Test-driven software upgrade of the LHC beam-based feedback systems

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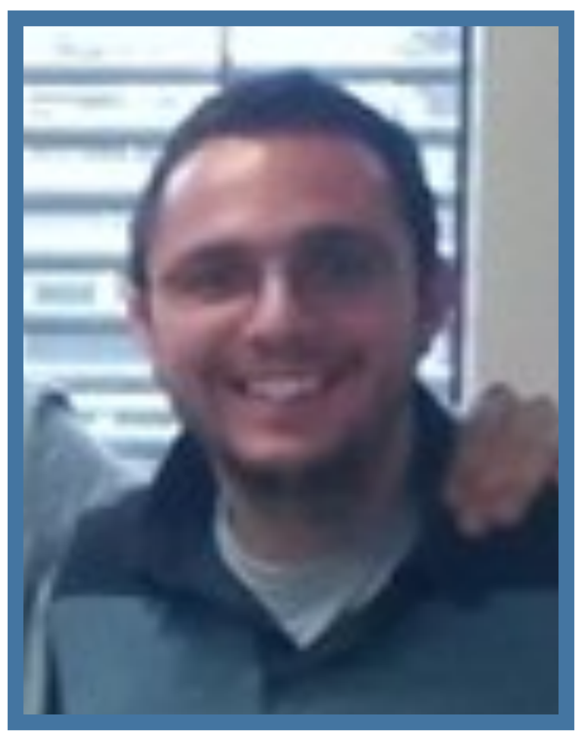
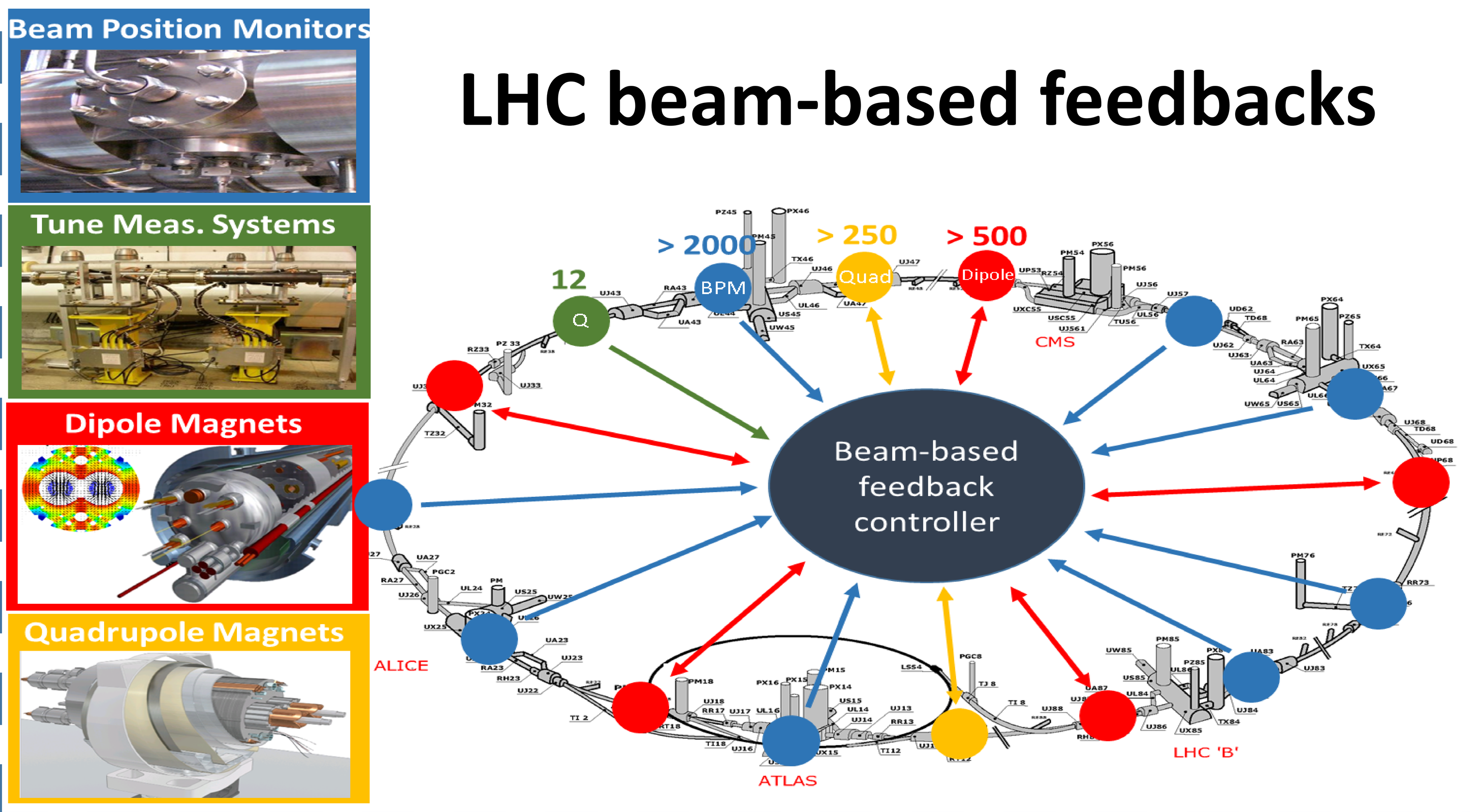


Abstract

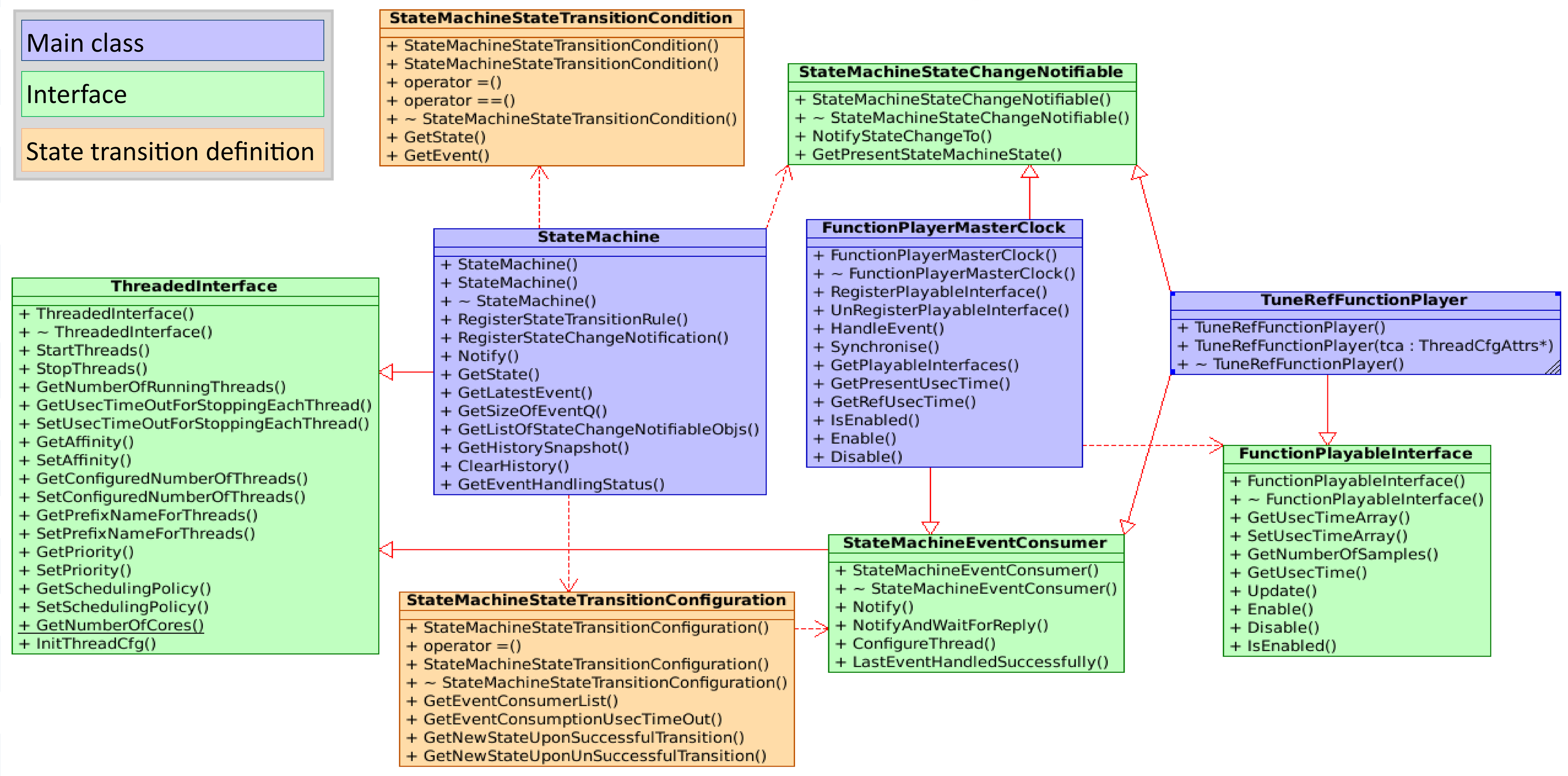
The beam-based feedback system is essential for the operation of the LHC. It comprises two C++ servers: a FESA-based acquisition and configuration proxy (**BFSU**), and a non FESA-based controller (**BFC**) which sanitizes the acquisition data and feeds it to multiple real-time feedback algorithms ensuring a stable orbit of the LHC's beams. Responsibility for the further development and maintenance of the servers was recently transferred to a new team, who have made considerable efforts to document the existing system as well as improve its operational reliability, performance, maintainability and compliance with CERN's software and operational standards. Software changes are accompanied by rigorous unit-testing with future releases tested outside the operational environment, thus minimizing the potential for beam downtime. This approach has proven very effective during re-commissioning for LHC's run 2, where the systems underwent significant changes.

In a bid to homogenize operational procedures for configuring LHC systems, a demand to improve the real-time configuration of the system's feedback references and optics was identified. To replace the existing ad-hoc method of real-time configuration, a new waveform-based server, pre-configured with sequences of N-dimensional values versus time, autonomously ensures that the system is re-configured at precisely the correct time.

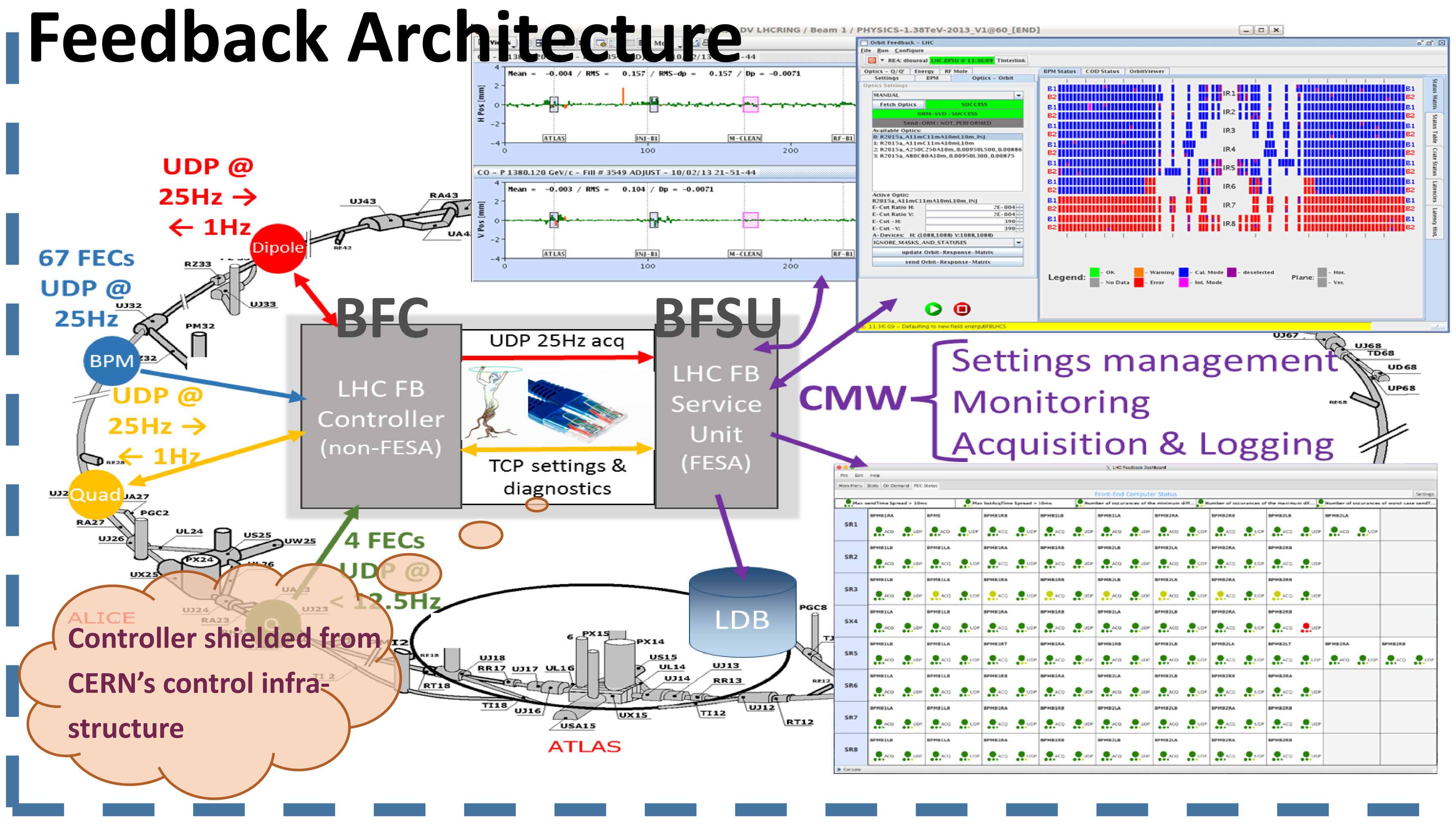
LHC beam-based feedbacks



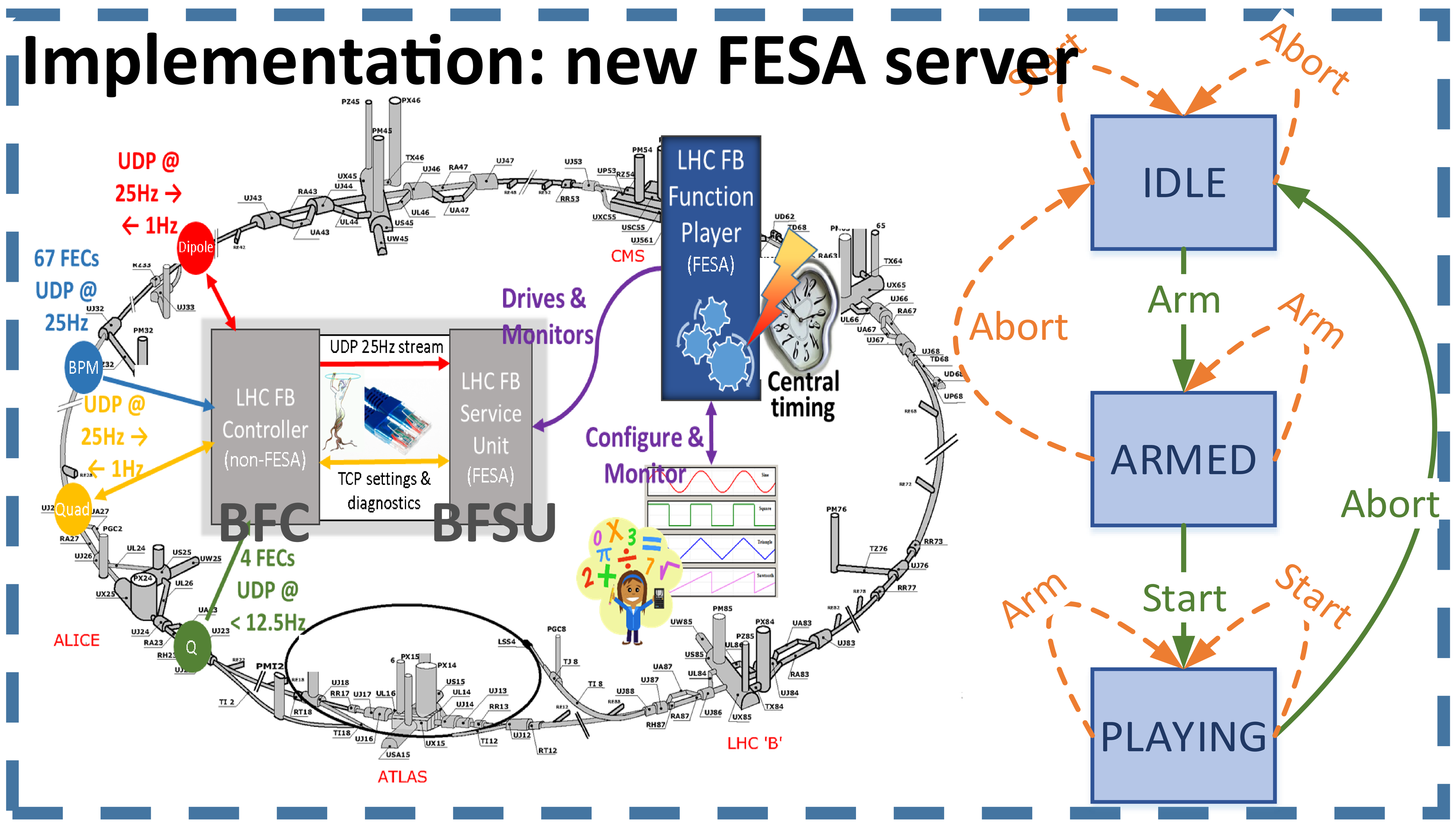
Generic functionality developed & unit-tested



Feedback Architecture



Implementation: new FESA server



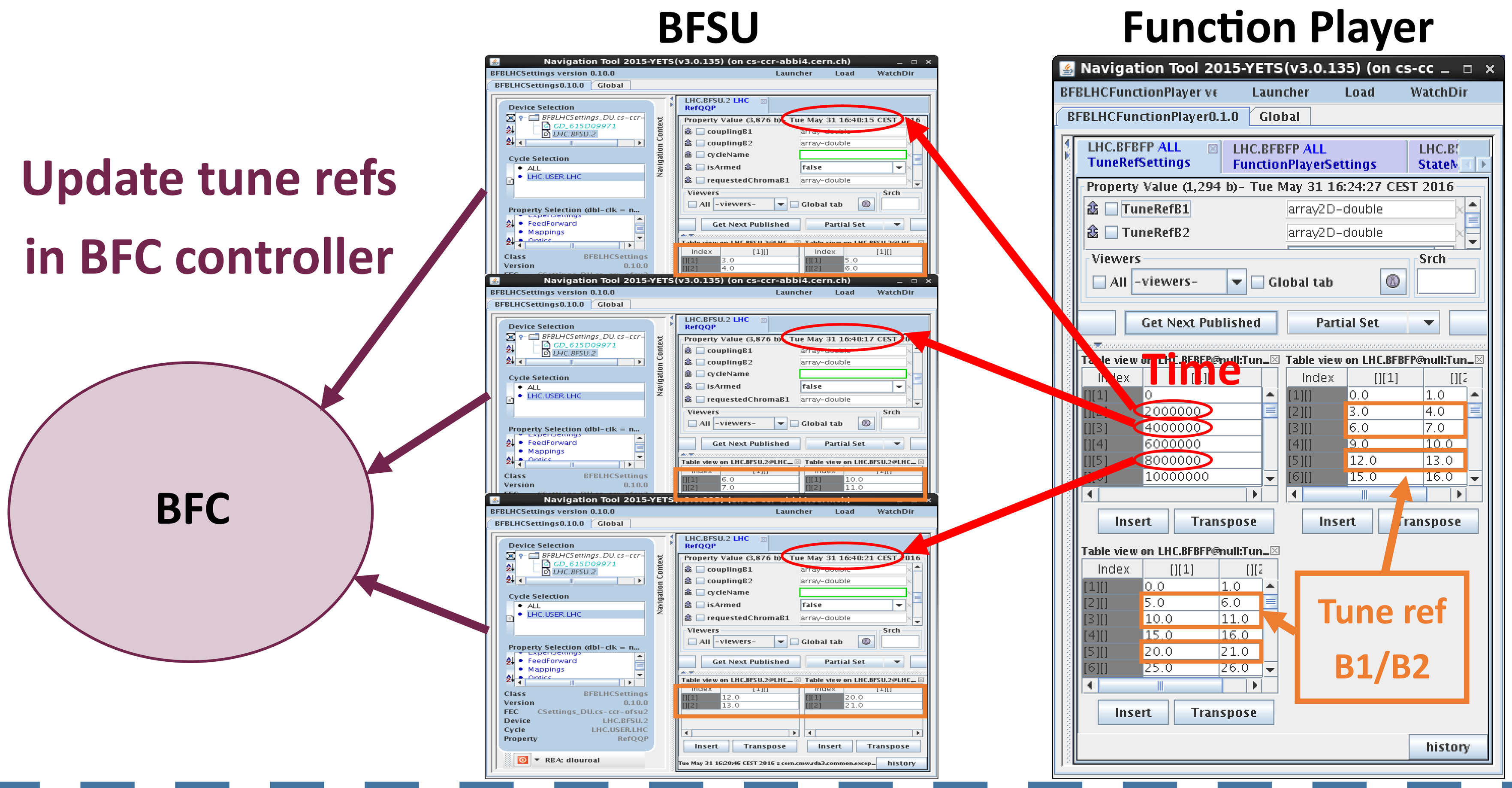
Requirement

- Provide facility to pre-configure (value vs time) feedback references and *"play them back"* at the right times!

Implementation options

Extension of BFC software	Extension of BFSU software	Ad-Hoc sw on BFC machine	New FESA server on BFSU machine
. Functions configured once . Change BFC	. BFC continuously configured via BFSU . Change BFSU	. Independent of BFSU . Change BFC . Non-standard	. BFC continuously configured via BFSU . No changes to BFSU or BFC . Standard

Preliminary testing



Conclusions

The required functionality has been designed, developed and unit-tested, in advance, even before the implementation strategy had been decided. Highly modular, and generic components, e.g. State Machine, were developed providing a high degree of flexibility in terms of configuration options. Seamless integration into FESA (a framework ubiquitous in CERN's control software infrastructure), was performed with the development of a simple and generic interface class. The system has been preliminarily tested with success and it is expected that its formal commissioning, initially with the tune reference as a use-case, will be performed this year, after which other interfaces will be added to configure e.g. the orbit reference and the optics.