LV network design: Voltage drop simulations and the Herman Beta method

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Overview

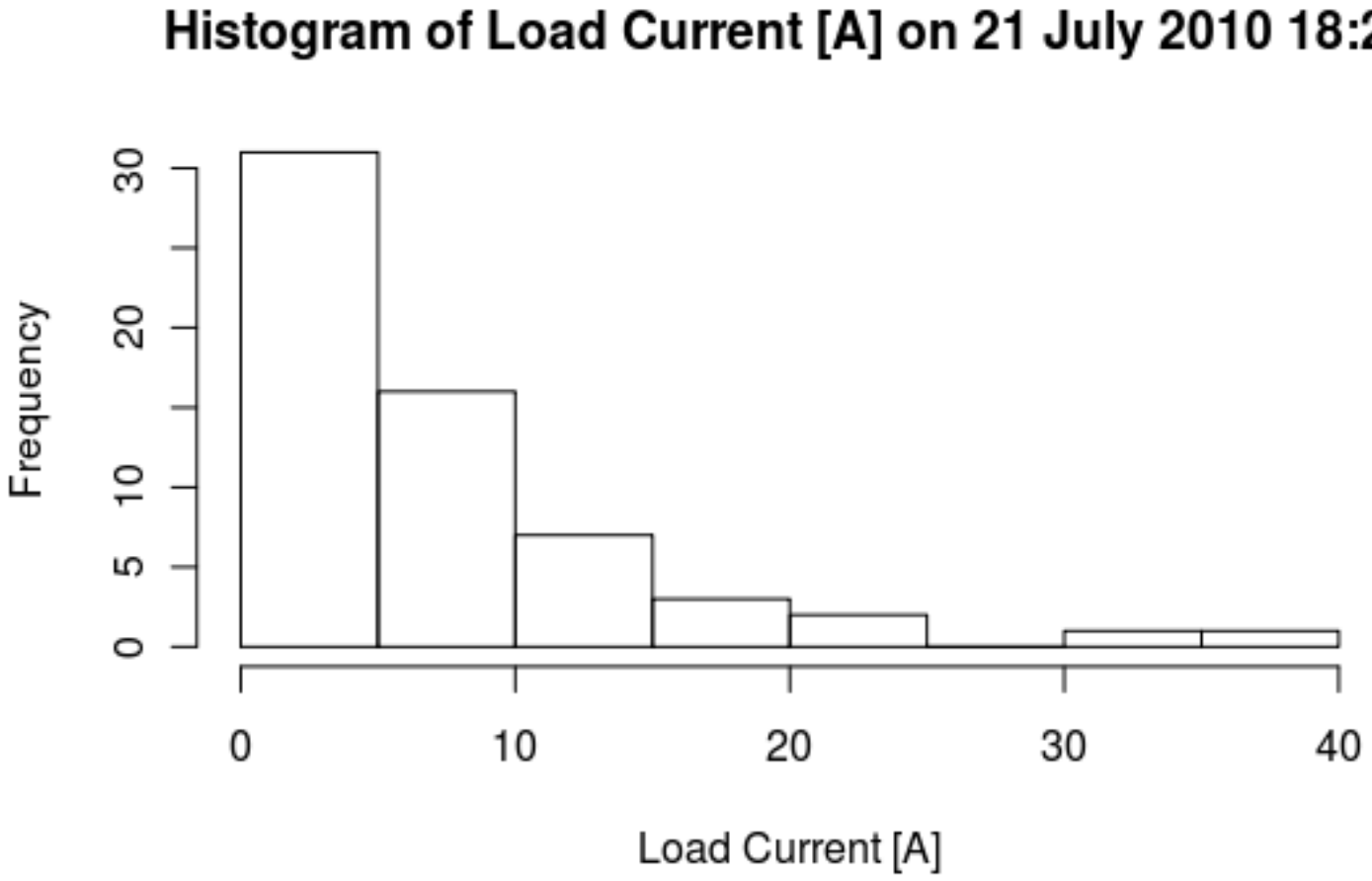
- Introduction
- Herman-Beta method
- NRS 034 vs NRS 048
- Field data collection
- Analysis of measured voltage performance
- Simulations

Objective

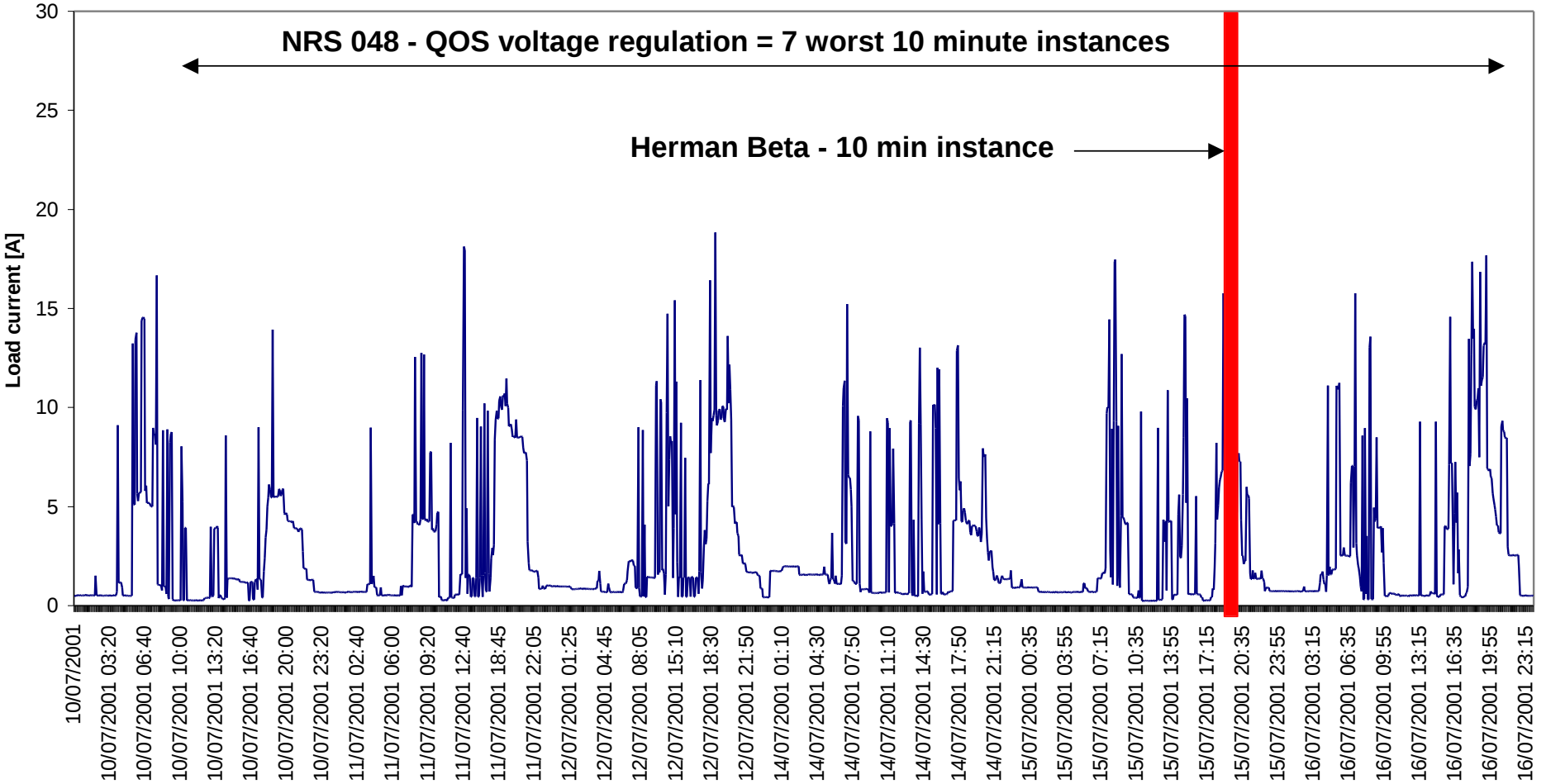
- The objective of this project is to establish a relationship between the design risk value of the Herman Beta method and the probability (or risk in this context) of not meeting the NRS048 QOS voltage criteria

Herman Beta Method

Herman Beta – NRS 034



NRS 034 vs NRS 048



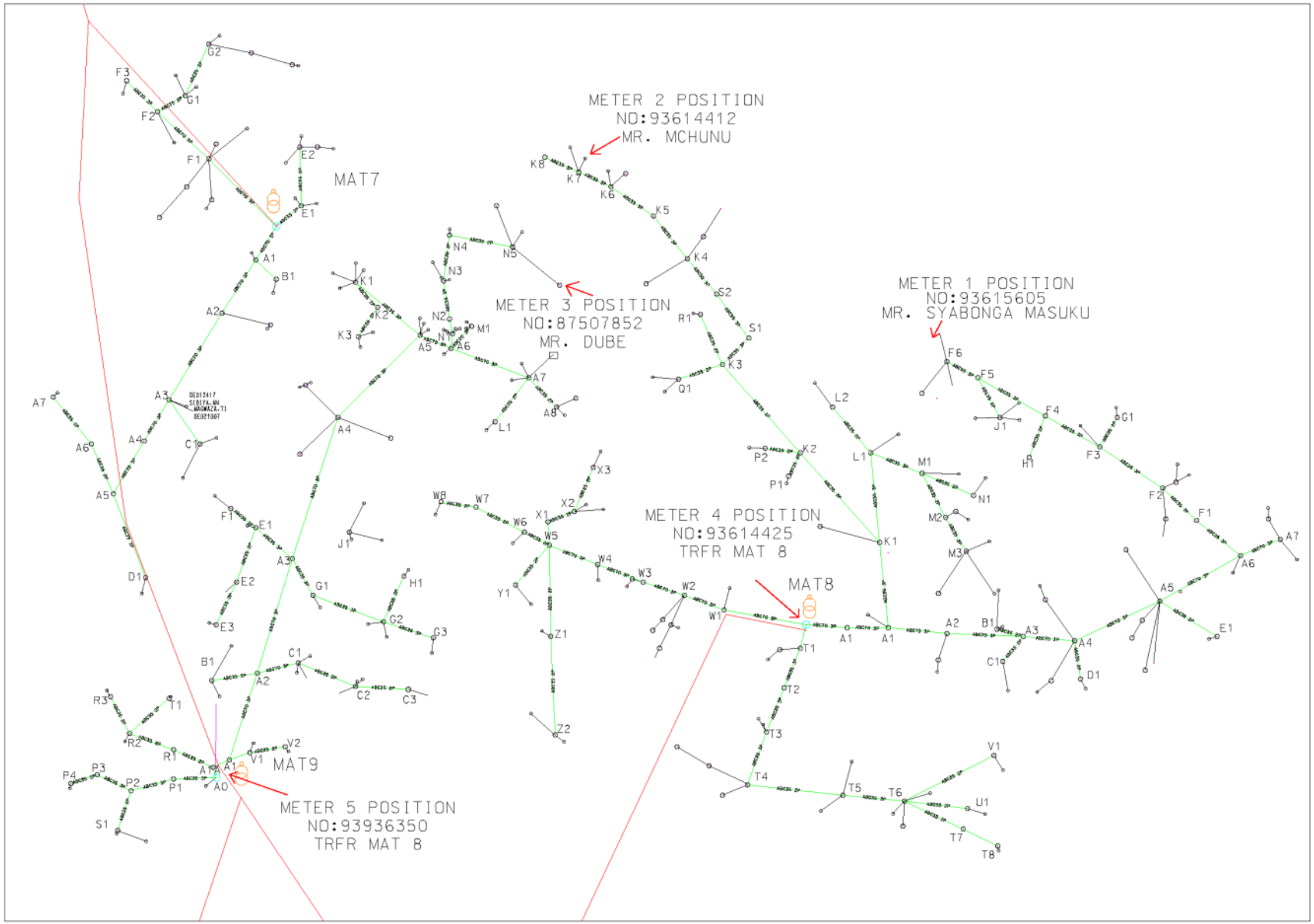
Approach

- Actual measurements
  - Feeder supply voltage
  - Conductor sizes and lengths
  - Connection counts
  - Phasing of connections
- Simulation
  - NRS048 QOS voltage performance

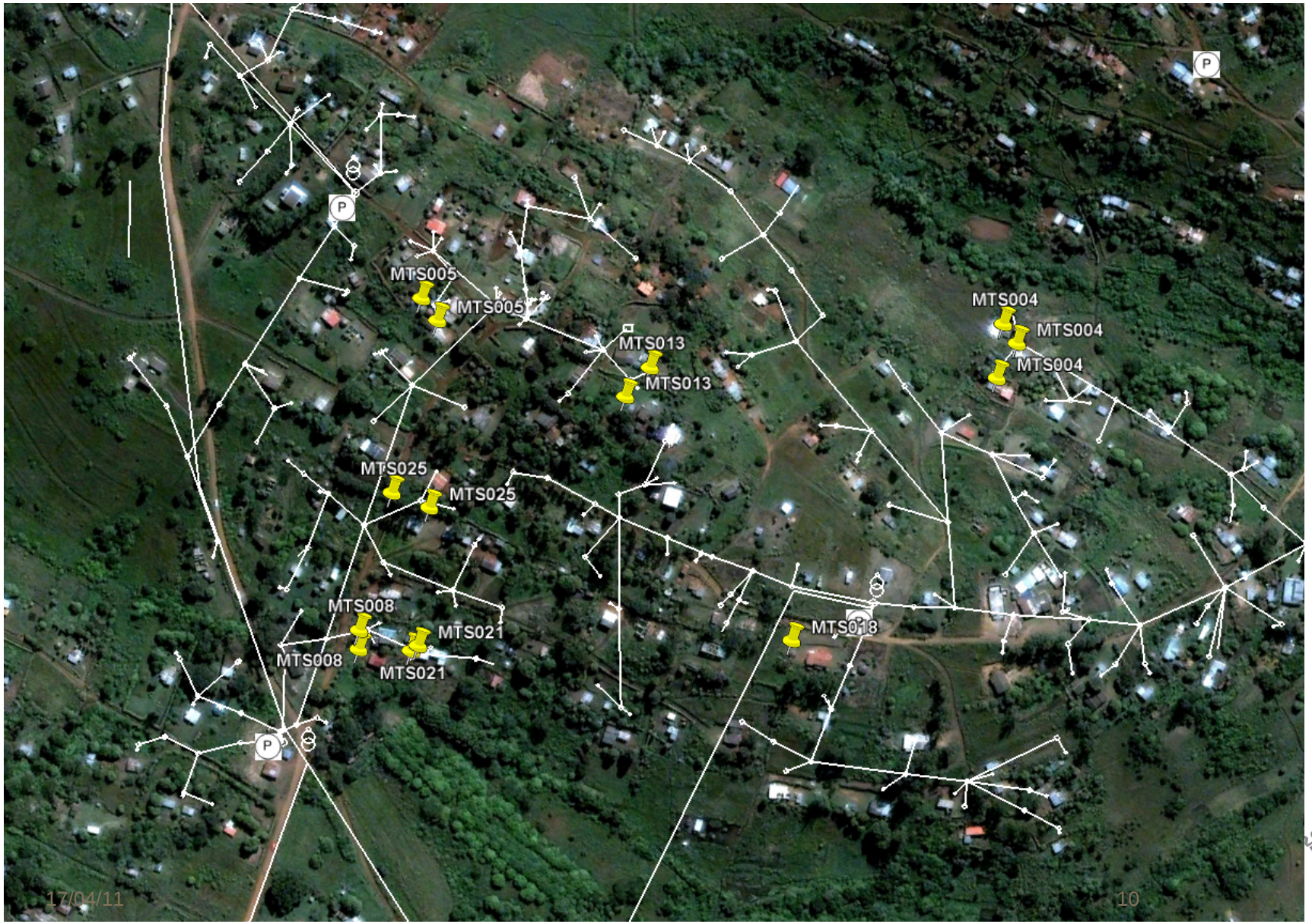
Actual measurements source

- Load research data
  - 5 min, V, A, kW, kVA
  - Site installation records
- Physical layout– dgn files (Microstation)
- Network diagram - Reticmaster files
- Consultant recorded data
- Research Report

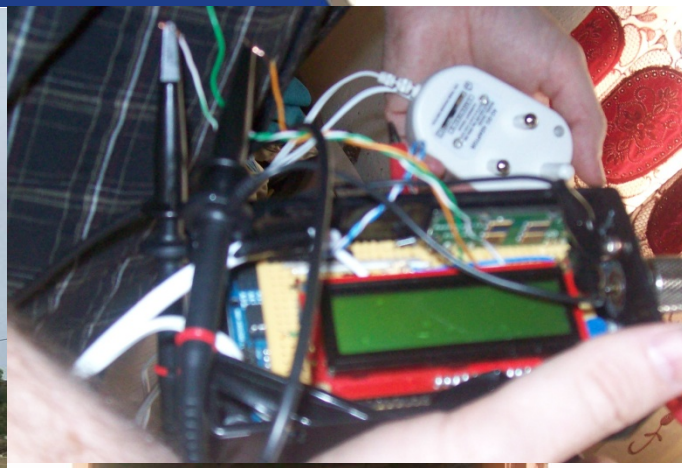
Microstation - DGN



Google Earth + DGN + LR



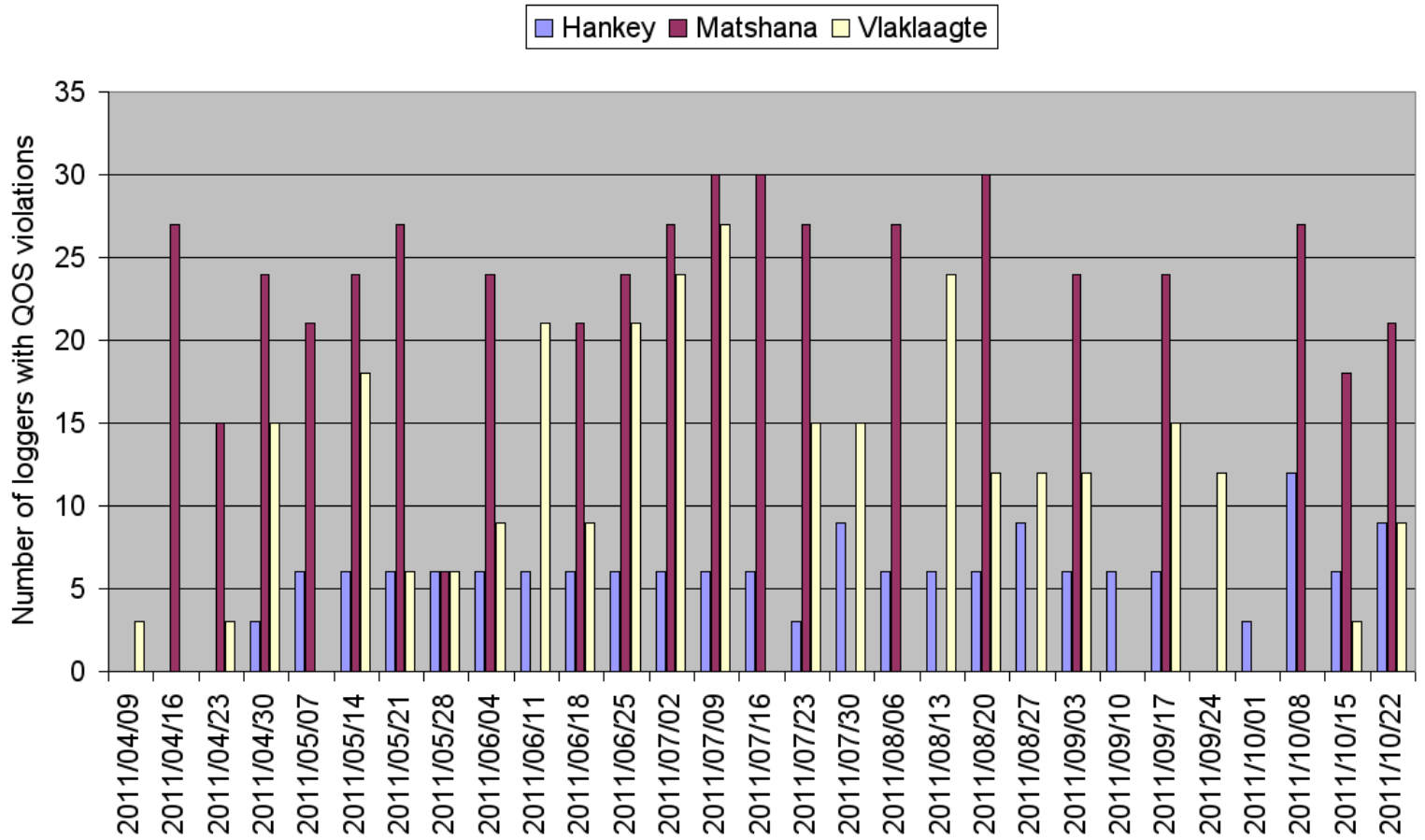
Phase detector



Phase balance survey

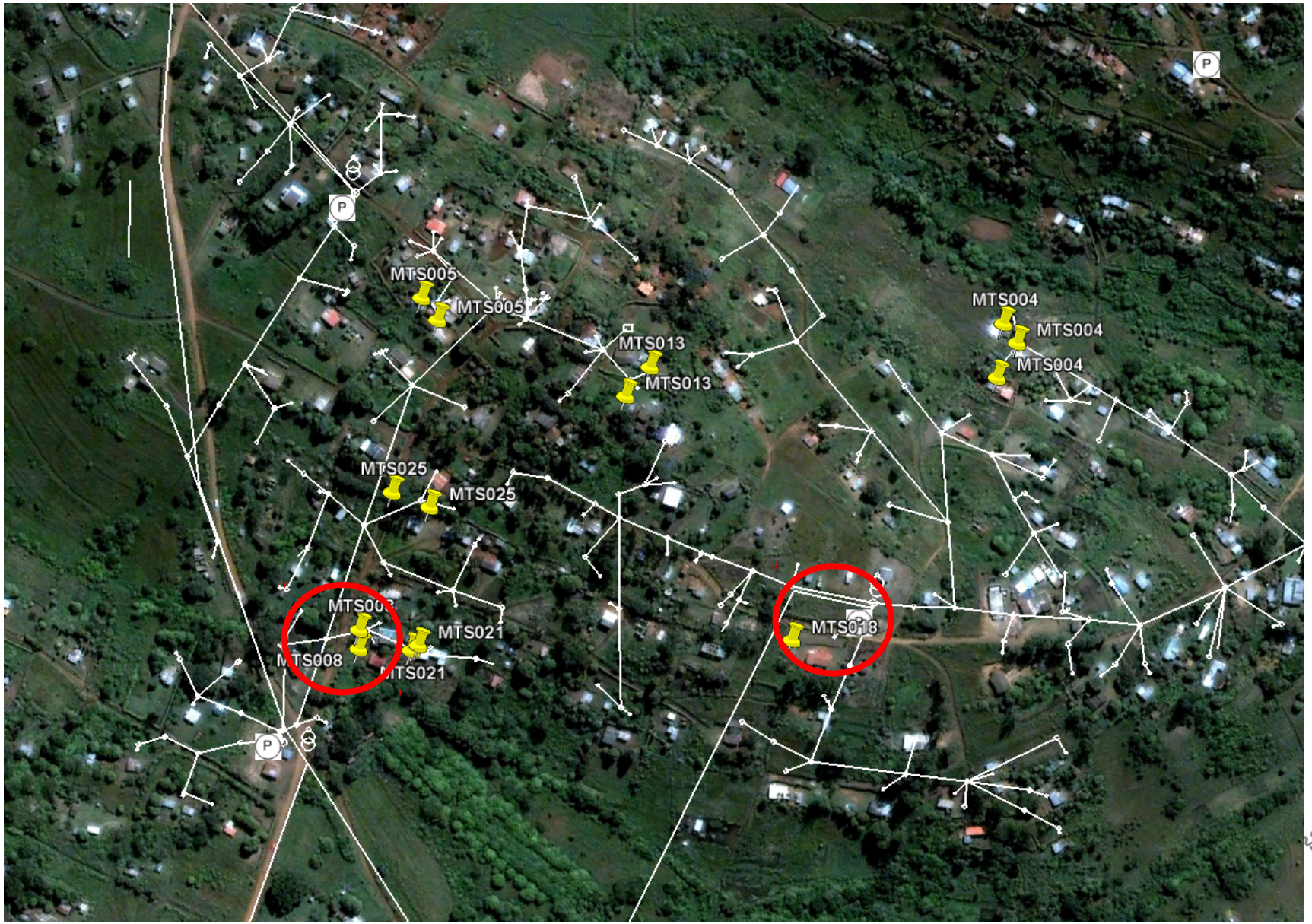
- Matshana
  - MAT08 - Blue phase not connected at transformer
  - MAT09 – Blue phase not used on main feeder
- Hankey
  - Many house connections with Live / Neutral swapped or Earth disconnected
  - Dangerous wiring

NRS048 QOS voltage violations at LR sites

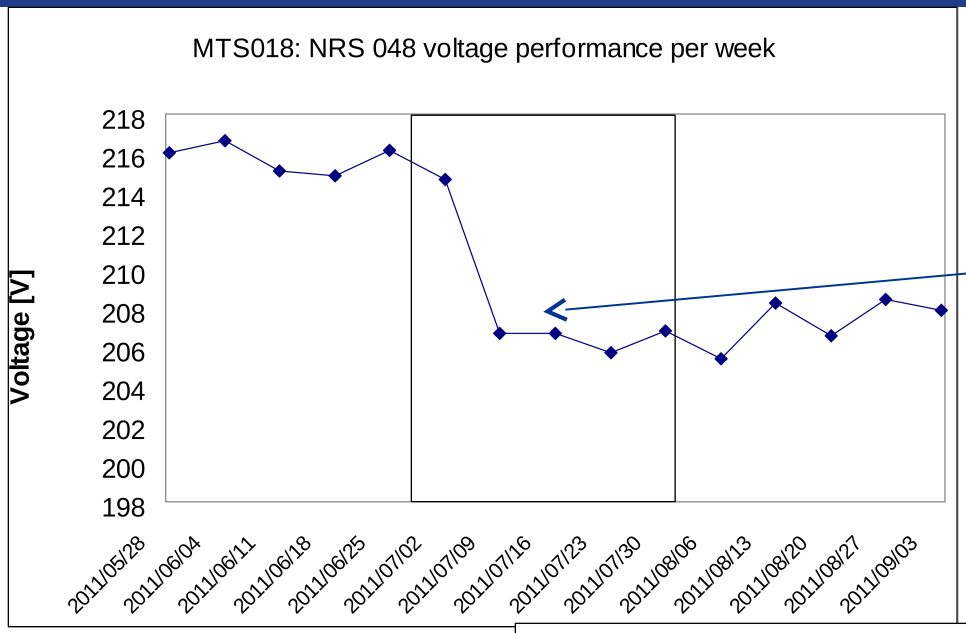


Used **measured** voltage and applied NRS 048 QOS criteria to obtain violations

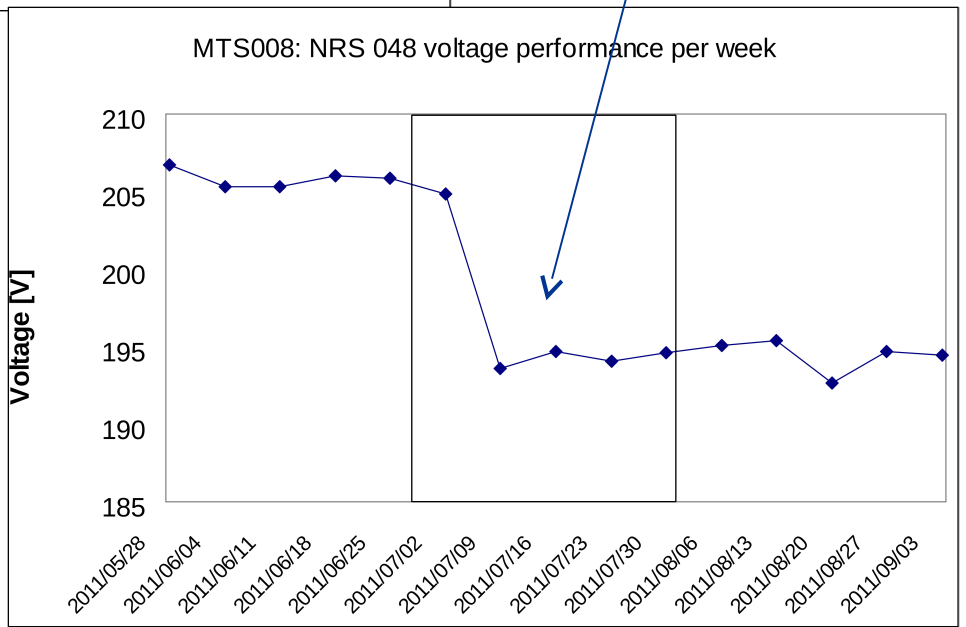
MTS008 / MTS 018 – close to transformer



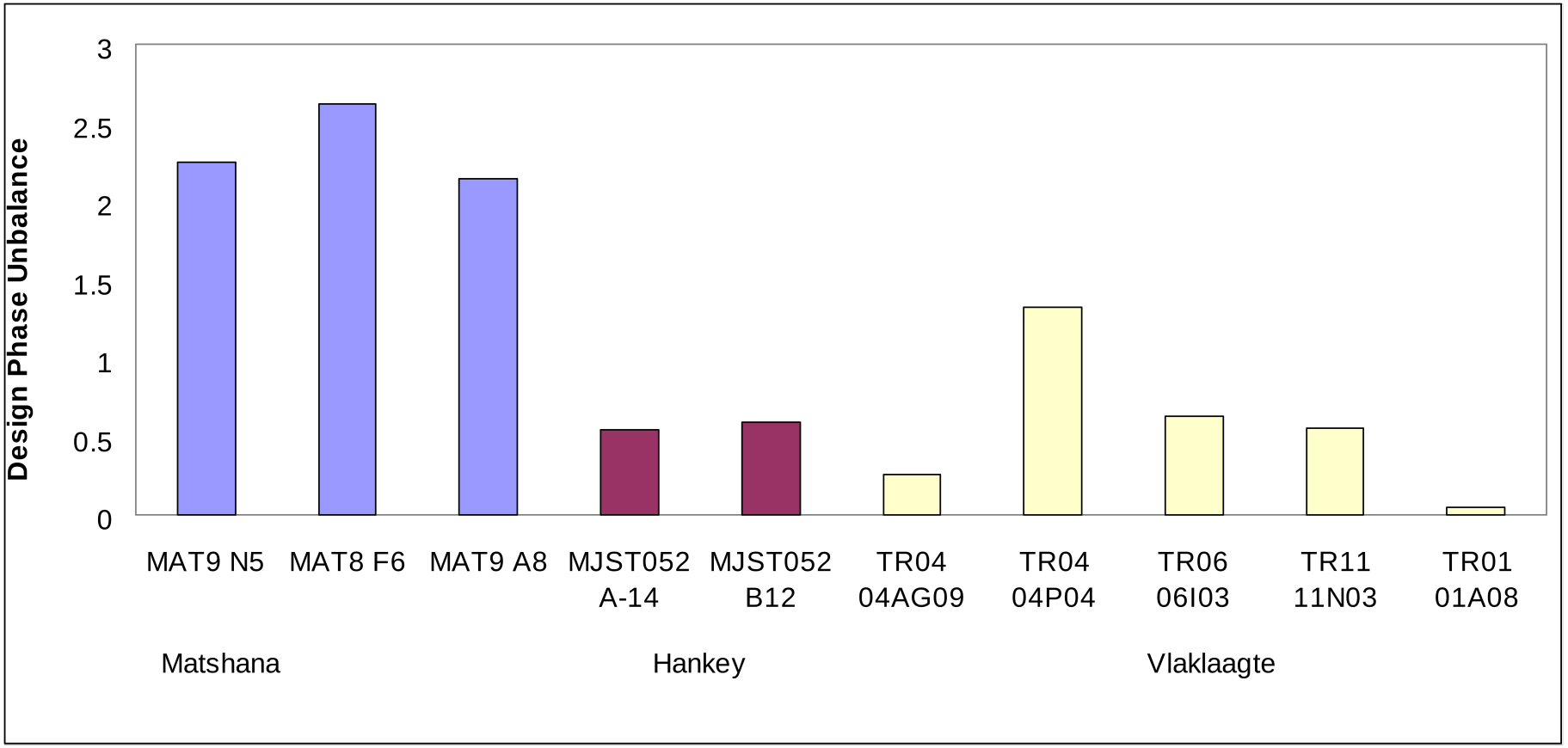
Voltage performance at MTS 018 & MTS 008



MV supply voltage movement



Phase unbalance



NRS 048 Voltage performance simulator

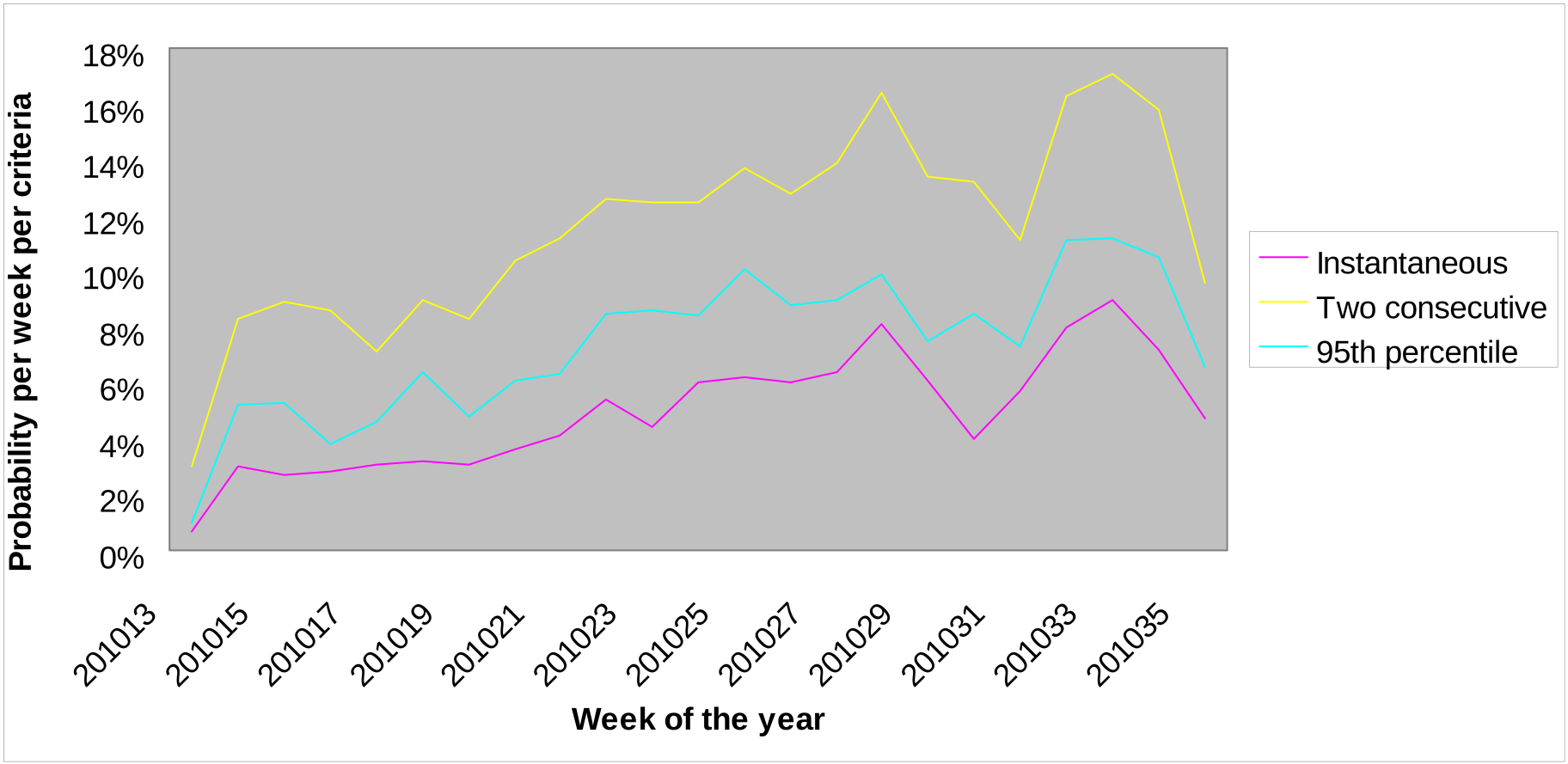
- Extend measured results to more general
- Uses household load measurements at a site
- Performs Monte Carlo simulations
- Calculates NRS048 voltage performance

- Compare with actual measurements

NRS 048

- Three conditions
  - 10 minute supply within +10% to -15%
  - 95th percentile per day
  - Two consecutive ten minutes
- Applied for 1 week
- All three phases

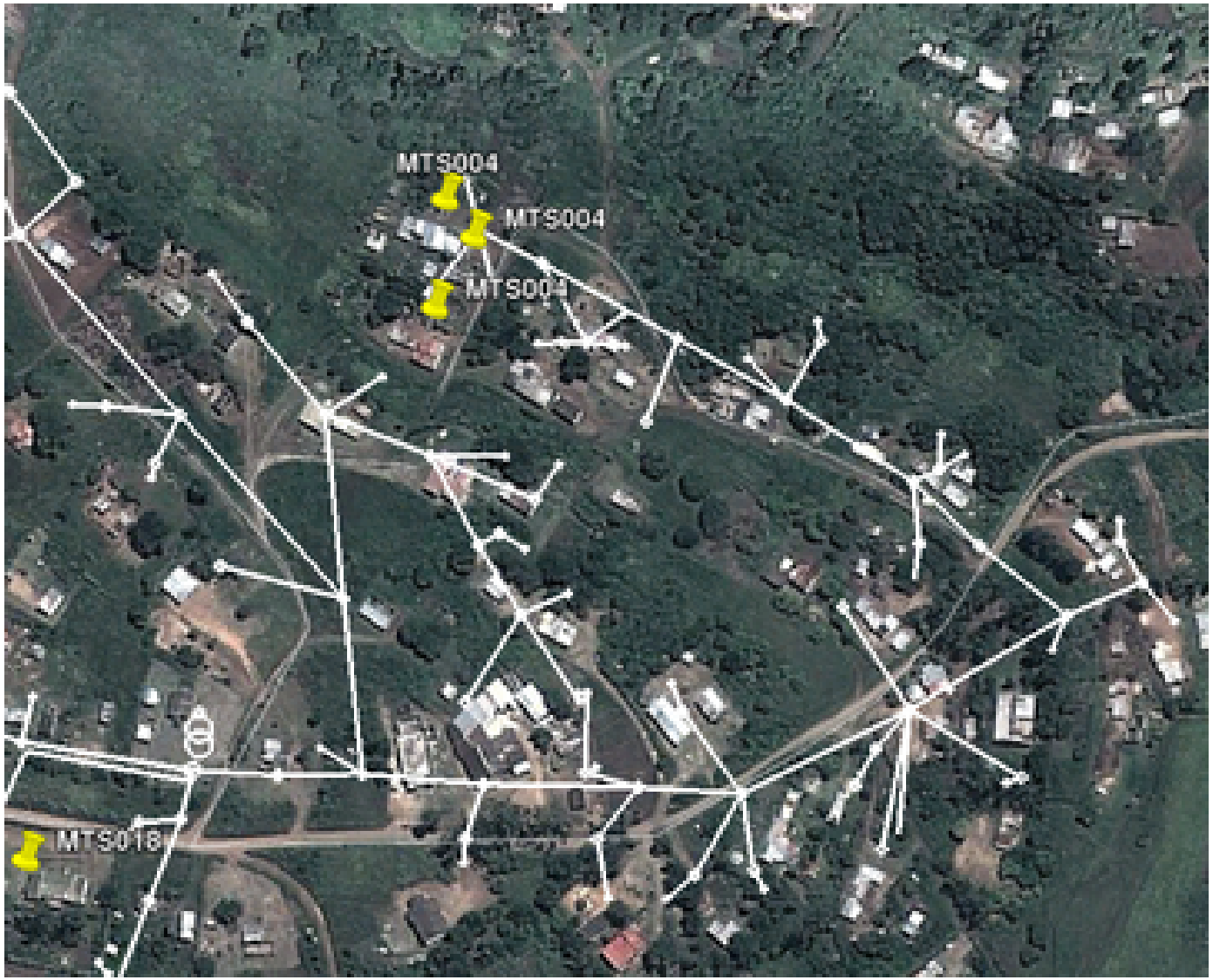
Two consecutive periods dominate



Simulation per site

- Matshana, Hankey and Vlaklaagte
- Select feeder such that
  - DLR logger at or near end
  - DLR logger at or near start
  - Both DLR loggers on the same phase

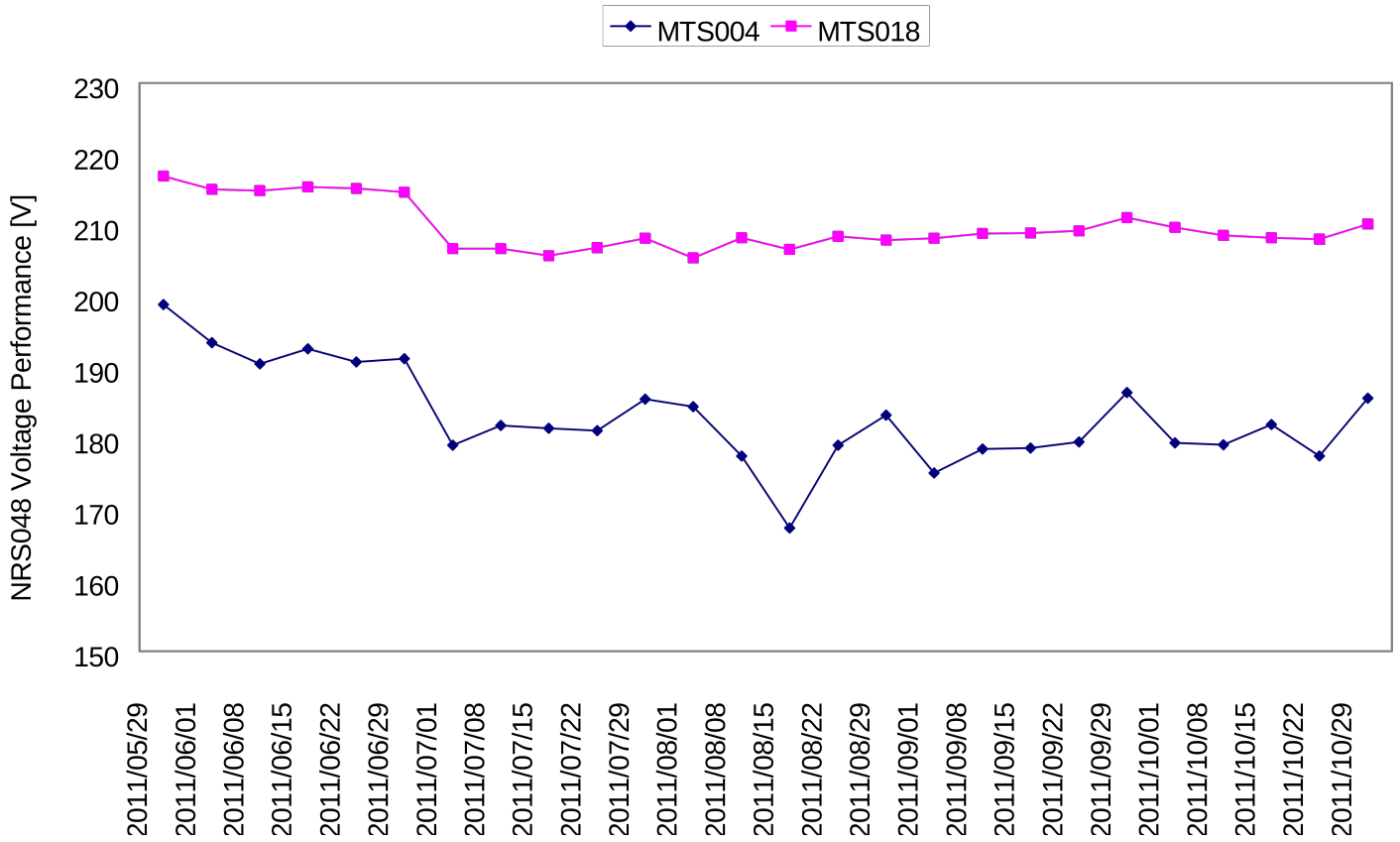
Matshana – selected feeder for analysis

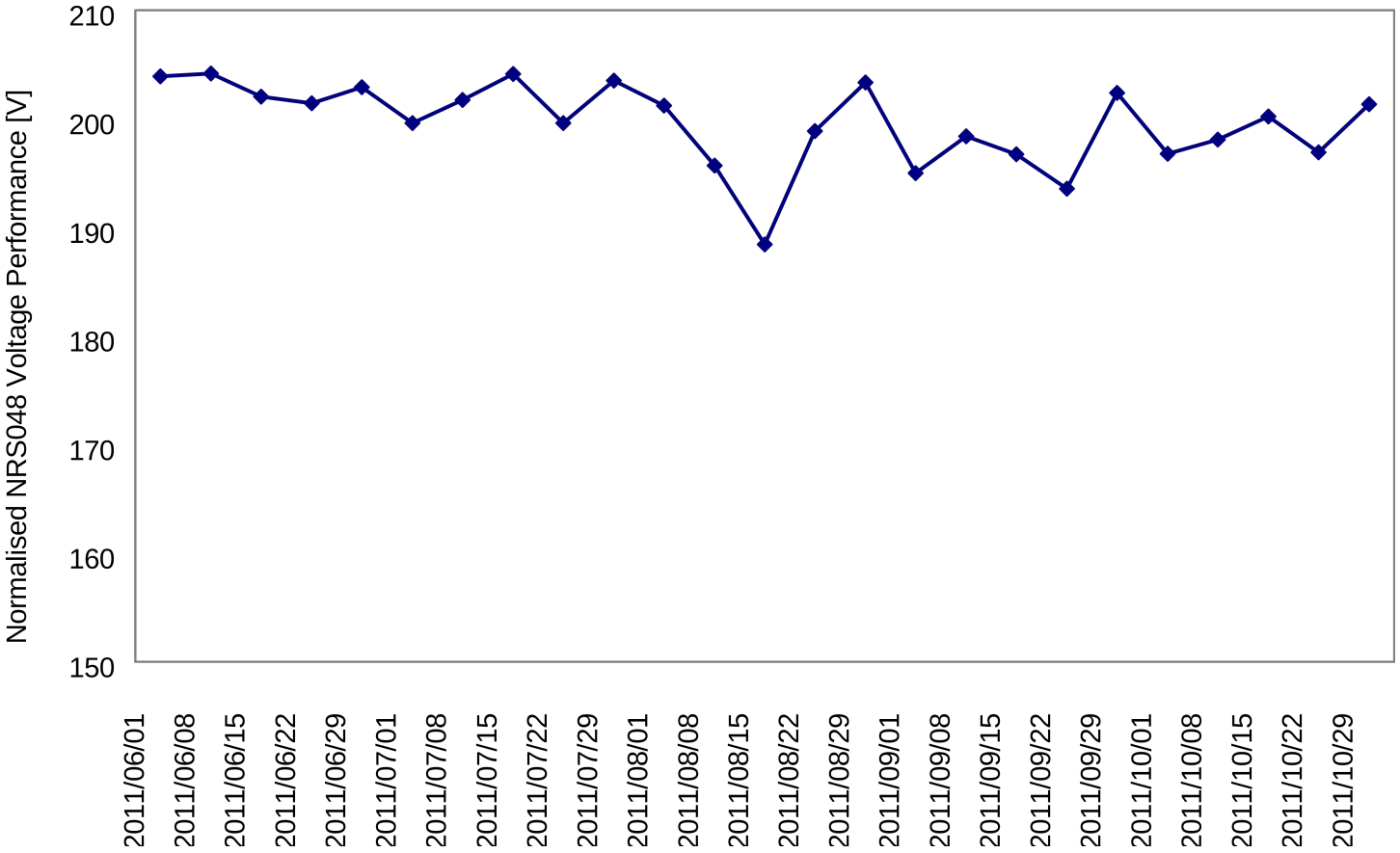


MatshanA - Feeder

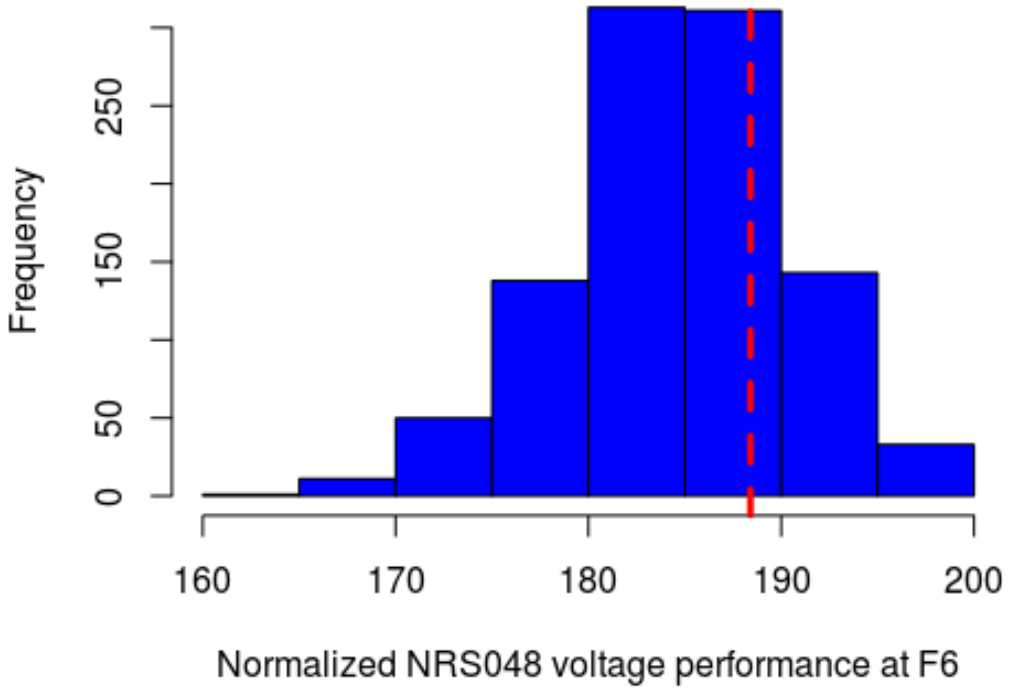
Red	White	Blue	Length	Conductor
0	0	0	28	ABC 70mm²
23	0	0	27	ABC 70mm²
2	0	0	45	ABC 70mm²
1	0	0	53	ABC 70mm²
4	0	0	6	ABC 70mm²
5	0	0	87	ABC 70mm²
3	0	0	60	ABC 70mm²
0	0	0	33	ABC 70mm²
0	3	0	35	ABC 70mm²
2	0	0	47	ABC 70mm²
0	0	0	50	ABC 70mm²
3	0	0	57	ABC 70mm²
3	0	0	15	ABC 70mm²

Matshana - Measurements

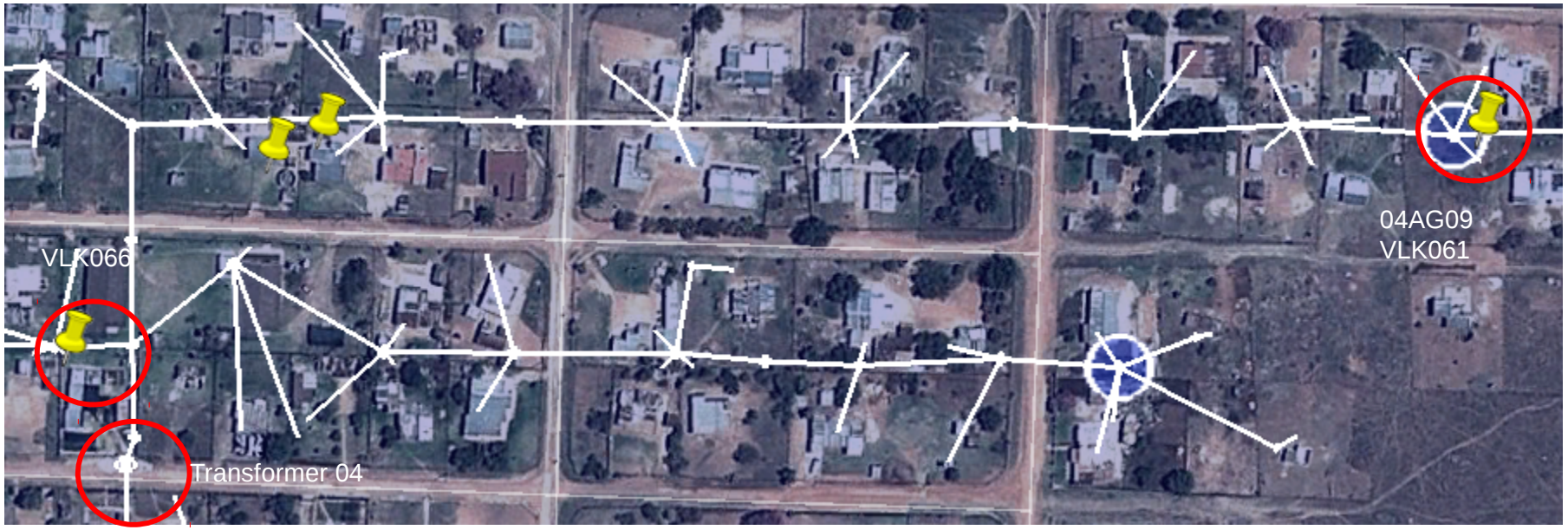



Normalised NRS048 Voltage Performance [V]
210
200
190
180
170
160
150
2011/06/01
2011/06/08
2011/06/15
2011/06/22
2011/06/29
2011/07/01
2011/07/08
2011/07/15
2011/07/22
2011/07/29
2011/08/01
2011/08/08
2011/08/15
2011/08/22
2011/08/29
2011/09/01
2011/09/08
2011/09/15
2011/09/22
2011/09/29
2011/10/01
2011/10/08
2011/10/15
2011/10/22
2011/10/29

Matshana - Simulation results



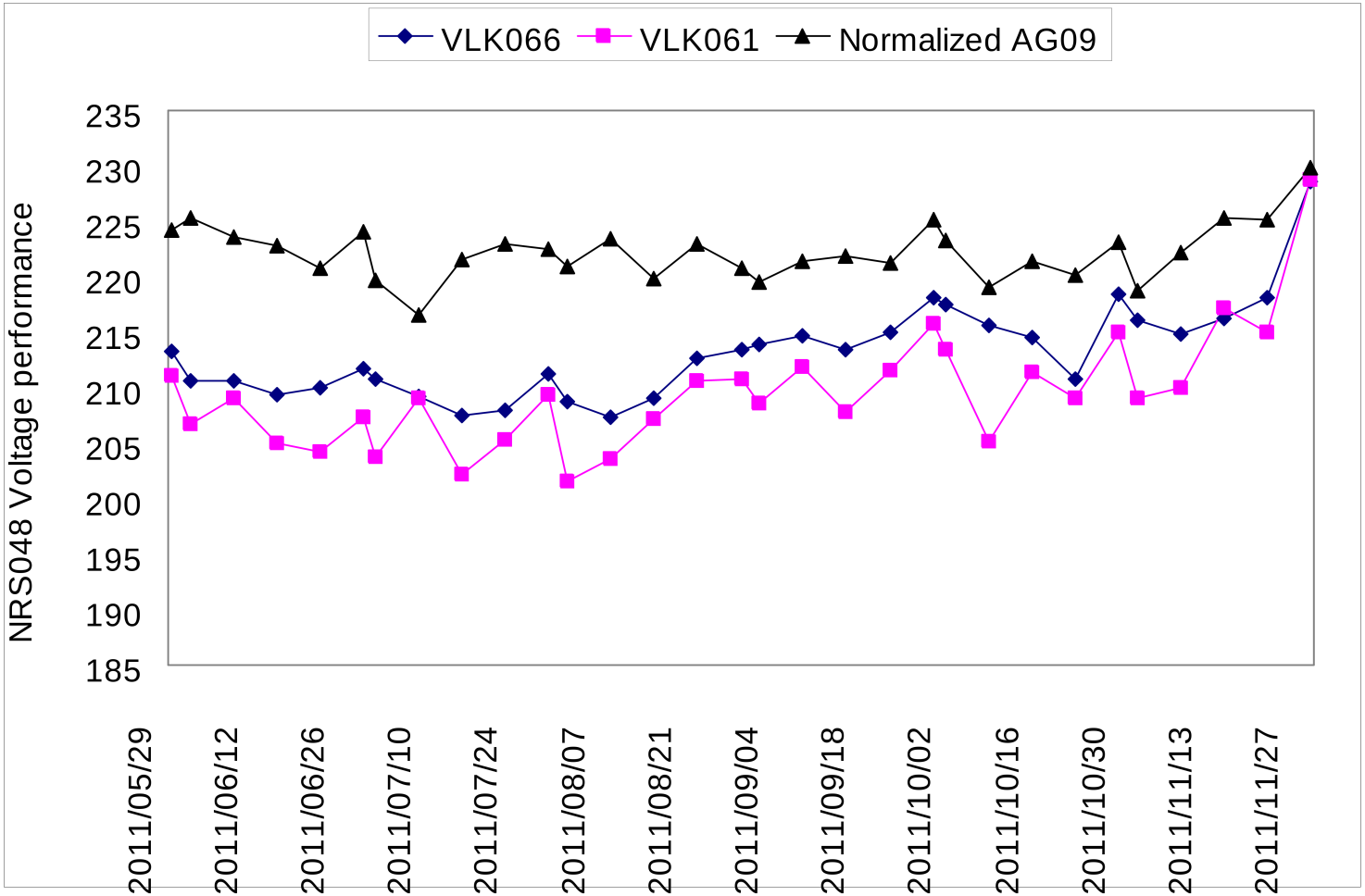
Vlaklaagte – selected feeder



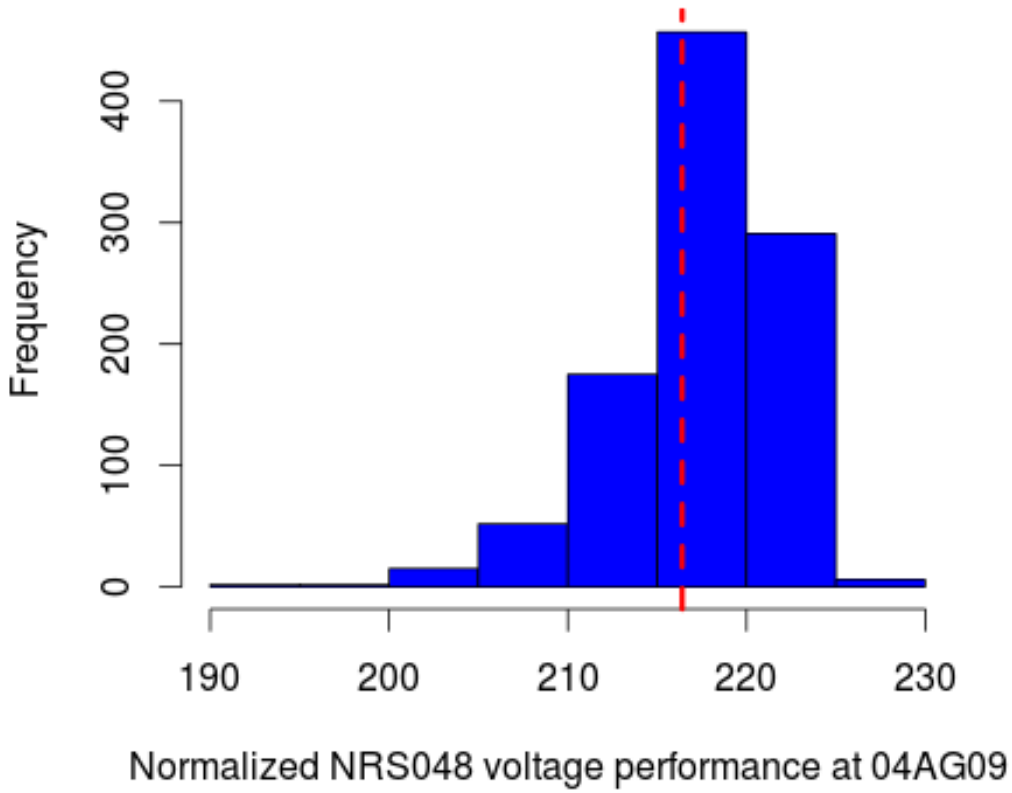
Vlaklaagte - feeder

Red	White	Blue	Length	Conductor
0	0	0	9	ABC 70mm²
11	16	13	29	ABC 70mm²
0	0	0	33	ABC 70mm²
4	14	3	36	ABC 70mm²
0	0	3	27	ABC 70mm²
5	0	0	53	ABC 70mm²
0	2	0	44	ABC 70mm²
0	3	0	49	ABC 70mm²
0	4	0	56	ABC 70mm²
1	0	0	52	ABC 70mm²
0	0	3	39	ABC 70mm²
0	0	4	51	ABC 70mm²
4	0	0	50	ABC 70mm²

Vlaklaagte - measurements

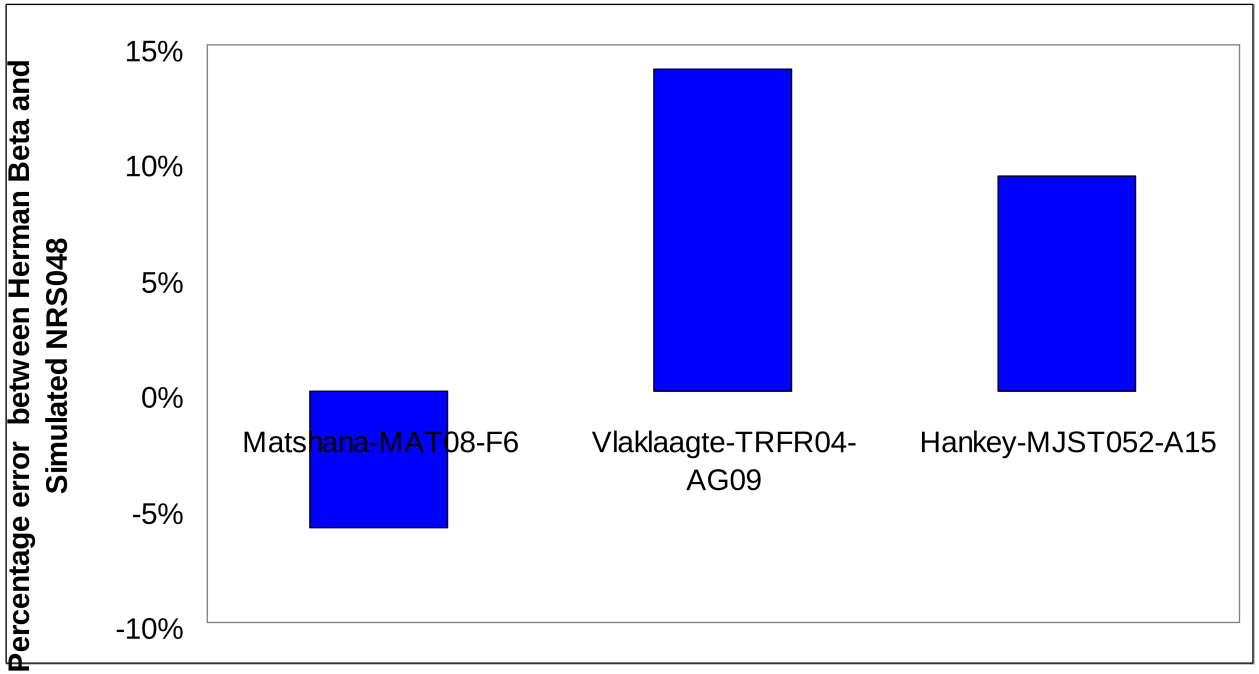


Vlaklaagte – simulation results

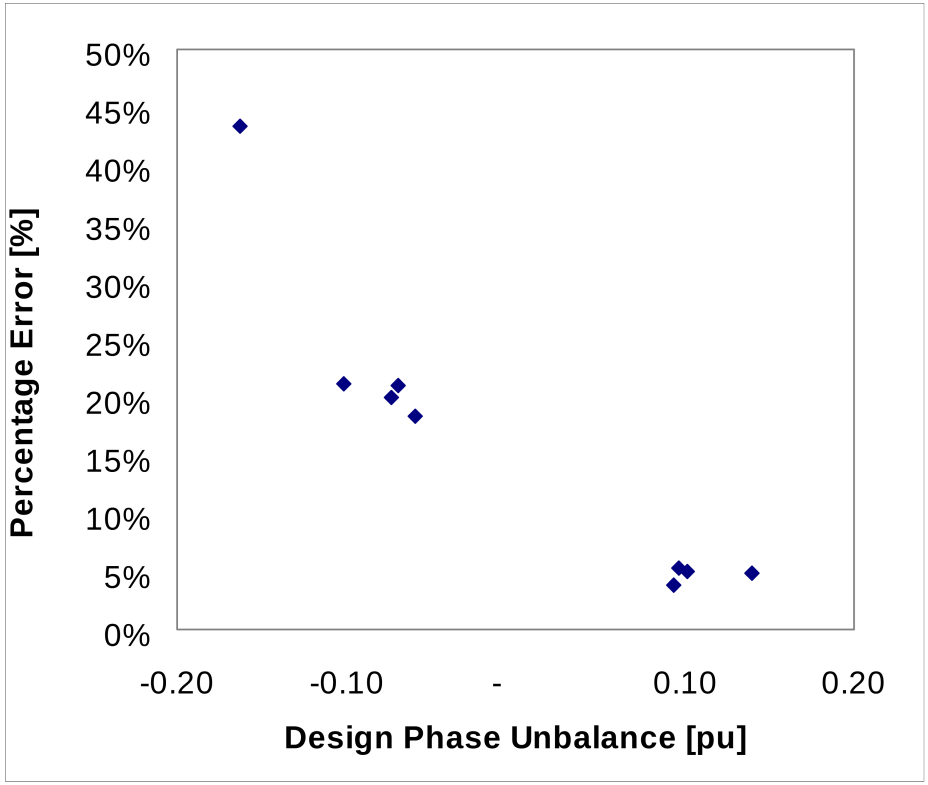


Herman Beta vs NRS 048 simulation

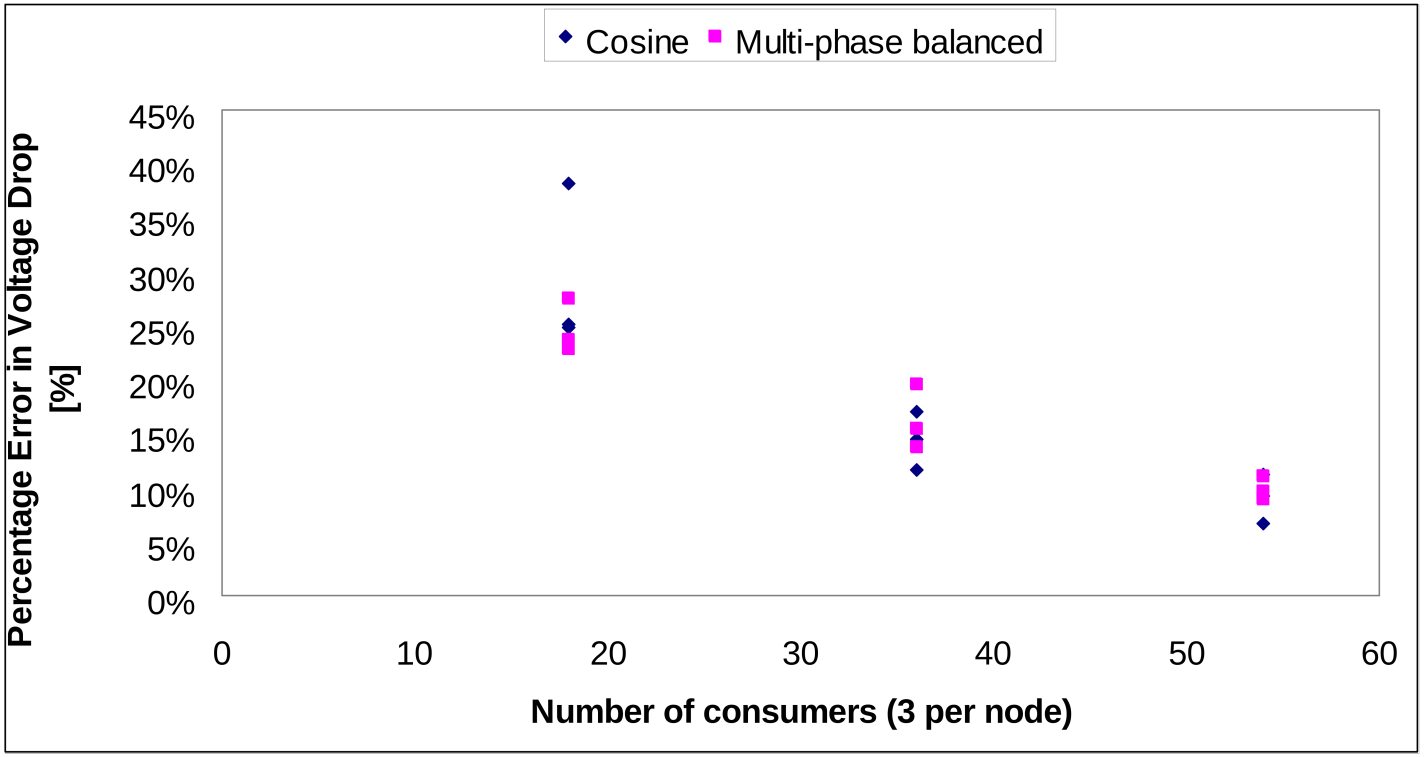
Site	ADMD	alpha	beta	Cb
Matshana	5.95	1.25	11.33	60.00
Vlaklaagte	4.80	0.46	5.29	60.00
Hankey	4.64	0.74	2.46	20.00



Percentage error vs design phase unbalance



Percentage error vs Number of consumers



Conclusion

- Comparison of real-world data and theoretical models
- Use of Monte Carlo simulations to handle load uncertainty
- Work in progress towards design recommendations