

## P4001 General Guidelines V1.0

The idea behind these guidelines was an attempt to capture some “common sense” ideas and re-state what might be considered “obvious” about our standard. This is intended as a living document and a working set of guidelines, not hard and fast rules. There is a high possibility that they might be violated in some parts of our work. Nonetheless, we hope these guidelines are considered as a useful aid, especially when we need to make decisions when a crossroad is reached.

This list may need to be supplemented with additional points from our work on terminology, use cases, or data formats, etc.

### 1. Guidelines for the overall standard

- 1.1. The standard should be application agnostic and consider a wide range of audiences ranging from manufacturers and optical scientists to first-time hyperspectral camera buyers with a presumed minimum understanding of hyperspectral technology, imaging and/or optical spectroscopy.
- 1.2. The camera characteristics, and other elements, of the standard should be chosen to be conventional / customary as far as possible.
- 1.3. Our standard should use or adapt other standards as far as possible, for example: IEEE-SA, EMVA1288, ISO, ASTM, etc.
- 1.4. P4001 has prioritised dispersive push broom cameras as a first target of the standard. However, it would be reasonable to define camera characteristics to be applicable to a wider range of camera architectures, as long as this is possible without significant extra effort. This is important for forward compatibility with future versions of the standard, and for supporting fair competition.
- 1.5. The standard is likely to contain many optional elements that may be used at the discretion of the manufacturer.

### 2. Guidelines for camera characteristics

- 2.1. The specification of a camera should be such that it guarantees a certain level of performance, without ambiguity, therefore helping to ensure that the camera meets user expectations.
- 2.2. The camera characteristics should include mean, typical, or best-case values, as well as the worst-case value, so long as this is informative to the user.
- 2.3. Camera characteristics should indicate the properties of the output image data (not the internal camera component properties).
- 2.4. The standard should define characteristics that enable fair comparison between cameras.
- 2.5. When possible, characteristics should be given as equivalent values for a direct-sampling (no resampling) dispersive imaging spectrometer.
- 2.6. Many optical quantities may be of interest to measure spectrally, for example:
  - at-camera radiance ( $W/m^2 \text{ sr nm}$ ),
  - emitted light from an extended source (exitance,  $W/m^2$ ),
  - emitted light from a point source (intensity,  $W/sr$ )
  - diffuse reflectance,
  - specular reflectance,
  - transmission,

If we need to prioritise between these, we should emphasise diffuse reflectance and at-camera radiance.

- 2.7. In most cases, processing of spectral images begins by a spectral analysis step and then the spatial dimension is taken into account. Therefore, it is important that the standard supports characteristics for the integrity of the spectral signal. In other words, hyperspectral is explicitly imaging spectroscopy.
  - 2.8. For a given measurand it will be accompanied by an estimated measurement uncertainty that will determine the number of significant digits. Consider referring to the GUM: Guide for Uncertainty in Measurements as appropriate.
3. Guidelines for testing
    - 3.1. Camera characteristics defined by the standard should be verifiable by testing of the camera as a "black box", with no access to camera internals.
    - 3.2. The standard should indicate test procedures that are adequate for "black box" testing.
    - 3.3. Manufacturers will be allowed to use other tests of their choice to determine values for the characteristics. It is the responsibility of manufacturers to ensure their methods provide correct estimates that correspond to results given by the "black box" test methods according to the standard.
    - 3.4. Characteristics should be defined so as to be measurable by commonly available test equipment.
  4. Guidelines for the work in the group
    - 4.1. Group, and Sub-Group, decisions that have been made provisionally in previous meetings are considered decisions that can be reviewed and changed as circumstances and insights change. These are living decisions.
    - 4.2. Membership review and consideration of communication methods for improving efficiency, for example: – SLACK, Google Docs, etc. Task groups are free to use whatever works for them and then report back to main working group on outcomes.