Project Report
Summer Student Program 2008
Hasylab at Desy

Upgrades and Commissioning at Beamlines BW1, BW2 and E2

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1 Introduction

DORIS was shut down in December 07 until September 2008. This fact was used for several enhancements and checks at the beamlines. During my stay at HASYLAB as summerstudent I

- accomplished the commissioning of new motor controllers at BW2,
- executed stability and reproducibility checks of the diffractometers at BW1, BW2, and E2,
- converted the monochromator flush to Helium and
- located and corrected the sphere of confusion error on the diffractometer at E2.

2 Commissioning of new motor controllers at BW2

The wiggler beamline BW2 is one of the most successful experimental station at HASYLAB. So far, part of its equipment was run under the control electronics that were not compatible to DESY standards. The shutdown was used to upgrade the control system to the current state. One of the new elements of the system are the OMSMAX motor controllers. These new generation electronic modules will become standard for DESY with the introduction of the PETRA III beamlines. There was so far no experience in using the new modules. In particular, one had to define the operation parameters of the controllers and test the new part of the control software that will then be used at all PETRA III beamlines.
The ONLINE program package for data acquisition and beamline control at HASYLAB is developed by the local experimental control group. It runs on a PC under LINUX, that is connected to the VME rack by a fibre optic cable.
The six controllers for the drivers by Oregon Micro Systems were introduced for the first time, so far there was no experience in operating these modules.
At first each controller had to get an unique adress by manually setting jumpers. After a successful communication check the following parameters had to be determined and transferred for each of the 40 motors:

- slew rate, slew-max and slew-min: Standard-, max- and min-speed of the motor movement
- base: Initial speed
- acceleration
- conversion: How many steps for one millimeter or degree
- backlash: Range of reverse movement in order to get rid of backlash

Afterwards all motors had to be checked for their direction, speed and conversion. Several bugs were located and reported to the experimental control group.

3 Stability and motion check of diffractometers at BW1, BW2 and E2

Being in permanent use for tens of years, the beamline mechanics should be regularly checked. Therefore I made some stability and accuracy measurements on the main movements of the diffractometers at the beamlines BW1, BW2 and E2.
For this I placed a mess gauge e.g. at the detector arm, which was put to a certain

Figure 1: Mess gauge at the detector arm at BW2

position often used during operation (see figure 1). Then the corresponding rotation axis was moved repeatedly back and forth in a wide range from the chosen set point. After some hundreds of repetitions I checked, whether the mess gauge - 0.01 mm scale - indicated any displacement at the that point.

With a distance of 50cm between mess gauge and rotation axis a typical value of set point shift was around 0.02mm: this means a difference of 0.002°. The observed displacements could not be attributed to the mechanics and were caused by the overall mechanical stability of the mess gauge mount system. A higher accuracy cannot be achieved by this type of setup.

All mechanics that were checked by me appeared to be operating properly.

4 Convertion of the flushing at the monochromator at E2

Figure 2 shows the transmission of a 100cm track filled with air, nitrogen or helium dependent on x-ray photon energy. It is obvoius that at lower photon energies the

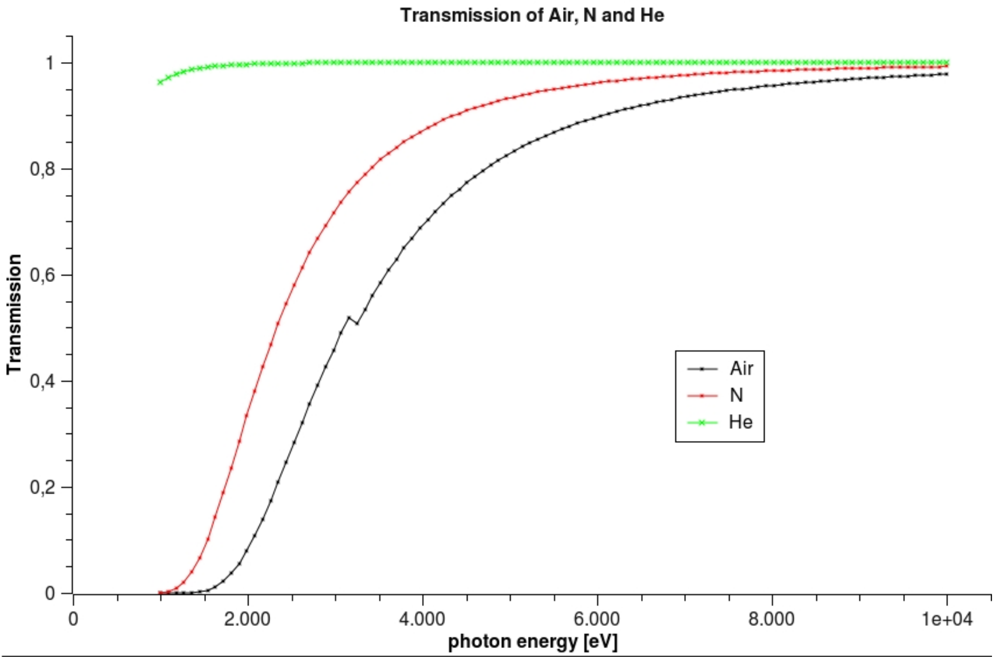


Figure 2: Transmission within 100cm of air, N and He (determined with `http://henke.lbl.gov/optical_constants/gastrn2.html`)

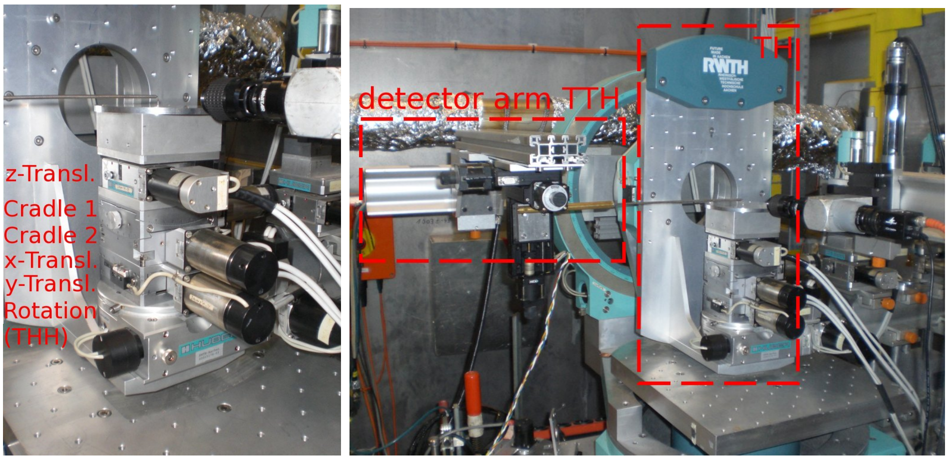
transmission of air is too low. Therefore components like flight tubes and monochromators at the beamlines are usually evacuated or flushed with nitrogen or helium. Due to the higher price of helium, nitrogen is used at higher energies. Because of upcoming experiments at lower photon energies we converted the flushing of the monochromator at E2 to helium.

After starting to flush the monochromator with helium we detected a leak. The alumium foil, separating the monochromator from the beryllium window, appeared to be damaged. We replaced it by a piece of Kapton foil. This will additionally improve the overall perfomance of the beamline at lower energies, as the transmission of Kapton is better than that of Aluminum.

5 Determination and alignment of rotation axes at E2

The diffractometer at the E2 beamline belongs to RWTH Aachen and is normally serviced by the owner. An analysis of the results obtained on the beamline showed that there is a systematical correction needed for the angular scale data. My reproducibility tests have shown that the mechanics of each single axis operates properly. This could mean that the inconsistencies are due to a mutual misalignment of the multiple axes of the diffractometer.

All rotation axes of a diffractometer have to intersect in one point. This point also has to be the impact point of the syncrotron beam on the sample. The possible misalignment is called sphere of confusion and is one of the main parameters defining the accuracy of a device. The first step was to determine the position of the rotation axes. Figure 3(a) shows the sample tower of the E2 diffractometer. It contains elements for



(a) Sample tower (b) Detector arm TTH, Rotation TH and sample tower

Figure 3: Set-up at E2

x,y,z-movement, rotation around a vertical axis (called THH) and two cradles. The sample tower is mounted on another goniometer with its rotation axis TH set normal to that of THH, see figure 3(b). The detector arm (called TTH) is also visible in figure 3(b). TTH and TH movements should have the same rotation axis. This axis has to be intersected by the rotation axis of THH.
In order to determine the rotation axis of THH an adjustment needle was placed on top of the sample tower, and its displacemt during the movements was observed by a video camera and a monitor. By an iterative procedure of turning the sample tower through 180° and readjusting the needle with the x- and y-tables I was able to determine the rotation axis with an accuracy of $50 \mu m$.
The rotation axis of TH was determined by the same method.

For the detector arm TTH, a new needle and its mounting construction had to be designed and manufactured at the workshop. It was then mounted on the detector arm for the determination of its rotation axis.
The measurements have shown that the rotation axes of the three main movements of the diffractometer are not well aligned. We were successful in reassembling the mechanics and correcting the displacement of the TH and THH axes. Possibilities to correct the misalignment of the TTH axis are very limited by the construction of the device. Ways to correct the mistake are still under investigation.

6 Conclusion

My activities during the summer student program improved the stability of operation and reliability of results obtained at the beamlines BW1, BW2 and E2.
In the nearest future I will join the group of Prof. Falta at the University of Bremen. It its planed that I will carry out the experiements connected to my diploma thesis at one of these beamlines at HASYLAB.

Finally I want to thank my supervisor Dmitri Novikov for his continued supervision and generous support during the summer student program.