SCAM Requirements for 4-Laser Operations

April 28, 2016

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Introduction

The SCAM (Service Building Catch All Module) is a programmable interface to the Laser Macropulse chassis to select modes of laser operation. The SCAM module used during CEBAF 6 GeV and through Spring 2016 supports 3-laser operation and both polarized and thermionic sources. The new 12 GeV era SCAM module supports 4-laser operation and only the polarized source. It is planned for deployment during the Summer 2016.

Laser Controls

The laser controls are partitioned five ways: Master, Laser A, Laser B, Laser C and Laser D. The Master partition limits the accessible operation of the individual Lasers (A, B, C, D). Each partition allows EPICS control for five orders of laser operation. Beam Off is the lowest order and prohibits laser output. All higher orders allow laser output, with User the highest order,

1. Beam Off
2. Viewer Limited
3. Tune
4. Continuous Wave
5. User

Beam Sync Marker Pulse

The pulsed order (Pulsed Viewer, Pulsed Tune, User) repeat a macropulse structure with a regular frequency that is transmitted by a Beam Sync marker pulse (Fig. 1). The macropulse structures are EPICS defined and described later. The Beam Sync frequency is EPICS controlled and may be either:

- *External Line Sync* – The SCAM receives an External Line Sync pulse from a line sync module detects zero crossing of one phase of site power. The SCAM delays the Beam Sync marker pulse by an EPICS defined Delay to Beam Sync value, which may be 0 to 16,000 us in 10 us increments.

- *Internal Clock Sync* – The SCAM module self-generates an internal Internal Clock Sync pulse using an internal 20 MHz oscillator. The frequency is EPICS defined an may be 40 to 200 Hz in 0.1 Hz increments. The SCAM delays the Beam Sync marker pulse by an EPICS defined Delay to Beam Sync value. The value depends, of course, on the desired frequency. Generally, the Delay to Beam Sync may span from 0 to 500 us less than the period of repetition. in 10 us increments. For example, if the Free Run Sync were set to 40 Hz the delay may be up to 24,500 us.

Beam Orders Defined

1. Beam Off - In this case EPICS may turn off all Lasers by setting the Master to Beam Off, or individually turn off the beam of any specific Laser (A,B,C,D).

2. Viewer Limited - In this case EPICS may individually set any Laser to Viewer Limited, provided the Master is of equal or higher order. Lasers of higher order than the Master will automatically be set to the Master order. The Viewer Limited macropulse structure (Fig. 1) has one ON pulse. This ON pulse is delayed from Beam Sync by an EPICS defined value of 340-360 us in 0.2 us increments and has an EPICS defined pulse width of 0.2-10 us in 0.1 us increments. All Lasers in Viewer Limited will have the same macropulse structure.

3. Tune - In this case EPICS may individually set any Laser to Tune, provided the Master is of equal or higher order. Lasers of higher order than the Master will automatically be set to the Master order. The Tune macropulse structure (Fig. 1) has two ON pulses. The first is triggered at Beam Sync with an EPICS defined pulse width of 100–250 us in 10.0 us increments. The second is delayed from Beam Sync by an EPICS defined value of 340-360 us in 0.2 us increments and has an EPICS defined pulse width of 0.2-10 us in 0.1 us increments. All Lasers in Tune will have the same macropulse structure.

4. Continuous Wave Mode - In this case EPICS may set individually any Laser to Continuous Wave Mode, provided the Master is of equal or higher order. In Continuous Wave Mode the beam is always ON, there is no macropulse structure.

5. User - In this case EPICS may set individually any Laser to a User mode, provided the Master is set to User. User modes are non-standard macropulse structures. All Lasers in a User mode will have the same macropulse structure.

User Modes Defined

1. User Mode 1 (Variable Duty Factor) - In this case EPICS may set any Laser to User Mode 1, provided the Master order is User. In this mode one ON macropulse will be generated for duration shorter than the selected regular period, beginning at T_{start} and ending at T_{end} relative to Beam Sync, both in 0.1 us increments.

2. User Mode 2 (Staggered Beam Sync) - In this case EPICS may set the Delay to Beam Sync output, thus allowing the user to delay Beam Sync and all subsequent beam structure e.g. Viewer Limited or Tune macropulse relative to the sync signal (either External Line Sync or Internal Clock Sync).

I/O Interface

In order to provide the above functionality and requisite CEBAF safety features the SCAM will have the following interfaces:

1. External Line Sync Input
2. Beam Sync Output
3. Pre-Trigger Output
4. Beam Mode Outputs
5. VME Bus I/O
6. Master Fast Shut Down (FSD) Input

We define the interfaces below. For clarity a timing diagram (Fig. 1) and an interface diagram (Fig. 2) are shown.

1. External Line Sync Input - The SCAM will receive on fiber from a Line Sync Module an External Line Sync input derived from the zero crossing of site power. The SCAM will provide (copy) the External Line Sync Input as TTL and Fiber.

2. Beam Sync Output - The SCAM will provide the Beam Sync Output pulse as TTL and Fiber.

3. Pre-Trigger Output - The SCAM will provide a diagnostic pre-trigger synchronous with Beam Sync. The Pre-Trigger pulse will be EPICS defined from 90-110 us before Beam sync in 0.1 us steps and with EPICS defined pulse width of 1-500 us in 0.1 us steps. The Pre-Trigger Output will be provided as TTL and Fiber.

4. Beam Mode Outputs - The SCAM will provide drive signals (x4) by fiber to the Laser Macropulse chassis enabling the Beam orders and modes of laser operation.

5. VME Bus I/O - The SCAM will have a VME bus interface. The user will access control and status registers through this interface in order to select the modes of the SCAM. The SCAM will identify itself by version identification through a register.

6. Master Fast Shut Down (FSD) Input - The SCAM will receive a courtesy copy of the MPS FSD input provided to the Laser Macropulse chassis. SCAM will provide both live and latched status of the Master Fast Shut Down Input as an EPICS readback.

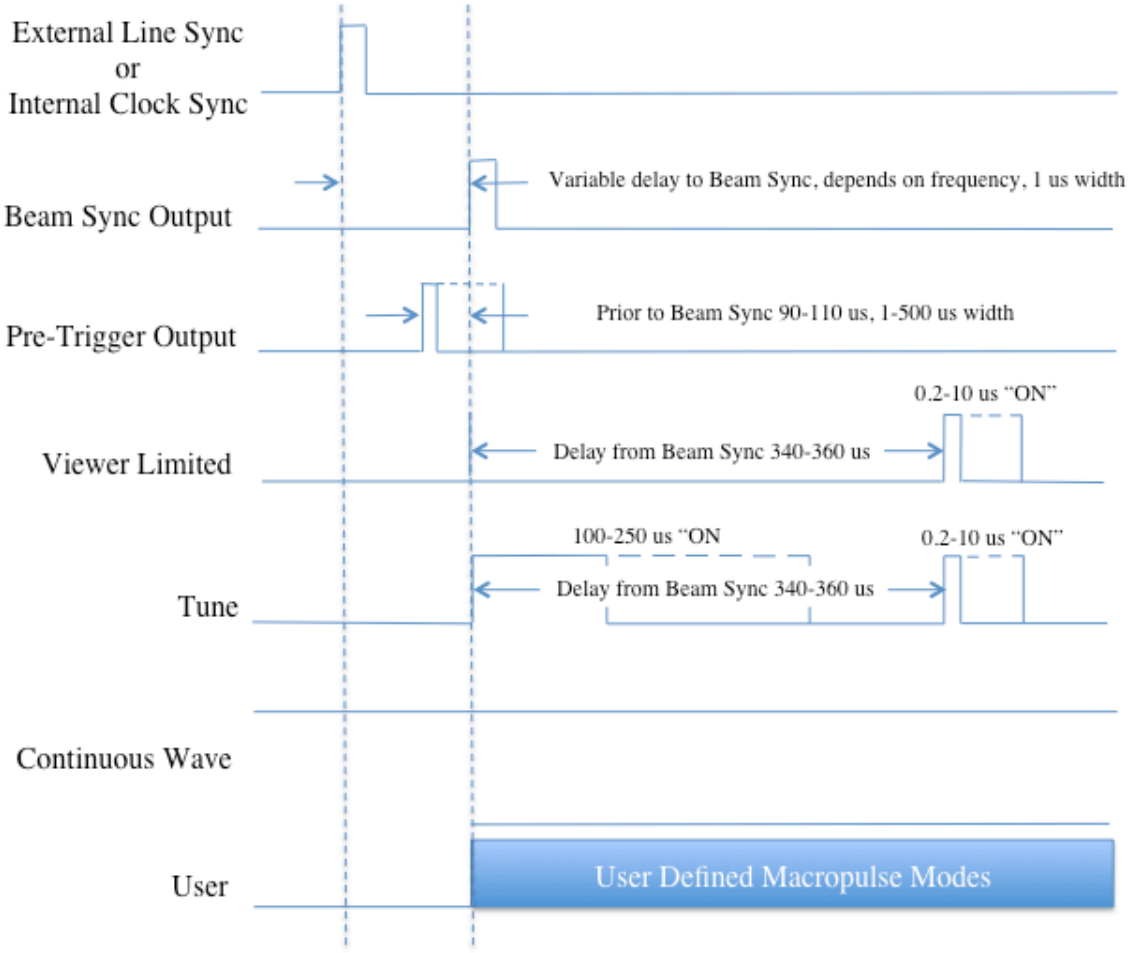

Fig. 1. The SCAM timing reference (External Line Sync or Internal Clock Sync), triggering signals (Beam Sync, Pre-Trigger) and orders of laser operation (Viewer Limited, Tune, Continuous Wave, User) are shown. Please note, all laser and diagnostic signals are time-stable relative to Beam Sync.

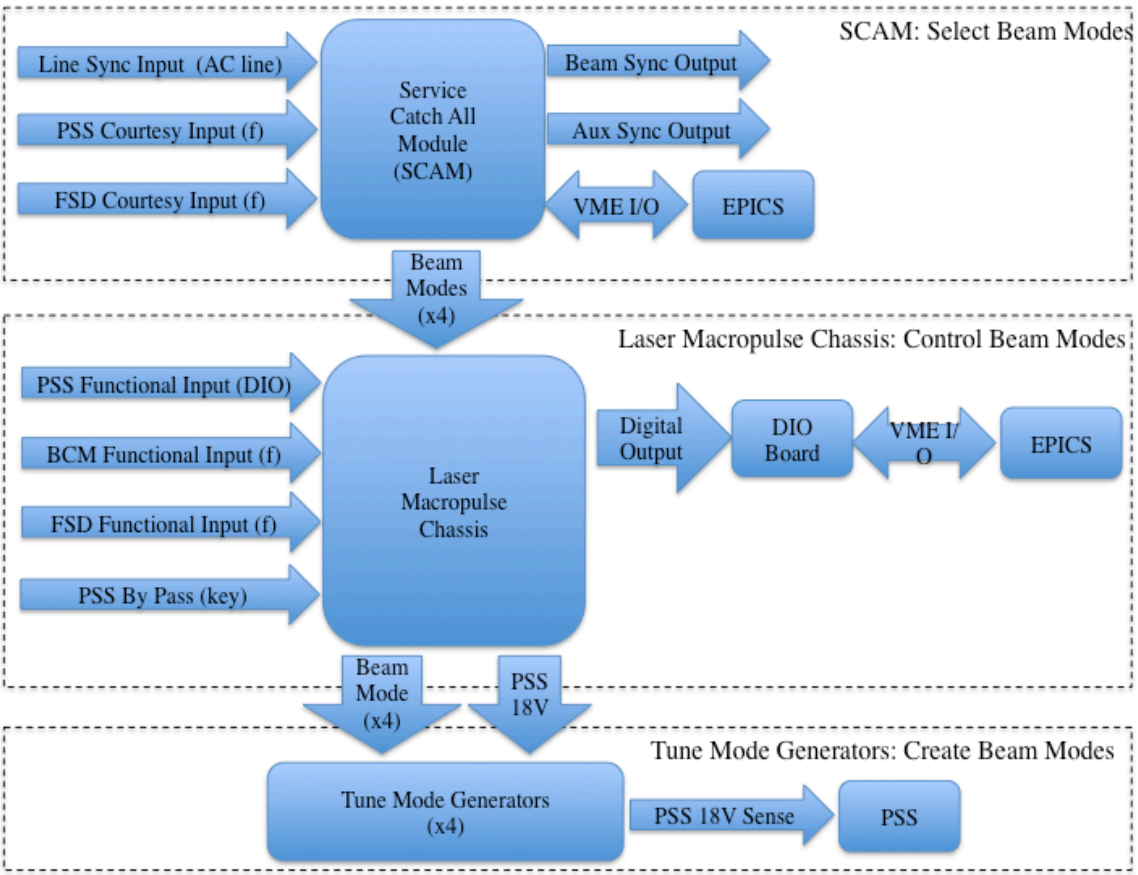

Fig. 2. Shown is the interface diagram of the SCAM, Laser Macropulse Chassis and Tune Mode Generators along with I/O dependencies and interface to the EPICS control system. The text "x4" refers to four independent channels for Laser A, B, C, D.