Operador Nacional do Sistema Elétrico

DISTURBANCE ON 08/15/2023 AT 08:30 AM INVOLVING INTERCONNECTIONS NORTH-NORTHEAST, SOUTHEAST-NORTHEAST AND NORTH-SOUTHEAST

Rio de Janeiro, August 25, 2023

DISTURBANCE INVOLVING THE NORTHERN INTERCONNECTIONS NORTHEAST, SOUTH-EAST-NORTH-EAST AND NORTH-SOUTH-EAST

ÿ General description of the disturbance

ÿ Presentation of the ONS •

Sequence of the main events, until the separation of the North and Northeast regions from the rest of the SIN • Preliminary analysis of the dynamic performance of the SIN

ÿ Presentation of Agents

• Description of the disturbance and analysis of the performance of the protection systems, with the agents' view of the events involving their assets

ÿ Restoration Process

ÿ Presentation of ONS

• Actions to stabilize the system right after the shutdown

• Analysis of the restoration of each electrical area • Main difficulties faced in the restoration process

ÿ Presentation of Agents

• Description of the asset recomposition process, main difficulties and steps taken or in progress trend

DISTURBANCE INVOLVING NORTH-NORTHEASTERN INTERCONNECTIONS, SOUTHEAST-NORTHEAST AND NORTH-SOUTHEAST

08/15/2023 at 08:30 am

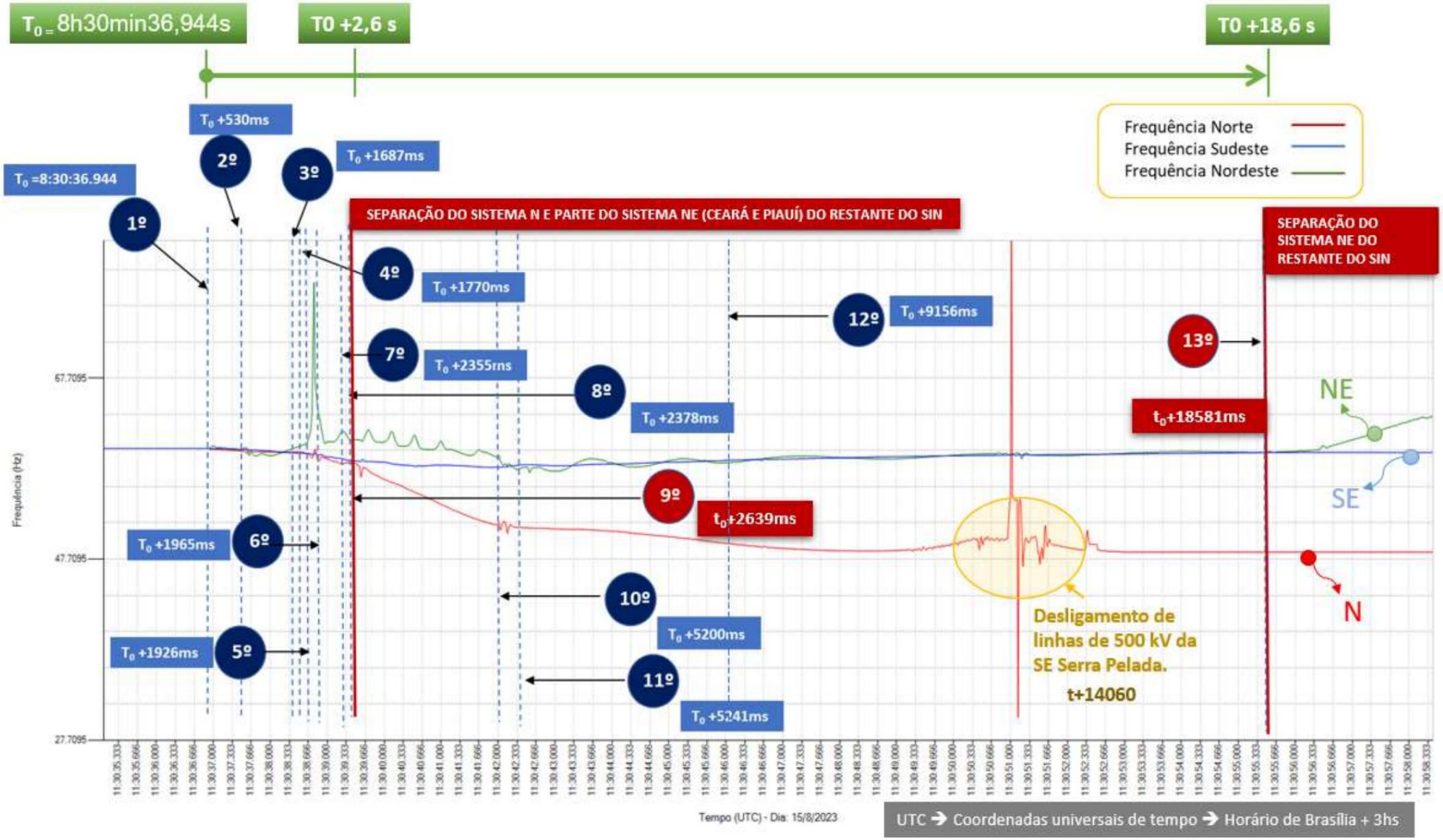
Start of disturbance:
LT 500 kV Fortaleza II – Quixadá

Area affected by load shedding

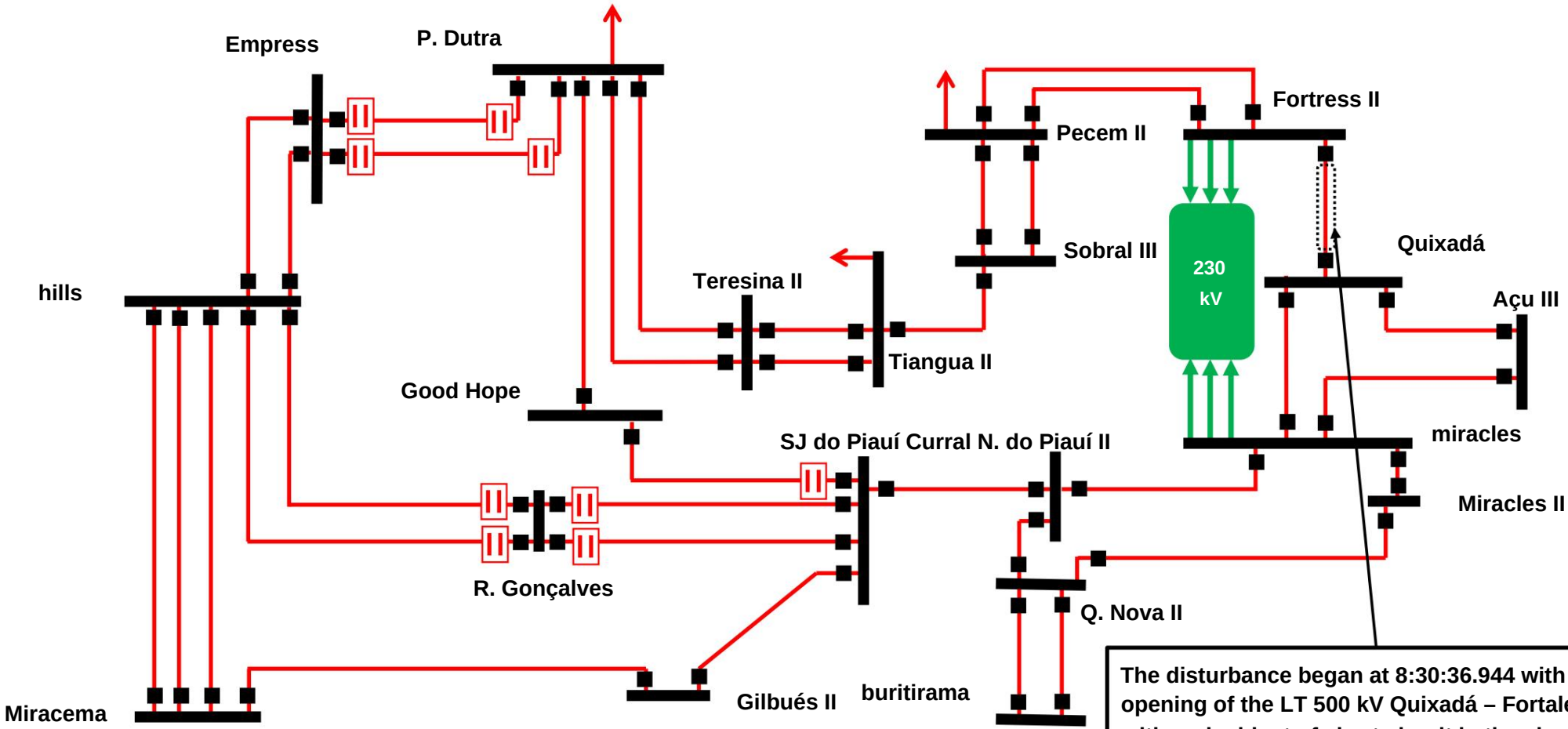
Total load cut ÿ 22,547 MW

N/NE ÿ 12,264 MW
S/SE/CO ÿ 10,283 MW

MAIN EVENTS OF SEPARATION OF THE NORTH AND NORTHEAST AREAS FROM THE REST OF THE SIN



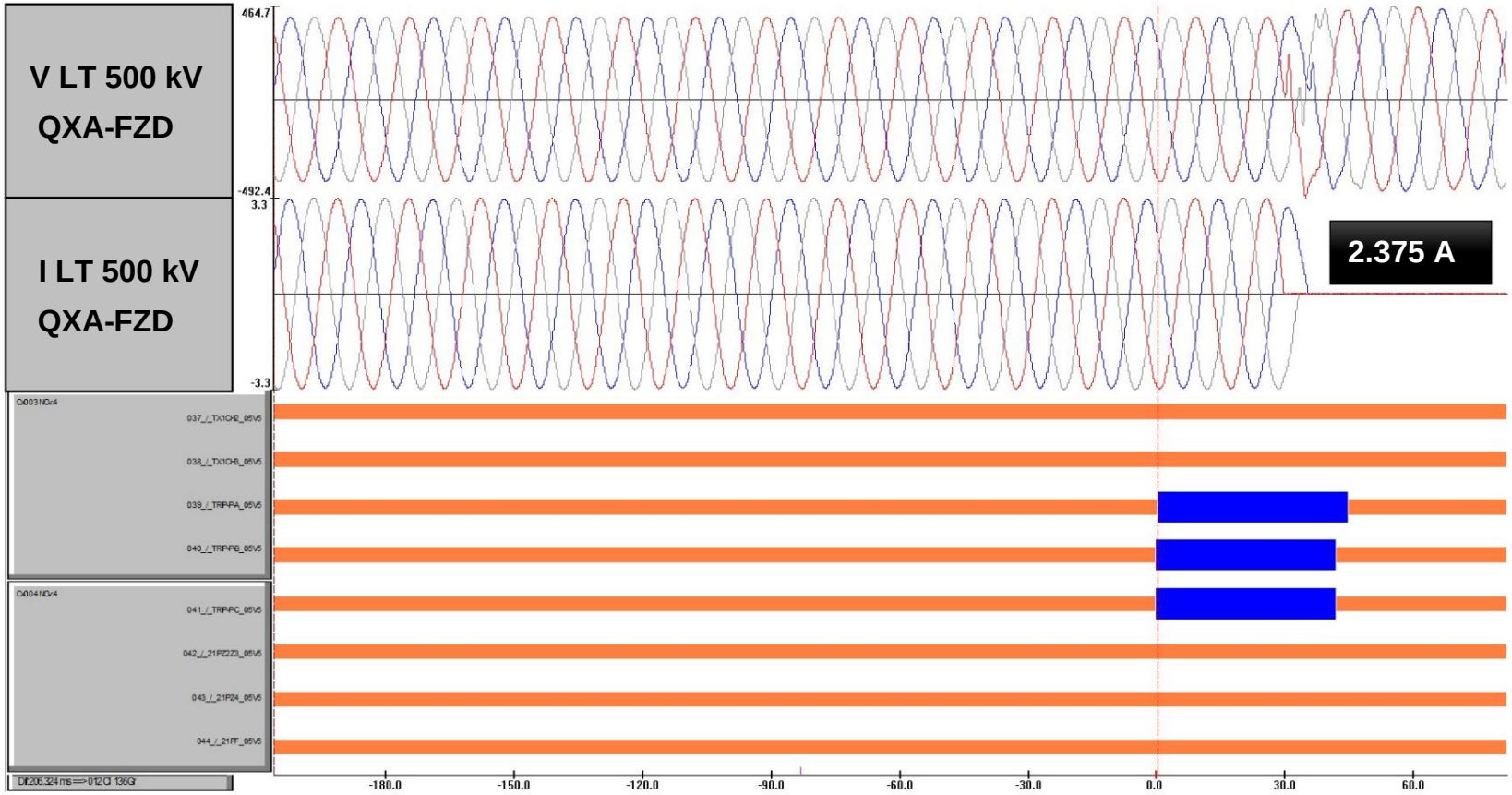
Origin of the Disturbance



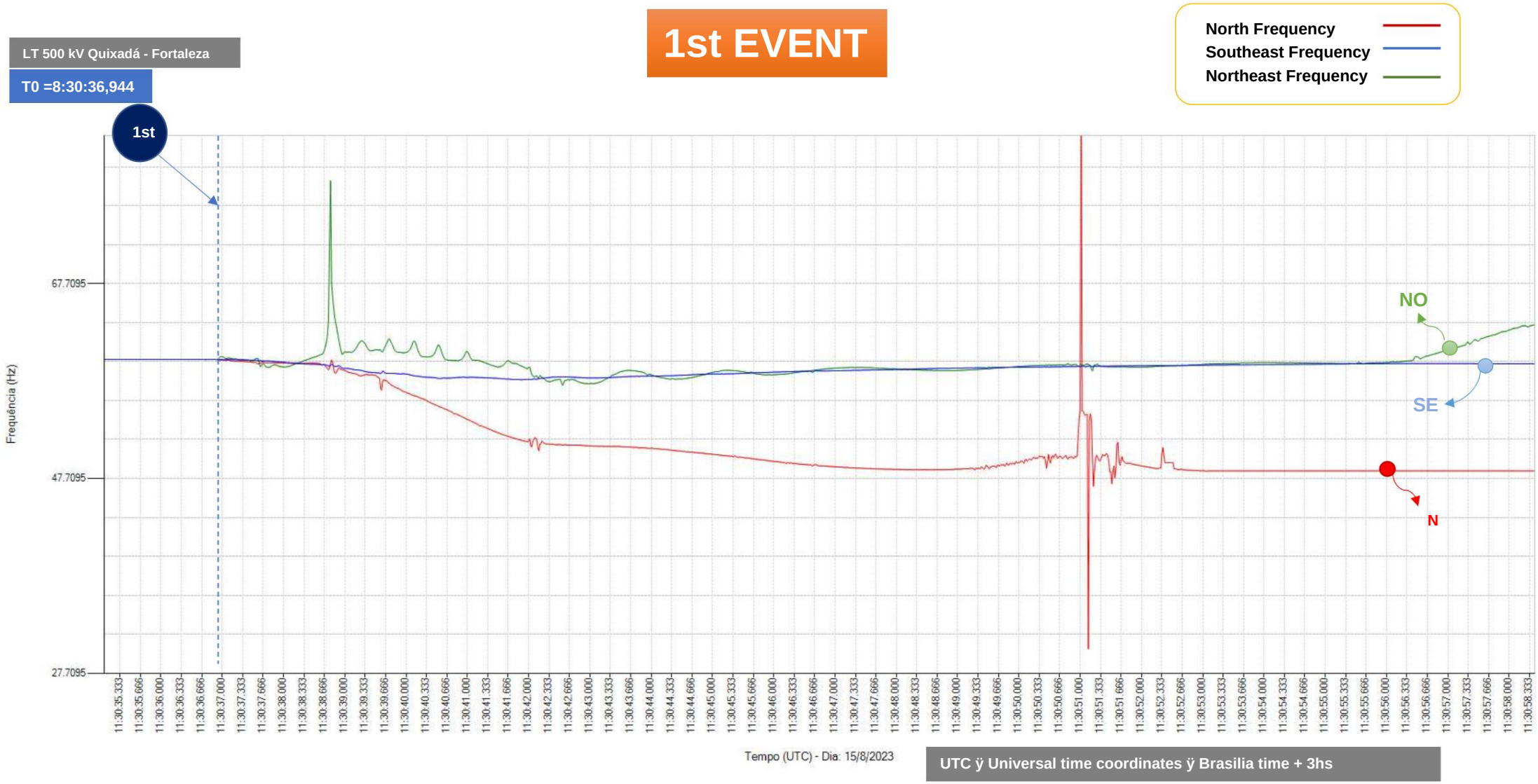
The disturbance began at 8:30:36.944 with the opening of the LT 500 kV Quixadá – Fortaleza II, with no incident of short circuit in the electrical system. The shutdown was caused by the incorrect operation of the Switch On To Fault (SOTF) logic.

Shutdown of LT 500 kV Quixadá – Fortaleza II

Limites de condição normal de operação (Longa duração)			
Período do ano	Período do dia	Valor operacional (A)	Fator limitante
01/Jan a 31/Dez	Diurno / Noturno	2.390	-



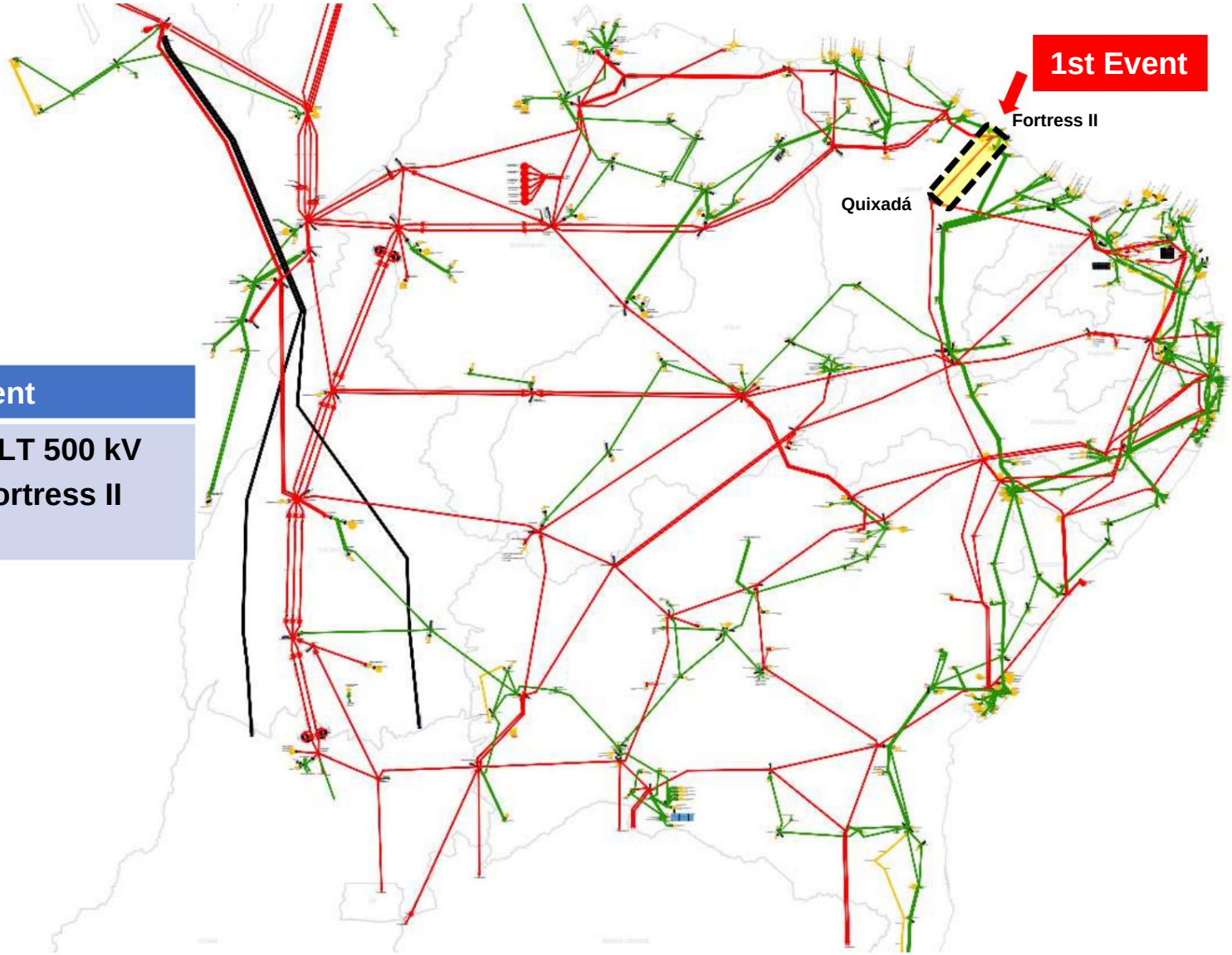
1st EVENT

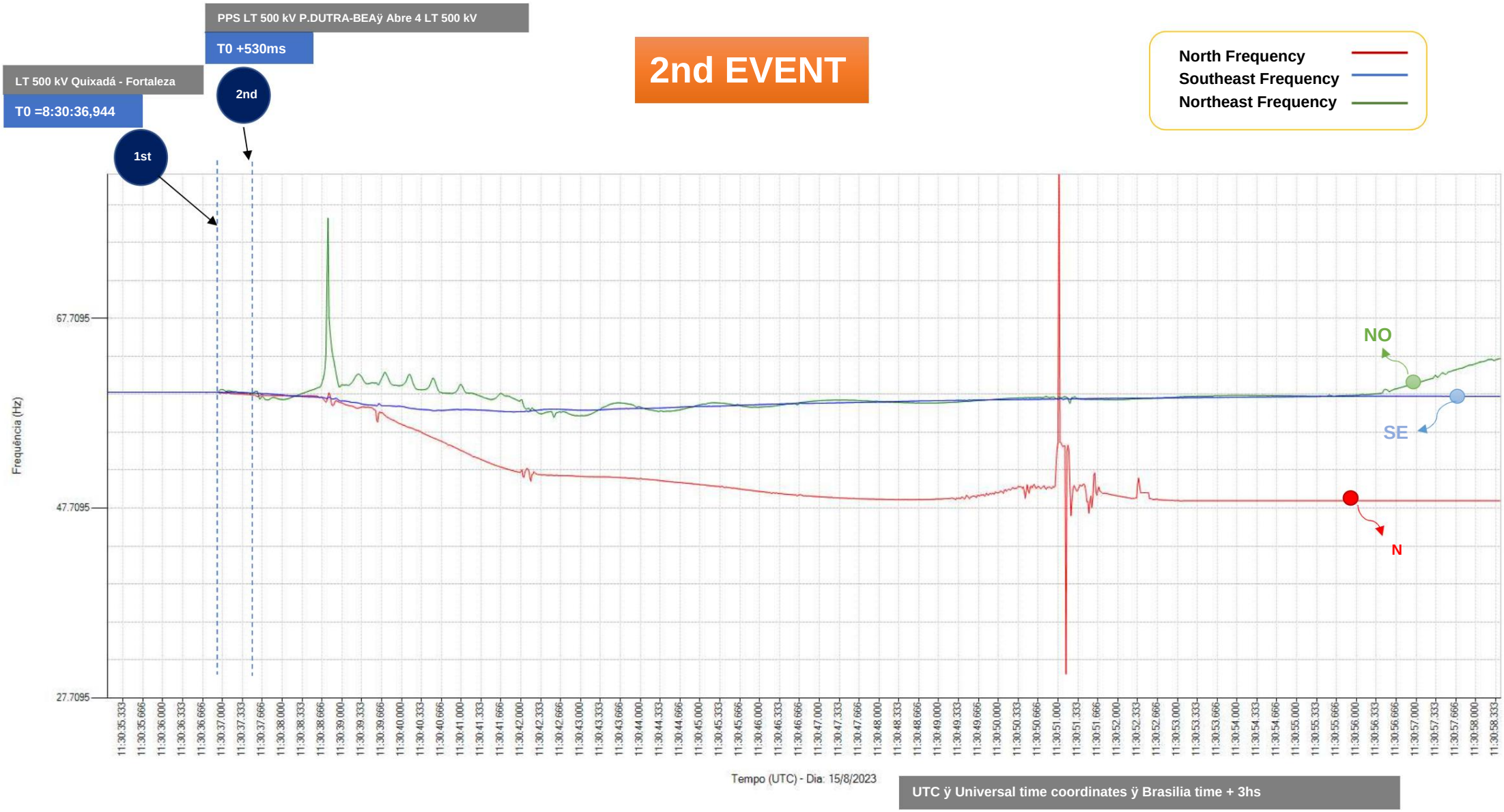


Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 = 8h30min36,944s

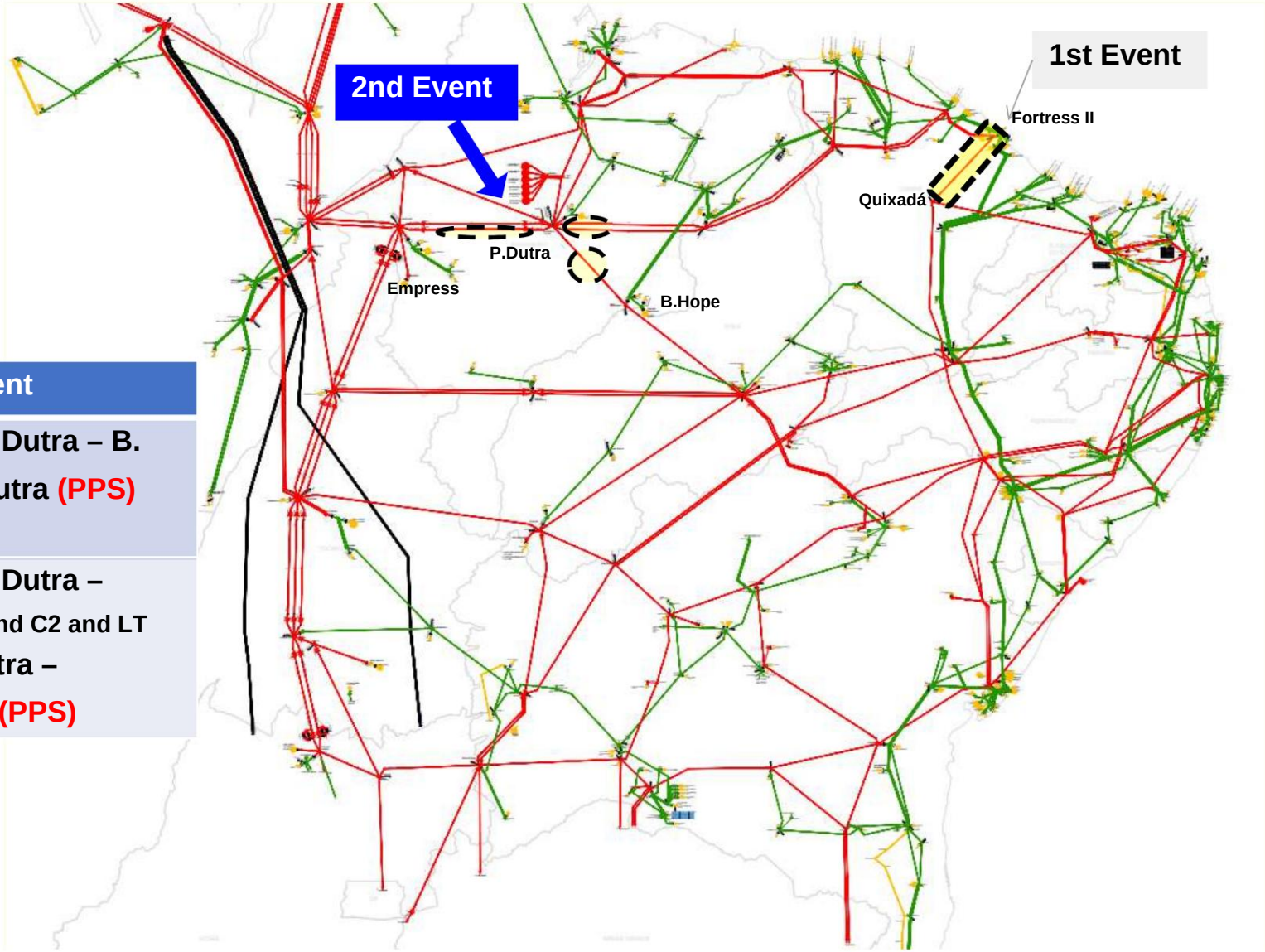
Time	Event
8h30min36,944s	Abertura da LT 500 kV Quixadá – Fortress II (SOTF)



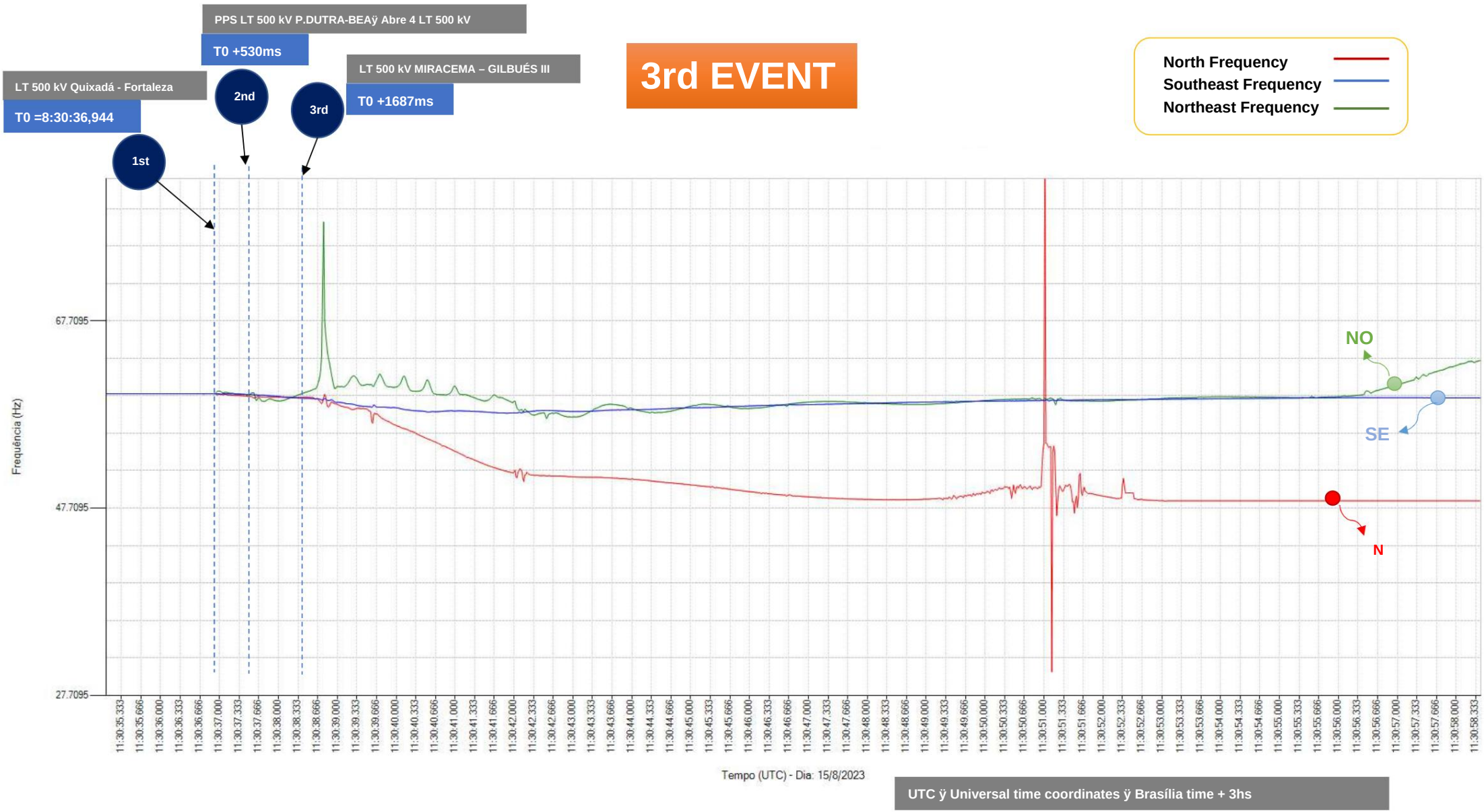


Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 530 ms



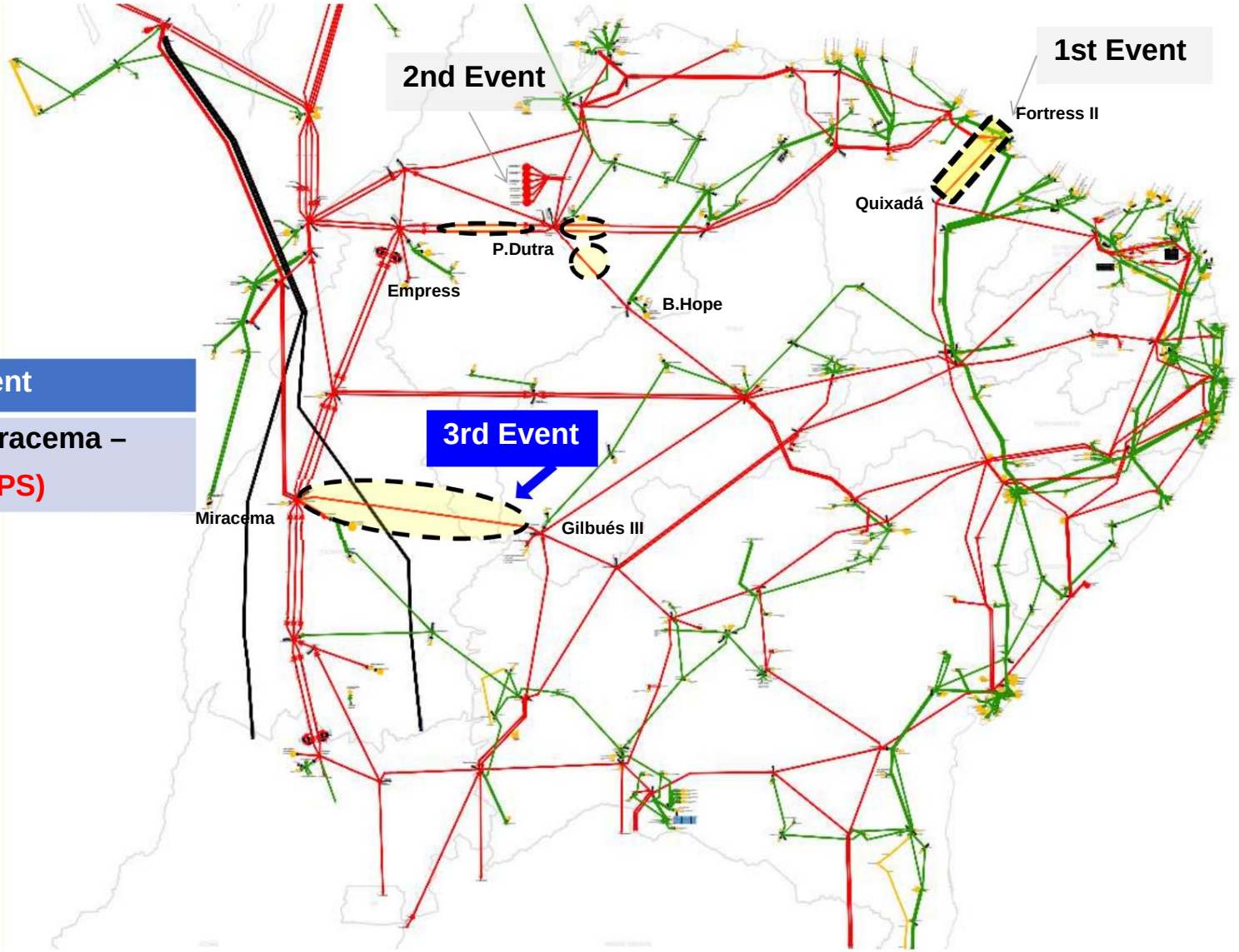
Time	Event
8h30min37,476s	LT 500 kV P. Dutra – B. Hope in P. Dutra (PPS)
8h30min37,512s	LT 500 kV P. Dutra – Teresina II C1 and C2 and LT 500 kV P. Dutra – Empress C2 (PPS)

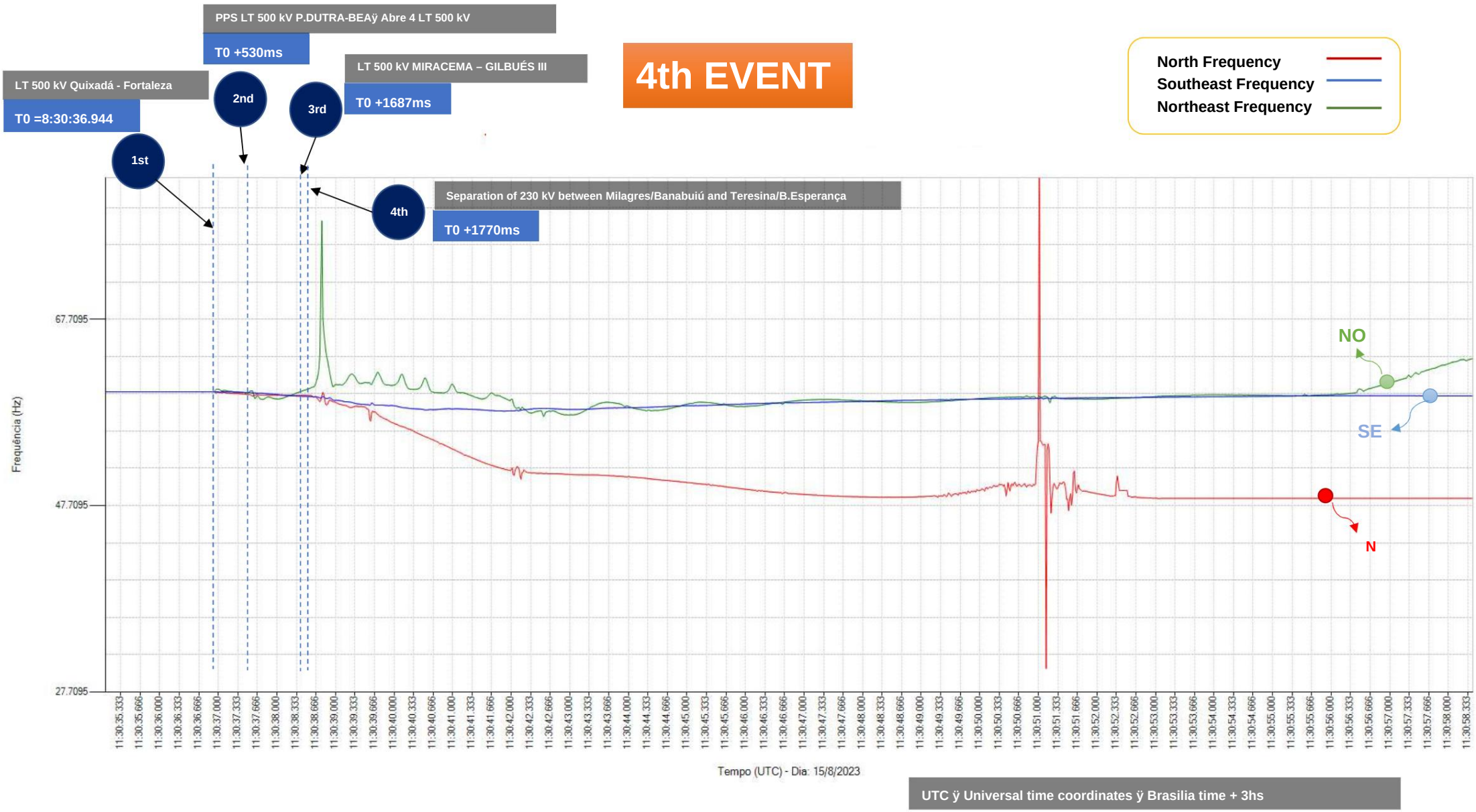


Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 1687 ms

Time	Event
8h30min38,633s	LT 500 kV Miracema – Gilbués III (PPS)

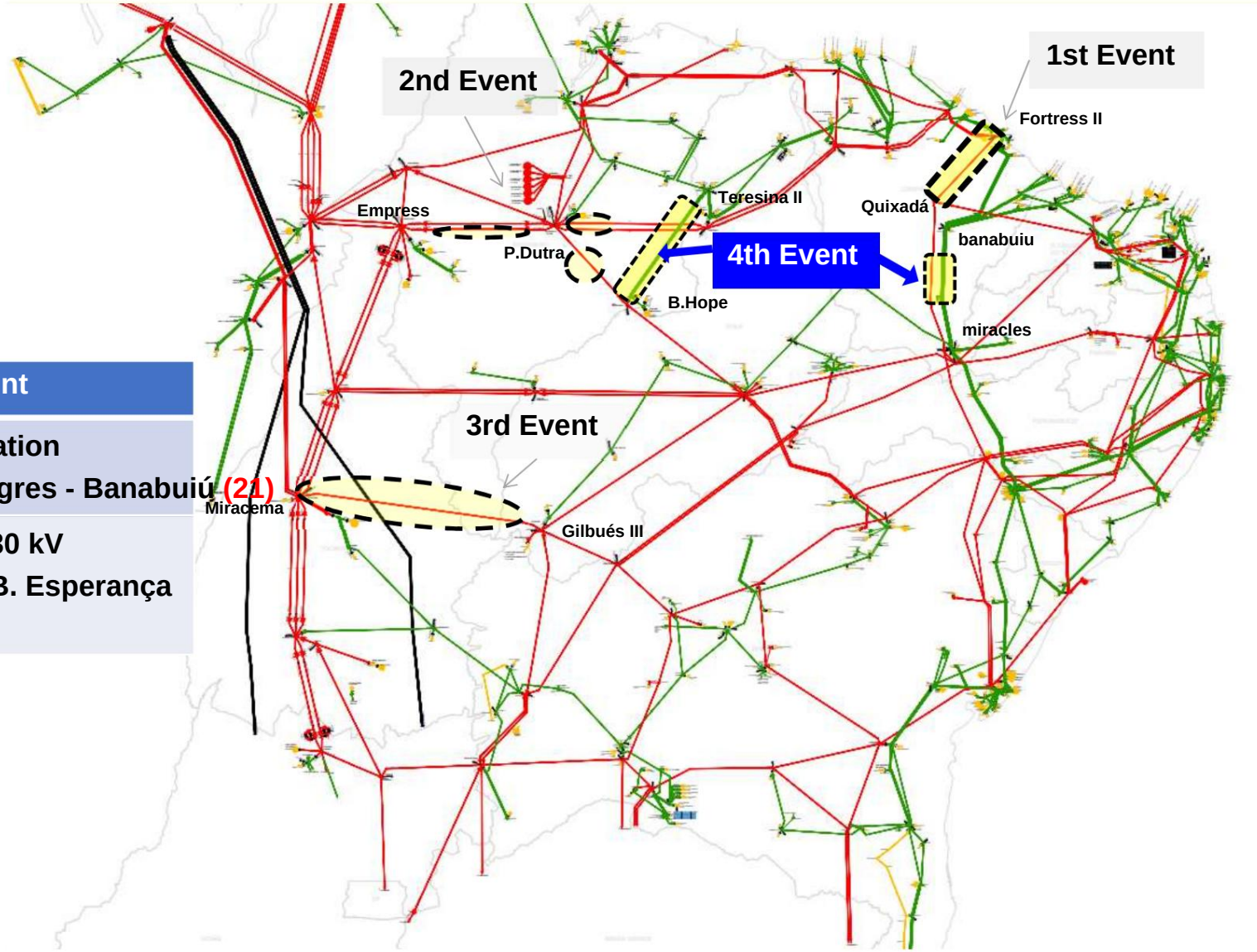


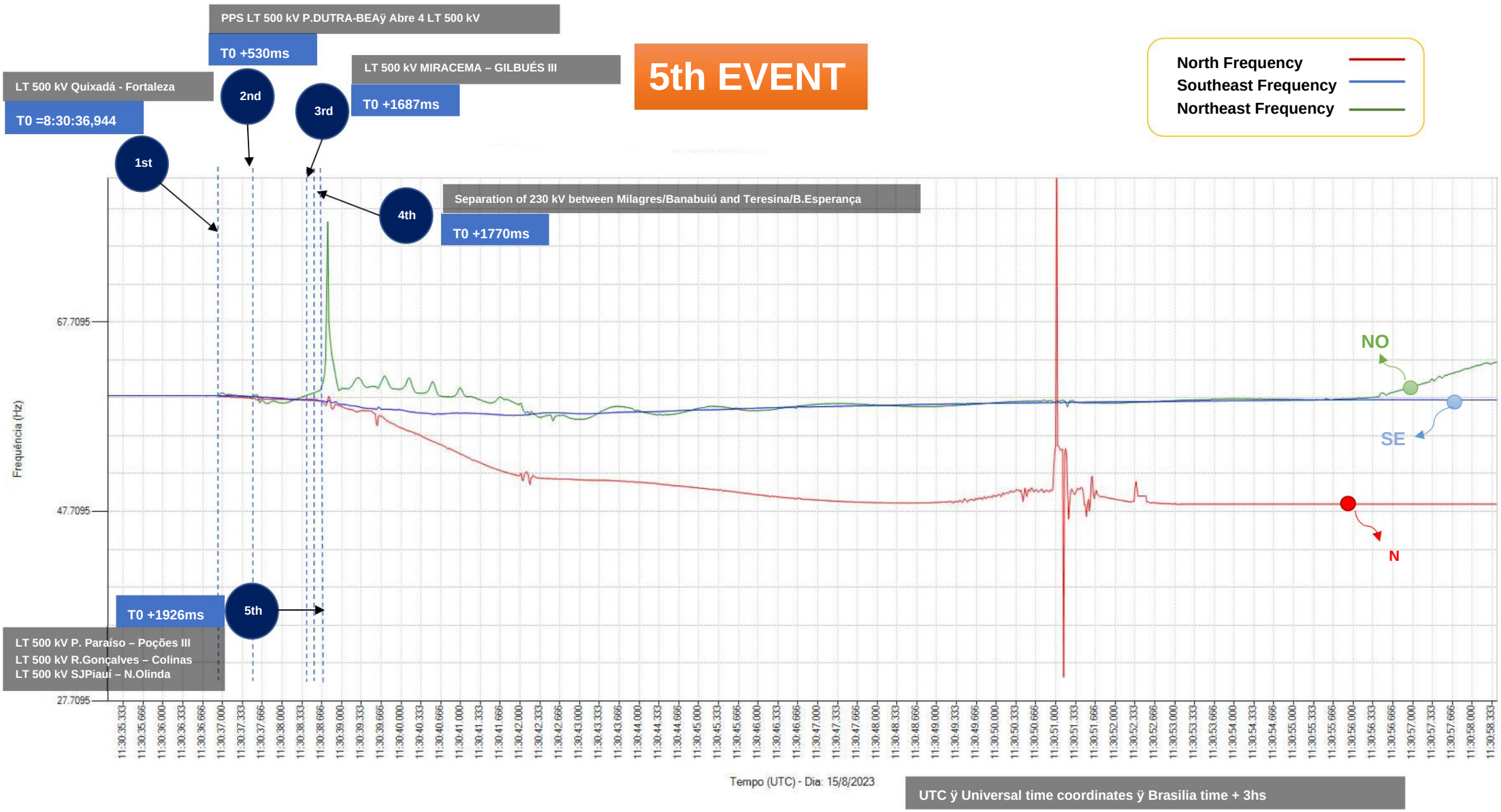


Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 1770 ms

Time	Event
8h30min38,716s	230 kV separation between Milagres - Banabuiú (21)
8h30min38,737s	Separation 230 kV Teresina II – B. Esperança (21)

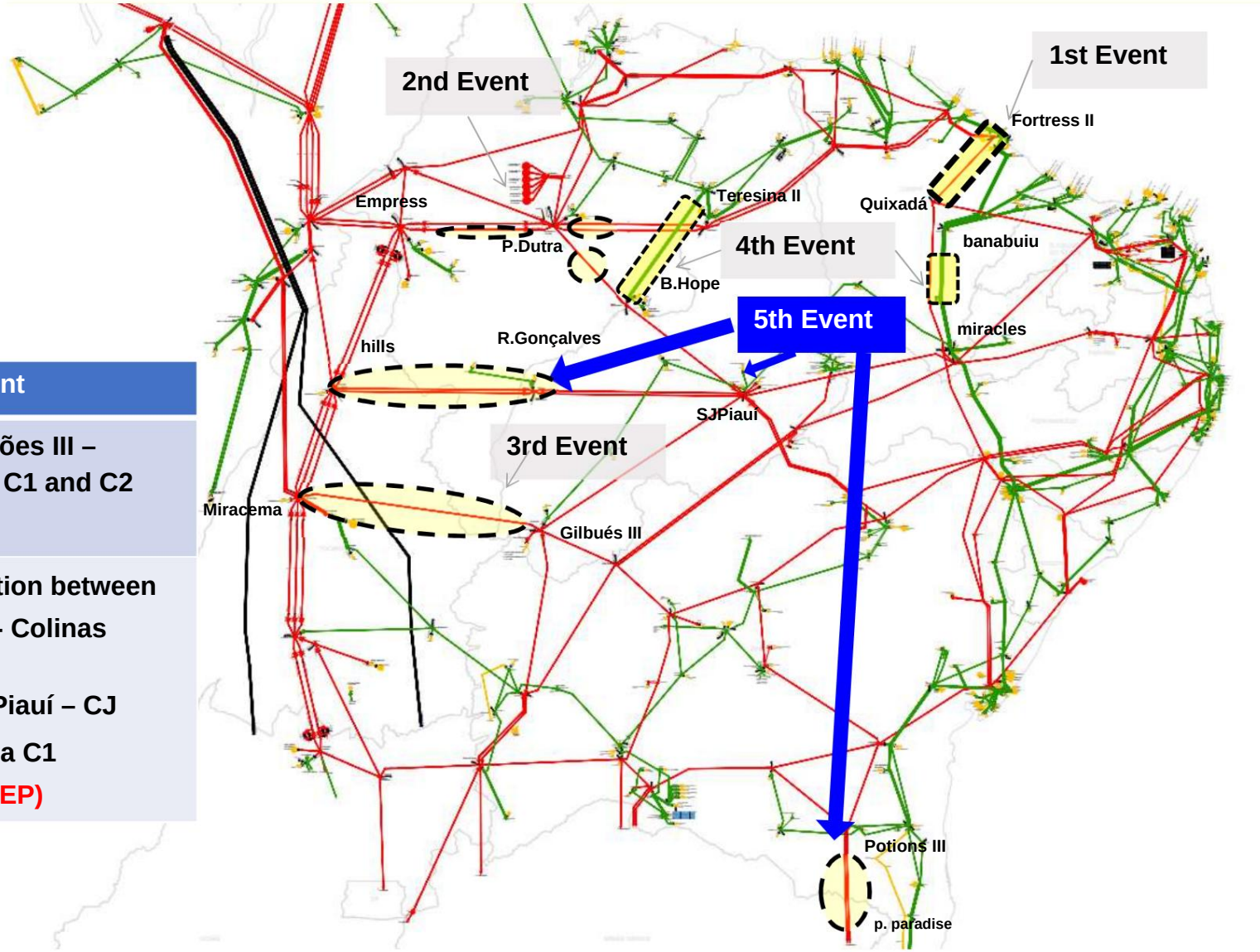


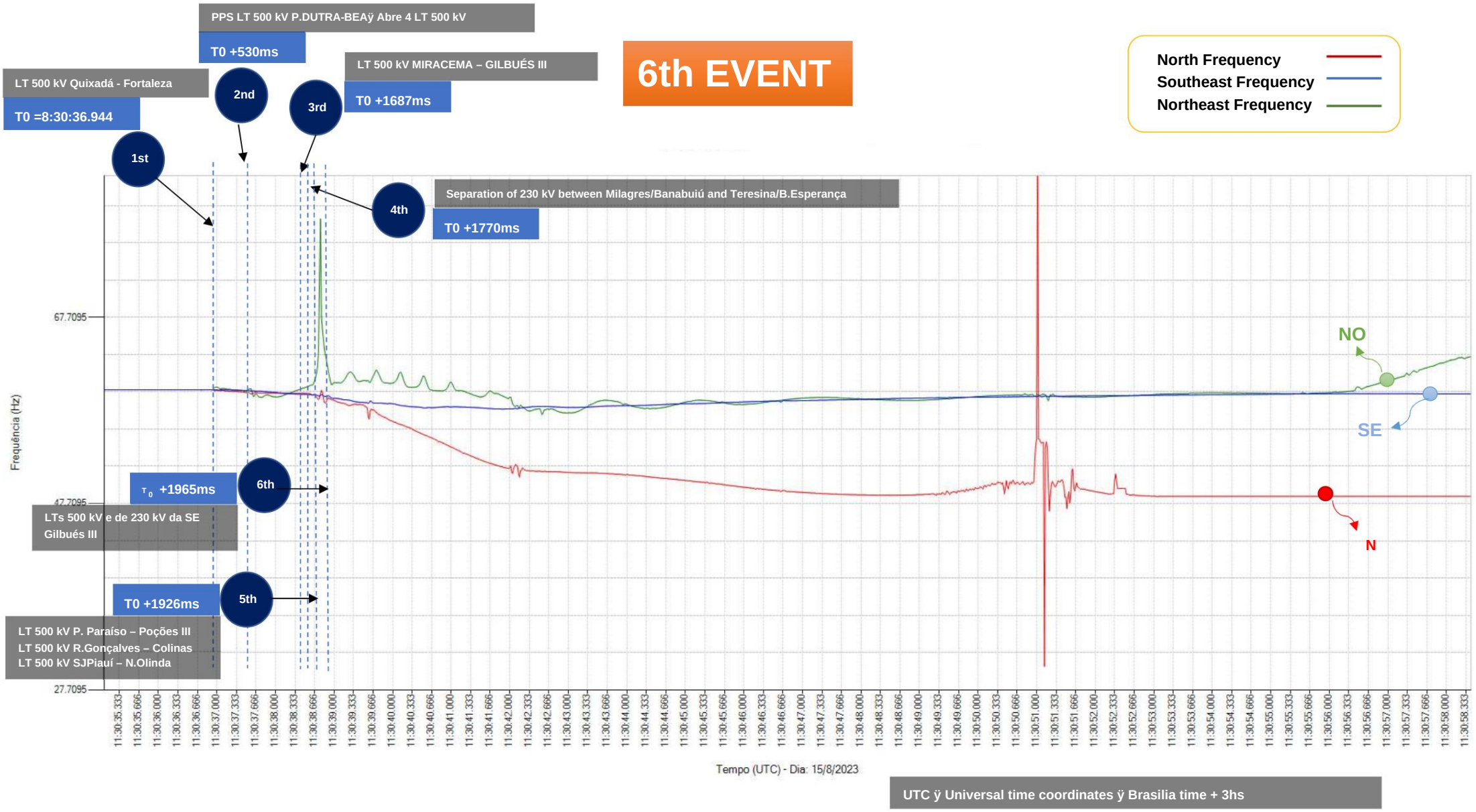


Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 1926 ms

Time	Event
8h30min38,777s	LT 500 kV Poções III – Padre Paraíso C1 and C2 (PPS)
8h30min38,872s	500 kV separation between R. Gonçalves - Colinas (21) LT 500 kV SJ Piauí – CJ FV Nova Olinda C1 (double loss SEP)

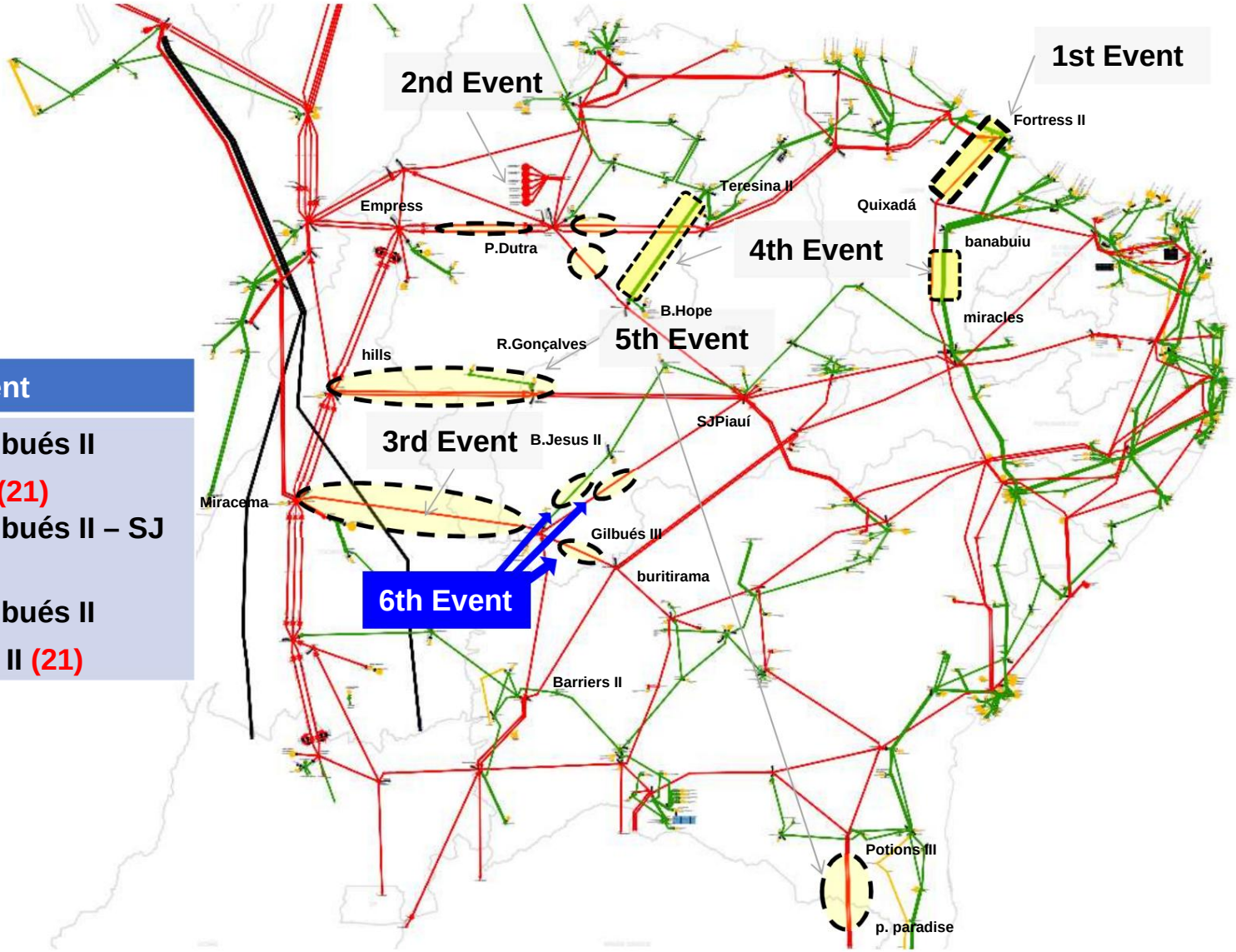


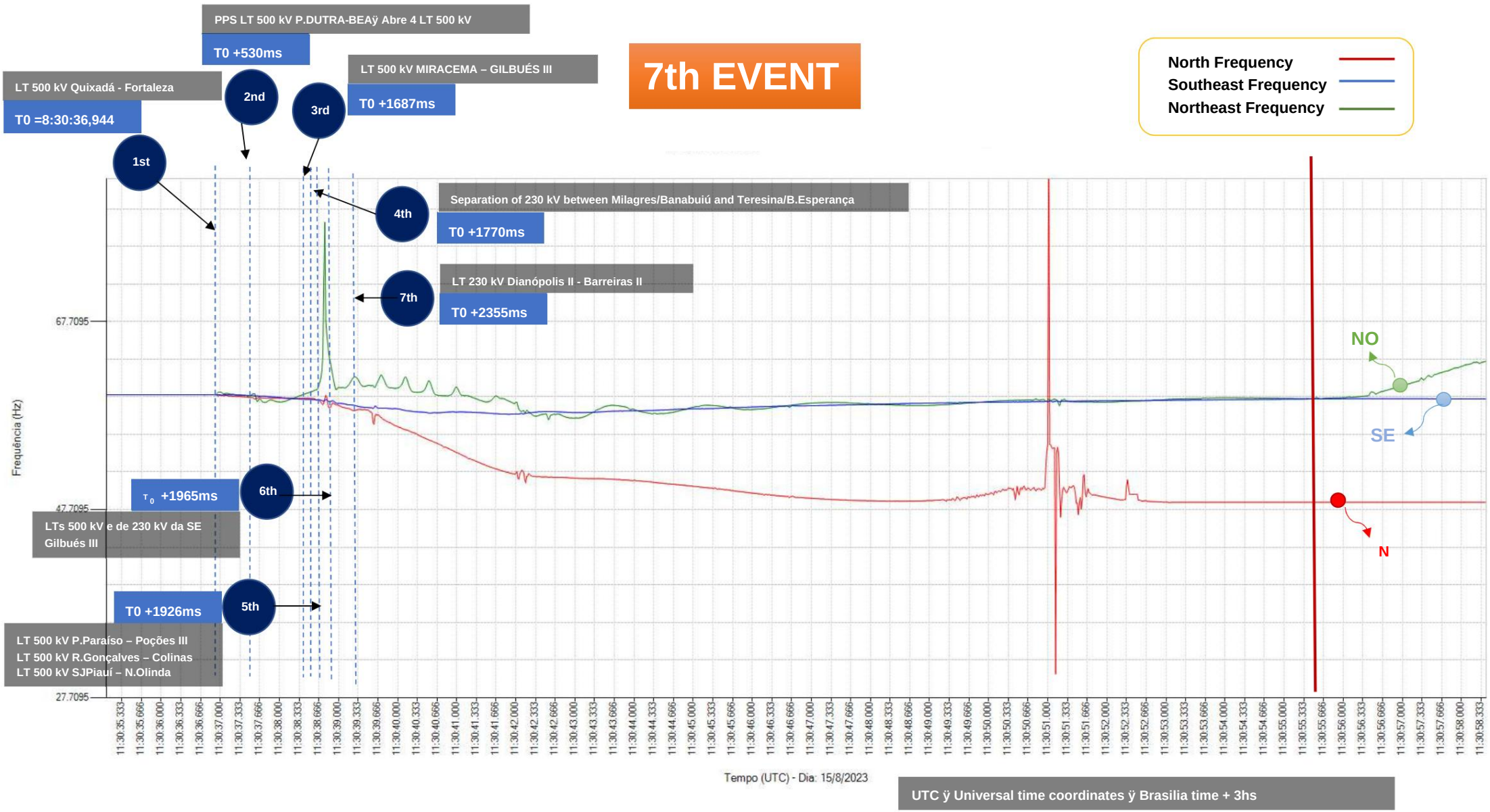


Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 1965 ms

Time	Event
8h30min38,911s	LT 500 kV Gilbués II – Buritirama (21) LT 500 kV Gilbués II – SJ Piauí (21) LT 230 kV Gilbués II – Bom Jesus II (21)

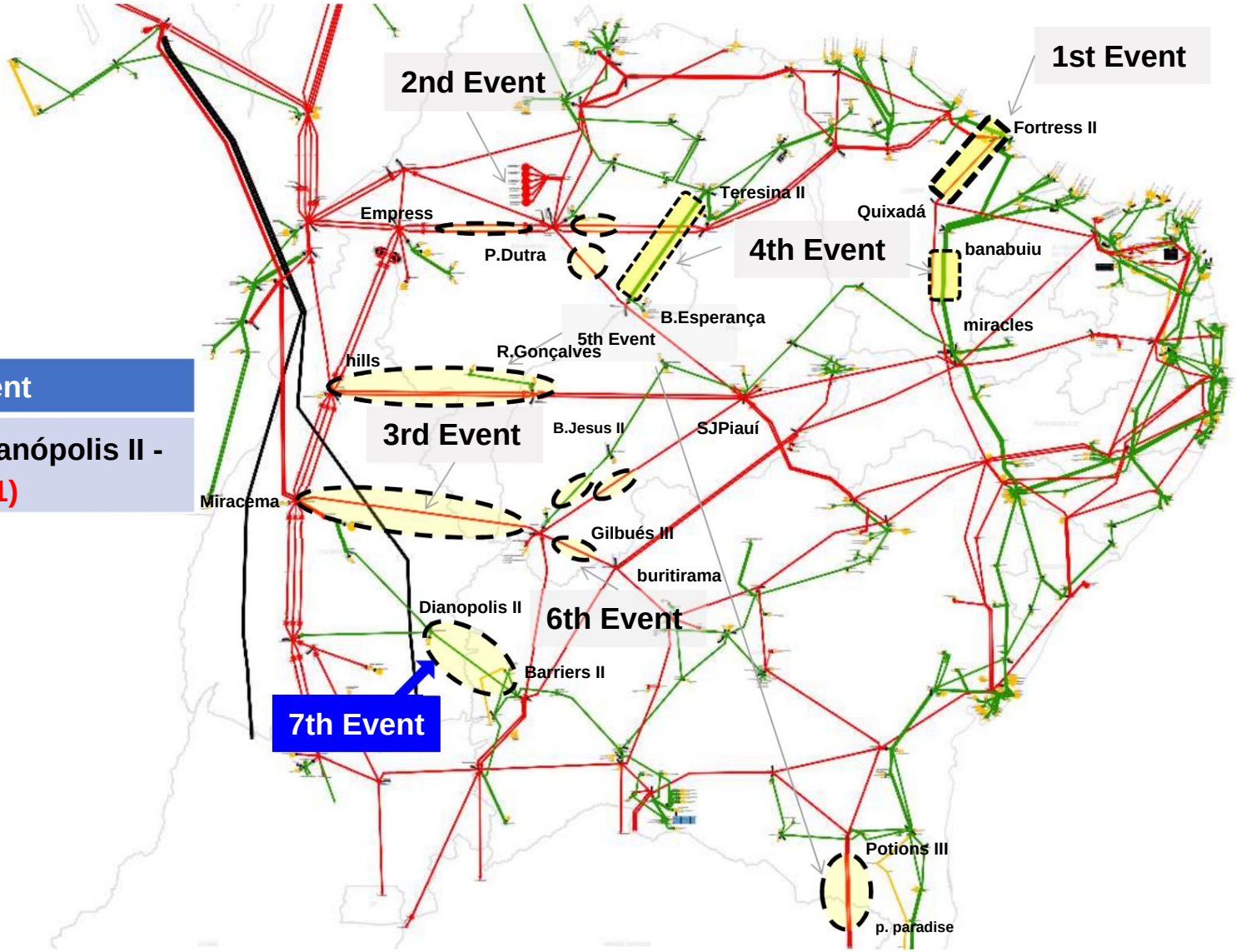


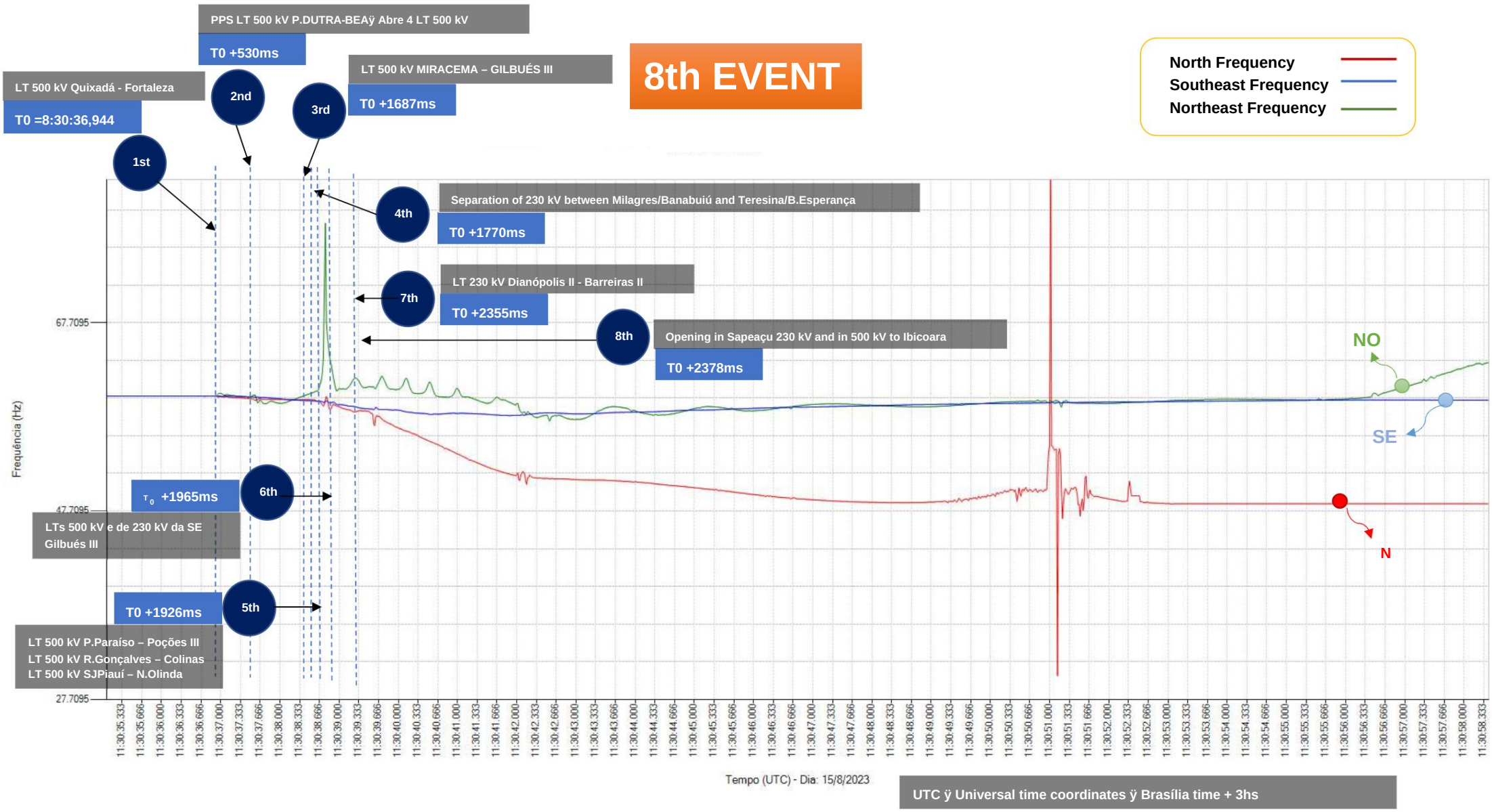


Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 2355 ms

Time	Event
8h30min39,301s	LT 230 kV Dianópolis II - Barriers II (21)

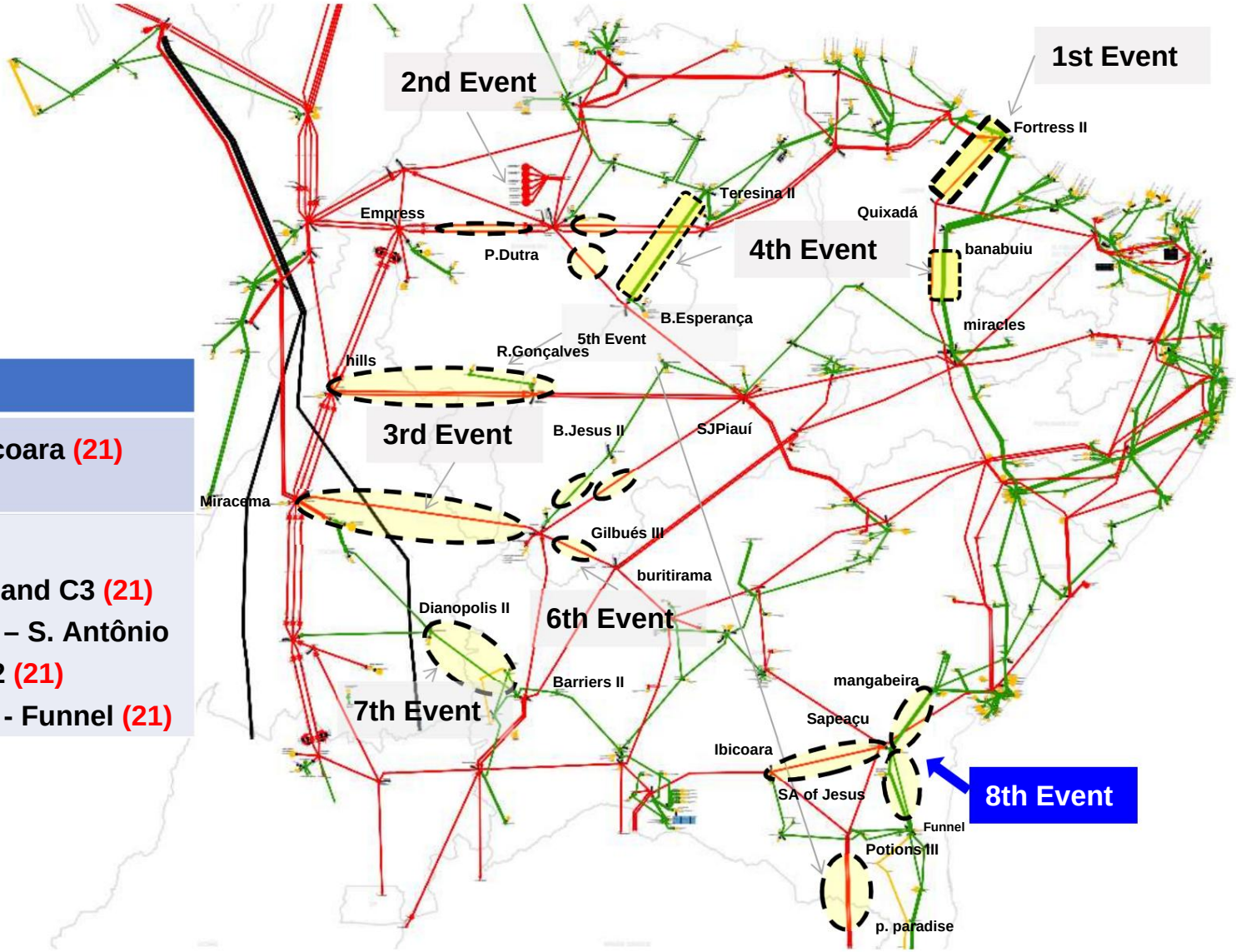


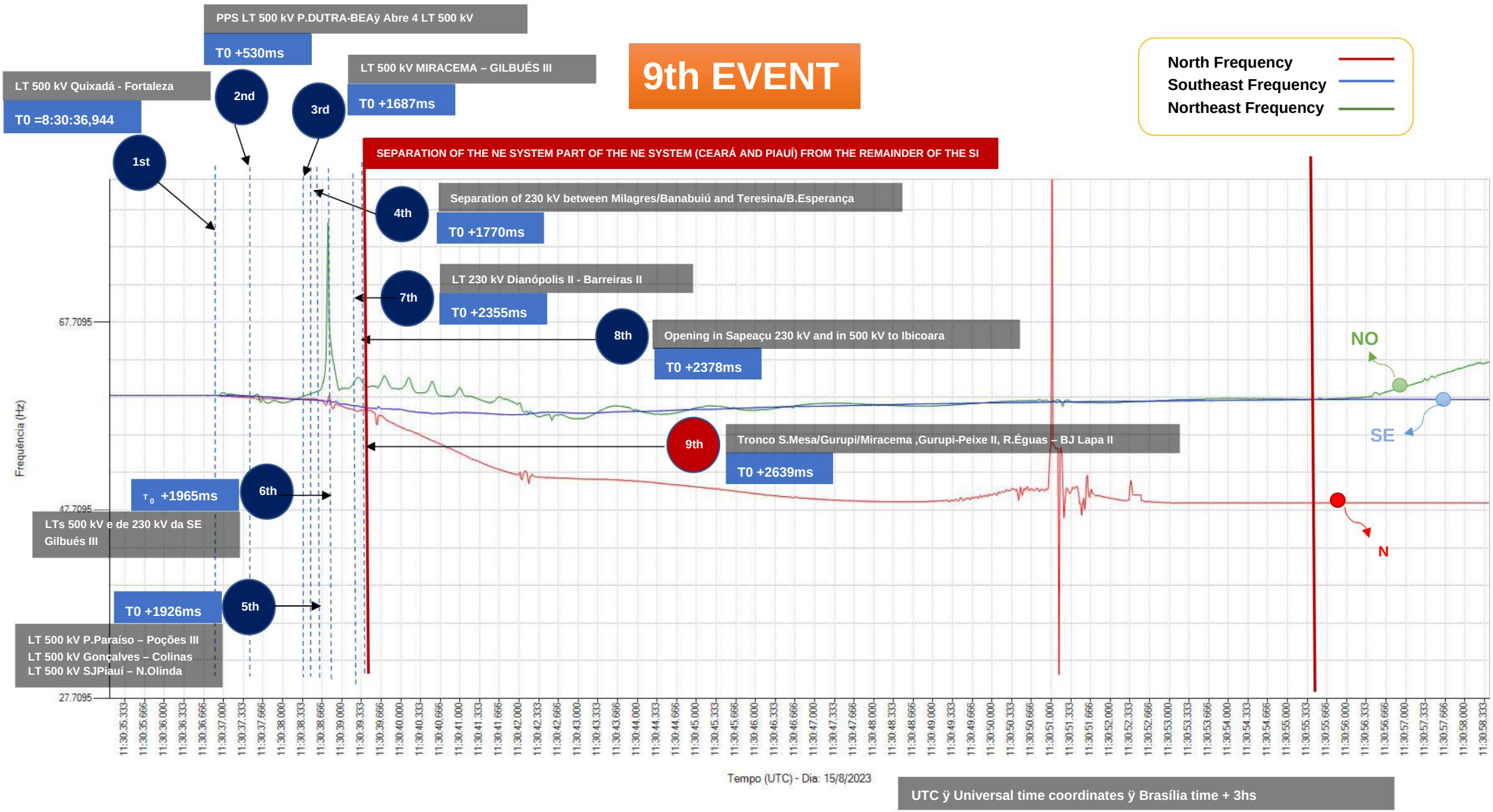


Main events of Separation of the North and Northeast Areas from the rest of the SIN

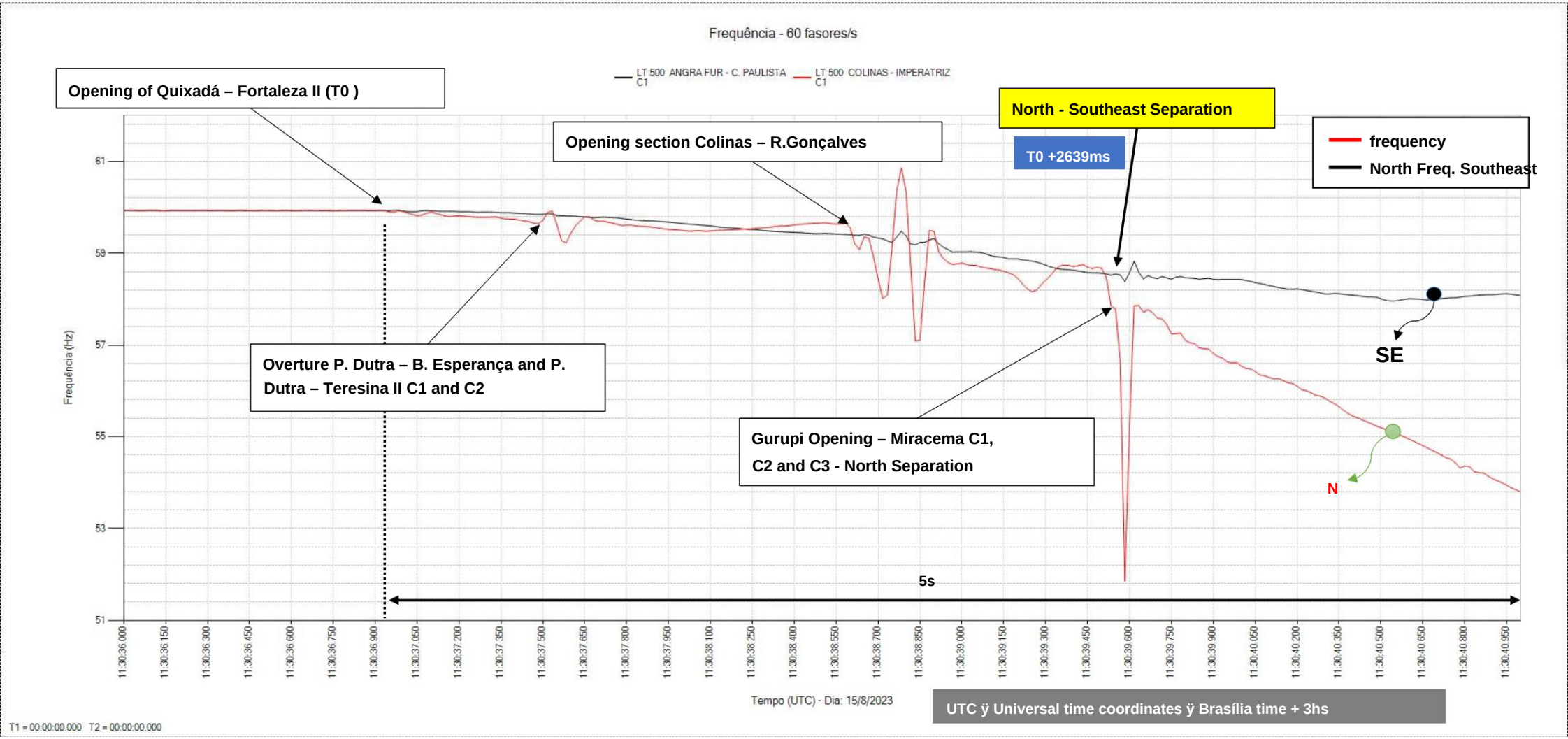
T0 + 2407 ms

Time	Event
8h30min39,324s	LT 500 kV Sapeaçu – Ibicoara (21)
8h30min39.353s	LT 230 kV Sapeaçu – Mangabeira C1, C2 and C3 (21) LT 230 kV Sapeaçu – S. Antônio de Jesus C1 and C2 (21) LT 230 kV Sapeaçu - Funnel (21)





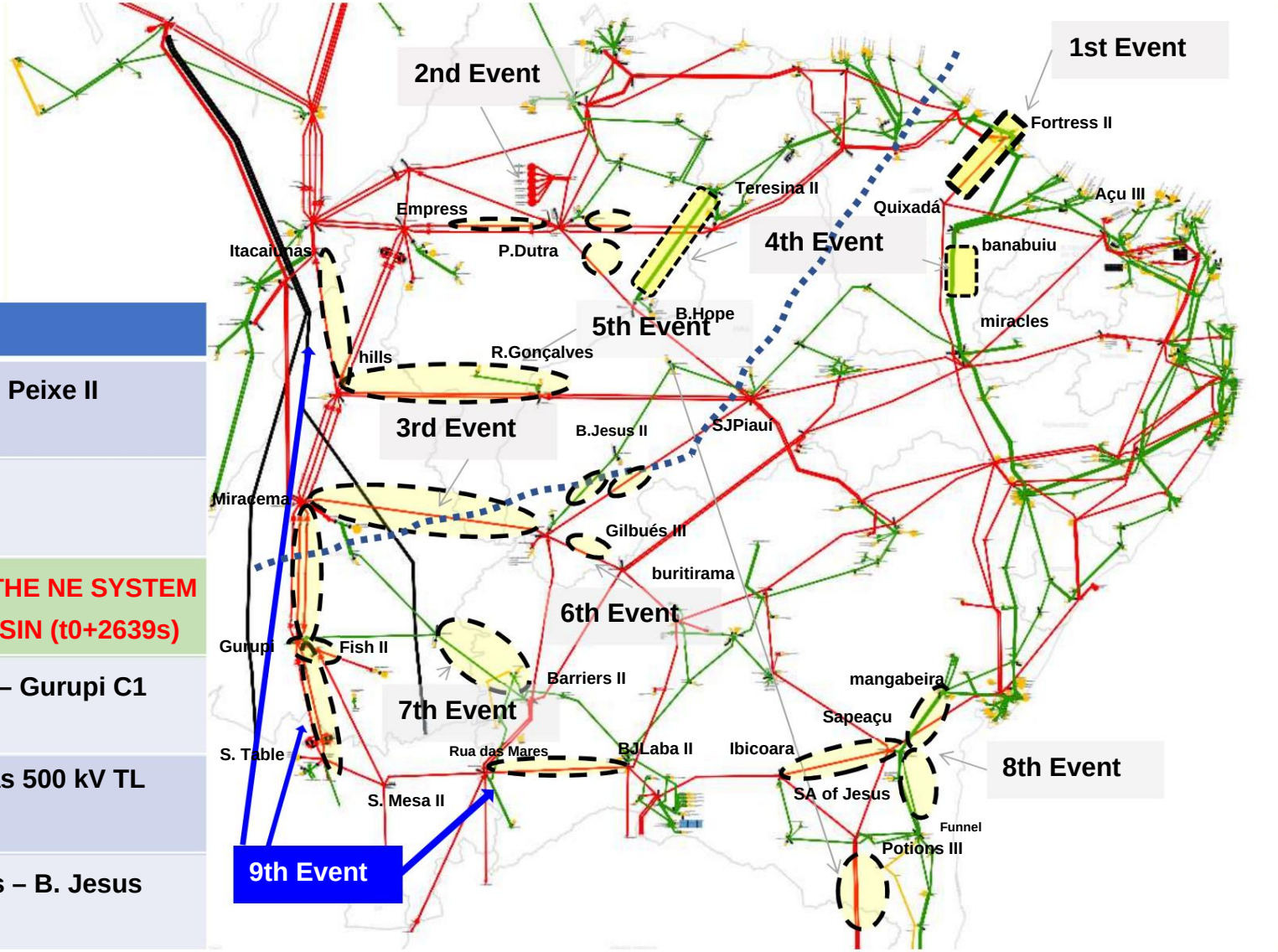
North/Southeast Separation - PMU

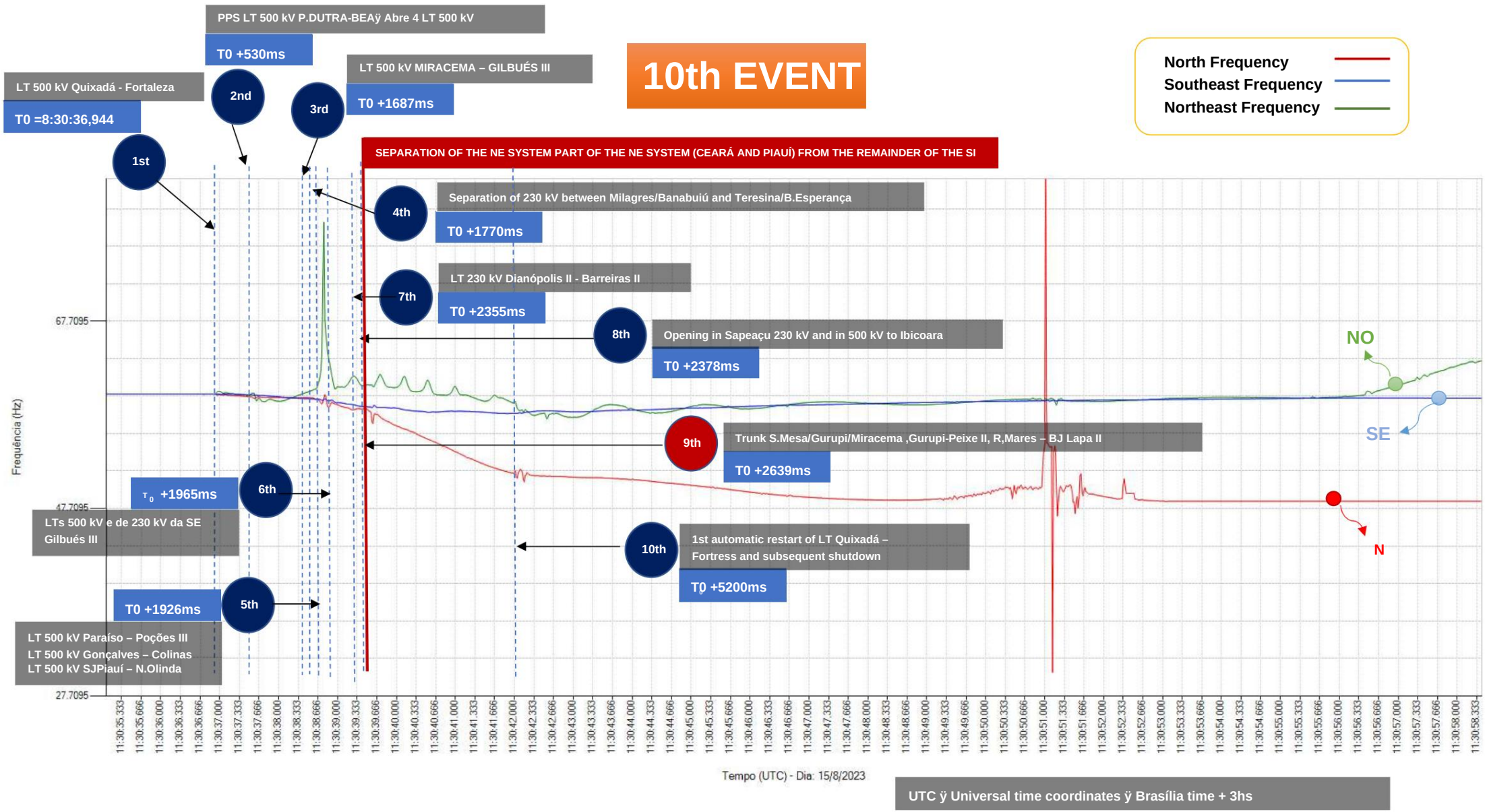


Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 4057 ms

Time	Event
8h30min39,535s	LT 500 kV Gurupi – Peixe II (21)
8h30min39.585s	Trunk 500 kV Gurupi – Miracema (PPS/21)
SEPARATION OF THE NE SYSTEM PART OF THE NE SYSTEM (CEARÁ AND PIAUÍ) OF THE REST OF THE SIN (t0+2639s)	
8h30min39,588s	LT 500 kV S. Mesa – Gurupi C1 and C2 (PPS)
8h30min40,048s	Colinas – Itacaiúnas 500 kV TL (21)
8h30min41,003s	LT 500 kV R. Éguas – B. Jesus da Lapa II (PPS)

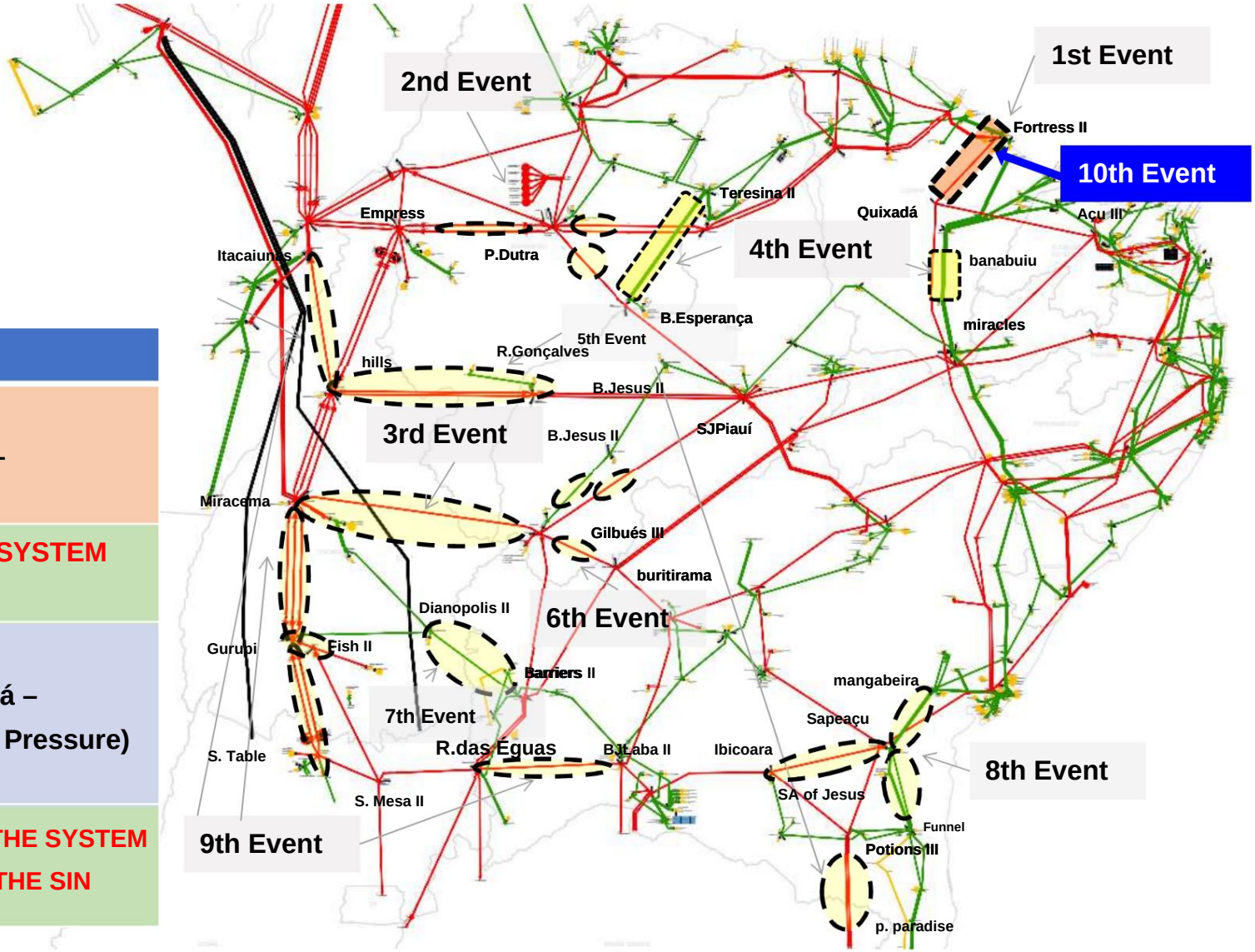




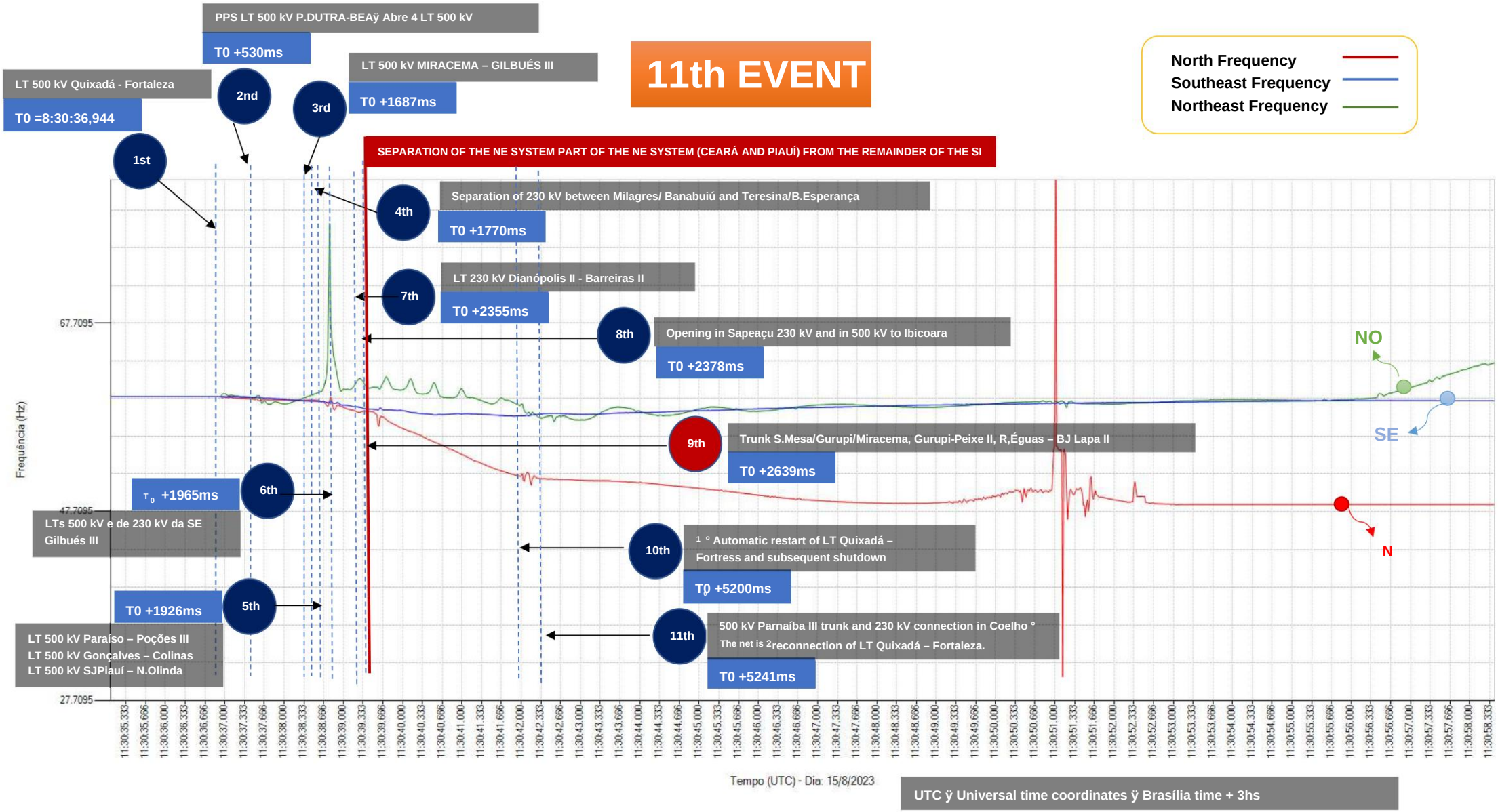
Main events of Separation of the North and Northeast Areas from the rest of the SIN

T0 + 5200 ms

Time	Event
8h30min41.993s	Automatic restart of LT 500 kV Quixadá – Fortress II
RECONNECTS O NORTH SYSTEM TO O SYSTEM NORTH EAST	
8h30min42.146s	Auto power off of LT 500 kV Quixadá – Fortaleza II (DJ Low Pressure)
SEPARATION OF THE SYSTEM AND PART OF THE SYSTEM NE (CEARÁ AND PIAUÍ) OF THE REST OF THE SIN	



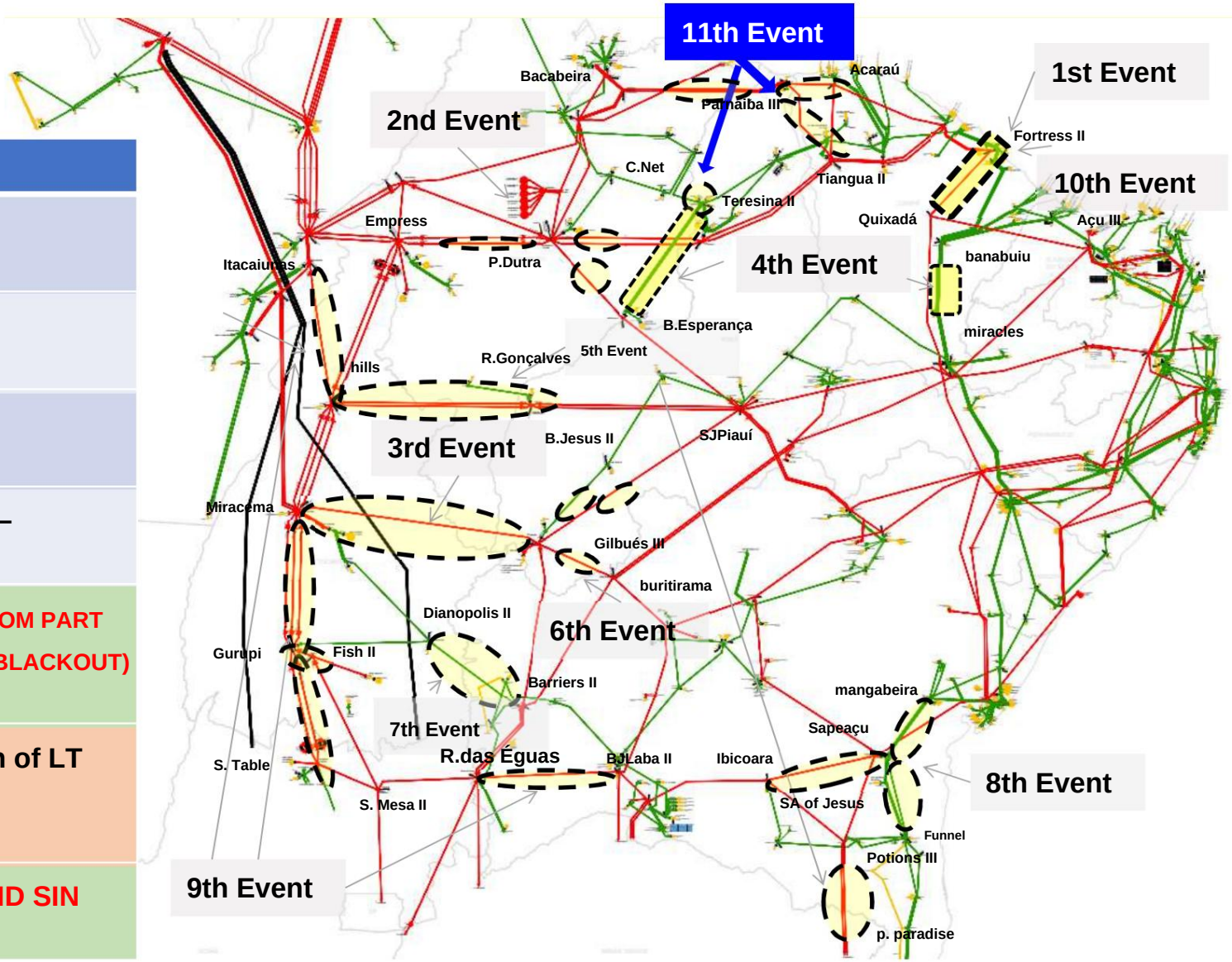
Machine Translated by Google



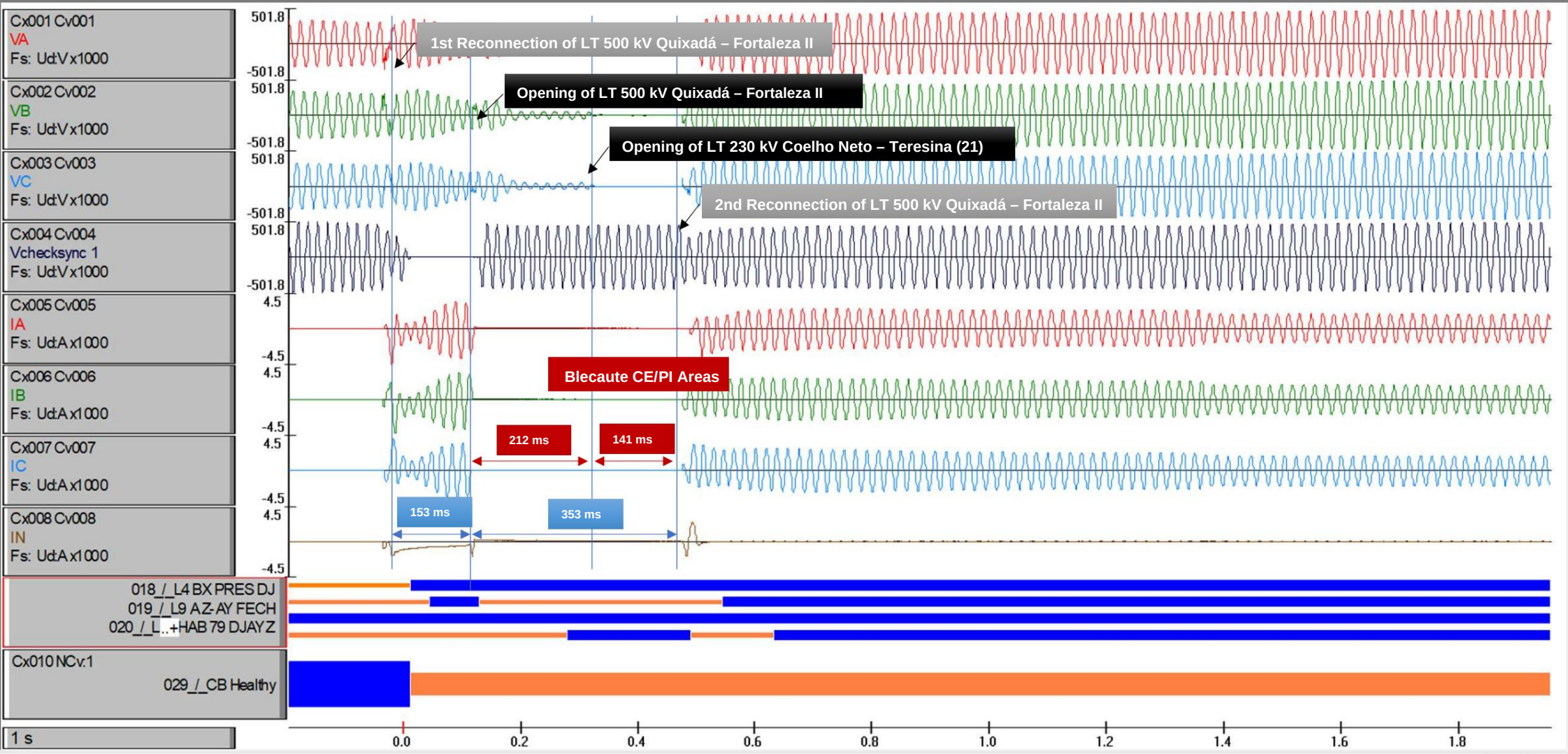
Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 5553 ms

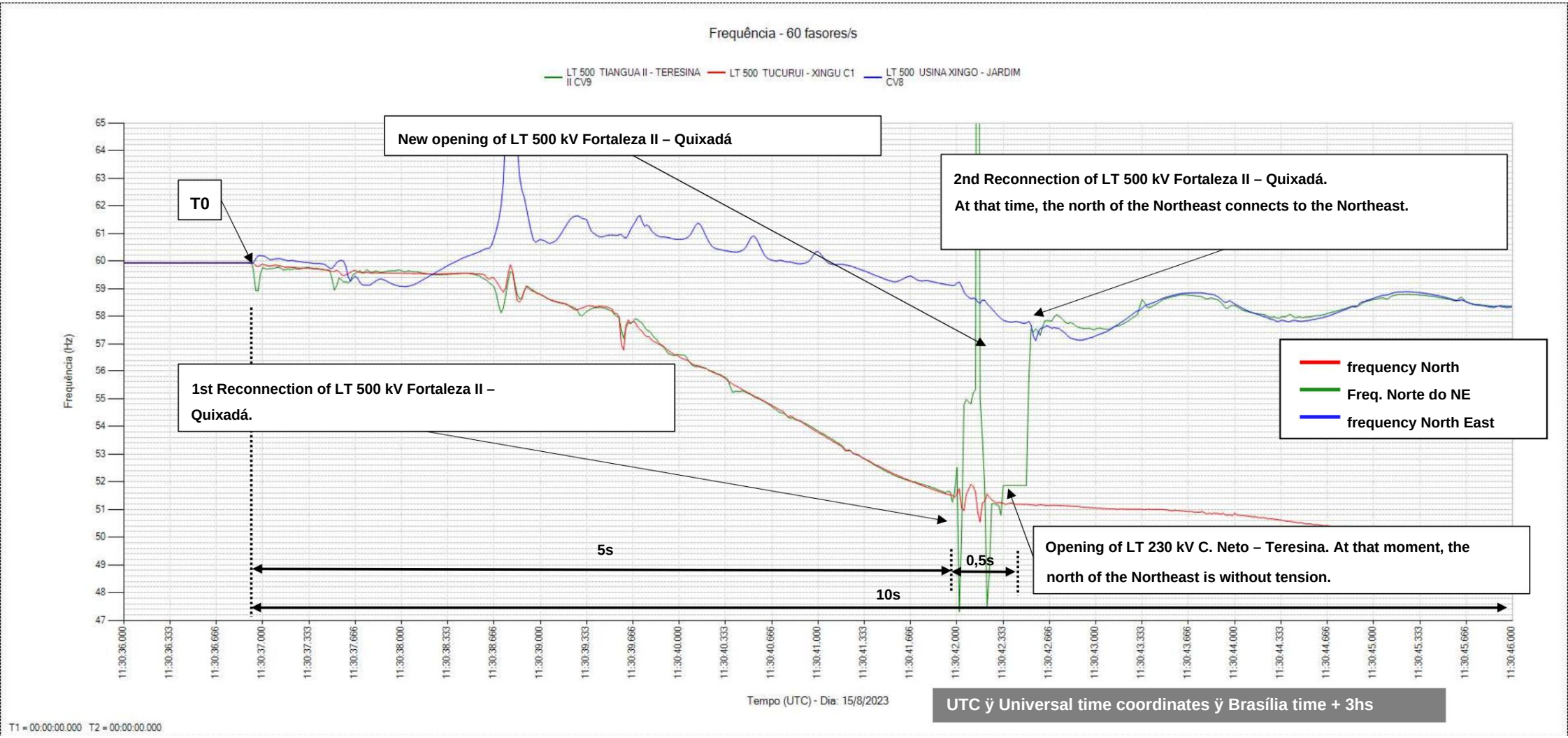
Time	Event
8h30min42.184s	LT 500 kV Parnaíba III - Tiangua II (21)
8h30min42.187s	LT 500 kV Parnaíba III – Acaraú (21)
8h30min42.197s	LT 500 kV Parnaíba III – Bacabeira (21)
8h30min42,358s	LT 230 kV Coelho Neto – Teresina (21)
SEPARATION OF THE NORTHERN SYSTEM FROM PART FROM THE NORTHEAST (CEARÁ AND PIAUÍ ÿ BLACKOUT) (T0 +5412)	
8h30min42,499s	Automatic reconnection of LT 500 kV Quixadá – Fortress II
CONNECTS CEARÁ/PIAUÍ TO NE AND SIN (DOES NOT OPERATE ISOLATED)	

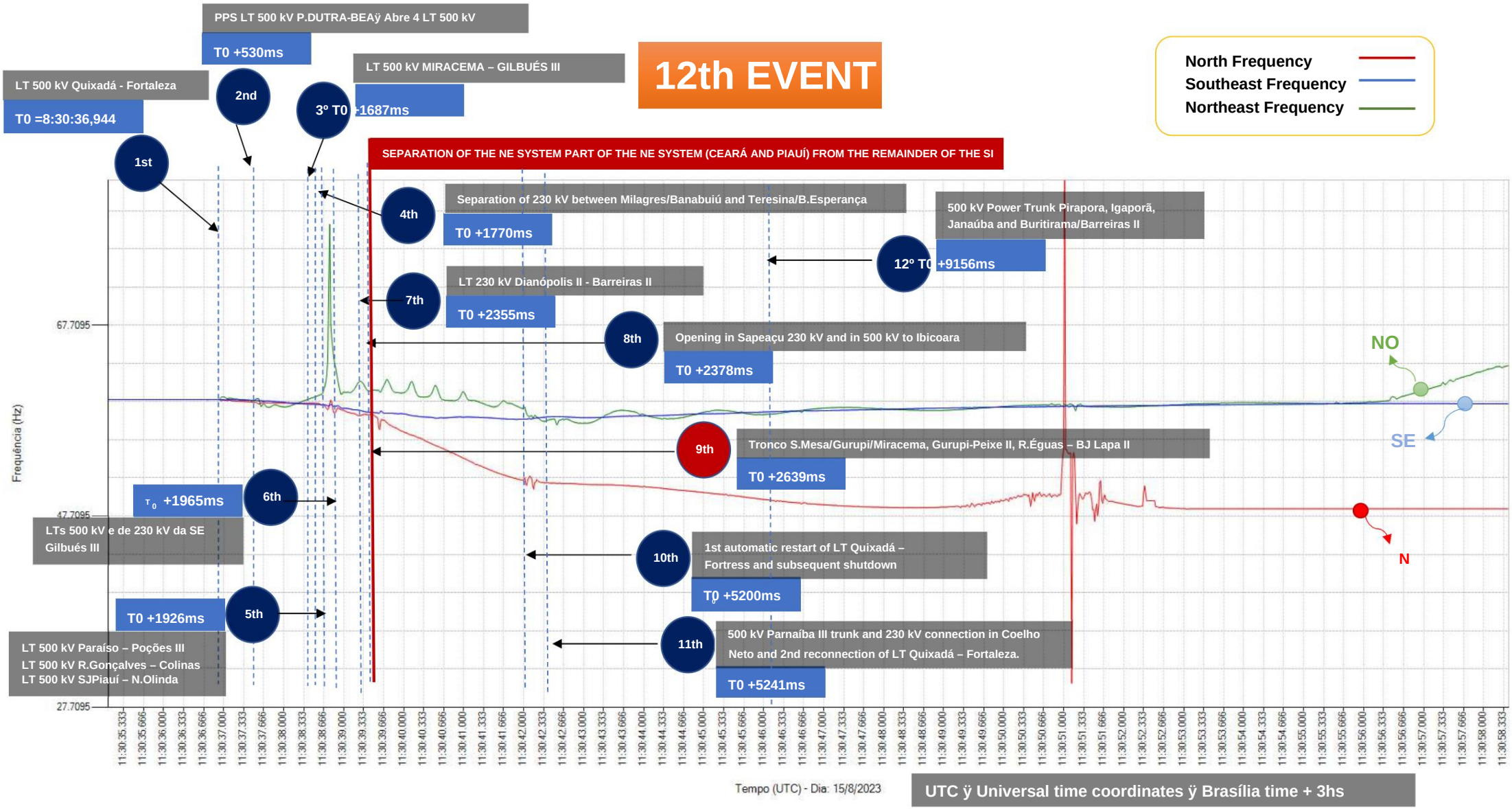


Reconnection of LT 500 kV Quixadá – Fortaleza II



Main events of separation of the North and Northeast Areas from the rest of the SIN

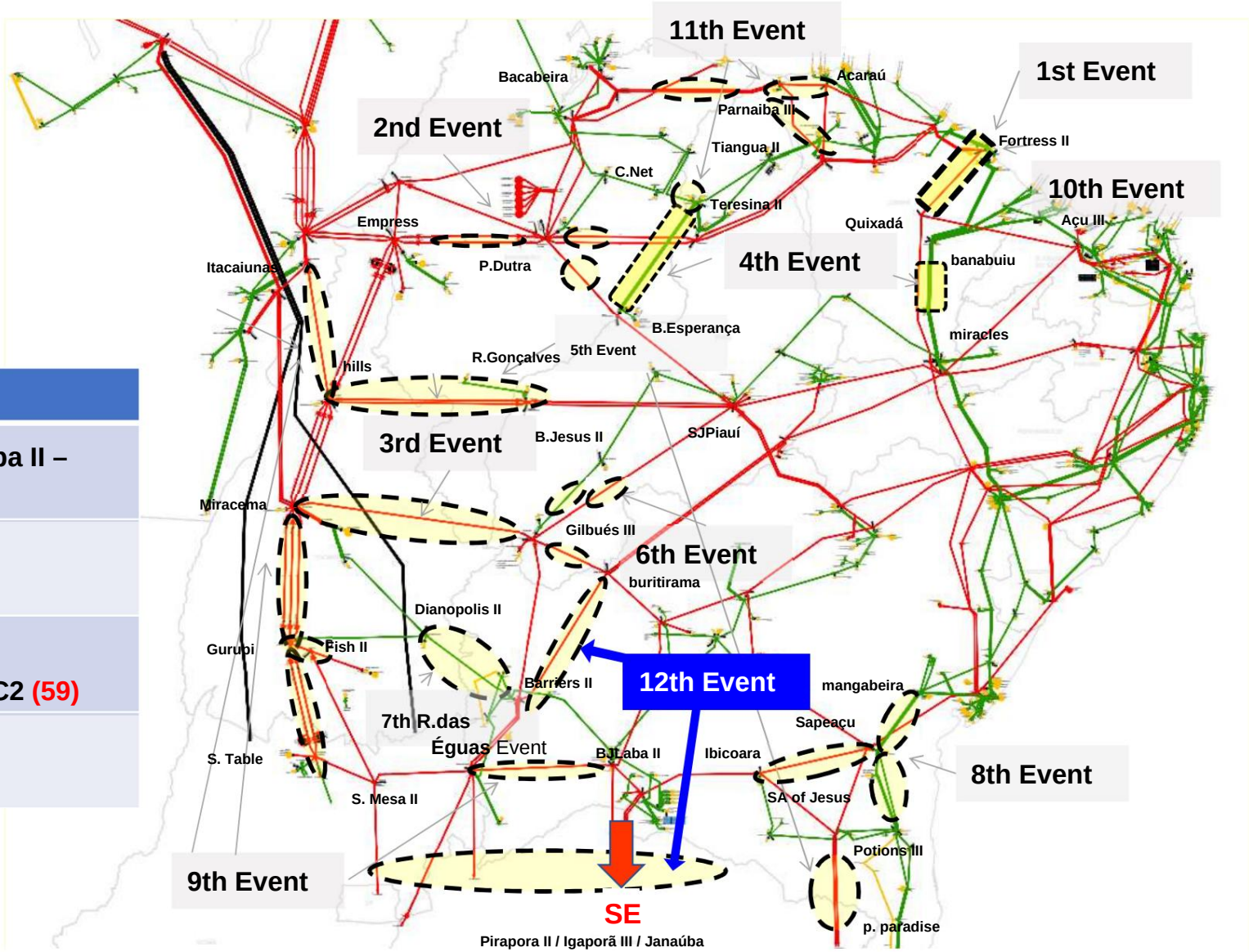


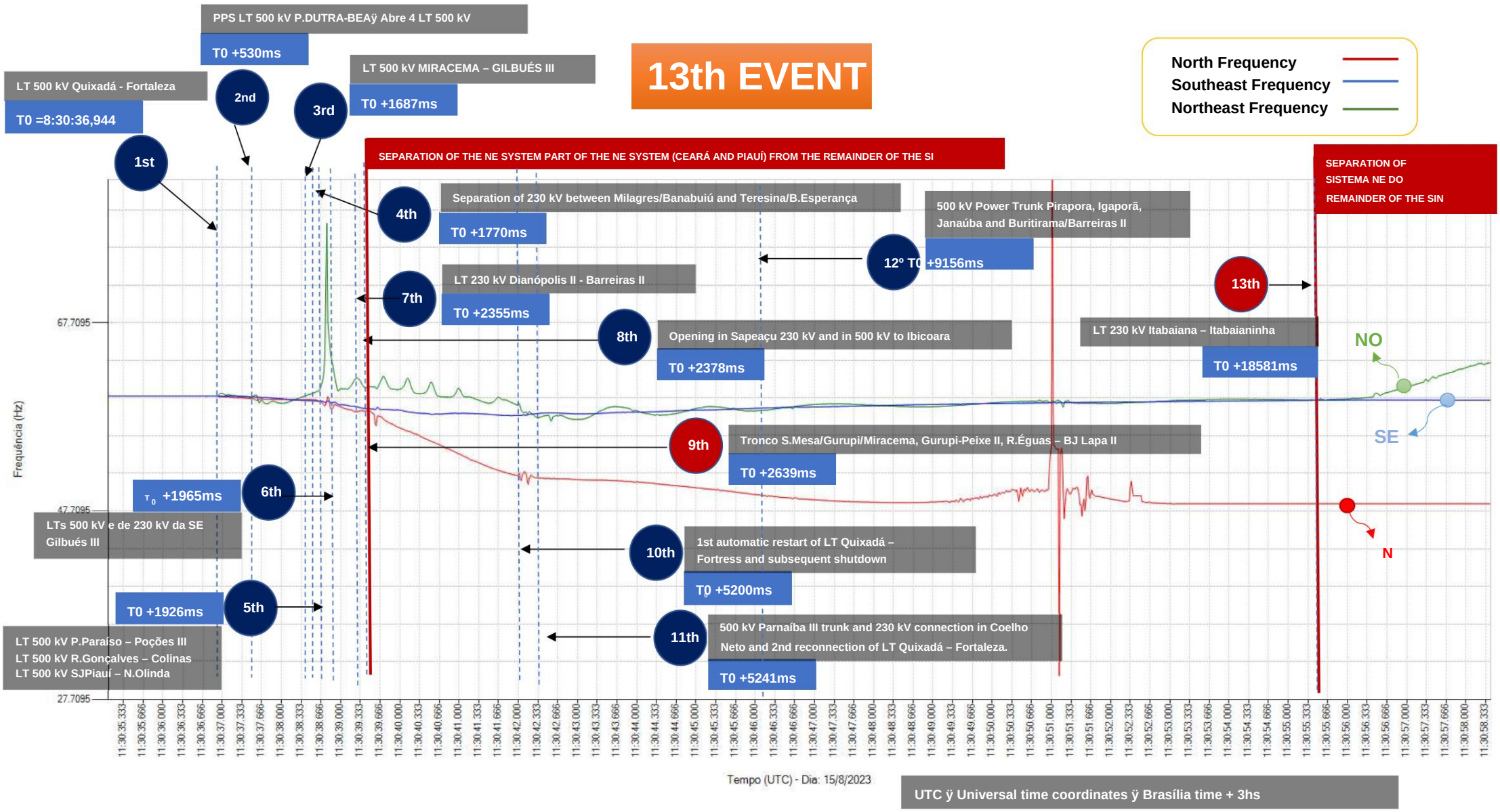


Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 9156 ms

Time	Event
8h30min43,964s	LT 500 kV B. Jesus da Lapa II – Janaúba III (59)
8h30min45.573s	LT 500 kV Janaúba III – Pirapora II (59)
8h30min46.067s	LT 500 kV Igapora III – Janaúba III C1 and C2 (59)
8h30min46.102s	LT 500 kV Buritirama – Barriers II (59)





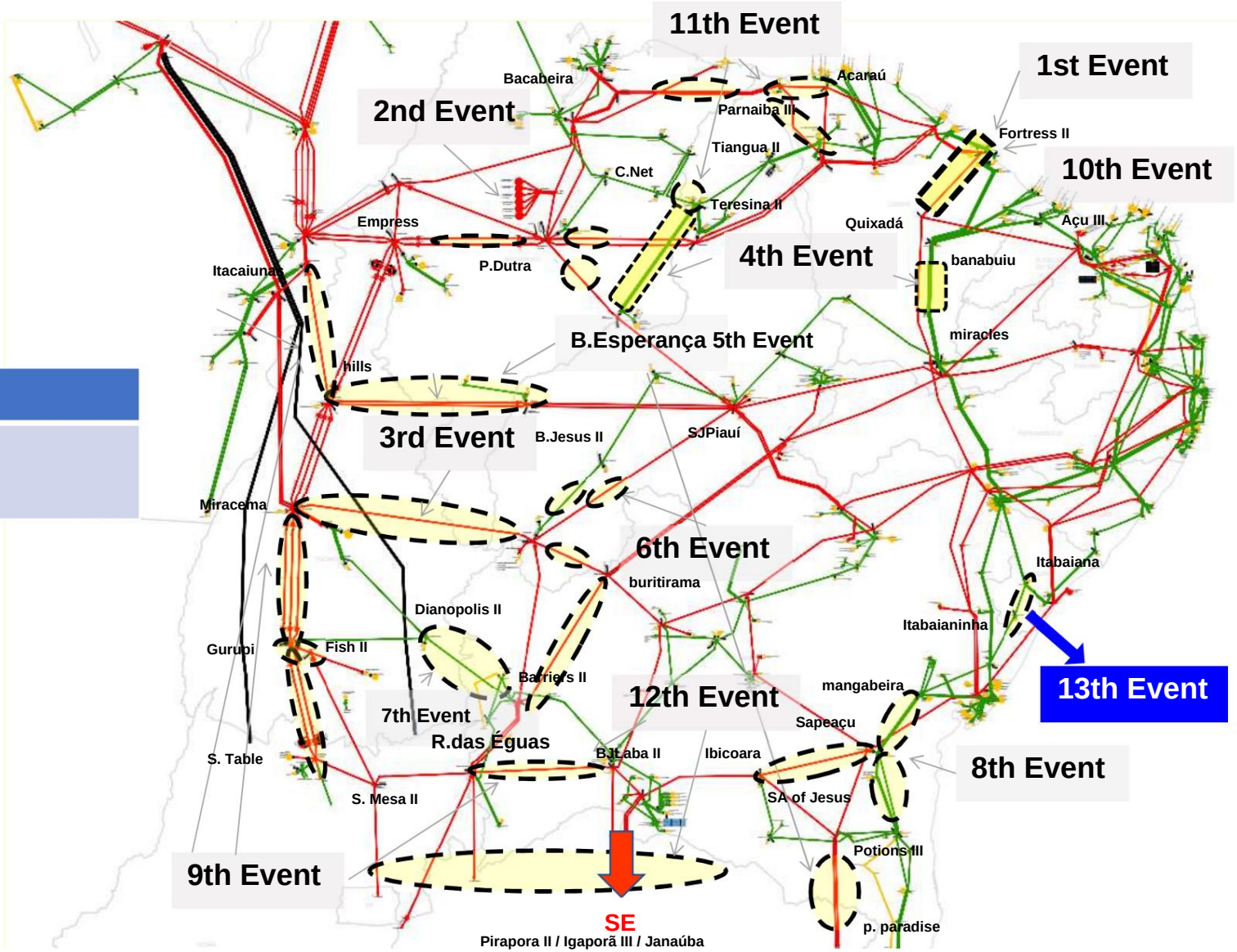
Main events of separation of the North and Northeast Areas from the rest of the SIN

T0 + 18581 ms

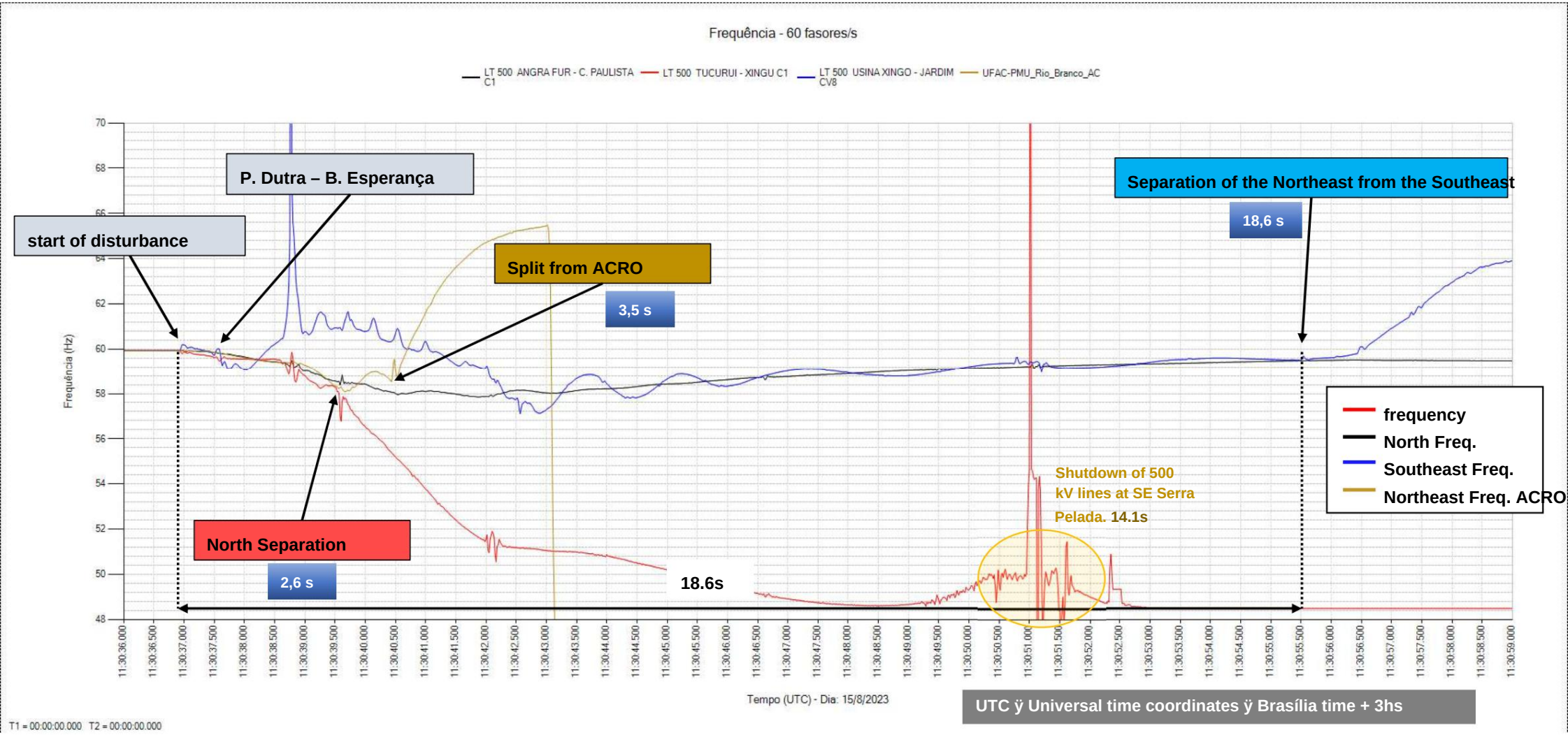
Time	Event
8h30min55.527s LT	230 kV Itabaiana – Itabaianinha

NE SYSTEM SEPARATION

THE REMAINDER OF THE SIN



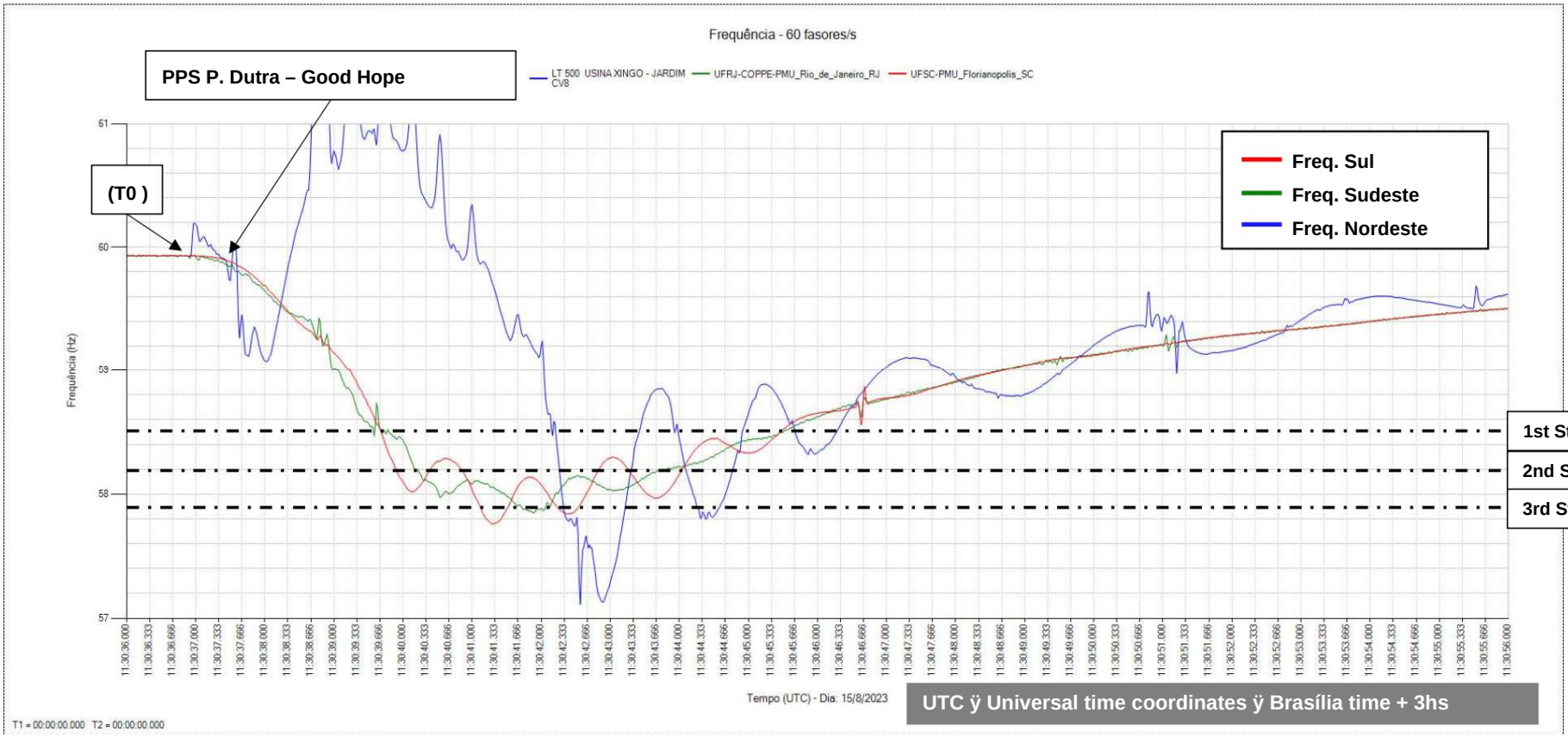
Separation of Subsystems - PMU



Satisfactory performance of the ERAC

- During the event, loss of generation was observed, based on the behavior of the frequency of the SIN. In this sense, in view of the generation deficit experienced by the SIN, the Regional Load Relief Scheme (ERAC) was implemented in order to promote the balance between load and generation.

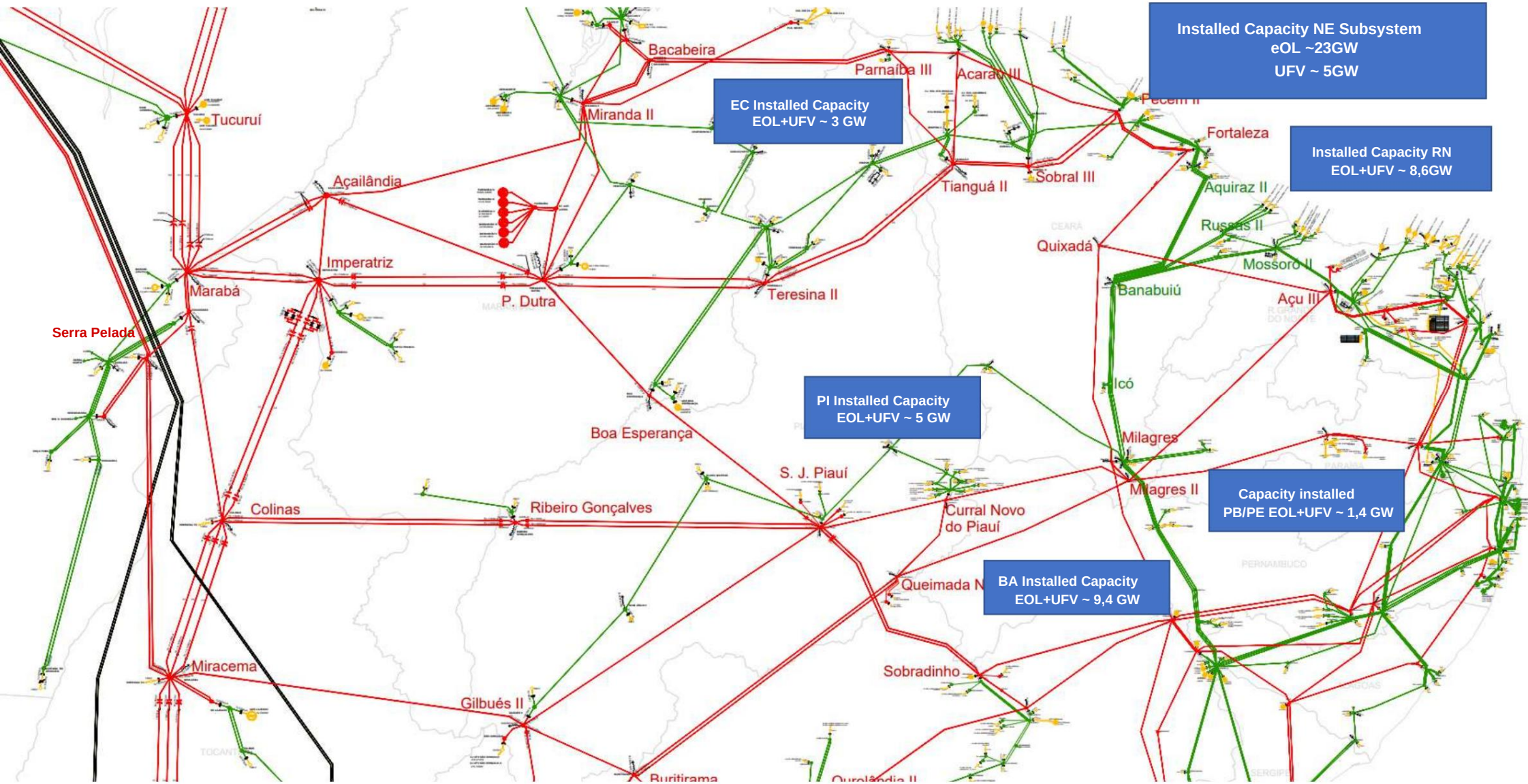
- The ERAC performance analysis will be carried out in a specific meeting, to be held on 01/09.



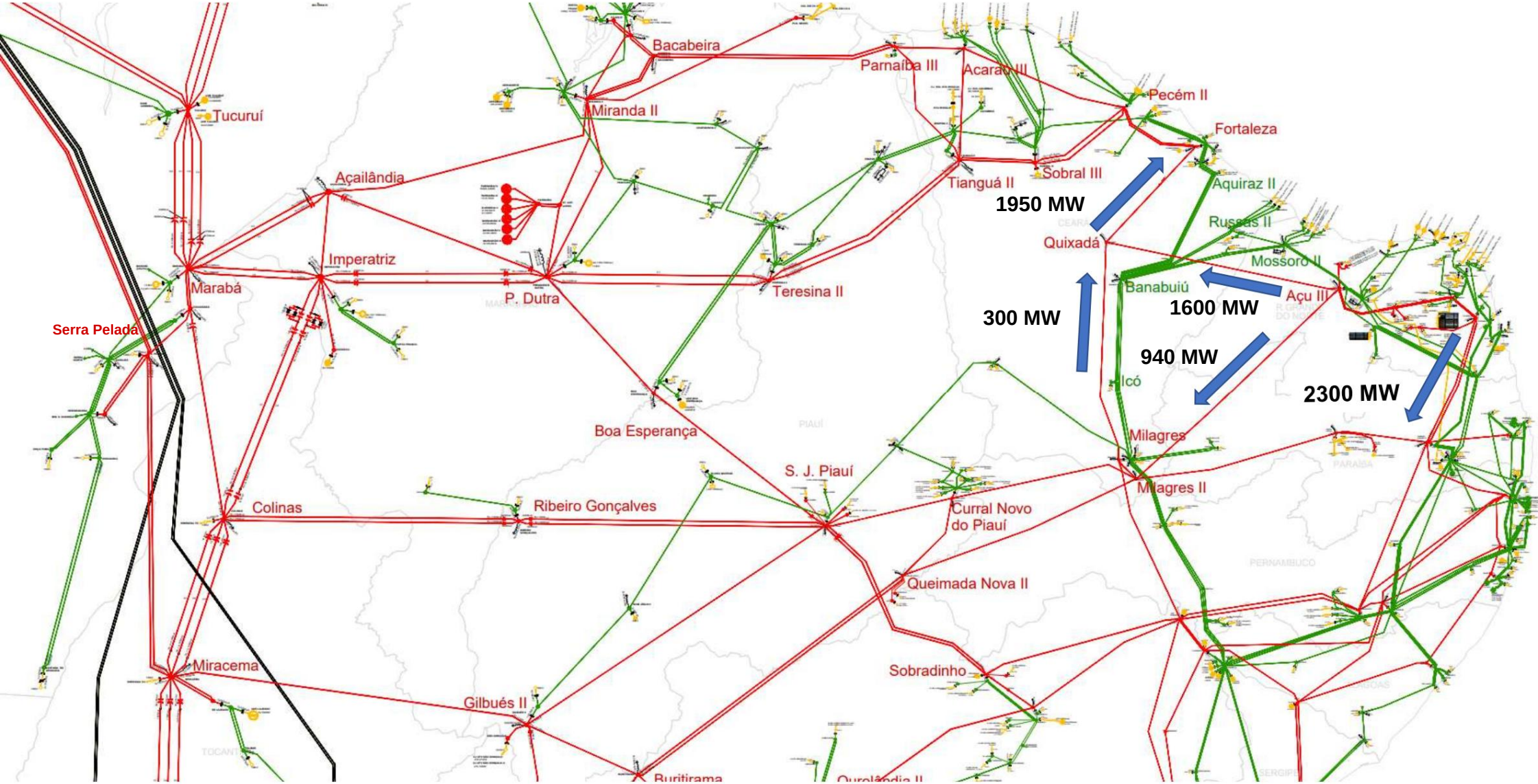
Operador Nacional do Sistema Elétrico

Preliminary Performance Analysis Dynamic

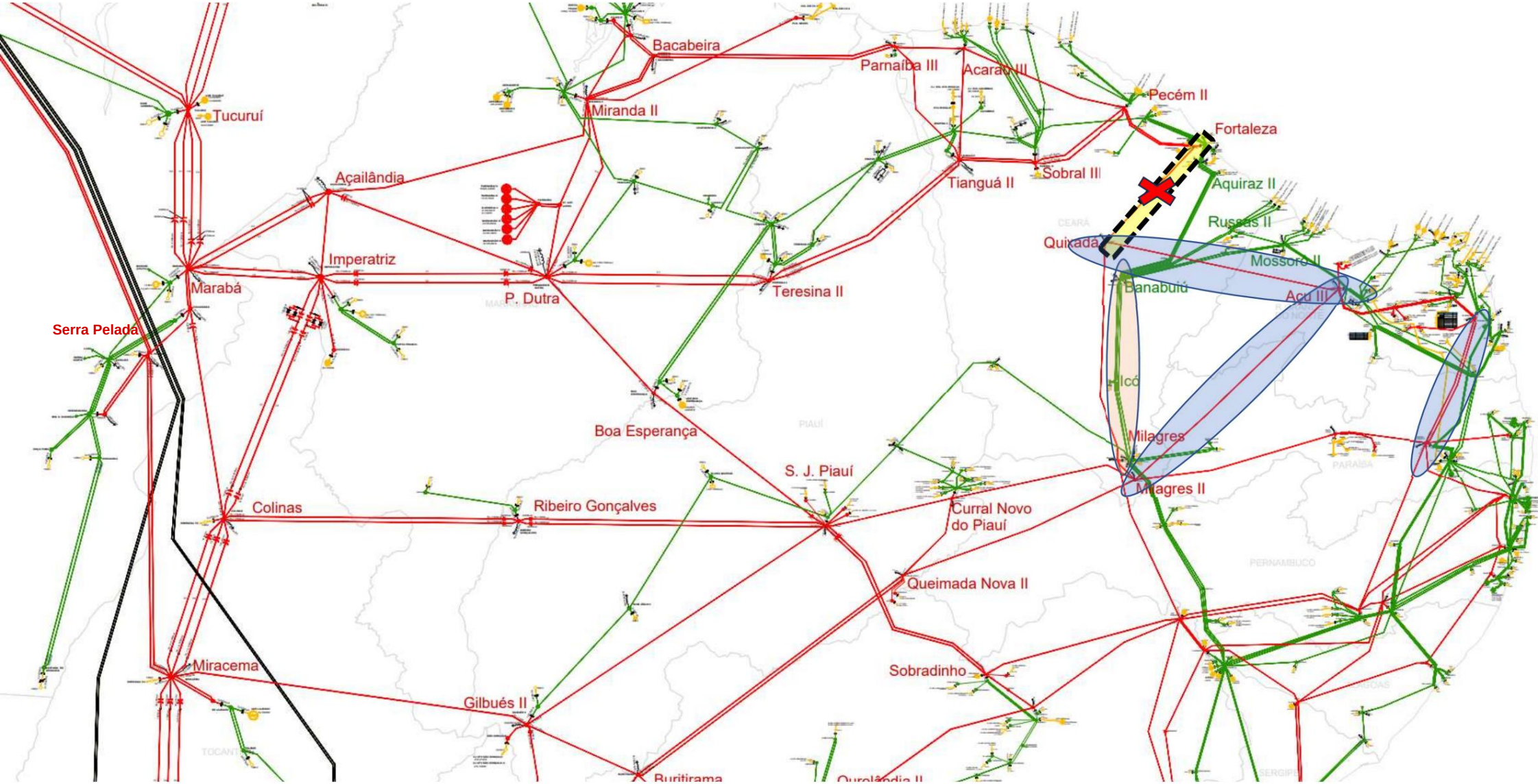
SIN Dynamic Performance



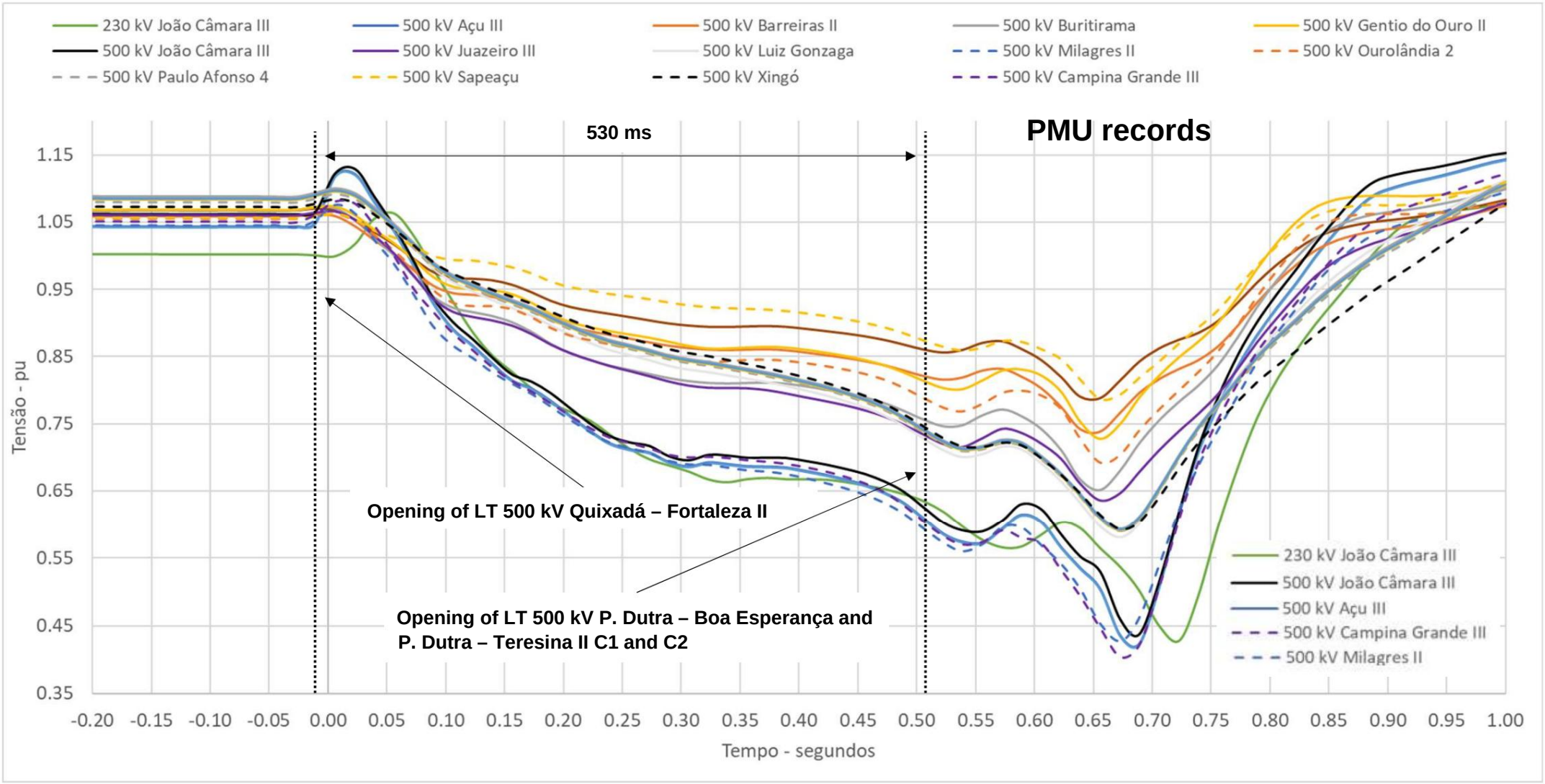
SIN Dynamic Performance - Pre-Occurrence Operating Conditions (08:30 am)



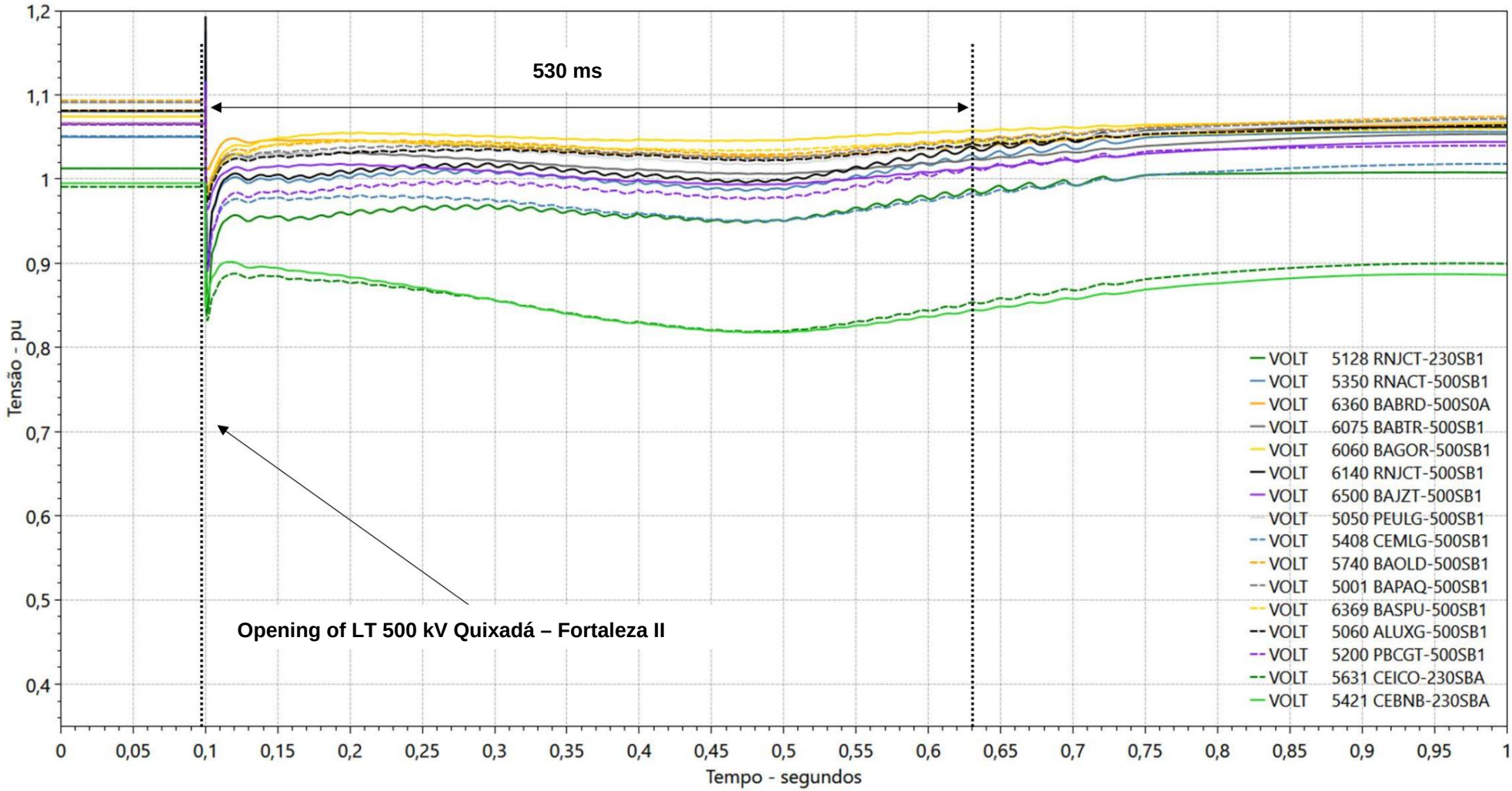
SIN Dynamic Performance



SIN Dynamic Performance – Opening P. Dutra – Boa Esperança (PPS Performance)

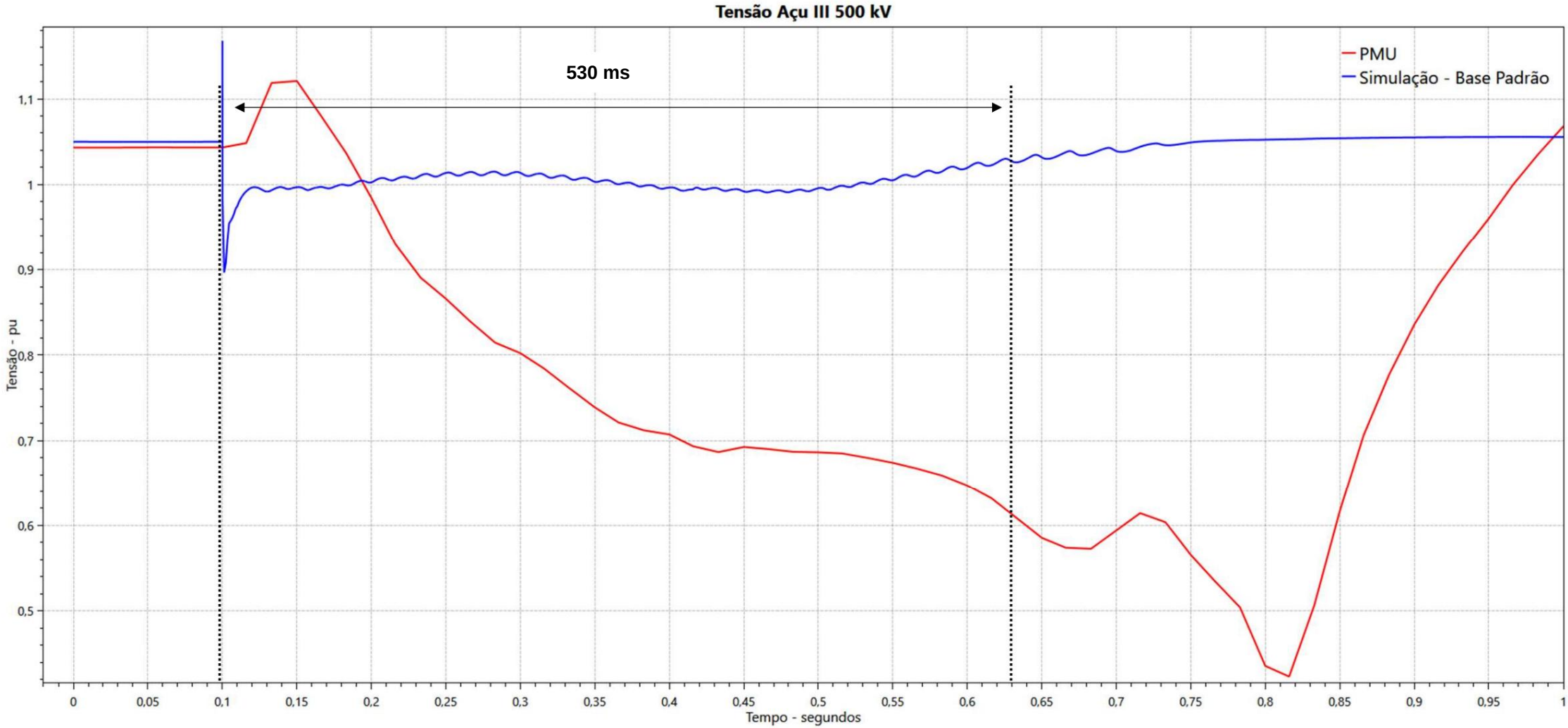


SIN Dynamic Performance - Event Simulation with Official Database (Real-time case)



Simulation of the operating point immediately before the disturbance with official database (Steady case obtained from real time)

Dynamic Performance of the SIN - Simulation with the Official Database x Event (PMU)



Simulation with official database x PMU registration

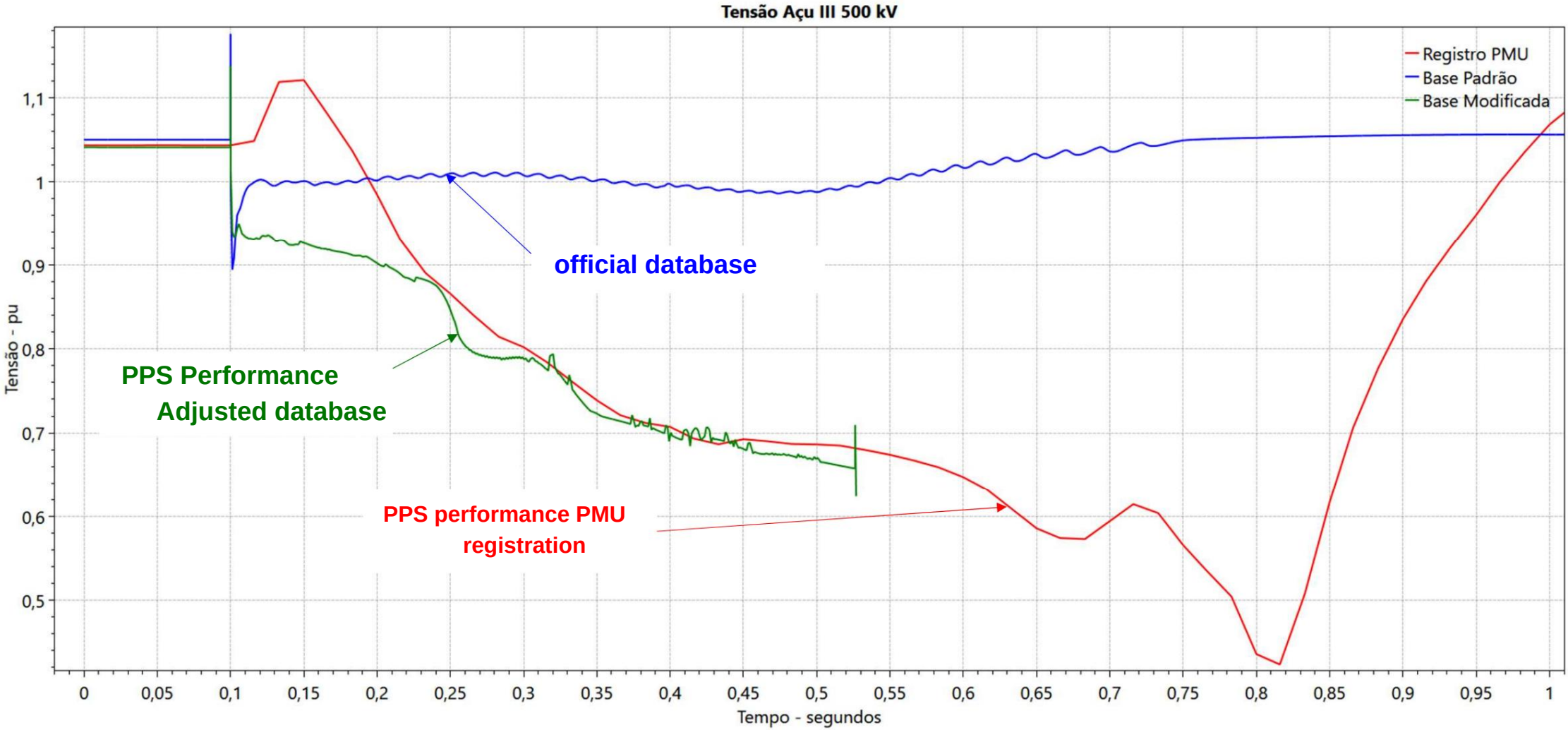
Glossary to Identify the Simulations Performed

- **Simulation with the official electromechanical transient database**
  - **The opening of LT 500 kV Quixadá – Fortaleza II was reproduced using the official ONS dynamic database.**

- **Simulation with adjusted electromechanical transient database**
  - **The official electromechanical transient database, distributed by ONS, was adjusted in order to approximate the simulation response to field response, considering the opening of LT 500 kV Quixadá – Fortaleza II. • For this, changes were made to some mathematical models of the generating parks in the region of interest, which are predominantly wind and photovoltaic.**
  - **The voltage observed in SE 500 kV Açu III is an indication that the adjusted models are more adherent to the field.**

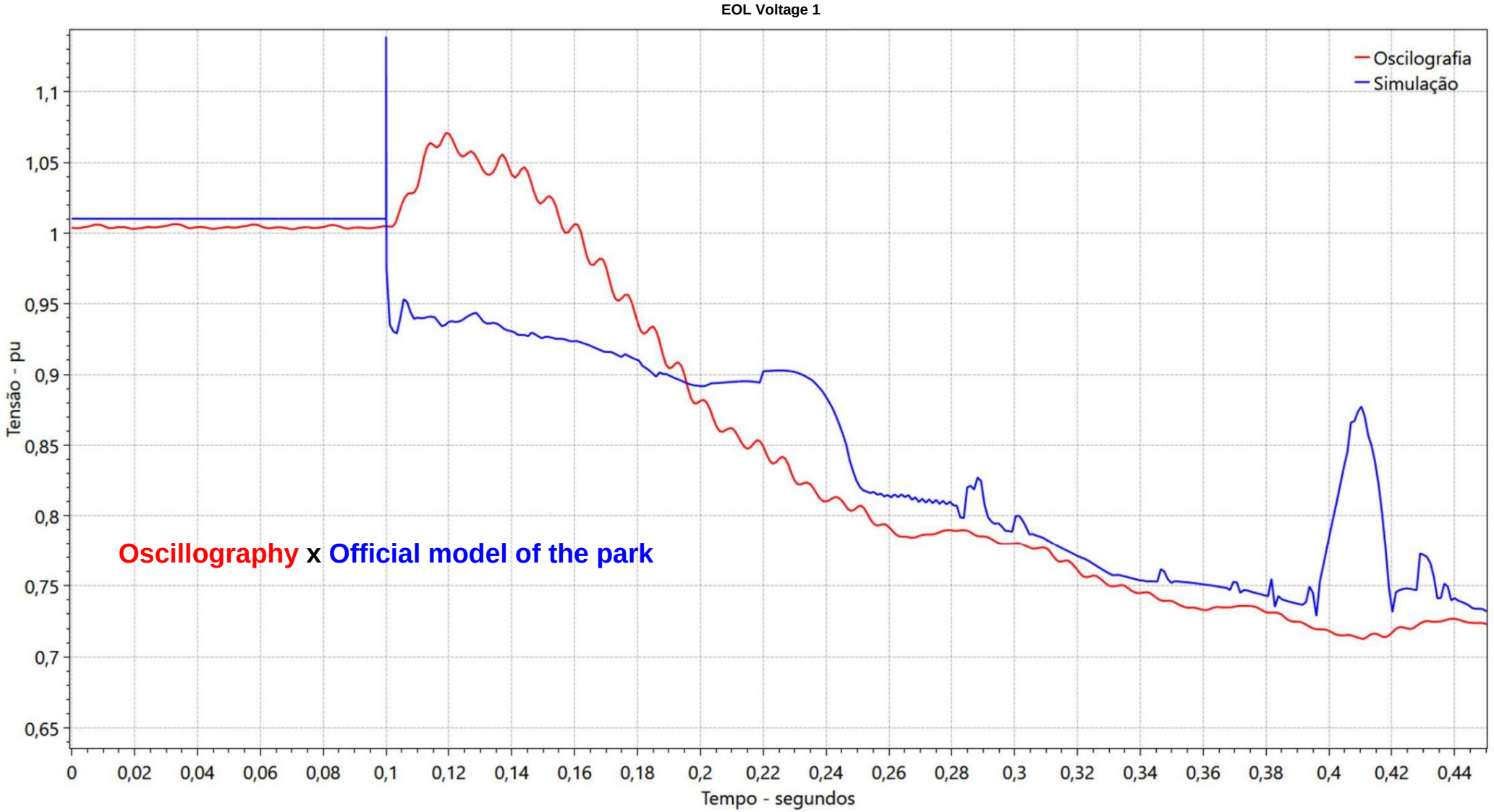
- **Simulation for comparison with oscillography records**
  - **The adjusted database was used as a reference, in view of its adherence to the field response of the voltage in SE 500 kV Açu III.**
  - **In each comparison below, a simulation was performed in Anatem with the base adjusted, replacing only the model under analysis by the model of the official base, with the objective of evaluating its performance against the condi of the event, using oscillography data as a reference.**

Official Base x PMU Register x Adjusted Electromechanical Transients Database

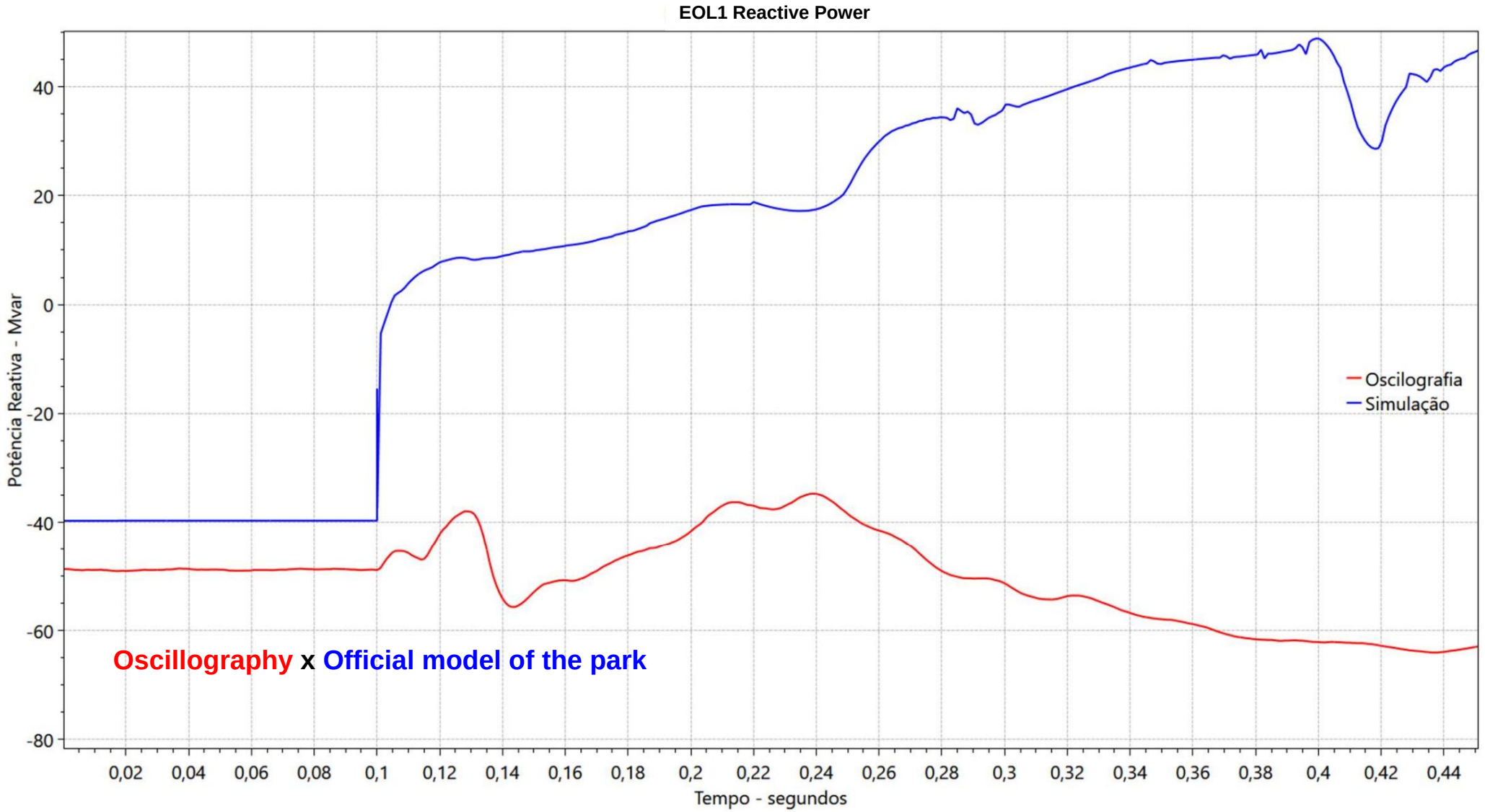


Official database x PMU registration x Adjusted database

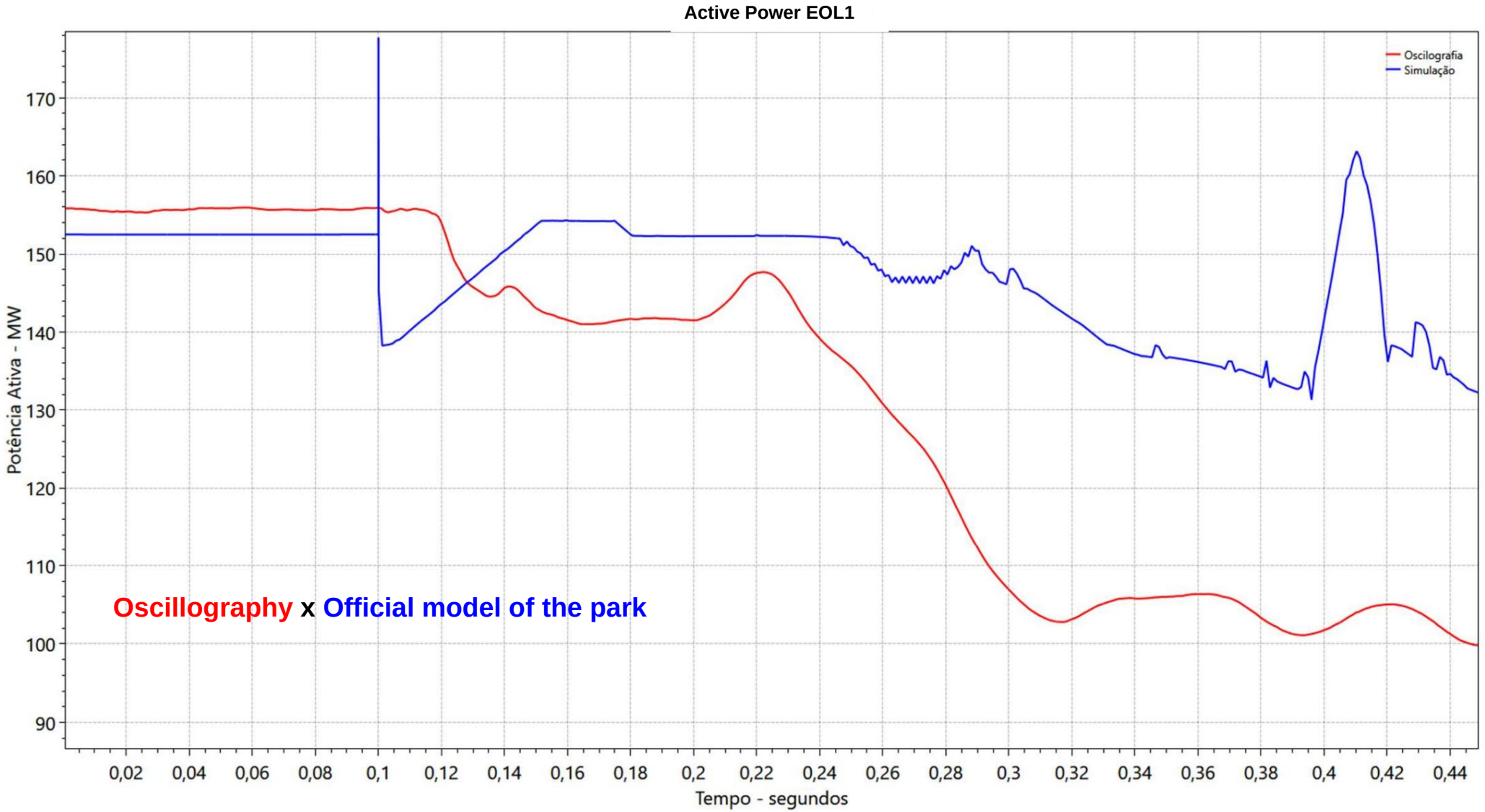
Comparison simulation between official database models and field response



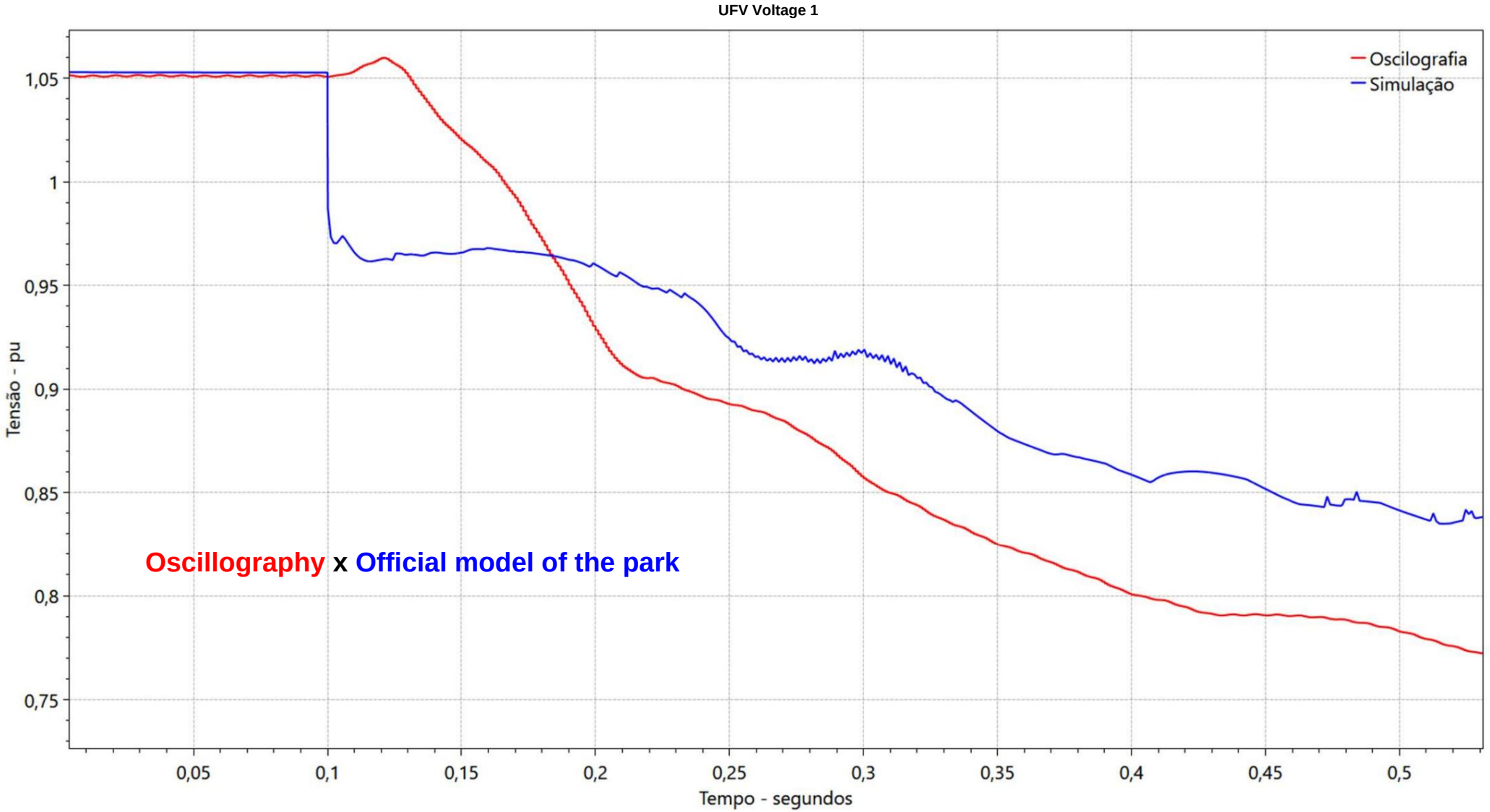
Comparison simulation between official database models and field response



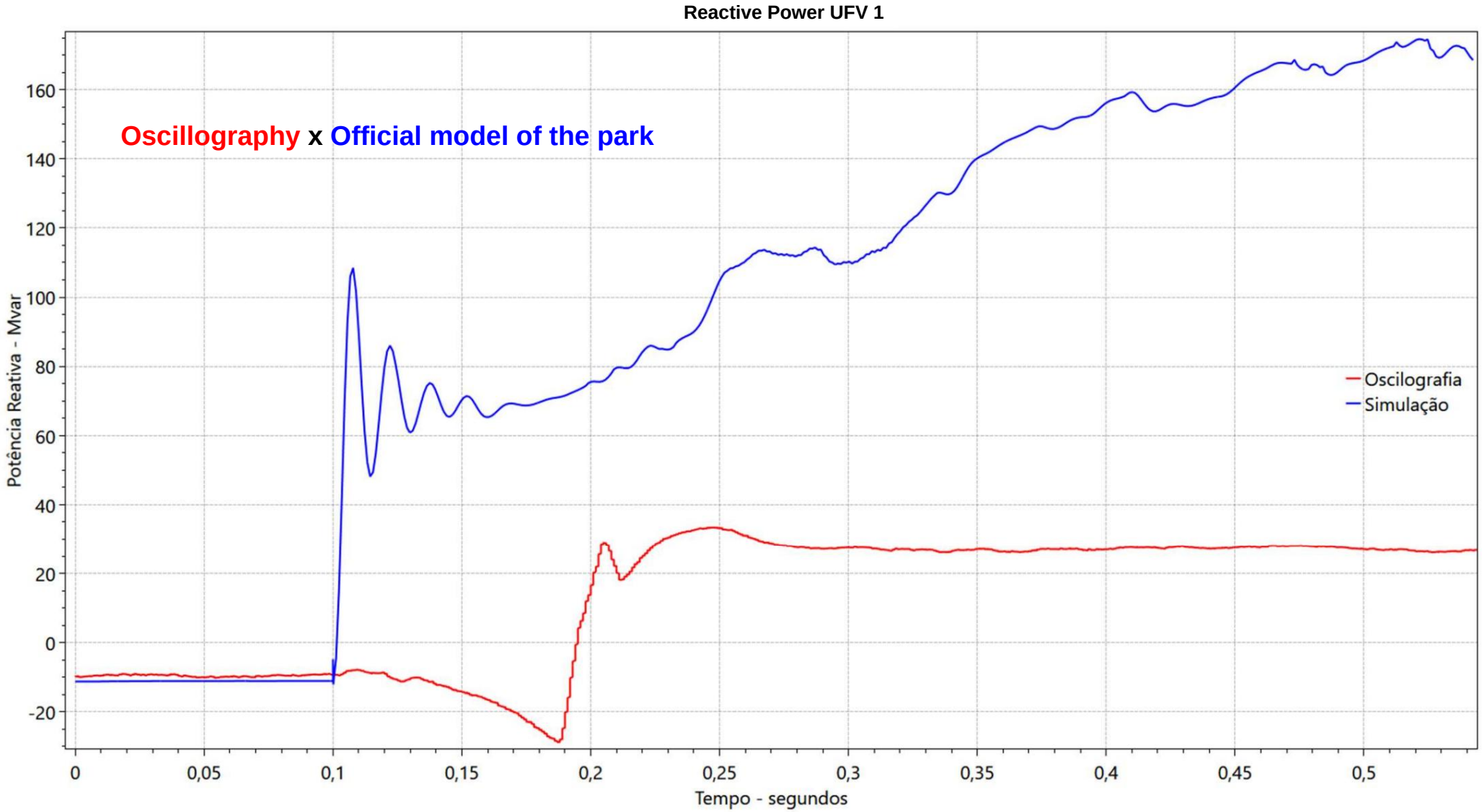
Comparison simulation between official database models and field response



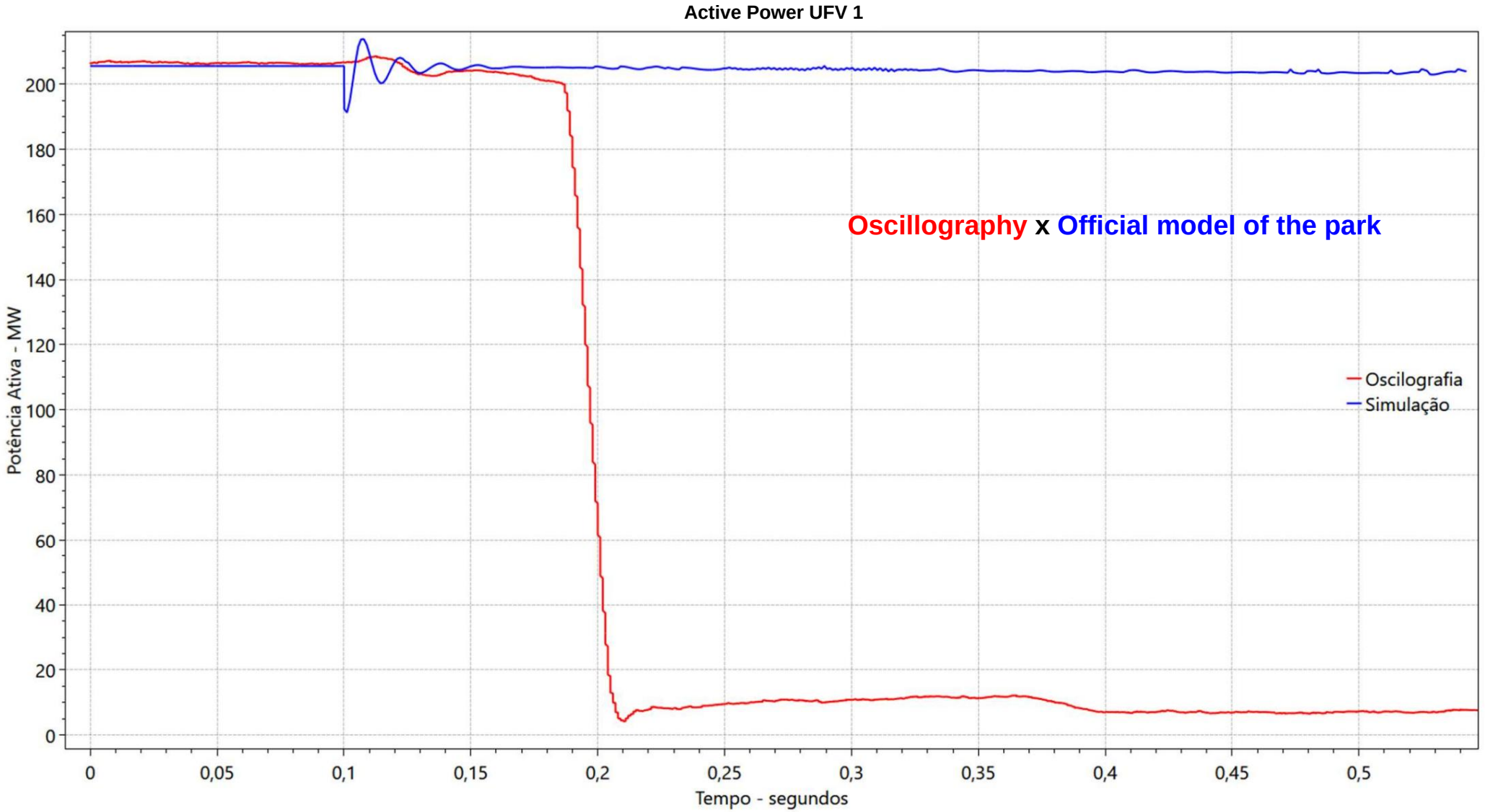
Comparison simulation between official database models and field response



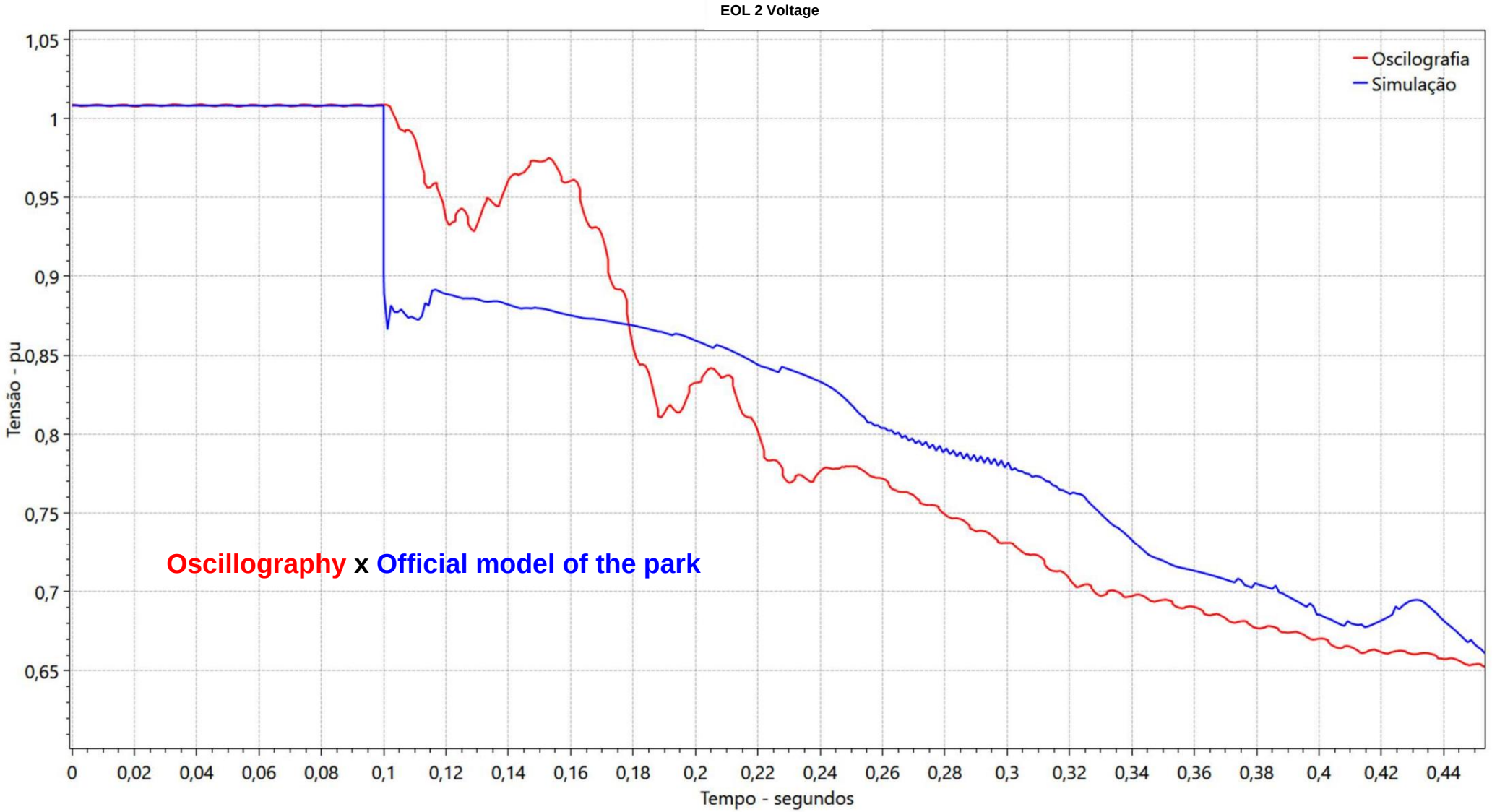
Comparison simulation between official database models and field response



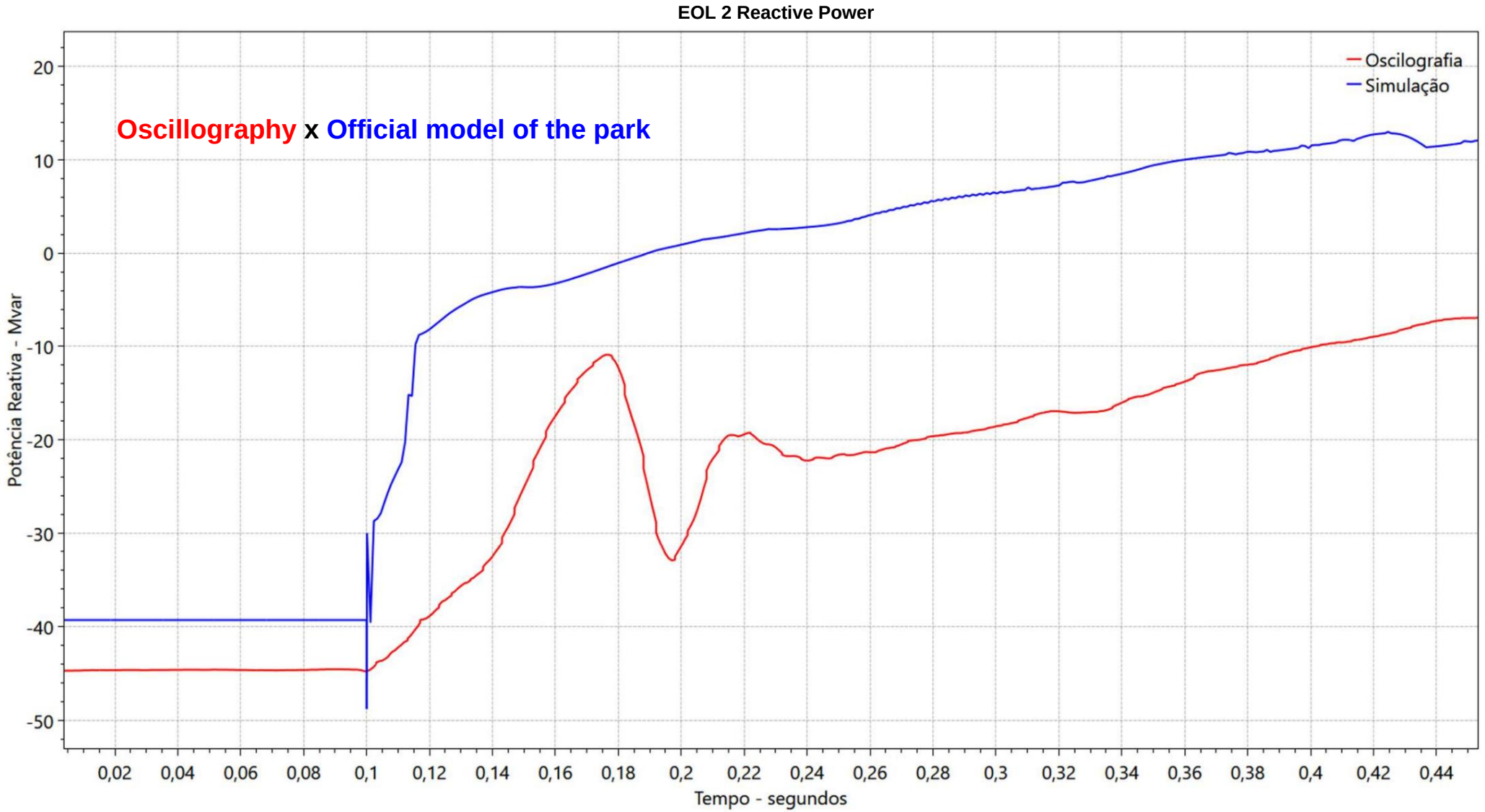
Comparison simulation between official database models and field response



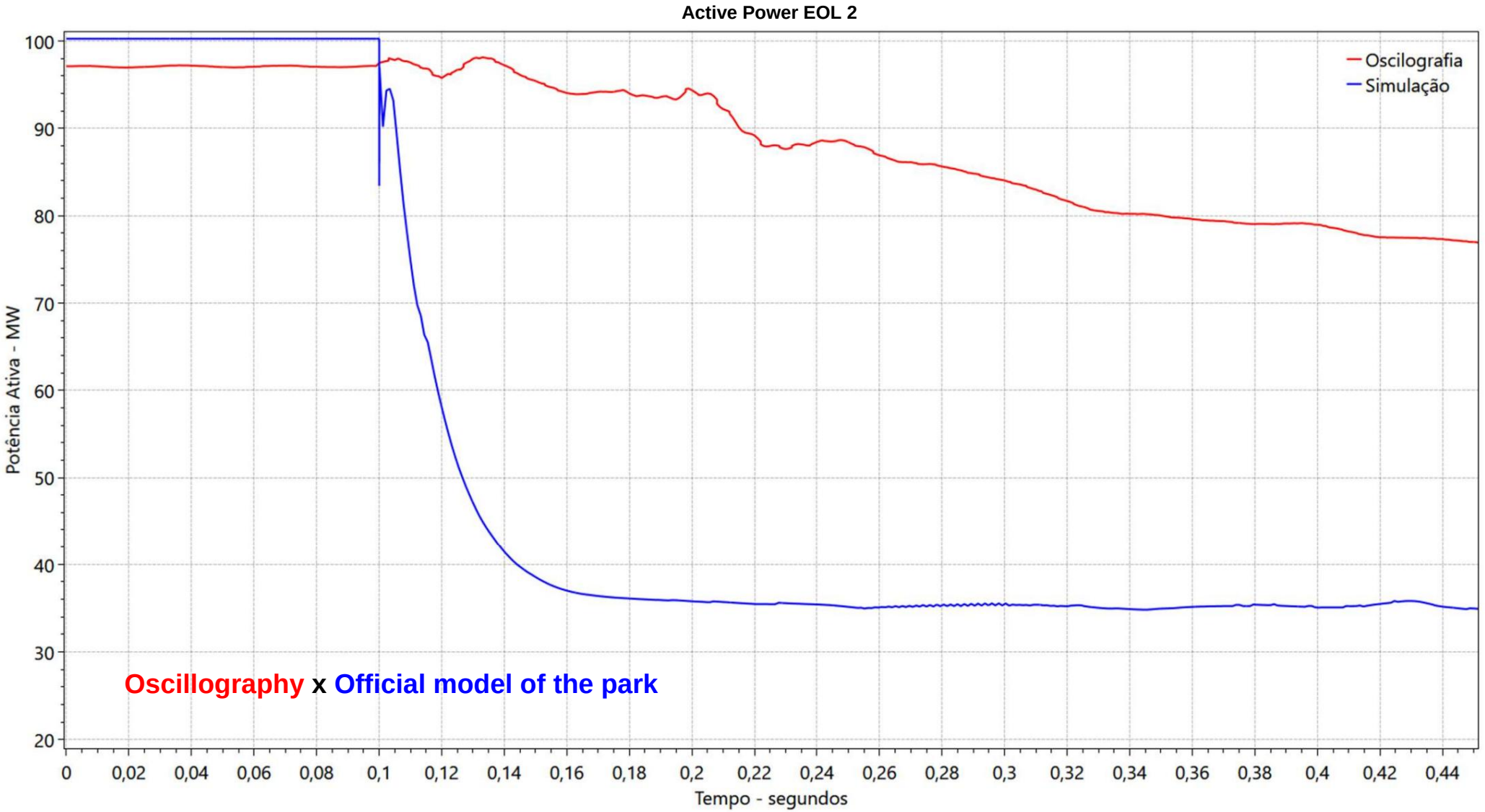
Comparison simulation between official database models and field response



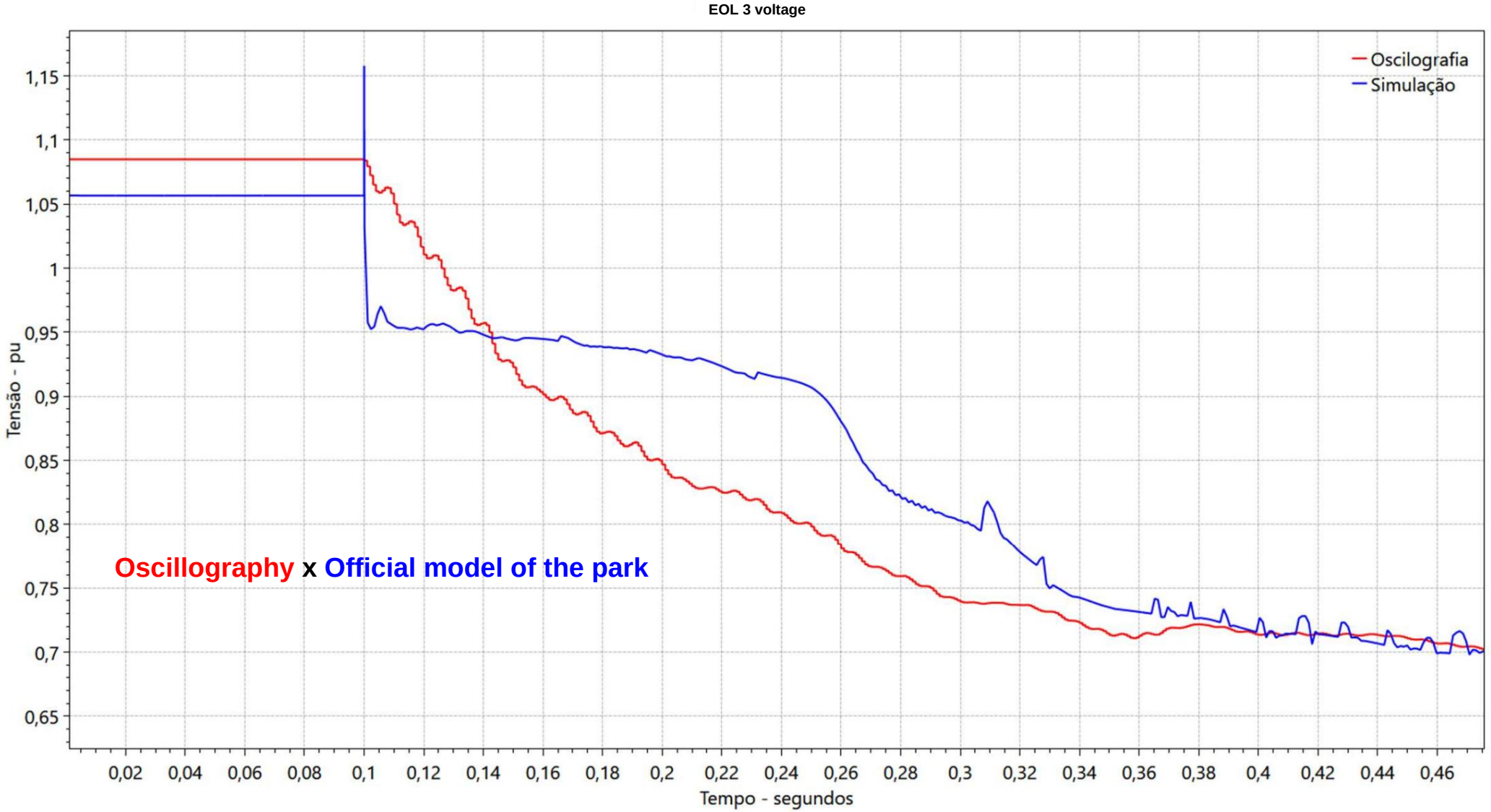
Comparison simulation between official database models and field response



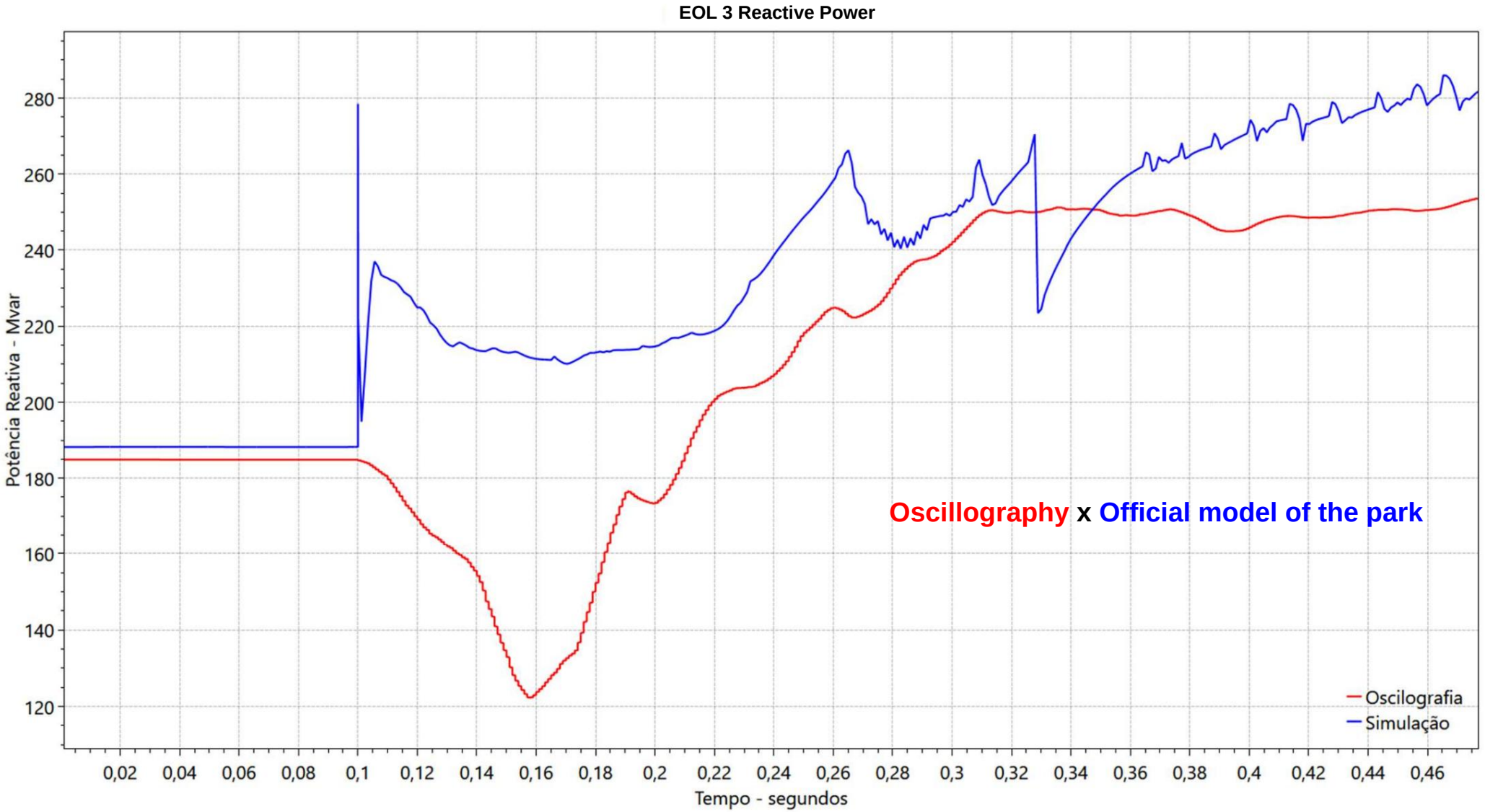
Comparison simulation between official database models and field response



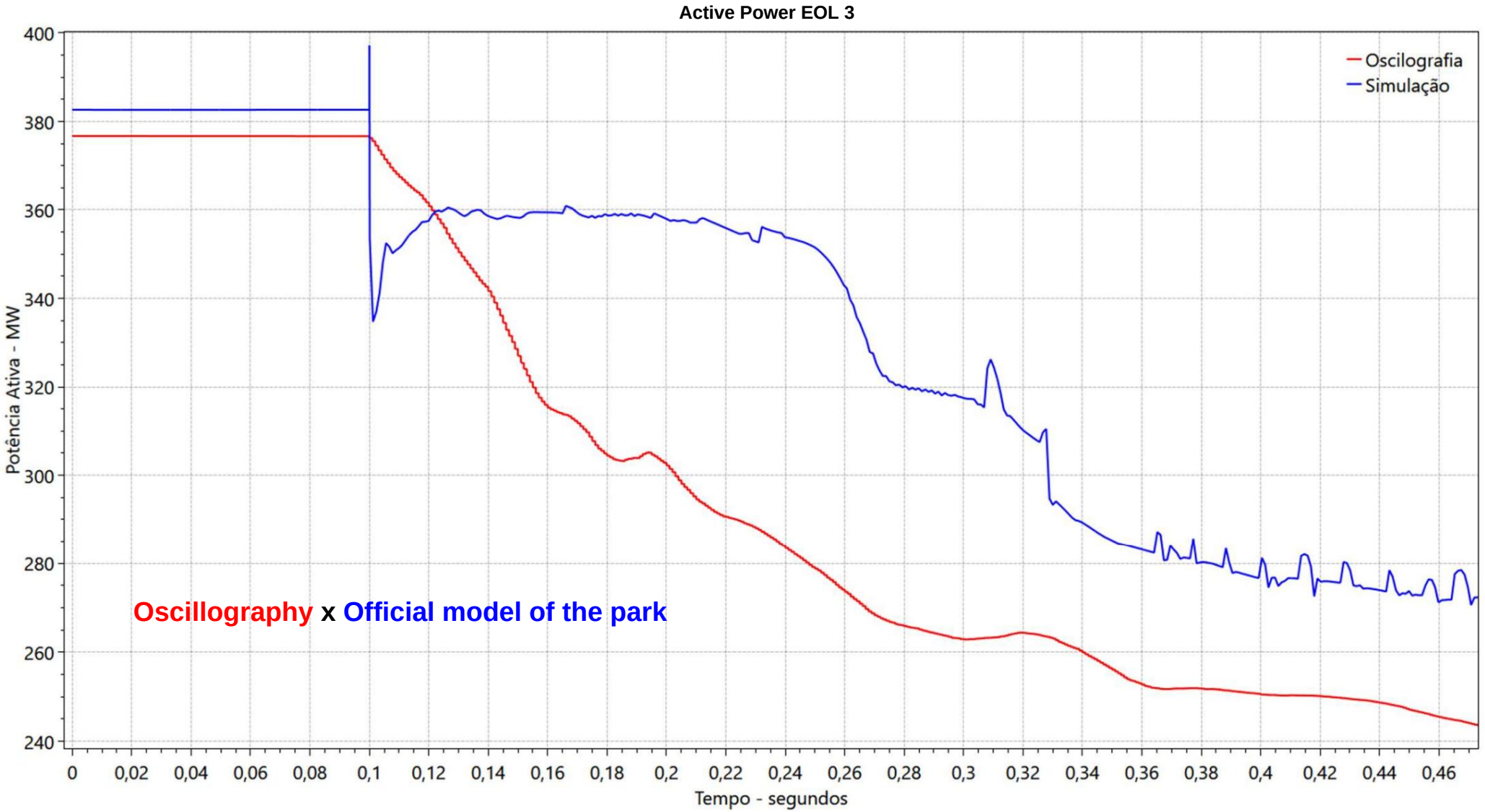
Comparison simulation between official database models and field response



Comparison simulation between official database models and field response



Comparison simulation between official database models and field response

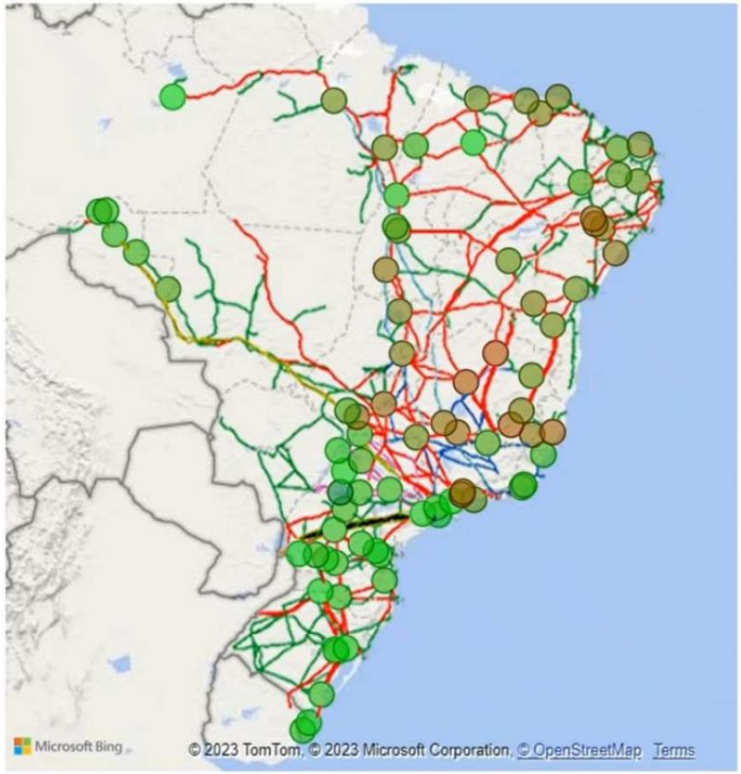


SIN Voltages and Frequencies Visualized from the Phasor Measurement System

Operador Nacional do Sistema Elétrico

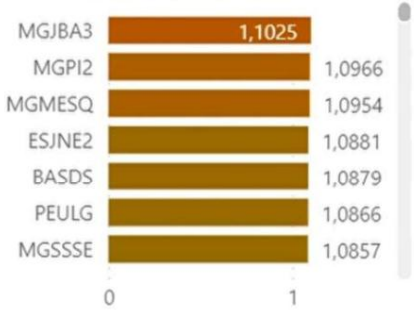
Tempo (s): -0,100 **Data/Hora:** 15/08/2023T08:30:36,833

Tensões (pu)



Menores Tensões

Maiores Tensões



Frequências (Hz)

Menores Frequências

Maiores Frequências

Main Preliminary Findings

- The opening of the LT 500 kV Quixadá - Fortaleza II was caused by the incorrect operation of the fault closing protection (Switch Onto Fault - SOTF) during normal line operation. It was also observed the improper performance of its scheme automatic reclosing.

- The opening of the LT 500 kV Quixadá - Fortaleza II caused a significant reduction of tension in the system, resulting in the opening o LT 500 kV Presidente Dutra – Boa Esperança for actuating the out-of-sync protection (PPS), which also commands the opening of the LT 500 kV Presidente Dutra – Teresina II C1 and C2 and LT 500 kV Presidente Dutra – Imperatriz C2 lines.

- The voltage reduction observed after the opening of the LT 500 kV Quixadá - Fortaleza II was not verified in the simulations carried out by the ONS to reproduce the disturbance of 08/15/2023, using the real-time steady state case and the official electromechanical transient database, based on information provided by agents.

- In all studies carried out by ONS to define guidelines for the operation of the system, which include opening of LT 500kV Quixadá - Fortaleza II, no voltage reduction was observed that violates the criteria established in Network Procedures and, therefore, any situation that resembles the occurrence of 08/15/2023.

- After the PPS action, there was a cascade shutdown of system equipment, leading to a blackout in the North region and the partial disconnection of loads from the Northeast region.

- After the separation of the North and Northeast by action of the protection systems, the performance of the Regional Scheme was ob of Load Relief (ERAC) in order to recover the balance between load and generation, reducing load shedding in the South, Southeast and Midwest, energy importers at that time.

Main Preliminary Findings

- Given the scope and complexity of this nuisance, the ONS requested and received a significant amount of oscillographic records, which made it possible to identify signs that the generation sources close to the area of interest did not perform as expected with regard to voltage control.
- The most consistent line of investigation points to this performance below expectations as a second event that triggered the entire subsequent transmission line shutdown process. the ONS was able to satisfactorily reproduce the disturbance by changing the transient database electromechanical, highlighting a possible difference between the behavior of equipment controls effectively implemented in the field and the performance of the mathematical models made available to the ONS.
- It is based on exhaustive simulations that ONS identifies safe regions of operation and determines the generation of the various energy sources that make up the SIN to supply the load, ensuring compliance with the performance standards set out in the Grid Procedures, particularly the criterion that Simple contingencies in the electrical network must not cause loads to be cut.
- In order for the ONS to guarantee safe operation 24 hours a day, 7 days a week, it is imperative that dynamic models in the database faithfully represent the performance of implemented controls in the field of all plants with a direct relationship with the Operator.
- Given the scope and complexity of this disorder, the ONS continues to deepen the analyzes of the disturbance to a final conclusion.

Operador Nacional do Sistema Elétrico

END

Disturbance on 08/15/2023 at 8:30 am involving the N/SE, N/NE and SE/NE interconnections

Analysis of the restoration process

RAP meeting - 08/25/2023

Agenda

1. Post-disorder initial situation

2. Main actions for system stabilization

3. Recomposition analysis: overview and by area

4. Main difficulties of the recomposition process

Pre-disturbance situation: 08:30

Data in MW

Solar generation and load without MMGD

North		
Generation	**Verified Scheduled** 2,493	2,514
Hydraulics		
Thermal	1.399	1.389
Wind	210	304
Solar	3	0
Total	4.104	4.207

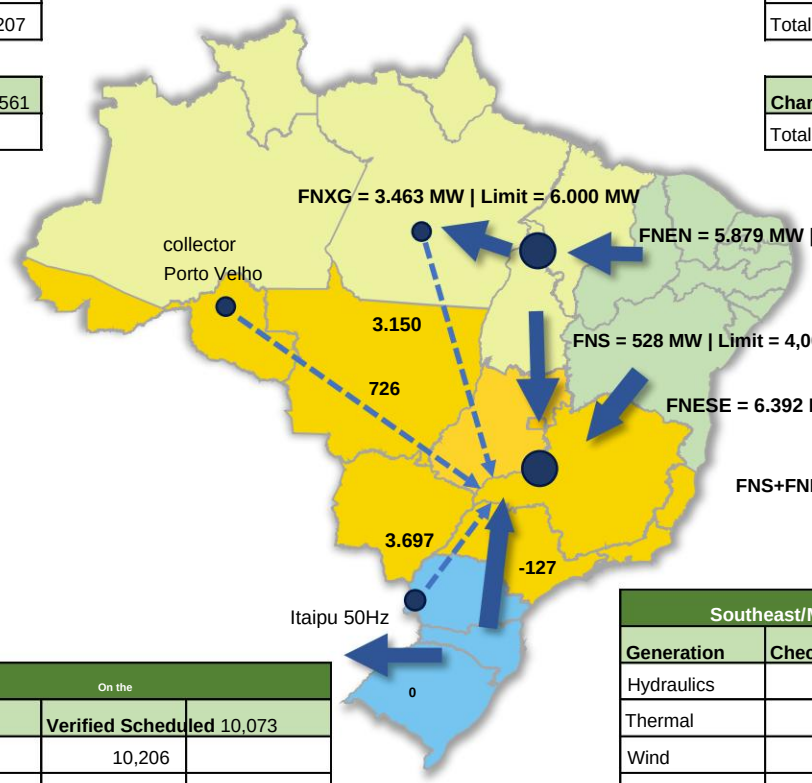
Charge	**Verified Scheduled** 6,588	6,561
Total		

Northeast		
Verified Scheduled Generation		
Hydraulics 2,459	2.539	
Thermal	387	449
Wind	16.317	16.745
Solar	3.211	3.681
Total	22.454	23.334

Charge	**Check Scheduled**	
Total	10.151	10.242

SIN		
Generation	**Check Scheduled**	
Hydraulics	35.284	35.267
Thermal	9.698	9.829
Wind	16.748	17.256
Solar	5.777	6.124
Total	67.508	68.476

Charge	**Check Scheduled**	
Total	67.507	68.200



On the		
Generation	**Verified Scheduled** 10,073	
Hydraulics	10,206	
Thermal	1.468	1.486
Wind	218	204
Solar	2	2
Total	11.761	11.898

Charge	**Check Scheduled**	
Total	11.887	12.232

Southeast/Midwest		
Generation	**Check Scheduled**	
Hydraulics	20.180	20.088
Thermal	6.445	6.505
Wind	3	3
Solar	2.562	2.441
Total	29.189	29.037

Charge	**Check Scheduled**	
Total	38.882	39.165

AC flow

DC flux

Post-occurrence situation: 08:40

Data in MW

Solar generation and load without MMGD

North		
Generation	**Verified Scheduled** 0 2,514	
Hydraulics		
Thermal	0	1.389
Wind	0	304
Solar	0	0
Total	0	4.207

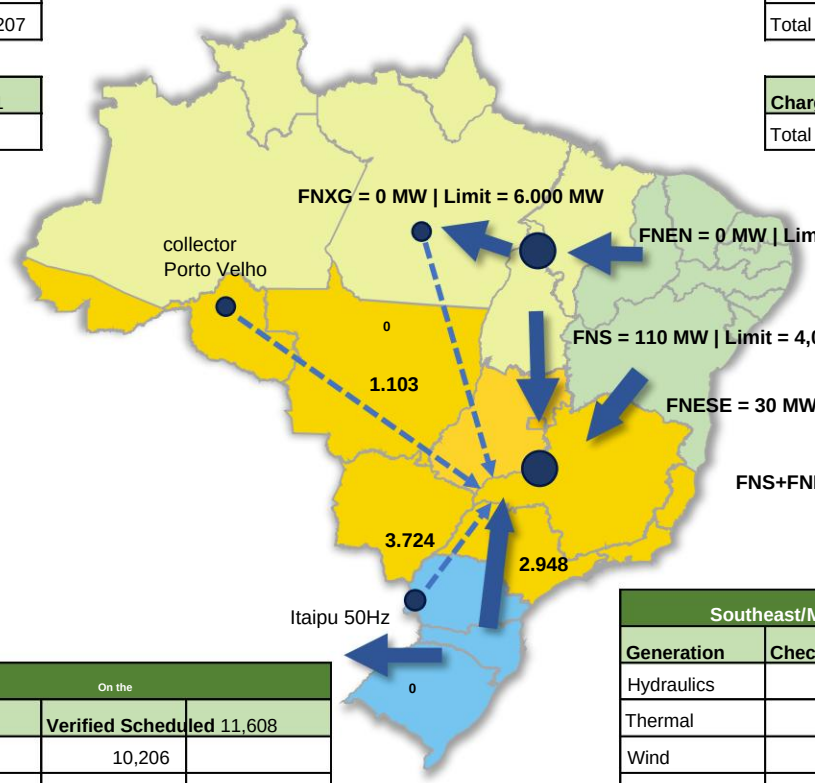
Charge	**Verified Scheduled** 30 6,561	
Total		

Northeast		
Verified Scheduled Generation		
Hydraulics 2,459	750	
Thermal	117	449
Wind	2.983	16.745
Solar	515	3.681
Total	4.365	23.334

Charge	**Check Scheduled**	
Total	4.335	10.242

SIN		
Generation	**Check Scheduled**	
Hydraulics	33.601	35.267
Thermal	6.910	9.829
Wind	3.172	17.256
Solar	1.949	6.124
Total	45.632	68.476

Charge	**Check Scheduled**	
Total	45.482	68.200



On the		
Generation	**Verified Scheduled** 11,608	
Hydraulics	10,206	
Thermal	1.115	1.486
Wind	186	204
Solar	3	2
Total	12.912	11.898

Charge	**Check Scheduled**	
Total	9.965	12.232

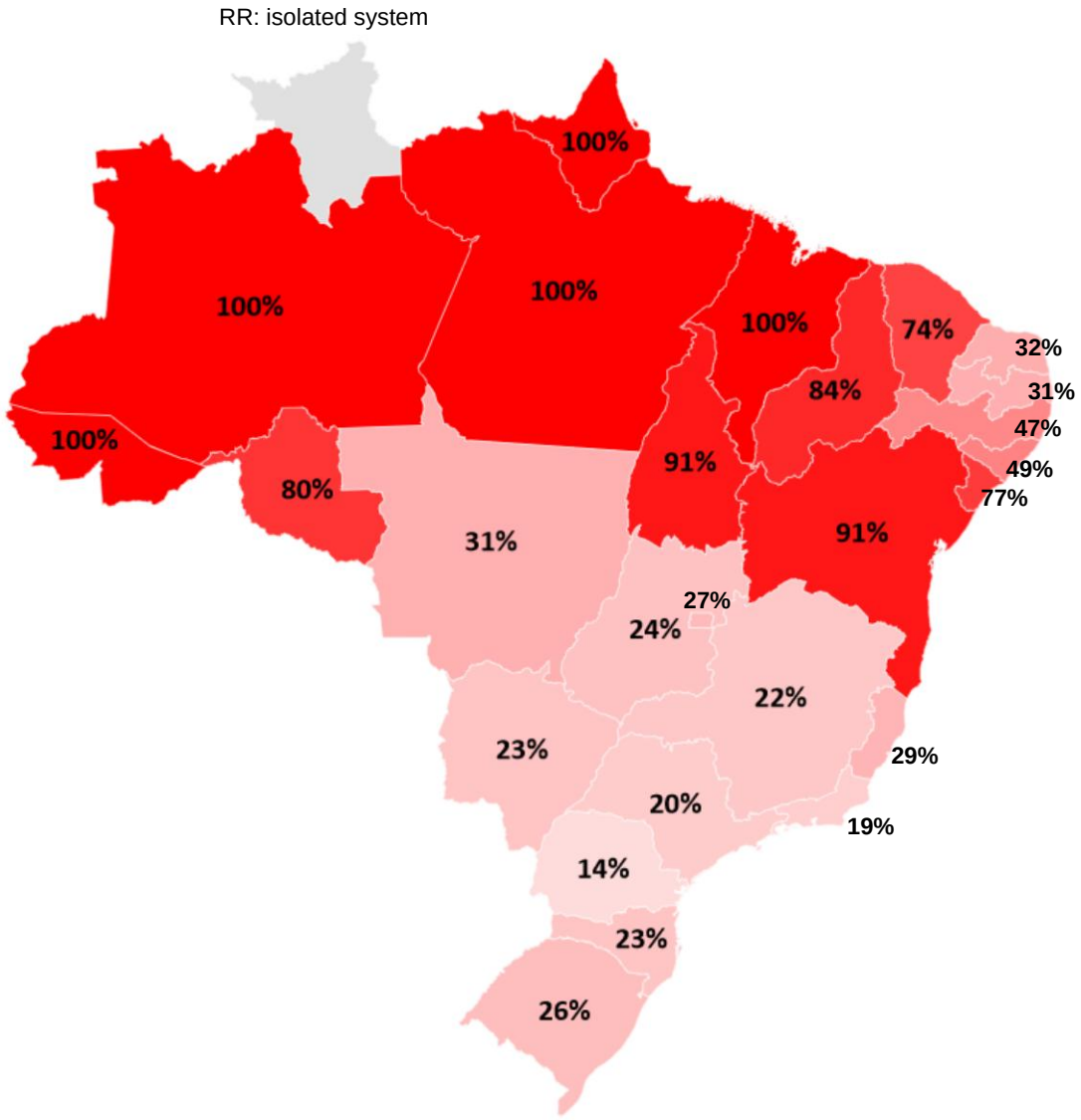
Southeast/Midwest		
Generation	**Check Scheduled**	
Hydraulics	21.243	20.088
Thermal	5.677	6.505
Wind	3	3
Solar	1.431	2.441
Total	28.355	29.037

Charge	**Check Scheduled**	
Total	31.153	39.165

AC flow

DC flux

Load shedding by state



31% do SIN

99.5% of the North

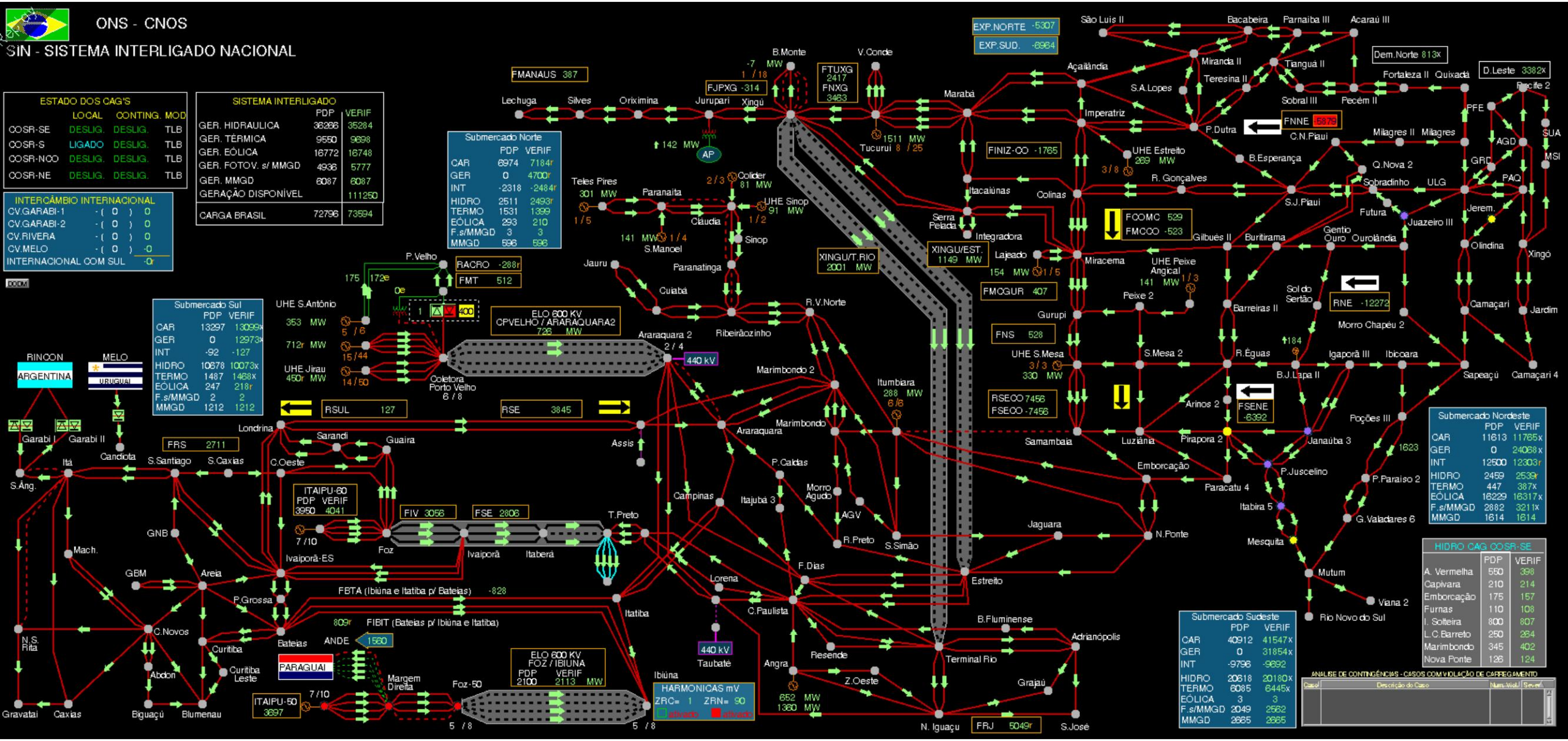
61% from the Northeast

20% from the

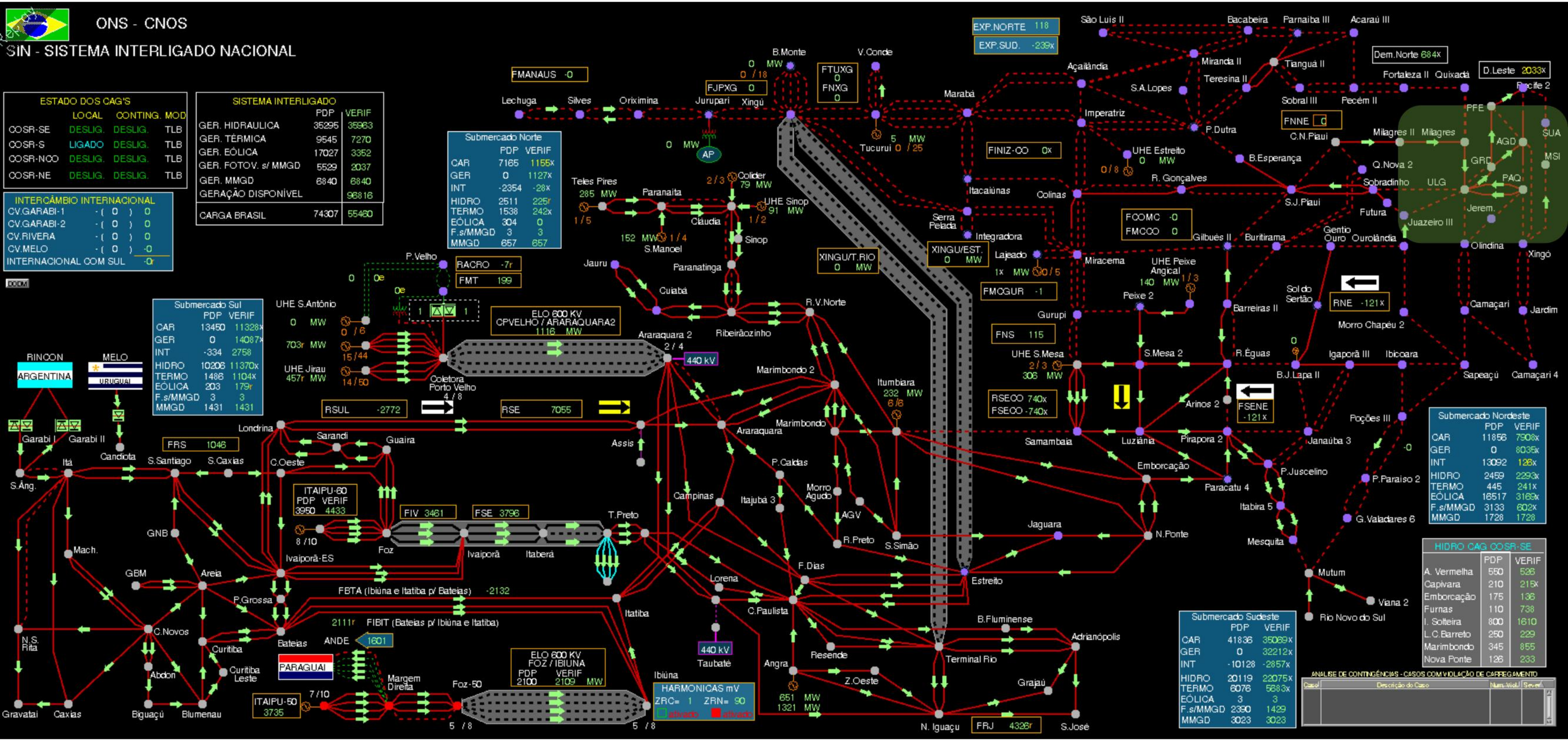
South **20%** from the Southeast/Midwest

Data provided by agents to prepare the BISE

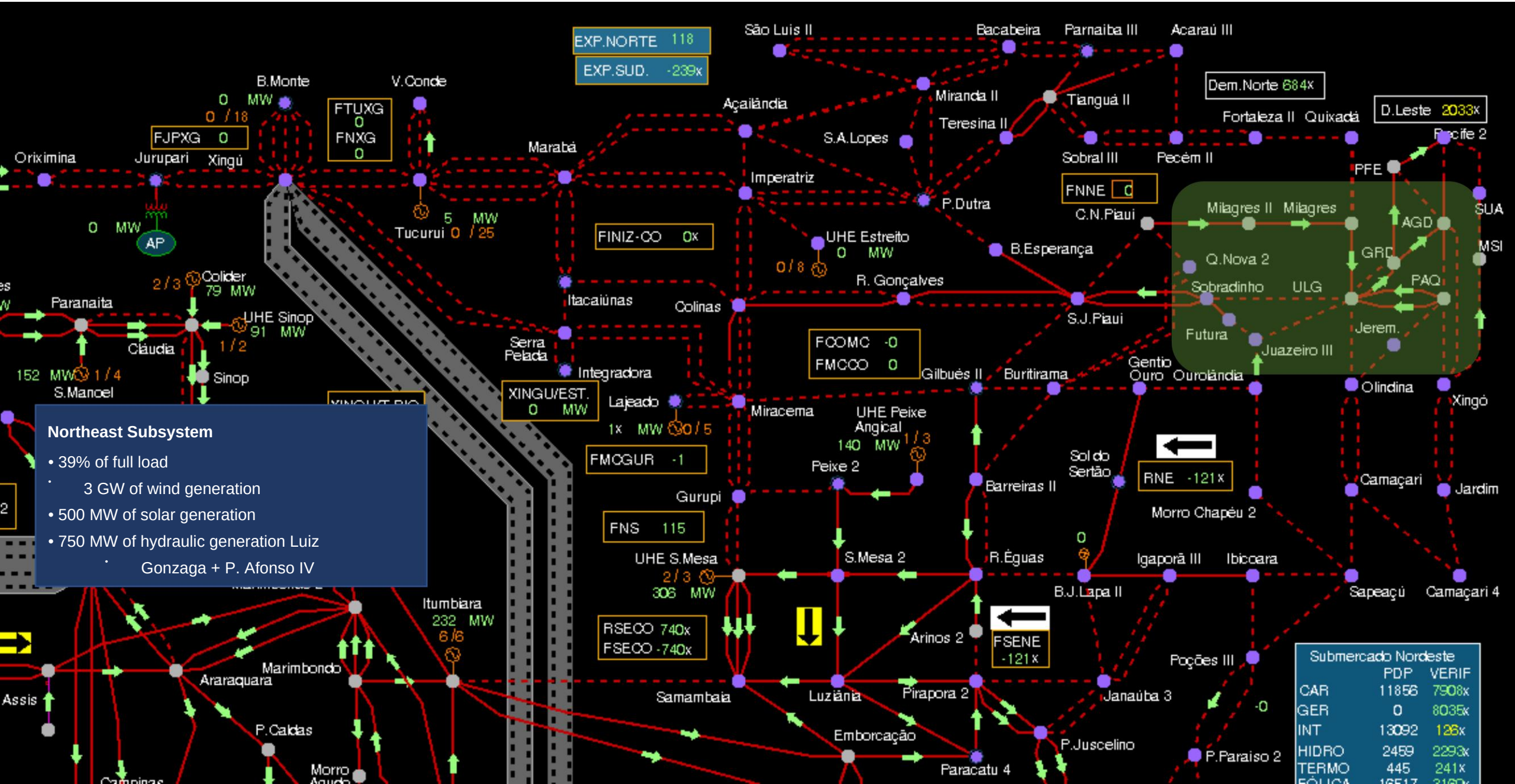
SIN Overview - Pre-disorder situation: 08:30 am



SIN Overview - Post-disturbance situation



SIN Overview - Post-disturbance situation



Post-occurrence control actions

1) In the Northeast:

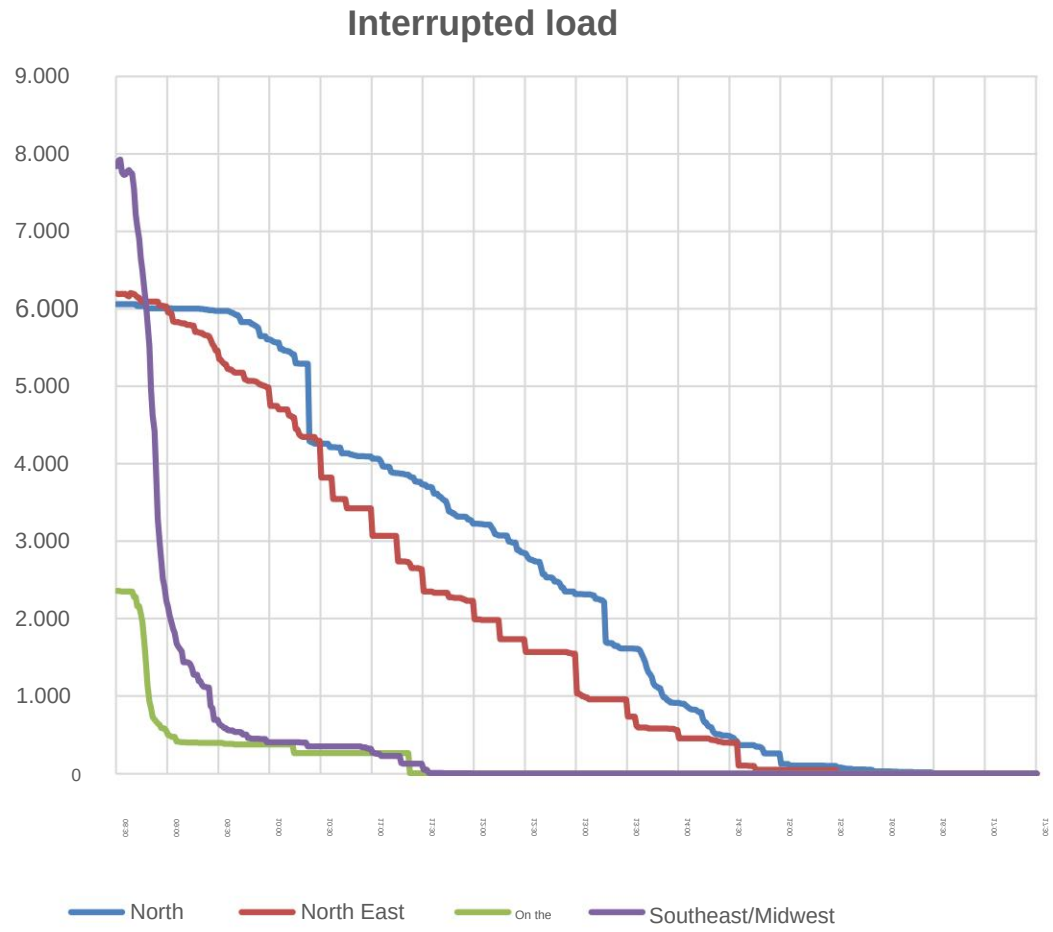
- Actions for voltage control.
- Limitation of wind and solar generation on the amount that remained synchronized after the occurrence.

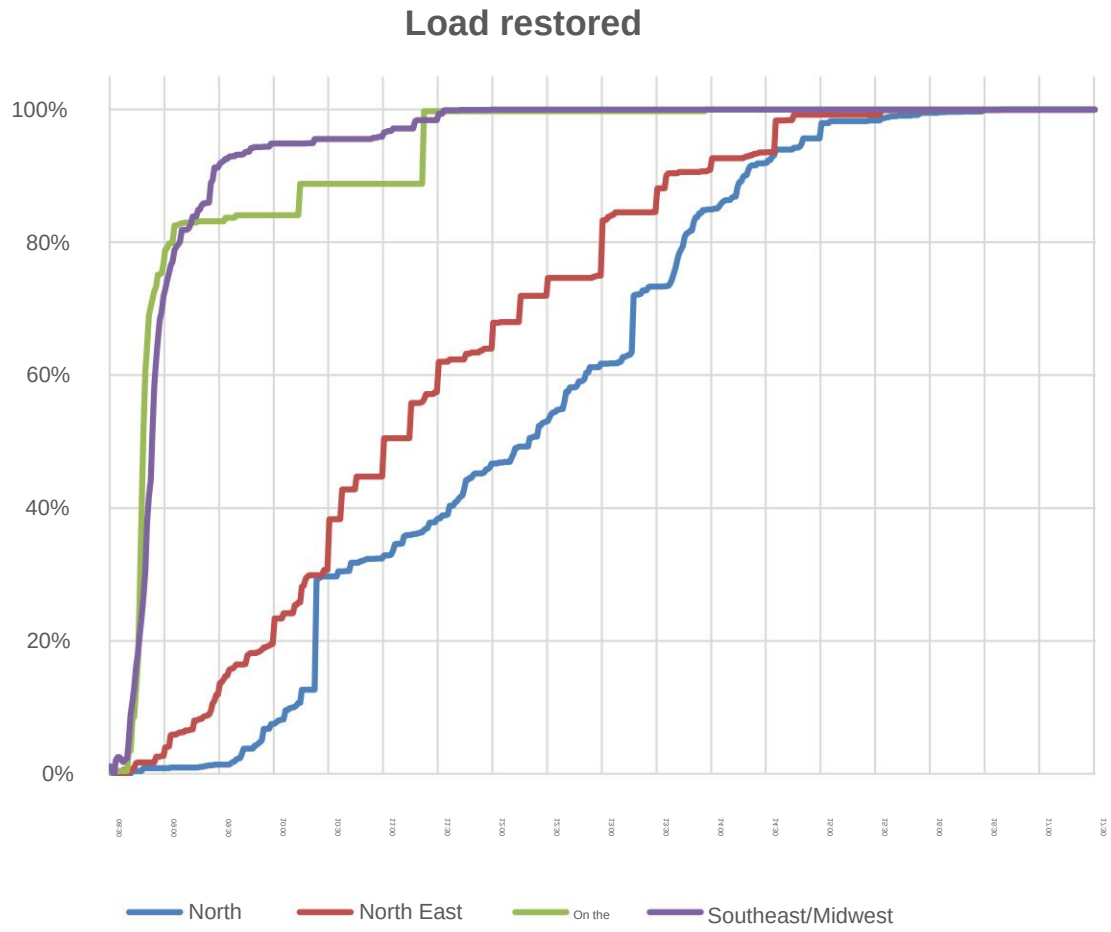
2) Well S/SE/CO

- Maximization of hydraulic generation in synchronized plants to restore load/generation balance.
- Actions for voltage control.

recomposition

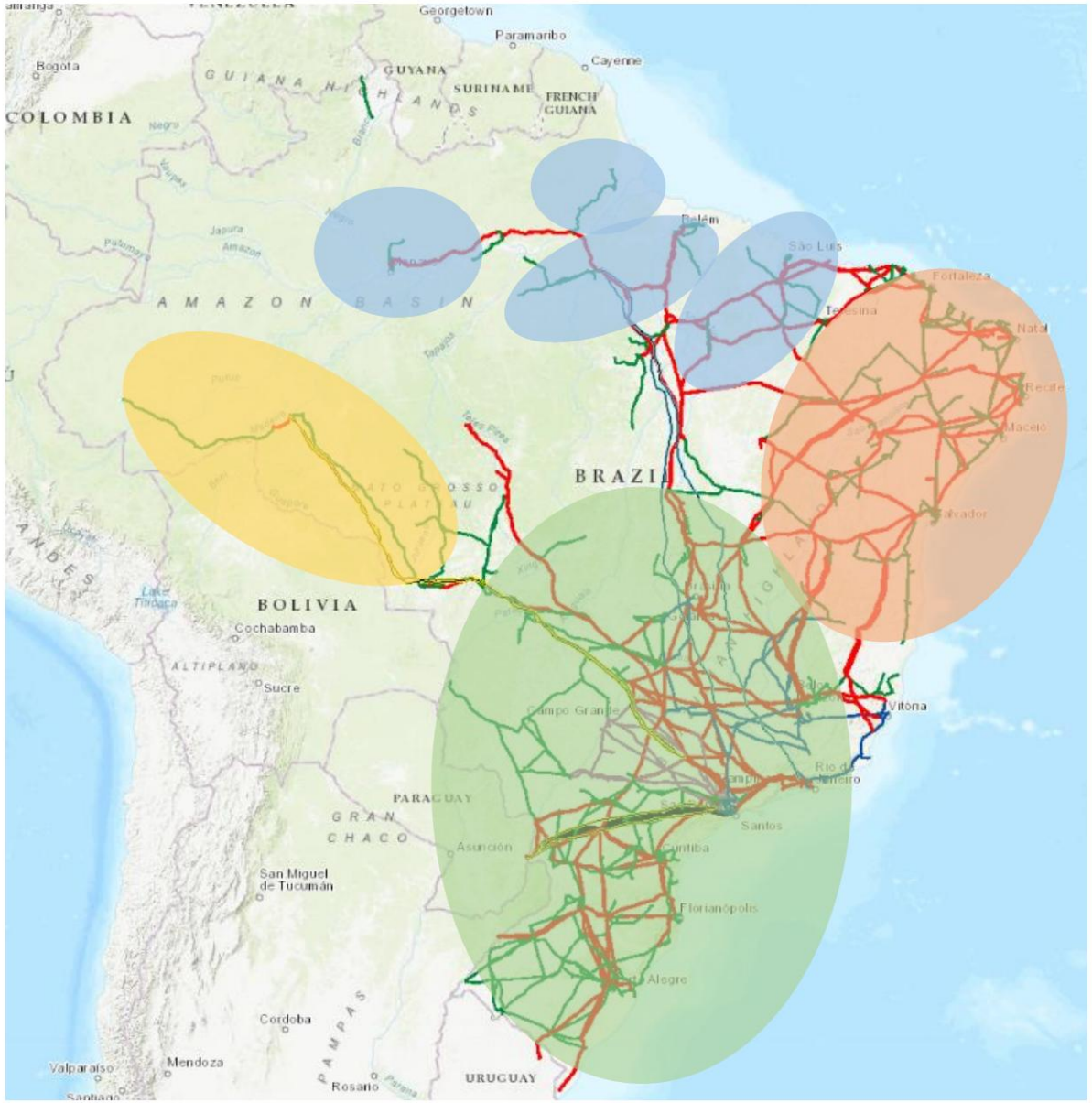
Evolution of recomposition





Data informed by the agents for the elaboration of the BISE

Evolution of recomposition

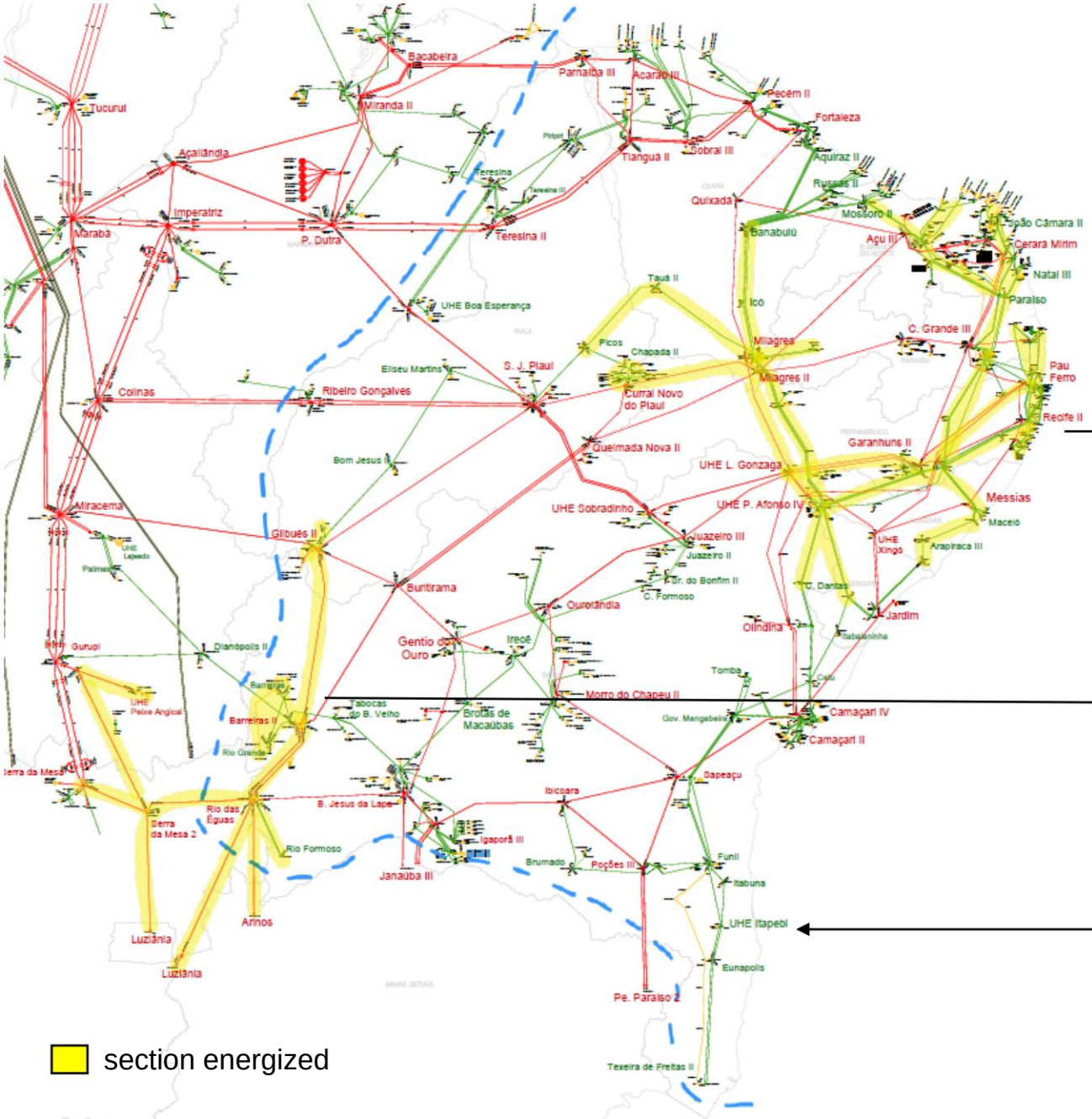


Equipment turned off

Subsystem	Transmission lines 156 202 0	transformers
N	12	199
NO	**370**	196
S		0
SE/CO		4
Total		**399**

Recomposition of the Northeast Subsystem

Configuration at 08:40 am - Start of recomposition



section energized

UHE Luiz Gonzaga
1 AND
188 MW

P. Afonso IV
2 AND
543 MW

Service Conditions – 08:40 am	
hydroelectric	750
Wind	2.983
photovoltaic	515
Thermal	116
FNESE – (NE -> SE)	30
FNEN – (NE -> N)	0
NE load	4.334

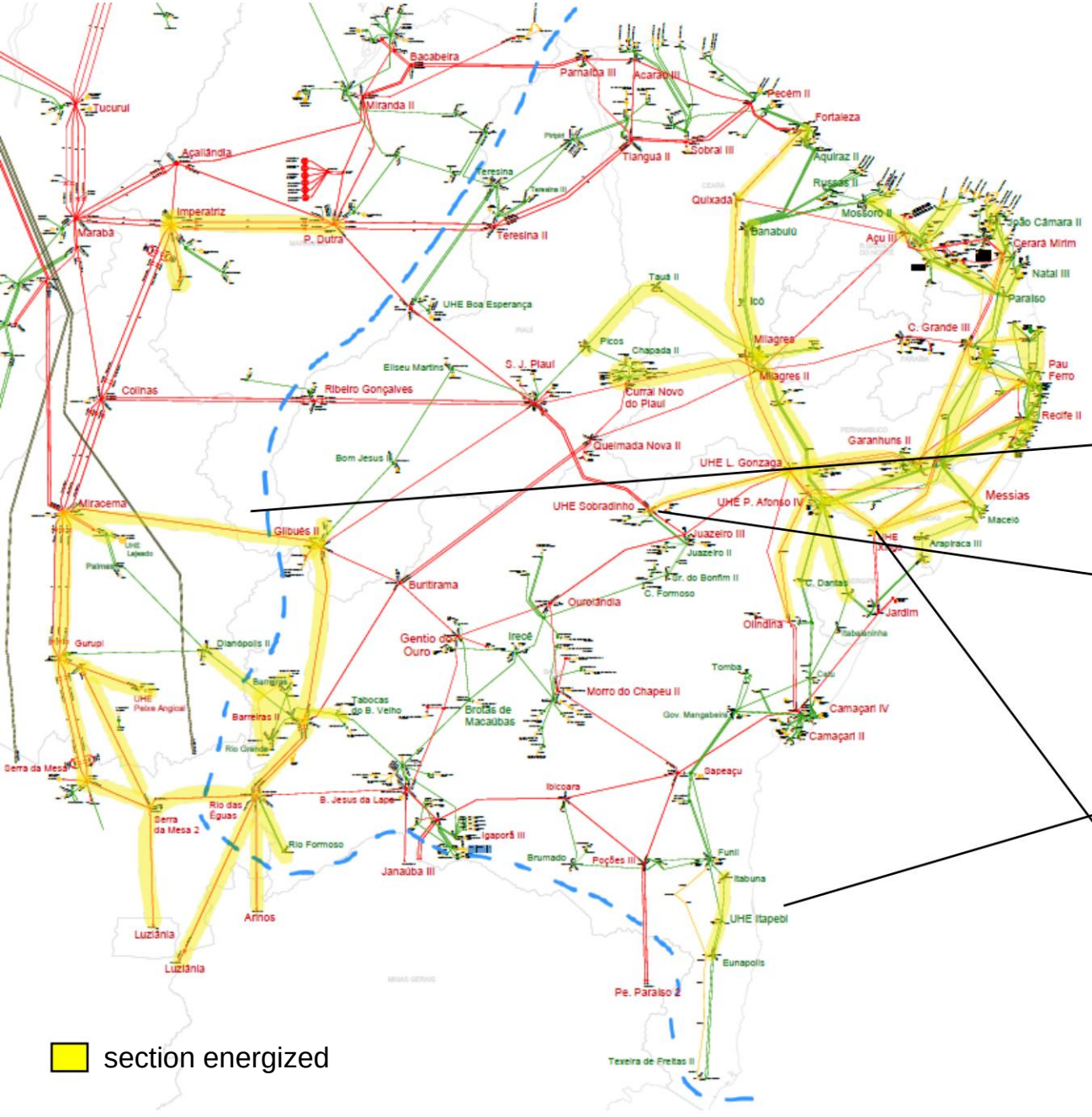
At 08:53, the ONS authorized the restoration of the interrupted load.

At 8:43 am, the 1st GU at UHE Itapebi was synchronized and the load taking started in the Itapebi Corridor.

At 9:22 am, the reestablishment of loads was authorized

Configuration at 09:41 – UHE Sobradinho energized

Service Conditions – 09:41	
hydroelectric	844
Wind	3.342
photovoltaic	686
Thermal	111
FNESE – (NE -> SE)	37
FNEN – (NE -> N)	-8
NE load	4.954



section energized

At 09:34, the LT 500 kV Miracema / Gilbués was turned on.

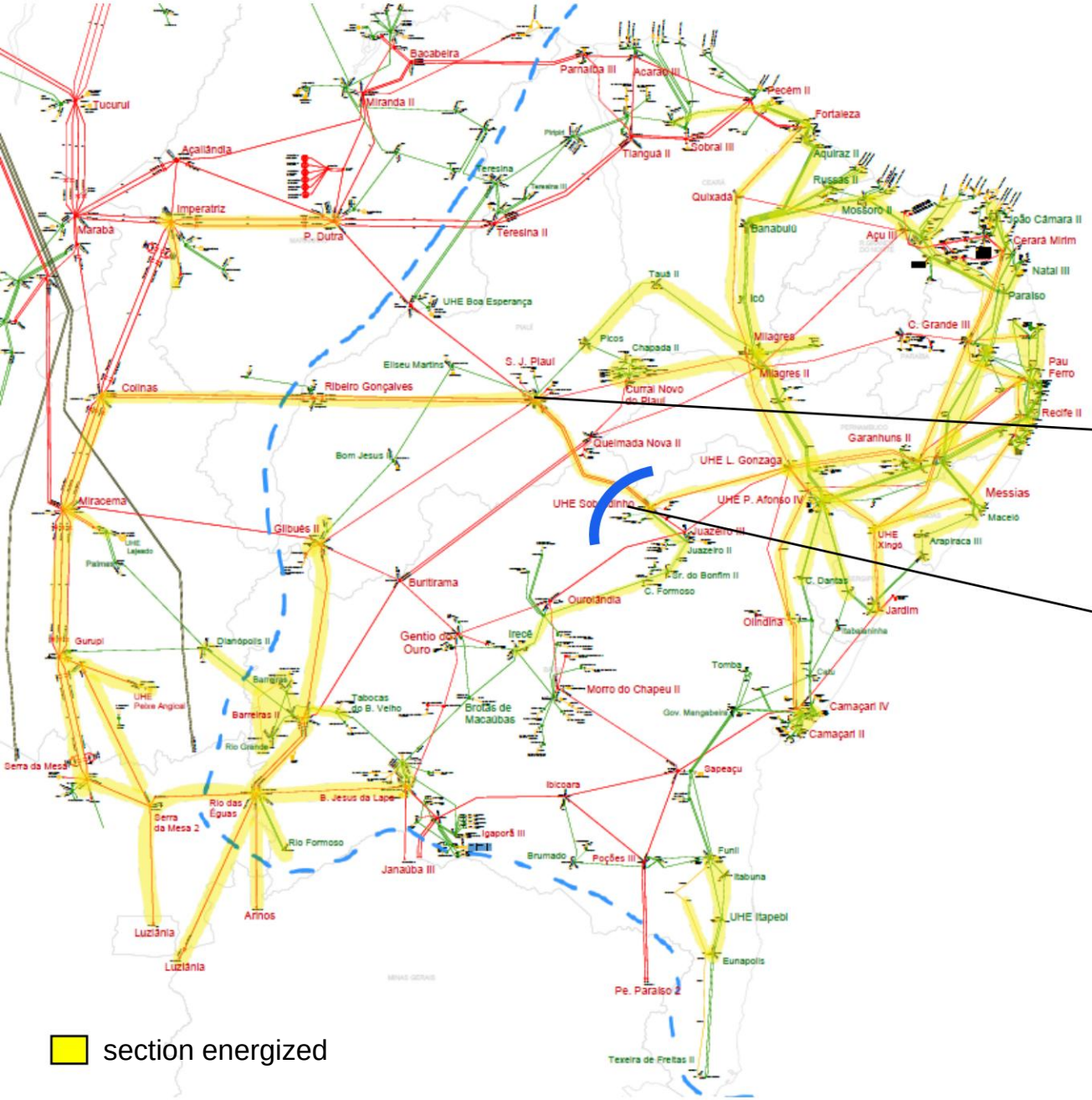
At 9:40 am, SE Sobradinho received voltage from SE Luiz Gonzaga.
Difficulty in self-healing at the UHE Sobradinho.

Às 09h41, syncronizada a 2ª UG na UHE Itapebi –
Difficulty synchronizing.

At 09:44, UHE Xingó integrated to the island through LT 500 kV Xingó / P. Afonso IV.

Configuration at 10:50 am – Northeast integrated to the SIN

Service Conditions – 10:50 am	
hydroelectric	2.536
Wind	3.060
photovoltaic	687
Thermal	110
FNESE – (NE -> SE)	185
FNEN – (NE -> N)	201
NE load	6.007



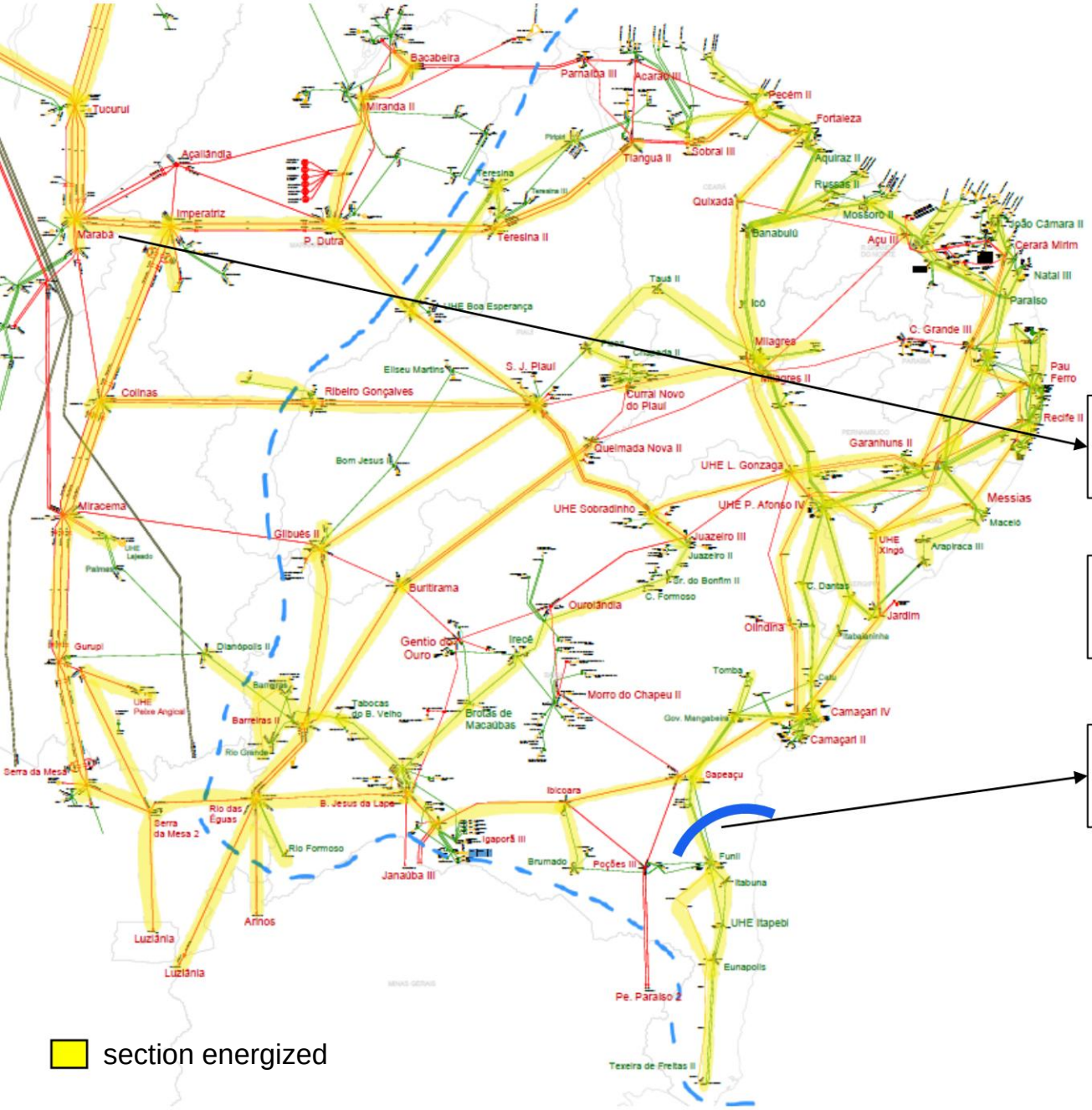
At 10:32 am, the SE São João do Piauí received voltage from the SIN through the SE Ribeiro Gonçalves.

At 10:49 am, parallel between the island of the Northeast area and the Southeast area through the LT 500 kV S. João do Piauí / Sobradinho, integrating the Northeast area to the SIN.

section energized

Configuration at 12:57 pm – Itapebi Corridor integrated into the SIN

Service Conditions – 12:57 pm	
hydroelectric	3.638
Wind	2.477
photovoltaic	792
Thermal	120
FNESE – (NE -> SE)	-499
FNEN – (NE -> N)	122
NE load	7.404



section energized

At 12:01 am, the LT 500 kV Imperatriz / Marabá C2 was turned on, integrating the North area to the SIN.

As of 12:12 pm, the release of EOL and UFV generation to service the load began .

At 12:56 pm, the LT 230 kV Santo Antônio de Jesus / Funil C2 was turned on, closing the Itapebi parallel with the SIN.

Configuration at 14:10 – Full load restoration released

section energized

Service Conditions – 2:10 pm	
hydroelectric	3.779
Wind	2.594
photovoltaic	1.275
Thermal	142
FNESE – (NE -> SE)	-1.726
FNEN – (NE -> N)	172
NE load	9.344

At 2:02 pm, the LT 500 kV Bacabeira / Paranaíba III was turned on, reinforcing the interconnection between the North and Northeast systems

At 2:10 pm, the ONS authorized the total restoration of loads (93% of loads in the Northeast area were restored).

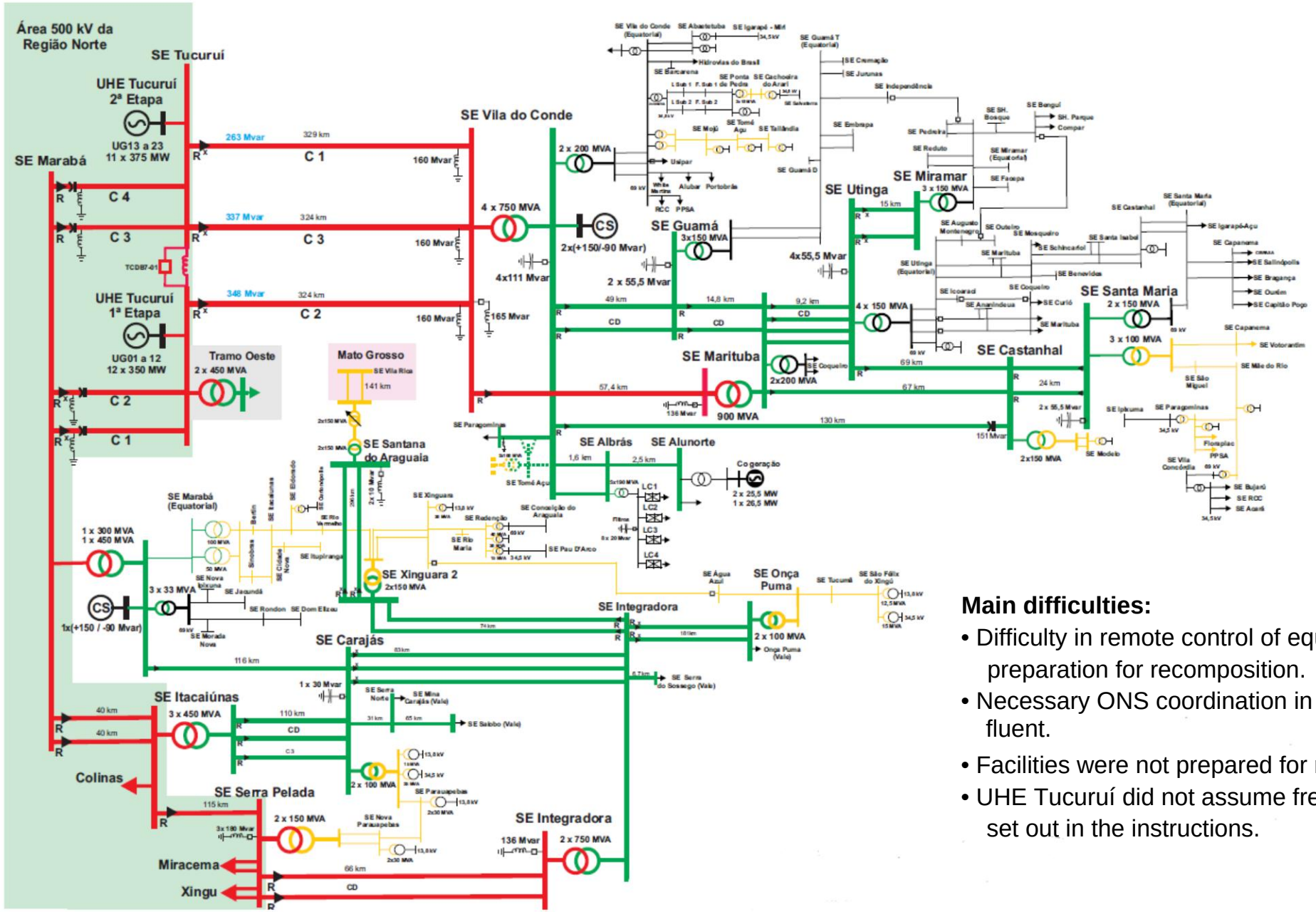
At 2:45 pm, the charges in the Northeast area were restored.

At 3:03 pm, LT 500 kV G. Valadares 6 / P. Paraíso C2 was switched on, reinforcing the Northeast / Southeast Interconnection.

Recomposition of the North Subsystem

Tucuruí / Pará Area

1st GU connected to UHE Tucuruí	09h11
4th UG connected to HPP Tucuruí	09h41
Home charging socket	10h26
Conclusion charging socket	14h33
Parallel	12h01

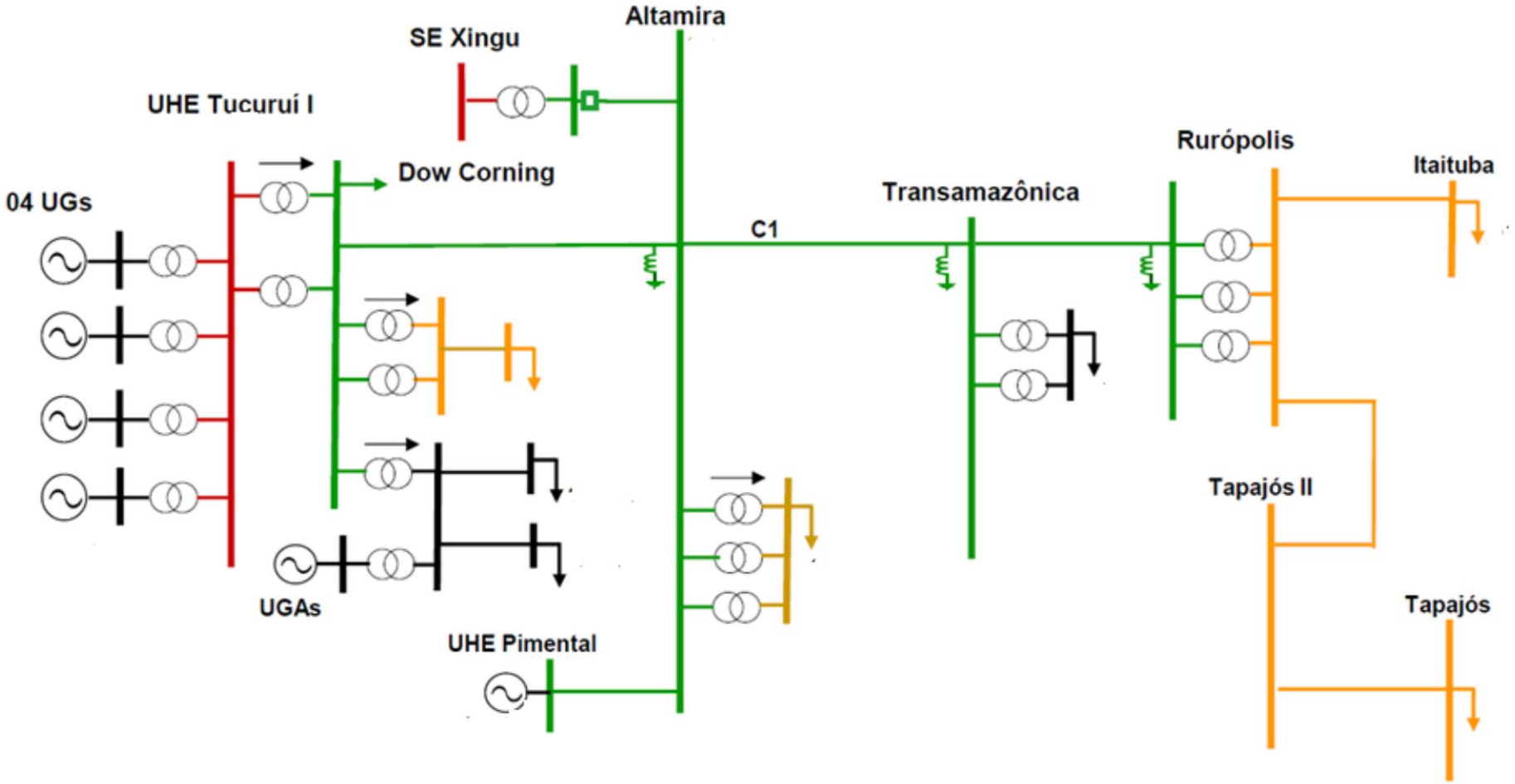


Main difficulties:

- Difficulty in remote control of equipment, compromising the preparation for recomposition.
- Necessary ONS coordination in practically the entire phase fluent.
- Facilities were not prepared for rebuilding.
- UHE Tucuruí did not assume frequency control, as per set out in the instructions.

Tucuruí Area / West Section

1st GU connected to UHE Tucuruí	09h11
4th GU connected to UHE Tucuruí	09h41
Home charging socket	10h35
Conclusion charging socket	13h42

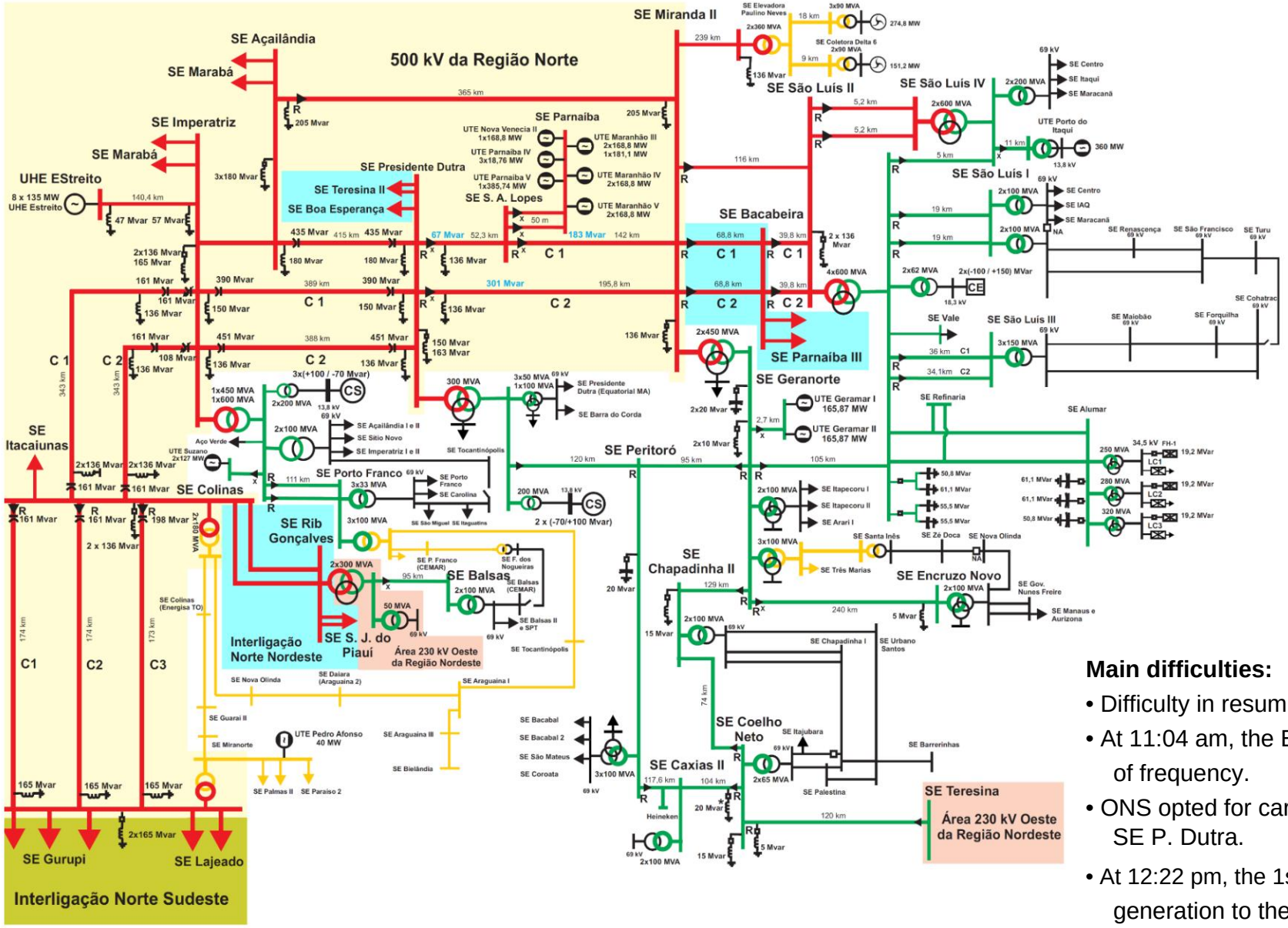


Main difficulties:

- At 12:47 pm there was a partial loss of reestablished loads, around 63%, due to the shutdown automatic 138 kV bus SE Rurópolis. The restoration of loads returned at 12:59 pm following normally until the end of the restoration. At 1:50 pm, COSR-NCO authorized the full restoration of loads from Pará.

Area 500/230 kV Maranhão / Estreito

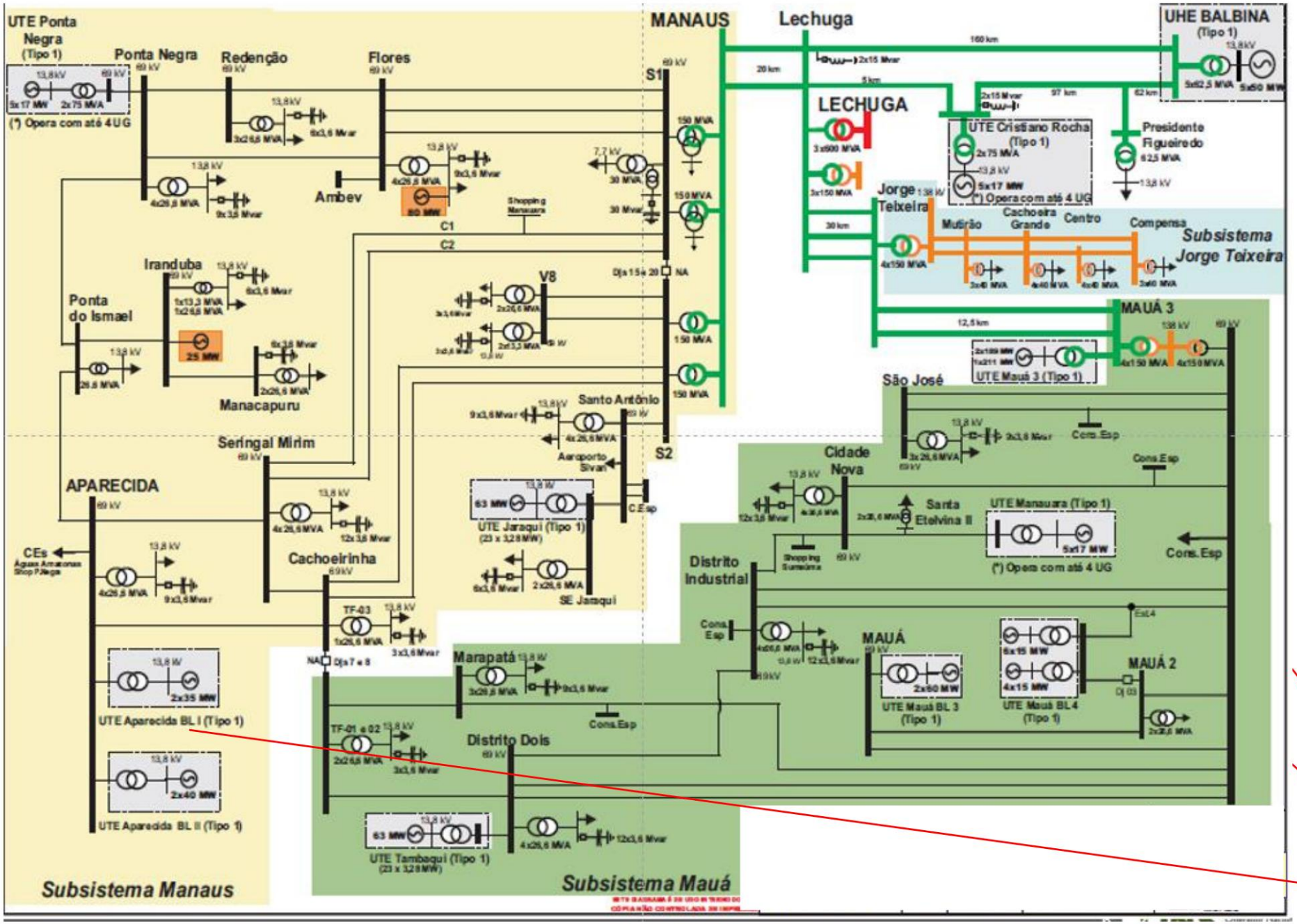
1ª UG ligada UHE Estreito	09h00
4ª UG ligada UHE Estreito	09h26
Home charging socket	10h35
Conclusion charging socket	14h41



Main difficulties:

- Difficulty in resuming load.
- At 11:04 am, the Estreito HPP was shut down due to oscillation of frequency.
- ONS opted for carrying out a recomposition alternative, for the 230 kV of the SE P. Dutra.
- At 12:22 pm, the 1st GU at Estreito HPP was synchronized and elevation started generation to the programmed value. At 12:31 the plant reached programmed generation value.

Manaus area



Balbina GUs connected to vacuum	09h04
Energization of SE Balbina	09h17

Manaus subsystem

Home charging socket	09h19
Conclusion charging socket	13h45

Mauá Subsystem

Home charging socket	09h52
Conclusion charging socket	13h45

Interconnection with the SIN	13h31

Main difficulties:

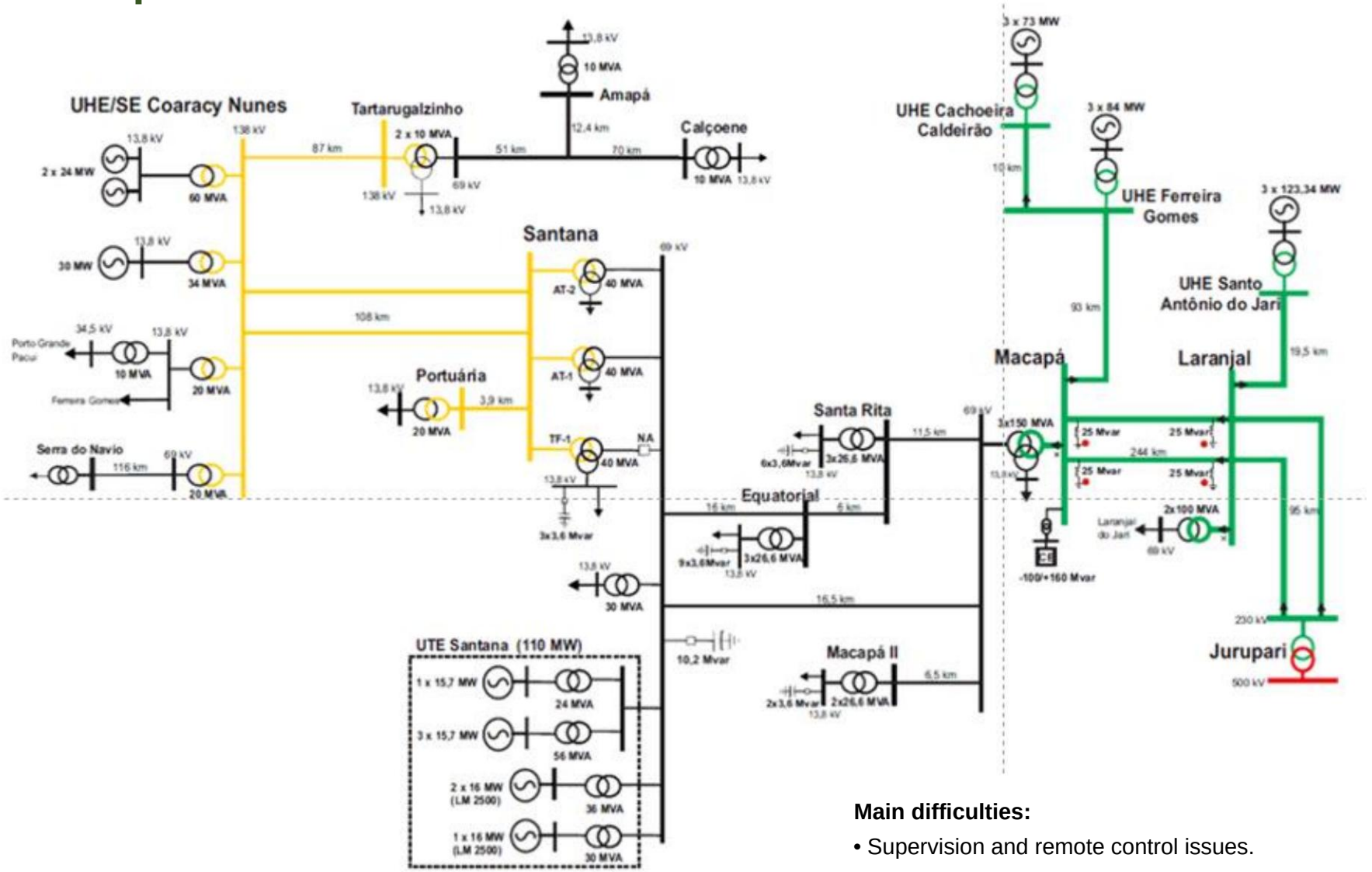
- Failure in communication channels.
- Delay in starting up thermal generation.

Mauá: 10:59 am

Manaus: 10:10 am

Appeared: 10:09 am

Amapá area



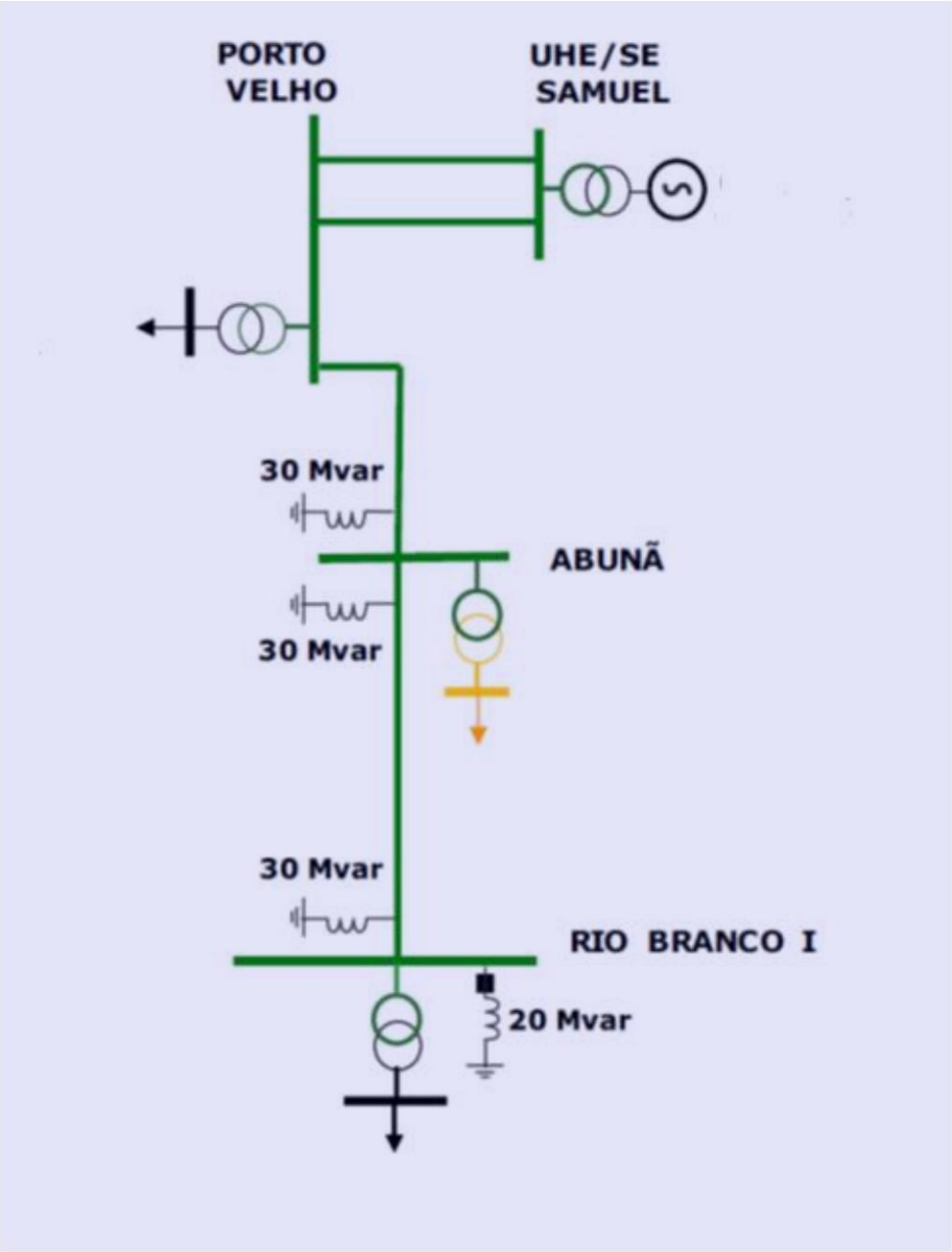
C. Nunes UGs linked to empty	08h46
Integration with SIN	13h34
95% of the load recomposed	14h17

Main difficulties:

- Supervision and remote control issues.
- Loss of communication channel with the distribution company between 09:12 and 13:48.
- During the fluent recomposition process, 4 situations occurred that caused the beginning of recomposition.
- At the time of interconnection with the SIN, UHE Coaracy Nunes served 25 MW of load.

Recomposition of Acre/Rondônia

Samuel Area – Acre/Rondônia



Rondônia

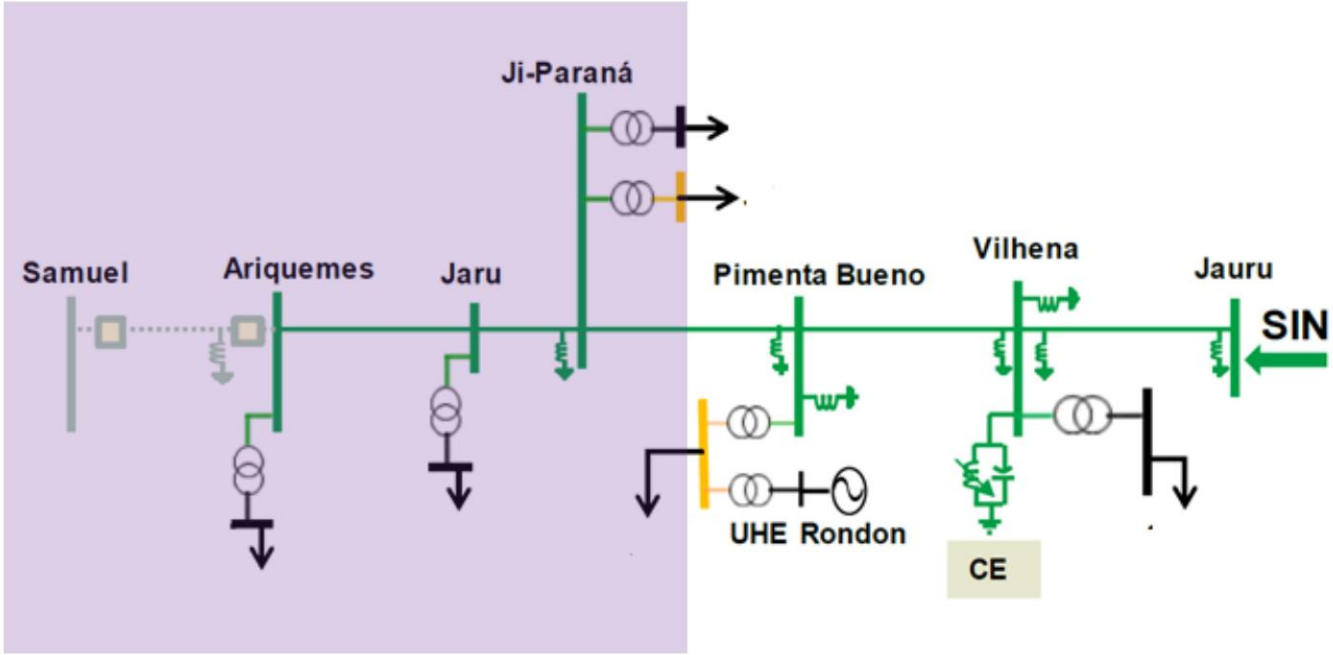
Synchronism 1ª UG de Samuel	08:51
Home charging socket	09h18
Conclusion charging socket	11h42
Parallel	10h29

Main difficulties:

- Lack of substation preparation
- Need for recomposition coordinate.

Acre

Synchronism 1ª UG de Samuel	08:51
Home charging socket	09h58
Conclusion charging socket	11:30 a.m.
Parallel	10h29



General aspects that made the recomposition difficult

General aspects that made the recomposition difficult

1. Large volume of calls from agents requesting information about the situation.
2. Many requests for guidance on restoration actions that should be fluent.
3. Fluent recomposition needed to be coordinated in several areas.
4. Many substations were not prepared for recomposition by agents.
5. Failure of supervision in several installations.
6. Failed agent teleassistance.
7. Need to move operators to the facilities.
8. Failure in communication channels with agents.
9. Need to use alternative unsupervised communication channels (cell phones).
10. Difficulty in communicating with some agents (missed calls).
11. Delay in responding to ONS requests (load connection, substation preparation, line energization, etc.).
12. Restoration of loads disconnected by ERAC before frequency stabilization at 60 Hz.

Major Disturbances - Last 15 Years

DAY AND HOUR	ORIGIN	TIME AVERAGE	Energy No Supplied (MWh)	LOAD INTERRUPTION									
				SIN		N		NO		S		SE/CO	
				MW	%	MW	%	MW	%	MW	%	MW	%
15/08/2023 08:30	LT 500 kV Quixadá / Fortress II	02:03	46.235	22.547	34	6.058	100	6.206	61	2.355	20	7.928	20
21/03/2018 15h48	Xingu Bipole Narrow	02:31	51.692	20.529	26	5.115	82	11.507	82	1.083			8	2.824	6
28/08/2013 14h58	LT 500 kV Ribeiro Gonçalves / São João do Piauí C1 and C2	02:41	23.189	8.610	13		80	1	8.530	81		-	-	-	-
26/10/2012 00h14	SE Hills	03:37	37.518	10.828	17	3073	68	7.661	78			-	-	183	1
04/02/2011 00h08	SE Luiz Gonzaga	03:13	23.793	7.363	12		-	-	7.363	80		-	-	-	-
10/11/2009 22h13	SE Itaberá	03:38	89.371	24.566	41		-	-	802	9	104	1	23.660	63	

Average time = Unsupplied Energy [MWh] / Load Shedding [MW]

ONS 25 ANOS
Operador Nacional do Sistema Elétrico

END