LHC Beam Dumping System Post-Operation Checks

The LHC Beam Dumping System (LBDS) kicker magnets are powered by high-voltage generators which are composed of internal redundant paths, and are triggered by four redundant Power Trigger Units (PTUs). The LBDS also relies on a complex Trigger Synchronisation and Distribution System (TSDS), partially fault-tolerant thanks to the implementation of a high level of system redundancy.

To guarantee that the LBDS is ‘as good as new’ for the next operational cycle, one has to make sure that all the fault-tolerant redundant parts operated properly for every beam dump.

The various IPOC systems deployed at the LBDS are used to acquire and analyse more than 500 waveforms after every beam dump.

Thyratron switches closed-loop control

The thyratron switches contain gas and use heater modules to maintain the gas pressure to a nominal value, to obtain the nominal rise time and turn-on delay. The thyratron switch control elements are the following:

• The Thyratron Heater Controller (THC) is based on a Siemens S7-400 industrial PLC system, controlling the heater power supplies.
• The Kicker Timing System (KiTS) is a VME crate, fitted with various off-the-shelf fine delay boards, that generates the precisely synchronised trigger.

To automatically compensate for ageing deviations of the thyratron switch, an IPOC system will analyse the kicker current waveform and perform a double feedback loop to adjust the THC and the KiTS settings.

Architecture & Implementation

An IPOC system is composed of a computer running the IPOC server application, fitted with one or more digitiser card(s).

The IPOC server application Real-Time part handles the scheduling of the core functions of the IPOC system, and the Server part provides the communication interfaces needed to control remotely the IPOC system.

Analysis Library

The IpocAnalysis library provides the Application Programming Interfaces (API) for developing an analysis module and the tools to create a new reusable analysis plugin library.

An analysis module implements a method that:
• Takes a collection of IpocData as input;
• Returns a collection of IpocData as output.

The analysis modules are initialised with:
• A ParameterData to configure the module;
• A LimitData to configure the analysis checks.

Digitiser Library

The various applications of the IPOC system use different types of off-the-shelf digitisers from various manufacturers.

The user libraries provided by the different manufacturers are proprietary and their (APIs) are not compatible with each other.

The ScopeCards library defines an abstraction layer, based on a simple model of the digitiser functionalities.

SUMMARY

The IPOC system is a fully-configurable pulse-to-pulse waveform acquisition and analysis system.

It allows macro-system configurations involving the control of any industrial system interfacing with the CERN Middleware.

It provides a plugin interface for analysis algorithms and supports a wide range of off-the-shelf digitisers.

It is integrated into the LBDS post-operation checks and is therefore a part of the LHC Machine Protection System. In this context, it has proven its reliability over the past 3 years of LHC operation.

The IPOC system is also being deployed on many other kicker systems at CERN, for instance in a complex configuration to realise a double feed-back closed-loop system for the automatic regulation of thyratron switching characteristics.