TECHNICAL NOTE

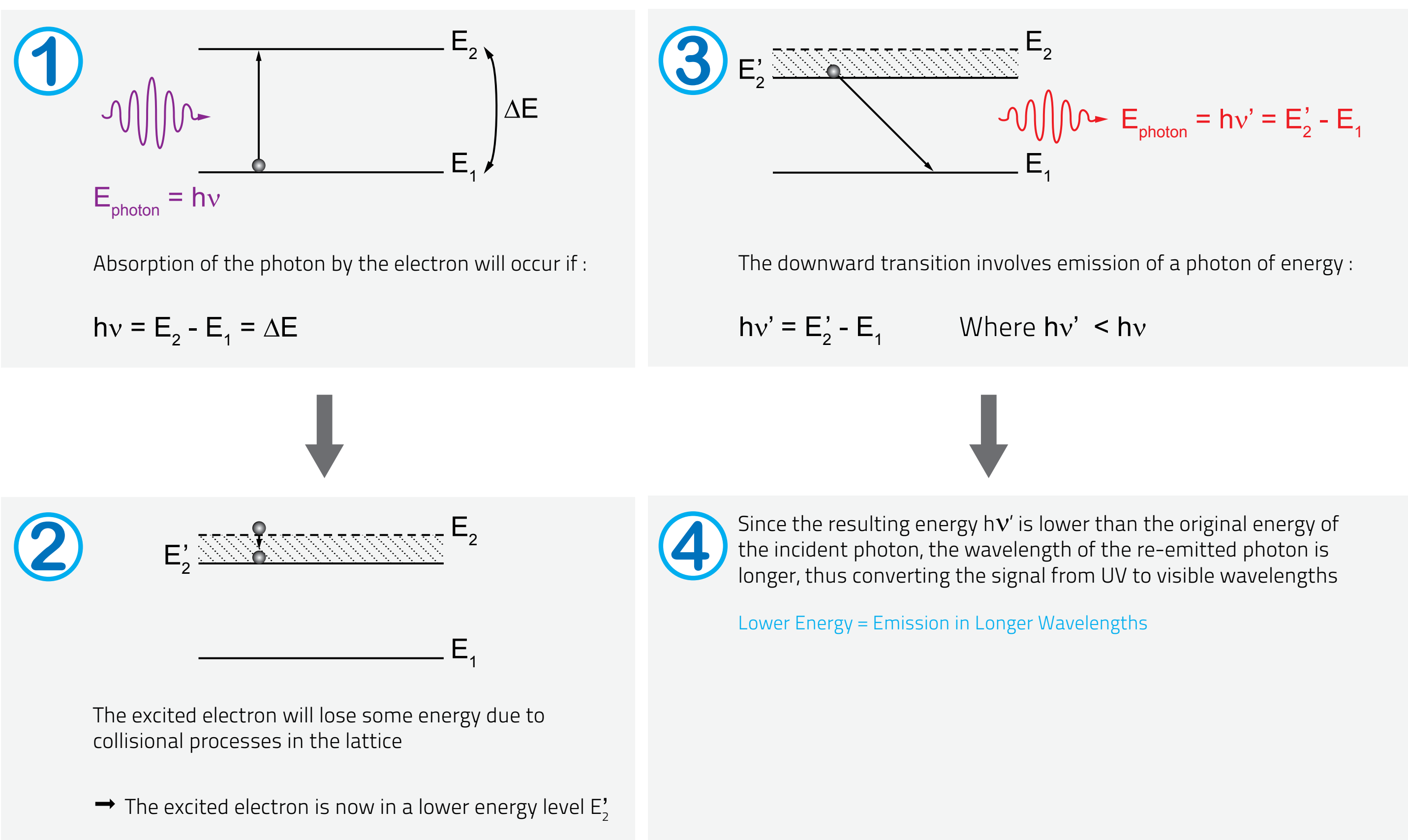
HOW TO CHOOSE A UV CONVERTER

UV Converters are used to extend the wavelength range of the BEAMAGE-4M 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-4M. 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-4M cameras to “see” the UV beams.

Figure 1: Fluorescence phenomenon and how the wavelengths are converted

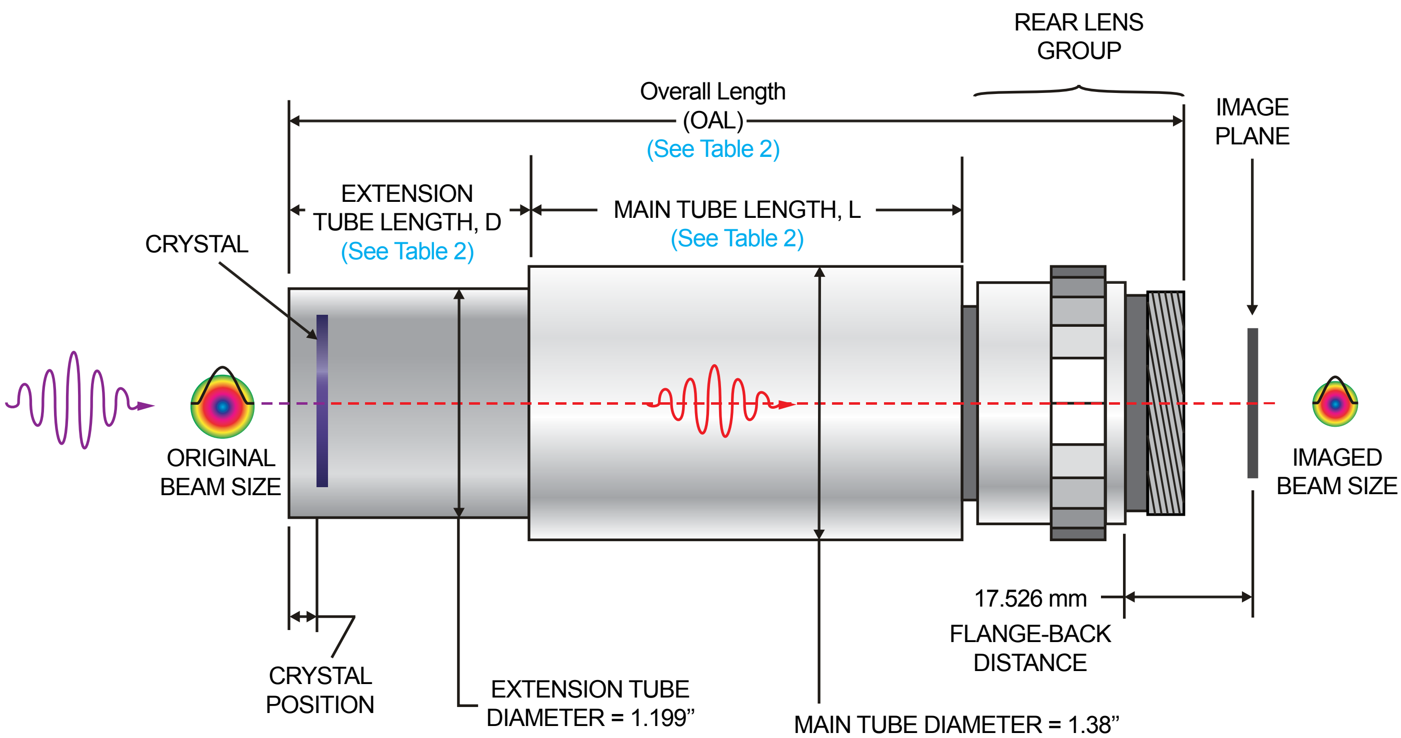


TECHNICAL NOTE

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



TECHNICAL NOTE

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: range vs laser wavelength, decay time vs repetition rate, saturation level vs laser power, etc.

Table 1: Crystal Specifications

Crystal Type	λ Range	Saturation Level (mJ/cm²)			Decay Time	Max Rep Rate
		193 nm	248 nm	308 nm		
C	110 - 225 nm	250	N/A	N/A	3 - 5 μs	20-30 kHz
G	X-ray - 400 nm	10	10	50	0.1 μs	1 MHz
P	10 - 350 nm	30	30	50	5 μs	20 kHz
R	110 - 532 nm	50	400	400	4000 μs	25 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 choose C for 193 nm excimer lasers because of its very high saturation level at that wavelength.

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 (4000 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 25 Hz.

TECHNICAL NOTE

NOMENCLATURE

Now that you have chosen the most important part of your UV Converter, the crystal, you can make up your product number using the nomenclature chart below:

Compatible Camera	Optical System Configuration	Magnification	Input Aperture	Crystal Type	Closest Camera Format	Camera Included?
B	**S**	**F**	**23**	**C**	**11.3**	**N**
B: Beamage-4M	S: Straight (Default)	F: Fixed (Default)	23: 23 mm Ø 47: 47 mm Ø	C: C type Crystal G: G type Crystal P: P type Crystal R: R type Crystal	11.3: 11.3 mm x 11.3 mm	N: No camera

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

BSF Model	L (mm)	D (mm)	OAL (mm)	Min Input Beam Diameter (µm)	Max Input Beam Diameter (mm)	Magnification of the Converter
23X11.3N	76.2	35	96.7	78.6	23	1.4
47X11.3N	43	87	214	183	47	2.9

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