



THE CONTROL SYSTEM OF CERN ACCELERATORS VACUUM [LS1 ACTIVITIES AND NEW DEVELOPMENTS]



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PS & AD RENOVATIONS

During LS1, vacuum control systems of PS & AD will be renovated, propagating the PLC/PVSS architecture, bringing the hardware & software to the level of the other machines, and thus enforcing standardization

TPG300 for Pirani/Penning (**VGR/P**), simply have their communication card replaced from RS232 to Profibus

Old custom controllers for Bayard-Alpert (**VGI**) cannot be upgraded ; replaced by modern Volotek, with Profibus interface

Outdated pumping-group (**VPG**) controllers will be eliminated or replaced by standard models, in AD

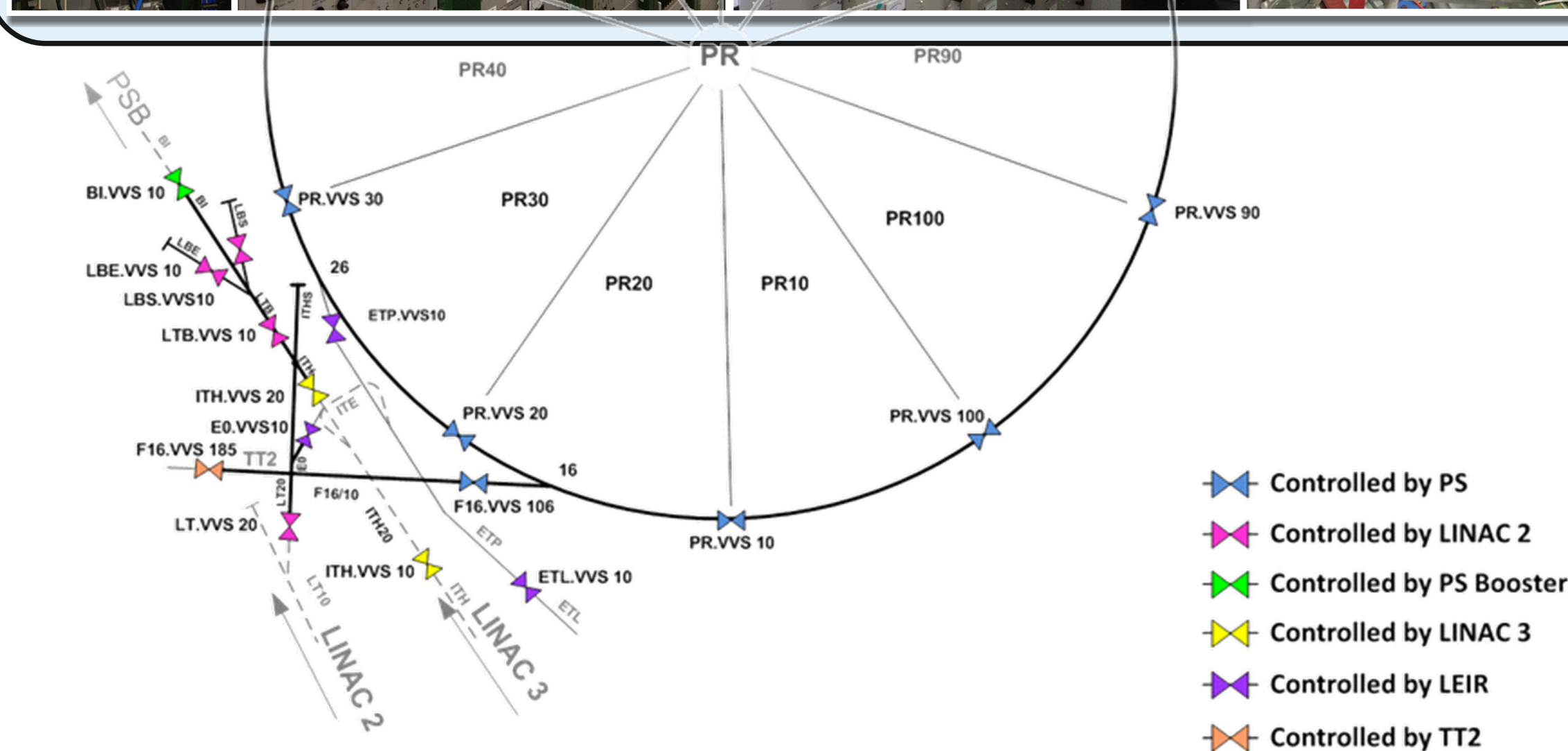
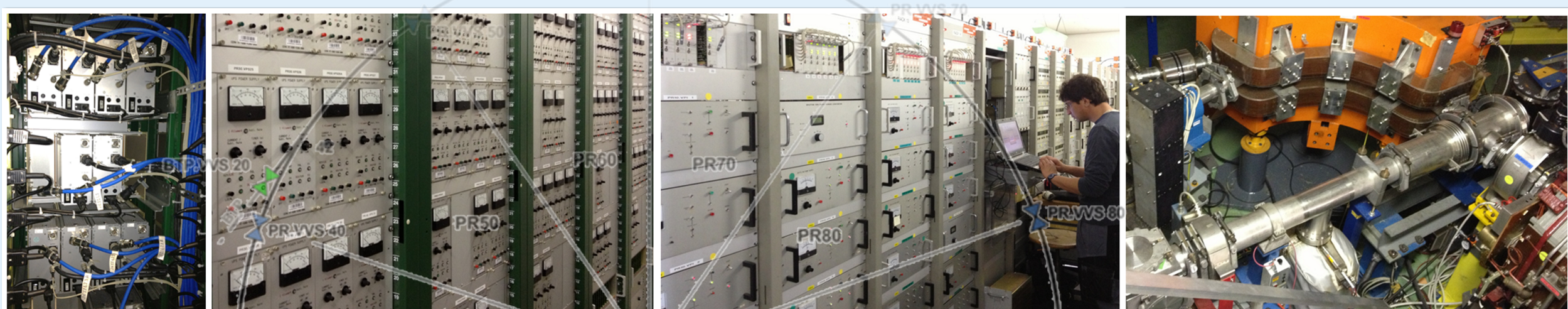
Profibus will be available for the mobile groups, along the AD ring ; in the PS there will be no renovation of VPG

Old ion-pump (**VPI**) controllers will be replaced by recent ones, accessed over standard remote-IO stations

Sublimation-pump (**VPS**) controllers will be kept, now connected through newly-designed remote-IO stations

Idem for the cryogenic-pumps (**VPC**)

Valve (**VVS**) controllers will be upgraded; controlled directly from the PLC local-IO



ABSTRACT

After 3 years of operation, the LHC entered its first Long Shutdown period (LS1) in early 2013. Major consolidation and maintenance works are being performed across the whole CERN's accelerator chain, in order to prepare the LHC to restart at higher energy, in 2015. The injector chain shall resume earlier, in mid-14.

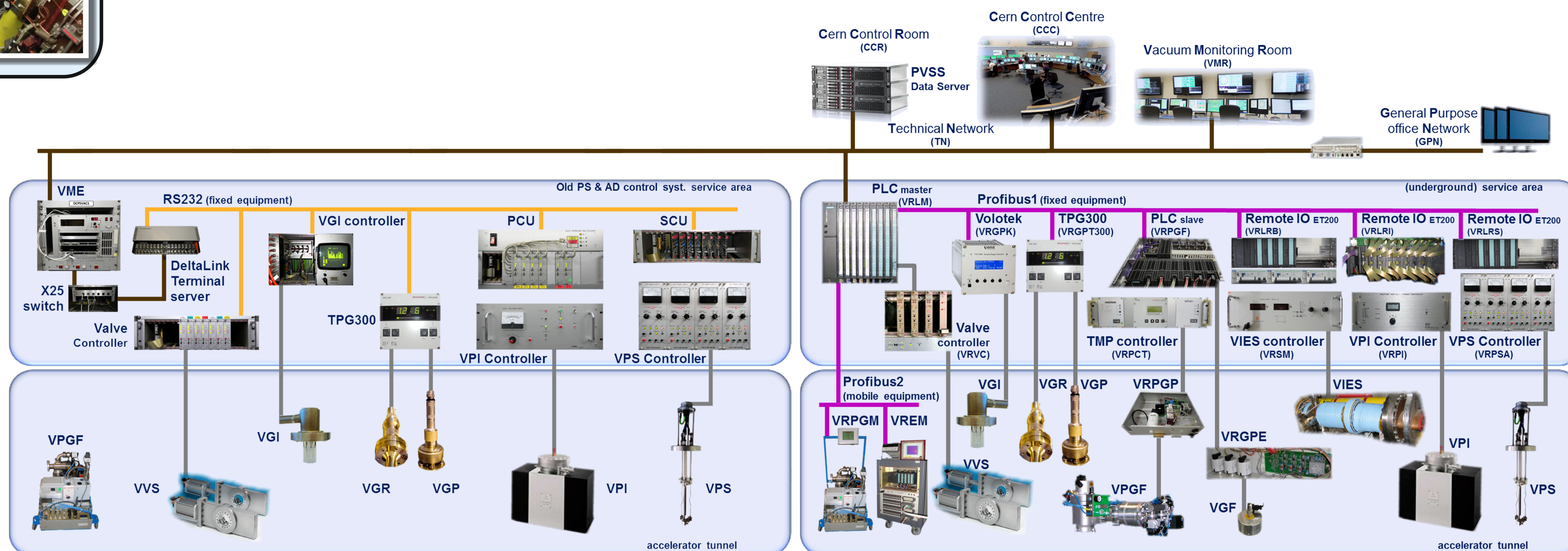
We report about the on-going vacuum-controls projects. Some of them concern the renovation of the controls of certain machines; others are associated with the consolidations of the vacuum systems of LHC and its injectors; and a few are completely new installations.

Due to the wide age-span of the existing vacuum installations, there is a mix of design philosophies and of control-equipment generations.

The renovations and the novel projects offer an opportunity to improve the uniformity and efficiency of vacuum controls by:

- reducing the number of equipment versions with similar functionality
- identifying, naming, labeling, and documenting all pieces of equipment
- homogenizing the control architectures, while converging to a common software framework

	VGR/P	VGI	VPG	VPI	VPS	VPC	VVS	TOT
PS	86			156	117		13	372
AD	72	19	16	65	100	6	15	293



SPS CONSOLIDATIONS

New ARC sectorization : Each of the 6 ARCs has only 2 long vacuum sectors (400m). To reduce pumping time, sectors will be split : 12 new sectors.

Due to budgetary & manpower limitations : no installation of cables or instruments during LS1.

Control racks are being prepared in advance :

- new controllers installed
- racks and internal cables re-arranged by vacuum sector

TT10 consolidation : instruments renovated in the injection line:

- VGR/P and VVS already had modern controllers
- VPI will have new cables and new standard controllers
- The 4 racks will be re-arranged by vacuum sector

Racks re-organization : Successive addition of equipment along the years : topology needs attention.

Start with racks already concerned by current activities: ARCs (6x4) and TT10 (4).

BA5 : all 15 racks and their internal cabling will be organized by sector prototype for evaluating feasibility & effort for the rest of SPS.

Controllers will be better recognizable and accessible.

Slots reserved for expansion without breaking the order.

BA1 : new sectors around a Kicker and a Dump, isolating them from leaks in the vicinity.

BA5 : two (ghost) VVS will be integrated in the control system, creating 2 new sectors.

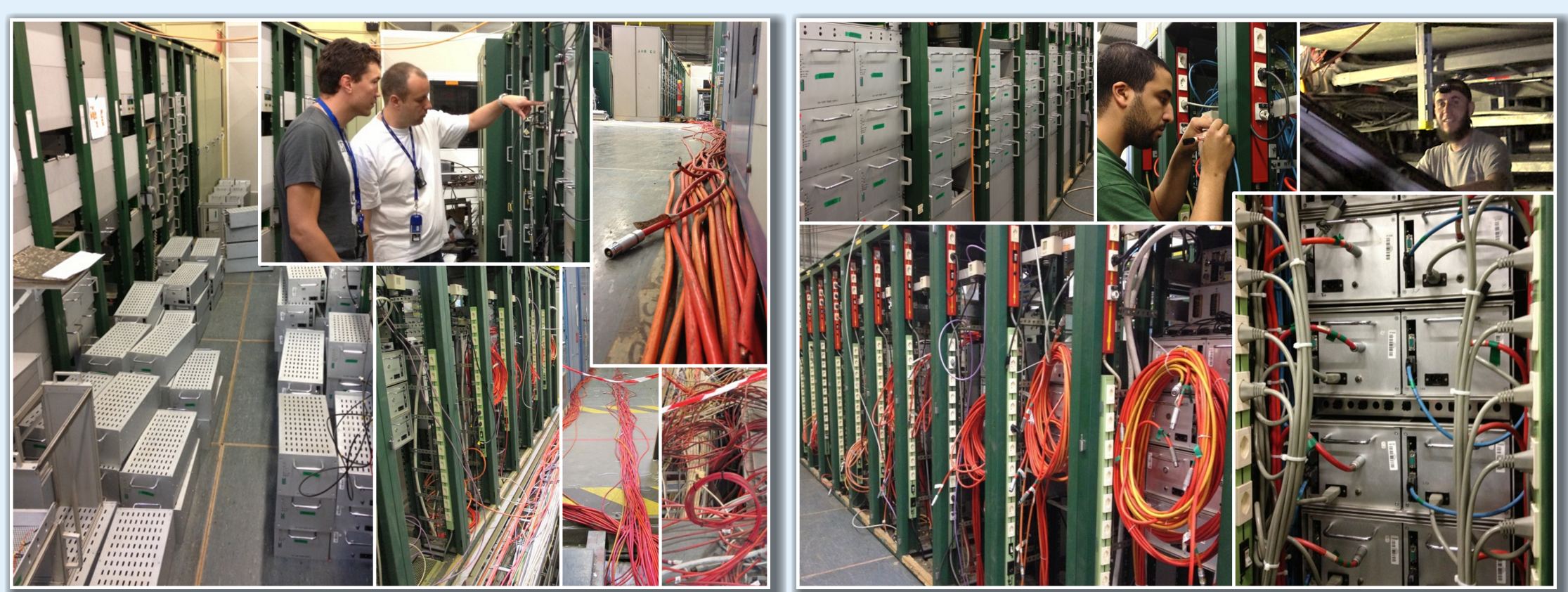
BA5 : new VGR/P to assess the performance of Carbon coating on beam pipe in magnets.

Damaged Cables : Radiation progressively degrades cables characteristics, eventually destroying them.

TS1+ , TDC2/TCC2 : Campaign of cyclic renovation of all the cables.

TS1- : problems steadily increasing - all cables will be replaced; patch-panel rack in tunnel.

TT20 : only damaged cables replaced.



CPS CONSOLIDATIONS

LINAC2 : The first 3 VPG had already been upgraded for Profibus; the remaining 6 will now become remotely accessible.

PS Booster : Renovated a few years ago, the Booster will now have its 43 VPS remotely controlled, like PS & AD.

TLs : All devices are presently controlled from LINAC2, PS or PSB : When LINAC4 will replace LINAC2, all controls will be concentrated on PSB. Technically possible in LS1, this was postponed.

Profibus for mobile : In LEIR new Profibus for mobile bake-out ; in PS, PSB, and TLs postponed due to budgetary constraints.



	New Instruments	New Cables	Damaged Cables
PS	372	365	21
AD	293	29	
CPS other	49	6	3
SPS	74	229	276
LHC	392	562	8
R2E LHC		480	
HIE-ISL	132	390	
L4	142	350	
NA62	102	200	
nTOF	19	60	
TOTAL	1 575	2 671	308

LHC CONSOLIDATIONS

570 new control cables for all consolidations.

NEG cartridges to increase pumping speed on Inner Triplets, Stand Alone Magnets, etc.

NEG pilot-sectors and electron-cloud diagnosis.

Remotely monitored thermocouples near the collimators (IP3, IP7).

Pumping groups

75 old VPGM upgraded, for extra pumping capacity during LS1.

16 additional VPGF, for redundancy at each extremity of the QRL.

New software for VPGF, with state machine, auto-restart & auto-venting.

Bypass valves

In the ARCs, a magnet insulation sector must be able to use the pumping of its neighbour: finish installation & integration in controls of valves by-passing the vacuum barriers.

New interlocks

Sector valves at the ARC extremities will trigger on a pressure rise on Q12/Q13, instead of Q7.

Re-organization of VPI interlocks in IP3 & IP7 : postponed.

Mobile equipment

New bake-out controller racks (20+25), with additional functionalities [1].

Limited number of predefined Profibus addresses : may need redistribution.

Temporary connections of mobile devices don't always respect the basic rules :

- consolidation of the network with fixed connection boxes to avoid star-points.

R2E

Radiation from accelerator systems may perturb or damage standard electronics.

All vacuum control equipment in UJ76 will be moved into a safe zone.

27 racks relocated; 282 cables extended from 300 to 500 m.

Special care with cable handling, routing and connection.

Active gauges in ARCs have local electronics, subject to radiation irradiation tests being prepared.

NEW PROJECTS

HIE-ISOLDE (2014-18) : like ISOLDE before, its extension will also be based on UNICOS framework. The main challenge will be the cryogenic modules, where beam & insulation vacuums are merged.

LINAC4 (2013-15) : the new linear accelerator, at the start of the injector chain, will have same control architecture as LHC, with specific developments as gas-injection for the source.

NA62 (2014) : renovation of the experimental line and detectors, to integrate in the SPS control system. Mix of turbo-molecular pumps & large cryogenic-pumps, for very wide beam pipes & detector chambers.

nTOF (2014) : renovation of the experimental line, to integrate in the CPS control system.



QUALITY MANAGEMENT [2]

A QM Plan is progressively being put into place ; methods & tools :

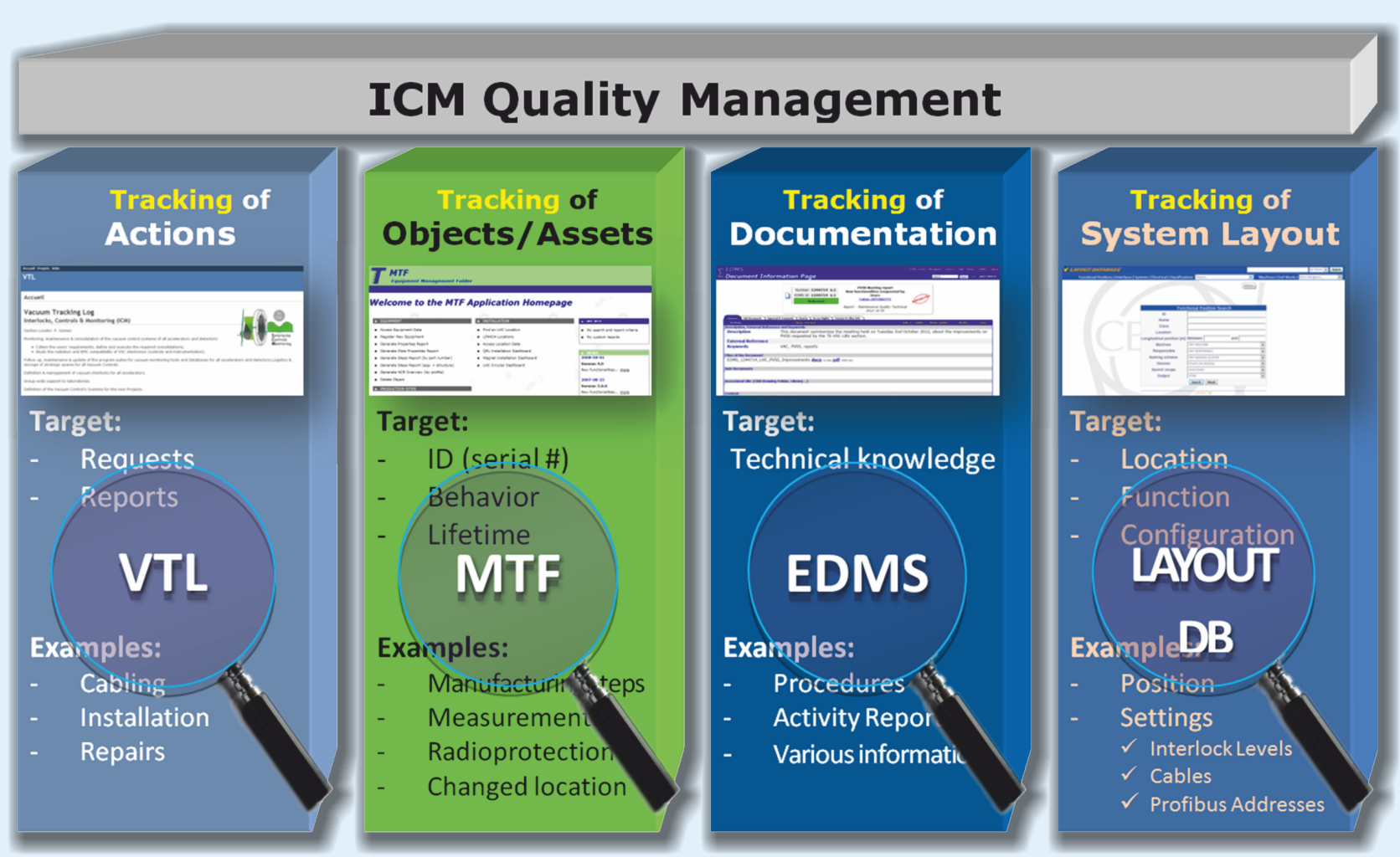
Naming : rules for coding equipment names, independently of machine.

VTL : track problems, requests, repairs, and other actions.

MTF : assign a unique "part-identifier" to each individual device; trace history.

EDMS : centralise information on architectures, procedures & settings.

Layout-DB : describe topology of control components.



SCADA DEVELOPMENTS [3]

SCADA applications for vacuum have been under significant evolution, regarding their ergonomics, configurability and standardization :

- simplified and normalized presentation of information
- coherent functionalities & menus, across all machines
- automatic scripts, instead of fastidious manual actions
- enhanced tools, for data analysis and interventions

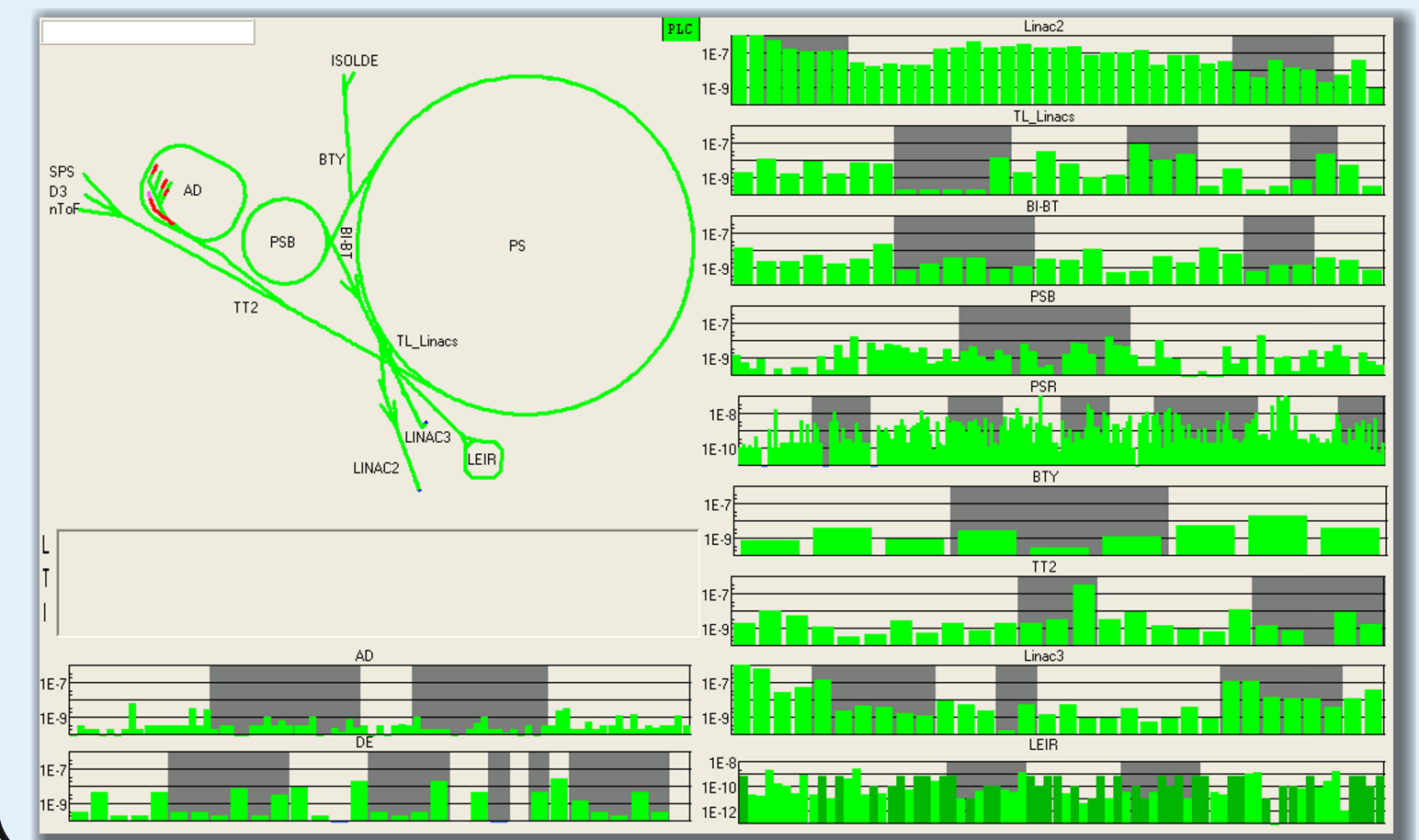
New features:

Warnings : predefined, with importable user configuration.

Archiving : smoothing automatically selected + auto-stop & restart.

Versions : ActiveX - QT, V3.6 - 3.8, Win - Linux.

UNICOS convergence : develop new libraries tailored for vacuum.



CONCLUSION

A large amount of maintenance, consolidation, renovation & optimization works is being performed on the vacuum control systems, during LS1. Overall, this involves controllers for more than 1 500 instruments, modified or manufactured, and then tested, installed & commissioned. The installation of some 3 000 new cables had to be defined and later followed, tested & connected. One major challenge will be to have all machines re-commissioned in time for restarting the LHC and injectors, ready for operation up to 14 TeV.

REFERENCES [1] ICALEPCS13 Poster: MOPPC026, S. Blanchard et al., "Bake-out Mobile Controls for Large Vacuum Systems"
[2] ICALEPCS13 Poster: TUPPC027, F. Antoniotti et al., "Quality Management of CERN Vacuum Controls"
[3] ICALEPCS13 Poster: MOPPC030, F. Antoniotti et al., "Developments on the SCADA of CERN Accelerators"

