UNILAC Controls Upgrade 2025

Part of Injector Controls Upgrade

Peter Gerhard/PSU on behalf of ACO a.o.

Outline

- Introduction
  - Motivation and approach
  - Retrospect: Beam time retreat 2023
  - General UNILAC control system strategy towards 2026

- Injector Controls Upgrade
  - Secure UNILAC beam operation through 2025
  - Project planning, organization and scope
  - Intermediate UNILAC emergency control system
  - Short report from dry run
  - Move to FCC: HKR modernization sub-project
  - UNILAC production control system
  - Further project planning

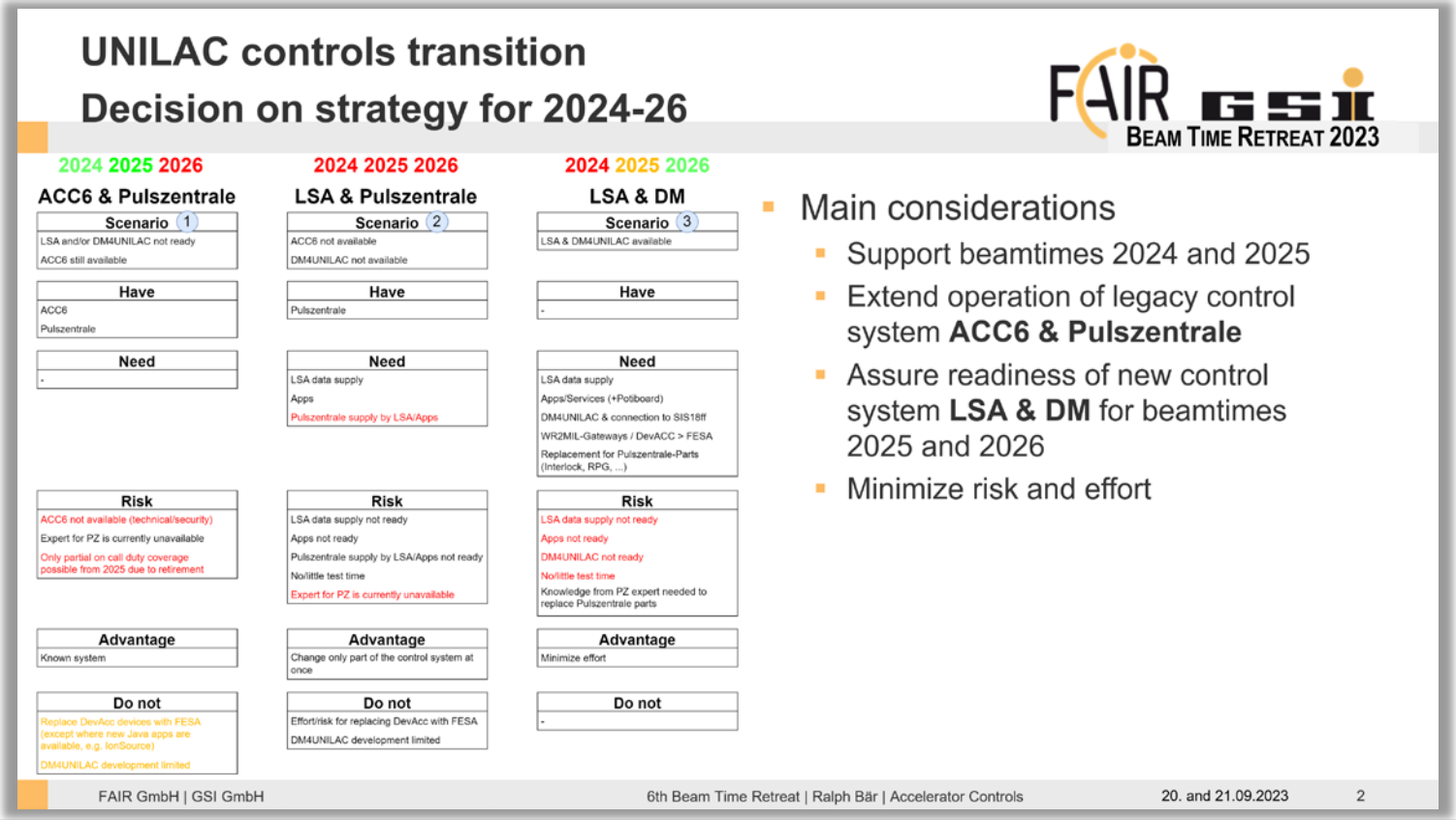
- Summary and outlook

Motivation and Approach

- Hard- and Software of existing UNILAC control system from the 1990s
  - obsolete, outdated, deprecated, not maintainable anymore
  - stuck with operating system running **beyond extended support contract from 2024**, leading to compatibility problems and security risks
  - drain of expert knowledge due to retirement
  - GSI can not maintain two separate control systems
  - move to new FCC main control room requires upgrades of control system

- Functionally, UNILAC would be able to serve FAIR today
  - use existing legacy control system as template, no new features necessary
  - integrate UNILAC into FAIR control system
  - new developments only where necessary or high benefit can be achieved at low effort
  - exploit new capabilities later

Retrospect: Beam Time Retreat 2023



General Strategy

- Step 0: secure UNILAC beam operation through beamtime 2025
  - replace existing operating cluster with virtual machines, replace terminals in MCR
  - implement IT security measures for operation extension
- Step 1: develop **emergency control system**
  - first viable version of new control system with reduced and simplified feature set
  - replace existing MIL timing system by White Rabbit-based system
  - **MCR modernization project**: replace/upgrade hardware devices in control room
  - serves as emergency backup for beamtime 2025
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  - enhance operability and efficiency
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Step 0: secure UNILAC beam operation through beamtime 2025 - milestones

⇒ UNILAC runs on legacy control system up to and including beamtime 2025

- Get rid of old, outdated control system hardware
  - change from server cluster to virtual machines
  - exchange terminal consoles in MCR (and console monitors as a consequence)
- Beamtime 2024
  - operation with legacy control system on extended support
- Dry Run 2024
  - apply final updates, implement IT security measures
  - verify operational readiness
- Reverify operational readiness after application of other CS updates, (databases, services, ...) in August and December
- Beamtime 2025
  - final operation of user beam time with legacy control system beyond extended support

- **Final shut down and decommissioning of legacy control system**

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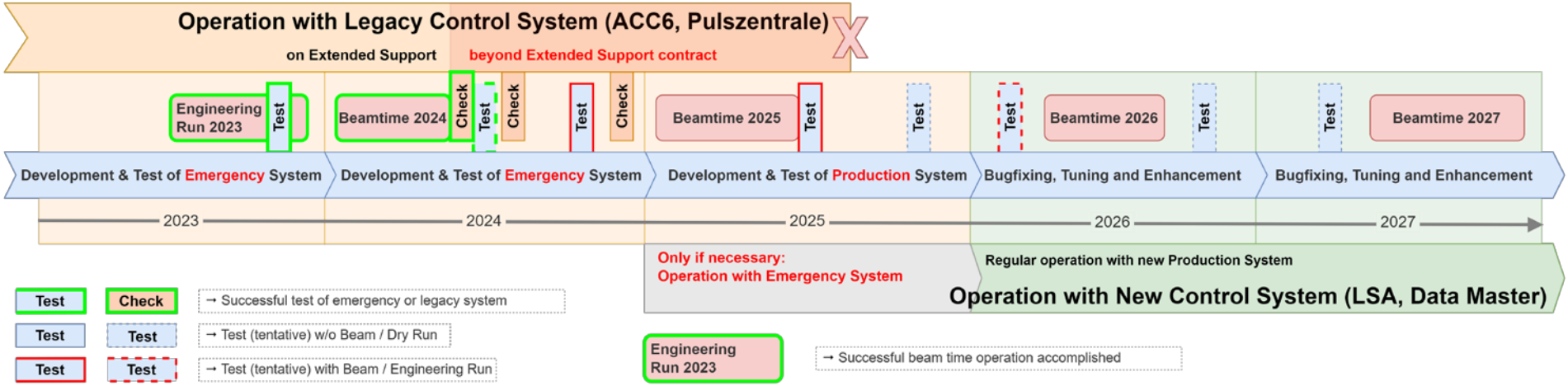
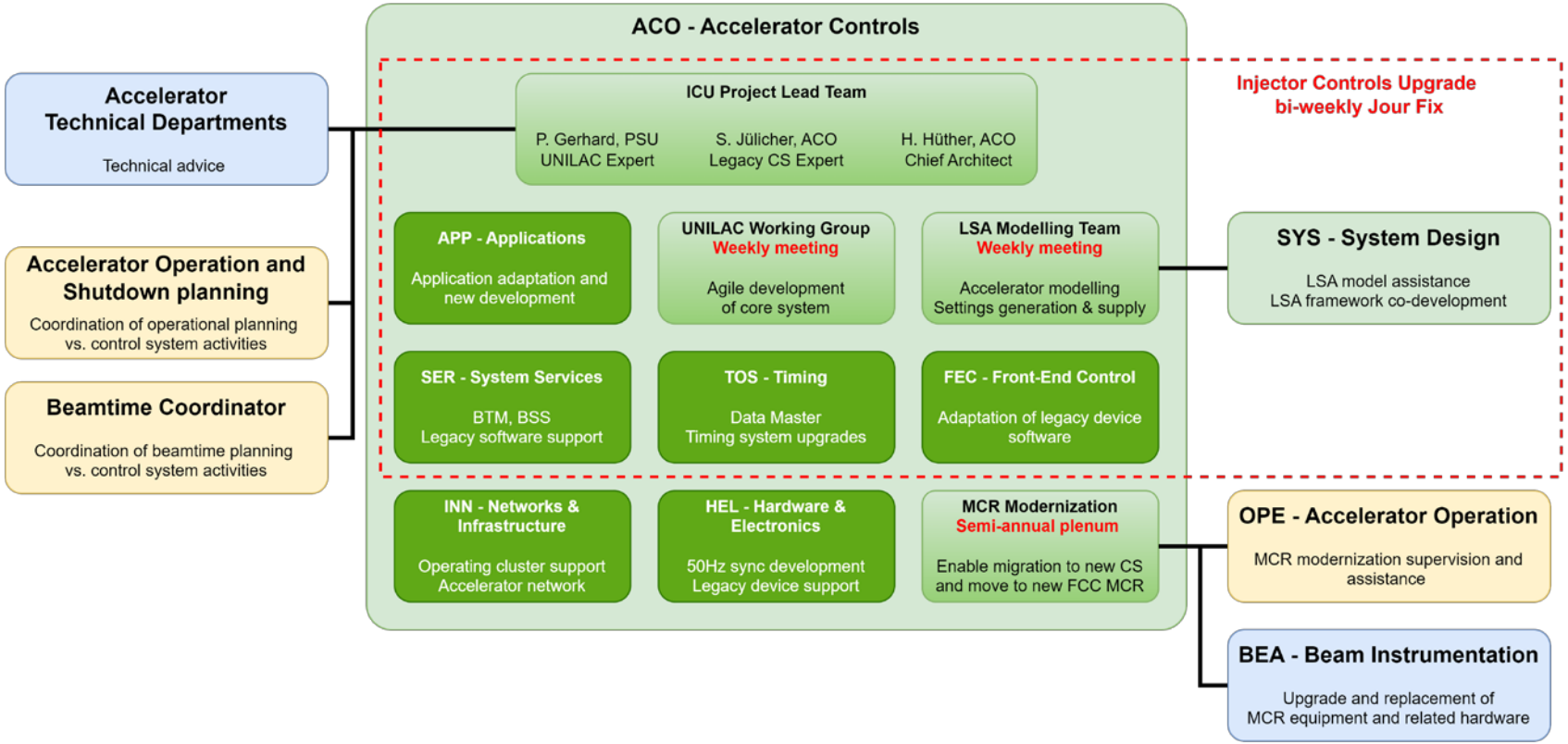
Timeline for Development and Test Strategy

- Develop emergency control system as intermediate step until beamtime 2025
- Regular operation with new control system from beamtime 2026
- Interleave control system tests with already scheduled beam times and shutdowns



Project Organization



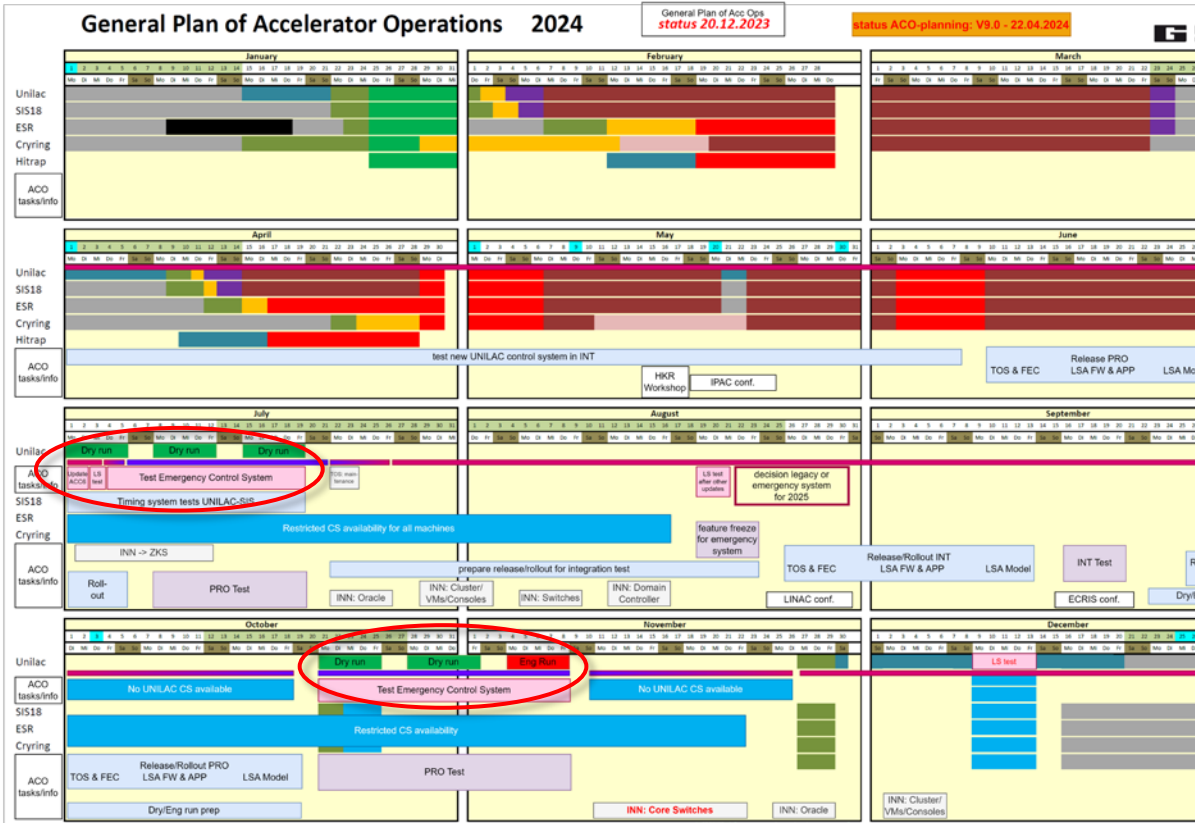
Project Planning 2024

Essential:

Dry run directly following the beam time

Engineering run only including UNILAC, not SIS18

Extremely dense shutdown

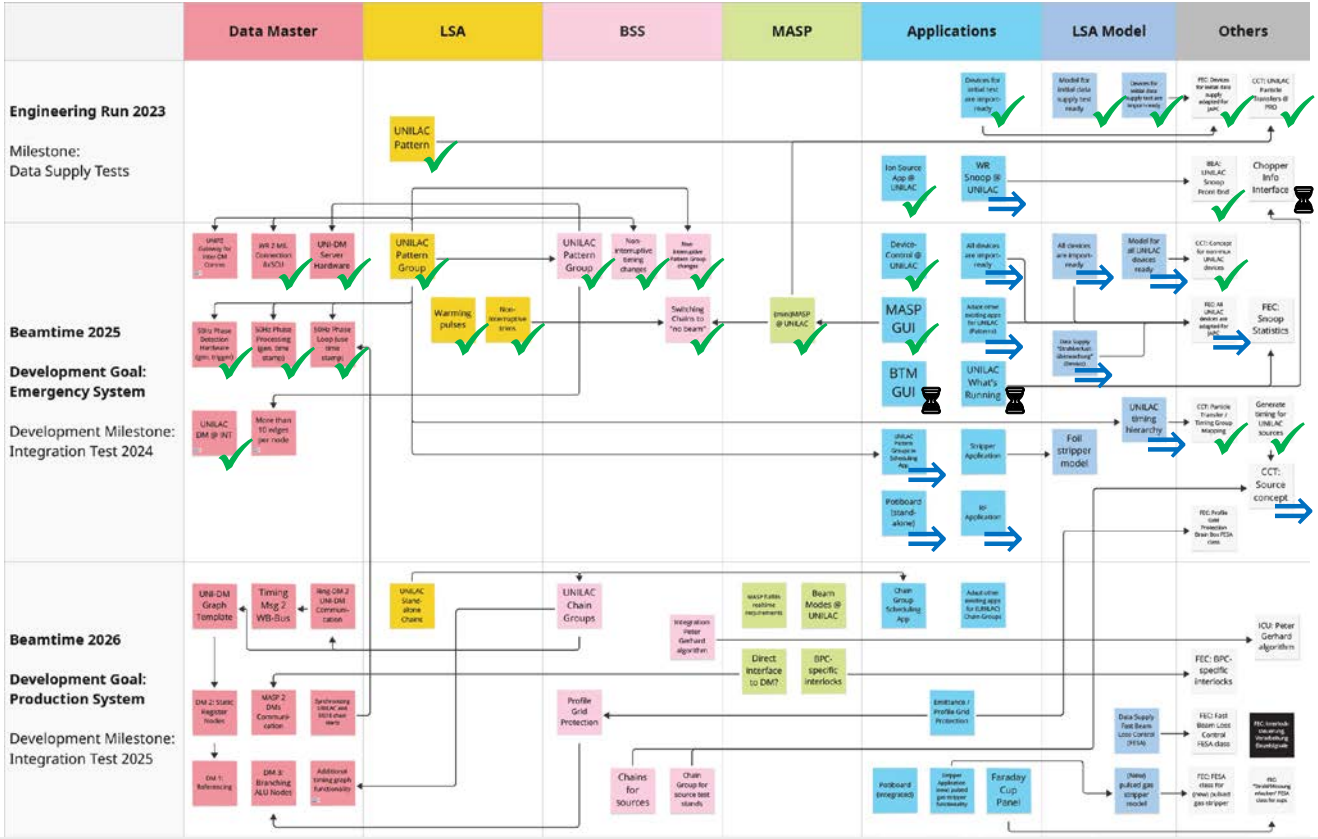


Integrated milestones and activities chart

✓ **achieved**

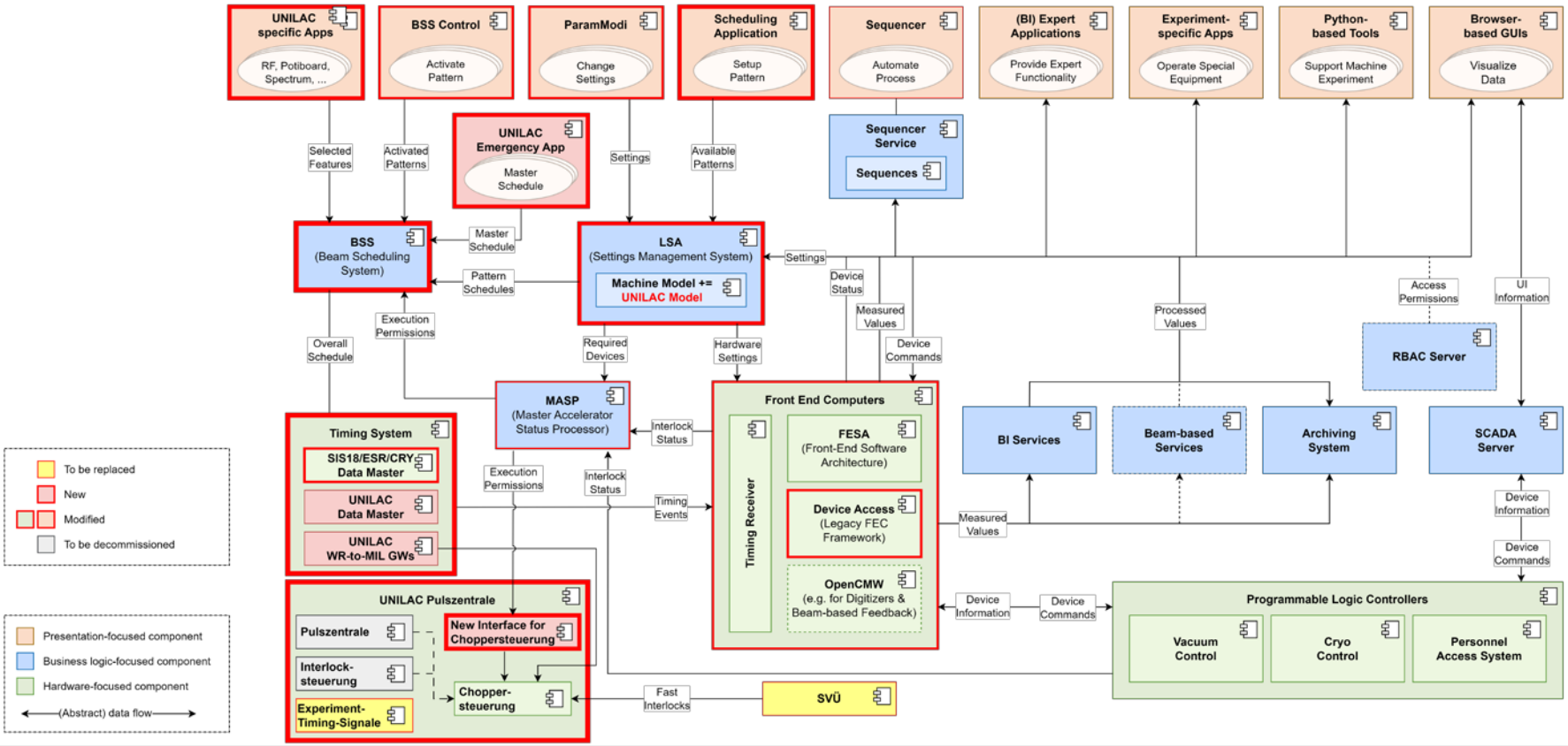
⇒ **in progress**

⌛ **delayed**



(tagging w/o obligation)

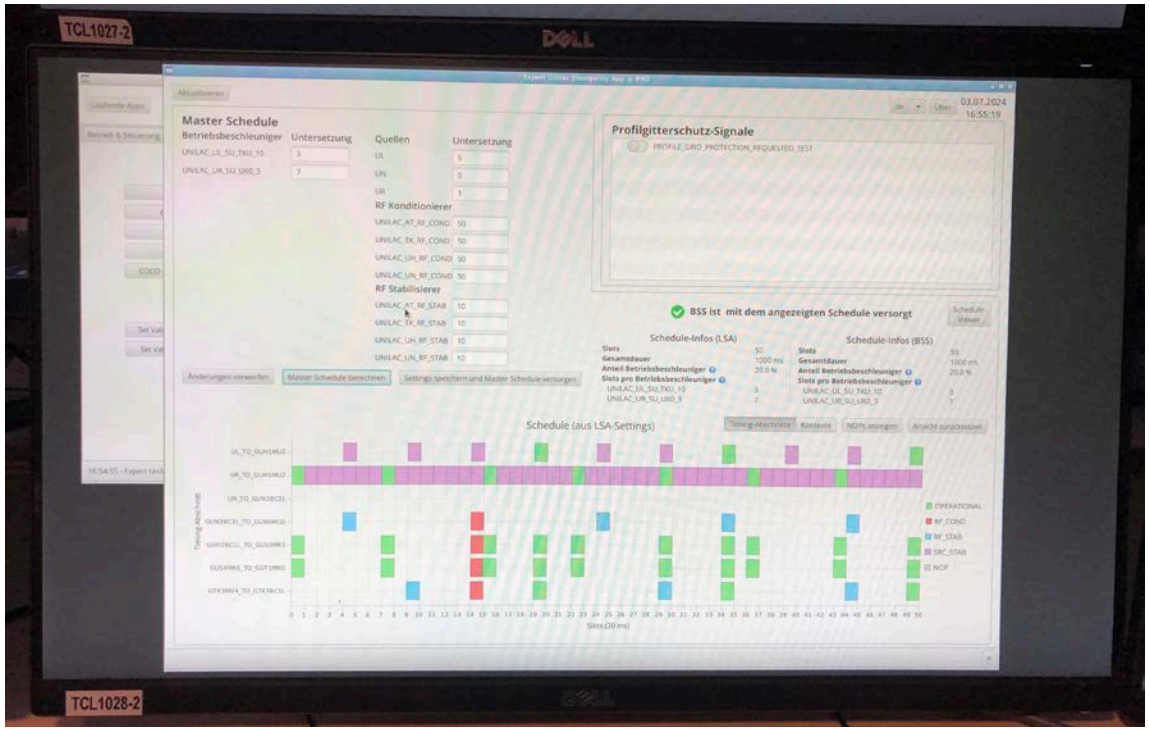
Control System Architecture Overview

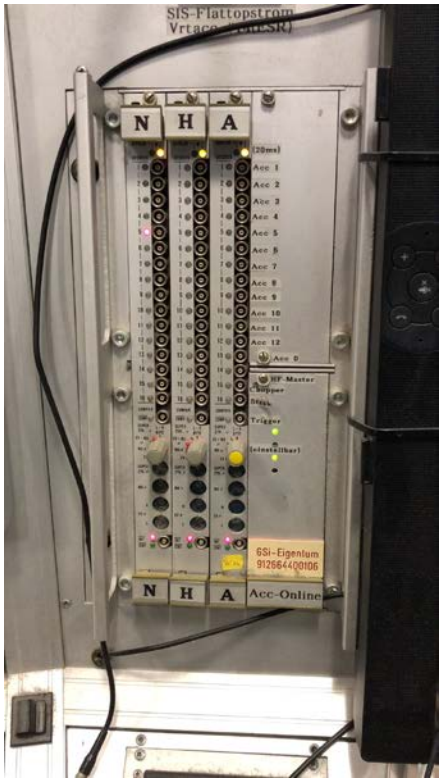


Step 1: develop emergency control system - milestones

- Dry Run 2023
  - first test of new control system components at UNILAC (settings generation and data supply)
  - testing assisted by legacy control system
- Implementation of new basic functionality
  - Patterns/Chains at UNILAC, based on existing concept
  - New timing generation and scheduling concept
  - Non-Multiplexed contexts for DC devices
- Dry Run 2024
  - verify main capabilities of emergency control system
  - core functionality complete, standalone testing possible
- Engineering Run 2024
  - test complete emergency control system with beam without SIS
  - feature complete emergency control system
  - Data Master: White Rabbit-based timing with some restrictions, interim pattern concept
  - complete, simplified settings generation and data supply
  - basic operating tools and applications, incl. most of MCR modernization
  - overall reduced operating features and efficiency
- Beamtime 2025
  - only if necessary: operation with emergency control system

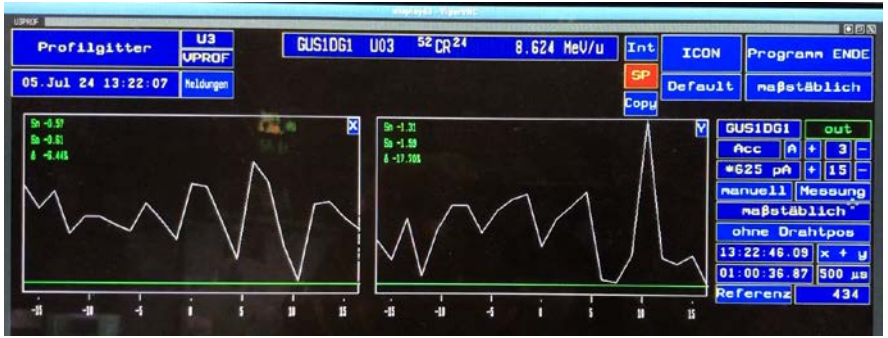
Dry Run 2024-2: Emergency App &
First Data Master Generated UNILAC Timing





taken 05.07.2024

Dry Run 2024-2: First Measurements with original DM WR-to-MIL Timing at UNILAC



taken 05.07.2024

MCR Modernization Overview and Status

Work package	Dept.	Description	Status
MAPS	BEA	Beam current measurement and display	**Commissioning**
UNIMON	BEA	RF cavity display	**Operational**
PHAS	BEA	Phase probe control, bunch shape and energy measurement	**In progress**
Cupid	BEA	Integrated video monitoring system	**Operational, full installation soon**
UNIPOS	BEA	Beam position measurement and display	**In progress**
BIF	BEA	Beam Induced Fluorescence monitor	**Operational, upgrade pending**
Chopper display	ACO	Status display for beam chopper requests	**In progress**
PG/EMI protection	ACO	Control and status display for SEM grid protection	**In progress**
Cup control	ACO	Control and status display for faraday cups	**In progress**
Interlock/beamloss display	ACO	Interlock and beamloss status display	**In progress**
Experiment signal display	ACO	Display any detector feedback from beam users	**Postponed**
WR-Snoop@UNILAC	ACO	WR timing diagnostic tool	**Operational, upgrade pending**
BTM	ACO	Beam Transmission Monitoring	**Pending**
Experiment timing	ACO	Trigger, sync and gate signals for beam users	**Pending**
Gas stripper	PSU	Pulsed hydrogen gas stripper	**In progress**
Potiboard	ACO/OPE	Realtime accelerator (magnet) adjust	**In progress**
Oscilloscopes	ACO/IQU	Signal display for ion sources	**Installation**

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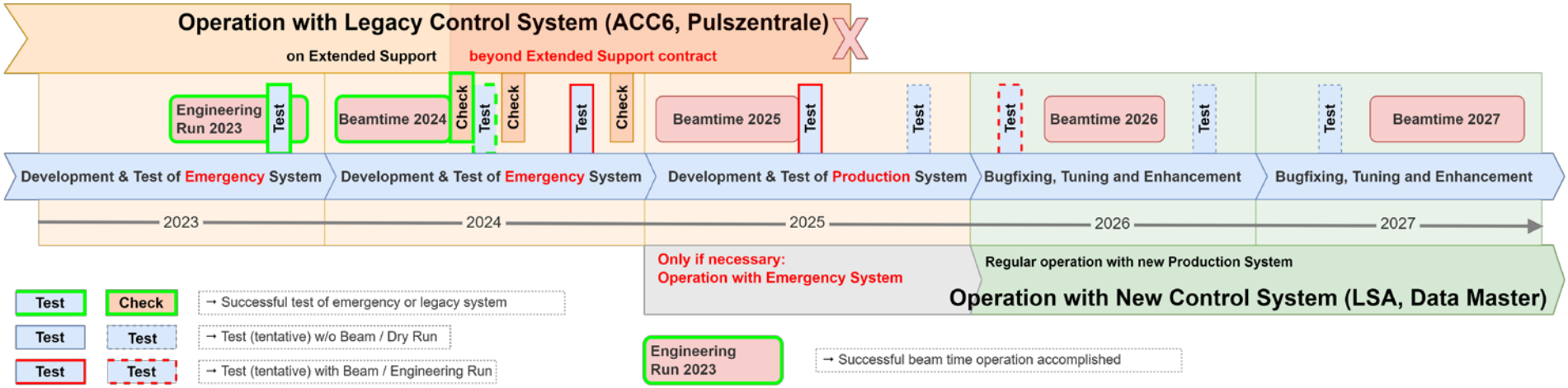
Step 2: develop production control system - milestones

- Complete and finalize implementation of initial production control system
  - starting point: emergency system
  - fully fledged White Rabbit-based timing system, new FAIR pattern scheduling concept
  - enhanced settings generation and data supply
  - full set of operating tools and applications
  - bugfixes, essential tuning and necessary enhancements
- Engineering Run 2025
  - test initial production control system with beam
  - first test of beam injection into SIS18 solely with new control system
- Dry Run / Engineering Run 2025/26
  - in between testing of further developments before first beamtime operation
- Beamtime 2026
  - initial production control system
  - first regular operation with new control system
- Beamtime 2027
  - improved production control system
  - first regular operation of **user beam time** with new control system

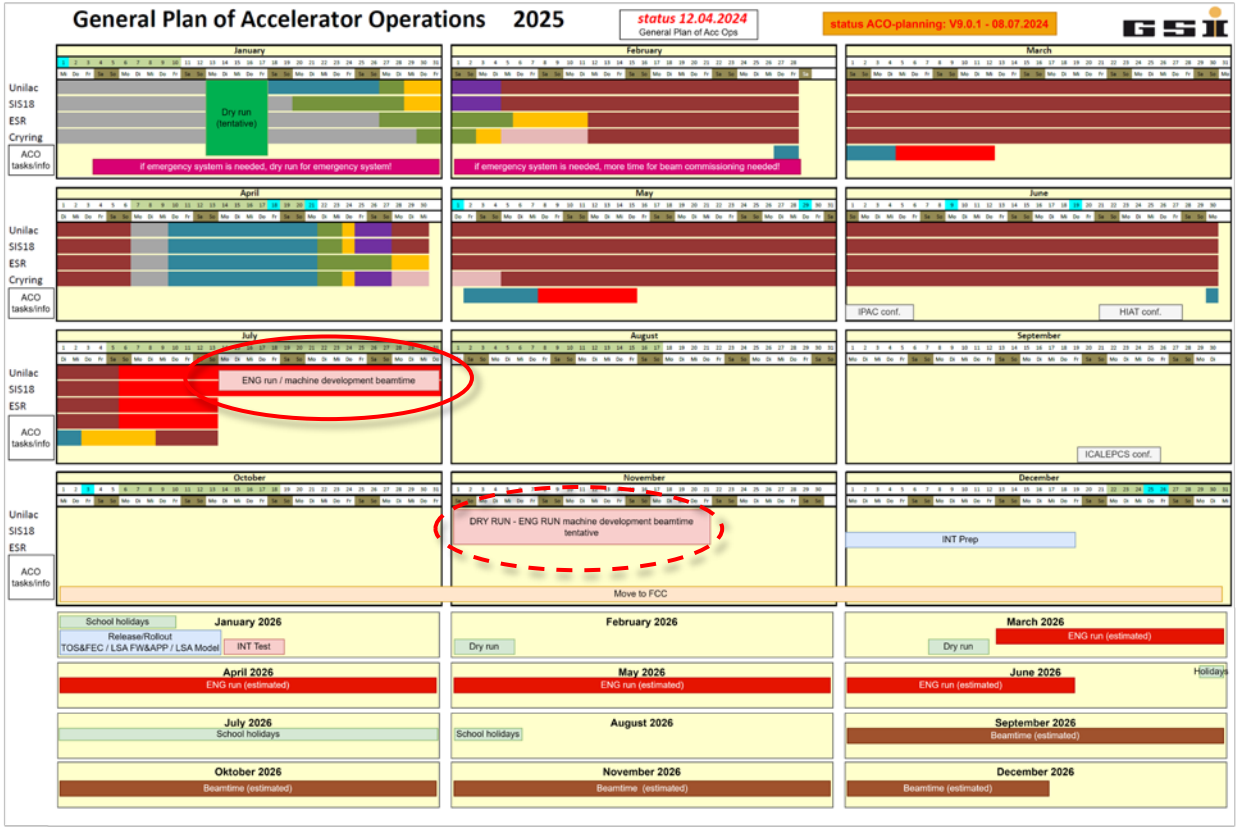
Timeline for Development and Test Strategy



Project Planning 2025/26

Essential:

Engineering run 2025 directly following the beam time and including UNILAC and SIS18 already communicated and fixed



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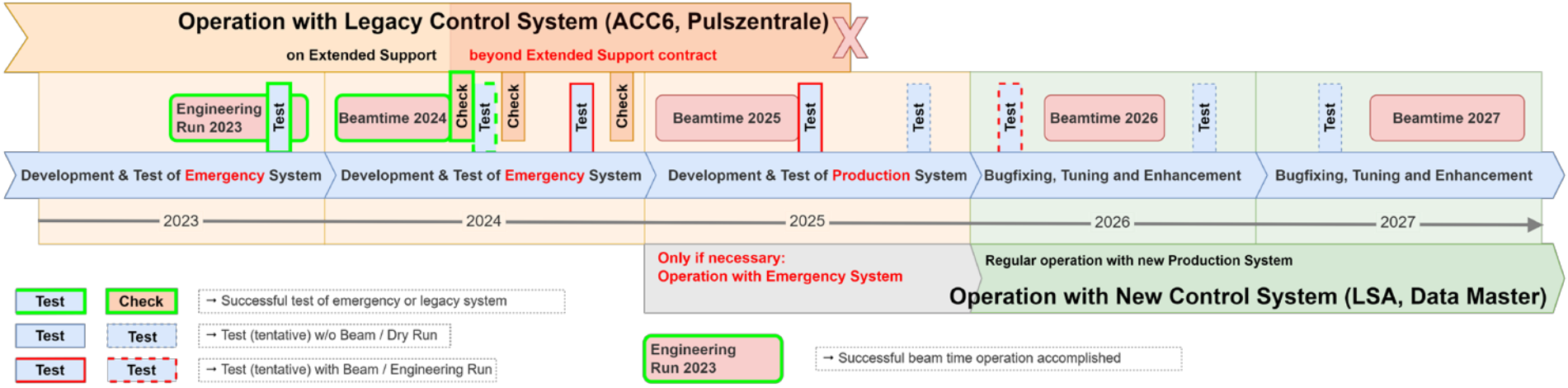
Timeline for Development and Test Strategy

- **Step 2** (develop production control system) **covers 2026 and 2027**
- **Step 3** (further development, include other linear accelerators) **starts 2028**
  - transition to normal development and maintenance
  - bugfixes, tuning and further enhancements ⇒ exploit new capabilities
  - use CS basis created for UNILAC on other machines



Summary and Outlook

- Injector controls upgrade - mission since 2020
  - provide new, LSA based/FAIR standard control system for GSI linacs
  - focus on FAIR injector UNILAC, use functionality as reference
  - enable move to new FCC MCR
  - secure operation of UNILAC through all planned and upcoming beamtimes

- Project
  - Planning, schedule and organization set up achieved
  - First major milestones reached, project well on track
  - Challenges and tight schedule ahead

Summary and Outlook

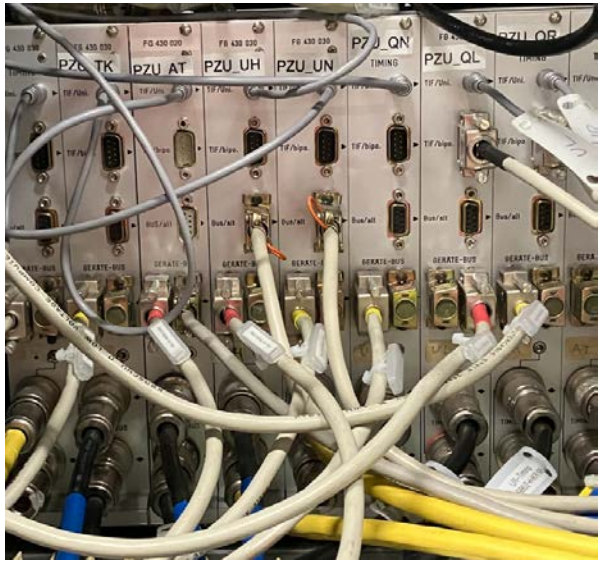
- Legacy System 2024/25
  - Beamtime 2024 served well
  - Last actions executed, testing successfully completed
  - Prepared for beamtime 2025

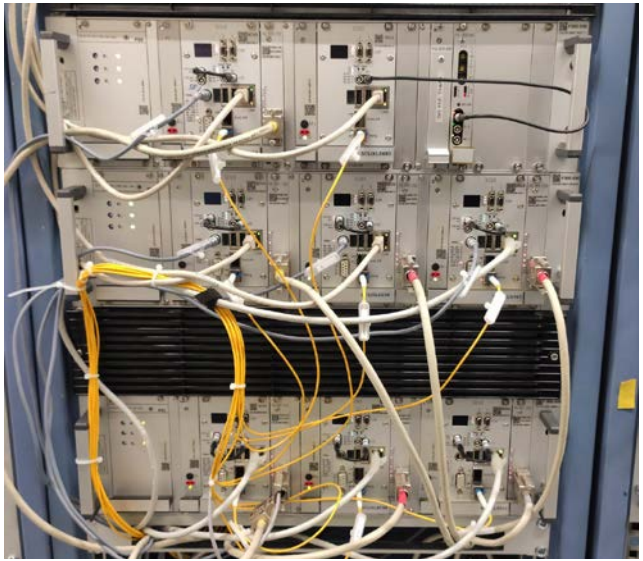
- Emergency System 2025
  - Dry Run 2023 successful, Dry Run 2024 promising, but still ongoing
  - Introduction of new fundamental concepts (Non-mux context)
  - Development largely on schedule
  - Capabilities far better than anticipated
  - Temporary solutions, drawbacks and limitations have to be accepted
    - Intermediate use of existing pattern/chain-concept, will be exchanged by new FAIR concept (standalone-chains)
    - Poor-man's coupling of SIS18 to UNILAC
    - Limited length of master schedule (super cycle) and number of chains (beams)
    - simplified settings generation
  - Complete replacement of UNILAC Pulszentrale remains as major challenge

Summary and Outlook

- Move to FCC:
  - Modernization project on track
    - Most parts will be ready for emergency control system
  - Development of initial production control system on time needed
  - Emergency control system serves as backup

Thank you for your attention!

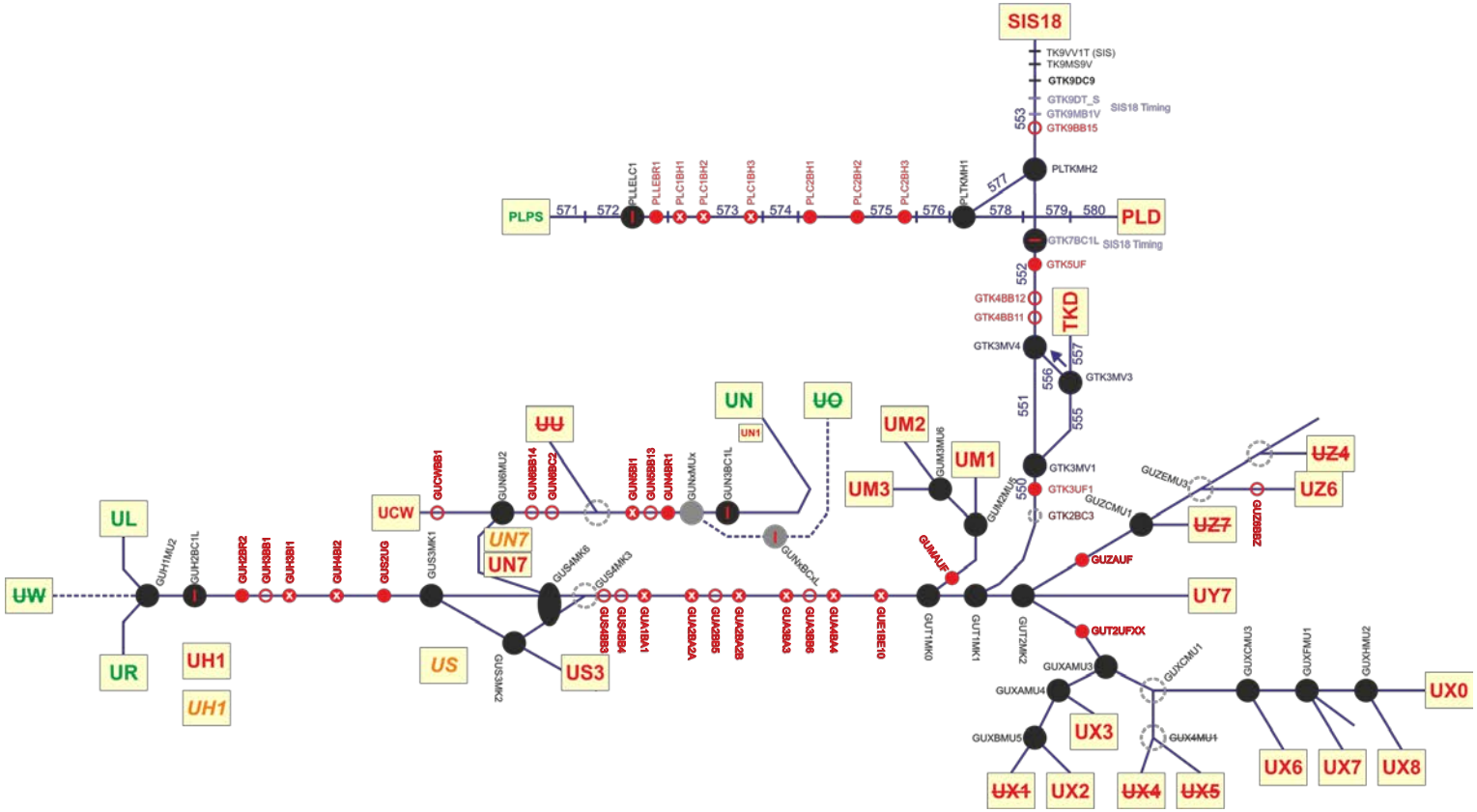
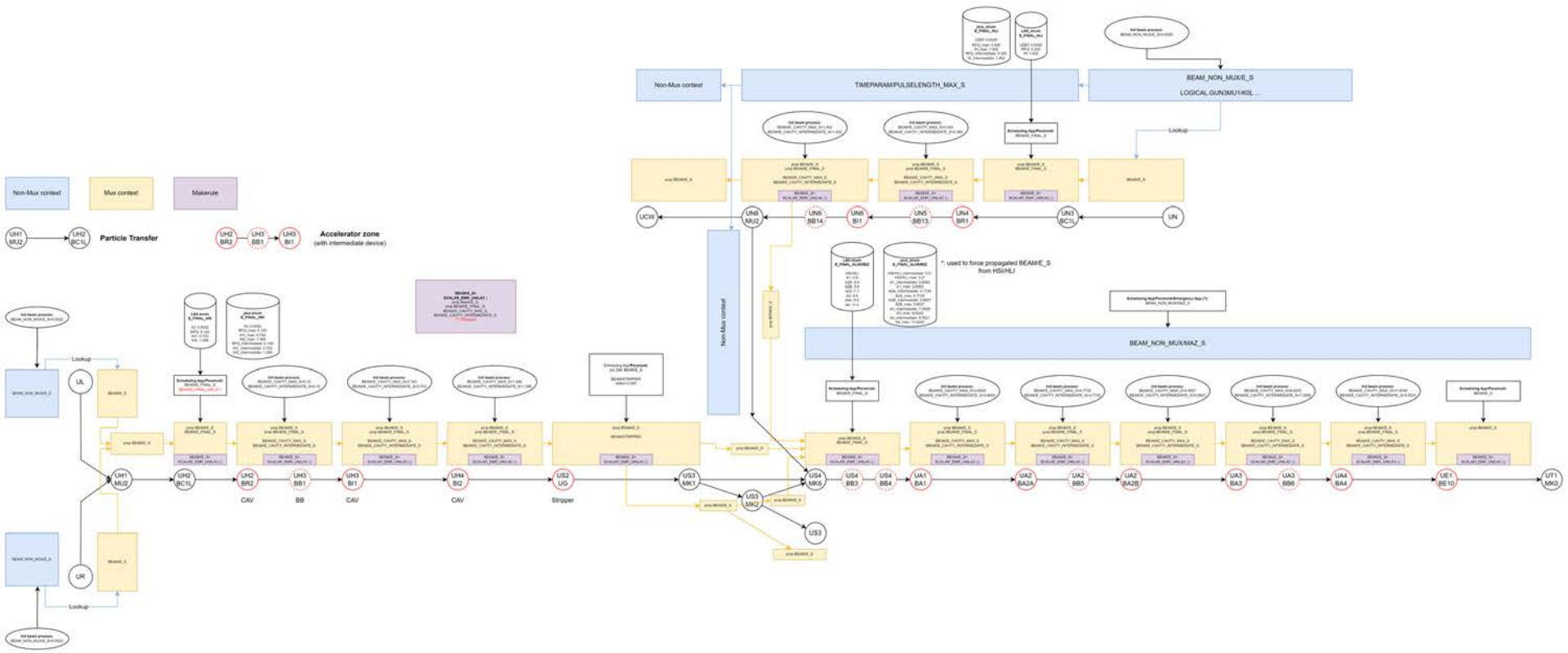




Timing system test on 28.06.24:

^{238}U beam accelerated to SIS18
by use of WR-to-MIL Gateways

Topographic Control System View on UNILAC



UNILAC LSA beam energy model