40 mm MCP Image Intensifiers

Introduction

ProxiVision offers large area image intensifiers with 40 mm active diameter. Check here the advantages and features of large-size image intensifiers.

Most efficient coupling to large area CCD

As a consequence of Liouville's theorem any optical demagnification (either by taper or by lens) is accompanied by a reduction of luminosity (N_φ m^{-2} s^{-1}). This applies to any stage of the optical chain: on the input side it applies to the projection of the image onto the image intensifier, the same holds true for the image transfer from the image intensifier onto the focal plane array (CCD or CMOS).

[The only exception from that law is the use of a demagnifying inverter, which on the other hand is restricted to fiber optics as an input substrate, thus limiting quantum efficiency and image quality.]

On the input side this effect is however more critical because any loss of input light will result in a loss of signal, whereas at the output it will affect only the signal intensity.

Therefore the performance of an optical sensor can be optimized in many cases by choosing a large area sensor with a matching image intensifier in front.

With the notable exception of night vision goggles, nowadays nearly all image intensifiers are combined to a focal plane array (CCD or CMOS). With ever increasing number of pixels, large area CCDs are of growing popularity. In particular scientific applications frequently tend to demand sensors larger than 25 mm. In such cases a 40 mm intensifier is the best choice because it allows to use the full active area without image demagnification, which would be accompanied by undesired side-effects, most notably distortion and reduced transmission.

Improved light collection with large active area

Not surprisingly, applications that require an image intensifier are typically light-starving. Thus any loss of light on the input side is to be avoided. The projection of the object onto the active device is accompanied with losses proportional to the squared aspect ratio. Thus a 40 mm intensifier will get 2.5 times increased number of photons compared to a 25 mm one.

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Faster acquisition upon direct contact with sample

One important usage of large intensifiers is the image acquisition in direct contact with self-emitting samples. The two most important fields of application are scintigraphy and X-ray imaging. As no lens can be used, the important parameter is the area directly covered because the acquisition time can be significantly reduced upon usage of a large-sized intensifier.

Advantages

In recent years, technologies competing with image intensifiers have been developed for low-light applications, known as EMCCD and sCMOS. Typical sensor formats are between about 8 and 21mm and thus considerably smaller than the 40mm image intensifier diagonal. As explained above, the reduction of the image size strongly affects the light collection from the object. Therefore an optical setup based on a large 40mm image intensifier format is more light-efficient than one with a smaller sensor but higher lens-optical demagnification.

Additional special features of image intensifiers are:

- gating (exposure time) down to 10ns for the 40mm type
- typical operation without cooling
- intrinsic light amplification before camera readout

Configurations

The common applications for 40 mm intensifiers typically require photocathodes for the visible spectrum, mostly for wavelengths below 600 nm. So S20 and Bialkali photocathodes are the most popular choices and they are well established at ProxiVision.

Indeed most short-gating applications are covered with a common S20 photocathode. The same is true in situations where the intensifier "looks" at a phosphor screen (e.g. in X-ray imaging). Furthermore S20 is more robust a photocathode than S25. For these reasons ProxiVision recommends the usage of S20 photocathodes. The S20 photocathode is also available as a broadband type with sensitivity in the UV and visible spectral range. Special “Solar-blind” or Bialkali photocathodes for the UV spectral range are available.

All useful configurations are ready for production:

- fiber or quartz input window
- UV / visible light sensitive photocathode
- single / double MCP
- glass / fiber output window
- high-voltage power supply available (ring with D=95mm or box type)
- gating electronics with integrated pulse generator available

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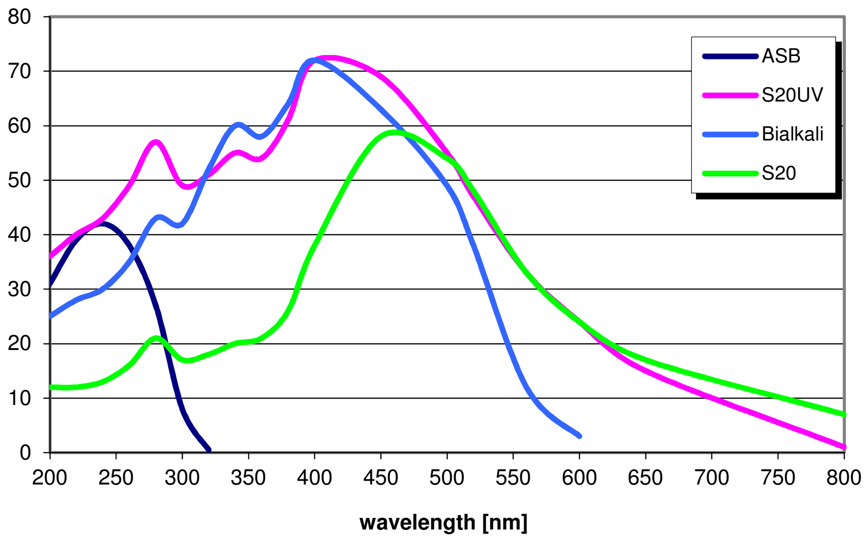
Typical specification

	single MCP	double MCP	
photocathode	Solar-Blind/Bialkali/S20		
sensitivity	50		mA/W @450 nm
useful diameter	40		mm
outer diameter	70		mm
outer length	≤23		mm
dynamic range	4000	1000	(over several frames incl. gain MCP adjustment)
resolution	⩾26	⩾22	lp/mm (for clear in/fiber out)
gain	>1E4	>1E6	W/W @480 nm
luminous non-uniformity	15	15	% st.dev. / mean
phosphor screen	P43/P46/P47		
input window	clear or fiber optic		
output window	clear or fiber optic		
electronic gain	>1E3	>1E6	el/el
EBI	<2E-7		lx
screen voltage	6		kV
gating	10ns - DC		ns

Spectral sensitivity



The sensitivities (in mA/W) shown above refer to non-gateable photocathodes on a quartz substrate.

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Blemish specification for 40mm MCP image intensifiers

	Total number of blemishes on D=40mm active area		
Image intensifier type	blemish size 0..80µm	blemish size 81..150µm	blemish size >150µm
clear input, clear output	minimal	2	0
clear input, fiber output	minimal	4	0
fiber input, fiber output	minimal	6	0

Comments

- "mininmal" means that the sum of all blemish areas of that blemish size class must not exceed 1% of the total active area.
- The size of a long blemish is considered equal to that of circular-shaped blemish with same area.
- Bright spots visible with a microscope and dark adapted eyes are not allowed at the recommended intensifier voltages inside the useful area of 40 mm.
- Same blemish specification for single and double MCP image intensifiers.

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