WAMSTER: Practical results

WAMSTER Ad-hoc synchrophasor measurement network

Introducing the WAMSTER2/SyncPQ multifunctional DIN-rail-mountable unit:
Modification of the STER PMU device into a new form factor with functional and measurement improvements (PMU, power quality, disturbance recorder)

Studio Elektronike Rijeka, September 2013 · www.ster.hr · www.wamster.net

Presentation Contents

1. About our company (STER) (Studio Elektronike Rijeka d.o.o.)
2. WAMSTER system description
3. WAMSTER achievements
4. SyncPQ: multifunctional synchrophasor unit for distribution systems in a DIN rail mountable enclosure

1. About out company

Studio Elektronike Rijeka

Our company → STER

Studio Elektronike Rijeka d.o.o. (STER)

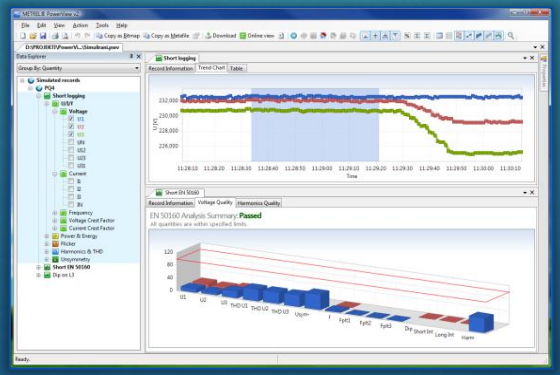
- Located in the Technology-Innovation Centre of Rijeka (TIC), J. P. Kamova 19
- Development of technological solutions in automation, measurement and electronics
- Founded in 2006 based on previous achievements in the field of power quality
- Currently employing 3 R&D engineers

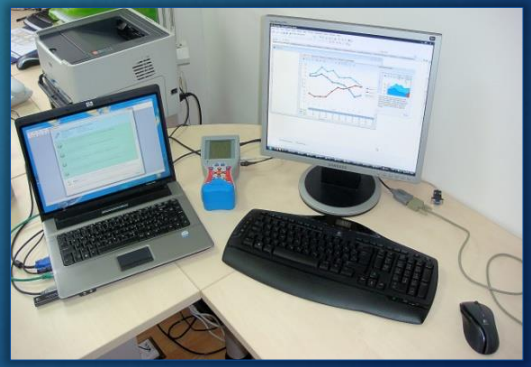
Our competence

- Complete service in the field of measurement:
  - Hardware development
  - Firmware/software development
    - firmware: development of real-time measurement and control algorithms
    - software: distributed systems for data acquisition, storage, analysis, event detection, alarming
  - Management of complex measuring campaigns
  - Locating faults in naval and terrestrial power systems
- Design and commissioning of automation systems
  - Steel plants, tobacco industry, shipyards and ships

Development for Metrel d.d. Slovenia

- METREL PowerQ4+
  - Class A power quality instrument
- METREL PowerView
  - Software for data acquisition, storage and analysis of measured data (Windows platform)
  - EN50160 / GOST compliant reporting





2. **WAMSTER system:** wide area monitoring system based on the synchrophasor (PMU) technology, using mobile telephony for data transmission

WAM – wide area monitoring
PMU – phasor measurement unit

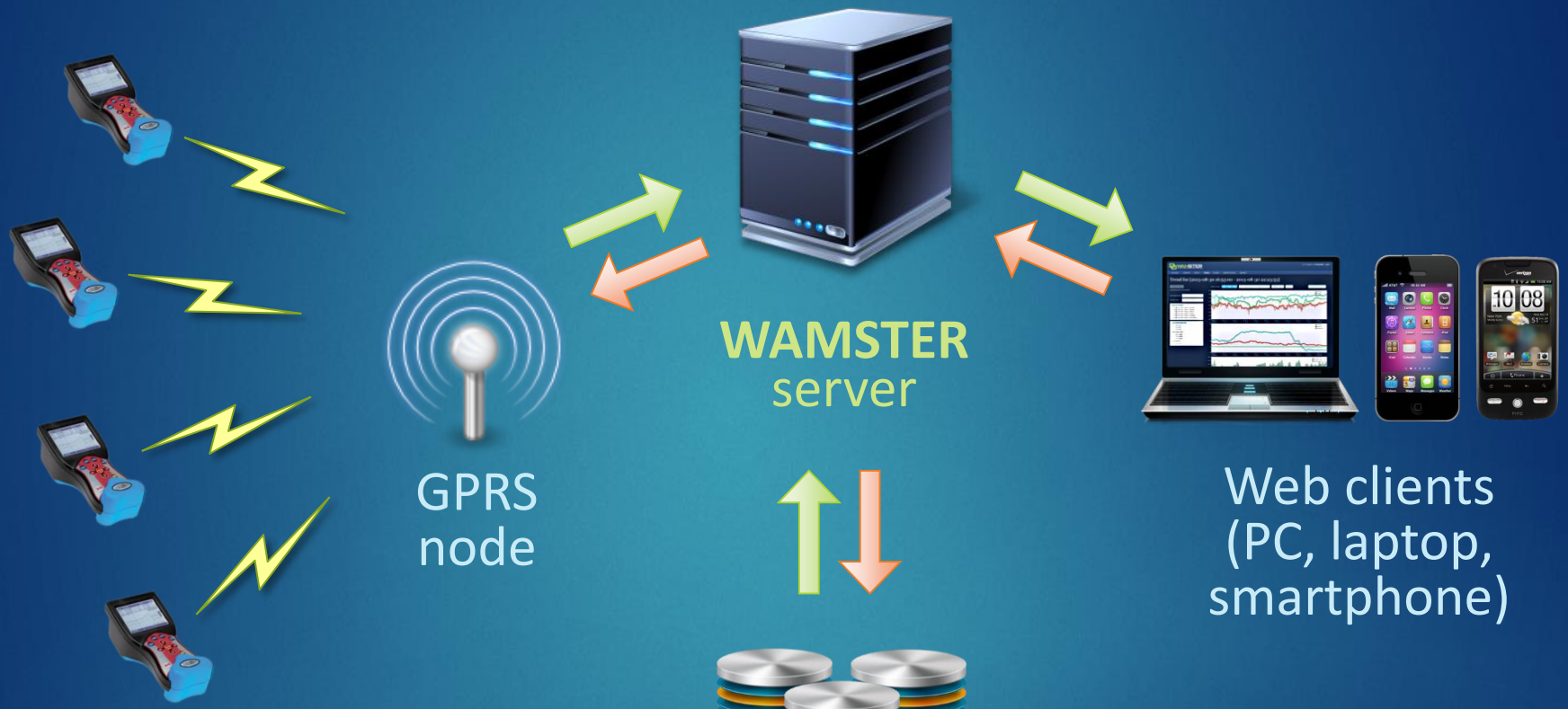
Synchrophasors

- GPS satellite signal provides an accurate time base (1μs) across the globe
- Precise time base allows system monitoring to be based on absolute phasor angles
- 50/60 samples per second

WAMSTER system

- Integrates measurement devices, data storage as a service and online analysis of distributed synchrophasor measurements
- Key properties:
  1. STER PMU: a handheld, portable device for synchrophasor measurements
  2. Uses the mobile network (GPRS/UMTS) for communication
  3. Server application (service) for data acquisition, storage, online (web) analysis, event detection and integration with third-party systems

WAMSTER
AD HOC PHASOR MEASUREMENT NETWORK



STER PMU

- Handheld phasor measurement unit
- 4 voltage + 4 current inputs
- 3 voltage ranges: 150/300/1000V
- External toroids / current clamps
- 32GB flash memory (5mo.)
- Battery backup (5h)
- GPS synchronization (1μs/3μs)
- GPRS communication
- RS232 / USB / Ethernet

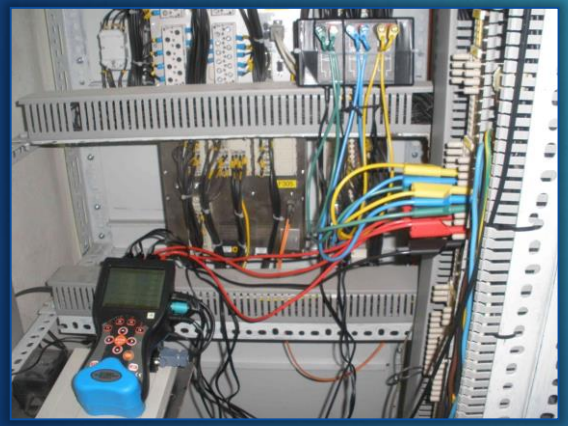
Technological advance:

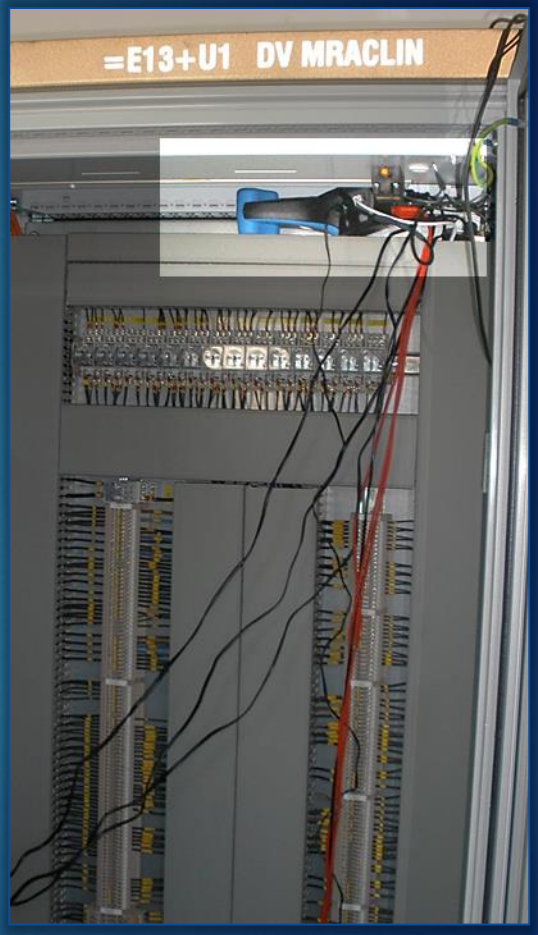
Mainstream PMU
- Switchboard weighing 80 kg
- Wired communication

STER PMU
- Handheld device (4 kg incl. bag)
- Wireless communications (mobile networks)

STER PMU

- Small dimensions
- No ventilation
- No rotating parts
- Installed in any position

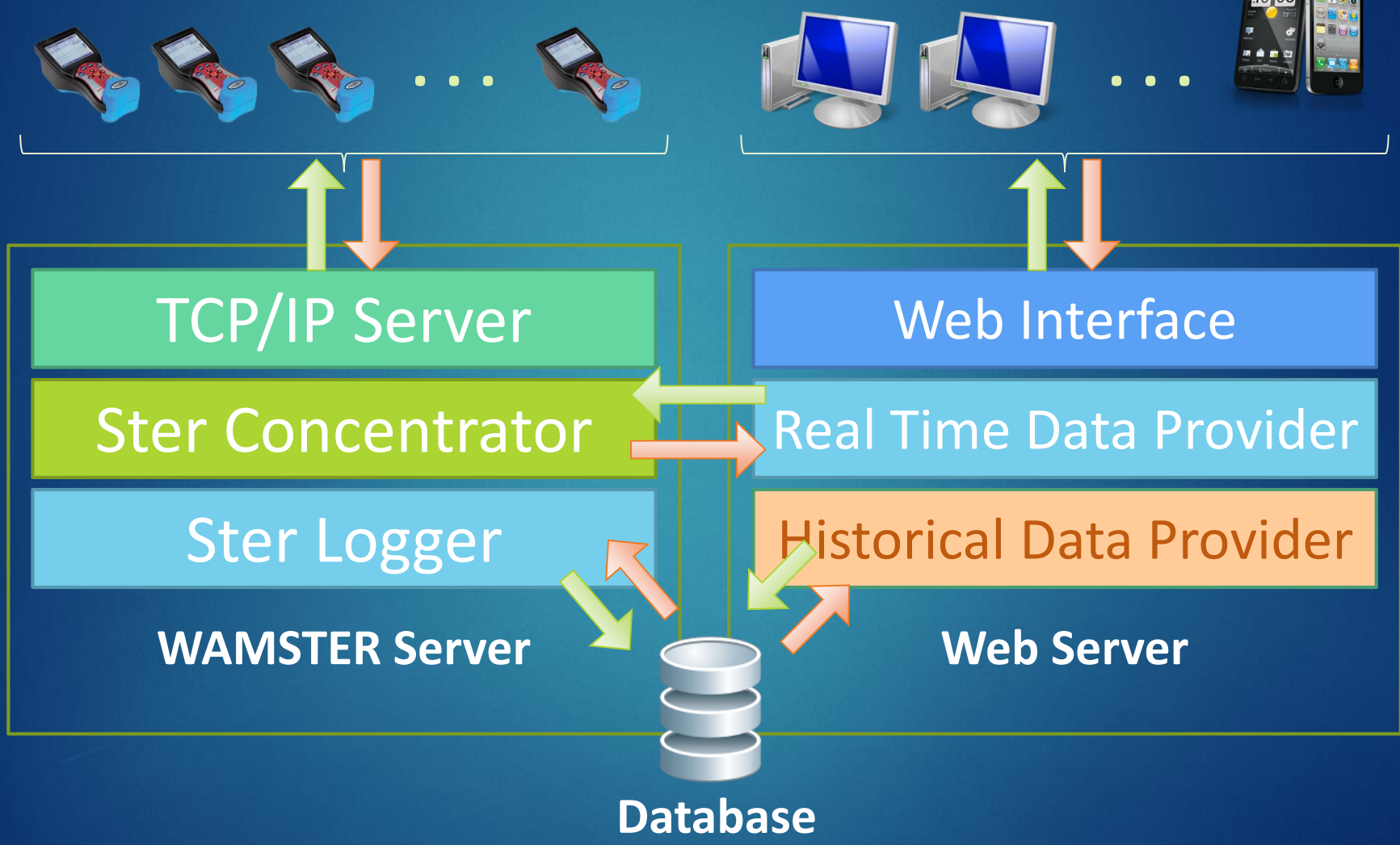




WAMSTER.NET

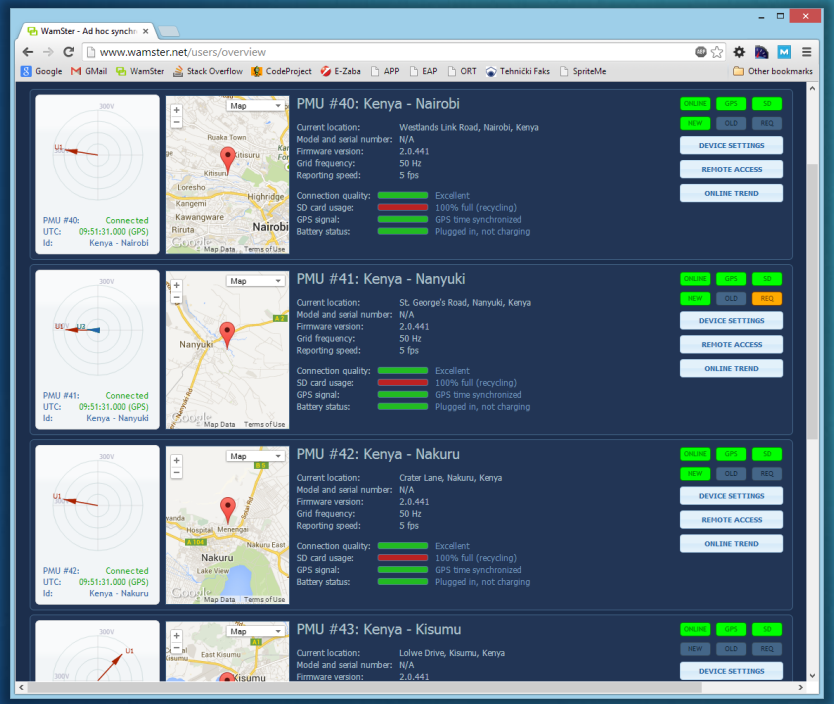
- Server application
- Data concentration over GPRS/Ethernet
- Data storage provided
- Online access from any web enabled device (laptop, smartphone)
- Online data analysis and event detection with configurable event triggering
- Extensions: integration with existing systems (continuous forwarding, offline/daily/weekly archiving, FTP uploading)

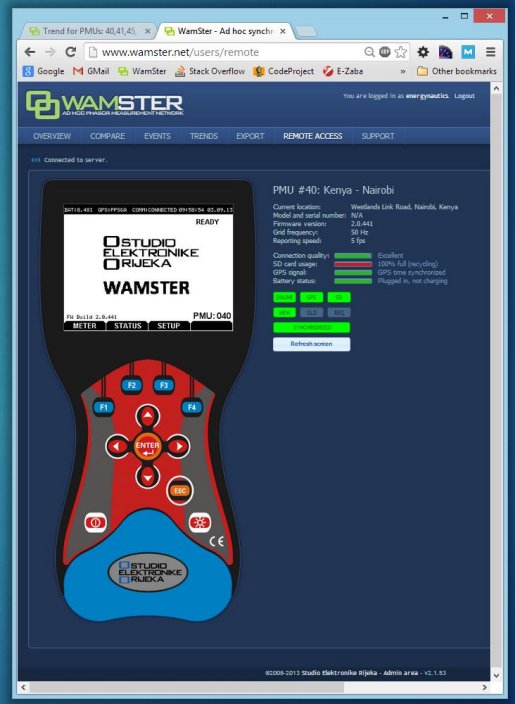
WAMSTER System



WAMSTER.NET

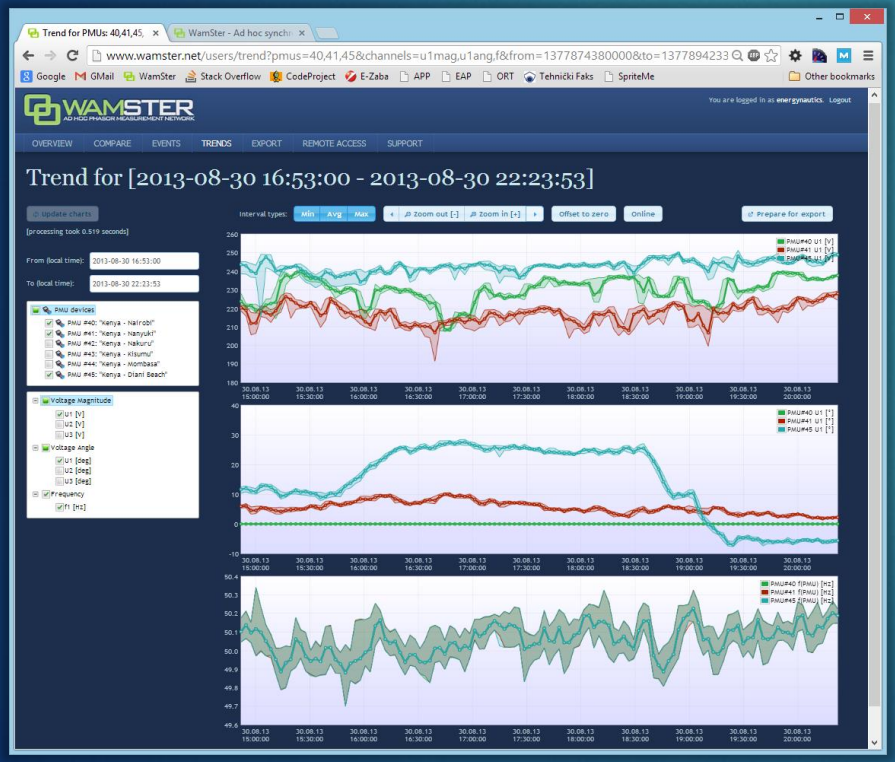
- Online device status monitoring
- Full remote access to all devices over web

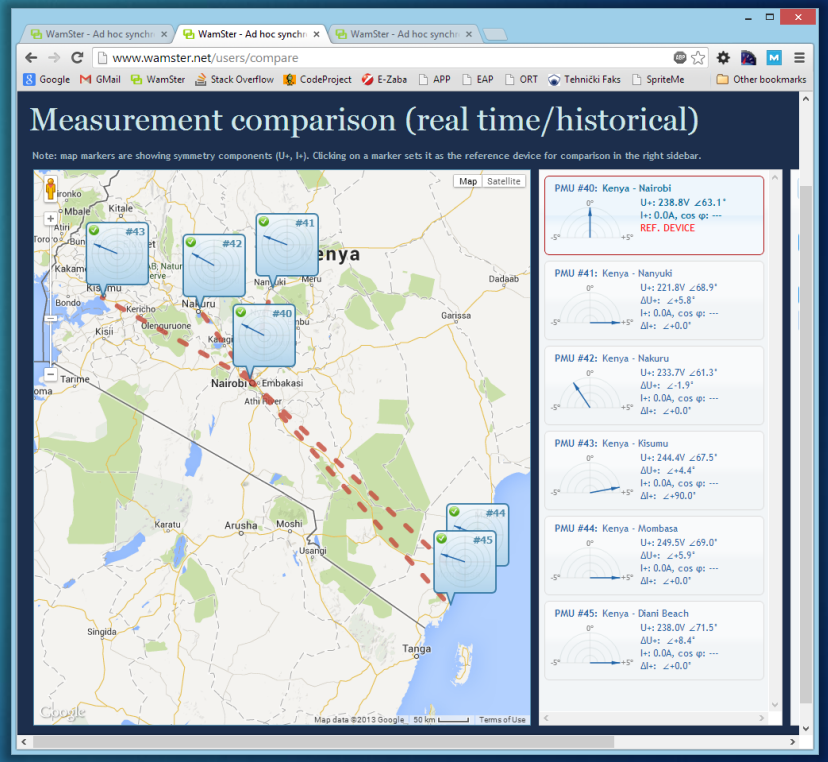




WAMSTER.NET

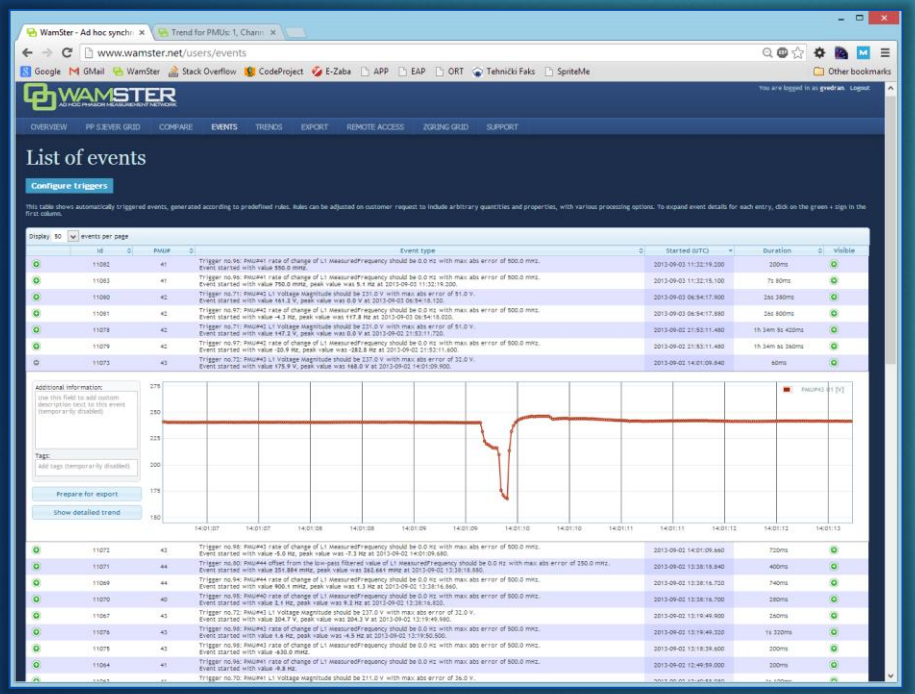
- Offline measurement analysis (trends)
- Online measurement comparison

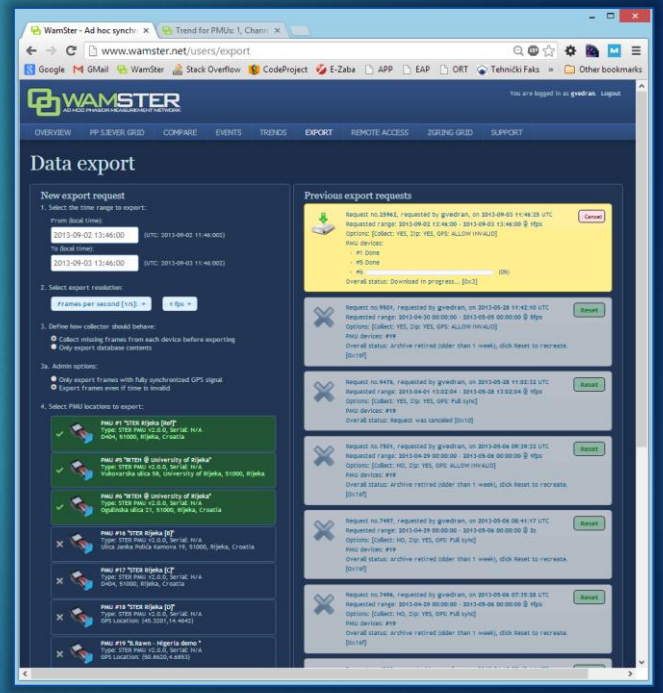




WAMSTER.NET

- Configurable event detection
- Export to other formats (CSV) and download





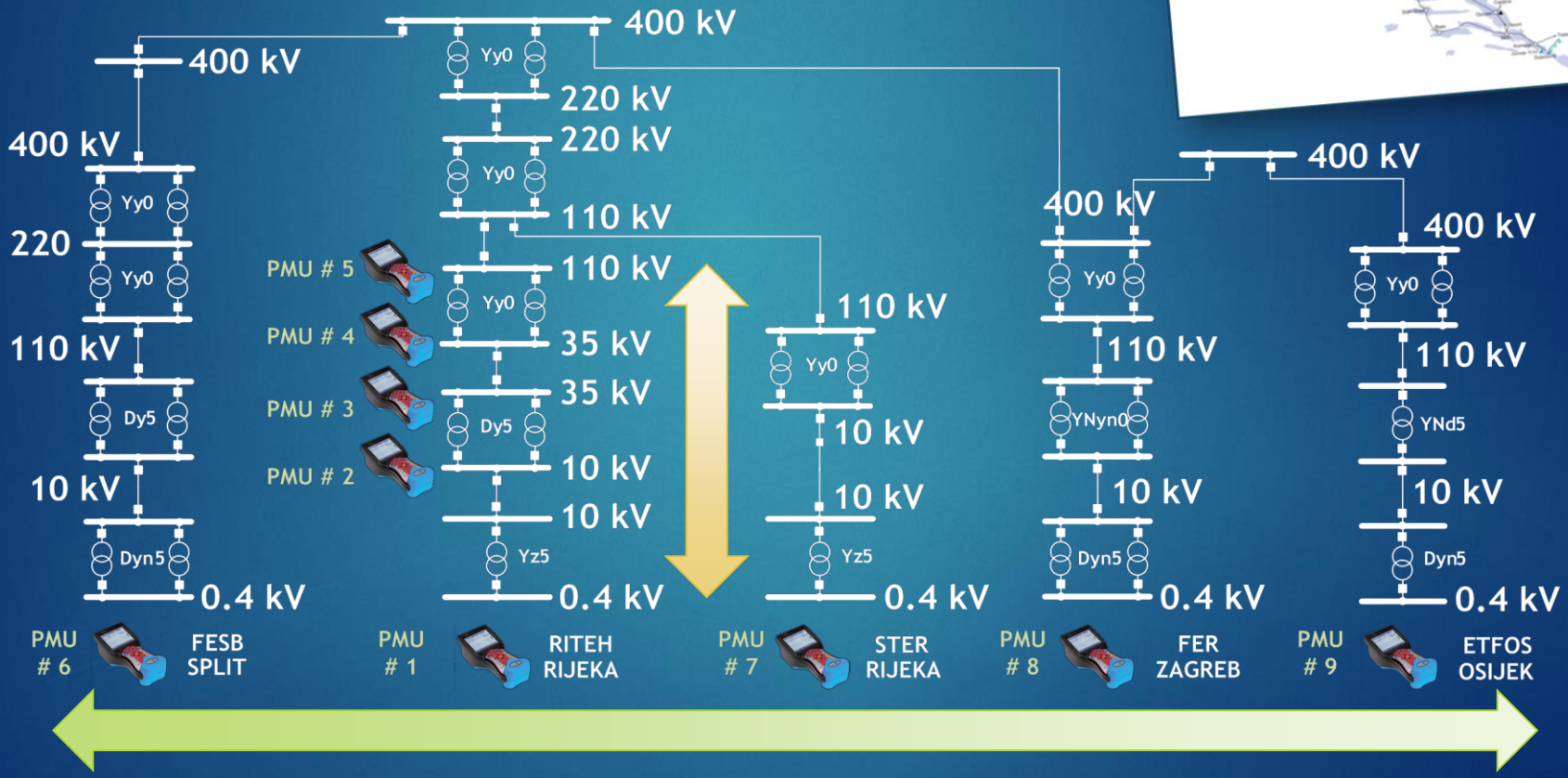
WAMSTER extensions

- Custom system state visualization on request
- Integration with other systems:
  - Synchroshield (2010) – continuous data forwarding over the Internet towards CARWAMS
  - Energynautics (2012-2013) – daily archives are automatically sent to the client's FTP server
- Custom communication protocols
- E-mail/SMS notifications

3. WAMSTER installations and use cases

CARWAMS

- Implemented for University of Rijeka
- Active since **09/2010** until **09/2011**
- Hor.: 0.4kV, Vert.: 0.4kV - 110kV
- Data stream towards the TSO PDC



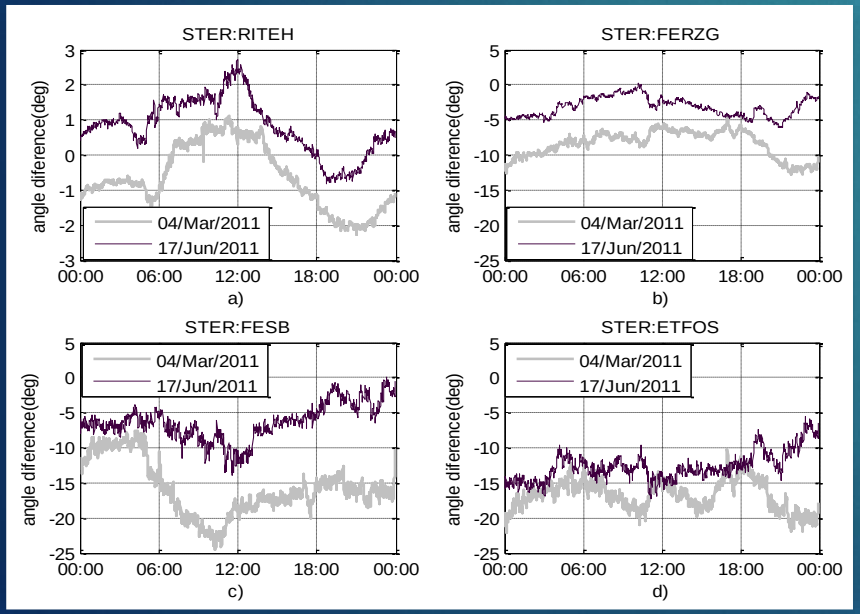
CARWAMS LV analysis

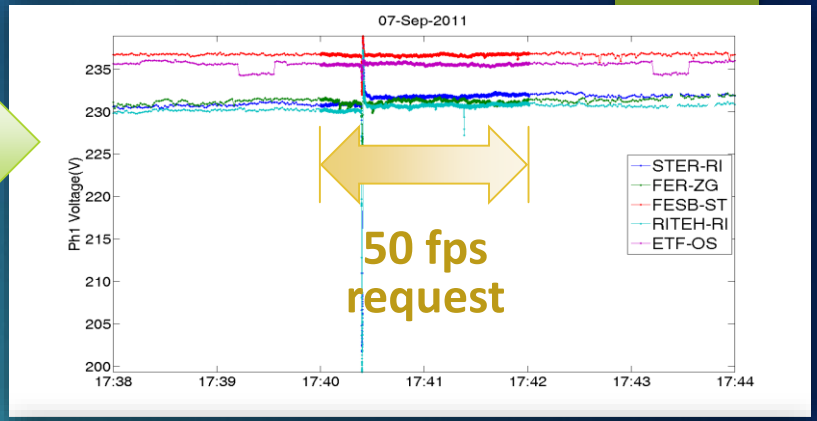
Event triggering:

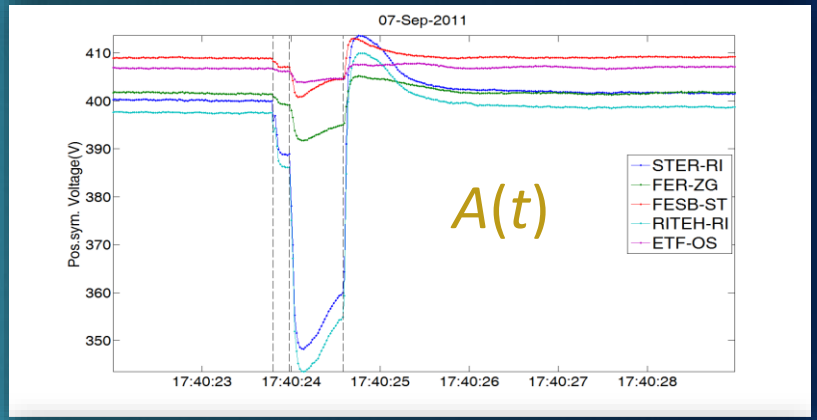
- **50 fps** on demand

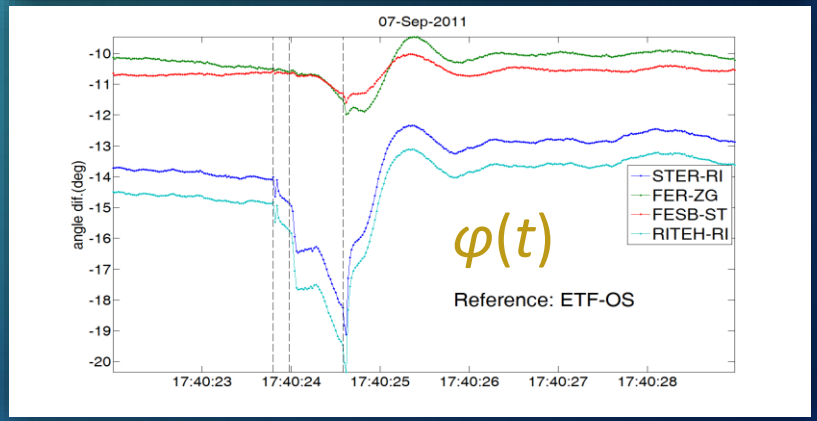
Monitoring and baselining:

- Continuous 1 fps reporting
- Daily angle fluctuations
- Seasonal fluctuations

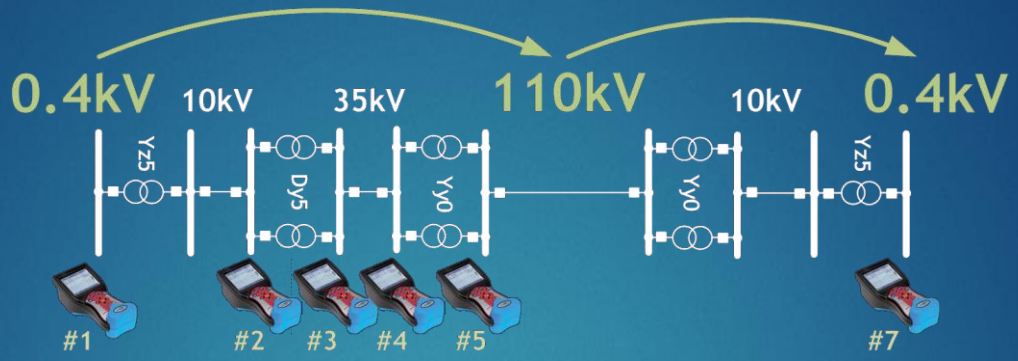


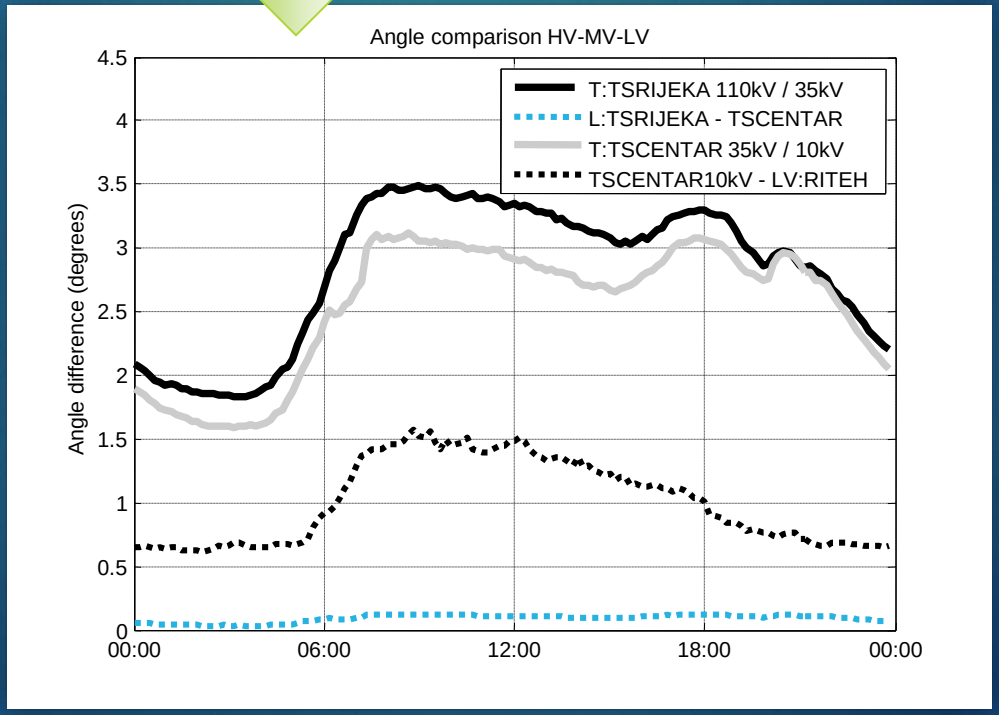






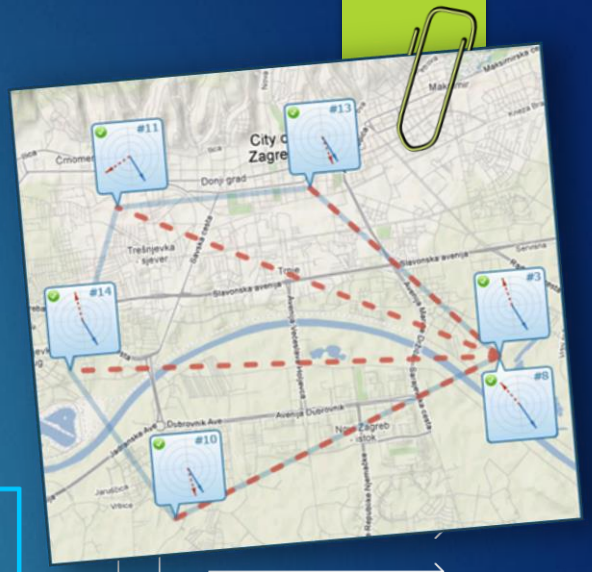
CARMAWS: HV-MV-LV voltage levels

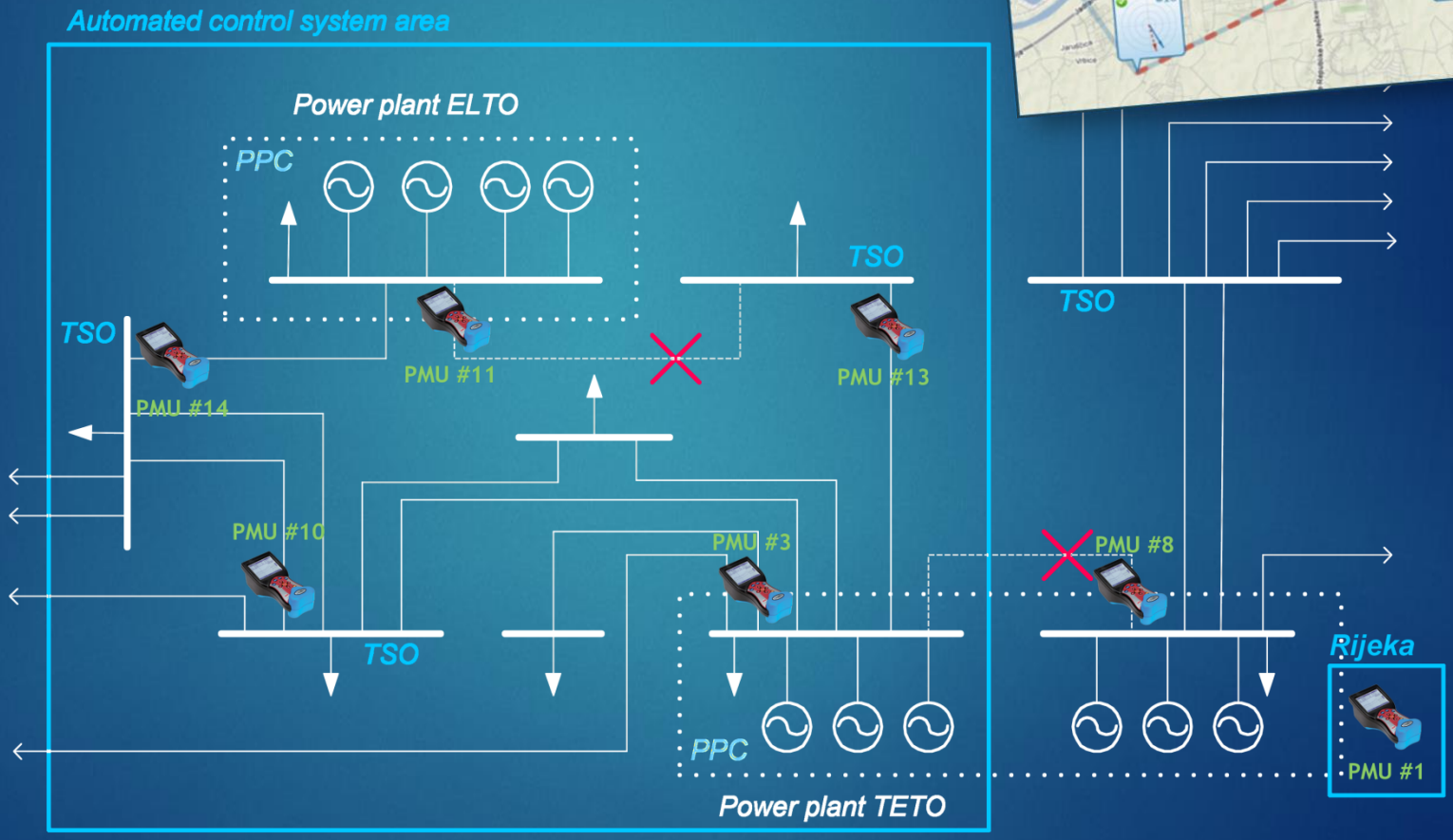




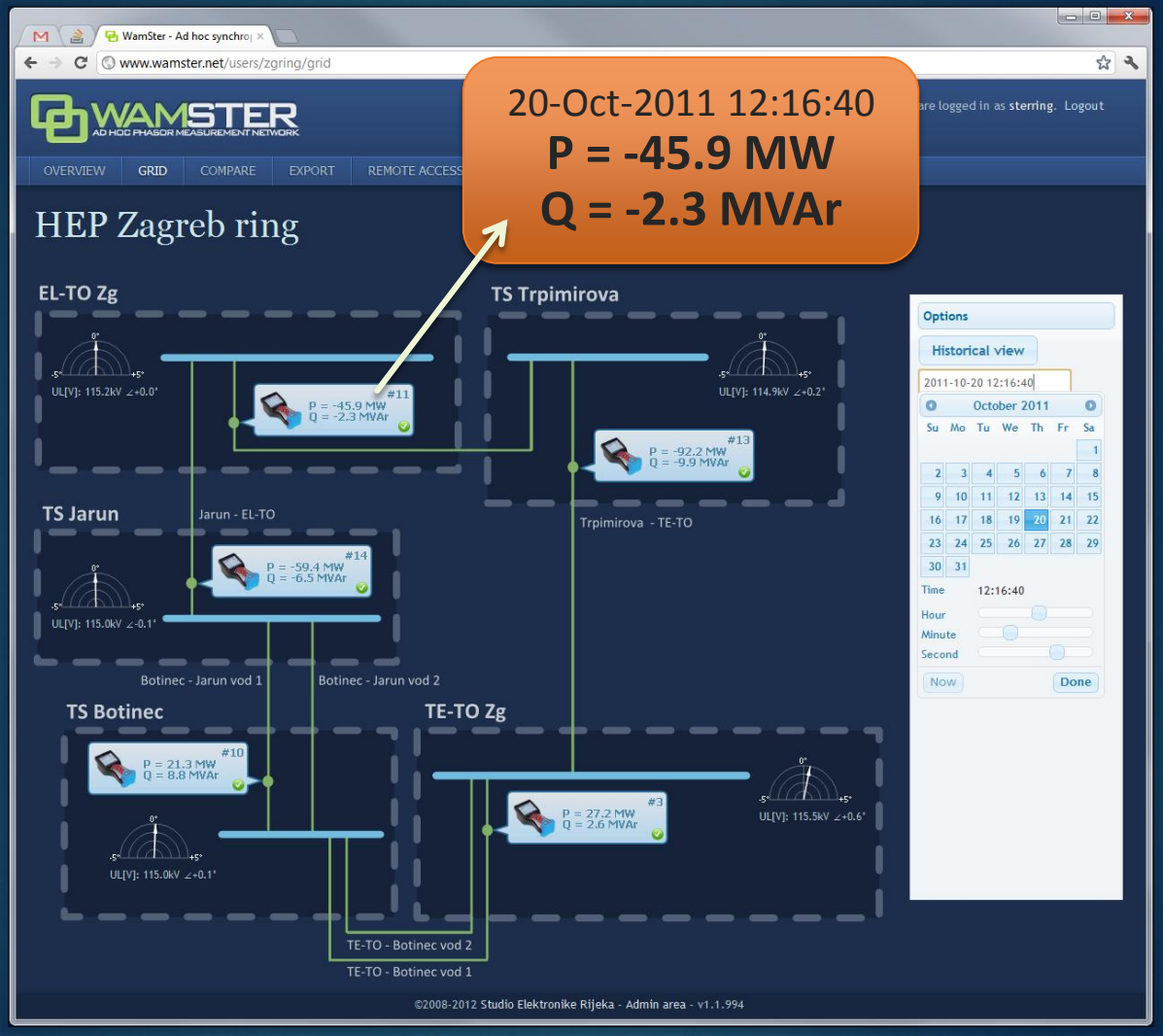
Zagreb ring 110kV

- SIPS Project / HEP, conducted by Faculty of Engineering Rijeka
- 09/2011 until 03/2012

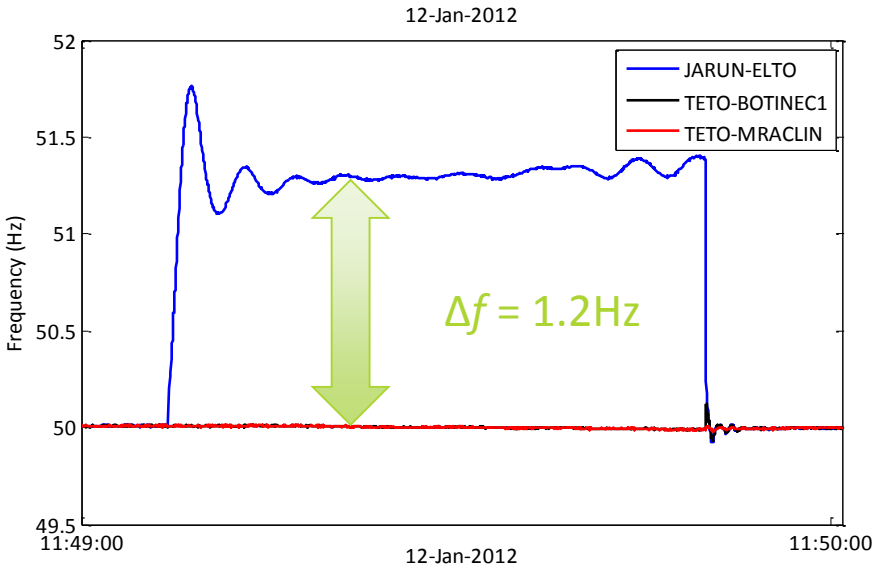


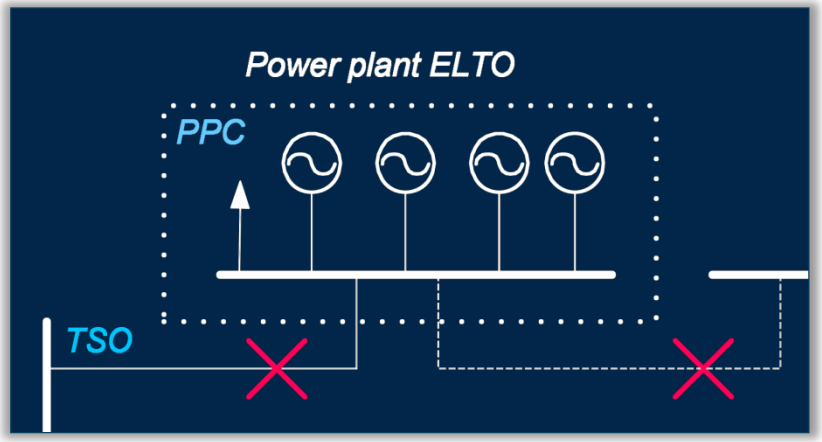


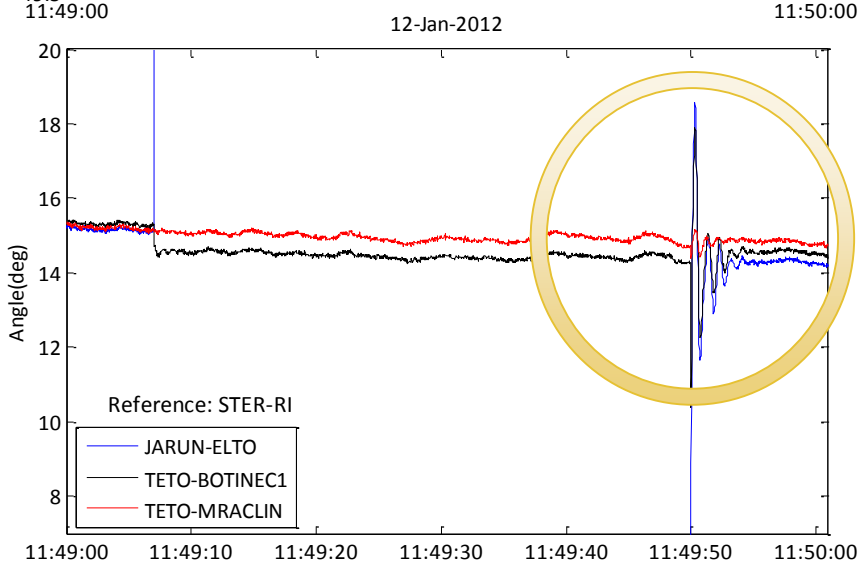
Zagreb ring: Topology loop reconfiguration

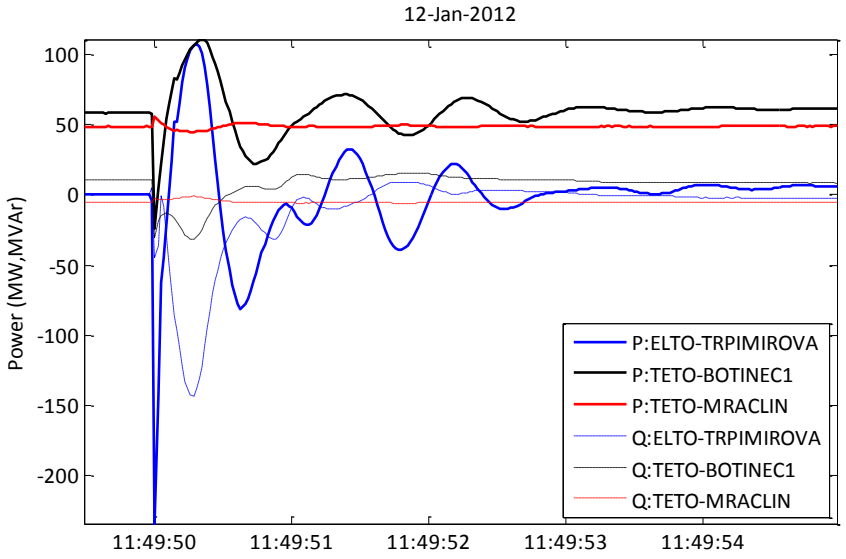


Zagreb ring: islanding caused by operator's mistake



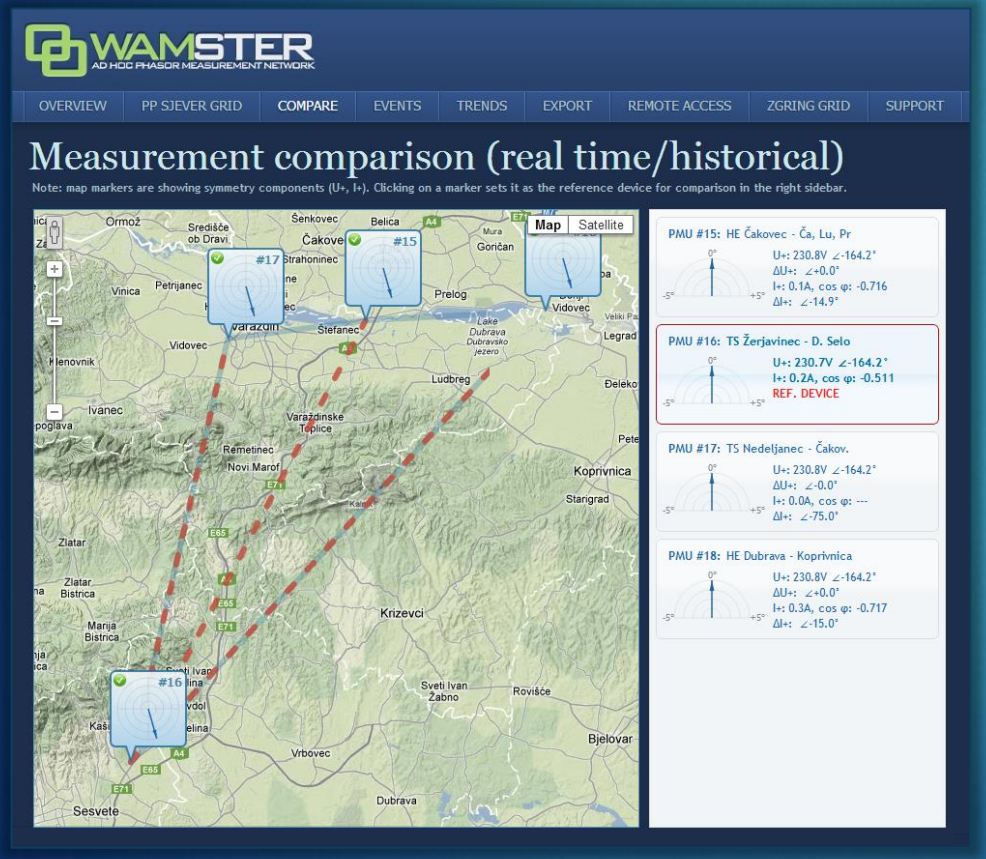






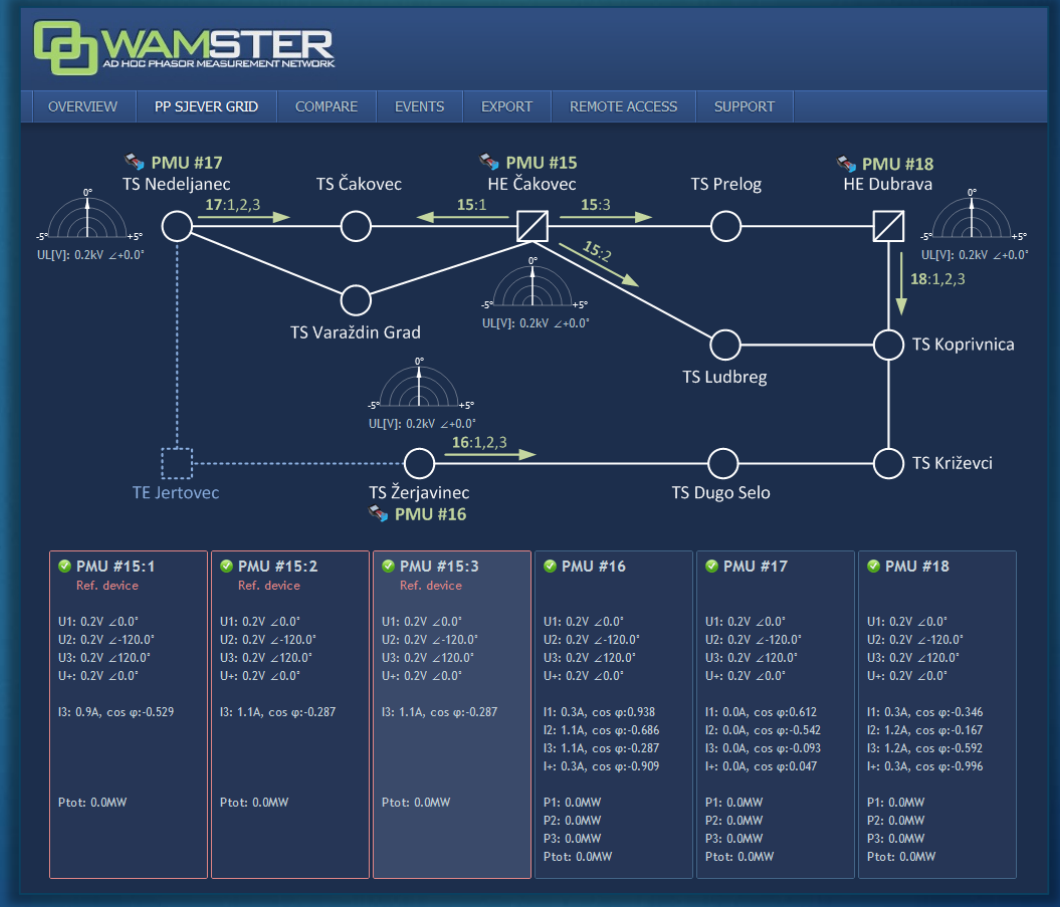
HEP PP Sjever

- TSO HEP Production, HE Sjever, Jul-Aug 2012.
- Problem: HP Dubrava power generator stopped due to power oscillations – cause unknown



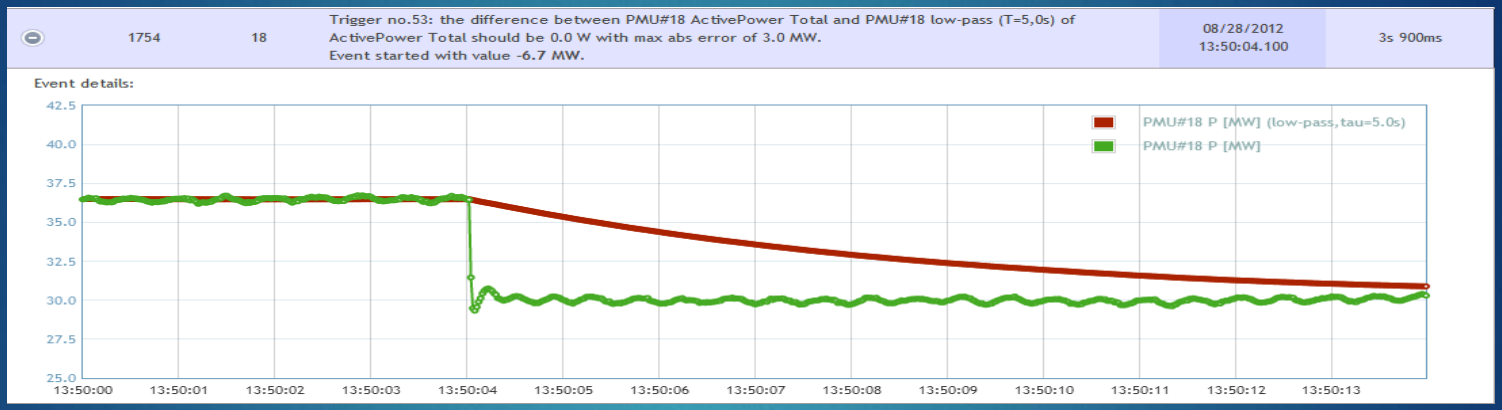
HEP PP Sjever

- Customer requested a custom page for system overview and online monitoring

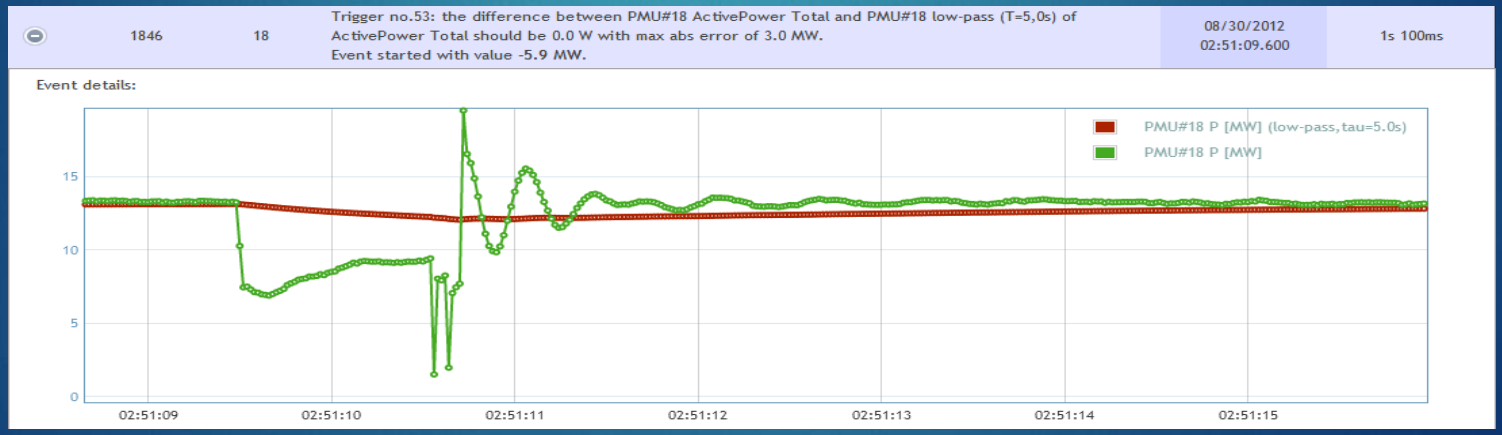


HEP PP Sjever

- Retrieved data provided new insights



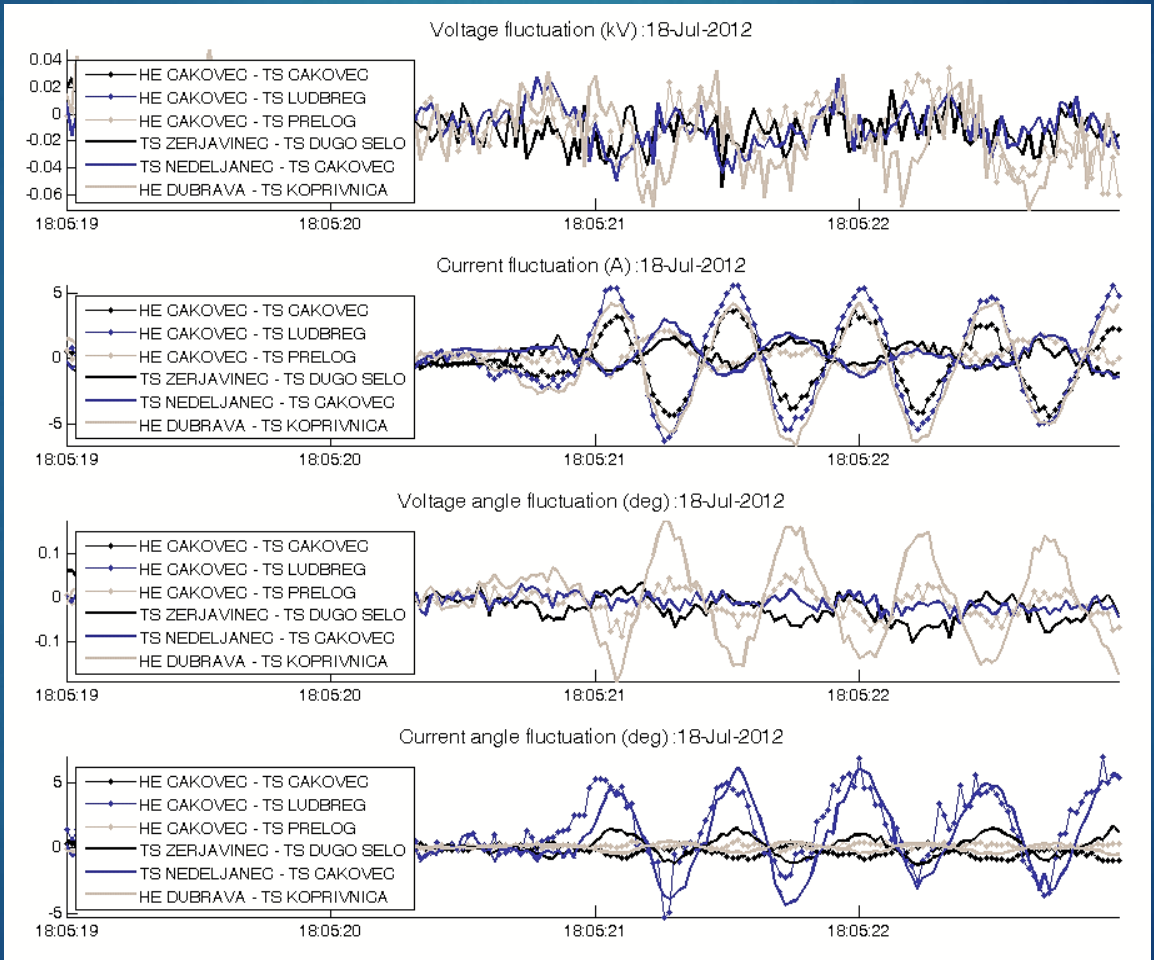
Switching events



Atmospheric discharges

HEP PP Sjever

- 18-Jul-201: Detected power fluctuations

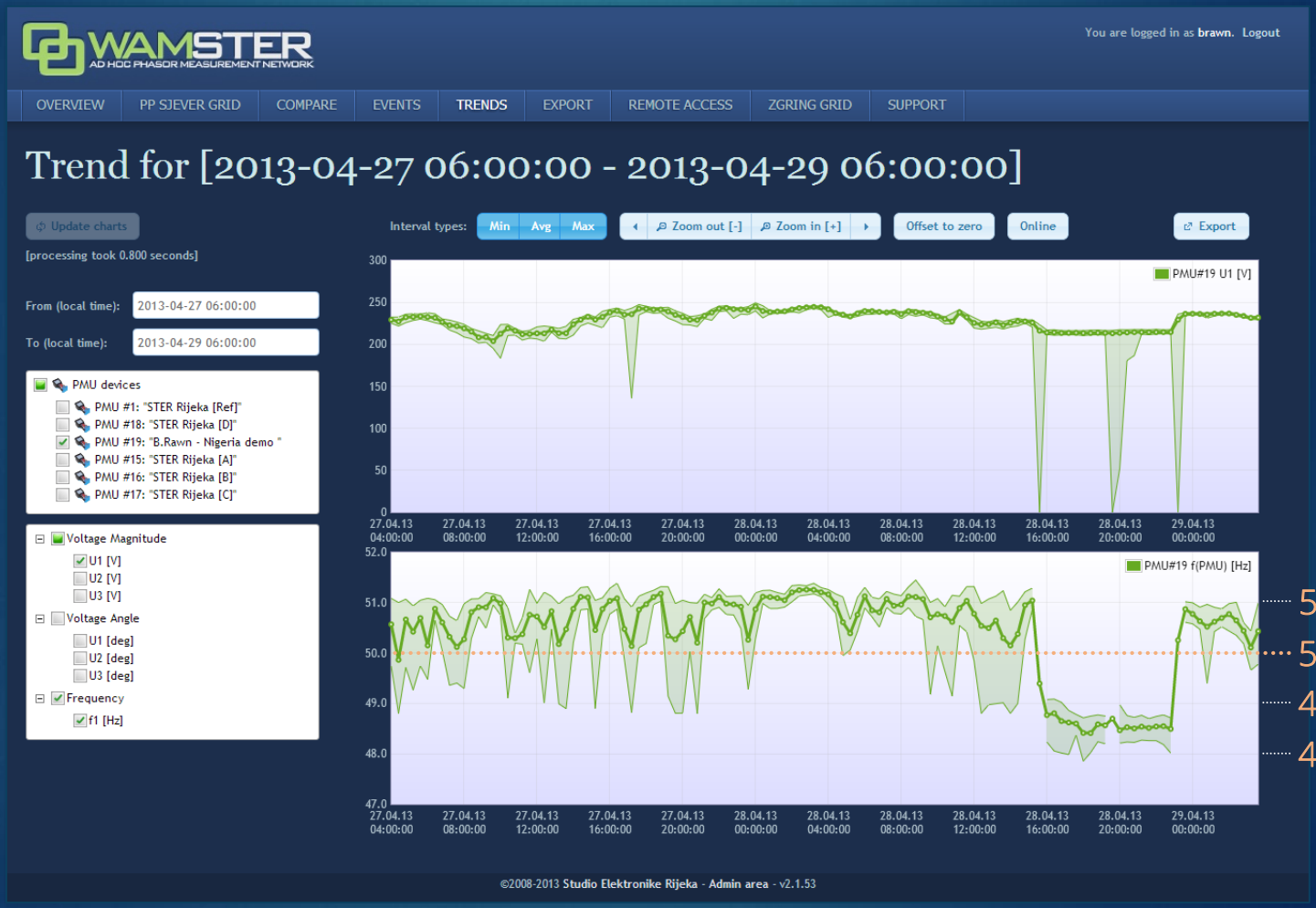


NIAF Abuja, Nigeria

- „Bridging SCADA“ demonstration, Apo Substation, in cooperation with:
  - KU Lueven, Belgium
  - Nigeria Infrastructure Agency Facility (NIAF), Nigeria
  - Bauchi State University, Nigeria

NIAF Abuja, Nigeria

- Typical frequency fluctuations (49-51 Hz), blackout and switch to the DG supply

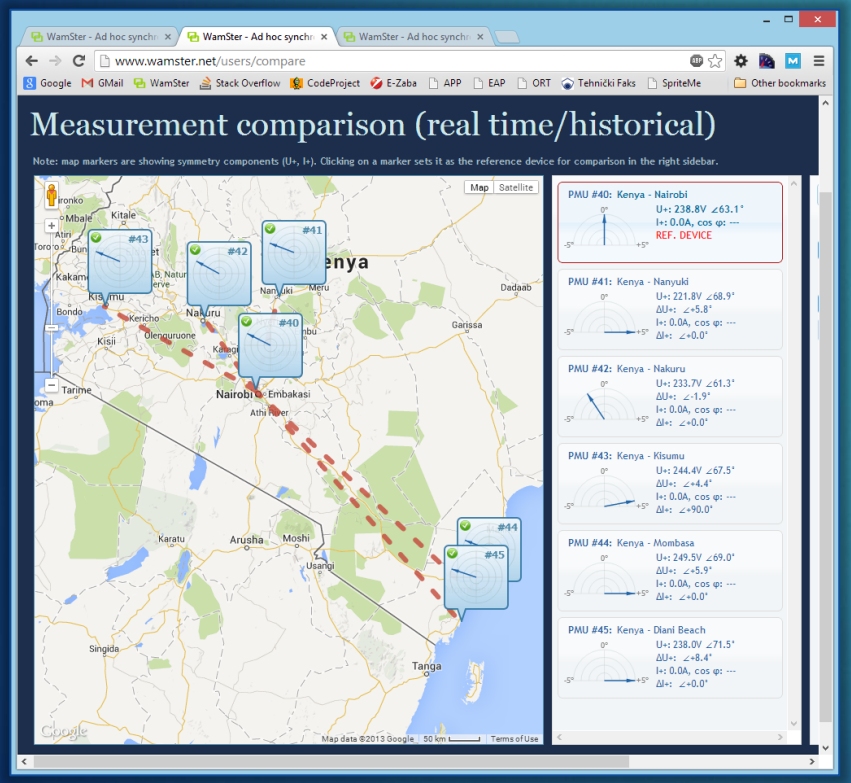


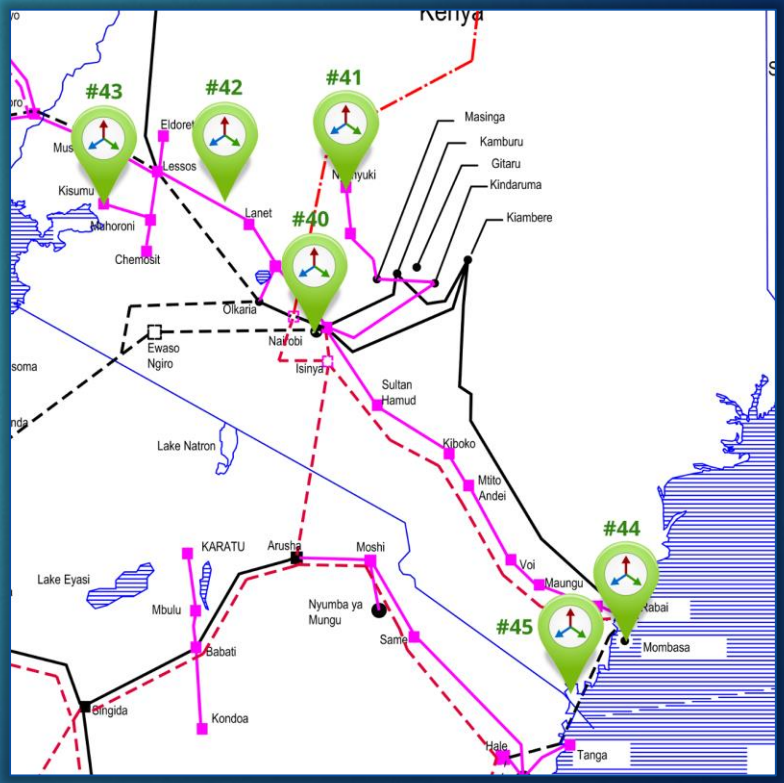
NIAF Abuja, Nigerija

- Frequency fluctuation details (2h interval)

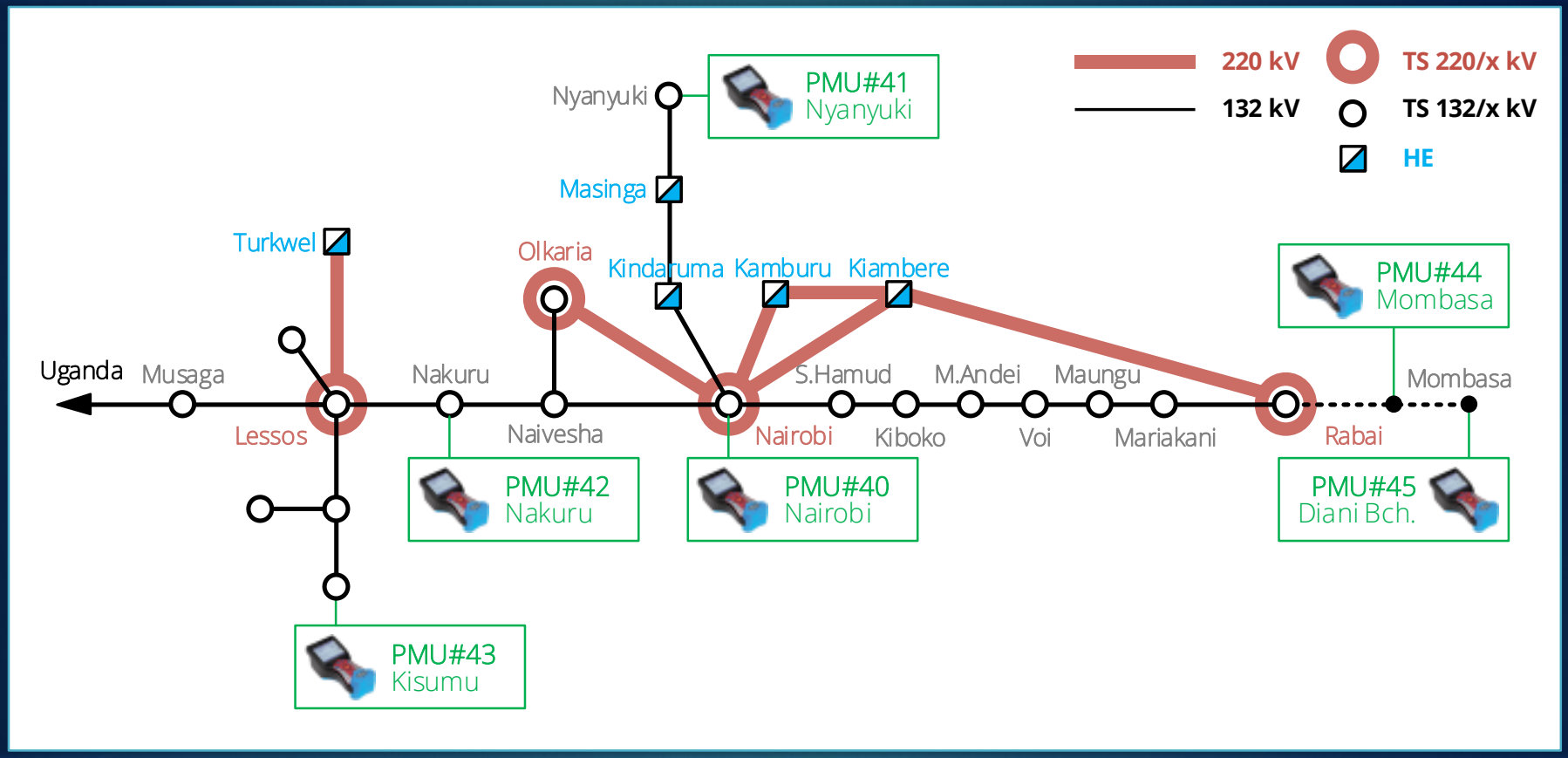
Kenya, Africa (2012/2013)

- Energynautics Germany, UMEME 24/7 Germany
- 6 PMU devices, event detection, FTP upload



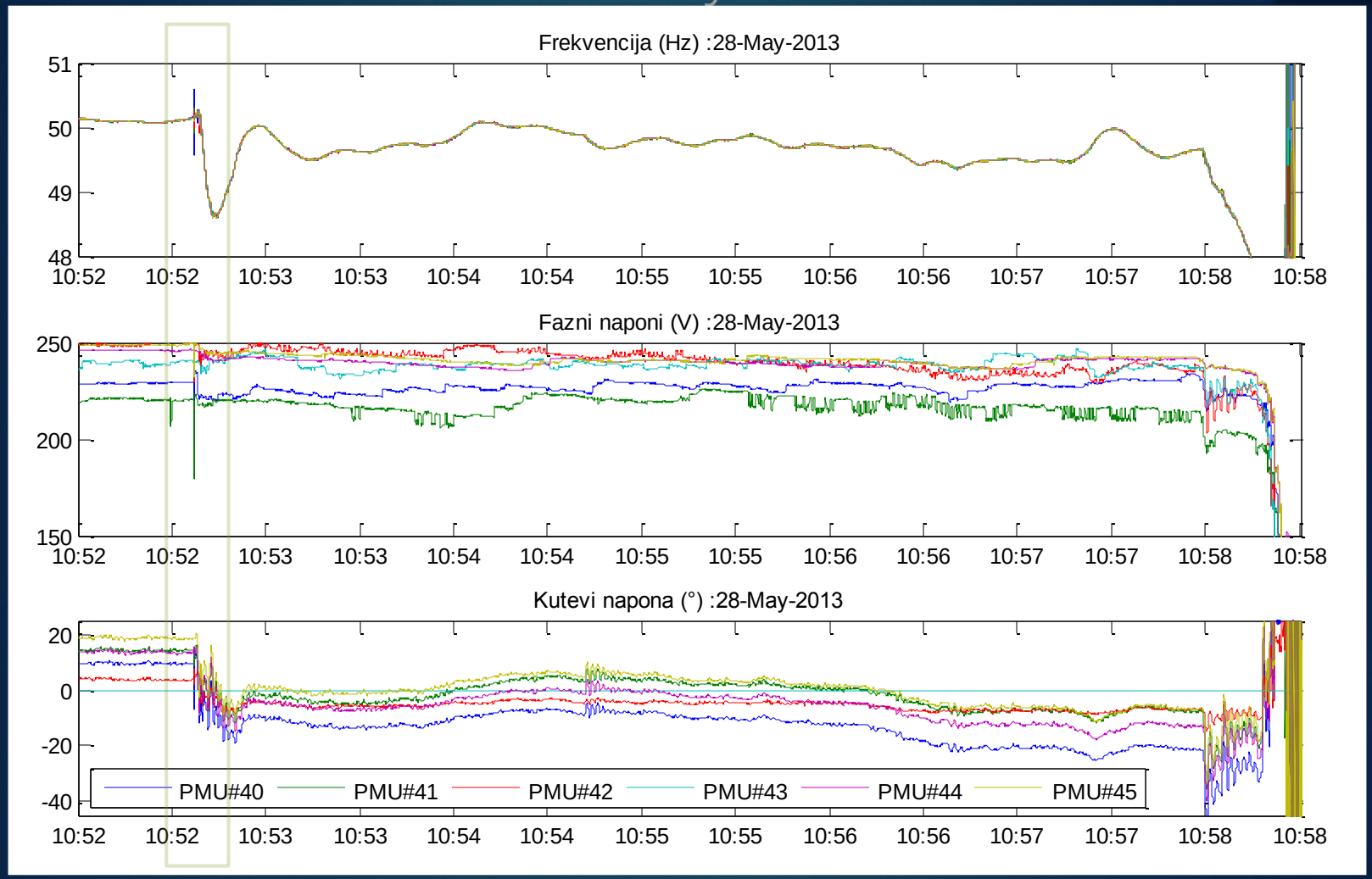


Kenya UMEME24/7



Kenya UMEME 24/7

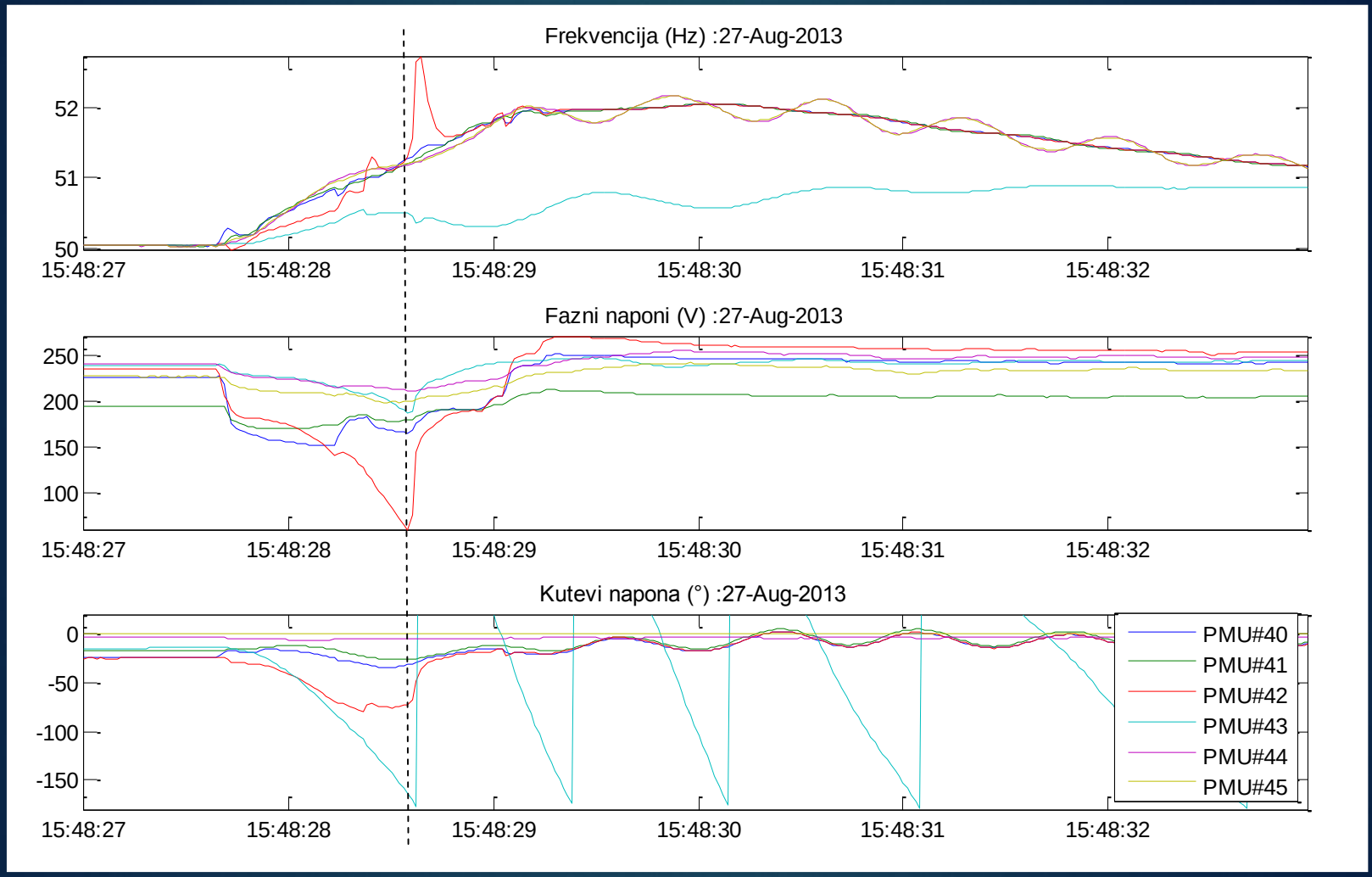
a) National blackout 28-May-2013



ref. angle: PMU#43 Kismu (-> Uganda). df/dt = 0.5 Hz/s

Kenya UMEME 24/7

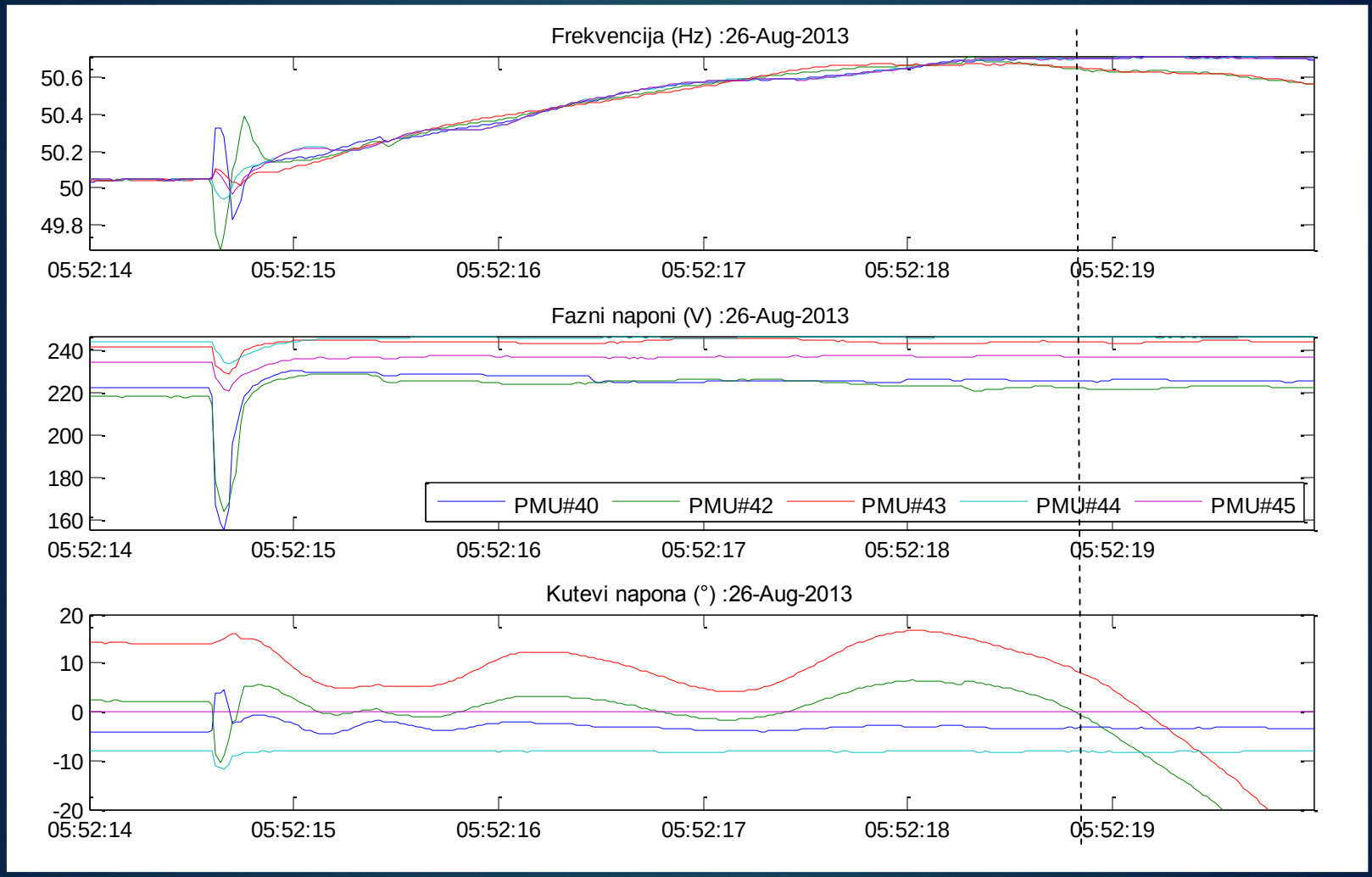
b) Synchronism lost (1/2)



ref. angle: PMU#45 Diani Beach. Angle at marker for PMU#43 = -161°

Kenya UMEME 24/7

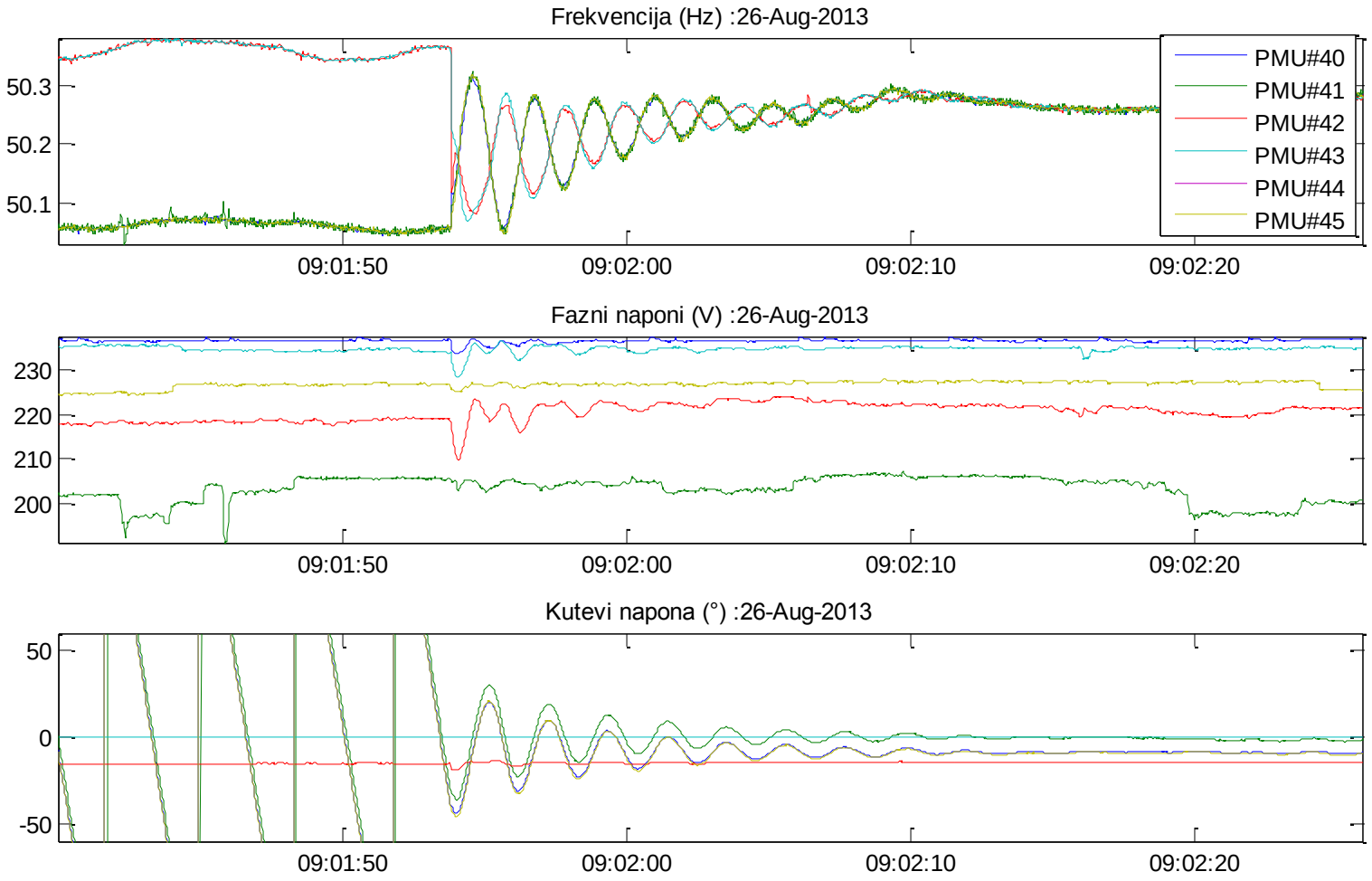
b) Synchronism lost (2/2)



ref. angle: PMU#45 Diani Beach.

Kenya UMEME 24/7

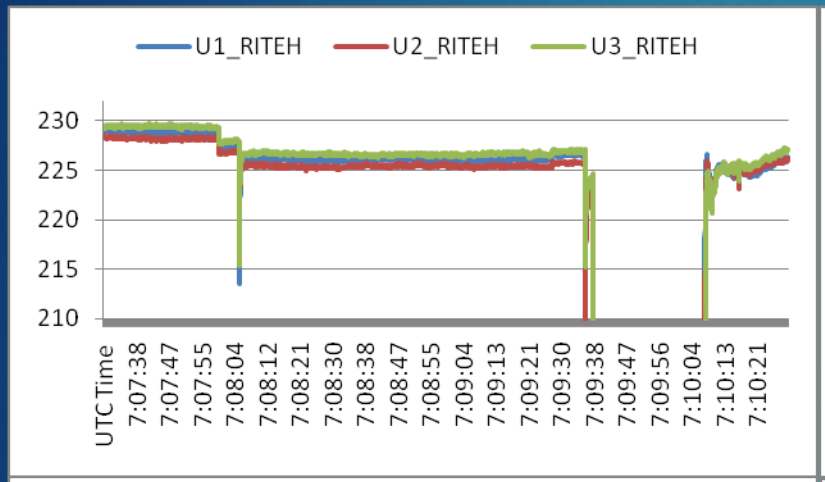
c) Resynchronization example

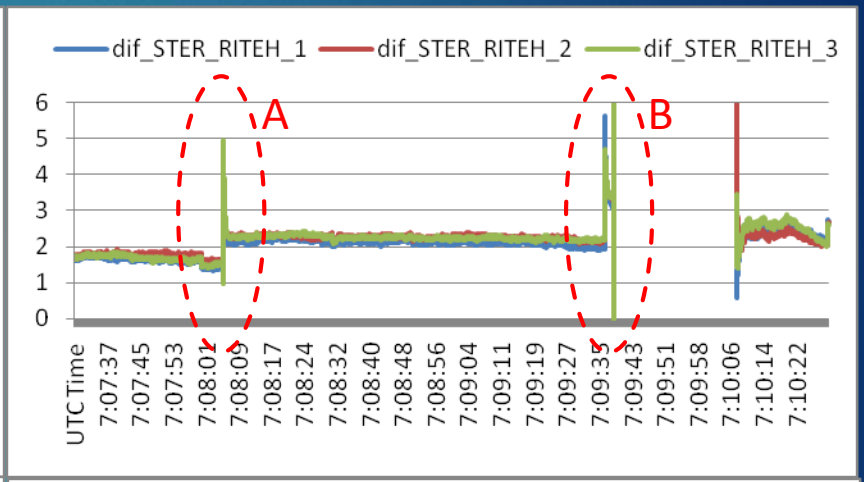


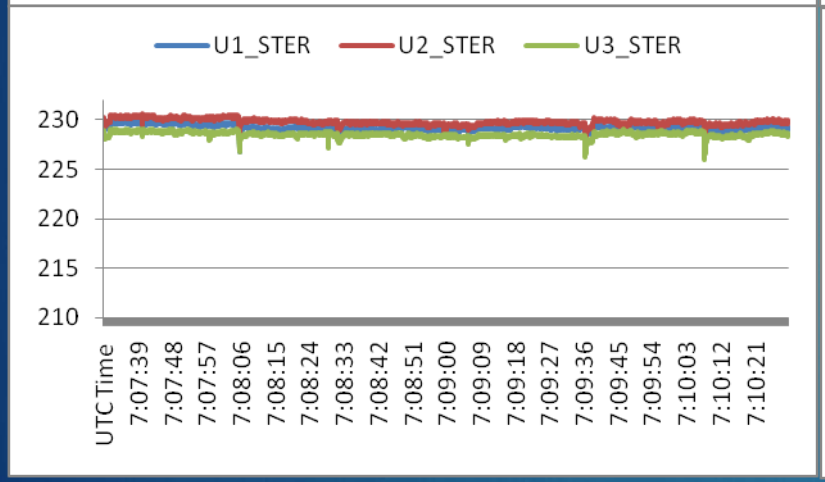
Example: Analyzing disturbances in the distributive network

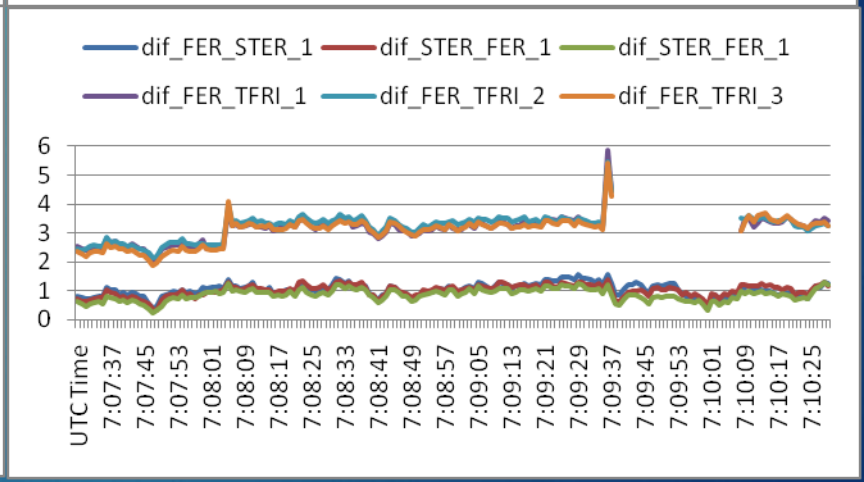
- Synchrophasor approach to analysis
- Allows angle comparison between key PMU measurement points in the system

Rijeka interruption on 23-Sep-2011



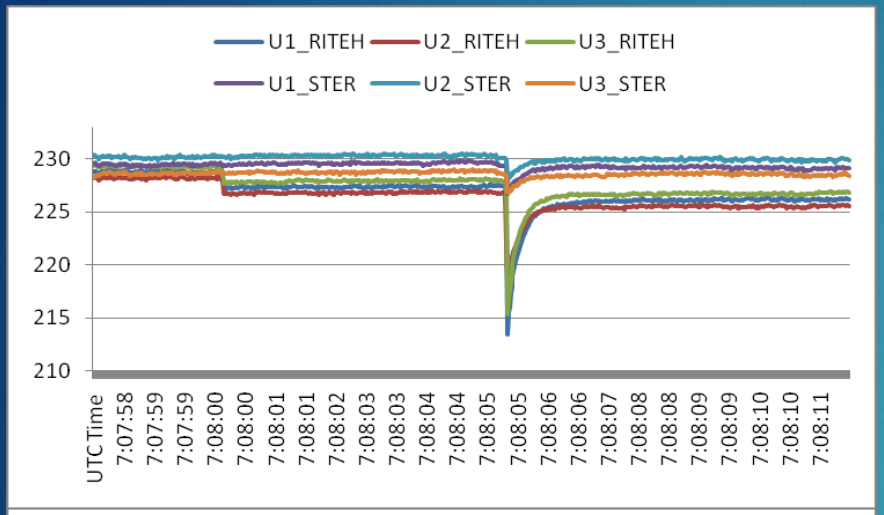


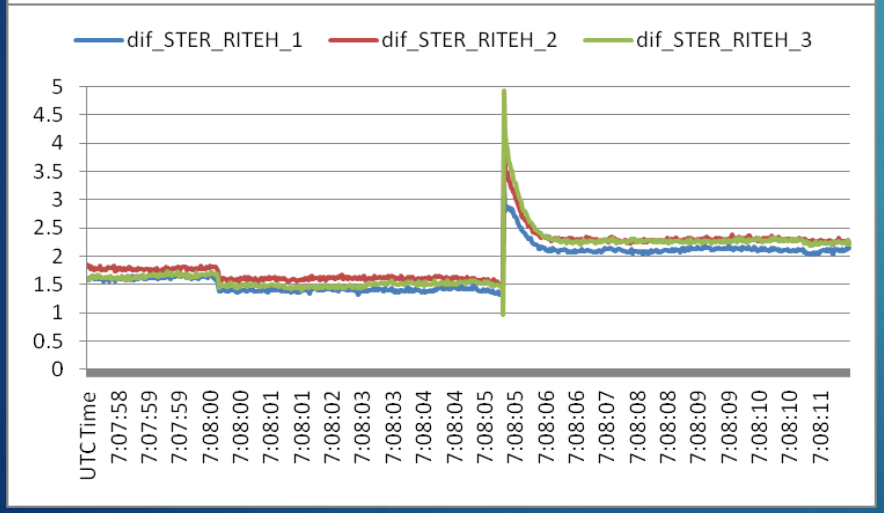




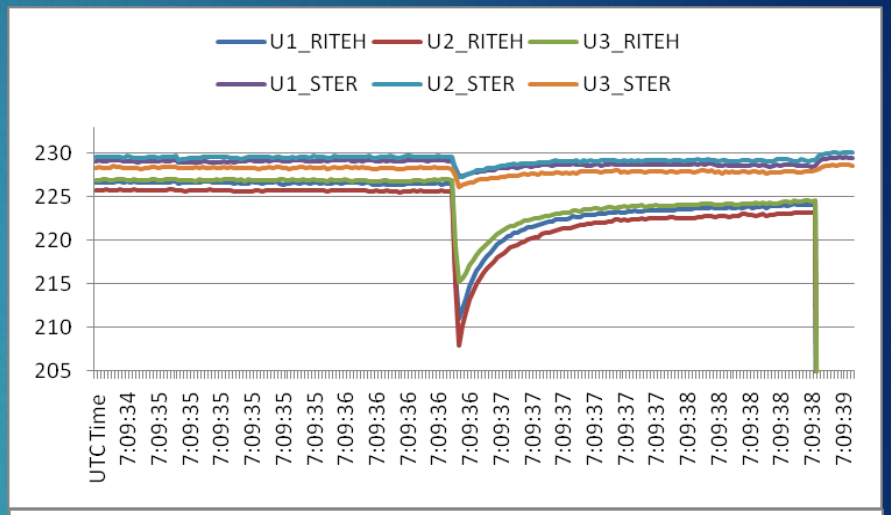
Rijeka interruption on 23-Sep-2011

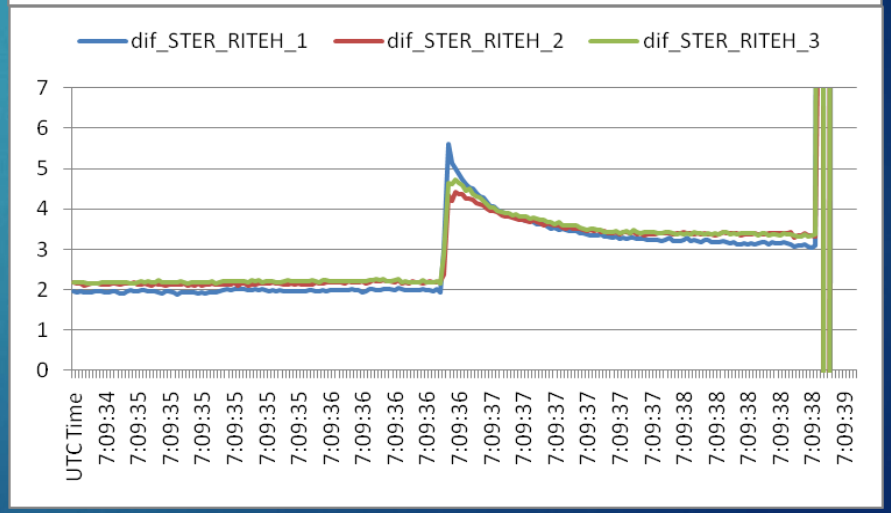
Detail "A"





Detail "B"



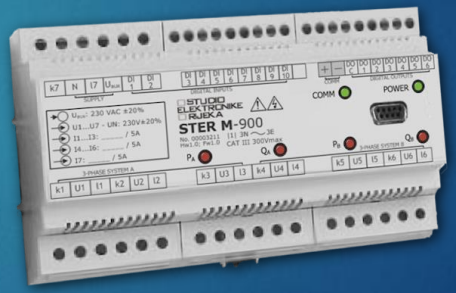


4. **Introduction to WAMSTER 2 / SyncPQ:** Rail mounted device with additional functions

New form factor: SyncPQ

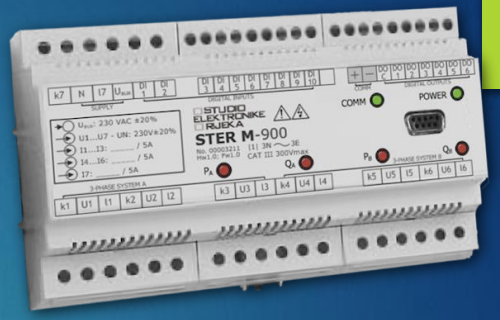
- DIN rail mounting for permanent switchboard installation
- Additional I/O and measurement functions

STER PMU



SyncPQ

SyncPQ

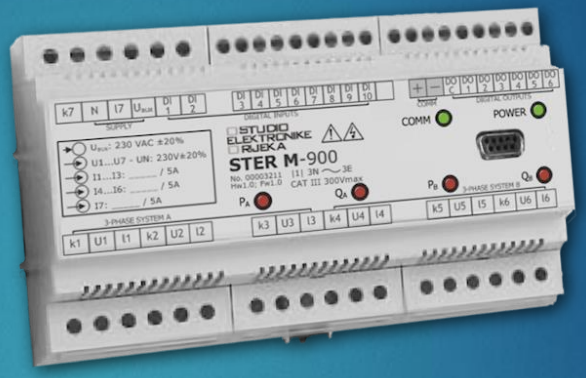


- Multifunctional device for permanent installation
- Synchronized measurements (PMU)
- Power quality measurements (PQ)
- Remote telemetry (RTU)
- Disturbance fault recorder (DFR)
- Configurable digital inputs
- Configurable digital outputs
- RS232/485, GPRS/UMTS, Ethernet

SyncPQ

Hardware under development:

- 6 voltage inputs
- 7 current inputs
- 10 digital inputs
- 6 digital outputs
- Communication: GPRS, Ethernet, WiFi, USB, RS232/485



We would appreciate your ideas and suggestions sent to info@wamster.net.

Thank you.

Contact us:

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