AUTOMATED BEAM LOSS MONITORING SYSTEM AT EXTRACTION
FROM U-70

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Abstract
This paper presents a description of the new beam loss monitoring system built and commissioned to detect beam losses in the IHEP extraction area at 16 places of interest. It yields information about possible beam interception by extraction elements over each mode of extracting. Multiple measurements with resolution 10ms are possible to study the dynamic processes over the slow extraction. This system is a part of the U-70 Control System.

INTRODUCTION
Last time total beam intensity at an extraction from Accelerator U-70 was substantially increased, up to $1.2 \times 10^{13}$ ppp at slow extraction (SE), at fast extraction (FE) this amount is higher as a rule. Each extraction is accompanied with growth of beam losses. That’s why optimization of parameters of the extraction equipment is stressed necessary when operated to reduce the irradiation of an accelerator equipment and build up use intensity. For that matter some beam parameters are measured, such as beam position, beam profiles, beam intensity. Measuring beam losses all over the Extraction Area is very fruitful tool as well, and in addition to the System for Continuous Measuring Beam Loss Monitoring (CMBL) over the ring [1] presents an additional flexibility for the extraction optimization because of an adaptation a separate system to measure beam losses covering the Extraction Area. This Extracted Beam Loss Monitoring (EBLM) system allows us to solve a number of problems, namely:

- Beam losses monitoring at places of specific interest only for extractions;
- Capability to distinguish losses caused by different extraction modes;
- To reach the time resolution of measures not worse than 10 ms;
- Opportunity of monitoring beam losses in analog mode;
- Opportunity to run under U-70 Control System [2].

EBLM system was put in operation in the spring of 2003. The brief description of this system is given below.

SYSTEM DESIGN AND OPERATION

Monitors
The presented system has been built similar to the CMBL, but has some novelties and features. So, new ionization monitors, air-filled at local barometric pressure, have been composed from a number of planar cylindrical plates. These monitors have increased sensitivity (300 nC/rad) due to enlarged volume of $1 \text{ dm}^3$. The monitors have been mounted on the pole-face windings of the downstream septa. Such a high sensitivity of the monitors allows us to investigate dynamic phenomena at low extracted beam intensity.

Schematic
A simplified block diagram of the EBLM is presented in Fig.1. The monitors collect charges proportional to the radiation losses. Current signals from the monitors are fed via individual long coaxial cables directly to the special Back End Electronics placed in the Extraction Control Room. As distinct from the CMBL a conversion current to frequency is done here for two stages. Input currents in individual channels are converted to proportional voltages and then a conversion voltage-to-frequency is produced finally, so full conversion is carried out as $(I \rightarrow V \rightarrow f)$. Such approach facilitates observing analog signals and presents opportunity to use commercial synchronous voltage-to-frequency converters similar to AD652 or so. The penalty to pay for this is decreasing dynamic range up to 60 dB. To prevent saturation at the conversion $I \rightarrow V$ at FE, input extending RC-chains are in use with time constant of 20 ms. The chains are off when SE executed, surely. All electronic channels have buffers with gain 1 or 10 to change the sensitivity of the system. In addition, the buffers allow us to split signals for analog observing. Built-in test generators perform testing system. Output pulses from converters are directly fed to inputs of 16 channels 16 bit gated counters. IN/OUT Register produces all control signals and reads all the status information. The BEE is placed in two crates. The analog electronics is done in NIM fashion, digital one is designed as Eurocard cassettes and are placed in Euromechanics crate with a MULTIBUS-1 compatible backplane bus.

Variable parameters of the EBLM are a gate width, a number of measures over the spill, amount of gain and clock for $V \rightarrow F$ converters. Software of the system is a part of U-70 Control System [2] and is not considered here. Acquired data are displayed as tables, histograms, etc. Figures 2 and 3 present examples of done measurements. Fig.2 gives an evolution of losses over a resonant SE (measures are separated by intervals of 100 ms) and the extraction performed by using a bent crystal. Fig.3 presents the integral losses at points of interest. Displayed data...
illustrate the profit of using EBLM for the best tuning Extraction System.

Fig.1: A simplified block diagram of the EBLM

Fig.2: Distribution of losses over SE spill

Fig.3: Distribution of beam losses all over the Extraction Area

REFERENCES
