Chinese Optics Letters

Volume 10
Number 6
June 10, 2012
www.col.org.cn

Contents continued

Test and analysis of the halo in low-light-level image intensifiers

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Received September 7, 2011; accepted December 29, 2011; posted online March 5, 2012

A halo tester is designed to analyze the halo formation in low-light-level (LLL) image intensifiers and the influencing factors on halo size. The tester is used to collect a 0.1922-mm hole image directly using a CoolSNAP$_{K4}$ charge-coupled device (CCD) in a darkroom under illumination conditions between 10^{-2} and 10^{-4} lx. The practical measurement result shows that the amplification ratio is 343.4. Then, the super second- and third-generation image intensifiers are placed after the hole, and the halo sizes of the hole images on the screens are determined as 0.2388 and 0.5533 mm, respectively.

OCIS codes: 040.3780, 110.2990, 120.4570.
doi: *10.3788/COL201210.060401.*

The International Telephone & Telegraph (ITT) Corporation offers the third-generation (Gen III) image intensifiers of the F9800 (MX-10160) and the F9815 (MX-11769) series. These tubes include ITT's Pinnacle® technology, which surpasses the performance of all other previous and current Gen III tubes in the field. Each model in these Gen III 18-mm image intensifier tube series consists of a highly efficient GaAs photocathode bonded to a glass input window, a microchannel-plate (MCP) current amplifier, and a P-43 phosphor screen deposited into an inverting fiber-optic output window. ITT has reported the performance parameters of these Gen III 18-mm image intensifiers. According to ITT's tube halo effect test, the input light spot diameter is 0.35 mm. The minimum resolutions for the F9800 and the F9815 series tubes are both 64 lp/mm. The maximum halo size for the F9800 series tubes is between 0.70 and 1.25 mm, and that for the F9815 ones is between 1.00 and 1.25 mm[1]. For the super second-generation (Gen II+) image intensifiers produced by PHOTONIS Corporation, the minimum resolution is between 45 and 64 lp/mm, and the maximum halo size, without the input light spot diameter, is between 0.8 and 1.0 mm[2]. PHOTONIS Corporation has conducted an experiment in the same environment observed with different night vision systems. The halo sizes are typically 0.8 and 2.0 mm for XR5™ and Gen III, respectively[3].

For the proximity focusing system of the low-light-level (LLL) image intensifiers, the pre- and post-proximity distances both determine the halo size. The shorter the distance, the smaller the halo size. A halo is not an important performance parameter for image intensifiers[4−7], but it indirectly affects the resolution and signal-to-noise ratio (SNR). Recently, studies on the halo size for LLL image intensifiers are scarce. Although foreign researchers have reported the halo size for different tubes, the halo sizes of domestic image intensifiers have not been studied. Thus, a halo tester was designed to analyze the formation mechanism and influencing factors of the halo on the image intensifier screen. The images of a 0.1922-mm hole on the Gen II+ and Gen III image intensifier screens were collected using a CoolSNAP$_{K4}$ charge-coupled device (CCD).

As stated earlier, the image intensifiers consist of a photocathode, a MCP, and a phosphor screen[8,9]. When a bright light spot of a certain size is viewed through LLL image intensifiers, the image of the input light spot on the phosphor screen can appear as a "halo" that is much larger than the "weak-signal" point spread function of the image intensifiers[10].

After a small light spot irradiating the photocathode of image intensifiers, the halo effect of image intensifiers is tested and the halo image is collected using a high-resolution CCD. The small input light spot diameter is usually between 0.1 and 0.4 mm, and the light spot can be obtained using a projection lens or an aperture. In this letter, the small light spot is obtained using an aperture because the photocathode surface of the tested image intensifier in the experiment is flat. The halo tester includes a light source, filters, an integrating sphere, a small hole, a photoelectric detector, a light-tight box, a magnifier lens, a CoolSNAP$_{K4}$ CCD, and a mechanism, as shown in Fig. 1.

The light-source component consists of a light source, filters, an integrating sphere, and a small hole. The light source is the OSPAM halogen lamp, whose working voltage and power are 6 V and 10 W, respectively. The light-source component should produce a uniform light spot with a certain illumination to prevent saturation when the CCD collects the halo image on the image intensifier screen. The integrating sphere insures that the input light spot is uniform. The light spot illumination

