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Data Acquisition System for Monitoring Input Array of Pulse Beams in KOMAC

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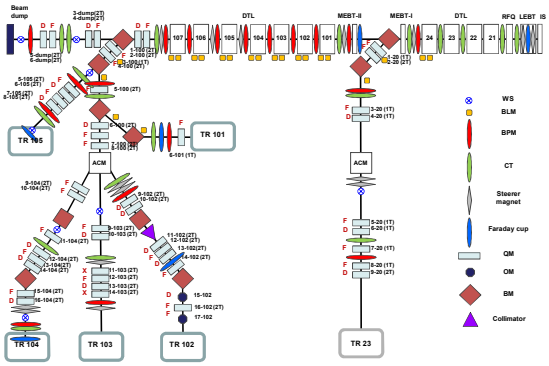
ABSTRACT: A control system is designed to allow beam signals measured at the 100-MeV linac and beam lines to be integrated and managed by remote access. The beam signal types collected from the beam diagnostic systems are processed into scalar and waveform data types. These waveforms should be monitored during beam operation. The data acquisition (DAQ) configuration for monitoring the beam signals consists of three types. The first is that an Experimental Physics and Industrial Control System (EPICS) Input Output Controller (IOC) is used to communicate with oscilloscopes to collect each waveform data in the linac. The second is the use of PCI digitizers to measure beam current and loss signals. The PCI digitizer is connected to a Linux-PC with a PCI slot, and the EPICS IOC requires a related functional library of device drivers. The third is to read waveform signals using an EPICS built-in data acquisition system formed by the System-on-Chip (SoC) architecture to measure beam signals in the beam lines.

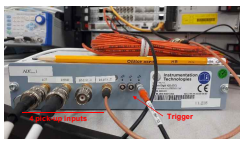
100MeV Linac and Beam Line



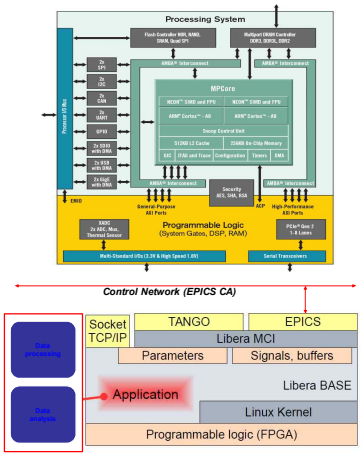
Beam Diagnostics installed on 00 MeV Linac and beam lines

New DAQ for monitoring waveform

- SoC (System On Chip) : Integrates CPU, GPU, DSP, ISP, GPS, ASP.
  : Libera digit 125 for monitoring beam current



Libera Digit 125	
Dimensions	44 mm × 210 mm × 210 mm
Input signals and connector	4, SMA connector
Maximum input signal level	AC-coupled: ±1 V @ 50Ω DC-coupled: ±5 V @ 50Ω, 1.25 V @ 1MΩ
Input gain / attenuation	31 dB
Input signal bandwidth	AC-coupled: 10 MHz – 700 MHz DC-coupled: 40 MHz
Input impedance	AC-coupled: 50 Ω DC-coupled: selectable 50 Ω / 1 MΩ
Trigger signal level and connector	3.3 V TTL, LEMO connector
ADC conversion	125 MSps, 14 bit
FPGA / CPU	Zynq-7020 / ARM Cortex-A9
Booting	Micro-SD, TFTP server
Power	PoE
Cooling	Passive



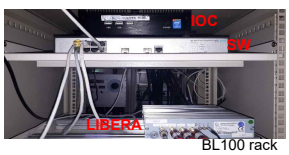
EPICS IOC : Application

Libera (2 sets, 8ch)

- Configuration
  - Libera sampling : 125 -> 100 MSPS
  - Libera memory : 8 -> 1 MB/Ch
  - Maximum repetition : 10 Hz
  - CA array : 30000 (300uS)

EPICS CA — IOC

Module1 → Module2 → OPI



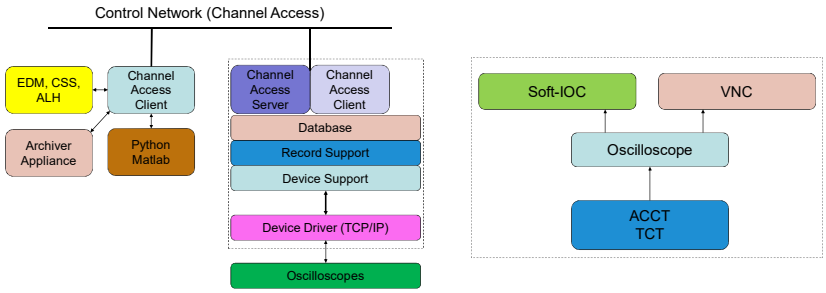
BL100 rack

- Module #1
  - Supports array operands and expressions for array calculation and output
  - Array calculation
  - Digit to Voltage
- Module #2
  - Generate statistical parameter of an input array for waveform analysis
  - Maximum value
  - Minimum value
  - Mean value
  - Mean absolute deviation
  - Variance
  - Standard deviation

Beam Waveform Monitoring System

Beam Signal Monitoring System

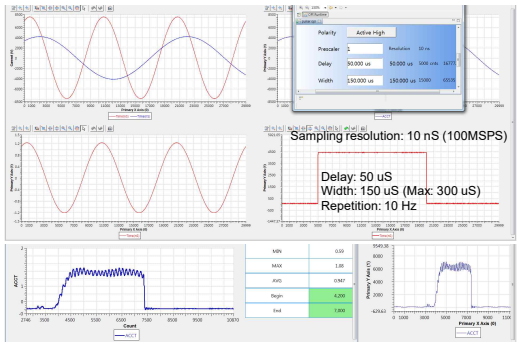
- Oscilloscope : LeCroy LXI VXI11 Protocol to transmit the channel voltage to the IOC.
- PC (Personal Computer) :EPICS OPI & EPICS Soft-IOC with Ethernet
- Oscilloscope waveforms use the VNC (Virtual Network Computing) as a server and client.
- SBC (Single Board Computer) : Onboard with microprocessor, memory, I/O (VME, CompactPCI)
- NI (National Instruments) : CompactDAQ, CompactRIO, NI-PCI DAQ , PXI (PCI eXtensions for Instrumentation)



EPICS OPI: Beam Current Waveform

OPI CS-Studio

- Sampling interval adjustable
- Maximum value
- Minimum value
- Mean value
- Mean absolute deviation
- Standard deviation

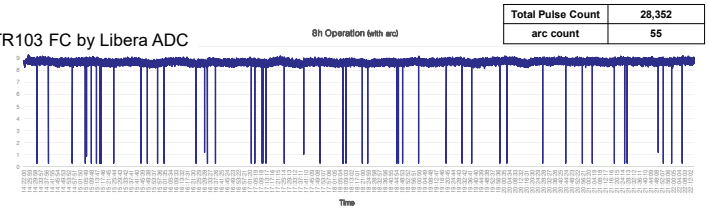


8-hour beam irradiation test

- Beam Current Monitoring System with Libera Digit 125 (ADC)
  - Unlike current ACCT and oscilloscope beam current measurements, pulse to pulse data can be recorded without missing data

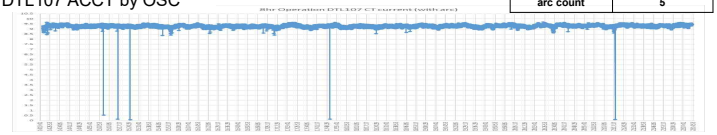
- TR103 FC by Libera ADC

Total Pulse Count	28,352
arc count	55



- DTL107 ACCT by OSC

Total Pulse Count	15,371
arc count	5



SUMMARY: The data acquisition systems are implemented to collect beam signals. For Ethernet-based oscilloscope signal acquisition, EPICS IOC and VNC were applied. To use PCI digitizer, a PCI digitizer was installed on a Linux PC to monitor beam waveforms. We also recently applied Libera SoC digitizer to monitor and analyze real-time waveforms. All beam signals are monitored and archived through the user interface over the accelerator network.