

FAIR Commissioning & Control Working Group

Notes from the meeting held on 1st July 2015

e-mail distribution: [FAIR-C2WG-ALL at GSI.de](mailto:FAIR-C2WG-ALL@GSI.de), [participants list](#)

Agenda:

- Beam Instrumentation for FAIR – an Overview ([jump below](#)), M. Schwickert
- AOB ([jump below](#))

1. Beam Instrumentation for FAIR – an Overview, M. Schwickert

In his presentation (see [slides](#)), M. Schwickert summarised the planned FAIR beam instrumentation systems (BI), focusing on beam intensity, beam profile, and beam position measurements at the SIS100 synchrotron and HEBT beam transfer lines. BI systems at the other FAIR accelerators and transfer lines are targeted to be either copies of the systems deployed at SIS100 and HEBT or outside the scope of GSI's BI Group.

M. Schwickert pointed out that GSI's Beam Instrumentation Group's primary mission is to provide the bare beam parameter measurements. It was modified over the past recent years in that respect that BI took on new responsibilities with respect to the development of front-end controllers (FEC), related FEC software, and BI-related electronics at beam transfer lines. However, M. Schwickert stressed that presently this would not include resources or efforts related to machine commissioning, support, or development of beam diagnostics¹ methods, nor the integration of these devices into the controls environment needed for day-to-day operation. M. Schwickert and R. Bär concurred that the latter would fall into the responsibility domain of CSCO and its Application Section in particular.

One of the main BI concepts is to focus on industrial standards in order to reduce the required R&D work, to improve the maintainability, to save manpower, and to reduce the required spare inventory. The data acquisition layer (German In-Kind Contribution) is separated from the low-level sensor hardware. The BI Group is committed to an open source and open hardware policy wherever possible or applicable.

BI thus decided in agreement with the other groups to use: FESA as common front-end software interface, CENTOS7 as FEC operating system, White Rabbit and BuTiS as timing sources, PROFINET as common field-bus, Siemens PLCs, VME, uTCA/xTCA, PCIe/IPC form factors, and MBox (a Cosylab development) for the stepper motor control. R. Bär highlighted that e.g. the SIS100 and Super-FRS cryogenic system control will be also based on the same type of PLCs.

¹ ie. combining and making use of multiple BI instruments, measurement procedures, or machine modifications in order to identify the nature and cause of a certain accelerator phenomenon, and to optimise and operate particle accelerators.

BI plans to deploy about 300 devices for SIS100 (details see [slide 12](#)), out of which the beam position monitors (BPMs) and beam loss monitors (BLMs) are the largest distributed systems. In HEFT, BI plans to install about 240 devices, split in about equal parts across beam instruments measuring intensity, position, and beam profile (details see [slide 14](#)).

Most devices are handled by one of the four generic acquisition systems developed by BI and that cover most of FAIR's large scale BI systems: LASSIE (beam intensity, loss, time dependent signals), CUPID or POLAND (beam profiles), and TOPOS (beam position and tune). Some expert GUIs to these systems are available (measurement data display only). However, these GUIs are not intended to be used during routine operation. Also, presently no BI-based interlocks nor integration into machine protection are foreseen under the current scope of planning.

Beam Intensity and Beam Loss

BI plans to deploy a wide range of different detectors in order to cover the beam intensity foreseen at FAIR and to cope with slow (typ. un-bunched) or fast extracted beam requirements: DC current transformers (DCT), fast current transformer (FCT), beam stopper, beam loss monitors (LHC-type ionisation chambers), resonant transformer (RT), cryogenic current comparators (CCC), particle detectors combinations (PDC) covering scintillators and secondary electron emission monitors.

The present base-line foresees that most of these systems are acquired by LASSIE (Large Analogue Signal and Scaling Information Environment). LASSIE is based on analog current- or voltage-to-frequency converters and modular VME-based counter cards. This framework also allows to acquire and integrate any other slow (N.B. kHz range) analog signal for non-real-time post-processing, archiving, etc.

Beam Profile

The acquisition of profile data is handled either by the CUPID (Control Unit for Profile and Image Data) system, a radiation-hard camera based acquisition system for screens, or POLAND (PrOfiLe AcquisitionN Digitizer) for wire-based profile measurements. Ionisation profile monitors (IPMs) are foreseen to be used as a non-intercepting beam instrumentation alternative to screens and wire grids. It is planned to deploy a high resolution IPM comparable to the installation in ESR also in SIS18 and SIS100.

Beam Position

The SIS100 and HEFT BPM system will largely be based on electrostatic shoe-box type pick-ups. The beam position is obtained through a high-bandwidth digitization of the individual electrode signals, that are in turn gated and post-processed in an all-digital approach (FPGAs) using TOPOS (Tune, Orbit and POSition, Slovenian in-kind, based on I-Tech's LIBERA Hadron digitizer). Providing beam position measurement and control of the closed orbit over the whole cycle, the system is also capable of providing data for a fast real-time orbit feedback.

Tune diagnostics will be provided either through the Base-Band Tune (BBQ) measurement System (copy of CERN-development) or TOPOS using the standard BPMs.

M. Schwickert summarised and addressed some of the open questions from a BI point of view:

- While BI detectors, devices, infrastructure and FEC SW are presently clearly well defined, ready for production and to great deal ready for tests (eg. Crying), superordinate/integrated systems (such as transmission monitoring, machine protection...) are NOT!
- No clear procedure for development of integrated systems yet! (who?, what?, how?)
- User requirements are missing to large extent! (For the moment we try to supply maximum set of parameters to be prepared.)
- Larger discussion / agreement on infrastructure topics (PROFINET, database, safety issues) is required.
- Open issues:
 - Definition, technical layout, manufacturing plan for interlock system (many ILKs from BI devices)
 - Definition, technical layout, manufacturing plan for machine protection system (many BI devices are sources/drains for machine protection, eg. BLMs, Stopper....)
 - Commissioning Concept for each machine (general strategy, required measurements....)

Discussion:

<Question to be clarified (M. Schwickert): Slide 11: is the mentioned maximum 8 μ s bunch length correct? The longest revolution period is below 4 μ s and SIS100 operated with an RF harmonic of 10 corresponding to maximum bucket lengths below 400 ns.>

R. Steinhagen commented on the interesting tomography results that would be useful for day-to-day operation, and asked whether this is based on the ring FCT and post-processing on the FEC (aim: archiving, usage for other semi-automated steering purposes)? M. Schwickert clarified that at the moment the analysis is more of an off-line post-processing that is based on the specific GUI.

R. Steinhagen mentioned that in order to operate FAIR safely and reliably with high-intensity beams, the present commissioning and operation strategy foresees the beam-presence and beam-setup-flag (see earlier [presentation](#) and [minutes](#) on accelerator and beam modes). Could these flags be derived from the FCT or DCCT in their present form? M. Schwickert replied that in principle these could be provided, however, not with the present acquisition hardware. A. Reiter and M. Schwickert iterated that a separate buffer amplifier for the analog signal and programmable logic would be needed. Such an integration into the machine protection concept has not been foreseen at this point, is a new requirement and as such would need to be discussed, specified, and agreed upon. Similarly, BLMs are at the moment also not foreseen to be integrated into the machine protection concept. Their present acquisition system Lassie would allow only off-line analysis, and would need to be complemented/replaced by another electronics providing the possibility to trigger real-time actions (e.g. fast beam aborts). R. Steinhagen mentioned that the use of BLMs as part of the machine protection concept is being discussed (C. Omet et al.), in particular in view of protection of sensitive equipment (e.g. septum), high-intensity operation (BLMs being more sensitive than FCTs/DCCTs to losses), and as a 'second line of defense' for

machine protection covering failure scenarios that have not been yet analysed or as redundant element in addition to other detection mechanisms. M. Schwickert, P. Spiller and R. Steinhagen agreed that further implications concerning costs and schedule will be discussed in a separate meeting.

R. Steinhagen asked whether the IPM could be operated in both planes at the same time? M. Schwickert replied that this is not foreseen right now, and that while both IPM magnets could be powered at the same time, their effect could be compensated only with one pair of corrector magnets at a time (ie. either horizontally or vertically). R. Steinhagen mentioned that this system would be particularly useful to continuously monitor the emittance/facility performance. M. Schwickert confirmed that (beside the one-plane limitation) the device could be used for that and run continuously.

M. Steck asked how the data is being represented to the operator? M. Schwickert explained that each device is controlled by one FESA class and that GUIs are available that subscribe to the device information and display their information. R. Bär elaborated that BI will provide the data plus expert application. However, CSCO-AP will have the responsibility for operational application after the functional requirements and operations concept is clear.

R. Steinhagen highlighted that the processing should be done as much as possible on the FESA level, so it can be archived or re-used by other systems. Display is only one purpose. Semi-automated feedbacks are needed and we have to discuss what is needed to do this. R. Bär agreed, usage scenarios need to be defined (presentation, archiving/post-mortem, automated corrections).

R. Steinhagen commented that key parameters of the accelerator have to be corrected in an automated way. The tools for doing this are paramount. He proposed to start with the following list of key beam parameters: transmission monitoring (losses), then orbit, then trajectory, then tune and chromaticity.

Discussions: R. Steinhagen stated that faults should be detected as early and on a as low level as possible (e.g. non-working BPM) as part of an intrinsic automatism per device. The final check would still remain with the operator.

F. Hagenbuck asked about the timeline w.r.t. the collection of requirements? R. Bär replied that there is a schedule, that everything was planned for FAIR could already be tested at CRYRING. He urged that CSCO would need input on the requirements for the integrated systems as soon as possible! M. Schwickert concurred and replied that the same urgency would apply similarly for the to be deployed BI system.

A. Reiter commented that the time scales, hardware, software architecture etc. would need to be worked out in detail.

R. Steinhagen commented that the priority for integrating beam based system is already defined for SIS18/SIS100. The full list of BI equipment that would need to be integrated w.r.t. machine

protection needs to be worked out. R. Bär suggested that a FMECA² analysis similar to the one for SIS100 would need to be done also for SuperFRS and the other machines.

P. Spiller proposed to use, for example, C. Omet's FMECA analysis as a starting point and to apply it for other machines. He also urged that the corresponding missing hardware would need to be defined urgently.

R. Steinhagen iterated that, for example, the bare BLM machine components (ie. ionisation chambers, high-voltage supply, current-to-frequency converter) that will be installed in the tunnel are clear, however, their acquisition systems are presently not. As proposed by P. Spiller, P. Spiller, R. Bär, and M. Schwickert agreed to meet regularly to iterate on this. D. Ondreka continued that presently most system functionalities are well defined, but that new requirements may emerge with different qualities. This would need to fit into an overall strategy.

M. Schwickert highlighted that the definition of these additional requirements needs to be agreed upon urgently, since BI wants to start purchasing the DAQ HW now! Requirements could come from integrated systems. R. Steinhagen commented that resources related to controls integration of beam-based systems are presently not planned! P. Spiller commented that prioritisation should be done according to machine priorities!

M. Schwickert agreed, but elaborated that not "everyone" would be able to do it. R. Steinhagen will organise an offline follow-up. R. Bär machine protection systems are being worked on, but a coherent concept is needed. S. Pietri commented that it would be hard to detail all the required information and requirements in the next months.

R. Bär commented that the list of requirements would be one aspect, but also that there are aspects beyond the list e.g. intensity check.

Next Steps and Actions:

- **P. Spiller (as SIS100-MPL), R. Bär (as MP-WLP), C. Omet, R. Steinhagen et al.:**
 - discuss and evaluate integration of BI systems into machine protection
 - discuss and evaluate HW specific integration, in particular of BLMs, FCT, DCCTs, and BPMs into the machine protection concept
 - discuss and evaluate priorities for integrated beam diagnostics systems (beam-based feedbacks etc.)
- **FC²WG-all:**
 - develop strategy for machine- and folded into that system-commissioning

2. AOB

R. Steinhagen indicated the FC2WG pause during the long summer break until beginning of September.

He reminded that all participants may provide feedback on the accelerator and beam mode and archiving proposal (presented earlier), and that the archiving data rate/volume estimates for the individual machines ([Excel sheet](#), send to R. Steinhagen) would be needed by end-August/beginning of September.

The next meeting is planned for: Wednesday 9th of September 2015, 15:00-17:00 (SE 1.124c)

Reported by J. Fitzek, S. Reimann, R. J. Steinhagen