CCPR-K6.2010

Pre-Draft A Documents: Notes for participants

Incomplete Data

Some laboratories did not submit data at some of the comparison points:

NMISA: Filter E, All wavelengths

VNIIOFI: Filter D, 380 nm and Filter E, 380 nm and 400 nm

NPL: Filter E, 380 nm

In addition, the filters measured at the NIST were not returned to the pilot in time for Step 5 measurements to be made so these were also omitted.

Cleaning

Some filters were cleaned after arrival at the pilot laboratory either at the beginning of Step 3 or Step 5. The laboratories concerned were consulted and agreed to any such cleaning taking place.

Covariance and correlation coefficients

The covariance between step 2 and step 4 measurements have been calculated as:

$$u_{1,2} = \sum_i r_i u_{i,1} u_{i,2}$$

where i runs over all of the uncertainty components, r_i is the reported correlation coefficient for that component (always equal to zero for type A), and $u_{i,1}$ and $u_{i,2}$ are the uncertainties for that component during the first and second measurements made by the participant. The correlation coefficient is then calculated as

$$r = \frac{u_{1,2}}{u_1 u_2}$$

where u_1 and u_2 are the total uncertainties reported for the two measurements.

Please check that these calculations have been carried out correctly for your measurements. If the correlation coefficient is ever greater than 1, then some transcription error has occurred in your uncertainty tables. Please look for any such errors and correct them.

Filter Instability

As pilot, MSL has been able to make 3 measurements on 10 sets of filters and has enough data to calculate a pooled estimate of uncertainty due to filter instability (See GUM H.3.6) accounting for drift, contamination and other unknown sources. After subtraction in quadrature of our Type A component of uncertainty, the result is shown in the table below. The values, while not insignificant, are in most cases an order of magnitude smaller than the instability observed during the previous K6 comparison. MSL has chosen to add this component of uncertainty to our Type B uncertainty budget rather than attempt to account for drift in individual filters.

	Wavelength (nm)							
	380	400	500	600	700	800	900	1000
Filter A	1.10E-04	1.12E-04	9.89E-05	7.87E-05	6.81E-05	5.57E-05	6.11E-05	6.16E-05
Filter B	2.31E-04	1.29E-04	1.33E-04	7.16E-05	6.53E-05	1.02E-04	8.21E-05	4.80E-05
Filter C	3.32E-05	2.61E-05	9.72E-06	7.39E-06	0	2.64E-05	2.31E-05	1.17E-05
Filter D	0	3.63E-06	2.09E-06	1.95E-06	5.60E-06	8.26E-06	4.91E-06	2.41E-06
Filter E	0	3.38E-07	0	7.14E-08	0	0	0	6.87E-07

Table 1: Pooled uncertainty due to filter instability calculated from all pilot measurements. The degrees of freedom for each of these uncertainties is 20.

Internal Consistency checking

At this stage in the comparison process, you will also be making assessments of the internal consistency between the two measurements you have made to decide whether any data should be discarded from the comparison process or whether your uncertainties should be increased. The relative data will reveal this to come degree, but for a rigorous test of consistency, we recommend a simple hypothesis test as follows.

To carry out the test, you should consider only the total uncorrelated uncertainty in your measurement calculated as (remember to include type A for which r is zero):

$$a_1{}^2 = \sum_i (1 - r_i) u_{i,1}{}^2 \quad \text{and} \quad a_2{}^2 = \sum_i (1 - r_i) u_{i,2}{}^2.$$

Then if

$$|\,\tau_1 - \tau_2| \leq 2\sqrt{a_1{}^2 + a_2{}^2} \qquad (*)$$

is true (the absolute difference in transmittance is less than or equal to two times the uncertainty), we cannot reject the hypothesis that the two measurements have the same mean at the 95% significance level [1, p. 345].

If $(*)$ is not true then the two measurements are inconsistent at the 95% significance level.

Inconsistency in your results can be accounted for by either

- accounting for filter drift or instability,
- removing one of the points from the comparison (the pilot may also need to remove a corresponding point in cases of clear instability)
- or increasing the uncertainty of the measurement (as MSL has done to account for filter instability).

Whatever approach you choose to achieve internal consistency should be reported to the pilot and all participants will be notified of any changes to uncertainty budgets and/or removal of data at the end of this process as per the CCPR Guidelines.

[1] Walpole, Myers, Myers and Ye. *Probability & Statistics for Engineers & Scientists, Eighth Edition*. Pearson Prentice Hall, NJ, USA 2007.