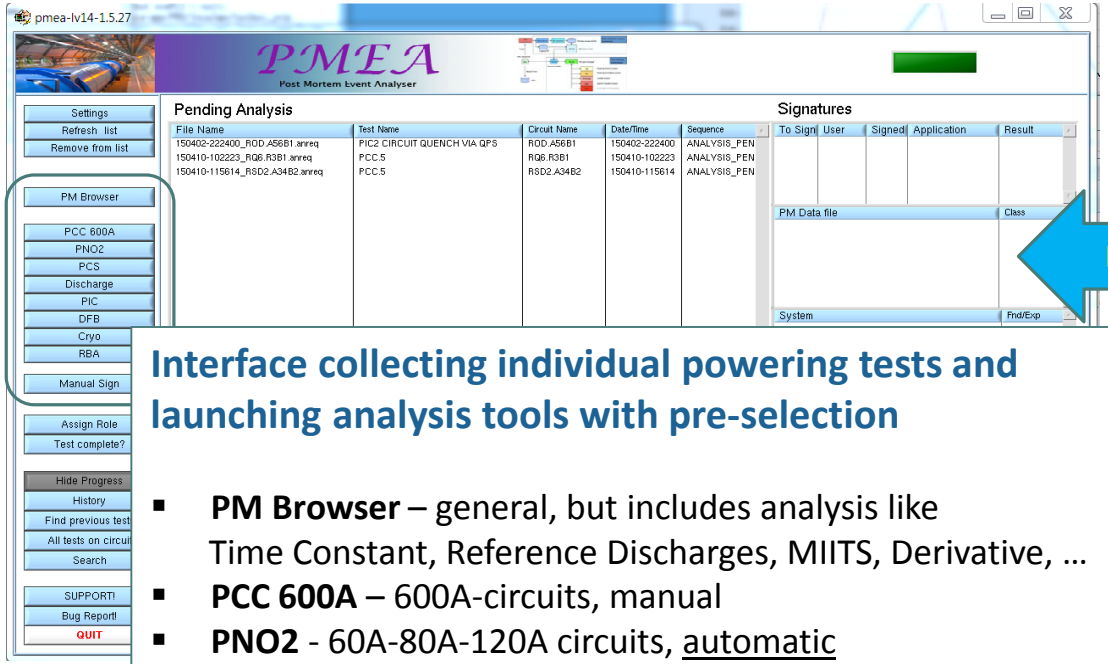
MP3 Review
Software tools

S. LE NAOUR & Z. CHARIFOULLINE

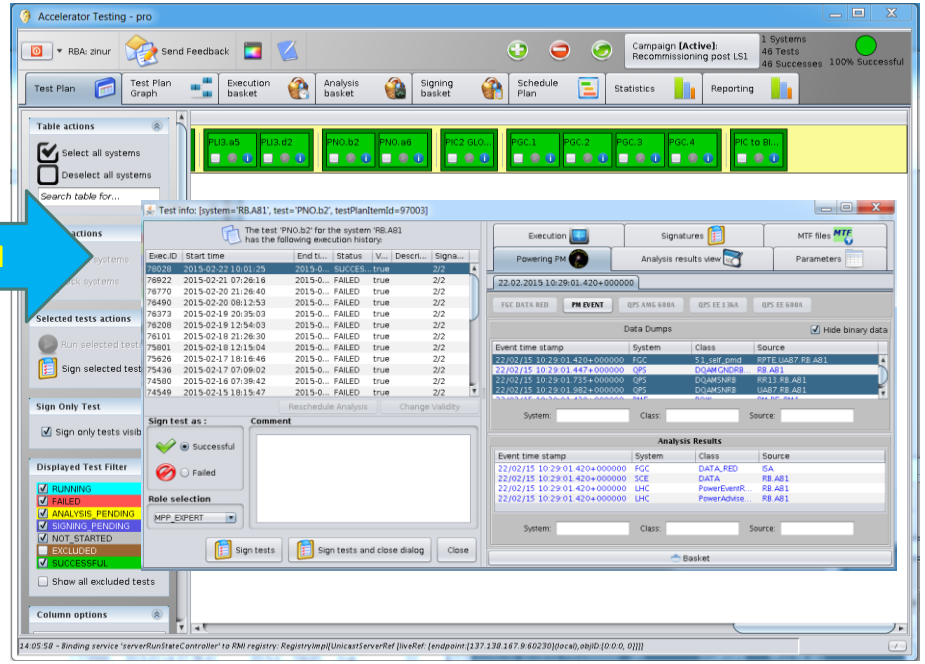
Tools available

PMEA + Analysis Tools (LabVIEW)



linked

AccTesting + Analysis Tools (Java)



Interface collecting individual powering tests and launching analysis tools with pre-selection

- **PM Browser** – general, but includes analysis like Time Constant, Reference Discharges, MIITS, Derivative, …
- **PCC 600A** – 600A-circuits, manual
- **PNO2** - 60A-80A-120A circuits, automatic
- **PCS** – 600A-circuits, automatic
- **Discharge** – used by EPC, manual
- **PIC** - manual/automatic depending on circuit
- **DFB** – general, manual
- **Cryo** - not used by MP3
- **RBA** – RB-circuit training quench viewer, manual analysis

+

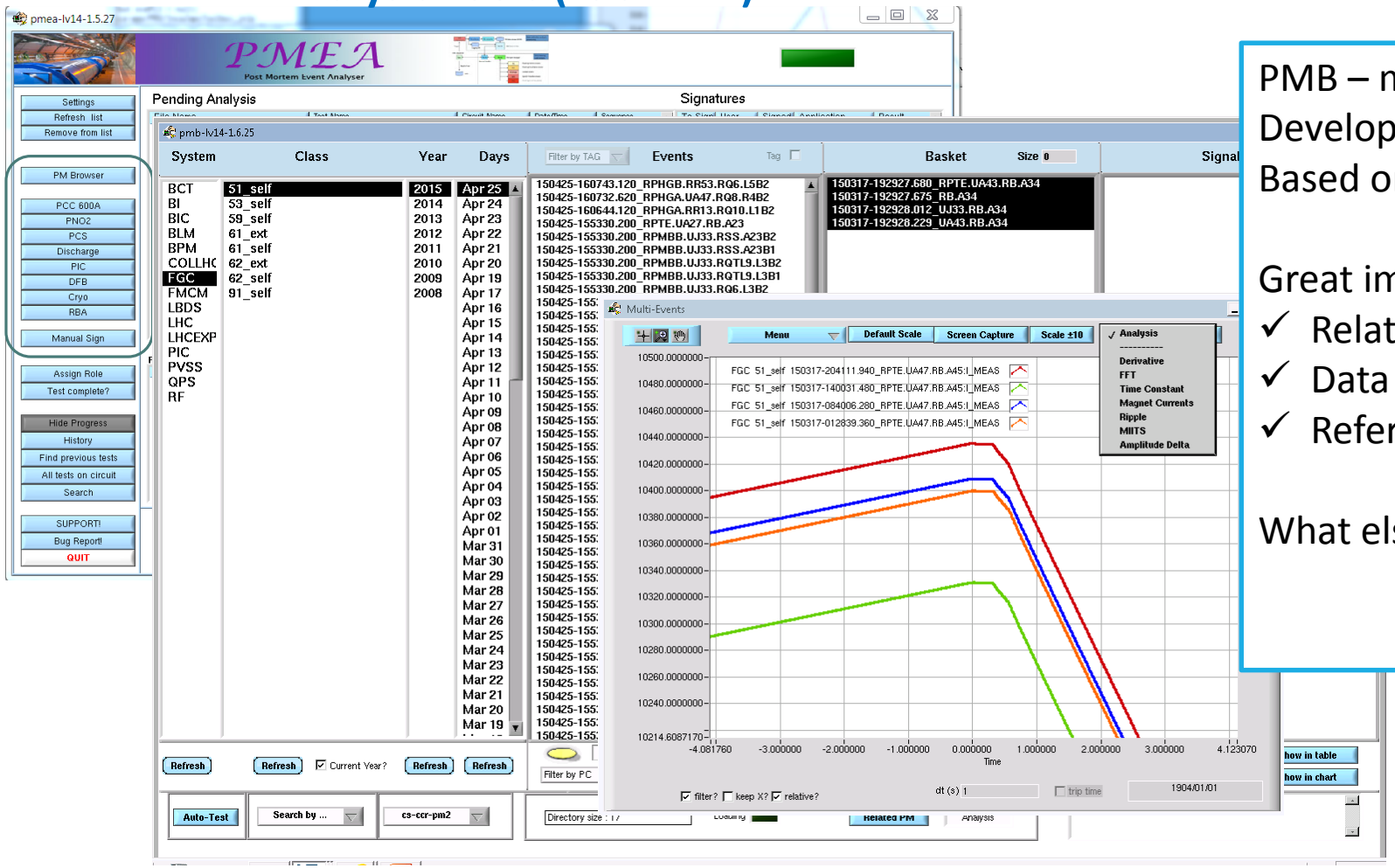
- **Splice Monitor** – RB&RQ splice analysis, manual
- **DS buffer viewer** – symQ signals, manual

Interface driving powering tests sequence and giving the test validation status (signature)

- **QPS EE 600A** – manual
- **QPS EE 13kA** – manual
- **PCC.1** – 60A-80A-120A circuits, automatic
- **PNO.d1** – 60A-80A-120A circuits, automatic

PM Browser

PMEA + Analysis Tools (LabVIEW)



PMB – most widely used application during HWC
Developed and supported by EN/ICE-MTA
Based on LabVIEW, RADE, SDDS PM data

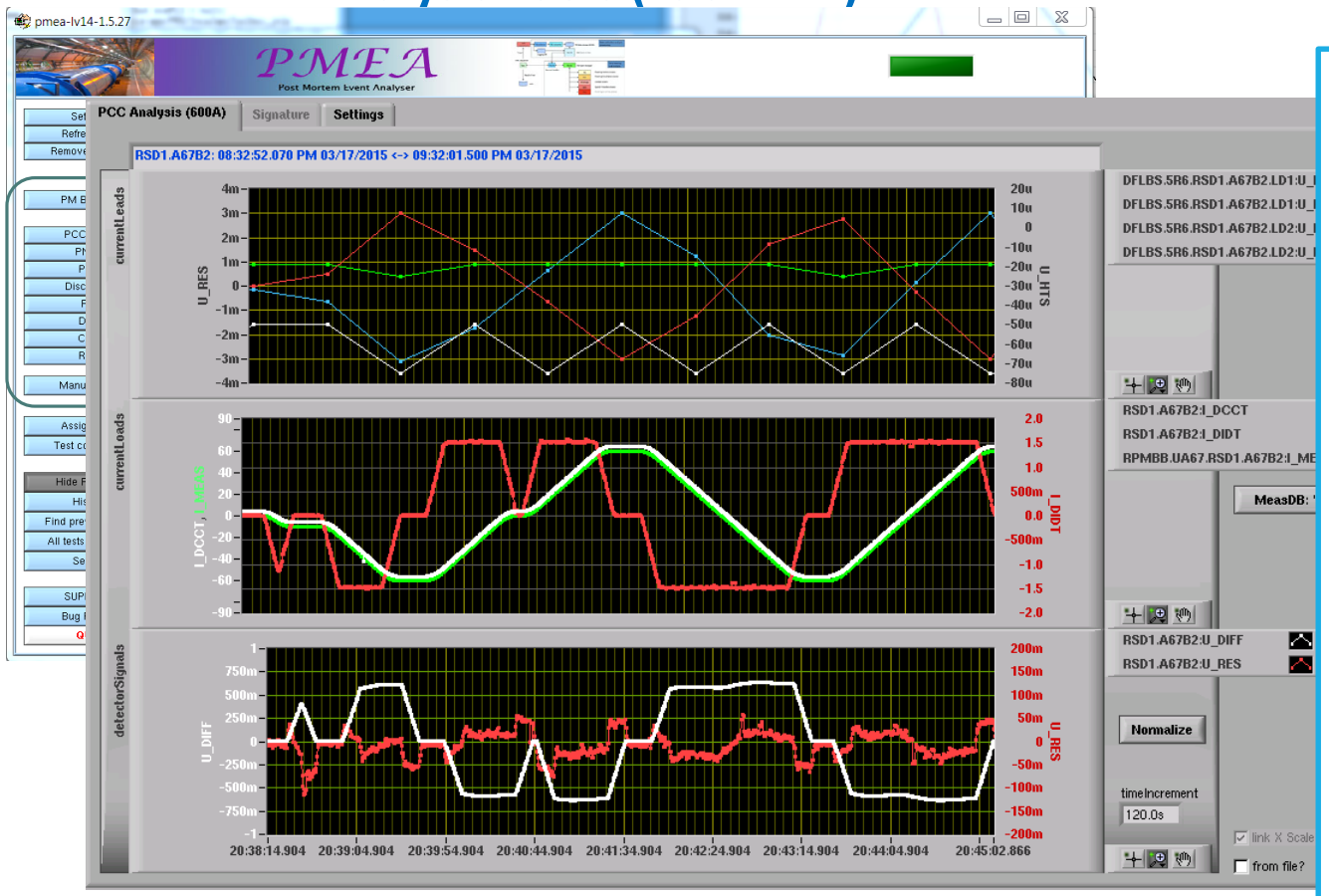
Great improvements like:

- ✓ Relative time scale option
- ✓ Data filtering
- ✓ Reference heater discharge curve by right click

What else can be improved? Added?

PCC 600A

PMEA + Analysis Tools (LabVIEW)



PCC 600A – application to check the QPS of 600A-circuits
Developed by ZCh
Based on LabVIEW, RADE, Logging DB data

PCC.5 is 1st powering test of the circuit =>
The points to be checked:

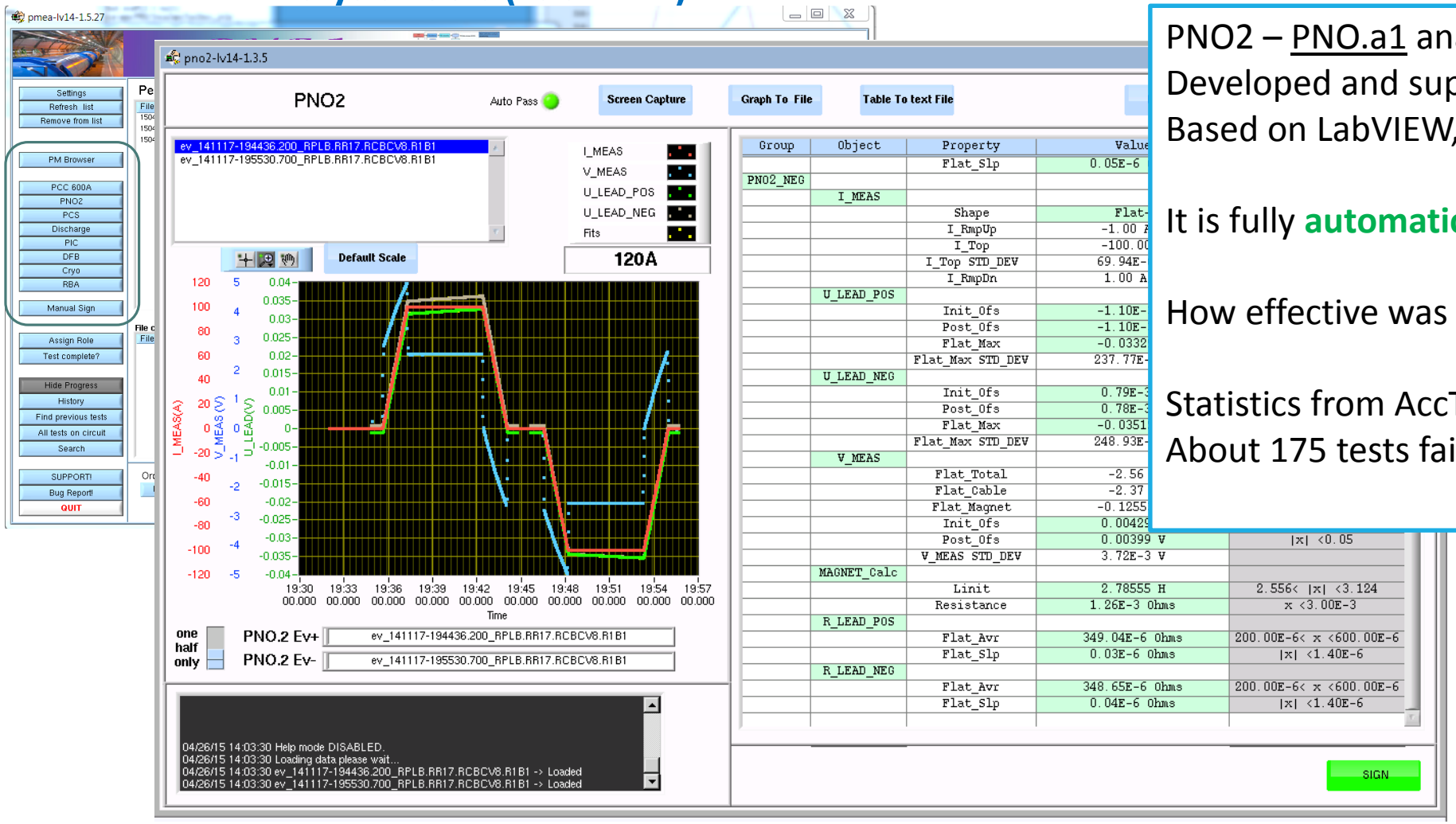
- Signal's presence and polarities
- Inductive compensation of quench signals

Can it be fully **automatic?**
Can it be extended to IPQ/IPD-circuits to minimize the heater firings we had?

Statistics from AccTesting:
about 300 tests failed out of 760 analysed in total

PNO2

PMEA + Analysis Tools (LabVIEW)



PNO2 – PNO.a1 analysis of 60A-80A-120A-circuits
Developed and supported by EN/ICE-MTA?
Based on LabVIEW, RADE, Logging DB data

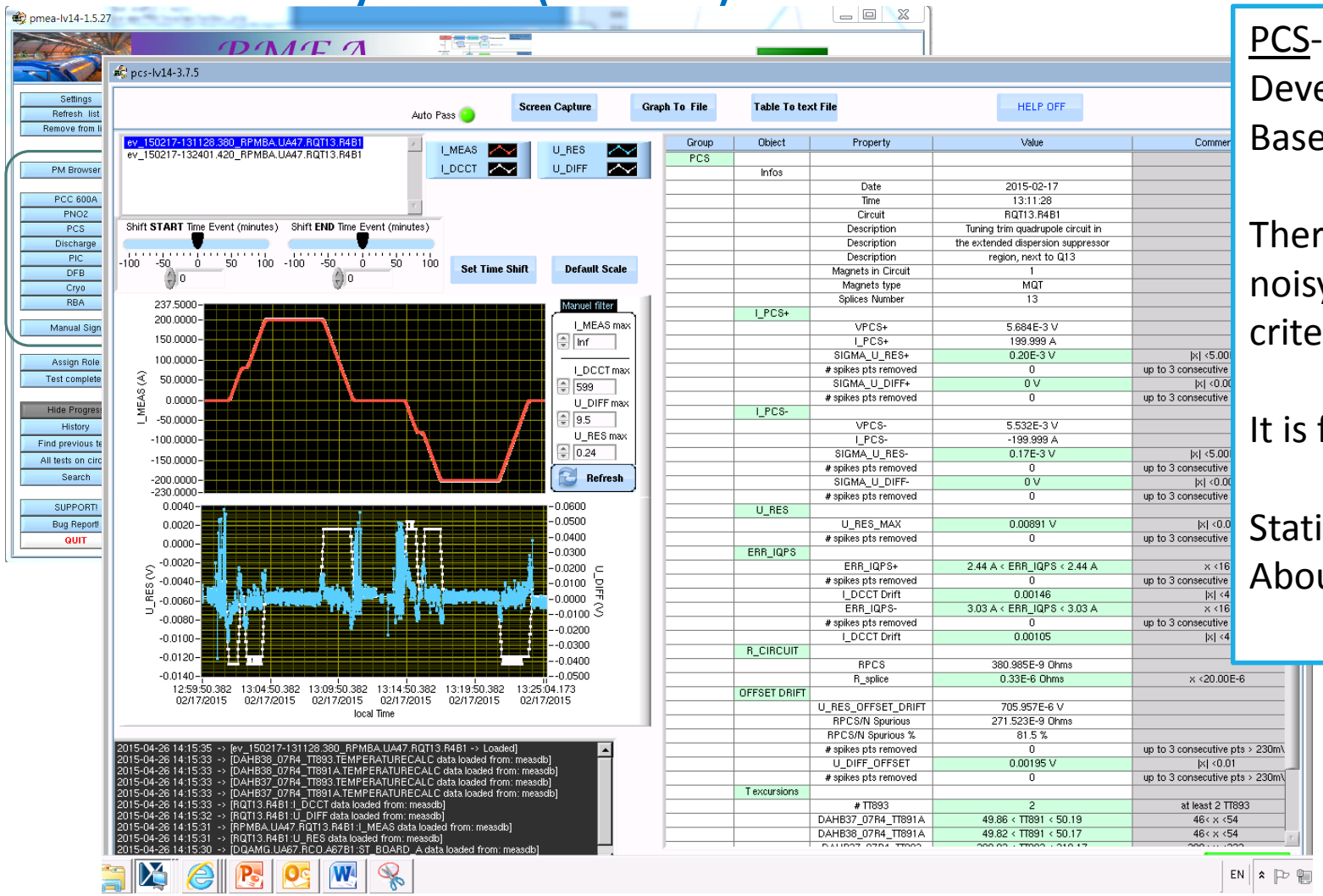
It is fully **automatic**, works well.

How effective was the follow of the failed cases?

Statistics from AccTesting:
About 175 tests failed out of 1230 analysed in total

PCS

PMEA + Analysis Tools (LabVIEW)



PCS-test analysis of 600A-circuits
Developed and supported by EN/ICE-MTA?
Based on LabVIEW, RADE, Logging DB data

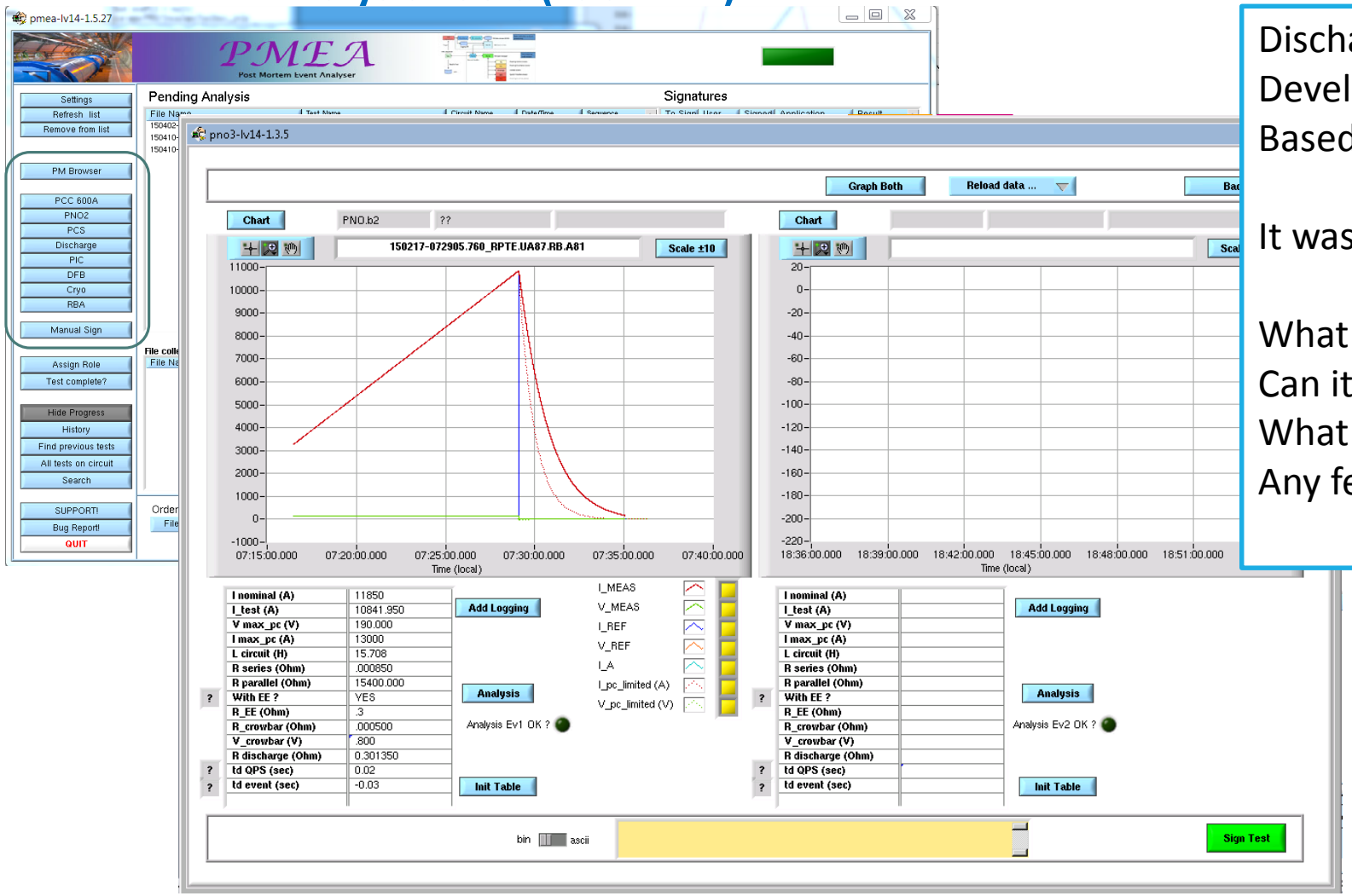
There were some problems in the beginning with noisy QPS data, board A/B toggling, acceptance criteria.

It is fully **automatic**, finally works well.

Statistics from AccTesting:
About 67 tests failed out of 484 analysed in total

Discharge

PMEA + Analysis Tools (LabVIEW)



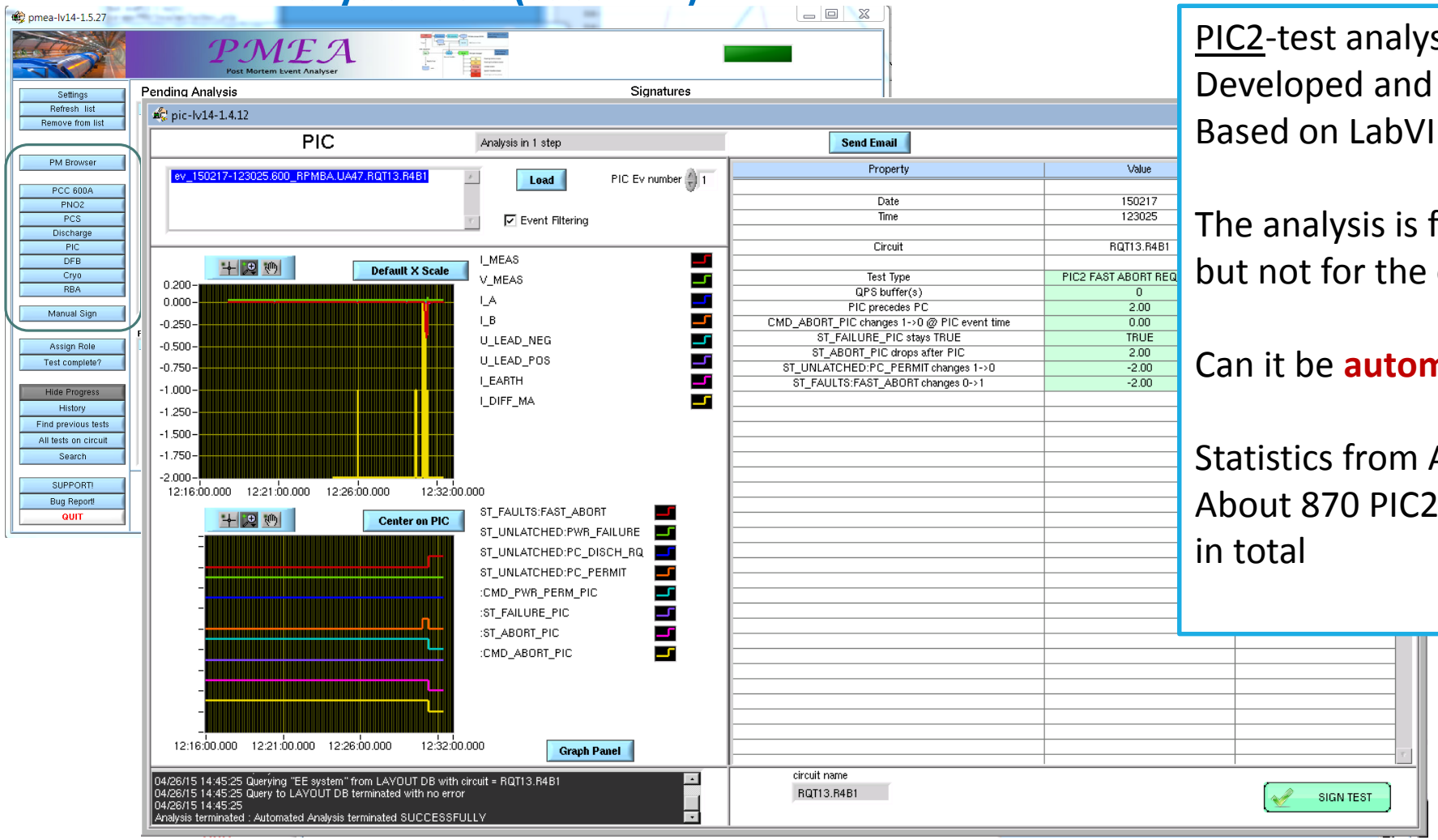
Discharge analysis of FGC data
Developed and supported by EN/ICE-MTA
Based on LabVIEW, RADE, SDDS PM data

It was used by EPC-team in manual mode.

What is the future of it?
Can it be **automatic**?
What about earth-fault detection to be added?
Any feedbacks from EPC-team?

PIC

PMEA + Analysis Tools (LabVIEW)



PIC2-test analysis tool
Developed and supported by EN/ICE-MTA
Based on LabVIEW, RADE, SDDS PM data

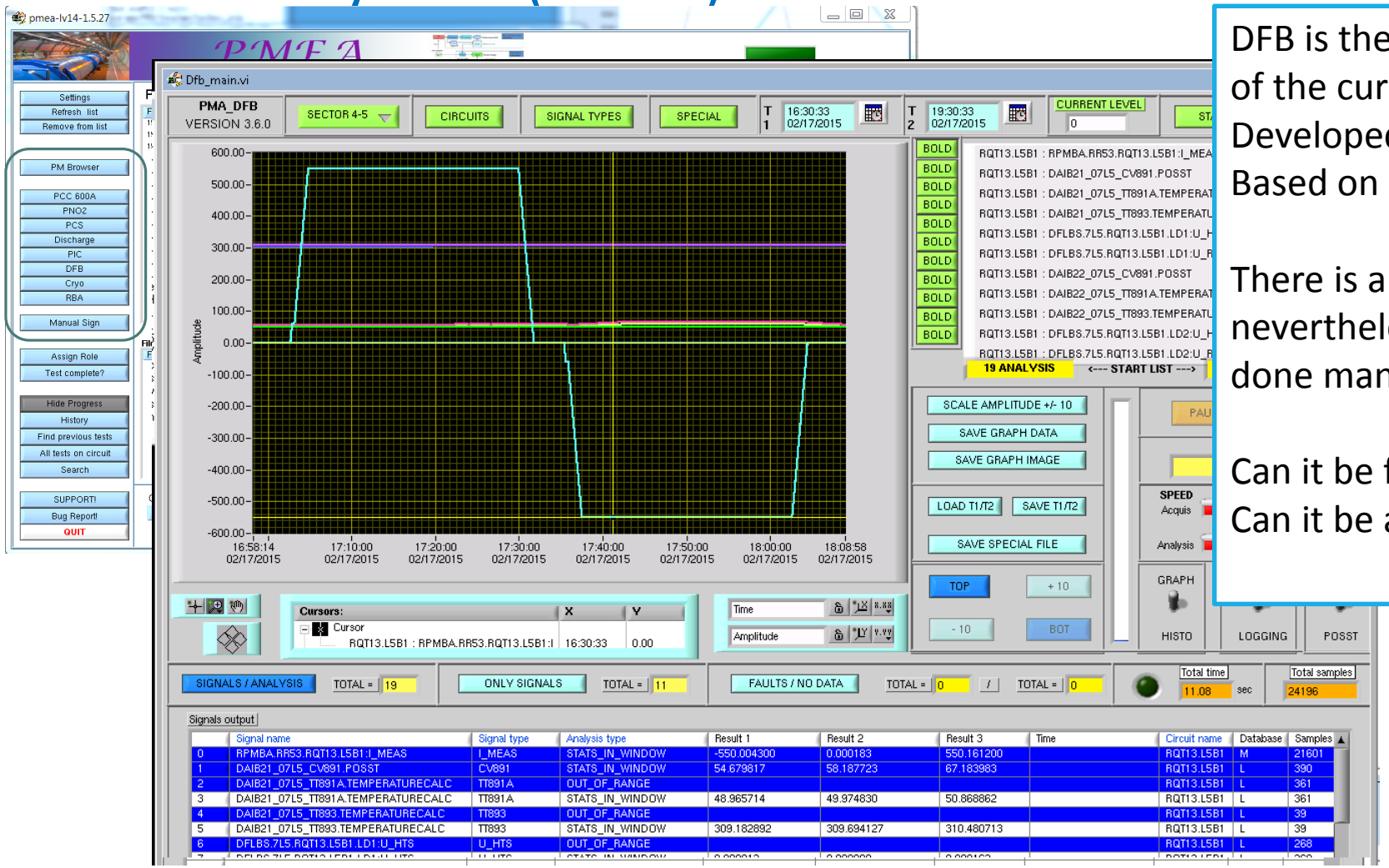
The analysis is fully **automatic** for some circuits but not for the others like RB, RQD/RQF, …

Can it be **automatic** for all circuits?

Statistics from AccTesting:
About 870 PIC2-tests failed out of 5300 analysed in total

DFB

PMEA + Analysis Tools (LabVIEW)



DFB is the tool to verify the correct functionality of the current leads
Developed and supported by EN/ICE-MTA
Based on LabVIEW, RADE, logging DB

There is a built-in acceptance check but nevertheless the analysis of this HWC tests was done manually.

Can it be fully **automatic**?
Can it be adapted or pre-set to analyse PGC-tests?

Cryo

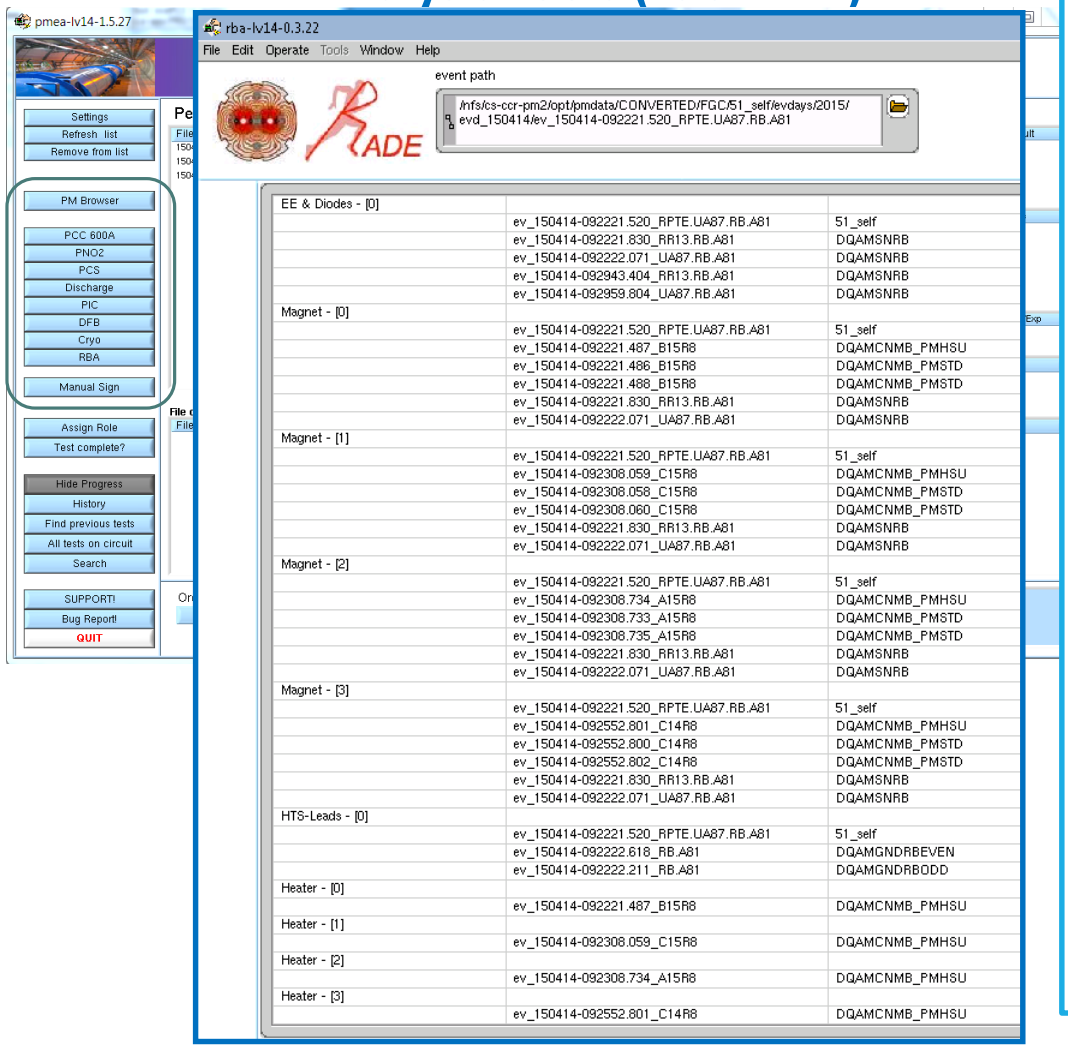
PMEA + Analysis Tools (LabVIEW)

Cryo is the tool to query the cold mass temperatures from logging DB
Developed and supported by EN/ICE-MTA
Based on LabVIEW, RADE, logging DB

It was not used by MP3
Any feedback from CRYO-team?
Should it be used to analyse PGC tests?

RBA

PMEA + Analysis Tools (LabVIEW)



RBA is a main dipole-circuit training quench analysis tool
Developed and supported by EN/ICE-MTA
Based on LabVIEW, RADE, SDDS PM data, Logging data

It was developed during HWC by request of MP3 (developing started after the 1st training quench)

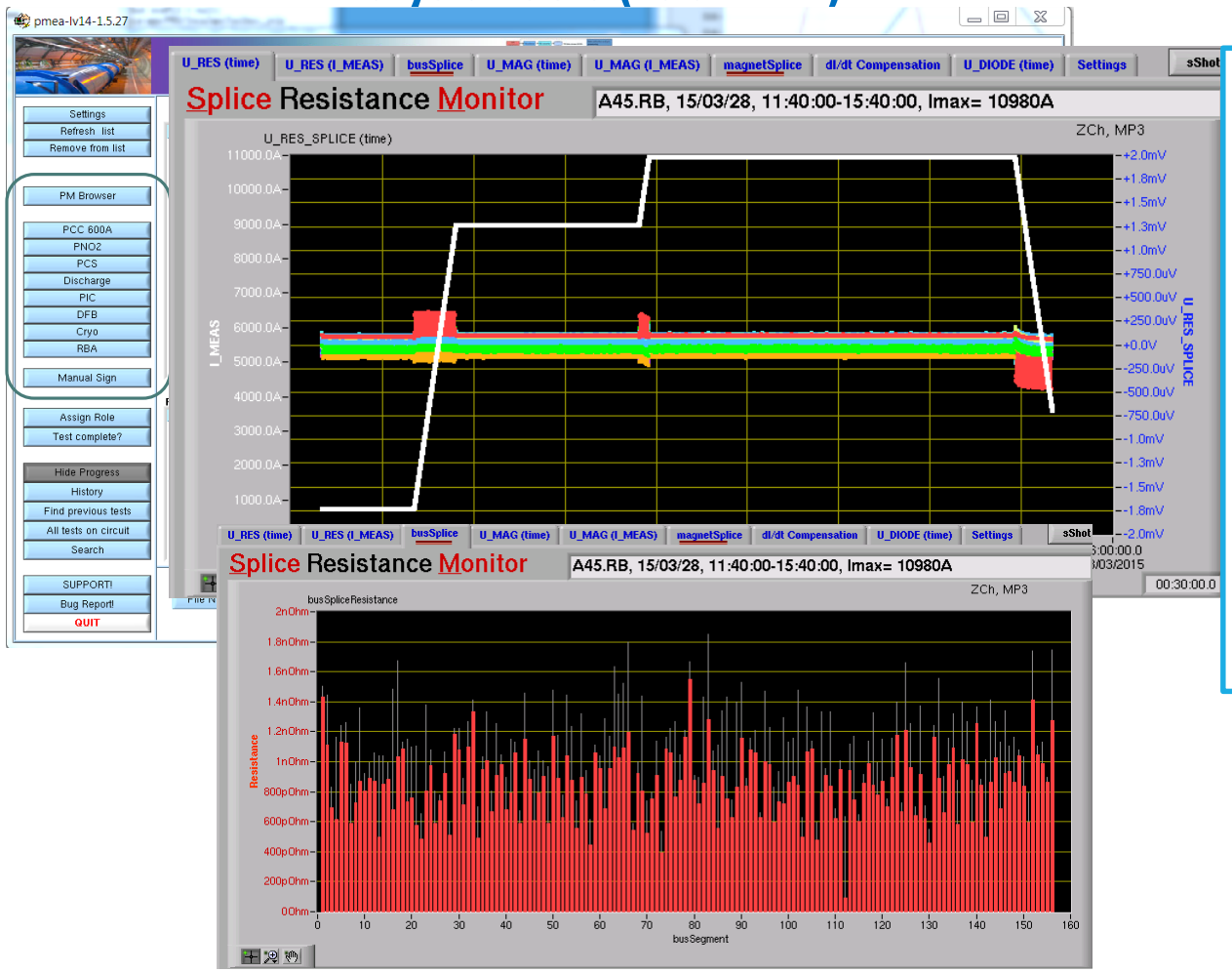
The application selects all data related to the RB training quench and shows it in the special views, which allows to make an effective manual analysis of all aspects of the RB circuit quench. The signals are pre-selected from many agents, systems, classes, where even experts got lost!!!

What can be the **future** of the RBA-application?
What about an **automation**?

Statistics from AccTesting:
176 PNO.b2 tests out of 372 in total for RB-circuits

Splice Monitor (1)

PMEA + Analysis Tools (LabVIEW)



SM is the application to check the cold splice resistances of the LHC main circuits
Developed and supported by ZCh
Based on LabVIEW, RADE, Logging DB data

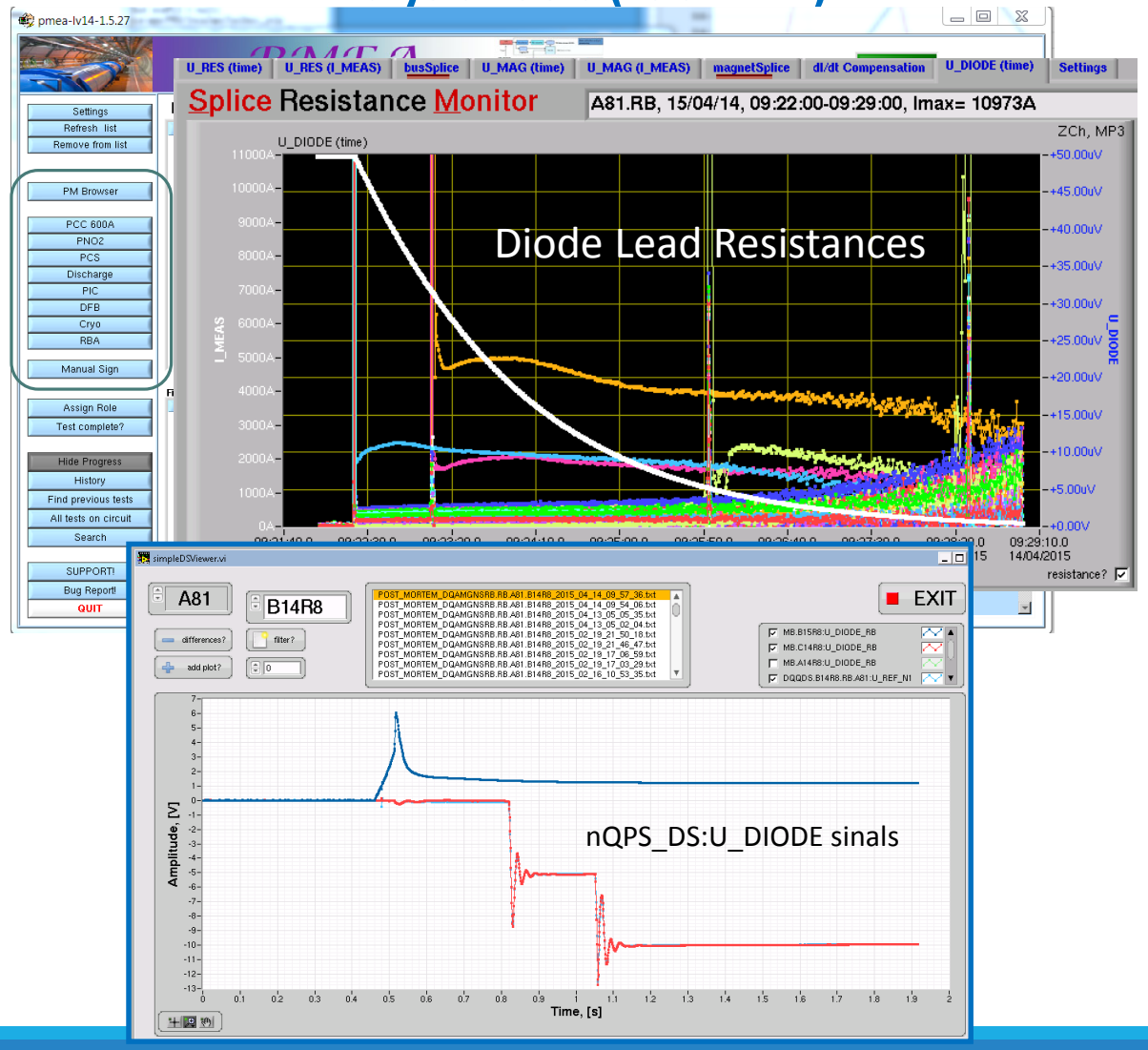
Originally it was developed to analyse the Splice Mapping tests and long plateau PNO tests.

Can it be fully **automatic** during HWC?

It was and it is fully **automatic** during LHC Runs.

Splice Monitor (2)

PMEA + Analysis Tools (LabVIEW)



SM is the application to check the cold splice resistances of the LHC main circuits
Developed and supported by ZCh
Based on LabVIEW, RADE, Logging DB data

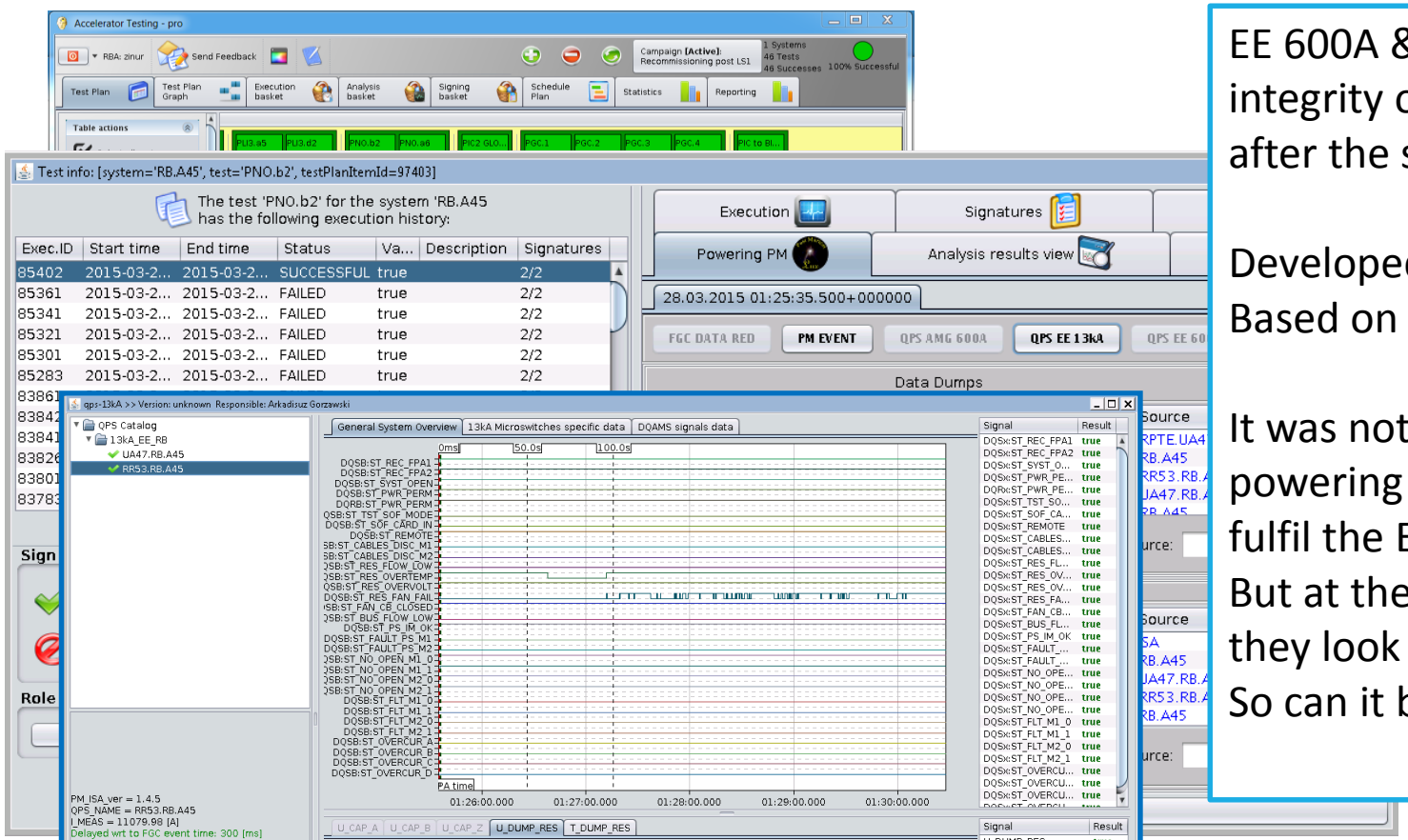
Originally it was developed to analyse the Splice Mapping tests and long plateau PNO tests.

+

During HWC it was modified to be able to check the diode lead resistances as well. And the browser of nQPS DS buffer U_DIODE signals has been added.
Should it be added to RBA-application?

EE 600A & 13kA

AccTesting + Analysis Tools (Java)



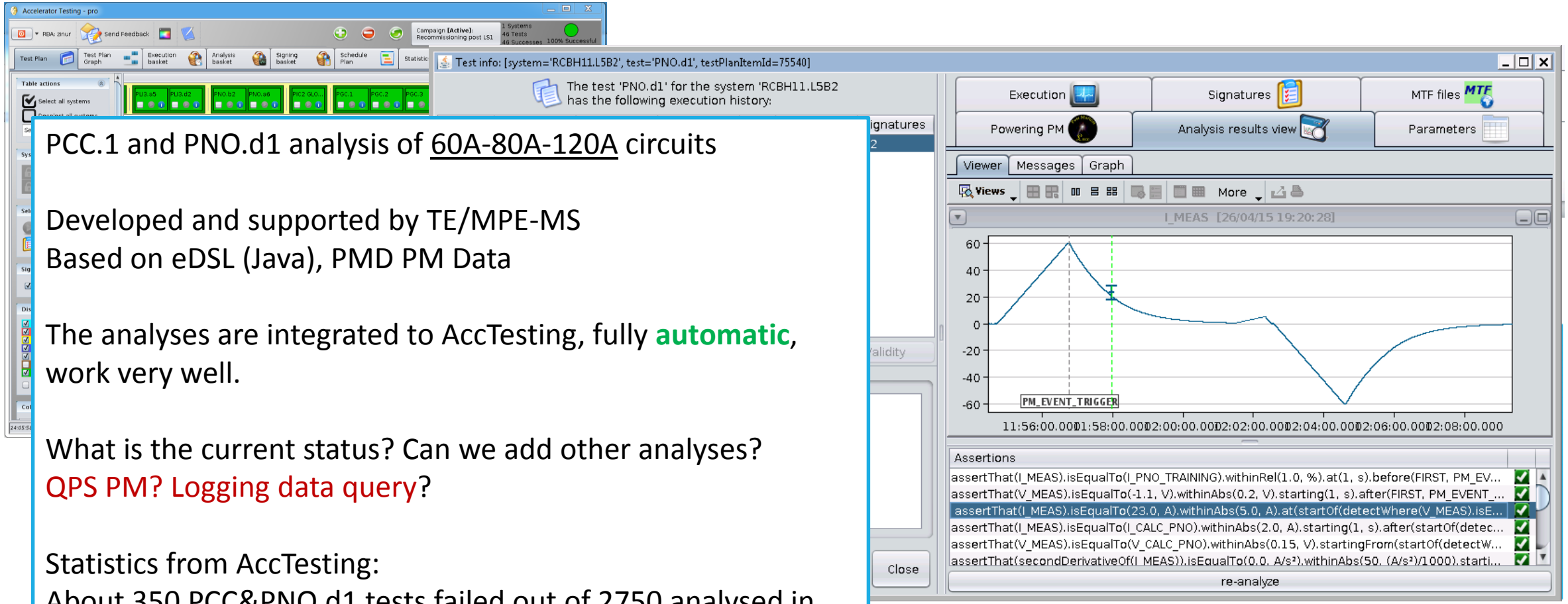
EE 600A & EE 13kA are the application to check the integrity of the digital and analog signals of EE systems after the switch opening by FPA.

Developed and supported by Ivan and Arek
Based on Java, PMD PM data

It was not always possible to run it. In many cases the powering test was signed as passed even if it did not fulfil the EE check.
But at the end of HWC the applications work well. Now they look like ready to be switched to automatic mode.
So can it be fully **automatic** now?

PCC.1&PNO.d1 by eDSL

AccTesting + Analysis Tools (Java)



PCC.1 and PNO.d1 analysis of 60A-80A-120A circuits

Developed and supported by TE/MPE-MS
Based on eDSL (Java), PMD PM Data

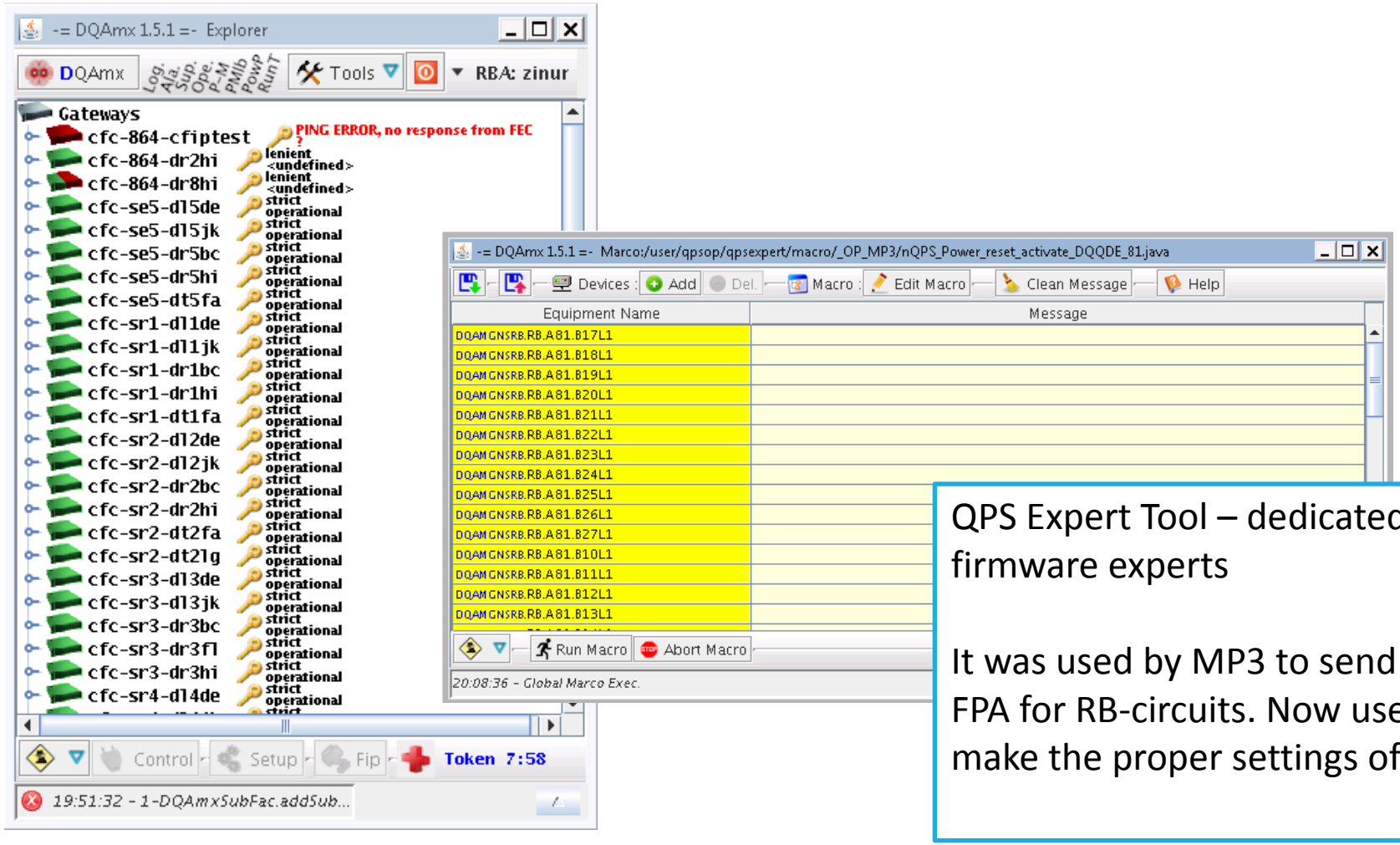
The analyses are integrated to AccTesting, fully **automatic**, work very well.

What is the current status? Can we add other analyses?
QPS PM? Logging data query?

Statistics from AccTesting:
About 350 PCC&PNO.d1 tests failed out of 2750 analysed in total

QPS Expert

Special and Expert Tools

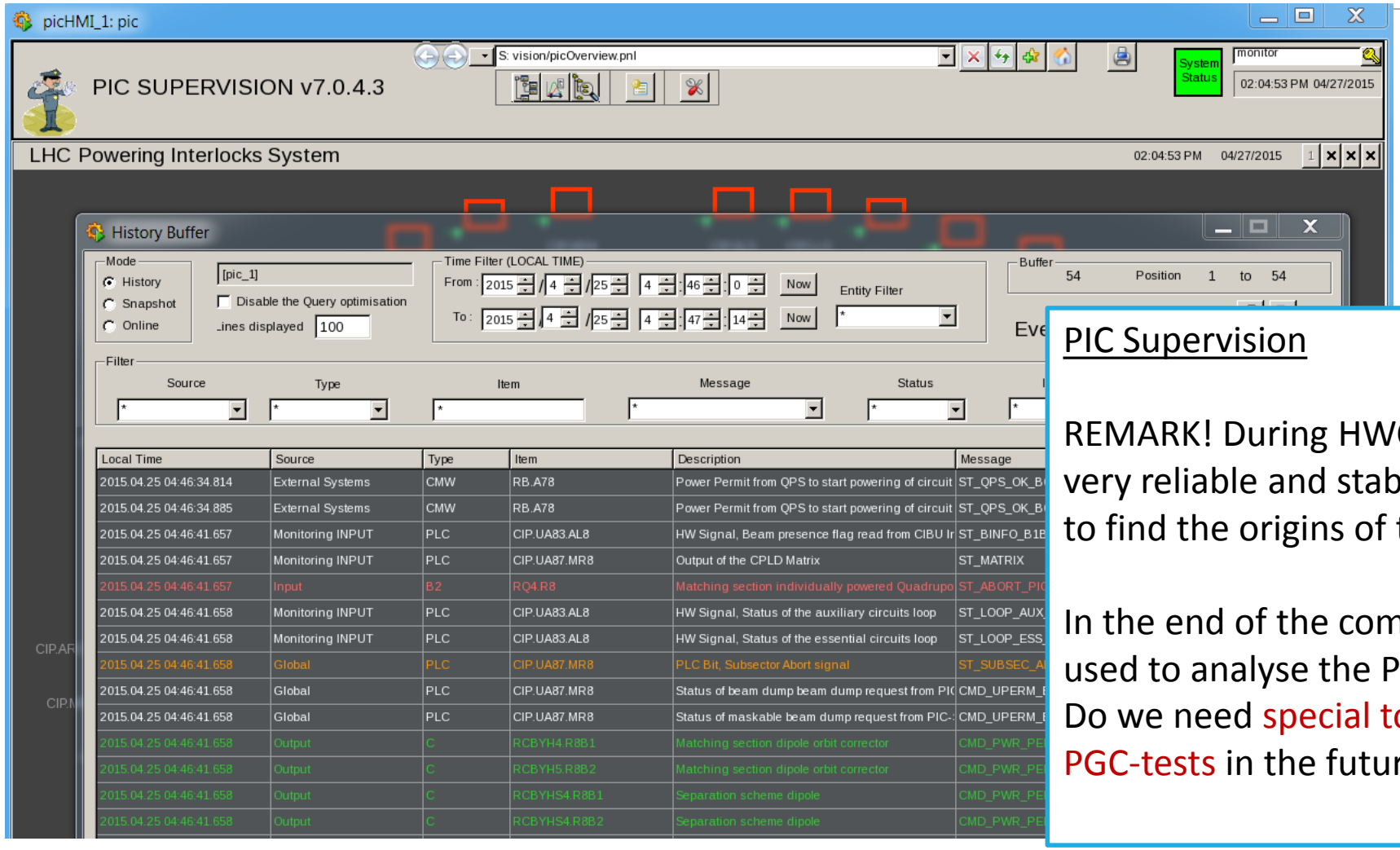


QPS Expert Tool – dedicated to the QPS hardware and firmware experts

It was used by MP3 to send the U_QS0 snapshots during FPA for RB-circuits. Now used by LHCOP to reset and to make the proper settings of the different circuits

PIC Supervision

Special and Expert Tools

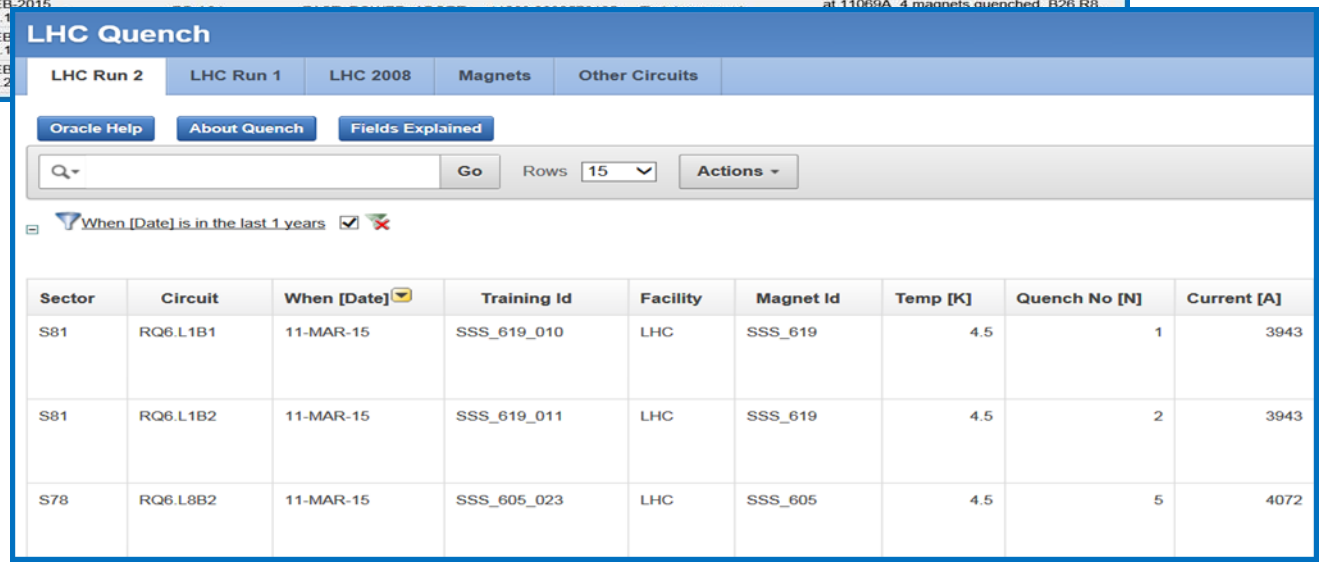


PIC Supervision

REMARK! During HWC-campaign the **PIC systems** work very reliable and stable. In many cases it was only a way to find the origins of the trip.

In the end of the commissioning the PIC Supervision was used to analyse the PGC tests.
Do we need special tool based on PIC-signals to analyse PGC-tests in the future?

Database for analysis (1)



PM Database (Oracle, Apex)

From 2011, all LHC PM events are recorded in this database.
During HWC 2014-15, additional description in the powering PM event (manually) by flagging the type of quenches (provoked, training, coolant induced…)

Reception test DB (Oracle, Apex)

For comparison with previous campaigns, the LHC Quench database provides magnet performance from reception tests and the first training quench campaign (2008).
For Run 1 and Run 2, quench information is not complete for RB, RQ circuits

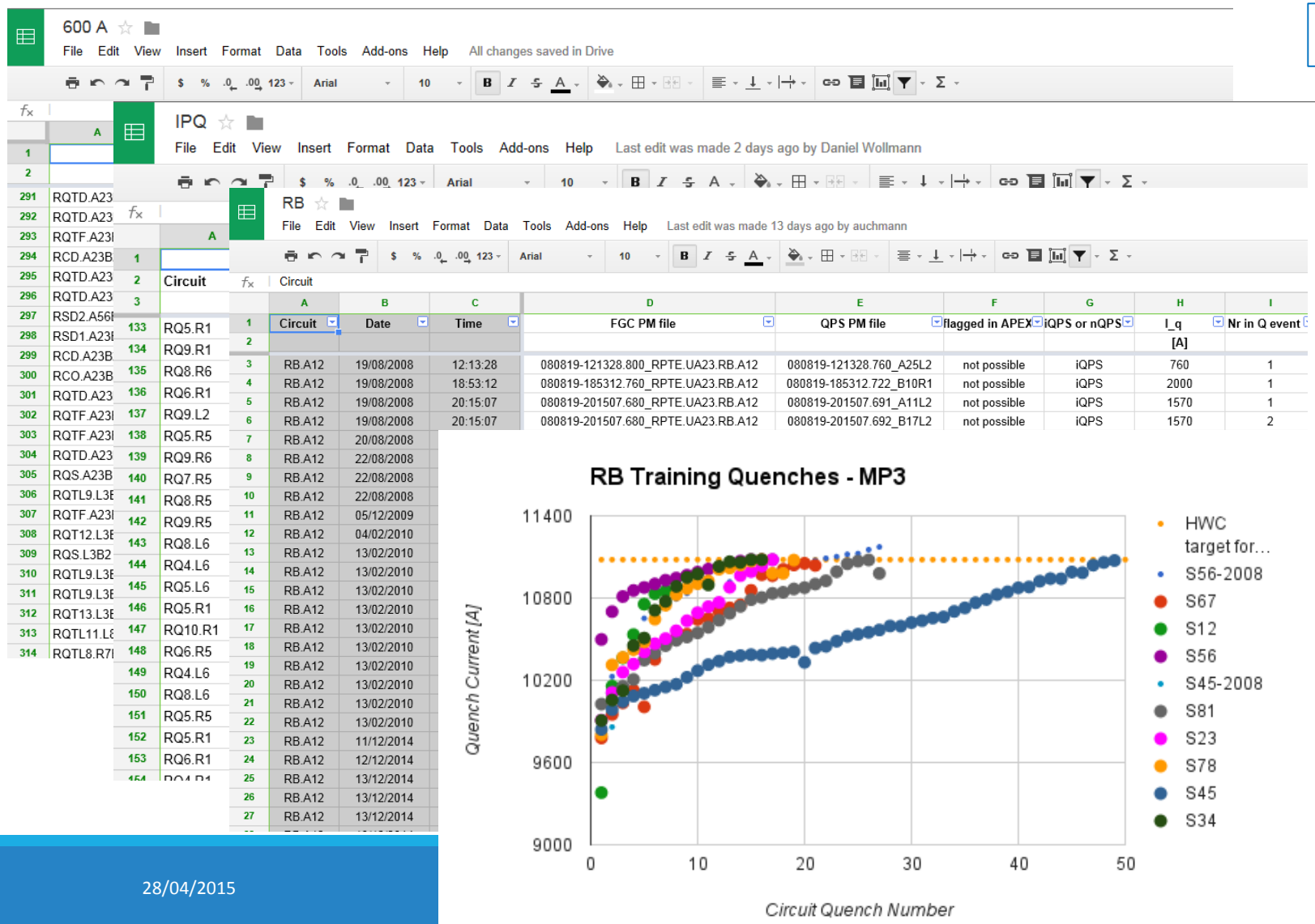
Database for analysis (2)

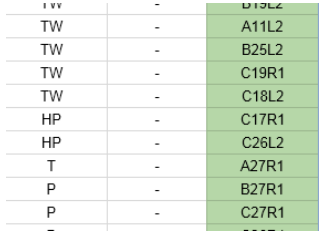
HWC Quench Database (Google,Excel)

To collect step by step all information about training quenches or provoked quenches, an excel google sheet was created for each type of circuits.

All entries are manual and hopefully systematic but without guarantee

Where these info can be implemented? What about an automation of some quench characteristics (calculation)?





Software communication

- **PMEA - Acctesting communication issues**

Powering test validation started with some software communication issues.

Because of some changes (upgrade) of data flow architecture (controllers, database, library, …) during LS1 with a late deployment, Post Mortem (PM) files collection and communication between PMEA and Acctesting were revised at the beginning of the HWC.

- **Connexion to LHC-logging database**

Communication with logging database became sometimes very slow (fixe?)

-> Fast reaction of EN/ICE team

2014-15 HWC Campaign

- HWC interface
  - 2 tools were used PMEA and Acctesting.

Developed with different purpose, will we merge the 2 tools?

Some flexibility are still missing in Acctesting . For example, the test validation (PASS/FAIL), analysis of complex circuits…

Will we have face other «data flow» upgrades?

2014-15 HWC Campaign

- Analysis tools
  - Inherited from the past, many specific analysis programs are available for specific powering tests. Some of them have been automatised with success
  - New analysis tools/data viewers have been implemented to ease some analysis but there are using different programming systems : LabView, Java, eDSL)

  Example : training quench of a RB circuit
  - RBA, QPS signals viewer (magnet signals, EE signals, heater discharge, current leads, …)
  - PM powering playback for EE analysis (analog and digital signals)
  - SM, for Splice resistance, diode voltage signals ,diode resistance…
  - Excel google sheet for quench characteristics

  If we have to analyse a quench of a IPQ circuit, other analysis tools are used!

What about homogeinisation of viewers (mix with logging and PM data) ?

2014-15 HWC Campaign

- Analysis tools

Automatic tools? Up to now automatic analysis tools are using logging data or FGC post mortem data and can be used for specific powering tests.

Is it possible to improve the quality of QPS signal in PM files? (many spikes/time shift/offset…)

Automatic tools for operation/HWC ?

Do we still miss some specific tool (PGC analysis)?

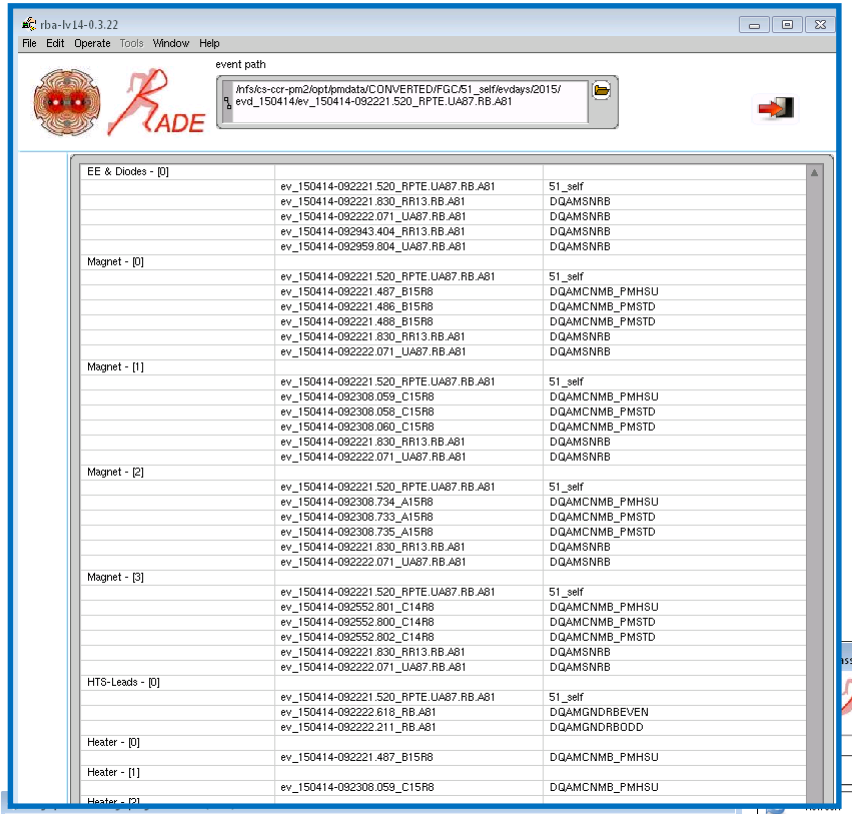
2014-15 HWC Campaign

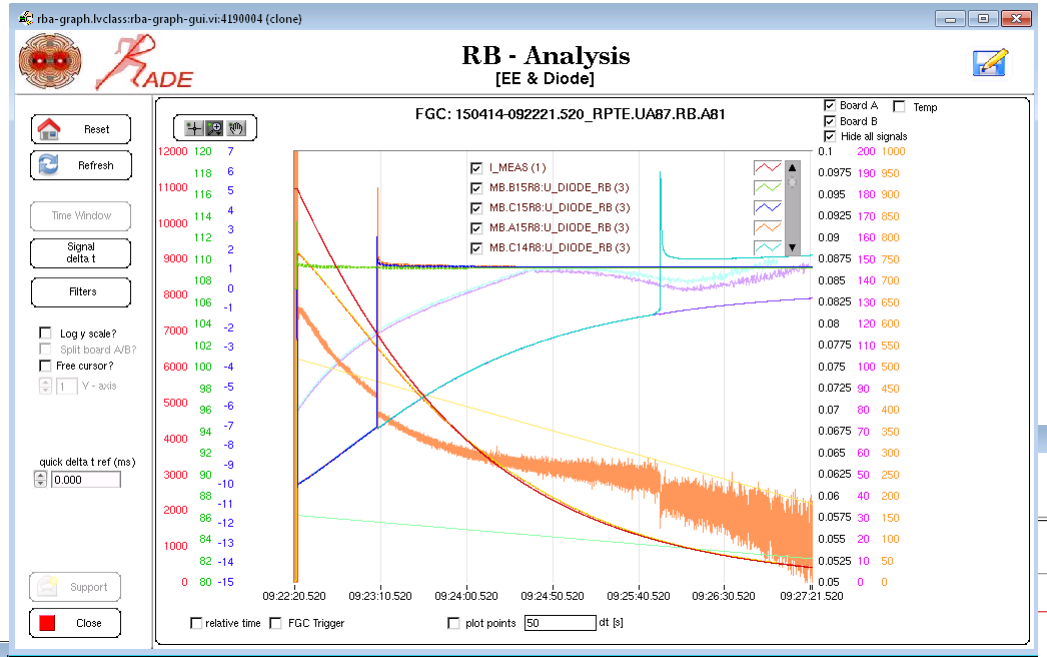
Database for analysed events

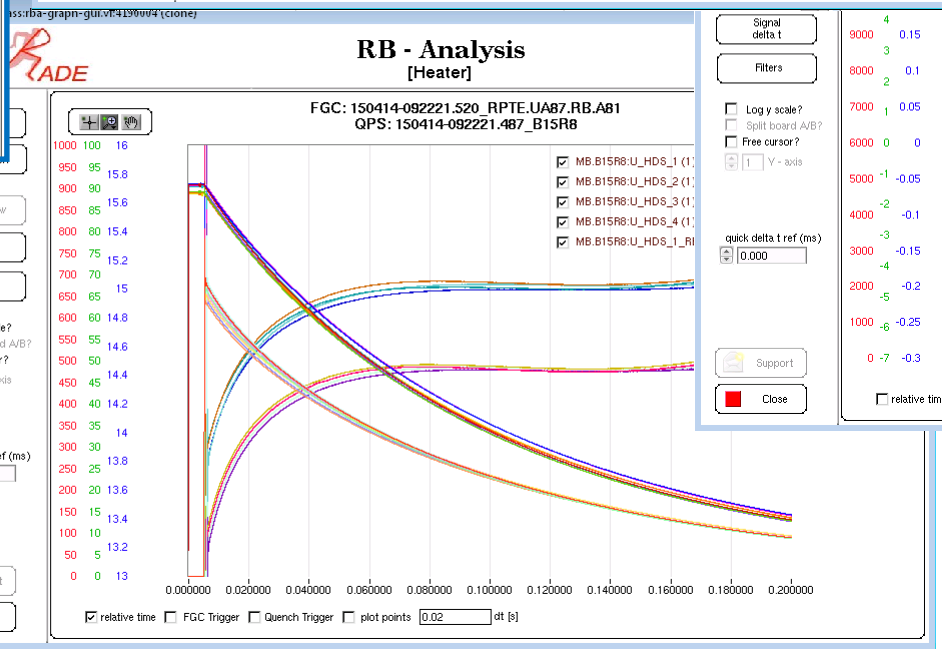
- Still missing but necessary. This point was «temporary» filled with google excel sheet

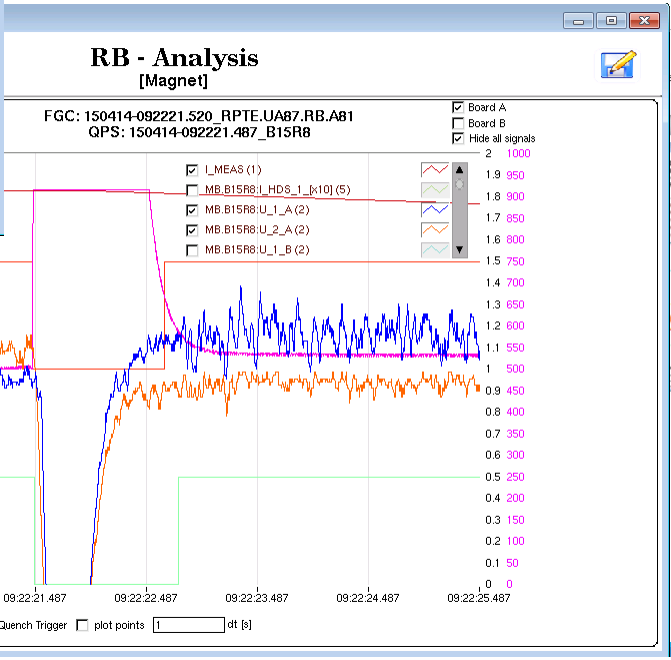
How to implement such a database to follow some circuit characteristics? (splice resistance, heater discharge, quench development…)

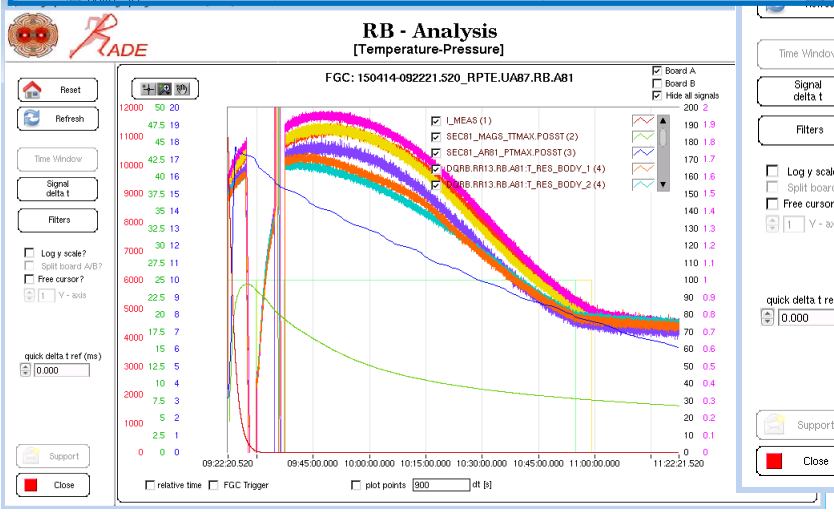
Appendix


rba-lv14-0.3.22
File Edit Operate Tools Window Help
event path
/nfs/cs-ccr-pm2/opt/pmdata/CONVERTED/FGC/51_self/evdays/2015/evd_150414/ev_150414-092221.520_RPTE.UA87.RB.A81
EE & Diodes - [0]
ev_150414-092221.520_RPTE.UA87.RB.A81 51_self
ev_150414-092221.830_RR13.RB.A81 DQAMSNRB
ev_150414-092222.071_UA87.RB.A81 DQAMSNRB
ev_150414-092943.404_RR13.RB.A81 DQAMSNRB
ev_150414-092959.804_UA87.RB.A81 DQAMSNRB
Magnet - [0]
ev_150414-092221.520_RPTE.UA87.RB.A81 51_self
ev_150414-092221.487_B15R8 DQAMCNMB_PMHSU
ev_150414-092221.486_B15R8 DQAMCNMB_PMSTD
ev_150414-092221.488_B15R8 DQAMCNMB_PMSTD
ev_150414-092221.830_RR13.RB.A81 DQAMSNRB
ev_150414-092222.071_UA87.RB.A81 DQAMSNRB
Magnet - [1]
ev_150414-092221.520_RPTE.UA87.RB.A81 51_self
ev_150414-092308.059_C15R8 DQAMCNMB_PMHSU
ev_150414-092308.058_C15R8 DQAMCNMB_PMSTD
ev_150414-092308.060_C15R8 DQAMCNMB_PMSTD
ev_150414-092221.830_RR13.RB.A81 DQAMSNRB
ev_150414-092222.071_UA87.RB.A81 DQAMSNRB
Magnet - [2]
ev_150414-092221.520_RPTE.UA87.RB.A81 51_self
ev_150414-092308.734_A15R8 DQAMCNMB_PMHSU
ev_150414-092308.733_A15R8 DQAMCNMB_PMSTD
ev_150414-092308.735_A15R8 DQAMCNMB_PMSTD
ev_150414-092221.830_RR13.RB.A81 DQAMSNRB
ev_150414-092222.071_UA87.RB.A81 DQAMSNRB
Magnet - [3]
ev_150414-092221.520_RPTE.UA87.RB.A81 51_self
ev_150414-092552.801_C14R8 DQAMCNMB_PMHSU
ev_150414-092552.800_C14R8 DQAMCNMB_PMSTD
ev_150414-092552.802_C14R8 DQAMCNMB_PMSTD
ev_150414-092221.830_RR13.RB.A81 DQAMSNRB
ev_150414-092222.071_UA87.RB.A81 DQAMSNRB
HTS-Leads - [0]
ev_150414-092221.520_RPTE.UA87.RB.A81 51_self
ev_150414-092222.618_RB.A81 DQAMGNDRBEVEN
ev_150414-092222.211_RB.A81 DQAMGNDRBODD
Heater - [0]
ev_150414-092221.487_B15R8 DQAMCNMB_PMHSU
Heater - [1]
ev_150414-092308.059_C15R8 DQAMCNMB_PMHSU
Heater - [2]


rba-graph.lvclass:rba-graph-gui.vi:4190004 (clone)
RB - Analysis
[EE & Diode]
FGC: 150414-092221.520_RPTE.UA87.RB.A81
I_MEAS (1)
MB.B15R8:U_DIODE_RB (3)
MB.C15R8:U_DIODE_RB (3)
MB.A15R8:U_DIODE_RB (3)
MB.C14R8:U_DIODE_RB (3)
Board A
Board B
Hide all signals
Temp
Reset
Refresh
Time Window
Signal delta t
Filters
Log y scale?
Split board A/B?
Free cursor?
quick delta t ref (ms)
Support
Close
relative time
FGC Trigger
plot points
dt [s]


RB - Analysis
[Heater]
FGC: 150414-092221.520_RPTE.UA87.RB.A81
QPS: 150414-092221.487_B15R8
MB.B15R8:U_HDS_1 (1)
MB.B15R8:U_HDS_2 (1)
MB.B15R8:U_HDS_3 (1)
MB.B15R8:U_HDS_4 (1)
MB.B15R8:U_HDS_1_RI
Signal delta t
Filters
Log y scale?
Split board A/B?
Free cursor?
quick delta t ref (ms)
Support
Close
relative time
FGC Trigger
Quench Trigger
plot points
dt [s]


RB - Analysis
[Magnet]
FGC: 150414-092221.520_RPTE.UA87.RB.A81
QPS: 150414-092221.487_B15R8
I_MEAS (1)
MB.B15R8:I_HDS_1_[x10] (5)
MB.B15R8:U_1_A (2)
MB.B15R8:U_2_A (2)
MB.B15R8:U_1_B (2)
Board A
Board B
Hide all signals
relative time
FGC Trigger
Quench Trigger
plot points
dt [s]

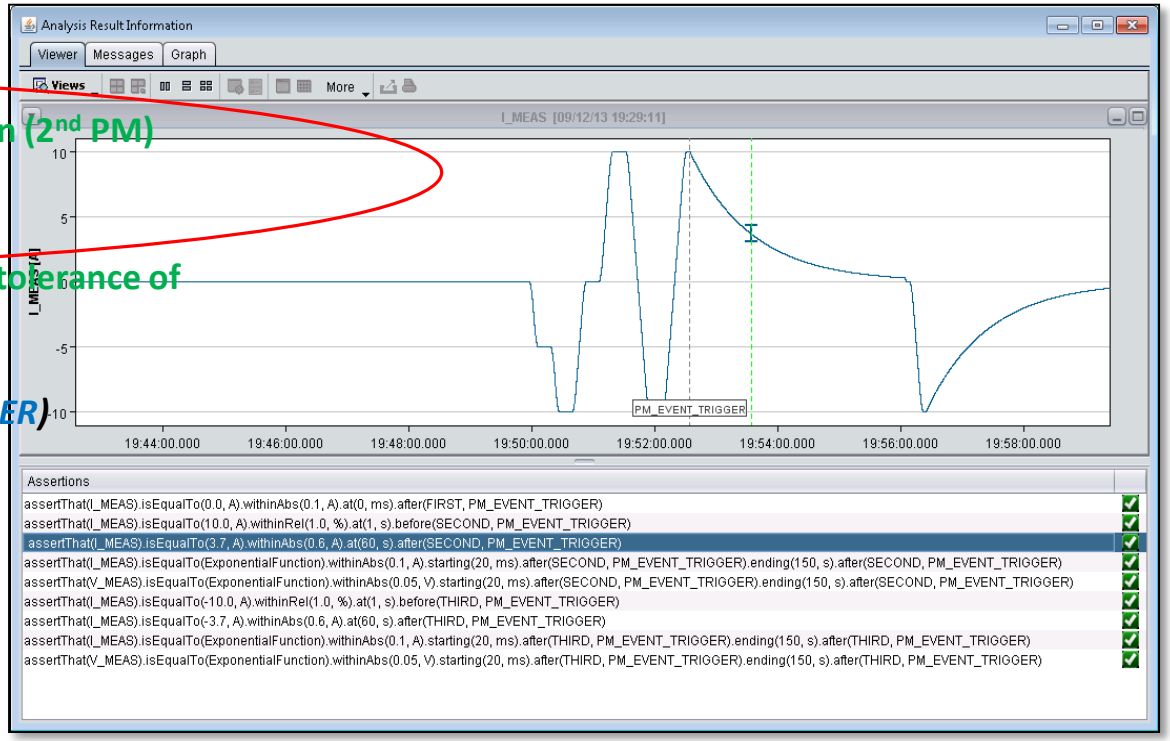

RB - Analysis
[Temperature-Pressure]
FGC: 150414-092221.520_RPTE.UA87.RB.A81
I_MEAS (1)
SEC81_MAGS_TTMAX.POSST (2)
SEC81_AR81_PTMAX.POSST (3)
DQRB.RR13.RB.A81.T_RES_BODY_1 (4)
DQRB.RR13.RB.A81.T_RES_BODY_2 (4)
Board A
Board B
Hide all signals
Reset
Refresh
Time Window
Signal delta t
Filters
Log y scale?
Split board A/B?
Free cursor?
quick delta t ref (ms)
Support
Close
relative time
FGC Trigger
plot points
dt [s]

- **Using the eDSL Java Interface** pass criteria can be written in an easy to read/understand sentence form

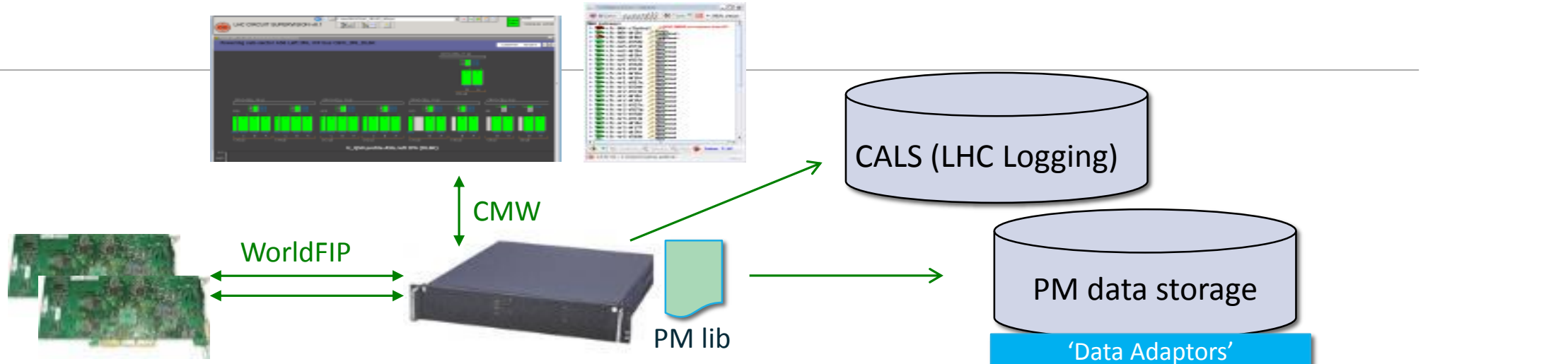
5.2.1 CROWBAR @ +PCC

#	Action	Description	Parameters	Criteria	Team
1	Analysis1	The converter current 60s after the crowbar activation		+3.7A±0.6A	TE-EPC
2	Decay waveforms	The converter voltage and current show a smooth waveform during the whole decay.		PASS / FAIL	TE-EPC

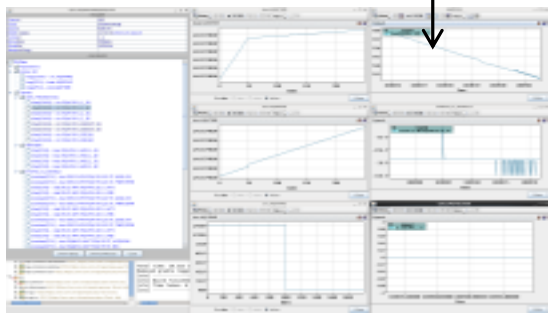
```
//Verify converter current to be +3.7A/+-0.6A 60seconds after the 1st crowbar activation (2nd PM)
assertThat(I_MEAS).isEqualTo(+3.7, AMPERE).withinAbs(0.6, AMPERE)
        .at(60, SECOND).after(Occurrence.SECOND, PM_EVENT_TRIGGER);
//Verify converter current & voltage decay is an exponential function with an absolute tolerance of
    0.1A/0.05V  starting 20ms after the 1st crowbar activation (2nd PM)
assertThat(I_MEAS).isEqualTo(EXP).withinAbs(0.1, AMPERE)
        .starting(20, MILLI(SECOND)).after(Occurrence.SECOND, PM_EVENT_TRIGGER)
        .ending(150, SECOND).after(Occurrence.SECOND, PM_EVENT_TRIGGER);
assertThat(V_MEAS).isEqualTo(EXP).withinAbs(0.1, VOLT)…
        …
```



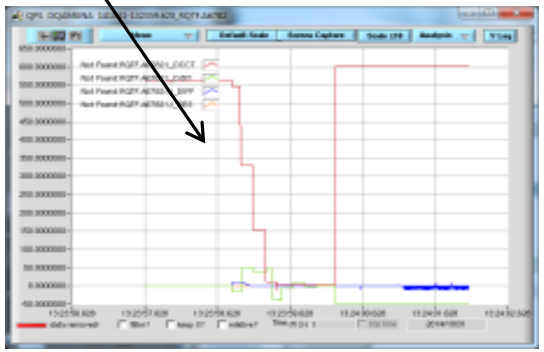
QPS Data infrastructure – what we should look at …



- Agents + WorldFIP (exchange protocol, state machines for exchange, bandwidth, data contents,..),…
- GW: state machines for data exchange, PM + CALS interfaces, data adaptors for PM data…
- SCADAs and expert tools: complex tasks + macros, sequencer,..
- Documentation + DB descriptions, configuration management,…



JAVA PM, ACCTEST



LV PM, PMEA

Courtesy of M.Zerlauth

PM data filtering example