CONTROL CONCEPT OF THE NEW EMBL-HAMBURG SAMPLE CHANGER

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Abstract

The EMBL is located at the DESY site in Hamburg and operates 6 beam lines at the DORIS synchrotron. Currently the EMBL Hamburg constructs three new beam lines at the new PETRA III synchrotron. In the last years the level of beam line automation is significantly increased. In the area of biological beam lines automatic sample changers were established. We present the control design of the new sample changer offering higher sample capacity, improved sample throughput and flexibility.

INTRODUCTION

Robotic sample changers are one part of the automation chain for protein crystallography beamlines. Automated sample changers mount protein crystals at the goniometer of the beamline. The crystal on the goniometer axis has to be aligned with respect to the X-ray beam. The protein crystals are cooled with liquid nitrogen and have to remain cold during the experiment. The experiment is started and experiment data are collected. After the data collection is finished the robot grabs the sample and dismounts it from the goniometer. The samples are stored in a cryo dewar container which is filled with liquid nitrogen.

The next experiment can be started, On top of this so called the data collection mode of a sample changer there is also a sample screening mode available. Screening is performed as a quick method to check if the sample is worth doing a data collection with the crystal. In difference to the data collection mode only one diffraction image is taken. The decision if it is worth doing a data collection on the crystal is taken later.

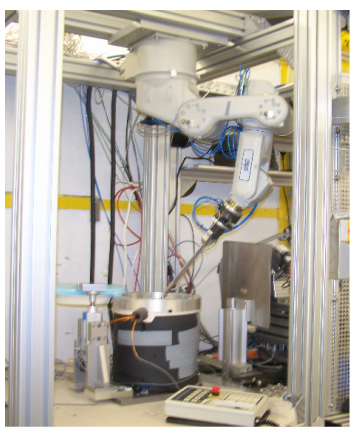

Figure 1: Sketch of the robot setup for BW7B

Every sample has a barcode printed to the button of the samples. This Barcodes are used for the identification of the samples. Barcode readers are used to identify the barcodes of the samples.

The original EMBL-Hamburg sample changer was a joint development with the Fraunhofer institute in Stuttgart started 2002. Since than several hardware and software changes have been implemented. At the moment we have disassembled the whole system and will start the commissioning of the new system in November 2008. It is planned to give the new system in the beginning of April 2009 to so called friendly users.

THE NEW HARDWARE OF THE ROBOTIC SAMPLE CHANGER

The robot will be mounted overhead at the beam line like shown in Figure1. This saves space at the beam line end station. The crystal gripping mechanism the so called cryogenic tongs are mounted under 45 deg. By this it is not any more necessary to rotate the sample. The robot mounts the sample without to turn the grippers by 90 deg as in the previous versions. This will reduce the time necessary for mounting from about 30 sec down to a few seconds [3].

Figure 2: GUI robotic sample changer control

The capacity of the sample container is increased from 40 up to > 100 samples. Almost all of the mechanic installations had to be reconstructed. The barcodes are read with a CCD video camera. All 10 barcodes of a standard ESRF puck can be recognized with one video snapshot.

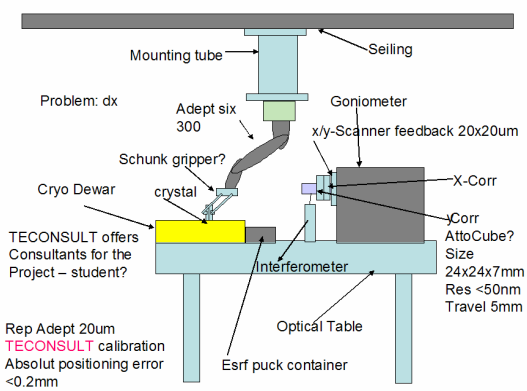

Figure 3: First layout of the new sample changer

The ADEPT SIX 300 Robot

The Robot has a working range of 0.6 m. The robot is equipped with a pneumatic gripper and a pneumatic crash protection as well.

The robot controller is a VME create, the driver a special ADEPT motor driving unit. The robot has DC drives which are connected to harmonic drive gearboxes. The system offers a position reproducibility of 0.2 mm and a absolute position precision of 1 mm.

CONTROL SOFTWARE CONCEPT

The robot control software has to be control system independent. This is necessary to reuse the system. If the system will be later operated at other facilities the independence of the control system will guarantee that the software architecture does not need to be modified.

The software will be written in C++.NET Visual Studio 2005. Advantage of this solution is the platform independence. C++.NET code can be ported from Windows to Linux using MONO. The existing codes have to be modified and ported from Visual Studio 6 to C++.NET.

Robot Software

There are several possibilities how to program a robot. The simplest is teaching, where the robot is guided by human force with one hand on the desired trajectories and the movement is then stored. This possibility is for the ADEPT system not available.

The robot is programmed with the ADEPT programming language V+. There are 3 different tasks running for the EMBL system. One for the cryo dewar control and one for the robot communication. A third task will manage all movement control used for the operation of the robot. The trajectories of the robot are also part of this task.

The communication to an external computer is performed by a socket communication which connects to two ports. This increases the possible speed for the communication between the robot controller and the external computer. The communication is established with an identification string and the command and status communication between the robot controller and the external control computer are string based of the format <EMBL Mount Sample>.

All position movements are relative to 3 reference points. One reference point is inside the cryogenic dewar the others are at the goniometer position and a third on top of the dewar. The programming of trajectories is straight forward. With the help of the move commands which are part of the ADEPT API the robot moves are executed.

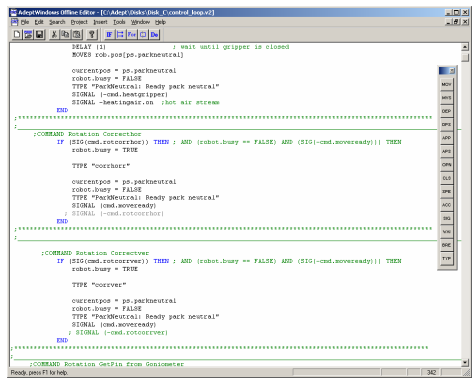

Figure 4: Adept V+ Editor with sample code

CONCLUSION

In the next month of finalization of the software and hardware we have to prove that the system is reliable enough for later use at the Petra III beamlines. The commissioning phase of the system will end in 4/2009. At this time first user operation will start. The robotic sample changer control software for the Doris III robotic system will have to be integrated into the existing control software of the beamline. Important is that the architecture has to be compatible also with the Petra III control architecture. The here presented concept fulfils this requirement.

REFERENCES

[1] R. Bacher, “The new control system for the Future Low-Emittance Light Source PETRA3 at DESY”
[2] http://tine.desy.de
[3] http://www.adept.com