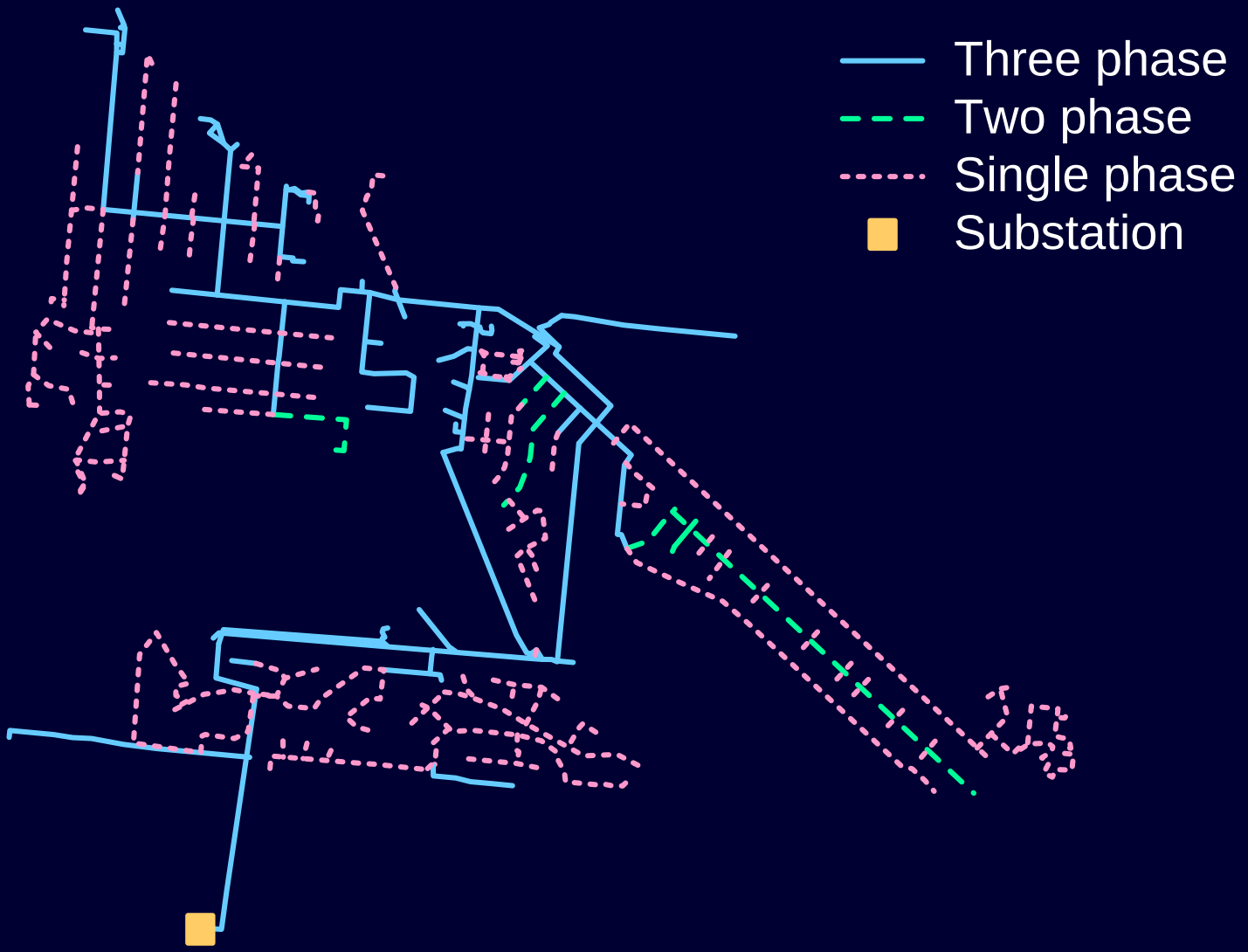
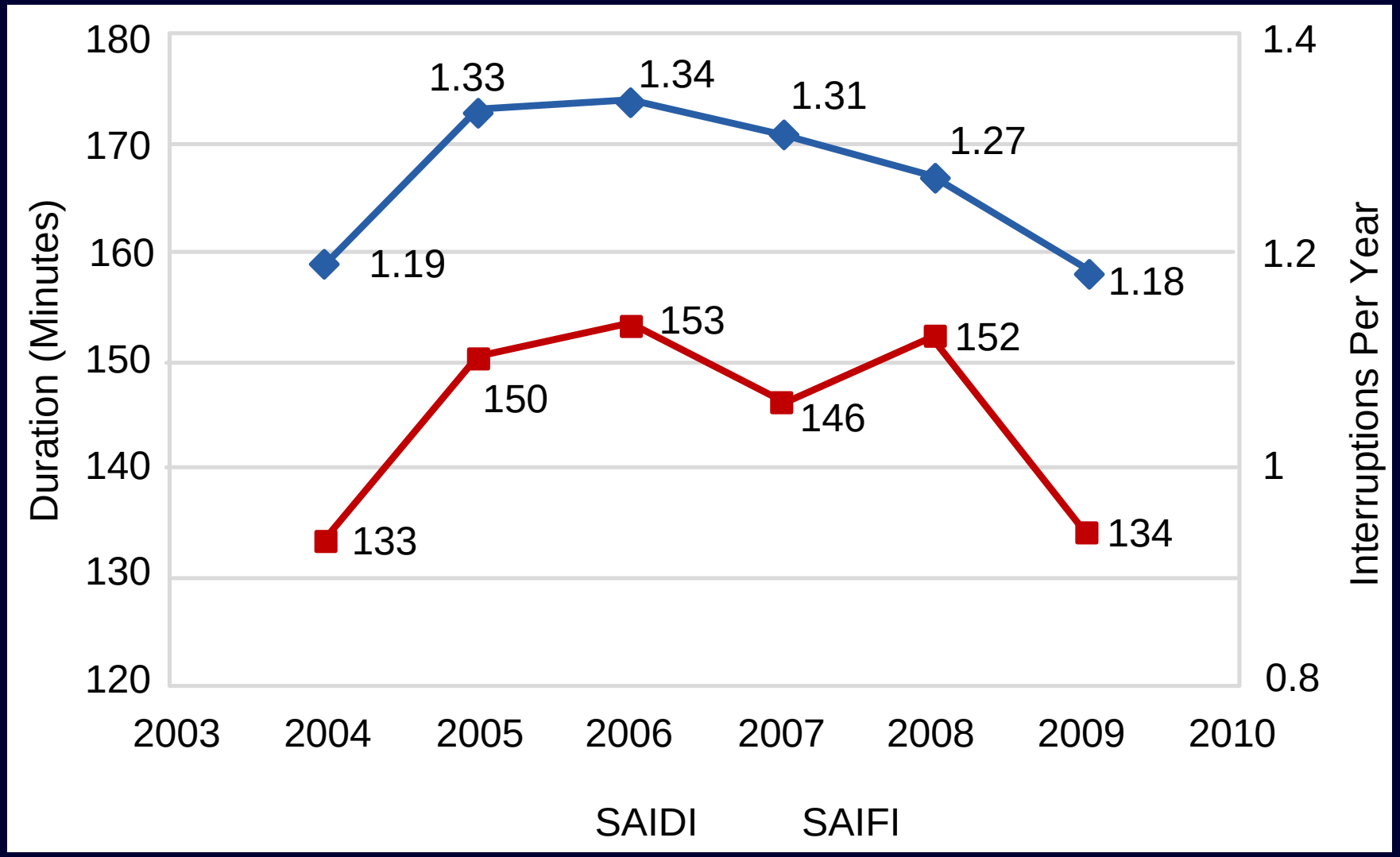
Distribution Feeder Fault Location Using IED and FCI Information

Yanfeng Gong and Armando Guzmán
Schweitzer Engineering Laboratories, Inc.

Locating Distribution Feeder Faults Is Challenging



Accurate / Fast Fault Location Information Improves Quality of Service



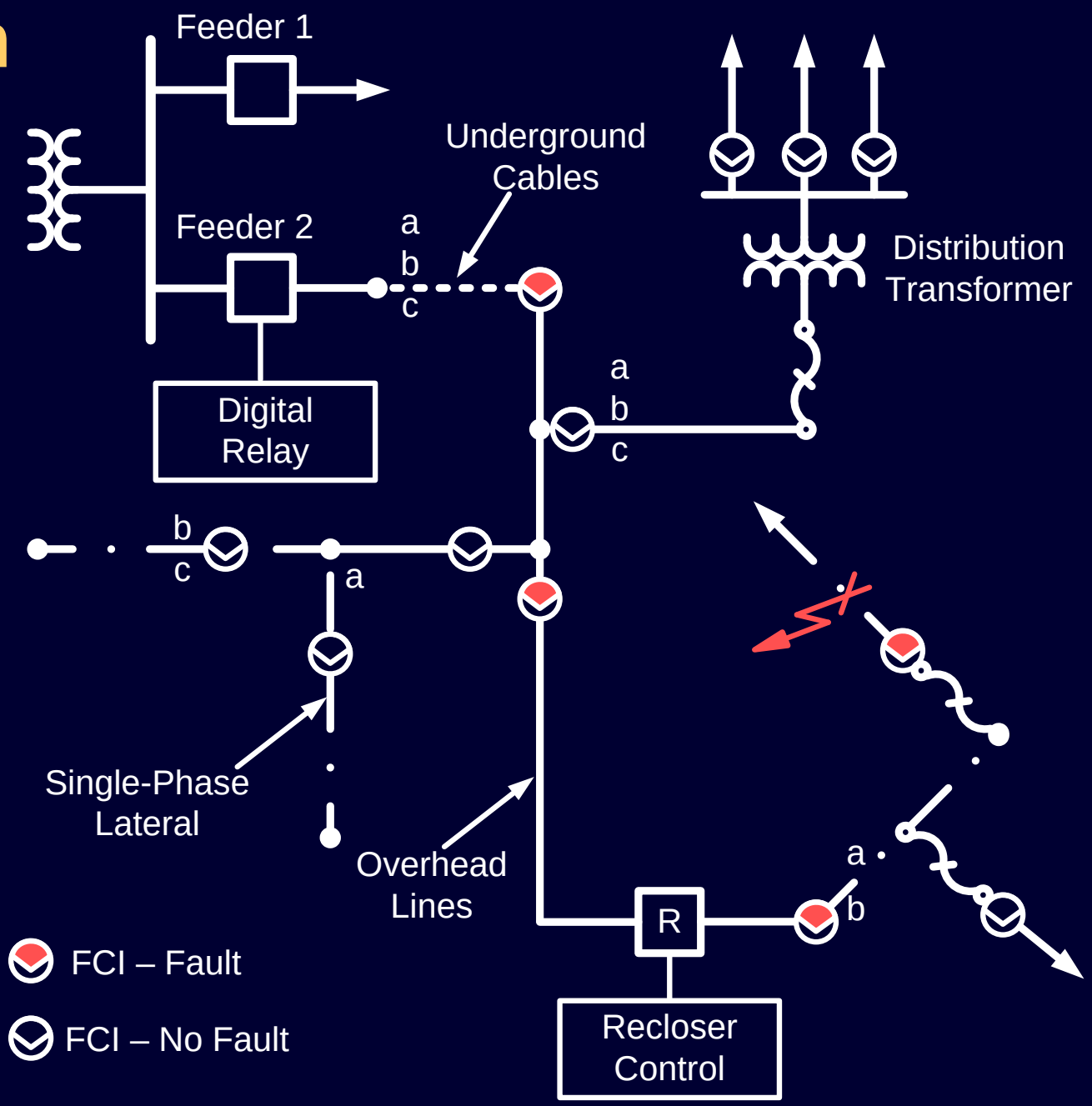
Reduce Duration of Outage

- Fault-monitoring technology can pinpoint fault location
- Personnel respond sooner and reduce outage length

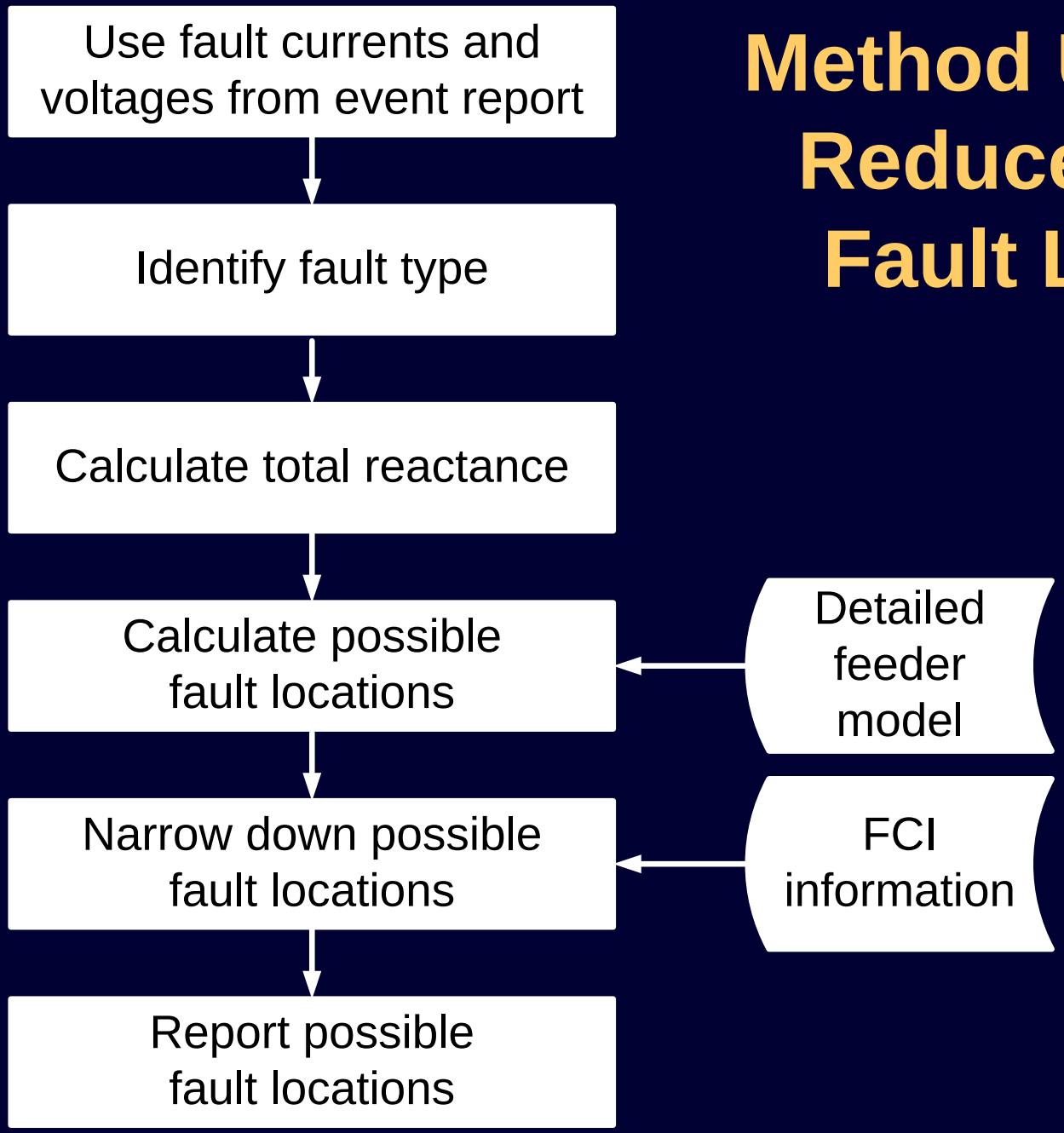
Existing Distribution Feeder Fault Location Method

- Traditional relay
- Fault current only
- AMR/Trouble call

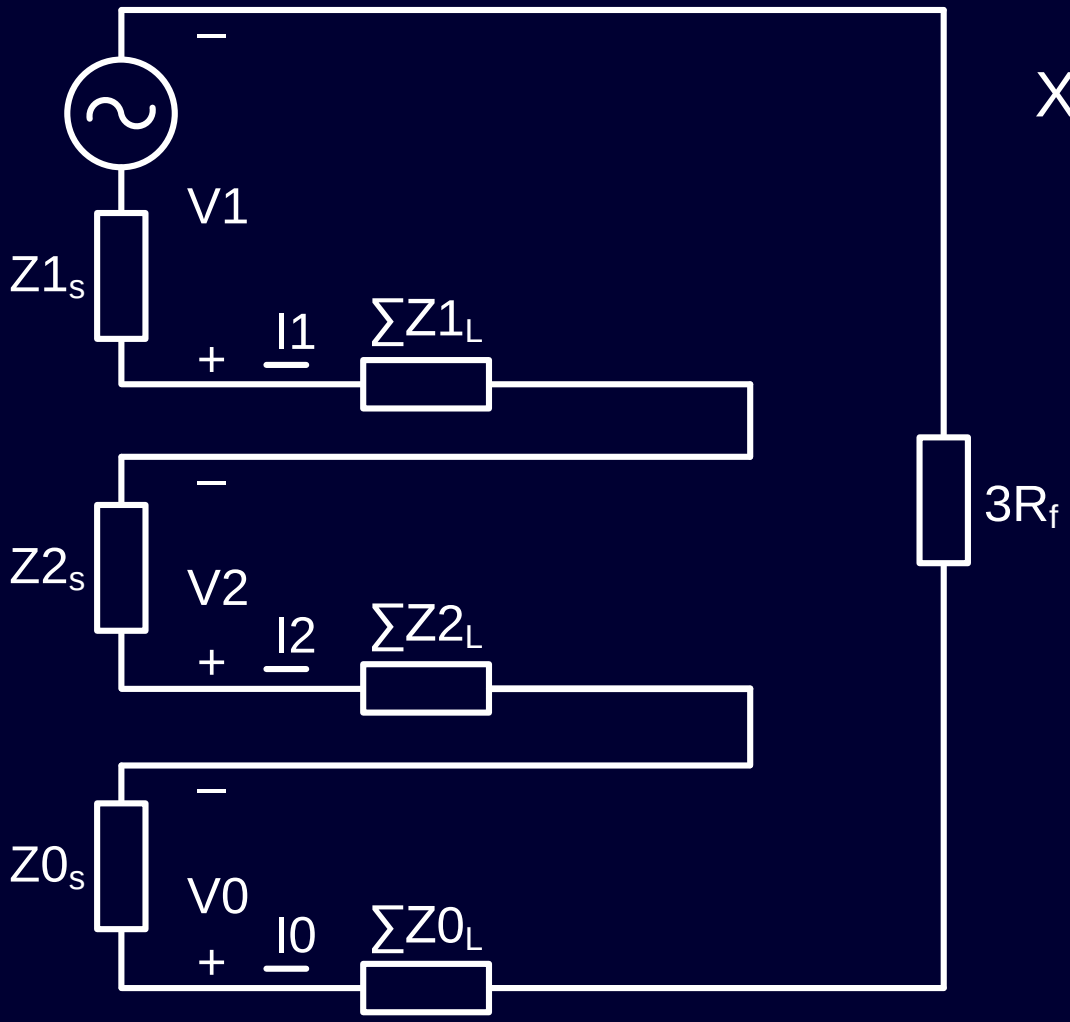
Distribution Feeder



Method Uses FCI to Reduce Possible Fault Locations



Reactance Calculation Using I2 for Single-Phase-to-Ground Faults

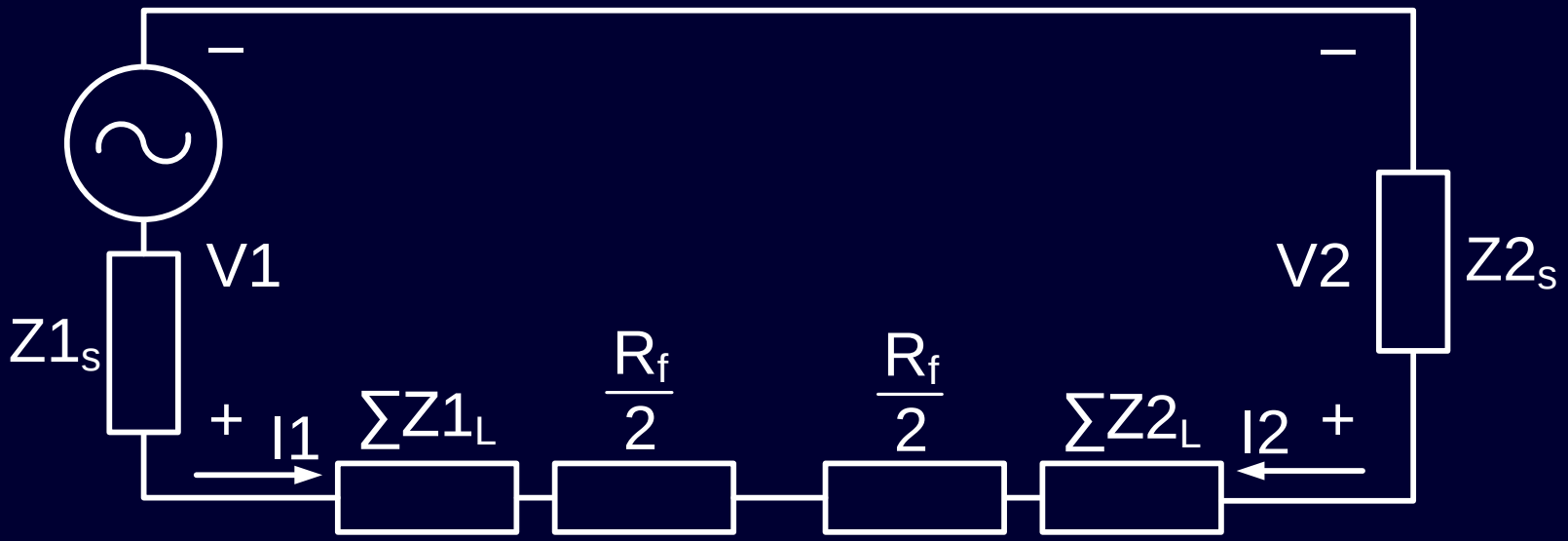


$$X_{total} = \sum_{i=1}^{k} \left(X1_i + X2_i + X0_i \right)$$

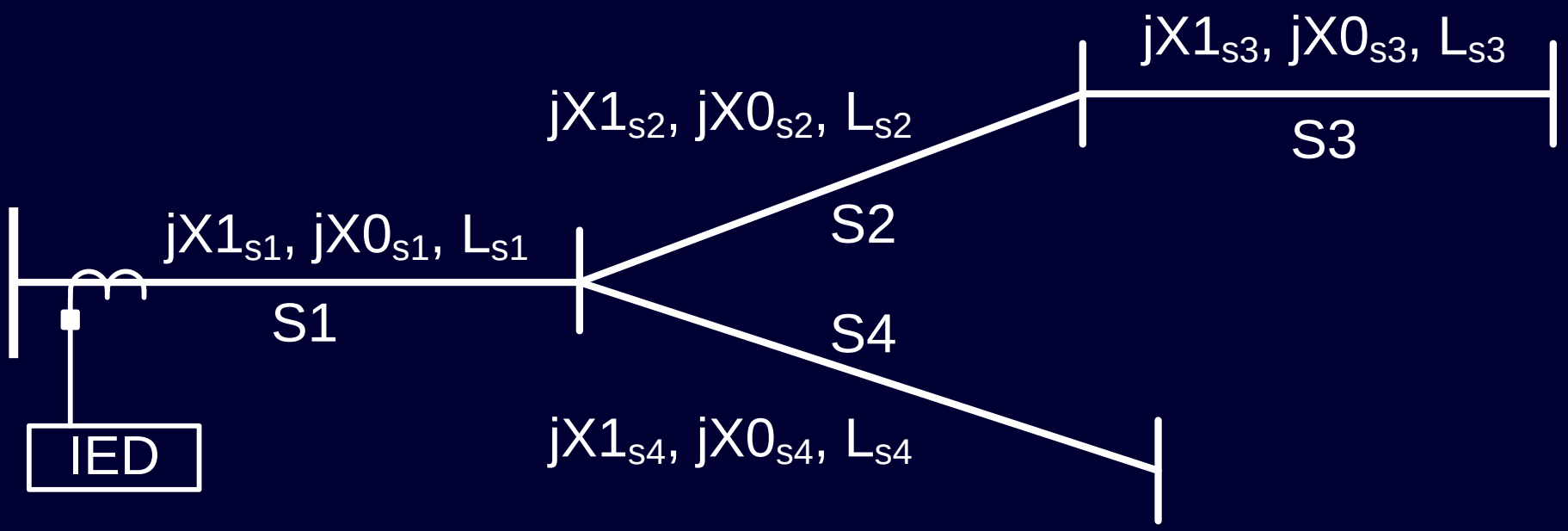
$$= \frac{\mathrm{Im}\left(V_{phase} \bullet I2^{*} \right)}{\left| I2 \right|^{2}}$$

Reactance Calculation Using I2 for Phase-to-Phase Faults

$$X_{total} = \sum_{i=1}^{k} X1_i = \mathrm{Im}\left(\frac{V2 - V1}{2 \bullet I2} \right)$$



Detailed Feeder Model Provides Accurate Results

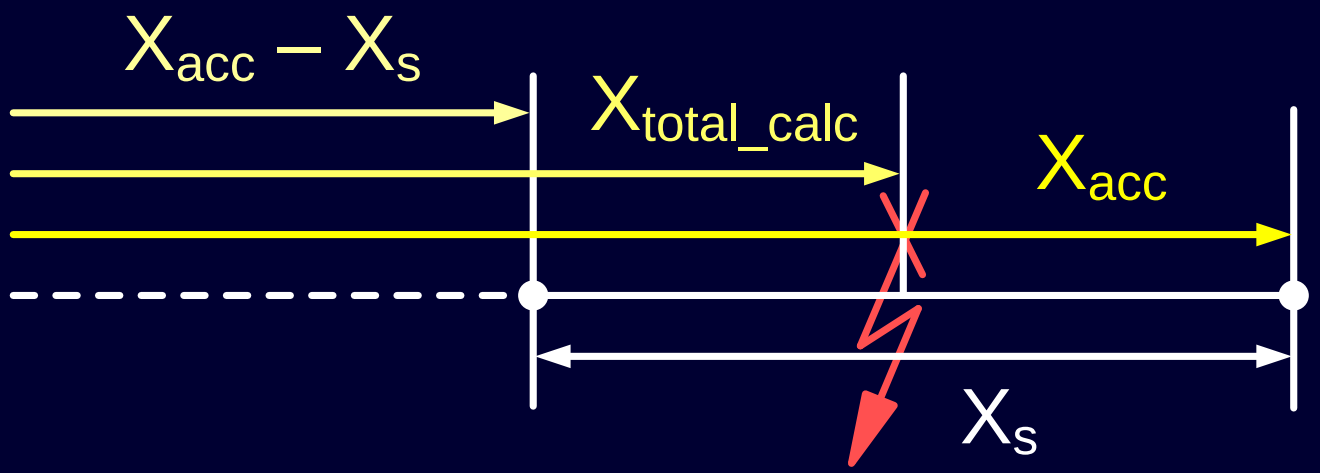


Available Feeder Data Simplify System Configuration

Use feeder models available in popular distribution system analysis software

Section ID	From Node ID	To Node ID	Phase	Length (ft)	R1 (Ω)	X1 (Ω)	R0 (Ω)	X0 (Ω)
Fd01	Fd0001	Fd0002	ABC	506	0.0662	0.755	0.2497	2.0687
Fd02	Fd0002	Fd0003	ABC	424	0.0452	0.558	0.2140	1.2560

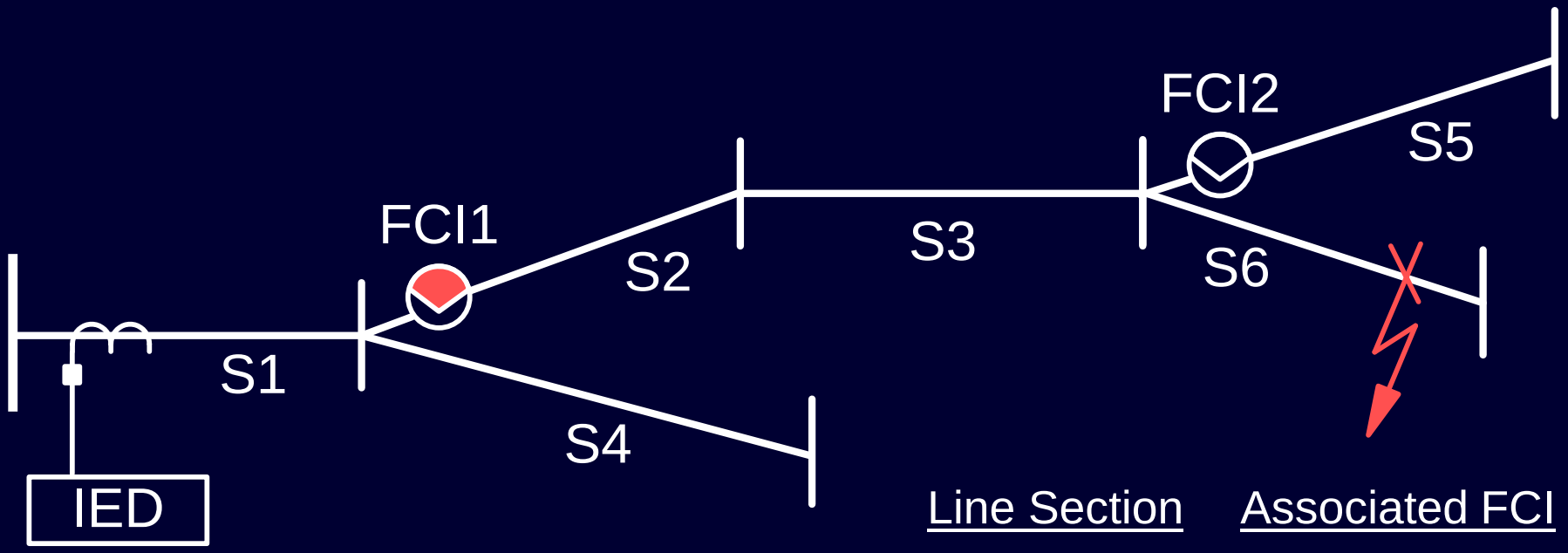
Faulted Line Section Criteria



Line section phase contains identified faulted phase

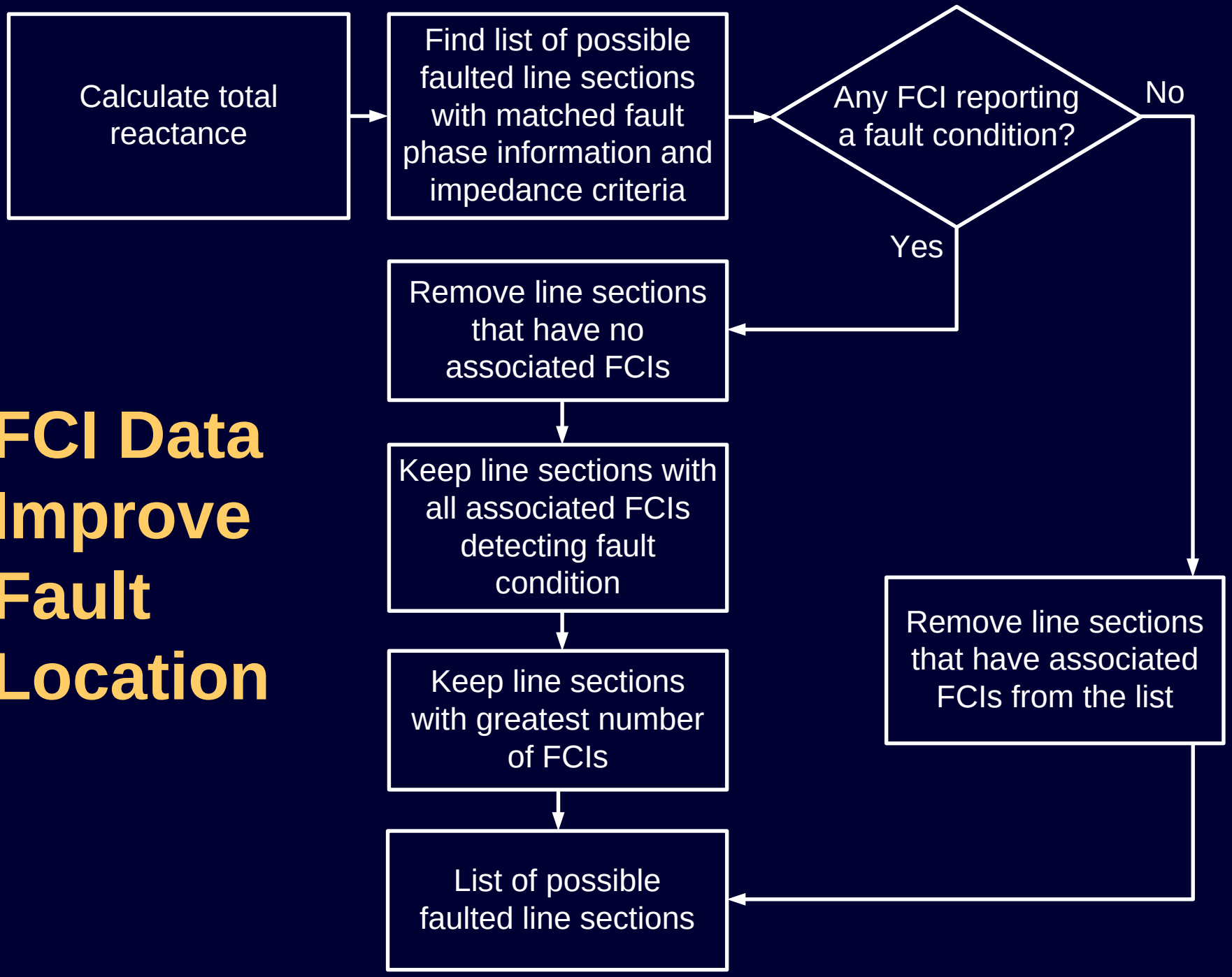
$$X_{acc} \geq X_{total\_calc} > X_{acc} - X_s$$

FCI Data Reduce Possible Fault Locations

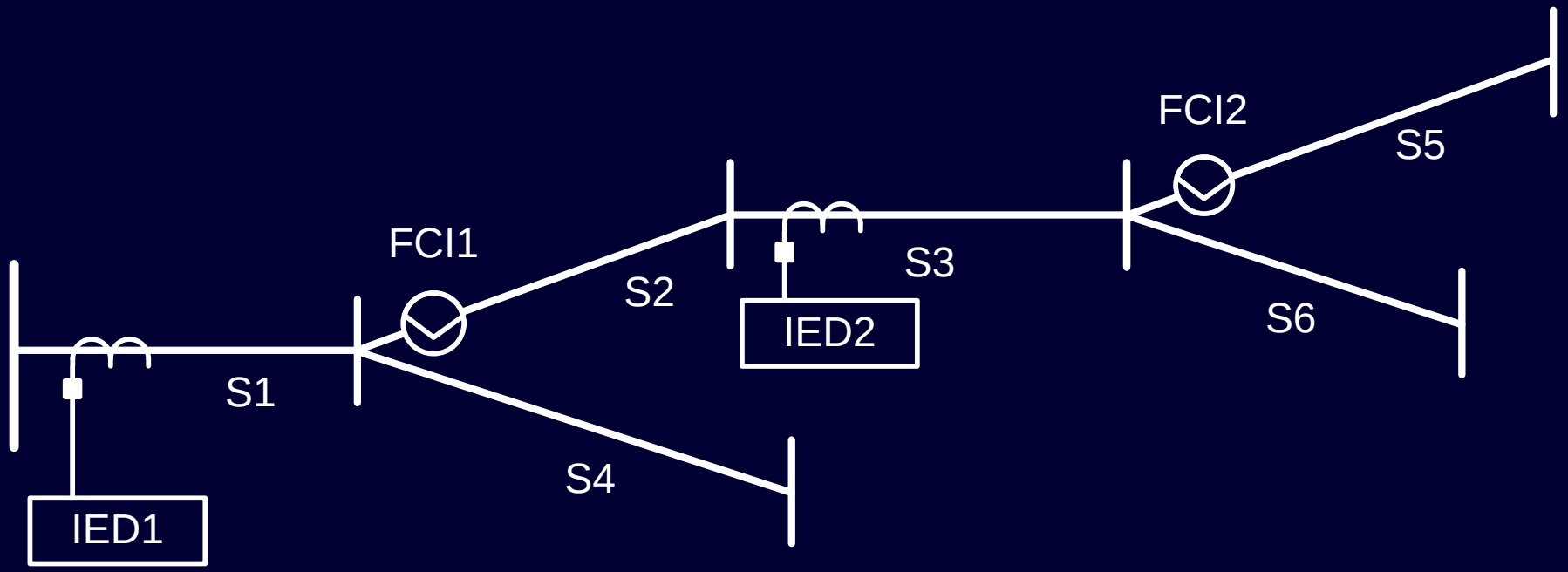


Line Section	Associated FCI
S1	{ }
S2	{FCI1}
S3	{FCI1}
S4	{ }
S5	{FCI1, FCI2}
S6	{FCI1}

FCI Data Improve Fault Location

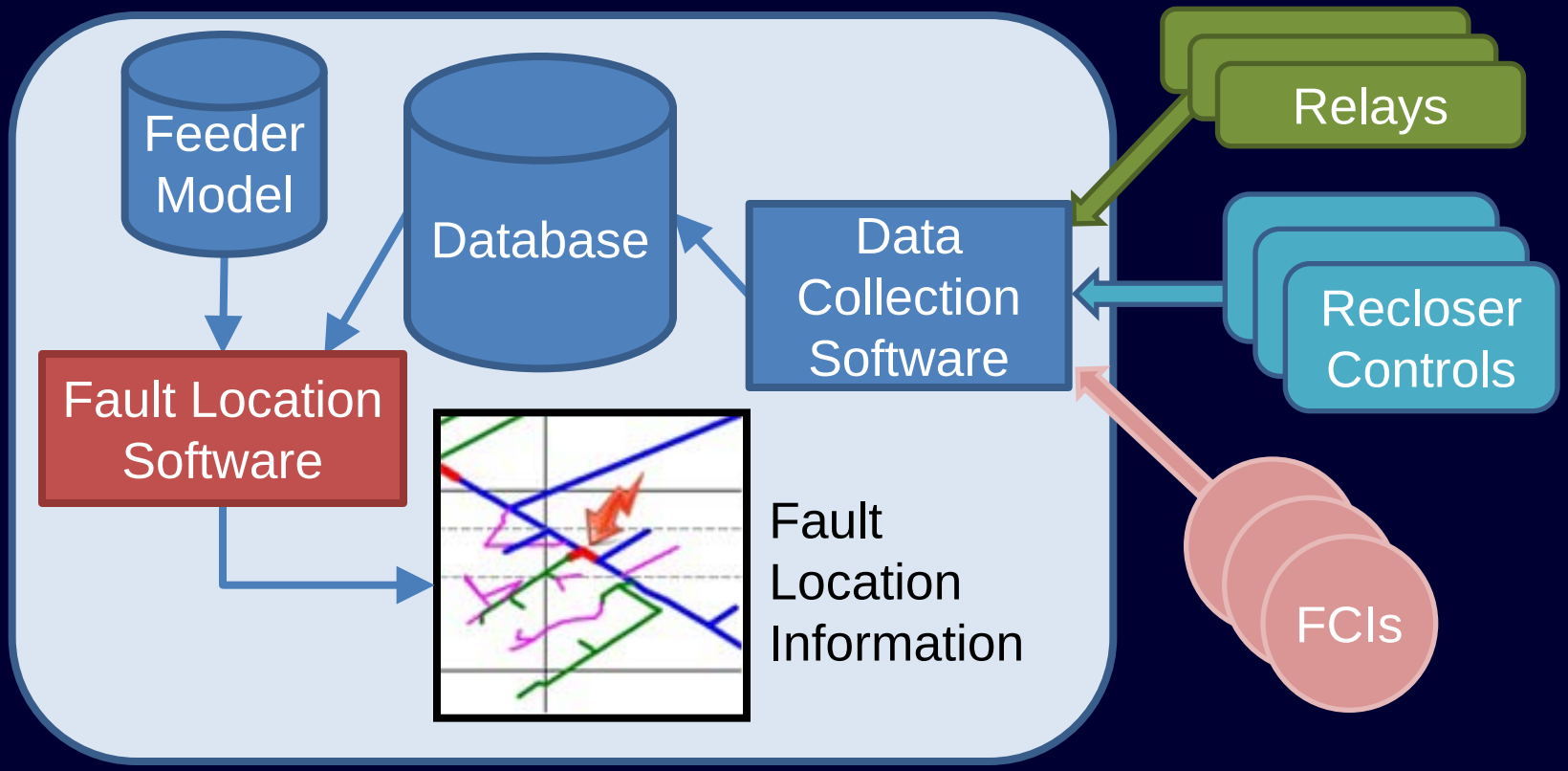


Recloser Control Data Improve Fault Location



- Use recloser control as FCI
- Calculate reactance with current / voltage measurement from recloser control

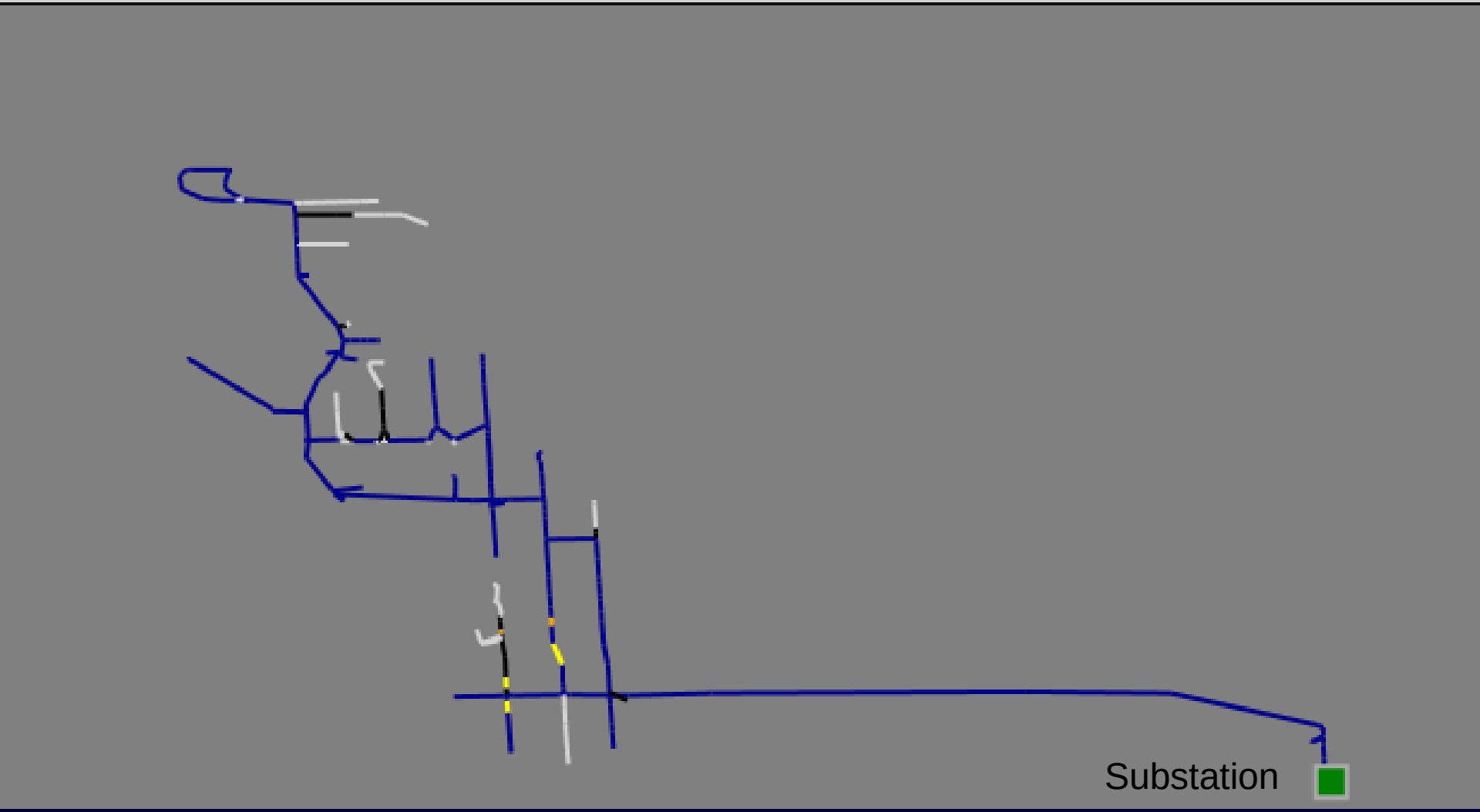
Distribution Fault Location System



Fault Location Results

Current Event: OakD0506_351S 2008 02 10 09 29 27 049.EVE

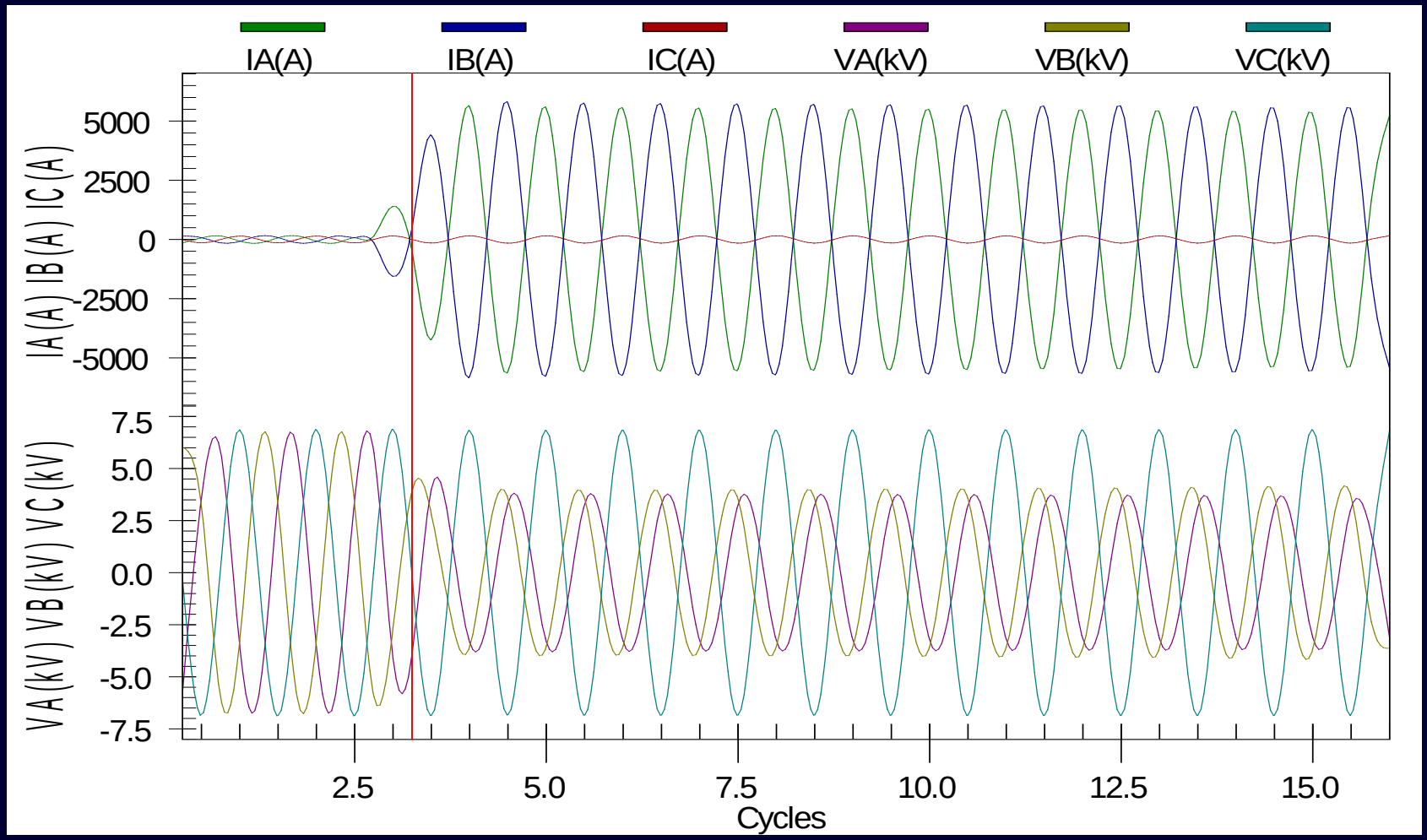
3 Phase | 2 Phase | 1 Phase | Z Method | I Method | Z+I Method



Field Case 1: Phase-to-Phase Fault Location Within 20 Feet

Existing relay: 1,636 feet

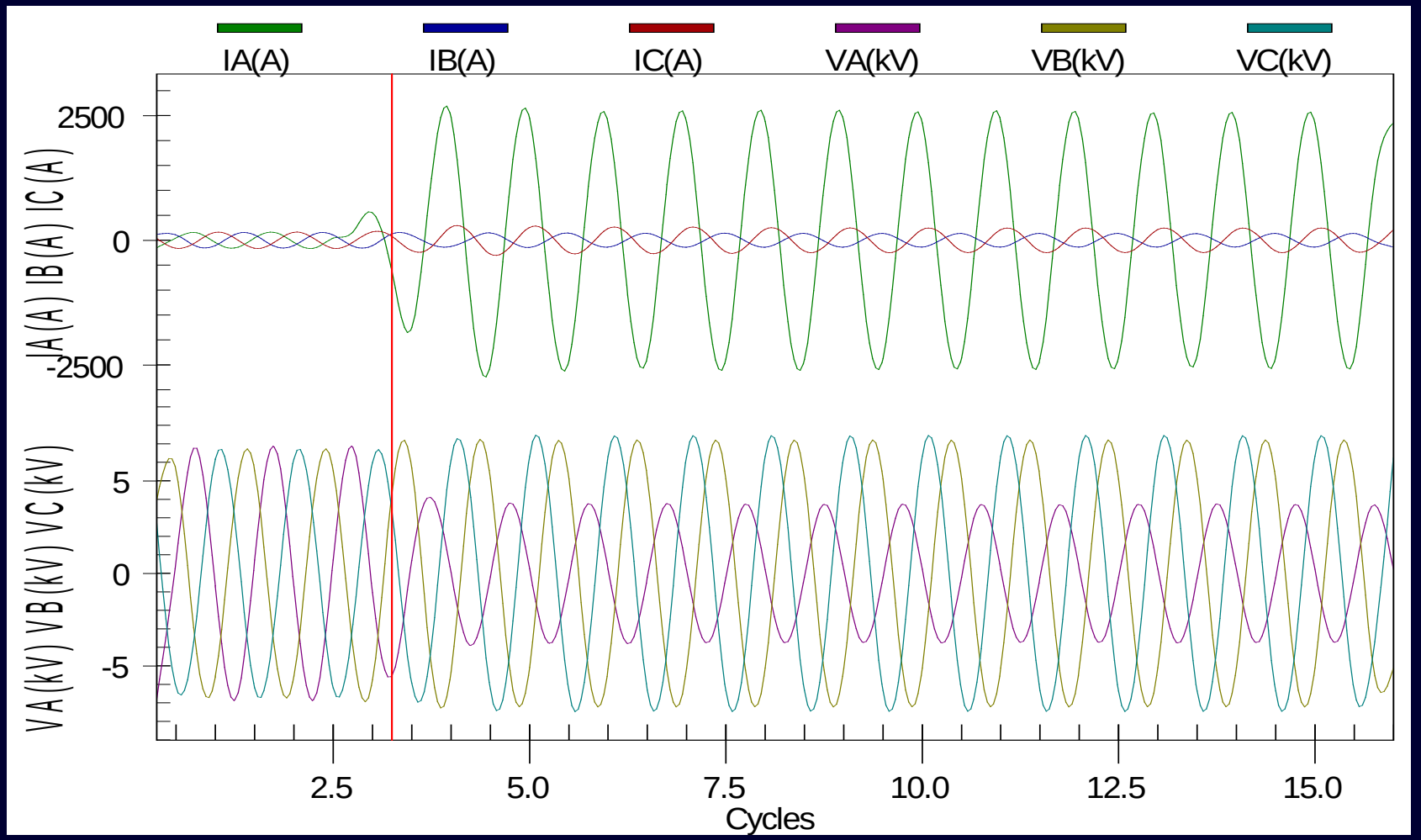
Proposed method: 20 feet



Field Case 2: Single-Line-to-Ground Fault Location Within 24 Feet

Existing relay: 1,697 feet

Proposed method: 24 feet



Conclusions

- Use detailed feeder model to accommodate nonhomogeneity of feeder
- Minimize impact of fault resistance using reactance method

Conclusions

- Use negative-sequence current only for single-phase-to-ground and phase-to-phase faults to minimize impact of mutual coupling
- FCI and recloser control data improve fault location accuracy

Thank you to Oncor for providing the feeder model and field events for this paper

Questions?