Instruments control software at the IBR-2 reactor: experience and prospects

A.S. Kirilov, I.A. Morkovnikov, S.M. Murashkevich, T.B. Petukhova, L.A.Truntova

Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research,
141980 Dubna, Moscow Region, Russia.
e-mail: akirilov@jinr.ru

History and Conception

- The *Sonix+* software complex [1] is the main instrument control software at the *IBR-2* reactor. It was originated in the beginning of 1990s for the Neutron Spectrometer with High Resolution (beam 6a of IBR-2). Later the complex was transferred to other instruments, including those located outside *FLNP*.
- Since that time the complex was installed on more than *20 instruments*, including 14 at the FLNP and 7 at other centers.
- When developing the complex, we were guided both by *world trends* [2] as well as by the *specifics* of the *laboratory*. Many important requirements were formulated by users, therefore they can be considered as real co-authors of the project.

<u>*Composition of the complex*</u>

In a broad sense, the complex includes:

- the instrument software itself, commonly referred to as *Sonix+;*
- the *Websonix* system [3] for remote supervising of measurements;
- the *Journal* system [4] for automatic registration of measurements being performed;
- the *central repository* [5] of measured data.

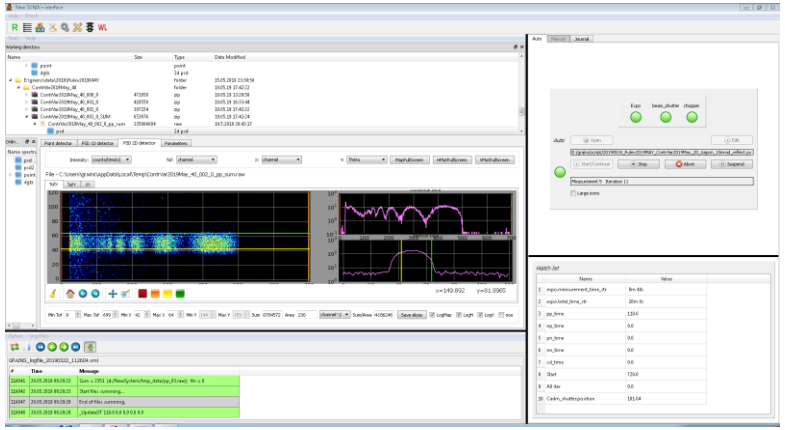
Instruments control software itself

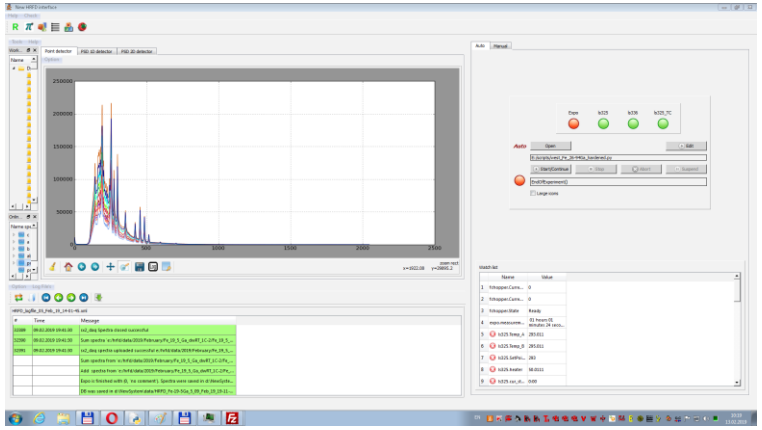
The *Sonix+* was created simultaneously with the popular the *Tango* [6] and the *Epics* [7] systems. The similar task generate similar solution, so *fundamental ideas* in these approaches *coincides*, i. e.:

- Using *modular hierarchical structure* with a unified inter module communication protocol;
- The communication is implemented on the basis of a so-called *database* - a parameter storage with fast access;
- C*onfiguring* all modules in a common file;
- Use of *scripting programming languages* (*Python* [5], etc.) to describe a measurement procedure.

At the same time there are some *essential differences*:

- The *Sonix+* is a *local system* originally designed for one control computer and one operating system. In practice, this has proven to be sufficient. There are some additional tools to serve rare exceptions.
- The choice of the *Windows* operating system was the desire of users as well as the fact that, in our opinion, the software development tools were more convenient at the time the decision was made.
- The *universal GUI* approach was proposed and successfully implemented.





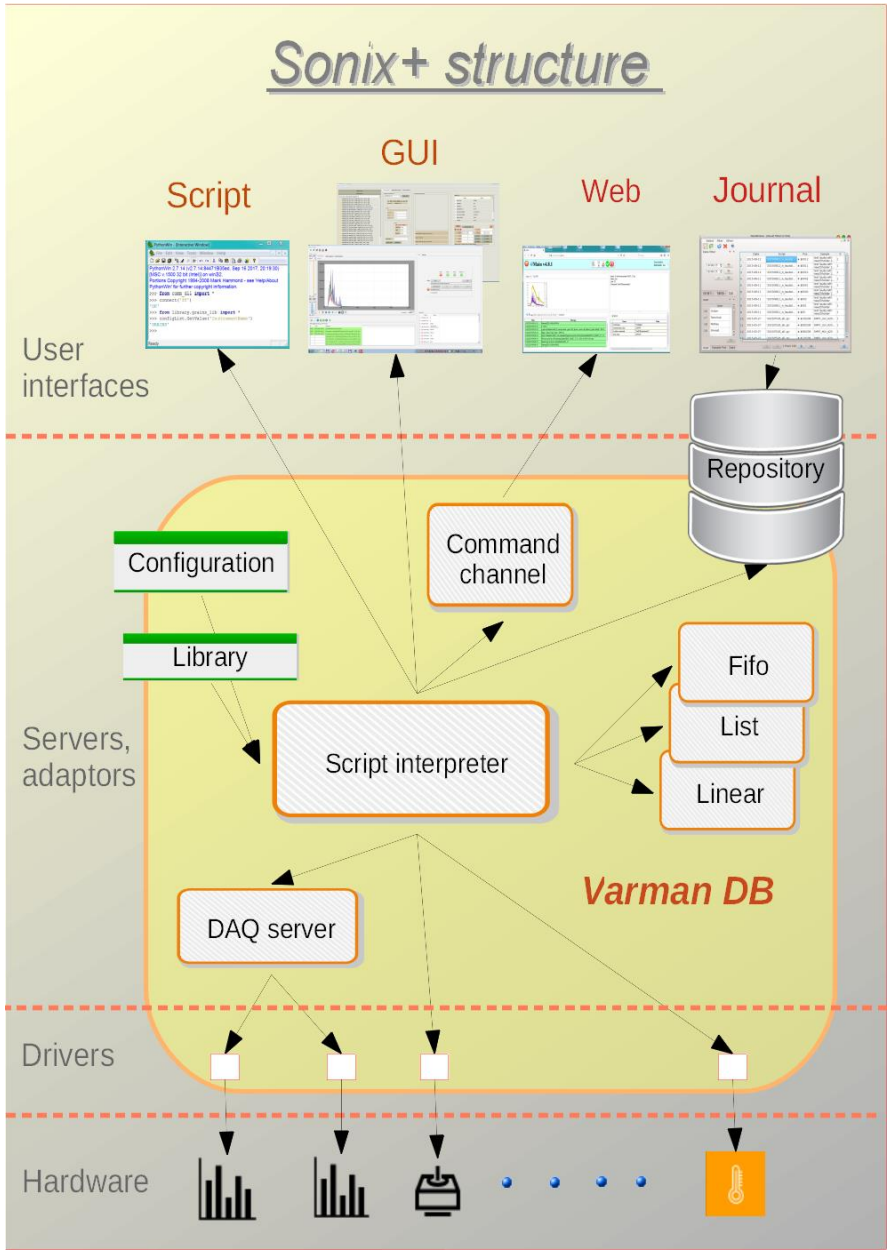
Instruments control software itself(2)

The structure

The *Sonix+ structure* was chosen to *minimize* the changes to install the complex at new instruments. To do this it is enough to *add some* modules to serve missing hardware units, if any, create the new *configuration file* as well as the appropriate *library of instrument operations*. The rest of the components do not require changes.

Conclusion

Over nearly 20 years of *Sonix+* operation, the equipment of instruments has been radically updated. Nevertheless, *the basic principles underlying Sonix+ and its structure have remained unchanged.* This confirms their reasonable choice.



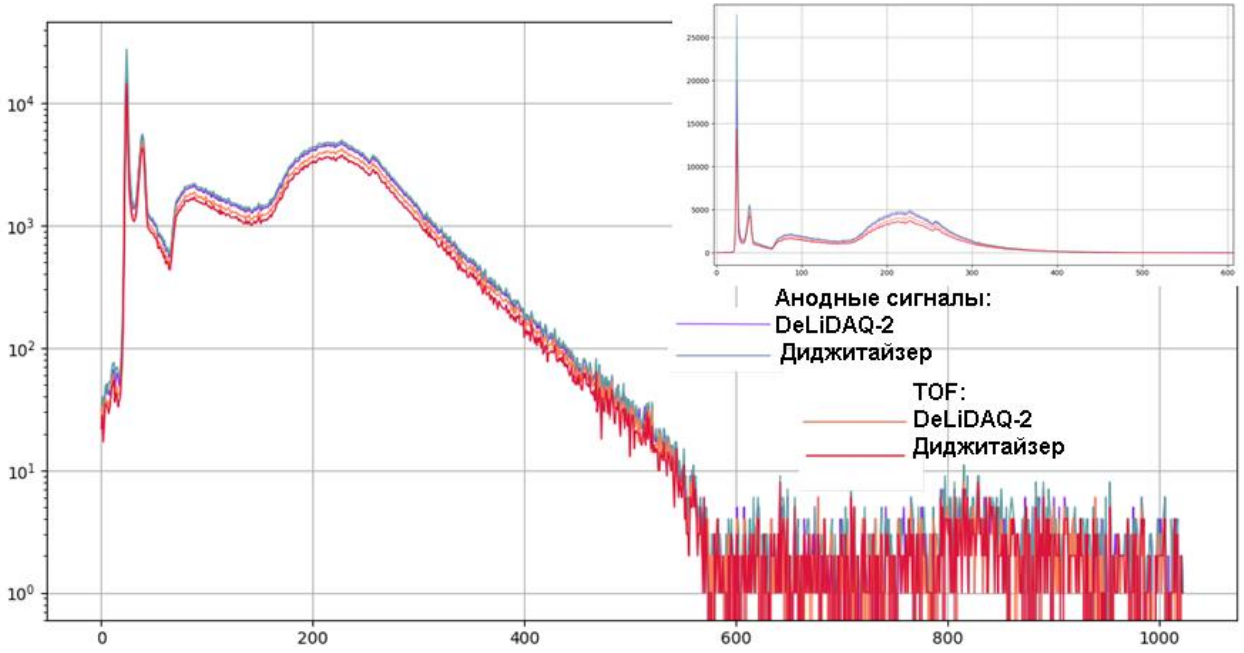
Recent changes to Sonix+

New DAQ controllers and list-mode data

Applying the *DeLiDAQ-2* controller and the *CAEN N6730* digitizer at the IBR-2 instruments required developing *additional software mod*ule [6].

This one is intended to construct spectral distributions of intensities (histograms) from the l*ist-mode* data files. This is very important because these controllers save information only in event list format.

The module was successfully verified at the *Grains* instrument (IBR-2 Beam 10) in October 2021.



Comparison of measurement results for Si/SiO2 sample, obtained by the DeLiDAQ-2 and the digitizer.
Plots of anodic signals and TOF are drawn both in *logarithmic* and *linear* (top right) scales.

Recent changes to Sonix+(2)

Refactoring experiment control code

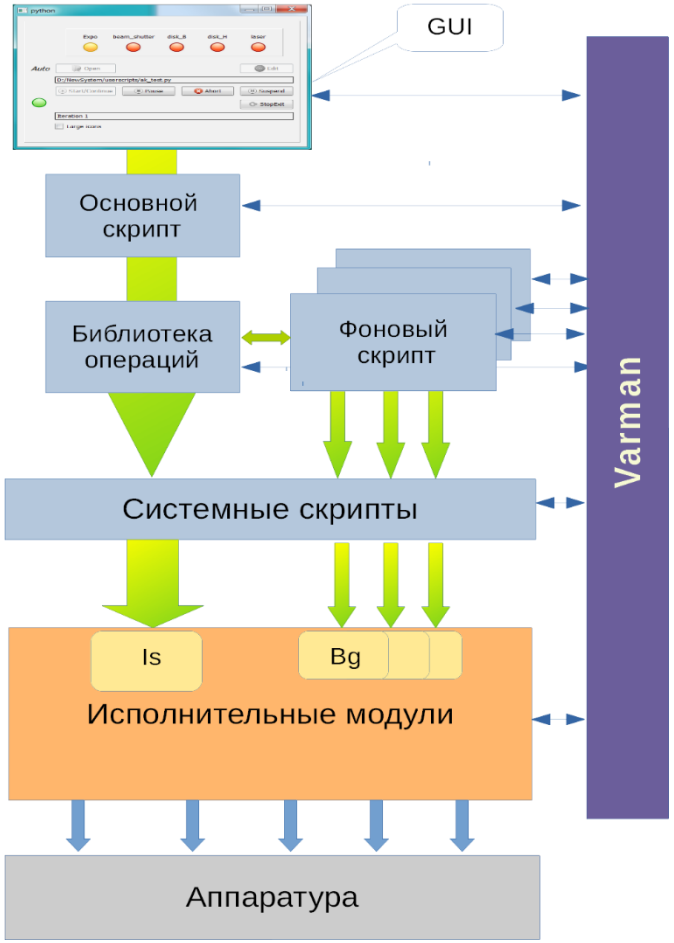
To exclude time consuming *mathematical operations* (such as matrix summation, building spectral distributions, etc.) from the *main experiment process*, its execution has been performed by the one or more *background* ones.

Besides, in the *instrument library of operations* the former control mechanism has been replaced with a *new* one, based on Python decorators and context managers. This approach *significantly simplify* the instrument library, makes its more *reliable*, and accelerate its development and modification time.

The *new version* of the complex was successfully tested in October 2021 at the *NERA* instrument [7].

Similar versions are expected to be prepared for *all* other *instruments* at the IBR-2In the near future.

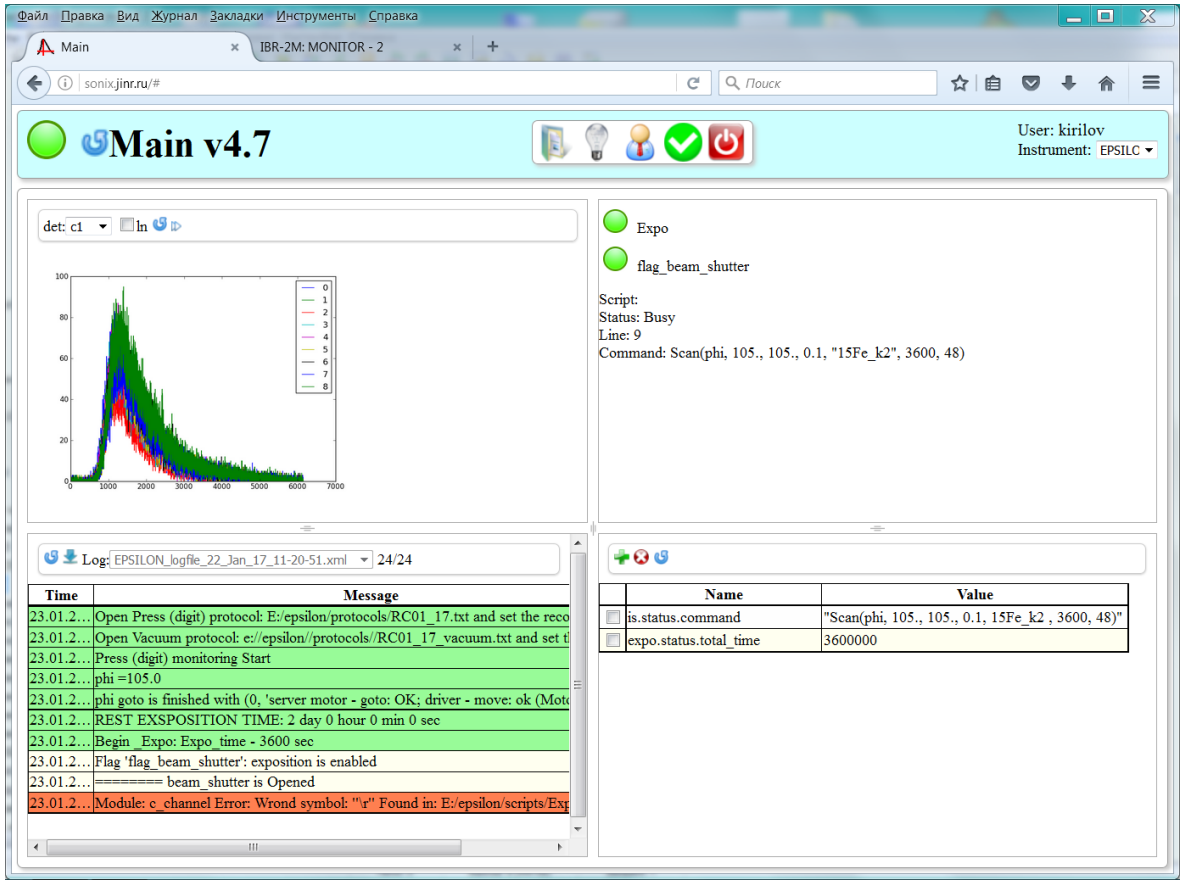
Note. *Code refactoring* is the process of restructuring existing computer code without changing its external behavior, i.e. functionality for the user.



The new measurement logic control scheme with *background devices* to perform mathematical operations separately.

The Websonix: features and real demands

- The system is intended for *remote supervising* of experiment by web browser. For this purpose the special site has been developed. The site pages correspond to the main *Sonix+ GUI* windows, including on-line visualization of data from the point detectors.
- At the moment *10 instruments at the IBR-2* are connected to the system.
- In practice, many users prefer to work via *Windows Remote Desktop* or similar commercially available systems. Nevertheless, the value of the *Websonix* is undeniable, since access via an external site does minimally interfere with the main process of an instrument control. Thus, the system support will be continued.



The Journal system

The system is designed for *automatic registration* of measurements, performed at concreate instrument, in a specialized database. Its design was initiated by users of *reflectometers* and the *YuMo*.

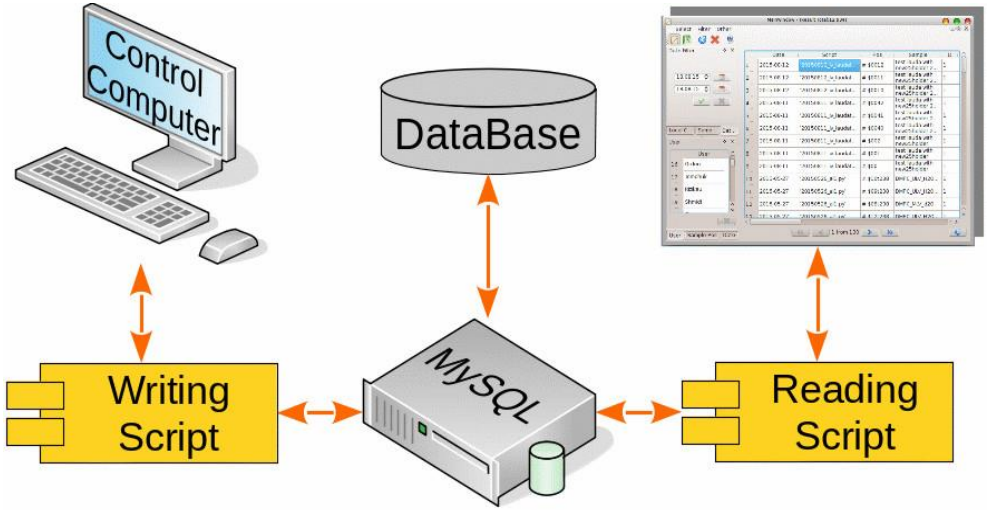
The *user interface* provides:

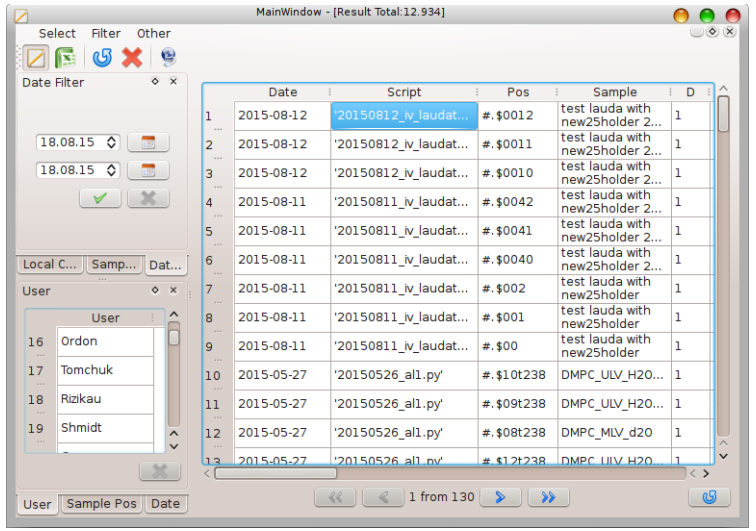
- *getting information* about each measurement made at the instrument;
- *search* by measurement *parameters* in the database ;
- searching of the *measurement data* in a file storage.

The system is implemented on *7 instruments* and is actively used at *Fourier* and *YuMO* instruments.

At the moment the *Journal* is not good enough to work with the *central repository* because it was designed and implemented *earlier*. This problem will be solved with design a new software for the *repository,* including GUI.

The Journal's structure and GUI





Central repository of measured data

The *repository* is designed for *backup storage of measurement data* and additional information at the user request. The data is saved *automatically*.

The system is implemented at the server with *24 disks* united in a *RAID6* array using a RAID controller. The *total volume* of the storage *is 55TB*.

At present *6 instruments* are connected to the repository and about *23TB* are filled, most space (*22TB)* are occupied by the *HRFD* data in the list-mode format.

The experience with *current version* of the repository has shown the necessity to:

- perform data saving process *more reliable*;
- eliminate the possibility of *overwriting data (*mainly due to users carelessness);
- guarantee *correct data saving* regardless of control computer errors.

There are more user-friendly GUI is also needed. For this purpose new user interface like the *Journal functionality* is expected. The new repository software will be proposed for discussion after some testing.

Important. Since the fact that users at some instruments are *not interesting* in working with the *central repository*, is it necessary to decide whether these instruments should be connected to the *repository* by default.

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Main areas of further development

- Updating the *Sonix*+ version at all IBR-2 instruments;
- Software support for the department's developments (detectors, DAQ controllers, PLC, etc.);
- Design of low level *Sonix*+ modules for new MPD-32, PLC and other new hardware devices;
- Design and implement an enhanced software for the central repository.

References

1. https://sonix.jinr.ru/wiki/doku.php?id=en:index
2. https://www.nobugsconference.org/
3. https://www.tango-controls.org/
4. https://epics-controls.org/
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6. Kirilov A.S., Murashkevich S.M. Adaptation of the Sonix+ Software Package to Work with DAQ Controllers DeLiDAQ-2 and Digitizer N6730 by CAEN. JINR, P10-2022-5, 2022.
7. Kirilov A.S., Truntova L.A. Enhancement of Experiment Control in the Sonix+ Software Package. JINR, P10-2022-4, 2022.