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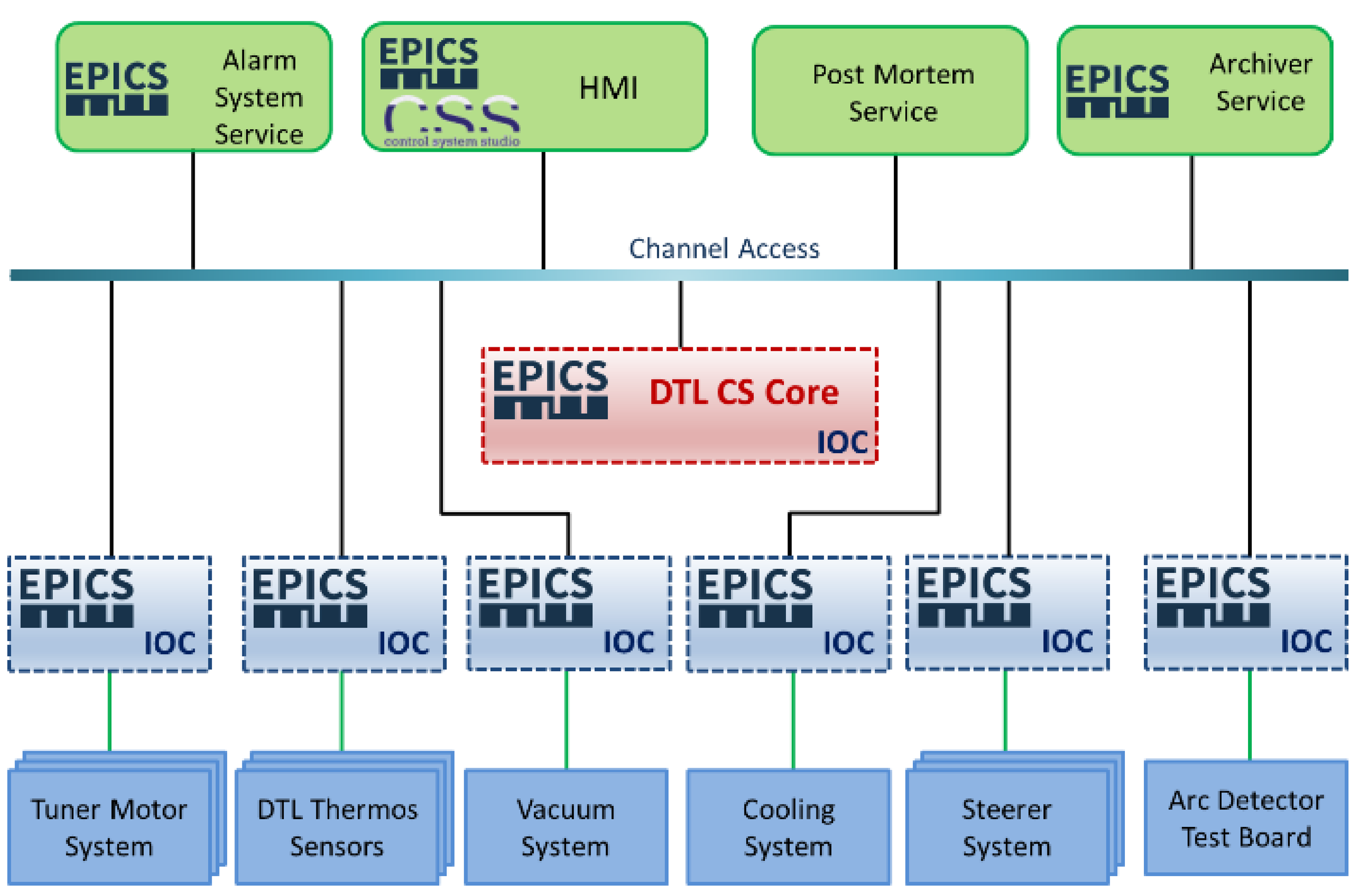
Ess Drift Tube Linac Control System Architecture and Concept of Operations

EUROPEAN SPALLATION SOURCE
INFN-LNL Istituto Nazionale di Fisica Nucleare EPICS
INFN Istituto Nazionale di Fisica Nucleare

M. Montis, L. Antoniazzi, A: Baldo, M. Giacchini, *INFN-LNL, Legnaro, Italy*
T. Fay, *ESS, Lund, Sweden*

The Drift Tube Linac (DTL) of the European Spallation Source (ESS) is designed to operate at 352.2 MHz with a duty cycle of 4% (3 ms pulse length,14 Hz repetition frequency) and will accelerate a proton beam of 62.5 mA pulse peak current from 3.62 to 90 MeV. According to the project standards, the entire control system is based on the EPICS framework. This paper presents the control system architecture designed for the DTL apparatus by INFN-LNL, emphasizing in particular the technological solutions adopted and the high-level control orchestration, used to standardize the software under logic design, implementation and maintenance points of view.

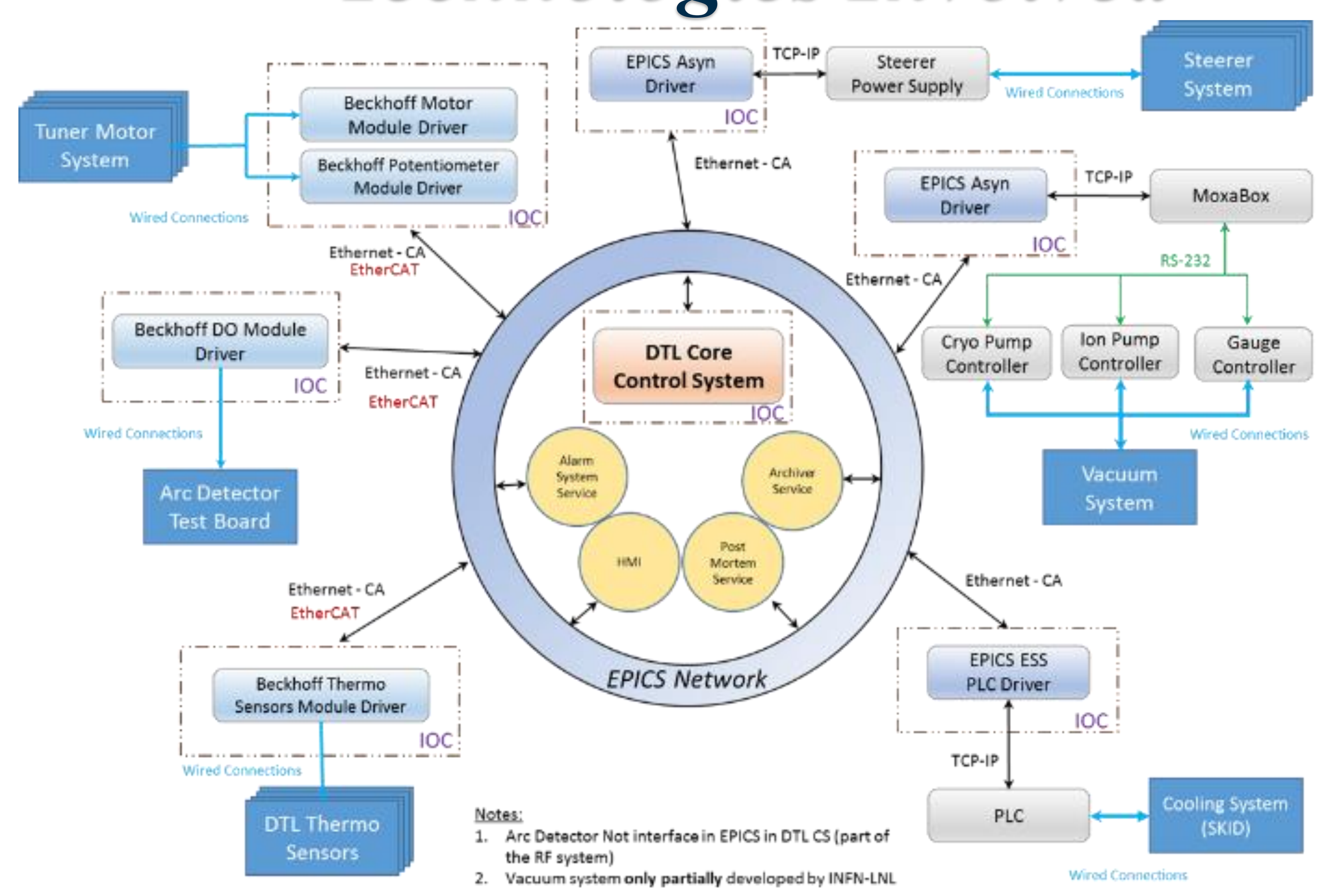
Control System Architecture



The architecture realizes the canonical 3-layer structure where:

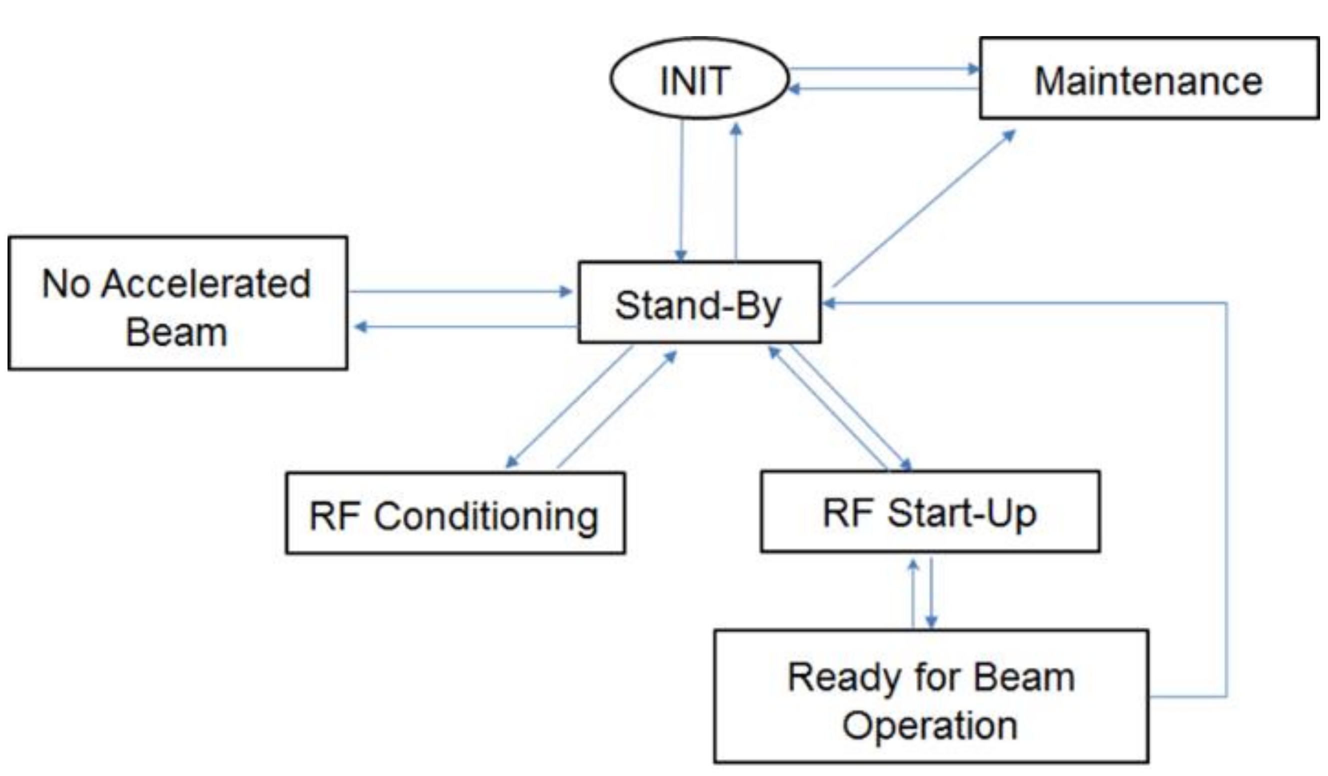
- At the lower level there are all the DTL functional sub-systems. Under CS aspects, the lower layer defining the field where the I/O signals come from.
- The middle layer defines the set of controllers used to perform the logic and the automation required by the application (Hardware and Software). In this layer all the control units (EPICS Input/Output Controllers - IOCs) run both the low-level interface applications and the high-level state machines (Control System Core).
- At the highest level, all the services provided by ESS-ERIC to performs the normal tasks to operate the Linac. The principal services and tools are:
  - Human-Machine Interface (HMI)
  - Archiver Appliance System
  - Alarm System

Sub-Systems and Technologies Involved



Sub-System	Hardware	Software	HW Integration Protocol
High-Level Control	No dedicated HW	EPICS framework	
Tubes Thermos Sensors	Beckhoff® HW	EPICS framework	EtherCAT
Vacuum System	HW provided by ESS	EPICS framework	Serial and TPC/IP communication
Water Cooling Control	Siemens® PLC	EPICS framework (integration)	ModBus and TPC/IP server/client communication
Tuner Motor System	Beckhoff® HW	EPICS framework	EtherCAT
Steerer System	Itest BILT system HW	EPICS framework	Serial and TPC/IP communication
Arc Detector	• HW based on AFT Microwave • Custom Electronic board and Beckhoff® HW	EPICS framework	EtherCAT protocol

Concept of Operations



The DTL apparatus can be seen as a modular system composed by 5 elements called tanks. Dedicated automation will be realized for each tank: the aim of this approach is to have the **maximum degree of freedom** during the operations the DTL has to perform:

RF Conditioning **Beam Operation**

In addition to the DTL-tank automation, for each functional sub-system a dedicated self-check logic will be designed in order to execute dedicated initialization procedure and verify continuously sub-system's health: in case of fault, the information will be propagated to the central core system. Every single functional automation also foresees to operate into a degraded condition, which is reflected at main core level. In this situation, the DTL apparatus can performs its operations conditioned to the acknowledge made by the operator. Every functional algorithm will implement the same logic flowchart, in order to standardize code structure and maintenance.

First Results and Conclusion

Based on the guidelines, documentation and standard adopted by the project, the entire DTL control system will be developed in EPICS: the framework will provide the main features in terms of integration and robustness at low level (logic to the field) and at high level (services and automation). Under software and logic aspects, a big effort has been required to define the automation devoted to manage and control the entire DTL apparatus: this approach will significantly reduce operation downtimes and, at the same time, will give us additional degrees of freedom during the installation stage in Sweden.

INFN-LNL: http://www.lnl.infn.it *EPICS@LNL: https://web.infn.it/epics* *ESS ERIC: https://europeanspallationsource.se*

Contact:
Maurizio Montis