Distribution FIDVR Monitoring

DOE-NERC FIDVR Workshop

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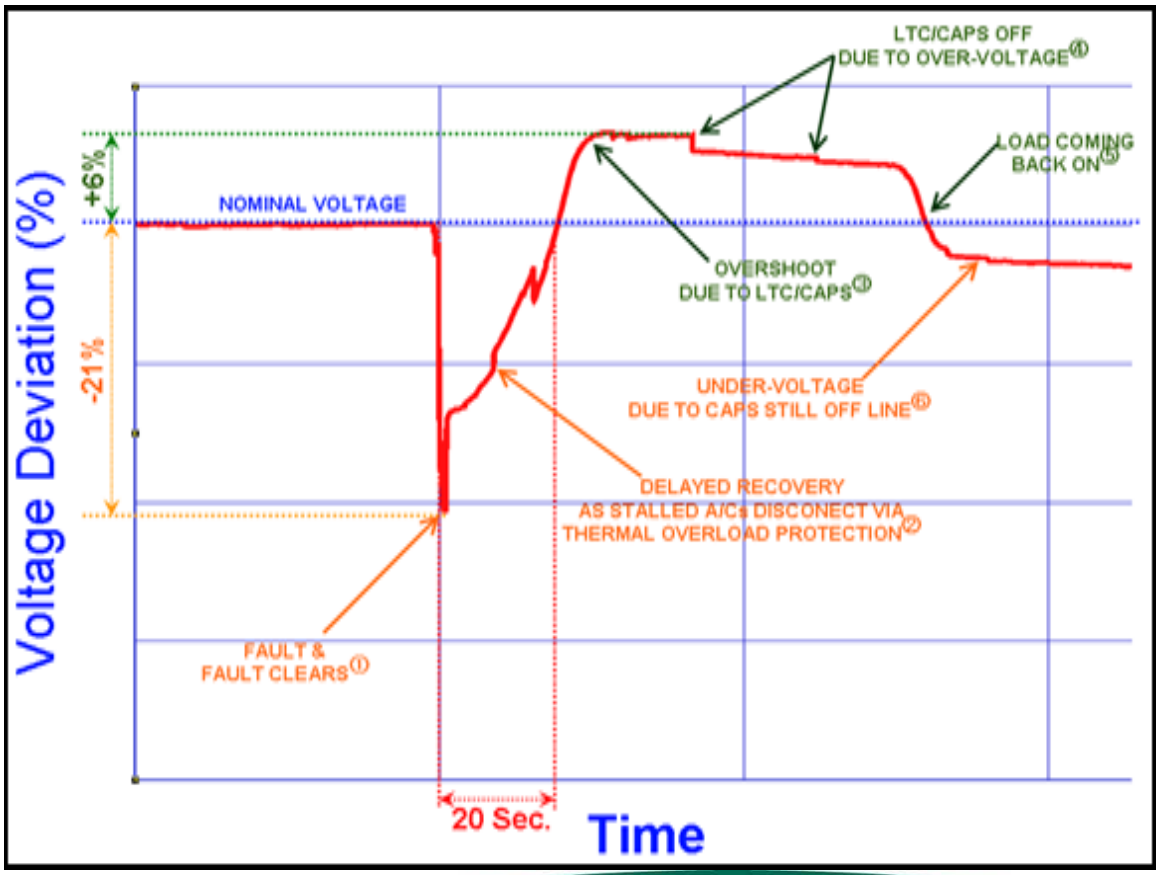
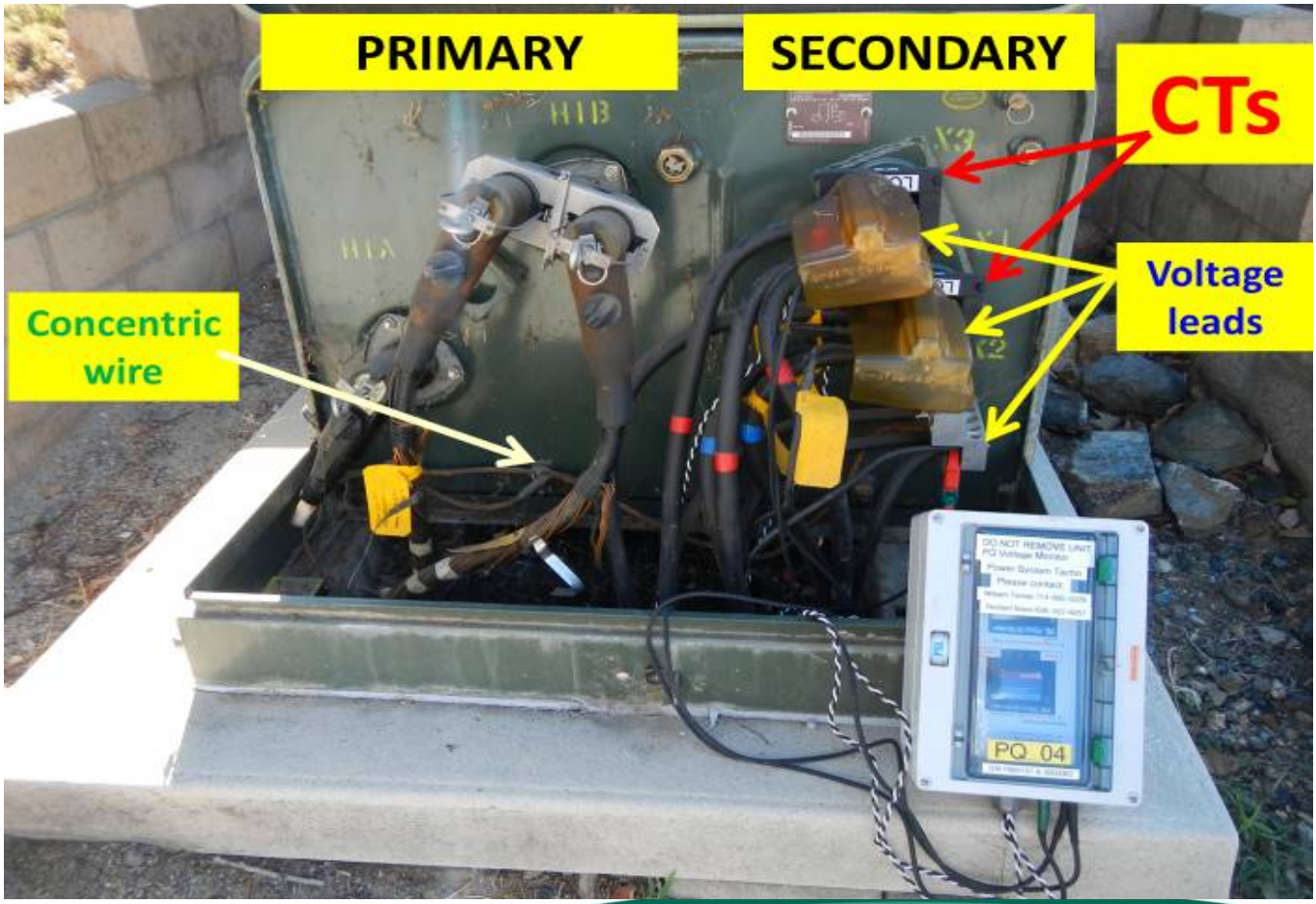
FIDVR Events

- PMUs has been recording FIDVR events for many years
- Limited information on how FIDVR events evolve in distribution system
- Distribution FIDVR events details needed to assess:
  - Spreading behavior
  - Voltage levels at T&D
  - Time of events
  - Real and reactive power demands



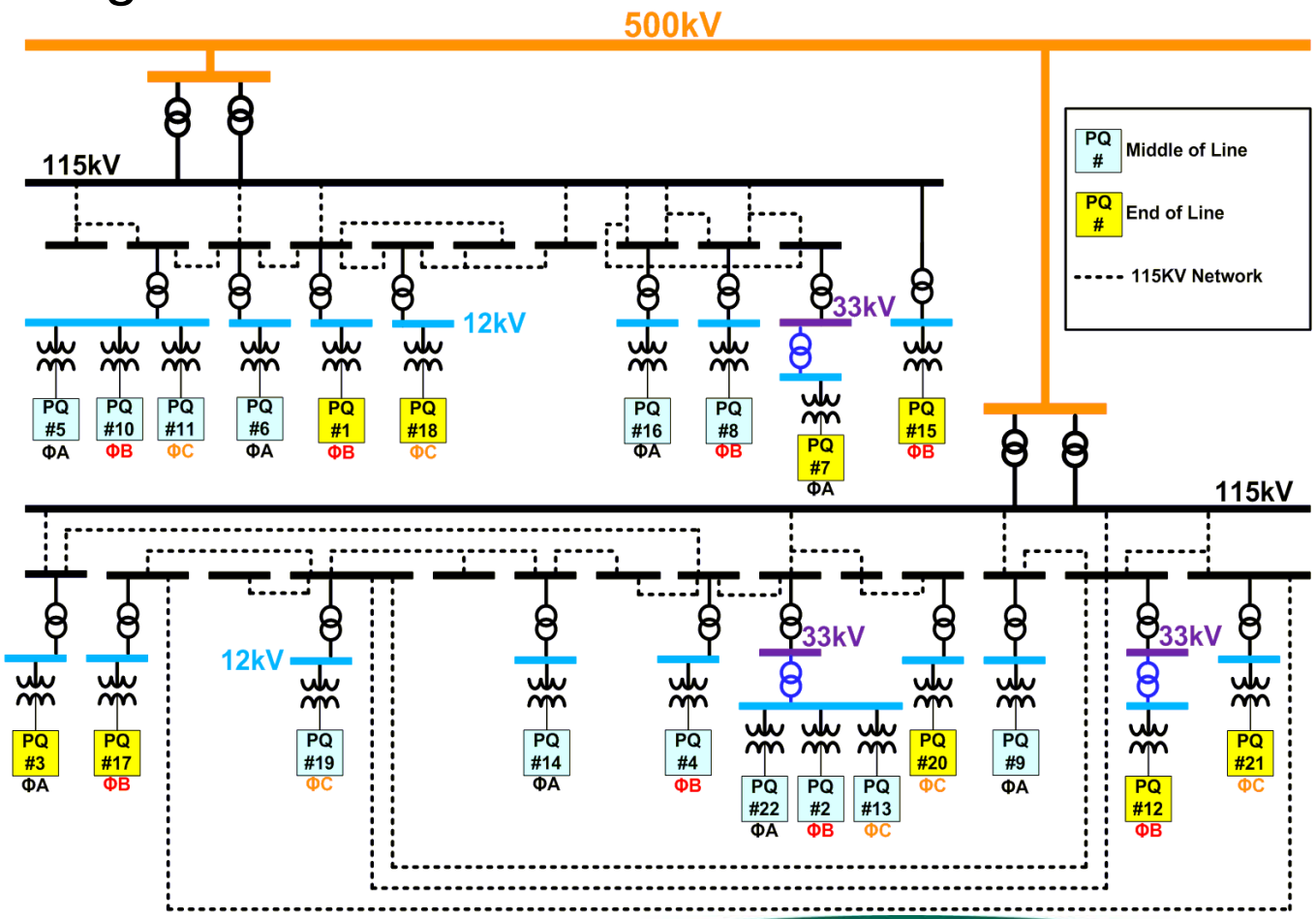
PQ Monitors on Residential Xmers

- Installed in pad-mount residential xmers secondary side: 240V
- Record residential loads aggregated behavior
- Record: V & I
  - Line to ground voltage
  - Line current (aggregated)



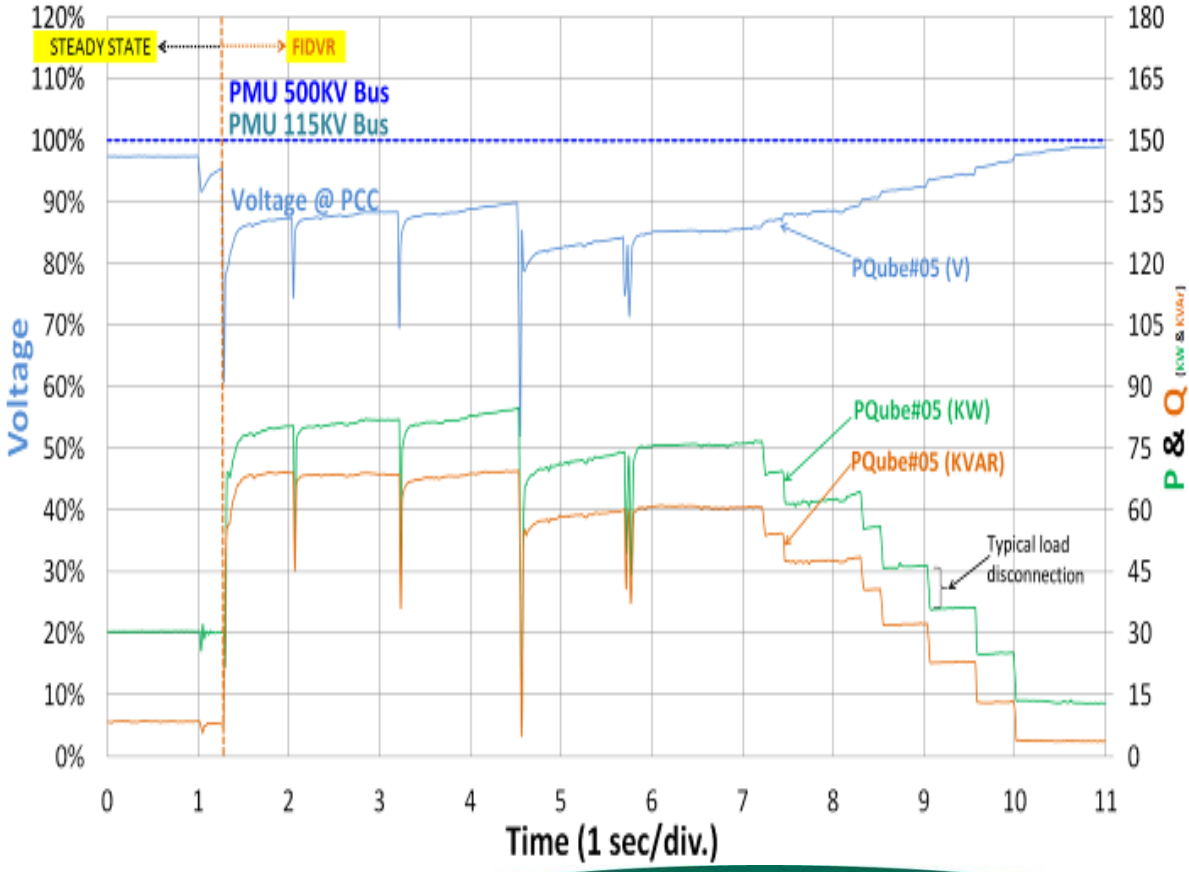
PQ Monitors Installations

- Installed in Valley system dist. circuits (1,500 MW peak load)
- PQ threshold settings:
  - UV triggers at 80%
  - OV triggers at 110%
  - Capture event
    - RMS
    - sinusoidal waveforms



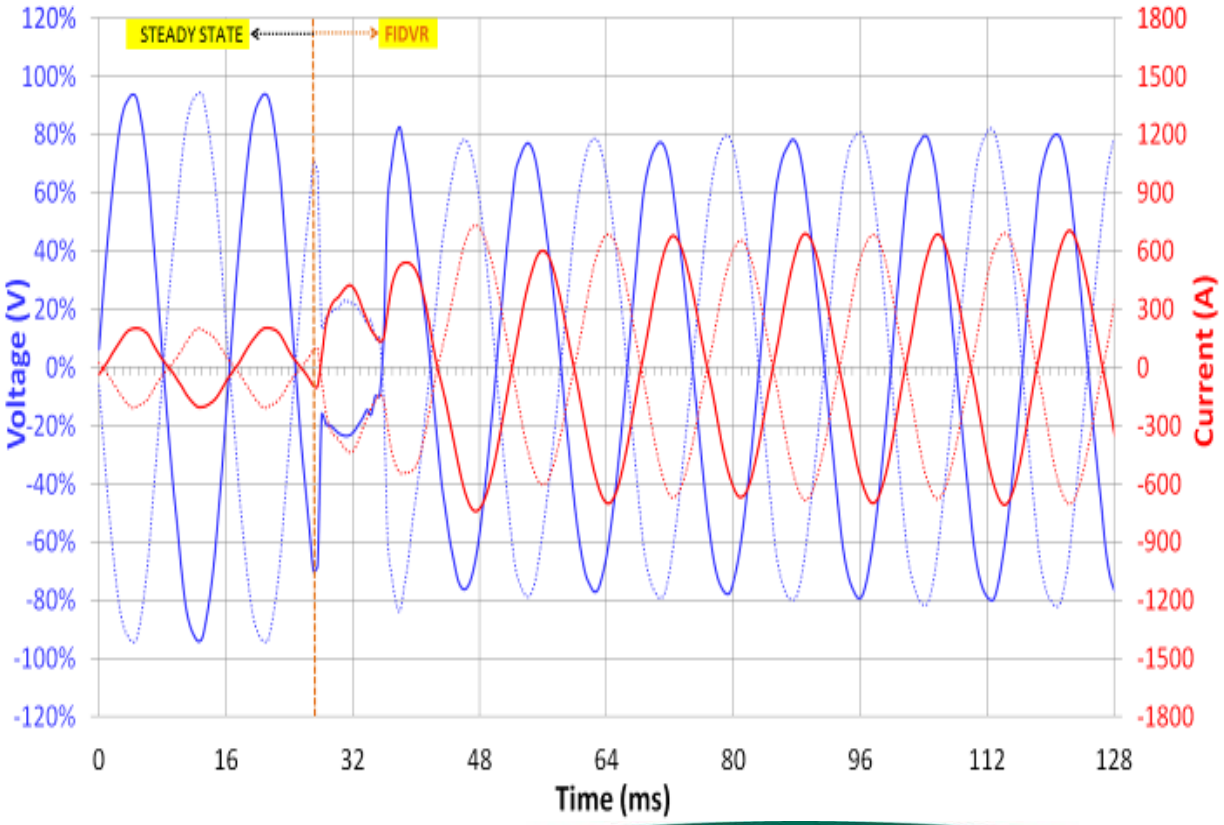
Event #1 (RMS)

- Multiple lightning strikes caused multiple distribution faults recorded by the PQ devices, but not by transmission PMU
  - P & Q increased during FIDVR
    - P=2.6 p.u. at V=90%
    - Q=7 p.u. at V=90%
  - FIDVR lasted 9 sec
  - TOPs open disconnecting loads after seven (7) second mark
- FIDVR recorded only in distribution system



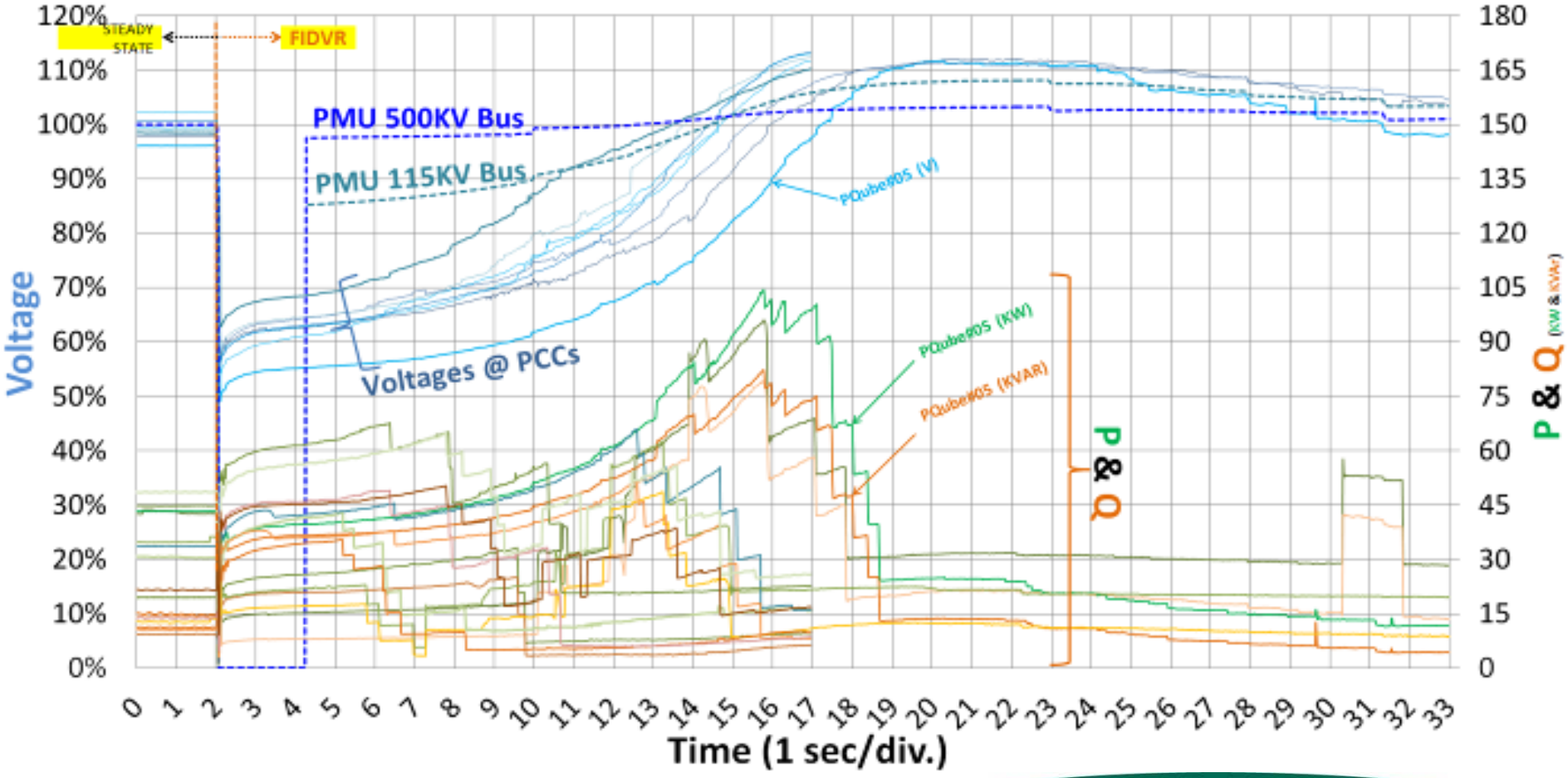
Event #1 (sinusoidal)

- Fault initiated at ~70 degrees of voltage waveform
- Fault must have been in adjacent circuit
- Fault cleared fast but not fast enough to prevent A/C stalling
- Stalling prevented voltage from recovering
  - Current waveform (red) increases significantly 200A → 700A
  - Voltage hold at 80%
  - Current lagging behavior increases significantly during the event



Event #6

- Lightning causes FIDVR event recorded by BOTH distribution PQ devices and transmission PMU

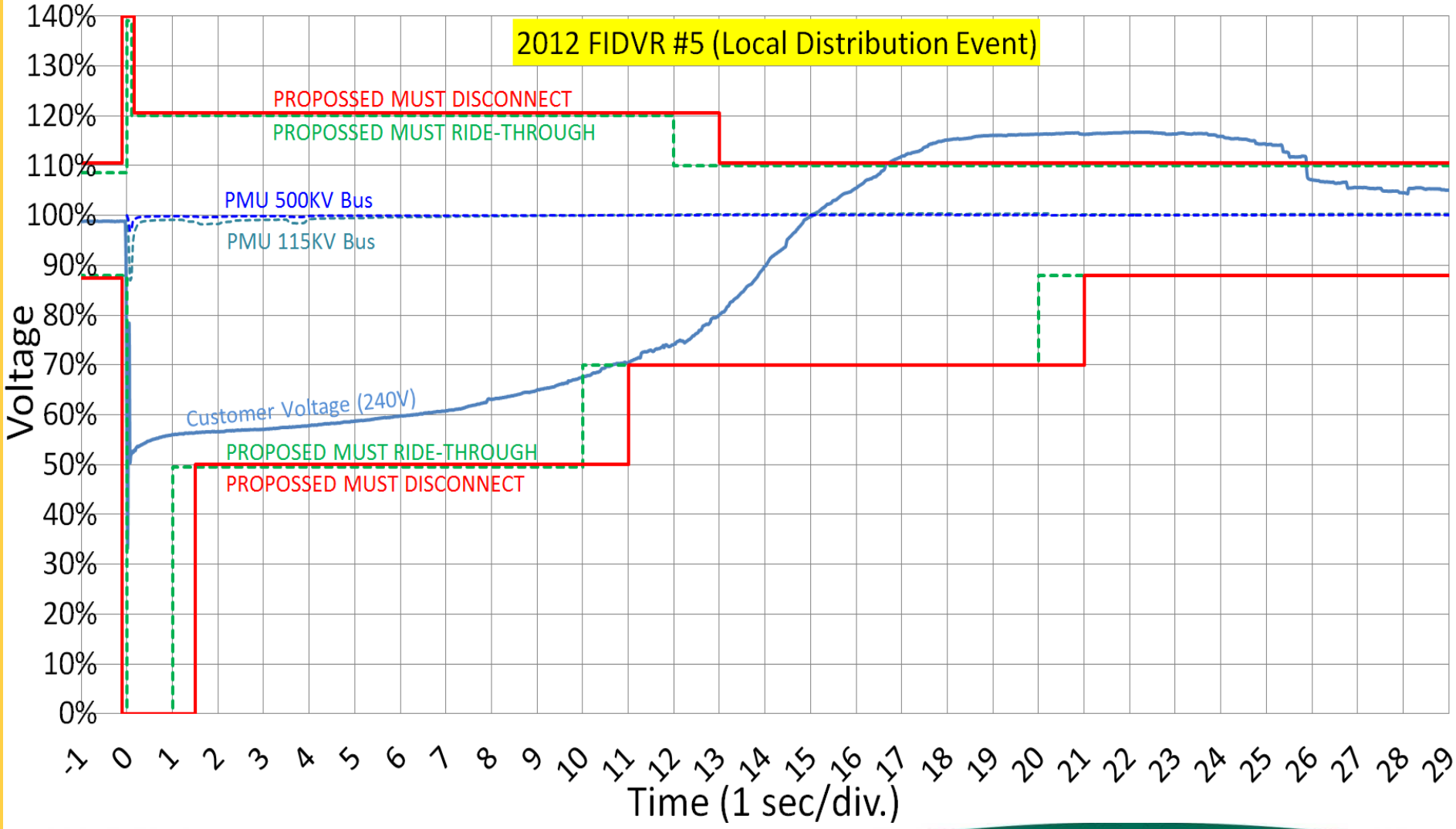


DER Proposed VRT

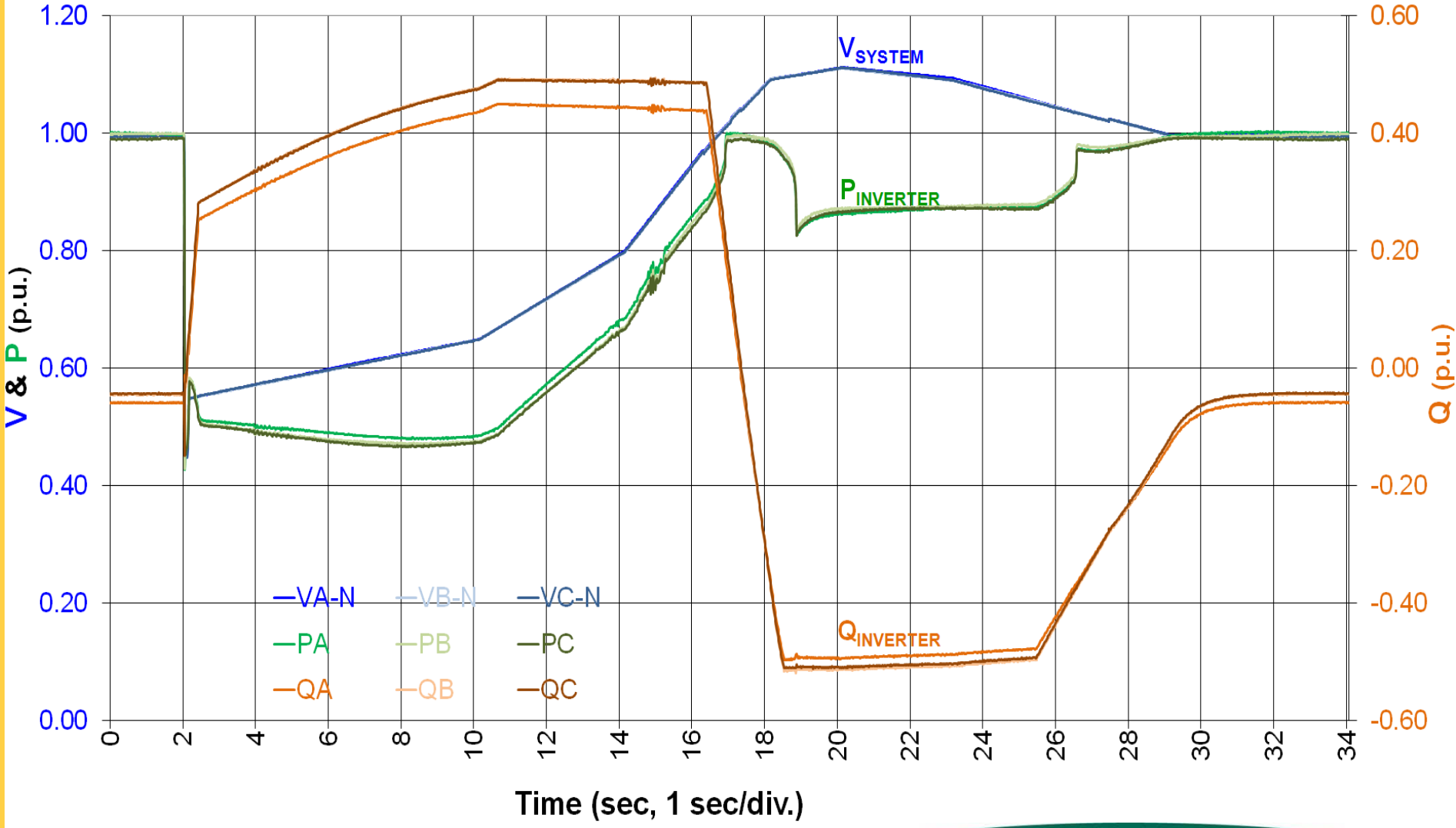
- DER penetration is increasing significantly and may become a major generating part of the grid during certain times
- Standards are being revised to allow voltage ride through

VOLTAGE (p.u.)	RIDE-THROUGH (seconds)	OPERATION	MUST DISCONNECT (seconds)
>1.2	none	Disconnect	0.16
1.1 ~ 1.2	12	Momentary Cessation	13
0.88 ~ 1.10		Continuous Operation	
0.70 ~ 0.88	20	Mandatory Operation	21
0.5 ~ 0.7	10	Mandatory Operation	11
0 ~ 0.5	1 sec	Momentary Cessation	1.5

Ride Through Grid Voltage Events



DER Can Provide Grid Support



Conclusion

- No linear relationship between T&D voltages during FIDVR
- Faults at any point in the waveform can provoke FIDVR if there is large induction motor load
- Stalling happens very quick within 2 cycles
- DER should ride through voltage events
- DER should supply VARs to support the voltage during voltage events
- Voltage support typically less than 30 seconds so minimum impact to generation revenew