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Generator Responses during the 2020 Mumbai Blackout

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(GitHub)

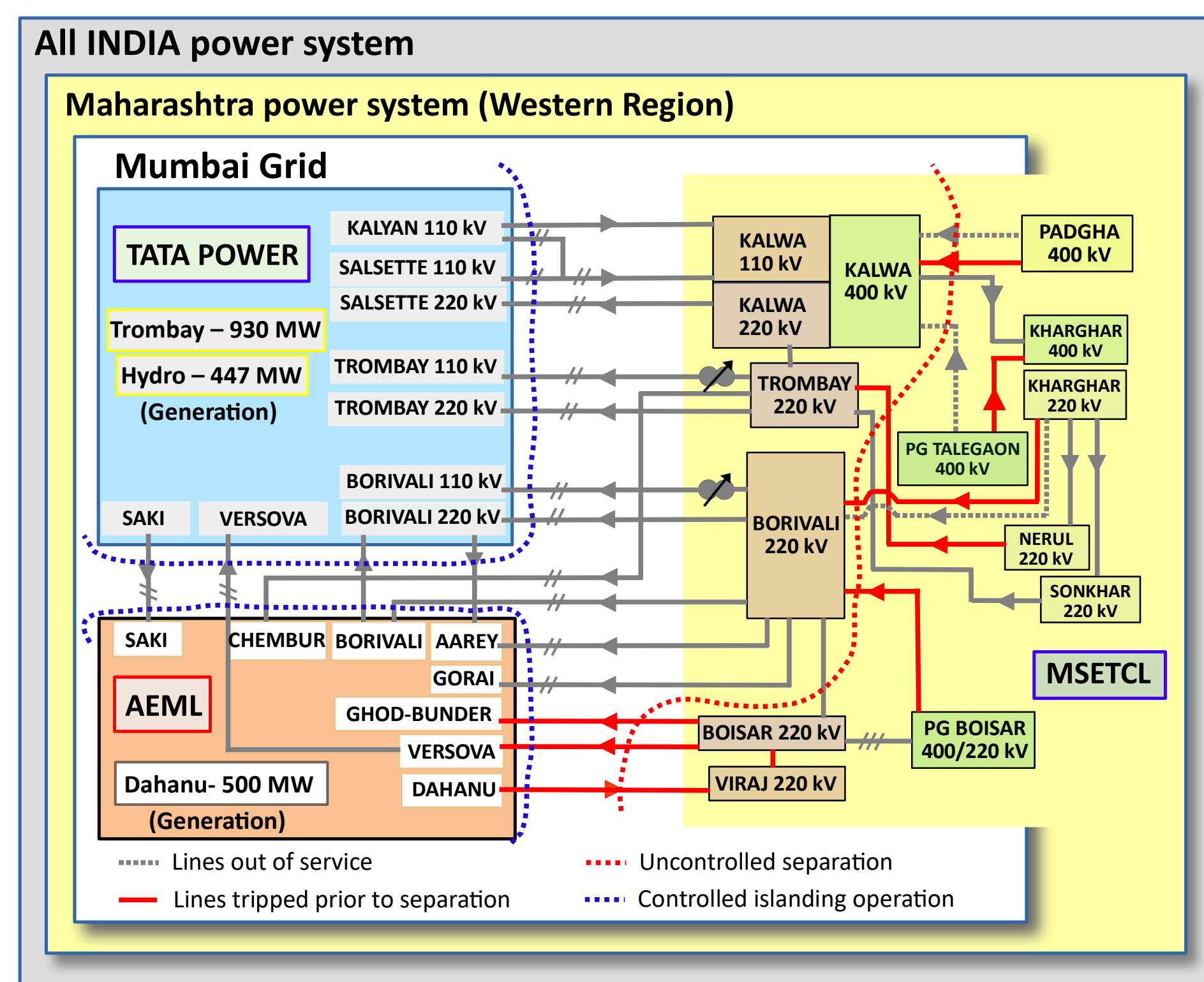## The Mumbai Blackout of 12th October 2020

Fig. 1: Network in and around the **Mumbai region**. The cut-set of the designed **controlled islanding scheme**, and **uncontrolled separation** during the disturbance of **12th October 2020** is also shown.
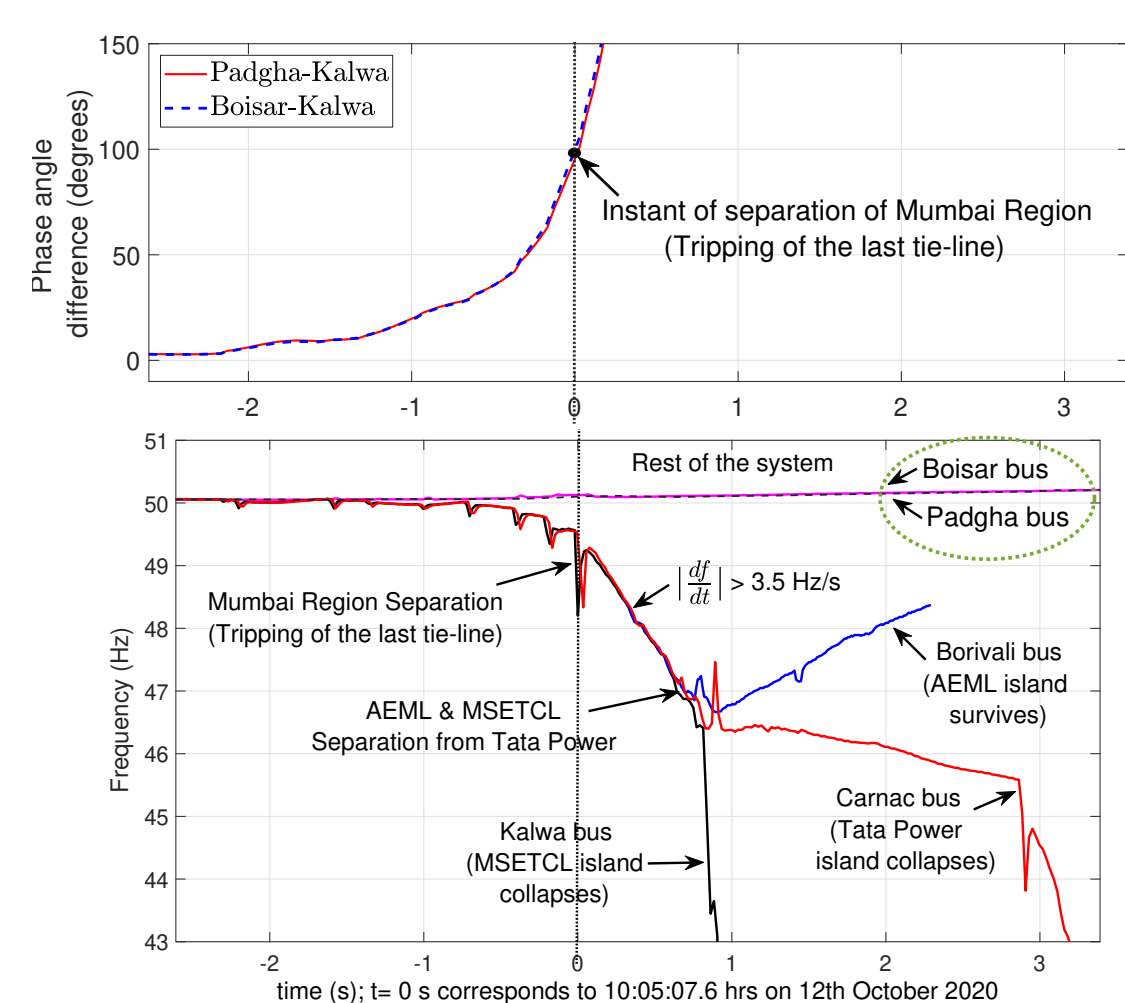AEML: Adani Electricity Mumbai Ltd., MSETCL: Maharashtra State Electricity Transmission Company.

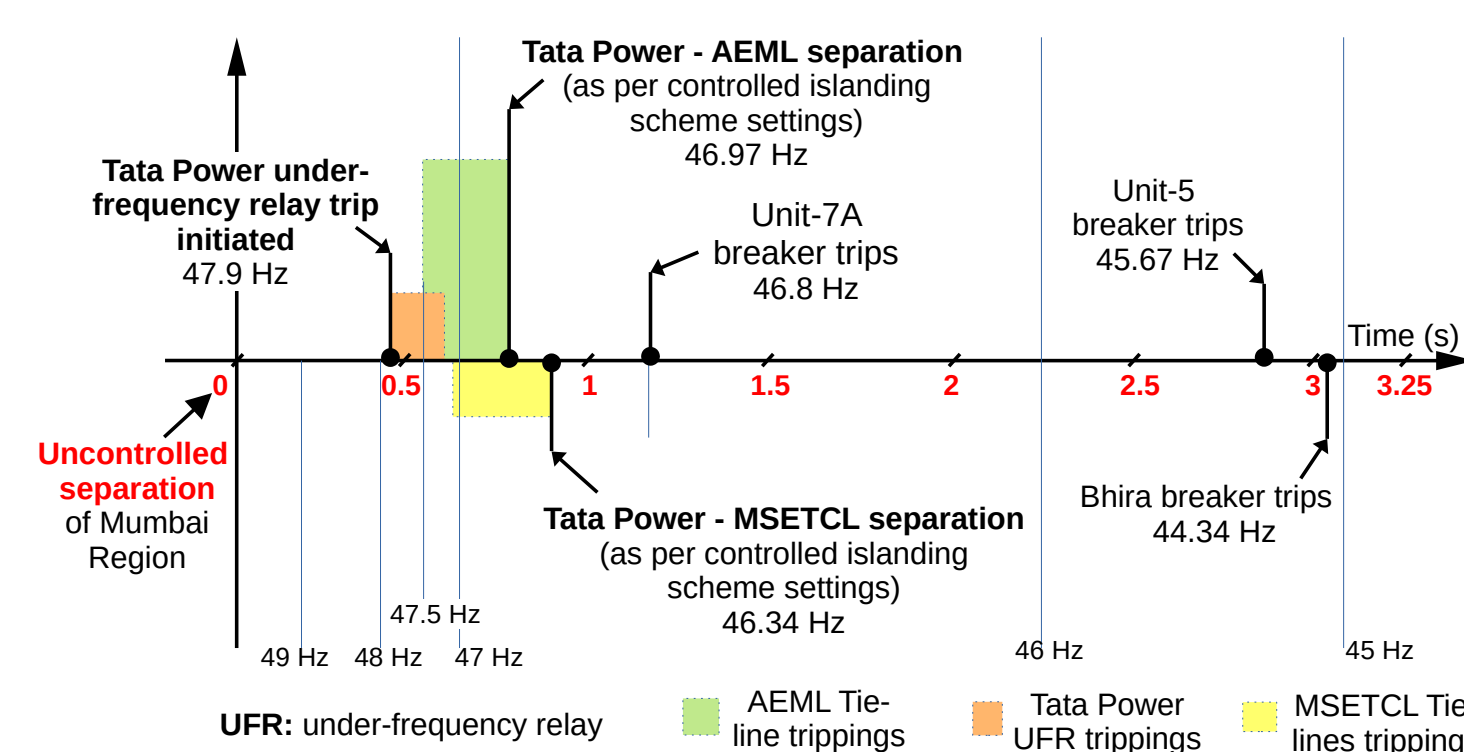Fig. 2: Angular difference and frequency transients during the disturbance.

Fig. 3: Timeline of trippings *after* the Mumbai region separated from the rest of the system. Frequency is computed from instantaneous waveforms of DRs.
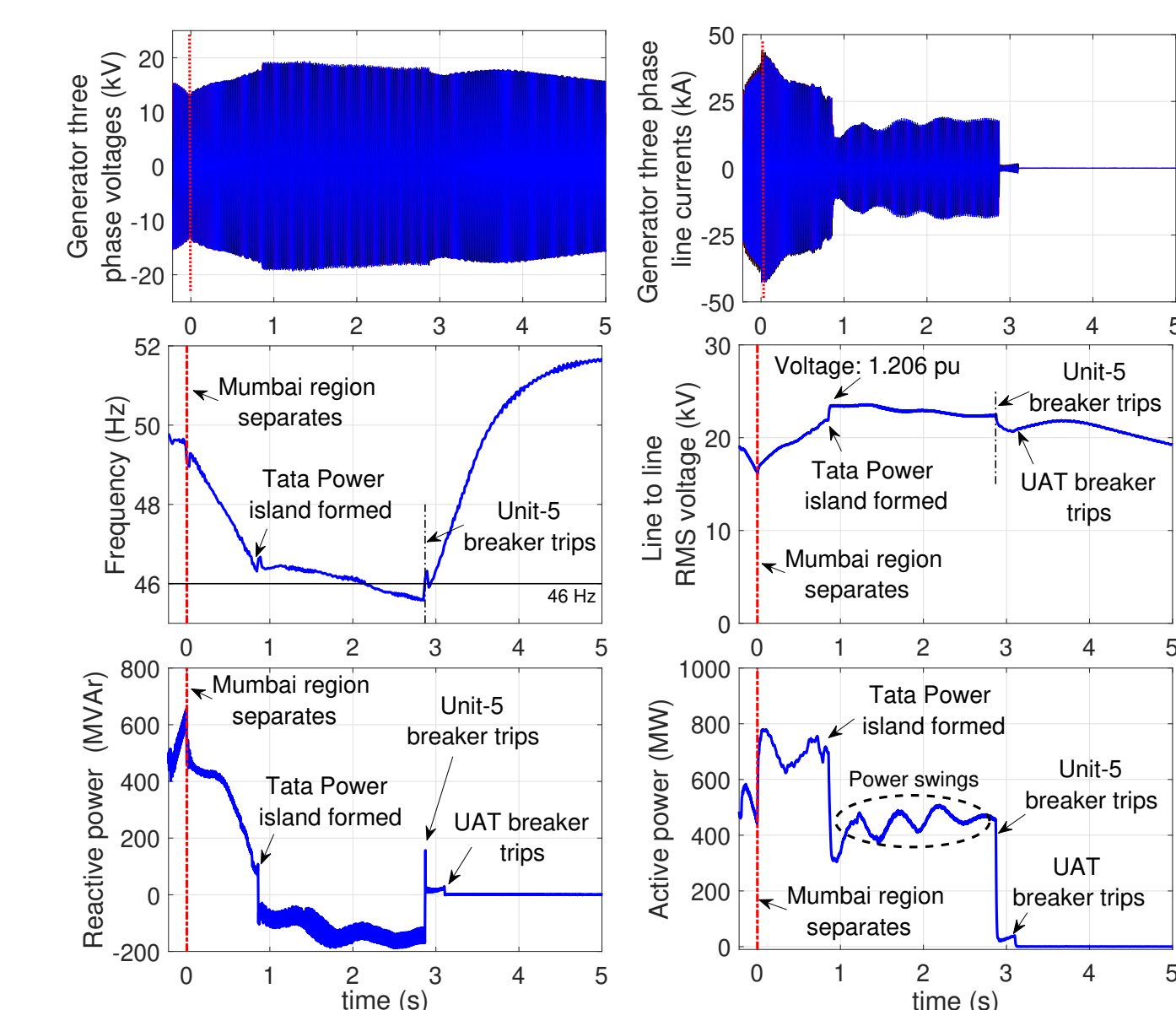
Measurement Pre-processing

- Measurements from several **DRs, PMUs** at 8 locations, and the pre-fault information from **SCADA**.
- Derived quantities from instantaneous voltage and currents.
- Time-aligning the data.

Fig. 4: Trombay Unit 5 **derived quantities** from the three-phase instantaneous voltages and currents.
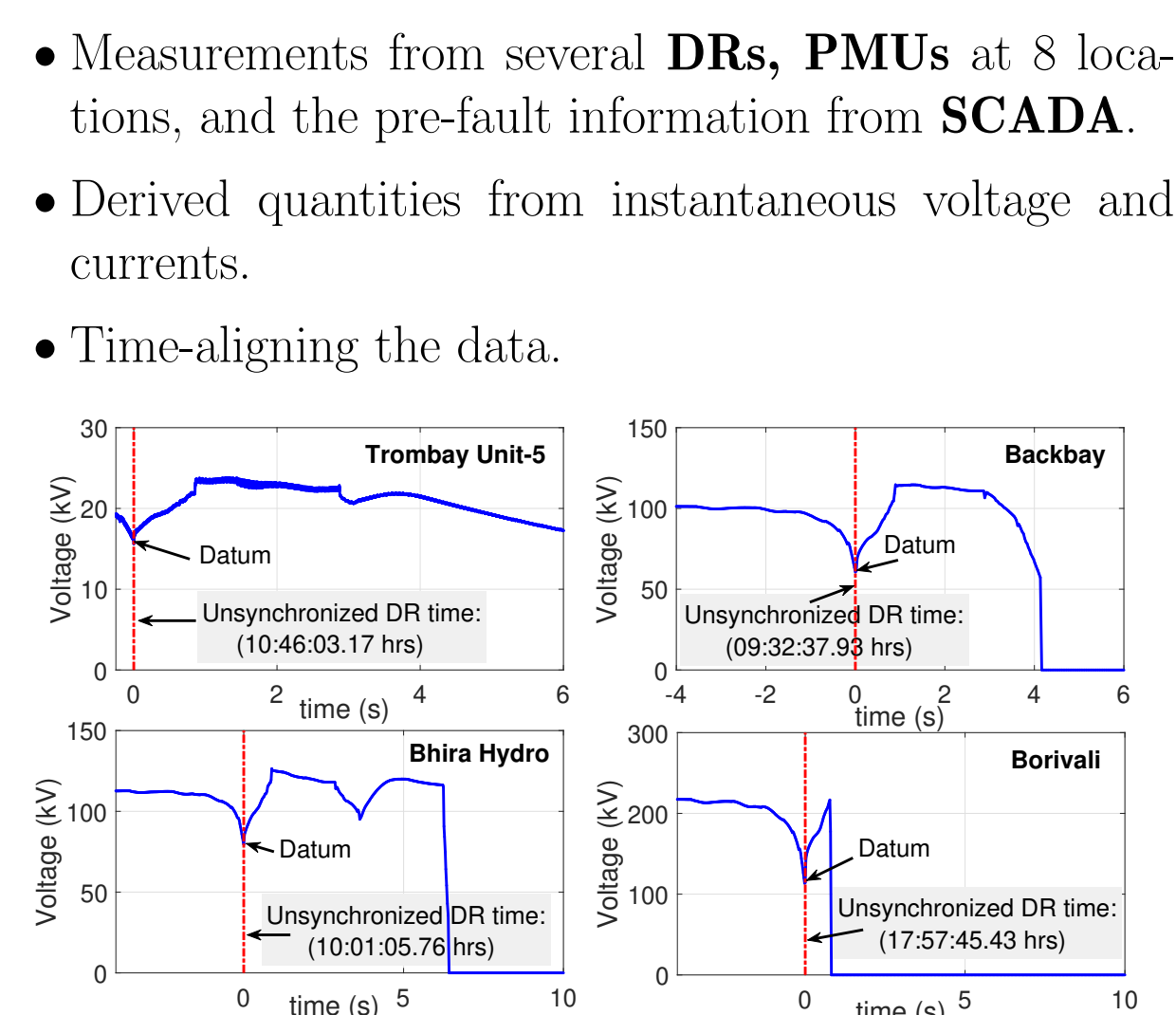

Fig. 5: Datum identification in various DRs.

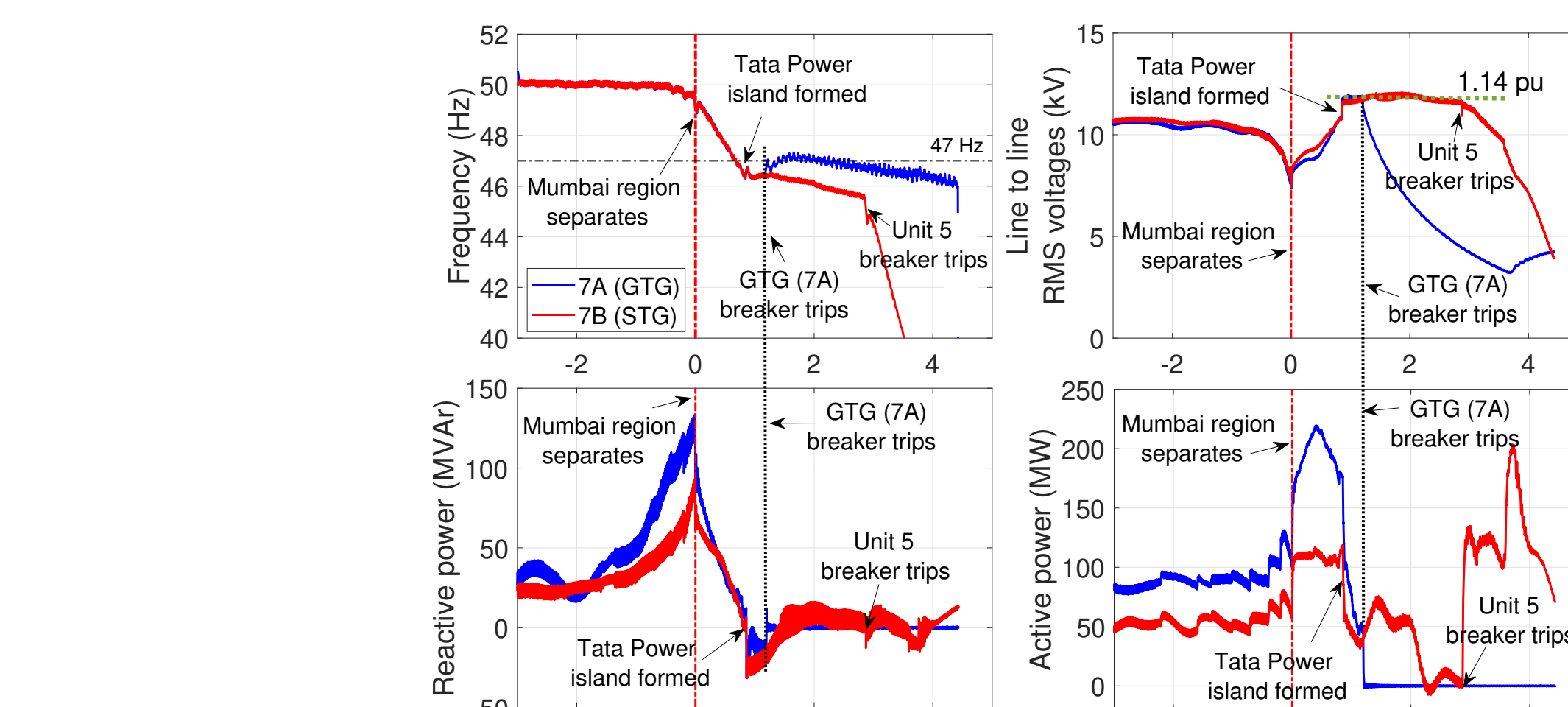## Behavior of Trombay Unit 7A and 7B Generators

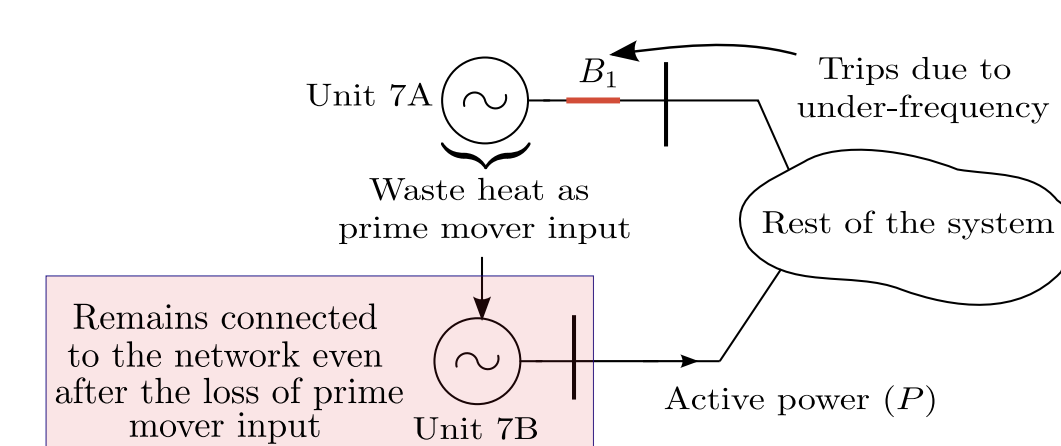
Fig. 6: Unit-7 generator responses.
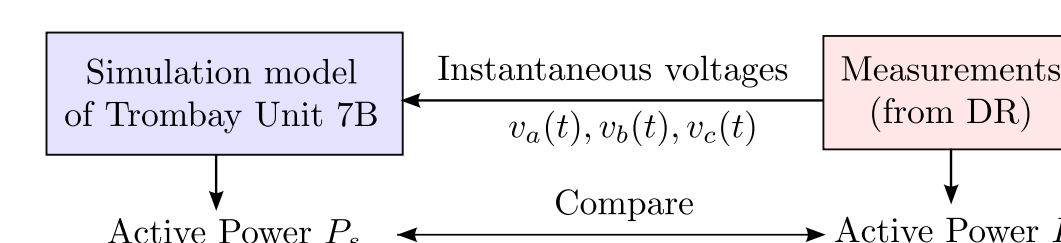

Fig. 7: Configuration of Unit 7A and 7B.

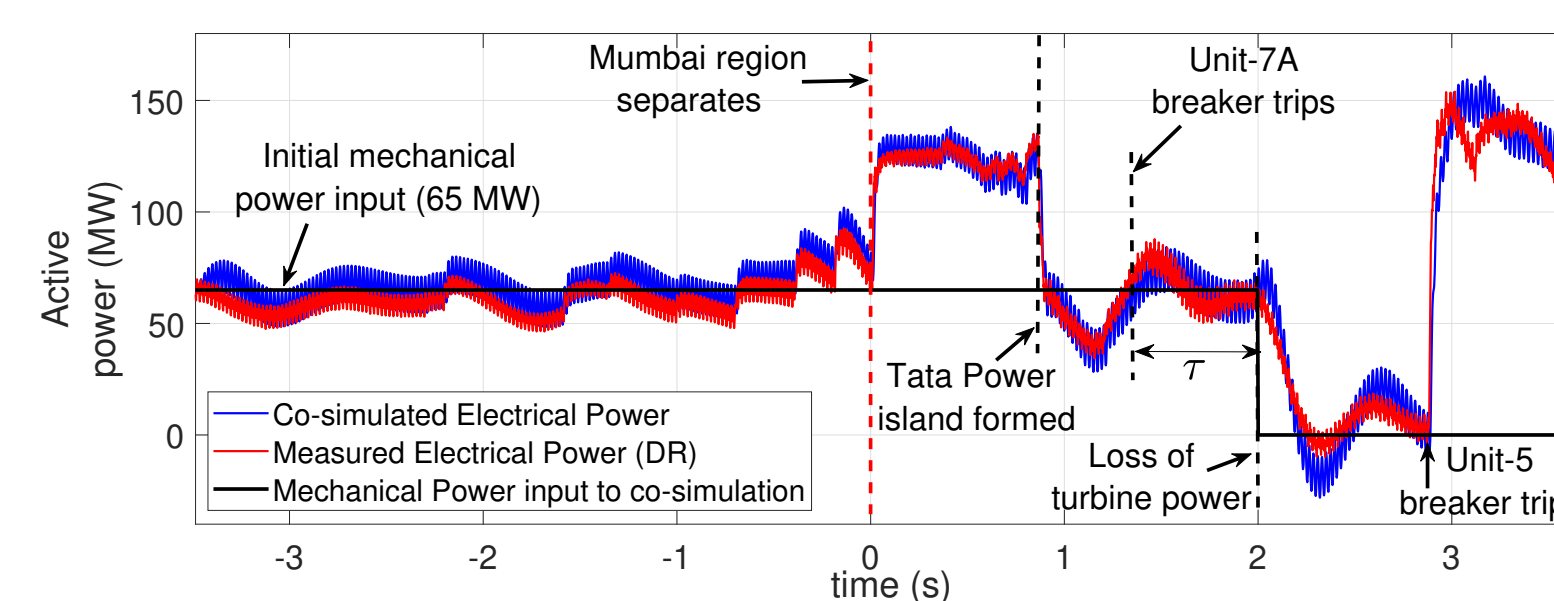Fig. 8: Co-simulation of Trombay Unit 7B with the DR data.

Fig. 9: Comparison of the co-simulated power response of Trombay Unit 7B with the observed power response.

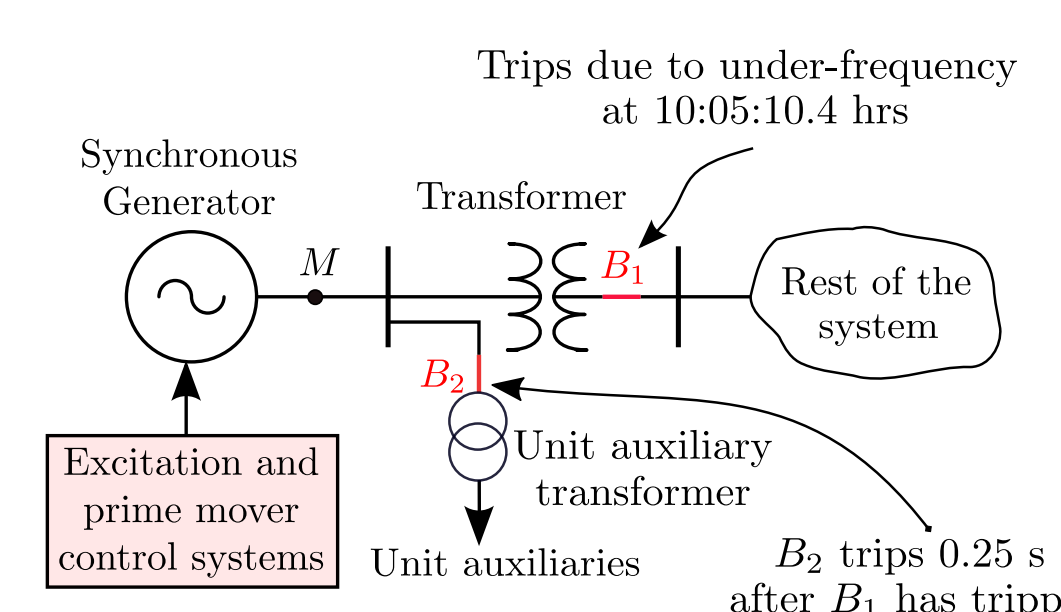## Behavior of Trombay Unit 5 Generator and its Auxiliaries

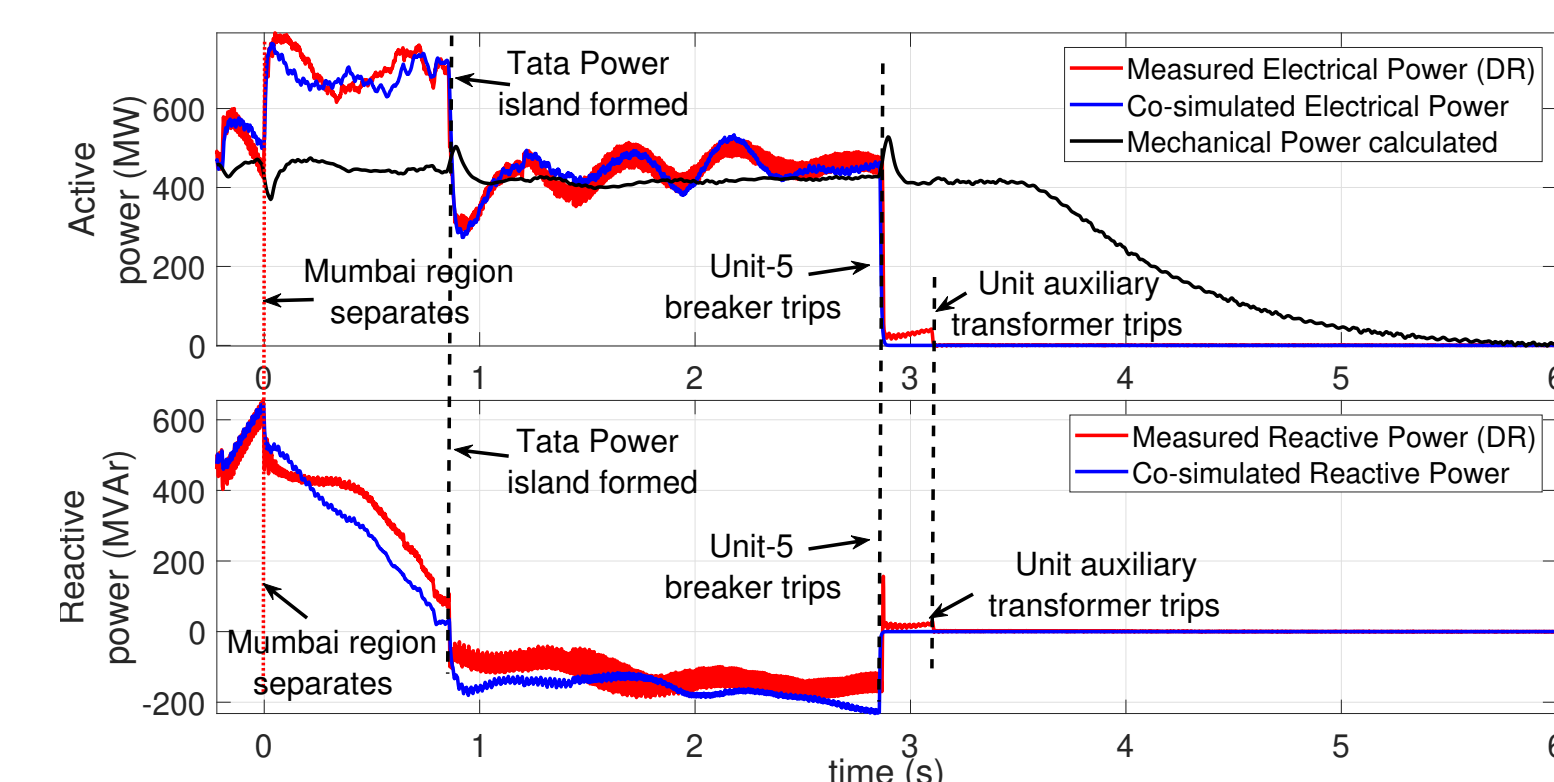Fig. 10: Tripping sequence in Unit 5.

Fig. 11: Tripping sequence in Unit 5. Comparison of the co-simulated power response of Trombay Unit 5A with the observed power response.
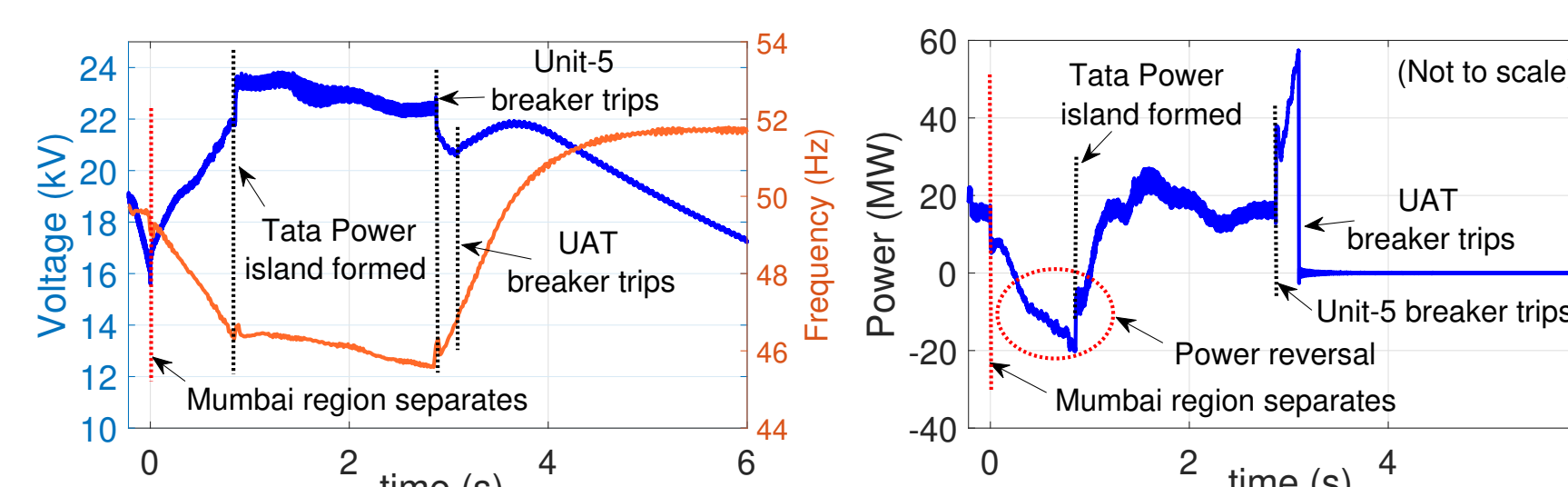

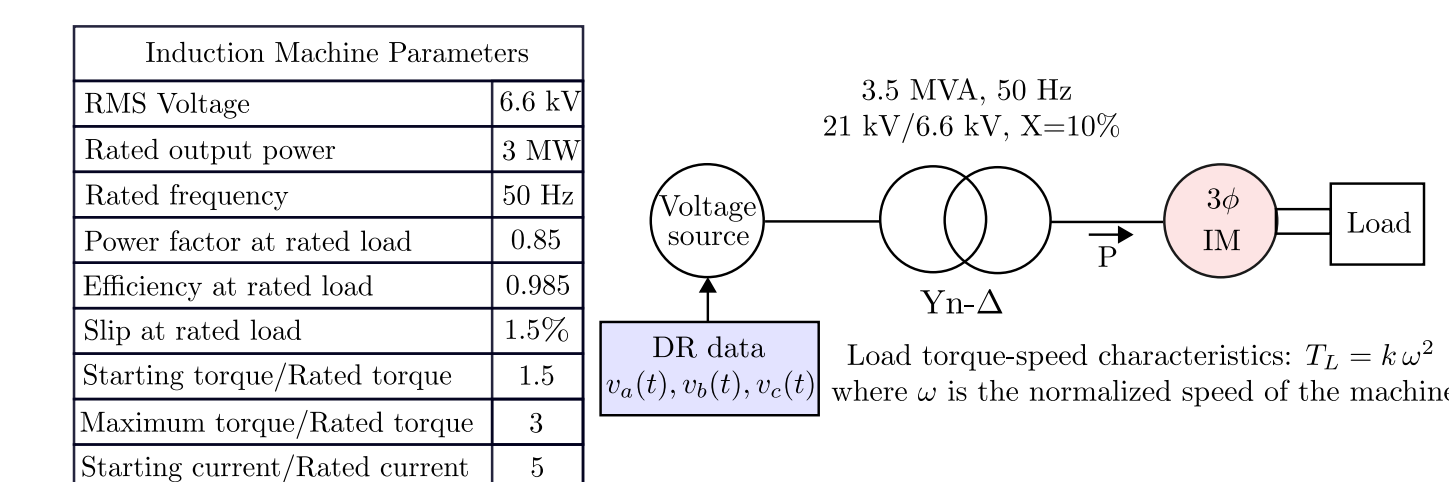Fig. 12: Power flow reversal in a UAT of Unit 5 during the transient.

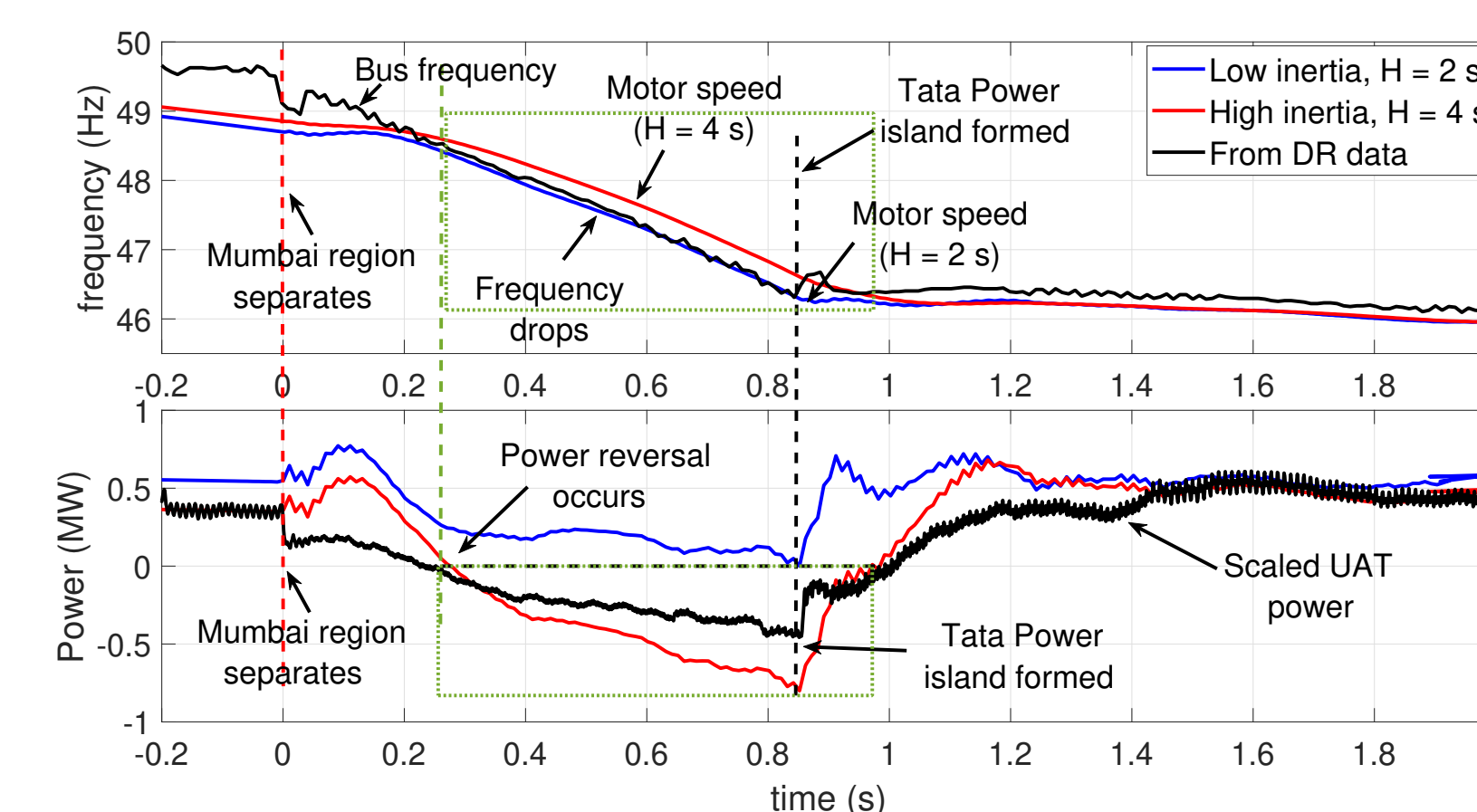Fig. 13: Co-simulating an induction motor with the DR data.

Fig. 14: Power reversal is seen for the large inertia motor when frequency dips.

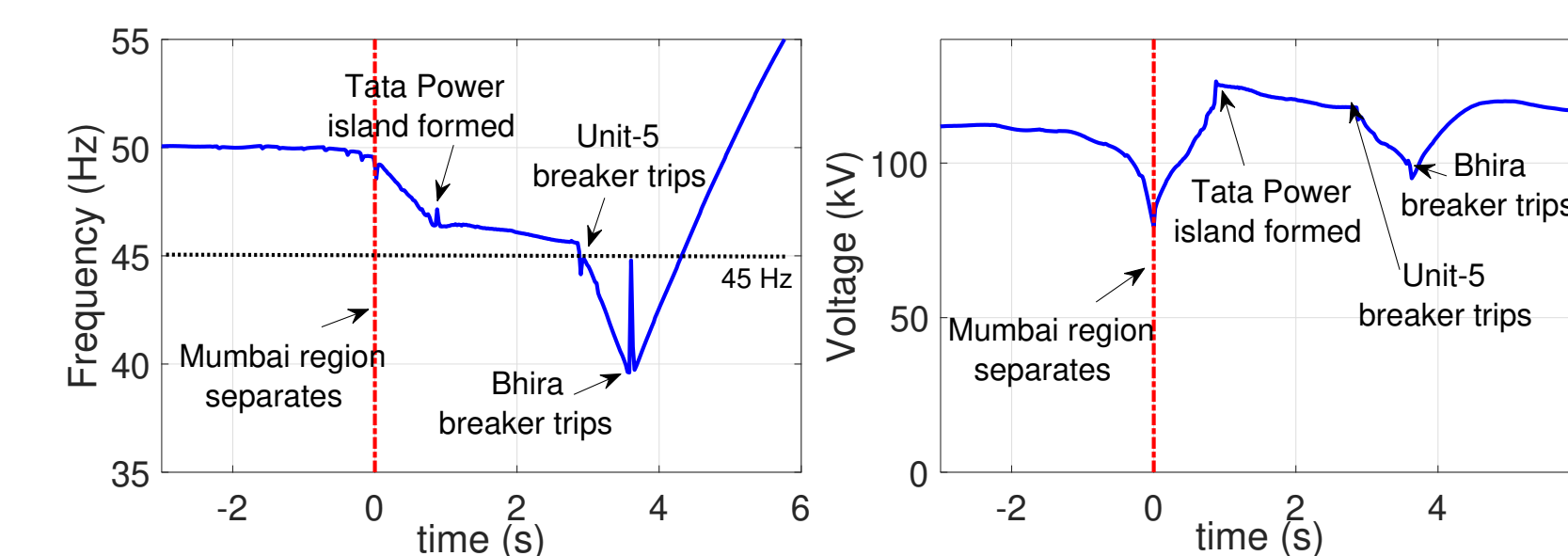## Behavior of Bhira Hydro Generator

Fig. 15: Bhira hydro-unit response.

Conclusion

1. The post-mortem analysis brought out generator responses that are not generally seen during normal operating conditions.
2. **Co-simulation** approach proved useful in such analysis.
3. The paper presented and analyzed some interesting features in these responses and corroborated the analysis by simulating the generator models with the played-back DR data.
4. We expect that the analysis presented will be of **educational value for students and practicing engineers**.

Reference

[1] P. Navalkar, A. M. Kulkarni, Santosh V. Singh, and S. A. Soman, "A proposal for a PMU based adaptive islanding scheme for Mumbai city," in 2022 22nd National Power Systems Conference (NPSC), IEEE, 2022.