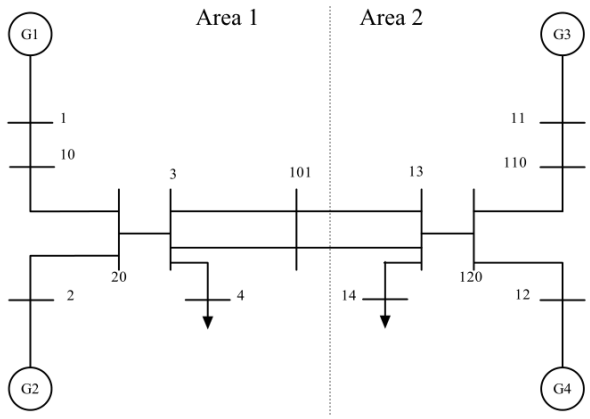
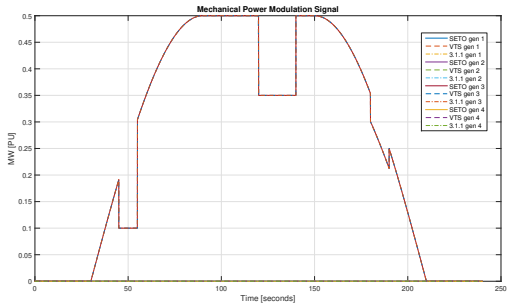
Scenario





- 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

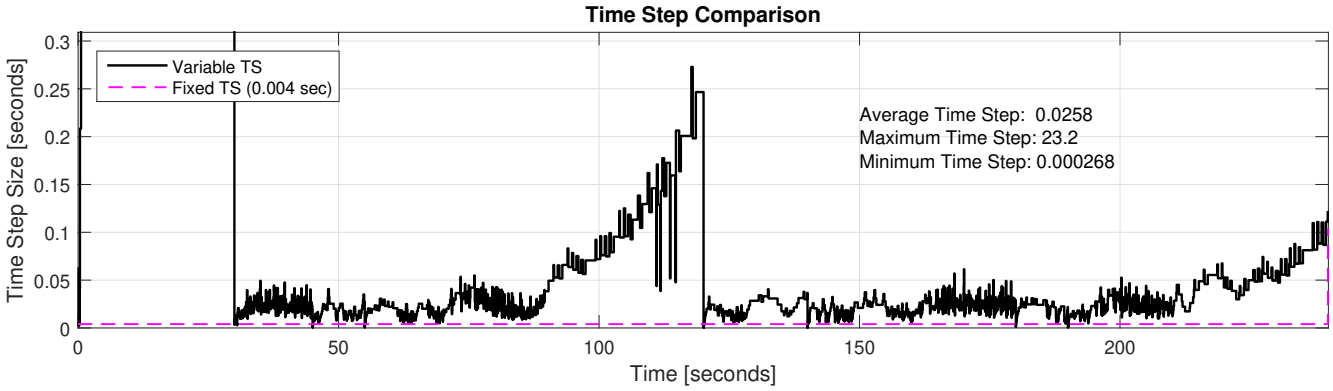
1. The SETO version is 3.65 times faster than PST 3.1.1.
2. Using variable time steps allows for a speed up of 14.84 over PST 3.1.1.
3. Results from all simulations are very similar.
4. Without creating an explicit time block at the beginning of an event, VTS events may not occur at the exact time they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

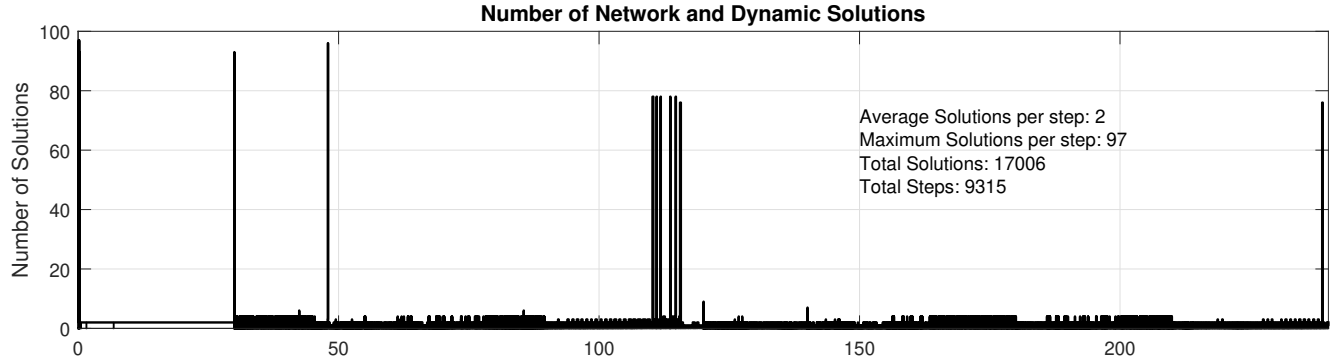
	Step Size [seconds]				Solutions Per Step				
PST Version	Max.	Min.	Ave.	Total Steps	Ave.	Max.	Total Slns.	Sim. Time	Speed Up
3.1.1	4.00E-03	4.00E-03	4.00E-03	59,975	2	2	119,950	916.24	1.00
SETO	4.00E-03	4.00E-03	4.00E-03	59,975	2	2	119,950	250.82	3.65
VTS	2.32E+01	2.68E-04	2.58E-02	9,315	2	97	17,006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

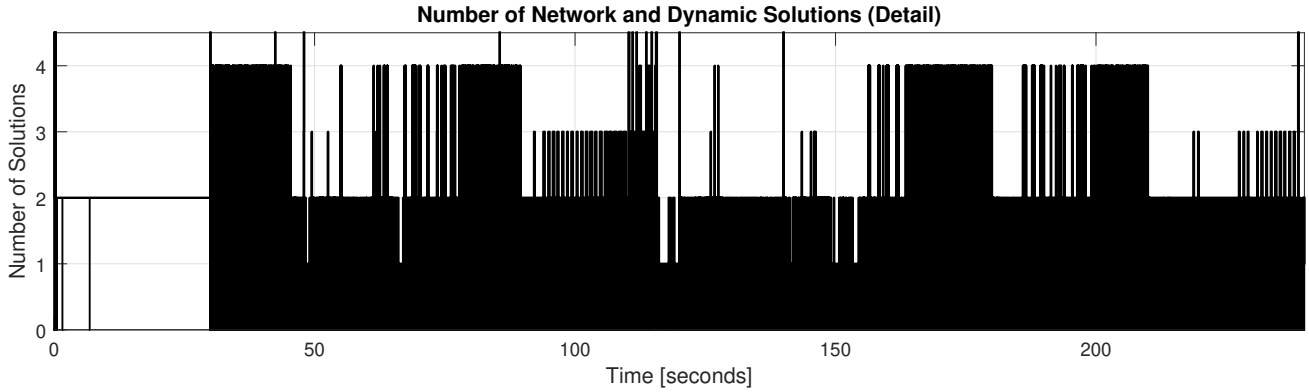
NOTE

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

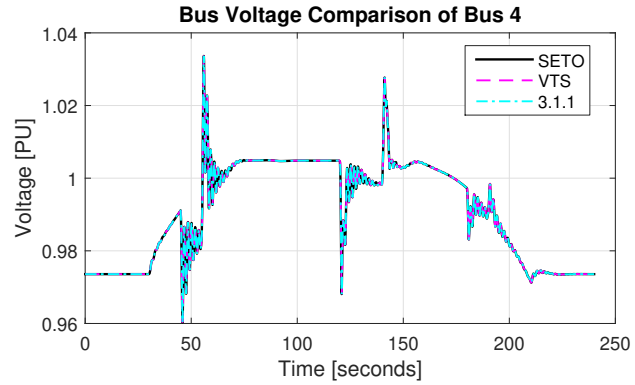
Plotted Results

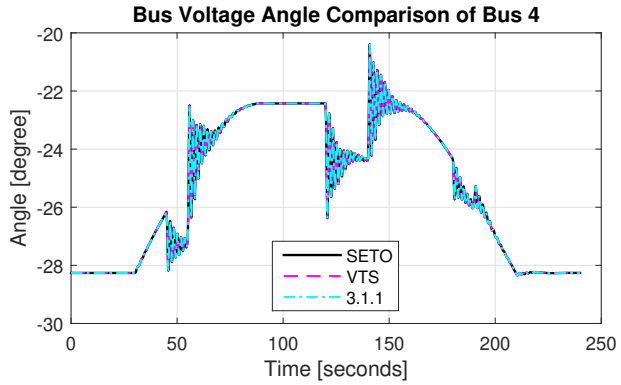


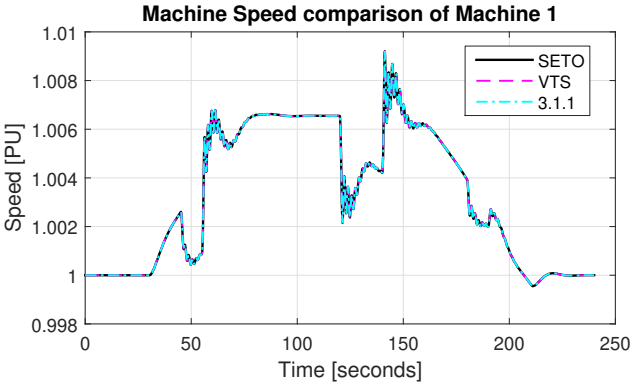


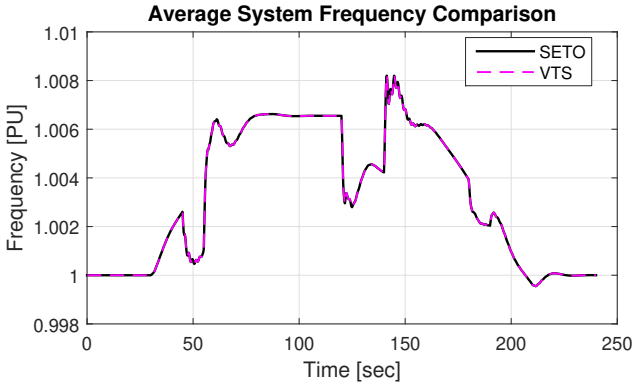


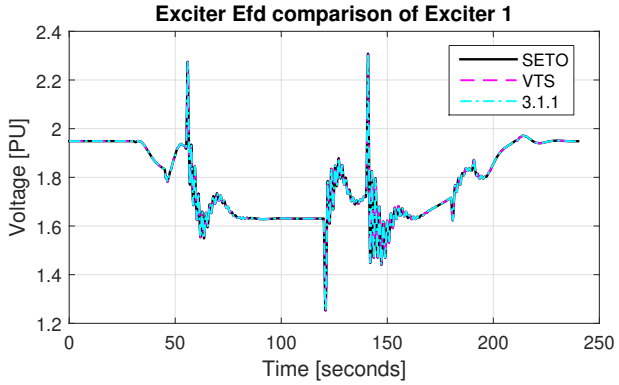
NOTE: Initial time steps before t=30 are much larger than the other time steps (multiple seconds) and are plotted off the axis.

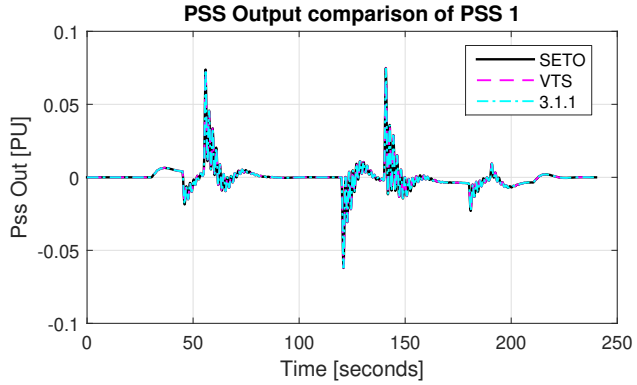




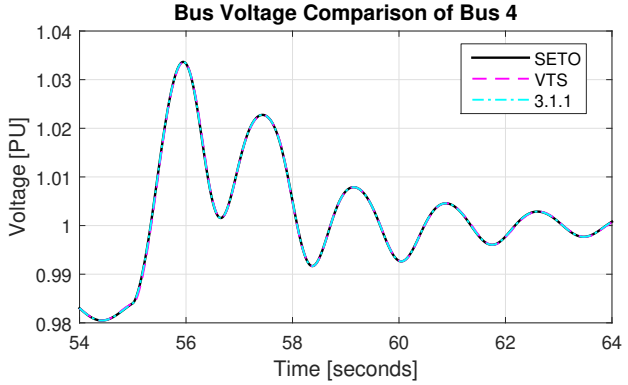


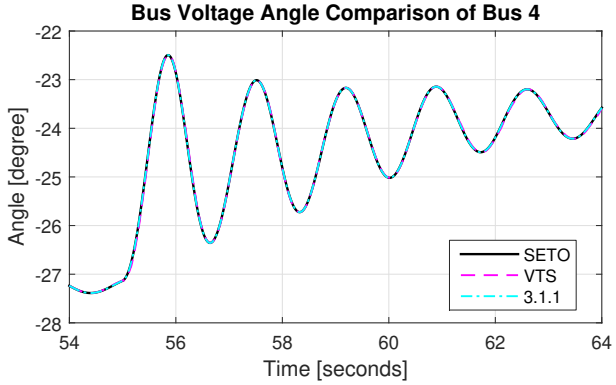


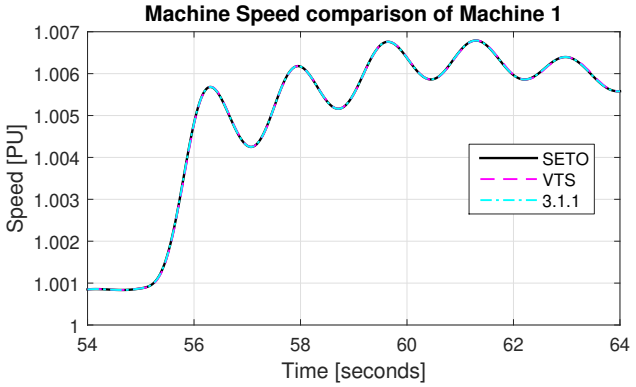


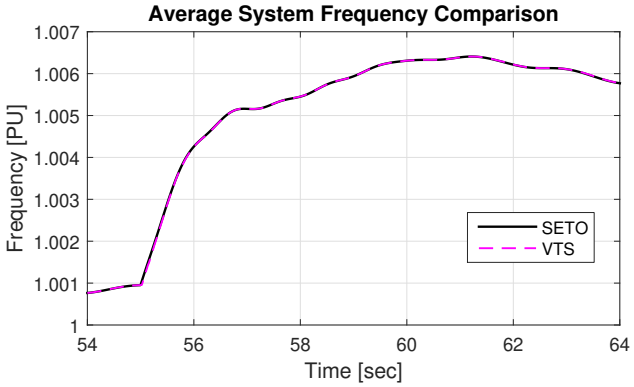


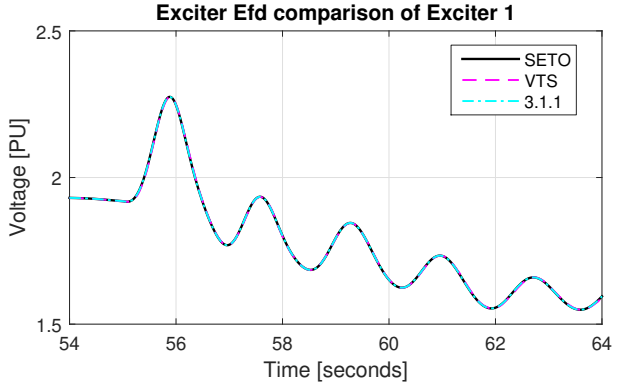
NOTE: 3.1.1 does not calculate average system frequency.

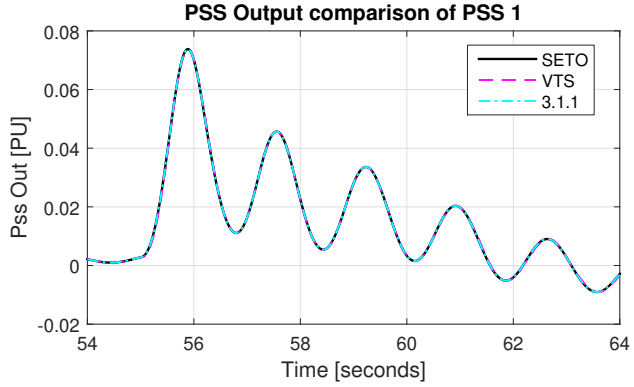




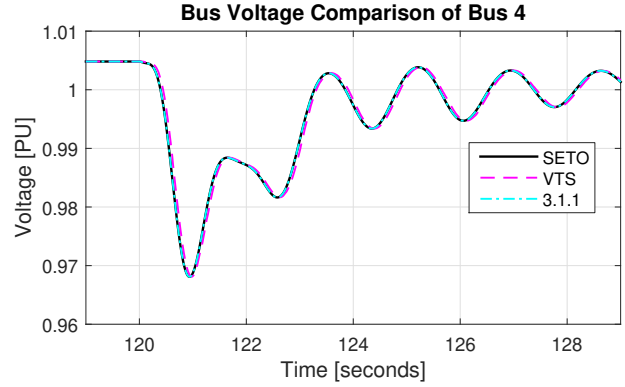


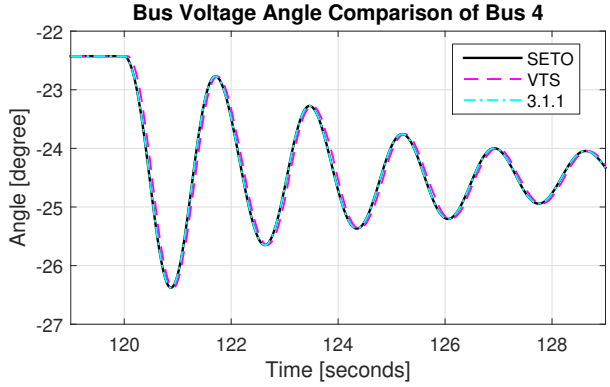


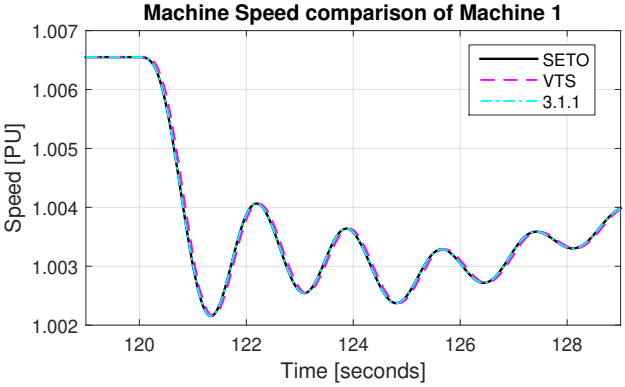


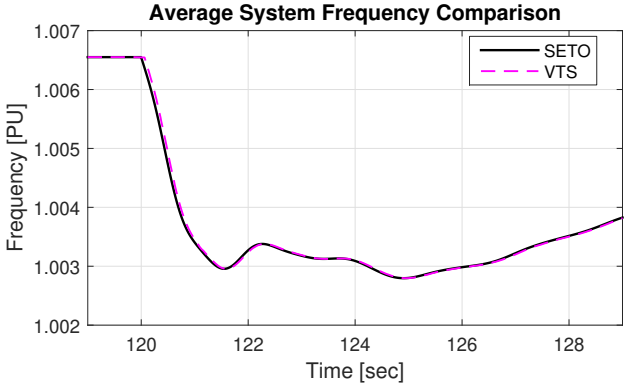


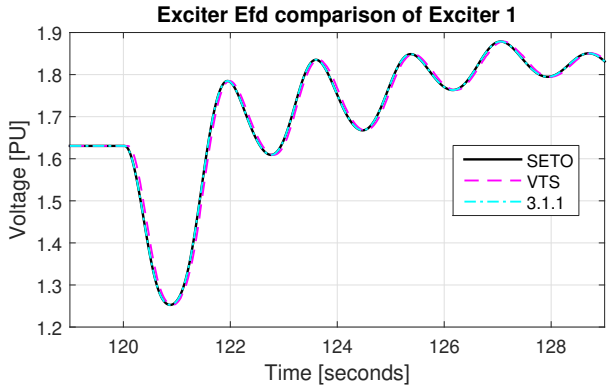
NOTE: 3.1.1 does not calculate average system frequency.

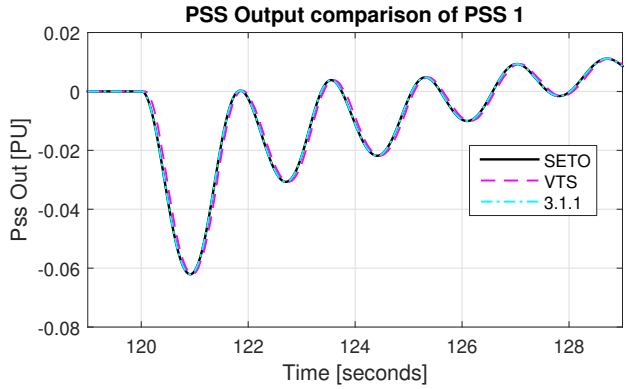






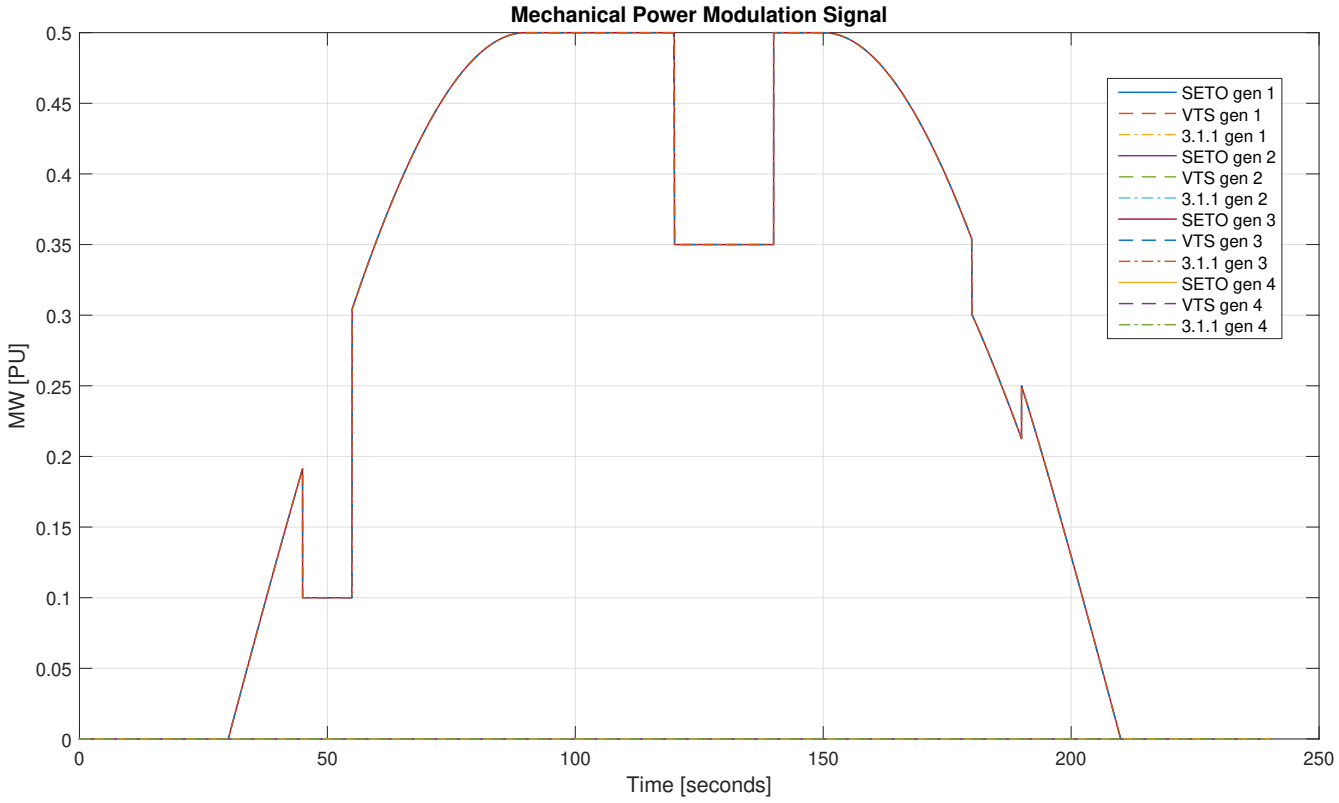


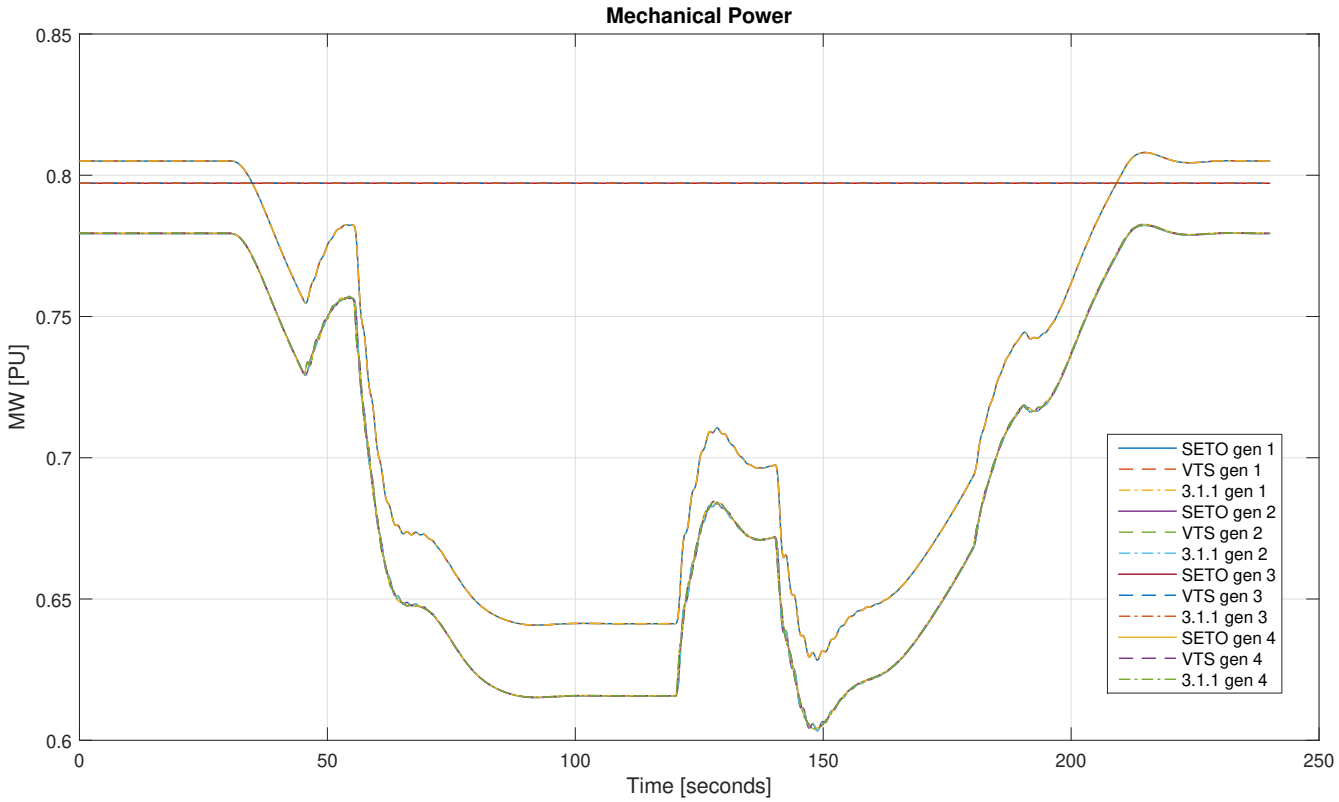


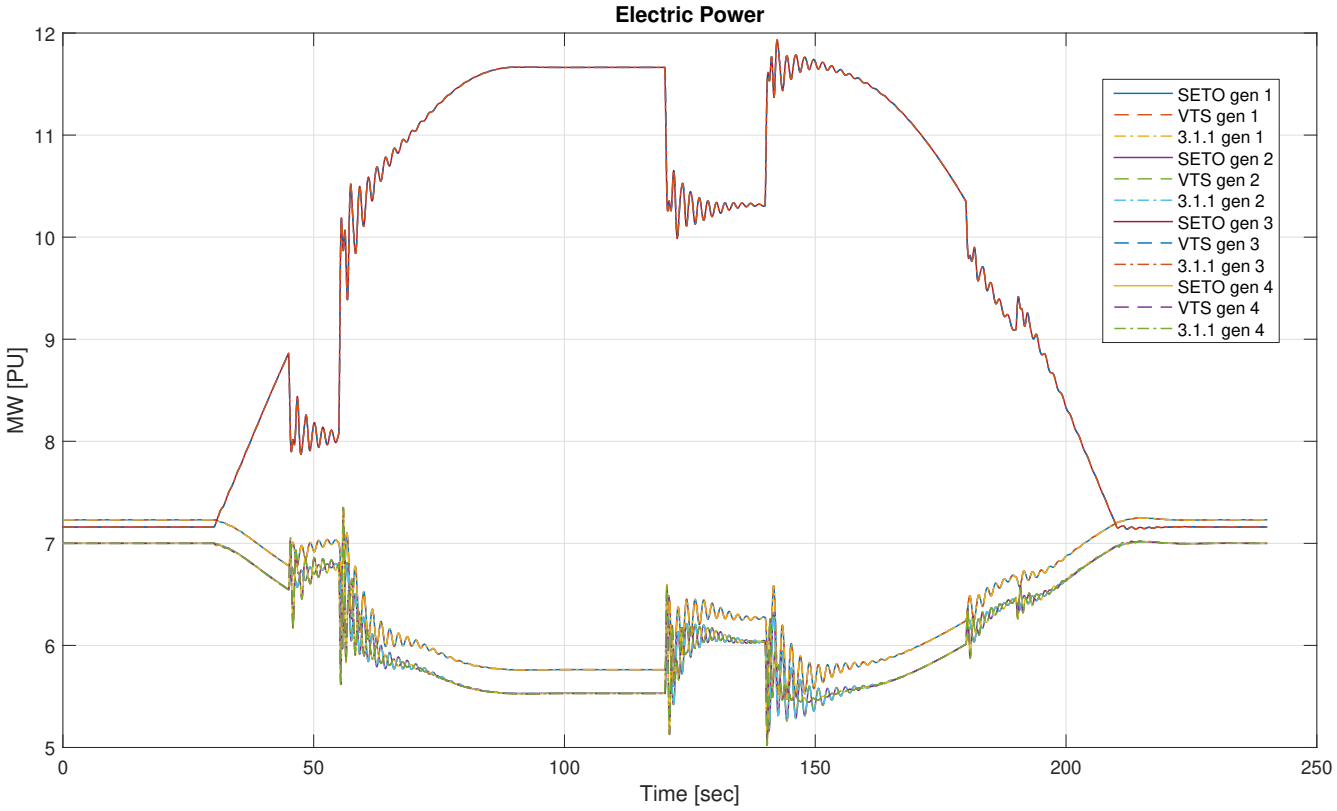


NOTE: 3.1.1 does not calculate average system frequency.

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.


Mechanical Power Modulation Signal
MW [PU]
Time [seconds]
SETO gen 1
VTS gen 1
3.1.1 gen 1
SETO gen 2
VTS gen 2
3.1.1 gen 2
SETO gen 3
VTS gen 3
3.1.1 gen 3
SETO gen 4
VTS gen 4
3.1.1 gen 4


Mechanical Power
MW [PU]
Time [seconds]
SETO gen 1
VTS gen 1
3.1.1 gen 1
SETO gen 2
VTS gen 2
3.1.1 gen 2
SETO gen 3
VTS gen 3
3.1.1 gen 3
SETO gen 4
VTS gen 4
3.1.1 gen 4



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