Wall Current Monitor using PXI and LabVIEW at CERN

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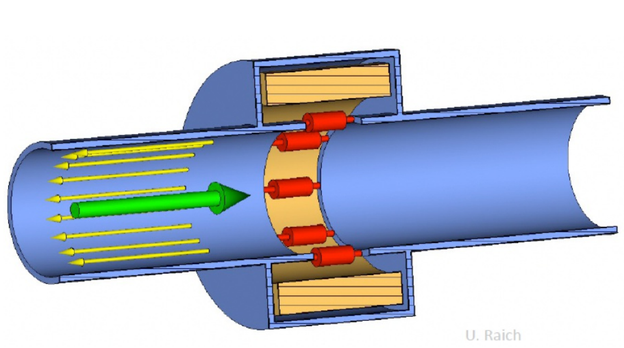
ABSTRACT

The new data acquisition system for the PS ring wall current monitors installed in the PS is able to perform high frequency measurements of a beam bunch up to a frequency of 2.7 GHz. This is an important improvement, since the oscillating signal within the bandwidth 500-700 MHz, is related to losses of a beam bunch. The losses can be reduced by measuring the frequency and classifying the cause of the oscillations. The PXI-5661 is used to carry out spectral analysis of this signal. The data acquisition is performed on a PXI running LabVIEW Real-Time and synchronized using a trigger from the accelerator timing system.

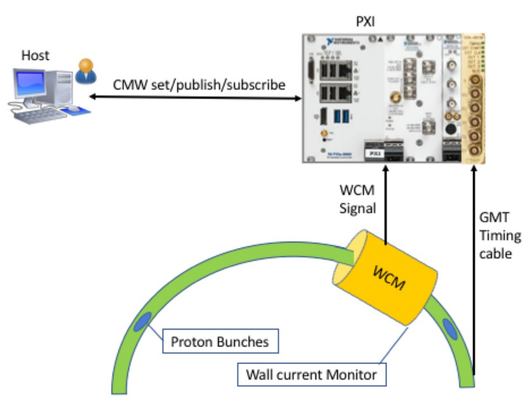
HARDWARE SETUP

Principle of the wall current monitor



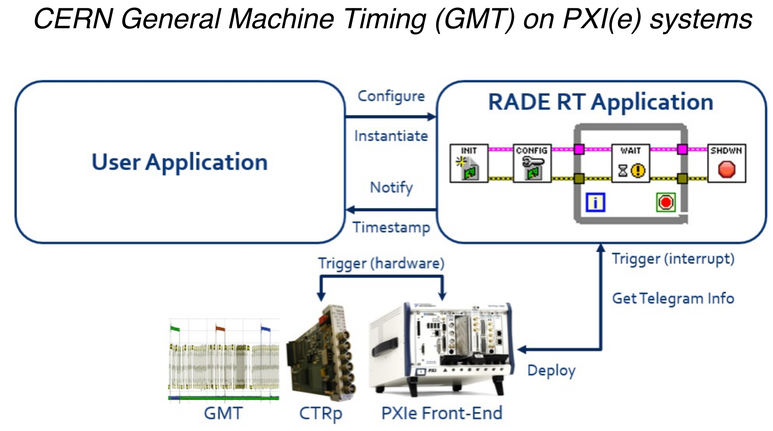
A schematic overview of a WCM. Here the green arrow is the beam current, which is accompanied by its own image current (yellow arrows). By implementing resistors (the red cylinders) a voltage can be measured. By using ferrite, which is electrically non-conductive, (light brown section) the image current will be forced to flow through the resistors.

This application is deployed on a PXI system, which can be triggered by using a Control Timing Receiver (CTR) card and the timing library ported to LabVIEW RADE. The Target application is integrated in the CERN accelerators to profit of services such as the CERN accelerator logging or to simply give the possibility to other applications in the Cern Control Center (CCC) to access the data published by the target application. The HOST application has been developed in LabVIEW using the RADE framework.



The PXI-5661 is a modular 2.7 GHz RF vector signal analyser (VSA) with a wide bandwidth and digital down-converter. To be able to analyse the data in real time by the PXI-5142 the device uses intermediate frequencies (IF). High frequency signals are down-converted to theIF by the 5600 RF downconverter.

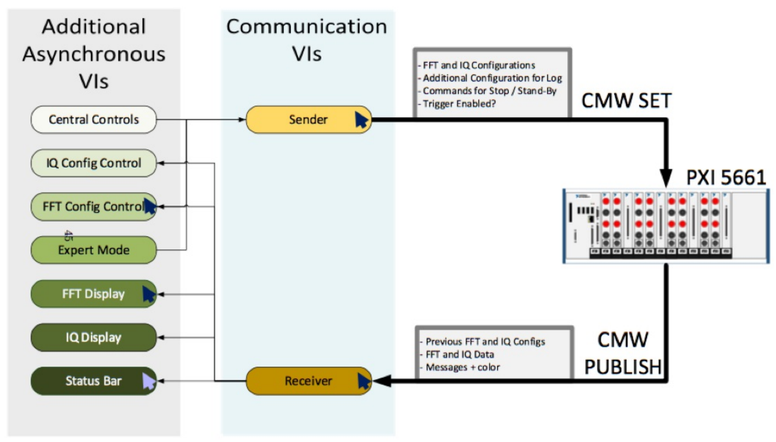
CERN General Machine Timing (GMT) on PXI(e) systems



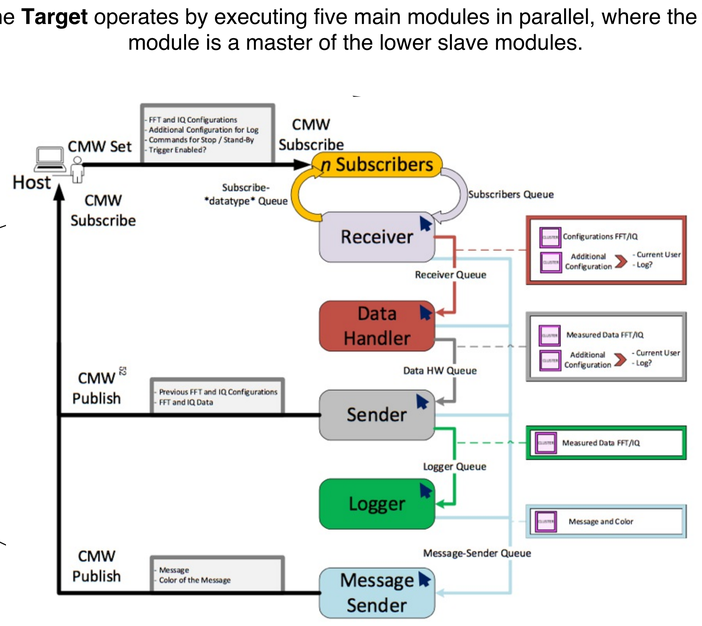
The timing library of the RADE framework enables LabVIEW users at CERN to configure a CTR module installed in a PXI(e) system to trigger hardware from General MachineTiming (GMT) events and to generate UTC synchronous absolute timestamps.

SOFTWARE ARCHITECTURE

The **Host**'s communication layers contain various asynchronously called VIs (functions) that are dependent on the user input such as start/stop frequency or resolution bandwidth.These functions are divided in submodules and processes.

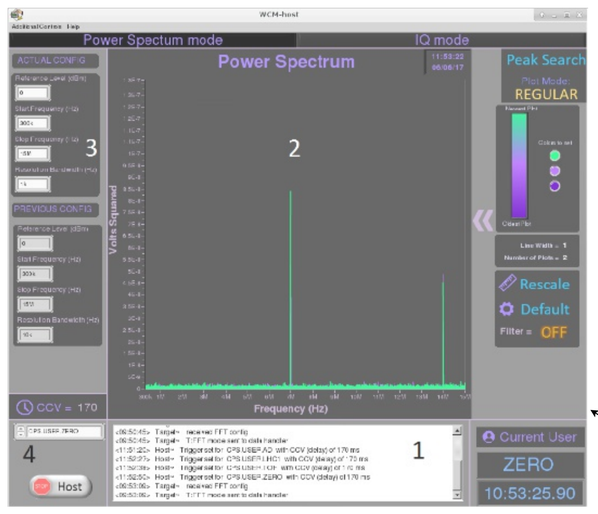


The **Target** operates by executing five main modules in parallel, where the top module is a master of the lower slave modules.



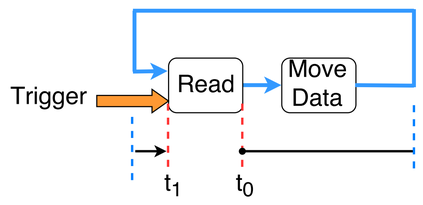
USER INTERFACE

The main user interface is modular and can load several panels. In the image shown the main user interface components are marked by numbers: 1 is the "host:status-bar" module, 2 the "host:display-spectrum",3 "host:power-spectrum-controls" and 4 the "host:central-controls" module.



Dead time

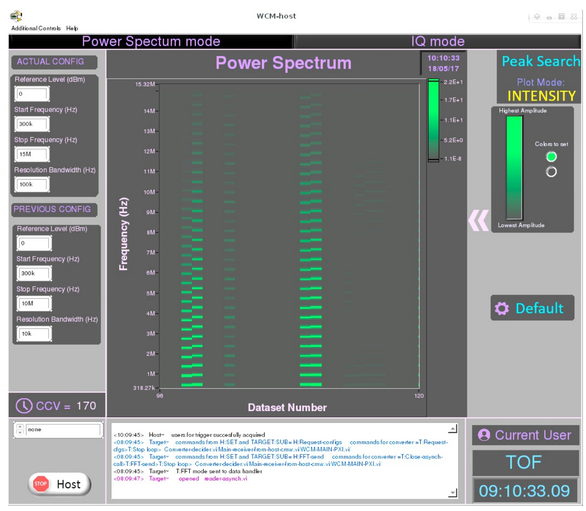
The WCM application uses looping to continuously perform triggered and continuous acquisition, where the dead time is the difference between t0 and t1. Note that this timing issue is only valid for power spectrum read mode, since I/Q mode fetches the data from memory of the card PXI-5661. The dead time varies from 50 us to 400 us depending on the number of point the retrieve.



Accuracy and reproducibility

For absolute amplitude, the typical accuracy is ±0.6 dB for f < 2 GHz and ±1 dB for f > 2 GHz. Frequency limits are also applicable to the hardware, a range of 9 kHz to 2.7 GHz with are solution bandwidth of 1 Hz to 10 MHz.

Reproducibility can be validated by performing a reference measurement over an extended period of time. The illustration on the left shows that the expected 7 MHz peak is stable over multiple measurements.



Example of a continuous power spectrum acquisition for an accelerating beam acquired by the WCM application.

CONCLUSIONS

The main goal of this project, to perform continuous and triggered spectral acquisition of a PS beam bunch and to provide a data visualisation and analysis tool, has been accomplished by developing aLabVIEW application on a Real-Time PXI system with a Vector Signal Analyser. With a typical setting (bandwidth 10 MHz) the signal can be acquired and the FFT calculated every 5ms. The communication between the two separate applications, RT target and visualisation, was realised by using CERN's Controls MiddleWare (CMW), which provides a common software communication infrastructure for the accelerator complex.

During the development phase, the software and hardware functionalities were validated by performing a reference measurements with a high accuracy input signal and low harmonic distortion. In addition to this first system, the PS operators have requested two additional systems to cover the transversal pick-up signal instabilities in the same manner. These additional systems will have to be integrated into the visualisation user interface.

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