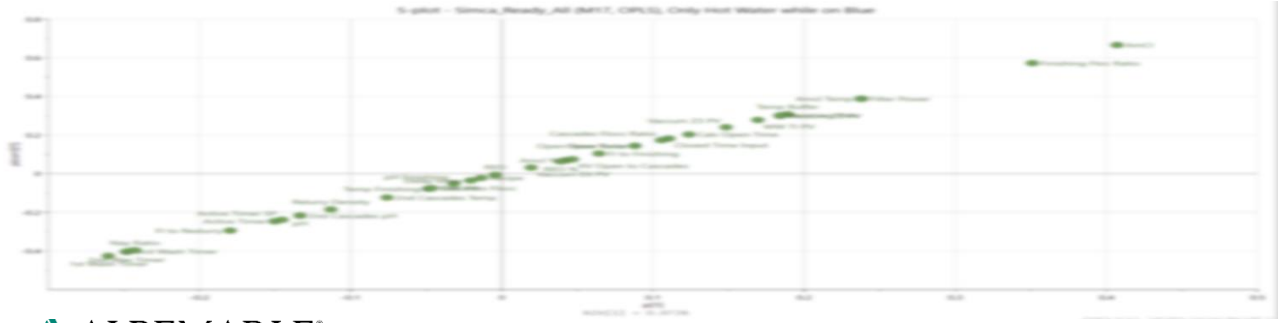
Executive Reporting

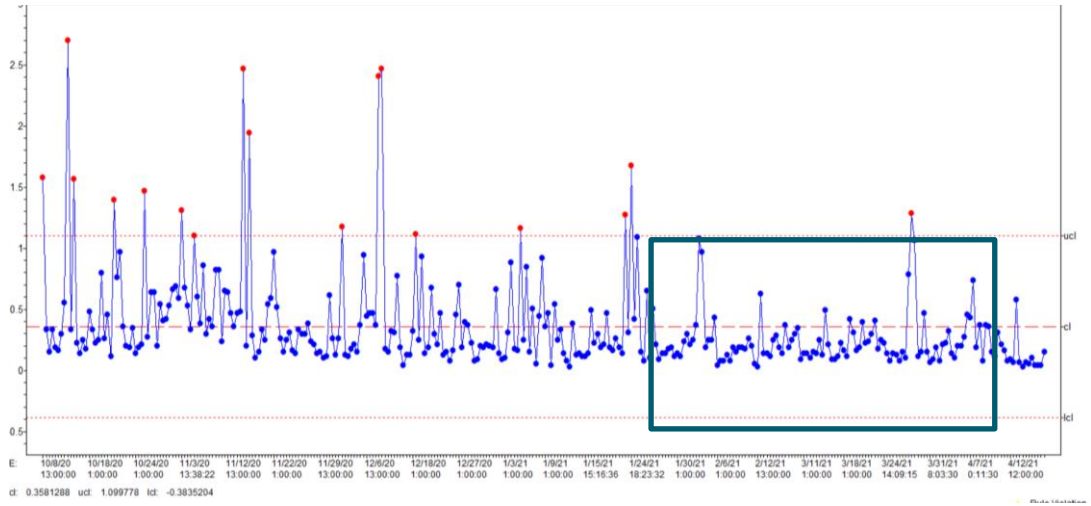
Albemarle Intelligence – Engineer Improvement Project

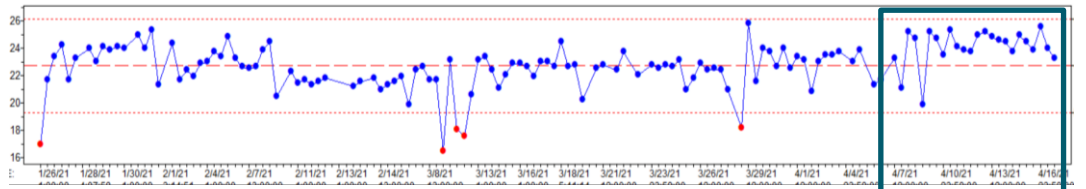
Capacity & Quality Improvements

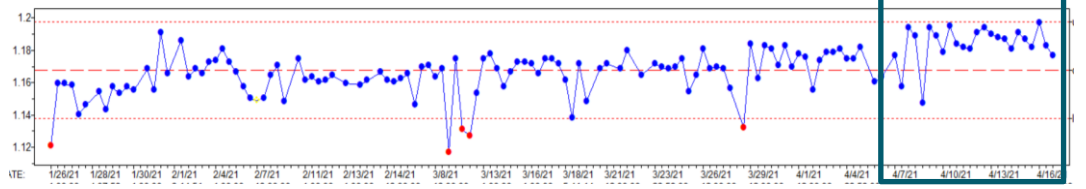
$450,000/yr









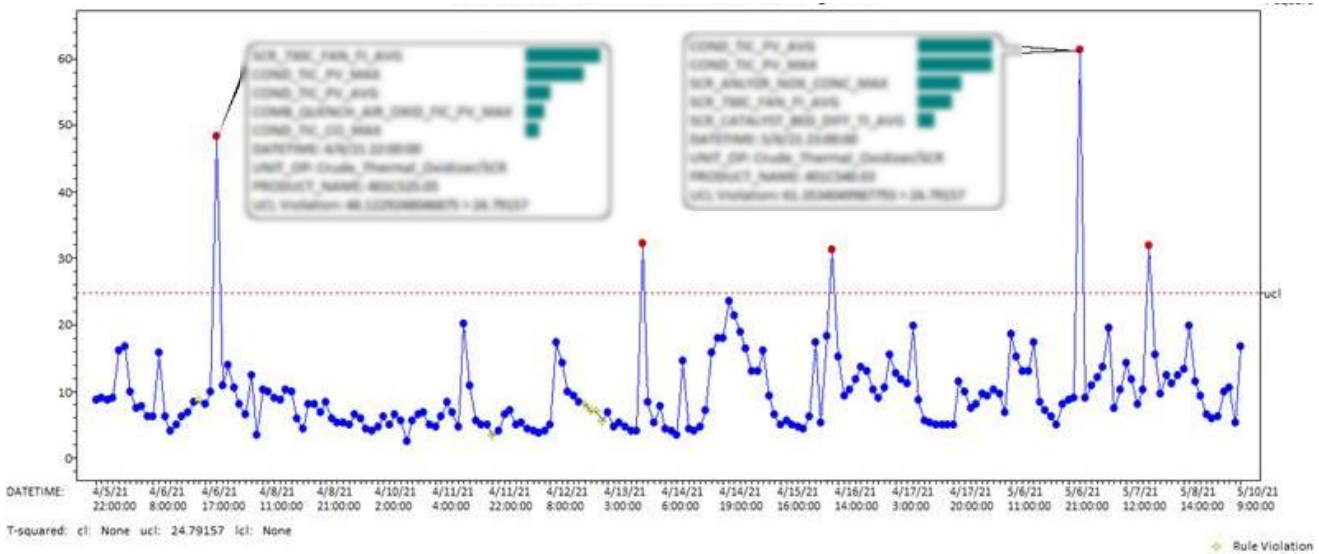


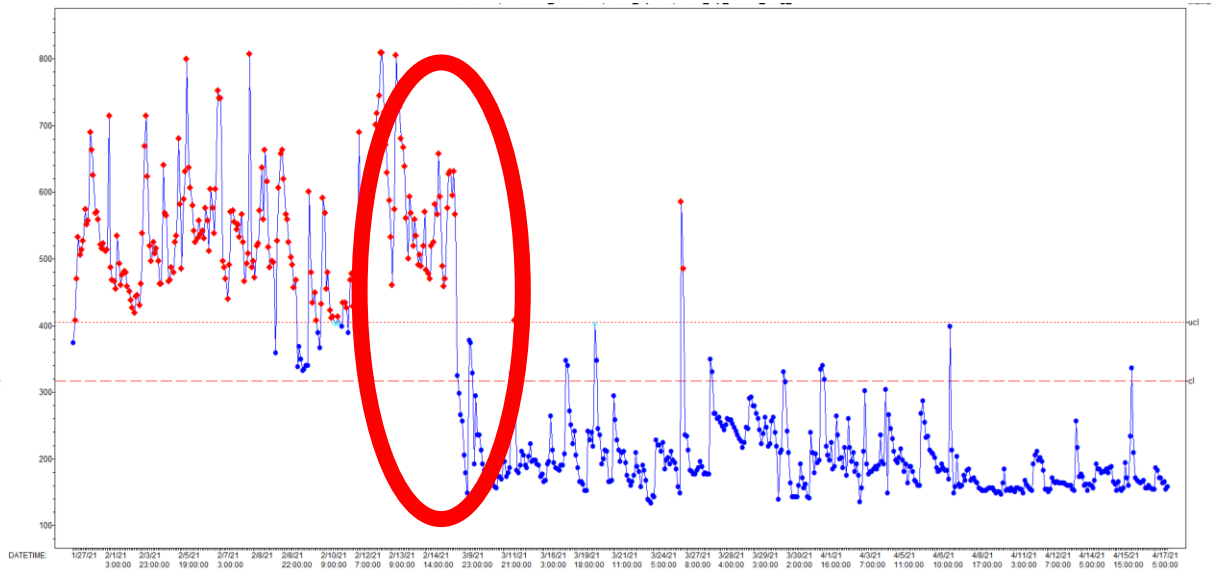
Proprietary information – all rights reserved.

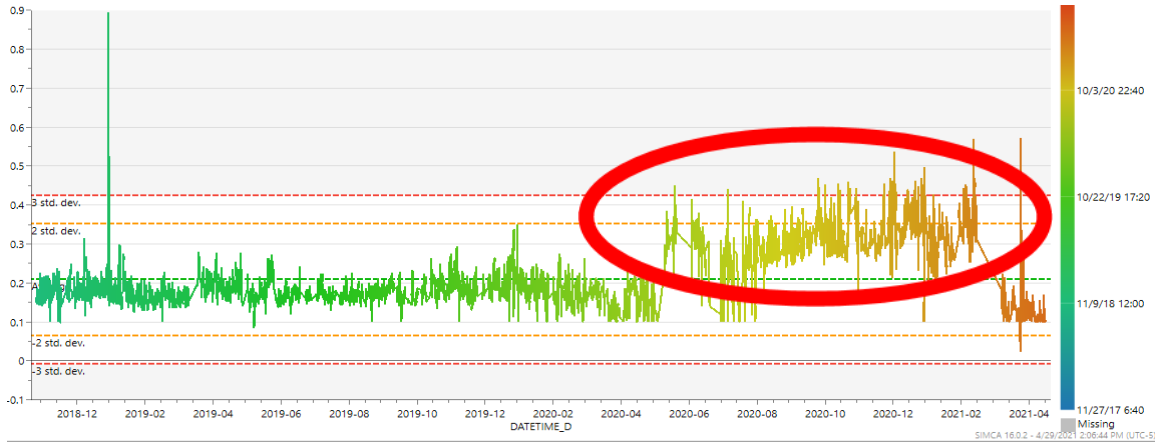
Albemarle Intelligence – Engineer Improvement Project

Downtime Reduction & Environmental Improvements

$350,000/yr





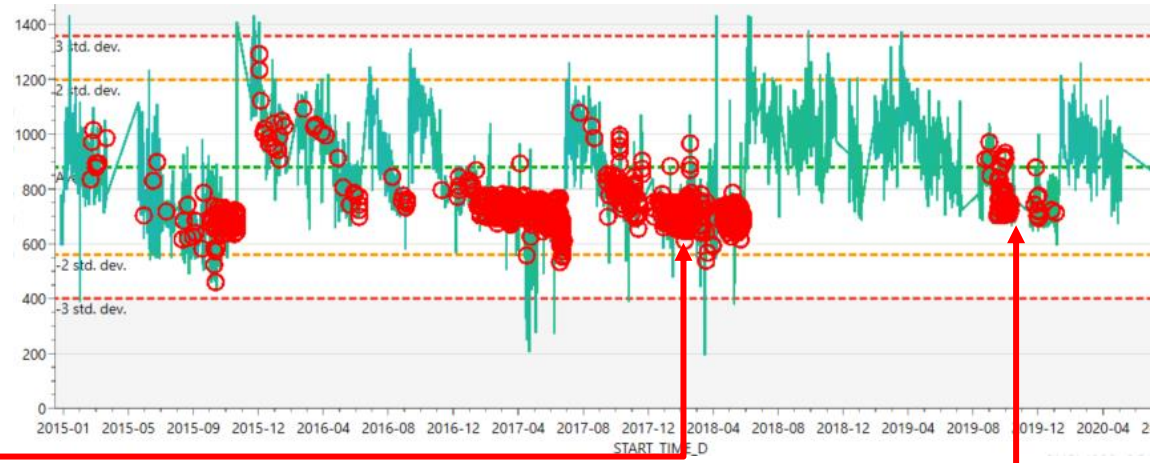


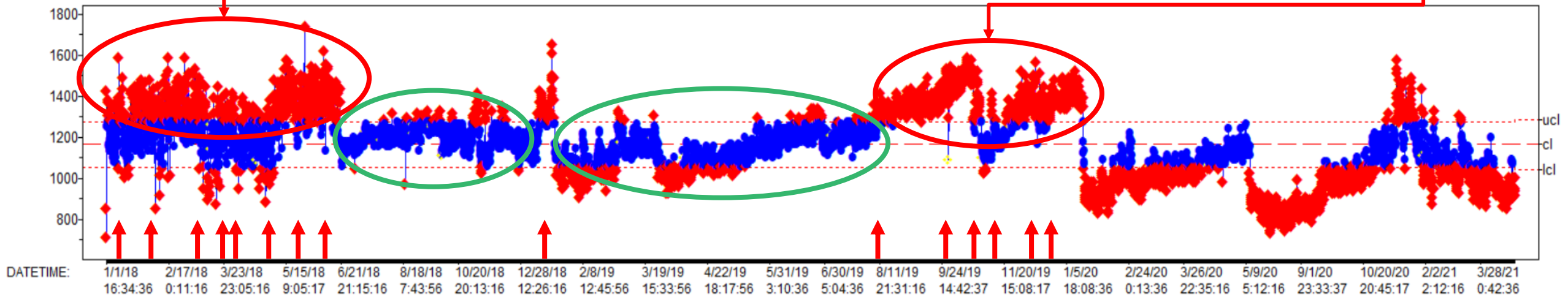
Proprietary information – all rights reserved.

Albemarle Intelligence – Engineer Improvement Project

Maintenance Equipment Reliability Improvement

$220,000/yr



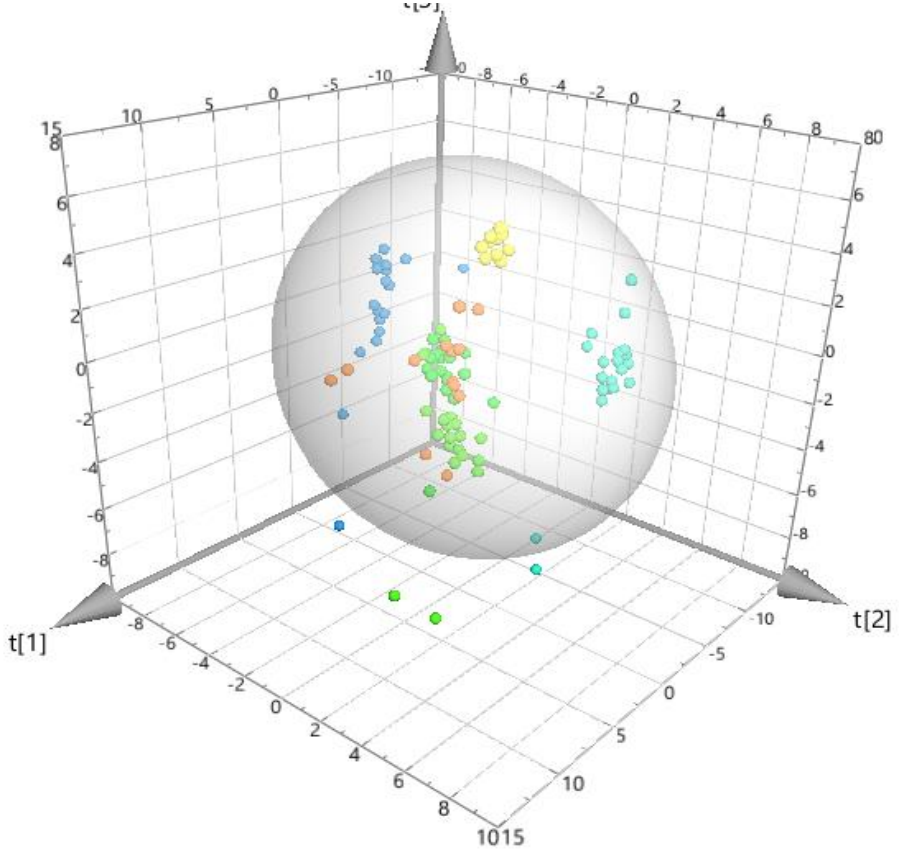


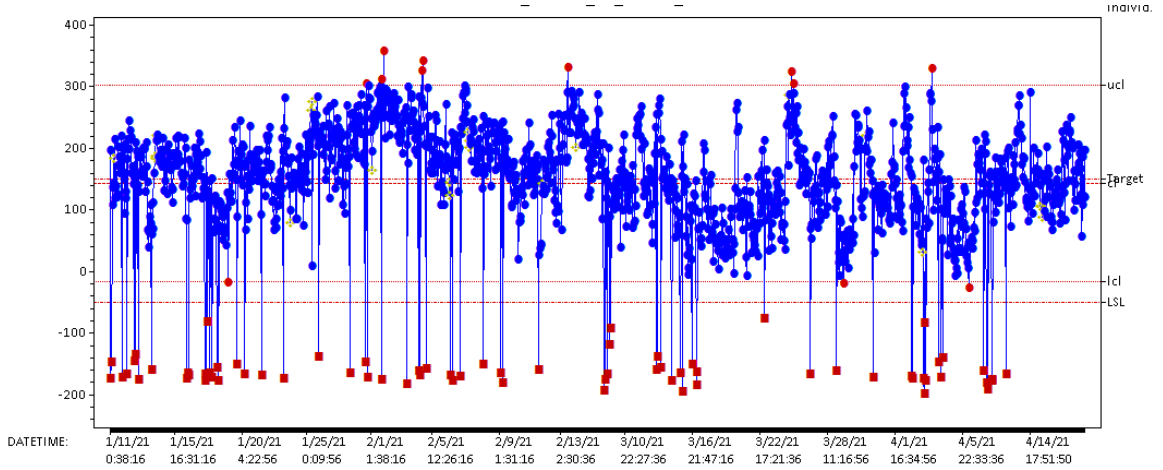
Proprietary information – all rights reserved.

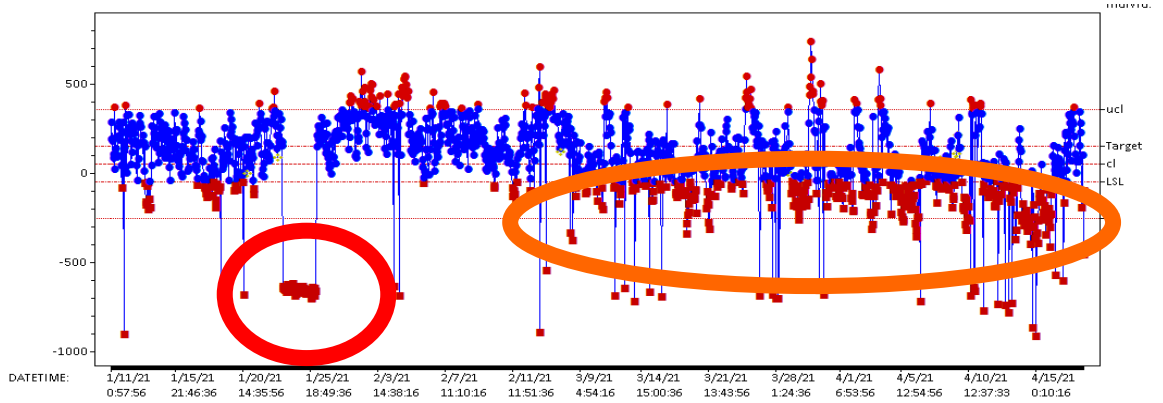
Albemarle Intelligence – Engineer Improvement Project

Raw Material Utilization, Quality, and Customer Satisfaction Improvements

$150,000/yr





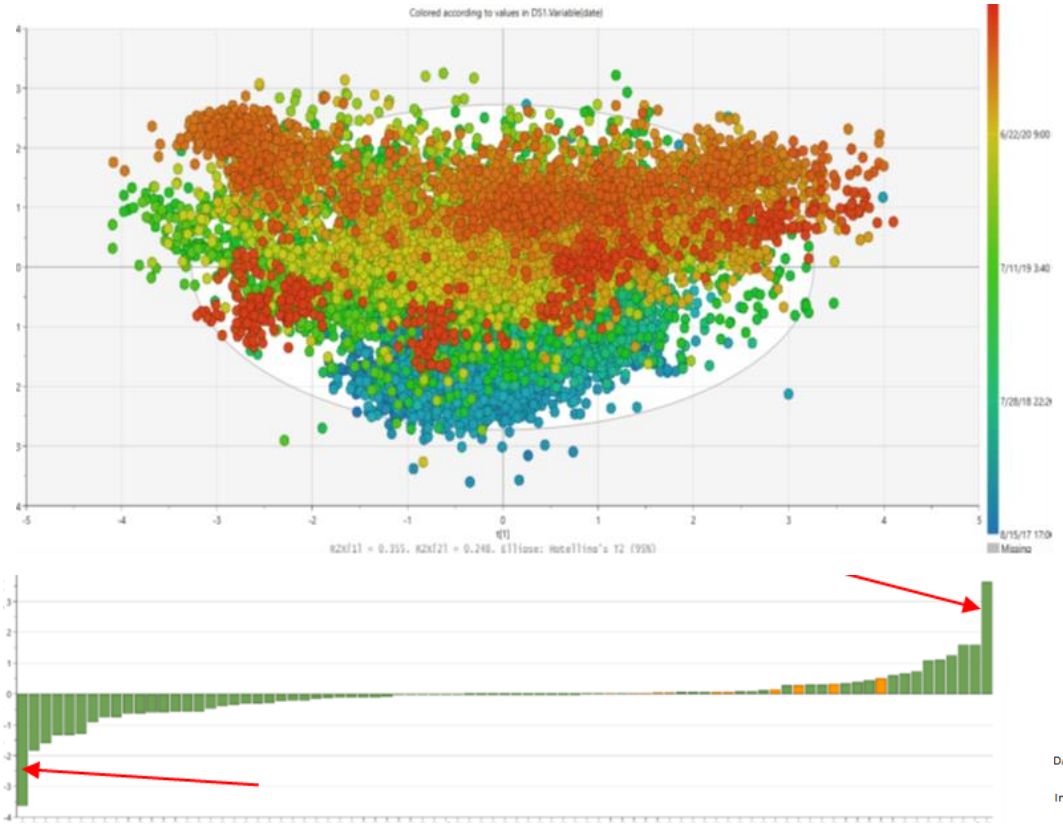


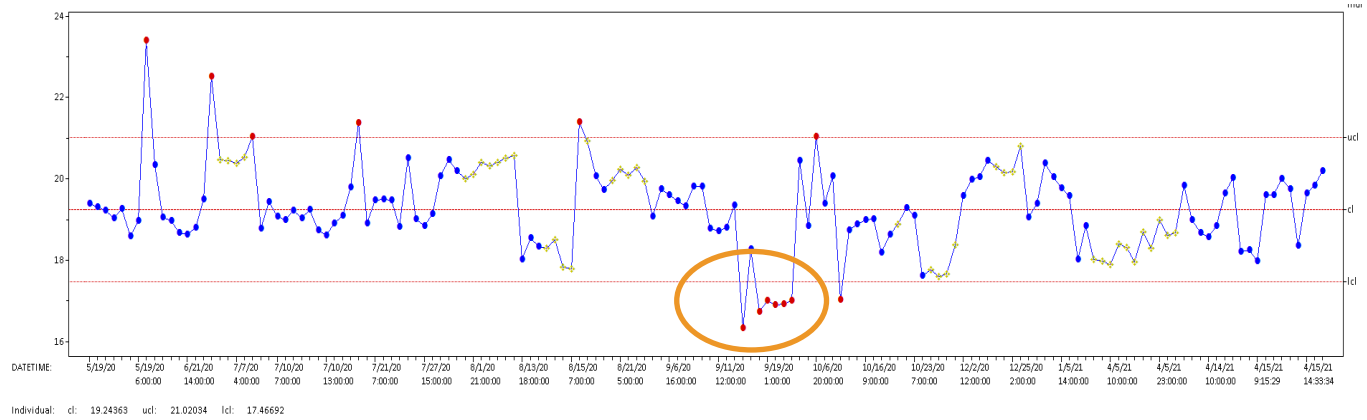
Proprietary information – all rights reserved.

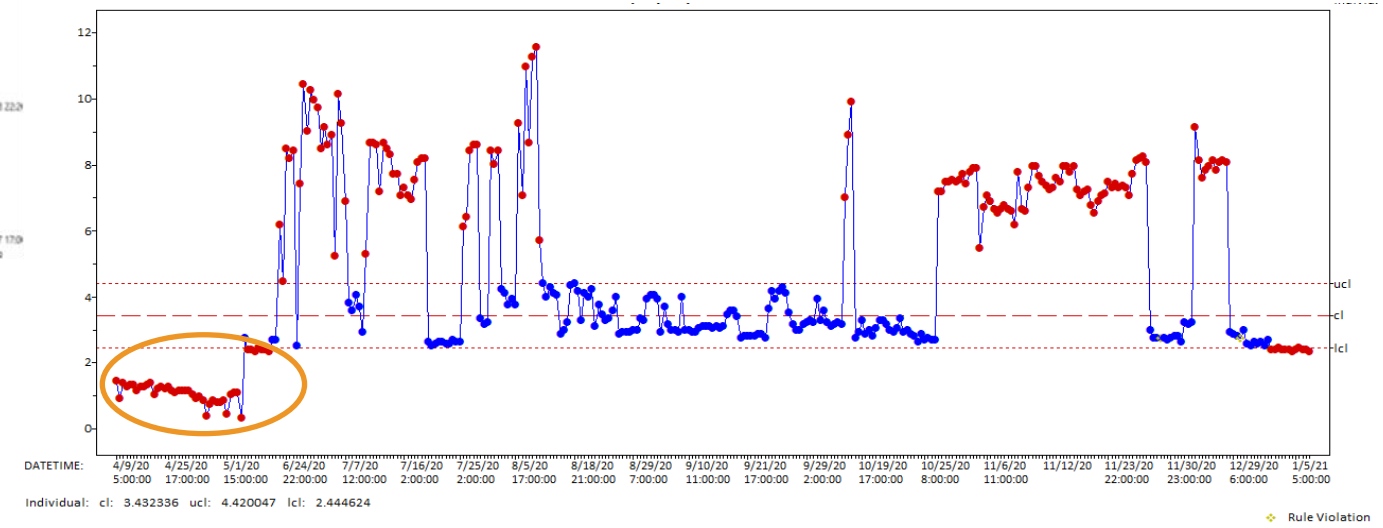
Albemarle Intelligence – Engineer Improvement Project

Quality and Rate Improvements

$840,000/yr

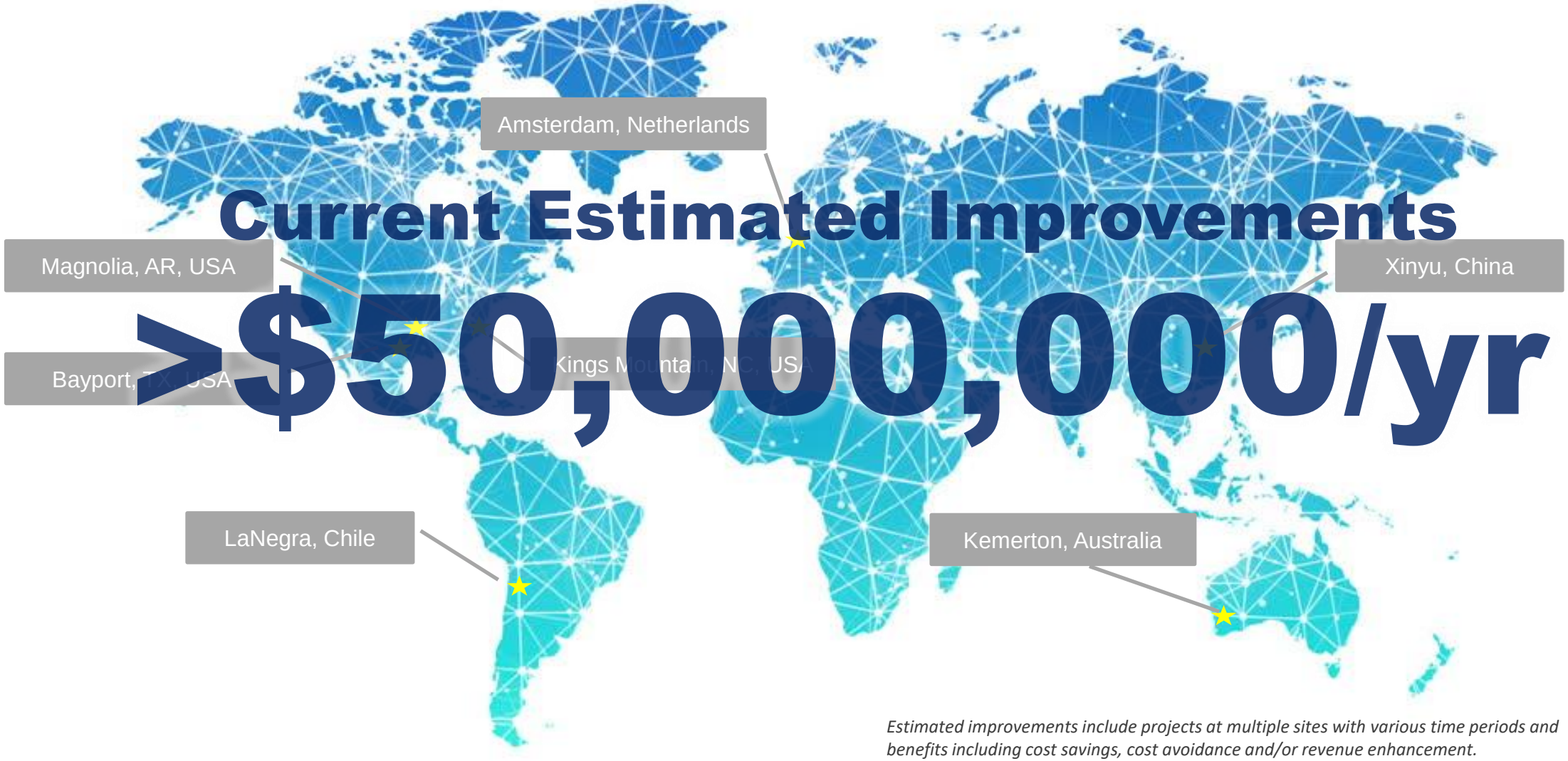






Proprietary information – all rights reserved.

ALBEMARLE INTELLIGENCE



Current Estimated Improvements

>$50,000,000/yr

Estimated improvements include projects at multiple sites with various time periods and benefits including cost savings, cost avoidance and/or revenue enhancement.

Proprietary information – all rights reserved.

Sustainability Framework Aligns with Strategy

Sustainability is not just doing the right thing, but doing it the right way

Natural Resource Management

Responsibly manage our use of resources and materials

Sustainable Shareholder Value

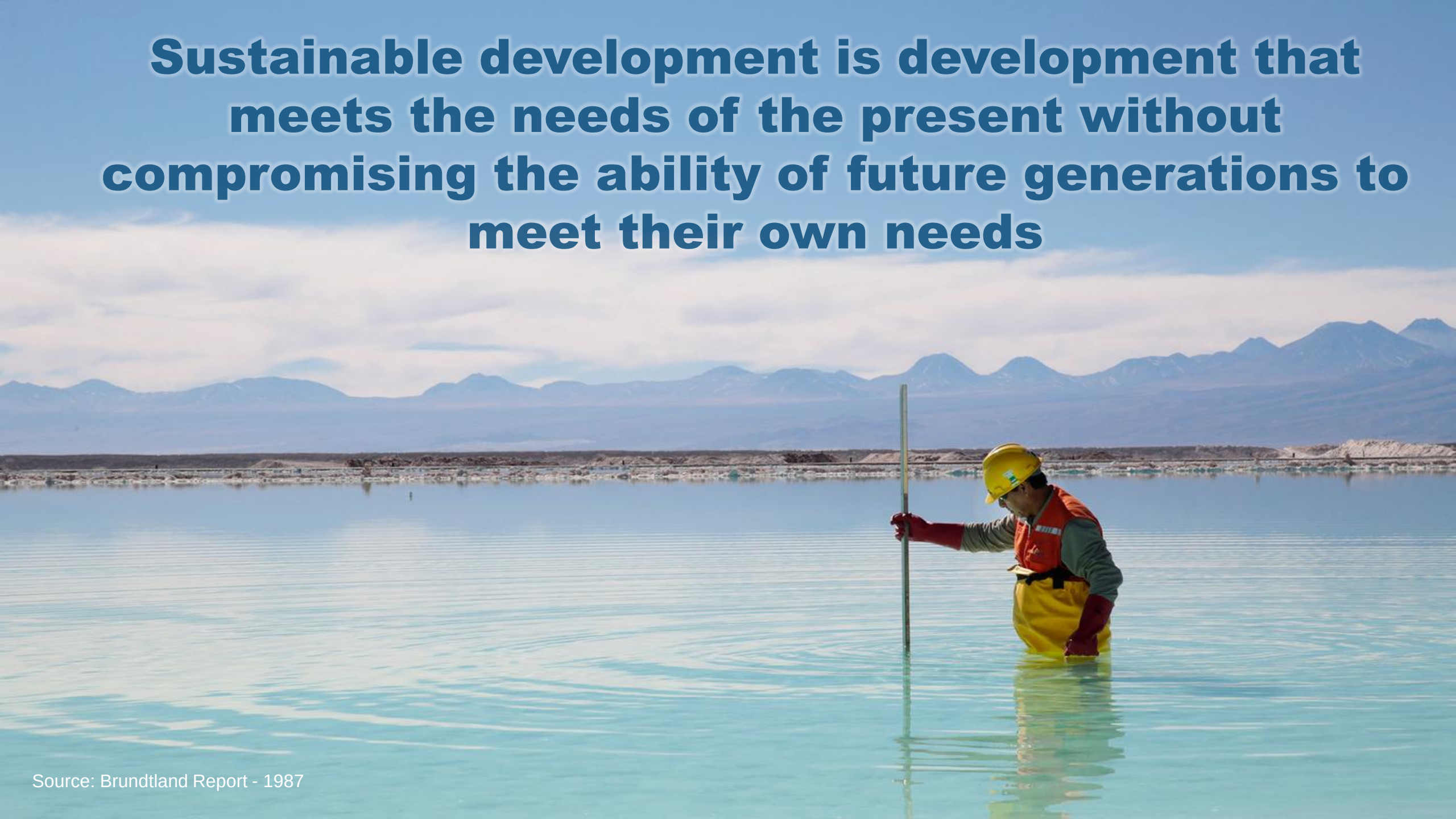
Foster the conditions that create sustainable value for shareholders

People, Workplace & Community

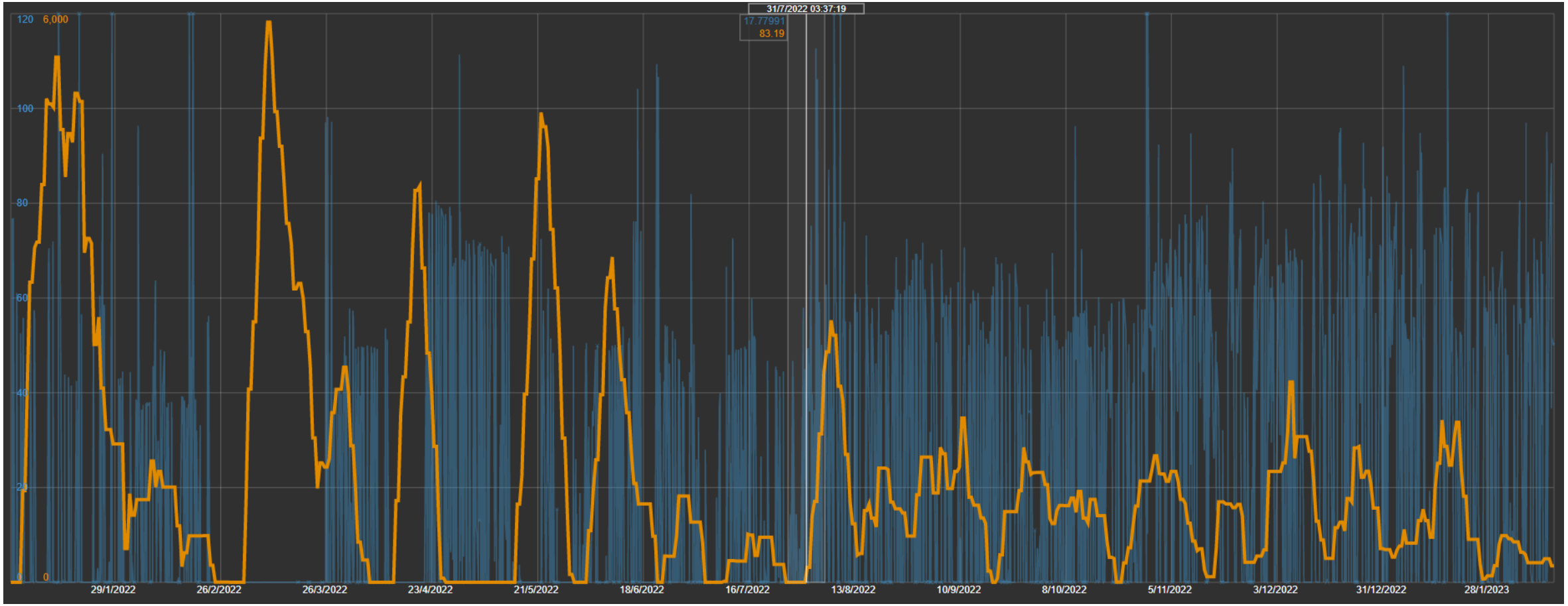
Build an inclusive and diverse workplace focused on safety, mutual respect, development and wellbeing

Actively collaborate and engage in the communities in which we work

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs

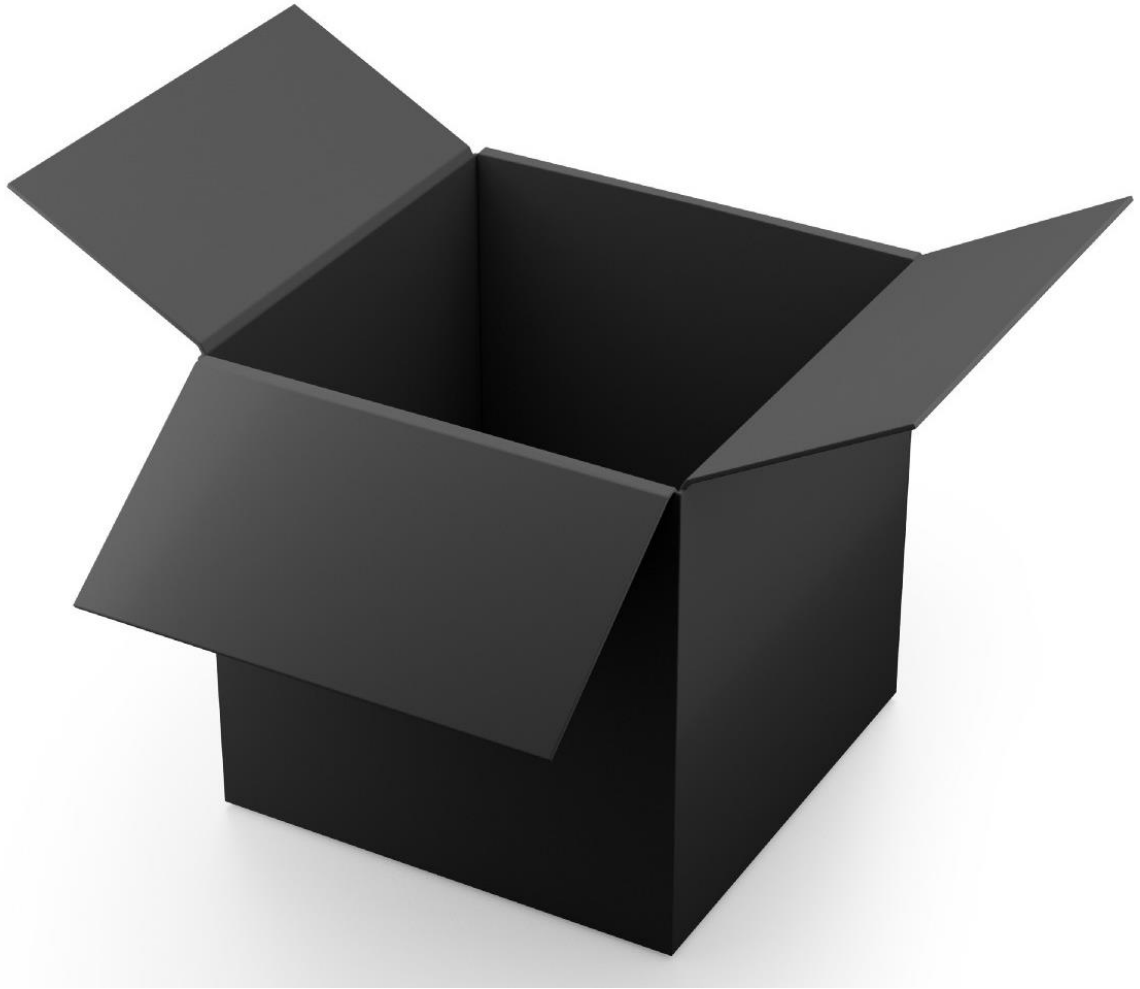


Source: Brundtland Report - 1987



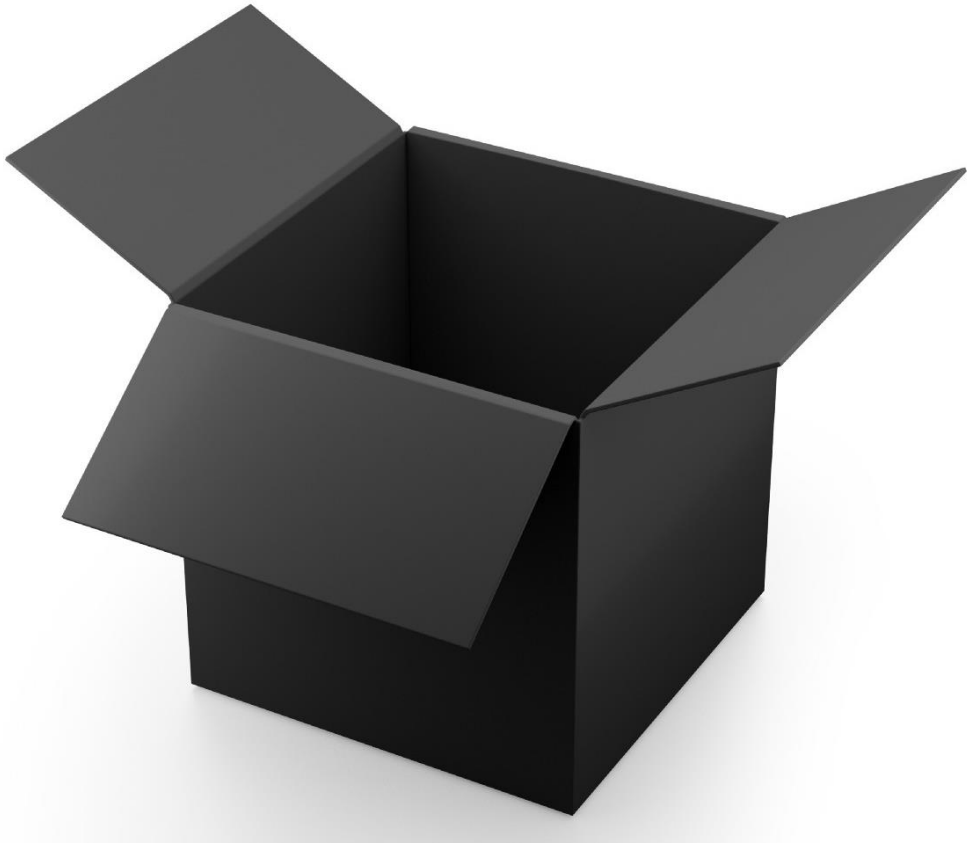
Proprietary information – all rights reserved.

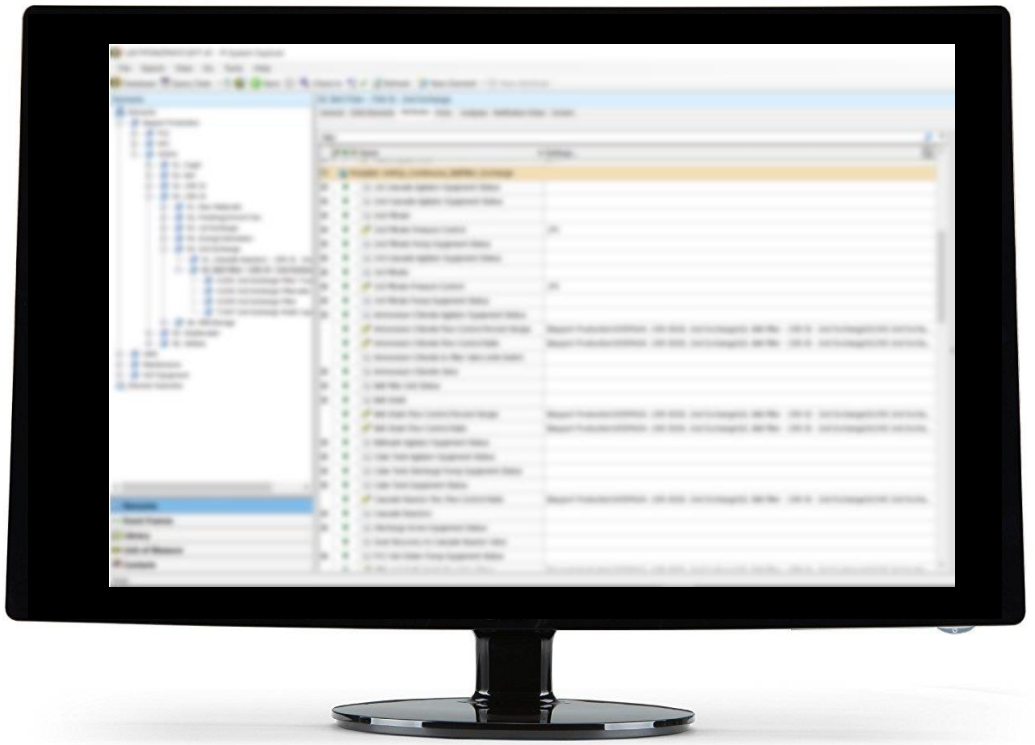
The “Black Box” Unit Operation



Proprietary information – all rights reserved.

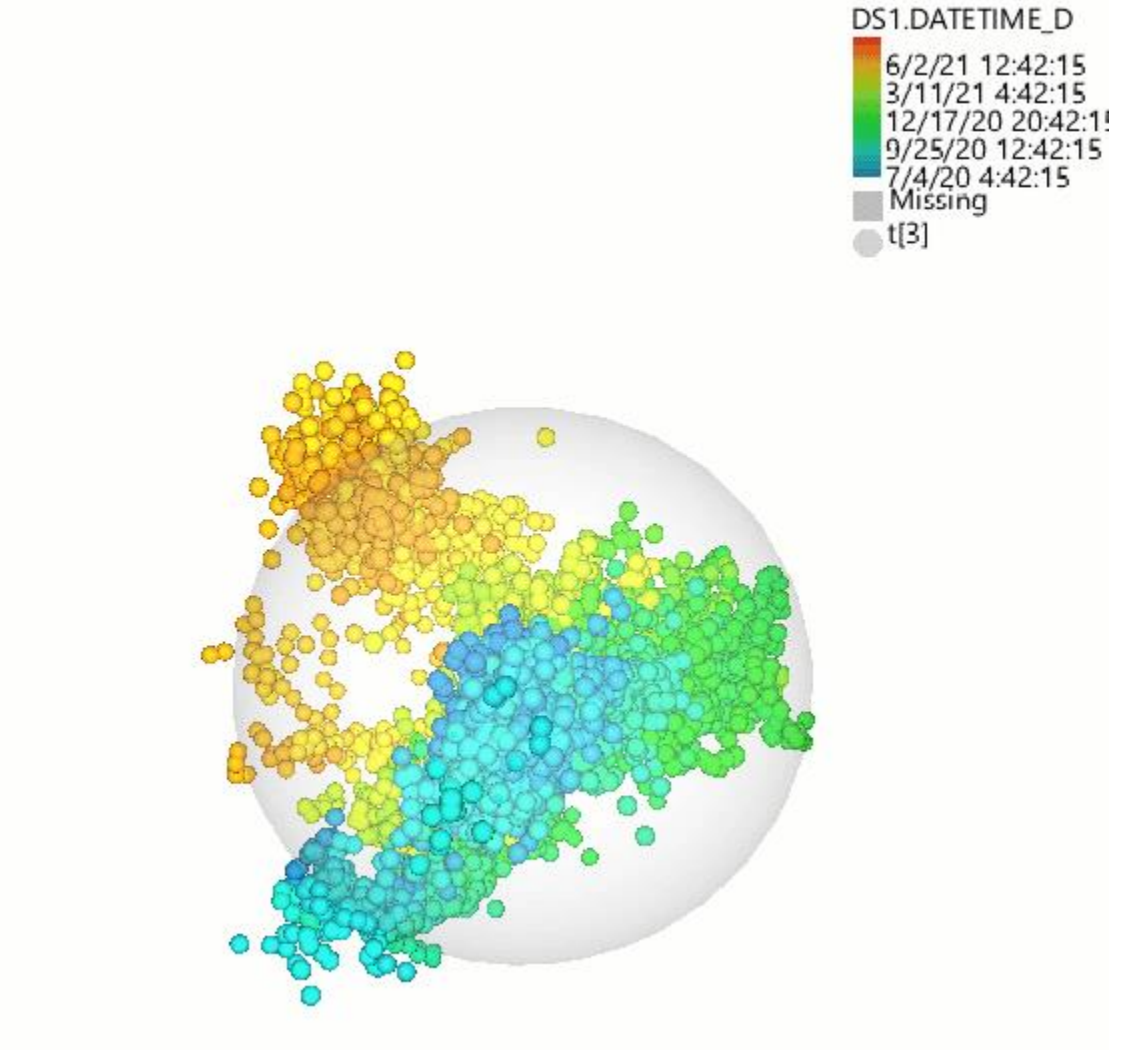
DEFINE





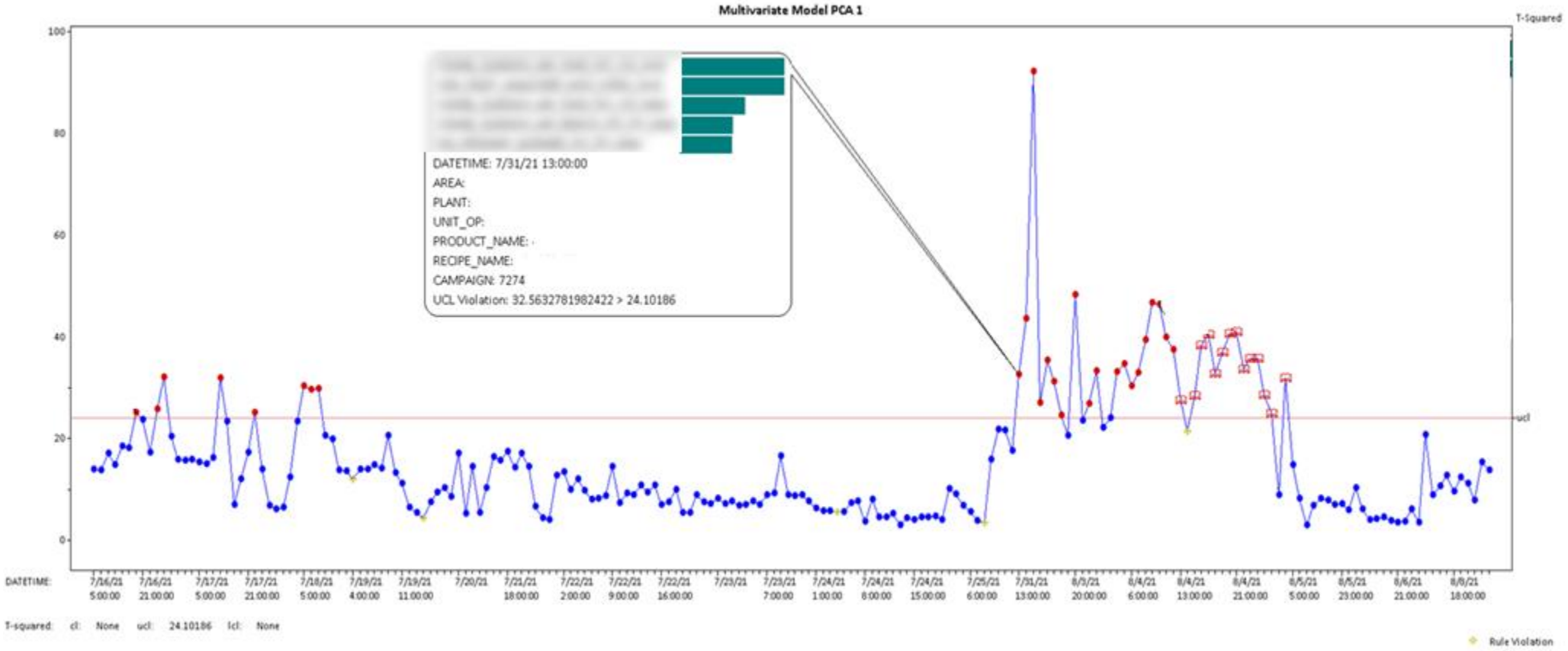
Proprietary information – all rights reserved.

Dissecting the “Black Box” with Machine Learning



Proprietary information – all rights reserved.

Real-Time Machine Learning



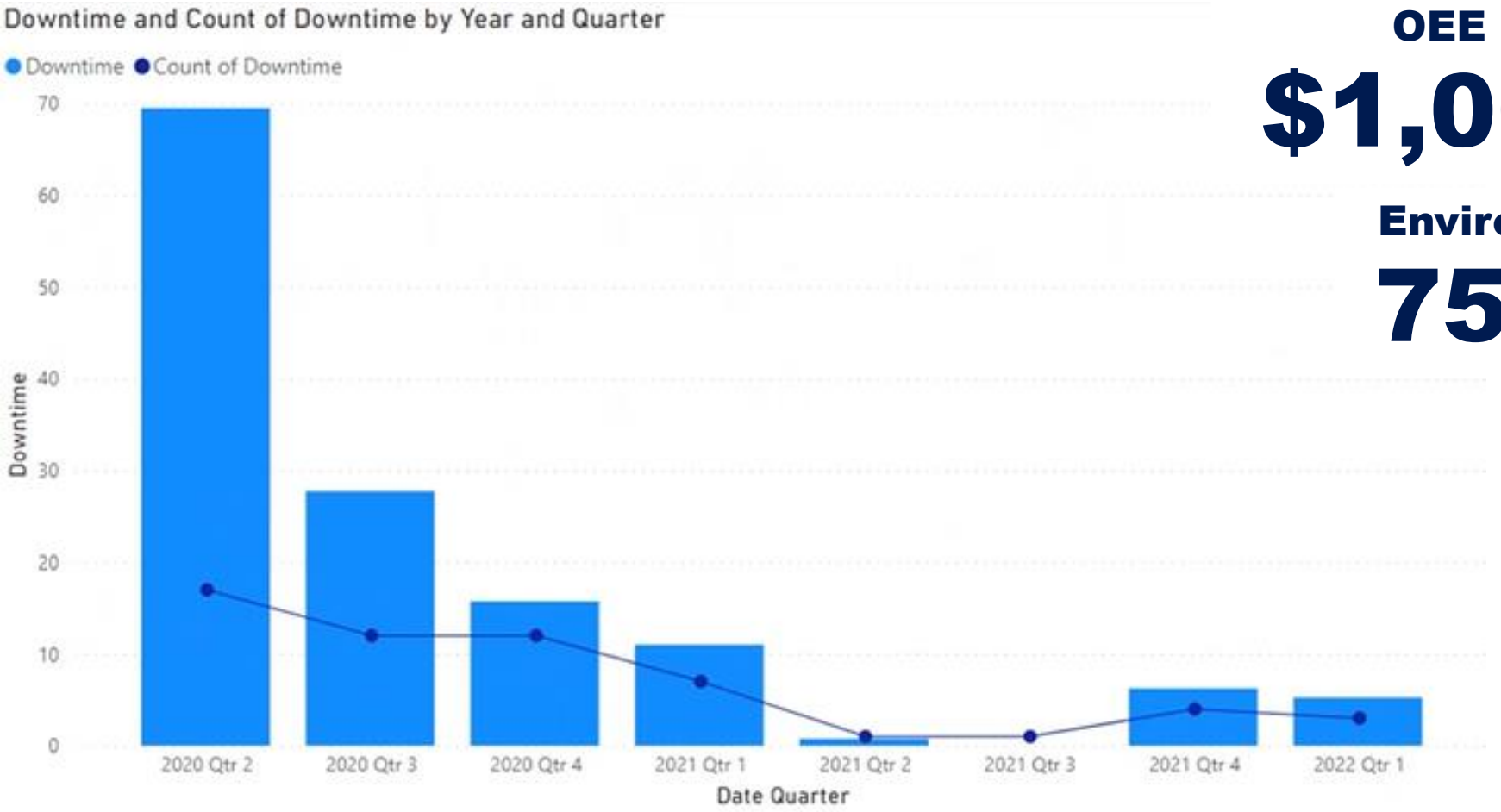
Proprietary information – all rights reserved.

SARTORIUS SIMCA®

Northwest Analytics

Proprietary information – all rights reserved.

The “Black Box” Real-Time Machine Learning Model



OEE Improvements

$1,000,000/yr

Environmental Incidents

75% reduction

Proprietary information – all rights reserved.

Automated Information

Analytics Innovation

Actionable Insight

AI
ALBEMARLE
INTELLIGENCE

Albemarle People
Empowered by Technology
Unlocking the value of information

AUTOMATIZACIÓN DE LA INFORMACIÓN

ANALÍTICA CON INNOVACIÓN

ACCIONES INFORMADAS

ALBEMARLE INTELLIGENCE

Personal de Albemarle,
Empoderados por la Tecnología,
Liberando el Valor de la Información

自动信息

分析创新

切实可行的洞察

ALBEMARLE INTELLIGENCE

雅保人，
技术赋能，
释放信息的价值

Ingeniero Proceso

ALBEMARLE
MANUEL REVECO A.
Ingeniero Proceso

ALBEMARLE
VALENTINA CASTILLO V.
Ingeniero Proceso

ALBEMARLE
LUIS BAEZA
Ingeniero Confiabilidad

ESPINOZA P.

ALBEMARLE INTELLIGENCE

ALBEMARLE PEOPLE, empowered by technology, unlocking the value of information.

Chemicals & Mining| San Francisco

Albemarle creates 20M PI Event Frames, with estimated improvements >$50 million annually

Challenge

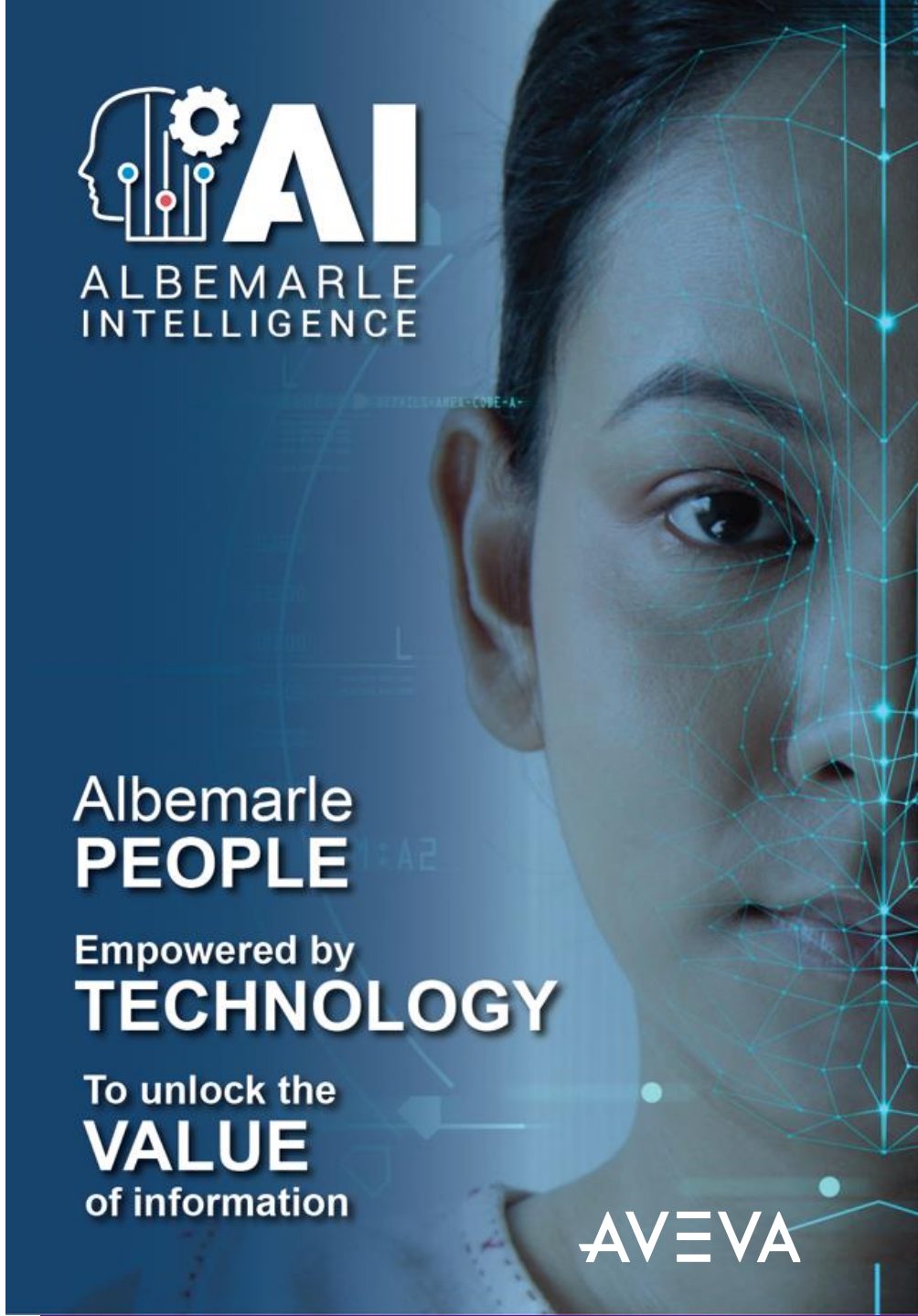
- Hundreds of thousands of data points
- Manual data sharing and reporting processes led to information bottlenecks
- Massive manufacturing growth and demand – fueling the need for more efficient manufacturing processes

Solution

- Deployed a massive, standardized implementation of the full AVEVA™ PI System™ to
- Created Albemarle Intelligence Program, merging the experience and skillset from all of our manufacturing employees, with world-class technology

Results

- **>$50 million in estimated annual improvements**



© 2023 AVEVA Group Limited and its subsidiaries. All rights reserved.

Jonathan Alexander

Manufacturing AI & Advanced Analytics Manager

Albemarle

jonathan.alexander@albemarle.com

Proprietary information – all rights reserved.

Questions?

Please wait for the microphone.

State your name and company.

Please remember to…

Navigate to this session in the mobile app to complete the survey.

Thank you!

© 2023 AVEVA Group plc and its subsidiaries. All rights reserved.

AVEVA

This presentation may include predictions, estimates, intentions, beliefs and other statements that are or may be construed as being forward-looking. While these forward-looking statements represent our current judgment on what the future holds, they are subject to risks and uncertainties that could result in actual outcomes differing materially from those projected in these statements. No statement contained herein constitutes a commitment by AVEVA to perform any particular action or to deliver any particular product or product features. Readers are cautioned not to place undue reliance on these forward-looking statements, which reflect our opinions only as of the date of this presentation.

The Company shall not be obliged to disclose any revision to these forward-looking statements to reflect events or circumstances occurring after the date on which they are made or to reflect the occurrence of future events.

© 2023 AVEVA Group plc and its subsidiaries. All rights reserved.

linkedin.com/company/aveva

@avevagroup

ABOUT AVEVA

AVEVA is a world leader in industrial software, providing engineering and operational solutions across multiple industries, including oil and gas, chemical, pharmaceutical, power and utilities, marine, renewables, and food and beverage. Our agnostic and open architecture helps organizations design, build, operate, maintain and optimize the complete lifecycle of complex industrial assets, from production plants and offshore platforms to manufactured consumer goods.

Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

Named as one of the world's most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 employees, 5,000 partners and 5,700 certified developers. The company is headquartered in Cambridge, UK.

Learn more at www.aveva.com

© 2023 AVEVA Group plc and its subsidiaries. All rights reserved.

AVEVA