

Hassayampa Event Sensitivity Studies and Validation

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2003 Hassayampa Event

- 7/28/2003 6:54 pm, a three-phase fault on the Hassayampa to Arlington Valley 500-kV line. The 500-kV breaker tripped in three cycles (50 milliseconds), clearing the fault from the system.
- No transmission trip, 440MW manual load shedding by APS

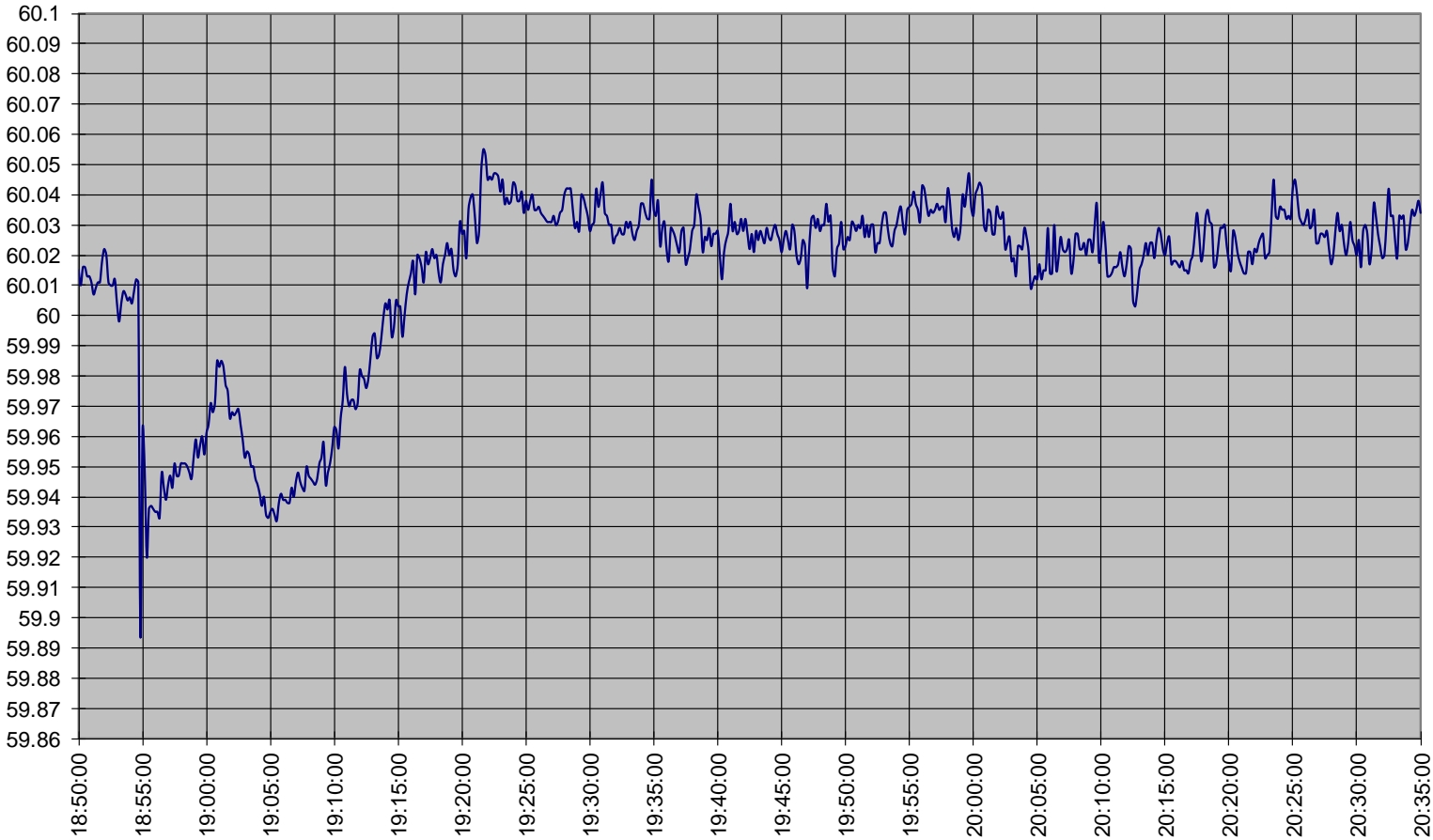
Generation tripping

- This event caused the immediate tripping of the following area generation:

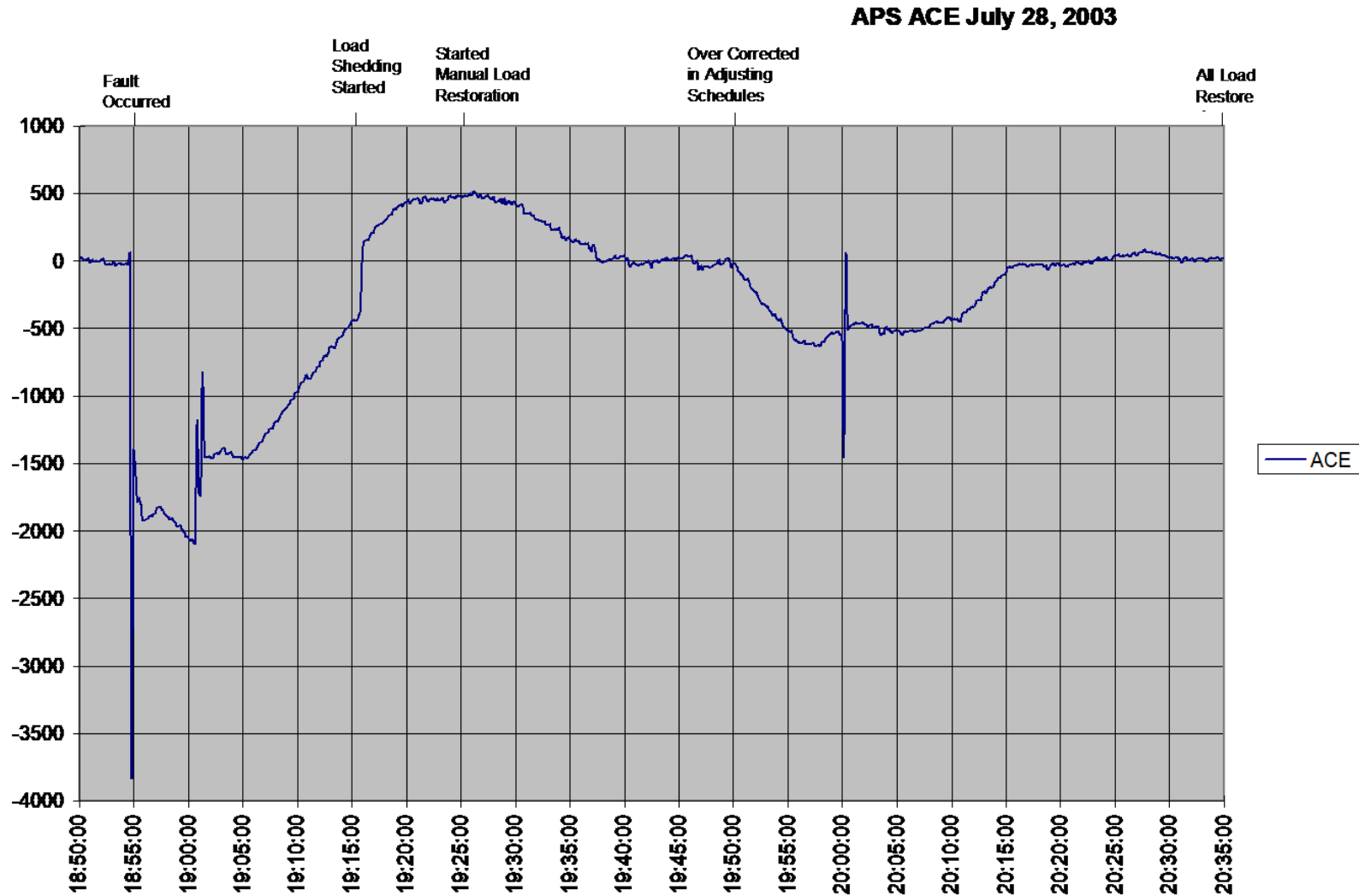
Total generation loss	2687 MW
APS generation lost	1799 MW
SRP generation lost	219 MW
EPE generation lost	198 MW
SCE generation lost	198 MW
PNM generation lost	128 MW
SCPA generation lost	74 MW
LDWP generation lost	71 MW

APS frequency

APS Frequency
July 28, 2003



APS ACE



Motor D Parameters

Parameter	Description
Vstall	Stall Voltage, the voltage per unit below which the motors will stall
Tstall	Stall Time Constant, the amount of time the voltage needs to be below Vstall to stall
Vrst	Restart Voltage, the voltage at which the motors will restart
Trst	Restart Time Constant, the amount of time the voltage needs to be above Vrst for the motor to restart
Frst	The fraction of motors that are capable of restarting
vtr	Undervoltage relaying threshold
ttr	Undervoltage relaying time constant
Fuvr	The fraction of motors with undervoltage relaying
Tth	Thermal Time Constant, the amount of time it takes for heat to trip the motor

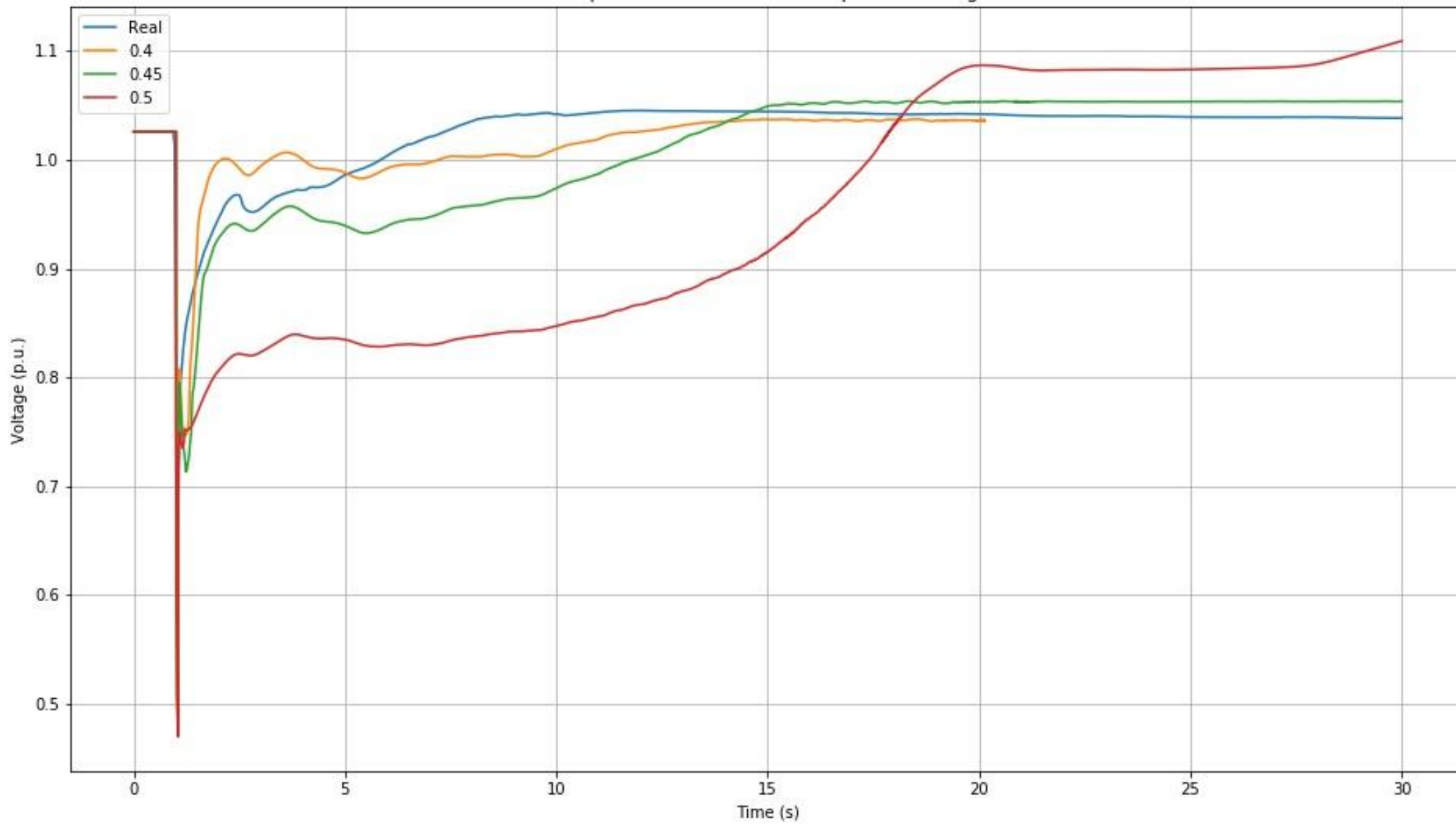
Sensitivity Studies

- Varied one parameter at a time to check for impact
 - Remaining parameters were kept at default value
- Measured PMU data from Pinnacle Peak 345 kV

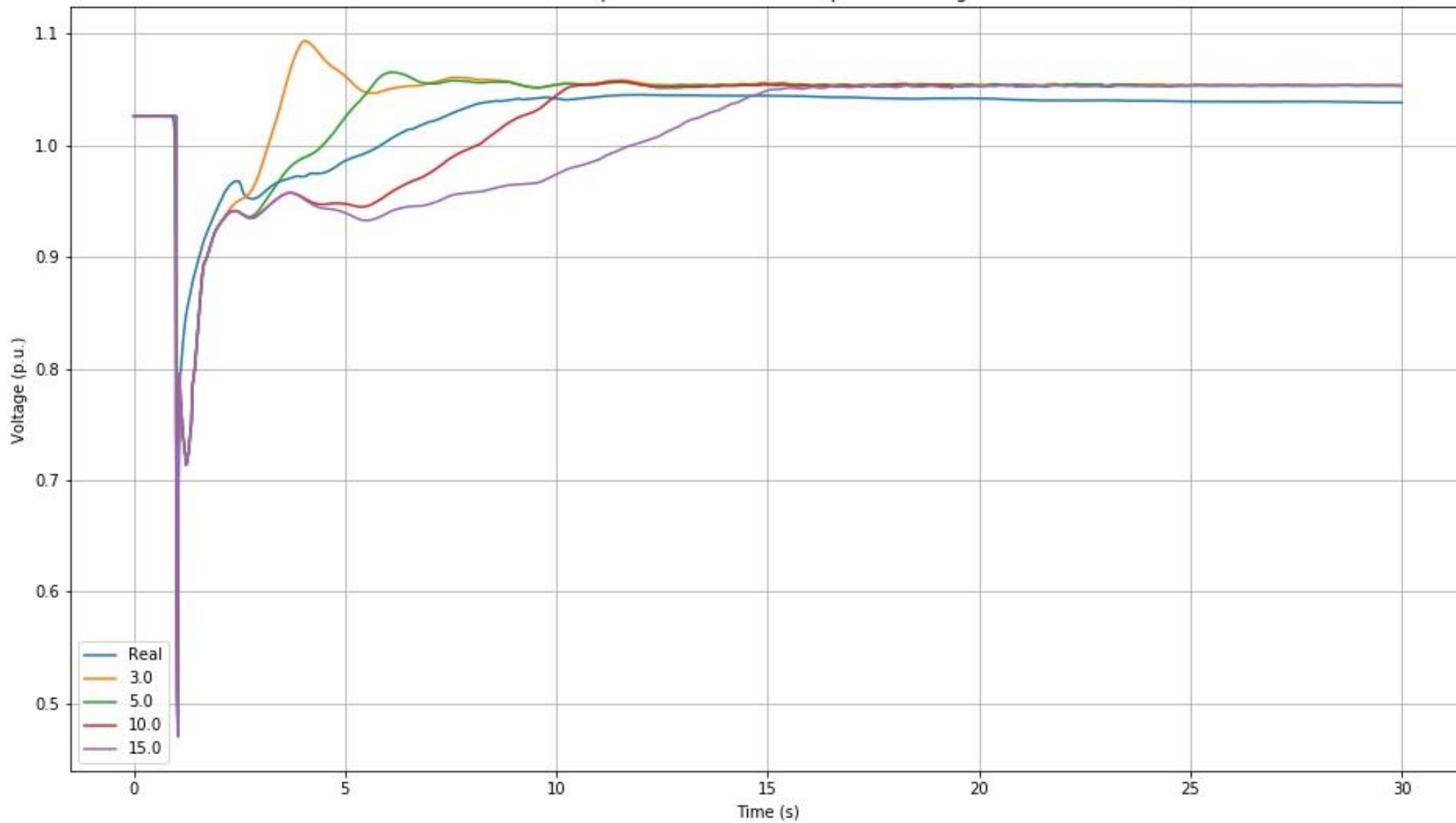
Motor Percentages(Desert Southwest)

	Motor A	Motor B	Motor C	Motor D	Power El.	Resistance	Current
Residential	7%	16%	3%	46%	10%	8.75%	9.25%
Commercial	21%	14%	3%	21%	14%	6%	21%
Mixed	16%	16%	6%	27%	12%	8%	15%

Comparison of Vstall Values Impact on Voltage



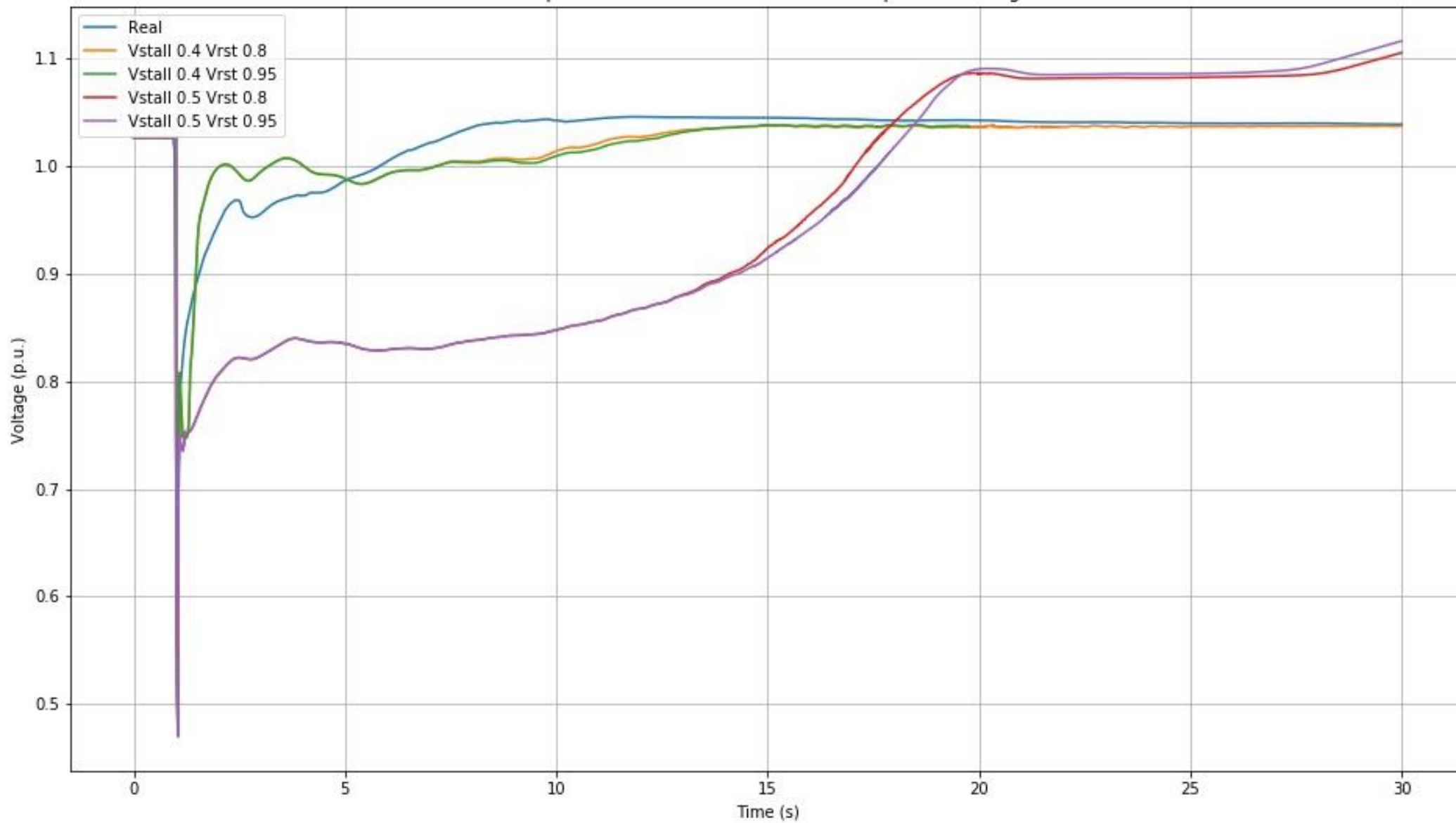
Comparison of Tth Values Impact on Voltage



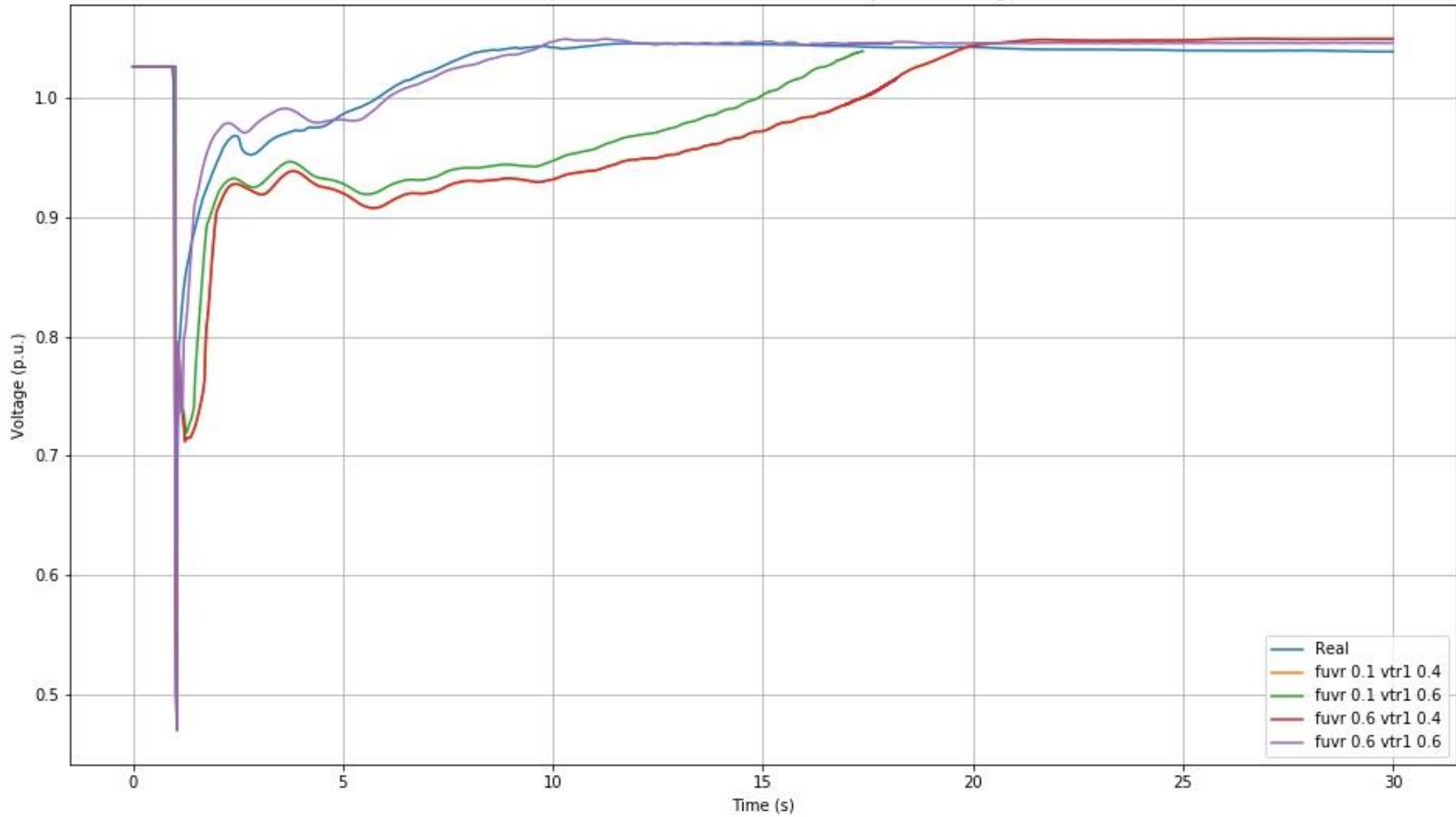
Motor D Sensitivity Studies Part 2

- Varied one parameter at a time for a low and high value of each other parameter to check for impact of each parameter on one another

Comparison of Vstall and Vrst Values Impact on Voltage



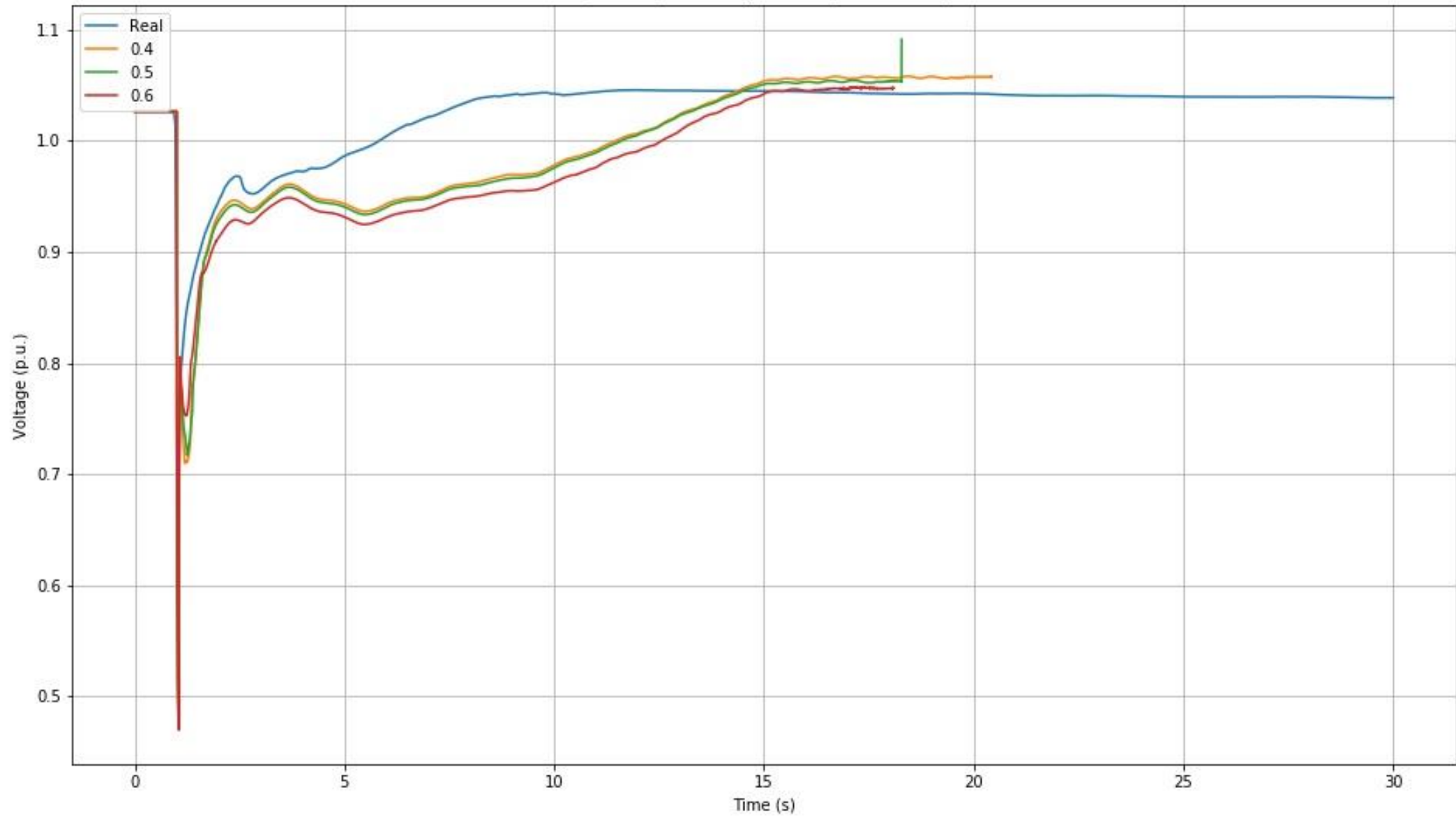
Comparison of fuvr and vtr1 Values Impact on Voltage



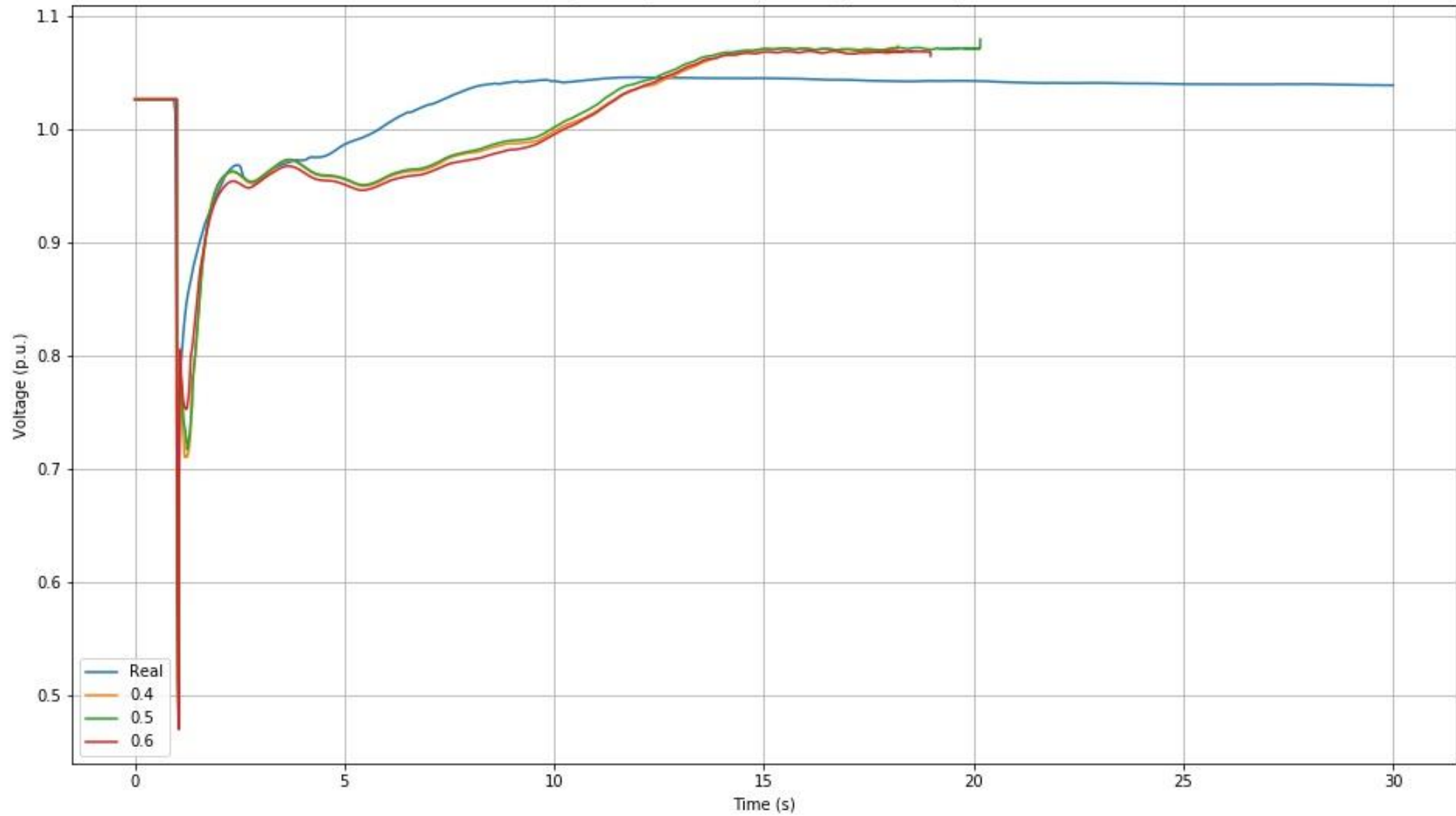
Motor A sensitivity studies

- Varied one parameter at a time for a few parameter value sets

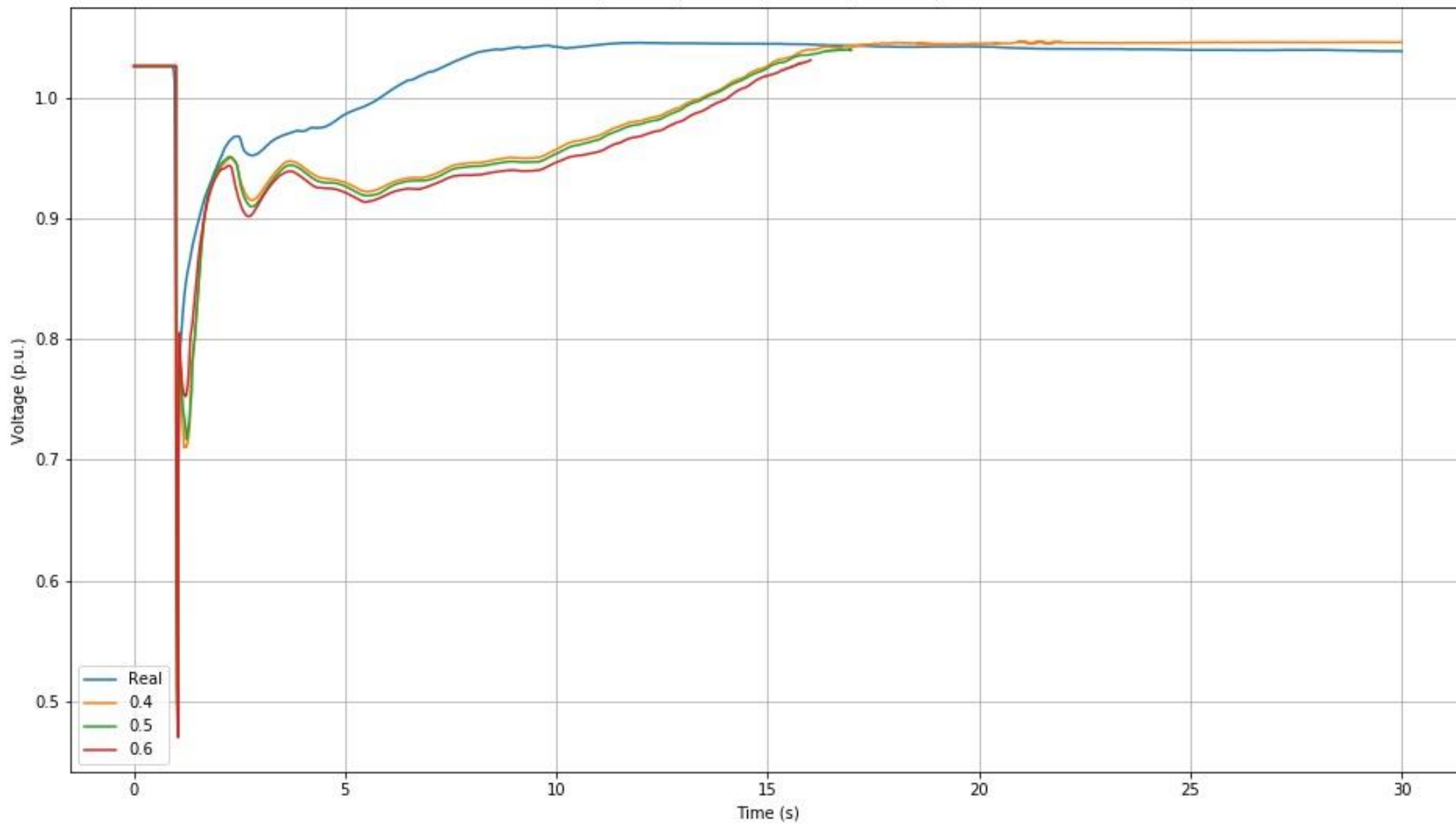
Comparison of Ftr1 Values Impact on Voltage
(Vrc1=.8, Trc1=.1, Vrc2=1, Trc2=9999)



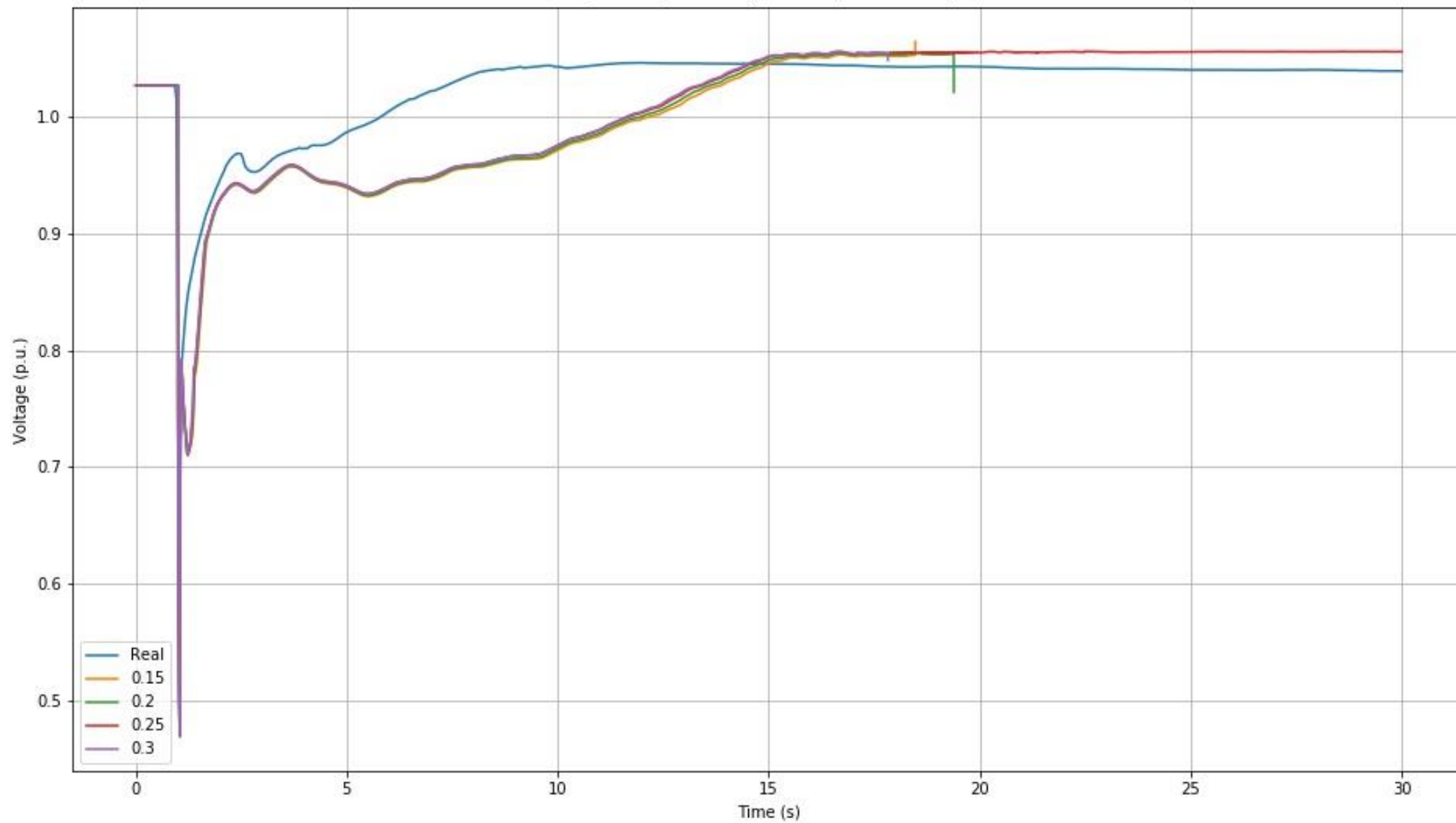
Comparison of Ftr1 Values Impact on Voltage
(Vrc1=1, Trc1=9999, Vrc2=1, Trc2=9999)



Comparison of Ftr1 Values Impact on Voltage
(Vrc1=.7, Trc1=1, Vrc2=.8, Trc2=.2)

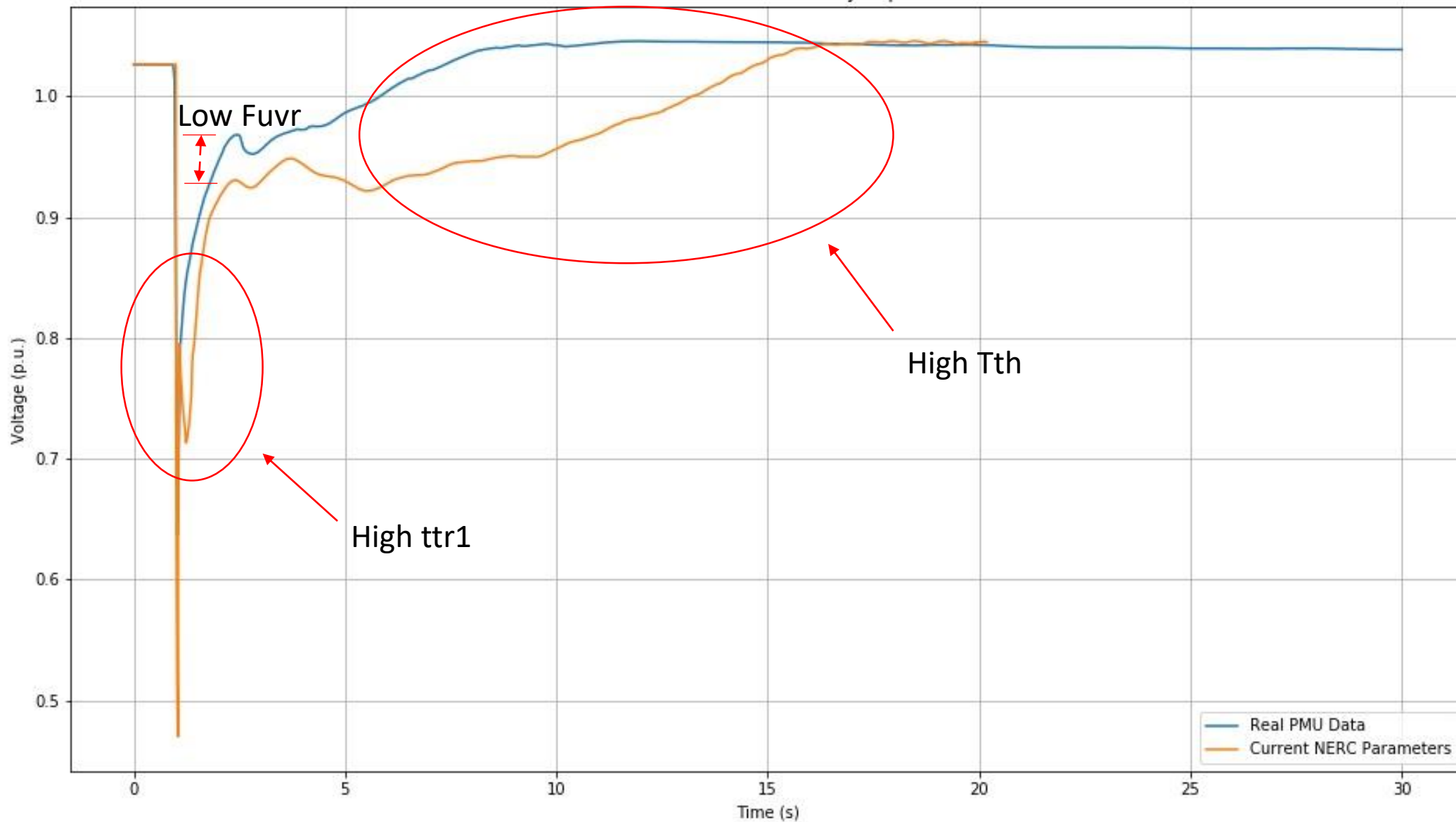


Comparison of Ftr2 Values Impact on Voltage
(Vrc1=.8, Trc1=.1, Vrc2=1, Trc2=9999)



Parameter Tuning for Event Matching

Transient Simulation of Hassayampa Event



Parameter Tuning for Event Matching

- Motor D Updated Values:

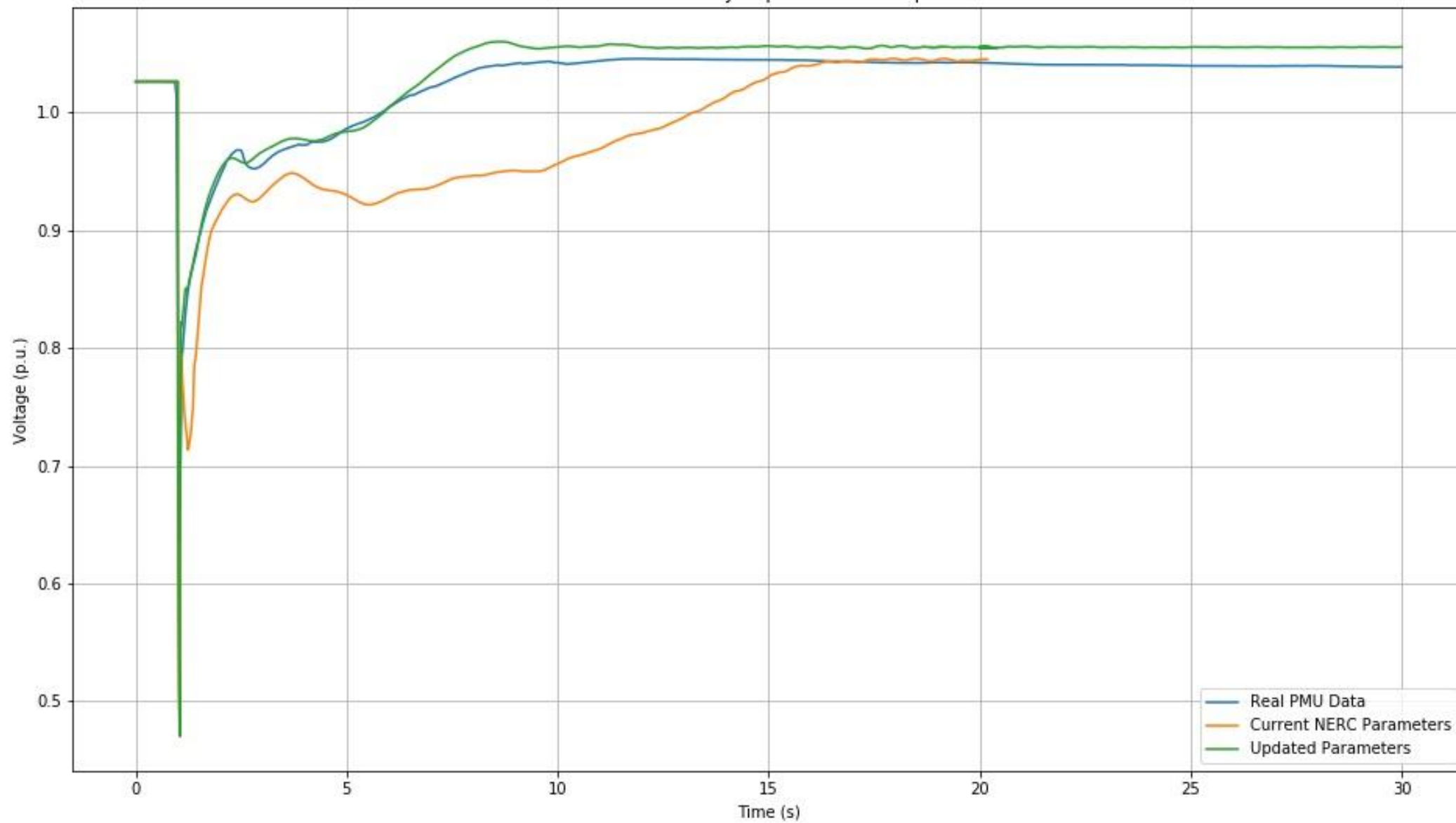
- Fuvr: 0.25 -> **0.45**
- Ttr1: 0.15 -> **0.02**
- Tth: 15 -> **10**

- Motor A Updated Values:

- Vrc1: 0.8-> **0.7**
- Vrc2: 1.0 -> **0.8**
- Trc2: 9999 -> **0.2**

MA		AC	
TYPE	M3	TYPE	AC
LF	0.75	LFm	1
Ra	0.02	CompPF	0.98
Ls	1.8	Vstall	0.45
Lps	0.12	Rstall	0.1
Lpps	0.104	Xstall	0.1
Tpo	0.08	Tstall	0.033
Tppo	0.0021	Frst	0.2
H	0.1	Vrst	0.95
Etrq	0	Trst	0.3
Vtr1	0.5	Fuvr	0.45
Ttr1	0.033	vtr1	0.55
Ftr1	0.5	ttr1	0.02
Vrc1	0.7	vtr2	0.65
Trc1	0.1	ttr2	0.15
Vtr2	0.6	Vc1off	0.5
Ttr2	0.15	Vc2off	0.4
Ftr2	0.25	VC1on	0.6
Vrc2	0.8	VC2on	0.5
Trc2	0.2	Tth	10
		Th1t	0.7
		Th2t	1.9
		Tv	0.025
		Tf	0.05
		LFadj	0
		Kp1	0
		Np1	1
		Kq1	6
		Nq1	2
		Kp2	12
		Np2	3.2
		Kq2	11
		Nq2	2.5
		Vbrk	0.86
		CmpKpf	1
		CmpKqf	-3.3

Transient Simulation of Hassayampa Event with Updated Parameters



Conclusions

- A few parameters have a significant impact, while many do not
- Current parameter values may need updating/tuning