



Helium Cryoplant Off-line Commissioning and Operator Training: two Applications of the PROCOS Simulation System at CERN

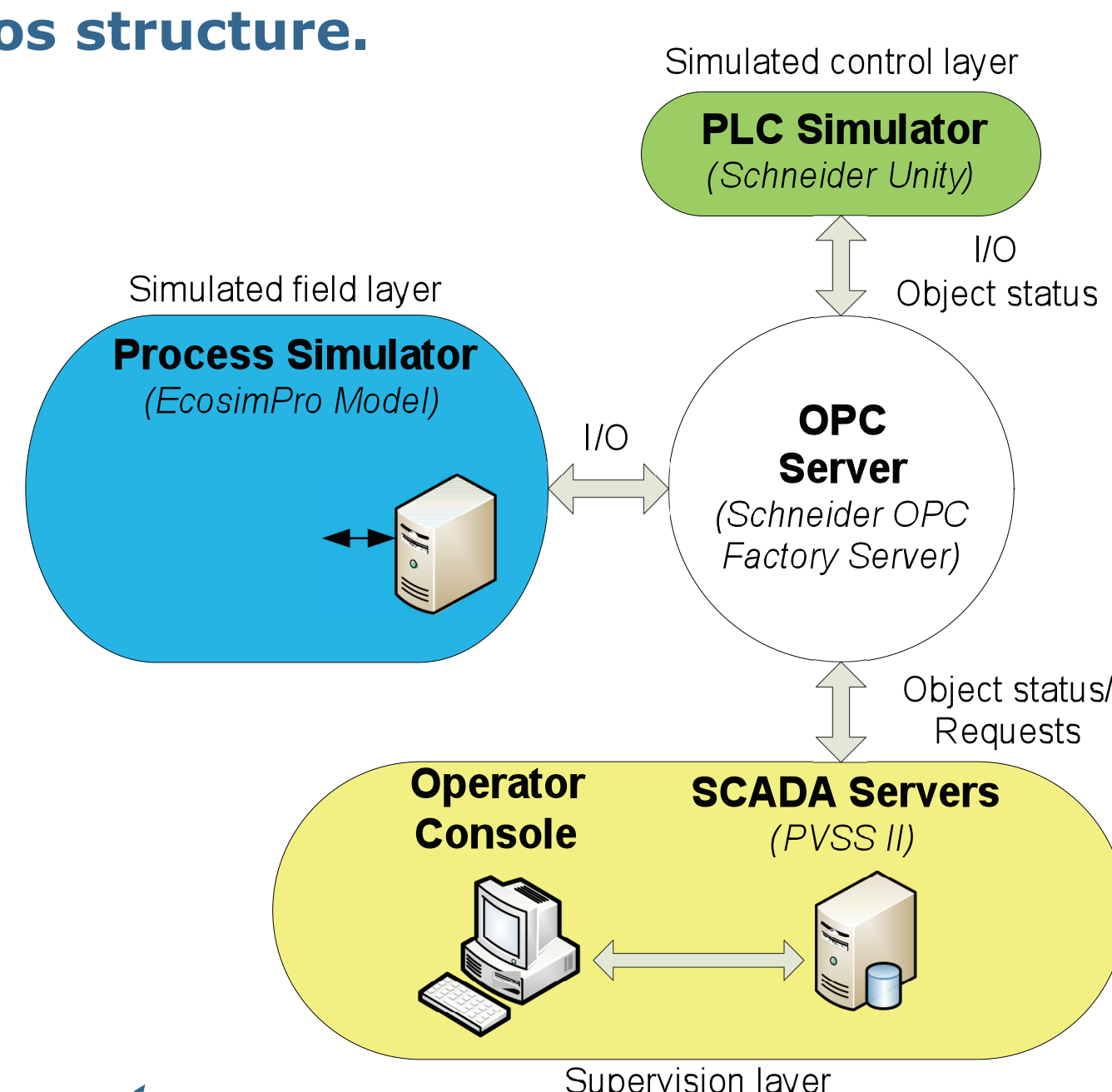
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Objectives

The off-line commissioning step, through reliable simulation of physical models, aims to correct and validate control systems before their implementation into real equipments. It prepares and minimizes plant commissioning phase and at the same time validates the efficiency of the new process control logic. This paper describes how different CERN/ UNICOS cryogenic control systems have been pre-commissioned off-line, using the CERN cryogenic simulation environment PROCOS.

VIRTUAL COMMISSIONING EXPERIENCE

Fig.1. The ProCos structure.



UNICOS standard uses typical three-layer control architecture (field, control and supervision layers) and the same architecture is used in simulation using PROCOS, see Fig. 1 where the PROCOS architecture is described. The PLCs are replaced by PLC simulators which are software provided by PLC manufacturers and the supervision system (SCADA) remains the same. All variables are exchanged through an OPC server also provided by PLC manufacturers. Thus, all variables have to be mapped differently inside PLCs and SCADA. Fortunately, UNICOS is based on code generators (for PLC and SCADA) allowing us to generate automatically all modifications in an efficient and fast way.

Helium compressor set

Hence the compressor start-up sequence and the high and low pressure control have been verified and adjusted. This step allows us to detect wrong variable connections and wrong ranges of some sensors.

Refrigerator helium flow circuit & turbines circuit

The control logic of the bypass valve in the J-T circuit has been tested with different configurations and the best solution has been chosen in order to achieve a better cool down speed of the system. Moreover the inlet and return valves of the phase separator have been adjusted in order to avoid, in a start up situation, abnormal oscillations caused by the warm helium contained in a close circuit between the client dewar and the cold box.

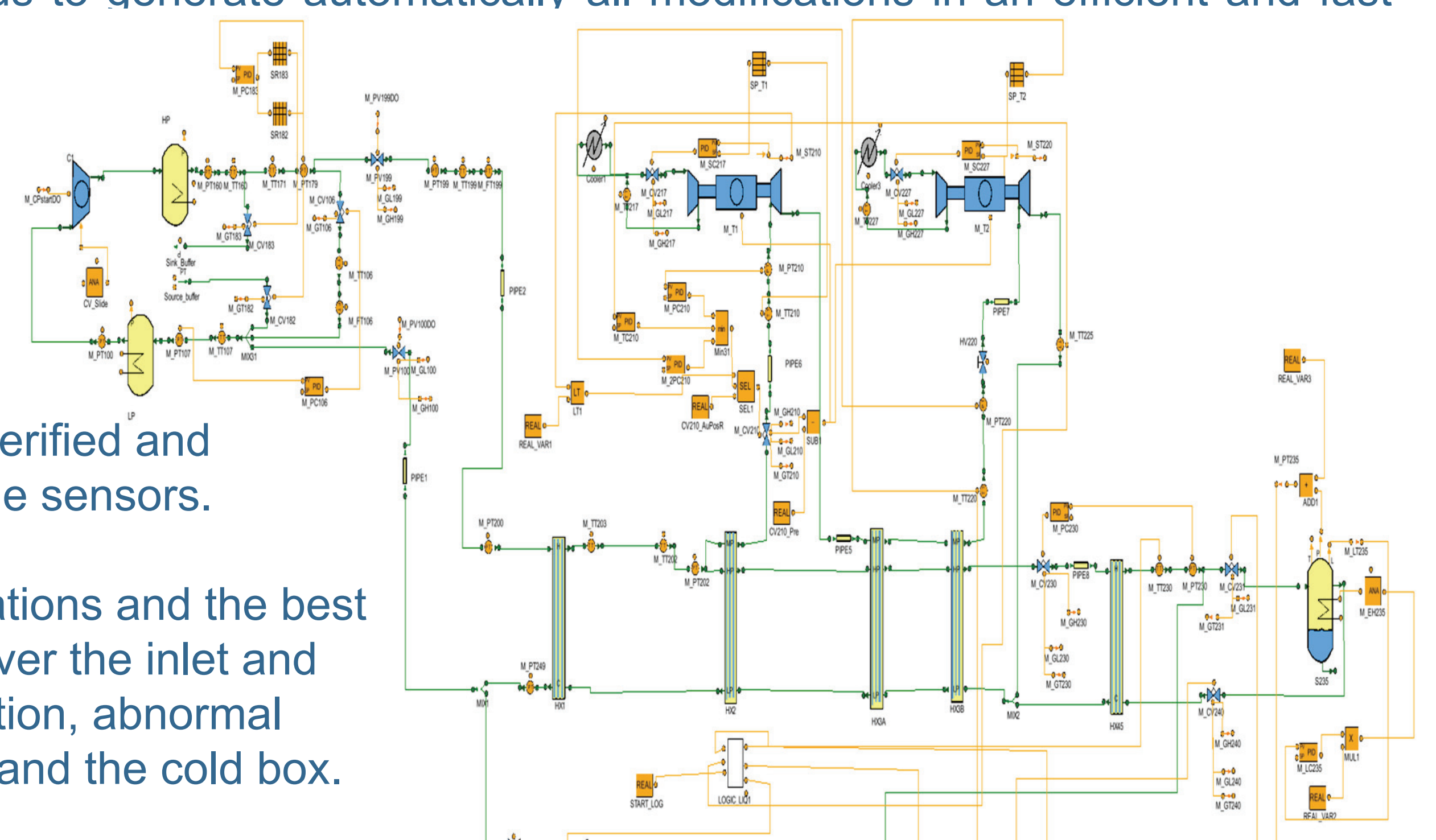


Fig.3. Timeline of VCP operation.

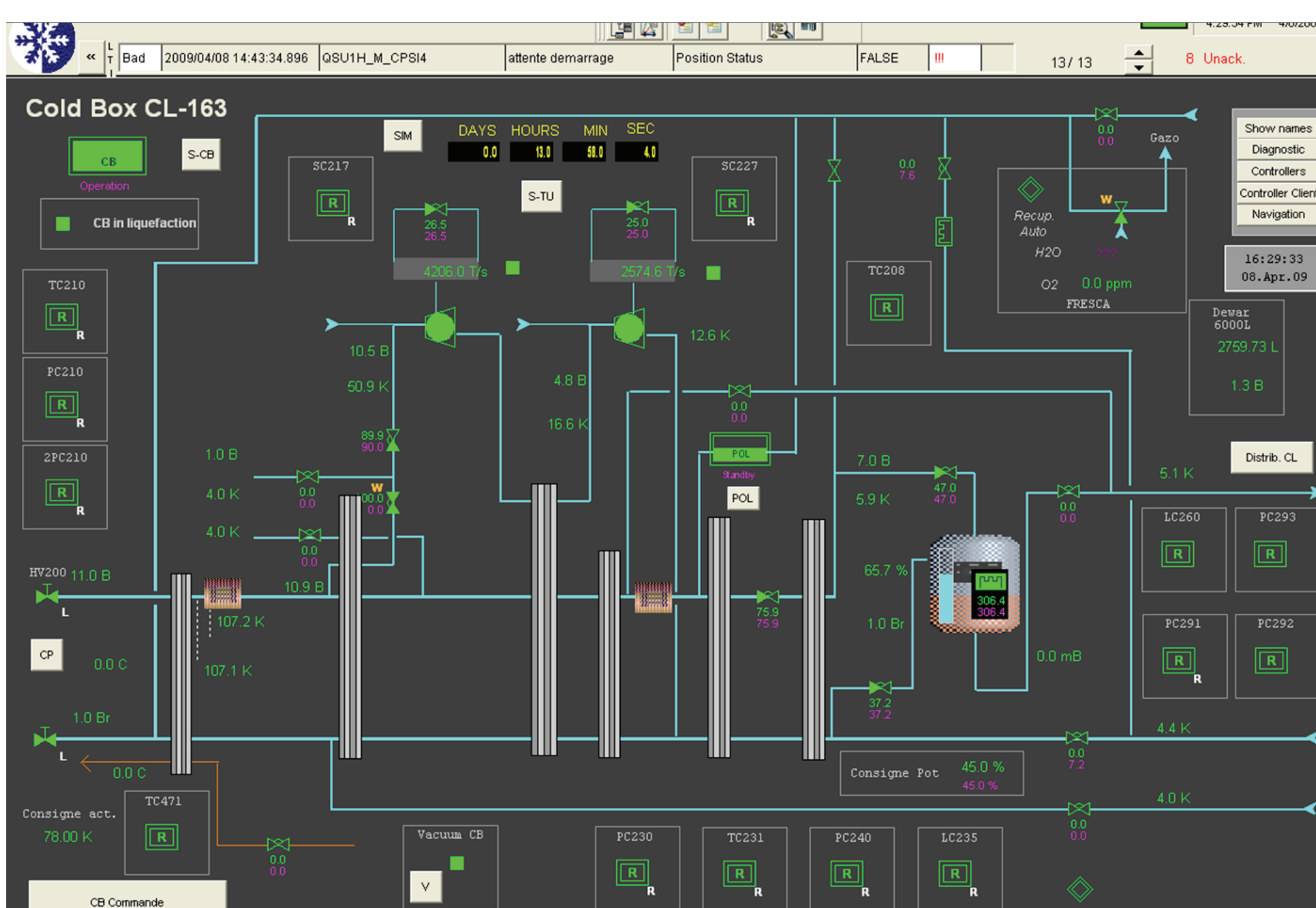


Fig.2. Refrigerator synoptic under PVSS-ETM@.

Familiarity within the UNICOS control framework

The UNICOS framework HMI interacts with operators by mean of widgets and dedicated panels called faceplates. The virtual operator training finds his best utilities when new technical personnel join the operation team and needs an appropriate and intensive training period for a global discovery of the operation tool.

Training in the critical cryogenic scenarios

PROCOS embeds different useful features for operator training such as the possibility to perform real-time or accelerated simulations and to run, freeze, save and restore predefined process states.

It can also introduce malfunctions in order to trail the operator skills. For example, critical interlocks can be generated such as a turbine failure in order to evaluate operator reactions.

Perspectives

The work herein presented has two main contributions: an optimized procedure for virtual commissioning of large-scale cryogenic processes and a starting project for setting up an operator training station.

CERN experience has shown that a control system which has been virtually commissioned with the PROCOS environment shows a high efficiency in the global context and needs only insignificant logic modifications during the real commissioning.

It will be useful to improve software tools in order to render the modeling step easier and faster. Off line commissioning is used only when the time constraint for a complete refurbishing of the control system is the critical factor.

The first results show that the virtual cryogenic operator training is an efficient and pedagogic tool. It allows operators to be trained on the most critical phases of real cryogenic processes. It can also serve as an efficient HMI UNICOS framework guide allowing cryogenic operators to become familiar within a short training period.