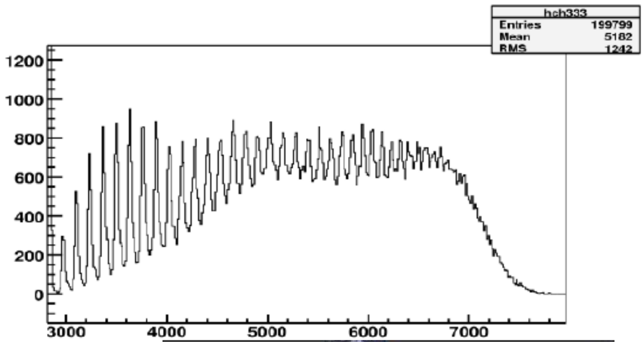

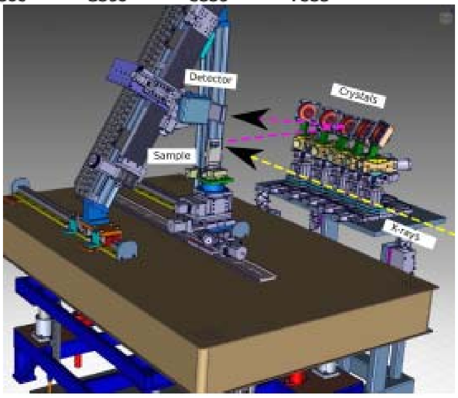

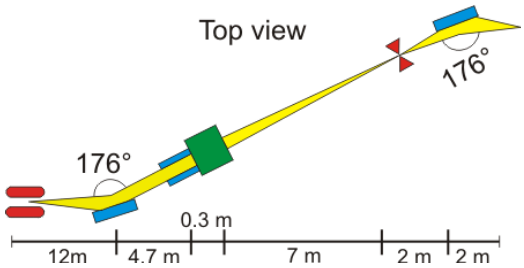

SLS Symposium on

X-Ray Instrumentation

Tuesday, December 7, 2010

10:00 to 12:15, WBGB/019

10:00 The optics layout of the PEARL beamline
P. Oberta, U. Flechsig and M. Muntwiler

10:30 Instrumentation for X-Ray absorption spectroscopy at the PHOENIX beamline
T. Huthwelker, Ch. Frieh, R. Wetter and M. Janousch

11:00 Coffee

11:15 X-ray emission spectrometer at the SuperXAS beamline
E. Kleymenov, J. van Bokhoven, M. Janousch, C. David and M. Nachtegaal

11:45 Charge integrating Readout ASICs for X-ray detection
A. Mozzanica

The Optics layout of the PEARL beamline

P. Oberta, *U. Flechsig, and M. Muntwiler*

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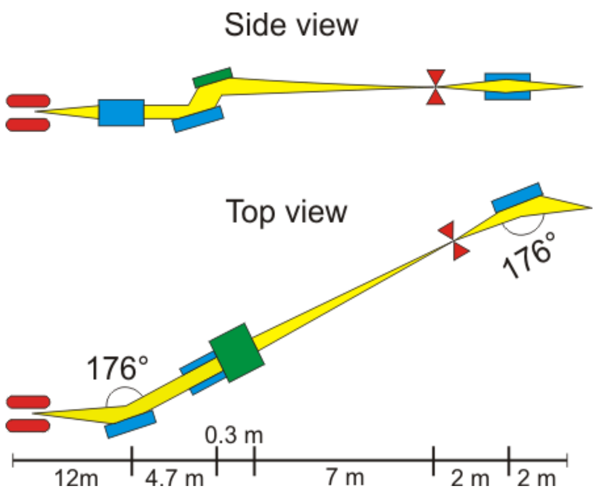
PEARL – the **P**hoto **E**mission and **A**tomic **R**esolution **L**aboratory – is a new soft X – ray beamline and surface science laboratory under construction at the Swiss Light Source (SLS). PEARL is dedicated to the structural characterization of local bonding geometries of molecular adsorbates on metal or semiconductor surfaces [1], of nanostructured surfaces, and of surfaces of complex materials [2] with atomic resolution. At its core, the laboratory features a soft X--ray beamline with an angle – resolved photo – electron spectrometer for angle – scanned and photon energy – scanned X – ray photo – electron diffraction (XPD) and spectroscopy (XPS). Scanning probe microscopy (STM/AFM) and standard in – situ surface preparation facilities complement the XPD facility, and will allow beamline users to carefully prepare and characterize their samples on site.

The PEARL beamline is based on a plane grating monochromator (PGM) concept [3], fig.1. It operates in the -1 diffraction order ($\alpha < \beta$). The bending magnet beamline covers an energy range between 100 and 2000 eV. Performance calculations for three different gratings were done (600 l/mm, 1200 l/mm and 1800 l/mm). The maximum delivered flux of the three gratings for the proposed beamline layout is between 10^{10} – 10^{11} ph./sec./0.1% BW. Furthermore a resolving power optimization was performed. As a result the highest achieved resolving power is around 10000. We introduced a two profile re – focusing mirror for switching the focal spot size between a focusing spot (170 μm × 73 μm) and a larger beam spot (1 mm × 1 mm), used for radiation sensitive samples.



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[1] R. Fasel, J. Wider, Ch. Quitmann, K.H. Ernst, T. Greber, Angewandte Chemie. 43(21) (2004) 2853.

[2] M. Treier, P. Ruffieux, R. Fasel, F. Nolting, S. Yang, L. Dunsch, Th. Greber, Physical Review B. 80 (2009) 081403.

[3] H. Petersen, H. Baumgartel, Nuclear Instruments and Methods. 172 (1980) 191--193.

Instrumentation for X-Ray absorption spectroscopy at the PHOENIX beamline

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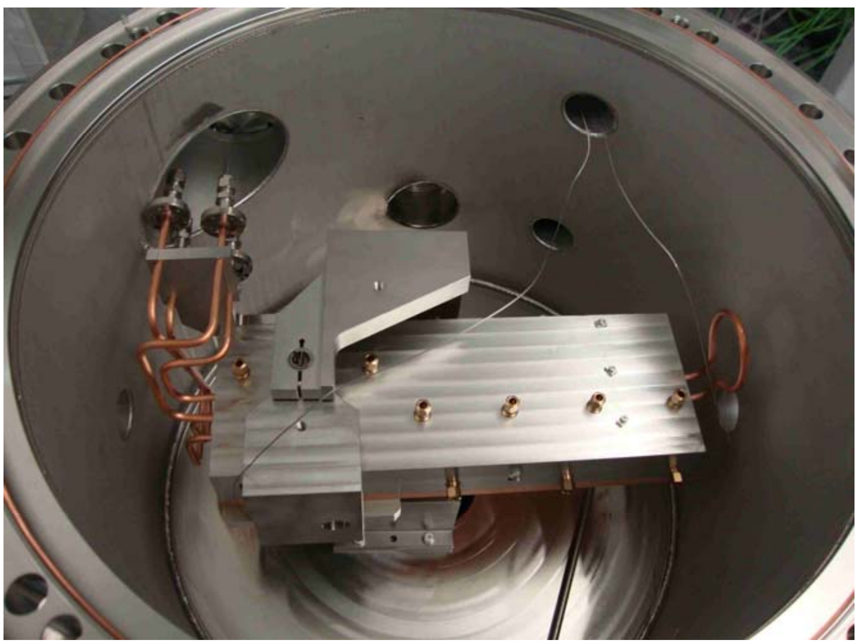
To perform X-ray absorption spectroscopy at a synchrotron beamline, a complex instrumentation is needed. Specifically, high precision mirrors, monochromators, sample environments, and detection systems are used. The talk gives an overview over the various techniques used for such experiments. Specific challenges occur, when using X-ray in the tender energy range (800-8000 keV). Photons in this energy range have a low penetration depth in the order of a few micrometers. At the PHOENIX beamline, we can perform X-ray absorption spectroscopy with photons in the tender energy range. The talk describes the instruments used at the PHOENIX beamline.



X-ray emission spectrometer at the SuperXAS beamline

***E. Kleymenov*, J. van Bokhoven, M. Janousch, C. David, and M. Nachtegaal**

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We report recent advances in X-ray emission spectroscopy at the SuperXAS beamline of the SLS. A five-crystal X-ray emission spectrometer to be used in a photon energy range between 5 and 20 keV was constructed and brought into operation. A Johann-type design with diffraction crystals of a radius-of-curvature of 1 m was used to achieve an optimal photon collection efficiency at a spectrometer bandwidth of about 1 eV. Five Si(111) crystals were produced in-house.

Employment of the spectrometer at a synchrotron beamline gives access to a range of hard-X-ray photon-in-photon-out techniques, such as XES, HERFD XAS, RIXS, and X-ray Raman spectroscopy. The typical application of the photon-in-photon-out techniques is determining the electronic structure of functional materials, including that of catalysts under reaction conditions.

We will review the design and performance of the spectrometer, give examples of applications, and discuss the possibility of using hard-X-ray photon-in-photon-out techniques at other SLS beamlines and SwissFEL.

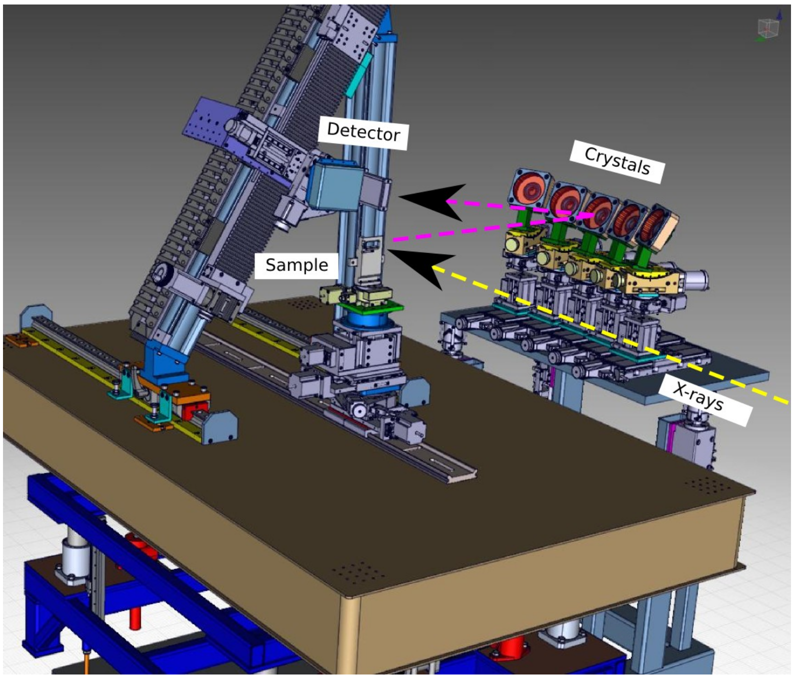

Figure: five-crystal X-ray emission spectrometer at the SuperXAS beamline

Charge integrating Readout ASICs for X-ray detection

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Abstract

In the coming years several X-FEL machines will come on-line. The pulsed beam provided by this new generation of sources places challenging constrains to the X-ray detectors: in particular the photon counting readout, a successful scheme in case of Synchrotron sources, cannot be used any longer. At the same time the data quality of Photon counting systems, i.e. the low noise and the high dynamic range, is essential.

Charge integrating readout chips with single photon resolution and dynamic range in excess of 10^4 photons for pixel and strip silicon sensors are being developed at PSI.

Few prototypes of the strip detector (GOTTHARD) and of the pixel one (AGIPD) have been fabricated, integrated and tested with X-rays. The results of the prototype characterization, validating the automatic switching gain architecture and the noise performances, will be reported in the talk, together with an outlook on the new possibilities made available by charge integrating detectors in a Synchrotron source environment, with particular focus on high rate and high resolution applications.

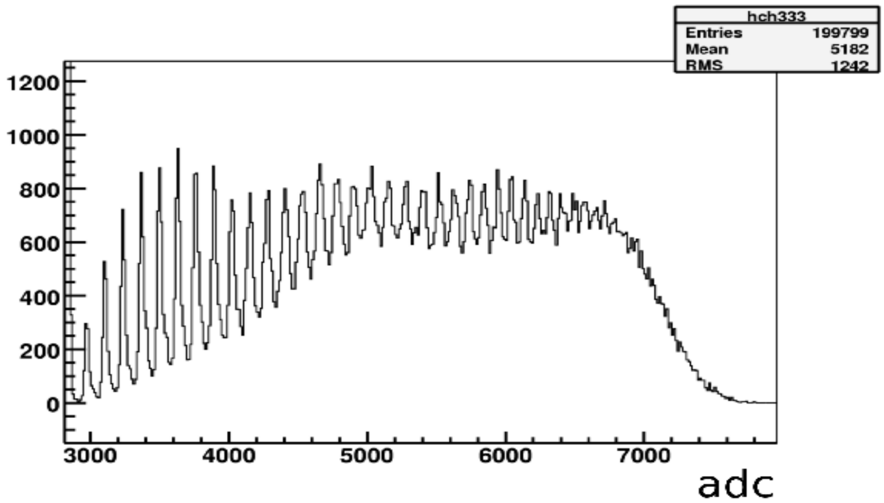

Fig. 1: Pulse Height distribution of a Gotthard channel, with a 17keV beam hitting the center of the strip (no charge sharing). Up to 30 gs can be distinguished; at the target frame rate of the system (~ 1 Mhz), photon rates per channel greater than 30MHz are then achivable while keeping a single photon resolution.

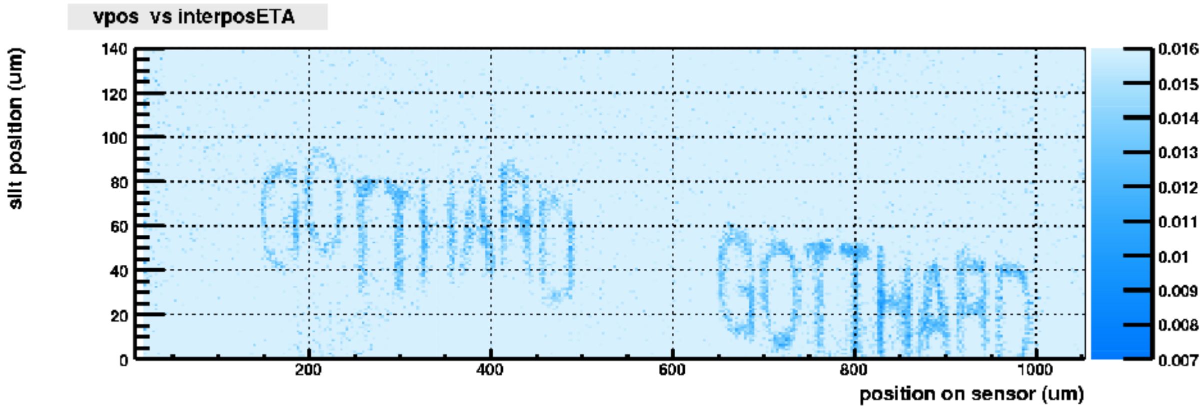

Fig. 2: The above image shows the high resolution image that can be obtained using a 20µm pitch strip sensor and charge interpolation algorithms. The sample, a 3um thick gold writing on silicon substrate (30% contrast at 15keV), was moved in front of a thin (2µm) vertical beam. At each scan position 20,000 frames at low intensity (few photons per frame) have been collected. A spatial resolution better than 2µm can be achieved with this system.

References:

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X. Shi et al., "*Challenges in chip design for the AGIPD detector*", Nucl. Inst. and Meth. in Phys. Res. A624, pp. 387-391, (2010).

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