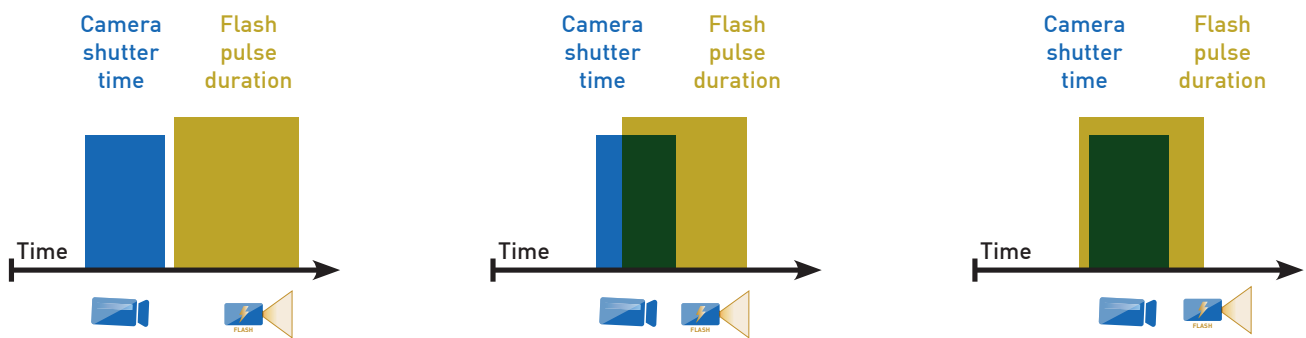# FLASH-CAMERA SYNCHRONIZATION

PHOTO TRAFFIC
ENFORCEMENT

In photography flash-camera synchronization is defined as the adjustment of the time of occurence, relatively to each other, of a flash firing and the activation of a camera sensor. The resulting exposure of a picture relies on the proper management of that synchronization. In the context of photo traffic enforcement such a matter is delicate, because shutter time and flash pulse duration are short in order to freeze vehicles' motion.

In this document, we will detail what synchronization means, and key aspects of its management.

In practice, what means synchronization?

The goal of synchronization is to assure that a flash light emission and an image capture by the camera occur simultaneously.

Light from the flash is not captured by camera sensor

Light from the flash is partially captured by camera sensor

Exposure and resulting image benefit from the flash illumination

Synchronization and system set up

The most common synchronization method is to use a camera output signal as a command to trigger a flash. In that approach, special care has to be taken to the time-lag between the trigger signal and the actual light emission. Camera settings have to be adjusted consequently, with camera latency in mind.

The other approach, basically opposite to the first one, consists in using a flash signal output as a command sent to the camera to start image acquisition, with a latency. Such an approach is made possible by the use of equipment with advanced features: the flash unit shall be able to detect the actual beginning of light emission before sending the trigger signal, and the camera shall have a known time-lag before actually grabbing an image. This is the most reliable set-up in terms of delays and synchronization management.

Why define and adjust synchronization between flash and camera?

#1: TAKE INTO ACCOUNT THE SYSTEM'S LATENCIES

In a flash unit, there is a time-lag between the trigger signal and the actual light emission (below 100µs for the best flash units).
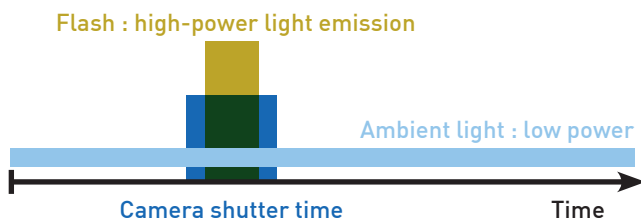
Cameras too have a time-lag before the beginning of integration. This time-lag is usually long ($\rightarrow$ 1 ms) on photographic still cameras, and most often undocumented.

Due to this diversity in time-lag, a flash unit shall not be used to trigger a still photographic camera if optimal synchronization is expected.

In an optimized system, both these time-lags shall be taken into account to ensure that the camera is able to capture all the possible light from the flash.

In this example, the camera ends image capture before the flash emission has ended, wasting light.
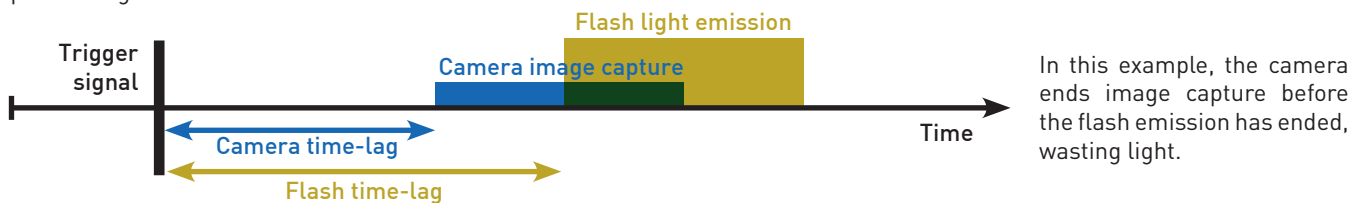
#2: MANAGE TIGHT TOLERANCES IN FLASH DURATION AND SHUTTER SPEED

In some cases, the flash duration and camera capture time are very short: tight management is mandatory.

For example, in order to produce images equally bright by day-time and by night, the short but powerful light from a flash must be made predominant over a weaker but continuous ambient light. This is possible when the camera shutter time is set not much longer than the flash duration.

#3: WORK WITH ROLLING SHUTTER SENSORS

In "Rolling Shutter" sensors, the information coming from the pixels is read sequentially, line by line, or "slot" by "slot" (see application note #7 "Global and Rolling Shutters"). During the short time-frame when all the lines or "slots" overlap and are exposed together, a short flash of light can contribute to expose all the pixels of an image. If the shutter time is too short, the lines or "slots" cannot overlap and may not all be equally exposed by a flash.
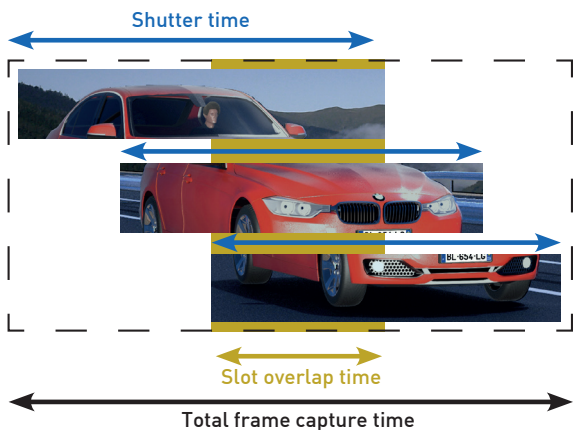

Illustration representing a "Rolling Shutter" sensor capturing an image in 3 slots

The "slots overlap time" is long enough under some conditions :

- **for a still camera,** if the camera's "shutter speed" is set below the "sync speed" specified by the camera's manufacturer. Only a short flash can freeze the image and avoid motion blur: that for, it has to be extremely powerful to surpass ambient light.

- **for a video camera or industrial camera,** shutter time shall be increased (i.e. shutter speed lowered) in order to create a "slot overlap time" long enough to accommodate a short flash. If the flash is longer than the total frame capture time, the light from the flash will be captured anyways.

- **special case:** a few video cameras do start capturing light at the same instant for all the lines, but do not end simultaneously. With such cameras, the flash must be predominant over ambient light, and must be off when the first lines stop capturing light so to avoid an exposure imbalance from line to line or from "slot" to "slot".