ISBN: 978-3-95450-193-9 doi:10.18429/JACoW-ICALEPCS2017-THPHA212

LISE/M – A MODERNISED AND UNIFIED MODULAR EXPERIMENT CONTROL SYSTEM FOR HZB BEAMLINES

O.-P. Sauer, J. Beckmann, P. Bischoff, D. Naparty, A. Pohl, A. Zahr
Department of experiment control an data acquisition,
Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Berlin, Germany

Abstract

After more than 15 years of stable operation it was time to develop a new standard experiment control and data acquisition system for HZB beamlines. The aim is to create a modular system based on commercial hardware components. Because of the convincing hardware interfacing and good experience with PXI devices we choose this as hardware platform and LabVIEW as software development system.

Starting in late 2015, we developed a framework with modules for configuration, (scan) processing, device communication, logging etc. The user interface is bisected as (i) graphical and (ii) scripting version. Where the 'included' script engine is python.

The system serves both, standard commissioning tools as well as specialised instrument setups. It is integrated into the metadata catalouge system (ICAT) of the HZB in terms of collecting log and meta data and storing those according to the data policy of the institute [1].

We present an overview of the system features in general and a specific instrument view of a rather complex beamline at HZB.

INTRODUCTION

A system of inhouse-developed hardware and software has been the standard measuring equipment used at the HZB storage ring. The components were working reliably but became more and more difficult to maintain. First ideas about an improved replacement based on commercial hardware components with a flexible software architecture lead to a first prototype in 2013. In 2015 this development became a regular project watched by the HZB management.

Influenced by results of projects like 'unified log data management' [2] the project started as MoVE (modernisation and unification of experiment control systems at the storage ring BESSYII) [3]. Putting emphasis on a modular design and based on best experiences with PXI hardware and the LabVIEW software stack, these components were chosen as a development base. In development our focus have been beamlines at the storage ring but the framework should serve as universal experiment control system.

ARCHITECTURE

The architecture of the LabVIEW program is based on a textual message bus (see figure 1). All modules are connected to this bus and send messages by event while receiving data by queues.

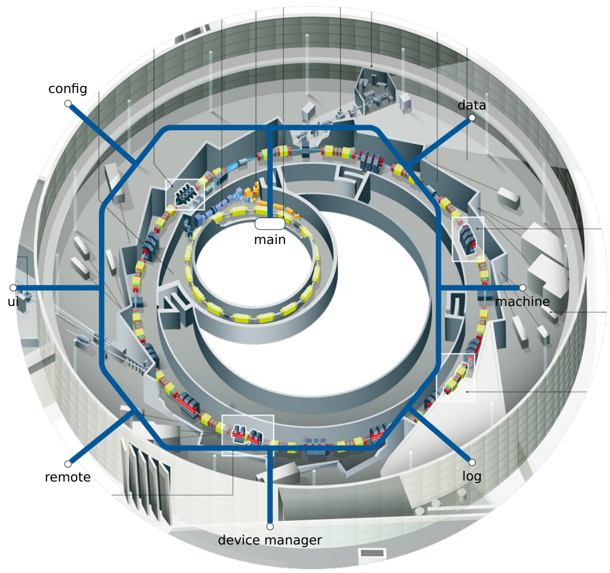

Figure 1: LISE's message bus system.

The message bus uses a common command set with a common command structure (message format):

```
sender|time stamp|instruction|[parameter]
```

Since all modules implement this textual command interface it is a relativly easy task to add new modules to the system.

Internally the bus is a slightly modified queued message handler approach with control queues for each module and an event subscriber bus for the module replies. Modules implement an individual queue for all regarding messages to avoid parsing 'classical' bus messages with an address header. The send direction of messages is handled via events. Each module broadcasts messages and any interested party could subscribe to this event bus to read and evaluate all relevant module answers.

The general system configuration is stored in XML files. An user friendly editor is provided to enable instrument scientists to set up e.g. device parameters and EPICS parameters. Experienced users could even change elements of the graphical user interface (see figure 6).

A special section is provided for user defined stuff as data file columns, additional devices etc. This is meant as the only section of config files for user access.

ISBN: 978-3-95450-193-9 doi:10.18429/JACoW-ICALEPCS2017-THPHA212

SYSTEM OVERVIEW

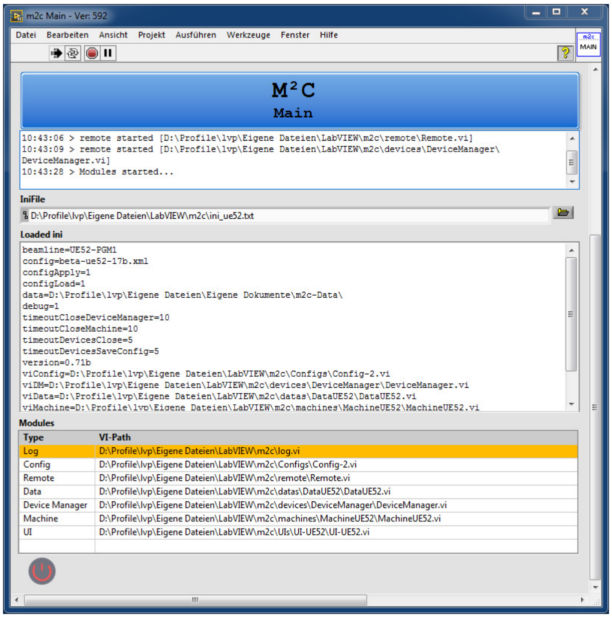

Figure 2: The initial window with some status information.

Due to the modular structure of the framework it is easy to tailor the system to different instrument needs. The initial view (figure 2) is the same for all variants. But we provide an universal version of the program as *commissioning* or main branch. This version is to be used at all instruments for common commissioning tasks.

Commissioning

The universal version of LISE offers some special features like free scalable numerical and graphical displays (figure 3) and up to 32 diagrams with 8 channels each. The scalable display sizes are essential for adjustment work near the devices in case of larger distances between control panel and processed hardware.

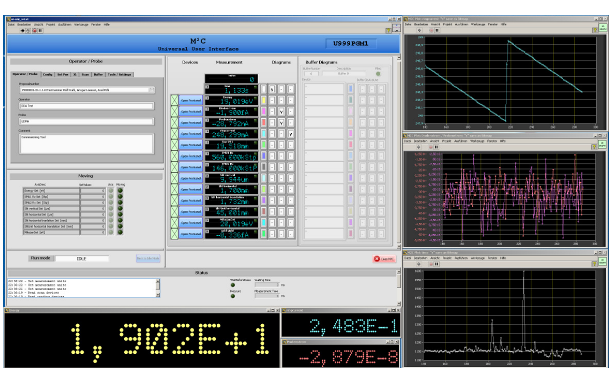

Figure 3: Universal resp. commissioning user interface.

The number of measurments is not limited and it is possible to nest up to 10 scan axis. For those scans a live display is provided but in parallel 16 buffers could be filled with full measurment cycles. All these buffers could be displayed separate or as overlay.

Specialised

The framework allows sophisticated configurations for very specific instrument needs. As a first system at HZB we run a nano-cluster trap instrument with our control system LISE (Figure 4).

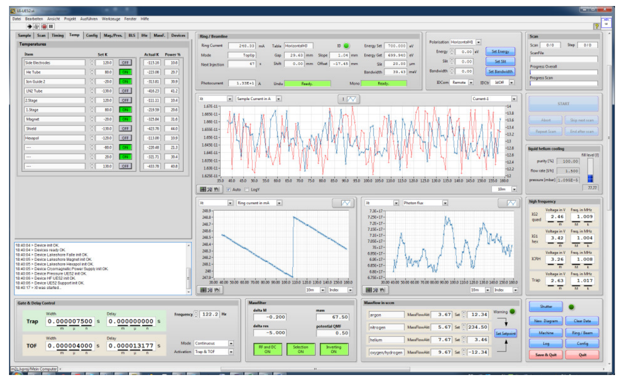

Figure 4: Complex user interface of the nanocluster trap.

Common Features

The framework provides some very useful features to be used in any version and configuration.

Considering scans LISE has some built-in modes such as a xt-mode to store values with time stamps. Basic scans are stackable via sequence definitions. That means one can easily set-up complex measurements out of pre-defined scan procedures.

Maximum flexibility for measurement cycles offers the remote interface of LISE. A web (javascript) and a python (figure 5) are implemented as first prototypes. At the python side the complete set of LISE functions could be used in plain python scripts. An editor5 is provided which acts as an light integrated development system with auto (re-)connect to the main system, syntax highlighting and auto completion of internal messages and commands.

Another approach to remote control LISE is access via EPICS. Our system implements EPICS server functions to be offered to external control systems.

To ease development tasks all modules (and devices) provide a simulation mode. Each (temporarily) unavailable module or device could be replaced by the simulation to check the overall functionality.

The device access is managed by a dynamic management module. It starts and stops devices and offers a dynamic reload.

ISBN: 978-3-95450-193-9 doi:10.18429/JACoW-ICALEPCS2017-THPHA212

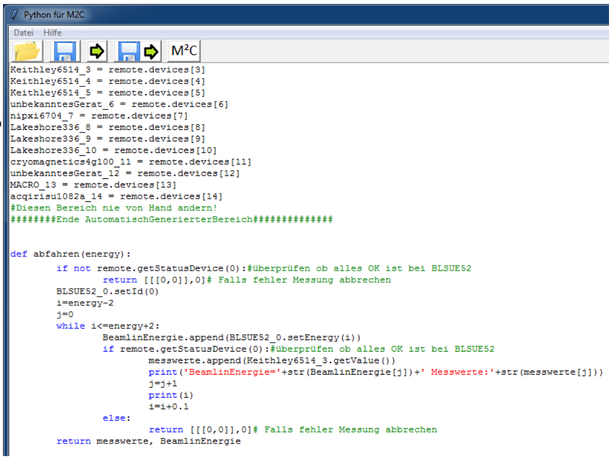

Figure 5: LISE's python script editor.

Data and logging modules are configurable by the central XML files (figure 6). Data output is implemented as ASCII-only (user demand) but includes the possibility to write NeXUS files as well as to connect to the HZB ICAT archive system. The latter is done via an HZB common transfer system.

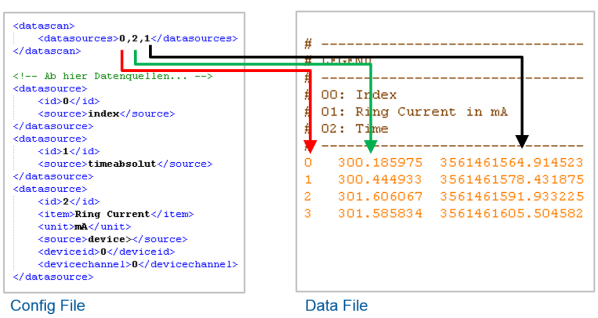

Figure 6: LISE: configuration and ascii data file.

In the near future the SeCOP interface will be integrated to control sample environment devices. A first prototype exists and will be used if the first devices implement this new approach of unified device handling.

Hardware

One of the project objectives was the usage of commercial hardware components. But in case of the connectors to the PXI-counter modules it turned out that a self developed BNC box (figure 7) met the needs much better than any device on the market.

OUTLOOK

The LISE/M development will continue, the framework will be extended and improved. Main focus will be on the remote and scripting interface of the system. This highly

Figure 7: Basic hardware set.

demanded interface is currently only available for the special instrument version of the control system at the nano cluster trap instrument. The next step will be the discussion of a command set for common and advanced commissioning tasks. Reffering to the spec/spock syntax we will implement this very soon.

In order to enable instrument experts to use LISE/M we will improve the documentation. To encourage them we prepare supplemental workshops and detailed start-up sessions.

Roll-outs for several commissioning stations are prepared as next steps at the storage ring.

Naming

The name LISE/M ('liːə ɛm), was given in honour of Lise Meitner (1878-1968) where the first prototypes of our software were just named 'M'. While the "full name" is somewhat cumbersome, the latter turned out to be too short. It was confusing from time to time in discussions as well as in technical documentation.

Ongoing development of the 'modular measurement and control' system lead us to 'm2c': short enough to mark member functions and to prefix dependent modules. So, m is short for m2c which is short for LISE/M - we'll settle this by the end of 2017.

CONCLUSION

LISE/M resp. m2c was successfully deployed at the first instruments in 2017. Both, the universal ('commissioning') version as well as the individual, special (e.g. 'nano cluster trap') version perform very well. The results show that the learning curve for the development team is manageable and the chosen approach can be used to tailor the system according to individual needs. The developed framework should work for a wide range of common measurement tasks. As system it works "out of the box" for typical commissioning tasks - the great flexibility allows approximately any kind of special system setup.

REFERENCES

[1] R. Krahl, HZB data policy, 2017, Version 1.1.

[2] R. Krahl, O.-P. Sauer, Meta data concept at HZB, 2015, project notice.

[3] A. Finke, O.-P. Sauer, Modernisierung und vereinheitlichung der experimentsteuerung an bessyii (move), 2015, project manual.