Scanning EXAFS Beamline, Indus-2 SRS

Introduction

Primarily, scanning EXAFS beamline is designed to perform experiments which have requirements that fall beyond the capabilities of Dispersive EXAFS beamline (BL-08), like requiring high resolution & fluorescence mode of EXAFS measurements. The key component of the beamline is Double Crystal Monochromator (DCM) which is used for energy selection from the white synchrotron beam.

Beamline Specification

Source	**Bending magnet (2.5 GeV Indus-2 Source)**
Energy Range	4.5-30 keV
Acceptance	3.0mrad(H) x 0.2 mrad(V)
Pre-Mirror	
Double Crystal Monochromator (DCM)	
Post-Mirror	
Observed beam @sample position	1 mm (H) x 0.2 mm (V)
Observed Resolution	10^4
Photon flux	10^{11}ph/sec/0.1 % band width @2.5 GeV, 300mA

Beamline Optics

Mainly BL-09 optics consists of

- Two Rh and Pt coated meridional cylindrical mirrors (reflectivity shown in Fig. 1):
  - Pre-mirror : Used for collimation, which is horizontally mounted on hexapod.

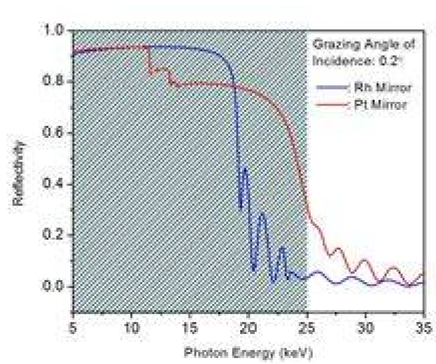
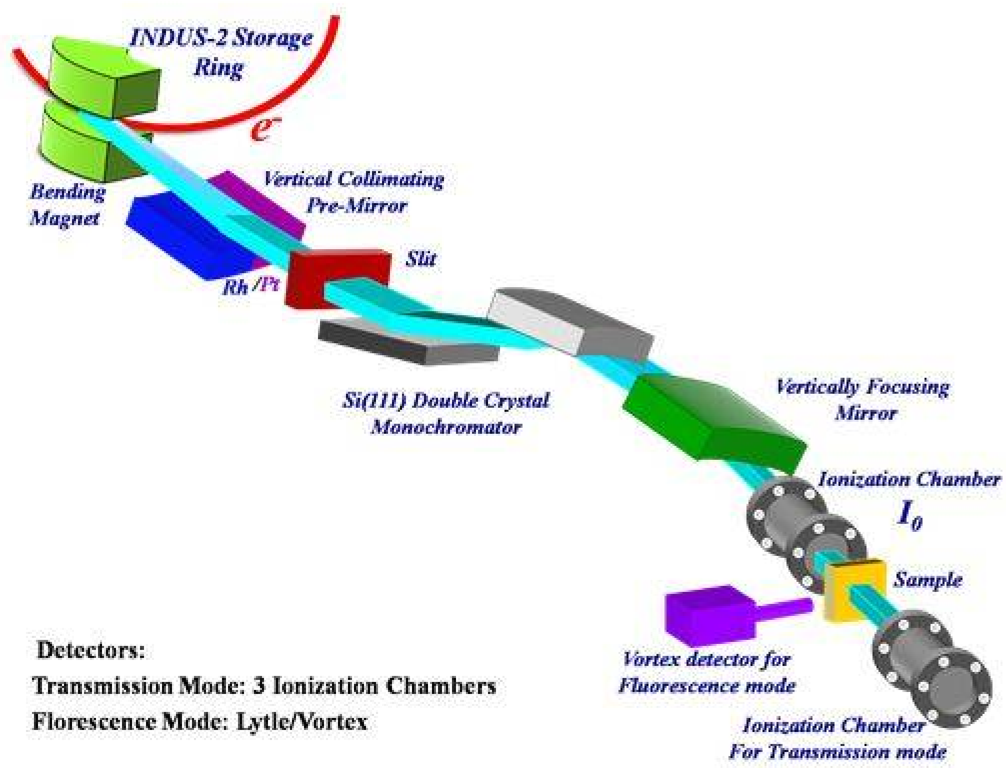


Figure 1: Rh and Pt mirror reflectivity as function of energy at 0.2° incidenc

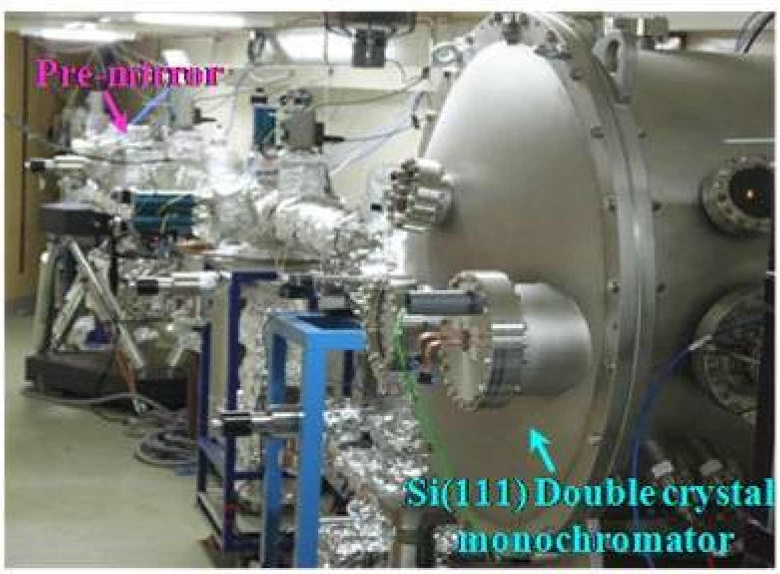
  - Post-mirror : Used For focusing the beam vertically at sample position.
- Si(111) Double Crystal Monochromator (DCM): Highly monochromatic radiation is

obtained using two Si(111) crystals. First one is plane crystal and second one is mechanically bendable (Sagittal) crystal which helps to focus beam horizontally at the fixed sample position.

Schematic layout



View of optics & experimental Hutch of BL-09



<u>Mode of Operation</u>

Transmission Mode: The absorption coefficient in transmission mode is given by

$$I = I_0 \exp[-\mu(E)x]$$

Fluorescence Mode: The absorption coefficient in fluorescence mode is given by

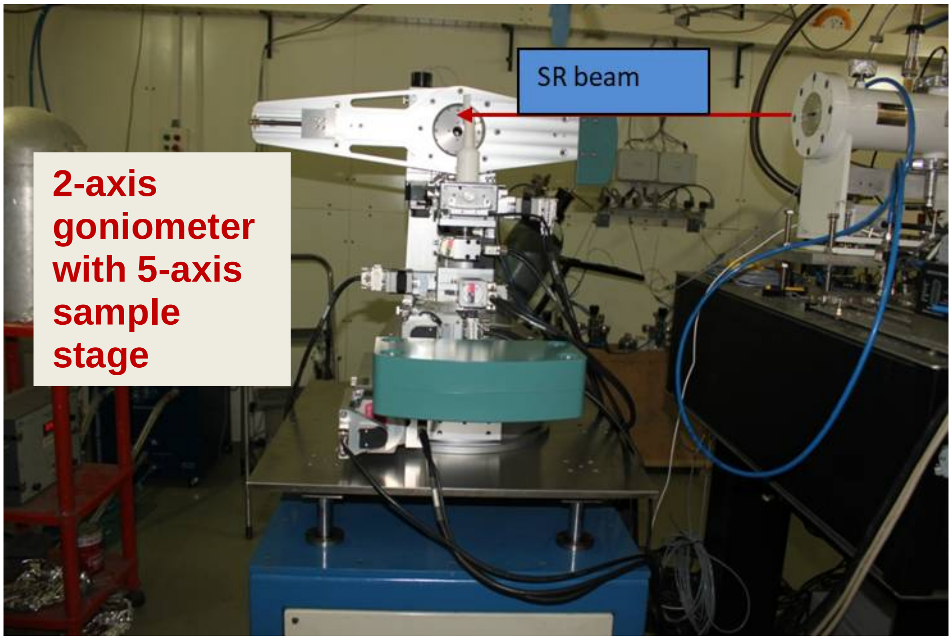
$$\mu = I_f / I_0$$

Where I_0 is the incident photon beam, I is the transmitted beam from the sample and I_f is the florescence intensity from sample, x is the distance travelled through the material, and $\mu(E)$ is the absorption coefficient of the material. For transmission mode EXAFS experiment, three Ionisation chambers are used filled with suitable mixture of gases depending upon the photon energy. A continuous scan simultaneously measures the incident and transmitted flux from the ionization chambers. A typical EXAFS measurement of 1000 eV takes around 5 minutes in transmission mode. For fluorescence mode EXAFS experiment, Ionisation chamber based Lytle detector or Vortex detector is used. For fluorescence measurements, a step-by-step scan typically takes around 45 minutes.

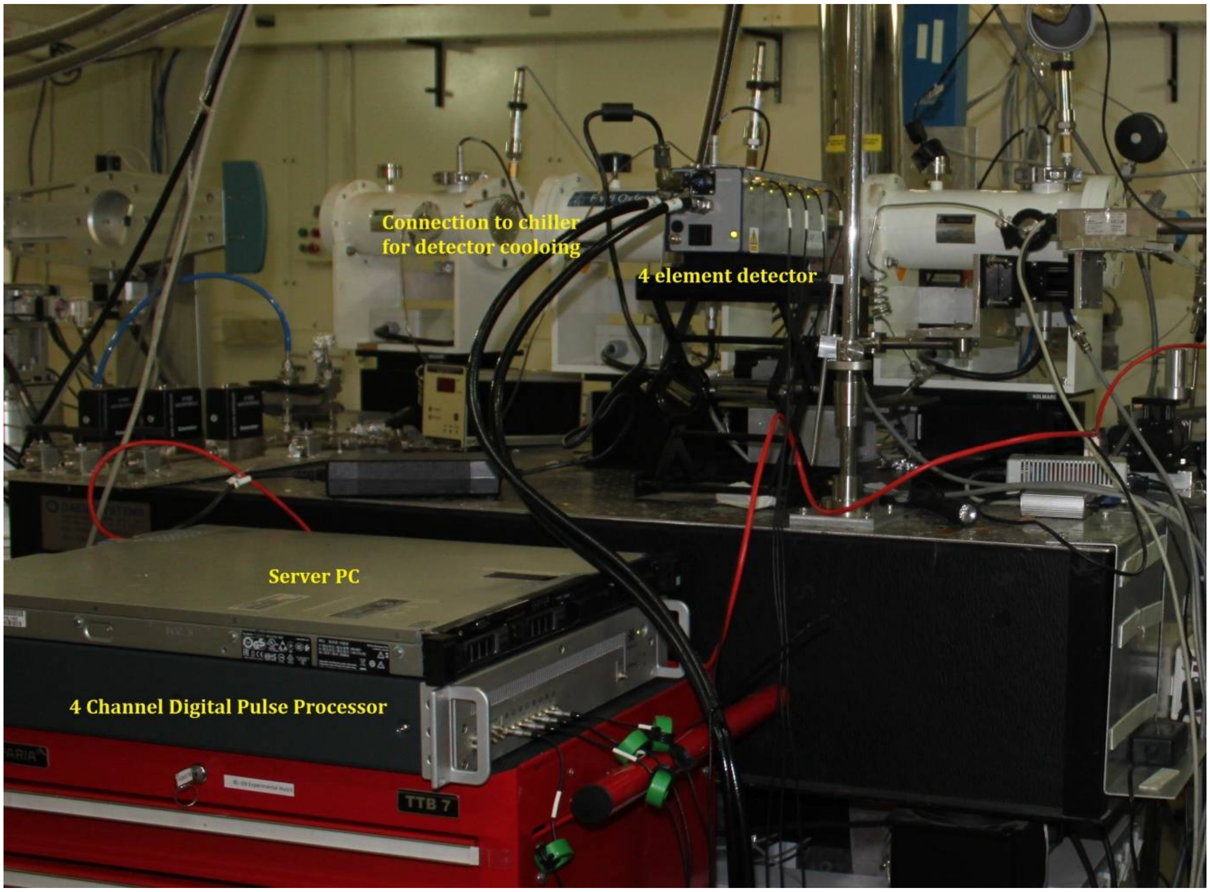
<u>Sample Environments at the beamline:</u>

<u>Facilities at the beamline</u>

- **Grazing Incidence EXAFS Facility**



- **4-Element X-ray Detection System for Biological & Dilute Samples**



- ✓ *In-situ* XAFS measurement set-up for catalysis & photo-catalysis reactions
- ✓ *In-situ* XAS measurement setup to study one pot synthesis

<u>Application</u>

The beamline can be used to study local structural properties around a specific element in materials like: liquids/solutions, single and polycrystalline materials, amorphous & highly disordered solids, thin film and doped material. The energy range (4.5-30 keV) available from the beamline is sufficient for K-edge studies of many elements in the range 20 < Z < 47(viz. Ti, Zn, Cu, Ga ,Zr, Rb, Sr, Mo etc.). For Z > 47(viz. Rare earth elements, Au, Pt, Th, U etc.) one can probe L-edges instead of K edge. The sample thicknesses for experiments are in the μm range for transmission experiments. However, thin film and/or dilute systems studies are possible in fluorescence mode.