Application note

No. 17

Synchronising the SI-LUX laser with High-speed video cameras

The SI-LUX laser illumination system was originally designed to illuminate nano or microsecond events being captured by the SIM framing and KIRANA Ultra high speed cameras from Specialised Imaging Ltd. (SI). The SI-LUX are connected directly to these cameras without a delay generator to synchronise the laser pulse and camera exposures. To expand the SI-LUX capability to include other laboratory cameras, the standard SI 1 channel delay generator (1CDG) can be connected between the SI-LUX laser and High-Speed Video (HSV) camera to synchronise the laser pulses and exposure times.

Limited frequency for constant pulse output:

For constant pulse output the SI-LUX is limited by a maximum 0.03% duty cycle:

Duration (S) x Frequency (Hz) ≤ 0.0003

The first table shows the maximum frequencies for a range of pulse durations. If frequencies above these maximum values are required, then the number of pulses becomes limited.

Pulse duration (ns)	Max Frequency (Hz)
10	30000
50	6000
100	3000
500	600
1000	300
5000	60
10000	30
30000	10

Limited number of pulses: The limiting 0.03% duty cycle of the SI-LUX laser means bursts of laser pulses at a max duty cycle of 100 % is possible provided the total laser active time during the burst is no more than 30μs. It is therefore possible to generate 3000 pulses of 10 ns duration, 300 pulses of 100 ns duration or 30 pulses of 1000 ns duration.

The table below shows maximum burst durations for this limited operating time at higher frequencies. This is applicable when the frequency is above 30kHz. The burst time is defined as the time between the first and last laser pulse. The Total laser active time is limited by both software and hardware to 30µs. This mode has been specially designed for the Specialised Imaging SIM and Kirana series of cameras but can be utilised by HSV cameras.

Pulse Duration (ns)	Repetition Frequency (Hz)	Burst Duration (ms)	Total laser active time (µs)
10	50,000	60.0	30.0
40	50,000	15.0	30.0
10	100,000	30.0	30.0
40	100,000	7.5	30.0
10	200,000	15.0	30.0
20	200,000	7.5	30.0
10	1,000,000	3.0	30.0
10	5,000,000	0.6	30.0
20	5,000,000	0.3	30.0
10	7,000,000	0.4	30.0

After such a burst the laser will remain inactive and ignore possible incoming sync signals for approximately 100ms.

The KIRANA camera has a maximum speed of 7MHz and limited to 180 images, which equates to a record duration of 25.7uS, so the SIL-LUX provides a Burst duration significantly more than this.

Using the SI-LUX with High-Speed Video cameras.

The limited number of pulses available at frequencies above 30kHz means using the SI-LUX with a high-speed video camera will limit the number of illuminated images, adds another level of triggering complexity and presents a possible health and safety issue. To control the laser, an SI 1CDG is connected between the camera and SI-LUX. This allows different polarity f.sync signals to be used from the camera, but the primary feature is the ability to limit the number of pulses sent to the laser in one of two ways:

1) The total duration of output pulses from the 1CDG to the SI-LUX is limited to 30uS during a 100uS time period. This protects the SI-LUX from damage.
2) When pulses are being received from the HSV camera, the "Enable" input on the 1CDG allows precise signal output on and off points when the unit is sending pulses to the SI-LUX. This provides a flexible way to start and stop the laser pulses relative to the event.

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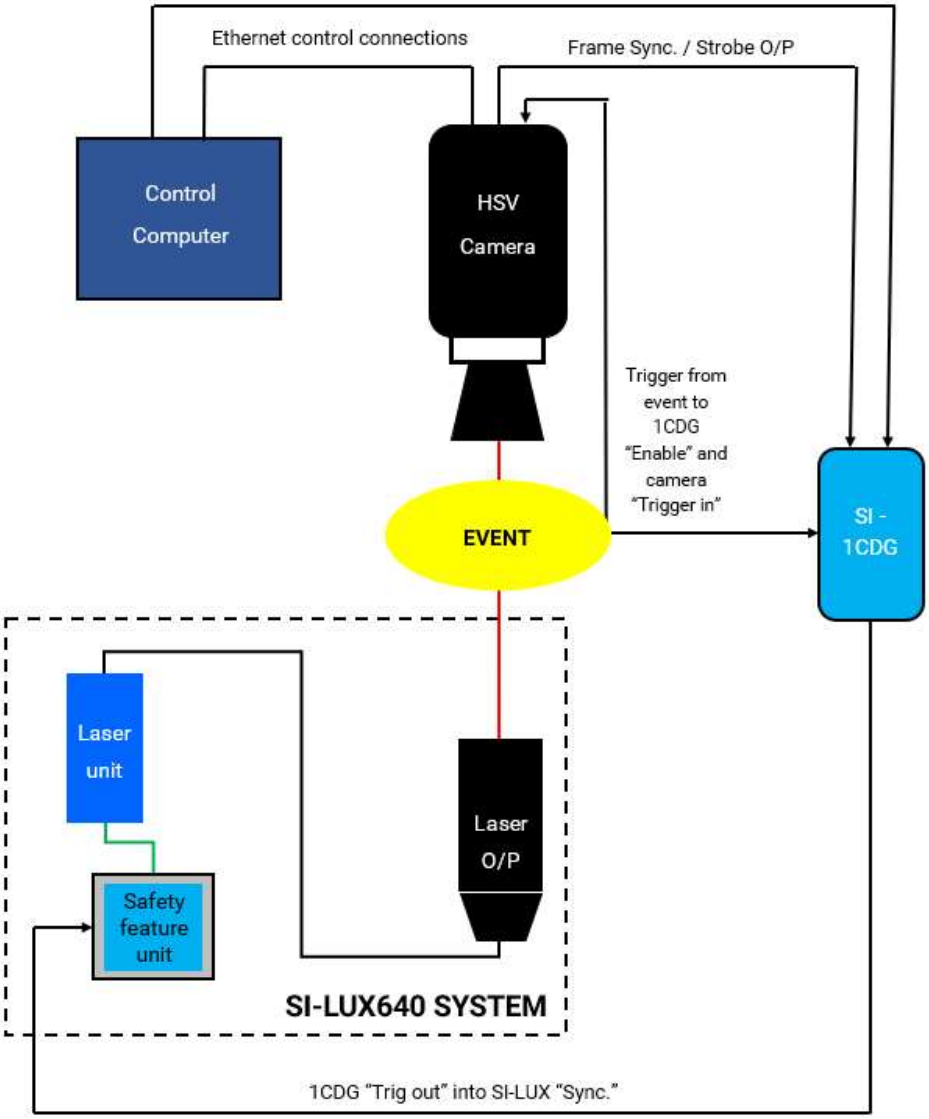
The schematic below shows the HSV camera, SI-LUX, 1CDG and control PC connections. Both the SI-LUX and HSV camera can be controlled using the same PC, provided there are enough ethernet ports (or via a Switch). Either Expose Pos, F.sync or Strobe output from the camera is connected to the 1CDG and the "Trig out" from the 1CDG is connected to the SI-LUX "Sync. Input". A trigger from the event is connected to the "Trigger" input of the camera. Either the same or an independent signal is connected to the "Enable" input of the 1CDG. Once armed the HSV camera will be sending f.sync. pulses (equal to the camera frame rate) to the 1CDG but until the "Enable" input changes state, no pulses will be sent from the 1CDG to the SI-LUX laser. The pulse width of the signal to the "Enable" input should be equal to the required duration. If the total laser active time reaches 30uS the 1CDG will stop the signal to the SI-LUX to prevent damage.



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