How to use the HotSpot / ColdSpot tool in RT32

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Outline

RT32 colors each displayed pixel in the measured image according to its luminance. A pass-fail color-mapping scheme is helpful to quickly identify regions that are within and outside of user defined tolerances. Typically the pass-fail mapping scheme looks as follows:

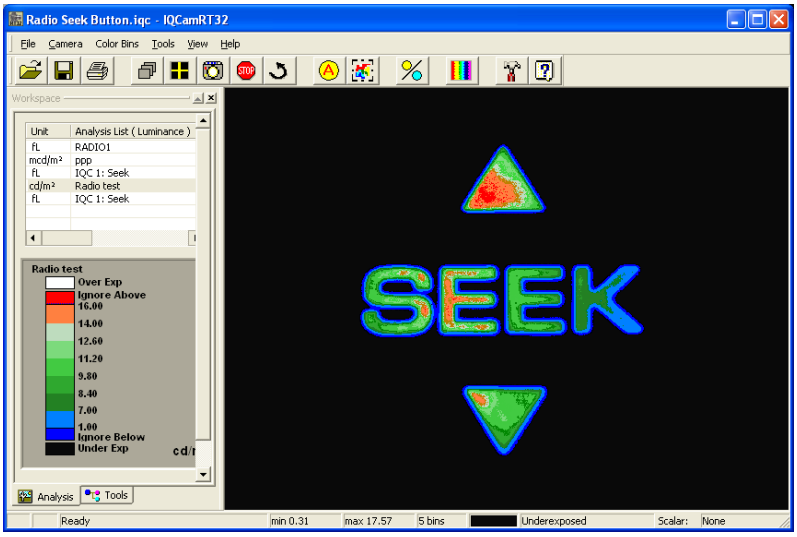


Figure 1: Pass-Fail testing shades dimmest areas blue, and brightest areas are shaded red or orange

The HotSpot / ColdSpot tool in RT32 is designed to quickly locate apertures which are too luminous or not luminous enough when compared to user supplied limits. For example, if characters on a specific production radio display should have a luminance of between 1.5 and 3.0 cd/m^2, the HotSpot / ColdSpot tool in RT32 will search over the entire image and report the apertures (if any) which have an average luminance value below 1.5 and above 3.0 cd/m^2.

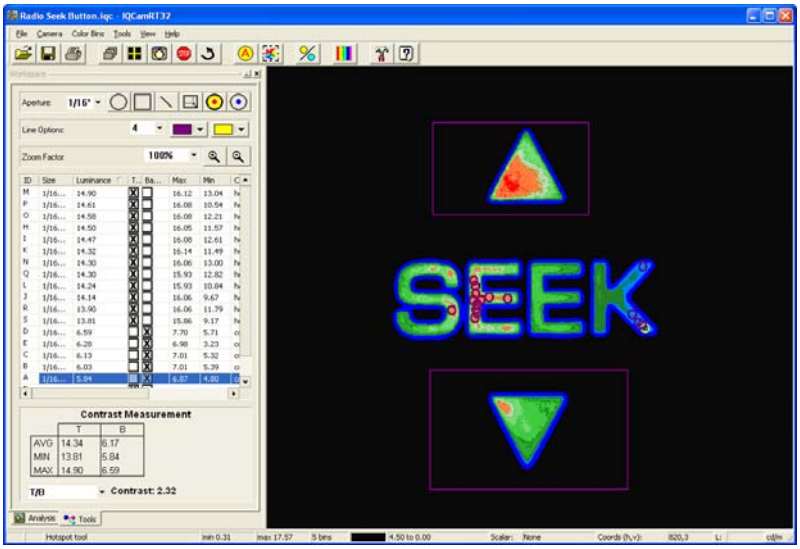


Figure 2: The HotSpot / ColdSpot tools identify several apertures which have average luminance values above and below the user tolerance values. Boxes have been drawn around the up and down arrows to exclude them from the HotSpot / ColdSpot search.

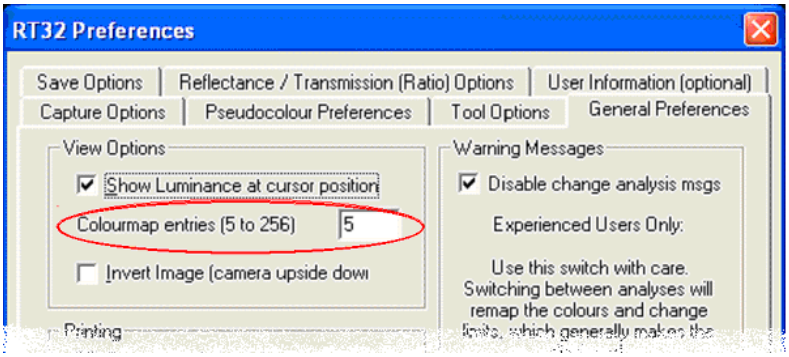
Procedure - How to use HotSpot / ColdSpot tool

There are four steps to setting up a measurement:

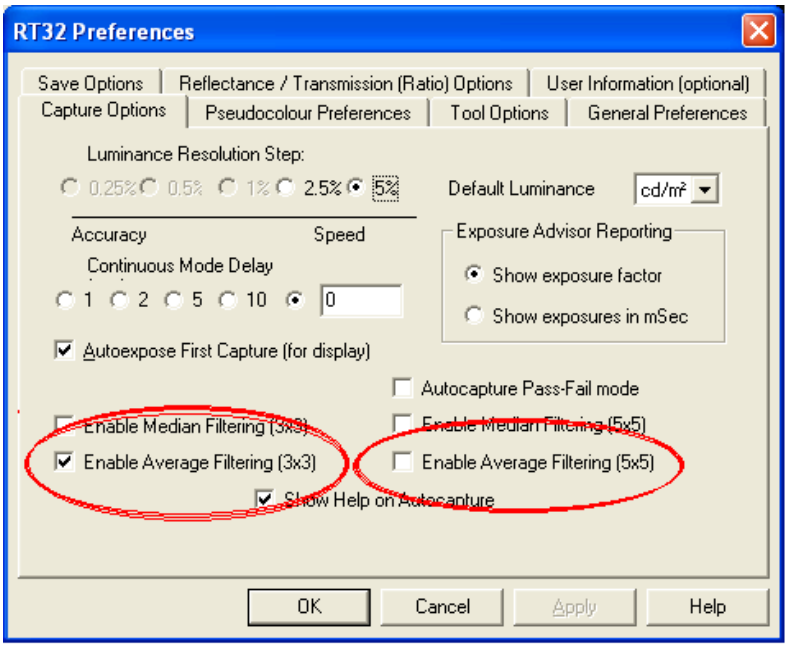
- Create an analysis
- Determine the character stroke width
- Setup the HotSpot / ColdSpot preferences
- Choose an appropriately sized aperture

1. Create an analysis with 5 colors

This is the default setting for pass-fail mode.
You can set the default for all new analyses to 5 color mode under Preferences – General Preferences as below:

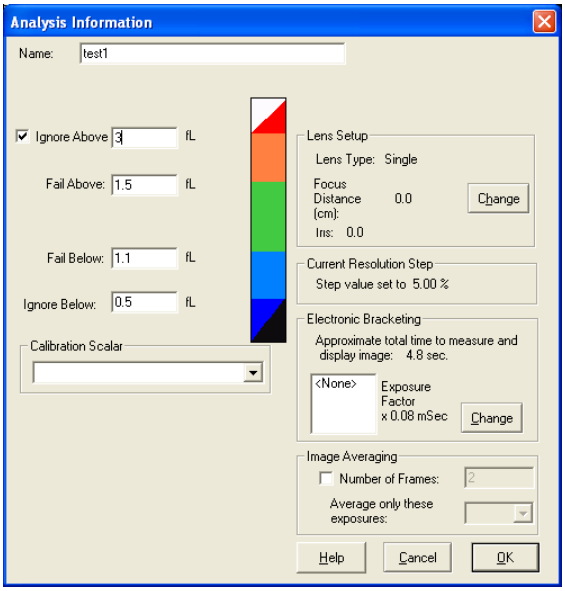


2. Choose averaging in the Preferences



Chose average filtering (3x3) for normal graphics. For apertures which have diameters of over 20 pixels use 5x5 averaging. Averaging greatly improves the ability for the HotSpot / ColdSpot tool to quickly and robustly locate the apertures of interest, especially for displays with very fine luminance speckling (high non-uniformity in very small areas – yet much more uniform after the averaging filter is applied).

3. Setup the analysis and capture



Input the Fail Above and Fail Below limits from your specification.
Set the Ignore Below value to be about half of Fail Below.
Set the Ignore Above value to be about twice the Fail Above value.
Finish defining the analysis

4. Capture an image of a graphic panel using the new analysis

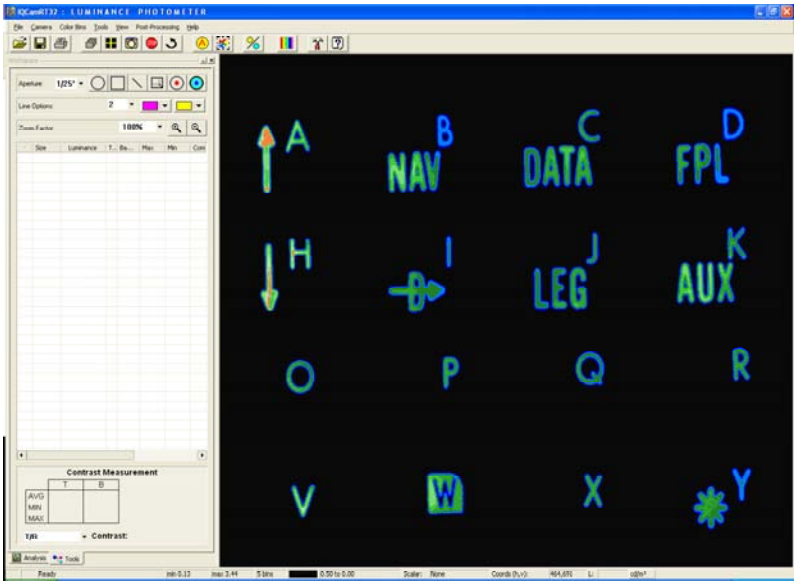


Figure 3: Sample screen shot of captured radio panel with a bright knob backlight. The Pass-Fail region is 1.1 to 1.45 ftL.

Check that the entire graphic characters are acquired within the wider limits of Ignore Above. If some of the areas of interest are white, black, red or dark blue, adjust the analysis limits and measure again.

5. Determine the stroke width of your graphic.

Use the ruler function or the mouse cursor while looking at the (h,v) coordinates displayed in the status bar lower right corner to determine the number of pixels across a stroke (character). You will likely need to zoom in 500x or greater to see the pixels clearly. The number of pixels across the stroke which are clearly inside the character, and not straddling the edge, should be counted.

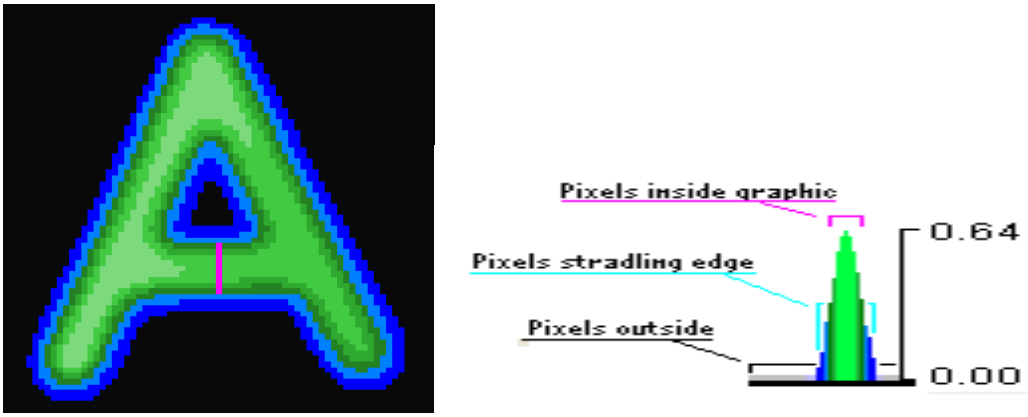


Figure 4: In this example the graphic for the letter A is zoomed 900% so that individual pixels are clearly visible. A ruler across the “bridge” in the letter also shows there are 7 pixels across the character stroke.

We recommend a minimum of 7 pixels across the stroke for imaging photometry to report reliable results. (More pixels across the stroke are better of course, but then the area of coverage is also smaller.)

Set up the HotSpot / ColdSpot preferences

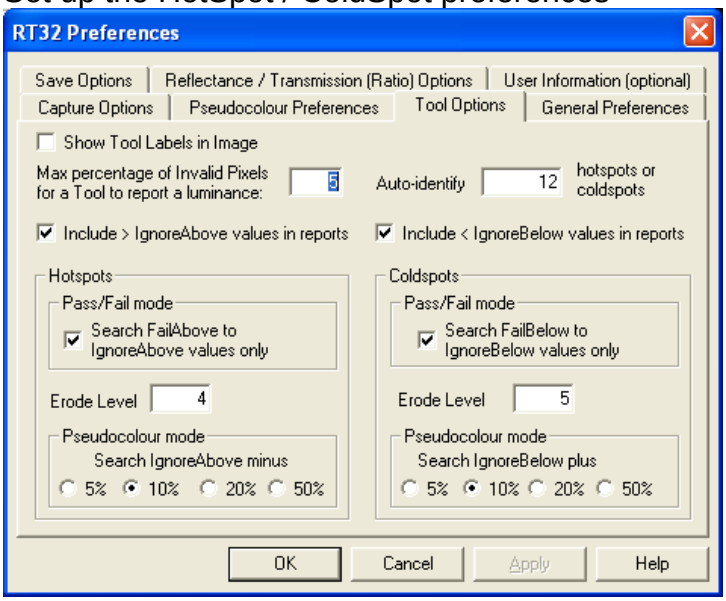


Figure 5: Preferences window

Max percentage of invalid pixels: Some pixels might not have been acquired as they were either under exposed or over exposed. This function sets a limit on the maximum percentage of invalid pixels which are contained in an aperture for said aperture to be reported to the user. For testing luminous graphics try setting the maximum number of invalid pixels at 5%. If the limit for invalids is exceeded, the tool will report “Err” for luminance.

Auto-identify N HotSpot / ColdSpots: This sets the number of apertures which the HotSpot / ColdSpot tool will attempt to identify for either the hotspot or the ColdSpot function in a single pass.

Include > IgnoreAbove | *< IgnoreBelow values in reports*: Values which are below IgnoreBelow or above IgnoreAbove they can be treated as invalids and not considered in the aperture results. In general, select both of these options if all of the areas of interest are between ignore below and ignore below. This feature is useful when you have pixels that cannot be excluded (from the analysis) in other ways.

HOTSPOTS

Search FailAbove to IgnoreAbove values only, Pass-Fail mode only: Select this if you want to locate apertures which fail because they are too bright. Deselect this if you also want to locate the most luminous apertures in the scene whether or not they fail.

Erode Level: This setting is critical for hotspot to work well. Set the erode level to be about 25 to 30% of the number of pixels across a stroke. For example if there are 13 pixels across a stroke, chose an erode level of 3 for hotspot. Operators can play with the parameters to achieve the best results for given panel types.

Stroke width (pixels)	spot size (pixels)	Erode level (pixels)
8	4	2
9	4	2
10	5	2
11	5	2
12	6	3
13	6	3
14	7	3
15	7	3
16	8	4
17	8	4
18	9	4
19	9	4
20	10	5

The hotspot tool will now consider centering any apertures only within the eroded areas.

Pseudocolour mode: This tool searches the pixel values in the scene which are within x% of the brightest pixel. This mode does not take into account Pass/Fail criteria. This mode becomes the default if there are more than 5

colors in the pseudocolour mapping scheme (i.e. Not the Pass/Fail scheme of dark blue, blue, green, yellow, red) When in Pass/Fail mode, this setting has no effect.

ColdSpots

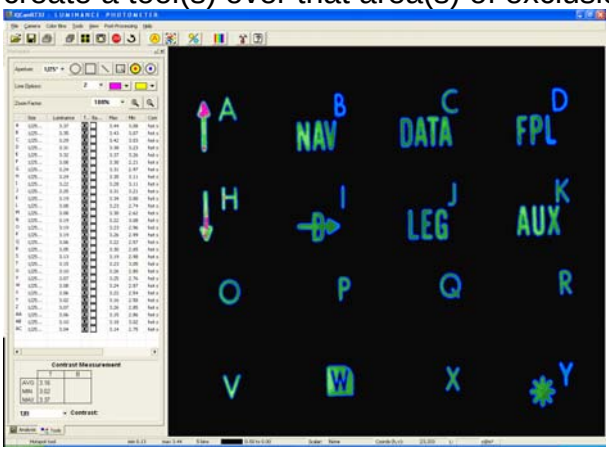
Search FailBelow to IgnoreBelow values only, Pass-Fail mode only: Select this if you want to locate apertures which fail because they are too dim. Deselect this if you also want to locate the most luminous apertures in the scene whether or not they fail.

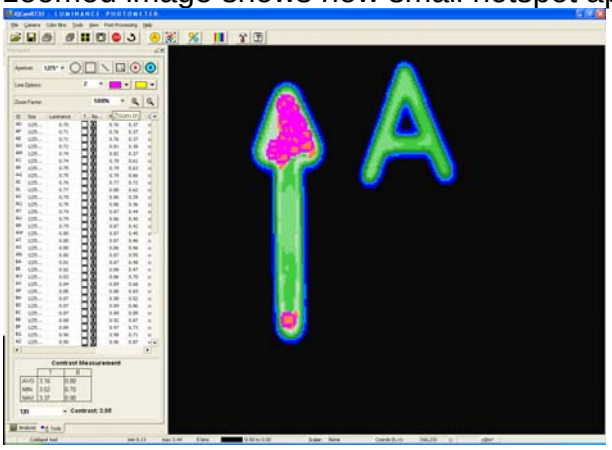
Erode Level: This setting is critical for ColdSpot to work well. Set the erode level to be about 35 to 40% of the number of pixels across a stroke. (That is a bit more than is used for hotspots.) For example if there are 13 pixels across a stroke, chose an erode level of 4 or 5 for ColdSpots. Operators can play with the parameters to achieve the best results for given panel types.

Stroke width (pixels)	spot size (pixels)	Erode level (pixels)
8	4	2
9	4	3
10	5	3
11	5	3
12	6	4
13	6	4
14	7	5
15	7	5
16	8	6
17	8	6
18	9	7
19	9	7
20	10	8

The ColdSpot tool will now consider centering any apertures only within the eroded areas.

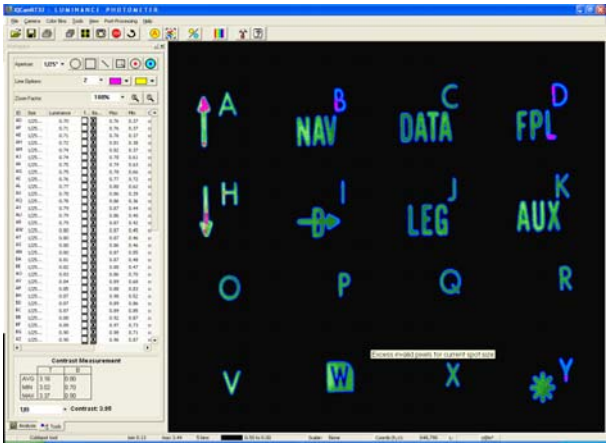
Pseudocolour mode: This tool searches the pixel values in the scene which are within x% of the brightest pixel. This mode does not take into account Pass/Fail criteria. This mode becomes the default if there are more than 5 colors in the pseudocolour mapping scheme (i.e. Not the Pass/Fail scheme of dark blue, blue, green, yellow, red) When in Pass/Fail mode, this setting has no effect.

6. **Applying the Hotspot tool:** 
    a. Choose an Aperture size which is ideally 50 to 70 percent of the minimum stroke width.
    b. Select hotspot.
        i. The software searches out the largest pixel values which are above the fail above value
        ii. If there are not too many invalids in the aperture drawn with that bright pixel at the center, then the aperture is reported.
        iii. The next highest pixel found is then searched and so on, until the requisite number of hotspots have been found, or the software can find no more.
    c. The reported tool list is displayed and sorted according to the maximum pixel value in each aperture. Some apertures might have average luminance values which pass even though some pixels do not meet the limits. Hotspots are identified as target values.
    d. Note: The tool will not place any new apertures which are centered inside an existing aperture, but tools may overlap less than 50% of an existing aperture area. If you wish the application to exclude an area, create a tool(s) over that area(s) of exclusion.
    e. 

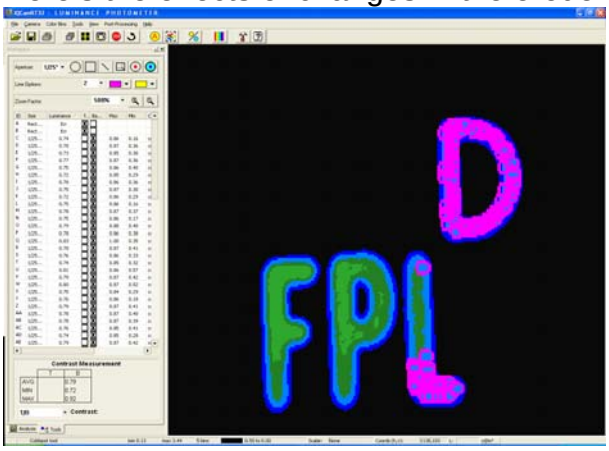
    These screen shot shows HotSpots clustered in two locations. The zoomed image shows how small hotspot apertures overlap.


7. **Apply the ColdSpot tool:** 
    a. Using the same aperture, as for Hotspot, select ColdSpot.
        i. The software searches out the minimum pixel values which are below the fail below value
        ii. If there are not too many invalids in the aperture drawn with that pixel at the center, then the aperture is reported.
        iii. The next dimmest pixel found is then searched and so on, until the requisite number of ColdSpots has been found, or the software can find no more.

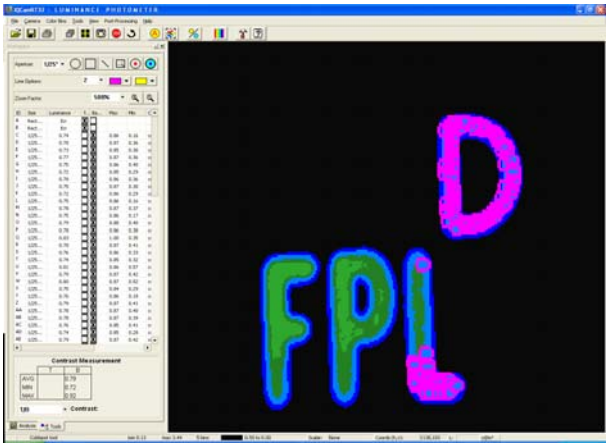
    b. The reported tool list is displayed and sorted according to the maximum pixel value in each aperture. Some apertures might have average luminance values which pass even though some pixels do not meet the limits. Hotspots are identified as target values; ColdSpots are automatically identified as background values.



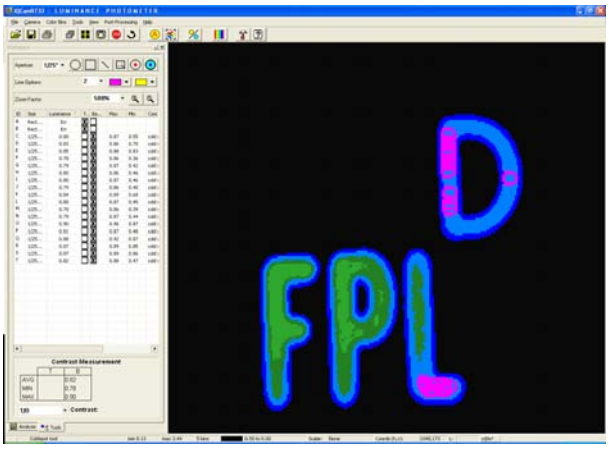
Here's the effects of changes in the erode level.



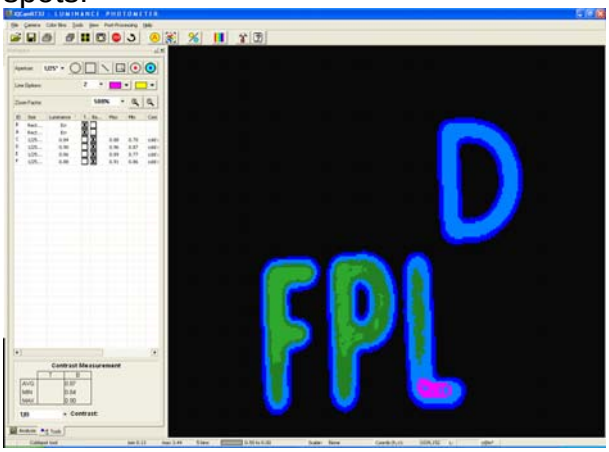
Erode level=2 picks out most of the "D" and portions of the "L".



Erode level =3 (in this case) gives essentially the same result as level 2.



Erode level =4 shows significant reduction in the number of reported spots.



Erode level =5 has caused the “D” and most of the “L” to be excluded from the search process, and the number of cold spots is minimized. If you were to set the erode level to 6, no spots would be reported, because the regions of interest have been completely eroded away, although the character is still visible.