NERC-DOE FIDVR Workshop
SCE FIDVR Study Experience

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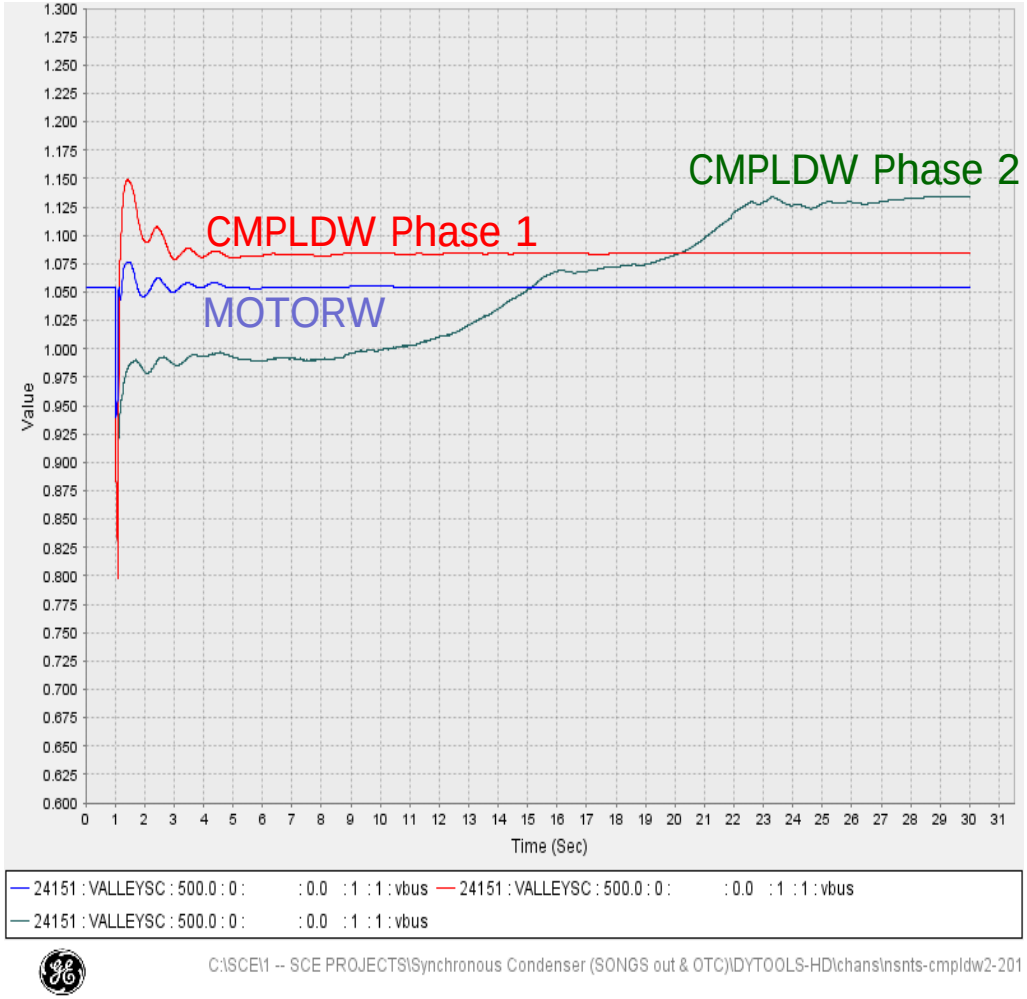
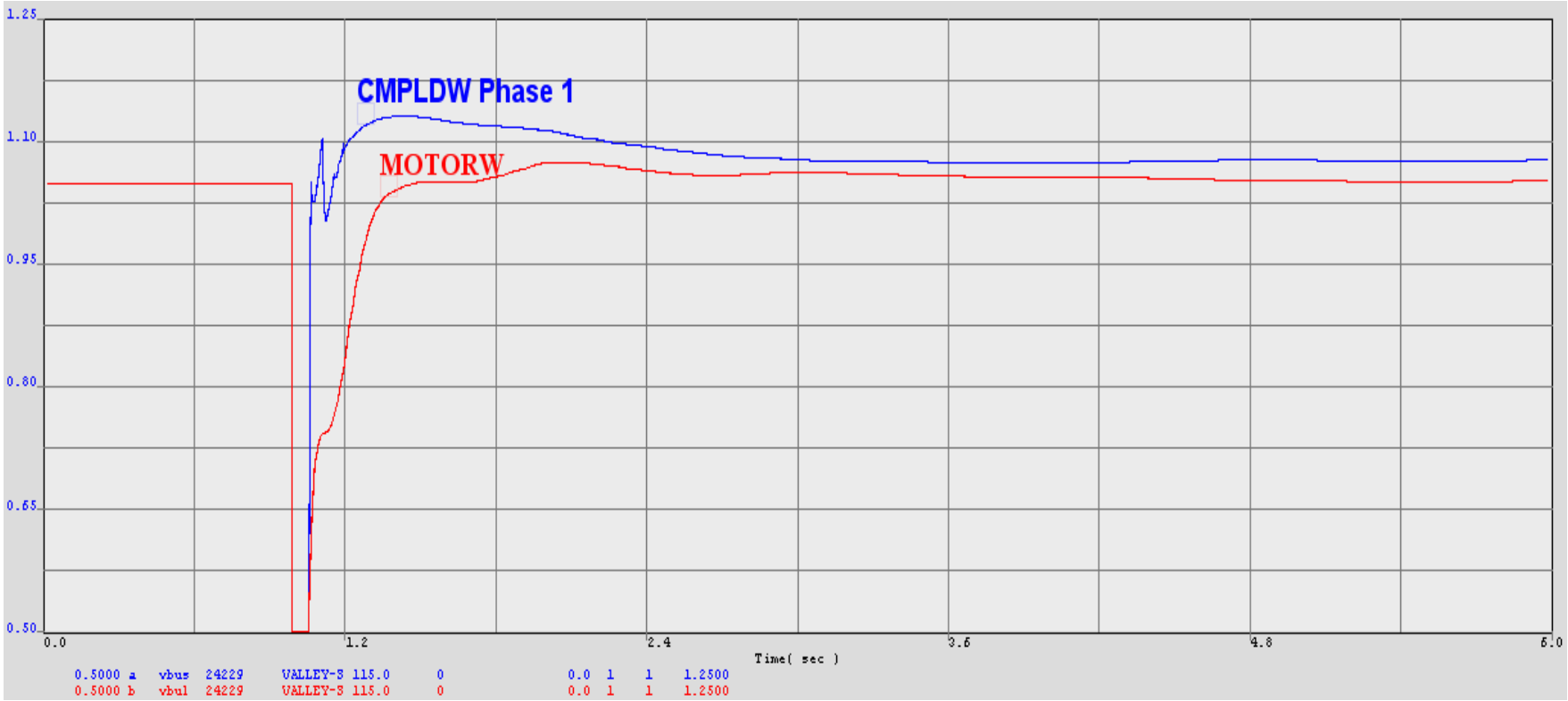
WECC Load Model Implementation

- MOTORW + ZIP (past)
- CMPLDW Phase 1 (now)
  - Tstall = 9999
  - Approved for implementation starting with 2014 WECC study program base cases.
- CMPLDW Phase 2 (future)
  - Tstall = 0.03
  - Improvements in progress



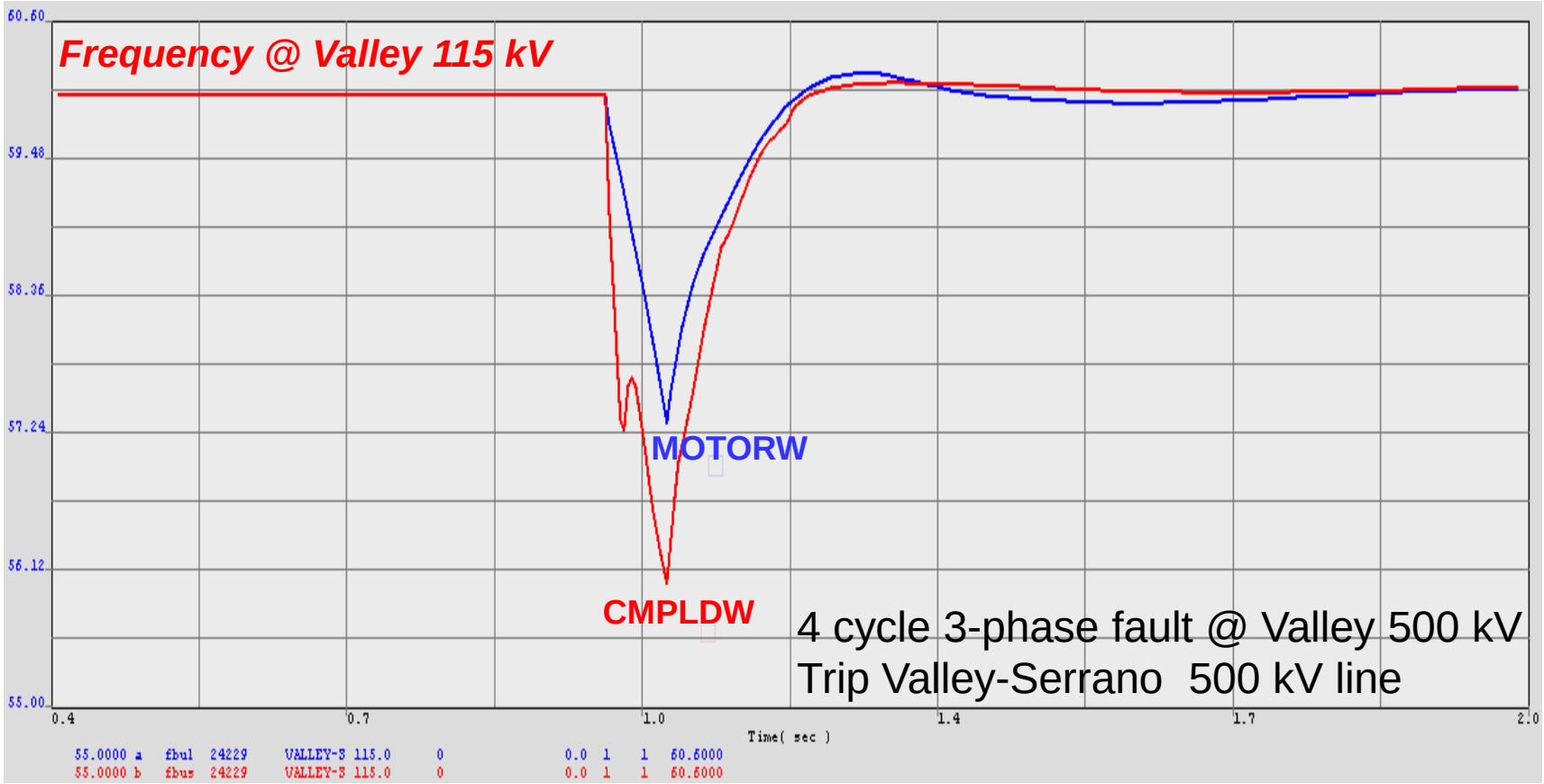
Phase 1 System Impact Study

- Higher voltage overshoot is generally seen after fault clearing with CMPLDW P1 due to motor tripping
- Higher post-transient voltage is generally seen using CMPLDW P1 due to motor tripping



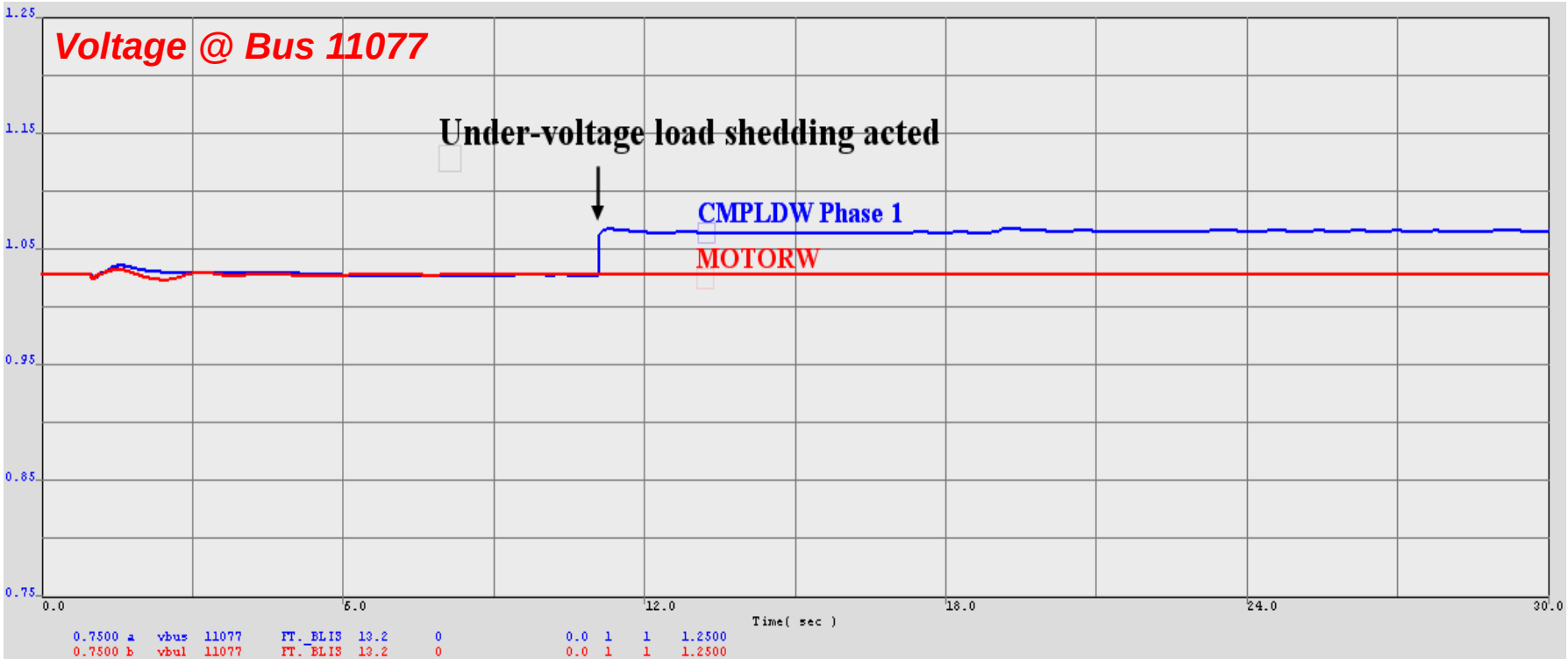
Phase 1 System Impact Study

- Additional under-frequency load tripping is seen using CMPLDW P1 under some contingencies



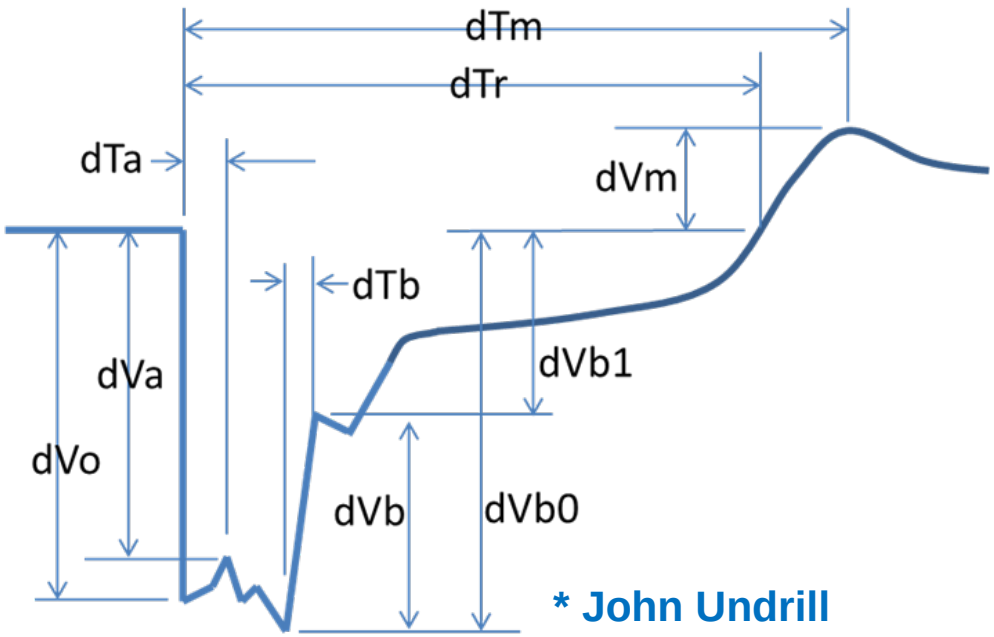
Phase 1 System Impact Study

- Additional under-voltage load tripping is seen using CMPLDW P1
  - 4 cycle 3-phase fault @ Valley 500 kV and trip Valley-Serrano 500 kV line, additional under-voltage load tripping is seen in Area 11
  - This is due to load shedding relay monitoring the lower voltage bus (911077), already fixed in later revision.



Phase 2 System Impact Study

Heavy summer case, selected N-1 contingencies with normal fault clearing at key 500 kV buses were studied.



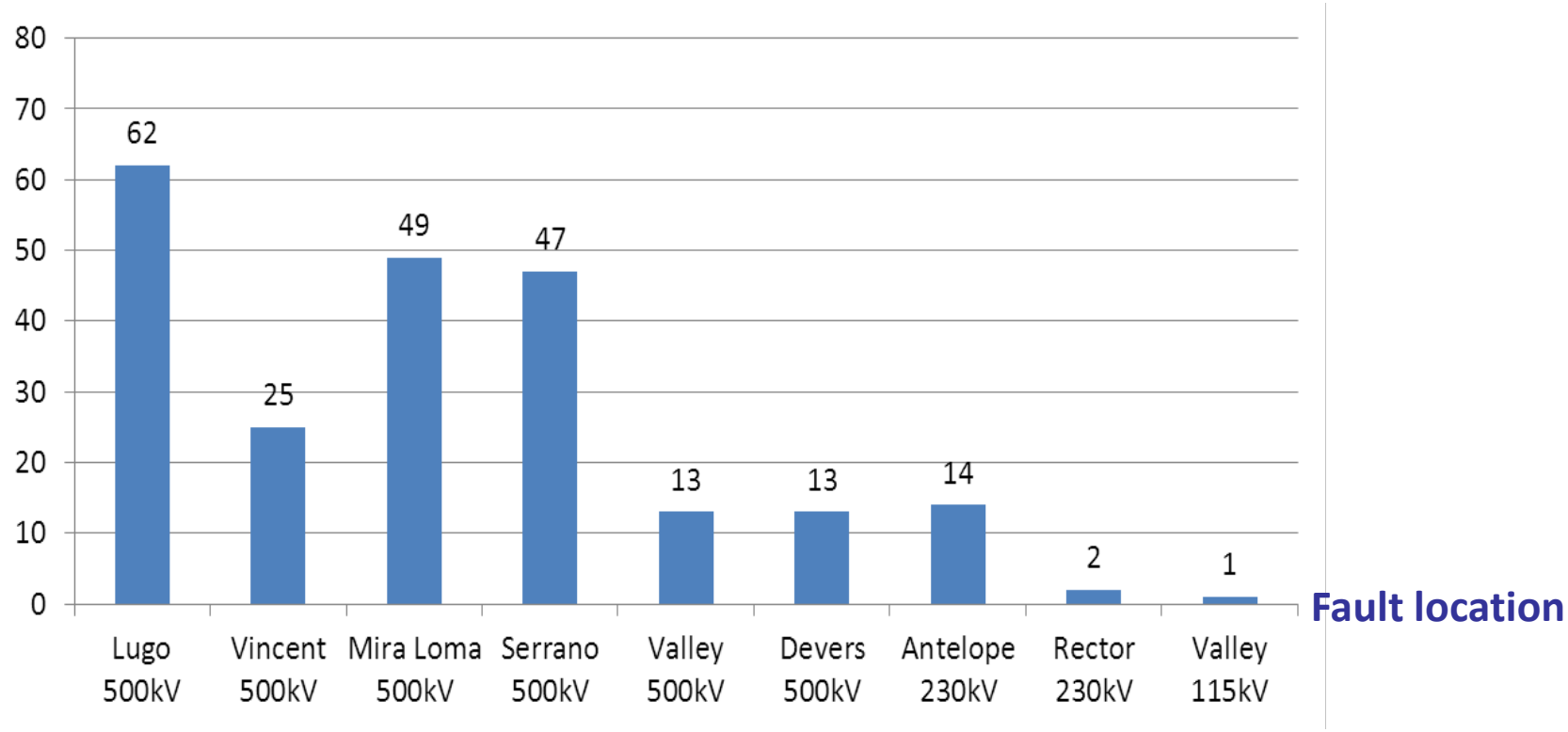
* John Undrill

Variable	Variable description
dVo (%)	First sample voltage dip
dVa (%)	Persistence voltage dip
dTa (cycl)	Persistence time
dVb0 (%)	Lowest value of dVb in %
dVb1 (%)	Highest value of dVb in %
dVb (kV)	dVb in KV
dTb (cycl)	Time from lowest to highest value of dVb
dVm (%)	Peak voltage overshooting
dTr (sec)	Time to reach initial volt level
dTm (sec)	Time to reach maximum voltage

- dVo: average 28.8%, 30% and more is seen in sub-transmission
- dVm: average 14%, maximum 21.7%
- dTr: average 21 second, maximum 25 sec

Phase 2 System Impact Study

Number of stalled buses



Note: Total 80 load buses in SCE's service territory are modeled with composite load models

Phase 2 Sensitivity Study

- Sensitivity study on the 3 phase commercial motor protection settings has been performed.

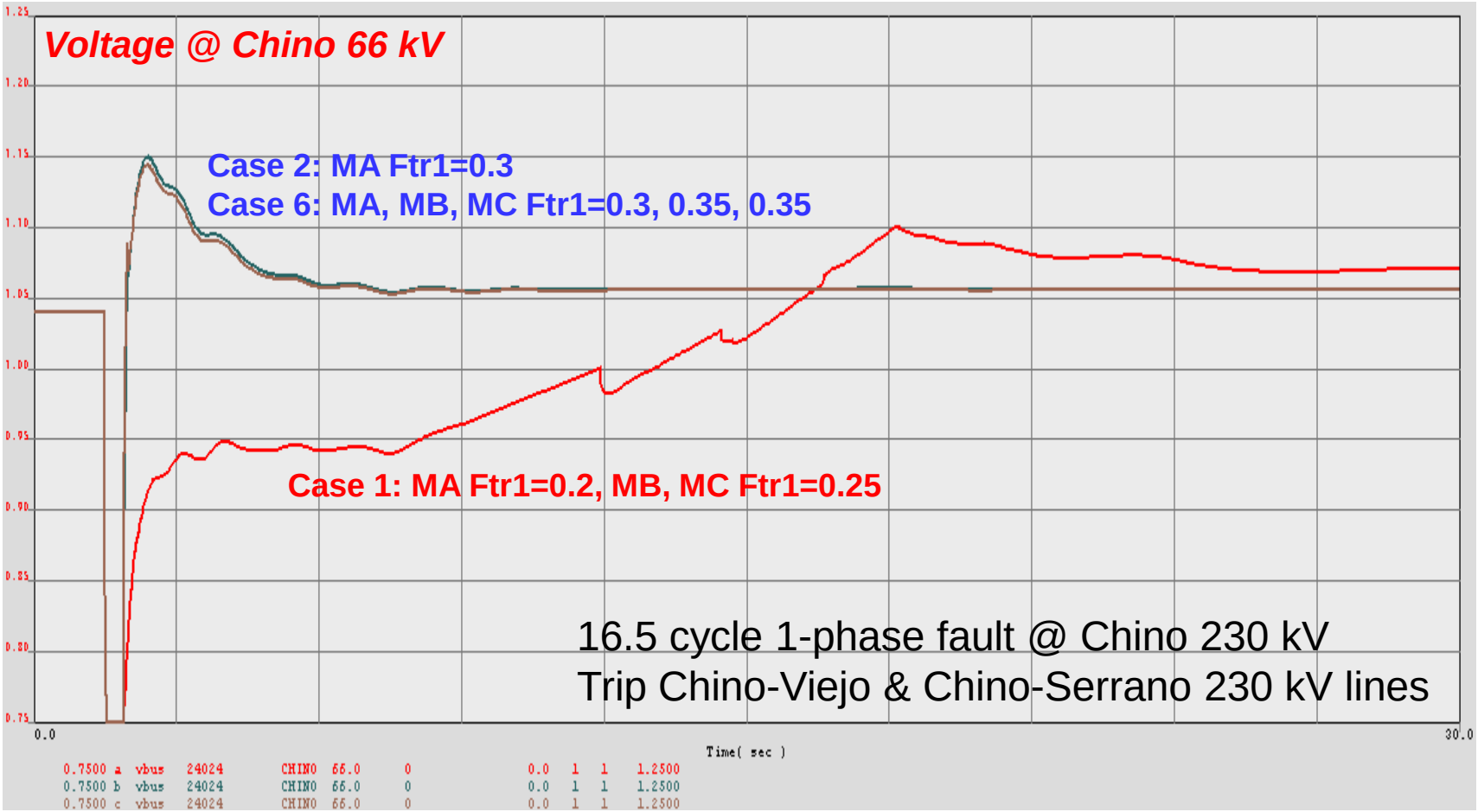
- Studied contingencies include: selected N-1 and N-2 with normal and delayed fault clearing at selected 500 kV, 230 kV, 115 kV buses

	Vtr1		Ttr1		Ftr1		Vrc1	Trc1		Vtr2		Ttr2		Ftr2		Vrc2	Trc2	
MA	0.6	0.7	0.02	0.033	0.2	0.3	1	9999	9999	0.5	0.5	0.02	0.033	0.6	0.7	0.65	0.1	0.2
MB	0.6	0.7	0.02	0.033	0.25	0.35	0.9	0.05	9999	0.5	0.6	0.02	0.033	0.5	0.6	0.85	0.05	0.2
MC	0.6	0.7	0.02	0.033	0.25	0.35	0.9	0.05	9999	0.5	0.6	0.02	0.033	0.5	0.6	0.85	0.05	0.2

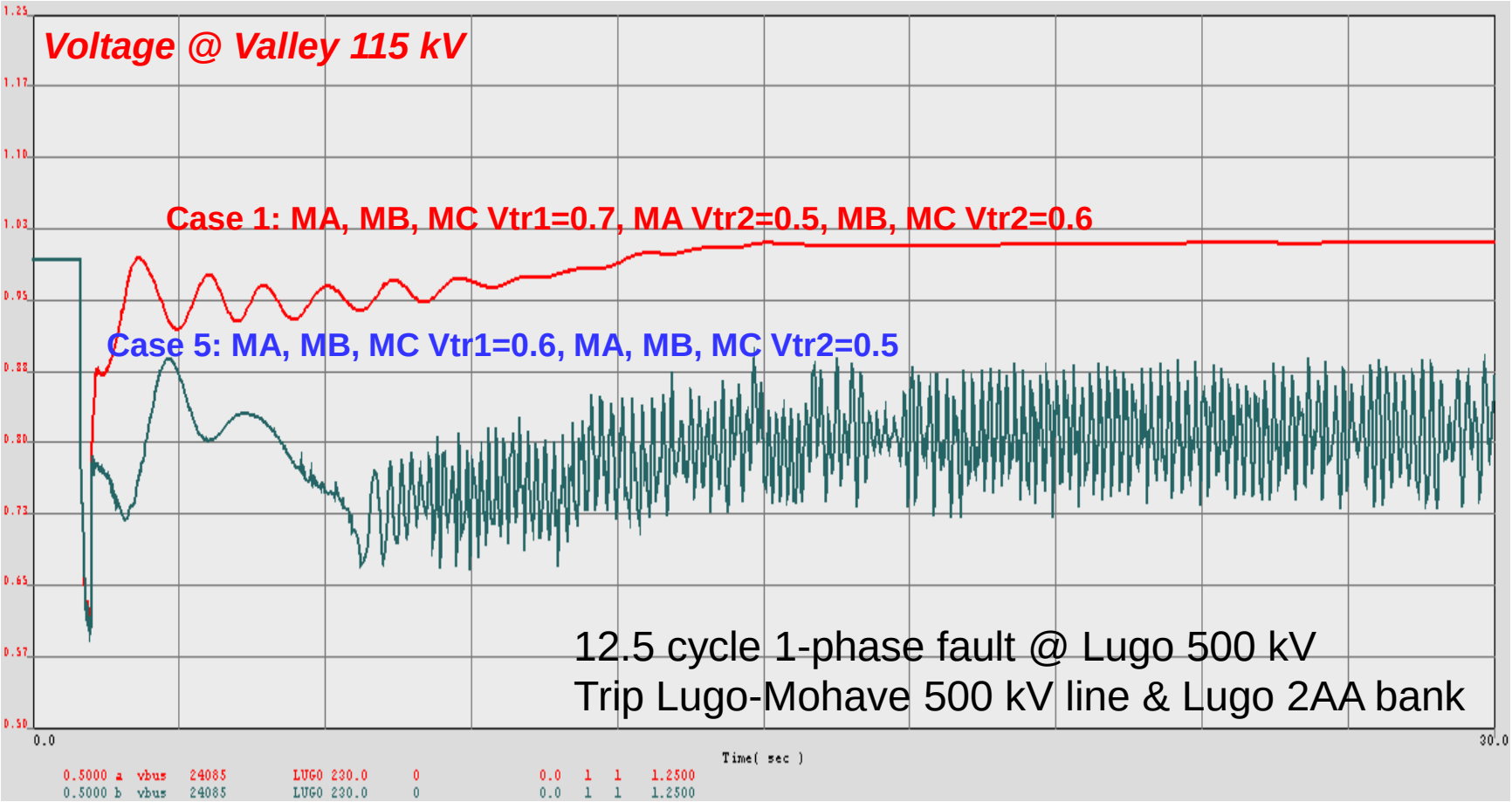
* Note: black – default, red - sensitivity

- Overall, little difference was observed.

Phase 2 Sensitivity Study
- Fraction of motor tripping (Ftr1)



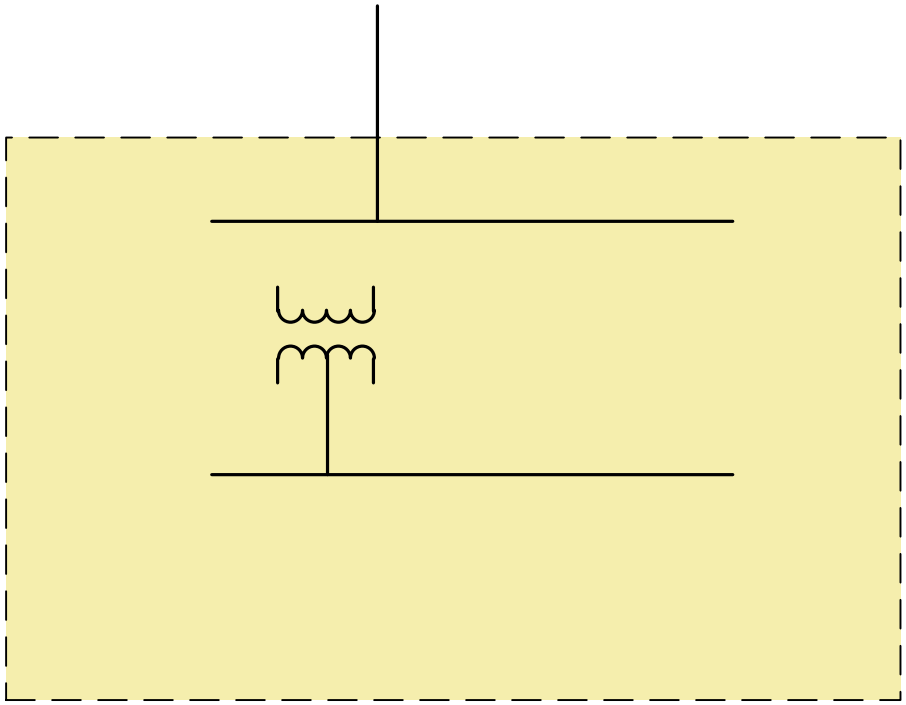
Phase 2 Sensitivity Study
- Voltage trip level (Vtr1, Vtr2)



Model Validation Study

July 24 2004 FIDVR Event

5:02 PM July 24, 2004, 115 kV bus connection equipment at Valley Substation failed resulting in a phase to ground fault. The fault cleared in four cycles isolating the number three 500/115 kV transformer bank.



Valley 115 Composite Load Model

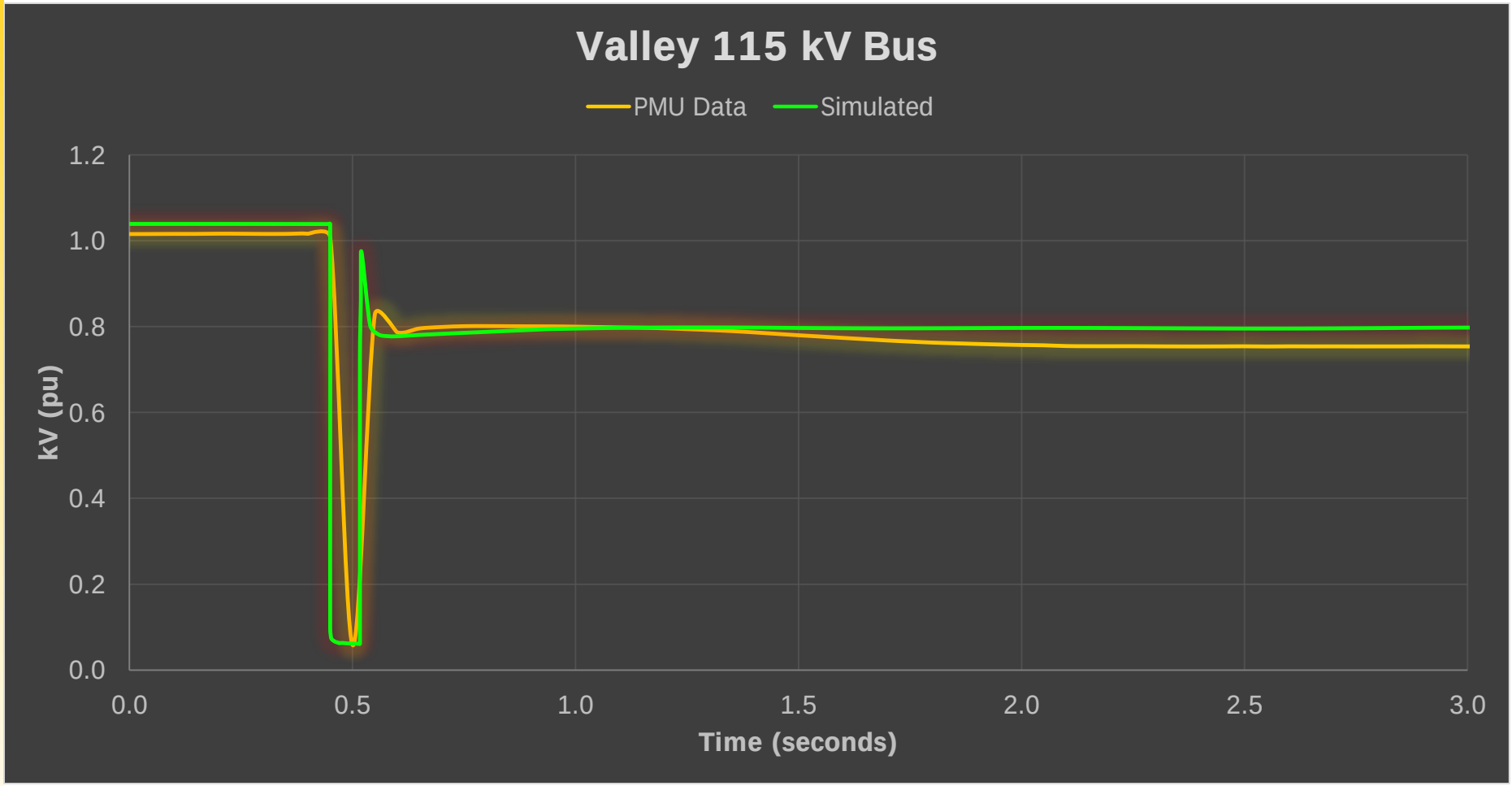
Default data set from LCM tool was used, no data tuning.

LONG ID	Condition	Hour (PST)
SCI_RES	1 = Normal Summer	17:00

Fma = 0.0822, Fmb = 0.1548, Fmc = 0.0311, Fmd = 0.3909
Fel = 0.1109, Fzip = 0.2301

cmpldw 24160 "VALLEYSC " 115.00 "1 " : #9 mva=-1.2000 "bss" 0.0000 "rfdr" 0.0400 "xfdr" 0.0400 "fb" 0.75000
"xxf" 0.0800 "tfixhs" 1.0000 "tfixls" 1.0000 "ltc" 0.0000 "tmin" 0.9000 "tmax" 1.1000 "step" 0.006250 "vmin" 1.0000
"vmax" 1.0200 "tdel“ 30.0000 "ttap" 5.0000 "rcmp" 0.0000 "xcmp" 0.0000 "fma" 0.0822 "fmb" 0.1548 "fmc" 0.0311 "fmd" 0.3909
"fel" 0.1109 "pfel" 1.0000 "vd1" 0.7000 "vd2" 0.5000 "frcel" 0.8000 "pfs" -0.997762 "p1e" 2.0000 "p1c" 0.554056 "p2e" 1.0000
"p2c" 0.445944 "pfrq" 0.0000 "q1e" 2.0000 "q1c" -0.500000 "q2e" 1.0000 "q2c" 1.500000 "qfrq" -1.0000 "mtypa" 3.0
"mtypb" 3.0 "mtypc" 3.0 "mtypd" 1.0 "lfma" 0.7500 "Rs" 0.0400 "Ls" 1.8000 "Lp" 0.1200 "Lpp" 0.1040 "Tpo" 0.0950
"Tppo" 0.0021 "H" 0.1000 "etrq" 0.0000 "vtr1" 0.7000 "ttr1" 0.0200 "ftr1" 0.2000 "vrc1" 1.0000 "trc1" 99999.0000 "vtr2" 0.5000
"ttr2" 0.0200 "ftr2" 0.7000 "vrc2" 0.7000 "trc2“ 0.1000 "LFmb" 0.7500 "Rs" 0.0300 "Ls" 1.8000 "Lp" 0.1900 "Lpp" 0.1400
"Tpo" 0.2000 "Tppo" 0.0026 "H" 0.5000 "etrq" 2.0000
"vtr1" 0.6000 "ttr1" 0.0200 "ftr1" 0.2000 "vrc1" 0.7500 "trc1" 0.0500 "vtr2" 0.5000 "ttr2" 0.0200 "ftr2" 0.3000 "vrc2" 0.6500
"trc2" 0.0500 "LFmc" 0.7500 "Rs" 0.0300 "Ls" 1.8000 "Lp" 0.1900 "Lpp" 0.1400 "Tpo" 0.2000 "Tppo" 0.0026 "H" 0.1000
"etrq" 2.0000 "vtr1" 0.6500 "ttr1" 0.0200 "ftr1" 0.2000 "vrc1" 1.0000 "trc1" 9999.0000 "vtr2" 0.5000 "ttr2" 0.0200 "ftr2" 0.3000
"vrc2" 0.6500 "trc2" 0.1000 "LFmd" 1.0000 "CompPF" 0.9800 "Vstall" 0.5600 "Rstall" 0.1000 "Xstall" 0.1000 "Tstall" 0.0300
"Frst" 0.2000 "Vrst" 0.9500 "Trst" 0.3000 "fuvr" 0.1000 "vtr1" 0.6000 "ttr1" 0.0200 "vtr2" 1.0000 "ttr2" 9999.0000 "Vc1off" 0.5000
"Vc2off" 0.4000 "Vc1on" 0.6000 "Vc2on" 0.5000 "Tth" 15.0000 "Th1t" 0.7000 "Th2t" 1.9000 "Tv" 0.0250

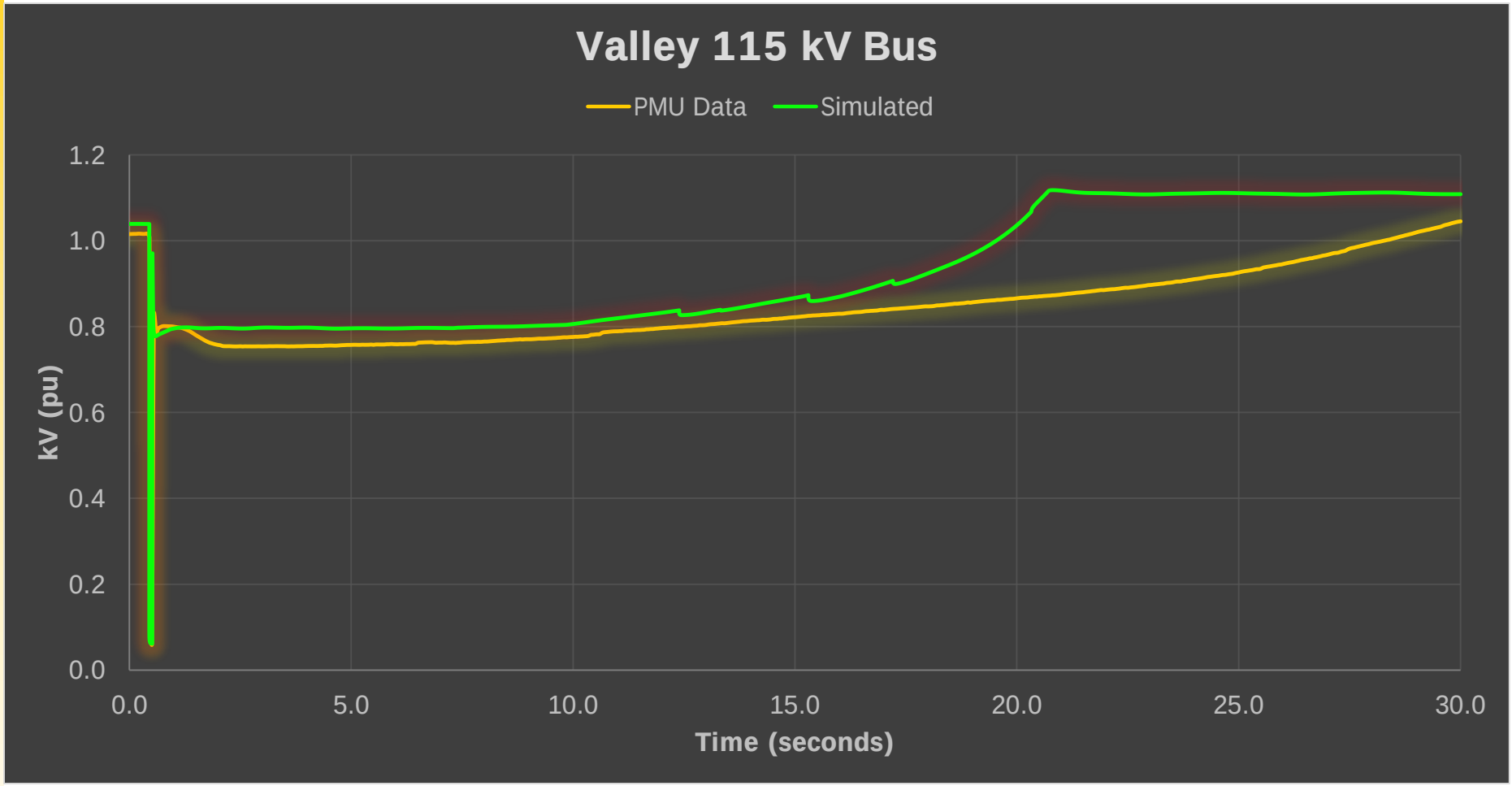
Measured versus simulated (3 seconds)



Total MW of Valley 115 kV load shed experienced : 400 MW

Total MW of Valley 115 kV load shed by cmpldw model: 386 MW

Measured versus simulated (30 seconds)



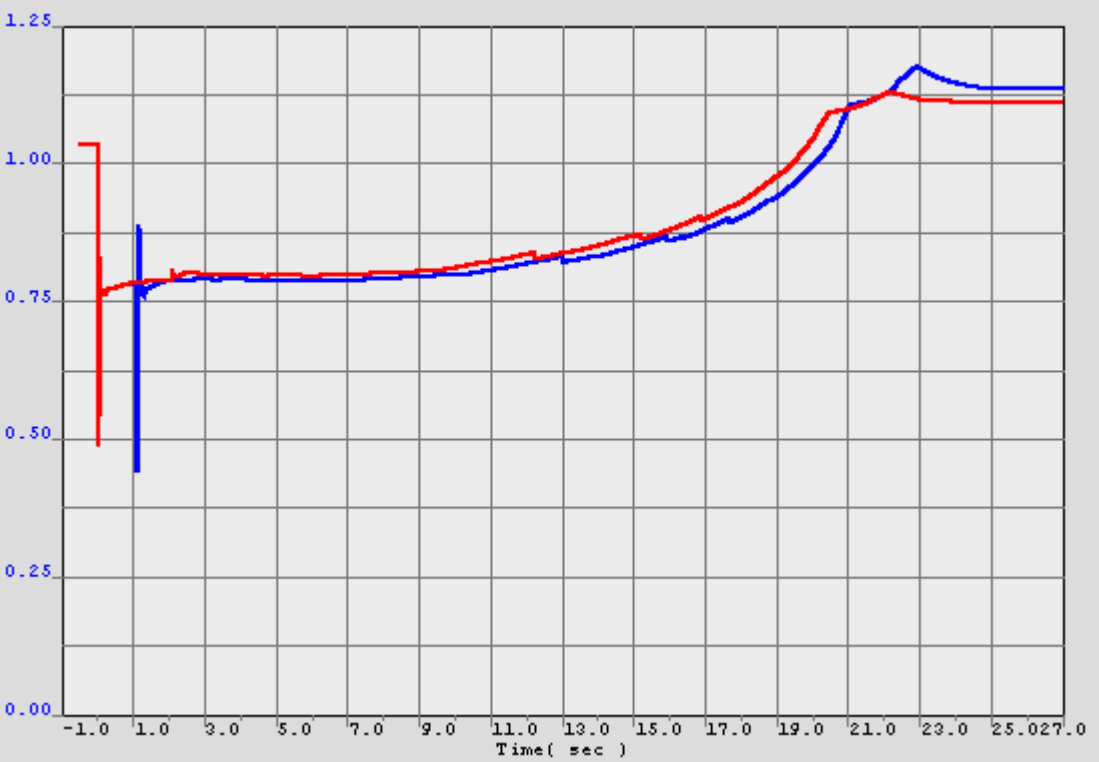
With default data set, the simulation showed a close match to PMU measurement (initial voltage recovery, post voltage recovery, and load loss). The simulation shows faster recovery than measurement (Tth can be modified to fit the curve).

Simulated Load Loss at Valley Substation

--P--	Type	-MdName-	--BUS--	--NAME--	--KV--	-SPREAD--
24160	fuva	cmpldw	24160	VALLEYSC	115	0.9
24160	fuvb	cmpldw	24160	VALLEYSC	115	0.5
24160	fuvc	cmpldw	24160	VALLEYSC	115	0.5
24160	fuvd	cmpldw	24160	VALLEYSC	115	0.1
24160	fthA	cmpldw	24160	VALLEYSC	115	1
24160	fthB	cmpldw	24160	VALLEYSC	115	0.926

High Speed Reclosing Study

TPL-001-4 Requirement R4.3.1.1: "Successful high speed (less than one second) reclosing and unsuccessful high speed reclosing into a Fault where high speed reclosing is utilized."



Single-phase to ground fault at time 0;

Red – successful reclosing at time 2 second

Blue – unsuccessful reclosing at time 1 second

THANK YOU