ALBA Timing System. A Known Architecture with Fast Interlock System Upgrade

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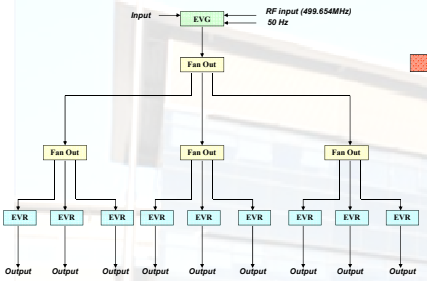
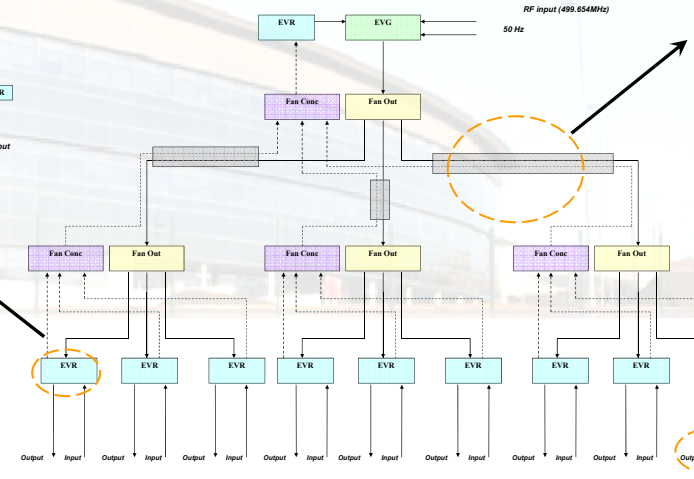
Like most of the newest synchrotron facilities the ALBA Timing System works on event based architecture. Its main particularity is that integrated with the Timing system a Fast Interlock System has been implemented which allows for an automated and synchronous reaction time from any-to-any point of the machine faster than 5µs.

Timing event based model



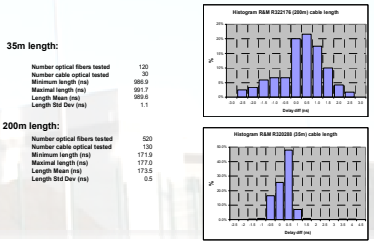
Timing System Upgrade to Fast Interlock System

The timing system offers a platform for producing synchronous outputs and also fast trigger transmission. Additionally it covers more than 80 different points all over the accelerator in Alba case. Therefore the idea of upgrading the timing system implementing a bidirectional communication link to implement the Fast Interlock System was considered as the best possible option.



Timing optic network

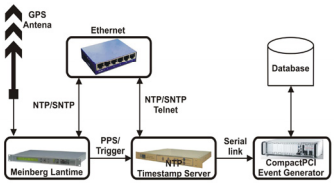
More than 10Km of OM3 cable with 4 fibers have been installed with a very low dispersion in the optic fibers length to avoid thermal effects in the delay change and also to minimize the delay adjustment procedure in the facility.



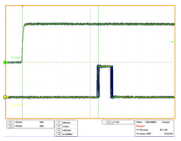
Timestamp System

Each EVR has an internal time reference of 8ns accuracy. The same timing network is used to distribute the global clock reference to all EVRs based in a in a GPS receiver with a built in OCXO oscillator.

In the case that a predefined event is received a timestamp log is possible to be acquired. This feature that is useful for triggering information it is still more interesting when interlock information can be acquired being possible to match triggering effects and interlocks.



Response time



In a typical timing system the delay between the trigger generation at the EVG and its distribution to the EVR is not an important issue as far as all the triggers outputs are delivered synchronously. But if the timing system is required to react to interlocks it is needed to characterize the response time of the system:

$$time \approx 240\,ns \times 7\,stages + 5\,{}^{ns}/_{m} \times 500\,m \sim 4.2\,\mu s$$

Applications

RF Plant fast Interlock

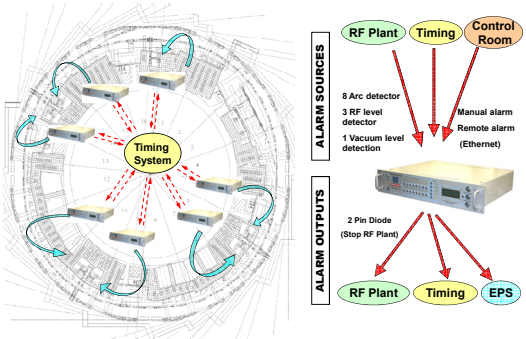
In total there are seven RF plants at Alba; six in the Storage Ring and one in the Booster. It has been developed in-house an electronic module that centralizes the safety conditions under which each one of the plants can operate. If those conditions are not fulfilled the plant is stopped locally and a different Fast Interlock event for each plant is generated. That event will execute in less than 5 µs all preprogrammed diagnostic and safety actions.

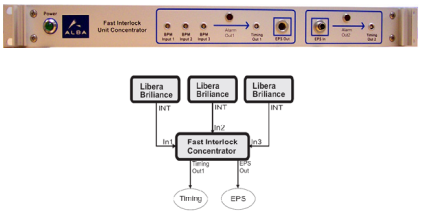
BPMs fast Interlock

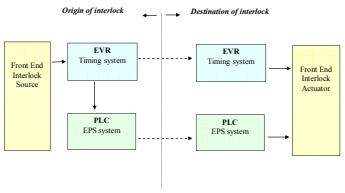
In case that an BPM interlock is detected a Fast Interlock event is generated and will produce an immediate stop of the RF Plants and a distribution of a Post Mortem trigger to the rest of BPMs for acquiring a synchronous snapshot of the orbit. It has been defined 32 different fast interlock events: one for each one of the sectors of the SR and the booster. Doing in this way it can be easily identified the first sector where the orbit was disturbed.

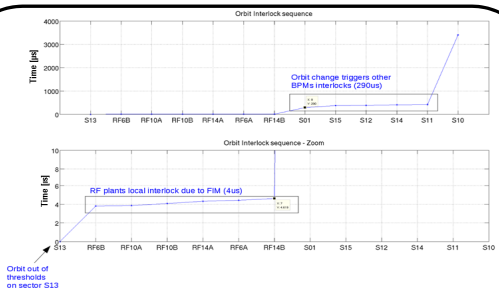
Front Ends

An independent Fast Interlock event has been defined for each Front End. In case of a vacuum loss scenario the RF plants will be automatically stopped to minimize the quantity of beam time that the vacuum gauges that closes had to absorb and to timestamp the beam loss.









Complete sequence of one BPM interlock timestamped with the Fast Interlock System: a orbit interlock is detected in one BPM in SR in sector 13 and timestamped. The Fast Interlock system induces a shutdown of the six RF Plants 4µs later and that leads to a loss of the orbit in the rest of BPM sectors after 290µs.

The list of benefits of combining the Timings System and the Fast Interlock System systems is large: very high flexibility, reuse of the timing actuators, direct synchronous output in different points of the machine reacting to an interlock, implementation of the Fast Interlock with very low cost increase as the timing optic fiber network is reused or the possibility of combined diagnostic tools implementation for triggers and interlocks.

The system has been designed, installed and extensively used during Alba Storage Ring commissioning with very good results.