Status of the uTCA Digitizer BPM design for SARAF Phase II

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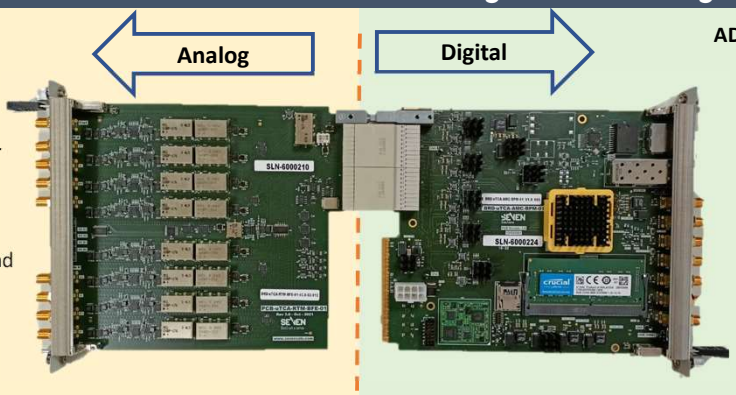
Abstract

One of the crucial monitoring systems of any particle accelerator is the Beam Position Monitor (BPM). The purpose of a BPM is to provide information on the position, phase and current of the beam along the accelerator line.
CEA Saclay must provide all beam diagnostics for SARAF-LINAC PHASE II in particular BPM. Based on the technical specifications of the CEA, Orolia-Spain is in charge of the design, development, manufacture and testing of the electronic system. A preliminary version of this system has been already installed in the SARAF accelerator in Israel at the beginning 2022 and the first results are going to be shown.

uTCA Hardware Architecture – 2 BPM digitizers on a single board

BFE (BPM Front-End) board

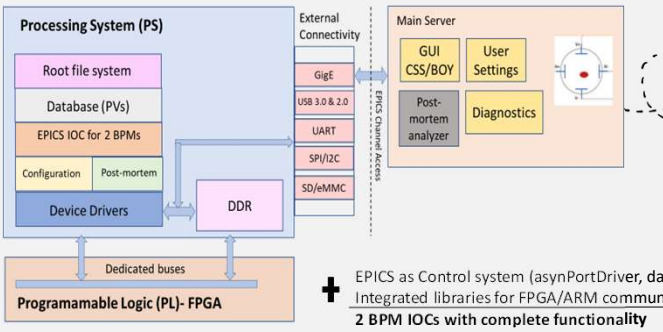
- SMA connectors:
  - 1 RF input for Fref: 176 MHz sine wave for BPM reference
  - 2 BPM channels (4 x RF inputs per channel) Amplitude range [-70, 0] dBm
  - 4 x Analog outputs (0 to 10 V)
- I2C RF switches to allow Channel and Cable calibration
- Temperature sensor
- EEPROM memory

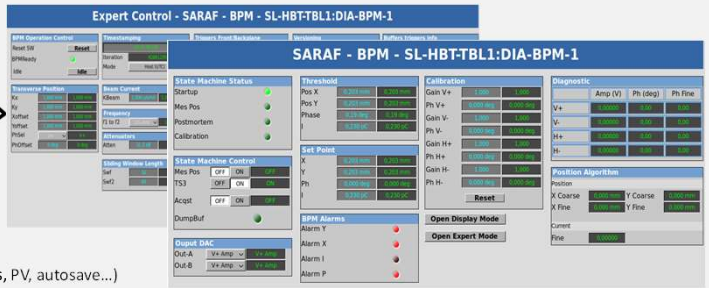


ADC board (AMC digitizer controller)

- 5 x Analog to digital converters (ADC)
- Zynq UltraScale+ FPGA from Xilinx
- PLL to generate internal clock signals
- 8GB DDR4 memory for processor and data storage (postmortem analysis)
- uTCA MMC stamp
- Temperature sensor
- uSD socket, uUSB port
- ETH & SFP port (White Rabbit compatible)
- 7 x configurable input/output TTL connectors

Software Architecture

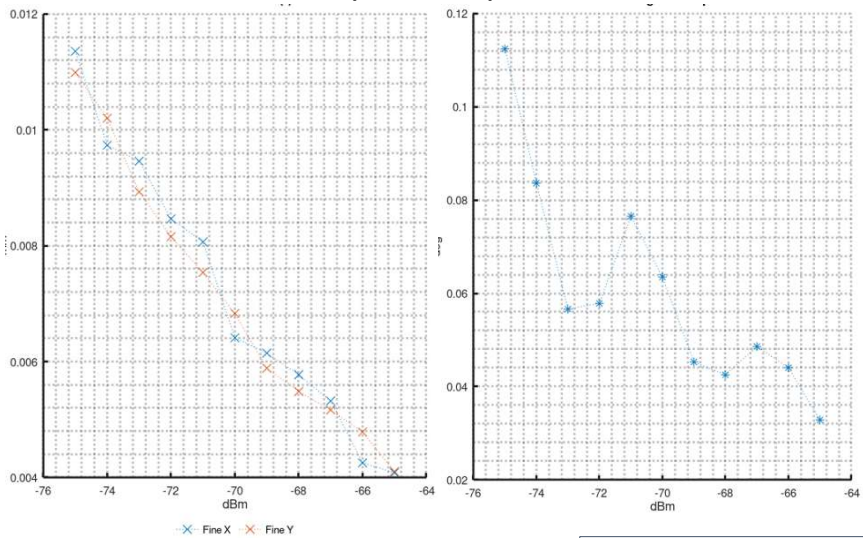




EPICS as Control system (asynPortDriver, databases, PV, autosave...)
Integrated libraries for FPGA/ARM communication (AXI based)
2 BPM IOCs with complete functionality

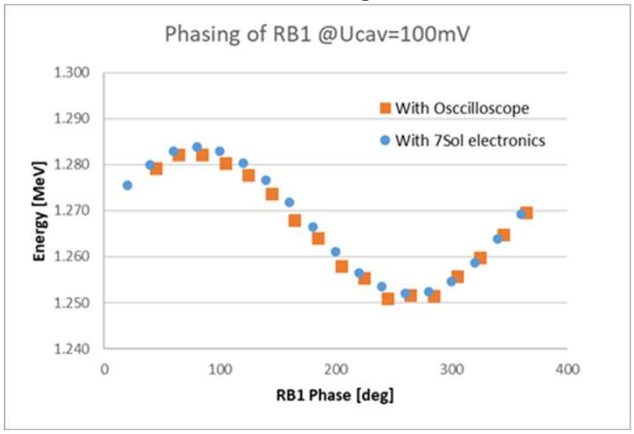
System Performance Measured

Precision in position and phase at 176 MHz



Range of measurement -75 to -65 dBm for fine position and averaged phase for a response time < 60 us

Beam commissioning



BPMs have been a principal tool in the commissioning phase; used for the beam energy after each rebuncher (RB) estimation by measuring the ToF difference between two BPMs downstream.

Moreover…

- **Dynamic range: [-75, 0] dBm**
- **Position precision < 25um**
- **Phase precision < 0.1°**
- **Position, phase and current alarms with response time < 2us.**
- **Position precision < 250um.**
- **Phase precision < 1°**

these performances are in worst case when receiving signals at -75dBm.

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