SEMI-AUTOMATIZATION OF EXISTING BEAM DIAGNOSTIC FACILITIES FOR BEAM-QUALITY EVALUATION

S. Dasgupta, A. Roy and C. Mallik

Variable Energy Cyclotron Centre, BARC, Calcutta 700 064, India

ABSTRACT

The available capacities of the ND-Computer based nuclear data-acquisition system has been used to gather data from stand-alone diagnostic equipments. Mixing of human intervention has generated a facility for observation of beam-properties with no extra cost, but with reasonable quickness. The set-up is expected to contribute significantly towards quality improvement of the cyclotron beam in near future.

INTRODUCTION

Our VEC machine was built in the early seventies and accordingly have rather old fashioned diagnostic aids and control systems. Operation of the current probes, the profile monitors were all effected manually and did not offer any facility for data logging. Consequently the study of beam-quality and its improvement was inefficient. Also beam-tuning and transport optimization tended to be time-consuming.

The above difficulties are necessary to be eased in future operations when heavy ion-sources like PIG and ECR will be put into operation.

The solution of installing larger variety (e.g., Emittance Measuring Device capacitive phase probes etc.) of computer compatible diagnostic equipments and a control computer for the purpose were not affordable.

It was conceived that the hardware and software resources of the existing nuclear data-acquisition system around a ND-Computer, could be judiciously mixed with manual operation of the existing diagnostic devices. This gave us a few semi-automatic computerized diagnostic facilities with all the consequent advantages, with which a beam-quality improvement program has been launched.

SET-UP

The diagnostic data logging system is implemented by utilising the CAMAC based nuclear data acquisition system [1]. The hardware of the nuclear DAS is extended by adding up asynchronous manual/stand-alone position controllers and suitable laboratory-made signal processing equipments and the software was tailored to suit the diagnostic requirements. One such hardware scheme is exemplified in fig.1.

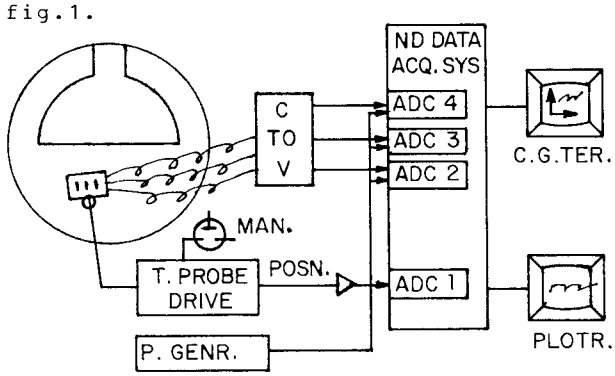

FIG.1. SET-UP FOR 3-FINGER PROBE

A laboratory pulse-generator is continually feeding the COINC. i/p's of the ADC's. The list mode data gathering is initiated through the computer simultaneously with the manual drives for the probes. The frequency of the pulse-generator is adjusted so that data-taking throughout the interesting range of the probes takes place as also sufficient resolution of position is guaranteed. On-line graphic displays provide insight into the beam-characteristics.

After carrying out a few studies in the above manner, presently the facility is being rebuilt around a personal computer for the convenience of on-demand usage in cyclotron operations.

Beam Profile

The beam-profile data and the time-marking fiducial pulses data from the wire-scanners (NEC-made BPM 6) on the transport-lines have been sampled and logged (fig.2). These data are processed to generate the shape, size and current density distribution of the particle beam to give very effective help in transport optimization [2]. This approach of freezing and monitoring those beam-characteristics is useful especially in cases of rapid positional instabilities of the beam.

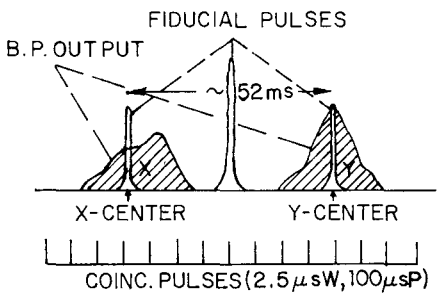

FIG.2. PROFILE SAMPLING TIMING

This has also facilitated beam-emittance measurement with reasonable speed, by the method of varying quadrupole currents.

Sampling rate of 10 KHz was selected to gather beam-profile and time-marker data, keeping allowance for worst-case conversion time of 100 microseconds. The list buffer size was chosen so as to allow about 256 samples for each of the X and Y scans over the entire scanning cross-section. Even a fine beam of 2 mm diameter allowed about 10 samples within the beam cross-sectional area.

Internal Current

Single finger probes are frequently used for quick assessment of the beam. The set-up in this case gives commendable ease in using them. Beam currents picked by various other types of internal probes were processed, digitized and logged to give quick current vs. radius plots for the cyclotron.

Three finger plots give valuable clue about beam behaviour in the vertical direction. Fig. (3) gives a typical display of such plot obtained during one of the runs with the mentioned set-up.

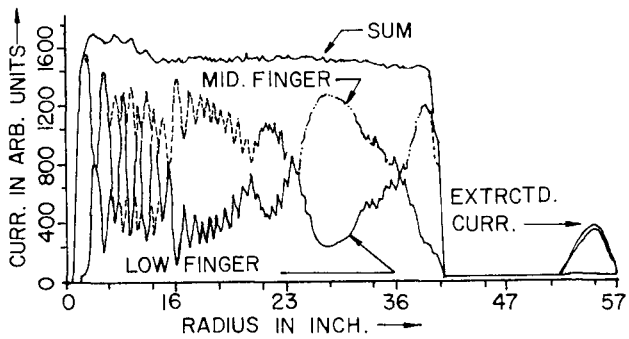

FIG.3. 3-FINGER PROBE PLOT

Similarly differential probe plots could be quickly obtained to assess radial beam-quality. Fig.(4) is a display of current on delta-R probe with the current set-up.

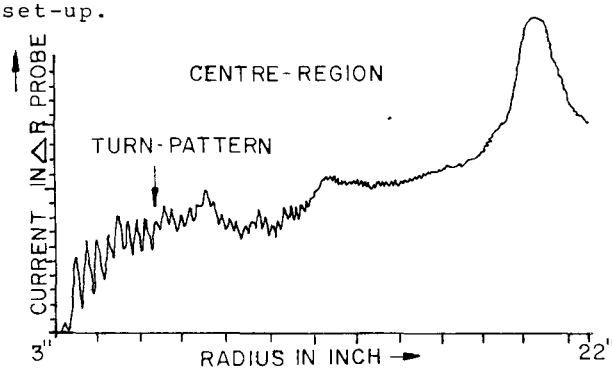

FIG.4. DIFFERENTIAL PROBE PLOT

This procedure of measurements intercepts the beam for about 2 minutes, which is although long, but tolerable when compared to the earlier set-up in which no data-logging was possible and plotting was possible with elaborate time consuming arrangements only.

CONCLUSION

The few and far between occassions when beam-time and free-time of ND-system could be combined to test the set-up, have given very encouraging results. On-line testings of the various front-end electronics units could be done only slowly.

A five-finger probe is under construction, to be hooked up to the computerization set-up, to enable better revolution in the study of vertical behaviour of beam.

An arrangement for non-destructive measurement and computer-logging of beam-phase with a special hardware technique is under development.

After the PC-based dedicated diagnostic system takes over, the facility is expected to run at regular tune-ups and

operations, to present all its advantages

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[2] S. Dasgupta et al., ibid, A276 (1989) 25