NRC·CNRC

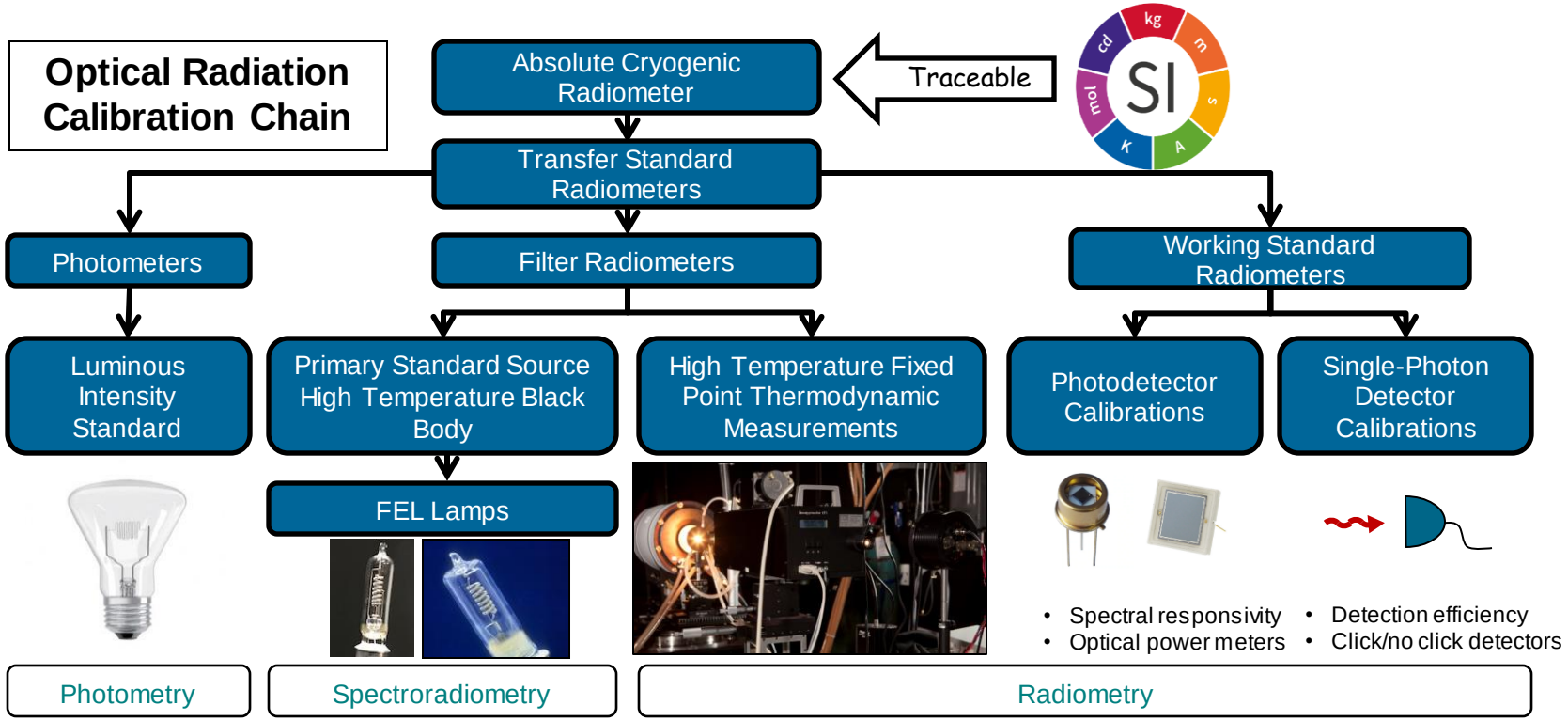
NRC: Cryogenic Radiometer and Scale Realization

Presented by Ka-ming Liu

National Research Council Canada | Conseil national de recherches Canada

Canada

Traceability Chain



Cryogenic Radiometer at NRC

- Electric-substitution absolute cryogenic radiometer
- 250nm to 1800nm
- Spectral lamps and Laser-driven light source
- Flexible vacuum bellow system

Absolute Cryogenic Radiometer

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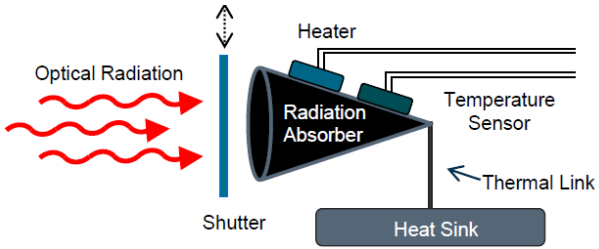
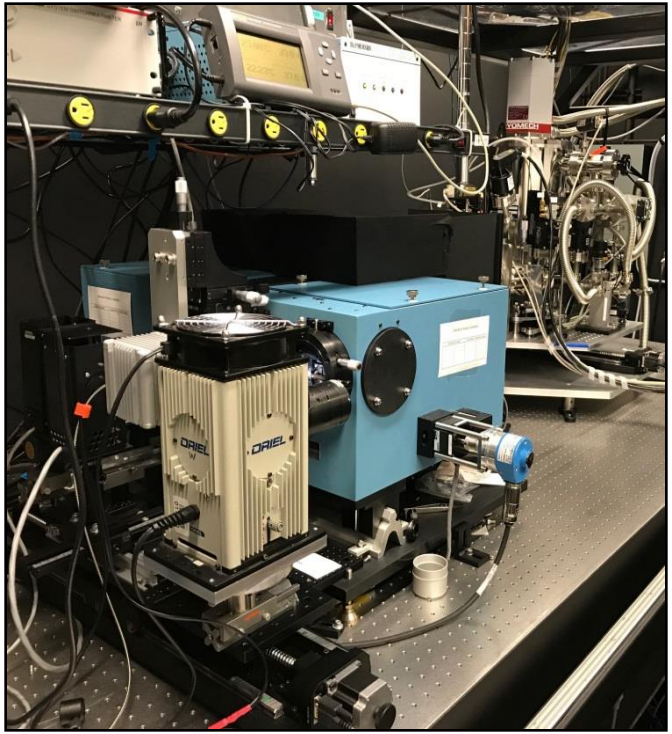
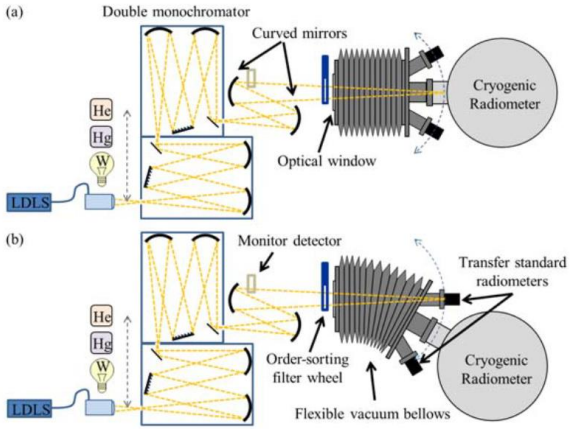
Transfer Standard Radiometers



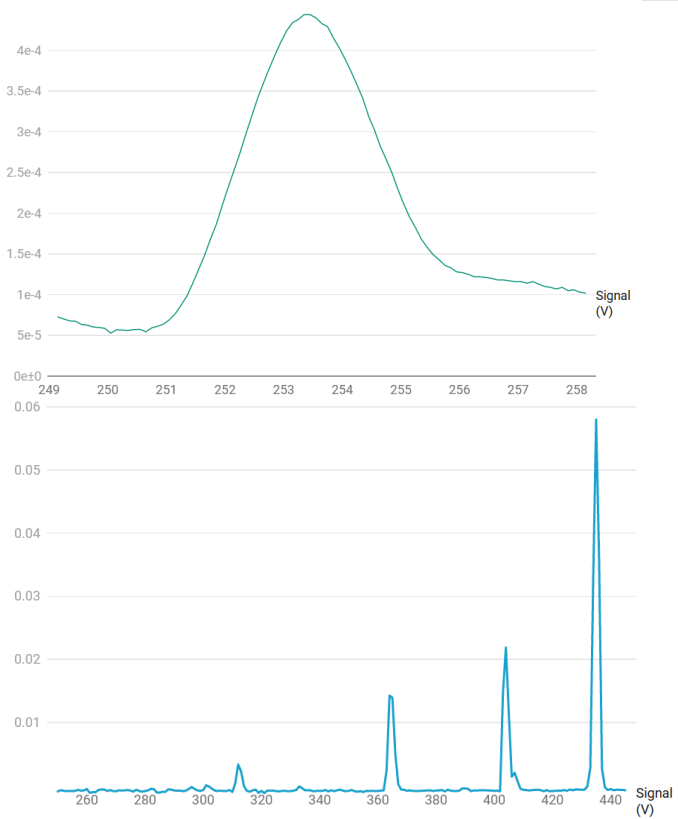


Cryogenic Radiometer at NRC

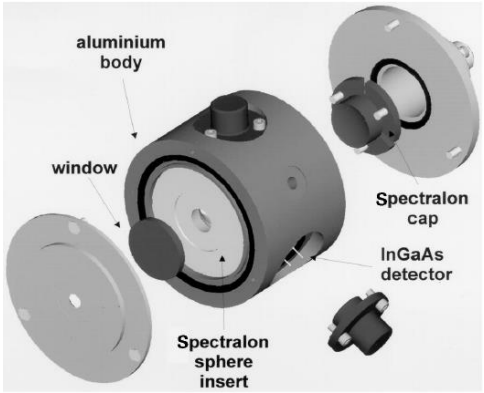
- Double monochromator system
- Gratings for UV, VIS and IR ranges
- Current work to extend our measurements down to 200nm.



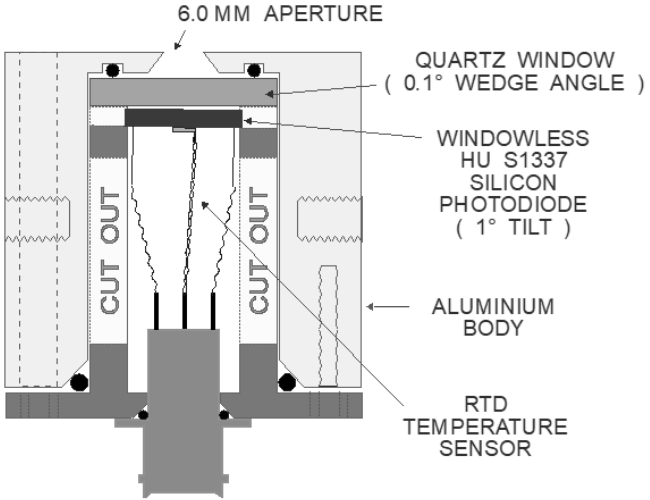
A Gamouras et al 2018 J. Phys.: Conf. Ser. ***972*** *012014*



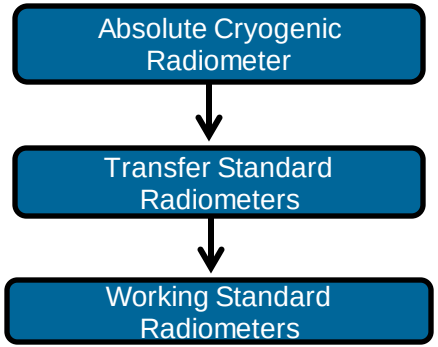
Transfer Standards



Phil Boivin, Metrologia, 2000



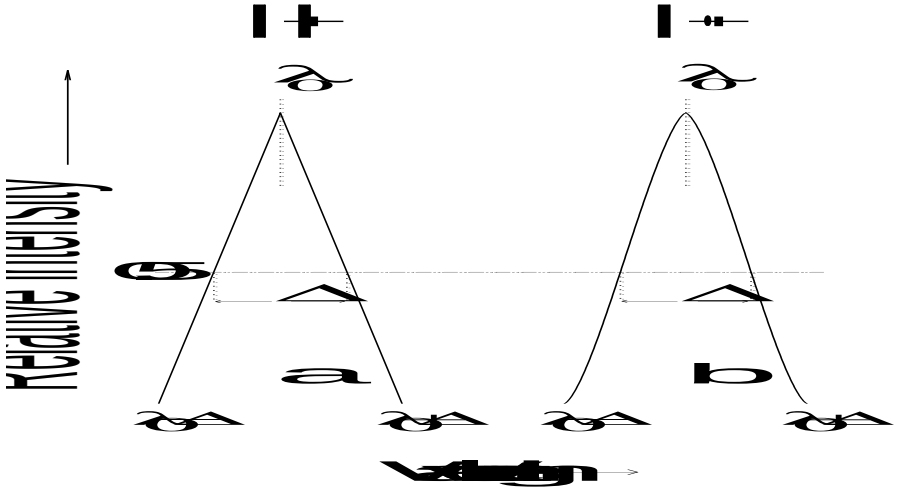
Phil Boivin, Metrologia, 1995



Uncertainties

- Temperature Effects
- Stray Light
- Electronic Noise
- Bandwidth
- Repeatability

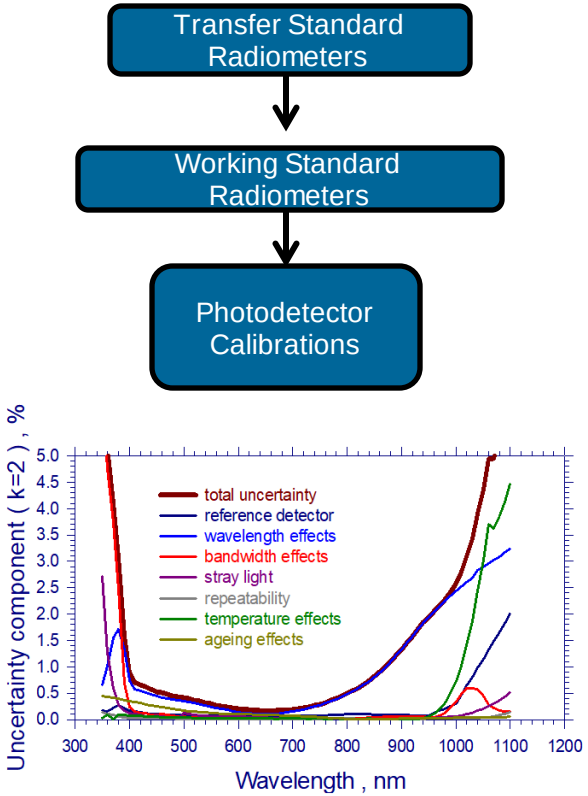
We need to check all our setup and uncertainty components



$$I(\lambda) = 0.5 - \frac{2}{\pi}\left[\frac{2(\lambda-\lambda_0)}{\Delta} - 1\right] \times \sqrt{\frac{|\lambda-\lambda_0|}{\Delta} - \frac{(\lambda-\lambda_0)^2}{\Delta^2}} - \frac{\sin^{-1}\left\{\left[2|\lambda-\lambda_0|/\Delta\right]-1\right\}}{\pi}$$

Phil Boivin, Appl.Opt. 2002

Uncertainty Budgets



Source Of Uncertainty	Calibration Of Reference Detector	Wavelength Calibration (± 1.0 nm)	Bandwidth Effects 4 nm FWHM	Stray Light	Measurement Repeatability : Electrical and Optical noise	Temperature Variation of Reference Detector (± 4°C)	Calibration of Electronic Equipment	Detector Size Effects	Ageing of Reference Detector	Quadrature Sum = Estimated Overall Uncertainty	QMS Overall Uncertainty
Type	B	B	B	B	A	A	B	B	B		
wavelength nm	Magnitude of uncertainty component , % (expansion factor k=2)										
250	1.60	0.89	0.83	0.27	0.24	0.17	0.04	0.00	0.65	2.15	**2.50**
260	1.34	0.80	0.33	0.15	0.20	0.14	0.04	0.00	0.63	1.74	**2.50**
270	1.07	0.57	0.18	0.10	0.16	0.19	0.04	0.00	0.61	1.40	**2.50**
280	0.81	0.43	0.23	0.06	0.14	0.06	0.04	0.00	0.59	1.13	**2.50**
290	0.55	0.36	0.15	0.03	0.12	0.02	0.04	0.00	0.57	0.89	**2.50**
300	0.28	0.28	0.08	0.02	0.10	0.05	0.04	0.00	0.55	0.69	**0.69**
310	0.23	0.18	0.06	0.02	0.09	0.03	0.04	0.00	0.53	0.62	**0.62**
320	0.18	0.14	0.03	0.01	0.09	0.02	0.04	0.00	0.51	0.57	**0.57**
330	0.18	0.14	0.02	0.01	0.08	0.02	0.04	0.00	0.49	0.55	**0.55**
340	0.17	0.12	0.02	0.01	0.08	0.00	0.04	0.00	0.47	0.52	**0.52**
350	0.17	0.16	0.05	0.01	0.07	0.02	0.04	0.00	0.45	0.52	**0.52**
360	0.16	0.40	0.41	0.01	0.07	0.09	0.04	0.00	0.43	0.74	**0.74**
370	0.21	0.68	0.49	0.00	0.07	0.01	0.04	0.00	0.41	0.96	**0.96**
380	0.27	0.77	0.23	0.00	0.06	0.09	0.04	0.00	0.39	0.94	**0.94**
390	0.22	0.60	0.19	0.01	0.06	0.09	0.04	0.00	0.37	0.77	**0.77**
400	0.17	0.37	0.07	0.01	0.06	0.08	0.04	0.00	0.35	0.55	**0.55**
425	0.59	0.21	0.01	0.01	0.06	0.06	0.04	0.00	0.30	0.70	**0.70**
450	0.10	0.17	0.02	0.04	0.06	0.05	0.04	0.00	0.25	0.33	**0.33**
475	0.14	0.14	0.02	0.03	0.06	0.04	0.04	0.00	0.21	0.30	**0.30**
500	0.08	0.11	0.02	0.04	0.06	0.04	0.04	0.00	0.17	0.24	**0.25**
525	0.12	0.06	0.01	0.03	0.06	0.03	0.04	0.00	0.14	0.21	**0.25**
550	0.08	0.05	0.01	0.04	0.05	0.02	0.04	0.00	0.13	0.17	**0.25**
575	0.07	0.06	0.01	0.04	0.05	0.02	0.04	0.00	0.11	0.17	**0.25**
600	0.07	0.06	0.01	0.05	0.06	0.02	0.04	0.00	0.10	0.17	**0.25**
625	0.07	0.07	0.01	0.06	0.06	0.02	0.04	0.00	0.10	0.17	**0.25**
650	0.07	0.10	0.00	0.07	0.05	0.02	0.04	0.00	0.09	0.18	**0.25**
675	0.07	0.10	0.00	0.07	0.05	0.02	0.04	0.00	0.08	0.18	**0.25**
700	0.07	0.10	0.01	0.07	0.04	0.02	0.04	0.00	0.07	0.17	**0.25**

Thank you

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