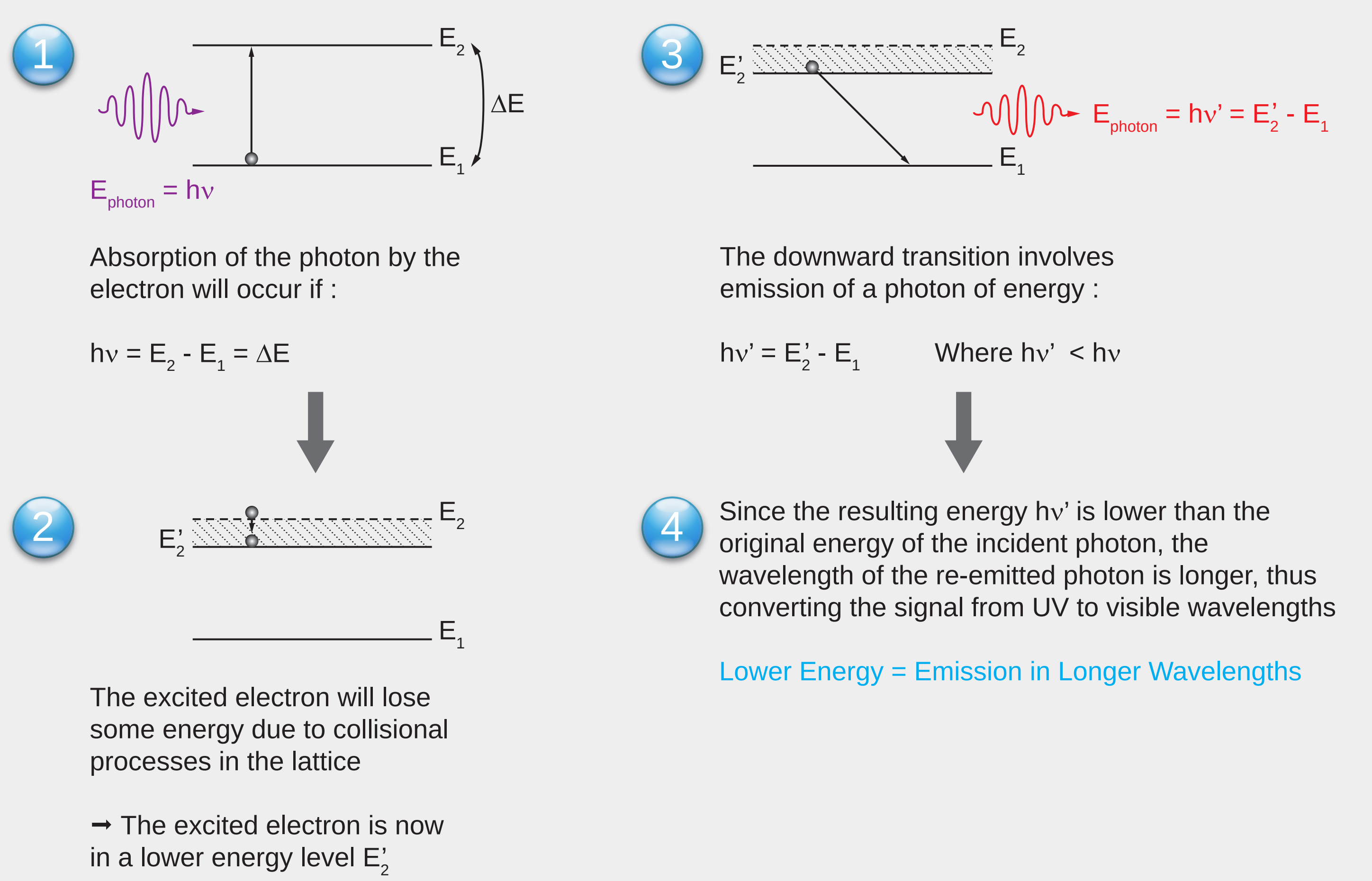
UV CONVERTER

UV Converters are used to extend the wavelength range of the Beamage-3.0 Series cameras into the UV. It consists of a tube extension containing optics and a conversion crystal that is simply screwed onto the aperture of the camera. The current document will go over the basic operating mode of the UV Converter for the Beamage-3.0 Series. It will also give a short procedure on how to chose the right UV Converter for an application.

How it Works: Fluorescence

The UV Converter takes advantage of a simple and very common phenomenon: fluorescence. Fluorescence is a luminescence that is mostly found as an optical phenomenon in cold bodies, in which the molecular absorption of a photon triggers the emission of a photon with a longer (less energetic) wavelength. In the case of the UV Converter, the absorbed photon is in the ultraviolet range, and the emitted light is in the visible and near-IR range, making it possible for the standard Si chips of the Beamage-3.0 cameras to 'see" the UV beams.

Figure 1: Fluorescence phenomenon and how the wavelengths are converted



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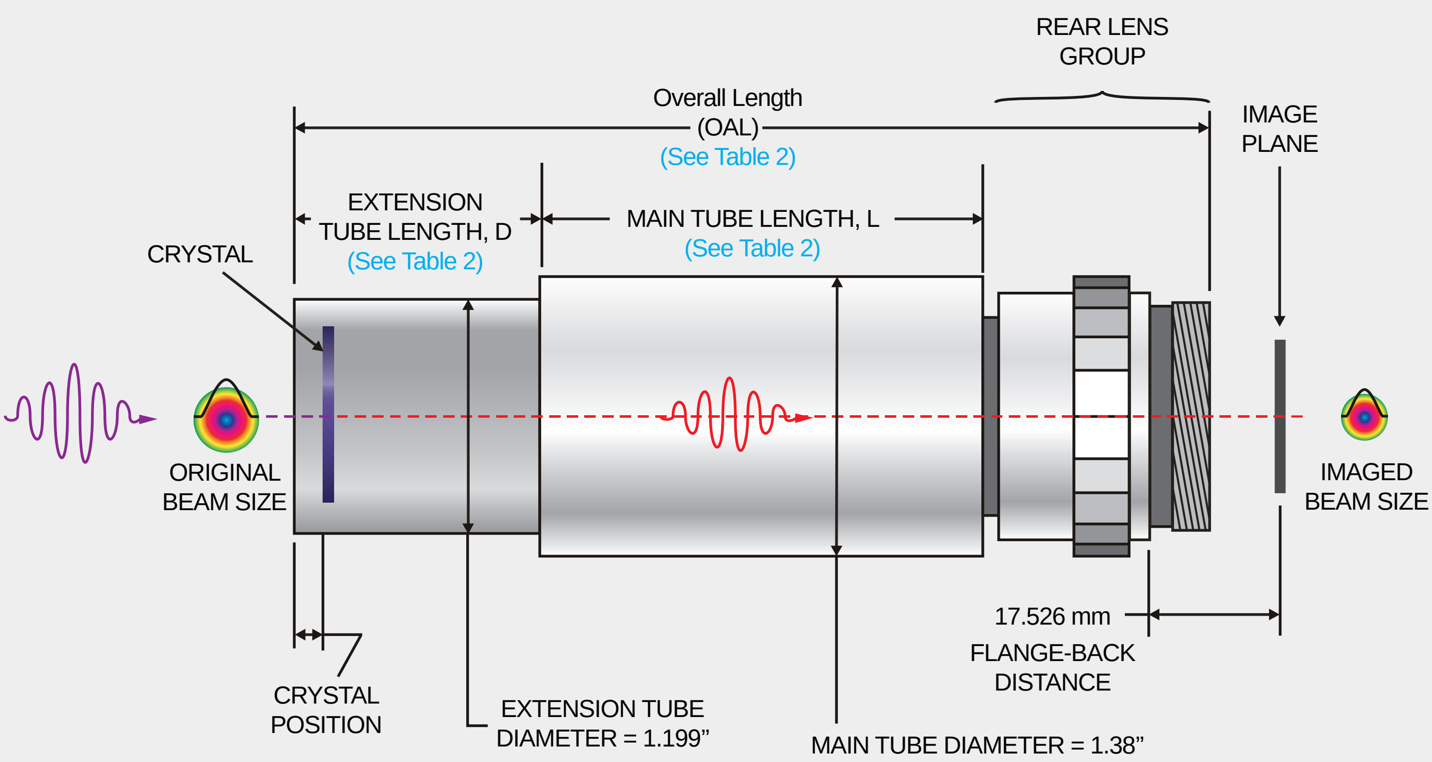
Technical Aspects and Dimensions

The UV Converters are designed to convert UV wavelengths to the visible and near-IR range and then re-image the beam onto a camera. In figure 2 below, we see that the fluorescent crystal is at the entrance of the converter, the rest of the device being mainly composed of optics, with an iris at the end to control the exposure on the sensing device. The emitted light is non-coherent and non-collimated. The multiple lenses in the converter affect the beam size, therefore, the UV Converters have magnification properties that are described in table 2. It is important to consider this when choosing the converter vs camera sizes since it means that the re-imaged beam can be smaller or larger than the original beam.

Figure 2: Diagram of the BSF Series UV Converters



Choosing the Crystal

The crystal is at the heart of the UV Converter. It is the part that decides which wavelengths can be converted, and how. When choosing the crystal, one has to consider many parameters at the same time: relative response vs laser wavelength, decay time vs repetition rate, saturation level vs laser power, etc. It is often possible to chose more than one crystal for an application.

Table 1: Crystal Specifications

Crystal Type	λ Range	Relative Response			Saturation Level (mJ/cm²)			Decay Time ➤	Max Rep Rate
		193 nm	248 nm	308 nm	193 nm	248 nm	308 nm		
C	110 - 225 nm	22	0.17	0.03	400	N/A	N/A	3 - 5 µs	30-20 kHz
G	X-ray - 400 nm	480	480	112	10	10	50	0.5 µs	200 kHz
P	110 - 350 nm	48	15	1	30	30	50	5 µs	20 kHz
R	110 - 532 nm	100	8	0.18	50	400	400	3000 µs	30 Hz

λ Range

Before looking at the rest of the specifications, the possible crystals should be chosen according to their wavelength range. Once that choice is determined, we can continue with the other parameters. Although all crystals can go down to 110 nm, it is recommended to chose C for 193 nm excimer lasers because of its very high saturation level at that wavelength.

Relative Response

The relative response specification is given in arbitrary units and gives a relative measure of the sensitivity of the crystal. The larger the number, the more sensitive the crystal will be at the specified wavelength. Care needs to be taken when choosing the crystal for the application; if the relative response is too small compared to the laser power, there may not be enough intensity at the end of the converter to do the profile. On the other end, if the relative response is too high, the crystal may saturate rapidly. This means that three factors should be considered simultaneously: relative response, saturation level and laser power.

Saturation Level

Just like the photo detectors, the crystals in the UV Converters have saturation levels. The higher the saturation level, the higher the power of the laser that can be profiled. At the end of the selection, If there is an equal choice between several crystals for an application, the final choice should go to the one(s) with the highest saturation level. This will ensure the user the widest range of possible laser powers. The saturation level also determines what outside attenuation will be needed

Decay Time

The fluorescence process explained in the first section isn't instantaneous. The molecule will stay in its excited state for a certain time before emitting a photon. This time is called decay time (sometimes referred to as lifetime). The decay time paremeter is important only for very fast (high repetition rate) lasers. For example, a 100 Hz laser cannot be used with a type R crystal since its decay time is too long (3000 µs). This paremeter should be verified at the end of the selection to make sure it will be fast enough for the laser. Any decay time is fine with lasers below 30 Hz.

Nomenclature

Before we start with the selection steps, lets check the various parts we will have to identify and their role in the part number of the converter:

Compatible Camera	Optical System Configuration	Magnification	Input Aperture	Crystal Type	Closest Camera Format	Camera Included?
B	**S**	**F**	**08**	**C**	**12**	**N**
B: Beamage-3.0	S: Straight (Default) R: Right Angle	F: Fixed (Default) Z: 6:1 Zoom V: Vacuum Flange for 6:1 zoom	08: 8 mm Ø 12: 12 mm Ø 23: 23 mm Ø 47: 47 mm Ø	C: C type Crystal G: G type Crystal P: P type Crystal R: R type Crystal	12: 1/2 inch 23: 2/3 inch	N: No camera

Table 2: UV Converter vs camera sizes with their respective magnification factors.

BSF Model	L (mm)	D (mm)	OAL (mm)	Max Beam Size on sensor (mm)	Min Input Beam Size (µm)	Max Input Beam Size (mm)	Magnification of the Converter
08X12	50	10.7	79.3	4.8 x 6.4	55	4.8 x 6.4	1
08X23	50	15.7	86.2	6.0 x 9.1	78	4.2 x 6.4	0.7
12X12	60	24.3	102.8	4.2 x 5.6	32	7.2 x 9.6	1.7
12X23	60	29.2	109.7	6.0 x 8.0	46	7.2 x 9.6	1.2
23X12	76.3	27.4	118.2	4.6 x 6.1	18	13.8 x 18.4	3
23X23	76.3	30.0	124.8	6.0 x 8.8	26	13.8 x 18.4	2.1

Note: $\text{Magnification} = \dfrac{\text{Max Input Beam Size}}{\text{Max Beam Size on the Sensor}}$