BEAM DIAGNOSTIC SYSTEM OF HIRFL

Shen Zhiqing and Wang Yude

Institute of Modern Physics, Academia Sinica,
P.O.Box 31, Lanzhou,China

ABSTRACT

In this paper the beam diagnostic devices set at HIRFL,such as central phase monitor,Faraday cup,slit system,emittance monitor and profile monitor are discribed.

1. INTRODUCTION

The heavy ion research facility at Lanzhou (HIRFL) is composed of two isochronous cyclotrons in cascade. A lot of eleberate beam diagnostic devices along the beam lines and inside SFC and SSC are mounted for the convinient tuning and efficient operation of the accelerator.

2.DIAGNOSTIC ELEMENTS ALLOCATION

1.Injector SFC: Four radial probes are set to measure the beam density,orbit location and beam vertical position. Seven central phase probes are used to measure the beam center phase along radial direction.

2.The Beam Line for SFC to SSC: Fig.1 shows the diagnostic element locations along the beam line from SFC to SSC.5 sets of Farady cups,20 sets of secondary emission multi-wire profile monitors and 3 sets of emmittance measurement system are mounted along the beam line.

The beam emergy and energy dispersion are measured by using 74° bending magnet,two slits (set respectively in the front and behind of the magnet) and a Faraday cup. Another method for measuring the beam energy and energy dispersion is by means of nuclear reaction,the target chamber is located behind the 50° bending magnet. The results of both methods can be corrected each other.

3.Main Accelerator SSC: Two kinds of diagnostic devices are used: a) Four radial probes are set separately along each sector axis to measure the beam radial density,orbit location,vertical position and time structure of the beam bunch. b) 15

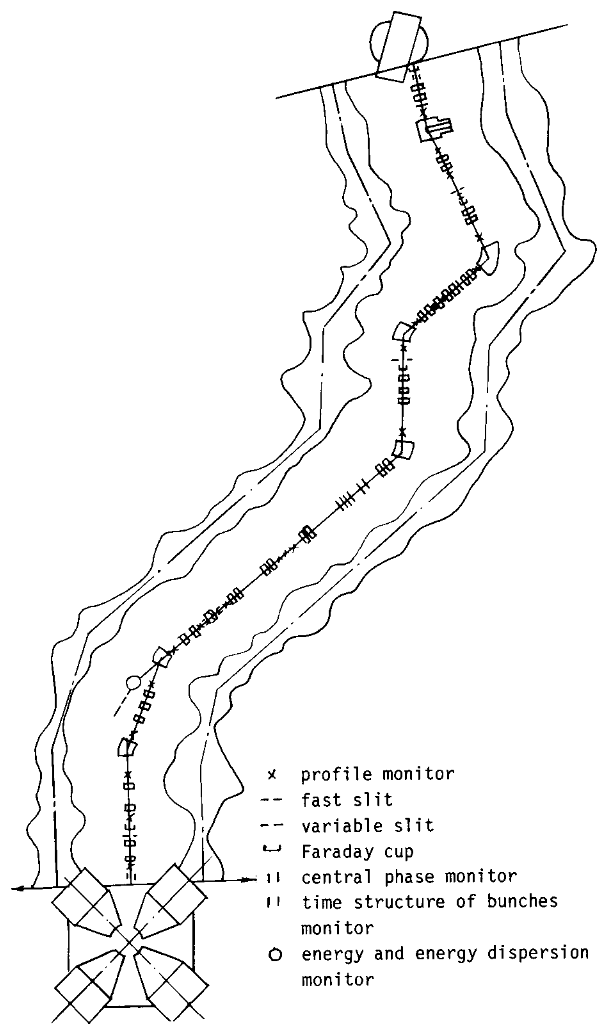


Fig.1: SFC-SSC diagnostic device locations.

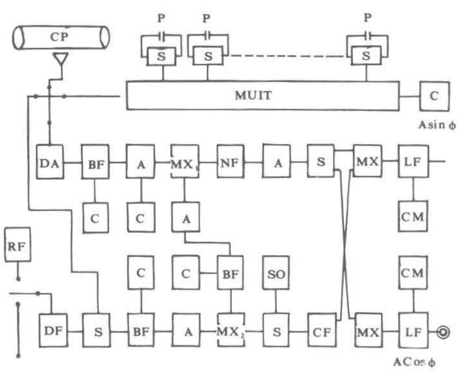
phase probes are located in one valley of SSC. They are used to adjust the isochronous field by measuring the center phase of the beam.

4.The Post Beam Line: The post beam line is 110m. The locating principle of the diagnostic device is the same as that of the injection beam line. The diagnostic elements and their numbers in HIRFL are as follows:

Faraday cup	15 sets	fast slit	8 sets.
multip-wire monitor	37 sets	movable slite	17 sets.
phase probe	26 sets	radio position probe	6 sets.
emittance device	4 sets	energy and energy dispersion measurement system	2 sets

3. MAIN BEAM DIAGNOSTIC DEVICES FOR HIRFL

1.Central Phase Measurement System: Fig.2 shows the analog processing block diagram. The signal is pickd up by second harmonic wave in order to limit the noise. There are two kinds of probes in HIRFL.



cp-cylindrical probe, p-plane probe, s-power splitter, c-CAMAC interface, MUIT-multiplexer, DA-delay line, BF-band-pass filter, A-high frequency amplifier, MX-mixer, NF-narrow band-pass filter, MX-multiplier, LF-low-pass filter, RF-high frequency producer, SO-crystal oscillator, DF-double frequency

Fig.2: Central phase measurement process.

a) In SSC

The plate capacitive probes are arranged along the center line of the valley. The electrodes are 100x100mm and 50x100mm respectively,which are 50 ohms to SSC and SFC. The distance between the median planes and each electrode is 25 mm. The signals from the upper and the lower electrode are added to improve SN ratio. The obtained signals (Asinθ and Acosθ) from the analogy processing device are transferred to the computer via the CAMAC modules for processing and displaying the phase history.

b) In the beam line

There are four cylindrical probes. The electrode is 100 mm long and the diameter is 70 mm. They charged on high impedance. The second harmanic signals picked up by the cylindrical electrode are transferred to the RF multiplexer. The probes selection is performed by the RF multiplexer. The accuracy is ±1°.

2.Radial Probe: The probe consists of a differetial interceptive target (three finger target) for measuring the beam vertical and radial position,a main target for measuring the beam intensity and a semi-interceptive wire target for measuring the time structure of bunches(Fig.3).

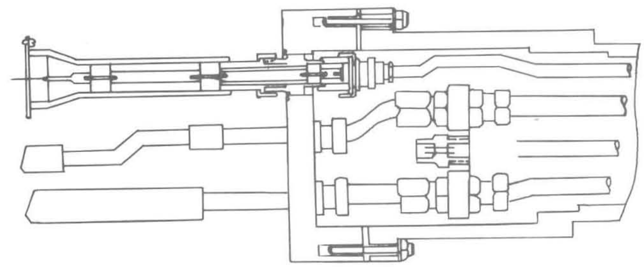


Fig.3: Radial probe.

The pick-up signals are transferred to the CAMAC module by an I/V converter. Final processing and displaying is performed by computer.

3.Secondary Emission Multi-wire Profile Monitor (Fig.4): It is used as a standard device along the beam line. It consists of two orthogonal wire planes interleaved between 3 HV.O. rings(300v).Each plane consists of 51 gold plated tungsten wires spaced 1mm. The diameter of the wire is 0.025 mm and soldered on printed-bord.

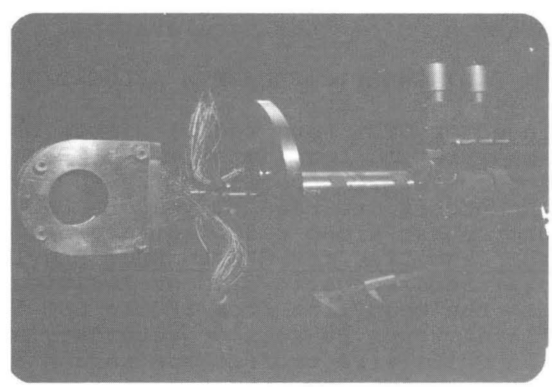


Fig.4

It is driven by compressed air with the stroke 100 mm. A capacitor is connected between the wire and the ground to integrate the current induced by the wire. To get the beam profile the output voltage of each wire is scanned with multiplexer and link to the CAMAC modules. The signals are displayed on a console or processed by the computer via CAMAC modules.

4.Faraday Cup: Fig.5 shows the Faraday cup. The diameter of the cup is 40 mm and internal form of the cup botton is conic to avoid partical hot. A negative ring (-200v) is located in the front of the cup for suppression of the second electrons. To protect the ring from being hit by the beam there is another ring in the front of

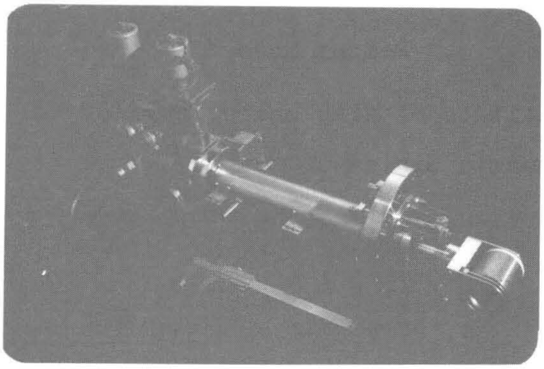


Fig.5

it which is connected to the ground. The cup is driven by compressed air and stroke is 100 mm. The pick-up beam signals from the cup are transferred to CAMAC modules via the current-voltage converter. The intensity measured is about 1 na to 10 na. The linearity is baout 1%.

5.Slit System: There are two kinds of slit: a) The slit width is fixed (Fig.6).

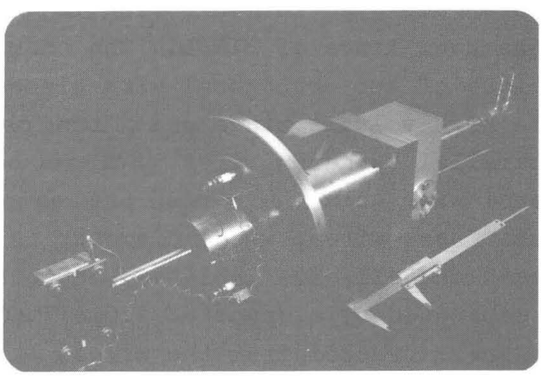


Fig.6

The adjustable limitation of the slit width is 0.05-5 mm. The range is -45 to 25 mm. It is used to measure the beam emittance,energy and energy dispersion. b)The slit width is variable (Fig.7). The variable limitation of the slit width is

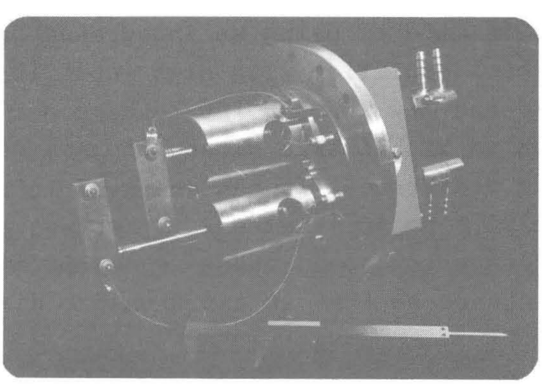


Fig.7

1-50 mmm. It is used to improve the beam emittance and energy dispersion. They are driven by stepping motor. The pick-up signals are converted to voltage by a bilogarithmic amplifier,which is located near the slit and controlled by a computer via the CAMAC modules.

6.Emittance Measurement: The beam emittance is measured with a slit system,which consists of two orthogonal fixed slit (H. and V.) and a multi-wire profile monitor for obtaining the emittance in horizontal and vertical. There are two sets of measuring devices in the beam line. They are located respectively in SFC exit and SSC entrance. The slit is 0.5 mm wide and 60mm long. The distance between the slit and themulti-wire monitor is 1.5 m,so the angular resolution is 0.7 mm mrad. The emittances in horizontal and vertical are obtained by the computer via CAMAC modules. There is another measuring device which make use of three neighbouring multi-wire profile monitors. The emittances obtained from above two kinds of method can correct each other.

4.CONTROL SYSTEM,DATA ACQUISITION AND PROCESSING

Fig.8 shows the control block diagram of the diagnostic system. The control loop is

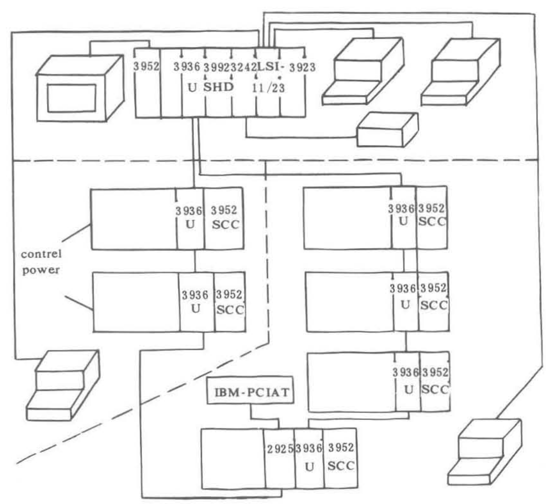


Fig.8: Control system.

a CAMAC serial highway system by using LSI-11/23 microcomputer as a control computer and CAMAC modules as the interface. There are five sets of CAMAC crates in the system,two of them are used to control the power suplies. The others are used to control the diagnostic devices. All of the CAMAC modules and measuring circuits are located near the diagnostic devices.