High throughput data acquisition at the XAS and SUL-X beamline at ANKA

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Abstract. The ANKA beamlines XAS and SUL were upgraded with a faster data acquisition and higher degree of automation, because of the increased number of in-situ measurements and higher demand on measurement on a number of different edges during one beamtime. We optimized the data acquisition by using the multi element semiconductor detector together with the XMAP-electronic (XIA LLC) in the mapping mode. By using the hardware-triggered mode with buffered read out the fluorescence detector data collection is done without no further delay.

1. Introduction
Over the last nearly 10 years of user operation at ANKA, the demand of users changed quite significantly. There are an increased number of in-situ measurements and also most beamtimes includes spectra taken at different absorption-edges. To enhance the performance of the XAS and SUL-X beamline further, we optimized the data acquisition and also reduced the time needed for the set-up of the beamline for measurements at a given absorption-edge.

2. Upgrades

2.1. Data acquisition upgrade
The wasted time for data read out at the beamlines is diminished quite dramatically. We use the multi element semiconductor detector together with the XMAP-electronic (XIA LLC) in the mapping mode, which allows a read-out of the full fluorescence spectra of all channels with a full data rate of 50 Hz. Because the struck counter card produces the initial trigger pulse, any in spec implemented stepwise or continuous scan mode can be used with this type of data acquisition. This enables the change of acquisition time and step size during Q-XAFS scans. Conversion boxes are allowing to transfer the trigger signal via a cat5-cable over large distances and to split the signal to up to 4 devices per trigger box (see figure 1). A nearly unlimited number of boxes can be stringed together to trigger various detectors. Special care was taken during installation of the trigger line to induce no further noise into the XMAP-electronic due to the trigger signal. The data acquisition with the xmap-detector electronic is done via a tango-server, which was developed in cooperation with Soleil [1]. A second tango-server is needed to combine the data from the counter card with the data from the fluorescence detector, which than produce again spec-like data files. Two further tango-servers act as the gateway to the personal and machine safety systems and the visualization software IgorPro [2].
Table 1: Tango server needed for the data acquisition with the X-Map detector electronic and their functionality.

| Server name       | Main Task and Usage                                                                 |
|-------------------|--------------------------------------------------------------------------------------|
| ds_MCADxpXmap      | Needed for loading of configs, Arm for mapping mode, getting the raw data in chunks of up to eighty spectra per channel from the digital electronic |
| ds_xmap_data       | Creates all data, which is not produced by the server above during Mapping mode (e.g. Software-Roi’s, MCA-Sum) |
| ds_likeSpecdata    | Combines data of point detectors (over counter-card), e.g. transmission data with the fluorescence data |
| rato_Abs           | Serves as an interface to get data from spec and to control spec remote – used for the interface with the visualisation based on IgorPro [2] |

With the above described set-up it was possible to shorten the dark time (time without measurements during a continuous scan) to below 12 (30) ms at the XAS (SULX) beamline. This enables the measurement of Q-XAFS scans with full fluorescence spectra at the Cu-K-edge with 2000 energy points per scan and 0.5 eV resolution in 50 seconds (measurement time 13 ms per point). Additionally slow Q-XAFS scans in 3-6 min with nearly no dark time compared to the acquisition time will most probably replace the standard step scans on the mid term, because they enable to check for beam damage and any time dependent change of the photon beam or sample consistence or sample environment. If we compare step-by-step EXAFS scans with reasonable time (40 min) to Q-XAFS with the same accumulated time, we do see better quality of the accumulated Q-XAFS data in transmission mode (figure 2 & 3) and the same or slightly inferior quality of the fluorescence mode.
We hope to enhance the quality of the Q-XAFS scan even further with larger energy step sizes and resulting longer acquisition times in the pre-edge and EXAFS region for this type of scans.

Figure 2. These two figures have been placed side-by-side to save space.

Figure 3. These two figures have been placed side-by-side to save space.

Figure 4. Fluorescence EXAFS data

2.2. Automation

We installed on both beamlines an automatic filling system for the ionization chambers (based on code on a Siemens S7 system), which adjusts the absorption of the chambers to reasonable values for a selected photon energy. The GUI can be seen in figure 5, which also shows the scheme of the system. The refilling systems do no only simplifies the handling of the beamline, but also speeds up the process. In cooperation with a logging mechanism any filling during the measurement time is recorded. The system can be controlled with scripts via spec and/or tango.

The time for beamline alignment is reduced to an absolute minimum at the XAS beamline by automatic vertical alignment of the components, stand-alone filling of the ionization chambers and scripts for activation of low energy mode (high harmonic reduction mirror in) and high resolution mode with Si<111> crystal. Any interruption of the storage ring operation (injection, beam dump) is
detected and the beamline reactivates the scans after restore of the storage ring operation. The automatic change from 3.5 KeV to 21 KeV in less than 15 min with just one command and no further user input allows to measuring plenty of different absorption edges in one beamtime with minimum of beamtime loss.

![Image of automatic refilling system for ionisation chambers]

**Figure 5.** Automatic refilling system for ionisation chambers

### 3. Conclusion and outlook

The implemented upgrade on the data acquisition system offers high-speed data acquisition in fluorescence mode with complete fluorescence spectra for each energy step combined with a high degree of flexibility. Without any change of the hardware any motor movement can used for fast scanning options (on basis of a simple implementation). In user operation is already the Q-XAFS scan option; the mapping option is up till now in testing. With the next upgrades we believe to be able to achieve even better data-quality for the Q-XAFS scan, which will lead to a replacement of the standard Q-XAFS scans.

Due to the high automation of the beamline the user can focus on their experiments and not on the preparation of the beamline. The misalignment due to wrong optimization of the beamline is thereby drastically reduced.

### References

[1] Synchrotron SOLEIL - L'Orme des Merisiers Saint-Aubin - BP 48 91192 GIF-sur-YVETTE CEDEX

[2] IgorPro - http://www.wavemetrics.com/