

Line Protection Response to a Three-Phase Intercircuit Fault

Ernie Hodge

Gainesville Regional Utilities

Ed Atienza

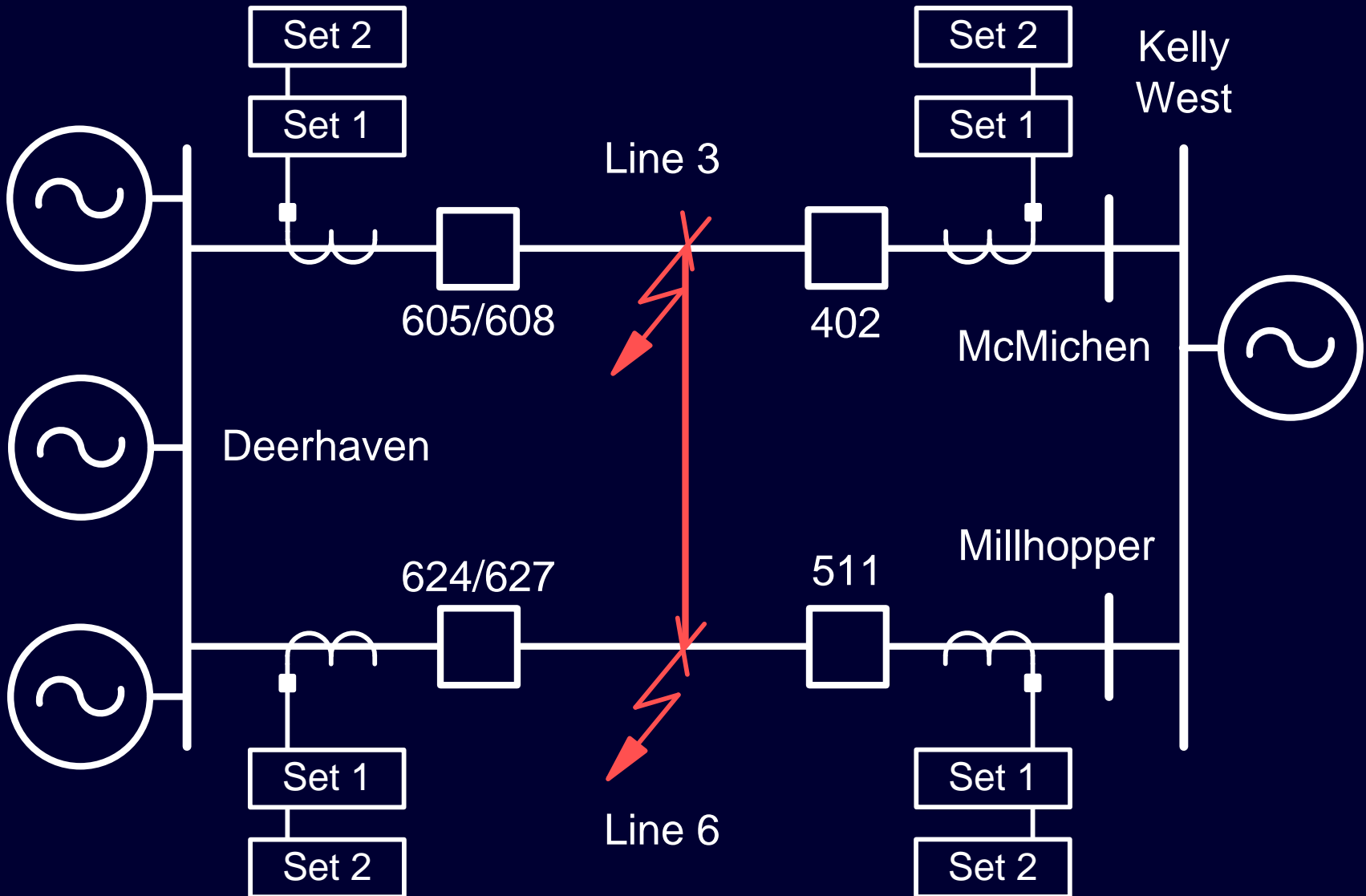
Schweitzer Engineering Laboratories, Inc.

Line 3 and Line 6 Intercircuit Fault

- Fault occurred on looped 138 kV system
- Parallel lines share towers
- Lightning data confirmed fault time and location



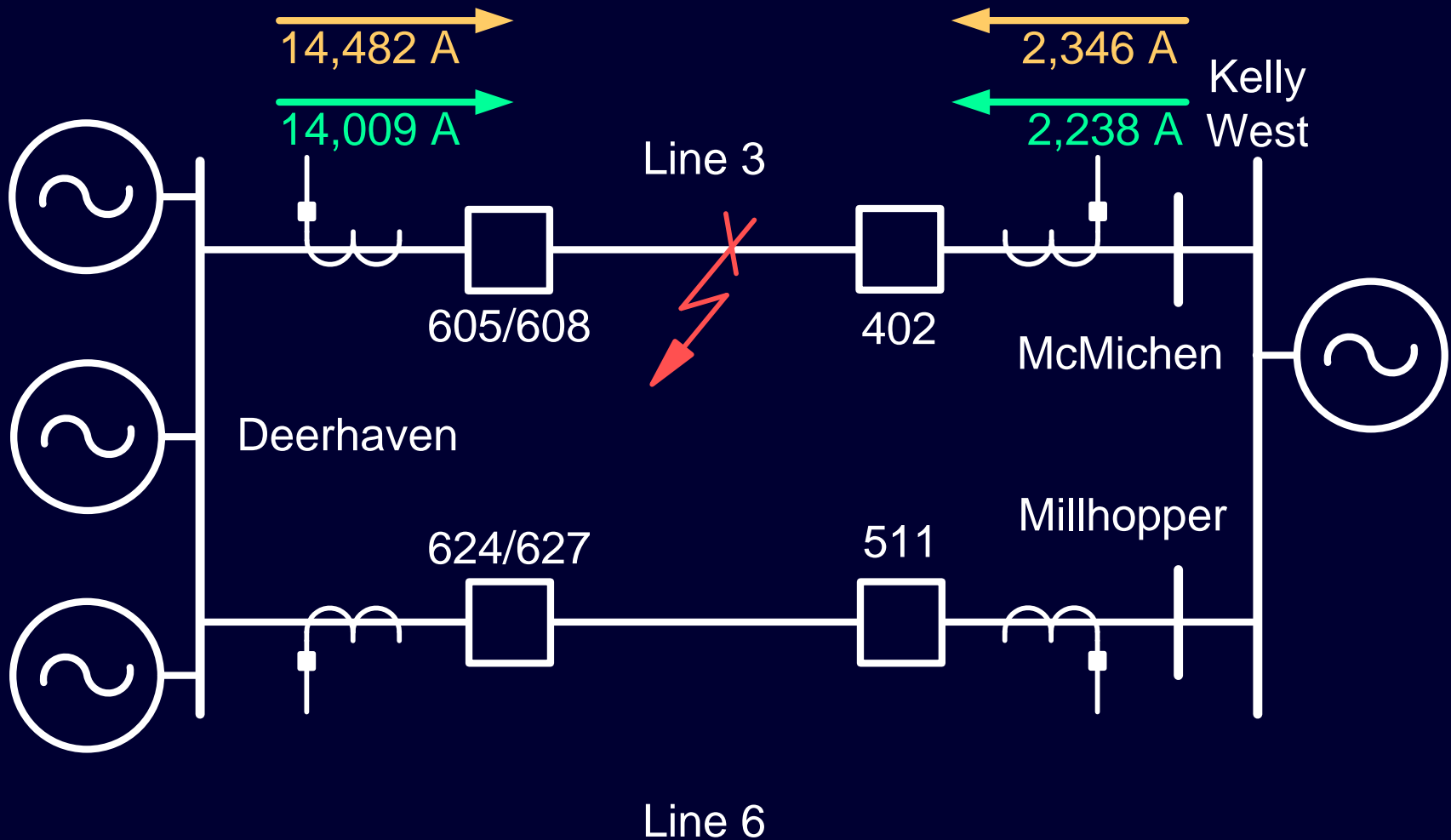
One-Line Diagram



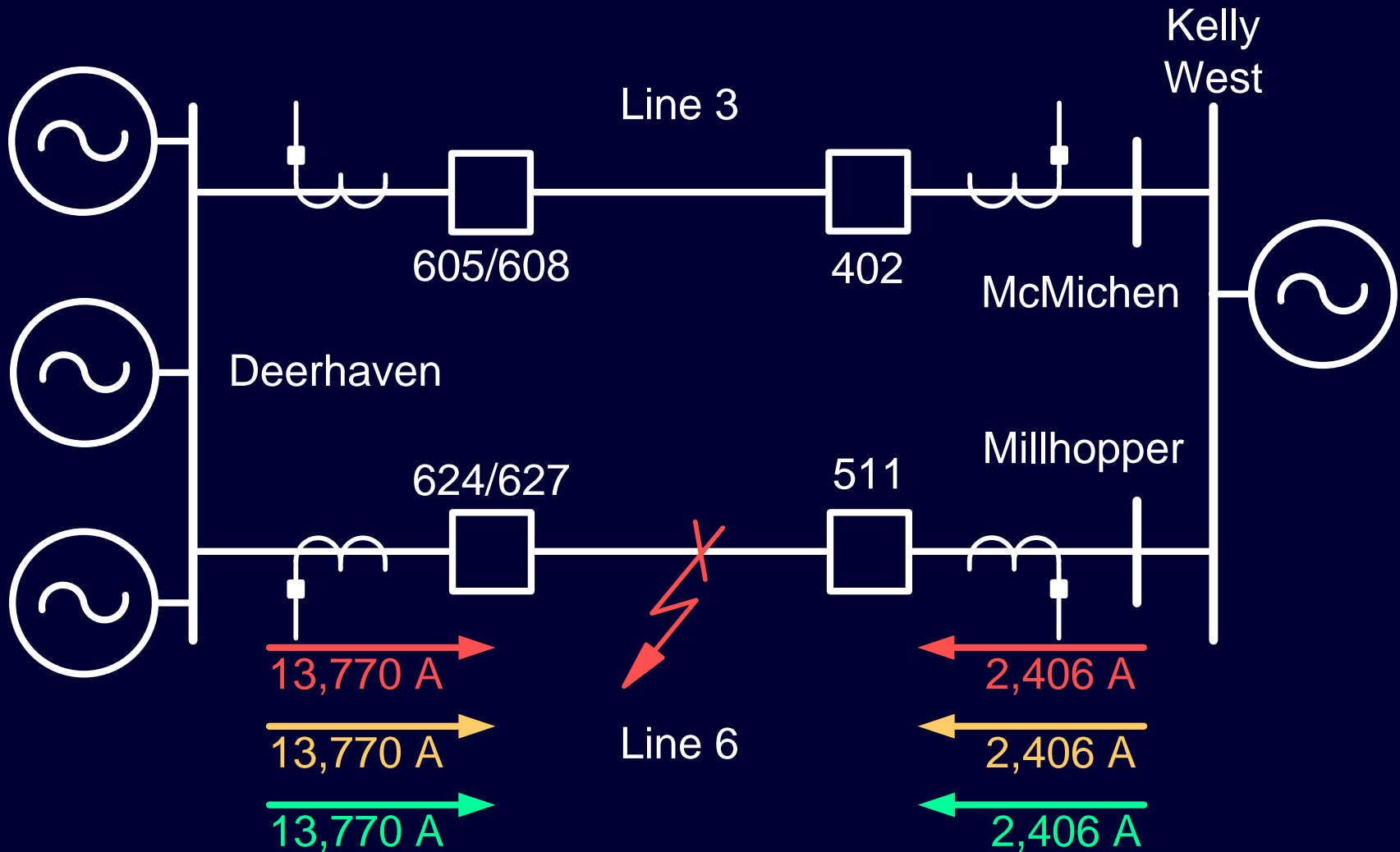
Post-Fault Analysis

- Fault studies
- Time alignment of data
- Alpha Plane differential elements
- Distance elements

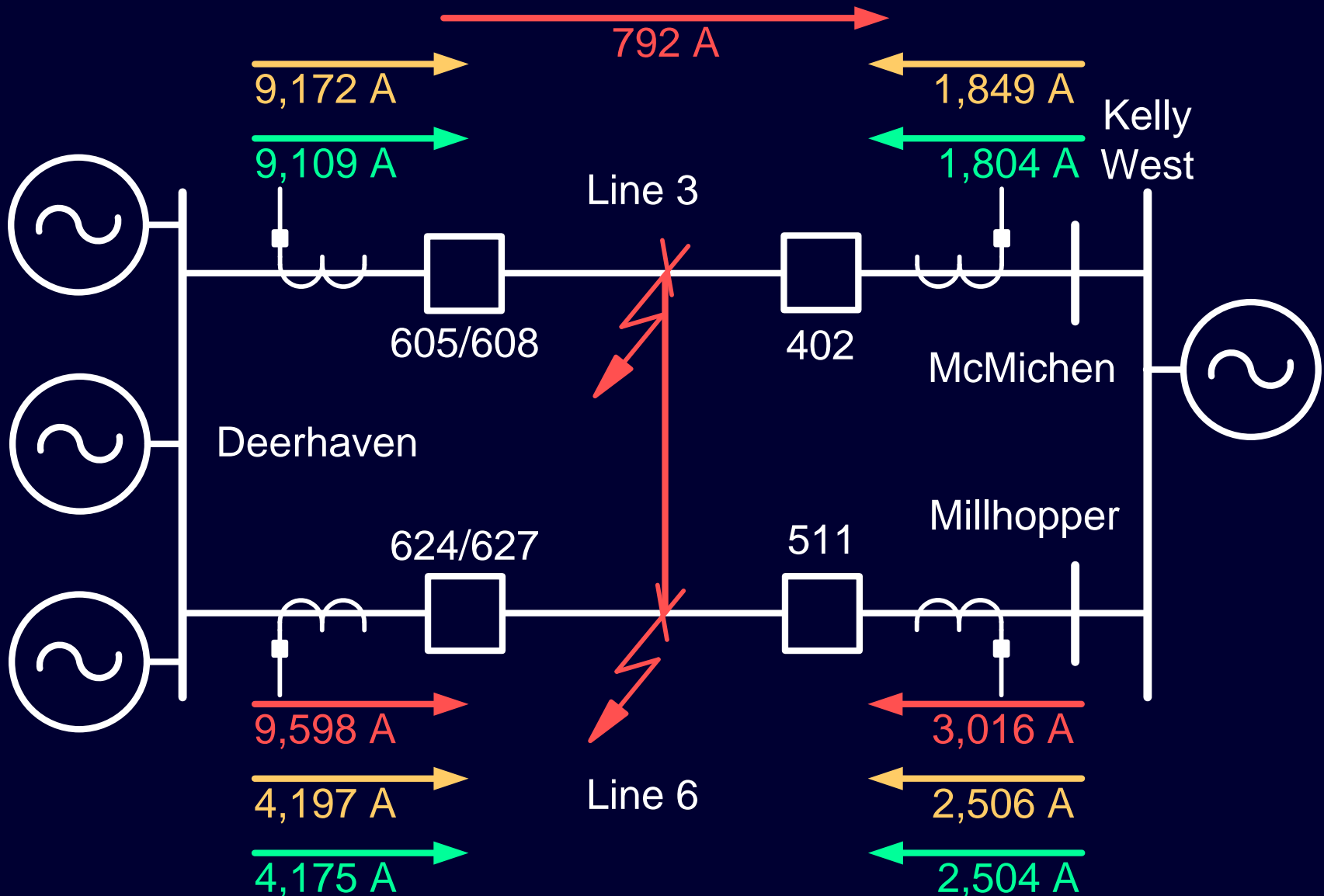
Simulation Fault Currents



Simulation Fault Currents



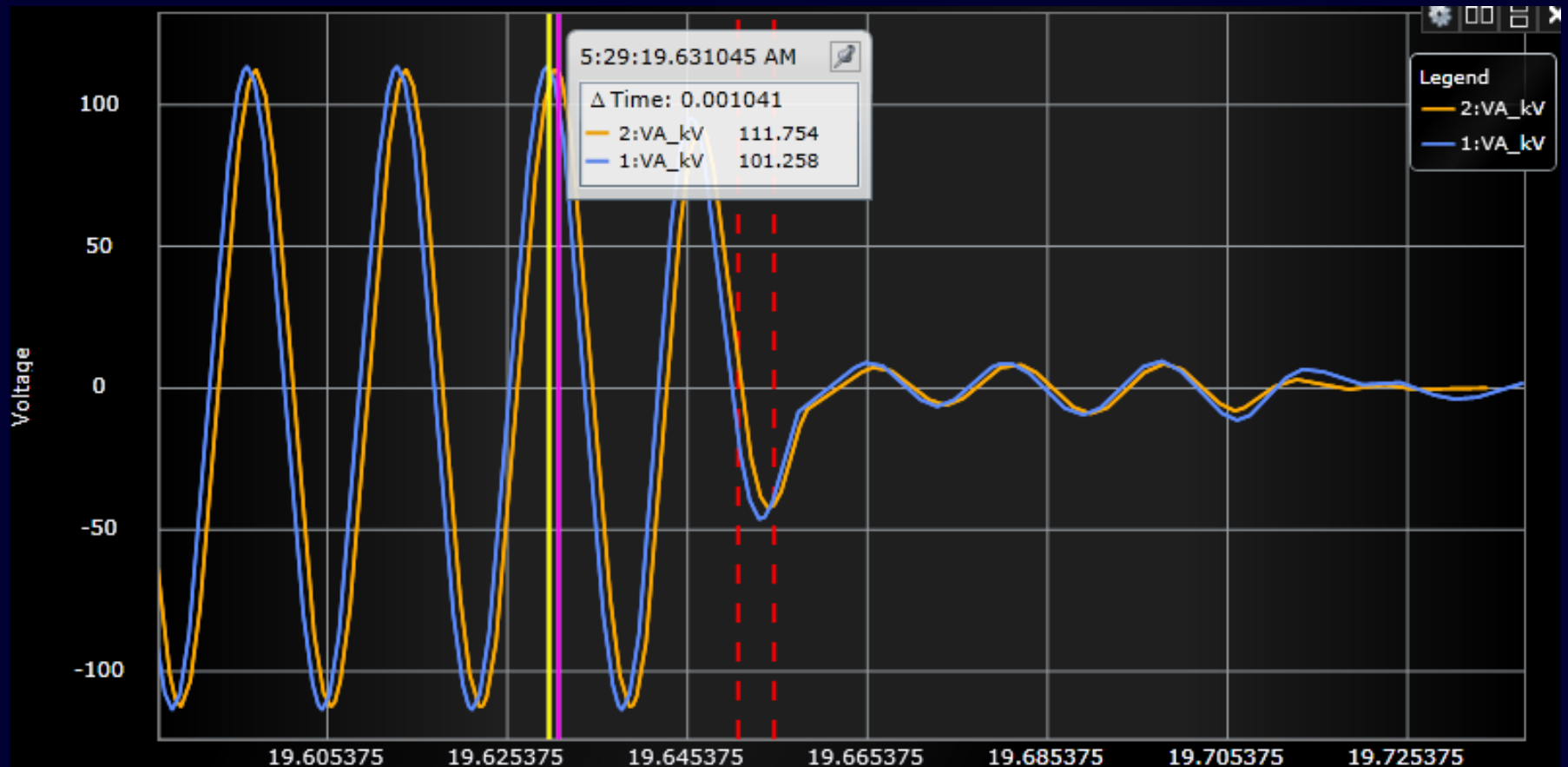
Simulation Fault Currents



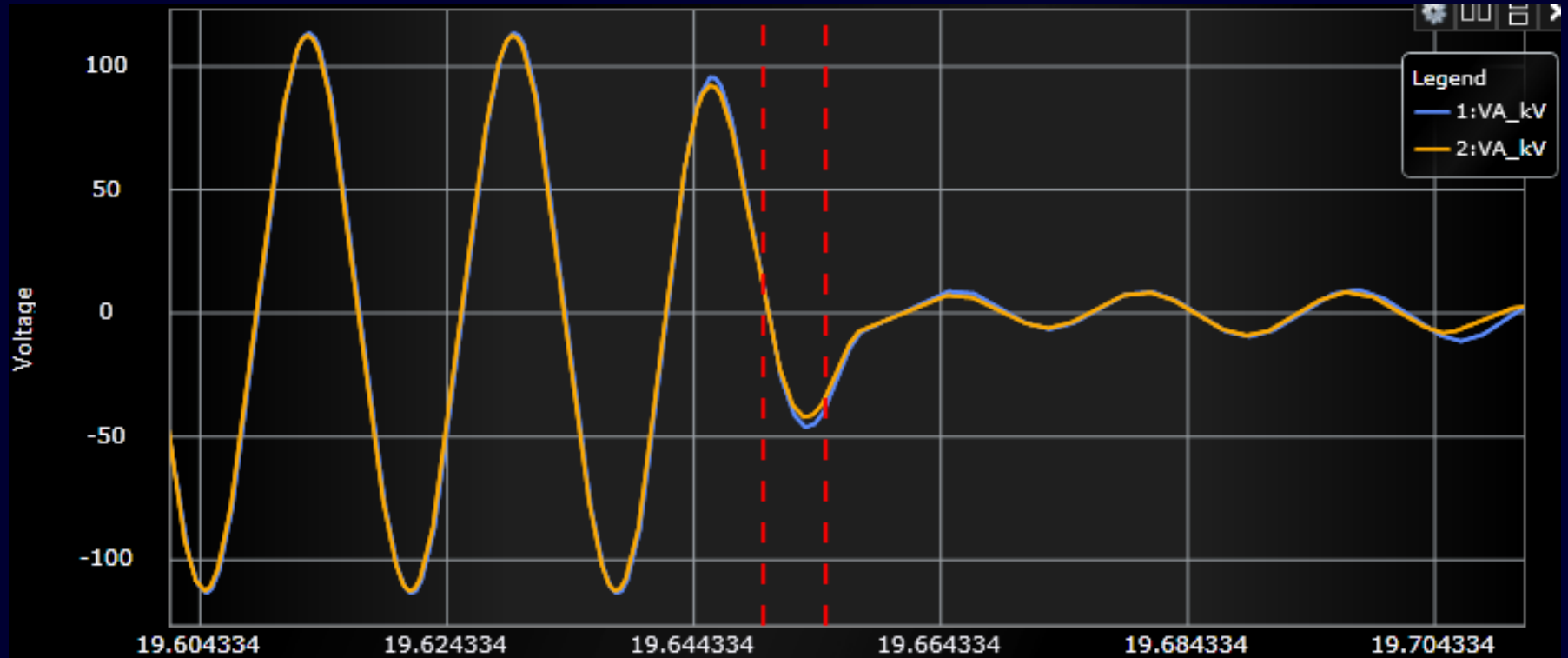
Distance Element Reach Settings

Line Terminal	Expected Impedance	Zone 1 Reach	Zone 2 Reach	Zone 4 Reach
Deerhaven Line 3	0.25	1.83	2.56	5.06
Deerhaven Line 6	0.26	0.66	1.82	5.90
McMichen Line 3	1.92	1.83	2.33	3.67
Millhopper Line 6	0.66	0.65	1.15	9.34

Time Alignment of Data

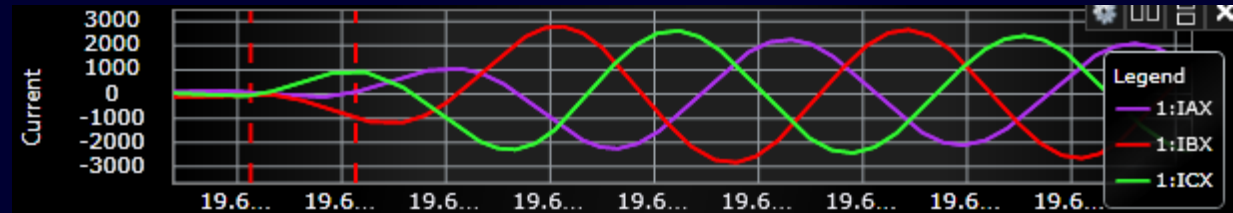


Time Alignment of Data

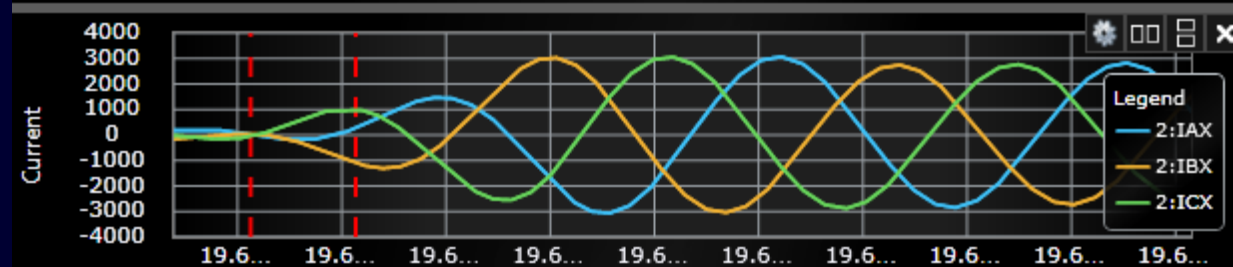


Millhopper and McMichen Currents

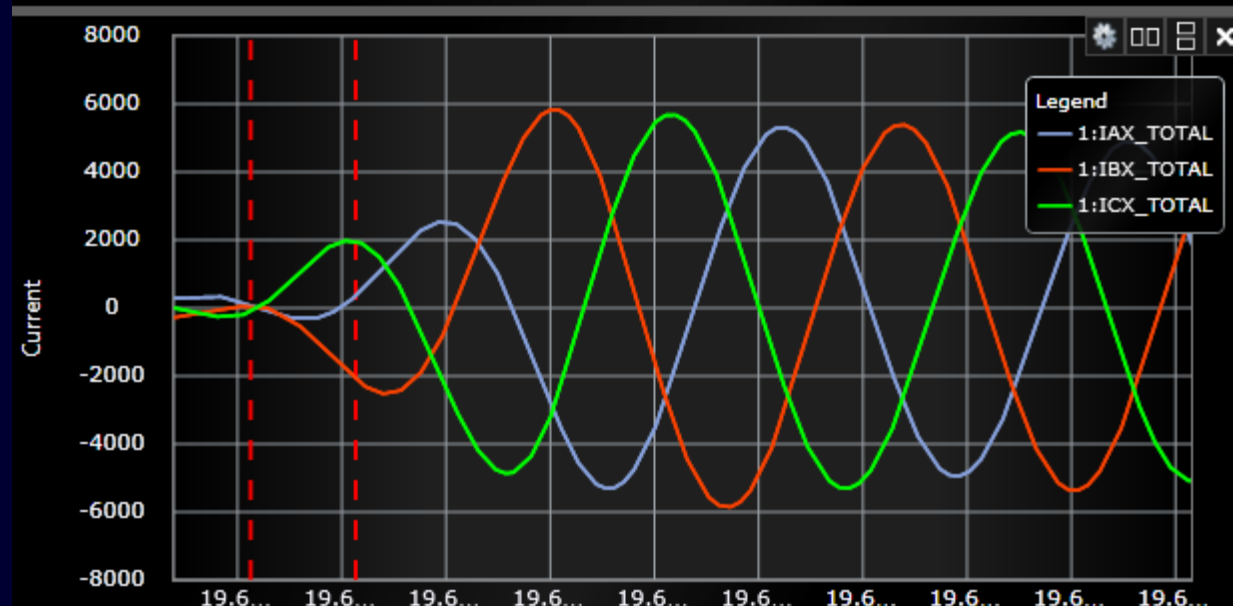
Line 3



Line 6

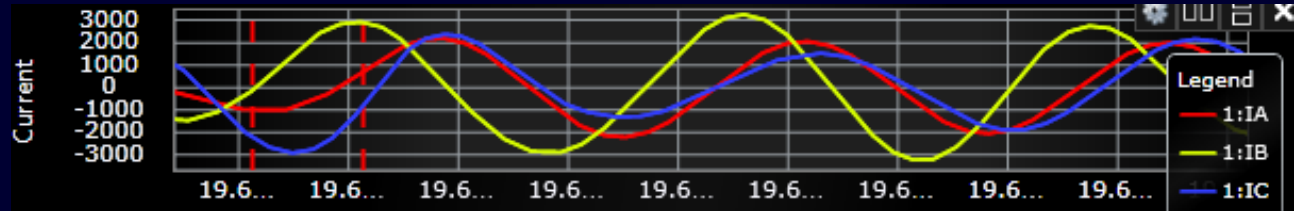


Combined

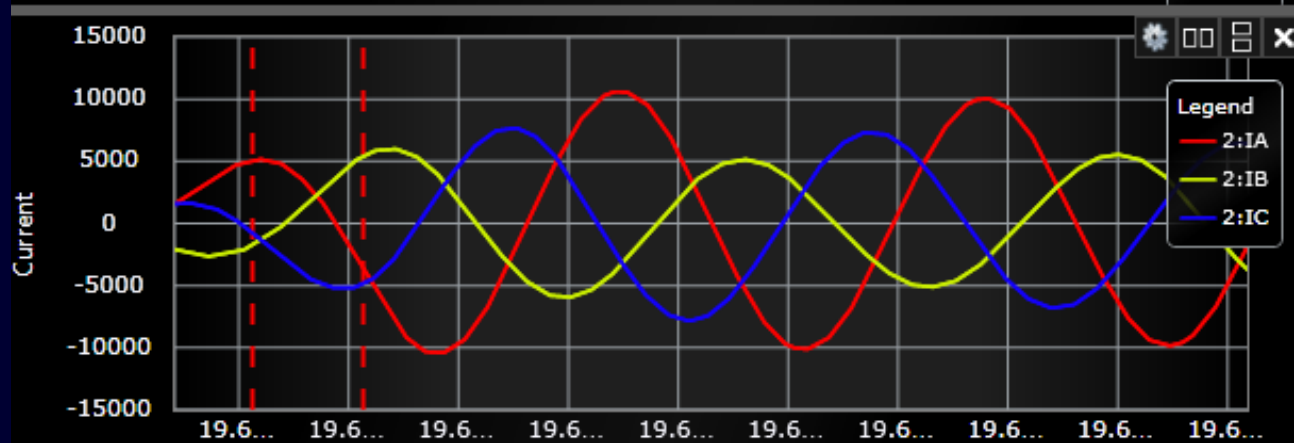


Deerhaven Currents

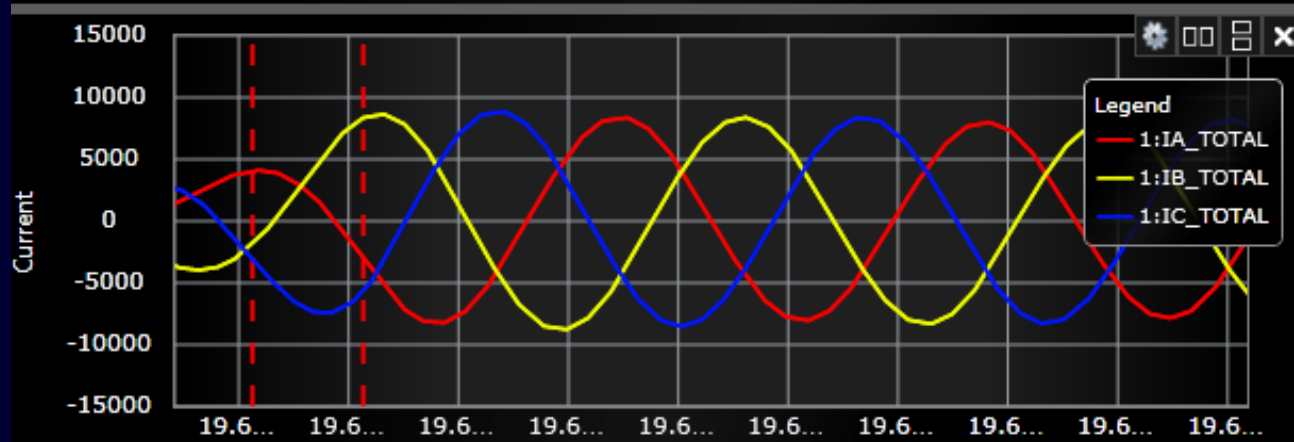
Line 3



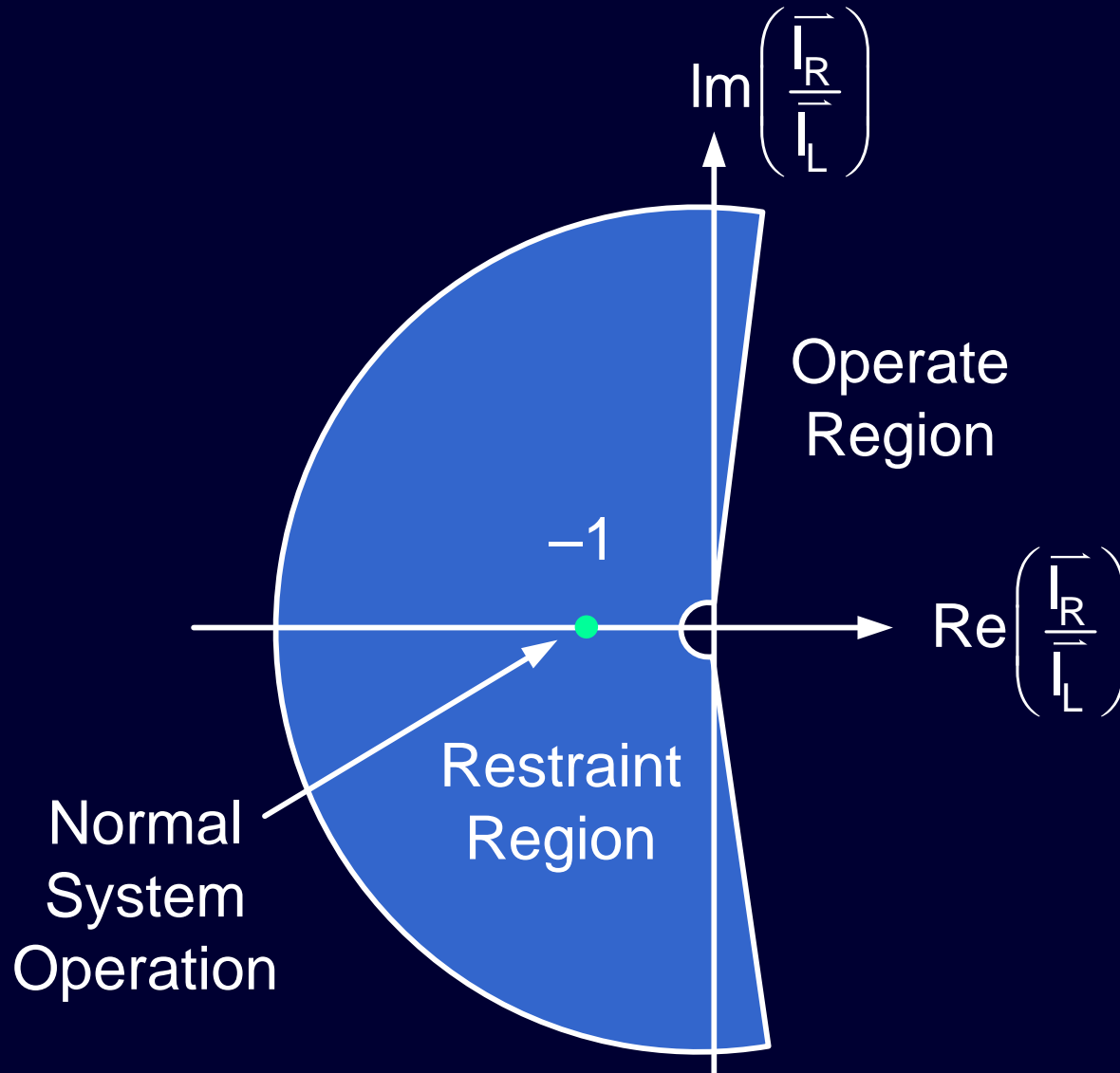
Line 6



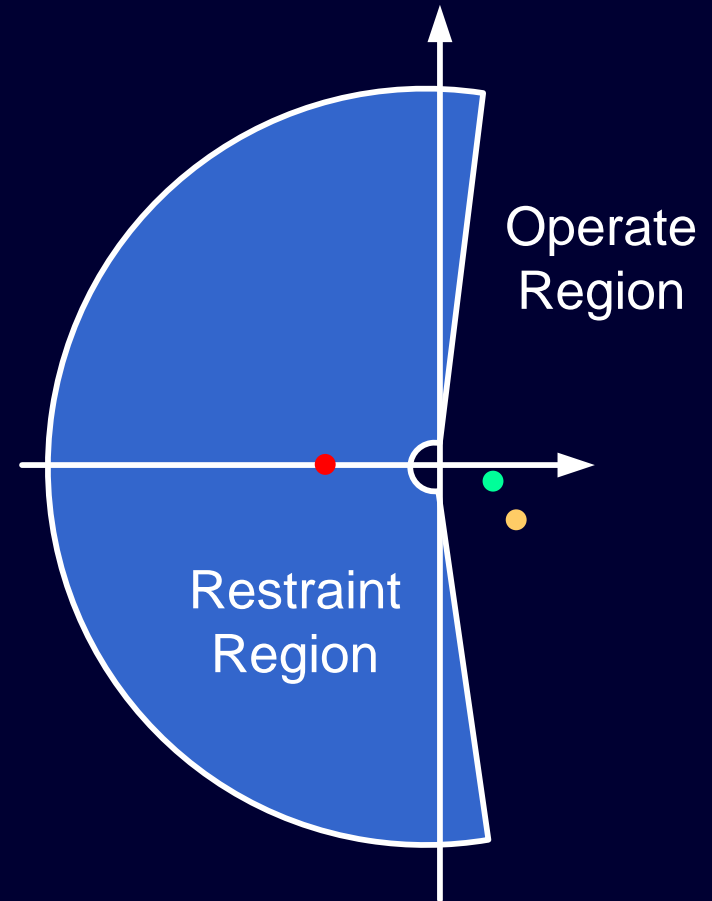
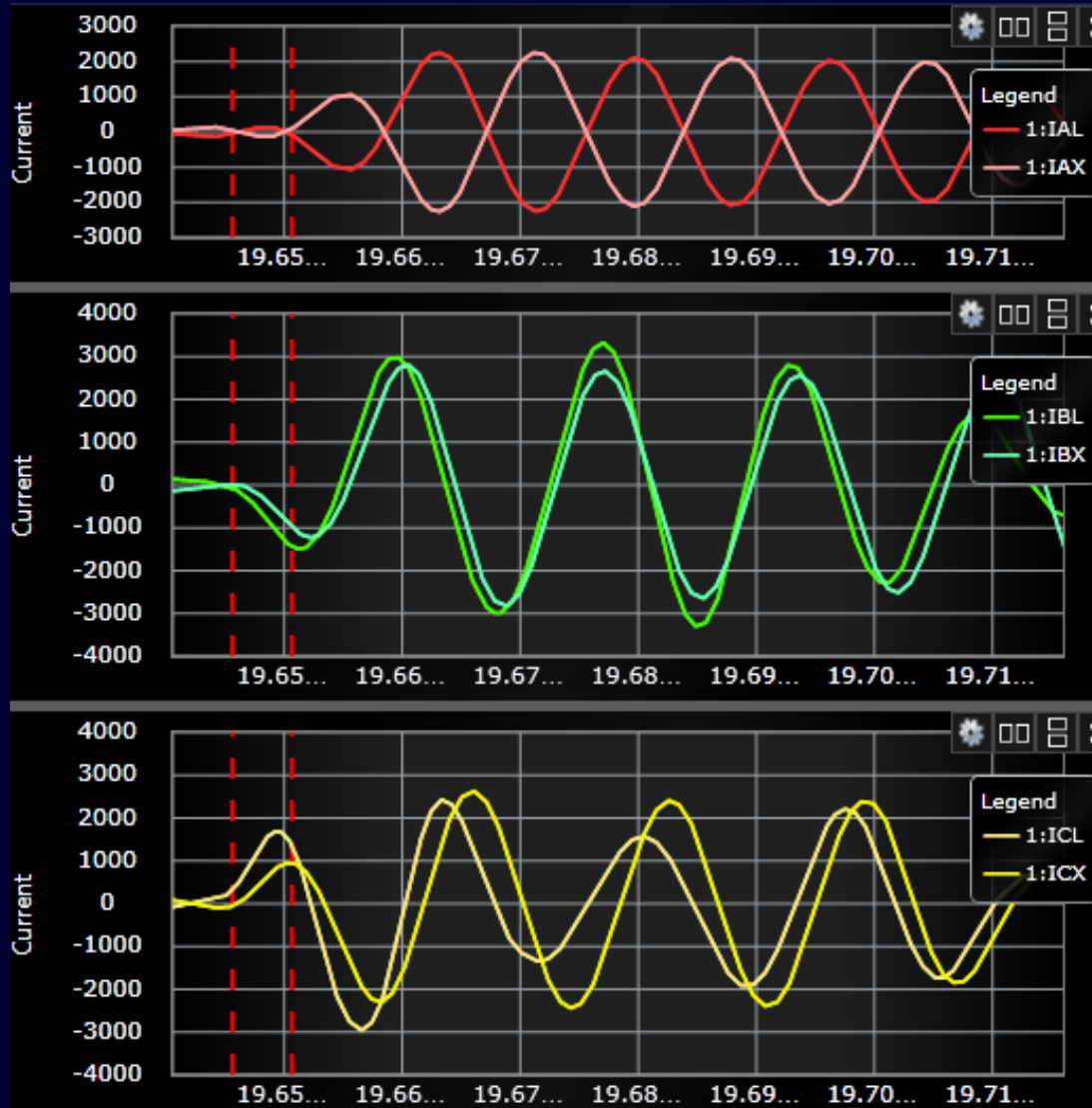
Combined



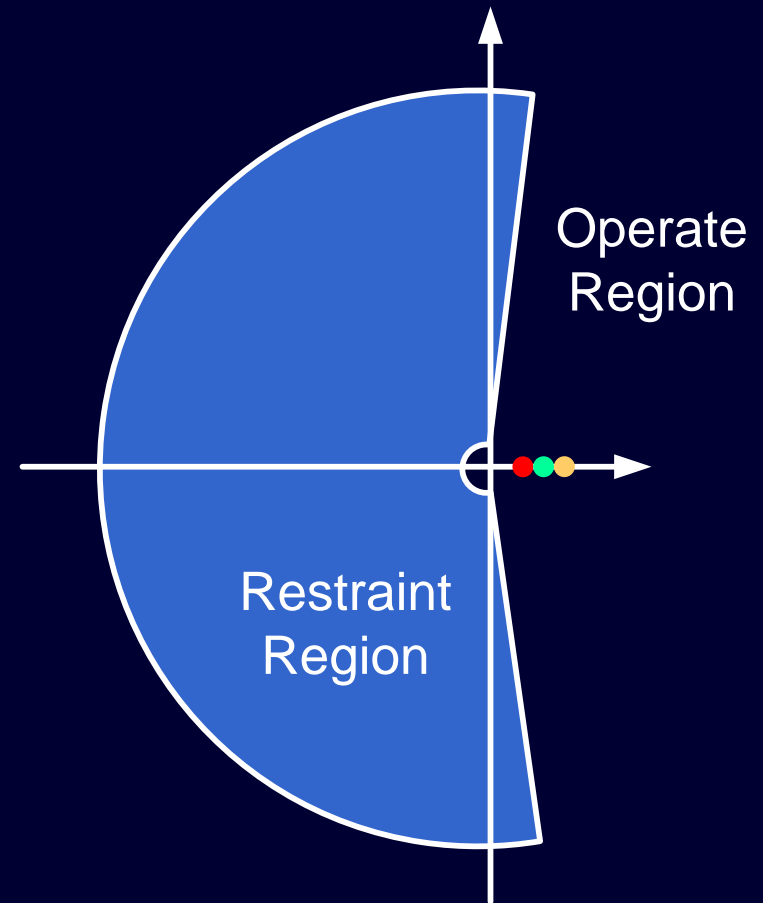
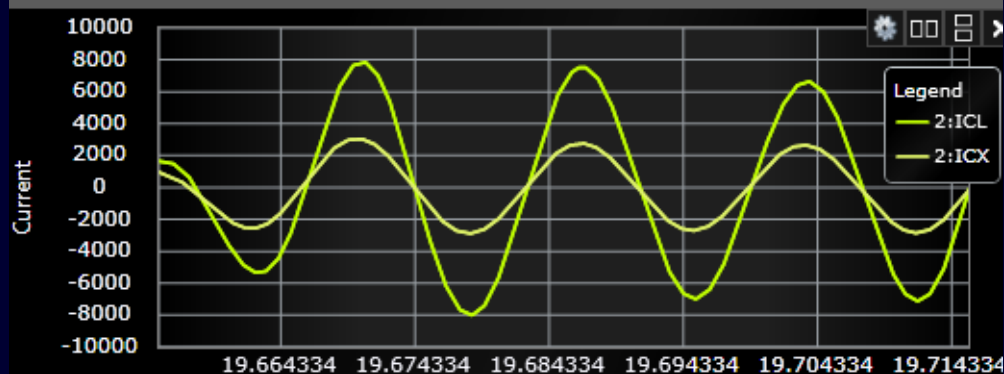
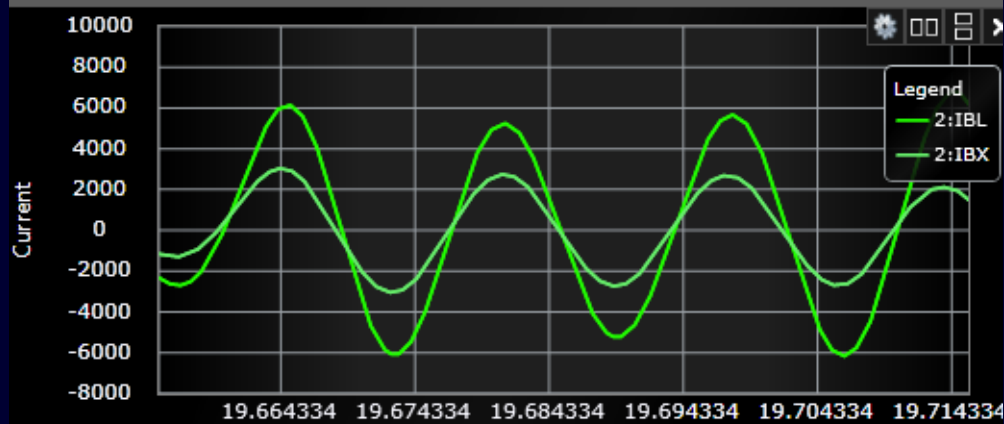
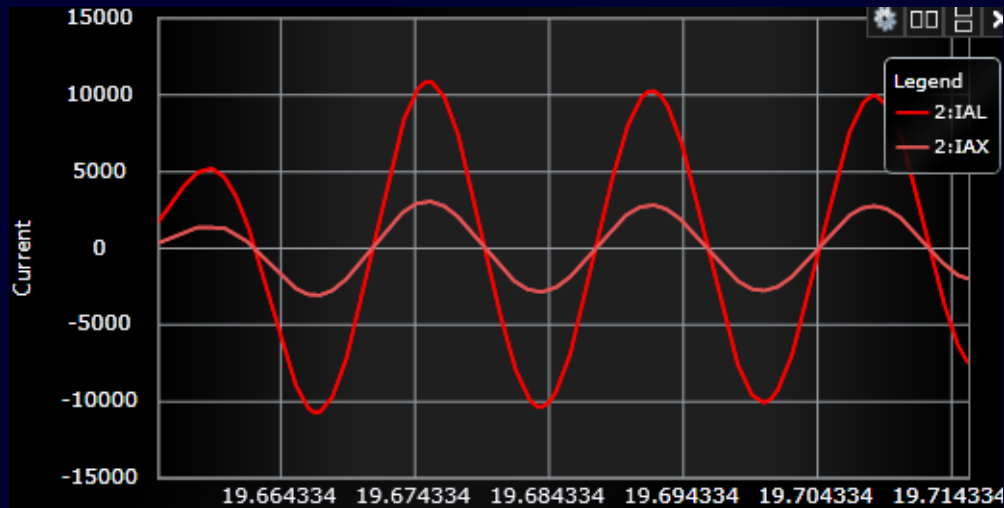
Alpha Plane Differential Characteristic



Line 3 Alpha Plane Differential



Line 6 Alpha Plane Differential



Line Differential Minimum Pickup

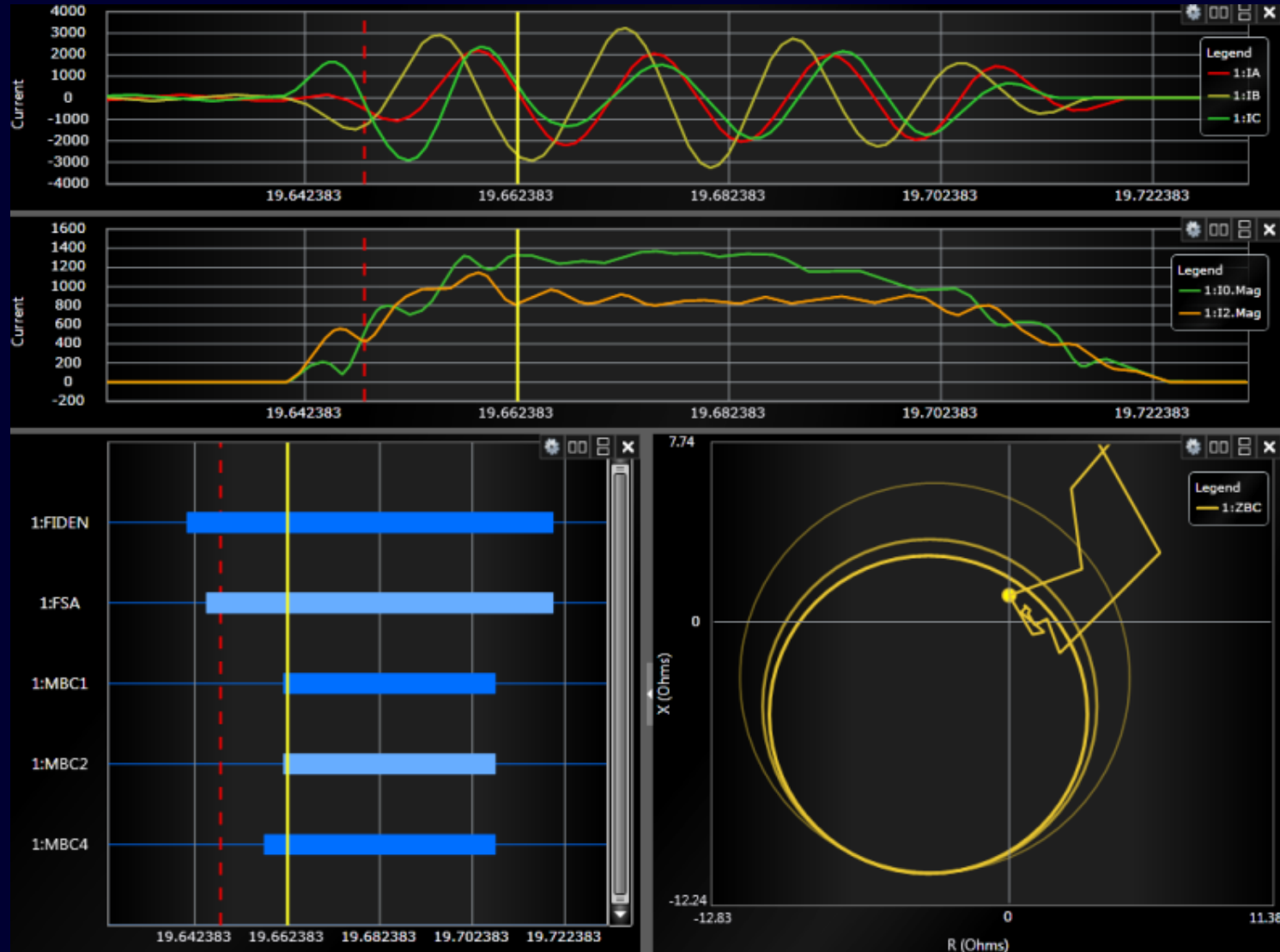
Line 3



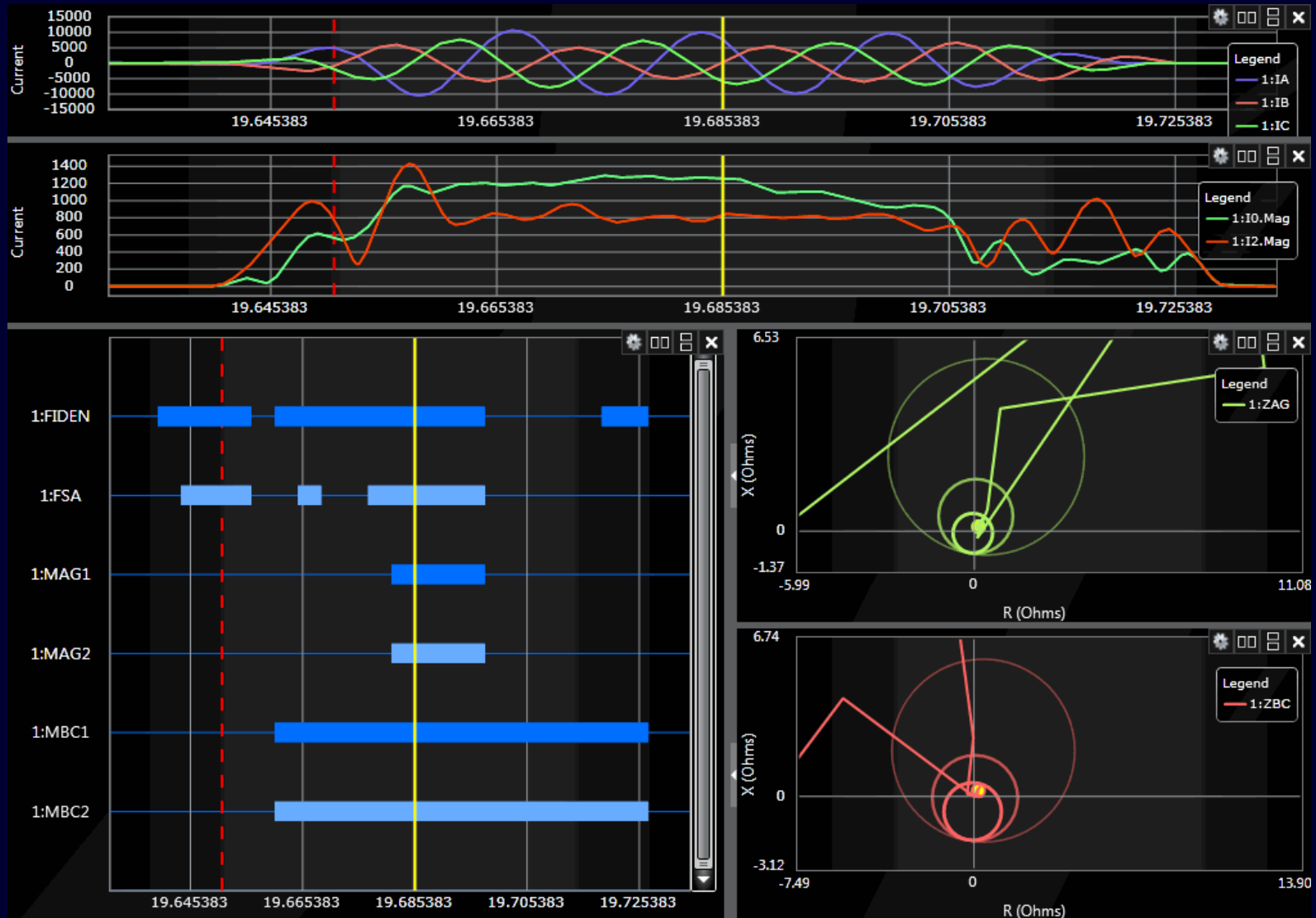
Line 6



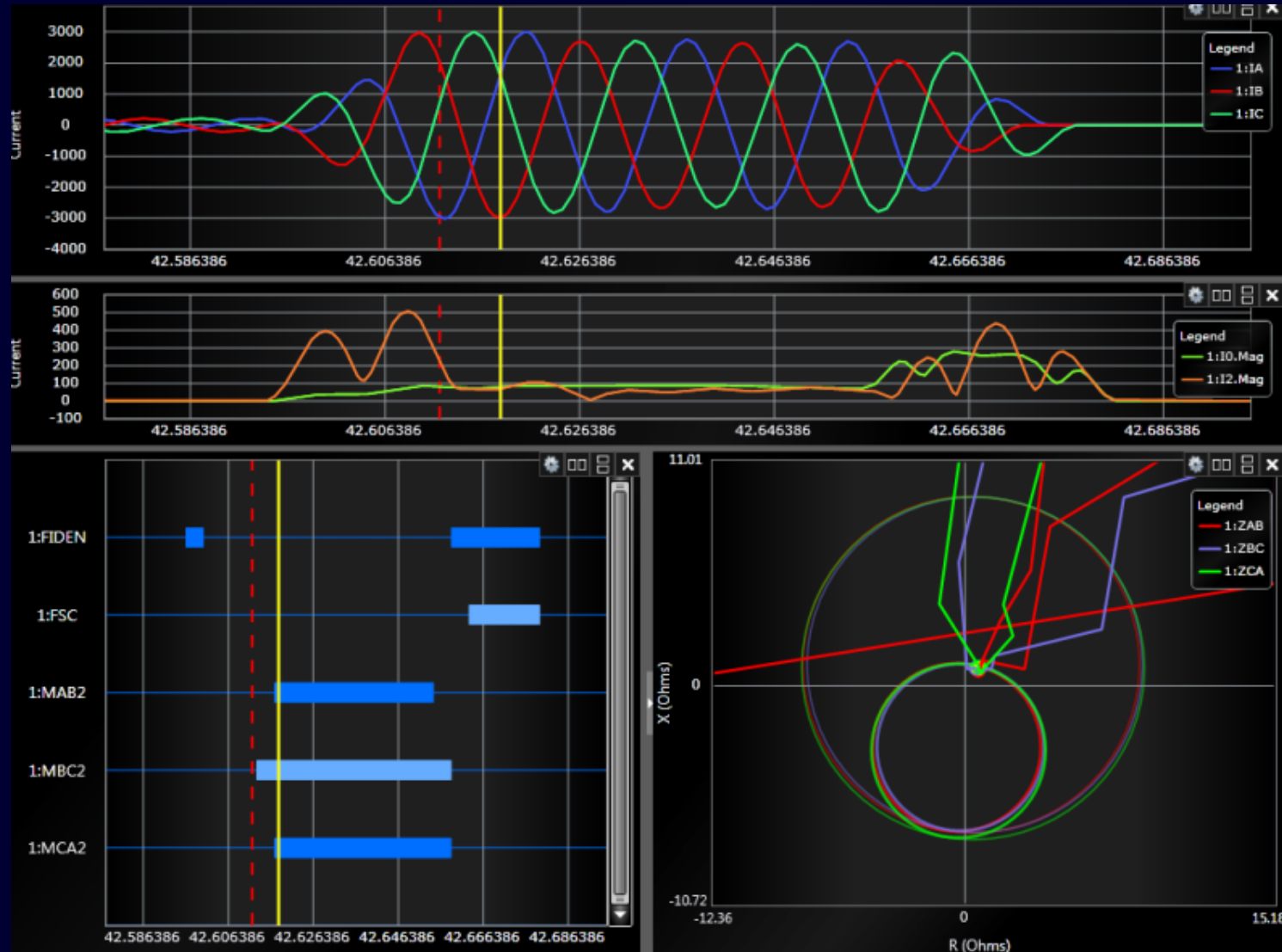
Deerhaven Line 3 Distance Elements



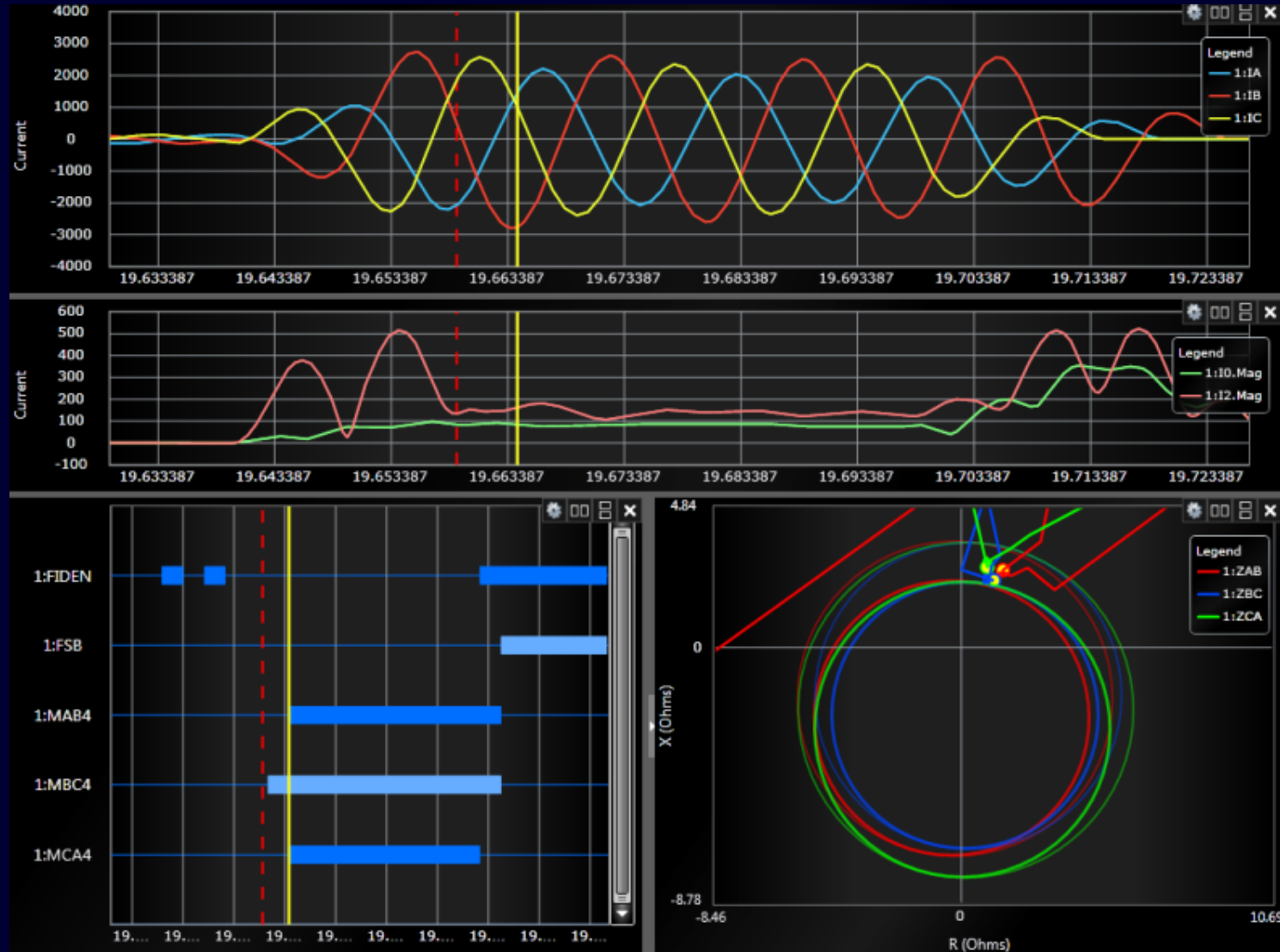
Deerhaven Line 6 Distance Elements



Millhopper Line 6 Distance Elements



McMichen Line 3 Distance Elements



Conclusions

- Intercircuit faults result in reduced fault currents
- Alpha Plane differential characteristic is both fast and sensitive for intercircuit faults
- Distance-based POTT can have difficulty seeing intercircuit fault with impedance
- Time-delayed Zone 4 distance element is critical if protection communications are lost

Questions?

