

# Variable Message Signs (VMS)

## Objective

Variable message signs (VMS) are increasingly used in the transportation sector to give information in order to improve and make the journey more efficient and safe. The visibility of these signs is of major importance.



In order to characterise and test the visibility of a message given on variable message signs an upcoming European Standard prEN 12966-1:2004 "Road vertical signs - Variable message traffic signs - Part 1: Product standard" specifies requirements and test methods for VMS.

The photometric and colorimetric tests are comprehensive, but with ICAM, an imaging photo- and colorimeter, tests can be done in a few 'shots'. In figure 1 an example of a VMS, with 64 lines and 144 columns of LED's, is shown. With ICAM the app. 10.000 LED's are measured simultaneously.



Figure 1. ICAM image of a variable message sign (FOCON demo LED display).

## Measurements

With only two 'shots' the following test results were obtained. By vision techniques the position of each LED is identified to sub pixel accuracy. Then the light from the LED is sampled in the image data and the luminance's and colour coordinates are calculated.

## Luminance ratio (LR)

To ensure that the VMS can be read during direct sunlight, the luminance of the VMS is measured twice (LED's on and off) when directly illuminated by a solar simulator. See figure 2. The luminance ratio is calculated as  $LR = (L_{on} - L_{off})/L_{off}$ , and is in this example calculated to  $LR > 6$  and fulfils class R2 for yellow light and a sign illuminance of 4000 lx.

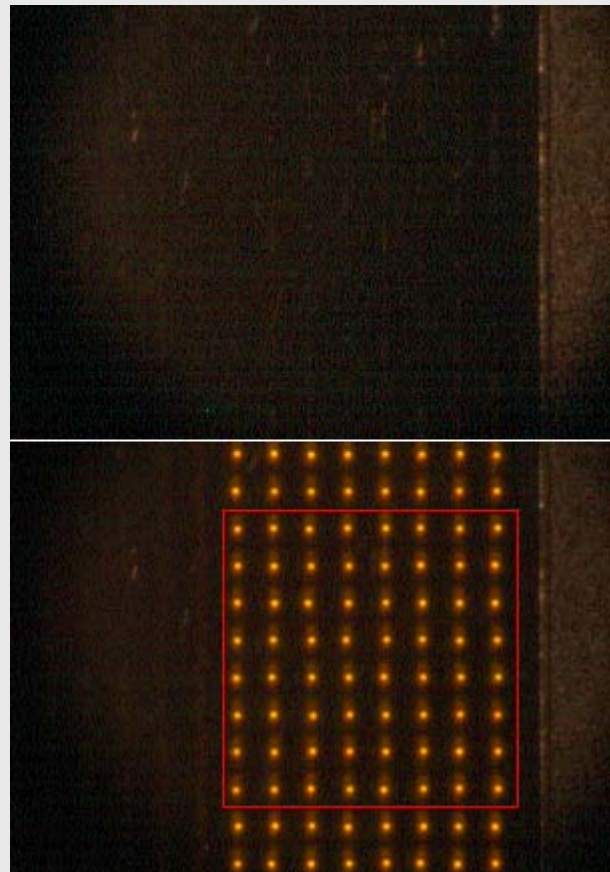
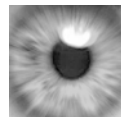


Figure 2. VMS illuminated by solar simulator. Top: no message. Bottom: with message. Red square indicates the area used for calculation of the luminance ratio (LR).



## Colour

The colour and colour variation of the message is important. In this example only yellow LED's are used. In figure 4 is shown the yellow colour border and the measured colour of  $8 \times 15$  LED's

See figure 11. The average wavelength was  $591.4 \text{ nm} \pm 1.55 \text{ nm}$  and all the LED's fulfil the yellow colour requirement.

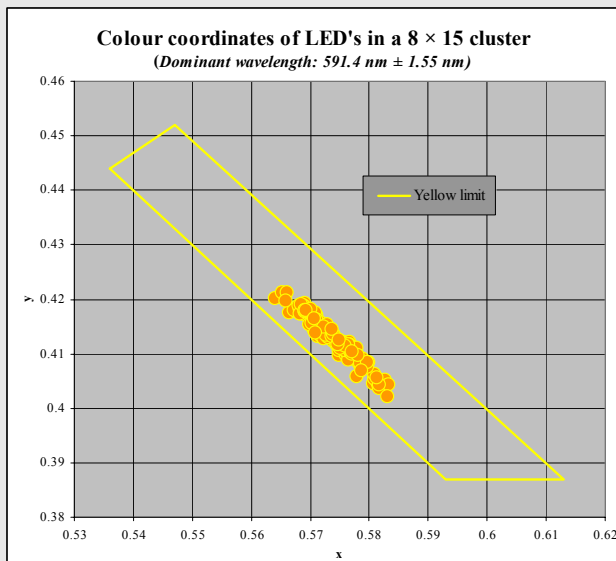


Figure 4. The colours of  $8 \times 15$  LED's compared to the yellow limit.

## Uniformity

According to prEN12966 the uniformities is calculated by two ratios. Between the 12 % most bright LED's and the 12 % least bright LED's and between the 4 % most bright LED's and the 4 % least bright LED's. The 12 % ratio is calculated to 1.28:1 and the 4 % ratio is calculated to 1.39:1. The requirements are respectively less than 3:1 and less than 5:1.

## Other features

From the same 'shots' a variety of other features can be extracted.

## LED statistics

From the geometry and the photometric values extracted from the ICAM data it is possible to calculate the luminous intensity of the LEDs. In figure 5 a histogram over the luminous intensity distribution is given and in figure 6 a histogram over the dominant wavelength distribution is given. From these diagrams it will be simple to evaluate if the LED supplier fulfil his specifications.

In figure 7 the measured relationship between luminance and dominant wavelength is given. From the 'best fit' line equation it can be found that the luminance variation causes a dominant wave-

length variation of app. 2 nm. Correcting the wavelength for luminance variations reduces the standard deviation of the dominant wavelength with app. 50%.

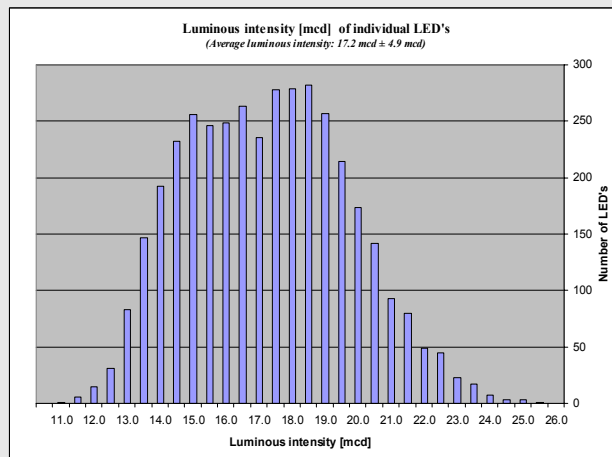


Figure 5. Variation of LED luminous intensity.

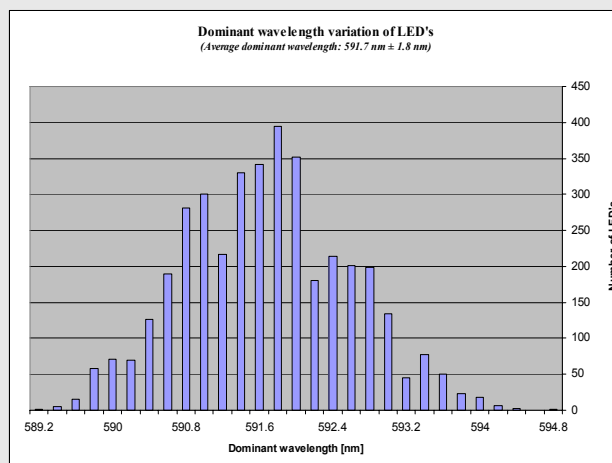


Figure 6. Variation of LED dominant wavelength.

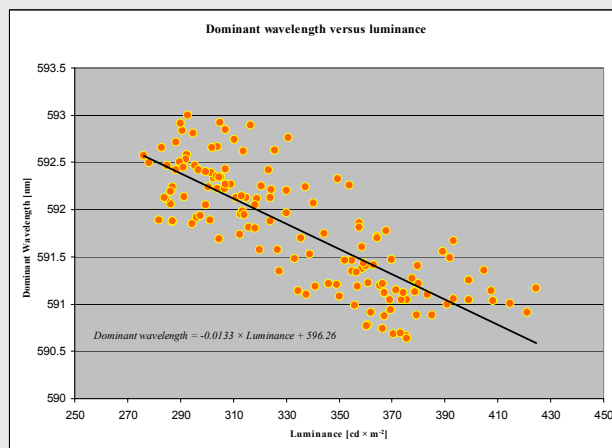
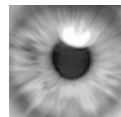
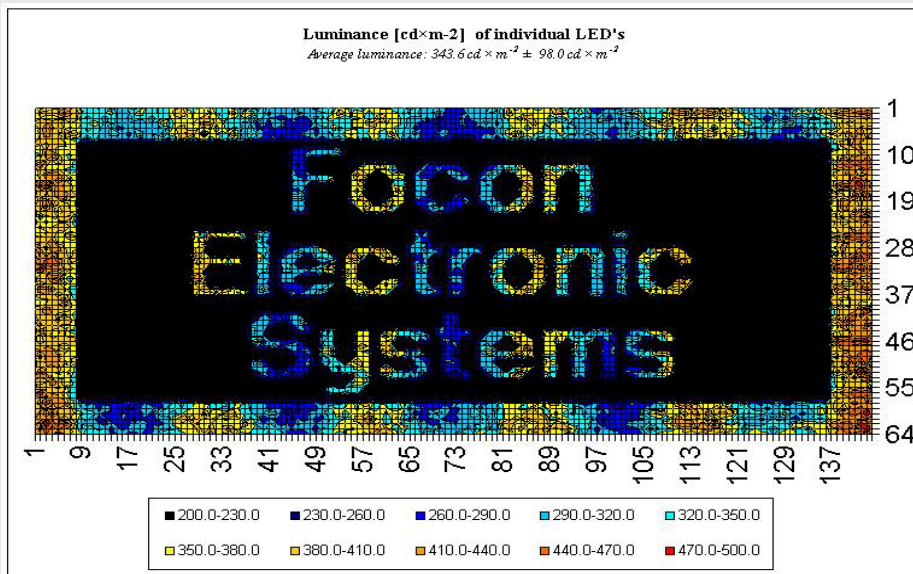


Figure 7. Variation of dominant wavelength with luminance.

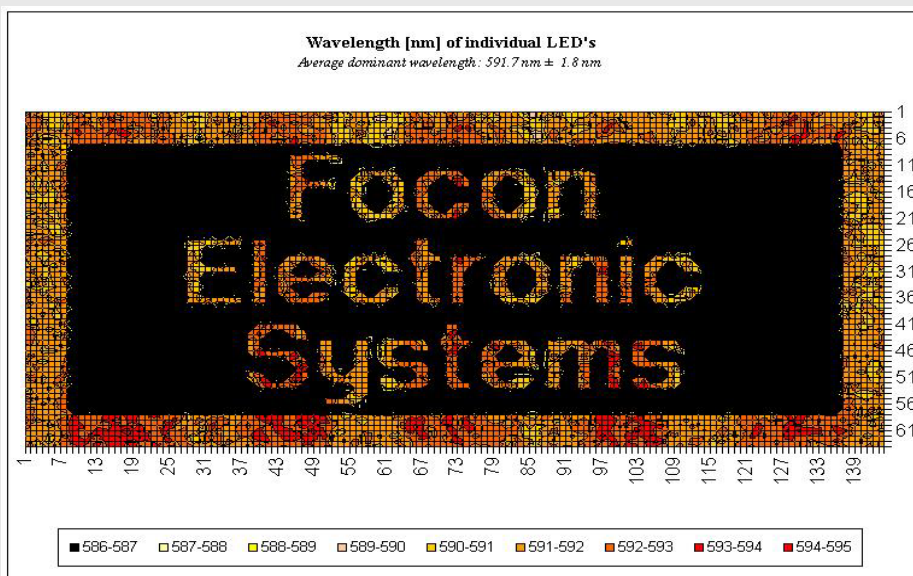


## Large scale uniformity of luminance and colour



In figure 8 the luminances of the LED's are shown. A wave pattern is seen.

Figure 8. False colour representation of the luminance distribution.



In figure 9 the dominant wavelength of the LED's are shown. A wave pattern is seen.

Combining the averages of the columns from figure 8 and 9 gives the diagram shown in figure 10.

Figure 9. False colour representation of the wavelength distribution.

These variations shows, that the colour of LED's with high luminance's are slightly more yellowish and the colour of LED's with low luminance's are slightly more reddish, but the variations are hardly visible.

The variations are due to a small variation in internal temperature. In this high output VMS thermal properties has been considered during design. Otherwise the variations would have been very visible.

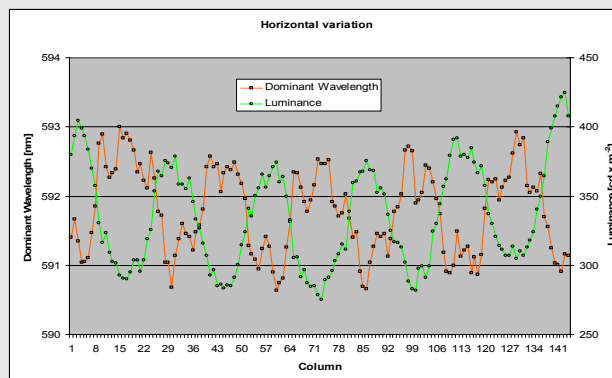
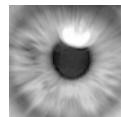


Figure 10. The average value of the LED's in each column.



## LED positions

By vision techniques the position of each LED's is identified to sub pixel accuracy. In this example both the wanted row and column spacing are 2.50mm. In figure 11 the misplacement of each LED is shown in the diagram. The average precision is found to  $57 \mu\text{m} \pm 71 \mu\text{m}$ .

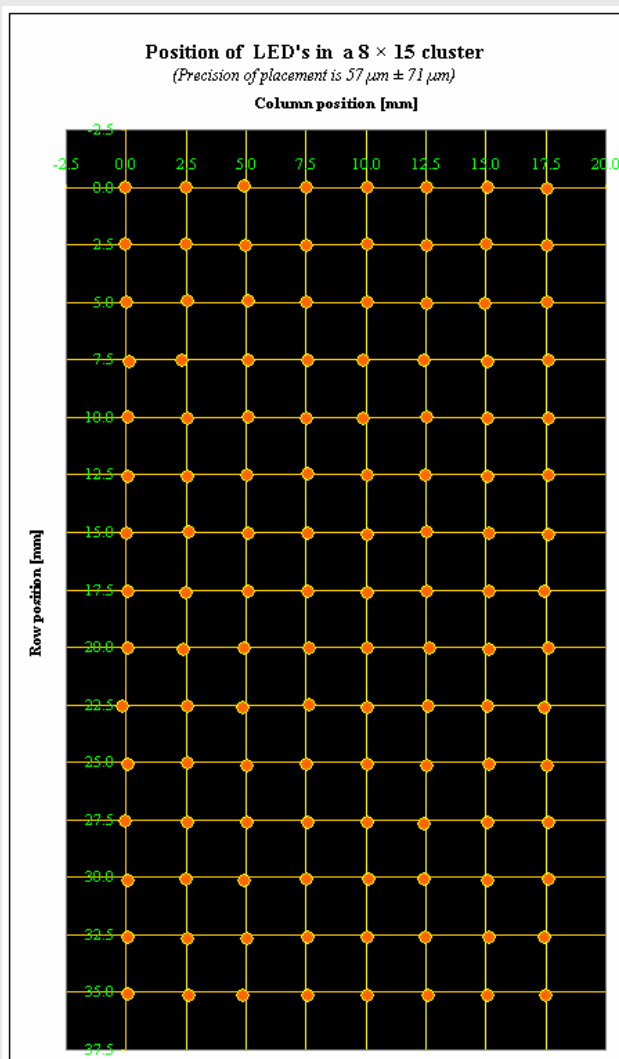


Figure 11. Precision in the positioning of LED's.

## Cross talk

A LED in the on-state will illuminate the neighbour LED's and hence this luminance leak will give cross talk. See figure 12 and figure 13. The contrast ratio, given as  $(L_{\text{high}} - L_{\text{low}}) / L_{\text{low}}$ , between column 0 and column -1, is 12.4 while the contrast ratio between column 3 and -5 is 19.4.

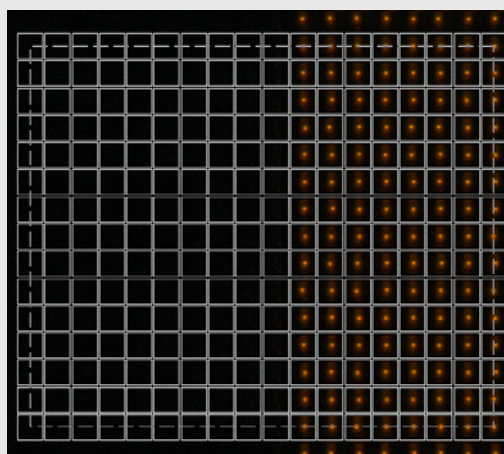


Figure 12. Lay-out of the 8 × 15 LED's and grid for 'Cross talk' calculation.

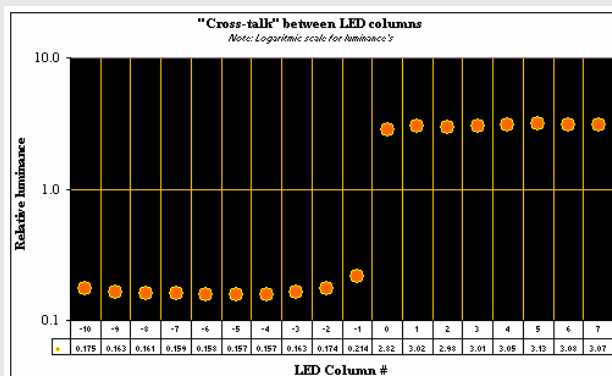


Figure 13. Relative luminance variation across line of off LED's to line of on LED's.

## Conclusions

Using ICAM for measuring Variable Message Signs reduce the time spend for measuring and gives the data for extracting many other relevant features like large scale variations of photometric properties, cross talk, mounting precision etc.

## ICAM advantages and features

Numerous LED's measured in one 'shot' of:

- Luminance / Luminous flux
- Chromatic coordinates / Dominant wavelength
- Large scale features / Details on pixel level
- Uniformity / Variations

## Other ICAM tasks

ICAM is also an efficient tool for measuring translucent run way signs for aerodromes and other signs where various standards request precise, reproducible and traceable photometric and colorimetric measurements. See ICAM application note "I201 Guidance signs for aerodromes".