FAIR Control System Status

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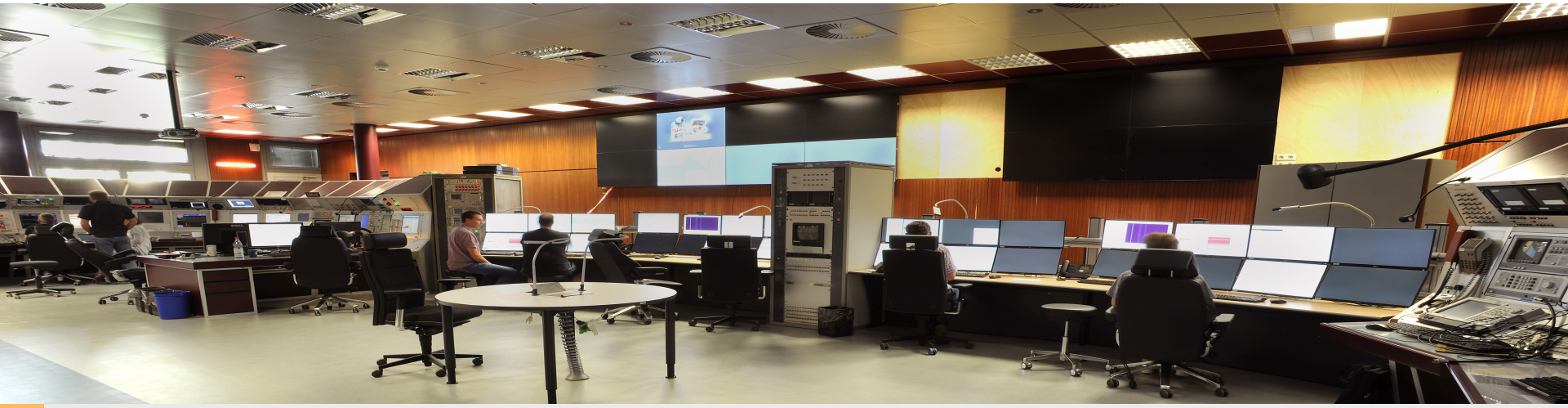
5th BINP-FAIR Collaboration Coordination Workshop

Presentation Outline

- FAIR Control System: Architecture & Overview
- Status of the Control System development and deployment
- Present activities 2020
- Preparations for (hardware) commissioning
- Status regarding CR controls
- Summary



The “Big Picture”

Strategic Considerations and Decisions

Development of a new Control System for GSI and FAIR

- **Design as Open Distributed System**
  - The CS is designed as an open distributed system, so that other technical groups can contribute to the development and bring in their specific expertise, e.g. the physics modelling of the accelerators (LSA), development of equipment classes (FESA), development of operational applications, beam-based control loops.
  - CS shall provide open interfaces to users, e.g. to Archiving, Settings Management

- **Collaboration Approach**
  - Profit from collaborations as much as possible (→CERN): reliable, tested solutions and focus to extend/enrich/develop features specific for GSI/FAIR. → e.g. LSA (setting management), FESA (front end system architecture), cmw (controls middleware), UNICOS (industrial controls), White Rabbit (timing).

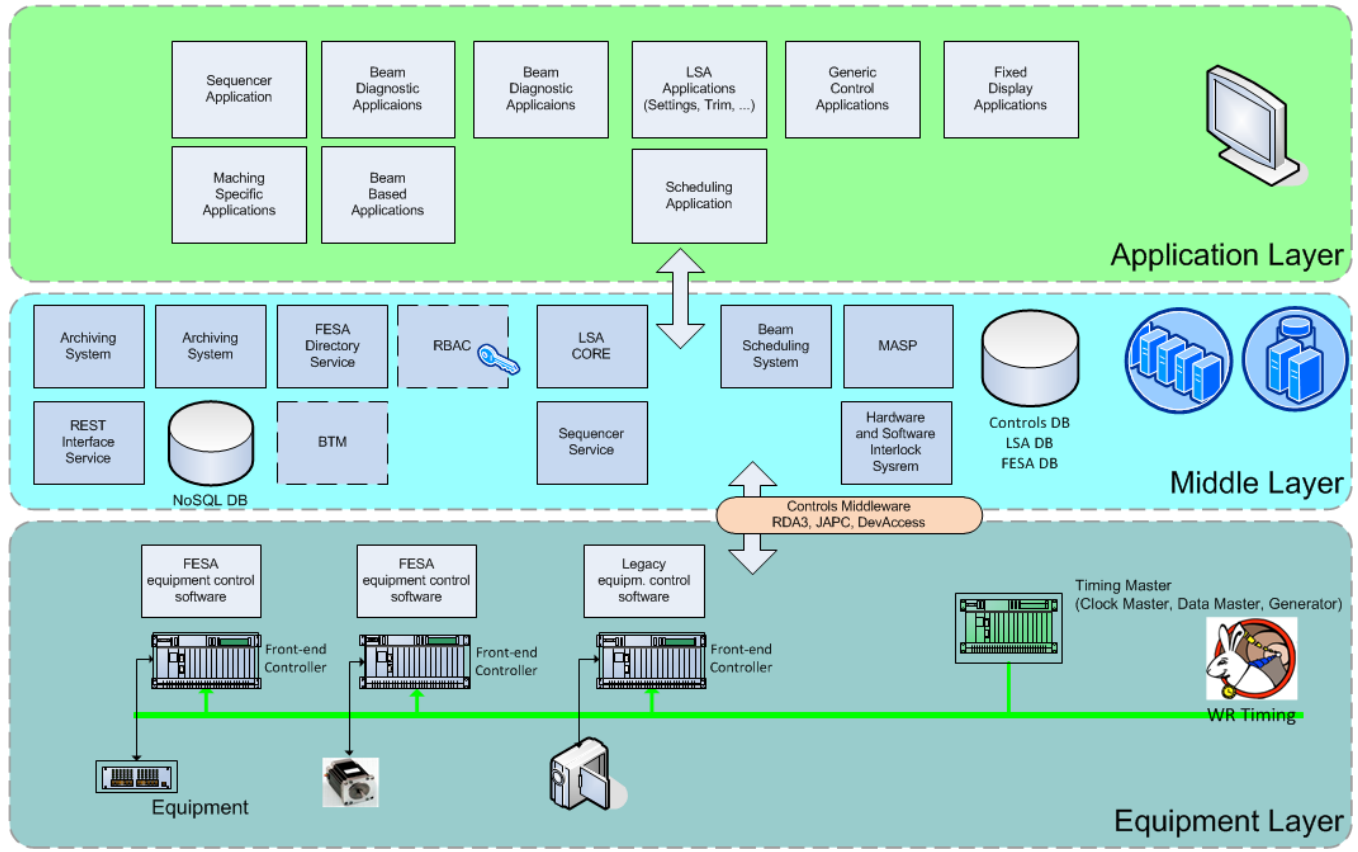
- **Deploy and test the FAIR control System at GSI first**
  - Get robustness and reliability as high as possible prior to FAIR commissioning
  - Identify possibly design flaws, bottlenecks, problems asap
  - Get operation and users involved and trained in the new system

Recap: The FAIR Control System Stack

Presentation Tier

Middle Tier powerful servers

Resource Tier FESA



- Standard 3 tier model; distributed OO system
- Modular design with well defined interfaces

Control System Status (1)

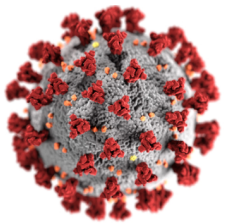
- Development of the FAIR Control System has made a big step forward within the last 2 years

- According to implementation strategy, the CS was already deployed at the existing GSI accelerator
  - SIS-18, ESR, CRYRING, HEBT (but not not yet at UNILAC)
  - Allows identification of possible design flaws, bottlenecks and other problems
  - Operations team and users can get involved, trained as early as possible, give feedback

- FAIR Control System was used under production conditions for already 2 physics beam times:

- **Beam time 2019**: only basic "synchrotron-like" mode, as planned
  Operation was successful, but difficult due to lack of stability, performance and usability

- **Beam time 2020:** Successful Operation (despite Covid-19 situation!)
  - Interactive "storage ring mode" functions added, as planned
  - Synchronized beam transfer SIS18→ESR→CRYRING



  - For SIS18/ESR/CRYRING/HEBT the basic feature-set of the CS is considered complete
  - Present operation mainly based on expert programs, but functions are there
  - Positive feedback and acceptance from users, however pressing issues to be addressed

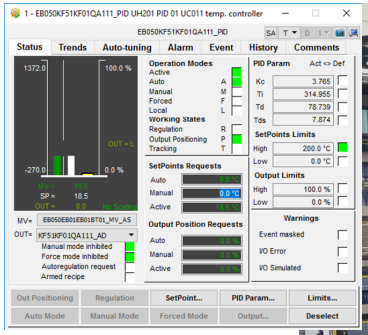
Control System Status (2)

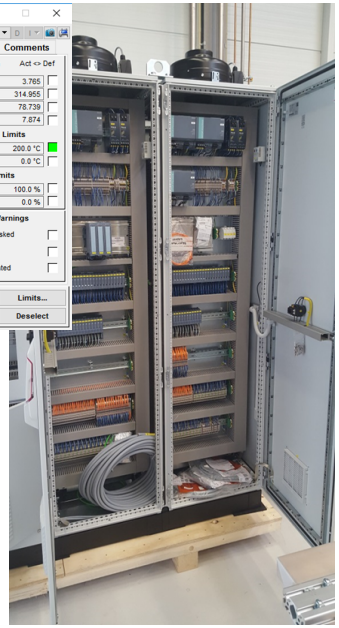
- Operation shows robust operation of central CS subsystems:
  - LSA-based setting generation and management system: good reproducibility of beam settings
  - Beam scheduling system BSS (beam requests and management, REST user interface)
  - Timing system: White Rabbit-based timing infrastructure and RT scheduler
  - Beam interlock system (MASP: hardware and software interlocks, beam modes)
  - UNICOS-based vacuum control system (including bake-out)

- Central system architecture and all new concepts have proven to be adequate for facility operation, no showstoppers identified

- As it stands today, normal conducting machines at FAIR could already be operated with the now existing control system.

Other Achievements (1)



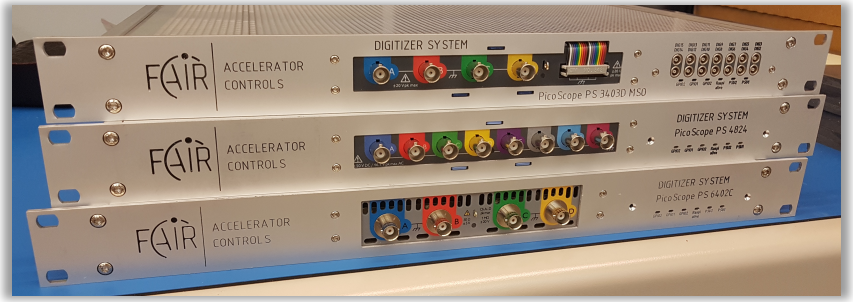


Significant progress has been made on a broad range of fields…
Selected achievements of the last 12 months:

- Vacuum Control
  - Obsolete UNILAC vacuum control system fully replaced by FAIR-type solution in 2019 (PLC- and UNICOS-based)
  - CRYRING vacuum and bake-out control: →in operation at CRYRING
  - Development of software and hardware pushed to a very advanced level
  - However, delivery of vacuum control system for FAIR is mainly Slovenian IK contribution
- Timing system
  - Timing system: all WR-switches produced by industrial suppliers, delivered and successfully tested (SAT for 320 units done, installed in Green IT-Cube)
  - Timing receivers in several form factors developed and/or delivered (SLO IK contribution)
- Software delivered as SLO in-kind contributions
  - Archiving system: measurement DB, storage service implemented
  - Ring BPM data acquisition software and data concentrator service implemented

Other Achievements (2)

- High-quality analog signals Digitizer System developed
  - COTS digitizer systems selected and integrated (scopes from Pico Tech.)
  - Electro-mechanical system integration done, CE certification
  - Time-domain FEC software integration done, freq. domain to be done
  - Hardware Platform for Time- and Frequency-Domain Acquisitions
  - Several user-level GUIs (standard Application)
  - Systems in roll-out for SIS-18



- Integration system (INT) established
  - Additionally to the development (DEV) system, improved testing capabilities
  - Allows testing and integration in parallel to operation (PRO)

Present Activities

Technical Consolidation Phase

Major activities in 2020 ➔ Top Priorities

- **Technical consolidation** on all fields
  - In the last years → implementation of new functions have been in the focus of development
  - Now → removing technical depts in all systems to come to a sound technical (code)base again for all further development (remove bugs, work-arounds, code refactoring, API cleanup, …)
    - LSA code merge with CERN completed
    - Migration codebase from svn to git (FESA)
    - New timing release

- **DAQ functions**
  - Read-back functions not rolled out for/during last beam time (Corona)
  - Roll-out of dedicated Digitizer systems

- **System performance optimization** → Task Force Performance (TFP)
  - System response times for LSA settings/trims is poor (not acceptable on the long run)
  - Issue well known, however not yet addressed (focus was not yet on providing functions)
  - Cross-system improvements introduced→ substantial improved operational efficiency
  - no fundamental flaws in control system design or architecture has been found so far
  - Performance will be further monitored during the coming beam times

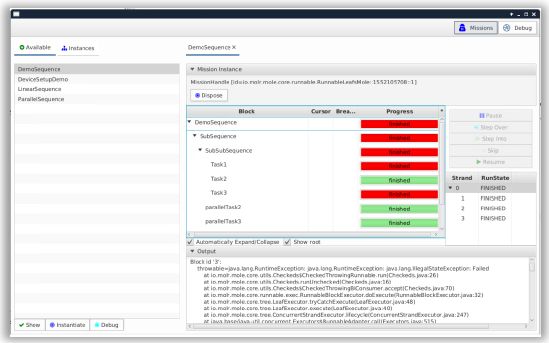
Present Activities

Next Steps & Preparations for HW Commissioning

- Preparation and support for **SIS-100 String Test** (early-2021)
  - Operate SIS-100 pattern in PRO environment (LSA model available)
  - Operation of ramped power supplies for s.c. magnets, DAQ, QD-trigger matrix, …

- Development of a **Sequencer Service** for FAIR commissioning and operation
  - Essential tool for operation and commissioning
  - 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

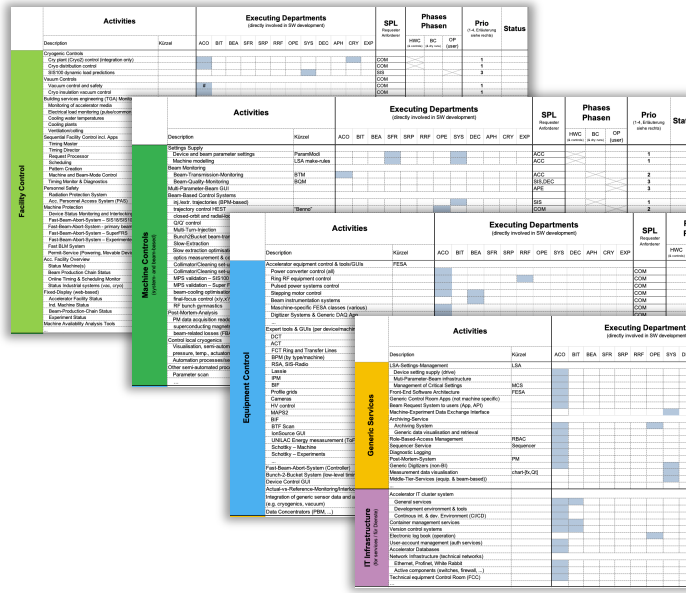
  - Controls provides the sequencer service (”the tool”)→ Prototype available
    however: exploitation of the sequencer needs to be done by users
    → need to engage and define precise test procedures,
    entry conditions, dependencies, ...
    → suggest to practice on small scale tests at existing
    machines before ramping up



- **UNILAC Controls Modernisation** (project started 2020)
  - Replace old CS: integration in FAIR, maintainability,
    migration operation to FCC in 2024

Next Steps: Preparation for Commissioning

Workshop on "Controls Developments for FAIR Commissioning and the Operation of the Existing Accelerator Complex" (16./17.09.2020)
Control system needs to be prepared well for these upcoming challenges of (hardware) commissioning



- Excellent presentation by O. Gorda on CR requirements
  - Many requirements are shared with other machines or are available already

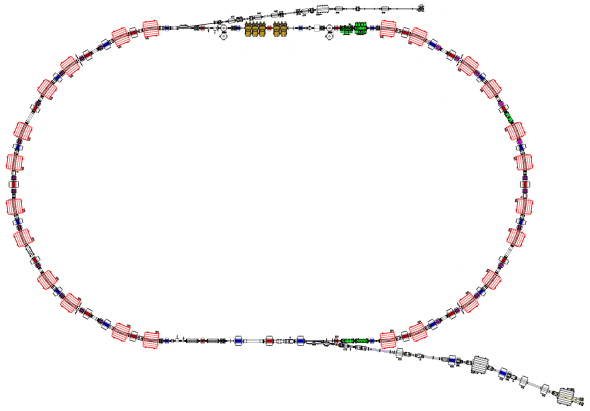
- As expected, high number of requests to the controls group
- Unrealistic for Controls group to satisfy all requests
  →consolidate and prioritize developments

- **Controls Steering Committee** presently being established (members from different areas: CO, FAIR Commissioning, Operation, FAIR Accelerators, Experiments, TI)

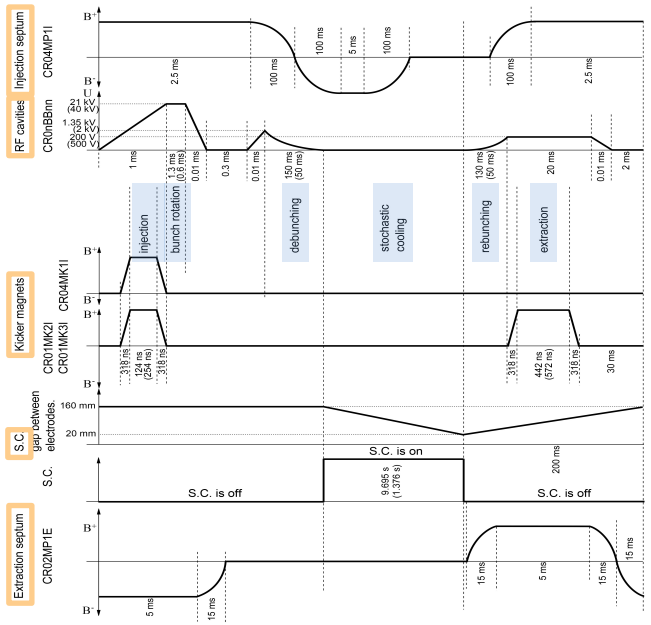
  - Consolidate activity list, define priorities (in line with re-based project plan) →present to management for decision
  - Continuous monitoring of status, adjustment and arbitration of activities

Status regarding CR Controls

- Presentation of O. Gorda is an excellent start
  - Information on equipment and operation mode
  - Commissioning without/with beam →tools, testing, …
  - →follow-up discussions to clarify and refine planning



- Major components are power Converters: SCU-based control is in an advanced state and already in standard operation
- Injection & extraction devices: developments ongoing for SIS-100 →standardized developments
- Timing system, trigger signals → already developed (FAIR timing system in operation)
- Data acquisition: SCU-based and PicoScope-based under development: basic functions available
- Sequencer for tests: under development →specific requirements for CR welcome →discuss
- Stochastic cooling system: integration need discussion



- LSA model for CR should be developed early:
  - Define pattern, cycle, specifics
  - Operation, Apps

Summary

- Significant progress in development of the FAIR Control System
- FAIR Control System is already in regular operation at existing GSI machines

- Present activities focus on consolidation, performance issues and operational improvements

- Preparations for FAIR commissioning has started
  - First controls tools are under development: Sequencer services, require users to engage
  - Workshop on Controls requirements for FAIR and Operation held in 09/2020
  - CO Steering Committee shall consolidate activities and suggest priorities to management

- Control system works for CR
  - Major work for standard components already done or under development for fore-front machines
  - Communication between CR & Controls Team → intensify and more regular

- Next steps
  - Consolidate requirements for CR (scope, refine interfaces/details)
  - Establish a more intense communication
  - Cooperate to define testing/commissioning sequences

50 YEARS GSI

thank you!