POWERMAX® [ˈpou (ə)r ˈmaks] *noun:*
a system designed to maintain stability

Niraj Shah
SPS Branch of SEL Engineering Services Inc.

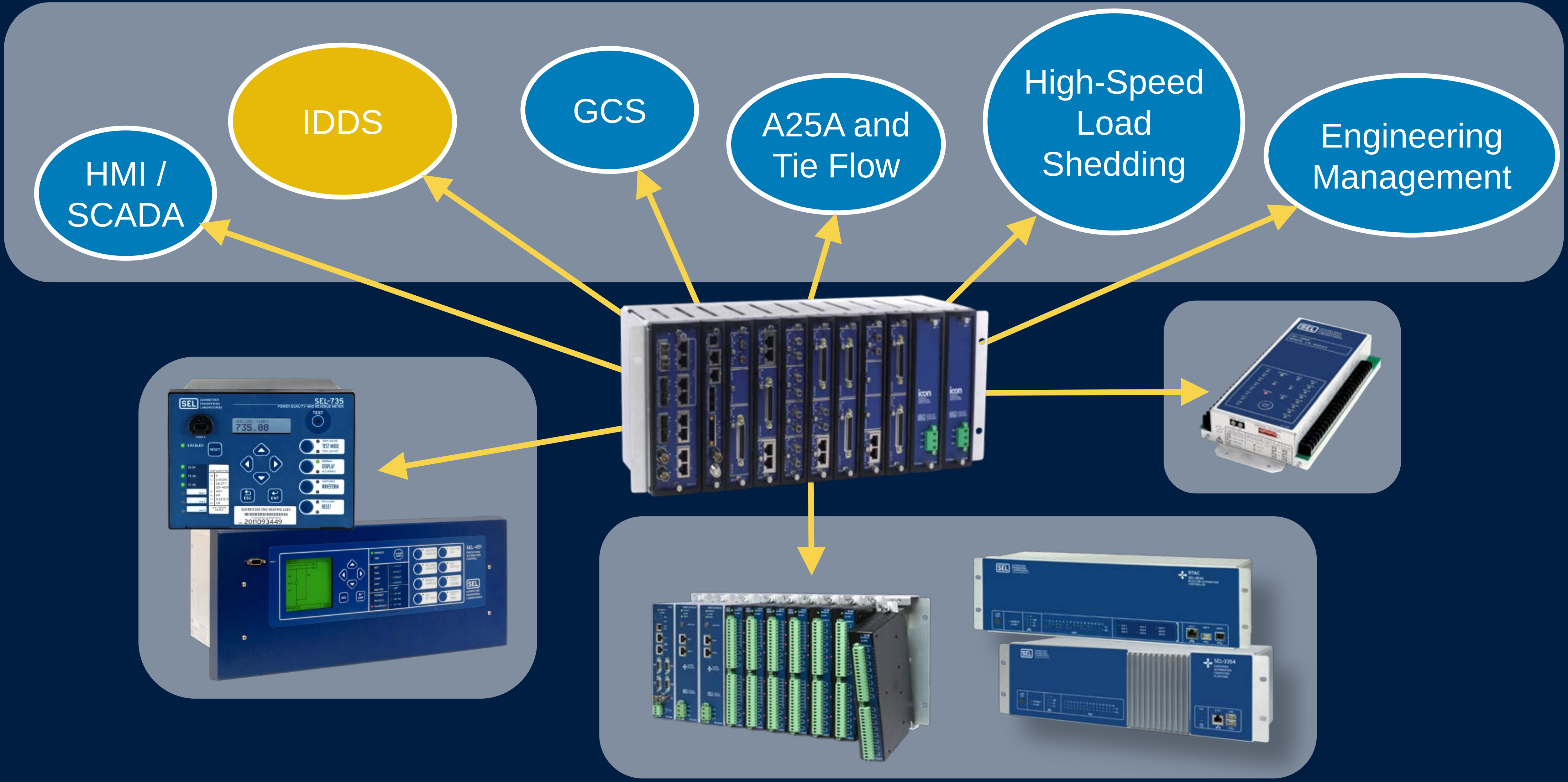
Agenda

- POWERMAX – Power Management System Introduction
- POWERMAX – Functionalities (IDDS, LSP, GCS, A25A)
- POWERMAX – Simulators
- MOTORMAX – LV Motor Management System Introduction

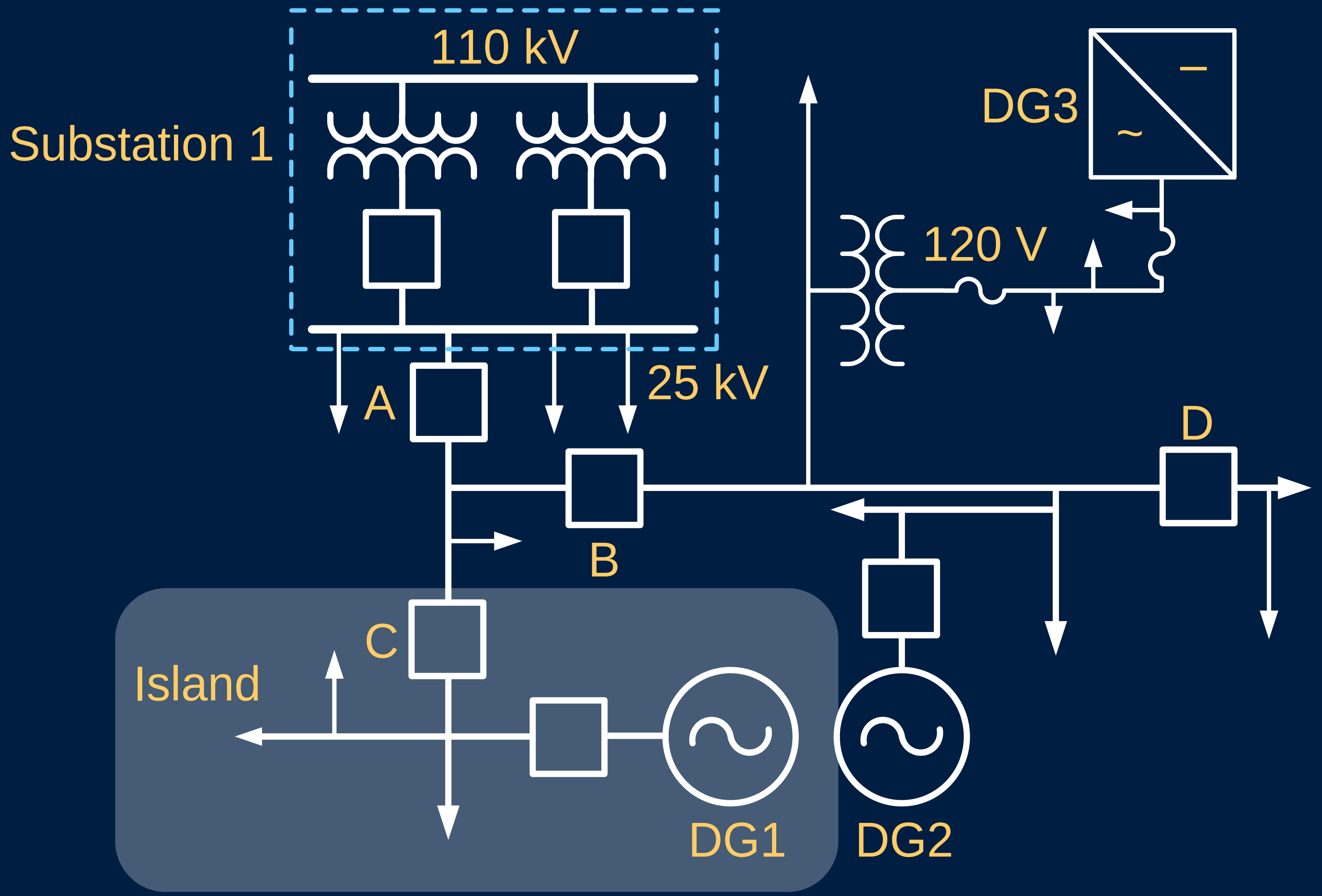
Agenda

- POWERMAX – Power Management System Introduction
- POWERMAX – Functionalities (IDDS)
- POWERMAX – Simulators
- MOTORMAX – LV Motor Management System Introduction

POWERMAX Functions



What Is an IDDS?



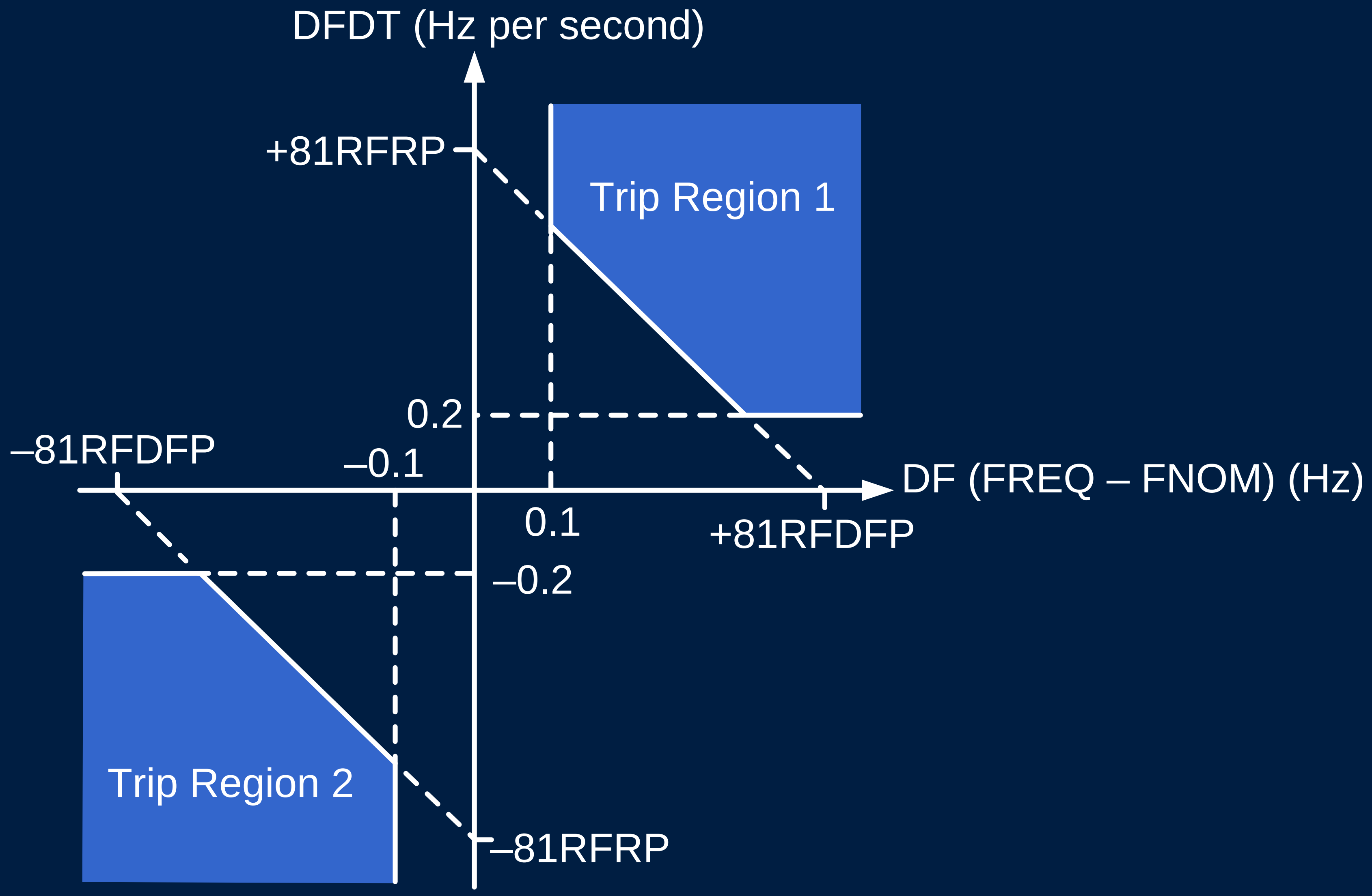
Islanding Detection and Decoupling

- Islanding detection – detects islanding condition when microgrid disconnects from utility power system
- Decoupling – microgrid capability of detecting an ongoing utility disturbance and intentionally islanding microgrid

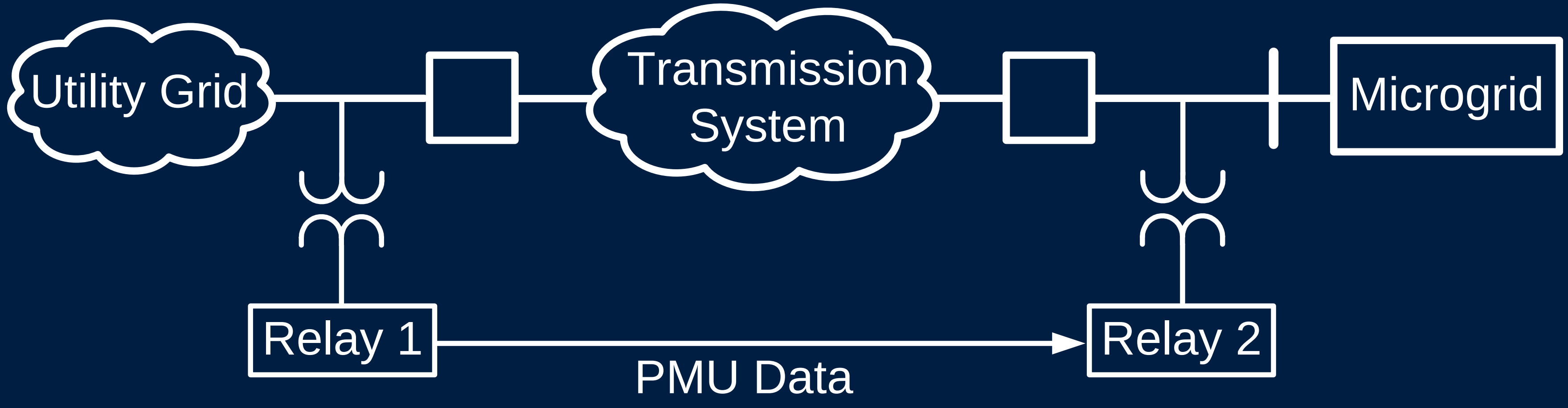
IDDS Schemes

- Direct transfer trip
- Local-area-based
  - Rate-of-change of frequency (81R) and fast rate-of-change of frequency (81RF)
  - Undervoltage / overvoltage and underfrequency / overfrequency
- Wide-area-based
  - Angle-based
  - Slip and acceleration-based

81RF Characteristic



Wide-Area-Based Schemes



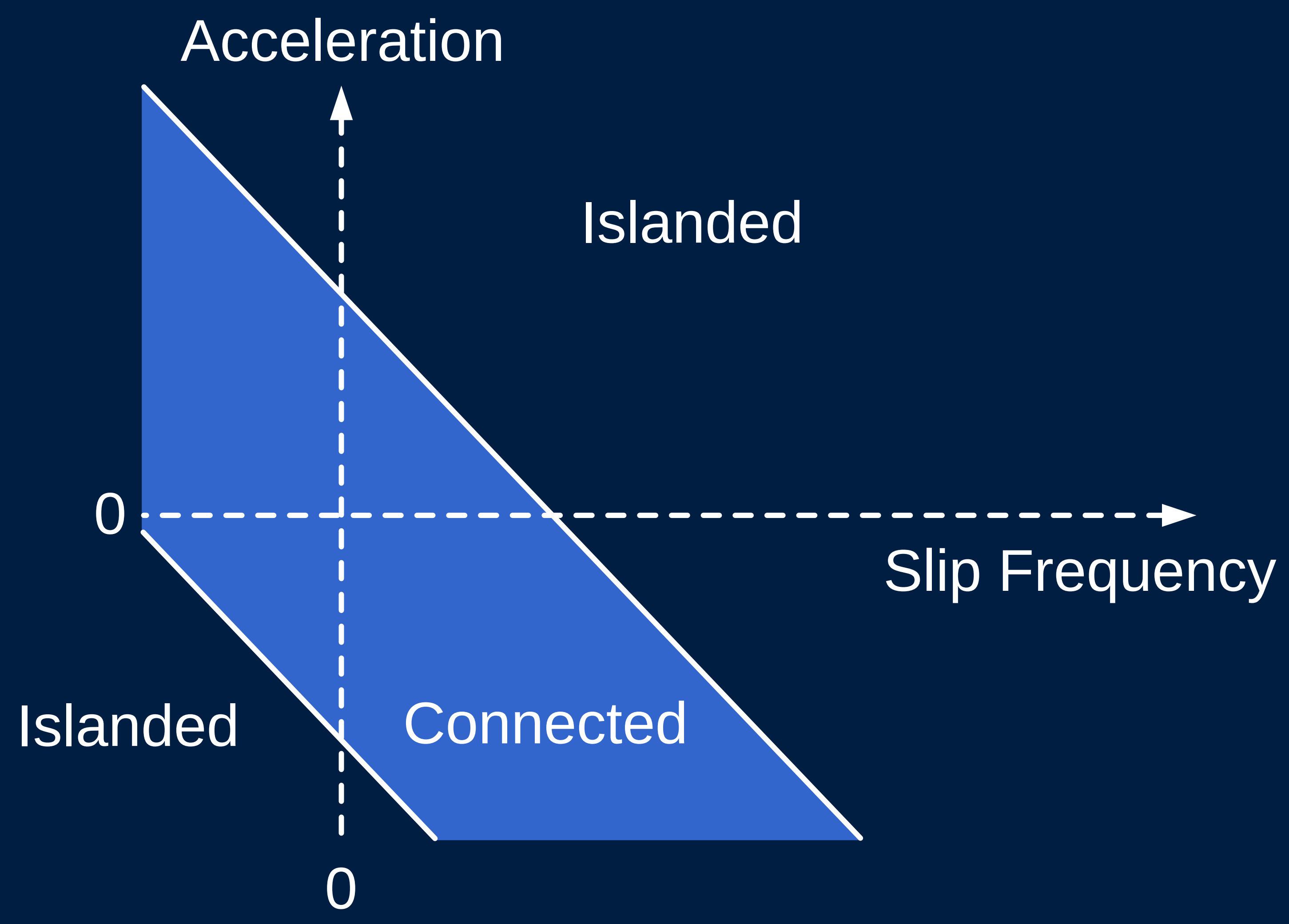
$$\text{Angle} = \delta_k = \angle V_k^{(1)} - V_k^{(2)}$$

$$\text{Slip frequency} = S_k = (\delta_k - \delta_{k-1})\frac{\text{MRATE}}{360}$$

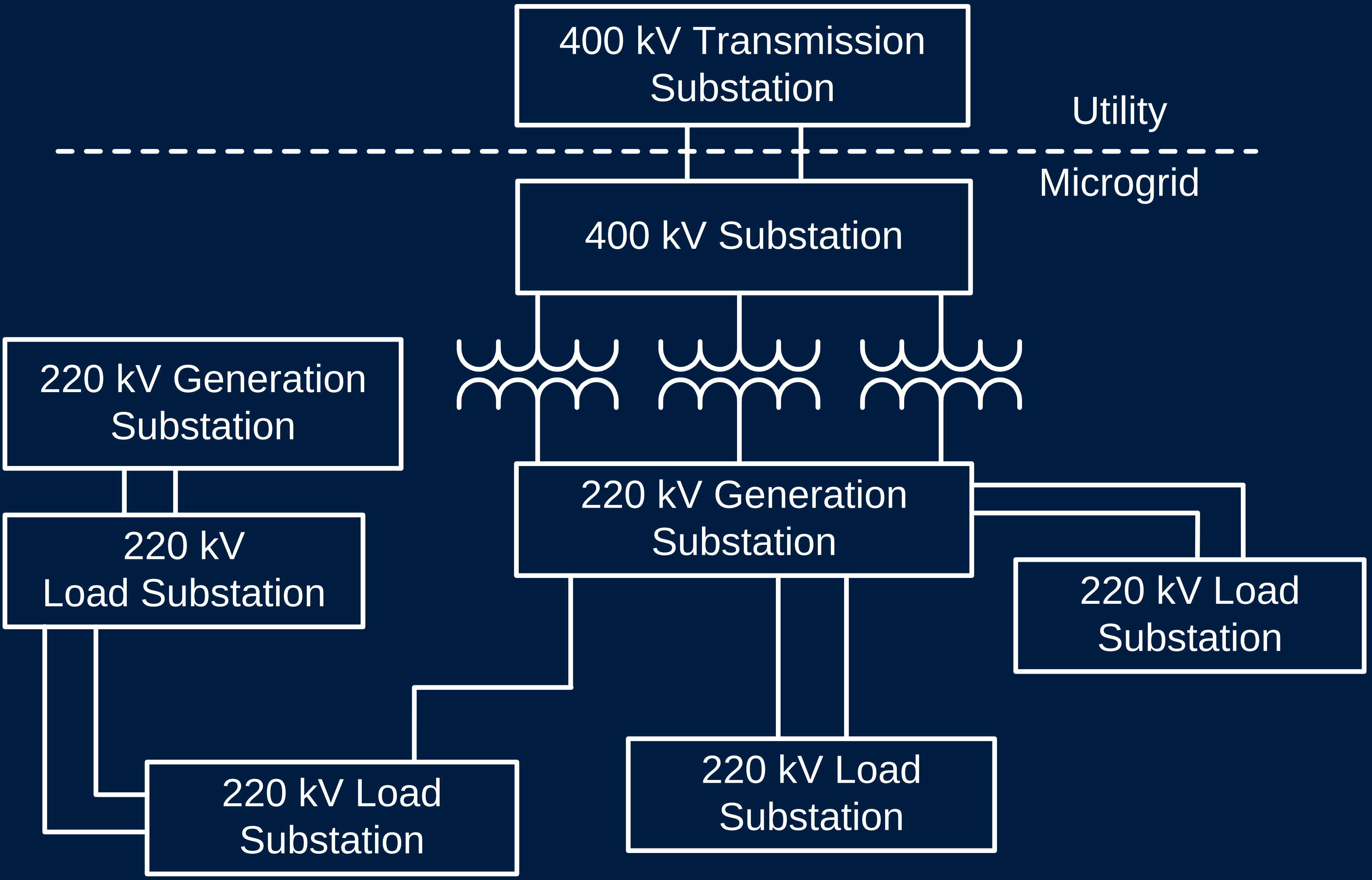
$$\text{Acceleration} = A_k = \left(S_k - S_{k-1}\right)\ \text{MRATE}$$

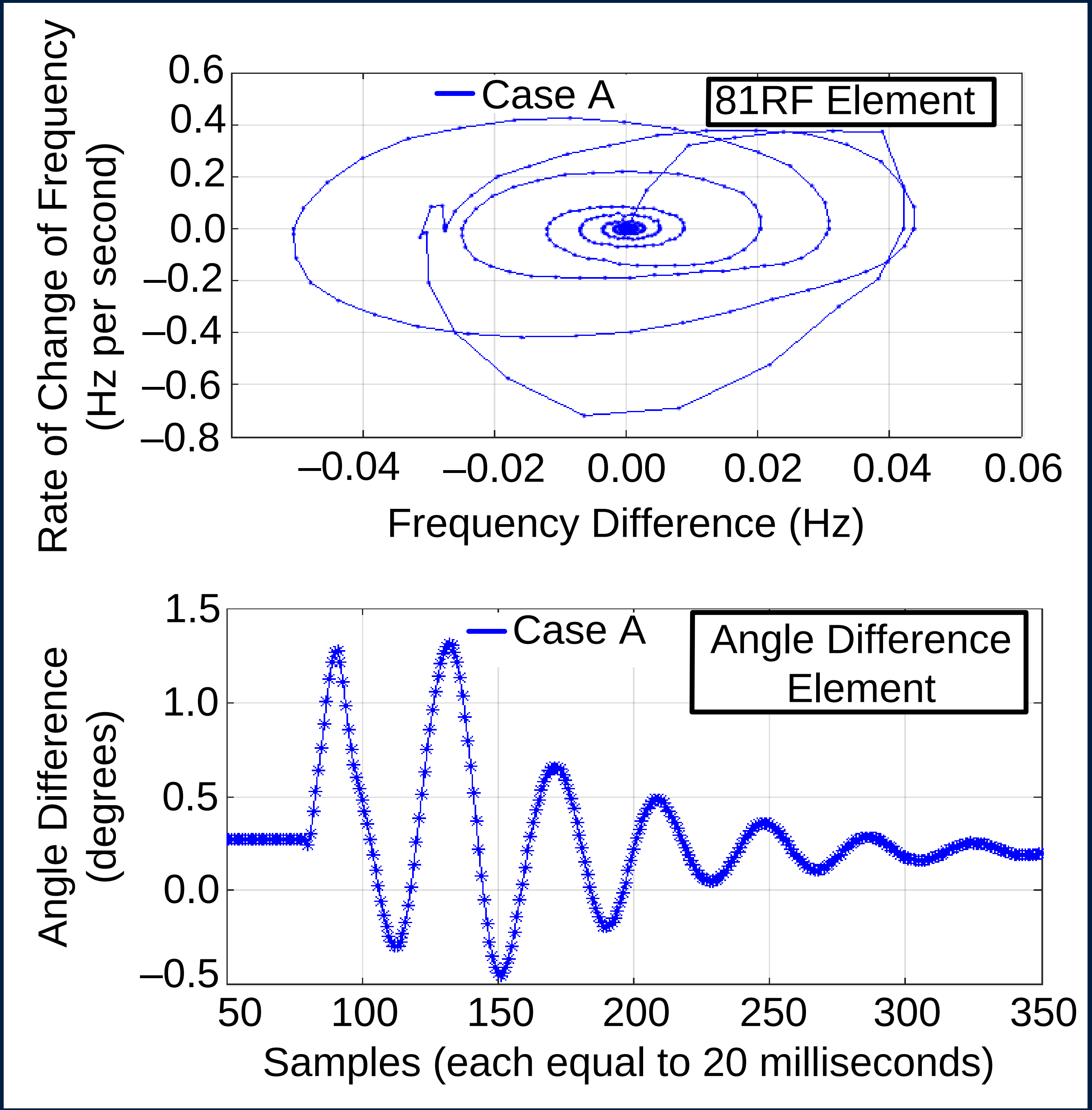
Slip Acceleration Characteristic

Detecting an Islanding Event



Example Industrial Power System





Case A

IDDS Blocked

Loss of
1,200 MW of
generation followed
by load shedding

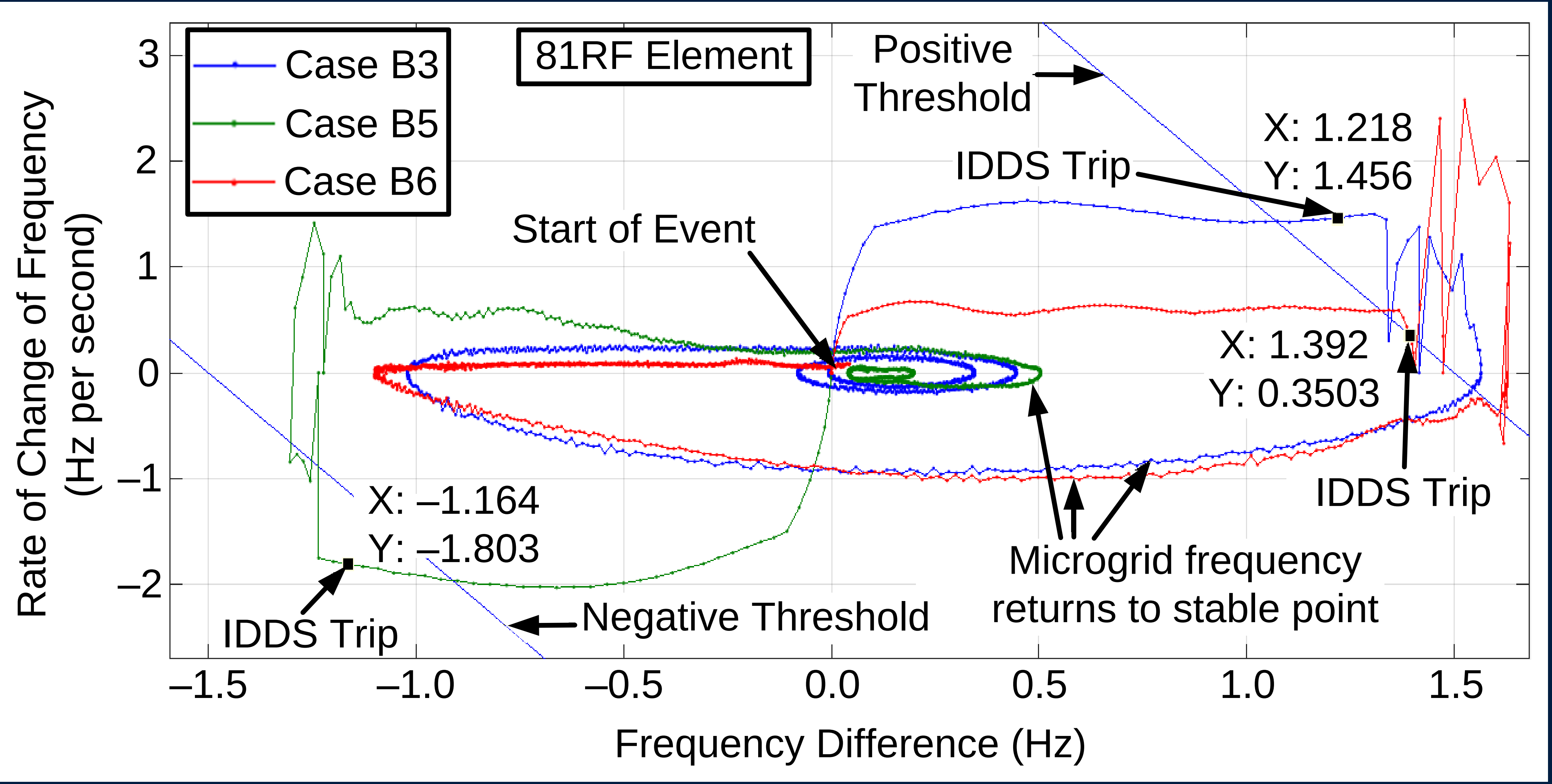
Utility Disturbance

Desired Condition: Detect and Decouple

Case	Frequency Rate (Hz / s)	Export (MW)	Detection Time (ms)
B3	1.5	260	900
B5	-1.8	800	720
B6	0.6	800	1,380

Utility Disturbance

Desired Condition: Detect and Decouple



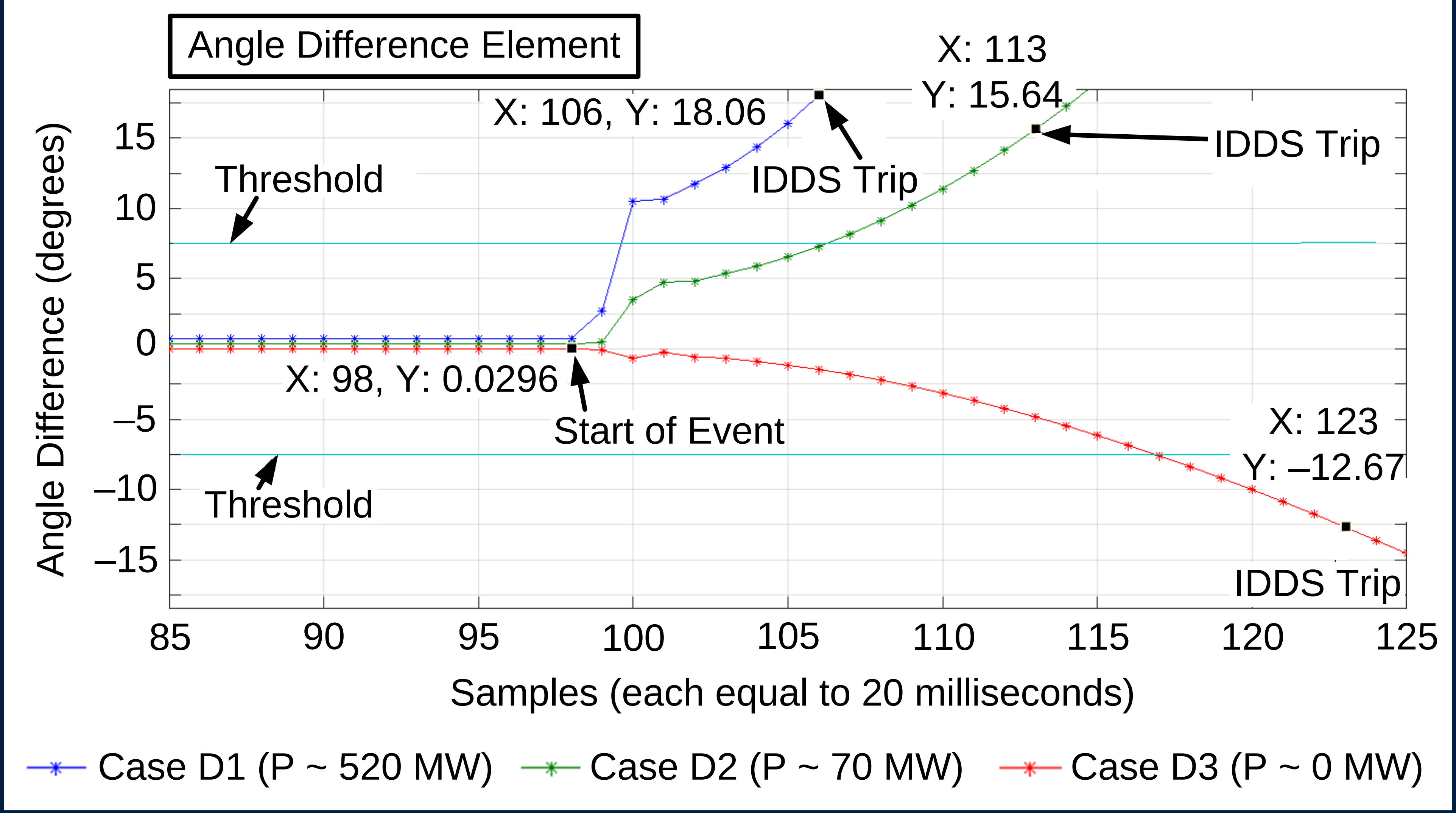
Angle-Based IDDS

Desired Condition: Detect and Decouple

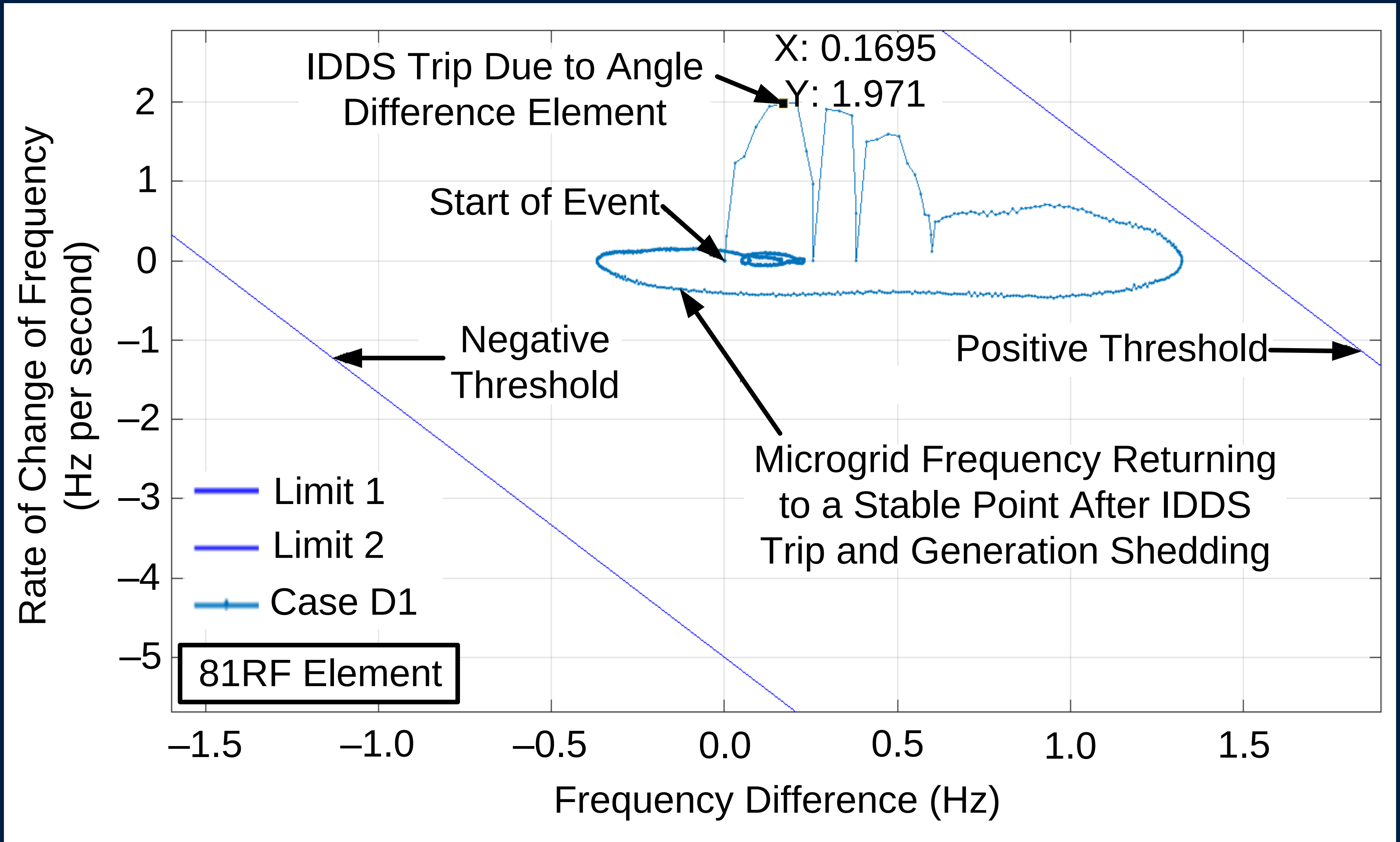
Case	Export / Import (MW)	Detection Time (ms)
D1	520	160
D2	70	300
D3	0	500

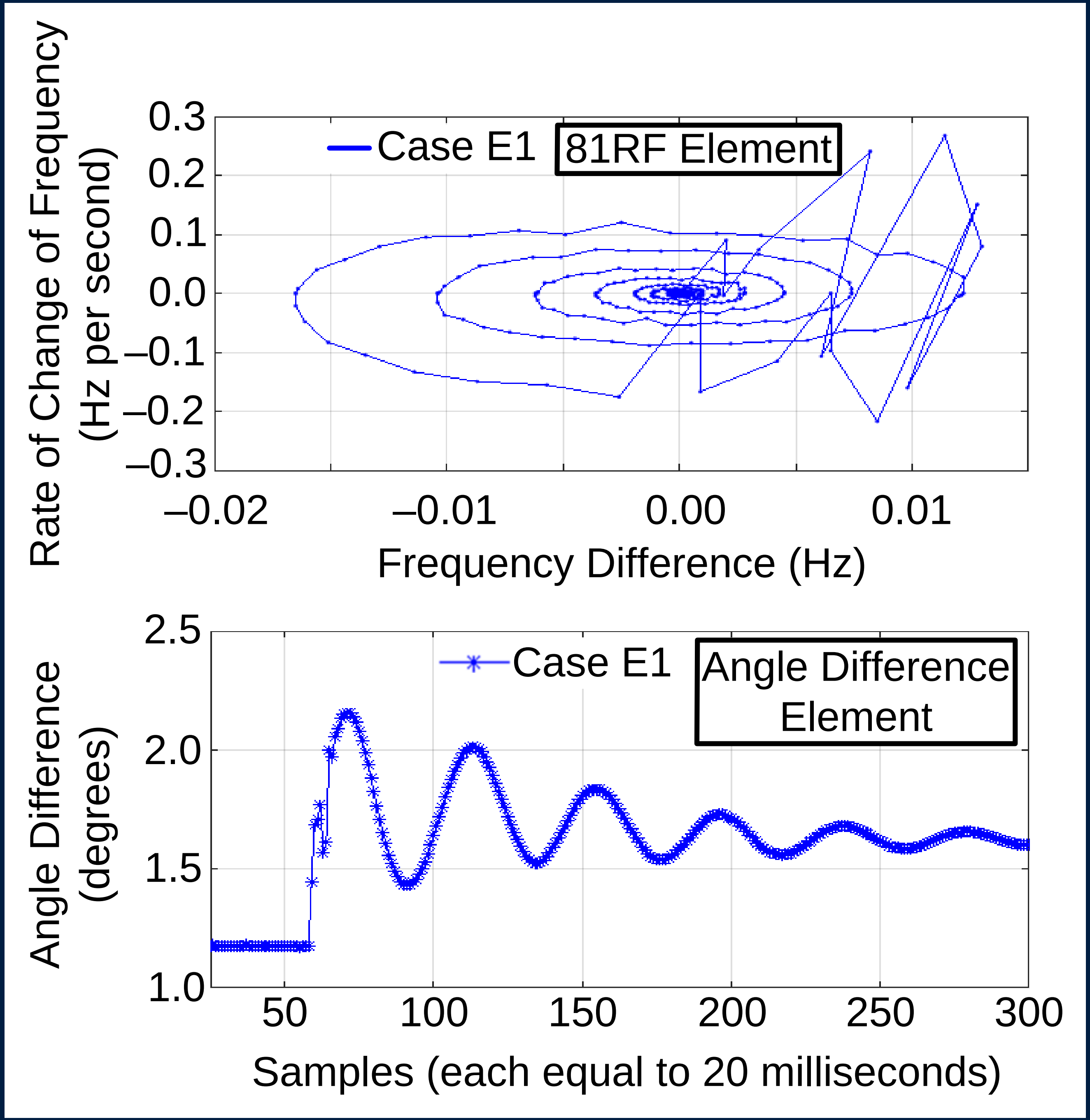
Angle-Based IDDS

Desired Condition: Detect and Decouple



Case D1
Slip and Acceleration Characteristic





Case E1

IDDS Rides Through (No Decoupling)

Single-phase fault and fault isolated by opening Line 1

Lessons Learned

Relative Effectiveness of Schemes

Criterion	DTT	Local-Area	Wide-Area
Remote communications available	Effective	Effective	Effective
Remote communications not available	Not effective	Effective	Not effective
Local generation matches local load during unintentional islanding	Effective	Not effective	Effective
Several remote side breakers that can create islanding	Not effective	Effective	Effective
Utility disturbances and no breaker opening	Not effective	Effective	Partially effective

Summary

- Sustainable electrical grids require fast and reliable IDDS combined with load and generation balancing
- DTT provides fastest speed for islanding detection
- Local-area-based 81RF provides reliable decoupling for utility disturbances
- Wide-area-based synchrophasor schemes detect islanding condition during very low power flow conditions

Questions?