EIGER2 – External Gating EXTG

EIGER2 detector systems offer the possibility to externally "gate" the detector. This functionality allows counting one or several "gated" time windows before a readout of the counter happens.

In this documentation a "gated window" describes the operation, time, and behavior of the detector between the transition from low to high and back to low of the signal on the external trigger input. Typical times for "gate windows" are a few tens of ns (lowest possible value to be determined) to a few 100 ns.

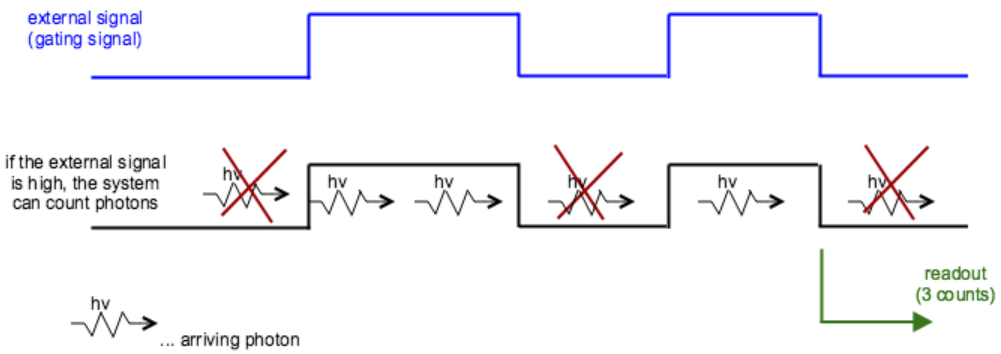

Figure 1: Simplified schemata of external gating

To use this feature, the **trigger_mode "extg"** needs to be set. If this mode is set, the behavior of the detector is controlled by a signal applied to the trigger input. In this mode, the enable out signal only mirrors the trigger input signal and does not give feedback on the internal status of the detector.

The EIGER2 application specific integrated circuit (ASIC) offers two 16 bit counters for each threshold. To allow maximum flexibility, two different gating modes are provided.

One with alternating counters called

- **Pump_and_Probe mode**

This mode allows to acquire images with two different delay times to be recorded during the same acquisition by alternating the two counters. For example, this can be used to acquire an image before and after the pump in the same acquisition.

The second mode is called

- **High_Dynamic_Range (HDR) mode.**

In this mode, the two 16 bit counters are connected to form one 32 bit counter (for each threshold). This makes it possible to make acquisitions with a very high dynamic range.

Both thresholds can be used simultaneously if required. The second threshold needs to be activated by setting the parameter threshold/2/mode to "enabled". If more than one threshold is activated, the data can only be retrieved via the monitor interface in the current software version (v2020.2.1). The threshold id can be read out from the tiff metadata. Refer to the Simplon API documentation for more details on the DECTRIS tiff metadata.

The disarm does not happen automatically in the external gating mode, a disarm request has to be sent to the detector after the required number of images have been acquired. However, the detector will stop writing images after the configured amount of images has been reached. Due to a known bug in software version v2020.2.1, the parameter "ntrigger" is used for this instead of "nimages". This behavior will change in future software releases.

For the best results, the count rate correction and retrigger mode should be turned off in gating mode:

- countrate_correction_applied : false
- retrigger_applied : false

1. *Pump-and-probe mode*

For pump-and-probe measurements, the two 16 bit counters of each threshold are alternated. If both thresholds are activated, their counters will count concurrently. To use this mode the following parameters must be set:

- trigger_mode: «extg»
- extg_mode: "pump-and-probe" (default)
- nexpi - number of exposures per image (maximum 32 bit - 4294967296)
- – this value refers to the number of gates that will be integrated in one counter (e.g. if nexpi=10000, the images will be read out after 20000 gates, i.e. 10000 gates per counter)
- *nimages – is not active in software version v2020.2.1. Due to a known bug, ntrigger has to be used instead.*
- *ntrigger – in software version v2020.2.1, ntrigger defines the number of images that shall be acquired in the running exposure series. In future versions, the parameter nimages will be used instead.*
- disarm – stops the exposure series (the current counter values will not be read out)

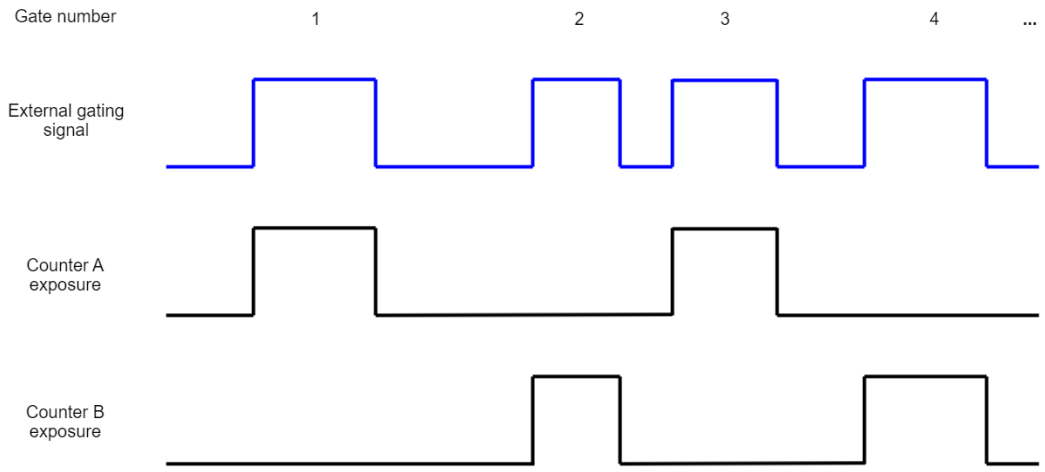

Figure 2: Simplified schema of pump-and-probe mode

The EIGER2 system will write the counts detected during the first "gated window" into counter A and the value of the second "gated window" into counter B. The next "gated window" will be added again to counter A and so on. After the number of "gate windows" reaches nexpi in counter A and B combined, a readout will happen. The readout takes around 2 ms after which the next image will immediately start again until the set number of ntrigger is reached (ntrigger=3 would correspond to 3 acquisitions).

While the actual readout happens, the input line will continue to alternate the counters for every window received (they likely come from a continuous overall timing clock - e.g. synchrotron ring clock). This way, the synchronization of the gates is maintained and the counters A and B will always be associated with the same gate delay in every readout.

In this mode, it is very important to check the quality of the trigger signal and avoid any ringing of the signal. Refer to the Technical Specifications for details on the trigger input signal level and impedance.

The images of the two counters can only be read out using the monitor interface in the current software version (v2020.2.1). The counter corresponding to each image can be figured out using the tiff metadata information image_id. Counter A will always have an even image_id, while counter B will always be uneven.

2. *HDR-gating*

For high dynamic range (HDR) measurements, both thresholds will connect their two 16 bit counters to form a single 32 bit counter. In HDR mode the system will not distinguish between pump and probe but only add up the signals in the combined counter. The advantage is one 32 bit counter bit depth for each threshold. Each gated window will increase the counter. After the desired number of "gated windows" is reached, as defined in nexpi, a readout will happen and produce a 32 bit image for each threshold enabled. The readout will take around 2 ms.

- trigger_mode: "extg"
- extg_mode: "hdr"
- nexpi - number of exposures per image (maximum 32 bit - 4294967296)
- *nimages – is not active in software version v2020.2.1. Due to a known bug, ntrigger has to be used instead.*
- *ntrigger – in software version v2020.2.1, ntrigger defines the number of images that shall be acquired in the running exposure series. In future versions, the parameter nimages will be used instead.*
- disarm – stops the exposure series (the current counter values will not be read out)