Provisional Interconnection Study Report for PI-2024-10

10/31/2024

Table of Contents

List of Figures

List of Tables

1.0 Executive Summary

The PI-2024-10 project is a Provisional Interconnection Service request for a 199 MW Battery Energy Storage System (BESS) Generating Facility with a Point of Interconnection (POI) at the Spindle 230 kV switching station. This PIS request is associated with Generation Interconnection Request 5RSC-2024-13 in the 5RSC cluster.

The total estimated cost of the transmission system improvements required for PI-2024-10 to qualify for Provisional Interconnection Service is $8.443 million (Table 8 and Table 9).

The initial maximum permissible output of PI-2024-10 Generating Facility is 199 MW. Additionally, the 199 MW of requested Grid Charging will be permitted since no upgrades were identified during the analysis.

The maximum permissible output of the Generating Facility in the PLGIA[1] would be reviewed quarterly and updated, if there are changes to the system conditions assumed in this analysis, to determine the maximum permissible output.

Security: PI-2024-10 is a request for Energy Resource Interconnection Service (ERIS). For ERIS requests, security shall estimate the risk associated with the Network Upgrades and the Interconnection Facilities and is assumed to be a minimum of $5 million.

In addition, the Interconnection Customer would assume all risk and liabilities with respect to changes between the PLGIA and the LGIA[2], including changes in output limits and Interconnection Facilities, Network Upgrades, Distribution Upgrades, and/or System Protection Facilities cost responsibility.

The Provisional Interconnection Service in and of itself does not convey transmission service.

[1] **Provisional Large Generator Interconnection Agreement (PLGIA)** shall mean the interconnection agreement for Provisional Interconnection Service established between Transmission Provider and/or the Transmission Owner and the Interconnection Customer. The pro forma agreement is provided in Appendix 8 and takes the form of the Large Generator Interconnection Agreement, modified for provisional purposes.

[2] Large Generator Interconnection Agreement (LGIA): Shall mean the form of interconnection agreement applicable to an Interconnection Request pertaining to a Large Generating Facility that is included in the Transmission Provider's Tariff.

2.0 Introduction

PI-2024-10 is the Provisional Interconnection Service[3] request for a 199 MW BESS Generating Facility located in Weld County, Colorado.

- The POI of this project is the Spindle 230 kV switching station.
- The Commercial Operation Date (COD) to be studied for PI-2024-10 as noted on the Provisional Interconnection request for is January 15, 2027.

The geographical location of the transmission system near the POI is shown in Figure 1.

[3] **Provisional Interconnection Service** shall mean an Interconnection Service provided by Transmission Provider associated with interconnecting the Interconnection Customer's Generating Facility to Transmission Provider's Transmission System and enabling that Transmission System to receive electric energy and capacity from the Generating Facility at the Point of Interconnection, pursuant to the terms of the Provisional Large Generator Interconnection Agreement and, if applicable, the Tariff.

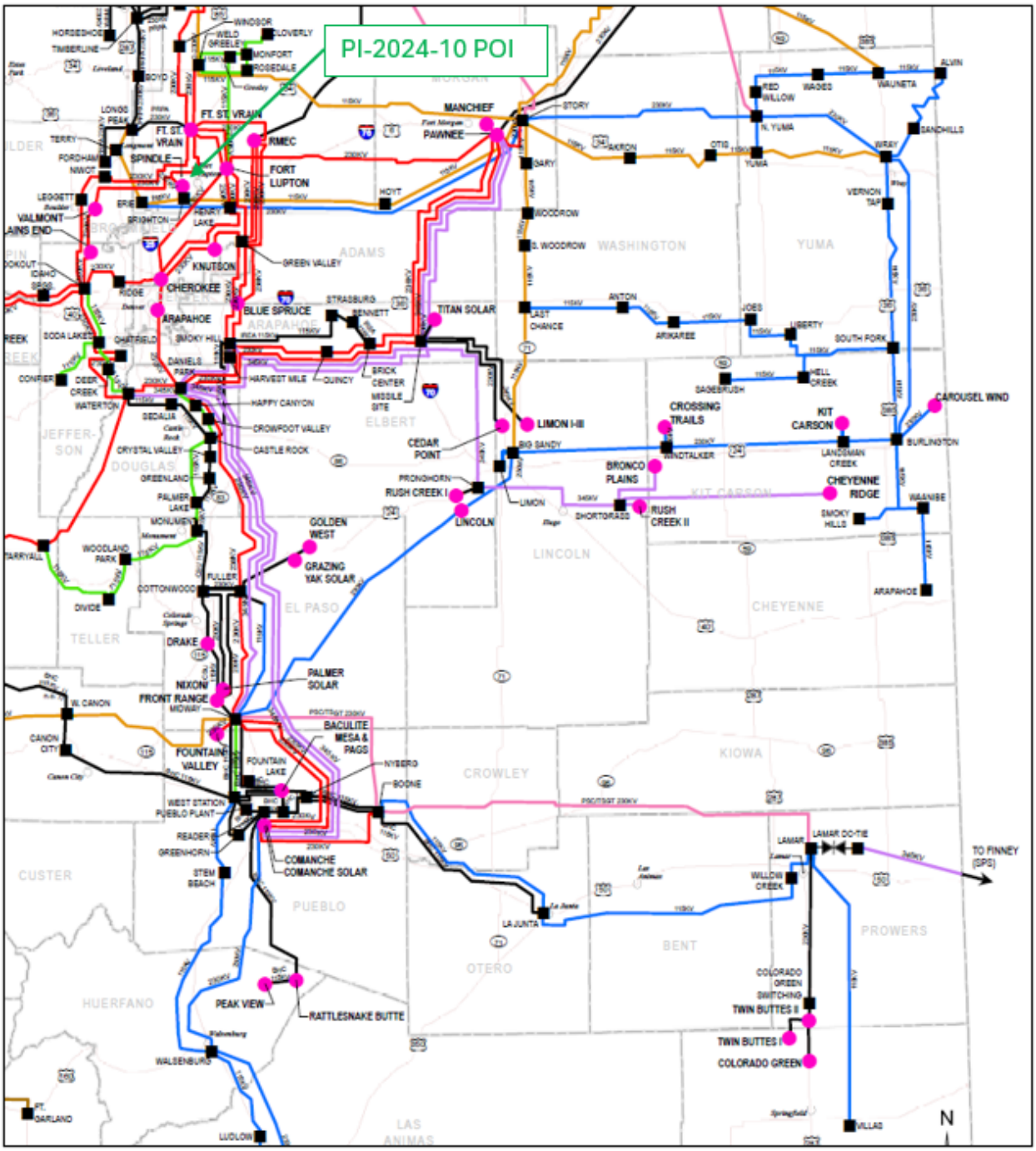


Figure 1: Point of Interconnection of PI-2024-10

3.0 Study Scope

The purpose of this study is to determine the impacts to the PSCo system and the Affected Systems from interconnecting PI-2024-10 for Provisional Interconnection Service. Consistent with the assumption in the study agreement, PI-2024-10 selected Energy Resource Interconnection Service (ERIS)[4].

The scope of this report includes voltage and reactive capability evaluation, steady state (thermal and voltage) analysis, transient stability analysis, short-circuit analysis, and cost estimates for Interconnection Facilities and Station Network Upgrades. The study also identifies the estimated Security[5] and Contingent Facilities associated with the Provisional Interconnection Service.

3.1 Steady State Criteria

The following Criteria are used for the reliability analysis of the PSCo system and Affected Systems:

P0—System Intact conditions:

Thermal Loading: <=100% of the normal facility rating

Voltage range: 0.95 to 1.05 per unit

P1 & P2-1—Single Contingencies:

Thermal Loading: <=100% Normal facility rating

Voltage range: 0.90 to 1.10 per unit

Voltage deviation: <=8% of pre-contingency voltage

P2 (except P2-1), P4, P5 & P7—Multiple Contingencies:

Thermal Loading: <=100% Emergency facility rating

Voltage range: 0.90 to 1.10 per unit

Voltage deviation: <=8% of pre-contingency voltage

[4] **Energy Resource Interconnection Service** shall mean an Interconnection Service that allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission system to be eligible to deliver the Generating Facility's electric output using the existing firm and non-firm capabilities of the Transmission Provider's Transmission System on an as available basis.

[5] **Security** estimates the risk associated with the Network Upgrades and Interconnection Facilities that could be identified in the corresponding LGIA.

3.2 Transient Stability Criteria

The transient voltage stability criteria are as follows:

a. Following fault clearing, the voltage shall recover to 80% of the pre-contingency voltage within 20 seconds of the initiating event for all P1 through P7 events for each applicable Bulk Electric System (BES) bus serving load.
b. Following fault clearing and voltage recovery above 80%, voltage at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds, for all P1 through P7 events.
c. For Contingencies without a fault (P2.1 category event), voltage dips at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds.

The transient angular stability criteria are as follows:

a. P1—No generating unit shall pull out of synchronism. A generator being disconnected from the system by fault clearing action or by a special Protection System is not considered an angular instability.
b. P2–P7—One or more generators may pull out of synchronism, provided the resulting apparent impedance swings shall not result in the tripping of any other generation facilities.
c. P1–P7—The relative rotor angle (power) oscillations are characterized by positive damping (i.e., amplitude reduction of successive peaks) > 5% within 30 seconds.

3.3 Breaker Duty Analysis Criteria

Fault Current after PI addition should not exceed 100% of the Breaker Duty rating. PSCo can only perform breaker duty analysis on the PSCo system. Before the PI goes in-service the Affected Systems may choose to perform a breaker duty analysis to identify breaker duty violations on their system.

3.4 Study Methodology

For PSCo and non-PSCo facilities, thermal violations attributed to the request include all new facility overloads with a thermal loading >100% and increased by 1% or more from the benchmark case overload post the Generator Interconnection Request (GIR) addition.

The voltage violations assigned to the request include new voltage violations which resulted in a further variation of 0.01 per unit.

Since the request is for Provisional Service, if thermal or voltage violations are seen, the maximum permissible Provisional Interconnection before violations is identified. For voltage violations caused by reactive power deficiency at the POI, voltage upgrades are identified.

The Provisional Interconnection request should meet the transient stability criteria stated in Section 3.2. If the addition of the GIR causes any violations, the maximum permissible Provisional Interconnection Service before violations is identified.

3.5 Contingency Analysis

The transmission system on which steady state contingency analysis is run includes the WECC designated areas 70 and 73.

The transient stability analysis is performed for the following worst-case contingencies shown in Table 1.

Table 1 – Transient Stability Contingencies

Ref. No.	Fault Location	Fault Category	Outage(s)	Clearing Time (Cycles)
1	-	P0	Flatrun	-
2	Spindle - FSV 230 kV	P1	Spindle - FSV 230 kV CKT 1	5
3	Spindle - Valmont 230 kV	P1	Spindle - Valmont 230 kV CKT 1	5
4	Spindle - NG 230 kV	P1	Spindle Generation	5
5	Spindle - PI-2024-10	P1	PI-2024-10 Generation	5
6	Valmont - Simms 230 kV	P1	Valmont - Simms 230 kV CKT 1	5
7	Valmont 230 kV	P1	Valmont 230/115 kV Transformer T7	5
8	FSV - Fort Lupton 230 kV	P1	FSV - Fort Lupton 230 kV CKT 1	5
9	FSV - Weld 230 kV	P1	FSV - Weld 230 kV CKT 1	5
10	FSV - Windsor 230 kV	P1	FSV - Windsor 230 kV CKT 1	5
11	FSV - Isabelle 230 kV	P1	FSV - Isabelle 230 kV CKT 1	5
12	FSV - Keenesburg 230 kV	P1	FSV - Keenesburg 230 kV CKT 1	5
13	FSV - Longpeak 230 kV	P1	FSV - Longpeak 230 kV CKT 1	5
14	FSV - Fordham 230 kV	P1	FSV - Fordham 230 kV CKT 1	5
15	FSV 345/230 kV Transformer	P1	FSV 345/230 kV Transformer T7	5
16	Spindle - FSV 230 kV	P7	Spindle - FSV 230 kV CKT 1 Spindle - Valmont 230 kV CKT 1 FSV - Isabelle 230 kV CKT 1 PI-2024-10 Generation Spindle Generation	5
17	Spindle - Valmont 230 kV	P7	Spindle - FSV 230 kV CKT 1 Spindle - Valmont 230 kV CKT 1 PI-2024-10 Generation Spindle Generation	5

3.6 Study Area

The North study area includes WECC designated zones 706. As described in Section 3.11 of the BPM, this study pocket is comprised of Northeast of Metro, North of Metro, and Northwest of Metro transmission systems. Below is the list of current generation comprising Pocket North:

- Northeast of Metro injecting at Keenesburg: Rocky Mountain Energy Center (RMEC) CC, Cedar Creek Wind, Blue Spruce
- North of Metro: Fort St. Vrain, Fort Lupton, JM Shafer
- Northwest of Metro: Spindle, Valmont, Plains Endall generations within the North area

The study did not identify any impacts to Affected Systems.

4.0 Base Case Modeling Assumptions

The 2029HS2a WECC case released on May 3, 2023, was selected as the Starting Case. The 2027 Heavy Summer Base Case was created from the Starting Case by including the following modeling changes.

- Shortgrass to Goose Creek uprate to 1439 MVA – ISD TBD
- Poncha – San Luis Valley 115 kV L9811 uprate to 239 MVA – ISD 8/20/2025.
- Daniels Park-Prairie-Greenwood Uprate L5707 to 956 MVA – ISD 6/1/2026.
- Leetsdale-Monroe-Elati line 5283 uprate to 956 MVA – ISD 5/31/2026.
- Uprate Lines 6935/6936 69 kV from Alamosa - Mosca - San Luis Valley to 800 A, 95 MVA – ISD 5/15/2026.
- Daniels Park-Prairie-Greenwood Uprate L5111 to 956 MVA – ISD 10/21/2026.
- Additional Harvest Mile to Smoky Hill 230 kV Line – ISD 5/14/2027.
- Leetsdale to University Line 9338 – ISD 9/9/2026.
- Tollgate Load Shift – ISD 7/7/2026.
- New Arapahoe T6 230/115 kV, 272/319 MVA – ISD 2/10/2027.
- Cherokee-Federal Heights-Broomfield L9558 Line rebuild – ISD 11/18/2026.
- MidwayPS 230/115 T1 Transformer Replacement with 280 MVA – ISD 10/7/2026.

Additionally, the following segments of the Colorado Power Pathway (CPP) were included in the Base Case:

- Segment #1: Fort St. Vrain – Canal Crossing 345 kV Double Circuit
- Segment #2: Canal Crossing – Goose Creek 345 kV Double Circuit
- Segment #3: Goose Creek – May Valley 345 kV Double Circuit

The Base Case model includes the existing PSCo generation resources and all Affected Systems' existing resources.

While the higher-queued Network Resource Interconnection Service (NRIS) requests were dispatched at 100%, the higher-queued ERIS requests were modeled offline.

4.1 Benchmark Case Modeling

The Benchmark Case was created from the Base Case described in Section 4.0 by changing the study pocket generation dispatch to reflect heavy generation in the Northern Colorado study pocket. This was accomplished by adopting the stressed generation dispatch given in Table 2.

Table 2 – Generation Dispatch Used to Create the North Pocket Benchmark Case (MW is Gross Capacity)

Generator Bus No.	Name	kV	ID	Pgen (MW)	Pmax (MW)
70188	FT_LUPTN_12	13.80	G1	41.31	45.90
70188	FT_LUPTN_12	13.80	G2	40.32	44.80
70409	ST.VRAIN	22.00	ST	286.02	317.80
70406	ST.VR_2	18.00	G2	147.33	163.70
70407	ST.VR_3	18.00	G3	140.40	156.00
70408	ST.VR_4	18.00	G4	156.22	173.58
70950	ST.VR_5	18.00	G5	140.85	156.50
70951	ST.VR_6	18.00	G6	139.05	154.50
70588	RMEC1	15.00	G1	132.39	147.10
70589	RMEC2	15.00	G2	140.49	156.10
70591	RMEC3	23.00	ST	288.72	320.80
70448	VALMNT6	13.80	G6	41.94	46.60
70557	VALMNT7	13.80	G7	36.63	40.70
70558	VALMNT8	13.80	G8	37.62	41.80
70487	JMSHAFR4	13.80	G5	29.70	33.00
70487	JMSHAFR4	13.80	G4	31.77	35.30
70490	JMSHAFR3	13.80	G3	34.02	37.80
70490	JMSHAFR3	13.80	ST	40.50	45.00
70493	JMSHAFR2	13.80	ST	42.48	47.20
70495	JMSHAFR1	13.80	G1	32.67	36.30
70495	JMSHAFR1	13.80	G2	31.50	35.00
700151	GI_2021_6	34.50	S1	203.30	203.30
70562	SPRUCE1	18.00	G1	122.85	136.50
70563	SPRUCE2	18.00	G2	121.95	135.50
70580	PLNENDG1_1	13.80	G0	4.86	5.40
70580	PLNENDG1_1	13.80	G1	4.86	5.40
70580	PLNENDG1_1	13.80	G2	4.86	5.40
70580	PLNENDG1_1	13.80	G3	4.86	5.40
70580	PLNENDG1_1	13.80	G4	4.86	5.40
70580	PLNENDG1_1	13.80	G5	4.86	5.40

Generator Bus No.	Name	kV	ID	Pgen (MW)	Pmax (MW)
70580	PLNENDG1_1	13.80	G6	4.86	5.40
70580	PLNENDG1_1	13.80	G7	4.86	5.40
70580	PLNENDG1_1	13.80	G8	4.86	5.40
70580	PLNENDG1_1	13.80	G9	4.86	5.40
70587	PLNENDG1_2	13.80	G0	4.86	5.40
70587	PLNENDG1_2	13.80	G1	4.86	5.40
70587	PLNENDG1_2	13.80	G2	4.86	5.40
70587	PLNENDG1_2	13.80	G3	4.86	5.40
70587	PLNENDG1_2	13.80	G4	4.86	5.40
70587	PLNENDG1_2	13.80	G5	4.86	5.40
70587	PLNENDG1_2	13.80	G6	4.86	5.40
70587	PLNENDG1_2	13.80	G7	4.86	5.40
70587	PLNENDG1_2	13.80	G8	4.86	5.40
70587	PLNENDG1_2	13.80	G9	4.86	5.40
70585	PLNENDG2_1	13.80	G1	7.29	8.10
70585	PLNENDG2_1	13.80	G2	7.29	8.10
70585	PLNENDG2_1	13.80	G3	7.29	8.10
70585	PLNENDG2_1	13.80	G4	7.29	8.10
70585	PLNENDG2_1	13.80	G5	7.29	8.10
70585	PLNENDG2_1	13.80	G6	7.29	8.10
70585	PLNENDG2_1	13.80	G7	7.29	8.10
70586	PLNENDG2_2	13.80	G1	7.29	8.10
70586	PLNENDG2_2	13.80	G2	7.29	8.10
70586	PLNENDG2_2	13.80	G3	7.29	8.10
70586	PLNENDG2_2	13.80	G4	7.29	8.10
70586	PLNENDG2_2	13.80	G5	7.29	8.10
70586	PLNENDG2_2	13.80	G6	7.29	8.10
70586	PLNENDG2_2	13.80	G7	7.29	8.10
70593	SPNDLE1	18.00	G1	128.76	143.07
70594	SPNDLE2	18.00	G2	126.53	140.59
70823	CEDARCK_1A	34.50	W1	176.00	220.00
70824	CEDARCK_1B	34.50	W2	64.00	80.00
70825	CEDAR2_W1	0.66	W1	100.00	125.00
70826	CEDAR2_W2	0.69	W2	80.64	100.80
70827	CEDAR2_W3	0.66	W3	20.00	25.00
Total (MW)				**3355.23**	**3766.64**

4.2 Grid Charging Benchmark Case Modeling

The Grid Charging Benchmark Case was created from the Base Case described in Section 4.0 by changing the study pocket generation dispatch to reflect a Grid Charging scenario. This was accomplished by adopting the stressed generation dispatch given in Table 3.

Table 3 – Generation Dispatch Used to Create the North Pocket Grid Charging Benchmark Case (MW is Gross Capacity)

Generator Bus No.	Name	kV	ID	Pgen (MW)	Pmax (MW)
70188	FT_LUPTN_12	13.80	G1	41.31	45.90
70188	FT_LUPTN_12	13.80	G2	40.32	44.80
70409	ST.VRAIN	22.00	ST	286.02	317.80
70406	ST.VR_2	18.00	G2	147.33	163.70
70407	ST.VR_3	18.00	G3	140.40	156.00
70408	ST.VR_4	18.00	G4	156.22	173.58
70950	ST.VR_5	18.00	G5	140.85	156.50
70951	ST.VR_6	18.00	G6	139.05	154.50
70588	RMEC1	15.00	G1	132.39	147.10
70589	RMEC2	15.00	G2	140.49	156.10
70591	RMEC3	23.00	ST	288.72	320.80
70448	VALMNT6	13.80	G6	41.94	46.60
70557	VALMNT7	13.80	G7	36.63	40.70
70558	VALMNT8	13.80	G8	37.62	41.80
70487	JMSHAFR4	13.80	G5	29.70	33.00
70487	JMSHAFR4	13.80	G4	31.77	35.30
70490	JMSHAFR3	13.80	G3	34.02	37.80
70490	JMSHAFR3	13.80	ST	40.50	45.00
70493	JMSHAFR2	13.80	ST	42.48	47.20
70495	JMSHAFR1	13.80	G1	32.67	36.30
70495	JMSHAFR1	13.80	G2	31.50	35.00
700151	GI_2021_6	34.50	S1	0.00	203.30
70562	SPRUCE1	18.00	G1	122.85	136.50
70563	SPRUCE2	18.00	G2	121.95	135.50
70580	PLNENDG1_1	13.80	G0	4.86	5.40
70580	PLNENDG1_1	13.80	G1	4.86	5.40
70580	PLNENDG1_1	13.80	G2	4.86	5.40
70580	PLNENDG1_1	13.80	G3	4.86	5.40
70580	PLNENDG1_1	13.80	G4	4.86	5.40
70580	PLNENDG1_1	13.80	G5	4.86	5.40
70580	PLNENDG1_1	13.80	G6	4.86	5.40

Generator Bus No.	Name	kV	ID	Pgen (MW)	Pmax (MW)
70580	PLNENDG1_1	13.80	G7	4.86	5.40
70580	PLNENDG1_1	13.80	G8	4.86	5.40
70580	PLNENDG1_1	13.80	G9	4.86	5.40
70587	PLNENDG1_2	13.80	G0	4.86	5.40
70587	PLNENDG1_2	13.80	G1	4.86	5.40
70587	PLNENDG1_2	13.80	G2	4.86	5.40
70587	PLNENDG1_2	13.80	G3	4.86	5.40
70587	PLNENDG1_2	13.80	G4	4.86	5.40
70587	PLNENDG1_2	13.80	G5	4.86	5.40
70587	PLNENDG1_2	13.80	G6	4.86	5.40
70587	PLNENDG1_2	13.80	G7	4.86	5.40
70587	PLNENDG1_2	13.80	G8	4.86	5.40
70587	PLNENDG1_2	13.80	G9	4.86	5.40
70585	PLNENDG2_1	13.80	G1	7.29	8.10
70585	PLNENDG2_1	13.80	G2	7.29	8.10
70585	PLNENDG2_1	13.80	G3	7.29	8.10
70585	PLNENDG2_1	13.80	G4	7.29	8.10
70585	PLNENDG2_1	13.80	G5	7.29	8.10
70585	PLNENDG2_1	13.80	G6	7.29	8.10
70585	PLNENDG2_1	13.80	G7	7.29	8.10
70586	PLNENDG2_2	13.80	G1	7.29	8.10
70586	PLNENDG2_2	13.80	G2	7.29	8.10
70586	PLNENDG2_2	13.80	G3	7.29	8.10
70586	PLNENDG2_2	13.80	G4	7.29	8.10
70586	PLNENDG2_2	13.80	G5	7.29	8.10
70586	PLNENDG2_2	13.80	G6	7.29	8.10
70586	PLNENDG2_2	13.80	G7	7.29	8.10
70593	SPNDLE1	18.00	G1	128.76	143.07
70594	SPNDLE2	18.00	G2	126.53	140.59
70823	CEDARCK_1A	34.50	W1	46.20	220.00
70824	CEDARCK_1B	34.50	W2	16.80	80.00
70825	CEDAR2_W1	0.66	W1	26.25	125.00
70826	CEDAR2_W2	0.69	W2	21.17	100.80
70827	CEDAR2_W3	0.66	W3	5.25	25.00
Total (MW)				**2826.95**	**3766.64**

4.3 Study Case Modeling

A Study Case was created from the Benchmark Case by turning on the PI-2024-10 generation. The additional 199 MW output from PI-2024-10 was balanced against PSCo generation outside of the North study pocket.

4.4 Short-Circuit Modeling

This request is for the interconnection of a 199 MW BESS Generating Facility (PI-2024-10) to the Spindle 230 kV switching station. The output will not exceed 199 MW at the POI.

This facility will consist of sixty-four (64) Power Electronics FREEMAQ PCSM 660 V FP4200M inverters rated at 4.20 MVA at 40°C, feeding sixty-four (64) 34.5 kV/660 V pad-mounted transformers rated at 4.20 MVA at 65°C. A 34.5 kV collector system will combine five (5) ESS feeders at the 34.5 kV switchgear and one (1) 230 kV/34.5 kV/13.8 kV main GSU transformer rated at 165/220/275 MVA with one (1) high side breakers will step up the voltage to the interconnection voltage level. . An approximately 0.80-mile-long generation tie line connects the project to the Spindle 230 kV switchyard.

All connected generating facilities were assumed capable of producing maximum fault current. As such, all generation was modeled at full capacity, whether Network Resource Interconnection Service (NRIS) or ERIS is requested. Generation is modeled as a separate generating resource in PSS CAPE software and included at full capacity in the short circuit study, regardless of any limitations to the output that would be imposed otherwise.

5.0 Provisional Interconnection Service Analysis

5.1 Voltage and Reactive Power Capability Evaluation

Per Section 4.1.1.1 of the BPM, the following voltage regulation and reactive power capability requirements are applicable to non-synchronous generators:

- Xcel Energy's OATT requires all non-synchronous generator Interconnection Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the high side of the generator substation. Furthermore, Xcel Energy requires every Generating Facility to have dynamic voltage control capability to assist in maintaining the POI voltage schedule specified by the Transmission Operator.
- It is the responsibility of the Interconnection Customer to determine the type (switched shunt capacitors and/or switched shunt reactors, etc.), the size (Mvar), and the locations (on the Interconnection Customer's facility) of any additional static reactive power compensation needed within the generating plant in order to have adequate reactive capability to meet the +/- 0.95 power factor at the high side of the main step-up transformer.
- It is the responsibility of the Interconnection Customer to compensate their generation tie-line to ensure minimal reactive power flow under no load conditions.

Per Section 4.1.1.2 in the BPM, the following voltage regulation and reactive power capability requirements are applicable to synchronous generators:

- Xcel Energy's OATT requires all synchronous Generator Interconnection Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the POI.
- The reactive power analysis performed in this report is an indicator of the reactive power requirements at the POI and the capability of the generator to meet those requirements. The Interconnection Customer is required to demonstrate to the satisfaction of PSCo Transmission Operations prior to the commercial in-service date of the generating plant that it can safely and reliably operate within the required power factor and the regulating voltage of the POI.

Per Section 4.4.1 in the BPM, the following steps shall be followed to perform the reactive power capability evaluation for synchronous generators:

a. The reactive power evaluation of the Synchronous generators is done by dispatching the generator at Pmax and changing the POI voltage till Qmax and Qmin are reached.
b. This step is repeated for Pmin.
c. The POI voltage and power factor for the two evaluations are noted. If the POI power factor of 0.95 is reached and the POI voltage stays under the voltage guidance values noted (1-1.04 p.u. for the 230 kV system, 1-1.05 for the 345 kV system and 1-1.03 for 115 kV system), the GIR is considered to meet reactive power requirements. If not, additional dynamic reactive support would be identified.

All proposed reactive devices in customer provided models are switched favorably to provide appropriate reactive compensation in each test, therefore identified deficiencies are in addition to any proposed reactive compensation.

All summary tables representing GIRs' Voltage and Reactive Power Capability tests adhere to the following color formatting representing the different aspects of the tests:

- Values highlighted in red indicate a failed reactive power requirement.
- Voltages outside of 0.95 – 1.05 p.u. are highlighted in yellow to provide additional information.

The PI-2024-10 GIR is modeled as follows:

Generator gross capacity: Pmax = 205.46 MW, Pmin = -205.46 MW, Qmax = 173.32 MVar, Qmin= -173.32 MVar

The summary for the Voltage and Reactive Power Capability Evaluation for PI-2024-10 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the interconnection service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for PI-2024-10 are summarized in **Table 4**.

Table 4 – Reactive Capability Evaluation for PI-2024-10

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
205.5	106.2	173.3	-173.3	1.02	199.0	67.8	1.04	0.9466	199.0	67.2	1.04	0.9474
205.5	-33.3	173.3	-173.3	0.99	199.0	-68.5	1.03	-0.9455	199.0	-69.0	1.03	-0.9448
0.0	0.1	173.3	-173.3	1.03	-5.0	0.1	1.04	-0.9998	-5.0	0.2	1.03	-0.9992

5.2 Steady State Analysis

Contingency analysis was performed on the North study pocket using the Study Case model. Both Discharging and Grid Charging scenarios are summarized below.

- System Intact analysis showed no thermal or voltage violations attributed to PI-2024-10 in either Discharging or Grid Charging scenarios.
- Single Contingency analysis (Discharging):

  Thermal results: Table 5 lists overloads attributed to PI-2024-10 for contingency conditions. All identified violations in Table 5 were alleviated through generation redispatch. The maximum allowable output of this project, without requiring system network upgrades, is 199 MW.

  Voltage results: No voltage violations attributed to PI-2024-10 were identified.

- Single Contingency analysis (Grid Charging):

  Thermal results: Single contingency analysis showed no thermal violations attributed to PI-2024-10.

  Voltage results: No voltage violations attributed to PI-2024-10 were identified.
- Multiple Contingency analysis (Discharging):

  Thermal results: Table 6 lists overloads attributed to PI-2024-10. Multiple contingency overloads are mitigated using system adjustments, including generation redispatch and/or operator actions. None of the multiple contingency overloads are attributed to this project.

  Voltage results: No voltage violations attributed to PI-2024-10 were identified.

- Multiple Contingency analysis (Grid Charging):

  Thermal results: Multiple contingency analysis showed no thermal violations attributed to PI-2024-10.

  Voltage results: No voltage violations attributed to PI-2024-10 were identified.

Xcel Energy®

Table 5 – North Pocket - Single Contingency Thermal Overloads – Discharging

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)	Redispatched Case Loading (%)
1	GI-2021-06 POI (700155) - Sky Ranch (70392) 230 kV CKT 1	SGL_230_020: Green Valley - Spruce (#5270)	230	70	484	101.35	104.83	3.48	100.00
2	Sky Ranch (70392) - Spruce (70528) 230 kV CKT 1	SGL_230_020: Green Valley - Spruce (#5270)	230	70	484	99.86	103.34	3.48	98.69

Table 6 – North Pocket - Multiple Contingency Thermal Overloads – Discharging

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
1	Fort Saint Vrain (70410) - Longpeak (78105) 230 kV CKT 1	BF_058a: Ft St Vrain - Ault/Fordham #5308	230	70	476	101.84	103.6	1.76
2	Green Valley (70048) - Keenesburg (70820) 230 kV CKT 2	P7_107: Green Valley - Keenesburg 230 kV CKT 1 Green Valley - RMEC 230 kV CKT 1	230	70	717	108.27	110.7	2.43
3	Green Valley (70048) - Keenesburg (70820) 230 kV CKT 1	P7_109: Green Valley - Keenesburg 230 kV CKT 2 Green Valley - RMEC 230 kV CKT 1	230	70	717	108.27	110.7	2.43

Ref. No.	Monitored Facility	Contingency Name	kVs	Areas	Rate Cont (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
4	Green Valley (70048) - Spruce (70528) 230 kV CKT 1	P7_111: Fort Lupton and Green Valley (Lines 5525, 5277, 5759, and 5275)	230	70	717	107.16	110.14	2.98
5	Clark (70112) - Jordan (70241) 230 kV CKT 1	P7_150: Buckley - Tollgate (Lines 5167 and 5285)	230	70	364	102.93	105.81	2.88
6	Valmont (70447) - Spindle (70592) 230 kV CKT1	P7_167: May Valley - Sandstone 345 kV CKT 1 May Valley - Sandstone 345 kV CKT 2	230	70	478	89.86	104.42	14.56
7	Green Valley (70048) - RMEC (70590) 230 kV CKT 1	P7_106: Green Valley - Keenesburg 230 kV CKT 1 Green Valley - Keenesburg 230 kV CKT 2	230	70	717	101.82	104.01	2.19
8	Eldorado (70164) - Valmont_1 (70444) 115 kV CKT1	P7_20: Valmont - Boulder 115 kV CKT 1 Valmont - Boulder 115 kV CKT 2	115	70	120	99.06	103.37	4.31

5.3 Transient Stability Results

The following results were obtained for the disturbances analysed in both Discharging and Grid Charging scenarios:

- ✓ No machines lost synchronism with the system.
- ✓ No transient voltage drop violations were observed.
- ✓ Machine rotor angles displayed positive damping.

A total of fourteen P1s and two P7s were simulated. The results of the contingency analysis are shown in Table 7. The transient stability plots are shown in Appendix A in Section 10.0 of this report.

Table 7 – Transient Stability Analysis Results

Ref. No.	Fault Location	Fault Category	Outage(s)	Clearing Time (Cycles)	Discharging		Grid Charging	
					Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
1	-	P0	Flatrun	-	Stable	Stable	Stable	Stable
2	Spindle - FSV 230 kV	P1	Spindle - FSV 230 kV CKT 1	5	Stable	Stable	Stable	Stable
3	Spindle - Valmont 230 kV	P1	Spindle - Valmont 230 kV CKT 1	5	Stable	Stable	Stable	Stable
4	Spindle - NG 230 kV	P1	Spindle Generation	5	Stable	Stable	Stable	Stable
5	Spindle - PI-2024-10	P1	PI-2024-10 Generation	5	Stable	Stable	Stable	Stable
6	Valmont - Simms 230 kV	P1	Valmont - Simms 230 kV CKT 1	5	Stable	Stable	Stable	Stable
7	Valmont 230 kV	P1	Valmont 230/115 kV Transformer T7	5	Stable	Stable	Stable	Stable
8	FSV - Fort Lupton 230 kV	P1	FSV - Fort Lupton 230 kV CKT 1	5	Stable	Stable	Stable	Stable
9	FSV - Weld 230 kV	P1	FSV - Weld 230 kV CKT 1	5	Stable	Stable	Stable	Stable
10	FSV - Windsor 230 kV	P1	FSV - Windsor 230 kV CKT 1	5	Stable	Stable	Stable	Stable
11	FSV - Isabelle 230 kV	P1	FSV - Isabelle 230 kV CKT 1	5	Stable	Stable	Stable	Stable
12	FSV - Keenesburg 230 kV	P1	FSV - Keenesburg 230 kV CKT 1	5	Stable	Stable	Stable	Stable
13	FSV - Longpeak 230 kV	P1	FSV - Longpeak 230 kV CKT 1	5	Stable	Stable	Stable	Stable
14	FSV - Fordham 230 kV	P1	FSV - Fordham 230 kV CKT 1	5	Stable	Stable	Stable	Stable
15	FSV 345/230 kV Transformer	P1	FSV 345/230 kV Transformer T7	5	Stable	Stable	Stable	Stable

Ref. No.	Fault Location	Fault Category	Outage(s)	Clearing Time (Cycles)	Discharging		Grid Charging	
					Post-Fault Voltage Recovery	Angular Stability	Post-Fault Voltage Recovery	Angular Stability
16	Spindle - FSV 230 kV	P7	Spindle - FSV 230 kV CKT 1 Spindle - Valmont 230 kV CKT 1 FSV - Isabelle 230 kV CKT 1 PI-2024-10 Generation Spindle Generation	5	Stable	Stable	Stable	Stable
17	Spindle - Valmont 230 kV	P7	Spindle - FSV 230 kV CKT 1 Spindle - Valmont 230 kV CKT 1 PI-2024-10 Generation Spindle Generation	5	Stable	Stable	Stable	Stable

5.4 Short-Circuit and Breaker Duty Analysis Results

A study was completed to determine whether any overstressed breakers resulted when several provisional interconnections (PIs) were added to the PSCo transmission system in the order of their Commercial Operation Date (COD). If the addition of the interconnection resulted in a requirement that one or more breakers be replaced in the Xcel system, it was considered that that customer would not be able to connect under a provisional interconnection agreement and it was removed from the study.

Taken into consideration were any existing plans for breaker replacement by Xcel Energy. Breakers that had already been assigned to projects were not considered as needing replacement by the interconnection customer.

The breaker duty study on the PSCo transmission system did not identify any circuit breakers that became over-dutied because of adding the PI-2024-10. Should any circuit breakers become overdue, the fault currents at the POI for three-phase and phase-to-ground will be provided in this report. Conversely, the fault currents can be made available upon request by the customer.

5.5 Affected Systems

The study did not identify any impacts to Affected Systems.

5.6 Summary of Provisional Interconnection Analysis

All single contingency thermal violations were alleviated through generation redispatch, therefore, the maximum allowable output of the GIR without requiring any additional system Network Upgrades is 199 MW. Additionally, the 199 MW of requested Grid Charging will be permitted since no upgrades were identified during the analysis.

6.0 Cost Estimates

The total estimated cost of the required upgrades for PI-2024-10 to interconnect for Provisional Interconnection Service at the Spindle 230 kV switching station is **$8.439 million**.

- **Cost of Transmission Provider's Interconnection Facilities (TPIF) is $3.394 million** (Table 9)
- **Cost of Station Network Upgrades is $5.049 million** (Table 10)
- **Cost of System Network Upgrades is $0**

The list of improvements required to accommodate the Provisional Interconnection Service of PI-2024-10 are given in Table 8, and Table 9.

Table 8 – Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (Million)
PSCo's Spindle 230 kV switching station	Interconnection of 5RSC-2024-13 (PI-2024-10) at the Spindle 230 kV Switching Station. The new equipment includes: • (1) 230 kV single bay dead end structure • (1) 230 kV single bay dead end extension structure • (1) 230 kV 3-phase arrester • (1) 230 kV 3000 A disconnect switch • (3) 230 kV 1-phase CT's for metering • (3) 230 kV CCVTs • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying	$3.194
PSCo's Spindle 230 kV switching station	Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead end structure, 3 conductors, insulators, hardware, jumpers and labor.	$0.200
Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities		**$3.394**

Table 9 – Station Network Upgrades

Element	Description	Cost Est. (Million)
PSCo's Spindle 230 kV switching station	Interconnection of 5RSC-2024-13 (PI-2024-10) at the Spindle 230 kV Switching Station. The new equipment includes: • (1) 230 kV 3000 A Circuit Breaker • (2) 230 kV 3000 A Gang Switches • (3) 230 kV CCVTs • Associated electrical equipment, bus, wiring and grounding • Station controls and wiring • Associated foundations and structures	$4.309
PSCo's Spindle 230 kV switching station	Install required communication in the EEE at the Spindle 230 kV Switching Station	$0.690
PSCo's Spindle 230 kV switching station	Siting and Land Rights permitting, no land purchase costs included	$0.050
Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities		**$5.049**

PSCo has developed cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of PI-2024-10 for Provisional Interconnection Service. The estimated costs provided in this report are based upon the following assumptions:

- The estimated costs are in 2024 dollars with escalation and contingencies applied.
- Allowances for Funds Used During Construction (AFUDC) is not included.
- The estimated costs include all applicable labor and overheads associated with the siting, engineering, design, and construction of these new PSCo facilities.
- The estimated costs do not include the cost for any Customer owned equipment and associated design and engineering.
- Labor is estimated for straight time only—no overtime included.
- PSCo (or its Contractor) will perform all construction, wiring, testing, and commissioning for PSCo owned and maintained facilities.

The customer requirements include:

- Customer will install two (2) redundant fiber optic circuits (one primary circuit with a redundant backup) into the Transmission Provider's substation as part of its interconnection facilities construction scope.
- Power Quality Metering (PQM) will be required on the Customer's generation tie-line terminating into the POI.

- The Customer will be required to design, procure, install, own, operate and maintain a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer substation. PSCo will be provided with indications, readings, and data from the LF/AGC RTU.
- The Interconnection Customer will comply with the most current version of the *Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW*, as amended from time to time, and available at: Interconnection | Transmission | Corporate | Xcel Energy

6.1 Schedule

This section provides proposed milestones for the interconnection of PI-2024-10 to the Transmission Provider's transmission system. The customer requested a back-feed date (In-Service Date for Transmission Provider Interconnection Facilities and Station Network Upgrades required for interconnection) for the Provisional Interconnection of June 19, 2026. This is attainable by the Transmission Provider, based upon the current schedule developed for this interconnection request. The Transmission Provider proposes the milestones provided below in Table 10.

Table 10 – Proposed Milestones for PI-2024-10

Milestone	Responsible Party	Estimated Completion Date
LGIA Execution	Interconnection Customer and Transmission Provider	January 2025
In-Service Date for Transmission Provider Interconnection Facilities and Station Network Upgrades required for interconnection	Transmission Provider	June 19, 2026
In-Service Date & Energization of Interconnection Customer's Interconnection Facilities	Interconnection Customer	June 19, 2026
Initial Synchronization Date	Interconnection Customer	July 1, 2026
Begin trial operation & testing	Interconnection Customer and Transmission Provider	July 19, 2026
Commercial Operation Date	Interconnection Customer	January 15, 2027

Some schedule elements are outside of the Transmission Provider's control and could impact the overall schedule. The following schedule assumptions provide the basis for the schedule milestones:

- Construction permitting (if required) for new facilities will be completed within 12 months of LGIA execution.
- The Transmission Provider is currently experiencing continued increases to material lead times which could impact the schedule milestones. The schedule milestones are based upon material lead times known at this time.
- Availability of line outages to interconnect new facilities to the transmission system.
- A Certificate of Public Convenience and Necessity (CPCN) may be required for the construction of the Interconnection Facilities and Station Network Upgrades. The expected time to obtain a CPCN approval is 18 months, which could impact the start of construction for the interconnection facilities.

7.0 Summary of Provisional Interconnection Service Analysis

The total estimated cost of the PSCo transmission system improvements required for PI-2024-10 to qualify for Provisional Interconnection Service is $8.439 million.

The initial maximum permissible output of PI-2024-10 Generating Facility is 199 MW. Additionally, the 199 MW of requested Grid Charging will be permitted since no upgrades were identified during the analysis. The maximum permissible output of the Generating Facility in the PLGIA would be reviewed quarterly and updated if there are changes to system conditions compared to the system conditions previously used to determine the maximum permissible output.

Security: Based on 5RSC-2024-13 in the 5RSC selection of Energy Resource Interconnection Service (ERIS), the security associated with the Network Upgrades that might be identified at the conclusion of the 5RSC-2024-13 Large Generation Interconnection Procedure (LGIP) in the 5RSC cluster is $5 million.

The Provisional Interconnection Service in and of itself does not convey transmission service.

8.0 Contingent Facilities

The Contingent Facilities identified for PI-2024-10 include the TPIF and Station Network Upgrades identified in Table 8 and Table 9, respectively.

9.0 Preliminary One-Line Diagram and General Arrangement for PI-2024-10

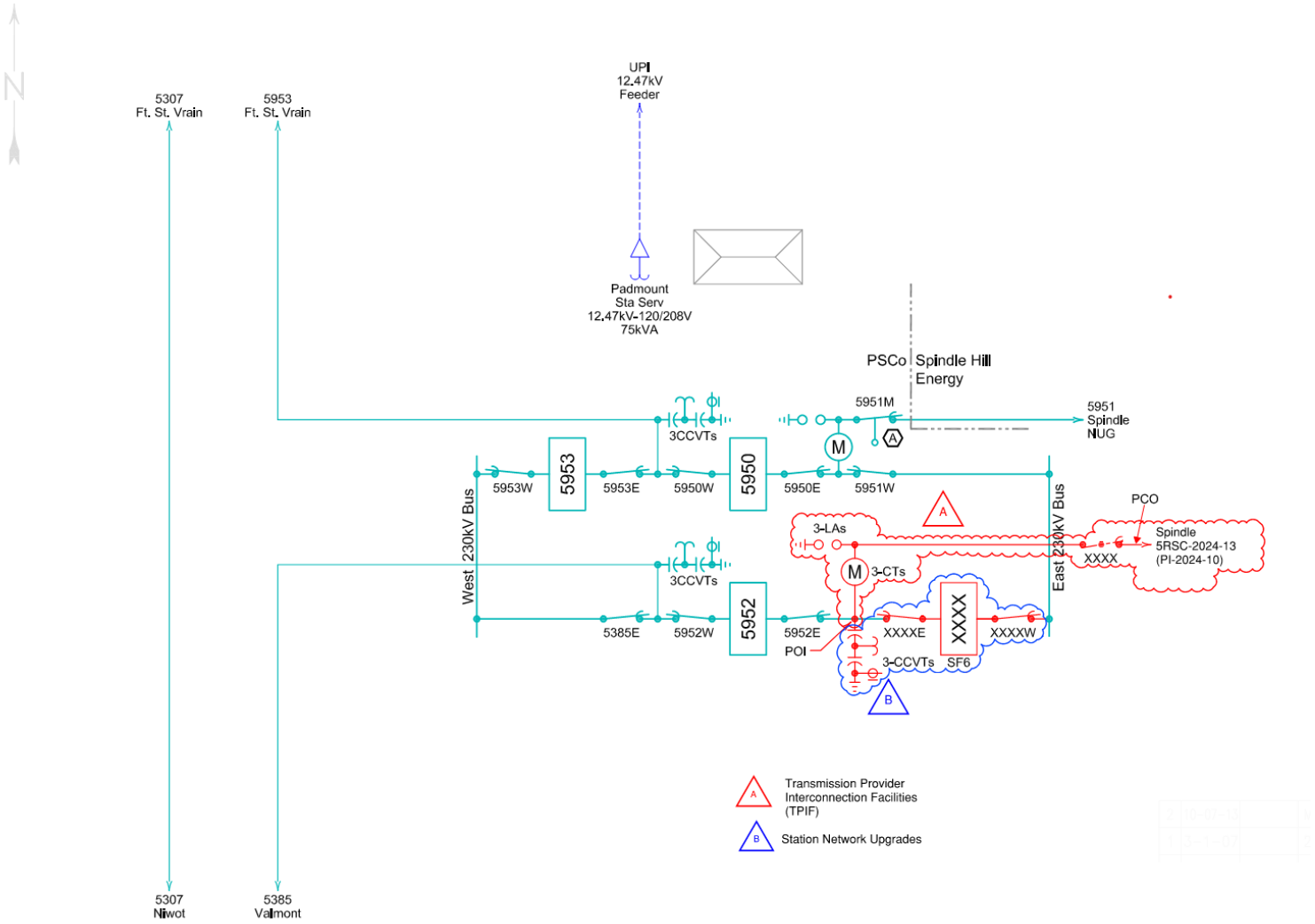


Figure 2: Preliminary One-Line for PI-2024-10 at the Spindle 230 kV switching station

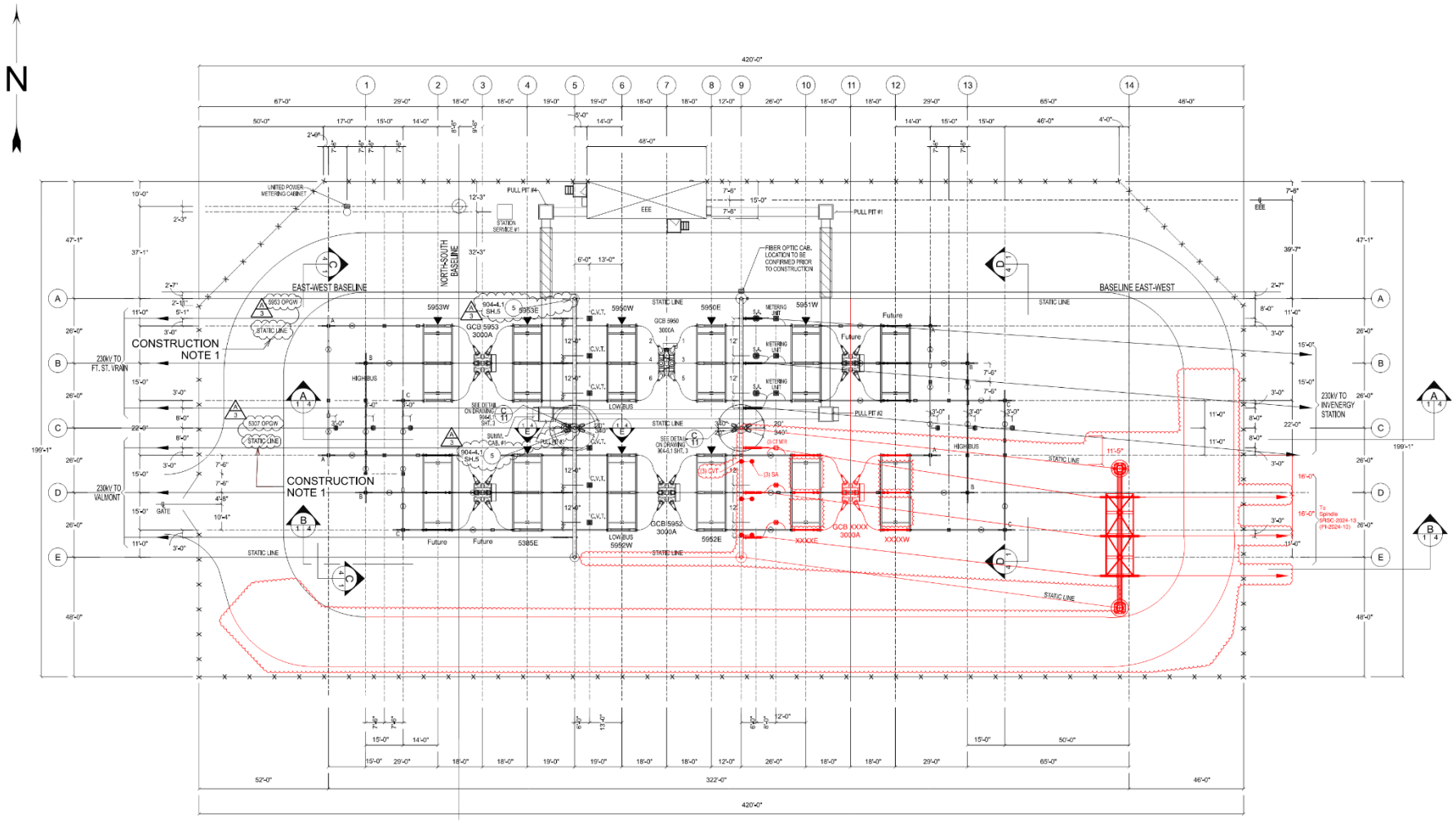
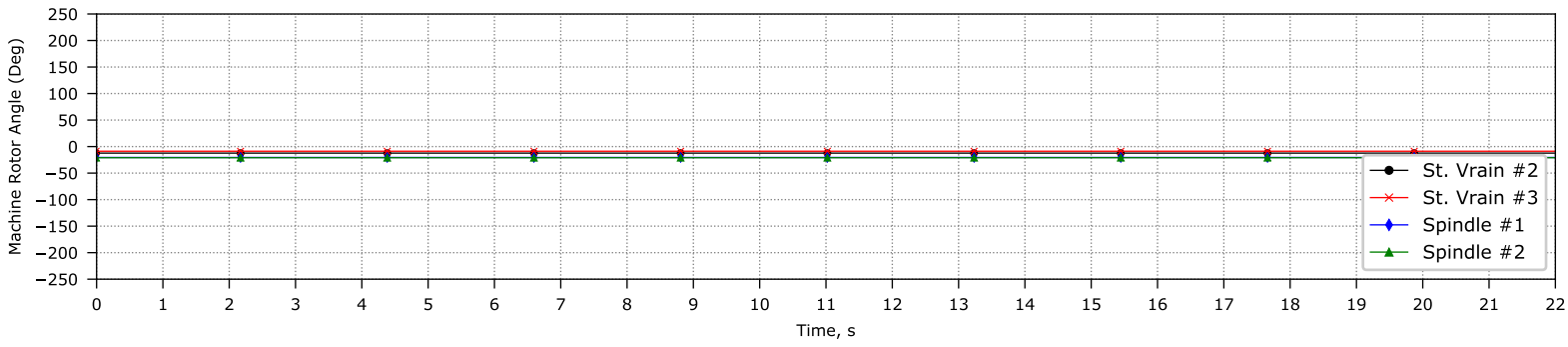


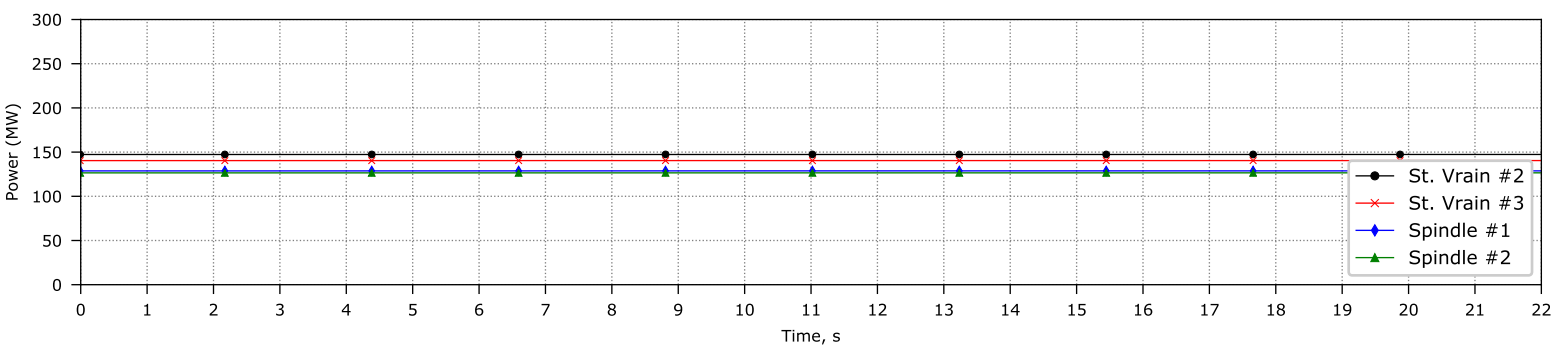
Figure 3: Preliminary General Arrangement for PI-2024-10 at the Spindle 230 kV switching station

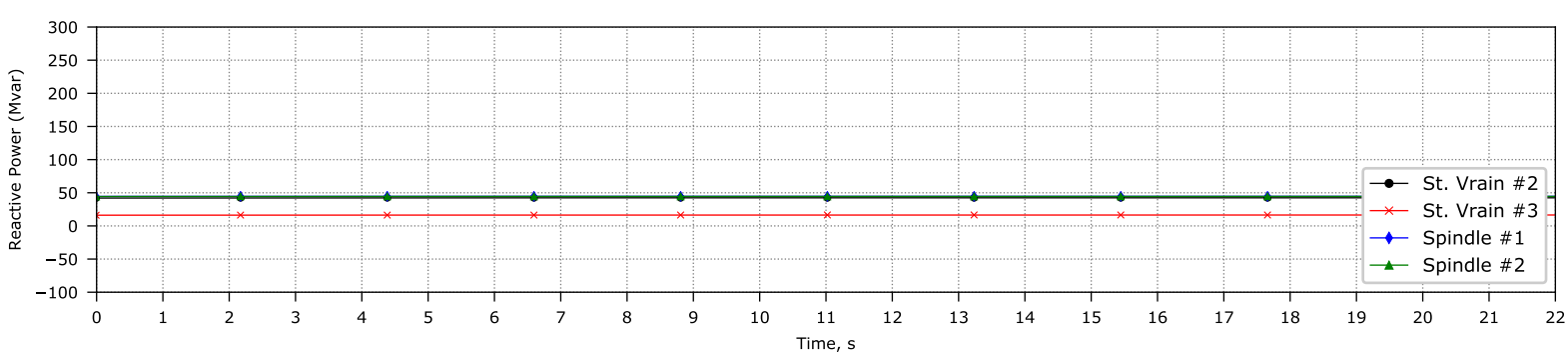
10.0 Appendices

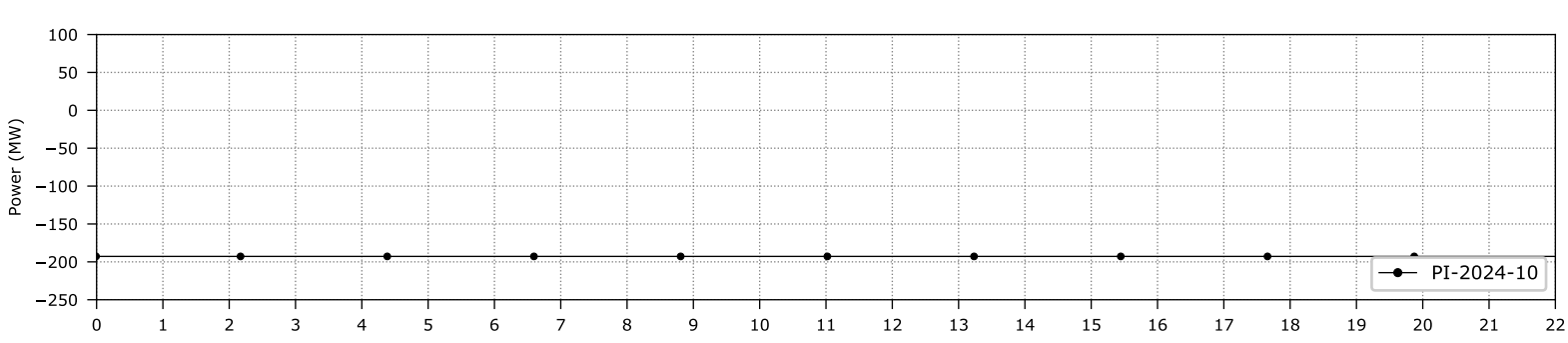
Appendix A: Transient Stability Plots – Discharging	PI-2024-10_Transient Stability Plots.pdf
Appendix B: Transient Stability Plots Grid – Charging	PI-2024-10_GC_Transient Stability Plots.pd

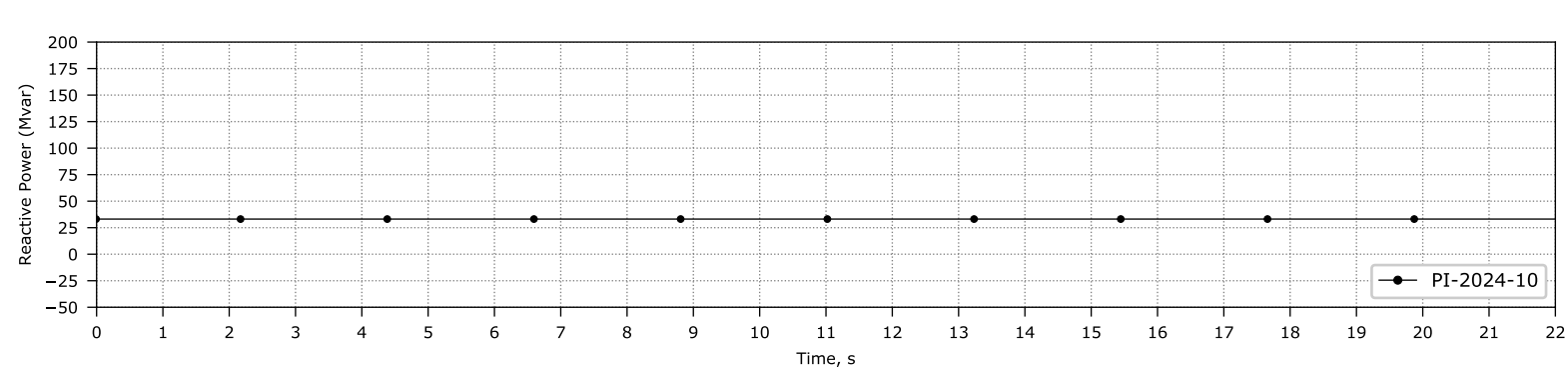
PI-2024-10_Study_North_GC_flatrun

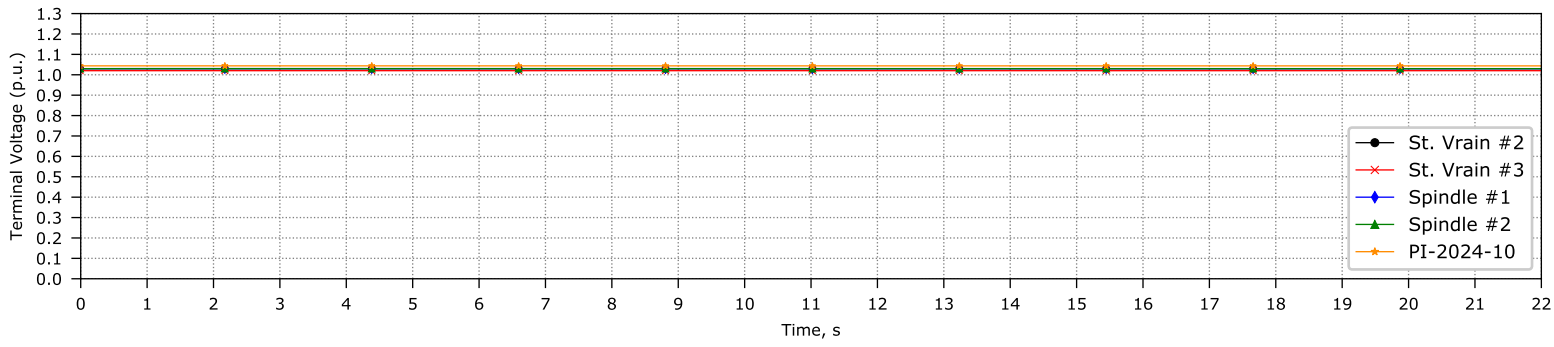


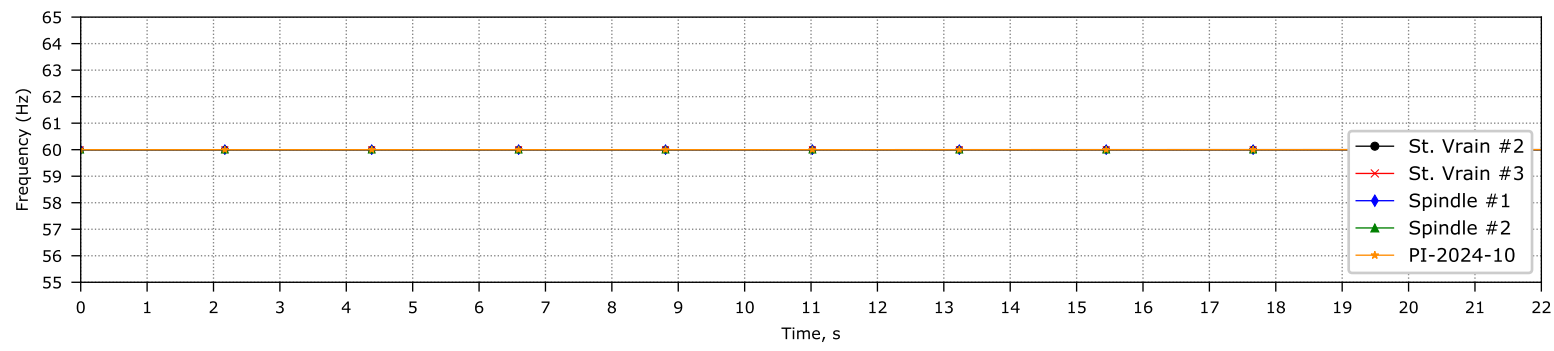


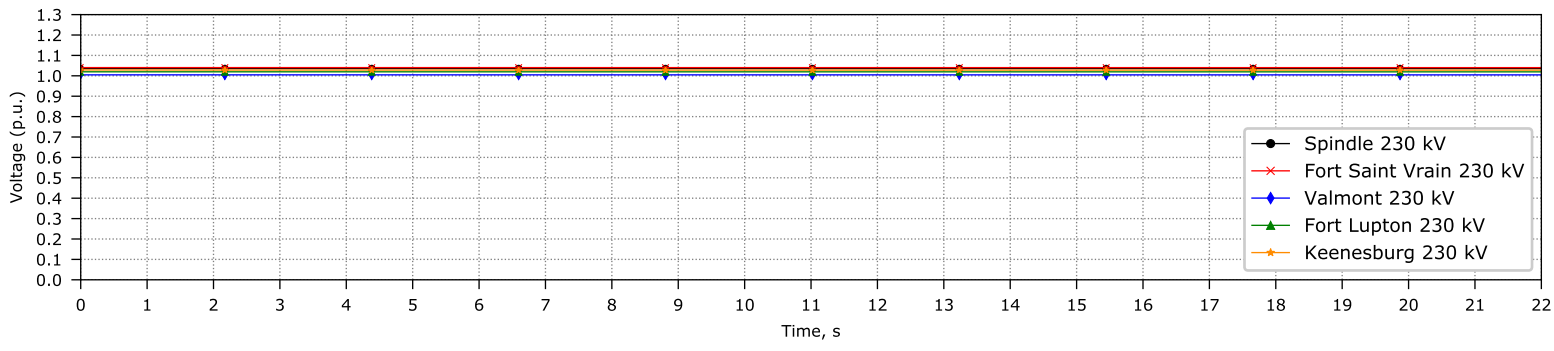




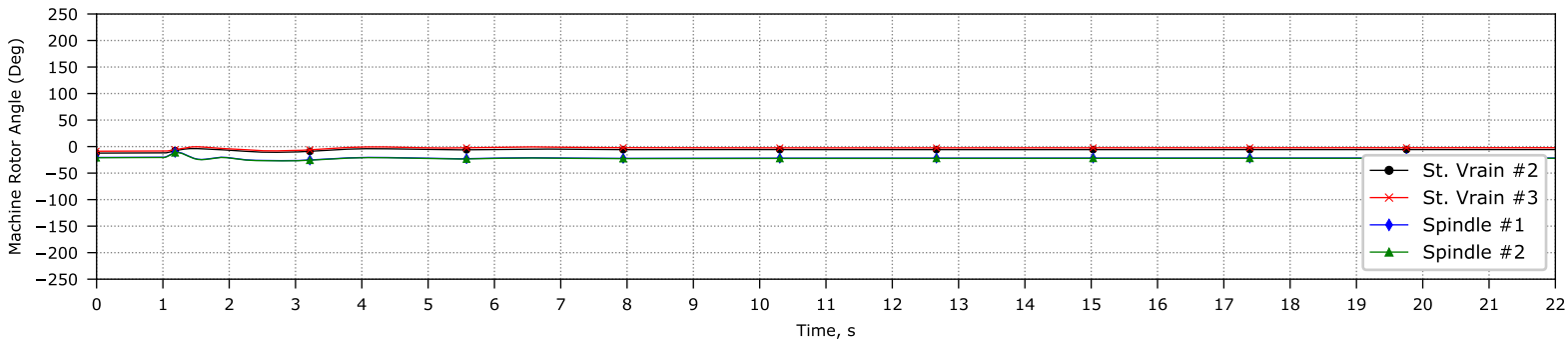


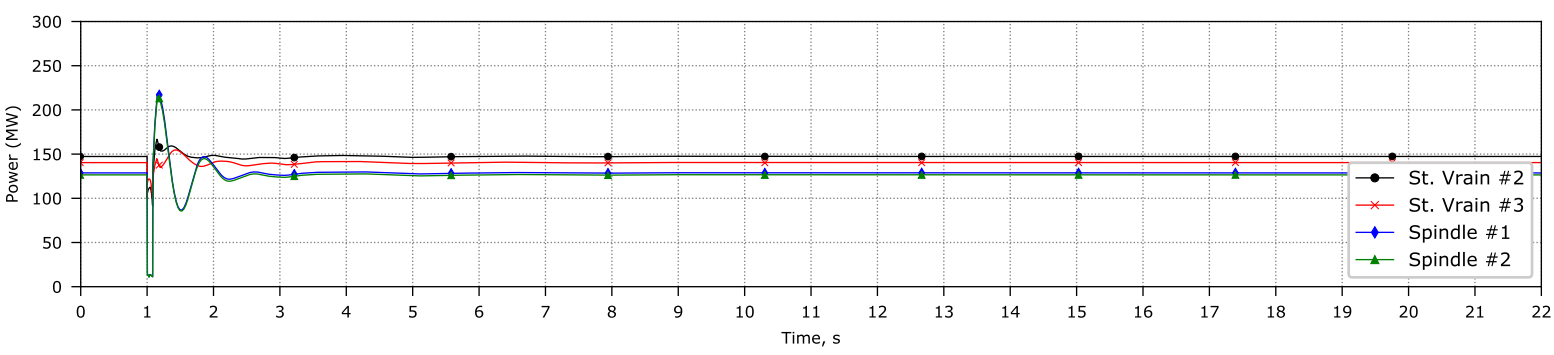


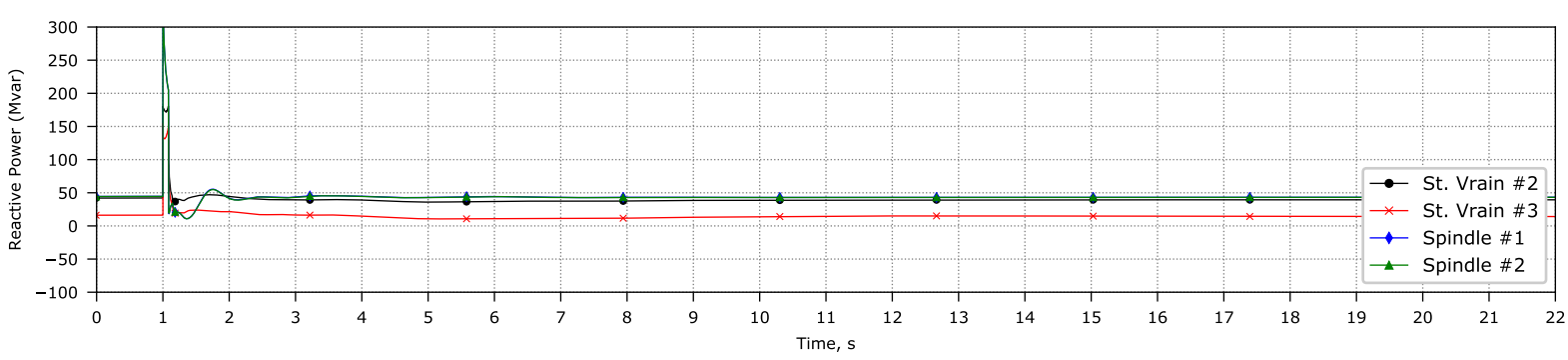


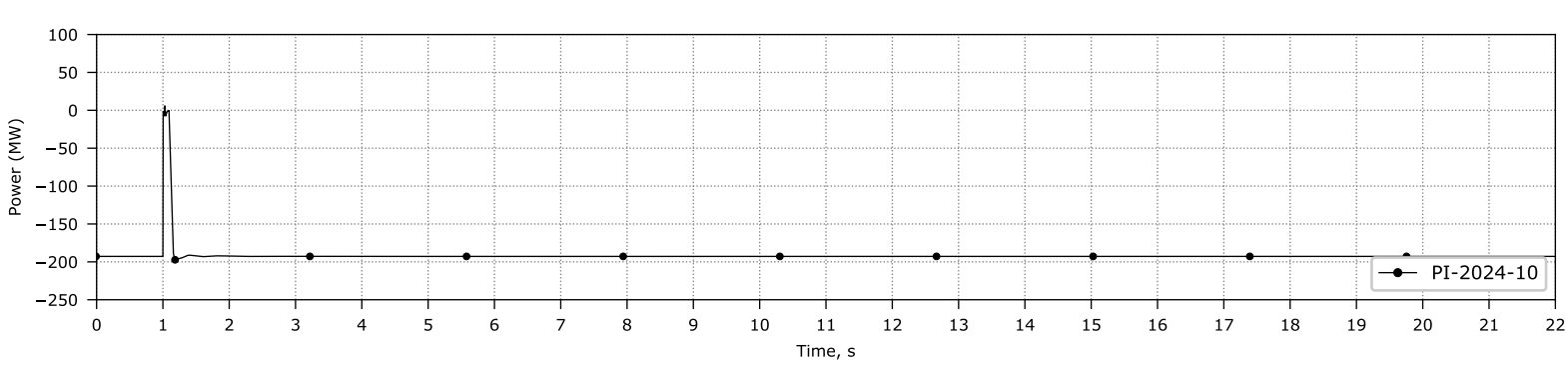


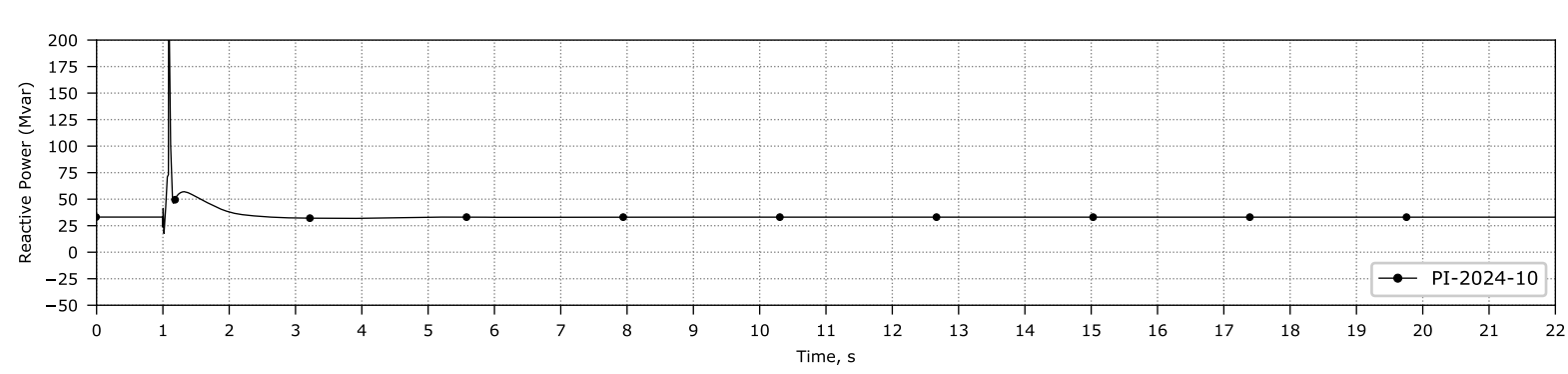
PI-2024-10_Study_North_GC_Spindle-FSV_230kV

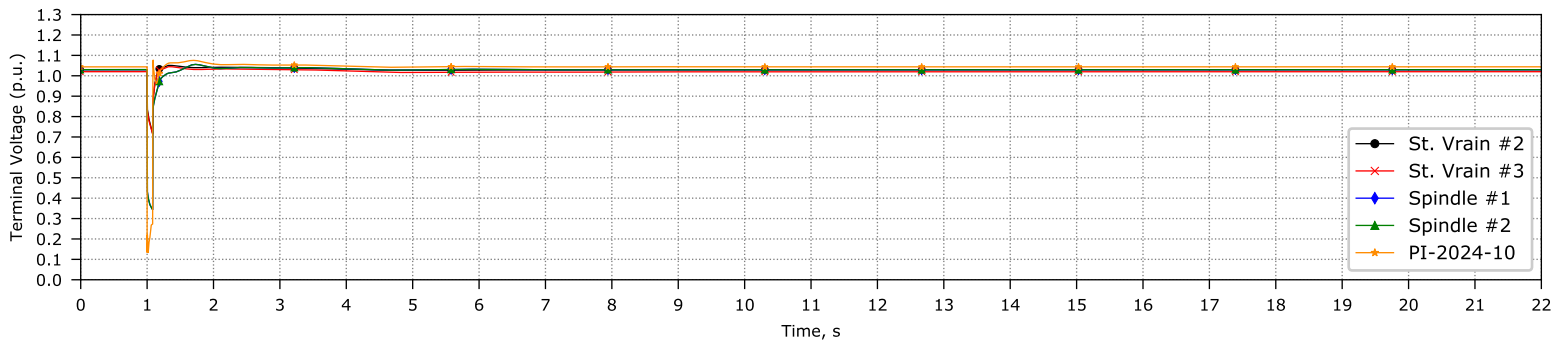


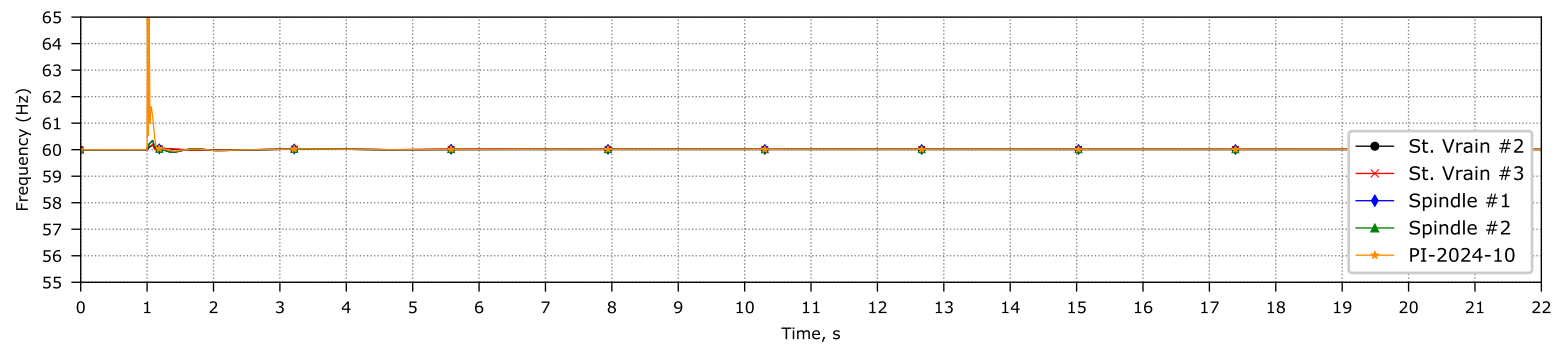


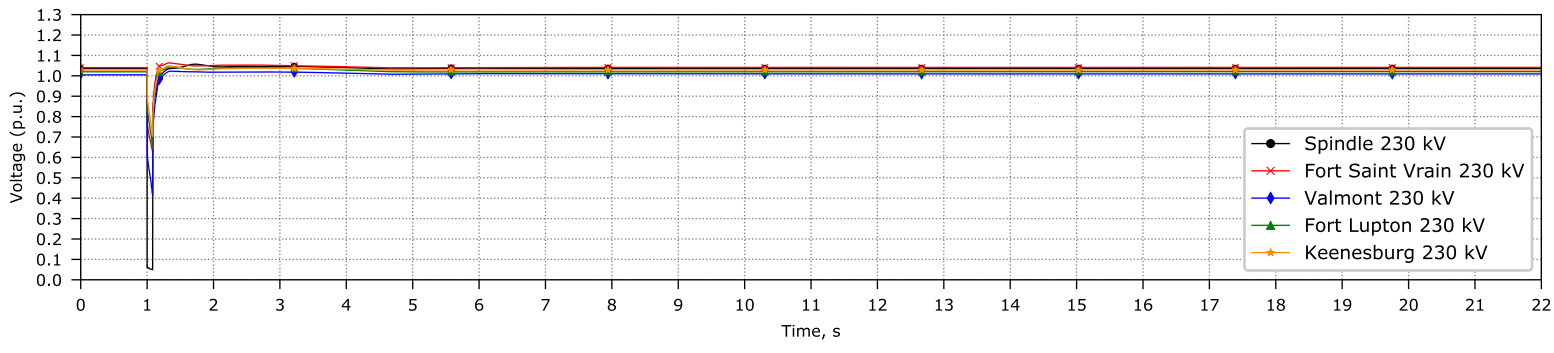




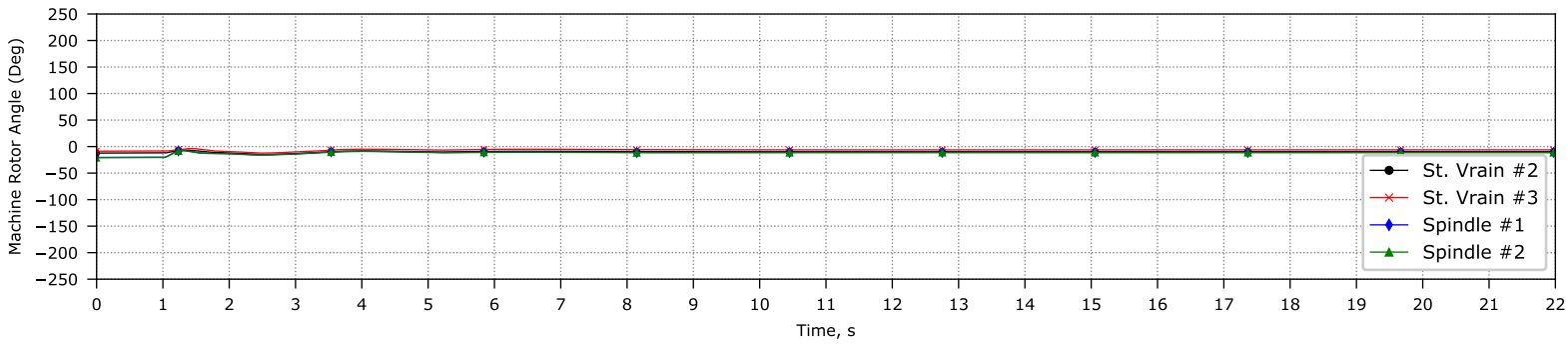


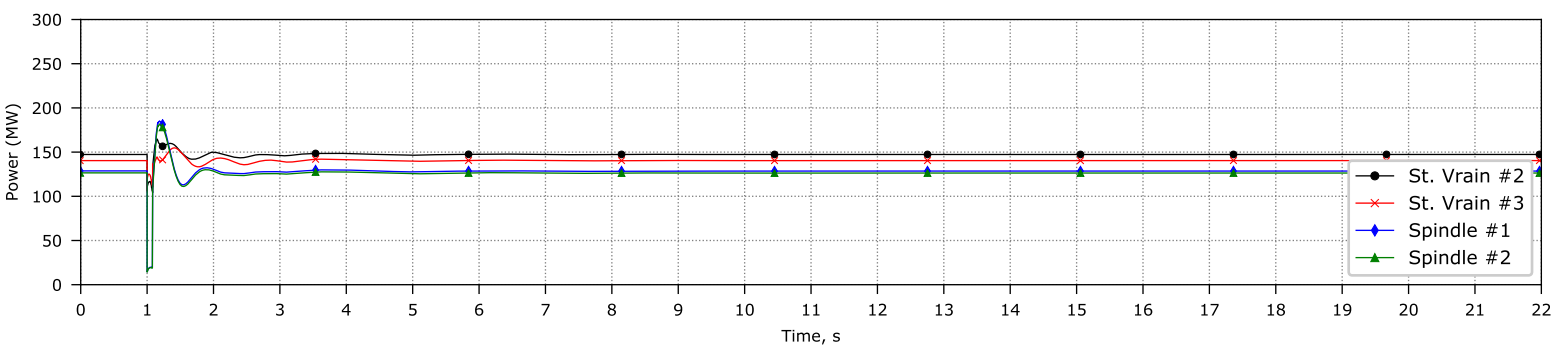


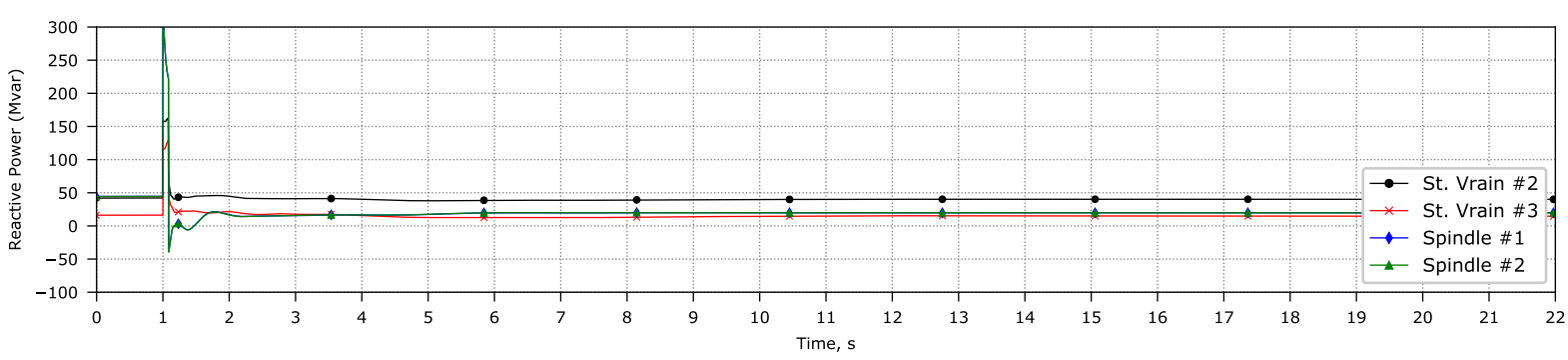


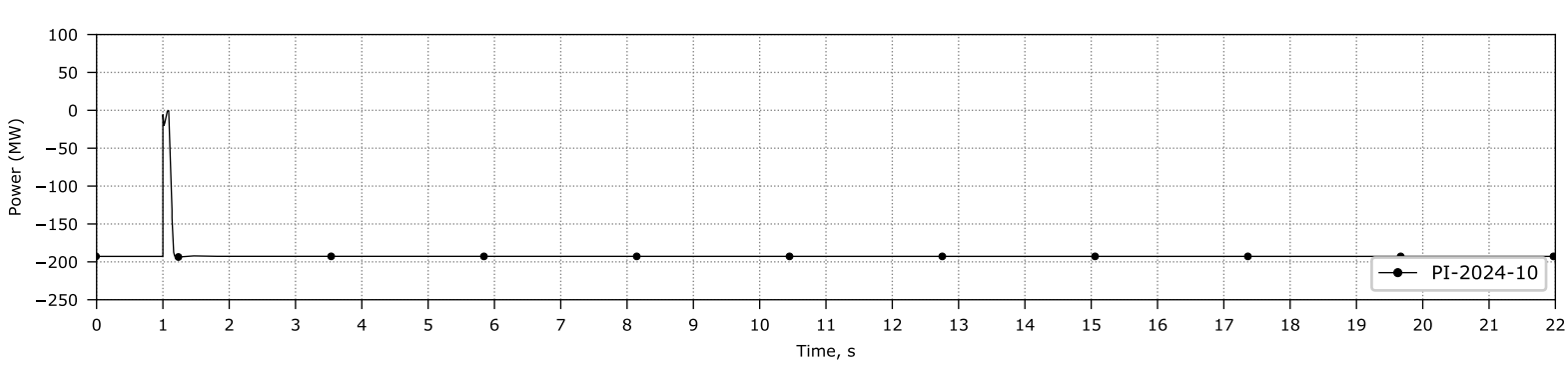


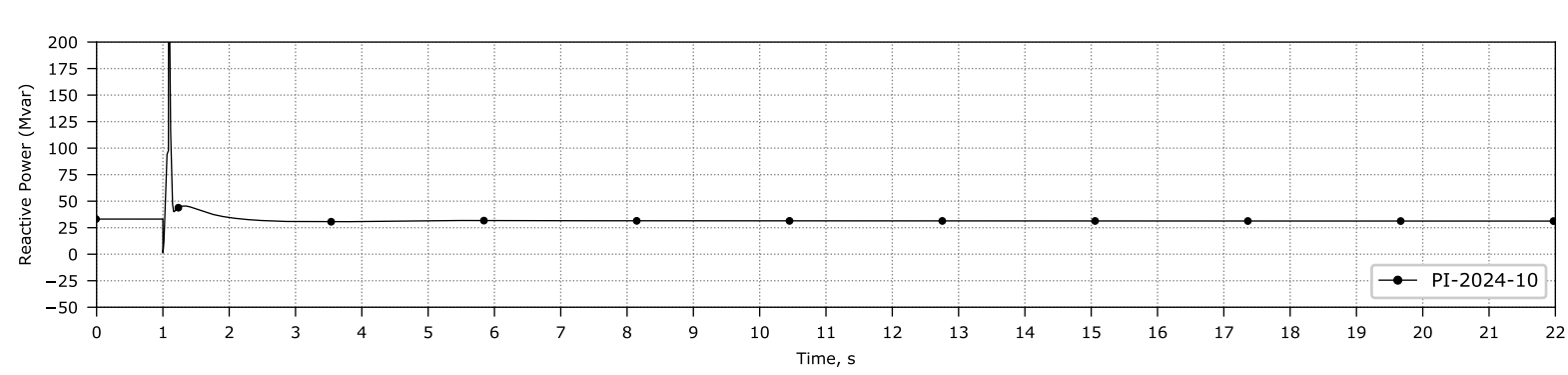
PI-2024-10_Study_North_GC_Spindle-Valmont_230kV

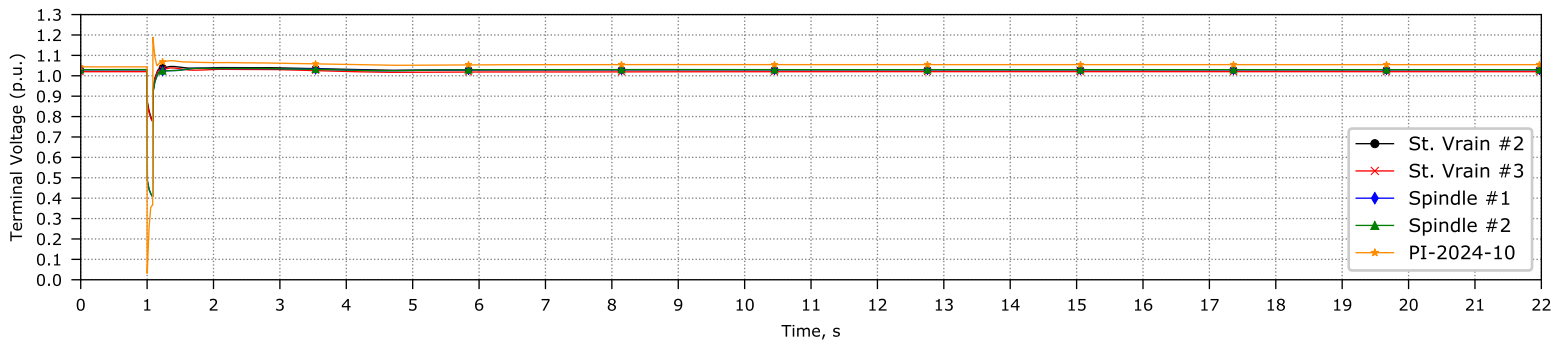


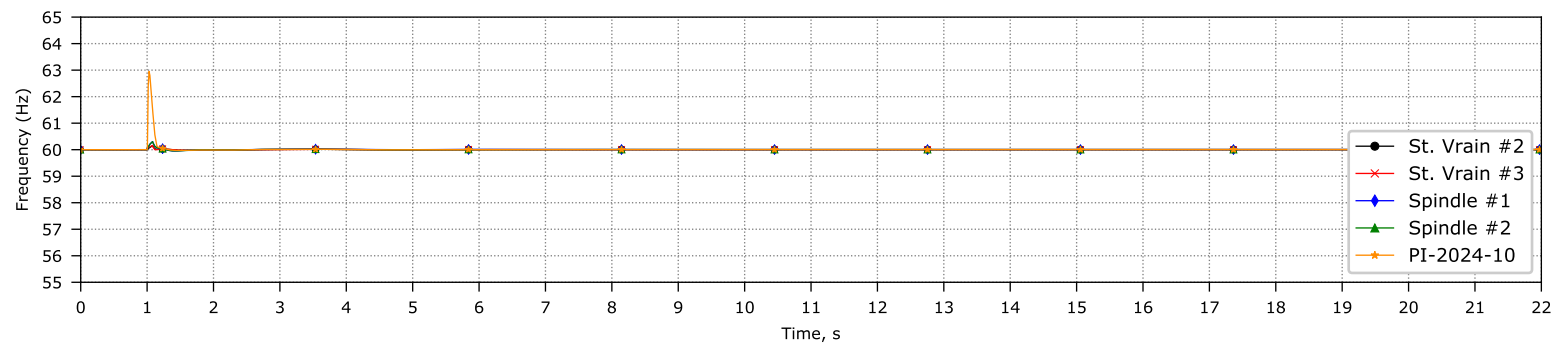


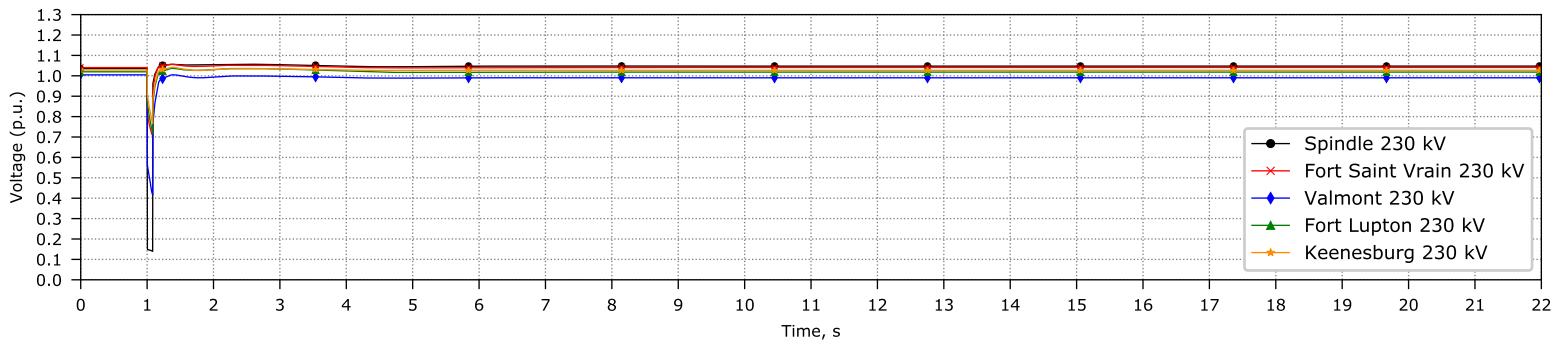




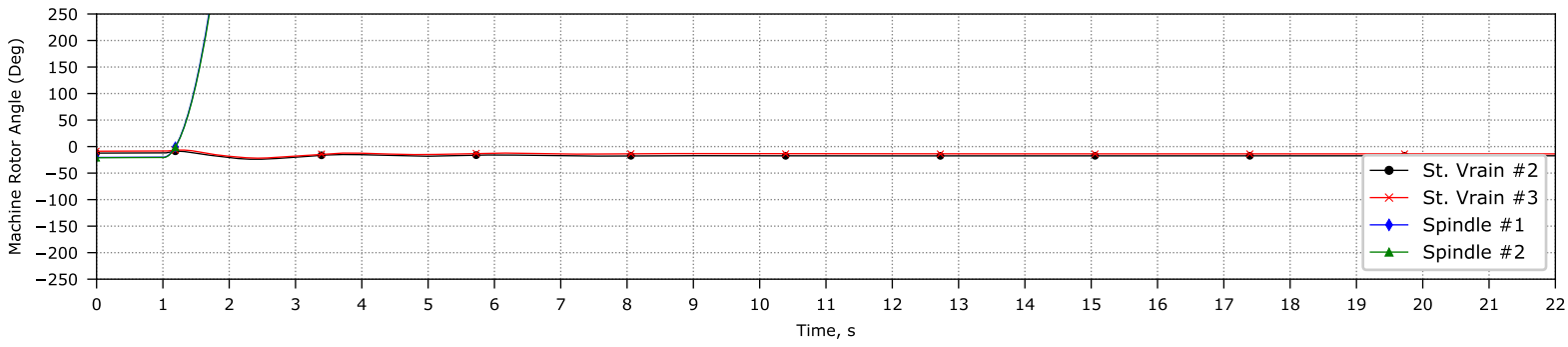


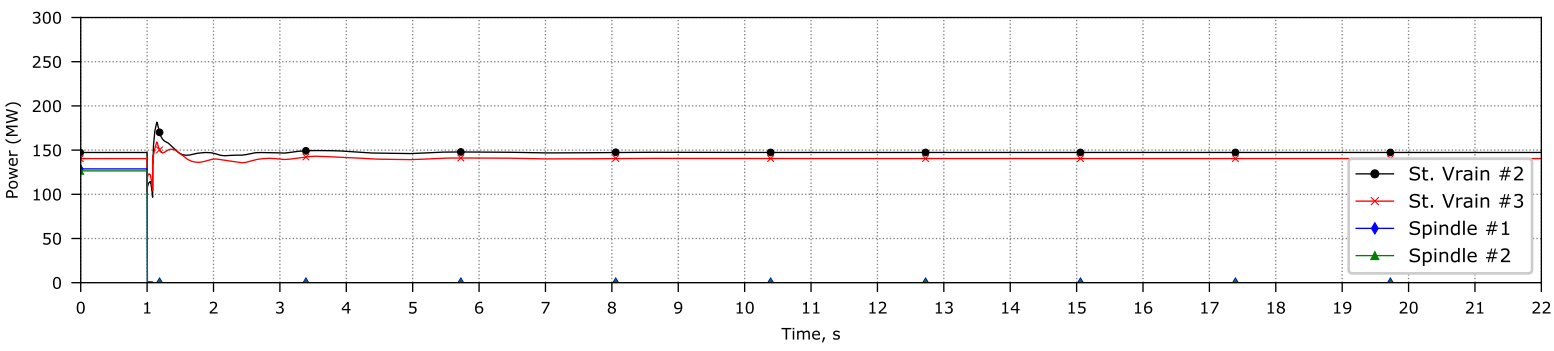


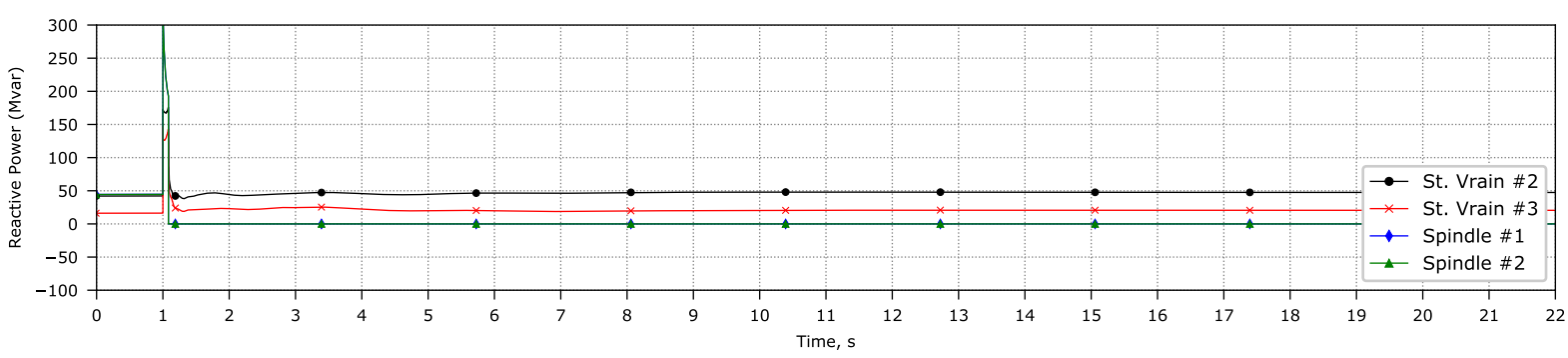


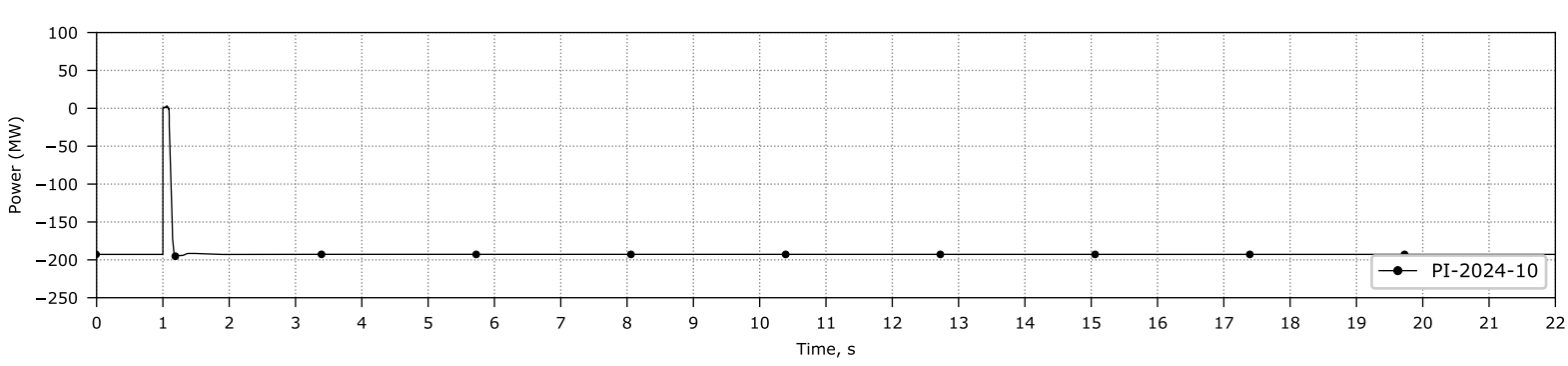


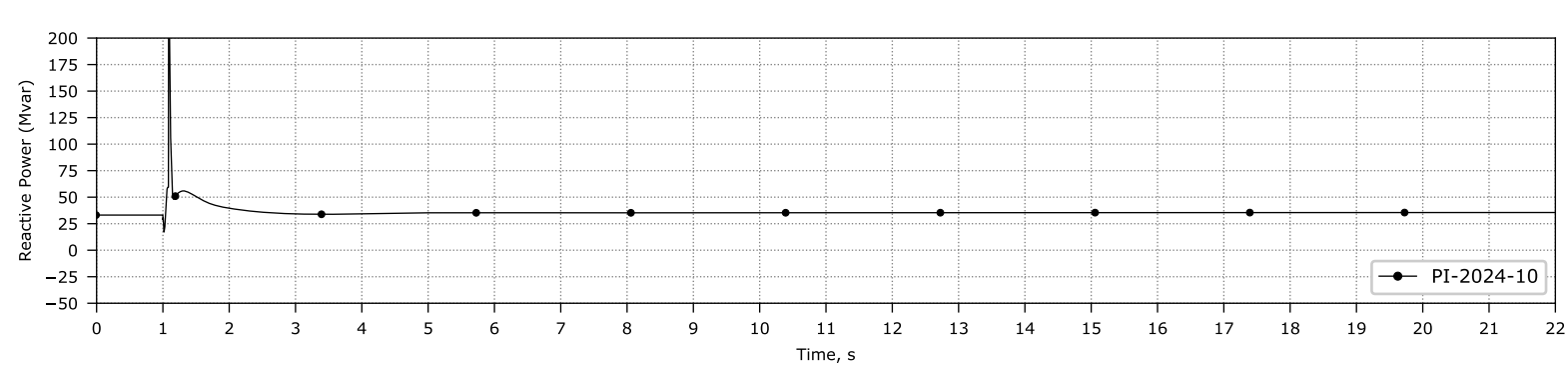
PI-2024-10_Study_North_GC_Spindle_NG

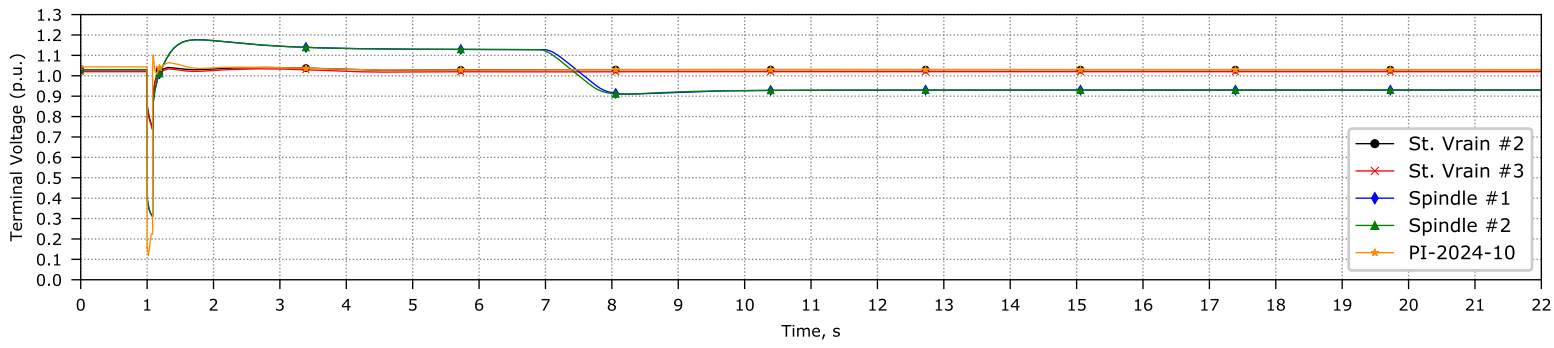


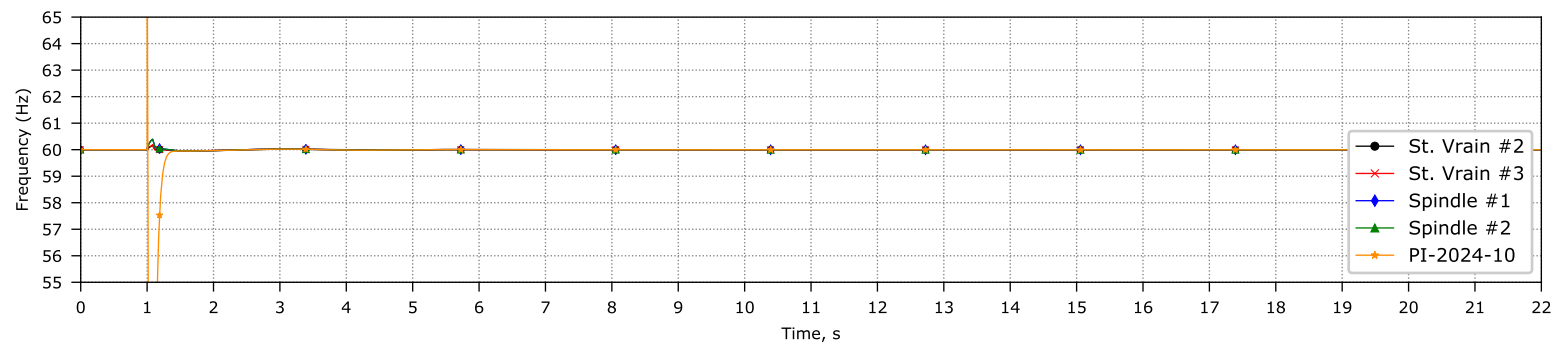


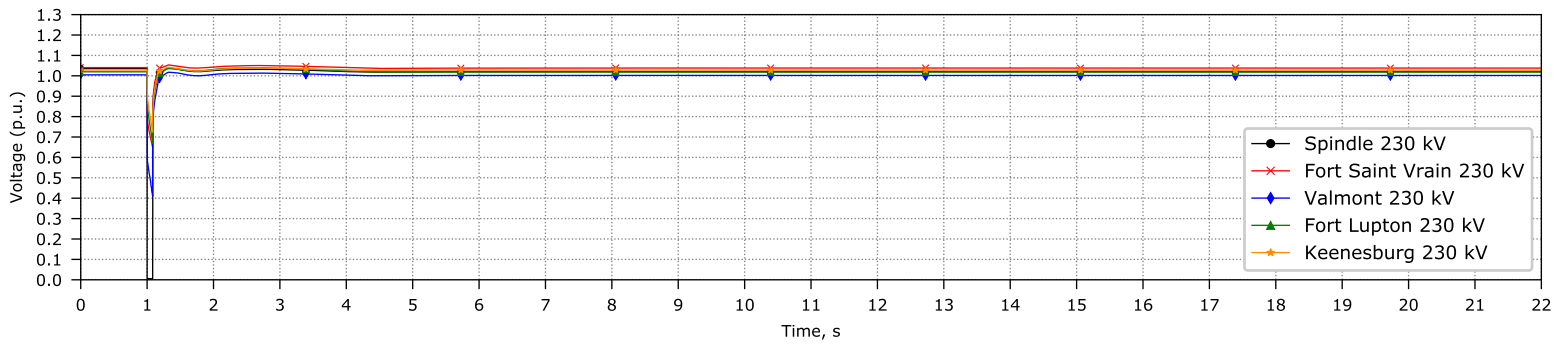




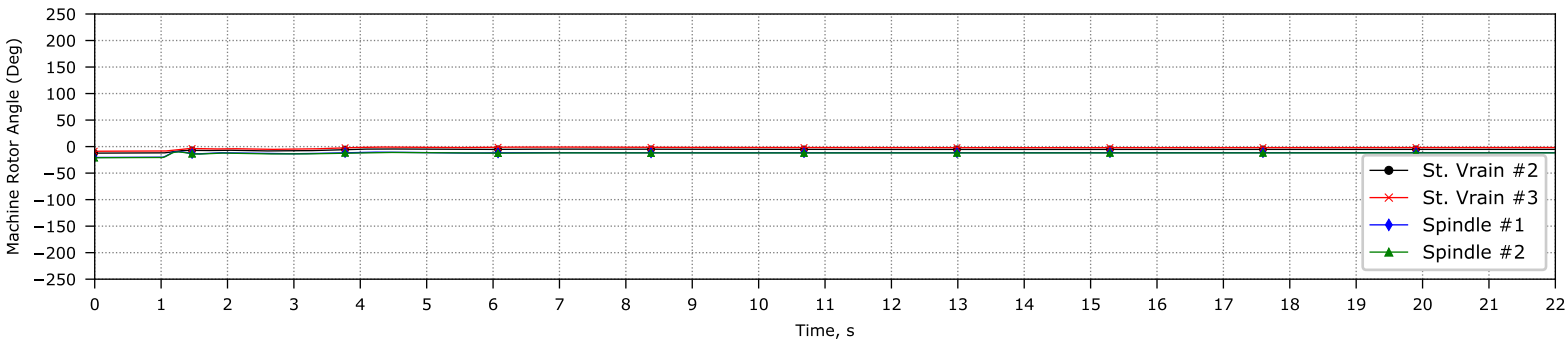


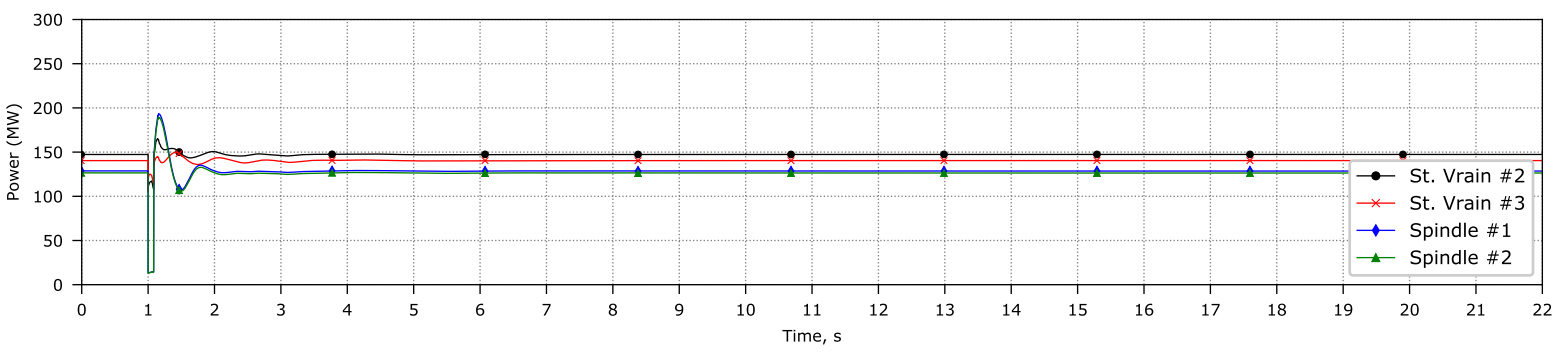


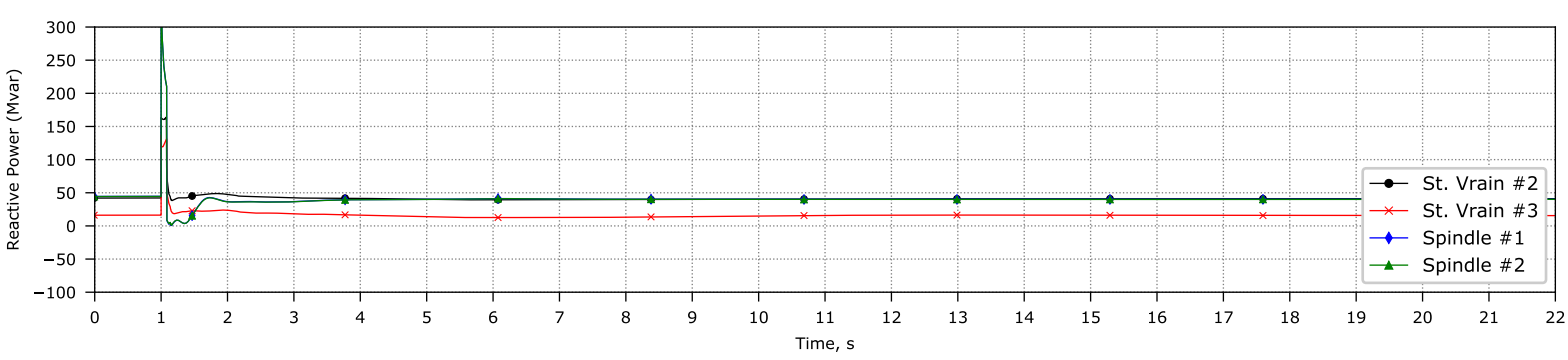


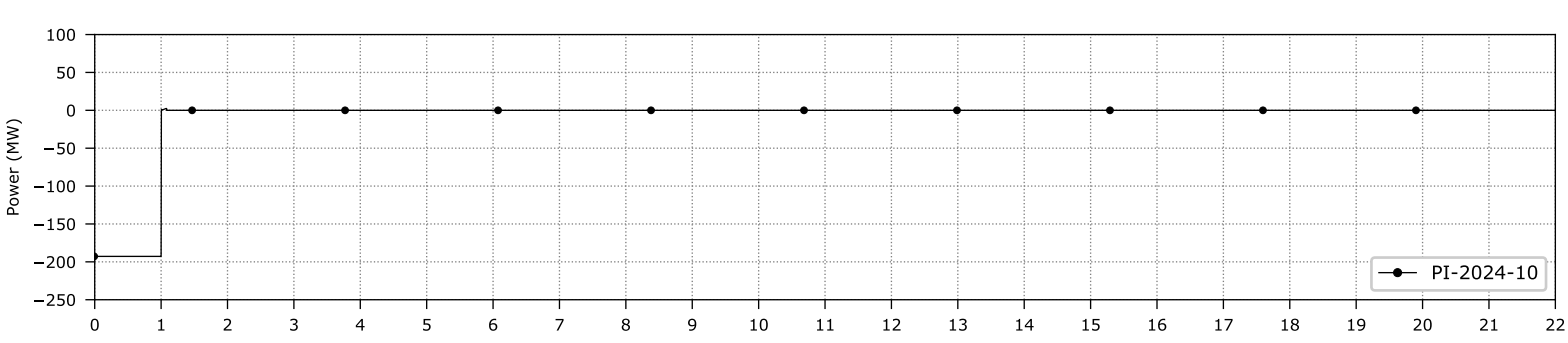


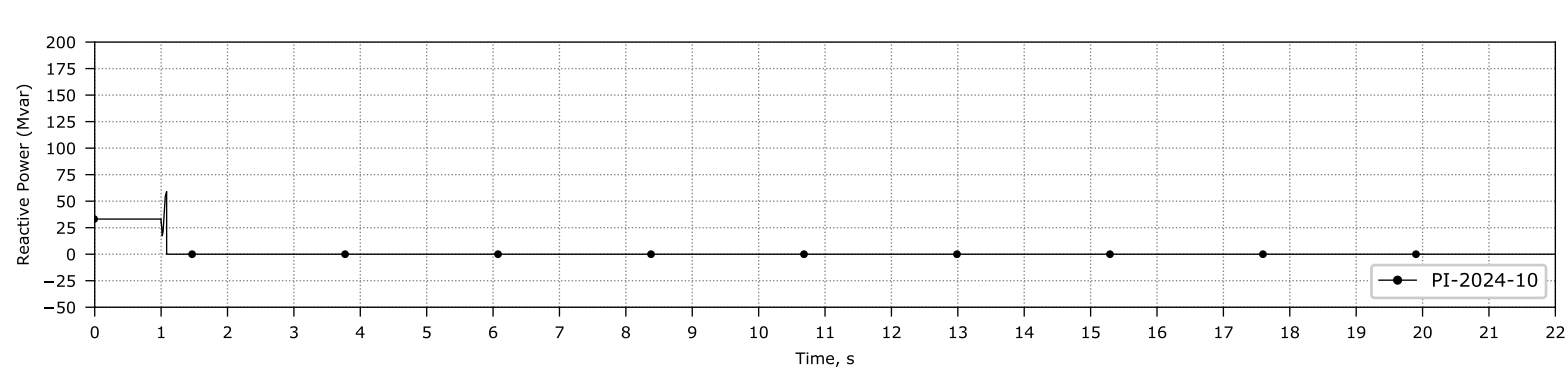
PI-2024-10_Study_North_GC_Spindle-PI-2024-10

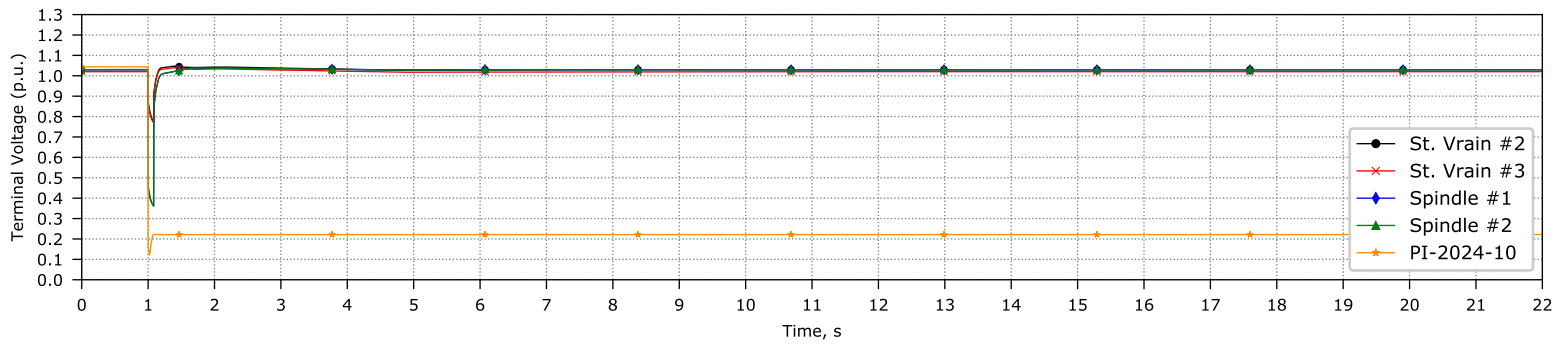


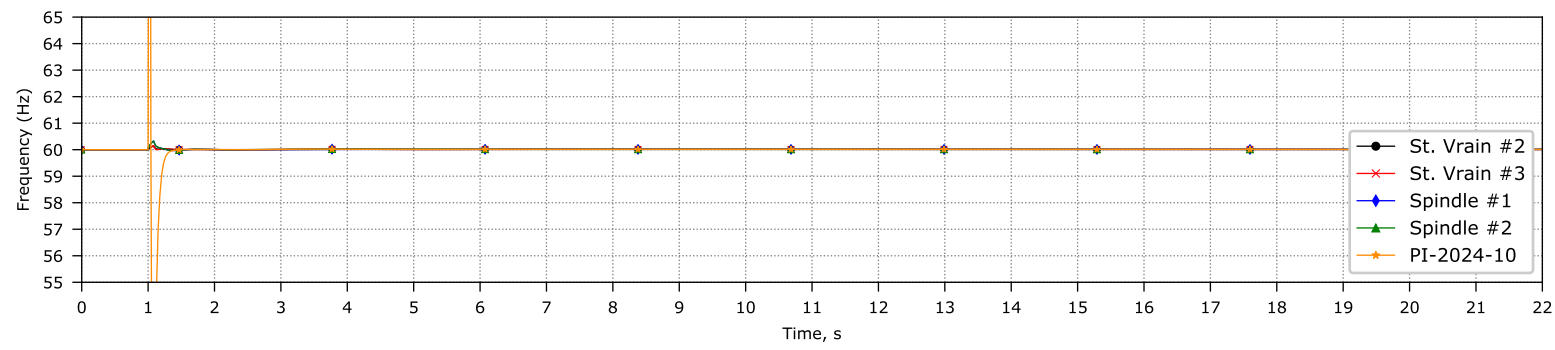


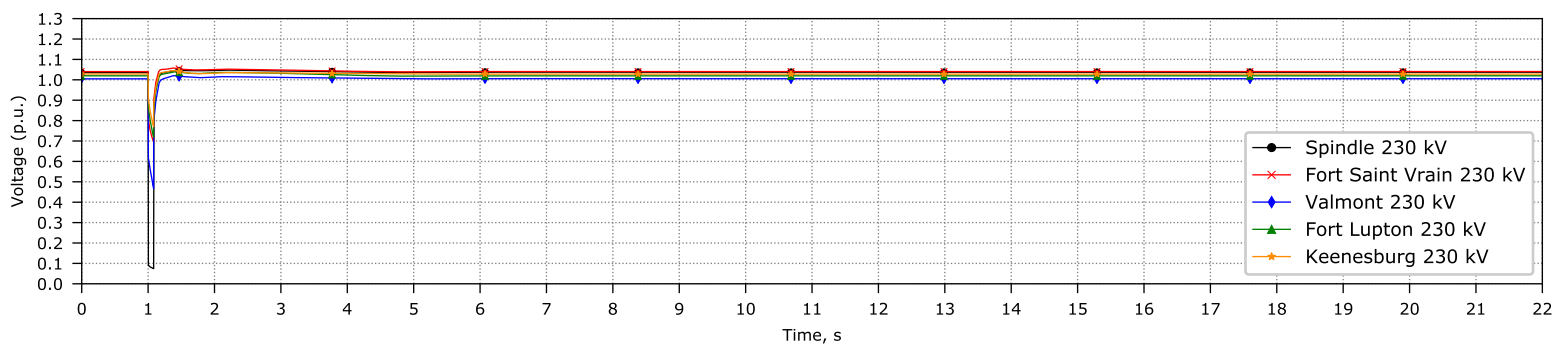




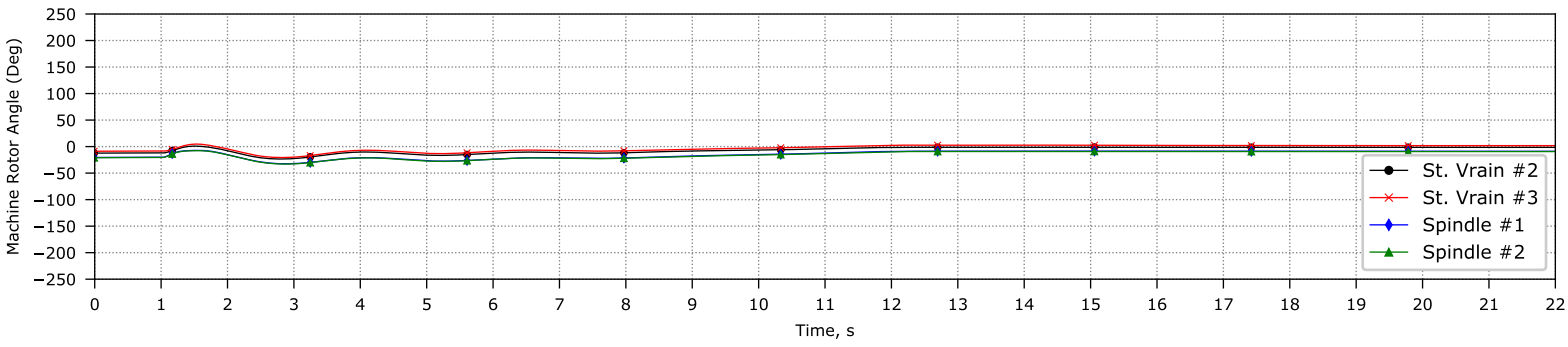


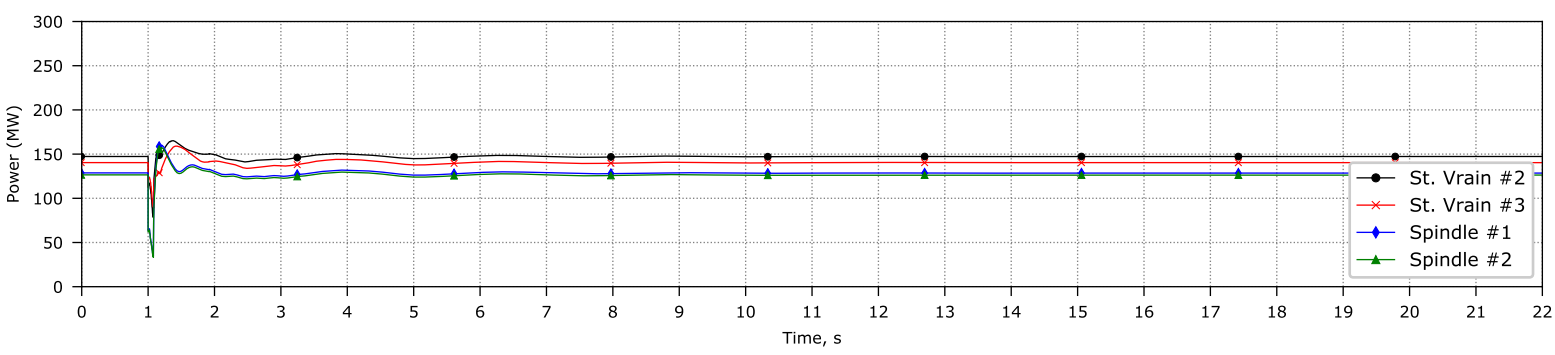


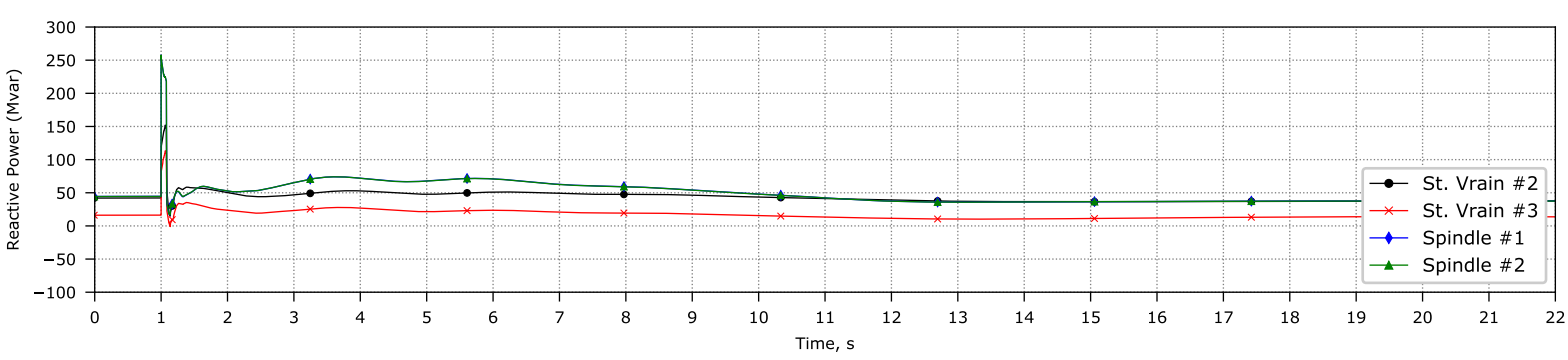


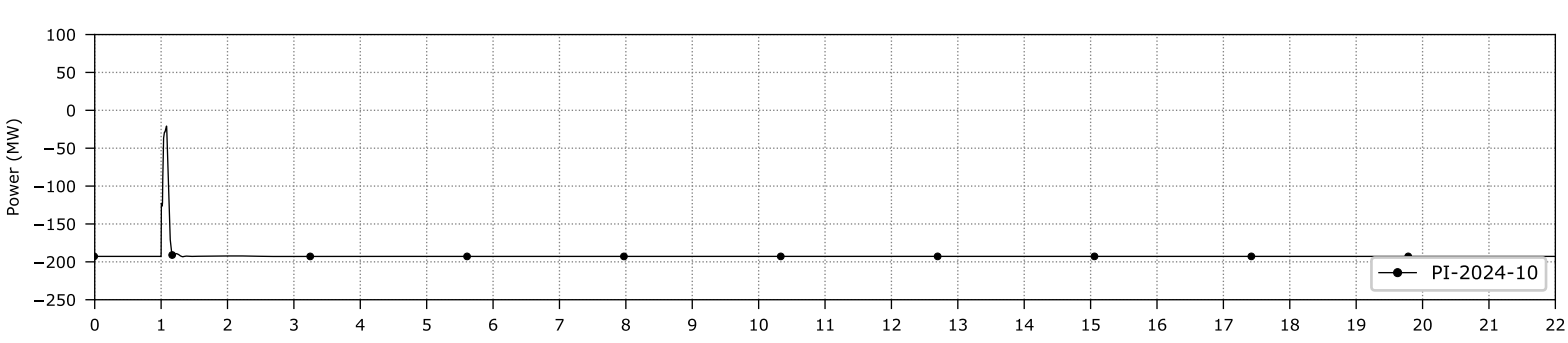


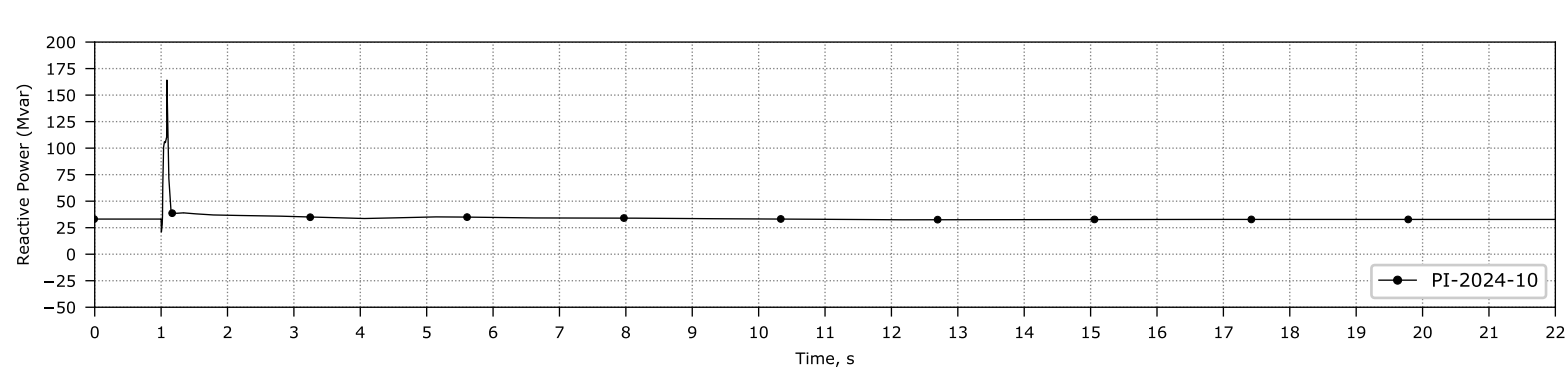
PI-2024-10_Study_North_GC_Valmont-Simms_230kV

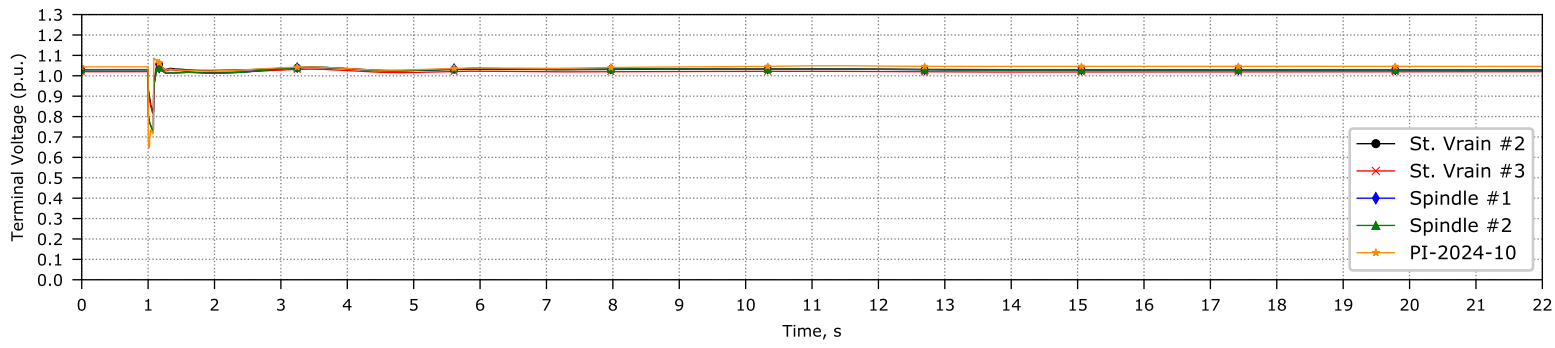


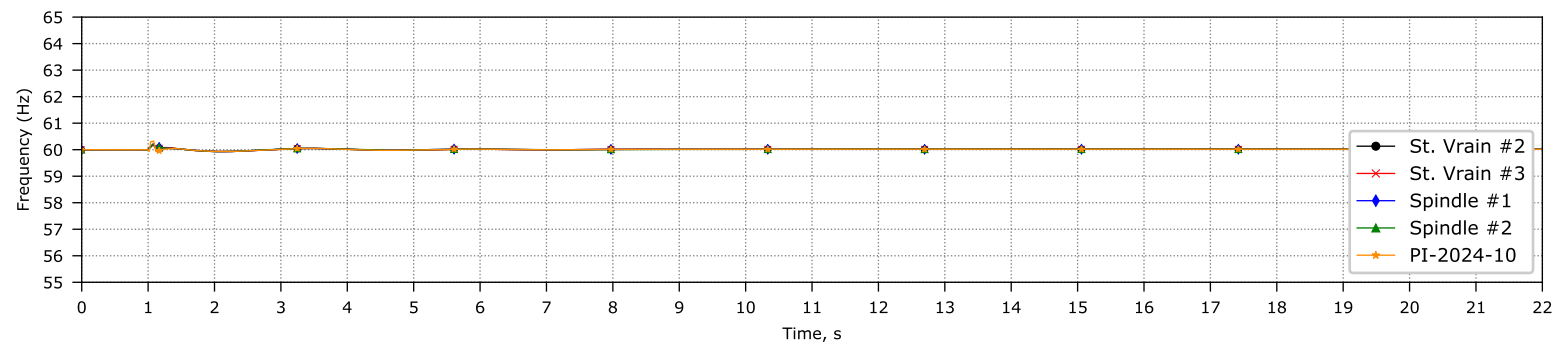


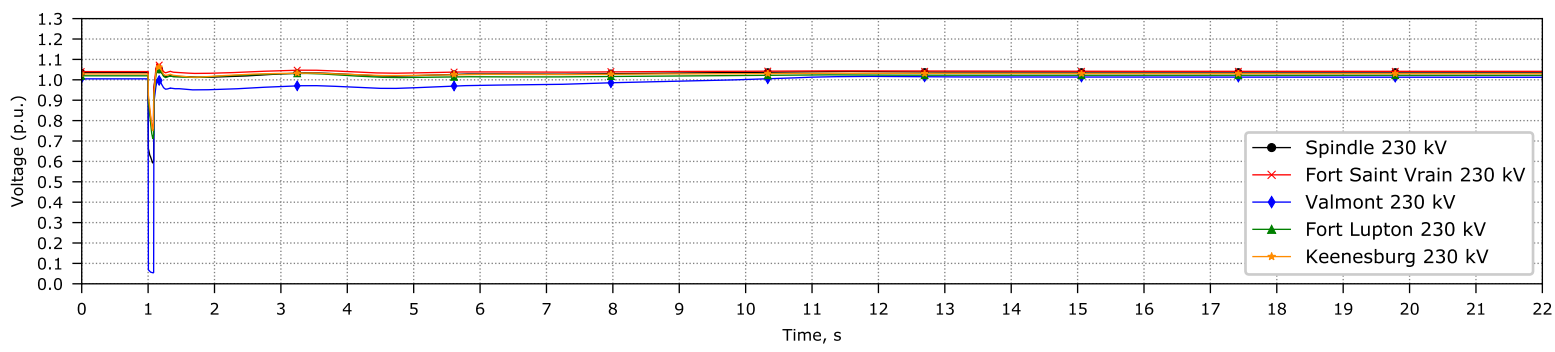




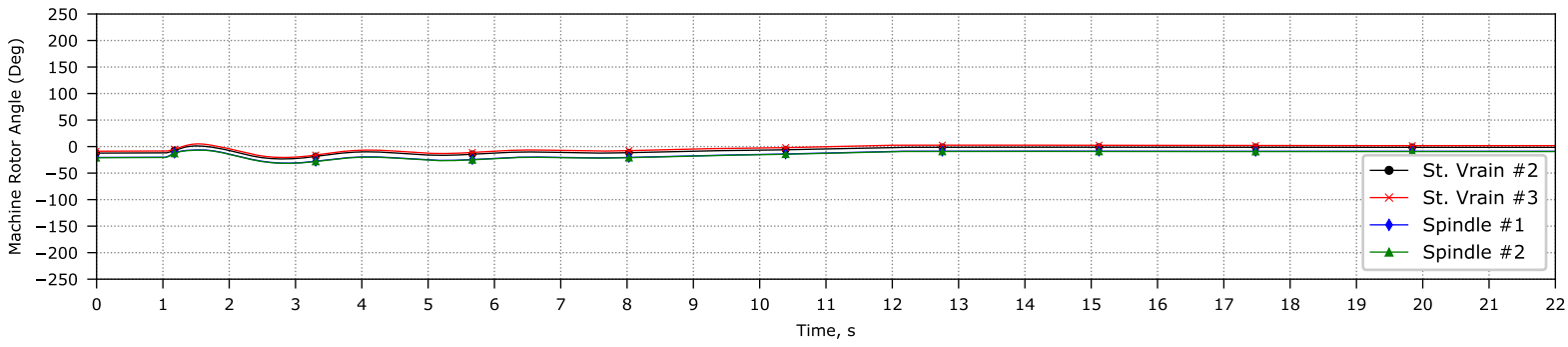


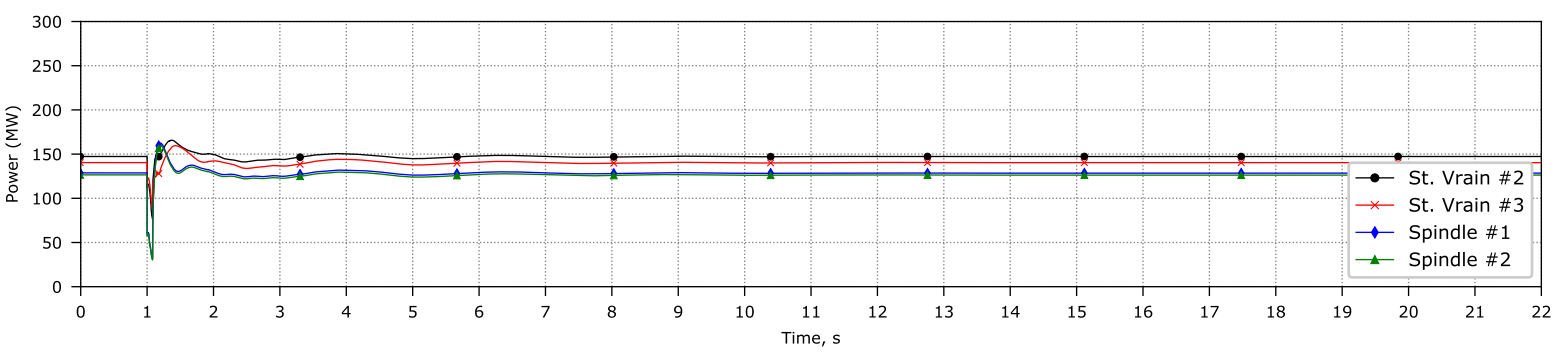


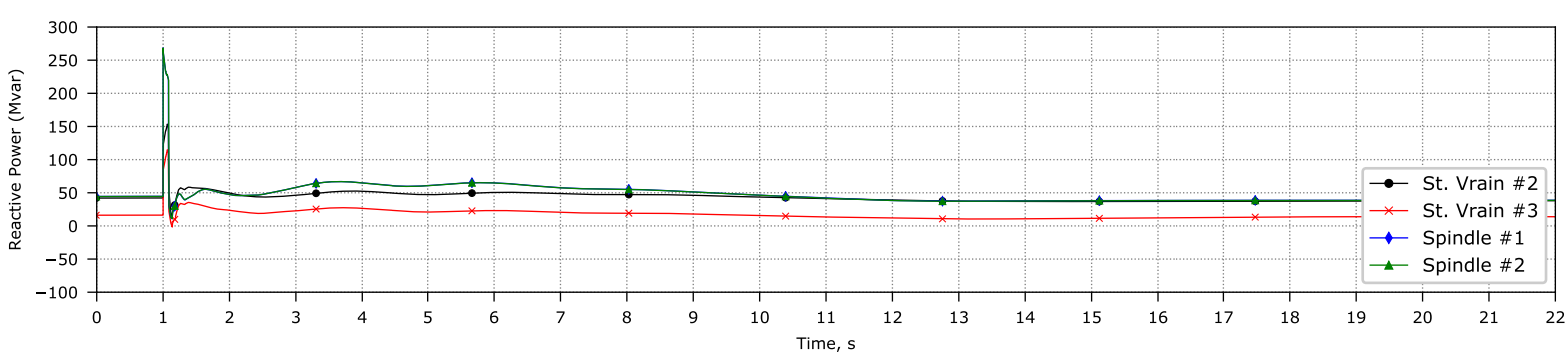


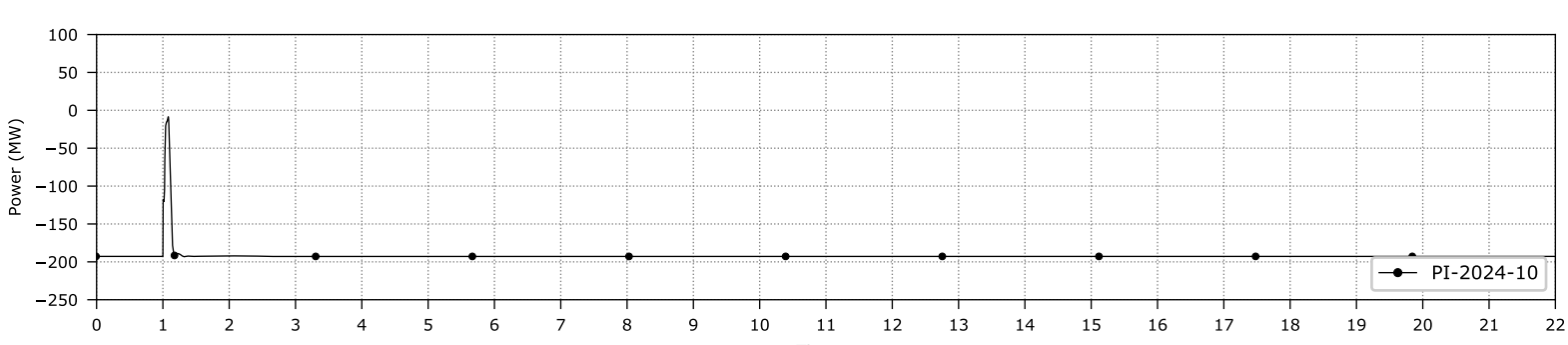


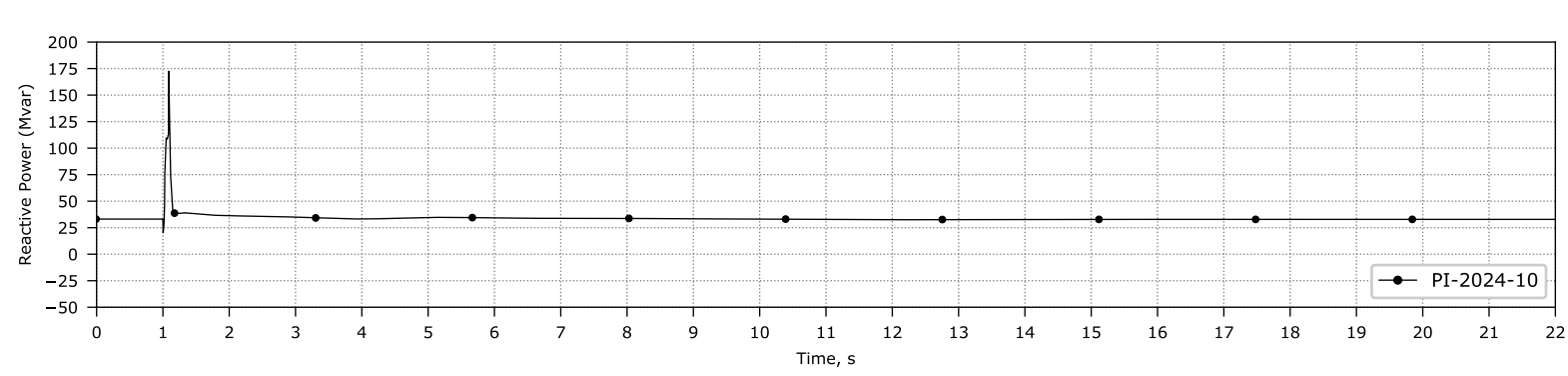
PI-2024-10_Study_North_GC_Valmont_Xfmr

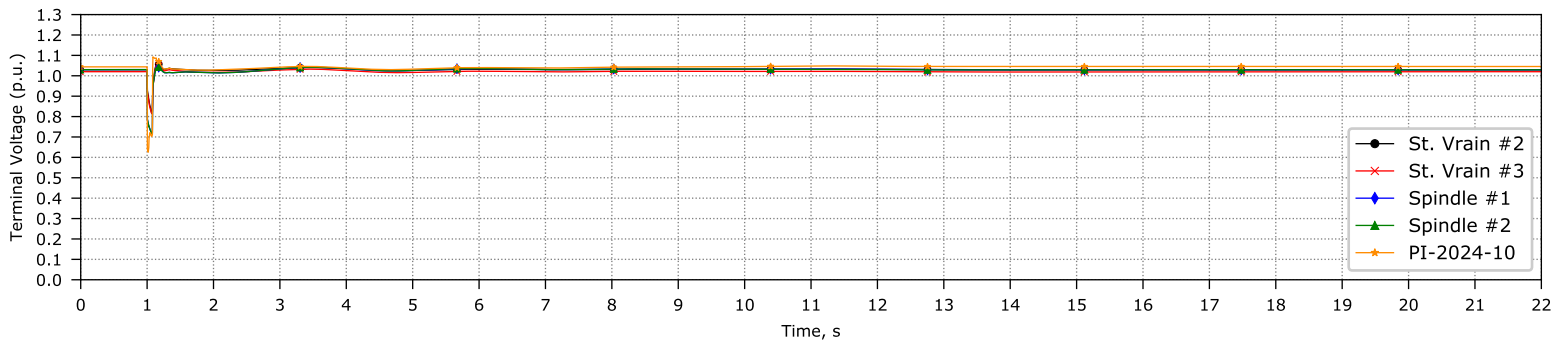


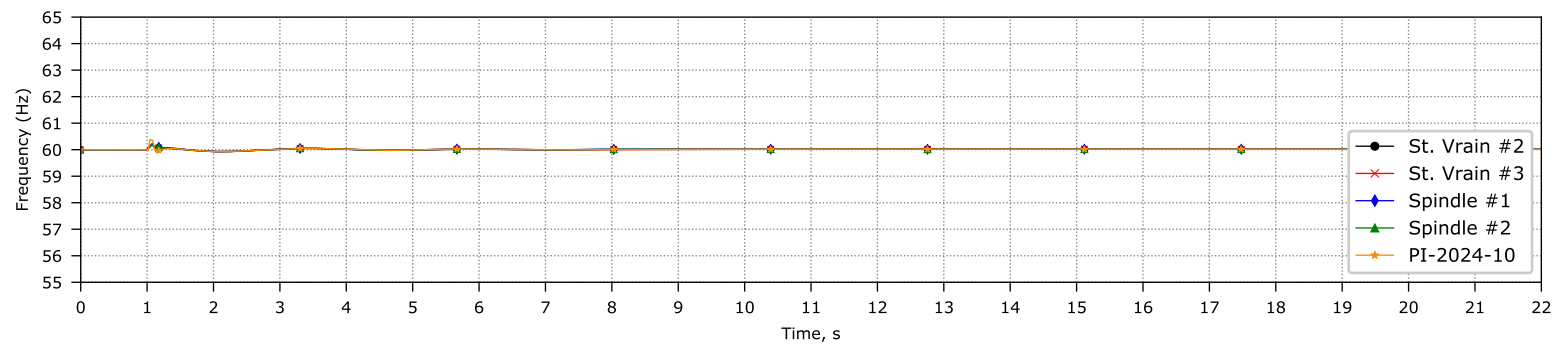


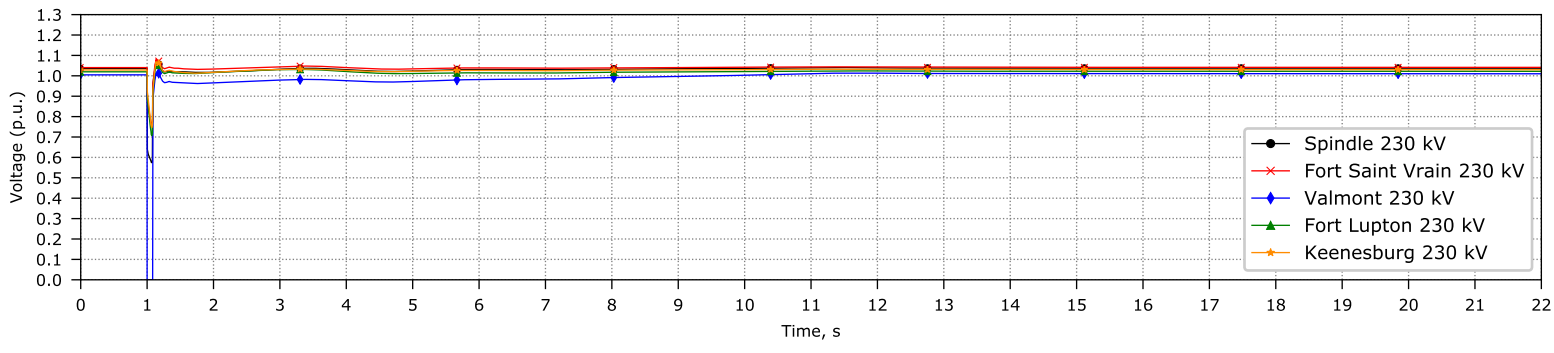




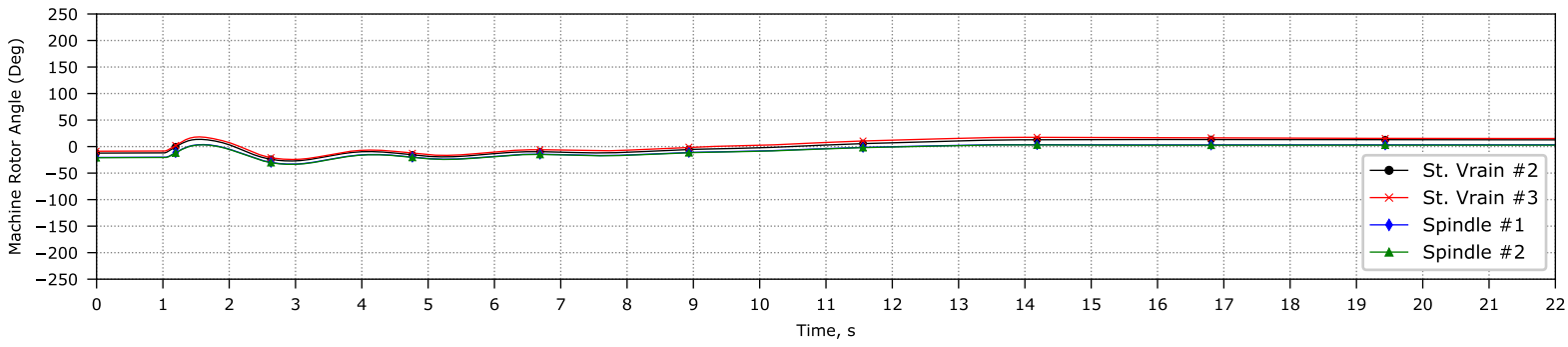


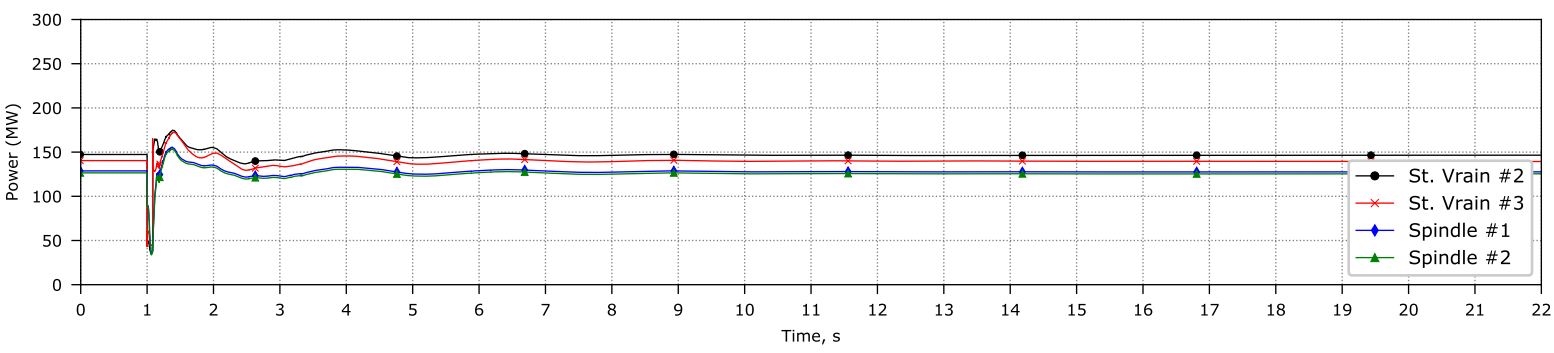


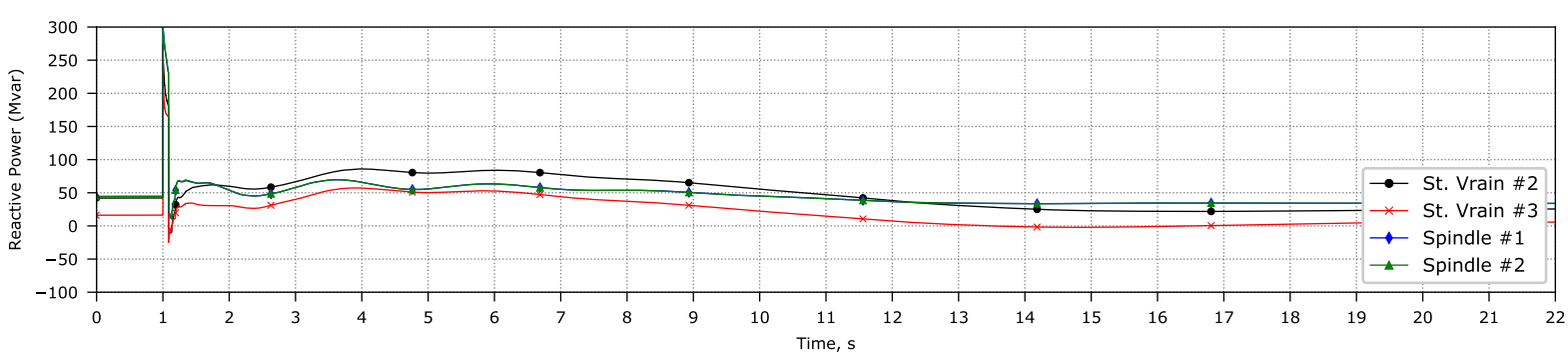


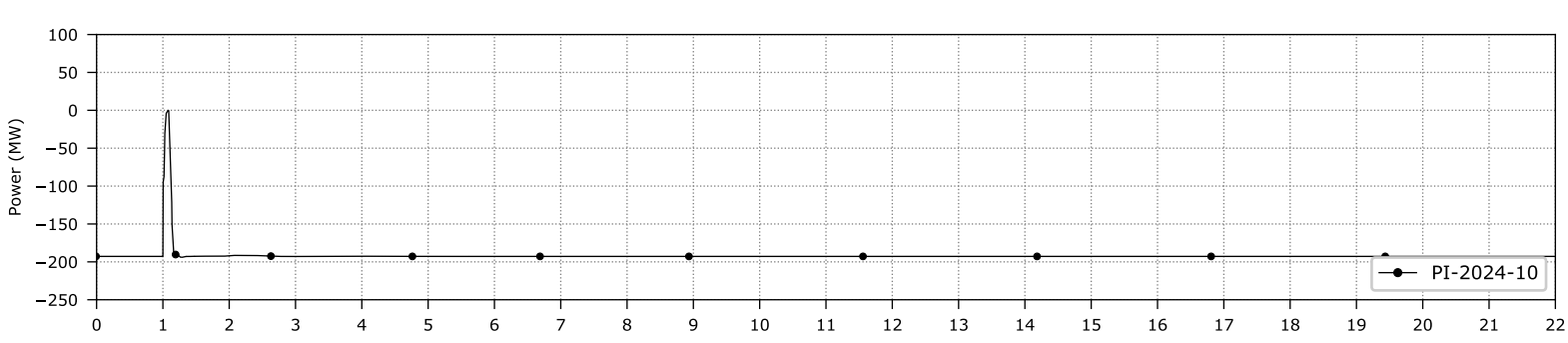


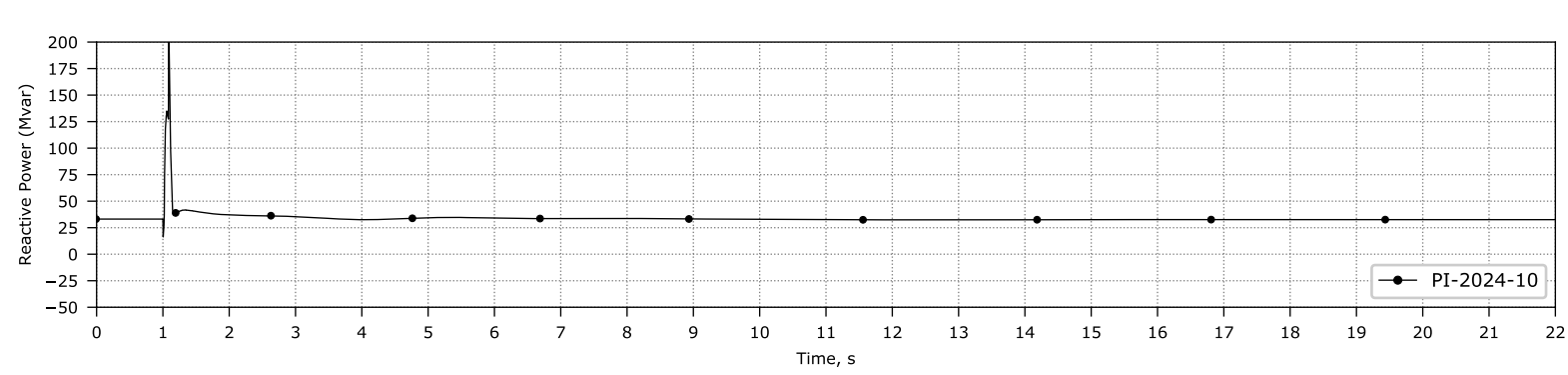
PI-2024-10_Study_North_GC_FSV-FtLupton_230kV

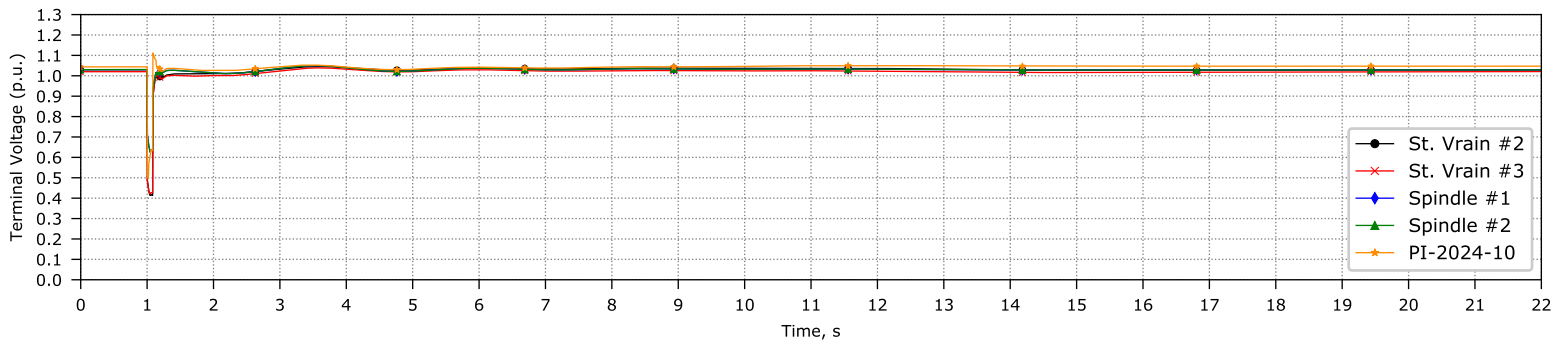


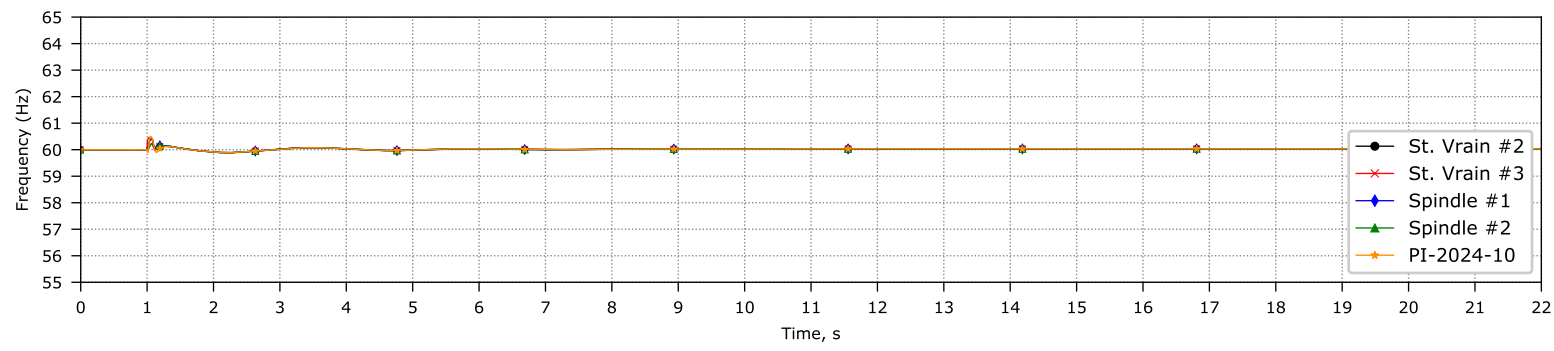


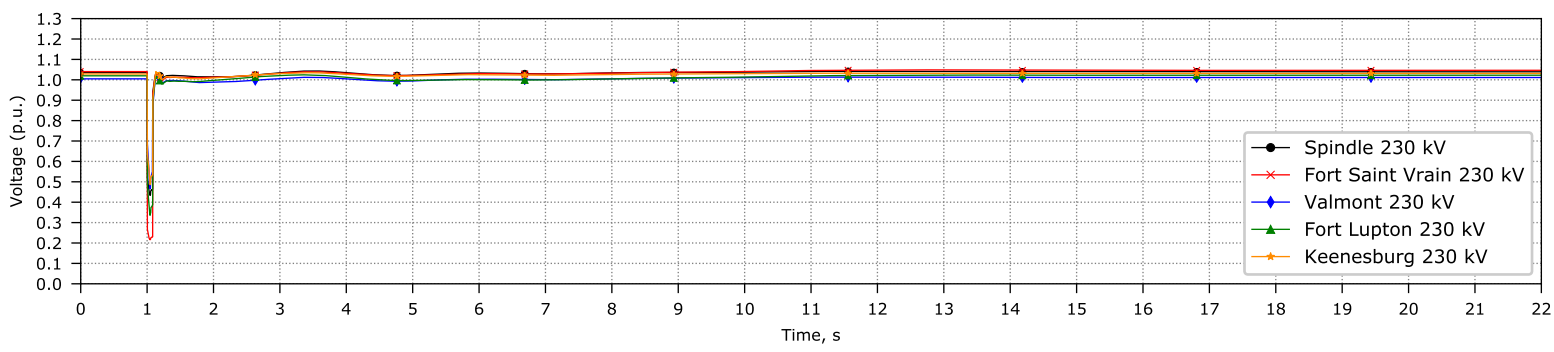




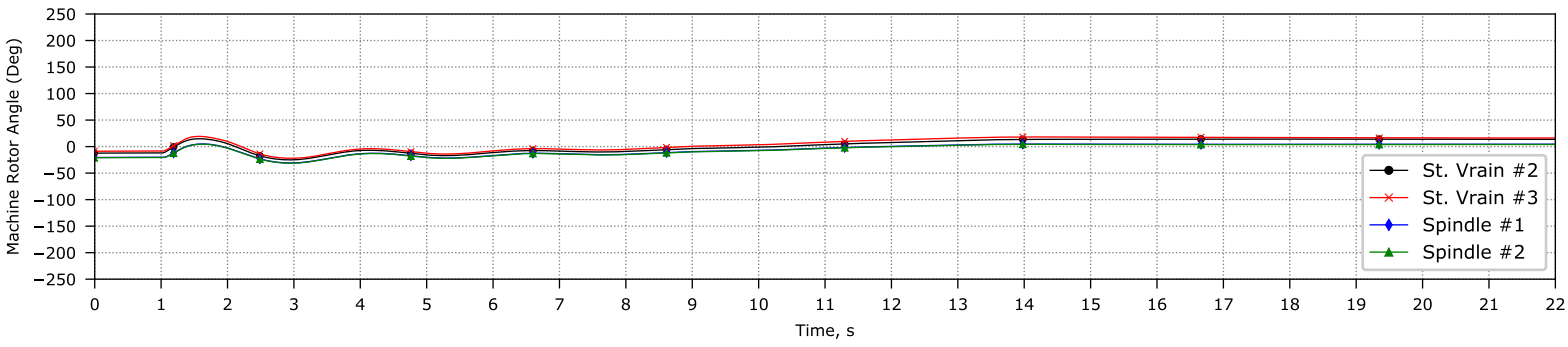


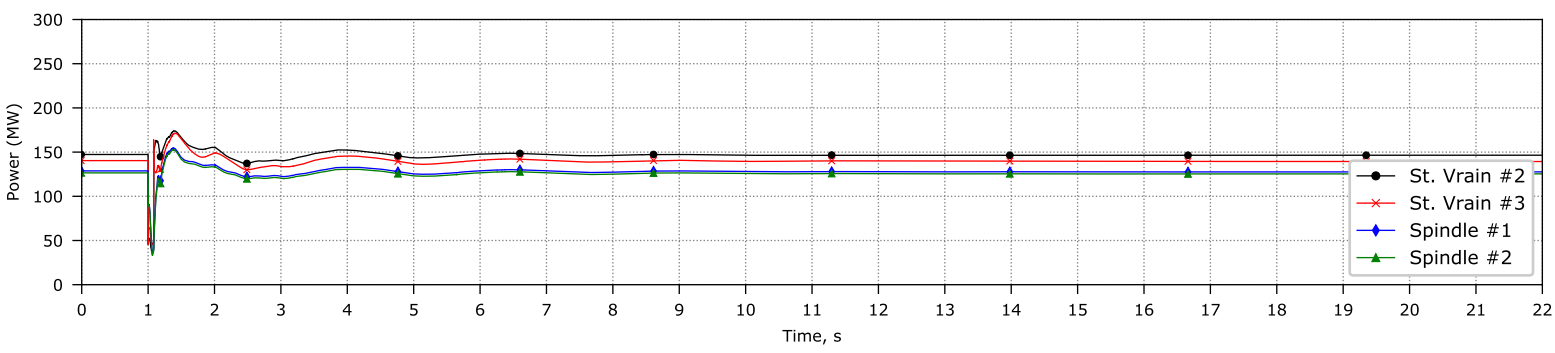


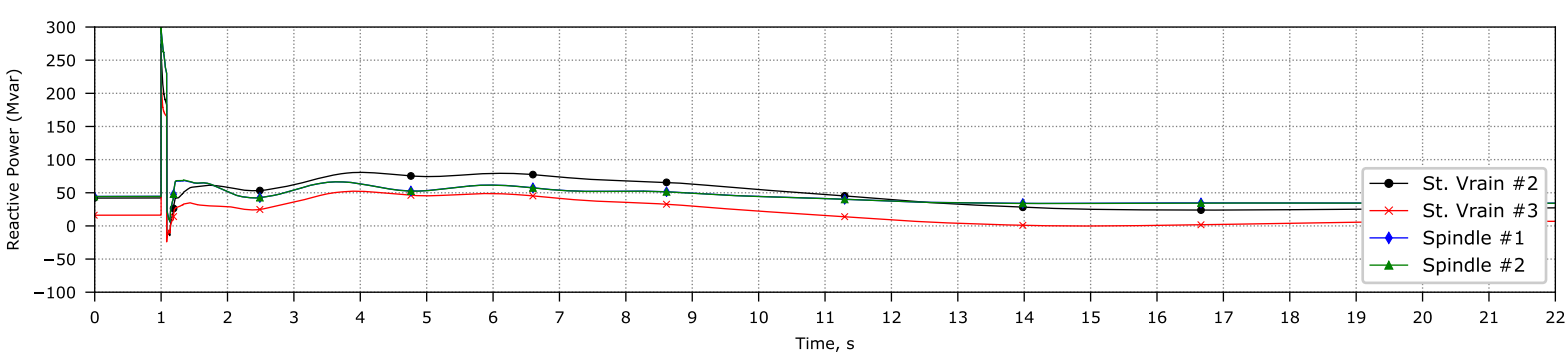


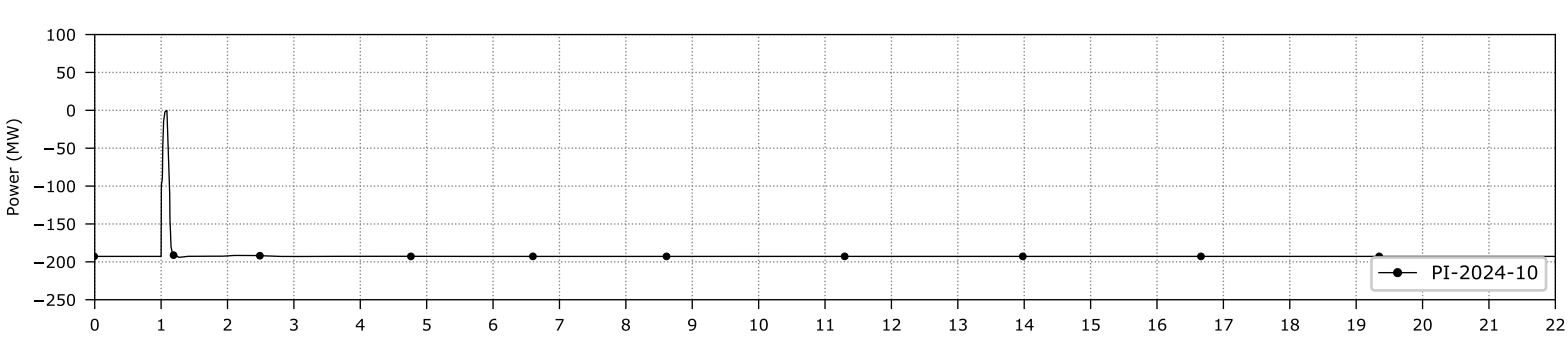


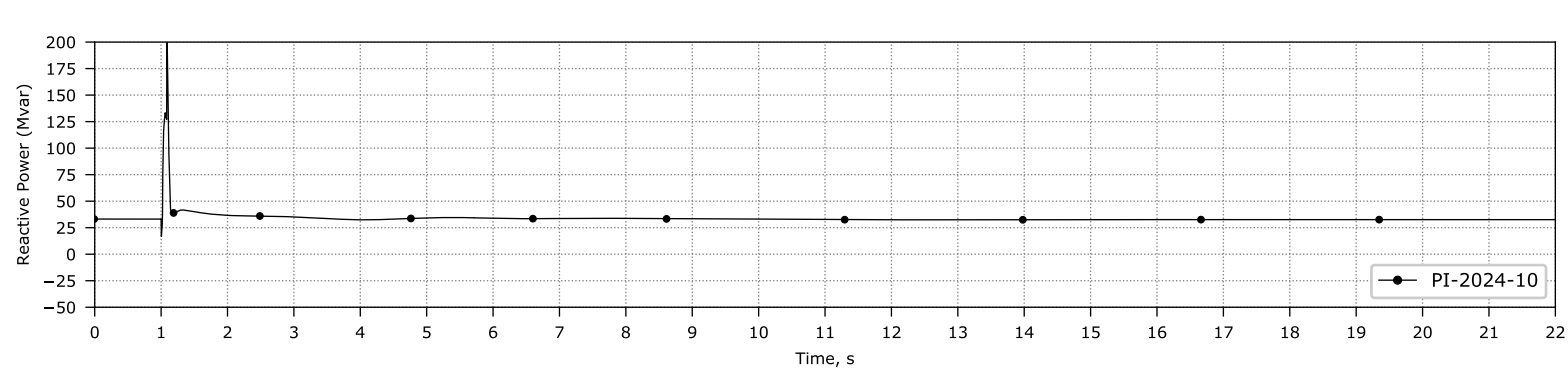
PI-2024-10_Study_North_GC_FSV-Weld_230kV

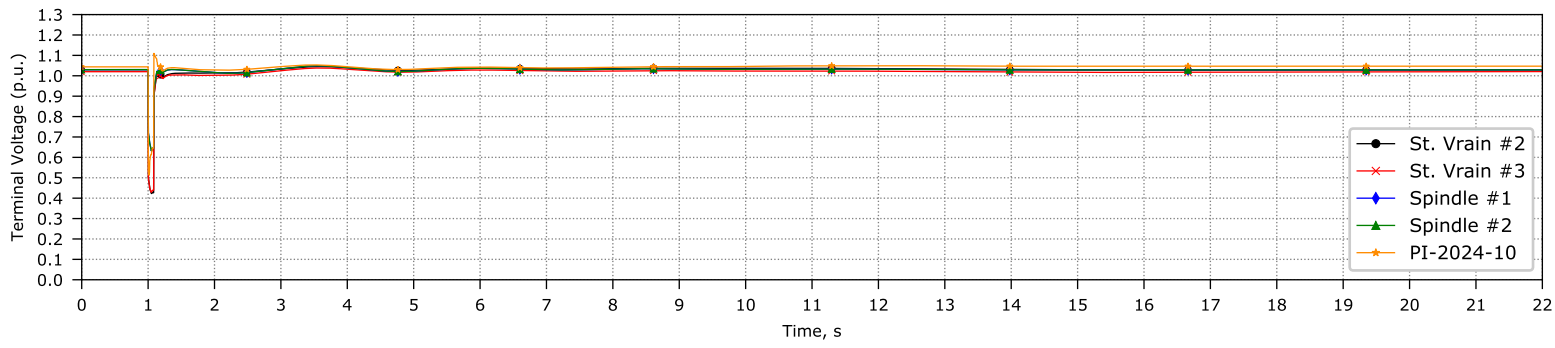


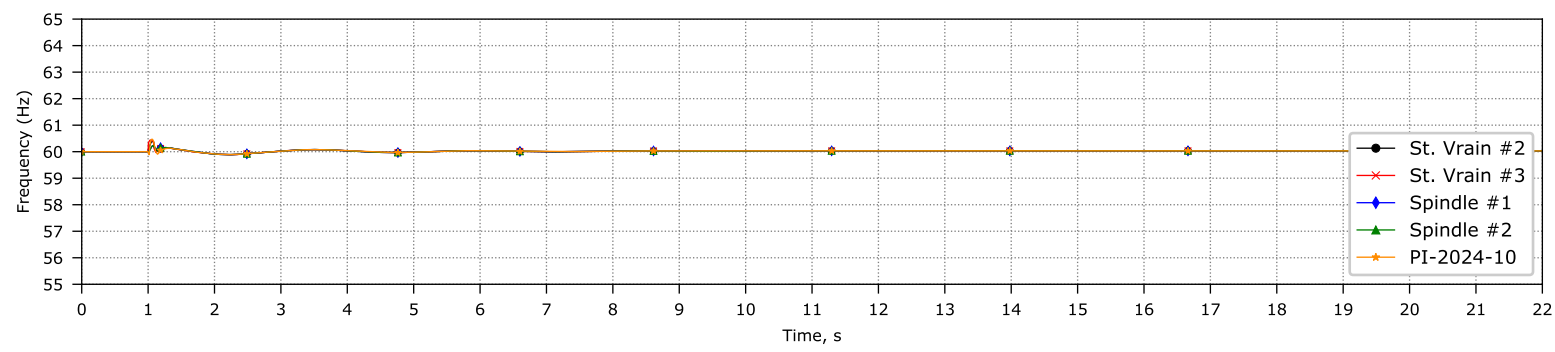


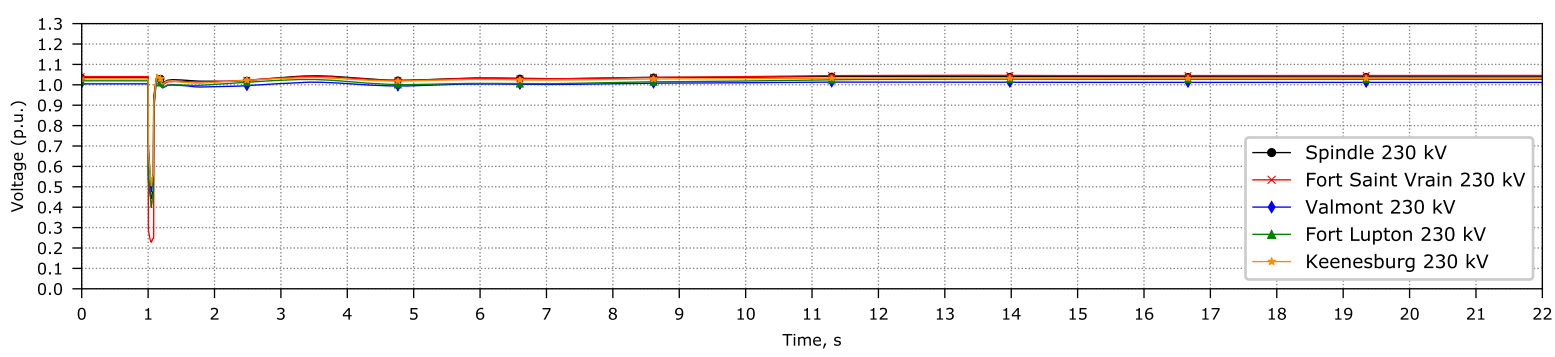




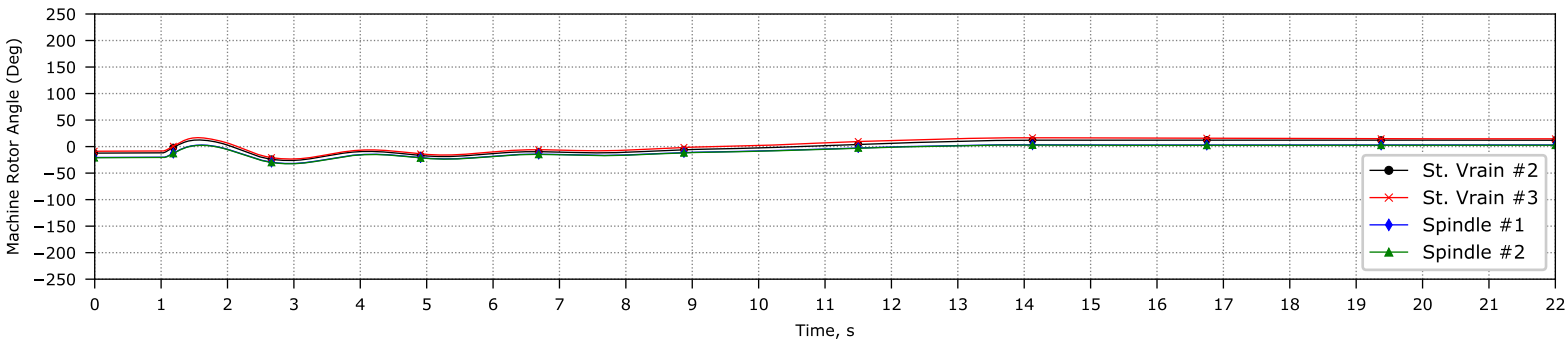


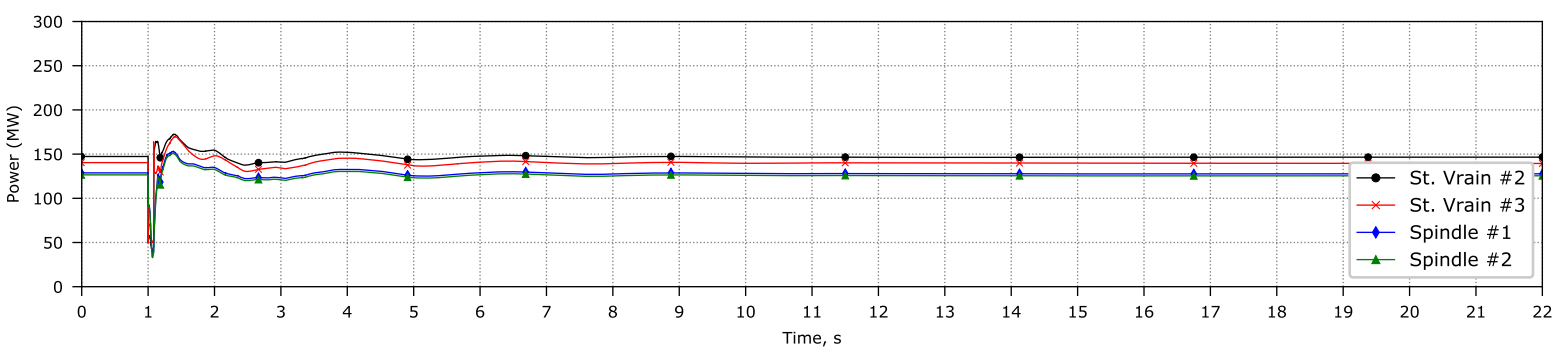


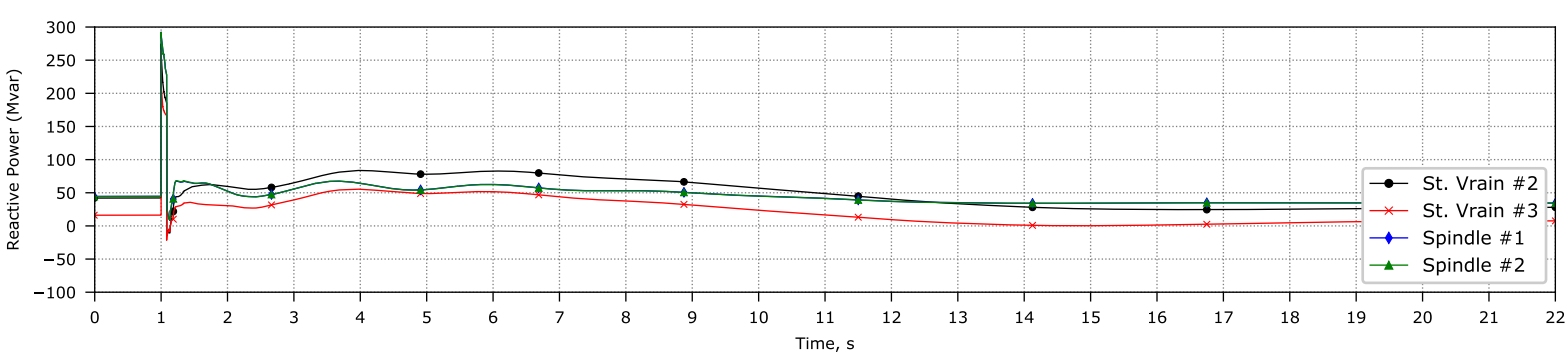


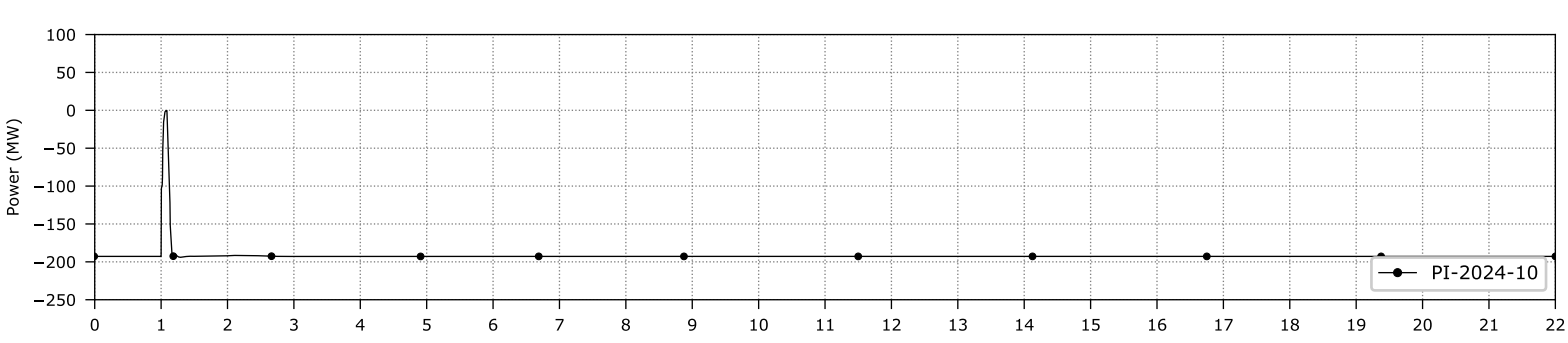


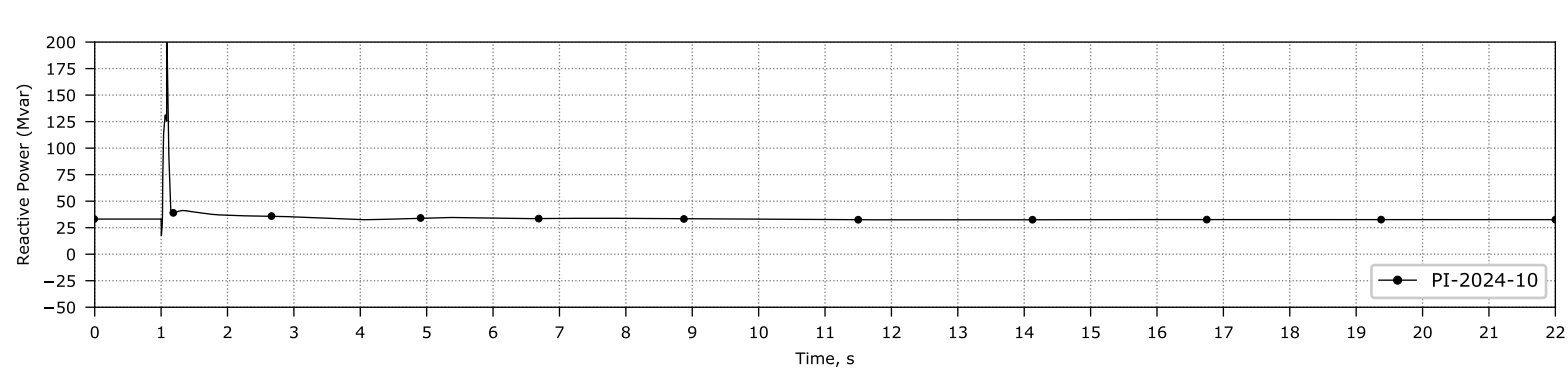
PI-2024-10_Study_North_GC_FSV-Windsor_230kV

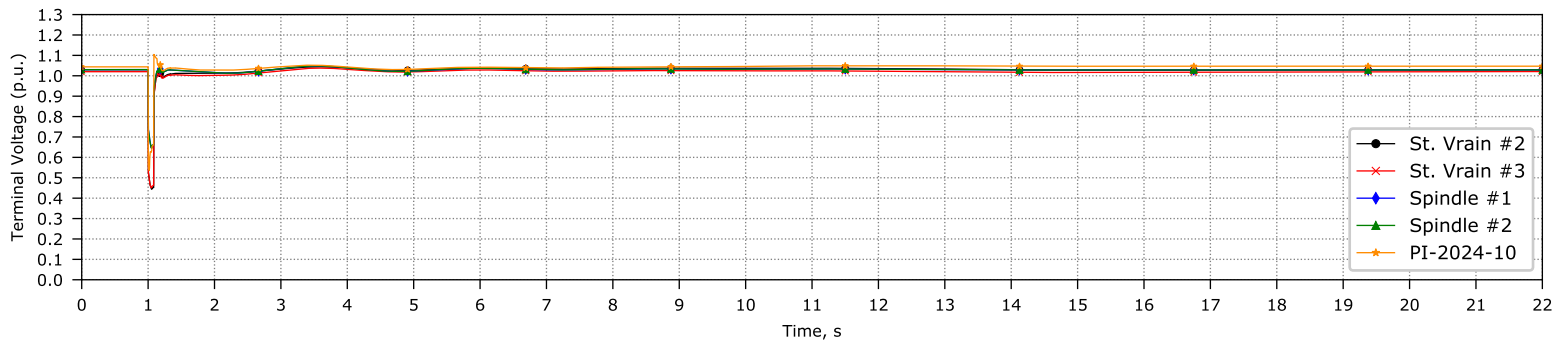


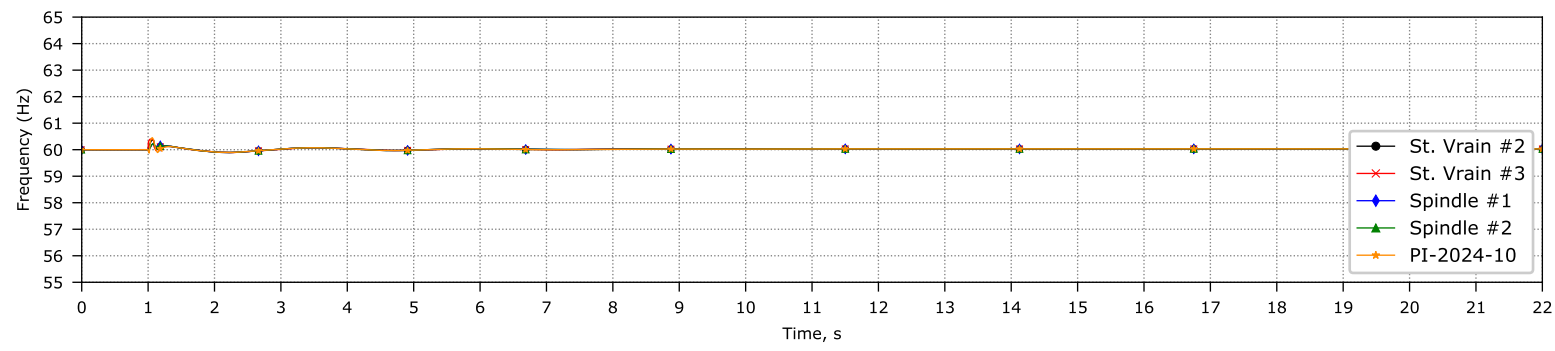


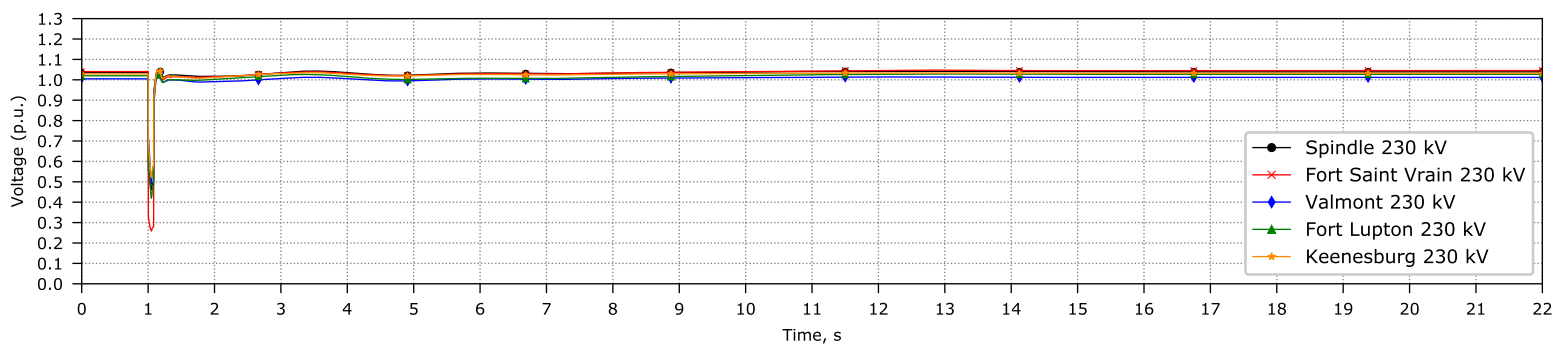




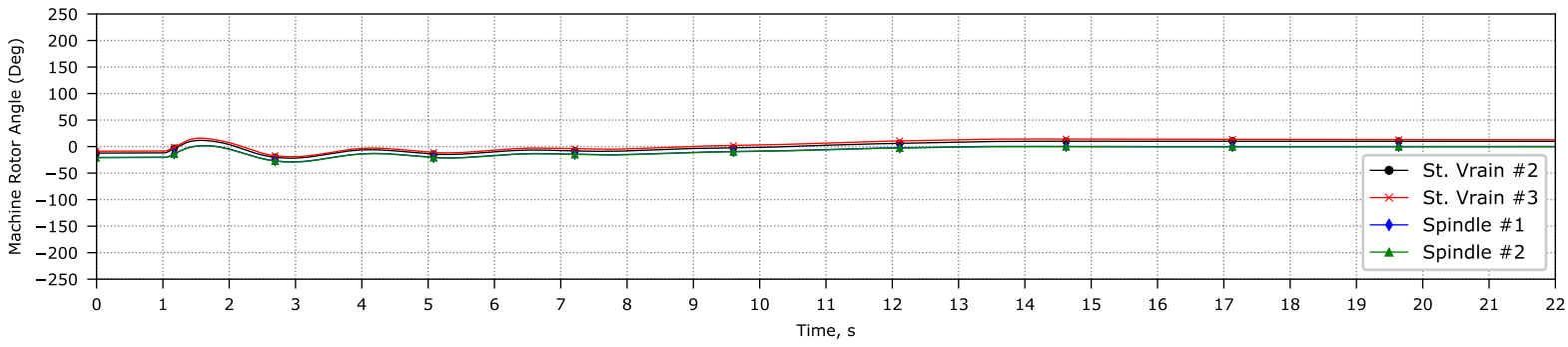


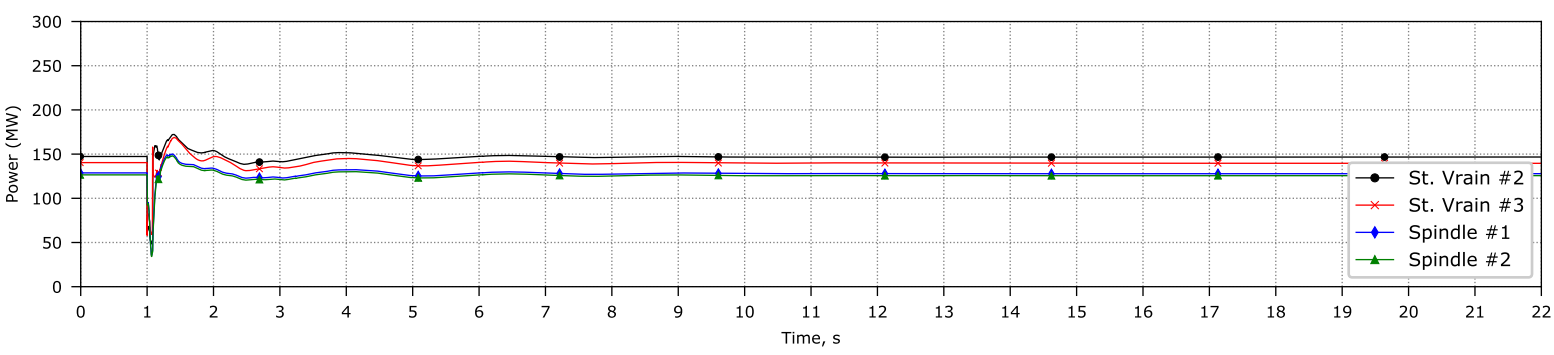


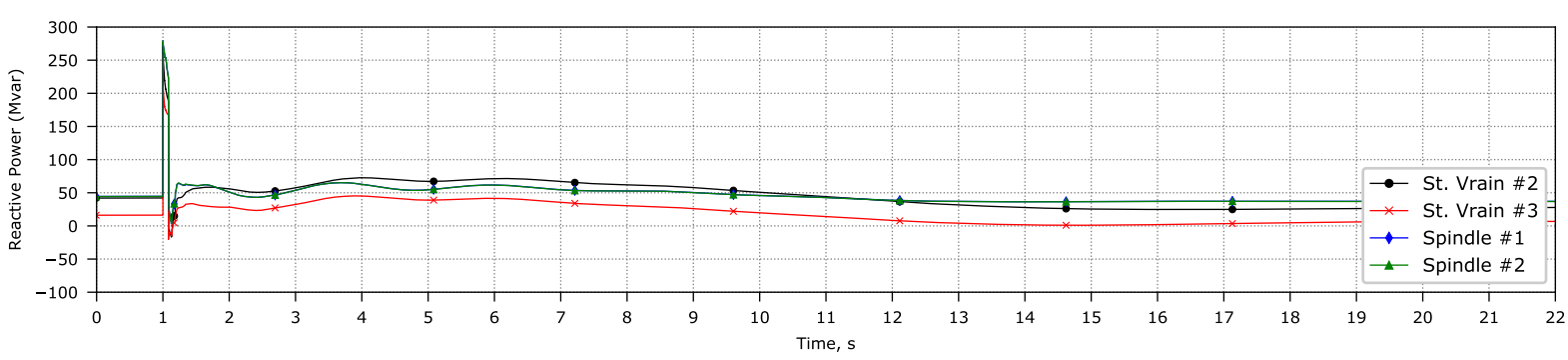


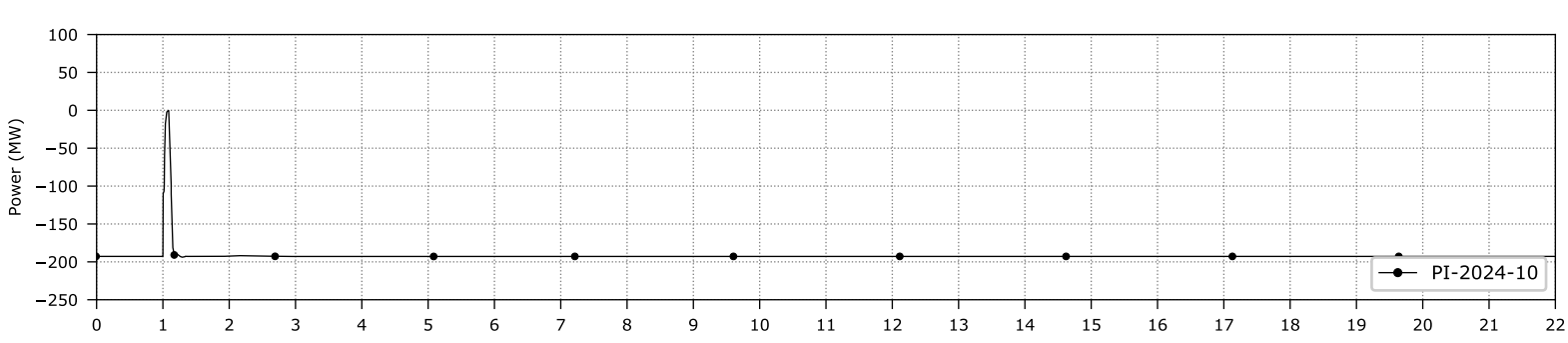


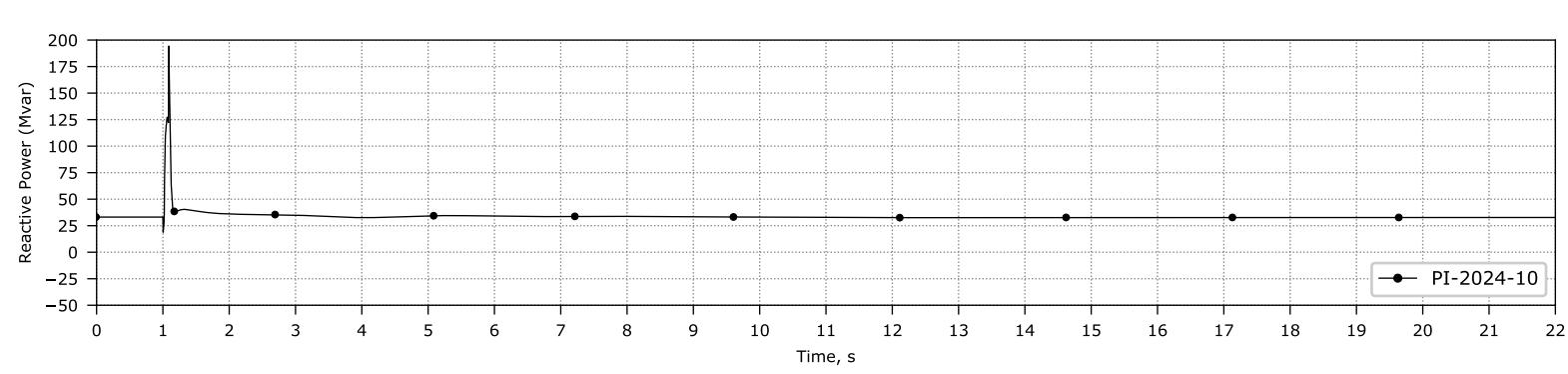
PI-2024-10_Study_North_GC_FSV-Isabelle_230kV

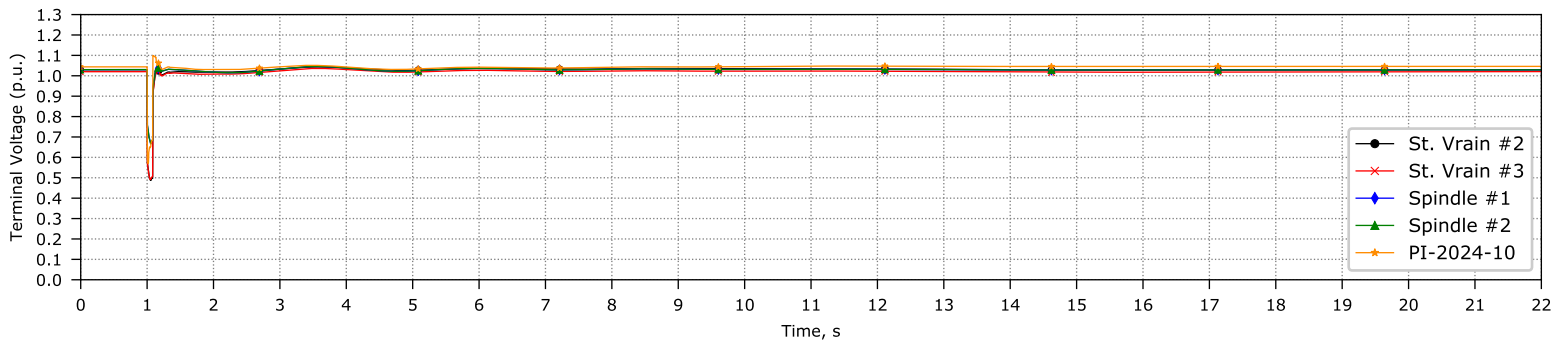


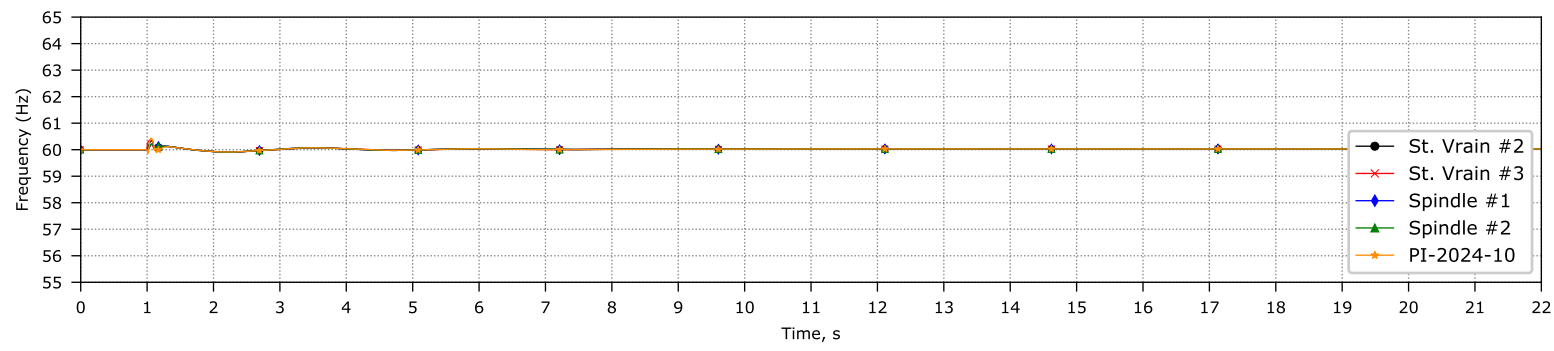


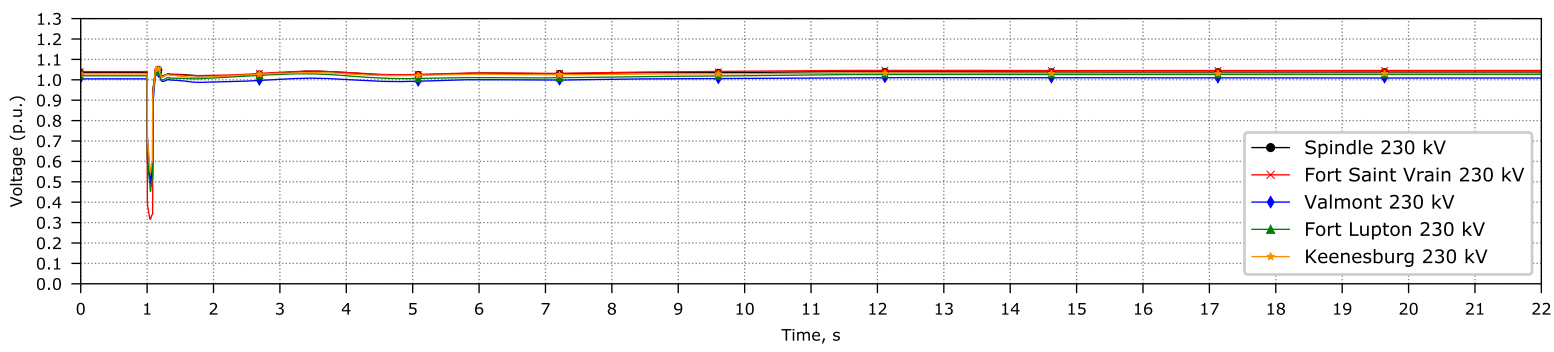




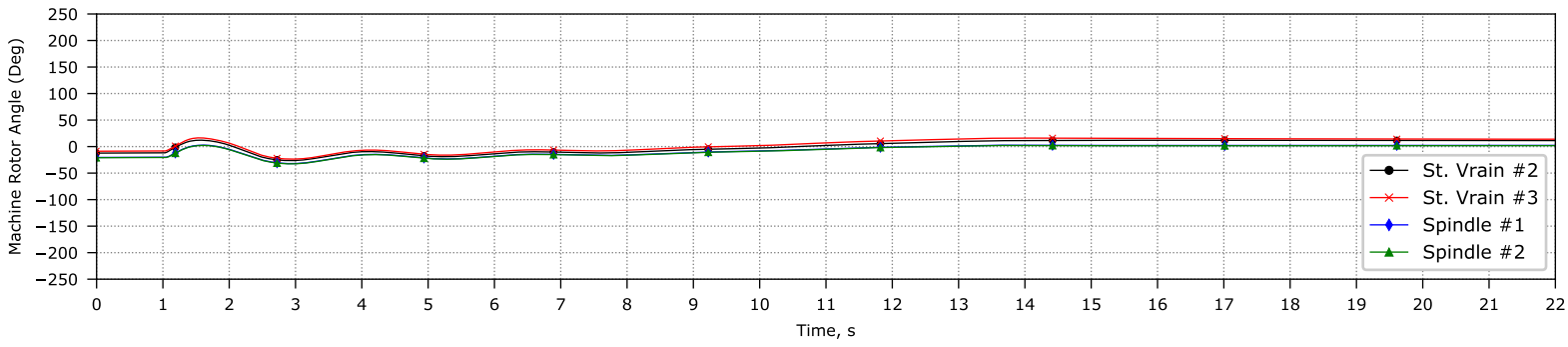


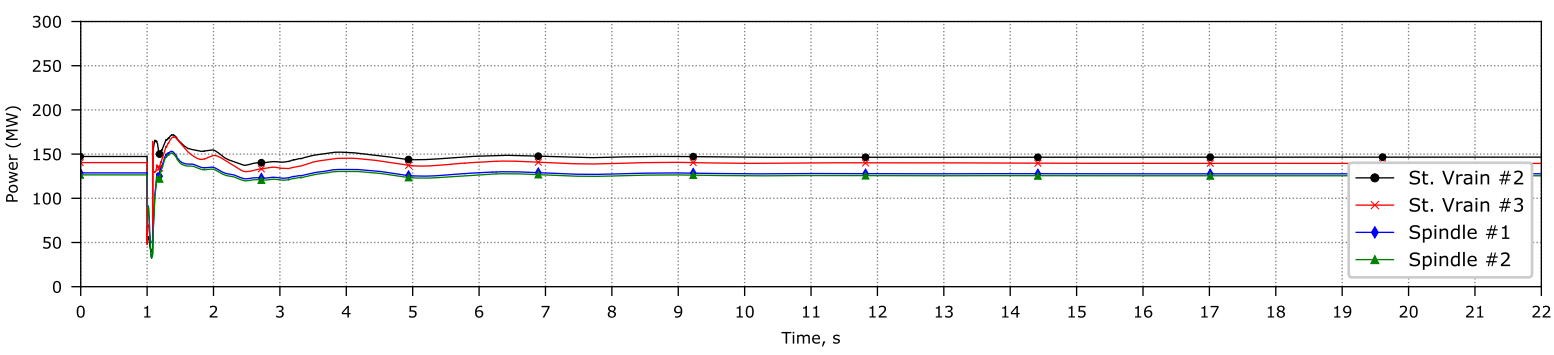


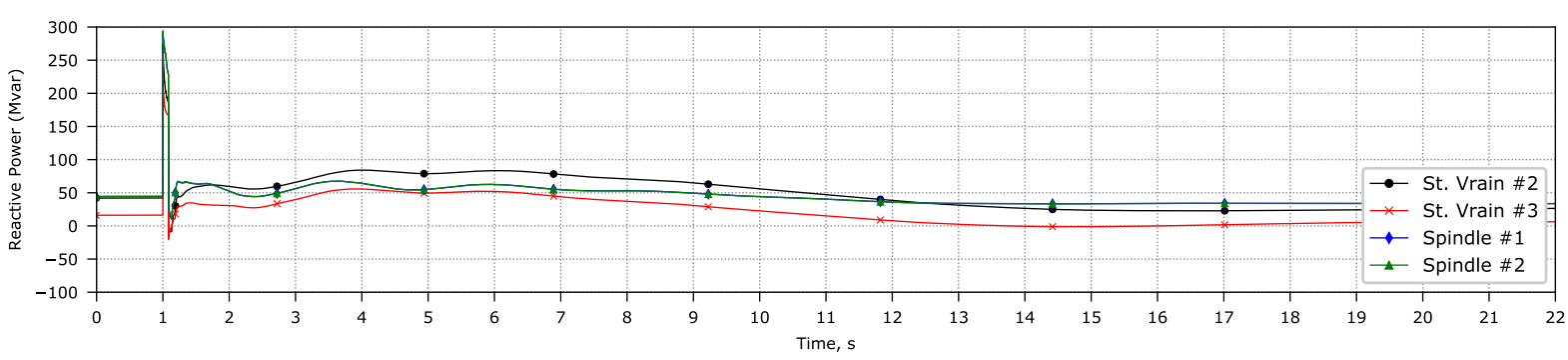


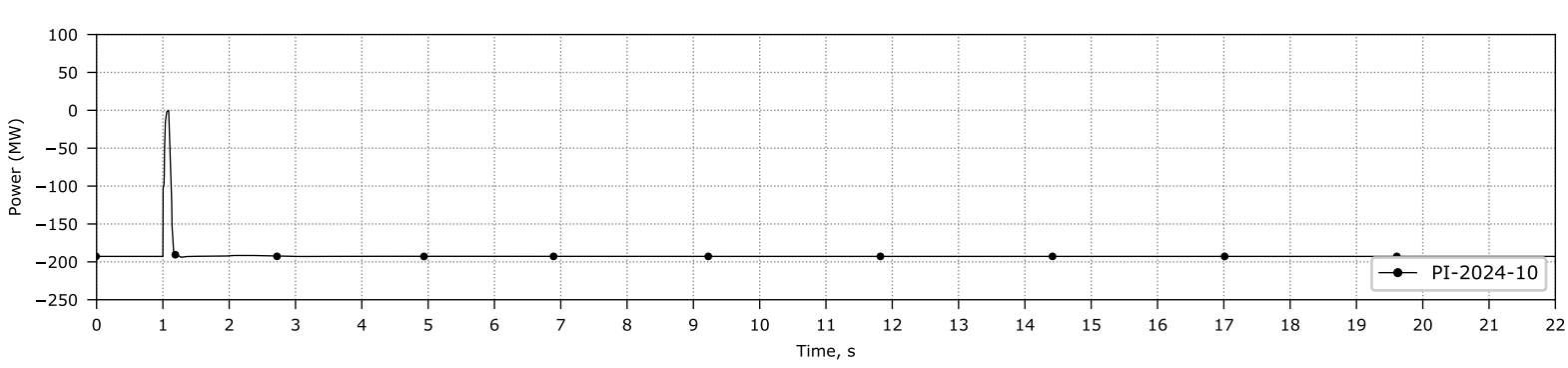


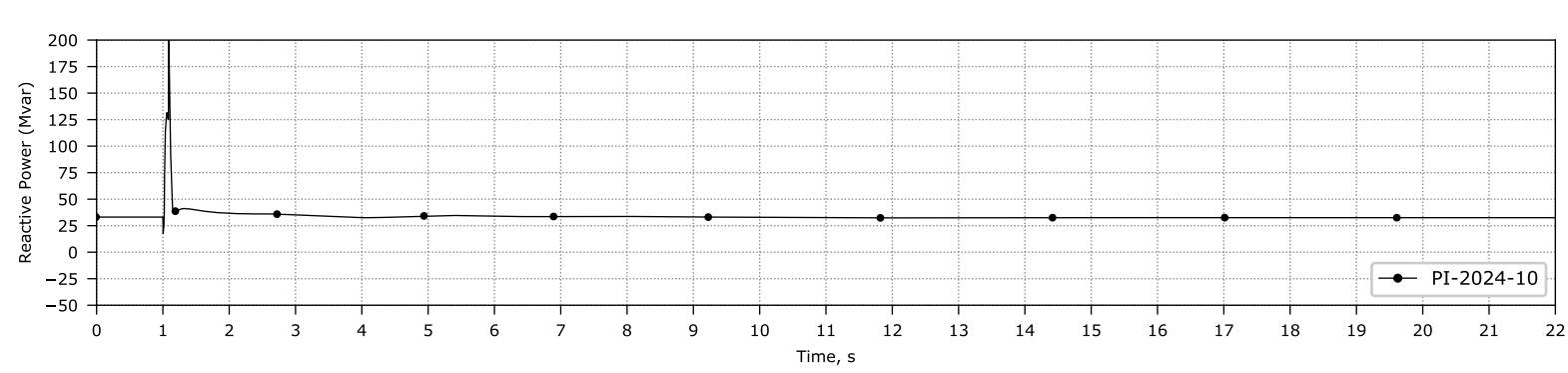
PI-2024-10_Study_North_GC_FSV-Keenesburg_230kV

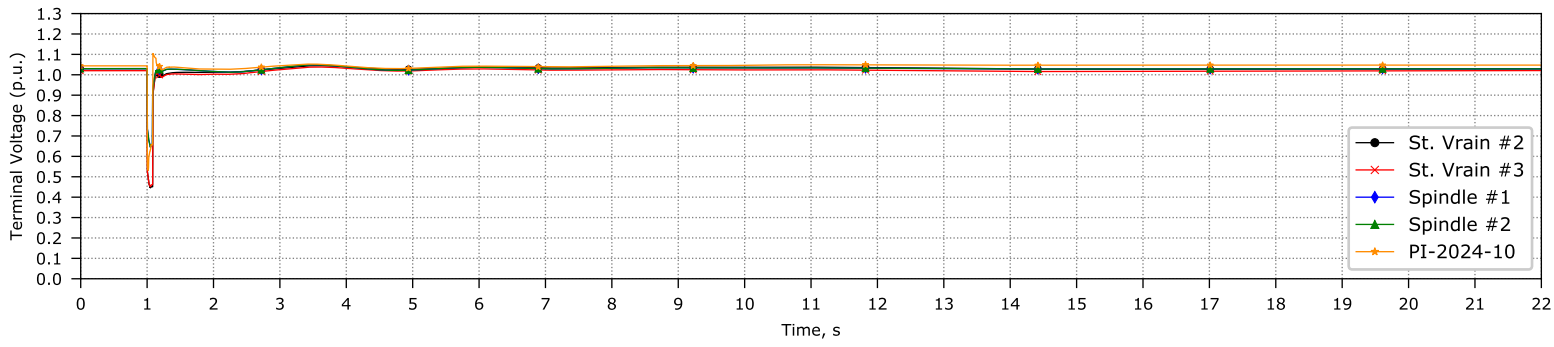


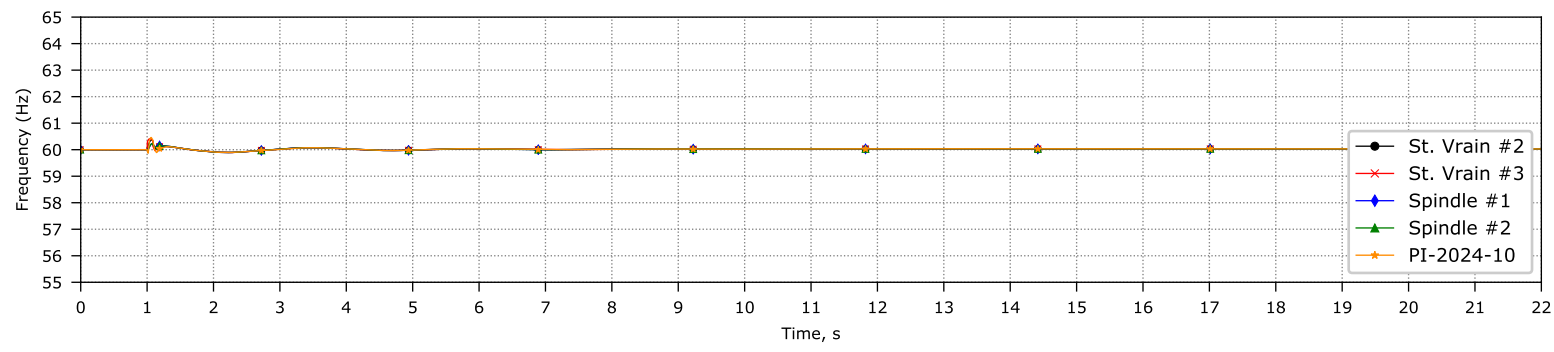


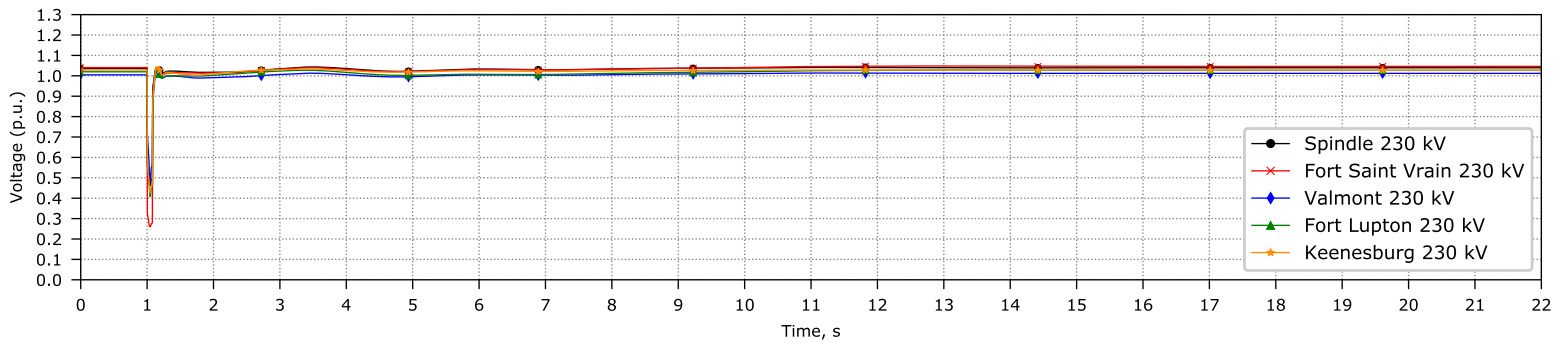




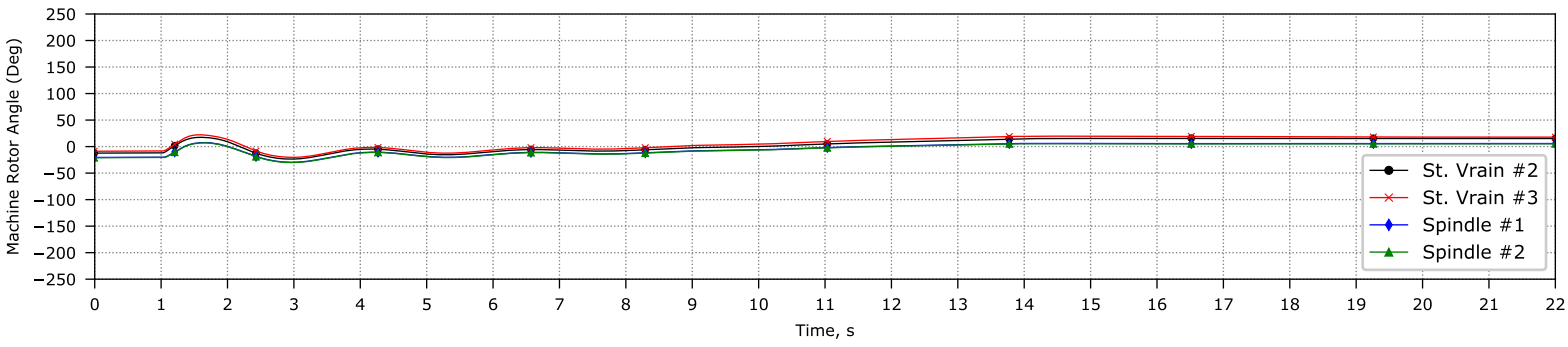


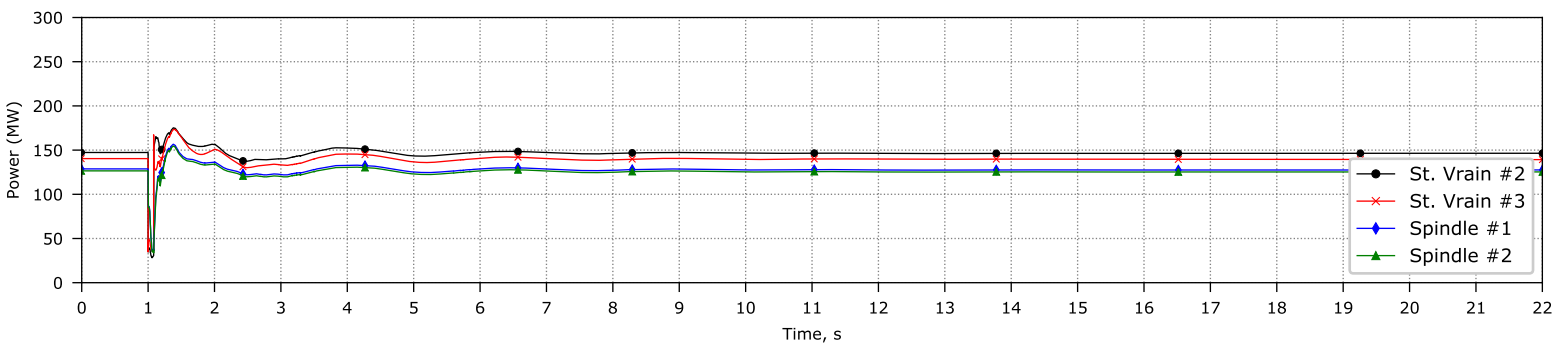


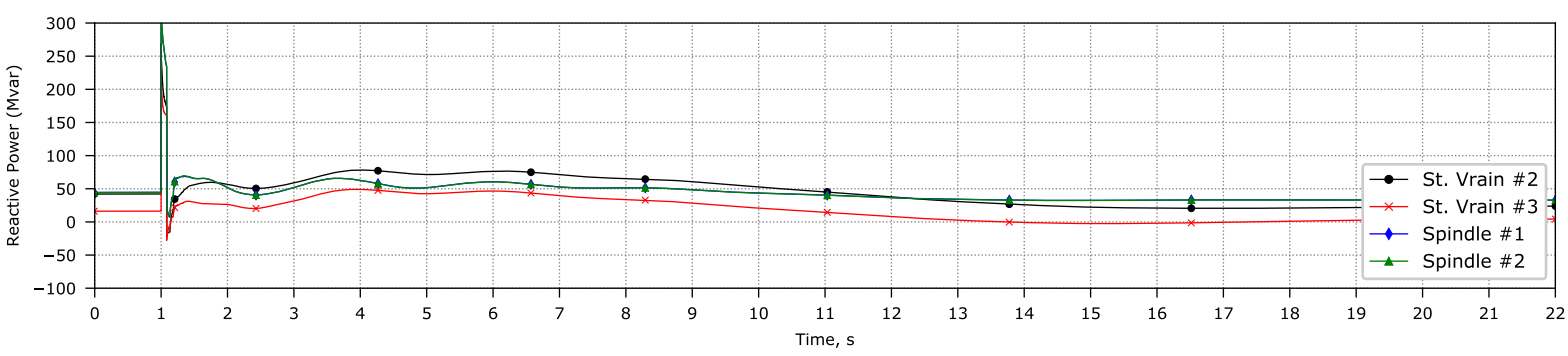


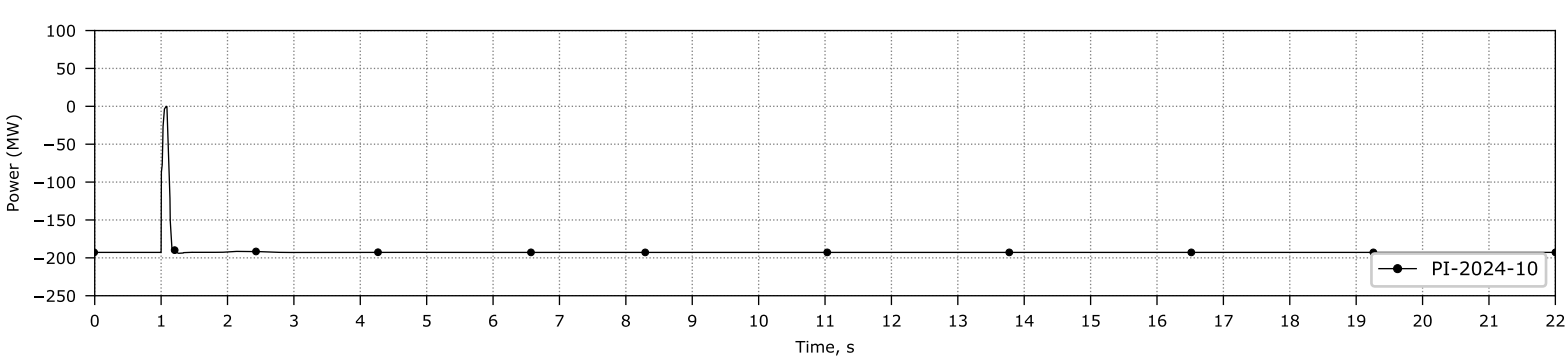


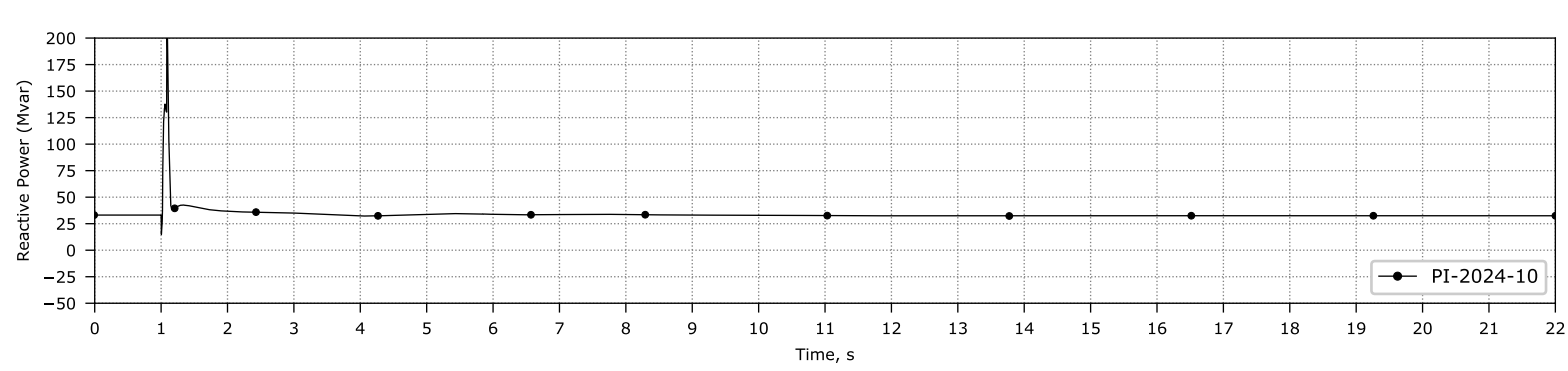
PI-2024-10_Study_North_GC_FSV-Longpeak_230kV

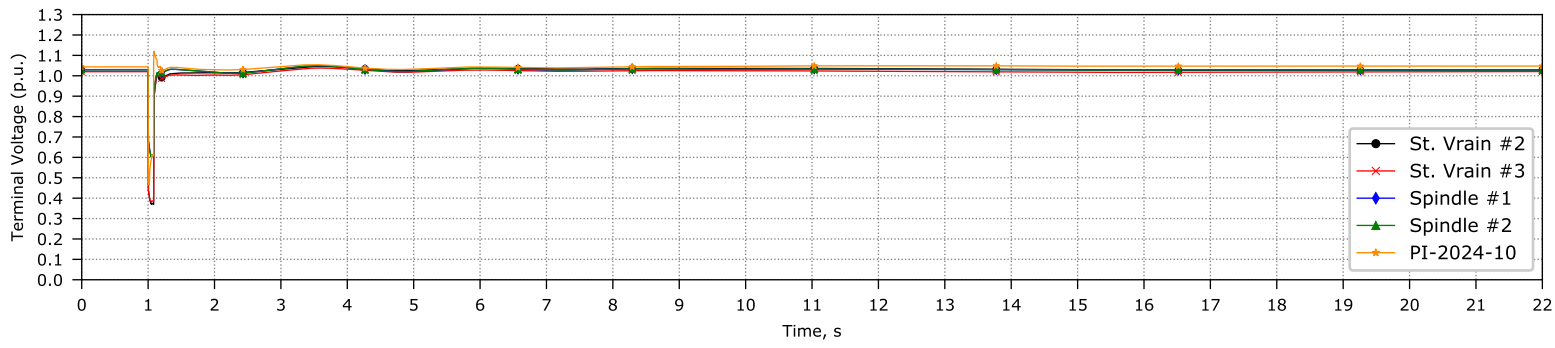


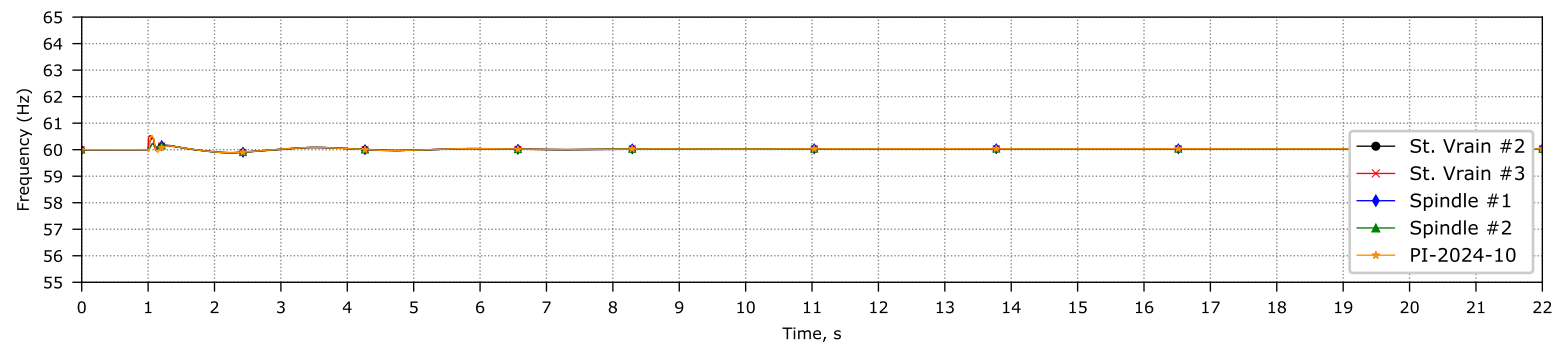


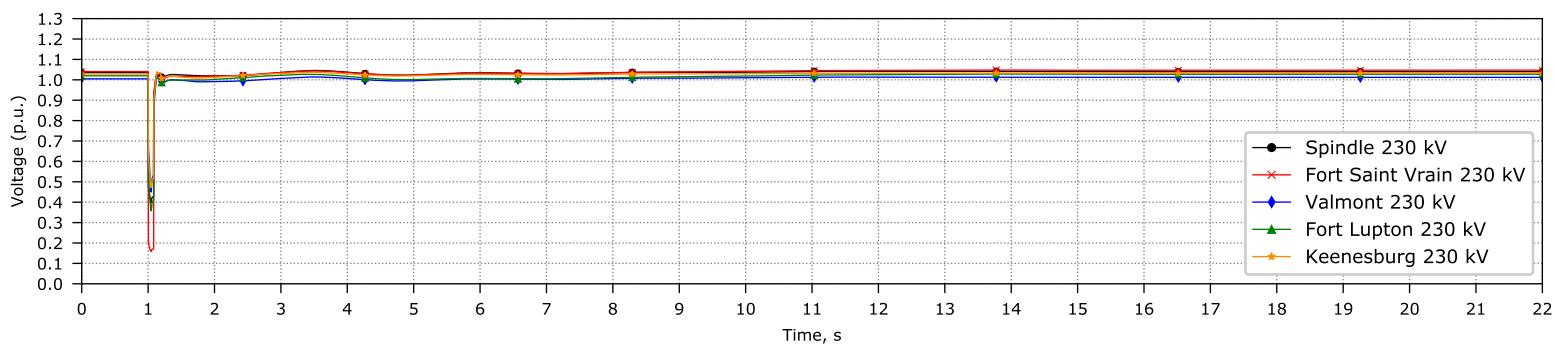




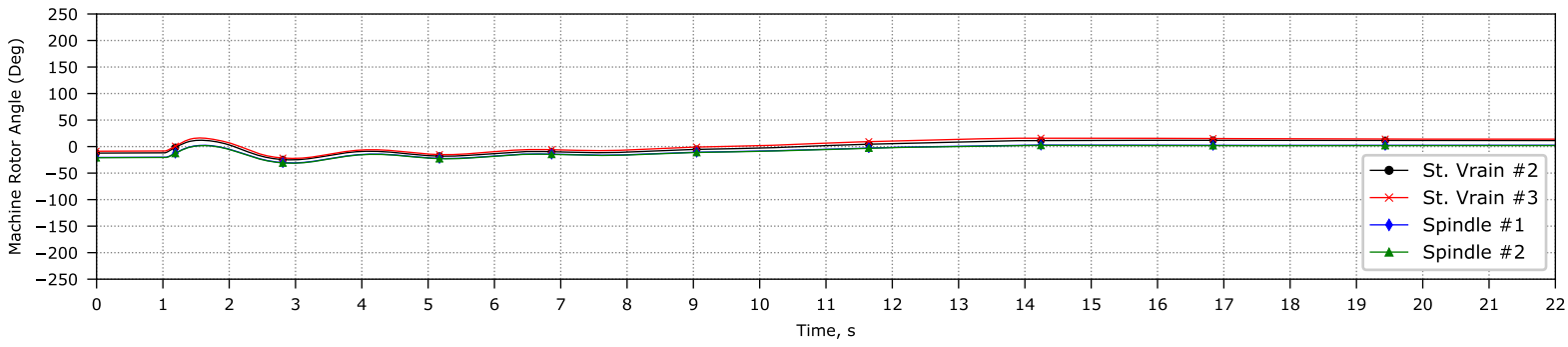


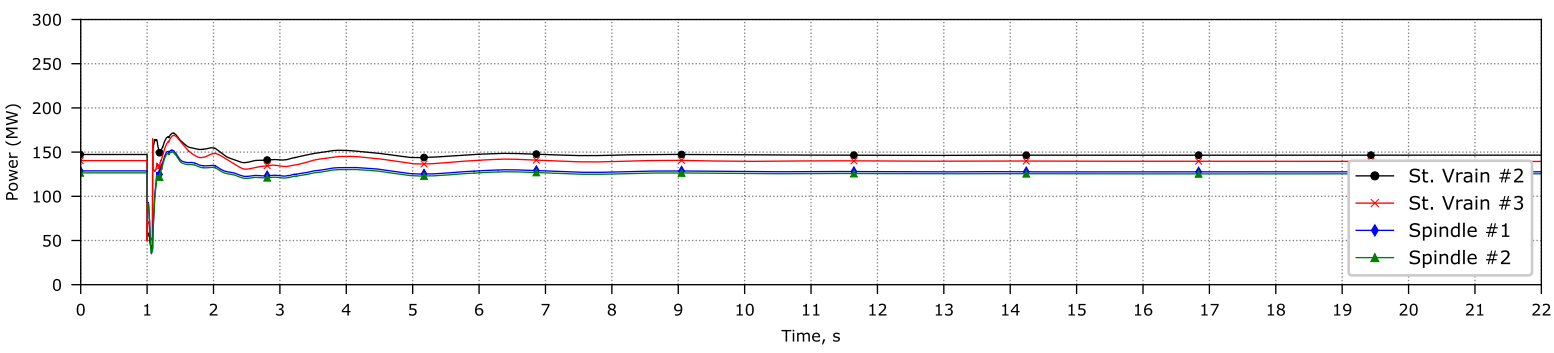


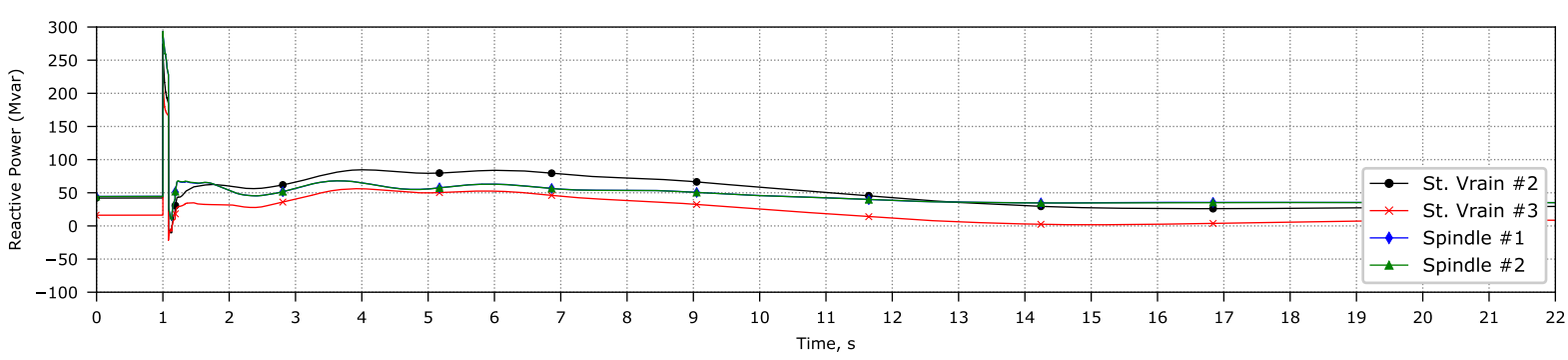


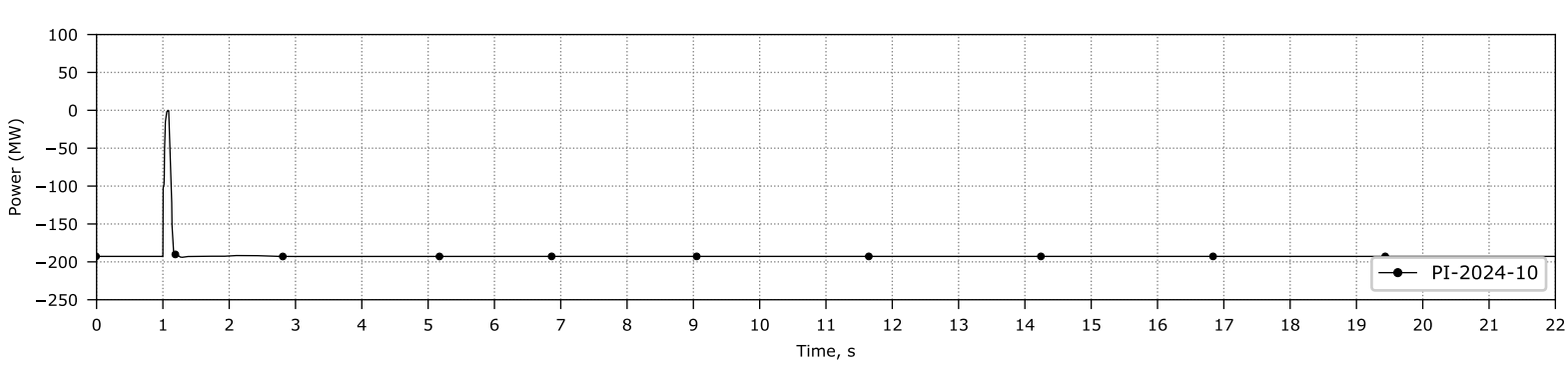


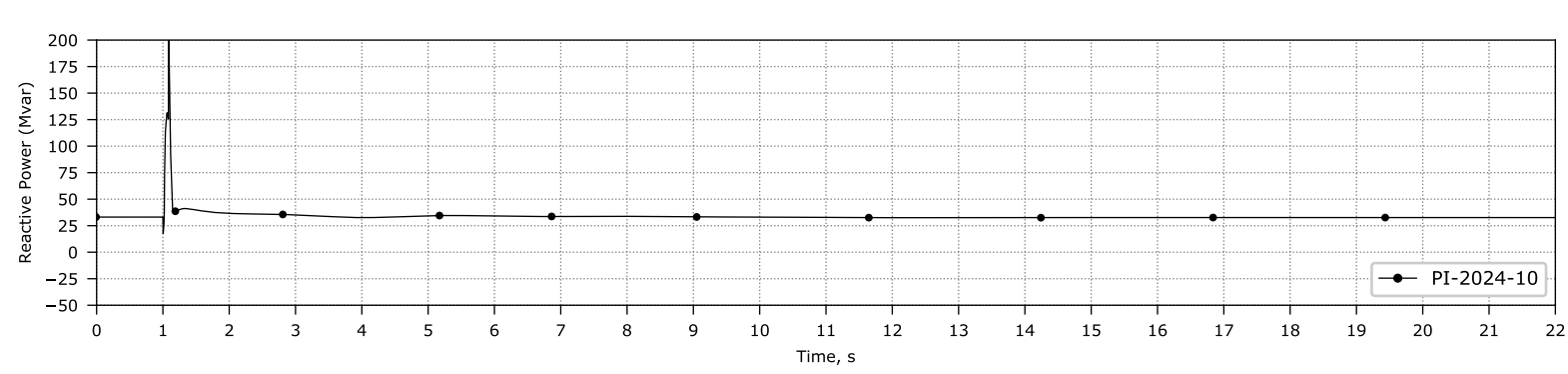
PI-2024-10_Study_North_GC_FSV-Fordham_230kV

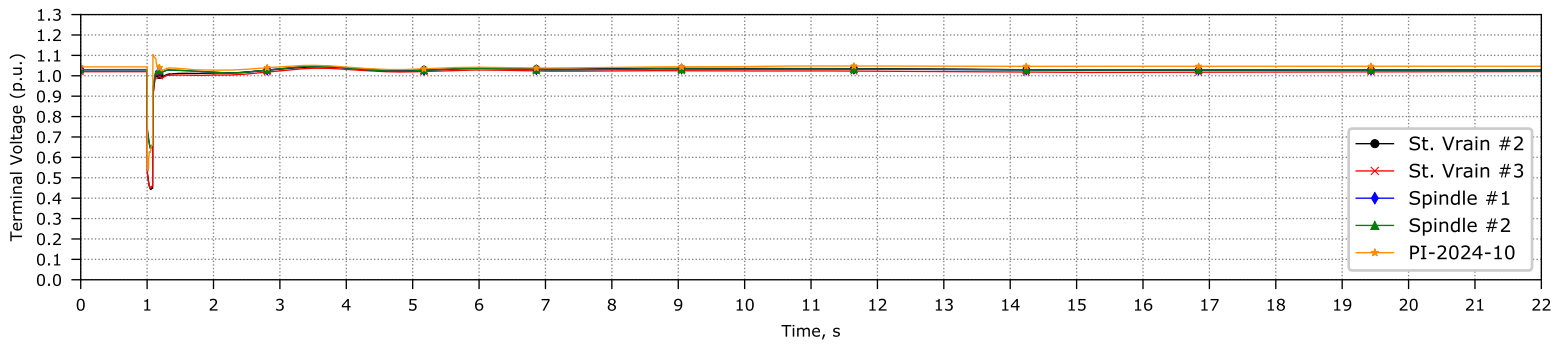


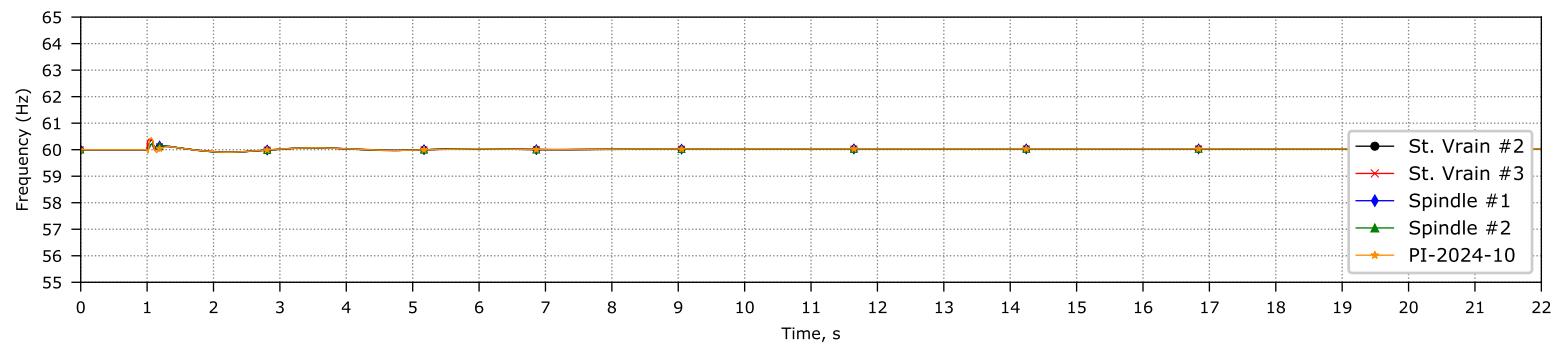


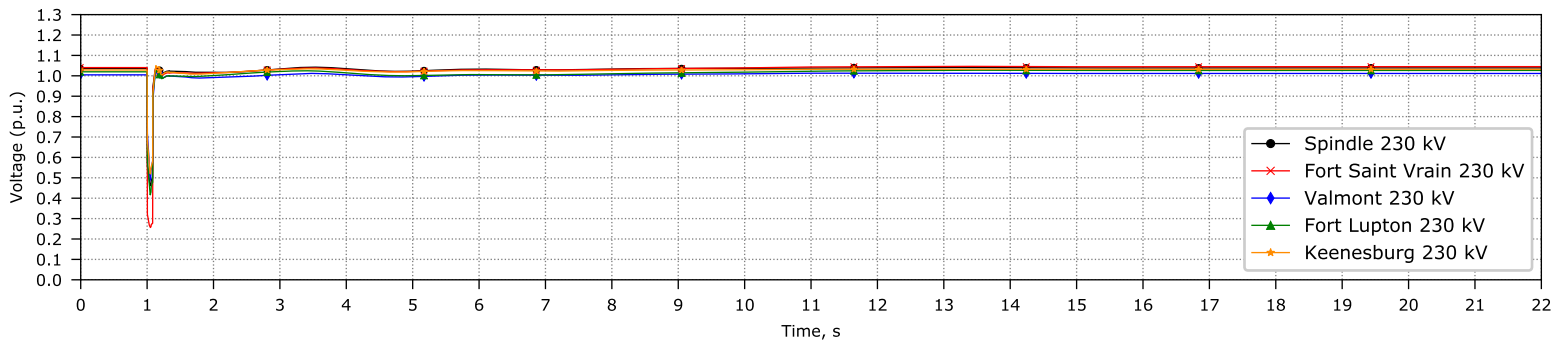




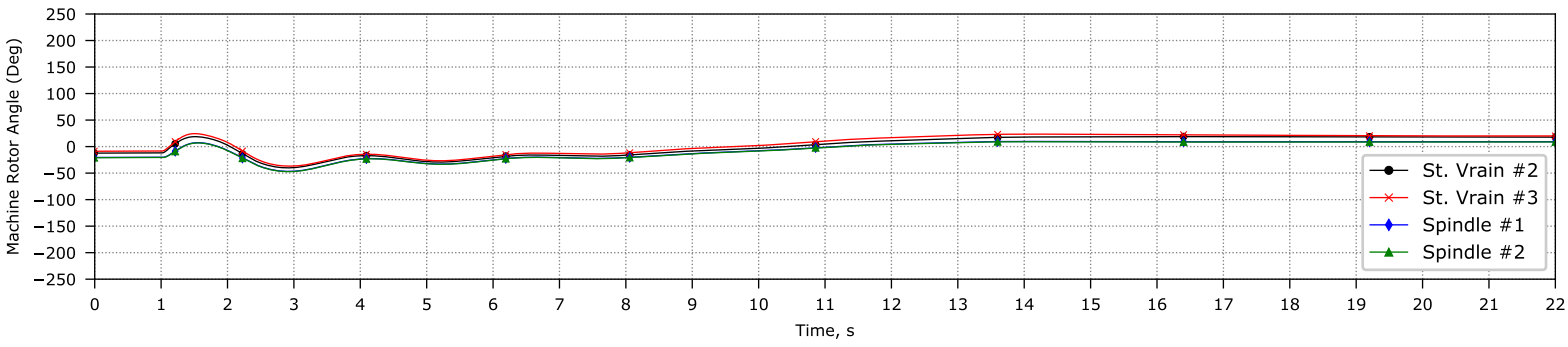


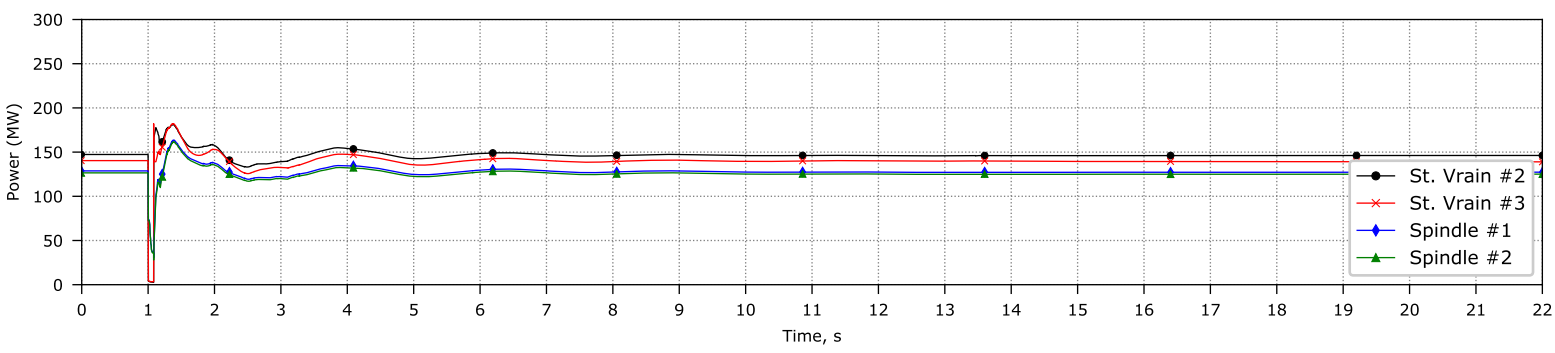


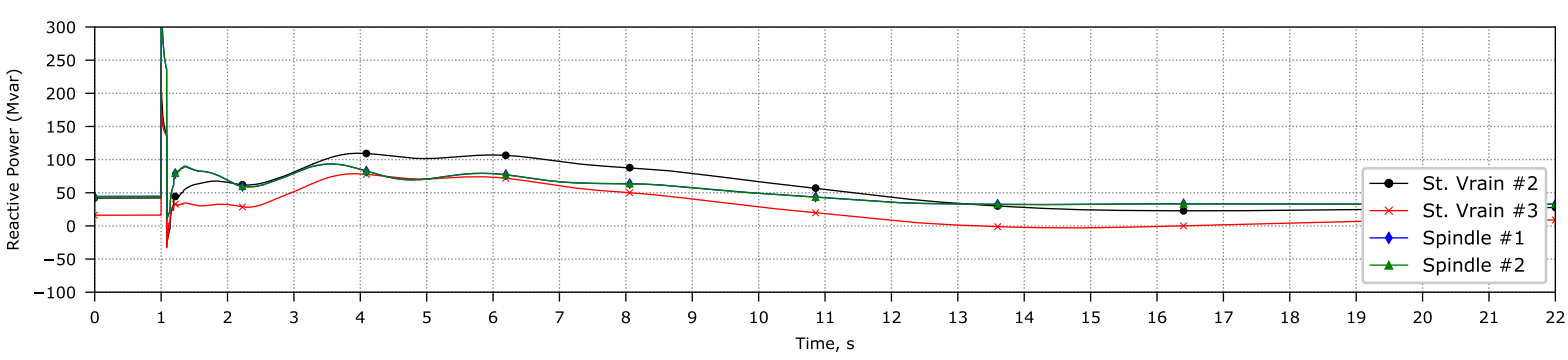


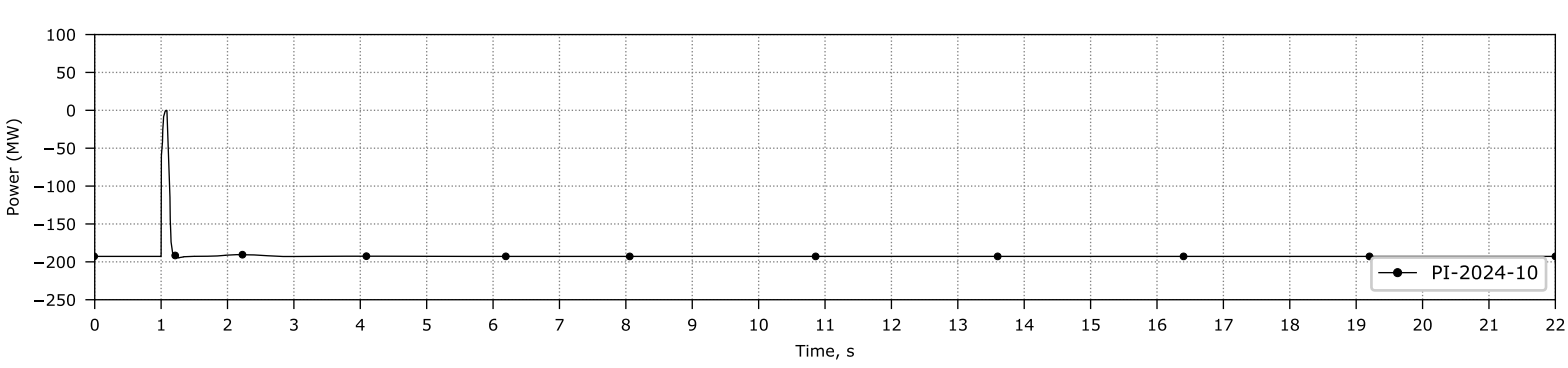


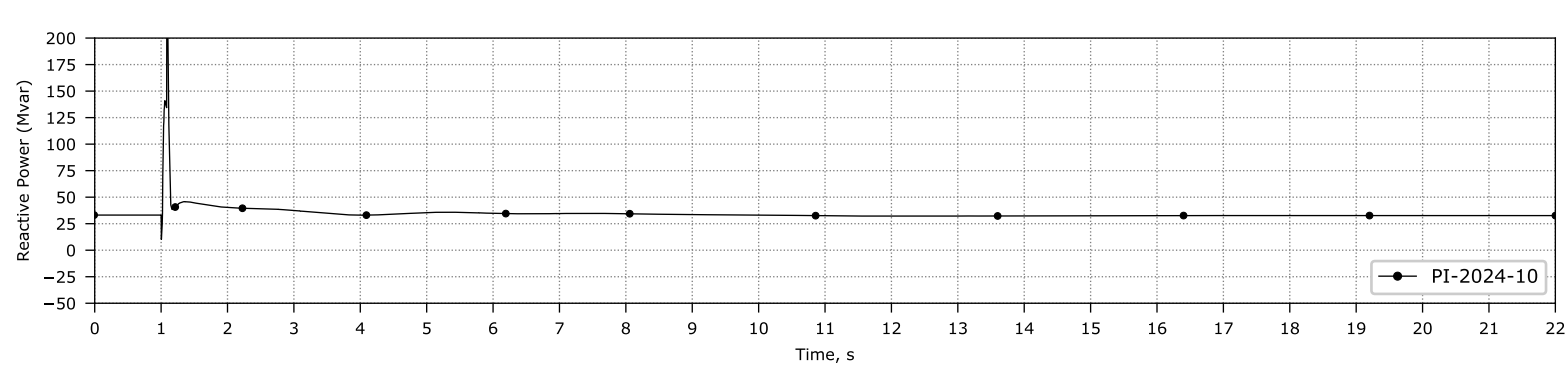
PI-2024-10_Study_North_GC_FSV_Xfmr

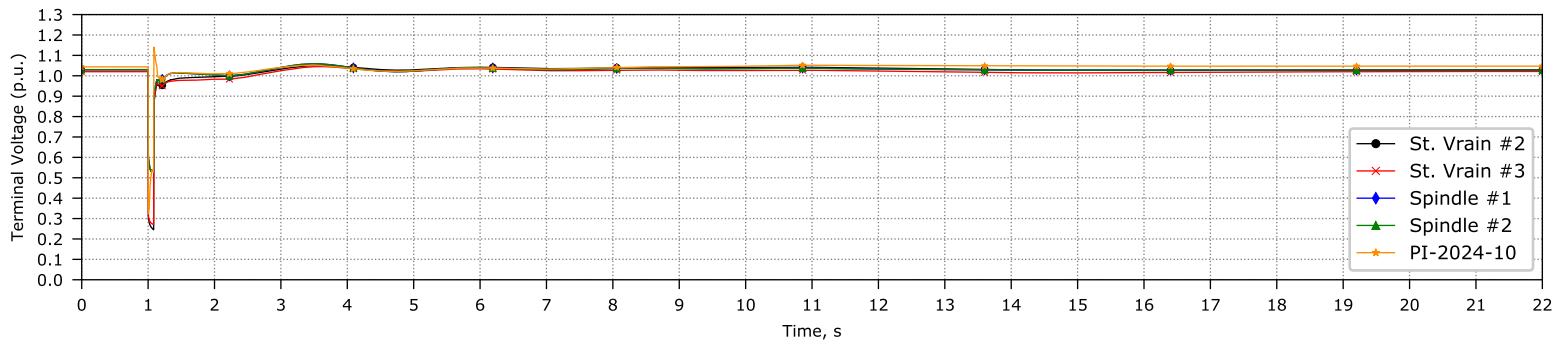


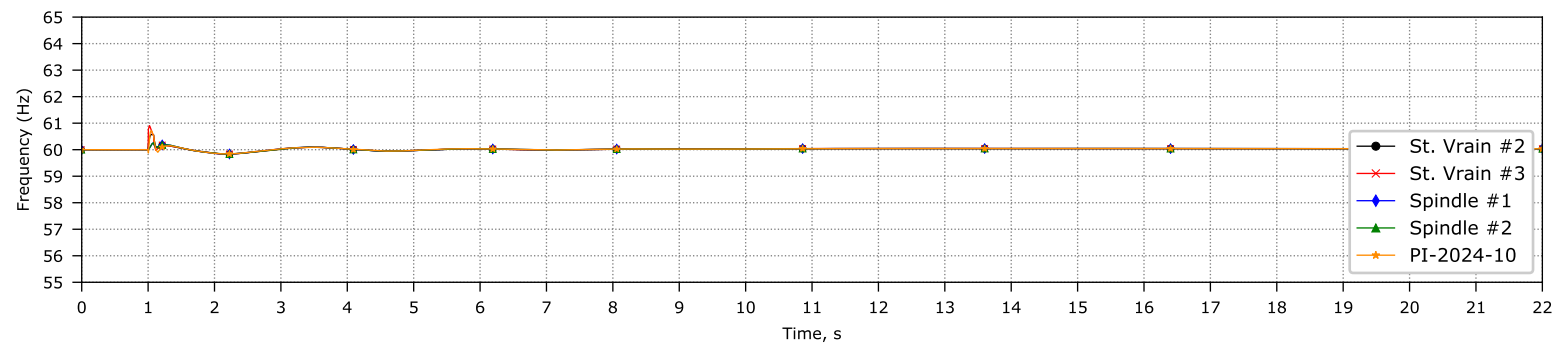


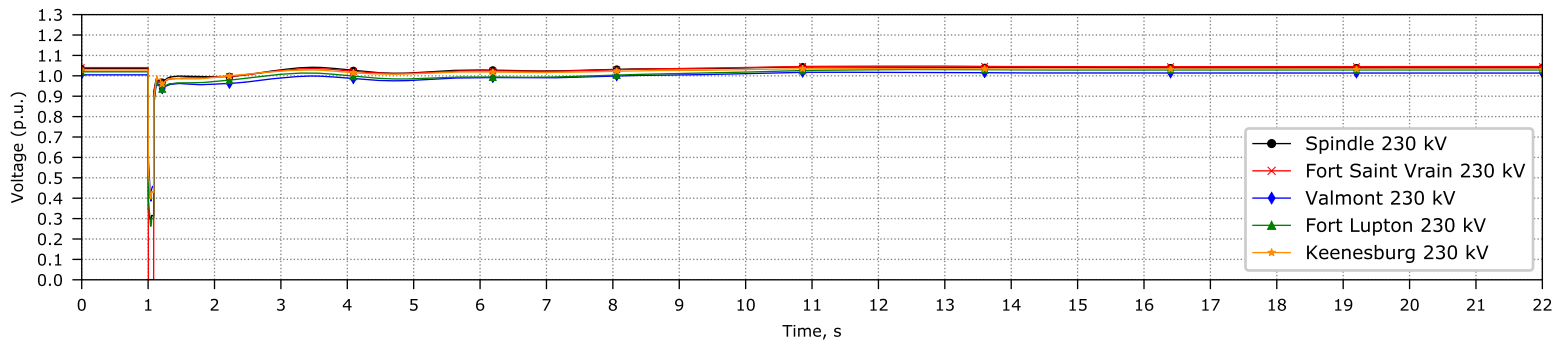




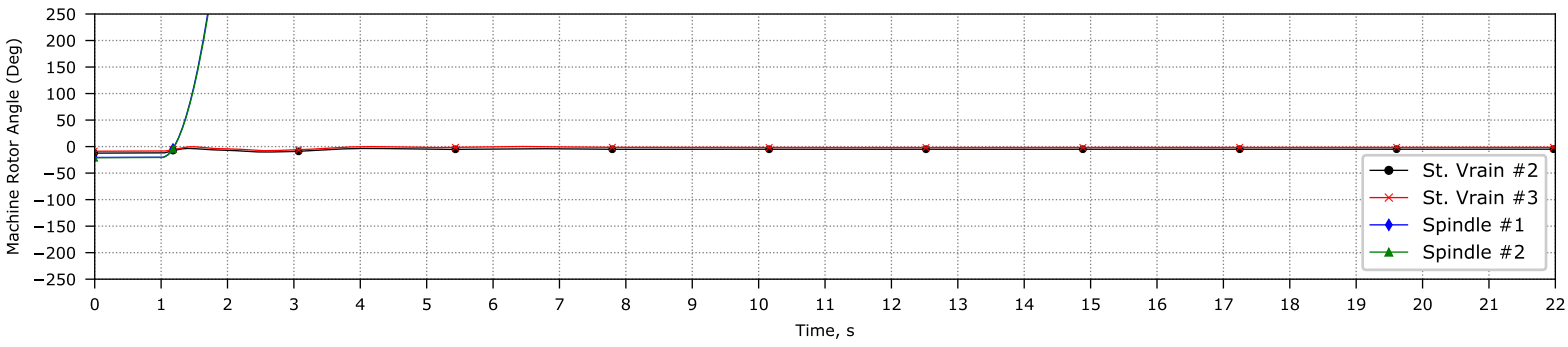


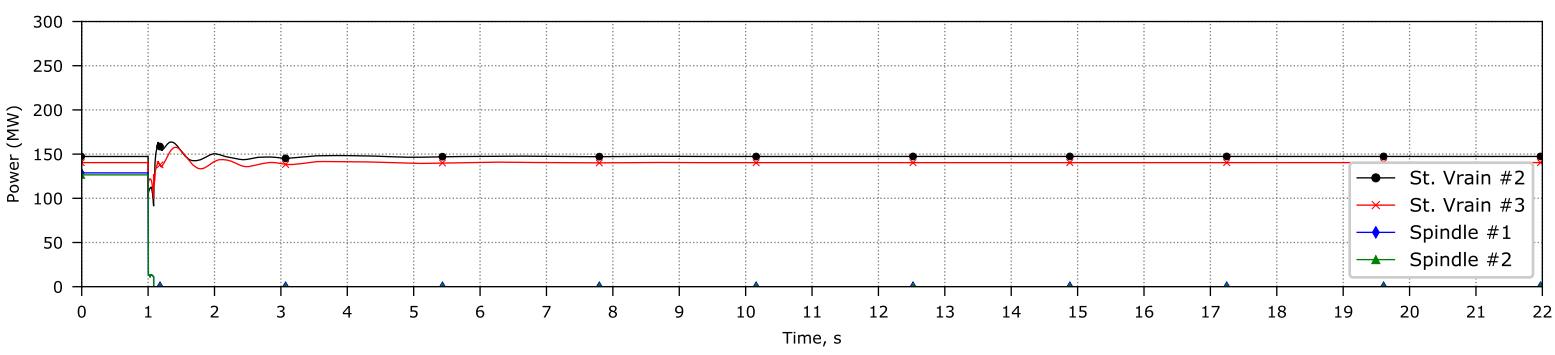


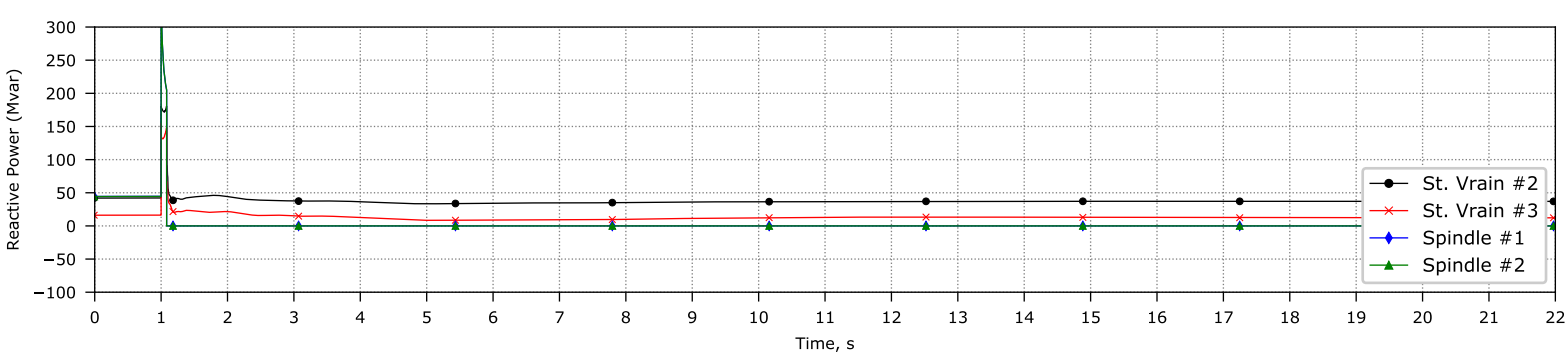


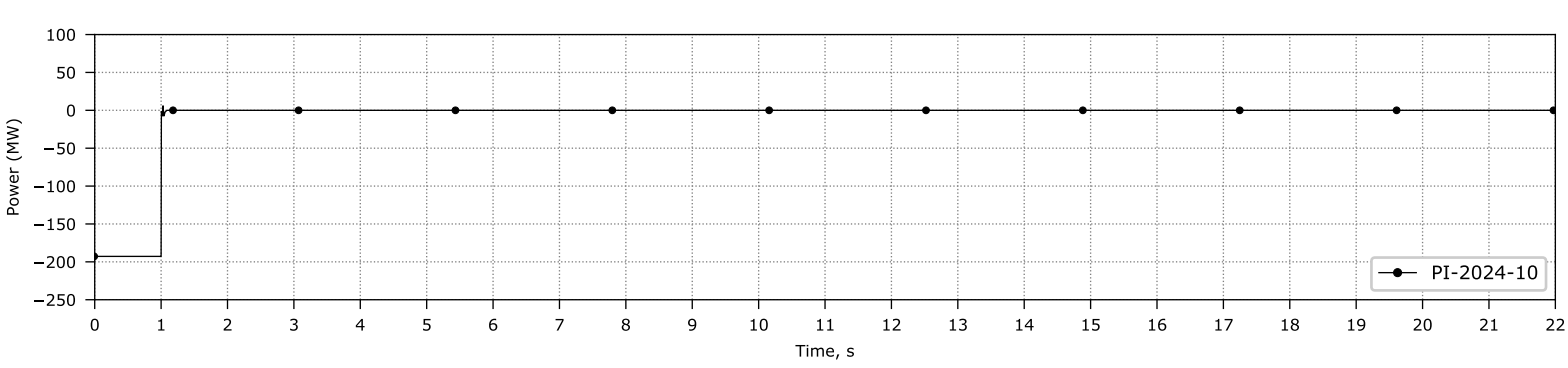


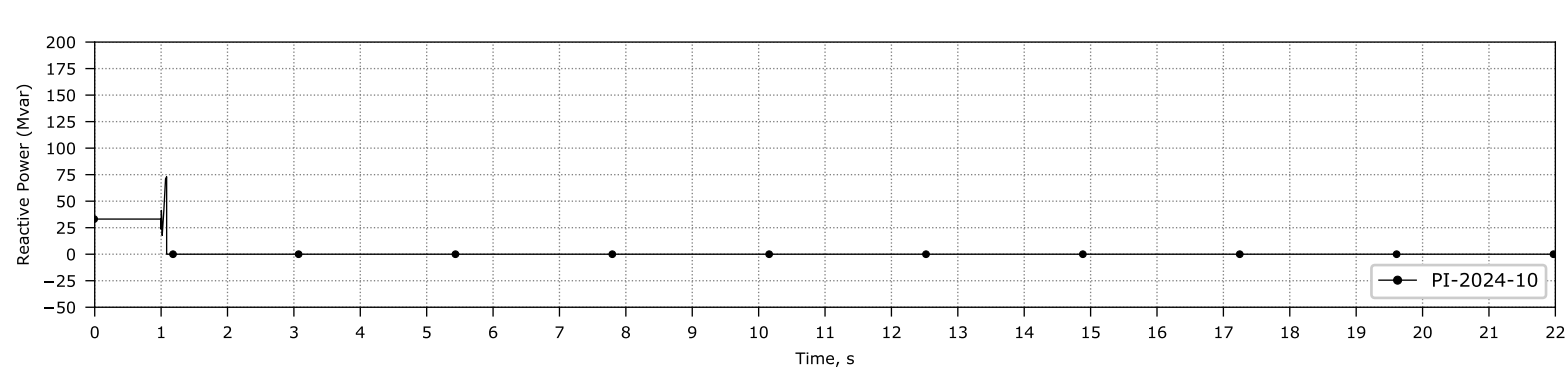
PI-2024-10_Study_North_GC_Spindle-P7_90

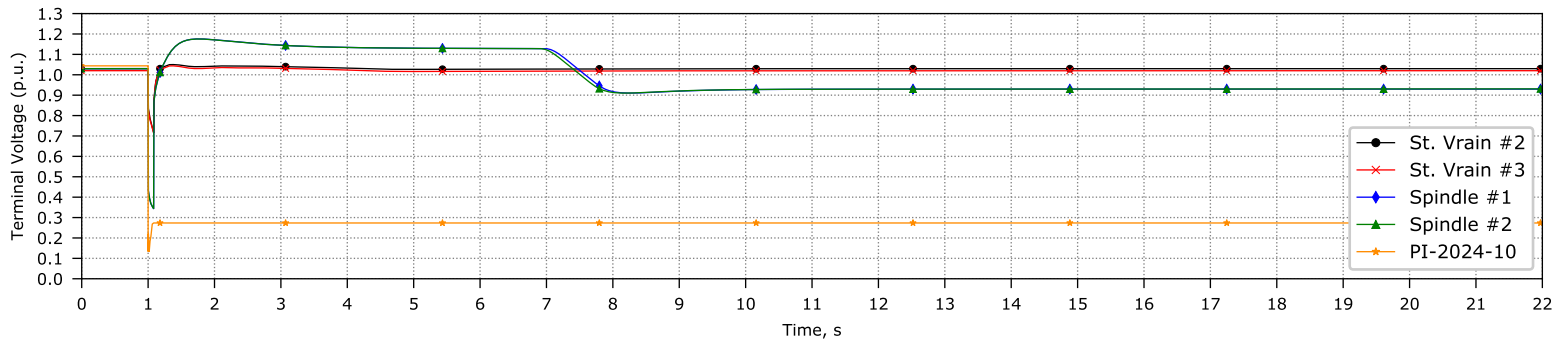


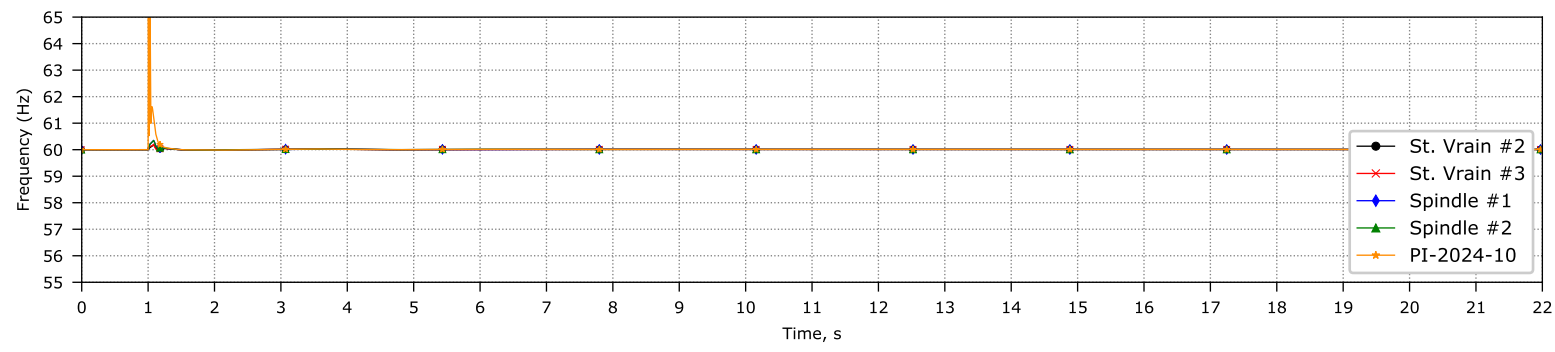


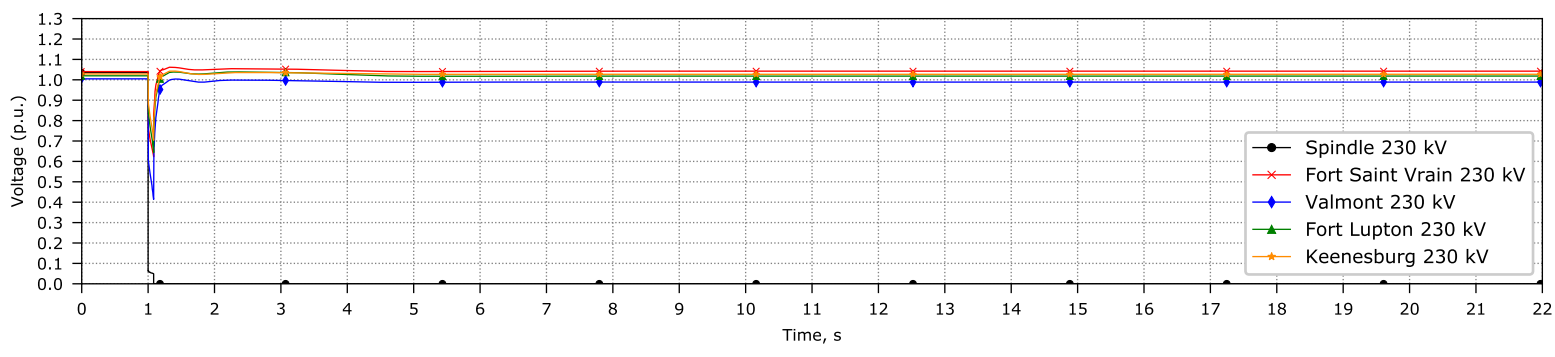




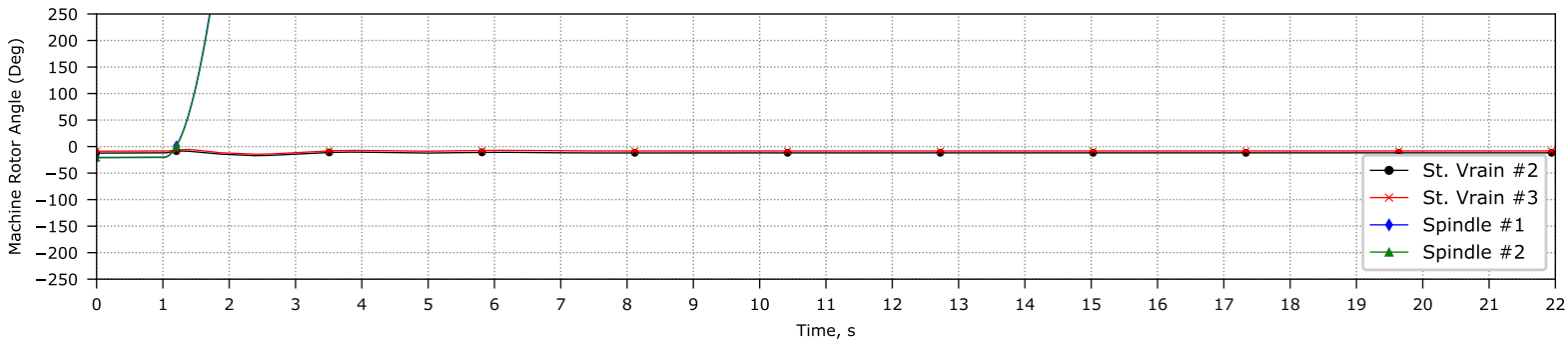


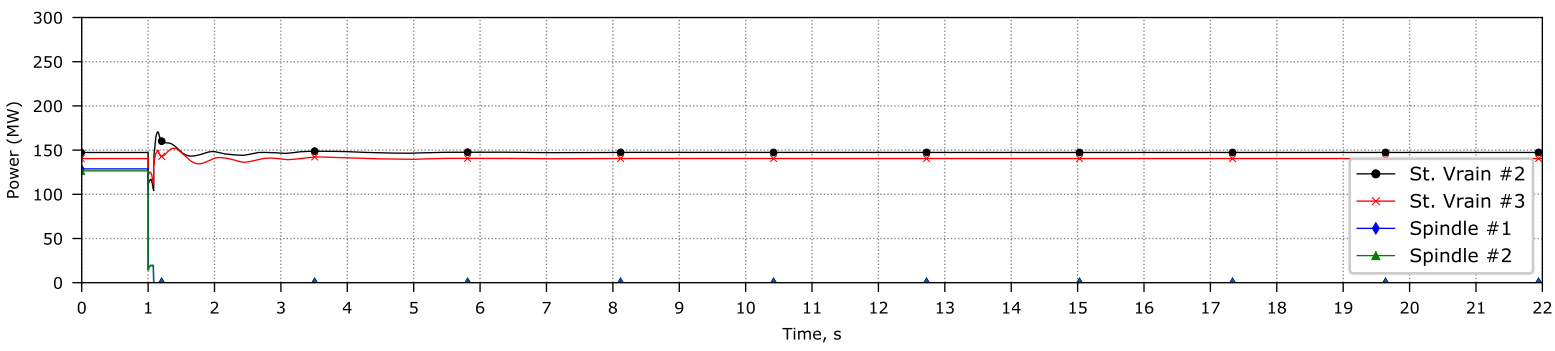


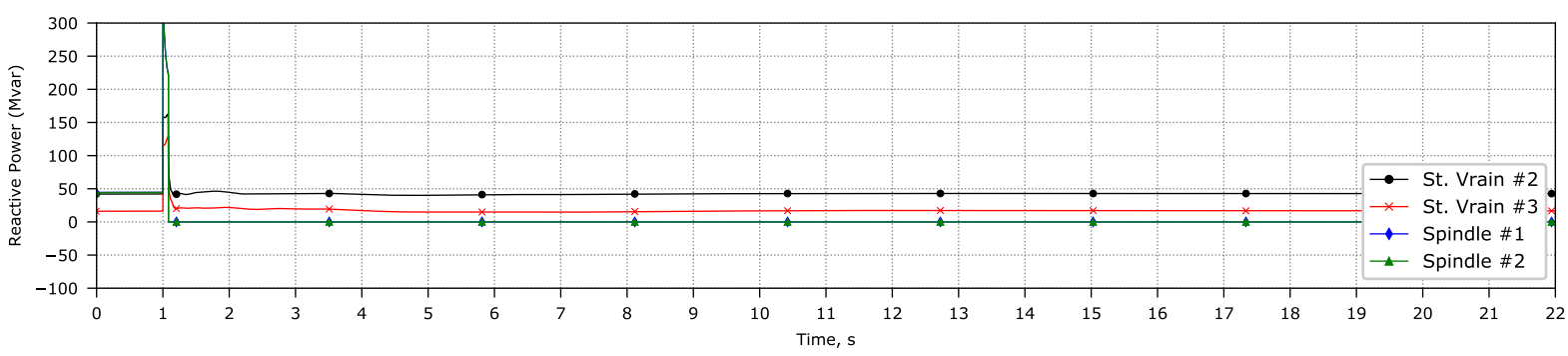


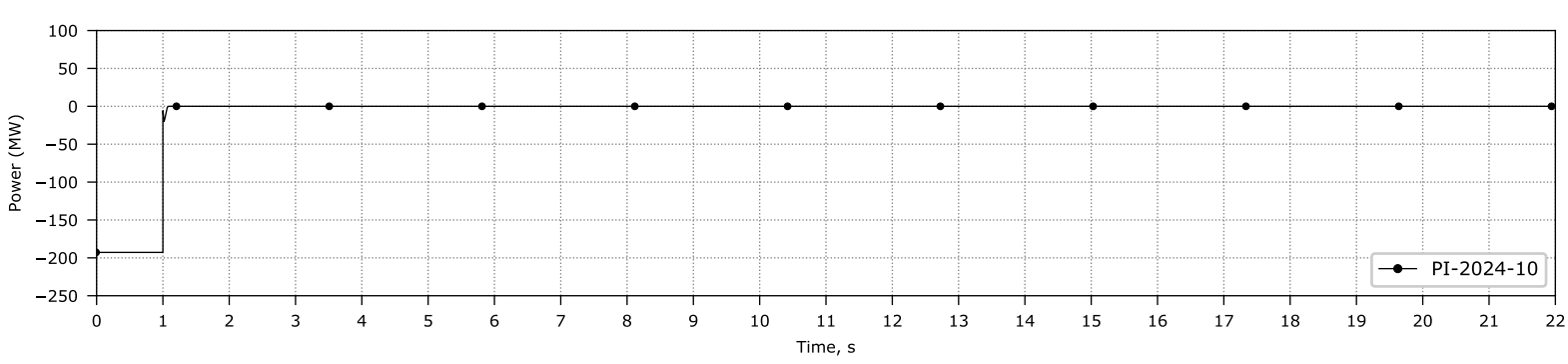


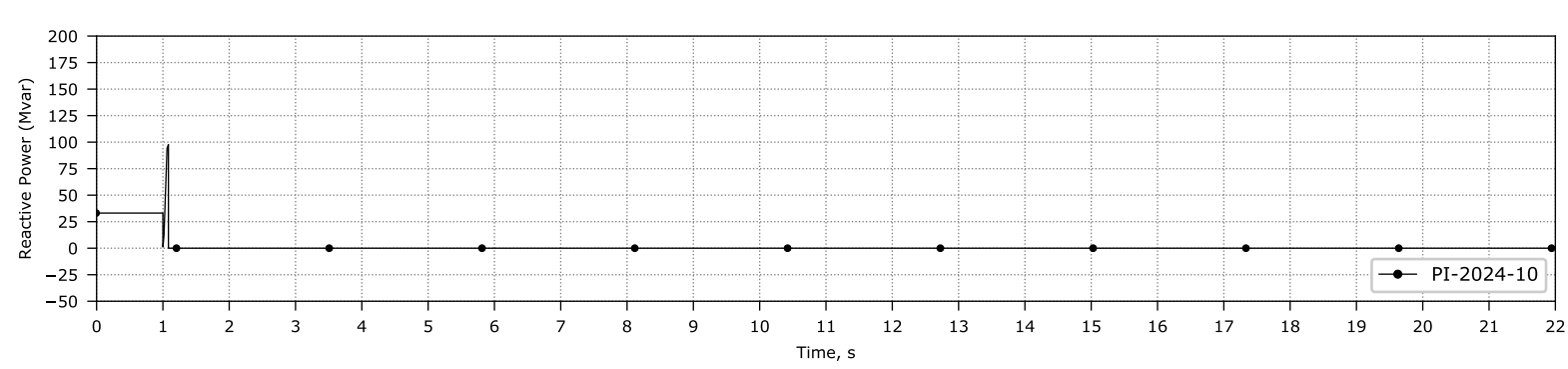
PI-2024-10_Study_North_GC_Spindle-P7_93

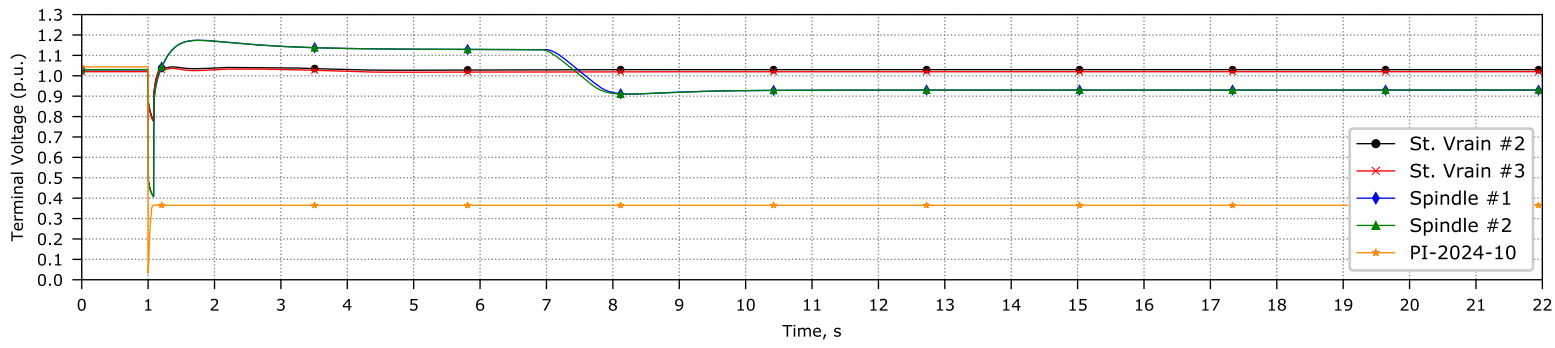


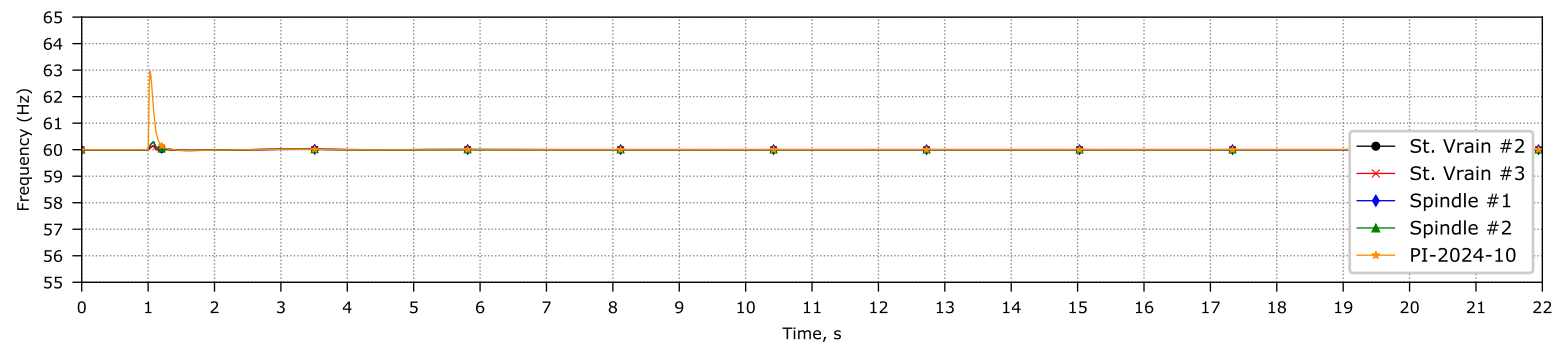


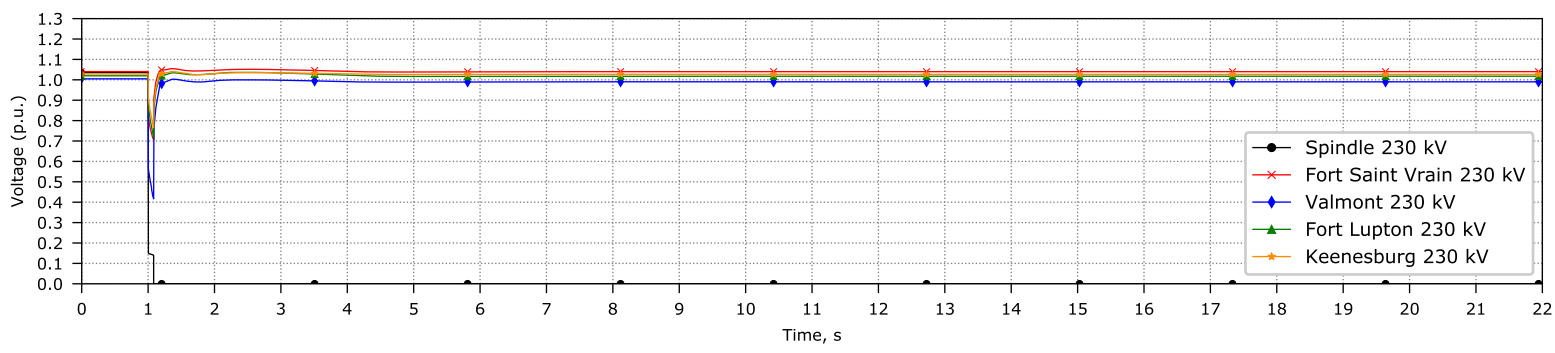




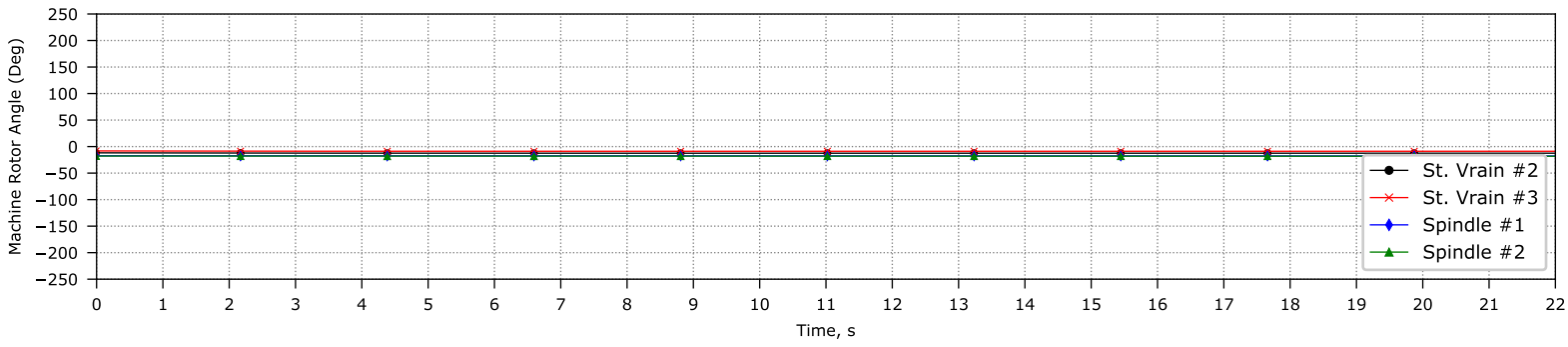


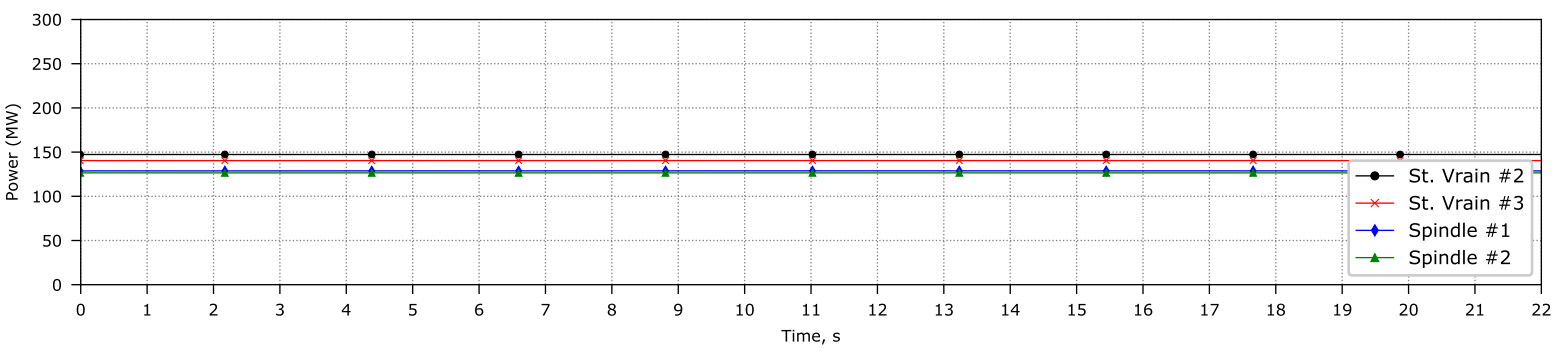


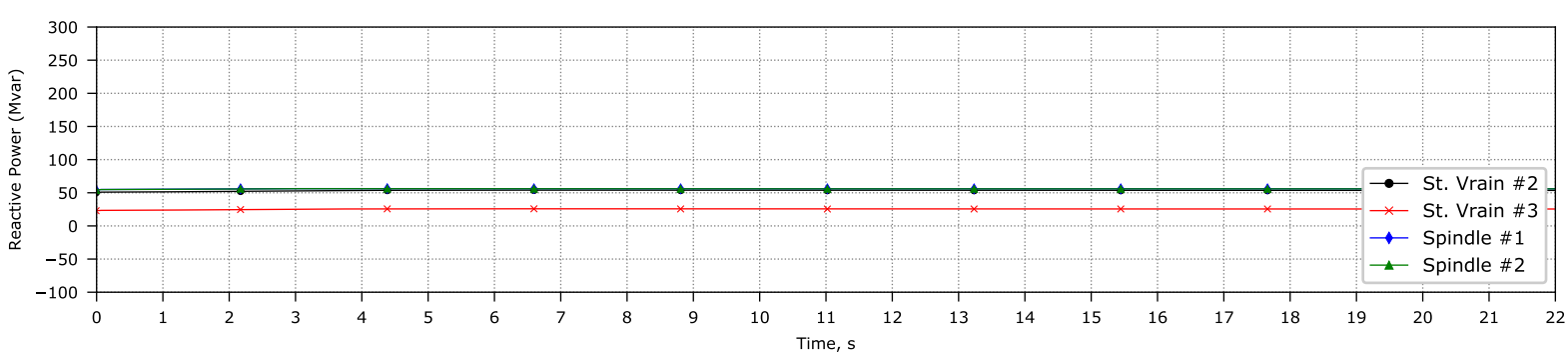


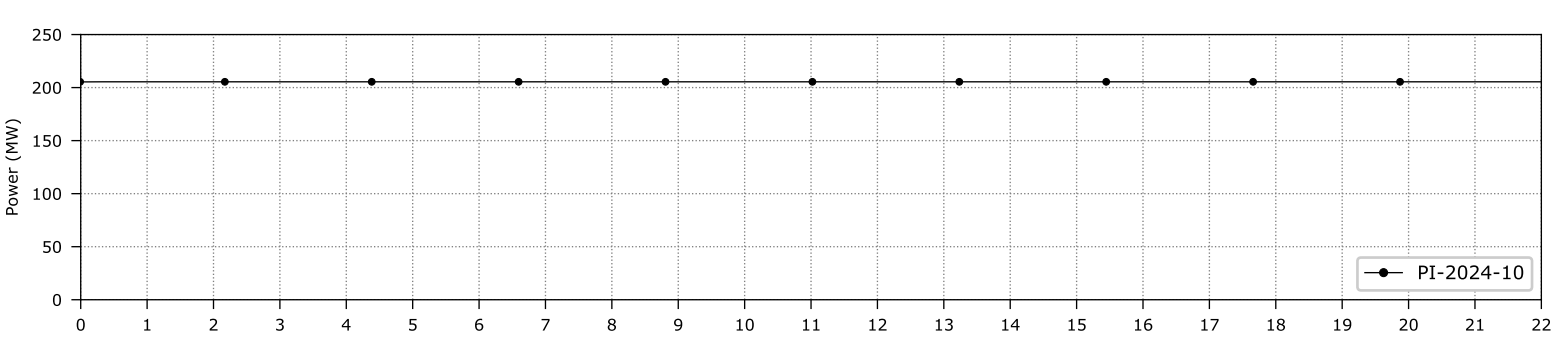


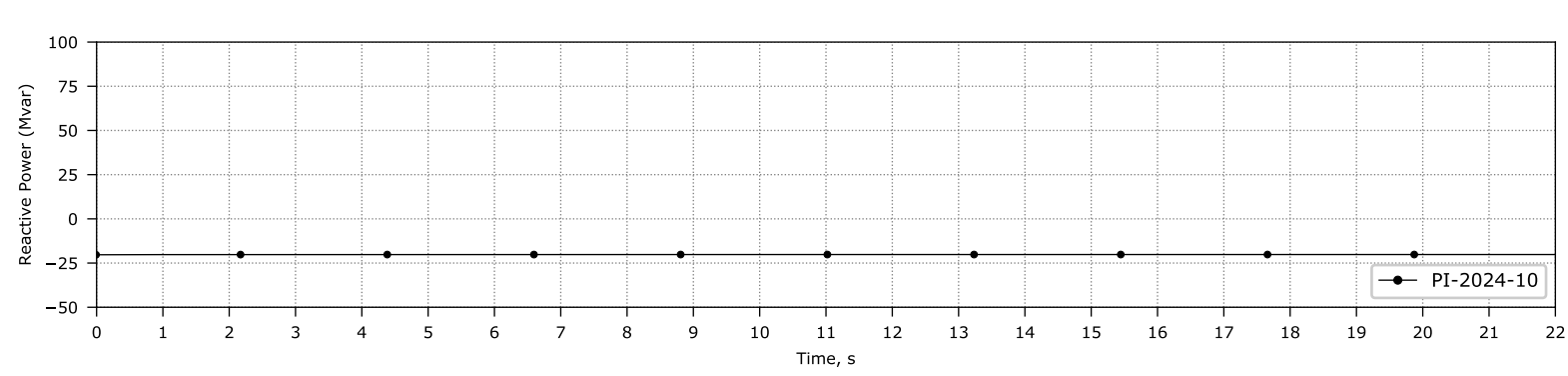
PI-2024-10_Study_North_flatrun

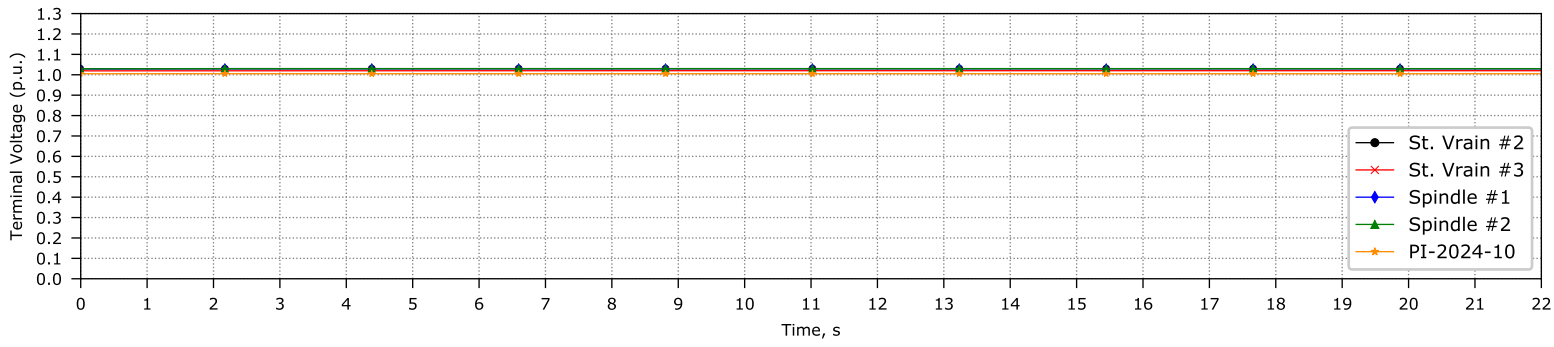


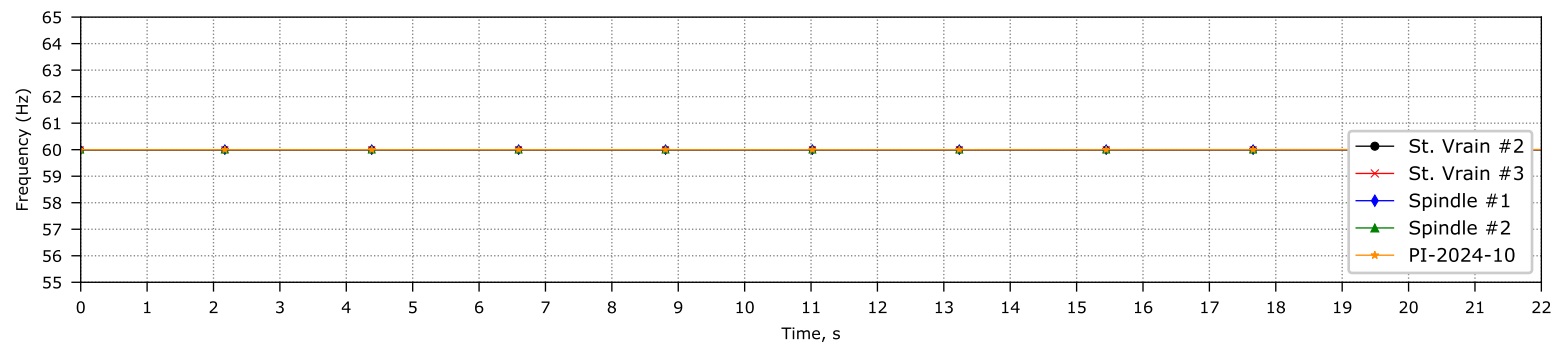


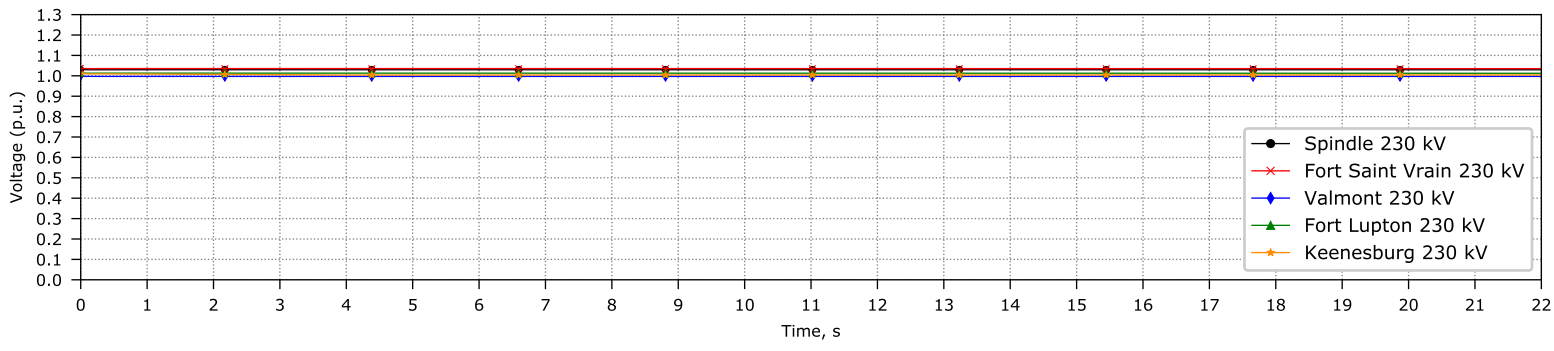




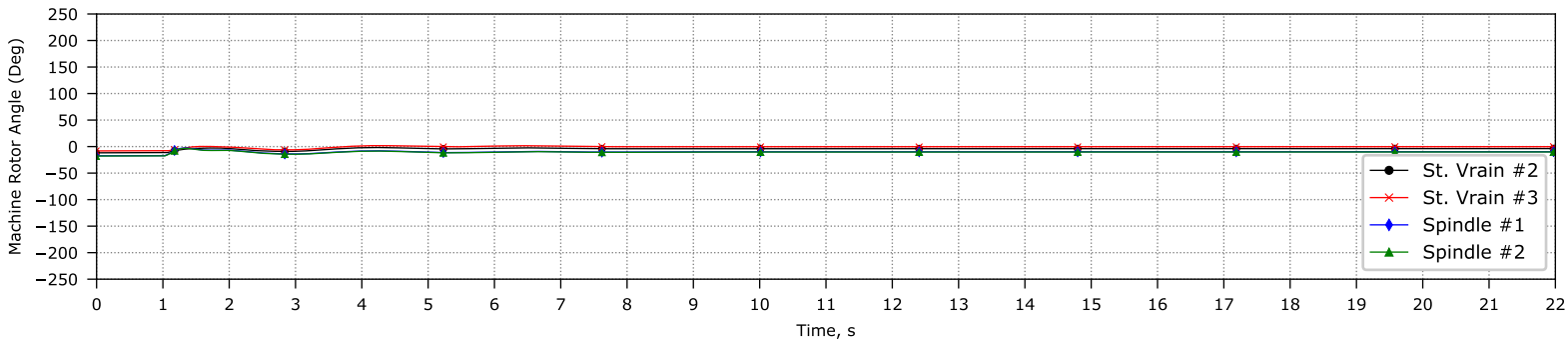


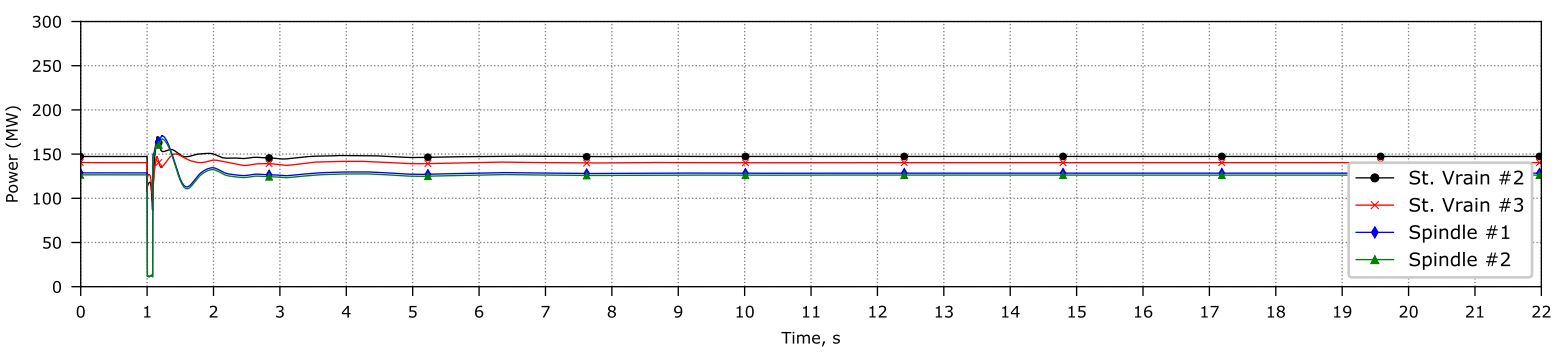


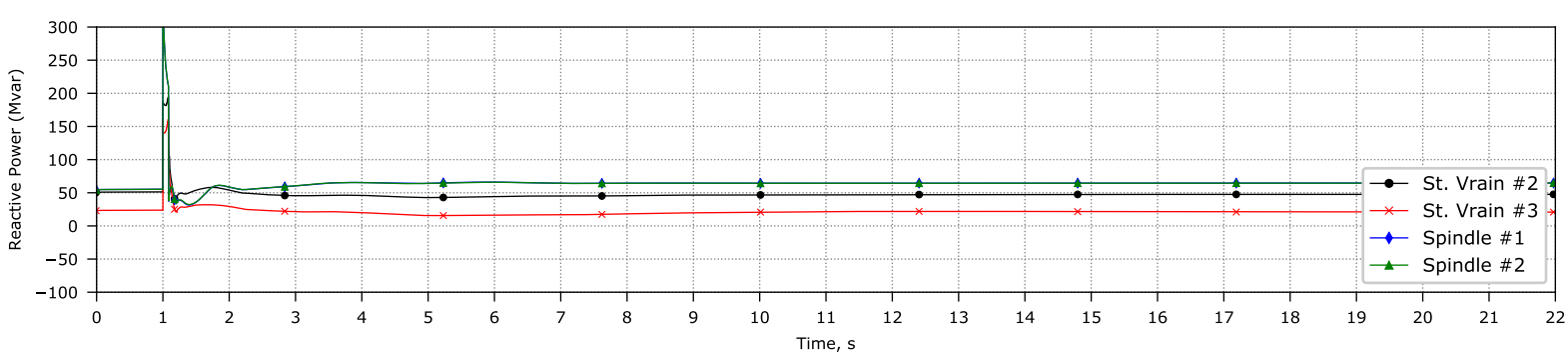


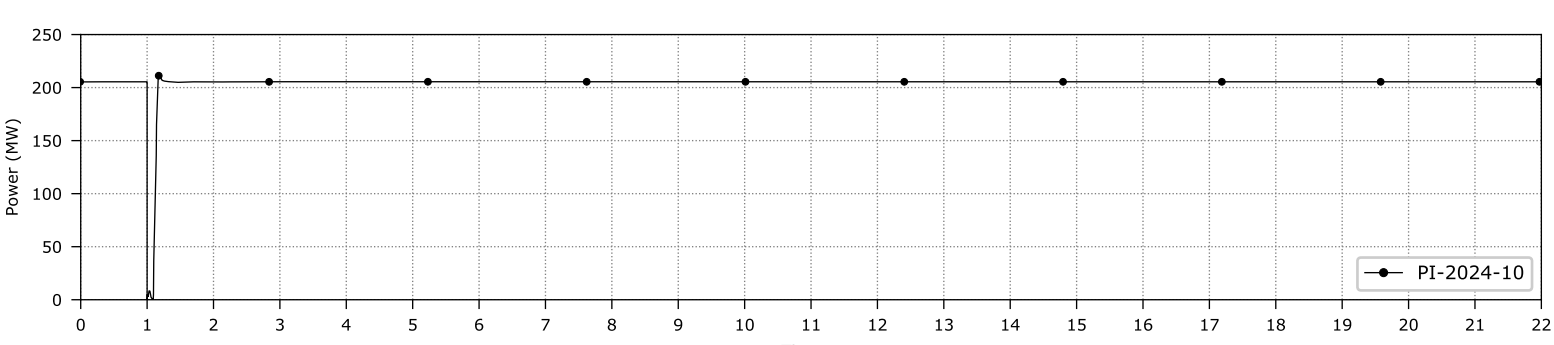


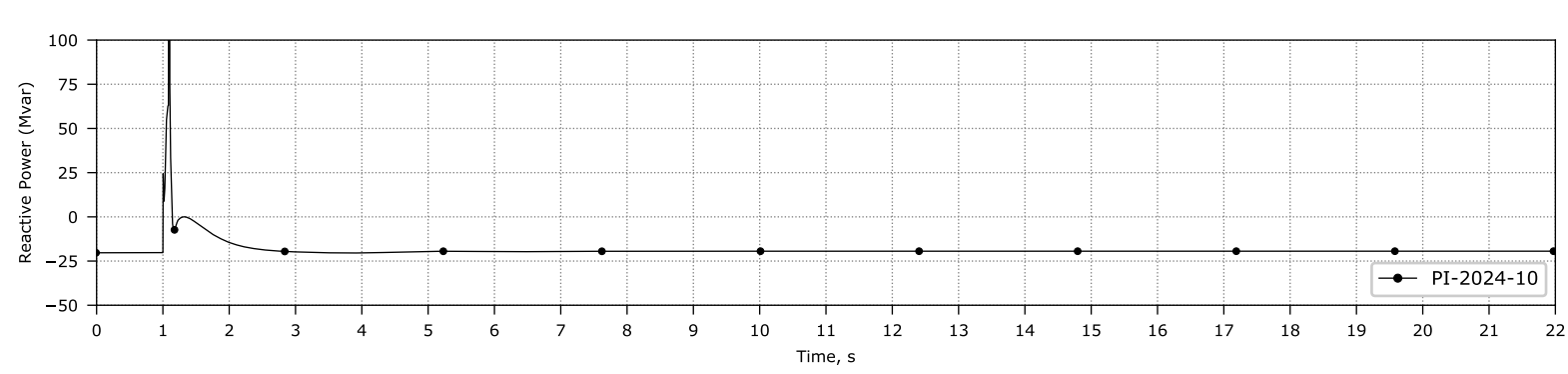
PI-2024-10_Study_North_Spindle-FSV_230kV

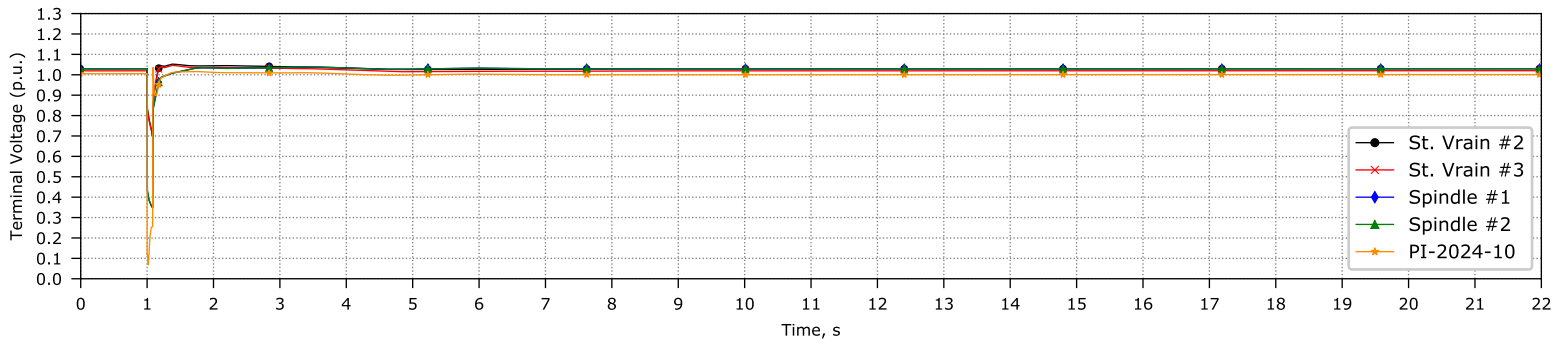


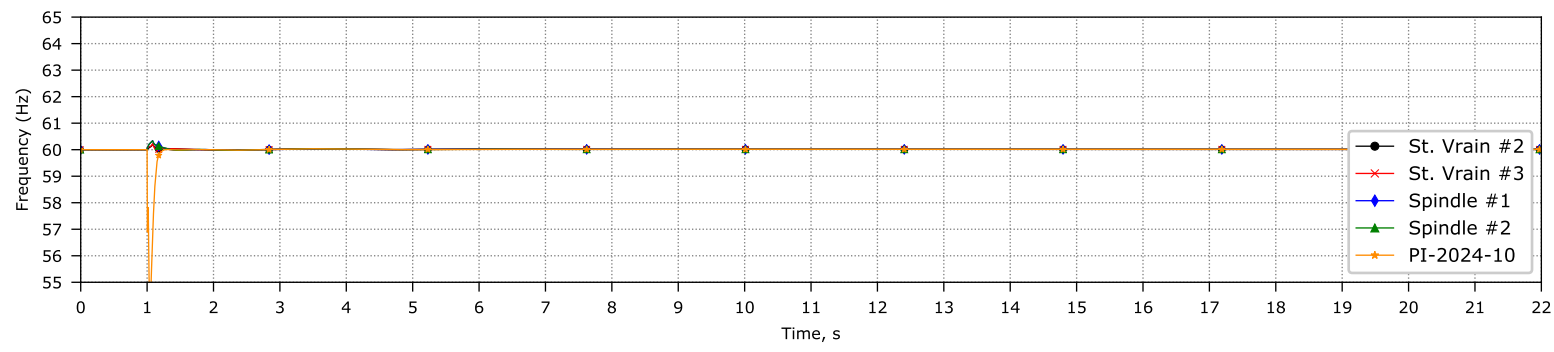


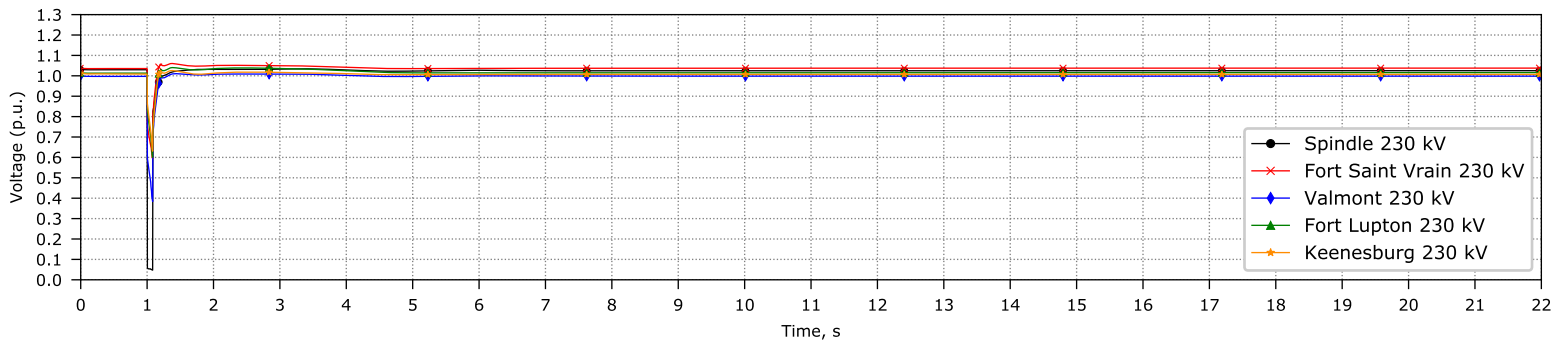




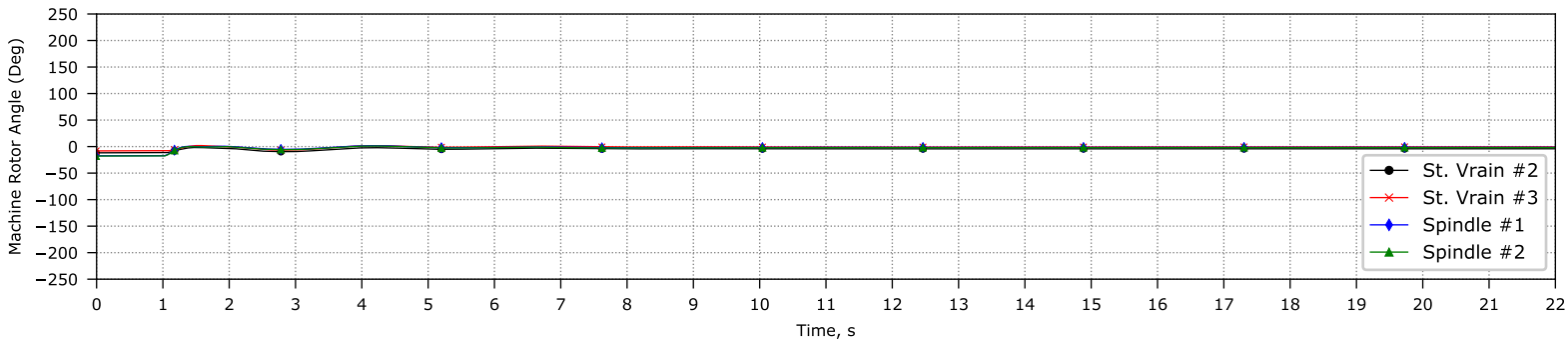


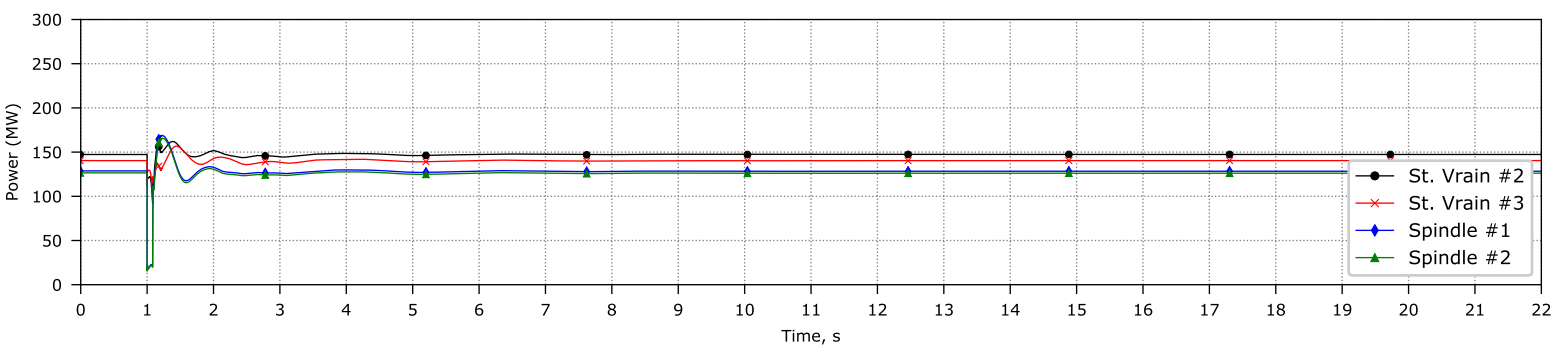


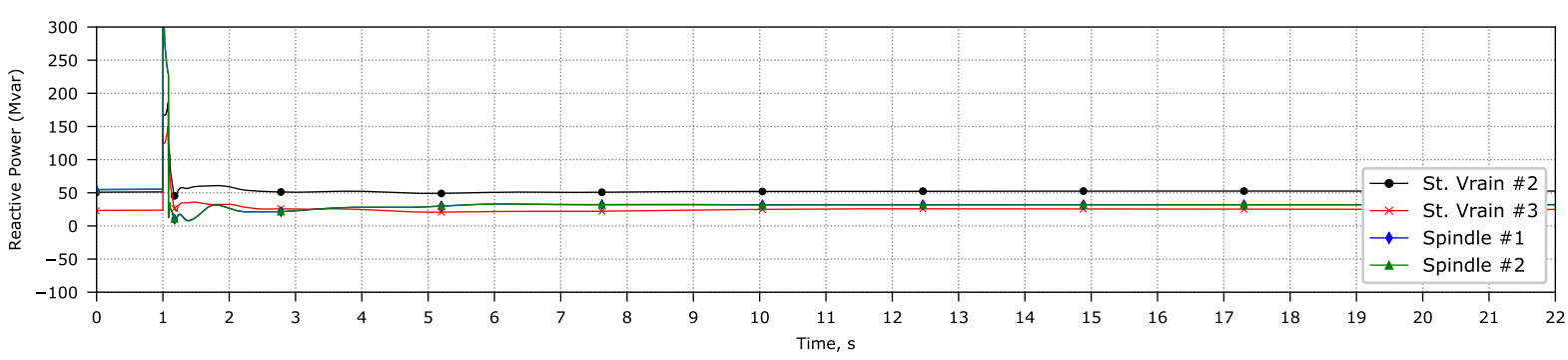


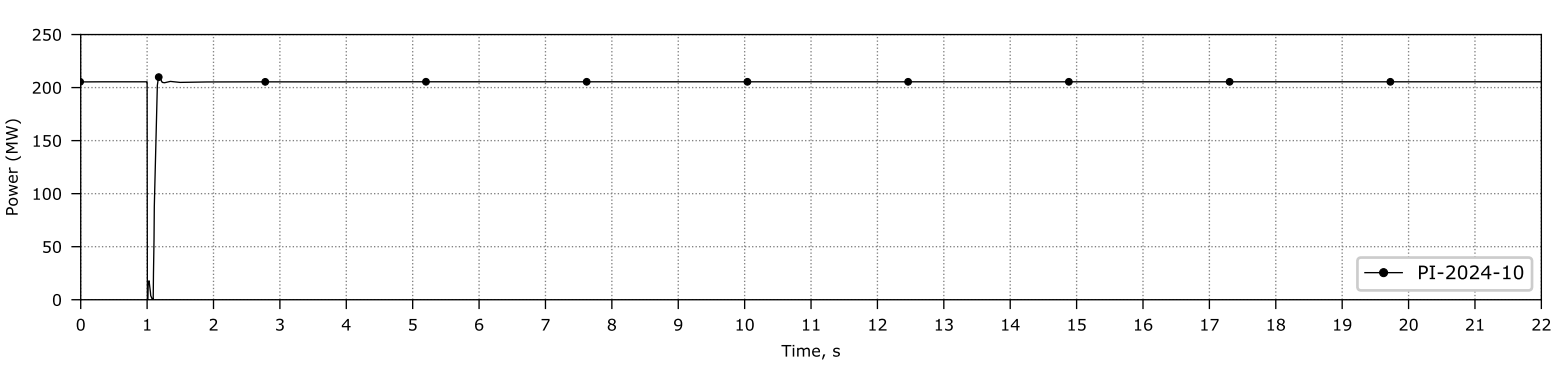


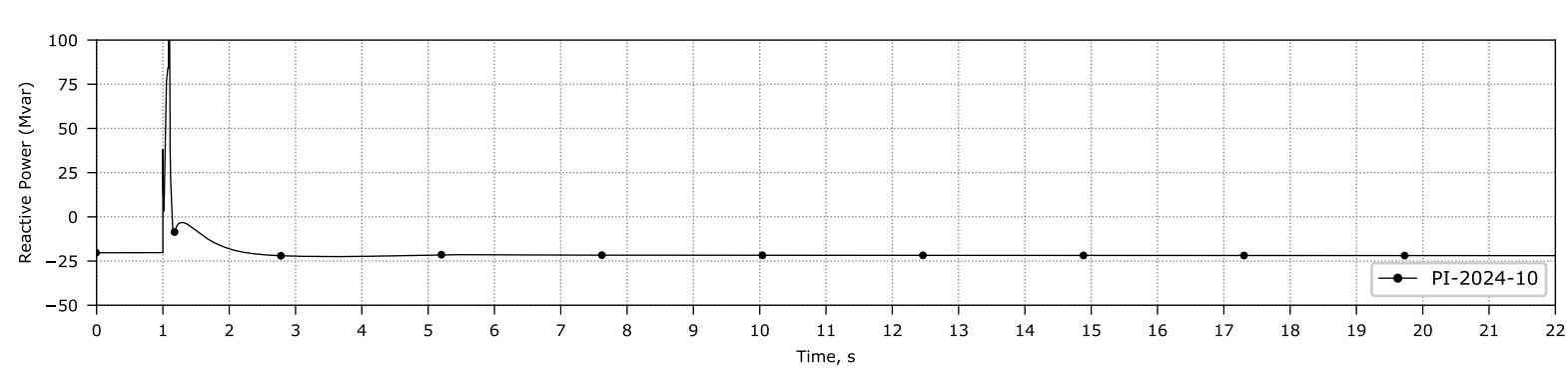
PI-2024-10_Study_North_Spindle-Valmont_230kV

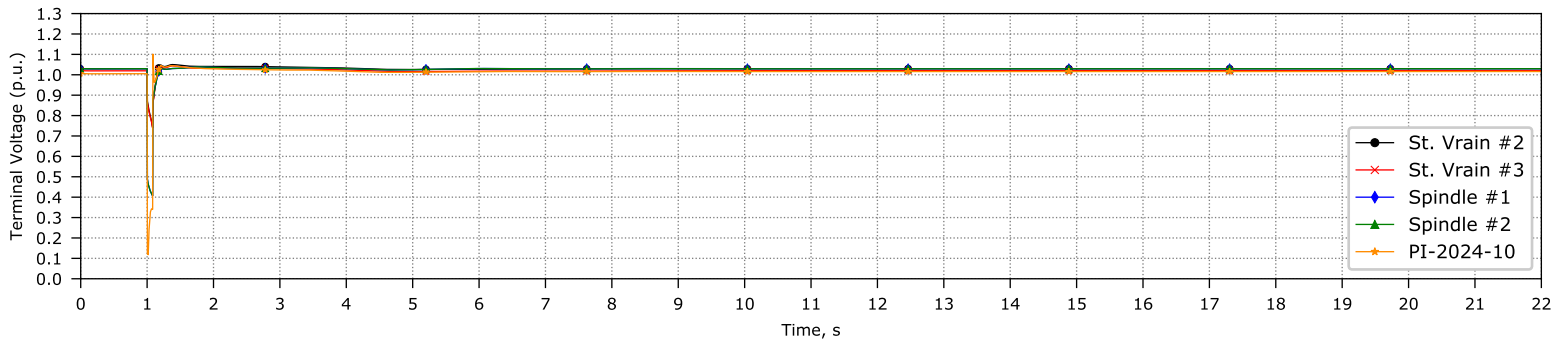


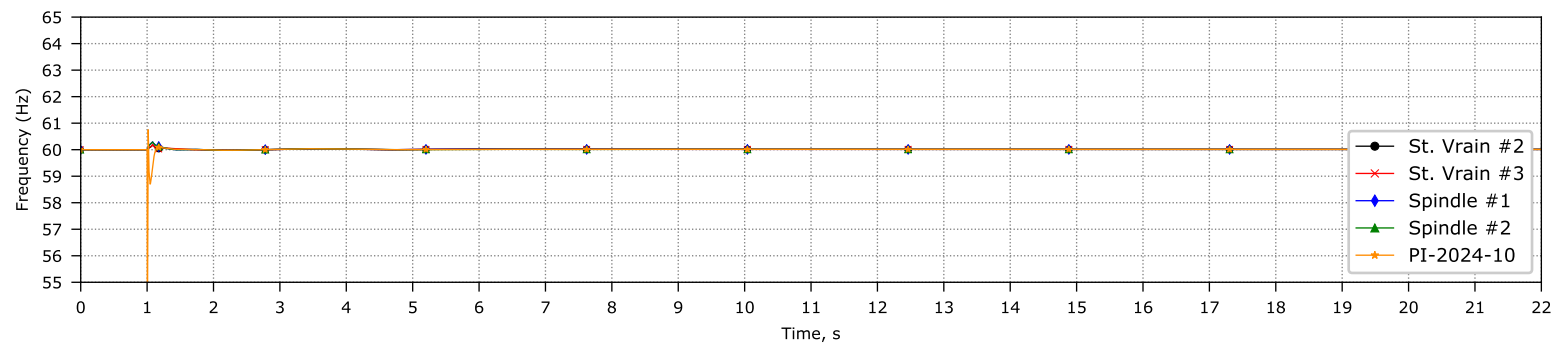


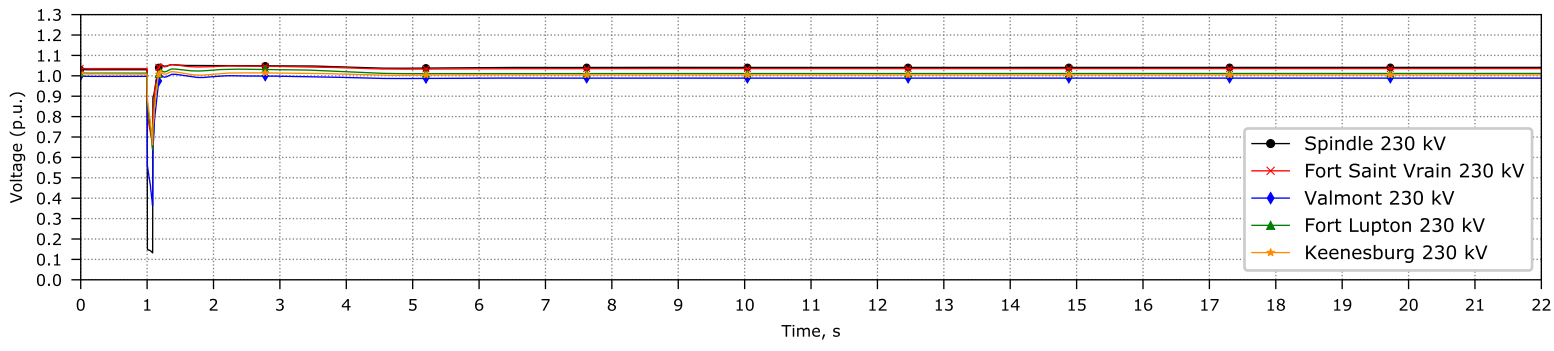




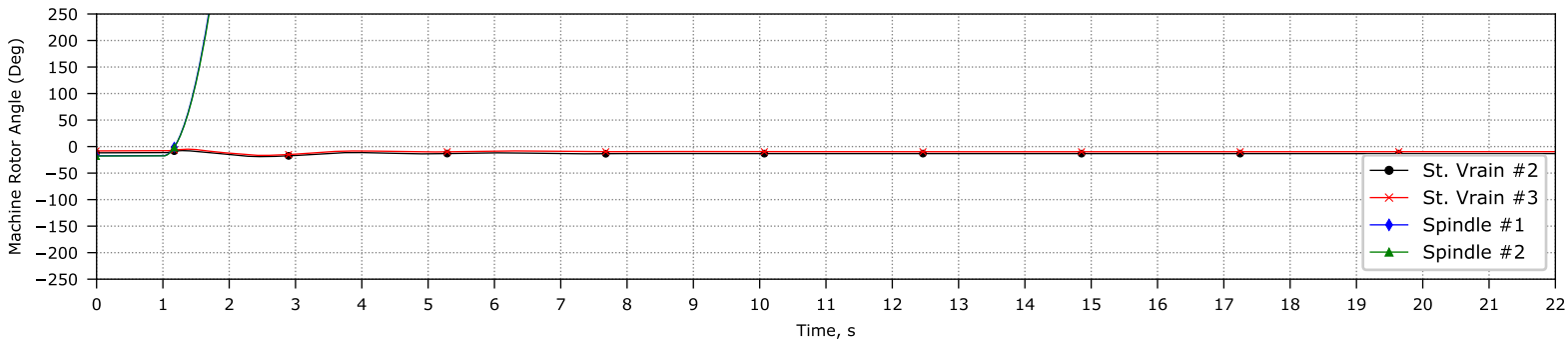


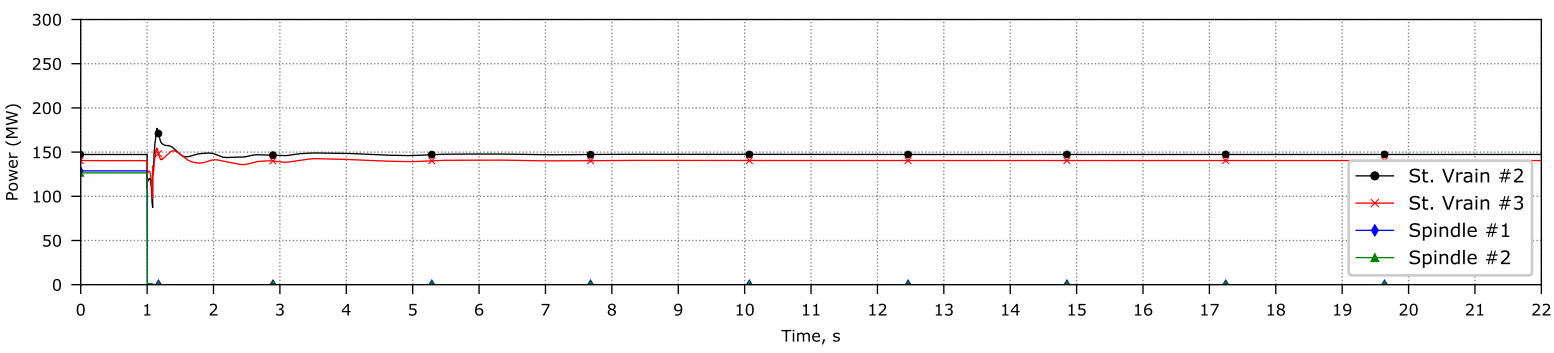


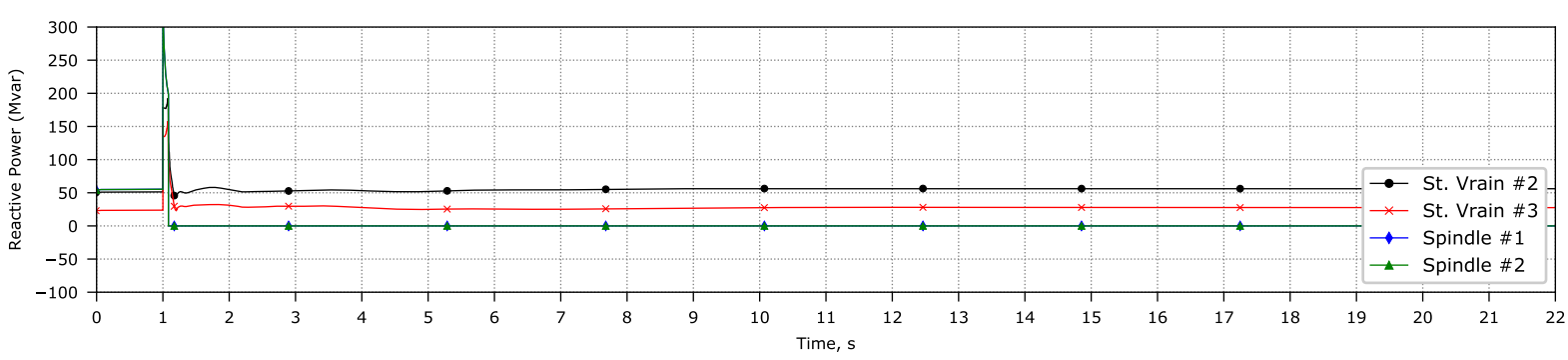


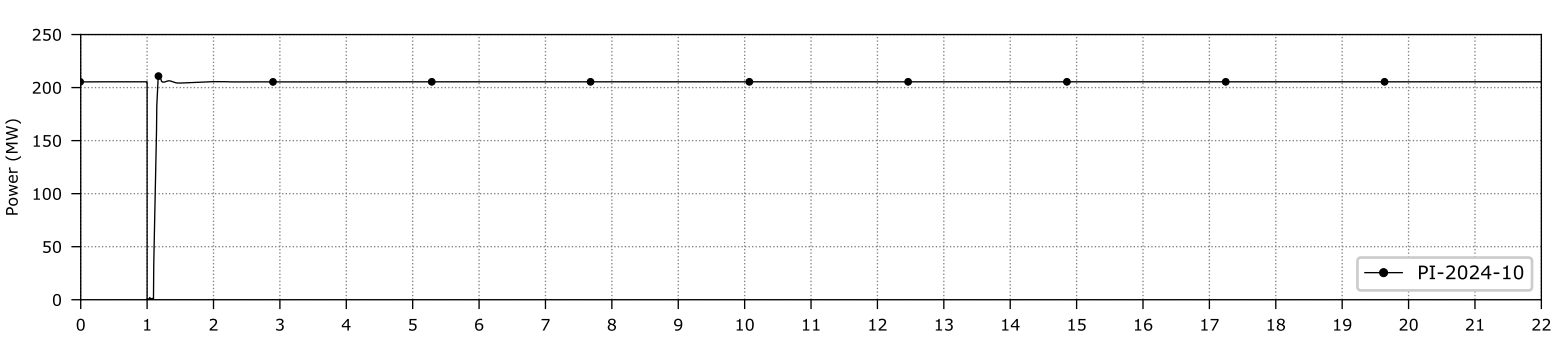


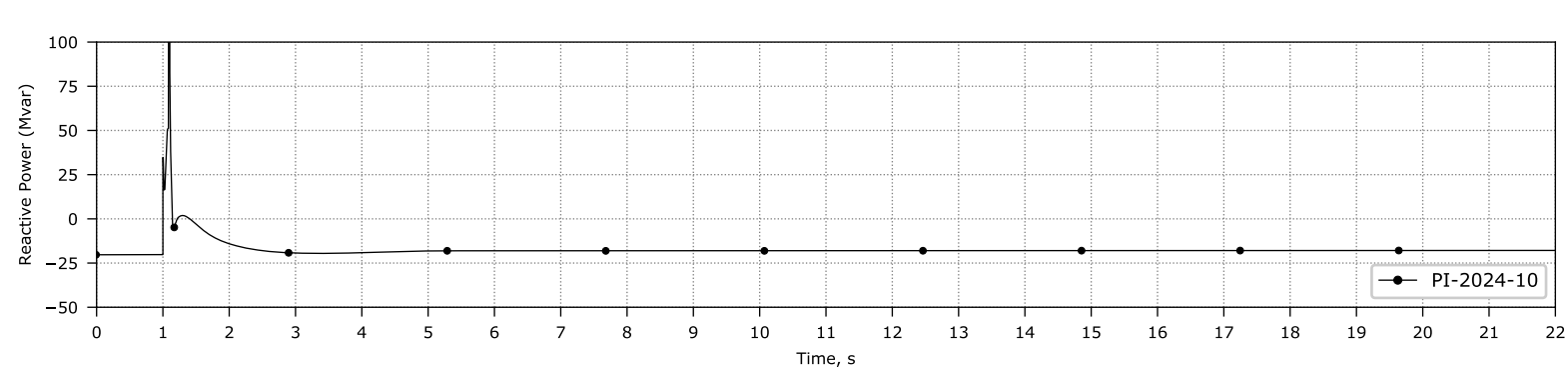
PI-2024-10_Study_North_Spindle_NG

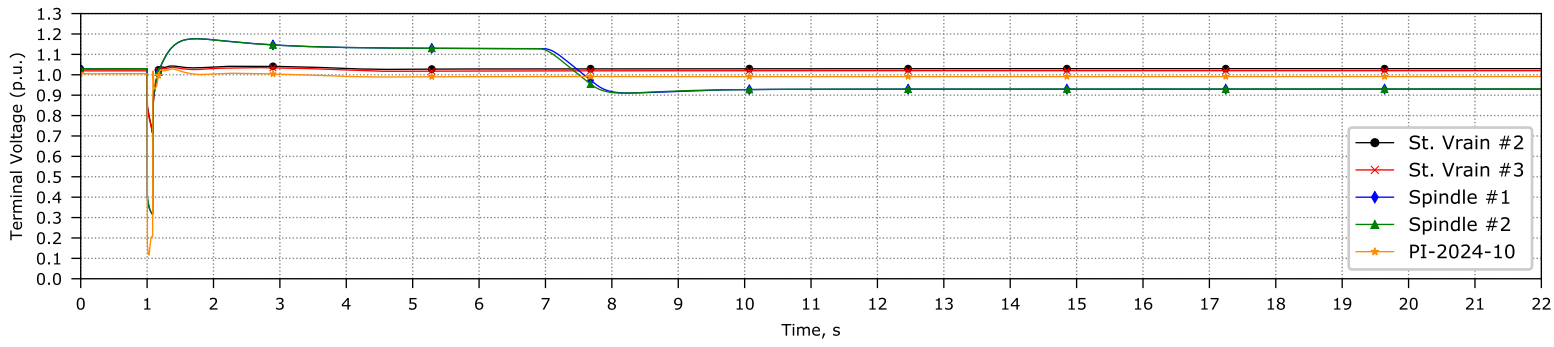


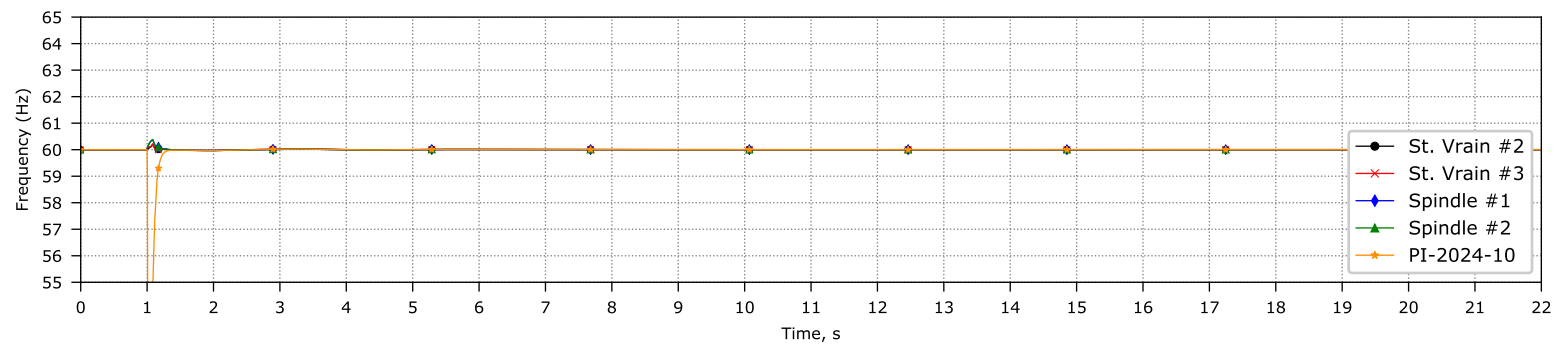


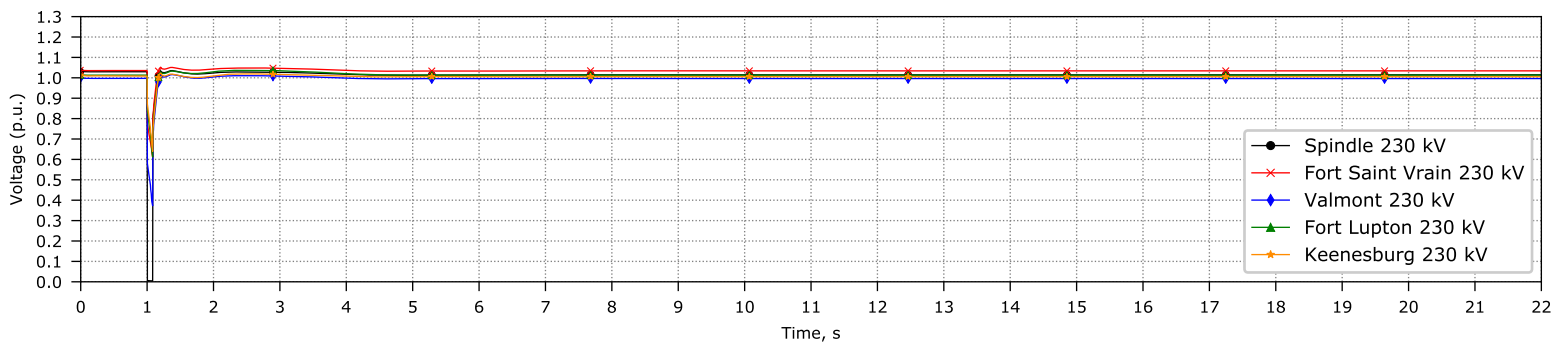




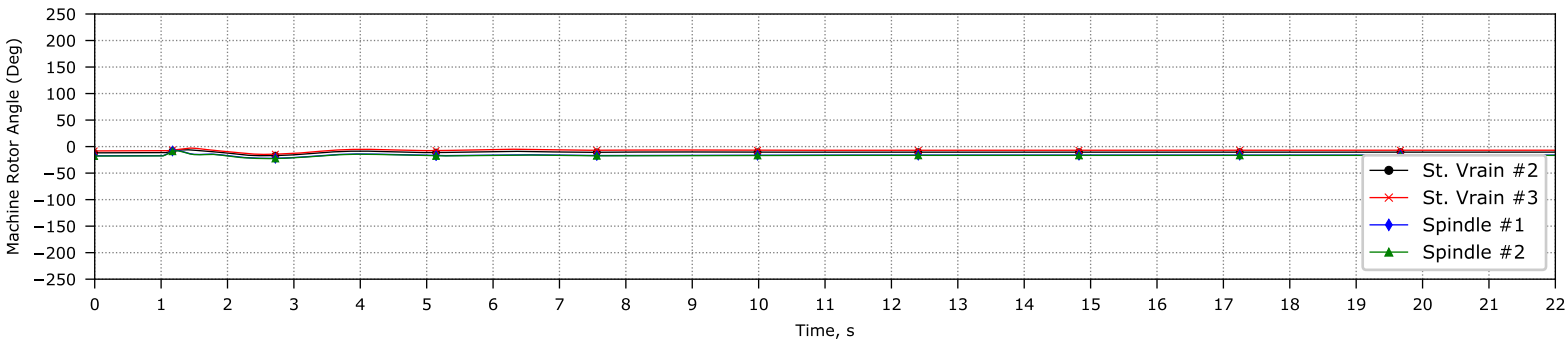


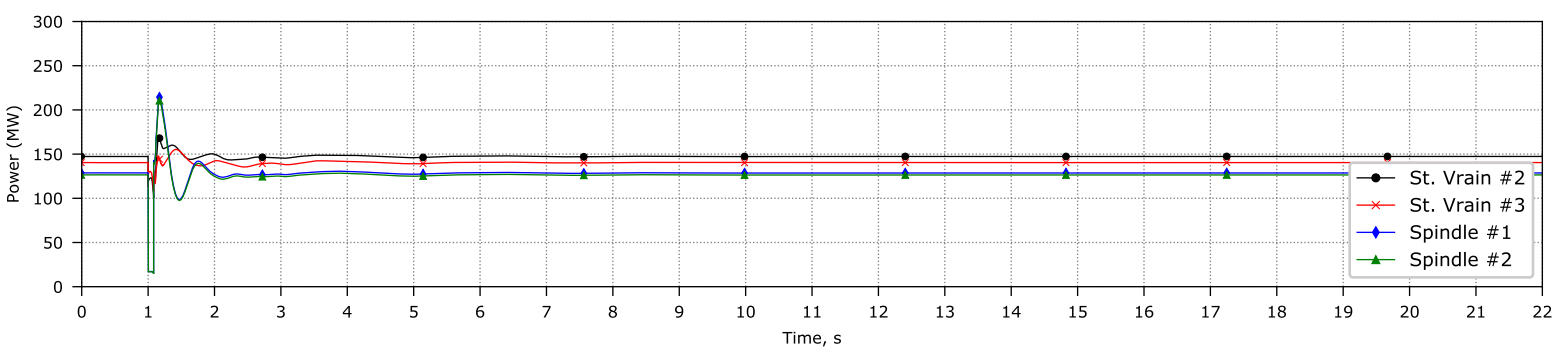


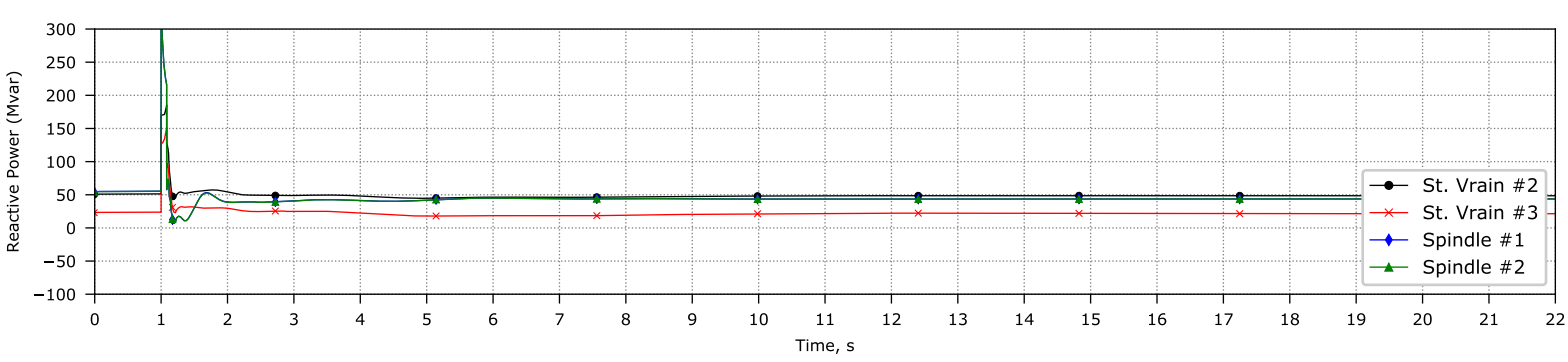


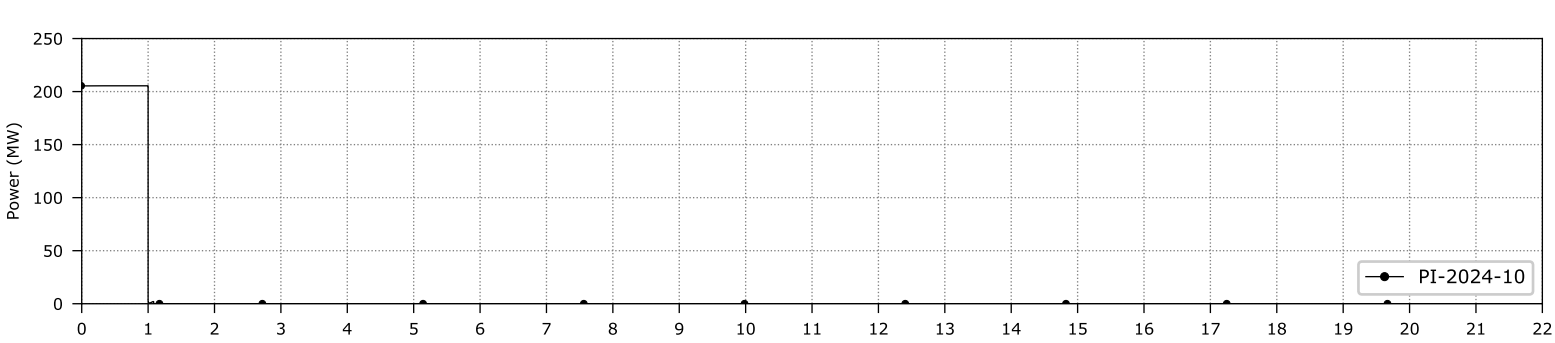


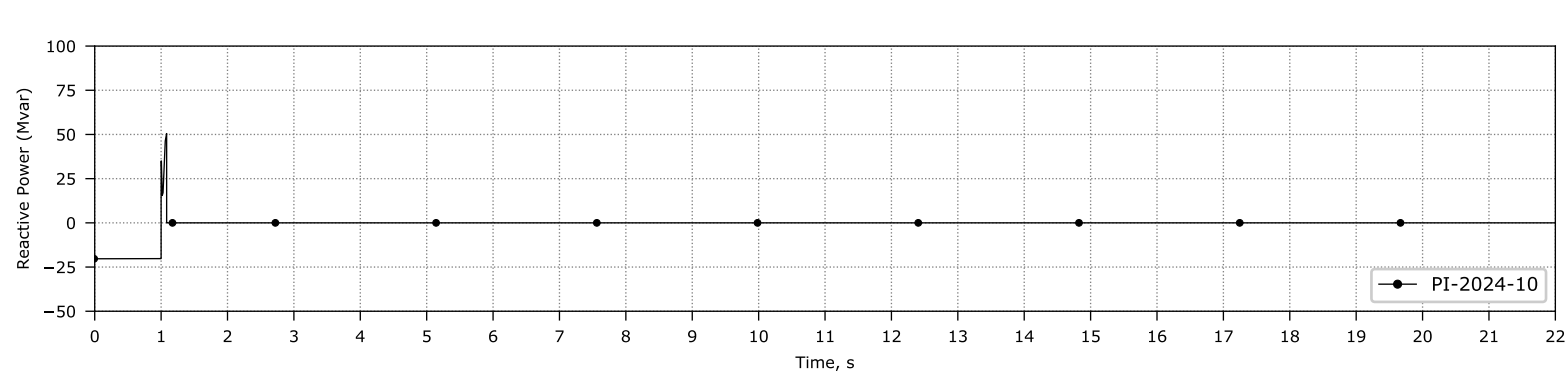
PI-2024-10_Study_North_Spindle-PI-2024-10

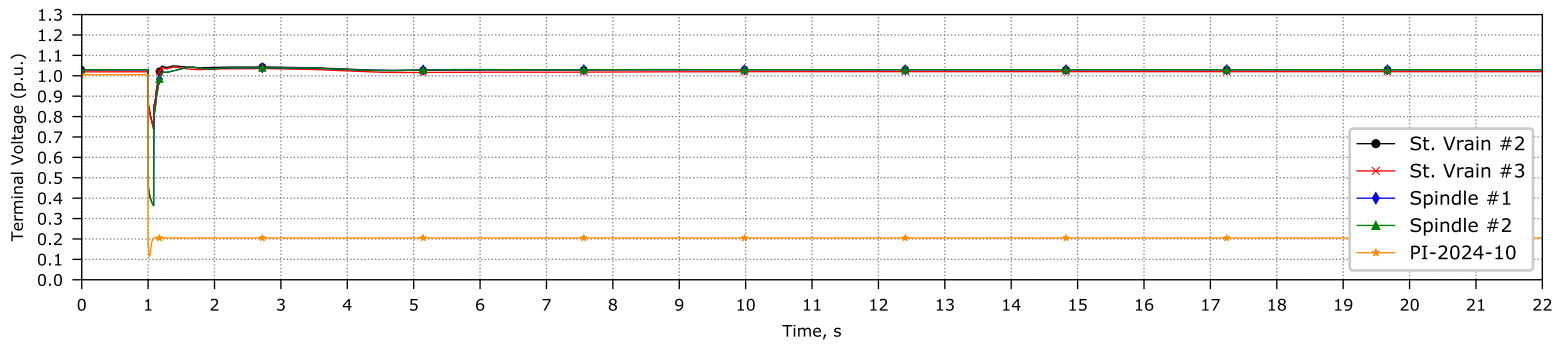


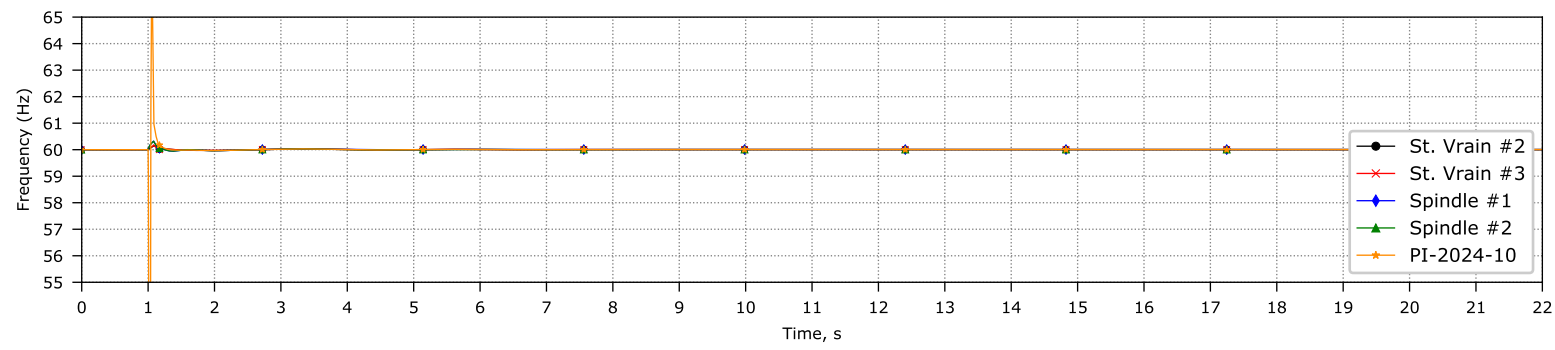


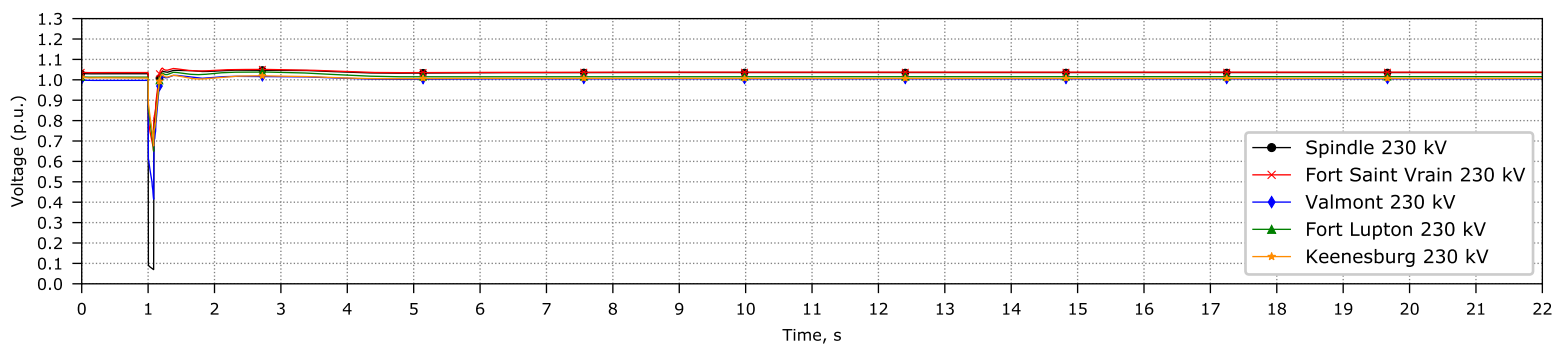




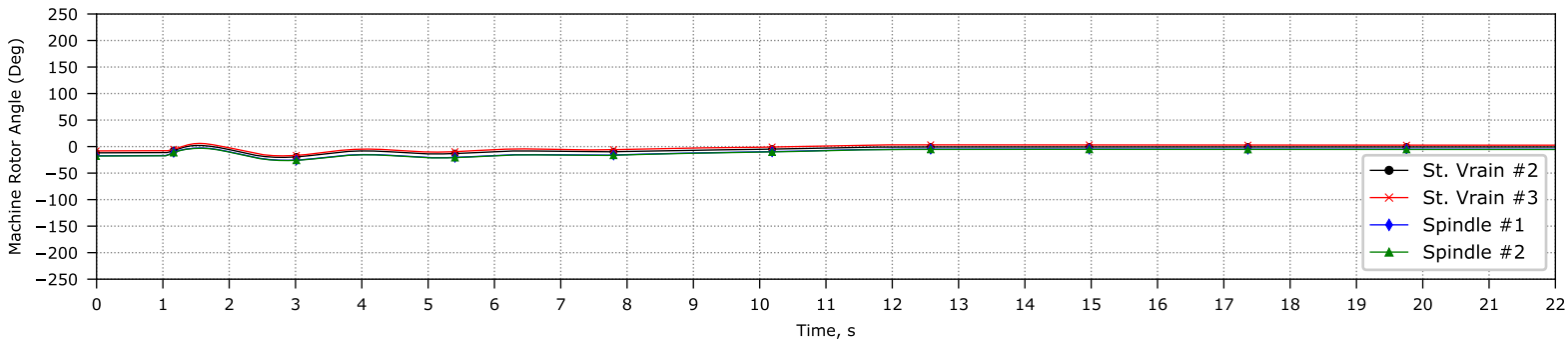


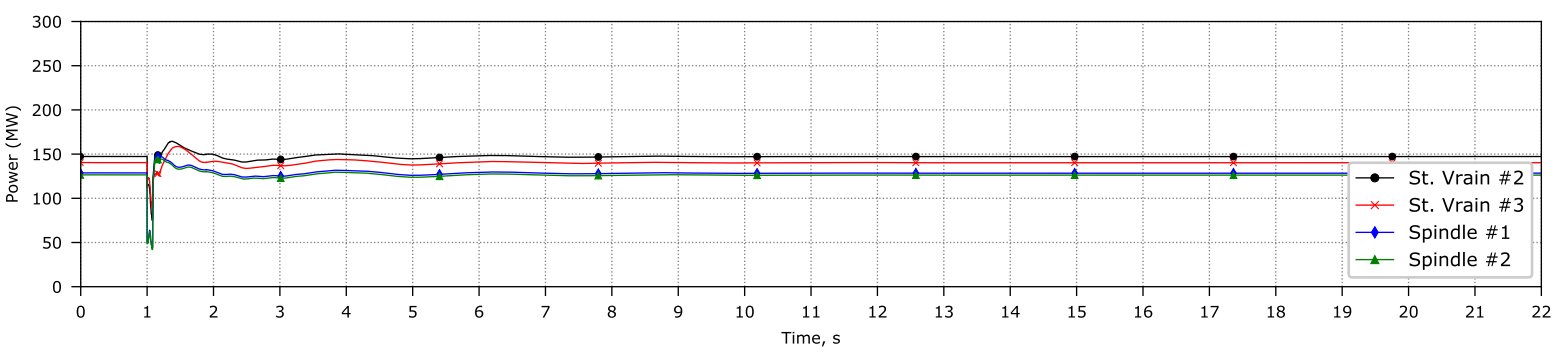


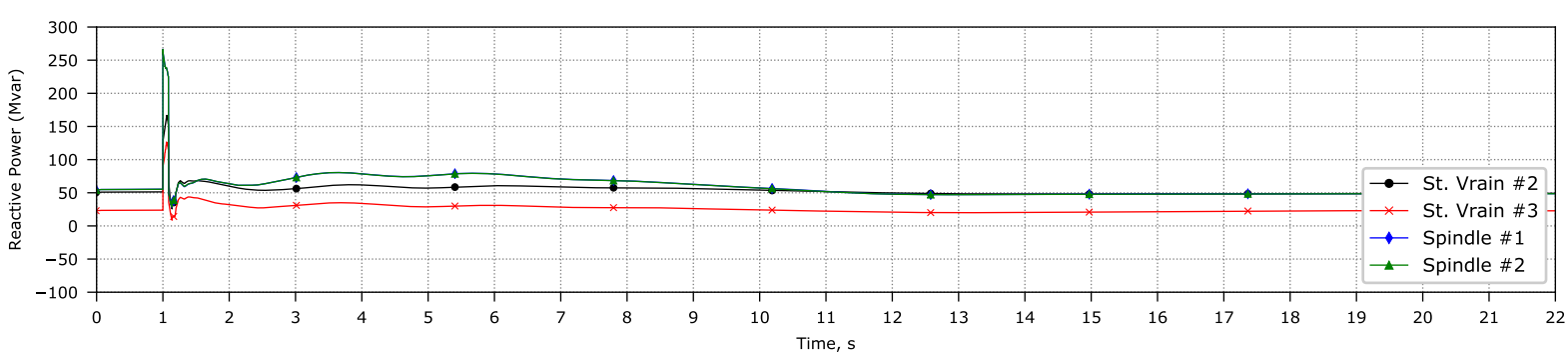


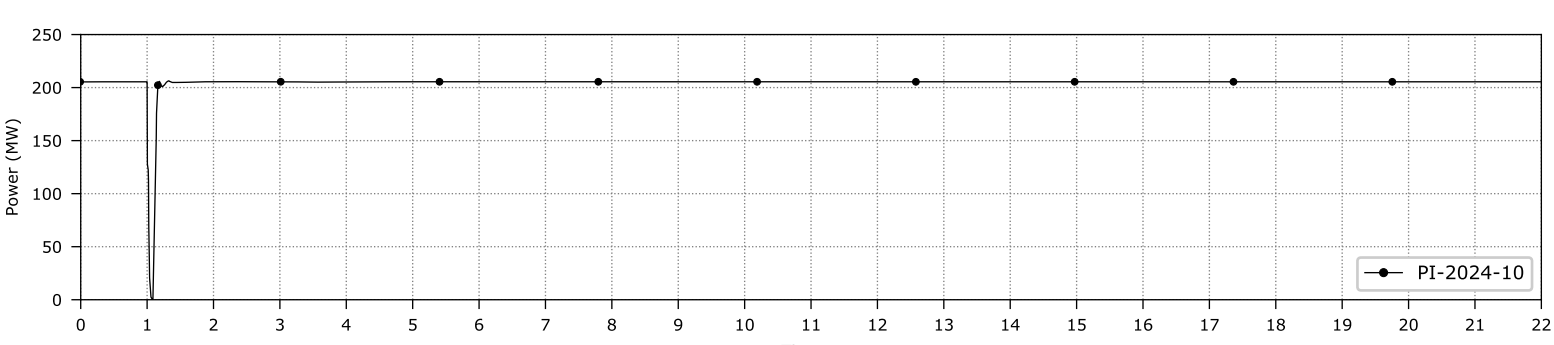


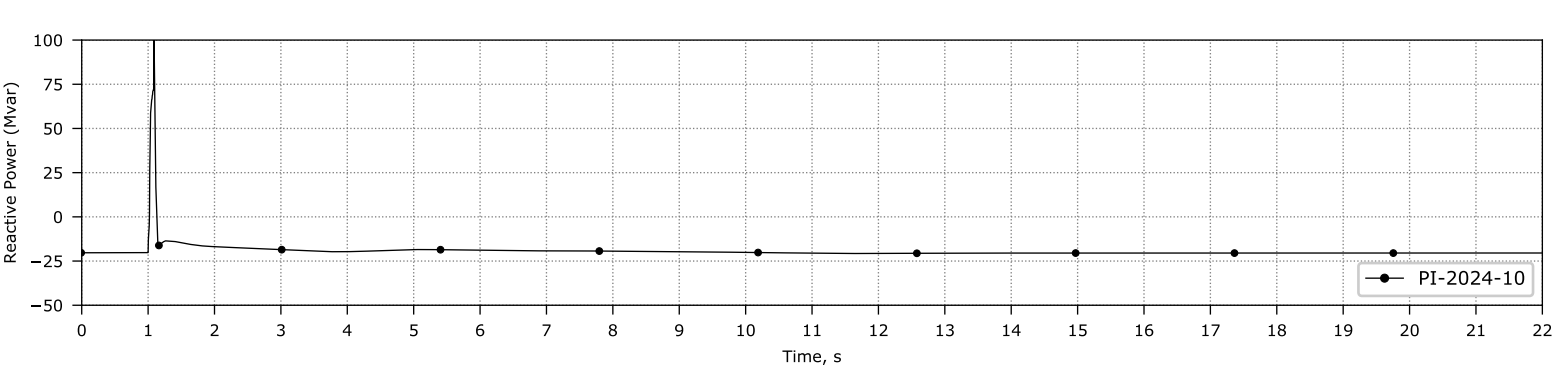
PI-2024-10_Study_North_Valmont-Simms_230kV

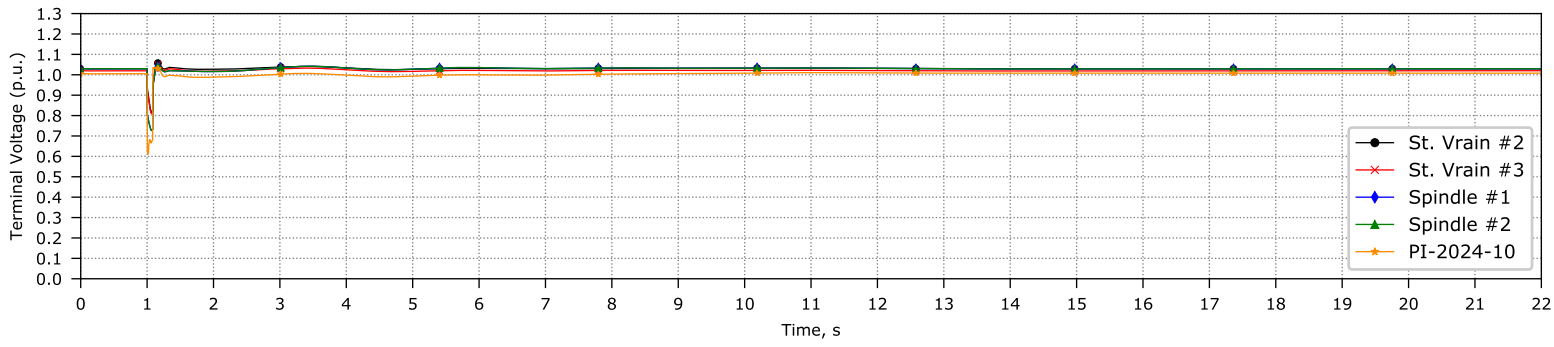


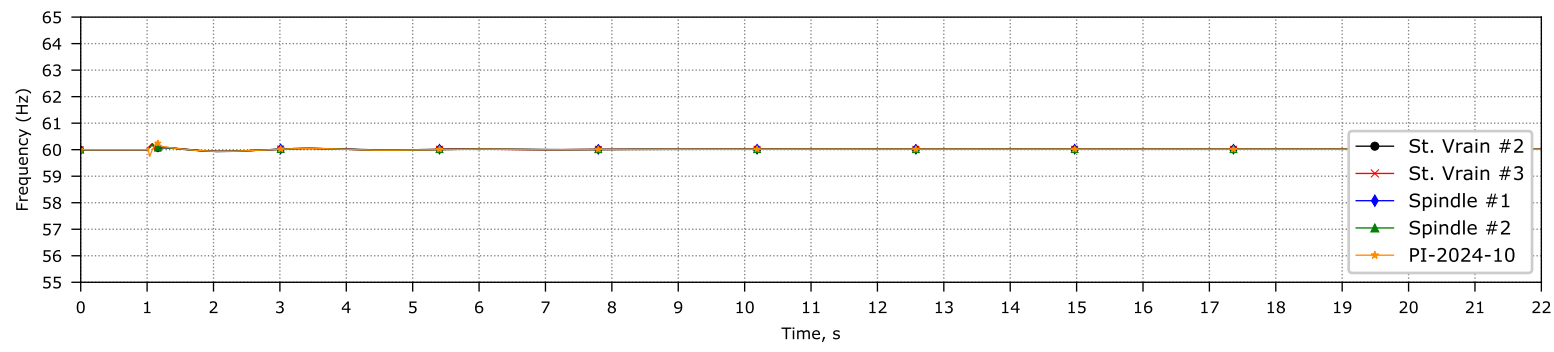


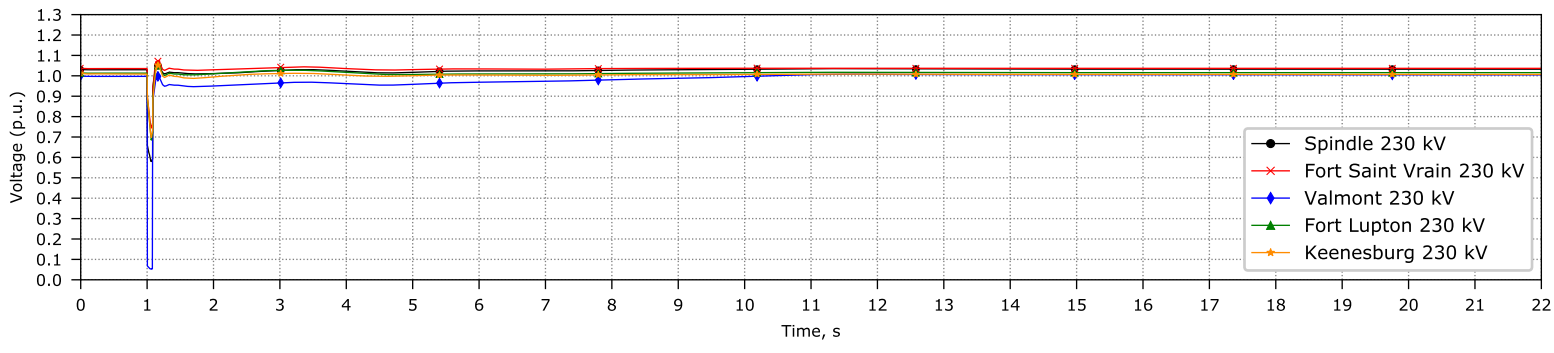




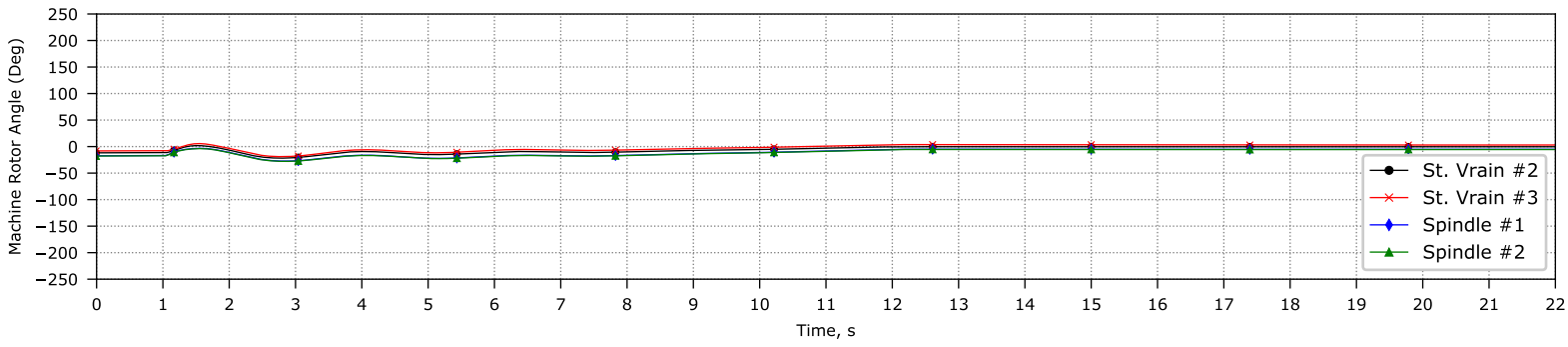


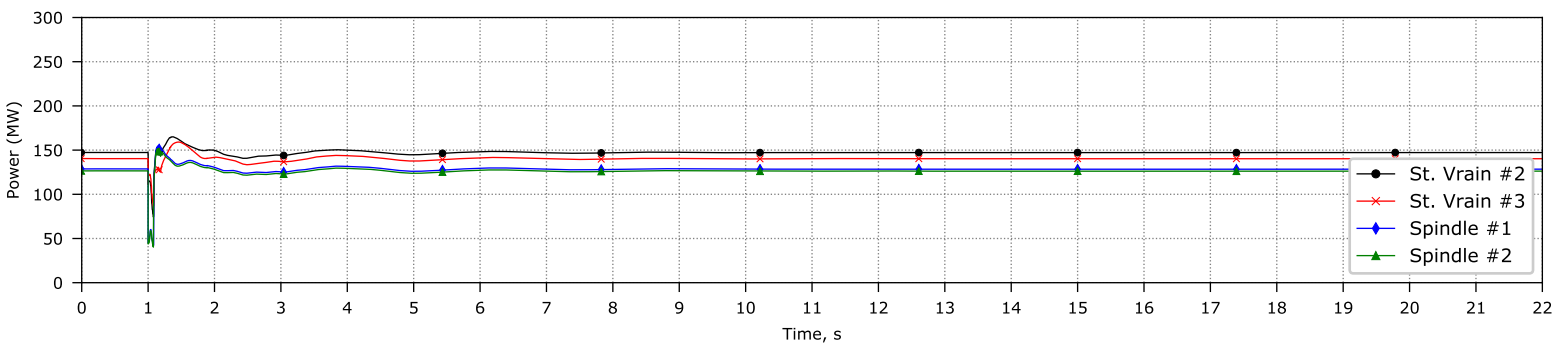


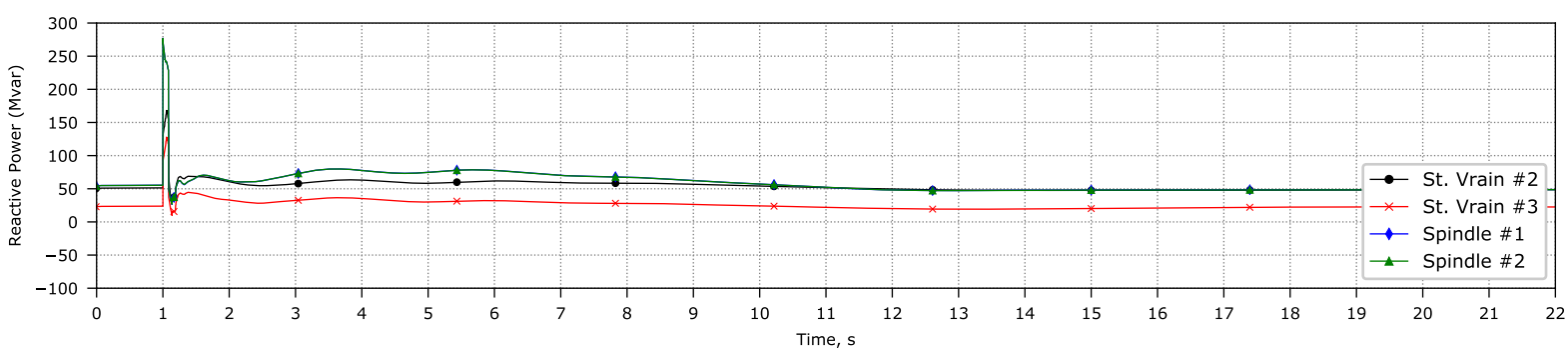


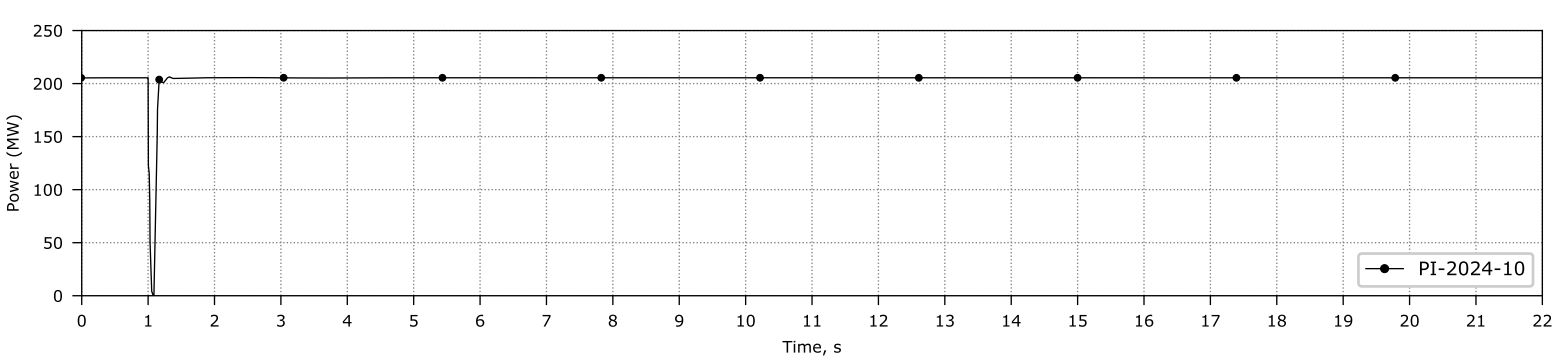


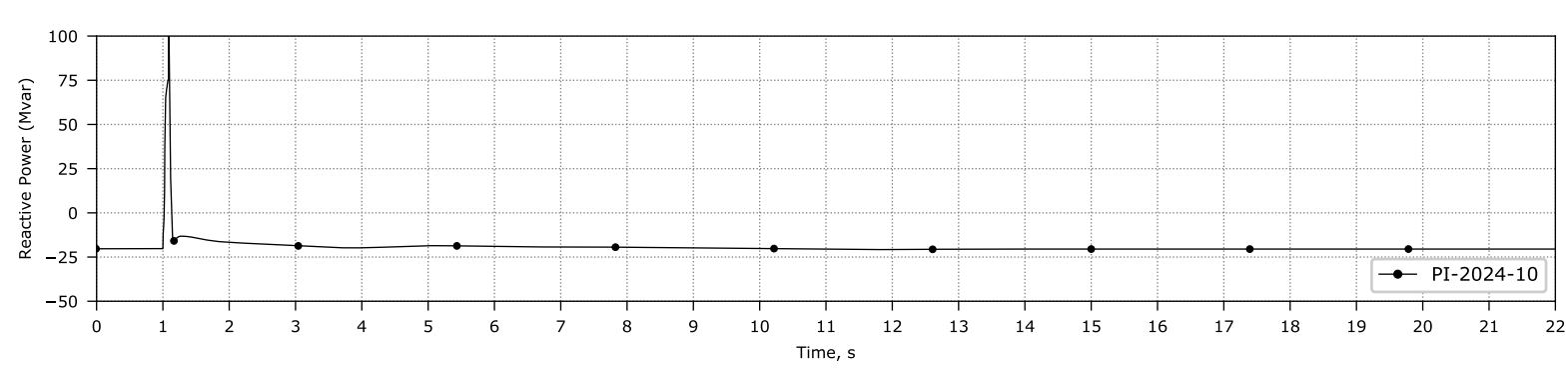
PI-2024-10_Study_North_Valmont_Xfmr

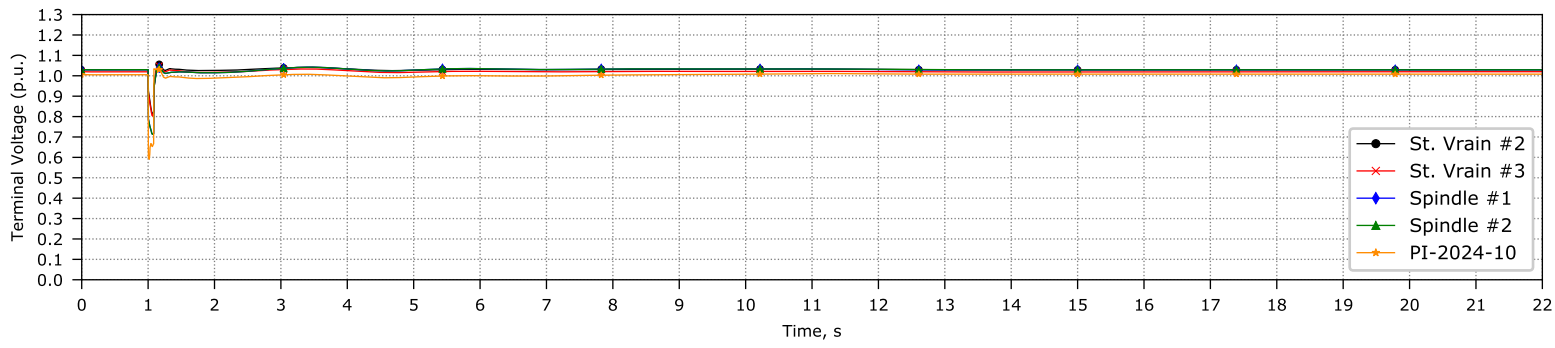


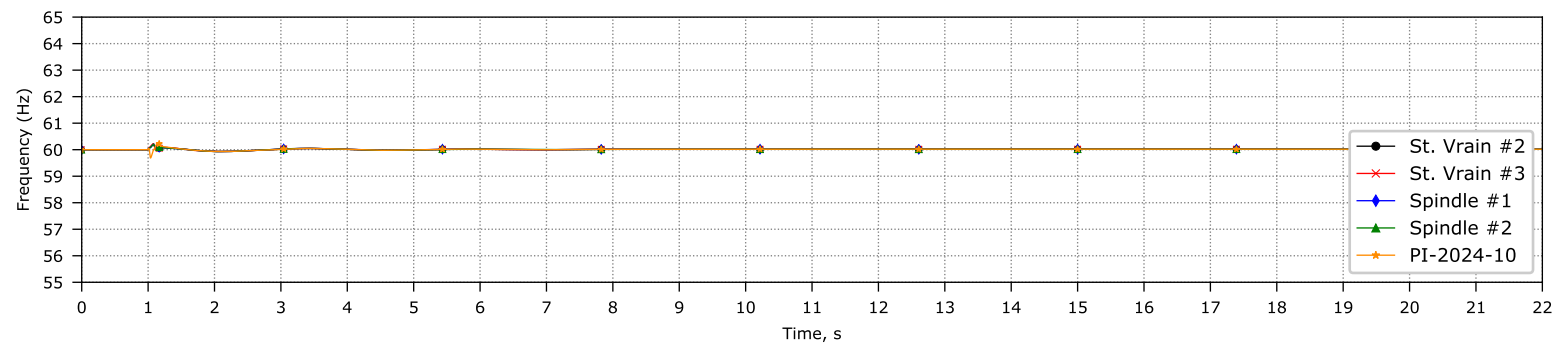


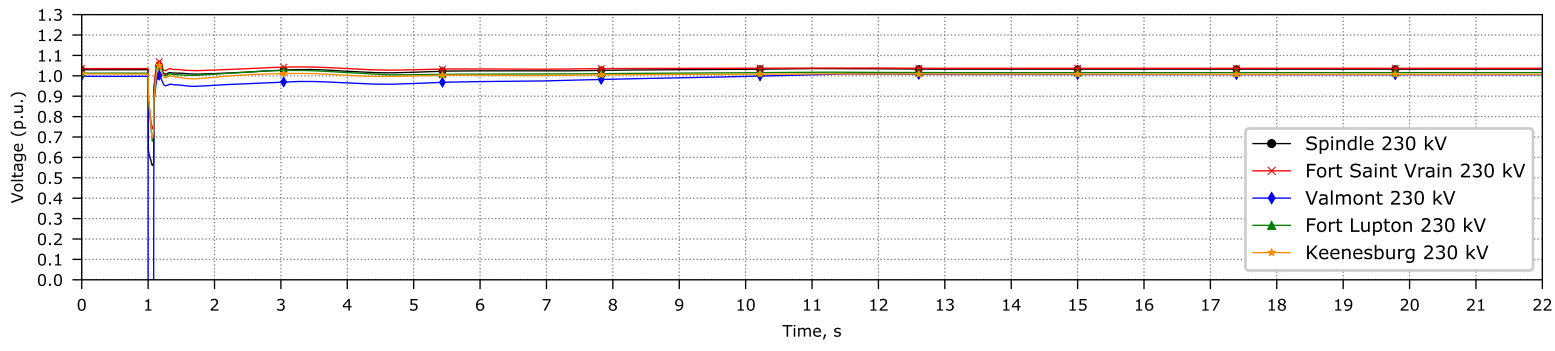




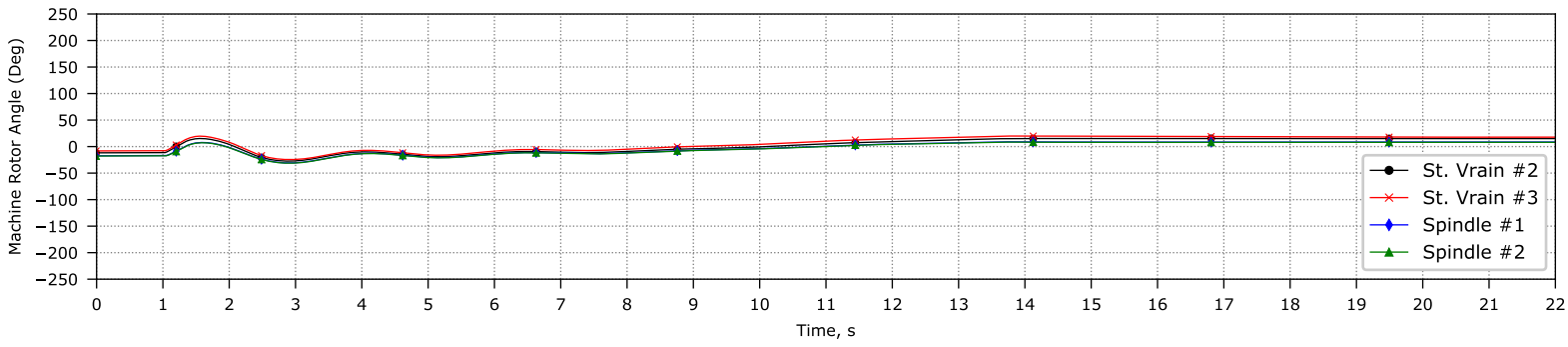


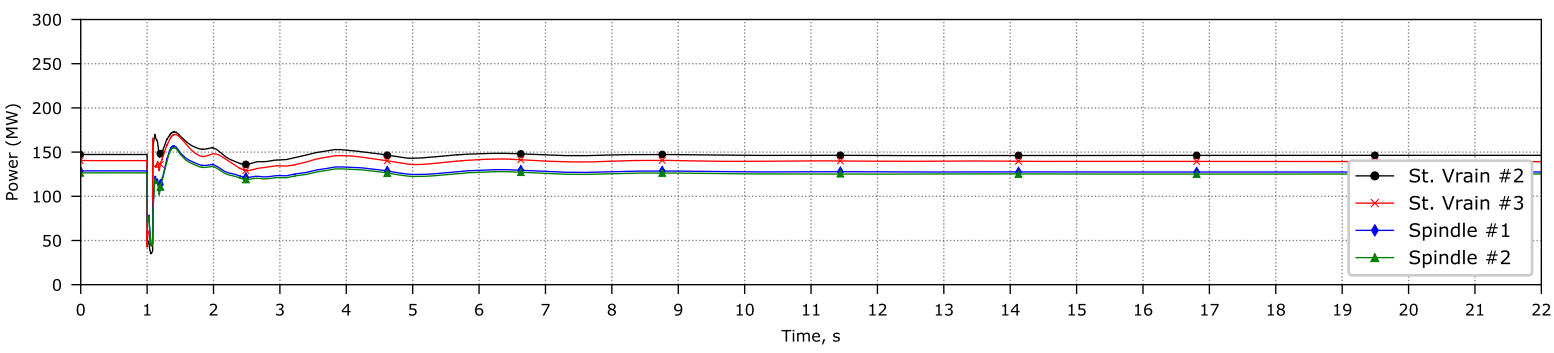


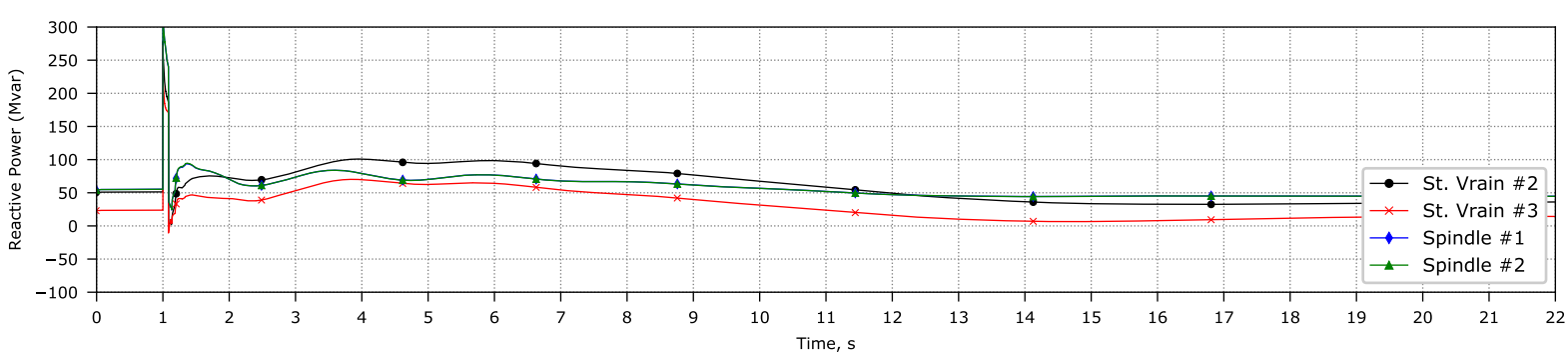


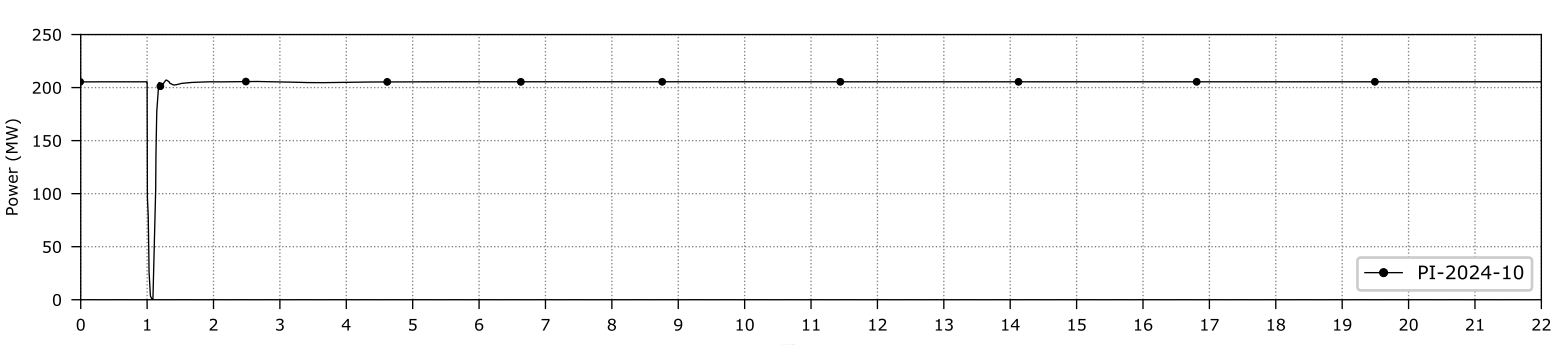


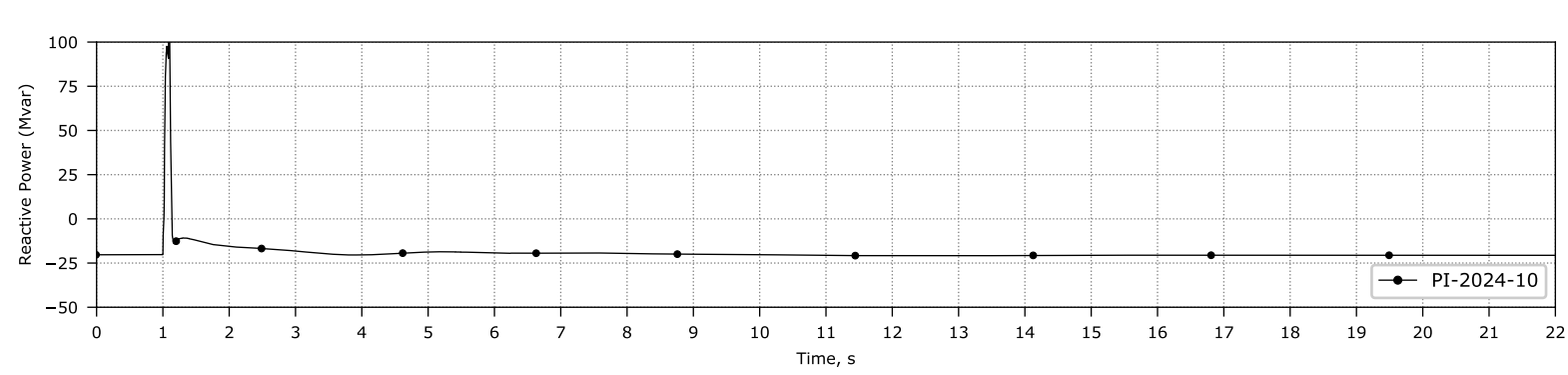
PI-2024-10_Study_North_FSV-FtLupton_230kV

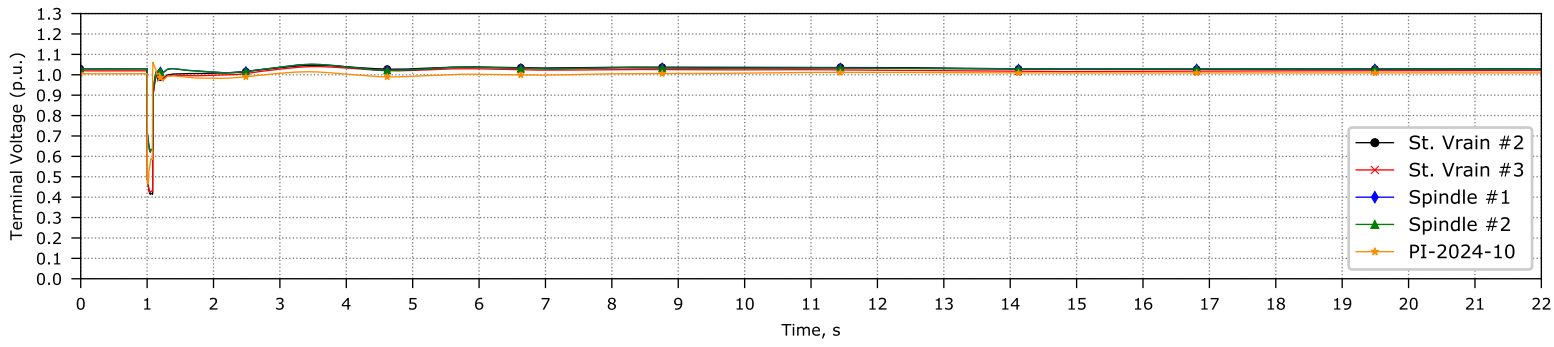


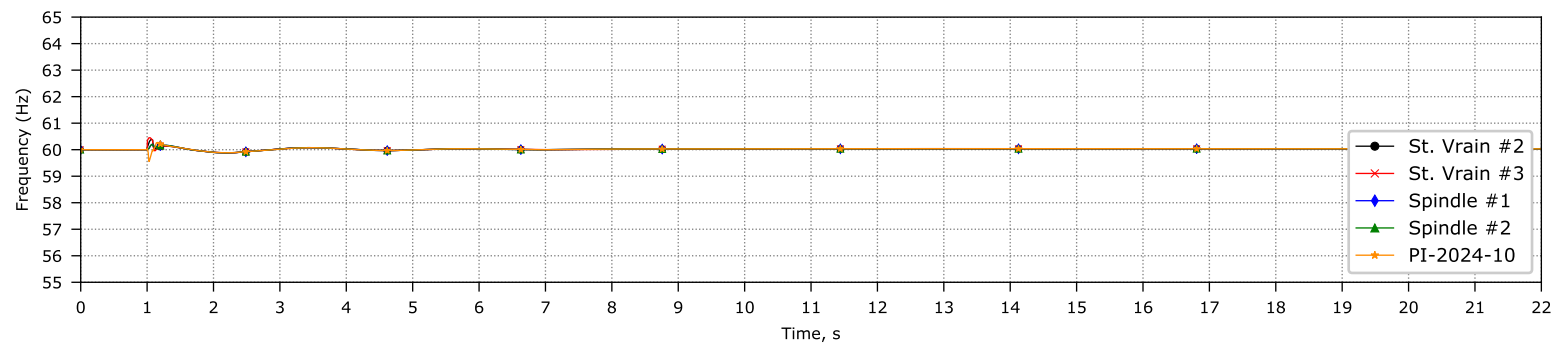


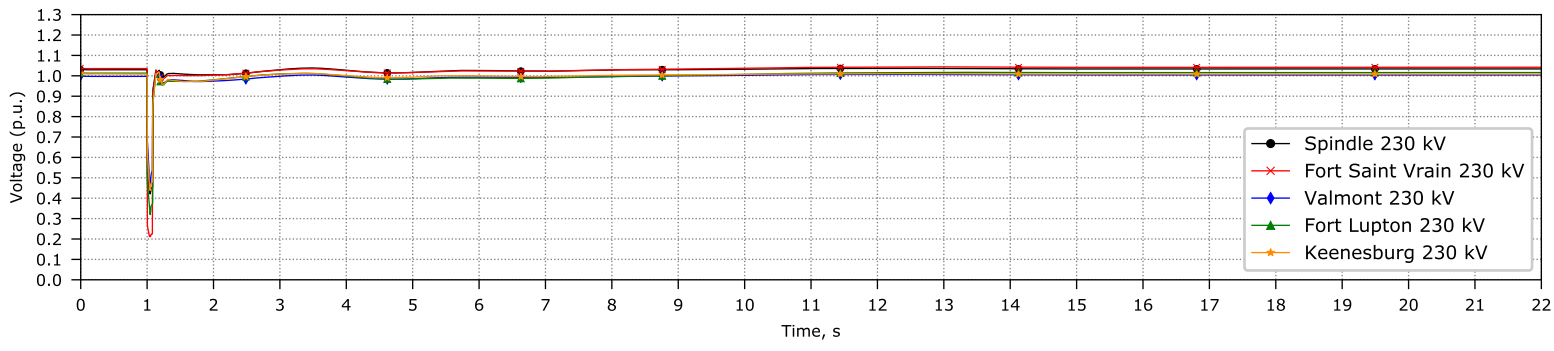




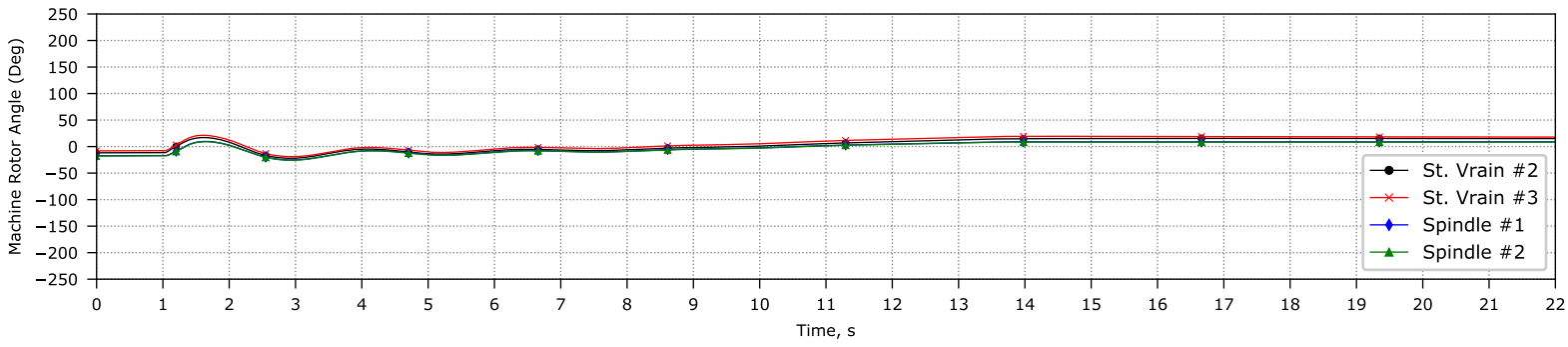


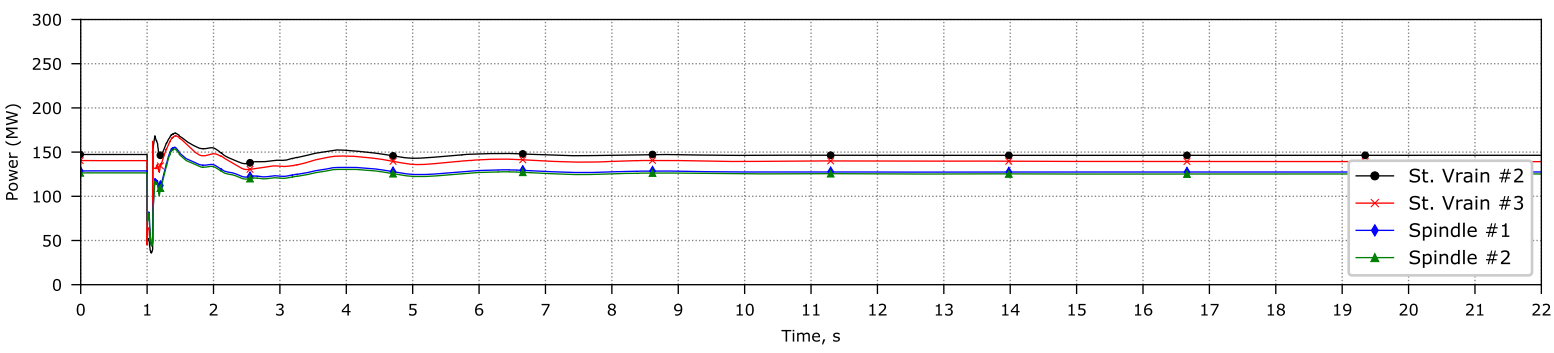


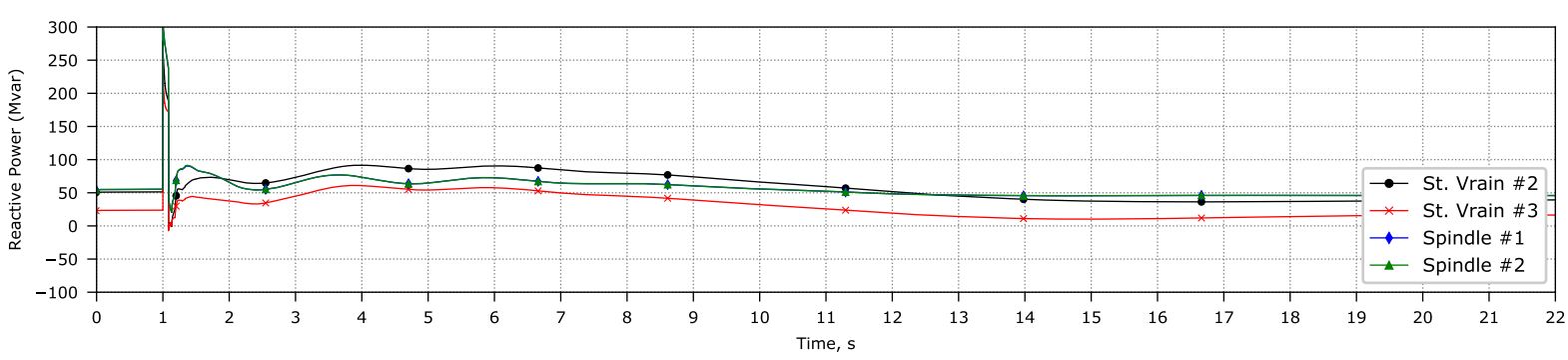


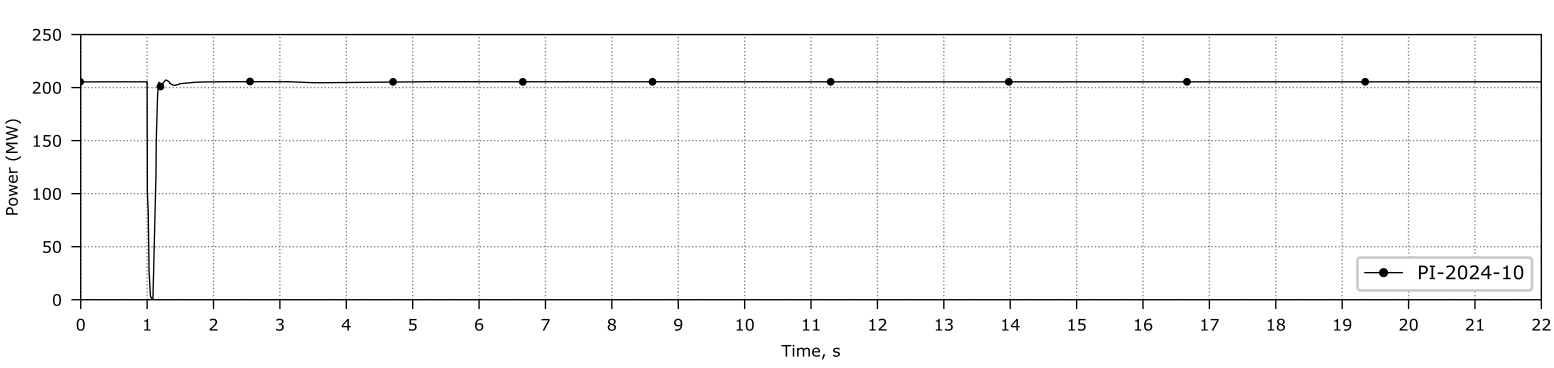


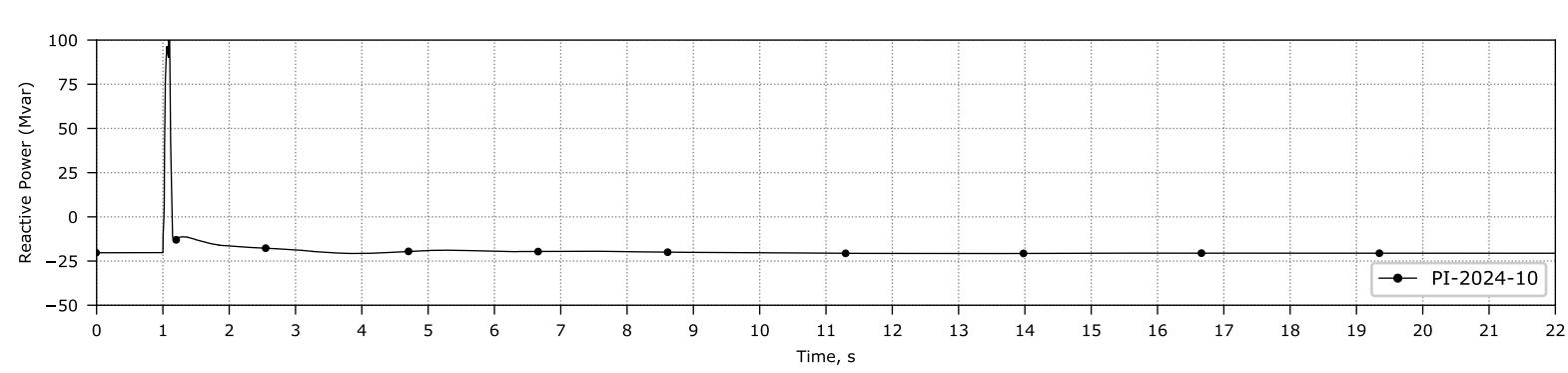
PI-2024-10_Study_North_FSV-Weld_230kV

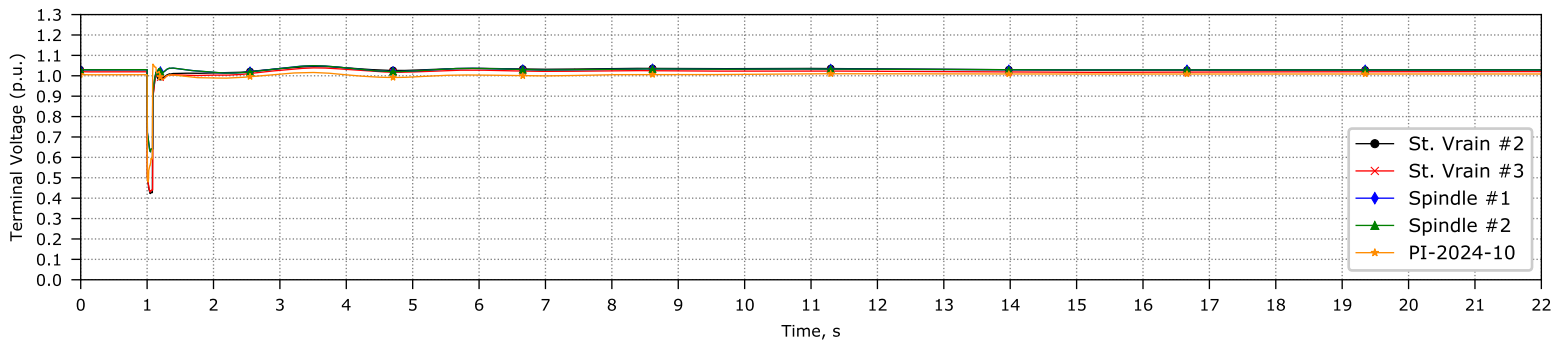


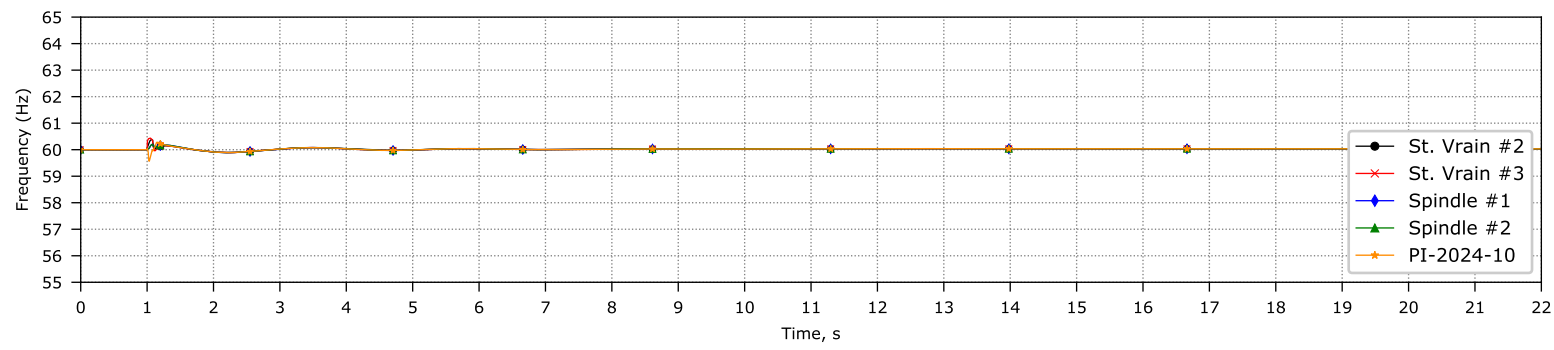


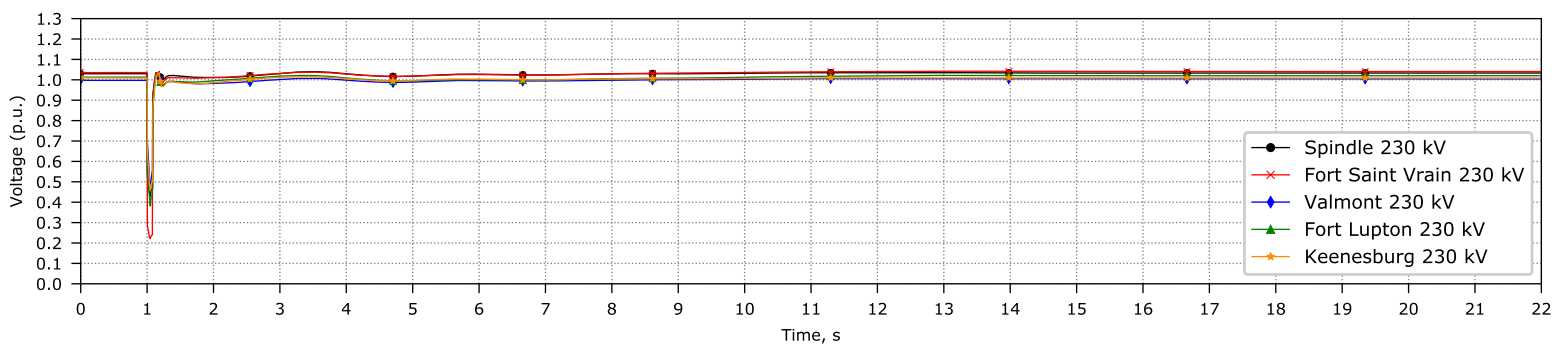




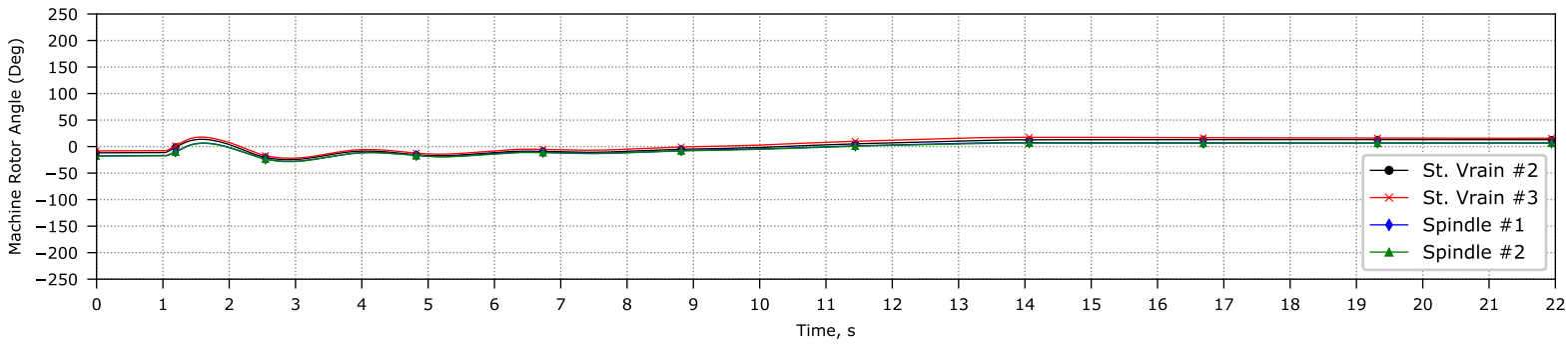


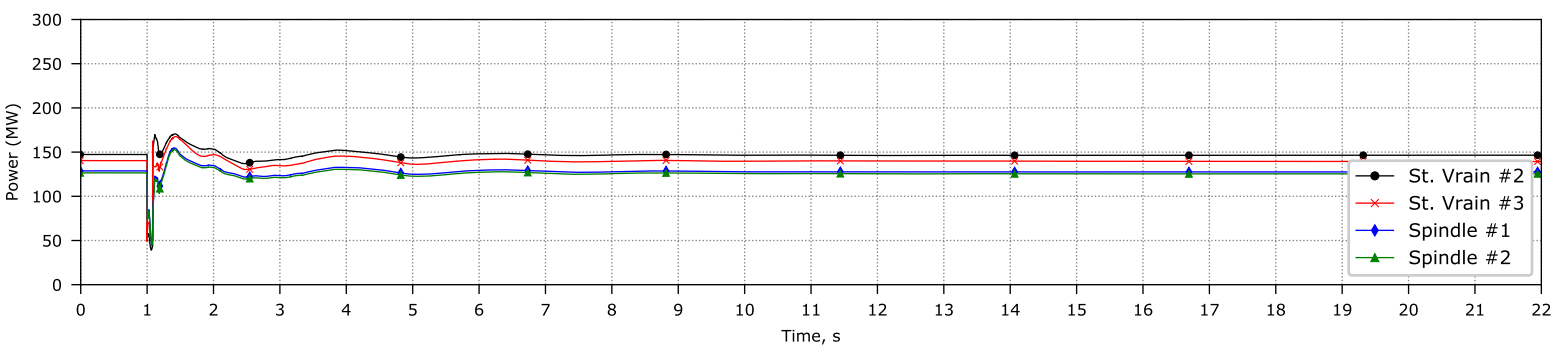


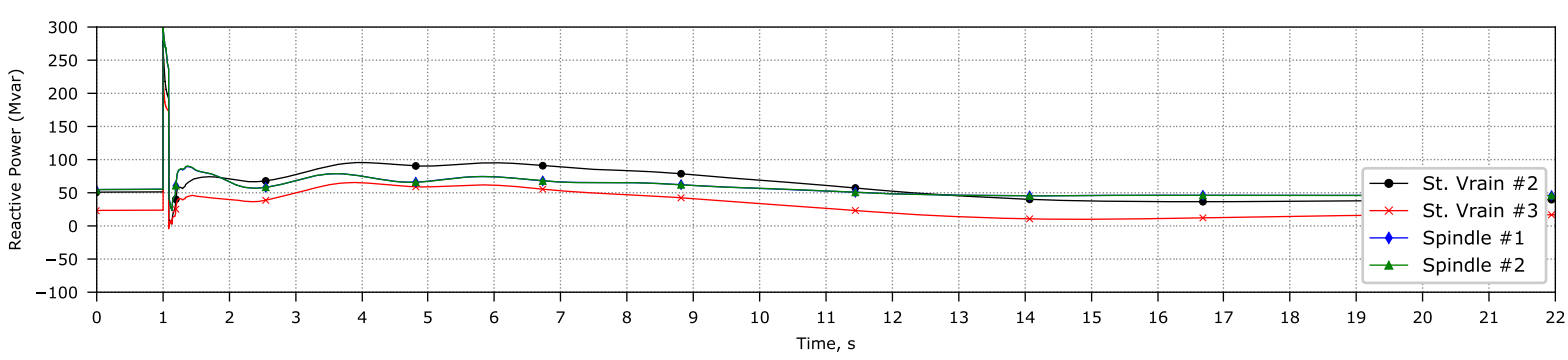


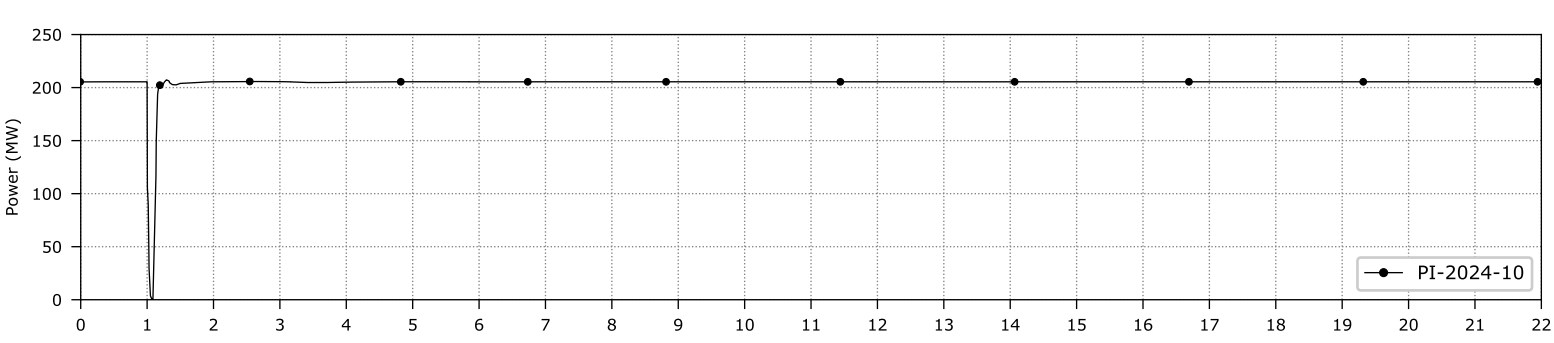


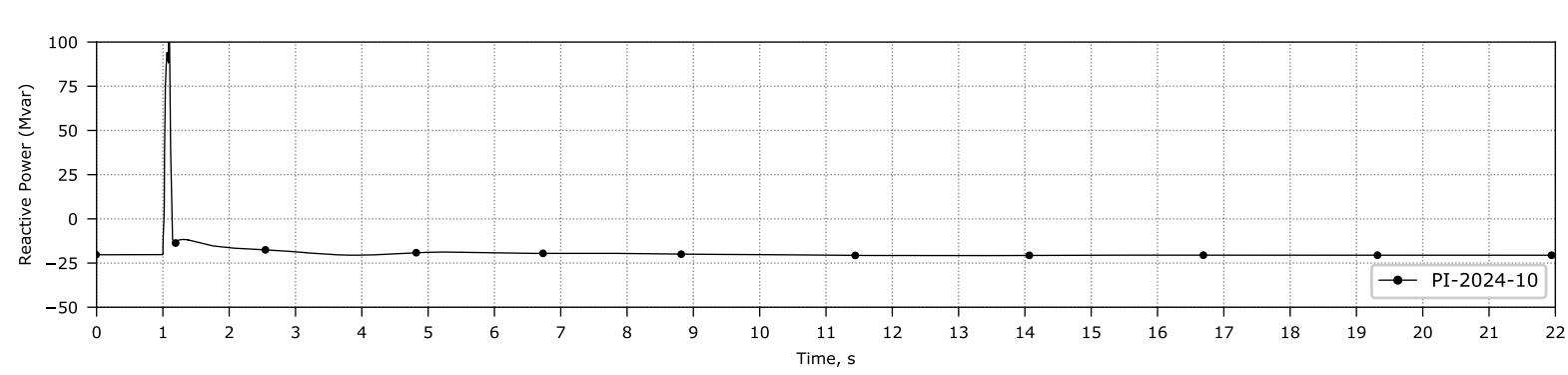
PI-2024-10_Study_North_FSV-Windsor_230kV

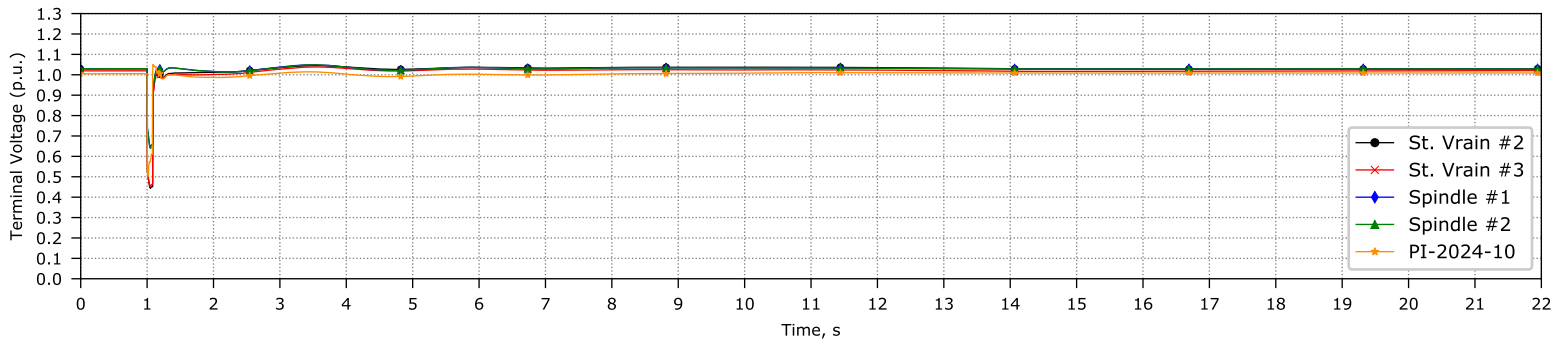


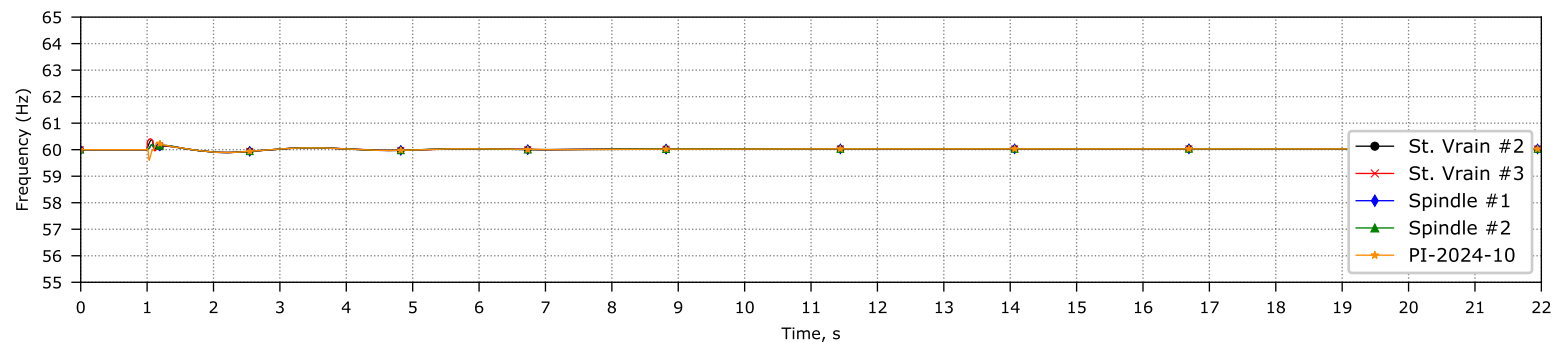


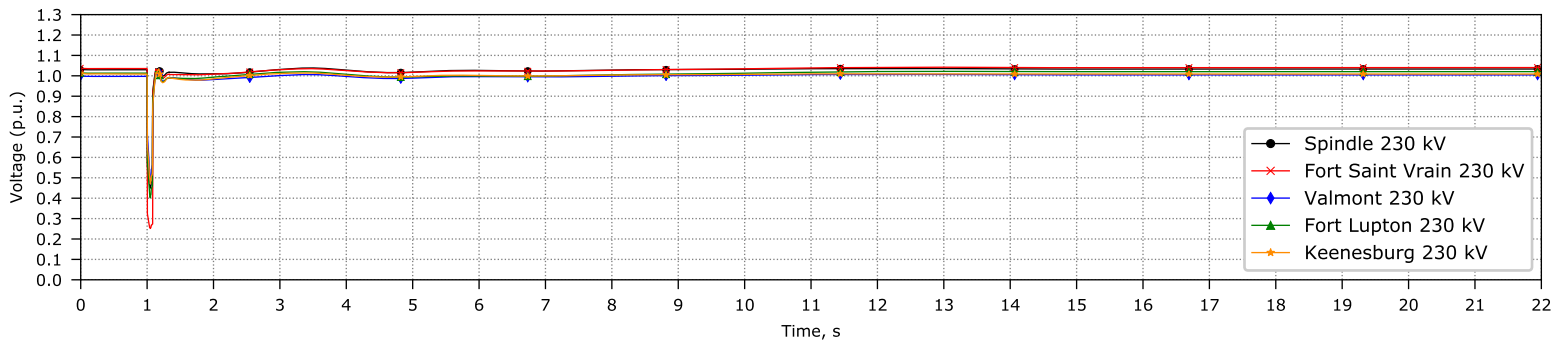




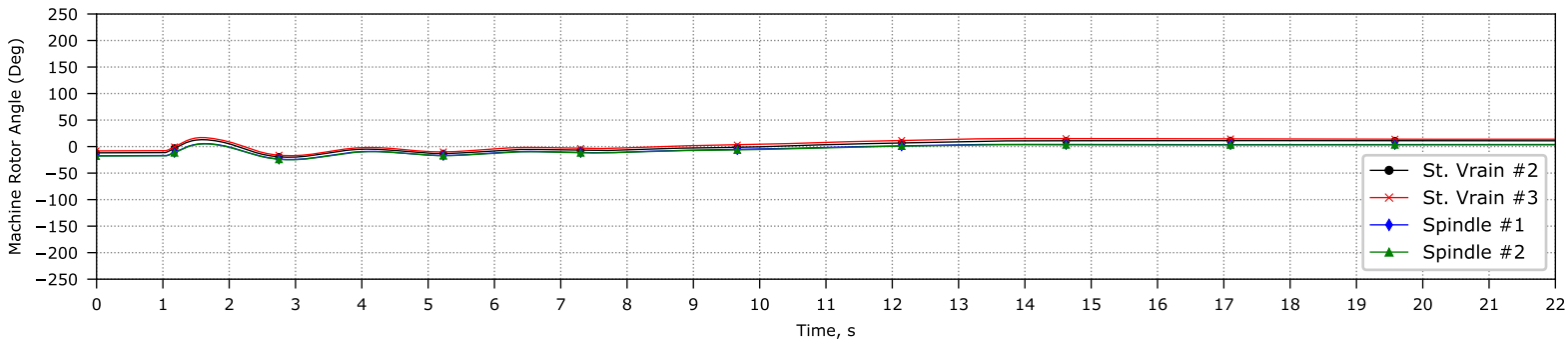


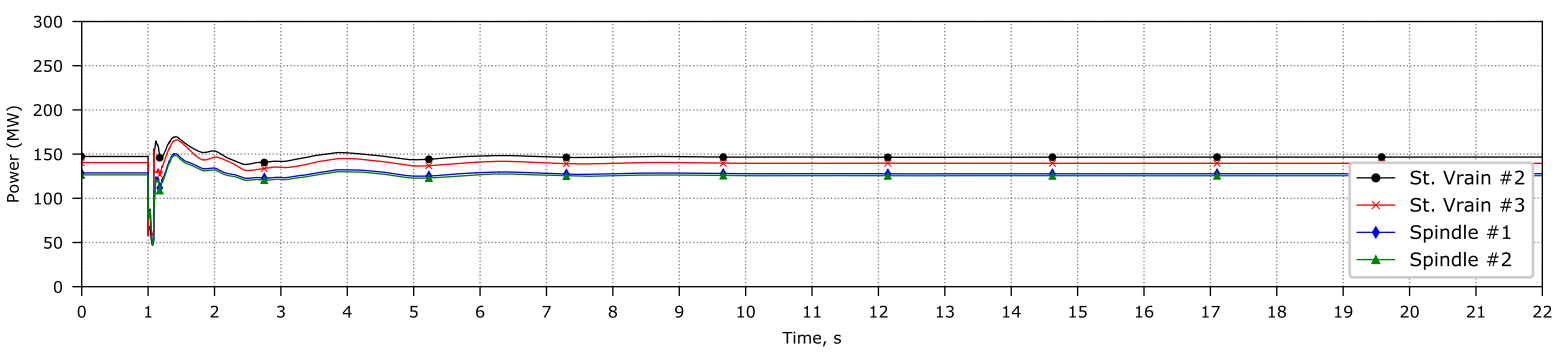


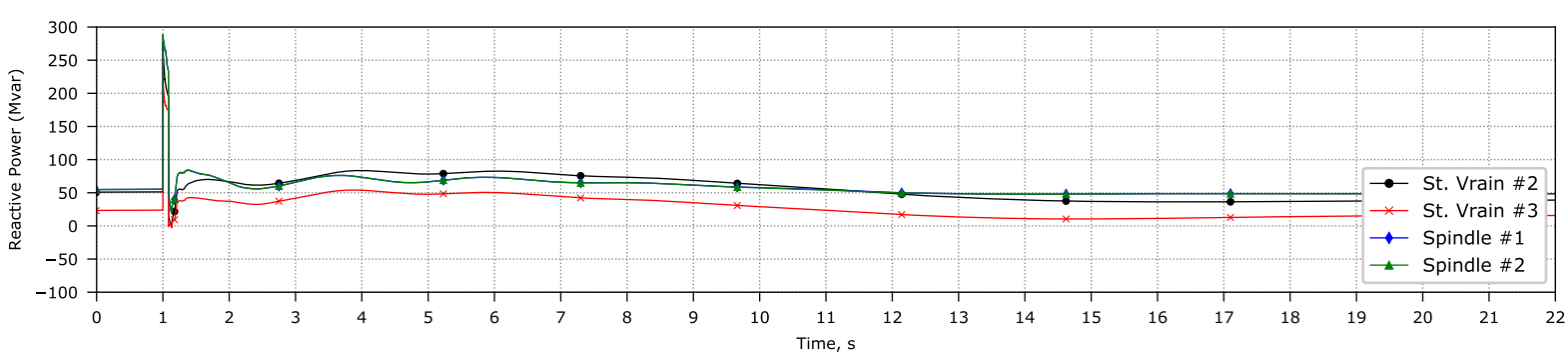


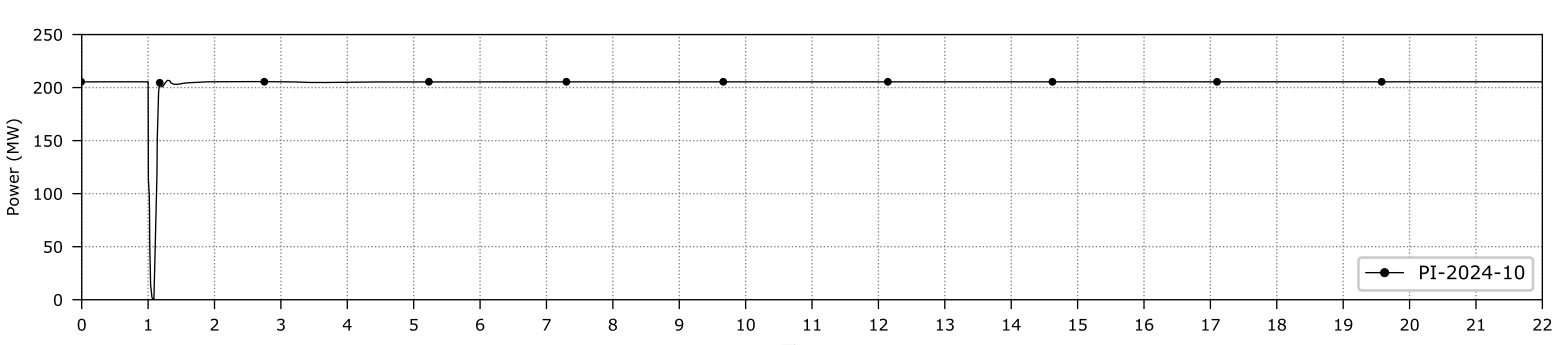


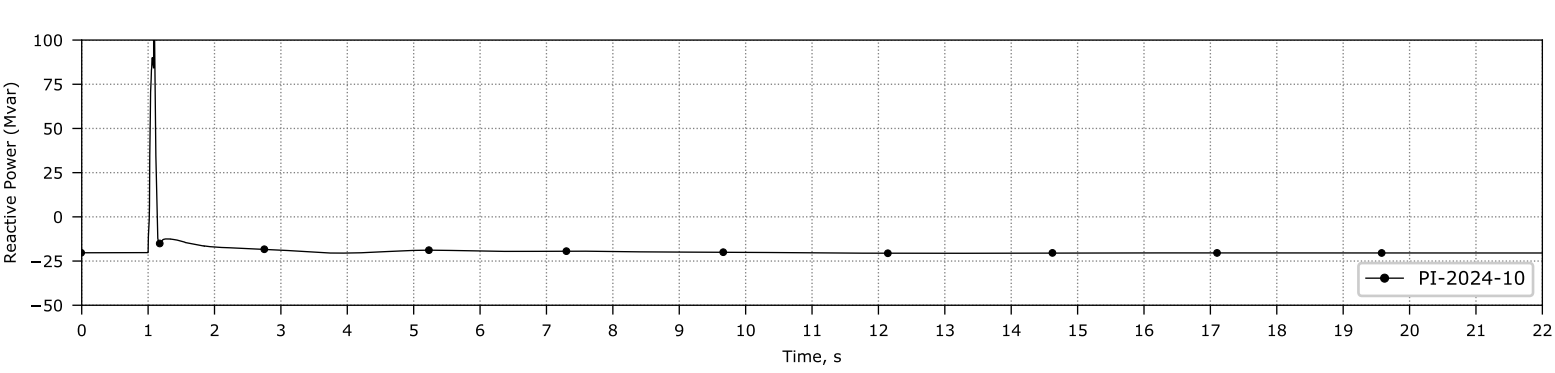
PI-2024-10_Study_North_FSV-Isabelle_230kV

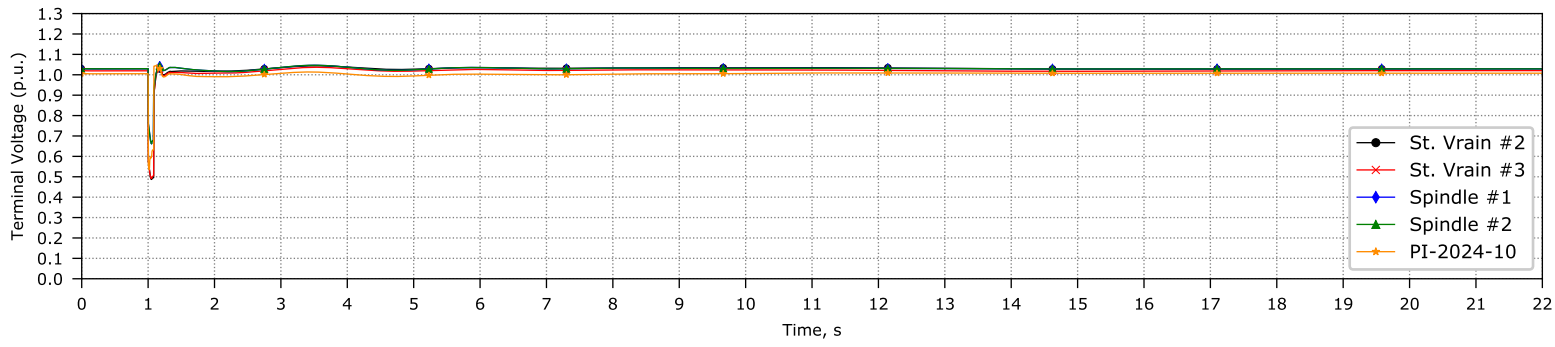


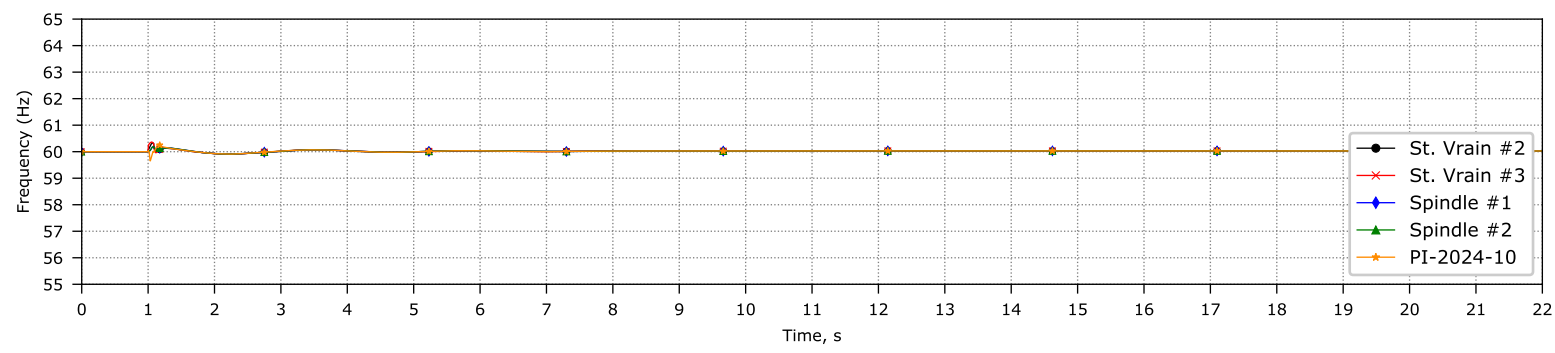


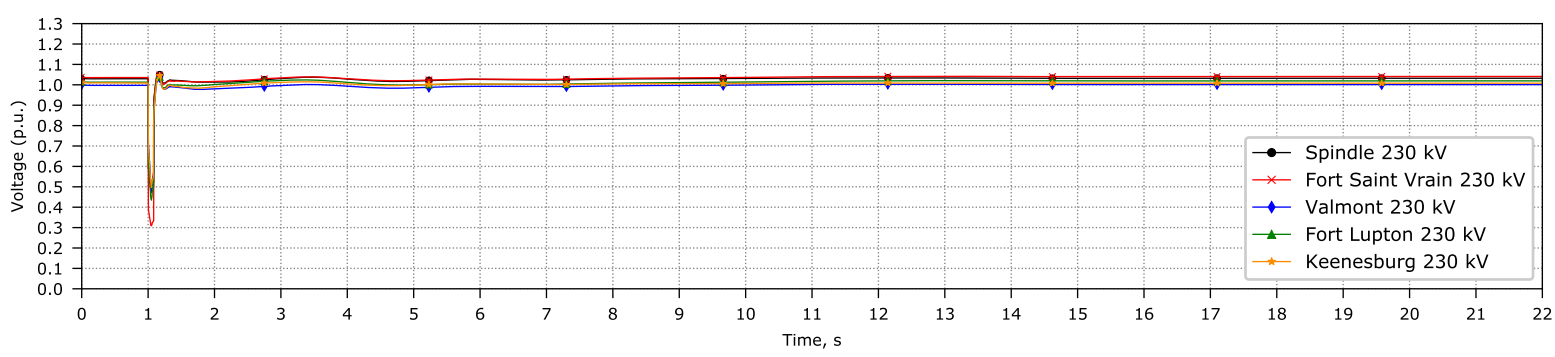




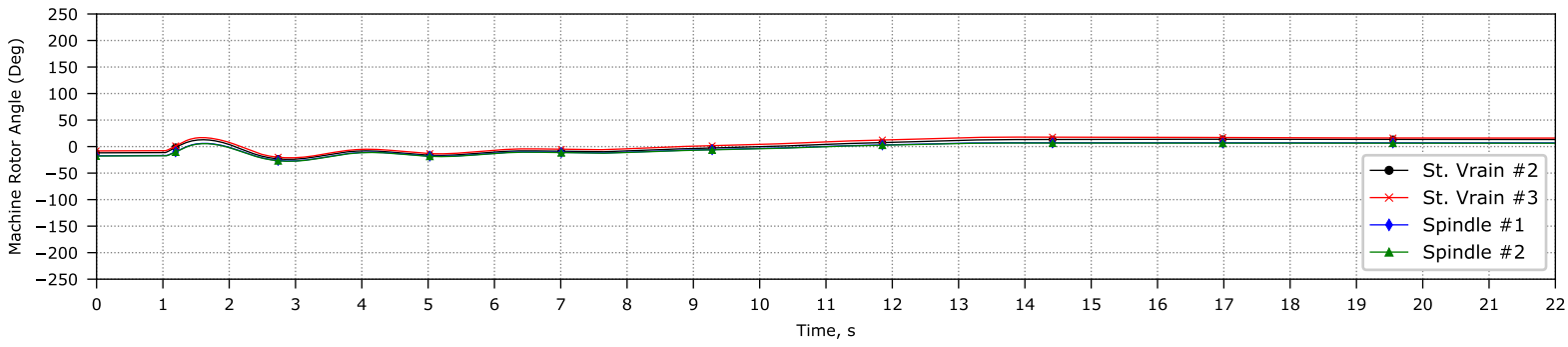


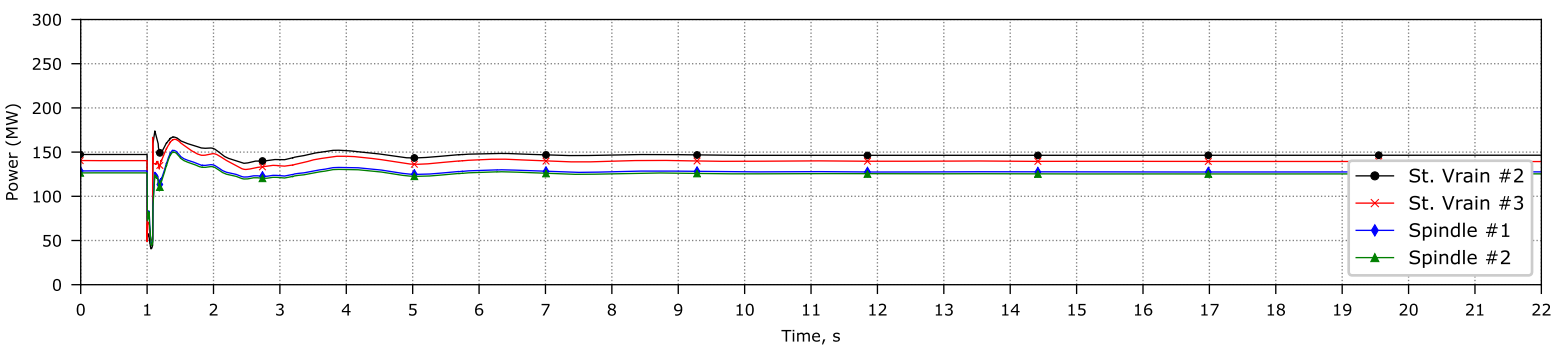


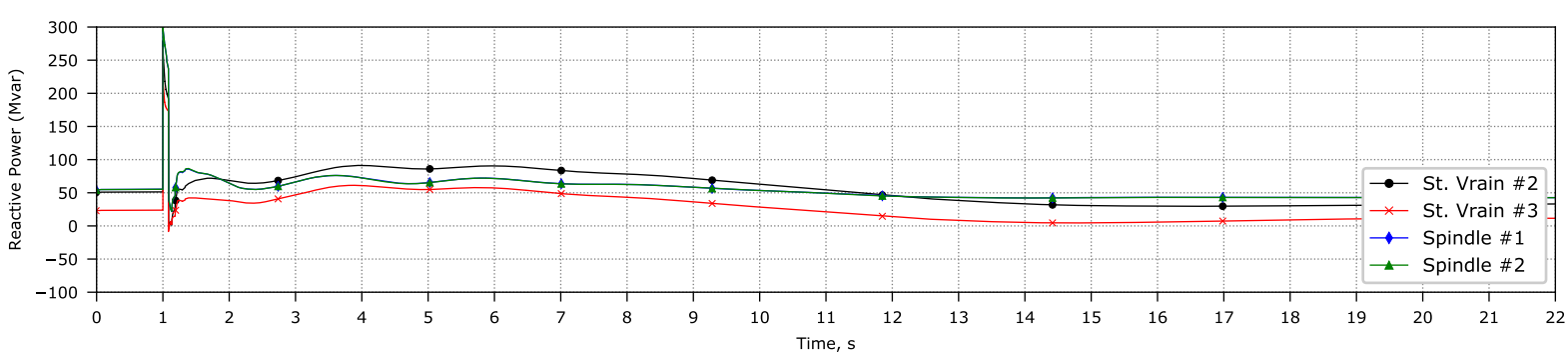


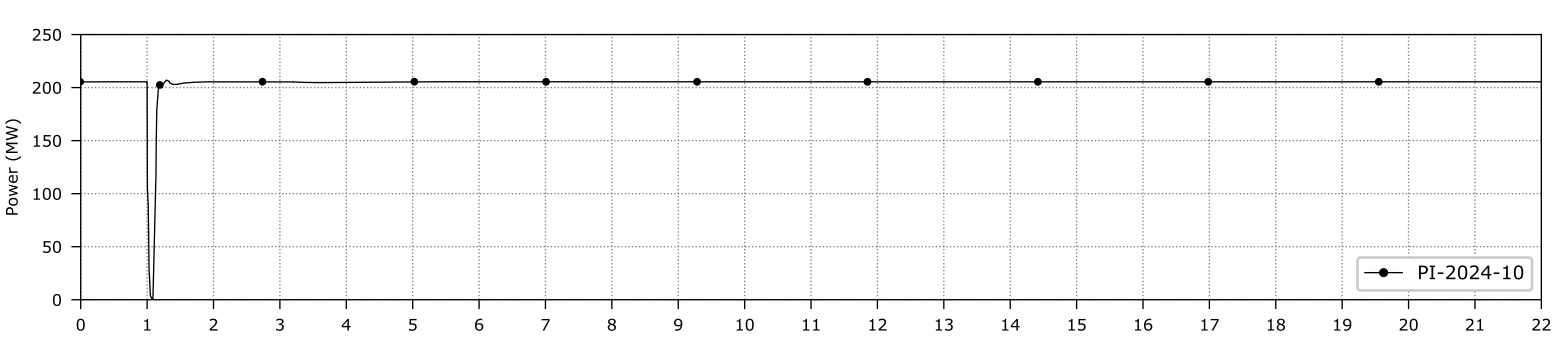


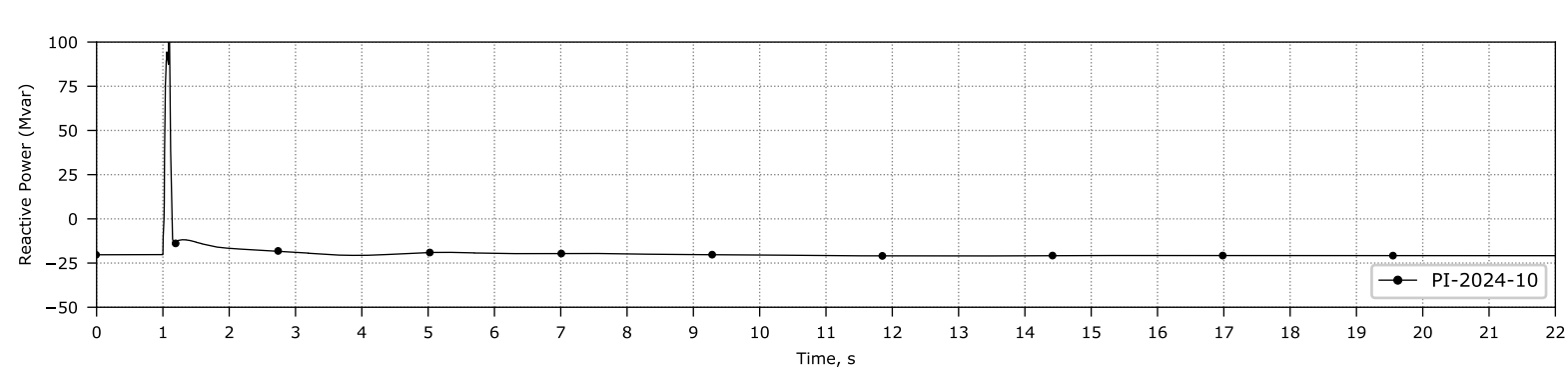
PI-2024-10_Study_North_FSV-Keenesburg_230kV

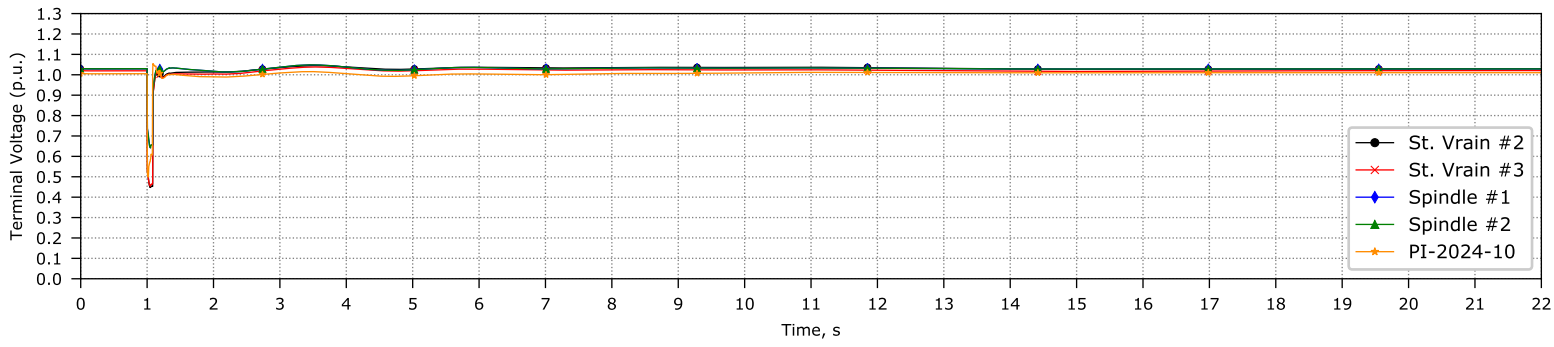


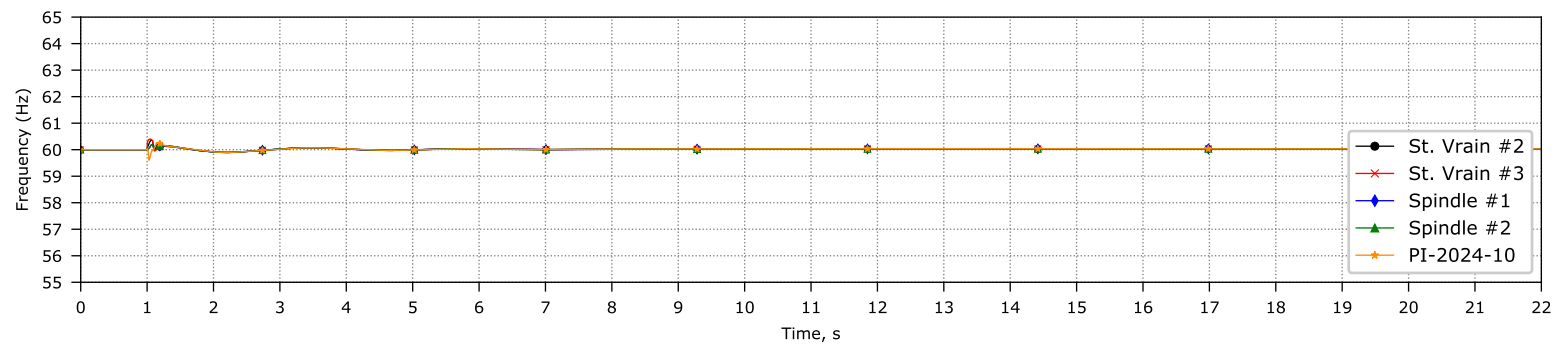


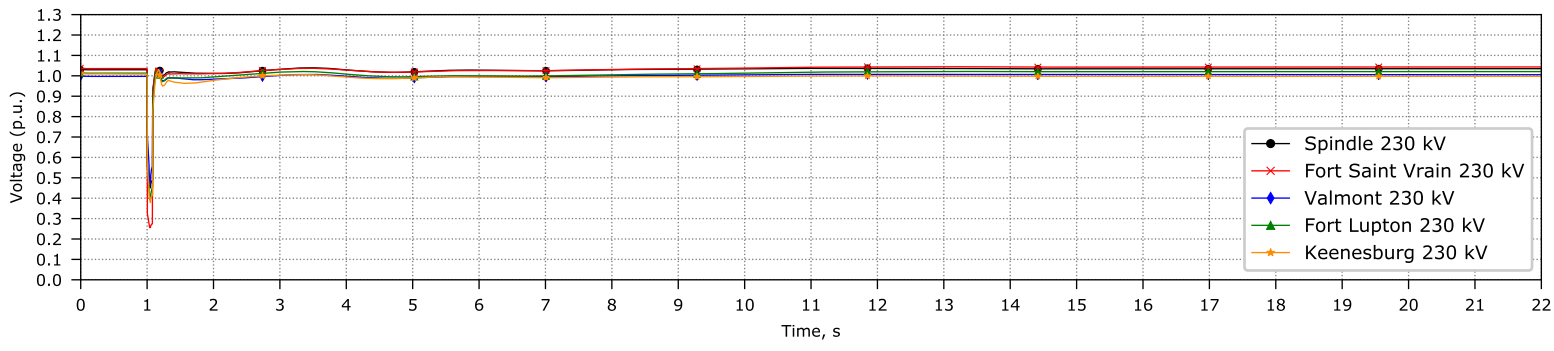




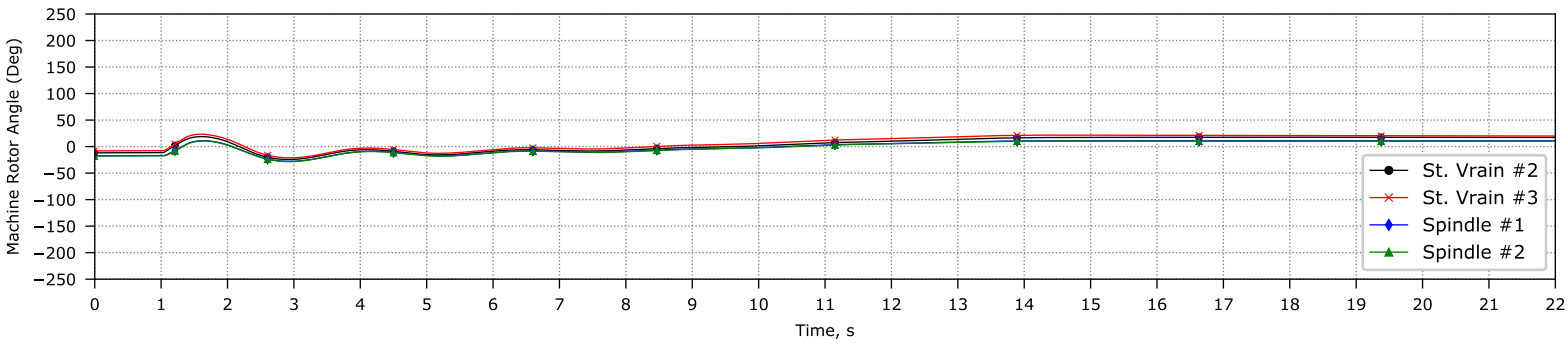


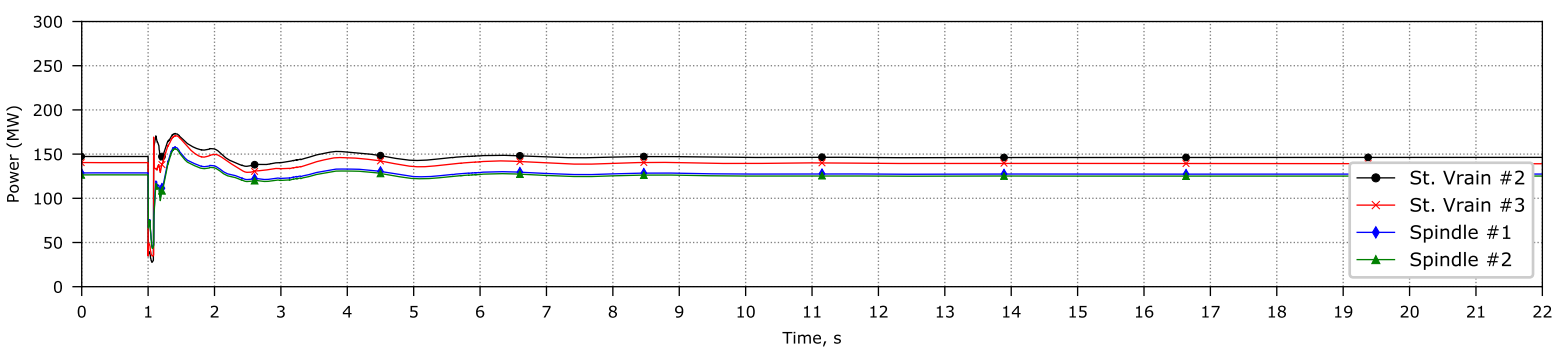


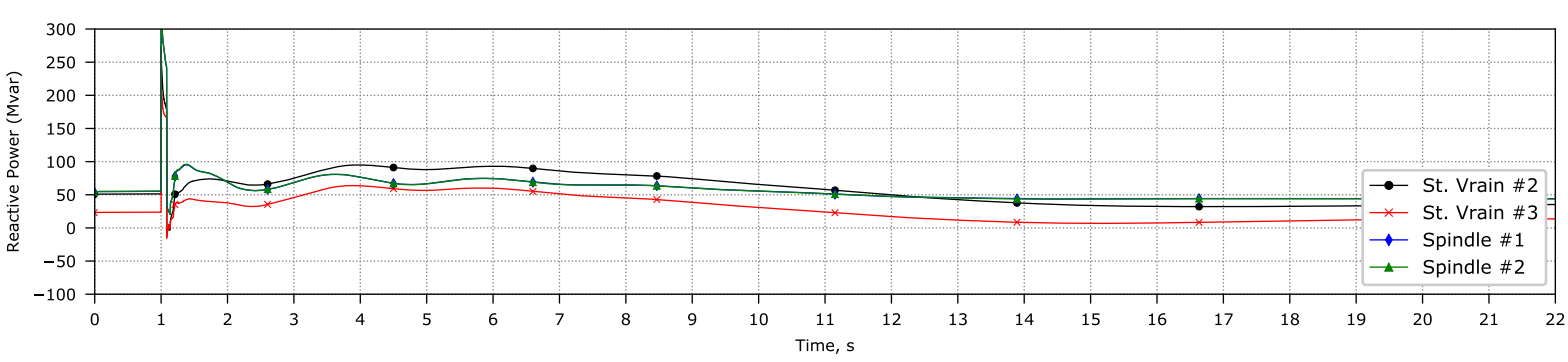


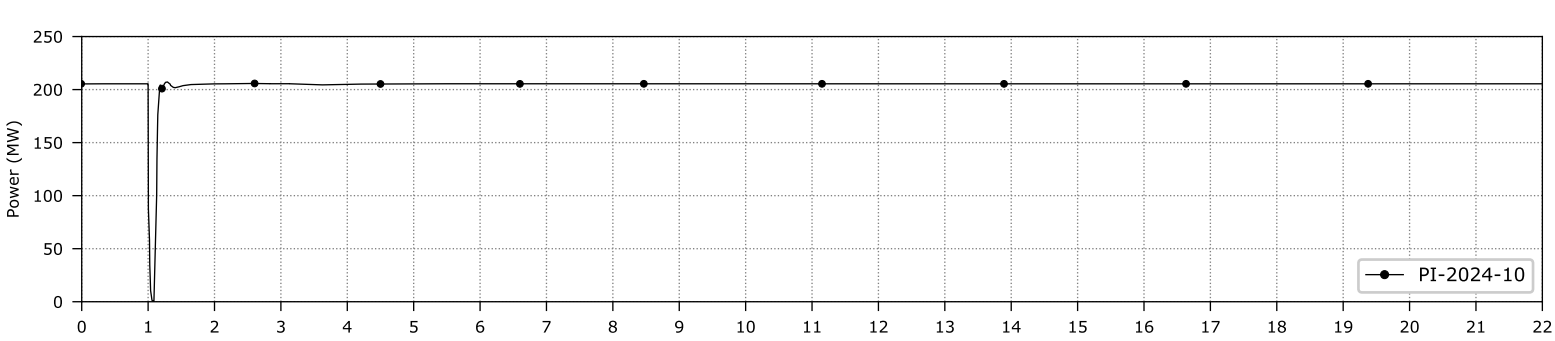


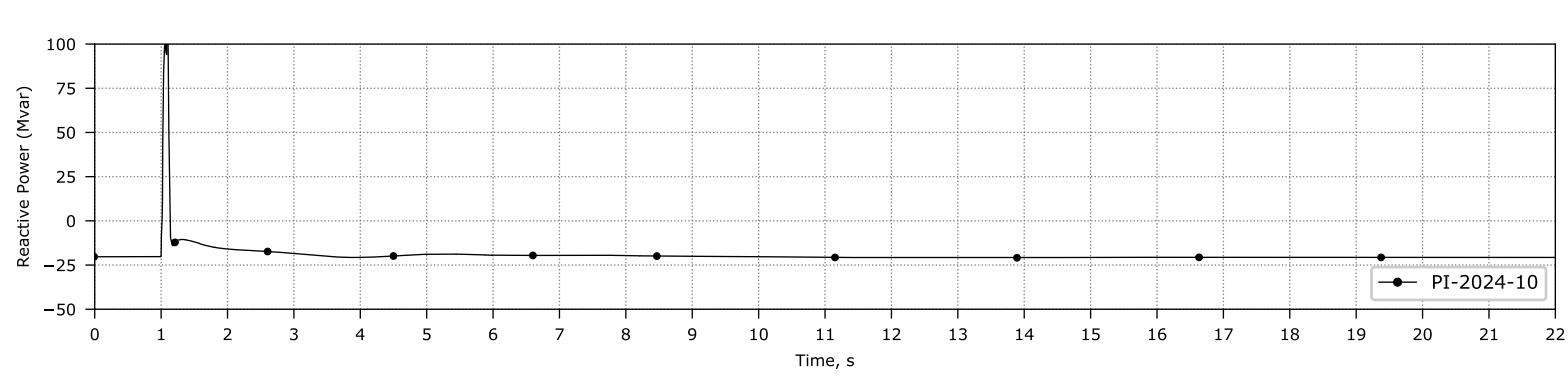
PI-2024-10_Study_North_FSV-Longpeak_230kV

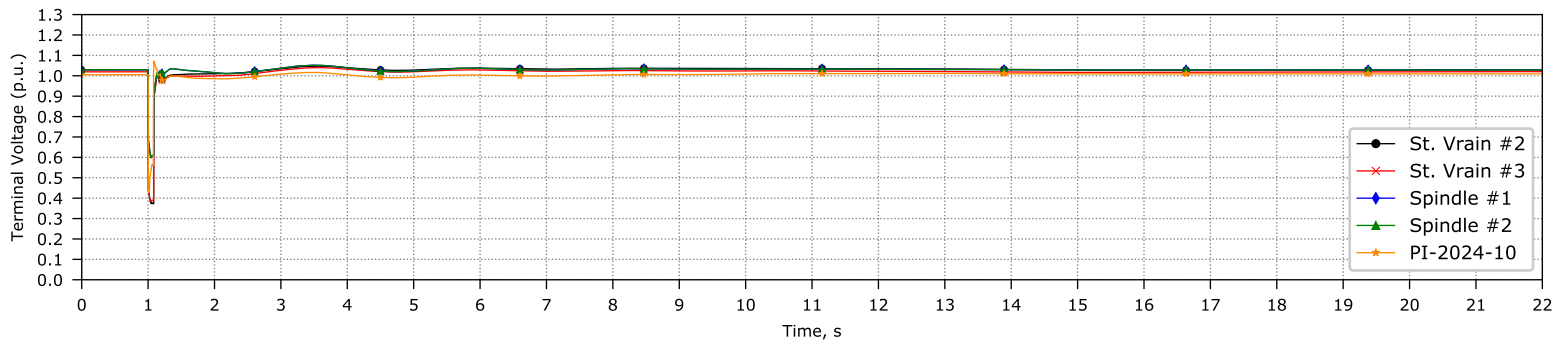


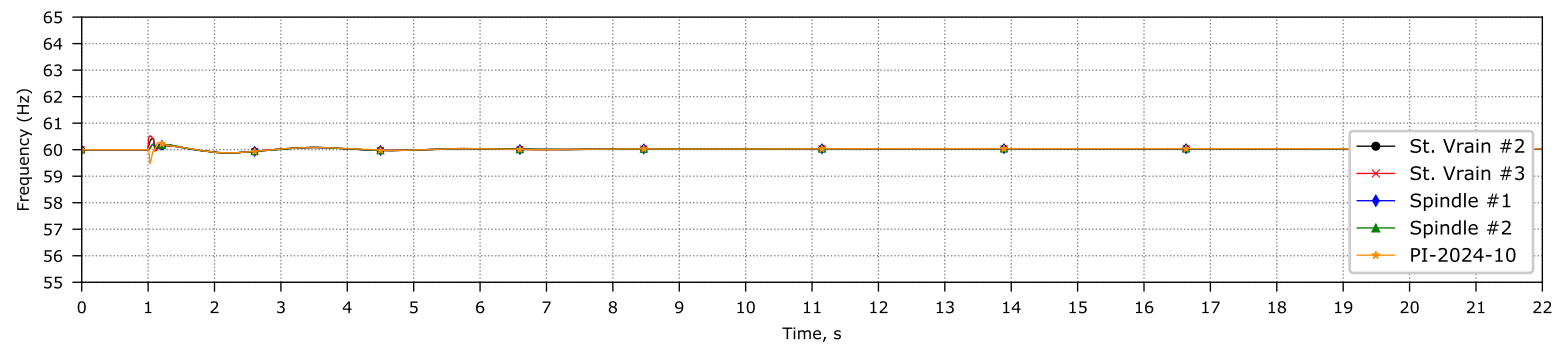


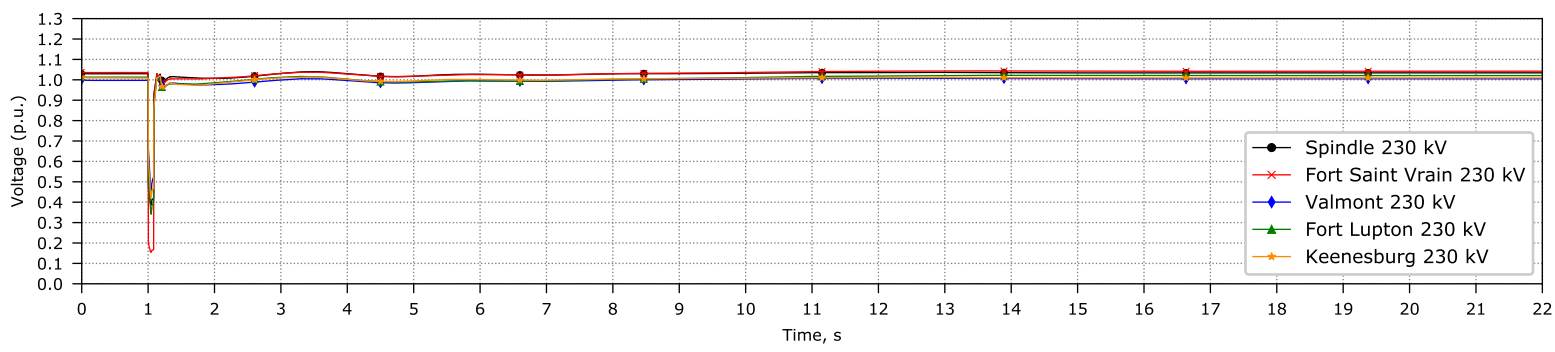




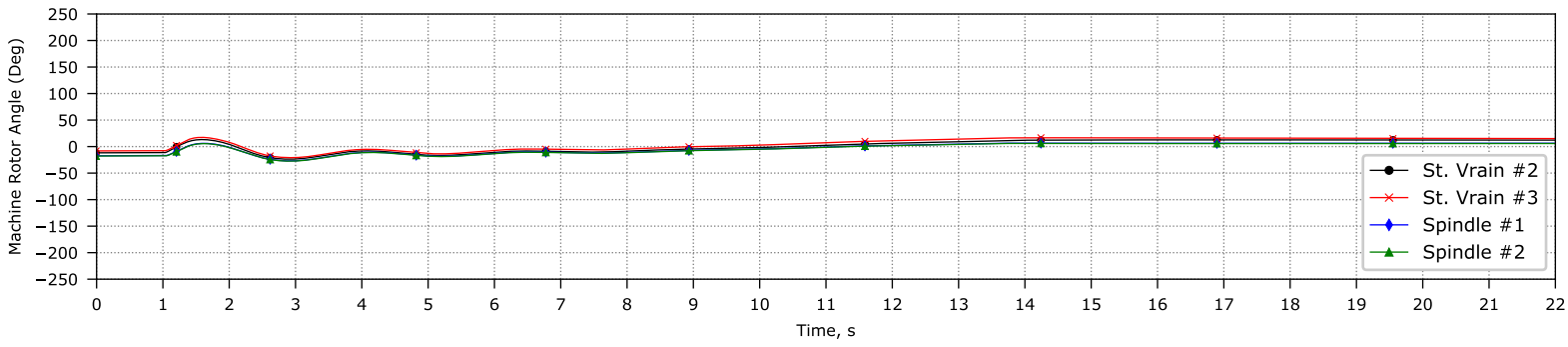


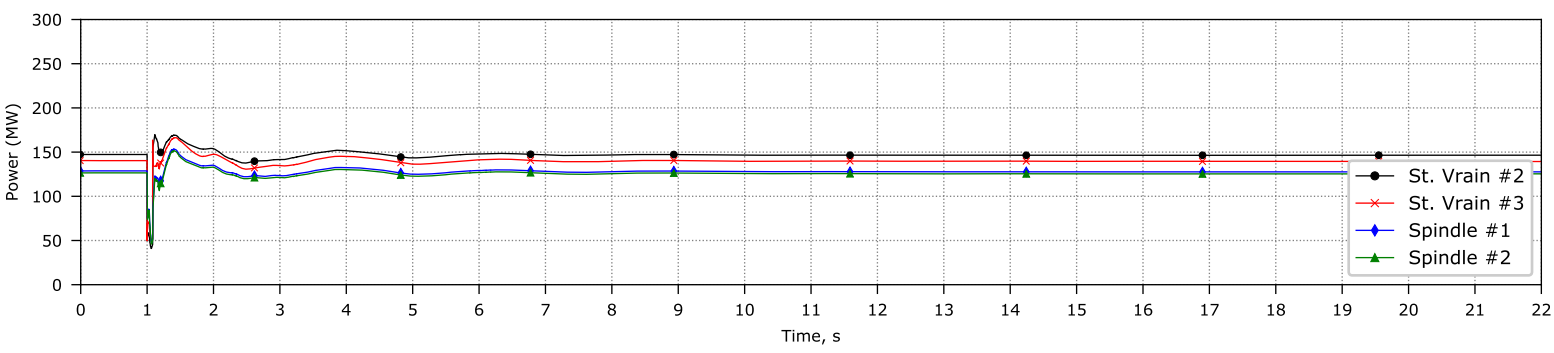


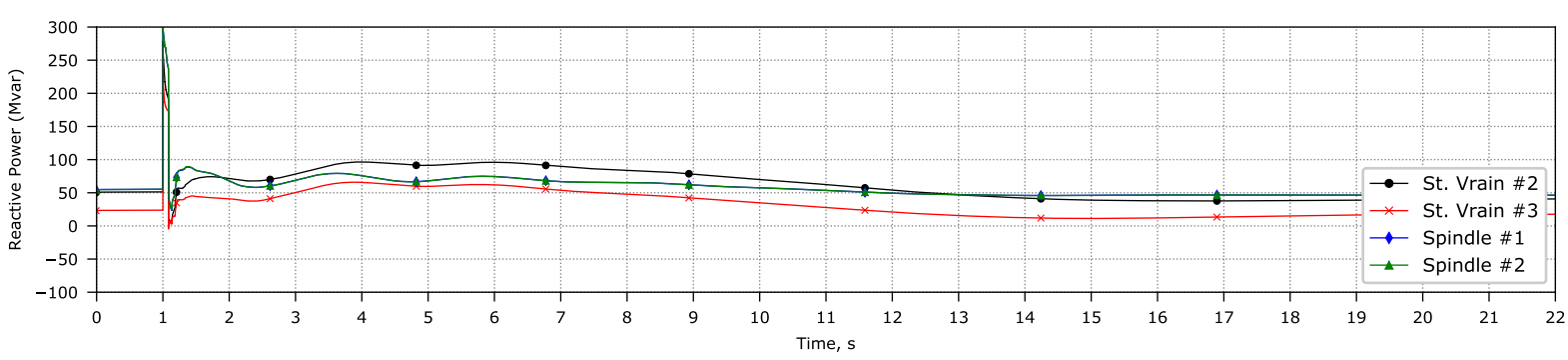


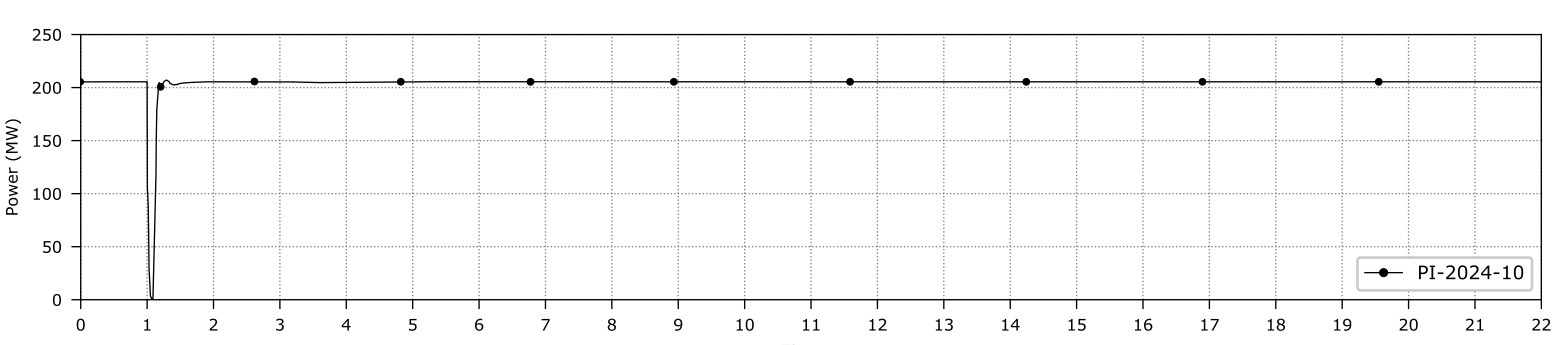


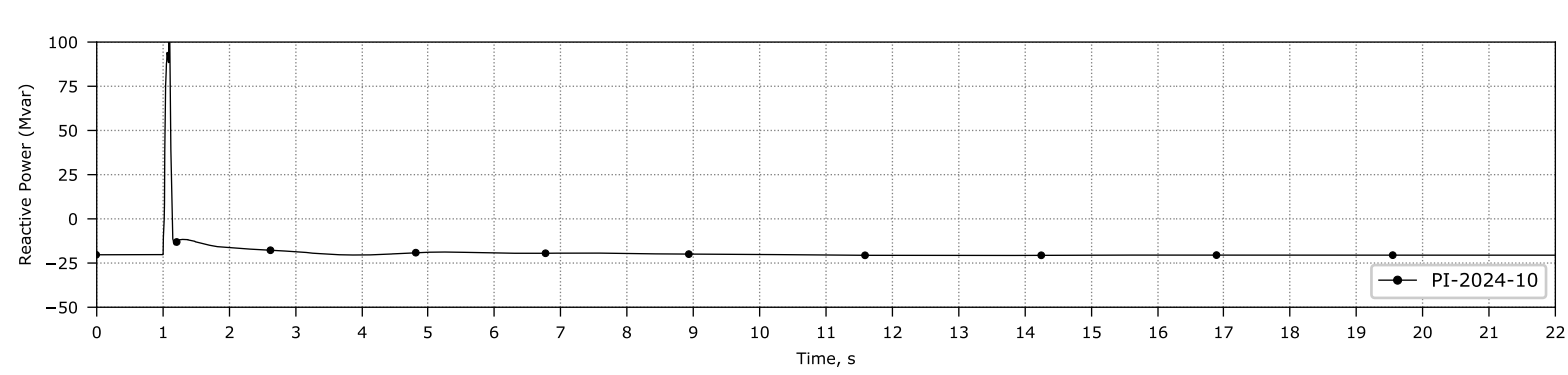
PI-2024-10_Study_North_FSV-Fordham_230kV

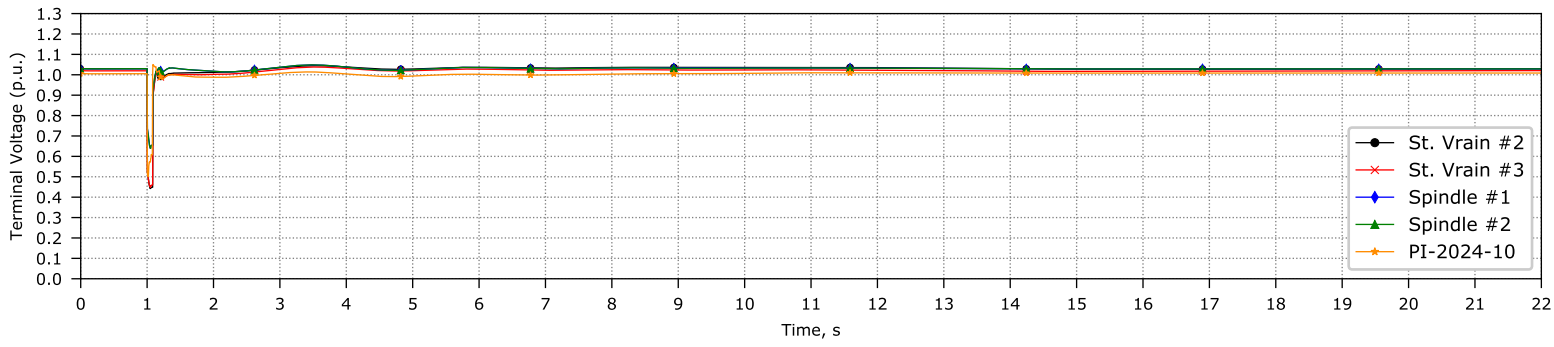


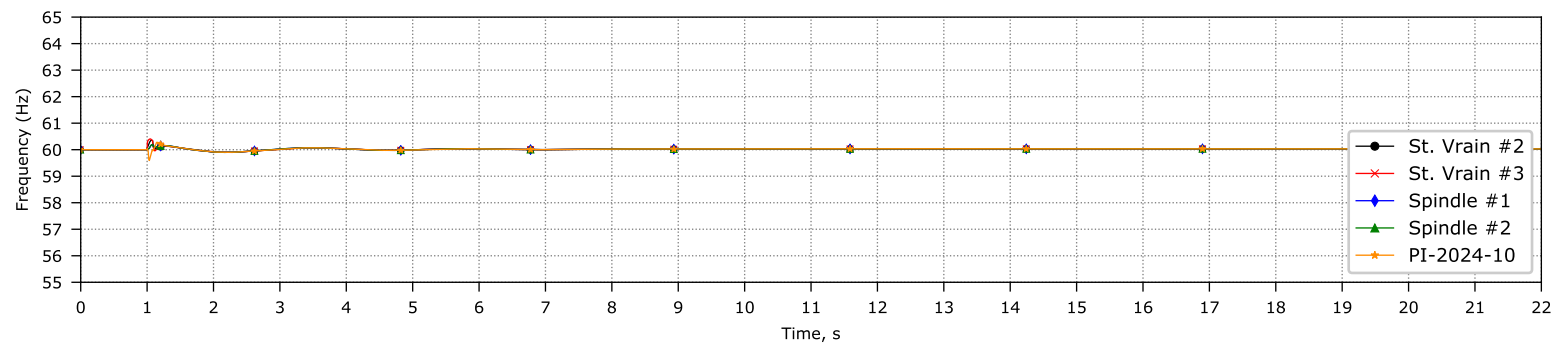


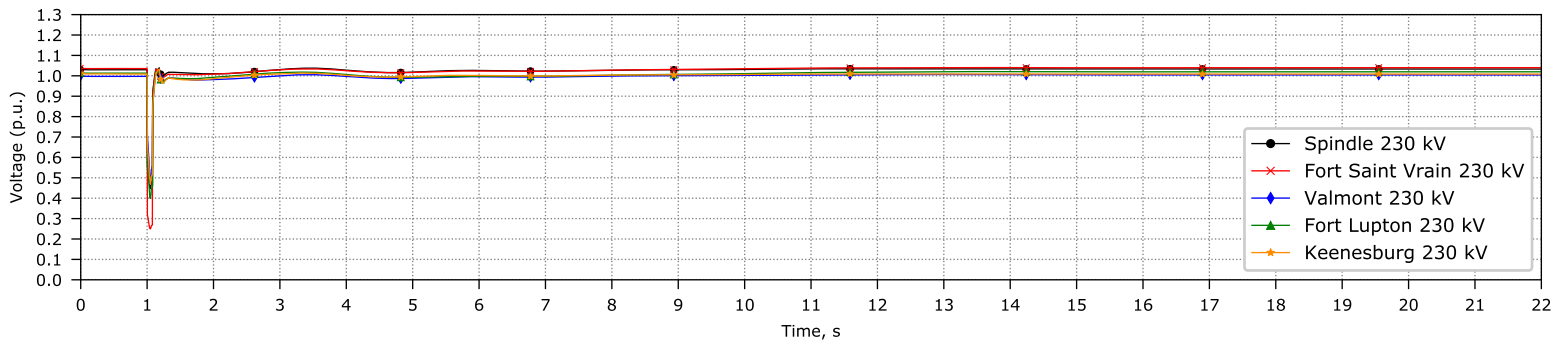




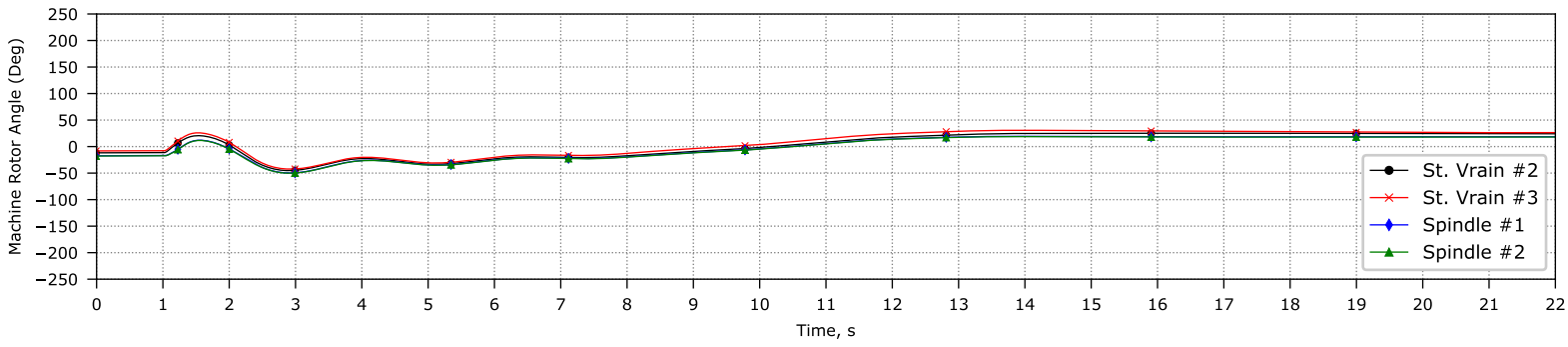


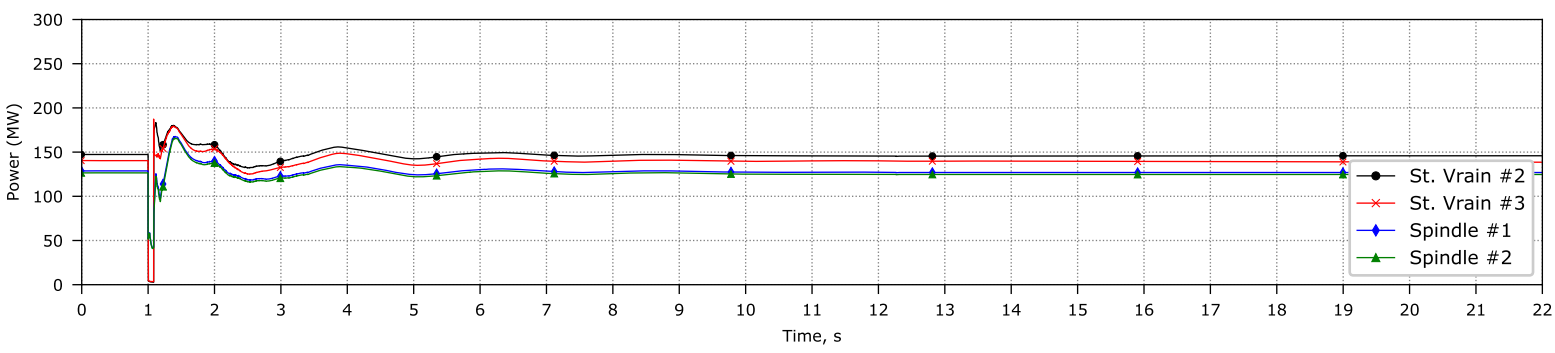


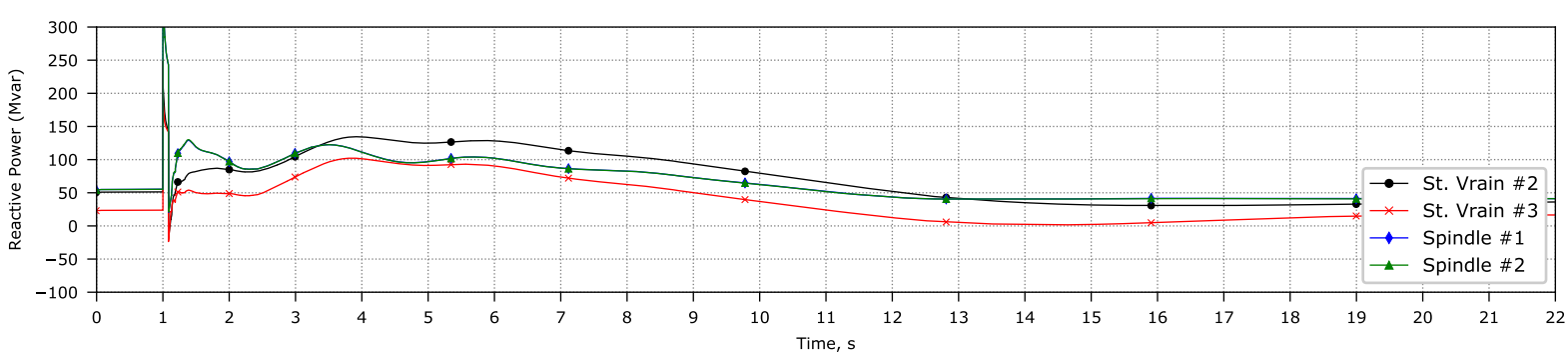


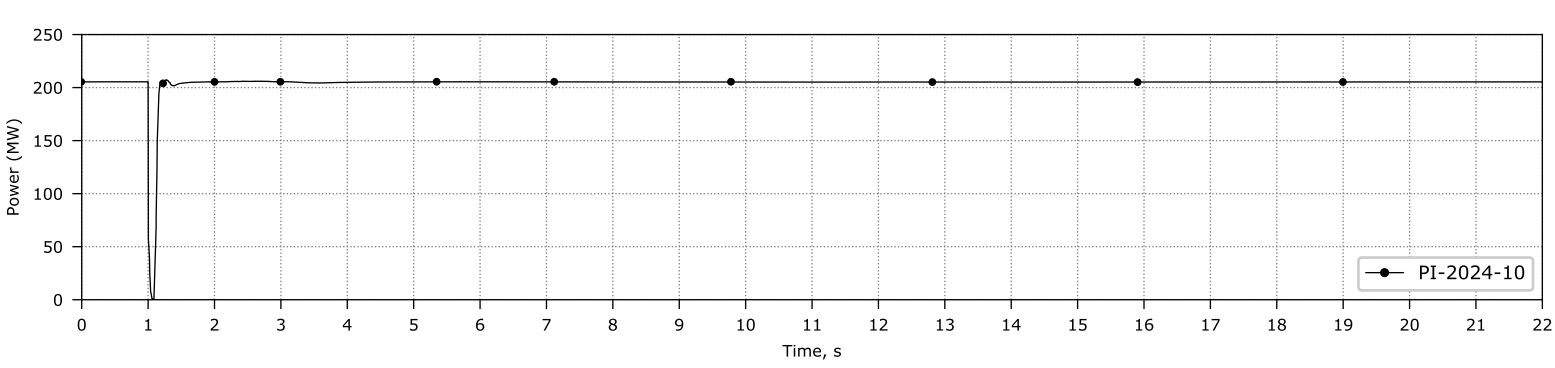


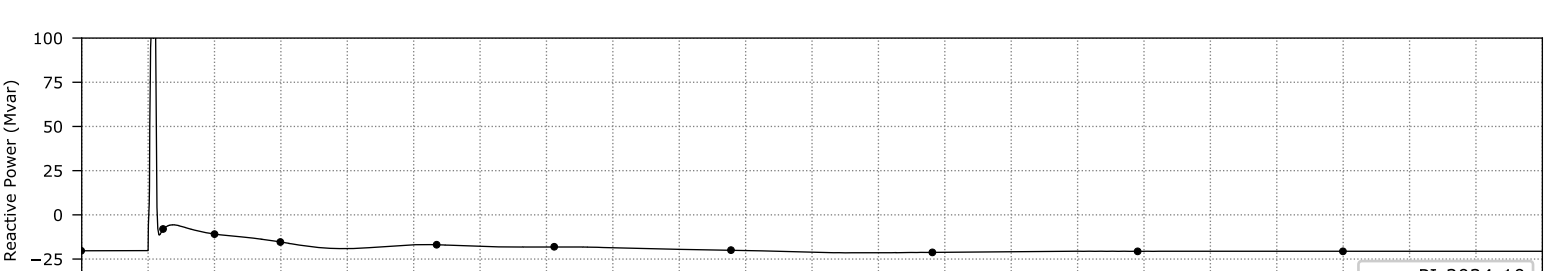
PI-2024-10_Study_North_FSV_Xfmr

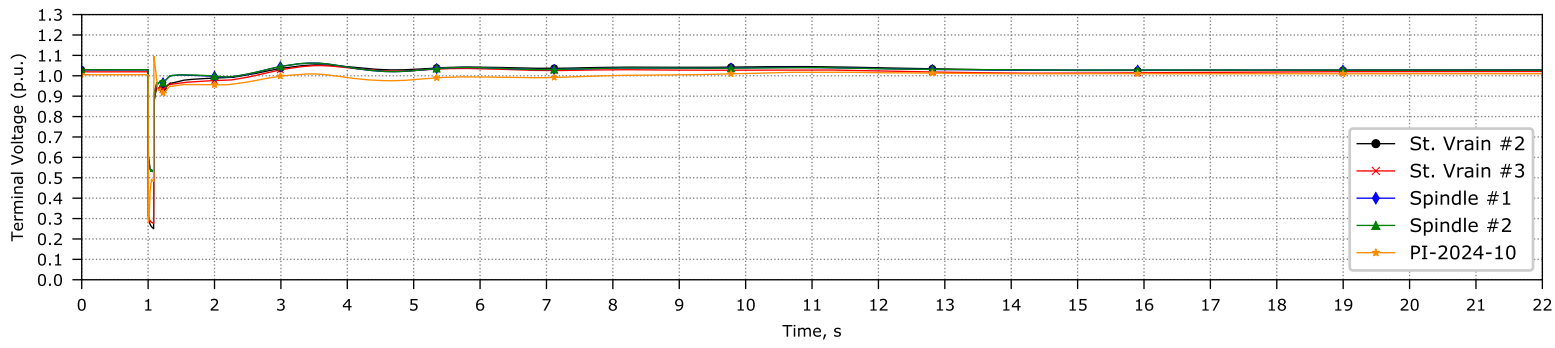


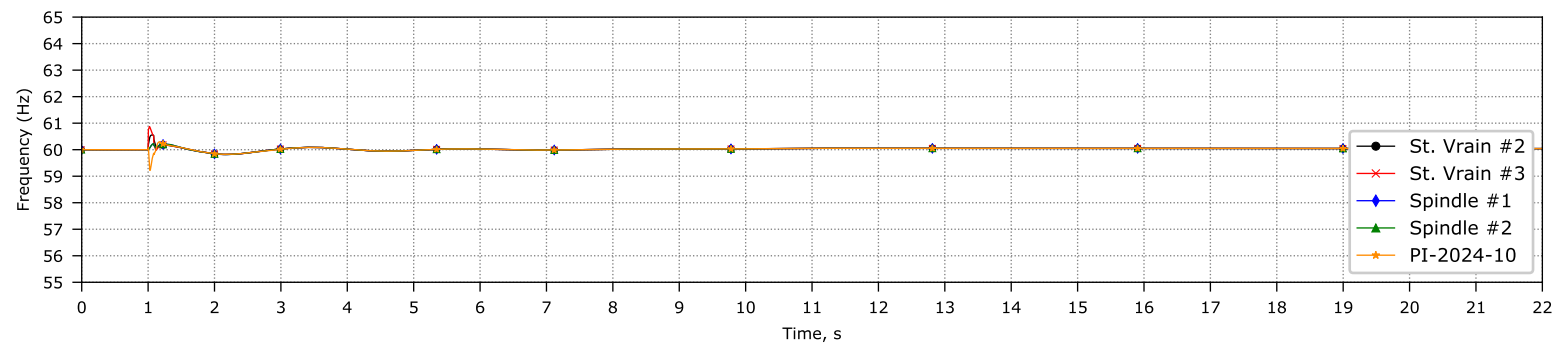


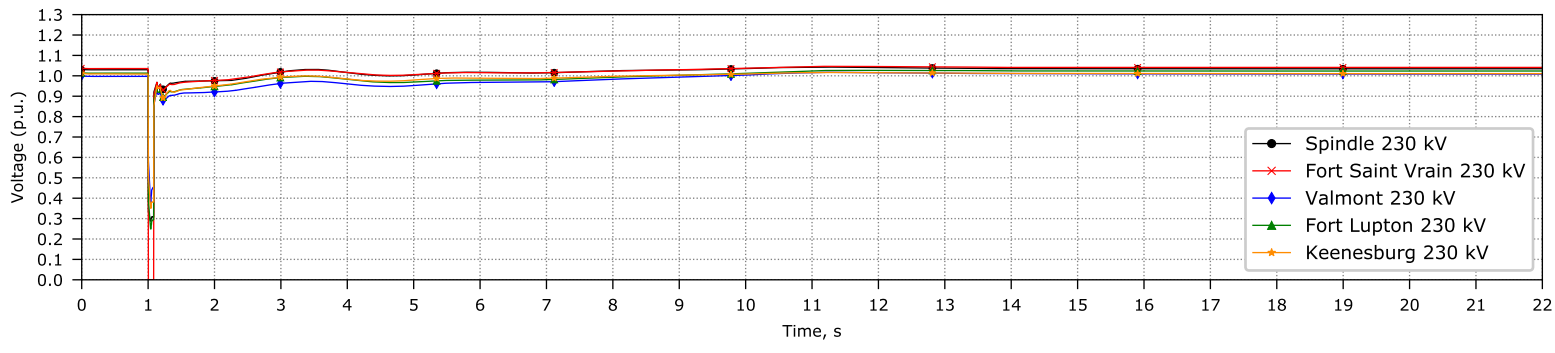




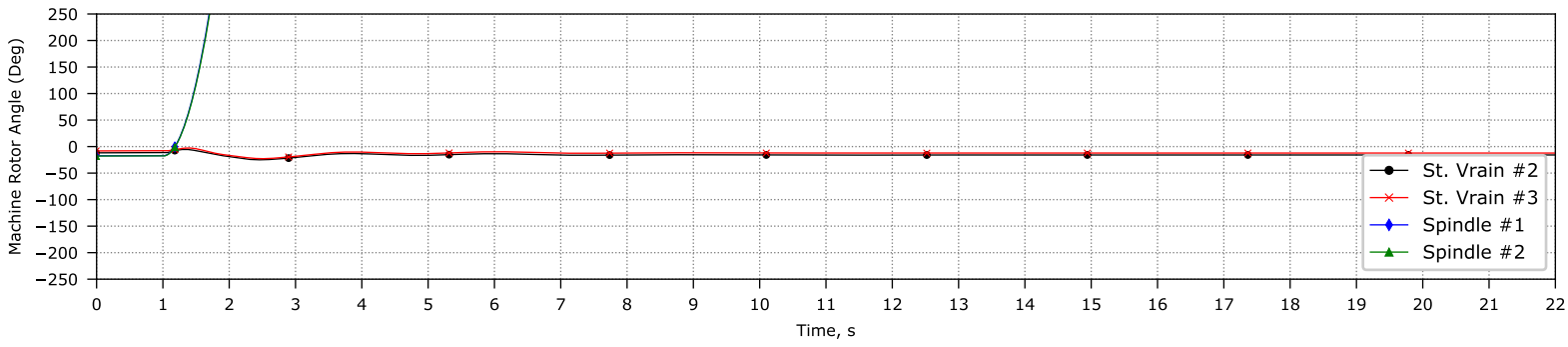


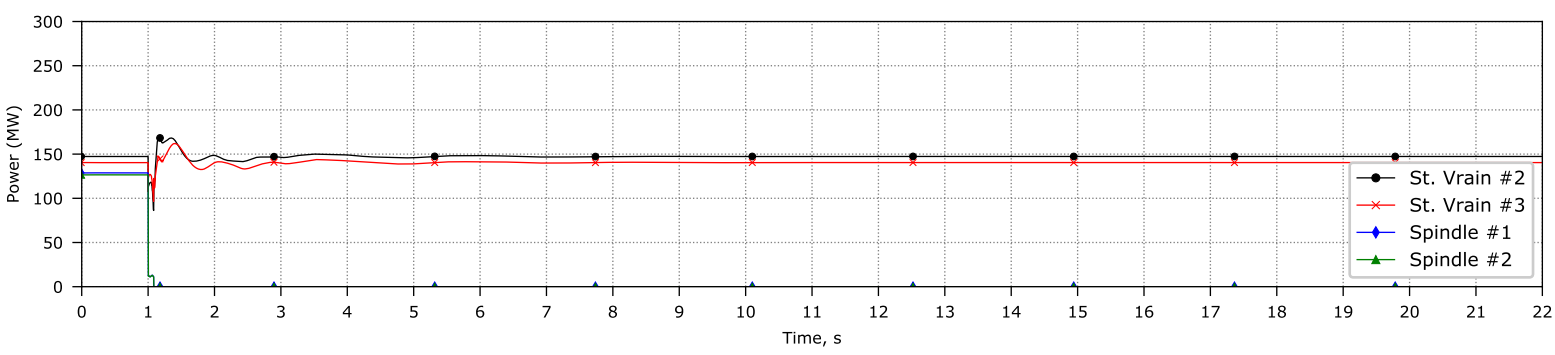


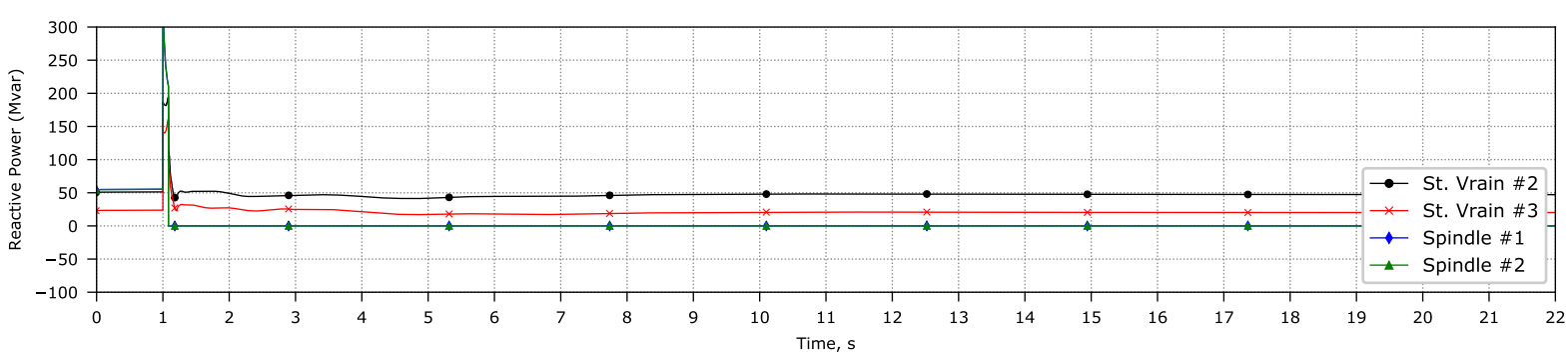


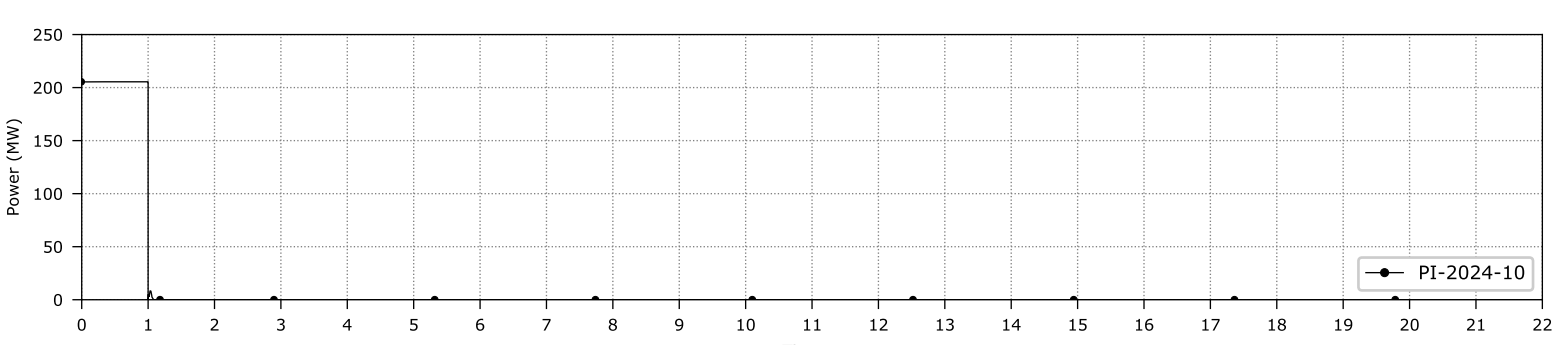


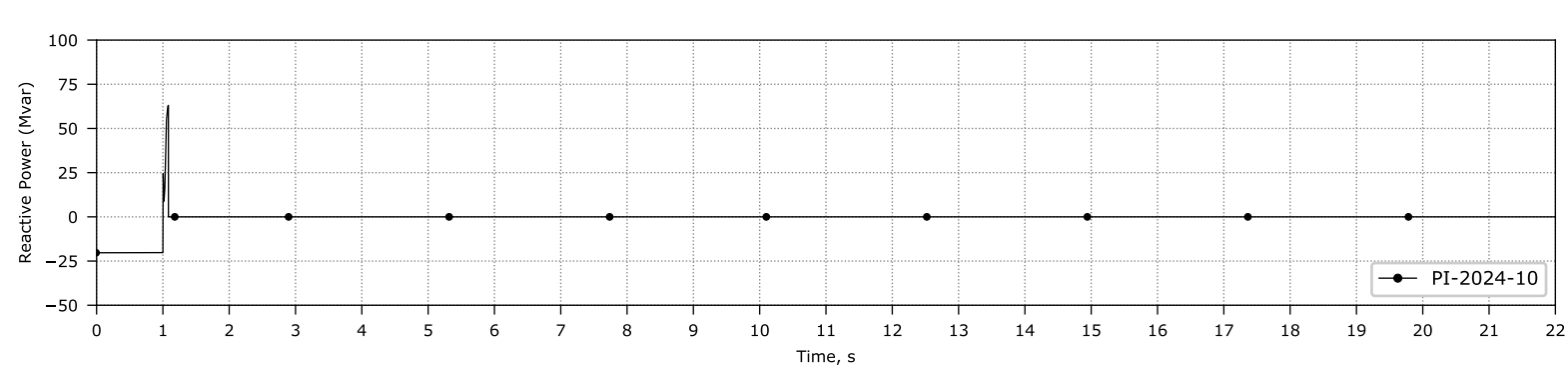
PI-2024-10_Study_North_Spindle-P7_90

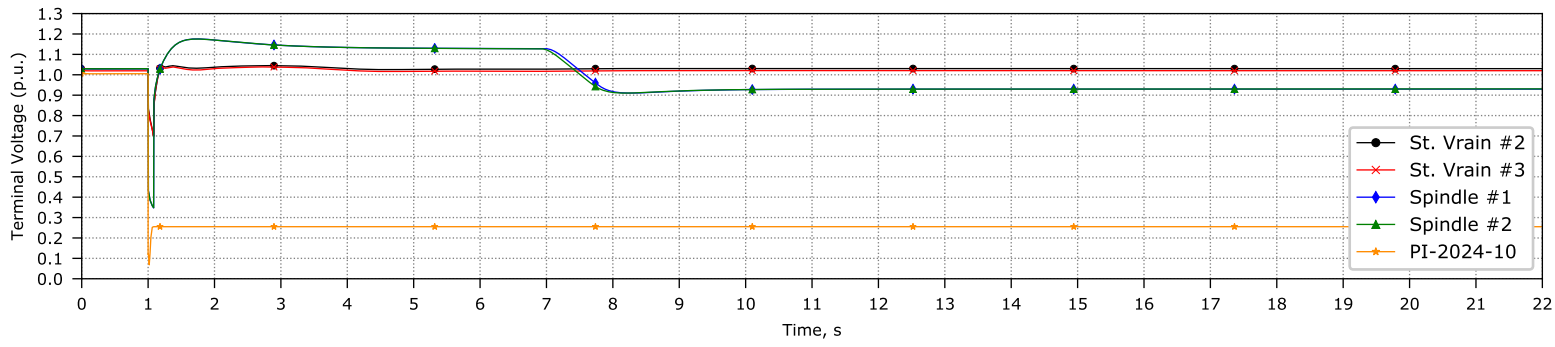


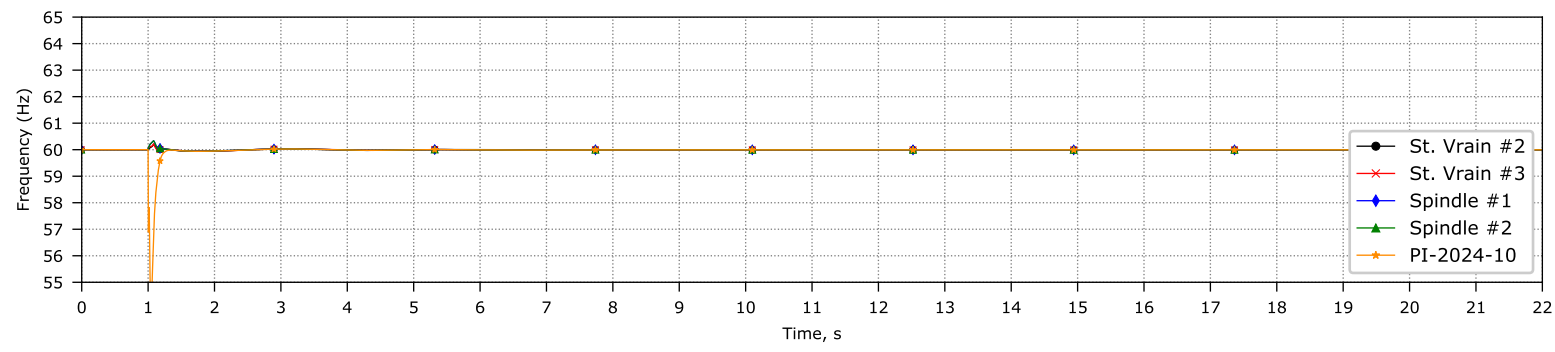


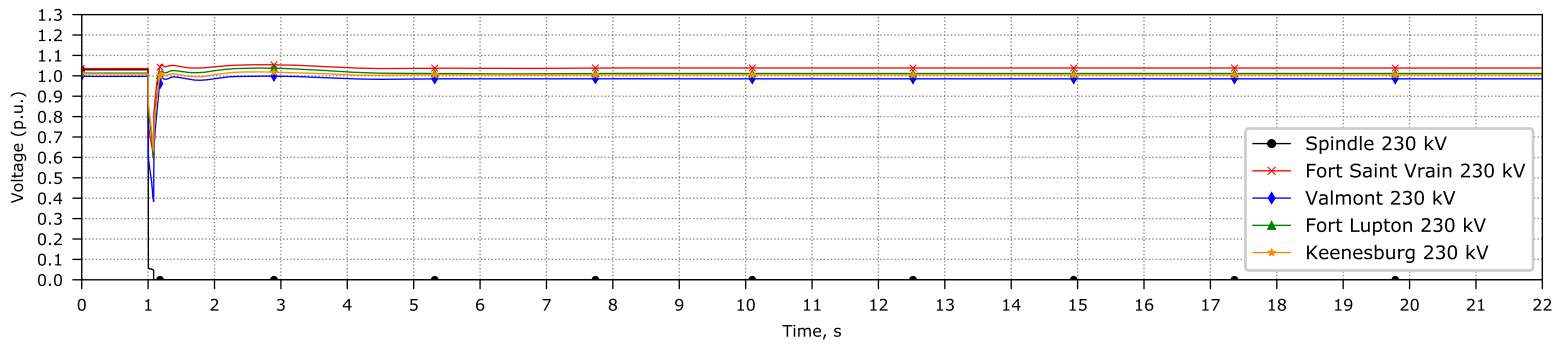












PI-2024-10_Study_North_Spindle-P7_93