A.E.S. T-PROJECT 2021-2022

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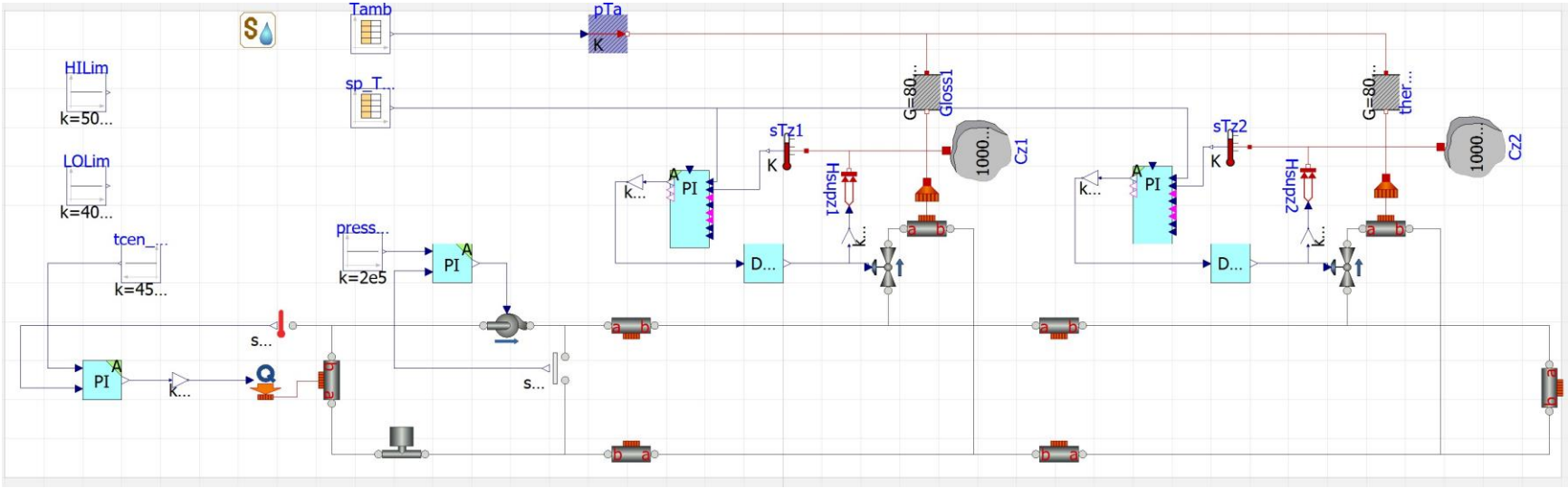
Automation of Energy Systems 2021/2022

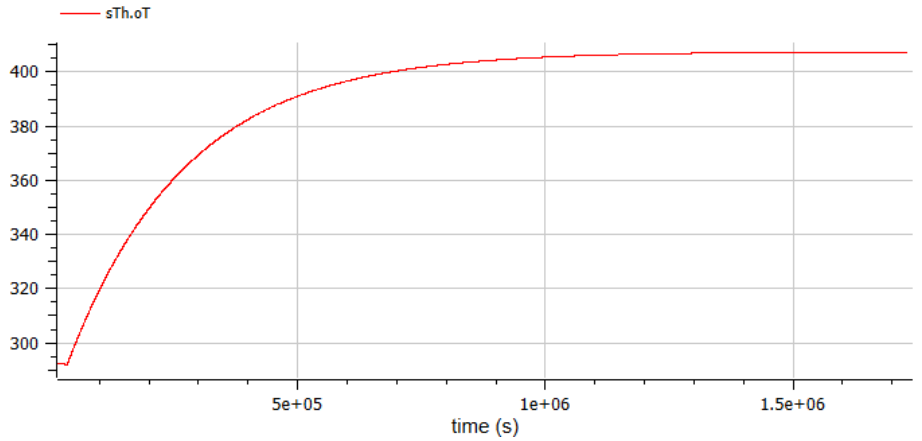
Assignment 1
Model with Control



Assignment 2
Open-Loop Step Responses for Central Control

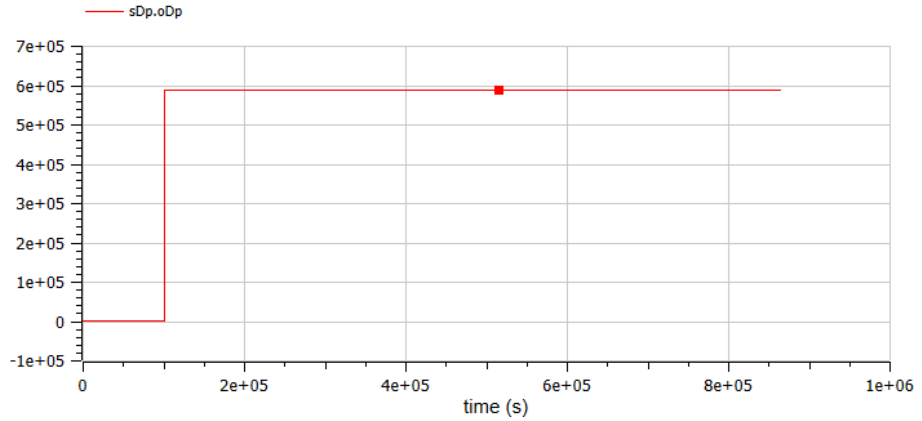
Central Heater [K]

$$P_{c-heat}(s) = \frac{115}{1 + 183200s}$$



Pump [Pa]

$$P_{pump}(s) = 577255$$

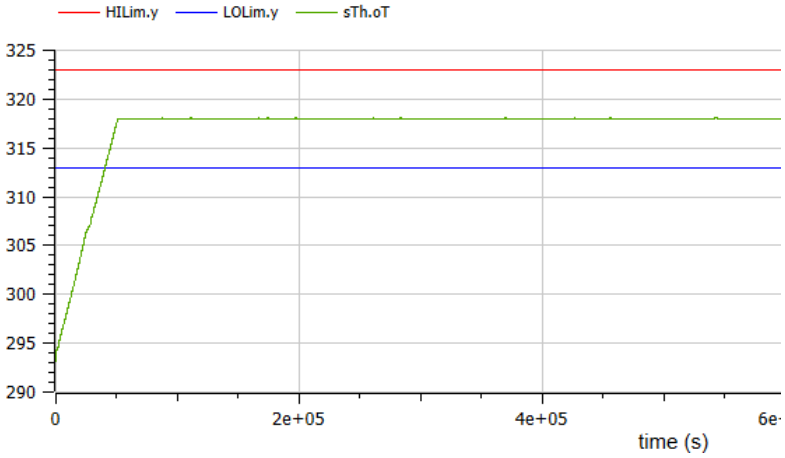


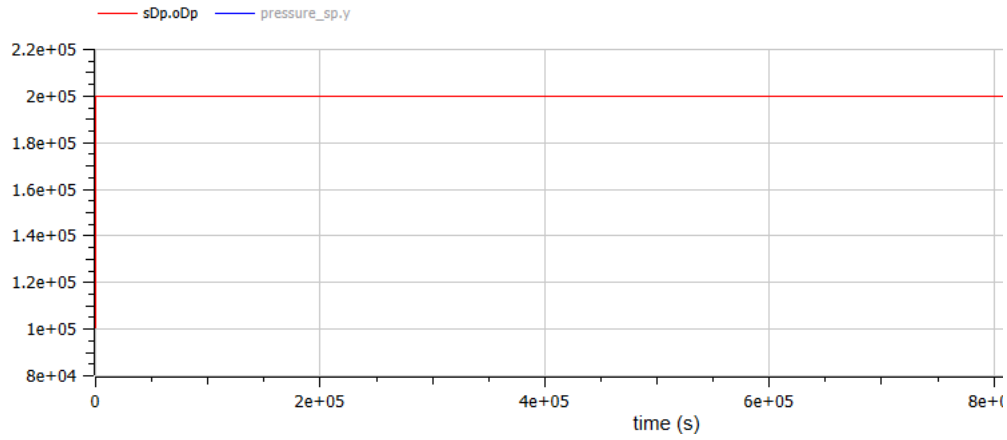
Assignment 2
Central Control Tuning

Tune by cancellation:

- PI Controller on Heater: $C_{c-heat}(s) = 1593\frac{1+183200s}{183200s}$

- PI Controller on Pump: $C_{pump}(s) = 1.732 \cdot 10^{-6}\frac{1+s}{s}$



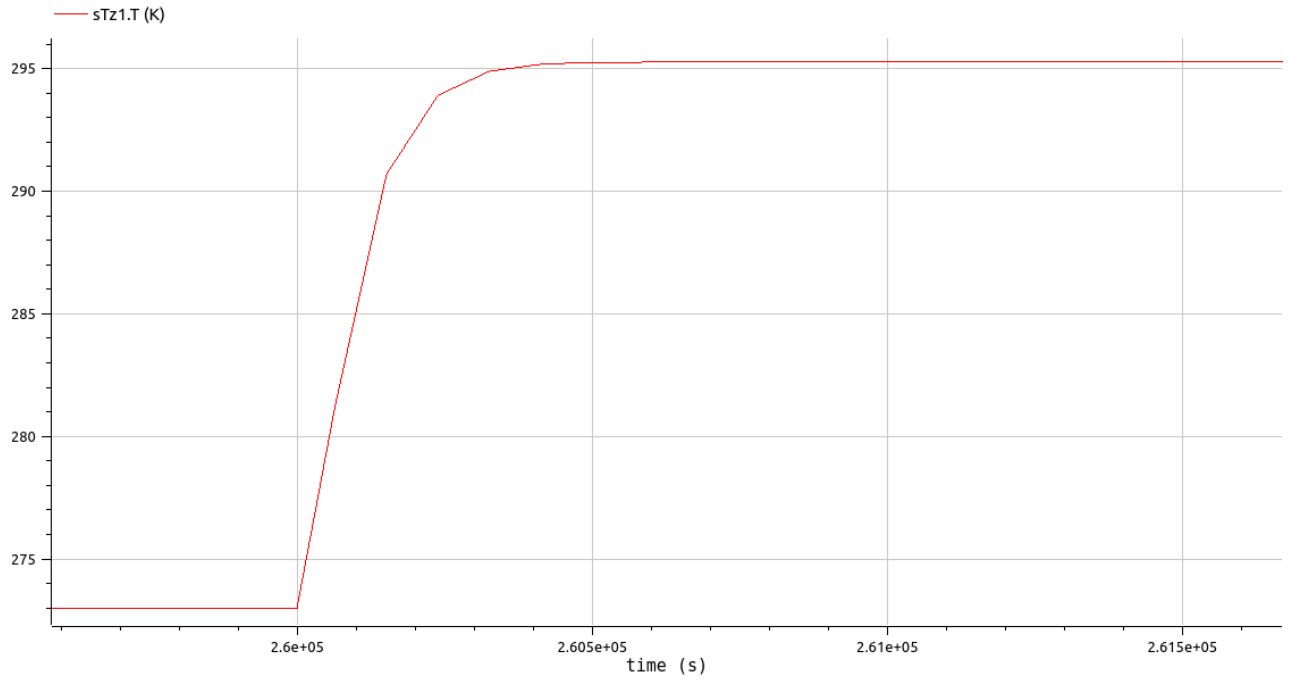


Assignment 2
Open Loop Step Responses for Local Control - Zone 1

Zone 1 - Valve 2 open

Step Response from 0 to 1 at 260000 [sec]

$$P_{z1}(s) = \frac{22.269}{1 + 63.6s}$$

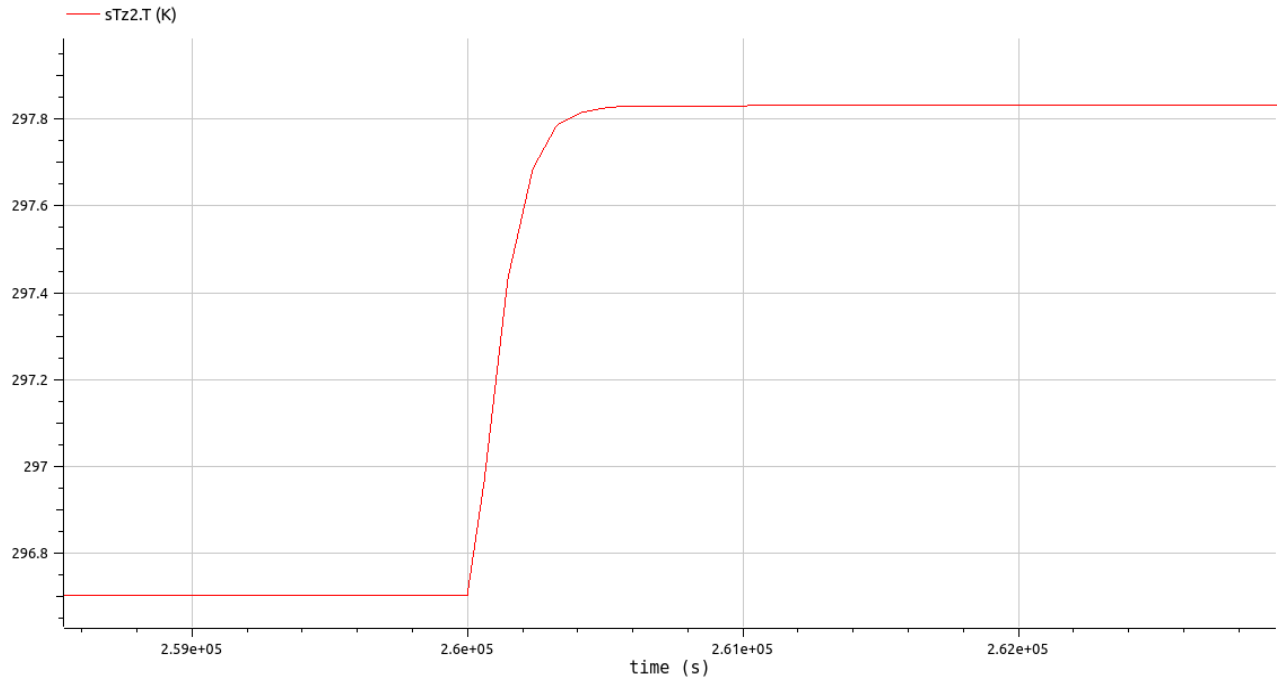


Assignment 2
Open Loop Step Responses for Local Control – Zone 2

Zone 2 - Valve 1 open

Step Response from 0.1 to 1 at 260000 [sec]

$$P_{z2}(s) = \frac{1.29}{1 + 77.4s}$$

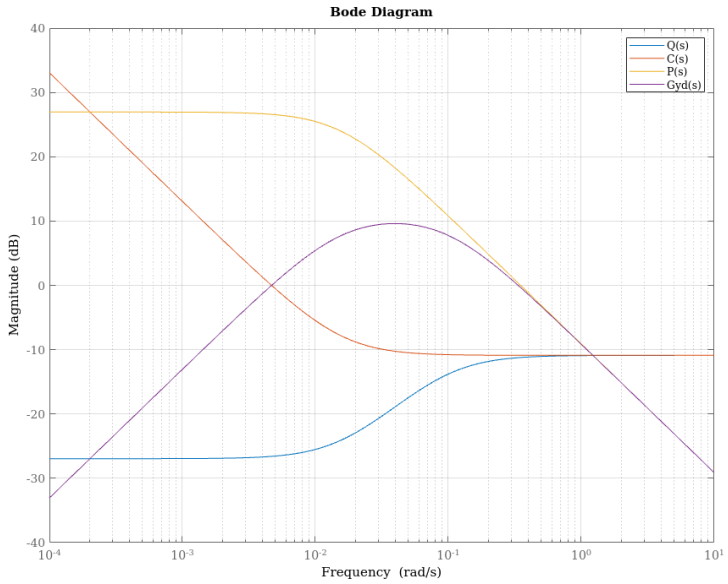


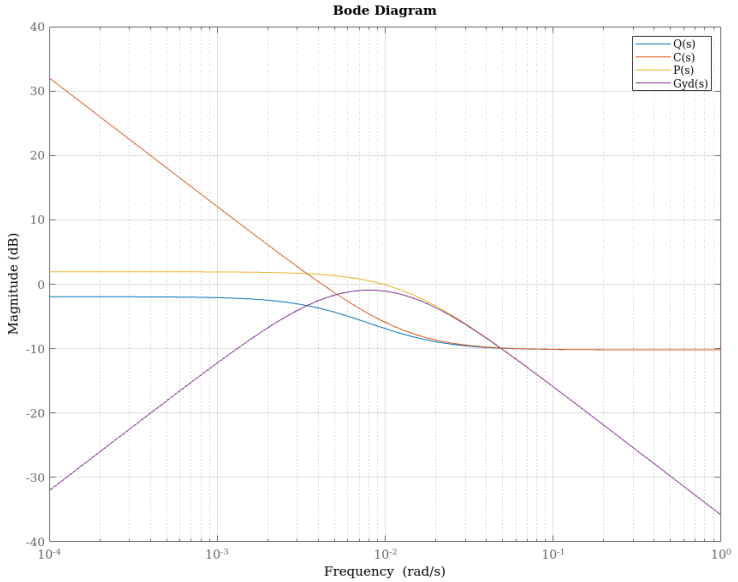
Assignment 2
Local Control Tuning

Tune by cancellation and study of the $Q(s)$:

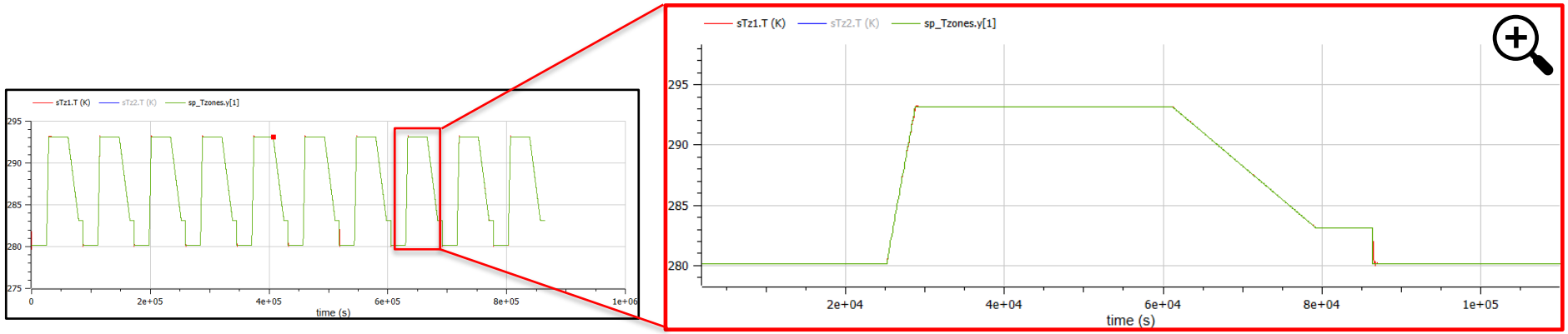
PI Controller Zone 1: $C_{z1}(s) = 0.286\frac{1+63.6s}{63.6s}$

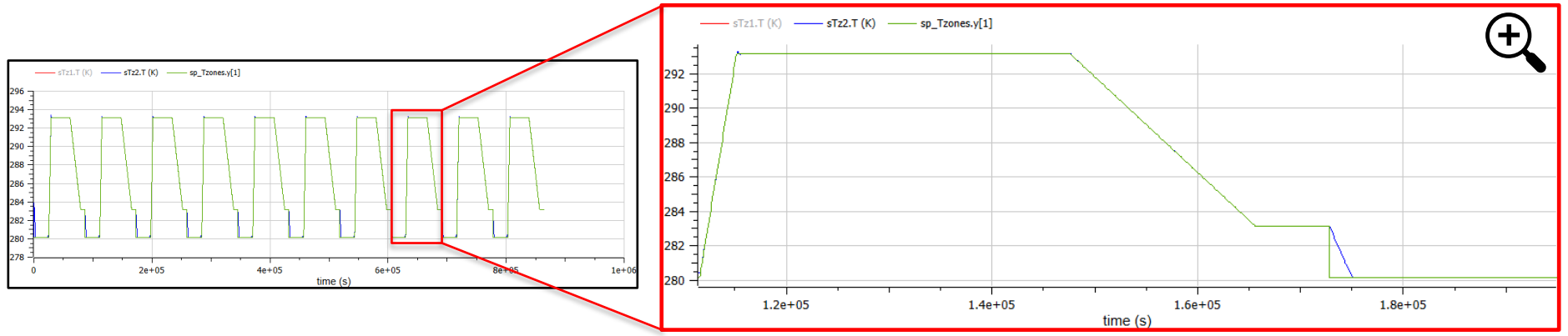
PI Controller Zone 2: $C_{z2}(s) = 0.31\frac{1+77.4s}{77.4s}$



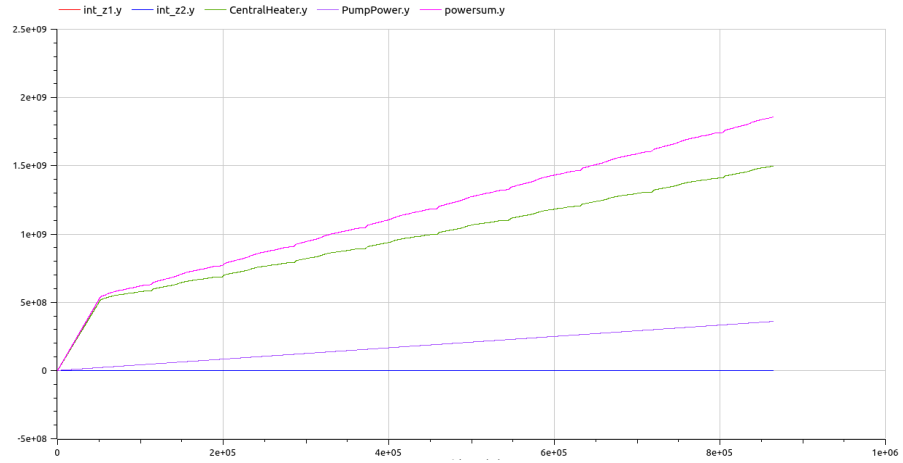


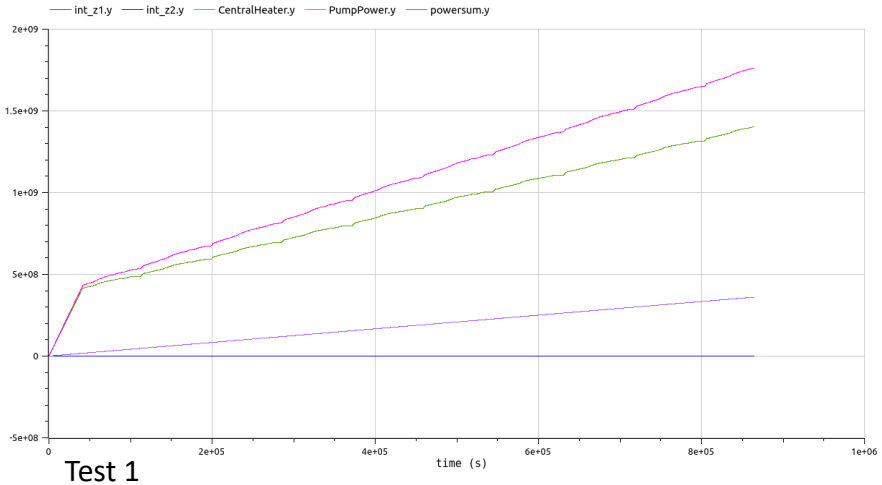
Assignment 2
Local Control Tuning - Results





Assignment 2
Scheme_1 optimization – Temperature





Test 1

Nominal Conditions:

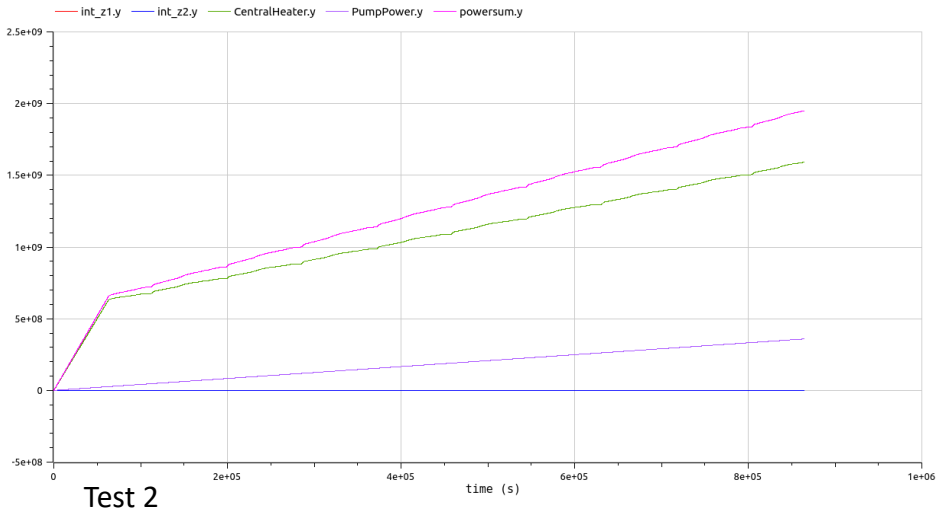
$T_{ref} = 45℃, P_{ref} = 2$ [bar]

Test 1:

$T_{ref} = 40℃, P_{ref} = 2$ [bar]

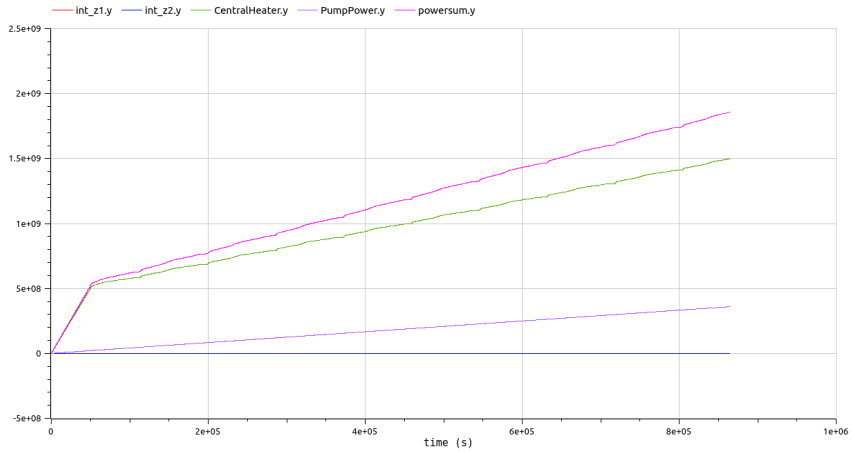
Test 2:

$T_{ref} = 50℃, P_{ref} = 2$ [bar]



Test 2

Assignment 2
Scheme_1 Optimization – Pressure



Nominal Conditions:

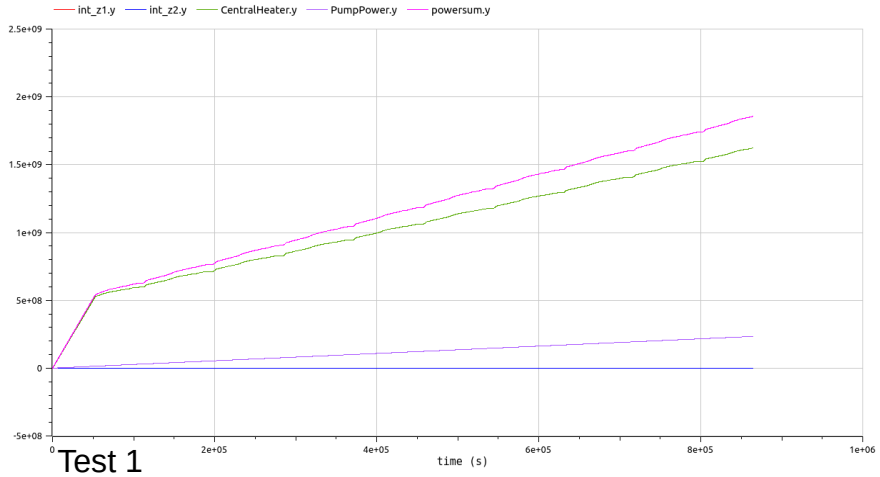
$T_{ref} = 45℃, P_{ref} = 2$ [bar]

Test 1:

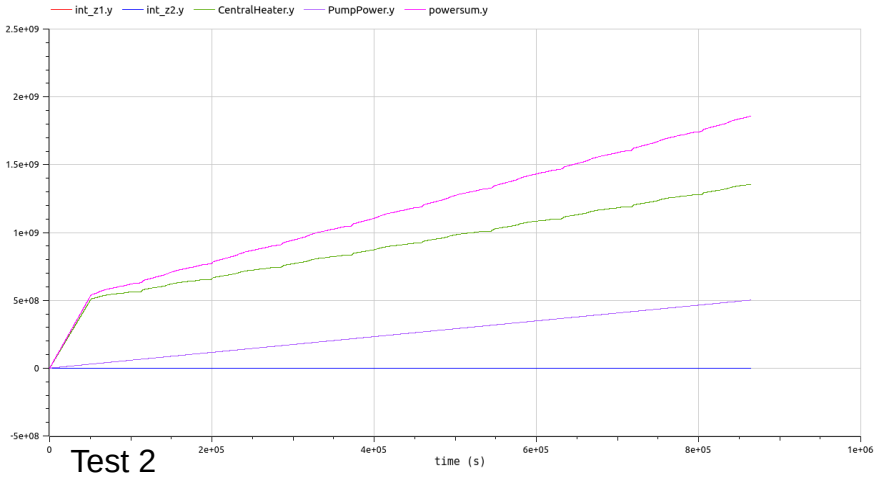
$T_{ref} = 45℃, P_{ref} = 1.5$ [bar]

Test 2:

$T_{ref} = 45℃, P_{ref} = 2.5$ [bar]



Test 1

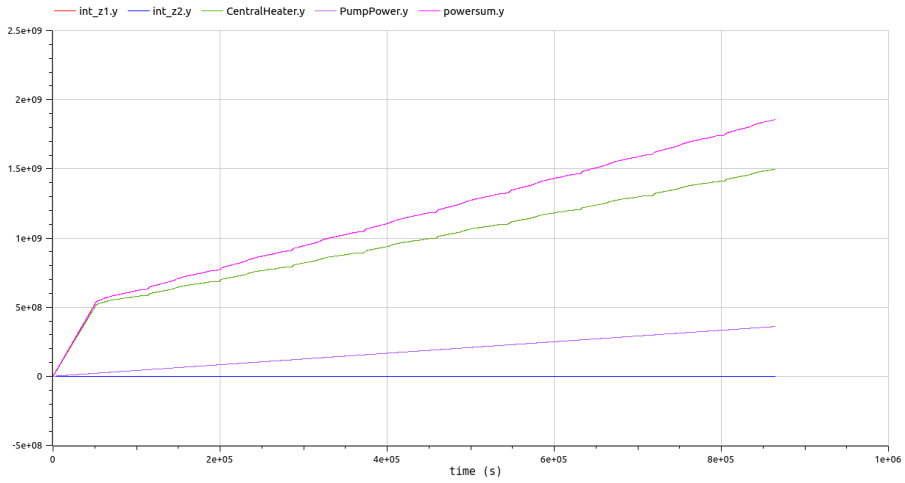


Test 2

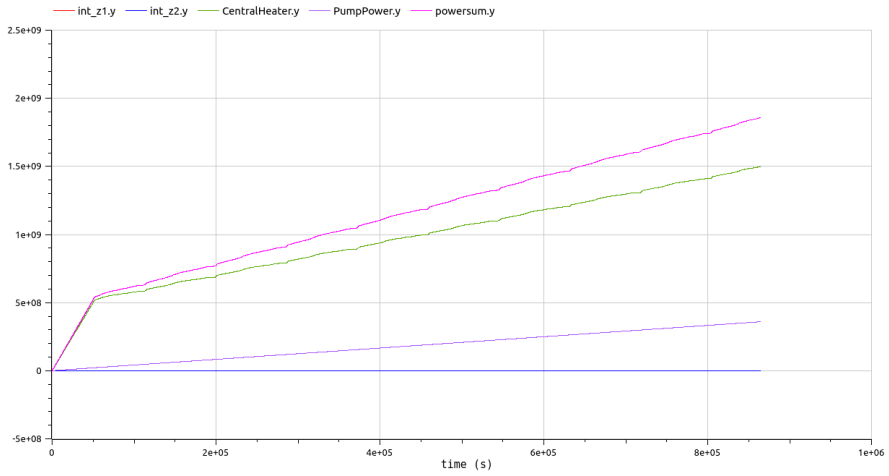
Assignment 2
Scheme_1 Optimization – Tuning Comparison

Total Power our tuning $= 1.85649 \cdot 10^9$ [J] $= 515.691$ [kWh]

Total Power random tuning $= 1.85652 \cdot 10^9$ [J] $= 515.700$ [kWh]

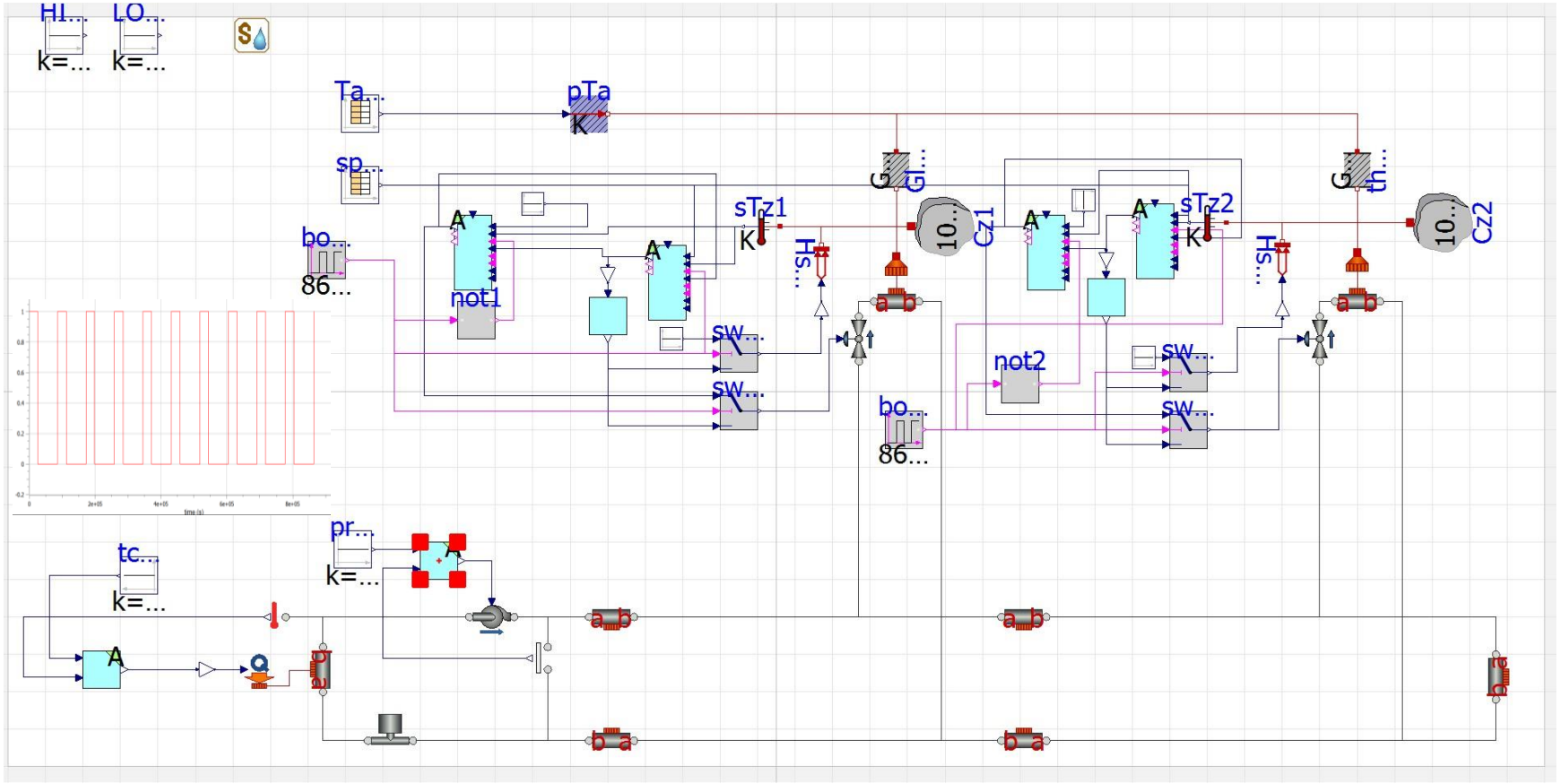


Our Tuning

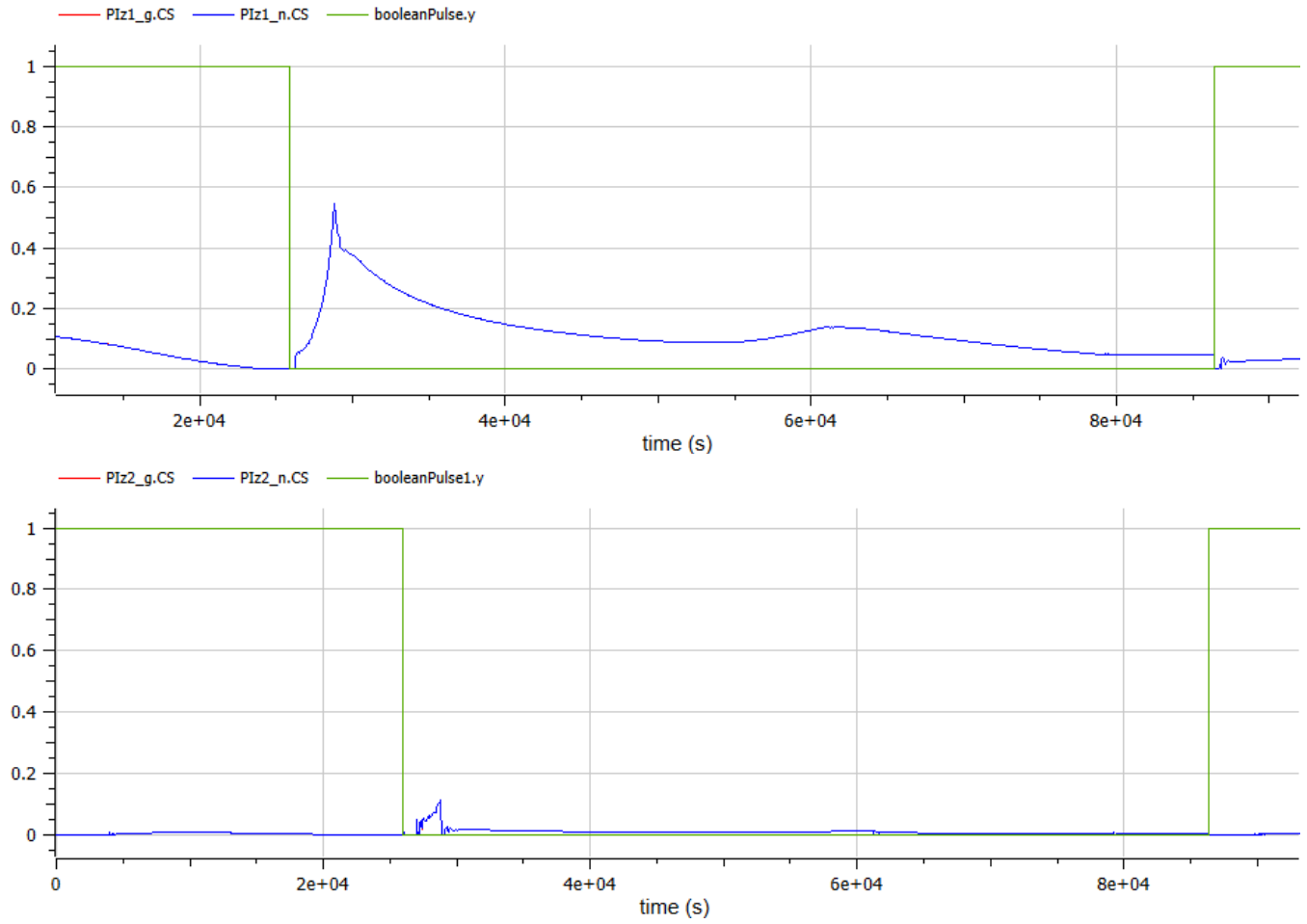


Random Tuning

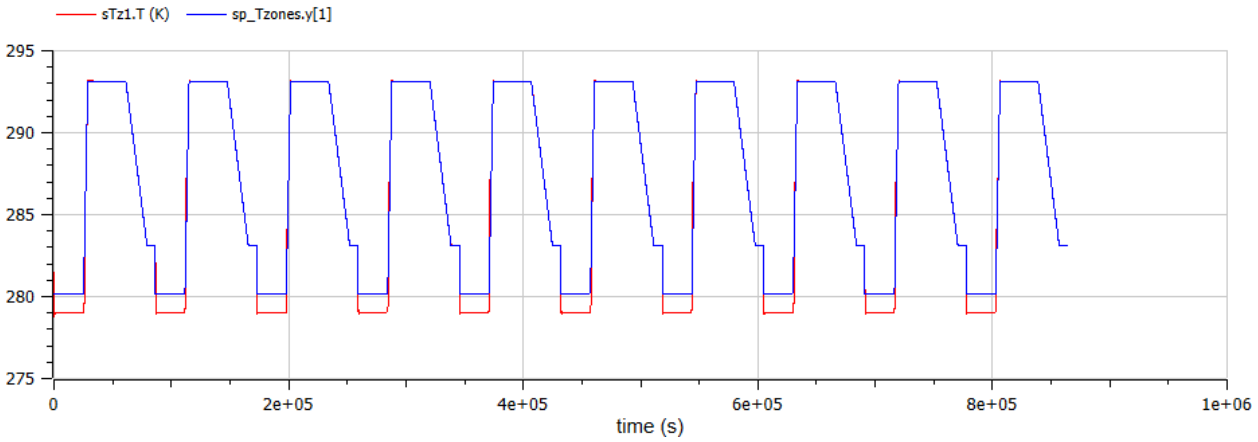
Assignment 3
Model with Day/Night Control

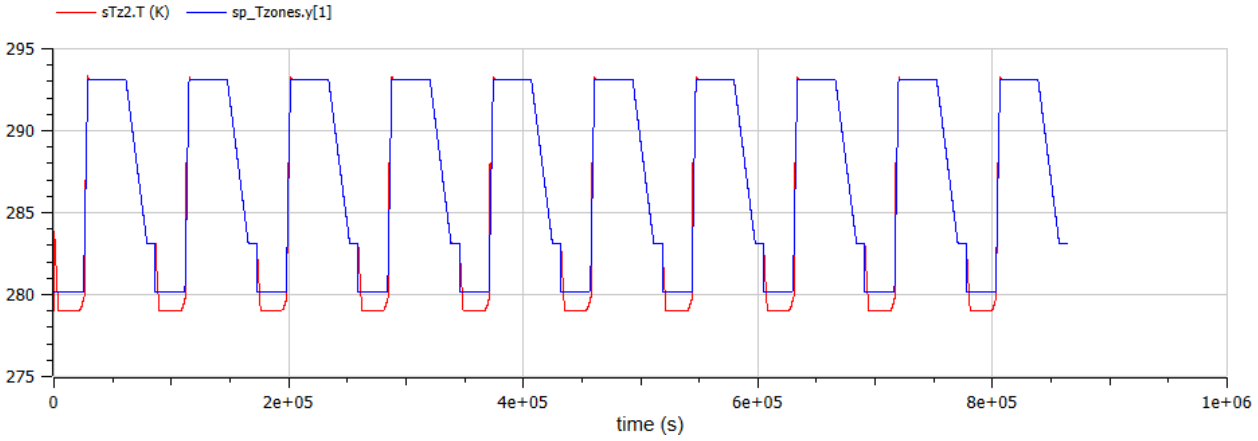


Assignment 4
Model with Day/Night Control - Using Tracking



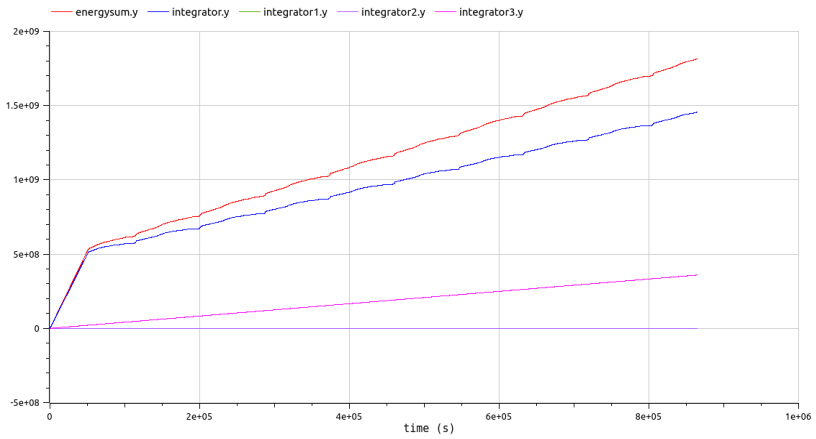
Assignment 4
Model with Day/Night Control - Zones Responses

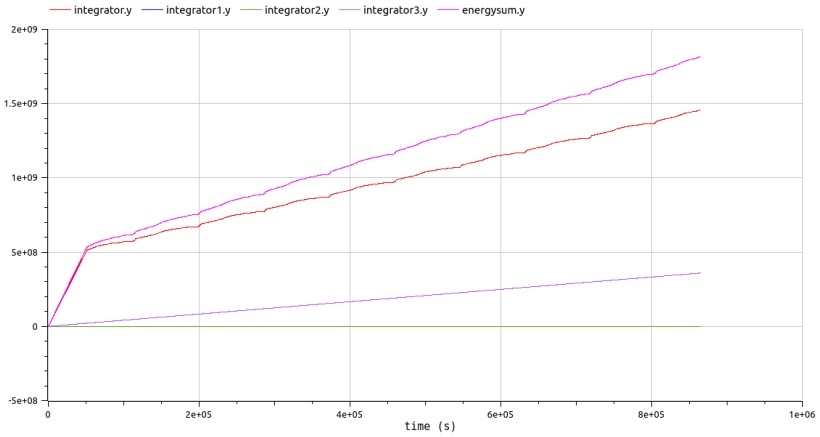




Assignment 4
Scheme_2 optimization – Local Controller 1

Nominal conditions





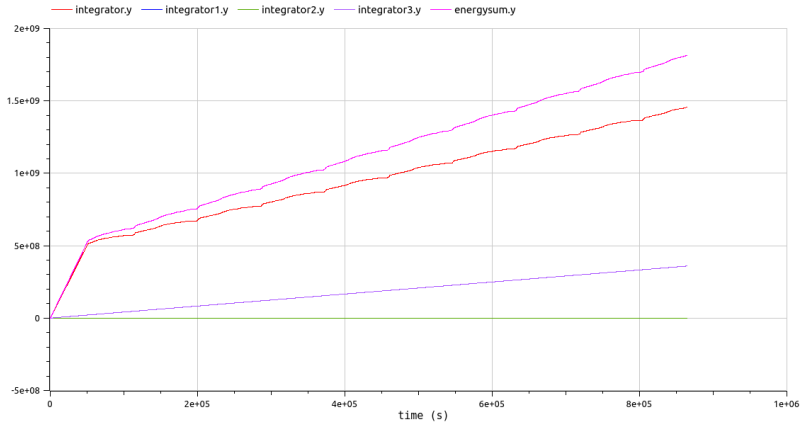
Test 1

Nominal Conditions:
$T_{central} = 45℃, P_{central} = 2$ [bar]

PI1 and PI2 tuned with cancellation + good Q

Test 1: $K_1 = \frac{63.6}{22.269} 0.5$

Test 2: $K_1 = \frac{63.6}{22.269} 0.05$



Test 2

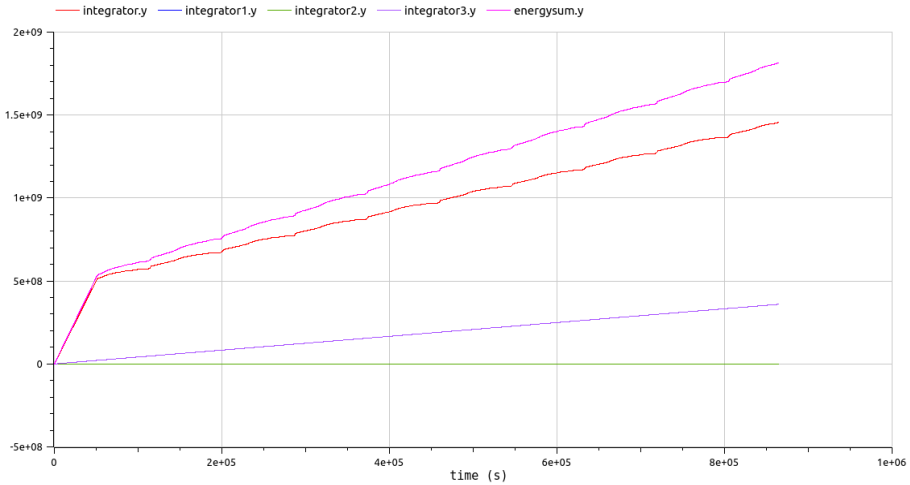
Assignment 4
Scheme_2 optimization – Local Controller 2

Test 3:

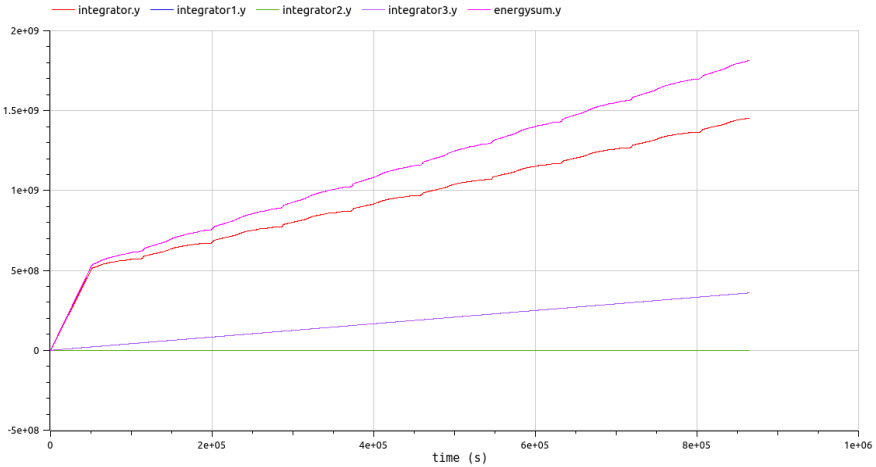
$K_1 = \frac{63.6}{22.269} 0.05$ and $K_2 = \frac{77.4}{1.25} 0.0025$;

Test 4:

$K_1 = \frac{63.6}{22.269} 0.05$ and $K_2 = \frac{77.4}{1.25} 0.0075$;



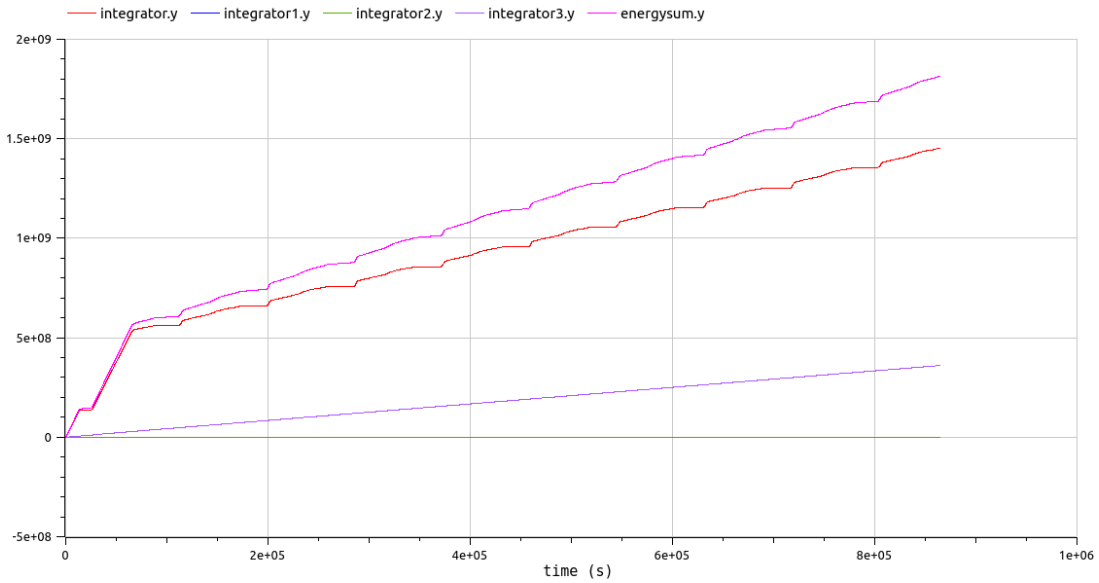
Test 3



Test 4

Assignment 4
Scheme_2 optimization – Central setpoint out of bound

Test:

$K_1 = \frac{63.6}{22.269} 0.05$ and $K_2 = \frac{77.4}{1.25} 0.0075$;

Central temperaure setpoint 27°C (i.e. in night mode)