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THE FUTURE OF NVIS DISPLAY MEASUREMENT

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The Future of NVIS Display Measurement

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Introduction

The high quality of instruments developed in the last decade has lead to measurements of NVIS compatibility of displays becoming almost routine. New technology is now available to improve the instruments still further, but what sort of improvements do users need? Some common answers include:

- Better sensitivity, so low luminance and small spot sizes can be easily measured.
- Less variation in results, so users can have more confidence in results without repeating scans.
- Faster scans, so more work can be done.
- Greater portability and ruggedness, for those off-site or field measurements.
- Lower cost, to fit an ever-shrinking budget.

In the past year, several independent fields of development at Optronic Laboratories have enabled radical changes to systems previously thought as unsuitable for NVIS display applications. Together, they provide the desired improvements.

Sensitivity and variation

Although not the same thing, these aspects are actually related. We can see why from Figure 1. First, let's look at the vertical axis. It is in radiance, which is a

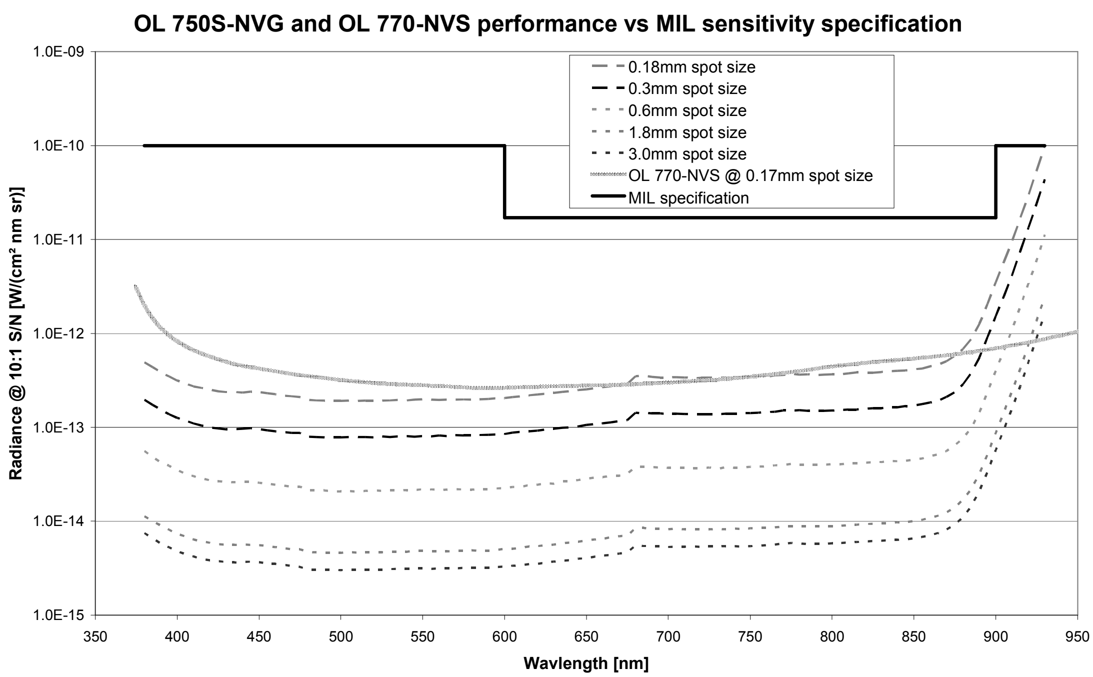

Figure 0. The sensitivities of current scanning systems and the new OL 770-NVS expressed in radiance per MIL specification.

measure of light. More sensitive systems can see a smaller amount of light, so downward is the direction of increasing sensitivity. Also, the scale is logarithmic so each division is a factor of 10 different from the next. The first thing to note from Figure 1 is that scanning systems are hundreds, and even tens of thousands, times more sensitive than is required over much of the spectral range. Based on GaAs photomultipliers, they inevitably lose sensitivity above 880 nm though, and can change by more than two decades to 930 nm. This has two effects on results:

1. systems must have high dynamic range to measure at 930 nm without saturating at lower wavelengths
2. noise above 880 nm is up to hundreds of times more significant to the result than noise below 880 nm.

The second effect is responsible for much of the variability in results between measurements.

The OL 770-NVS system shows comparable sensitivity, but because it is based on silicon the detector does not lose sensitivity beyond 880 nm. This in turn has the effect of reducing the variation in results.

Instrument design

At this point you may be thinking “if it is that simple, why weren’t silicon detectors used before”? The answer is that silicon detectors are hundreds of times less sensitive than photomultipliers, so in order to perform adequately another

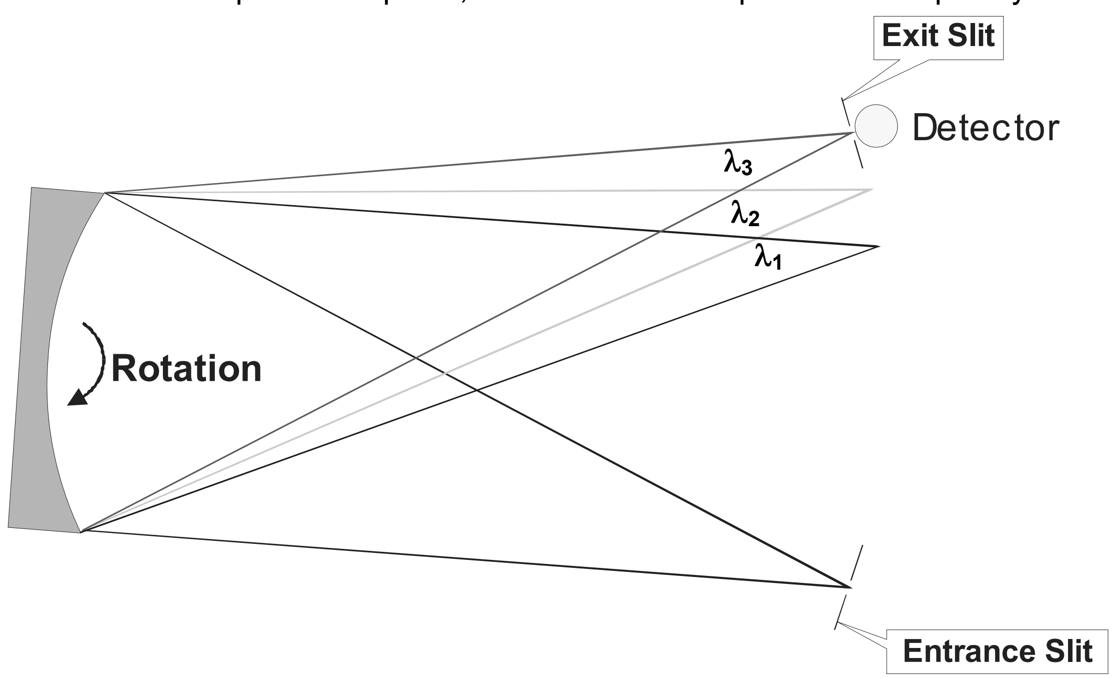

Figure 2. Concept drawing of a scanning spectroradiometer. As the grating is rotated the individual wavelengths move past the exit slit and are measured by the detector.

approach was required.

Figure 2 shows a scanning spectroradiometer. A measurement is made at each wavelength of interest, which in the case of NVIS displays is a total of 111 separate wavelengths. What if, instead of measuring them one after another, we could measure them all at the same time? More time in measurement means the system sensitivity increases. If we could spend the entire scan time measuring all wavelengths it would therefore be a great advantage. In fact it has a name: ***the multiplex advantage***.

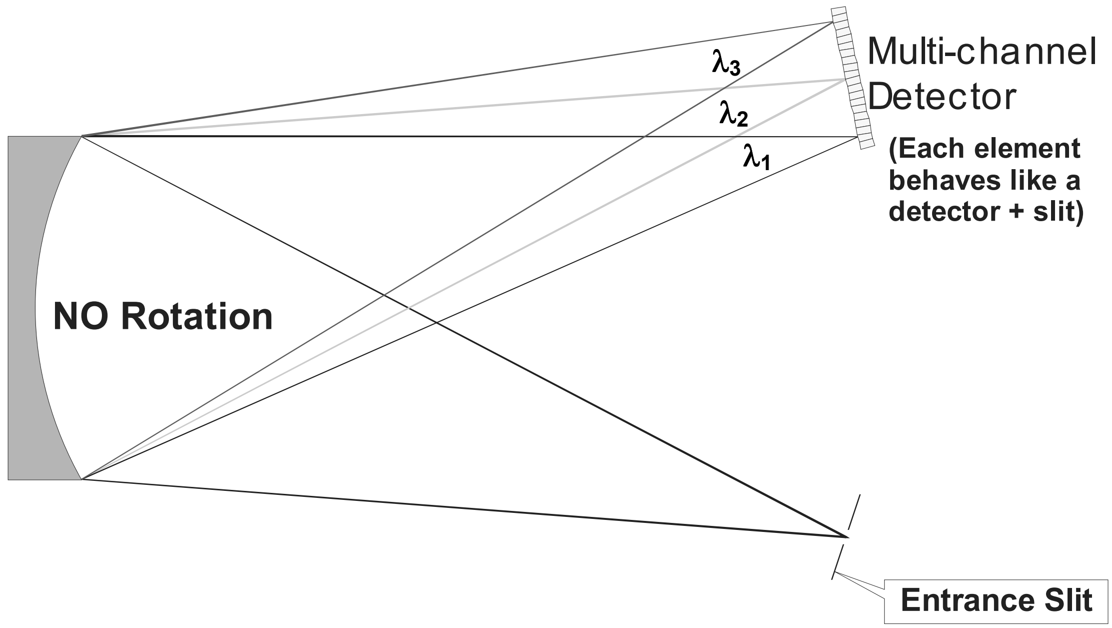

Figure 3. Concept drawing of a multi-channel spectroradiometer. All wavelengths are measured at the same time.

Figure 3 shows a multi-channel spectroradiometer that has this advantage. For NVIS compatibility measurements a special high sensitivity, ultra-low stray light performance version of this basic concept was developed: the OL 770-NVS. All MIL specifications are easily satisfied.

The OL 770-NVS has several other benefits over older systems:

- Since there are no moving parts
  - the construction is rugged and compact
  - results are highly repeatable
- Since there is no photomultiplier
  - A very expensive component is avoided
  - The detector is not damaged by strong light
  - High voltages are not required
- Since all the wavelengths are measured at the same time
  - It doesn't matter if the source is d.c., a.c., modulated or flashed

A comparative study

Ultimately, the proof of performance lies in testing real displays using several instruments and comparing results. A display featuring NVIS Green B, NVIS Yellow and NVIS Red devices was measured using 3 separate and independent OL 770-NVS systems. Measurements were performed as the intensities of the displays were varied in a rigorous study that lasted several days.

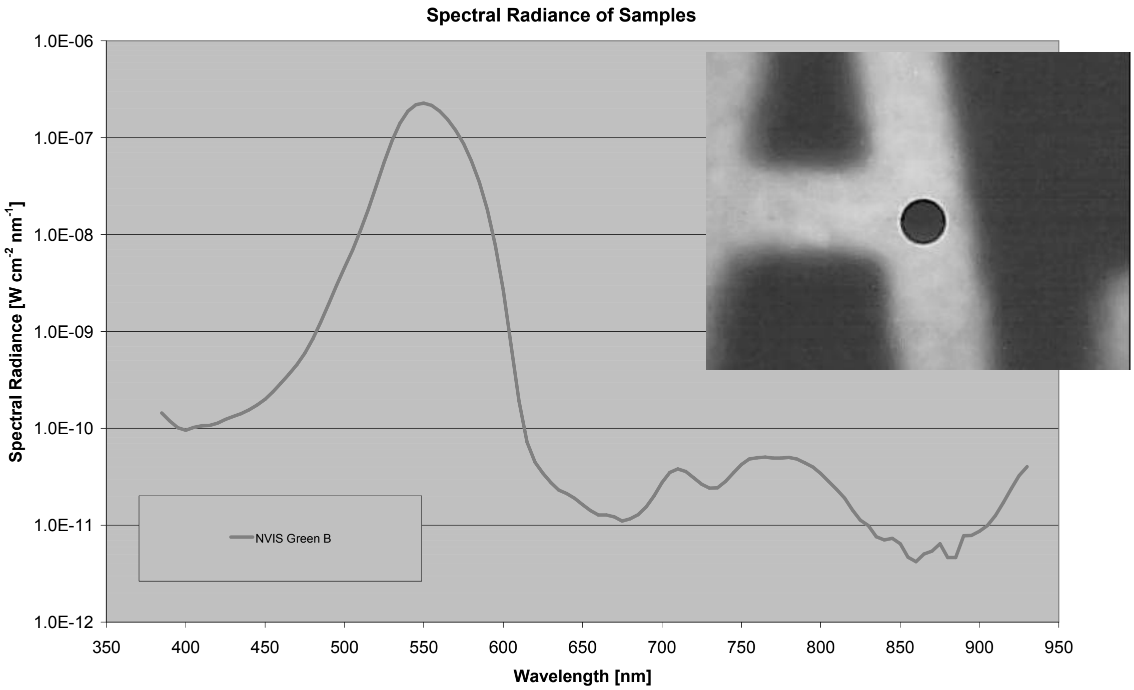

Figure 4. The measured spectral radiance of the green B device using the OL 770-NVS

Figure 4 shows a result of measurement of the green B device (shown in the picture) at 15 fL. Quantities such as chromaticity and NVIS radiance were calculated for all measurements and compared.

For brevity, only some representative results are shown here. Figure 5 shows results for NRb radiance and Figure 6 shows chromaticity results for the NVIS yellow device. Fuller details, including results for all devices, are included in a

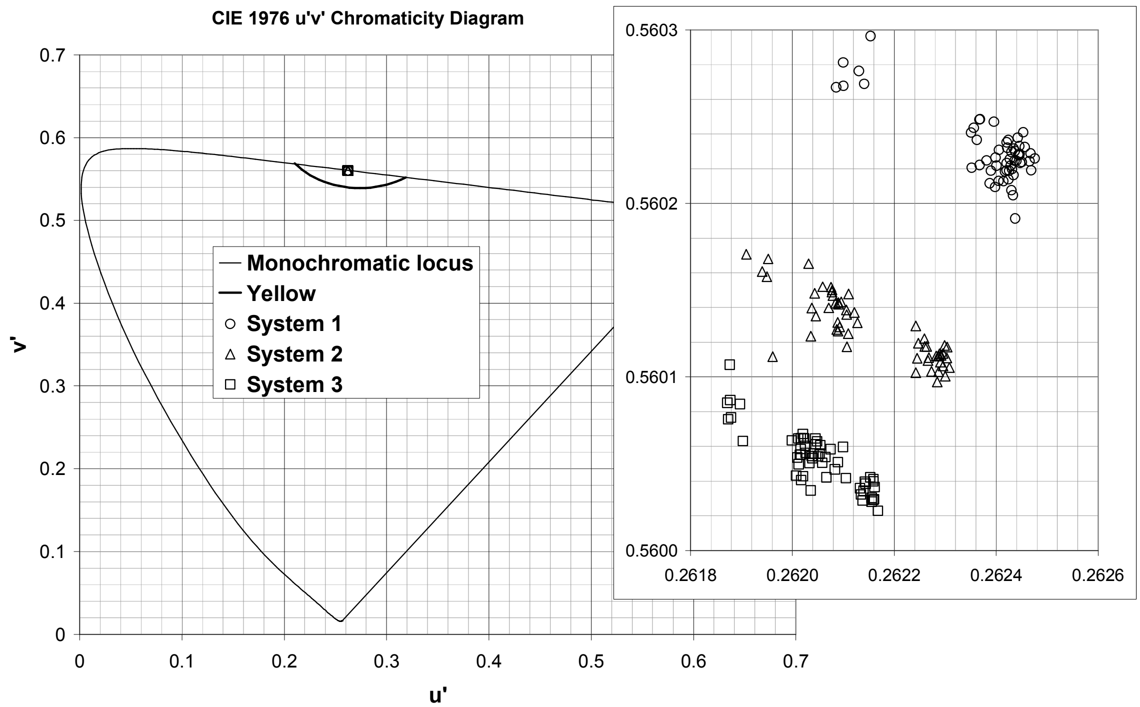

Figure 6. Measured chromaticity of the NVIS yellow device set to approximately 0.1, 5 and 15 fL. All systems gave extremely good agreement and repeatability.

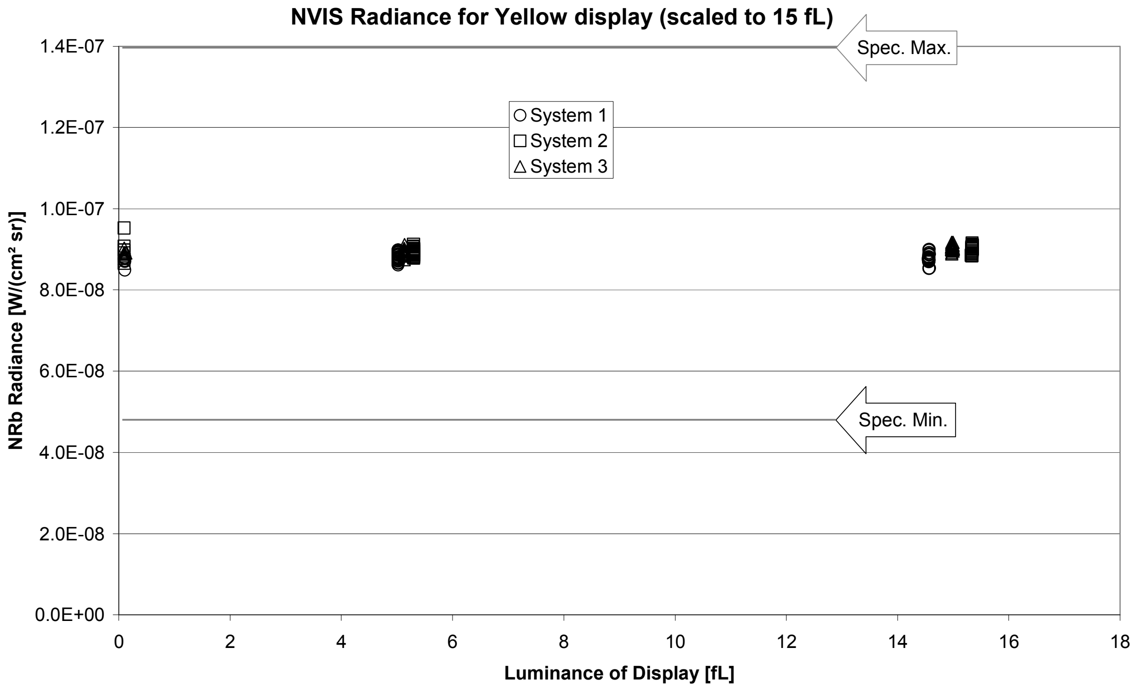

Figure 5. Measured NRb radiance of the NVIS yellow device set to approximately 0.1, 5 and 15 fL. All systems gave essentially the same result for the device.

PowerPoint presentation available from ALI.
Even though the source was switched off between tests, the luminance was only set approximately, the spot was realigned and focussed for each test (only the general area was the same) and three completely different systems were used, the results show that excellent agreement is obtained.

Typically, a 15fL source takes less than a second to measure. A 0.1 fL source is measured in about one or two minutes, depending on color. These times are far faster than any system previously developed for NVIS measurements, and represent a quantum leap in speed and performance. All the wish-list items are fulfilled, MIL specifications satisfied and several never-before-seen features added.