E.6: Development of an indigenous VME32 DAQ card for Fast Current Transformer interface

An indigenous, VME32-compliant DAQ card has been developed for pulse-by-pulse beam parameter measurement using FCT sensors for LINACs operating at a 300 Hz pulse repetition rate. This system is designed to capture e-beam data and extract parameters such as pulse width, height, and charge. The measured charge is utilized for beam power calculations, which are essential for dose calculation. To ensure reliable measurement, the board incorporates an automated in-application calibration mechanism that simulates e-beam behaviour using a dedicated calibration source.

Figure E.6.1 and E.6.2 shows the hardware and implementation scheme. The developed hardware is a VME32-compliant DAQ board designed for pulse-by-pulse beam parameter measurement using FCT sensors. The card is equipped with two signal processing chains, allowing it to interface with two FCT sensors simultaneously. Upon detecting a valid trigger, the board captures a beam pulse window and utilizes a 16-bit ADC to sample the signals at 125 MSPS. By performing a charge comparison between the two channels, the system can detect beam loss events and generate critical control signals to protect the machine hardware. The extracted pulse charge is further utilized for beam power and dose calculations. To maintain measurement integrity, the board integrates an FPGA and a MicroBlaze softcore processor to automate an in-application calibration process using a dedicated current source.

Fig. E.6.1: In-house developed VME32 FCT card

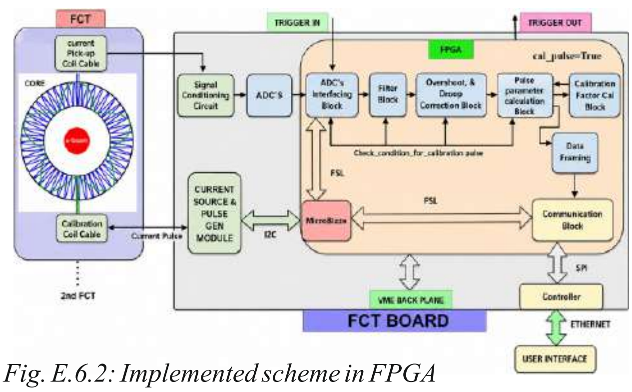

Fig. E.6.2: Implemented scheme in FPGA

Figure E.6.3 shows the measured electron beam pulse during field testing confirms that the system successfully removes high-frequency noise and restores the FCT pulse. The system software extracts/ calculated critical parameters, including pulse width and charge, on a pulse-by-pulse basis at a 300 Hz repetition rate.

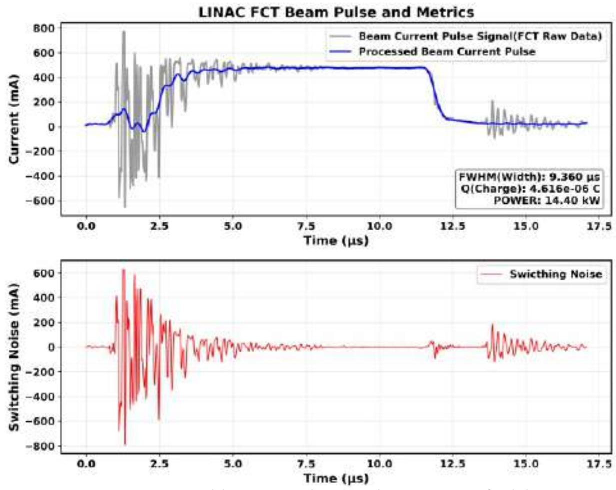

Fig. E.6.3: Measured beam pulse and metric in field

Figure E.6.4 shows a 10 ms communication snapshot of the data framing used to support the 300 Hz pulse repetition rate (PRR) within the limited bandwidth of the SPI bridge. To achieve this, a compression algorithm based on a band-pass filtering technique was implemented to group processed data into batches of three pulses per channel. These batches are subsequently framed into a unified data structure over a 400 ms scan cycle. Each frame includes these compressed pulse parameters—such as pulse width and charge—alongside a complete raw signal trace of the first pulse for verification.

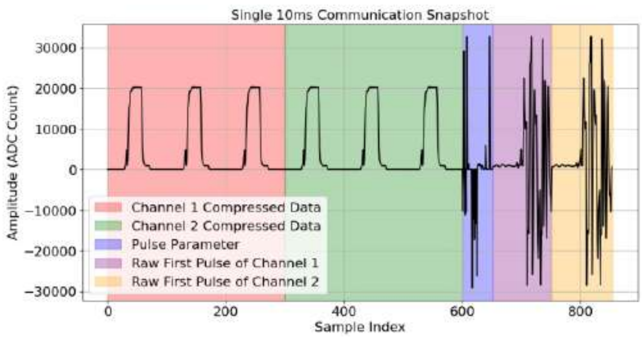

Fig. E.6.4: Communication snapshot of a 10 ms frame illustrating the grouping of 3-pulse compressed data and raw traces for two channels

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