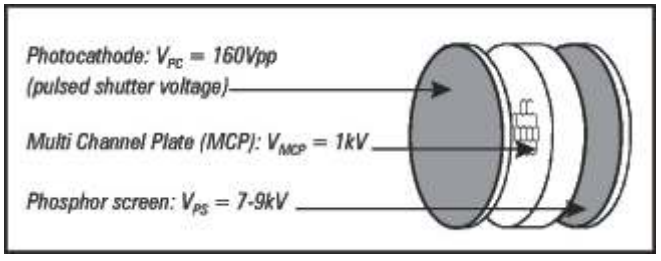
High performance image intensifier

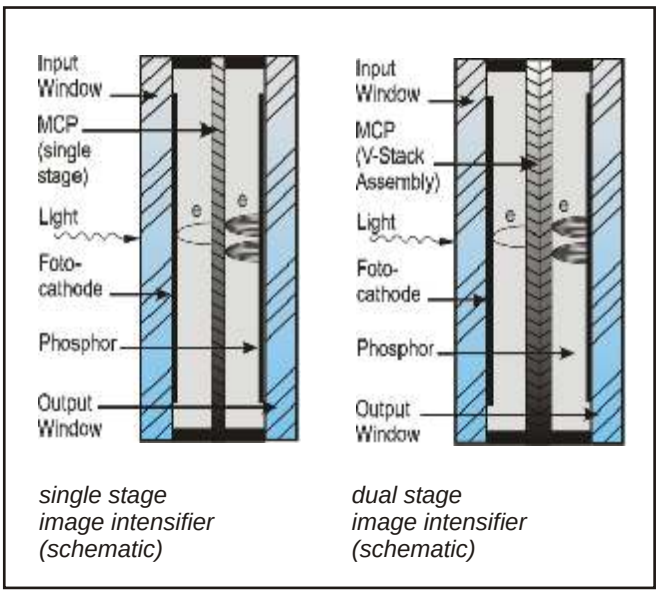
Guidance to make the right choices in order to get the most suitable image intensifier.

The image intensifier is a key component of each ICCD camera. This section deals with the fundamental characteristics of image intensifiers and their options.
Different applications of ICCD cameras have different demands and requirements on the camera and thus on the image intensifier.

Following questions need to be addressed

- What are the spectral characteristics of illumination?
  → Does determine the suitable photocathode.
- What spatial resolution is neccessary?
  → Does determine the size of the image intensifier.
- How fast need to be the shutter/shortest gating time?
  → Highest shutter speed does have some constrains to e.g. size of the image intensifier.
- How much light is there?
  → Dual stage MCP's have better performance at low light environments.
- High speed or low light imaging?
  → Does determine the suitable phosphor screen.





single stage image intensifier (schematic)

dual stage image intensifier (schematic)

First the incoming photon releases an electron in the photocathode, second the electron is accelerated and amplified to an electron avalanche within the multi-channel plate (MCP), third the accelerated electrons are converted into photons by the phosphor screen.

Photocathodes

	Type	Nb	Spectral range	
Standard	S20	I	UV - VIS	approx. 165 - 820nm
	S25	II	VIS - IR	approx. 350 - 920nm
Optional	S20 (MgF2)*	III	UV - VIS	approx. 110 - 820nm
	Broadband*	IV	UV - IR	approx. 190 - 920nm
	Solar Blind*	V	UV	approx. 180 - 340nm
	S1*	VI	IR	approx. 700 - 1300nm

** Please ask for availability in advance for 18 or 25mm MCP and 1.2ns minimum gate time.*

Image intensifier specifications

Diameter
The diameter of the image intensifier is one key parameter. The 18mm image intensifier provides high shutter speed and a higher specific resolution than the 25mm image intensifier. This makes the 18mm image intensifier to the standard and most suitable to many applications of ICCD cameras. If you are looking for the best spatial resolution with the drawback of slower shutter speeds the 25mm image intensifier is the preferred choice.

Shutter speed
The shutter speed is limited by the speed of light since any electromagnetic signal does not travel faster. Due to this physical constraint the shutter of the 25mm image intensifier is slower.

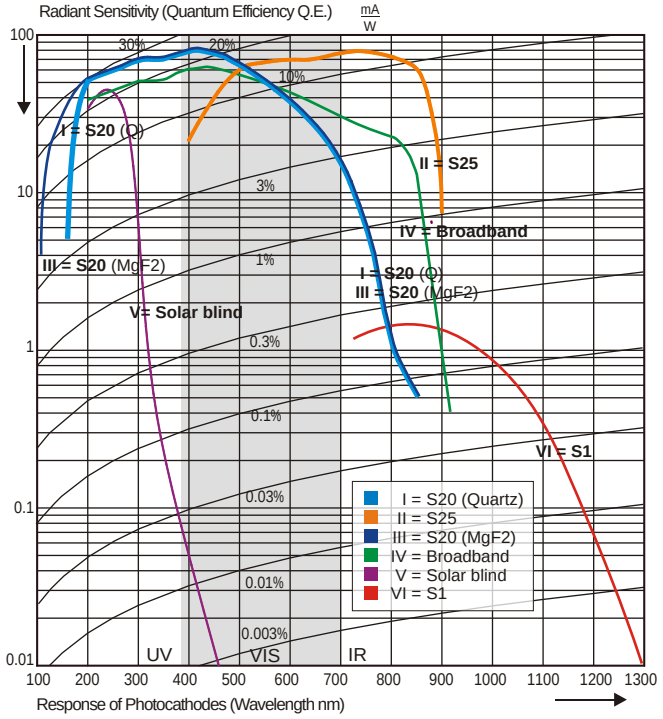
Input window
The standard input window is made of quartz. This limits the UV spectral range below 165nm. The optional Magnesium Fluoride (MgF2) window enables measurements down to 110nm.

Photocathode
Photocathodes define the sensitivity and the spectral response of the image intensifier.

Phosphor screen
There are three important considerations in choosing a luminous (phosphor) output screen.

1. spectral emission range
2. efficiency
3. phosphor decay time

The P43 phosphor screen has a higher efficiency, however, a longer decay time. For fast applications e.g. double frame mode with interframing time of 500ns the P46 phosphor screen is neccessary to avoid gost images from the previous exposure.



Multi-channel-plate (MCP)
Image intensifiers can be equipped with single or double stage MCP's. The single stage MCP features excellent signal gain and fits most applications of the ultra high speed ICCD cameras.

The V-stacked double MCP's are especially used for extreme low light environments. The increased electron multiplication provide single photon detection with increased signal to noise ratio and reduced ion feedback noise. Therefore, the double MCP is mainly used for long exposure measurements and extreme low light applications

Phosphor screen

Type	Composition	Efficiency	Decay time		Emission spectral range
			90% to 10%	10% to 1%	
P43	$Gd_2O_2S:Tb$	185 ph/e @6kV	1.5ms	3.3ms	360 - 680nm
P46	$Y_3Al_5O_{12}:Ce$	90 ph/e @6kV	0.2µs	10µs	490 - 620nm

Micro-channel-plate (MCP)

Type	Electron multiplication	S/N ratio	Notice
Single stage	up to 10^3	very good	best image quality
Double stage	up to 10^6	excellent	highest sensitivity