NETWORK PARAMETER QUALITY TRACKING - BC HYDRO PRACTICES

Djordje Atanackovic
Engineering Team Leader, Operations Support

Greg Dwernychuk
Manager (RTS), Operations Support

Raju Vinnakota.
Senior Engineer, Operations Support

Qing Zhu
Engineer, Operations Support

NETWORK PARAMETER QUALITY TRACKING OVERVIEW

- Advanced EMS applications
- Network model characteristics
- Parameter tracking
  - Model requirements
  - Calculation method
- Examples
- Next steps

NETWORK ONLINE SEQUENCE

- State estimator
- Transient stability analysis
- Contingency analysis
- Voltage stability analysis
- Voltage var dispatch

BC HYDRO NETWORK MODEL CHARACTERISTICS

BC hydro

- Voltage levels from 500kv down to 25kv feeders
- Large portion of 60kv network is modeled in detail
- Presence of lines with high r/x ratio
- Zip load model
- HVDC model

BC HYDRO MODEL CHARACTERISTICS

- Redundant telemetry in 500kv and portions of 230kv network
- Unobservable areas in parts of 230kv, 138kv and 60kv networks
- Large unobservable areas in external networks
- Large number of current measurements
- Significant number of summed measurements

PARAMETER QUALITY TRACKING SCOPE

- Line resistance
- Line reactance
- Line charging admittance

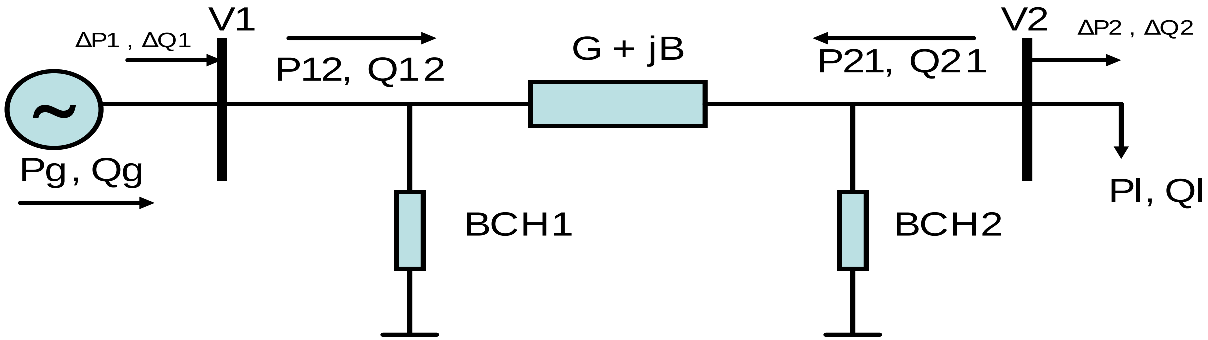
PARAMETER QUALITY TRACKING METHODOLOGY

- Parameter tracking performed on a network pocket
- The concept of network pocket– a contiguous portion of the network that meets the following requirements:
  - Measurement redundancy level > 2.5
  - State estimator solution quality meets performance criteria
  - Measurements in the pocket meet stringent quality requirements

PARAMETER QUALITY TRACKING
PARAMETER ERROR CALCULATION

- Based on the concept of bus mismatch
- KCL constraint in state estimator is met with margin of error (sum of injections/flows at a bus is not zero)
- For pockets with high measurement redundancy and measurement accuracy the parameter error contributes to bus mismatch
- Parameter errors can be calculated from power flow equations as function of measured real and reactive power injections, power flows, bus voltage magnitudes and bus mismatches

PARAMETER QUALITY TRACKING
TWO BUS EXAMPLE



BChydro

$$\Delta G = g_1(V_1, V_2, G, \Delta P_1, \Delta P_2, P_{12}, P_{21})$$

$$\Delta B = g_2(V_1, V_2, B, \Delta Q_1, \Delta Q_2, P_{12}, P_{21})$$

$$\Delta BCH_1 = g_3(V_1, V_2, \Delta Q_1, \Delta Q_2, \Delta G, \Delta B, Q_{12}, Q_{21})$$

$$\Delta BCH_2 = g_4(V_1, V_2, \Delta Q_1, \Delta Q_2, \Delta G, \Delta B, Q_{12}, Q_{21})$$

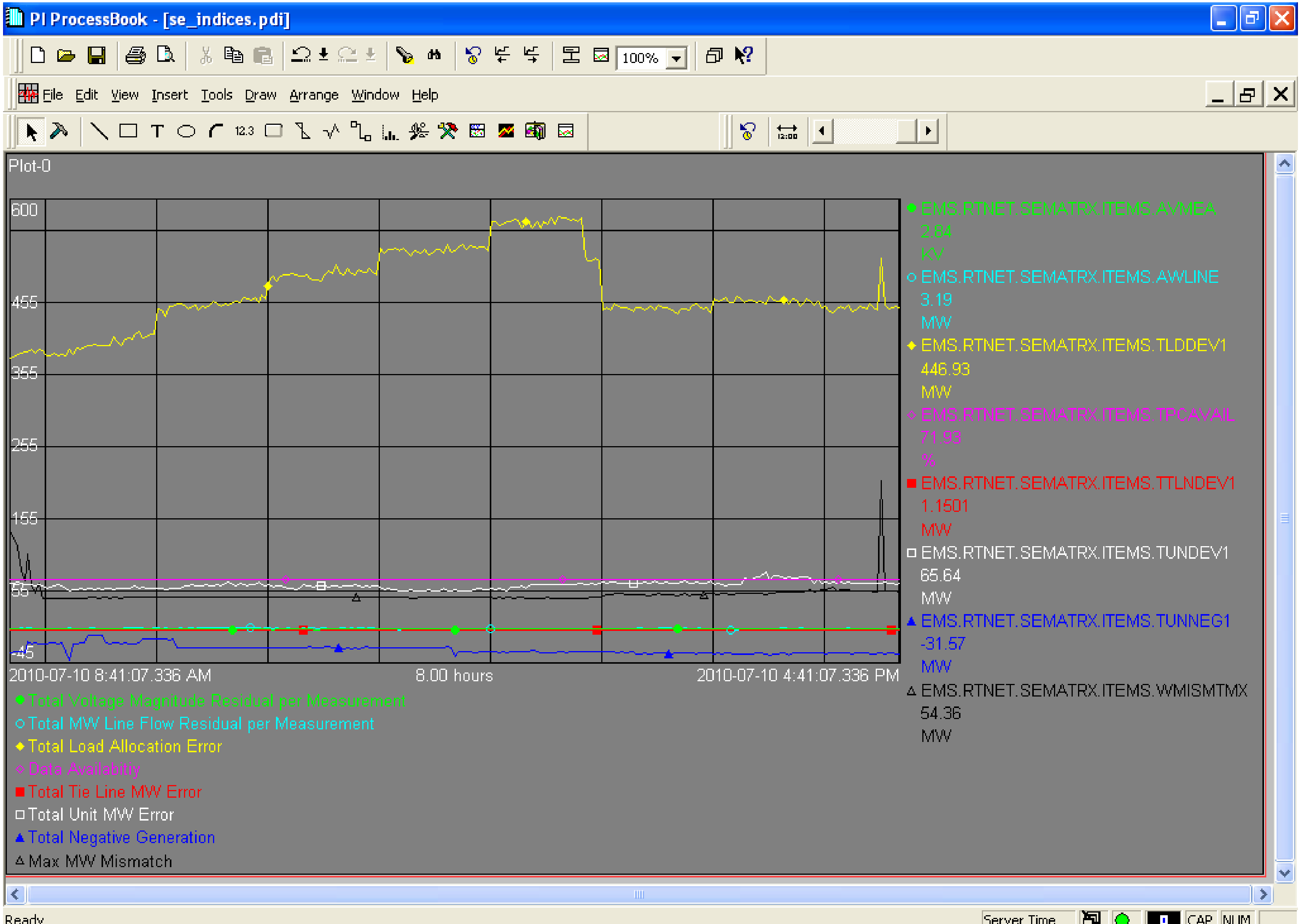
$\Delta P_1, \Delta P_2, \Delta Q_1, \Delta Q_2$ are bus mismatches

$V_1, V_2, P_{12}, P_{21}, Q_{12}, Q_{21}$ are telemetered values

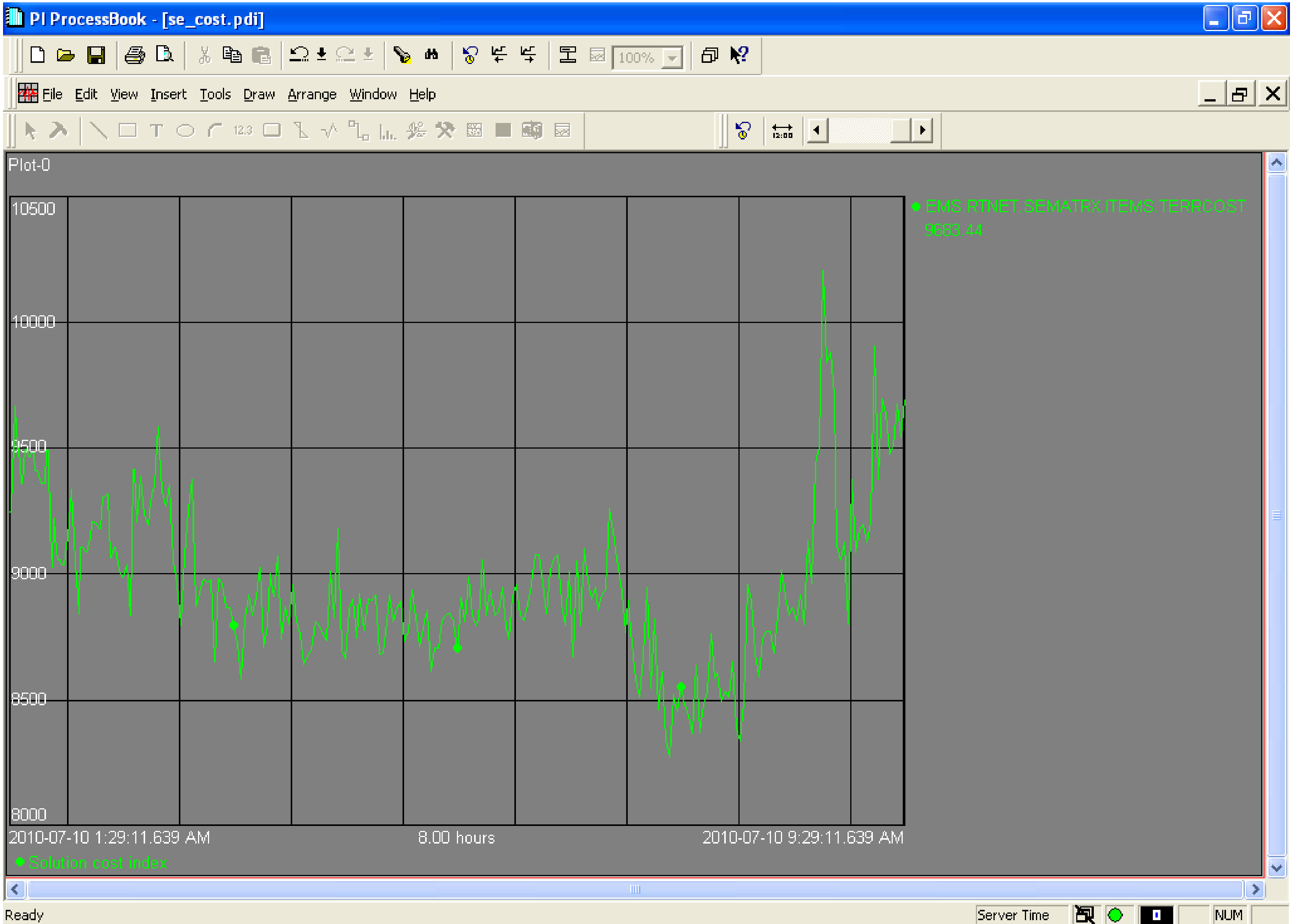
STATE ESTIMATOR SOLUTION QUALITY PERFORMANCE CRITERIA

- State estimator cost < 15000
- Data availability > 70%
- Maximum MW mismatch < 20 MW
- Load allocation error < 350 MW
- Total unit mw error < 50
- Total tie line error < 20

STATE ESTIMATOR SOLUTION QUALITY
BASIC QUALITY INDICES



STATE ESTIMATOR SOLUTION QUALITY COST FUNCTION

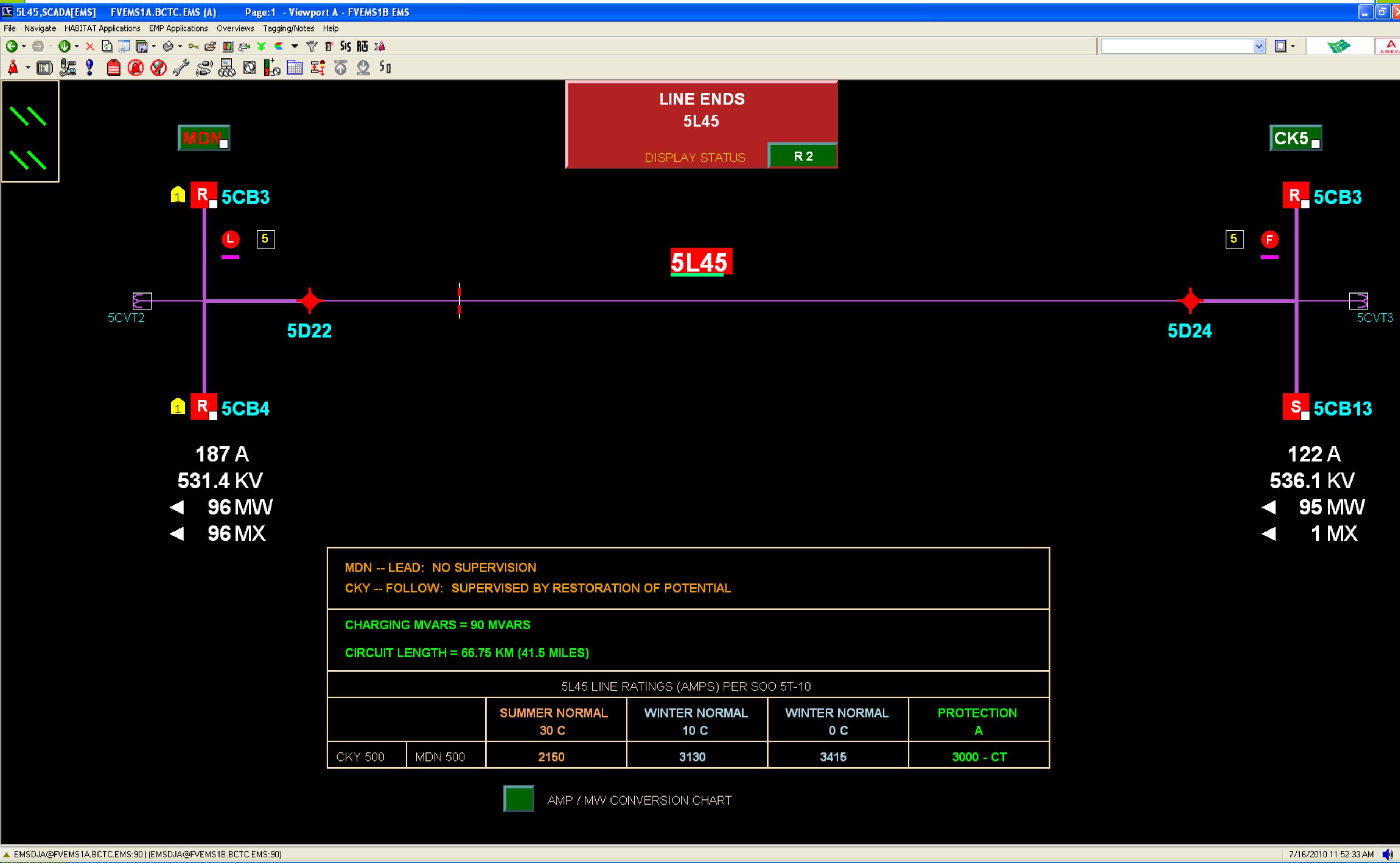


MEASUREMENTS QUALITY REQUIREMENTS

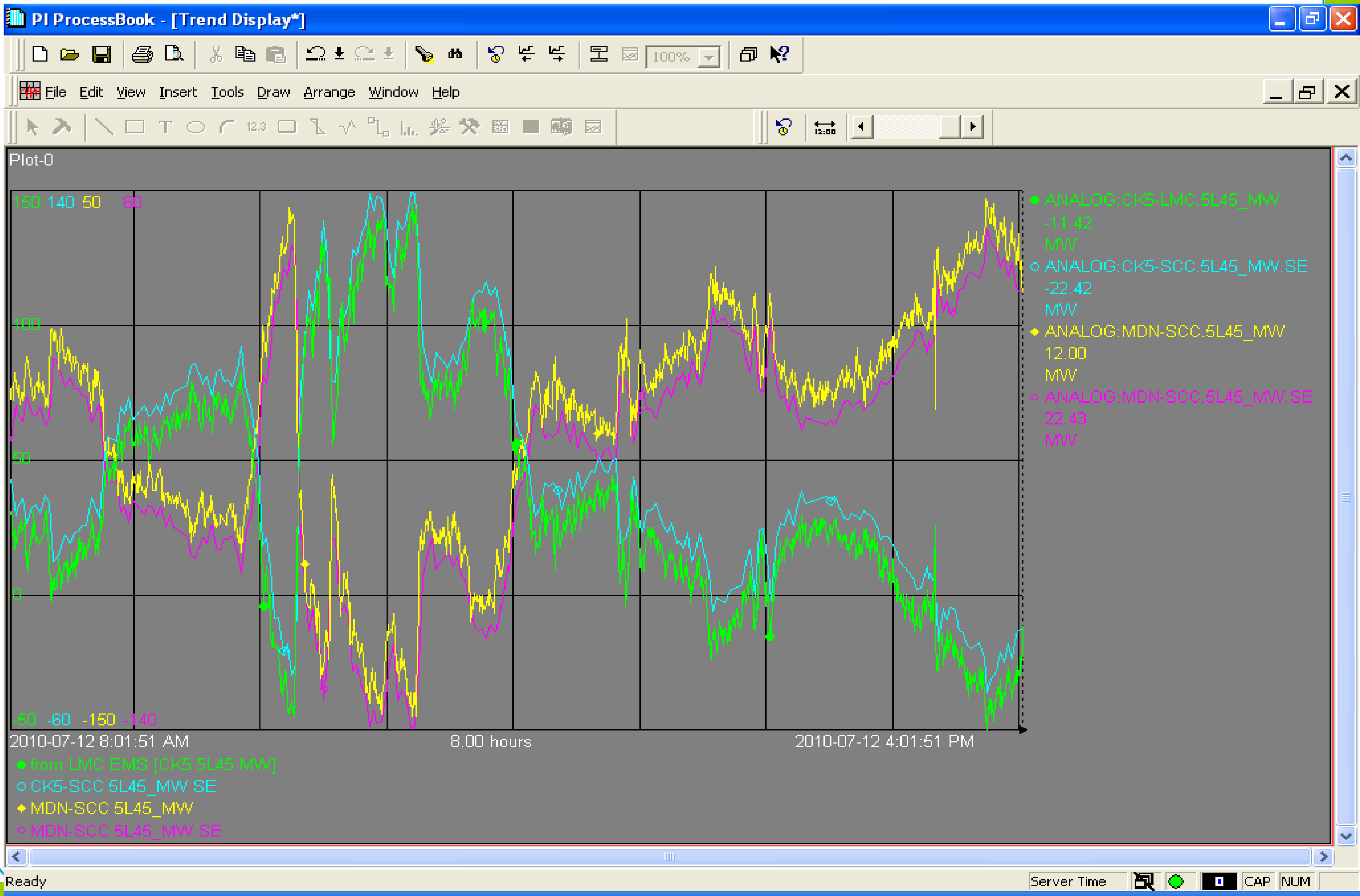
- Normalized residual < 7.5
- Long term average standard deviation consistent with static standard deviation (within 95%)
- Long term average bias < 2% of the rating

PARAMETER QUALITY TRACKING
5L45 EXAMPLE

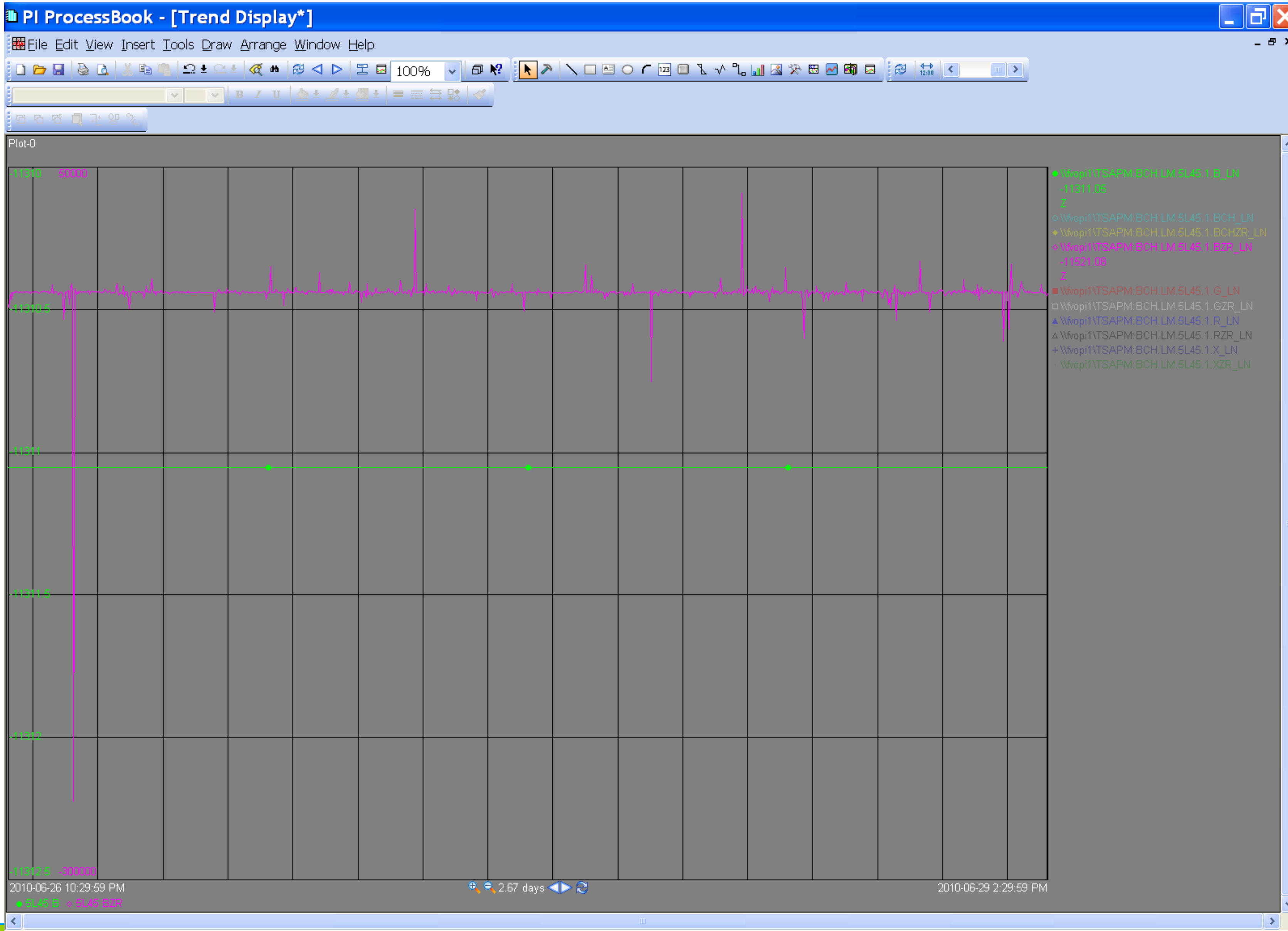
BC hydro



LINE 5L45 EXAMPLE - MEASUREMENT QUALITY

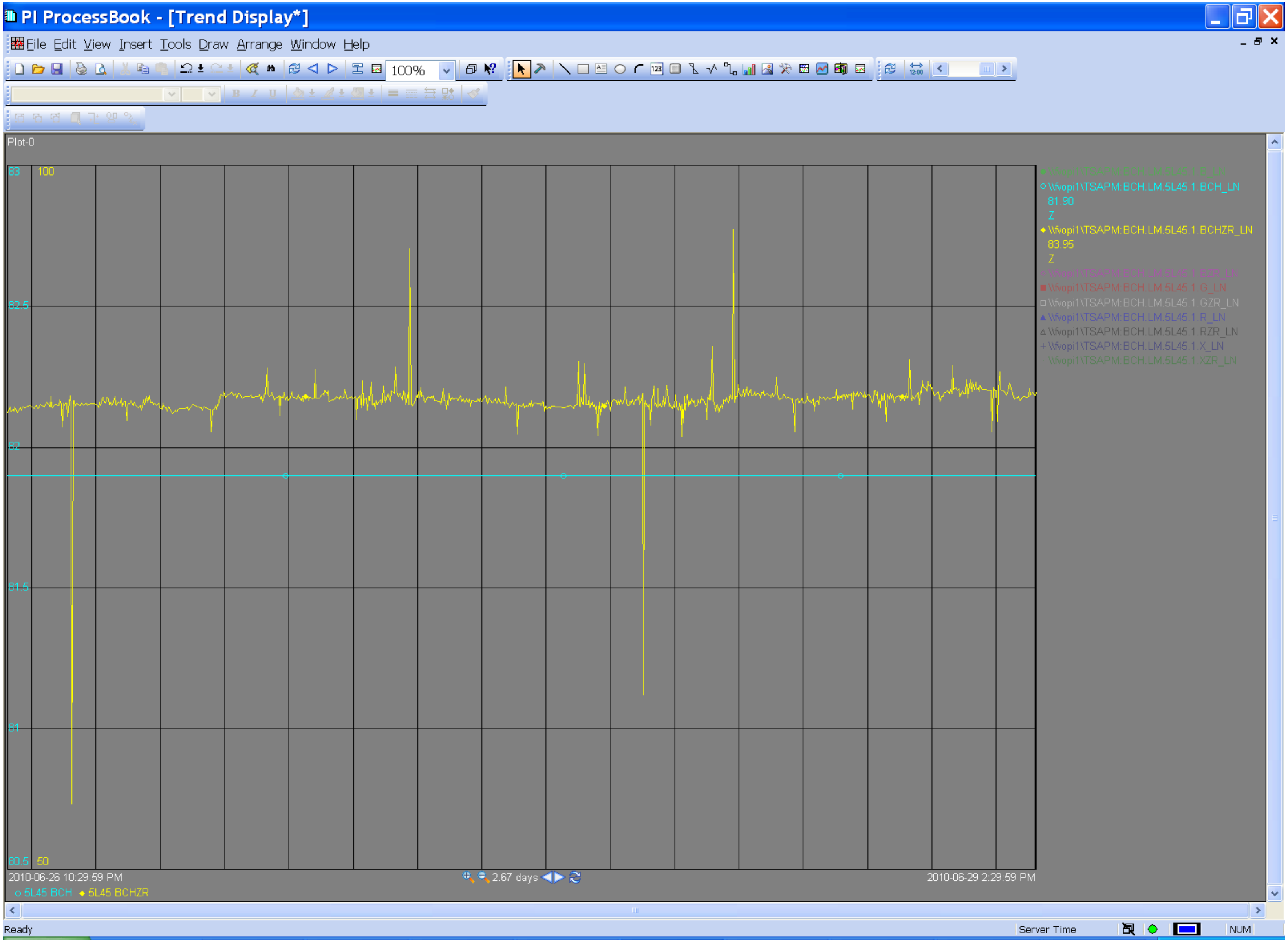


LINE 5L45 EXAMPLE – REACTANCE TRACKING

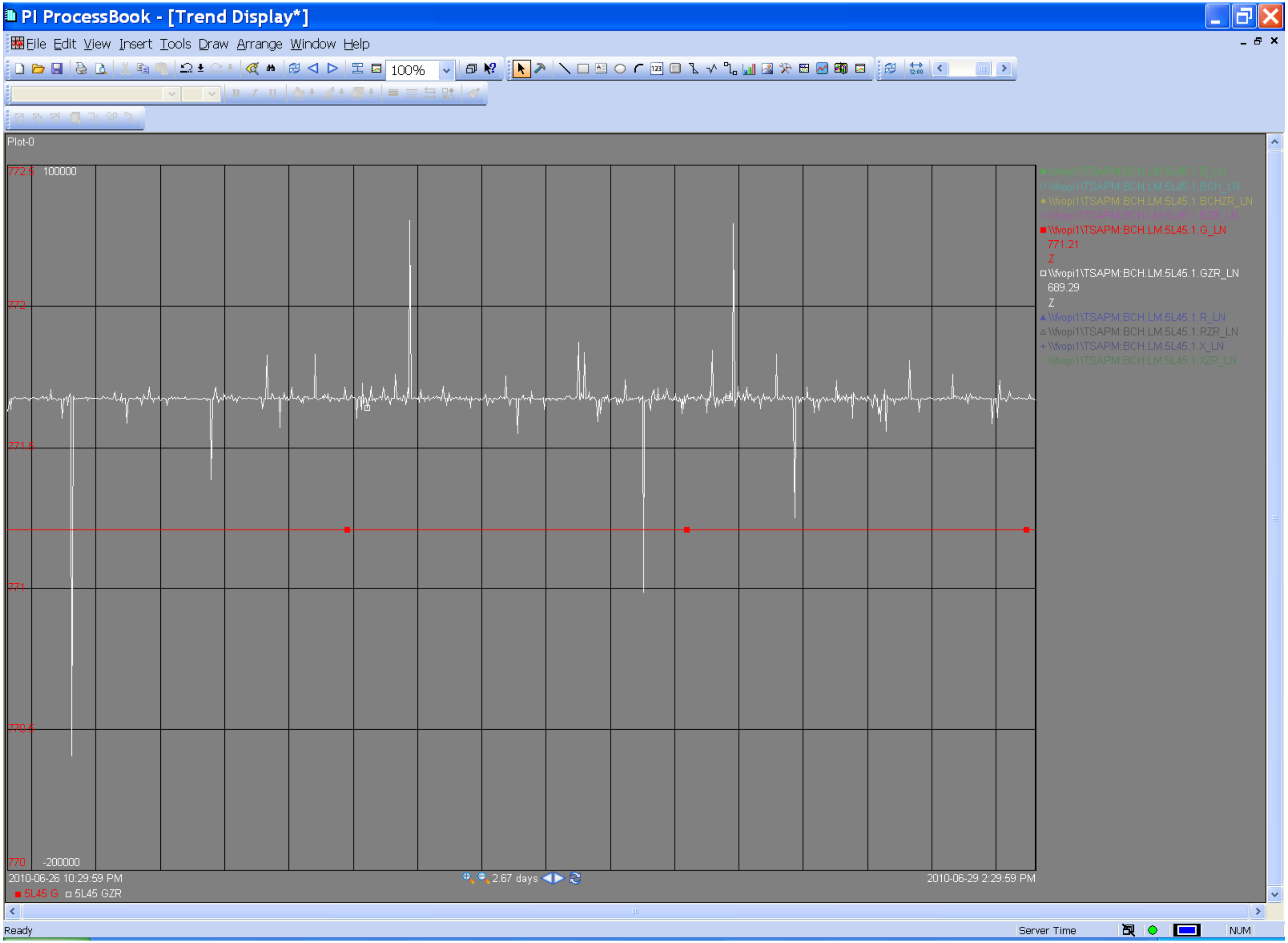


LINE 5L45 EXAMPLE - CHARGING

BC hydro

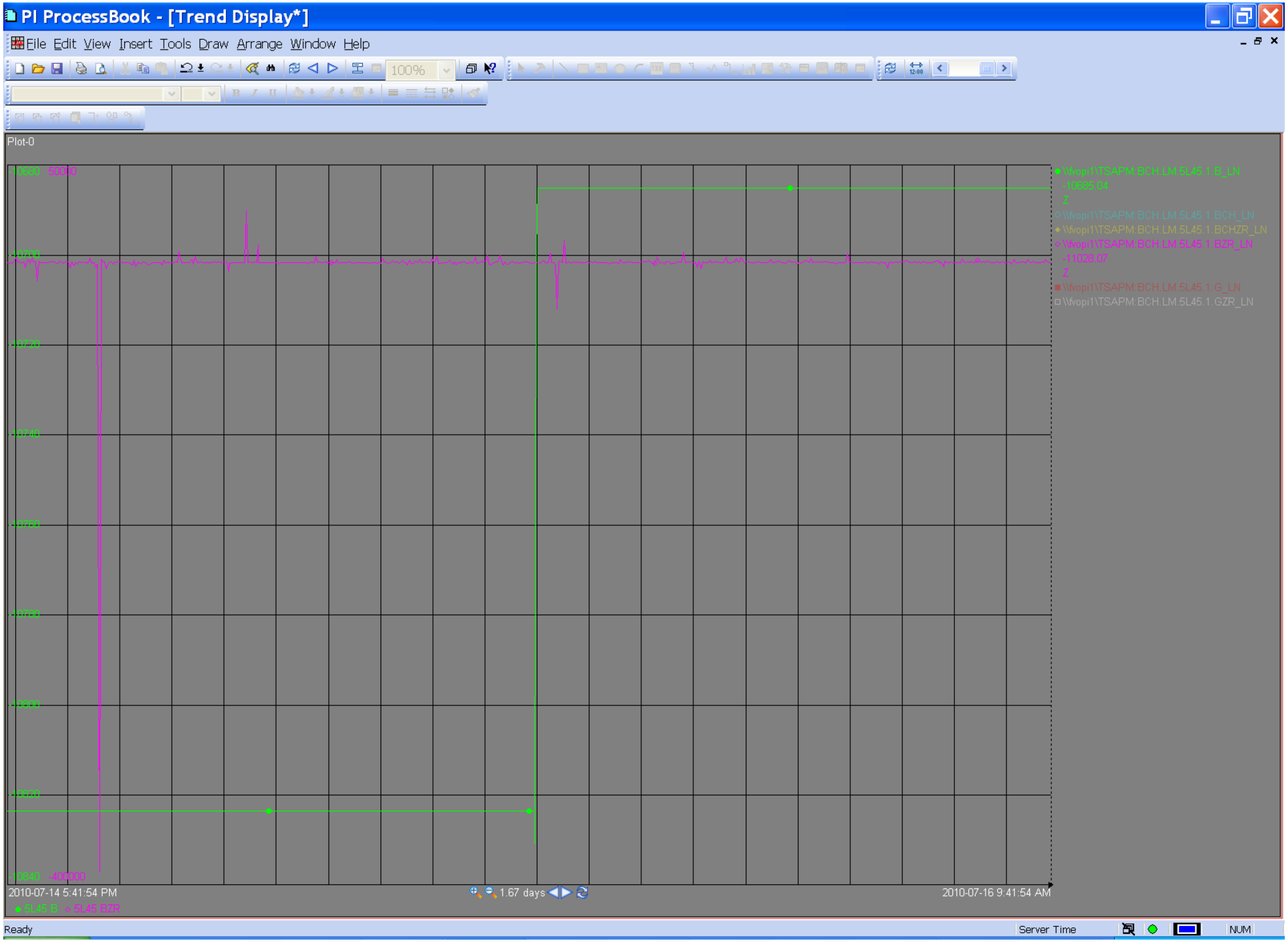


LINE 5L45 EXAMPLE - RESISTANCE

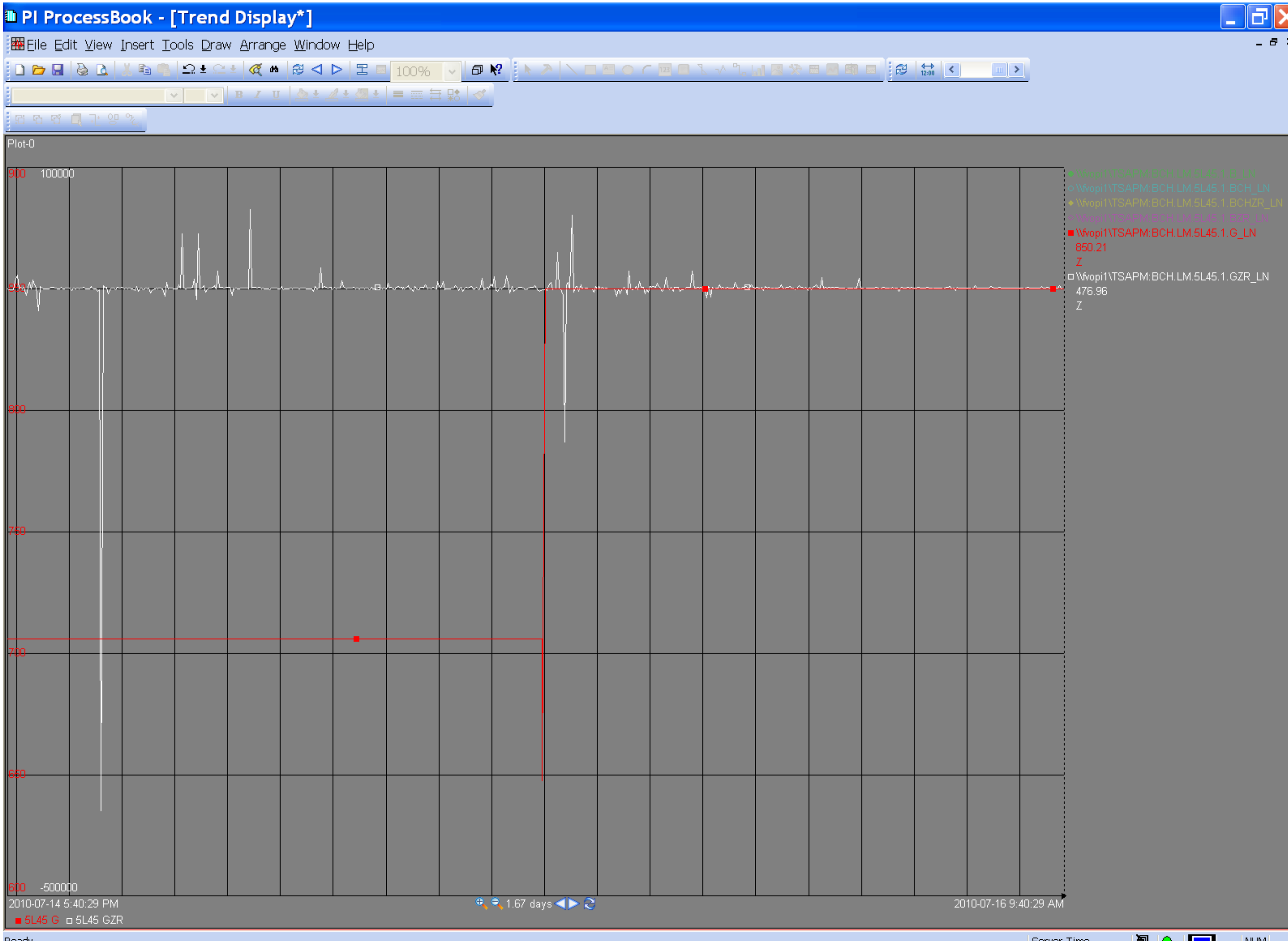


LINE 5L45 EXAMPLE – REACTANCE AFTER CORRECTION

BC hydro



LINE 5L45 EXAMPLE – RESISTANCE AFTER CORRECTION



PARAMETER QUALITY TRACKING
NEXT STEPS

- Implement detailed model for parameter error calculation for larger portions of the network
- Track quality of transformer parameters
- Develop global parameter quality index as part of global state estimator solution quality analysis

QUESTIONS?