

SPALLATION

MEBT Integration Status and Plans

Joao Paulo Martins **Control Systems Engineer** European Spallation Source ERIC 2020-01-30





- This time slot won't give sufficient duration for many details.
- Intention here is mostly to provide a rapid-fire overview.
- Several internal ICS projects need to reach "usable" maturity for RFQ commissioning and beam to MEBT FC (Calibration Service, Critical PV access authorisation, IOC deployment).

- MEBT Control System Overview
- EPICS Integration Aspects
- MEBT Chopper Controls
- MEBT Magnets Controls
- Conclusion





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MEBT Control System Overview MEBT at a glance



• The full-scale MEBT:



- Eleven (11) Magnets (quadrupoles with combined H/V correctors);
- Three (3) RF cavities (bunchers);
- Chopper;
- Nine (9) different types of diagnostics instruments;

MEBT Control System Overview The Full Scale Control System



• Controls Hardware



MEBT Control System Overview Estimation of the number of IOCs

- Controls Software: an (rough) estimation of the number of IOCs:
 - Not considering MPS, Vacuum and various soft IOCs running on VMs;



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MEBT Control System Overview The Full Scale Control System



• Controls Hardware



MEBT Control System Overview The system for first phase (SSR2A)



• Controls Hardware



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EPICS Integration Aspects ESS EPICS Environment (E3)

• Motivation:

- Speed up IOC development;
- Standardization;
- To support different EPICS Base version, different EPICS modules versions, for different architectures;

• What E3 is?

- A build facility for EPICS IOCs;
- A runtime environment for EPICS IOCs;
- A collection of EPICS modules (extensions) and IOCs maintained by ICS;

• What E3 is not?

- The deployment system for the EPICS IOCs;
- Something that will prevent your IOC to run (if the workflow is followed);

EPICS Integration Aspects ESS EPICS Environment (E3)

- I have this IOC running on EEE, now I have to port it to E3;
 - The structure is almost the same, for *most* of the IOCs this is a matter of minutes (or hours);
 - HW & Integration Group is here to help you;
- I need this EPICS extension on my IOC, is it compatible with E3?
 - Please take a look to the pool of modules already supported on E3. Almost everything you need will be there (calc, stream, sequencer, mrfioc2, ecmc, ADCore, any many more);
 - If not, HW & Integration Group is here to help you;
- Is my IOC going to load the same modules after reboots, E3 updates, etc..?
 - YES. Your IOC will load the modules according to the versions that YOU specified;
- I need to learn how to develop with E3!
 - There is extensive training material on Confluence: <u>https://confluence.esss.lu.se/display/HAR/ESS+EPICS+environment+%3A+e3</u>

EPICS Integration Aspects ESS EPICS Environment (E3)

- There is a lot to be developed and integrated yet, though:
 - Deployment system;
 - Critical PV access authorization;
 - Calibration Service;
 - MASAR service;
 - Experiment data archiving;
- ICS is committed to the deliver all the Control System Services with quality, but focus should be to run IOCs!
- EPICS Base version 7.0.3.1 is the default; (<u>https://confluence.esss.lu.se/x/4iN8Ew</u>)
- CS-Studio / Phoebos / BOY / Display Builder still work to do;

EPICS Integration Aspects Standard IOC Features

• Autosave:

- Periodically saves the current value of pre-defined PVs into a text file;
- ICS Infra Group already have the permanent storage (with backup) for these files;
- iocStats:
 - Provides EPICS PVs with diagnostics about the running IOC: memory and CPU consumption, uptime, heartbeat signal;
 - Enables remote reboot of the IOC;
- recSync:
 - Publish the list of PVs of the IOC to Channel Finder Service;
- Archiving:
 - Configuration of the archiving system is made outside the IOC: Archiver Appliance;
- Alarms and Access Security:
 - Built-in features of EPICS; Should be defined by system leader and implemented by integrator;

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MEBT Chopper Controls Architecture





MEBT Chopper Controls Status

- Rack components were installed with temporary power;
- Local tests performed:
 - Pulsers communication;
 - Event Receiver and fine delay outputs (standalone mode);
 - PLC integration with EPICS;
- Main OPI already in Display Builder format;
 - PLC IOC OPI needs to be ported;
- Next activities:
 - Clear definition of timing events that will drive the MEBT Chopper;
 - Integrated tests;
 - Verification of PLC signals;



MEBT Chopper Controls Future integration with FBIS

• For the next phase: integration with FBIS;

- FBIS needs to know if emergency mode really happened;
- Overall status (LPS status) informed to MPS from the PLC;
- Digitalization of the voltage signals that goes to the loads;
- Interface Control Document (under review):
 - CHESS Document: ESS-1530169

MEBT Chopper Controls Operation

- High-voltage pulsers configurable parameters (PVs):
 - Manual/remote;
 - Amplitude (1 kV to 2.75 kV);
 - Pulse Width (1us to 20us);
- Trigger configurable parameters:
 - Coarse delay from event reception;
 - Fine delay (nanosecond range);
 - Distance between pulses *;



• Event Receiver System (MRF EVR) is flexible and easily configurable, we need clear definition on when to trigger the pulsers from an operational point of view;

MEBT-010:BMD-Chop-001 Chopper





MEBT Chopper Controls Operation



Timing System Events and HV Pulsers Outputs



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MEBT Magnets Controls Architecture

- MEBT Magnets combine quadrupole with horizontal and vertical corrector functions;
- One dedicated power supply for each component: 11 x 3 = 33 PS;
 - Unipolar PS with 300 A output for quadrupole;
 - Bipolar PS for the H/V correctors;
- One dedicated rack for each magnet;
- Local Protection System implemented with Siemens PLC;
 - EPICS IOC runs on virtual machine;





MEBT Magnets Controls Steerers Controls

- CAEN FAST PS has an embedded EPICS IOC;
 - The integration is extremely facilitated by this feature;
- The same power supply will be used in the LEBT;
- OPIs already re-designed and compatible with Display Builder;
- 20 units placed in FEB racks;







MEBT Magnets Controls Quadrupole Controls



- Dedicated unipolar quadrupole power supply;
- Up to 300A output;
- MODBUS interface;
- FAT to happen soon!
- IOC needs to be validated;
- OPIs to be converted to Display Builder;

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lar PS Configura	ion						
urrent Setpoints	A	mA u/	Volta	age Setpoints	v	mV	υV
utput Current Set	DA R		Outs	out Voltage Set	οv	0 mV	lo uV
Summer Line is Cast				and Limb Cat		lo má	- Dut
urrent Limit Set	PA P	ma pu	Volt	age Limit Set	þν	10 mA	PuA
lode	Gro	und	1				
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Output 0	Jurrent			Output Vol	tage		
120.3525	87 A			10.745689 V			
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Error Regist	er 1	Error Re	gister 2		iternal Chambe	Temp. 74	4.1 C
bit 15: Extr	rnal Chamber	bit 15			ternat champe	. remp. 7	
bit 14: Inte	rnal Chamber	🥥 bit 14		V	enna Temperat	ure 84	4.1 ⊂
Ak 12- DCC	л	bit 13					126
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MEBT Magnets Controls Local Protection System

- Local Protection System implemented with Siemens S7 PLCs (CPU + distributed IO modules);
- PLC monitors the following signals for each individual magnet:
 - Magnet windings sensor (thermoswitch);
 - Cooling water temperature;
 - Cooling water flow;
 - Power Supply status (hardwire);
- In case of any faulty condition, local permit to the PS will be revoked and Machine Protection (MPSMag) will be notified;
- MPSMag ICD (under review): ESS-0494755





MEBT Magnets Controls Local Protection System





QUADRUPOLES INTERLOCKS

QUAD 1 QUAD 2 QUAD 3 QUAD 4 QUAD 5 QUAD 6 QUAD 7 QUAD 8 QUAD 9 QUAD 10 QUAD 11

QUADRUPOLE 1

Power Supplies Status		PLC Status
Unipolar Power Supply Interlock Status		
Horizontal Steerer P. Supply Interlock Status		Horizontal Steerer P. Supply ON Status 🛛 🔘
Vertical Steerer P. Supply Interlock Status		Vertical Steerer P. Supply ON Status 🛛 💩
Status Alarm Reset	•	VALUE ######## Reset • •
Status Alarm Reset	•	VALUE ######## Reset • •
Vater Flow Switch Status Alarm Reset	•	VALUE ######## Reset • • • • • • • • • • • • • • • • • • •
Status Alarm Reset	•	VALUE ####### Reset • • • Low Warning 0 $\frac{5}{-1}$ ######## High Warning 0 $\frac{1}{-1}$ ########
Status Alarm Reset	•	VALUE ####### Reset # Low Warning 0 - - ####################################





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- MEBT Chopper is *almost* ready for integrated tests;
- Correctors Magnets PS needs firmware update and registration to the Control System, but after that they are ready for integrated tests;
- Quadrupoles PS will be integrated and tested in Bilbao;
- Diagnostics systems (FC, BPM, BCM) being developed and led by BI with the support of ICS;
- ICS is fully committed to deliver high level services and controls;
- HW&I Group feels enthusiastic about the next commissioning round: focus to "make system run";
- What still needs to be done:
 - All OPIs ported/developed to Phoebus/Display Builder;
 - IOC configurations for alarms, archiving and access control (need input from system owners);
 - All sorts of adjustments and optimizations...
 - Documentation;



- Questions / discussions;
- Special thanks to Idoia Mazkiaran and ESS Bilbao team;

MUITO OBRIGADO!



"Courageous convictions will drag the dream into existence."

- Neil Peart (1952 – 2020) - Vital Signs, Rush – Moving Pictures