

### Managing control HMI with artificial intelligence

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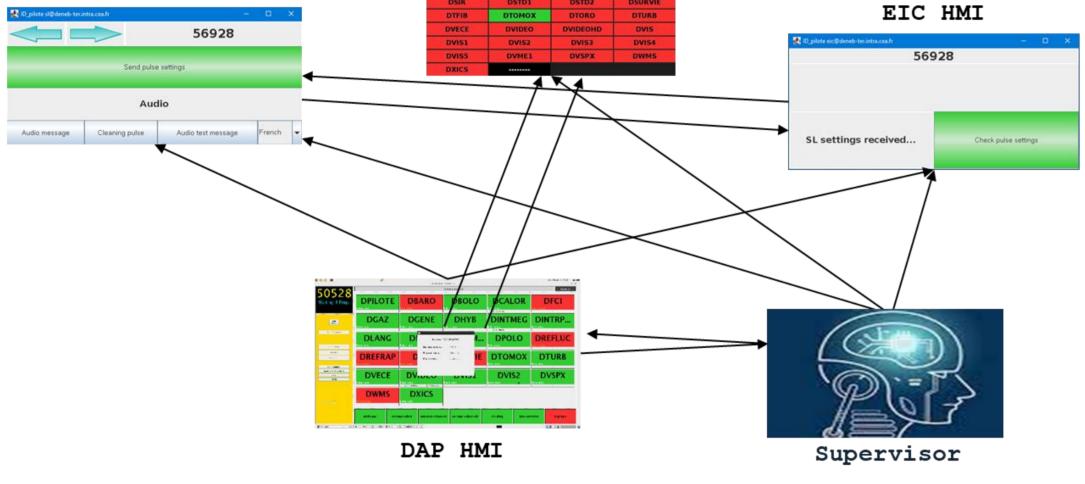
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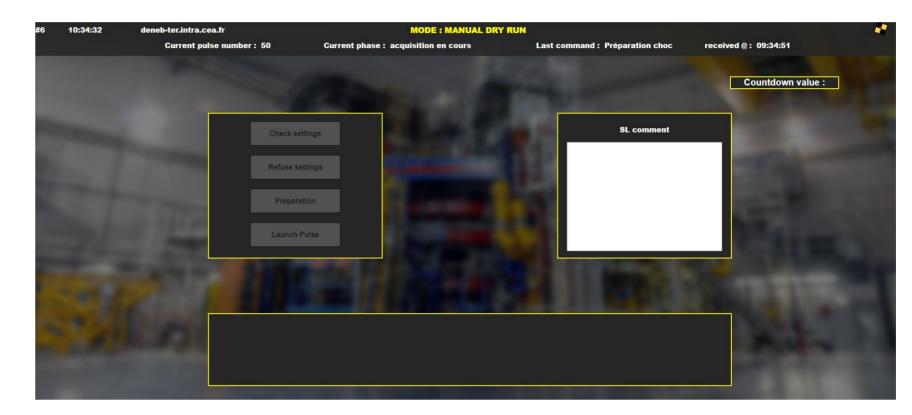
# Introduction

Over the years, the operational teams in charge of WEST operation have separately updated their respective software tools and user interfaces (HMI) in the control room to display always more information as required by their respective control room responsibilities. It appeared recently that the information displayed on the various HMIs could be inconsistent which could affect machine availability and safety. To alleviate such risks, a decision was made to redesign the whole operation toolset.

Allow the Supervisor to become the main actor		Improved user experience						
	Acquisition Unit Status							
	DPILOTE DBARO DBOLO DCALOR	#2 10:33:50 deneb-ter.intra.cea.fr	DDE : MANUAL DRY RUN	#5 10:34:10 deneb-ter.intra.cea.fr	MODE : MANUAL DRY RUN			
	DECERAP DEQUI DECL DGAZ	Change Pulse : 50 @ acquisition en cours	Last command : Préparation choc @ 09:34:51	Current pulse number : 50	Current phase : acquisition en cours Last command : Préparation	choc received @: 09:34:51		
	DGENE DHYB DIFDOP DINTMEG	Change pulse mode						
	DIR1 DIR2 DIR3 DIR4 DIR5 DLANG DMAG	Day beginning TO DRY RUN TO PULSE	TO CALIBRATION Countdown value :					
SL HMI	DMAGMHD DNEUTRON DDGA DPC1	Renard Mandatory						
		Prepare Manuatory		Convert	Add comment t	or eic here		

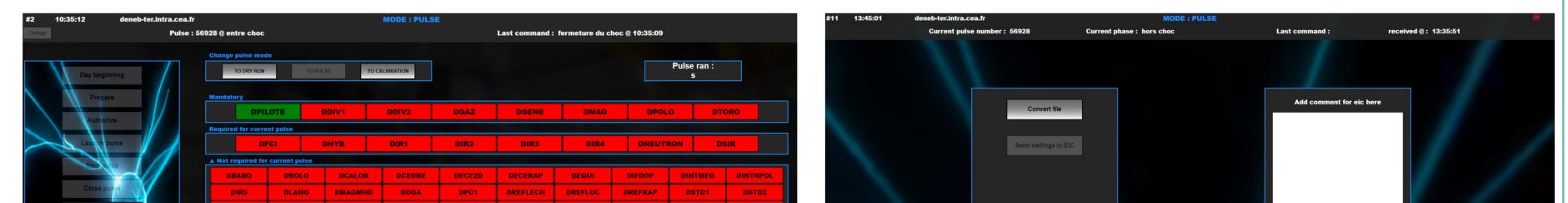






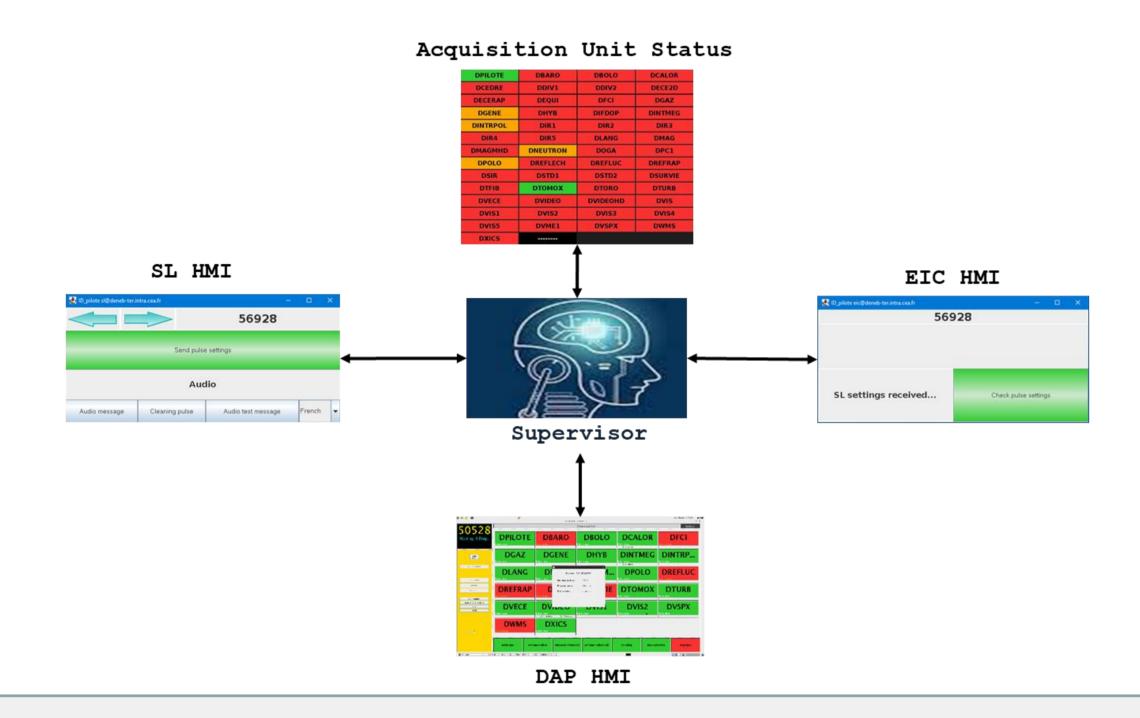
*Fig* : view of the operational team HMIs in dry run mode (yellow)

All user interfaces have been rebuild using the language (HTML/Javascript) and the same graphical charter as well. The main data that is shared is the operation status : either test pulse, calibration, or pulse mode. Each mode is associated with a color that is used in every HMI.



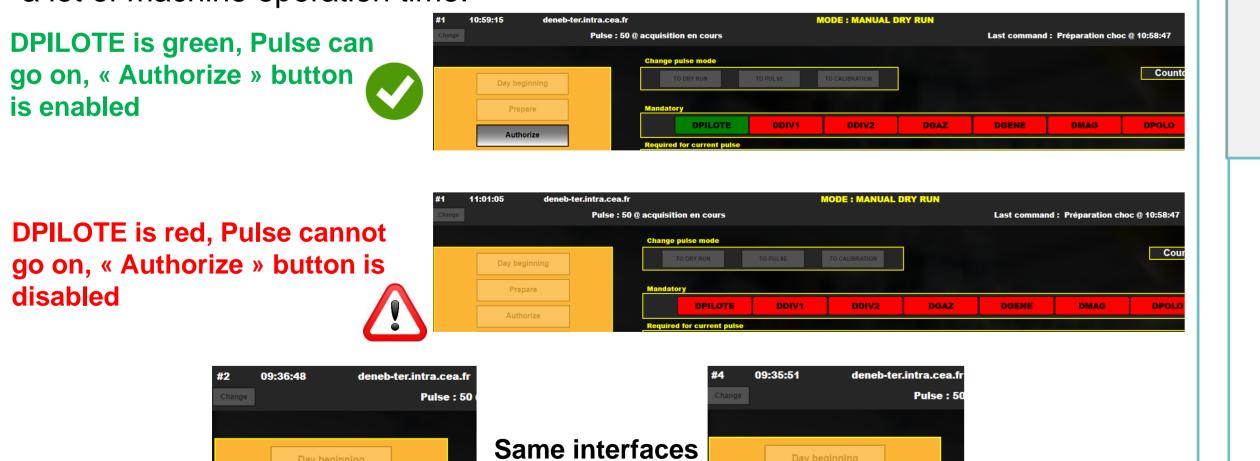
After several years of development, the old way of exchanging information between processes has become widely unmaintainable. The new solution builds on a unique centralized source of tokamak information and its status, and passive HMIs which are mediators between the centralized

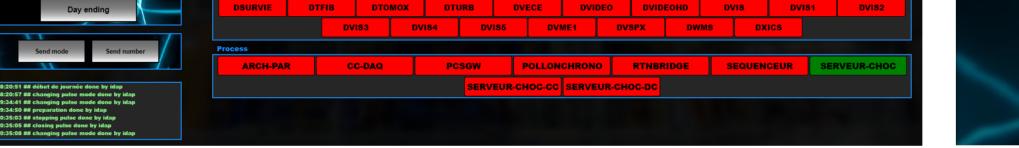
description and the users. To achieve this centralization, we took advantage of the existing expert system (called WEST Supervisor) in charge of managing the sequential steps of plasma experiments since the beginning of WEST.



# Taking advantage of Artificial Intelligence

Thanks to the centralized data exchange, the WEST Supervisor knows everything about every process involved in the pulse. New rules have been developed in the expert system to continuously check what action is allowed/possible or not. In case of trouble, the WEST Supervisor immediately disables actions that could have undesired effects. This is a new **preventive detection** that has already save a lot of machine operation time.





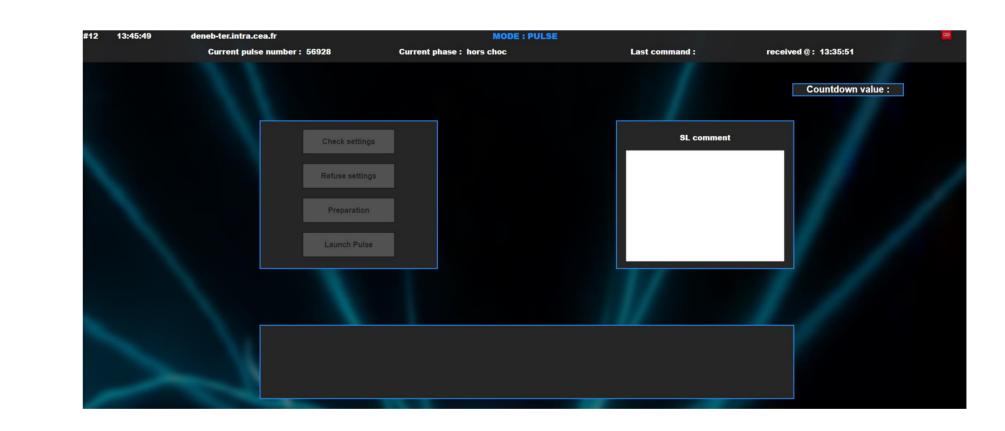
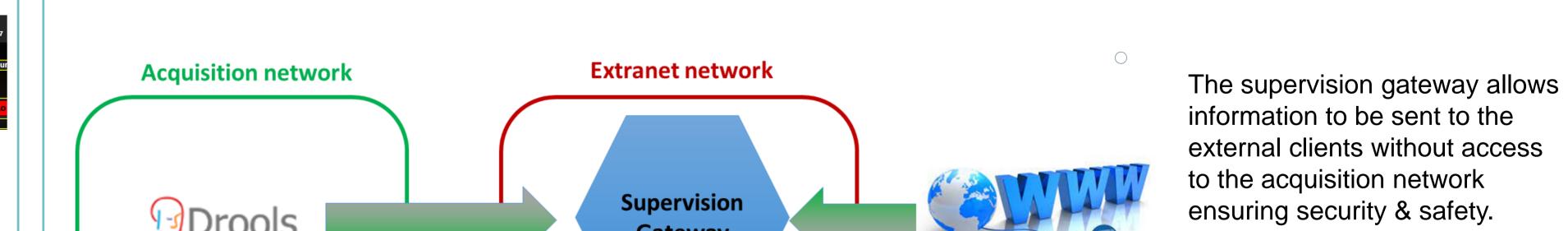


Fig : view of the operational team HMIs in plasma mode (blue)

## **Remote participation**



Day beginning	Same interfaces	Day beginning				Gateway		People can participate to the
Prepare	opened twice,	Prepare						
Authorize	commands are	Authorize						experimental campaign with the
Addionze	given only once			WEST Supervisor broadcast				same information as the local
Launch pulse	(left). Next users	Launch pulse		information to the gateway				
Stop pulse		Stop pulse		,	Data ar	re received and sh	hown	operation team.
Close pulse	are only allowed	Close pulse						
	to see	Descention			to the o	lients		
Day ending	information	Day ending						
	right).							
Send mode Send number	(···9···/·	Send mode Send number						
			- I L		 			

### Conclusion

The new WEST Supervisor has been successfully integrated into the WEST control infrastructure and has been used on real plasma experiments during the C6 Campaign in July 2022. All HMIs have been easily adopted by the different operation teams. In the future, the new infrastructure has been design to offer a lot a new capabilities for remote participation. Some of which are still under development: accessing data and status of acquisition unit, operate the West tokamak and conduct plasma experiments remotely.



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