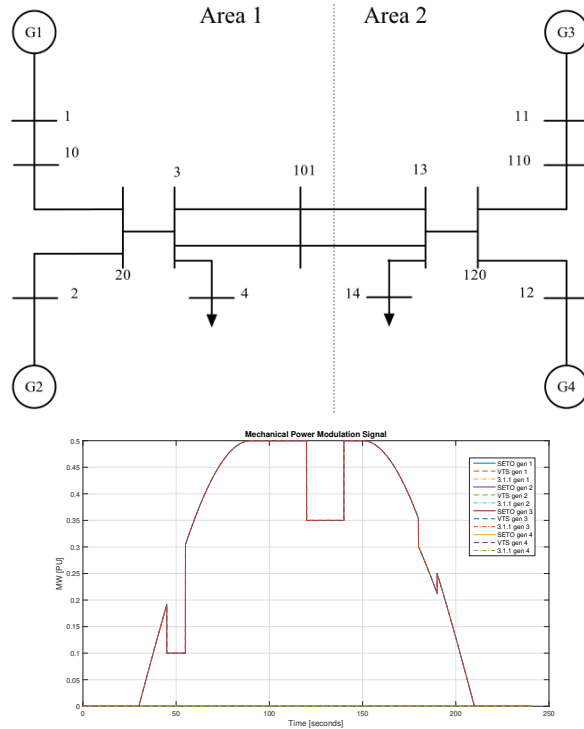


**Scenario**

- Kundur 4 machine system packaged with PST
- Constant Z load model
- System has governors, exciters, and PSS.
- Governor of generator being perturbed by pm\_sig removed
- Perturbance was meant to mimic a solar ramp with various situations of cloud cover:  
(larger plot of pm\_sig on Page 6)

% time [seconds]

% 0-30 - no action

% 30-90 - ramp up 0.5 PU (50 MW)

% 90-150 - hold peak

% 150-210 - ramp down 0.5 PU (50 MW)

% 210-240 - no action

% cloud cover events

% 45-55 - 20% max gen (generation of 0.1 PU)

% 120-140 - 30% cover (generation reduction to 70%)

% 180-190 - 15% cover (generation reduction to 85%)

**Summary**

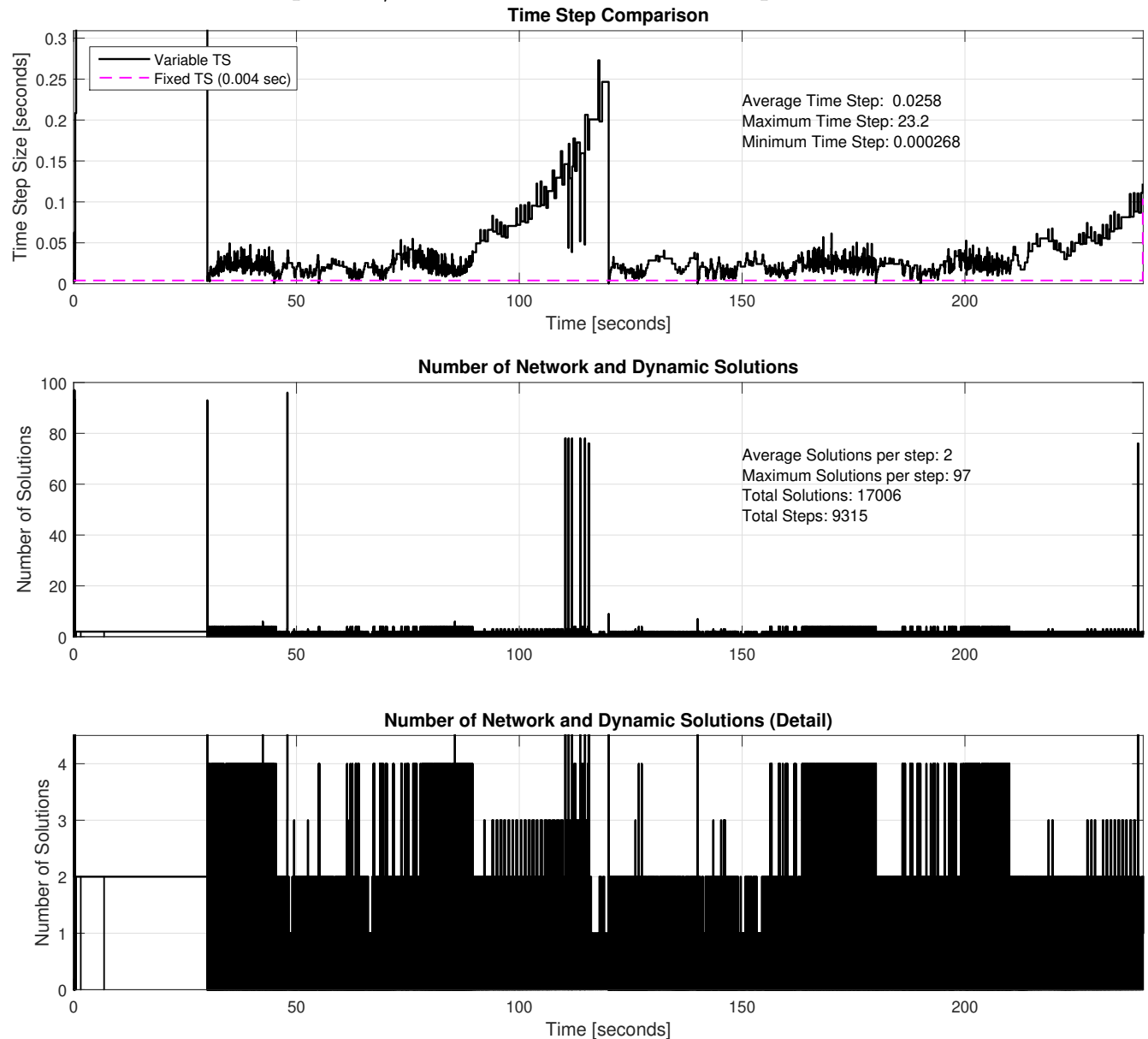
1. The SETO version is 3.65 times faster than PST 3.1.1.
2. Using variable time steps allows for a speed up of 14.84 over PST 3.1.1.
3. Results from all simulations are very similar.
4. Without creating an explicit time block at the beginning of an event, VTS events may not occur at the exact time they are programmed.
5. VTS reduces logged data size by  $\approx 4$  times compared to the SETO version.

PST Version	Step Size [seconds]			Solutions Per Step				Sim. Time	Speed Up
	Max.	Min.	Ave.	Total Steps	Ave.	Max.	Total Slns.		
3.1.1	4.00E-03	4.00E-03	4.00E-03	59,975	2	2	119,950	916.24	1.00
SETO	4.00E-03	4.00E-03	4.00E-03	59,975	2	2	119,950	250.82	3.65
VTS	2.32E+01	2.68E-04	2.58E-02	9,315	2	97	17,006	61.73	14.84

**NOTE**

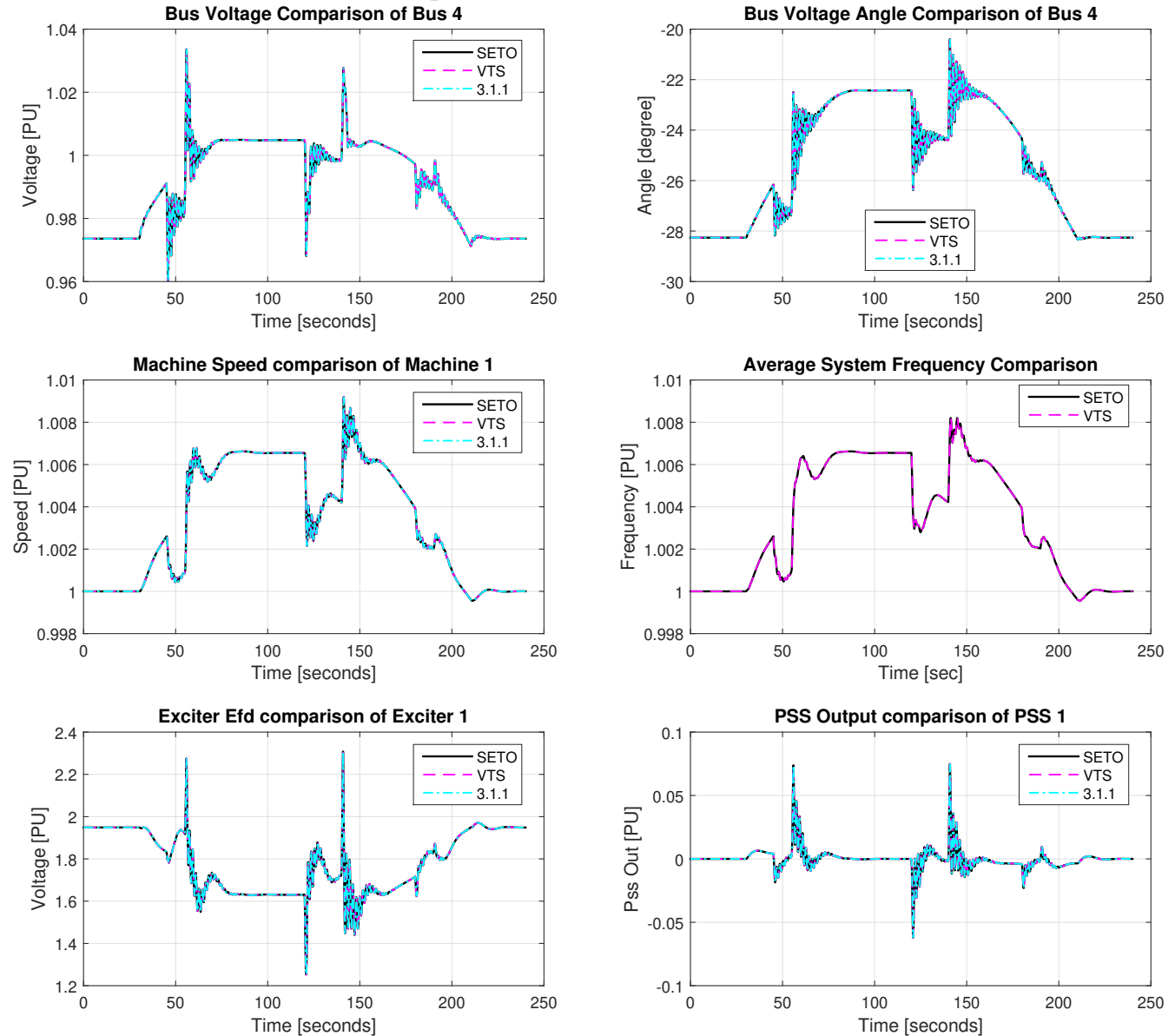
- VTS is still 'experimental' and not completely validated/verified.
- Related files are on github in the MT-Tech-SETO\PST\0-examples\extendedTerm folder.

## Plotted Results - Step Size / Number of Solutions Comparison



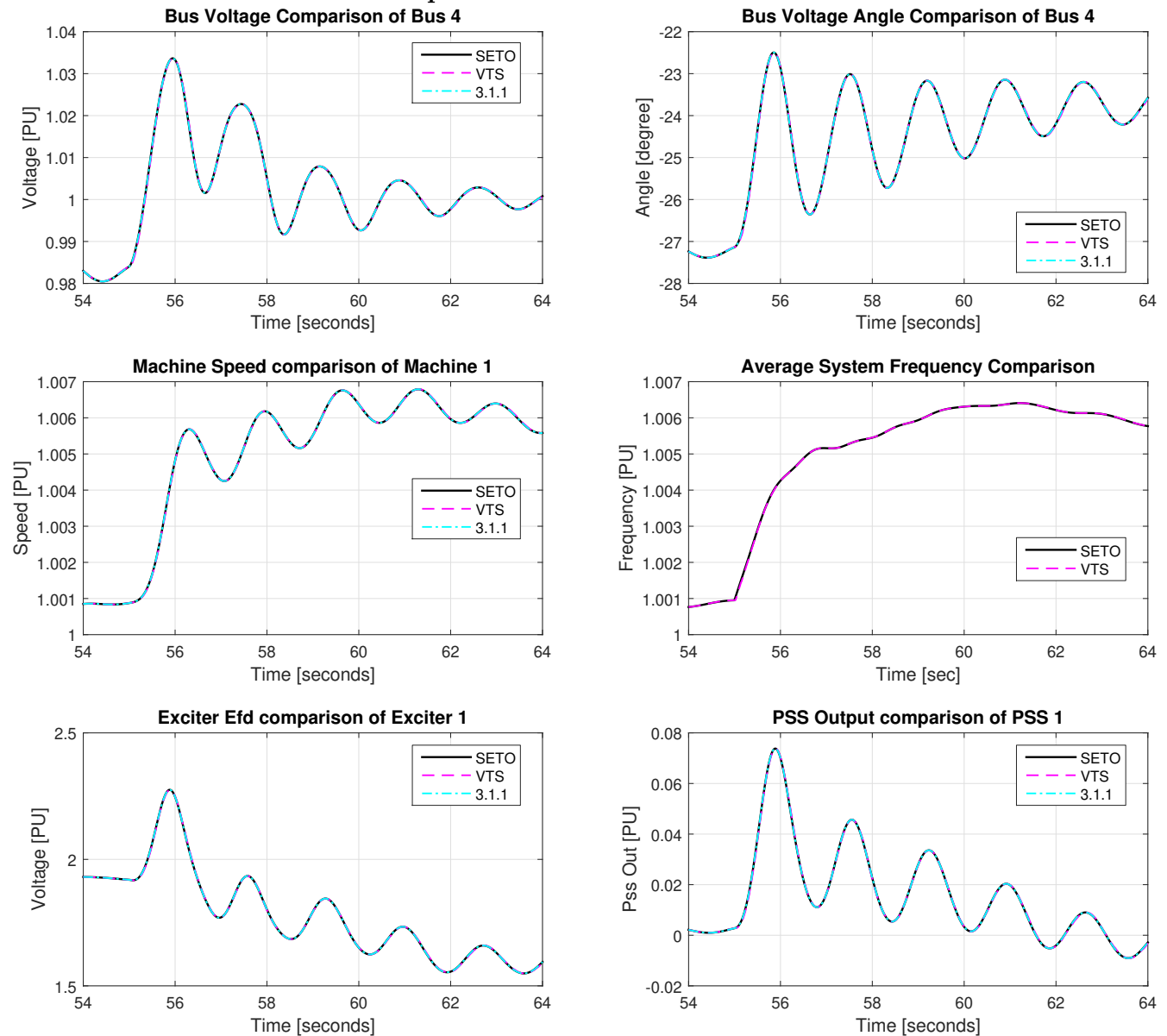
NOTE: Initial time steps before  $t=30$  are much larger than the other time steps (multiple seconds) and are plotted off the axis.

## Plotted Results - Various Comparisons



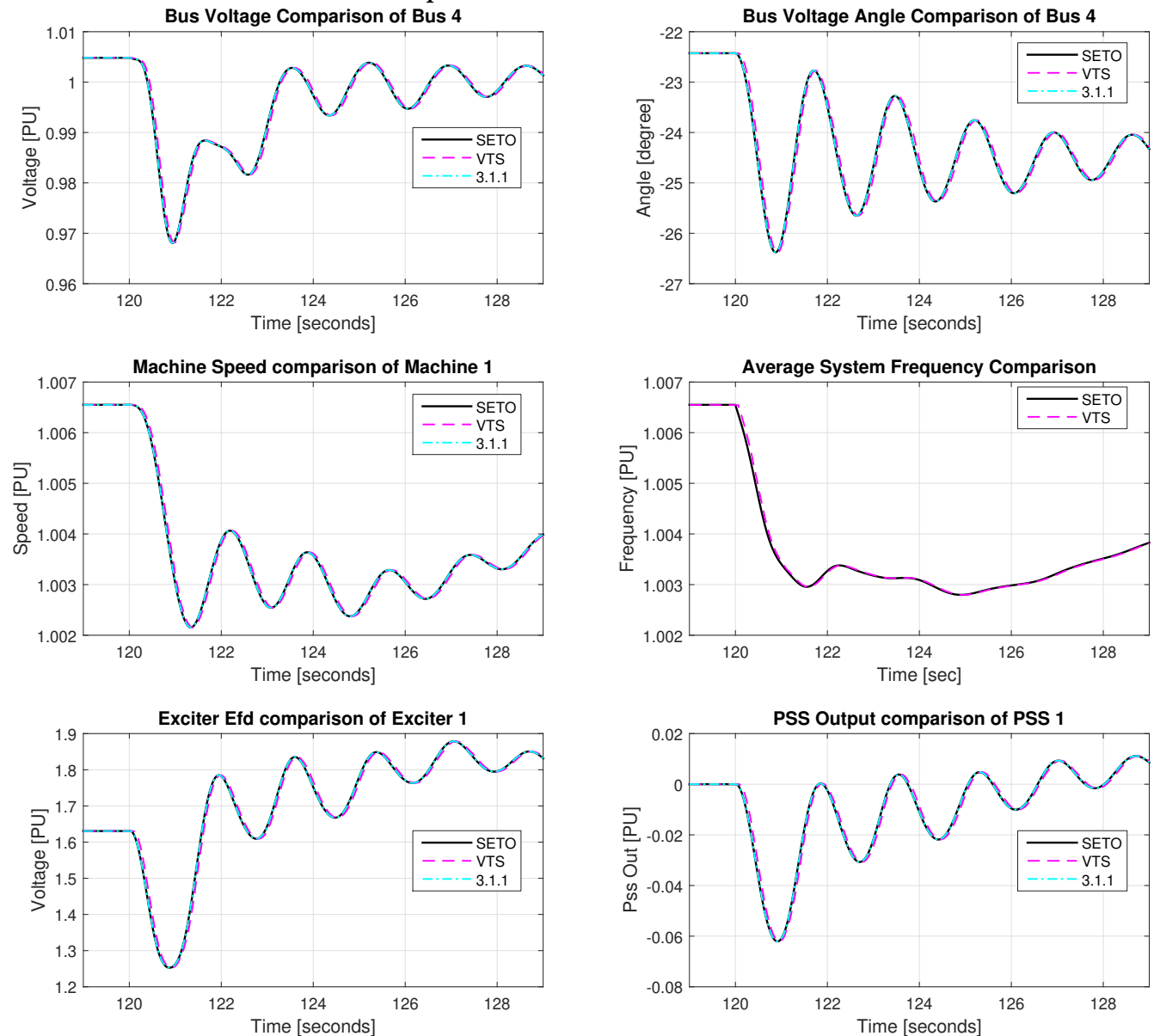
NOTE: 3.1.1 does not calculate average system frequency.

## Plotted Results - Various Comparisons - Detail 1



NOTE: 3.1.1 does not calculate average system frequency.

## Plotted Results - Various Comparisons - Detail 2

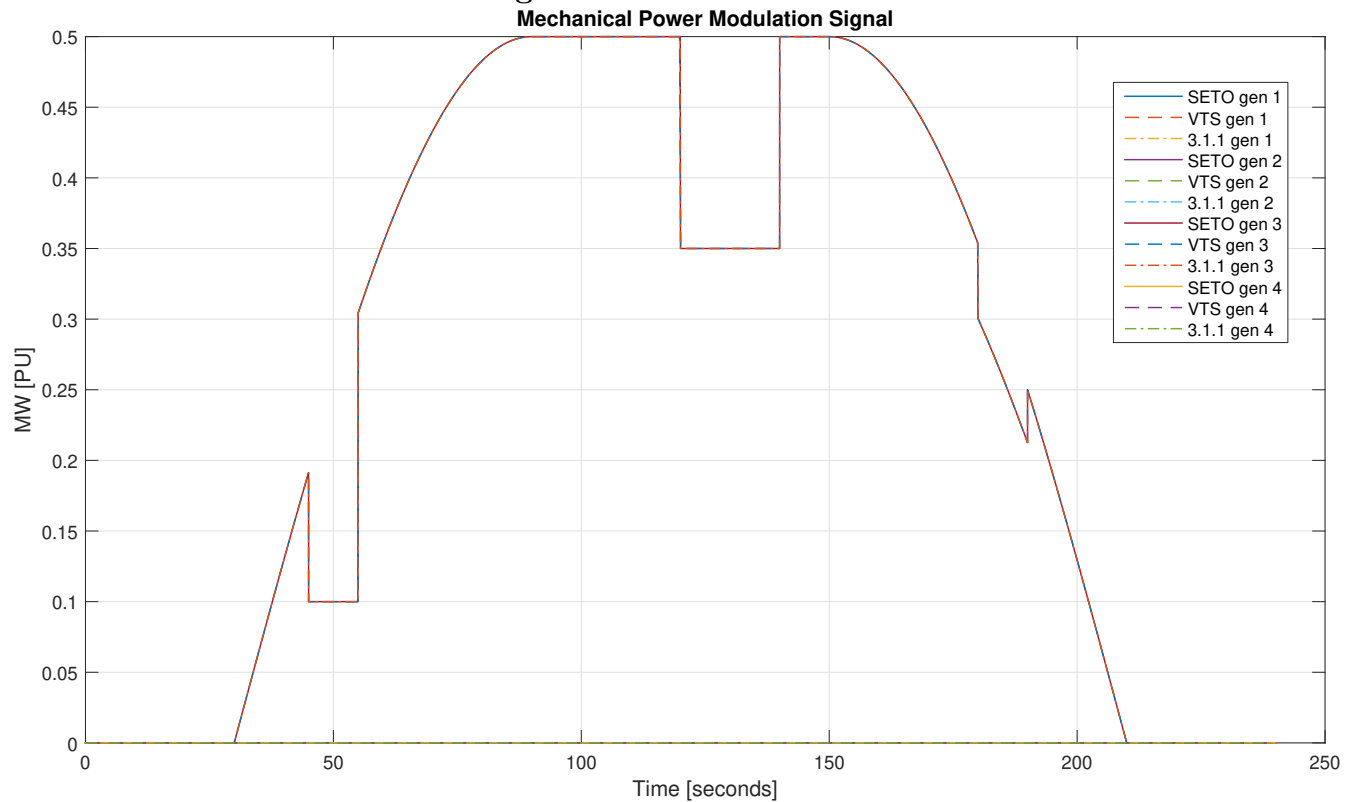


NOTE: 3.1.1 does not calculate average system frequency.

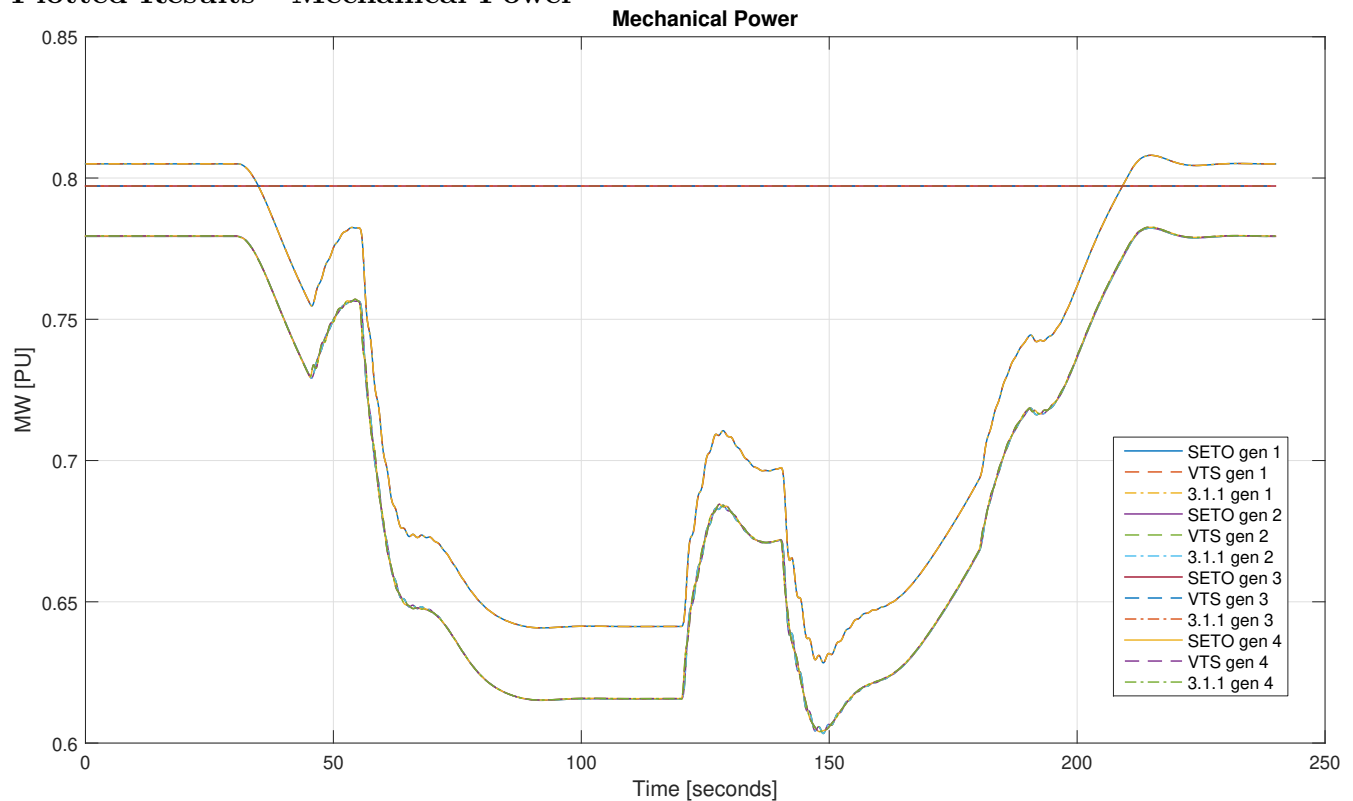
VTS events may not occur at exact specified time due to the nature of variable time steps.

Breaks in the `sw_con` can be created to account for this, however, the variance in time is often relatively small.

## Plotted Results - Modulation Signal

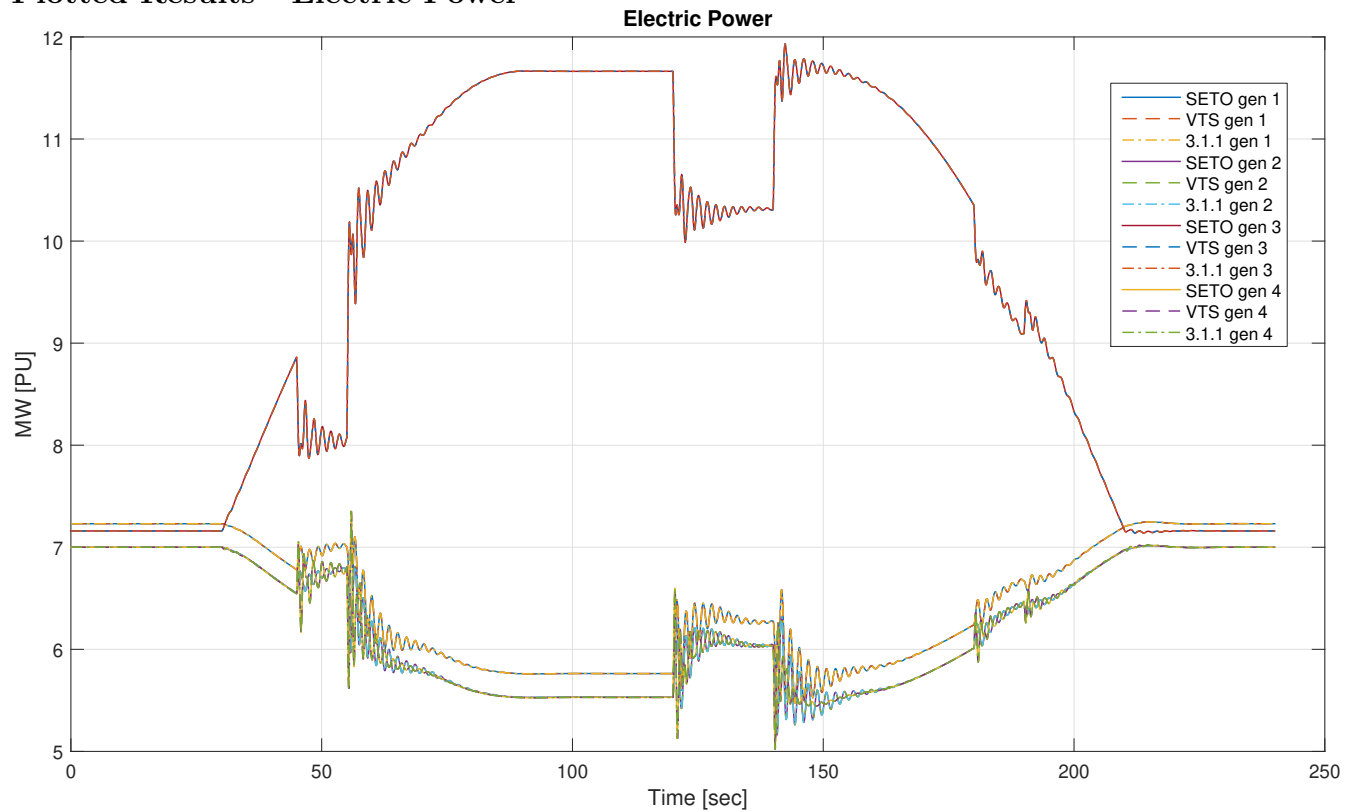


## Plotted Results - Mechanical Power



Note that the modulated mechanical power signal is not added to the recorded mechanical power.

## Plotted Results - Electric Power



## Plotted Results - Electric Power - Detail

Detail of generators 1, 2, and 5 from  $t = 140$  to  $150$ :

