Control System towards FAIR Commissioning

Workshop on Controls Development for FAIR Commissioning and GSI Operation of Existing Acc. Complex

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FAIR Commissioning Phase

Commissioning

"*Process of assuring that all systems and components are designed, installed, tested, operated, and maintained according to the design and operational requirements of the project owner (e.g. WPL, equipment specialist, SPL) until the final handover to operation*".

Key Aspects of Commissioning

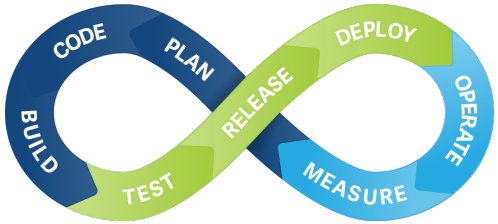
- Comprehensive unit tests → testing procedures, sequences, check-lists
- Definition of interfaces → which & when a given functionality required, definition of entry conditions & lead times to achieve these functionalities)
- Definitions of goals → exit conditions
- Documentation of executed tests

Targets

- Commissioning of the Control System itself
  → While being the fabric and tool for other equipment, the CS is by itself is a complex collection of sub-systems that also need to be commissioned.

- Control system support to commission accelerator components, systems, the accelerator
  - Individual component/system tests
  - Integration tests
  - Higher level tests → Dry-runs → Commissioning with beam

Control System Commissioning



Iterative Development Approach

The control system is not a monolithic single system that follows (or for the matter can follow) a simple start/stop development paradigm

- CS is a collection of sub-systems bound by a robust middleware, timing system, settings management system, …
- Evolving standard best tracked by CI (continuous integration), continuous delivery and agile programming paradigms rather linear start/stop, functionality and interfaces are often complex and require re-iterations.

Accelerator Control System Commissioning

- The Controls infrastructure team provides technical networks (Ethernet, Profinet, WR Timing, Interlocks) →pre-requisite for all equipment groups
  Installation and commissioning of the technical networks as soon as the civil construction progress/conditions allows (and installation makes sense)

- Control system commissioning strategy
  → test as much at the existing facility prior to starting FAIR hardware commissioning
  → work out commissioning plans for functions not testable at existing machines

Control System Commissioning Support

Commissioning Support

CS needs to provide tools to support to commission components, systems, the accelerator

- Individual component/system tests (responsibility WPL)
- System integration tests
- Higher level tests → Dry-runs → Commissioning with beam (responsibility SPL)

Essential tools for this phase:

- Sequencer service (automation, semi-automation
- Archiving (measurement DB) to store test results and PM data
- Diagnostic logging system

Further technical support requests shall be identified after the FAIR machine presentations of this workshop

Sequencing and Semi-Automation

Sequencer

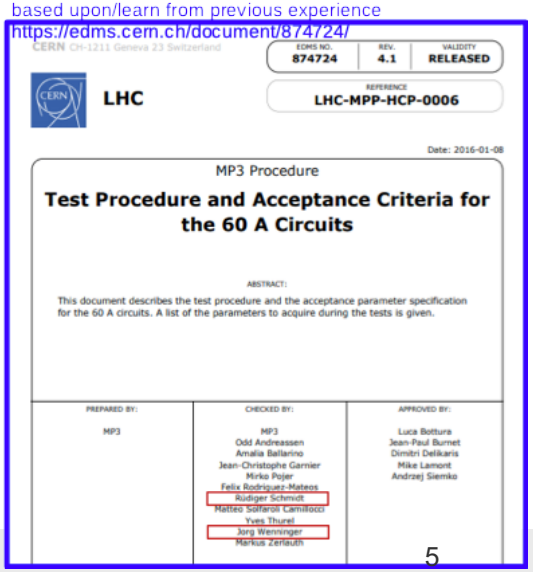
- Essential tool for operation and commissioning
- Sequencer service under development ➔ presentation by Stefan Krepp (ACO)
- Optimize routine tasks so that operation crew and commissioning team can focus on more important tasks that cannot be automated
- Sequencer tasks: big time-saver for large-scale equipment acceptance/integration tests, re-commissioning, or dry-runs

Testing Approach

- Controls provides the sequencer service (”the tool”)
  however: exploitation of the sequencer needs to be done by users
- Users need to define precise test procedures, entry conditions, dependencies to other systems, etc.
- User writes sequences/tasks with the sequencer (code)
- Controls can support coding of sequences/tasks on best effort and resource capacity

- → Equipment specialists need to follow complete development cycle of their equipment (including controls integration)
- Lead-times must be considered (i.e. resource load)
- → need to practise on small scale tests before ramping up procedures to full FAIR

based upon/learn from previous experience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MP3 Procedure

Test Procedure and Acceptance Criteria for the 60 A Circuits

ABSTRACT:

This document describes the test procedure and the acceptance parameter specification for the 60 A circuits. A list of the parameters to acquire during the tests is given.

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Activities, Contributors and Priorities

The control system is not exclusively the product of the Controls department,
several other departments/partners contribute to the full set of the CS
→ Biggest workload/effort is software development

Overview table for Software Development prepared* (Draft RFC)

- Tool to visualize, organize, and prioritize developments
- Harmonize and coordinate developments, avoid (unintended) double-developments
- Define clear scope of responsibilities

→ **Table should be carefully reviewed by the sub-projects**
further input should be added, suggestions to improve welcome!

Definition of priorities:

1: Essential function: no operation without
2: Important function: operation at the expense of personnel resources & (in)efficiency
3: Required function for quality- and high intensity operation
4: Operation with degraded operational efficiency possible

Project phases:

HWC: Hardware commissioning
BC: Beam commissioning
OP: Operation

**special thanks to SIS100 project team (Spiller/Ondreka/Steinhagen)*

Activities, Contributors and Priorities

	Activities		Executing Departments (directly involved in SW development)												SPL Requester Anforderer	Phases Phasen			Prio (1-4, Erläuterung siehe rechts)	Status
	Description	Kürzel	ACO	BIT	BEA	SFR	SRP	RRF	OPE	SYS	DEC	APH	CRY	EXP		HWC (& controls)	BC (& dry runs)	OP (user)		
Facility Control	Cryogenic Controls																			
	Cry plant (Cryo2) control (integration only)														COM				1	
	Cryo distribution control														COM				1	
	SIS100 dynamic load predictions														SIS				3	
	Vauum Controls														COM					
	Vacuum control and safety		#												COM				1	
	Cryo insulation vacuum control														COM				1	
	Building services engineering (TGA) Monitoring																			
	Monitoring of accelerator media																		4	
	Electrical load monitoring (pulse/common mains)														SIS				3	
	Cooling water temperatures																		4	
	Cooling plants																		4	
	Ventilation/colling																			
	Sequential Facility Control incl. Apps	Timing																	1	
	Timing Master														ACC				1	
	Timing Director														ACC				1	
	Request Processor														EXP				1	
	Scheduling	BSS Control													ACC				1	
	Pattern Creation	Scheduling App													ACC				1	
	Machine and Beam-Mode Control														ACC				1	
	Timing Monitor & Diagnostics														ACC				2	
	Personnel Safety																			
	Radiation Protection System														SRP				1	
	Acc. Personnel Access System (PAS)	PAS													SRP				1	
	Machine Protection																			
	Device Status Monitoring and Interlocking	MASP													all				1	
	Fast-Beam-Abort-System – SIS18/SIS100	FBAS													SIS				3	
	Fast-Beam-Abort-System - primary beam lines	FBAS																	3	
	Fast-Beam-Abort-System – SuperFRS	FBAS													SFR				3	
	Fast-Beam-Abort-System – Experimente	FBAS													EXP				3	
	Fast BLM System																		3	
	Permit-Service (Powering, Movable Devices)	MASP																	3	
	Acc. Facility Overview																			
	Status Machine(s)																		1	
	Beam Production Chain Status																		1	
	Online Timing & Scheduling Monitor														ACC				1	
	Status Industrial systems (vac, cryo)																		2	
	Fixed-Display (web-based)																			
	Accelerator Facility Status														ACC				1	
	Ind. Machine Status														ACC,SIS				1	
	Beam-Production-Chain Status	BPC Status													SIS				1	
	Experiment Status														EXP.ACC				1	
	Machine Availability Analysis Tools														OPE				4	
	...																			

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	Description	Kürzel	ACO	BIT	BEA	SFR	SRP	RRF	OPE	SYS	DEC	APH	CRY	EXP		HWC (& controls)	BC (& dry runs)	OP (user)		
Machine Controls (system- and beam-based)	Settings Supply																			
	Device and beam parameter settings	ParamModi				■				■					ACC	X			1	
	Machine modelling	LSA make-rules				■				■					ACC	X			1	
	Beam Monitoring																			
	Beam-Transmission-Monitoring	BTM	■												ACC		X		2	
	Beam-Quality-Monitoring	BQM													SIS,DEC			X	3	
	Multi-Parameter-Beam GUI														APE			X	3	
	Beam-Based Control Systems																			
	inj./extr. trajectories (BPM-based)									■					SIS		X		1	
	trajectory control HEST	"Benno"							■						COM			X	2	
	closed-orbit and radial-loop									■					SIS		X		1	
	Q/Q' control									■					SIS		X		3	
	Multi-Turn-Injection	MTI								■					SIS,DEC			X	3	
	Bunch2Bucket beam-transfer	B2B								■					SIS		X		1	
	Slow-Extraction									■					SIS		X		3	
	Slow extraction optimisation (spill form/structure)									■							X		2	
	optics measurement & correction									■		■	■		SIS		X		3	
	Collimator/Cleaning set-up – SIS100									■					SIS			X	3	
	Collimator/Cleaning set-up – SFR					■									SFR					
	MPS validation – SIS100									■					SIS			X	3	
	MPS validation – Super FRS					■									SFR					
	beam-cooling optimisation														SIS			X	3	
	final-focus control (x/y,x'/y', β, …)									■					COM			X	3	
	RF bunch gymnastics									■					SIS		X		2	
	Post-Mortem-Analysis														SIS,SFR			X	3	
	PM data acquisition readout and persistence	PM	■																	
	superconducting magnets (quench analysis)														SIS,SFR	X			1	
	beam-related losses (FBAS, pBar operation, …)														SIS,PLI			X	3	
	Control local cryogenics																			
	Visualisation, semi-automatic control (sensors, pressure, temp., actuators, heater, ...)		■										?		SIS,SFR, COM	X			1	
	Automation processes/sequences		■										?		SIS, COM			X	3	
	Other semi-automated procedures																			
	Parameter scan									■	■	■			SIS,OPE			X	4	
	…																			

Activities, Contributors and Priorities

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	Description	Kürzel	ACO	BIT	BEA	SFR	SRP	RRF	OPE	SYS	DEC	APH	CRY	EXP		HWC (& controls)	BC (& dry runs)	OP (user)		
Equipment Control	Accelerator equipment control & tools/GUIs	FESA																	1	
	Power converter control (all)		■												COM				1	
	Ring RF equipment control		■					■							COM				1	
	Pulsed power systems control		■												COM				1	
	Stepping motor control		■		■										COM				1	
	Beam instrumentation systems				■										COM				1	
	Maschine-specific FESA classes (various)		■												COM				1	
	Digitizer Systems & Generic DAQ App		■												COM				1	
	...																			
	Expert tools & GUIs (per device/machine)																			
	DCT				■															
	ACT				■															
	FCT Ring and Transfer Lines				■															
	BPM (by type/machine)				■															
	RSA, SIS-Radio				■															
	Lassie				■															
	IPM				■															
	BIF				■															
	Profile grids				■															
	Cameras				■															
	HV control				■															
	MAPS2				■															
	BIF				■															
	BTF Scan				■															
	IonSource GUI		■						■											
	UNILAC Energy mesasurement (ToF)				■															
	Schottky – Machine									■					SIS				3	
	Schottky – Experiments													■						
	...																			
	Fast-Beam-Abort-System (Controller)		■					■											3	
	Bunch-2-Bucket System (low-level timing)		■					■								✕			1	
	Device Control GUI		■																1	
	Actual-vs-Reference-Monitoring/Interlocking		■							■					SIS		✕		2	
	Integration of generic sensor data and actuators (e.g. cryogenics, vacuum)		■																2	
	Data Concentrators (PBM, ...)		■																2	

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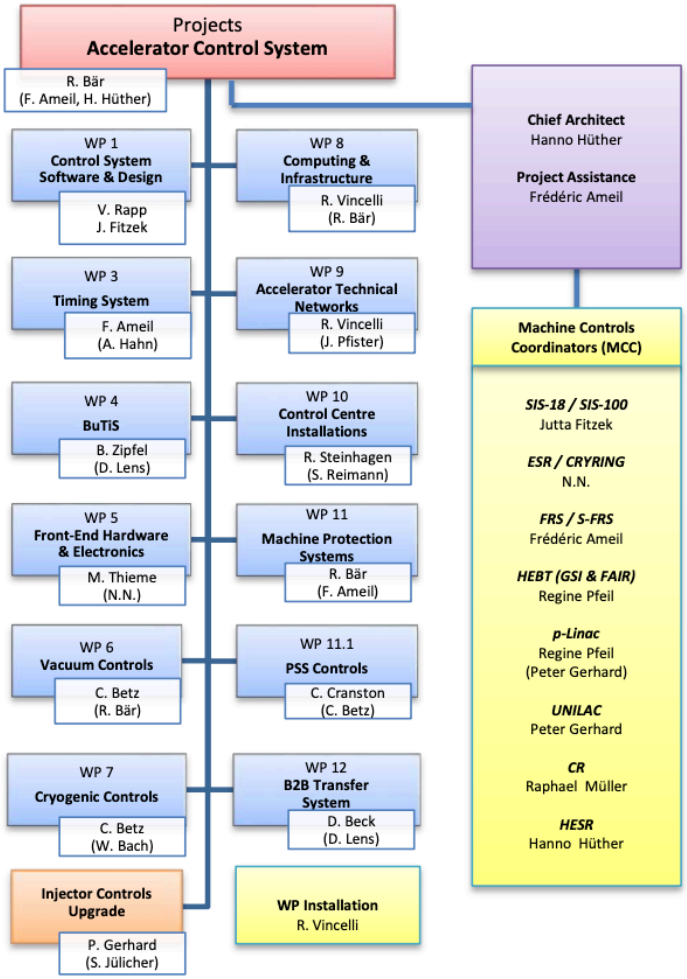
	Description	Kürzel	ACO	BIT	BEA	SFR	SRP	RRF	OPE	SYS	DEC	APH	CRY	EXP		HWC (& controls)	BC (& dry runs)	OP (user)		
Generic Services	LSA-Settings-Management	LSA																		
	Device setting supply (drive)		■																1	
	Muti-Parameter-Beam infrastructure		■																3	
	Management of Critical Settings	MCS	■																3	
	Front-End Software Architecture	FESA	■																1	
	Generic Control Room Apps (not machine specific)		■																1	
	Beam Request System to users (App, API)		■																1	
	Machine-Experiment Data Exchange Interface									■				■					4	
	Archiving-Service																			
	Archiving System		■						■						ACC				1	
	Generic data visualisation and retrieval		■																	
	Role-Based-Access Management	RBAC	■																1	
	Sequencer Service	Sequencer	■																1	
	Diagnostic Logging		■																1	
	Post-Mortem-System	PM	■																1	
	Generic Digitizers (non-BI)		■							■					SIS				1	
	Measurement data visualisation	chart-[fx,Qt]								■					SIS				1	
	Middle-Tier-Services (equip. & beam-based))									■					SIS				1	
	...																			
IT Infrastructure (for services / für Dienste)	Accelerator IT cluster system																		1	
	General services		■	■											SIS				1	
	Development environment & tools		■																1	
	Continous int. & dev. Environment (CI/CD)		■												SIS				1	
	Container management services		■	■															2	
	Version control systems		■	■															1	
	Electronic log book (operation)								■						ACC				1	
	User-account management (auth services)		■												ACC				3	
	Accelerator Databases		■																1	
	Network Infrastructure (technical networks)																		1	
	Ethernet, Profinet, White Rabbit		■																1	
	Active components (switches, firewall, ...)		■																1	
	Technical equipment Control Room (FCC)		■												ACC				1	
	...																			

Structured Communication

Controls Internal Organisation



Development and Commissioning phase require clearly structured responsibilities and communication.

MCC (Machine Controls Coordinators)

- Meetings and communication is usually organized “per accelerator”
- MCC serves as contact person for all matters concerning specific machine
- MCC organizes activities for respective machine within the Controls group

thank you!