E10-2017-89

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INSTRUMENT CONTROL SOFTWARE AT THE **IBR-2**: DIRECTIONS OF DEVELOPMENT

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Программное обеспечение спектрометров на ИБР-2:
направления развития

Работа посвящена направлениям развития программного комплекса Sonix+, который используется для управления спектрометрами на реакторе ИБР-2 в ЛНФ. В настоящее время комплекс включает в себя программы для непосредственного управления экспериментом на пучках, систему WebSonix для удаленного слежения за измерением и программу Journal для автоматической регистрации измерений. Разработка всех этих компонентов будет продолжена. Появление новых устройств в составе спектрометров, прежде всего DAQ контроллеров Delidaq2 с интерфейсом USB3, будет поддержано в рамках существующей структуры комплекса. Развитие сетевых сервисов направлено на повышение защищенности, устойчивости в работе и удобства использования. Значительное внимание будет уделено разработке и реализации концепции централизованного хранилища результатов измерений.

Работа выполнена в Лаборатории нейтронной физики им. И. М. Франка ОИЯИ.

Сообщение Объединенного института ядерных исследований. Дубна, 2017

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Instrument Control Software at the IBR-2:
Directions of Development

The work is devoted to the development trends of the Sonix+ software complex, which is used as instrument control software at the IBR-2 reactor at the FLNP. Currently, the complex includes programs for direct control of beam experiments, the WebSonix system for remote measurement supervision and the Journal program for automatic registration of measurements. Development of all these components will be continued. The appearance of new devices in the setup, first of all, DAQ controllers Delidaq2 with USB3 interface, will be supported within the existing structure. Enhancement of network services is aimed at increasing the security, stability in operation and ease of use. Considerable attention will be paid to the development and implementation of the concept of a centralized repository of measurement results.

The investigation has been performed at the Frank Laboratory of Neutron Physics, JINR.

Communication of the Joint Institute for Nuclear Research. Dubna, 2017

Over the past few years, the Sonix+ [1] software package has been installed at all instruments of the IBR-2 reactor, with the exception of the KOLKHIDA spectrometer. The modular organization of the software and use of the Python language for describing the configuration and experiment script make it relatively easy to adapt it to the specific features of various instruments. In addition, the software is well designed, contains data visualization, instrument tuning programs and other useful tools. The last important addition to Sonix+ is the universal GUI based on the set of PyQt widgets [2]. Of course, the package will be supplemented with modules to support new devices and controllers as well as adapted to new versions of the software and Windows operating system. But, in general, the structure of the complex has been formed and tested by many years of service. Therefore, the focus of attention within the Sonix+ project will be shifted from the software of instrument control computers to the development of central services, namely, the central data storage with related programs as well as to the WebSonix service [3, 4].

SONIX+ STRUCTURE

In a modular system, every component (module) is responsible for some device or function. In practice, a set of modules for each instrument has a non-linear structure (Fig. 1). Some modules control hardware devices — they are at a lower level of the hierarchy. Other modules are used to maintain operation of the others. We have chosen these components and tried to create them as universally as we can expect. We called these modules 'servers'. If one has to port Sonix+ to another instrument, servers can be used without redesign.

The development of new detectors, new DAQ controllers will also have a significant impact on the control computer software. This will require further development of the corresponding Sonix+ modules. Replacing the DeliDAQ-1 controller with DeliDAQ-2, on the one hand, will increase the size of data files by almost an order of magnitude, and, on the other hand, allow the use of 64-bit versions of the Windows operating system. It was impossible due to the lack of an appropriate driver for the DeliDAQ-1.

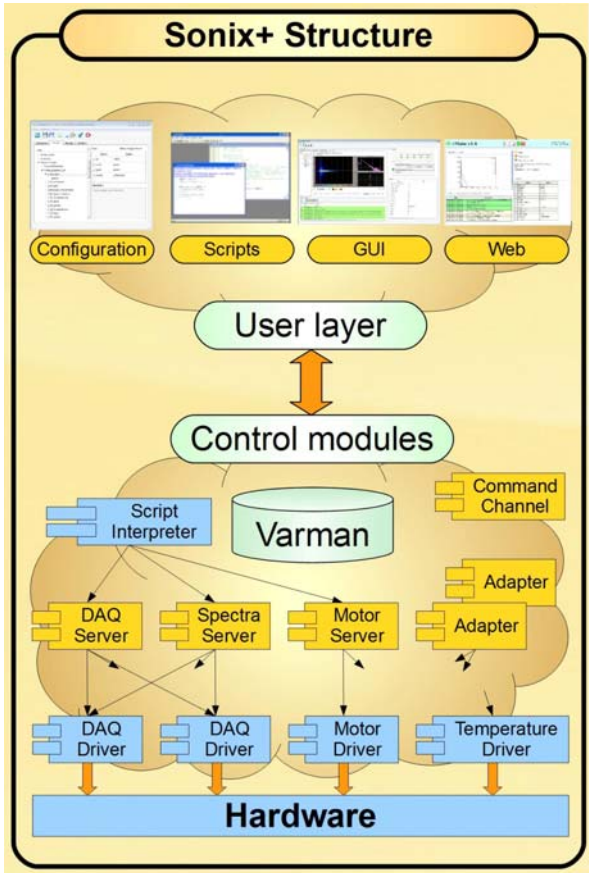

Fig. 1. Sonix+ structure

The increase in the volume of recorded data, as well as a significant increase in the transfer speed after USB-2 interface is replaced with USB-3, will require further improvement of Sonix+ with modern versions of the used packages, but should not change the structure and basic principles of the complex organization.

USER INTERFACES

There are generally three kinds of Sonix+ interfaces: command line, GUI and web interface.

The command line allows one to enter commands as a Python string using any of standard shells. The Sonix+ GUI has also undergone a long evolution

from an individual window for each controller to a single common window. There are both universal and specialized GUI. The universal GUI is available at all instruments. It is organized according to the principle — each sub-window is dedicated to one of the main user's needs. There are three key points of interest for users to monitor: current state of the instrument, measurement history (log file), and picture of spectra (spectrum). The fourth one is to control the measurement process. Thus, four programs (windows, widgets) are generally sufficient to conduct an experiment. There are additional programs as well (Load control panel, Configuration editor and some others).

Specialized GUI are created by special request, for instance, for instrument tuning. Some specialized interfaces were developed for instruments at other centers.

SPECTRA VISUALIZATION

Spectra visualization includes a set of widgets for visualization of data from mono detectors, 1D and 2D PSD. Spectra can be read from files (including zipped files) or from DAQ controllers directly. The matplotlib library panel is used to display a graph. In addition to curve drawing, the panel implements typical operations like scaling, shifting, etc.

Our users, in particular, I. V. Gapon, have recently actively participated in the development of the visualization program (Fig. 2). New options will include representation in Q-space, in wavelengths and also some modes convenient for reflectometry data analysis.

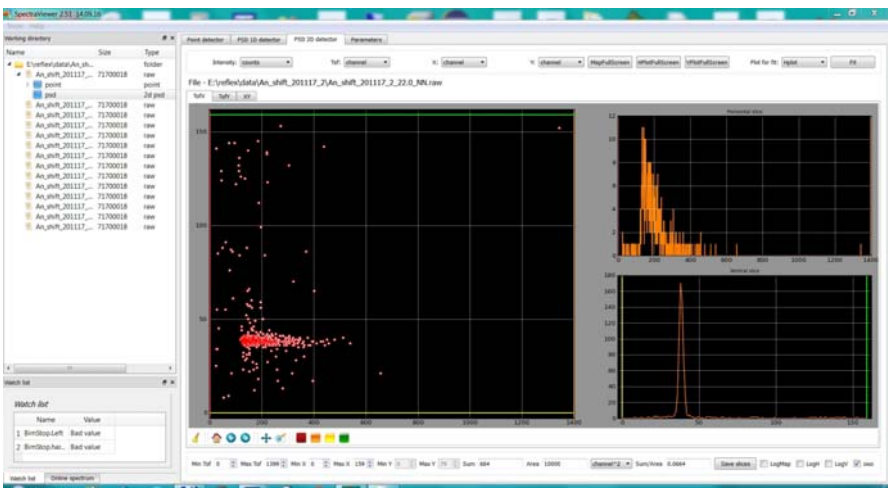

Fig. 2. Specific mode of visualization of reflectometry data for reflected beam search

THE PYTHON BENEFITS

Using the Python programming language to control the experiment allows the user, in particular, automatic preprocessing of measured data in the experiment scenario. For this purpose, software tools such as NumPy [5] or Matplotlib [6] are available. The NumPy is a fundamental package for scientific computing with the Python. It includes powerful and comprehensive tools for multidimensional numerical data processing. The Matplotlib is a free analog of MATLAB. At present, this possibility is used on the YuMO spectrometer to prepare data for processing in the SAS program. We hope that this useful function will find application at other instruments as well.

WEBSONIX SERVICE

The service is designed for remote measurement monitoring and instrument control. It includes the central website and modules for communication with instrument control computers. Service was designed as a universal tool and can be easily adapted to the specific features of any instrument.

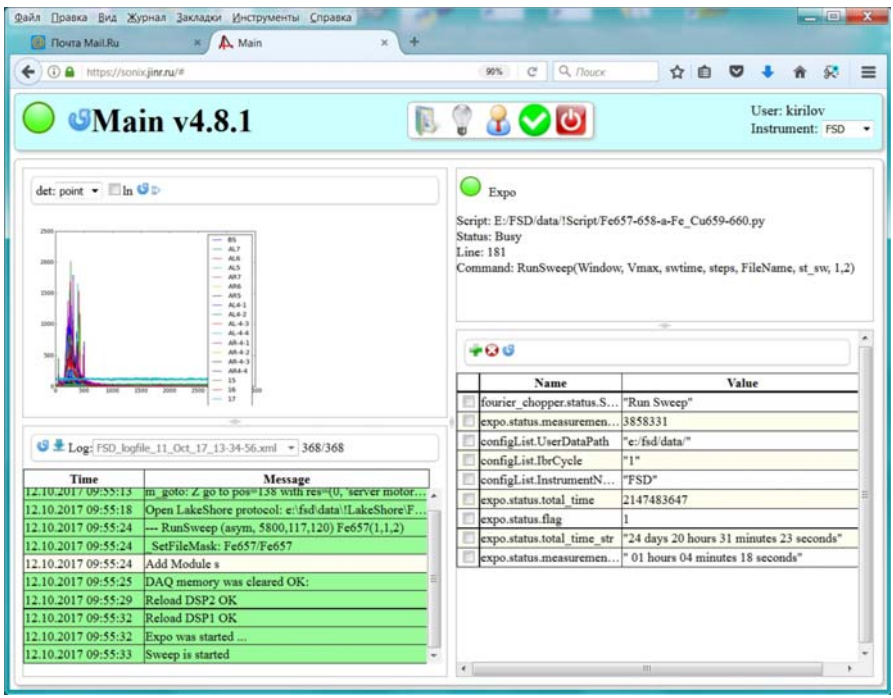

Fig. 3. Example of the WebSonix main page

The history of the WebSonix development is quite long and includes several versions. In the process of service development the main attention was paid to reliability, speed of response and operation stability.

The design of web pages corresponds to the main Sonix+ GUI structure (Fig. 3). There is a main page, which displays the current status of all components of the instrument, shows the measurement log file and picture with spectrum graphs. More detailed information will be available on specialized pages.

There is a special page for remote control of the experimental script interpretation. Currently, this option is temporarily disabled, but after some modifications are made to ensure sufficient security against hacking, it will be available again. At the moment, this service is available at the SKAT, NERA-PR, DIN-2PI, YuMO, REMUR, GRAINS, FSD, HRDF and REFLEX instruments. The rest of the instruments will be connected in the near future if required.

CENTRAL EXPERIMENTAL DATA STORAGE

The development and implementation of the concept of central storage of measurement results are the most important area of the development of Sonix+. First of all, it is necessary to make a decision on the content and format of the saved data. Since FLNP does not adopt a unified format for experimental data, direct application of popular universal systems like ICAT [7] is impossible. Besides, this is not enough to save data. It is necessary to provide convenient services for data upload and search. This, in turn, requires the unification of the data format. The solution is likely to be a compromise. The discussion of the concept with users is already going on.

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Received on December 11, 2017.

Редактор *Е. И. Кравченко*

Подписано в печать 12.01.2018.
Формат 60 × 90/16. Бумага офсетная. Печать офсетная.
Усл. печ. л. 0,5. Уч.-изд. л. 0,7. Тираж 200 экз. Заказ № 59316.

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