Upgrade of the KEDR detector DAQ system

Dmitriy Maximov, Alexey Talyshev, Alexander Ruban, Alexey Kozyrev for the KEDR Collaboration

Budker Institute of Nuclear Physics and Novosibirsk State University, Novosibirsk, Russia

D.A.Maksimov@inp.nsk.su

Abstract

The KEDR experiment is ongoing at the VEPP-4M e^+e^- collider at Budker INP in Novosibirsk. The collider center of mass energy range covers wide area from 2 to 11 GeV. Most of the up-to-date statistics were taken at the lower end of the energy range around charmonia region. Planned activities at greater energies up to bottomonia would lead to significant rise of event recording rates and accelerator backgrounds, thus stressing the existing DAQ and trigger systems beyond their limits. Described DAQ upgrade plan includes: redesign of trigger electronics using modern components to improve trigger decision time; development of new readout processors using ethernet connections; new software for collecting events and electronics management; high level of parallelization of data transfers and events processing; improved reliability based on readout computing cluster with redundancy. The upgraded DAQ system is going to be very flexible and could be considered as a concept prototype for the perspective BINP project of Super Charm-Tau Factory.

1. Introduction

The KEDR detector (Figure 1) is a universal magnetic detector for experiments at the VEPP-4M collider.
The physical program of the KEDR detector is very wide and includes the following basic experiments: precise particle mass measurements of ψ and Υ mesons and τ lepton; measurement of the ratio R (ratio of the cross sections for the reactions $e^+e^- \to hadrons$ and $e^+e^- \to \mu^+\mu^-$) in the energy range $E_{cm} = 2 - 11\ GeV$; measurement of the $\Upsilon \to hadrons$ cross section and investigation of two-photon processes.

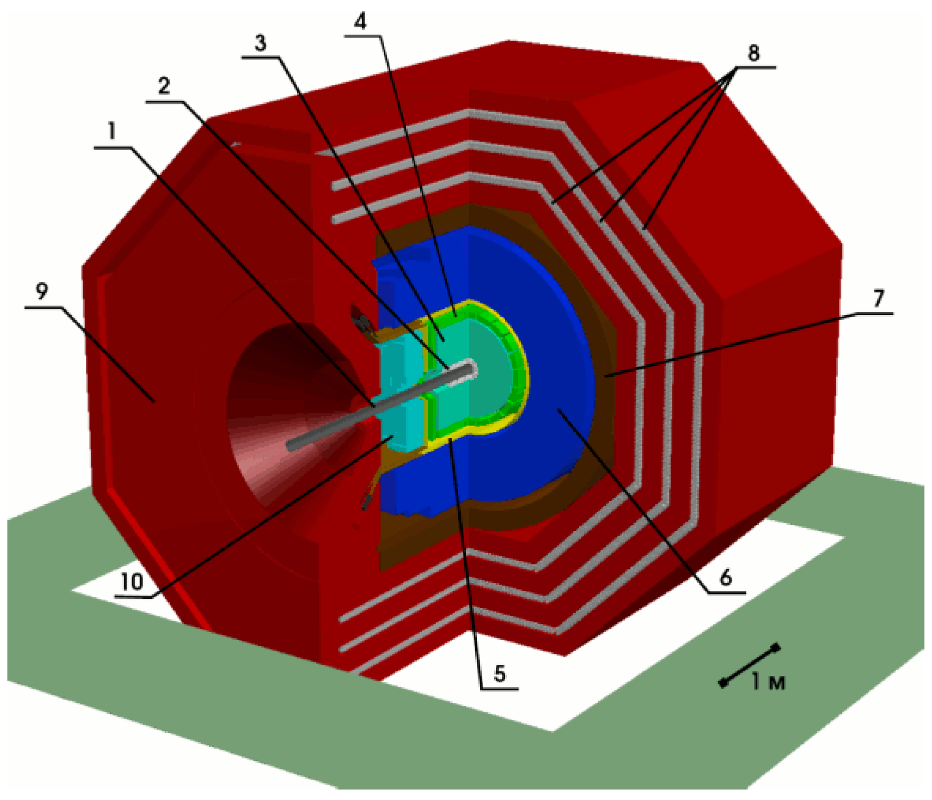

Figure 1: *KEDR detector: (1) vacuum chamber, (2) vertex detector, (3) drift chamber, (4) aerogel Cherenkov counters, (5) scintillation counters, (6) LKr calorimeter, (7) superconducting magnet, (8) muon system, (9) magnet yoke, (10) CsI endcap calorimeter.*

The data acquisition system (DAQ) of the KEDR detector is based on the KLUKVA standard developed by the BINP. It is composed of special crates with a fast data bus and a set of electronic units. There are several types of KLUKVA DAQ units. Information boards (IBs) receive signals from detector cells and measure the amplitude, arrival time or shape of the input pulses, depending on subsystem. The readout processor (RP) reads data out of the IBs and transfers it to the DAQ computers via CAMAC.
To maintain compatibility with existing information boards and to reduce overall costs this upgrade touches readout processor only on the KLUKVA side.

2. Data Acquisition system components

Simplified DAQ scheme is presented in Figure 2.

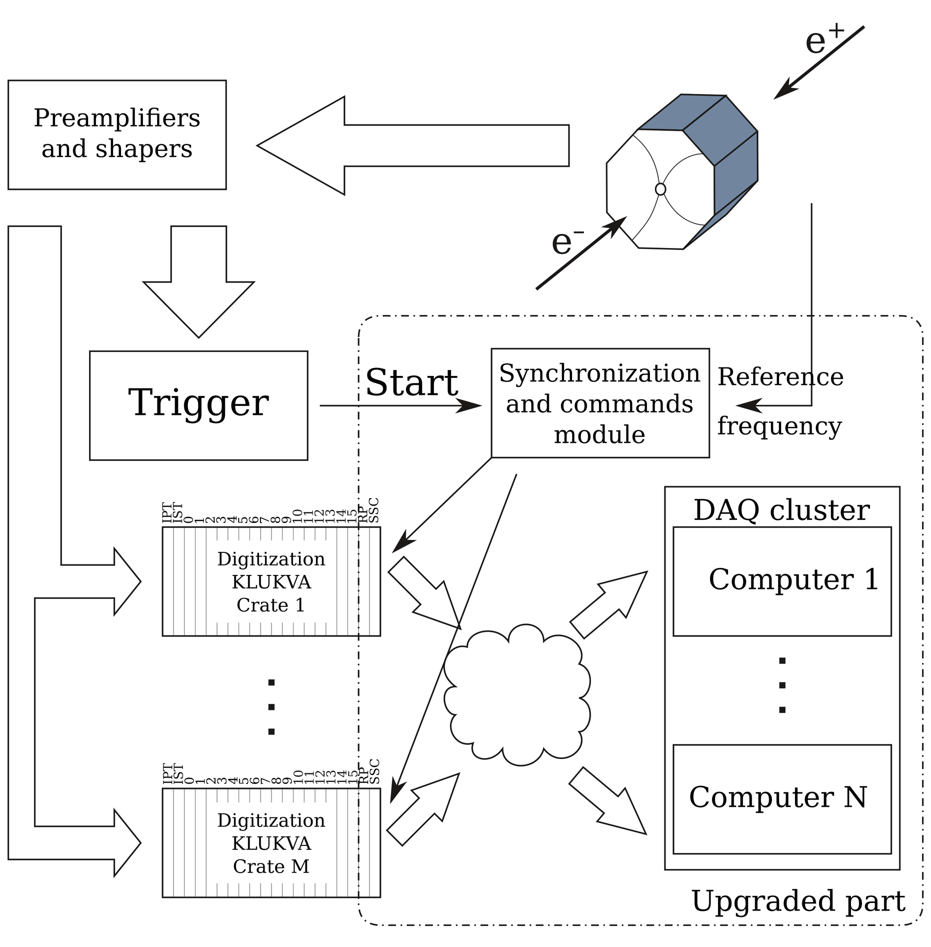

Figure 2: *Main components of the KEDR DAQ system*

Data Acquisition system consists of several large units:

- Digitizer electronics of the detector signals;
- Two-level hardware trigger;
- DAQ synchronization subsytem;
- Event building system;
- Interface to the event storage system.

3. DAQ hardware

Trigger system consists of special electronic modules combining signals from several subsystems (Figure 3).
During this upgrade "Mask units" and "Decision unit" were reimplemented as a single unit using modern hardware. The new version checks signals coincidence in parallel for all configured combinations, thus significantly reducing decision time.

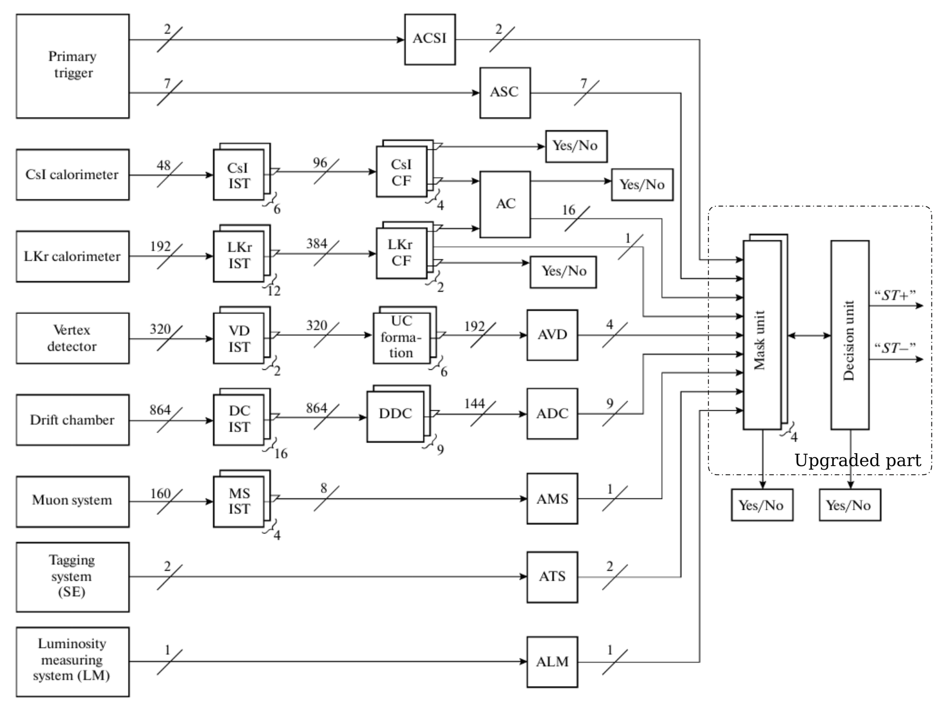

Figure 3: *Block diagram of the secondary trigger.*

DAQ hardware synchronization is provided by Synchronization and Commands Module (SCM), which:

1. Receives signals from hardware trigger;
2. Manages the events queue and events enumeration;
3. Provides reference synchrosignals, distrubute them to all devices of the DAQ system;
4. Generates commands for data readout from information boards and control DAQ devices;
5. Retransmits prepared commands in the 'follower' working mode.

Events building system consists of readout processors (RP), DAQ network switches and DAQ computing cluster.
Readout processors (Figure 4) made in KLUKVA formfactor are installed one per crate with information boards. It receives commands from SCM, reads data from information boards and sends them to the DAQ network (Figure 5).

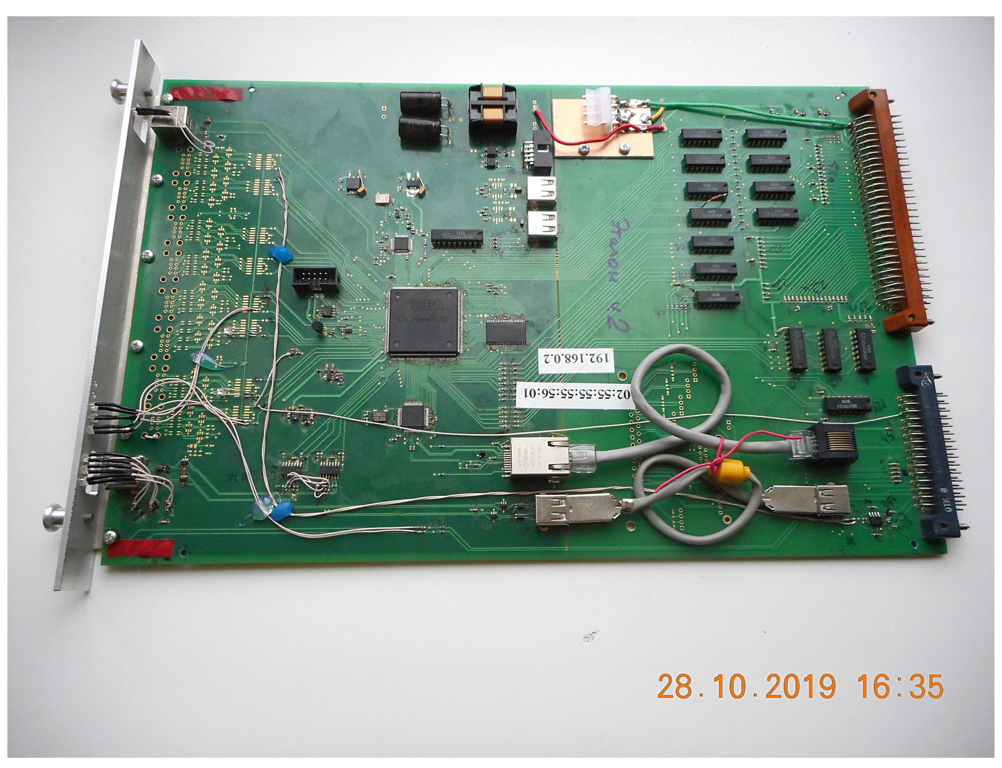

Figure 4: *Readout processor prototype*

DAQ computing cluster is a set of several computers similar to each other, executing the same specially developed software, interacting with each other. It receives data from the DAQ network, process them according to hardware configuration and builds the events from the fragments transmitted by each RP.

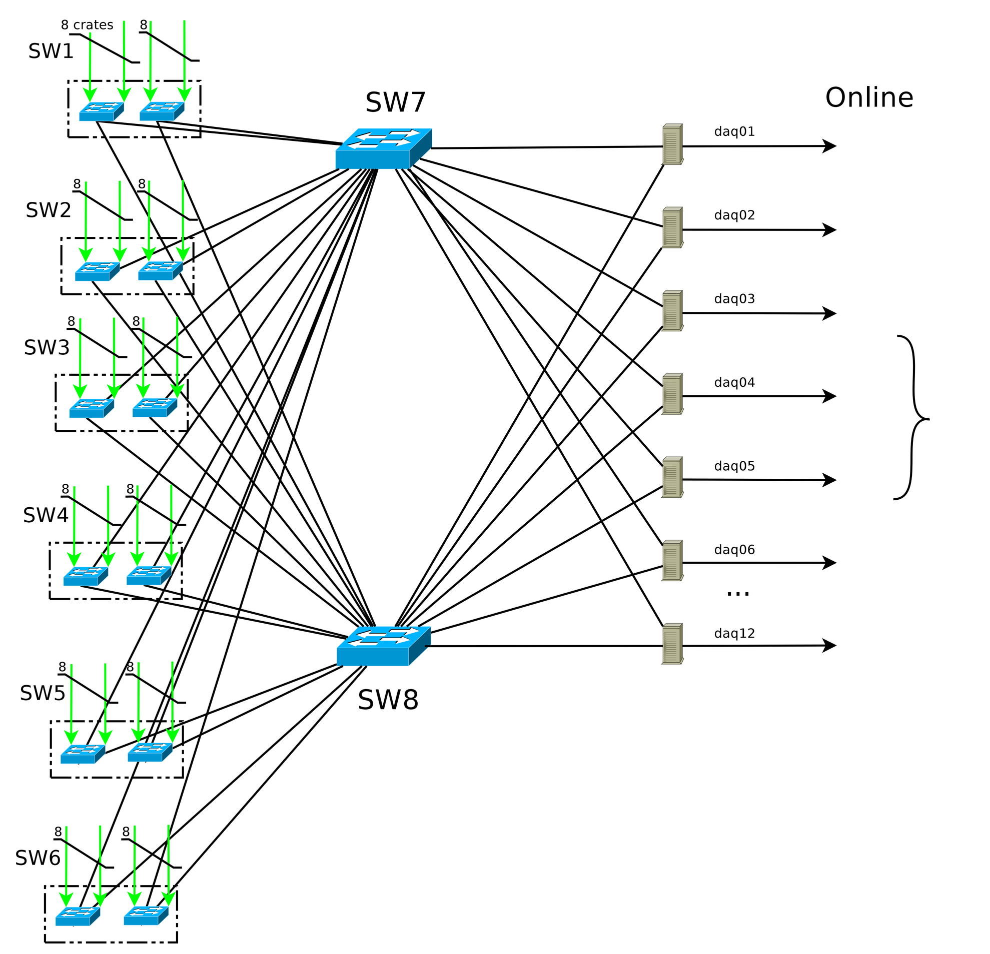

Figure 5: *DAQ network and cluster scheme*

4. Software

Software covers all tasks for managing DAQ system:

- Logically binds all hardware together;
- Plays key role in high availability of the whole system;
- Defines and maintains hardware settings;
- Reacts on configuration changes and hardware failures;
- Implemented as a set of services exchanging messages.

Software has the following components (Figure 6):

- Distributed online database of the states and configuration;
- Cluster coordination service;
- Data processing subsystem;
- Monitoring and data quality subsystems;
- Interface to the storage system;
- Command-line interface;
- Applications interface.

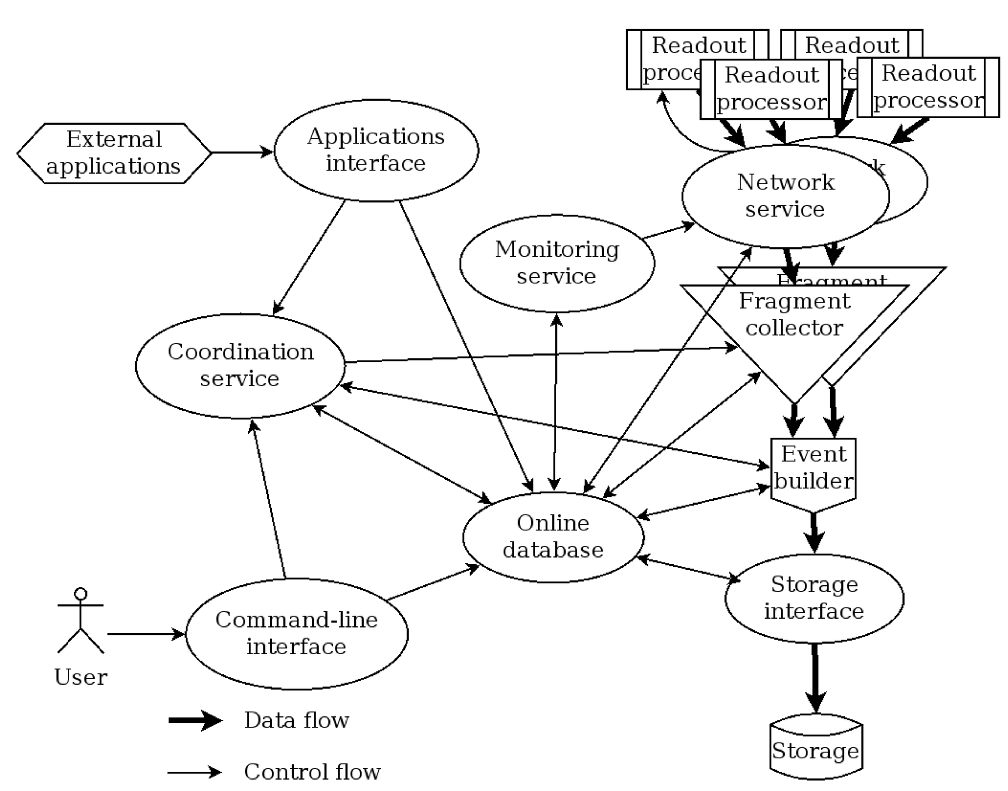

Figure 6: *DAQ software components*