FAIR CONTROL CENTRE (FCC) – CONCEPTS AND INTERIM OPTIONS FOR THE EXISTING GSI MAIN CONTROL ROOM

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Abstract

The 'Facility for Anti-Proton and Ion Research' (FAIR) which is presently under construction, extends and supersedes the existing GSI. Present operation still largely relies on laborious manual tuning based on analogue signals routed directly to the existing control room. The substantial scope increase from 3 to more than 8 FAIR accelerators requires more intricate and precise control across longer accelerator chains, while providing a high degree of multi-user operation, with facility reconfiguration required on time-scales of a few times per week. A new FAIR Control Centre (FCC) is being planned to accommodate the required larger accelerator crews as well as accelerator-based experiments. While targeting a single control room for up to ~35 people, emphasis is put on ergonomics, operational processes, and minimising unnecessary strain on personnel already during the design stage. This contribution presents digital control room concepts, console layout, and beam-production-chain paradigms aimed at achieving good operational performances and that influence the new FCC design. Prior to FCC completion, interim upgrade options of the existing control room are being investigated.

INTRODUCTION

The Facility for Antiproton and Ion Research (FAIR), presently under construction [1,2], supersedes and extends the present GSI facility [3,4,5,6,7], and consists of two linacs, two fast cycling synchrotrons, a dedicated anti-proton production and two fragment separators and four storage rings as illustrated in Fig. 1. The primary beam chain consists of the UNILAC, a UNiversal Ion LinAC that can provide up to three ion species from three independent ion sources at the same time [3,4], a dedicated proton linac [8] and two fast ramping SIS18 and SIS100 synchrotrons [1,2,5,6], targeted to provide highest proton and ion intensity beams ranging from protons with $3x10^{13}$ ppp (particles per pulse) at 29 GeV/u up to U^{28+} with $5x10^{11}$ ppp at 2.7 GeV/u. The targeted intensity of these beams is up to a factor 100 above the intensities presently achieved in any existing facility for these energies which in itself provides numerous operational challenges. The produced primary beams are extracted from each accelerator either within a single turn or over several 100 ms to tens of seconds using resonant slow-extraction onto targets in front of the experimental caverns. Besides experiments with primary beam, these targets are used produce a wide range of secondary beams ranging from anti-proton, mesons, hadrons or other rare isotope beams (RIBs). The anti-protons are collected by a dedicated pBar separator and the RIBs by two dedicated fragment separators (FRS & Super-FRS) prior to being collected in one of the four storage rings which are used to cool, prepare or to conduct experiments with these beams within the storage ring itself.

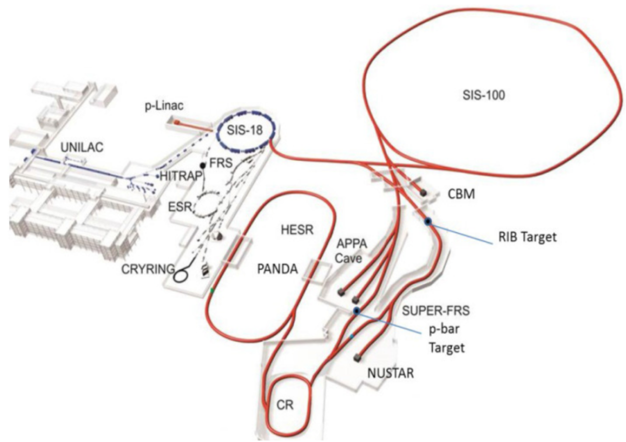

Figure 1: Layout of the existing (blue) GSI and the extended FAIR facility (red).

MAIN CONTROL ROOM

The UNILAC, SIS18 and ESR are operated from the existing GSI main control room (MCR). Routinely, only the UNILAC and SIS18 are operated by a team of 3 operators and a crew of accelerator experts while the ESR is predominantly setup by accelerator experts is conjunction with the experiments physicists. In the control room the operators have to the set-up, re-tune and optimise the machine parameters, while documenting shift events and machine state. With FAIR the scope is substantially increased from 3 to more than 8 accelerators or accelerator-like sub-systems [9]. This provides a number of operational challenges that cannot be reliably extrapolate from operation of the existing. It is expected that there will be a constant flux of frequent adaptations to new cycles/beam parameters and that the facility needs to continue to provide a high degree of flexibility reconfigure the facility for routinely about 4 to 5 experiments in parallel, with many of these experiment lasting often only 5 to 6 days (N.B. median duration). Thus smart and efficient commissioning procedures, training and tools need to be developed. Complementary to this, it was decided to build a new dedicated FAIR

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Control Centre (FCC that provides the required space for a larger new control room for the efficient operation of the enlarged accelerator and technical infrastructure, as well as experiments that are tightly linked to accelerator operation (e.g. storage ring experiments). The control and operational aspects are reflected in the FCC design and user requirements.

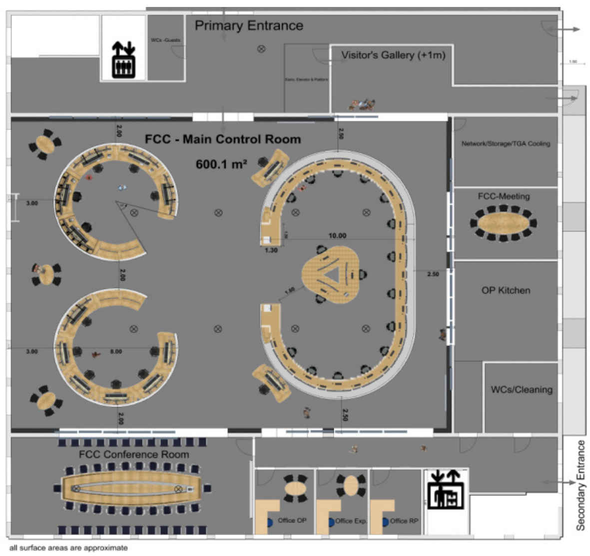

Figure 2: Example of a new control room.

FCC CONCEPTS

The extension towards FAIR enlarges the accelerator complex and requires more personnel and more work space for the operation of the accelerator and associated infrastructure. Due to the limited size of the present control room an effective operation was deemed not adequate in view of the operational requirements and challenges. In the existing control room each accelerator is presently operated by a dedicated operator or specialist. The FCC design criteria include not only the size of the control room and the number of work station, but also the objective of improved open communication lines, a low ambient noise floor and a high ceiling of the room. Figure 2 shows a possible reference implementation of the new control room which includes three single control islands. The primary large island is dedicated to the regular operation of the accelerators, the technical infrastructure and the cryogenics. The other two smaller islands are intended for machine development, (re-)commissioning or experiments tightly linked to accelerator operation. Minimum operation of FAIR, notably during nights and weekends, is expected to require a skeleton crew of up to seven operators for routine tasks of maintaining already set-up beam production chains (BPC), their monitoring and re-tuning, or handling of exceptions (e.g. hardware faults). Full operation, typically during day-time is expected to require an extended crew of up to 25 people for machine set-up of new experiments, (re-)commissioning of accelerators, storage ring experiments, or other experiment with more complex beam parameter requirements. Separate rooms like meeting and conference rooms, kitchen, ready rooms, rest rooms and a visitor's gallery are also foreseen to be placed nearby. Fully digitized signals and controls allow working on each accelerator from all workstations, so the operators can also use one of the two standing tables which are motorised and height adjustable.

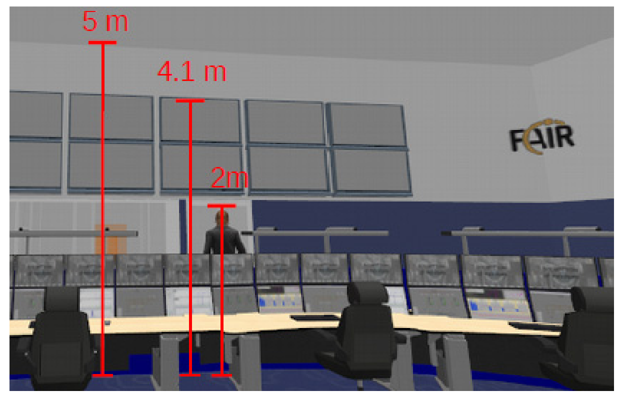

Figure 3: Planned FCC console, screen and fixed-display layout in relation to the control room´s reference ceiling height.

Another important aspect is the ceiling height. A high ceiling height is required to facilitate the fixed-display concept, to minimise the `parking garage effect´ associated with insufficiently high ceiling heights, and to minimise the air speed/draft of the ventilation. A bigger volume of the room also implies lower sound pressure and less standing wave issues. A high ceiling is also beneficial for indirect lighting. The fixed display will be installed above the door with a minimum height of about 2.3 m. Figure 3 illustrates the relation between the ceiling height, fixed displays and console screens. The design aim is that each individual workstation has a good overview of the workplace-related monitors as well as the fixed-display monitors on the wall.

FCC CONSOLE REQUIREMENTS

For each console it is planned to have six independent 24" flat screens divided in two rows, and a set of two 24" screens on either side shared with the neighbouring stations. The upper three screens are semi fixed display, which are targeted to have only rare interactions, e.g. showing beam transmission, beam-loss, status of feedback systems and transverse as well as longitudinal emittance preservation through the beam production chain (BPC). The lower row of screens is used for interactive applications. The set of shared screens between stations will be used for information that is common across different BPCs such as machine interlock status, access system configuration, or similar. For an overview of the whole accelerator facility there will be fixed 60" or 65" display in two rows on the wall. They should be visible across the control room, show the status of all accelerators and overview of all FAIR beam production chain.

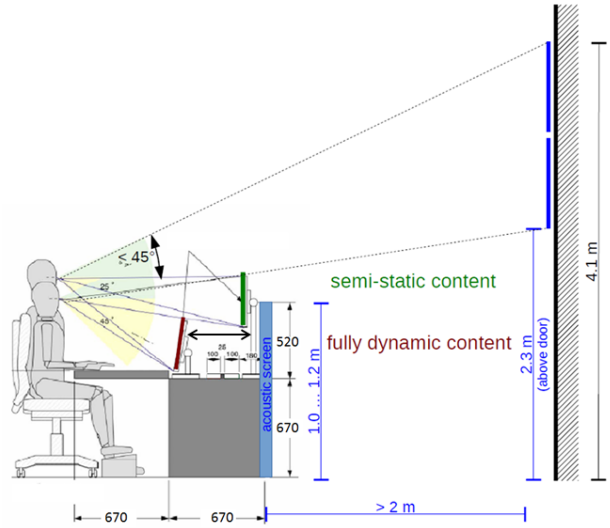

Figure 4: Nominal console and screen geometry in relation to fixed-displays and required distances, based in part on earlier CCC design described in [10].

Figure 4 shows the console geometry in relation to fixed-displays and required distances. The following points have been considered to improve the user ergonomics the wiring of PCs are hidden, -the table targeted to have a minimum depth of 65 cm and the footing of the table shall allow the operators to move their chairs along the console without encountering any obstacle for their legs and feet. The distance between each of the control display and the operator's eyes shall be horizontally adjustable form 50 cm to 70 cm without restraining the usable area of the table. The control and fixed displays shall be fully viewable from both a sitting and standing position. The rim of the highest display shall be at a maximum of 155 cm. Self-standing anti-noise acoustic walls with a high of 120 cm will be located behind the console are used to improve speech privacy and intelligibility, and notably to minimise the noise of the PCs (about 100 PCs are anticipated in the MCR).

UPGRADE OPTION

The retro fitting and migration of the control system to the new FAIR standards is presently in progress. While the FCC is expected not to be ready before 2021, it was deemed necessary to upgrade part of the existing MCR in view of the upcoming recommissioning of the existing facility with the new control system in 2018. This upgrade implements some of the FCC concepts and designs, notably the consoles for the operation of SIS18 and ESR as proof-of-concept prototypes for the FCC. In addition the existing analogue –presently required for operation of SIS18- will be fully digitized and tested alongside the existing oscilloscope based visualisation. This allows gaining experience, may potentially helping and improving upon possible operational short-comings early on and hopefully improving acceptance by the operation crews prior to the full move to the FCC and FAIR control.

Figure 5: First generation prototype height-adjustable standing console.

A photo of a prototype console is shown in Fig. 5. This console is designed for one working place. The new consoles consist of two workstations, each having six monitors and a set of two monitors installed between the workstations. The additional monitors may be used for interlock system, access system, shift documentation or either generic administrative tasks.

CONCLUSION

The planning for the new FAIR control room has almost been completed. Important aspects were worked out together with the users and suggestions for improvement will be included in the FCC design. The old consoles for SIS18 and ESR have been removed in the existing MCR, and the installation and equipment of the consoles is expected to be completed by end of 2017. This should provide sufficient time to facilitate the testing of the new control system in the upgraded control room prior to the SIS18 and ESR recommissioning mid-2018.

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