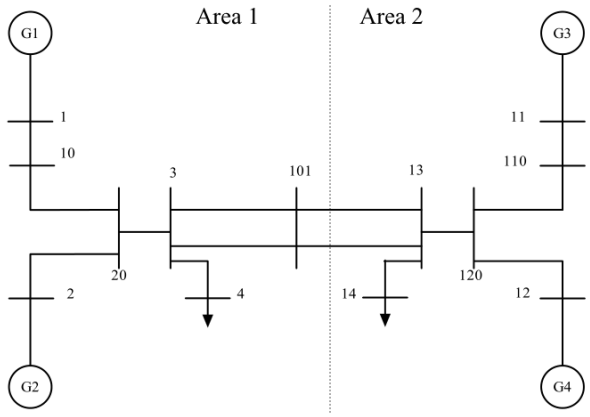
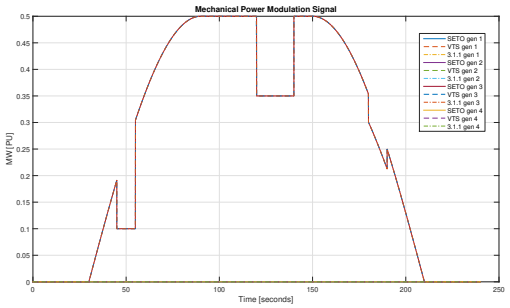
## Scenario




- 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:

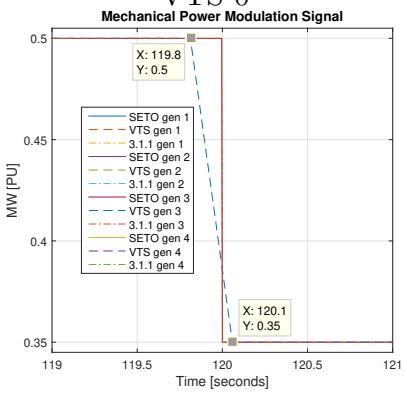
```
% time [seconds]
% 0-30      - no action
% 30-90     - ramp up 0.5 PU (50 MW)
% 90-150    - hold peak
% 150-210   - ramp down 0.5 PU (50 MW)
% 210-240   - no action

% 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. Delay in executing pm_sig caused by VTS created a noticeable delay in VTS dynamics.
2. Decreasing ODE solver tolerances did not resolve the issue.
3. Creating a new time block near the event in question did resolve the issue.

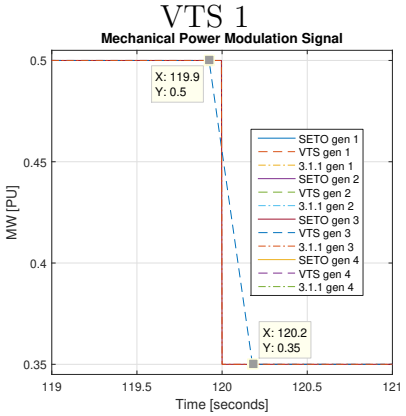
As shown below, VTS may result with event start times ending up between computed time steps without additional user action/foresight.

VTS 0



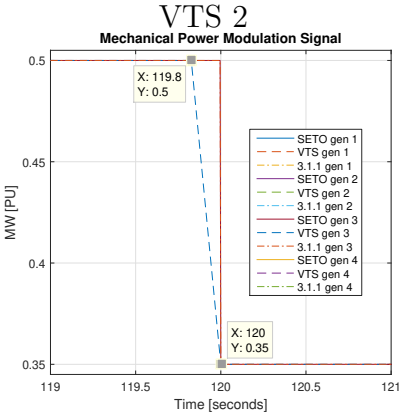

Original Simulation

VTS 1




Decreased Tolerance

VTS 2




Additional 'time block'

### sw_con Changes

The original switching array is shown below.

```
ts = 0.004;
sw_con = [...
.1      0          0          0    0    0    ts;   % sets intitial time step
0.2     101        3          0    0    6    ts;   % Do Nothing
30.0    0          0          0    0    0    ts;   % Do Nothing
240.0   0          0          0    0    0    0];   % end simulation
```

The altered switching array adds a null event at t = 120 to ensure the pm_sig step is processed at the designed starting time.

```
ts = 0.004;
sw_con = [...
.1      0          0          0    0    0    ts;   % sets intitial time step
0.2     101        3          0    0    6    ts;   % Do Nothing
30.0    0          0          0    0    0    ts;   % Do Nothing
120.0   0          0          0    0    0    ts;   % Do Nothing <- Added row
240.0   0          0          0    0    0    0];   % end simulation
```

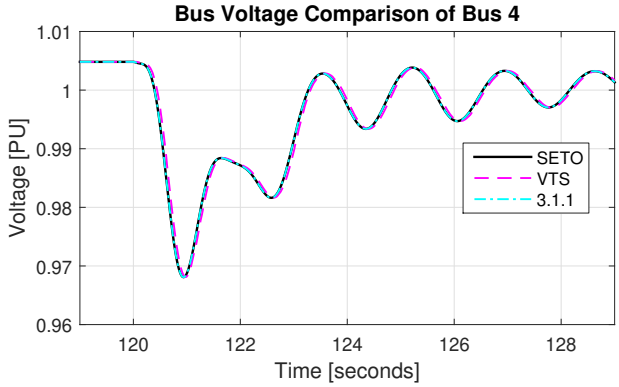
NOTE: The start time of 0.1 was an oversight during case creation.

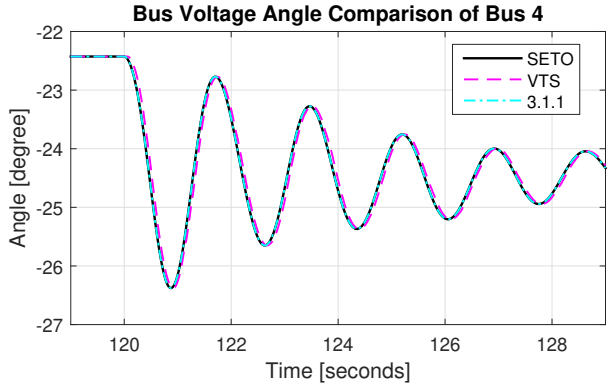
### Performance Effects

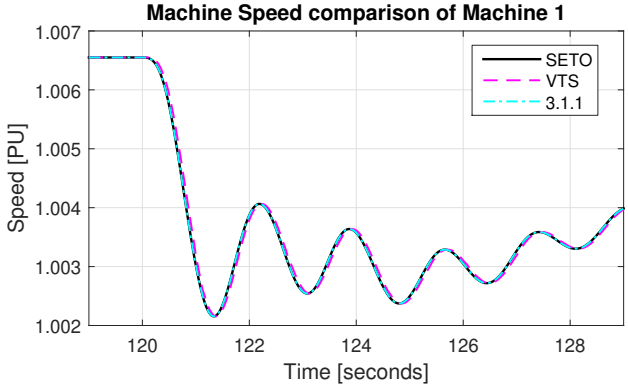
The decreased tolerance case (VTS 1 - with Relative Tolerance of 1e-5 instead of 1e-4) took more time to simulate as it took many more steps. VTS 2, with the altered sw_con, performed slightly slower than the original (VTS 0).

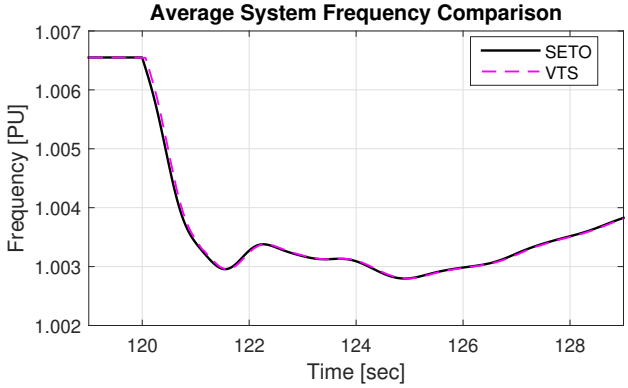
| | Step Size [seconds] | | | | Solutions Per Step | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Version | Max. | Min. | Ave. | Total Steps | Ave. | Max. | Total Slns. | Sim. Time | Speed Up |
| VTS 0 | 2.32E+01 | 2.68E-04 | 2.58E-02 | 9,315 | 2 | 97 | 17,006 | 61.73 | 1.00 |
| VTS 1 | 2.32E+01 | 1.36E-04 | 1.38E-02 | 17,353 | 2 | 96 | 27,243 | 106.09 | 0.58 |
| VTS 2 | 2.00E+01 | 2.19E-05 | 2.58E-02 | 9,504 | 2 | 100 | 17,927 | 66.59 | 0.93 |

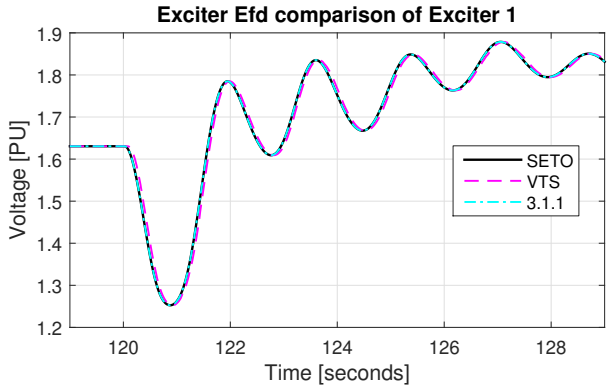
## Original Results (VTS 0)

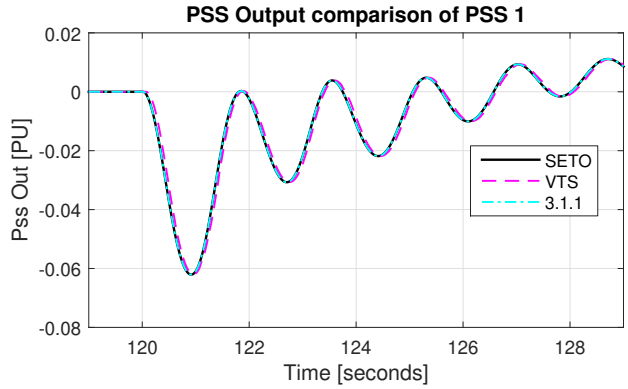


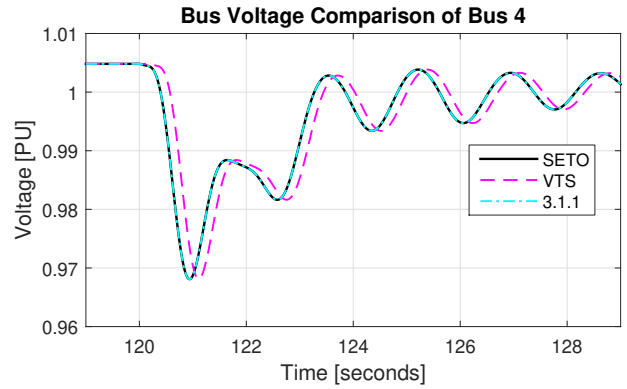



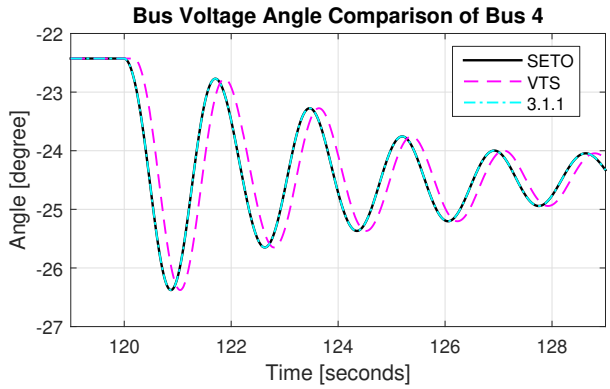



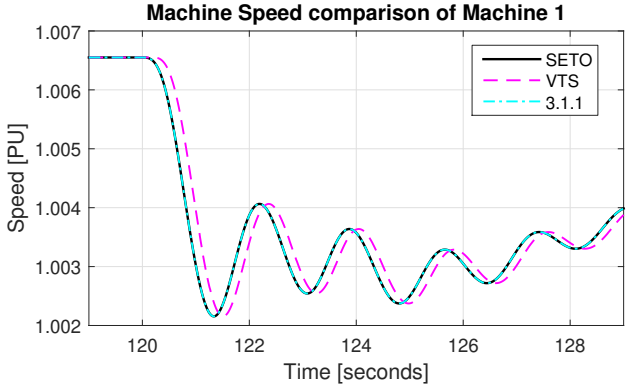



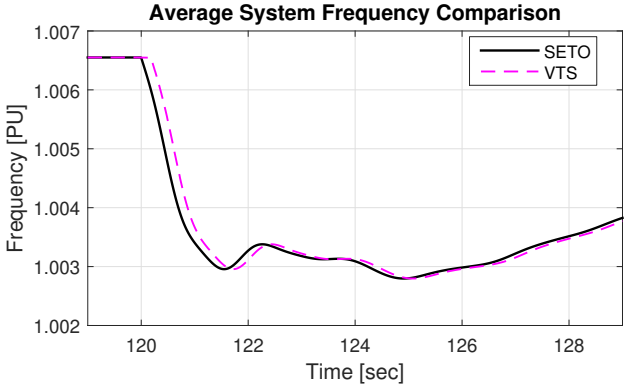



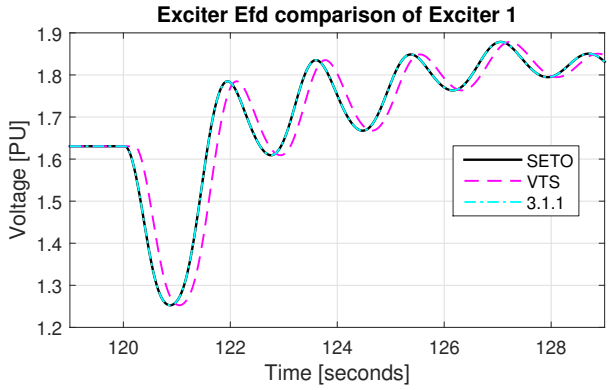
## Decreased Tolerance Results (VTS 1)

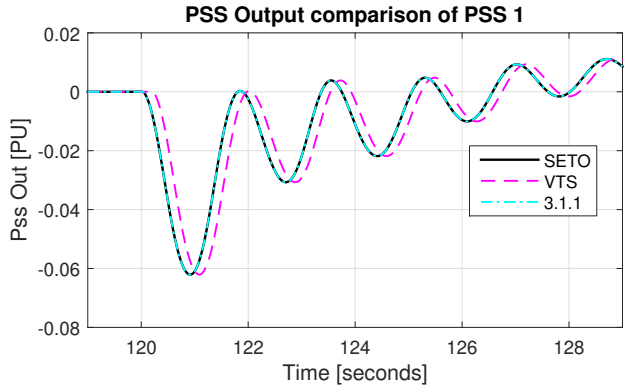


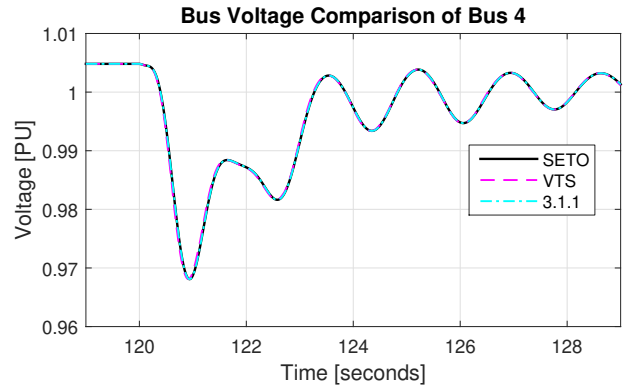



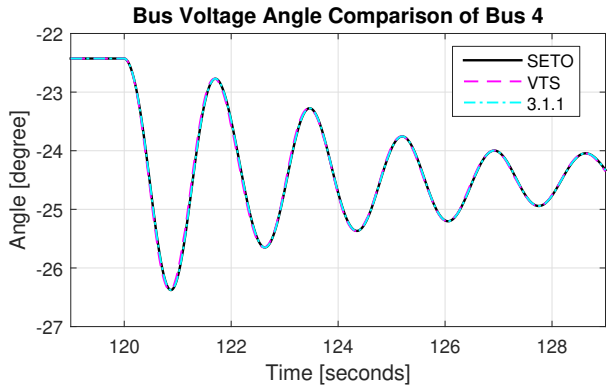



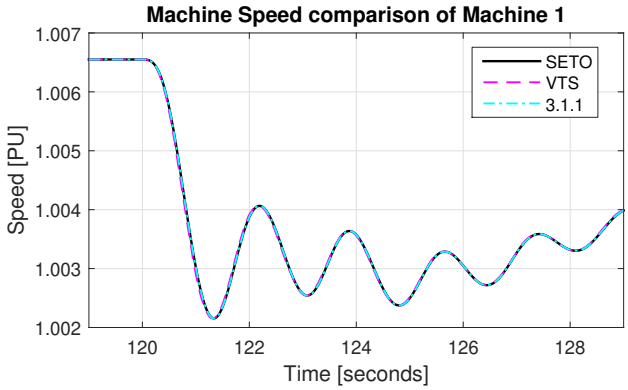



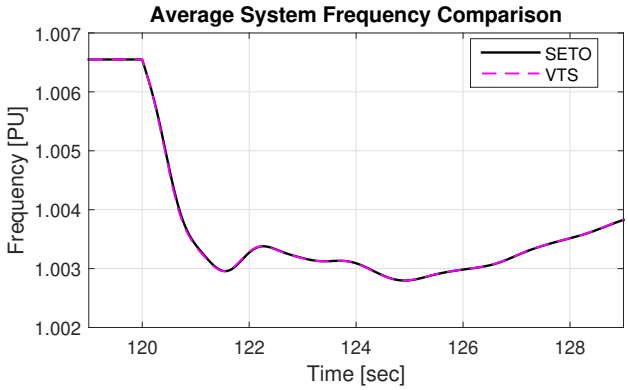

Results actually appear worse than VTS 0 as there is more variance between expected and actual start time of the modulation signal.

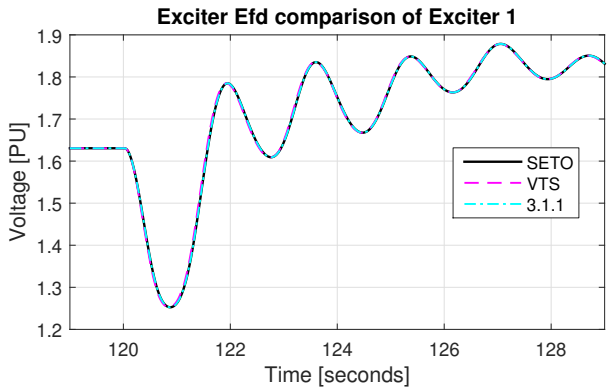
## Altered sw_con Results (VTS 2)

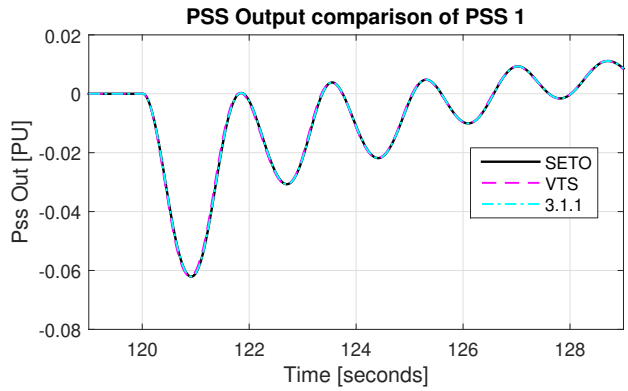



The additional row in the switching control array seemed to resolve delayed dynamic issue.