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SOFTWARE FOR THE ENGINEERING MATERIALS DIFFRACTOMETER (TAKUMI) AT MLF, J-PARC

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ABSTRACT

The Engineering Materials Diffractometer "TAKUMI" designed to solve many problems in engineering materials has been constructed at the Materials and Life Science Experimental Facility (MLF) in Japan Proton Accelerator Research Complex (J-PARC). A common software framework has been developed to control devices, acquire and analyze data in our facility. In accordance with it, common analyzing library (Manyo-Lib) and data acquisition middleware (DAQ-middleware) have been also developed. In our instrument TAKUMI, we have developed a software package named the Engineering Materials Diffractometer Application Kit (EMAKi) which is based on the MLF Software Framework, Manyo-Lib and DAQ-middleware.

1. Introduction

In the field of engineering materials, the study of strain and residual stress is one of the most important topics. Neutron diffraction is a powerful technique for the measurement of them. "TAKUMI" the Engineering Materials Diffractometer has been constructed at BL19 of MLF in J-PARC for such measurements. It is time-of-flight (TOF) type diffractometer which use 25Hz pulsed neutron from a spallation neutron source in MLF. The *d*-range is approximately from 0.55 to 3 Å and the highest resolution is $\Delta d/d = 0.2\%$. Its detailed specification is reported in references [1] and [2]. Meanwhile, a graphical user interface (GUI) based software system has been developed to treat devices and data of TAKUMI. We named the software the Engineering Materials Diffractometer Application Kit "EMAKi". In this paper, we report concept and some examples of EMAKi.

2. Concept and features

MLF is one of the highest intense neutron and muon facility in the world. MLF instruments are shared-use and continuously developed to keep its progress. Therefore, their softwares are demanded to be high performance, easy to use, flexible and scalable, as are most application softwares. Solutions for these issues are parallel and/or distributed processing, GUI and a utilization of common components and libraries. Moreover, software development languages have been fixed to object oriented languages Python and C++ to reduce development cost by the MLF computing environment group. In addition, an event recoding system, which enables us flexible data treatment, is adopted at MLF. Then they have developed three common softwares; “DAQ-middleware” [3], “Manyo-Lib” [4] and the MLF Software Framework [5]. Fig. 1 shows a conceptual design of these softwares and EMAKi. DAQ-middleware is a software framework to record huge data for various detector types. Manyo-Lib is a C++ class library to analyze data and wrapped to Python. The MLF Software Framework provides experimental status panel, common devices and DAQ-middleware control, operation logging and so on. EMAKi stands on these bases and is equipped instrument unique functions. Special attention was paid to usability and fast processing, because TAKUMI has much measurements and novice users than other instruments.

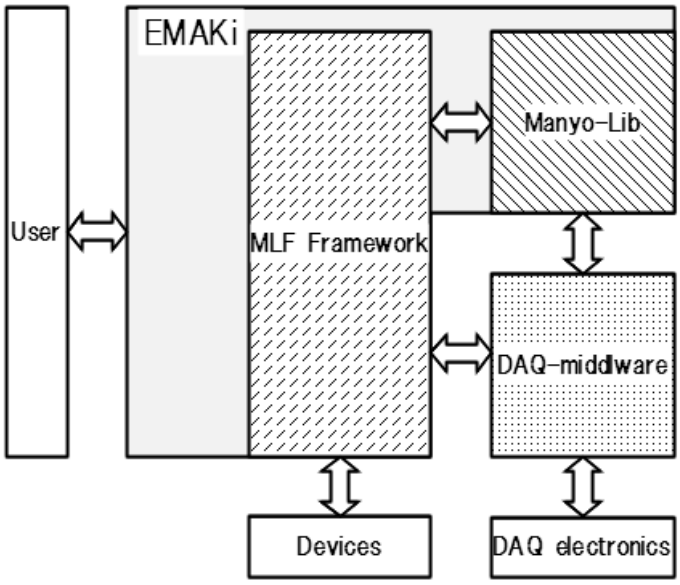

Fig. 1. Conceptual design of three common softwares and EMAKi

3. Function example

EMAKi has many functions to perform experiment. Here we introduce particularly important functions.

3.1. Data reduction

An event data recorded by event recording system is a sequence of encoded information, which is TOF, pulse ID, time, pixel position and so on. Therefore, a data reduction from event data to histogram data is necessary to make easy human realization

and analysis data. Fig. 2 is a screenshot of data reduction software. It is designed to take advantages of event data as much as possible. Users can select flexibly TOF binning, pixel binning and time range. Furthermore, they can make easily 2-dimensional histogram of TOF-pixel or TOF-time. Examples of histogram are introduced in section 4. This software is very frequently used during and after measurements. Therefore, modification for usability and fast processing is constantly repeated. Our goal for it is a use without wait time and instruction manual and user's stress.

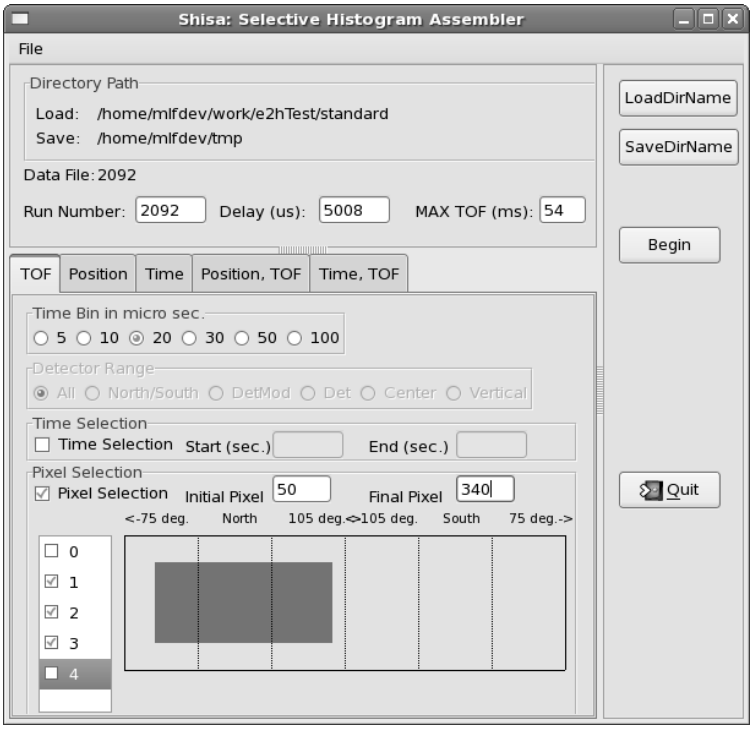

Fig. 2. Interface of data reduction software.

3.2. Measurement Scheduler

TAKUMI users mainly perform a sequential strain mapping measurement for large specimens. "Measurement Scheduler" has been implemented for these measurements. Now it controls only pulse motor driven devices like sample table, but we will apply it for a loading machine, a furnace and so on.

3.3. Real-time Histogram Monitor

To decide a strategy of an experiment, we need monitoring histograms in real-time. For this purpose, DAQ-middleware continuously creates them as side process during event data recording. In addition, monitoring software shown in Fig. 3 periodically collects and displays them.

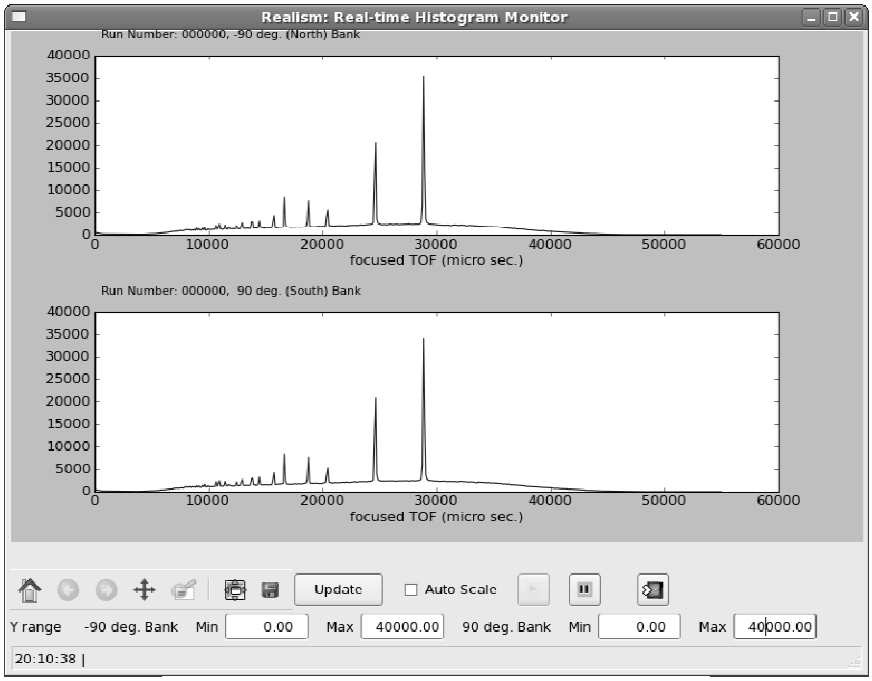

Fig. 3. Interface of real-time histogram monitor.

4. Data example

Because of the event recording system, we can create histograms in various conditions, as we want. We typically use 1-dimensional histogram as Fig. 3, but sometimes require 2-dimensional histogram. A *TOF*-pixel, i.e. *TOF-2θ*, histogram is necessary to discuss a texture and a grain size of specimen. Fig. 4 shows example of this type histogram. Continuous lines come from non-oriented materials in composite specimen and diffraction spots come from highly oriented material in it.

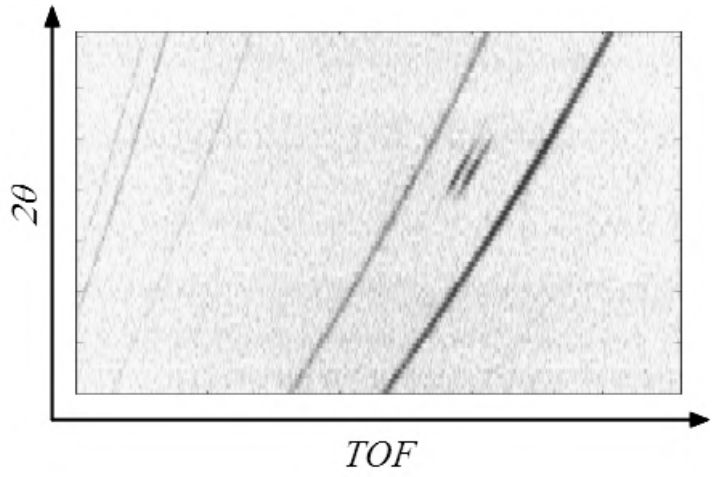

Fig. 4. *TOF-2θ* histogram of composite specimen.

Event recording system is especially well working for such transient measurements, because of event data stores time information without degradation. Therefore, we can choose a time split condition with a unit of neutron pulse.

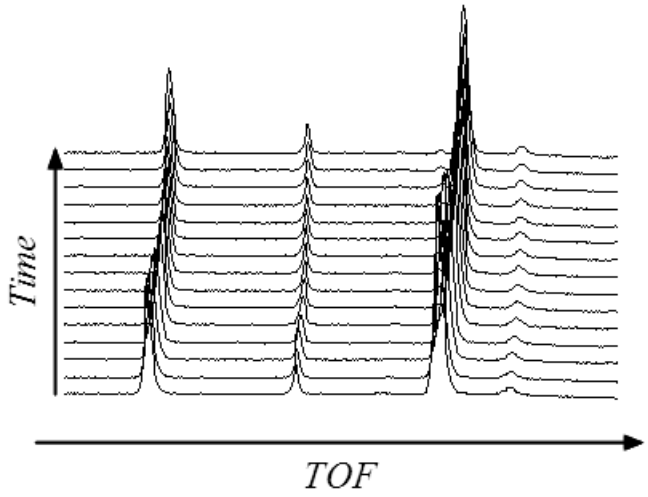

Fig. 5. TOF-time histogram durign thermal process.

5. Summary

We have developed the GUI based software EMAKi for TAKUMI. We have confirmed its usability and through our commissioning and general user's experiments. We continue improvements and upgrading of the software based on comments from the users.

6. References

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