DAFNE BEAM LOSS MONITOR SYSTEM

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Abstract

At the DAFNE collider a beam loss monitor system has been installed to continuously monitor the particle losses. The acquisition is based on 32 Bergoz beam loss monitors, of the Wittenburg type, installed close to the main rings vacuum chamber, buffer and monitoring circuitry and a scaler (SIS 3801) as acquisition board. We developed a front-end software that allows acquiring the integrated value of the BLM counts and a stream of 1000 point for each monitor, to cover a history of 3000 s. The operator program allows displaying the instantaneous BLM values over the machine together with a representation of the past history.

1 INTRODUCTION

DAFNE [1] is an electron/positron collider, composed by two rings and with two interaction regions. More than 1 A has been stored in collision. With beams at high current any beam loss along the machine pipe becomes a source of high background. To understand if we have anomalous beam losses we installed a beam loss monitor system on the machine pipe. The small size of the accelerator allows us to try a first installation with a low monitor number. A requirement to the installation is to allow upgrading the system in the future without any change in the software environment.

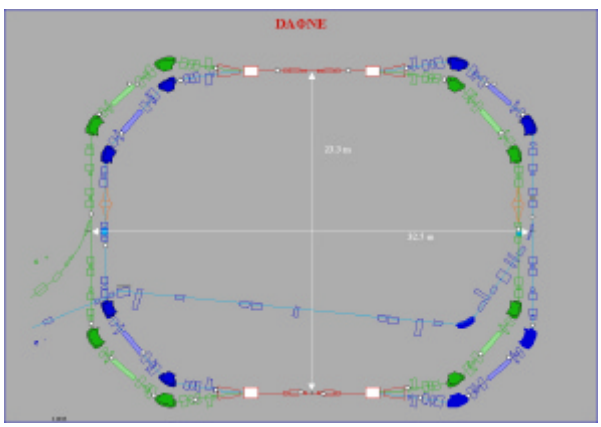

Fig.1 Dafne BLMs positions

We installed 31 monitors in total: 13 on the electron ring, 14 on the positron and 4 near the interaction region. The position has been chosen downstream already existing beam scrapers on the machine. Other monitors are placed at the point where the pipe is narrow near the splitter. Some other are near the dipoles and the wiggler. The BLMs are placed in equivalent positions in both rings. There are some monitors near the two experiments as well.

2 HARDWARE

The high density of elements installed on the DAFNE accelerator requires a compact beam loss monitor; moreover the monitor must be easy to install on the vacuum pipe. We chose the Beam Loss Monitor by Bergoz [3] for his compact size (33.5 x 68.5 mm^2) and performances, a VME counter/scaler by Struck SIS 3801 [5] as acquisition board with an in house developed fan out. The acquisition board and the fan out are put inside a VME control system crate.

Fig 2 illustrates BLM operation. The BLM produces voltage pulses when the active area of a PIN photo-diode is struck by minimum ionizing particles (MIP), usually created by high energy particles striking residual gas molecules or a beam pipe obstruction. Presumably a MIP produces current flow in both detectors while a photon does not.

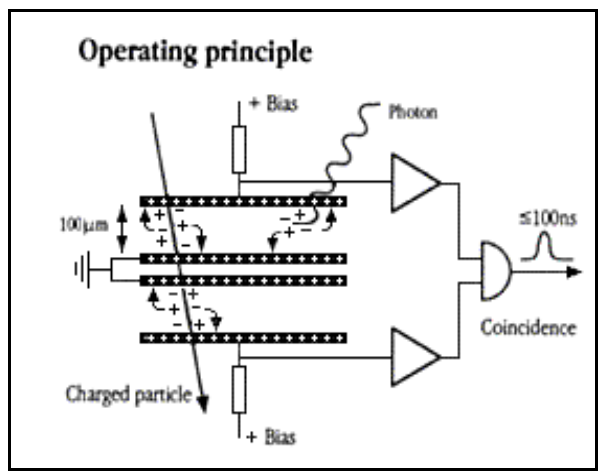

Fig 2 Operating principle (courtesy of Bergoz)

The acquisition board (SIS 3801) is a 100 MHz 32-channel scaler/counter. To synchronize the acquisition we use the 25 MHz internal clock which can be read on the first channel of the board. To the other 31 channels we connect the BLMs. A fan out board has been developed to interface the monitor with the acquisition board.

The beam loss monitor fan out is a VME module designed by the DAFNE electronics laboratory with the aim to interface mechanically and electrically the commercial parts and simplifies the test of the system. The fan out module is made of terminals to interface 32 Bergoz input sensors, 32 channel TTL buffers, 2 channel outputs with BNC connectors for diagnostics purpose, two manual knobs to select the channels to be monitored, and terminals to connect easily the SIS3800 counter. The diagnostics interface allows checking each input channel

using an oscilloscope, looking at the pulses in time domain and correlates these data with the counter outputs.

3 SOFTWARE

The DAFNE control system [2] is based on distributed CPUs with a memory resident database to exchange information with the consoles in the accelerator control room. The DAFNE control system allows separating the acquisition program from the human interface on the control room console. The acquisition program runs on the CPU that has in charge the beam loss monitor while the display program runs on one of the consoles.

The exchange of data between the front-end and the console is based on a real time database. The descriptive record in the real time database contains all the information needed to manage the acquisition board and to exchange data with the consoles (fig 3). The real time record is divided in two parts. The static record contains all the information needed to manage the VME board, the SIS381 board address, the beam loss monitor name and the address of the history storage area. The dynamic record contains all variables acquired by the VME board. In detail, the record contains the counting data in two different formats, the total counts and the counts per second.

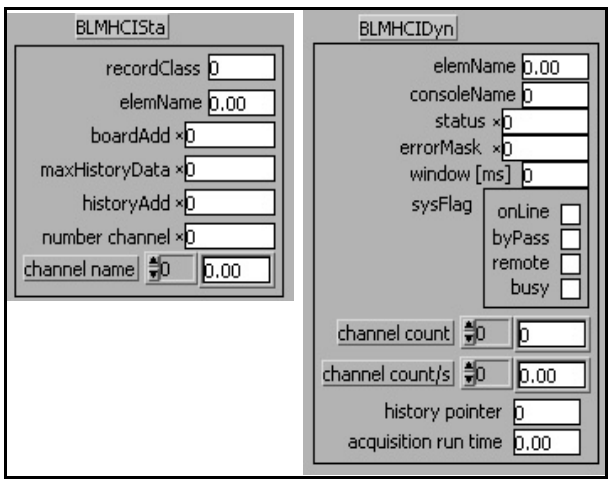

Fig 3 Real Time Data Base records

The acquisition program continuously runs on the beam loss monitor acquisition CPU.

The program is integrated in the standard control system acquisition program. When the clock register reaches the integration time the program puts the data in the real time database and in the history memory.

The history memory is 1000 points deep for each channel. In the default case the time window for each point is 3 seconds that gives us 3000 seconds of acquired memory. The history memory is a circular memory that is continuously written. The dynamic record contains all information about the current position of the last written data.

The console level program allows the display of the data in different ways to give better understanding of the behavior of the particle losses. The program displays in real time all BLMs divided in the positron and electron area. In each part we can display the instantaneous data, the intensity chart of 200 points and with a cursor we can read a single BLM value and his position on the schematic machine layout. We can also display cumulative data such as the sum of all BLMs and the ratio between the counts and the beam current. We can also take a reference data and display the ratio between these data and the acquired ones.

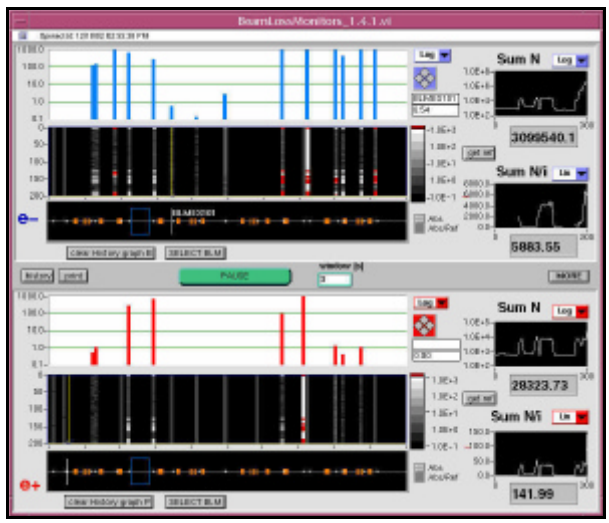

Fig 4 Console display

The console program allows selecting the beam loss monitor to display on the window. With this program the history data can also be displayed, showing the evolution of each monitor in the last 3000 s (fig 5).

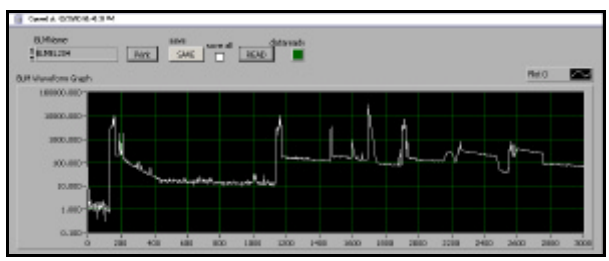

Fig 5 History Display

This tool allows us also to save the history data in tab-formatted file for an offline analysis .

4 CONCLUSIONS AND FUTURE DEVELOPMENTS

The BLM monitoring system demonstrated its potentiality to understand the sources of background. From the data analysis there isn't any evidence of beam scraping the vacuum pipe. We started a study to use the beam loss monitor as a general tool to setup other system

installed in the machine. The scraper setup can be optimized by monitoring the beam losses as a function of the scraper position.

The system can be easily upgraded to increase its performance just adding monitors and acquisition boards.

We will start with a systematic measurement in different operating conditions of the accelerator to possibly find a cleaner use of the machine. To make this measurement easier we beam loss monitors are included on the automatic data logging system of the DAFNE control system [6]

5 ACKNOWLEDGEMENTS

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