Modernization of VEPP-2000 control system*

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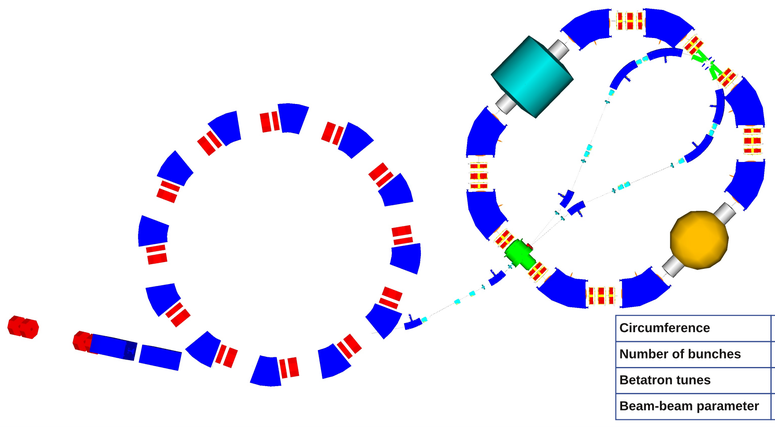
Abstract

Electron-positron collider VEPP-2000 delivered data for the high energy physics since the end of 2009. In the summer of 2013 the long shutdown was started dedicated to the deep upgrade of the wide range of subsystems. The main goal of the improvements is to reach or exceed design luminosity in the whole energy range from 200 MeV to 1000 MeV per bunch.

The hardware of the accelerator complex consists of high current main field power supplies, low current power supplies for steering and multipole magnets, pulsed power supplies for channel's elements, RF subsystems, BPM and some other special subsystems (such as vacuum, temperature, etc.). The control system is based on CANbas, CAMAC and VME devices. The wide range of software corresponding to specific hardware subsystems forms complicated interacting system that manages all parts of the VEPP-2000 accelerator facility. Automation software is running on several TCP/IP connected PC platforms under operating system Linux and uses client-server techniques.

The paper presents general overview and changes made in architecture, implementation and functionality of hardware and software of the VEPP-2000 collider control system.

VEPP-2000[1][2]

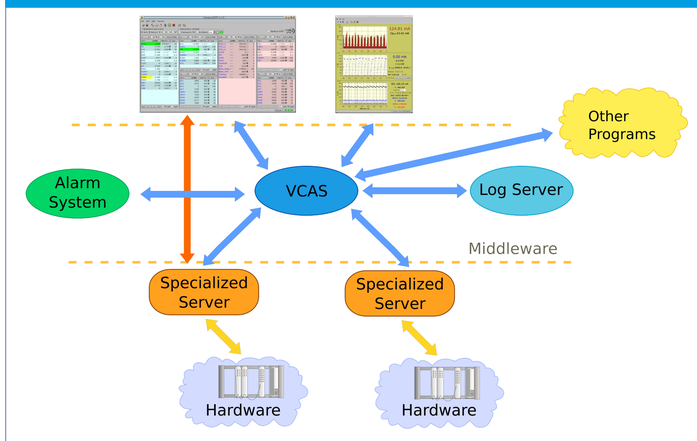


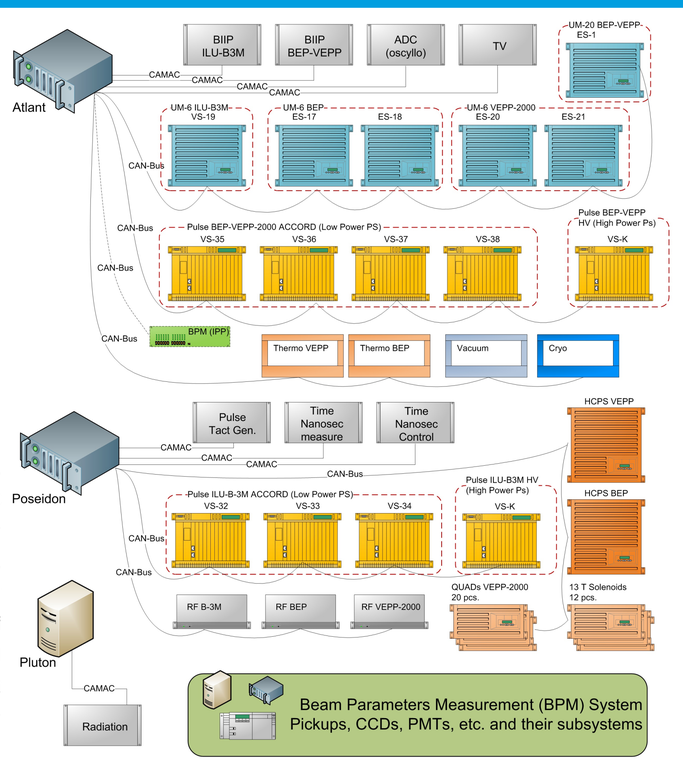
4 solenoids with 12 power supplies
8 bending magnets
24 quadrupole lences
12 skewquadrupoles
20 x-correctors
16 z-correctors
8 sextupoles

4000-5000 control channels

Circumference	**24.388 m**	**Energy**	**160÷ 1000 MeV**
Number of bunches	**1**	**Number of particles**	**5×10^{10}**
Betatron tunes	**4.1/2.1**	**Beta-functions**	**5-10 cm**
Beam-beam parameter	**0.1**	**Luminosity**	**$1\times10^{32}cm^{-2}s^{-1}$**

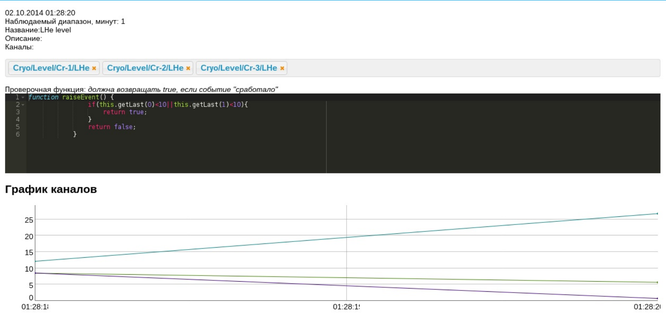
Scheme of Control System[3]





The architecture of VEPP-2000 software is based on three-layer structure. Specialized services (hardware layer) control one or several CAN or CAMAC buses and allow client applications to have access to hardware. The main application of Middleware layer is VCAS (VEPP-2000 Channel Access Server). Third level is presented with GUI applications, which provides to facility operator powerful and convenient instrumentation for beam tuning and diagnostics of possible systems malfunctioning. For the high loaded data channels like control systems of magnetic structure of storage and collider rings it is possible direct communication between GUI and hardware layers. Another important application in the middleware layer in specially designed Log Server.

Alarm system



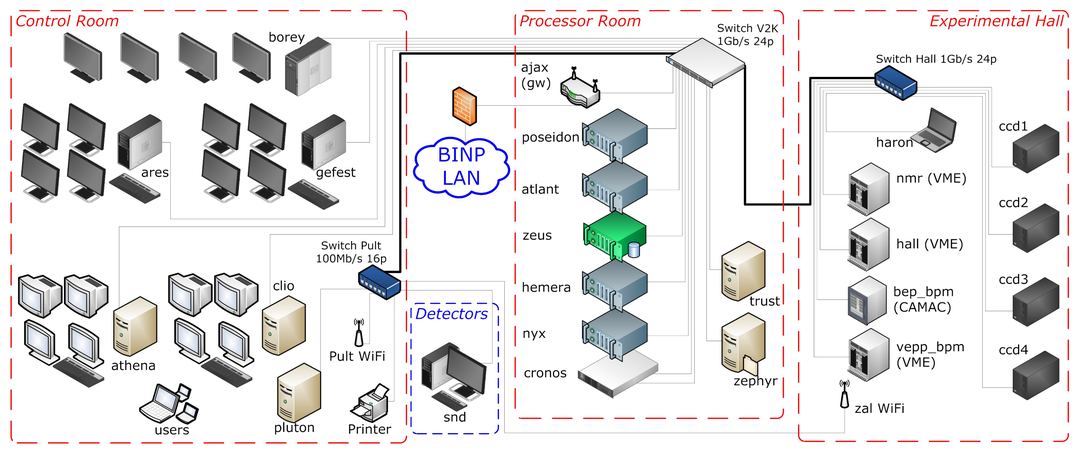
Rule based system.
Implementation:
- •javascript (V8)
- •Node.js
- •AceEditor on-line editor

Spectroscope

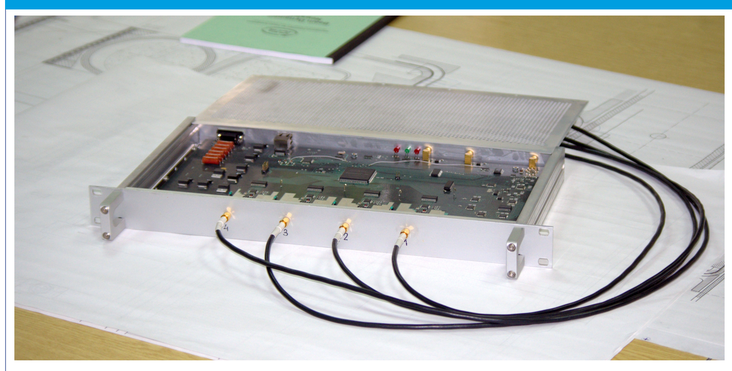
Spectroscope:
- •Beam position
- •Spectrum
- •Spectrogram

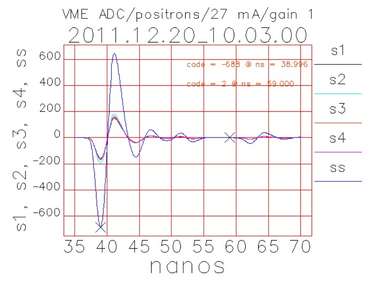
Implementation:
- •python
- •numpy
- •pyqtgraph

Network layout



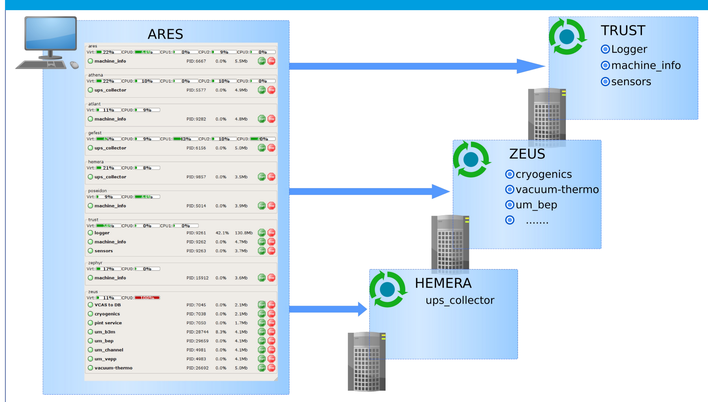
Beam Position Monitor (BPM)





Before 2012 2013 working season the Beam Position Monitor System (electrostatic BPM) was equipped with new electronics designed and produced at BINP. New design allows combining the preamplifier and ADC in a single device located nearby from pickup electrodes. Pickup station (shown at fig. 1) has 4 inputs for analogous signals from pickup electrodes and 3 inputs for from VEPP-2000 timing system (RF frequency, revolution frequency, external trigger). Each input signal from pickup passes through 420 MHz lowpass filter, low noise tunable attenuator (dynamic range 20 dB) and digitized with 14 bit ADC. New system is capable to store up to 8192 points per channel with turn by turn resolution (at revolution frequency) in memory for future use so called fast acquisition, and up to 1024 points with averaging slow acquisition. The VME interface allows to have 8192 turns of the beam history at 5 Hz frequency and beam position (2048 averaging) at 10 Hz. This bandwidth is fully limited by VME bus and should be improved in new Ethernet interface (prototype will be commissioned until end of 2014). Our estimates show bandwidth limited only by Ethernet capabilities. Fig.2 shows digital output of pickup station while single bunch flew through BPM (picture taken with stroboscope method by varying digital delay between ADC clocks and revolution frequency).

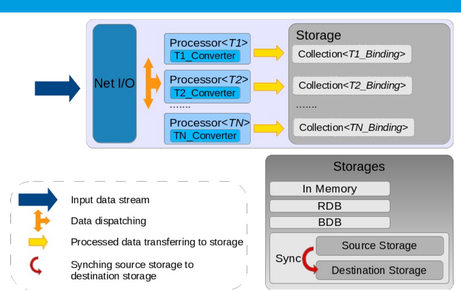
Supervision subsystem



Service monitoring subsystem:
- •Service auto-start
- •Service info(status,CPU, memory)
- •Manual service start/stop
- •Node workload (per CPU, memory)

Implemetaion:
- •Supervisord
- •Custom made plugin (Pyhton)
- •User interface (Qt)

Logging server[4]



In memory - all data stored in memory.
RDB storage - relation database as backend
BDB - BerkeleyDB JE
Sync - sync data from source to destination

Production configuration

Sync storage with BDB as source and RDB (Postgresql) as destination.

References

[1] Yu.Rogovsky et al., "Status and Perspectives of the VEPP-2000 Complex",RuPAC'14, Obninsk, Russia ,October 2014, TUY01.
[2] "VEPP-2000 Project", http://vepp2k.inp.nsk.su
[3] A. Senchenko et al., "VEPP-2000 Collider Control System", PCaPAC'12, Kolkata, India, December 2012, FRCB04, http://www.JACoW.org.
[4] A. Senchenko, D. Berkaev, "VEPP-2000 Logging System", PCaPAC'12, Kolkata, India, December 2012, WEPD14, http://www.JACoW.org

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