First Production Use of the new Settings Management System for FAIR

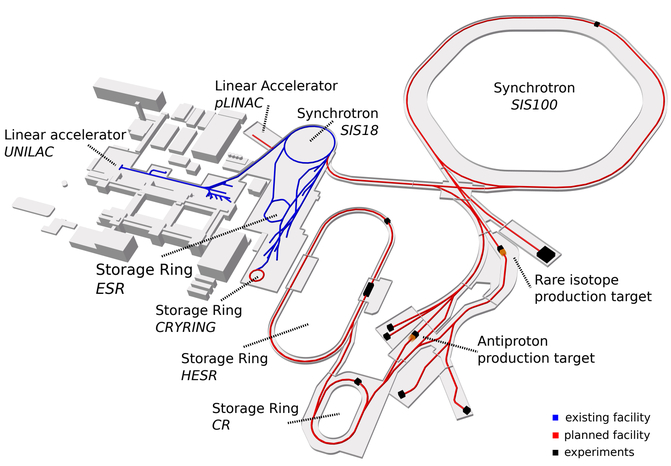
J. Fitzek, H. Hüther, R. Müller, A. Schaller *GSI, Darmstadt, Germany*

Abstract

With the successful commissioning of CRYRING, the first accelerator being operated using the new control system for FAIR (Facility for Antiproton and Ion Research), also the new settings management system is now used in a production environment for the first time.
Development efforts are ongoing to realize requirements necessary to support accelerator operations at FAIR. At CRYRING, new concepts for scheduling parallel beams are being evaluated. After these successful tests and the first production use, the focus now is to include major parts of the existing facility (synchrotron SIS18, storage ring ESR and transfer lines) into the system in the context of the Controls Retrofit project. First dry runs are planned for Q4 this year.
The settings management system is based on the LSA framework, that was introduced at CERN in 2001 and is being developed and enhanced together in a collaboration with GSI. Notwithstanding all successes of LSA at both institutes, a review study was set up with the goal to make the LSA framework fit for the future. Outcomes of this study and impacts on the settings management system for FAIR are being presented.

Current Control System Milestones

- CRYRING (Swedish in-kind contribution to FAIR)
  - Commissioning in 2015, several beamtimes up to now
  - First machine to be fully operated with the new FAIR control system on all levels
- Existing GSI accelerators
  - Currently in shut-down for the FAIR upgrade
  - Retrofit project (2016-2018) to operate the existing machines (except UNILAC) with the new control system
  - Beamtime in Q2/2018



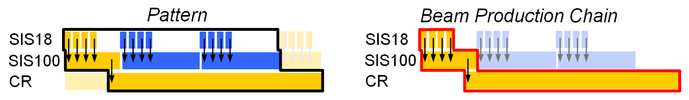
FAIR facility, FAIR, GSI.

Making LSA ready for Production Use

The settings management system is based on LSA, that was started at CERN in 2001 and is being developed and enhanced together in a collaboration. At GSI, LSA is used in production for the first time.

- Database:
  - Setup of a production DB from a defined state using database versioning tools → see TUPHA041
  - Only allow import scripts, no manual data modification
  - Data sources must be either other DBs (e.g. accelerator layout, devices, calibration curves, etc) or versioned scripts (e.g. optics, twiss information)
- Release Procedure:
  - Official releases of the control system every half year
  - Introduced release branches on all levels (LSA and applications, ~50 projects)
  - Using Maven release plugin, first tests with the reactor plugin to do the release in one go
- Calculation of the timing schedule for the new White Rabbit-based timing system:
  - Schedule is generated in LSA, kept as regular settings
  - Timing system is treated as just another “device”
  - Ongoing: improvements to the timing system interface to make it more flexible and comfortable

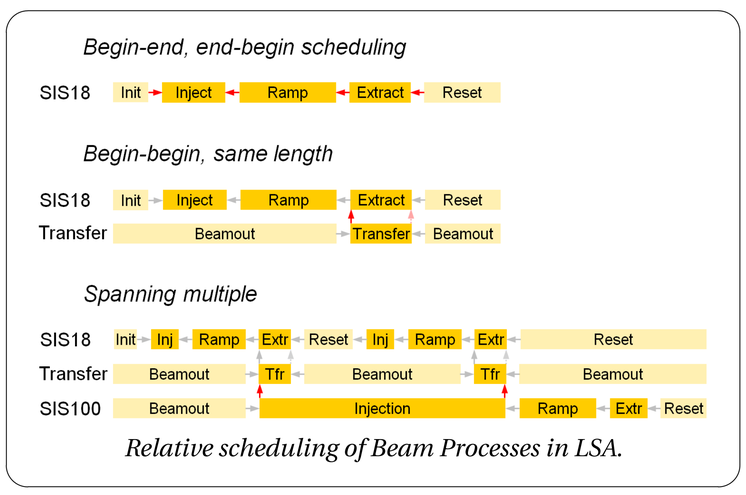
Realization of New FAIR Concepts



Patterns and Beam Production Chains as new concepts for scheduling beams, D.Ondreka, GSI.

FAIR operation poses unique challenges with up to five parallel beams and pulse-to-pulse switching between particles. New parallel beam scheduling concepts have been designed and are now realized also in LSA, with first successful use at CRYRING.

- New: Beam Production Chains represent single beams
- New: Patterns group those Beam Production Chains into scheduling blocks that are executed in the machine
- Existing: Beam Processes in LSA describe single steps in the machine like injection, ramp, extraction and are central objects for keeping settings. This concept has been kept: Beam Production Chains are composed of Beam Processes.
- New: Relative scheduling, instead of scheduling Beam Processes at fixed times
  - ✔ begin-end: Beam Process for ramp comes after injection
  - ✔ begin-begin, same length: Beam Process for the transfer line is scheduled parallel to the extraction in the ring
  - 🕘 end-begin: Beam Process without beam (beam-out) extends until the next injection begins
  - 🕘 spanning multiple: Beam Process for injection in SIS100 spans multiple SIS18 booster mode extractions



Relative scheduling of Beam Processes in LSA.

LSA Tasks for the Retrofit Project

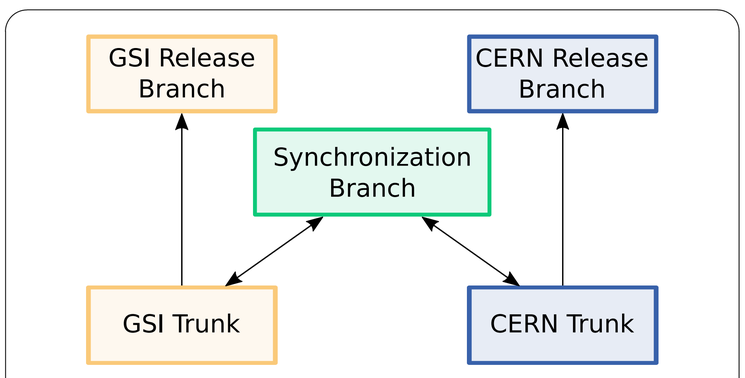
The existing accelerators (except UNILAC) will fully controlled with the new control system beginning with the beamtime in 2018. Related to the settings management system, the following steps have been taken.

- Import of master data
  - ✔ Transformation of accelerator layout into LSA structures
  - ✔ Import scripts provided, no manual data entry allowed
  - ✔ First import of device data for Dry Run #1 performed
  - ✔ Import of the existing SIS18 physics model successful
  - 🔧 Import of transfer line model and ESR model
- Integration of legacy equipment controller software
  - ✔ Communication using a specific middleware plugin
  - 🔧 Some data types and complex structures are not compatible with LSA, review and modification started
  - 🔧 Mapping of timing events defined, include events for existing devices in the new schedule
- Quality Measures
  - 🔧 Implement “self-sufficient” test cases that run in both institutes
  - ✔ “Mock” FESA devices
  - ✘ No mocks for legacy equipment controller software
  - 🔧 Setup of integration system for controls started
  - 🕘 Dry runs starting in Q4/2017

Organization of the Collaboration

In the past, transferring features from CERN to GSI and vice versa was performed using the SVN trunk at CERN and it was almost impossible to get one feature without retrieving other unfinished changes. Therefore a new mechanism has been set up:

- ✔ Introduced new synchronization branch to be able to exchange features on the Java side more easily
- ✔ Decoupled the time schedules: both institutes can pick features when it fits to their plannings
- 🔧 Using database versioning at GSI and in the future also at CERN will help exchanging corresponding DB changes



Repository setup including the new synchronization branch for feature exchange.

LSA Review

Review Study at CERN

The LSA system has been developed over 15 years now. Goal of the Study was to really question LSA itself, its structure and its functionality. Developers from GSI contributed to this study with their experience with LSA. List of proposals, i.a.:

- LSA core is quite big, gets harder to maintain. Proposal to inverse the logical structure, with a very slim settings management core plus additional functionality in layers
- Remove institute specifics from the common core
- Improve parameter relations management and move it from a DB implementation up to a more maintainable Java version
- Enhance configuration possibilities, e.g. physics rules on a per-parameter basis instead of parameter type
- Improve settings archiving mechanism
- Improve testing of the core

Performance Review at GSI

Frequent changes of top-level parameters (e.g. energy) are performed at GSI. Such trims affect a great part of the parameter hierarchy and lead to recalculation of many settings that takes some time. Therefore, an LSA performance review was done:

- Sequential as well as parallel optimizations performed
- Huge speedup was achieved → see TUPHA019
- Allows the user to change top-level parameters without much noticeable delay
- Next step: merge these changes into the common codebase to make them available also at CERN

Summary and Outlook

- Successful first production use of LSA at CRYRING
- Ongoing efforts to realize the Pattern concept
- Next steps: finalize features needed for the Controls Retrofit Project in 2018, e.g. parallel execution of disjunct Patterns
- Upcoming topic at GSI will be the storage ring concept with stop points and alternative execution paths
- Advance the exchange of features in the collaboration, e.g. by introducing nightly builds with a corresponding sync DB

presented at ICALEPCS 2017