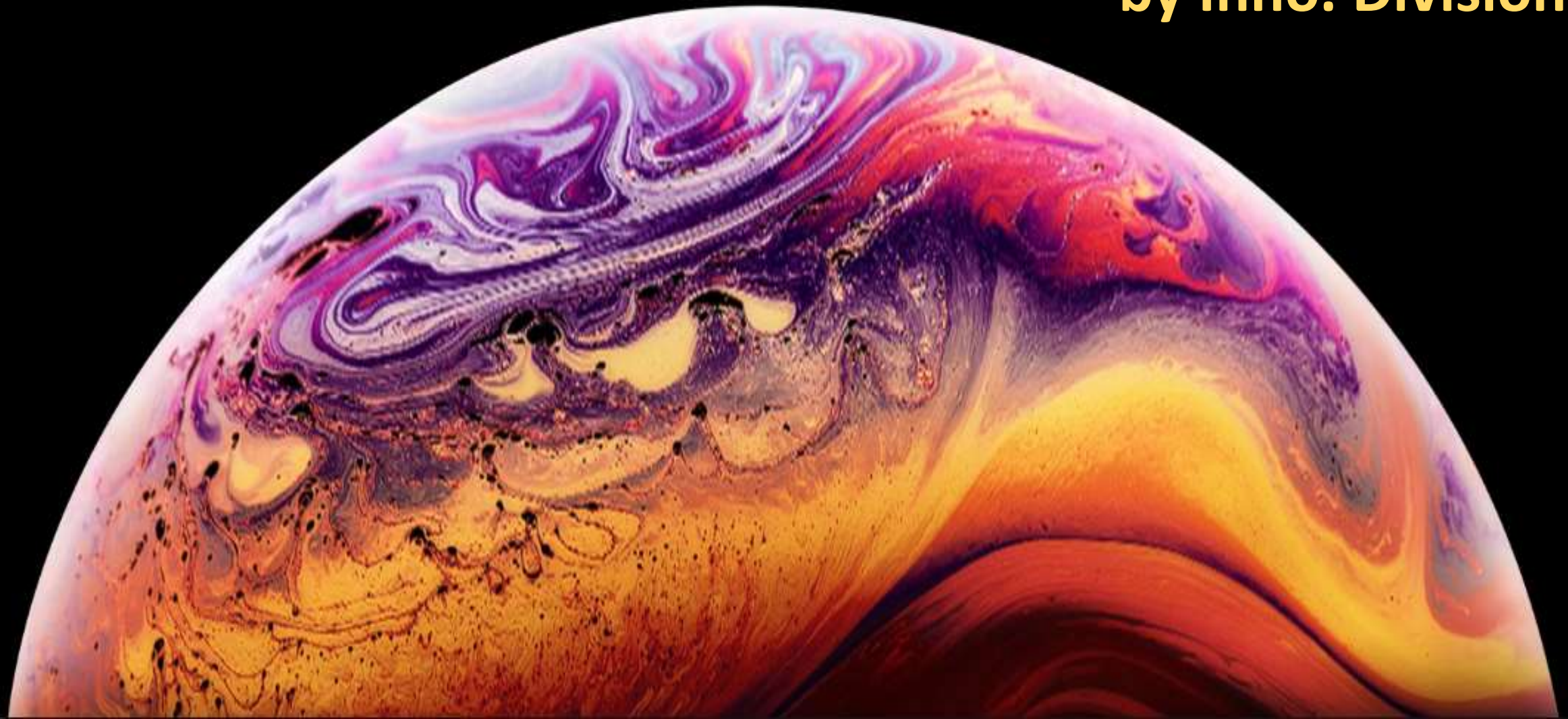
Ai-Sensor project

by Inno. Division



AGENDA

- Background
- Proof of Concept (POC)
- Prototype Model
- Next Step

Background: RVP

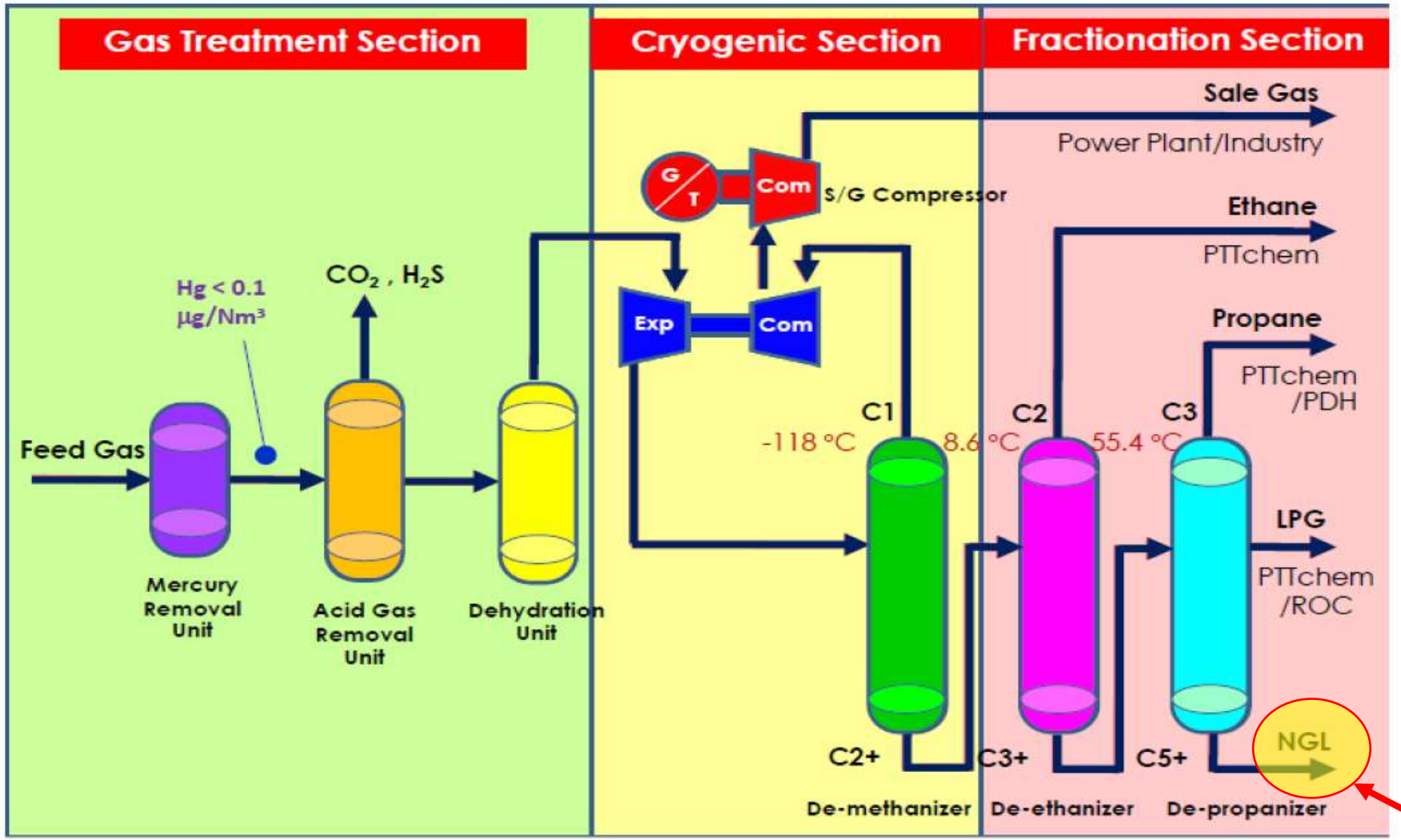


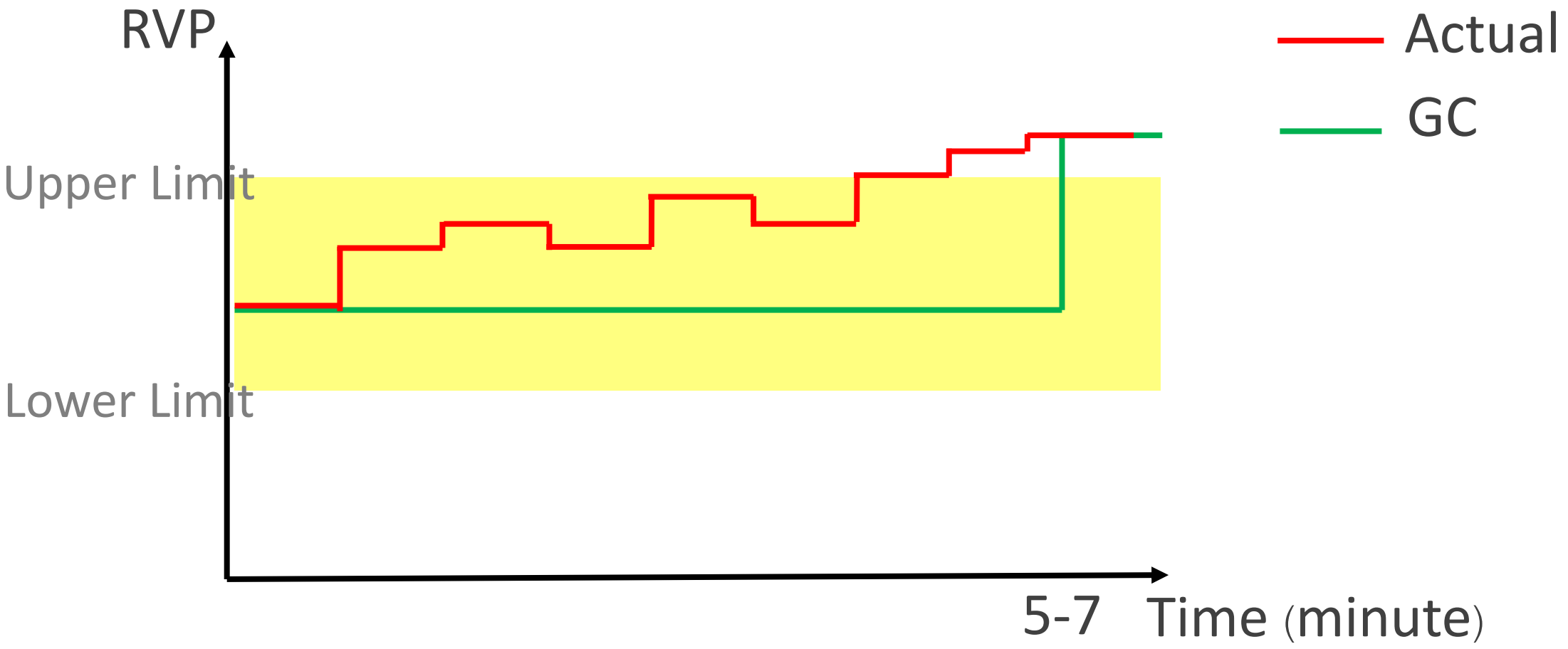
Fig. 1 ภาพรวม Process ของโรงแยกก๊าซธรรมชาติ

The spec. of NGL is control by RVP (Reid Vapor Pressure) spec.

Background: On-Line RVP Analyzer

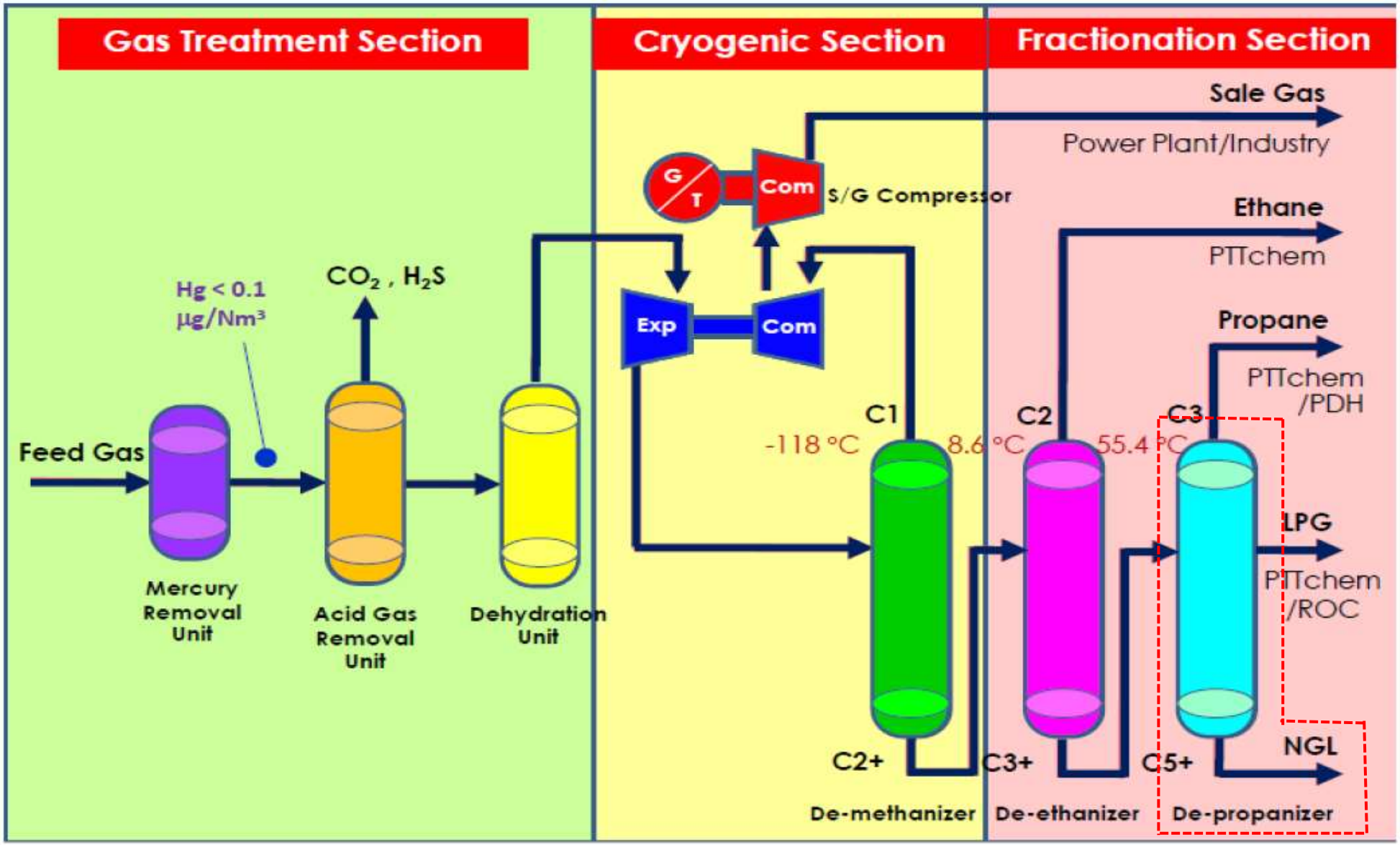
This device is used in the plant to online measure the RVP value for NGL. The interval of measurement is 5-7 minute/time.

Background: Pain Point

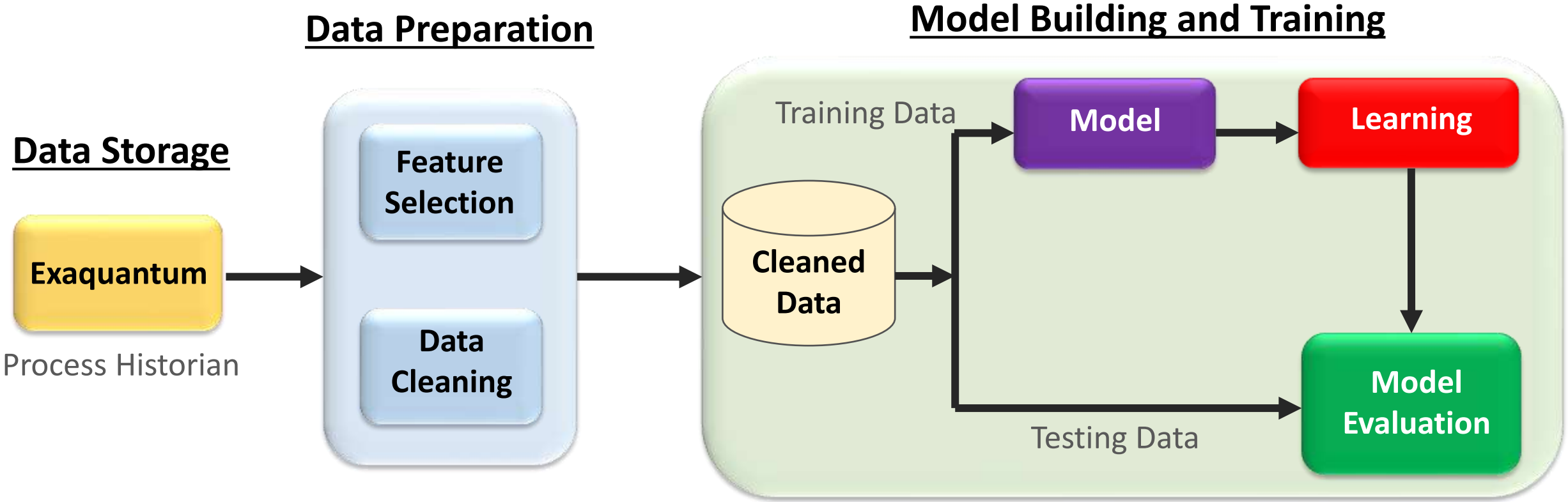


The wide interval time of measurement can lead to mis-operation issue.

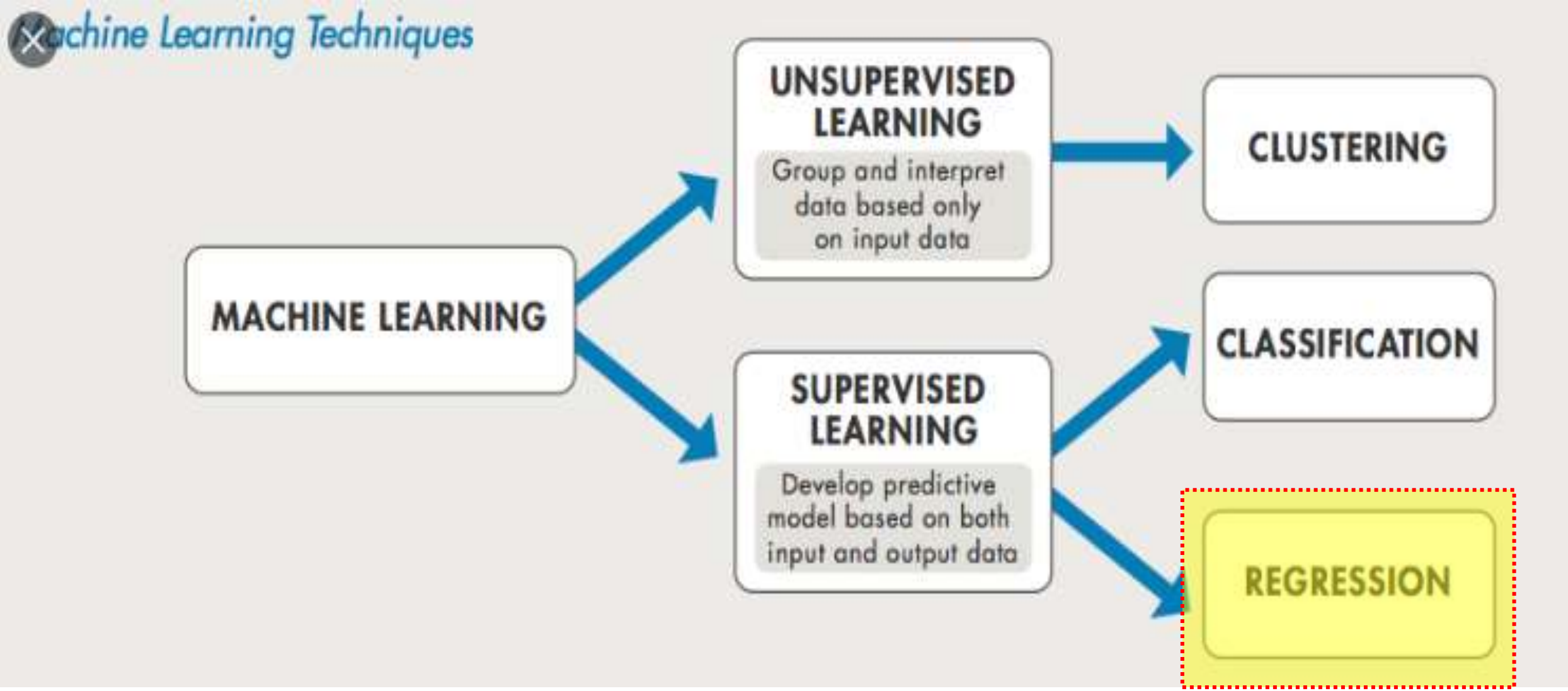
Scope of Work



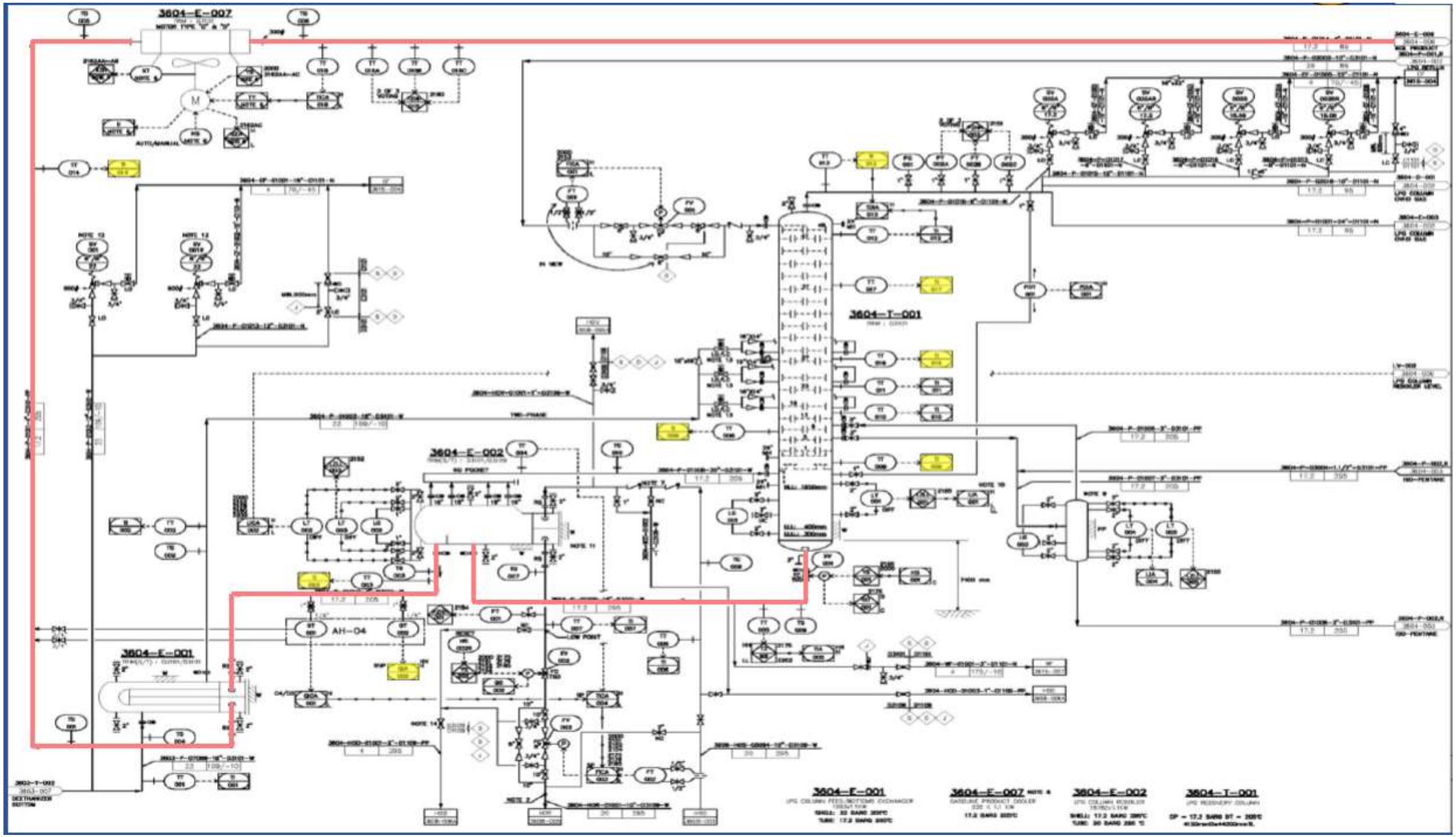
Concept


Data Preparation
Model Building and Training
Data Storage
Exaquantum
Process Historian
Feature Selection
Data Cleaning
Training Data
Cleaned Data
Model
Learning
Model Evaluation
Testing Data

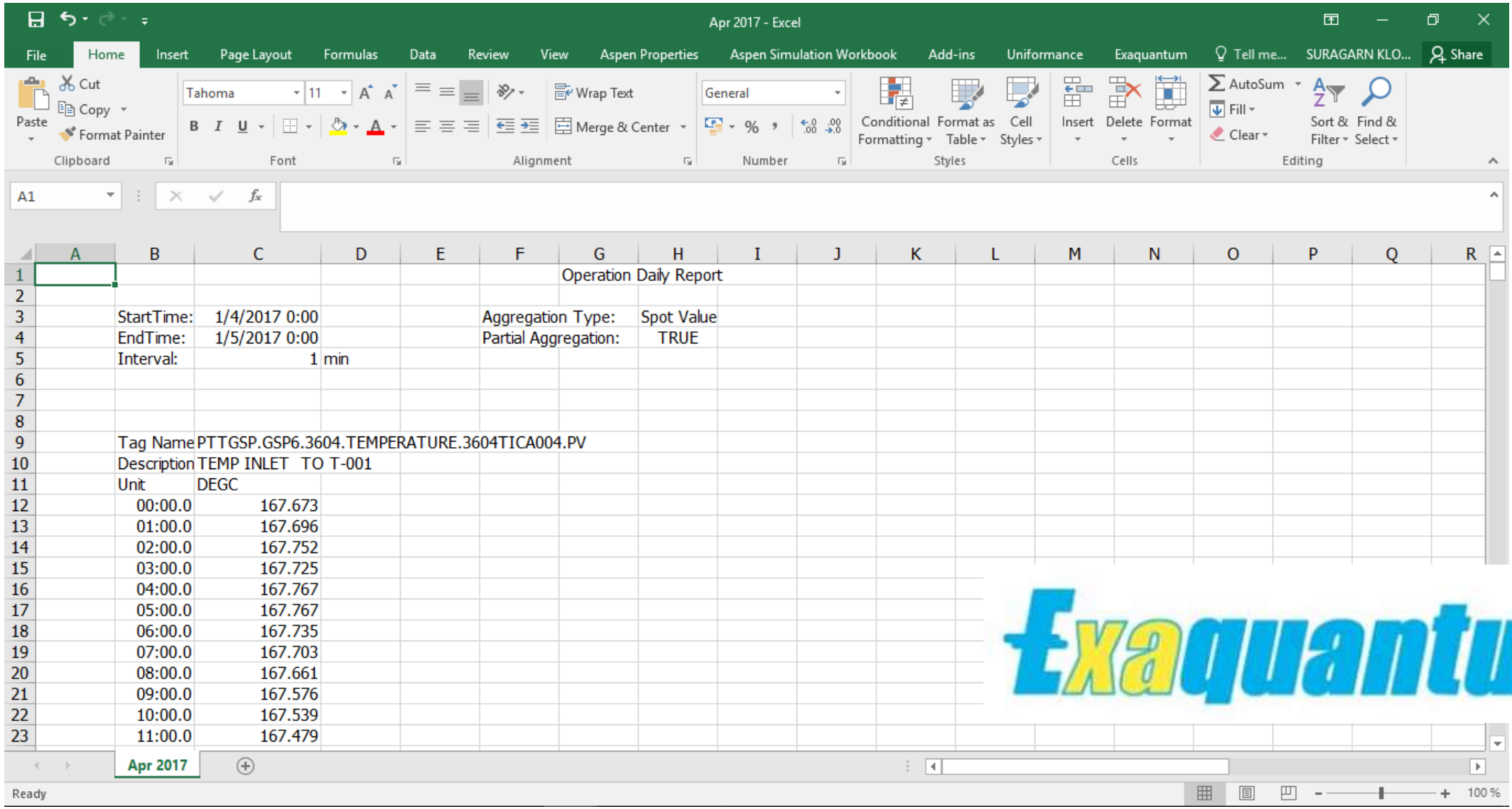
Proof of Concept



Proof of Concept



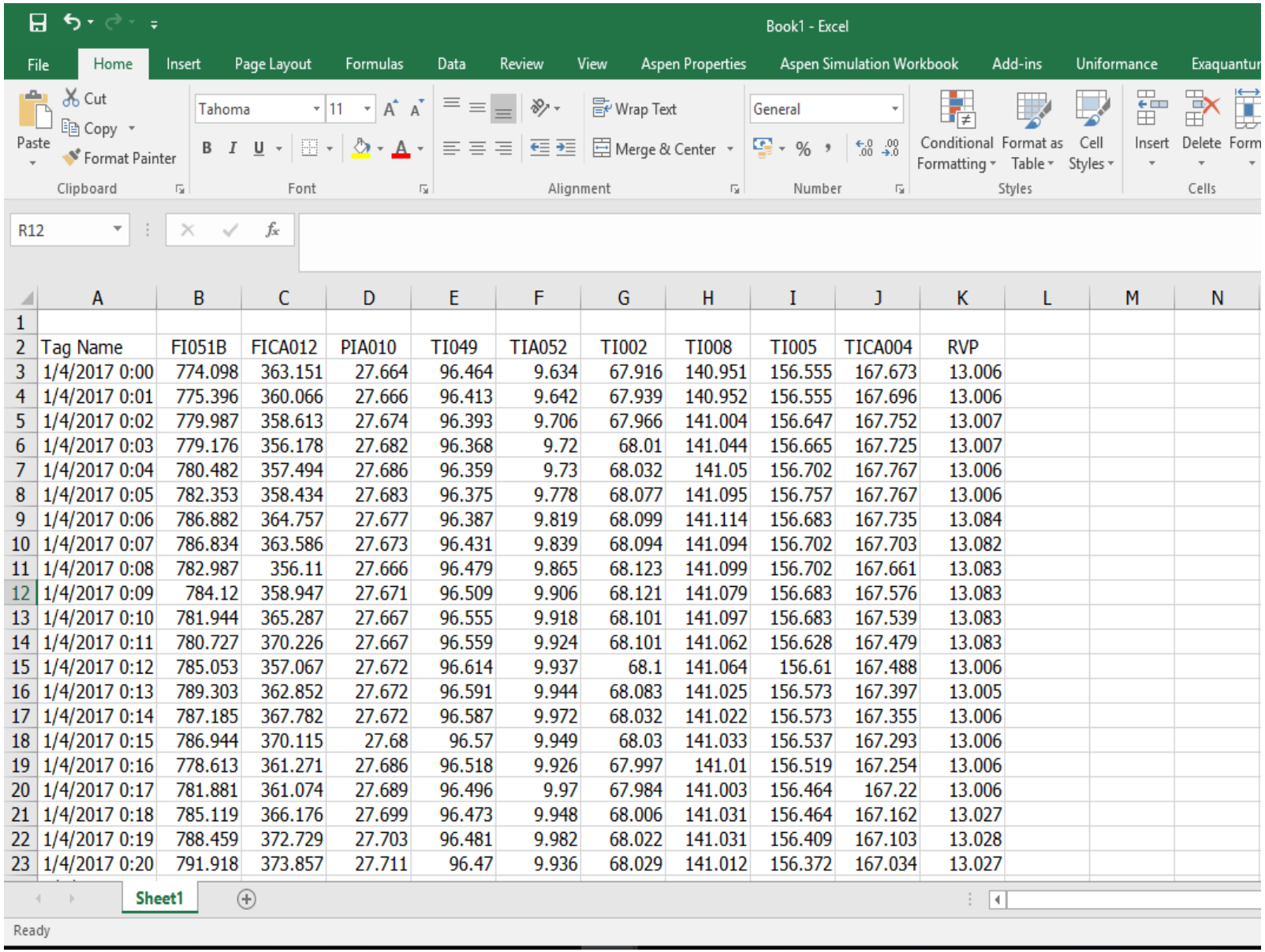
Proof of Concept



Exaquantum

Data Extraction via Exaquantum: Each Tag per file &1 min Interval for 1 month as CSV

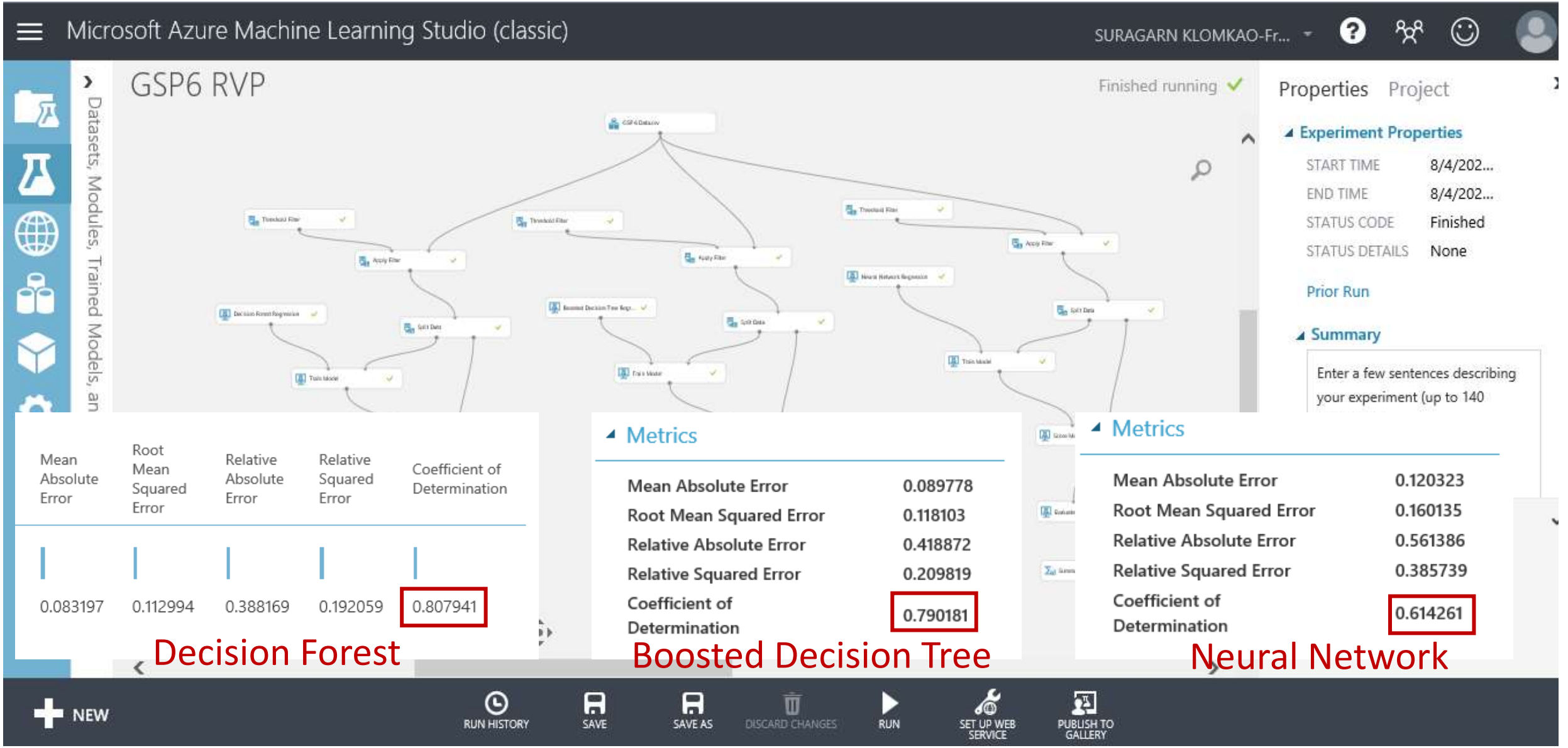
Proof of Concept



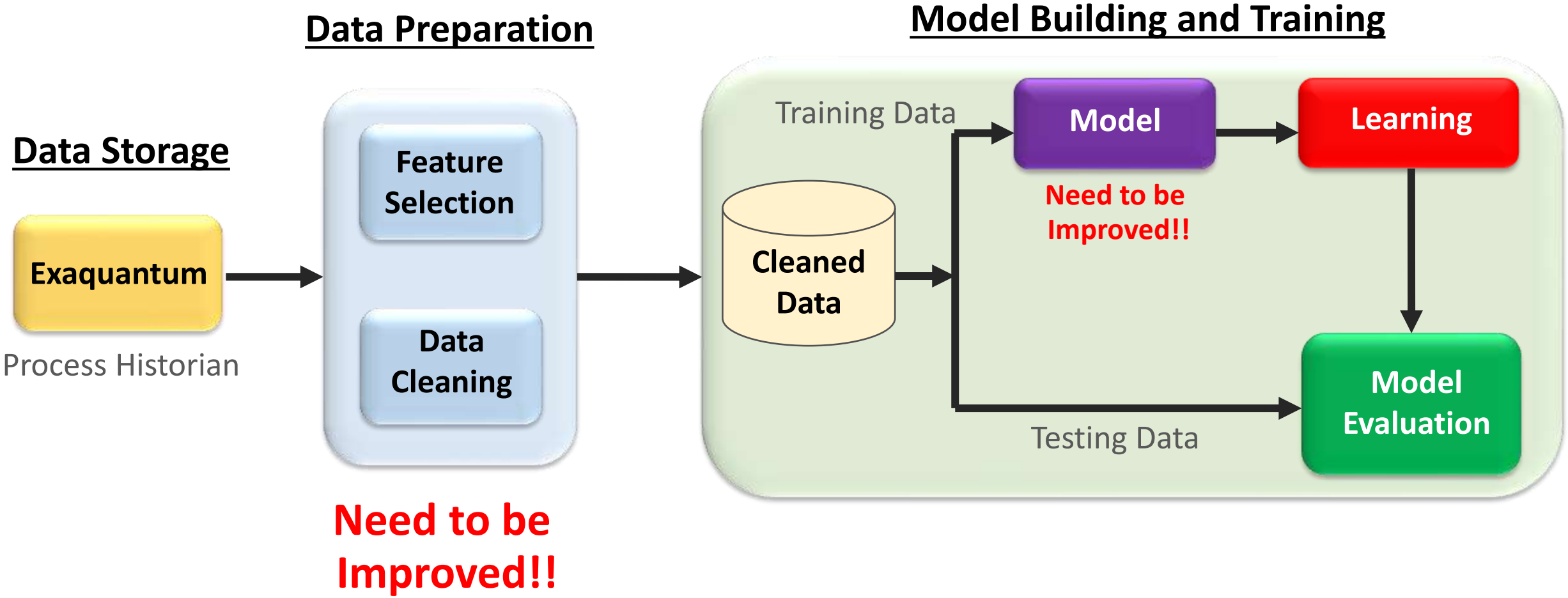
	A	B	C	D	E	F	G	H	I	J	K
1											
2	Tag Name	FI051B	FICA012	PIA010	TI049	TIA052	TI002	TI008	TI005	TICA004	RVP
3	1/4/2017 0:00	774.098	363.151	27.664	96.464	9.634	67.916	140.951	156.555	167.673	13.006
4	1/4/2017 0:01	775.396	360.066	27.666	96.413	9.642	67.939	140.952	156.555	167.696	13.006
5	1/4/2017 0:02	779.987	358.613	27.674	96.393	9.706	67.966	141.004	156.647	167.752	13.007
6	1/4/2017 0:03	779.176	356.178	27.682	96.368	9.72	68.01	141.044	156.665	167.725	13.007
7	1/4/2017 0:04	780.482	357.494	27.686	96.359	9.73	68.032	141.05	156.702	167.767	13.006
8	1/4/2017 0:05	782.353	358.434	27.683	96.375	9.778	68.077	141.095	156.757	167.767	13.006
9	1/4/2017 0:06	786.882	364.757	27.677	96.387	9.819	68.099	141.114	156.683	167.735	13.084
10	1/4/2017 0:07	786.834	363.586	27.673	96.431	9.839	68.094	141.094	156.702	167.703	13.082
11	1/4/2017 0:08	782.987	356.11	27.666	96.479	9.865	68.123	141.099	156.702	167.661	13.083
12	1/4/2017 0:09	784.12	358.947	27.671	96.509	9.906	68.121	141.079	156.683	167.576	13.083
13	1/4/2017 0:10	781.944	365.287	27.667	96.555	9.918	68.101	141.097	156.683	167.539	13.083
14	1/4/2017 0:11	780.727	370.226	27.667	96.559	9.924	68.101	141.062	156.628	167.479	13.083
15	1/4/2017 0:12	785.053	357.067	27.672	96.614	9.937	68.1	141.064	156.61	167.488	13.006
16	1/4/2017 0:13	789.303	362.852	27.672	96.591	9.944	68.083	141.025	156.573	167.397	13.005
17	1/4/2017 0:14	787.185	367.782	27.672	96.587	9.972	68.032	141.022	156.573	167.355	13.006
18	1/4/2017 0:15	786.944	370.115	27.68	96.57	9.949	68.03	141.033	156.537	167.293	13.006
19	1/4/2017 0:16	778.613	361.271	27.686	96.518	9.926	67.997	141.01	156.519	167.254	13.006
20	1/4/2017 0:17	781.881	361.074	27.689	96.496	9.97	67.984	141.003	156.464	167.22	13.006
21	1/4/2017 0:18	785.119	366.176	27.699	96.473	9.948	68.006	141.031	156.464	167.162	13.027
22	1/4/2017 0:19	788.459	372.729	27.703	96.481	9.982	68.022	141.031	156.409	167.103	13.028
23	1/4/2017 0:20	791.918	373.857	27.711	96.47	9.936	68.029	141.012	156.372	167.034	13.027

- 9 Feature
- 1 Target
- 30 Days Period
- 430,000 Cells of Data

Proof of Concept



Concept


Data Preparation
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Need to be Improved!!
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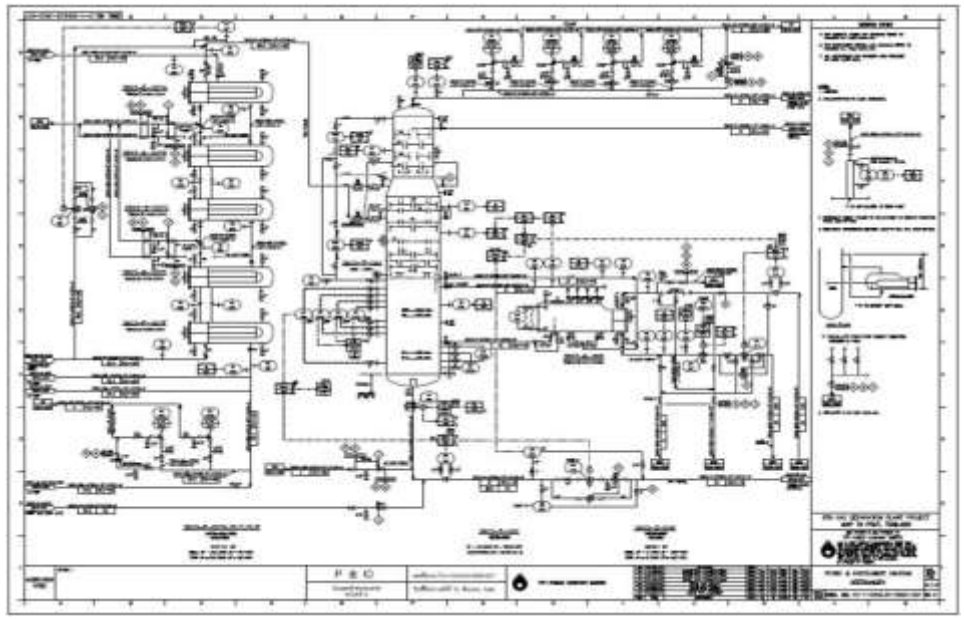
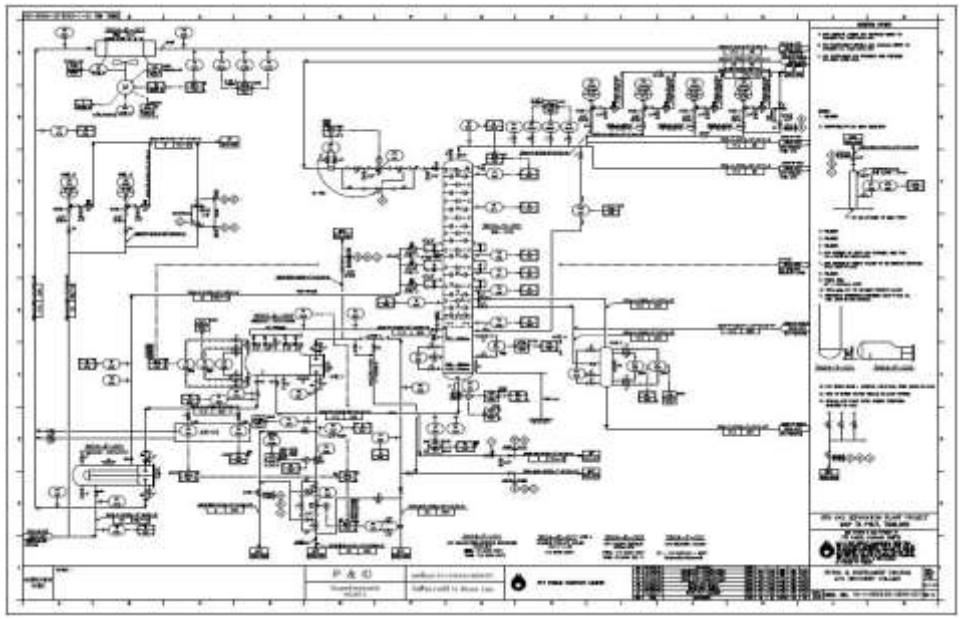
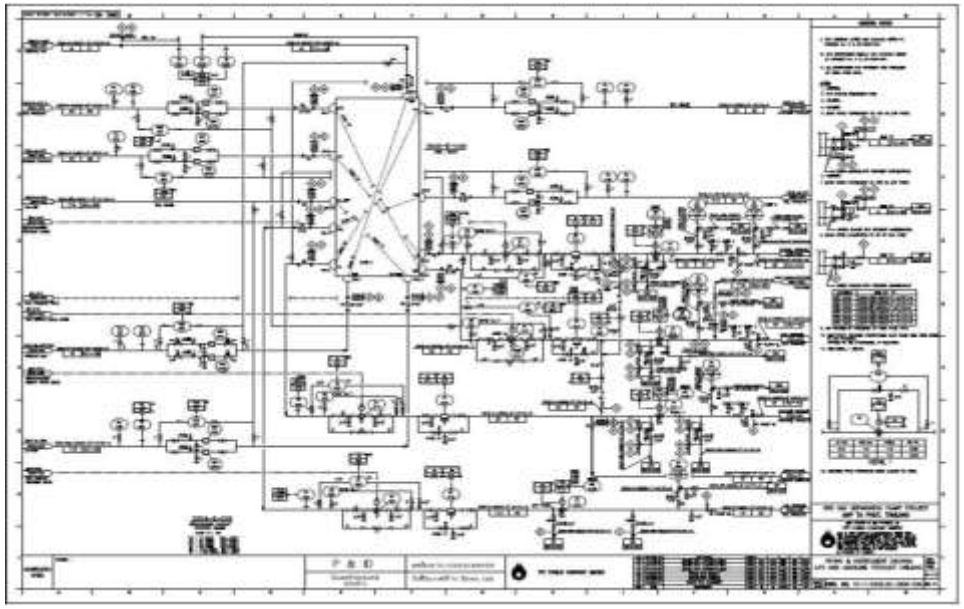
Model Evaluation

Data Preparation: Feature Selection

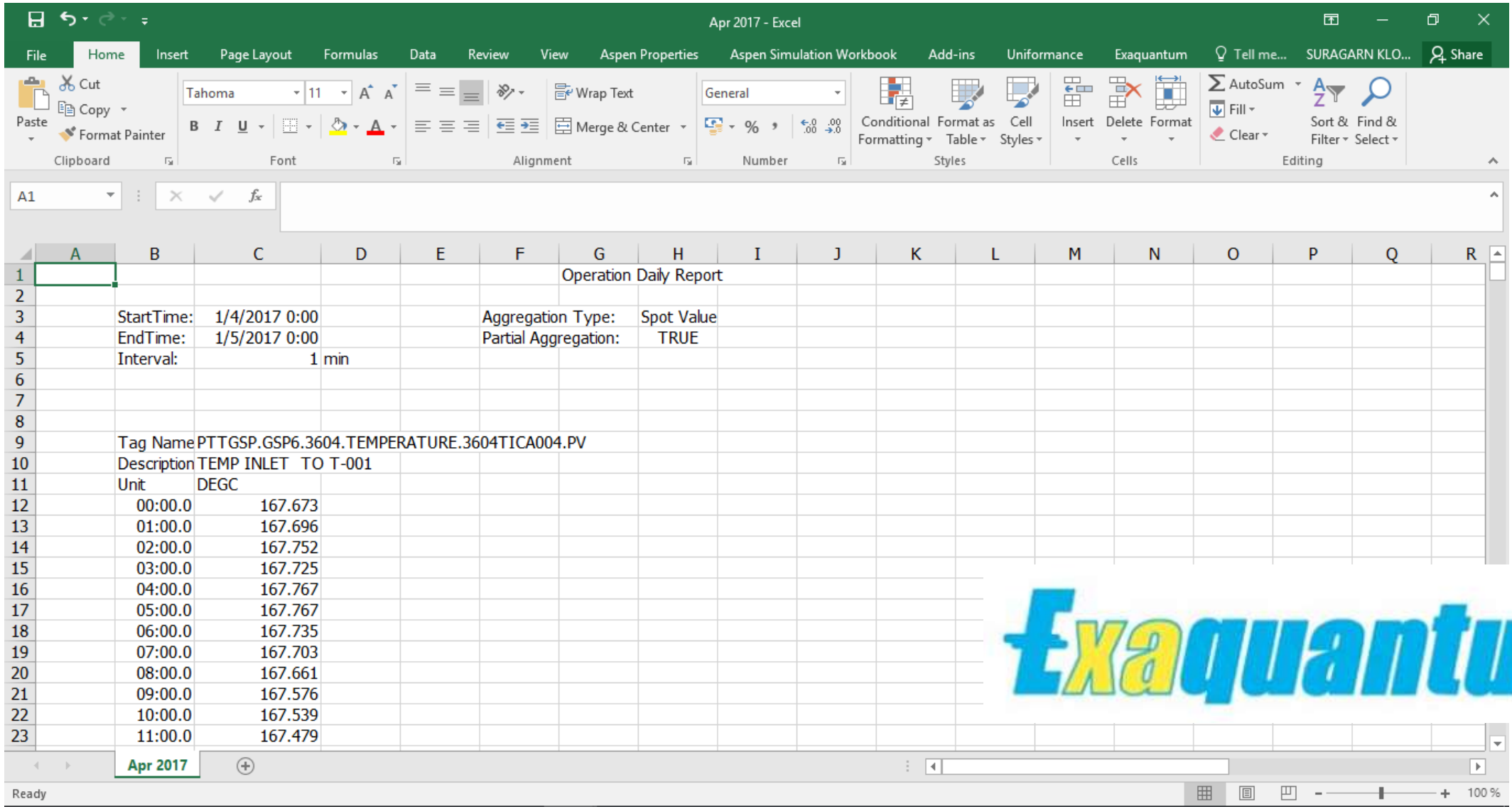






- **Feed Inlet**
- **DeEthanizer Column**
- **LPG Recovery Column**
- **NGL Product to Storage**

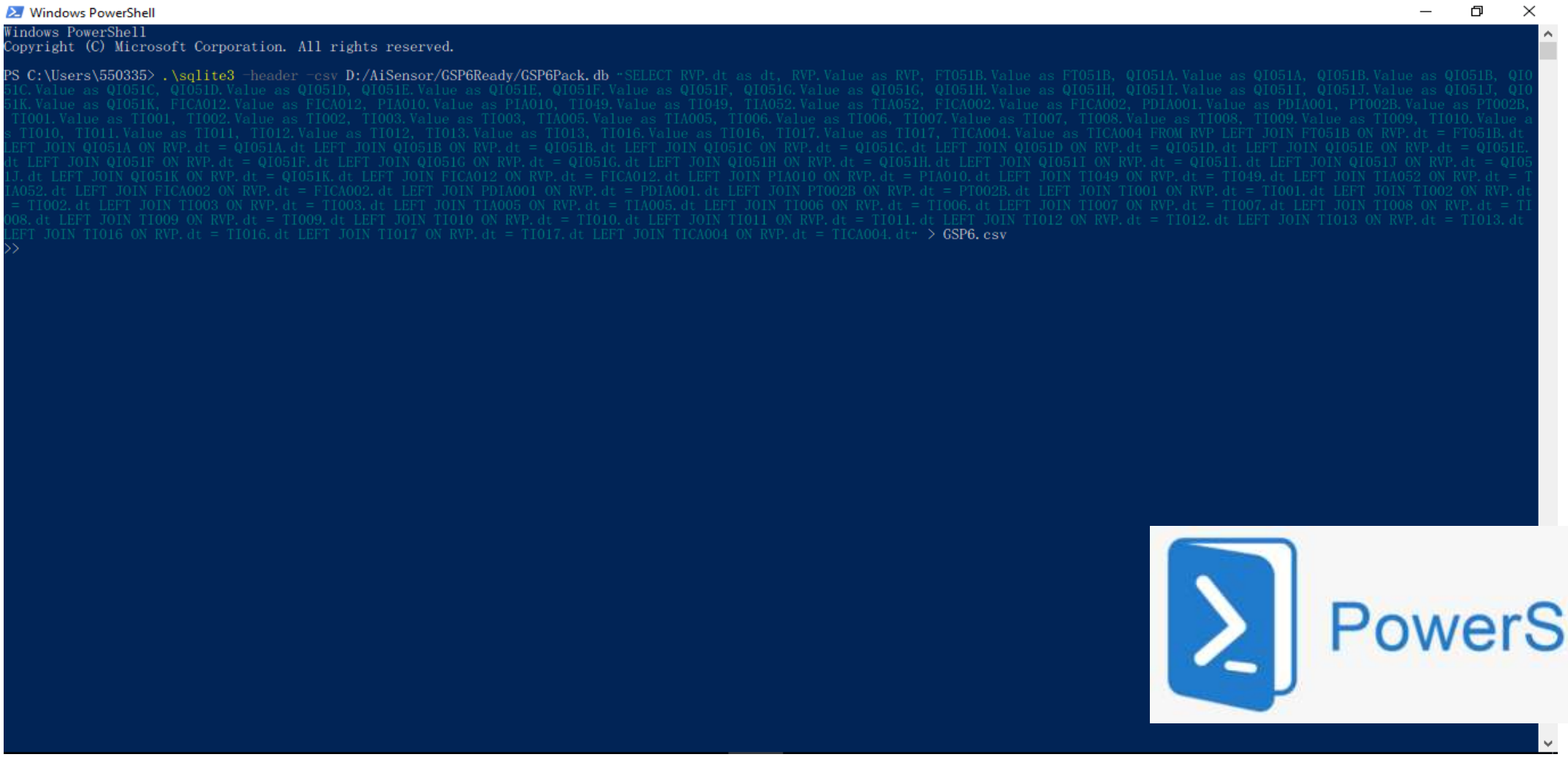
Data Preparation: Pack Data



Exaquantum

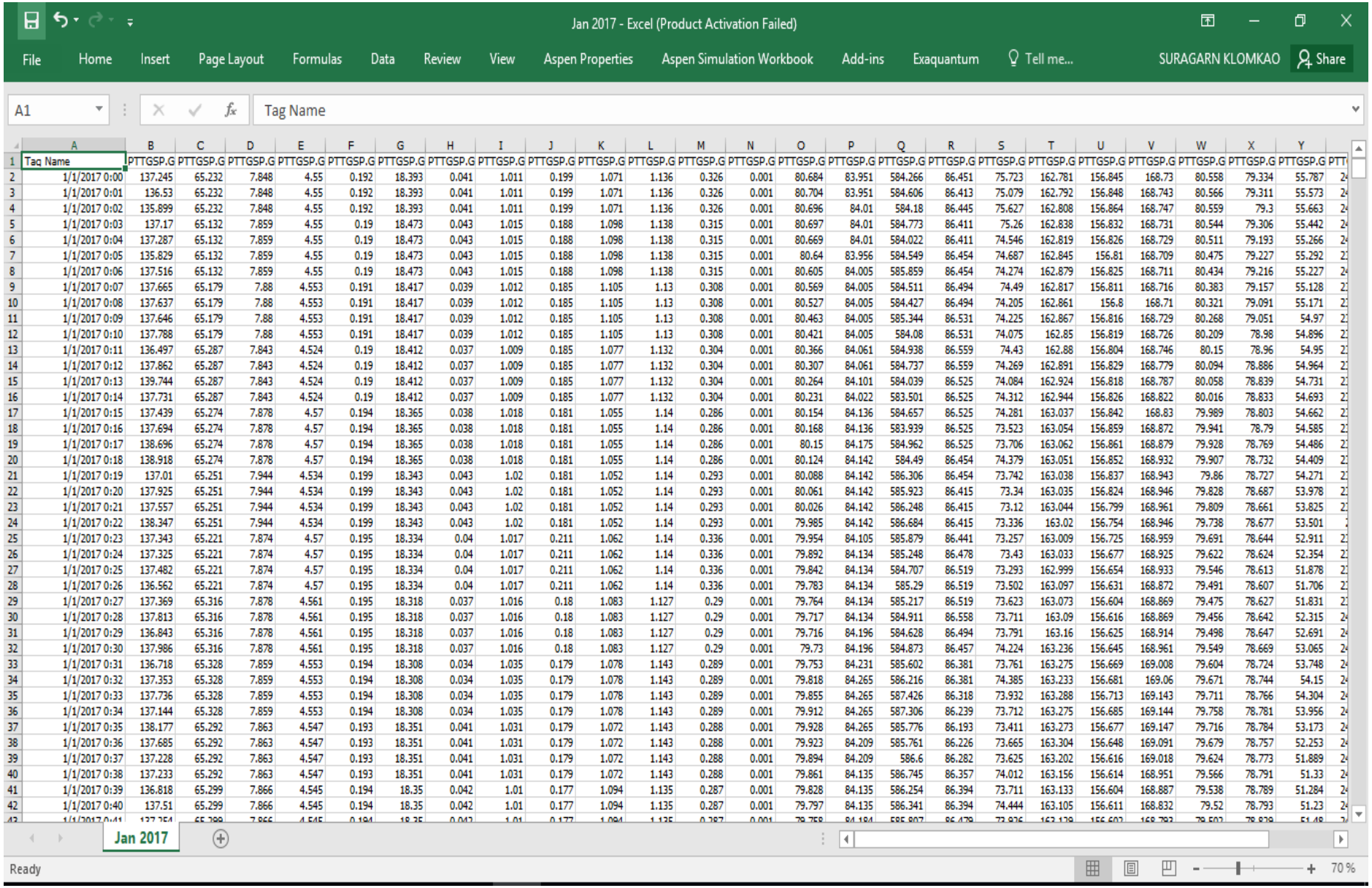
Data Extraction via Exaquantum: Each Tag per file &1 min Interval for 2.5 Years as CSV

Data Preparation: Pack Data



Pack Data to only 1 file and via PowerShell

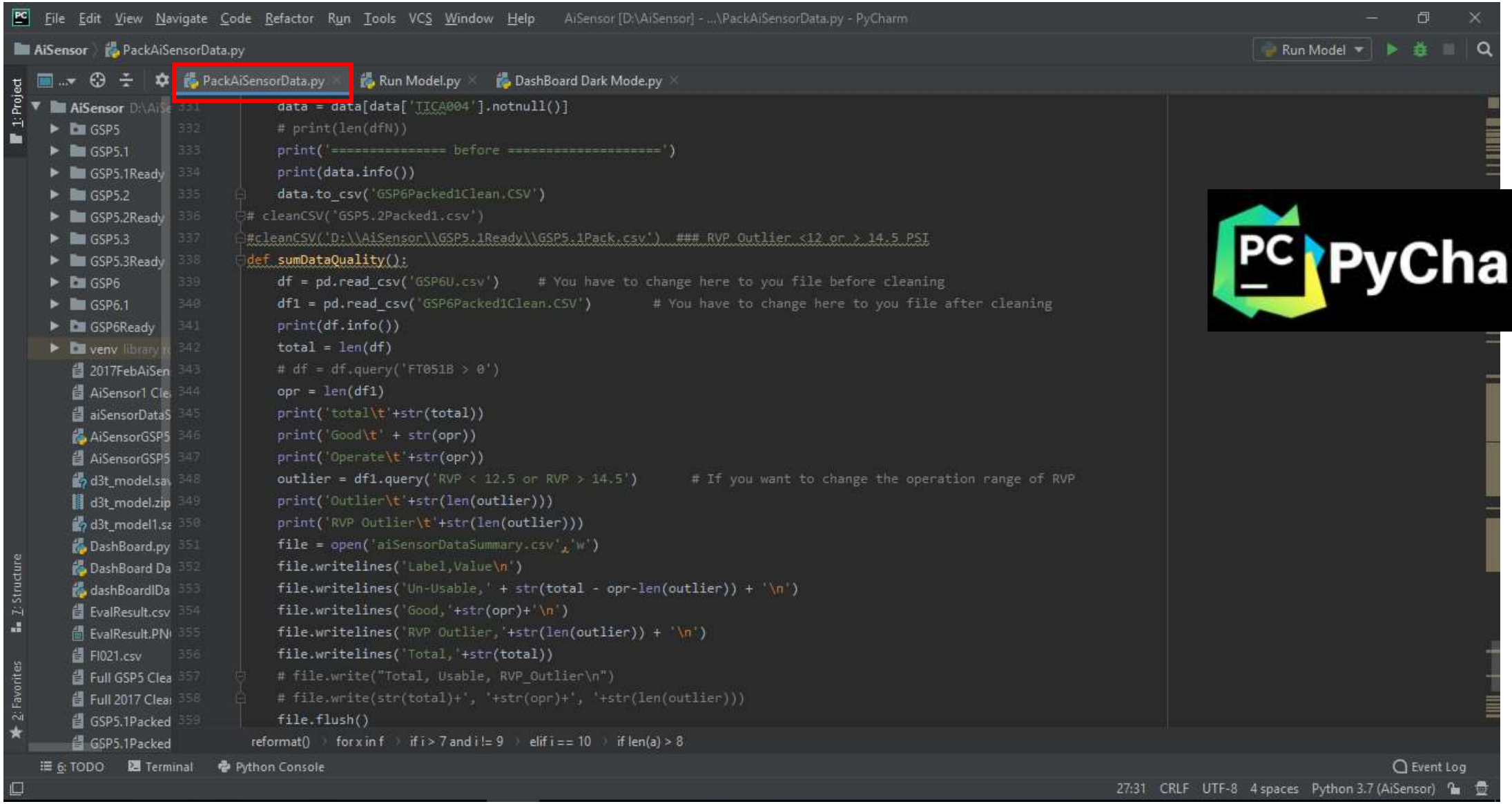
Data Preparation: Pack Data



Tag Name	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTTGSP.G	PTT
1/1/2017 0:00	137.245	65.232	7.848	4.55	0.192	18.393	0.041	1.011	0.199	1.071	1.136	0.326	0.001	80.684	83.951	584.266	86.451	75.723	162.781	156.845	168.73	80.558	79.334	55.787	2
1/1/2017 0:01	136.53	65.232	7.848	4.55	0.192	18.393	0.041	1.011	0.199	1.071	1.136	0.326	0.001	80.704	83.951	584.606	86.413	75.079	162.792	156.848	168.743	80.566	79.311	55.573	2
1/1/2017 0:02	135.899	65.232	7.848	4.55	0.192	18.393	0.041	1.011	0.199	1.071	1.136	0.326	0.001	80.696	84.01	584.18	86.445	75.627	162.808	156.864	168.747	80.559	79.3	55.663	2
1/1/2017 0:03	137.17	65.132	7.859	4.55	0.19	18.473	0.043	1.015	0.188	1.098	1.138	0.315	0.001	80.697	84.01	584.773	86.411	75.26	162.838	156.832	168.731	80.544	79.306	55.442	2
1/1/2017 0:04	137.287	65.132	7.859	4.55	0.19	18.473	0.043	1.015	0.188	1.098	1.138	0.315	0.001	80.669	84.01	584.022	86.411	74.546	162.819	156.826	168.729	80.511	79.193	55.266	2
1/1/2017 0:05	135.829	65.132	7.859	4.55	0.19	18.473	0.043	1.015	0.188	1.098	1.138	0.315	0.001	80.64	83.956	584.549	86.454	74.687	162.845	156.81	168.709	80.475	79.227	55.292	2
1/1/2017 0:06	137.516	65.132	7.859	4.55	0.19	18.473	0.043	1.015	0.188	1.098	1.138	0.315	0.001	80.605	84.005	585.859	86.454	74.274	162.879	156.825	168.711	80.434	79.216	55.227	2
1/1/2017 0:07	137.665	65.179	7.88	4.553	0.191	18.417	0.039	1.012	0.185	1.105	1.13	0.308	0.001	80.569	84.005	584.511	86.494	74.49	162.817	156.811	168.716	80.383	79.157	55.128	2
1/1/2017 0:08	137.637	65.179	7.88	4.553	0.191	18.417	0.039	1.012	0.185	1.105	1.13	0.308	0.001	80.527	84.005	584.427	86.494	74.205	162.861	156.8	168.71	80.321	79.091	55.171	2
1/1/2017 0:09	137.646	65.179	7.88	4.553	0.191	18.417	0.039	1.012	0.185	1.105	1.13	0.308	0.001	80.463	84.005	585.344	86.531	74.225	162.867	156.816	168.729	80.268	79.051	54.97	2
1/1/2017 0:10	137.788	65.179	7.88	4.553	0.191	18.417	0.039	1.012	0.185	1.105	1.13	0.308	0.001	80.421	84.005	584.08	86.531	74.075	162.85	156.819	168.726	80.209	78.98	54.896	2
1/1/2017 0:11	136.497	65.287	7.843	4.524	0.19	18.412	0.037	1.009	0.185	1.077	1.132	0.304	0.001	80.366	84.061	584.938	86.559	74.43	162.88	156.804	168.746	80.15	78.96	54.95	2
1/1/2017 0:12	137.862	65.287	7.843	4.524	0.19	18.412	0.037	1.009	0.185	1.077	1.132	0.304	0.001	80.307	84.061	584.737	86.559	74.269	162.891	156.829	168.779	80.094	78.886	54.964	2
1/1/2017 0:13	139.744	65.287	7.843	4.524	0.19	18.412	0.037	1.009	0.185	1.077	1.132	0.304	0.001	80.264	84.101	584.039	86.525	74.084	162.924	156.818	168.787	80.058	78.839	54.731	2
1/1/2017 0:14	137.731	65.287	7.843	4.524	0.19	18.412	0.037	1.009	0.185	1.077	1.132	0.304	0.001	80.231	84.022	583.501	86.525	74.312	162.944	156.826	168.822	80.016	78.833	54.693	2
1/1/2017 0:15	137.439	65.274	7.878	4.57	0.194	18.365	0.038	1.018	0.181	1.055	1.14	0.286	0.001	80.154	84.136	584.657	86.525	74.281	163.037	156.842	168.83	79.989	78.803	54.662	2
1/1/2017 0:16	137.694	65.274	7.878	4.57	0.194	18.365	0.038	1.018	0.181	1.055	1.14	0.286	0.001	80.168	84.136	583.939	86.525	73.523	163.054	156.859	168.872	79.941	78.79	54.585	2
1/1/2017 0:17	138.696	65.274	7.878	4.57	0.194	18.365	0.038	1.018	0.181	1.055	1.14	0.286	0.001	80.15	84.175	584.962	86.525	73.706	163.062	156.861	168.879	79.928	78.769	54.486	2
1/1/2017 0:18	138.918	65.274	7.878	4.57	0.194	18.365	0.038	1.018	0.181	1.055	1.14	0.286	0.001	80.124	84.142	584.49	86.454	74.379	163.051	156.852	168.932	79.907	78.732	54.409	2
1/1/2017 0:19	137.01	65.251	7.944	4.534	0.199	18.343	0.043	1.02	0.181	1.052	1.14	0.293	0.001	80.088	84.142	586.306	86.454	73.742	163.038	156.837	168.943	79.86	78.727	54.271	2
1/1/2017 0:20	137.925	65.251	7.944	4.534	0.199	18.343	0.043	1.02	0.181	1.052	1.14	0.293	0.001	80.061	84.142	585.923	86.415	73.34	163.035	156.824	168.946	79.828	78.687	53.978	2
1/1/2017 0:21	137.557	65.251	7.944	4.534	0.199	18.343	0.043	1.02	0.181	1.052	1.14	0.293	0.001	80.026	84.142	586.248	86.415	73.12	163.044	156.799	168.961	79.809	78.661	53.825	2
1/1/2017 0:22	138.347	65.251	7.944	4.534	0.199	18.343	0.043	1.02	0.181	1.052	1.14	0.293	0.001	79.985	84.142	586.684	86.415	73.336	163.02	156.754	168.946	79.738	78.677	53.501	2
1/1/2017 0:23	137.343	65.221	7.874	4.57	0.195	18.334	0.04	1.017	0.211	1.062	1.14	0.336	0.001	79.954	84.105	585.879	86.441	73.257	163.009	156.725	168.959	79.691	78.644	52.911	2
1/1/2017 0:24	137.325	65.221	7.874	4.57	0.195	18.334	0.04	1.017	0.211	1.062	1.14	0.336	0.001	79.892	84.134	585.248	86.478	73.43	163.033	156.677	168.925	79.622	78.624	52.354	2
1/1/2017 0:25	137.482	65.221	7.874	4.57	0.195	18.334	0.04	1.017	0.211	1.062	1.14	0.336	0.001	79.842	84.134	584.707	86.519	73.293	162.999	156.654	168.933	79.546	78.613	51.878	2
1/1/2017 0:26	136.562	65.221	7.874	4.57	0.195	18.334	0.04	1.017	0.211	1.062	1.14	0.336	0.001	79.783	84.134	585.29	86.519	73.502	163.097	156.631	168.872	79.491	78.607	51.706	2
1/1/2017 0:27	137.369	65.316	7.878	4.561	0.195	18.318	0.037	1.016	0.18	1.083	1.127	0.29	0.001	79.764	84.134	585.217	86.519	73.623	163.073	156.604	168.869	79.475	78.627	51.831	2
1/1/2017 0:28	137.813	65.316	7.878	4.561	0.195	18.318	0.037	1.016	0.18	1.083	1.127	0.29	0.001	79.717	84.134	584.911	86.558	73.711	163.09	156.616	168.869	79.456	78.642	52.315	2
1/1/2017 0:29	136.843	65.316	7.878	4.561	0.195	18.318	0.037	1.016	0.18	1.083	1.127	0.29	0.001	79.716	84.196	584.628	86.494	73.791	163.16	156.625	168.914	79.498	78.647	52.691	2
1/1/2017 0:30	137.986	65.316	7.878	4.561	0.195	18.318	0.037	1.016	0.18	1.083	1.127	0.29	0.001	79.73	84.196	584.873	86.457	74.224	163.236	156.645	168.961	79.549	78.669	53.065	2
1/1/2017 0:31	136.718	65.328	7.859	4.553	0.194	18.308	0.034	1.035	0.179	1.078	1.143	0.289	0.001	79.753	84.231	585.602	86.381	73.761	163.275	156.669	169.008	79.604	78.724	53.748	2
1/1/2017 0:32	137.353	65.328	7.859	4.553	0.194	18.308	0.034	1.035	0.179	1.078	1.143	0.289	0.001	79.818	84.265	586.216	86.381	74.385	163.233	156.681	169.06	79.671	78.744	54.15	2
1/1/2017 0:33	137.736	65.328	7.859	4.553	0.194	18.308	0.034	1.035	0.179	1.078	1.143	0.289	0.001	79.855	84.265	587.426	86.318	73.932	163.288	156.713	169.143	79.711	78.766	54.304	2
1/1/2017 0:34	137.144	65.328	7.859	4.553	0.194	18.308	0.034	1.035	0.179	1.078	1.143	0.289	0.001	79.912	84.265	587.306	86.239	73.712	163.275	156.685	169.144	79.758	78.781	53.956	2
1/1/2017 0:35	138.177	65.292	7.863	4.547	0.193	18.351	0.041	1.031	0.179	1.072	1.143	0.288	0.001	79.928	84.265	585.776	86.193	73.411	163.273	156.677	169.147	79.716	78.784	53.173	2
1/1/2017 0:36	137.685	65.292	7.863	4.547	0.193	18.351	0.041	1.031	0.179	1.072	1.143	0.288	0.001	79.923	84.209	585.761	86.226	73.665	163.304	156.648	169.091	79.679	78.757	52.253	2
1/1/2017 0:37	137.228	65.292	7.863	4.547	0.193	18.351	0.041	1.031	0.179	1.072	1.143	0.288	0.001	79.894	84.209	586.6	86.282	73.625	163.202	156.616	169.018	79.624	78.773	51.889	2
1/1/2017 0:38	137.233	65.292	7.863	4.547	0.193	18.351	0.041	1.031	0.179	1.072	1.143	0.288	0.001	79.861	84.135	586.745	86.357	74.012	163.156	156.614	168.951	79.566	78.791	51.33	2
1/1/2017 0:39	136.818	65.299	7.866	4.545	0.194	18.35	0.042	1.01	0.177	1.094	1.135	0.287	0.001	79.828	84.135	586.254	86.394	73.711	163.133	156.604	168.887	79.538	78.789	51.284	2
1/1/2017 0:40	137.51	65.299	7.866	4.545	0.194	18.35	0.042	1.01	0.177	1.094	1.135	0.287	0.001	79.797	84.135	586.341	86.394	74.444	163.105	156.611	168.832	79.52	78.793	51.23	2

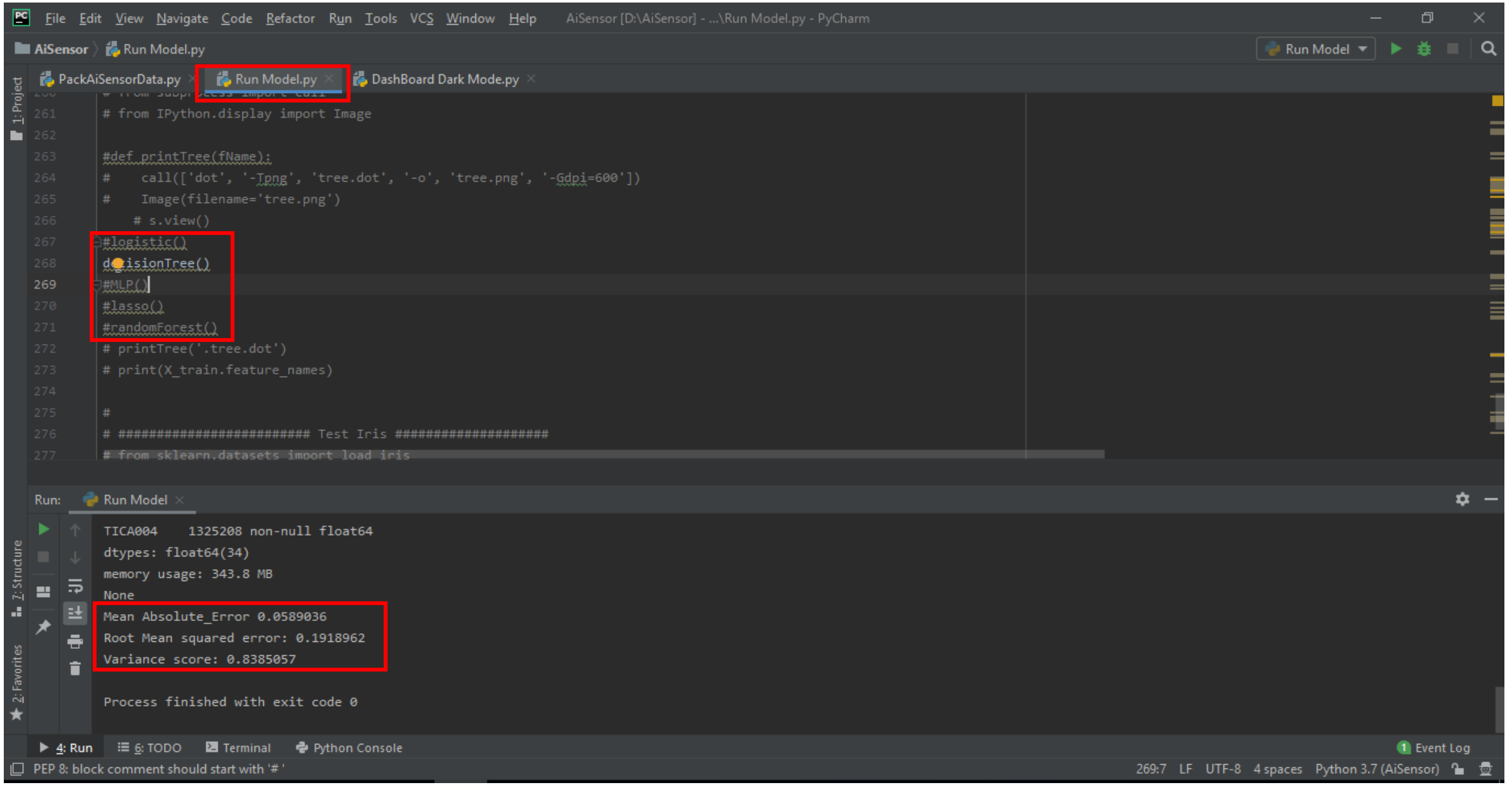
- 36 Feature
- 1 Target
- 30 Months Period
- 50M Cells of Data

Data Preparation: Data Cleaning

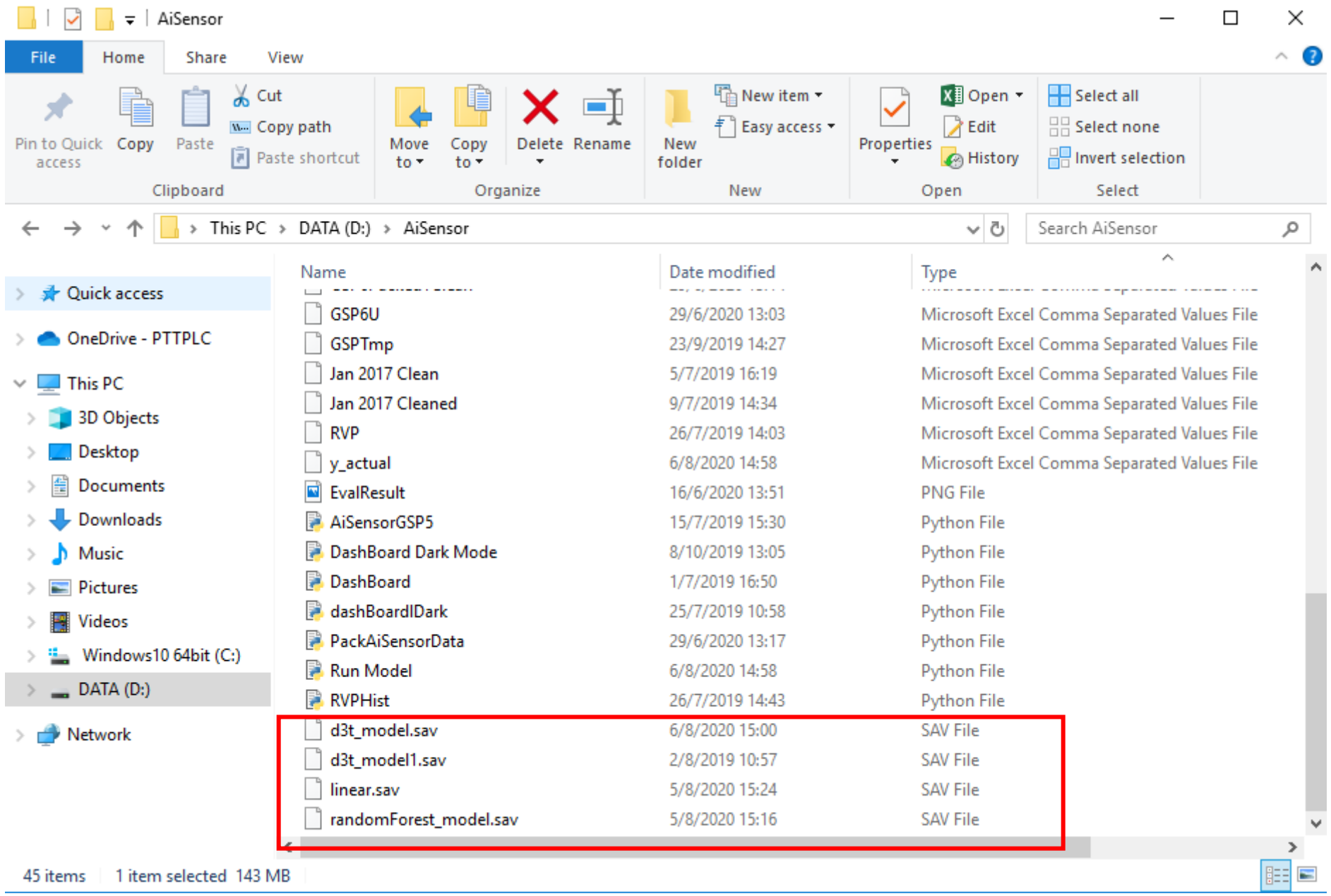


NULL & Zero Value & Outlier (RVP <12.5 or RVP >14.5 psi)

Prototype Model Development



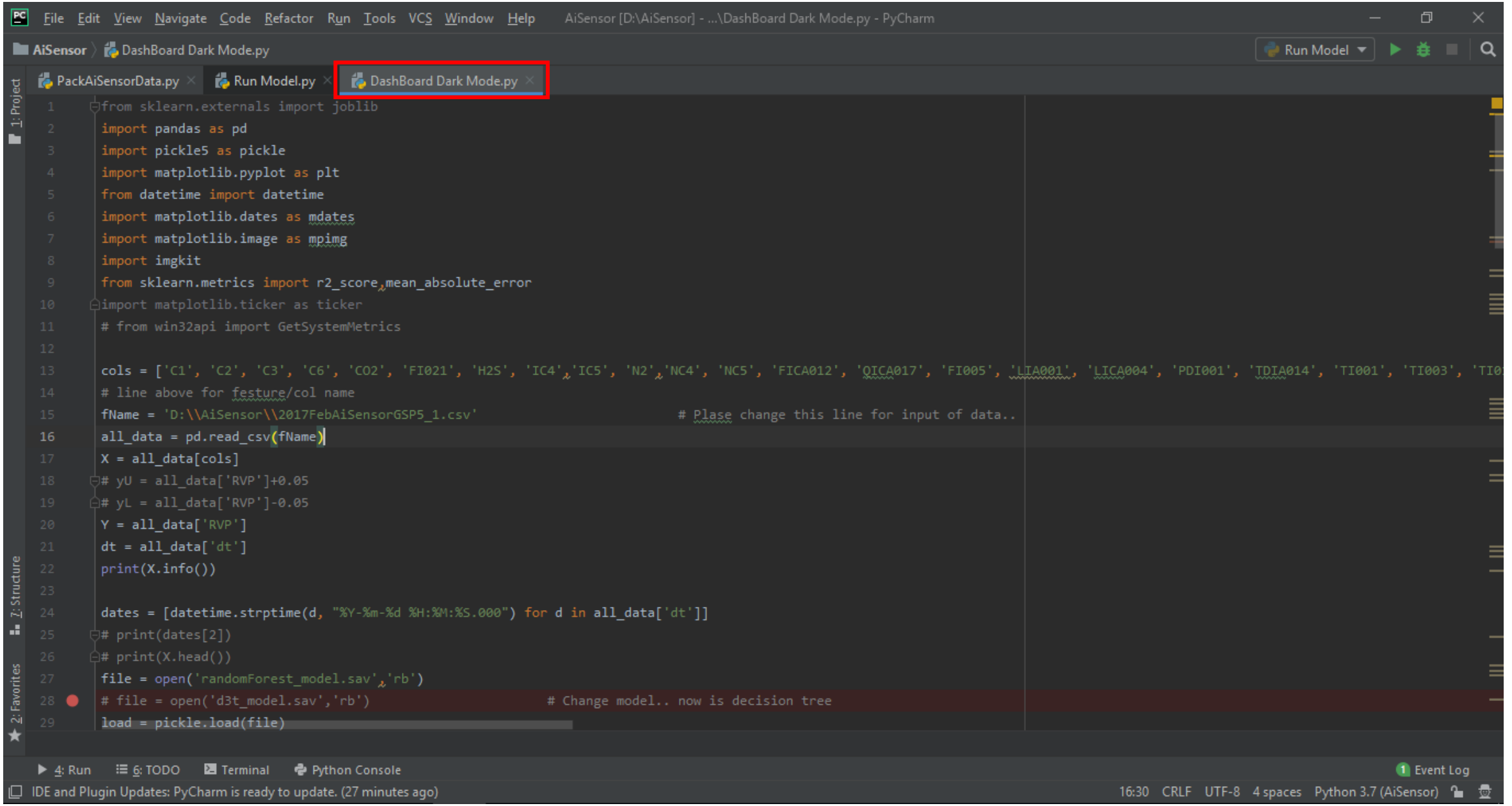
Prototype Model Development



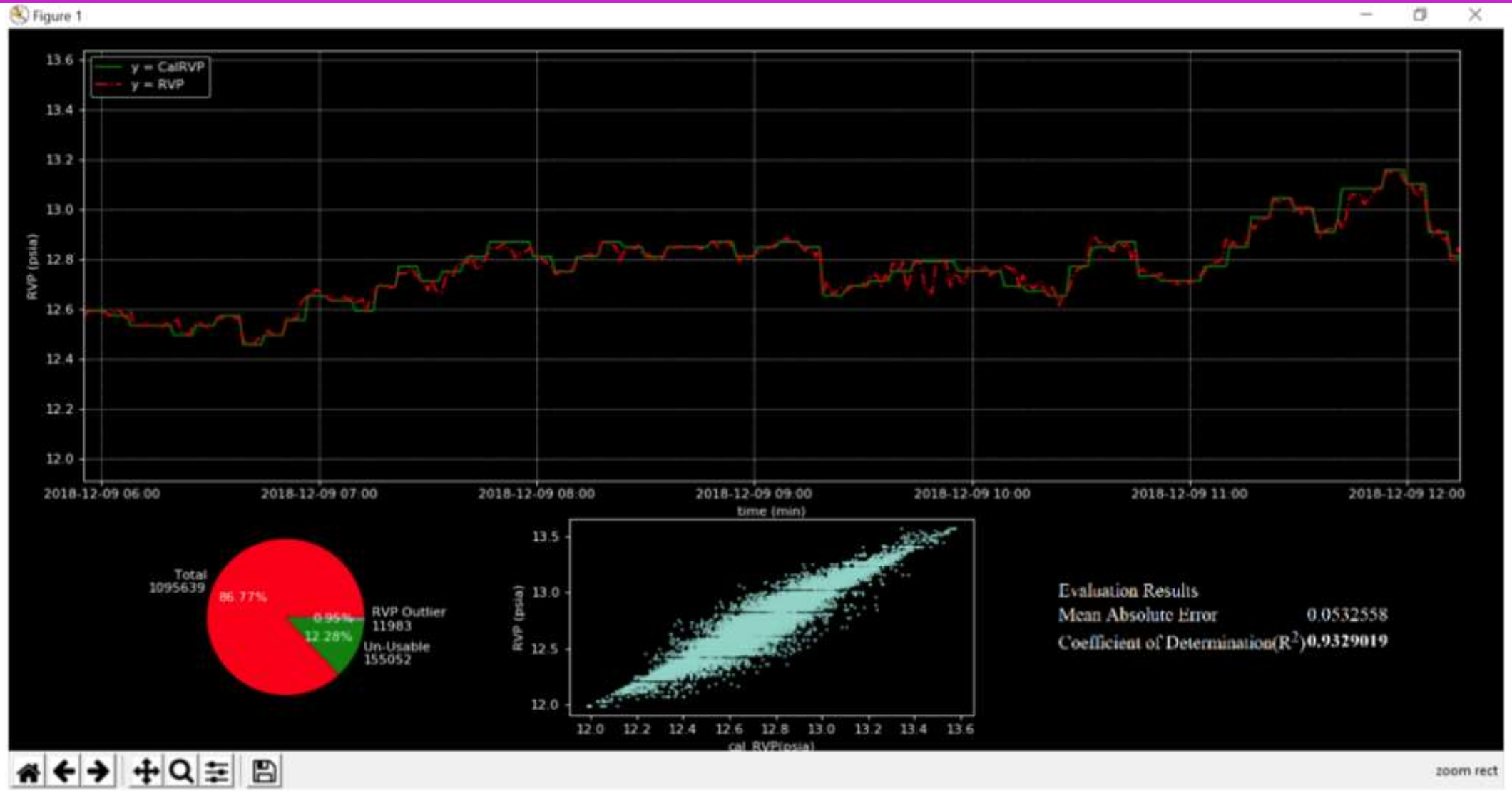
Prototype Model Results

	Mean Absolute Error	Root Mean Square Error	R-Square
LASSO	0.244	0.445	0.13
DECISION TREE	0.058	0.191	0.84
RANDOM FOREST	0.058	0.137	0.92
MLP	-	-	-

Prototype Model Visualization



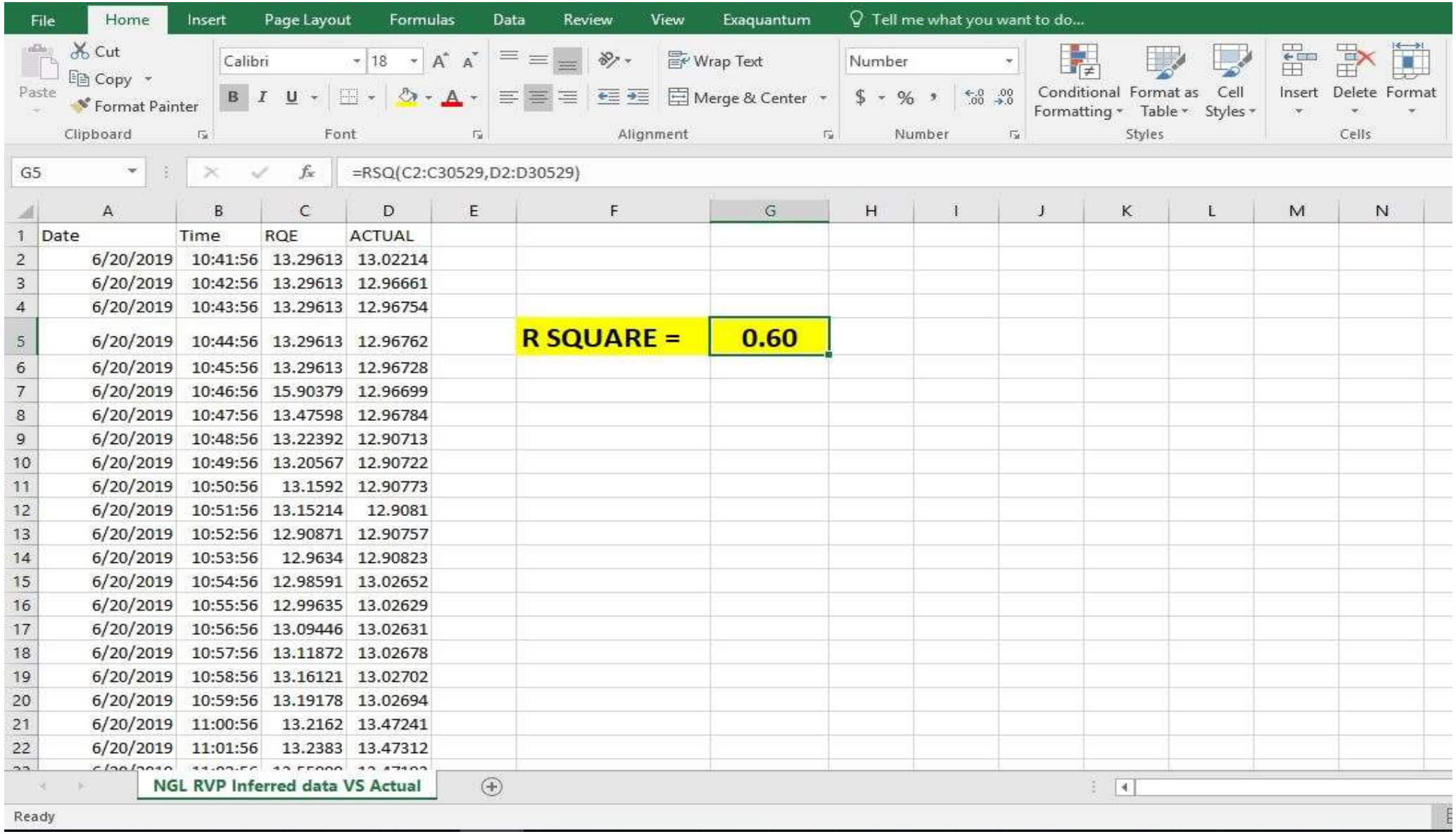
Prototype Model Visualization



GSP#6 RVP Prediction Model: R2 = 0.92, Error = 0.05 psi

***GSP#5 RVP Prediction Model: R2 = 0.93, Error = 0.05 psi**

RQE Results

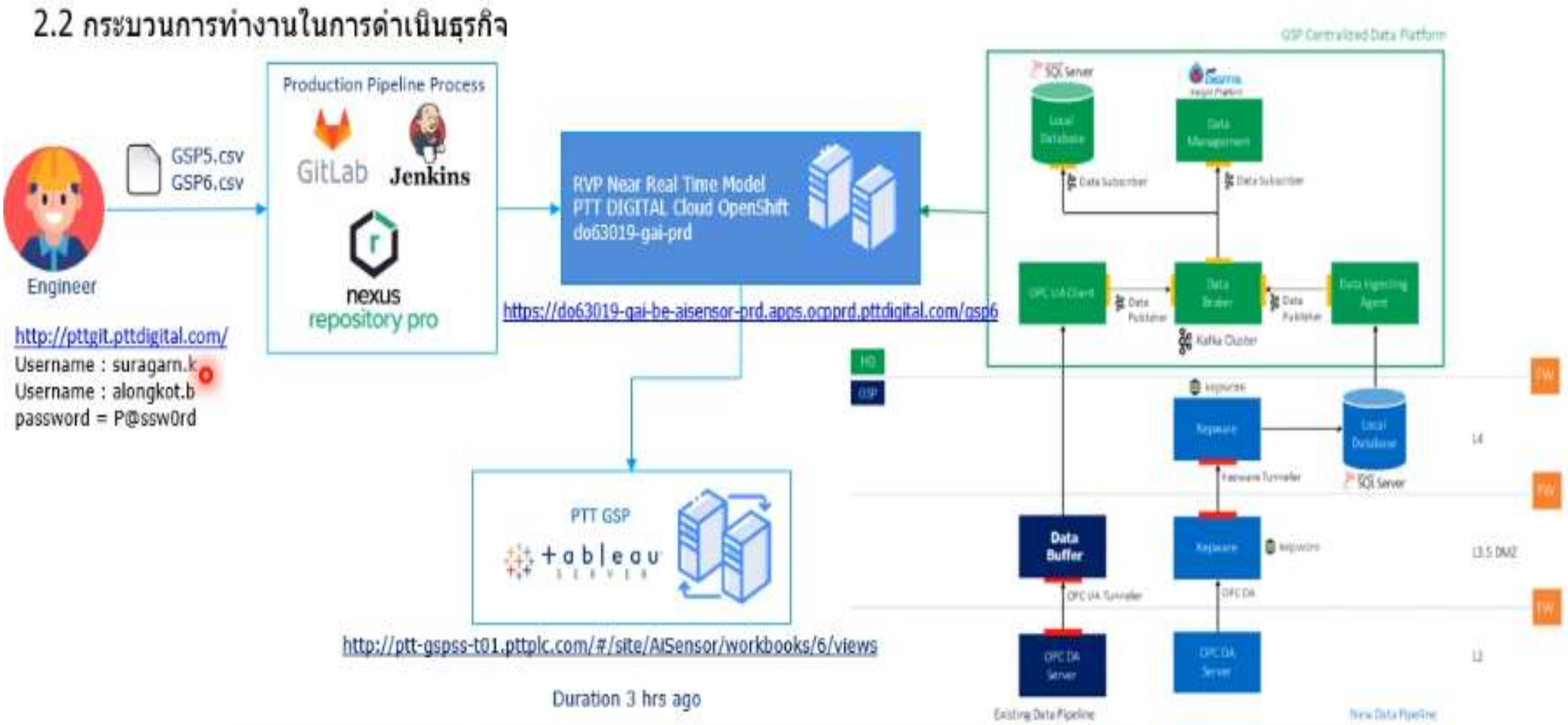


	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Date	Time	RQE	ACTUAL										
2	6/20/2019	10:41:56	13.29613	13.02214										
3	6/20/2019	10:42:56	13.29613	12.96661										
4	6/20/2019	10:43:56	13.29613	12.96754										
5	6/20/2019	10:44:56	13.29613	12.96762		R SQUARE =	0.60							
6	6/20/2019	10:45:56	13.29613	12.96728										
7	6/20/2019	10:46:56	15.90379	12.96699										
8	6/20/2019	10:47:56	13.47598	12.96784										
9	6/20/2019	10:48:56	13.22392	12.90713										
10	6/20/2019	10:49:56	13.20567	12.90722										
11	6/20/2019	10:50:56	13.1592	12.90773										
12	6/20/2019	10:51:56	13.15214	12.9081										
13	6/20/2019	10:52:56	12.90871	12.90757										
14	6/20/2019	10:53:56	12.9634	12.90823										
15	6/20/2019	10:54:56	12.98591	13.02652										
16	6/20/2019	10:55:56	12.99635	13.02629										
17	6/20/2019	10:56:56	13.09446	13.02631										
18	6/20/2019	10:57:56	13.11872	13.02678										
19	6/20/2019	10:58:56	13.16121	13.02702										
20	6/20/2019	10:59:56	13.19178	13.02694										
21	6/20/2019	11:00:56	13.2162	13.47241										
22	6/20/2019	11:01:56	13.2383	13.47312										

Benchmarking

Method	Interval	R-Square
RVP On-Line	5-7 min	1
RQE	1 min	0.6++
AI Sensor	1 min	0.9++

Next Step (Currently on work)



Next Step

- Energy Index Prediction
- WI prediction
- Other Prediction Model

What I have Learned

- **Data Preparation is the Key**
  "Garbage-In Garbage Out"
- **Simple is the Best**
- **AI is not everything**

Q&A