At CERN, six synchrotrons use a so-called B-train system to measure the field of the bending magnets and to distribute it in real-time to various users, including the RF subsystem, via White Rabbit (WR). This paper proposes an improvement for the read-out and debugging of the distributed field values.

Currently, the magnetic field produced by a given current applied to a certain reference magnet is monitored by decoding the WR frame payload and plotting the output signals with a Python GUI-based application running on a workstation connected with the receiving WR switch. This setup is limited since there is no mechanism to access it remotely; more importantly, the Python application does not support real-time time-stamped debugging and alarms, which are crucial features to detect possible faults and link the signals to the operational status of the accelerators.

A new monitoring system was developed in order to provide simple remote access to the B-train signals and to add the missing time-stamp feature. This paper presents the developed hardware and software, together with the results of the first validation tests.

The strong requirements in terms of flexibility and remote access, led the development to use the CompactRIO (cRIO) platform from National Instruments (NI). The optical fibers, chosen physical link to broadcast the measurement signals, arrive to two optical fiber switches from the operational (OP) and spare (SP) chains. To decode the WR B-train data, a cRIO White Rabbit module (CRIO-WR) was used. CRIO-WR is a standalone WR node implementation on a PCB with a form factor for NI cRIO crates. The board is originally derived from and keeps maximum firmware compatibility with the established boards SPEC and CUTE-WR. To control the optical fiber switch, a DIO module NI-9401 connected to a Switch Controller was used.

To host and control the CRIO-WR and the DIO modules, a cRIO crate controller NI-cRIO-9040 is used. The processor runs a real-time software target used to access the device and therefore the B-train data from any PC on the same network with an Ethernet connection. A simple overview of the proposed architecture is depicted in Fig. 1.

We presented a new real-time WR monitoring and debugging system based on a CompactRIO platform and on a cRIO-WR module, to improve flexibility and remote access to the signals of the new B-Trains at CERN. A proof of concept was successfully obtained under a platform never used previously in this context, demonstrating that the requirements in term of both performance and operational flexibility can be met.

This work showcases the power and possibilities offered by WR, as a new and flourishing standard in the general context of distributed acquisition and control system, especially when accurate timing and synchronization are important. This monitoring device will cover a key role in the final implementation of the new B-train system at CERN, as it will allow real-time data logging, monitoring and visualization of multiple data streams to an unprecedented level of accuracy and resolution. In the immediate future, our work will be focused on sending and decoding the entire field and current frame payloads, and develop a user-friendly mechanism to log the data into files or even a database accessible from a web application.