

The Advanced Application of Wide Area Measurement System in Hebei Provincial Grid, China

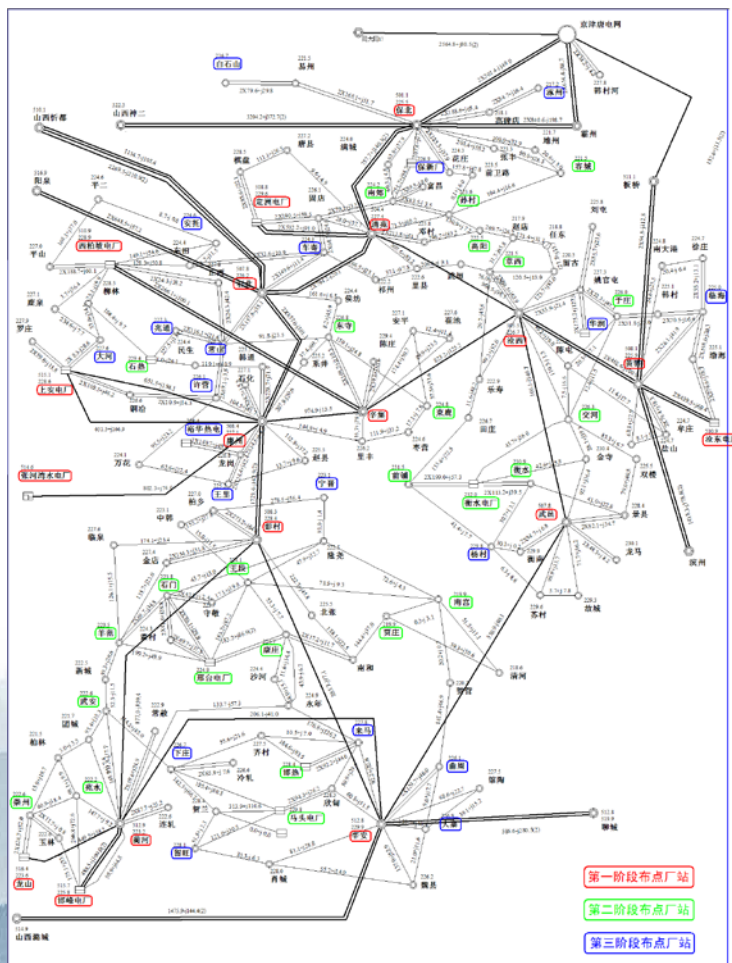
XuYong

China EPRI

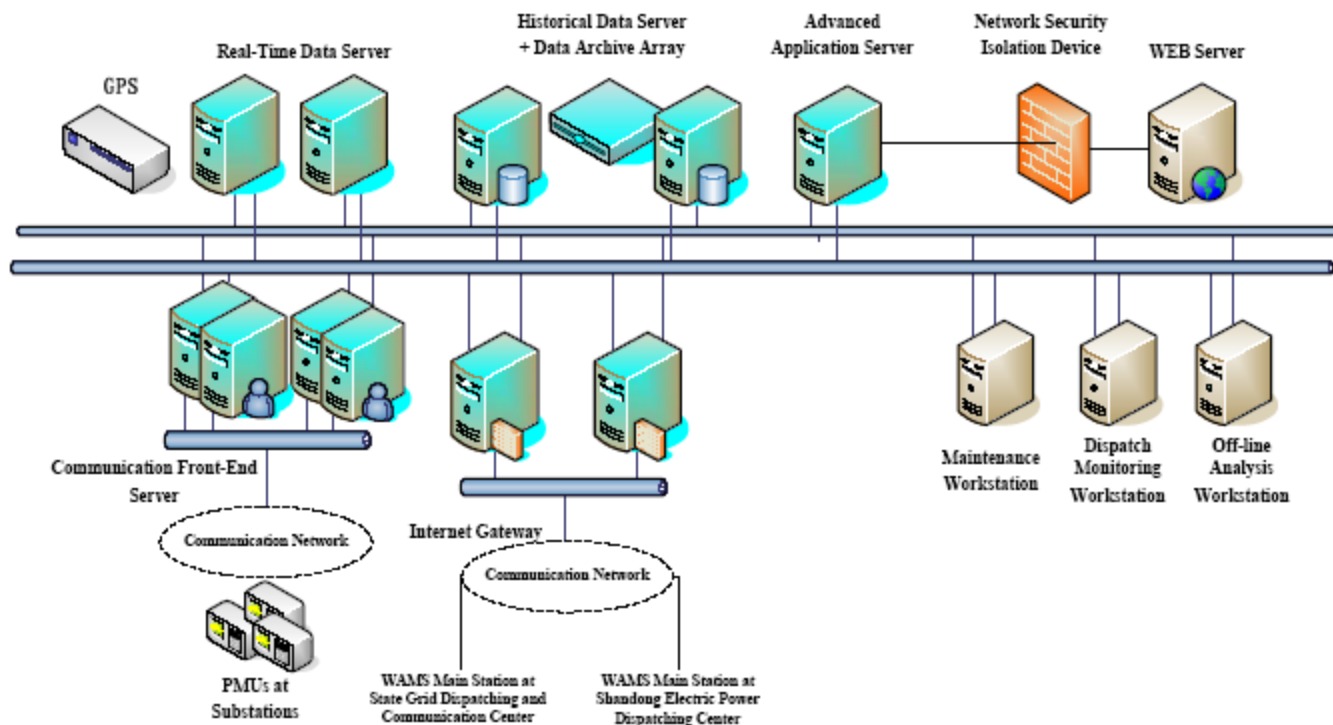
PMU location

35Pmus

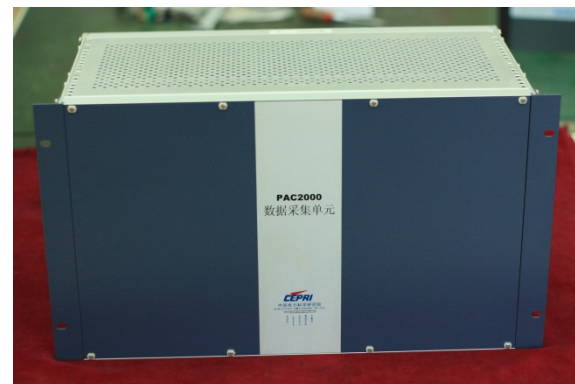
- 11 Pmus at 500kV substation
- 15 Pmus Large power plant
- 9 Pmus 220kV substation



Framework of main station



PAC-2000, PMU of CEPRI



PAC-3000, WAMS main station of CEPRI

application	电网运行 状态 监视		低频振荡 监测分析		励磁系统 分析		一次调 频、AGC 统计分析		小干扰分 析	
Basic function	数据采集	数据存储	人机组态		智能告警		离线数据 调取		WEB发布	

Public service	图形工具	报表工具	数据通信	告警服务	事件服务	WEB服务
Bus level	集成总线					

OS	HP-UX	HP-UX	Windows 2003 server	Windows 2003 server	Windows 2003 server	Windows XP
hardware	主前置服务器 HPPrx3600	备前置服务器 HPPrx3600	主数据服务器 HPPrx6600	备数据服务器 HPPrx6600	应用服务器 HPPrx3600	工作站 HPxw4400

Information from WAMS

1. Phasor

- three phase voltage, three phase current
- Positive voltage, positive current
- Generator angle

2. Analog

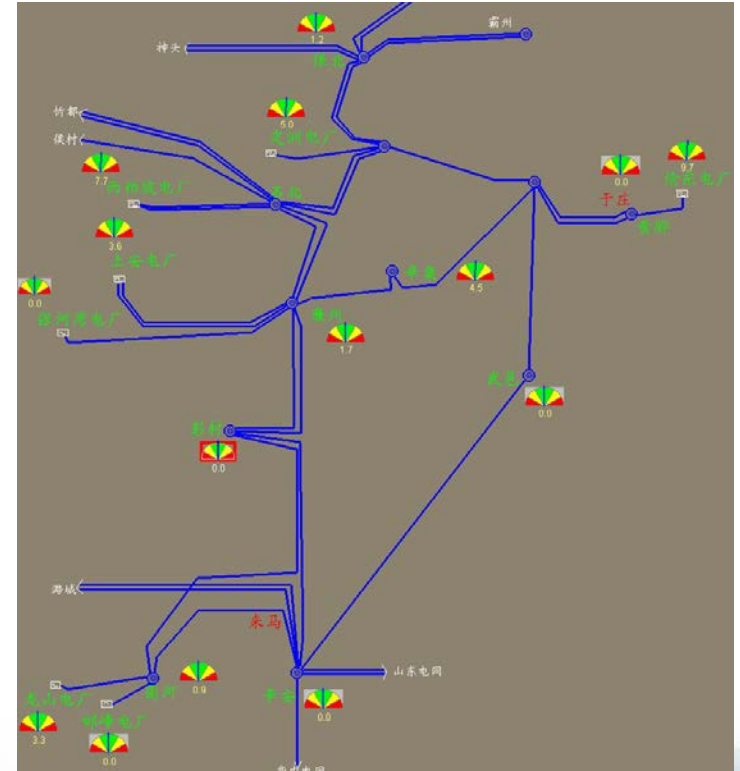
- P, Q
- Frequency

3. Digital signal

System characteristic

- Data sending rate: 25Hz
- History data storage period: 1 month
- Double front-end server and historical data server, automatic switch

Application in main station



Generator status monitoring

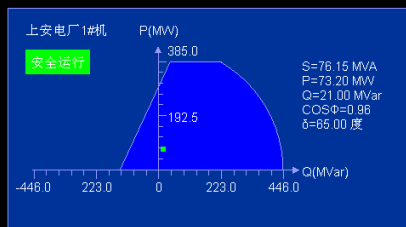
返回主页

返回上级

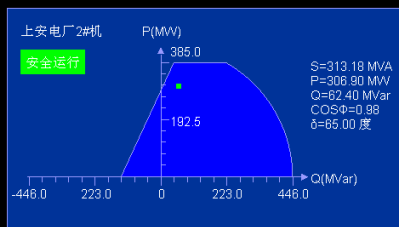
返回接线图

上安电厂发电机组PQ图

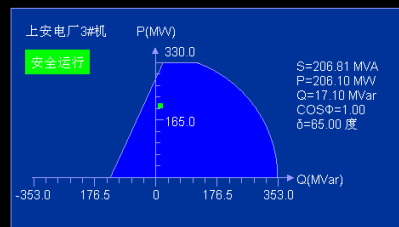
#1机



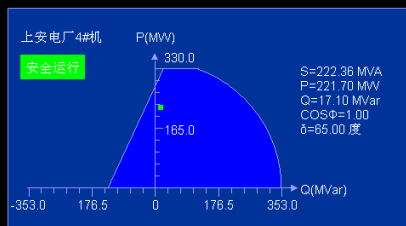
#2机



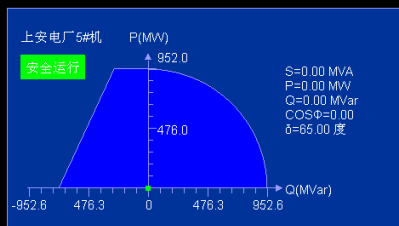
#3机



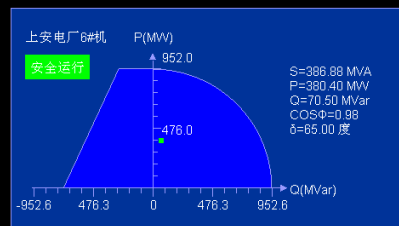
#4机



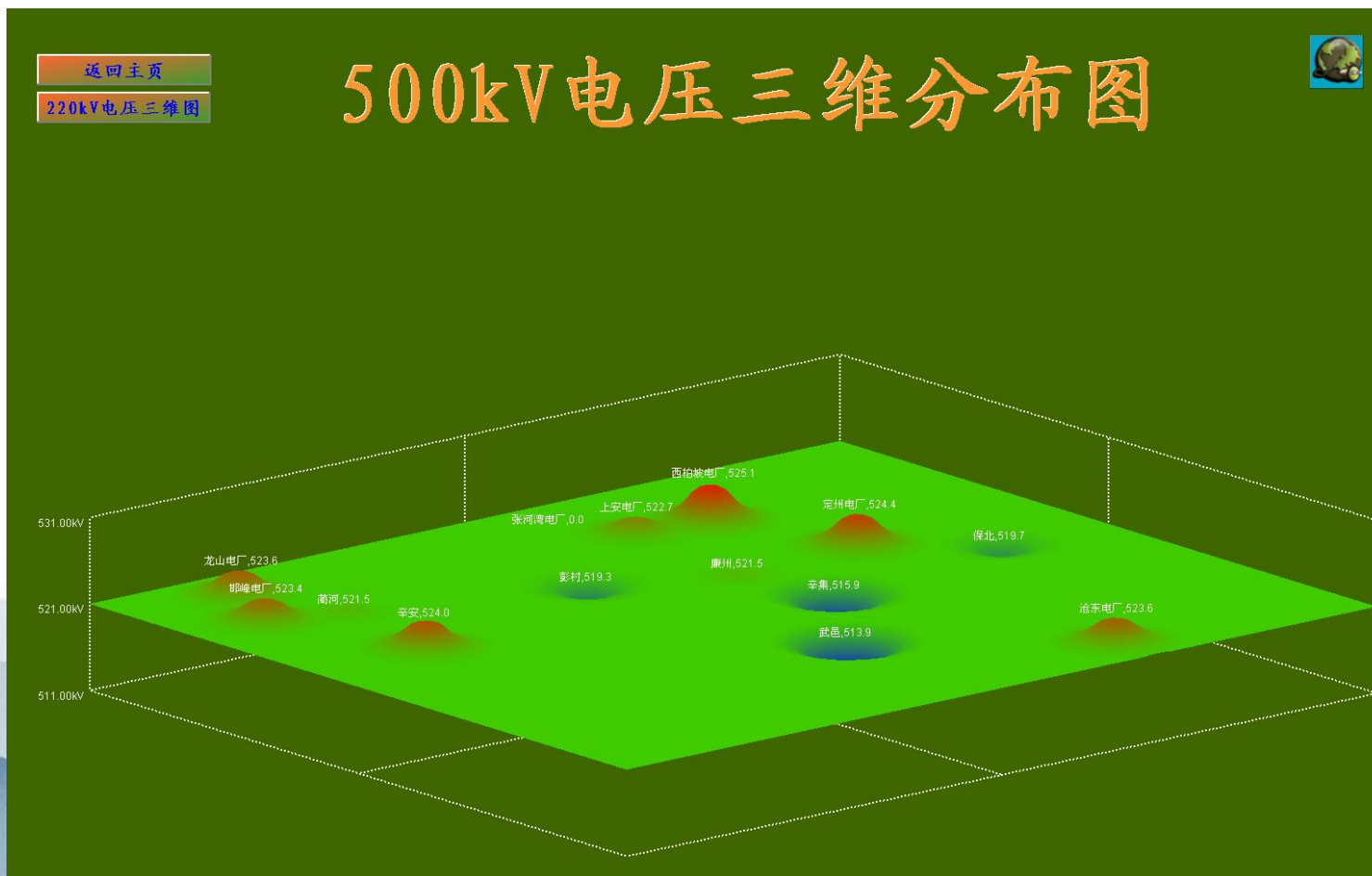
#5机



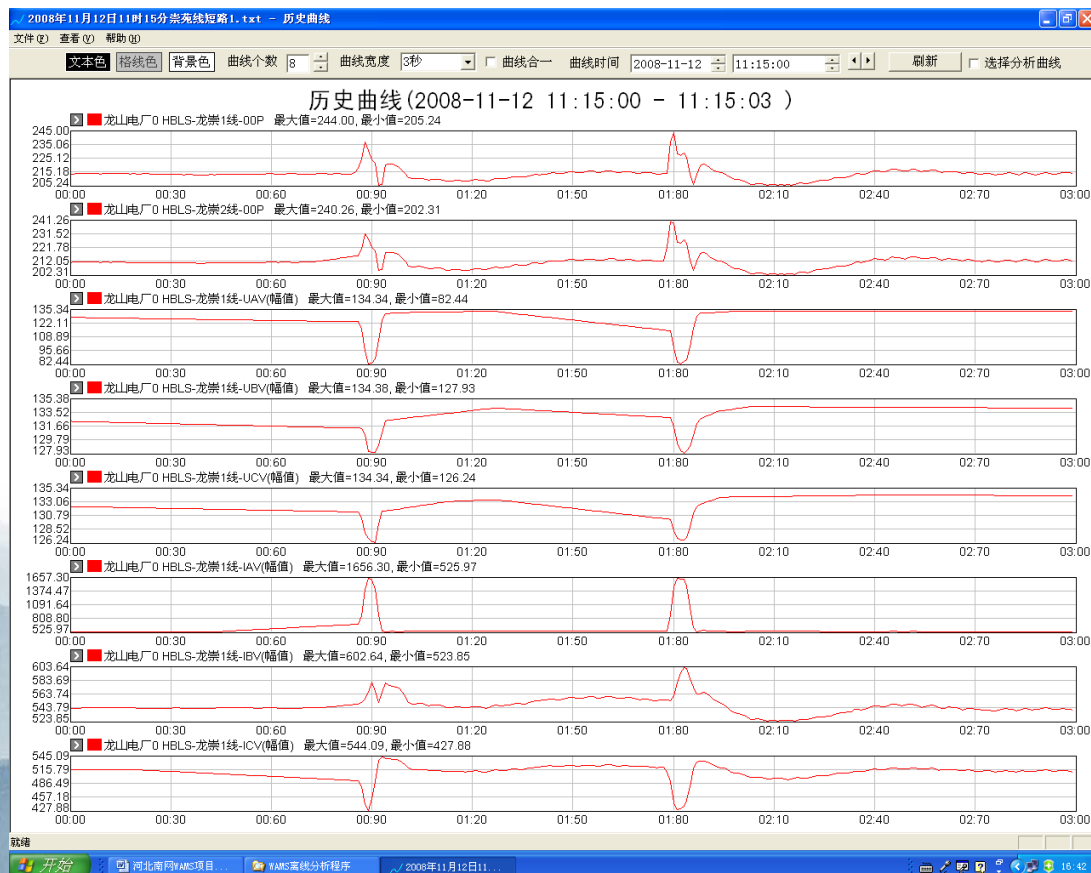
#6机



3D voltage monitoring

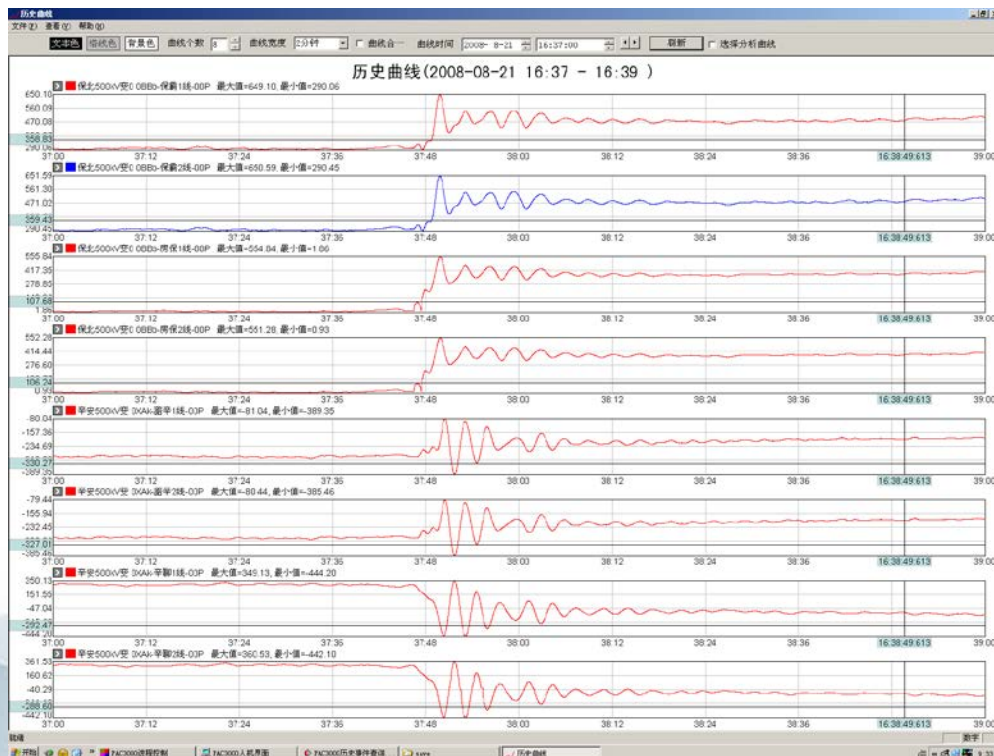


Fault analysis

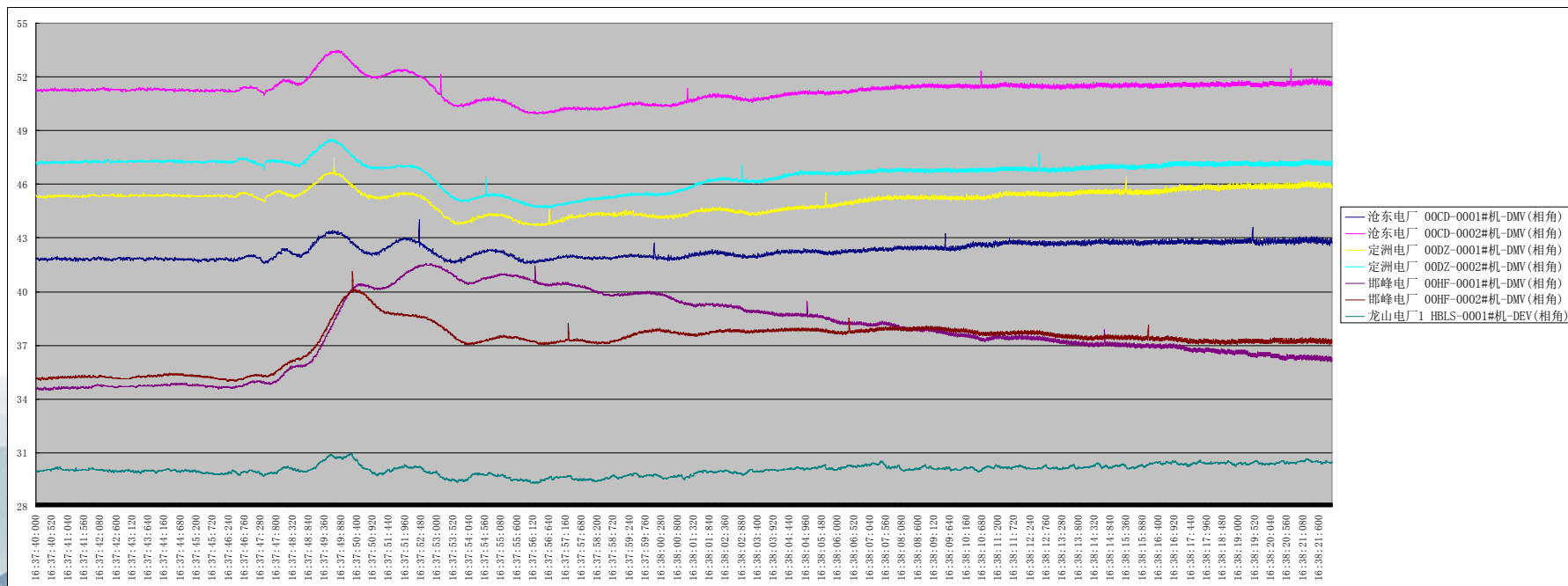


Phase A-to-ground
Fault On Nov,22,2008

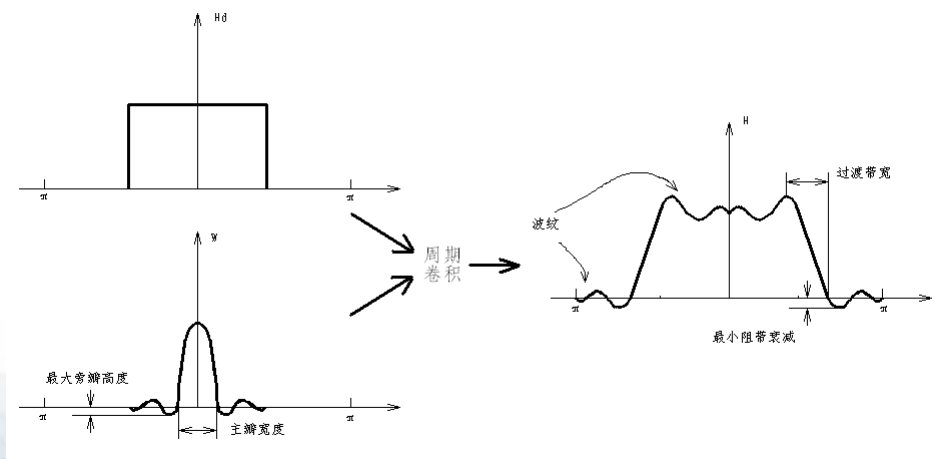
Disturbance On August, 21, 2008



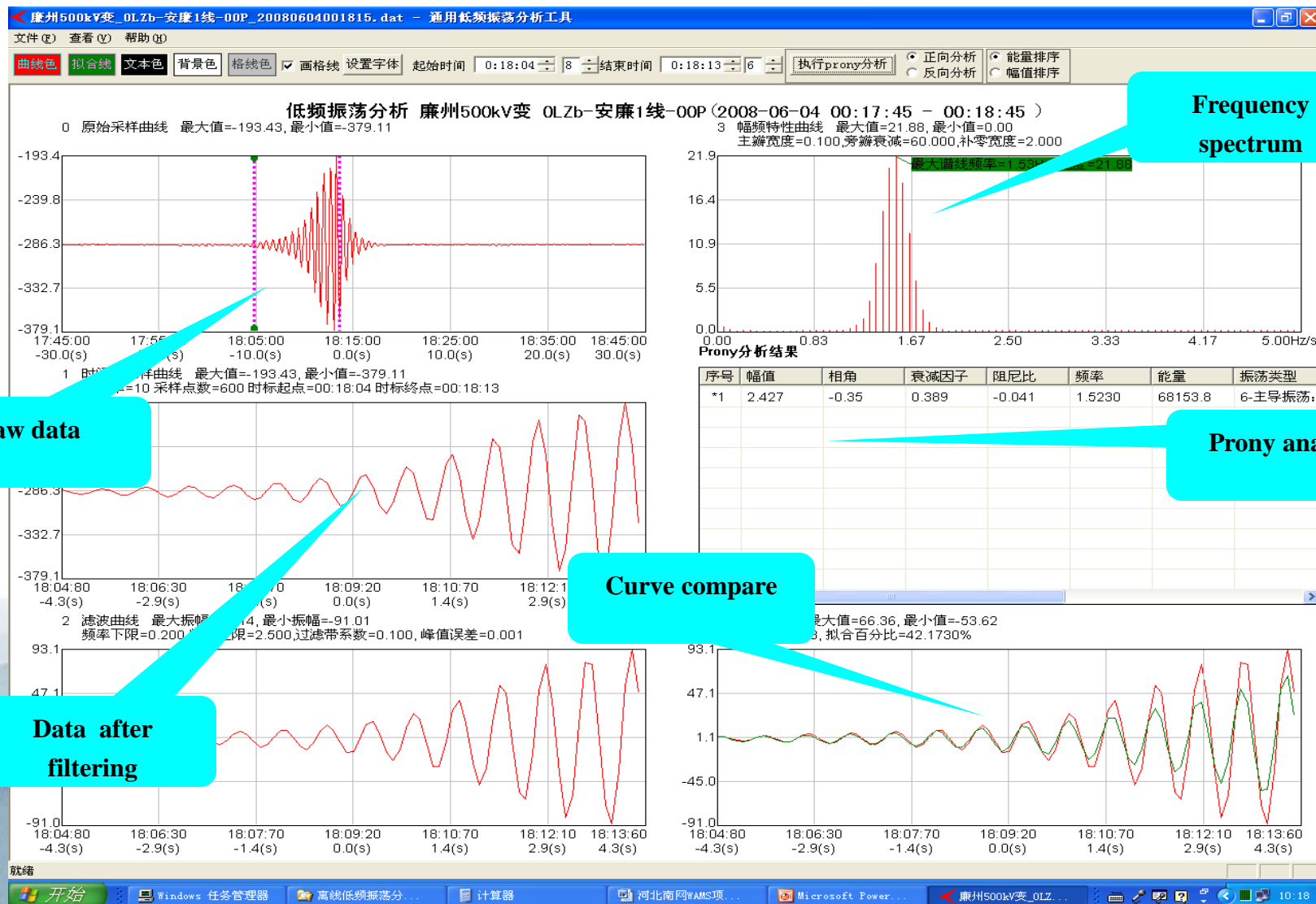
Angle curve of different generator in 8.21 disturbance



Fast On-line low frequency oscillation recognize using band filter method



On-line low frequency oscillation analysis



Frequency spectrum

Raw data

Prony analysis

Curve compare

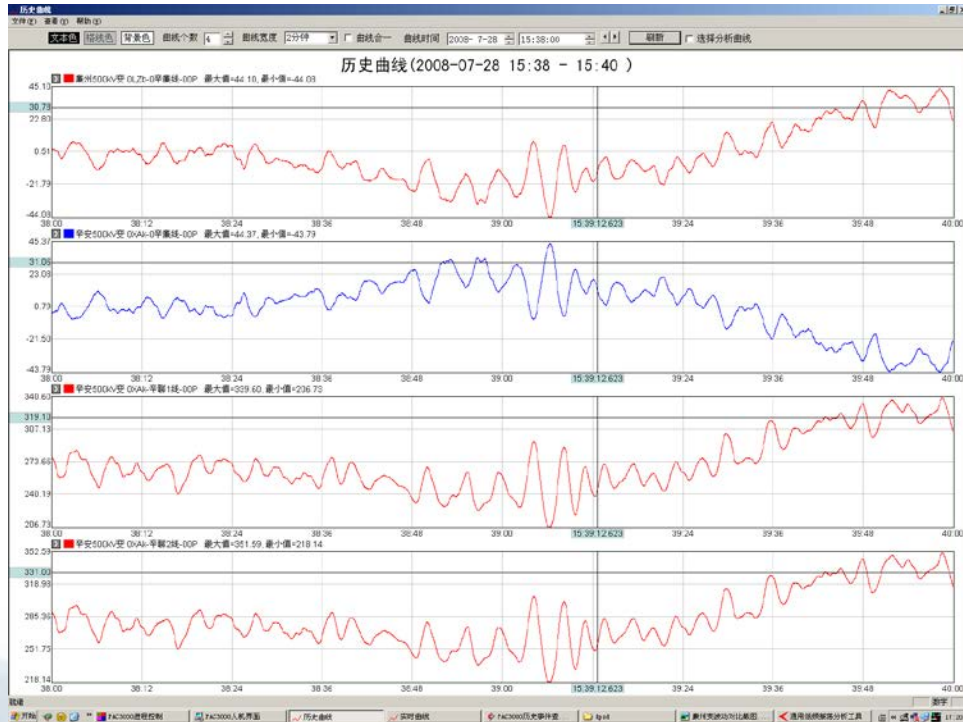
Data after filtering

Prony analysis output

模型类型	频率 (Hz)	衰减因子 (阻尼比)	幅值	相角 (度)
选择所有				
1 -域间振荡	0.263702	0.085735	140.589588	-94.569662
2 -直流分量	0.000000	-----	8.592813	0.000000
3 -直流分量	0.000000	-----	0.000249	180.000000
4 -域间振荡	0.495630	0.025018	4.060178	32.154878
5 -暂态振荡	1.771754	0.642946	18.530111	10.373354
6 -发散振荡	0.643535	-0.103063	0.111184	-157.868768
7 -局部振荡	1.326052	0.014257	2.242493	177.810690
8 -局部振荡	1.752968	0.013661	2.296017	-108.134460
9 -高频噪声	2.514897	0.025140	3.614878	-96.235737
			信噪比10.336552 dB	

Report of low frequency oscillation analysis

编号	振幅	频率 (Hz)	衰减因子	相位 (度)
1	5.024778	1.041040	-0.018116	-16.224095
2	6.654831	0.000000	----	180
3	0.000283	0.000000	----	0.000000
4	3.041149	2.053285	0.130783	-48.321195
5	0.168694	2.562322	0.021701	164.174752
信噪比	57.390986 dB			
是否产生 低频振荡	是			
主导振荡	主导振荡是振幅为5.024778，频率为1.041040的振荡模式			
振荡类型	局部振荡			
起振原因	系统大扰动致使系统的特征根发生变化，且产生附加的负阻尼，抵消了系统中固有的正阻尼，导致增幅振荡			



Power swing
between Hebei
grid and Henan
grid, swing
frequency is
0.27Hz

Assessment of primary frequency regulation of generators

