The experimental station will consist of a six-circle diffractometer. Four main circles are in the incident beam while two circles are in the scattered beam, and contain the analyzer crystal. The experimental station sits on a stand with five degrees of freedom for sample adjustments. The 2θ resolution of 0.15^0(mode A), 0.02^0 (mode B) and 0.15^0 (mode C) will be achieved in the set up. There will be scintillation counter as well as area x-ray detectors.

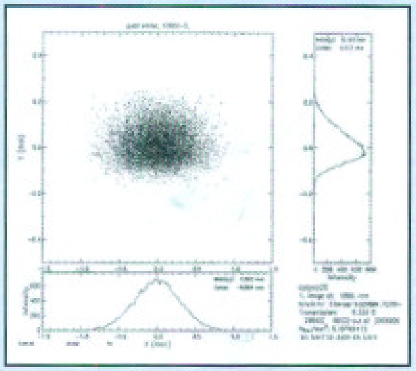

Fig. A.9.2 The spot diagram for 5-element configuration, WLS source and the angle of incidence of the photon beam on the mirror is 3 mrad for mode A

(Contributed by: Dr. RV Nandedkar; nrv@cat.ernet.in)

A.10 Radiation safety in Indus-1

Due to interaction of electrons with vacuum components, structural materials and residual gas molecules in vacuum envelope, ionizing radiation is produced which is the main occupational hazard in Indus-1. The prompt radiations, which are present, only when accelerator is 'ON' are Bremsstrahlung x-rays and photo-neutrons. Bremsstrahlung x-rays have a broad spectrum with energies extending up to the primary electron energy and are highly angle dependent. Intensity of these x-rays peak in the forward direction of the beam. Dose due to photo-neutrons is insignificant in comparison with x-ray dose rates.

Bremsstrahlung x-ray spectrum measurements were carried out at experimental hall of Indus-1 using a 2" x 2" BGO detector, in search for any high-energy photons reaching the experimental area. The measurements indicated that the photons reaching at most of the experimental stations are within 10MeV. The injection and storage mode operation did not indicate significant change in the spectra (fig. A.10.1). Besides, the comparison of direct (without any shield) and transmitted (with 8 cm lead shield) at the high-resolution beam line showed that the spectra extends up to several hundreds of MeV. Various measurements have proved that all the experimental stations in use have a radiation level ~ 0.1μSv/hr (10μRem/hr), similar to background radiation levels.

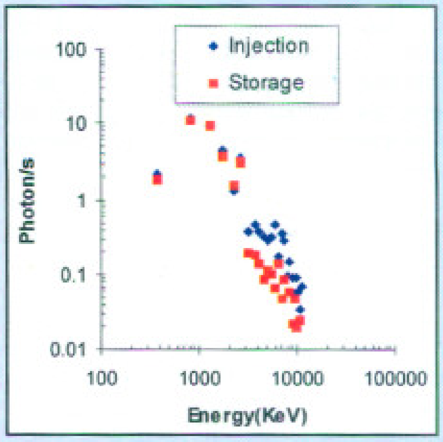

Fig.A.10.1 Bremsstrahlung spectra at reflectivity beam line during injection & storage

(Contributed by: Haridas G Nair; haridas@cat.ernet.in)

A.11 Gas phase multiple ionisation experiments at Indus-1

Photoionisation cross-sections of rare gases have been measured in the past, but there is a paucity of accurate experimental data for higher charge-states. The aim of this series of experiments is to generate a systematic data set for thresholds of multiple ionisation and for energy dependence of ionisation cross-sections. These measurements are important for understanding the correlated behavior of multi-electron systems.

A time-of-flight mass spectrometer (TOF) was designed and indigenously built for these measurements. The spectrometer uses two uniform, linear electric fields, conforming to the Wiley-McLaren geometry (fig. A.11.1). Ion charge states are separated on the basis of their flight times. Ions formed in a small overlap volume of the crossed neutral beam and photon beam. The neutral beam is formed by effusion of a gas through a capillary, whose position is fixed with respect to the other spectrometer components.

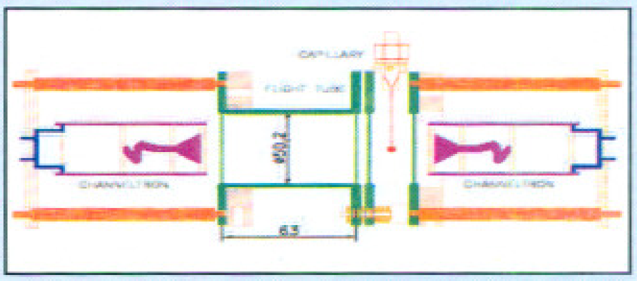

Fig. A.11.1 Spectrometer field layout

Ions, after acceleration, drift in 63mm long field free region and are detected by a channeltron. A second detector, again a channeltron, placed very close to the ionisation region, but on the opposite side of the ion flight tube, is used to detect electrons. Both detectors are operated in the particle counting mode. Signals from the two detectors are processed by fast amplifiers followed by constant fraction discriminator. Time-of-flight measurement is done by using the electron detector signal as the start pulse and ion detector signal as the stop pulse. The time difference between the start and stop pulse gives the information about the flight time and thus the charge state of the produced ions. Although the photon beam is pulsed, its repetition rate is too high to be useful for ion flight time measurement.

Gas pressure is monitored using a capacitance manometer. Measuring the current from a photodiode monitors the photon flux. For comparing ion yields at different photon energies, the ion yield for each charge state is normalised to the integrated photon flux and gas flow rate. Data acquisition and control is developed on a LABVIEW platform.

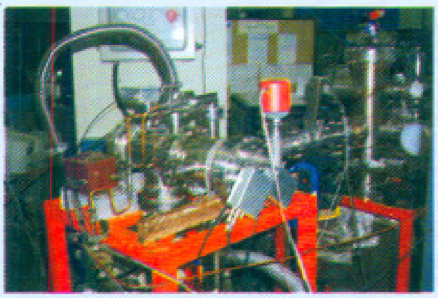

Fig. A.11.2 TOP Experimental station on CAT TGM beamline

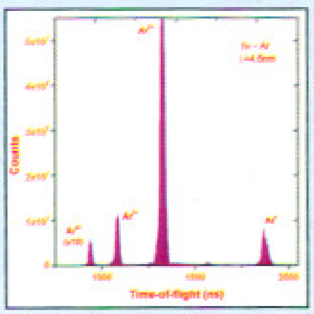

Fig. A.11.3 TIOF Spectrum of photoionized argon

We are currently studying multiple ionization of argon. Significant changes in the yield of different calibration charge states are observed around the argon L edge (245eV). Charge states upto Ar^{4+} have been identified (fig.A.11.3). This work was done in collaboration with a team from PRL, Ahmedabad.

(Contributed by: B. Bapat, R K Singh, K P Subramanian, G S Lodha; lodha@cat.ernet.in)

A.12 Valence bands offset measurement between two semiconductors using Indus-1

A modified method has been used to measure the valence bands offset by photoelectron spectroscopy (PES) between low doped and depleted semiconductors. PES measurements have been done on the angle resolved photoemission spectroscopy beam line of Indus-1 synchrotron radiation source. The valence bands offset at the heterojunction of depleted ZnSe film and doped GaAs substrate have been measured. ZnSe films were deposited on doped GaAs substrates by the laser ablation technique. The surface photovoltage (SPV) and the charging effects modify the PES spectra of depleted semiconductors. The shift of PES spectra of ZnSe film by about 6eV has been observed due to the charging and SPV effects. The charging and SPV effects on PES spectra have been reduced to negligible values in the presence of excess plasma density (due to absorption of white light from a tungsten lamp (the secondary source) of the order of $10^{18}cm^{-3}$.

In figure A.12.1, shifts of PES spectra of 1μm thick ZnSe film, sample1, are shown in the presence of increasing secondary photon fluxes. Curve 1 is in the dark background (i.e. tungsten lamp was off). Secondary photon fluxes for curves 2, 3 and 4 are about $9x10^{11}cm^{-2}sec^{-1}$, $1.2x\ 10^{12}cm^{-2}sec^{-1}$ and $5x10^{12}cm^{-2}sec^{-1}$ respectively. The inset shows the shift of the Zn-3d peak as a function of the secondary photon fluxes. The energy of the primary beam was 154eV and the photon flux for all the curves was in the range of $2\text{-}5x10^{11}cm^{-2}sec^{-1}$. In figure A.12.2, PES spectra of ZnSe film of thickness 0.2μm are shown. Curves 1 and 2 are in the dark background and in the presence of the secondary photon flux $5x10^{12}cm^{-2}sec^{-1}$ respectively. The energy of the primary beam was 130eV and the photon flux for all the curves was in the range of $2\text{-}5x10^{11}\ cm^{-2}sec^{-1}$. These results clearly show that the effect of the charging and SPV are different for two samples. The PES spectra measured in the presence of the excess plasma density ($\approx 5x10^{18}cm^{-3}$) have been used to measure the valence band onset energies of GaAs and ZnSe and the core level energies of Ga-3d and Zn-3d. These values of valence band onset energies and core level energies have been used to calculate the valence bands offset between ZnSe and GaAs and it is found to be 1.1±0.1eV.

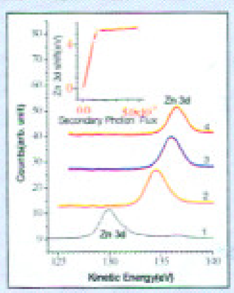

Fig. A.12.1

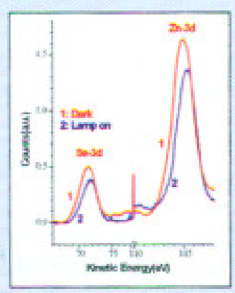

Fig. A.12.2