MANAGING THE FAIR CONTROL SYSTEM DEVELOPMENT

Ralph C. Bär, Frédéric Ameil
GSI Helmholtz Center for Heavy Ion Research, Darmstadt, Germany

Abstract

After years of careful preparation and planning, construction and implementation works for the new international accelerator complex FAIR (Facility for Antiproton and Ion Research) at GSI have seriously been started. The FAIR accelerators will extend the present GSI accelerator chain, then being used as injector, and provide anti-proton, ion, and rare isotope beams with unprecedented intensity and quality for a variety of research programs.

The accelerator control system (ACS) for the FAIR complex is presently being designed and developed by the GSI Controls group with a team of about 50 soft- and hardware developers, complemented by an international in-kind contribution from the FAIR member state Slovenia.

This paper presents requirements and constraints from being a large and international project and focusses on the organizational and project management strategies and tools for the control system subproject. This includes the project communication, design methodology, release cycle planning, testing strategies and ensuring technical integrity and coherence of the whole system during the full project phase.

FAIR PROJECT

FAIR, the new Facility for Antiproton and Ion Research is a new international accelerator facility for the research with antiprotons and ions. It is being built at GSI in cooperation of an international community of countries and scientists. The accelerator facilities significantly extend the present GSI accelerator complex, then being used as an injector for the FAIR machines.

In October 2010, nine countries signed the international agreement on the construction of FAIR under international law. FAIR will be financed by a joint international effort of so far 10 member states. The Federal Republic of Germany together with the local federal state of Hesse will provide the major part of the budget. International partners in Europe and overseas will substantially contribute as well, about 30% of the construction costs, some of them already being shareholders of FAIR. The countries will contribute both in kind, by supplying facility components, and in cash.

FAIR will be realized in several modules. The funding for the modularized start version, 1 billion Euro in 2005 prices, has been acquired. The FAIR start version [1] comprises the superconducting SIS-100 ring, CR, HESR, SFRS, Proton-linac and about 3.5 km of beam line.

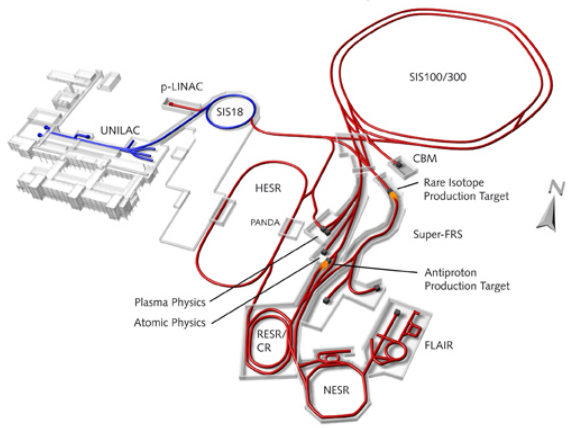

Figure 1: Schematic overview GSI (blue, existing) and FAIR (red, to be built) accelerators and beam lines.

FAIR PROJECT MANAGEMENT

Considering the substantial scope of the FAIR project (with its three sub-projects accelerators, experiments and civil construction), the technical and organizational complexity as well as the high financial investments needed, the FAIR council and mainly the German funding agency has required for a high and professional standard project management.

Consequently, in the past years GSI has established a project organization and management that is adequate for a project of this dimension. In 2012 GSI has been completely reorganized in order to fully focus on the FAIR construction phase. Besides the line-hierarchy, a matrix-like project organization was introduced:

- Project Leader FAIR@GSI (PL)
- Machine Project leaders (MPL)
- Work Package Leaders (WPL)

For the accelerator subproject, a Project Leader (PL) was appointed and a Project Management Office was built up. For the individual machines (e.g. SIS-100, CR, HESR, etc.) 7 Machine Project Leaders were introduced. For the technical subsystems (e.g. power converters, RF systems, vacuum, beam instrumentation, magnets, etc.) about 100 Work Package Leaders (WPL) have been installed and assigned to the respective machines.

Integrated Project Planning

To manage time schedules and resources of the GSI contribution to FAIR, Integrated Project Planning group has been established and project planning tools introduced and customized for FAIR. For resource-loaded project planning, an MS Project 2010 server environment has

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been set up and is intensively used. Project plans for FAIR are organized in 3 levels (see Figure 2):

- Level 1: Master Schedule for the Accelerator Subproject (all machines)
- Level 2: Major Milestone Plans for every FAIR Machine or singled out Major Technical System
- Level 3: Detailed Plans for every work package

Plans are loaded with resources (financial data and generic type human resources, e.g. engineers) and are linked with each other by either hard-links (milestones will move automatically) or soft-links (information on moved milestones only). Links allow identifying major delays in the whole project, establishing the critical path and helping to adjust the resources in order to optimize with the actual capacity. In order to handle to complexity, certain rules for links have been introduced.

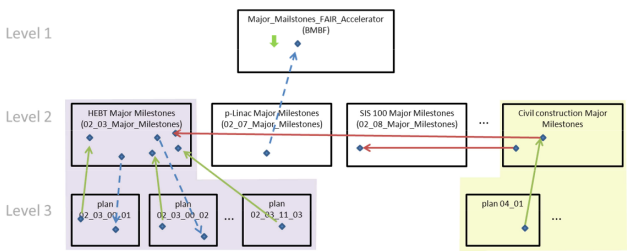

Figure 2: Hierarchy of project plan and links.

CONTROL SYSTEM ISSUES

Since this paper is not intended to describe general FAIR project planning activities we will focus on aspects of the control system development.

In-kind Contribution

For many reasons the ACS for FAIR has been declared as an in-kind contribution to be provided by the FAIR host-lab, GSI. However, about 20% of the ACS cost book value will be complemented as an in-kind contribution by the member state of Slovenia. ACS subprojects with clearly defined interfaces have been mutually agreed to be contributed by developers from the Slovenian consortium. Although based on detailed technical specifications, working our concepts and implementation requires a high level of communication and familiarity with the general ACS architecture and GSI development team. The approach to have a permanent Slovenian project manager/ developer resident at GSI has turned out to be a very successful model. Regular (weekly) Jour-Fixe meetings with the ACS project lead team are established to discuss problems, progress and clarify open questions

Organization

While all technical systems are usually assigned to a specific FAIR accelerator, the ACS is considered an orthogonal aspect to the standard matrix organization. Reason for this is that the ACS is considered a “Common System” for all machines, i.e. there is only one ACS for all GSI and FAIR accelerators. Consequently, in project management, the ACS development is considered an accelerator-like project, is managed by a MPL and is represented by a Major Milestone plan (see Figure 2) that in turn has 10 level 3 plans for

However, since project meetings and communication is usually organized “per machine”, the role of Machine Controls Coordinators (MCC) have been introduced in the controls group. A MCC serves as a contact person for all matters concerning a specific FAIR machine and organizes activities within the controls group.

Design Team

During the design and implementation of a large and complex soft- and hardware project special attention must be paid that a clean design and system architecture is being worked out and followed during implementation. We decided to establish a Controls Core Team (CCT) to create, continuously refine and modify functional specifications and the architectural blueprint of the ACS. This team, constituted of 4 senior developers, ensures the integrity and coherence of the whole system during the full project phase, defines architectural principles and provides formal and technological guidelines wherever necessary.

Project Planning

The development effort of the ACS covers many aspects of hardware and software design and about 50 engineers, scientist and technicians are working presently in the control system group in GSI.

Such a large and complex development project may lead to a too high complexity regarding planning. Thus for practical reasons project planning for the development of the ACS is being done at two different levels of detail. The project planning for development of the ACS needs indeed to target two objectives.

- Integrated planning for each Work Package for the full project period (2013 to 2020) required by the project coordination.
- Detailed planning for all activities

In order to keep the integrated project planning complexity as low as possible the planning of the development of the ACS is organized following an iterative approach. Thus a release chain was introduced with two major releases per year with fixed due dates and a content being adapted to the overall FAIR machine schedule, in other words time schedule remains and content is modified. This cycle length of half a year was considered as optimal.

Then needed milestones for each machine are derived from the release chain and provided for other plans in order to link against them. Furthermore this allows a flexible planning especially considering uncertainties in the FAIR civil construction work.

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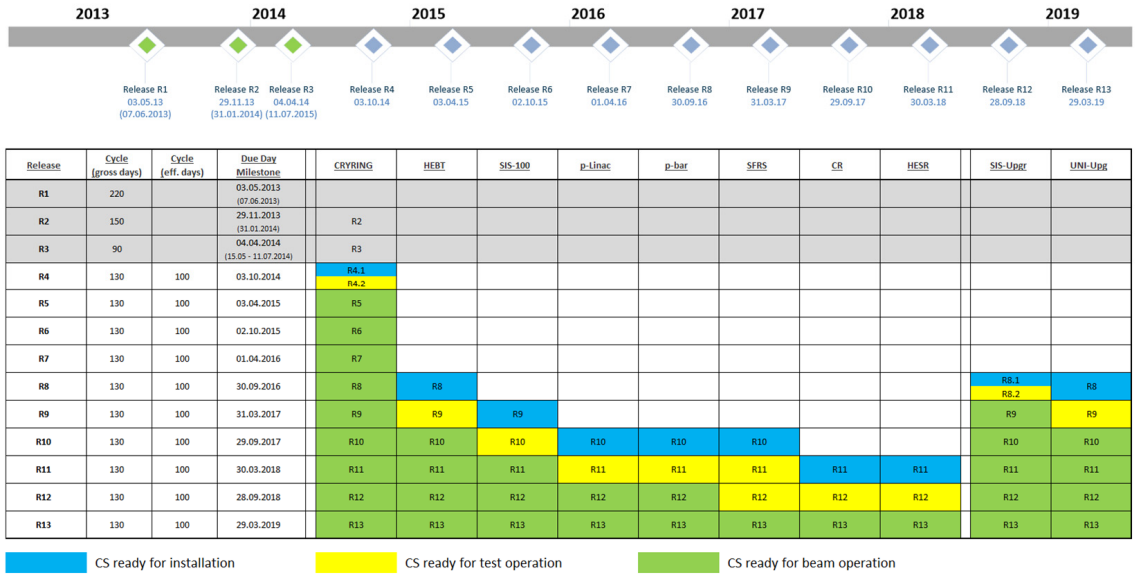

Release	Cycle (gross days)	Cycle (eff. days)	Due Day Milestone	CRYRING	HEBT	SIS-100	p-Linac	p-bar	SFRS	CR	HESR	SIS-Upgr	UNI-Upg
R1	220		03.05.2013 (07.06.2013)										
R2	150		29.11.2013 (31.01.2014)	R2									
R3	90		04.04.2014 (15.05 - 11.07.2014)	R3									
R4	130	100	03.10.2014	R4.1 R4.2									
R5	130	100	03.04.2015	R5									
R6	130	100	02.10.2015	R6									
R7	130	100	01.04.2016	R7									
R8	130	100	30.09.2016	R8	R8							R8.1 R8.2	R8
R9	130	100	31.03.2017	R9	R9	R9						R9	R9
R10	130	100	29.09.2017	R10	R10	R10	R10	R10	R10			R10	R10
R11	130	100	30.03.2018	R11	R11	R11	R11	R11	R11	R11	R11	R11	R11
R12	130	100	28.09.2018	R12	R12	R12	R12	R12	R12	R12	R12	R12	R12
R13	130	100	29.03.2019	R13	R13	R13	R13	R13	R13	R13	R13	R13	R13

CS ready for installation CS ready for test operation CS ready for beam operation

Figure 3: Schedule and release chain until 2019/2020.

Beside this a detailed planning is performed. This is done one release ahead, a detailed planning over a longer period being not realistic. This planning is activity based detailed resources loaded. All required activities for the achievement of the release content are planned and loaded with necessary resources.

Such an iterative and two stage approach represents several advantages both for the development and the planning aspects:

- The system functionality can be extended from release to release (iterative development paradigm)
- Avoid an unrealistic and unmanageable planning for the whole project
- The overload of the resources capacity can be easily avoided
- Tracking of progress allows project to be steered (e.g. modify priorities, move functions to later releases, etc.)

DEVELOPMENT METHODOLOGY

Based on the main requirements for the FAIR control system, an overall system architecture have been set up and a vertical slice through all layers of the control system has been built with basic functionality. Then, in further iteration cycles, components are replaced by newer versions, implementing more functionality, and additional components are added to the base system. By these iterations, the ACS will be extended to the full specified functionality.

In each single iteration cycle leading to a release as described above, requirements and designed functionality can be refined and adjusted, the functionality is implemented and the achieved components as well as the overall functionality are tested. Iteration holds for the system as a whole as well as for single components.

TEST STRATEGY

Presently, the heavy-ion storage ring CRYRING, being a Swedish in-kind contribution to FAIR and before decommissioned in Stockholm, is being installed behind the existing GSI Experimental Storage Ring (ESR) [2]. CRYRING can decelerate, cool and store heavy, highly charged ions that can come from ESR down to a few 100 keV/nucleon. It is equipped with its own injector line that will even allow CRYRING operation while the full GSI accelerator chain is shut-down until mid of 2017 for necessary FAIR upgrade and civil construction works.

As CRYRING has been dedicated as a test ground for the FAIR accelerator control system (as well as for a variety of other technical subsystems), the next step is to set up the control system for re-commissioning CRYRING in the next months to come. The main intention is to test and validate fundamental concepts, technologies and gaining experiences under real conditions in order to identify possible design flaws, limitations, and assure the quality of the control system components involved. While in the beginning the control system and its building blocks will only provide basic features, the intention is to add more and more functionality in the next control system releases to come.

REFERENCES

[1] O. Kester et al., “Status of the FAIR Accelerator Facility”, WEPRO060, IPAC 2014, Dresden, Germany.

[2] F. Herfurth et al., “The Low Energy Storage Ring CRYRING@ESR”, THPM1HA01, COOL2013, Murren, Switzerland.

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