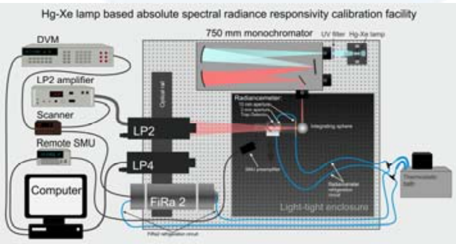
PERFORMANCE OF DIFFERENT LIGHT SOURCES FOR THE ABSOLUTE CALIBRATION OF RADIATION THERMOMETERS

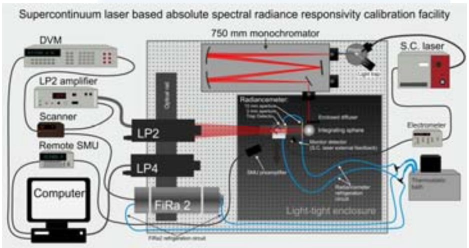
M. J. Martín[1], J. M. Mantilla[1], D. del Campo[1], M. L. Hernanz [2], A. Pons[2] and J. Campos[2]

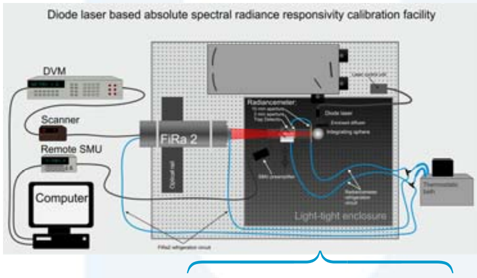
[1] Centro Español de Metrología, Tres Cantos, Spain

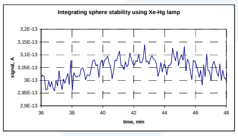
[2] Instituto de Óptica, Consejo Superior de Investigaciones Científicas, Madrid, Spain

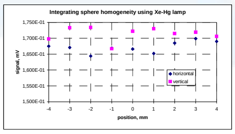
SUMMARY – Primary radiometry has been proposed as an alternative to the ITS-90 at high temperatures and will be included in future revisions of the *MeP*-K. CEM, as a first step towards measuring thermodynamic temperatures, calibrated its standard radiation thermometer (an imaging radiometer) for radiance responsivity with traceability to the Spanish standard electrical substitution cryogenic radiometer maintained by the Instituto de Óptica which is part of the Spanish Research Council (IO-CSIC).The radiation thermometer calibrated in this way has been used to determine the thermodynamic temperature of the fixed points of Cu, Co-C, Pt-C and Re-C for InK Project with **expanded uncertainties (*k* = 2) ranging from 0.4 ° C to 1.1 ° C**. This uncertainties are considerer high and they are similar to the ones obtained using ITS-90, so CEM/IO-CSIC has tried to improve their experimental setups.The aim of this paper is to describe the characterization process of the absolute calibration experiment (using radiance method) at CEM/IO-CSIC with different light sources and radiometers and/or radiation thermometers.

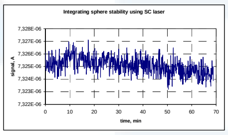


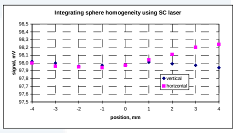


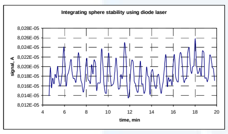


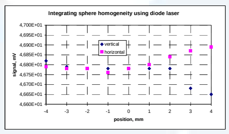




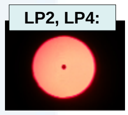


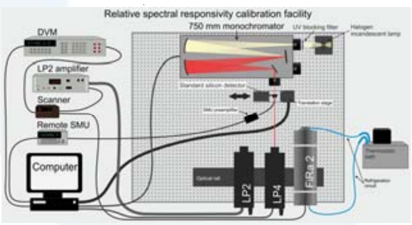




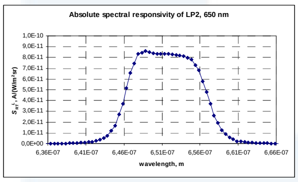


LP2, LP4:

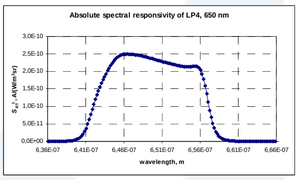




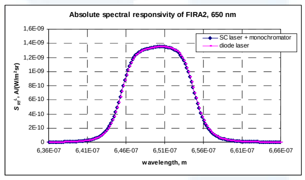
LP2 with SC laser



LP4 with SC laser



FIRA2 with SC and diode laser



Calibration uncertainties

SC laser

Uncertainty component	Value	Uncertainty at Cu FP, K	Uncertainty at Co-C FP, K	Uncertainty at Pt-C FP, K	Uncertainty at Re-C FP, K
λ_0: Wavelength	0.03 nm	0.025	0.027	0.029	0.027
Drift	0.05 nm	0.042	0.045	0.048	0.046
σ	0.02 nm	0.002	0.002	0.003	0.003
H:					
Trap detector	0.052%	0.022	0.030	0.048	0.089
Aperture area	0.1%	0.042	0.058	0.092	0.171
Distance	0.02%	0.008	0.012	0.018	0.034
Sphere spatial uniformity	0.1%	0.084	0.116	0.184	0.342
Source stability	0.01%	0.008	0.012	0.018	0.034
Diffraction at apertures	0.01%	0.002	0.003	0.005	0.010
Signal to noise ratio	0.08%	0.019	0.027	0.042	0.079
Stability of the trap	0.052%	0.025	0.035	0.055	0.103
	Combined	**0.11**	**0.15**	**0.23**	**0.42**

diode laser

Uncertainty component	Value	Uncertainty at Cu FP, K	Uncertainty at Co-C FP, K	Uncertainty at Pt-C FP, K	Uncertainty at Re-C FP, K
λ_0: laser calibration	0.002 nm	0.001	0.002	0.002	0.002
σ	0.02 nm	0.002	0.002	0.003	0.003
H:					
Trap detector	0.052%	0.022	0.030	0.048	0.089
Aperture area	0.1%	0.042	0.058	0.092	0.171
Distance	0.02%	0.008	0.012	0.018	0.034
Sphere spatial uniformity	0.12%	0.100	0.139	0.220	0.411
Source stability	0.04%	0.033	0.046	0.073	0.137
Diffraction at apertures	0.01%	0.002	0.003	0.005	0.010
Signal to noise ratio	0.08%	0.019	0.027	0.042	0.079
Stability of the trap	0.052%	0.025	0.035	0.055	0.103
	Combined	**0.12**	**0.17**	**0.26**	**0.49**

Fixed points absolute temperatures

Fixed point, InK assigned temperature	Thermodynamic temperature, K				Expanded uncertainty, K			
	KE-LP2 SC laser	KE-LP4 SC laser	FIRA2 SC laser	FIRA2 Diode laser	KE-LP2 SC laser	KE-LP4 SC laser	FIRA2 SC laser	FIRA2 Diode laser
Cu, 1357.80	1357.76	1357.72	1358.29	1358.25	0.23	0.23	0.26	0.27
Co-C, 1597.39	1597.18	1597.10	1598.04	1597.99	0.30	0.31	0.33	0.36
Pt-C, 2011.43	2011.19	2011.19	2012.41	2012.32	0.46	0.46	0.48	0.55
Re-C, 2747.84	2747.49	2746.64	2748.46	2748.30	0.84	0.84	0.86	1.00

CONCLUSIONS - Different light sources have been tried for the absolute calibration of radiometer/radiation thermometers using radiance method: a Xe-Hg lamp, diode laser and a supercontinuum laser:

-Xe-Hg lamp: It is the cheaper option however the light intensity is really low and ~~because of this~~ the stability and uniformity of the integrating sphere is not enough good.

- Diode laser: The experiment is much more easy because a monochromator is not needed, however interference fringes are seen in commercial radiation thermometers.

- Supercontinuum laser: It is the most expensive option but it supplies enough light flux. As this light source is not as coherent as the diode laser, interference fringes have not been observed at LP2 and LP4. The laser gets an optimum stability when a power feedback is used.

SC and diode laser methods have been used with radiometer FIRA2 ~~and they~~ giving the same result for the absolute spectral radiance. These results validate the measurements done. **The uncertainties obtained for both methods are similar ranging from 0.22 ° C to 0.84 ° C (*k*=2)**

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Diapositiva 1

JC1 Absolute Radiometry
Joaquin Campos; 23/05/2016

JC2 Hav been tested
Joaquin Campos; 23/05/2016