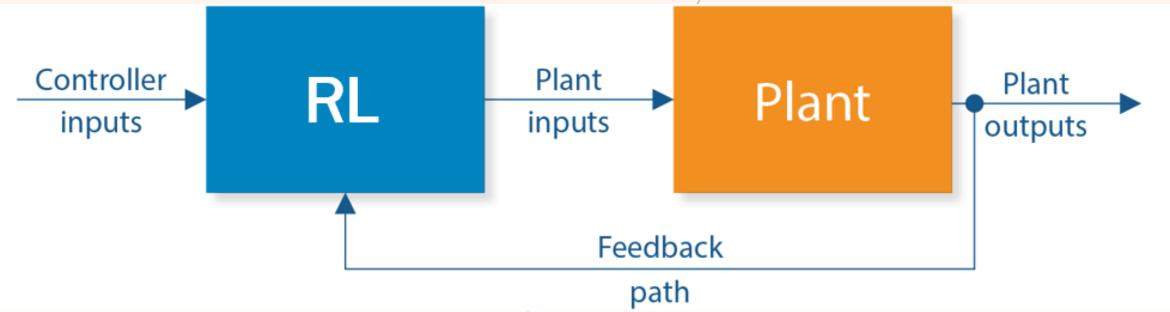
GF SYNC MEETING ON **RL** ACTIVITIES

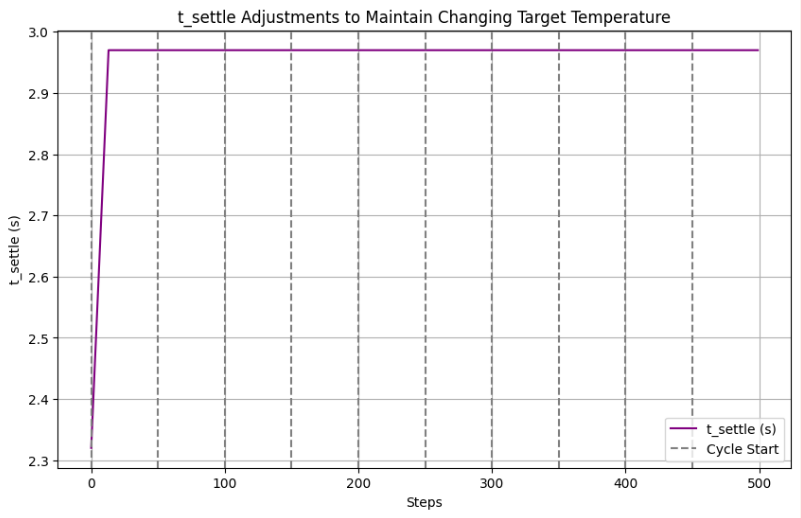
2025-01-15

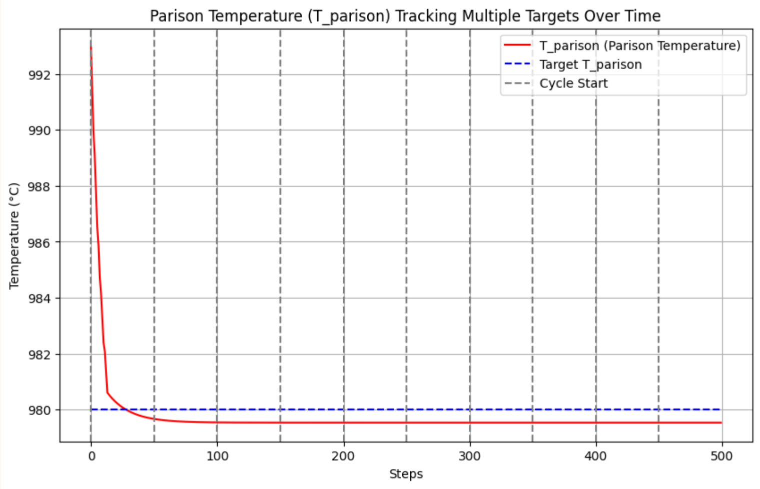
PREVIOUSLY DISCUSSED...

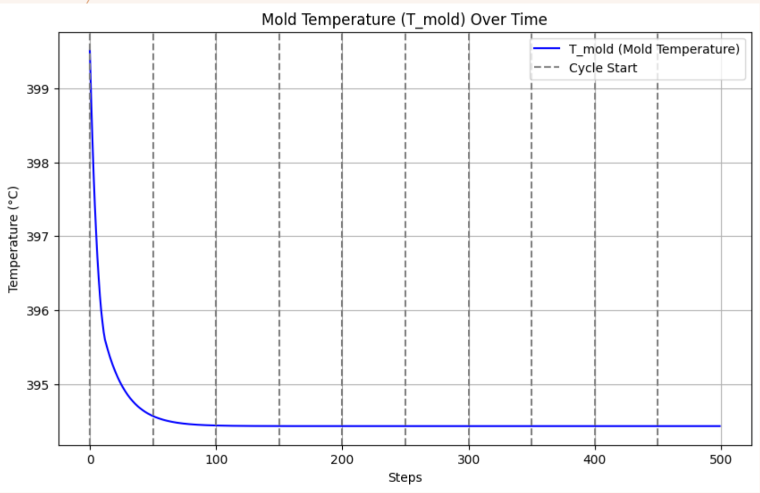
Close loop SISO adjustment

Accepted tolerance 1 degree





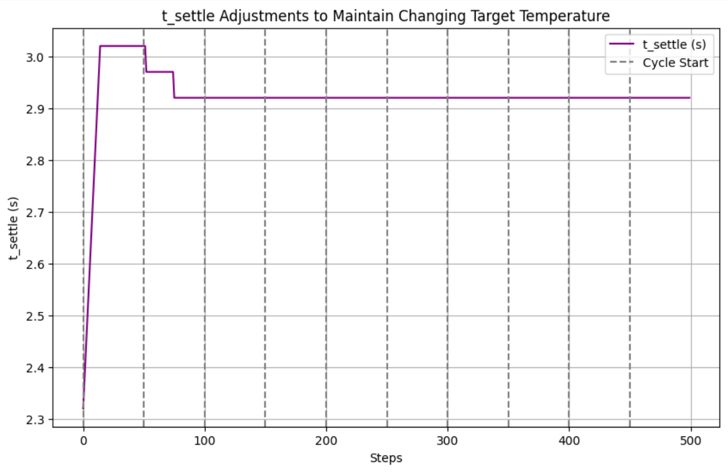


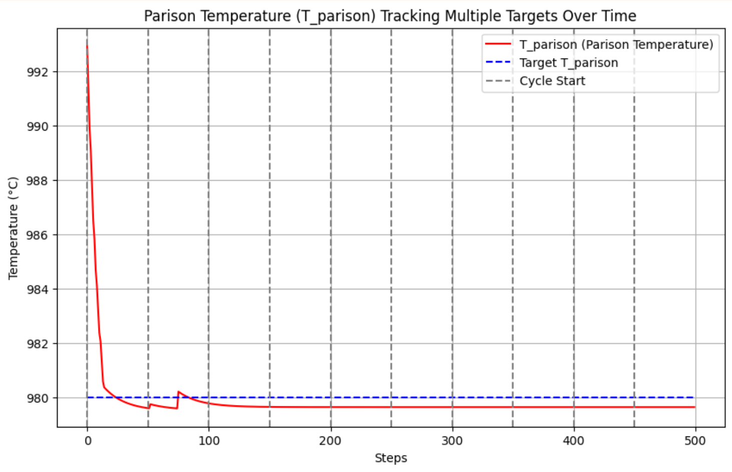


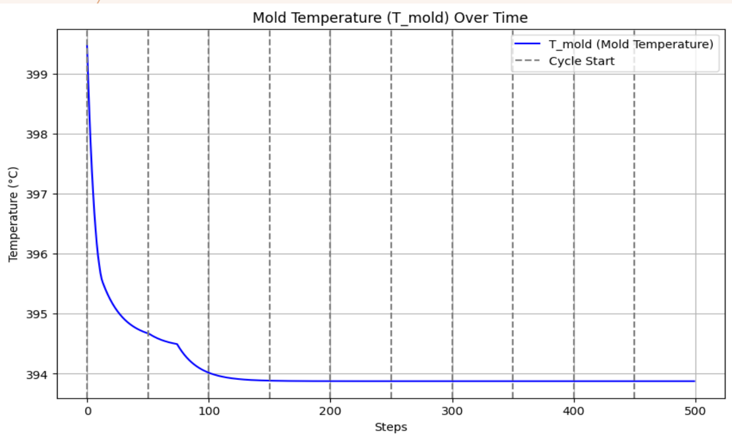
PREVIOUSLY DISCUSSED...

Close loop SISO adjustment

Accepted tolerance 0.4 degree





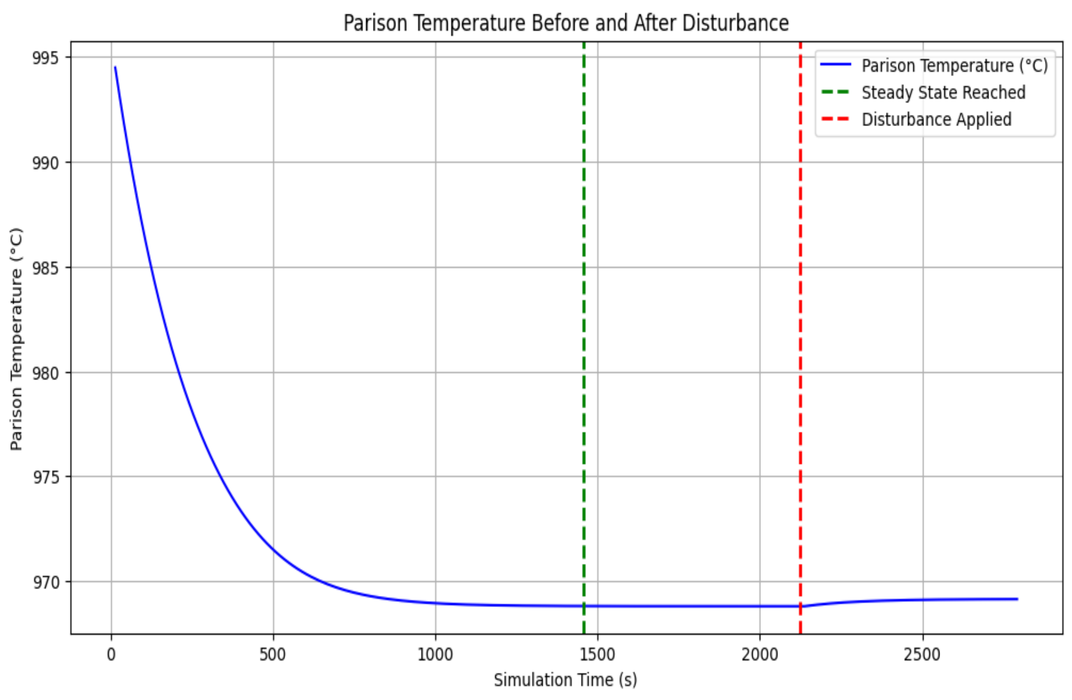


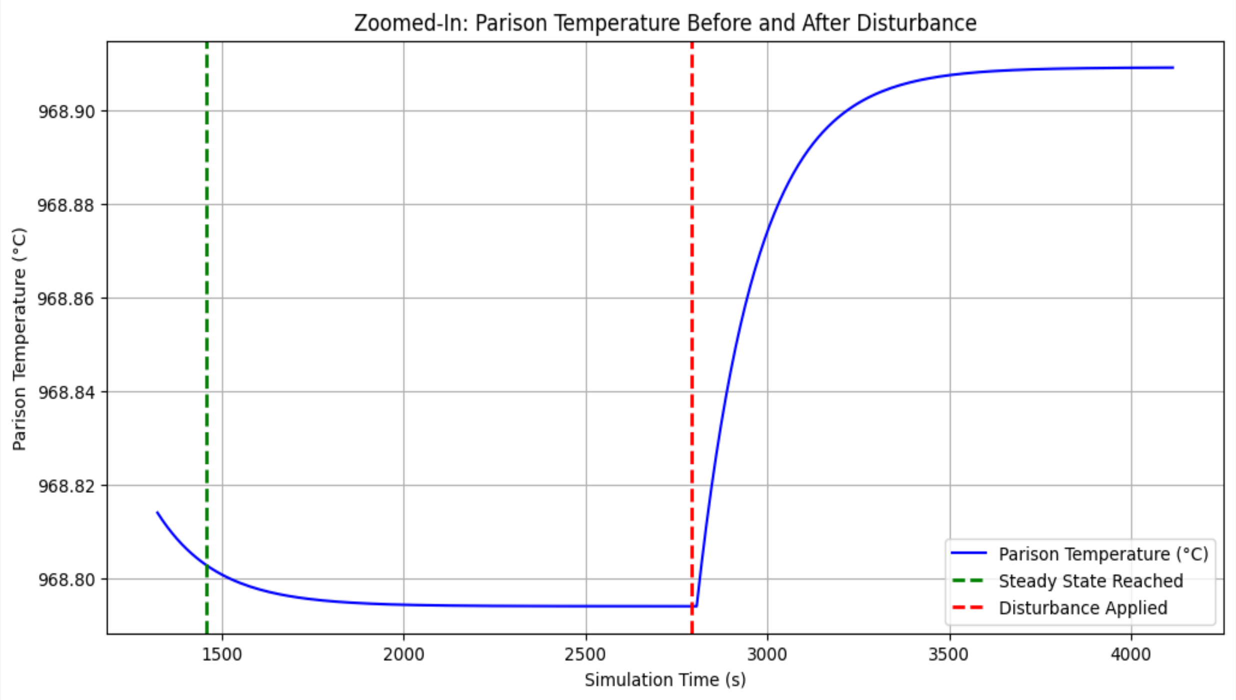
PREVIOUSLY DISCUSSED...

Developing the pipeline to check the disturbance injection for different scenarios

```
Steady state reached at cycle 108

Steady State Information:
Steady Point Cycle: 108
Steady Mold Temperature: 374.73°C
Steady Gob Temperature: 968.80°C
Steady t_contact: 106.00°
Steady t_cooling: 120.00°
```

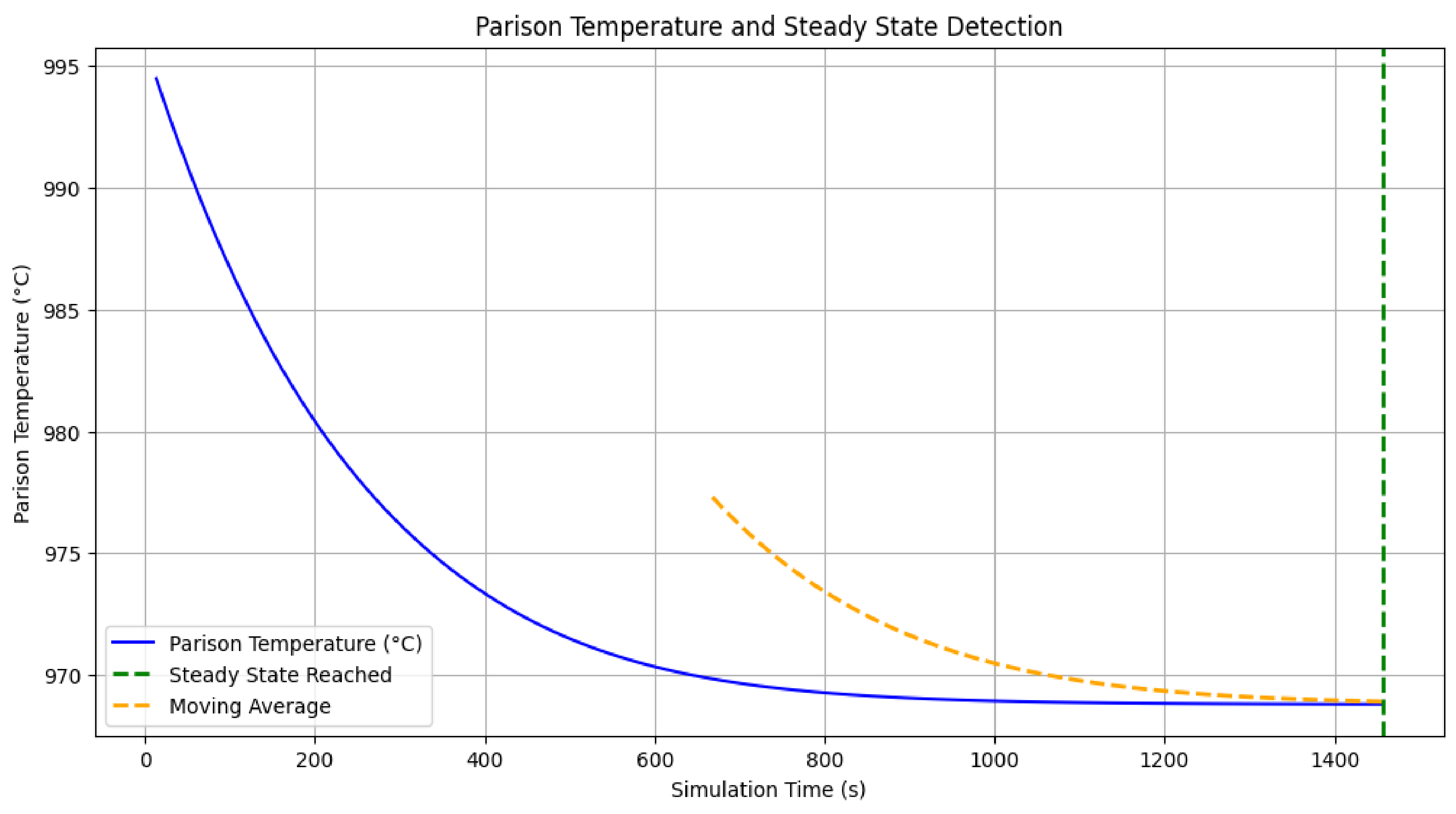




PREVIOUSLY DISCUSSED…

Parametric Stability Checking:

- **Cycle length**
  Default = 13.36
- **Changeable Tolerance**
- **Introducing parametric average window**

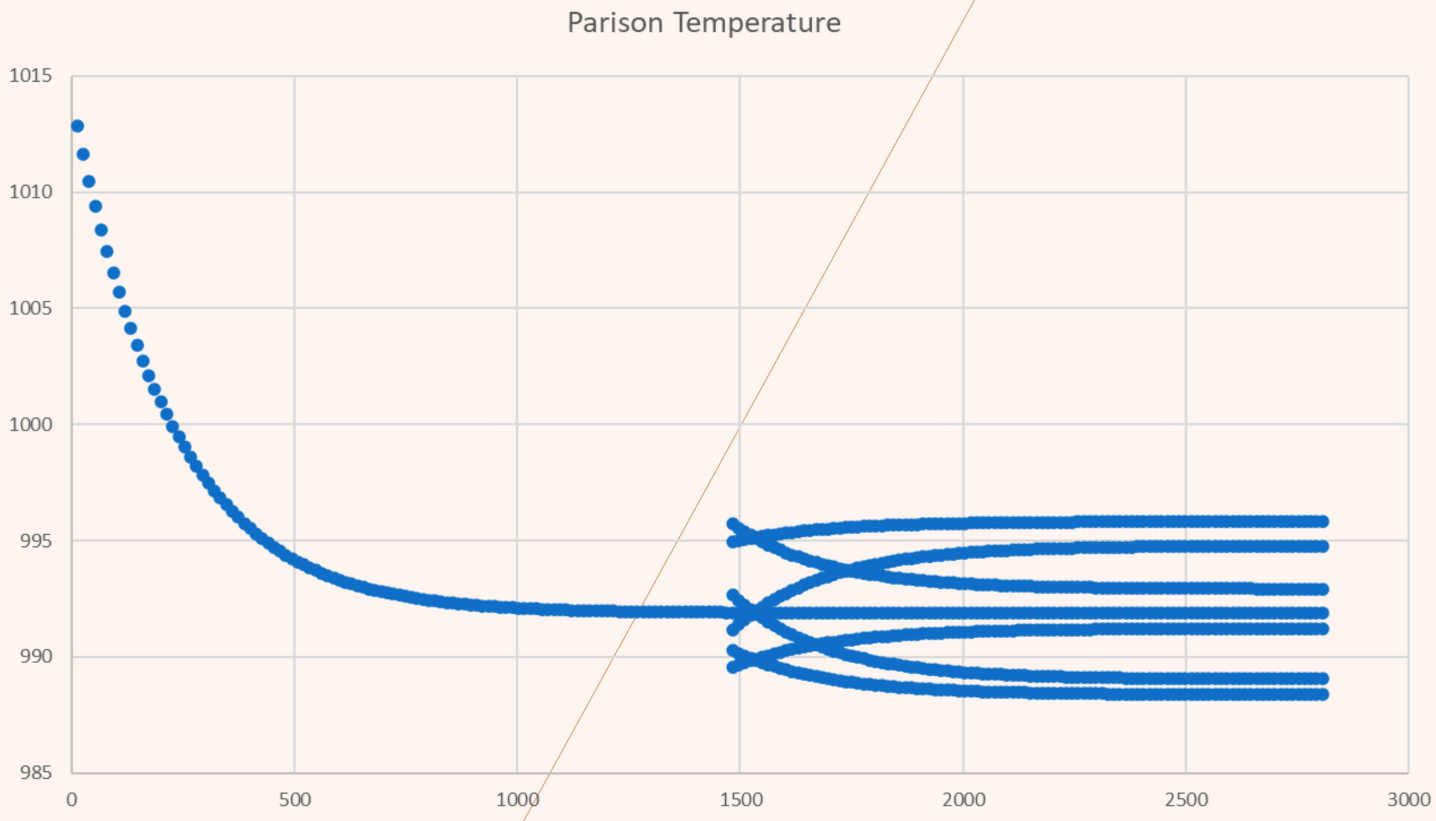


PREVIOUSLY DISCUSSED...

Analyzing control parameter behavior considering the bounds agreed on requirement document

- t_contact
  - Nominal = 106
  - Min= 101
  - Max= 111

- t_cooling
  - Nominal = 120
  - Min= 115
  - Max= 125



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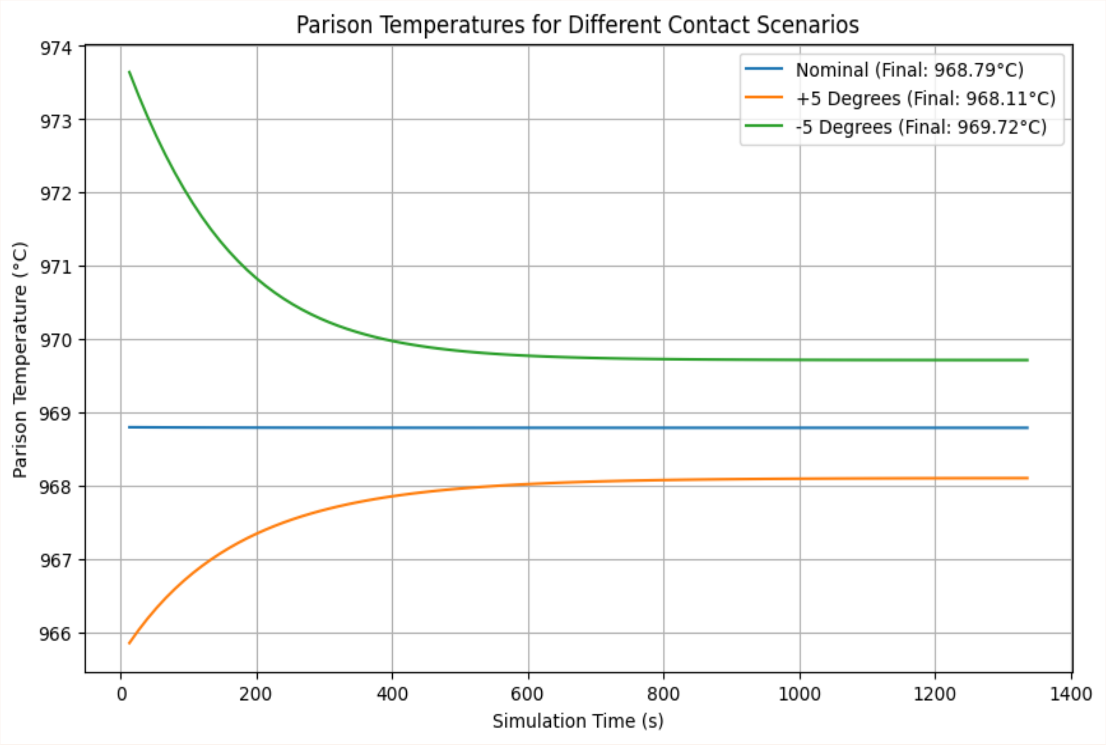

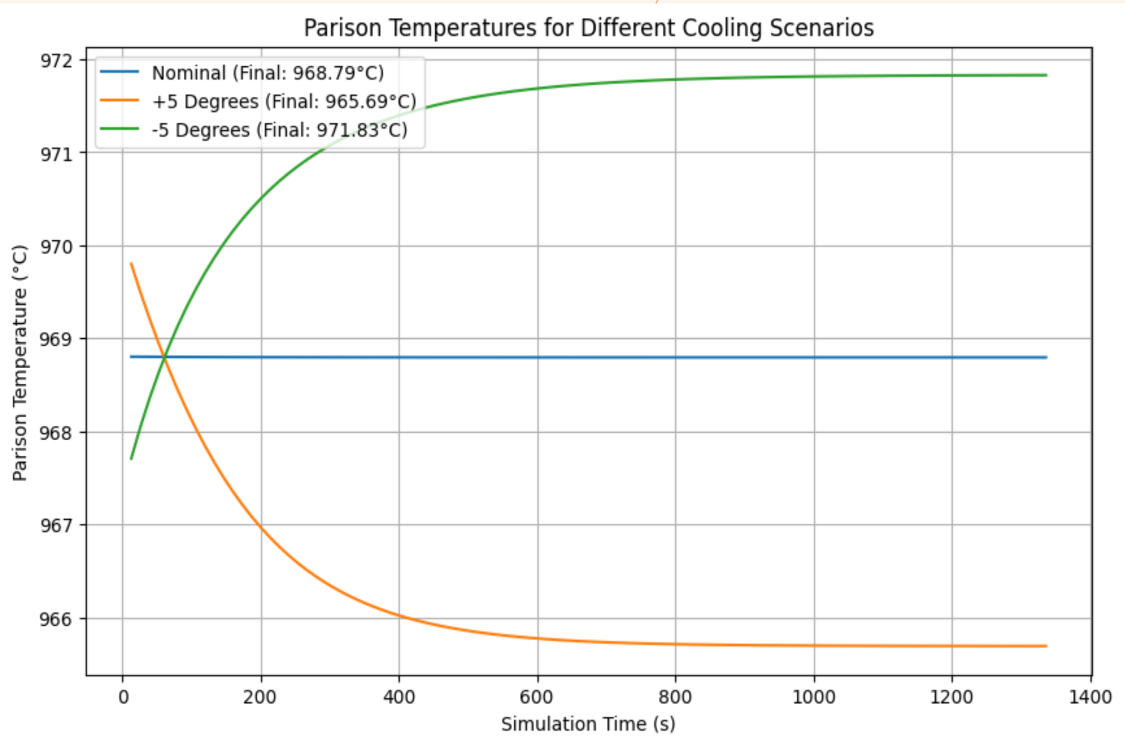

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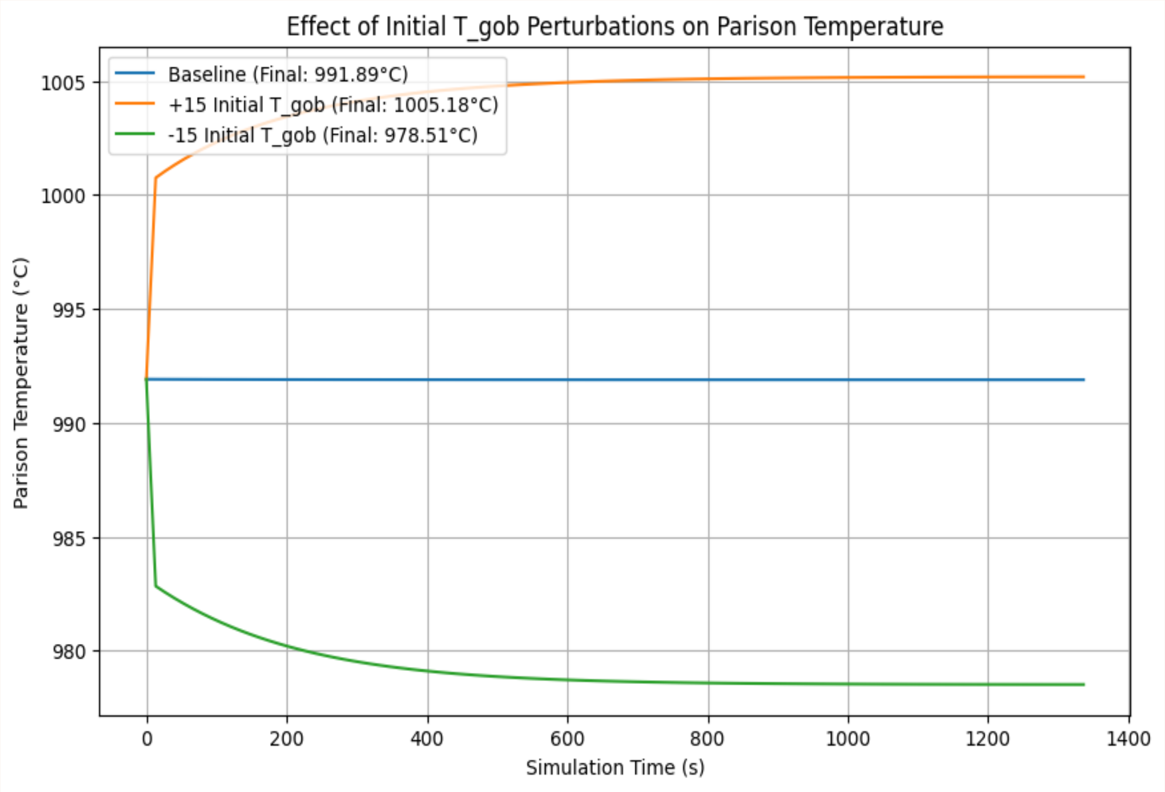
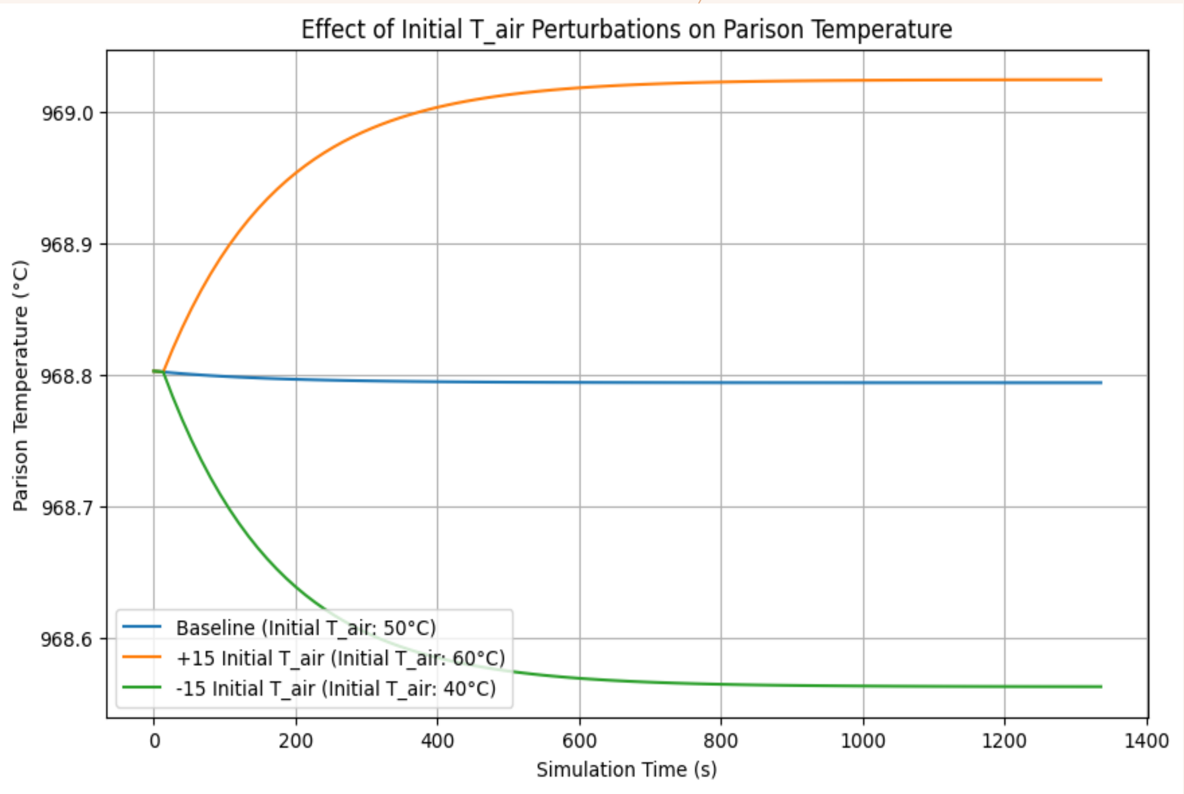




NEW IMPROVEMENTS

- Extending the model to accept and control both t_contact and t_cooling

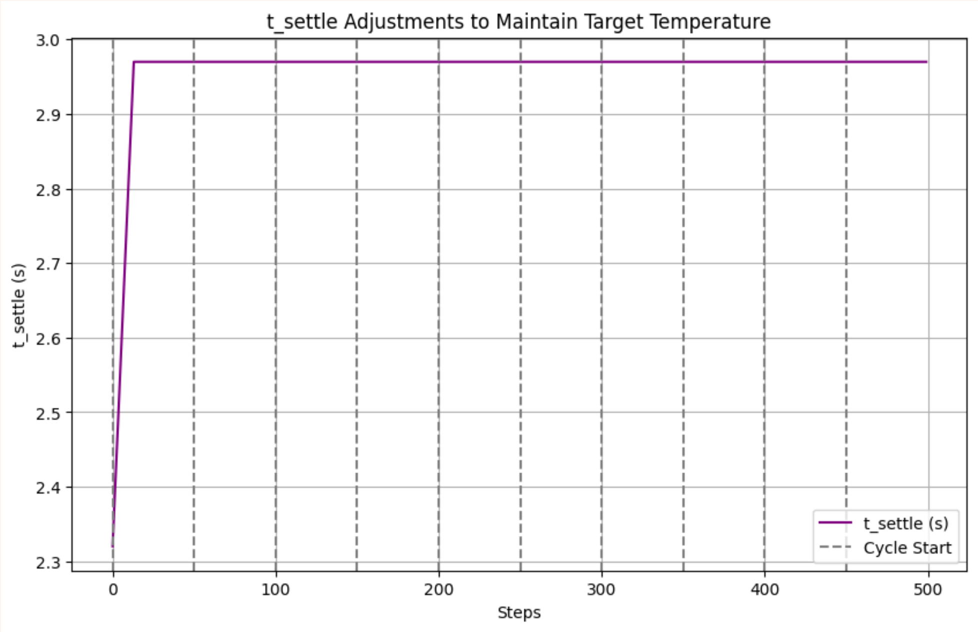
- Deploying the trained RL in the disturbance scenarios to capture system recovery

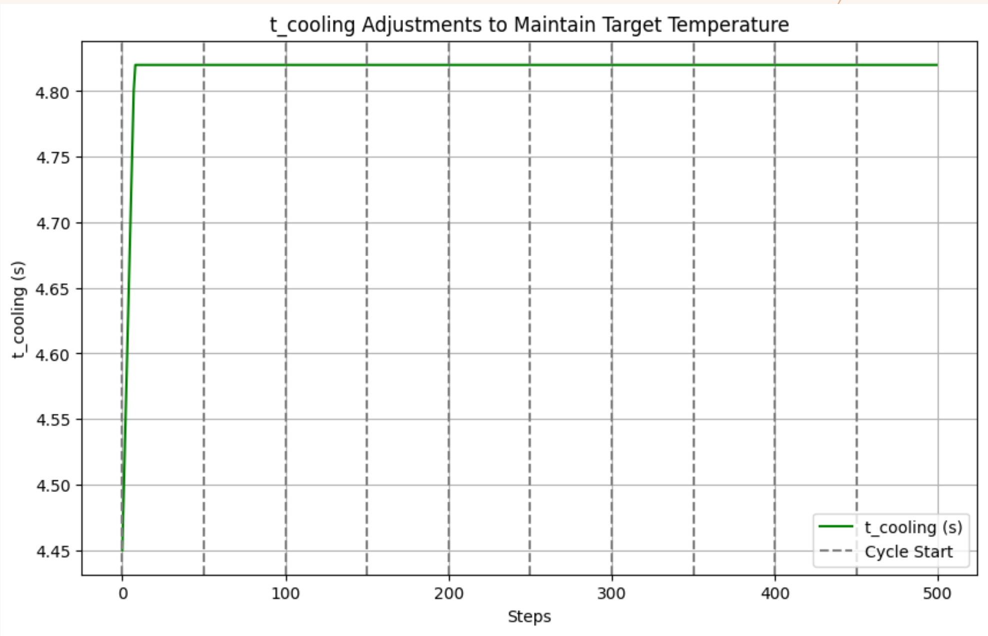
CONSIDERING BOTH CONTROL PARAMETERS

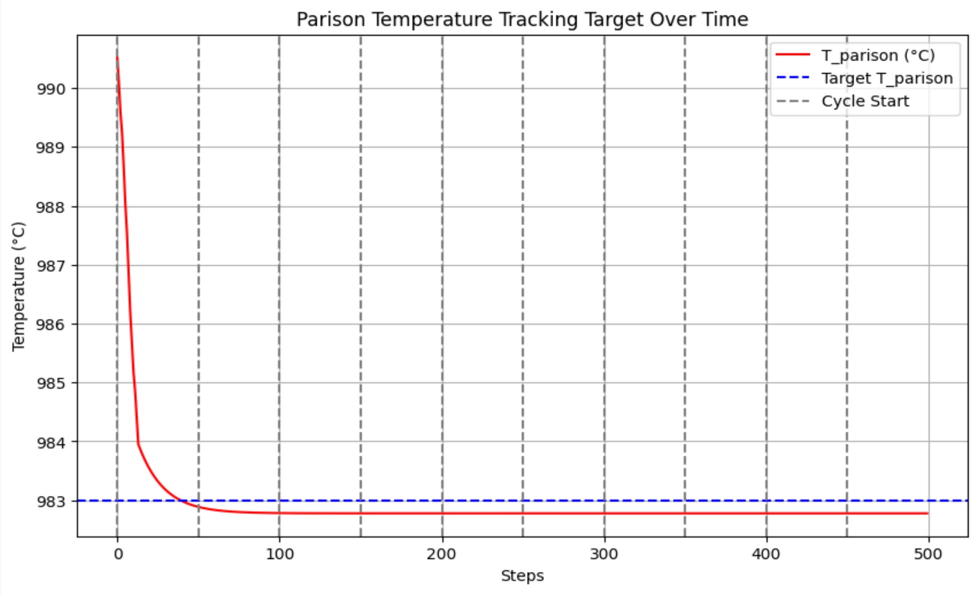
In the close loop we define new target value and with manipulating both t_settle and t_cooling we minimize the difference between the obtained value and target value.

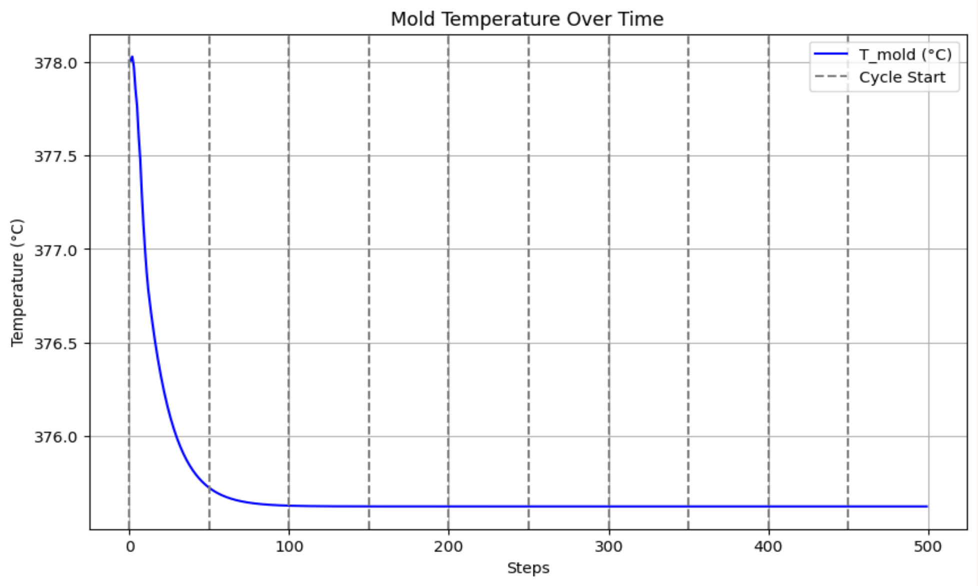
```
Starting control cycle 1
Cycle 1, Step 0: T_parison = 990.52°C, t_settle = 2.37, t_cooling = 4.50
Cycle 1, Step 10: T_parison = 985.18°C, t_settle = 2.87, t_cooling = 4.82
Cycle 1, Step 20: T_parison = 983.53°C, t_settle = 2.97, t_cooling = 4.82
Cycle 1, Step 30: T_parison = 983.17°C, t_settle = 2.97, t_cooling = 4.82
Cycle 1, Step 40: T_parison = 982.99°C, t_settle = 2.97, t_cooling = 4.82
Starting control cycle 2
Cycle 2, Step 0: T_parison = 982.89°C, t_settle = 2.97, t_cooling = 4.82
Cycle 2, Step 10: T_parison = 982.84°C, t_settle = 2.97, t_cooling = 4.82
Cycle 2, Step 20: T_parison = 982.81°C, t_settle = 2.97, t_cooling = 4.82
Cycle 2, Step 30: T_parison = 982.79°C, t_settle = 2.97, t_cooling = 4.82
Cycle 2, Step 40: T_parison = 982.79°C, t_settle = 2.97, t_cooling = 4.82
Starting control cycle 3
Cycle 3, Step 0: T_parison = 982.78°C, t_settle = 2.97, t_cooling = 4.82
Cycle 3, Step 10: T_parison = 982.78°C, t_settle = 2.97, t_cooling = 4.82
Cycle 3, Step 20: T_parison = 982.78°C, t_settle = 2.97, t_cooling = 4.82
Cycle 3, Step 30: T_parison = 982.78°C, t_settle = 2.97, t_cooling = 4.82
Cycle 3, Step 40: T_parison = 982.78°C, t_settle = 2.97, t_cooling = 4.82
```

CONSIDERING BOTH CONTROL PARAMETERS



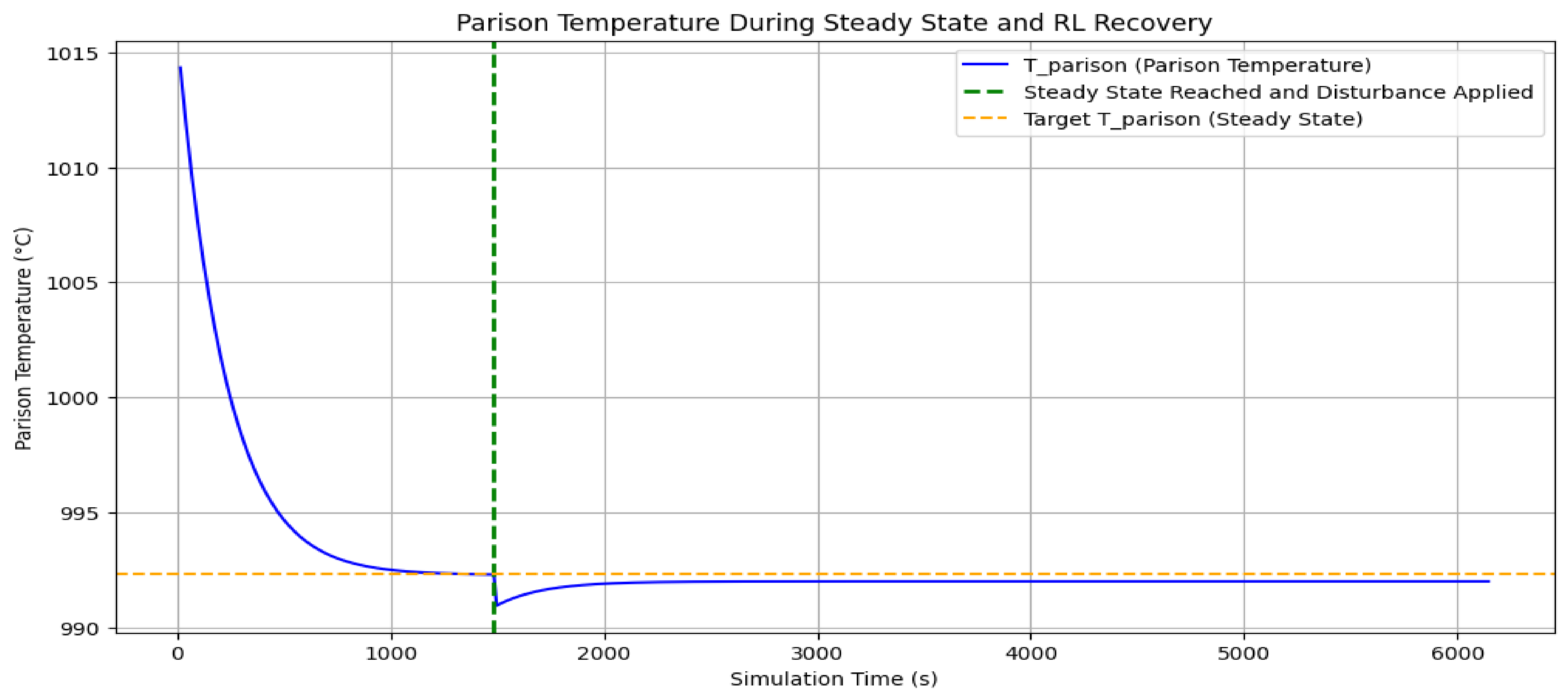




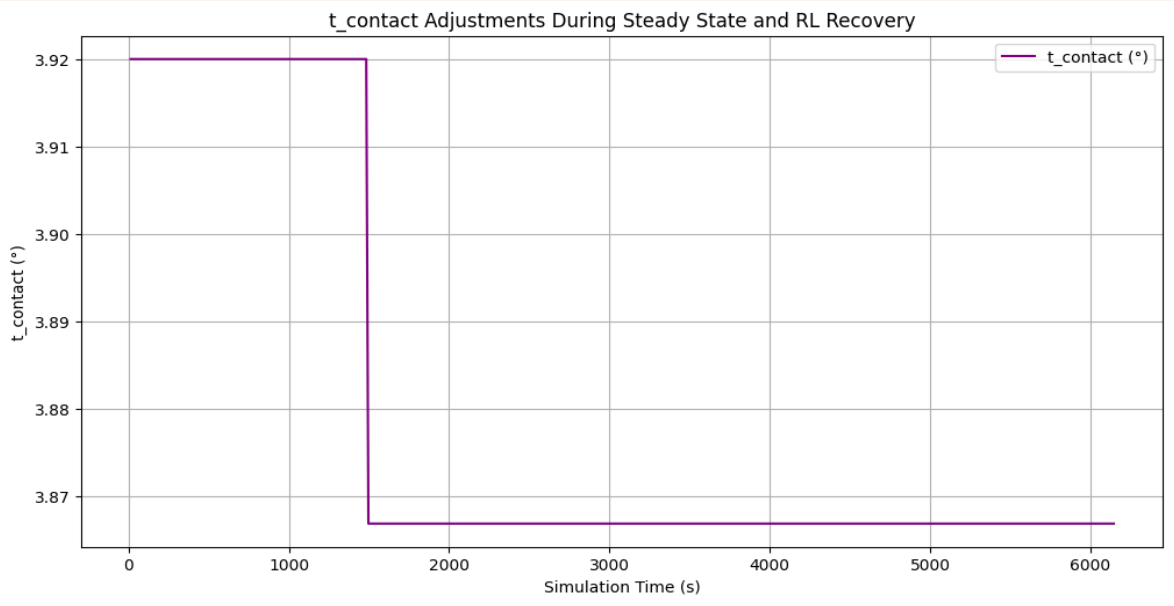


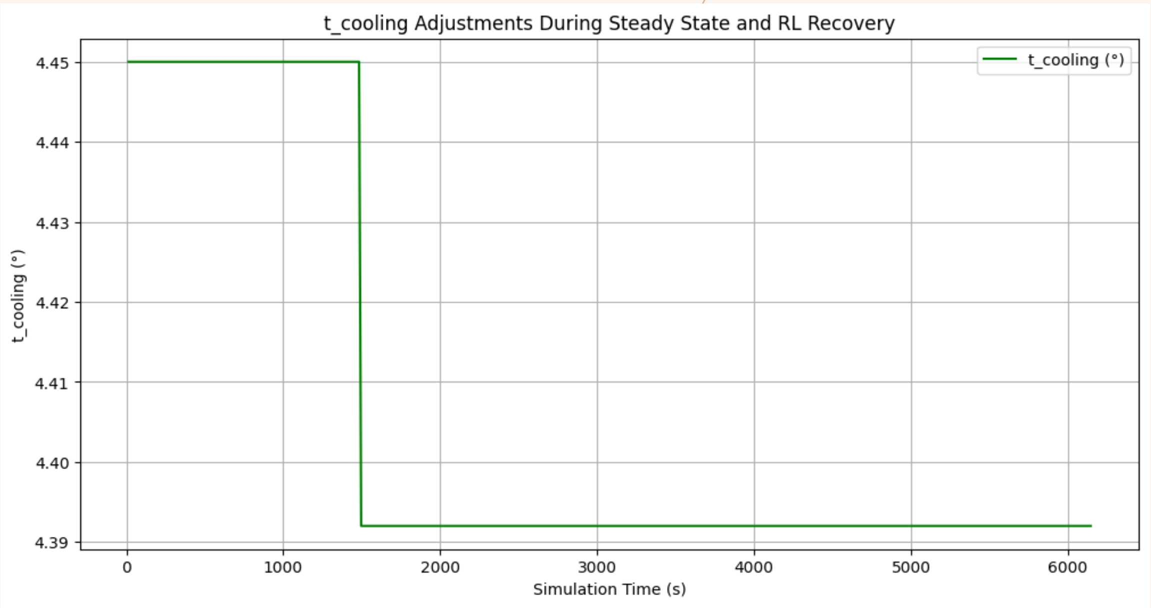
INTRODUCING THE DISTURBANCE

- Using the model that is capable of modifying both control parameters in the pipeline where we let the system stabilize and then we introduce the temperature of gob initial disturbance



INTRODUCING THE DISTURBANCE





INTRODUCING THE DISTURBANCE

Cycle	Time	T_parison	T_mold	T_gob	t_contact	t_cooling	Error	Reward
111	1496.32	990.9444	377.9935	1123	3.86692	4.392009	1.352579	-1.35258
112	1509.68	991.0079	378.0522	1123	3.86692	4.392009	1.289001	-1.289
113	1523.04	991.0677	378.1073	1123	3.86692	4.392009	1.229267	-1.22927
114	1536.4	991.1238	378.1591	1123	3.86692	4.392009	1.173145	-1.17314
115	1549.76	991.1765	378.2077	1123	3.86692	4.392009	1.120418	-1.12042
116	1563.12	991.2261	378.2534	1123	3.86692	4.392009	1.070883	-1.07088
117	1576.48	991.2726	378.2963	1123	3.86692	4.392009	1.024347	-1.02435
118	1589.84	991.3163	378.3366	1123	3.86692	4.392009	0.980629	-0.98063
119	1603.2	991.3574	378.3745	1123	3.86692	4.392009	0.939559	-0.93956
120	1616.56	991.396	378.4101	1123	3.86692	4.392009	0.900977	-0.90098
121	1629.92	991.4322	378.4435	1123	3.86692	4.392009	0.864732	-0.86473
122	1643.28	991.4663	378.4749	1123	3.86692	4.392009	0.830684	-0.83068
123	1656.64	991.4982	378.5044	1123	3.86692	4.392009	0.798699	-0.7987
124	1670	991.5283	378.5321	1123	3.86692	4.392009	0.768653	-0.76865
125	1683.36	991.5565	378.5582	1123	3.86692	4.392009	0.740427	-0.74043
126	1696.72	991.583	378.5826	1123	3.86692	4.392009	0.713913	-0.71391
127	1710.08	991.6079	378.6056	1123	3.86692	4.392009	0.689006	-0.68901
128	1723.44	991.6313	378.6272	1123	3.86692	4.392009	0.665608	-0.66561
129	1736.8	991.6533	378.6474	1123	3.86692	4.392009	0.643629	-0.64363
130	1750.16	991.674	378.6665	1123	3.86692	4.392009	0.622983	-0.62298
131	1763.52	991.6933	378.6844	1123	3.86692	4.392009	0.603588	-0.60359
132	1776.88	991.7116	378.7012	1123	3.86692	4.392009	0.585369	-0.58537
133	1790.24	991.7287	378.717	1123	3.86692	4.392009	0.568254	-0.56825

OTHER ONGOING EXPERIMENTS

Checking other training algorithms that are suitable for the continuous search space:

Soft Actor-Critic (SAC)

SAC maximizes entropy, promoting better exploration and stability in environments with continuous and bounded action spaces.

Its off-policy nature improves sample efficiency, reducing training time—critical for iterative simulations.

Twin Delayed Deep Deterministic Policy Gradient (TD3)

TD3 improves upon DDPG by reducing overestimation bias and smoothing policy updates, making it highly stable for environments requiring fine control.

Effective for tasks with high precision in control.

Less computationally intensive compared to SAC.

OTHER ONGOING EXPERIMENTS

Checking different scenarios and analyzing the generality of the solution

- Introducing Cascade disturbances in the T_gob_init
- Introducing disturbance of T_air
- Modifying the parison setpoint and analyzing the degree in which controller can track

THANKS