NASPI North American SynchroPhasor Initiative

Using PMUs for Validation of Real Time Model in WECC- a Step toward Dynamic Assessments of SOLs

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WECC

BONNEVILLE POWER ADMINISTRATION

GE imagination at work

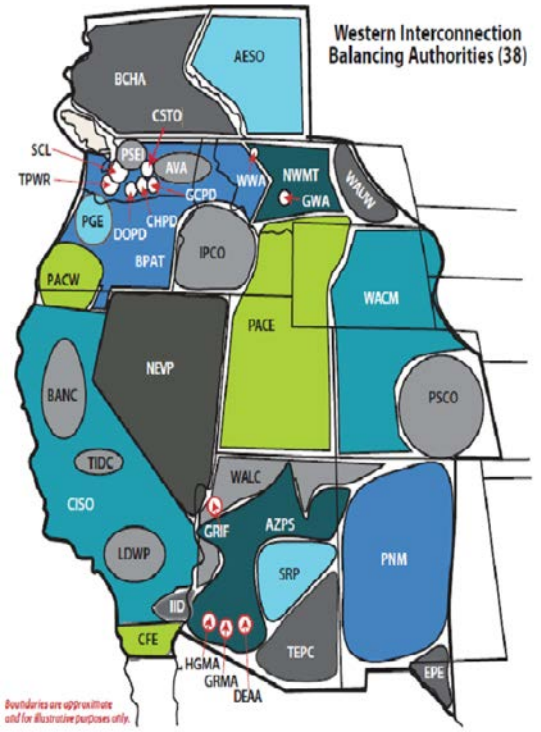
PEAKRELIABILITY
assuring the wide area view

Overview :

- Introduction;
- Present Challenges and Our Vision;
- Where we are at;
- Results;
- Conclusion;

About Peak Reliability

- Peak Reliability provides situational awareness and real-time monitoring of the RC area within Western Interconnection;
  - 14 US states, B.C. and northern portion of Baja;
  - Tools we use:
- State Estimator;
- RTCA (run every 5 min.);
- Voltage Stability;



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Introduction:

- Model is keystone of power system operation and planning:
  - Planning studies - capital investments;
  - Operation studies to set up SOLs:
    - Reliability;
    - Economy of the operation;
- SOLs depend on system model, study assumptions and tools. Seasonal SOLs are static, conservative and result in unused transmission capacity;
- In operation we want to stay within SOLs;

Introduction:

- Dynamic SOLs assessment is crucial to overcome uncertainties of wind generation penetration;
- Model Validation:
  - Plant validation – very good PMU based applications;
  - MOD-33 for system model validation;
- Better models and less uncertainties leads to enhanced reliability and more transmission capacity;
- SOLs studies are performed using WECC base-case (bus-branch model);
- RCs rely on WSM (node breaker model)- monitor system against SOLs exceedance;

Present Challenges and Our Vision;

- We want to maximize model quality and to minimize uncertainties in order to unlock additional transmission capacity and enhance reliability;
  - Perform studies from real-time model;
  - Frequent system model validation (benchmarking model for different levels of stress of the system);
- Obstacles:
  - Real time applications use EMS system;
  - Real time applications use node-breaker model;
  - Those responsible for SOLs evaluation are not familiar with EMS and with node-breaker model;

Where we are at?

- Western Interconnection is the first in the world to:
  - Develop full topology model (EMS node-breaker model) representing entire Western interconnection;
  - Transfer this model in common format, in full topology, into the traditional off line tools engineers are accustomed to (PSLF, V&R Energy, PowerWord);
  - Standardized full topology (node-breaker) powerflow format (same format used by PSLF, V&R Energy, PowerWord);
  - Match EMS model to planning dynamics database and can run dynamic simulation of system events in PSLF and compare to PMUs;

Where we are at?

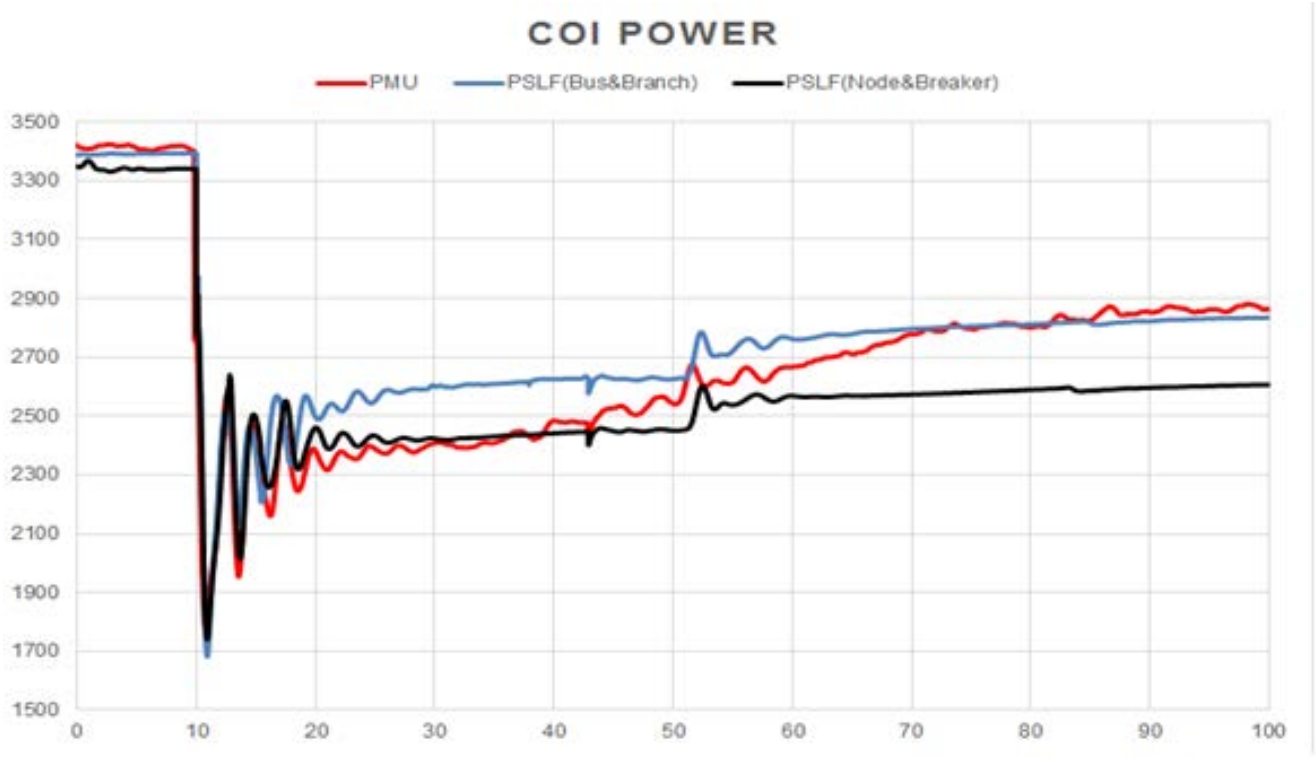
- Create an archive of complete system event cases so that WECC operation entities can easily access and use for validations for their own footprint providing they have PMUs installed;
- Create an archive of powerflow cases that can be used without EMS system to be used to run system studies on demand using off line tools and real-time model;
- Link permanently WSM to WECC base-case in order to be able to cross-check both models;
- Ensuring and testing consistency in between both models through system events;

Results:

- Multiple events simulated in PSLF and results benchmarked against PMUs (we are showing just a few examples):
  - COI baselining for different events (e.g. the benefits of a 100 MW increase in transfer capability on COI to be $35 million to $75 million over 40 years);
  - May 28, 2015 (reclosing of Garrison Taft-switching event);
  - June 17, 2015 (Ch. Jo brake test);

Results (COI flow benchmark-1):

- May 16, 2014 (2,563 MW generation drop)



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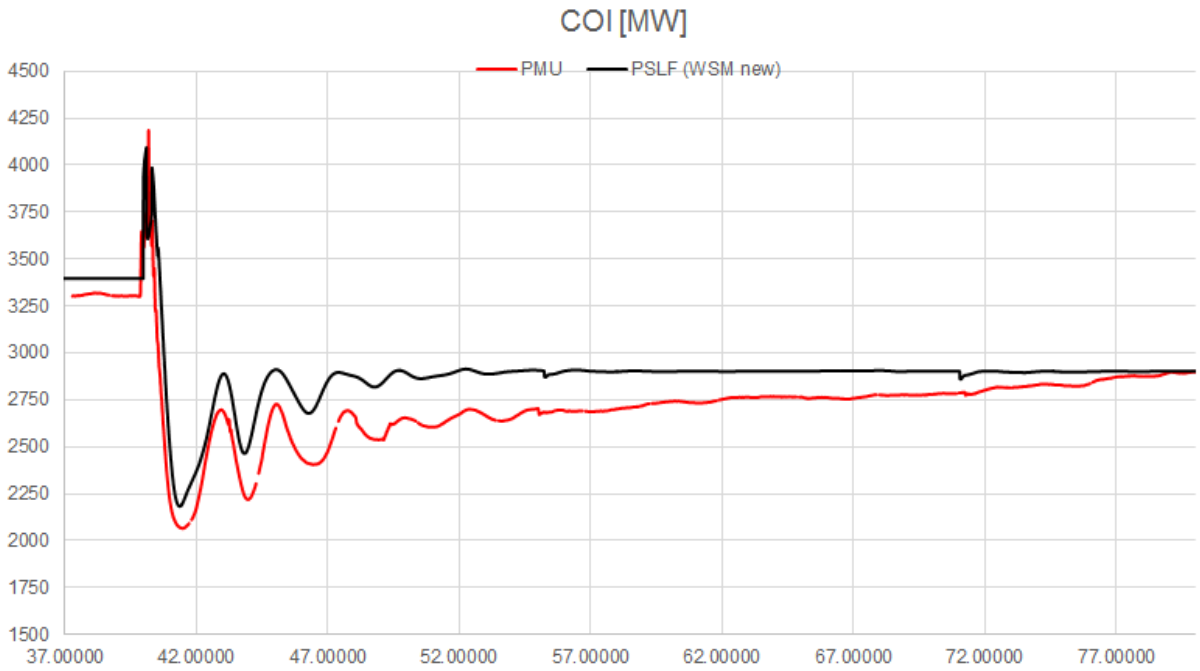
Results (COI flow benchmark-2):

- Event: May 26, 2014 (failure of Celilo 2,826 MW generation drop)



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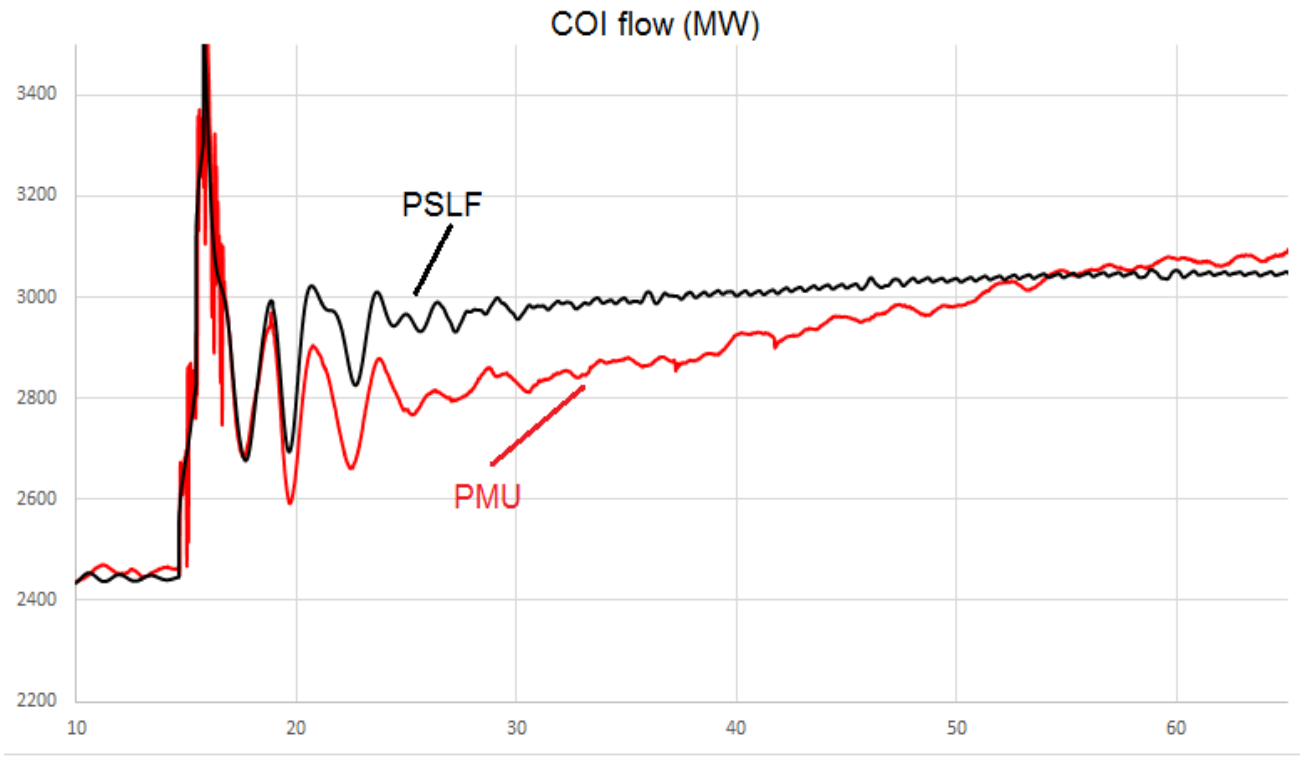
Results (COI flow benchmark-3):

- Event: April 28, 2015 (PDCI trip 1,708 MW generation drop)



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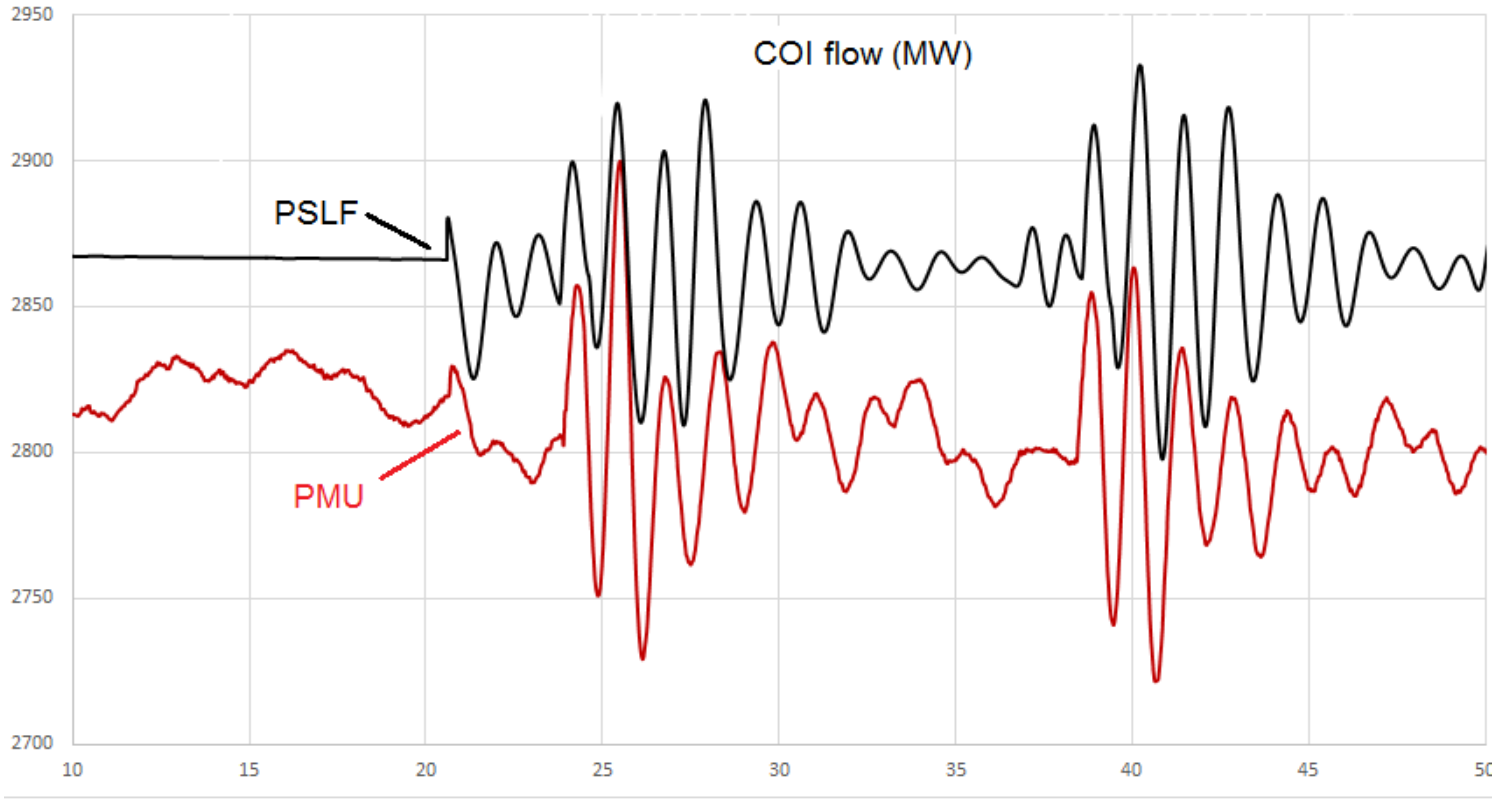
Results (COI flow benchmark-4):

- Event: May 28, 2015 (reclosing of line Garrison-Taft)



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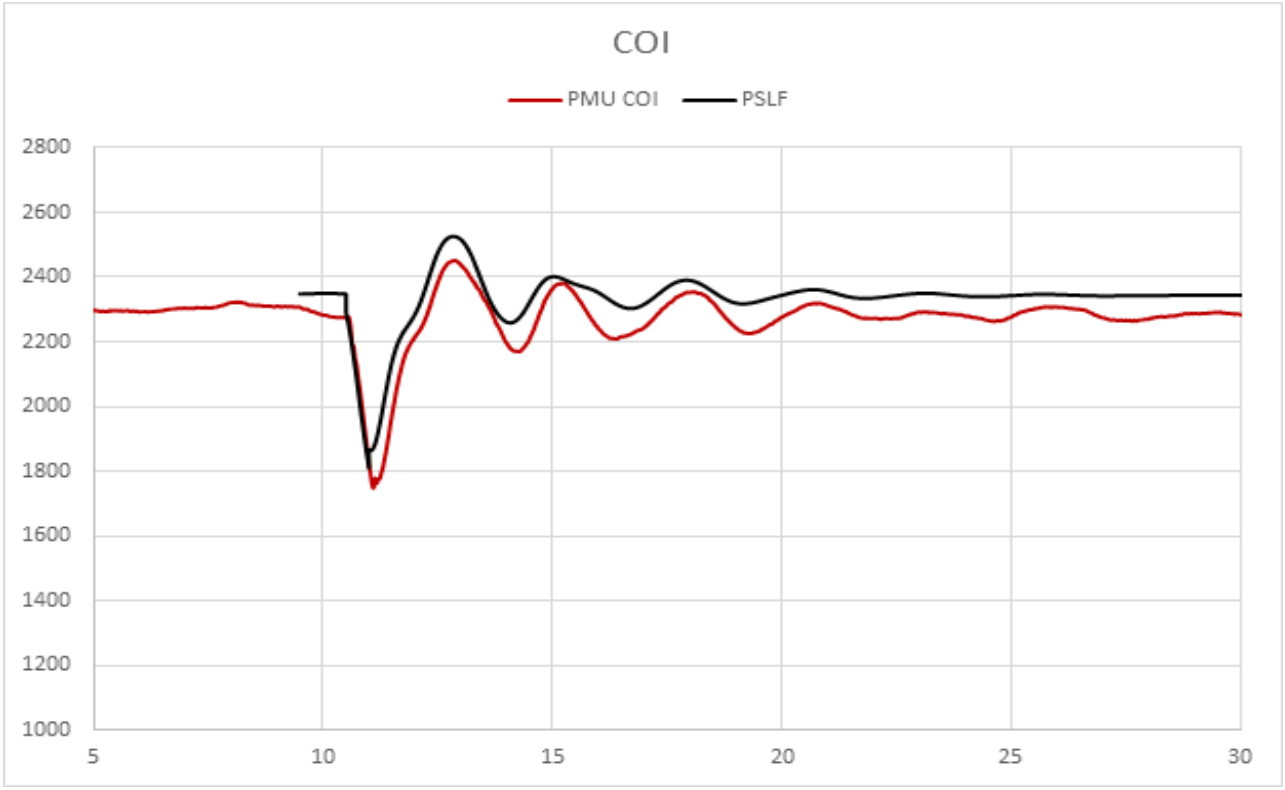
Results (COI flow benchmark-5):

- Event: Chief Joseph brake Insertion



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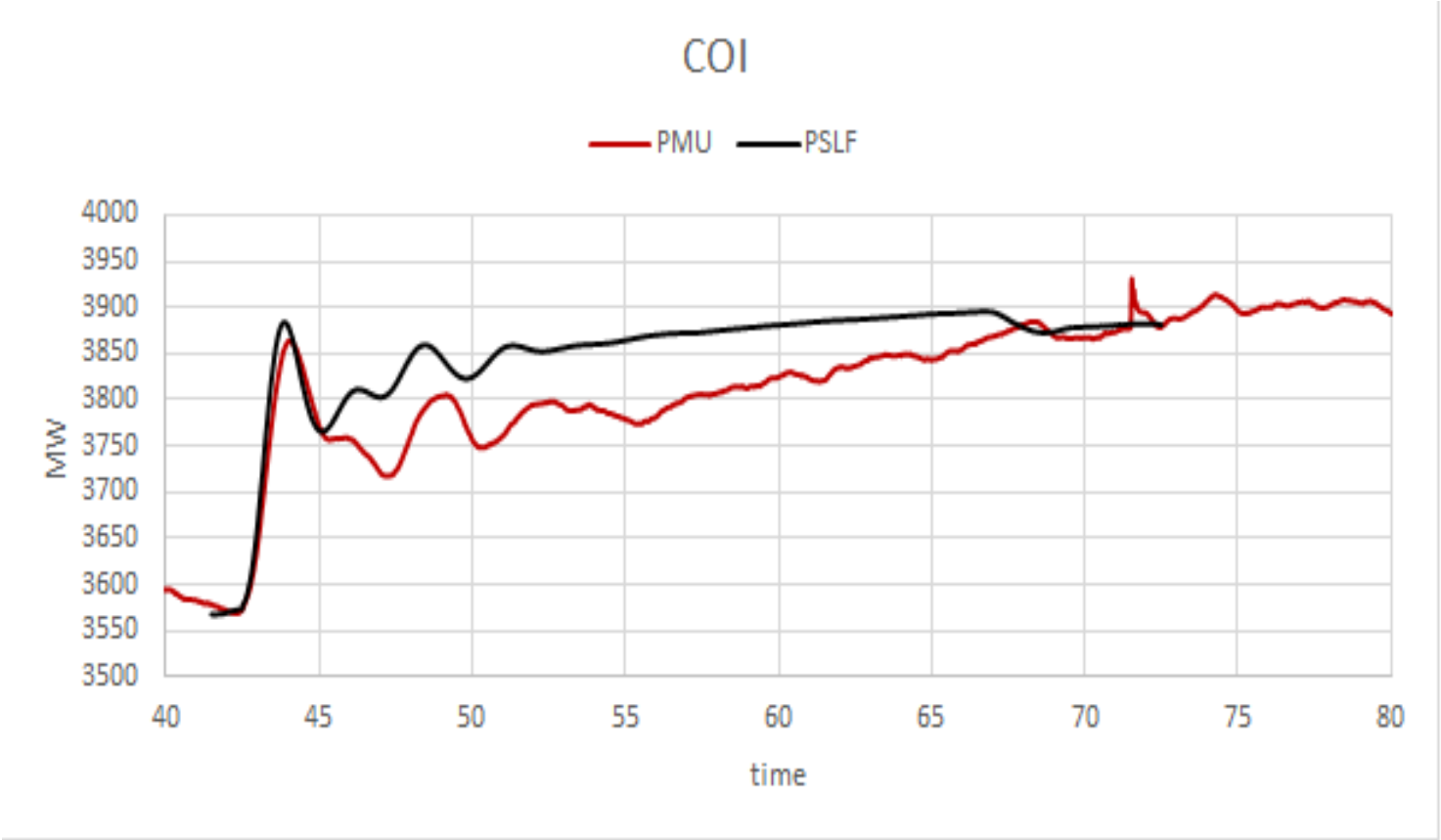
Results (COI flow benchmark-6):

- Event: September 1th, 2015 (Navajo unit trip)



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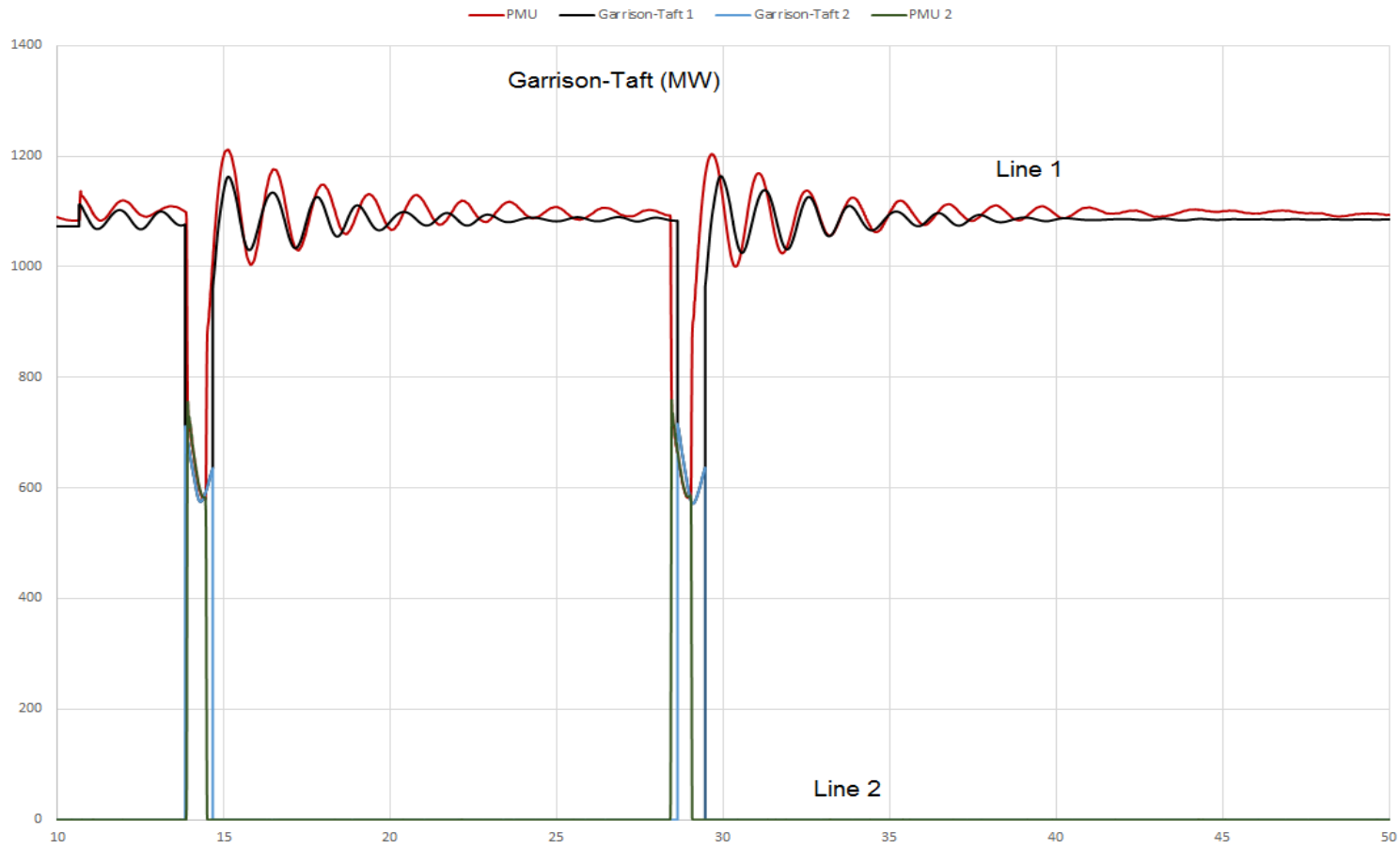
Results (May 28th disturbance):

- Here is what do we see from PMU data:
  - About 12:38:50.65 – Taft voltage jumps 25-kV, Garrison jumps only about 8-kV, no MW flow on Garrison – Taft #2, no MVAR flow on Garrison end, 500 MVAR flow from line to bus at Taft end – clearly line is energized at Taft
  - About 12:38:53.9 – looks like line is closed from Garrison
  - About 12:38.54.45 – looks line opened at Garrison
  - About 12:39:08.35 – line closed again at Garrison
  - About 12:39:09.05 – line opened again at Garrison

Results (May 28th disturbance):

- Event: May 28, 2015 (reclosing of line Garrison-Taft)



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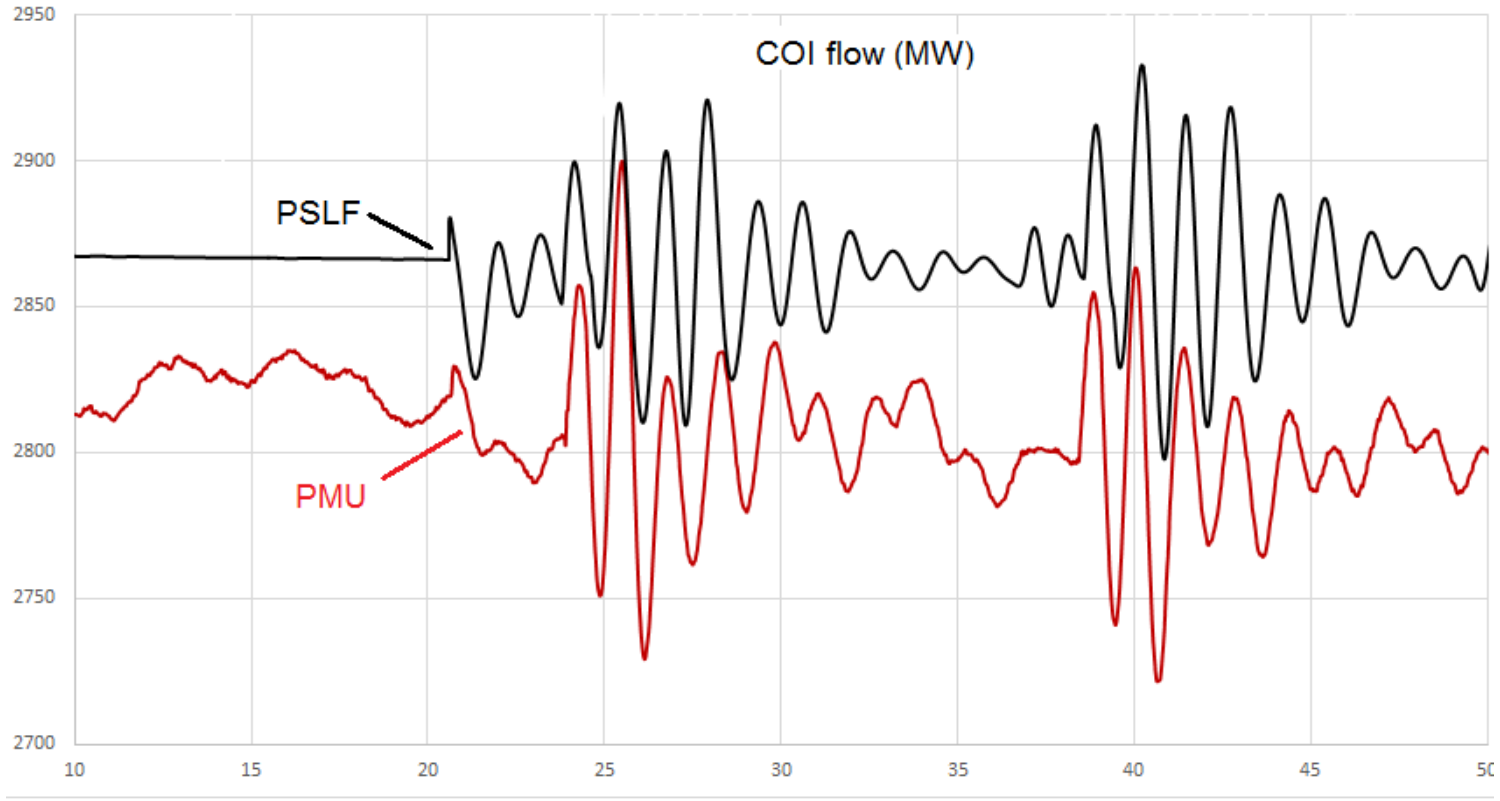

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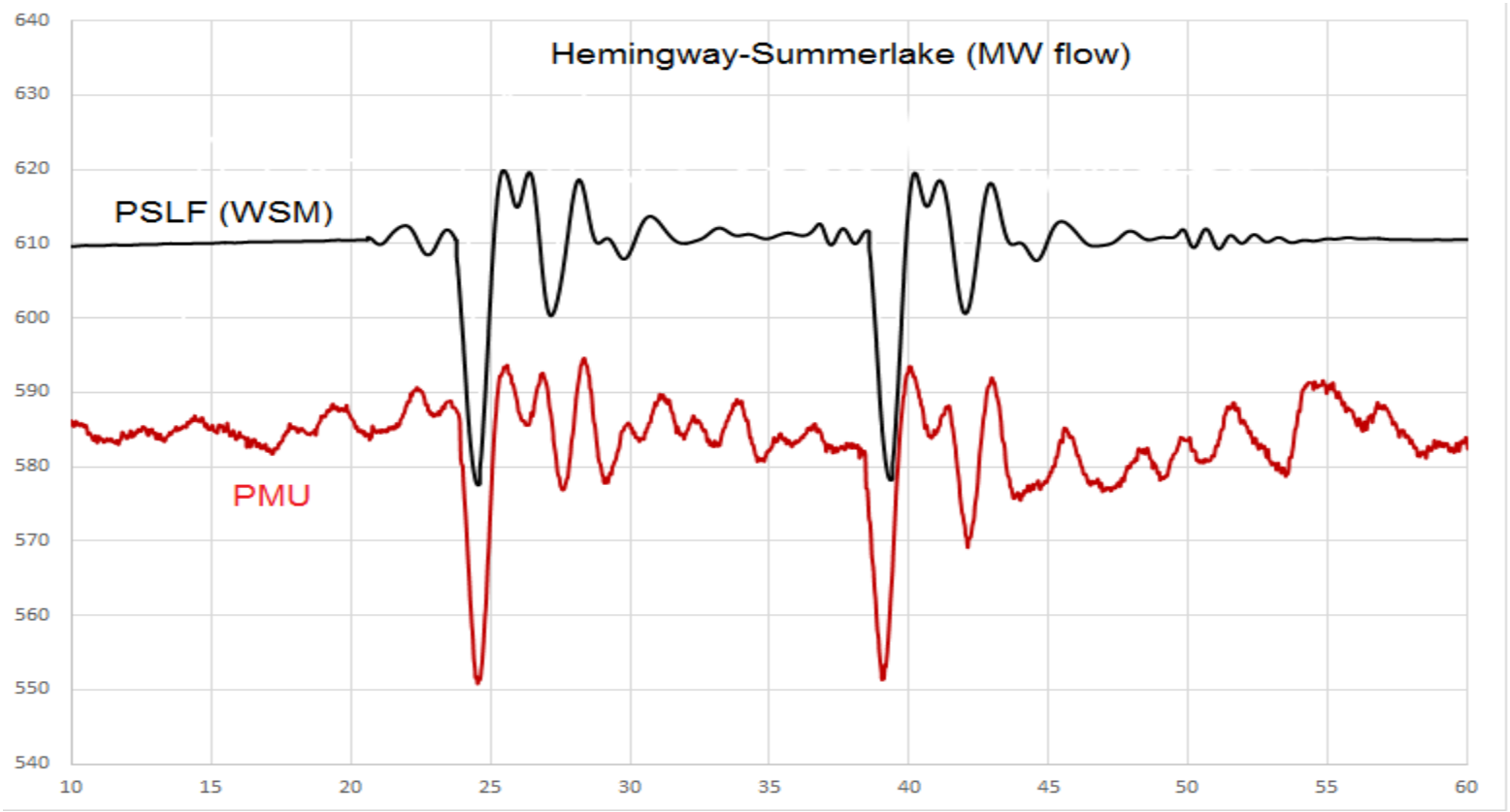

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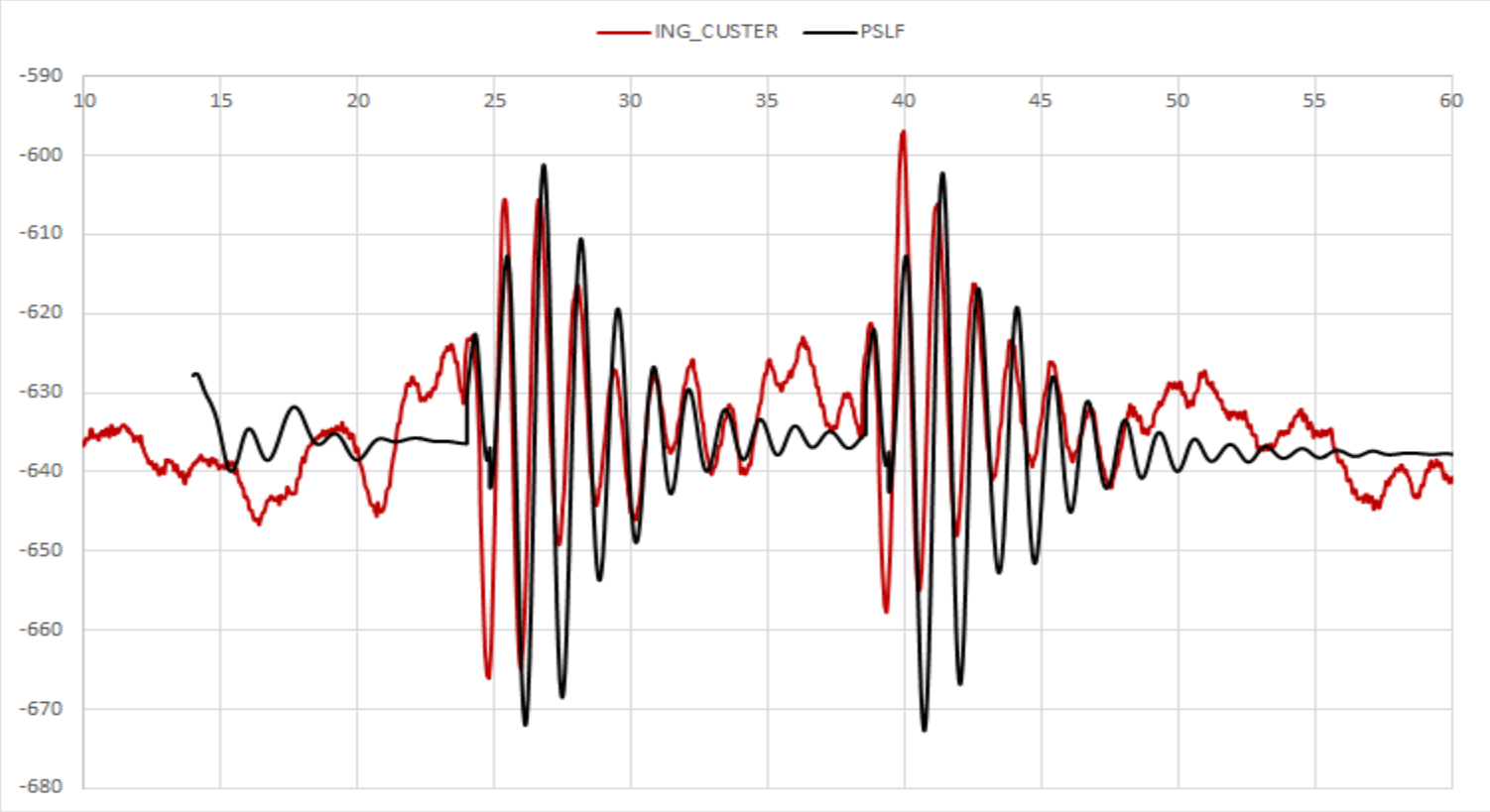
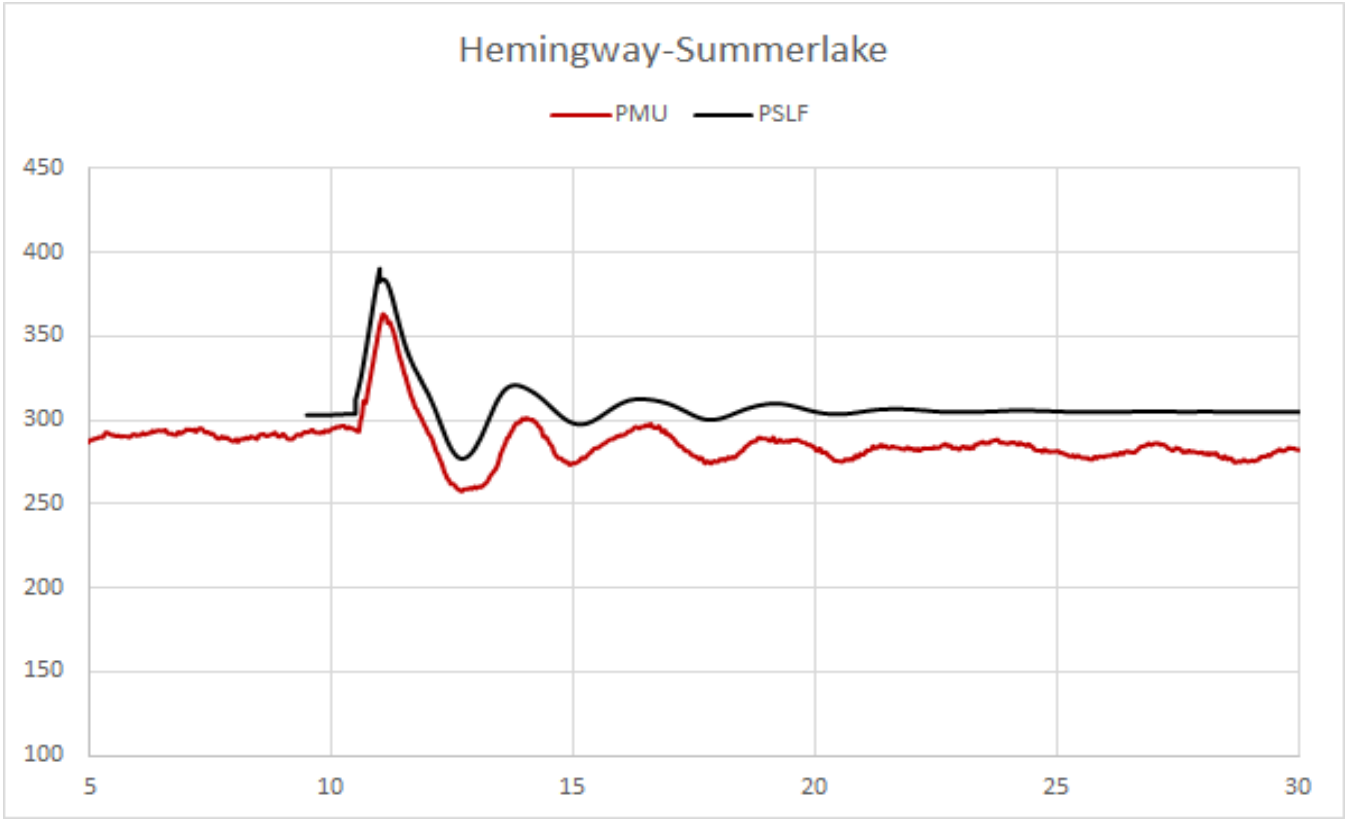


PEAKRELIABILITY

Results (June 17th Chief Joseph brake test):



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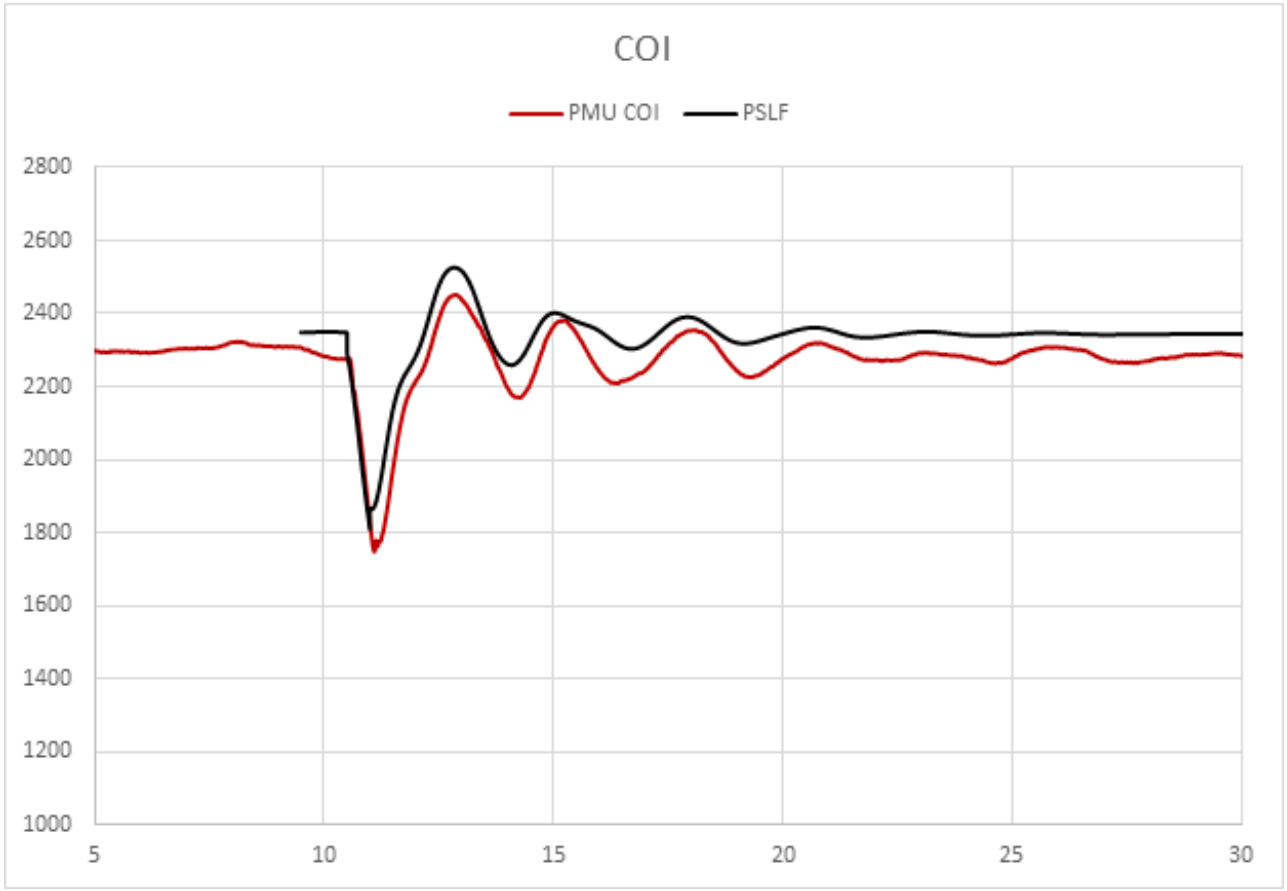

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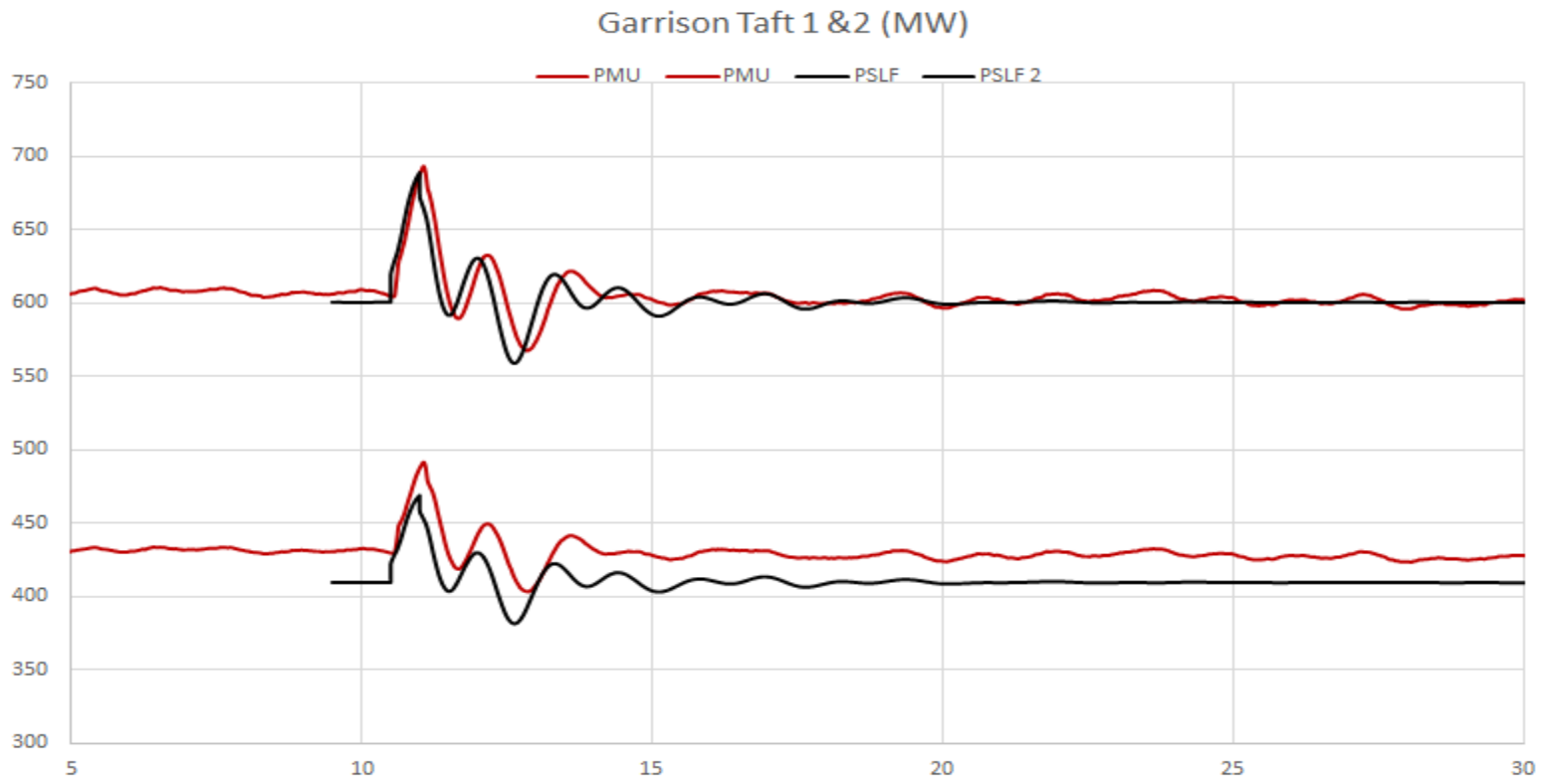

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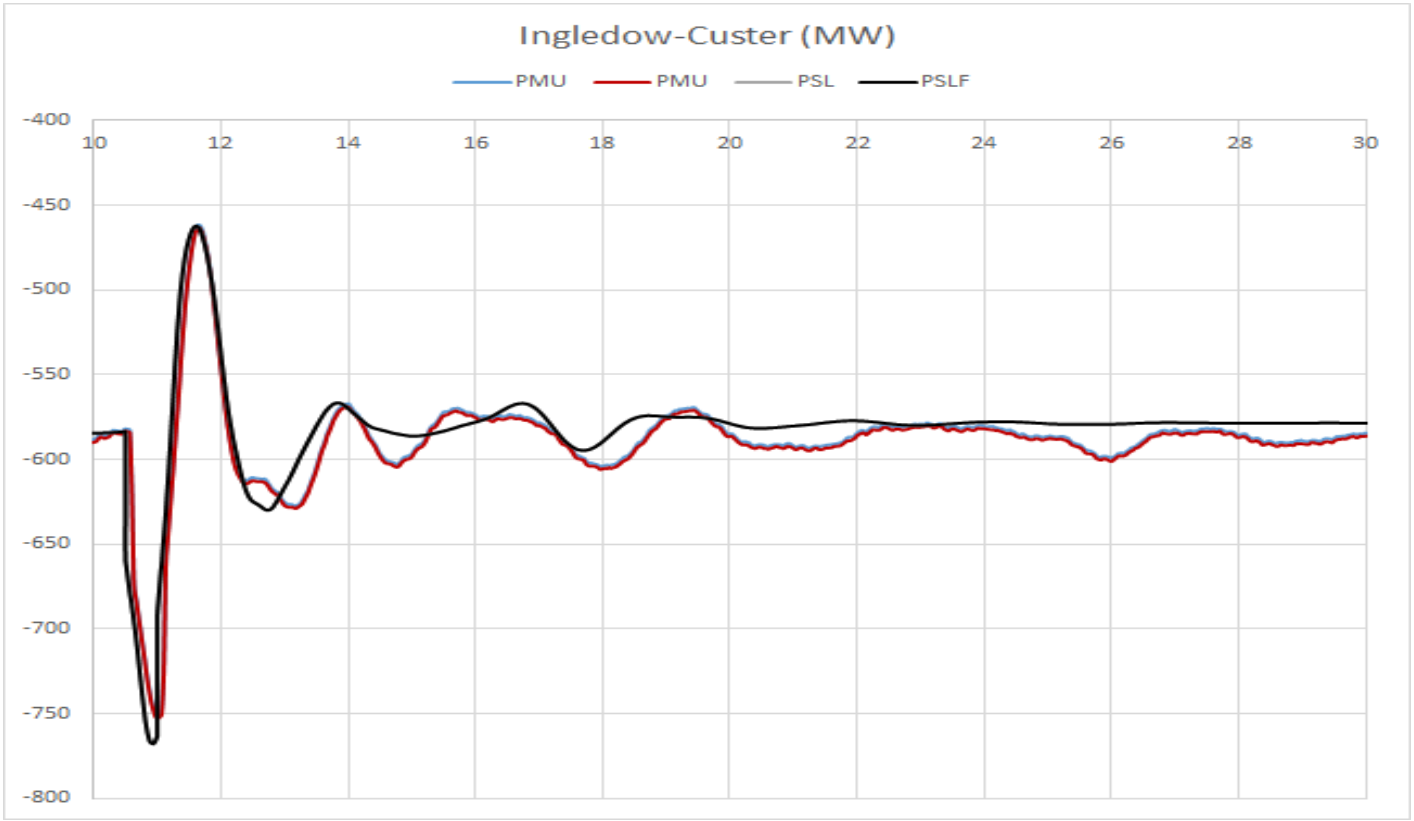

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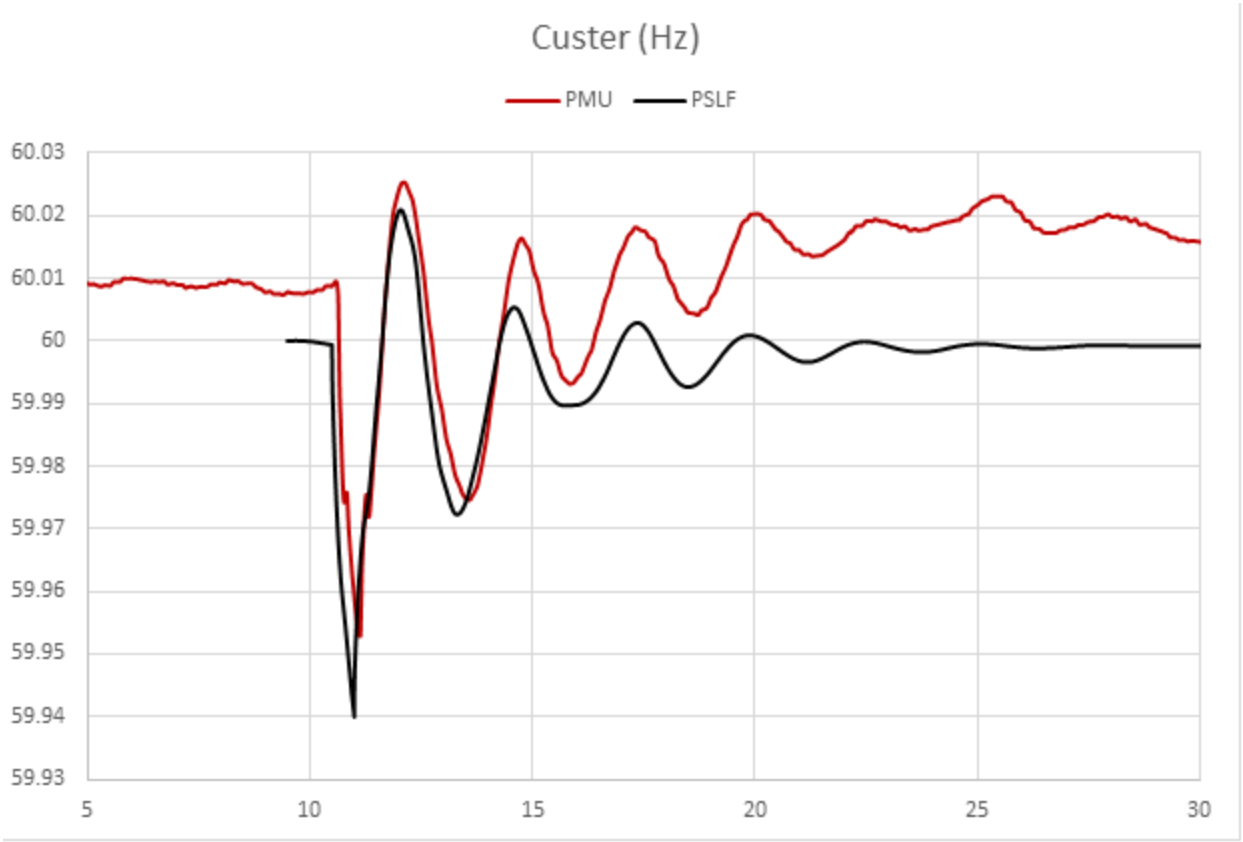

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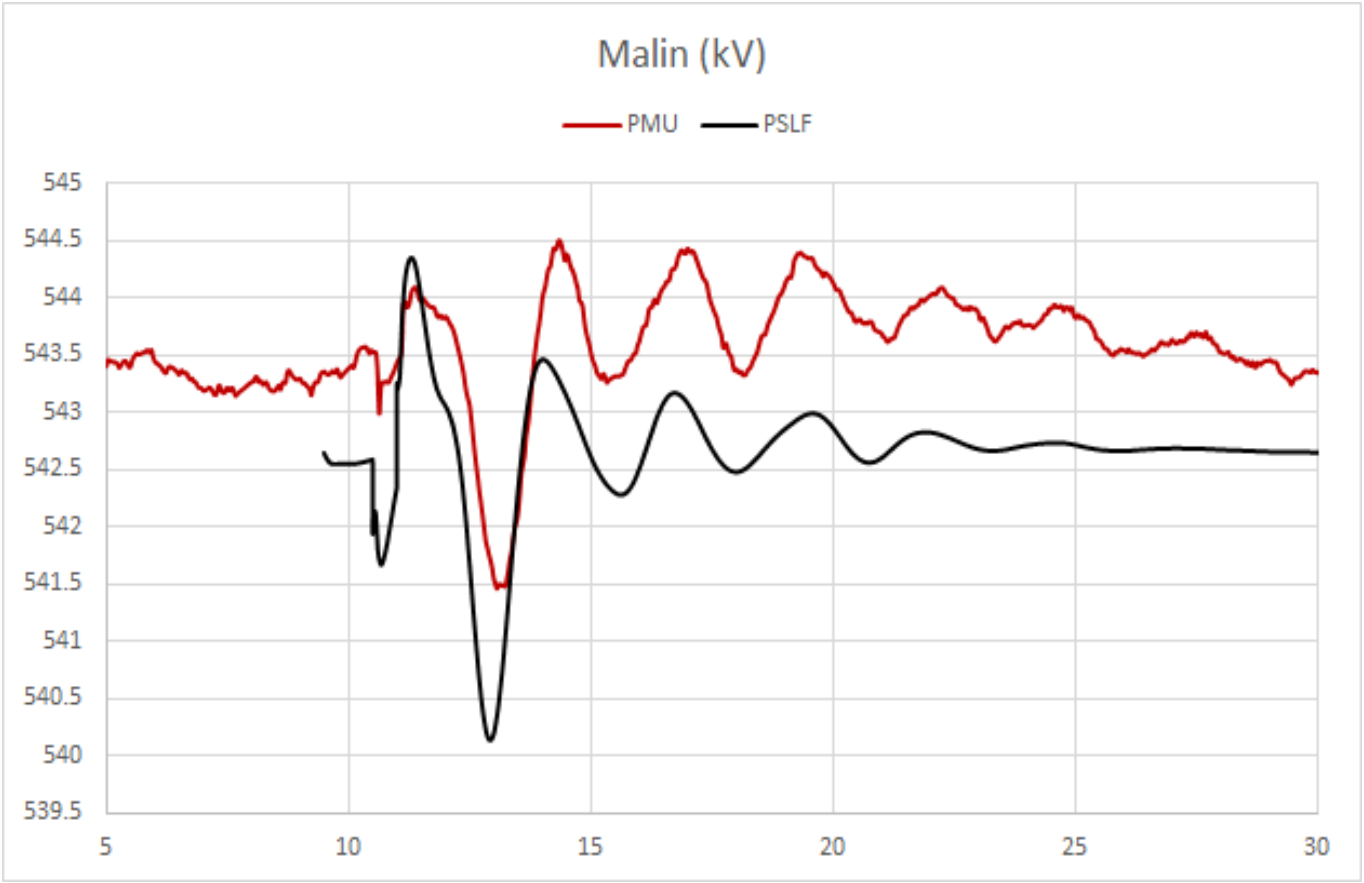

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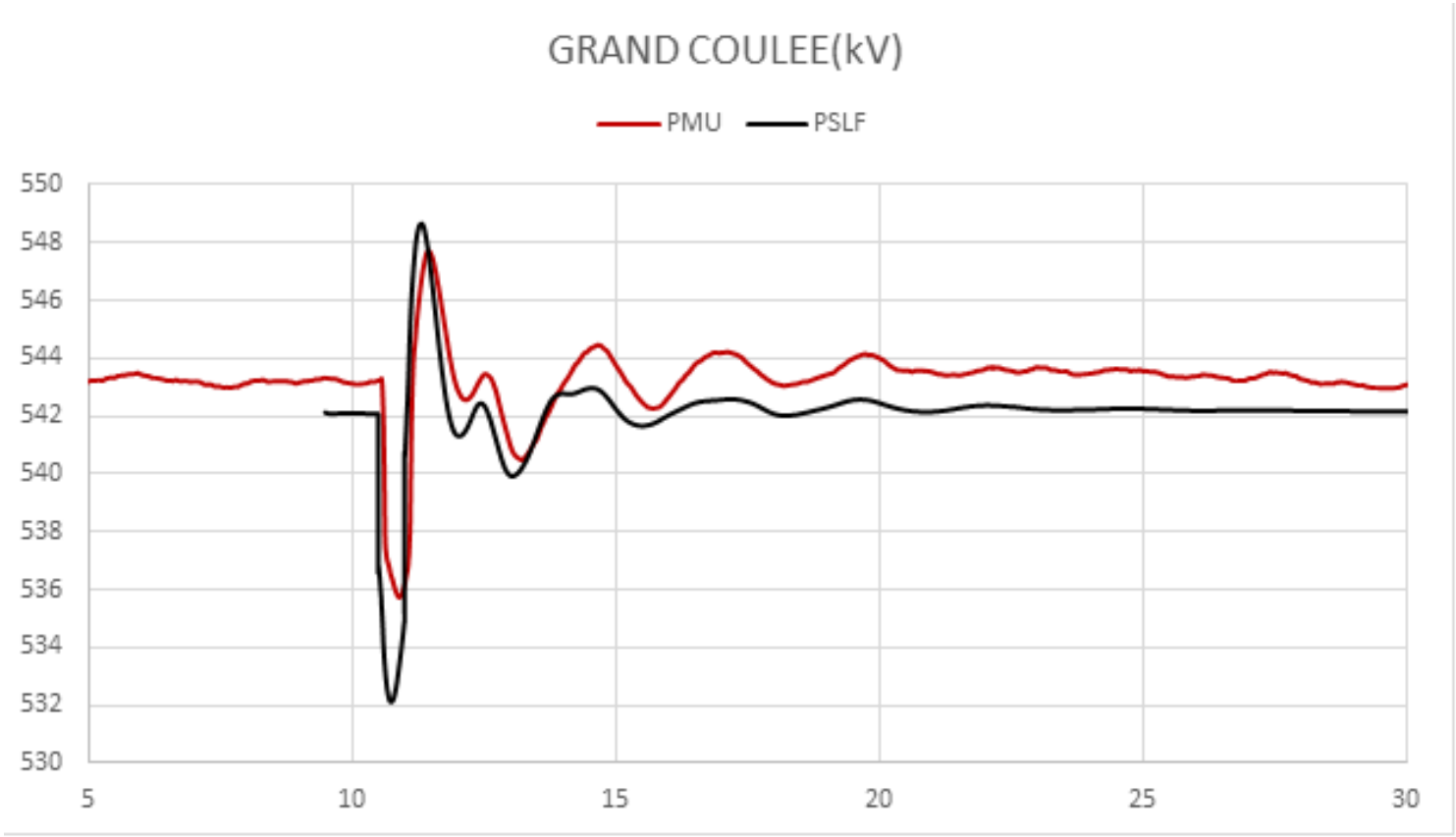

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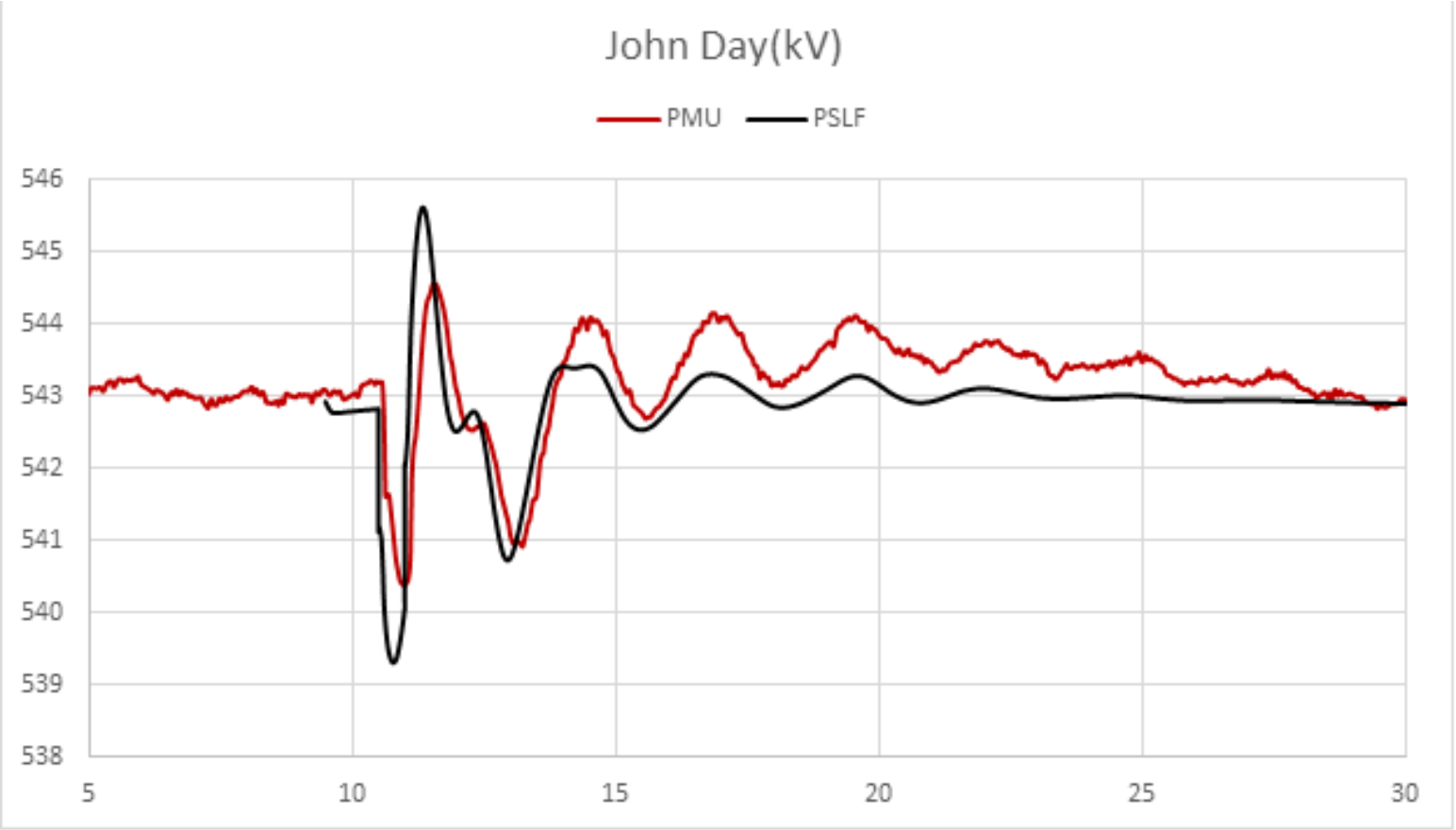

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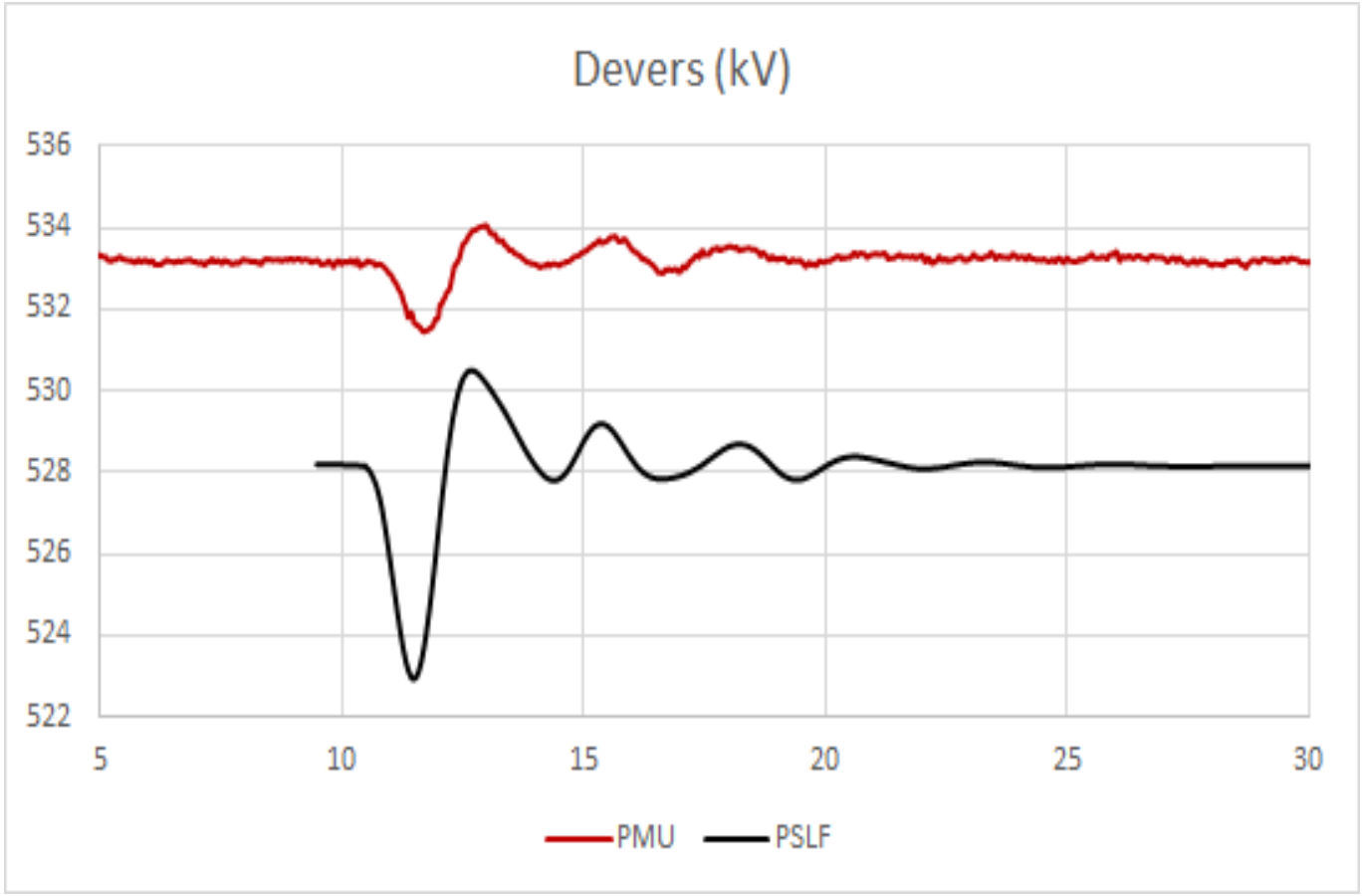

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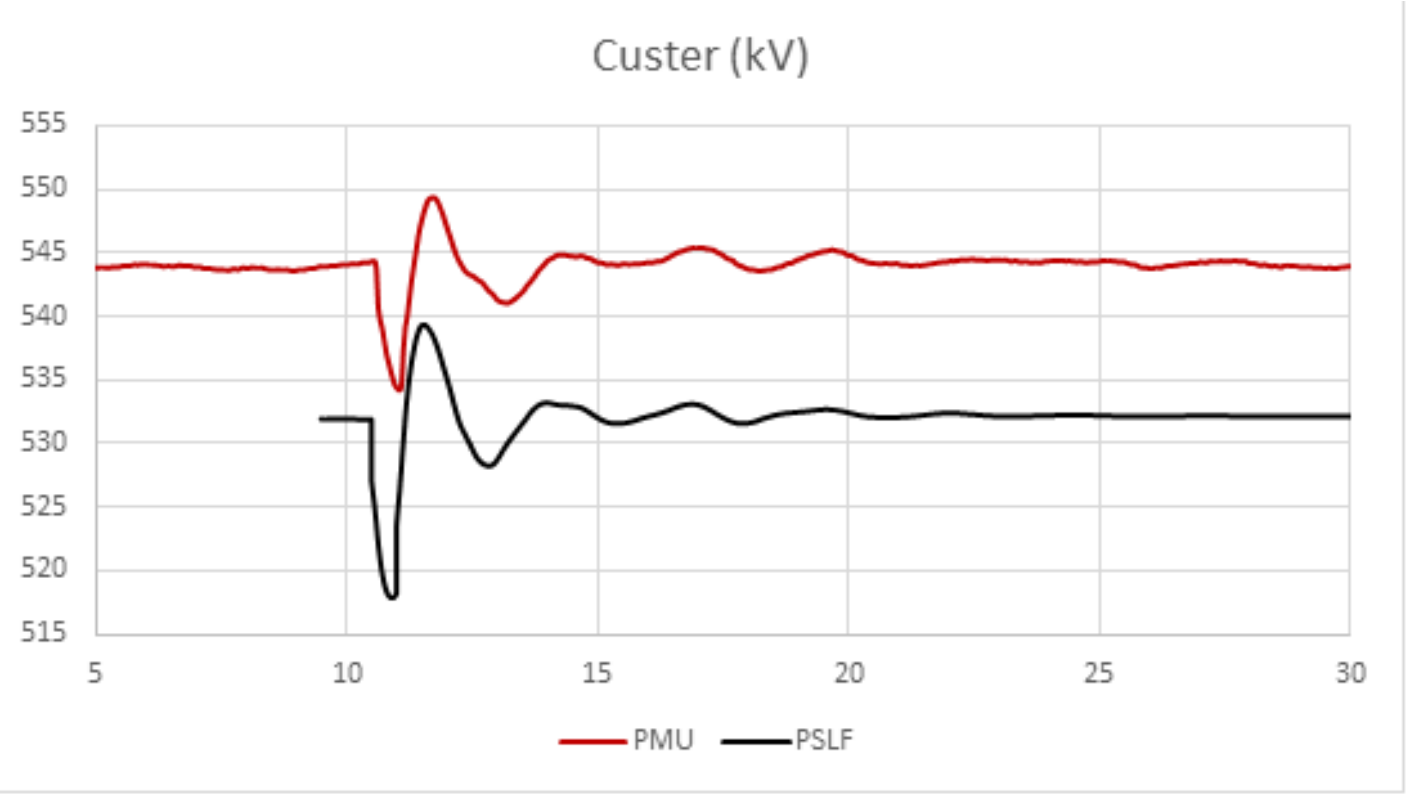

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Conclusions:

- We are putting pieces of puzzle together trying to create new ways and tools that will open new avenues that can help make power system more reliable and efficient;
- PMUs are integral and essential part of that process;
- PMUs allows as to see;
- We need more PMU to better validate system model and studies;