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# Computationally Efficient Partitioned Modeling of Inverter Dynamics with Grid Support Functions

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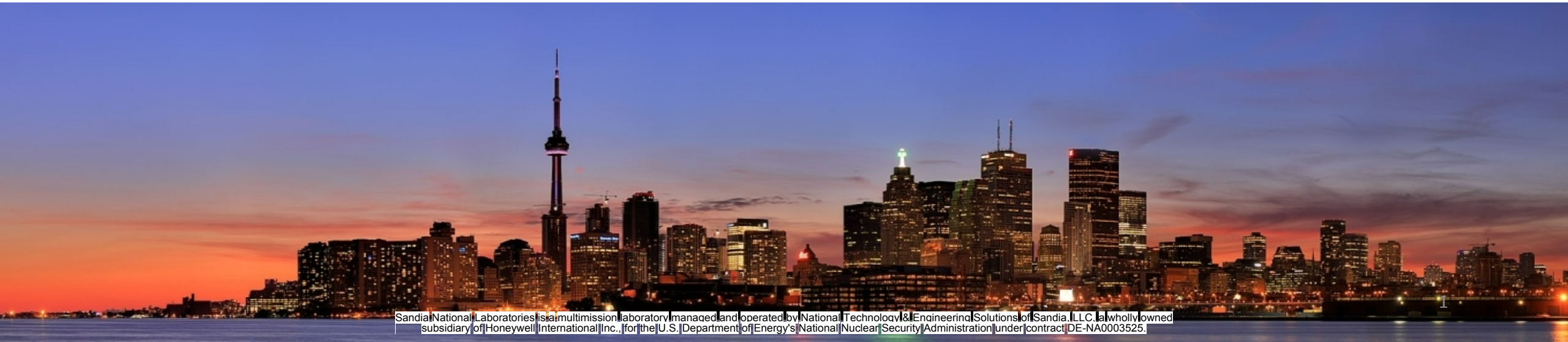
**Presenter: Sunil Subedi**





# Converter Dominated Power System (CDPS)

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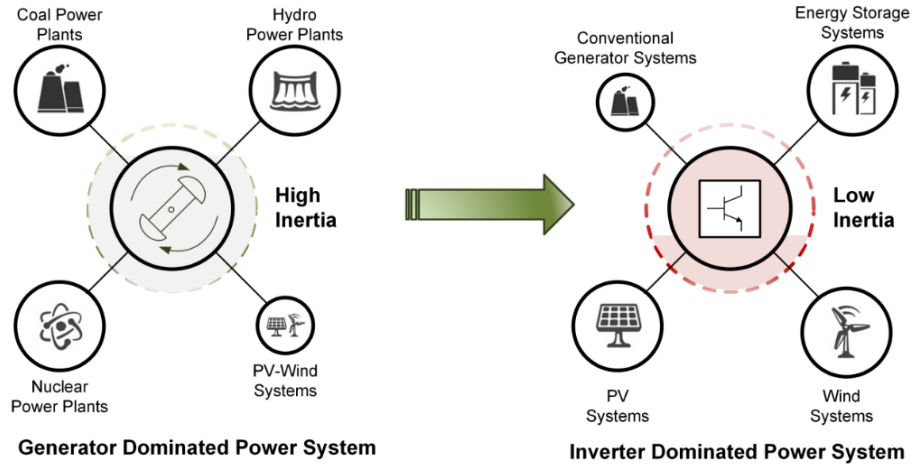
- converters with advanced grid support functions (GSFs)
  - introduces non-linear and complex dynamics
  - conventional modeling techniques computationally intractable
- increases complexity of power system analysis
  - grid operators and researchers rely on computational tools/simulations
  - proprietary models change in their parameters
  - topology and control design often unknown
  - inaccurate modeling — stability and reliability issues




**Objective:**
speed up simulation and reduce computational complexity of CDPS within an acceptable accuracy

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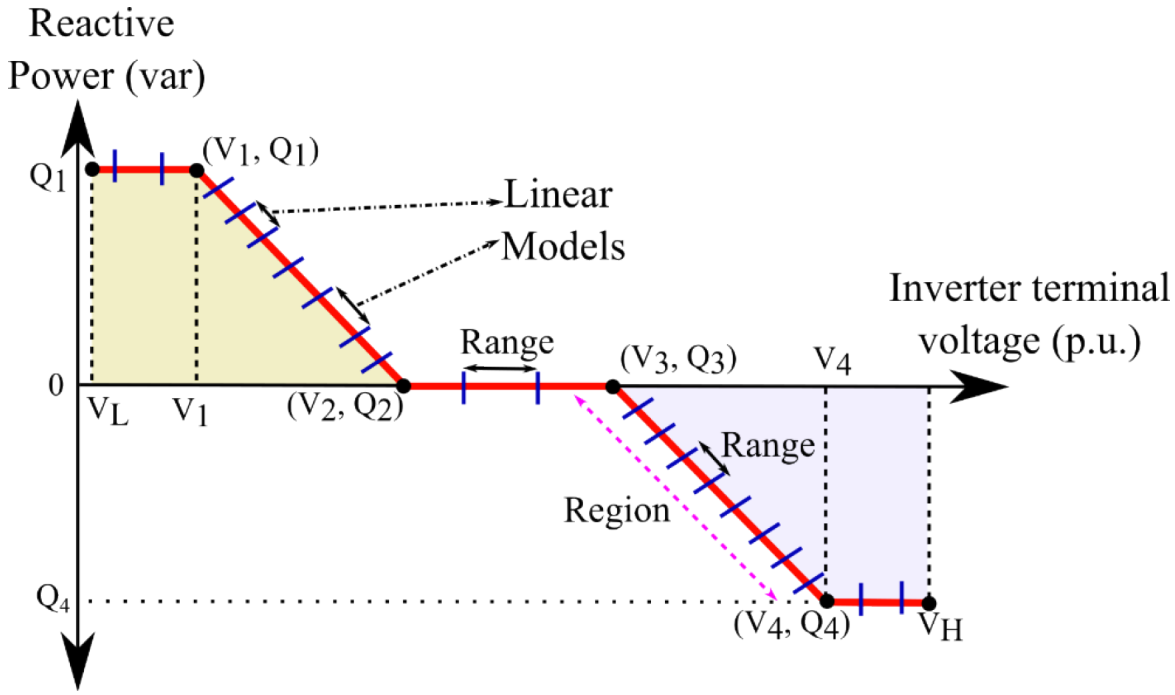
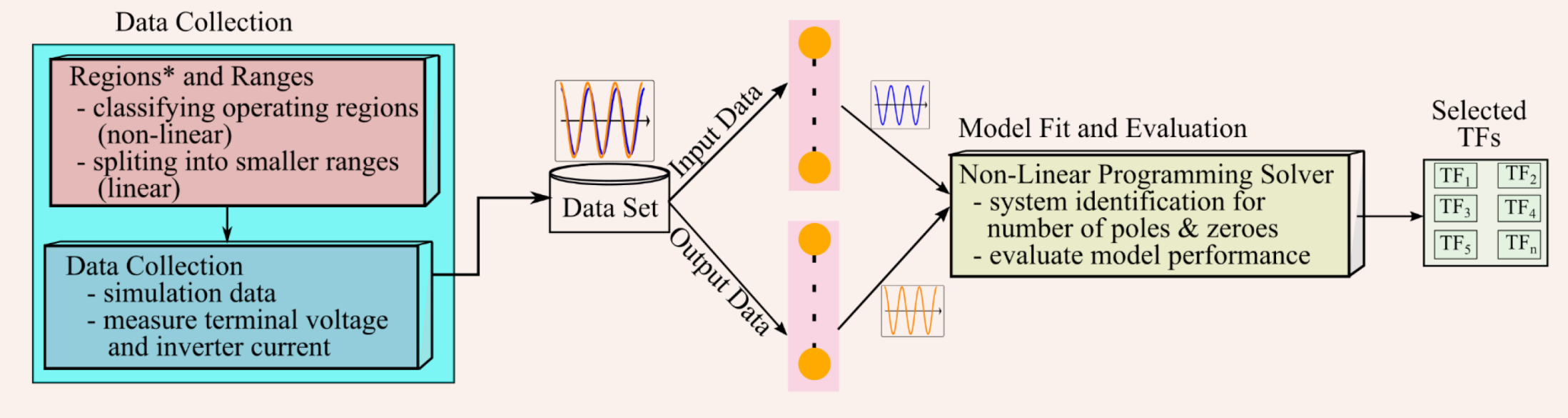
# Linearized Partitioned Modeling

- Volt-Var piecewise curve
  → droop makes operation non-linear
- single linearized transfer function (TF) model
  → do not capture detailed dynamics
- partitioned model
  → trades off speed and accuracy
- can be extended to other system states as a general framework for other GSFs

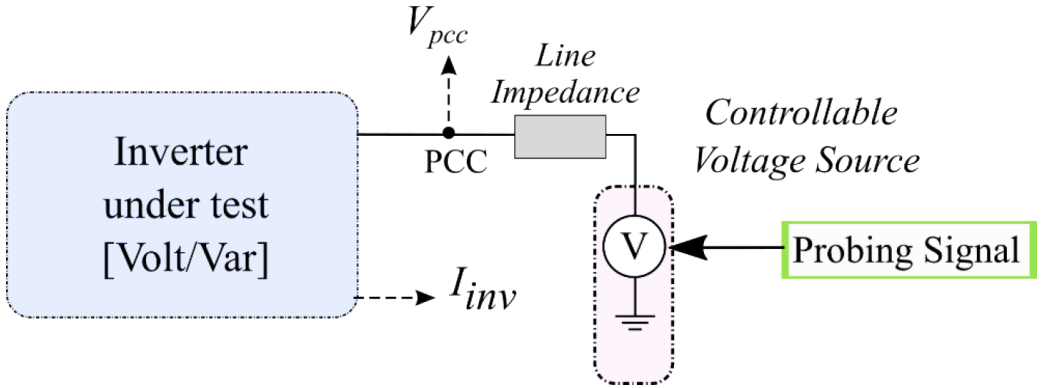



region : set-point set by IEEE standard 1547
range : further partitioning regions

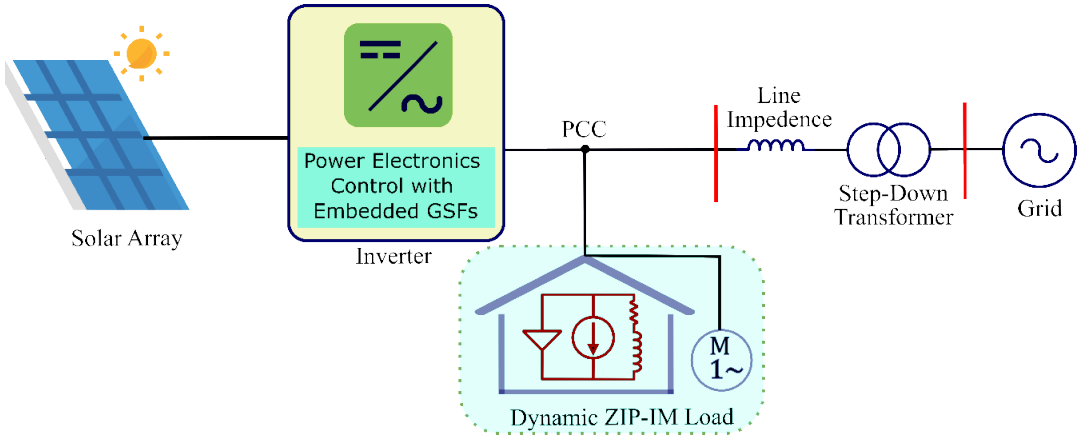
# Partitioned Dynamic Modeling of Converter

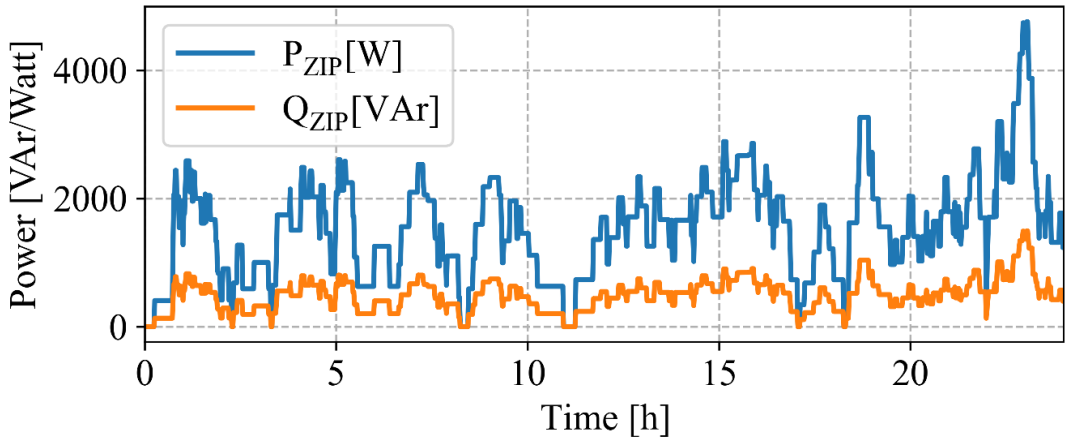



- square wave for perturbating voltage
  - RMS voltage and current for system identification
- best fit transfer function (TF) for each range is selected
- overall dynamics - aggregating TF models during simulation
  - seven number of TFs representing region 3 and 4



# Simulation Setup: Model Validation



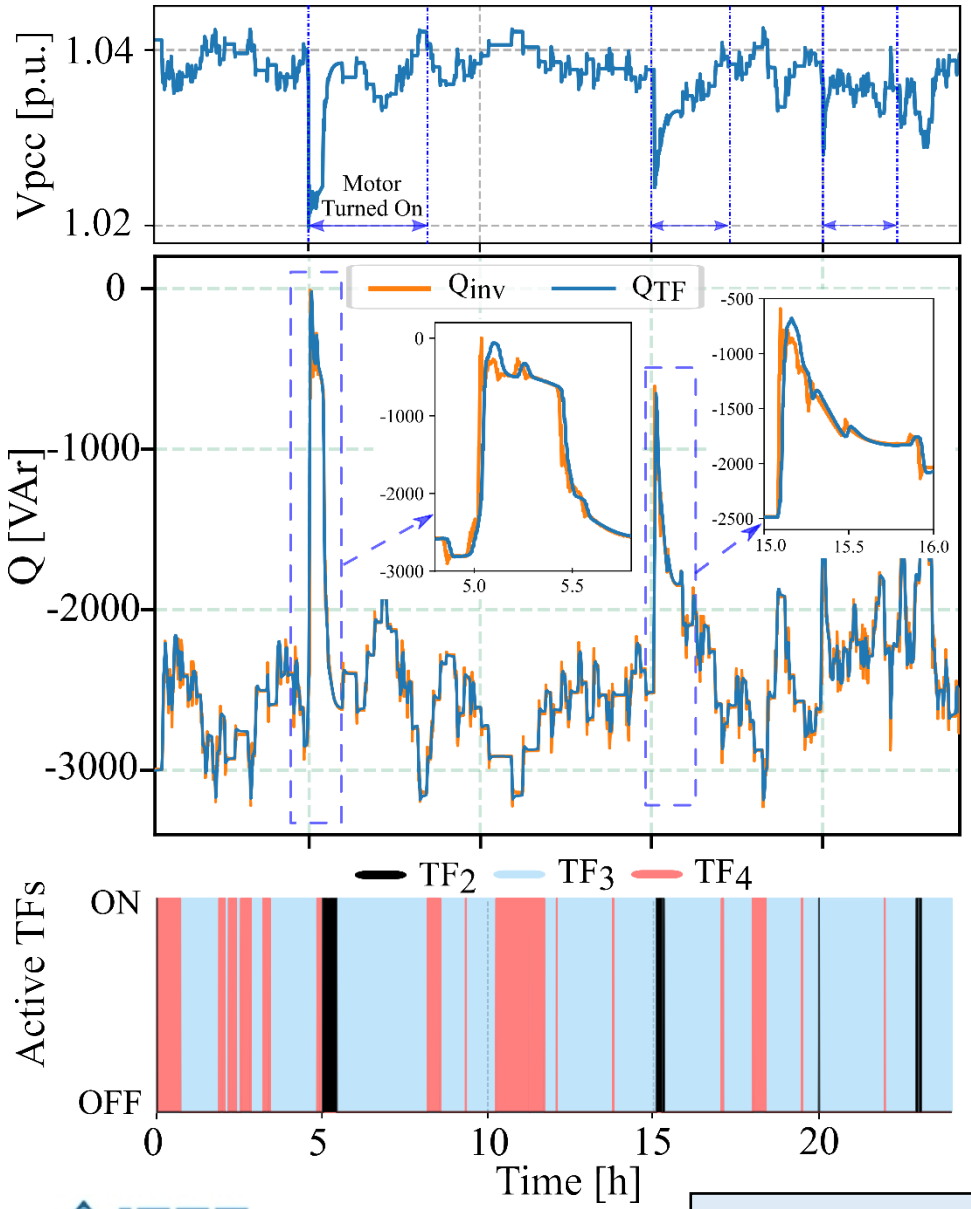



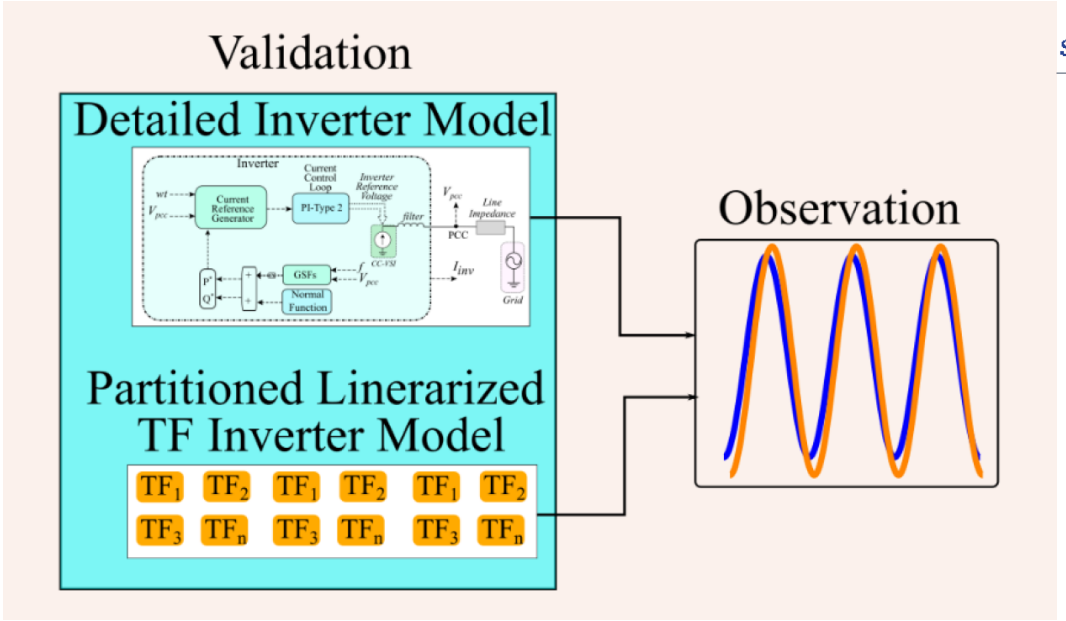

- 8.4 kW PV detailed inverter set in 0.7 p.u. for Volt-Var mode study
- IM of power 0.15 kW
- reference active and reactive power:
  - ZIP load model, PV generation, IM load, and GSFs of inverter

- unique load data, queueing model
  - statistically aggregates to a reference input load curve
  - power factor of 0.96

IM – Induction Motor, constant impedance (Z), current (I), and power

# Model Validation and Performance Analysis




- response from both models is compared
  - least NRMSE error of 1.91%
  - developed linearized models closely followed response from detailed inverter model
- four times speedup in simulation time compared to detailed model

NRMSE – Normalized Root Mean Square Error

# Conclusions

- preliminary results shows that:
  - developed partitioned model is faster
  - approximate detail system dynamics
- allows utilities and researchers to perform voltage dynamic study in CDPS with large number of converter

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