

AVEVA PI WORLD

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# Scaling AI -Albemarle Intelligence

Leveraging PI Asset Framework for SPC & Machine Learning

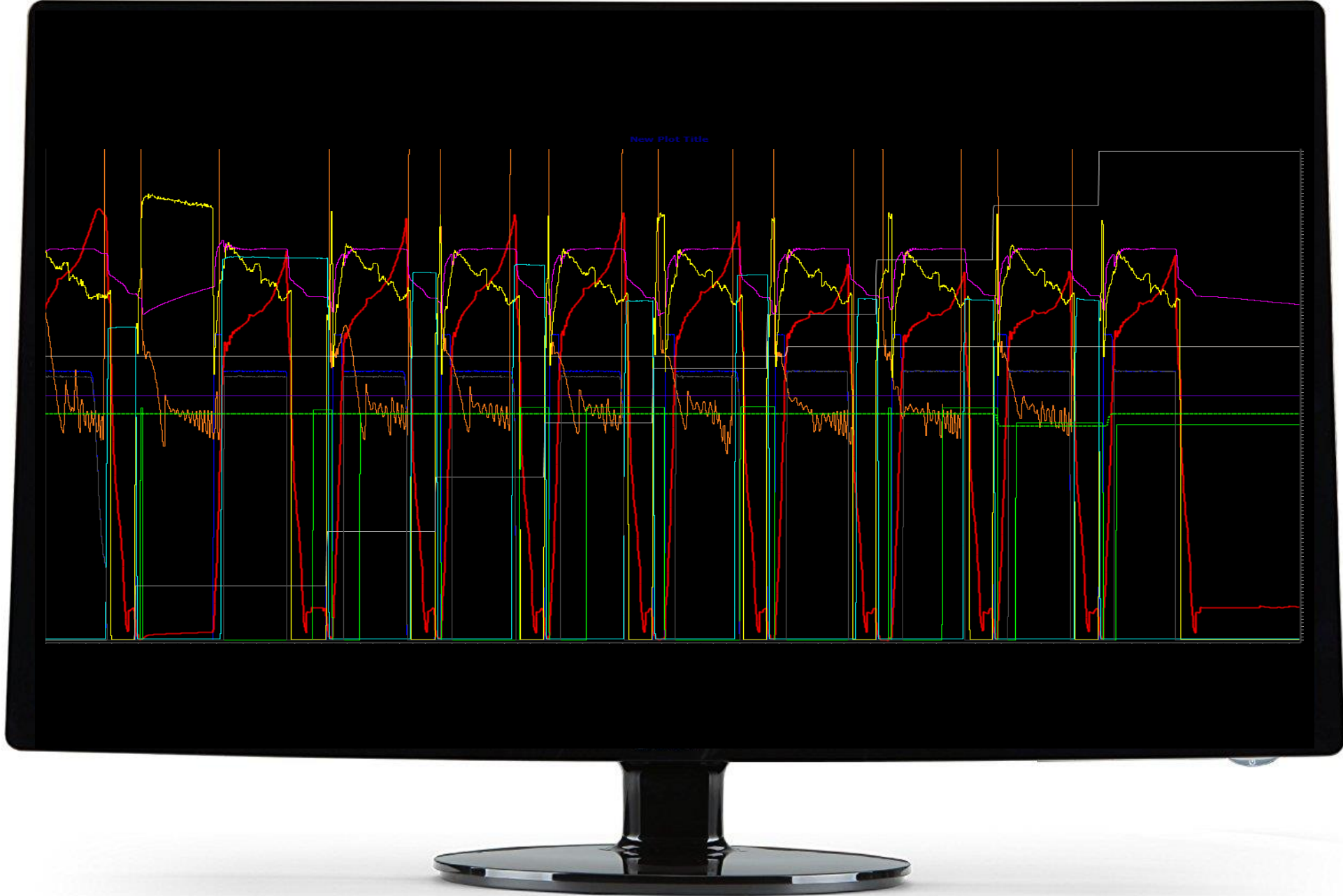
Presented By: Jonathan Alexander

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AVEVA

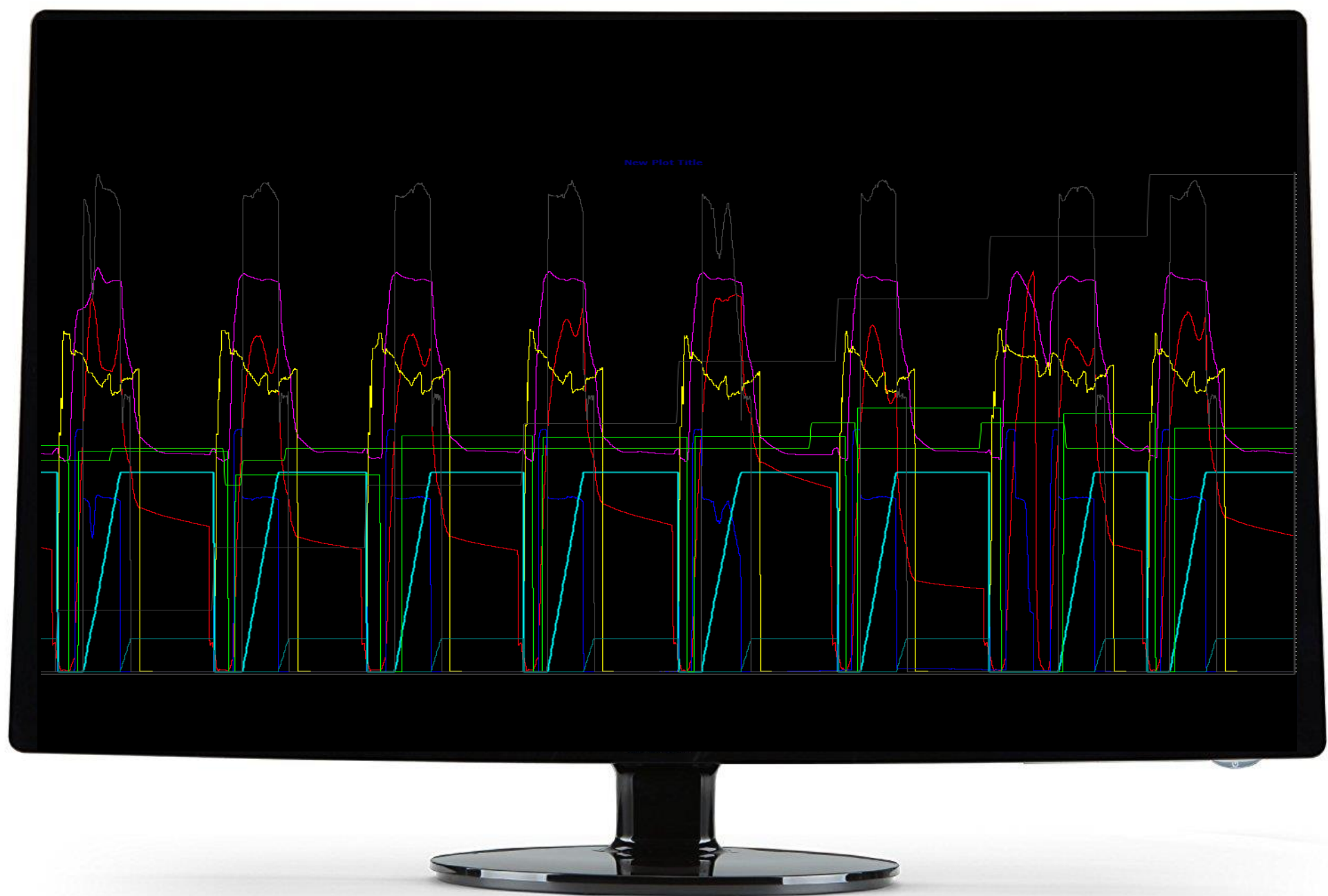


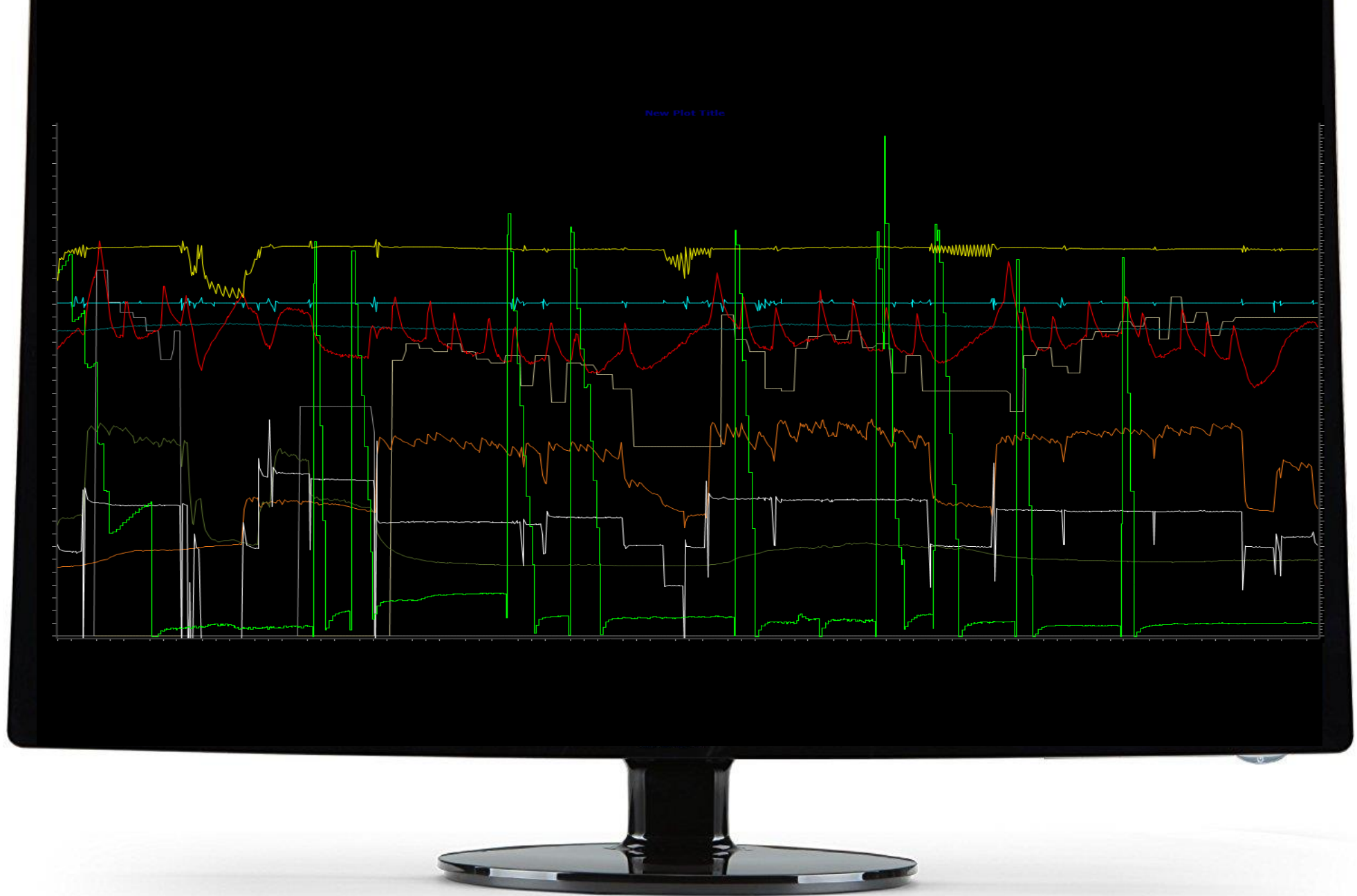


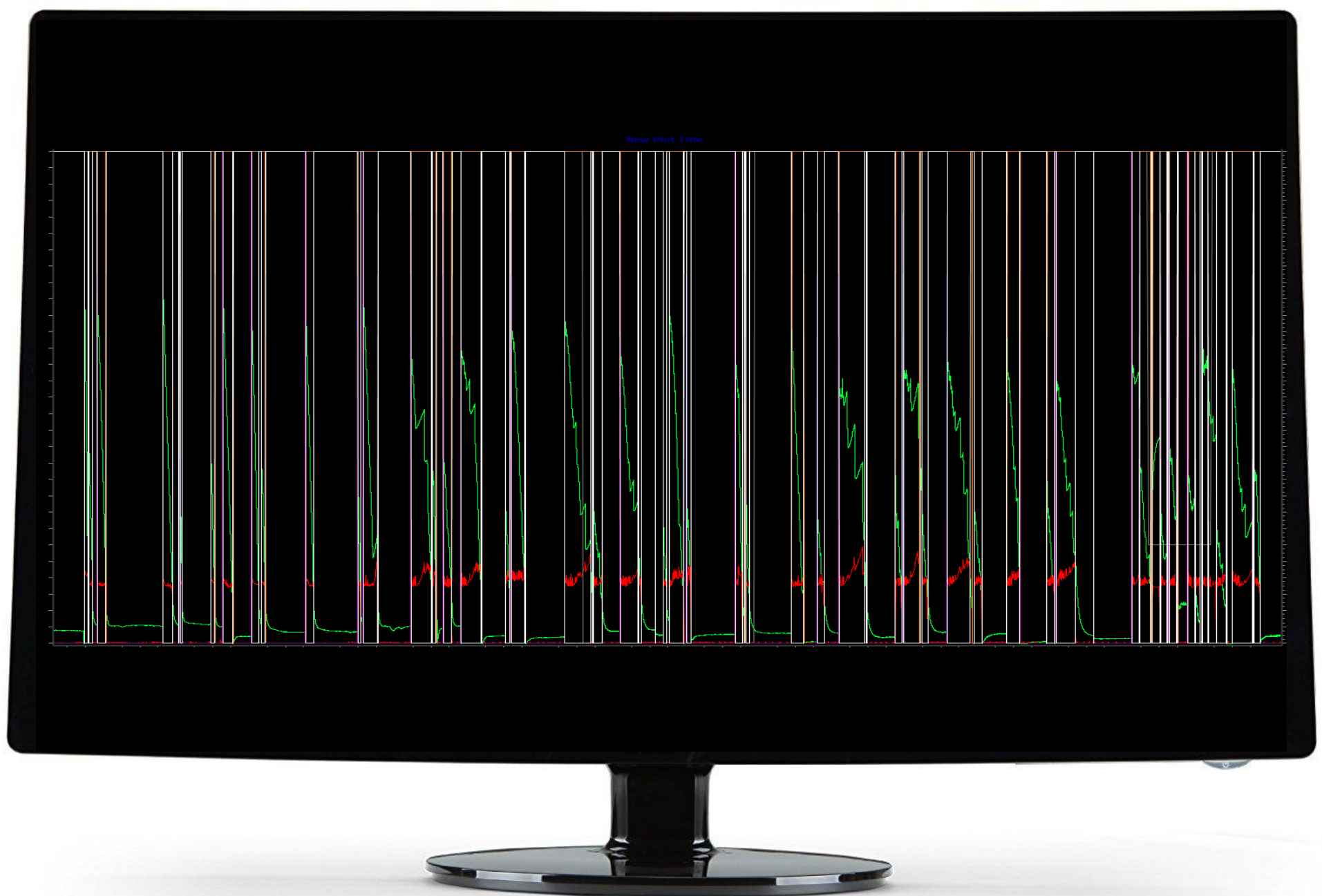












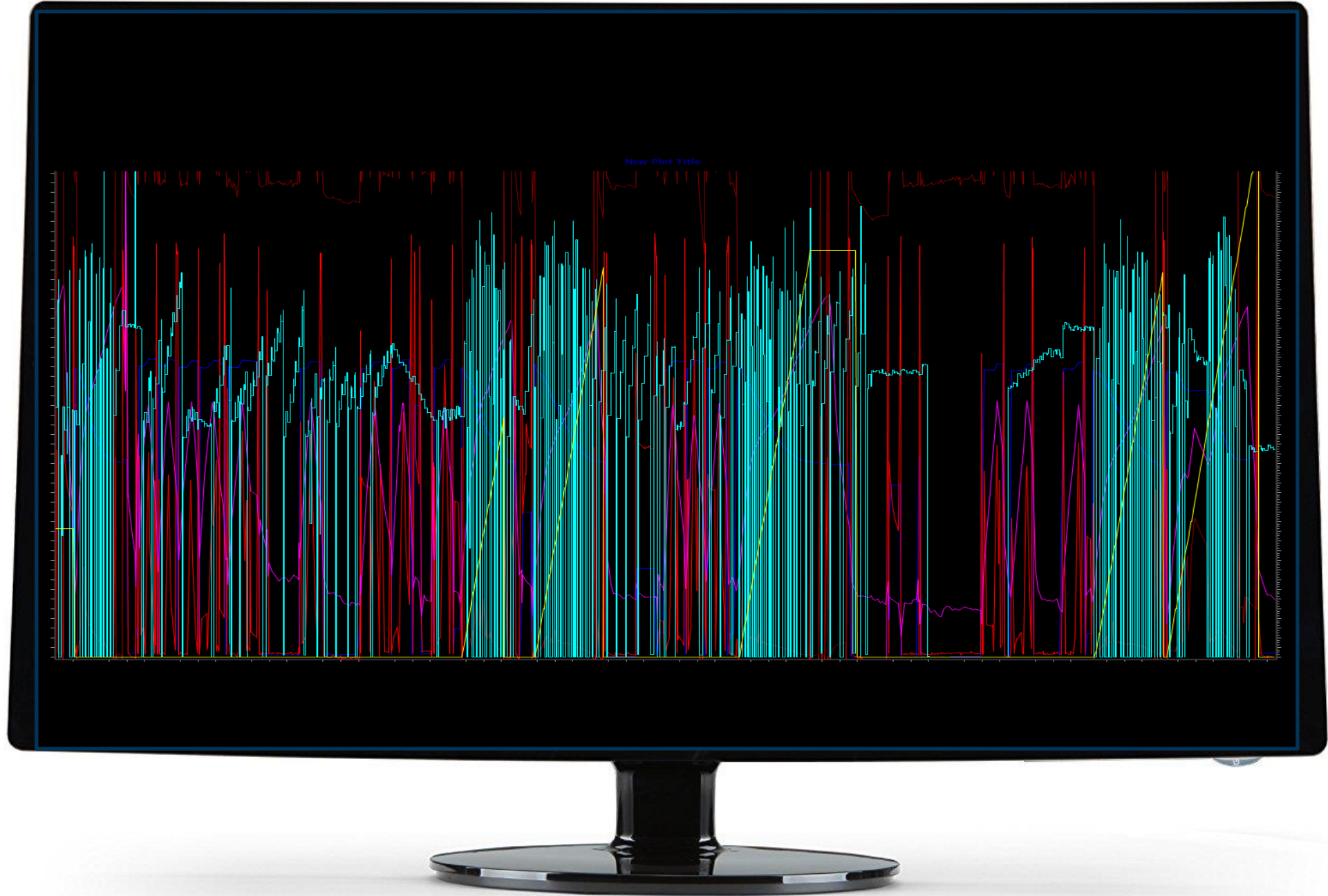


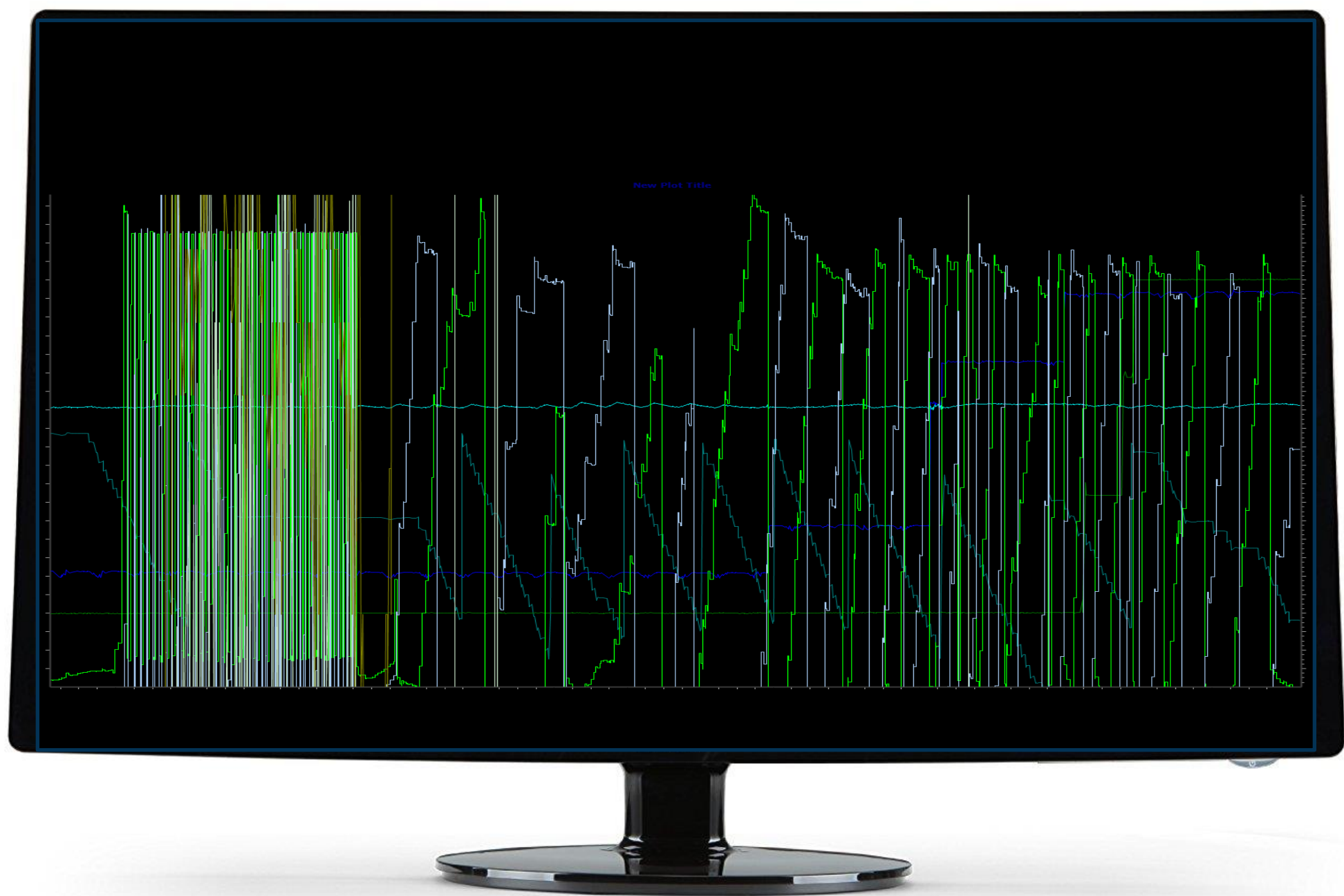






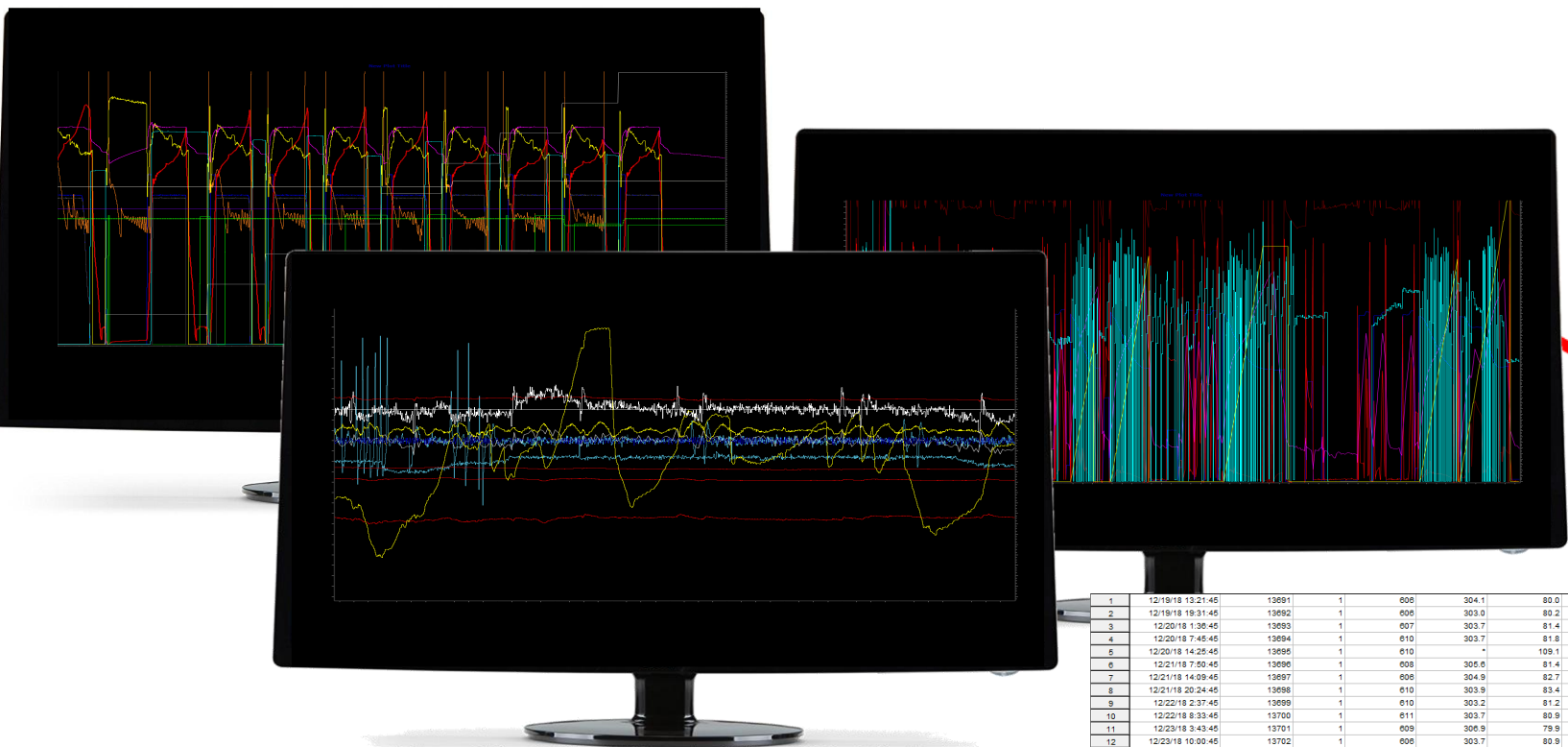












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2	12/19/18 19:31:45	13692	1	606	303.0	80.2	2048	44.5	23	101	136	77	164.01	7148	6390.6	2.3	8409.153
3	12/20/18 1:30:45	13693	1	607	303.7	81.4	2226	44.5	24	101	125	77	164.13	7149	6390.1	2.3	8478.928
4	12/20/18 7:45:45	13694	1	610	303.7	81.5	2316	44.5	25	98	132	77	164.01	7151	6327.4	2.3	8499.395
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7	12/21/18 14:09:45	13697	1	606	304.9	82.7	2054	45	28	98	148	79	162.27	7151	6362.6	2.3	8832.448
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10	12/22/18 8:33:45	13700	1	611	303.7	80.9	2013	45	31	117	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	87	80	162.38	7148	6525.2	2.3	7762.932
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14	12/23/18 22:54:45	13704	1	*	311.6	81.9	2048	45	35	102	125	74	162.70	7152	6026.4	2.3	10093.03
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16	12/24/18 14:37:45	13706	1	645	309.5	84.2	2043	45	37	95	183	74	161.79	7157	5705.0	2.3	11832.73
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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
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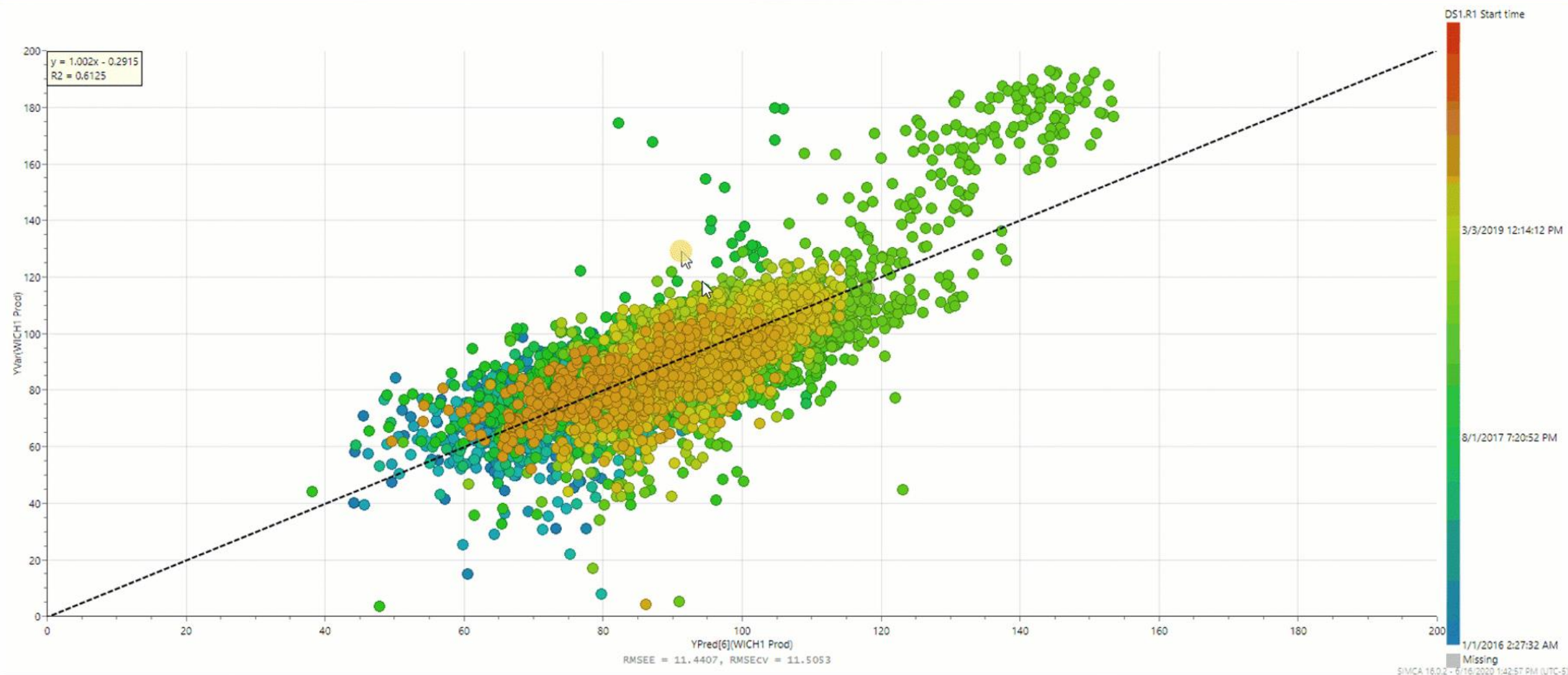
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6	12/21/18 7:50:45	13696	1	608	305.6	81.4	1227	45	27	108	148	80	162.42	7149	6447.5	2.3	8683.598
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18	12/25/18 2:45:45	13708	1	603	309.8	82.2	2050	45	39	94	119	70	162.32	7156	5818.0	2.2	11451.3
19	12/25/18 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
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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
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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
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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
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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
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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	1980	45	70	119	124	81	161.91	7147	6095.9	2.4	10440.04



Project Window - M20 (PLS) - Up to Dec '19

Number	Model	Type	A	N	R2X(cum)	R2Y(cum)	Q2(cum)	Date	Title	Hierarchical
17	M17	PLS	5	641	0.294	0.302	0.254	4/30/2020		
18	M18	PLS	10	641	0.526	0.299	0.241	4/30/2020		
19	M19	PLS	10	639	0.537	0.306	0.251	4/30/2020		
20	M20	PLS	6	7230	0.337	0.389	0.385	6/16/2020	Up to Dec '19	

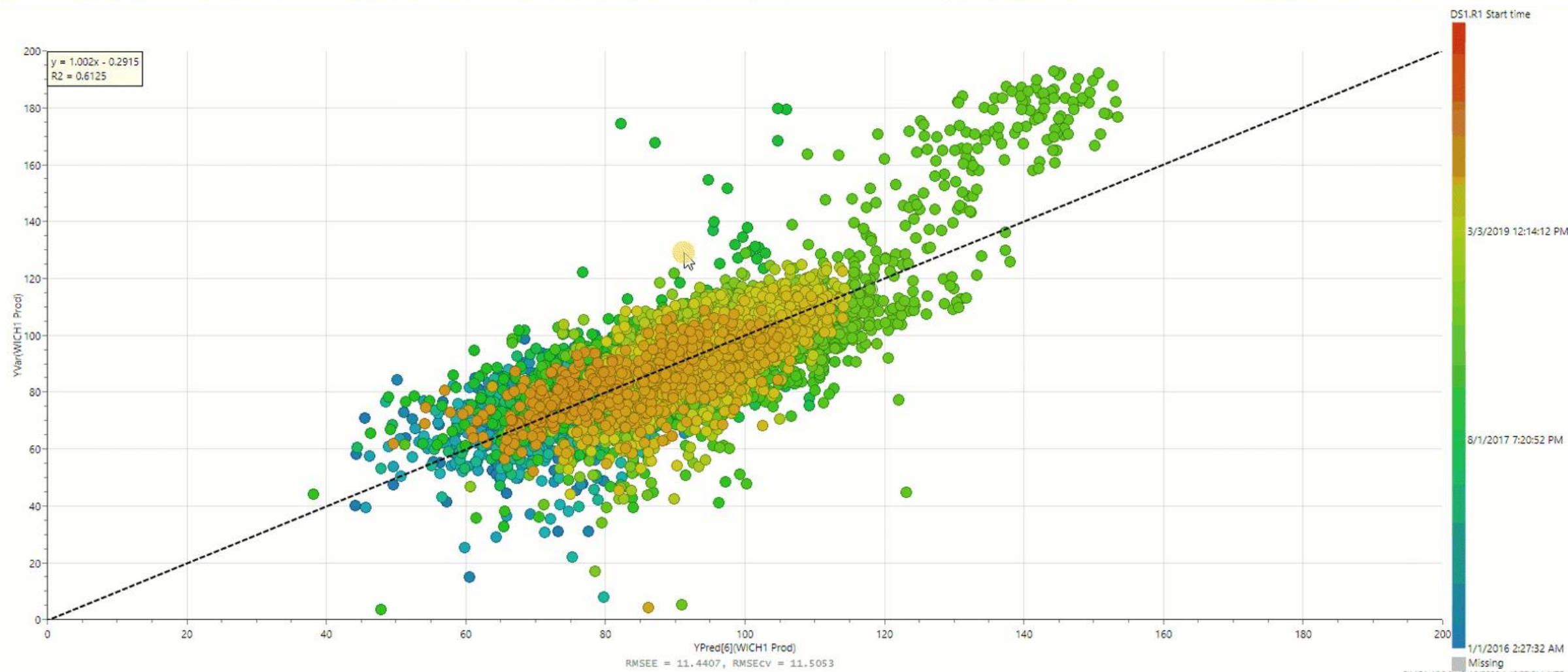
Observed vs. Predicted [M19] Loading Scatter Plot [M19] Score Scatter Plot [M19] Contribution Plot [M20] Observed vs. Predicted [M20] X Contribution Plot [M20] XVar Plot [M20] Contribution Plot [M20] XVar Plot [M20]



Project Window - M20 (PLS) - Up to Dec '19

Number	Model	Type	A	N	R2X(cum)	R2Y(cum)	Q2(cum)	Date	Title	Hierarchical
17	M17	PLS	5	641	0.294	0.302	0.254	4/30/2020		
18	M18	PLS	10	641	0.526	0.299	0.241	4/30/2020		
19	M19	PLS	10	639	0.537	0.306	0.251	4/30/2020		
20	M20	PLS	6	7230	0.337	0.389	0.385	6/16/2020	Up to Dec '19	

Observed vs. Predicted [M19]	Loading Scatter Plot [M19]	Score Scatter Plot [M19]	Contribution Plot [M20]	Observed vs. Predicted [M20] X	Contribution Plot [M20]	XVar Plot [M20]	Contribution Plot [M20]	XVar Plot [M20]
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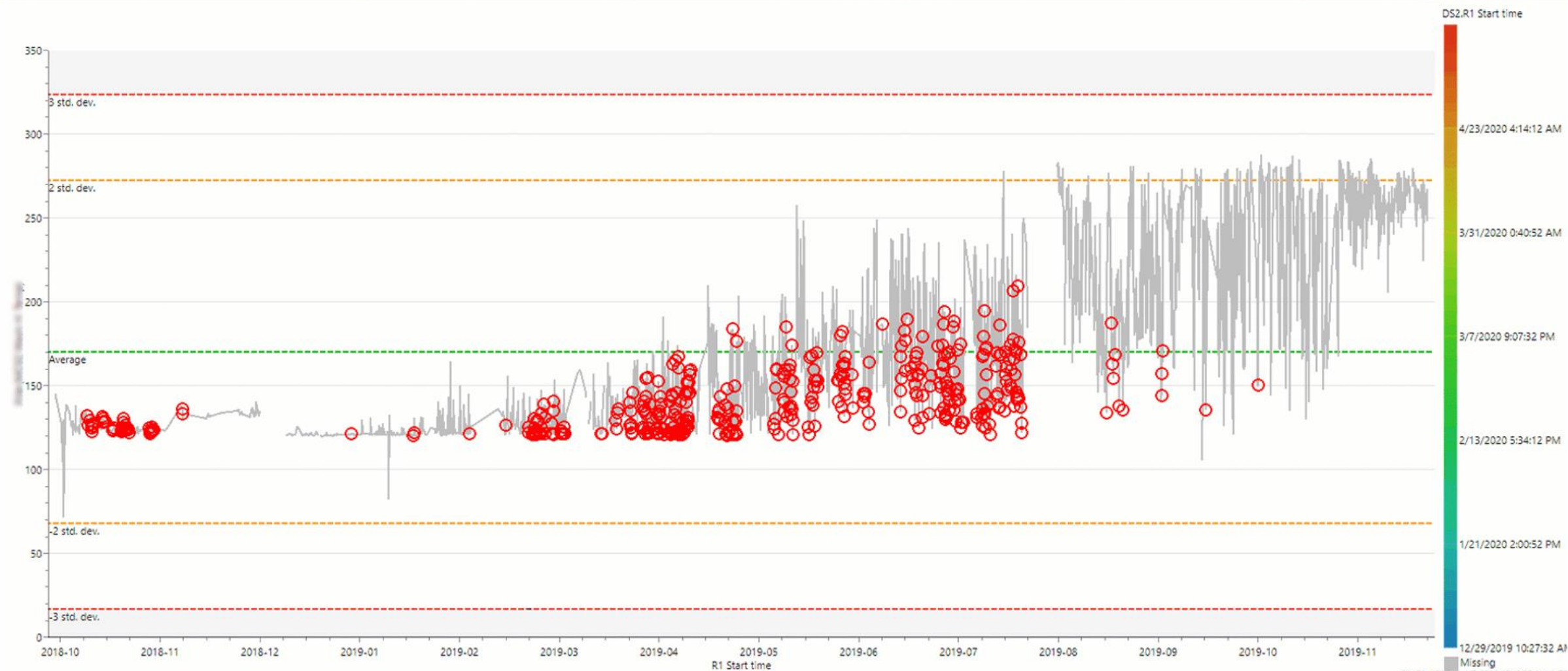




Project Window - M20 (PLS) - Up to Dec '19

Number	Model	Type	A	N	R2X(cum)	R2Y(cum)	Q2(cum)	Date	Title	Hierarchical
17	M17	PLS	5	641	0.294	0.302	0.254	4/30/2020		
18	M18	PLS	10	641	0.526	0.299	0.241	4/30/2020		
19	M19	PLS	10	639	0.537	0.306	0.251	4/30/2020		
20	M20	PLS	6	7230	0.337	0.389	0.385	6/16/2020	Up to Dec '19	

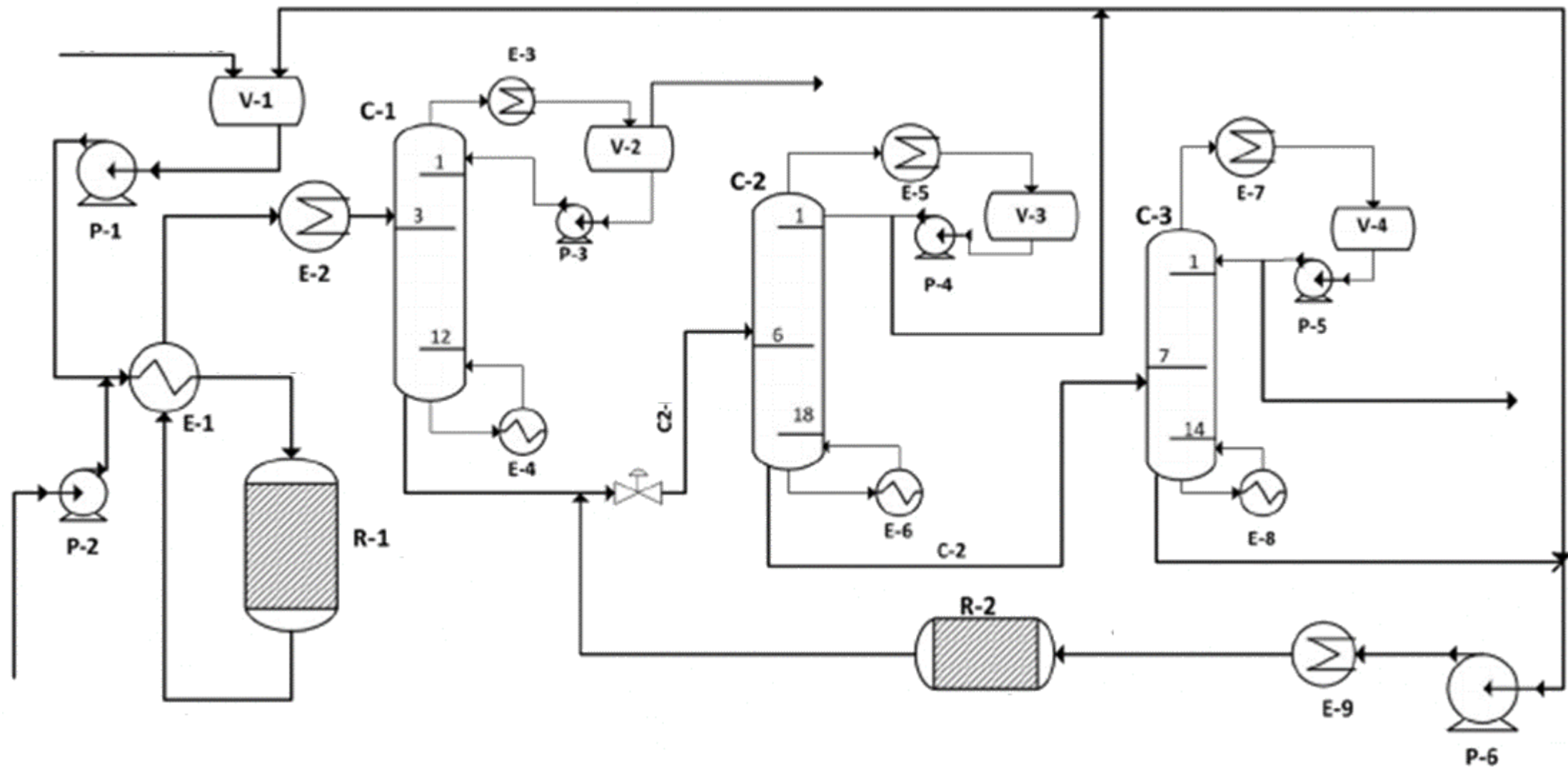
Scatter Plot [M19] Score Scatter Plot [M19] Contribution Plot [M20] Observed vs. Predicted [M20] Contribution Plot [M20] XVar Plot [M20] Contribution Plot [M20] XVar Plot [M20] Contribution Plot [M20] XVar Plot [M20] X

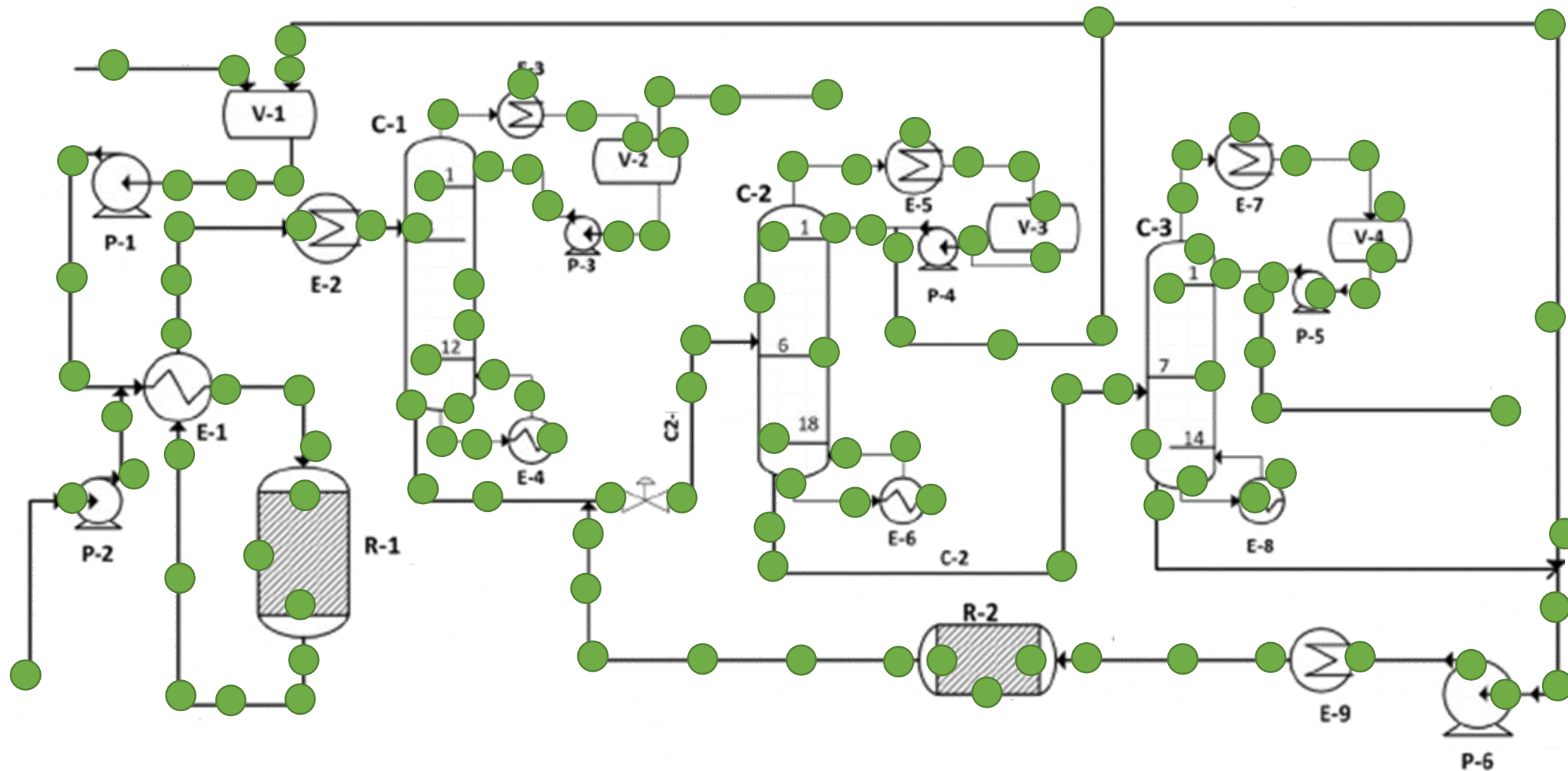


# Creating an Enterprise

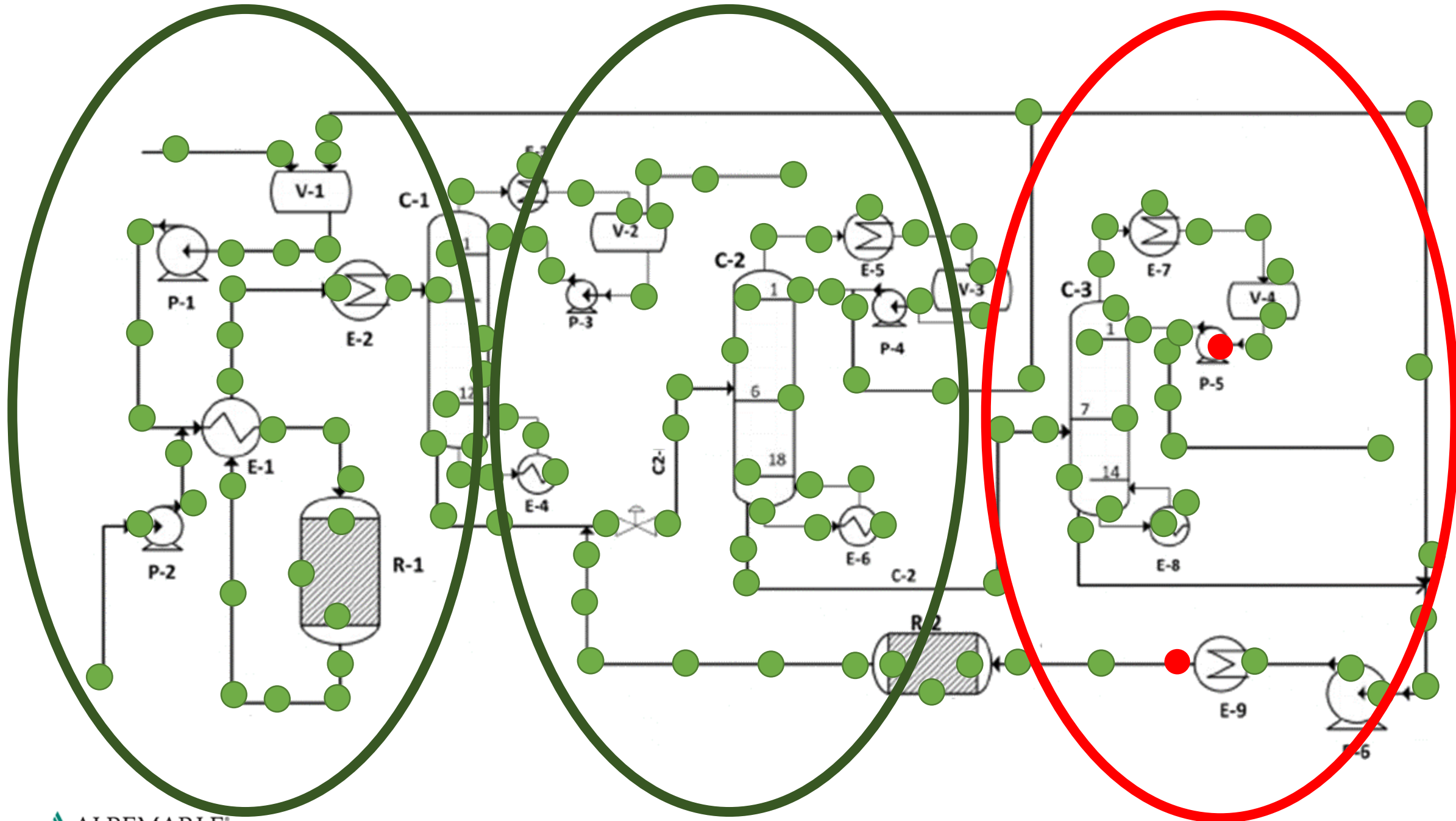
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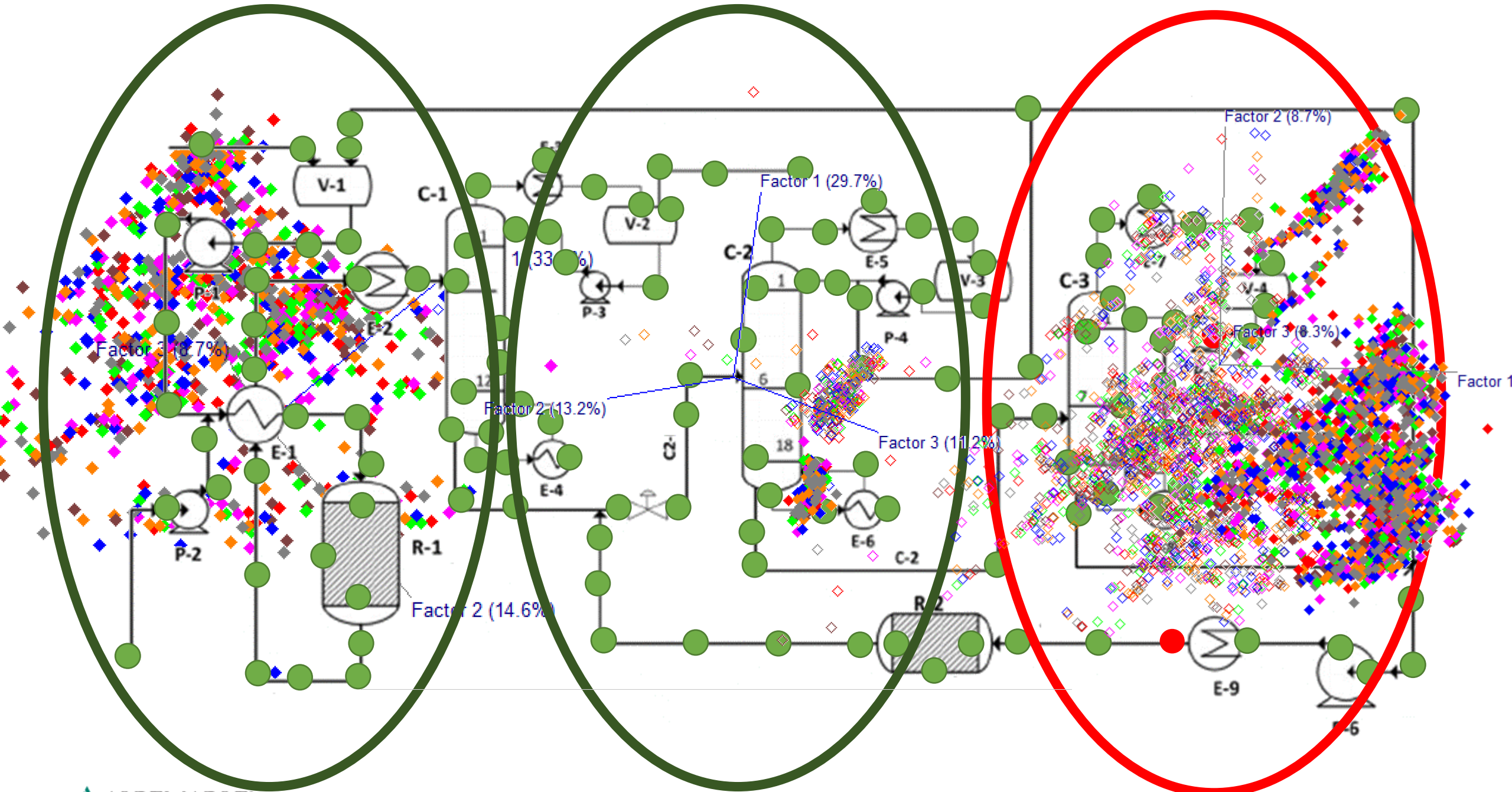




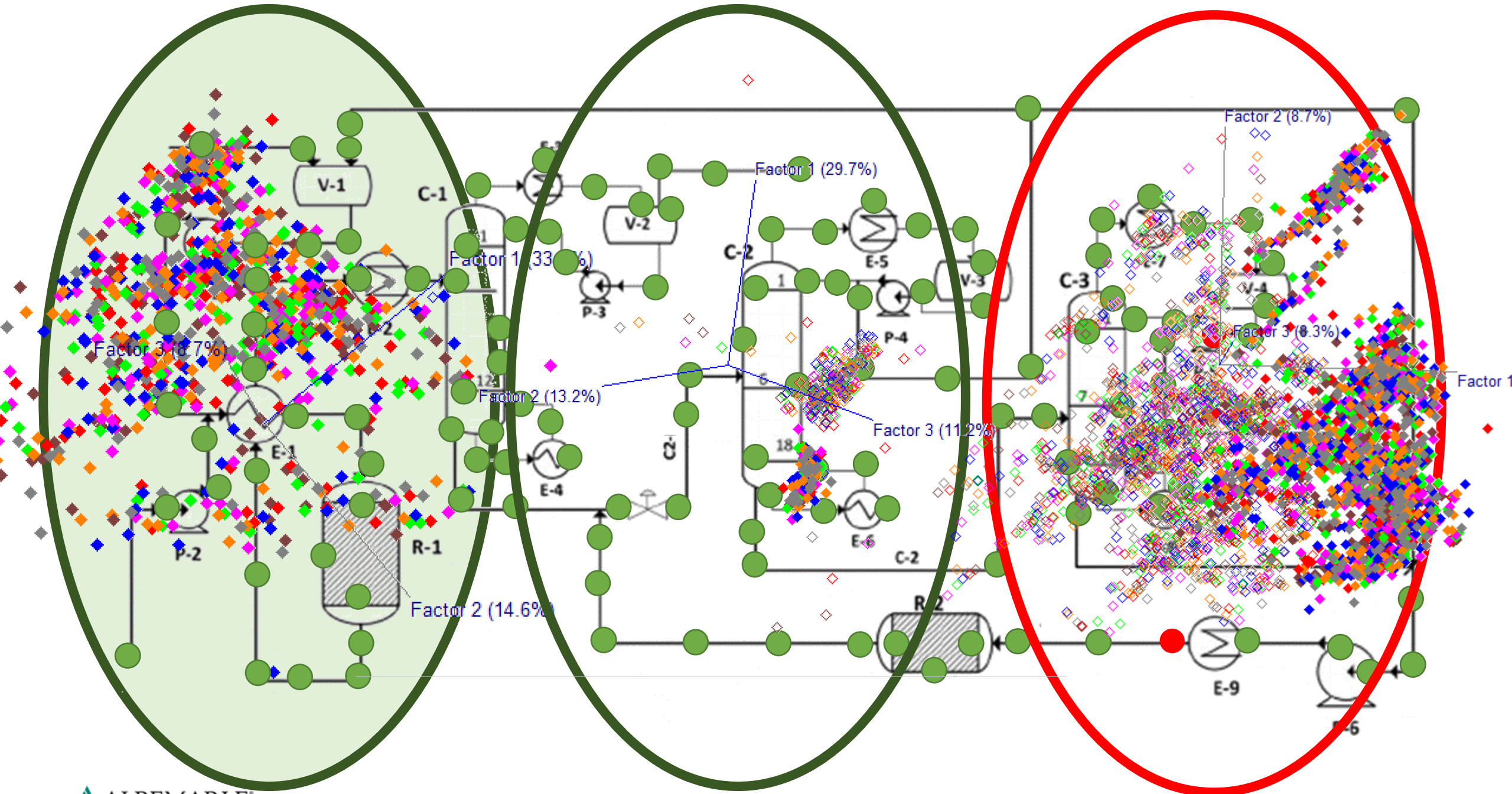


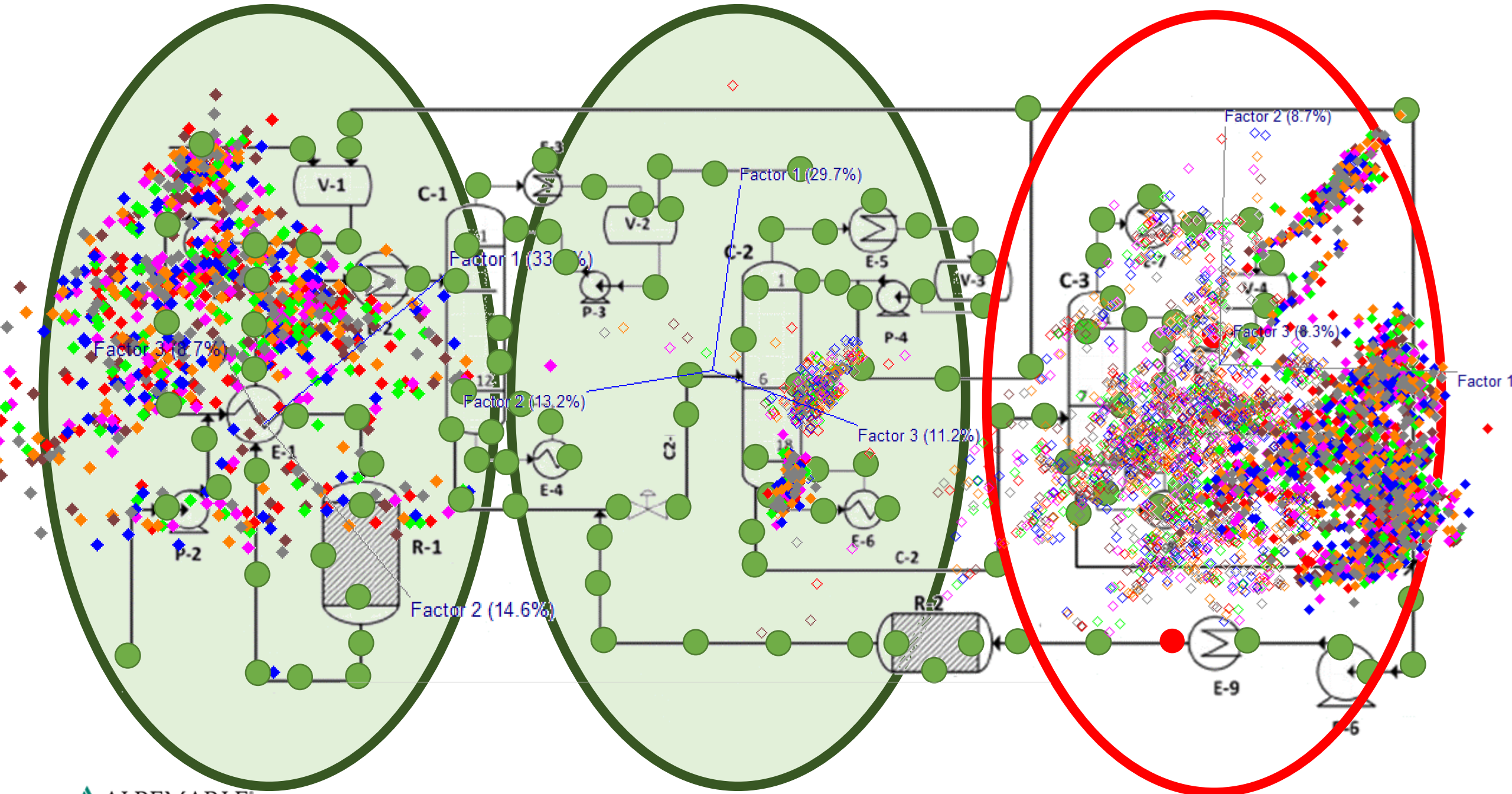




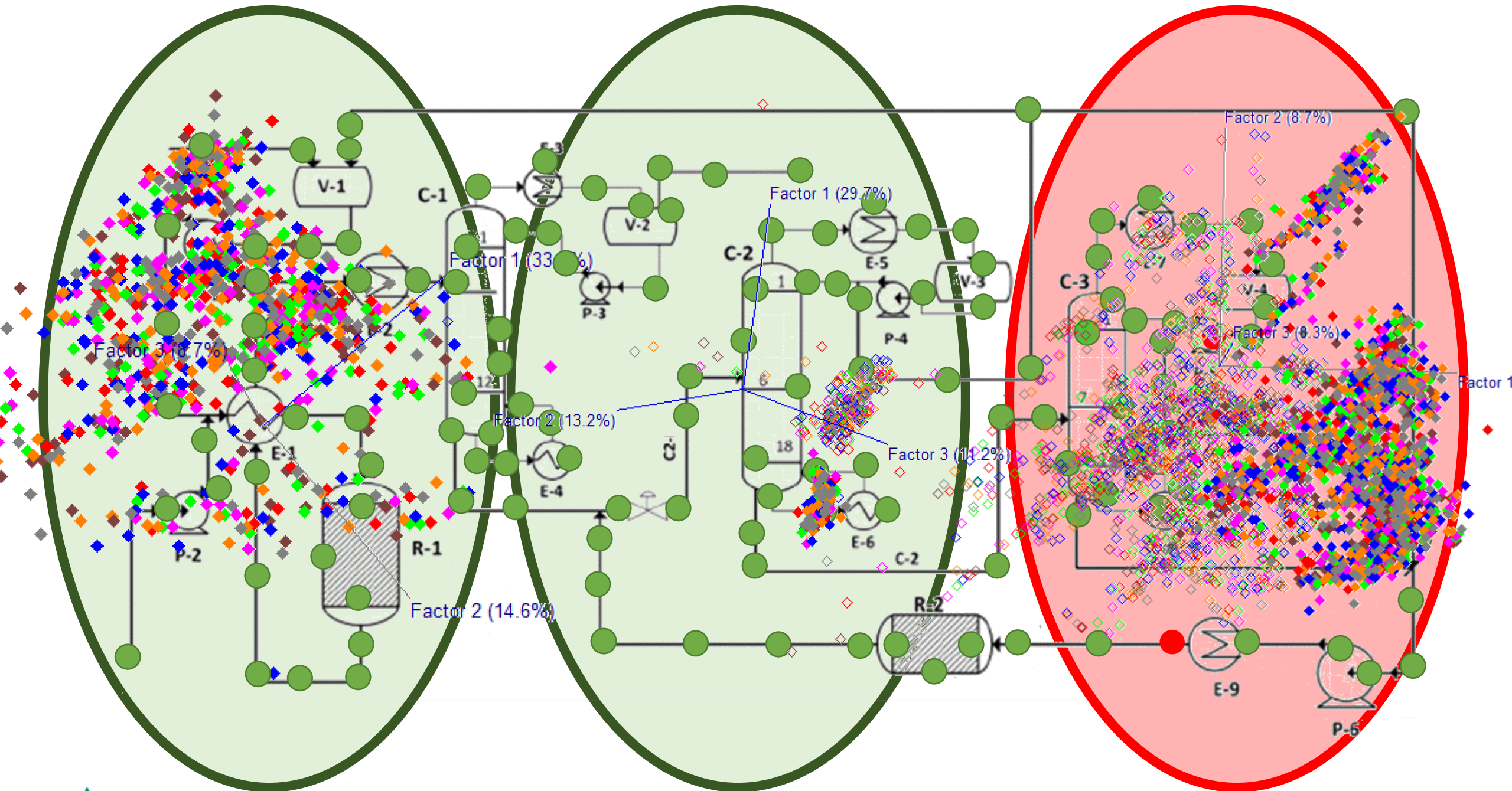


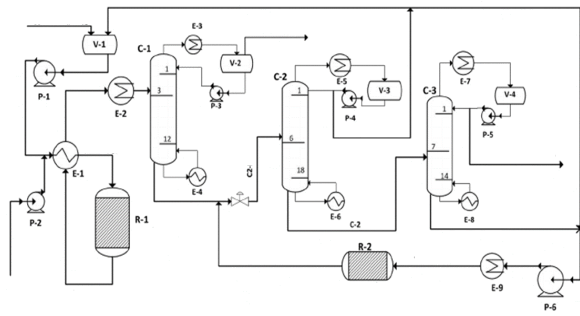


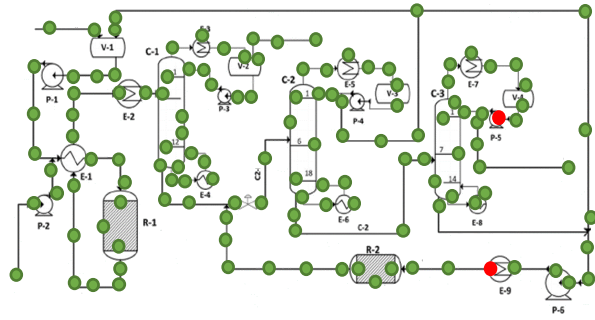


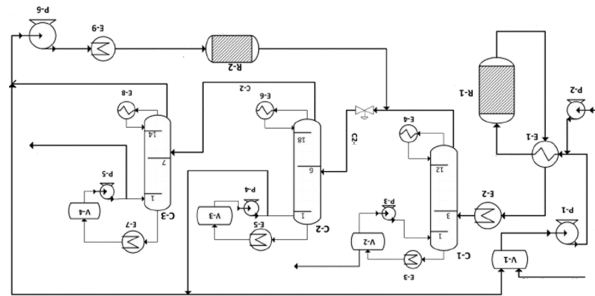
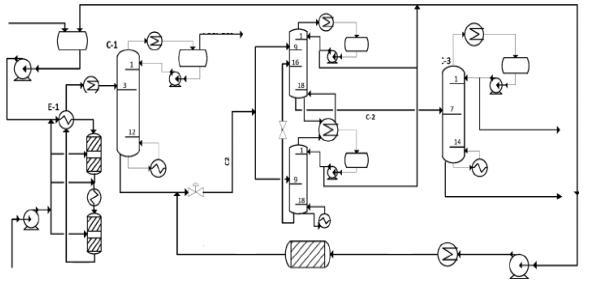
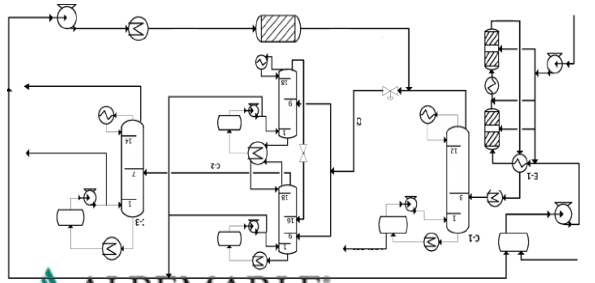
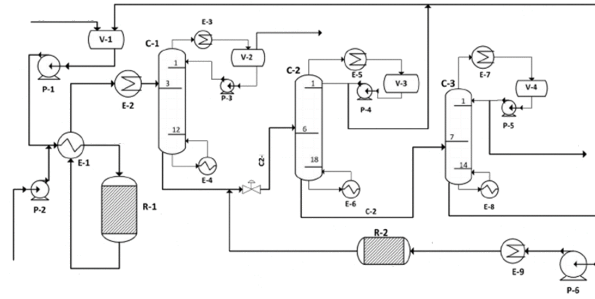
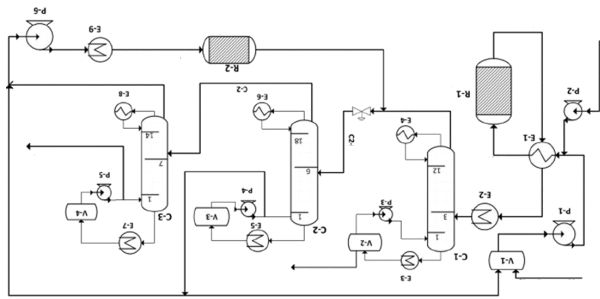
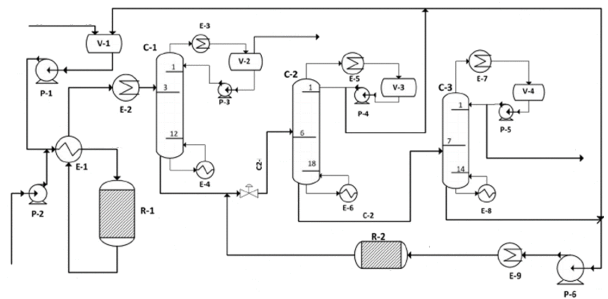
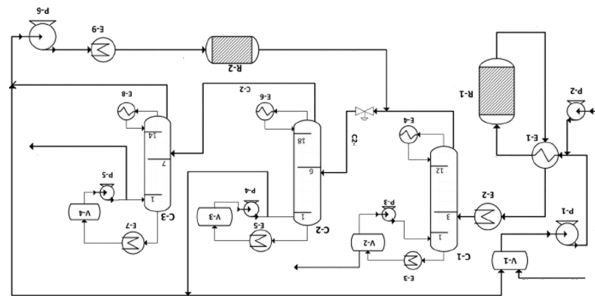
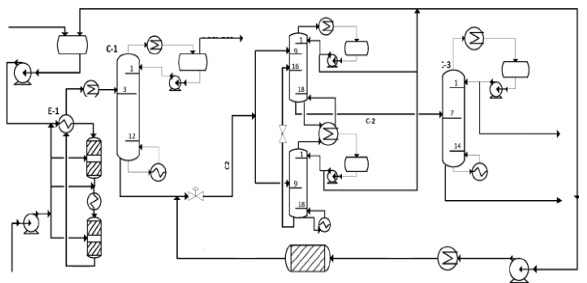
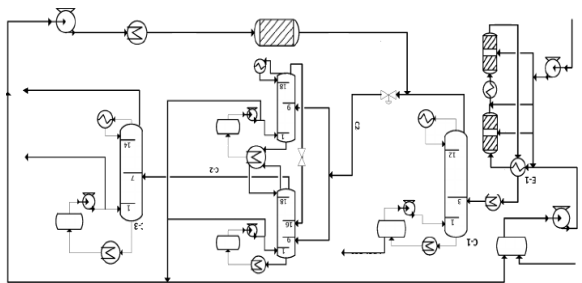
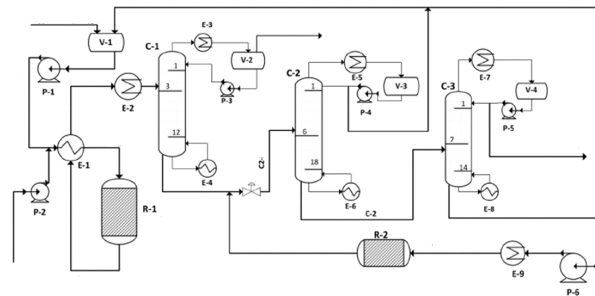
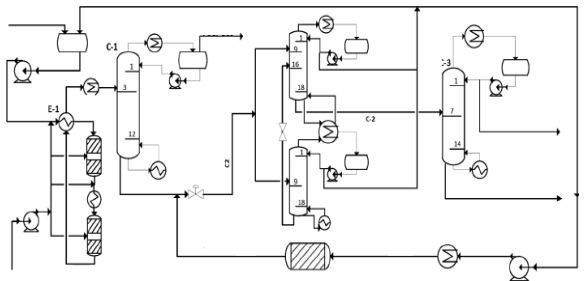
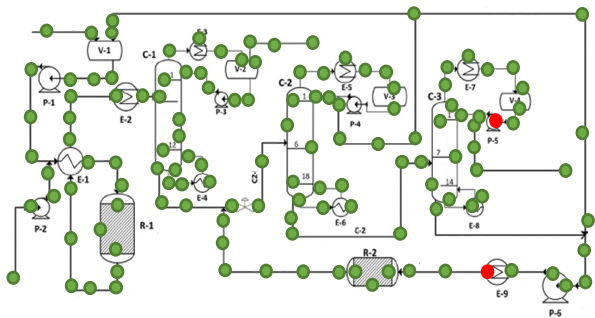




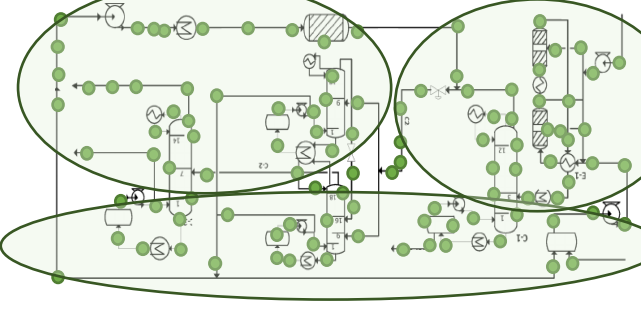
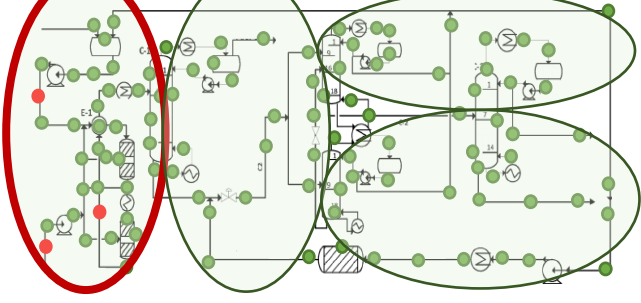
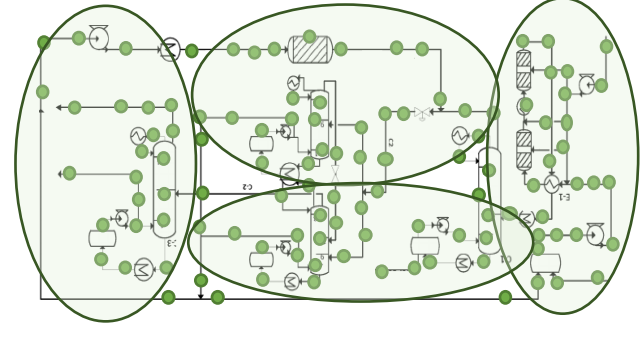
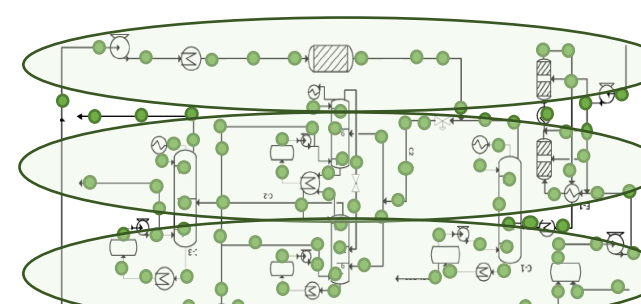
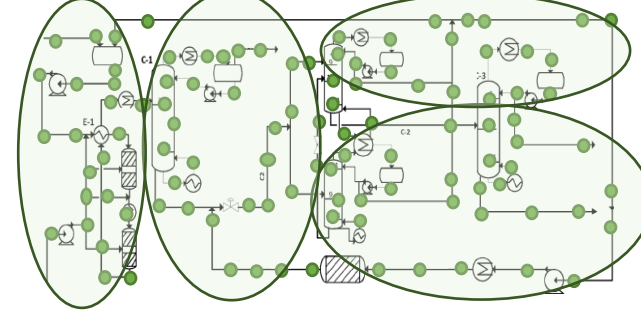
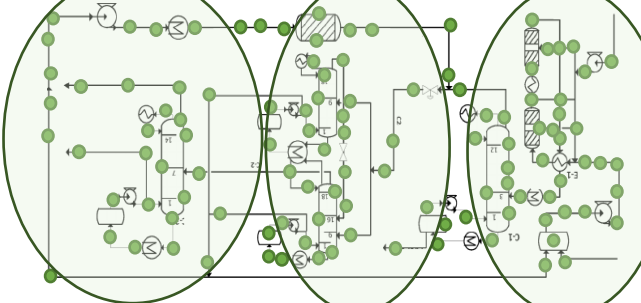
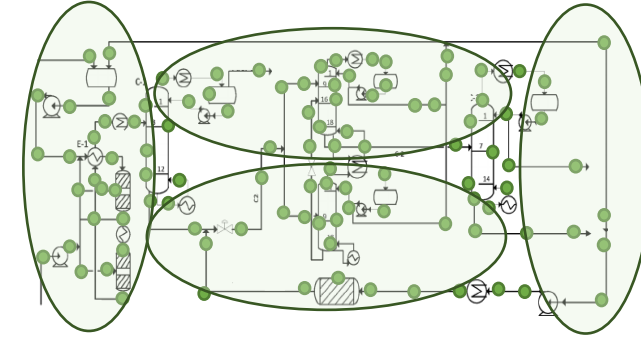
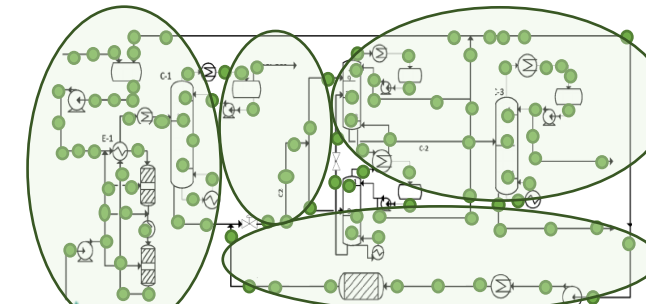
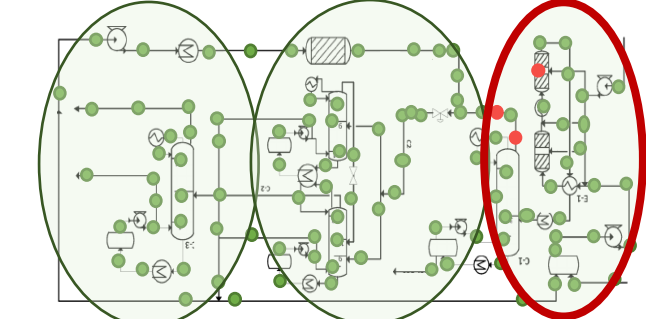
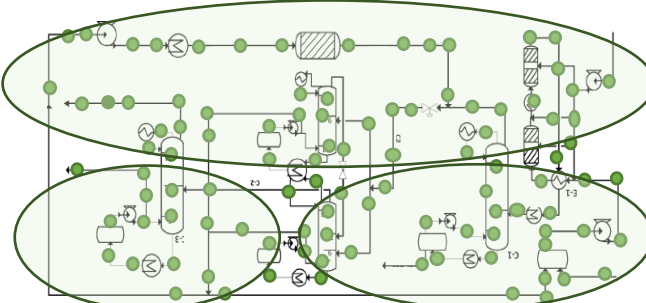
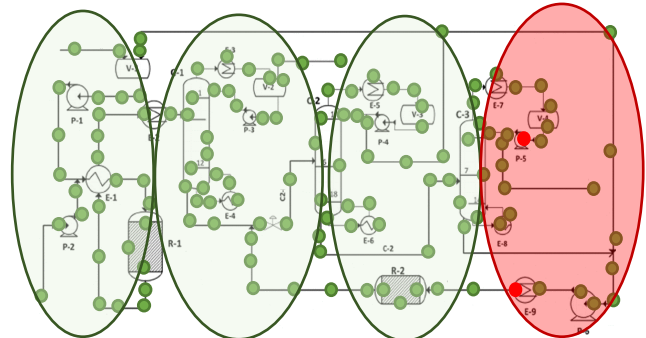


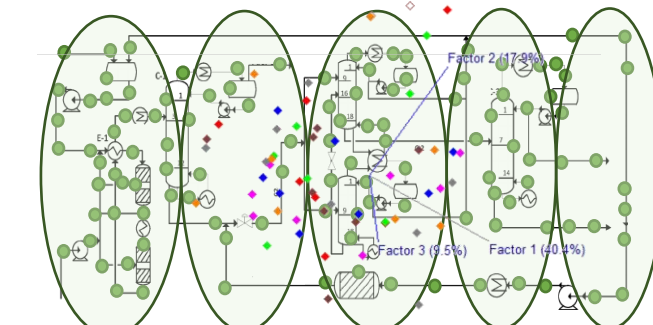
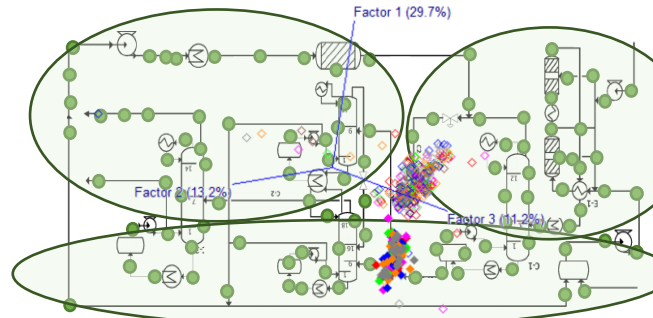
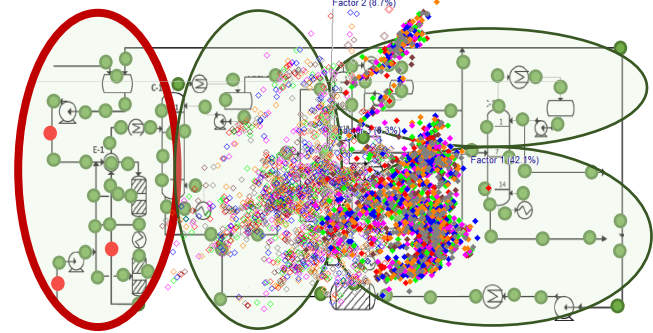
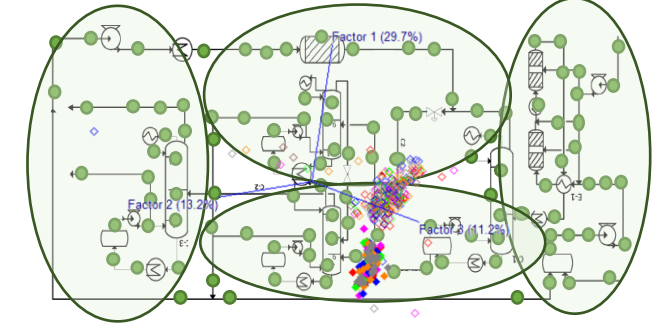
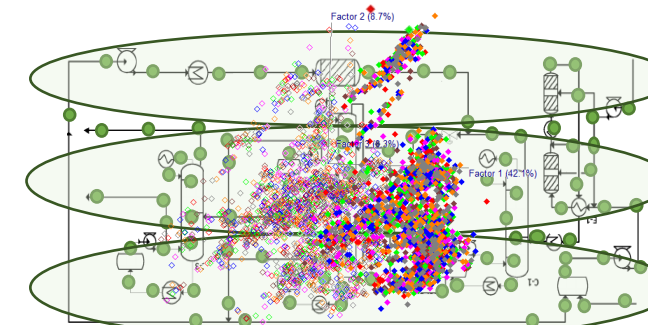
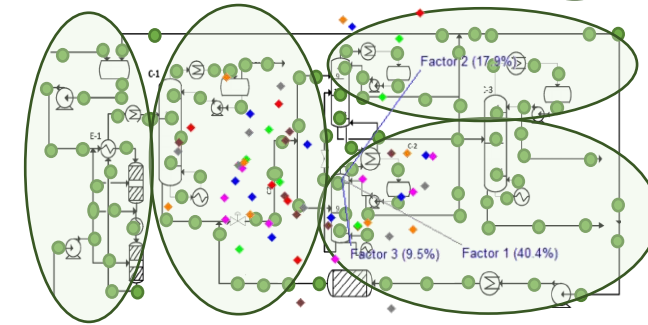
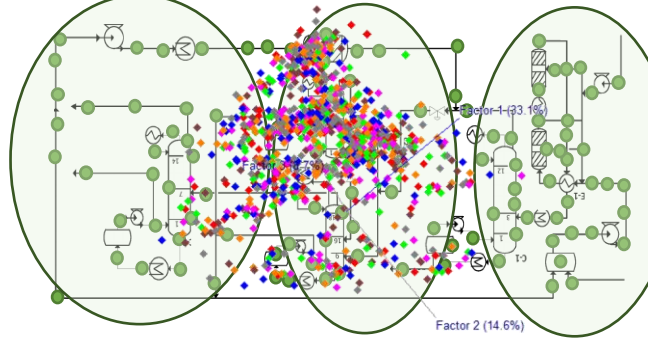
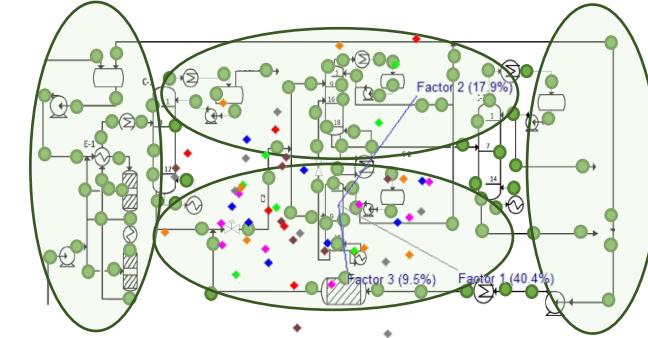
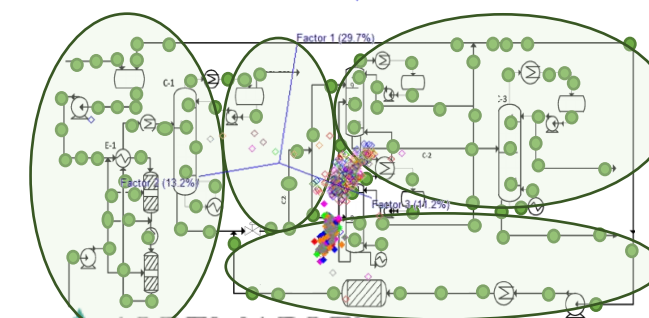
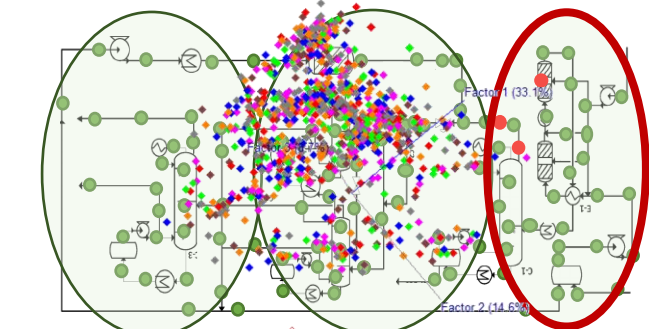
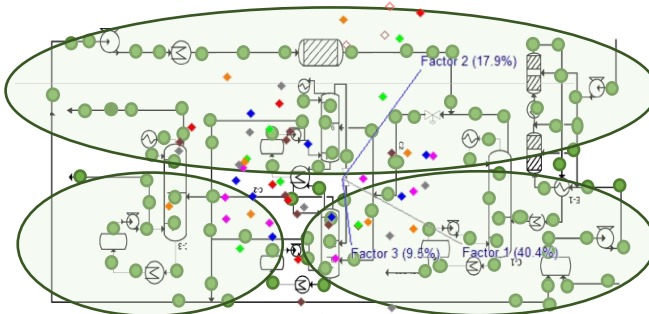
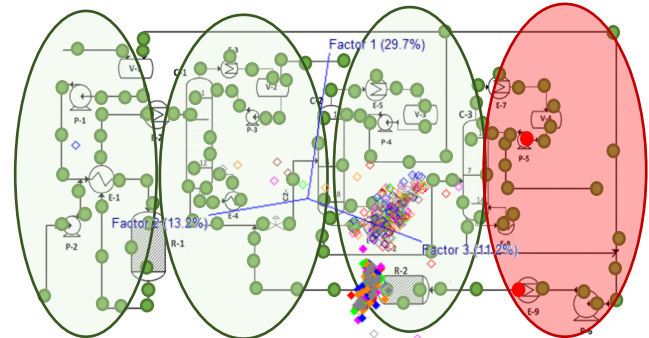




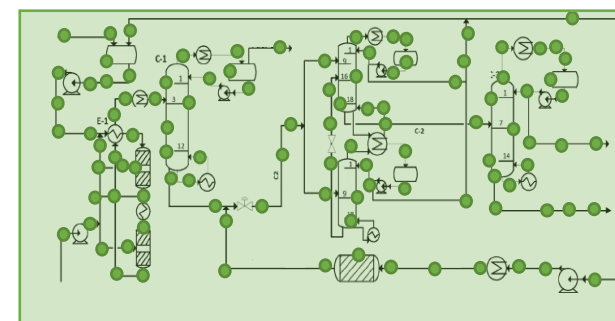
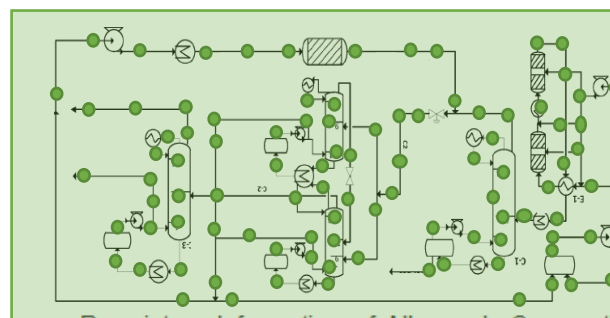
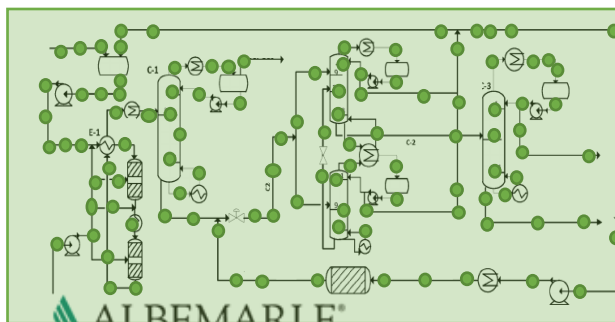
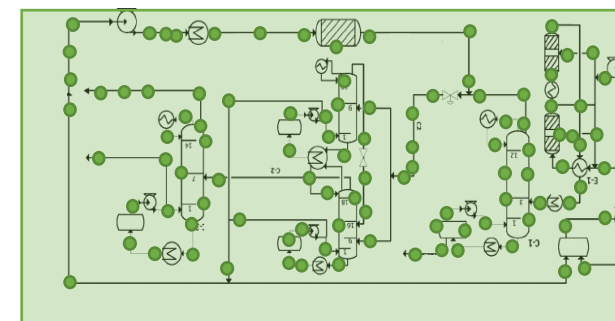
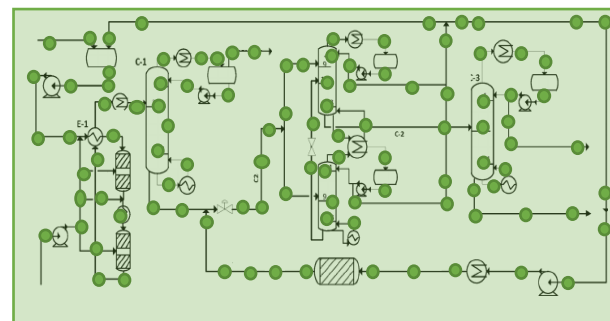
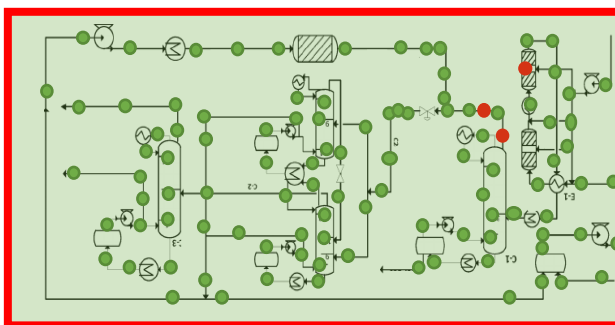
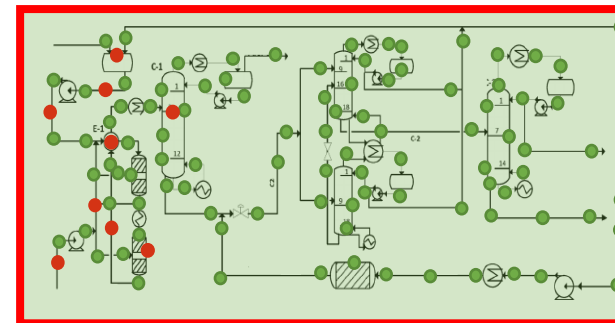
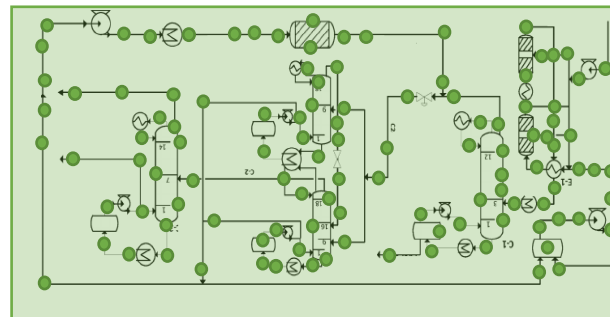
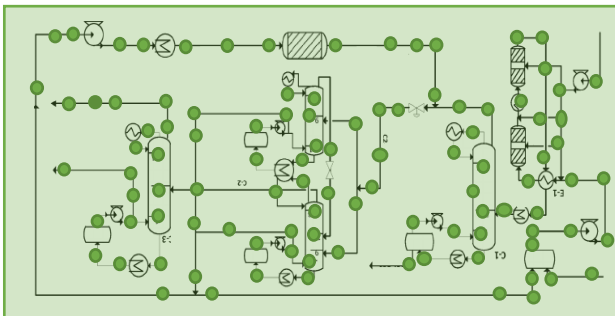
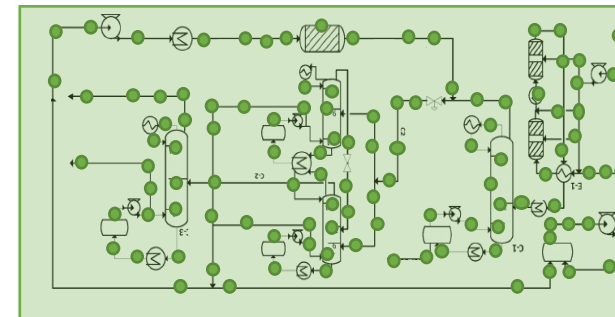
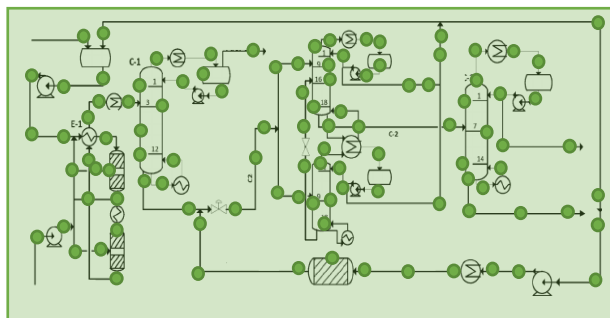
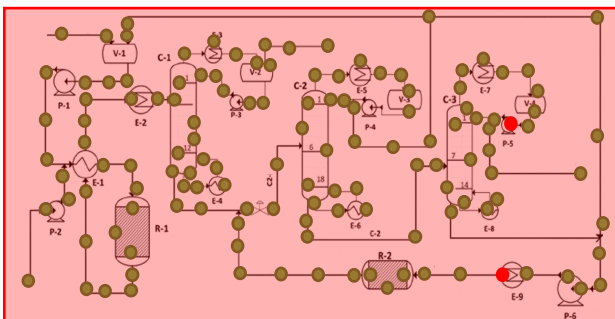


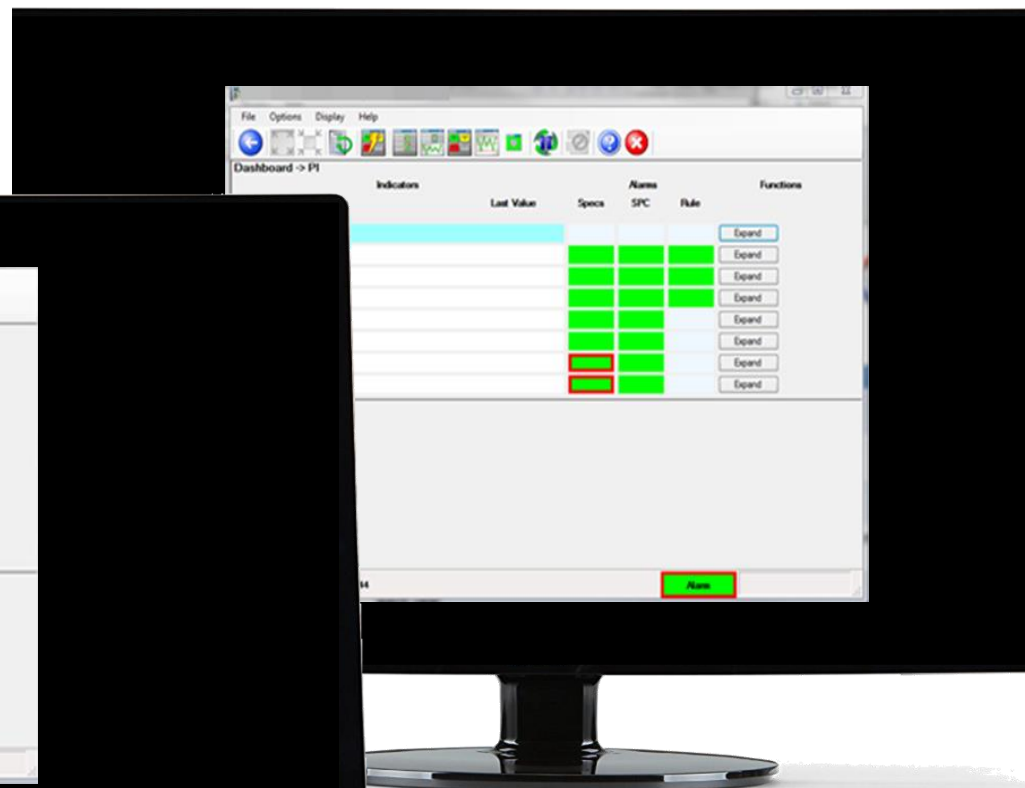
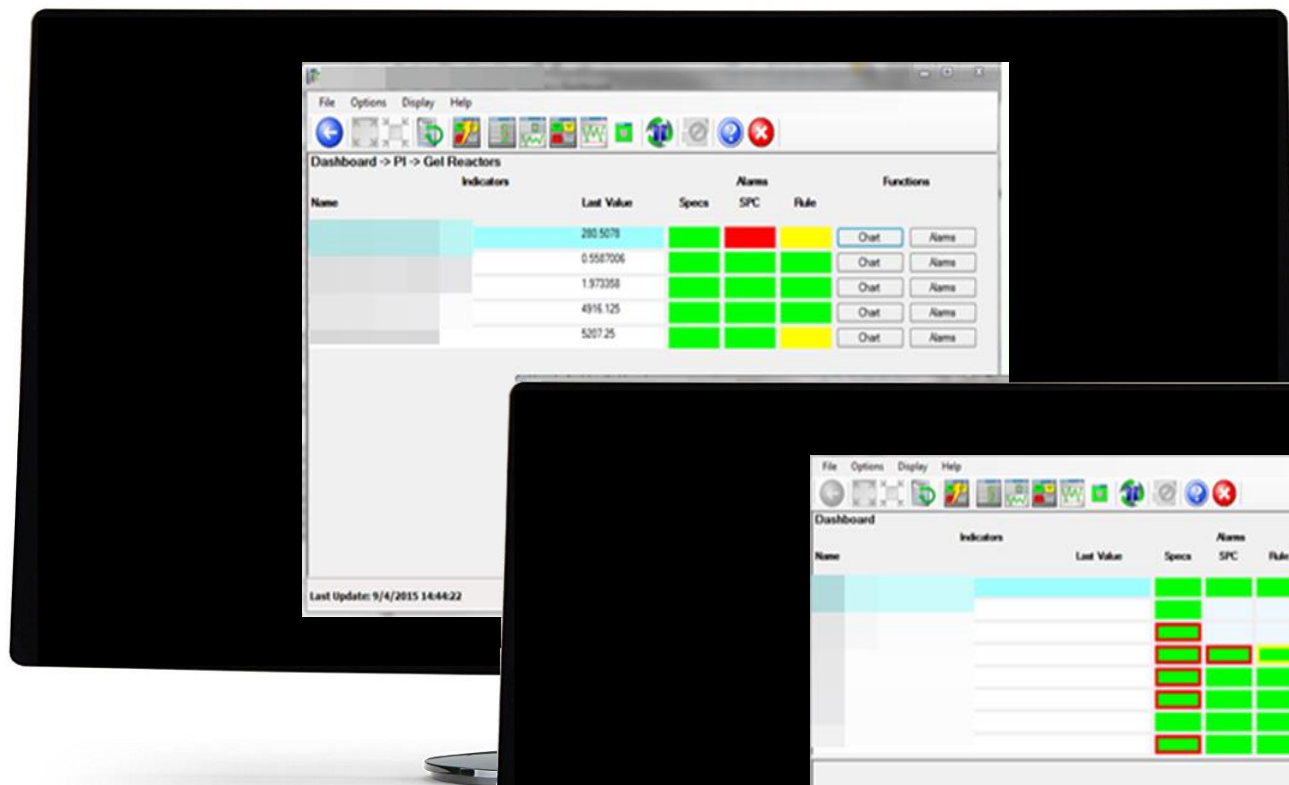














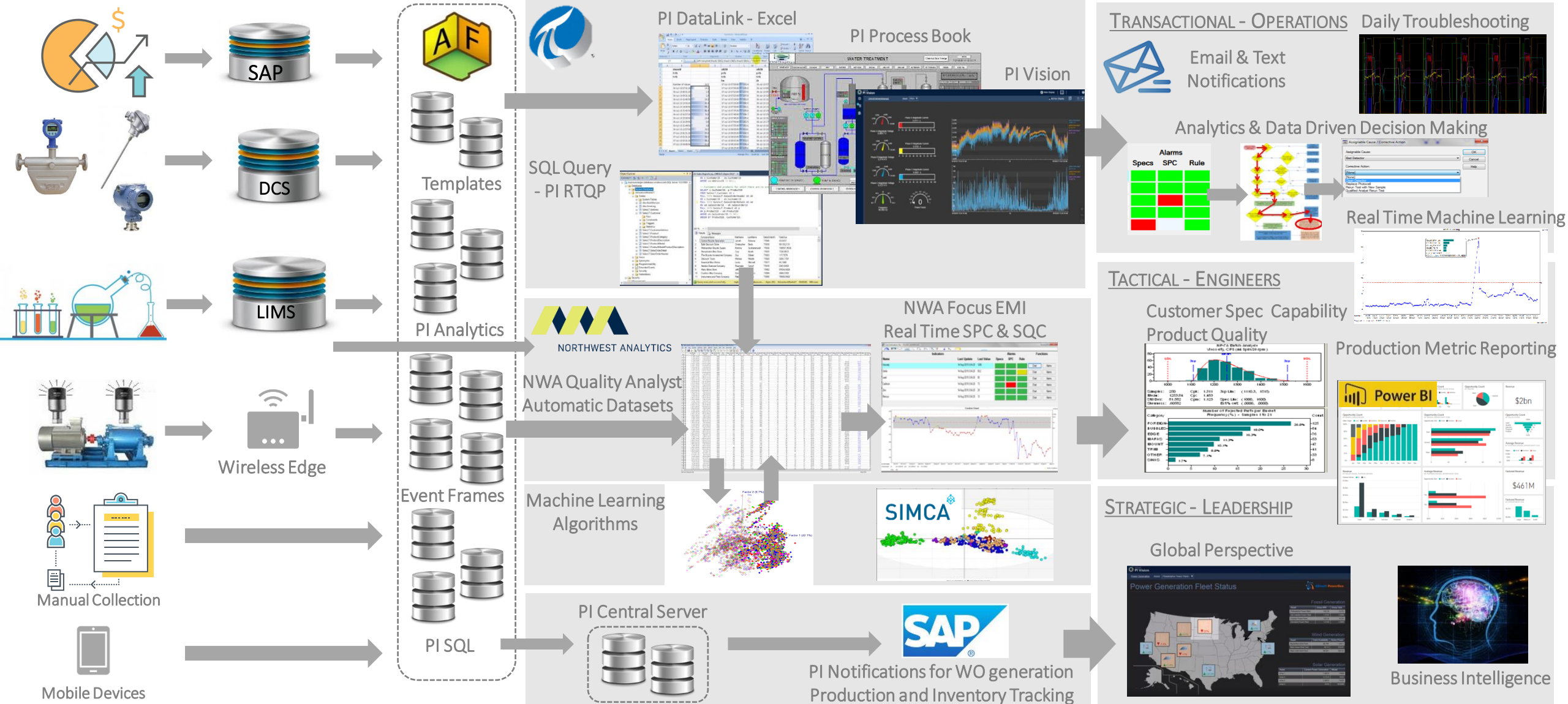
# Albemarle Intelligence - Infrastructure

## DATA SOURCES

## OSISOFT PI ASSET FRAMEWORK

## DATA ANALYTICS SUITE

## USER ROLES



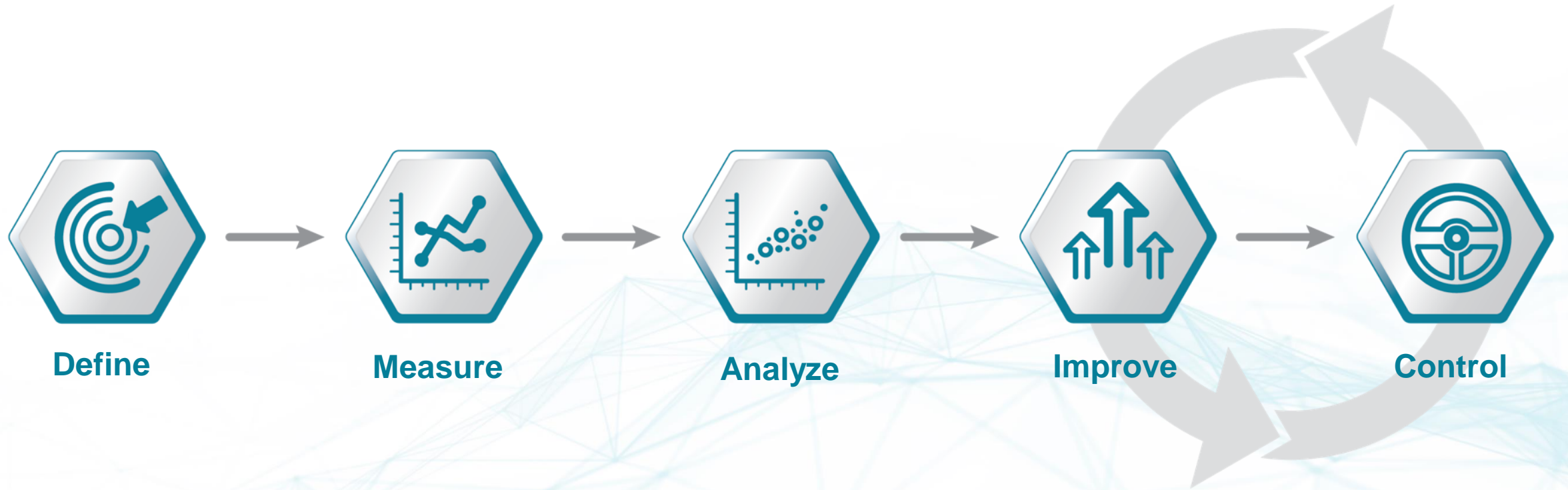
# Project AI - Global Implementation

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# Six Sigma: Manual Version

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# Six Sigma: Automated



**Define**



**Measure**



**Analyze**



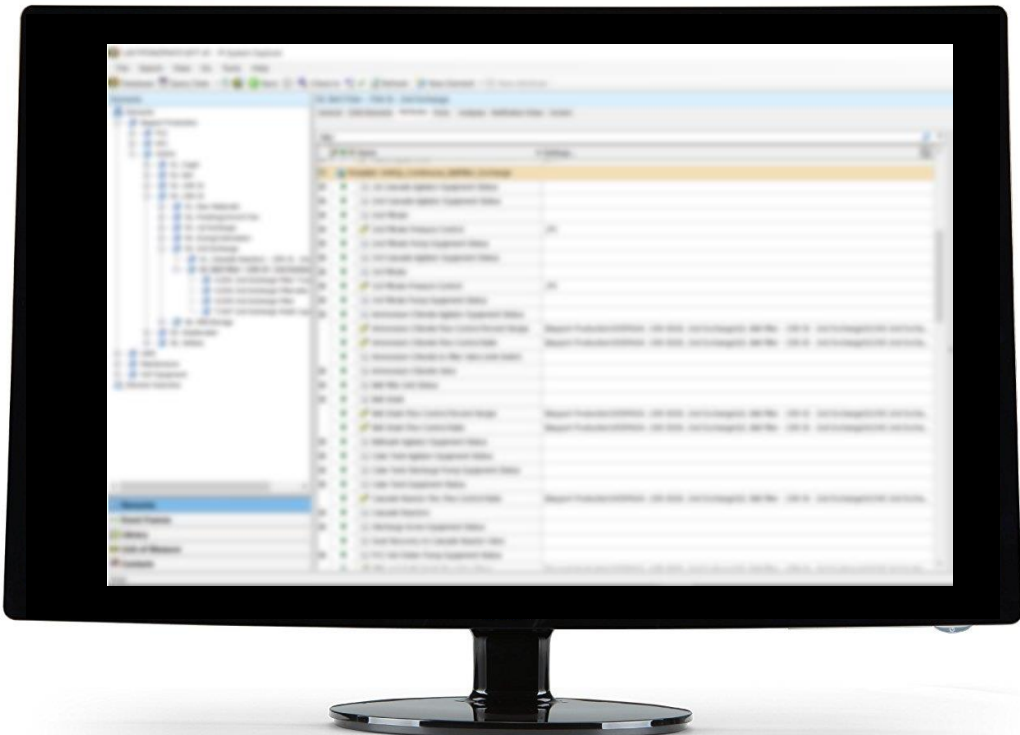
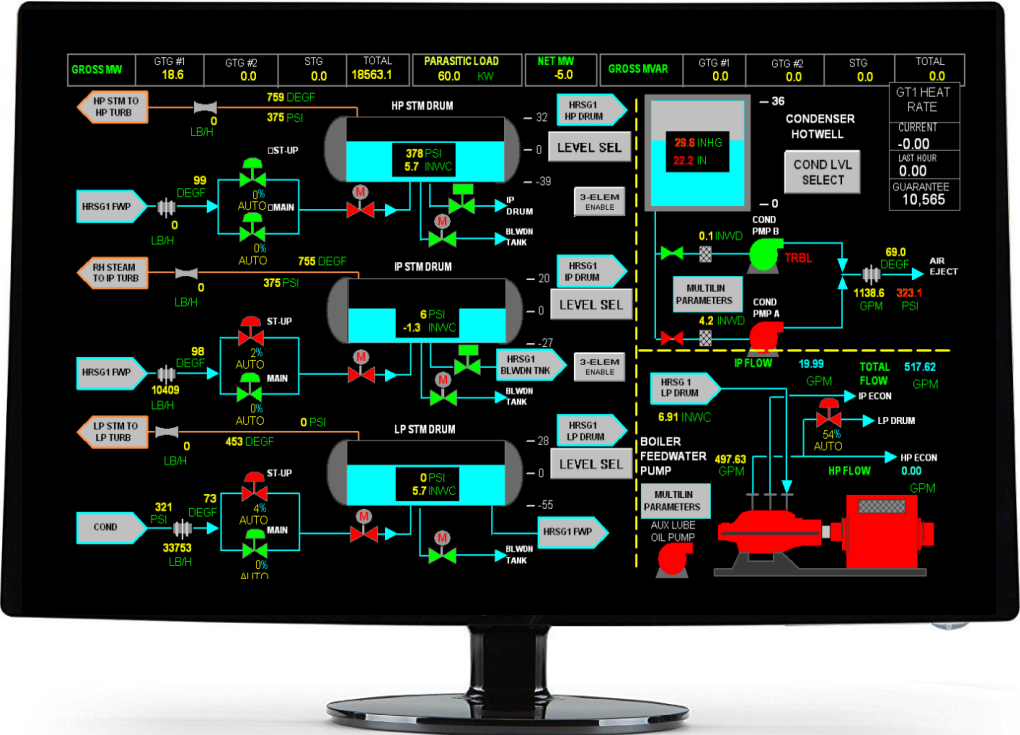
**Improve**

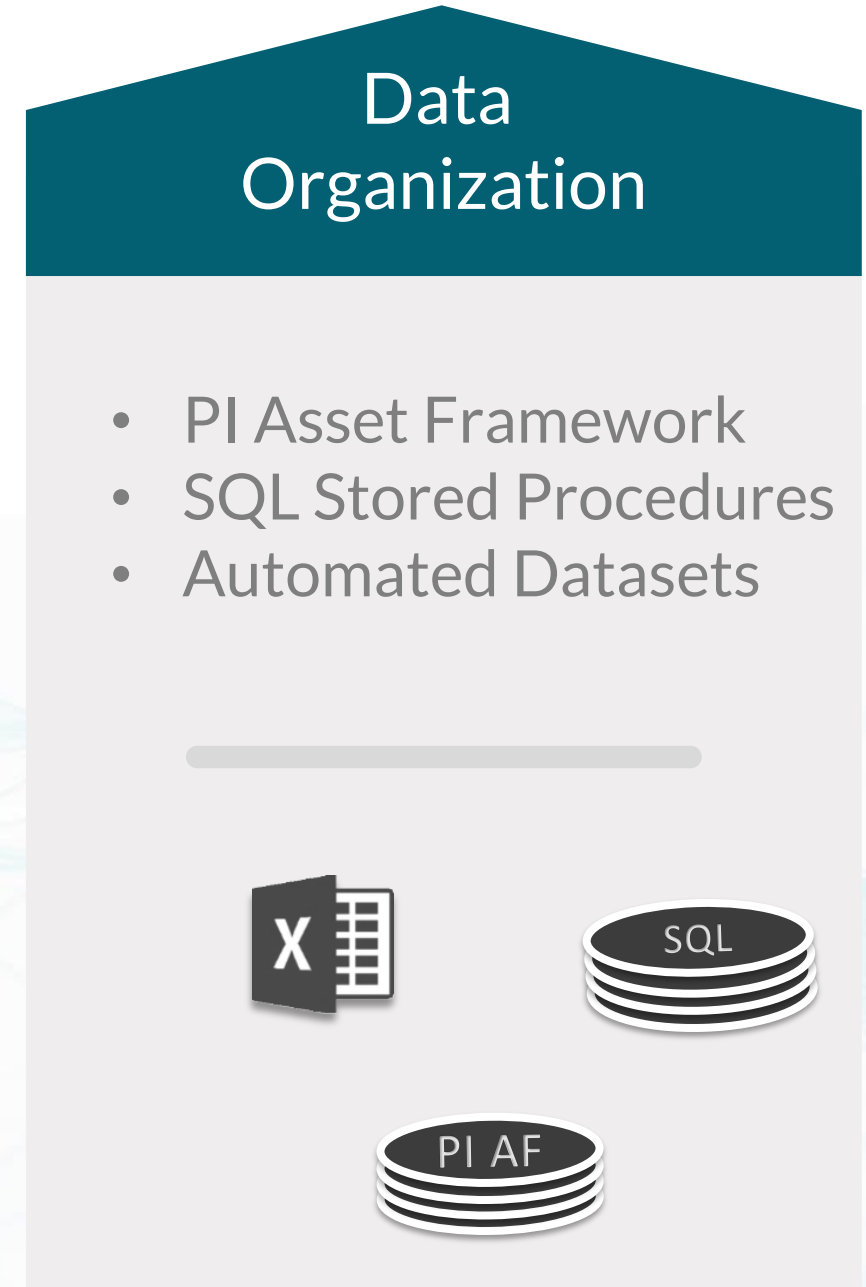
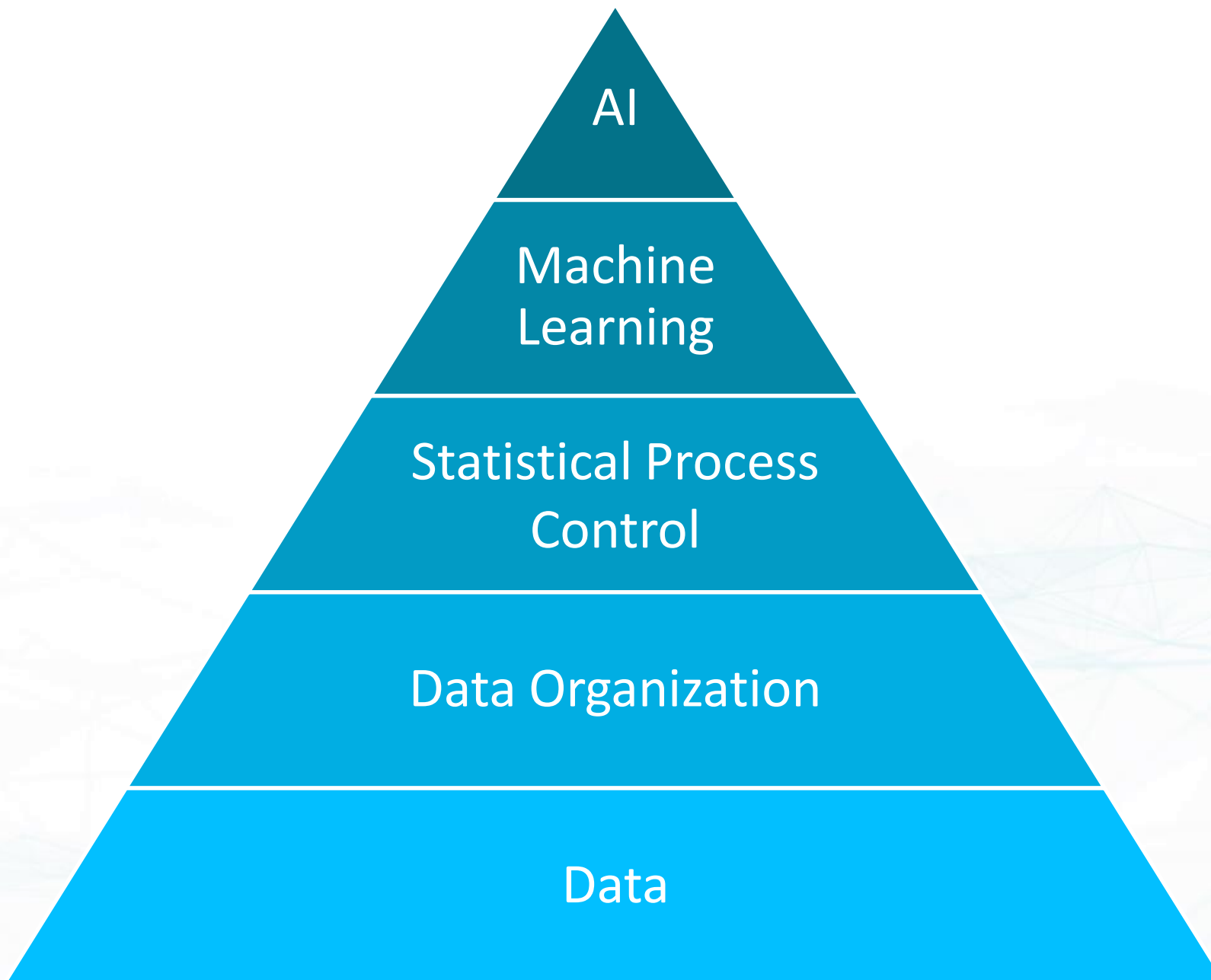


**Control**



# DEFINE

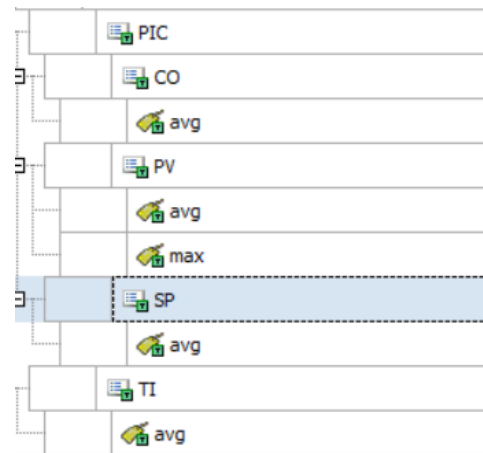




# MEASURE

- Event Frames created to be triggered when unit is down, starting up, or running at steady state.
- PI Vision utilized when deciding which attributes to capture and what summary analytics were needed for best analysis of calciner performance
- Query to align EF on an hourly basis onto a single row.
- Filter Dataset by Relational Fields:
  - Product
  - Recipe
  - Campaign
  - Unit Operation
  - Shift
  - Status Flag
  - Weather
- LIMS Laboratory data can be merged with PI Process data to predict production rate and quality issues

PI AF Event Frames  
Capture Key Process Indicators



PI Vision – Time Series Trend



Time Series Data converted to NWA Automated Dataset

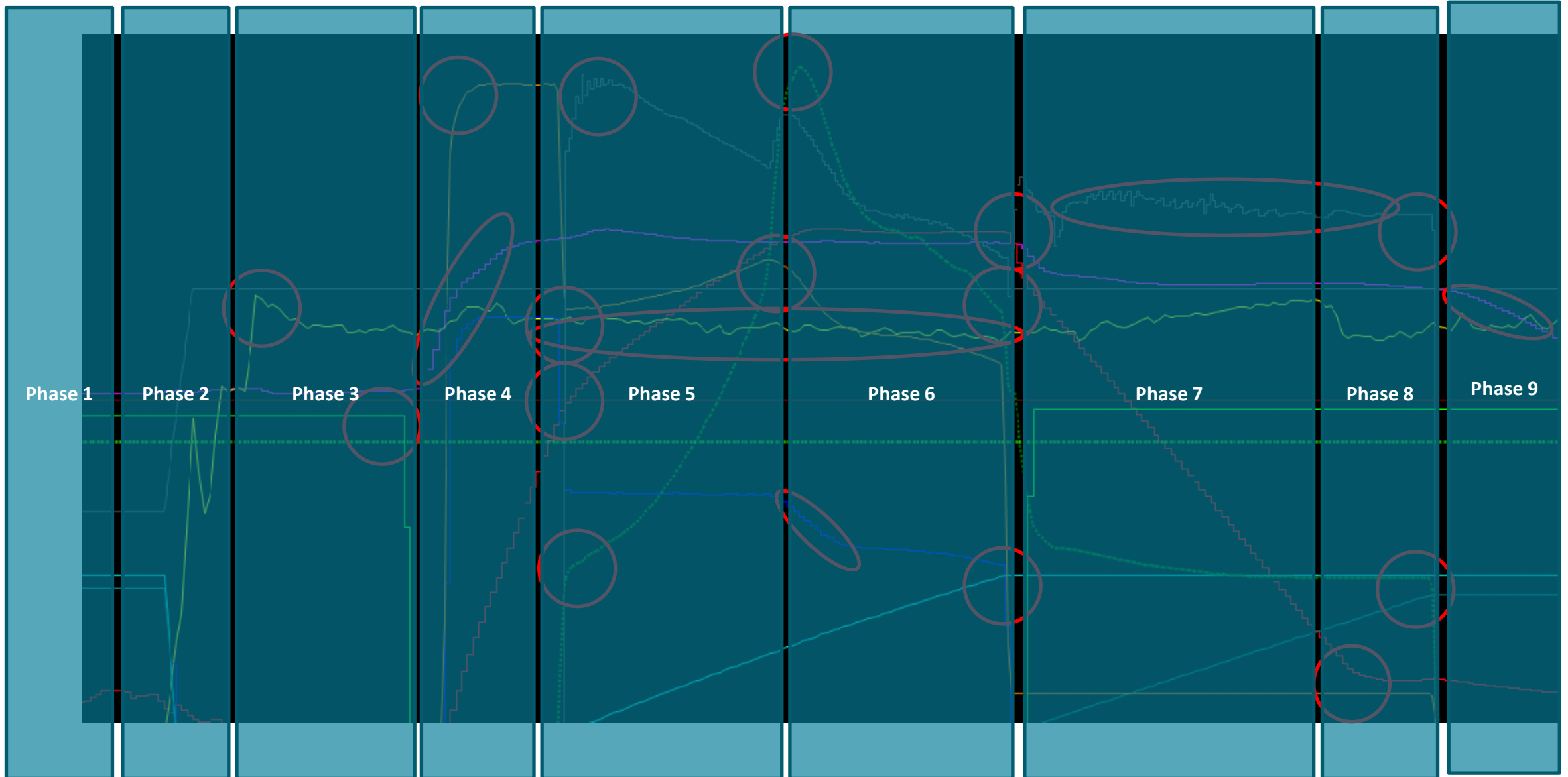
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StartUp	-0.4279914	-0.2840576	322.860671633938	0.1736194	63.82583
Running	-0.4223962	-0.3425598	305.745576461575	0.1763347	62.06646
Shutdown	-0.4734771	-0.324707	298.052300682118	0.1772715	61.86706
Running	0.2159671	0.4127502	220.930605507834	-0.1006555	313.9682
Down	-0.5094602	-0.2527466	284.357069405793	0.1859251	60.79785
StartUp	-0.5613872	-0.3166433	278.476235698077	0.2133375	68.21075
Running	-0.5736619	-0.4169922	284.672640178253	0.2123941	73.50066
Running	-1.567335	0.441864	137.47848703637	-0.1426007	371.2763
Running	-0.5626348	8.453369E-03	302.569833874908	0.2008539	71.44946
Running	-1.412884	0.4262085	102.067914653533	-0.1506102	391.2102
Running	-0.5321657	-0.1895752	360.878072756626	0.2073481	70.59
Running	0.4135617	0.4399414	93.1583761218026	-0.1381288	355.4965
Running	-0.539593	-0.2280273	405.759095291282	0.2009507	73.90455
Running	0.4200543	0.4533997	88.5530691171617	-0.1277233	384.5705
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Running	0.4203337	0.4443359	86.7404389593375	-0.1268579	388.081
Running	-0.5972258	-0.2887268	408.247829732666	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	84.9105852121235	-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	400.786887646635	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	171.854726951085	-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	258.128296187607	-0.1338389	391.7454

# Dataset Theory – Continuous Unit Operation - Status Flag





# PI Asset Framework Event Frames - Capturing Key Process Indicators



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 3:20 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 6:34 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

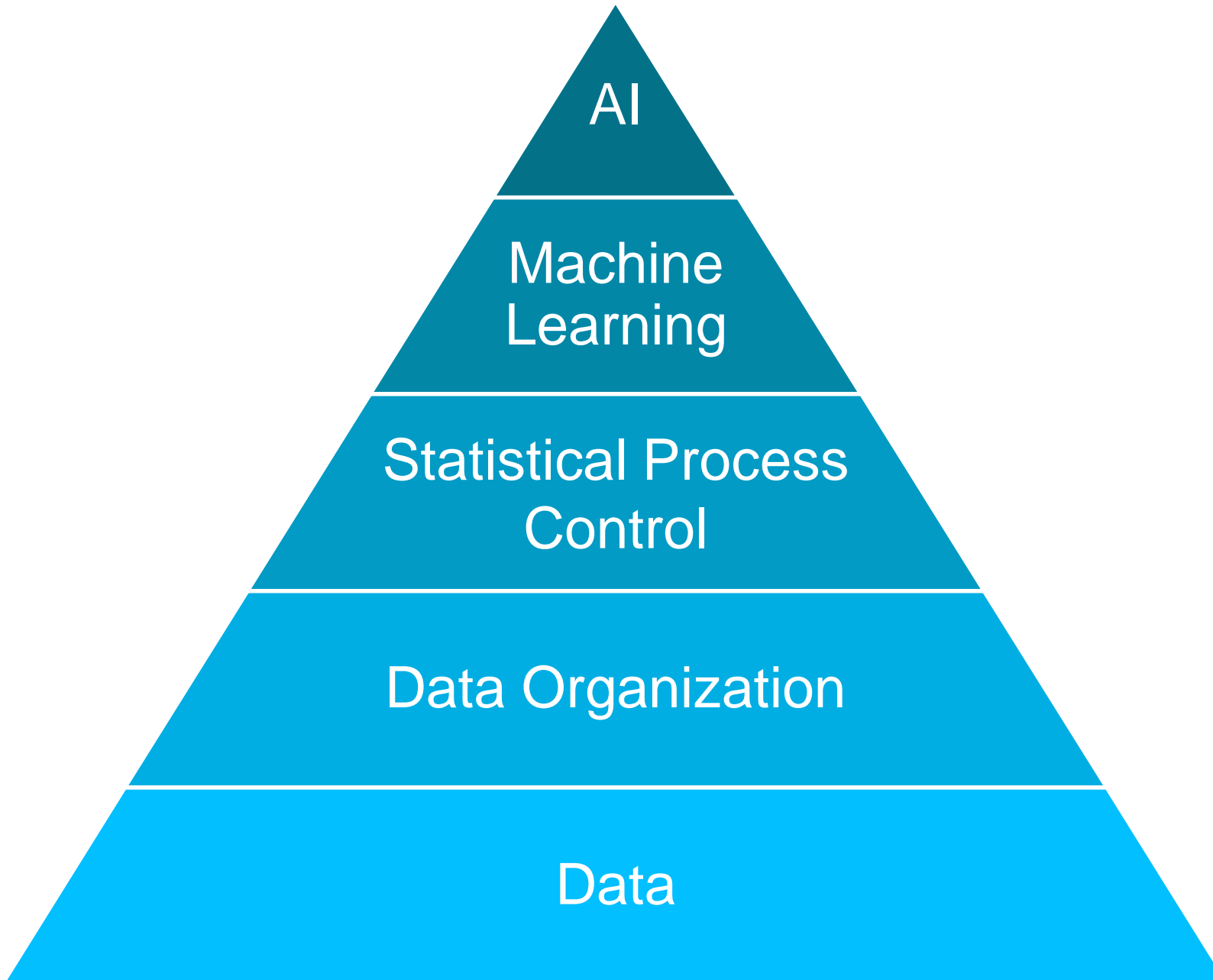
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1/8/20 12:07 PM	10001	2	x	200	x	x	x	x	x	x	x	x
1/8/20 12:12 PM	10001	3	x	x	5000	x	x	x	x	x	x	x
1/8/20 12:19 PM	10001	3	x	x	x	315	x	x	x	x	x	x
1/8/20 2:20 PM	10001	5	x	x	x	x	120	x	x	x	x	x
1/8/20 2:56 PM	10001	5	x	x	x	x	x	600	x	x	x	x
1/8/20 3:06 PM	10001	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

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		



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


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	1980	45	70	119	124	81	161.91	7147	6095.9	2.4	10440.04



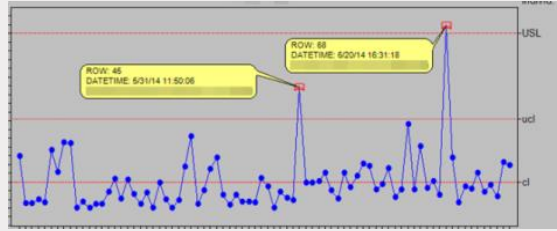
## Statistical Process Control

- SPC
- Eliminating Noise
- Focus on What Matters

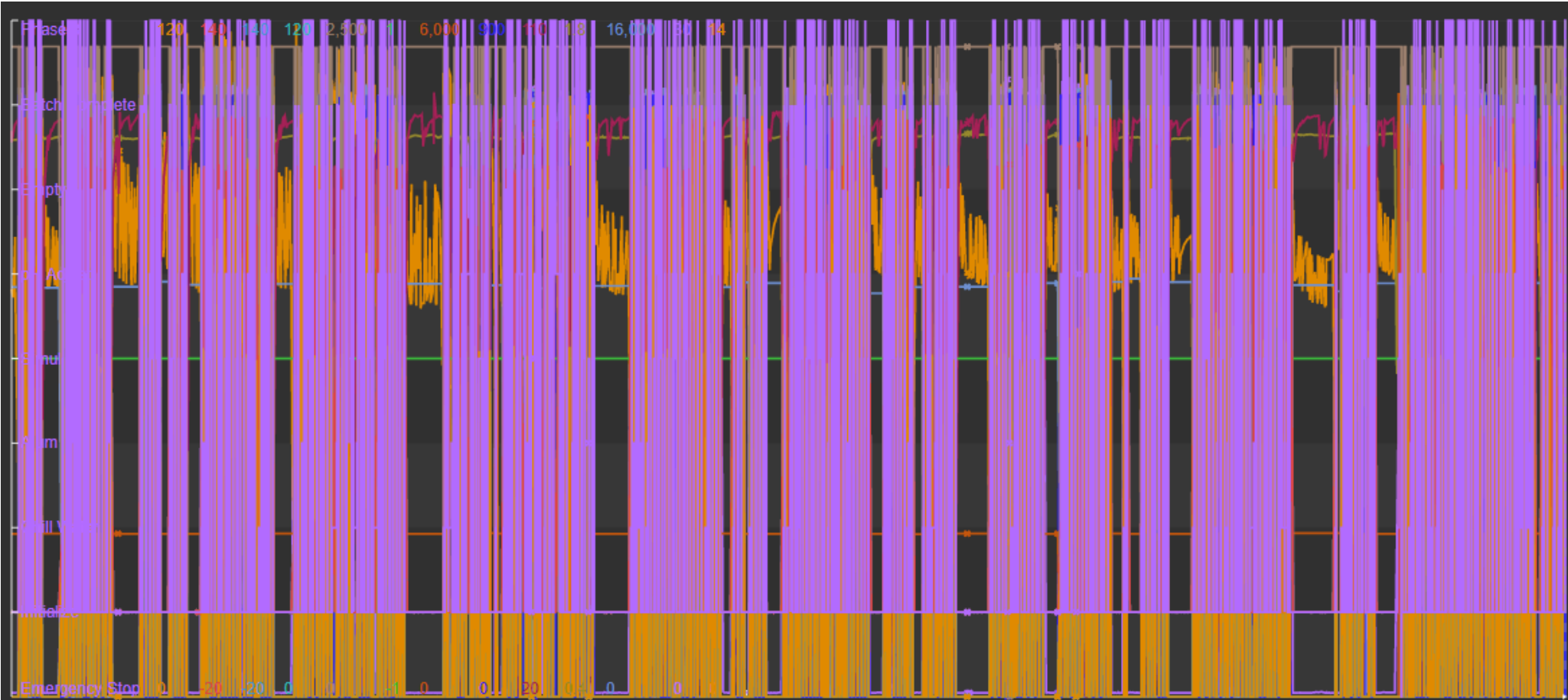
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NORTHWEST ANALYTICS

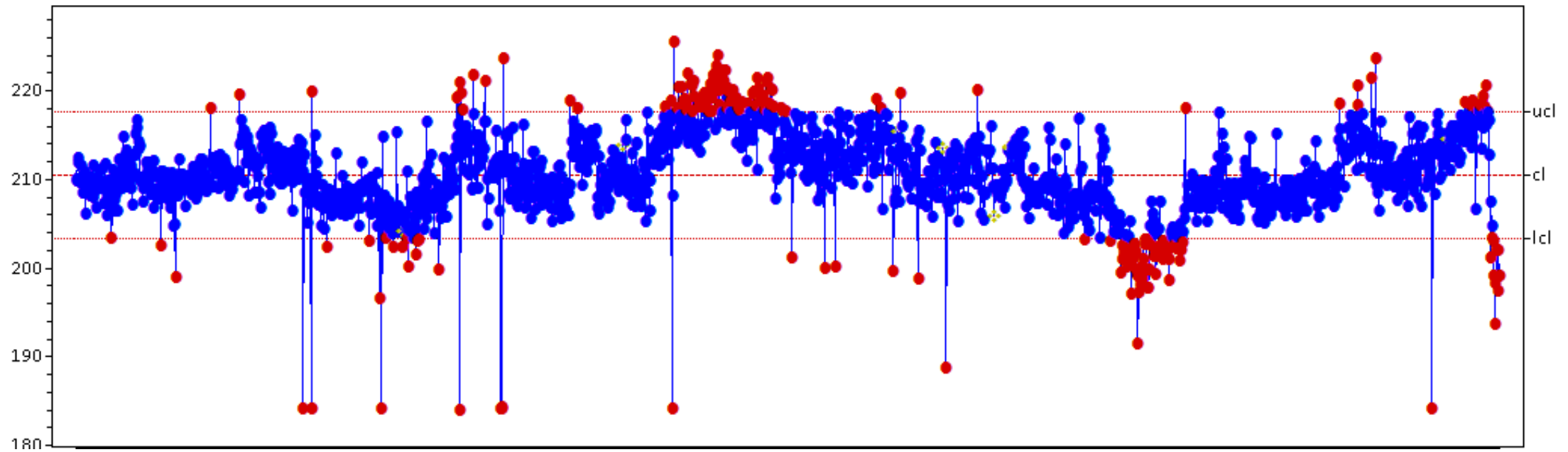


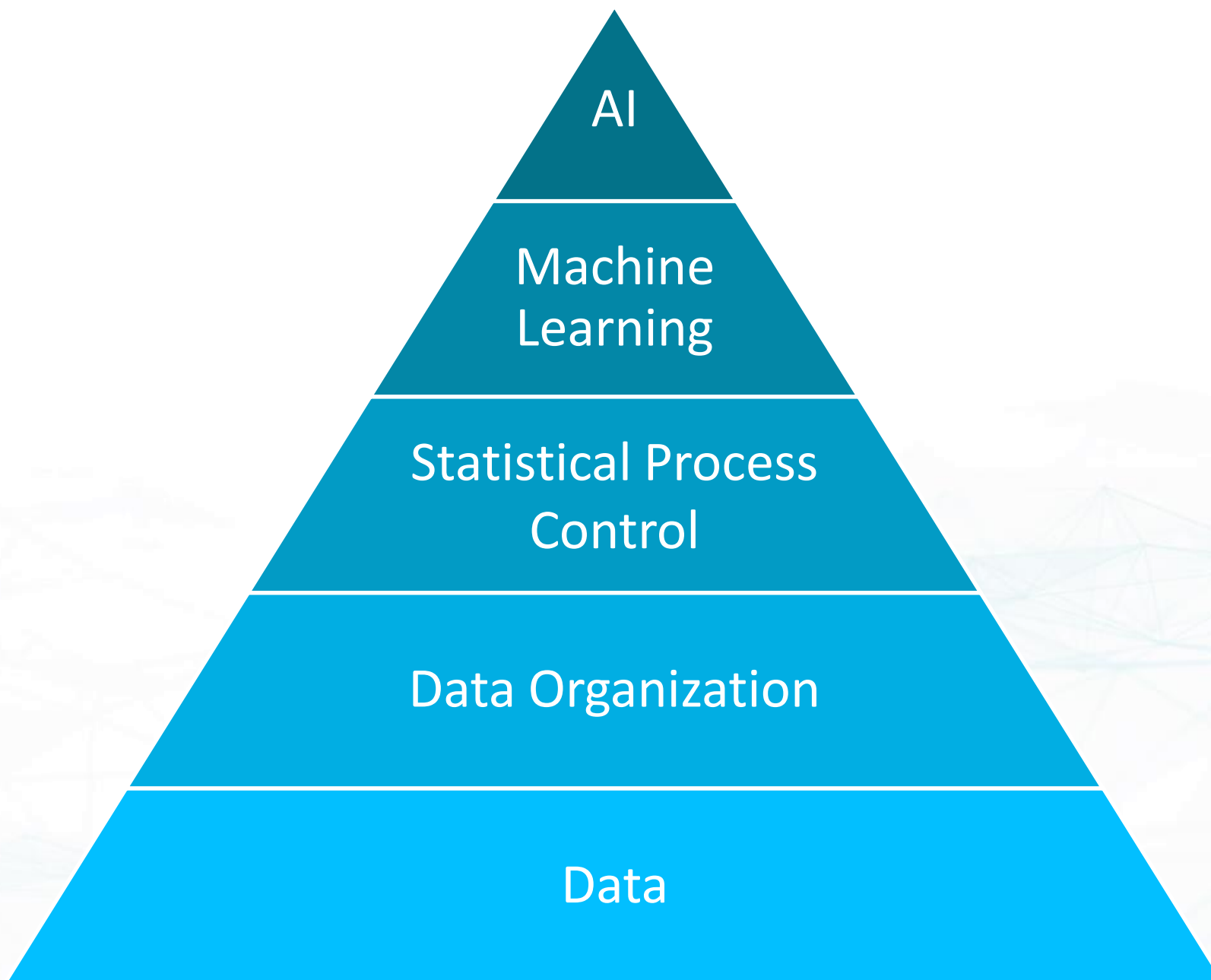
# 3 Month PI Vision Trend – No Event Frames





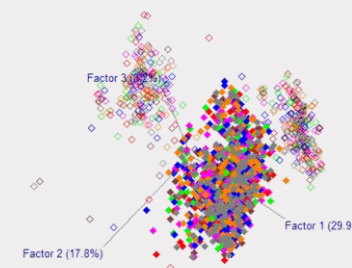
# 3 Month Statistical Analysis – w/ Event Frames



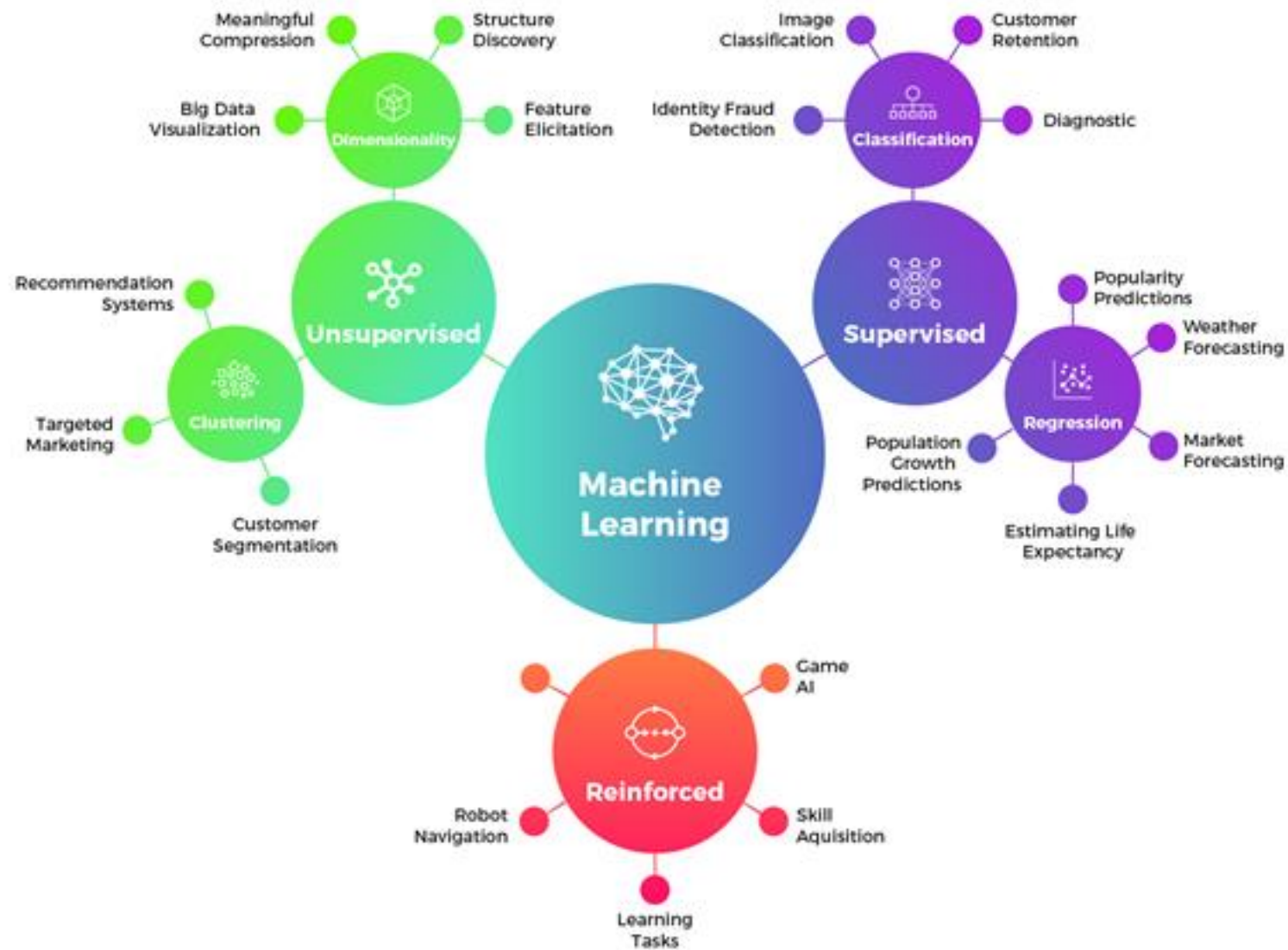


## Machine Learning

- Multi-dimensional Models
- Discovering Unknown Correlations
- “Signals Between the Signals”



# DIFFERENT TYPES OF MACHINE LEARNING

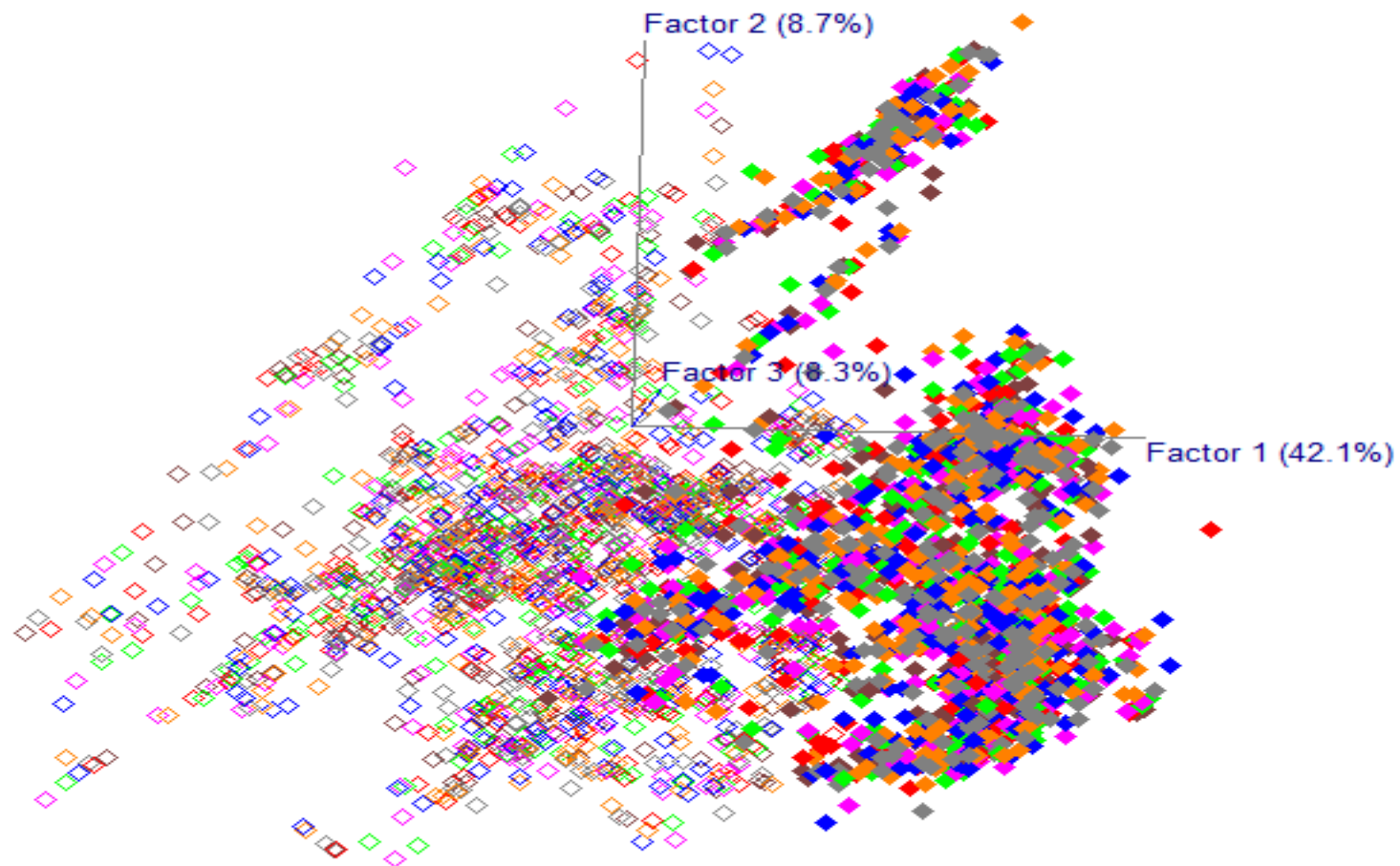


# Real Time Machine Learning - Pilot

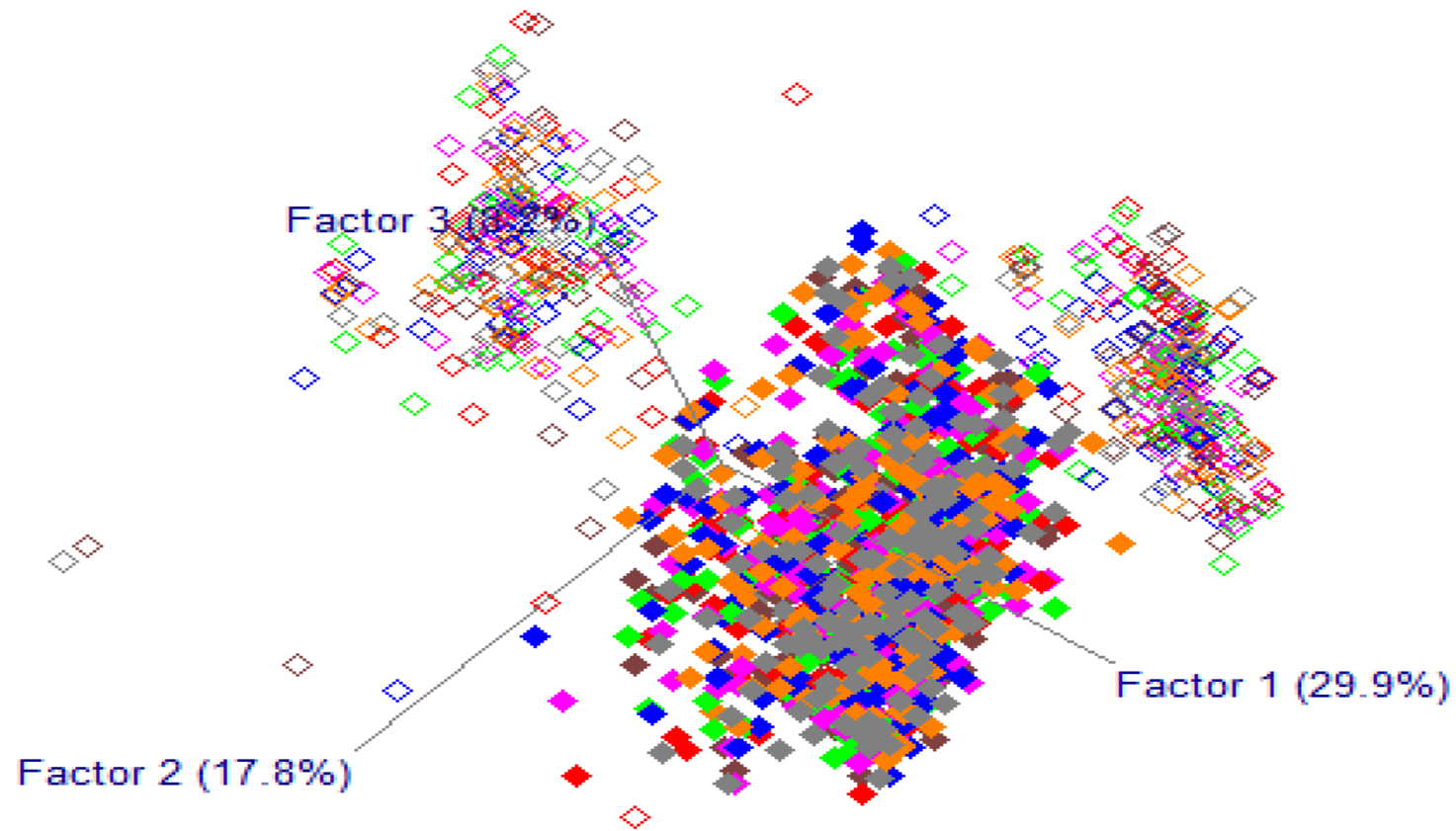
1/1/2017 10:04 AM	315.24	69.08	66.76	315.23	314.94	69.49	67.85	0.39	69.09	68.3	14.45	-2.7	106.9	69.94	70.16	0.97	70.64	35.17	71.26	0.09	77.47	115.23
1/1/2017 2:04 PM	315.25	72.77	70.46	315.25	314.93	74.69	71.41	0.27	74.35	72.18	13.96	-2.7	106.9	72.1	73.81	1.05	74.27	35.2	78.68	-0.01	74.53	116.77
1/1/2017 6:04 PM	315.25	70.06	70.28	315.22	314.94	70.74	69.55	0.26	71.43	71.16	14.52	-2.69	106.9	73.63	72.43	1.19	71.67	34.9	73.95	-0.01	72.45	117.75
1/1/2017 10:04 PM	315.25	69.33	69	315.22	314.94	69.5	68.74	0.26	69.91	69.9	14.62	-2.69	106.9	73.46	71.64	1.14	70.72	34.99	71.69	-0.01	70.91	117.6
1/2/2017 2:04 AM	315.25	71.28	70	315.23	314.94	71.85	70.42	0.26	71.83	71.04	14.13	-2.7	106.9	73.83	73.59	1.14	72.62	35.24	73.16	-0.01	71.82	117.74
1/2/2017 6:04 AM	315.24	70.32	70.77	315.24	314.94	71.88	70.17	0.27	72.57	71.39	9.87	-2.7	106.9	74.96	73.33	1.27	73.7	35.25	72.12	-0.01	71.68	117.79
1/2/2017 10:04 AM	315.25	67.37	66.53	315.23	314.94	66.61	66.41	0.31	66.8	67.86	9.73	-2.7	106.9	73.05	68.16	1.1	71.07	35.11	65.79	-0.02	67.94	110.86
1/2/2017 2:04 PM	315.24	72.6	70.46	315.25	314.93	76.51	71.88	0.29	74.32	73.39	8.46	-2.7	106.9	73.1	73.35	1.01	74.33	35.43	76.99	-0.02	71.21	111.07
1/2/2017 6:04 PM	315.25	69.46	70.5	315.22	314.94	71.2	69.44	0.29	71.71	72.5	9.29	-2.69	106.9	73.65	71.14	1.26	73.65	34.75	71.9	-0.03	71.06	113.04
1/2/2017 10:04 PM	315.26	65.35	66.98	315.22	314.95	65.69	65.58	0.31	66.52	68.17	9.78	-2.7	106.9	71.78	66.99	1.32	70.47	34.54	66.6	-0.03	68.65	113.66
1/3/2017 2:04 AM	315.27	62.47	64.01	315.23	314.95	62.36	62.83	0.28	63.09	64.9	10.04	-2.7	106.9	69.21	63.93	1.31	67.93	34.43	63.14	-0.04	66.31	113.21
1/3/2017 6:04 AM	315.27	62	62.14	315.22	314.95	61.52	61.89	0.31	61.67	63.14	10.15	-2.7	106.9	66.69	63.17	1.23	67.04	34.54	61.41	-0.04	64.67	112.25
1/3/2017 10:04 AM	315.25	70.95	67.62	315.24	314.93	71.36	69.2	0.4	70	69.55	9.12	-2.7	106.9	67.99	70.66	1.15	74.41	35.3	70.1	-0.04	68.28	112.48
1/3/2017 2:04 PM	315.25	75.14	73.68	315.25	314.92	78.27	74.4	0.33	76.77	75.55	8.33	-2.7	106.9	72.13	74.7	1.19	76.48	35.29	78.88	-0.04	72.77	114.21
1/3/2017 6:04 PM	315.25	68.58	70.93	315.22	314.94	69.79	69.15	0.37	71	71.67	9.25	-2.7	106.9	73.51	70.12	1.39	73.23	34.95	70.35	-0.04	71.37	115.07
1/3/2017 10:04 PM	315.26	57.85	61.3	315.24	314.97	57.19	59.39	0.4	58.75	61.35	10.42	-2.7	106.9	68.05	59.9	1.33	66.71	34.53	56.77	-0.04	64.45	112.55
1/4/2017 2:04 AM	315.26	51.47	53.69	315.25	314.97	50.35	53.03	0.36	51.17	54.14	10.95	-2.69	106.9	60.35	53.53	1.36	60.46	34.21	49.4	-0.05	57.85	108.46
1/4/2017 6:04 AM	315.27	49.93	50.67	315.25	314.97	48.83	51.13	0.38	48.88	51.35	10.95	-2.7	106.9	55.26	51.69	1.33	57.79	34.21	48.02	-0.05	54.56	105.98
1/4/2017 10:04 AM	315.26	53.9	52.12	315.25	314.97	53.32	54.13	0.47	52.38	53.57	10.33	-2.7	106.9	54.44	53.63	1.22	57.33	34.64	54.27	-0.04	54.88	163.93
1/4/2017 2:04 PM	315.28	56.45	55.54	315.24	314.97	56.86	56.93	0.42	56.4	56.76	10.04	-2.7	106.9	55.53	56	1.22	57.61	34.53	61.01	38.56	76.77	164.79
1/4/2017 6:04 PM	315.25	54.87	55.61	315.25	314.97	54.84	55.93	0.36	54.99	56.19	10.46	-2.7	106.9	56.28	54.98	1.32	56.54	34.38	63.73	42.1	60.35	160.54
1/4/2017 10:04 PM	315.26	54.81	54.96	315.25	314.98	53.89	55.42	0.34	54.02	55.26	10.5	-2.7	106.9	44.29	51.12	55.12	56.64	34.8	70.11	42.1	61.62	143.16
1/5/2017 2:04 AM	315.26	54.79	55.03	315.25	314.97	54.26	55.51	0.26	54.39	55.22	10.45	-2.7	106.9	50.75	53.16	59.79	59.06	34.38	73.37	42.1	63.88	133.87
1/5/2017 6:04 AM	315.26	54.97	54.85	315.25	314.97	54.39	55.57	0.27	54.41	55.23	10.41	-2.7	106.9	53.09	54.14	67.51	58.01	34.43	67.03	42.1	65.01	127.69
1/5/2017 10:04 AM	315.28	57.05	56.07	315.23	314.97	56.81	57.23	0.29	56.54	56.7	10.04	-2.7	106.9	54.82	56.3	55.86	59.77	34.58	64.3	42.1	67.05	143.61
1/5/2017 2:04 PM	315.28	57.92	57.29	315.23	314.96	57.82	58.15	0.26	57.77	57.86	10.02	-2.7	106.9	56.6	57.36	58.41	60.58	34.58	64.85	42.1	68.6	172.81
1/5/2017 6:04 PM	315.27	56.52	57.27	315.24	314.97	56.61	57.38	0.28	57.13	57.39	10.16	-2.7	106.9	57.6	56.82	90.51	58.26	34.45	65.85	42.1	68.63	172.95
1/5/2017 10:04 PM	315.27	50.64	52.8	315.25	314.96	49.42	52.31	0.3	50.53	52.47	10.77	-2.7	106.9	56.48	51.4	99.51	53.88	34.18	66.86	42.1	65.68	172.72
1/6/2017 2:04 AM	315.28	47.71	49.27	315.25	314.96	46.63	49.48	0.3	47.23	49.15	10.94	-2.7	106.9	54.22	48.6	99.6	52.5	34.11	67.14	42.1	63.32	153.74
1/6/2017 6:04 AM	315.3	42.89	45	315.25	314.96	41.43	45.17	0.35	42.14	44.63	11.37	-2.7	106.9	51.84	44.28	99.59	49.49	33.88	65.34	42.1	60.28	145.31
1/6/2017 10:04 AM	315.31	41.29	42.46	315.25	314.97	39.8	43.46	0.39	40.01	42.22	11.58	-2.7	106.9	48.95	42.15	99.61	47.27	33.8	63.83	42.1	57.42	153.45
1/6/2017 2:04 PM	315.31	39.53	40.49	315.25	314.97	37.94	41.62	0.41	38.04	40	11.77	-2.7	106.9	46.55	40.18	99.76	46.34	33.6	61.47	42.1	54.86	155.64
1/6/2017 6:04 PM	315.31	38.47	39.39	315.25	314.98	36.99	40.68	0.48	37.05	38.71	11.79	-2.7	106.9	44.57	38.75	99.76	44.82	33.52	60	42.1	53.58	160.37
1/6/2017 10:04 PM	315.31	34.85	36.54	315.27	314.97	32.96	37.53	0.51	33.27	35.32	12.25	-2.7	106.9	42.38	35.34	99.81	41.85	33.3	57.76	42.1	51.39	168.53
1/7/2017 2:04 AM	315.31	32.71	33.84	315.29	314.98	30.46	35.46	0.56	30.51	32.73	12.35	-2.7	106.9	39.85	33.02	99.79	39.43	33.29	56.22	42.1	48.94	177.24
1/7/2017 6:04 AM	315.31	31.44	32.43	315.31	314.99	28.69	34.26	0.59	28.76	30.88	12.47	-2.7	106.9	37.58	31.55	99.74	38.59	33.19	57.14	42.1	47.04	180.77
1/7/2017 10:04 AM	315.31	36.61	34.26	315.26	314.97	33.51	37.8	0.35	32.35	33.49	11.92	-2.7	106.9	36.58	34.6	96.58	41.64	33.82	56.31	42.1	45.92	181.27
1/7/2017 2:04 PM	315.3	44.16	41.53	315.25	314.96	45.75	45.6	0.72	42.67	42.33	10.52	-2.7	106.9	38.44	40.76	87.52	44.3	34.36	59.17	42.1	47.65	181.79



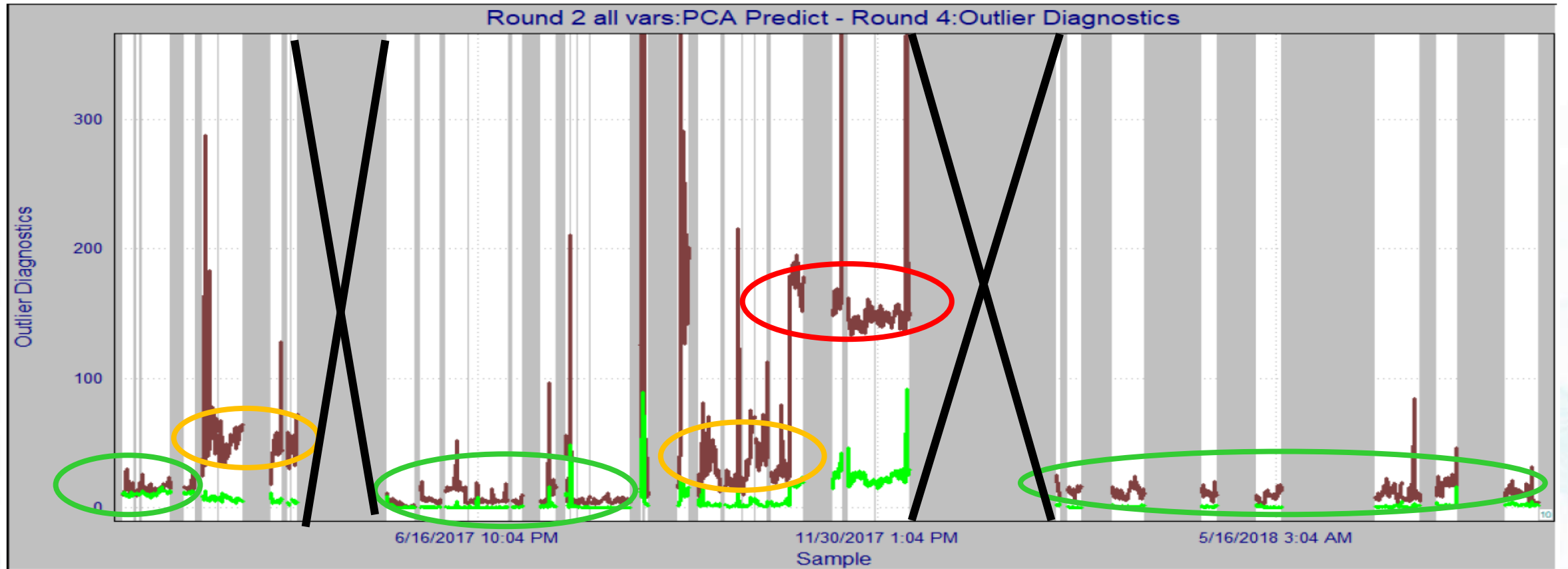
# Real Time Machine Learning - Pilot



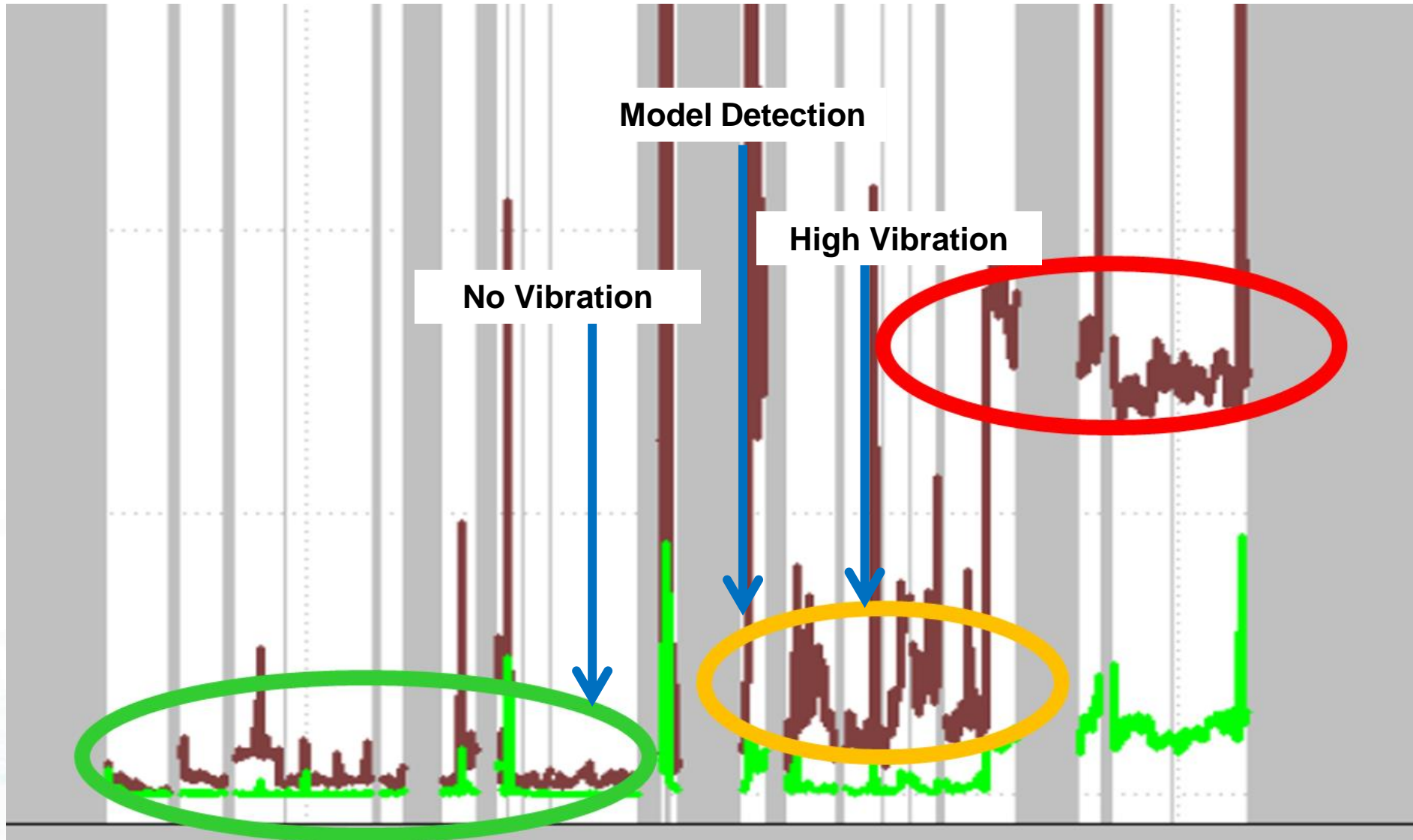
# Real Time Machine Learning - Pilot



# Real Time Machine Learning - Pilot



# Real Time Machine Learning - Pilot





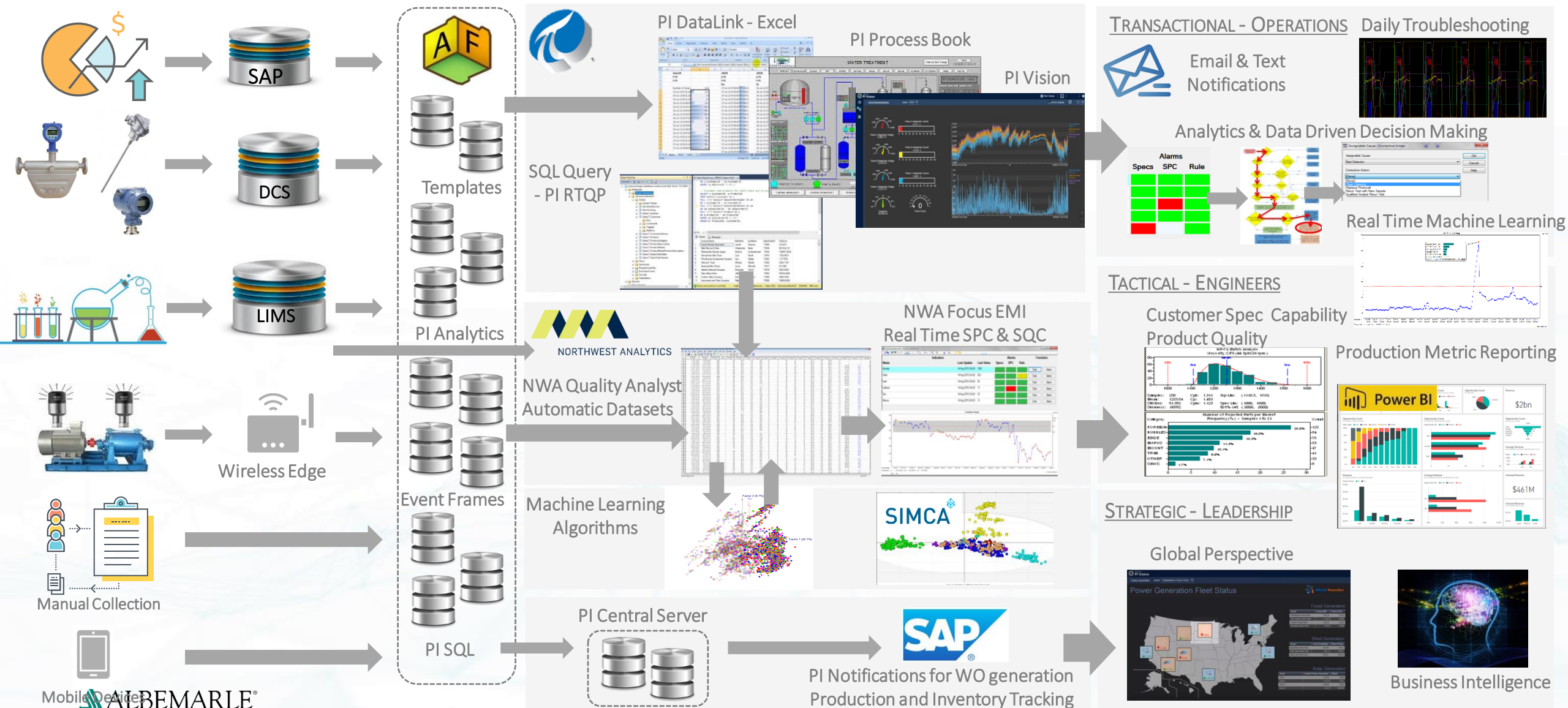
# Albemarle Intelligence - Infrastructure

## DATA SOURCES

## OSISOFT PI ASSET FRAMEWORK

## DATA ANALYTICS SUITE

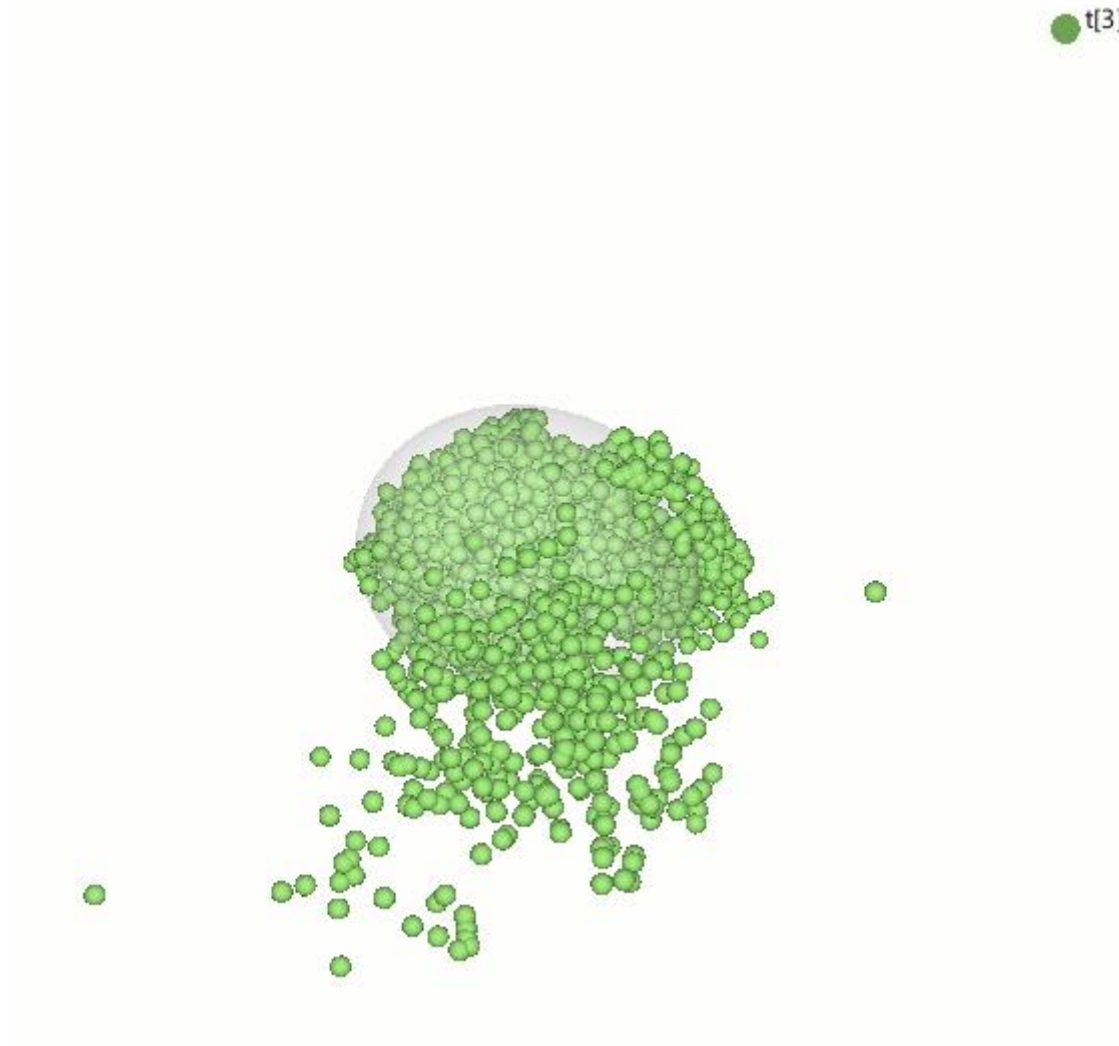
## USER ROLES



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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
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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
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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
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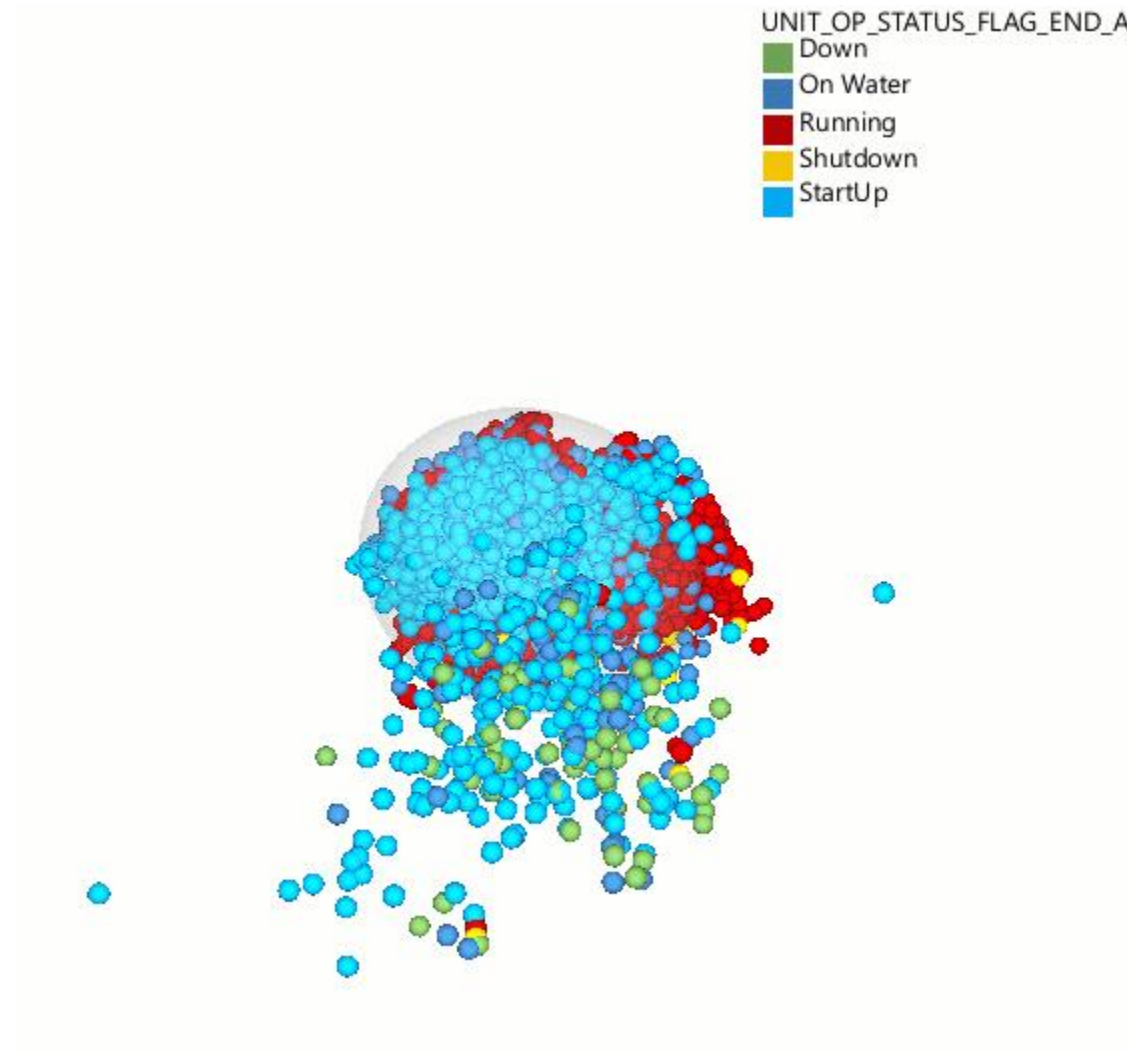
# Machine Learning Model

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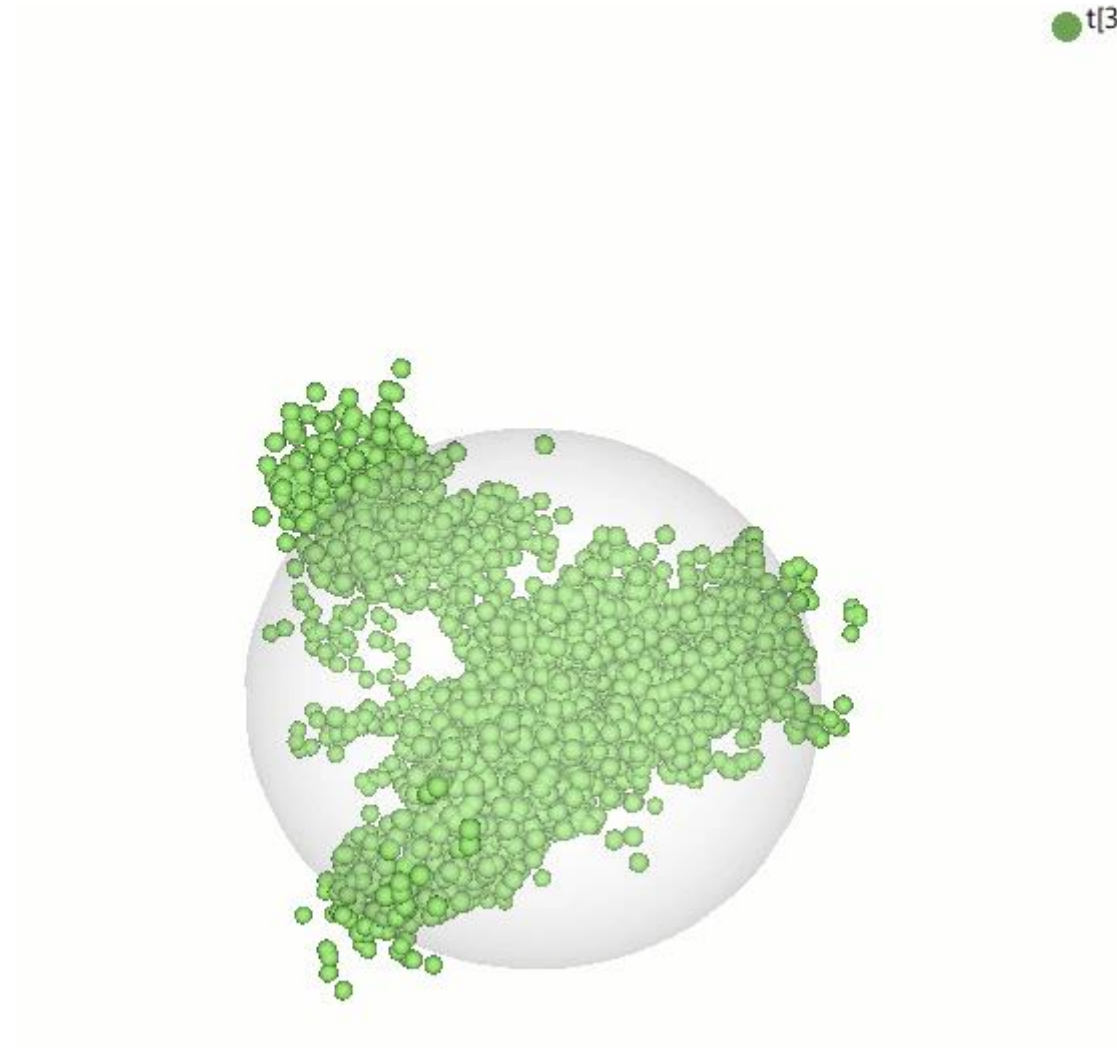
# Digital Workforce

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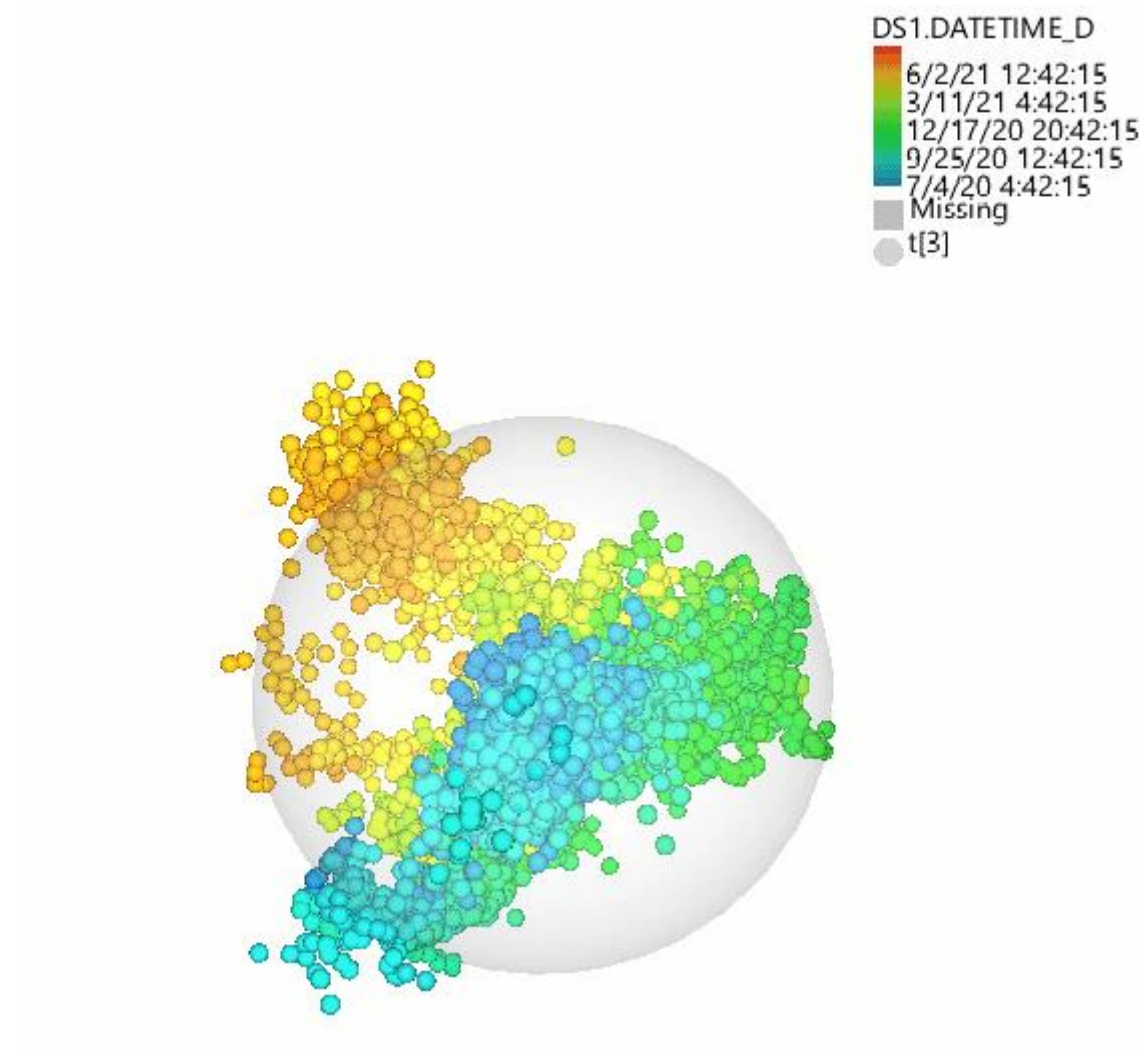
# Digital Workforce

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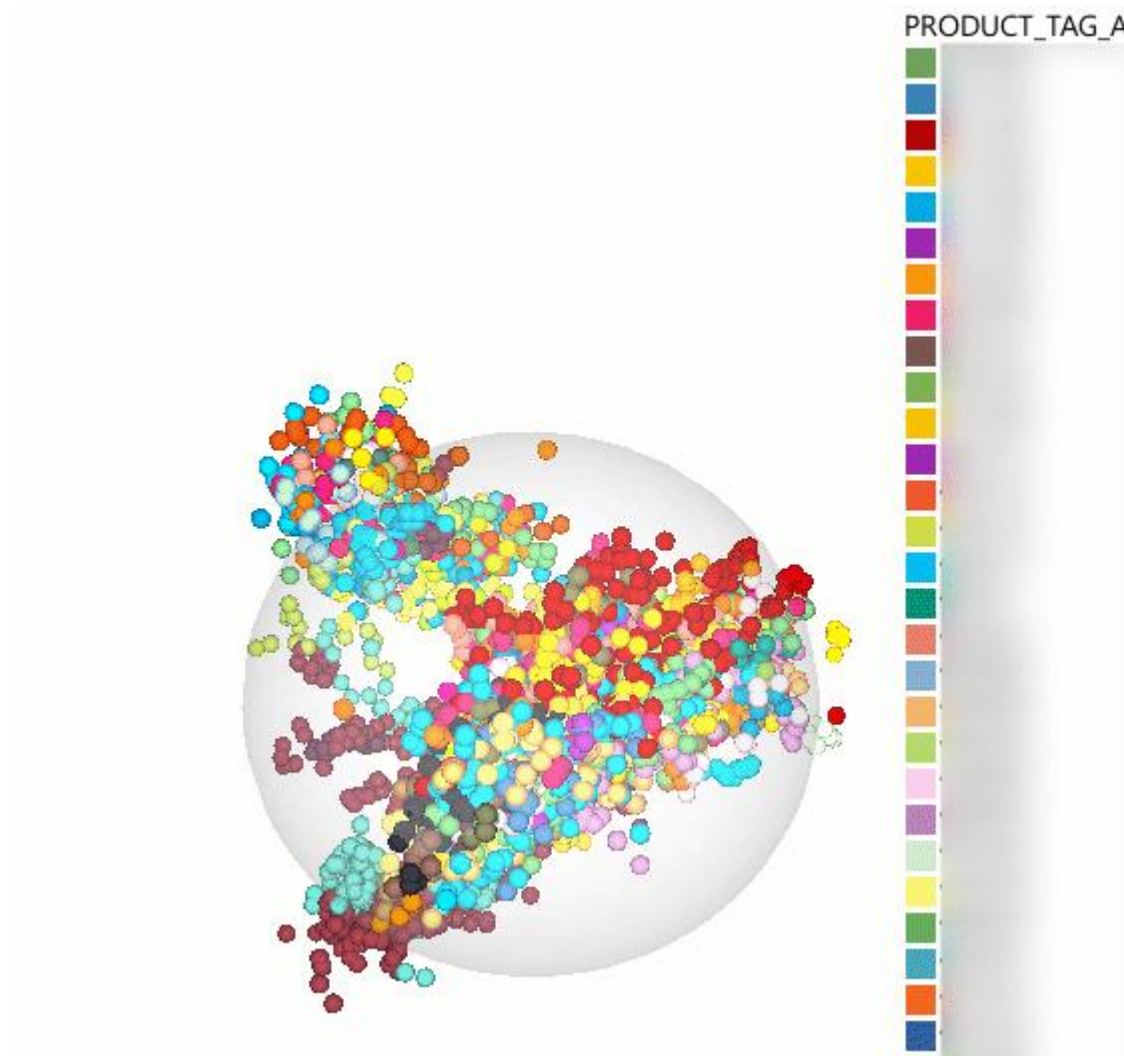


# Digital Workforce



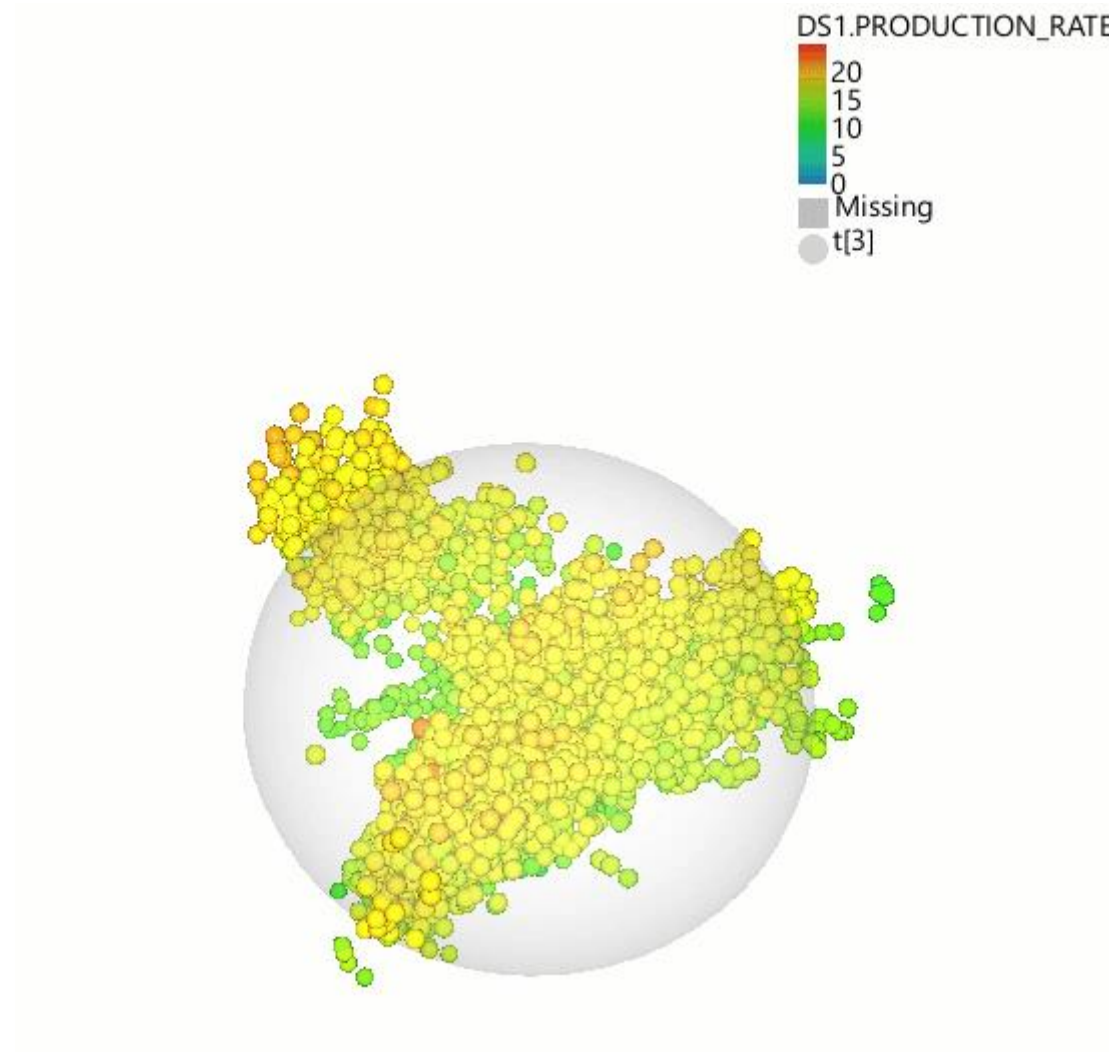
# Digital Workforce

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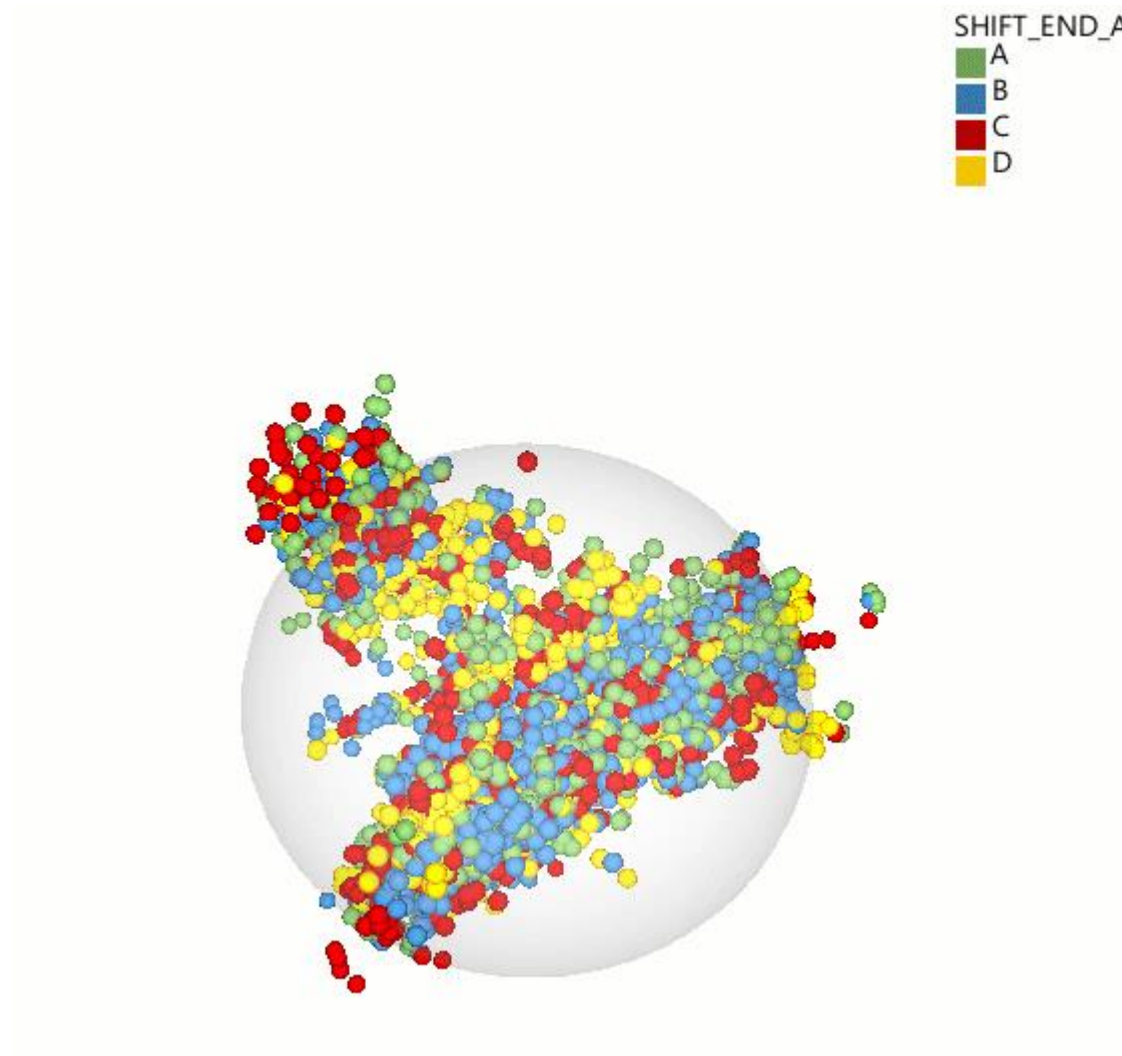
# Digital Workforce

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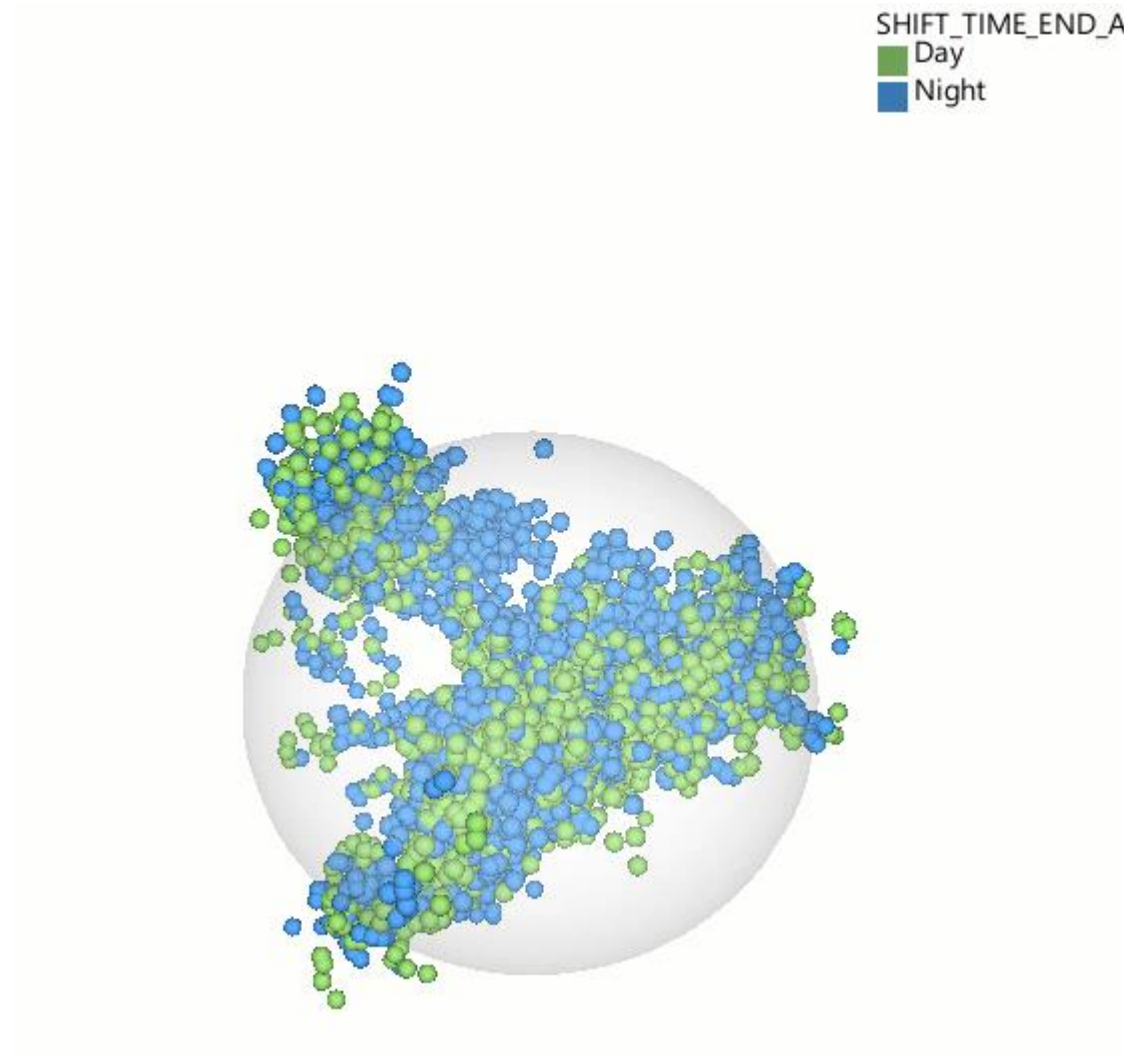
# Digital Workforce

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# Digital Workforce

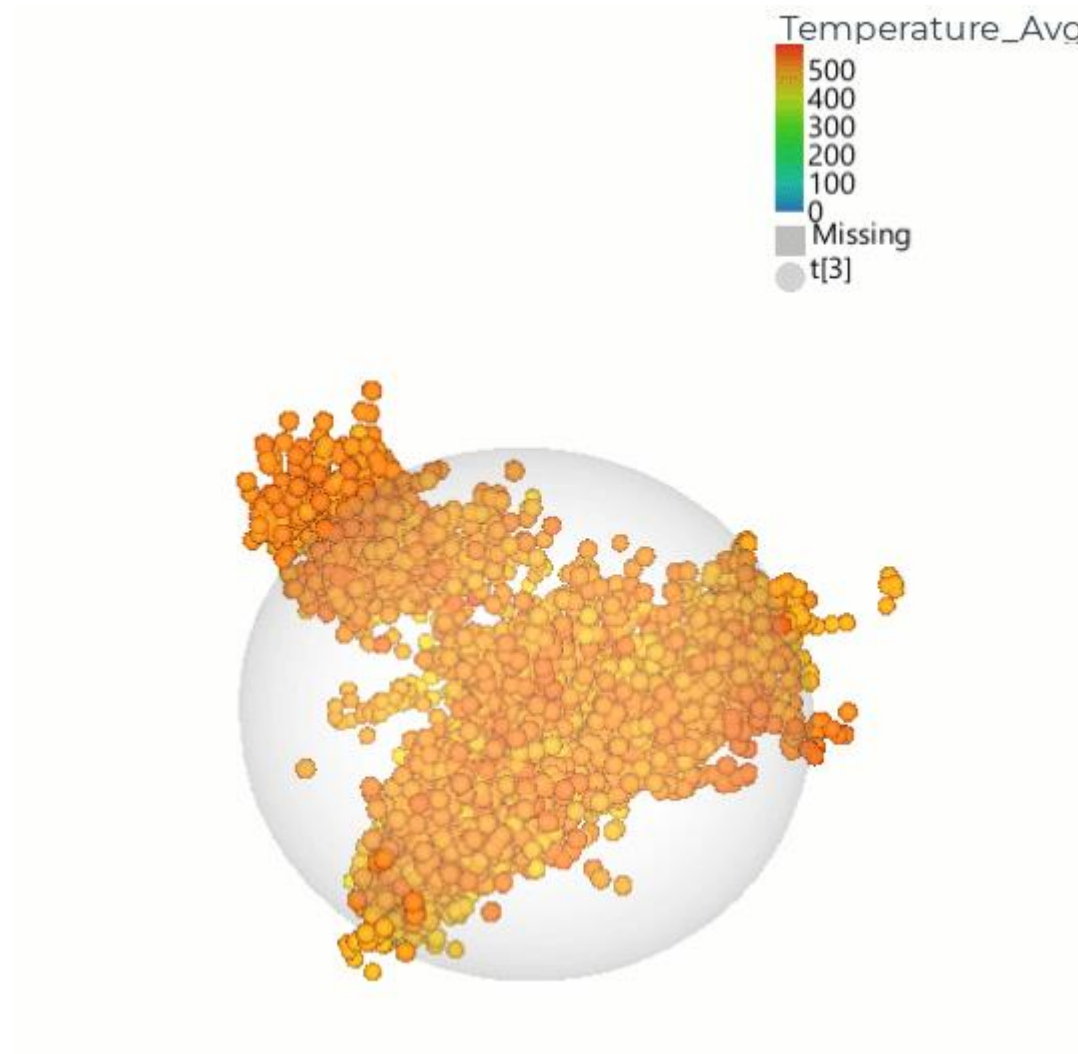
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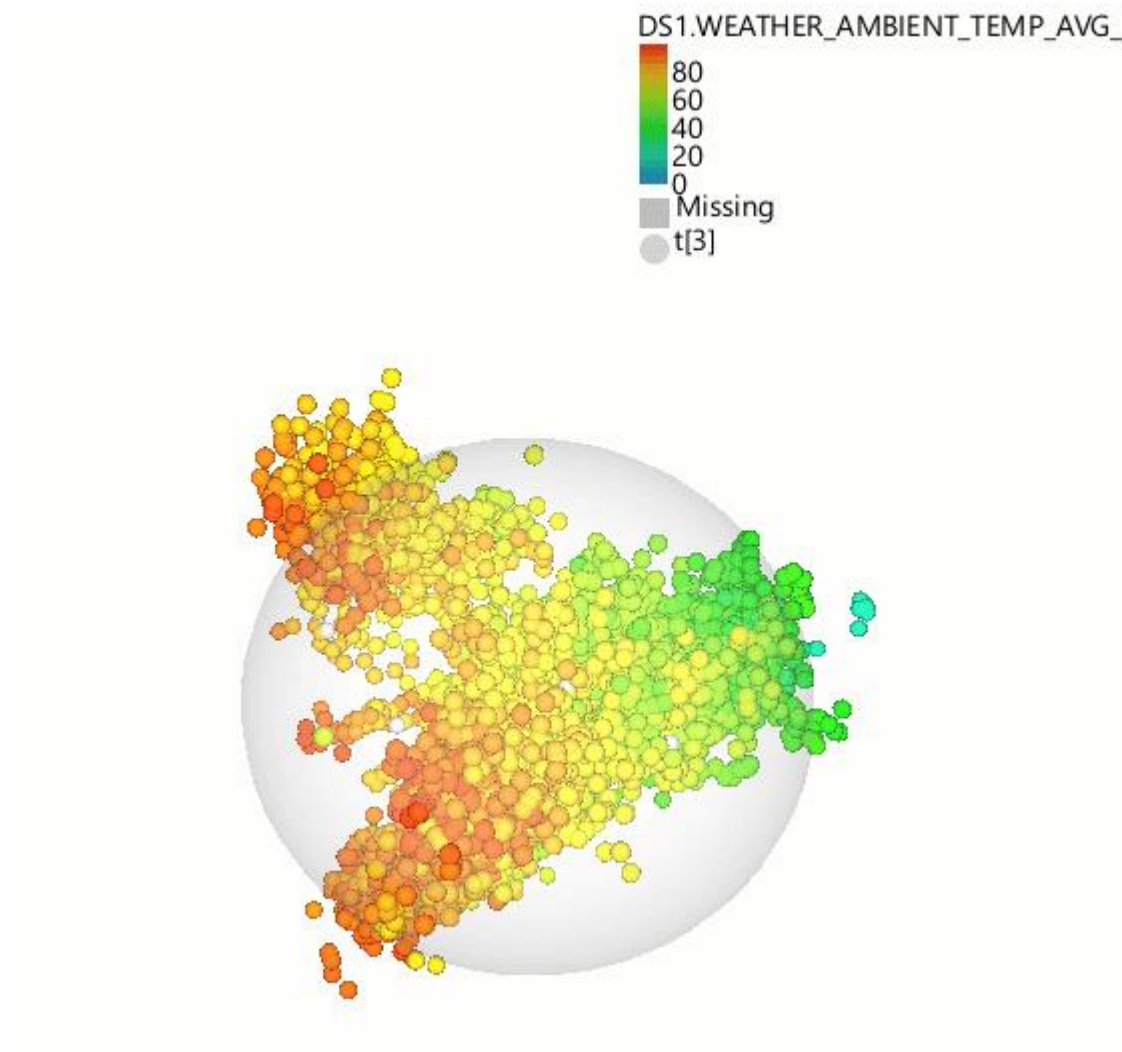
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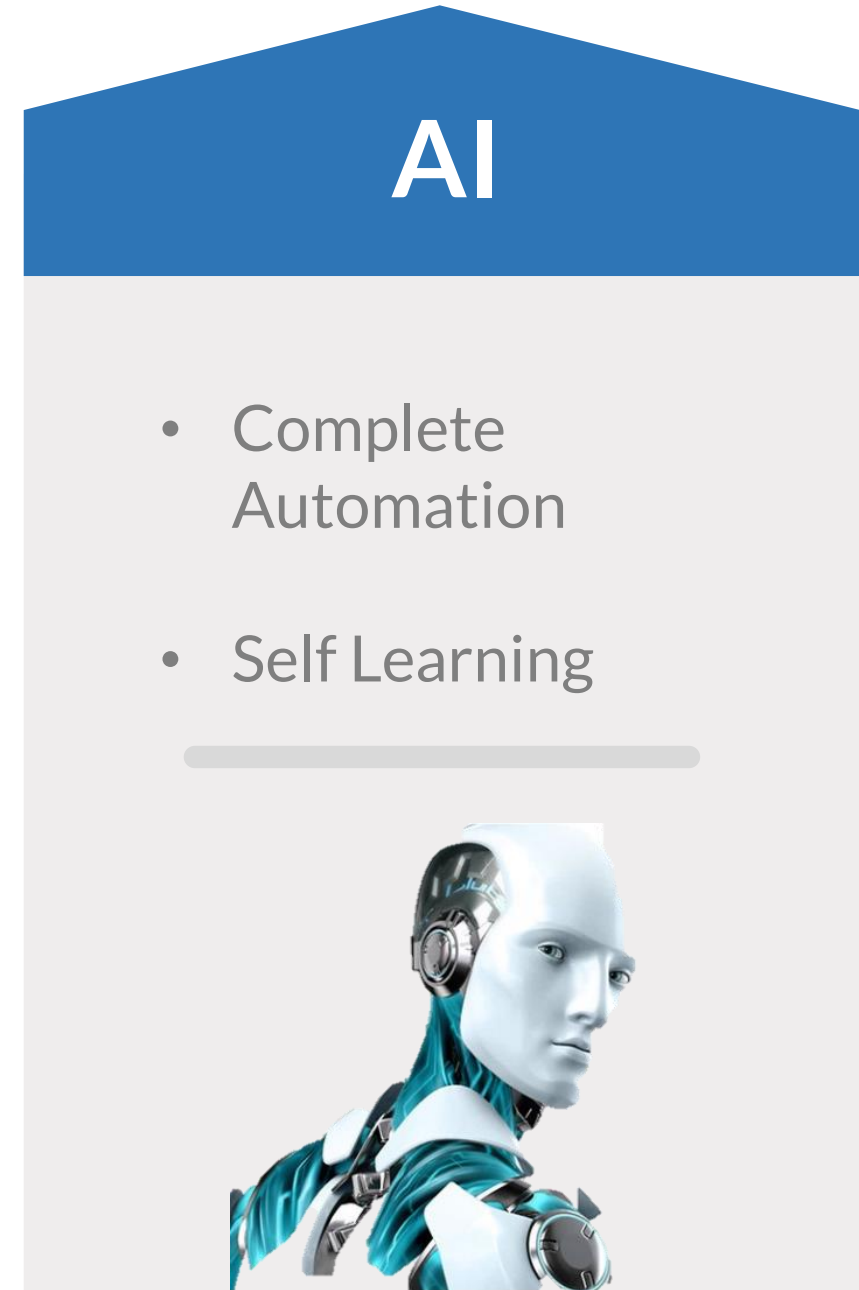
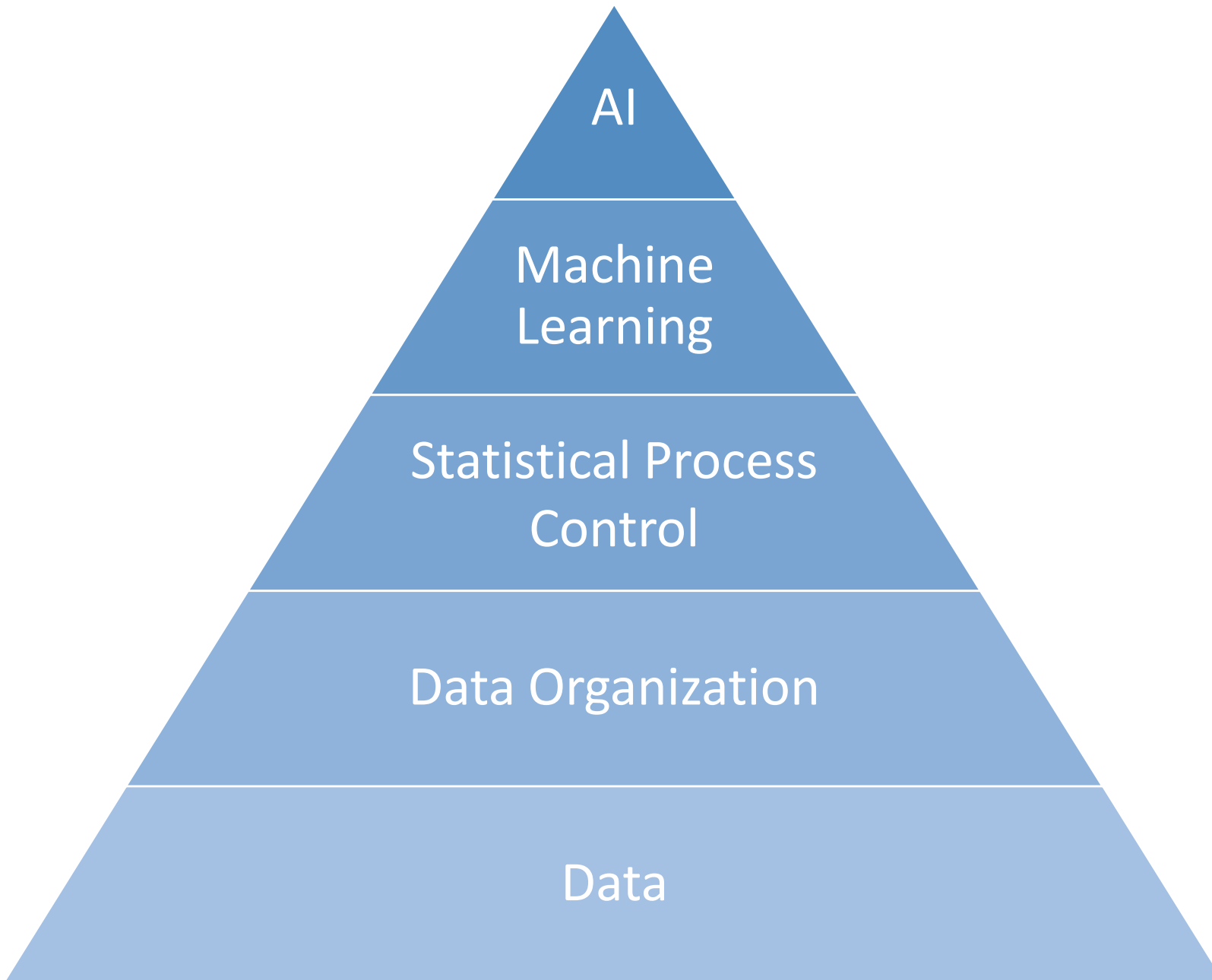
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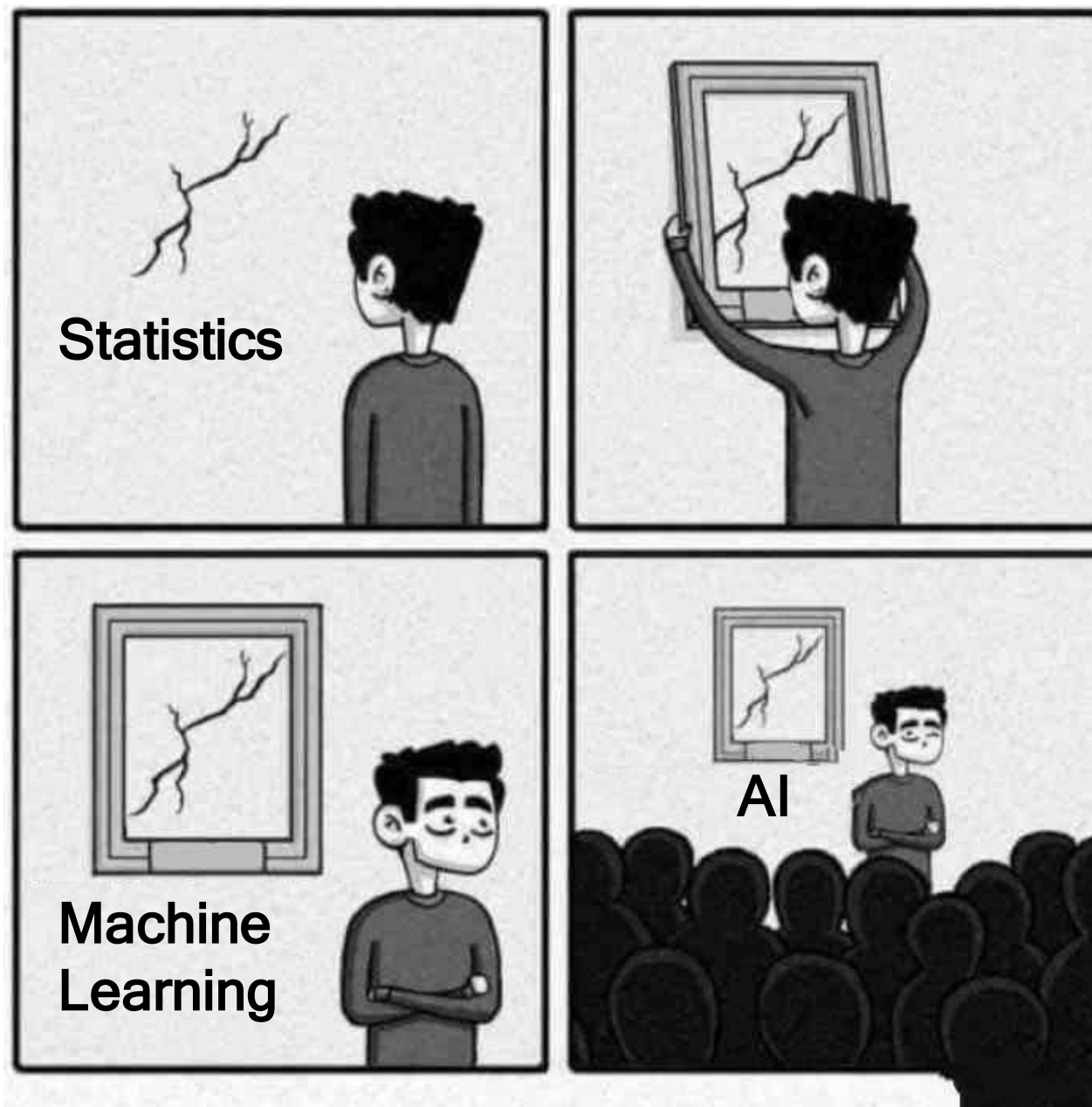


# Digital Workforce

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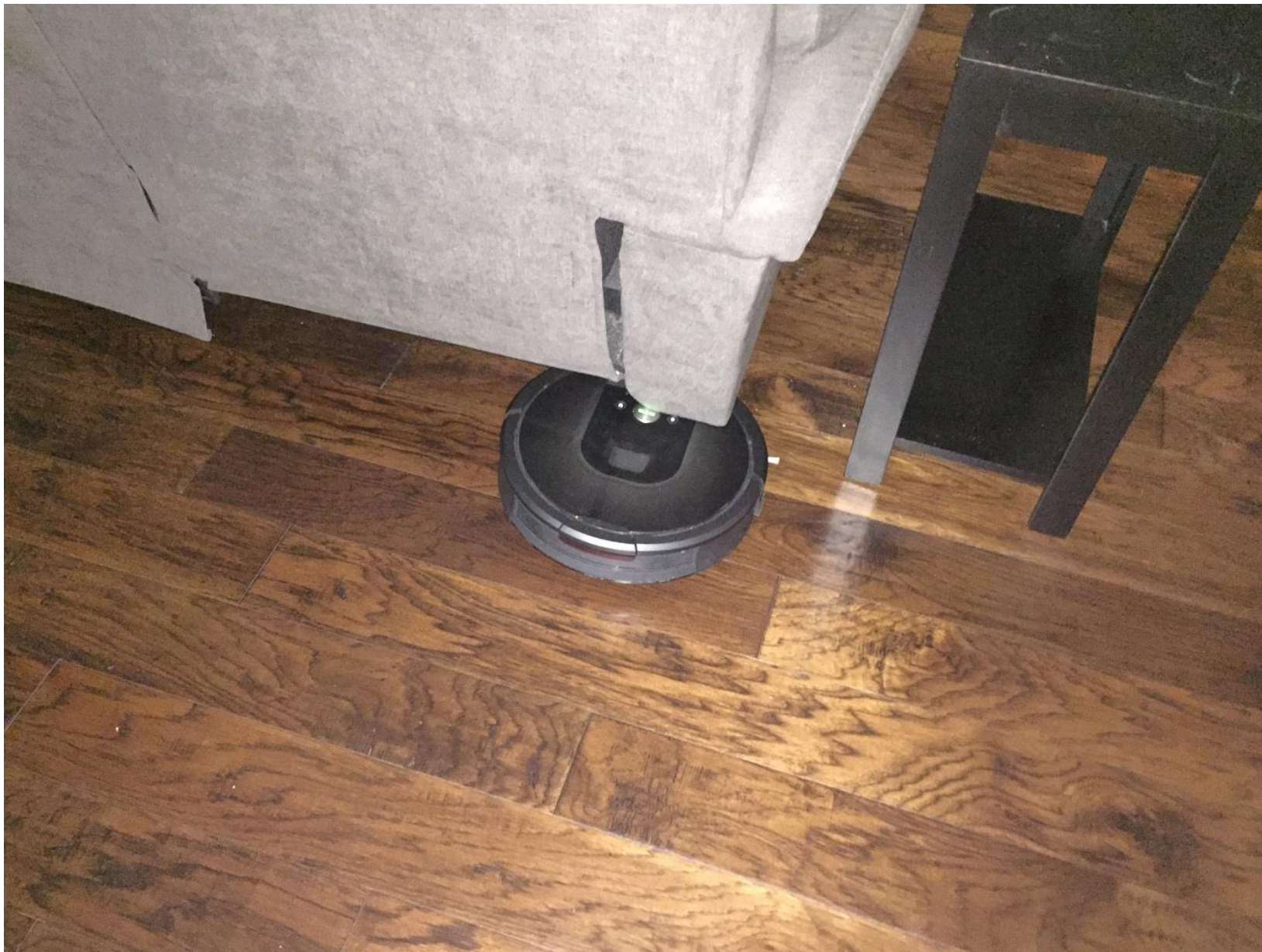








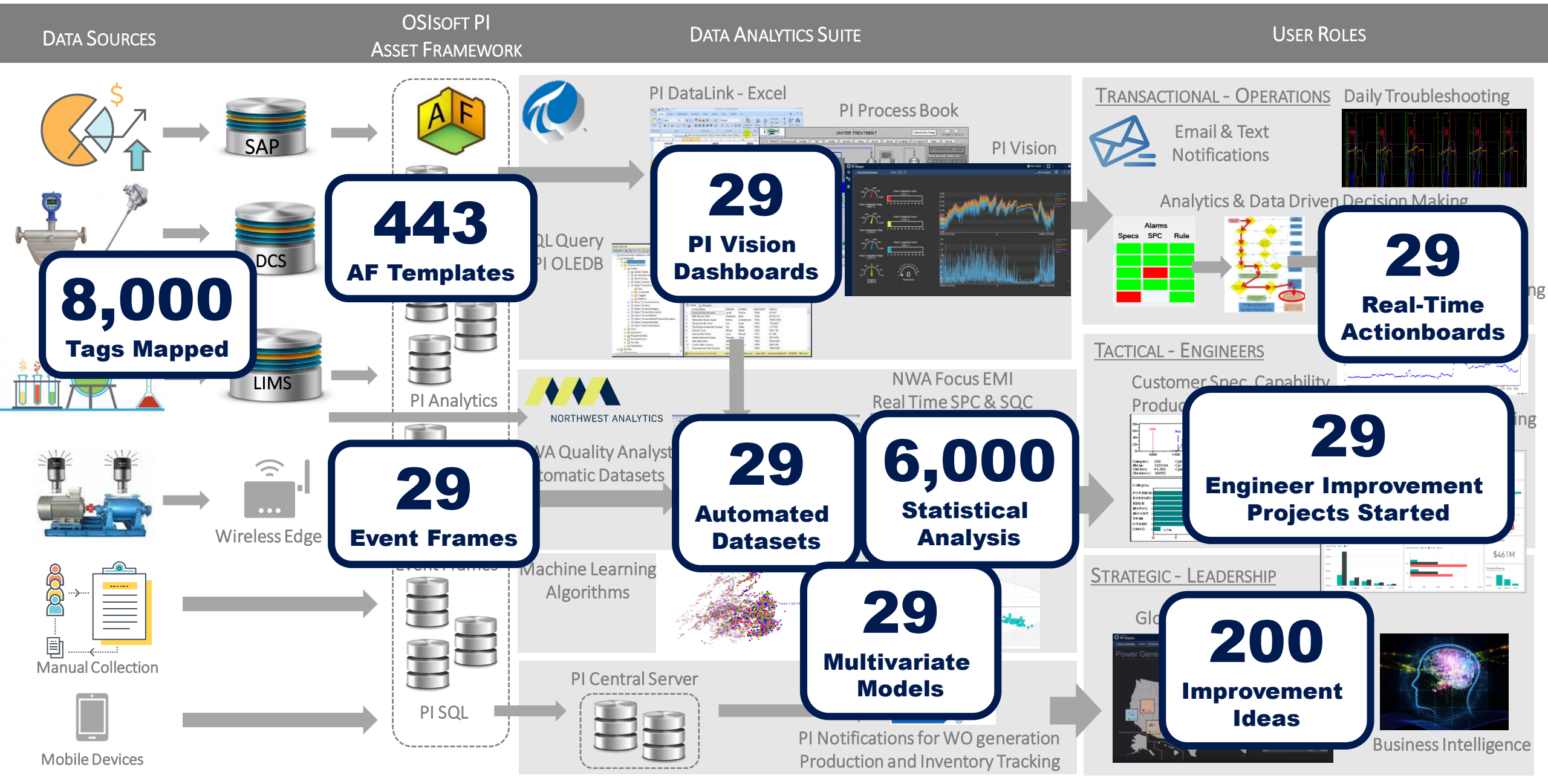






**ALBEMARLE PEOPLE,  
empowered by technology,  
unlocking the value of information.**

# Albemarle Intelligence - Infrastructure

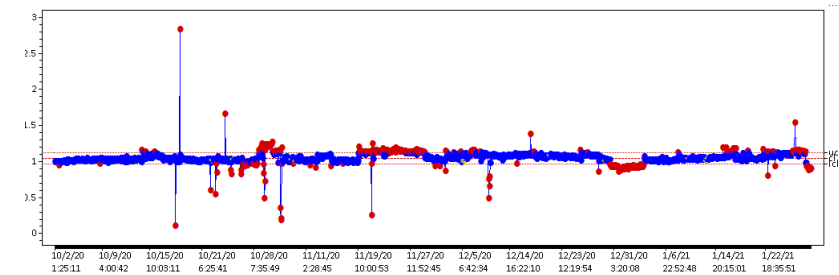
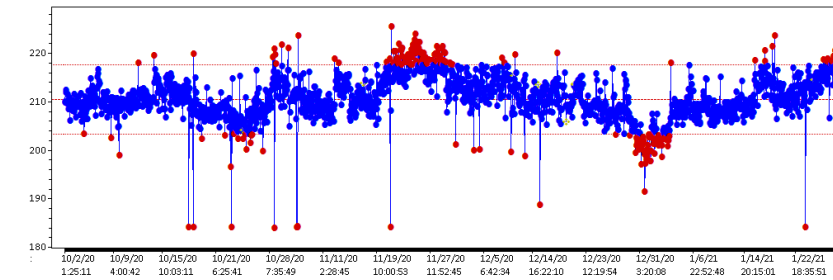
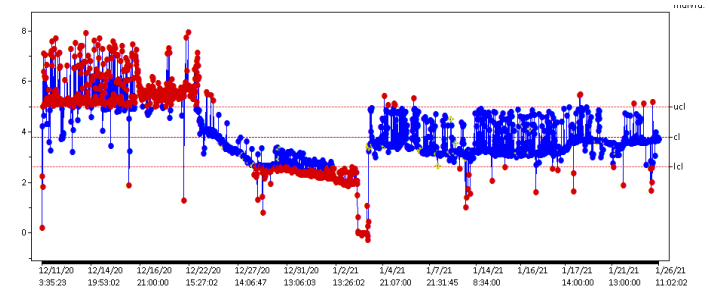
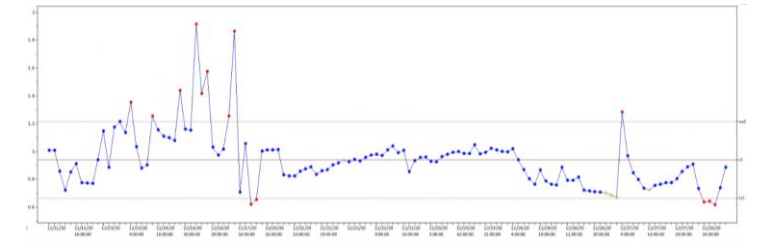
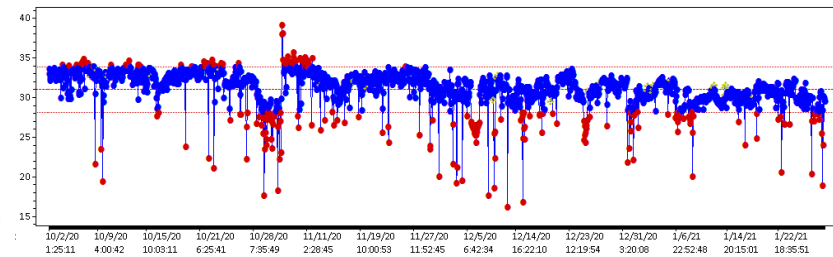
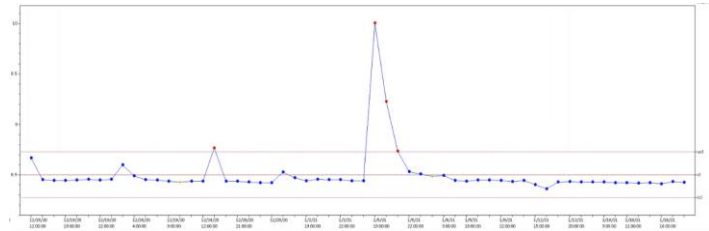
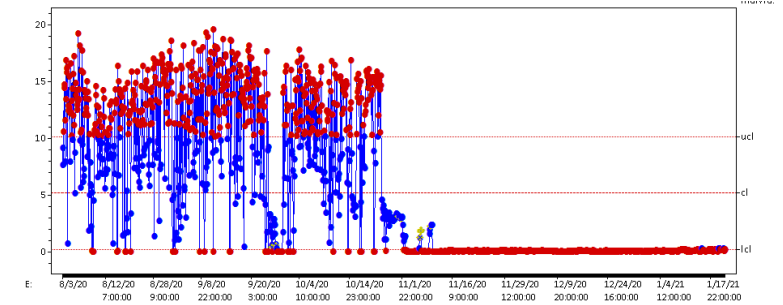
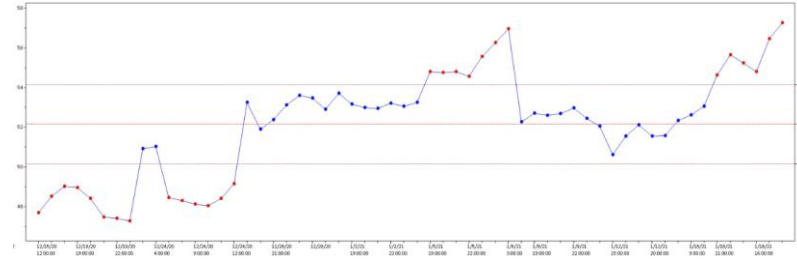
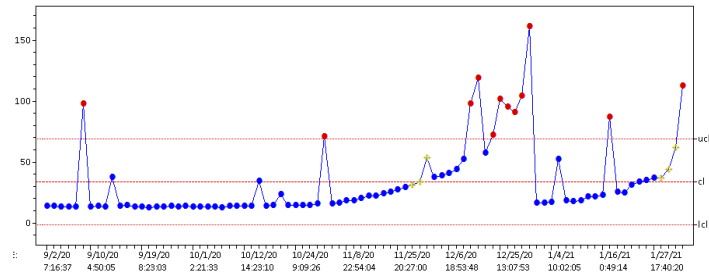


# Improvement Project List

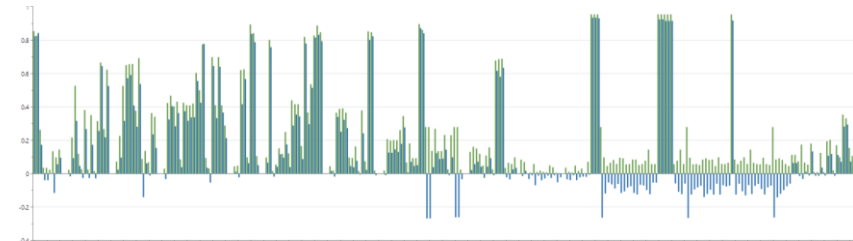
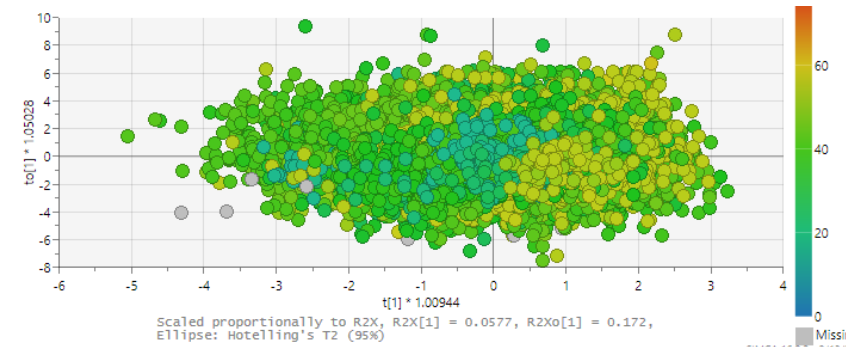
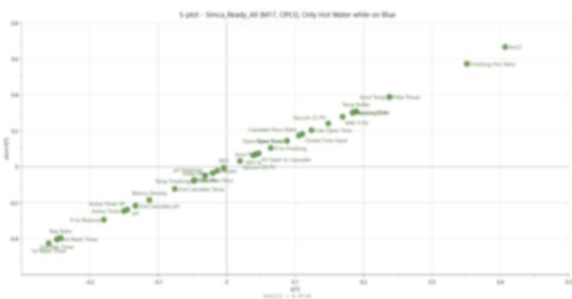
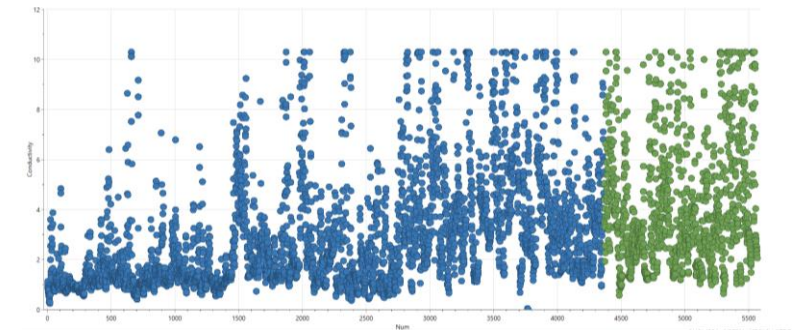
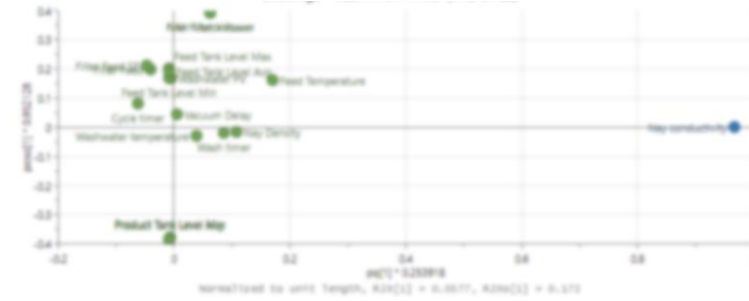
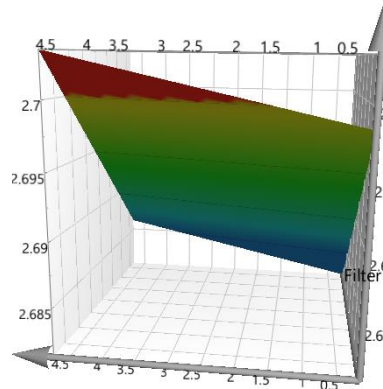
Manufacturing Engineer	Department	Unit Op	Entitlement
Mechanical Engineer	Maintenance - Mechanical	Continuous Unit Operation #1	\$126,000
Controls Engineer	DCS	Batch Unit Operation #2	In Progress
Chemical Engineer	Research & Technology	Continuous Unit Operation #3	\$100,000
Chemical Engineer	Research & Technology	Continuous Unit Operation #4	\$80,000
Chemical Engineer	Research & Technology	Batch Unit Operation #5	\$10,000
Chemical Engineer	Operations	Batch Unit Operation #6	\$50,000
Mechanical Engineer	Maintenance - Mechanical	Continuous Unit Operation #7	In Progress
Electrical Engineer	Maintenance - I&E	Continuous Unit Operation #8	In Progress
Mechanical Engineer	Maintenance - Mechanical	Batch Unit Operation #9	\$222,000
Controls Engineer	DCS	Batch Unit Operation #10	In Progress
Chemical Engineer	Operations	Continuous Unit Operation #11	\$450,000
Electrical Engineer	Maintenance - I&E	Batch Unit Operation #12	In Progress
Chemical Engineer	Research & Technology	Continuous Unit Operation #13	\$600,000
Chemical Engineer	Operations	Batch Unit Operation #14	\$18,000
Mechanical Engineer	Maintenance - Mechanical	Continuous Unit Operation #15	\$60,000
Electrical Engineer	Maintenance - I&E	Continuous Unit Operation #16	In Progress
Chemical Engineer	Research & Technology	Batch Unit Operation #17	\$150,000
Chemical Engineer	Operations	Continuous Unit Operation #18	\$80,000
Controls Engineer	DCS	Batch Unit Operation #19	In Progress
Chemical Engineer	Research & Technology	Batch Unit Operation #20	\$200,000
Chemical Engineer	Operations	Continuous Unit Operation #21	\$67,000
Chemical Engineer	Research & Technology	Continuous Unit Operation #22	In Progress
Chemical Engineer	Research & Technology	Continuous Unit Operation #23	In Progress
Chemical Engineer	Research & Technology	Continuous Unit Operation #24	\$135,000
Chemical Engineer	Operations	Continuous Unit Operation #25	\$350,000
Electrical Engineer	Maintenance - I&E	Continuous Unit Operation #26	\$10,000
Chemical Engineer	Research & Technology	Continuous Unit Operation #27	\$37,000
Chemical Engineer	Operations	Batch Unit Operation #28	\$100,000
Chemical Engineer	Operations	Continuous Unit Operation # 29	\$844,000
Total			\$3,700,000



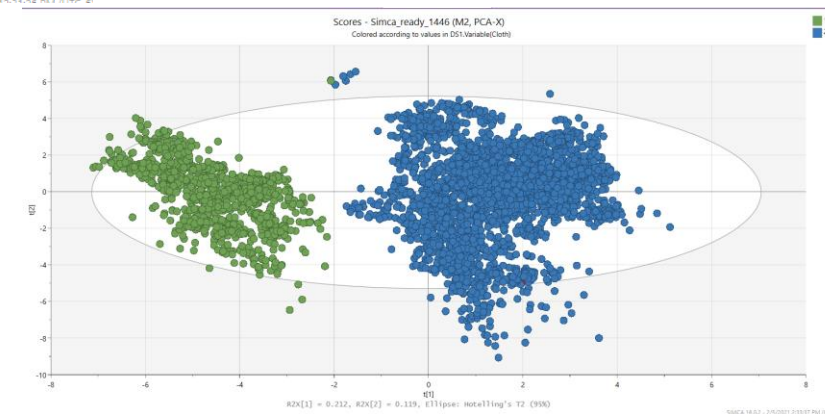
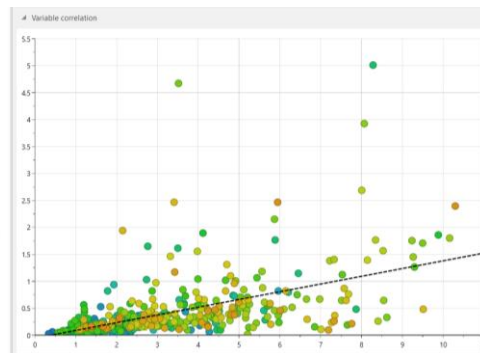
# Process Optimization Academy – “Eurekas”



# Process Optimization Academy – 29 Multivariate Models on 29 different Unit Operations

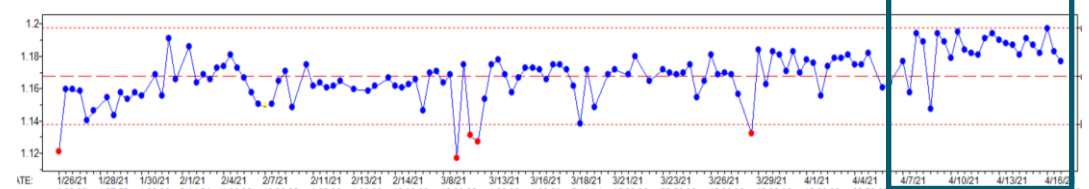
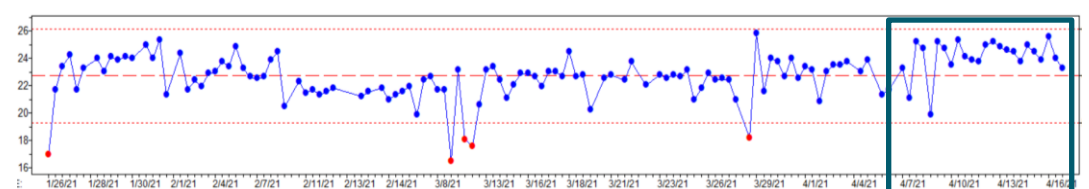
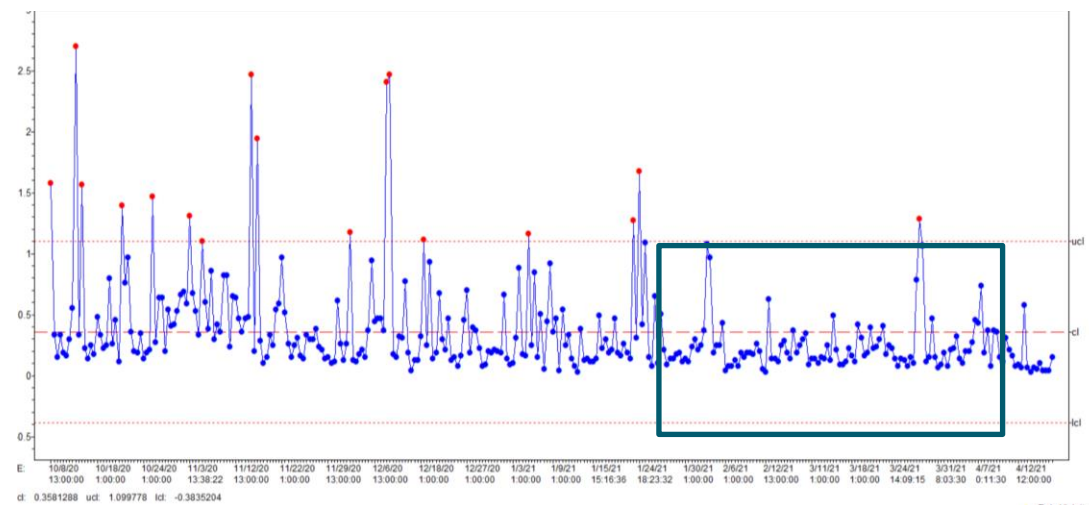
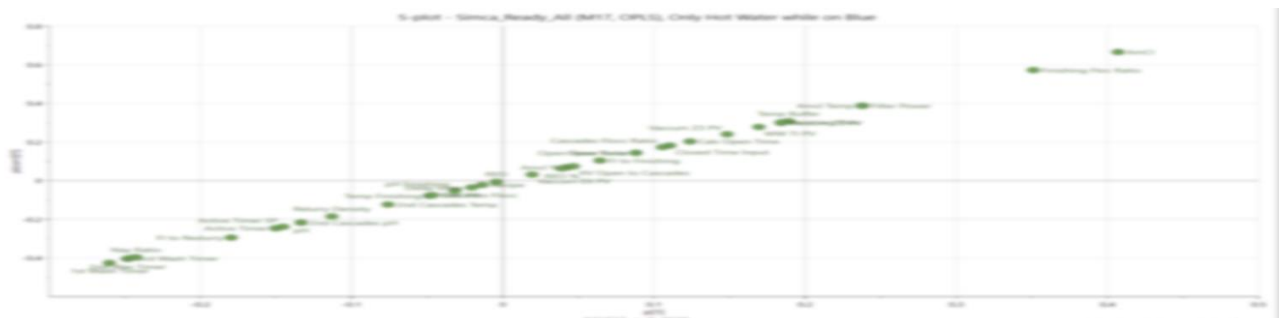
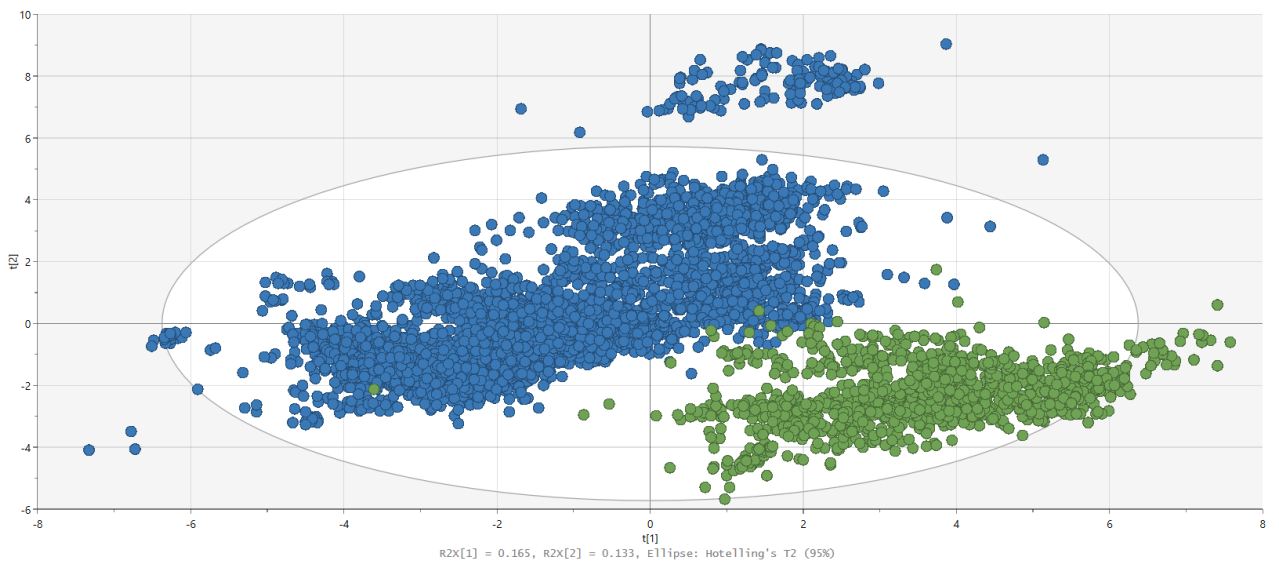


0.00144341	-0.374805	0.141114	0.477081	-0.000599	0.155656
-0.0400827	-0.0497571	-0.0189704	-0.113061	-0.065119	0.047031
-0.155667		0.0446395	0.0496597	-0.0539105	-0.0434938
-0.0204929	-0.377993	-0.0140632	-0.381396	0.0437605	0.0094193
-0.195983	-0.277508	0.0407337	-0.182006	0.0333995	0.0382354
-0.0138846	-0.316735	-0.00120541	-0.102029	0.0225619	0.0187545
-0.0596194	-0.230944	0.137343	0.327496	0.0261085	0.0495462
0.0294917	0.243116	-0.0464274	-0.1746619	-0.0332042	-0.0666184
0.0159529	0.0248534	-0.0809645	0.218528	0.0323704	0.0203016
7.09235e-06	-0.215209	0.105024	-0.245376	0.0697546	0.0478892
-0.117267	-0.0432677	0.0171665	0.0361676	0.0649409	0.081861
-0.162331	-0.191634	0.0141539	-0.197745	0.0364238	0.0733066
-0.190399	-0.152656	0.0882304	-0.160822	-0.068472	-0.0647452
0.041187	-0.230738	-0.280903	0.011101	0.0569952	0.0723836
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		0.0412689	0.0489632	-0.0537399	-0.0431221
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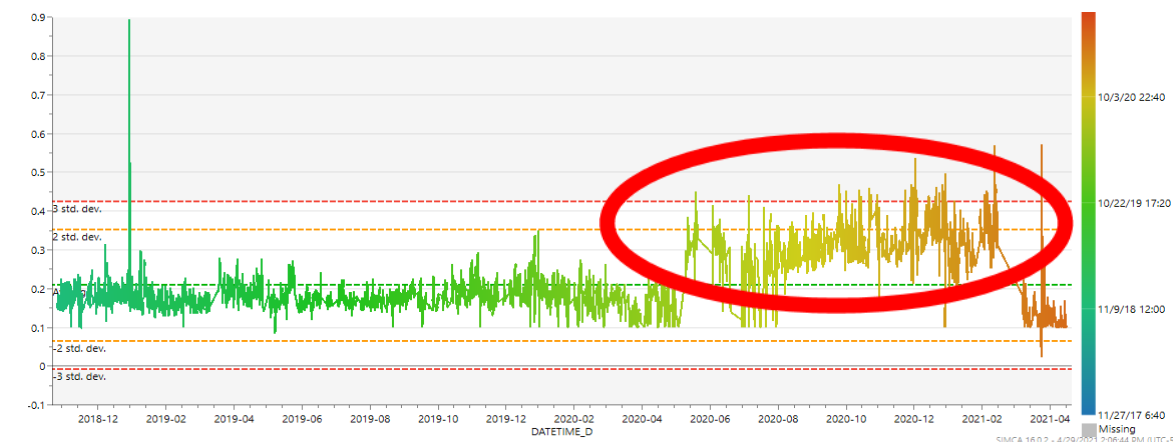
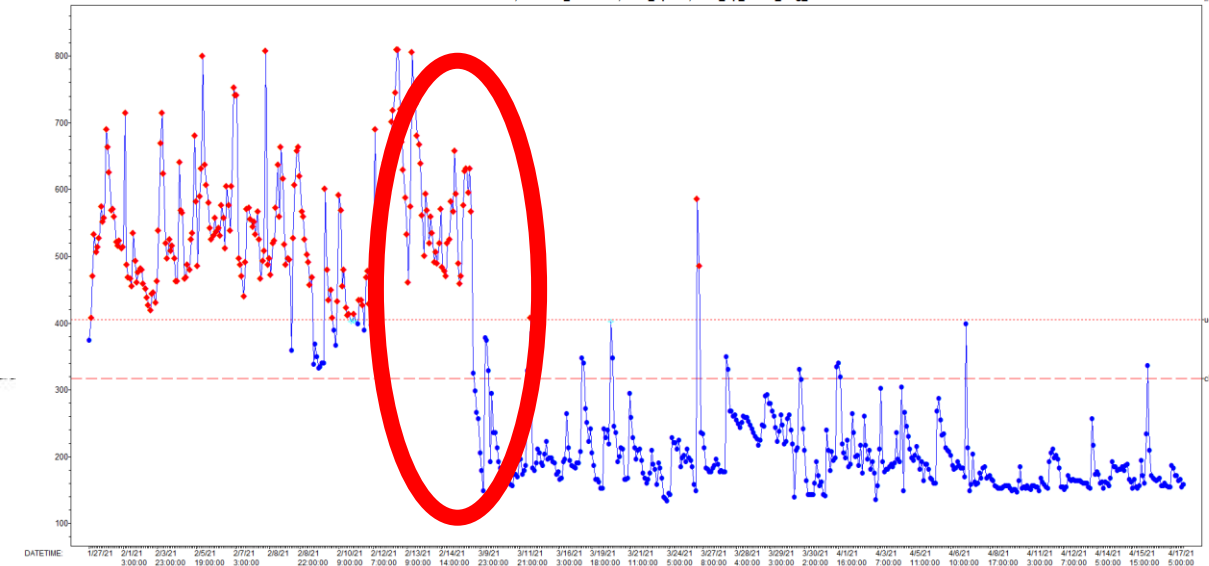


# Albemarle Intelligence – Engineer Improvement Project

Capacity & Quality Improvements  
**\$450,000/yr**



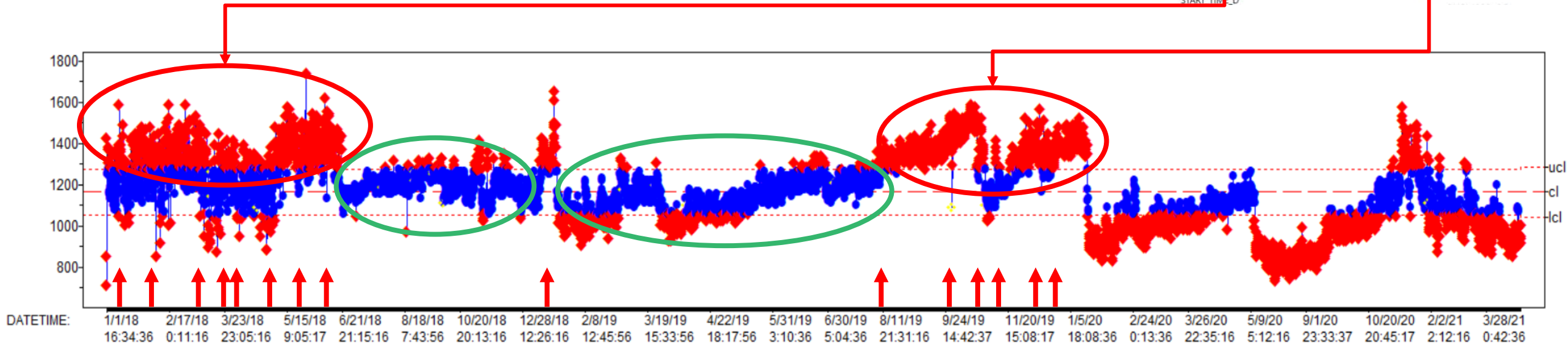
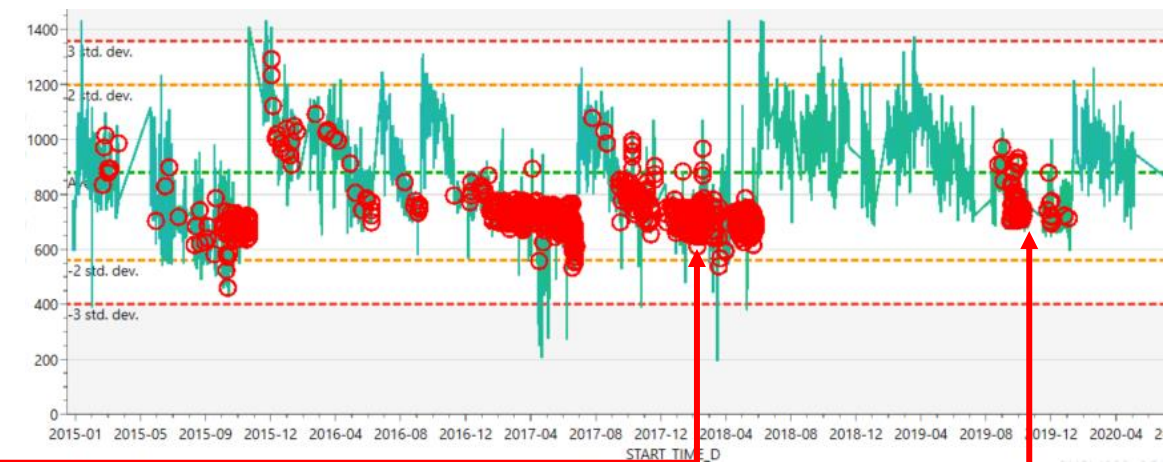
## Downtime Reduction & Environmental Improvements





# Albemarle Intelligence – Engineer Improvement Project

Maintenance Equipment Reliability  
Improvement  
**\$220,000/yr**

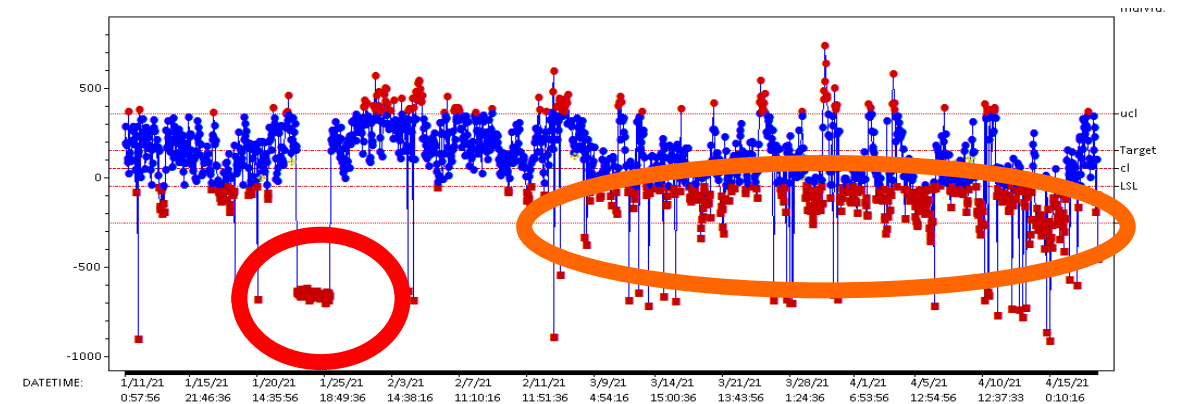
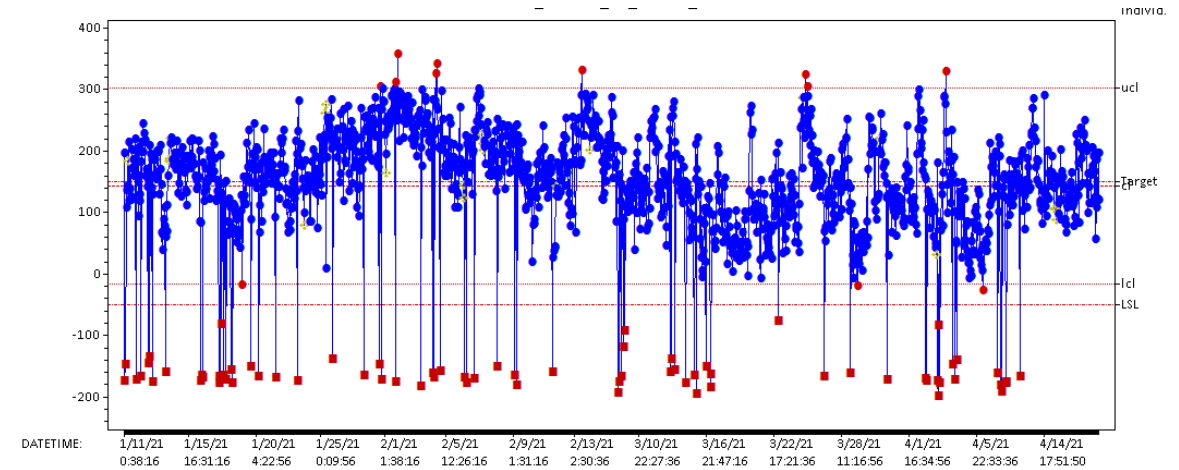
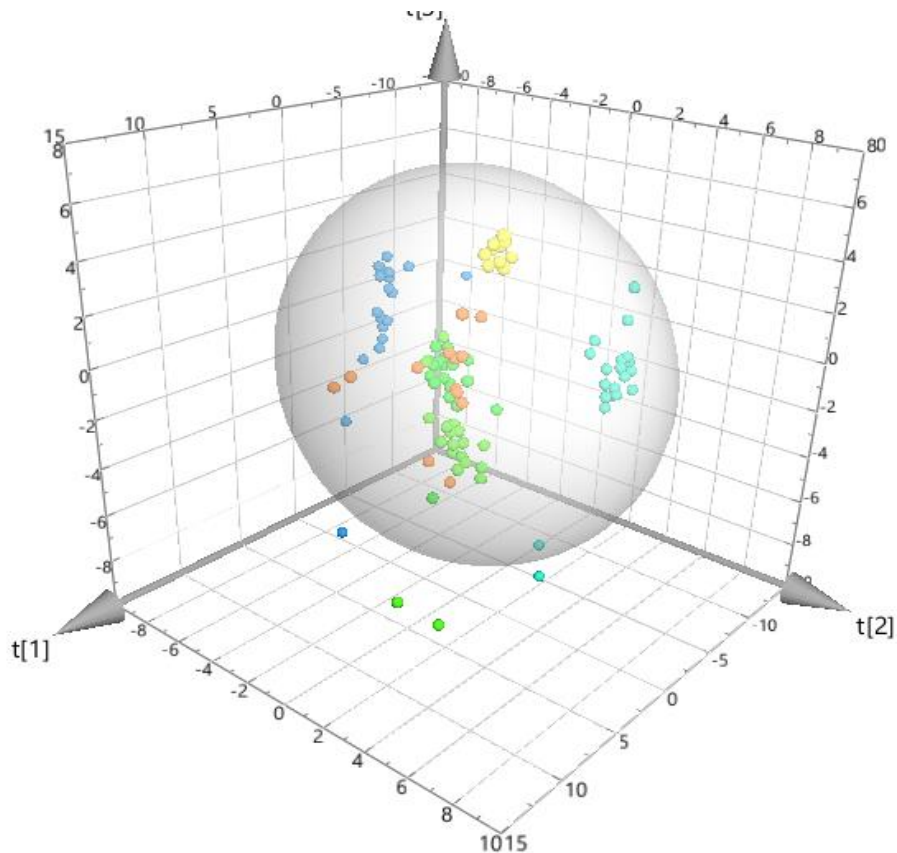




# Albemarle Intelligence – Engineer Improvement Project

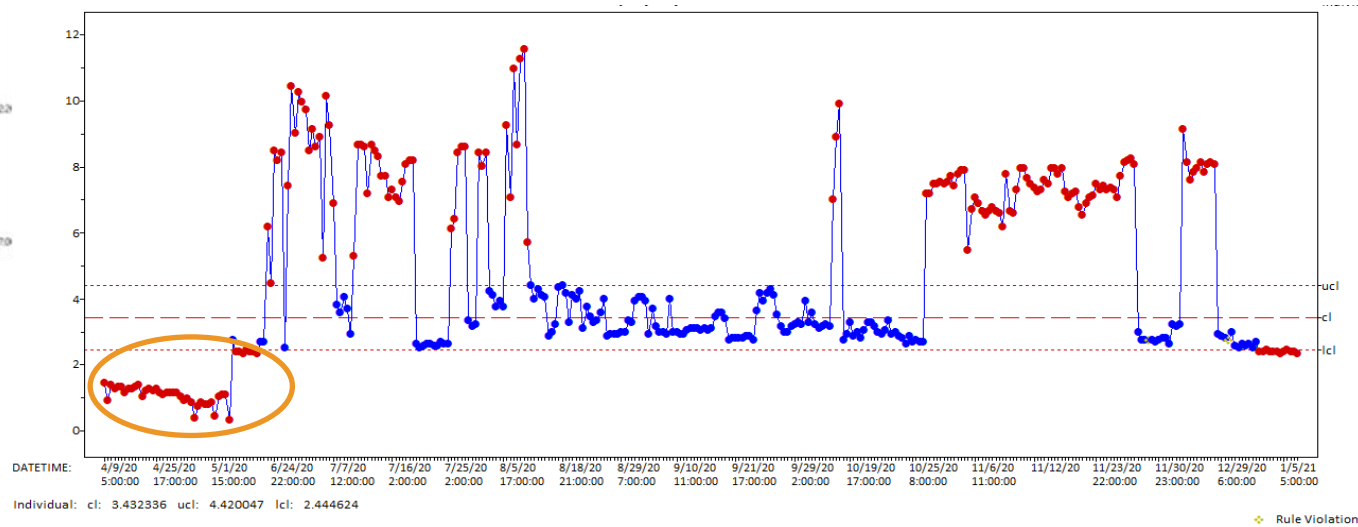
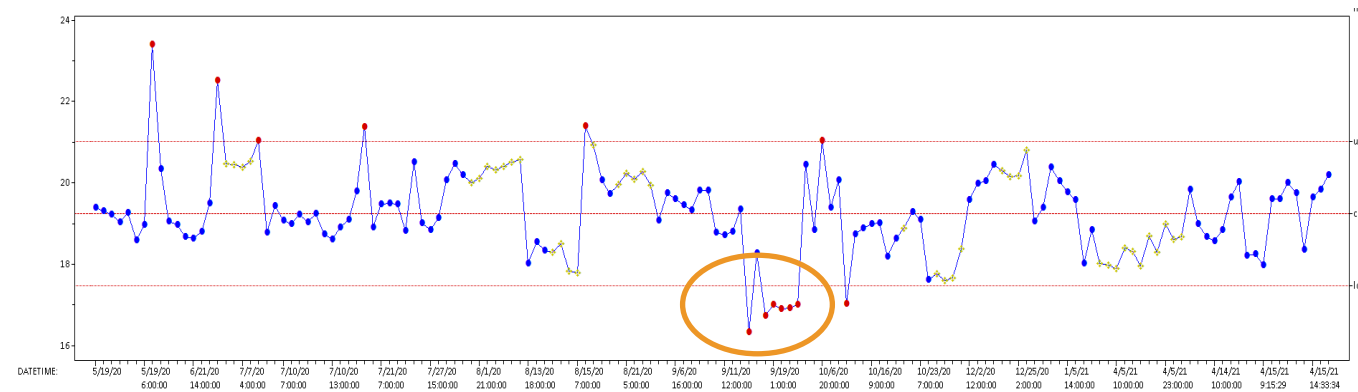
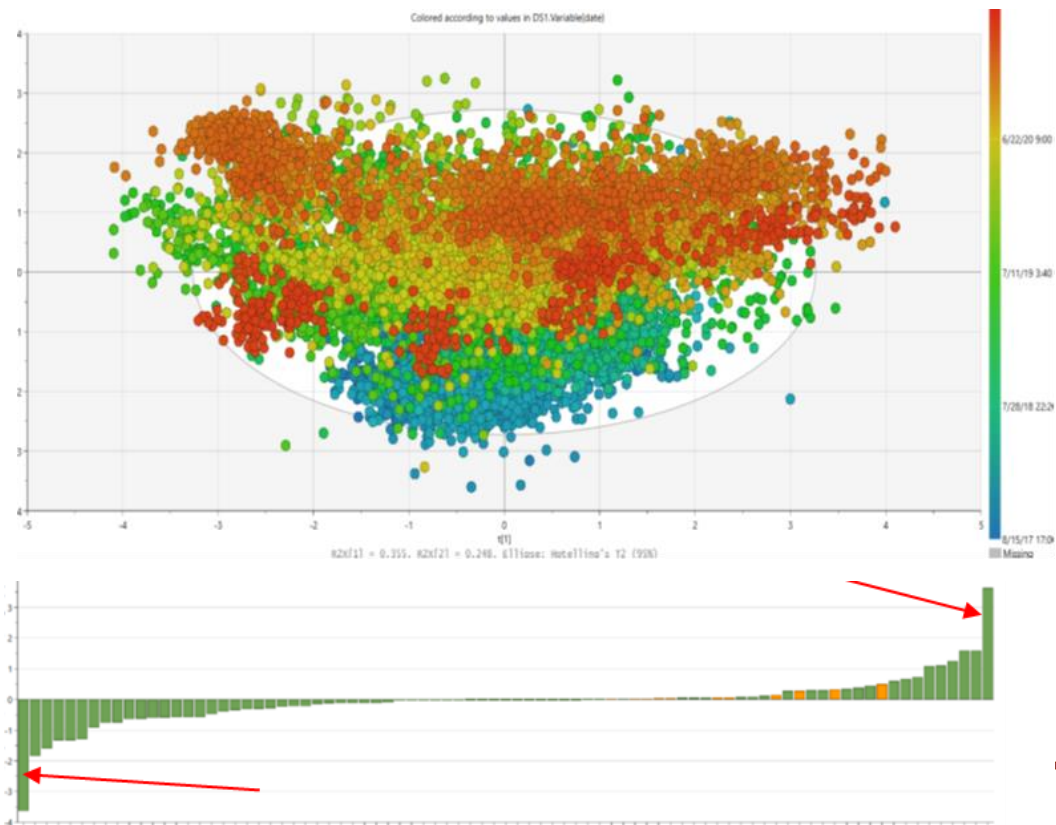
**Raw Material Utilization, Quality, and  
Customer Satisfaction Improvements**

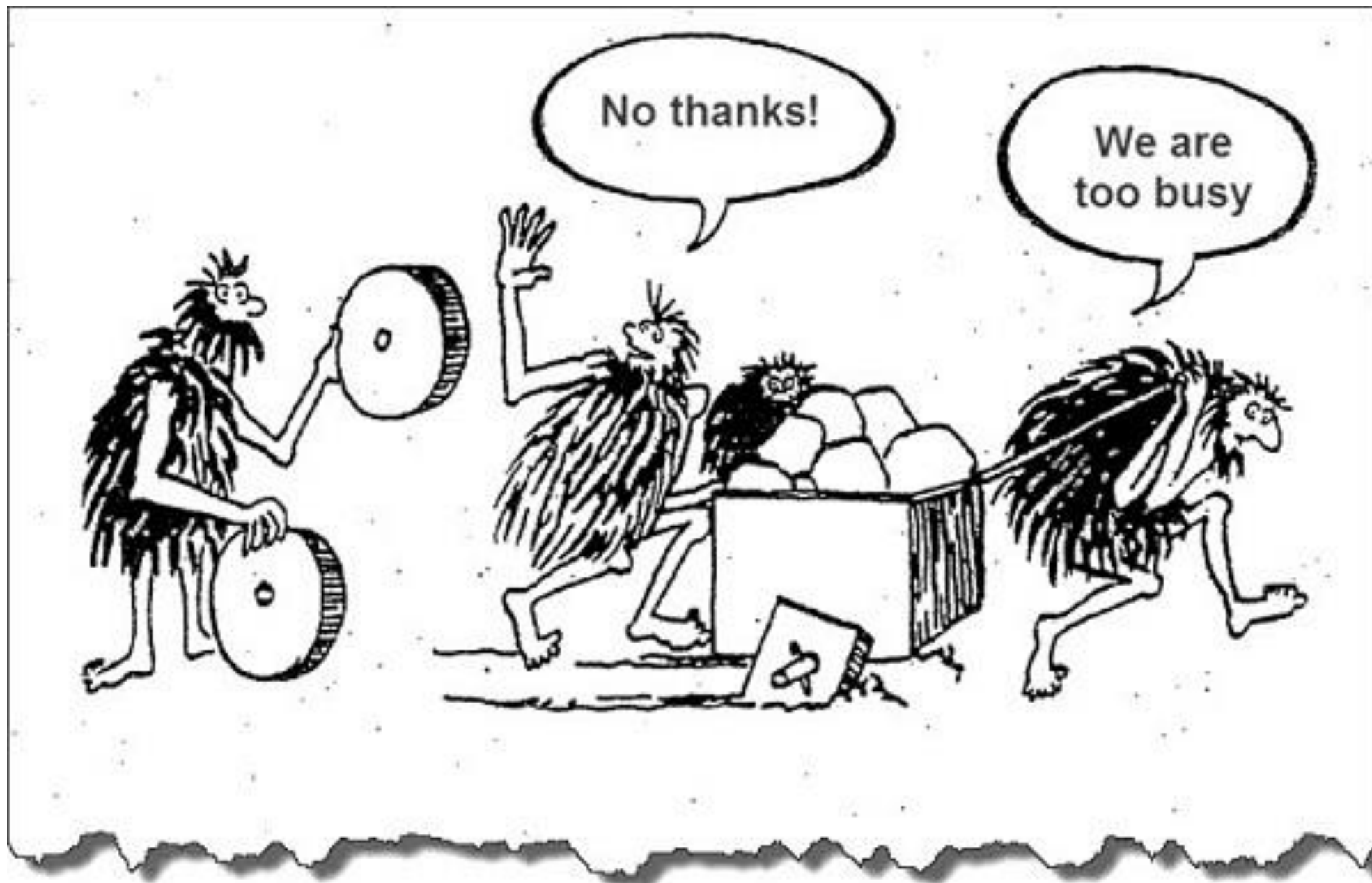
**\$150,000/yr**



# Albemarle Intelligence – Engineer Improvement Project

Quality and Rate Improvements  
**\$840,000/yr**



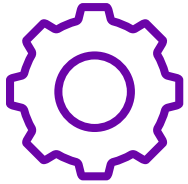








# World-class upstream operations



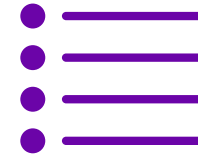
## Challenge

- Scaling Machine Learning & AI across a global enterprise, within a Specialty Chemical Company with thousands of unique chemical processes and data sources



## Solution

- Deployed the latest AVEVA PI System technology including PI AF, PI Event Frames, PI Analytics, Northwest Analytics SPC, and Sartorius SIMCA Multivariate Analysis



## Benefits

- Increased production and operational efficiency, reduced costs, mobile inspections, exception-based surveillance, significantly accelerated 'Time to Value' for Advanced Analytics & Machine Learning projects



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# Jonathan Alexander

## Manufacturing Data Analytics Leader

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# Appendix

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