APS UPGRADE RADIATION SAFETY BEAM CURRENT INTERLOCK

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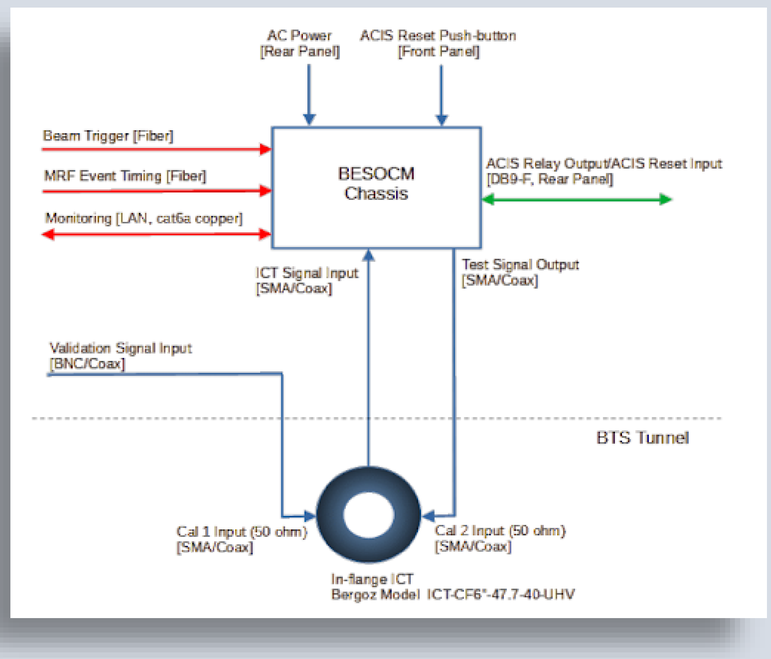
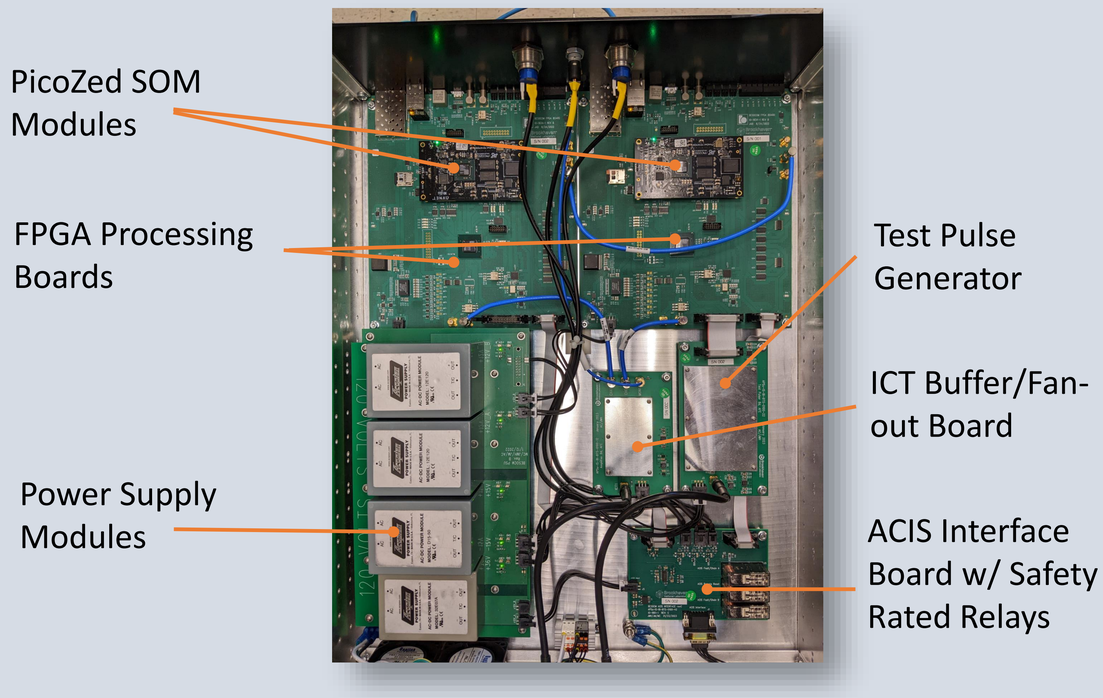
Abstract

The Advanced Photon Source upgrade (APS-U) replaces the APS storage ring with a new Multi-Bend Acromat (MBA) storage ring utilizing on-axis swap-out injection requiring up to 20nC charge per injected electron bunch, more than a three-fold increase from the original ring. Enforcement of radiation safety limits for the new storage ring will be accomplished by a new beam charge monitor interlock that acquires the accumulated beam charge in the Booster-to-Storage ring (BTS) transfer line and disables injection when the charge limit over a preset time period is exceeded. The new interlock is based on the existing APS Beam Shut-Off Current Monitor (BESOCM) that has been in operation in the APS injector for many years, and incorporates significant improvements over the existing system. New features include use of direct digitization and FPGA signal processing, extensive remote monitoring capabilities, expanded self-test and fail-safe functions, and the ability to adjust settings and monitor status remotely via EPICS. The new device integrates a test pulse (self-check) feature that verifies the integrity of the integrating beam current transformer (ICT) and cable system used to detect the beam signal. This paper describes the new BTS interlock (BESOCM) design and presents results of bench test and in-machine evaluation of the prototype and production units.

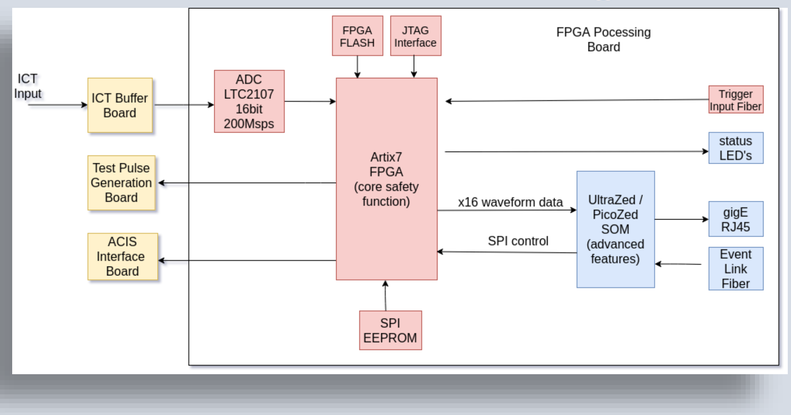
System Diagram



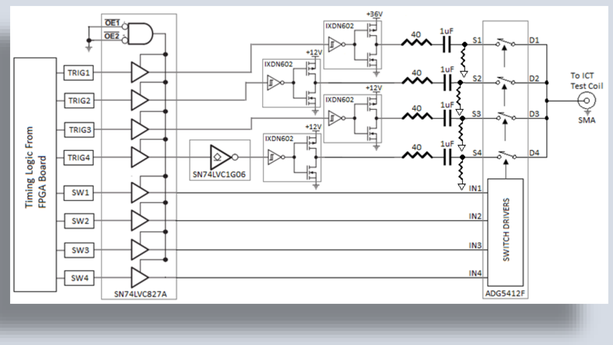
BESOCM Chassis Layout



Electronics Block Diagram



Self-Test Pulse Generator Circuit

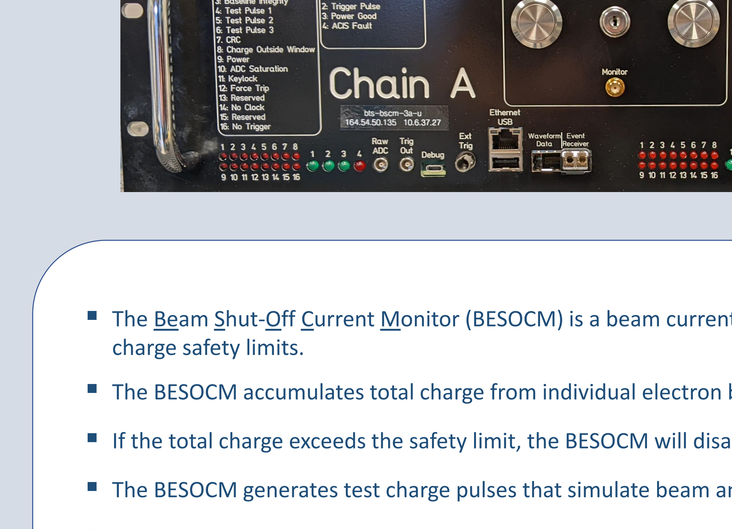


- The Beam Shut-Off Current Monitor (BESOCM) is a beam current monitor that enforces accelerated charge safety limits.
- The BESOCM accumulates total charge from individual electron bunches over a pre-set time period.
- If the total charge exceeds the safety limit, the BESOCM will disable beam injection.
- The BESOCM generates test charge pulses that simulate beam and monitors the response continuously.
- Fail-safe system faults will also disable beam.
- An onboard PicoZed System-On-Module provides Linux and EPICS PVs, enabling extensive remote monitoring of the BESOCM status.
- System parameters, such a beam and test pulse limits are adjustable via PVs using GUI screen.
- A keylock on the front panel enables parameter changes, and protects against unauthorized changes.

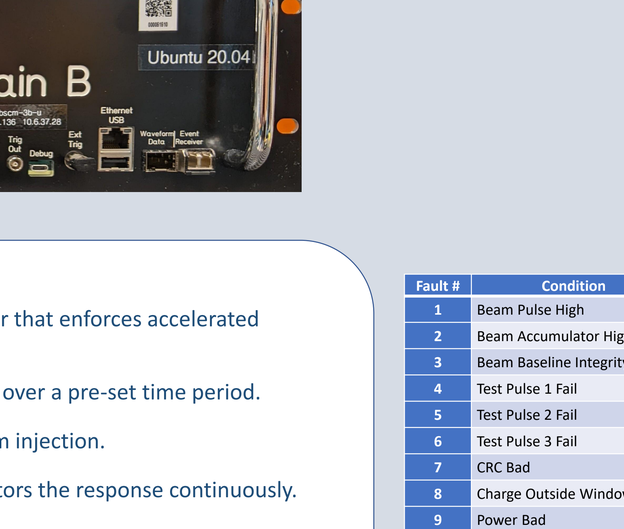
Fault #	Condition
1	Beam Pulse High
2	Beam Accumulator High
3	Beam Baseline Integrity
4	Test Pulse 1 Fail
5	Test Pulse 2 Fail
6	Test Pulse 3 Fail
7	CRC Bad
8	Charge Outside Window
9	Power Bad
10	ADC Saturation
11	Keylock in Program
12	Force Trip
13	ACIS Reset Hold-off
14	No Clock
15	(reserved)
16	No Trigger

Engineering Screens (CSS)

Summary Screen



Tests Pulse Screen



Settings Screen

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