Characterization of the measurement setup for measuring spectral irradiance at NMISA.

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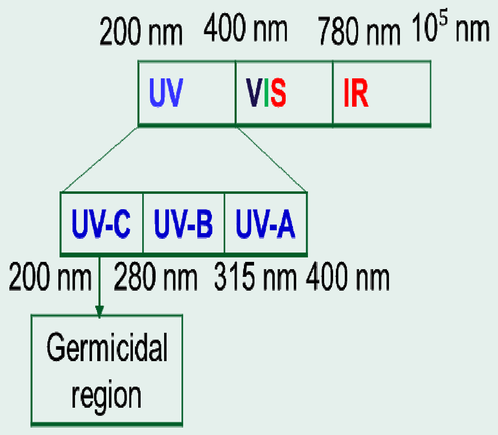
INTRODUCTION

Metrology is concerned with the accurate measurement of physical quantities and requires the determination of uncertainty of measurement. Radiometry is the science of measuring radiation in any portion of the electromagnetic spectrum. This study focuses on the measurement of UV-C radiation. Ultraviolet germicidal irradiation (UVGI) devices can be used to prevent the spread of airborne diseases, such as mycobacterium tuberculosis (TB) in hospitals. The accurate measurement of UV-C is therefore important to the health and safety of the citizens of South Africa.



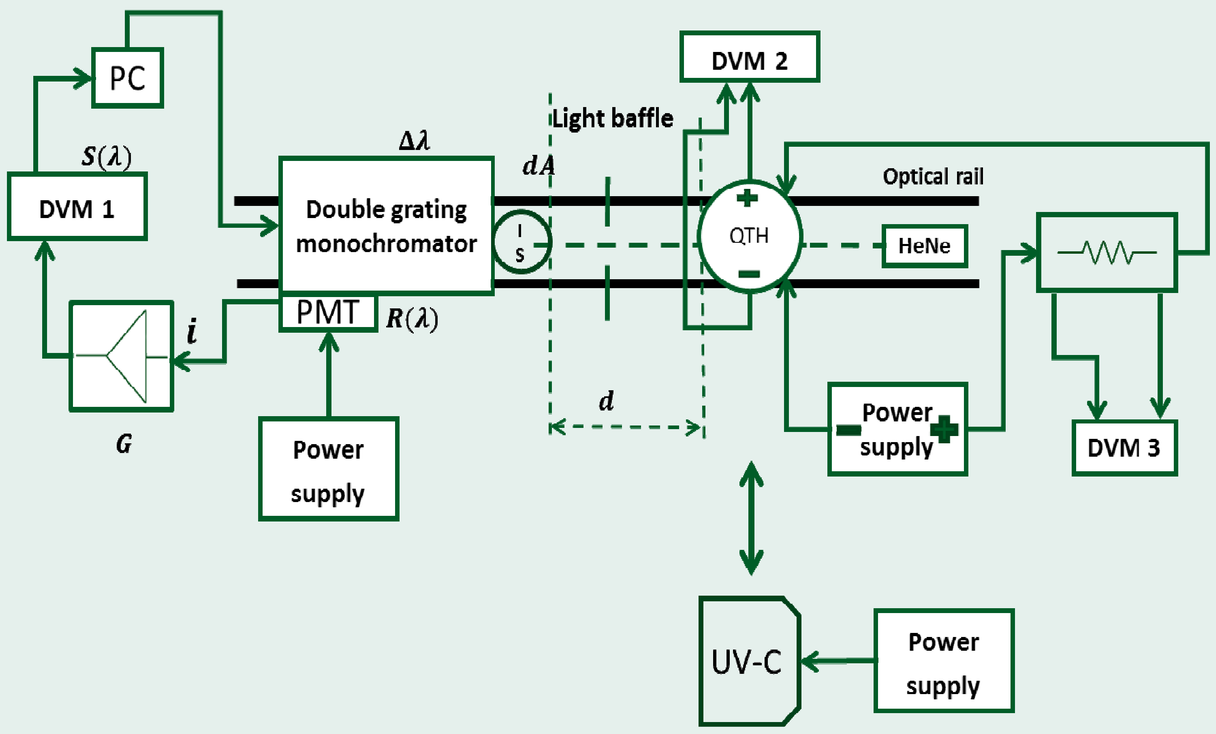
QUANTITIES USED IN RADIOMETRY

Quantity	Symbol	Equation	Unit
Radiant energy	Q	hv	J
Spectral flux	$\Phi(\lambda)$	$(dQ/t)/d\lambda$	W/nm
Spectral intensity	$I(\lambda)$	$(d\Phi/\Omega)/d\lambda$	W/sr/nm
Spectral irradiance	$E(\lambda)$	$(d\Phi/A)/d\lambda$	W/m^2/nm
Spectral radiance	$L(\lambda)$	$[d\Phi/(A\Omega)]/d\lambda$	W/sr/m^2/nm
Spectral irradiance responsivity	$R(\lambda)$	$(dS/E)/d\lambda$	V/(W/m^2/nm)

AIM AND OBJECTIVE

- To characterize the spectral irradiance measurement setup in terms of stability, translation and orientation of the sources.
- To investigate the use of a quartz tungsten halogen (QTH) lamp as a standard for UV-C spectral irradiance measurements.
- To determine the suitability of a UV-C low pressure mercury lamp as a source standard for calibration of UV-C radiometers.

MEASUREMENT SETUP



MEASUREMENT EQUATIONS

The measured output voltage can be derived from the measurements setup:

$$dS_{REF}(\lambda) = (d\Phi_{REF})\,(dA)\,(d\lambda)\,(R(\lambda))\,(G) / d_{REF}^{\,2}$$

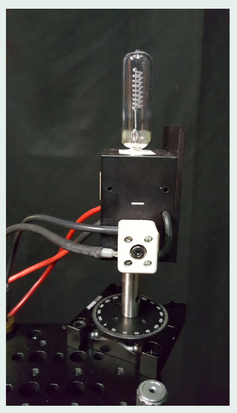
$$dS_{UUT}(\lambda) = (d\Phi_{UUT})\,(dA)\,(d\lambda)\,(R(\lambda))\,(G) / d_{UUT}^{\,2}$$

The optical power of the reference lamp can be related to the electrical parameters according to:

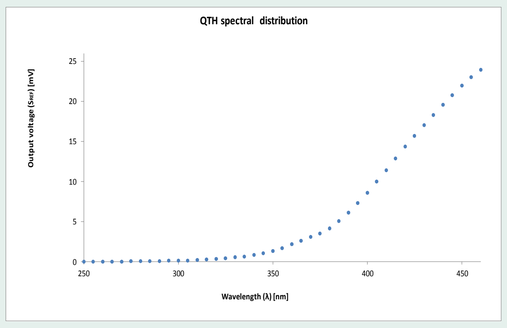
$$d\Phi \sim V_{REF} \times I_R = V_{REF} \times V_R / R$$

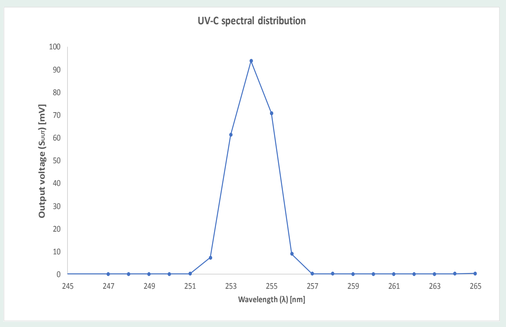
RESULTS

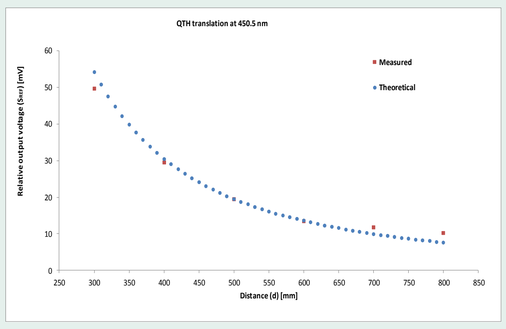
1000 W quartz tungsten halogen (QTH) lamp

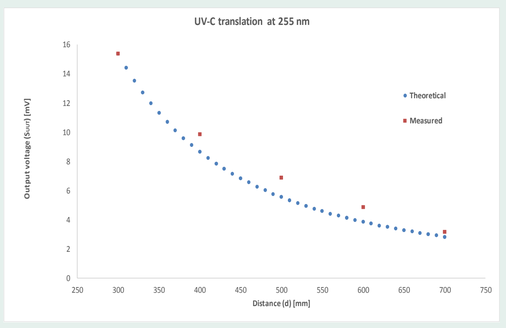


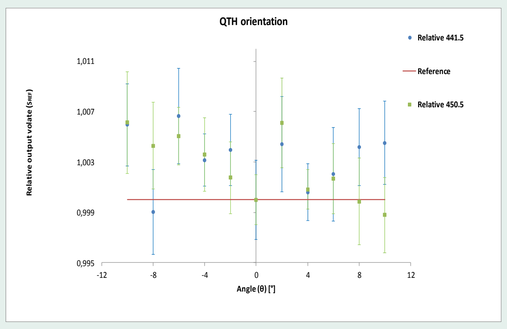
30 W UV-C low pressure Hg lamp

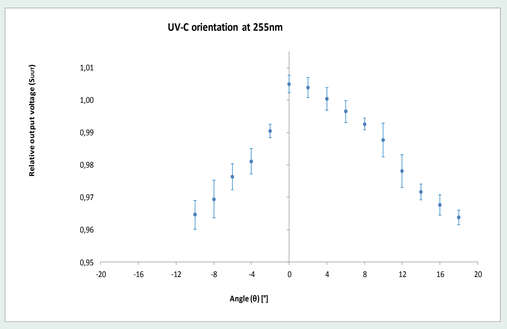












Stability of the QTH reference lamp

Time	$t_{1=}$ before	t_{2} = during	t_{3} = after	Average
Voltage (U) [V]	111,589	111,613	111,648	111,620
ΔU [%]	0,0269	0,00627	0,0254	-

Effect of small translation and rotation

Lamp	Δd [mm]	ΔS [%]	$\Delta\theta$ [°]	ΔS [%]
QTH	1	0,825	1	0,281
UV-C	1	0,773	1	0,639

UNCERTAINTY COMPONENTS

Symbol	Description	Type	Uncert-estimate	Units	Distribution	Divisor	Standard uncert-	Sensitivity coefficients	Uncert-contribution
U_{REF}	Stability	A	0,01	Volts	Normal	1	0,01	0,0269 %/V	0,000269 %
d_{REF}	Translation	B	1	mm	Rectangular	√3	0,577	0,825 %/mm	0,476 %
θ_{REF}	Orientation	B	1	° (degree)	Rectangular	√3	0,577	0,281 %/°	0,162 %
d_{UUT}	Translation	B	1	mm	Rectangular	√3	0,577	0,773 %/mm	0,446 %
θ_{UUT}	Orientation	B	1	° (degree)	Rectangular	√3	0,577	0,639 %/°	0,369 %

CONCLUSION

- The spectral irradiance setup was characterized for stability, translation and orientation.
- The UV-C low pressure Hg lamp is not ideal as a source standard for calibration of UV-C radiometer, due to the large uncertainties.
- Investigate Deuterium lamp as spectral irradiance standard for UV-C

RESOURCES

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