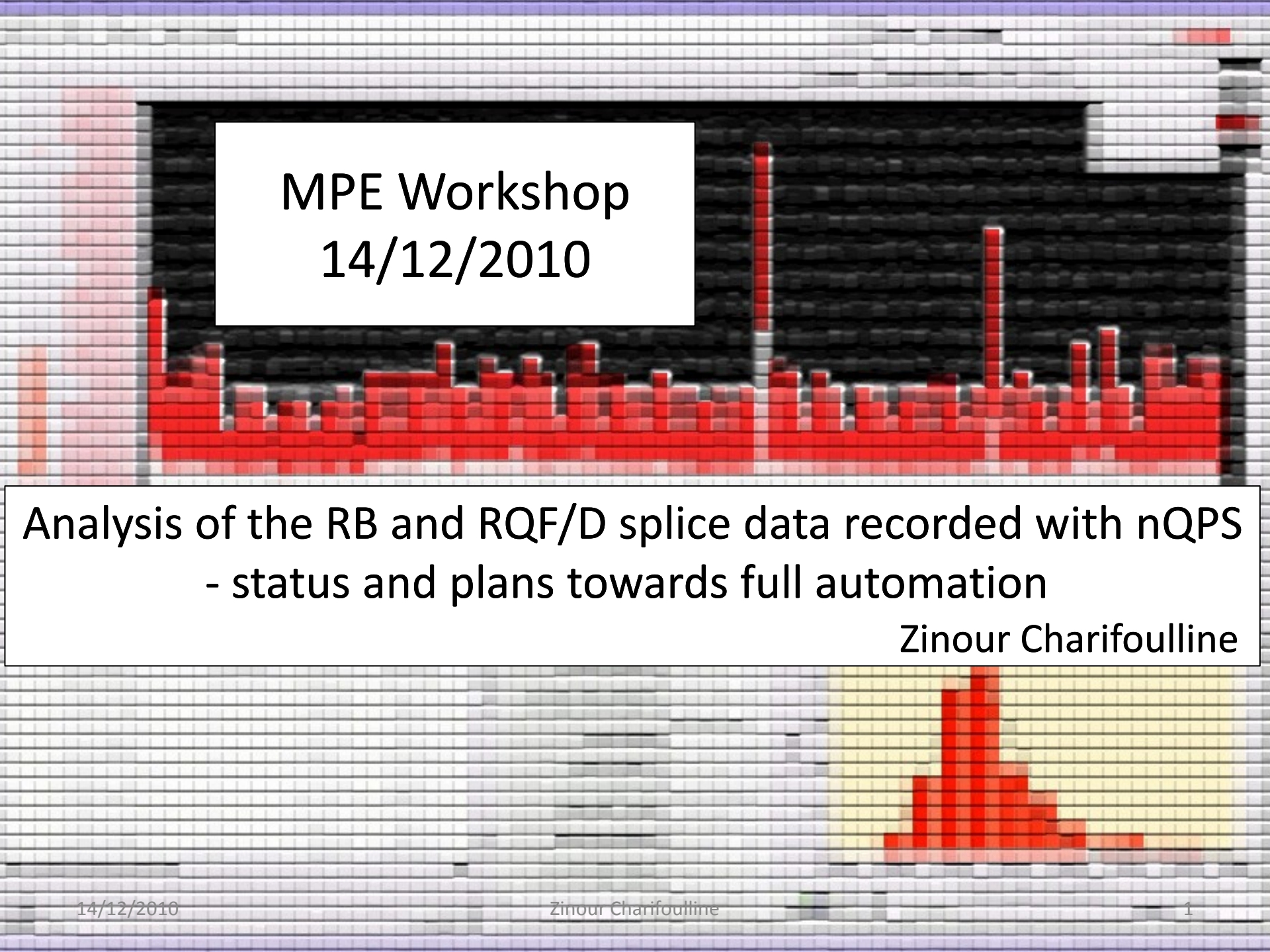


MPE Workshop 14/12/2010

Analysis of the RB and RQF/D splice data recorded with nQPS - status and plans towards full automation

Zinour Charifoulline

Analysis of the RB and RQF/D splice data recorded with nQPS - status and plans towards full automation

Splice Resistance Monitor application had been developed based on the following input signals:

nQPS RB and RQF/D Splice Data, recorded to LoggingDB (2048 channels):
- **U_RES(time)**, voltage drop on Bus Segments, ±12.8mV@24bits(1.5nV), 5Hz, 10s moving average (~50points);
- **U_RES_SPLICE(time),** decimated version of U_RES(time), every 10th points;
- **U_MAG(time)**, voltage drop on Magnets, ±15.9V@24bits(1.9µV), 5Hz, 10s moving average (~50points);
- **U_MAG_SPLICE(time)**, decimated version of U_MAG(time), every 10th points;

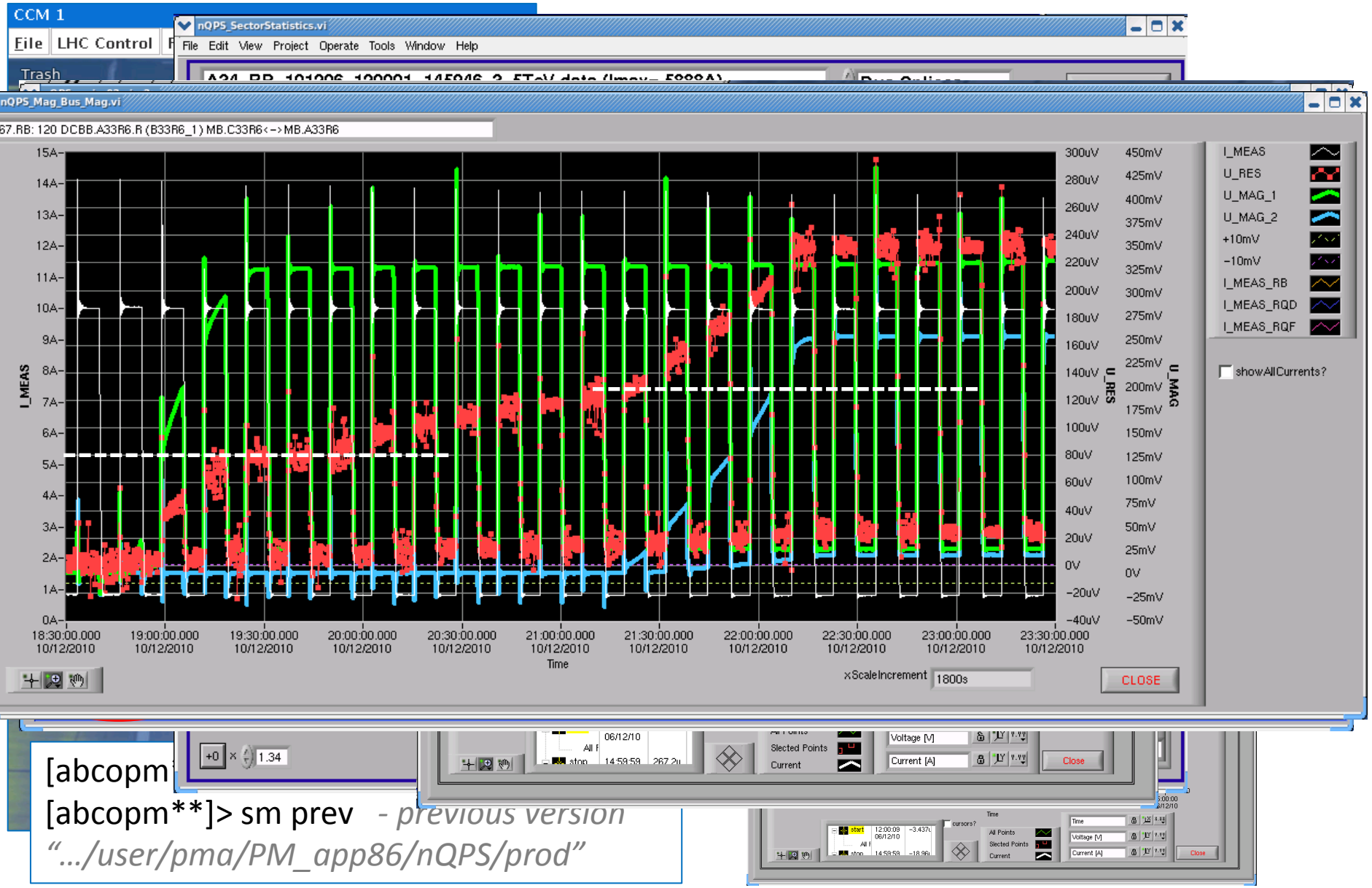
FGC Data, recorded to MeasDB and LoggingDB, 24 channels
- I_MEAS(time), main magnet circuits currents, 10Hz@MeasDB or decimated clone in LoggingDB;

Originally **Splice Resistance Monitor** was designed to measure the bus segment splice resistances (main target), but it had acquired some important additional functionalities (development & commissioning at the same time):
- nQPS (BS&DS) signals monitoring interface – widely used during LHC HWC and start up (cables connections check, powering events analysis, …)
- compensation coefficients calculation - done by analyzing of U(I)-curves during the ramps;
- noise statistics, noisy channels detection;
- bus segment resistance calculation – done by a linear fit of U(I)-curves taking into account only plateau points;
- linear fit details window;
- statistical analysis of a whole powered sector – average splice resistance, excess resistances, statistics, …;
- magnet resistance calculation (but resistance being evaluated by statistical approach on outputs from many ramps!);

Still missing (☹): user manual, technical report about analysis details, results summary report;

Under development: special sophisticated analysis of a single bus segment together with neighbored magnets – might be useful for RRR tests, quench propagation investigations, …

Analysis of the RB and RQF/D splice data recorded with nQPS - status and plans towards full automation



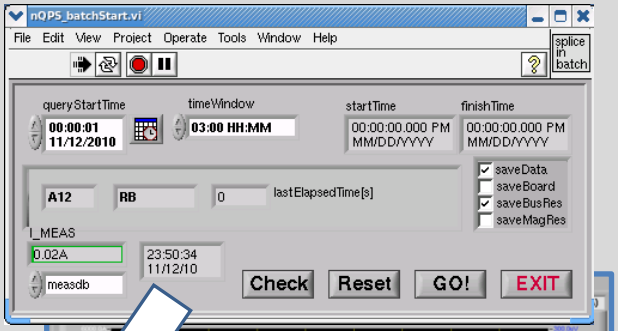
[abcopm
[abcopm**]> sm prev *- previous version*
"…/user/pma/PM_app86/nQPS/prod"

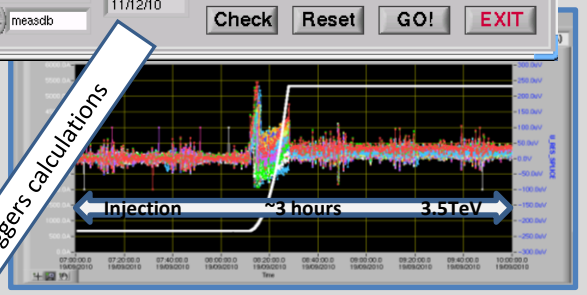
Analysis of the RB and RQF/D splice data recorded with nQPS - status and plans towards full automation

Special "**nQPS_batchStart**" application:
- detects "good" 3.5TeV ramps (1h@inj & 1h@top);
- triggers resistance calculations for all sectors in batch mode;
- save results (ascii csv-files for the time being);

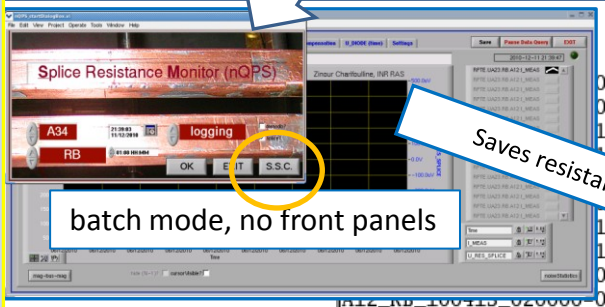
Status:
- debugged, run 3-4 months on the desktop;
- manual and fully automated modes;
- ready to start in server mode (on "cs-ccr-qpsm", qpsop?);
- main target was to collect the internal magnet splice data;

Problem to solve: "step" noise filtering;





Triggers calculations



batch mode, no front panels

Saves resistances

```
065939_3_5TeV_about.txt
065939_3_5TeV_busSegRes.csv
185958_3_5TeV_about.txt
185958_3_5TeV_busSegRes.csv
_about.txt
eV_busSegRes.csv
_about.txt
195901_3_5TeV_busSegRes.csv
055944_3_5TeV_about.txt
055944_3_5TeV_busSegRes.csv
A12_RB_100414_030000-195949_3_5TeV_about.txt
A12_RB_100414_030000-195949_3_5TeV_busSegRes.csv
A12_RB_100415_030000-065956_3_5TeV_about.txt
A12_RB_100415_030000-065956_3_5TeV_busSegRes.csv
A12_RB_100416_030000-055921_3_5TeV_about.txt
A12_RB_100416_030000-055921_3_5TeV_busSegRes.csv
A12_RB_100417_020000-065939_3_5TeV_about.txt
A12_RB_100417_020000-065939_3_5TeV_busSegRes.csv
A12_RB_100418_030000-065949_3_5TeV_about.txt
A12_RB_100418_030000-065949_3_5TeV_busSegRes.csv
A12_RB_100418_083000-112937_3_5TeV_about.txt
A12_RB_100418_083000-112937_3_5TeV_busSegRes.csv
```

Pilot version of **S**plice **S**tatistical **C**ontrol package is included now to the production version of Splice Monitor. It allows to:
- analyze all saved results,
- check time evolutions,
- create last ramp report, …

Not yet realized:
- user friendly interface (for experts now);
- no criteria to send an alarm/sms;

Next step: fix alarms criteria and apply them just after the new ramp resistances being saved.
It will be not so simple to avoid fake alarms …

Resistance results storage?

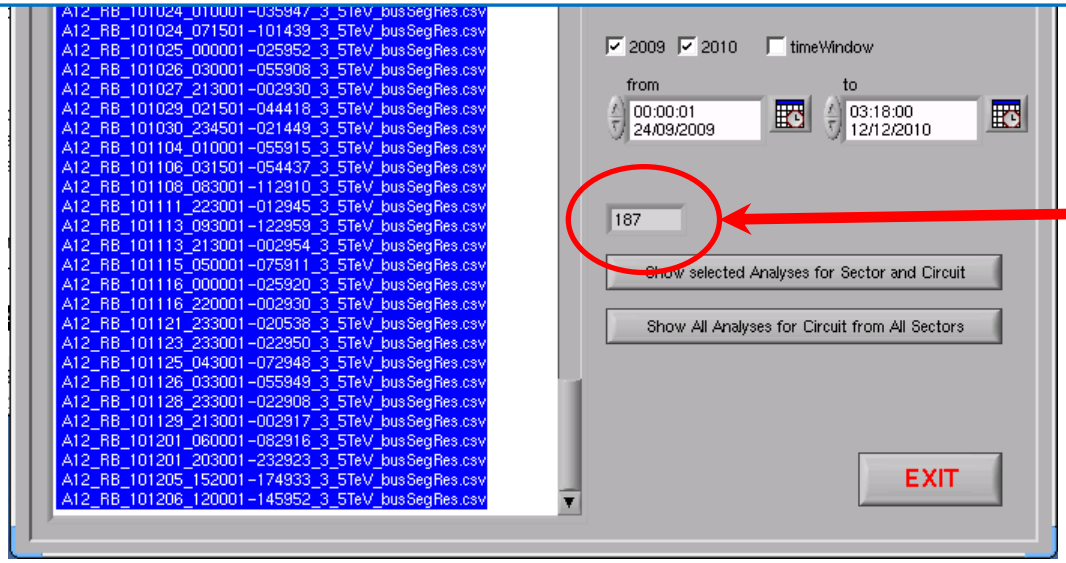
- now they are saved to ASCII csv-files;
- it takes already some time to read the data back: about 200 files per circuit already being collected;
- it would be faster to save results in binary format, but it may create other problems;

Best solution -> **Oracle** with properly designed tables containing all information from SM application and from EXCEL tables collected by Mike.

Advantages:

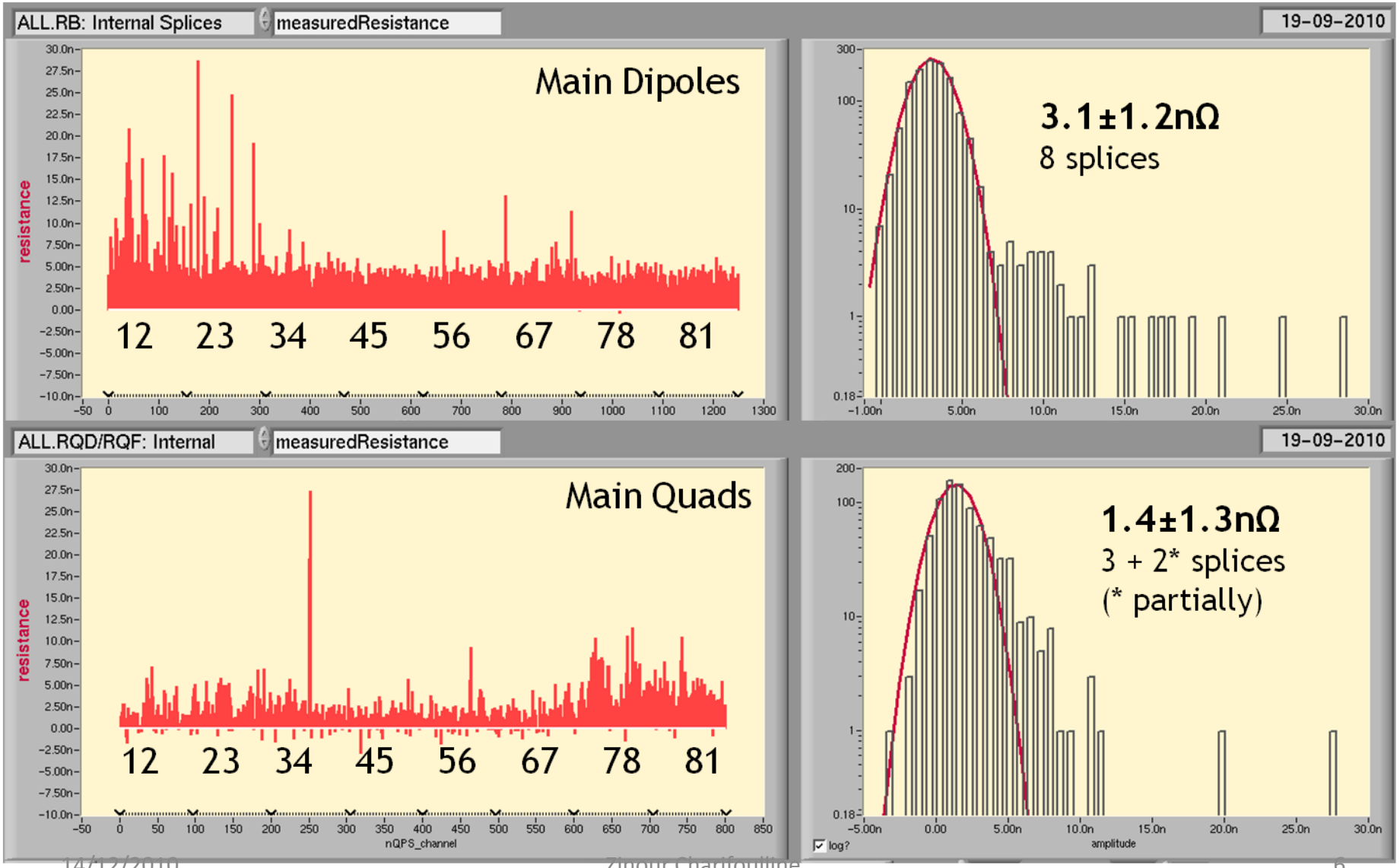
- centralized data storage with relatively easy access from anywhere;
- automatic data integrity (uniqueness, primary keys, constraints, …);
- possibility to trigger alarms by PL/SQL code integrated with tables;
- plenty of instruments for data selection and user interfaces: SQL/Plus, java, Benthic, ApEx, LabView … ;

In future it may become quite useful and powerful database for Splice Consolidation task.



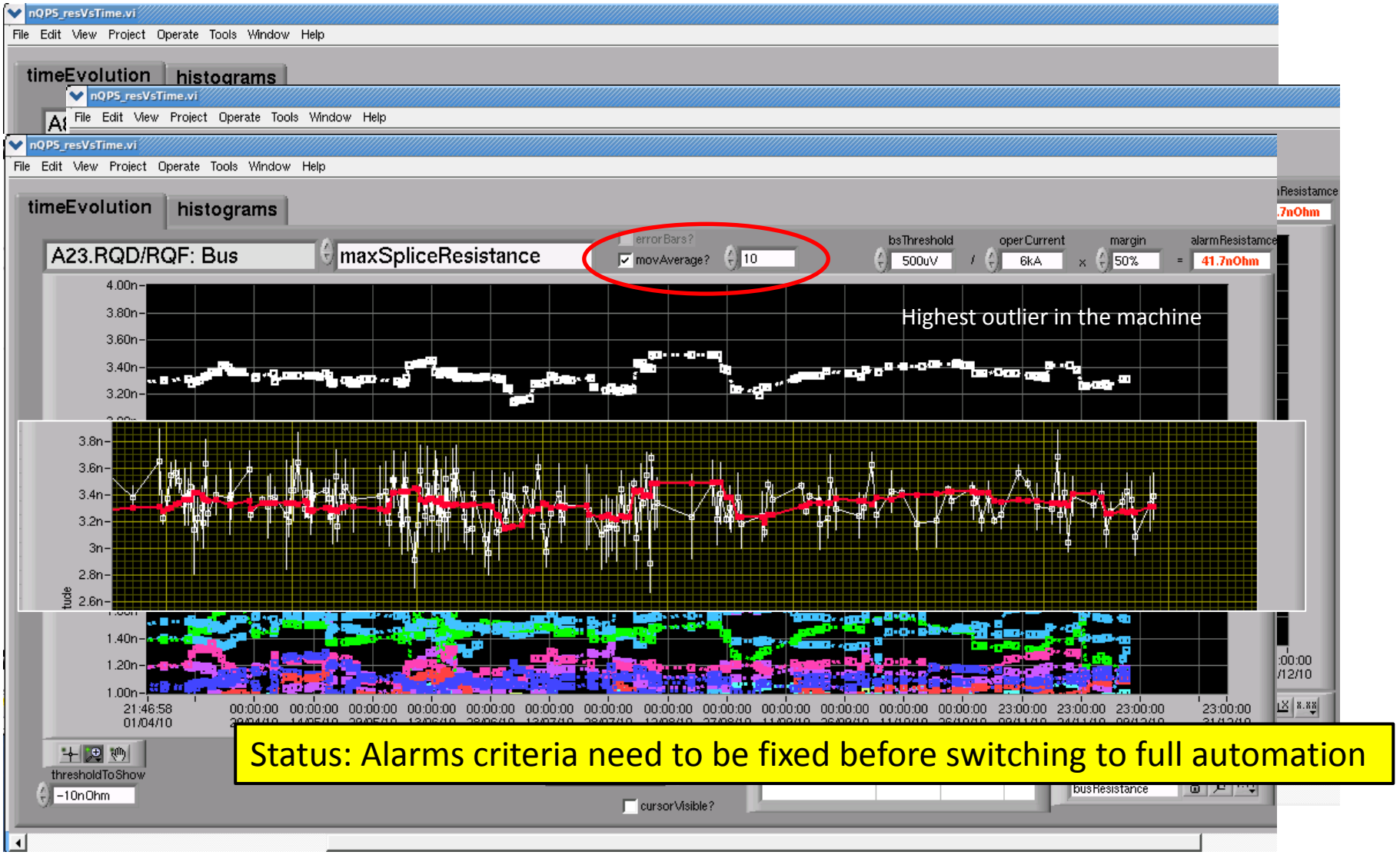
LHC main splices today: magnets SC

From Z. Charifoulline



Analysis of the RB and RQF/D splice data recorded with nQPS - status and plans towards full automation

Few examples of "**Splice Resistance versus Time**" plots.



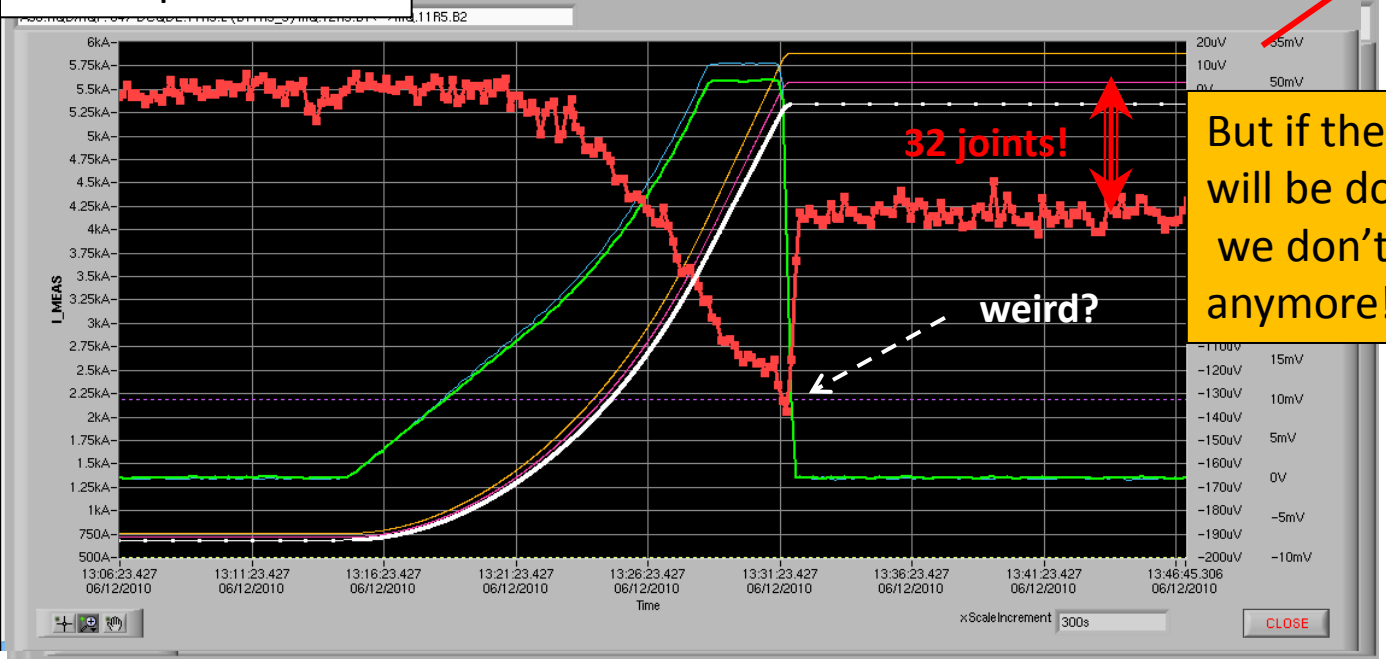
Status: Alarms criteria need to be fixed before switching to full automation

Few examples of "**Compensation Coefficients**" efficiency (sector 5-6).

"Towards 7 TeV"

- Compensation coefficients need to be re-tuned, especially if we will go back to 300µV thresholds.
- Long quad buses: 32*350pΩ*12.5kA => 140µV!!!
- Some strange cases need to be explained.

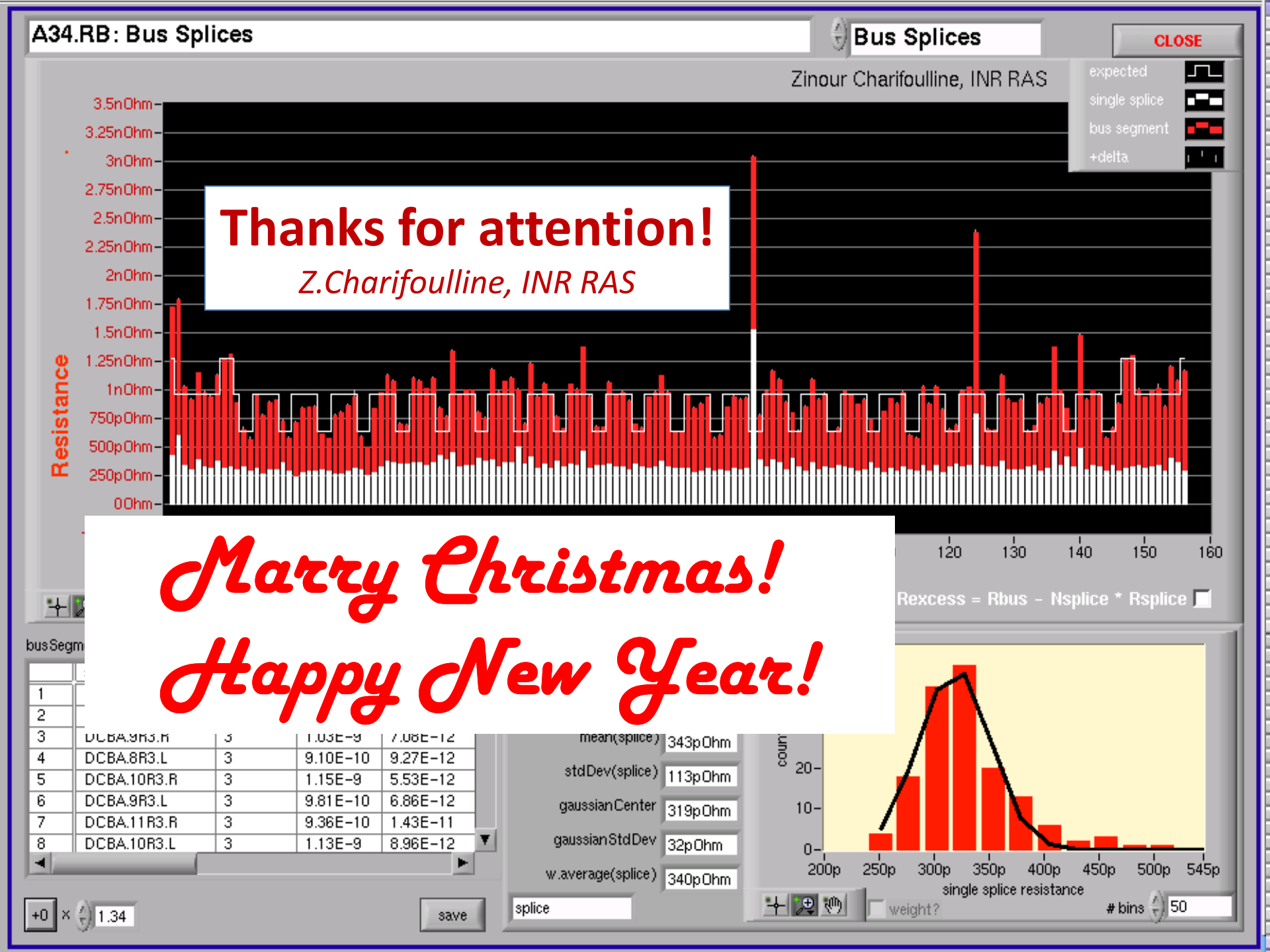
Some special cases



But if the Splice Consolidation will be done before "7 TeV" we don't need the compensation anymore!

Session on “Towards 7 TeV”

4. **16:45 Analysis of the RB and RQF/D splice data recorded with nQPS (Z.CH.?)**
   - Status of data analysis, are we making use of all recorded data?
     - If “nQPS_batchStart” is active, every long enough 3.5TeV ramp up will be analyzed, 1h@INJ&1h@TOP. So it is about 2.5-3.0 hours of a front edge of long ramps, but not all data recorded to loggingDB.
   - How can the analysis and result recording of splice data be automated, eventually triggering warnings in case of substantial increases over time?
     - “nQPS_batchStart” running on any of “abcopm” machine will do the job (see above). But the automatic warning mechanism is not established yet: “substantial” criteria, what to do with noisy channels, where to save the growing amount of analysis results (I think as few months of work).
   - Outlook to 7TeV, do we need additional work/analysis to identify out layers?
     - Periodic check of known outliers; it will be nice to replace few “insensible” and noisy channels to be sure than nothing is hidden behind;
   - Are the tools adapted to work for 7TeV and with the additional shunts,…?
     - From machine safety point of view the tools will be adapted for 7TeV after complete automation. Will we need “really online” resistance monitoring during ramps? If so, additional work will be required. Shunts -> re-measuring all splices at cold, which will be the part of re-commissioning.
   - Accessibility for non experts, integration into OP software environment, maintenance of software tools, software platform …?
     - Application Splice Monitor integrated into OP software since November 2009. Software platform is linux, but it can be adapted to windows as well. It needs RADE library to query data from logging database. There is a small “How to” in MP3-QPS Repository (thanks to B.A.) Maintenance …


A34.RB: Bus Splices
Bus Splices
CLOSE
Zinour Charifoulline, INR RAS
expected
single splice
bus segment
+delta
Resistance
3.5nOhm
3.25nOhm
3nOhm
2.75nOhm
2.5nOhm
2.25nOhm
2nOhm
1.75nOhm
1.5nOhm
1.25nOhm
1nOhm
750pOhm
500pOhm
250pOhm
0Ohm
120
130
140
150
160
Thanks for attention!
Z.Charifoulline, INR RAS
Marry Christmas!
Happy New Year!
Rexcess = Rbus - Nsplice * Rsplice
busSegm
DCBA.8R3.L 3 9.10E-10 9.27E-12
DCBA.10R3.R 3 1.15E-9 5.53E-12
DCBA.9R3.L 3 9.81E-10 6.86E-12
DCBA.11R3.R 3 9.36E-10 1.43E-11
DCBA.10R3.L 3 1.13E-9 8.96E-12
mean(splice) 343pOhm
stdDev(splice) 113pOhm
gaussianCenter 319pOhm
gaussianStdDev 32pOhm
w.average(splice) 340pOhm
splice
count
20
10
0
200p
250p
300p
350p
400p
450p
500p
545p
single splice resistance
weight?
bins 50
+0
x 1.34
save