Data Acquisition System for Studying Beam Scrapping in the IHEP U-70 Mashine

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In the framework of IHEP-SNS (BNL) collaboration Data Acquisition System for studying beam scrapping in the IHEP U-70 accelerator has been designed, installed and tested during the spring run in April 2000. The system measures distribution of beam losses near the scraper and beam density on a jaw of the scraper and provides data of scattering target position, bumps currents, beam intensity, etc. This presentation gives description of all main components of the system, software and reports the first results of comissioning.

INTRODUCTION

The design of the Spallation Neutron Sourse (SNS) accumulator ring [1]is severely constrained by beam loss budget considerations. It is then mandatory to have an accurate prediction of the collimation systems efficiency and uncontrolled loss distribution at low energy (1GeV). Significant effort is being invested in benchmarking of the codes for collimation at SNS. Applicable experiments are performing in the AGS Booster at BNL and in the U-70 Machine at IHEP [2]. These proton machines operate at low energies, similar to the SNS baseline of 1GeV. As for U-70, 1.3Gev injection flat-top is used. Immediately after injection, half a second is available for experiments at 1.3 GeV energy. The collimation measurements are performed in parasitic mode taking only a fraction of the injected beam for a small number of cycles from physics operation. The first results were obtained during the last spring run. Data Acquisition System (DAS), serving these experiments, is presented below.

EXPERIMENTAL SETUP

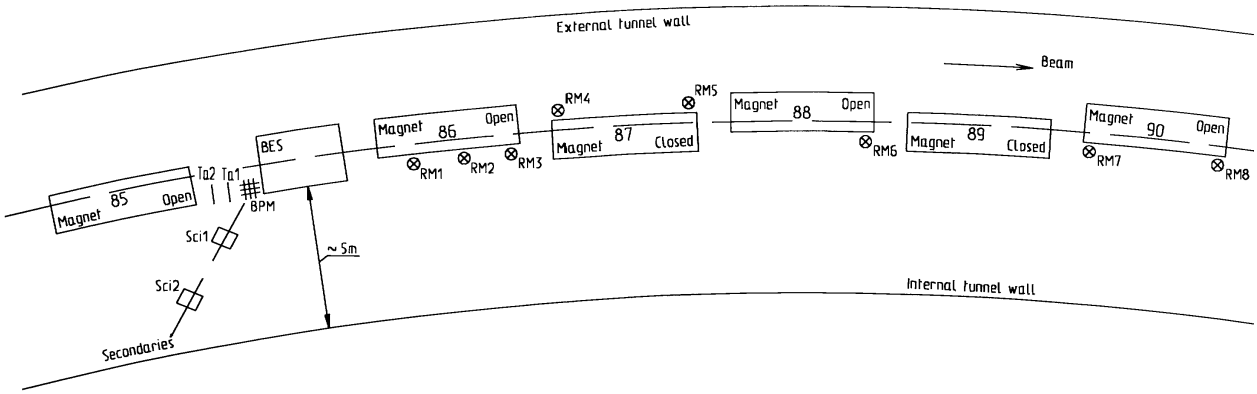
The main components of the experimental setup are:

- A two meters collimator block nicknamed Beam Emittance Shaper (BES),l ocated in straight section 86.
- Thin C and Si targets, mounted downstream of the BES and positioned remotely.
- A local bump created by magnets 76-88 and 79-91.
- Eight beam loss monitors, located along the next super period following the BES.
- A bi-plane stationary Beam Profile Monitor (BPM), installed upstream of the collimator jaw.
- Two movable fast beam loss detectors based on scintillator counters.

The procedure of experimental study of beam collimation is given in [2]. The circulating beam is moved to the edge of the collimator at different velocities by means of bump programming. BPM measures the impact parameters in both planes. Radiation monitors measure the secondary particle flux from the collimator.Fig.1 represents the lay-out of the beam detectors mentioned above.

Eight small air-filled ion chambers as radiation monitors (RM) [3] are located inside or outside the ring depending on the corresponding bending magnet polarity. For the sake of homogenity the RM`s are one meter away from the beam pipe. Bi-plane (24H + 32V) BPM has been made from stainless steel thin wall tubes, 1.25 mm apart [4]. Both electrode arrays are separated from each other with Cu collector foil at +250 V potential w.r.t. the tubes. Such performance of the BPM causes high radiation and heat resistance. Two scintillators with high

output capability PMT`s are installed in front of the BES to avoid counting of background signals and secondary particle flux caused by losses in magnet bodies. To reduce noise scintillator assemblies are oriented vertically. It is foreseen both counting and integrating modes will be used. For the first case scintillator detectors will be configured as a telescope focusing the BES and the beam will be unbunched.



BPM - Beam profile monitor, biplane, 24 channels per plane, step 1,25 mm.
RM - Loss monitor, air-filled ionization chamber.
Sci1, Sci2 - Two scintillator counters.
Ta1, Ta2 - Positioned targets.

Fig. 1: *BES beam monitors layout.*

Signal processing is based on two-level electronics. Currents from the BPM (56 channels) and eight signals from RM`s are fed to the Front End Electronics (FEE) packaged in two home made mini-crates. The crates are located in the accelerator basement, where the radiation field is not too high. Each crate contains 12 modules: eight 8-channel charge integrators with S&H circuit, 32-channel multiplexer and some auxiliary circuitry. Sensitivity of the integrators is selected in two ranges. Note that sensitivity of the RM integrators is an order of magnitude lower w.r.t. the BPM ones. Outputs of integrators proportional to the integral of the input current present during the gate interval are fixed when the gate is off. Then holded levels are time multiplexed by TTL inputs containing the binary channel number and via long coaxial cable fed to the Back End Electronics (BEE) situated in Main Control Room. Each multiplexer has an output current buffer with cable driving capability, that is why high noise immunity is ensured. One crate processes the signals from the horizontal BPM (24 channels) and the RM`s. Another one is used only for the vertical BPM. The signals from the scintillators monitors are directly fed via coaxial cables to the BEE.

The BEE crate is made in SUMMA style (IHEP version of CAMAC) and contains 8-input ADC, Scanner unit serving the FEE, 2-channel Current-to-Frequency Converter (CFC) [5],followed by 8-channel 16-bit counter to perform digital integration of PMT`s currents when integrating mode of the scintillator detectors is used, some modules for counting mode. A number of another analog signals (machine intensity, bump currents, target positions) are digitized as well by ADC mentioned above.

Fig.2 gives full schematic of DAS, serving experimental study of beam collimation.

Software is created as a Graphic User Interface (GUI) and has two levels. The lower level is based on assembler, the program is kept in μP-unit. The second level has been written on Visual Basic and installed in the PC. CNAF codes are transferred to μP-unit, the last one controls the BEE. Software operates in real time. A GUI plots and stores the measured data for measurement control and posterior analysis. Fig.3 represents the data acquired per one successful experiment.

First results received during the spring run in April 2000 encourage upgrading experiments. The given system will be adapted for a wide range of conditions. In particular 120 beam loss monitors distributed along the ring [3] will be integrated temporarily in the DAS to be read at the same time as experiments are performed.

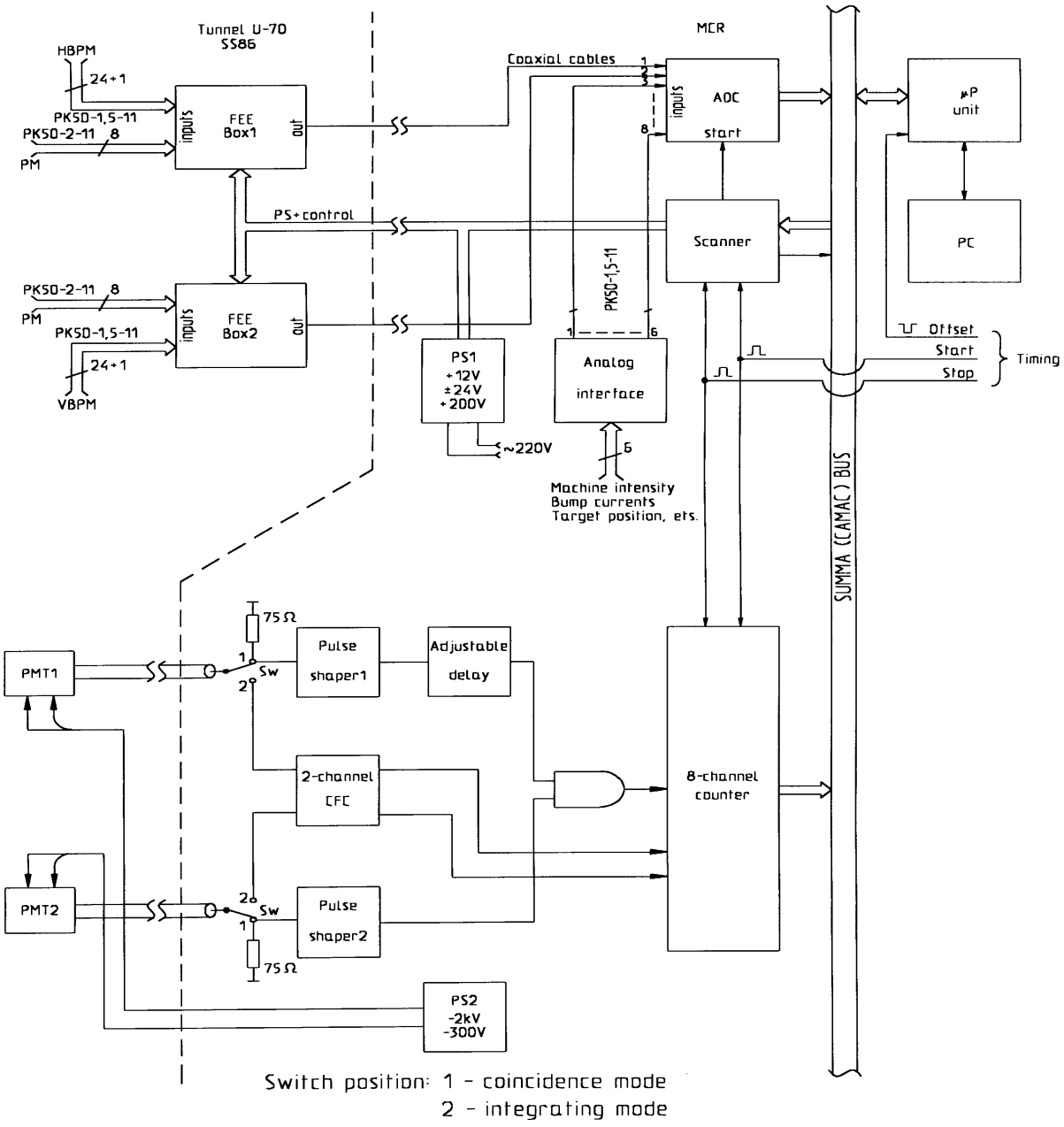


Fig. 2: *Schematic of the Beam Instrumentation for the BES experiment.*

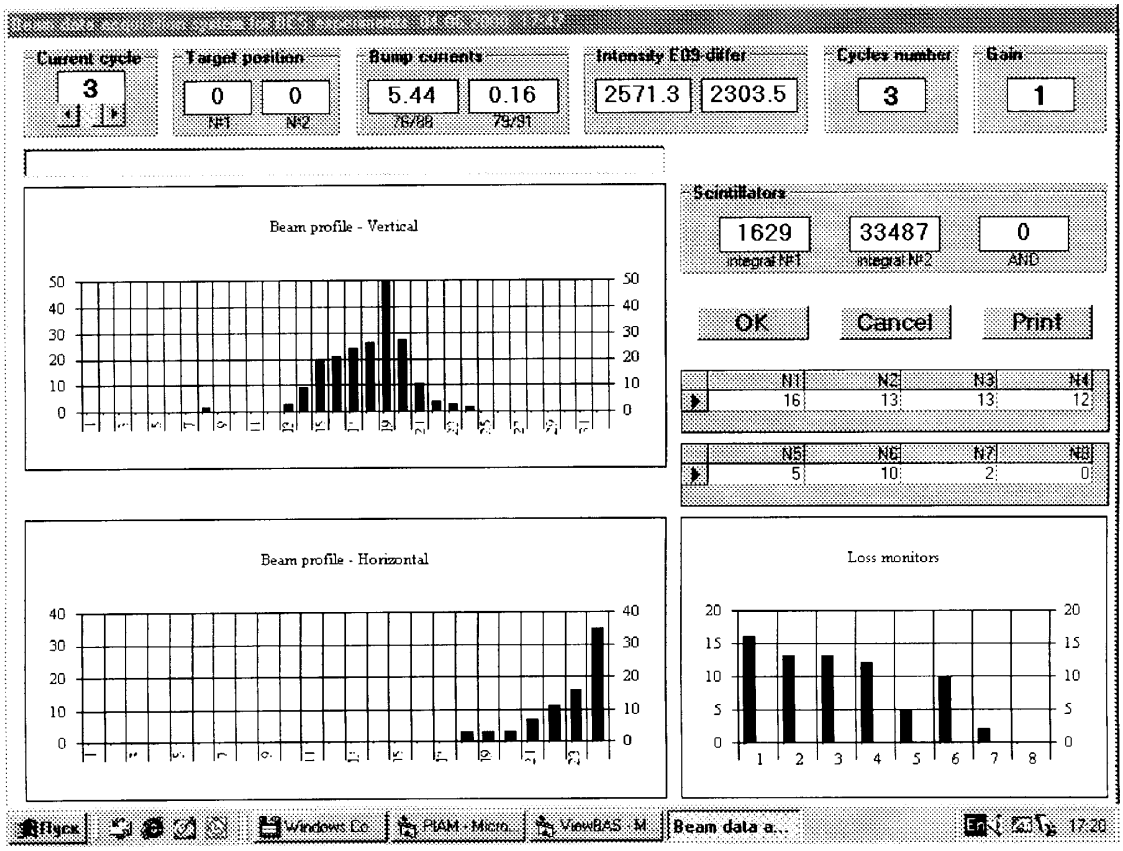


Fig. 3: *Onlin e data display.*

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