Title: **Next Generation CESR Beam Position Monitor System Requirements**
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Introduction:

This document contains the functional requirements for a new CESR beam position monitoring system. The system will use existing button pickups to provide four electrical signals which are used to measure the horizontal and vertical position of a particle beam within the CESR beam pipe. There are approximately 125 sets of buttons located throughout the accelerator which can be utilized by the system to provide complete orbit measurements. Measurements at these different locations are synchronized to provide bunch by bunch and turn by turn information.

The system being proposed is an evolution of the existing CBPM system. The new system will maintain the synchronous peak sampling method used by CBPM and utilize much of the existing infrastructure. Triggering and synchronization will be provided by the existing CBPM Clock connections. Control and data recovery will utilize the existing Ethernet connections with an upgrade to Gigabit capability.

The content of this document is limited to the definition of the basic system requirements and does not cover design and implementation choices. There are "Potential" modes of operation which need to be proven feasible prior to detailed design.

Measurement Types:

Raw Data:

The system *shall* have the capability of collecting synchronous digital conversions of the analog button signals over a meaningful number of turns. These digital values will be provided on a bunch by bunch and turn by turn basis. The collected data shall be presented to the user via raw data files.

Processed Position:

The system *shall* have the capability of measuring beam position based on the relative values of the digitized button signals on a bunch by bunch and turn by turn basis. The collected data shall be presented to the user via position data files.

Processed Phase:

The system *shall* have the capability of measuring the betatron phase advance and coupling of the particle beam. This measurement requires coordination with other CESR instrumentation (digital tune tracker) and active elements (shaker magnets, stripline kickers).

Measurement Modes:

Precision Synchronous Mode:

Precision Synchronous Mode *shall* be used to collect tightly synchronized samples of button signals. These measurement are synchronized with the CESR Fast Timing system and include Raw Data, Processed Position and Processed Phase measurements. This mode is used for precision measurement after beam to detector synchronization has been established.

Asynchronous Amplitude Mode (Potential):

Asynchronous Amplitude Mode *could* be used to coarsely measure beam position prior to having beam to detector synchronization established. It does not provide bunch by bunch turn by turn measurements. It provides peak detection of low current beams for injection and storage diagnostics. Button amplitudes and button sums provided.

Calibration Mode (Potential):
Calibration Mode *could* be used to measure the impedance characteristics of the button signal path with the goal of using the measured information to normalize all button inputs. This mode utilizes a driver circuit to make a "pitch-catch" measurement by driving a signal onto a button and the other three buttons are measured for the response.

Machine Studies:

Measurement	Measured Bunch Structure	Bunch Current	Required Resolution	Mode	Required Features
Orbit	Single	0.5 mA fiducial bunch	2.5 um	PS*	10 Hz rate
Injection Turn Trajectory	Single Multi (14ns)	1 uA to 20 uA	1 mm	PS AA*	10 Hz rate Synchronous Asynchronous
Pulsed Bump Closure	Single Multi (14ns)	0.1 mA to 0.5 mA	2.5 um	PS AA	10 Hz rate Synchronous Asynchronous
Injection Tuning	Single Multi (14ns)	1 uA to 100 uA	1 mm Intensity	PS AA	10 Hz rate Synchronous Asynchronous
Fast Orbit Feedback	Single Multi (14ns)	0.5 mA fiducial bunch	2.5 um	PS	10-1000Hz local rate
Train Studies	Single Multi (14ns)	0.1 mA to 5 mA	10 um	PS	Multi bunch measurement
OSC Injection	Single	1uA to 100 uA	1 mm intensity	PS	
Position Interlocking	Single	0.5 mA fiducial bunch	2.5 um	PS	Excursion monitoring

*PS = Precision Synchronous
*AA = Asynchronous Amplitude

Performance Metrics:

Parameter / Mode	Precision Synchronous	Asynchronous Amplitude
Resolution	2.5 um	1 mm
Dynamic Range	20 uA to 5 mA	1 uA to 100 uA
Sample Rate	72MSPS max. required	72 MSPS max. required
Measurement Rate	10 Hz	10 Hz
Measurement Depth:	65k turns	1k turns

Software & Integration:

- All control and analysis software *shall* be compatible with CLASSE Linux platforms.
- The system *shall* interface with the CESR Fast Timing System via the CESR MPM and its database.
- The system *shall* interface with CESRV via a yet to be determined method.
- All data *shall* be stored on the CLASSE NFS.
- Results displays *shall* be visible via CESR control terminals