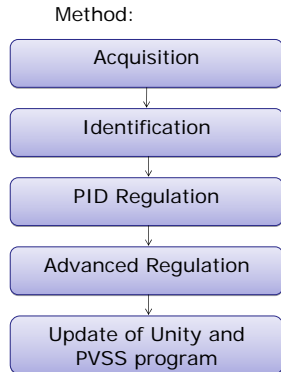
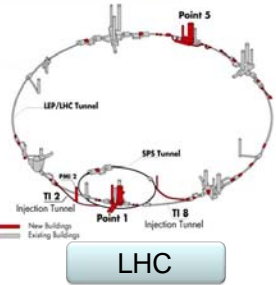




Real time identification and advanced control in the barrels of ATLAS current leads

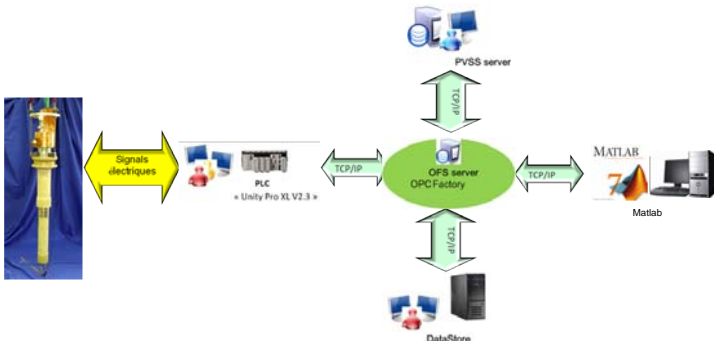


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Each current lead provides 21 kA to the detector ATLAS. Without any cooling system the current lead would melt down. There is a system which cools down the current leads with Helium and it is controlled by a PI. With the value of the current, we know how much He we have to send to the current leads. The problem was the big oscillations of the flow due which the PI doesn't manage to attenuate. We couldn't let a PI controller to regulate the flow with this problem so we decided to use advanced control. Furthermore, we had to identify the system to get a mathematical model which has the same behavior of the real process in order to find the best advanced controller with the best parameters.

Real time Identification



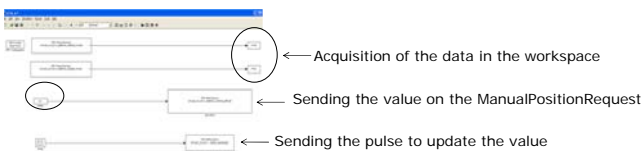
•We collected data from the real process to study how reacts the process when it's stimulated. To do that, we use an innovative and useful method. We sent a SPBA (a binary sequence pseudo random which has the particularity to be rich in frequency so we could identify every system order) to the PLC from Matlab and collected the flow with Matlab and DataStore.

•We used the advantage of Matlab (fast and easy computing) to do the identification in real time instead of computing in a complicated way, a system in Unity or PVSS!

•This architecture is very adaptive, easy and fast to reuse or modify.

•Another advantage is that we don't need to modify the Unity and PVSS programs so we are sure that nothing will degrade them.

Matlab Program used to send the SPBA and collected the data:



Advanced control

Multicontroller

Multicontroller in Unicos:



Constraints:
The multicontroller is included in the generators, it has the same mechanism of the controller (management mode, regulation or positioning mode, limits etc). It respects every constraints of the Unicos standard

Innovation:
It is possible to switch of regulation with only one click and we can save the parameters of the selected regulator to load them late.

Multicontroller in PVSS:

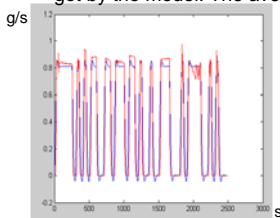


The multicontroller contains six algorithms of regulation :

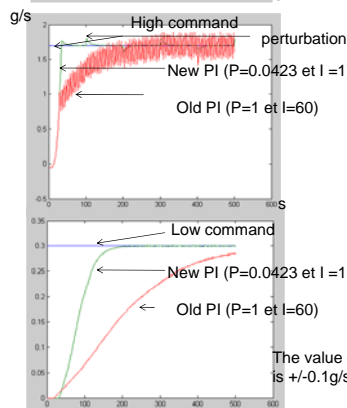
- PID
- Smith Predictor
- SF1 (predictive with first order model and delay)
- IF1 (predictive with first order model integrator)
- DC3 (predictive with third order model and delay)
- PFC (functional generalized predictive)
- RST

Test and Simulation

Above there is the flow measured during the test session and the flow got by the model. The average quadratic error is 0.00169.

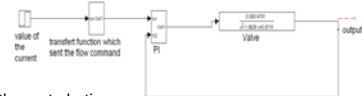


$$\text{The model : } \frac{0.00014791}{z^2 - 1.8628z + 0.8719} z^{-2}$$



This process is a non linear second order with delay so the PID Smith and Predictive Controller should give better performance than the PID

Without and with perturbation, we managed to improve the performance of the PI. The process is better controlled and the oscillations are hugely reduced. But we can get better performance but not with a PID so we think about cascade or/and loop to get a better stability. You can see that the actual parameters work with a low command but are not well tuned for higher command



Current control loop