Improvement of Beam Diagnosis

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Abstract

During the operation (since 1987 to now) of BEPC (Beijing Electron Positron Collider), the beam diagnostic system is essentially satisfied the requirement of machine study. However, we also found out that there are many problem and we are facing some new requirement from machine physicist. Consider to above situation, we are trying to set a prototype of beam diagnostic system so that we can improve our system with high efficiency, low cost. This paper will describe the problem we met and present status.

I. Instruction

Recent 7 year, the beam diagnostic system have been set and operated for machine study with success. However, we found some problem. In LINAC, observation of the weak position beam wave form is difficulty under environment with strong noise inference. In Ring, according to the requirement upgrading luminosity, the bunch length measurement, BPM measurement with high accuracy are desired.

So far, the whole beam diagnostic system is not satisfied the requirement of upgrading BEPC. So we are going to develop a set of dedicated electronics modules, interface and various software etc.

II. Physical requirements

BEPC is collider machine with following major parameters:

*Energy 1.1-1.55 Gev
*Pulse width 2.5ns
*RF frequency 199.527MHZ
*Peak luminosity (2.6-7) x 10^30

Essential beam diagnostic system are consists of following monitors:

Monitor Type	LINAC	LINE	RING
Fluorescent Screen	8	20	10
Beam Current monitor	12	18	
Wall current monitor			1
Energy Analyzer	2		
BPM			32
DCCT			1
Synchrotron Light Monitor			2
Beam Loss monitor	40	20	
Q-measurement			1
Beam Stopper		2	
Scraper			2
Energy slit		3	

Due to BEPC have been designed for both purpose of high energy physics and synchrotron light application. After conference of "Workshop on BEPC Luminosity Upgrades", more high performance of beam diagnostic system is desired as follows:

a. Bunch length measurement is needed and its accuracy is required better then 0.2cm
b. The measurement accuracy of Beam Position is expected from 0.2mm to 0.02mm
c. The value of T-T shift and Q-measurement should be displayed on screen of console for various operating mode
d. Observation of Beam Phase, it's used for research of beam instability
e. To set up a bunch feedback system for keep the stable position of synchrotron light
f. LINAC:
*To increase the S/N of Positron beam signal
*Dynamic numeric display the distribution of electron and positron beam along beam line.

III. Present Problem

At first , we have analyzed the problems we met as follows:

a. Most of beam diagnostic instrumentation have been run over 7 years. Some of them are needed to replace. However the spare parts is difficult to supplement in Chinese market directly
b. Processing of Non-standard module and instrumentation have take long period time
c. Budget is limited, Most of beam instrumentation have been fixed already. It's difficulty to improving 10 times performance for some subsystem without change whole structure of subsystem such as BPM
d. The man-power of young researcher over 5 year experience are reducing.

IV. Structure of upgrading beam diagnostic system

We have investigated various control system and beam diagnostic system, compare supported environment and considered exact satiation in CHINA. A heretical architecture will be adopted for improve our system. the

block diagram of beam diagnostic system is illustrated in Fig.1.

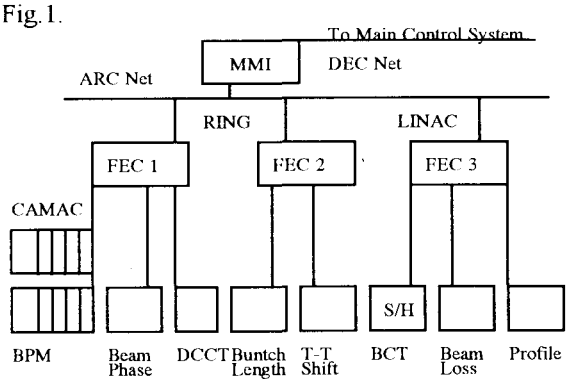


Fig. 1 Block diagram of Beam Diagnosis

A. Design philosophy

a. Selection of task priority. According to the requirement of physics, we have sorted these subjects then arranged them to complete on different stages

b. Standardized module of hardware and software
After analyzed various requirement from LINAC and RING, we adopted standard electronics module, so that we can save lot of man-power and budget.

c. Commercial products have been chosen
Recently, more powerful support becomes stronger in CHINA, so we are going to change our original policy (all design, fabrication, testing in our LAB) instead of commercial products

d. At first, set up a prototype
We try to build a prototype using commercial product as soon as possible it 's consists of standard electronics, interface, FEC, Local Net, MMI (man-machine interface) and various software of mathematical calculate for data processing.

B. Interface and electronics

The Tab. 2 show us there are many same modules are used for difference purpose of beam measurement.

	ns S/H	FastMux	Clock	DSP
BM profile			X	
BCT	X	X	X	X
BPM	X	X	X	X
Q/T-T meas.	X	X	X	X
BM loss			X	
Phase Monitor	X	X	X	X
Orbit feedback	X	X	X	X

According to above, we have developed some dedicated modules such as ns S/H which is not available on commercial . its major function as follows:

* Single width of NIM module

*Fast tracking

*2 channels of ns Sample/Hold

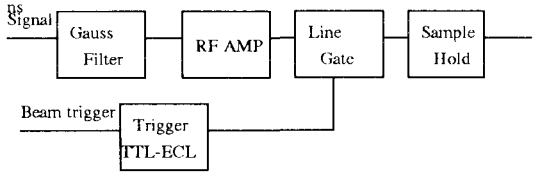


Fig.2. Block Diagram of ns Sample/Hold

Its block diagram and test result are illustrated in Fig. 2. This module can be used for dynastic distribution of beam in the LINAC and used for many purpose in the RING. DSP technique have been adopted. Nowadays, DSP technique is widely used for beam diagnosis as it has fast operating speed so that fast calculation and feedback could be possible .An example of FEC with DSP is illustrated in Fig. 3. its function has:

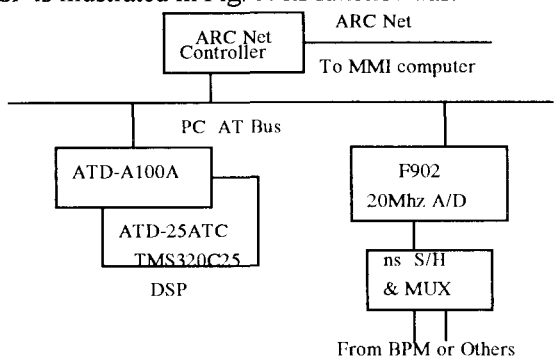


Fig.3. An example of DSP

*DSP controller TMS32025(or 30, 50)

*40 Mhz clock

*ATD-100 is a single chip reconfigurable subsystem suitable for many imaging and signal processing system its operating speed is 320MOPS.

*Support various mathematics calculation such as FFT,DFT,IIR,FIR etc.

C. Selection of FEC and local network

We compare many I/O conditioning such as CAMAC, VME, Multibus, STD and PC ATbus, there are many advantages and disadvantages individually. At last, PC AT bus is selected depended on the following reason:

*Low cost compare other bus standard.

*The fast processing can be separated by DSP linked with PC AT bus.

*Developing tools can easily got from many source on market

*Multitask operation system on the FEC can select many types such as RMX for Window, AMX, VRTX operation system of Readsystem Inc. are adopted as multitask management. VRTX is widely use for various industry environment with high reliability. Also it can easily link with Intel's chips 8086/80186/80386 and Motorola's 6800/20/30/40.

*More powerful hardware and software can be supported from market.

D. MMI(man-machine interface)

In order to provide friend interface between operator, physicist and machine, we have chosen IN-Touch (MMI)as interactive software. It has more advantages:

*Easiest to set up

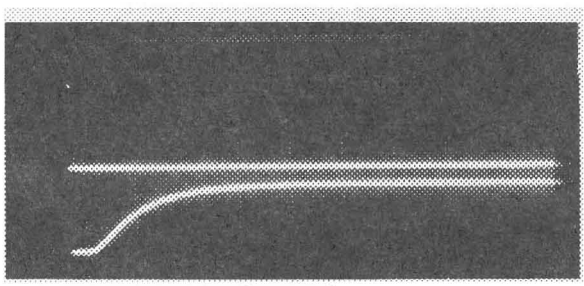
*Wonderware IN-Touch's object-oriented graphics offer total flexibility and virtually unlimited creative freedom to quickly produce even the most complex application.

*Utilizing Wonderware's Net DDE, it can share data with application in other operation environments. When using DDE, it can share data with ,windows application.

V. Present Status

A prototype is being set.

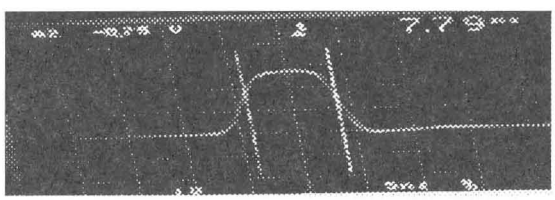
*The ns Sample/Hold modules have been tested with success.



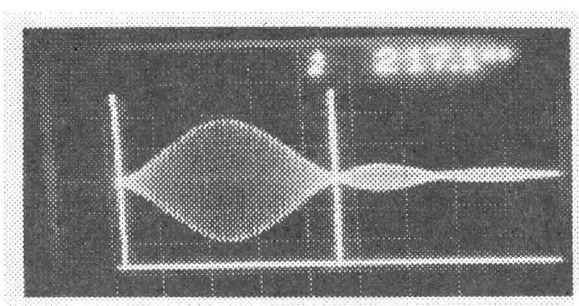
Upper: 7ns pulse from pulse generator
Down; outport of smple/hold

*In-touch(MMI)software is run now

*DSP workstation and its developed environment is being set up



7ns pulse from pulse generator



The outport of SAW pulse width is extended to 217ns

*Measurement of beam spectrum of LINAC shown Fig. 4

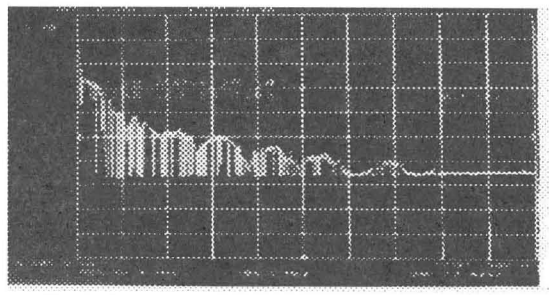


Fig.4-1 The beam spectrum of LINAC tested by HP 8568B

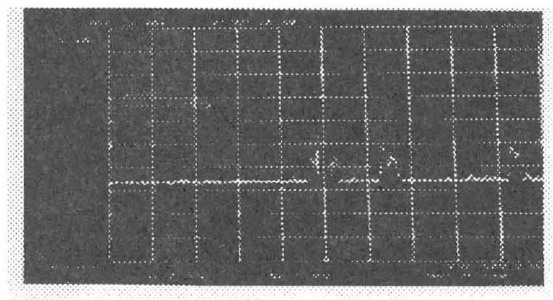


Fig.4.-2 The high frequency component passed throw SAW with better S/N

*SAW (surface acoustic wave)are tested as filter

*New beam diagnostic system are being developed

VI. Conclusion

A new prototype of beam diagnostic system is necessary for improve our system , We expect that there are more resource of hardware and software can be shared each LAB on the world.

Acknowledgment

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Reference

[1] Peter Clout, "Sharing Control System Software", in Proceeding go 1993 Particle Accelerator Conference Vol. 3 of 6 pp 1801 to 1813.

[2]M.E.Thuot, "control system architecture: The stand and Non-standard modules in proceeding of 1993 Particle

Accelerator conference Vol. 3 of 6 PP 1850 to 1810

[3]K.T.Hso 'Diagnostic Instrumentation System for SRRC 1.3 Gev Synchrotron Radiation Light Source