

A Data Acquisition System for Abnormal RF Waveforms at SACLA



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Motivation of the development

We have been using two types of DAQ systems since the beginning of commissioning in 2011.

- A data logging system with a cycle of several seconds
 - ✓ environmental temperatures
 - ✓ the flow of cooling water
 - ✓ etc
 } slow fluctuation
- An event-synchronized data acquisition (sync-DAQ) system
 - Shot-by-shot data are tagged with a master trigger number to identify the beam shot to which the data belong.
 - ✓ Beam currents
 - ✓ Beam position
 - ✓ The phase and amplitude of the RF signals
 } in synchronization with the beam operation cycle

In addition, the sync-DAQ system collects RF waveform data every 10 min. If any fluctuations were observed in shot-by-shot data, it is important for the failure diagnosis to capture the waveform data of when the failure occurred. But, waveform collection every 10 min may not capture an abnormal RF waveform from a rare failure event that may occur only a few times a day.



We developed a new DAQ system.

- Capture an abnormal RF waveform for the diagnosis of suddenly occurring failures
- Store all the related waveform data in database

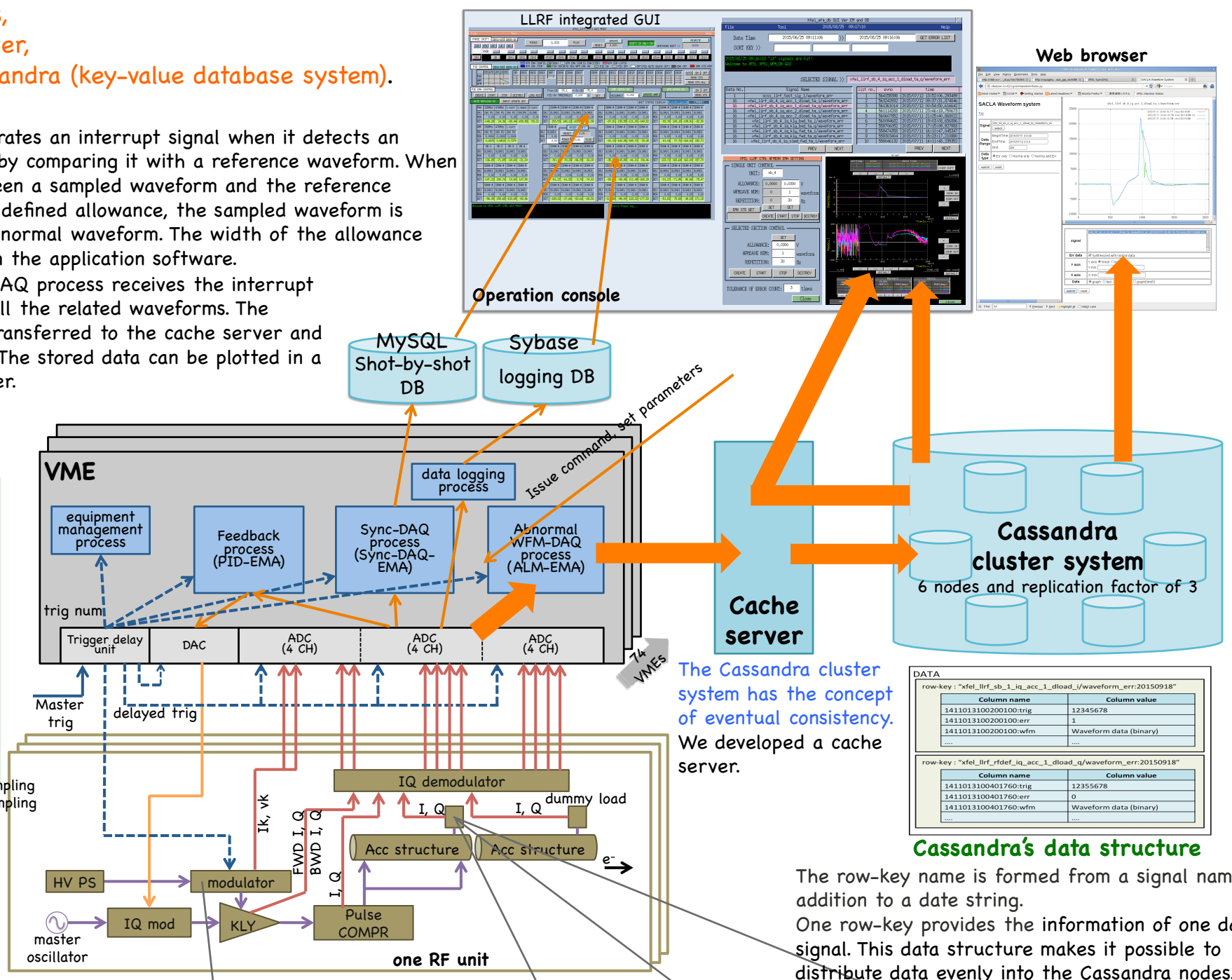
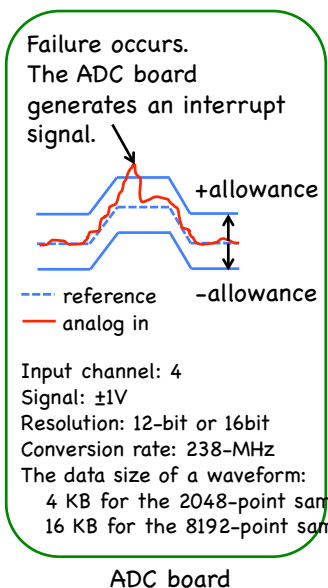
Abnormal waveform DAQ system

The abnormal WFM-DAQ system consists of

- VME systems,
- a cache server,
- Apache Cassandra (key-value database system).

Overview

- The ADC board generates an interrupt signal when it detects an abnormal waveform by comparing it with a reference waveform. When the difference between a sampled waveform and the reference waveform exceeds a defined allowance, the sampled waveform is categorized as an abnormal waveform. The width of the allowance can be changed from the application software.
- An abnormal WFM-DAQ process receives the interrupt signal and acquires all the related waveforms. The waveform data are transferred to the cache server and stored in Cassandra. The stored data can be plotted in a GUI or a web browser.



DATA

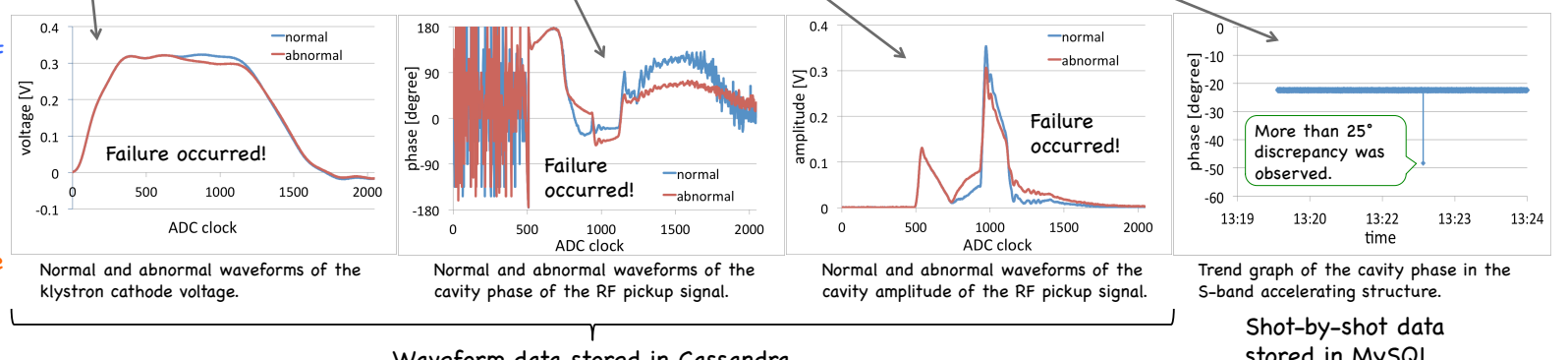
row-key	Column name	Column value
"xfel_lirf_sb_1q_acc_1_dload_w/waveform_err:20150918"		
1411013100200100:trig	12345678	
1411013100200100:err	1	
1411013100200100:wfm	Waveform data (binary)	
...		
"xfel_lirf_rdef_1q_acc_1_dload_q/waveform_err:20150918"		
1411013100401760:trig	12355678	
1411013100401760:err	0	
1411013100401760:wfm	Waveform data (binary)	

Cassandra's data structure

The row-key name is formed from a signal name in addition to a date string. One row-key provides the information of one day's signal. This data structure makes it possible to distribute data evenly into the Cassandra nodes.

Example of acquisition

The WFM-DAQ system captured all the waveforms belonging in the specific S-band RF unit and investigated the cause. In this case, we guess that a high-voltage discharge in the klystron modulator caused the high-voltage deficit and considerable change of the amplitude and the phase of the RF power. Since this abnormal waveform frequently occurred in a specific RF unit, we replaced the modulator during the summer shutdown period. Currently, the failure has not occurred.



Waveform data stored in Cassandra

Shot-by-shot data stored in MySQL