VEPP2K LOGGING SYSTEM*

A. Senchenko#, D. Berkaev
BINP SB RAS, Novosibirsk, Russia
Novosibirsk State University, Novosibirsk, Russia

Abstract

The electron-positron collider VEPP-2000 has been constructed in the Budker INP at the beginning of 2007 year. The first experiments on high-energy physics hasbeen started at the end of 2009. The collider state ischaracterized by many parameters which have to betracked. These parameters called channels could bedivided into continuous (like beam current or beamenergy) and pulsed. The main difference is that the firstone related to the moment of time while the second one tothe beam transport event. There are approximately 3000continuous channels and about 500 pulsed channels at theVEPP-2000 facility. The Logging system consists ofserver layer and client layer. Server side are a specializedserver with an intermediate embedded database aimed atsaving data in case of external database fault. Client layerprovide data access via API, CLI and WUI. The systemhas been deployed and is used as primary logging system on VEPP-2000.

VEPP-2000 PROJECT

VEPP-2000 is a new collider with luminosity up to 1032cm–2s–1 and the beam energy up to 2в1 GeV [1,2].
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. New collider uses the existing beam production chain of accelerators: ILU – a pulsed RF cavity with a voltage of 2.5 – 3 MeV, a 250 MeV synchrotron B-3M and a booster storage ring BEP with the maximum project beam energy of 900 MeV (see Figure 1). The lattice of VEPP-2000 has a two-fold symmetry with two experimental straight sections of 3m length, where Cryogenic Magnetic Detector [3] and Spherical Neutral Detector [4] are located. Two other long straights (2.5m) are designed for injection of beams and RF cavity, and 4 short technical straight sections accommodate triplets of quadrupole.
The closed orbit steering and gradient corrections are done with 1-2% coils placed in the dipole and quadrupole magnets.
Beam diagnostics is based on 16 optical CCD cameras that register the synchrotron light from either end of the bending magnets and give the full information about beam positions, intensities and profiles. In addition to optical BPMs, there are also 4 pick-up stations in the technical straight sections and one current transformer as an absolute current monitor.
The magnetic field of 2.4 T in the bends is required to reach the design energy of 1 GeV in the constrained area of the experimental hall.

* Work partially supported by Russian Ministry of Education and Science, basic project of BINP SB RAS 13.3.1,
Physics branch of RAS project OFN.1.1.2,
Scientific school NS-5207.2912.2 and Grant of the Novosibirsk region Government 2012
#senchenko.alexander@gmail.com

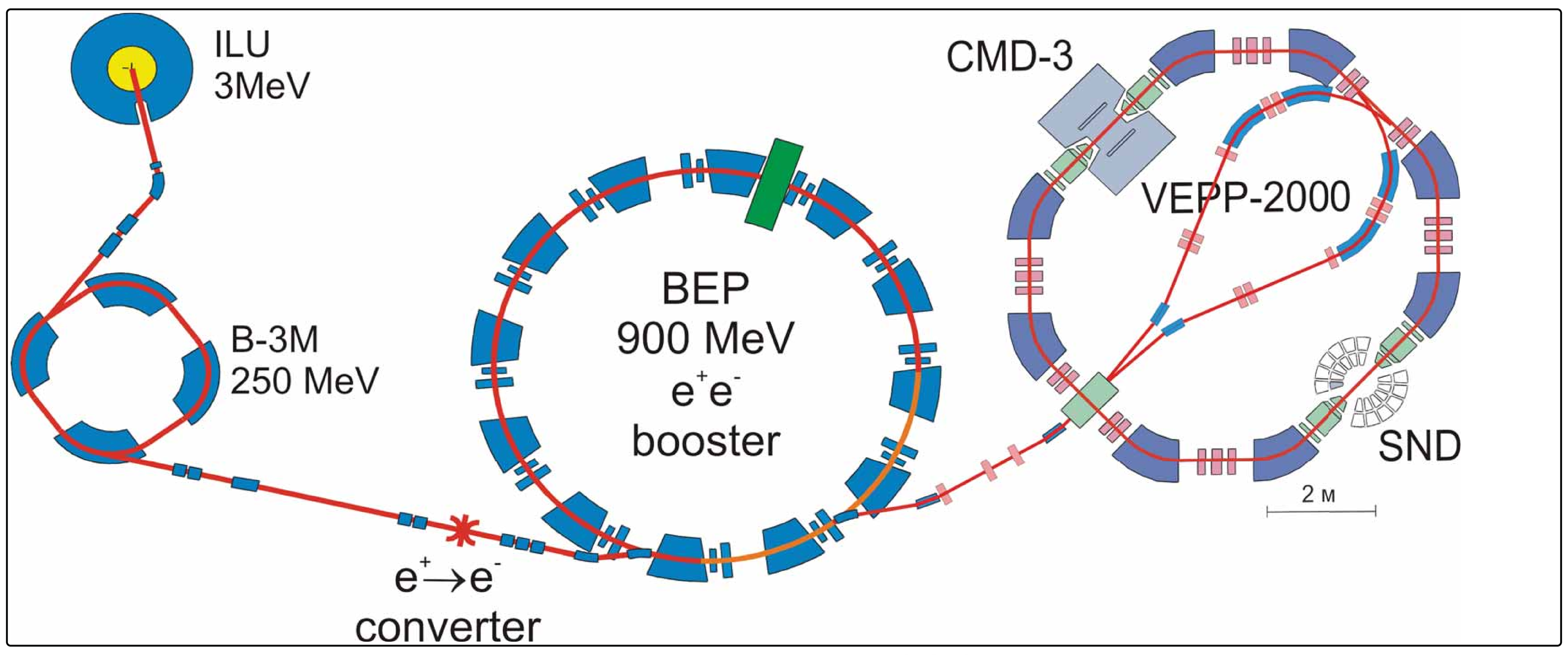

Figure 1: VEPP-2000 facility layout.

CONTROL SYSTEM (SOFTWARE)

Modern accelerator facility is a complex system both physical and technical meaning. It consists of many subsystems and units, which are difficult to automatize.
Collider state is characterized by many parameters which have to be tracked. These parameters could be divided into two groups: continuous (like beam current or beam energy) with typical speed of change from two time at second up to one time at ten minutes and pulsed which are related to some event (e.g. beam transport event called "Shot"). There are approximately 3000 continuous channels and about 500 pulsed channels at VEPP-2000 facility.
Control system is multilayer distributed system with specialized hardware server at lower layer, client program at upper and utility server between them. It was build according to the concept of independent subsystem control. Such approach allows us to create a small program with strictly divided responsibility.

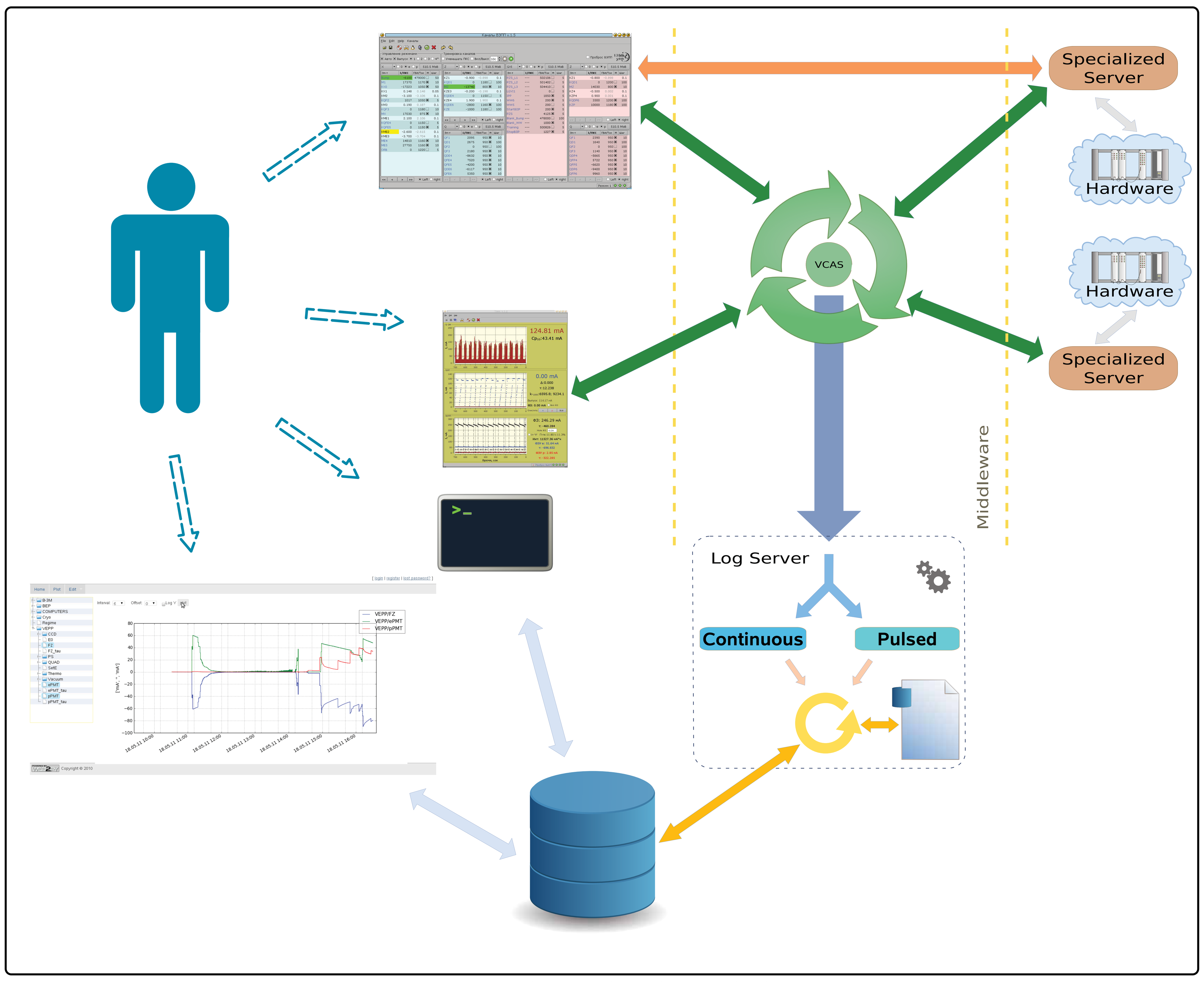

Figure 3: Constrol system (software) layout and data flow.

LOGGING SYSTEM

Rationale

The collider state is characterized by many parameters which changes with a different rate. Some time operator can't detect deviation of parameter and analyse it. That's why it is necessary to save changes of all parameters.
Such information could be used for investigation of system faults and correlation of subsystems.

Architecture

The Logging system is built on client-server architecture. Client layer provide data access via API, CLI and WUI. Server side are a specialized server with an intermediate embedded database aimed at saving data in case of external database

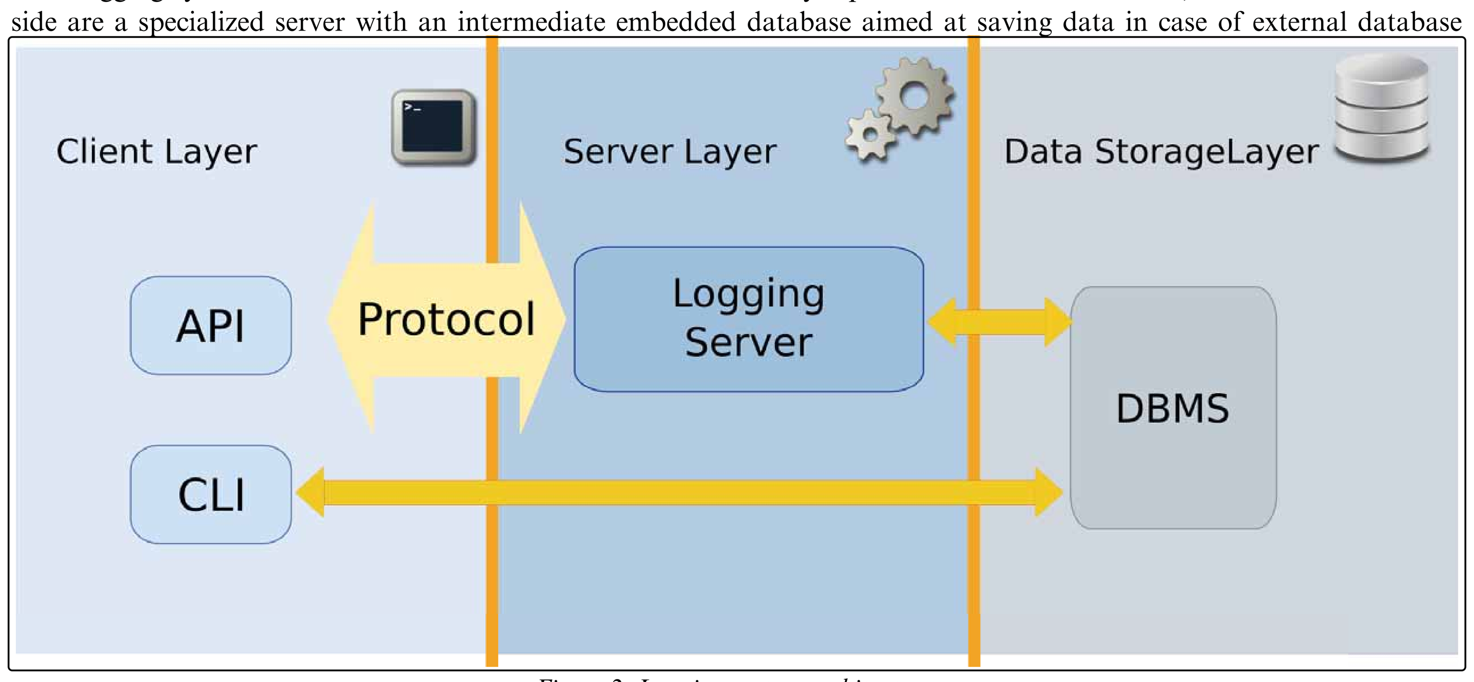

Figure 2: Logging system architecture.

Data Storage Layer

Logging system produces a large amount of data. To access data in reasonable time, it should be indexed. The most common decision is to use relational DBMS. Postgresql[5] was chosen. There are several reasons: team of VEPP-2000 has experience of working with it, itis in active development, it has tools for replication andbalancing.

Server Layer

The server layer consist of logging server. Logging server is a core of logging system. It perform data collection and data optimization.Logging sever consists of network module, continuousmodule, pulsed module and storage module. Network subsystem handles network communicationand dispatches request to the appropriate module.Continuous module perform data optimization andsimple data validation.Pulse module handles pulse data connect interestingcontinuous data records to certain pulsed data record.
Storage module saves data to temporary database and moves saved records from temporary database to main database. Temporary databased is used for data buffering before bulk insert to DBMS. It allows to save data in case of main DBMS fault or inaccessibility. For this purpose BerkeleyDB Java Edition[6] was chosen. It has no external non-Java dependencies and could be launched regardless of the installed software.
The prototype of server was developed in python. It had acceptable throughput, but peak loads may cause instability of whole system. Current version of server was implemented in Java. Test shows good server stability incase of 8000 channels

Optimization algorithm

The main purpose of optimization algorithm is to reduce disk resources used by stored data.
All continuous channels have different rate of change. Some channels change every second (beam currents), some every 5 seconds or more infrequently. That's why is seems rational to introduce some threshold. If the difference of the previous and new values is less than threshold, then value considered unchanged.
This algorithm allows to reduce the rate of data growth from 3.4 MB/day to 1.28 MB/day per channel.

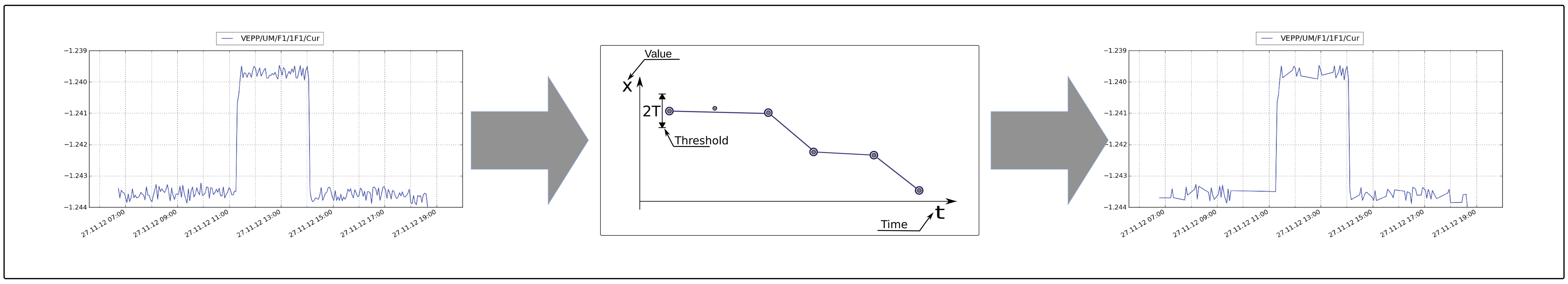

Figure 4: Optimization algorithm example. Curent in 1F1 magnetic element of VEPP-2000. a) data before optimization; b) optimization alrorithm; c) data afterm optimization. The number of points decreased in 2 times.

Client Layer

Client layer consists of API for interacting with logging server and CLI for accessing data. API and CLI were implemented in C/C++, since most of the clientapplications were implemented in C++. To simplifyextending VCAS[7] with logging, Qt version of API was developed as well.

Web User Interface

Web user interface provide interactive access to stored data. At the present time WUI is implemented in Python using web2py framework [8] and mathplotlib[9]. Thisframework was chosen for several reasons: author's wideexperience with Python development and fast applicationdevelopment. An interactive plotting also available. It allows to zoom in part chart. It was developed on browser unsig javascript library dygraph[10]. It provides ability to plot up to several thousans of points (24 hours, few channels).

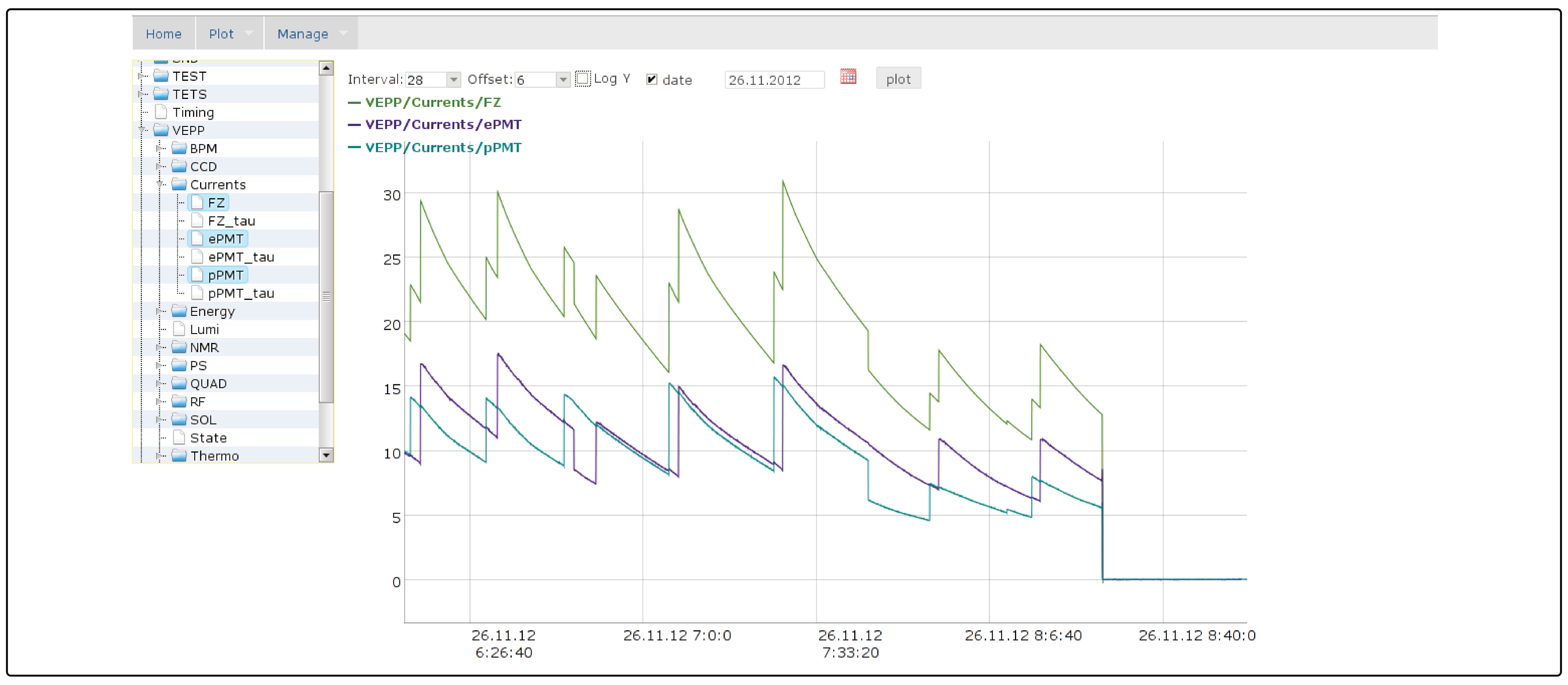

Figure 5: Interactive plot. Beamcurrents in VEPP-2000.

REFERENCES

[1] Yu.M.Shatunov et al., "Status of VEPP-2000 Collider", RuPAC'12, St.-Petersburg, Russia, September 2012; MOYCH01,http://www.apmath.spbu.ru/rupac2012.
[2] "VEPP-2000 Project", http://vepp2k.inp.nsk.su.
[3] "CMD-3 Project", http://cmd.inp.nsk.su.
[4] "SND Project", http://wwwsnd.inp.nsk.su.
[5] Postgresql, http://www.postgresql.org/
[6] BerkeleyDB Java Edition,http://www.oracle.com/technetwork/database/berkeleydb/overview/index.html
[7] A. Senchenko et al., "VEPP-2000 Collider ControlSystem", PCaPAC'12, Kolkata, India, December2012, FRCB04, http://www.JACoW.org.
[8] Web2py framework, http://www.web2py.com/
[9] Mathplotlib, http://matplotlib.org/
[10] Dygraph, http://dygraphs.com