Multiplexer System for the SPEAR3 Booster BPM Upgrade

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Abstract

BPM measurements in booster synchrotrons are often only critical during accelerator commissioning or when a problem occurs. As a result, many facilities do not make large investments in booster BPM signal processors; they either have very few BPMs and/or use older generation processors. The SPEAR3 booster BPM processor system, for instance, has operated since 1990 with commercial multiplexers to switch between BPM button signals into a single dated analog BPM processor that was developed at SLAC. This system has reached its end-of-life so we are in the process of upgrading to modern multiplexers that feed a pair of turn-by-turn Libera SPARK-ERXR processors. This low-cost solution gives us the ability to arbitrarily multiplex between BPM signals during the energy ramp with modern BPM processors. The system can either measure 2 BPMs turn-by-turn in parallel during the entire energy ramp, or sequentially measure all BPMs (2 at a time) at different time slices within the ramp. Here we show measurements of the MiniCircuits switch we chose as well as our architecture for the upgrade.

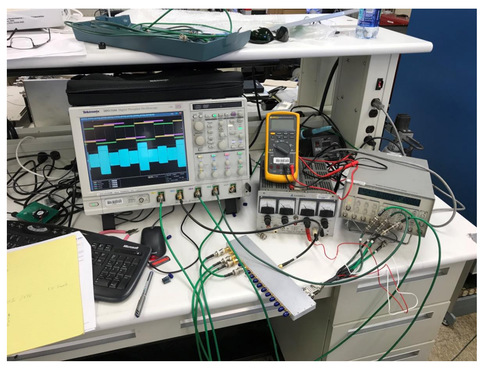
SPEAR3 Overview

- SPEAR3
  - 3 GeV / 500 mA 3rd Gen. Synchrotron
  - Commissioned in 2004
  - Injector commissioned in 1990
  - Several systems near end of life
- Booster BPM System:
  - 2 levels of multiplexers for 20 BPMs
  - 1 analog BPM processor
  - Measures 1 BPM at a time or all BPMs in a number of time slices during the ramp
  - System near end of life
- We are developing an upgrade:
  - Use low-cost MiniCircuits switches
  - 2 Libera SPARK-ERXR processors

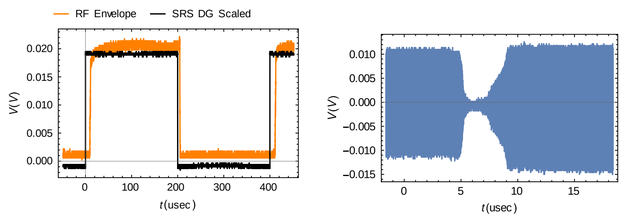
Frequency	1 MHz – 8 GHz
Isolation	63 dB Min (0 GHz – 3 GHz)
Transition Time	5 µs
Power Handling	30 dBm
Insertion Loss	7.5 dB Max (0 GHz – 3 GHz)
Interface	USB & TTL
Inputs	16
Price	$1,835

MiniCircuits USB-1SP16T-83H Switch Specs

Time Domain Measurements



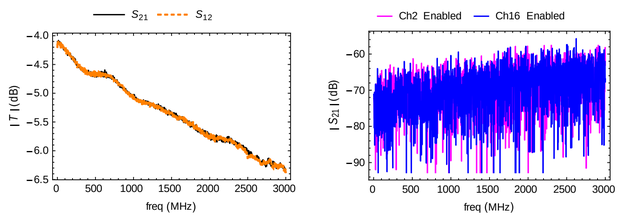
Measurement setup. The scope shows the continuous switching between 4 channels of different frequency and amplitude.



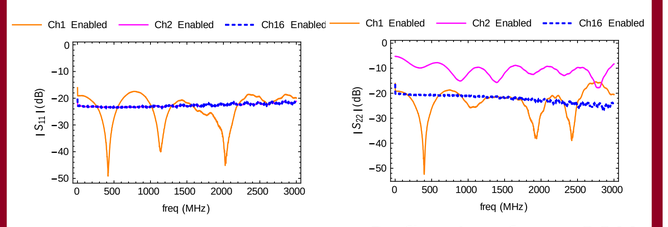
On/Off characteristics and switching between two input channels.

- Switching jitters about 10 usec from trigger
- Effective dead time 20 usec

VNA Measurements



Attenuation and isolation data.

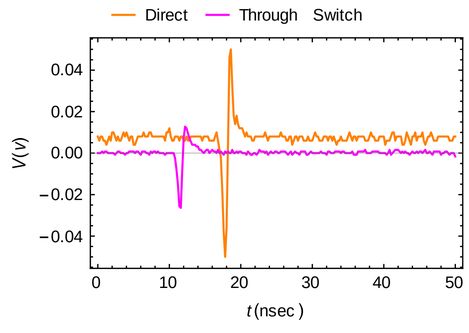


Reflection from channel 1 | Reflection from COM port

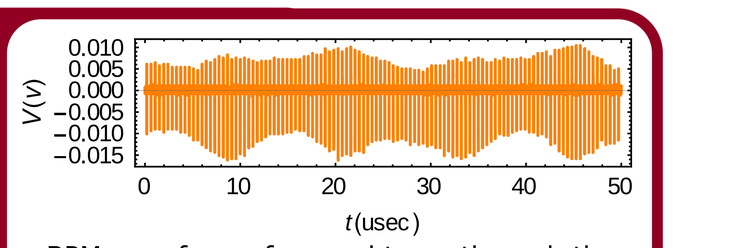
- Switch is near perfectly reciprocal
- Inputs are always well-matched
- Improved response compared to existing system

Beam Tests

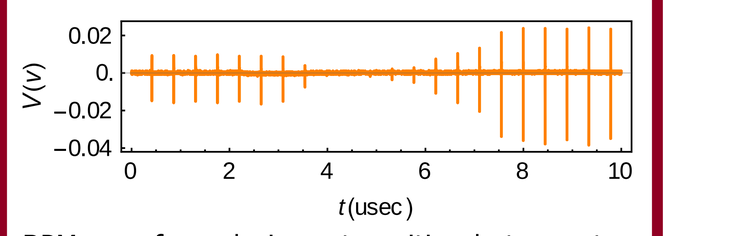
- Tested switch with actual BPM signals
- Signal amplitude is half as expected



Direct BPM waveform and through the switch

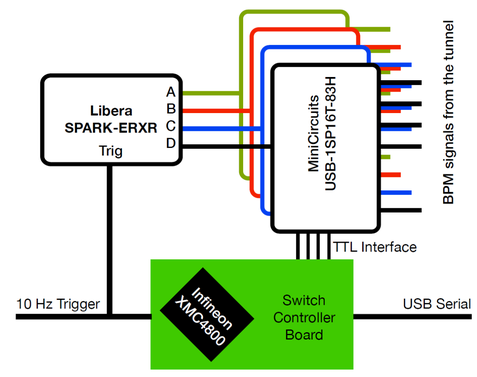


BPM waveform of several turns through the switch

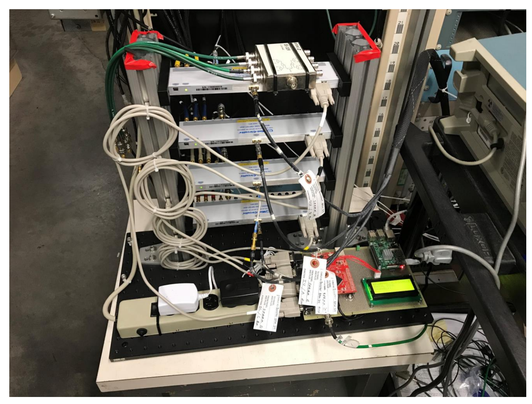


BPM waveform during a transition between two channels

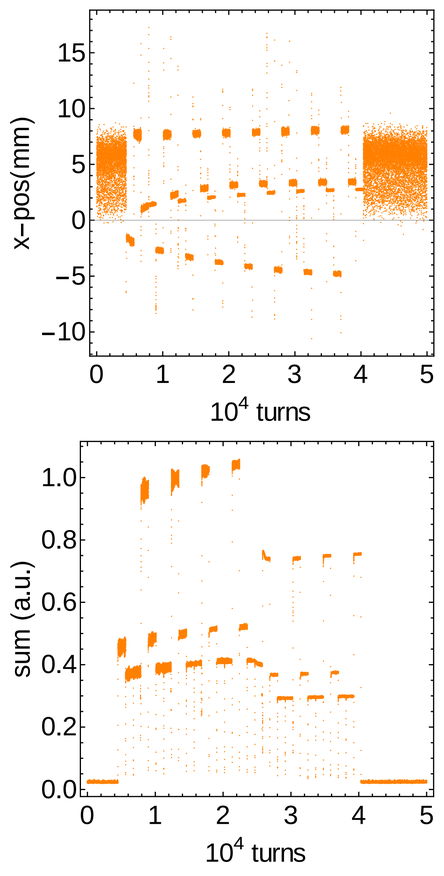
System Prototype



Schematic of the proposed system upgrade.



Picture of proof-of-concept prototype.



Measured data from the SPARK while switching between four BPMs. We can identify the transitions using the sum information.

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