VEPP-2000 COLLIDER CONTROL SYSTEM*

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Abstract

VEPP-2000 electron-positron collider construction has been completed in the Budker INP at the beginning of 2007 year. The paper presents architecture, implementation and functionality of the software of the collider control system. The software according to hardware system consists of interacting subsystems responding on different acceleration facility parts. Control system software is based on several TCP/IP connected PC platforms working under operating system Linux and uses client-server techniques. The paper describes implementation, operating possibilities and perspectives of VEPP-2000 software.

The paper also presents structure, architecture and implementation of the hardware of the collider control system. The system consists of pulse-elements, steering coils power supplies, high-current main field power supply, RF subsystems and some other special subsystems (such as vacuum, temperature, etc. control subsystems). The system is based on CAN-Bus protocol and specialized electronic BINP manufactured blocks according the standard. The paper describes implementation of different subsystems, devices, and operating characteristics and possibilities.

VEPP-2000 PROJECT

VEPP-2000 is a new collider with luminosity up to $10^{32}cm^{-2}s^{-1}$ and the beam energy up to 2×1 GeV [1].

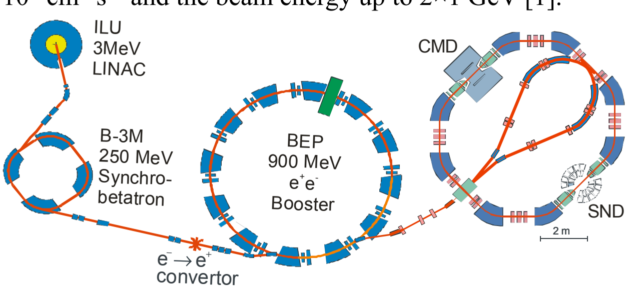

Figure 1: VEPP-2000 facility layout.

This project is a development of a previous facility of VEPP-2M which has worked at BINP over 25 years in energy range up to 1.4 GeV in c.m.s. and has collected of about 75 pb^{-1} integrated luminosity.

VEPP-2000 HARDWARE

From the point of view of automation accelerator complex VEPP-2000 is a complicated system. Over than 500 control channels and 1000 monitoring channels and their joint usage apply rigid restriction on control system‡.

Acceleration complex VEPP-2000 consists of 5 subsystems: ILU and channel to B-3M, B-3M and channel to BEP, BEP ring, electron and positron channels from BEP to VEPP-2000, VEPP-2000 ring. Each of subsystems includes several sub-subsystems: pulse elements, steady elements, RF-systems, and some additional systems like vacuum and temperature monitoring.

Control system of VEPP-2000 complex is based on several PC platforms under Linux operating system, connected into VEPP-2000 private net. Layout of automation system of VEPP-2000 collider is presented on Fig. 2.

As it was mentioned above VEPP-2000 complex is a modernization of old VEPP-2M facility. This leads to necessity of taking into account a wealth of 20-year experience on the one hand and using modern automation solutions on the other hand.

On choice of hardware protocol one should be guided by capacity, support and standards. For automation system for VEPP-2000 facility two main protocols was chosen: well-known CAMAC and CAN-Bus [2]. Table 1 specifies subsystems and used protocols with approximate number of channels.

Table 1: Subsystems and Channels

System	Subsystem	Protocol	N of chan.
ILU & channel	Pulse	CAMAC CAN-Bus	50 40
	Steady	CAN-Bus	30
B-3M & channel	Pulse	CAMAC CAN-Bus	50 40
	Steady	CAN-Bus	40
	RF	CAN-Bus	20
BEP	Steady RF	CAN-Bus CAN-Bus	500 20
BEP–VEPP-2000 channels	Pulse	CAMAC CAN-Bus	30 100
	Steady	CAN-Bus	50
VEPP-2000	Steady RF	CAN-Bus CAN-Bus	500 20
Technological	Vacuum Temperature Cryogenics	CAN-Bus CAN-Bus CAN-Bus	50 80 50

Control units, used at VEPP-2000 complex, are made in BINP [3, 4]. CAMAC standard is used at the places where heavy traffic is needed (pickup stations) and also at the systems where migration on a new standards during

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‡ Not including beam measurement channels.

modernization was considered inadequate (old systems like ILU, B-3M) which will be removed in future. CAN-Bus protocol is used at the complex automation as a base protocol. It is very convenient for spatially distributed automation systems and allows reduce wire commutations significantly.

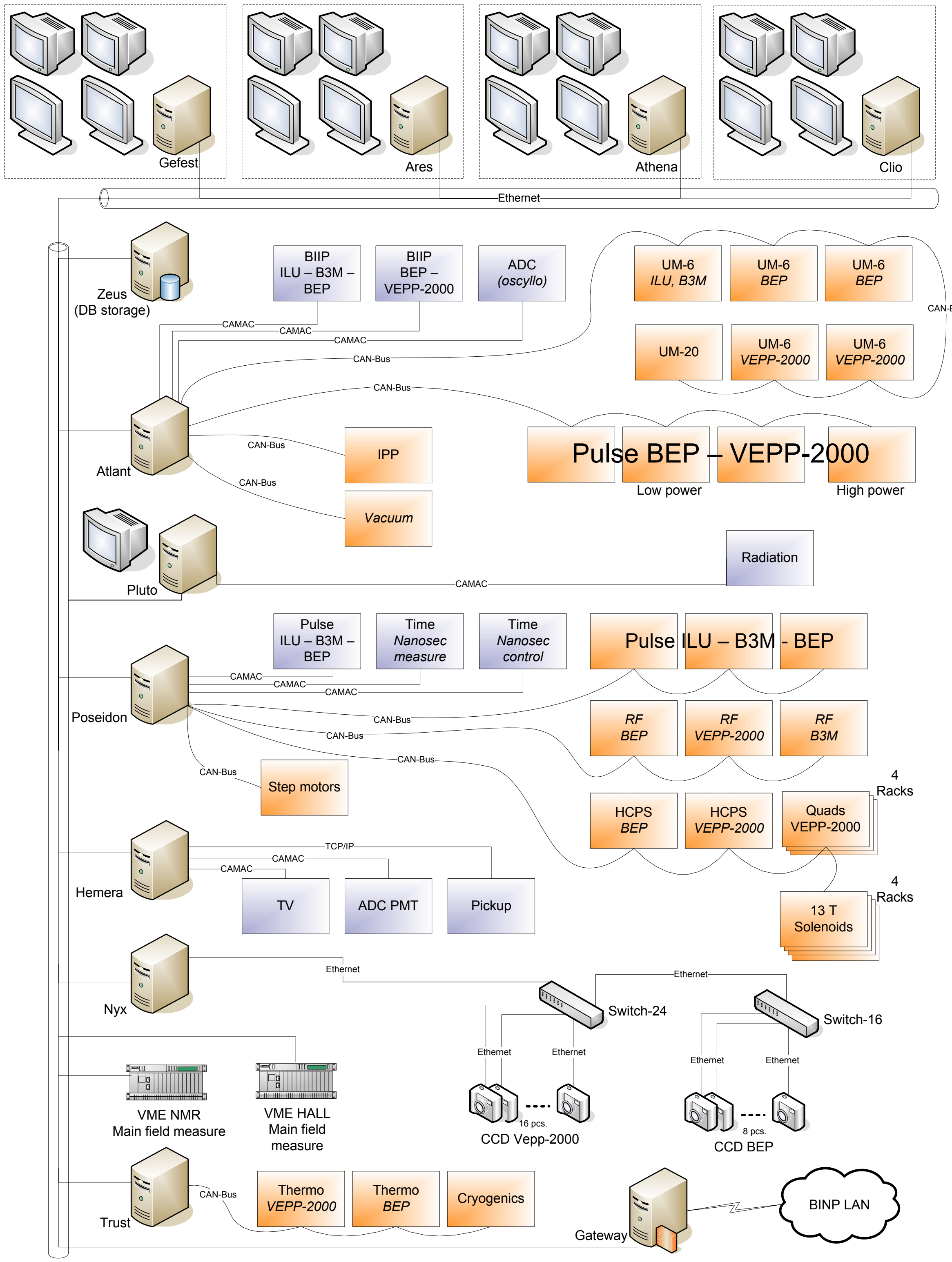

Figure 2: Hardware of VEPP-2000 Complex automation system.

VEPP-2000 SOFTWARE ARCHITECTURE

Principles of software construction arose from hardware architecture. Specialized service controls one or several CAN or CAMAC buses and allows client applications to have access to hardware.

The point is that several user-end applications working on special PC at the Main Control Room can control and monitor state and working of the hardware units. Applications can exchange messages about common system events (like injection or change energy or working regime) thru special Message Service. Each application can store own data or properties in individual or common Data Storages.

The second point is hiding from operator details of hardware configuration and implementation of each service. All information about hardware configuration contains in special Data Bases, personal for each server. All foresaid is schematically shown on Fig. 3.

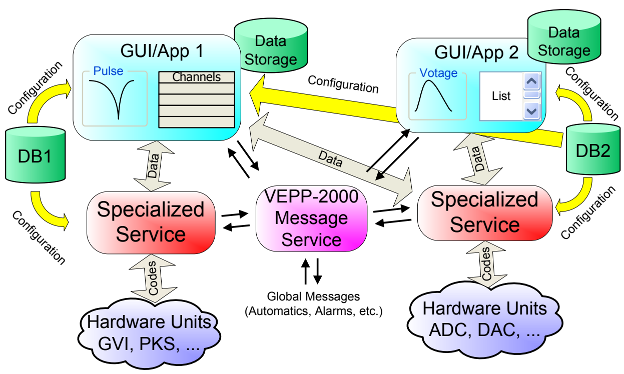

Figure 3: Principles of VEPP-2000 software construction.

The third point is modular principle of VEPP-2000 automation system construction. This allows including new features and hardware without significant reconstruction of on-line operating software from one hand and fast and clean searching and removal of any hardware of software faults.

Thus, software system allows user to manage and monitor different hardware subsystems sometimes very different from each other in one manner. Operator uses very similar applications GUI-styled as well as console-like to steer different parts of VEPP-2000 acceleration complex.

Two examples of VEPP-2000 user-end application are presented on Fig. 4 and 5.

CONCLUSION

VEPP-2000 automation system is based on made in BINP (Novosibirsk) hardware in CAMAC and modern CAN-Bus standards. Software system substantially corresponds to hardware system. It allows to operator independently steering of different VEPP-2000 subsystems like ILU, B-3M and BEP, VEPP-2000 and beam channels.

In spring 2009 VEPP-2000 started its first experiments with colliding electron-positron beams.

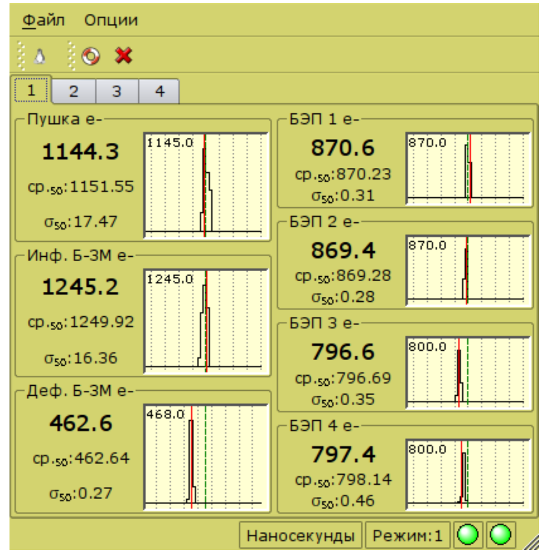

Figure 4: Measurements of nanosecond pulses of generators for different deflectors and inflectors.

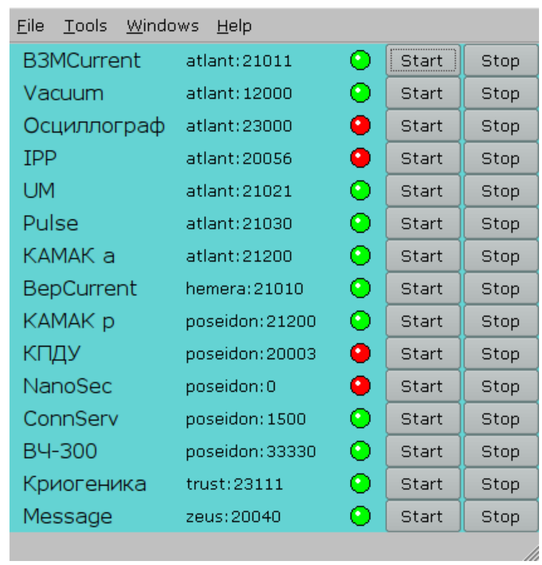

Figure 5: Application for monitoring and control VEPP-2000 hardware services.

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