Power Grid Dynamic Monitoring and Disturbance Identification

Beijing Sifang Automation Company
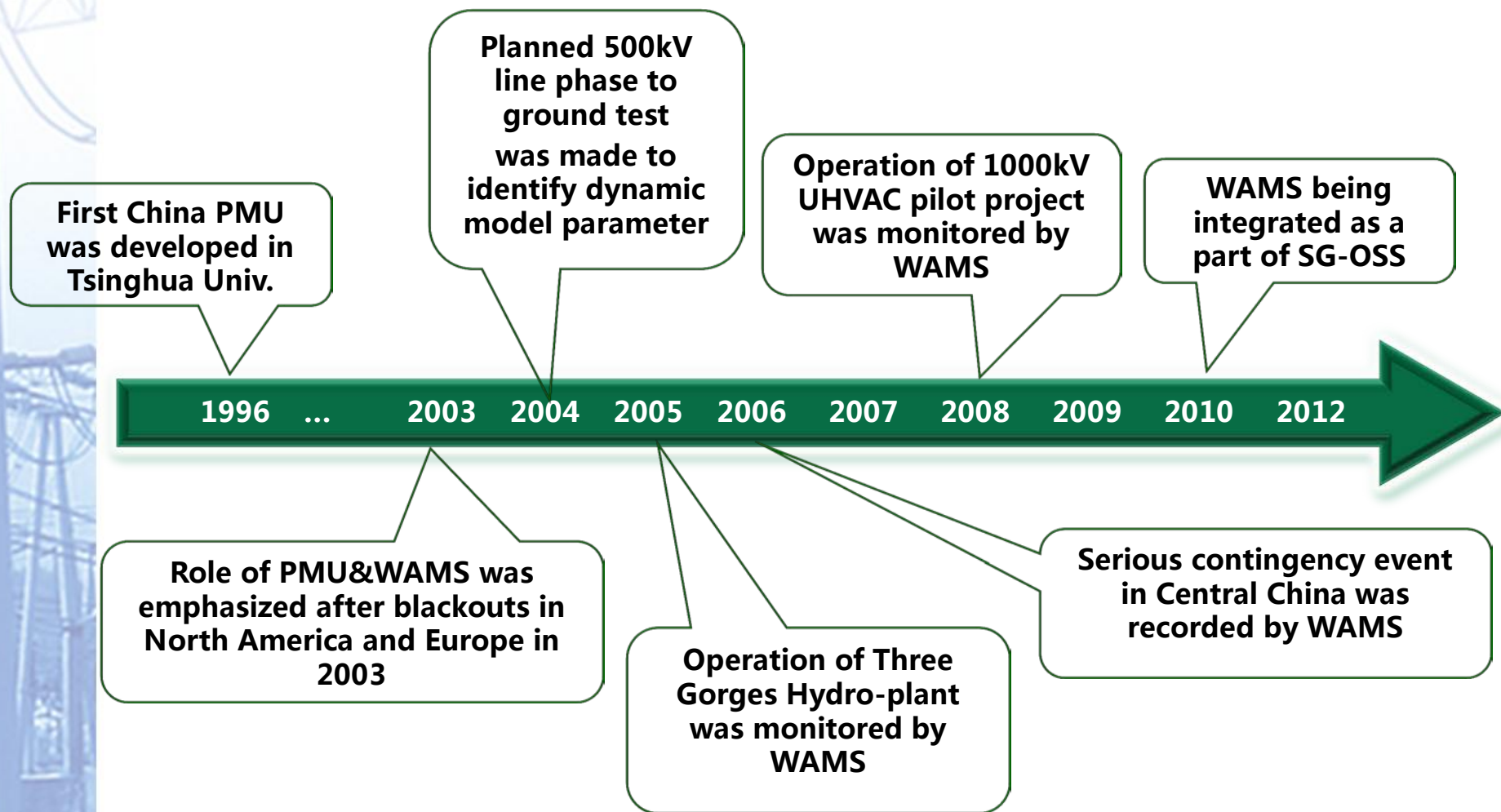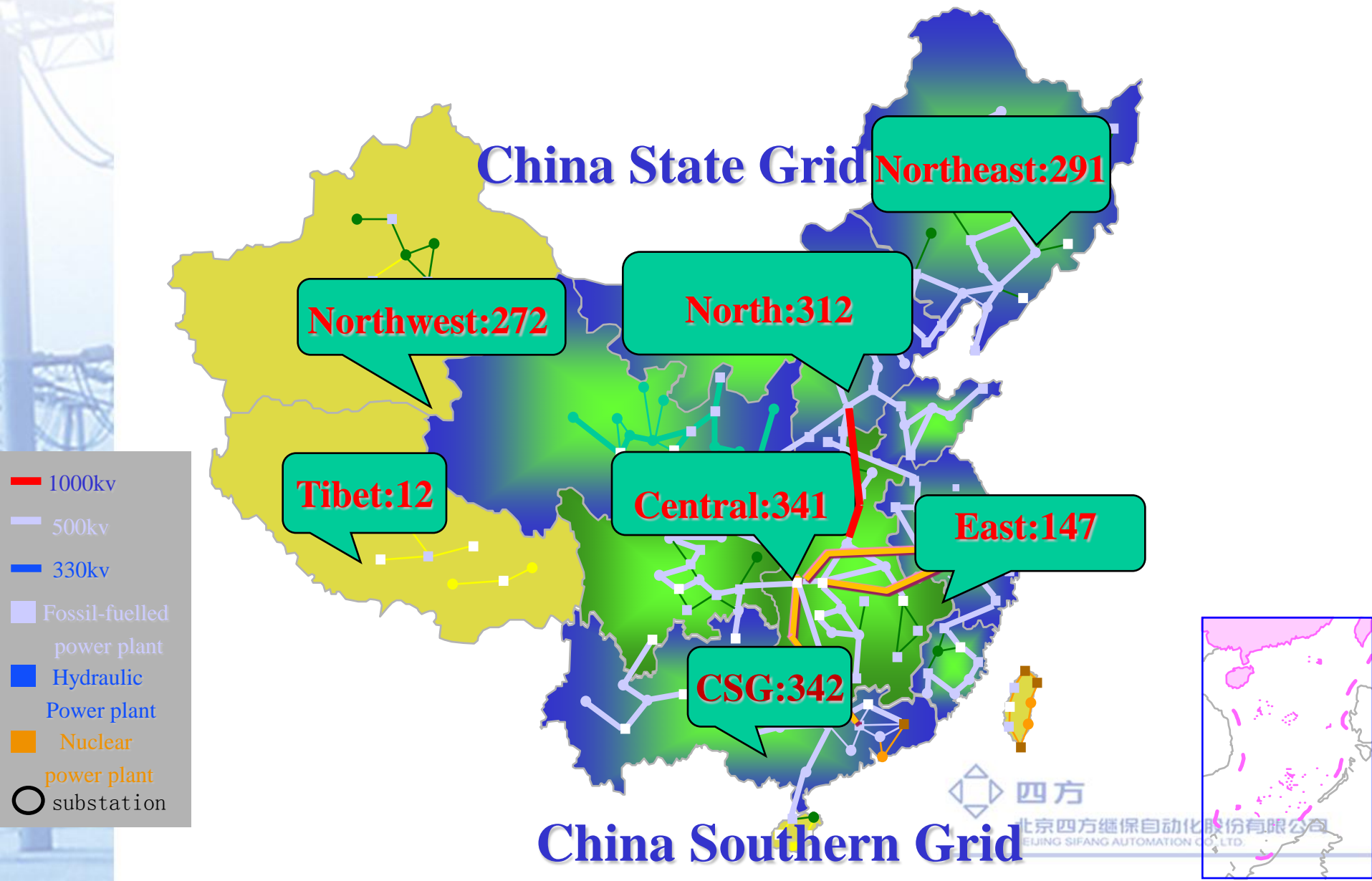## Feb. 2013

Outline

- Overview of PMU/WAMS

- Disturbance Detection by WAMS

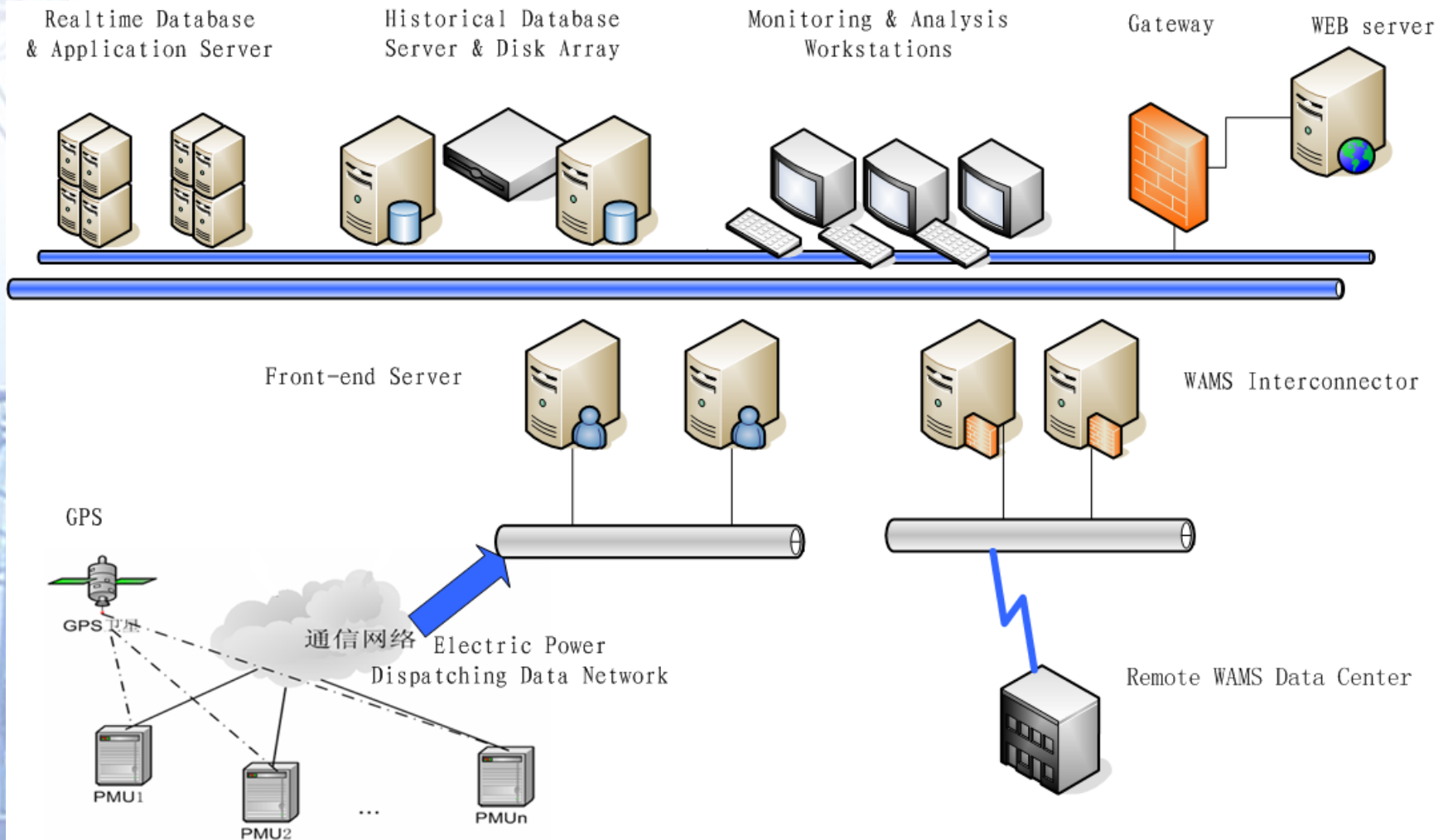- Oscillation Detection & Analysis by WAMS

- Conclusion and Future Work

Development of PMU/WAMS in China

Planned 500kV line phase to ground test was made to identify dynamic model parameter

First China PMU was developed in Tsinghua Univ.

Operation of 1000kV UHVAC pilot project was monitored by WAMS

WAMS being integrated as a part of SG-OSS

| 1996 | ... | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2012 |

Role of PMU&WAMS was emphasized after blackouts in North America and Europe in 2003

Operation of Three Gorges Hydro-plant was monitored by WAMS

Serious contingency event in Central China was recorded by WAMS

北京四方
北京四方继保自动化股份有限公司
BEIJING SIFANG AUTOMATION CO.,LTD.

PMU Coverage in China

WAMS Architecture in Control Center

Realtime Database & Application Server

Historical Database Server & Disk Array

Monitoring & Analysis Workstations

Gateway

WEB server

Front-end Server

WAMS Interconnector

GPS

GPS卫星

通信网络 Electric Power Dispatching Data Network

PMU1

PMU2

...

PMUn

Remote WAMS Data Center

四方
北京四方继保自动化股份有限公司
BEIJING SIFANG AUTOMATION CO.,LTD.

Outline

四方
北京四方继保自动化股份有限公司
BEIJING SIFANG AUTOMATION CO.,LTD.

Disturbances Encountered by Dispatchers

- Short circuit faults
- Generator tripping
- HVDC blocking
- etc.

Short Circuit Fault Identification

■Fault line recognized by features of curves

◆Before faults, the voltage and current of each phase are kept within normal range;

◆When fault occurs, sudden change of certain phase current is larger than threshold;

◆During fault, current of certain phase decreases to zero due to action of protection relay, voltage of certain phase also decrease remarkably
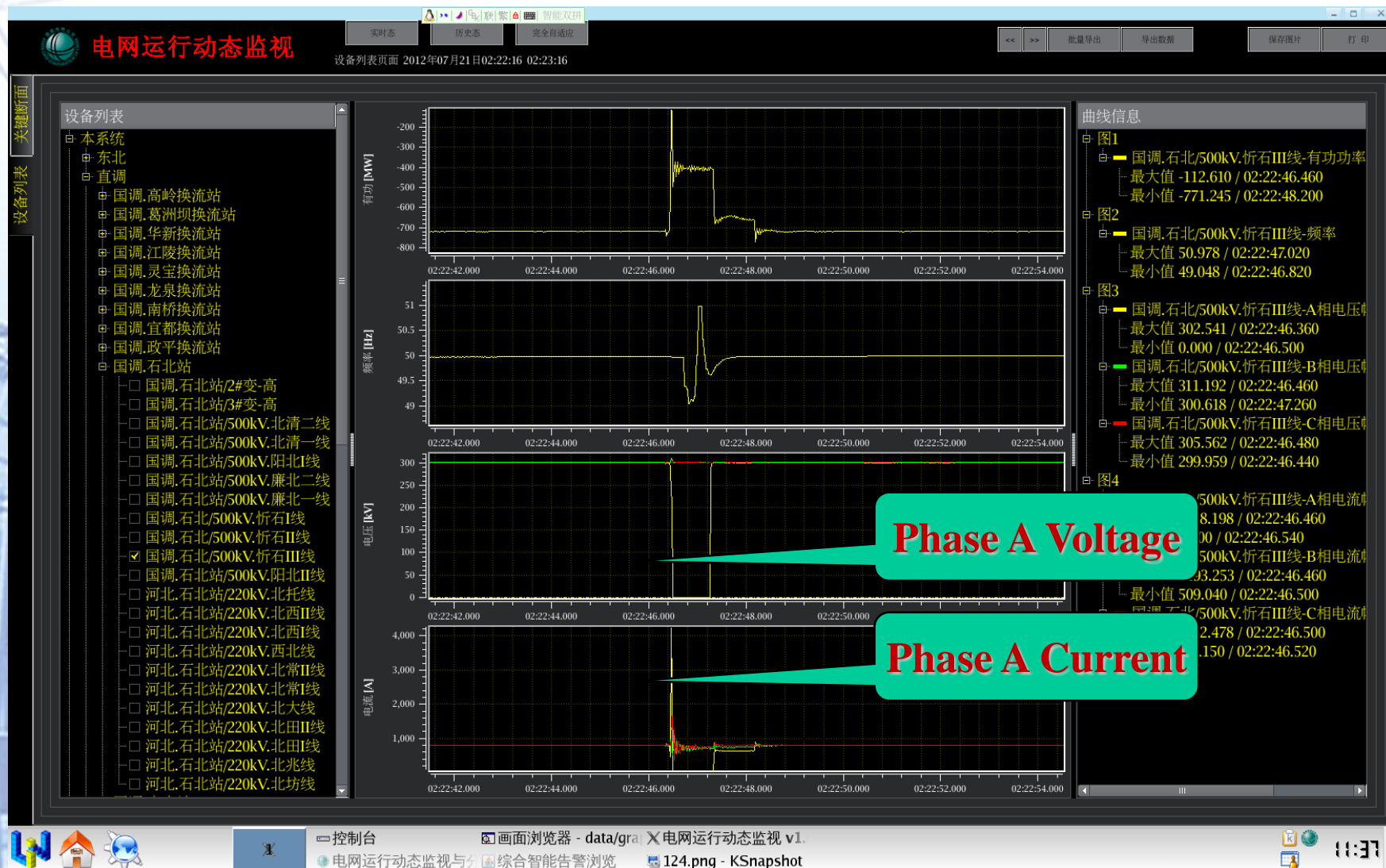
Direct Detection of Line Fault

Line single phase to ground fault

Alarm offered by WAMS

Direct Detection of Line Fault

Phase A Voltage
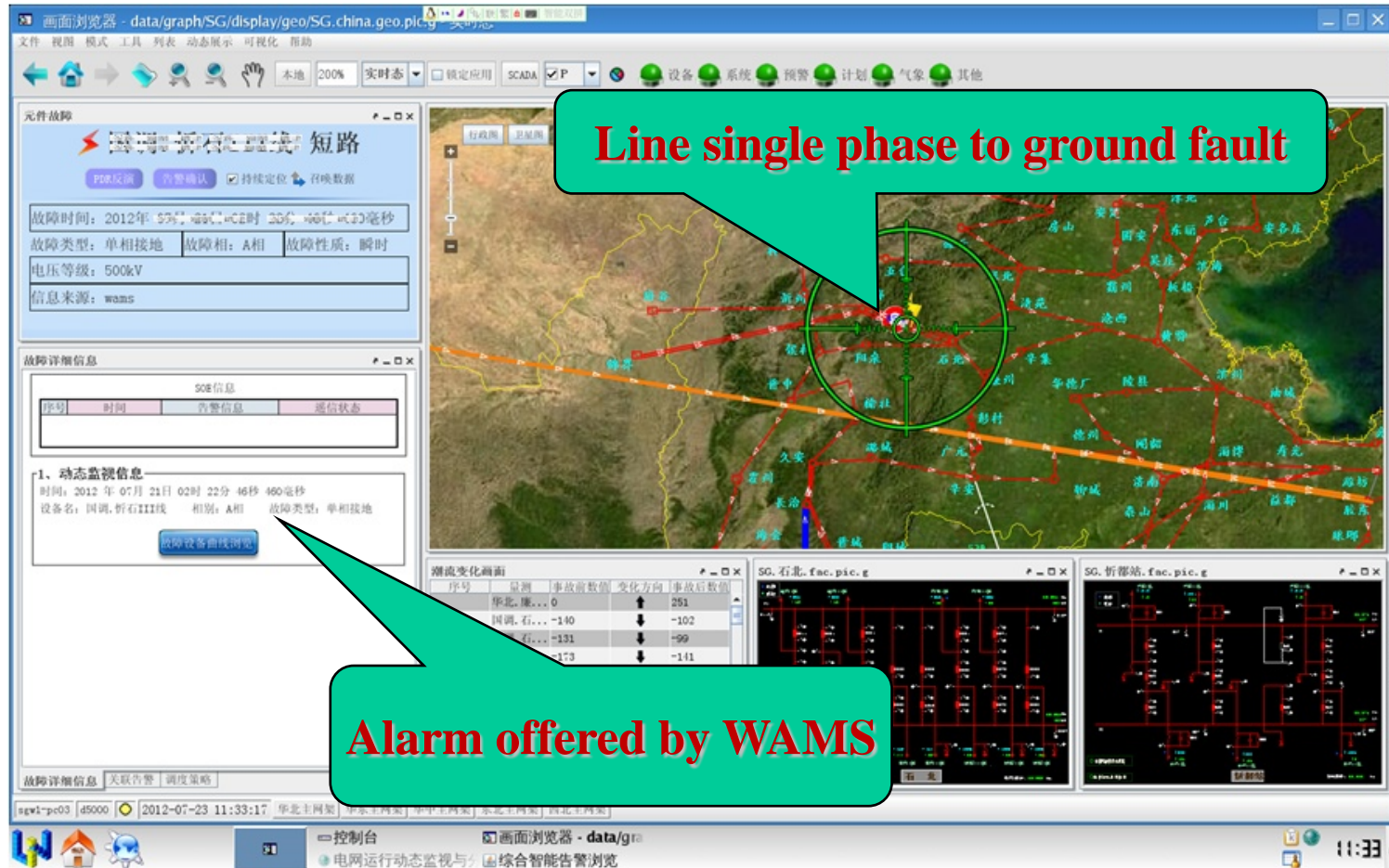
Phase A Current
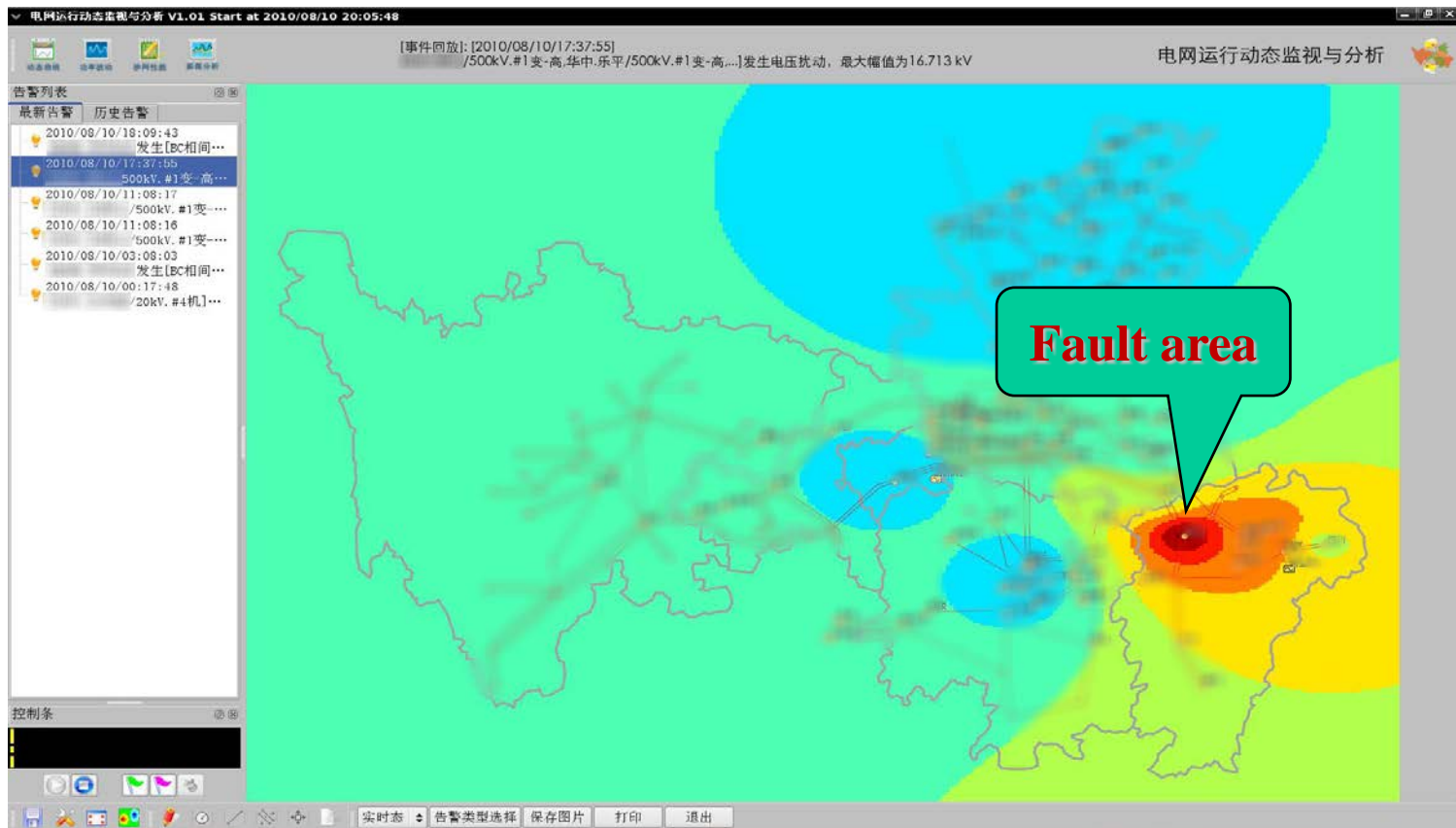
Fast Short Circuit Fault Positioning

- Visualizing node voltage variations by contour map, some fault information on lower voltage level without PMU can be obtained quickly

Generator Tripping & HVDC Blocking Detection

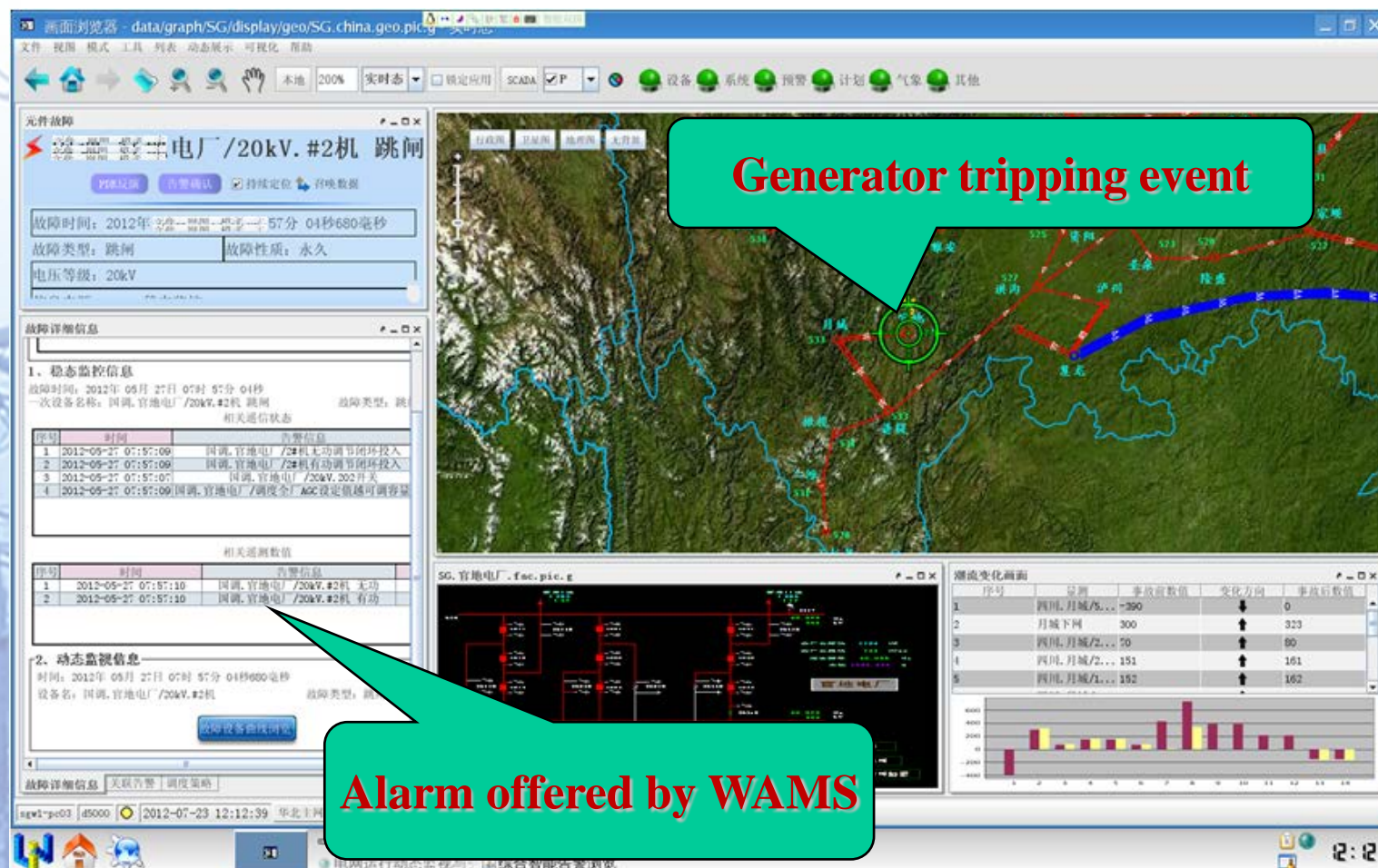■Generator tripping & HVDC blocking recognized by features of curves

◆Before event, output active power and positive sequence current both are larger than threshold;

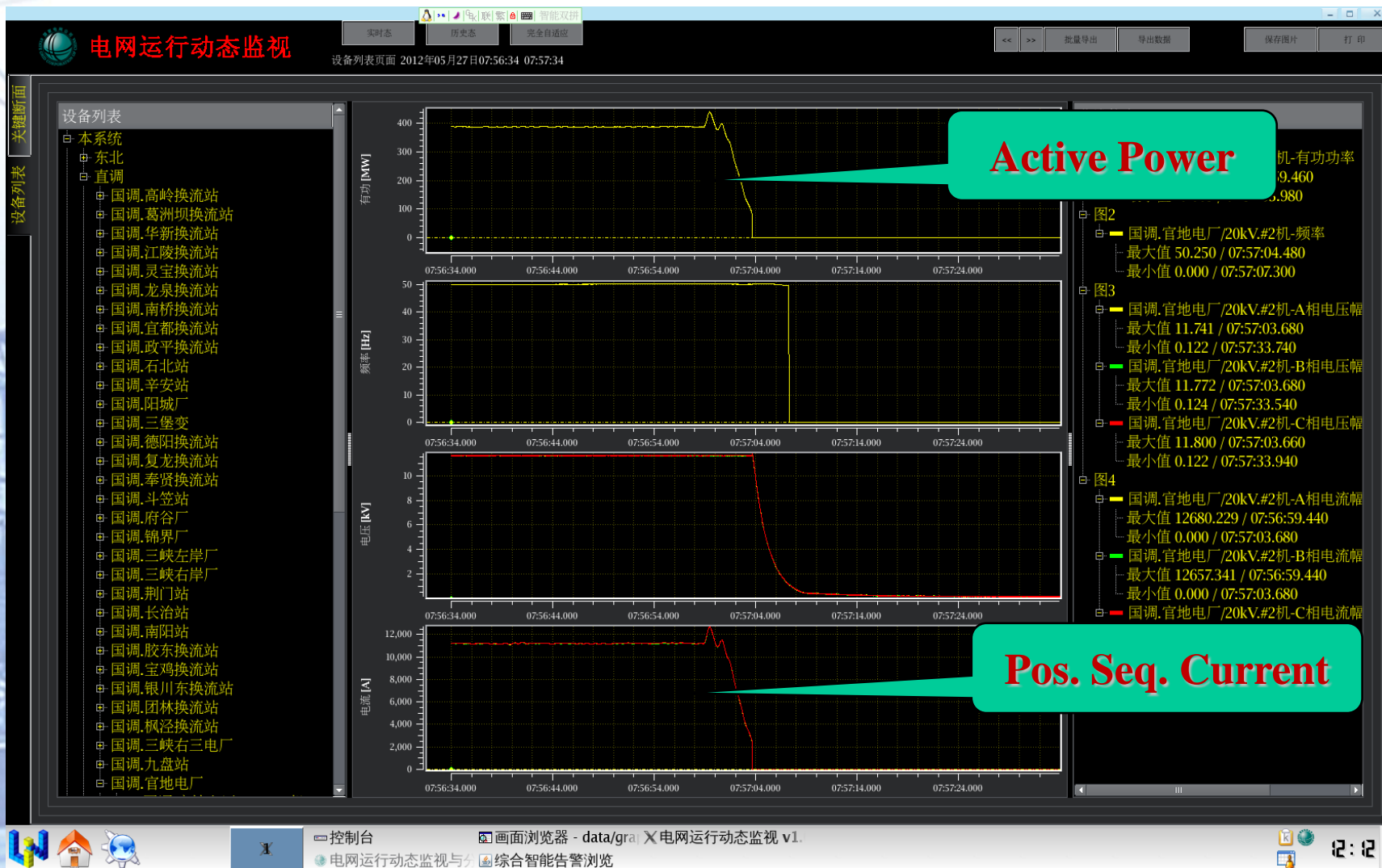◆When event occurs, active power decreases to zero, and positive sequence current decreases to zero

四方
北京四方继保自动化股份有限公司
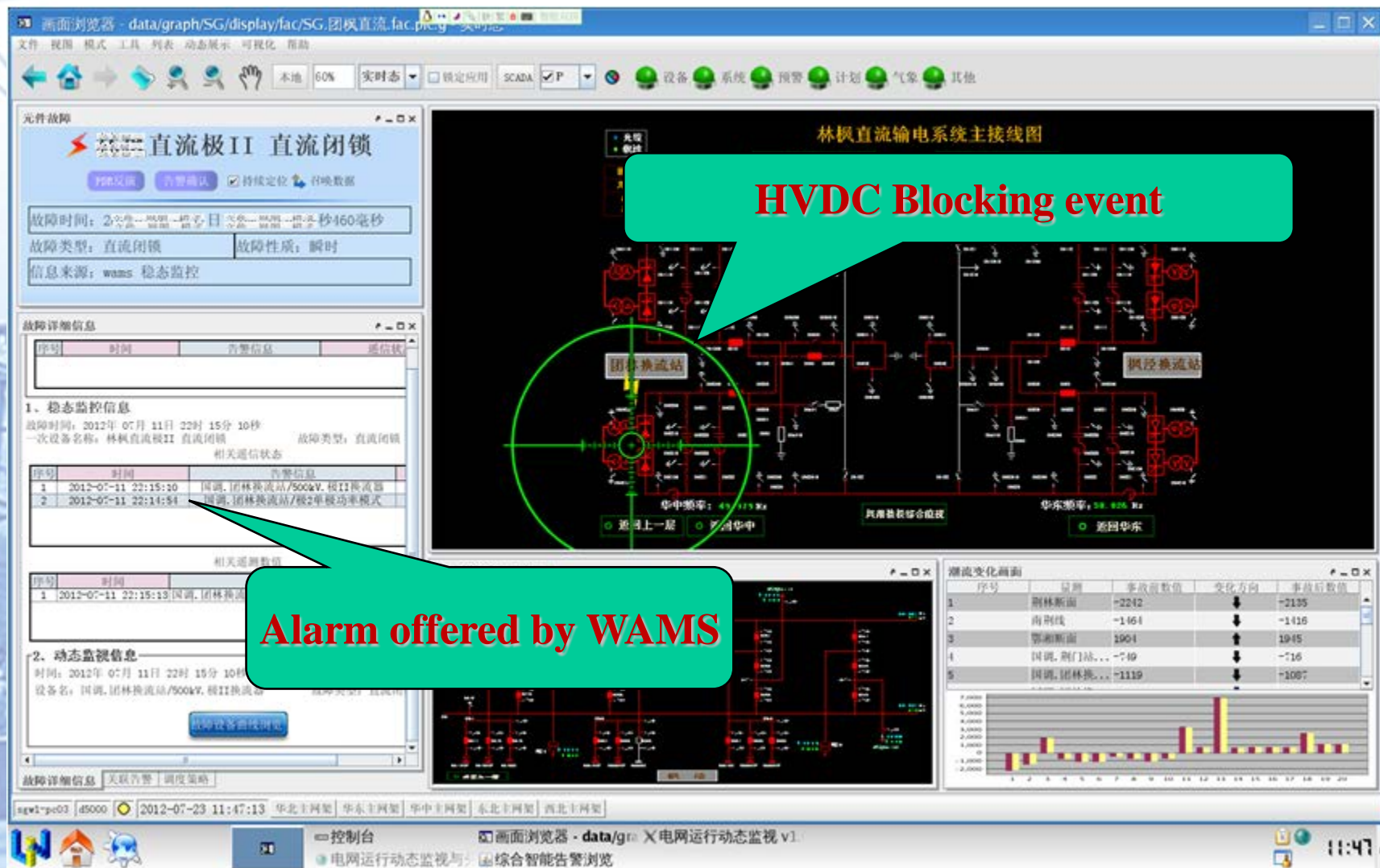BEIJING SIFANG AUTOMATION CO.,LTD.

Generator Tripping

Generator tripping event

Alarm offered by WAMS

Generator Tripping

HVDC Blocking

HVDC Blocking event

Alarm offered by WAMS
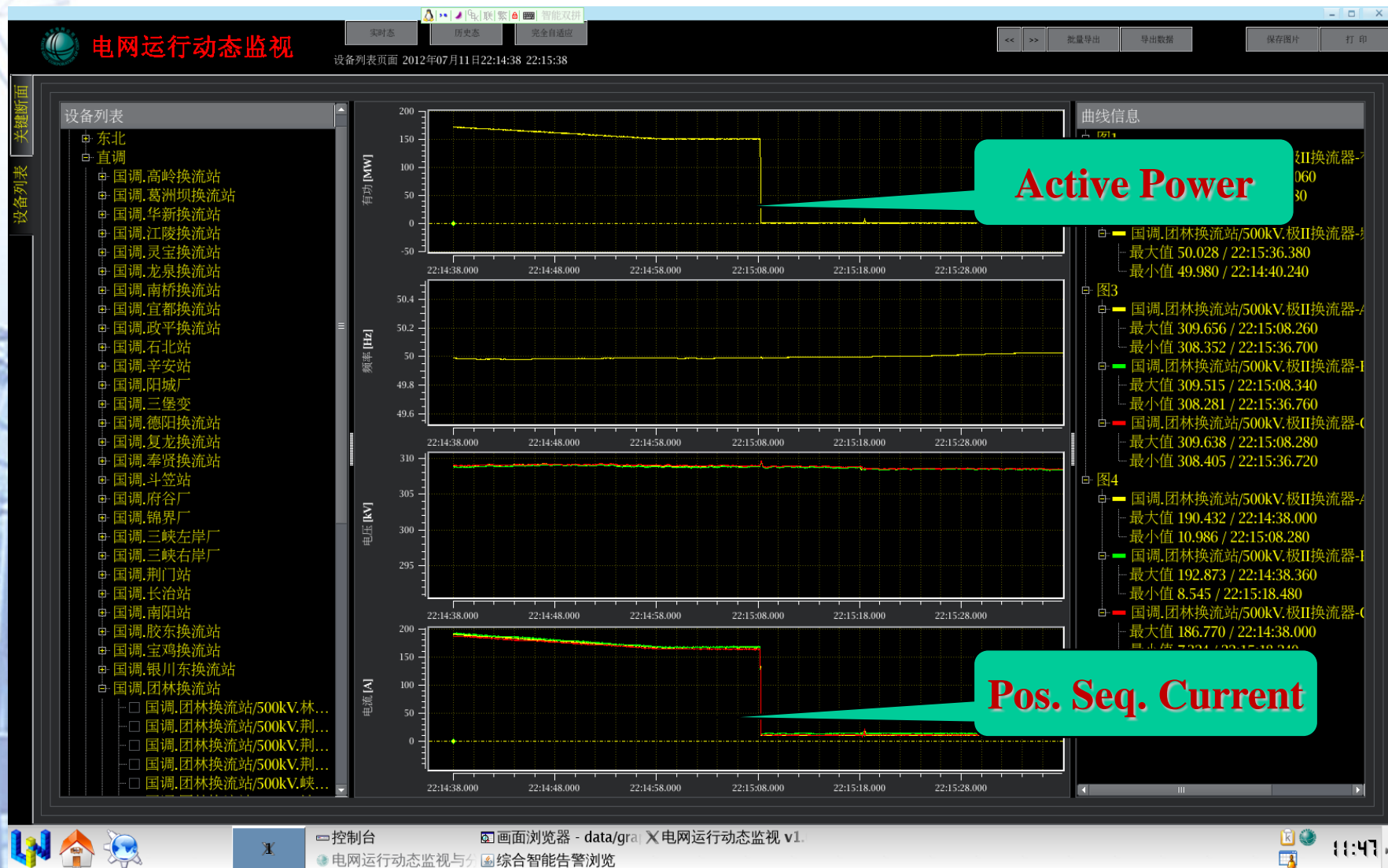
HVDC Blocking

Outline

- Overview of PMU/WAMS

- Disturbance Detection by WAMS

- Oscillation Detection & Analysis by WAMS

- Conclusion and Future Work

四方
北京四方继保自动化股份有限公司
BEIJING SIFANG AUTOMATION CO.,LTD.

Low Frequency Oscillation in Power Grid

- Nature problem of modern interconnected power grid

- Endangers the power grid operation and restrict the power transfer capability

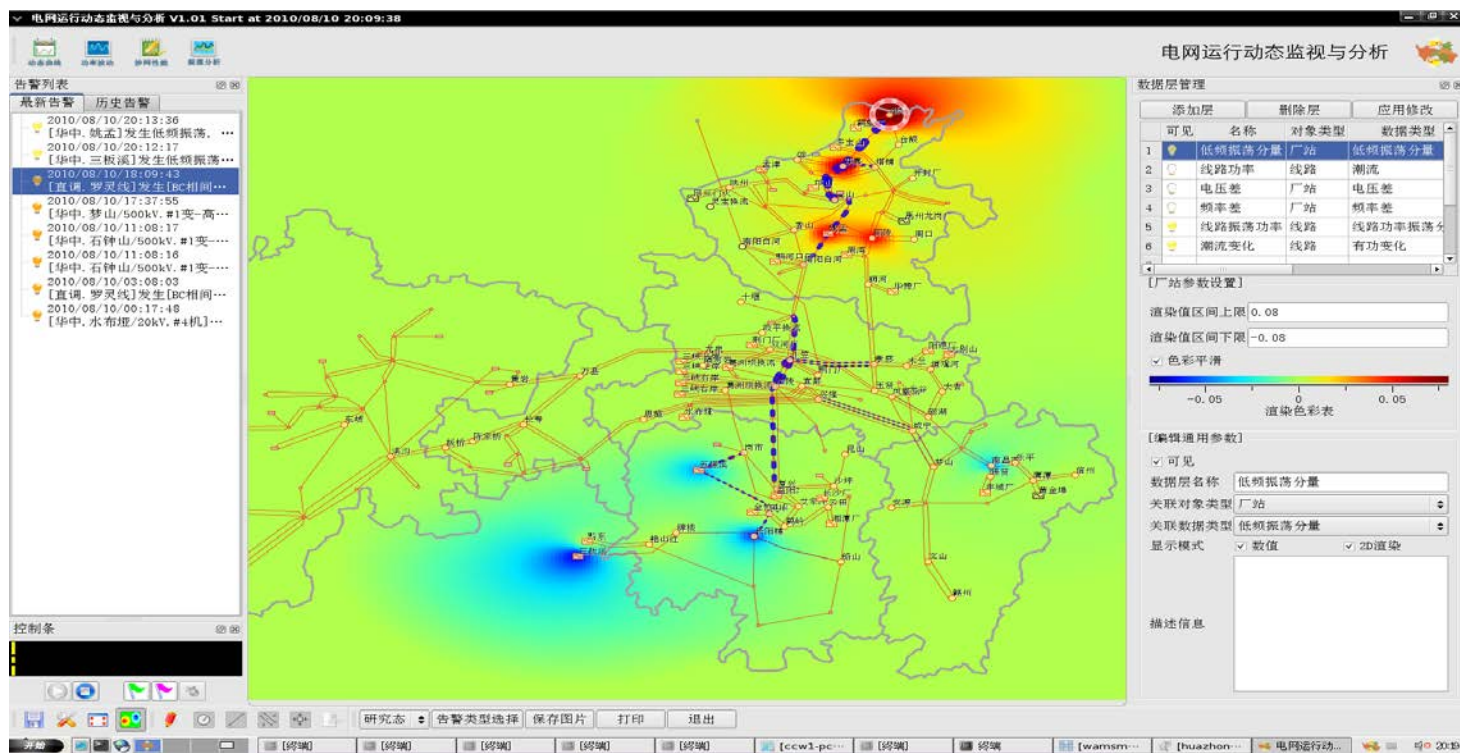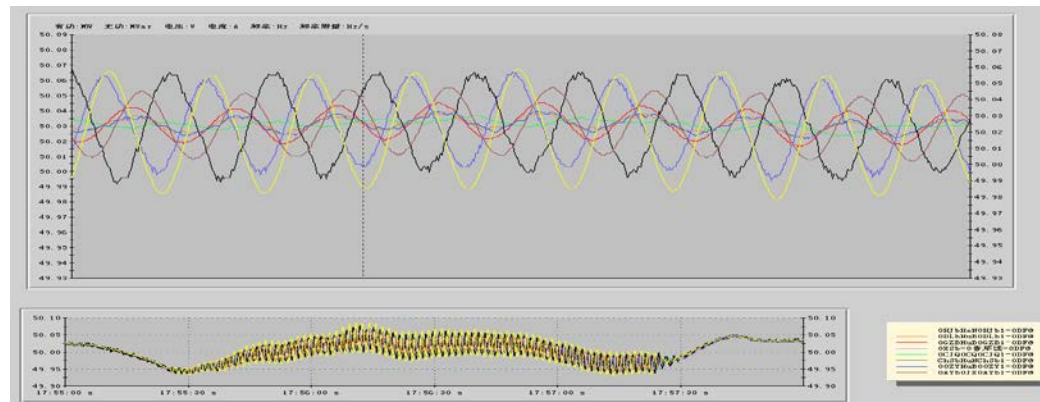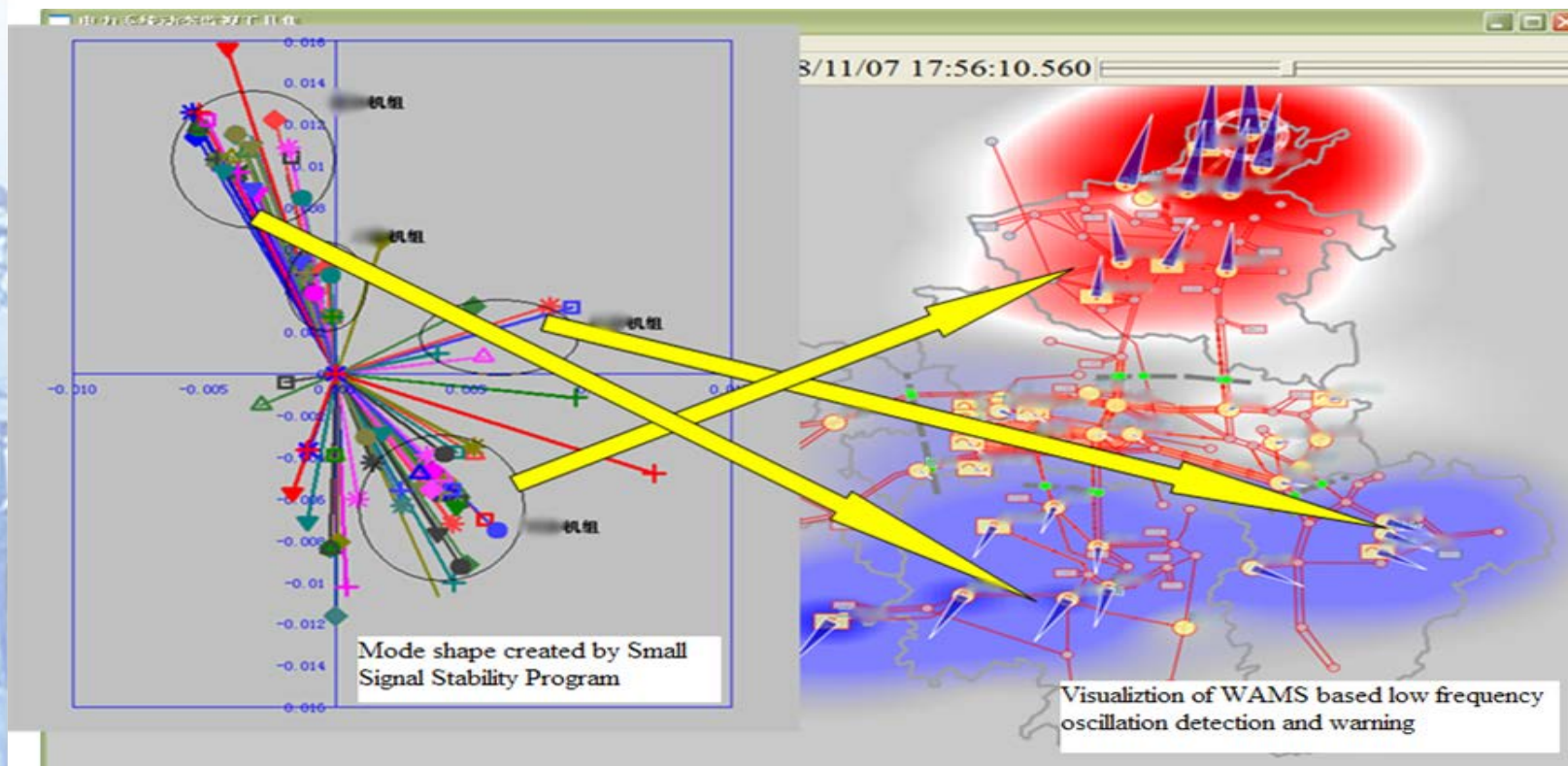- Dispatcher should know what happens and take some measures if necessary

Low Frequency Oscillation Monitoring

- Detect occurrence of oscillation and involved buses/lines

- Coherent bus grouping and visualization

Enhancing WAMS Analysis Result by Online Simulation

- Match the WAMS result with online simulation result by detected oscillation frequency

- Detailed information about generator participation can be provided by online simulation

Mode shape created by Small Signal Stability Program

Visualiztion of WAMS based low frequency oscillation detection and warning

四方
北京四方继保自动化股份有限公司
BEIJING SIFANG AUTOMATION CO.,LTD.

Outline

- Overview of PMU/WAMS

- Disturbance Detection by WAMS

- Oscillation Detection & Analysis by WAMS

- Conclusion and Future Work

Conclusion and Future Work

- Through the history of PMU/WAMS deployment and application, dynamic monitoring function offered by PMU/WAMS plays an important role in power grid operation.

- Further work such as model parameter identification, wide area real time coordinated control, power grid data mining among multiple data source, is being taken and outcome of some pilot projects has been proved to be fruitful.

四方
北京四方继保自动化股份有限公司
BEIJING SIFANG AUTOMATION CO.,LTD.

Thank you!