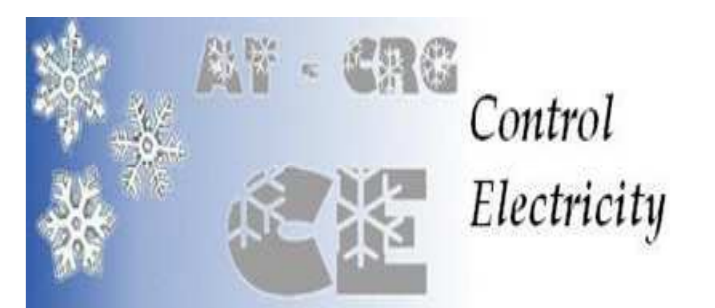




Conversion of the ABB control system for the Cryolab Central Liquefier with a =S= PREMIUM UNICOS PLC

Accelerator Technologies Department – Cryogenics Group
Control and Electricity



Central liquefier of Cryolab

Objectives and Main Challenges



Central liquefier of CERN Cryolab has to produce liquide Helium for small experiments at CERN during all year.

The Cold Box produces 260 000 Litre of liquid Helium per Year with 70g/s flow and 3 LHe distribution lines.

The main challenge is to upgrade the control system and the electrical distribution in a minimum time and guarantee a maximum efficiency for liquid Helium production.

Budget and Planning

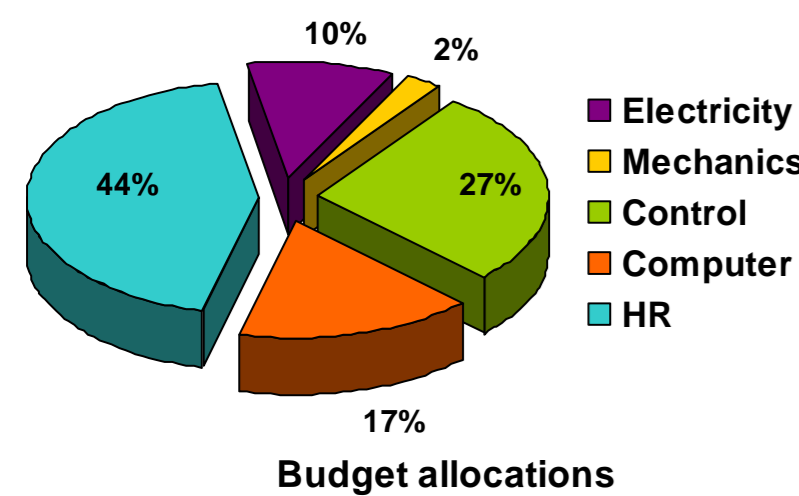
The project was spread out between September, 2007 and February, 2008. The date of conversion was settled according to the shutdown availability of the ColdBox by the Operation team.

The conversion was made during September, 2007, during the annual shutdown of the installation.

The duration of the installation shutdown was reduced to the minimum thanks to the use of the ColdBox simulator.

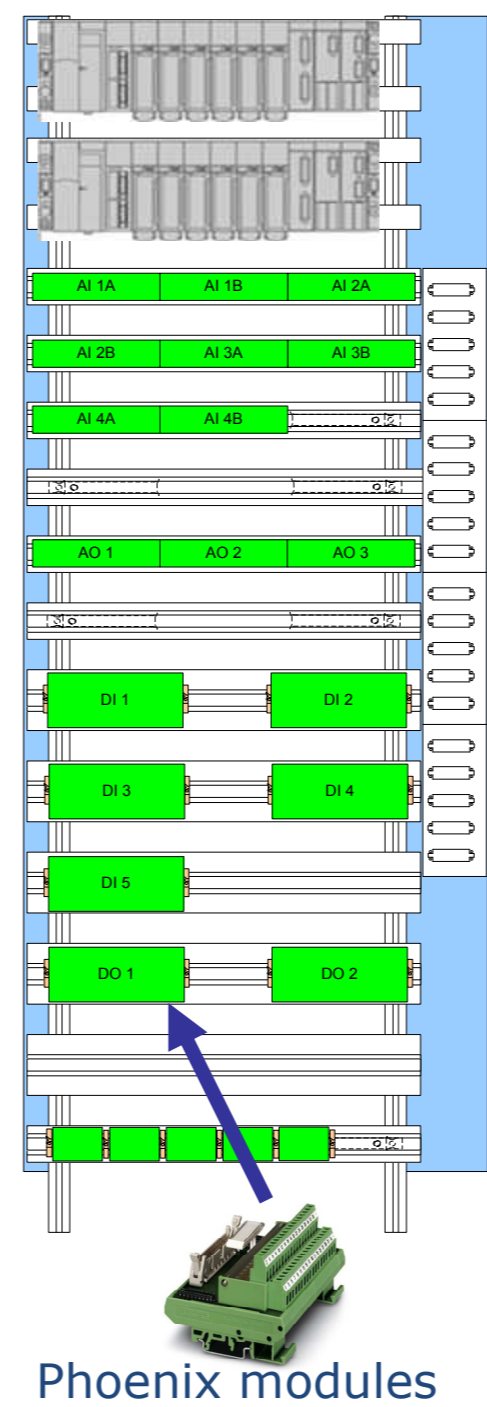
Only one week has been necessary to change the PLC mechanically and electrically.

ID	Task Name	Start	Finish	Duration	2007	2008
1	Analysis	03/09/2007	14/09/2007	2w	■	
2	Technical study	10/09/2007	28/09/2007	3w	■	
3	Mechanical construction of electrical cupboard	01/10/2007	26/10/2007	4w	■	
4	ABB logue extraction	24/09/2007	09/11/2007	7w	■	
5	Disassemble UNICOS production	01/10/2007	19/10/2007	3w	■	
6	UNICOS Logic specification production	15/10/2007	23/11/2007	6w	■	
7	Unity software production	19/11/2007	07/12/2007	3w		■
8	PVSS synoptics production	22/11/2007	16/12/2007	4w		■
9	ColdBox Simulator production	12/11/2007	30/11/2007	3w		■
10	Task of the logic with CB simulator	03/12/2007	25/01/2008	8w		■
11	Installation and commissioning	28/01/2008	01/02/2008	1w		■
12	PLC logic test	04/02/2008	15/02/2008	2w		■
13	Documentation	18/02/2008	07/03/2008	3w		■



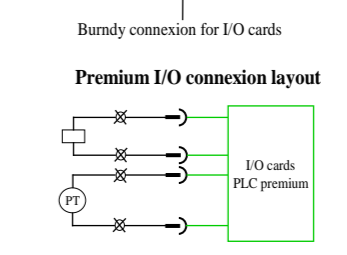
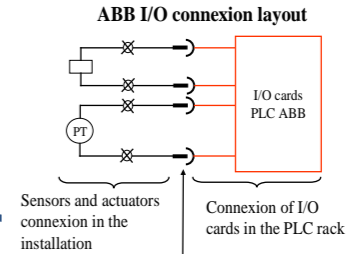
The upgrade budget is around 100K CHF with the costs of full-time project associate, cryogenic engineer and electricians.

Hardware modifications



Phoenix modules

The compatibility of the Input and Output cards of the new PREMIUM PLC with the old ABB PLC was analyzed and tested before the upgrade. So no major modification was brought to the installation. The connection system for sensors and actuators by Burndy plugs was kept. This allowed the early preparation for the cabling of the I/O cards and to decrease the time of reconnection of the installation with the pre-cabling modules. Finally the hardware modifications takes only 1 week.



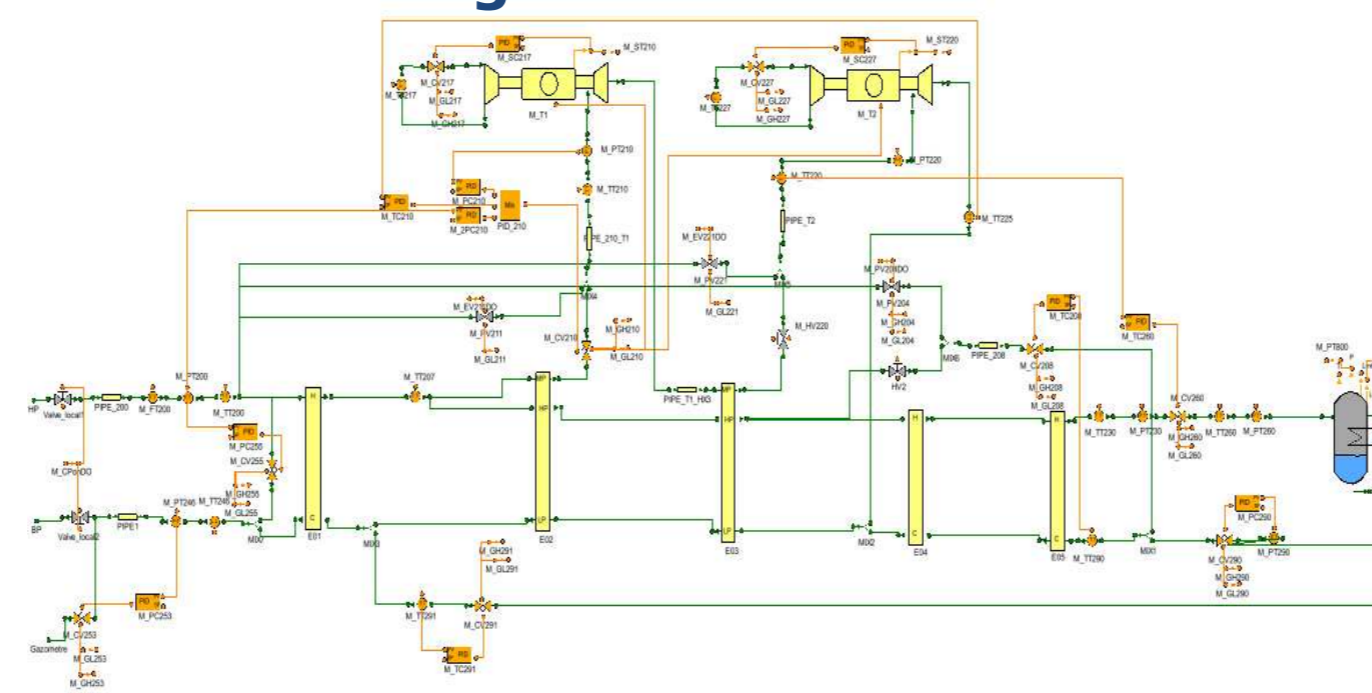
The 220V and 24V distribution made by special frames were replaced by new frames with the same features to comply with the new electric standards.

Virtual commissioning with cryogenic simulator

To reduce the commissioning time of the PLC program during the migration, we used a cryogenic simulator of Cold Box developed by AB/CO/IS to test virtually the logic. Numerous corrections were able to be made in the program without the risk of damaging the installation.

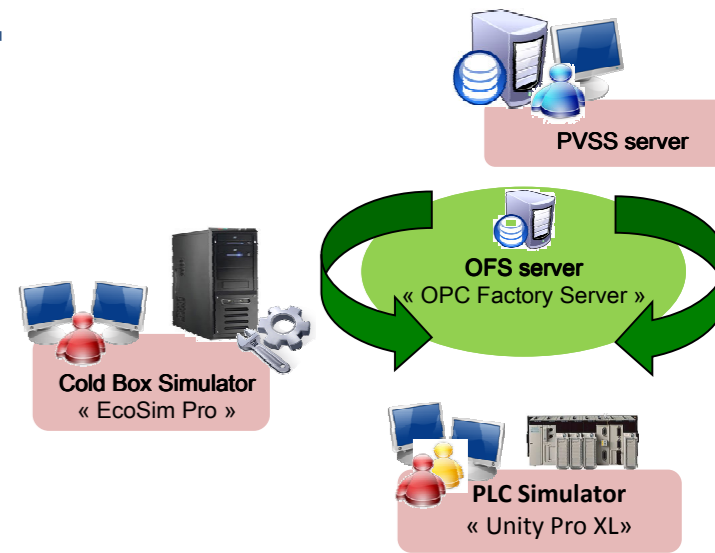
The supervision for the simulator is the same as the installation supervision. The communication between PVSS and PLC is made by OPC communication instead of Modbus communication.

The simulator can be also used for the operation training of the installations or for new methods of regulation tests.



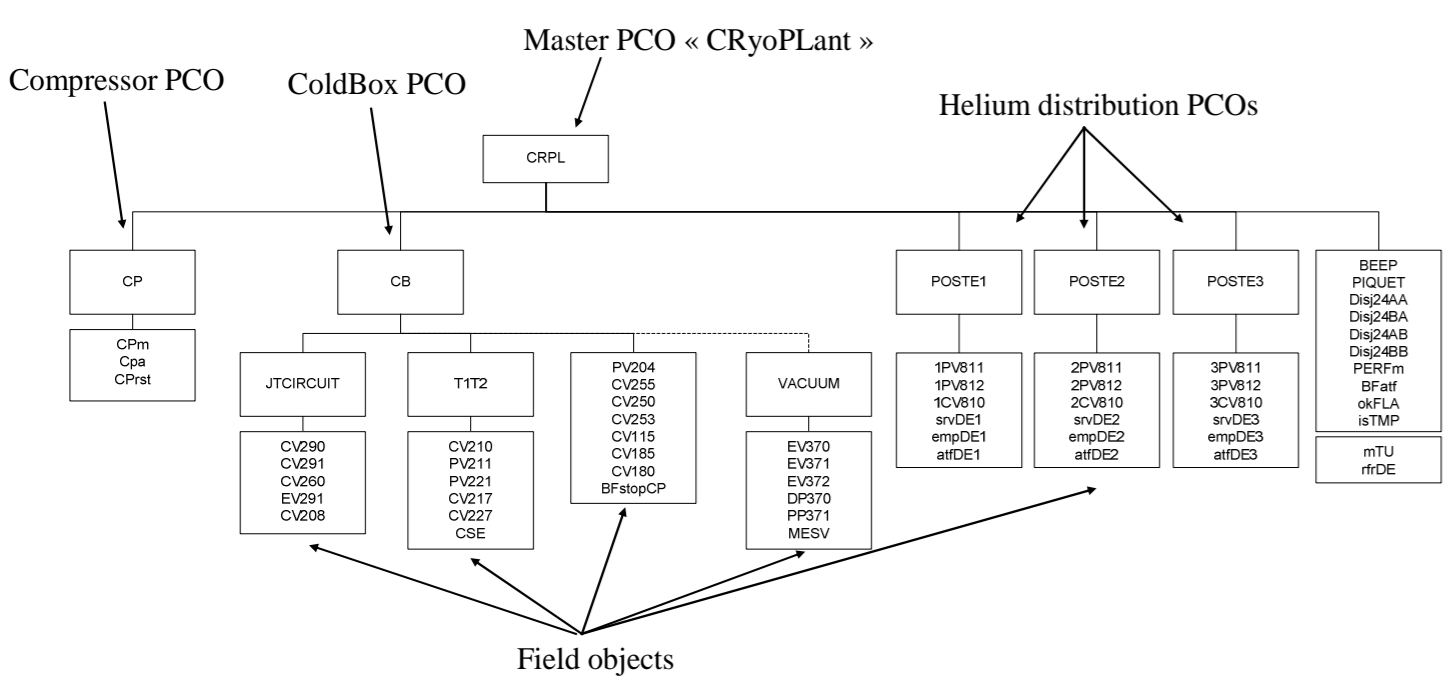
The computing architecture to realize the simulation consists of 3 powerful computers:

- A PVSS datserver with OFS server;
- A CB simulator with EcoSim Pro;
- A PLC simulator with Unity.

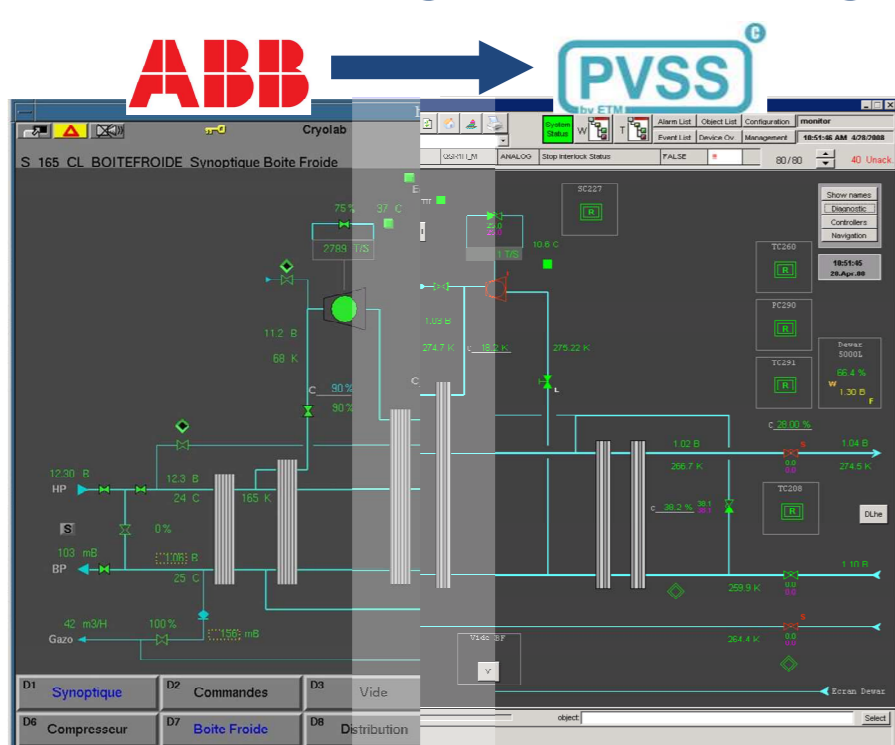


UNICOS control system application

Modular Process Control Objects respects the hardware structure cutout of the installation for easiest control



- ✓ 9 PCO objects to control all the installation
- ✓ 1 PCO master for the installation and 1 PCO by functional group
- ✓ 312 I/O = 88 Analog I/O + 224 digital I/O



The PLC migration needs to replace the ABB scada system with the CERN standard scada system : PVSS.

To facilitate the migration for the operators, the images of the synoptics were kept in PVSS.

The logic translation in UNICOS collides with the incompatibility between the function programming of ABB and the objects oriented programming of UNICOS. 3 months were necessary to write the UNICOS specification and the Unity program.

During the installation shutdown, the migration of the control system required 3 weeks to return to normal production.

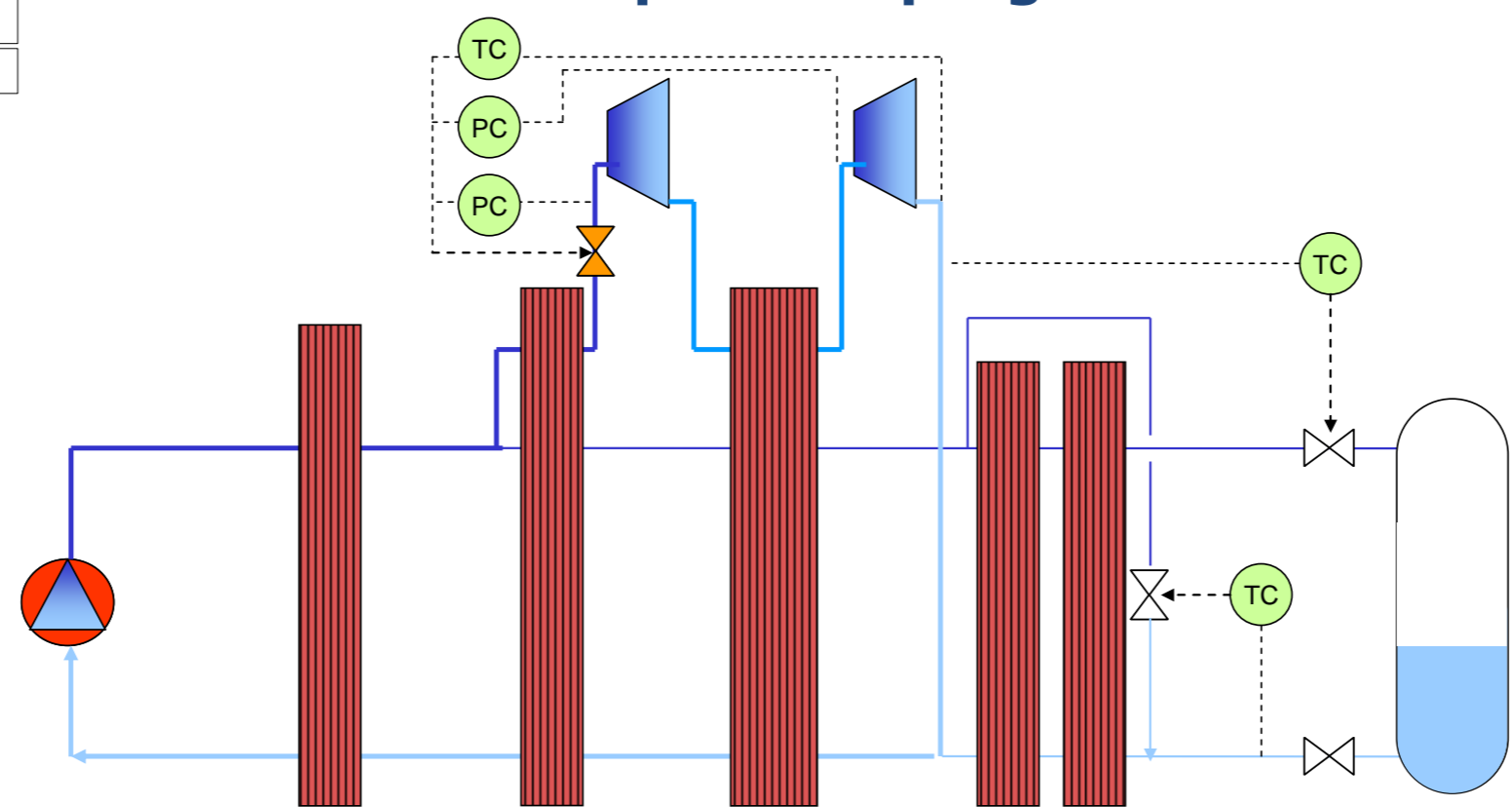
The turbines control, liquide Helium clients distribution and Joule-Thomson valve were the most delicate parts to program because of their multitudes of functioning mode.

The turbines control was modified to guarantee better functioning and higher safety.

The control of the turbines input valve is realized by 3 controllers in parallel. These three controllers regulate the input pressures of turbines and the output temperature of the second turbine.

This new turbines control mode allows a softer starting up.

The brake control has also been improved to avoid overspeeding by optimization of the controllers coefficients of the turbines.



The installation contains 1 tank of 5000 liters and 3 distribution lines of liquid Helium. These lines are controlled by steppers under ABB with a lot of possibilities of step movement. It was necessary to reprogram them completely in the UNICOS standard by taking into account present optimization in the code ABB.

Finally We obtained a program for the installation of the building 165 which uses all the UNICOS features and keeps the optimal features of ABB.

