THE LINAC4 VACUUM CONTROL SYSTEM

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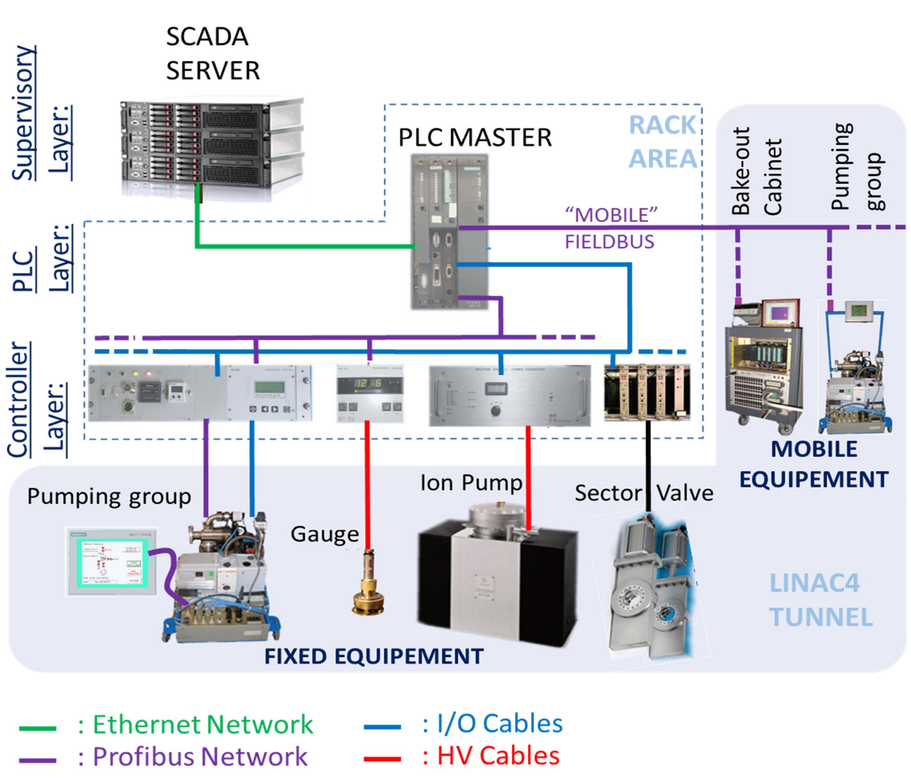
ICALEPCS2017
Barcelona · Spain, October 8-13
Palau de Congressos de Catalunya
www.icalepcs2017.org

October 12, 2017
Paper ID: THPHA056

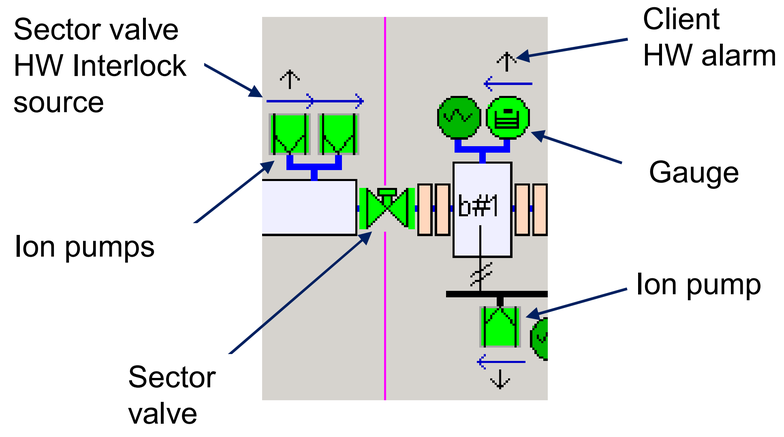
Abstract

Linac4 is 160 MeV H- linear accelerator replacing Linac2 as the first injector to the CERN accelerator complex, that culminates with the Large Hadron Collider. This new linac will increase the beam brightness by a factor of two. The vacuum installation consists of 235 remotely controlled pumps, valves and gauges. These instruments are either controlled individually or driven by pumping stations and gas injection processes. Valves and pumps are interlocked according to gauge pressure levels and pump statuses. The vacuum control system communicates with the beam interlock system, the ion source electronics and the Radio Frequency control system, through cabled digital and analog signals. The vacuum control system is based on commercial Programmable Logical Controllers (Siemens PLCs) and a Supervisory Control And Data Acquisition application (Siemens SCADA: WINCC OA). This paper describes the control architecture and process, and reports on the control requirements and the implemented solutions.

Vacuum Control Hardware Architecture

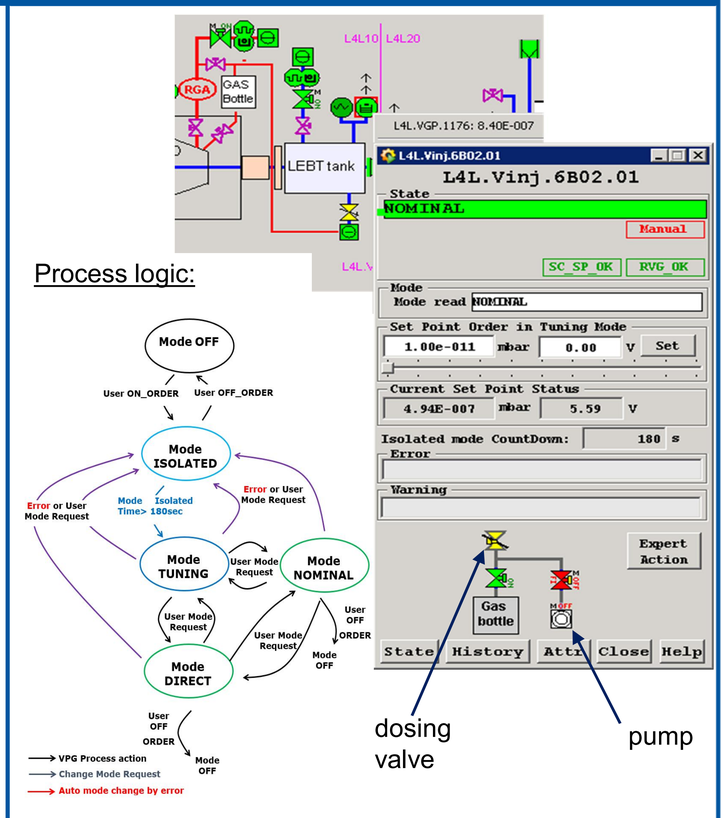


Hardware Interlocks

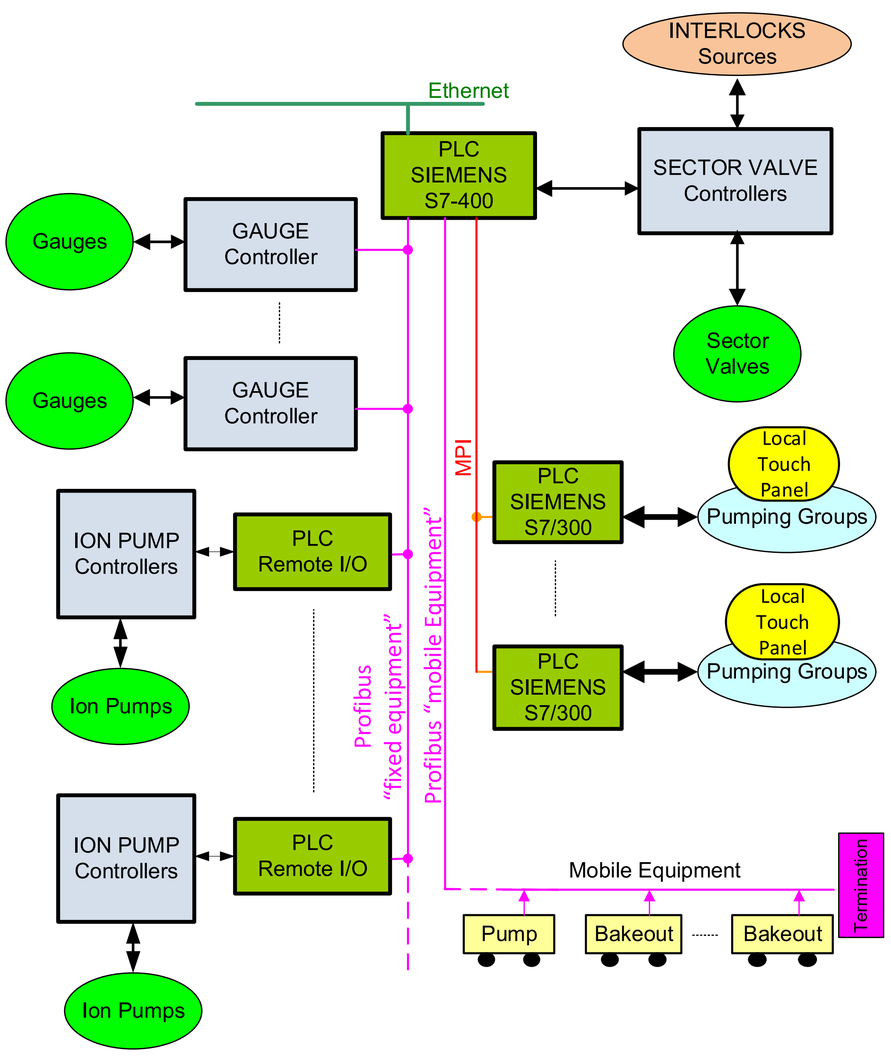


Vacuum controls of Linac4 have a hardware interlock system to prevent pressure increase propagation and to protect beam instruments. Sector valve crates are connected to the Beam Interlock System, in case of sector valve closed the beam is stopped. The sector valves are interlocked by relays of both gauge controllers and ion pump power supply units. The ion pumps are preferred because they are less sensitive to pressure spikes and so reduce the number of not relevant beam stop.

Gas injection System

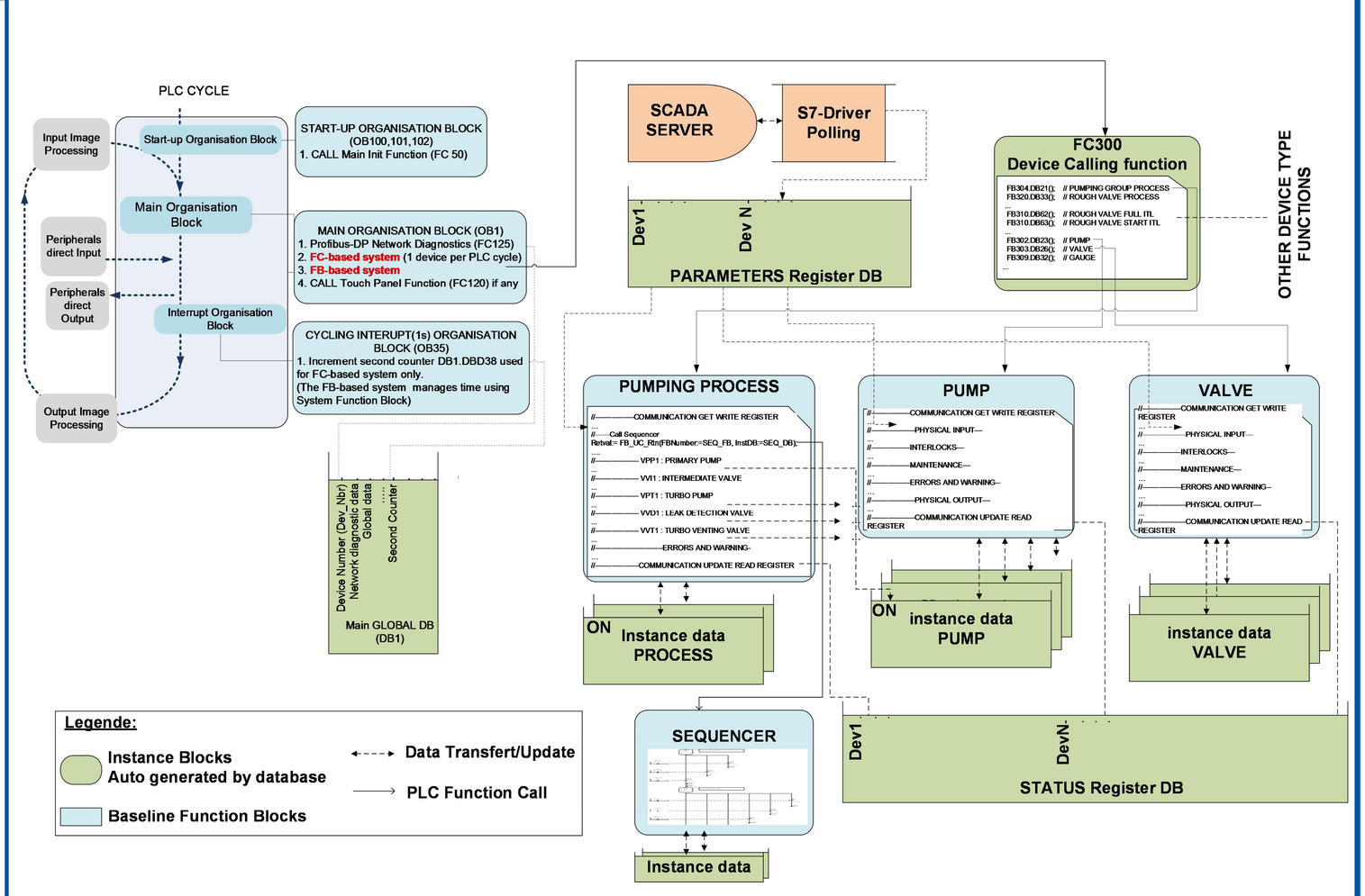


Automation/PLC Layer



The main PLC is a Siemens S7-400, it controls beam line gauges, sector valves and HV pumps. The main PLC owns remote I/O station installed close to I/O interfaced controllers to reduce cabling cost and use standard remote I/O crates. The control of fixed pumping groups, gas injection system and mobile equipment is delegated to slave PLC.

PLC Software



The automation software has been developed for the LHC and its injectors. It has been updated for the Linac4 but the architecture remains the same. PLC software started to be developed using Statement List Siemens (STL) language and functions without instantiation (FC-based System). Then new instruments and new specifications were required, from 2011, new functions have been developed using Structured Text (SCL) language and device oriented Function Block (FB-based System).

Conclusion

The Linac4 is not yet connected to the LHC injectors but the installation of the most critical sectors has been completed. The machine has already run a complete year of beam commissioning without any vacuum controls issues. In autumn 2017 the Linac4 has been integrated in the list of machines monitored and maintained by the vacuum stand-by team enlarging the Linac4 vacuum control users (previously limited to beam operators and Linac4 vacuum experts) to the whole CERN Vacuum group. This smooth transition demonstrated the user friendliness of the vacuum control system.

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ICALEPCS17, October, 2017

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