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DEVELOPMENT OF THE FLNP MEASUREMENT-AND-COMPUTATIONAL COMPLEX

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ABSTRACT

In the present paper consideration is given to the problems connected with creation of a new generation of systems for experiment automation at the IBR-2 and IBR-30 pulsed reactors at the Frank Laboratory of Neutron Physics (FLNP).

1. Introduction

The purpose of this work is radical innovation of the electronics and software for spectrometers as well as development of the informational and computational infrastructure (ICI) of the FLNP, to make it possible to carry out experiments in the fields of condensed matter physics and of neutron nuclear physics at an up-to-date level at the IBR-2 and IBR-30 reactors and, in the future, at the IREN installation.

The implementation of a number of technical proposals [1-6] has laid down the basis for large-scale transition of the measurement and control systems of the FLNP spectrometers to a new generation of electronics, computational hardware and software involving the VME system and workstations integrated into the local computational network (LCN).

Keywords: Data acquisition, Electronics, Networks, Workstations

These systems, as compared with those already in operation (based on PCs and CAMAC devices), should exhibit qualitatively new measurement (this, for example, concerns IREN) and operational parameters and provide for parallel (including remote) control over data acquisition and accumulation, over variation of conditions at a sample, over information processing and visualization.

An essentially new requirement voiced by physicists-users is the requirement to create a unified set of hardware and software means for the entire complex of the Laboratory spectrometers, centralized archives of experimental data and unified means for analyzing data and for their graphical presentation. Implementation of this requirement will result in simplifying service of the spectrometers and essentially facilitate transition to the user policy at the experimental setups.

The overall problem of developing systems for the automation of experiments and for the Laboratory measurement-and-computational complex involve several independent ranges of activities, each of which is worth being examined individually.

2. Measurement and control systems for the spectrometers.

Recently, there have been purchased over 10 standard crates of the VME equipment, each of which comprises the following:

- a crate together with the power supply;
- a CPU based on the Motorolla 68020/30/40 processor with a RAM of 4 Mbytes;
- a HDD with a capacity of 100-300 Mbytes;
- a floppy disk driver;
- an ETHERNET card;
- an ADC and DAC block;
- input/output registers;
- a serial interface module.

Creation of a system for automation of the spectrometers requires developing and purchasing electronics for the readout, amplification, analog processing and transformation of signals from the detectors, for registration and accumulation of spectra, for control and management of the detector equipment (devices for substituting and positioning irradiated samples - step motors, goniometers etc.; devices for changing conditions at samples - the temperature, pressure, magnetic field, etc.).

The actual measurement-and-control spectrometer systems in operation were developed during various periods of time and in accordance with individual technical assignments. This has resulted in the electronics exhibiting an extremely low level of standardization, which hinders its operation and development and practically renders impossible any unification of the software. Moreover, a significant part of the electronic blocks have become obsolete and their parameters do not meet present-day enhanced requirements (thus, for experiments to be performed with the IREN installation a time encoder will be needed operating at a rate of 10^6 pulses/sec with a minimum channel width of 50 ns, amount of channels up to 16384 and with up to 16 detector inputs; a spectrometric ADC with up to 8192 channels and conversion time of $3 \div 5$ μs will also be needed). Therefore, in transition to VME systems we cannot just copy the electronics operating within the CAMAC standard; what are needed are a radical innovation of the component base and of circuitry-and-engineering solutions, an improvement of the measurement characteristics, a reasonable limitation of the nomenclature of blocks to be developed and to be purchased, and, in certain cases, a revision of the techniques adopted for data readout and registration. When choosing a technical solution, such factors as the experience of other physical centers [7-10], standards accepted in JINR and available material base, are taken into account.

We shall now consider the main tasks and approaches in developing the electronics.

2.1. Detector electronics

Various types of detectors are utilized in the FLNP spectrometers:

- semiconductor detectors (Ge(Li)- and Si- detectors, high resolution Ge- detectors);
- scintillation detectors (detectors with Na(J) crystals, multi-section detectors with a liquid scintillator and with Li-glass windows);
- ionization and proportional chambers, including fission chambers;
- helium and boron neutron counters;
- position-sensitive neutron detectors (linear and two-coordinate PSD).

Each type of detector requires its own special electronics for the readout and optimum filtration of signals.

Most of the equipment for the semiconductor detectors is to be purchased at the market (probably, with the exception of the above-mentioned ADC).

The electronics for the scintillation detectors requires significant updating. The disadvantages of this equipment include the following: only current signals are read out, a low degree of integration, and, consequently, difficulties in production and adjustment. We propose to develop a preamplifier for the readout of charge signals as well as charge-to-digital converters based on up-to-date components. Thus, at present joint work is under way together with the Moscow Engineering Physics Institute (MEPI) for developing fast electronics for the scintillation detectors, making use of analog matrix crystals. The planned introduction of a large amount of detectors with Li-glass requires the development of standard multi-channel blocks of fast amplifiers and shapers. From a methodical point of view, an important task consists in suppression of the γ-background applying methods for analyzing the shape of pulses from these detectors, i.e. the creation of electronics for n-γ separation.

Owing to large differences in the operating conditions, in the constructions, and the gas fillings of ionization and proportional chambers, standardization of the analog electronics for this group of detectors is difficult. A new generation of preamplifiers involving the readout of current and charge pulses must be developed. Unification must concern such blocks as amplifiers, discriminators, shapers, etc.

The amount of point-like neutron detectors continuously increasing necessitates the development of new electronic blocks extensive involving integral microcircuits (chips). The degree of integration necessary is such that the electronics for 16 or more detectors must occupy a single card. At present, work has started on testing a series of domestic and of imported microcircuits (chips) for the readout electronics from these detectors. A unified circuitry solution is under development for the entire electronics channel.

The spatial resolution of the linear PSD utilized in the FLNP is far from being up-to-date. One of the reasons is the low quality of the readout and processing electronics, which requires serious modernization and, also, probably, development of another method for signal readout, for example, making use of delay lines. The planned startup, at the DN2 spectrometer, of a high precision two-coordinate PSD (a neutron chamber with gas filling) will require the development of time-to-digital converters in the nanosecond range.

The nanosecond electronics, comprising discriminators, shapers, precise timing devices coupled with pulses from the detectors, coincidence circuits, summators, splitters of logical signals, etc., also requires up-dating.

Most of the detector electronics will be located in available CAMAC and NIM crates, which are most suitable for analog devices. Amplitude encoders, realizing the transformation of signals from the detectors may be located both in a CAMAC crate or incorporated in VME. In both cases the ADC digital codes are transmitted to the blocks producing event codes or to the histogram memory via connectors on the front panels of these blocks without making use of the VME bus.

2.2. Control and management systems of the equipment for the spectrometers

A large amount of equipment is used in experimental installations for positioning samples and detectors and for varying the conditions at the sample. The executive mechanisms of these devices, which include step motors, asynchronous motors of neutron beam choppers, furnaces, refrigerators, current/voltage supplies for producing constant and pulsed magnetic fields, high-voltage supplies for the detectors etc., exhibit great variety at various spectrometers, which significantly complicates unification of the electronics. For this reason, a decision has been adopted, now, to provide for maximum standardization of this equipment and, correspondingly, of the control-and-measurement equipment, of the regulators, and of the sensors. The whole complex of these problems and the technical solutions proposed are dealt with in separate work. Herein we only raise certain issues of the development and unification of electronics for the equipment mentioned, relevant to the utilization of VME systems.

The general functional control-and-management scheme for the executive mechanisms (EM) is presented in Fig.1.

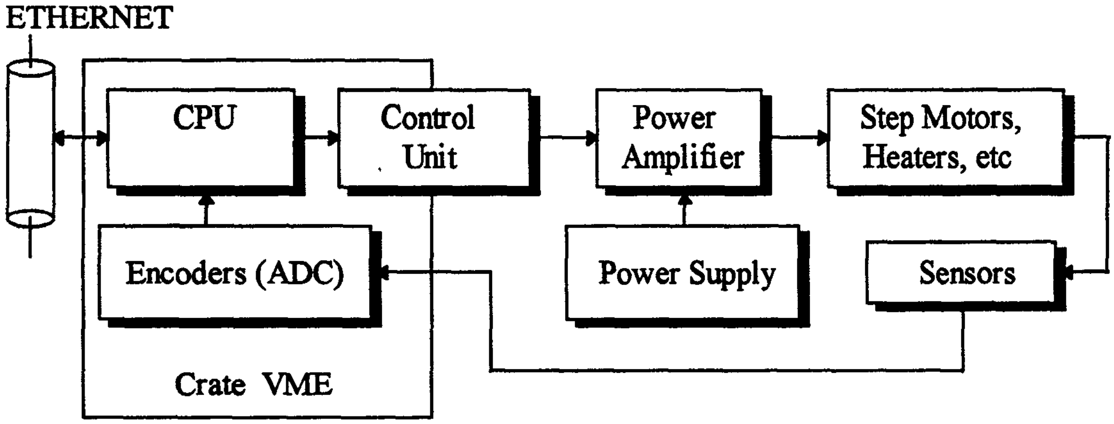

Fig.1. General functional control-and-management scheme for the executive mechanisms.

One of the main problems consists in the choice of a control block corresponding to the entire EM variety. This is evidently possible only if control is realized by means of software, i.e., if all the specific features exhibited in the concrete EM operation are taken into account in its control system. Two versions are possible for constructing such a block:

- involving an incorporated "intellect" (microcomputer);
- utilizing simple input/output registers and control from a VME processor.

The second version is preferable owing to its simplicity and to utilization of the same software environment OS-9 for the entire automation system. The first experience in application of the VME system at the NSVR high resolution neutron spectrometer has revealed that not more than 3-5% of the CPU resources are taken up in running EM control tasks [2]. Utilization of autonomous microprocessor blocks is justified, when the EM are sufficiently far away from the control crate (> 20 m) or when the equipment of the spectrometer is purchased together with the control block.

Unification of power amplifiers for the step motors is done quite simply. At present a power amplifier for alternate control of the motors is under development. The connection of the amplifiers with the control block is also to be developed in a unified form, suitable for connecting the amplifiers both to the input/output registers and the microprocessor blocks. The connection scheme is consistent with the scheme provided by the company Middex, whose equipment is utilized in many FLNP spectrometers.

At present, practically none of the spectrometers has a comprehensive system for acquisition of analog information on the state of the physical setup. The task of accumulating analog parameters and of producing control influences for the regulator is to be performed using ADC blocks with multiplexors at the input and multichannel DACs. Preamplifiers for each sort of sensor and power amplifiers for the regulators will have to be developed individually owing to the contradictory requirements of their input and output parameters, although even here standard solutions may be suggested. Anyhow, a significant part of these problems will be resolved in the course of standardization of the equipment surrounding the sample.

2.3. Data acquisition and accumulation

Figure 2 presents the general scheme for data acquisition and accumulation in experiments in condensed matter physics. From the Figure it can be seen that the encoding device assigns each detected event a time channel number and a detector number in the multidetector system (SCD point detectors, scintillation detectors, neutron detectors) or in the position group involving PSD, which are combined into a sole event code. This code is input to the histogram buffer memory, which interprets it as an address code and by hardware means increments by "1" the content of the respective memory cell. Thus, accumulation of spectrometric data proceeds directly inside the histogram memory without participation of the processor, which permits freeing the VME bus from performing routine operations continuously and provides for a minimum dead time.

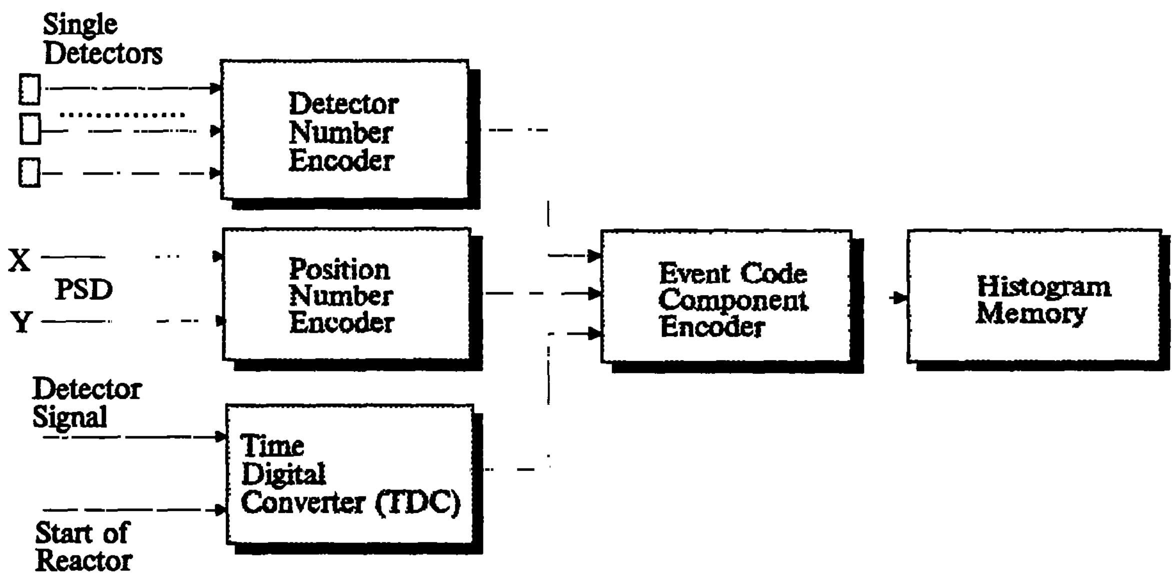

Fig.2. General scheme for data acquisition and accumulation

The number of point detectors utilized in experiments may be up to 128; the number of positions in linear PSD up to 64, and in two-coordinate PSD up to 128 x 128; the number of channels in TDC up to 1K ÷ 4K (up to 16K are planned). Thus, an information word (address) in present-day experiments may occupy from 10 up to 26 bits. A memory volume of 64 Mwords is required for accumulation of this amount of information. However, utilization of information re-encoders, involving the selection of events with the aid of "digital windows", makes possible reduction of the number of bits occupied by the event code and, accordingly, of the required memory volume. Another way of reducing the required memory volume consists in the application of a programmable scale in the TDC, i.e., in division of the time interval into several subintervals with channel widths differing from each other. In real experiments both methods are applied and in most cases a memory of 1 M sixteen-bit words turns out to be sufficient for data accumulation. Such a memory has been developed earlier in the VME standard [4], it represents a dual-port memory with an operation cycle of 350 ns.

The code of an event comes via connector on the front panel of the block. As viewed from the bus, this VME block represents an ordinary RAM, which is available to the processor at any moment (even during accumulation of spectra). If several detector systems are used in the experiment, then an appropriate number of encoders and memory blocks is required for data accumulation.

Now two VME modules are under development: a unified TDC (with the parameters indicated above) and a histogram memory based on SIMM modules, foreseeing the possibility of varying its volume from 1 to 64 Mbytes, depending on the concrete requirements of the experiment, with 32-bit words and a FIFO memory at the input for smoothing out the intensity peak.

In multiparameter experiments in neutron nuclear physics the information on an event represents a set of codes arriving from spectrometric ADC and TDC, which are stored in sequence in the buffer memory and, when it has been filled up, rewritten on magnetic carriers (hard disks, streamers etc.). The number of parameters registered in these experiments is from 3 to 8, while the maximum address space amounts to 10^{19} (the CASCADE spectrometer). These data cannot be sorted on-line, even taking into account that a significant part is discarded at the stage of accumulation.

Modernization of the existing equipment for multiparameter analysis will be carried out by improving the methods of selection and of data accumulation, and also by performing operations for sorting out on-line integral spectra over individual parameters for establishing control of the experiment. The electronic blocks for these purposes will be realized on the basis of digital signal processors (DSP) or transputers, which are to be utilized both at the stage of data accumulation and during subsequent (or parallel) processing. These blocks will have a large volume of dual-port memory available to the VME processor, and data transfer via the bus will be realized in arrays, as the memory is filled up. In order not to overload the network, raw data will be accumulated on a local disk and written to the archive in an off-line mode.

A prototype of a DSP-based [12] RTOF correlator costing nearly two orders of magnitude less, than correlators of the parallel type [13], has been developed for the High Resolution Fourier Diffractometer (HRFD), where correlation analysis of the inverse time of flight is applied. At present, a correlator is under development in the form of an autonomous VME module, in which data accumulation and processing is performed without participation of the VME processor. All four detector systems of the spectrometer will be equipped with such correlators.

The development of unified electronics for the automation systems of the spectrometers will be based on broad application of software-controlled microprocessor techniques (DSP, transputers) intended for real-time operation and of programmable logic matrices (ALTERA, XILINX).

3. The general concept underlying the organization of experiment automation systems

Control over the experiment as a whole and over the equipment of the spectrometer is performed by a computer in a VME crate, which provides for the following: data acquisition and accumulation; control of the equipment of the spectrometer and implementation of the experimental program; interaction with the Graphic User Interface (GUI); storage of the data on a local disk or in the file-servers of the ETHERNET network. The VME manager crate has a built in disk, a multiprogram real-time operation system OS-9, TCP/IP and NFS network software.

For effective work the VME processor is assumed to have sufficient productive capacity and the VME bus is freed as much as possible from routine operations of accumulating spectra capable of loading it completely or nearly so. Note that data are exchanged via the VME bus between built in disks, streamers, and other programmable control blocks, and a broad range of network operations is performed too.

From the point of view of organization, the software for the automation systems is divided into the interface part GUI and the control part. Control and monitoring of an experiment and of the entire system is implemented by the user from GUI based on a workstation within the X-Windows environment and included in the ETHERNET. It represents combination of menus, windows, on-line help etc., i.e. programs providing interaction with the control system in the style adopted for the Windows system. Individual application programs of the graphics interface allow setting the configuration of the system, provide interactive control over separate devices of the spectrometer, testing the efficiency of its subsystems, and also control over the operation conditions of measurements. Realization of the user's interface in the Windows environment makes possible the presentation of information on the screen in text, numerical, and graphical forms at the same time.

The user's commands are transmitted via the GUI for implementation by the control part. Connection between the GUI and the control software is realized by means of the software of the ETHERNET network supporting the TCP/IP protocol. Since a personal computer (X-terminal) or a workstation can be included into the local network at any site, then, upon realization of such a user's interface, we acquire the possibility both of remote control over the spectrometer and of control from a computer located directly at the experimental setup.

The control part of the software is realized in the VME system and its operation is controlled by the OS-9 system. It performs all the functions, essential for carrying out the experiment, of direct control of the equipment of the spectrometer, acquisition and accumulation of information, preliminary data processing and storage in archives. The organization of software is discussed in greater detail in [1].

Thus, the VME electronics and software fully realize all the functions relevant to performing the experiment. The workstation is utilized as a user's graphic terminal during the dialogue between the user and the experiment automation system, i.e. it performs service functions and is intended for the organization of readily mastered and modern in style means of communication between the experimenter and the system. An essential point in this approach consists in the achievement of high reliability of the measurement systems, which is due to the VME computer being capable of monitoring the experiment and accumulating data even in the case of failure of the equipment of the network, the file-servers and the workstations.

When the experiment is being performed, the physicist must have the possibility to carry out at the same time data analysis and processing, examination of the experimental information represented in graphical form. This can be done at any computer incorporated in the network, since during the experiment the data are recorded and stored by network file-servers in standard format.

4. Data formats

The representation of data within the automation systems may vary for different spectrometers and depend on the equipment and method of transforming information during the experiment, but the results of measurements and of subsequent processing must be written down in unified format. This is necessary for creating a unique software complex permitting, without additional transformations, to process and analyze data from different experimental installations, and also for convenience in comparison of the results of processing, obtained for the given sample under other conditions or at another setup. Essential also are the problems of unification in the processes of archive creation, searching for, and identification of collected data and of compatibility at the data level when various types of computers are utilized. The problem of choosing the data format should be resolved together with the problem of choosing the data base, the control system of the data base, and the software packages for the data processing and analysis. Commercially supported systems, being universal, exhibit significant superfluity, so at many centers specialized systems are under development. Obviously, it would be expedient to define the laboratory format, which would be economical for concrete tasks in the FLNP, and to develop programs for transforming it into international formats [14] or into formats adopted in collaborating organizations.

5. Creation of data archives

An archive is divided into two levels. The first is operational and has short access time (on hard disks) for files written in the archive at the current run. The second level is for long-term storage of data on rewrittable laser disks.

The amount of data obtained in experiments at IBR-2 and IBR-30 is constantly rising. Thus, for instance, during the period from November 1992 to June 1993, when 9 two-week cycles were carried out, data were obtained for ~ 450 samples [11] with the 11 spectrometers of the IBR-2. On the average, the volume of data accumulated during one IBR-2 cycle exceeded 1 Gbyte. This figure will increase significantly, when the spectrometer REFLEX are put into operation, new detectors for some of the spectrometers are established (a two-coordinate PSD for the DN-2 spectrometer, two large multi-section scintillation detectors for HRFD, a PSD for the MURN small-angle scattering spectrometer), and the nomenclature is expanded of devices for variation of the conditions at the sample.

The spectrometers at IBR-30 provide less information (~ 0.3 Gbyte per cycle), but it must be noted that in multiparameter experiments the volume of information is artificially restricted (selection using "digital windows") owing to the low capacity of the accumulating systems. The situation will become even more complicated, when the IREN setup is installed, the expected enhancement in the neutron flux intensity being of about an order of magnitude.

Determining the volume requirements of disk memory for organization of the archive and, in a broader sense, for supporting the entire information-and-computational infrastructure of the Laboratory, is a complex problem, the solution of which must involve taking into account a great number of inter-related and inter-dependent parameters, many of which are difficult to predict.

Theoretically, the capacity of the archive should be planned starting from maximum possible information flows from the spectrometers, although more precise estimations are based on the actual amount and conditions of experiments to be carried out during the period predicted. The memory volumes of the first and second levels of the archive depend, also, on the rate and profundity (degree) of data processing, which, in turn, depend on the efficiency of the computers utilized, on the quality of available software, on the existence of local computational facilities at the spectrometers, on the organization of data accumulation and processing, and on a number of subjective factors.

It must be pointed out that the operational archive and ICI make use of the same memorizing environment shared between the users, spectrometers, and system problems. Therefore, in estimating the resources of disk subsystems required it is necessary to take into account the constantly and rapidly rising demands related to development of the infrastructure (the appearance of new software, the creation and utilization of various data bases, enhancement of the number and activity of users, expansion of communications with other centers, improvement of the informational service, the constant rise of intrasystem overhead expenses etc.).

Finally, the world experience reveals that in normal conditions the computational facilities and volumes of disk space must double at least every three years [7]. When new setups, spectrometers, detectors etc. are put into operation the doubled figures indicated must be accordingly increased. It is also well-known that the requirements of disk memory cannot be overestimated, since users are capable of filling up any informational space in relatively short time. At present, somewhat over 30 Gbytes are at the disposal of the FLNP SUN-cluster. Taking into account the above mentioned factors we plan significant enhancement of the disk capacity both for operational and long-term data storage. Specifically, the Jukebox archive system on rewrittable magnetic-optical disks of total capacity 40 Gbytes was purchased a few months ago.

6. Software packages

As a rule, each scientific research center makes use of some software package for analyzing and processing experimental information. Thus, for instance, RAL applies GENIE, the center for nuclear physics in Rossendorf uses AVS, HMI (Berlin) applies

PV-wave, and CERN uses PAW. But, besides this, often packages of more general purpose are applied, since the problems dealt with by physicists in planning an experiment or in designing an experimental setup may include general mathematical calculations, simulation, etc. It is expedient to let the users choose the graphics package or processing program most appropriate for the concrete case. First of all, this implies the graphics software packages intended for utilization in data processing and analysis with application of computer graphics. Effective application of any of the packages with the purpose of analysis and processing experimental information in FLNP requires the development of specialized application software (such as for standard operations with spectra: summation, normalization, background subtraction, decomposition of peaks, calculation of measurement errors, etc.), besides the facilities provided by the package itself.

The packages listed above are all organized in the same way, from the point of view of the user. They provide the user with a set of programs for processing and transforming data, a set of graphics programs and an interpreter, which makes possible easy utilization of available graphical facilities and of means for data processing, and, also, the construction, without any detailed knowledge of computer graphics, of applications in the form of interpretable programs for integrating the graphics and processing. Such packages, as a rule, permit creating C and FORTRAN programs, which are specialized for a concrete range of applications, and utilizing them in interpretable programs together with standard commands.

The libraries of programs for data processing and the graphical facilities of packages determine their lines of application, although they may overlap to a certain extent. There also exist differences in the resources required and in the operation speed (the more sophisticated the package, the slower it is and the more disk and operational memory it needs).

At the FLNP for the first step, GENIE and PV-Wave packages are to be installed and mastered.

7. Network and computer infrastructure

As one can see from the above, performing experiments at an up-to-date level, as well as normal activity in the Laboratory, are practically impossible without reliable operation of LCN, its continuous development, and enhancement of resources.

Until recently, many of the FLNP LCN parameters have not even satisfied the everyday demands of users, first of all owing to the low reliability of the network equipment, to the capacity of the disk subsystems being insufficient, to the inadequate physical and logical configuration of the network, to the absence of many software products, to the bad service etc.

In 1994-95 significant efforts have been undertaken for the ICI development, new workstations (two of the SPARCstation 10 type and four SPARCstation 20), additional disks, four network HP LaserJet 4Si/MX printers, two colour HP DeskJet 1200 C/PC printers, five X-terminals, etc. have been purchased and installed. The new configuration of the network resources and its logical organization are presented in Fig.3. Measuring systems of spectrometers and PCs in physicists' offices are included into LCN. The SUN-cluster, which consists of servers and workstations, holds a central position in the network. At present, more than 150 PCs, 2 servers and 14 workstations are incorporated into the network. Twenty three PCs of the total number are placed in the experimental halls and pavilions of the IBR-2 and IBR-30 reactors. These computers are connected to the CAMAC equipment and provide for data acquisition and accumulation, as well as for control over the experiment. They are run by the MS-DOS system and the PC-NFS network software. In addition, PCs in users' offices make use of the MS-Windows system.

The SUN-cluster includes different models of SPARCstation computers, all of them are run by the SunOS 4.1.3 system and network software supporting the TCP/IP protocol. The NFS (Network File System) is used for organization of the distributed file system of the cluster. More than 230 users are registered in the SUN-cluster. The X-Windows system (version 5), installed in the computers of the SUN-cluster, allows the user to work with any computer (or with several computers simultaneously) both in a remote mode and at the console of the workstation.

At the moment the NQS (Network Queue System) is being installed on the SUN-cluster computers for automatic distribution of tasks between the computers in the cluster, and also in order to provide for even workload and to increase the rate of running non-interactive tasks. This system enables the user to put the task on the queue to be executed, and the NQS system will send it to a less loaded computer of the cluster. NQS periodically autosaves the task context and this makes it possible to continue its execution in case of a failure in the cluster operation. It is of importance for time-consuming tasks.

The shared resources of the SUN-cluster computers include: disk space and computational resources; CD-ROM; devices for storing information on the EXABYTE magnetic tape of capacity 2.3 Gbytes and 10 Gbytes; devices for reading/writing data to rewrittable magnetic-optical disks; the JukeBox archive system.

Figure 3 also presents information on "specialization" of the SUN-cluster computers, i.e., it indicates the main tasks which should be executed by this or that computer, the content of software packages which require considerable amount of the disk and RAM memory and high performance of the processor. In spite of the mentioned specialization, the users may work on all the cluster computers in a usual computational mode.

Part of the workstations are intended to exercise control over the experiment, to perform an on-line analysis and processing of the accumulated data, therefore the names of the spectrometers to which these computers are assigned, are given in this figure. At the HRFD, NERA-PR and NSVR spectrometers, the greater part of the work connected with transition of electronics to the VME-based equipment, will be completed by the end of 1995.

Today, from a logical point of view, all the computers are connected to a single segment of the network (physically to several lines interconnected with repeaters), which,

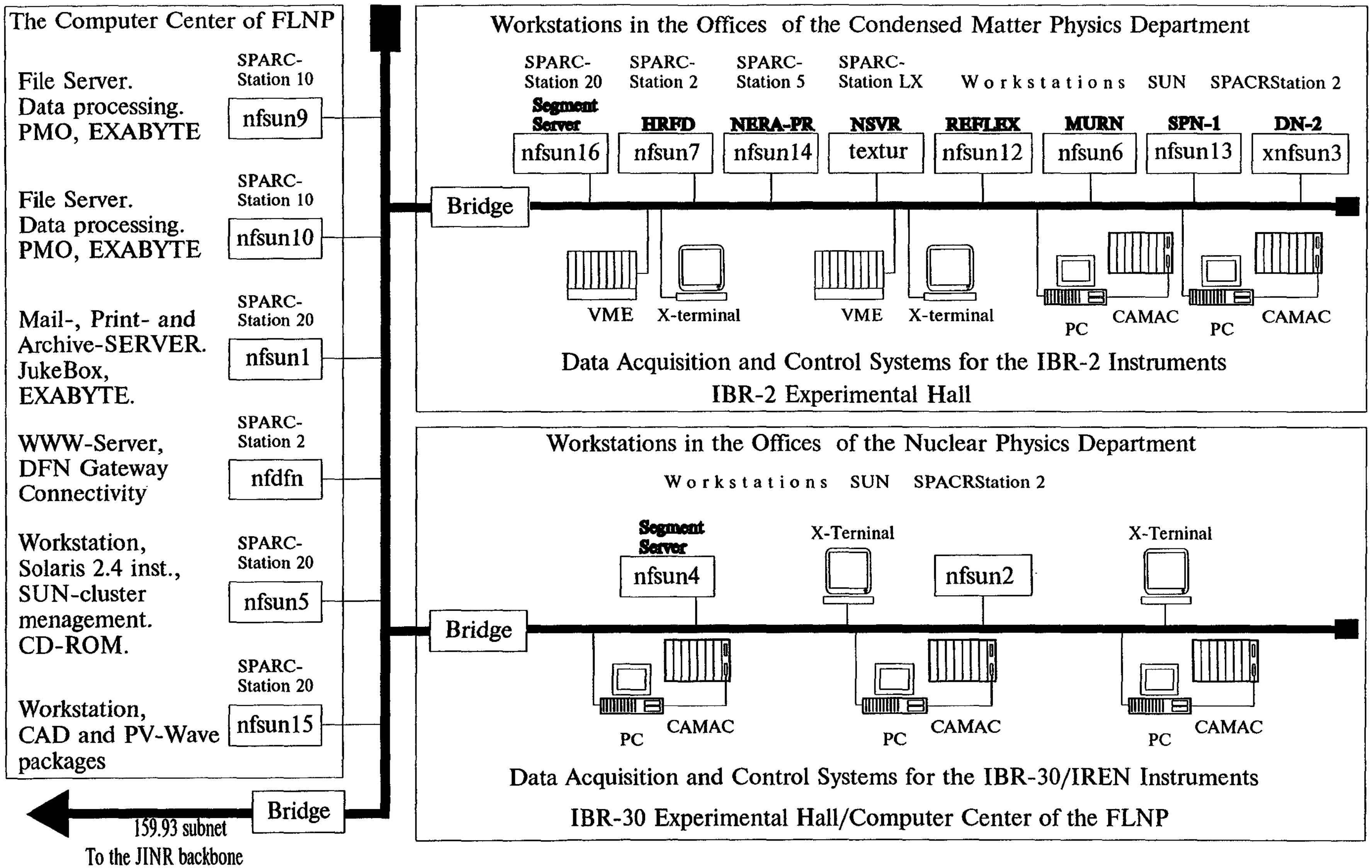

Fig. 3. Structure of the local area network of the FLNP.

in turn, is one of the segments of the JINR network and is separated from it by a network bridge. A network of the ETHERNET type is known to function effectively when its load does not exceed 30%, after which its capability of operation drops drastically. From general LCN construction principles it follows that the elements of the network, including sources of information and accumulation means (i.e. actually representing a closed information system) must represent an individual segment and be separated from the rest of the network by a bridge connecting the information flows inside this segment. Outside such segments one finds, as a rule, equipment which itself does not generate large information flows and to which access must exist from all segments. Such are the system of archiving for long-term storage, file-servers with general-purpose software (translators, libraries etc.), powerful computational servers for operation in the package processing mode, etc. Usually, at the central segment there are located computational means of distributive or administrative services, which must have the same easy access to all the other network segments and which, also, do not create large flows of information.

At the end of 1995 we shall complete the work aimed at dividing the single FLNP network segment into a central segment and segments of physics departments, and also for incorporating into the network the computers located in all the Laboratory buildings [15]. Thus, all the computational means of the measurement systems of the spectrometers at the IBR-2 and IBR-30 and the computational means serving the reactor equipment directly and practically operating independently of each other will be divided into two separate segments.

Ideally, each spectrometer or, which is more realistic, each group of similar spectrometers with common means for generation, storage and processing of information should be made to represent an individual segment. This means that it is necessary to concentrate, as much as possible, the data storage and processing at the place where the data were obtained, and thus to essentially reduce the load of the network. For financial reasons, however, this work is postponed. The problem of current concern is to replace the section of the ETHERNET network which includes servers and computers providing service for the Laboratory, for the ATM type network to provide more effective operation of servers.

8. Conclusion

The FLNP spectrometers have much in common and at the same differ essentially from each other in the amount and type of detectors, in the equipment used for varying the conditions at the sample, in the volume and speed of data accumulation, in the control algorithms, etc. Accordingly, the automation systems of the experiments also have their own specific features, although attempts are made in developing them to achieve maximum unification of both the electronics and the software. At the same time the problems of data formats and archive creation, of developing the graphic user interface, of applying standard mathematical processing packages and of graphical representation of the data, of integrating local computational means of the spectrometers into the LCN are common in nature and will be resolved in the same way for all the experiments carried out in the Laboratory.

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