A.6: Development of pulsed magnetic field measurement system

A pulsed magnetic field measurement system is crucial to characterize the field quality (dB/B~10^{-3}) of pulsed magnets such as septum, kicker and pinger magnets. A computer based high speed and high resolution pulsed magnetic measurement data acquisition system was developed using 14-bit PCIe digitizer card and LabVIEW environment.

Search coil (of area A) made of copper wire, wound over a non-magnetic insulating and rigid material (Macor) is used for pulsed magnetic field measurement. It can be moved in x, y and z direction with less than 1 mm resolution. When the coil is placed inside the aperture of pulsed magnet, a voltage (V_0) is induced in the coil due to the time varying (pulsed) magnetic field (B). The induced voltage is given by $V_0 = -\frac{d\varnothing}{dt} = -\frac{d(B.A)}{dt}$. Since the search coil is firmly fixed, A is constant. Therefore, $B = -\frac{1}{A}\int V_0 dt$.

Signal from search coil is fed to one of the analog inputs of spectrum make M3i.4142 PCIe digitizer card having 2 analog input, 2 digital input, 14-bit resolution at 400 MS/s sampling rate and 200 MHz bandwidth. Each of the input channel has its own analog to digital converter and programmable input amplifier, which allows to record signals simultaneously on both channel with 14-bit resolution, without any phase delay. The 512 Mbyte on-board memory allows long time recording at highest sampling rate (200 MS/s when both channels are on). The FIFO mode activation on the card provides acquisition of data continuously for online display, processing, calculation and storage.

To reduce systematic errors (offset and drift), the integration of induced voltage is obtained by numerical integration technique (trapezoidal rule) program developed in LabVIEW. Real time current pulse signal (the topmost trace) and its time-integrated signal (second from top) are displayed on front panel is shown in Figure A.6.1. The integrator is calibrated using a standard volt-second signal applied at analog input.

The developed DAQ system has provision to choose analog input sensitivity, sampling rate, time period and trigger etc. using the GUI as shown in Figure A.6.1. The acquired signal is further integrated numerically to calculate the magnetic flux density at peak or at any position specified by the user. The acquired data as well as its time-integrated form is displayed on screen as a graph as shown in Figure A.6.1. Some salient points (peak value and cursor values) on the graph can also be saved on excel files as shown in Figure A.6.2.

Using the developed system, magnetic field measurement and analysis has been carried out using this system for horizontal and vertical pinger magnets, new kicker magnets and septum magnets.

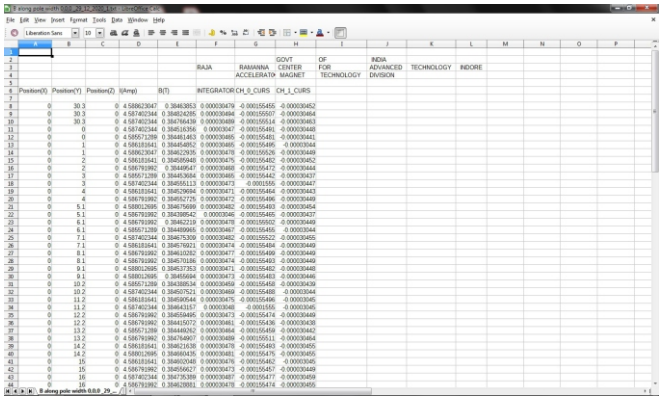

Fig. A.6.2: Measurement data of new kicker magnet in excel format.

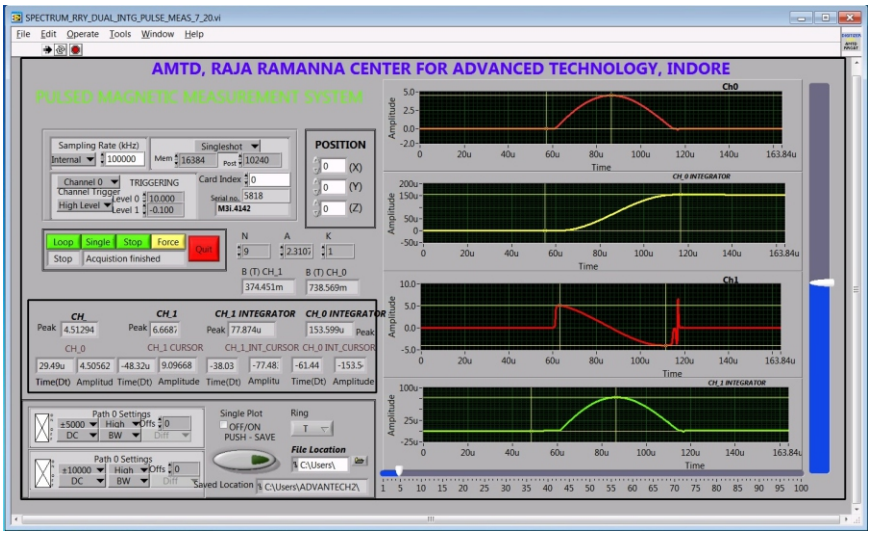

Fig. A.6.1: Graphical user interface of the developed system for real time control and display.

Reported by:
Ram Raj Yadav (rryadav@rrcat.gov.in)