3. Photon beam position monitors (BPM)

BPM measures the average position of the X-ray beam. The first monitor is located just after the beam collimator and the second monitor approximately 5-10m downstream. The BPMs provide real time position and profile information. If the position of the photon beam is known at two places along the beamline, then the average position and angle of the electron beam in the X- ray source can be determined.

4. Fixed mask (FM)

A fixed mask is a water-cooled copper plate with a rectangular hole in the center. The purpose of FM is to provide the required beam size for a particular beam line. Typical thermal load on fixed mask is about 150 –200 watts depending upon the opening.

5. Safety shutter

The purpose of safety shutter is to absorb bremsstrahlung gamma radiation generated from electron beam scattering. The safety shutter essentially comprises of a vacuum chamber, inside of which is placed a radiation absorber head made of steel clad lead or densimate a tungsten alloy. A water cooled copper plate is placed at 45^0 before the head to protect it from the heat load. Typical size of the absorber head made of densimate are 200 x 100 x 60mm^3 which is very massive. It is moved by a pneumatic cylinder through a welded bellow.

(Contributed by: V.K.Raghuvanshi (vkraghu@cat.ernet.in) and R.V.Nandedkar)

A.4 Large area ionization chamber for intensity monitoring in hard X-ray beam lines in Indus- 2

Ionization chamber (IC) is commonly used in hard X-ray beam lines to measure intensity. ICs are gas (in this case argon) filled detectors, which can be used for various purposes in a beam line. They are kept just before the experimental station to monitor the incident intensity (I_0) of X-ray beam. They can also be kept immediately after a double crystal monochromater (DCM) to align for DCM crystals and used in detuning the second crystal to suppress higher order harmonics [CAT 2004–19].

A large area IC has been fabricated and tested on 3kW, CuKα X-ray source. Fig. A.4.1 shows the photograph of the set up. The IC consists of a cylindrical chamber of 450mm length and 150mm diameter. This has two 203mm diameter flanges at the ends with rectangular cross section holes for the passage of X-rays. 50μm thick Kapton windows are stuck on these rectangular holes with the help of an adhesive. Six ports, welded on the circumference of the main pipe, contain flanges of 70mm diameter each. Both the electrodes are electrically isolated from the body of the IC. In one of the flanges high voltage feed-through is attached. Voltage up to 3kV is applied through this port. The IC is then filled at desired argon pressure and sealed. For this set of measurements, pure argon gas was filled at pressures between 1.0 and 1.8bar. The IC is first evacuated to a pressure of ~ 10^{-2}mbar, using a rotary pump. The IC current is measured using a Keithly electrometer.

Fig. A.4.1 Ionization Chamber along with the high voltage power supply and ammeter

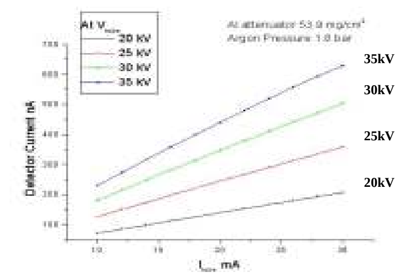

Fig. A.4.2 *I_{det} plotted as a function of I_{tube} for various values of V_{tube}*

The IC was tested on X-ray source. We find that the ionization region for the IC is between 500volts and 1000volts depending upon incident intensity. For a given accelerating tube voltage, IC current is approximately linear with the X-ray tube current for lower values of IC current (fig. A.4.2). Non-linearity sets in when the incident X-ray intensities are high.

(Contributed by : A.K.Sinha (anil@cat.ernt.in) and R.V.Nandedkar)

A.5 Development of ECR proton source

50keV, 30mA Electron cyclotron resonance (ECR) proton source (fig. A.5.1) for use as an ion source for a proton linac is designed and fabricated. The source is excited with 350watts of microwave power at 2450MHz frequency to produce hydrogen plasma. Two-electrode extraction geometry is designed for extraction of the proton beam. The extraction aperture of the plasma electrode is 8mm and ground electrode is 10mm. The proton beam current 5mA (peak) at 15keV with a pulse width of 5msec., and repetition rate 100Hz is obtained. The beam current is measured 100mm down the source using a Faraday cup. The proton current v/s extraction voltage is shown in fig. A.5.2 (a) and pulse shape of beam is shown in fig.A.5.2 (b).

Fig. A.5.1 *ECR proton source*

In ECR source, plasma is produced by matching the frequency of the microwave source to the cyclotron frequency (2450MHz) of electrons, in the magnetic field (875gauss). The measured field profile is shown in fig. A.5.4. The magnetron is used as a source of microwave power and it can deliver maximum 2kW power at 2450MHz frequency. 5kV, 1A high voltage DC power supply is used to energize the magnetron. 5V, 20A AC power supply floating at 5kV is used to power the filament.

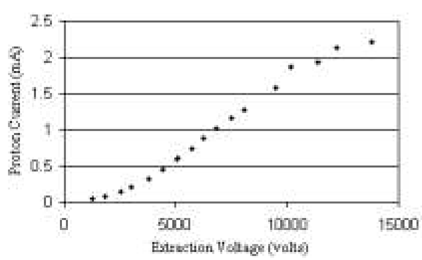

Fig.A.5.2(a) *The proton current v/s extraction voltage*

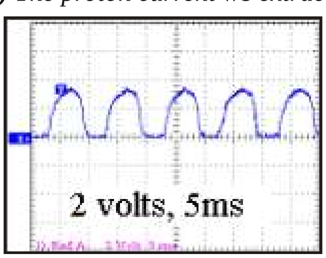

Fig. A.5.2(b) *The pulse shape of beam*

The microwave transfer line is developed using WR-284 rectangular waveguide section. The microwave power is coupled to the plasma chamber via ridged waveguide with window and DC break. The forward and reflected power is monitored using 50dB loop directional coupler. The plasma impedance is matched and reflected power is minimized using triple stub tuner. A high power isolator is used to protect the magnetron from load imperfections by directing the reflected power to the load. The isolation offered from reflected power is 25dB.

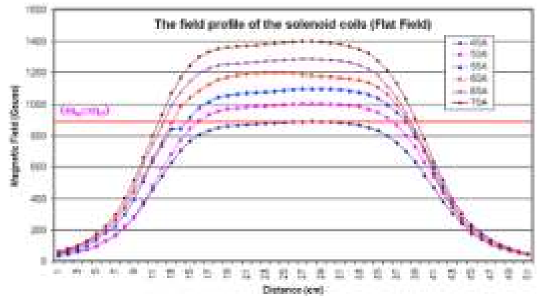

Fig. A.5.4 *The measured field profile (Flat Field)*

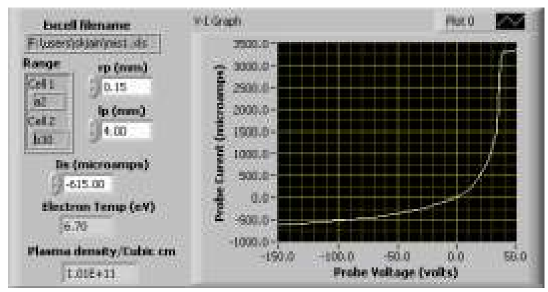

Fig. A.5.5 *The V-I characteristics of the ECR source*

Turbo molecular pump (400litre/sec.) is used for the evacuation of the plasma chamber (SS304) and $1x10^{-6}$mbar base pressure is maintained. Hydrogen gas flow is controlled through the precision needle valve. The source is operated at the hydrogen pressure at $2x10^{-4}$ mbar. The plasma parameters, plasma density and electron temperature is measured using Langmuir probe. The hydrogen plasma density in the order of $2\text{-}4x10^{11}cm^{-3}$ and electron temperature 3-7eV is obtained. The V-I characteristics of the Langmuir probe obtained from the ECR source is shown in Fig. A.5.5. The data obtained from the V-I characteristics, various plasma parameters are obtained.

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A.6 Fabrication of injection septum magnets for Indus-2

Septum magnet will inject the electron beam into the Indus-2 storage ring. Injection process will be completed in two stages firstly by bending the beam through (19+2)° in septum magnets and thereafter kicking the same in to the beam path using a kicker magnet Injection septum magnets were designed and developed at CAT.

Since septum magnets are placed in UHV environment hence its construction is entirely different than rest of the magnets of Indus-2. This segment has a parallel edge type core