III MATERIALS AND METHOD

3.1 Plasma focus device

The plasma focus used in this experiment is a standard UNU/ICTP [7] plasma fusion facility of Mather type[6]. In this device, a single 30μF, 15kV, 3kJ Maxwell capacitor is discharged to supply the energy to the plasma via a parallel plate swinging cascade air sparkgap. The sparkgap is triggered from a high voltage SCR pulse circuit [8] coupled with a high voltage TV transformer. The design of experimental parameters may be computed from a dynamic snow-plow model given by Lee [7,9]. The basic parameters are summarized in table 1 as follows.

Table I

Capacitance	C	30	μF
Circuit inductance	L	110	nH
Charging voltage	V	15	kV
Radius of anode	a	0.95	cm.
External radius (cathode)	b	3.2	cm.
Length of anode		16.0	cm.
Electrodes material		copper	
Base pressure		2×10^{-2}	torr.
Operating pressure		1-3	torr.
Electrode sleeve material		ceramic	

The capacitor is charged automatically by a constant current charger [10]. Further improvement to the device is the incorporation of a gas puff device in order to improve impurities and current sheet velocity.

3.2 Plasma diagnostics and data aquisition system

Some diagnostics used on the device are described.

1. Voltage probe. Voltage on the plasma focus electrode is measured by a resistive dividing probe with the ratio 100:1.A 40kV Tektronix probe is also used. The spike on the voltage signal is used as an indication of focussing time of the discharge.

2. The Rogowski coil. The coil is of a current transformer type, it is used to measure the total plasma current. The derivative of the discharge current (dI/dt) is also another way of determining the time of maximum compression.

3. X-ray detectors. Two types of X-ray PIN diode detectors are employed in our laboratory to study time resolved soft x-ray spectra.

(a) Quantrad PIN diode detector. The Quantrad model 100-PIN-250 diode is used with reversed biased voltage of -300V supplied by batteries. This detector is very sensitive due to its large collecting area of 100 mm^2. The rise time is 2nS. It also has a sharp hard x-ray cut-off. Fig 1. Shows the biasing circuit.

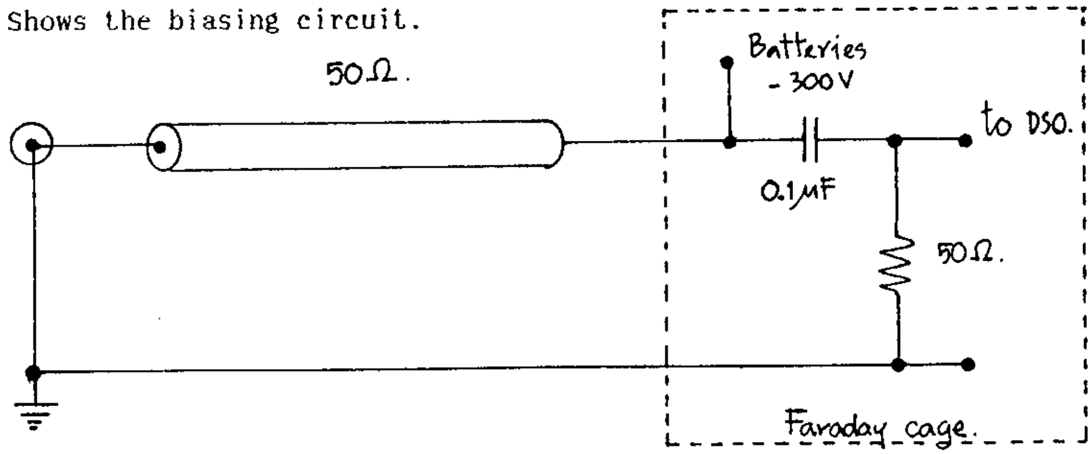

Fig.1 The Quantrad PIN diode biasing circuit

The assembly of PIN diode and the x-ray absorption foils is mounted using a perspex holder [11]. A 50 μm mylar sheet is used as vacuum seal while Be foil provides shielding against visible and UV light. The perspex holder is fixed onto one arm of side diagnostic ports of the vacuum chamber.

(b) The five channels BPX-65 diode spectrometerr. This diode spectrometer was developed by Wong [12] using a smaller general purpose BPX-65 PIN diode. The effective detection area of each diode is 1 mm^2, it has faster rise time of 0.5 ns. Each diode is reverse-biased at 4.5V using the circuit shown in Fig.2

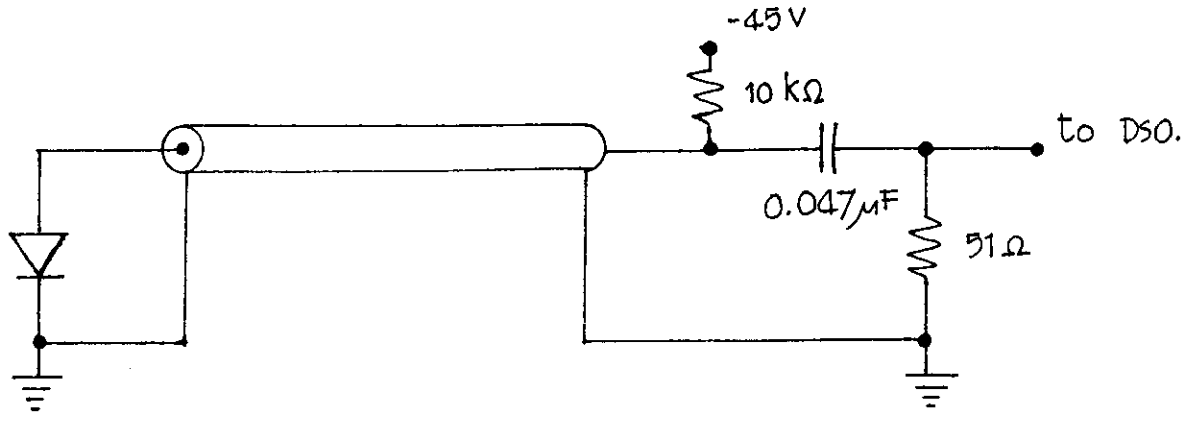

Fig.2 The biasing circuit for BPX-65 diode

The five PIN diodes are assembled into five channels Spectrometer with appropriate sets of filters. Two types of spectrometers are designed by Wong [12].

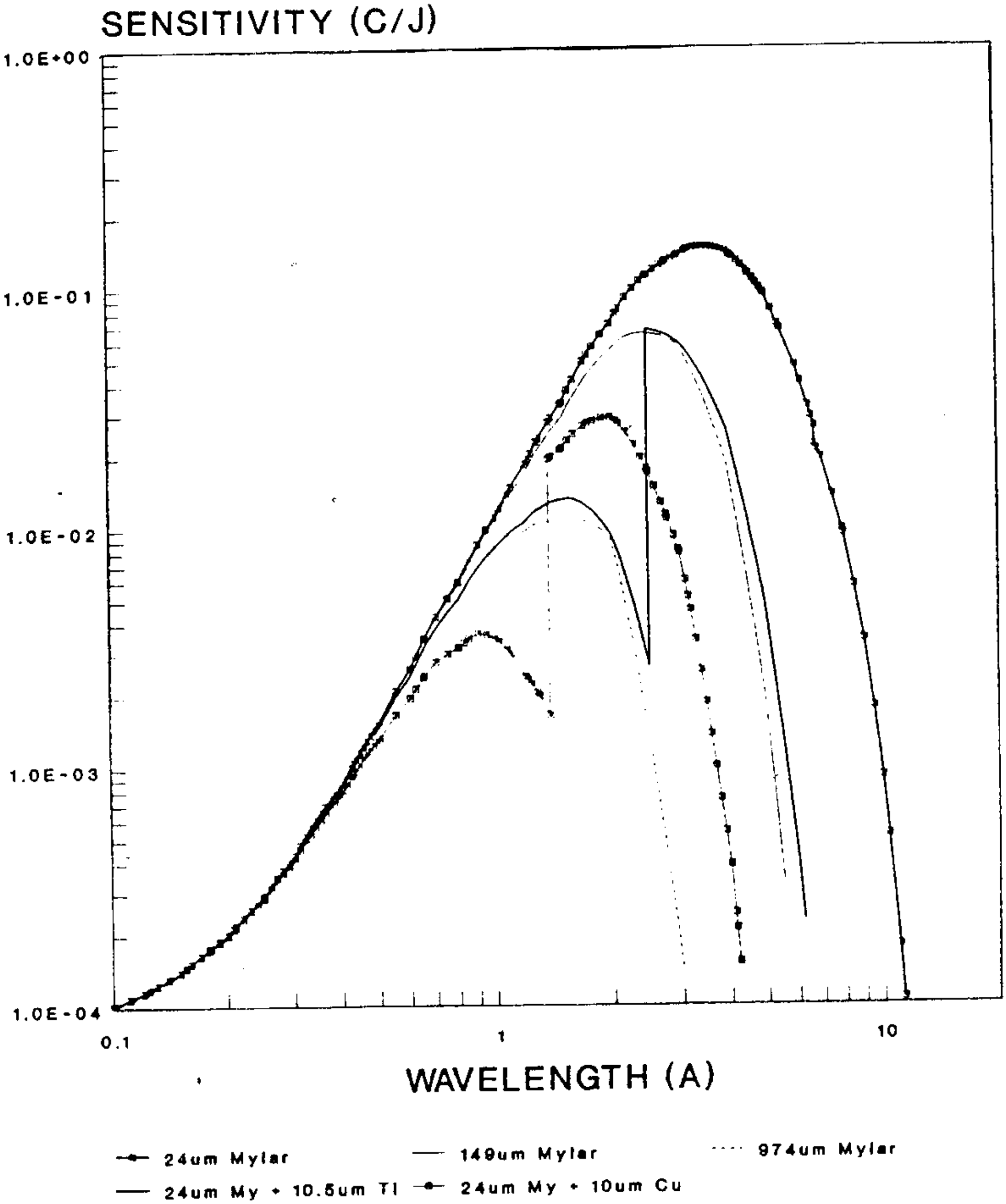

Fig.3 BPX-65 sensitivily with foil absorption folded in as a function of wavelength.
[taken from Instruction Manual ICAC-UM/DXS-2 type A]

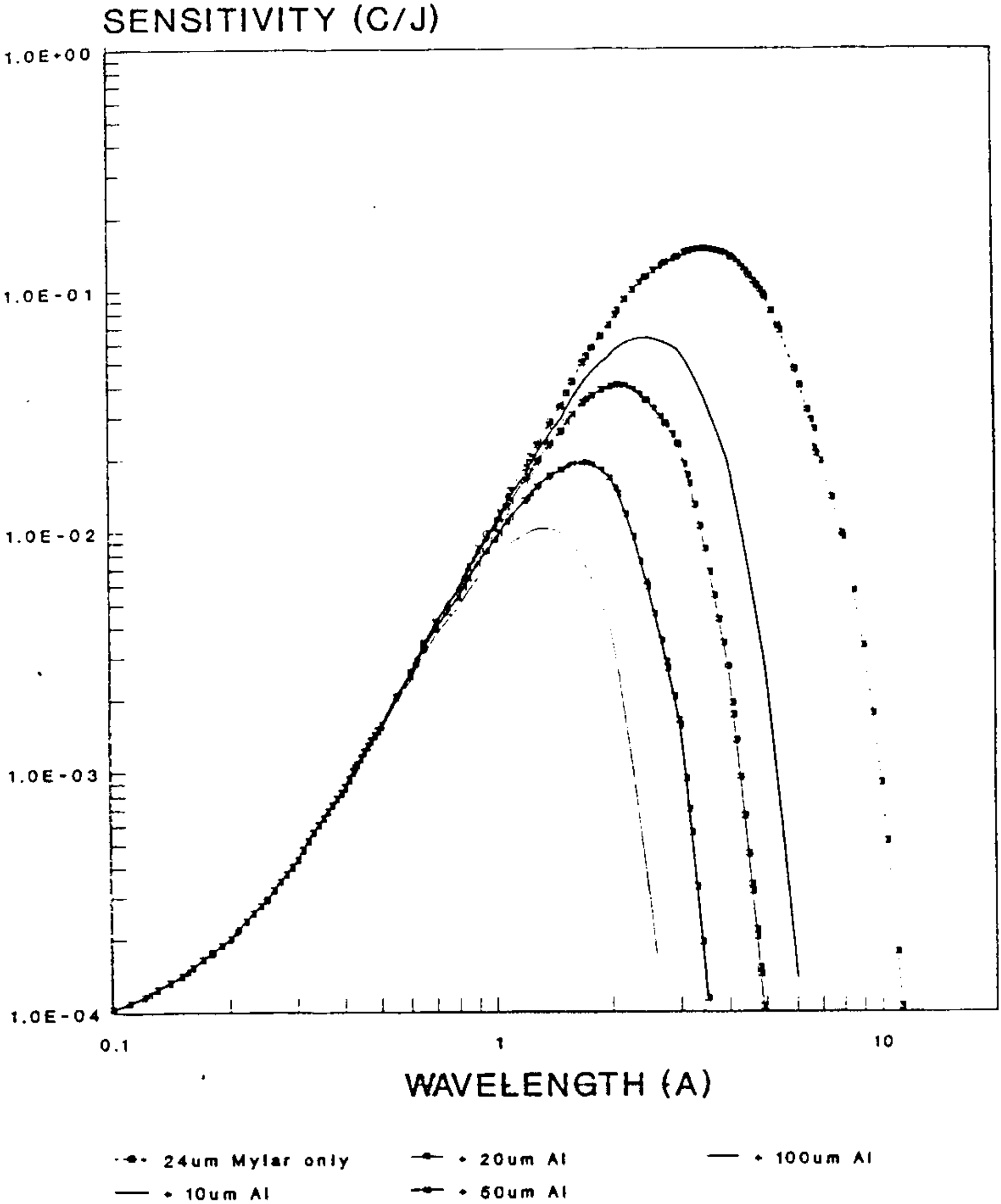

Fig.4 BPX-65 Sensitivity with foil absorption folded in for various foils.
[taken from Instruction Manual ICAC-UM/DXS-3 type B]

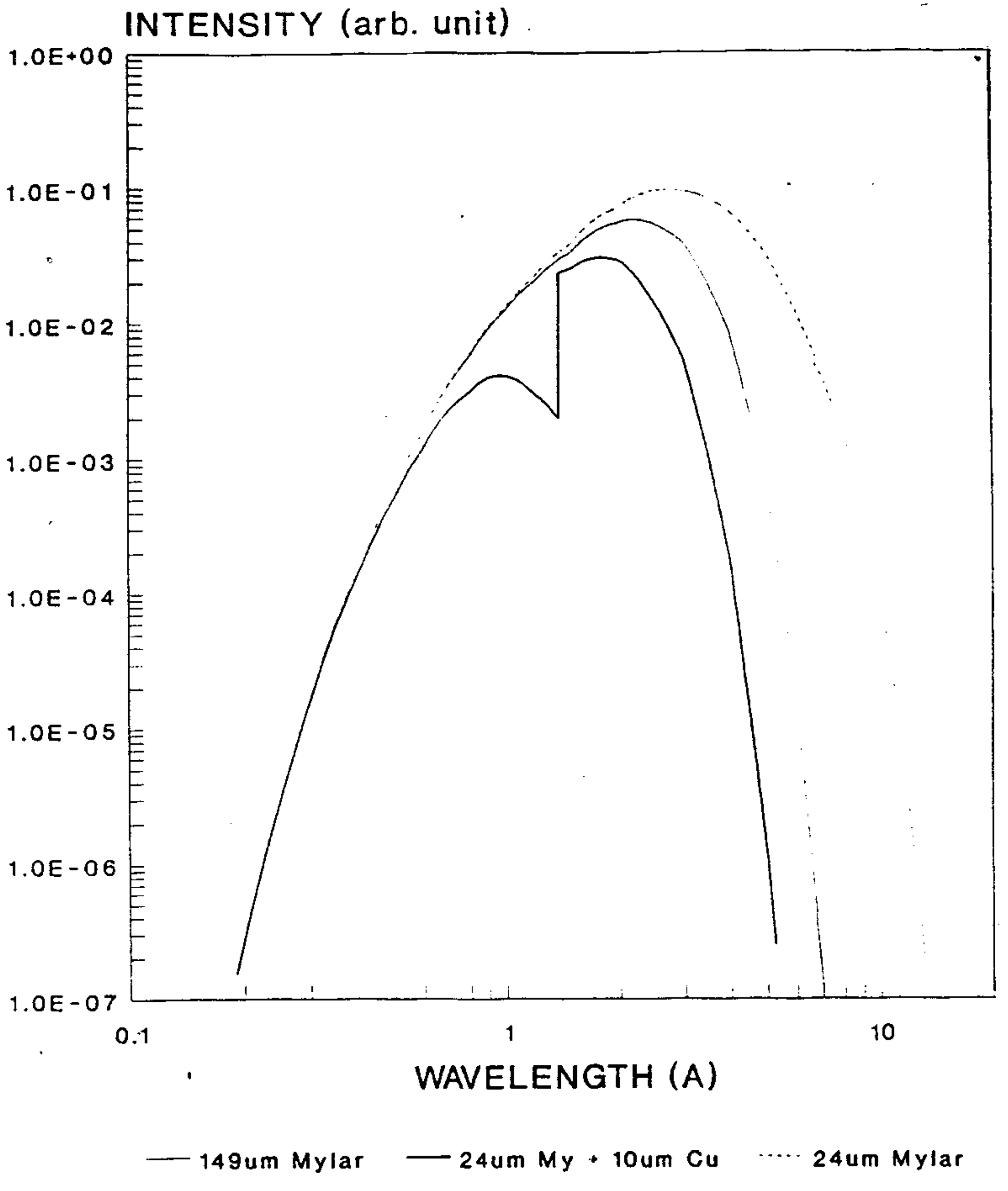

Fig.5 H continuum detected by BPX-65 at Te ~ 5000 eV
[taken from Instruction Manual ICAC-UM/DXS-2 type A]

Table 2

Channel	Type A	Type B
1	149μm aluminised mylar	24μm aluminised mylar
2	24μm al. mylar + 10.5μm Ti	24μm al. mylar + 30μm Al
3	24μm al. mylar	24μm al. mylar + 60μm Al
4	24μm al. mylar + 10μm Cu	24μm al. mylar + 90μm Al
5	974μm al. mylar	24μm al. mylar + 120μm Al

The x-ray transmission characteristic curves of absorption foils may be found in ref.[13]

The sensitivity with foil absorption folded in of BPX-65 PIN respectively. The continum radiation from hydrogen plasma with Te~5 keV, as detected by BPX-65, is shown in Fig.5. The various foil combinations are designed specifically for application to hydrogen or hydrogen-argon plasma with temperatures in the range of a few keV. Since the plasma spectrum is most likely to be contaminated by copper impurity from the electrodes. Type A channels 4 is equipped with 10μm copper foil to facilitate checking the extent of the copper contamination.

For the present study, type B spectrometer is used to investigated x-ray spectra in pure deuterium, nitrogen and argon plasmas separately.

(c) Hard x-ray detector. Hard x-ray is always presented and can be easily detected by a photomultiplier with NE 102A plastic scintillator. The radiation is collimated by a lead cylinder and a 5 cm thickness aluminium block provides an estimate of x-ray energy.

4. Data acquisition system. Due to manpower shortage, it is aimed to operate PSU plasma focus by a single person with automatic control and fast data acquisition. A Hewlett Packard two channels digital storage oscilloscope (DSO) model HP 5 4502 A is used to monitor transient signals such as voltage, current, magnetic field and PIN diode signals. A Thinkjet printer provides the hard copy of the oscilloscope traces. Signals may also analysed by an IBM PC/AT compatible microcomputer. HP ScopeLink software assists in communication between DSO and the computer via an IEEE interface card. A homemade double screens Faraday cage provides shielding against electrical interferences from sparkgap.