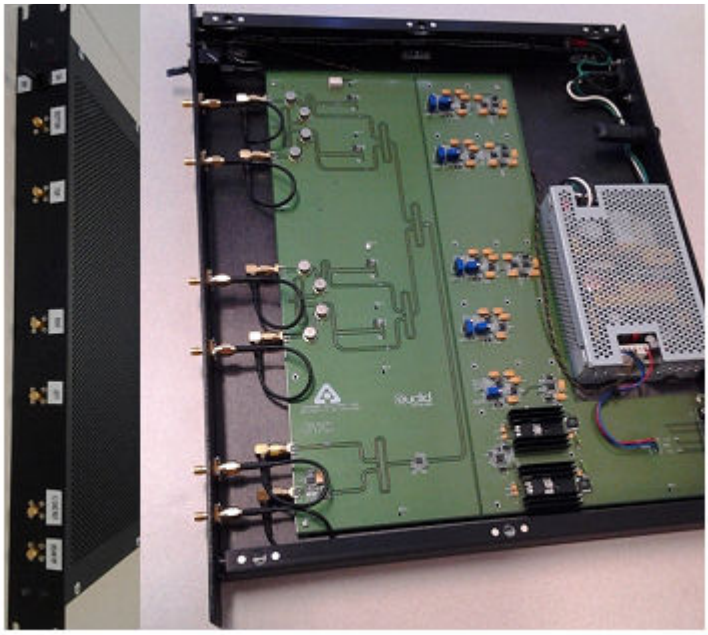

A new readout device – A Compact Electronics Module for the Small Scale Accelerator Facility has been developed by Euclid Techlabs LLC (http://www.beamphysics.com). The device accepts input from either a stripline or a button type RF pick-up and integrates 3 measurements in a single module: **B**eam **P**osition, RF Phase (**Φ**), and Charge (**Q**) **M**onitor (BPΦQM). Its output is held high until the user resets it making it ideal for use at a low-repetition rate (e.g a single pass linac) accelerator facility. Two VCOs (Voltage Controlled Oscillators) are included on board to provide a unique online electronic error correction for each signal channel. The BPΦQM electronics module is ideally suited for small scale accelerator facilities (with RF frequencies up to 2.7 GHz) because of its simplicity and low cost.

The overall system consists of three major functional blocks: 1) a standard 4-way stripline RF pickup device that generates the signal; 2) a BPΦQM module that processes the signal; and 3) a commercially available (low-cost) analog-to-digital-converter (ADC) to read out the module.

SIGNAL GENERATION. The RF pickup device consists of a 4-x stripline RF pickup with each input followed by a bandpass filter (BPF). The choice of the pickup is based on the desired resolution and accuracy, vacuum aperture size, layout consideration, radiation, and cost. The purpose of the BPF is twofold: first, to stretch the raw pulse from the ps

scale to the hundreds of ns scale for easy (slow) processing and readout; and second, to convert the pulse from broadband to narrowband for phase measurement.

SIGNAL PROCESSING. Each BPΦQM card has 8 inputs: the four beam RF signals from the RF pickup/BPF denoted Bottom, Top, Left, Right (B,T,L,R), one RF reference signal (Φ_{REF}) for phase comparison, one level control signal for an on- board phase shifter which is used to center the phase comparator output, one sample/hold trigger signal, and one rf relay control signal to switch the BPΦQM board to the on-board calibrator mode; and 5 outputs: 4 stretched signals for the ADC → horizontal beam position (X), the vertical beam position (Y), relative phase (ΔΦ) and the amount of charge (Σ); and one RF signal derived from the pickup, (Φ_{BEAM}). The purpose of the last output, Φ_{BEAM}, is to permit comparison of the phase of two different pickups located at different locations in the beamline for making time-of-flight (TOF) measurements.

The log-ratio technique is used for the beam position measurement which, with the help of log-amplifier IC chips, can provide an accurate measurement over a wide dynamic range. Meanwhile, microstrip line based directional couplers are used to pick off a fraction of each input beam RF signal after which the four RF signals are combined in a microstrip-based combiner. The output of the combiner is sent to two locations: an SMA RF output, Φ_{BEAM}, and to one input of a phase comparator.

The other input of the phase comparator is an RF reference phase input, to produce the analog output, ΔΦ. The 4 analog signals that contain beam information (X, Y, Σ, ΔΦ) are sent to an on-board sample and hold section of the card. This feature greatly reduces the speed requirements of the ADC board, from ~100 MHz to ~100 kHz, thus greatly lowering the overall cost of the system. Shortly before the next beam pulse, the control system sends V to reset the S&H circuit.

SIGNAL CALIBRATION. As the standard calibration signal source, two 1.3 GHz Voltage Controlled Oscillators (VCOs) are incorporated into the BPΦQM card to improve the accuracy of the beam measurement. They can be used to calibrate the electronics errors due to the temperature variation or aging of the electronic circuits. The input signals can be switched between the normal beam pickup signals and the on-board VCOs through a few controlled RF relays.

SIGNAL READOUT. An ADC is used to digitize the analog outputs of the BPΦQM card for data acquisition and signal processing. Adapting the interface of the card to a standard PC based industrial data bus (PXI) is planned. The card can then be easily incorporated into a standard PXI rack and share the data with other modules in the system.

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