Data Acquisition System of SND experiment [1]

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Since the beginning of 1995 a non magnetic Spherical Neutral Detector(SND) at the VEPP-2M collider in Novosibirsk has been taking data. Data Acquisition System used in the experiments with this detector is presented in this article. The readout and trigger electronics of the system uses the bus-based standard KLUKVA, specially developed at BINP. The DAQ and detector control software created in the context of the experiment is implemented in the distributed computing environment of the general purpose computers running VMS and UNIX operating systems. The software has the high level of scalability and flexibility due to using the multi-layer and the functionally-modular approaches.

Key words: data acquisition; distributed systems

1 Introduction

The e^+e^- collider VEPP-2M[1] is the world only machine in a pre-ϕ-factory era, operating in the energy range 2E from 0.4 to 1.4 GeV, covering the energies of resonance production of lightest quarkonia: ρ, ω, ϕ. The maximum luminosity of the collider depends on its energy, and is equal to $2 \cdot 10^{30}\ cm^{-2}sec^{-1}$ at the center mass energy of 1 GeV. Spherical Neutral Detector(SND) [2] began the data acquisition in the March, 1995 [3]. The physics program of the experiments requires to collect several tens of inverse picobarn during the first three years of operation. This corresponds to 1 TByte of the raw data to be recorded.

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2 Data acquisition system architecture

The readout and trigger electronics of the system (Fig. 1) makes use of the KLUKVA [4] hardware, the bus-based standard that was specially developed in BINP by the beginning of 90-th.

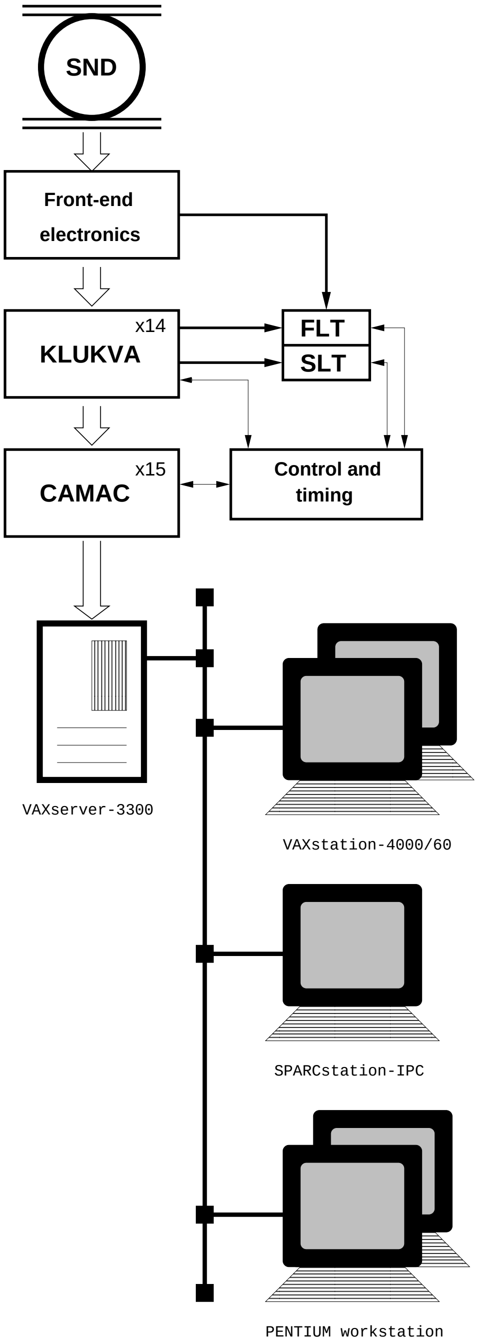

Fig. 1. SND DAQ system architecture

The DAQ system has a three-level trigger scheme. The first two levels FLT and SLT are implemented in hardware. They are tightly integrated with the readout electronics by

KLUKVA timing and control scheme. The third level trigger is a special fast computer code running at the data acquisition computers. The KLUKVA system performs automatic zeroes suppression and event fragments buffering in their internal RAMs. The full event building is done by the front-end DAQ computer which reads the event fragments from these RAMs through KLUKVA to CAMAC interfaces.

The computing environment of the experiment is composed from the Local Area VAX cluster of three VAXes running VMS operating system and SPARC and PENTIUM workstations running UNIX operating systems, all connected via 10 Mbit/sec Ethernet LAN. The resources of this cluster are shared by the DAQ and OFF-LINE systems. One VAX computer is dedicated for the special use as a front-end interface to the experimental equipment hosted in KLUKVA and CAMAC racks.

The experimental data are stored by the experimental data management system ART [5], that was specially developed for the SND experiment.

3 Software

One of the specifics of the HEP experiments with detectors is that they usually last for quite a long period of time(up to 10 years). This is why the design of the DAQ system software must be based on the principles of the scalability and flexibility in mind. These goals at the SND DAQ system were achieved by building the system which:

– is distributed;
– has several(vertical) layers;
– is functionally-modular.

The following 3 layers were identified in the DAQ system architecture: Service, Application, and Interactive. Each layer is represented by a set of programs or processes each one implementing a separate DAQ function. The software "map" of the DAQ system layers and their interaction to each other is shown in the Fig. 2.

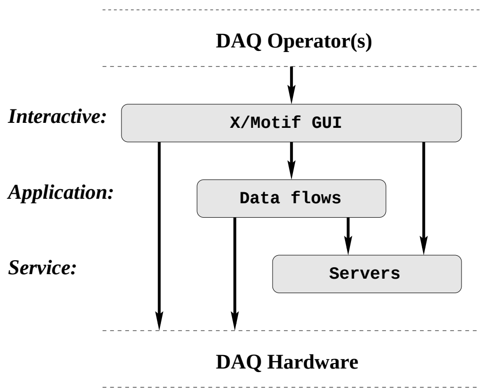

Fig. 2. The layers in the DAQ software

The Service layer has two general classes of functions. Firstly, it provides access to the DAQ system resources and information (formatted detector events, scalers, systems status, etc.). And secondly, it provides communication tools for the system components. The following distributed services have been developed and incorporated into the DAQ system:

– IMAN - status and control information management system [6];
– DEM - distributed buffers manager [7];
– RPD - distributed run parameters data base [8];
– ART - experimental data management system;

In addition, two services were derived from the CERN MODEL [9] project: OSP and EMU.

The Application layer includes the following core functions of the DAQ system, implemented as permanently running processes or groups of them:

– run control;
– detector events readout, formatting, rejection (TLT), and recording;
– full events reconstruction for some portion of events;
– scalers readout and recording;
– luminosity monitoring;
– communication with the accelerator control system;
– on-line electronics control.

TLT is implemented as a fast computer code running on the data acquisition computers. The trigger code was derived from SND OFF-LINE [10] reconstruction software. The trigger checks and rejects events background before recording. In addition TLT identifies collinear events of Bhabha scattering and two gamma annihilation. These events are used to monitor collider luminosity.

This Interactive layer serves as an interface between DAQ system operators and the system itself. An operator is given the ability to run about 80 interactive programs and scripts organized in a hierarchical set of menus. The following classes of functions are implemented here:

– management of the Application and Service layers;
– interaction with the run control system;
– run parameters manipulation in the corresponding data bases;
– sub-detectors calibration;
– electronics tests;
– detector control;
– various visualization programs.

The DAQ code was written on C and FORTRAN-77 programming languages.

4 Conclusion

The current version of the data acquisition system allows to process 1 kByte detector events with a maximum rate of 100 Hz before the TLT. During the first two years of experiments with SND there were acquired about 5 inverse picobarn of experimental data. About $5 \cdot 10^7$ of raw events were recorded.

In the nearest future the hardware platform of the system will be essentially upgraded due to planned increasing of the VEPP-2M luminosity [11]. The flexibility of the already existing software, achieved by using of the long-term solutions in the system design, will allow to minimize the code modifications.

References

[1] A.N.Skrinsky, Proceedings of Workshop on Physics and Detector for DAΦNE, INFN, Frascati, 1995.

[2] V.M.Aulchenko et al., Proc. Workshop on Phys. and Detectors for DAΦNE, Frascati, April 1991, p. 605

[3] V.M.Aulchenko et al., Proc. The 6th Inter. Conf. on Hadr. Spectroscopy "Hadron 95", Manchester, UK, 1995

[4] V.M.Aulchenko et al., Data acquisition system for new detectors in INP. Proceedings of the International Conference on Calorimetry in High Energy Physics, FNAL, 1990

[5] A.A.Korol, Prep. BINP 94-62 (in Russian)

[6] Information management system, SND internal note, BINP.

[7] Distributed Events Manager, SND internal note, BINP.

[8] Run parameters data base, SND internal note, BINP.

[9] D.M.Sendall at al., MODEL: A Software Suite for Data Acquisition, CERN. DD division report, DD/89/26, 1989.

[10] K.Hanssgen, V.N.Ivanchenko, this Proceedings.

[11] A.N.Filippov at al., High energy accelerators. Hamburg, 1992.