DEVELOPMENTS ON THE SCADA OF CERN ACCELERATORS VACUUM

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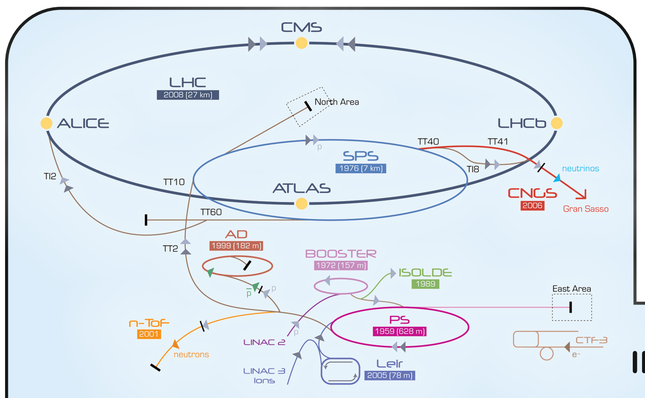


ABSTRACT

During the first 3 years of LHC operation, the priority for the SCADA (Supervisory Control And Data Acquisition) of vacuum controls was to attend to user requests, and to improve its ergonomics and efficiency: access & presentation of information simplified and normalized; coherent functionalities & menus across all accelerators; automatic scripts instead of fastidious manual actions; enhanced tools for data analysis and for maintenance interventions.

Several decades of cumulative developments, based on heterogeneous technologies and architectures, have been asking for a homogenization effort.
The first LHC Long Shutdown (LS1) provides the opportunity to further standardize the vacuum controls systems, around Siemens-S7 PLCs (Programmable Logic Controllers) and PVSS SCADA.

Meanwhile, exchanges with other Groups at CERN and outside Institutes have been promoted: to follow the global update policy for software libraries; to discuss philosophies and development details; and to accomplish common products. Furthermore, while preserving the current functionalities, a convergence towards the CERN UNICOS framework is under preparation.

INTRODUCTION

Vacuum Controls Architecture

For half a century, the architecture of vacuum controls in CERN accelerators has been following the availability of new technologies, at the time of construction or renovation; cumulative developments, from different generations, often coexist in the same machine.

In 2000: the SPS renovation, followed by the LHC construction and the partial renovation in the PS complex;
During the LS1[1]**:** the homogenization of the vacuum control systems to be extended to the rest of the PS Complex (PS Ring, AD), and to some experimental areas (NA62, nTOF).
The new Linac4 is also being built in the same way; it will later evolve closer to UNICOS.
The ISOLDE facility, already using UNICOS, will be extended into HIE-ISOLDE.

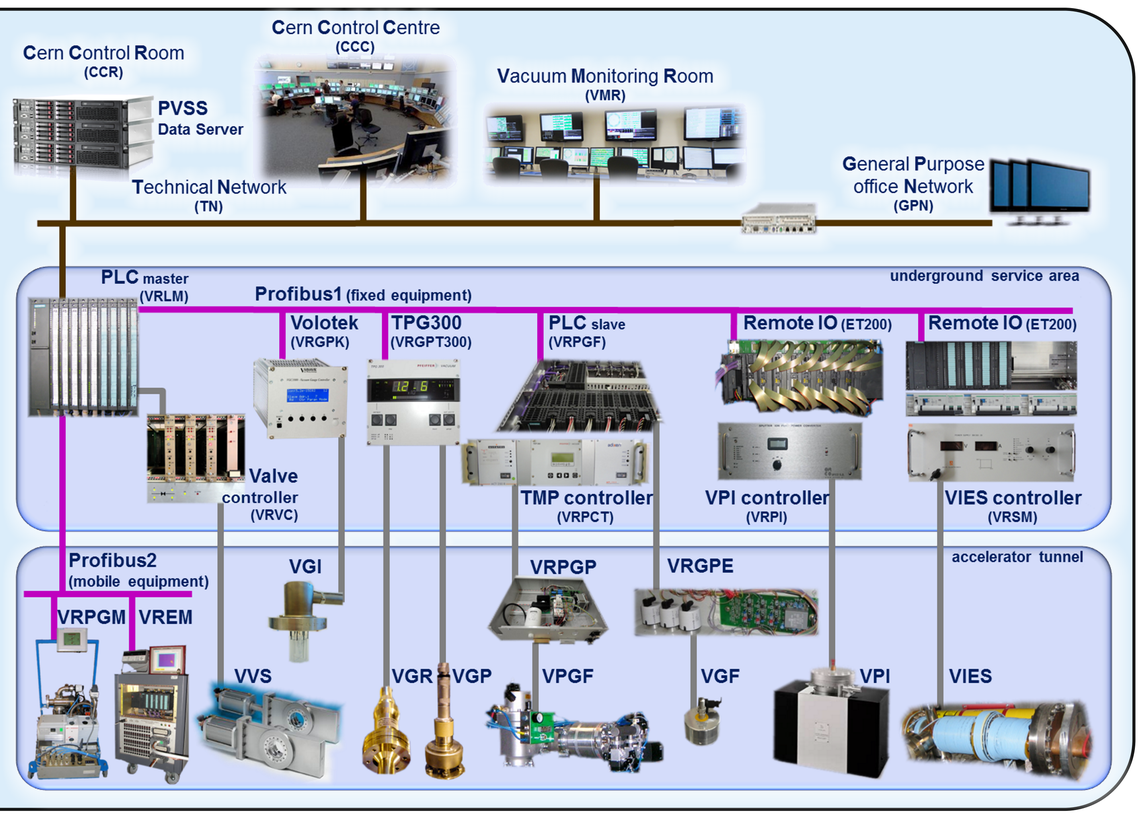
Hardware: upgraded to a PLC-based architecture with Siemens™ S7 and PVSS® (now called WinCC®-OA).
Software: developed for both PLC and SCADA within the vacuum group, as a custom framework; it has integrated an increasing number of elements from the CERN-wide UNICOS framework.
Network communication: between the PLCs and the PVSS Data-Servers, through the Ethernet Technical Network (TN), which is restricted to the control & operation of accelerators and technical infrastructures.
Office computers, on the General Purpose Network (GPN), may have limited access to the TN, for monitoring.

Security Chain: Interlocks, Alarms & Warnings

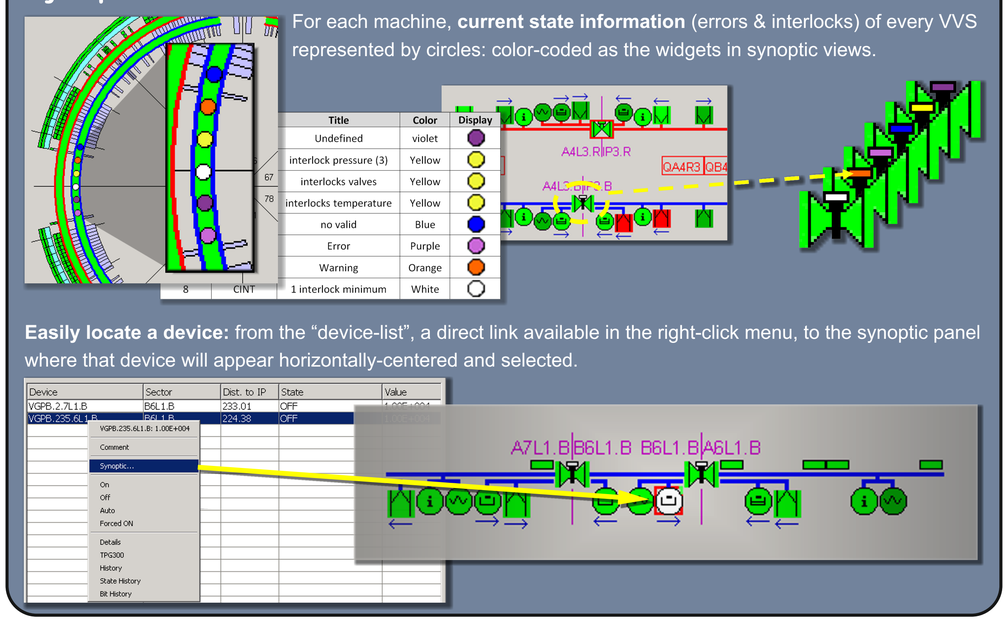
In case of vacuum degradation: if the pressure readings (Penning Gauge-VGP and Ionic pump-VPI) rise above given thresholds, an Interlock is sent to the valve (VVS) controller. Depending on the logic combination, the neighboring valves will automatically close.

Data Sharing

Process values & status published through the middleware interfaces CMW and DIP:
can be used by any CERN control system to publish / subscribe data, synchronized with the global Accelerators Timing.
The SCADA historical data is locally stored, and periodically sent to a central repository: the LOGGING-DB.



Synoptics



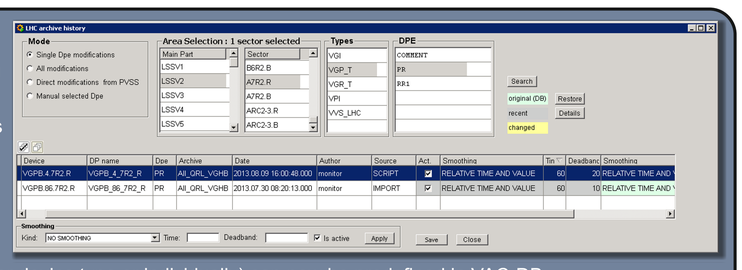
For each machine, **current state information** (errors & interlocks) of every VVS represented by circles: color-coded as the widgets in synoptic views.

Easily locate a device: from the “device-list”, a direct link available in the right-click menu, to the synoptic panel where that device will appear horizontally-centered and selected.

Noisy Devices

History depth limited by **noise-polluted channels** saturating the archive files; A PVSS script now makes:
- the archive parameters smoothed with adaptive parameters
- the archiving blocked if the algorithm cannot decrease the amount of meaningless values
- all blocked channels restarted every night
- any parameter evolution and archive blocking are traced

Additionally, the default parameters for archive smoothing (per device type or individually) can now be predefined in VAC-DB.



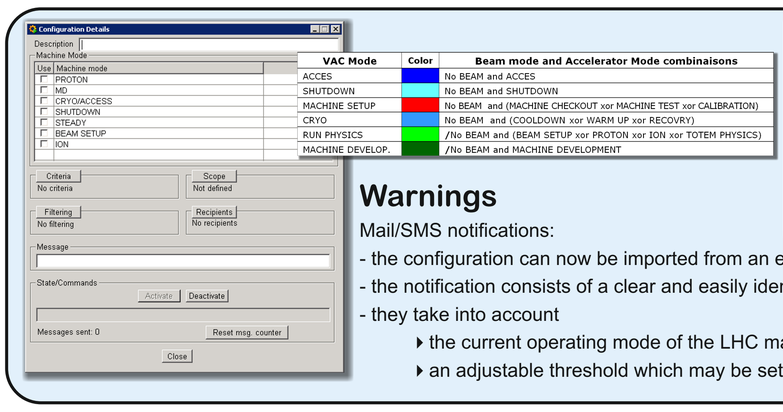
VAC-DB[3]

For the LHC machine, the position of vacuum instruments can be automatically retrieved from Layout-DB by a synchronization script into VAC-DB; in 2012, a more robust version was put into place:
- launching a simulated synchronization with the production of a report
- launching a real synchronization:
  - several validation steps to be followed
  - synchronization can be partial
- templates created to easily import/export data into VAC-DB
- all actions are traced

Bake-Out Controllers[2]

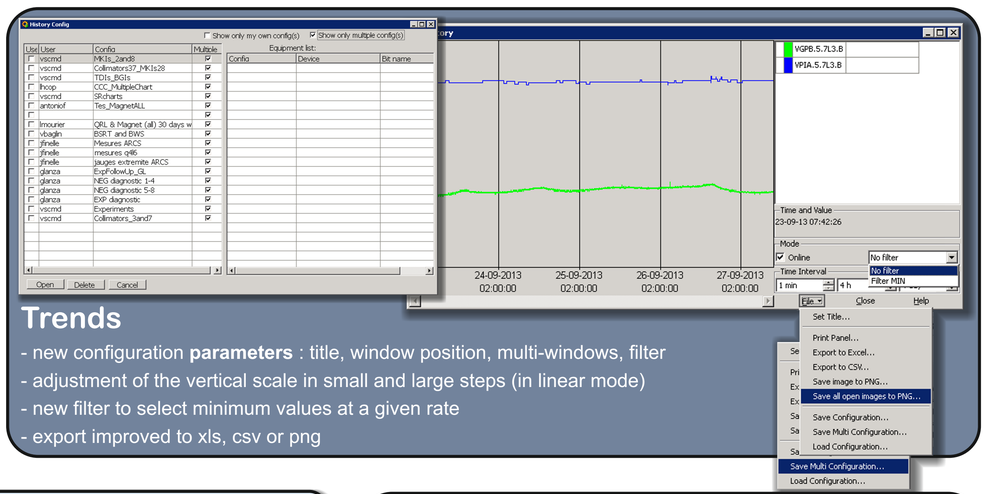
The new version includes :
- more channels
- a safety general power cut
- an Ethernet communication facility
- a new PID regulation with auto-tuning

The SCADA has been updated accordingly, also including the specific mail/SMS Warnings.



Warnings

Mail/SMS notifications:
- the configuration can now be imported from an externally prepared table, following a well-defined format
- the notification consists of a clear and easily identifiable text (ID + customizable text)
- they take into account
  - the current operating mode of the LHC machine
  - an adjustable threshold which may be set to the relevant range of pressure



Trends

- new configuration **parameters** : title, window position, multi-windows, filter
- adjustment of the vertical scale in small and large steps (in linear mode)
- new filter to select minimum values at a given rate
- export improved to xls, csv or png

Standardizations

- PVSS Data-Servers:
  - migration from Windows to Linux performed in 2012
  - physically moved into the CCR building
- SCADA application:
  - updated from version 3.6 to 3.8
  - integrated and operational in the CCC (CERN Control Centre)
  - new functionalities incorporated (e.g. MOON by EN-ICE)
- Tracking:
  - Software Versioning service (SVN) used since 2012, to follow software development
  - all improvements & changes listed and sent to the users
  - most important actions described in detail and recorded in EDMS

Collaborations & Exchanges with:

- other groups at CERN and outside Institutes
- EN-ICE (SCADA support)
- BE-CO (Data-Servers support)
- CERN IT security team (“TN Disco test” held on March 2013)

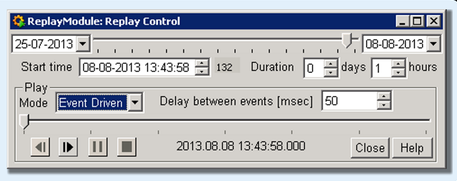
Next Steps

- the SCADA will be upgraded to the WinCC®-OA 3.11 (better compatibility with the last versions of Windows)
- SCADA archiving will be moved to an external and independent Oracle server
- preparation to a full convergence towards the CERN UNICOS framework, tailored for vacuum (partnership between VSC-ICM, GSI and Cosylab, launched by EN-ICE)

These collaborative and normalization efforts will ensure to be in conformity with CERN best practices, security rules, and recommendations, and will allow to benefit from reliable and first-rate centralized support.

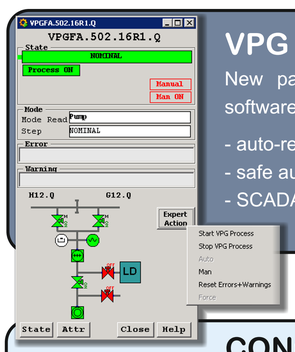
Replay

The past animation of a synoptic or bar-graph easily displayed useful to:
- illustrate the global evolution
- help with post-event analysis
- train newcomers



Gauge Controllers

Interlock thresholds stored in the Pfeiffer-Balzers TPG300® controllers:
- PVSS communication script improved
- possibility to load & display at the same time the parameters of several TPGs (connected to a given PLC)
- daily traceability of user changes extended into the other machines (originally LHC)



VPG Controllers

New parameterized functionalities introduced in the control software (VPG6A) for the turbo molecular pumping group:
- auto-restart
- safe auto-venting of the turbo pump after a power-cut
- SCADA panel updated according to these new functionalities

Other Functionalities developed

- PLC Remote-Reset functionality integrated in the SCADA
- map with the zones under access and Device-list improved with additional information and filters
- errors on server-client communication are now visible
- possibility to hide temporarily the vacuum lines/parts under maintenance

CONCLUSION

The SCADA applications for vacuum are under significant improvement, regarding their ergonomics, configurability and standardization.
The major objective for the end of LS1 is to have all upgrades ready for the restart of the LHC & injectors, in the best conditions to ensure three years of seamless operation up to 14 TeV.
The next step will be the preparation of the convergence with the UNICOS framework; having it ready, for Linac4 in 2015, will be the first full-scale experience, before the deployment on the whole accelerator chain during LS2.
In parallel, several new user requests, about automatic tools for data mining and data analysis, are currently being investigated, with the target of being operational during 2015.

REFERENCES:
[1] ICALEPCS13 Poster: MOPPC027, P. Gomes et al., "The Control system of CERN Accelerators vacuum [LS1 Activities And New Developments]"
[2] ICALEPCS13 Poster: MOPPC026, S. Blanchard et al., "Bake-out Mobile Controls for Large Vacuum Systems"
[3] ICALEPCS13 Poster: TUPPC027, F. Antoniotti et al., “Quality Management of CERN Vacuum Controls”

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