HyperCal and Comet Tail Elimination (CTE)

Introduction

When using DataRay CCD products, a vertical comet tail or 'smear' may appear in the image data. This is caused by incident light leaking past the metal sensor plate and onto the vertical transfer registers, which most often occurs at short exposure times, long wavelengths, or non-orthogonal beam incidence. This note discusses means of reducing the comet tail effect as well as the specifics of both the Comet Tail Elimination and HyperCal features available in DataRay software, including how they are implemented and when they can be used. For more information on CCD sensors and the comet tail effect, see Smear in CCD-Sensors.

Implementation

Both HyperCal and Comet Tail Elimination are implemented in the same way, using a background subtraction technique to remove unwanted background patterns from measurements. A dark frame with the lowest possible exposure time (zero-exposure frame) is captured every 16 frames during live data capture and is continuously averaged with previous dark frames up to a 5 frame average. This continuously updated dark frame is subtracted from each full exposure image during live data capture to remove unwanted background patterns. The uses of the two features differ in that Comet Tail Elimination is purposed for use with DataRay CCD cameras to correct the comet tail described above, while HyperCal is useful with non-CCD cameras for reducing fixed pattern noise in any image.

The **Comet Tail Elimination** toolbar button  toggles that feature when using a CCD device. The **HyperCal** toolbar button  toggles that feature when using a non-CCD device. Depending on the device type, one of the buttons will be grey and unusable.

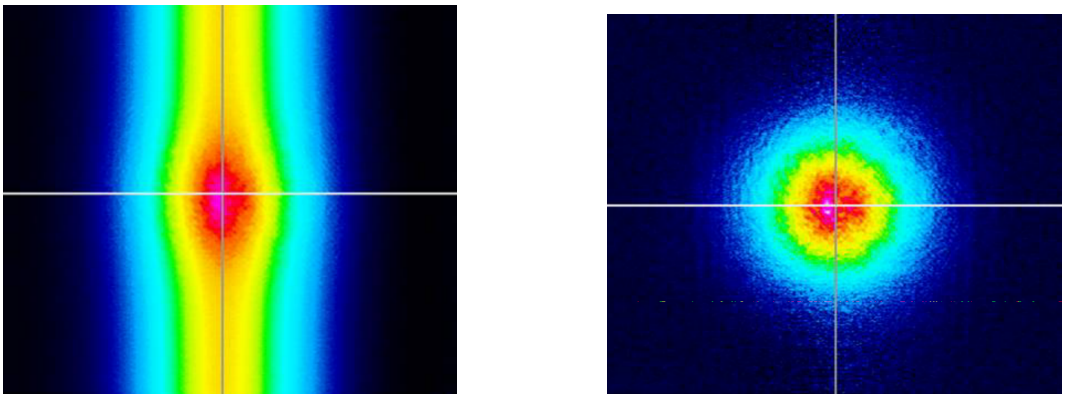
Comet Tail Minimization

The following are the first steps to minimizing an existing comet tail:

- Use exposure times at greater than 10 ms whenever possible. Always use exposure times greater than 1.0 ms. This requires using more attenuation.
- Ensure that light is incident at as close to 90°as possible, fine tuning the angle around the vertical axis of the sensor.
- Optional: Set the crosshairs to 45°to move the measured profile off the comet tail.

Using Comet Tail Elimination

The images in Fig. 1 were taken with a CW 1064 nm beam. Beams with such long wavelengths can create severe comet tails. To eliminate the comet tail in Fig. 1a, toggle the **Comet Tail Elimination** toolbar button to the on state. The resulting image is shown in Fig. 1b (with **Average 20**).

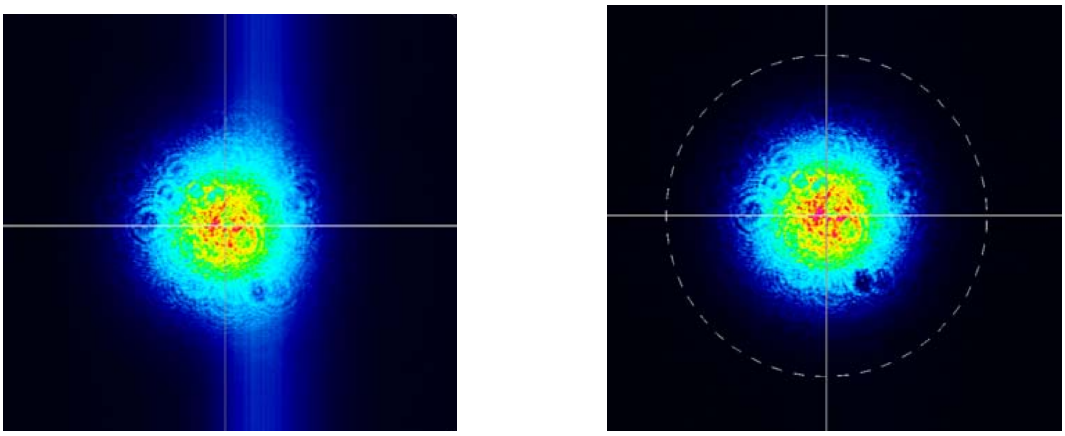


(a) Comet tail caused by long wavelength of incident light

(b) Result of engaging DataRay **Comet Tail Elimination**

Figure 1: Images taken using beam with long wavelength (1064 nm) to demonstrate comet tail

The images in Fig. 2 were taken with a 675 nm laser at an exposure time of 0.043 ms. Such short exposure times can also produce a comet tail, though not typically as severe as those caused by beams with long wavelengths.



(a) Comet tail caused by short exposure time

(b) Result of engaging DataRay **Comet Tail Elimination**

Figure 2: Images taken using short exposure time (0.043 ms) to demonstrate comet tail

Limitations of HyperCal and CTE

If the ADC values of the zero-exposure frame (see **Implementation**) are too high to be handled properly (greater than 15% of ADC peak), a red warning reading 'Exposure too low for HyperCal' will appear near the bottom left corner of the image (see Fig. 3). If such a warning appears, decrease the beam power or increase attenuation until the warning disappears.

Figure 3: A warning for extreme leakage occurs at 15% of ADC Peak. Lower the incident power or increase attenuation for valid measurements.