The NPL Transfer Standard Absolute Radiance Source (TSARS)

Heather M. Pegrum*, Emma R. Woolliams, Nigel P. Fox,
National Physical Laboratory, Queens Road, Teddington, Middx, TW11 0LW, UK

The radiance calibration of a spectrometer requires a large area, uniform source of known radiance. NPL has developed a range of new radiance transfer standards specifically targeted to meet these requirements [Woolliams, et al., 2002], known as the Transfer Standard Absolute Radiance Source (TSARS) (***Figure 1***). The TSARS consist of an integrating sphere that is illuminated by a number of external lamps and has a large area circular exit port. This is common with other such sources; however, NPL has put significant effort into selecting and positioning sources to improve the uniformity. In addition a set of filter radiometers has been included to allow active stabilisation and monitoring of performance.

Figure 1: Photos of the NPL TSARS

The NPL TSARS can be configured in a number of ways to suit specific measurement requirements. At present we have concentrated on relatively small exit ports (<100 mm), although the same concept is easily scaled up and applicable for larger sources. The first TSARS was based on a 30 cm diameter Spectralon coated sphere made by Labsphere with a 100 mm diameter exit port. The exit port of this source could be reduced using inserts. Versions of this design were used to calibrate Geostationary Earth Radiation Budget (GERB) instrument now flying on Meteosat Second Generation and also at Applied Spectral Research Inc of Canada for calibration of a range of EO instruments.

In 2004 a smaller version was designed, with increased portability as one of the design objectives. This device was based on a 230 mm diameter sphere and has a maximum exit port diameter of 75 mm and was illuminated via optical fibres by two external lamps. This source also made use of more compact optical and electronic configurations. To demonstrate the flexibility of NPL's new transfer standards, a collaborative project was established with TNO TPD in Delft. As part of this project the smaller TSARS was taken to TNO TPD in Delft to be included in the radiometric calibration of the Global Ozone Monitoring Experiment (GOME 2) – FM3 [Pegrum, et al., 2004].

Uniformity and Stability

The key requirements of the TSARS are that it provides a stable and uniform area radiance source. Tests performed at NPL, show that the uniformity is better than ± 0.5% across exit port (***Figure 2***) with a stability of ± 0.20 % over a period of 4 hours (***Figure 3***).

* Heather.Pegrum@npl.co.uk

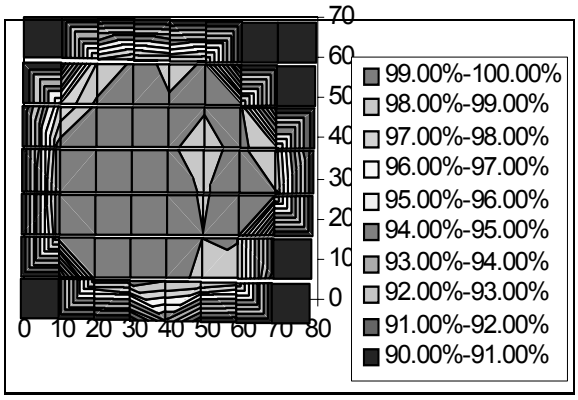

Figure 2: Uniformity of the NPL TSARS

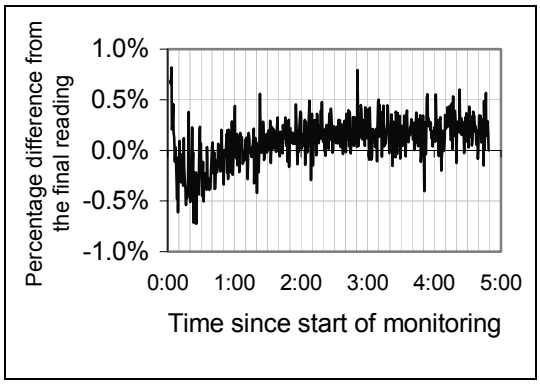

Figure 3: Stability of TSARS

Radiance Calibration and Uncertainty Budget

The radiance transfer standards are calibrated at NPL by direct comparison with the primary black body source [Woolliams, et al., 2005] and thus the radiance level at the time of calibration can be determined with an accuracy of better than 0.5% across the visible and near IR, rising only slowly at shorter and longer wavelengths. The overall uncertainty budget for the NPL TSARS gives an uncertainty between 450–500 nm between 0.70% and 0.99% at the 95% confidence level ($k = 2$). Within the spectral region of 500–700 nm, the 95% confidence uncertainty is better still, between 0.56% - 0.74%. Above 700 nm the uncertainties are between 0.61% - 1.18%, this is shown in ***Figure 4***.

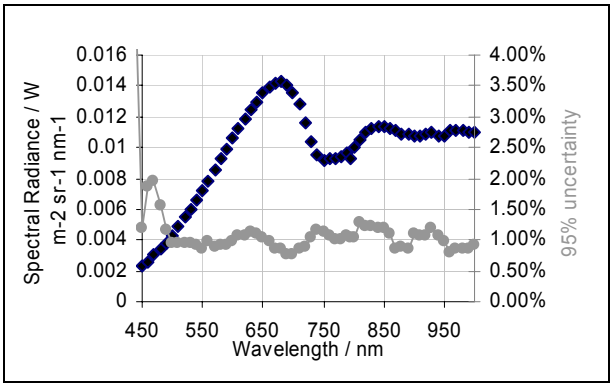

Figure 4: Spectral Radiance of the NPL TSARS and the calibration uncertainty for the NPL TSARS, at the 95% confidence level.

References

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