

## Performance Index

### Variable Definitions

Types of Variables:

- a. **process variables.** Process variables are measured and may be influenced by the automation system.
- b. **disturbance variables.** Disturbance variables influence the process. They are measured but they cannot be directly influenced by the automation system.
- c. **decision variables.** Decision variables are measured and may be influenced by the automation system. They are used to determine the **performance index**.

#	Variable	Variable Type	Abbreviation
1	BatchRunTime	Process Variable ▾	PBatTim
2	L21003	Process Variable ▾	PL1
3	L22003	Process Variable ▾	PL2
4	L23003	Process Variable ▾	PL3
5	N11001	Disturbance Variable ▾	DN11
6	N12001	Disturbance Variable ▾	DN12
7	N22500	Decision Variable ▾	EN25
8	PD14006_SP	Disturbance Variable ▾	DPD14
9	ScenID	Not Used ▾	
10	Y14001	Disturbance Variable ▾	DY1401
11	Y14005	Disturbance Variable ▾	DY1405
12	Y21001	Decision Variable ▾	EY2101
13	Y21006	Disturbance Variable ▾	DY2106
14	Y22004	Not Used ▾	
15	Y22006	Disturbance Variable ▾	DY2206
16	Y23001	Decision Variable ▾	EY2301
17	Y23006	Disturbance Variable ▾	DY2306

Apply

### Optimize to Minimum/Maximum

☒ Minimize Performance Index ☐ Maximize Performance Index

Apply

### Performance Index Formula

#### Supported Functions and Examples

C=PBatTim

PBatTim: BatchRunTime, PL1: L21003, PL2: L22003, PL3: L23003, EN25: N22500, EY2101: Y21001, EY2301: Y23001, DN11: N11001, DN12: N12001, DPD14: PD14006\_SP, DY1401: Y14001, DY1405: Y14005, DY2106: Y21006, DY2206: Y22006, DY2306: Y23006  
The performance index is stored in variable C. Thus, please assign C in the last line of the formula.  
Conformality with javascript and python will be checked.

Constant Constraints

You may edit constant constraints for each variable.

#	Variable	Lower bound	Upper bound
1	BatchRunTime	<input type="text" value="0"/> <small>Smallest value: 154</small>	<input type="text" value="896"/> <small>Largest value: 896</small>
2	L21003	<input type="text" value="2.83637166023254"/> <small>Smallest value: 2.83637166023254</small>	<input type="text" value="15"/> <small>Largest value: 20.6590003967285</small>
3	L22003	<input type="text" value="6.5502028465271"/> <small>Smallest value: 6.5502028465271</small>	<input type="text" value="8.44835090637207"/> <small>Largest value: 8.44835090637207</small>
4	L23003	<input type="text" value="6.32740211486816"/> <small>Smallest value: 6.32740211486816</small>	<input type="text" value="13"/> <small>Largest value: 20.6575527191162</small>
5	N11001	<input type="text" value="2000"/> <small>Smallest value: 2000</small>	<input type="text" value="2800"/> <small>Largest value: 2800</small>
6	N12001	<input type="text" value="0"/> <small>Smallest value: 0</small>	<input type="text" value="2000"/> <small>Largest value: 2000</small>
7	N22500	<input type="text" value="600"/> <small>Smallest value: 600</small>	<input type="text" value="1500"/> <small>Largest value: 1500</small>
8	PD14006_SP	<input type="text" value="0.6"/> <small>Smallest value: 0.6</small>	<input type="text" value="1.4"/> <small>Largest value: 1.4</small>
10	Y14001	<input type="text" value="70"/> <small>Smallest value: 70</small>	<input type="text" value="99"/> <small>Largest value: 99</small>
11	Y14005	<input type="text" value="0"/> <small>Smallest value: 0</small>	<input type="text" value="1"/> <small>Largest value: 1</small>
12	Y21001	<input type="text" value="50"/> <small>Smallest value: 50</small>	<input type="text" value="100"/> <small>Largest value: 100</small>
13	Y21006	<input type="text" value="40"/> <small>Smallest value: 40</small>	<input type="text" value="100"/> <small>Largest value: 100</small>
15	Y22006	<input type="text" value="25"/> <small>Smallest value: 25</small>	<input type="text" value="75"/> <small>Largest value: 75</small>
16	Y23001	<input type="text" value="50"/> <small>Smallest value: 50</small>	<input type="text" value="100"/> <small>Largest value: 100</small>
17	Y23006	<input type="text" value="25"/> <small>Smallest value: 25</small>	<input type="text" value="55"/> <small>Largest value: 55</small>

Equations for Linear approximation for Process Variables

The equation for the linear model and a table with coefficients is presented.

$$P_{dependant} = c_0 + c_{E_{N25}} E_{N25} + c_{E_{Y2001}} E_{Y2001} + c_{E_{Y2006}} E_{Y2006} + c_{D_{N11}} D_{N11} + c_{D_{N12}} D_{N12} + c_{D_{PD14}} D_{PD14} + c_{D_{Y1401}} D_{Y1401} + c_{D_{Y1405}} D_{Y1405} + c_{D_{Y2006}} D_{Y2006} + c_{D_{Y2106}} D_{Y2106} + c_{D_{Y2206}} D_{Y2206} + c_{D_{Y2306}} D_{Y2306}$$

☐ Show all digits

Linear coefficients

$P_{dependant}$	$c_0$	$c_{E_{N25}}$	$c_{E_{Y2001}}$	$c_{E_{Y2006}}$	$c_{D_{N11}}$	$c_{D_{N12}}$	$c_{D_{PD14}}$	$c_{D_{Y1401}}$	$c_{D_{Y1405}}$	$c_{D_{Y2006}}$	$c_{D_{Y2106}}$	$c_{D_{Y2206}}$	$c_{D_{Y2306}}$
BatchRunTime	1,314.66	0.088	-6.48	-3.68	-0.019	0.012	-42.65	-0.57	-28.54	-2.41	-2.11	-0.083	
L21003	26.34	0.005	-0.045	-0.17	0.001	0.001	2.06	-0.052	0.87	-0.14	-0.017	0.083	
L22003	5.35	-0.001	0.019	0.026	0.000	0.000	0.71	-0.000	-0.035	-0.011	-0.012	-0.022	
L23003	15.64	0.004	-0.16	0.22	0.000	0.000	3.08	-0.043	0.61	-0.027	-0.12	-0.18	

Scaled, linear coefficients												
$P_{\text{dependent}}$	$c_0$	$c_{E_{N25}}$	$c_{E_{Y200}}$	$c_{E_{Y200}}$	$c_{D_{N11}}$	$c_{D_{N12}}$	$c_{D_{Y204}}$	$c_{D_{Y140}}$	$c_{D_{Y1405}}$	$c_{D_{Y206}}$	$c_{D_{Y206}}$	$c_{D_{Y206}}$
BatchRunTime	-0.49	0.089	-0.36	-0.21	-0.017	0.028	-0.038	-0.018	-0.032	-0.16	-0.12	-0.003
L21003	0.087	0.39	-0.19	-0.69	0.053	0.12	0.14	-0.12	0.072	-0.68	-0.070	0.20
L22003	-0.74	-0.35	0.49	0.70	0.071	0.040	0.30	-0.005	-0.018	-0.35	-0.32	-0.35
L23003	-0.21	0.51	-1.22	1.62	0.013	0.13	0.37	-0.19	0.092	-0.24	-0.91	-0.81

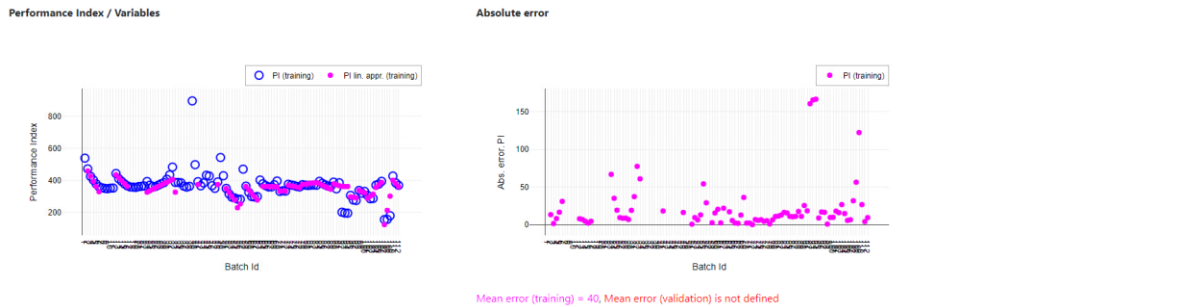
PBatTime: BatchRunTime, PL1: L21003, PL2: L22003, PL3: L23003, EN25: N22500, EY2101: Y21001, EY2301: Y23001, DN11: N11001, DN12: N12001, DPD14: PD14006\_SP, DY1401: Y14001, DY1405: Y14005, DY2106: Y21006, DY2206: Y22006, DY2306: Y23006

Equations for Quadratic approximation for Process Variables												
The equation for the quadratic model and a table with coefficients is presented.												
$P_{\text{dependent}} = c_0 + c_{E_{N25}} E_{N25} + q_{E_{N25}} E_{N25}^2 + m_{E_{N25}, E_{Y200}} E_{N25} E_{Y200} + m_{E_{N25}, E_{Y200}} E_{N25} E_{Y200} + m_{E_{N25}, D_{N11}} E_{N25} D_{N11} + m_{E_{N25}, D_{N12}} E_{N25} D_{N12} + m_{E_{N25}, D_{Y204}} E_{N25} D_{Y204} + m_{E_{N25}, D_{Y140}} E_{N25} D_{Y140} + m_{E_{N25}, D_{Y1405}} E_{N25} D_{Y1405} + m_{E_{N25}, D_{Y206}} E_{N25} D_{Y206}$												
<input type="checkbox"/> Show all digits												
Status	$P_{\text{dependent}}$	$c_0$	$c_{E_{N25}}$	$c_{E_{Y200}}$	$c_{E_{Y200}}$	$c_{D_{N11}}$	$c_{D_{N12}}$	$c_{D_{Y204}}$	$c_{D_{Y140}}$	$c_{D_{Y1405}}$	$c_{D_{Y206}}$	$c_{D_{Y206}}$
Ok	BatchRunTime	-3,351,646.23	605.52	35,244.64	27,922.43	154.34	-30.05	19,513.94	8,309.34	-48,883.82	-1,446.50	-858.26
Ok	L21003	44,513.06	-22.20	-415.28	-409.42	1.10	0.66	-688.39	-92.39	1,158.55	12.36	66.34
Ok	L22003	-8,868.32	1.77	74.97	79.61	1.13	-0.10	93.97	16.59	-162.15	-4.35	-8.31
Ok	L23003	-22,617.66	2.91	353.16	20.77	3.06	0.43	4,107.42	105.30	-1,227.65	60.45	-99.04

Scaled, quadratic coefficients												
Status	$P_{\text{dependent}}$	$c_0$	$c_{E_{N25}}$	$c_{E_{Y200}}$	$c_{E_{Y200}}$	$c_{D_{N11}}$	$c_{D_{N12}}$	$c_{D_{Y204}}$	$c_{D_{Y140}}$	$c_{D_{Y1405}}$	$c_{D_{Y206}}$	$c_{D_{Y206}}$
Ok	BatchRunTime	-3.74	-24.31	-47.44	-51.45	-4.34	1.25	-3.47	-7.80	1.19	0.54	-3.92
Ok	L21003	3.06	22.62	43.99	42.53	-2.15	0.28	-0.56	5.93	-1.36	1.05	-2.32
Ok	L22003	-3.65	-19.85	-40.93	-43.42	-3.22	1.71	2.85	-7.16	1.86	-0.29	-6.75
Ok	L23003	-1.76	-15.45	-30.64	-25.12	-40.36	18.38	205.85	8.52	-2.16	7.63	-12.39

Linear coefficients start with 'c', quadratic coefficients start with 'q', mixed coefficients start with 'm'.  
PBatTime: BatchRunTime, PL1: L21003, PL2: L22003, PL3: L23003, EN25: N22500, EY2101: Y21001, EY2301: Y23001, DN11: N11001, DN12: N12001, DPD14: PD14006\_SP, DY1401: Y14001, DY1405: Y14005, DY2106: Y21006, DY2206: Y22006, DY2306: Y23006

The performance index and, for each process variable, data and its linear approximation is plotted. Optionally, data for decision and disturbance variables is displayed.												
The root mean square error $\Delta$ is defined as												
$\Delta = \sqrt{\frac{1}{N} \sum_{i=1}^N (V_i - V_{ia})^2}$												
where $V$ is a process variable and $V_a$ is its approximation. $N$ is the number of samples (batches).												
<input type="checkbox"/> Show disturbance and decision variables												
Sort order												
Sort by <input checked="" type="radio"/> Batch Id <input type="radio"/> Performance Index <input type="radio"/> Timestamp <input type="radio"/> BatchRunTime <input type="radio"/> L21003 <input type="radio"/> L22003 <input type="radio"/> L23003 <input type="radio"/> N22500 <input type="radio"/> Y21001 <input type="radio"/> Y23001 <input type="radio"/> N11001 <input type="radio"/> N12001 <input type="radio"/> PD14006_SP <input type="radio"/> Y14001 <input type="radio"/> Y14005 <input type="radio"/> Y21006 <input type="radio"/> Y22006 <input type="radio"/> Y23006												



Im Folgenden sind die Optimierungsergebnisse in drei verschiedenen Qualitätsstufen dargestellt.

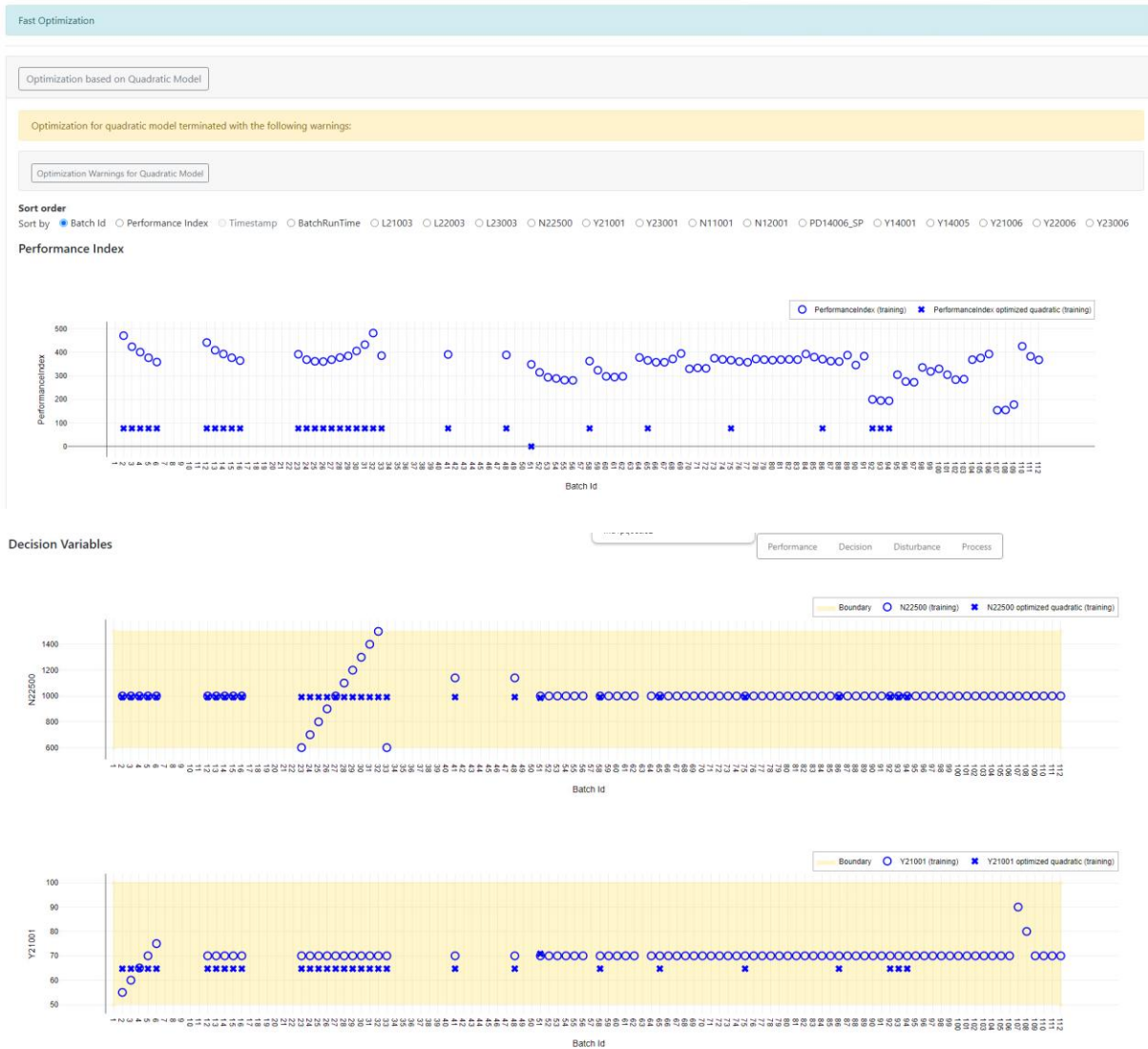
Schnelle Berechnung: ca. 1 min für alle Batches

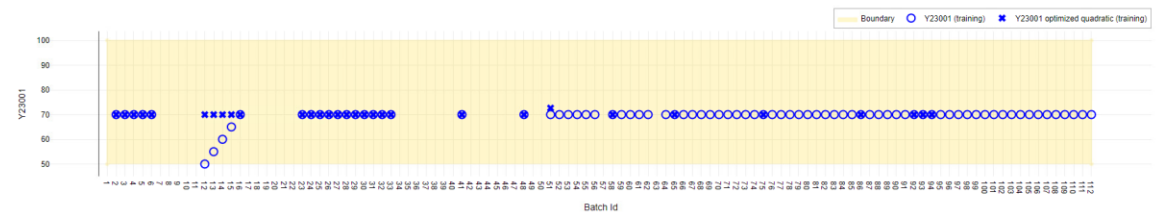
Stufe 2: Berechnung ca. 10 min für alle Batches

Stufe 3: Berechnung ca. 1 h für alle Batches

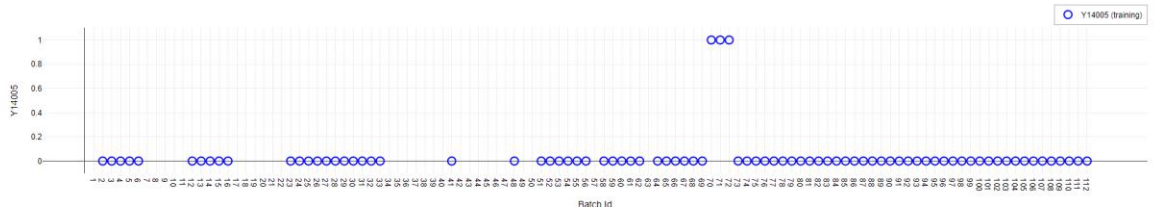
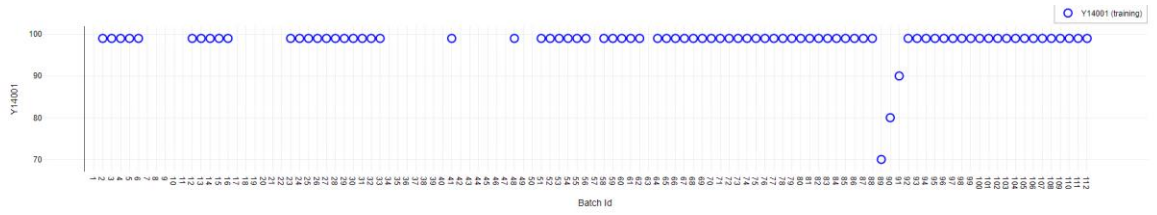
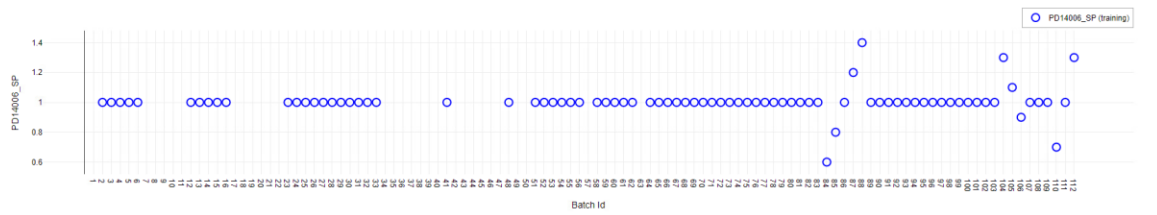
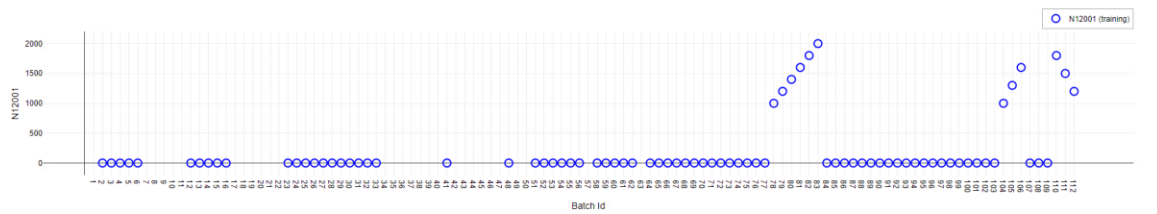
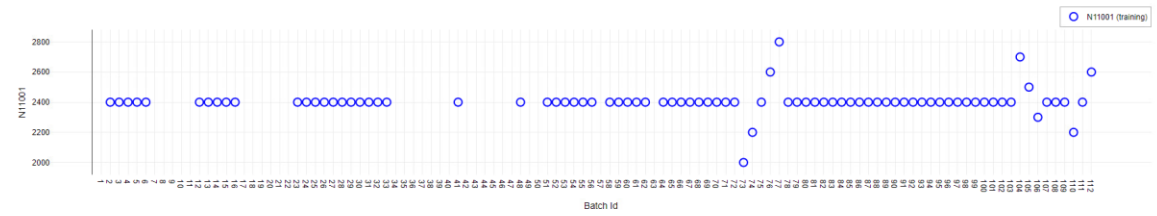
Zum Vergleich auf den optimierten Performance Index achten.

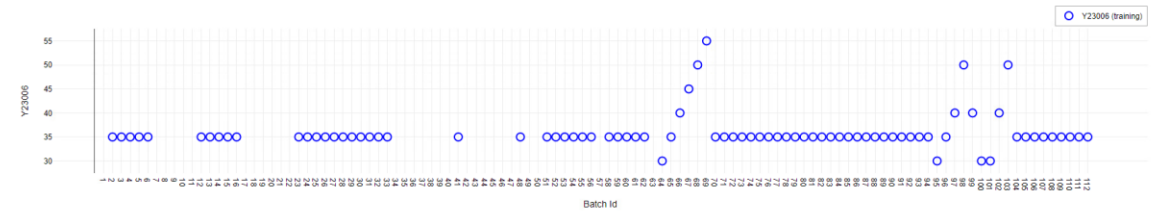
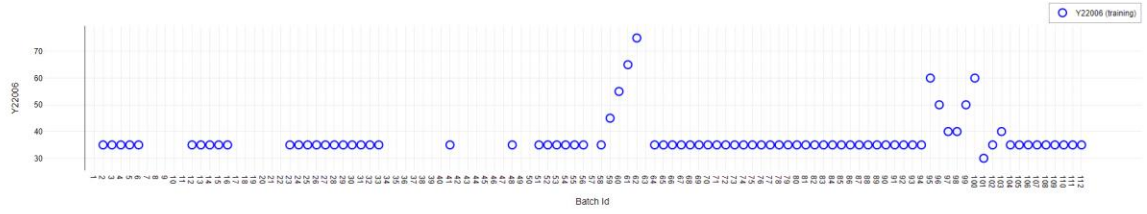
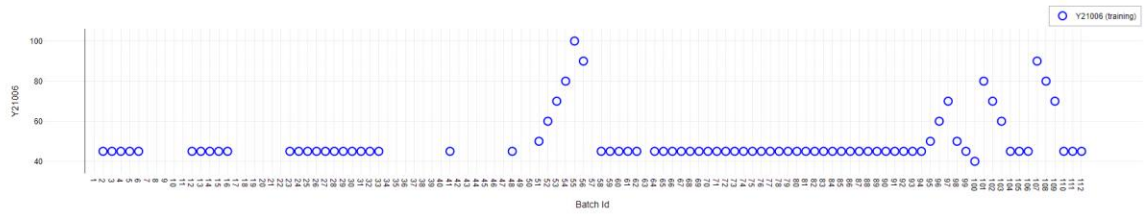
**Ergebnisse für schnelle Berechnung:**



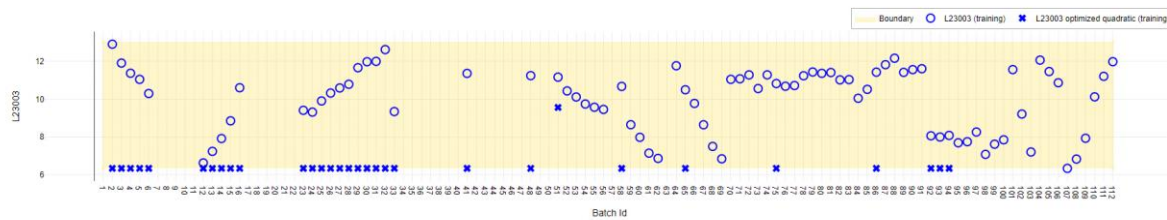
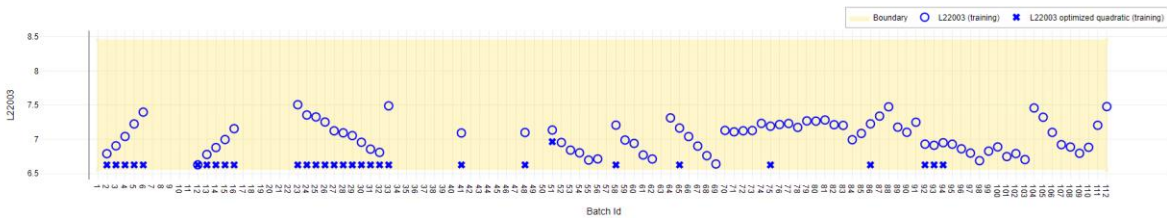
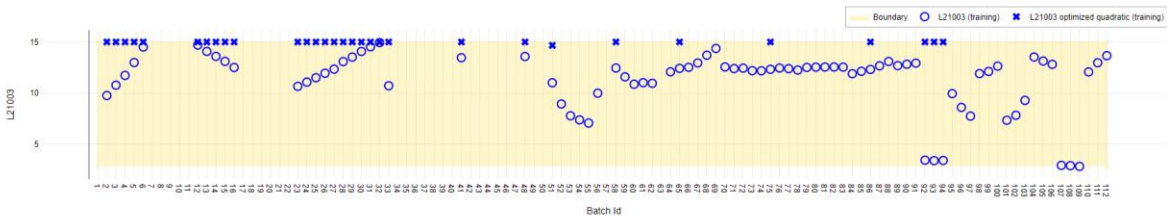
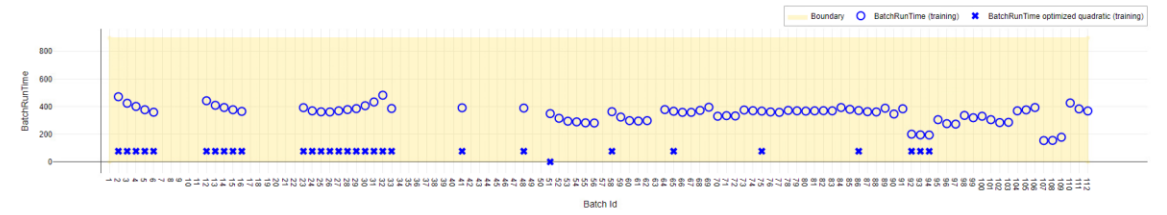


Disturbance Variables

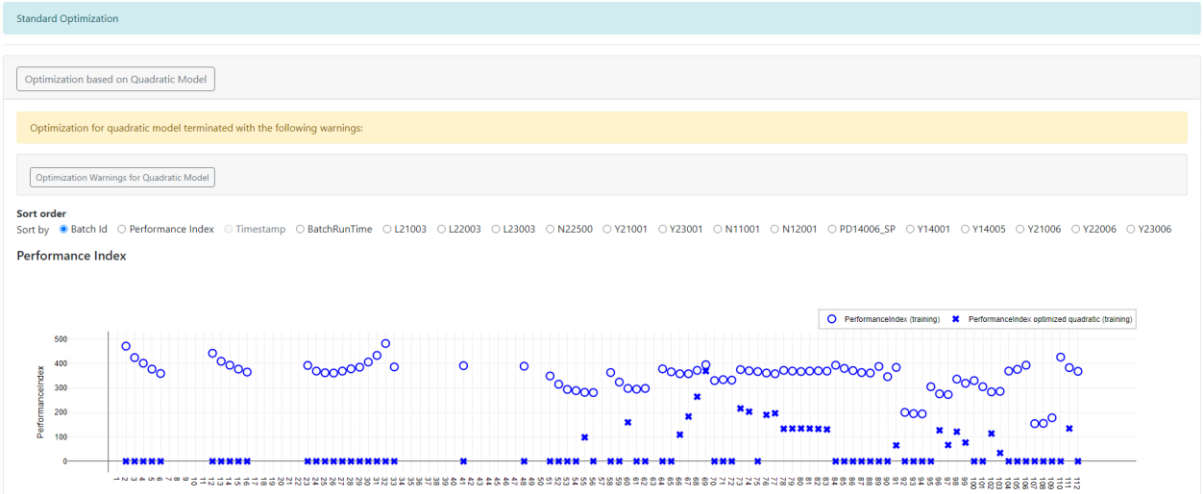




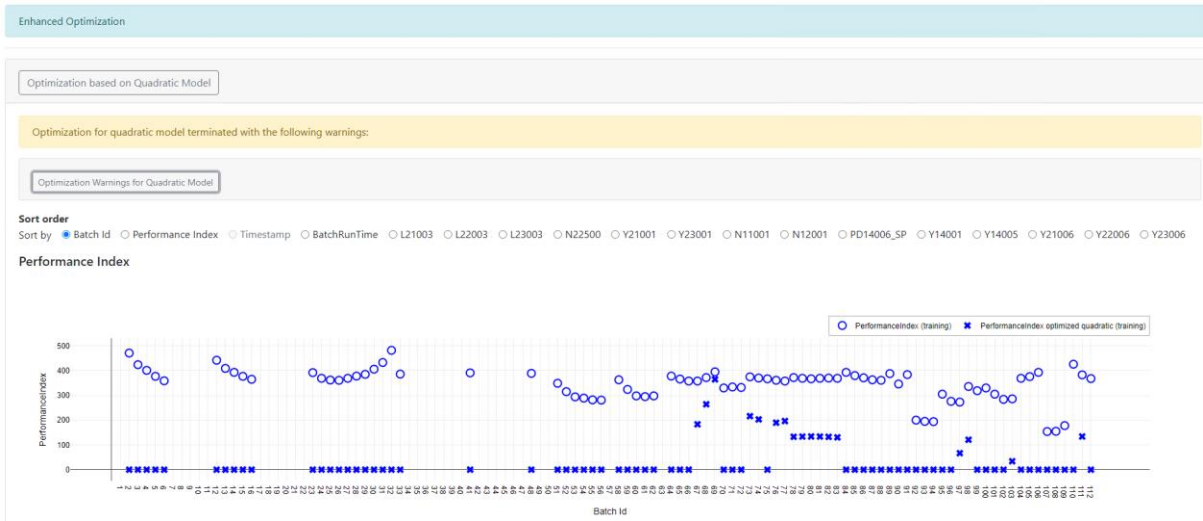
#### Process Variables



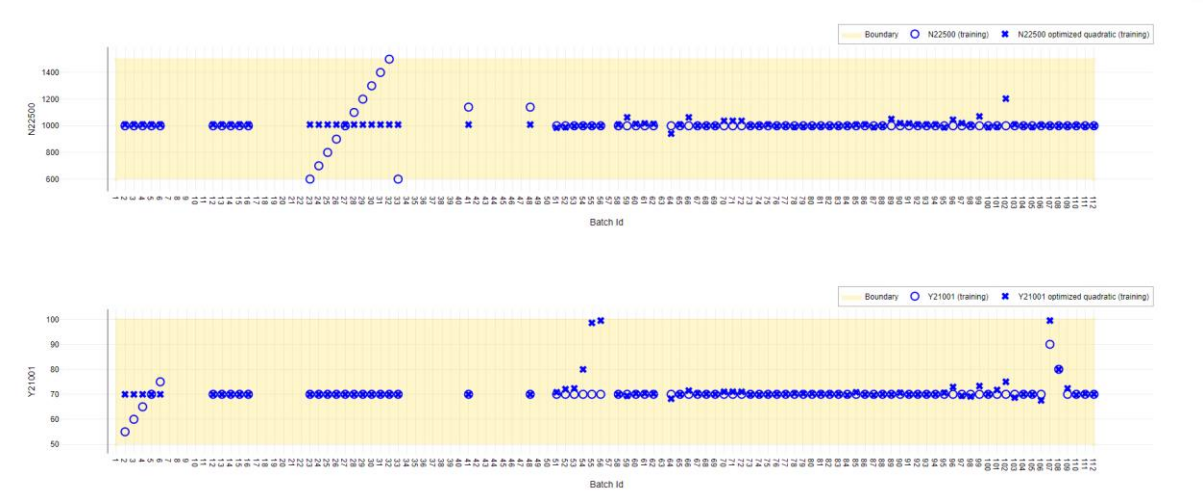
Ergebnisse für mittelschnelle Berechnung (nur Performance Index dargestellt):



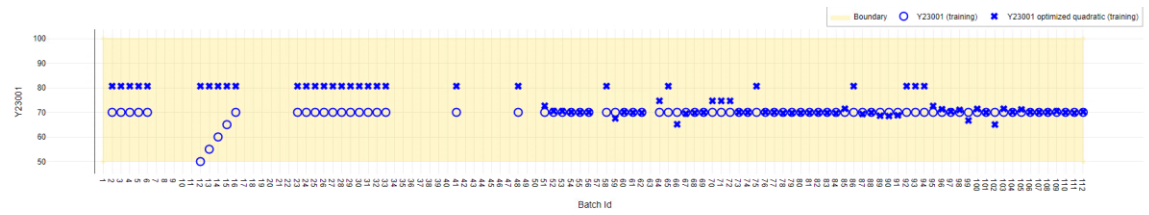
Ergebnisse für langsame Berechnung, optimales Ergebnis:



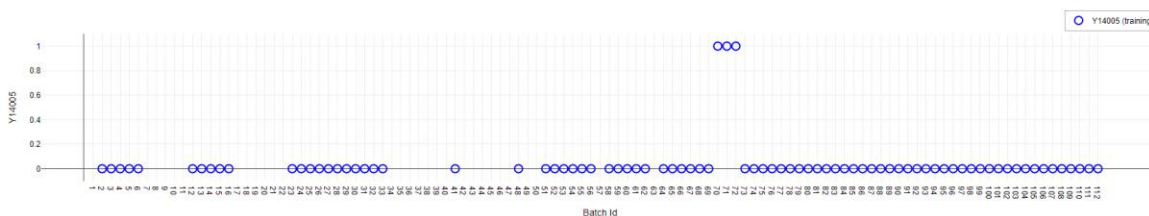
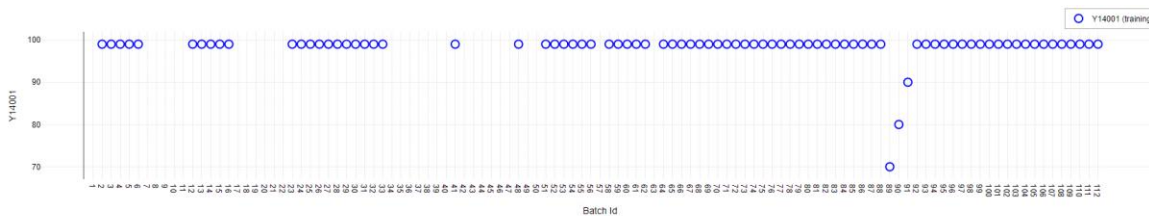
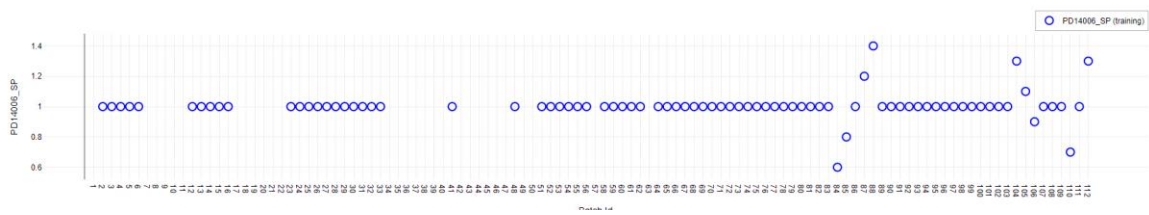
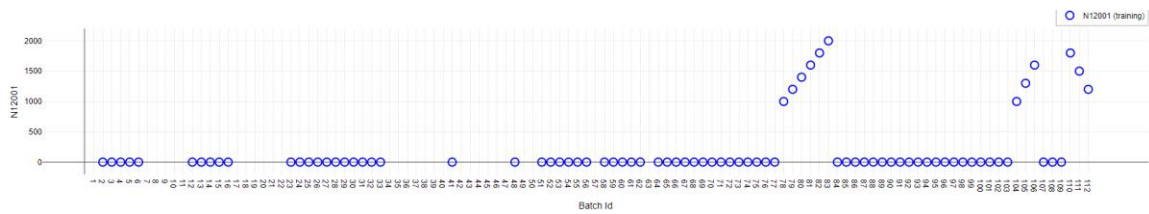
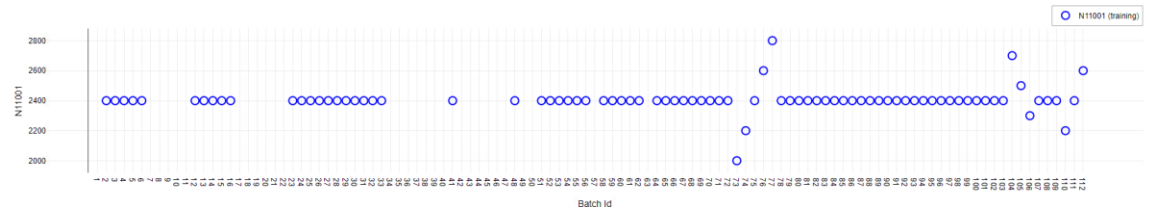
Decision Variables



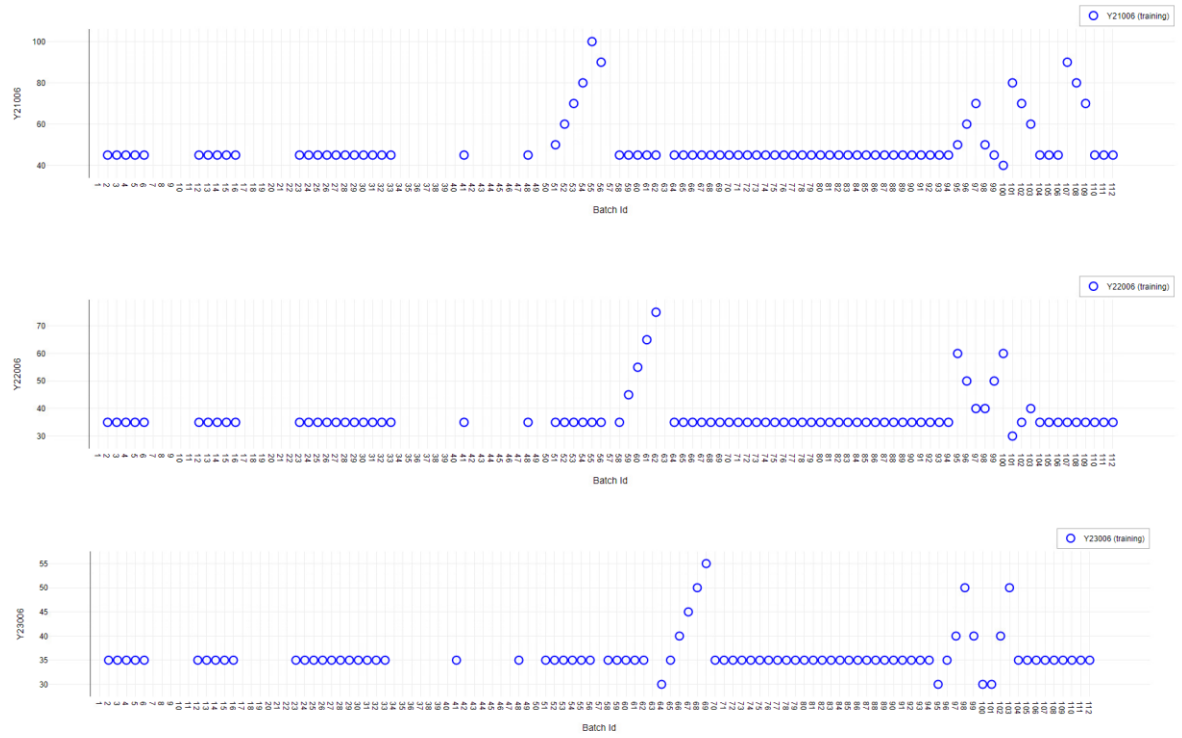




### Disturbance Variables







#### Process Variables

