

# THE DATA-TAKING AND DISPLAY SYSTEM BY VXI FOR OBSERVING A CIRCULATING BEAM PROFILE WITHOUT ANY DISTURBANCE

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## Abstract

The non-destructive beam profile monitor (NDPM) in KEK-PS uses the phenomenon that a circulating beam in a synchrotron collides with residual molecules in the vacuum ring while producing positive ion and electron pairs. These positive ions are led to a Micro-Channel Plate (MCP) and amplified to multi-collectors as an electric signal. The PS-booster ring has one horizontal (H) and one vertical (V) monitor; the main ring has two Hs (at small and large dispersion position) and one V. The VME computer system was adopted for data-taking and to display the beam profile; however, the program is too complicated and the data-transfer time from the local to the central computers is too long. In order to improve these weak points, we changed to the VXI system and use the Labview software. This system can show a mountain view of beam profiles, and the time variation of the beam center, size, momentum spread and emittance by a very simple program and with a short transfer time.

## 1 MEASURING SYSTEM

### 1.1 Mechanical and Electric system<sup>1</sup>

The mechanical plan of the NDPM is illustrated in Fig.1. Circulating proton beams hit the residual gas in the vacuum chamber and produce ion-electron pairs. The ions are led perpendicular to the beam direction by an ion collecting electric field, and reach the surface of the MCP in which electrons are amplified in proportion to the number of ions; 32 anodes are set on the output surface of the MCP. Every anode is connected to a low-pass filter (LPF), a pre amplifier (AMP), a voltage frequency converter (V/F), a F/V, a main amp. and memories (see Fig.2). After rearranging the signals from 32 anodes by the computer, mountain views of the beam profiles, time dependence of the beam size, beam center, momentum spread and emittance are displayed. In this system, the calibration of the gain of 32 channels is most important, which is done perfectly by the special method described in the Footnote 1.

### 1.2 VME computer system (conventional system)

The VME computer system comprises local computers and a central ones. The former computers

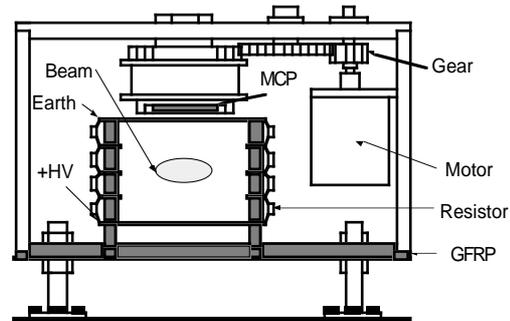


Figure: 1 Plan of NDPM using MCP

provide successive operations for data taking and keeps data from the A/D converter. After transferring the data from the local computer to the central one, they are calculated and rearranged so as to display the various results described in sub-section 1.1. This procedure takes about two minutes.

### 1.3 VXI computer system (improved system)

In order to decrease the procedure time, a new computer system comprising the VXI (Windows NT) and workstation (UNIX) has been adopted. The signals of 32 anodes of the MCP arrived at two A/D converters (VX4244) in VXI, one of which can take signals of 16 channels simultaneously with a resolution of 16 bits. Every channel has a minimum sampling speed of  $5\mu\text{s}$  and a memory of 64K words. It starts by an external trigger; A/D converts with the setting sample speed and keeps the data in the memories (see Fig.2). In order to increase the S/N ratio, we take an averaged value with time. For example, in the case of averaging every five neighboring time steps (minimum step is  $5\mu\text{s}$ ), the maximum and minimum values are rejected, and another three data are averaged, as shown in Fig.3. In this case, therefore, the minimum time unit is five times  $5\mu\text{s}$  ( $=25\mu\text{s}$ ). Since VXI has more memory of the A/D converter than VME, the time resolution is improved by more than 5 times. Calculating and data-transfer speed is faster by 5 and 100 times, respectively.

For calculating the data and displaying the measuring results, computer-aided measurement software, called "Labview", is used, by which we can make calculating and display programs in a much shorter time than in the old system. We can also change display parameters, such as the time scale, very easily while observing the output of the measuring results.

<sup>1</sup> T. Kawakubo et. al., N.I.M., A302 (1991) p397

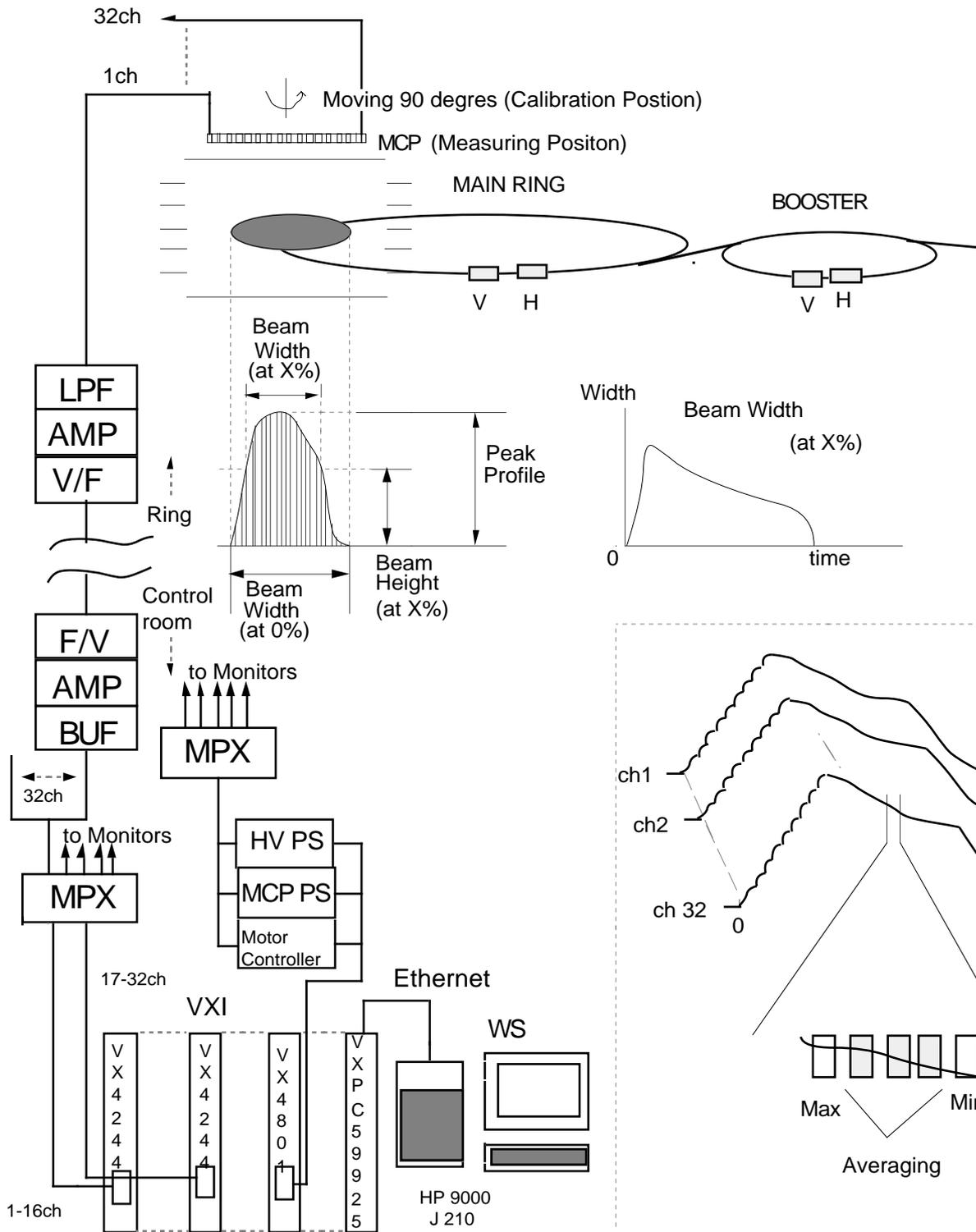


Figure: 2 NDPM measuring system using VXI

Figure: 3 Time-averaging method for data from the A/D converter

## 2 MEASURED RESULTS

The following results were taken by the NDPMs for the horizontal plane in the main ring, which are set in a straight section, called I-3F (with small dispersion)

and IV-5F (with large dispersion function). Figs.4 and 5 show a mountain view of the beam profile and the time variation of the beam center at I-3F, respectively. Figs.6 and 7 are the time variation of the half beam width at 20% height from the bottom to the top of the beam profile at

I-3F and IV-5F, respectively. Calculating from these beam sizes, the time variation of the horizontal beam emittance and the momentum spread in the main ring are obtained as Figs.8 and 9, respectively<sup>2</sup>. In the VME

system, all figures were displayed by pushing touch buttons one by one. In the VXI system, on the contrary, all figures are displayed on the same screen and at the same time. It takes about one minute from the beginning of the measurement to the display.

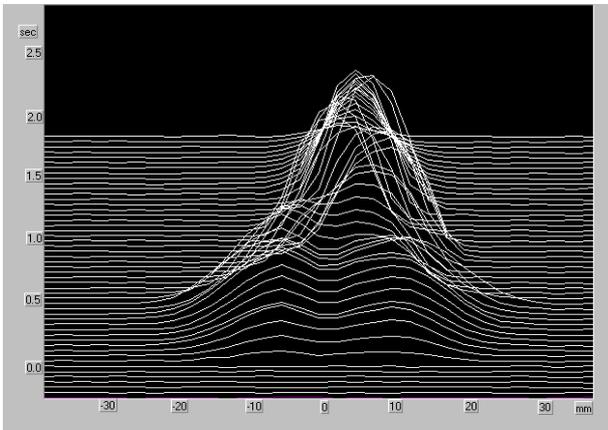


Figure: 4 Mountain view of the horizontal beam profile at I-3F of the main ring.

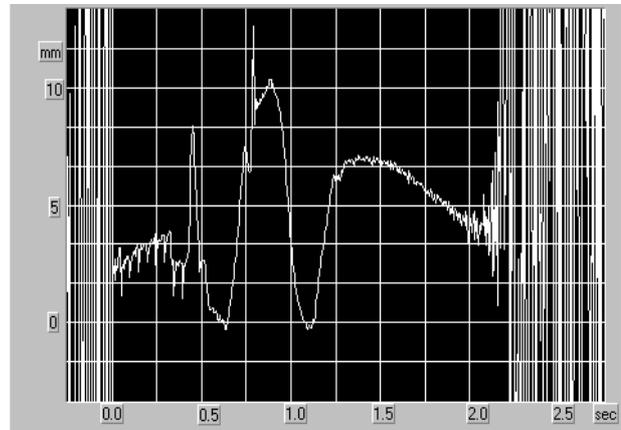


Figure: 5 Time variation of the horizontal beam center at I-3F of the main ring.

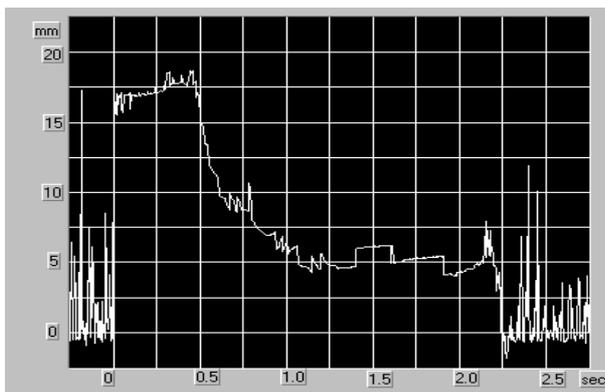


Figure: 6 Time variation of the horizontal half beam width at 20% height at I-3F of the main ring.

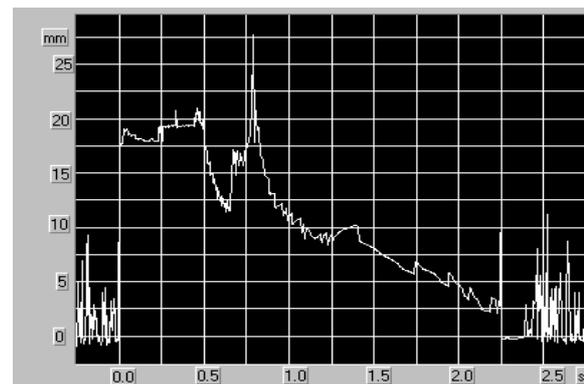


Figure: 7 Time variation of the horizontal half beam width at 20% height at IV-5F of the main ring.

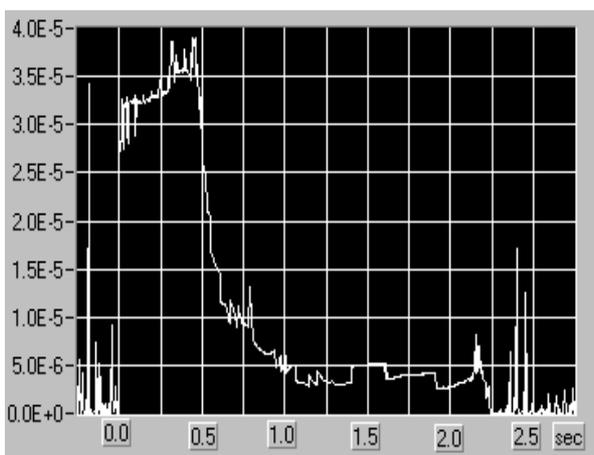


Figure: 8 Time variation of the horizontal beam emittance of the main ring.

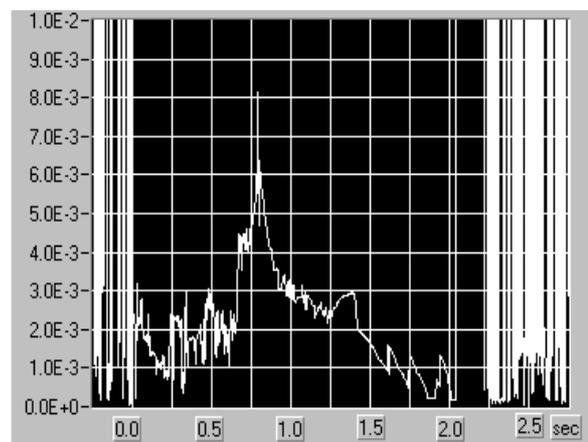


Figure: 9 Time variation of the momentum spread in the main ring.

<sup>2</sup> T. Kawakubo et. al., ICALEPCS'91, KEK (1991) p399