Guide To LBNL Pigment Characterization Charts

Each pigment is described by a series of four charts labelled (a) - (d). The following is a cursory introduction to these charts and to LBNL's pigment characterization process, which will be detailed in a forthcoming paper.

(a) Spectrometer Film Measurements. The reflectance and transmittance of an approximately 25-µm-thick free paint film ("reflectance over void", "transmittance") are measured across the solar spectrum (300 – 2,500 nm @ 5-nm intervals) with a Perkin-Elmer Lambda 900 UV-VIS-NIR spectrometer. Free-film absorptance is calculated from the relation

$$\textit{absorptance} = 1 - (\textit{reflectance} + \textit{transmittance}).$$

The film's reflectance is also measured over an opaque white background ("reflectance over white") and over an opaque black background ("reflectance over black"). Film thickness is measured at the center of the film with a digital micrometer (precision ±1 µm, accuracy ± several µm). Note: the suffix after each pigment's name (e.g., "[A]") is just an LBNL identification tag.

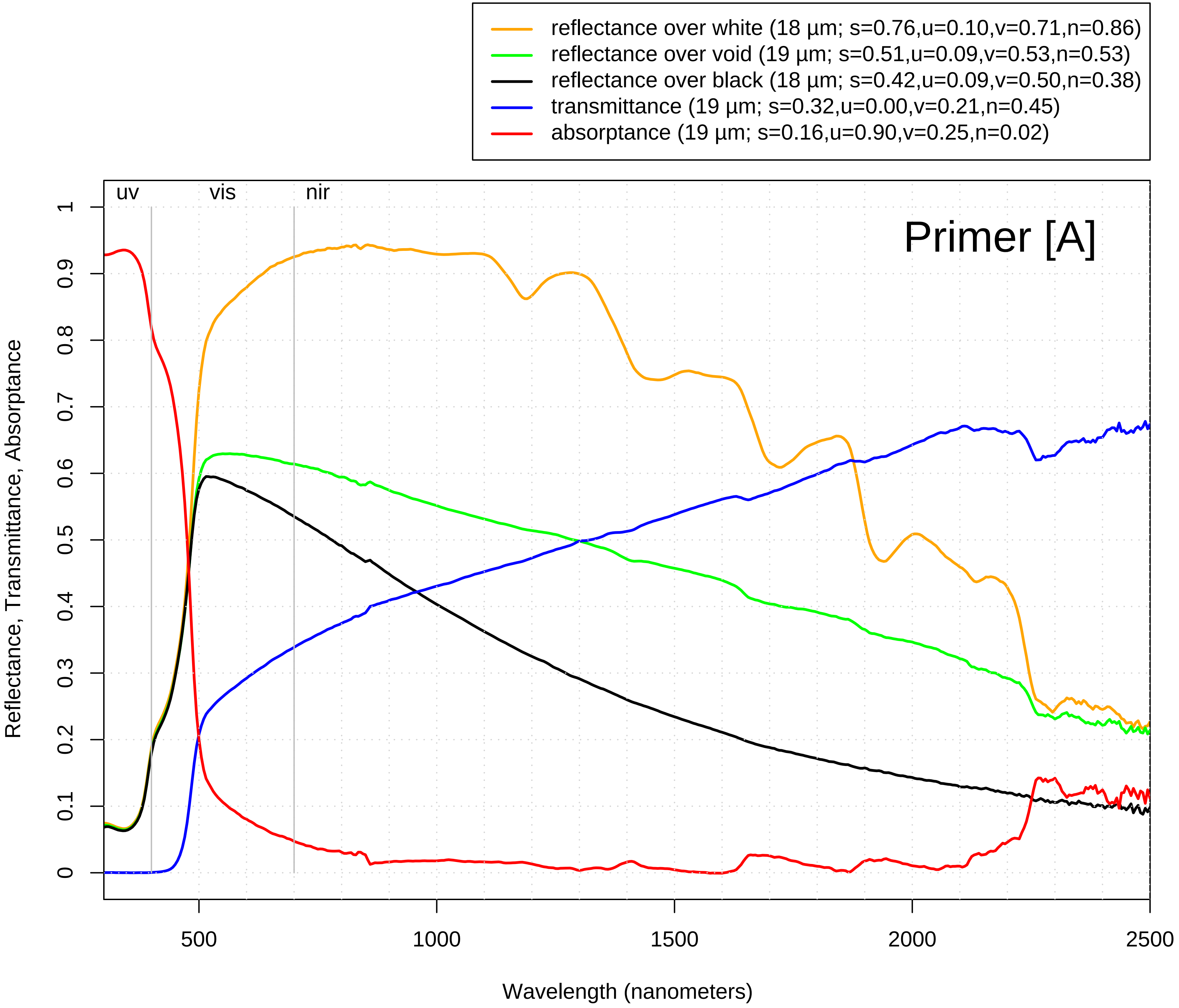
Optical properties are weighted with the ASTM air-mass 1.5 global solar irradiance spectrum to integrate averages over the solar (s; 300-2,500 nm), ultraviolet (u; 300-400 nm); visible (v; 400-700 nm), and near-infrared (n; 700-2,500 nm) spectra.

(b) Kubelka-Munk Calculations. The pigment's optical properties (strictly speaking, the optical properties of the pigment suspended in a vehicle of refractive index 1.5) are computed from the paint film's optical properties. More specifically, an adaptation (see "ancillary calculations", below) of the classic Kubelka-Munk two-flux theory is used to calculate the pigment's absorption coefficient K and backscattering coefficient S from the transmittance and reflectance of the free film. The reflectance of an opaquely thick paint film made from this pigment is also shown. (The opaque reflectance is a function of the ratio K/S. When the free film is opaque at a given wavelength, the only pigment property that can be reported is opaque reflectance. When the free film is not opaque, the opaque reflectance is determined from the ratio of the computed values of K and S.)

(c) Ancillary Calculations. The measured reflectance and transmittance of the paint film are influenced by "interface" reflectances that occur when light passes from air (refractive index 1) to film (refractive index 1.5) and vice-versa. Interface reflectances can depend strongly on the degree to which the spectrometer's collimated light beam is diffused by passage through the film. The extent of this diffusion is parameterized by the film's characteristic "diffuseness" which gauges the extent to which an initially collimated beam is diffused by a single passage through the film. The diffuseness ranges from zero (fully collimated) to one (fully diffuse).

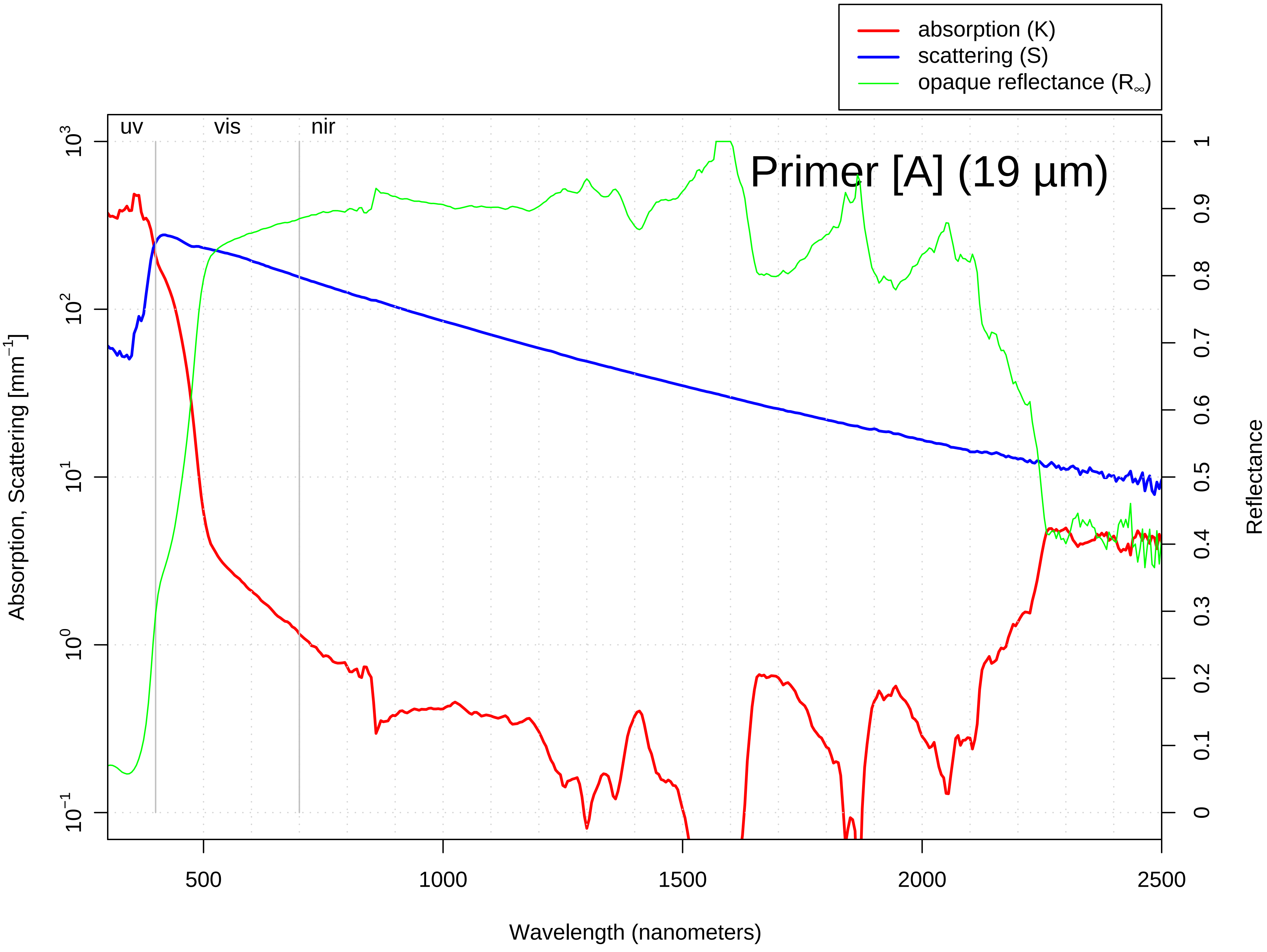
The film's characteristic diffuseness is adjusted until the Kubelka-Munk calculations yield values of K and S that accurately predict the measured reflectance of the film over an opaque black background. A second parameter, the ratio of the pigment's back scattering to its total scattering (forward and backward) is then adjusted to make the values of K and S consistent with the film's characteristic diffuseness.

(d) Calculated vs. Measured Reflectances. Film reflectances computed from K and S are compared to measured reflectances to validate the accuracy of K and S. We expect the predicted value of film-reflectance-over-black to match the measured value because the measured value is used in ancillary calculations that affect K and S. However, comparing predicted and measured values of film-reflectance-over-white is a good check, because the measured film-reflectance-over-white is not used in any of the calculations that yield K and S.



(a) Spectrometer Film Measurements

Sunday, 09 March 2003 12:19 PM



(b) Kubelka−Munk Calculations

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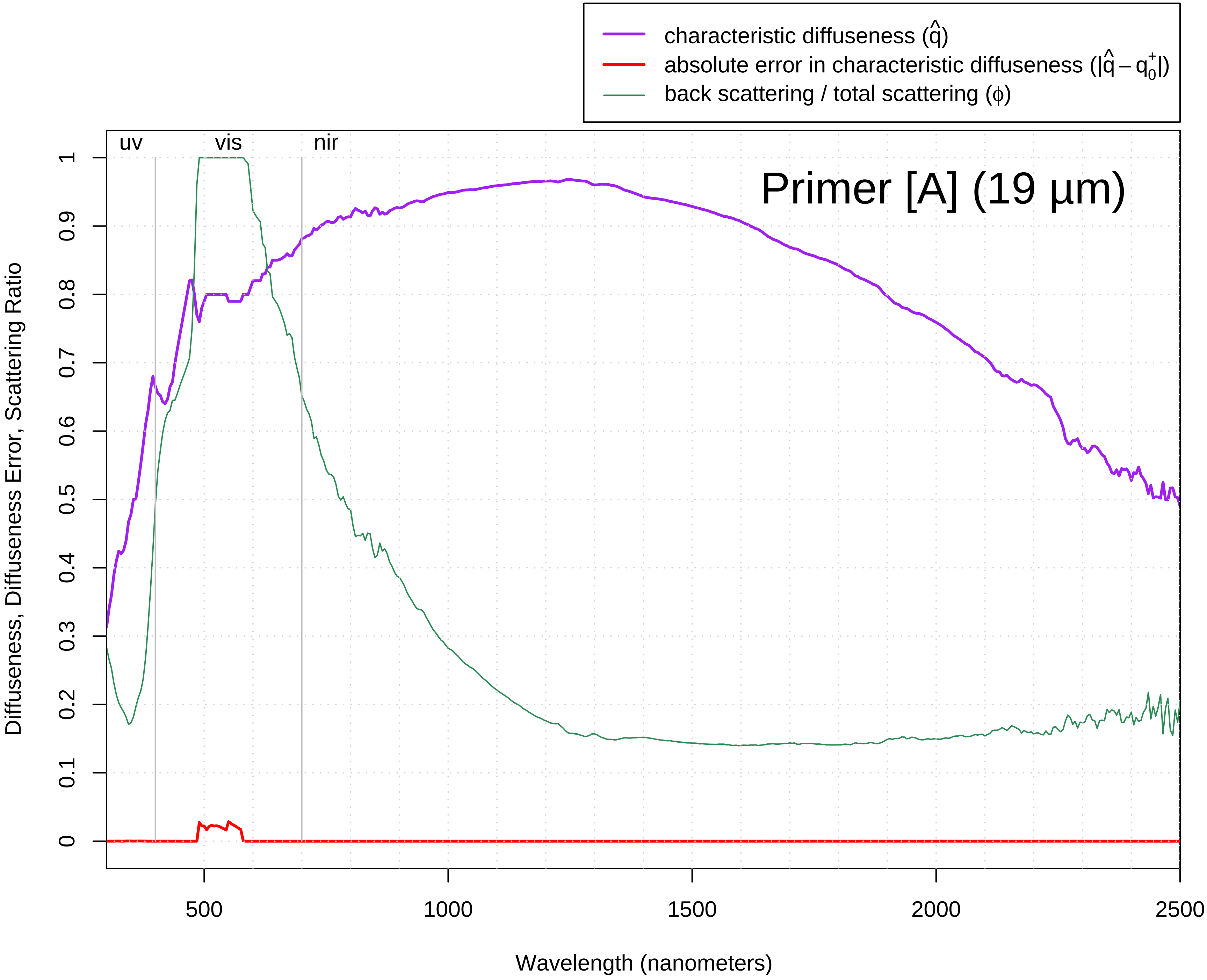

(c) Ancillary Calculations

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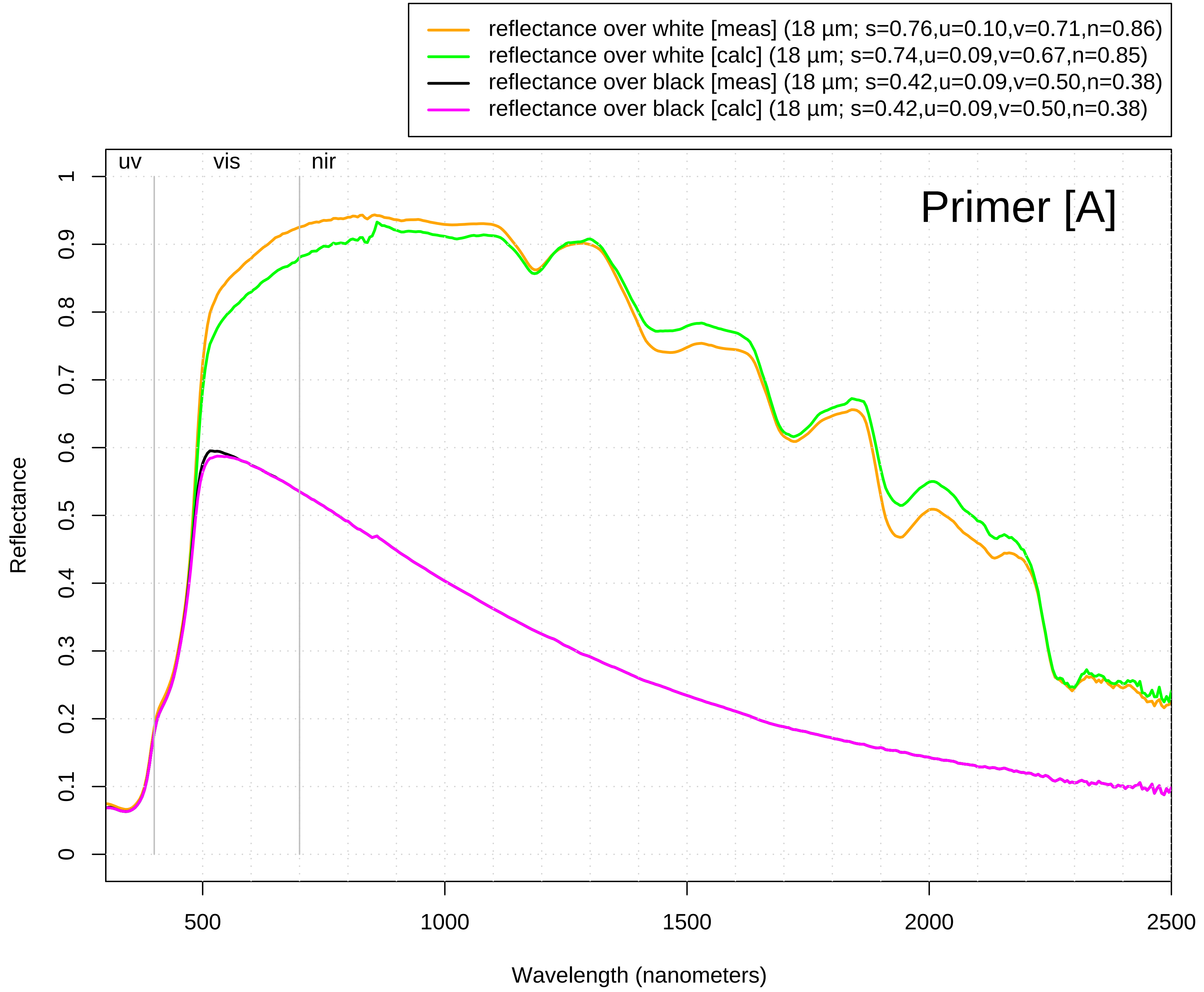

(d) Calculated vs. Measured Reflectances

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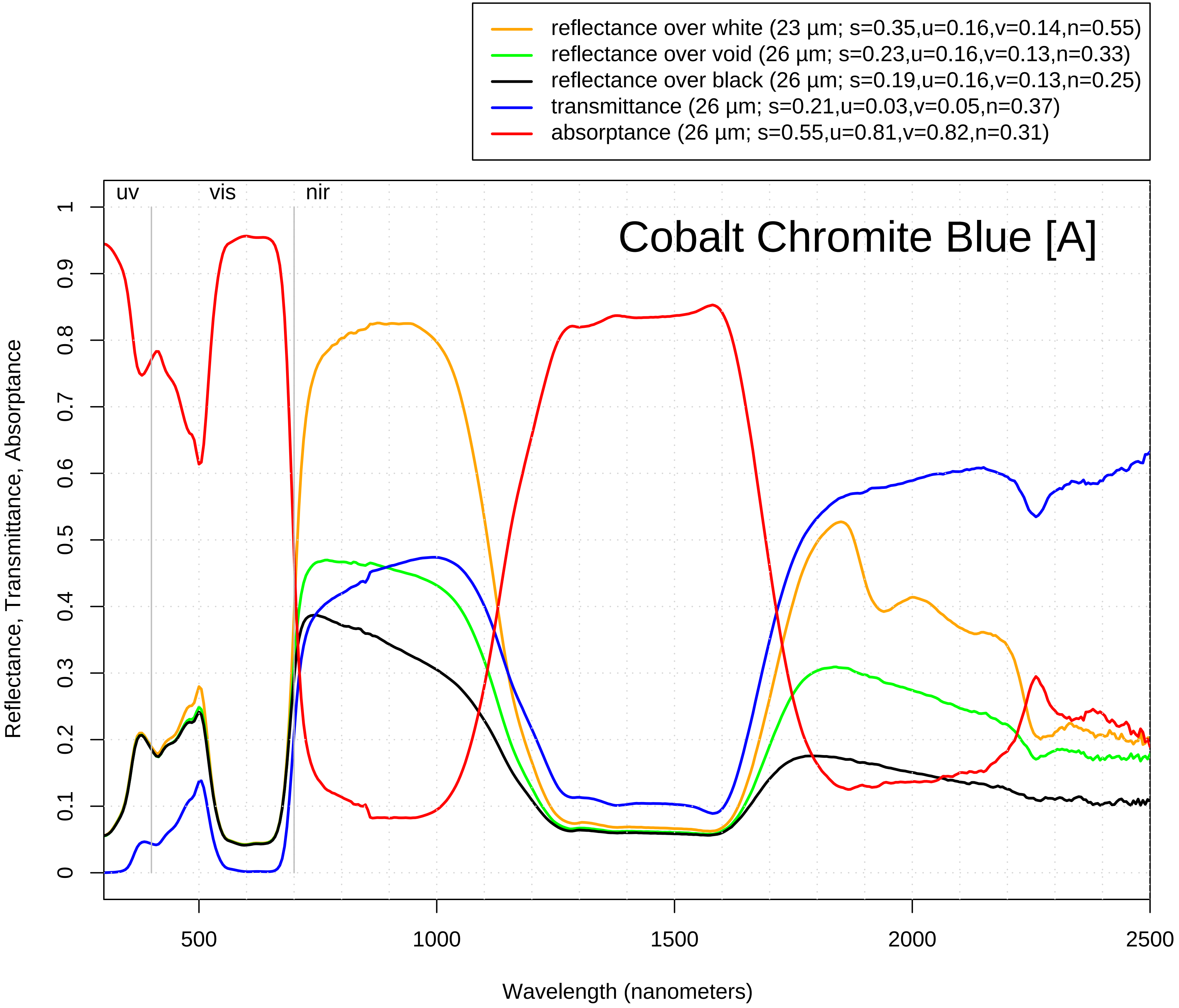

(a) Spectrometer Film Measurements

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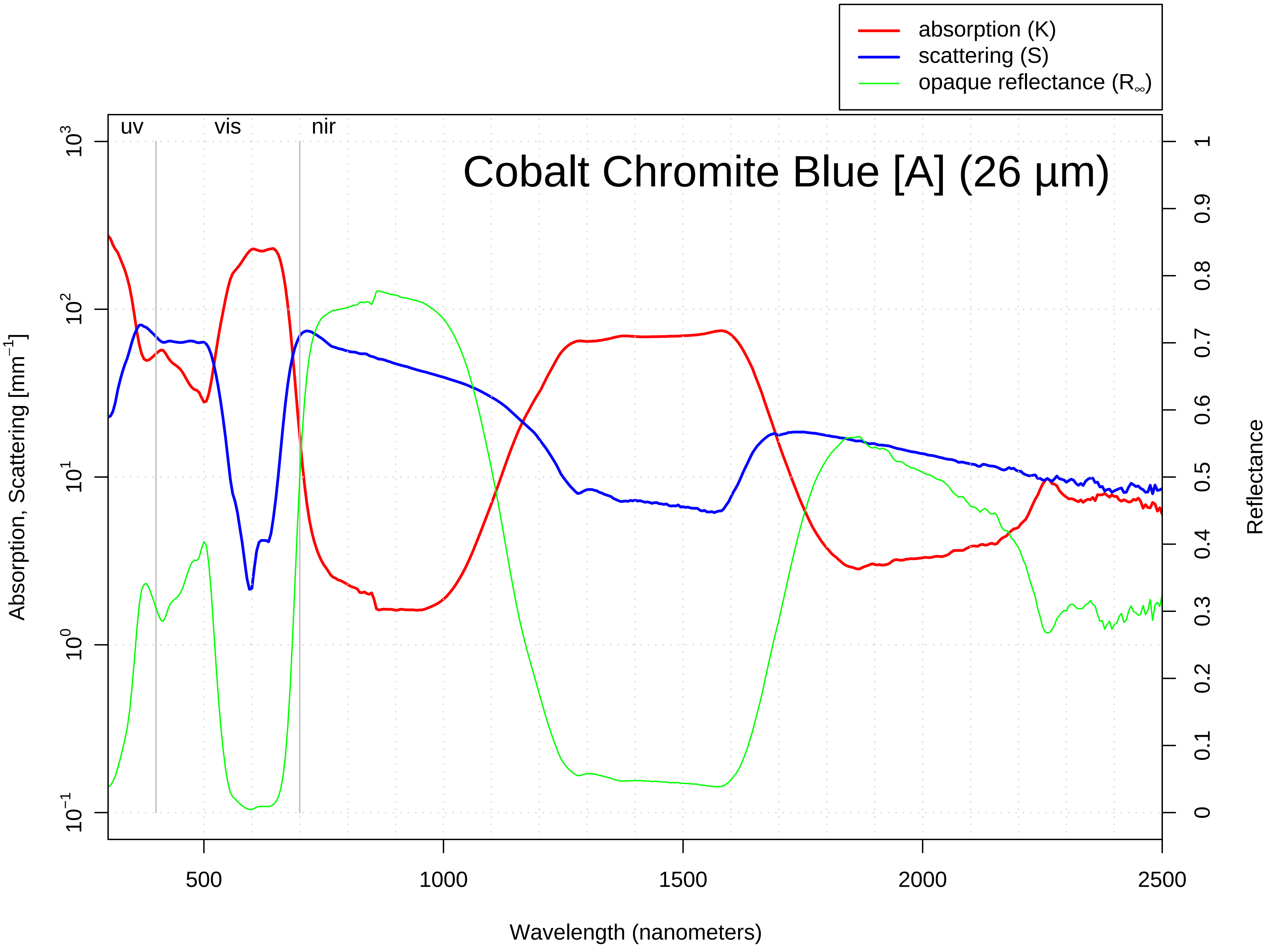

(b) Kubelka−Munk Calculations

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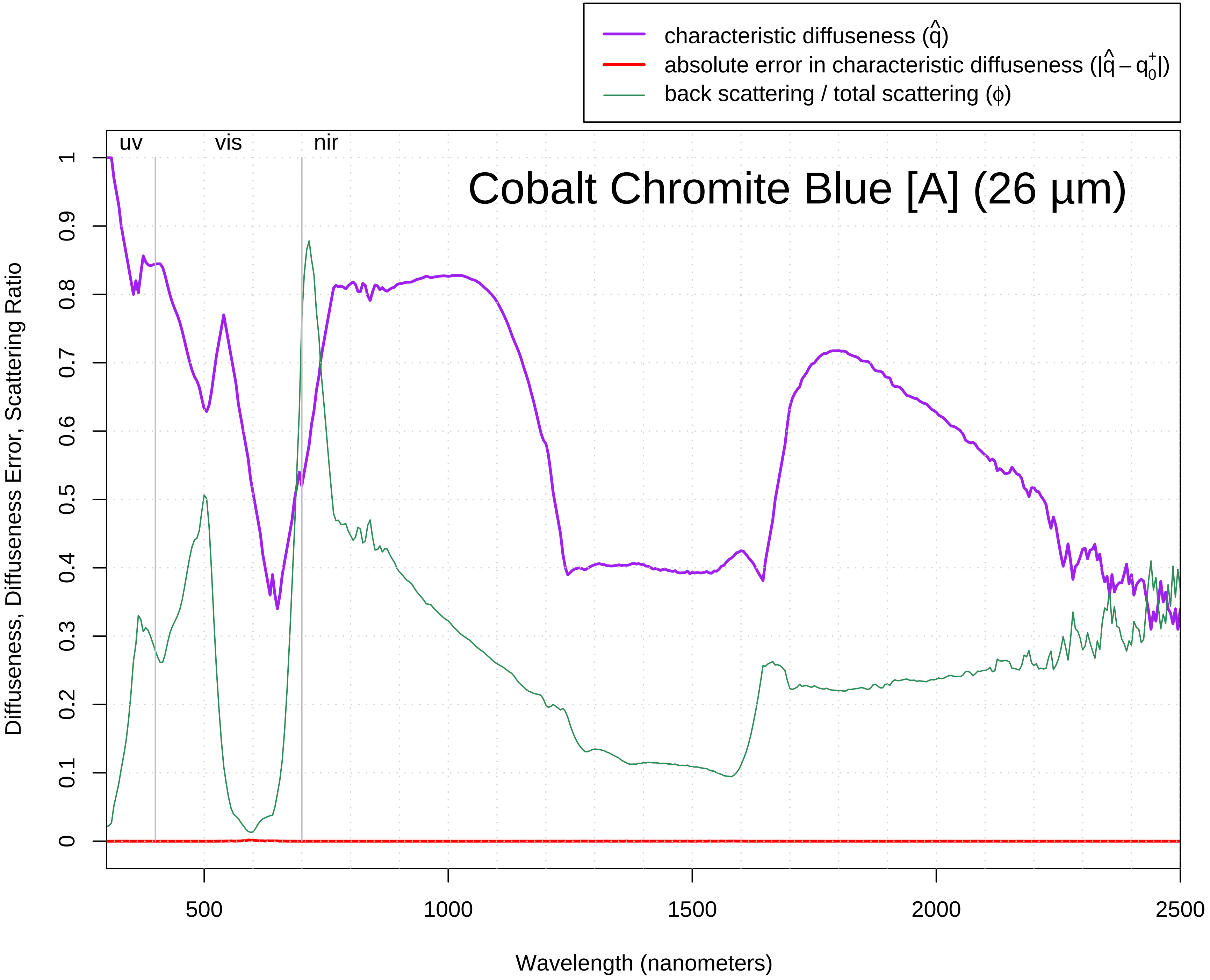

(c) Ancillary Calculations

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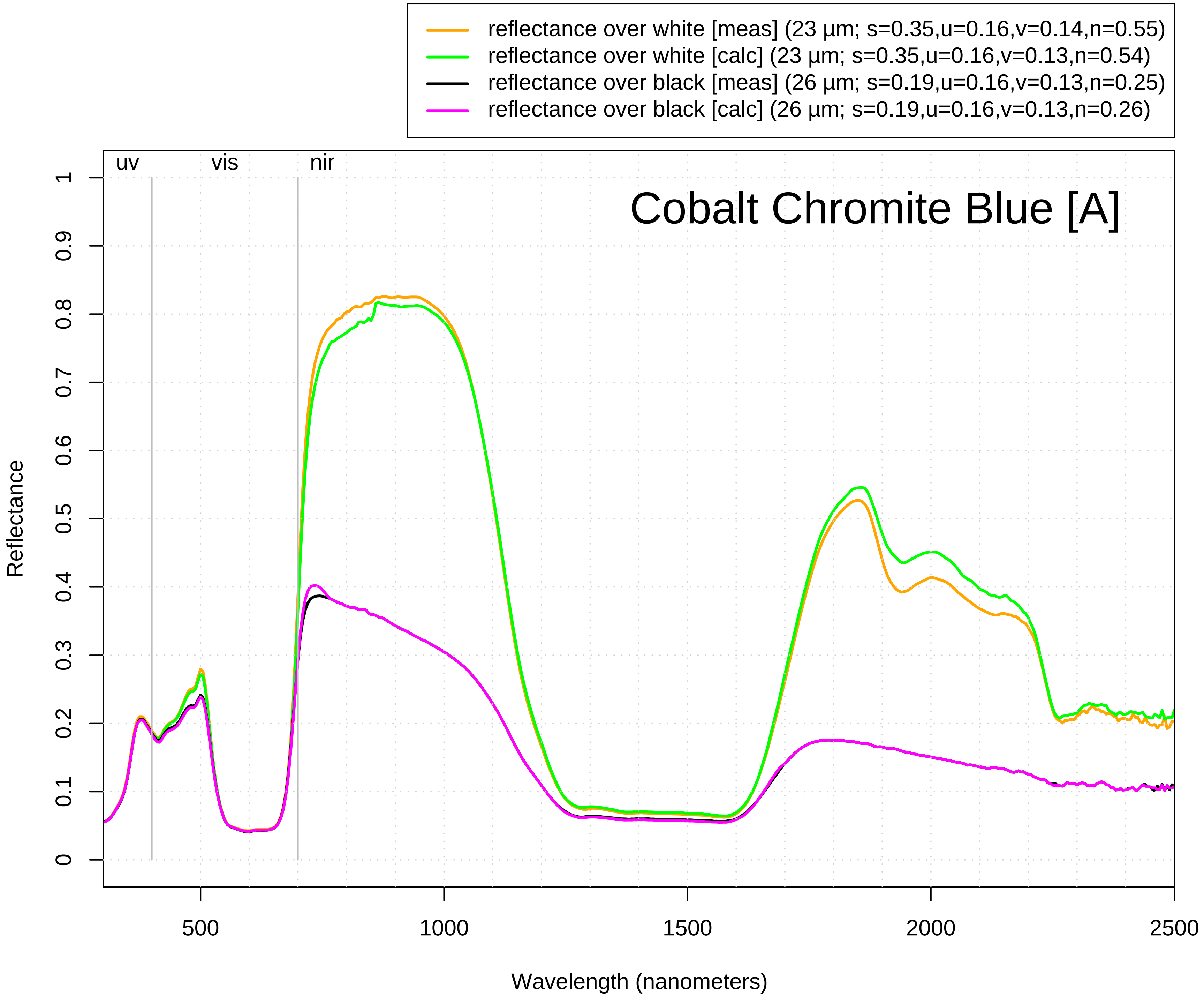

(d) Calculated vs. Measured Reflectances

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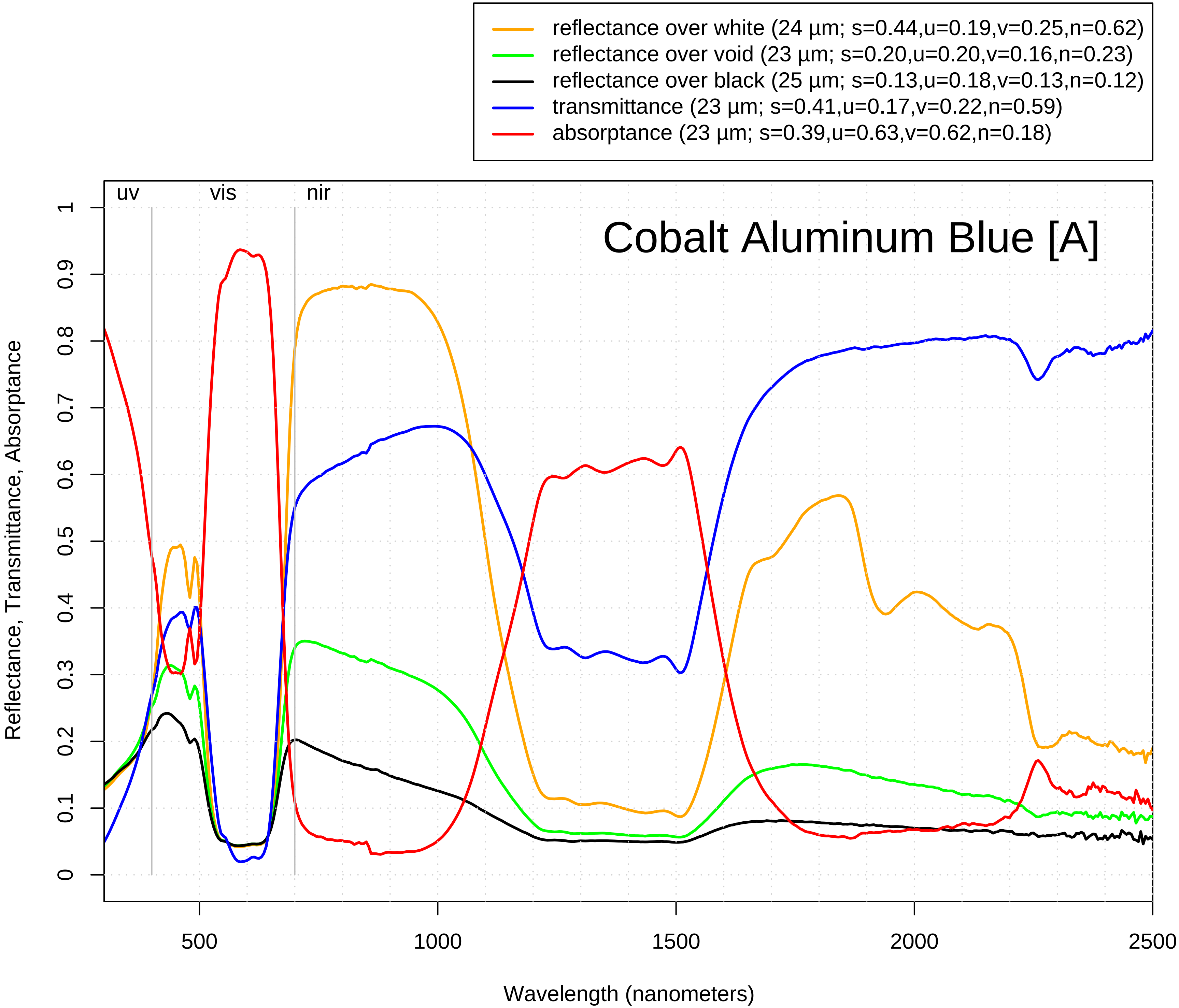

(a) Spectrometer Film Measurements

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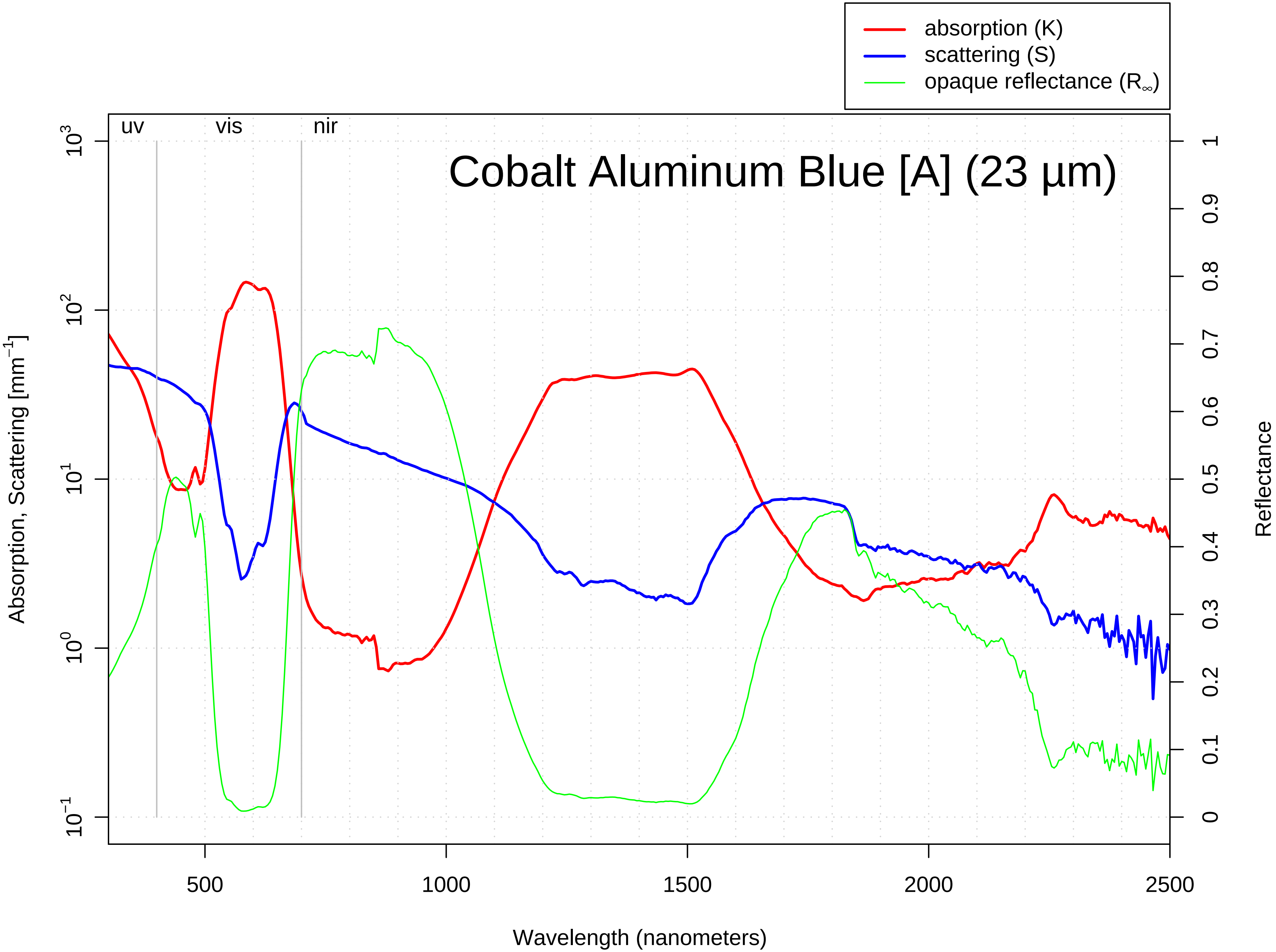

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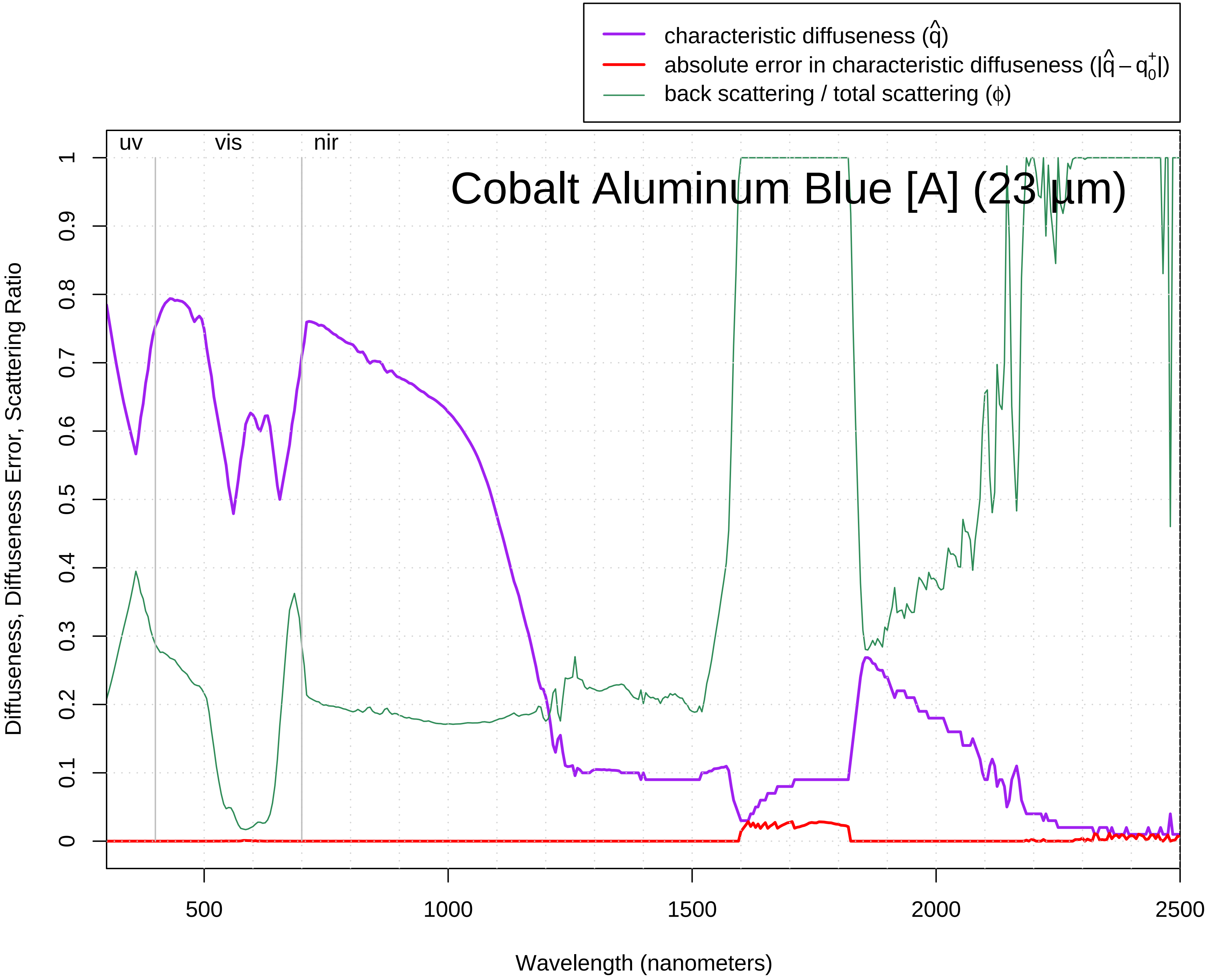

(c) Ancillary Calculations

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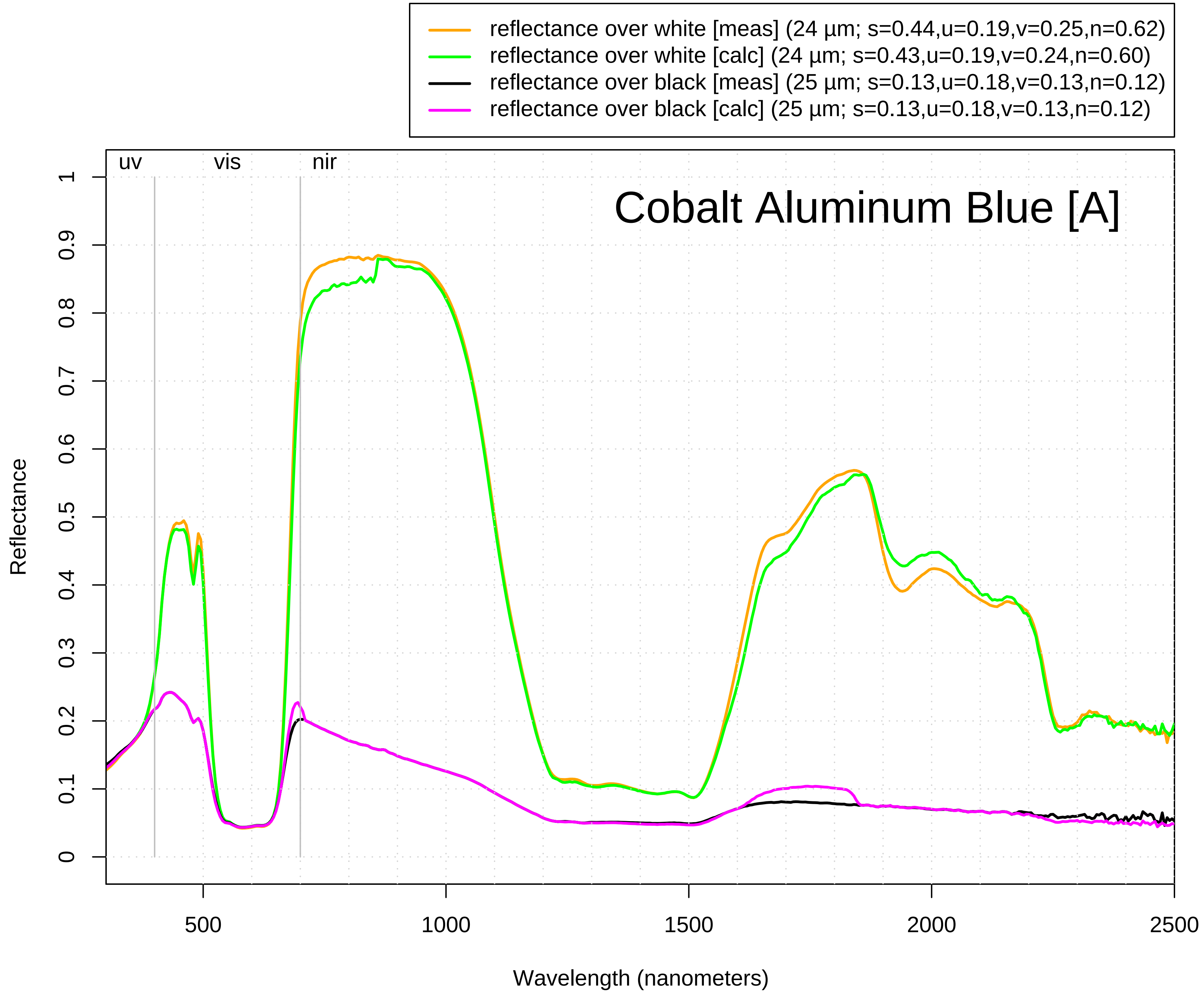

(d) Calculated vs. Measured Reflectances

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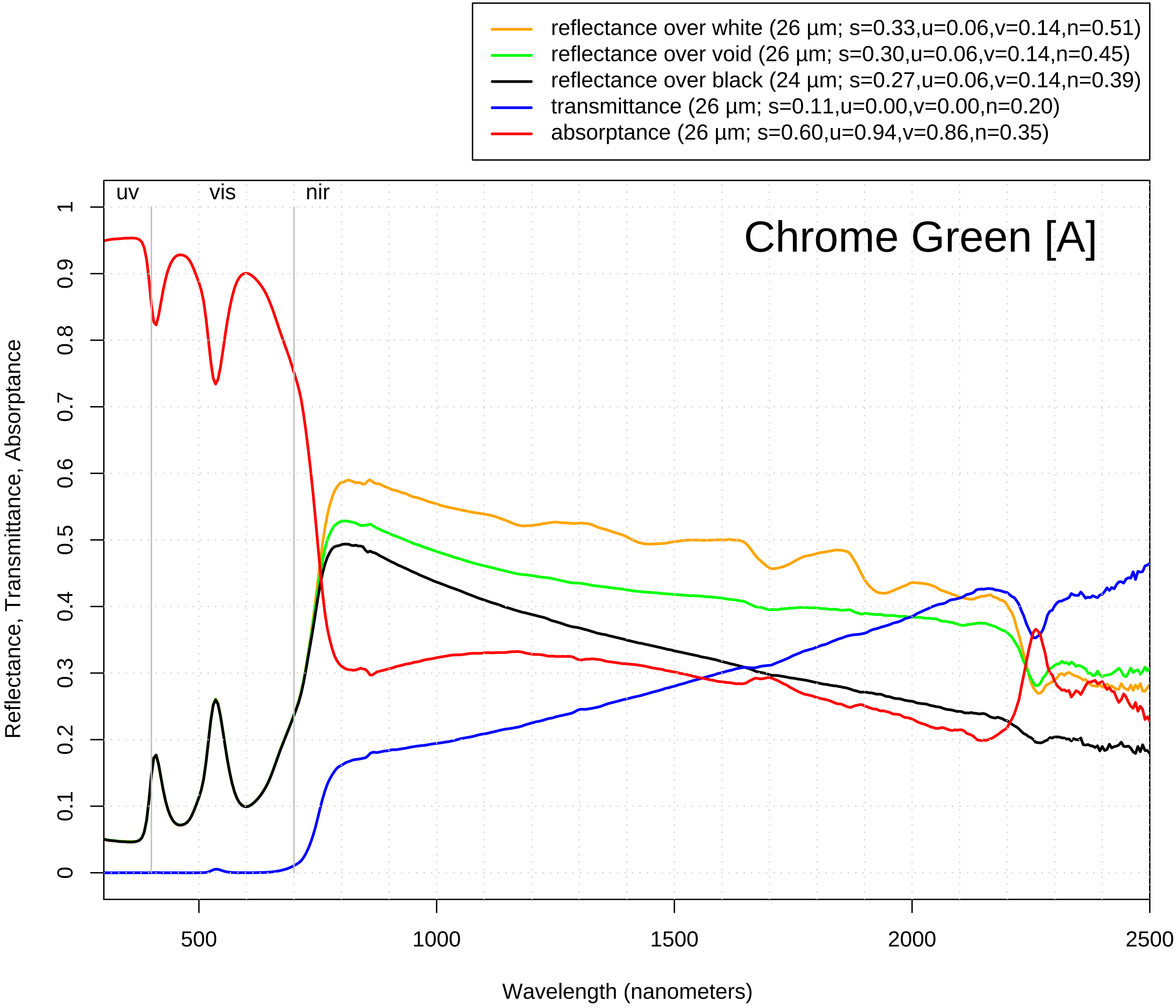

(a) Spectrometer Film Measurements

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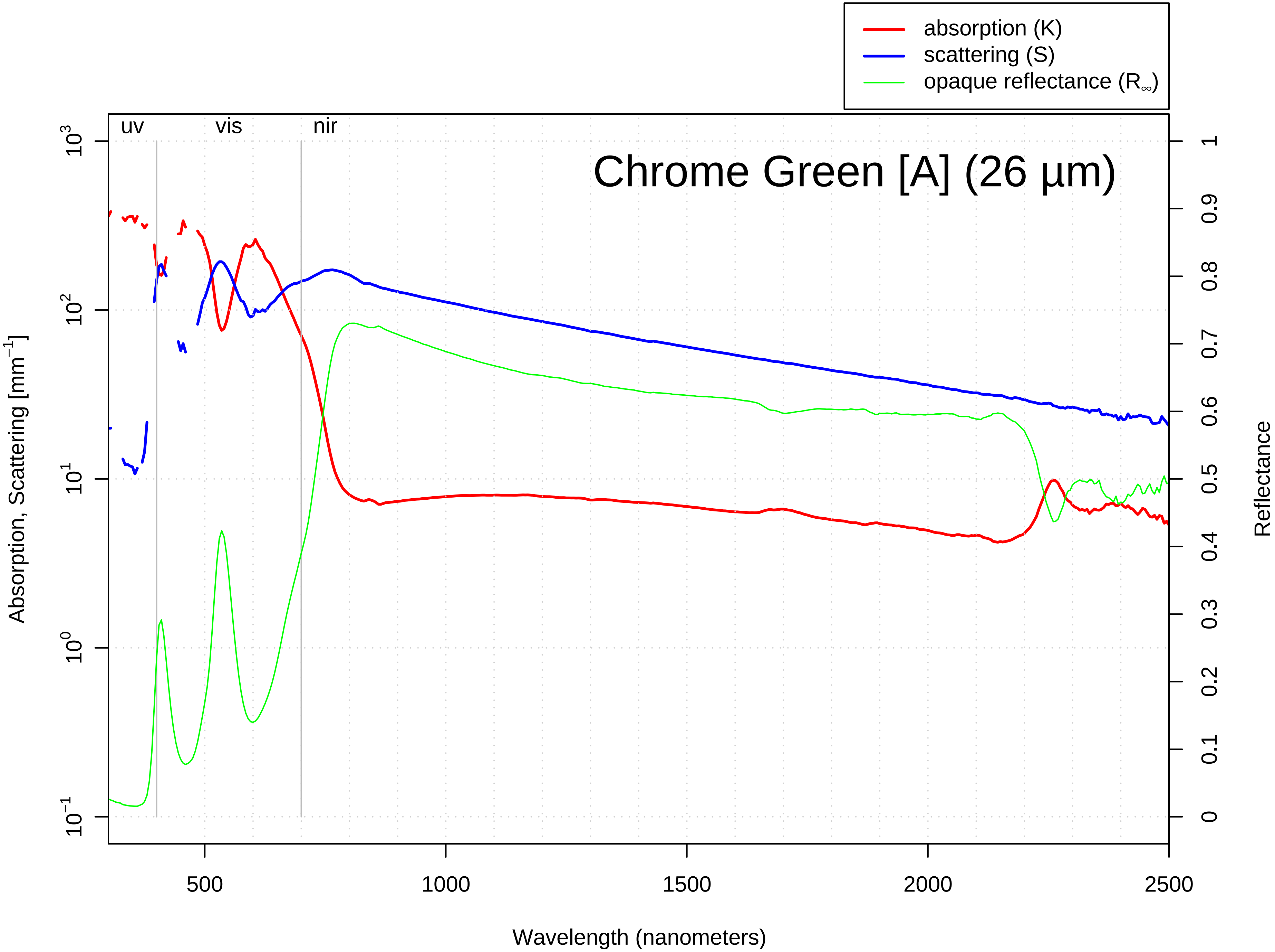

(b) Kubelka−Munk Calculations

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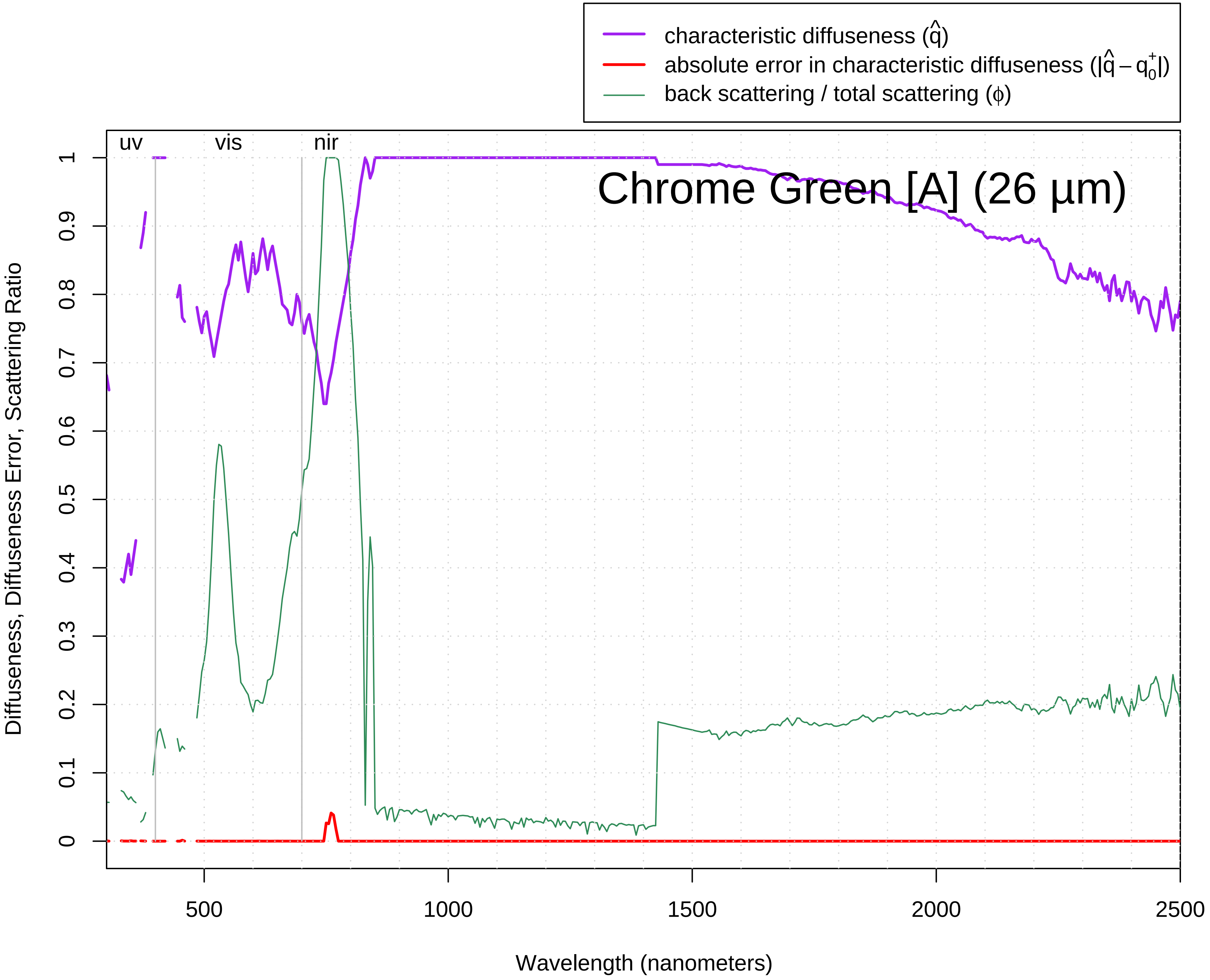

(c) Ancillary Calculations

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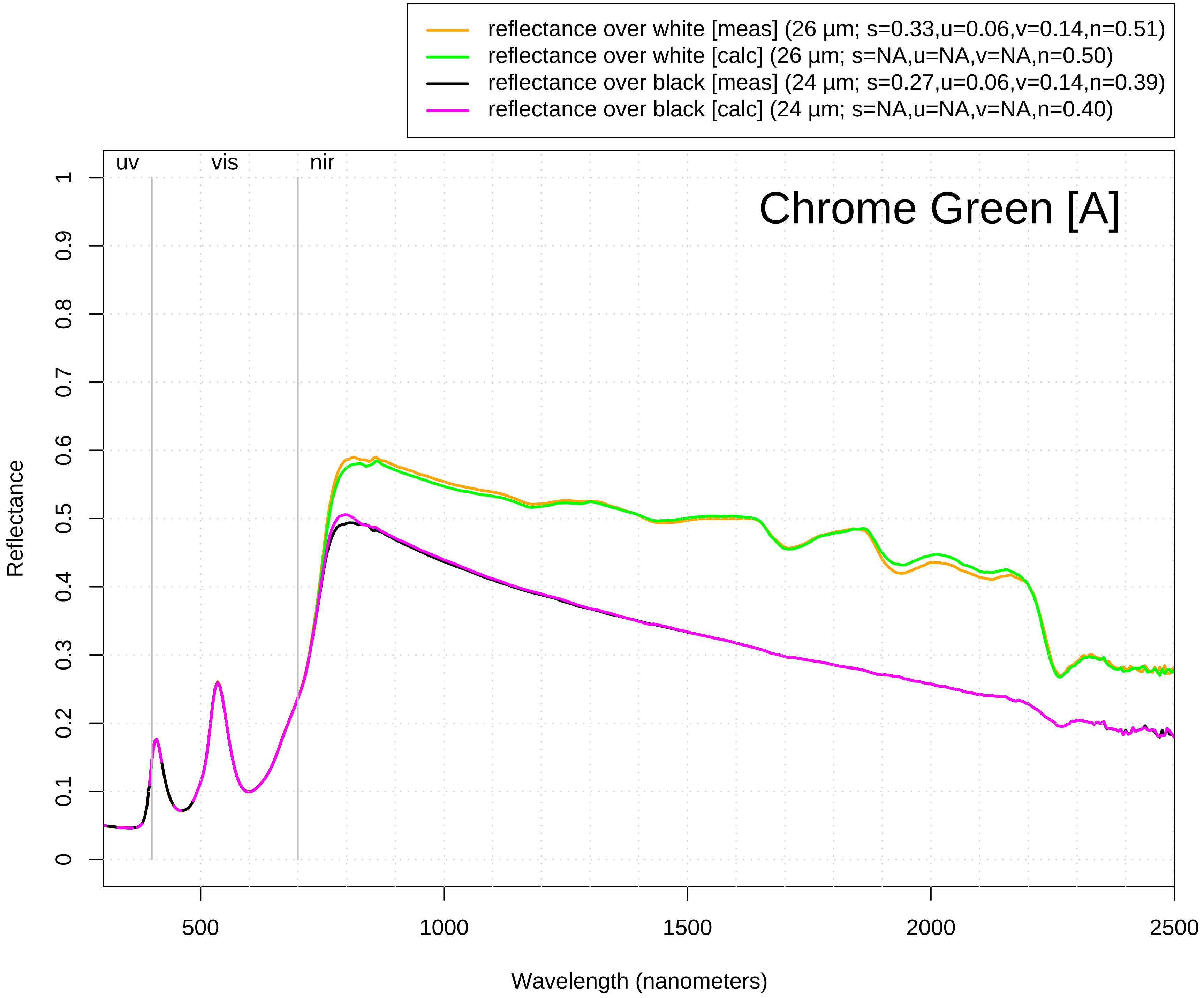

(d) Calculated vs. Measured Reflectances

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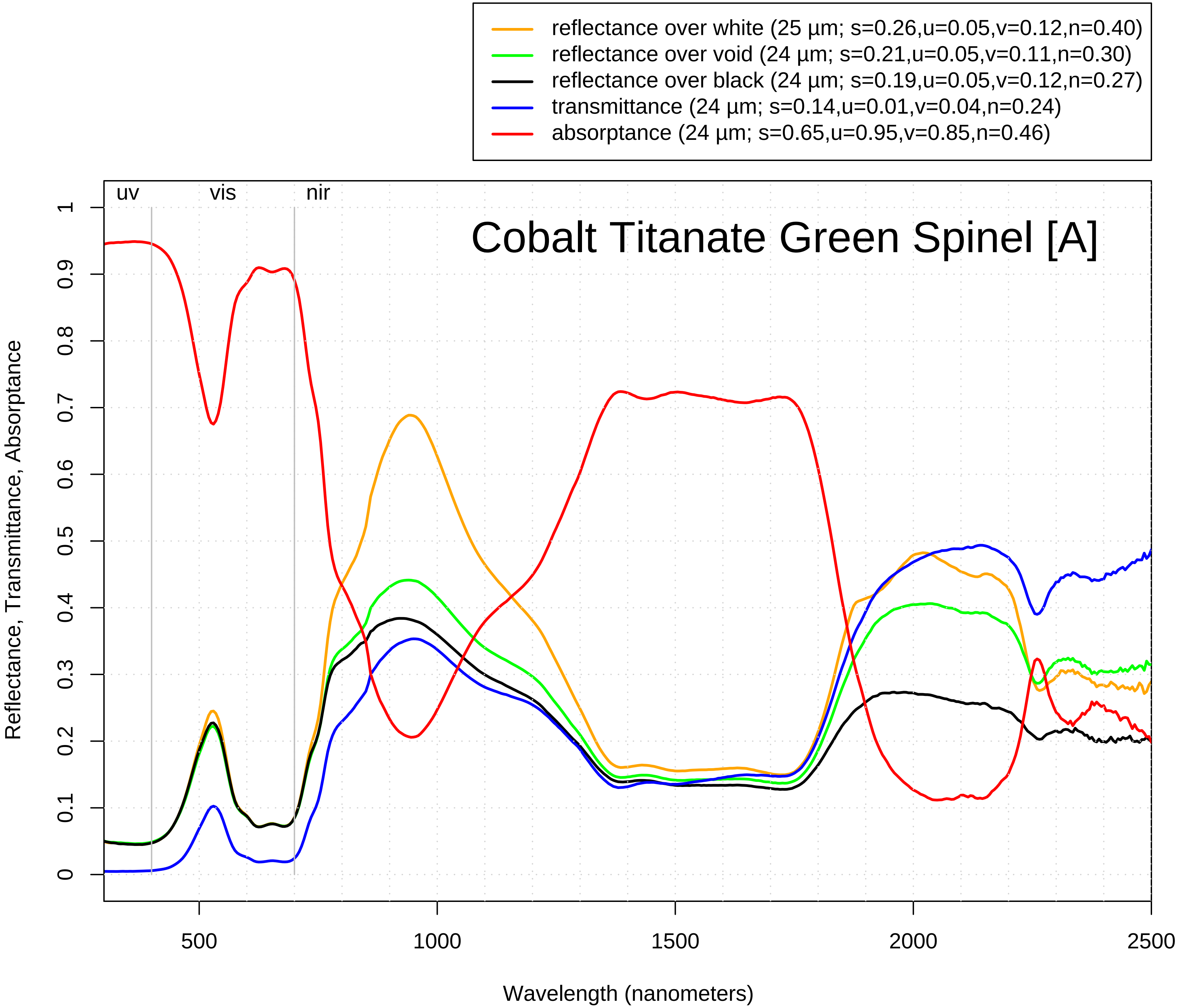

(a) Spectrometer Film Measurements

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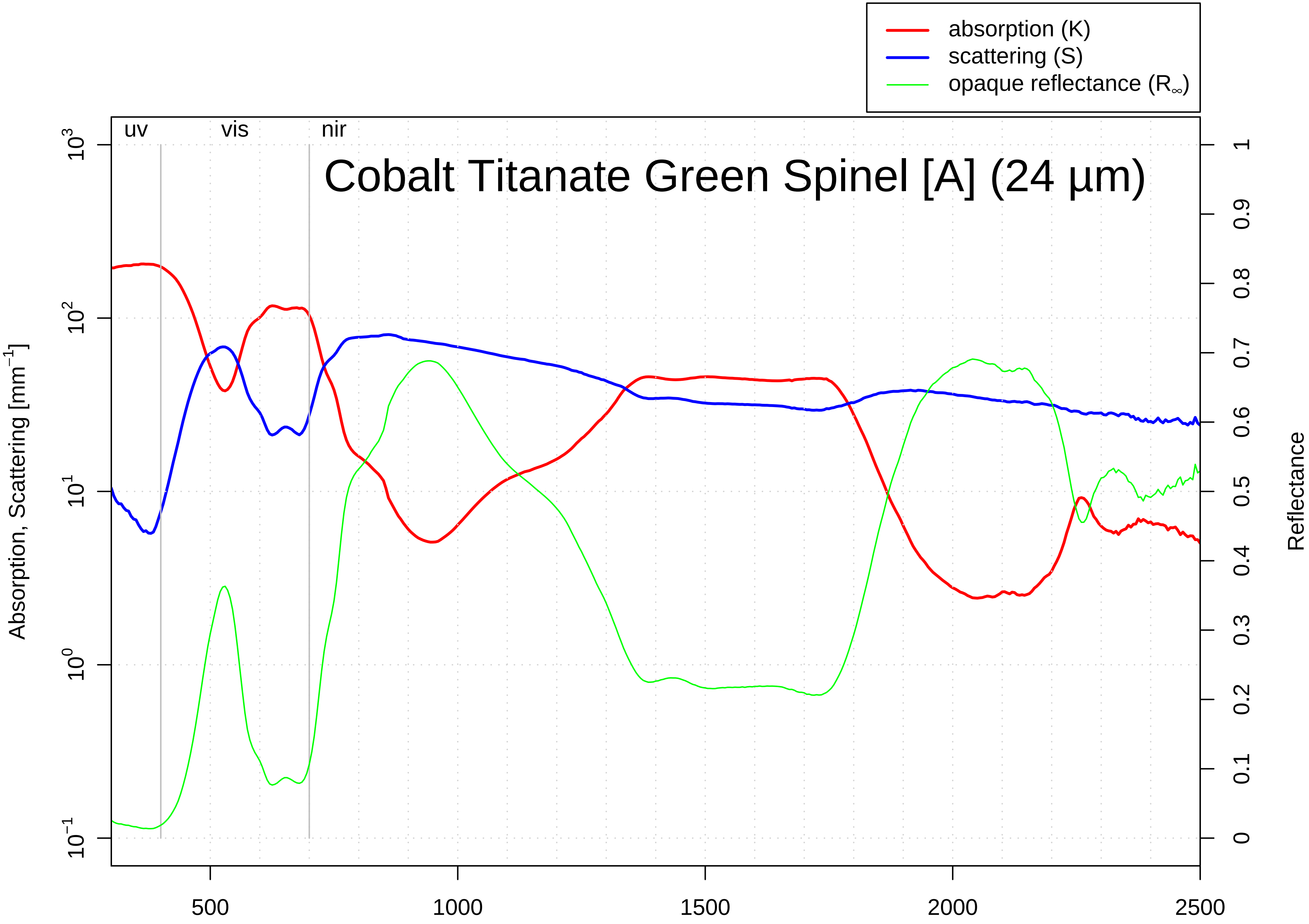

(b) Kubelka−Munk Calculations

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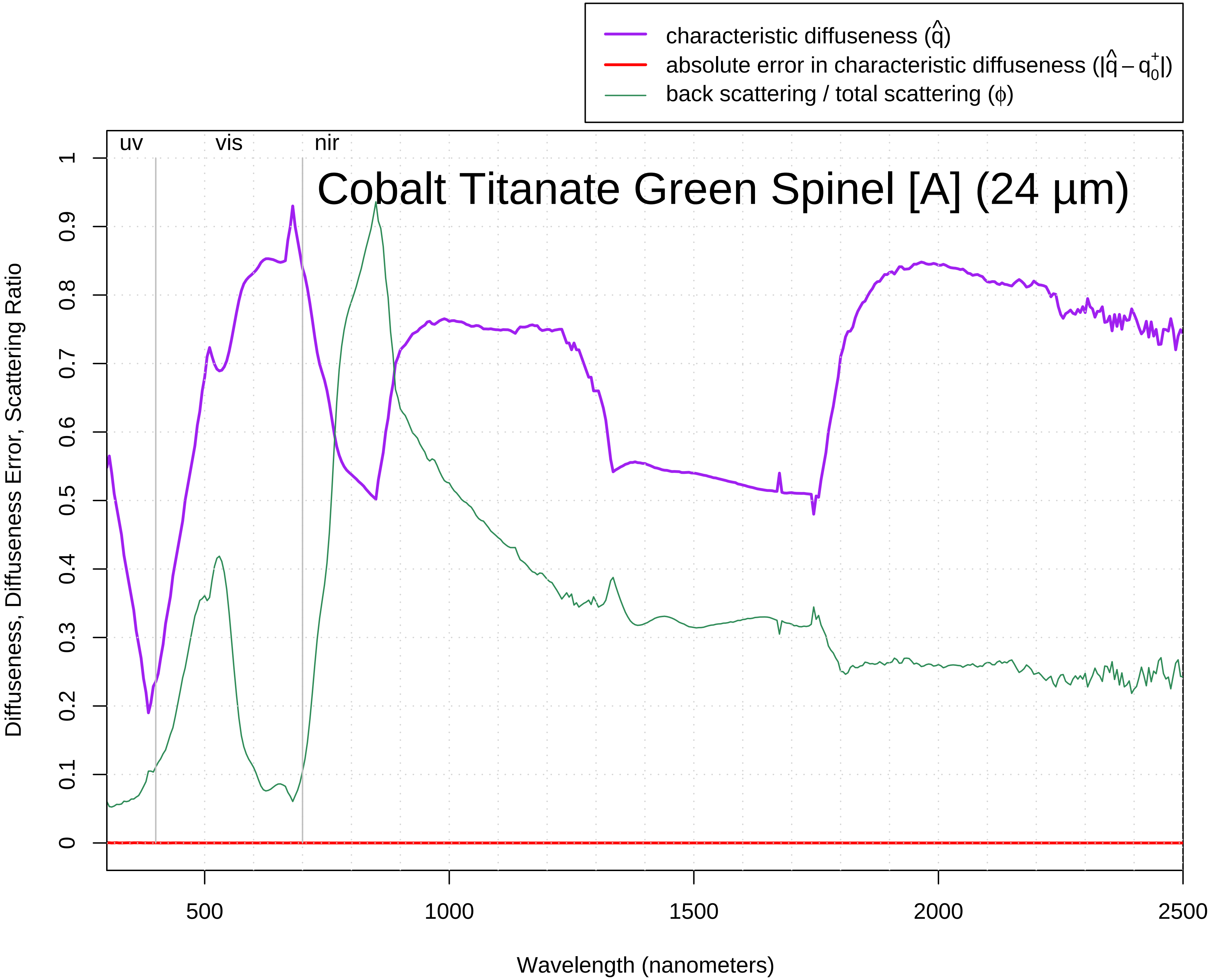

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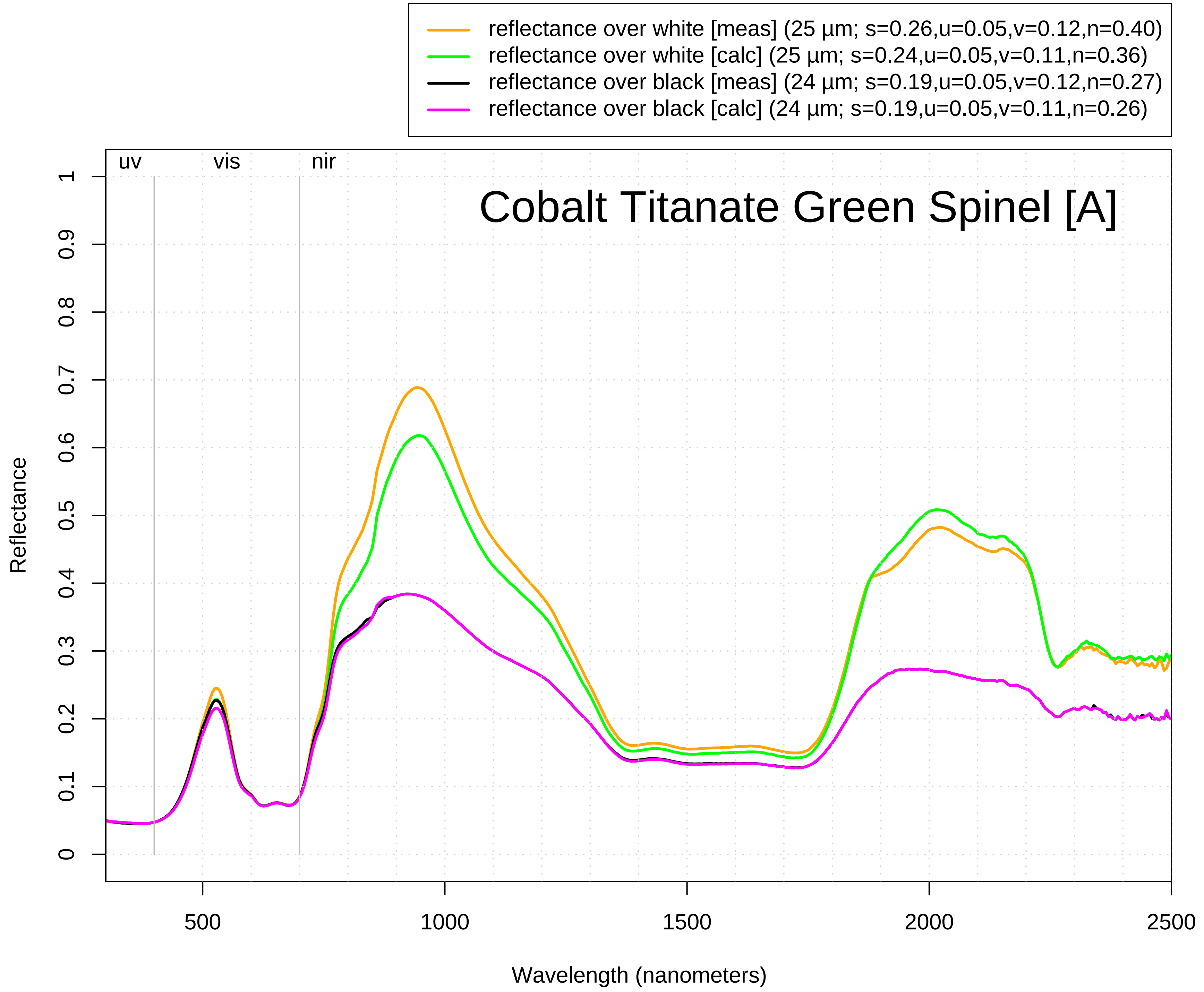

(d) Calculated vs. Measured Reflectances

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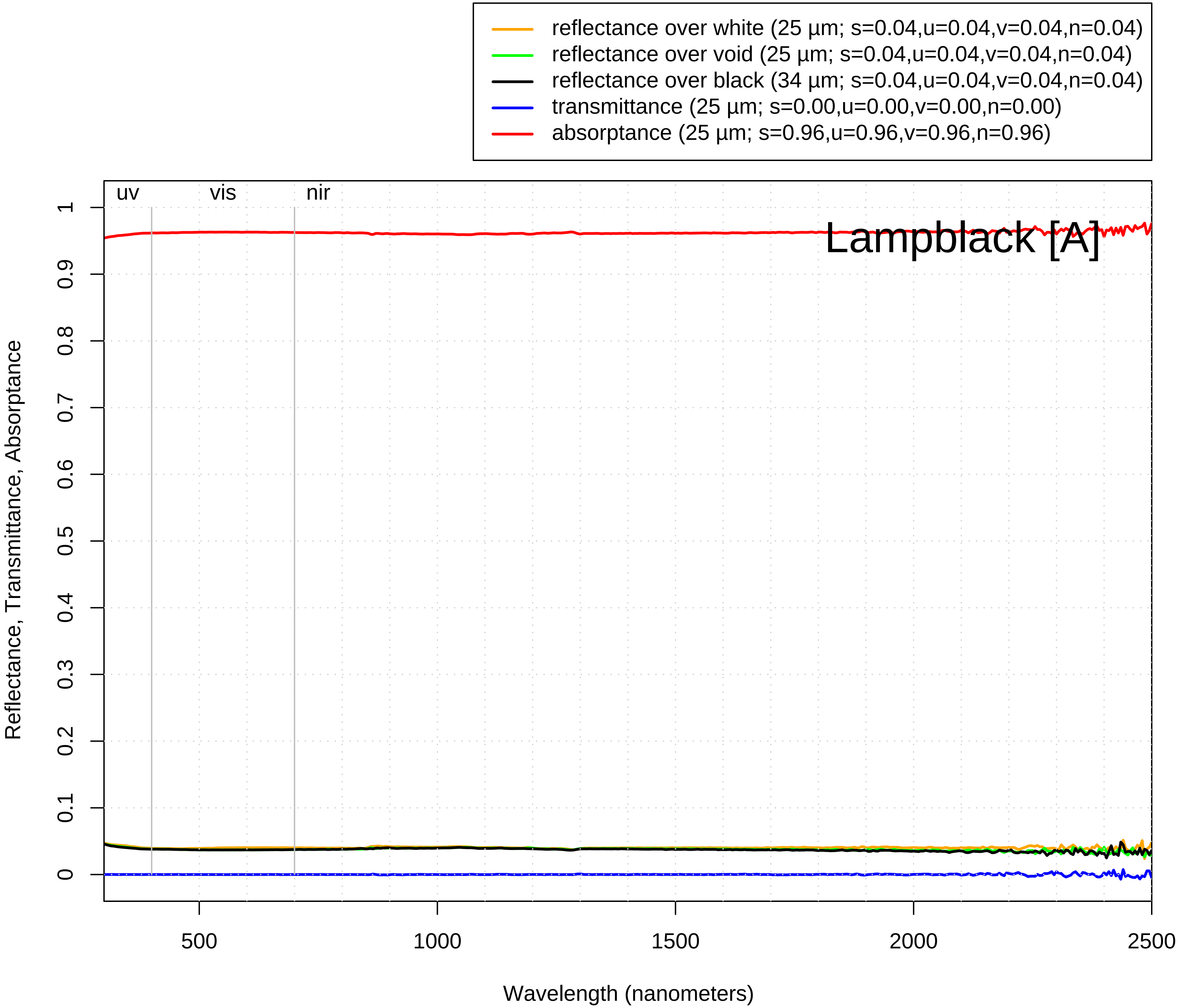

(a) Spectrometer Film Measurements

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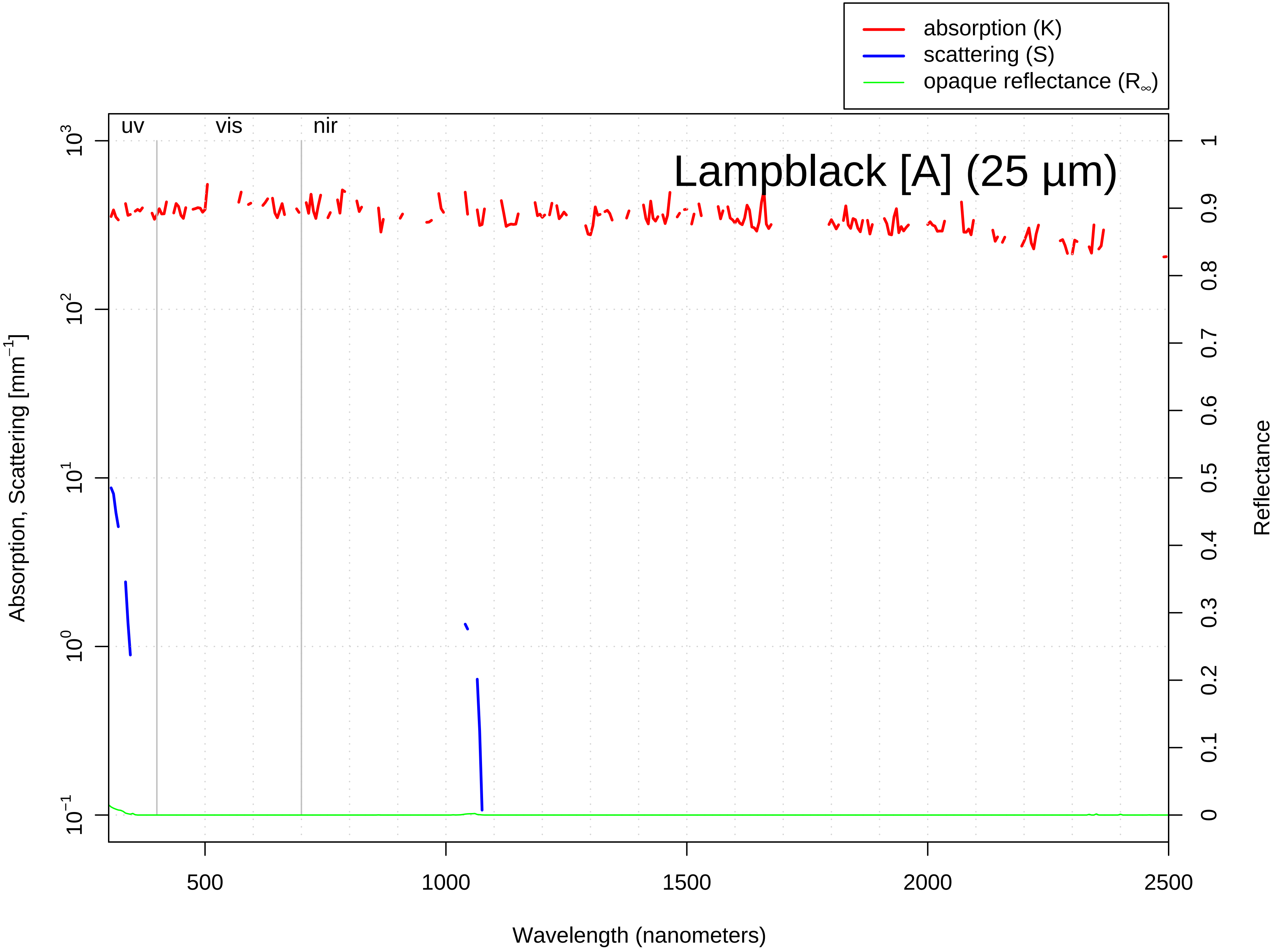

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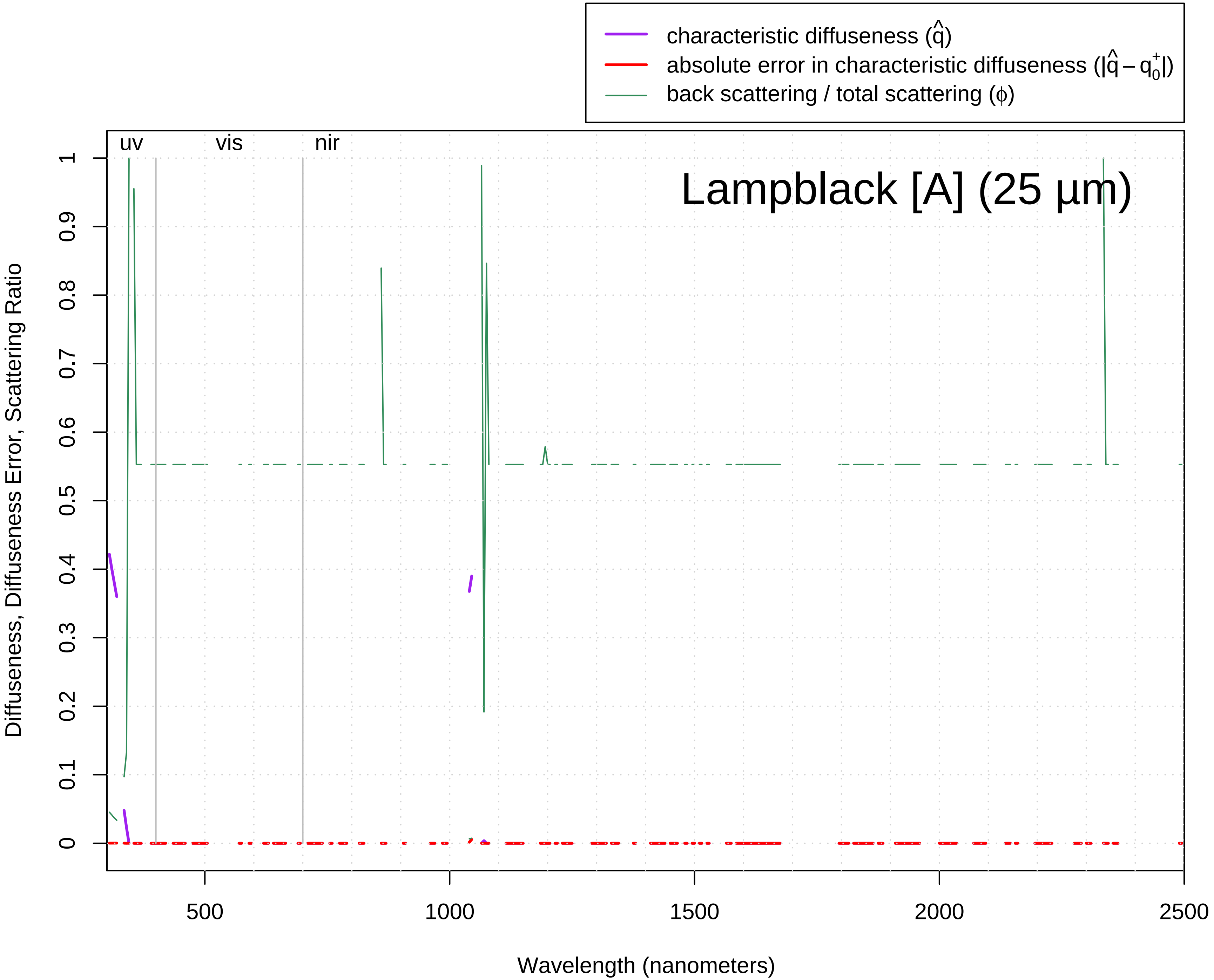

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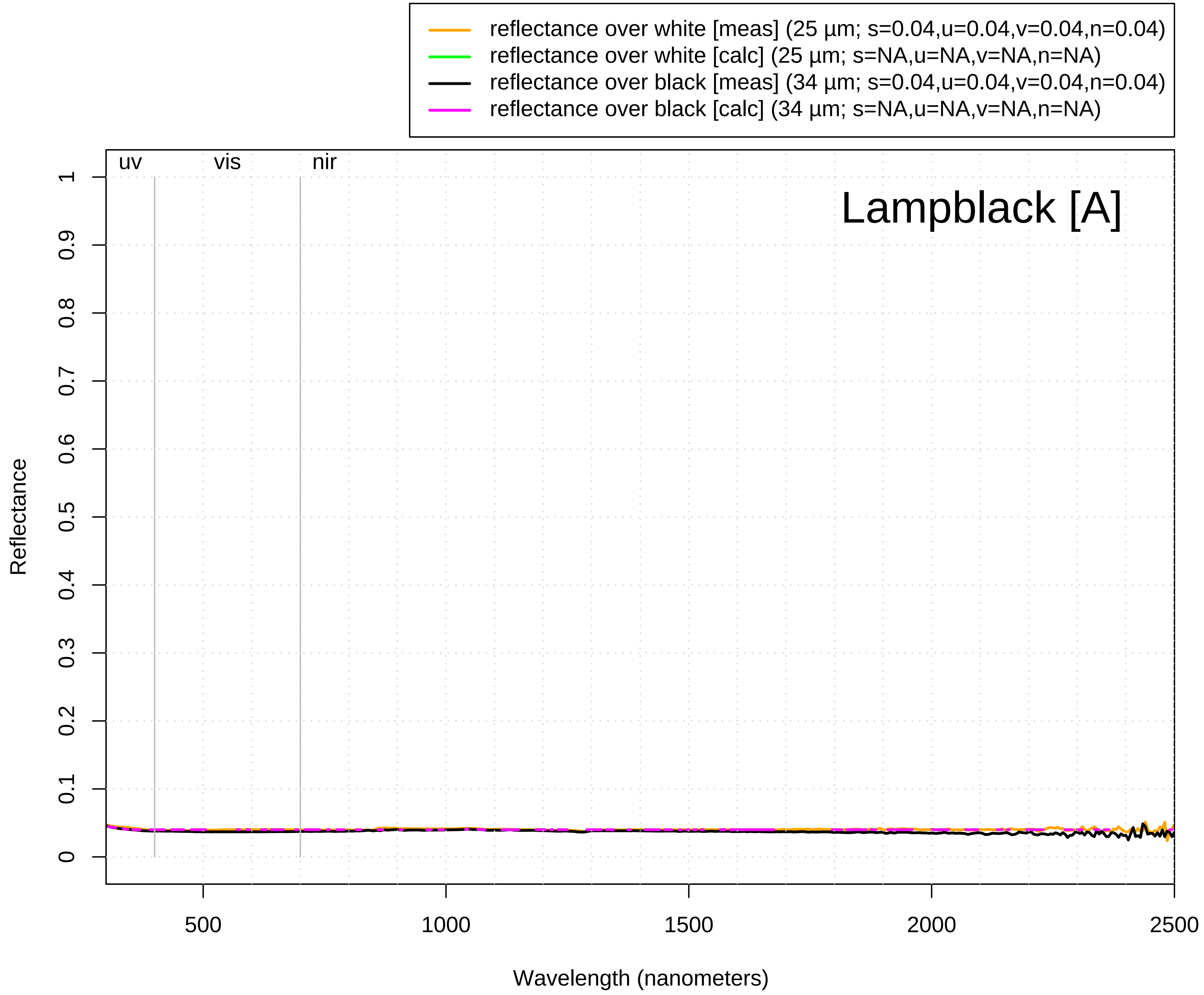

(d) Calculated vs. Measured Reflectances

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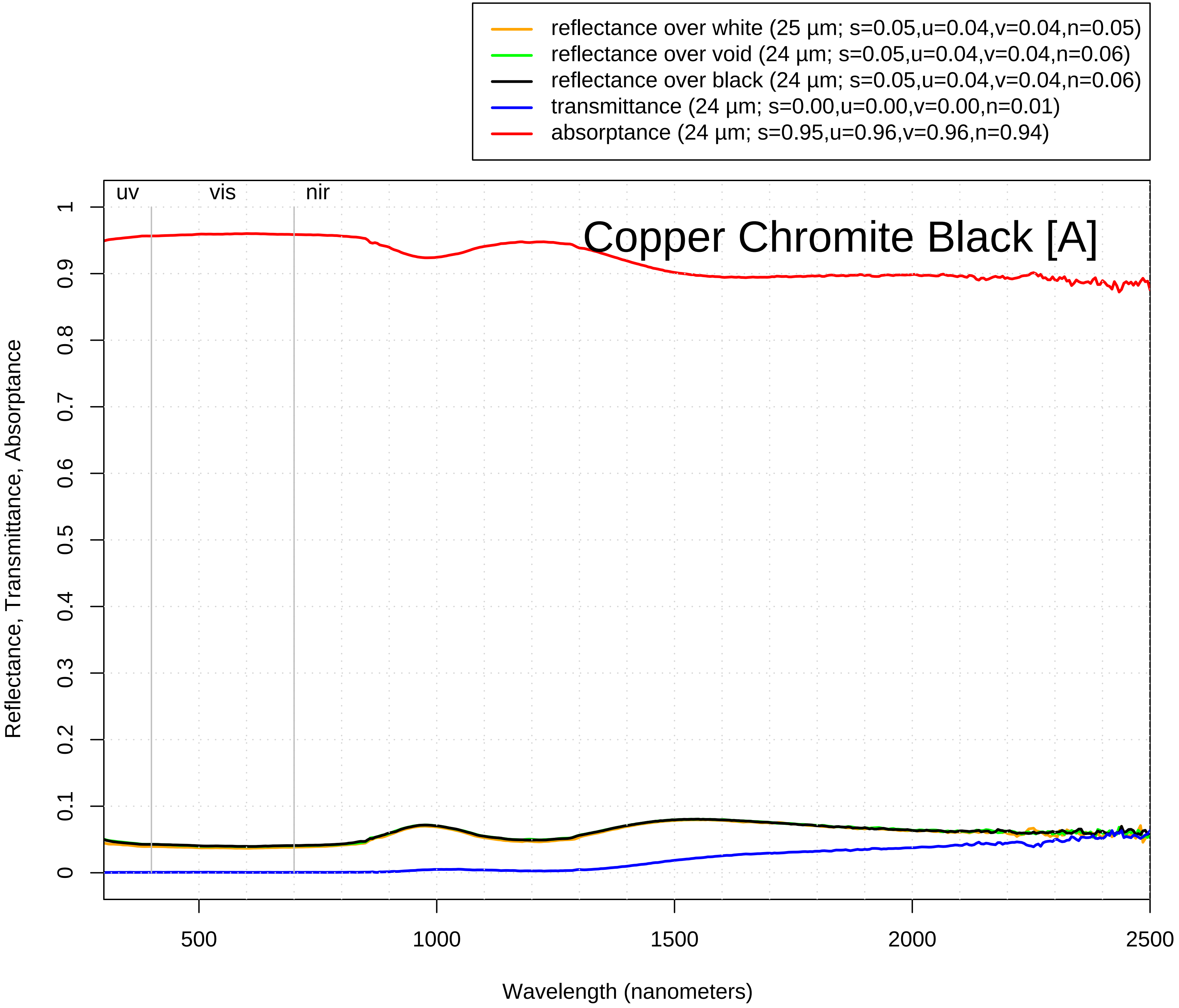

(a) Spectrometer Film Measurements

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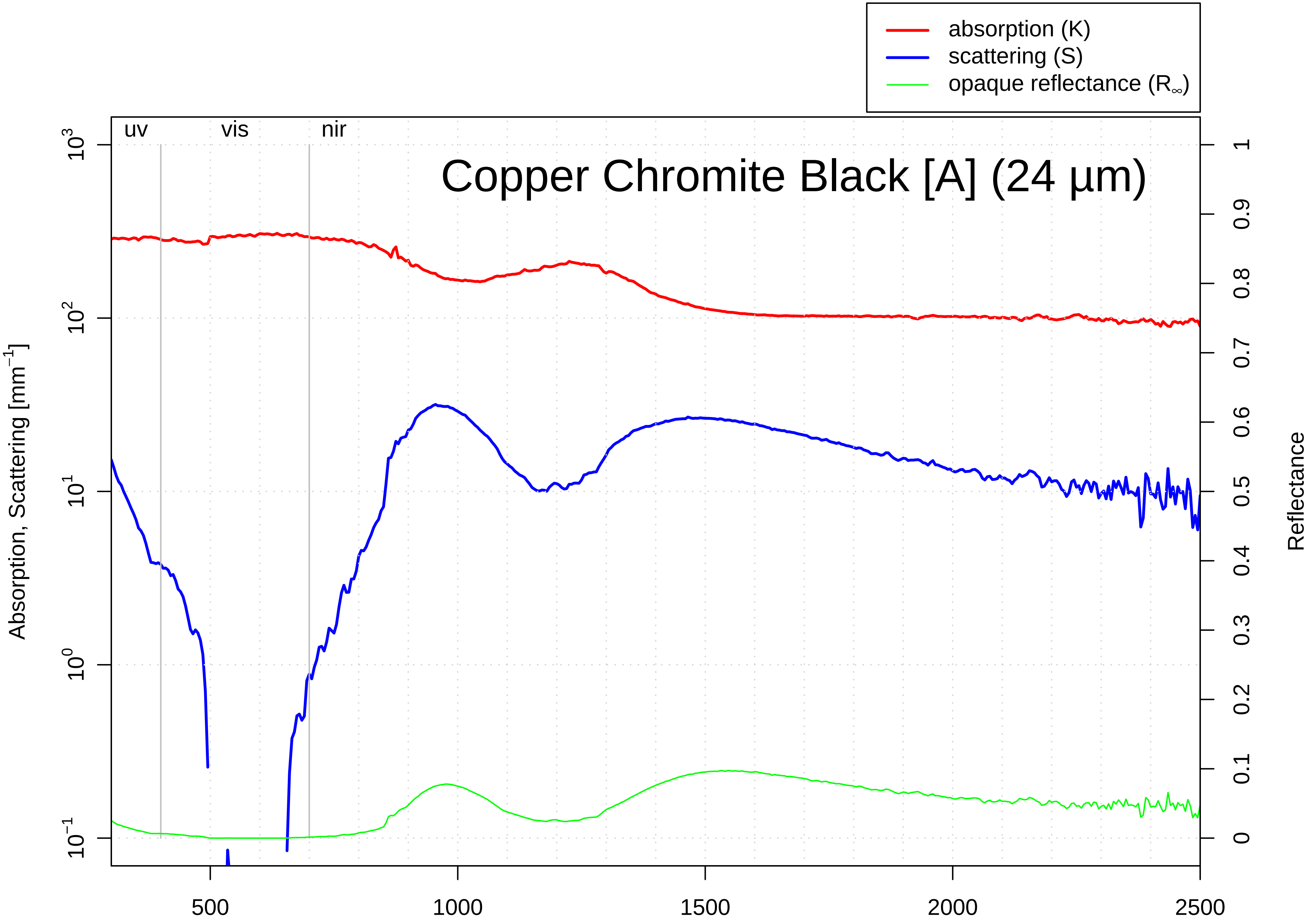

(b) Kubelka−Munk Calculations

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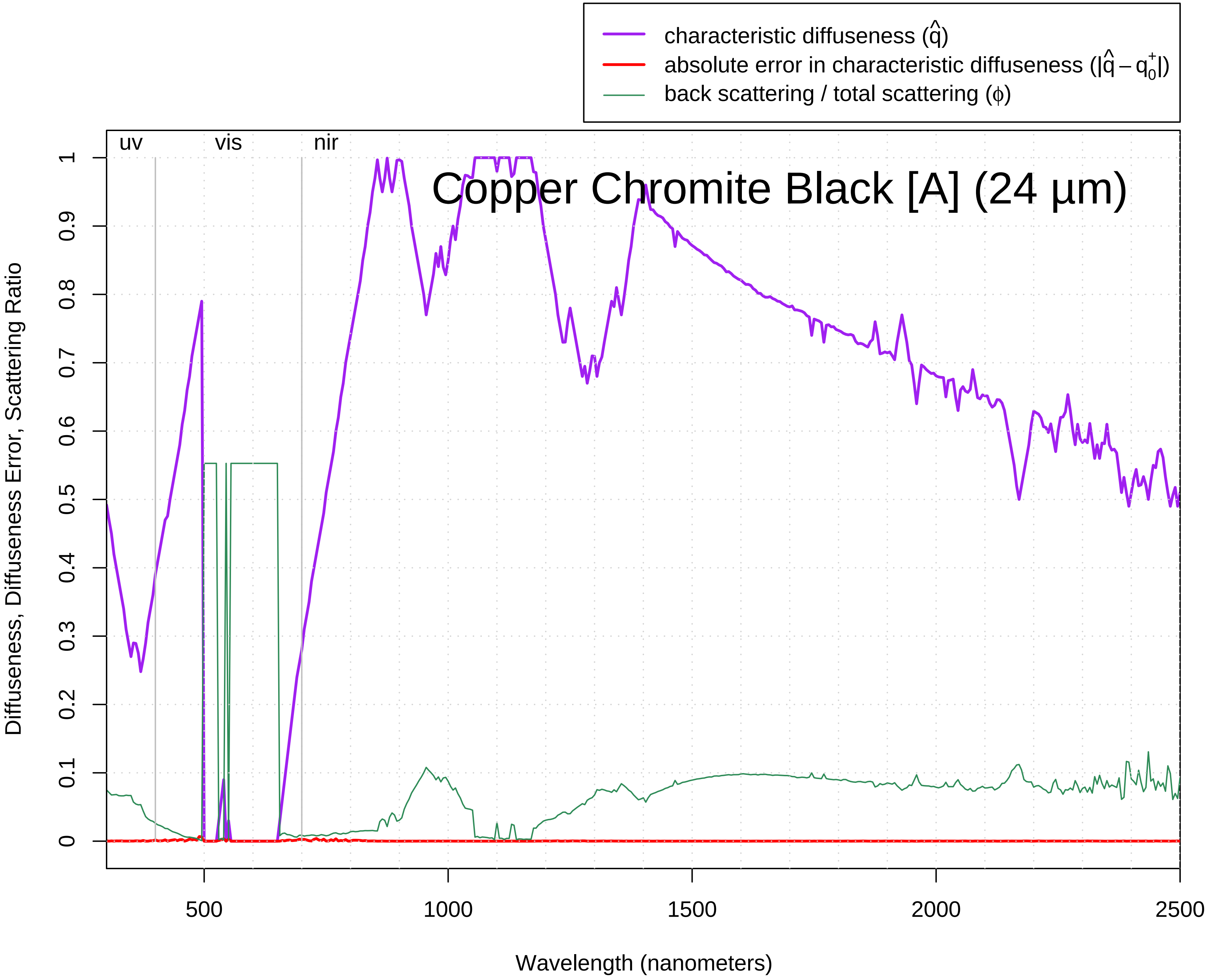

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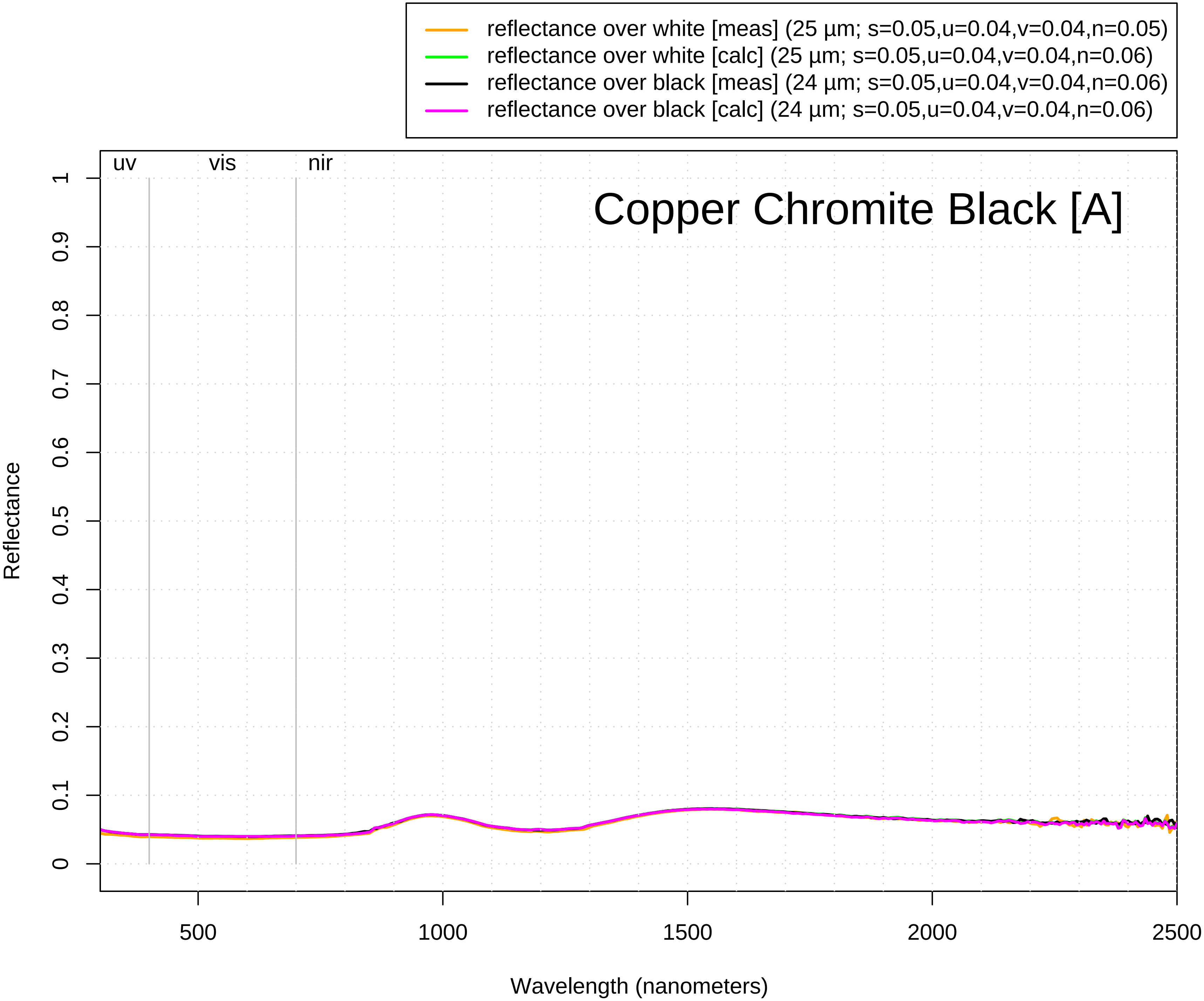

(d) Calculated vs. Measured Reflectances

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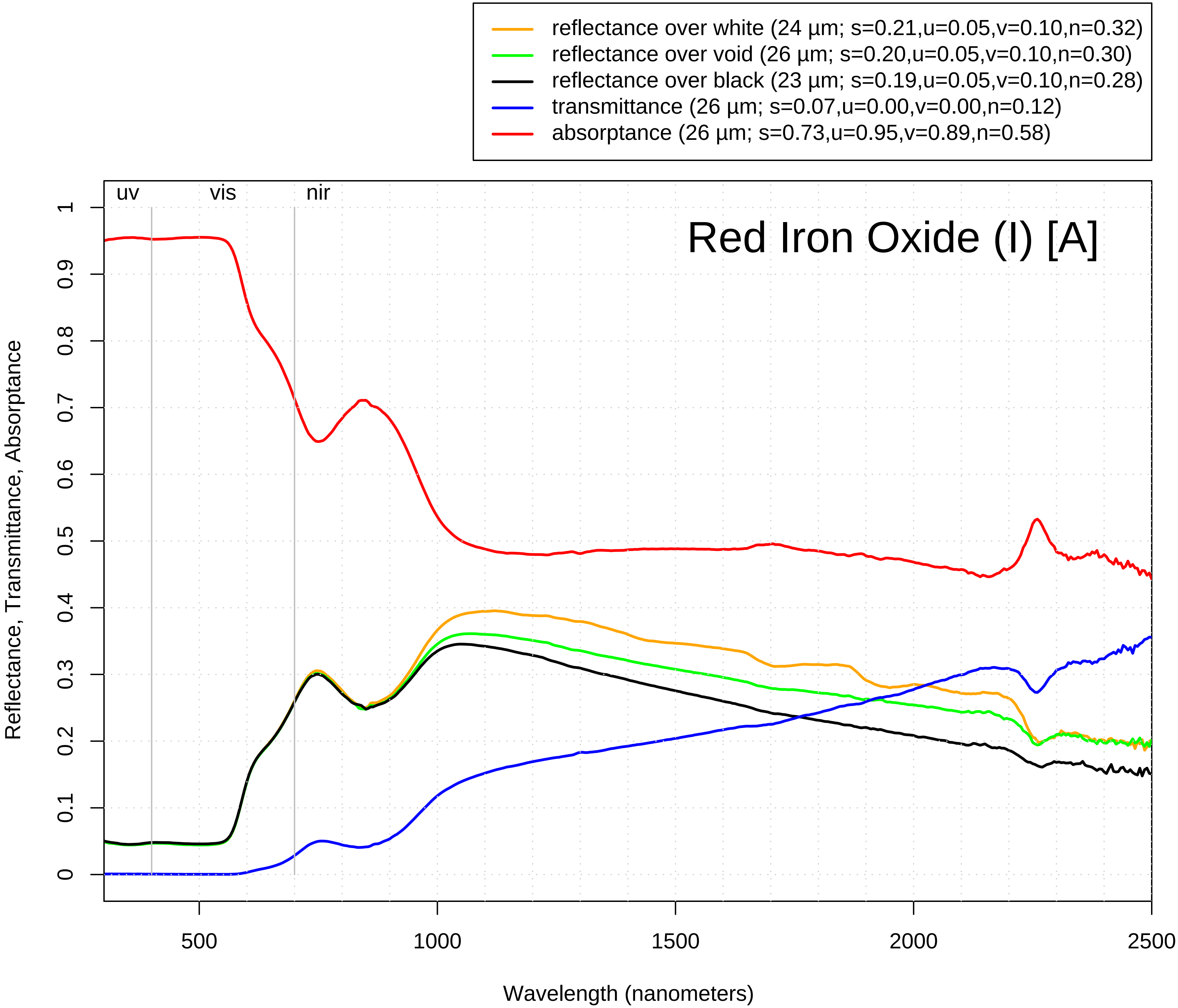

(a) Spectrometer Film Measurements

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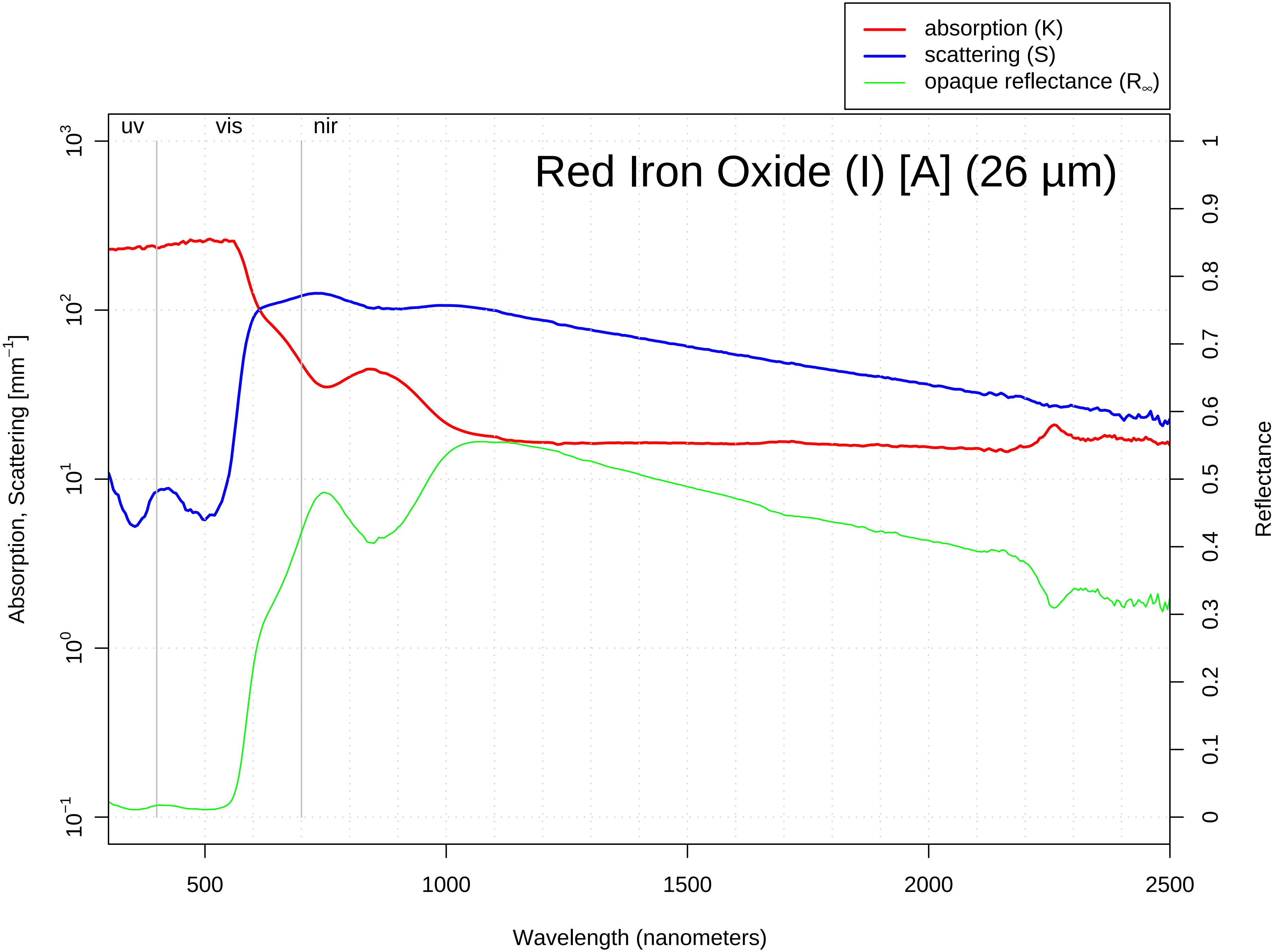

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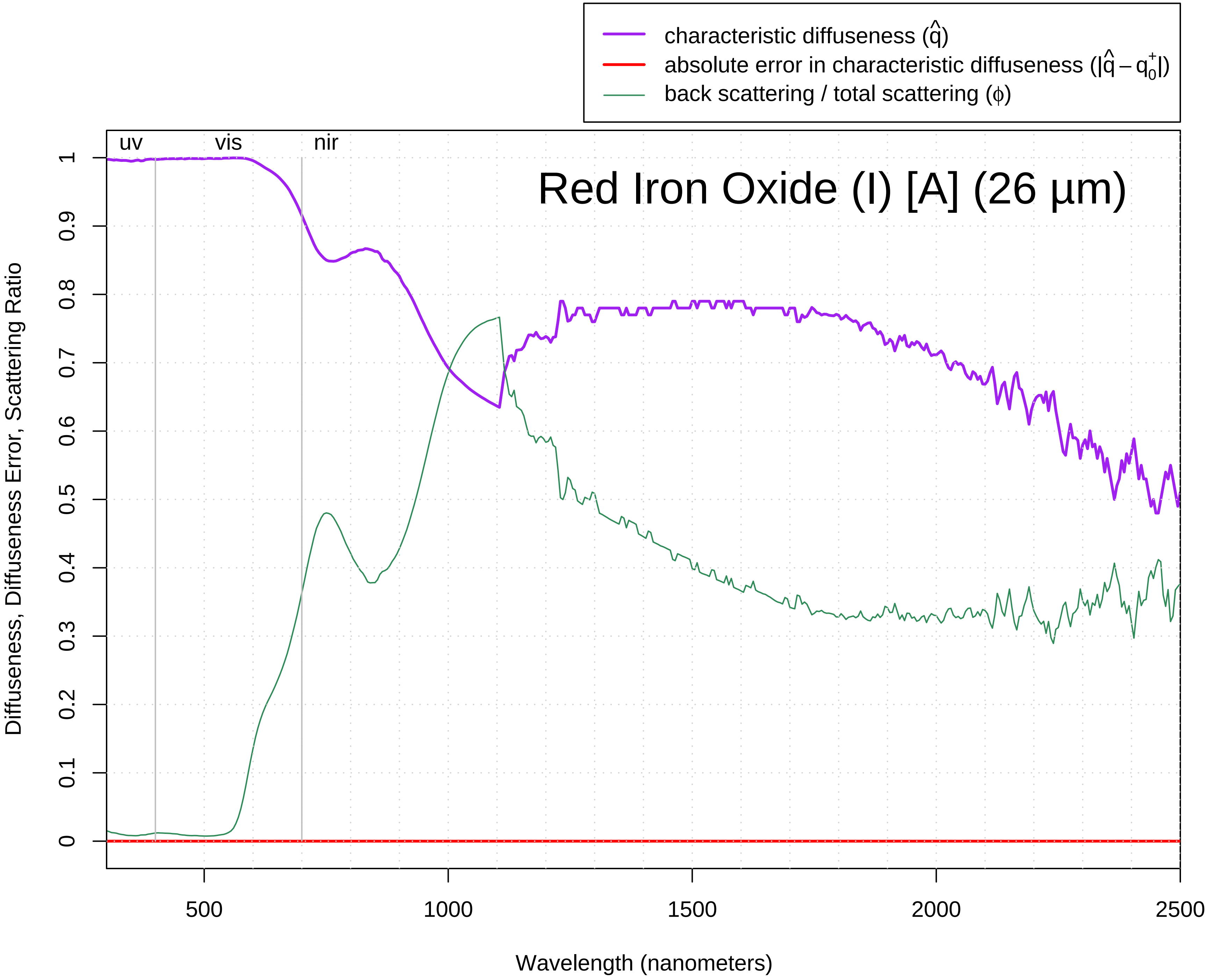

(c) Ancillary Calculations

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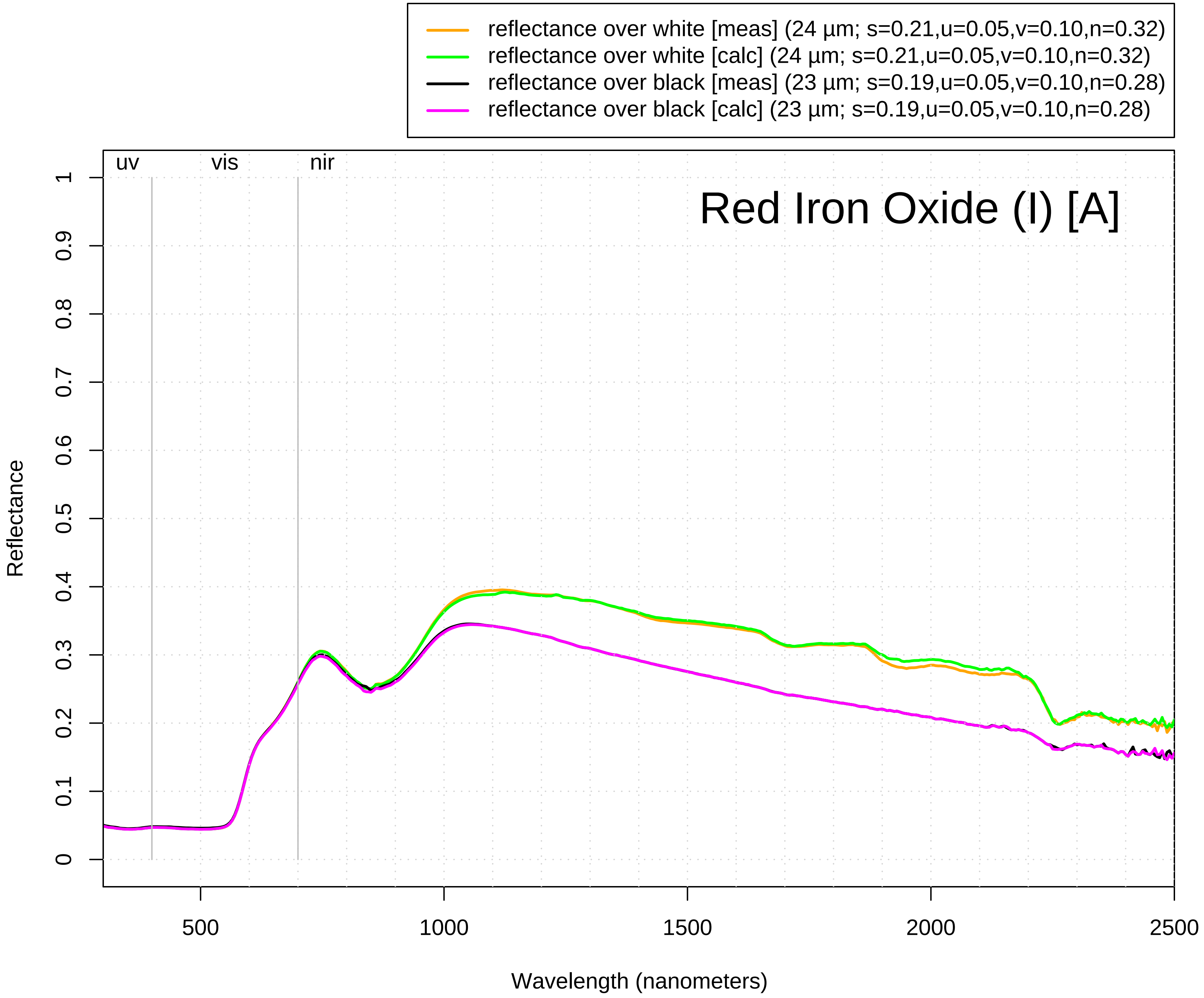

(d) Calculated vs. Measured Reflectances

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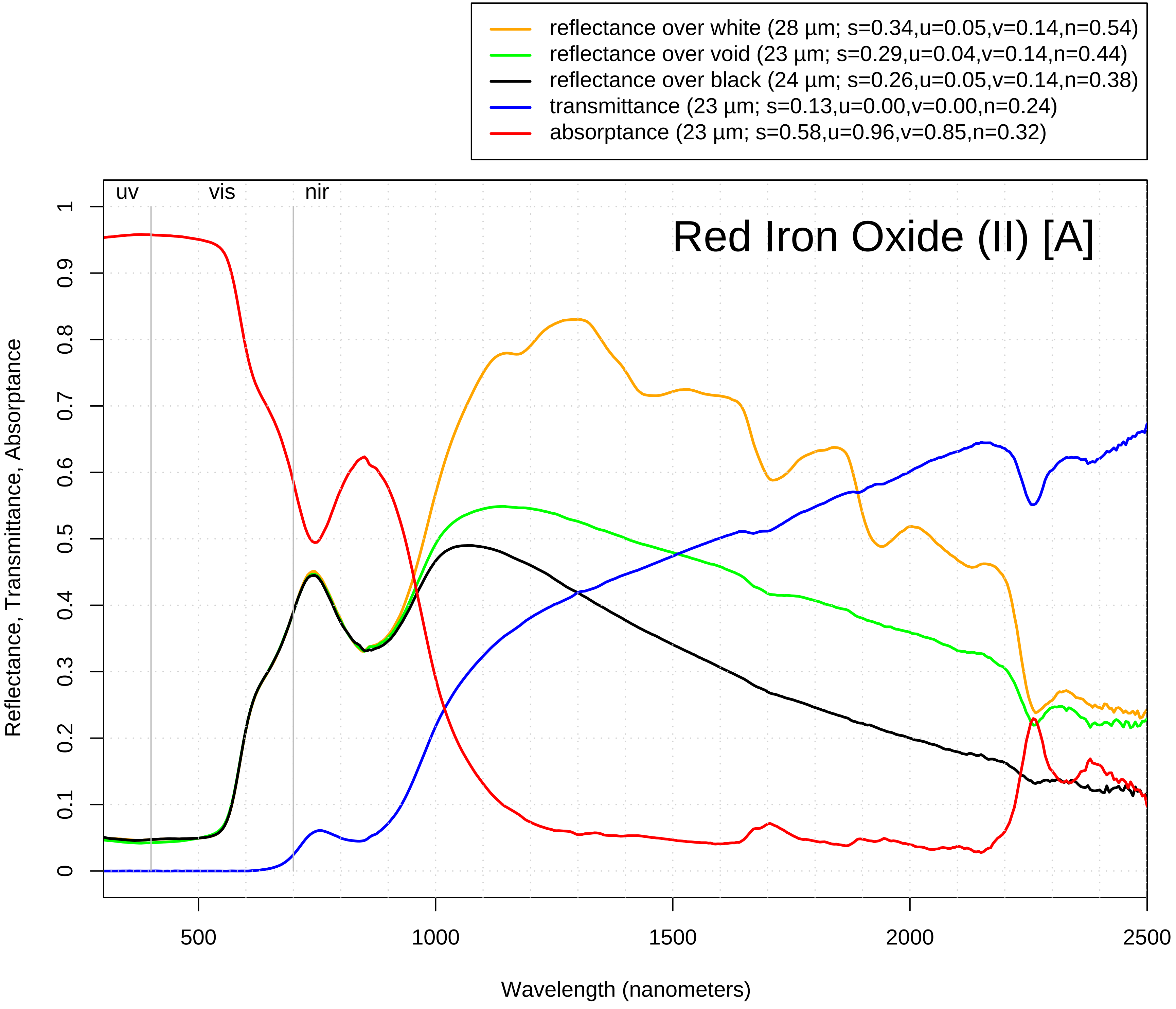
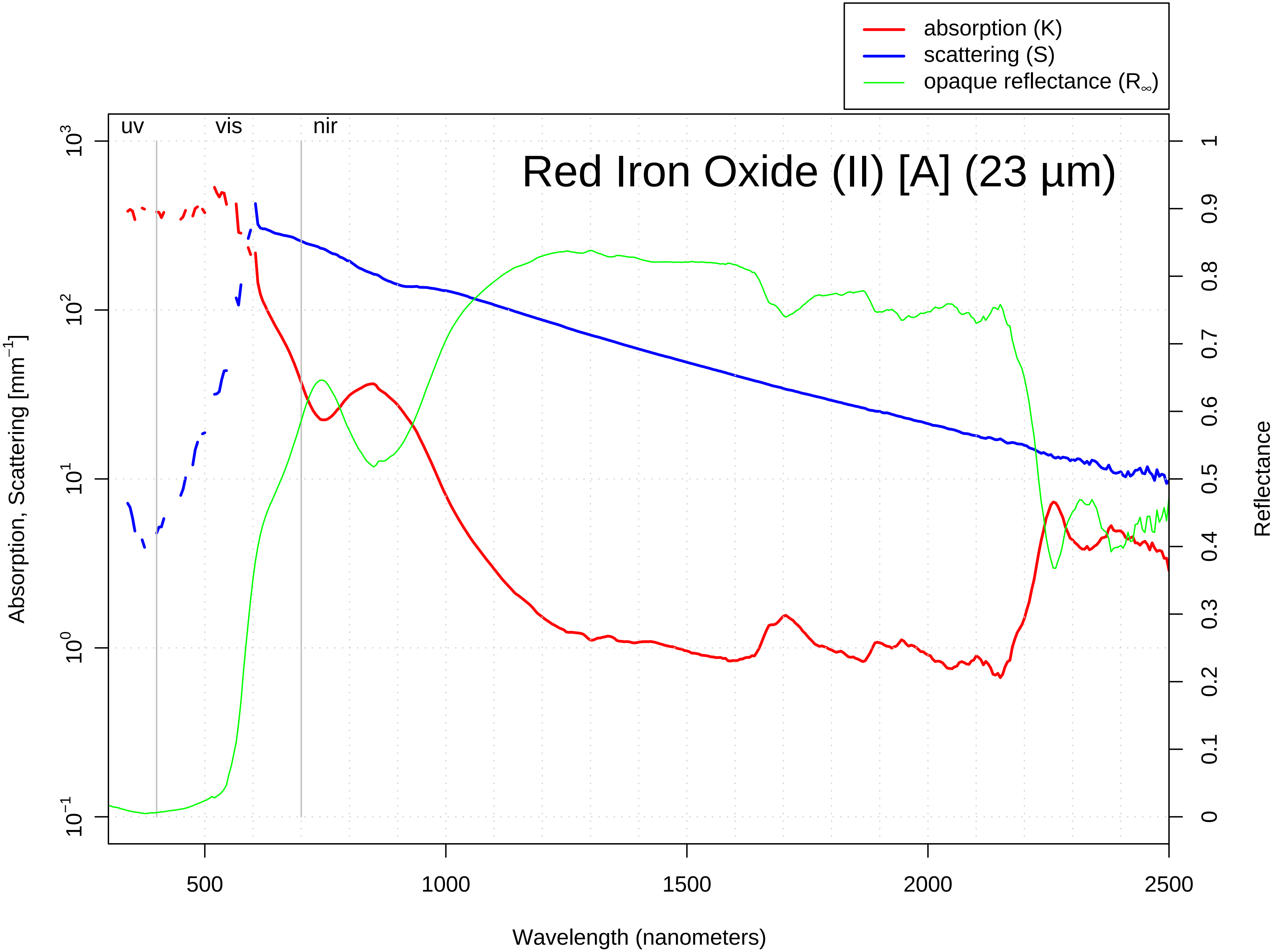


(a) Spectrometer Film Measurements

Sunday, 09 March 2003 12:38 PM



(b) Kubelka−Munk Calculations

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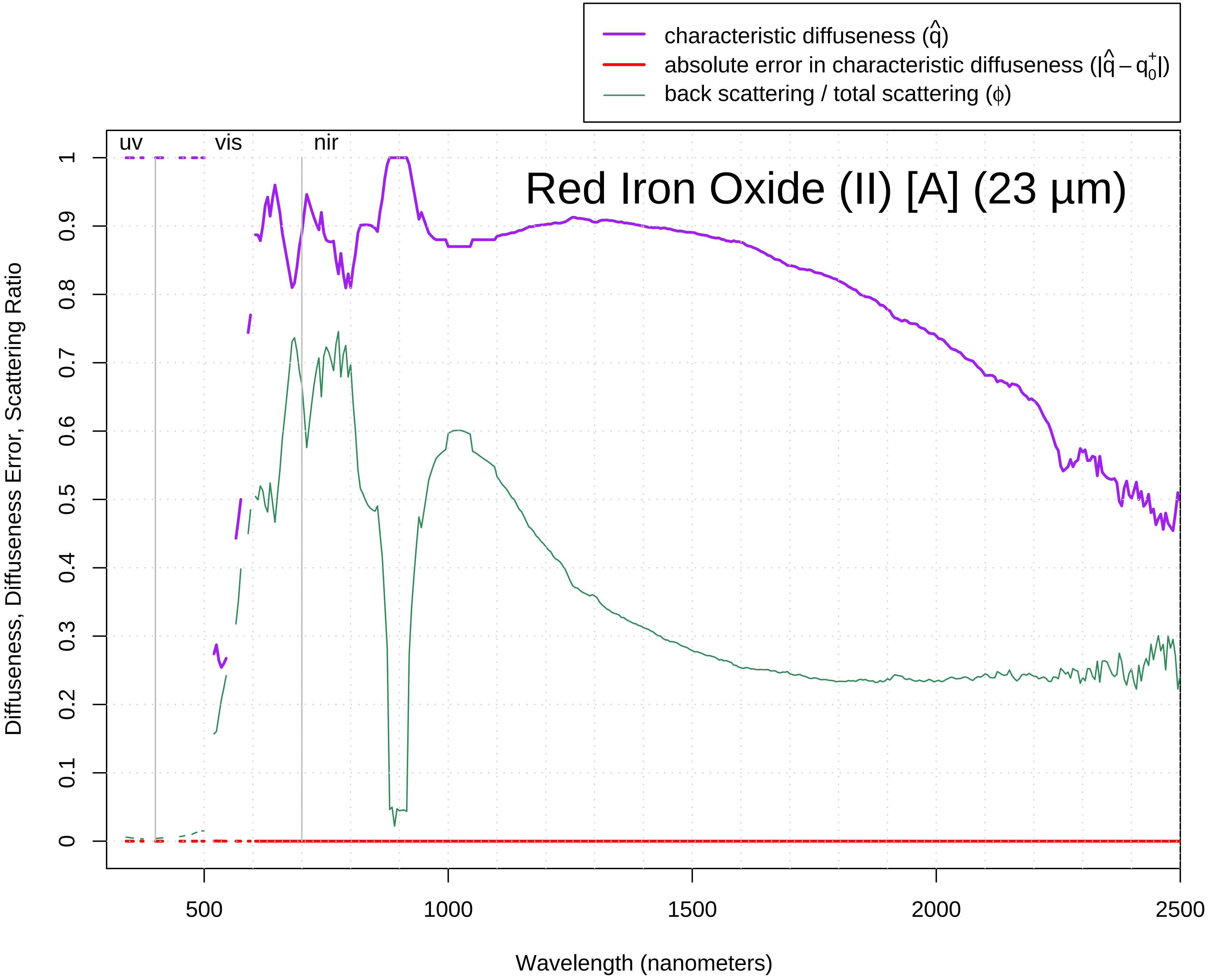

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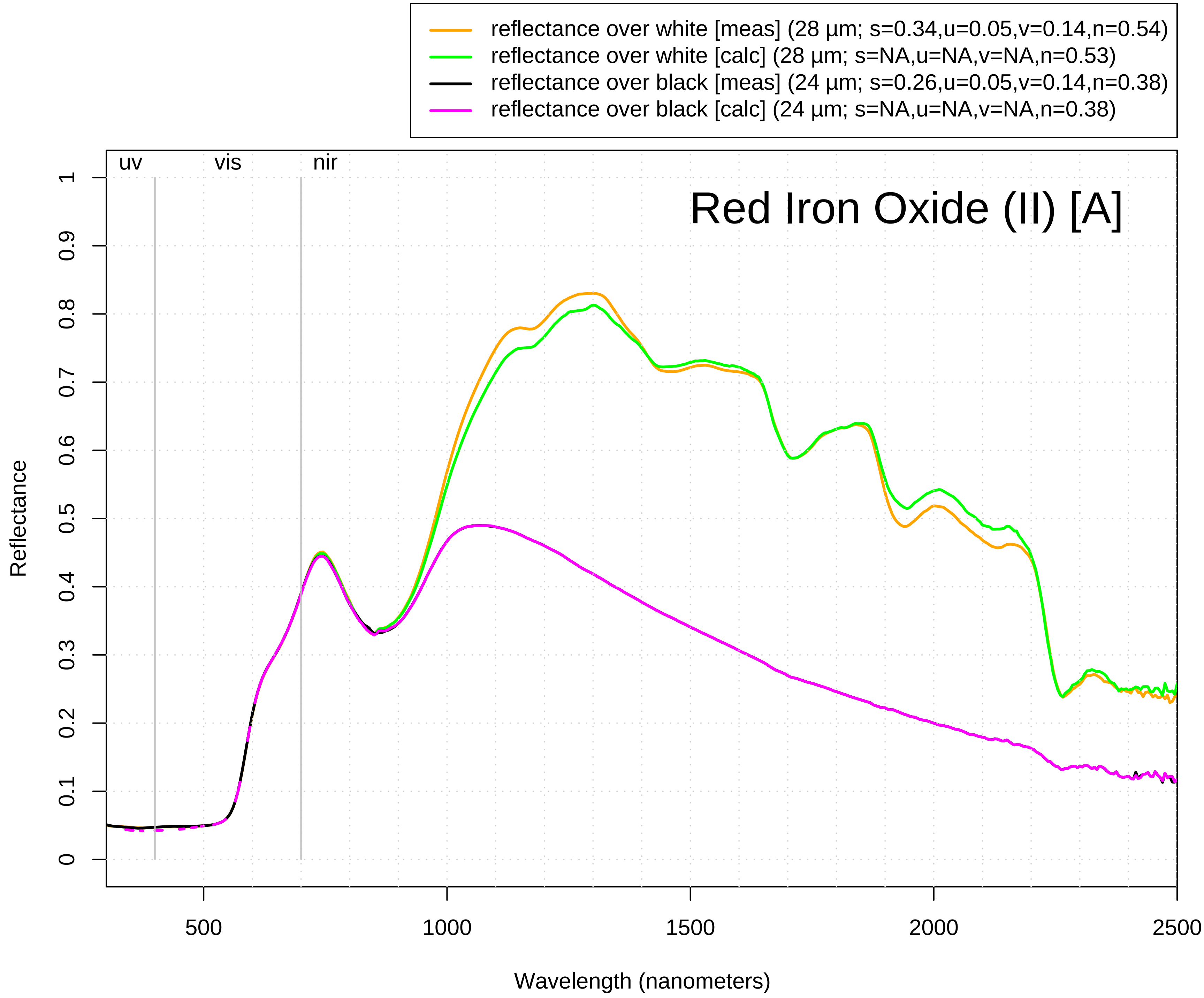

(d) Calculated vs. Measured Reflectances

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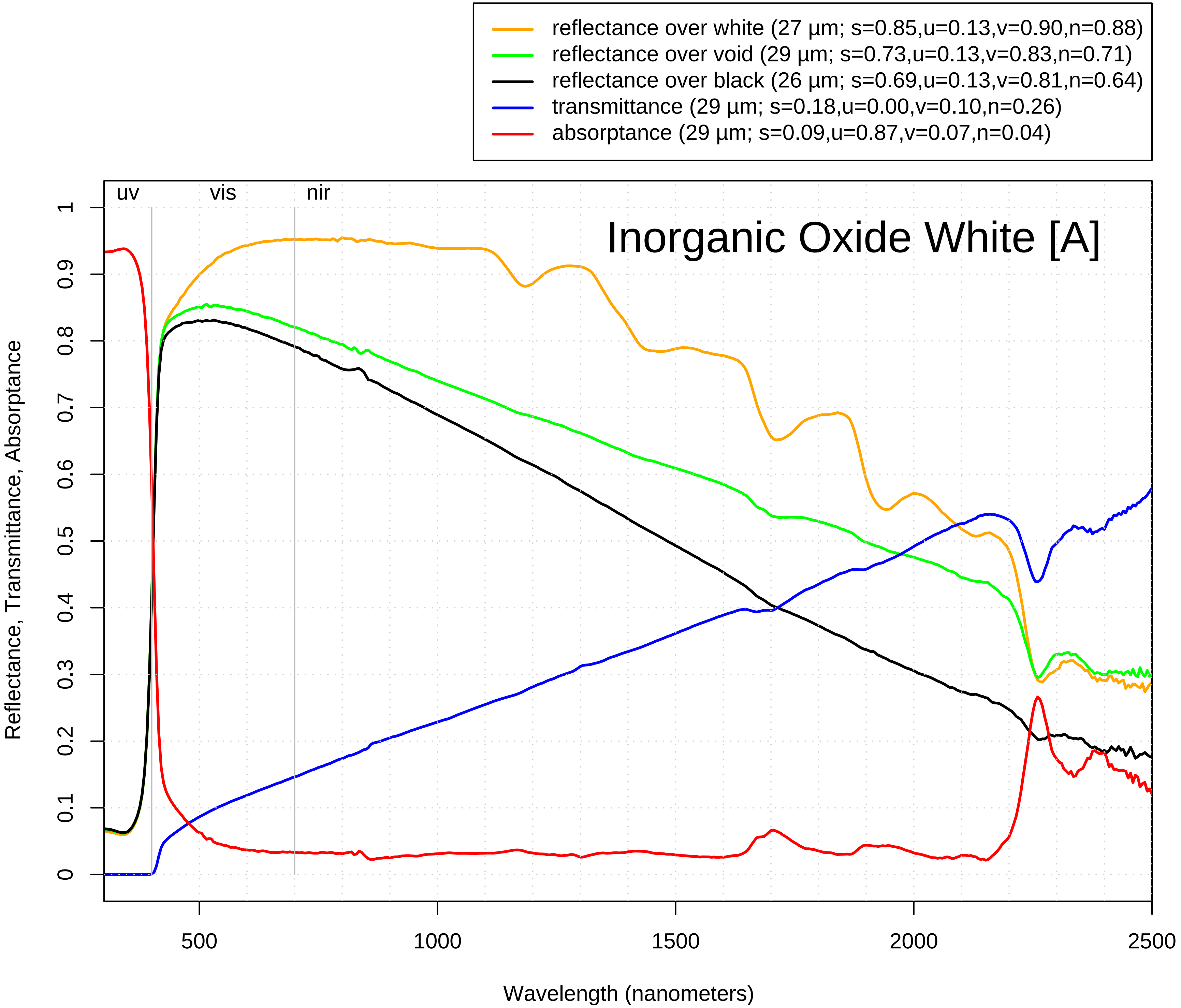

(a) Spectrometer Film Measurements

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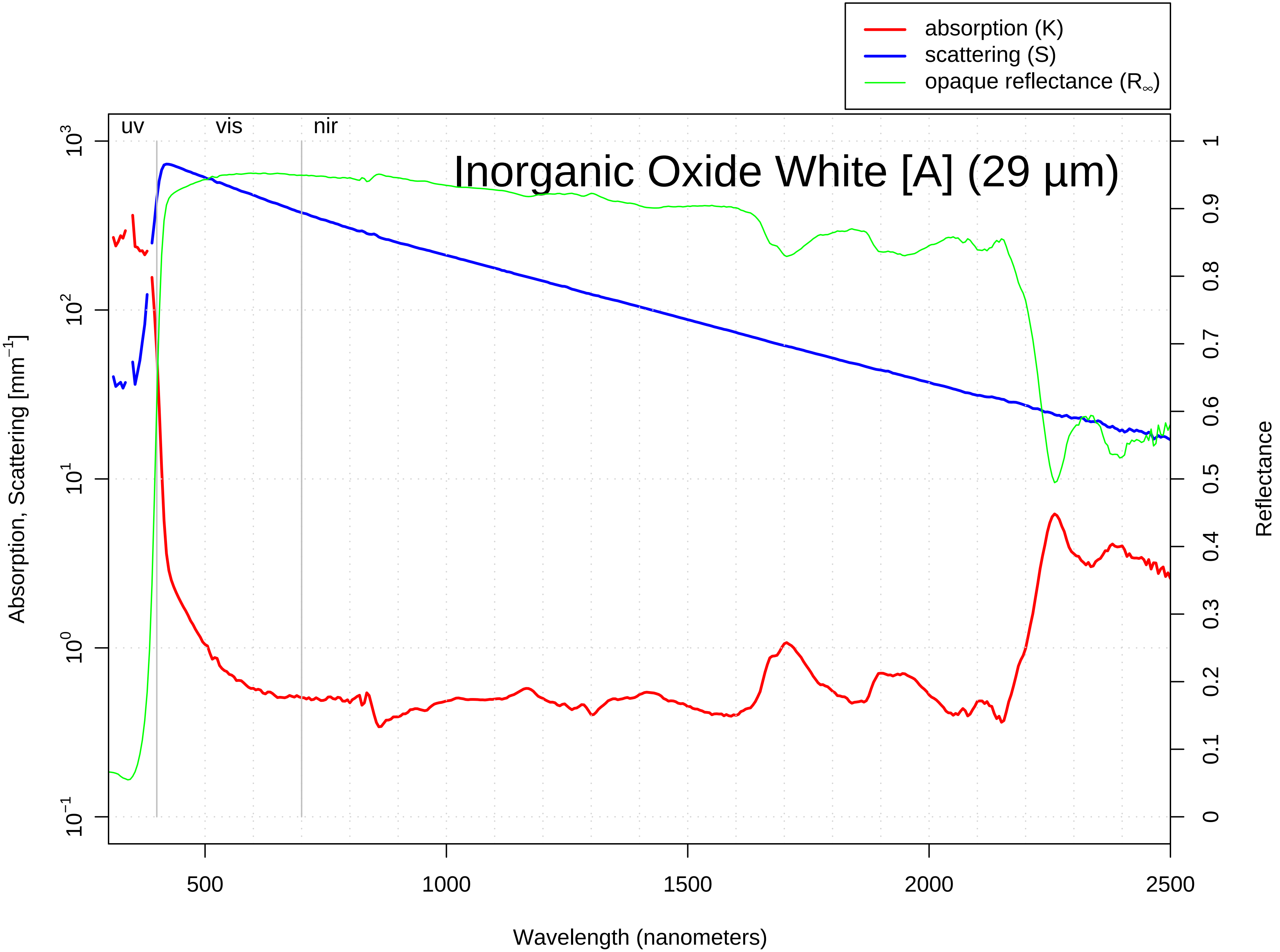

(b) Kubelka−Munk Calculations

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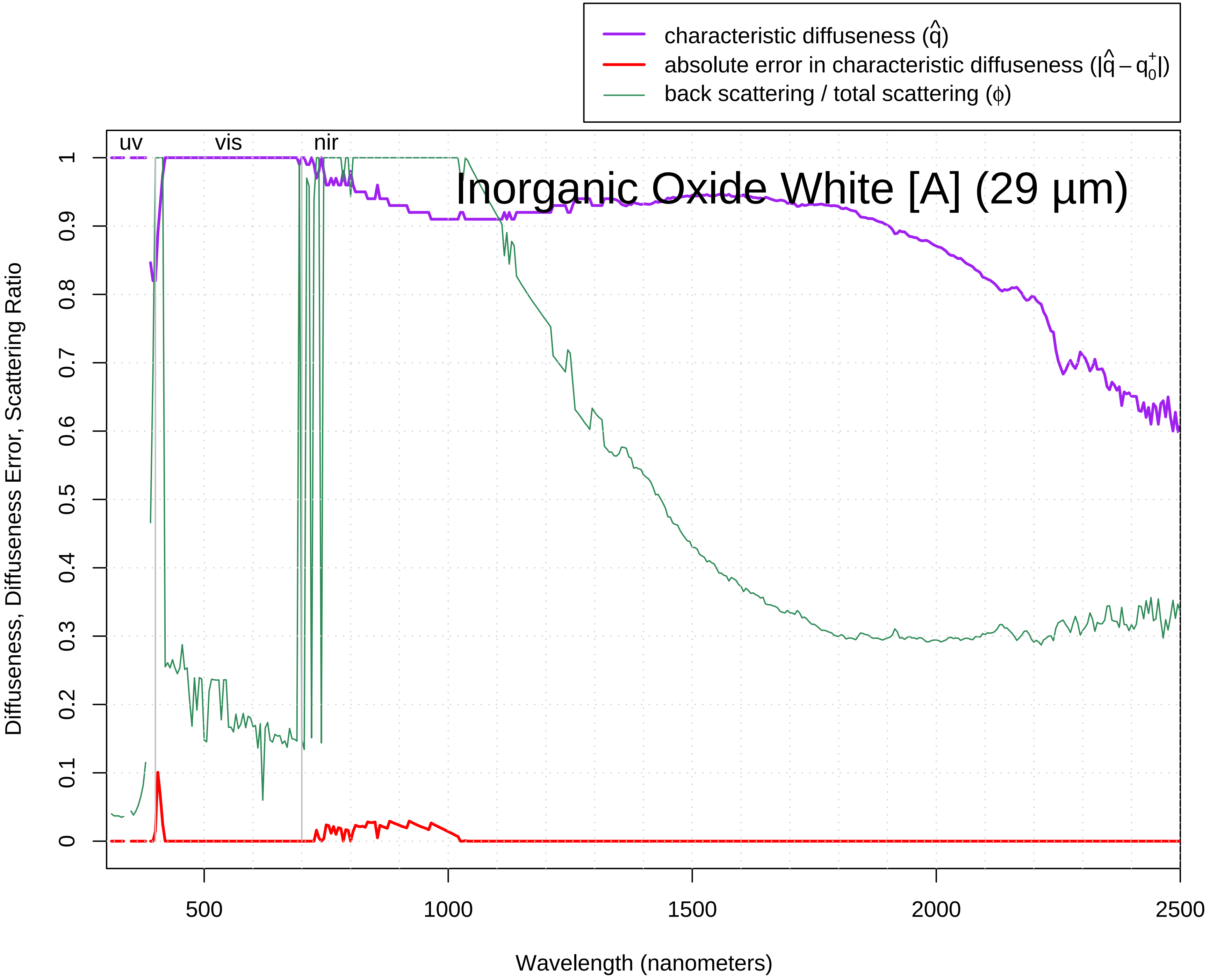

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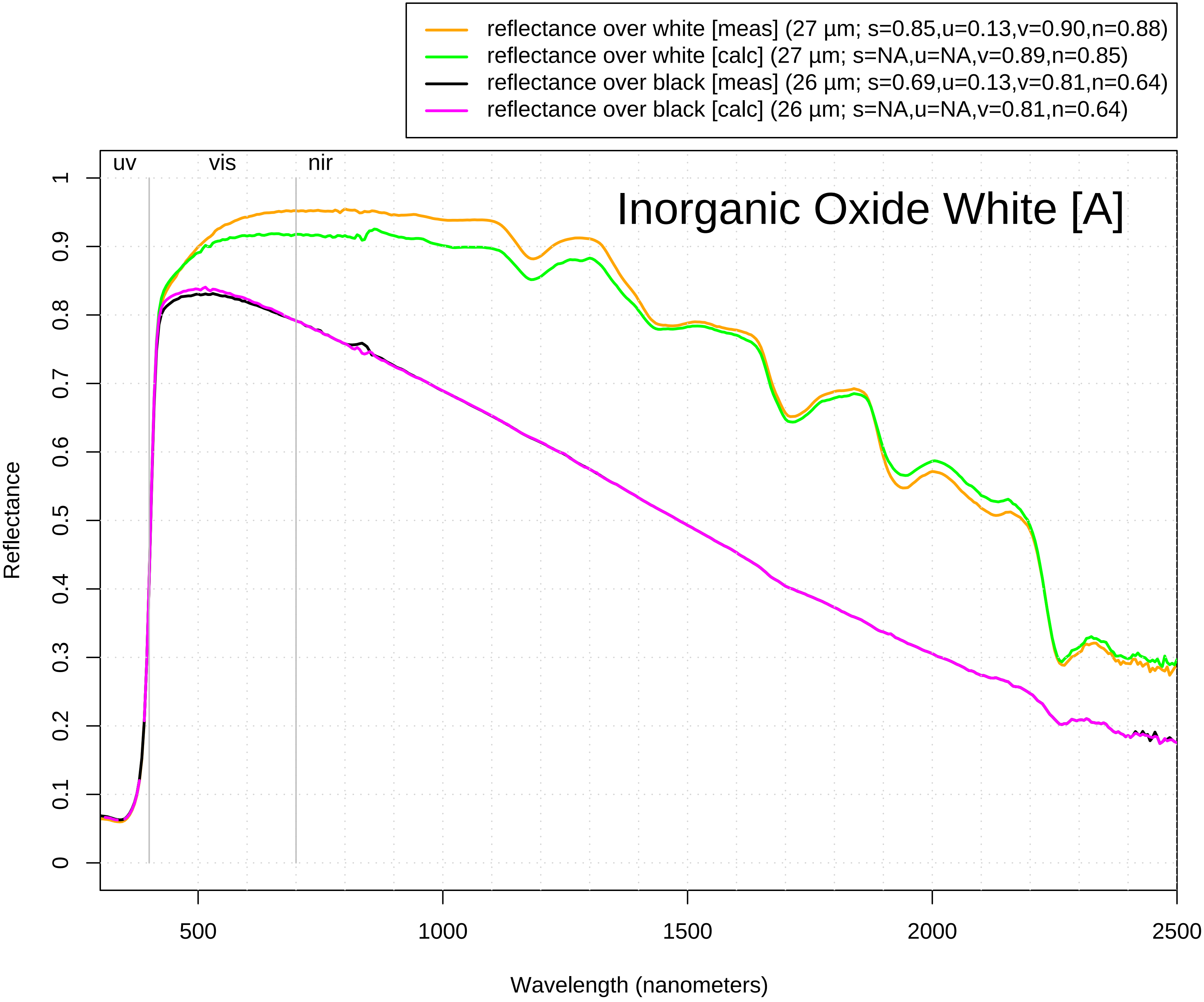

(d) Calculated vs. Measured Reflectances

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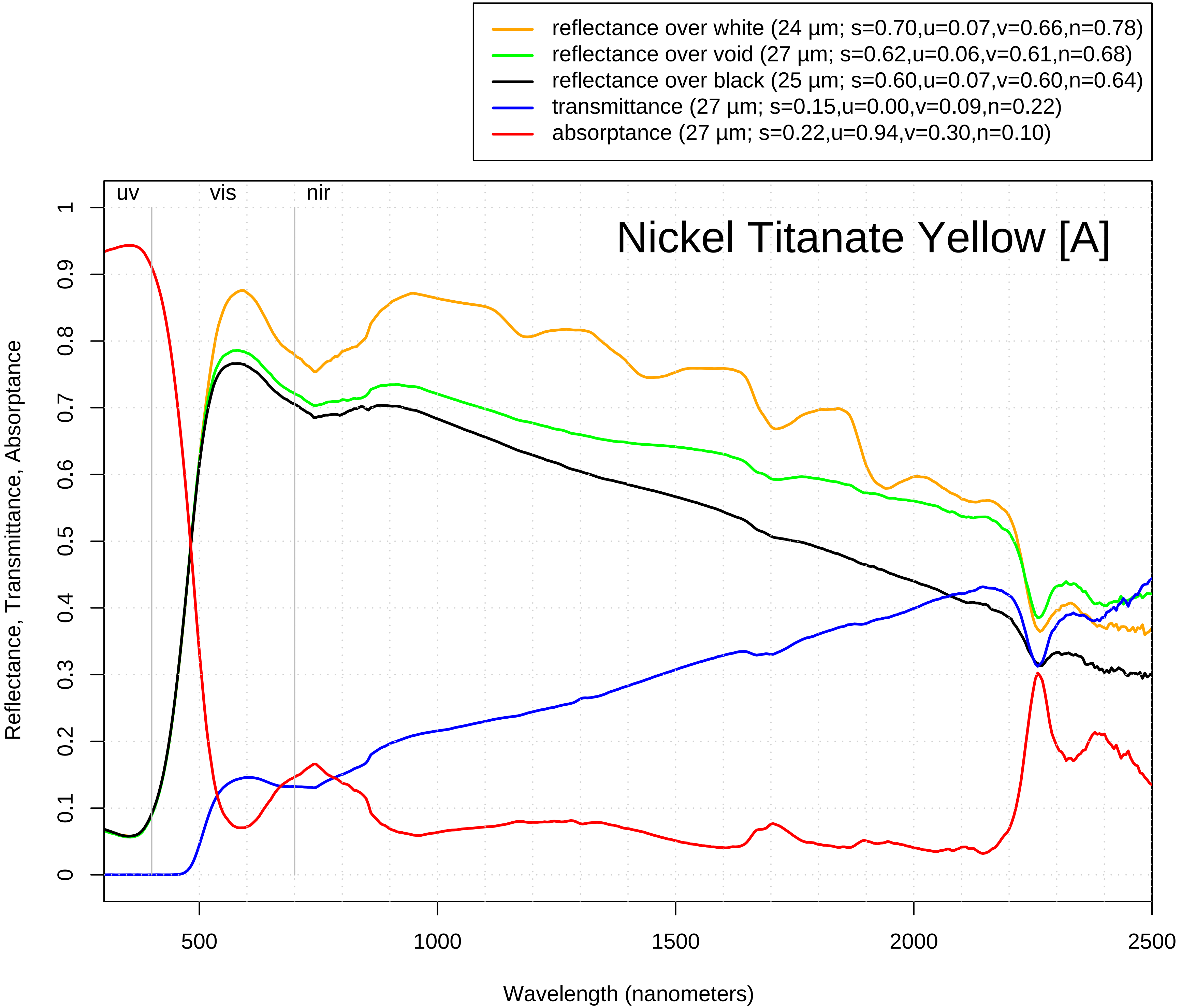

(a) Spectrometer Film Measurements

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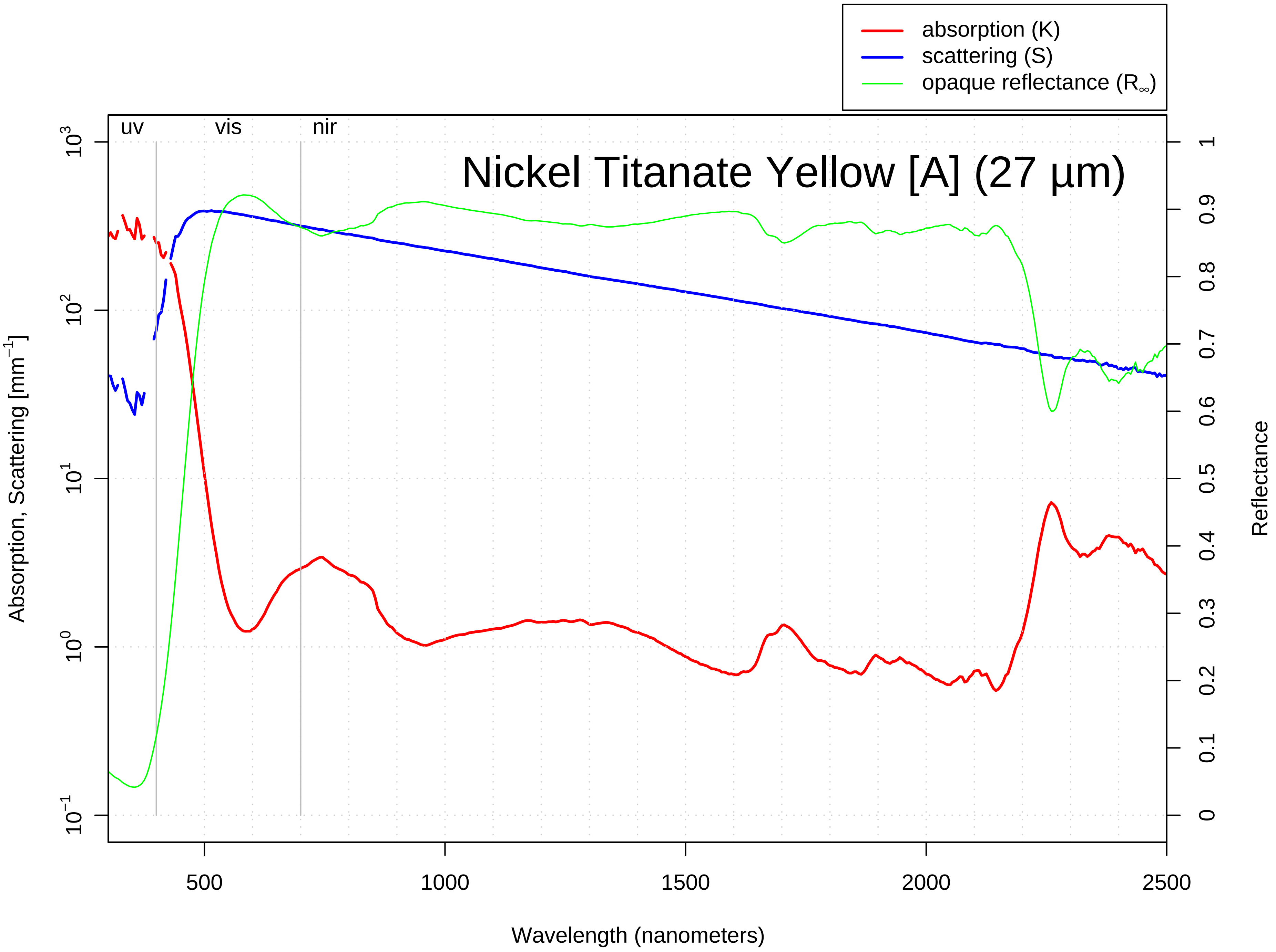

(b) Kubelka−Munk Calculations

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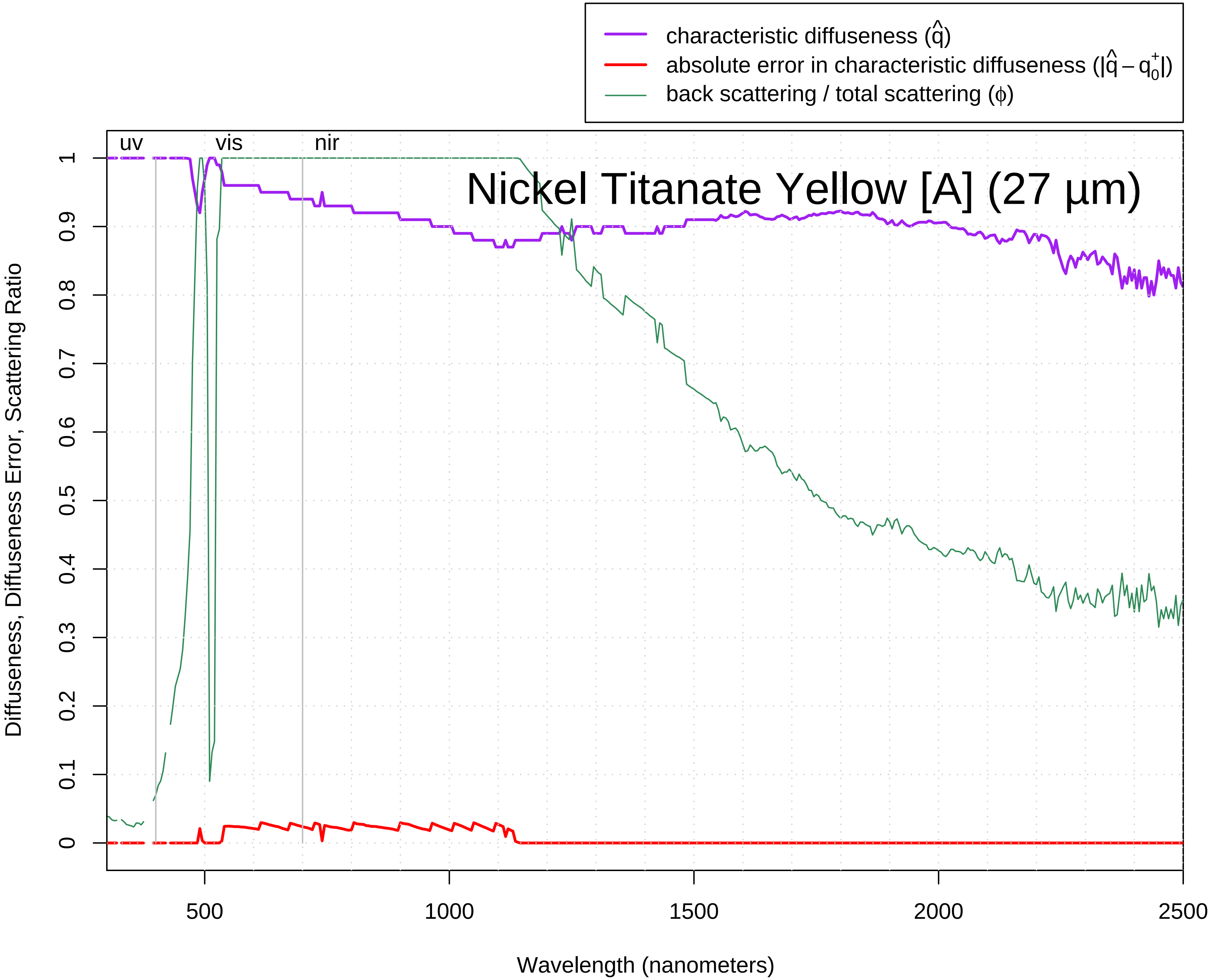

(c) Ancillary Calculations

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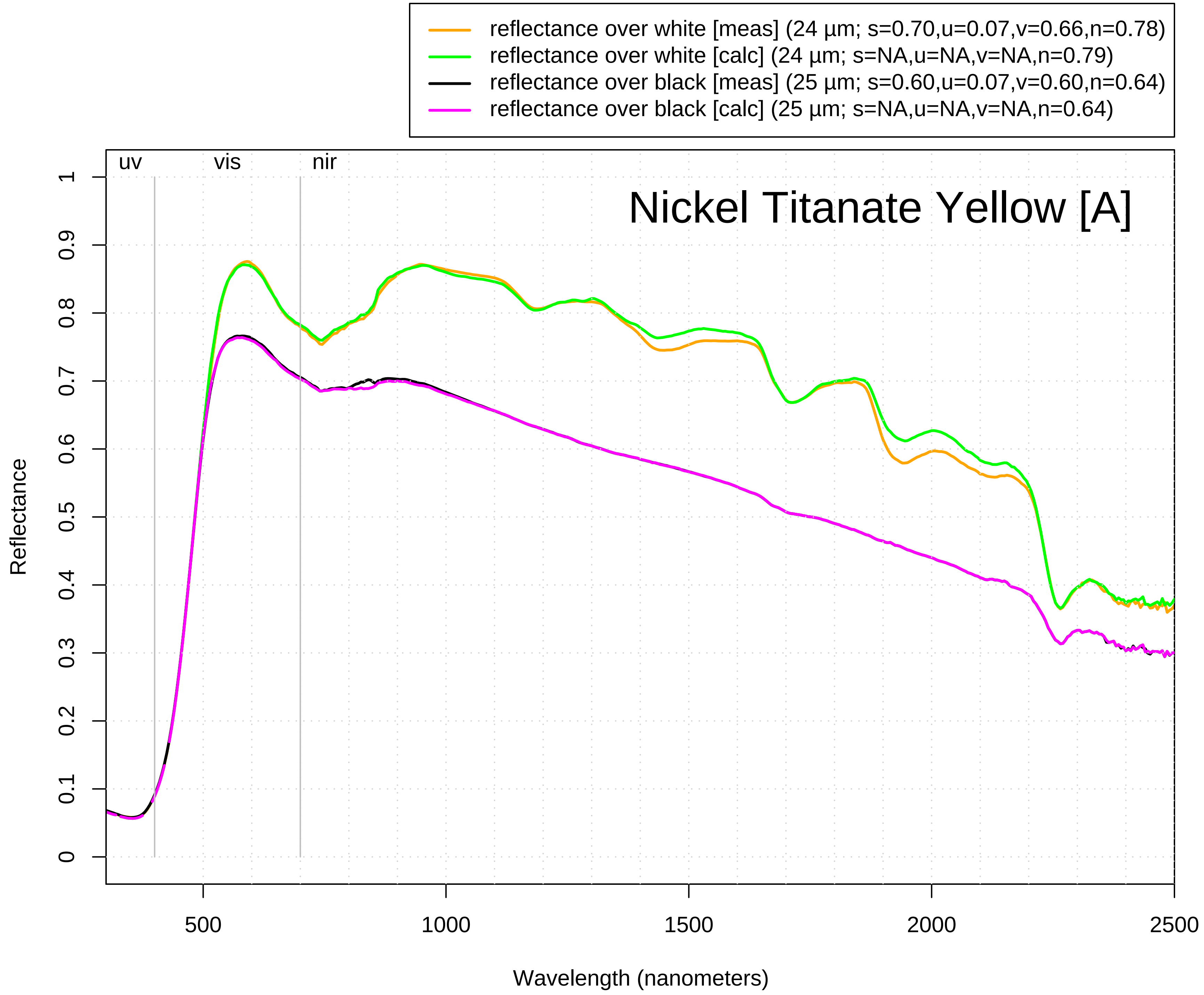

(d) Calculated vs. Measured Reflectances

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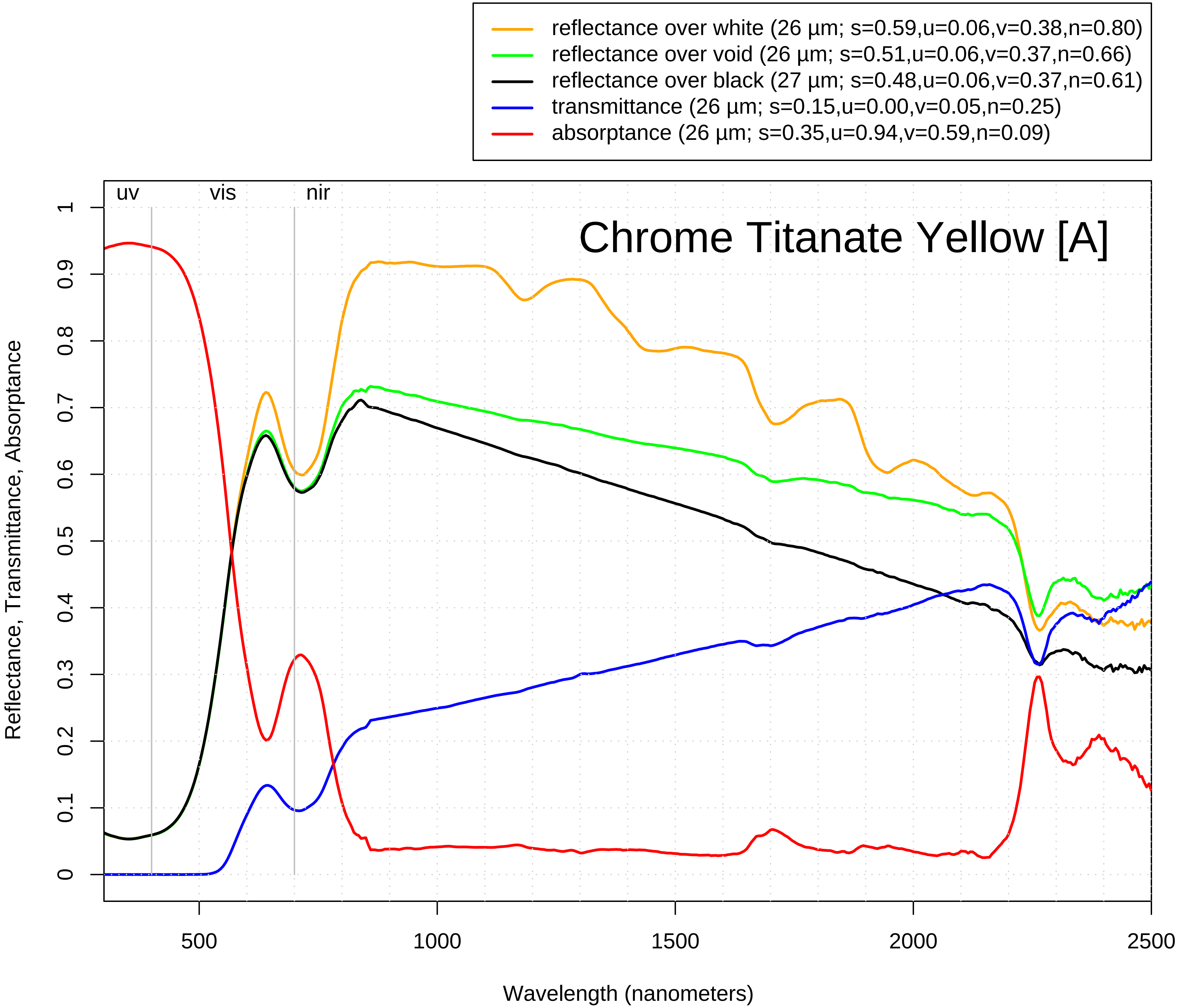

(a) Spectrometer Film Measurements

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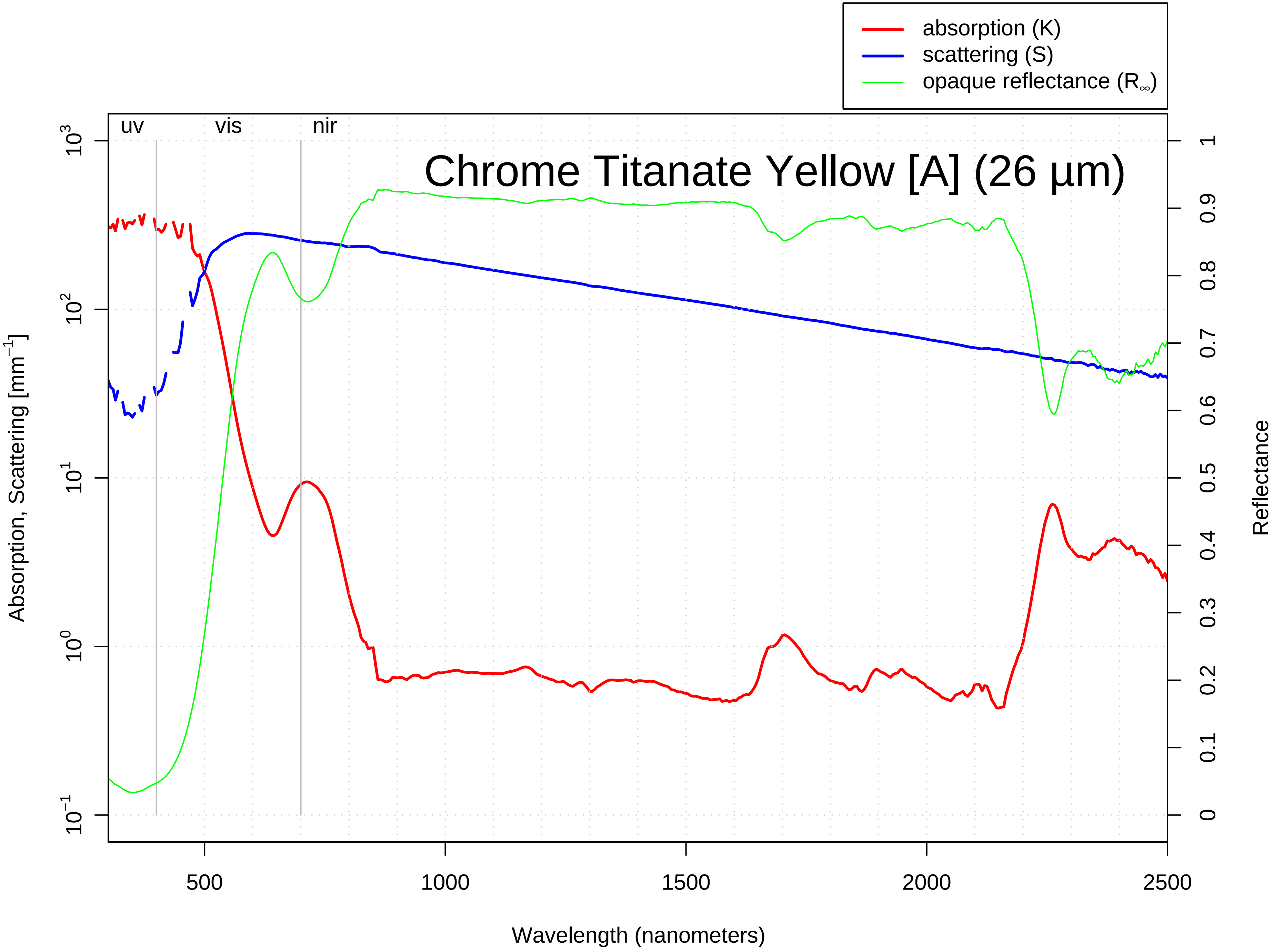

(b) Kubelka−Munk Calculations

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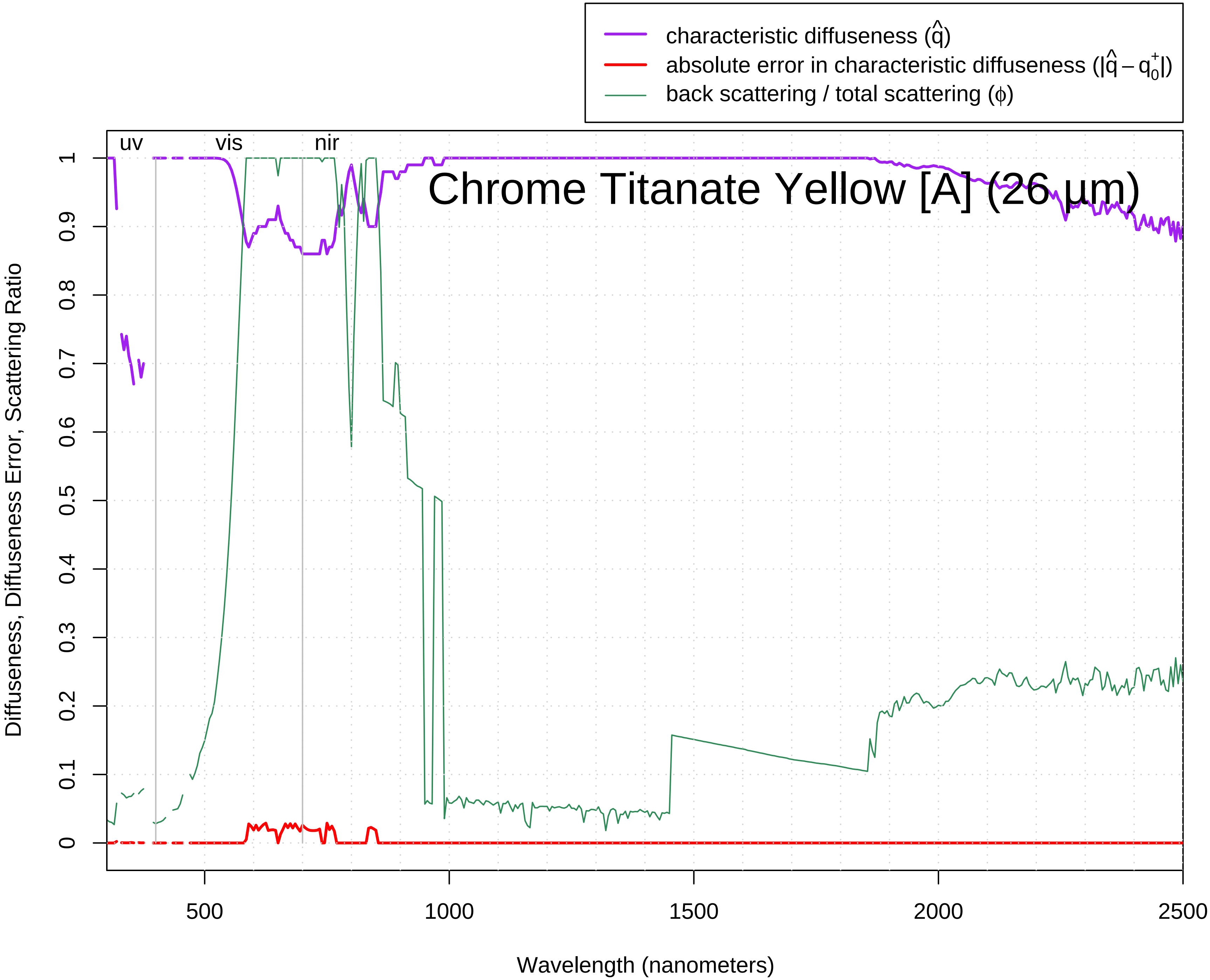
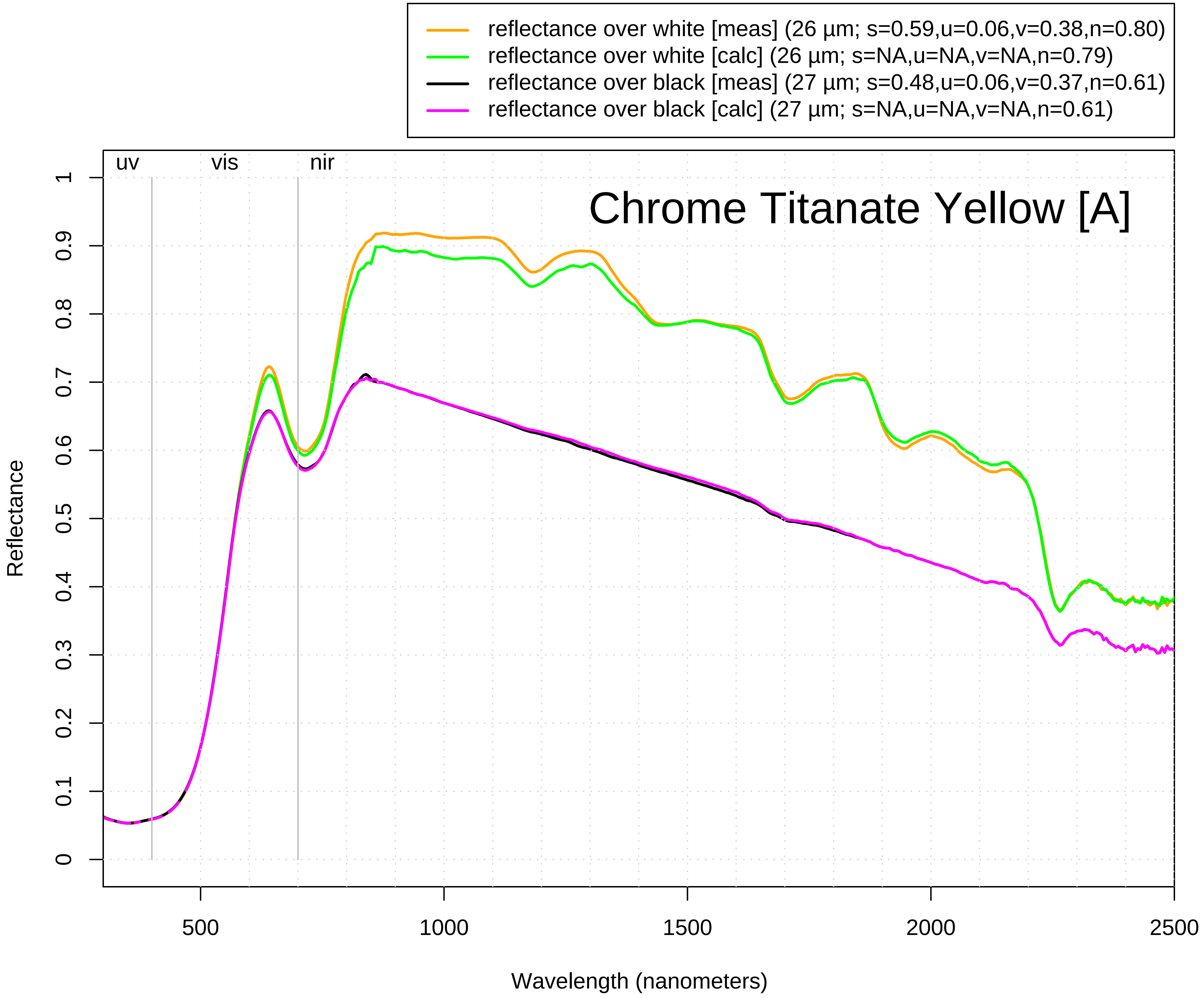


(c) Ancillary Calculations

Sunday, 09 March 2003 12:44 PM



(d) Calculated vs. Measured Reflectances

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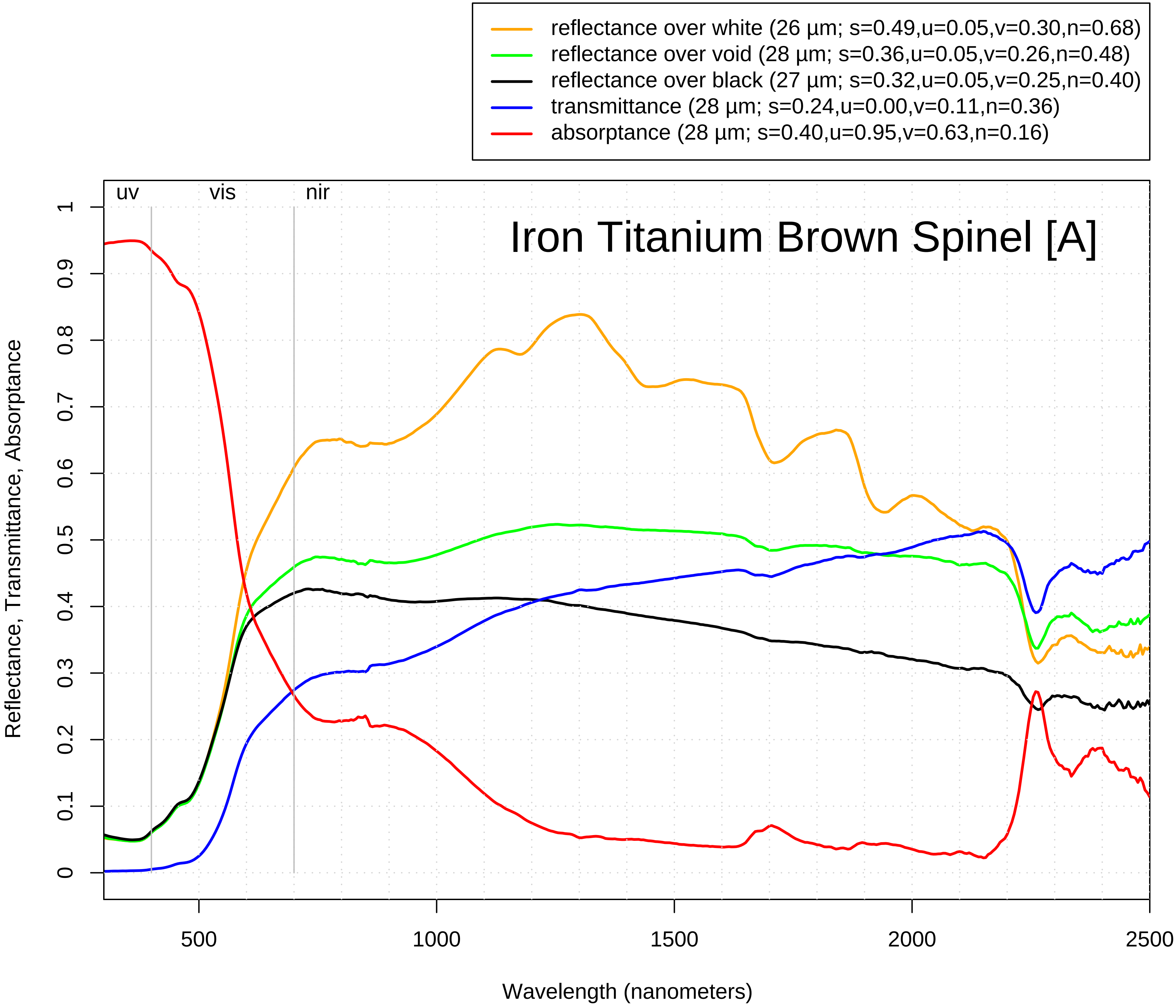
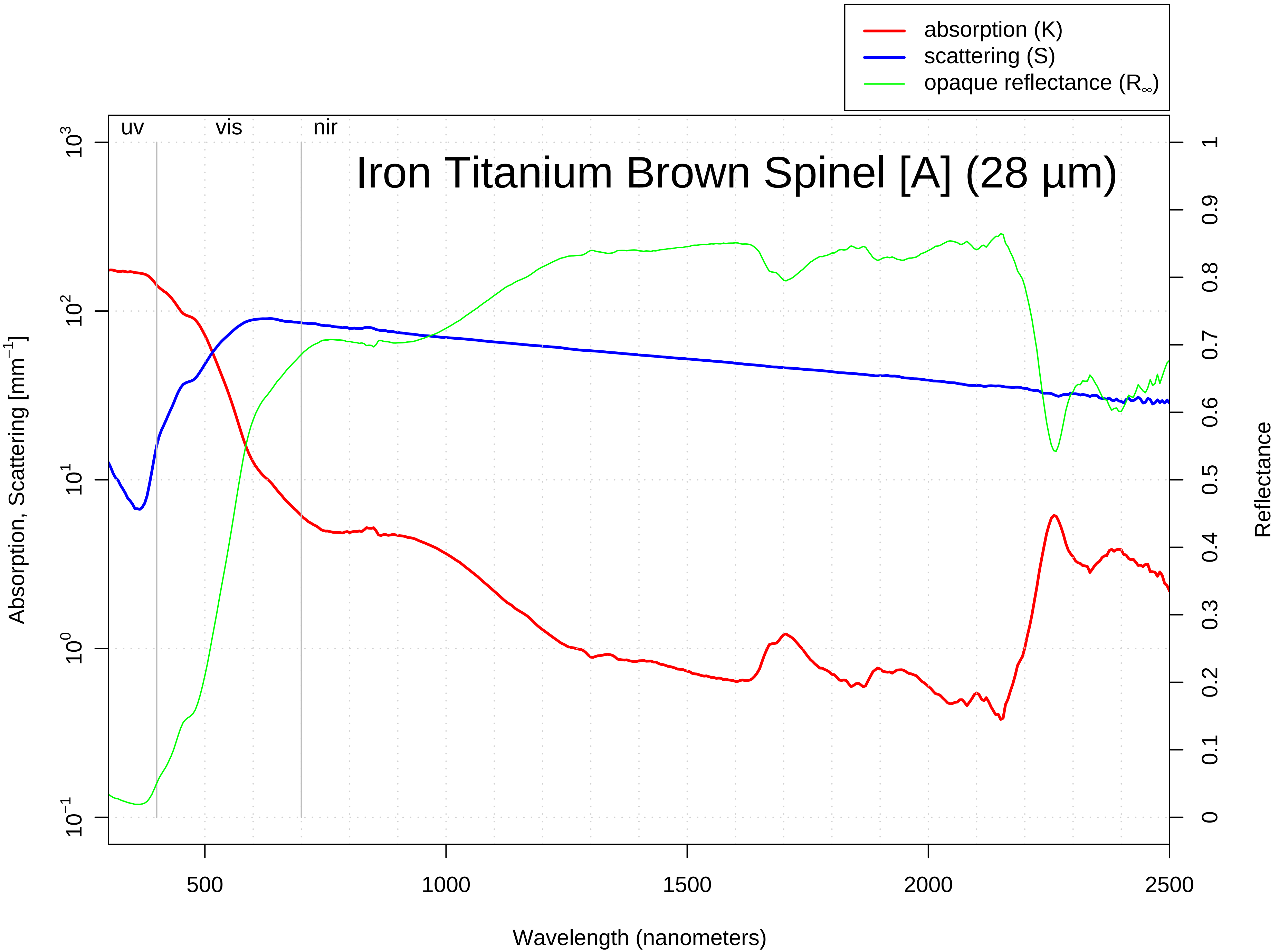


(a) Spectrometer Film Measurements

Sunday, 09 March 2003 12:46 PM



(b) Kubelka−Munk Calculations

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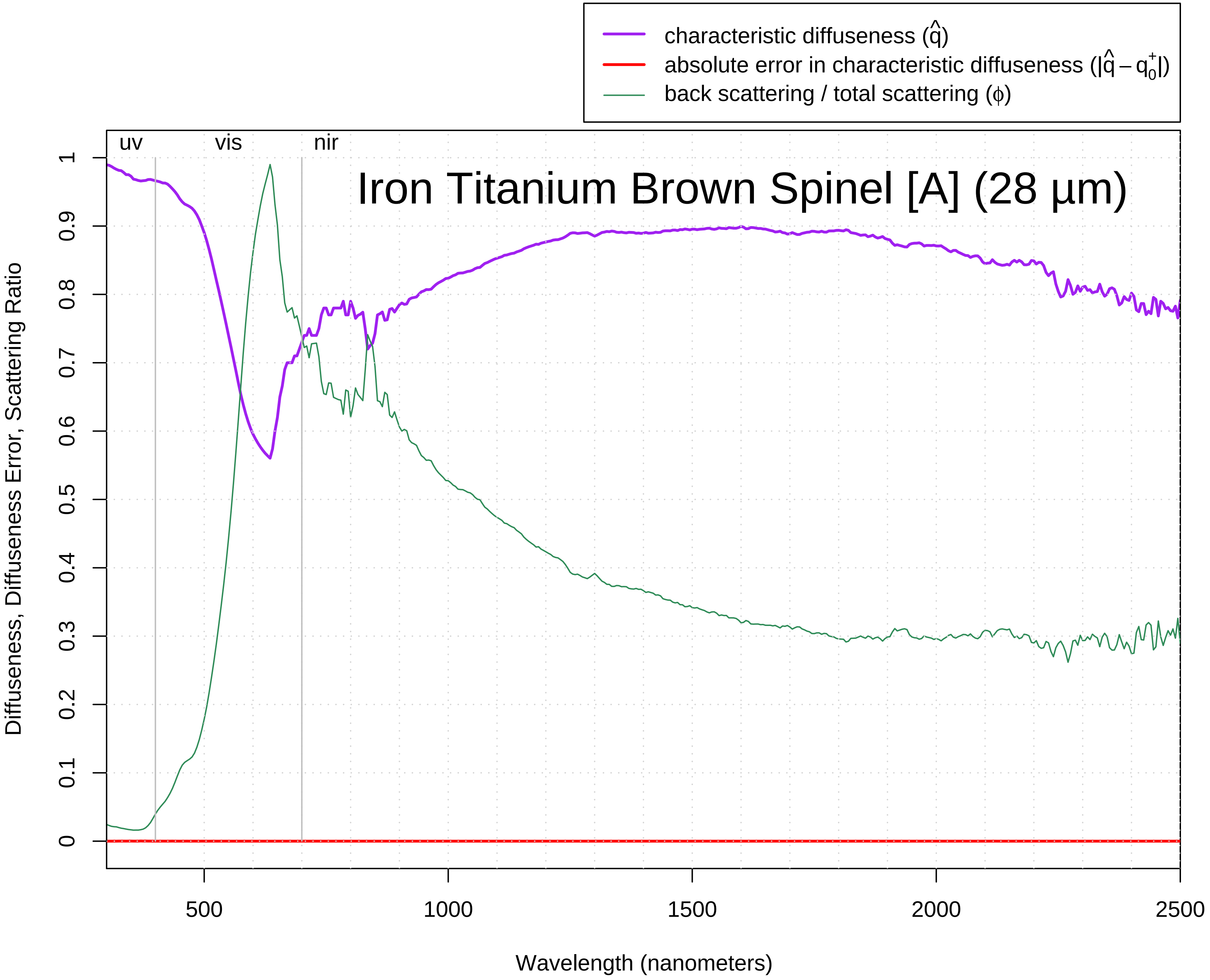

(c) Ancillary Calculations

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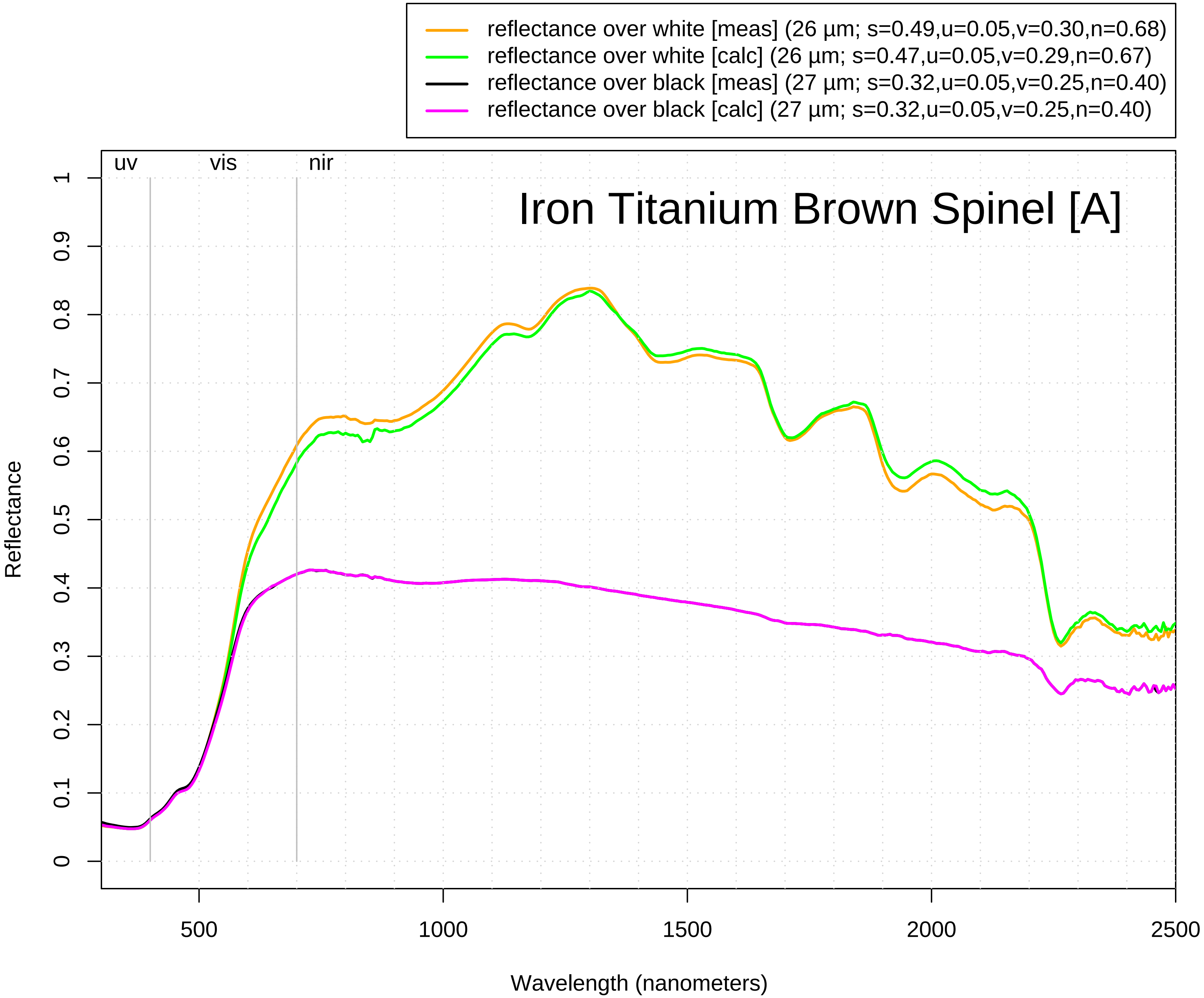

(d) Calculated vs. Measured Reflectances

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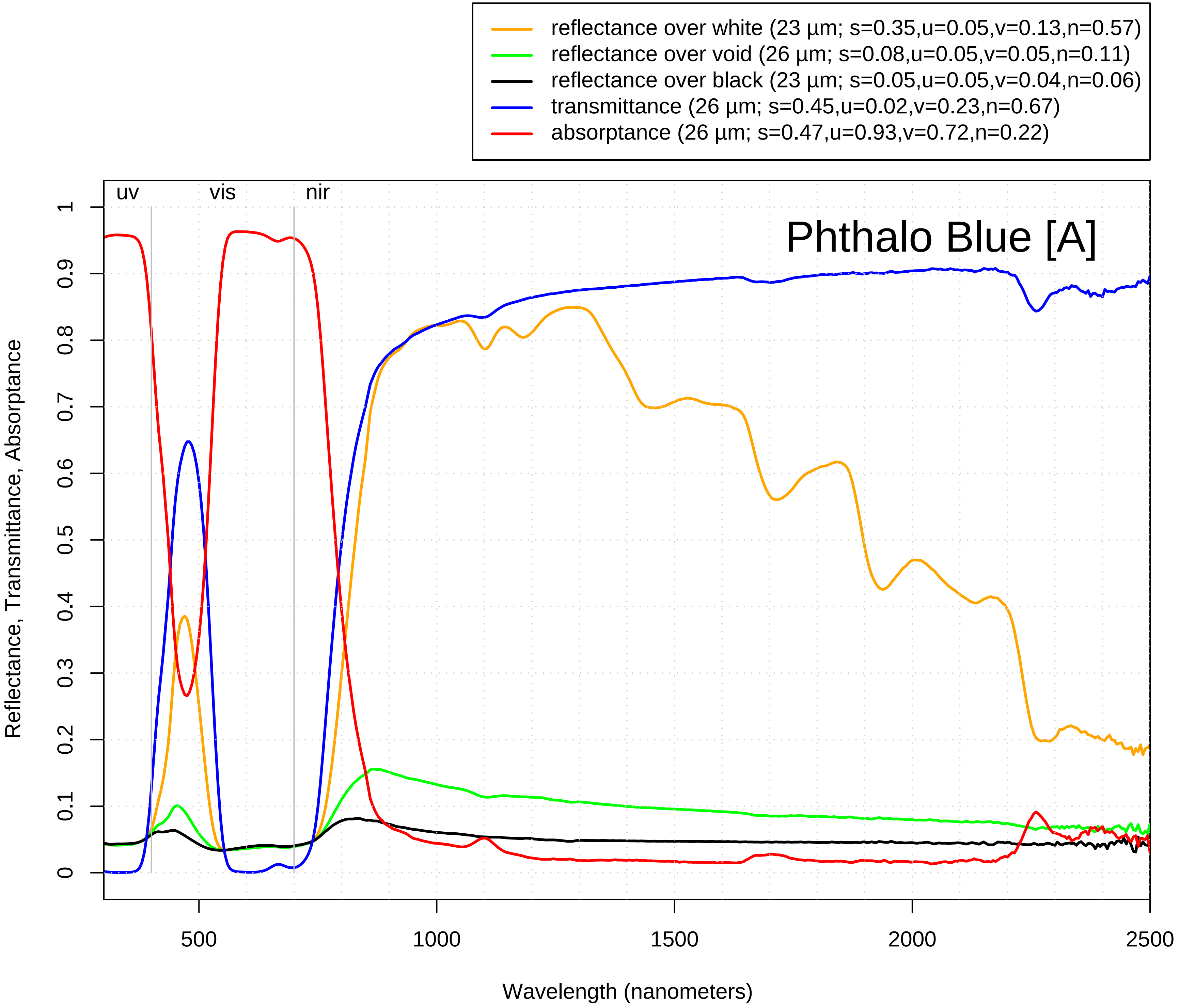

(a) Spectrometer Film Measurements

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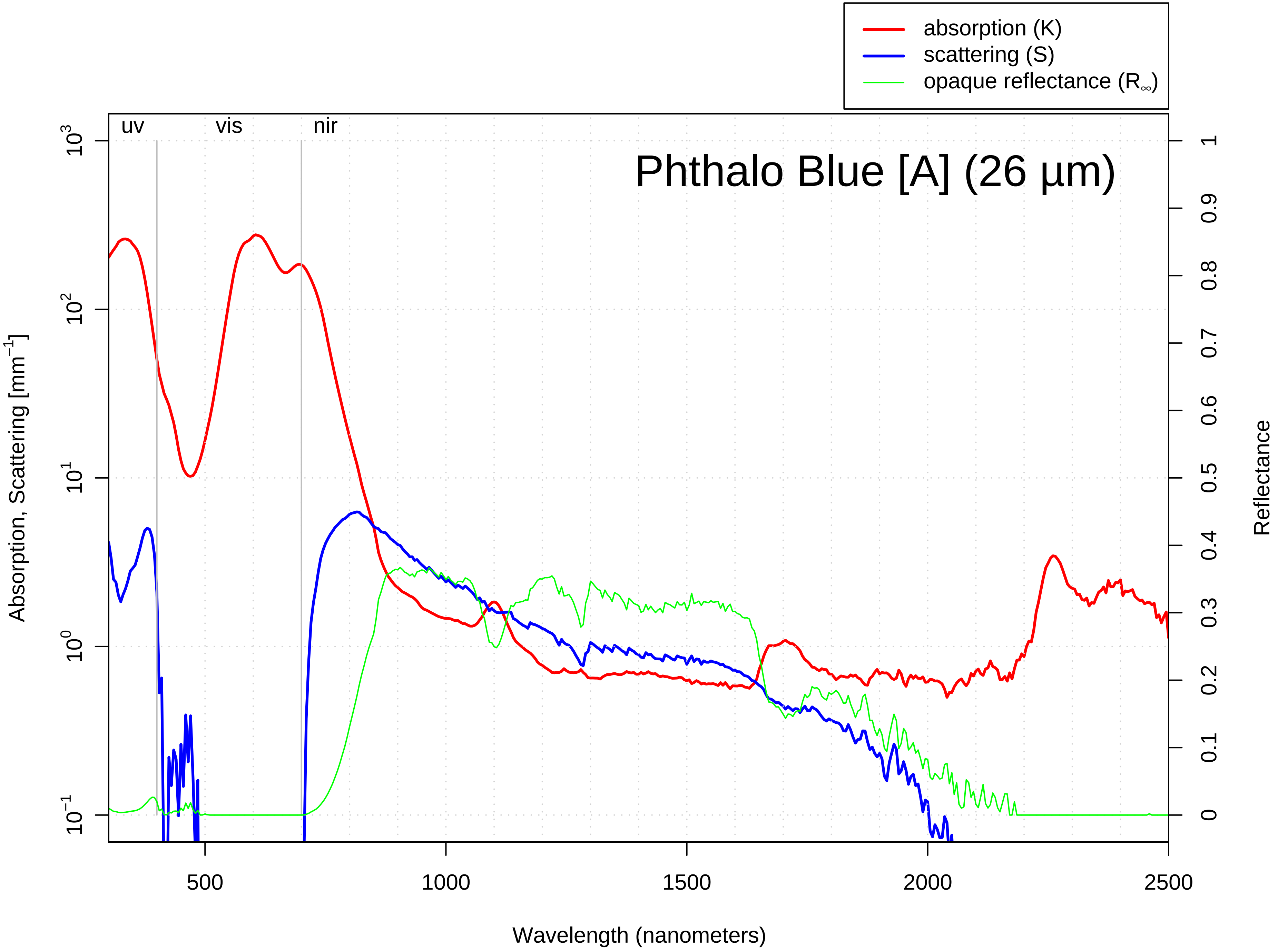

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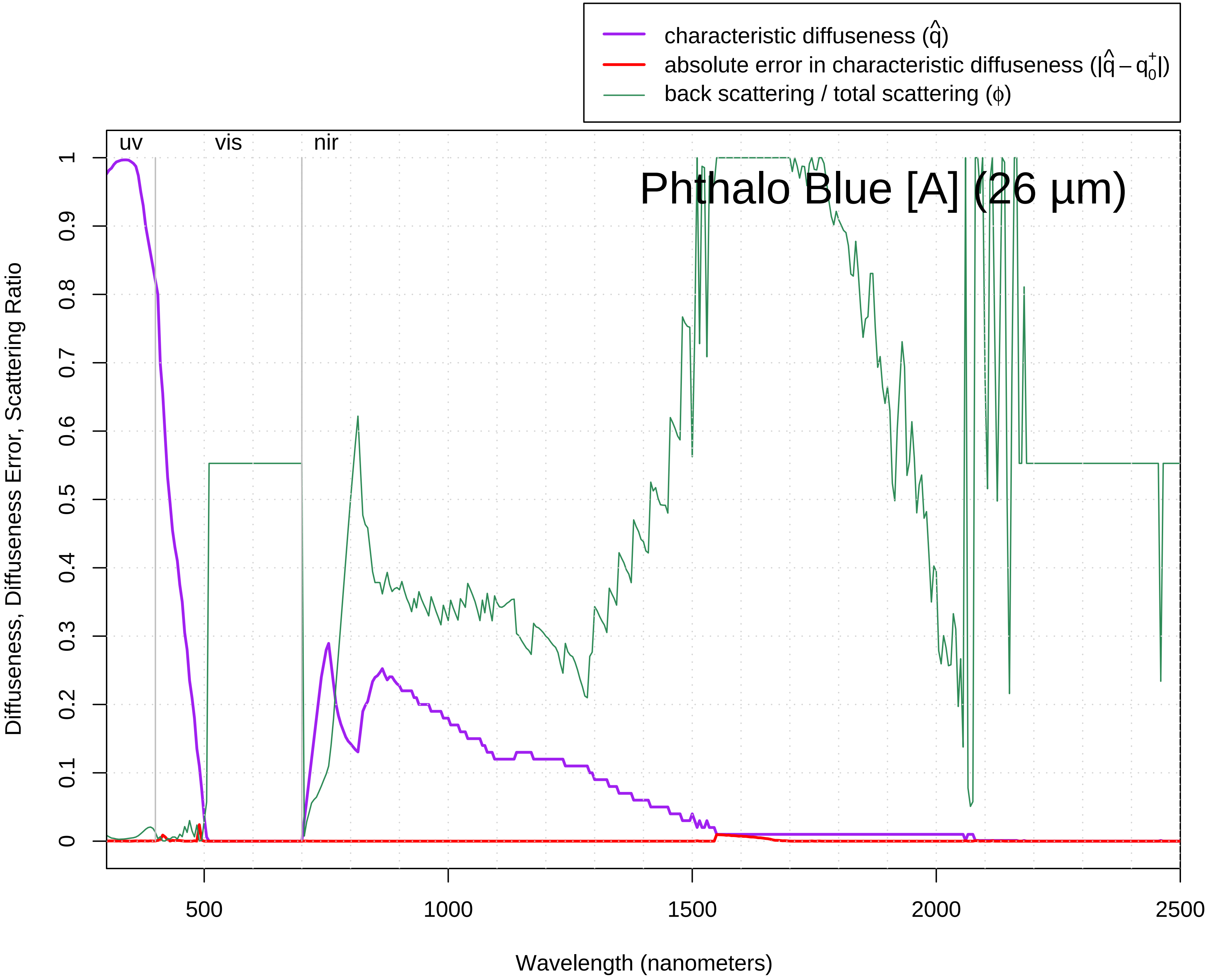

(c) Ancillary Calculations

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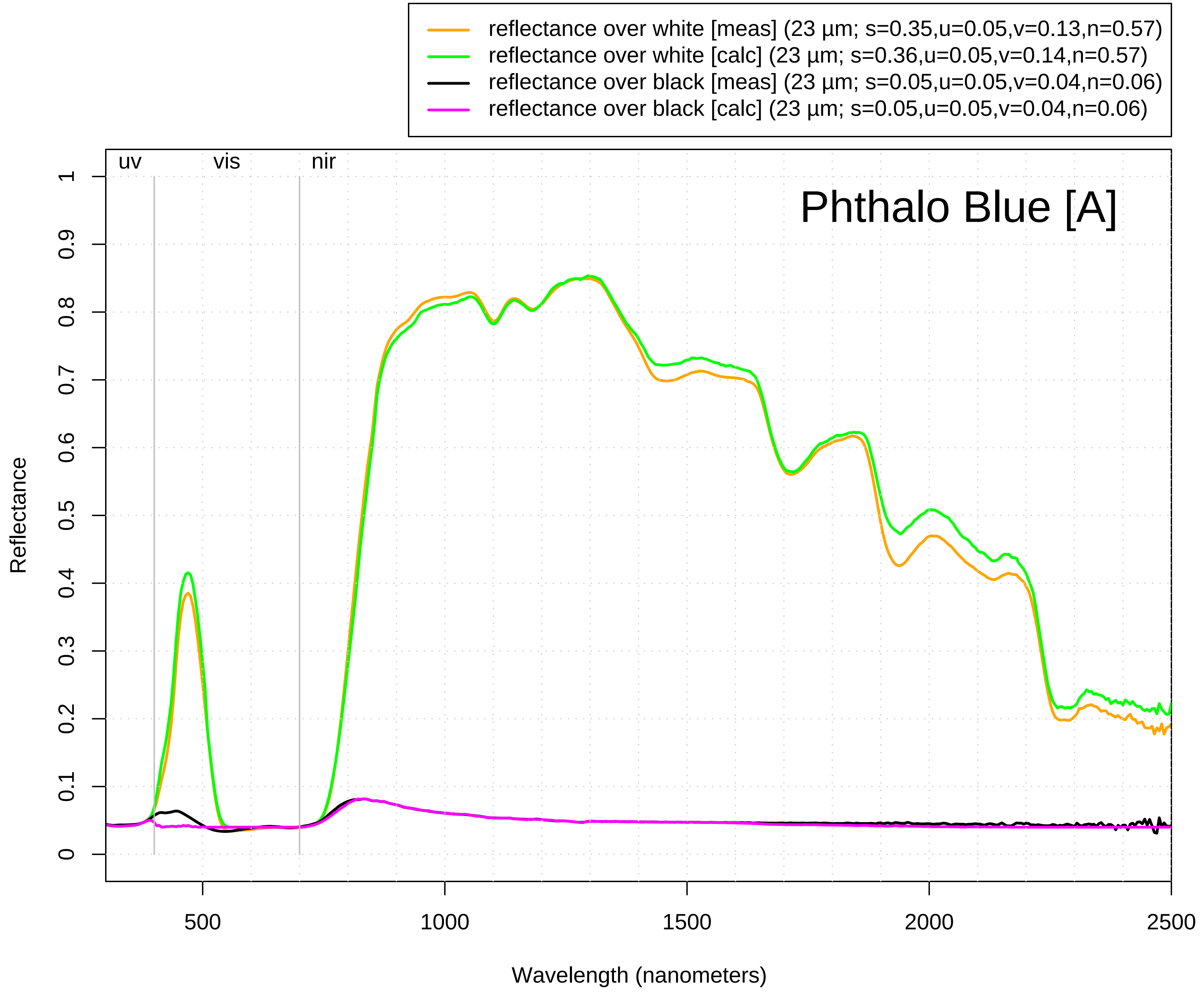
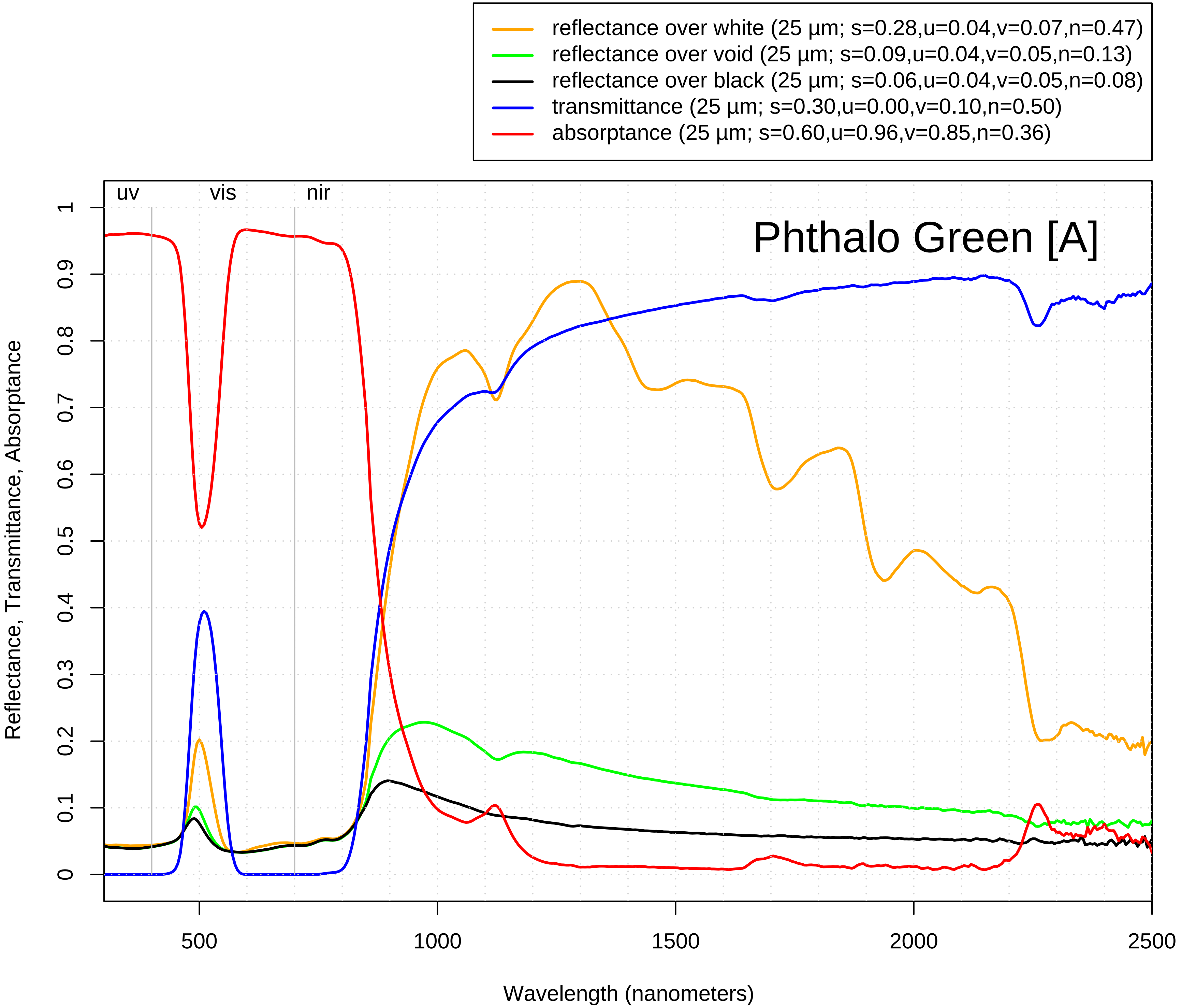


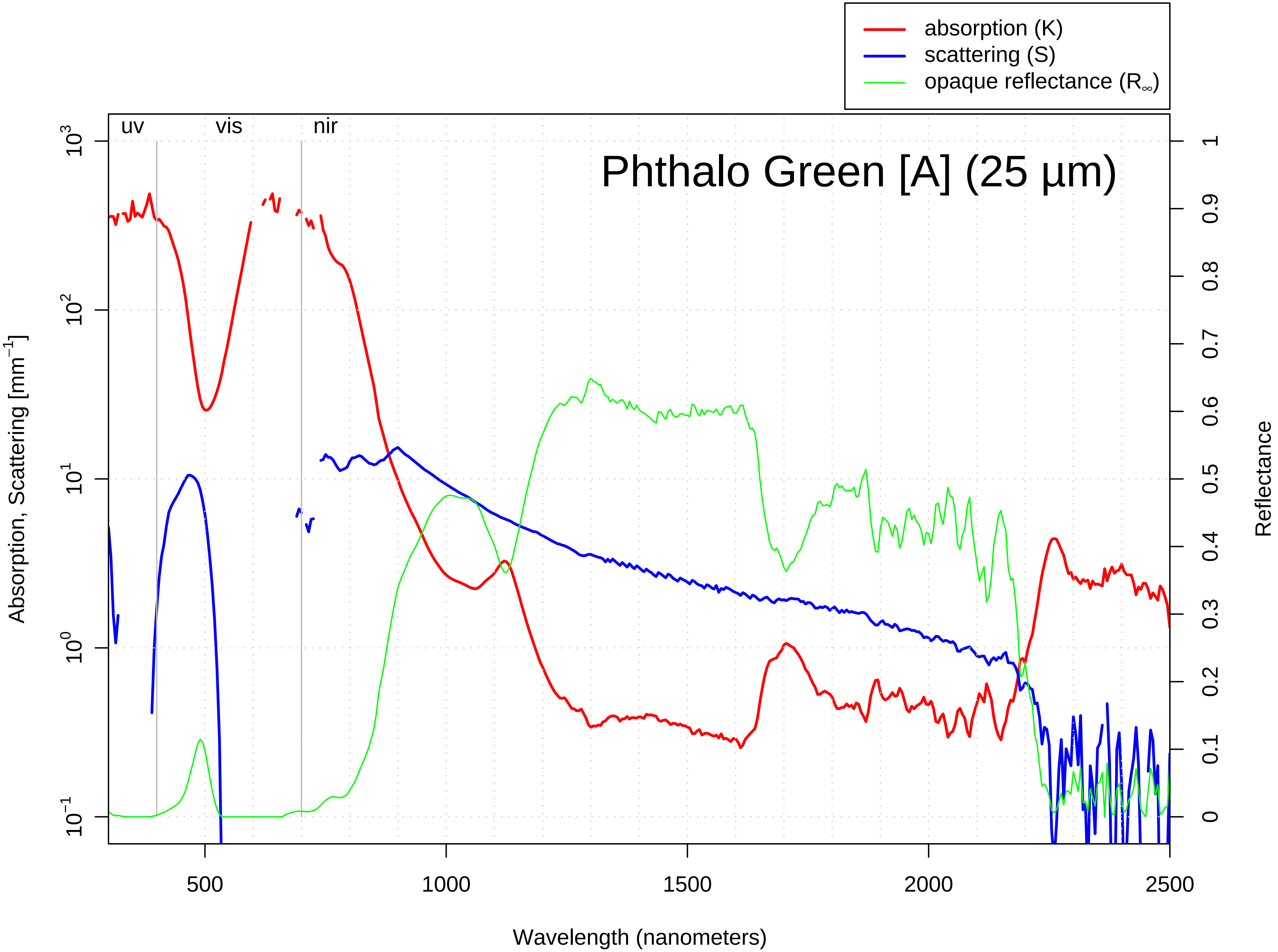
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 12:50 PM



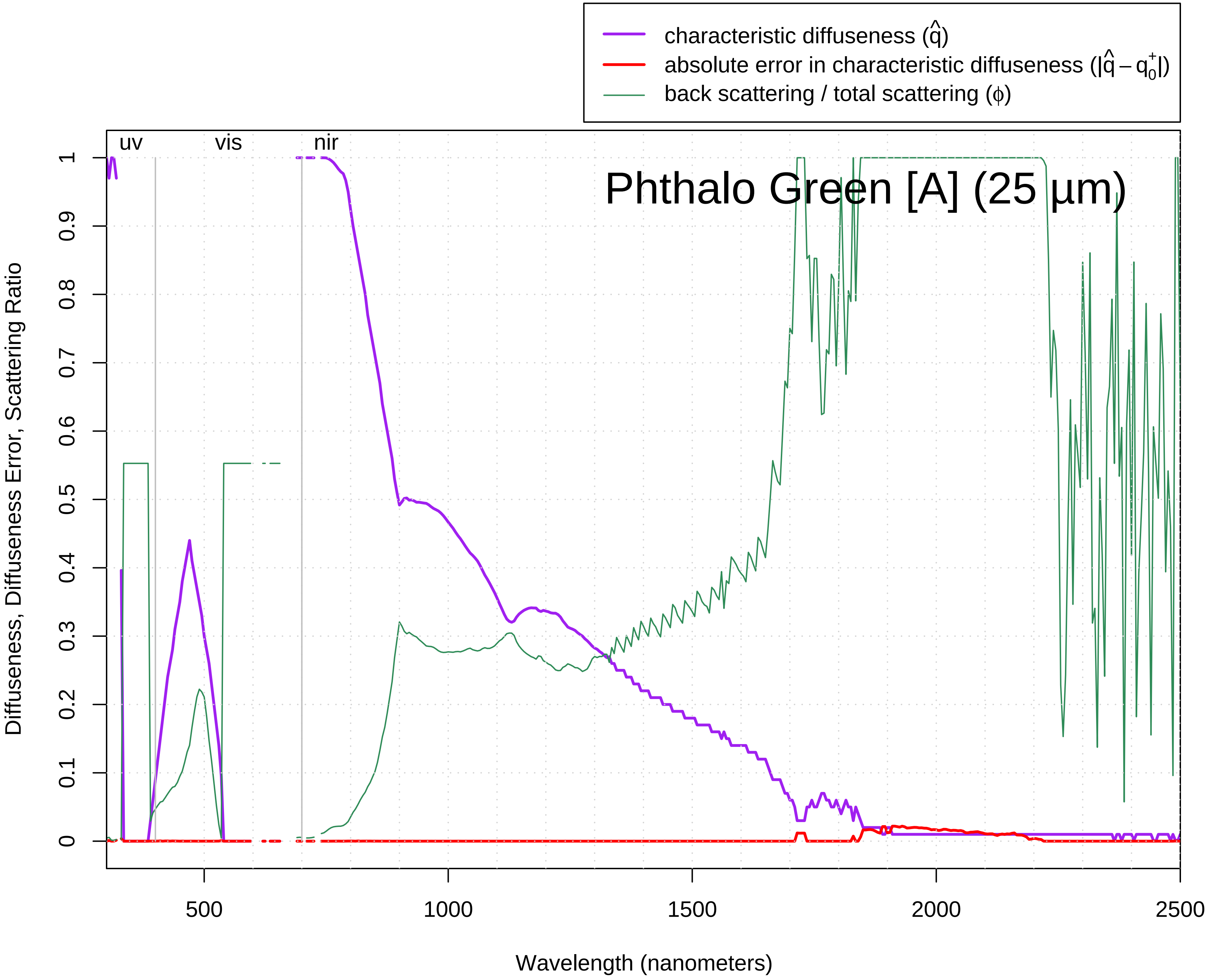
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 12:52 PM



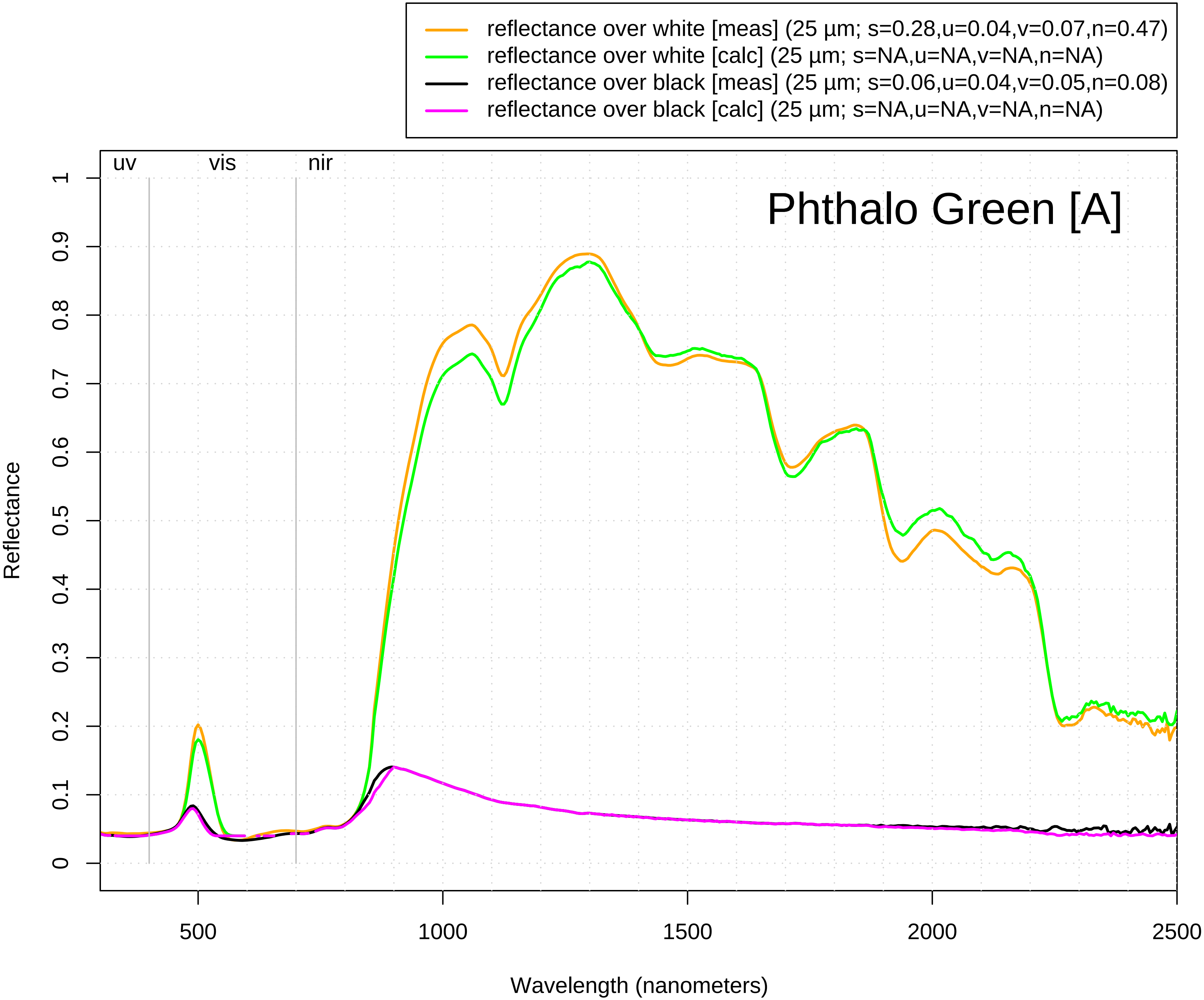
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 12:52 PM



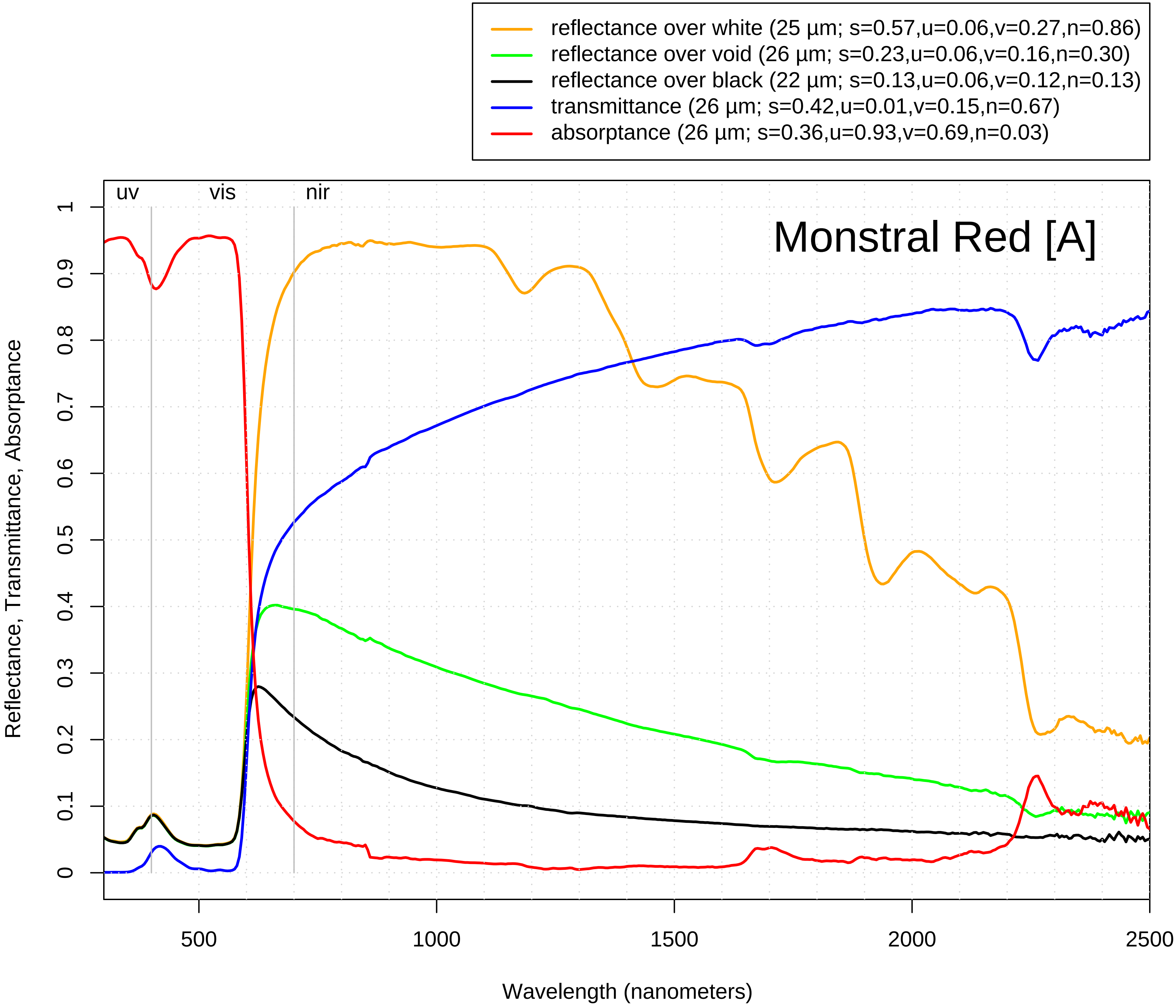
(c) Ancillary Calculations

Sunday, 09 March 2003 12:52 PM



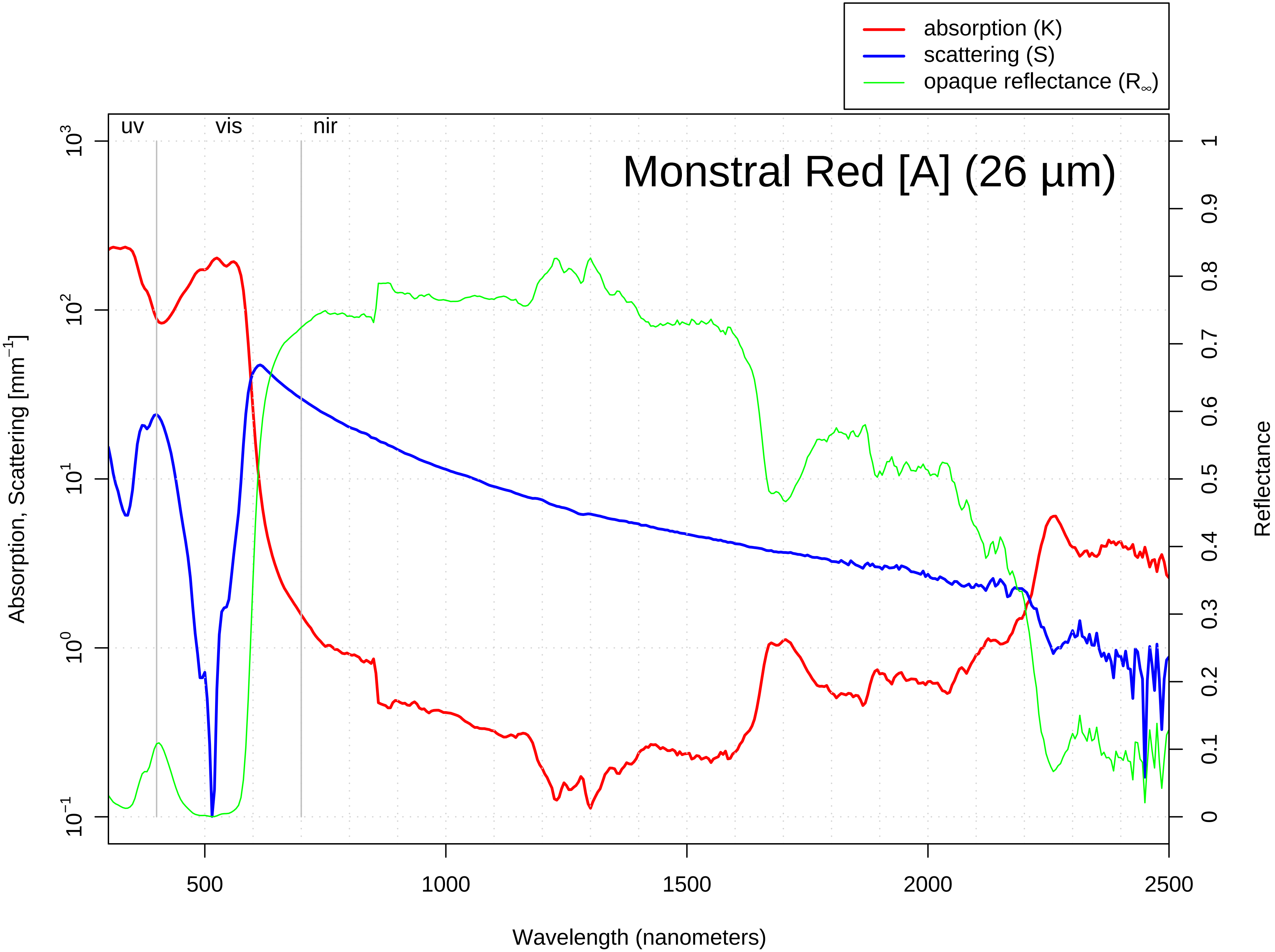
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 12:52 PM



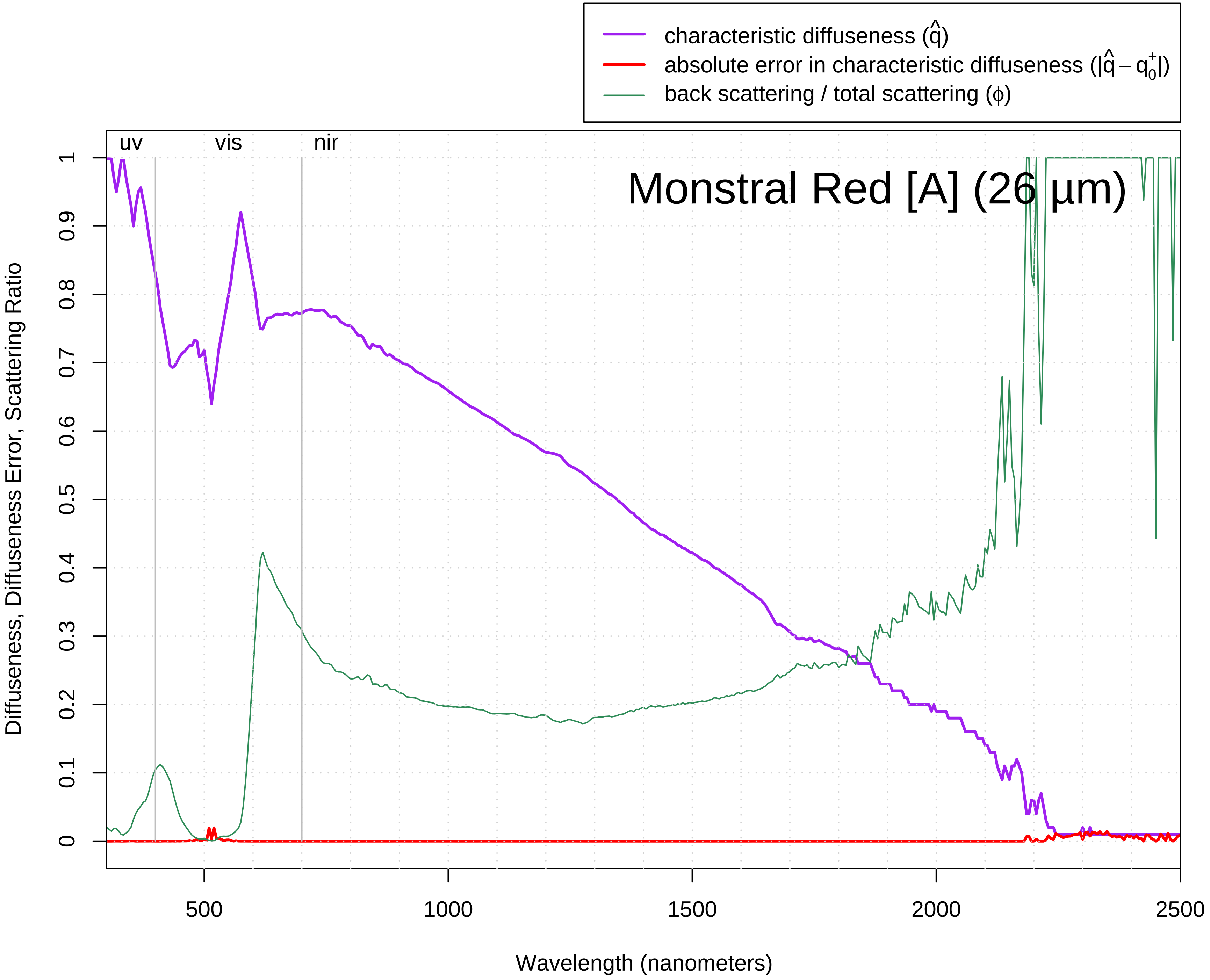
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 12:53 PM



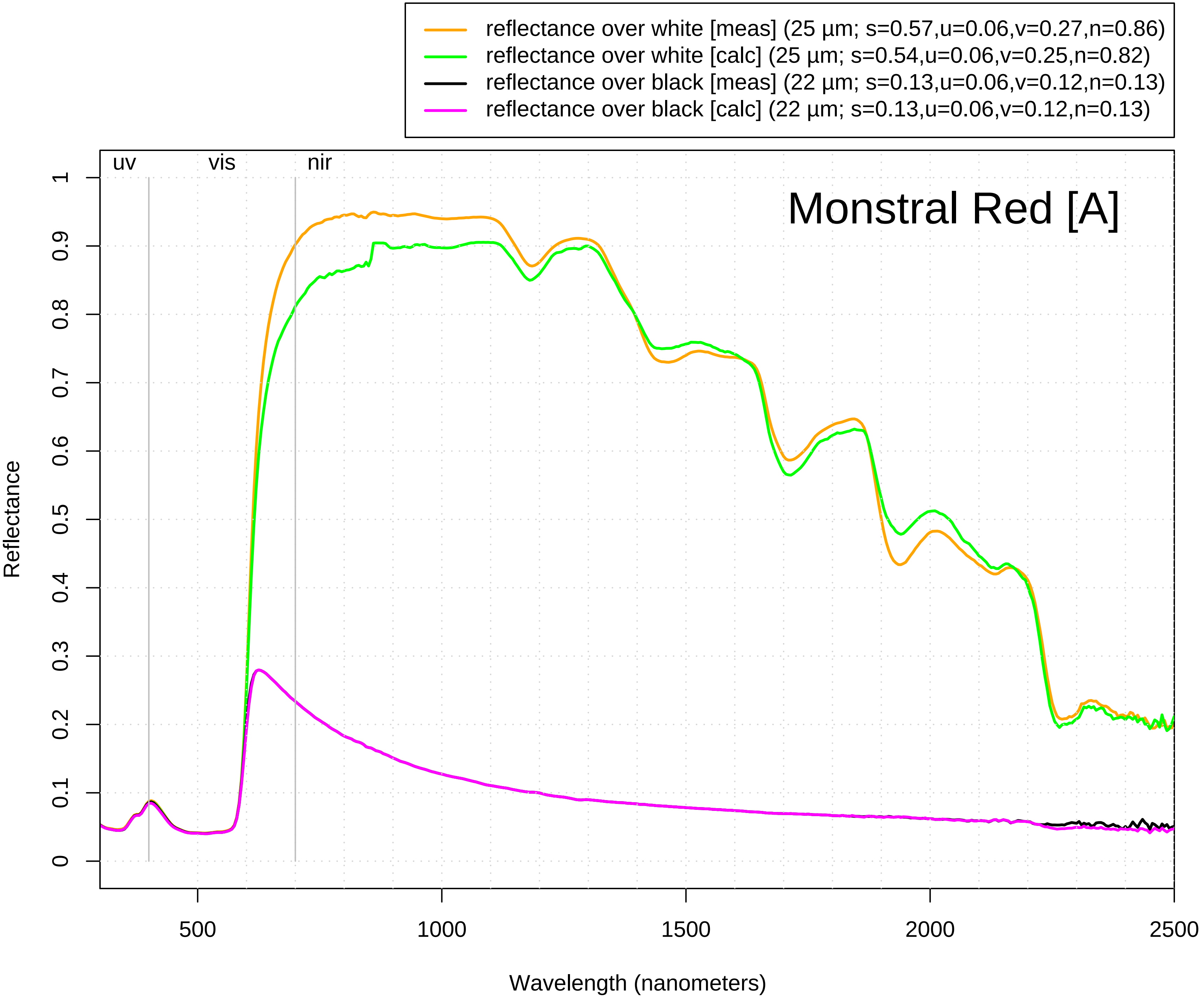
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 12:53 PM



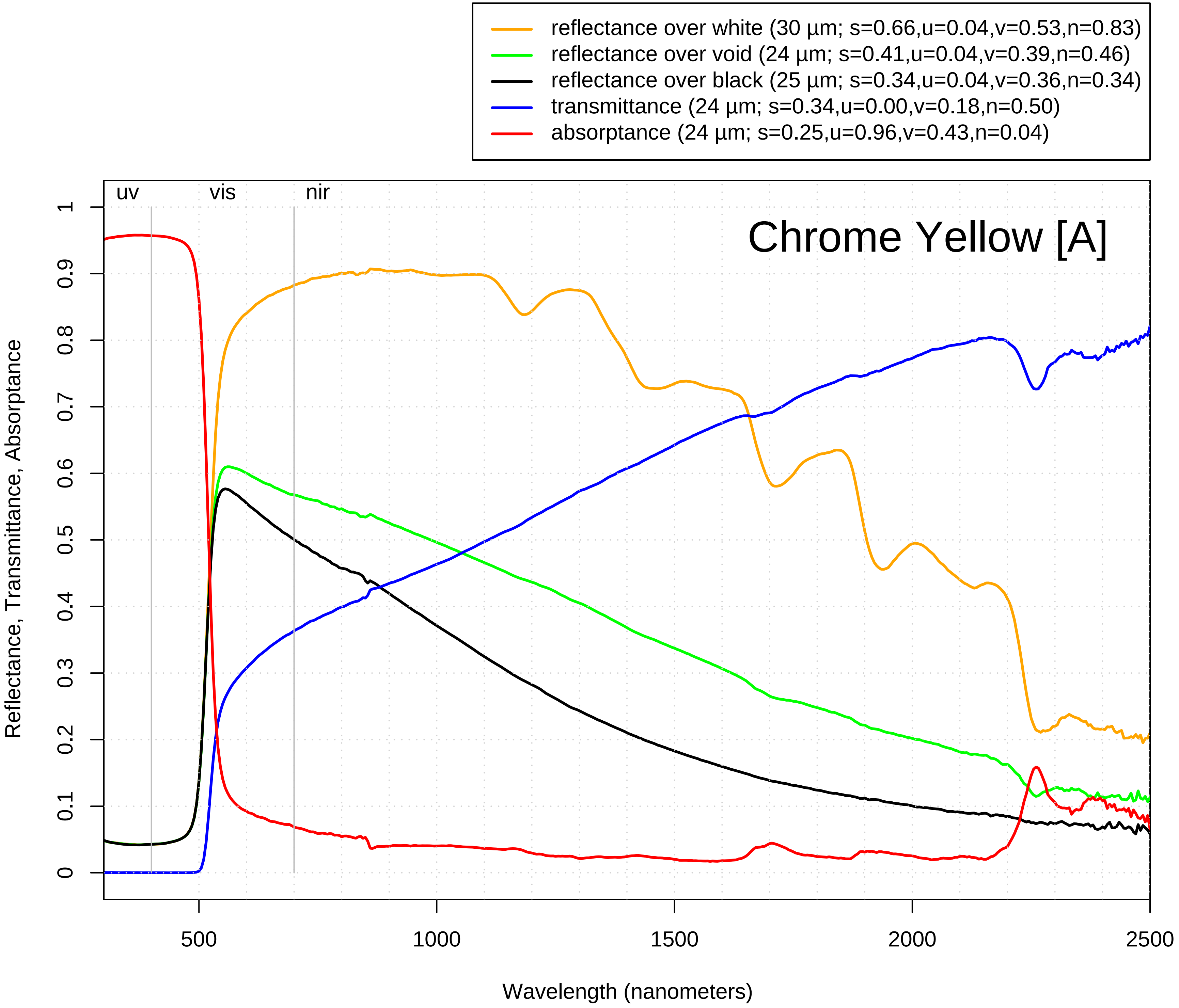
(c) Ancillary Calculations

Sunday, 09 March 2003 12:53 PM



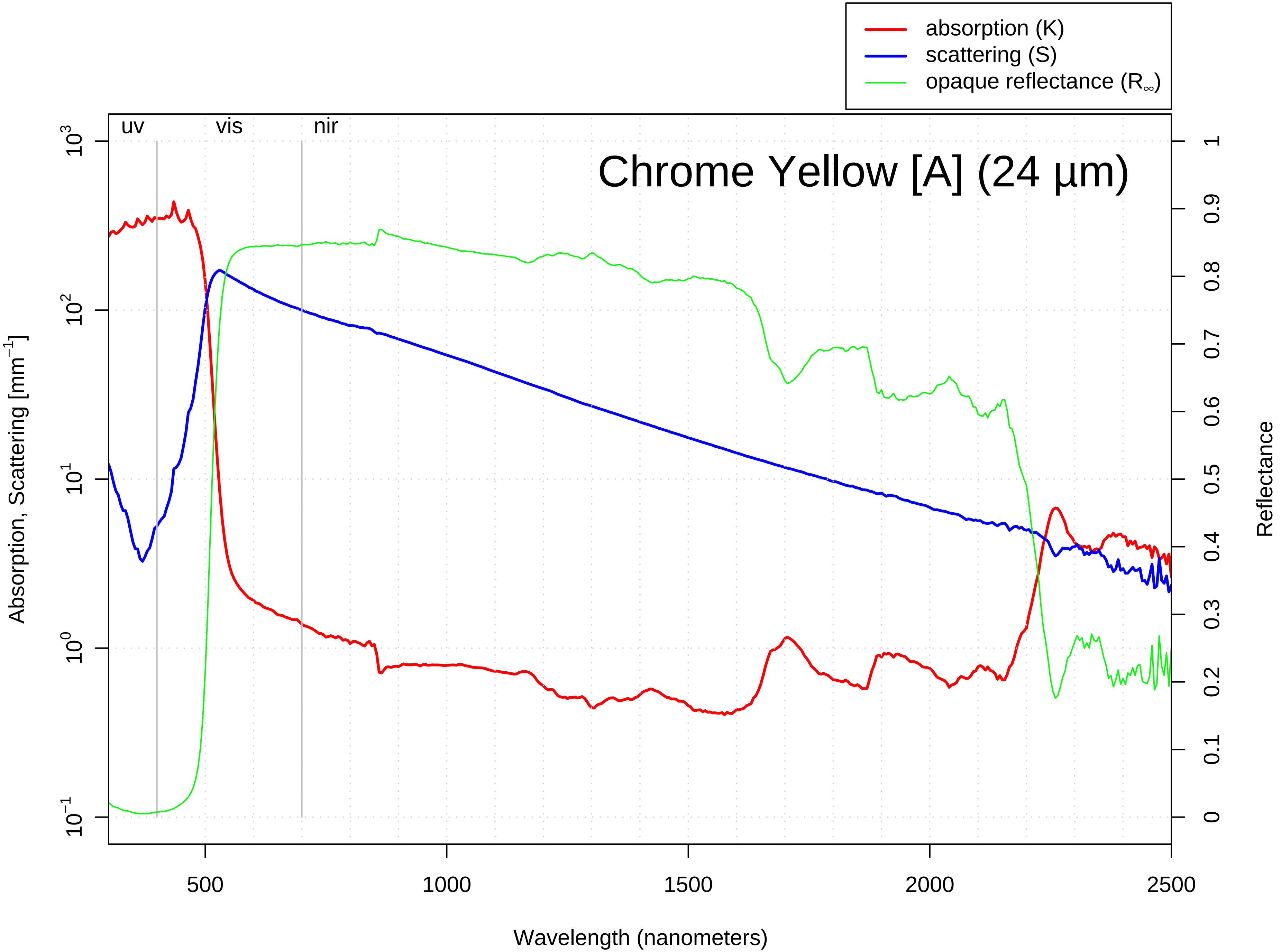
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 12:53 PM



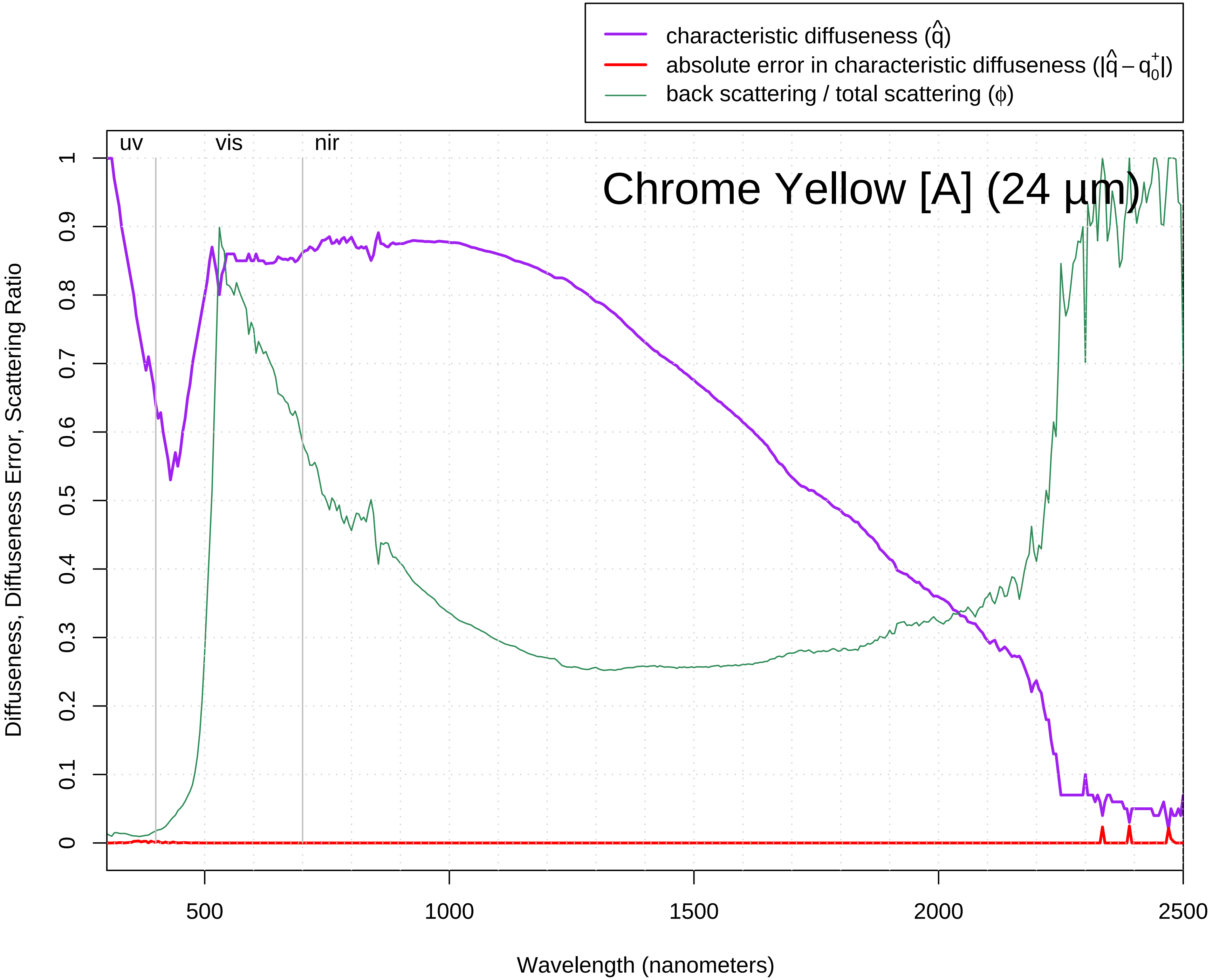
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 12:54 PM



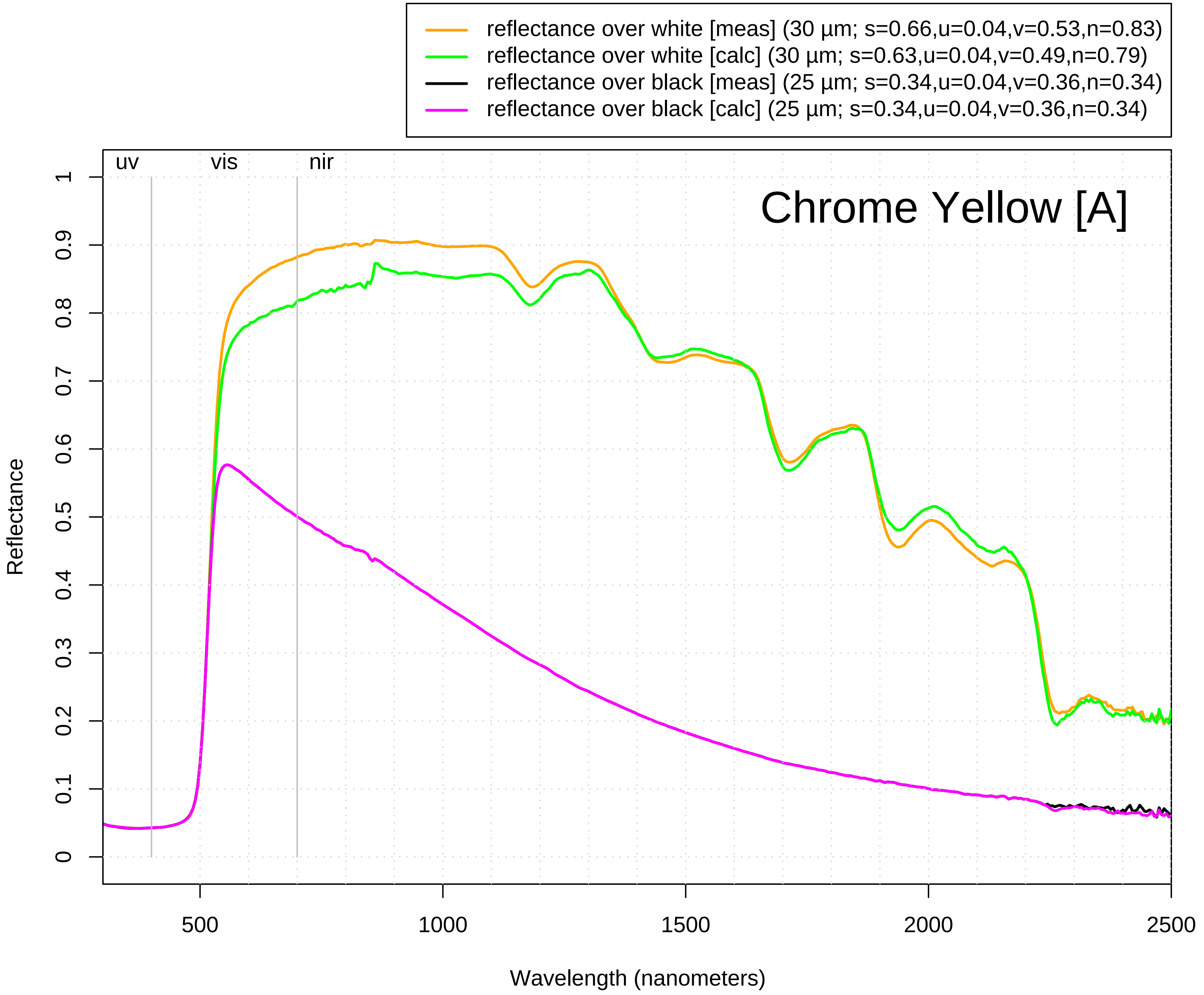
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 12:54 PM



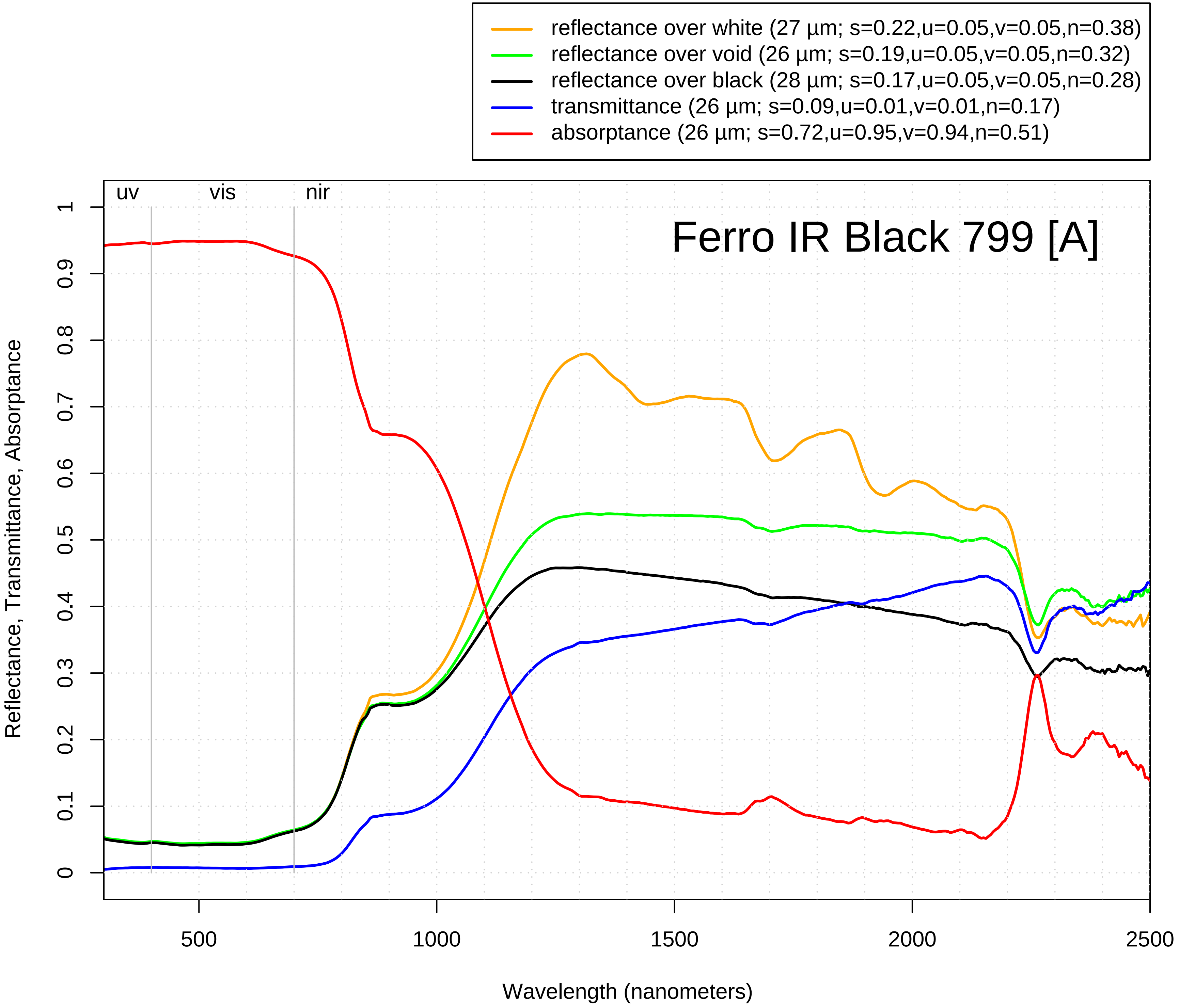
(c) Ancillary Calculations

Sunday, 09 March 2003 12:54 PM



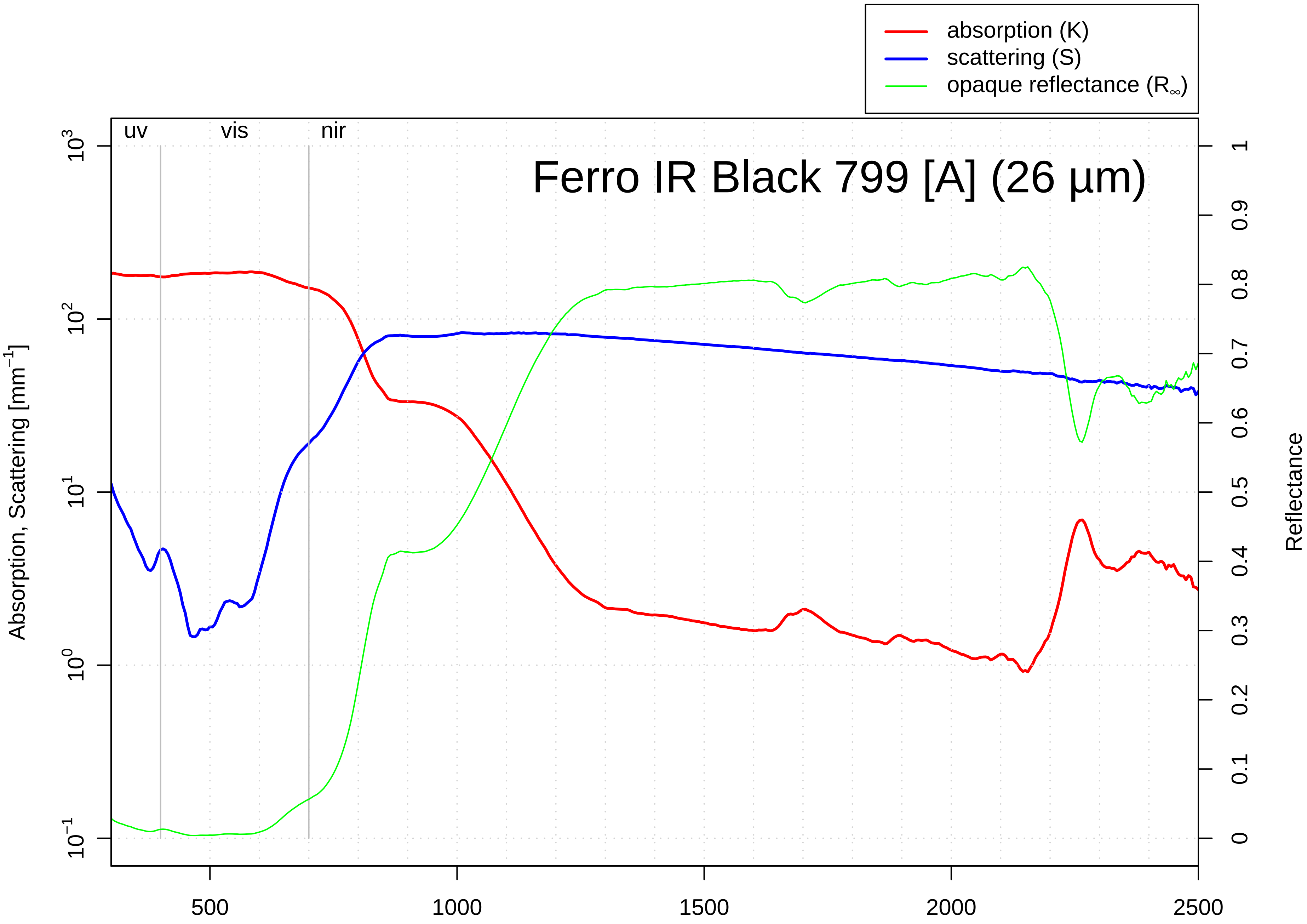
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 12:54 PM



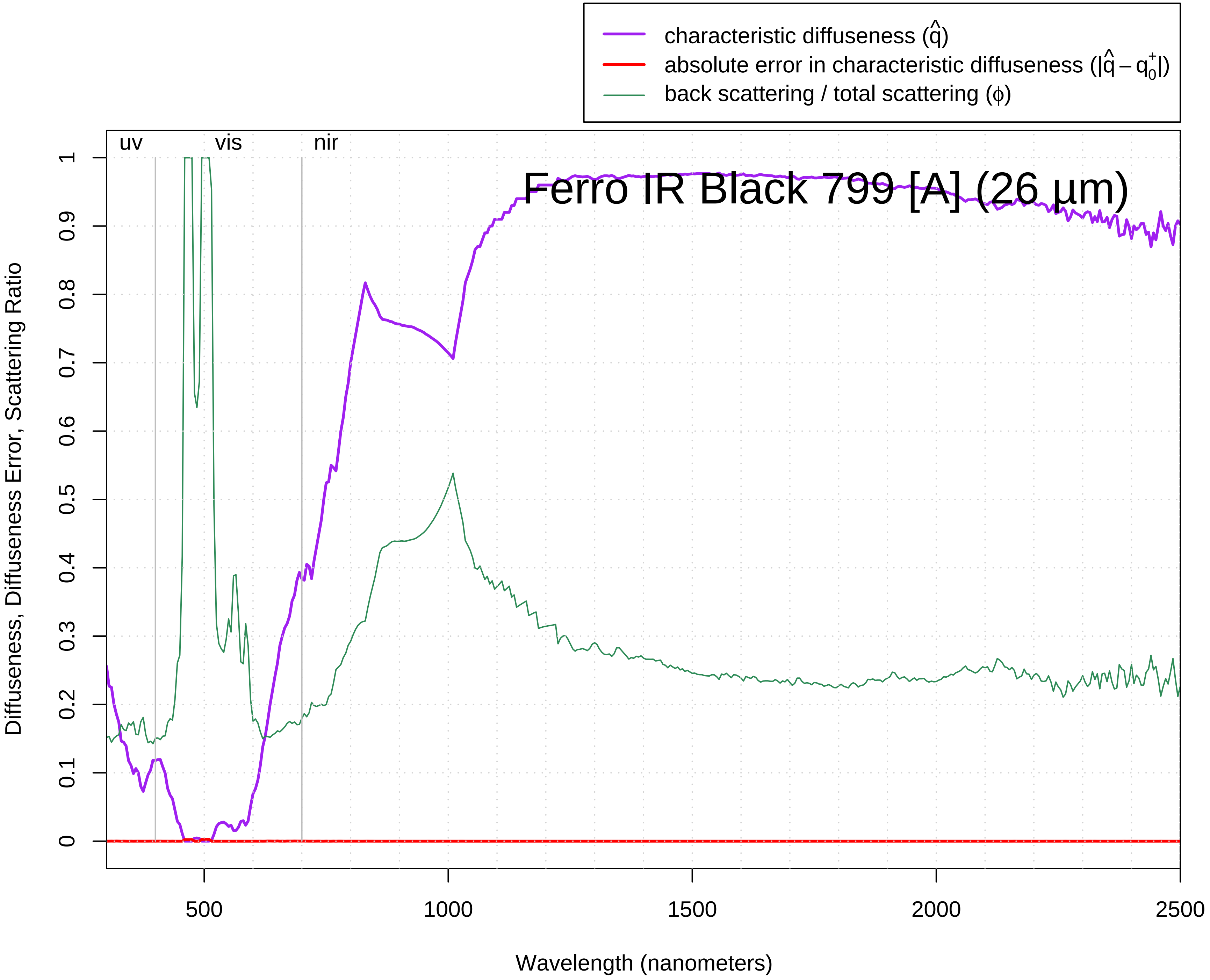
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 12:56 PM



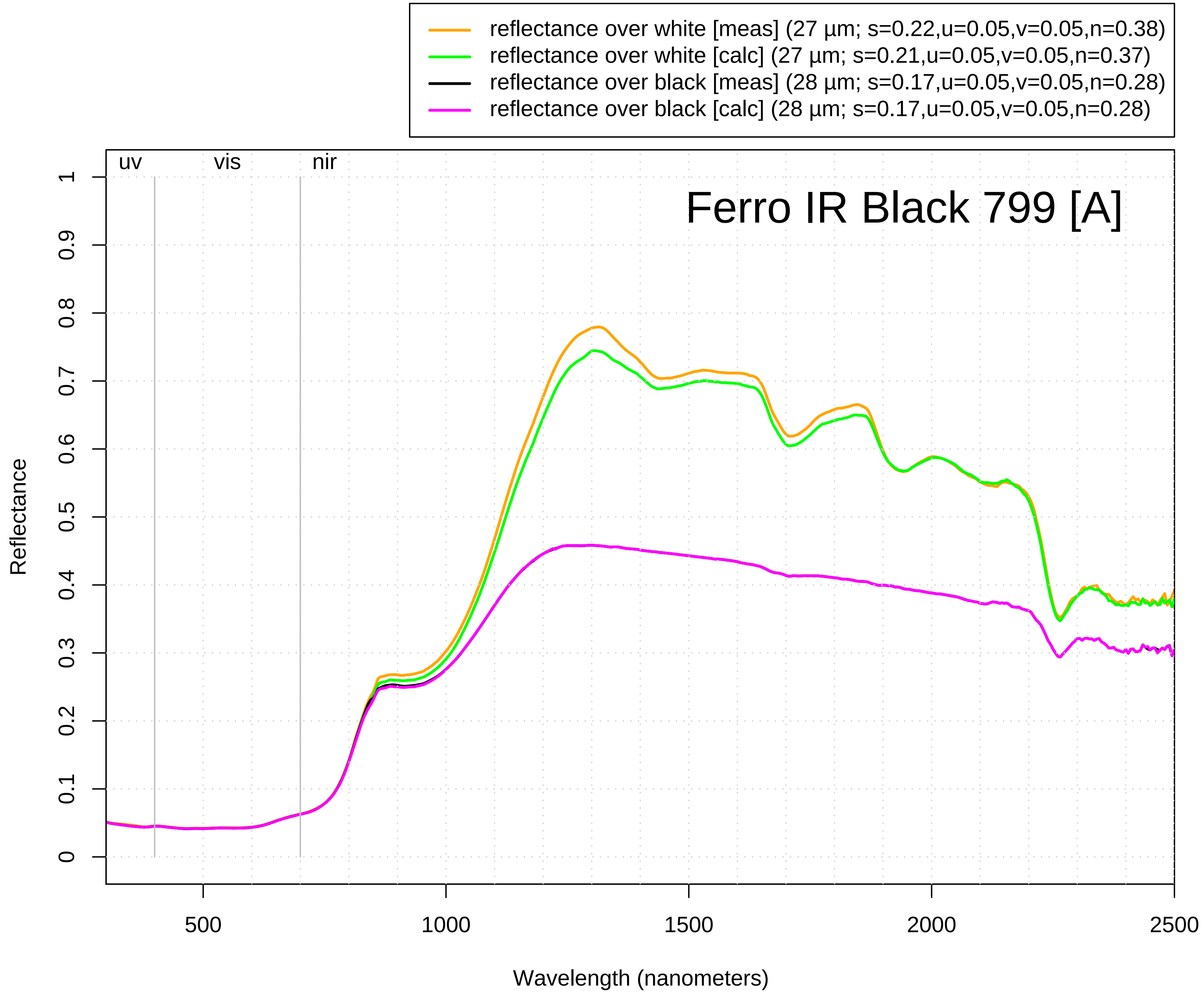
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 12:56 PM



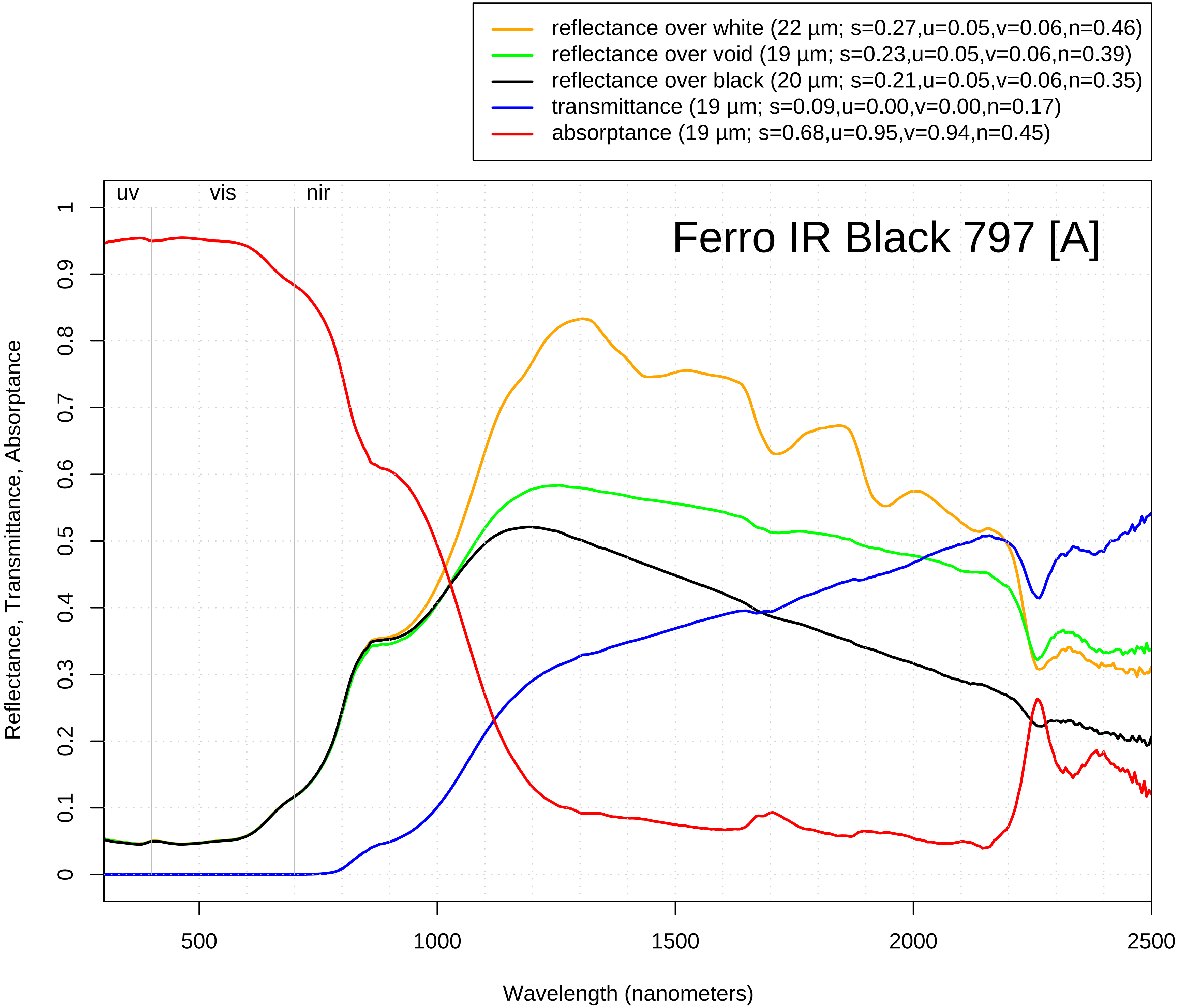
(c) Ancillary Calculations

Sunday, 09 March 2003 12:56 PM



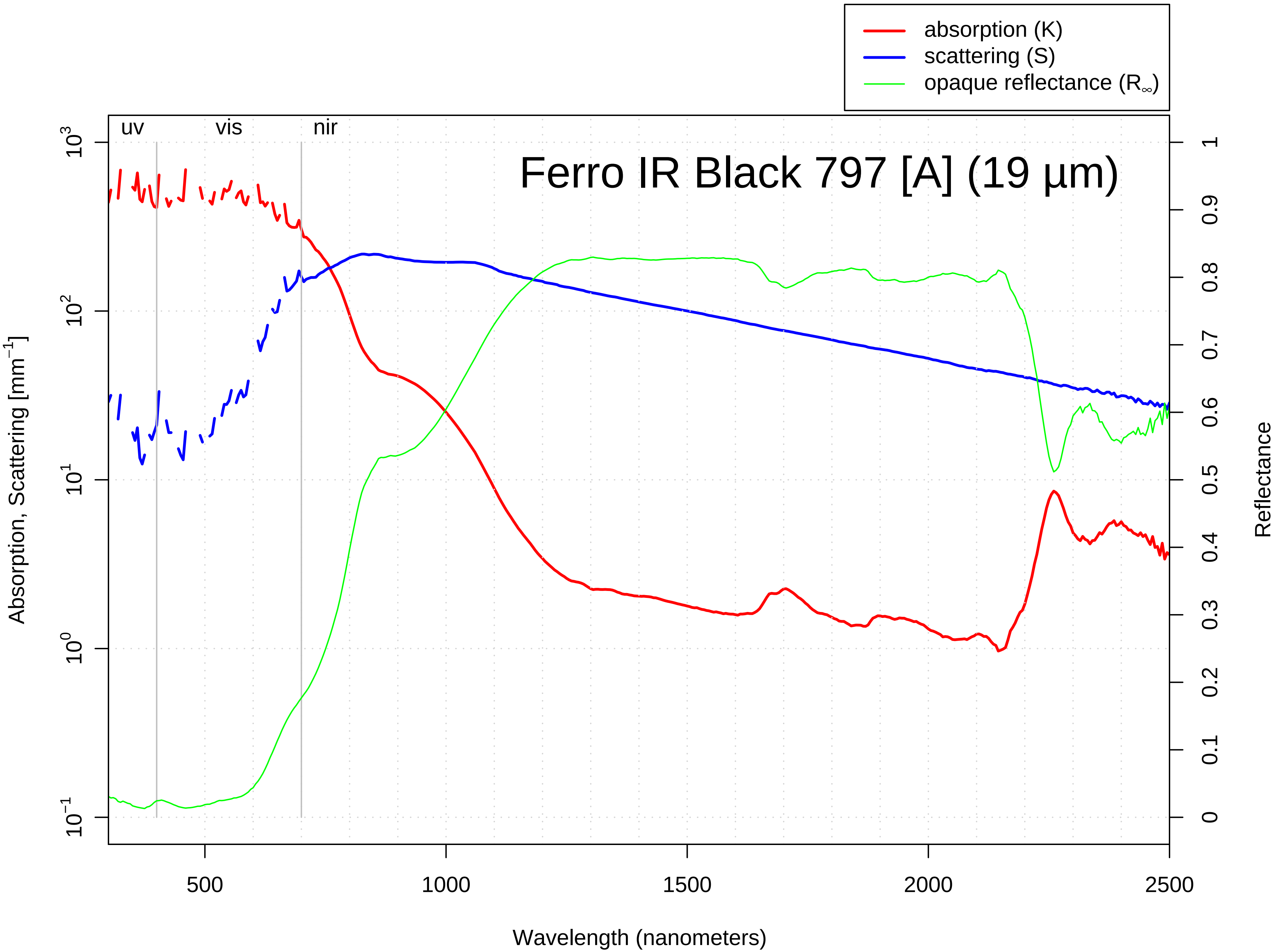
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 12:56 PM



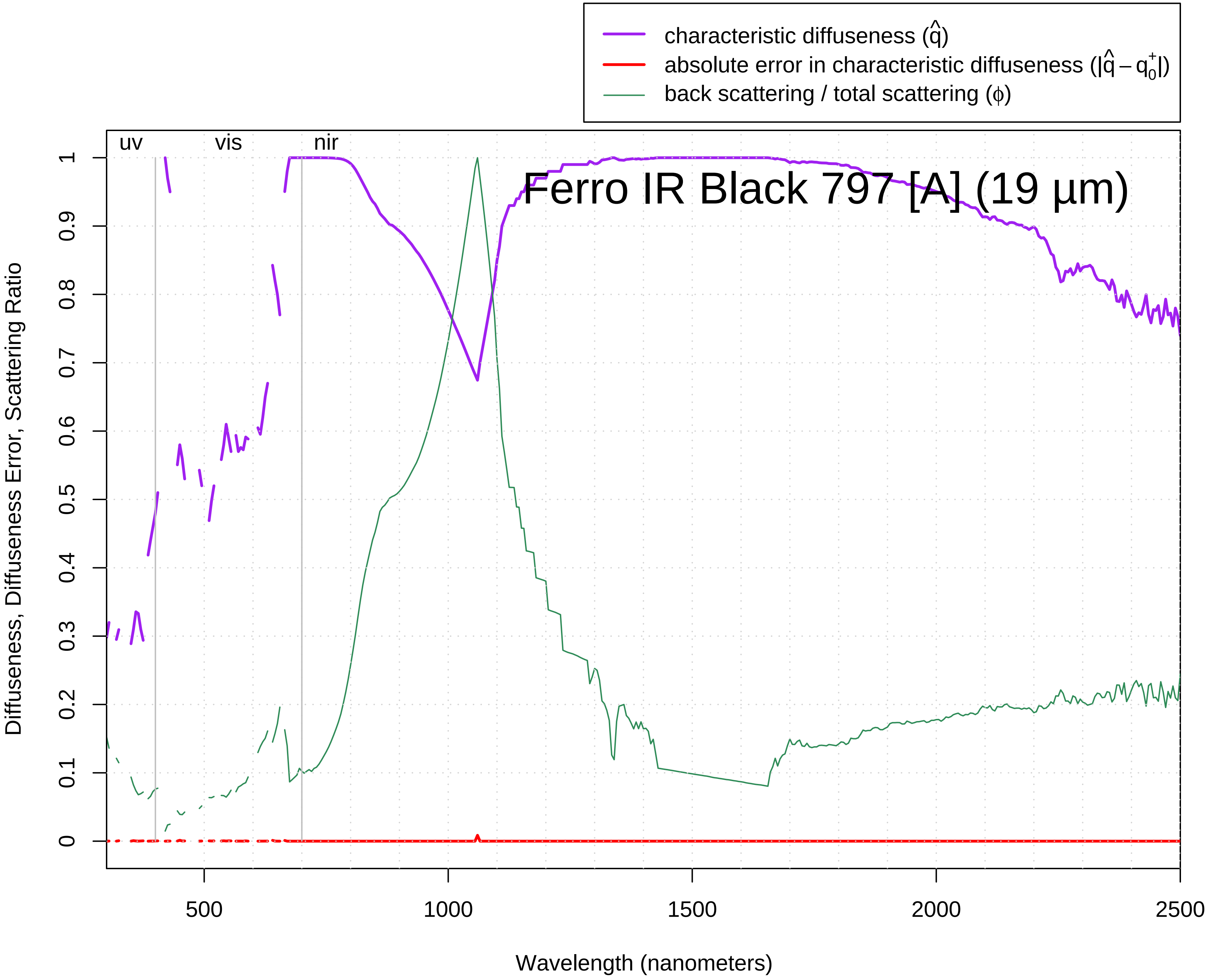
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 12:57 PM



(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 12:57 PM



(c) Ancillary Calculations

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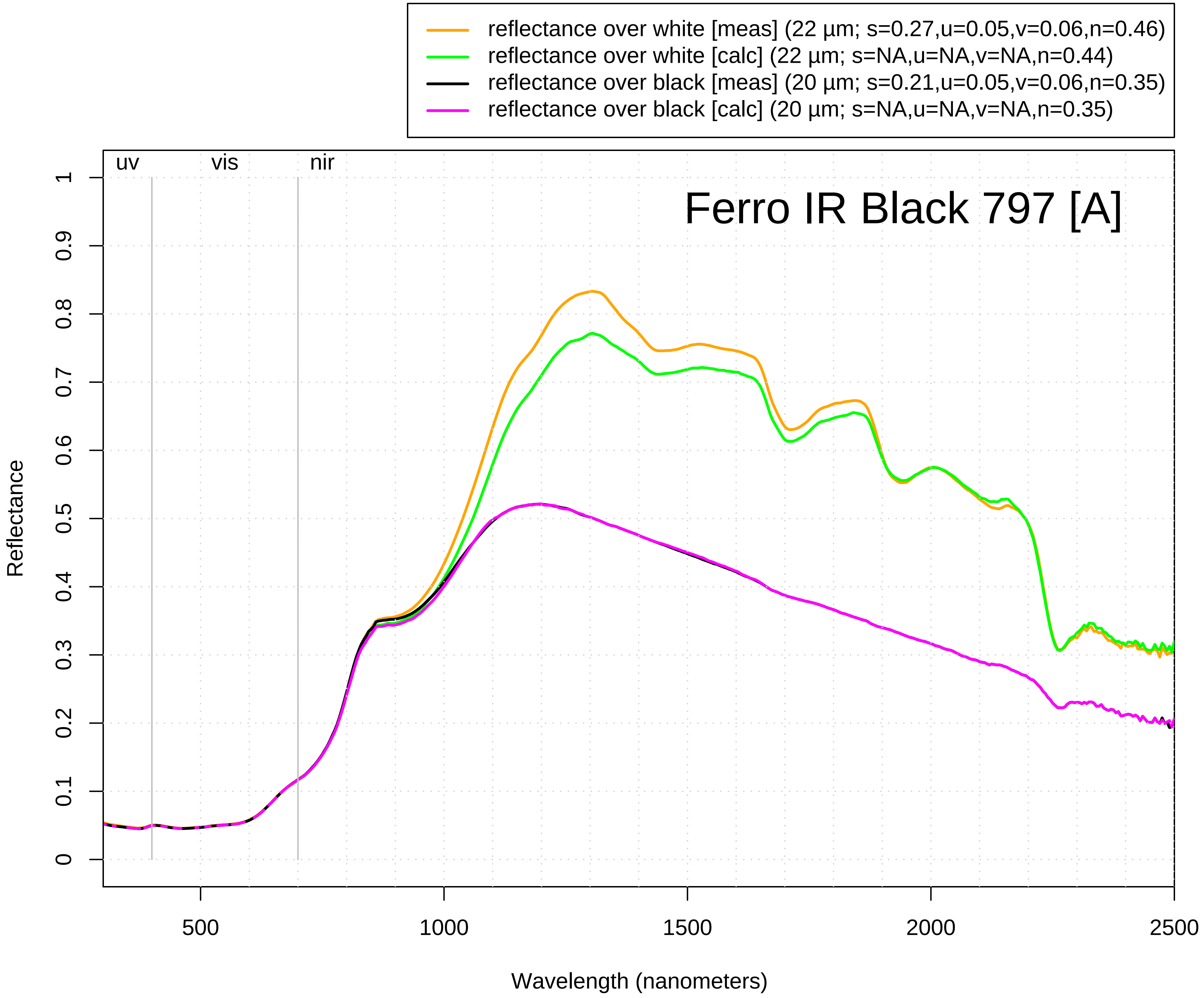
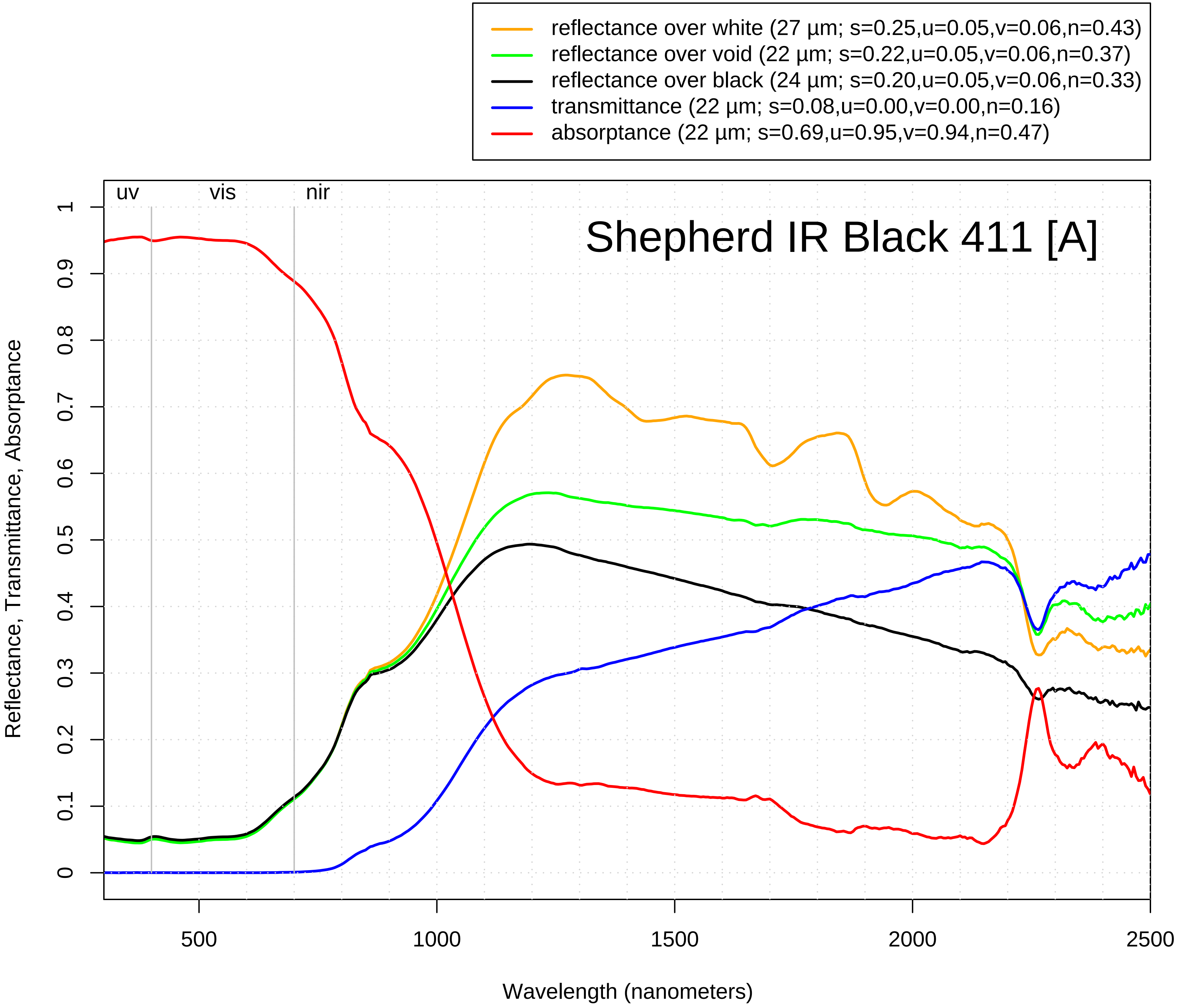


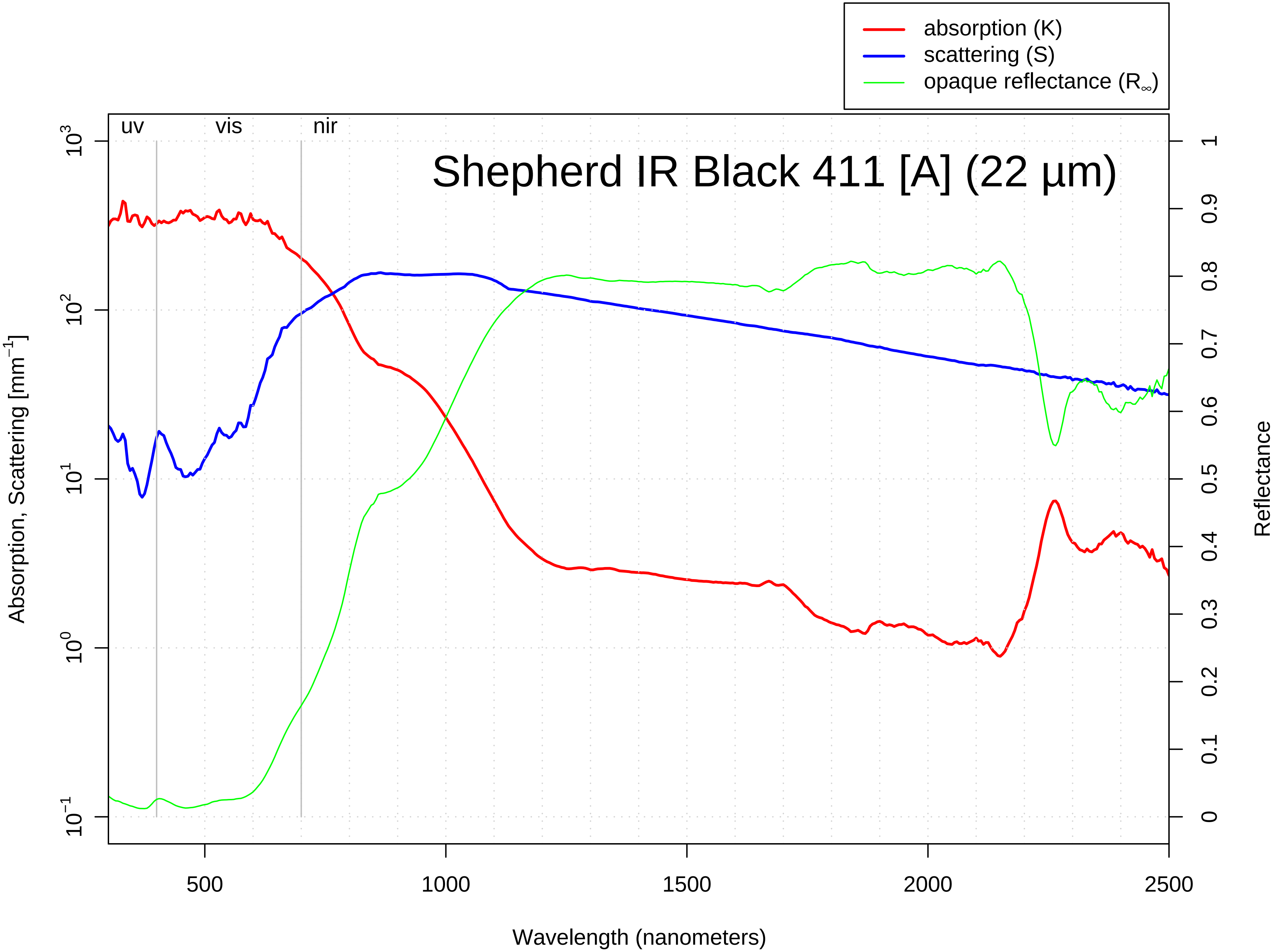
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 12:57 PM



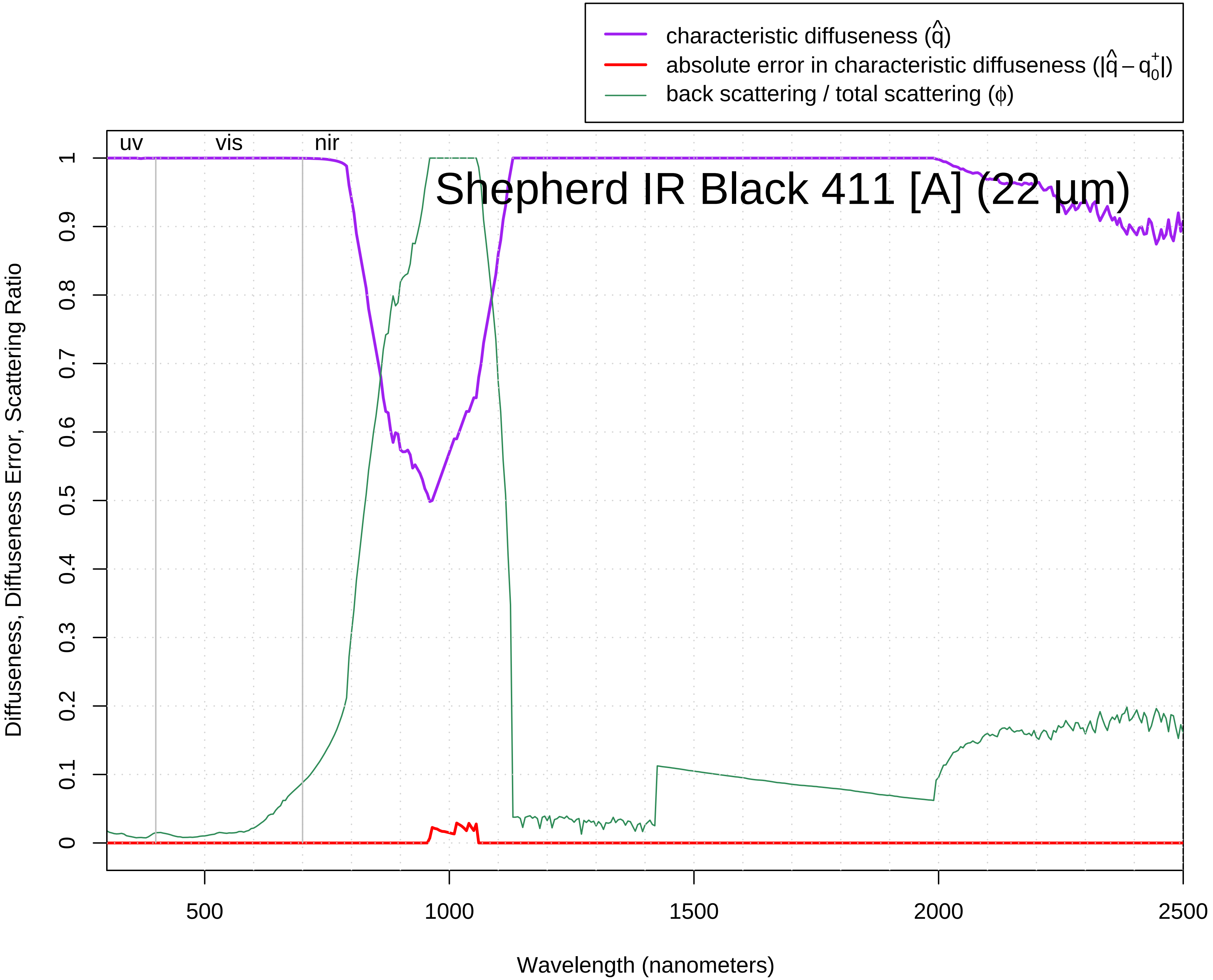
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 12:59 PM



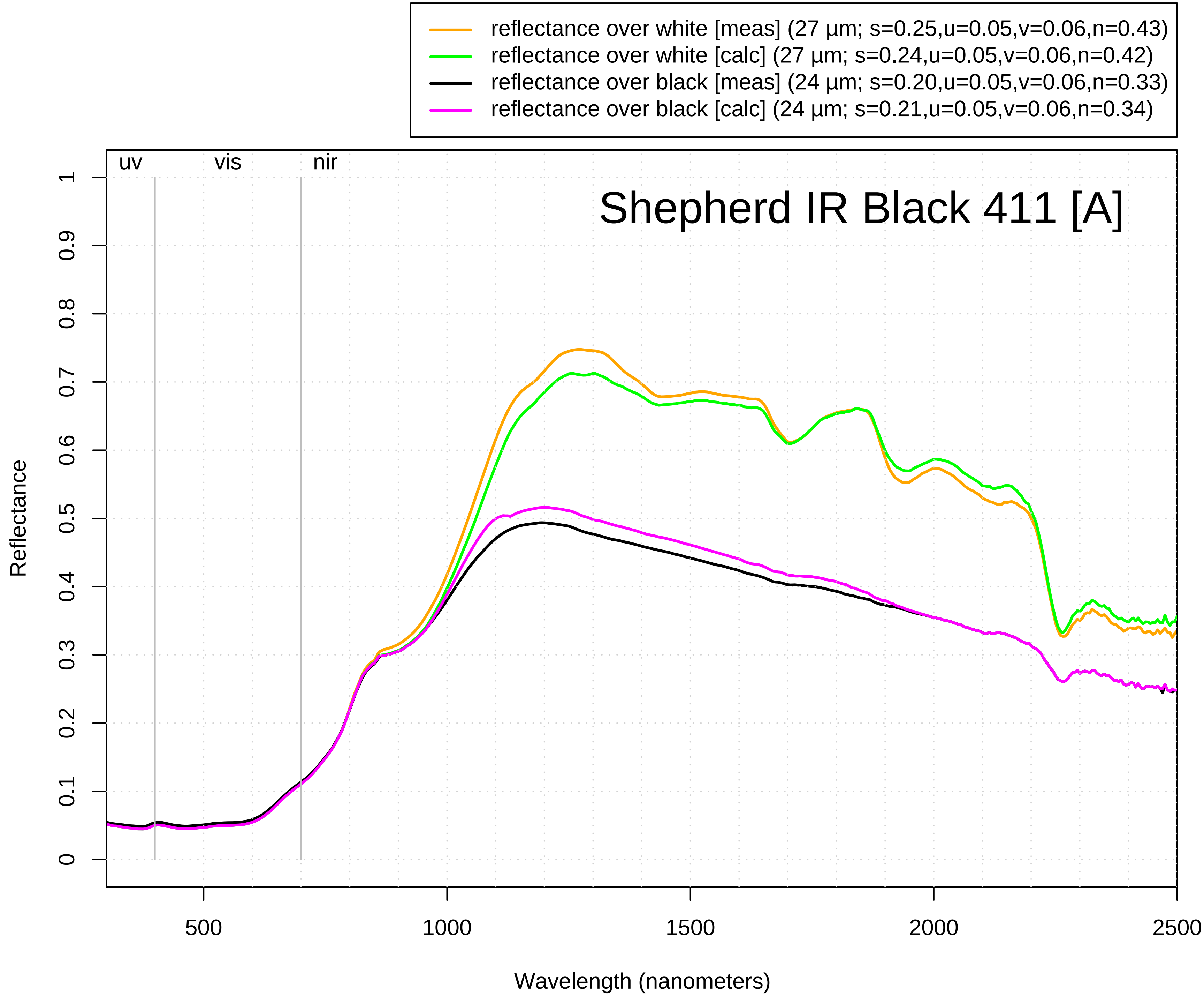
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 12:59 PM



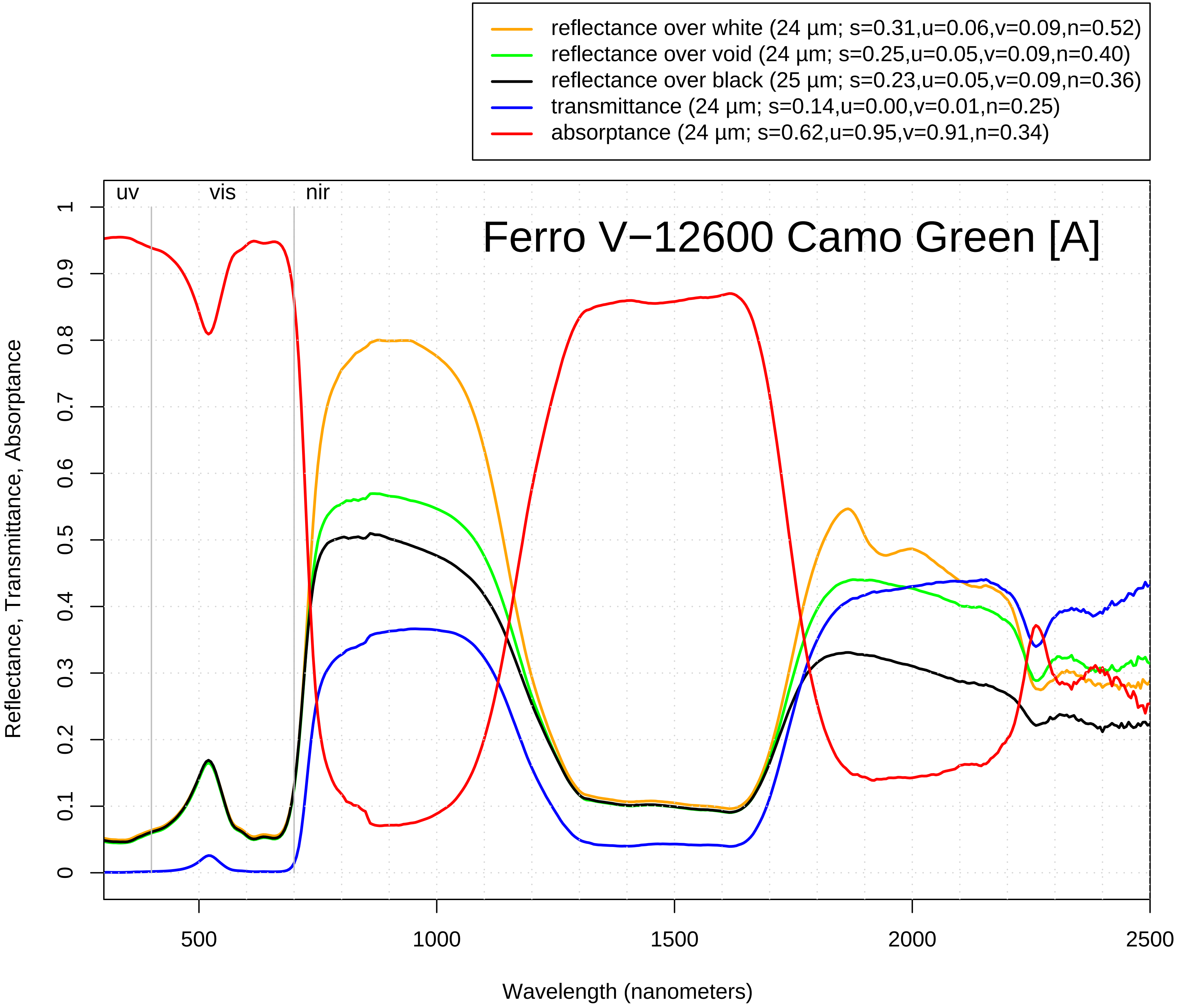
(c) Ancillary Calculations

Sunday, 09 March 2003 12:59 PM



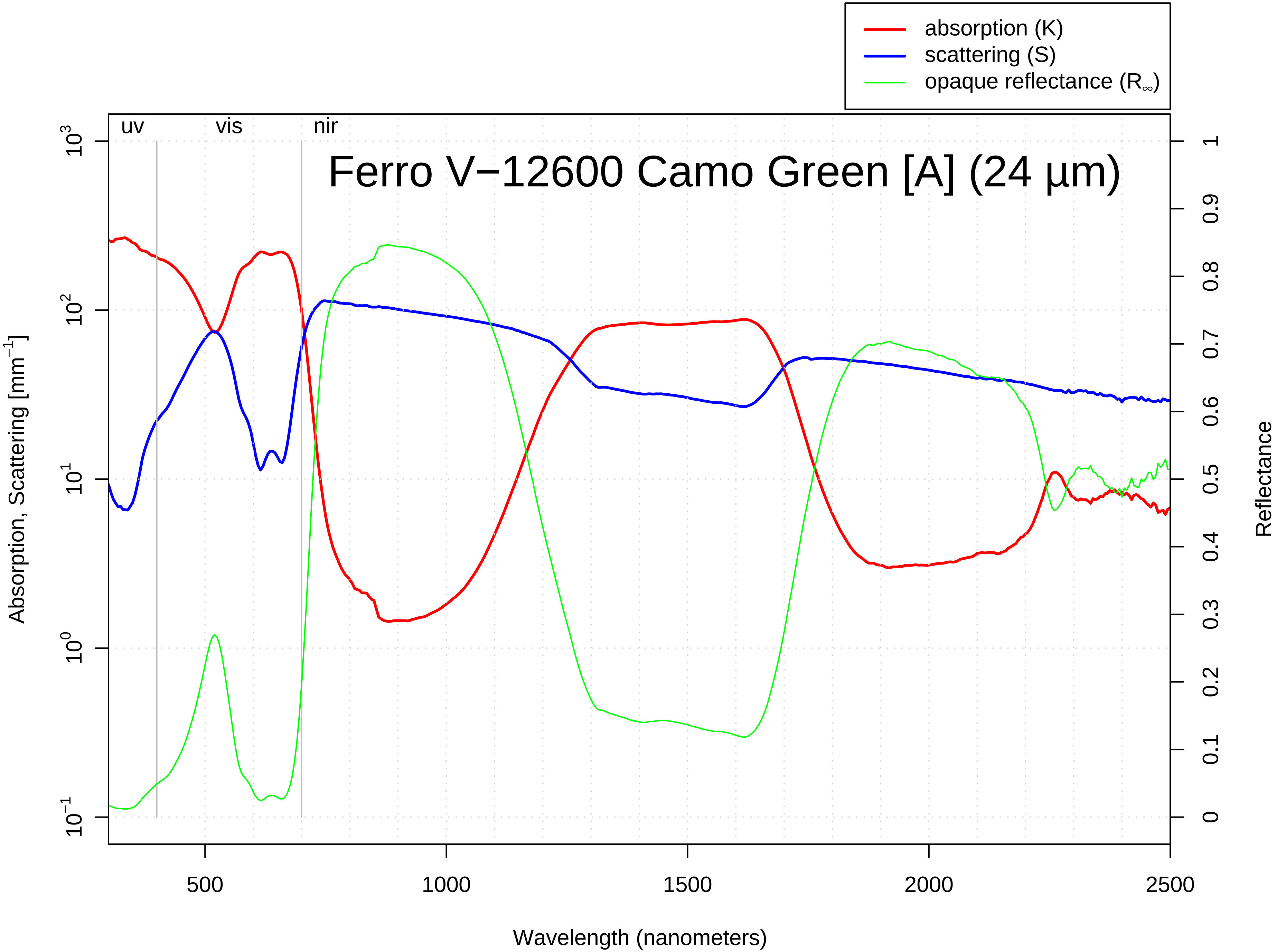
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 12:59 PM



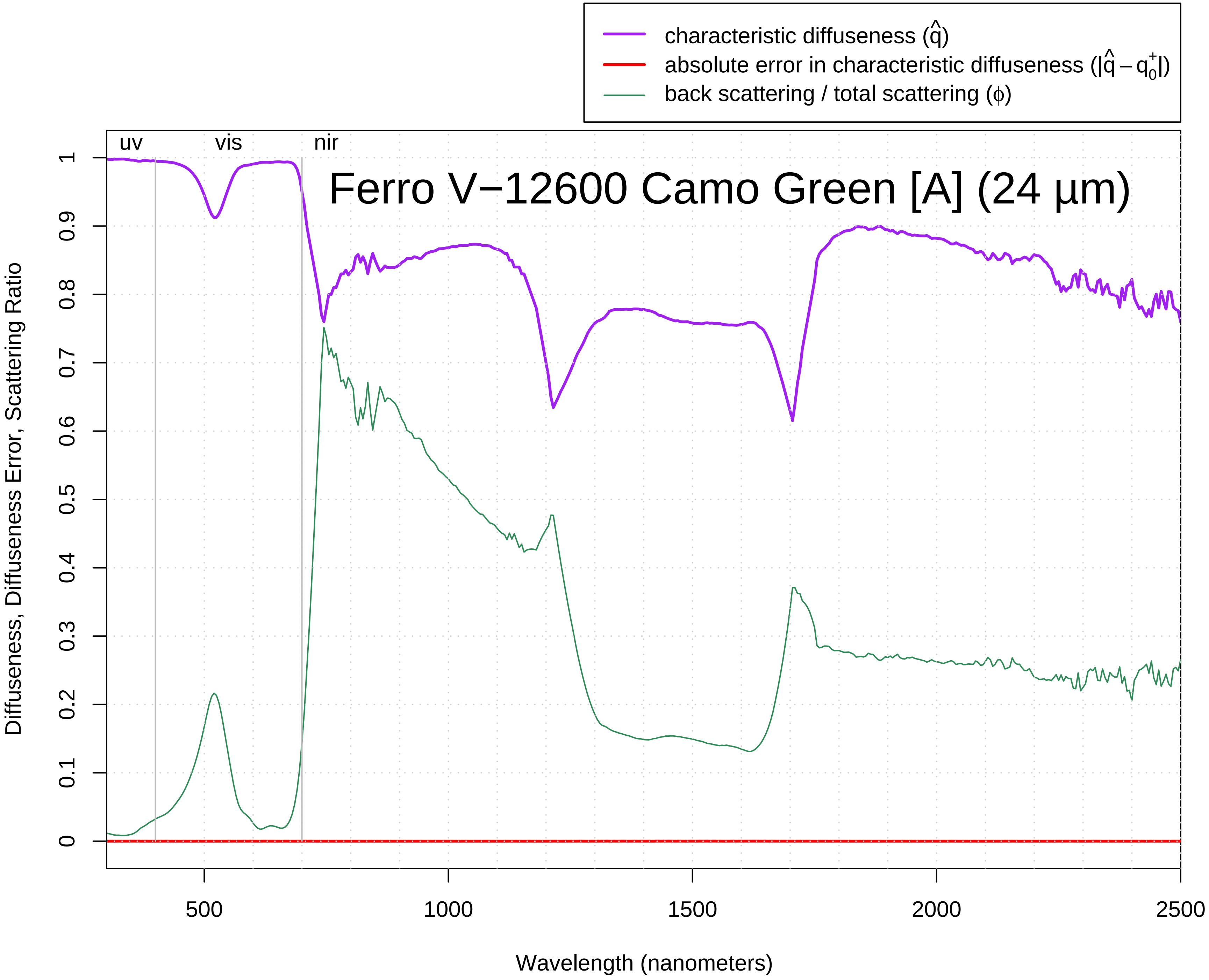
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:01 PM



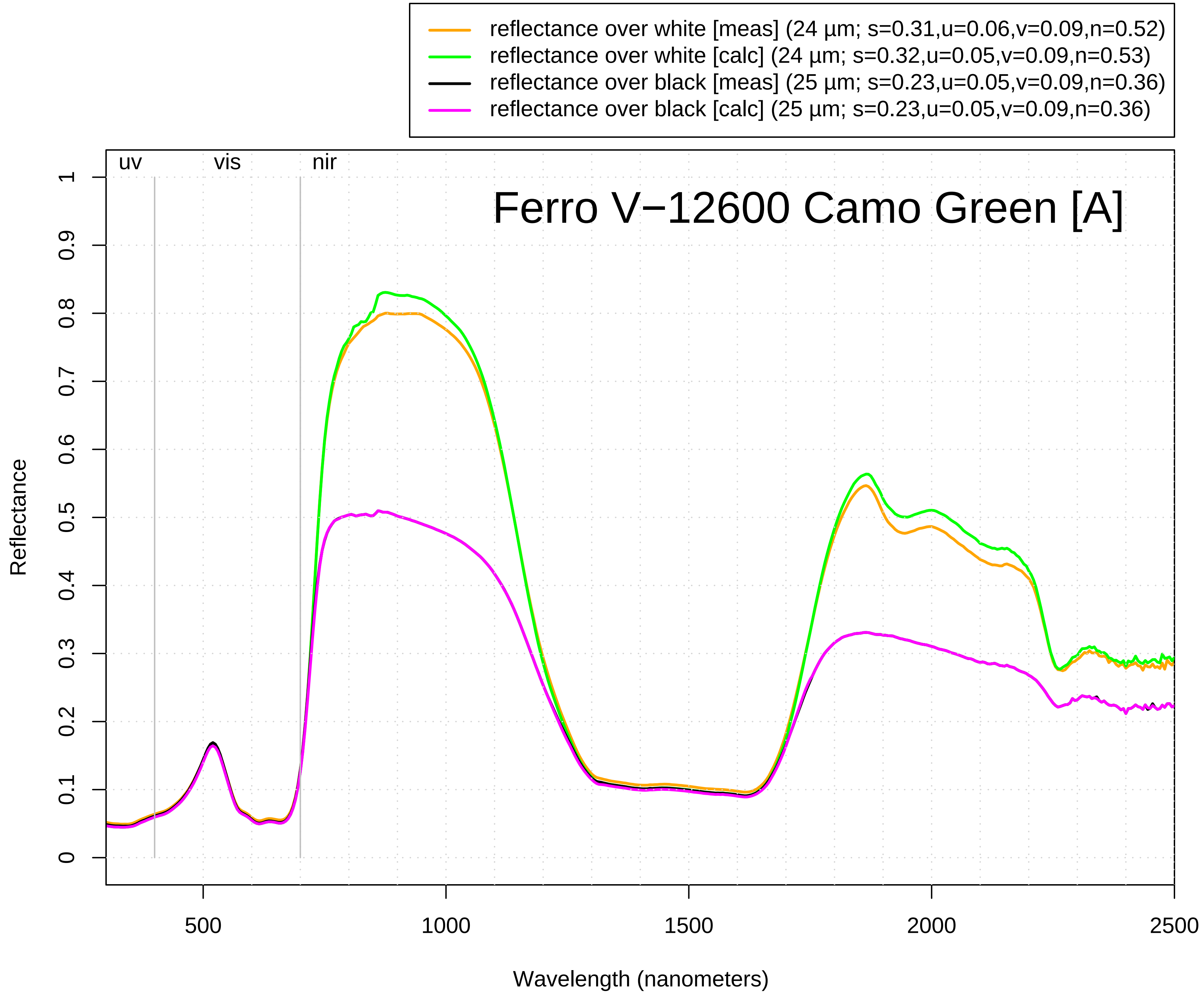
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:01 PM



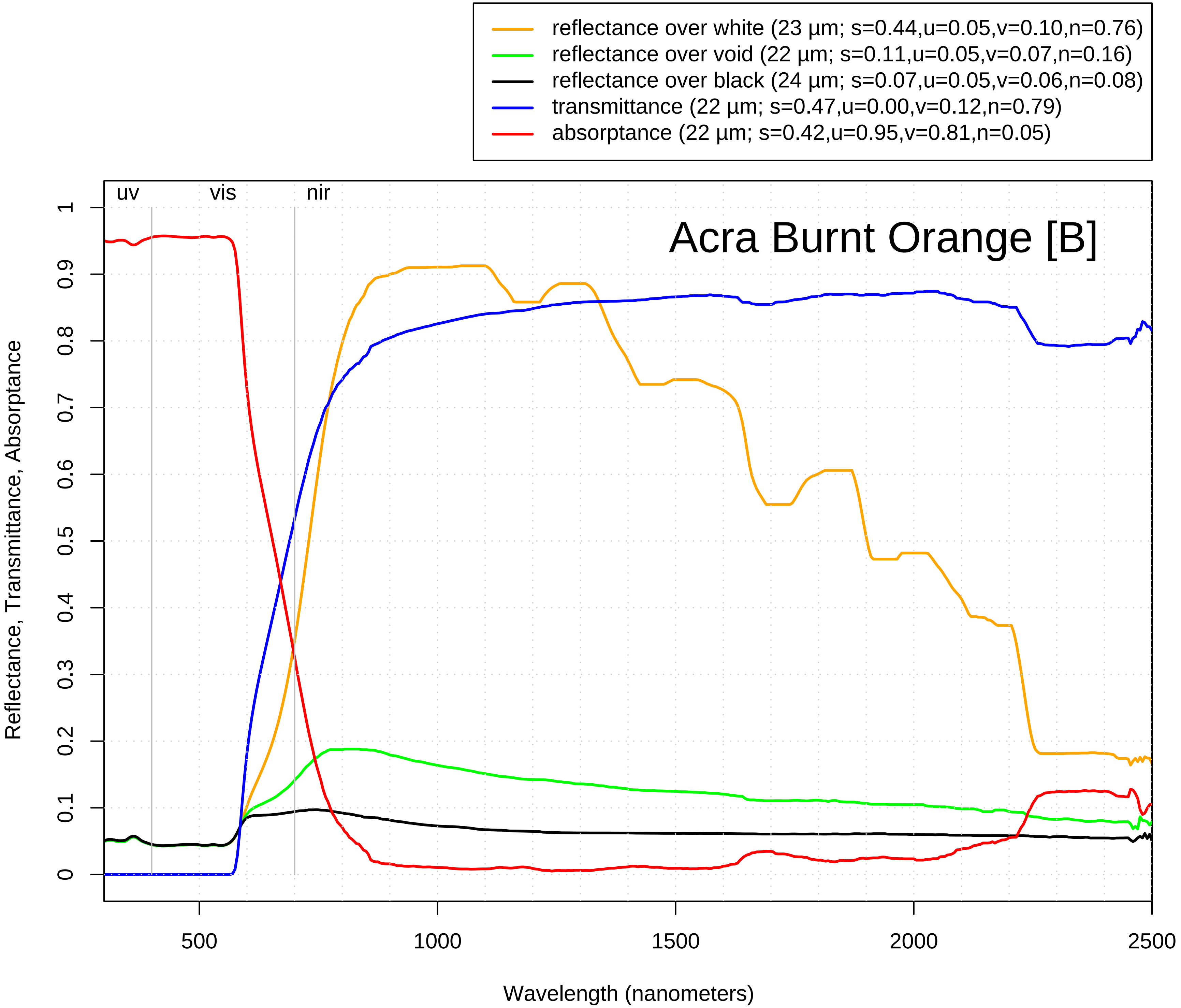
(c) Ancillary Calculations

Sunday, 09 March 2003 01:01 PM



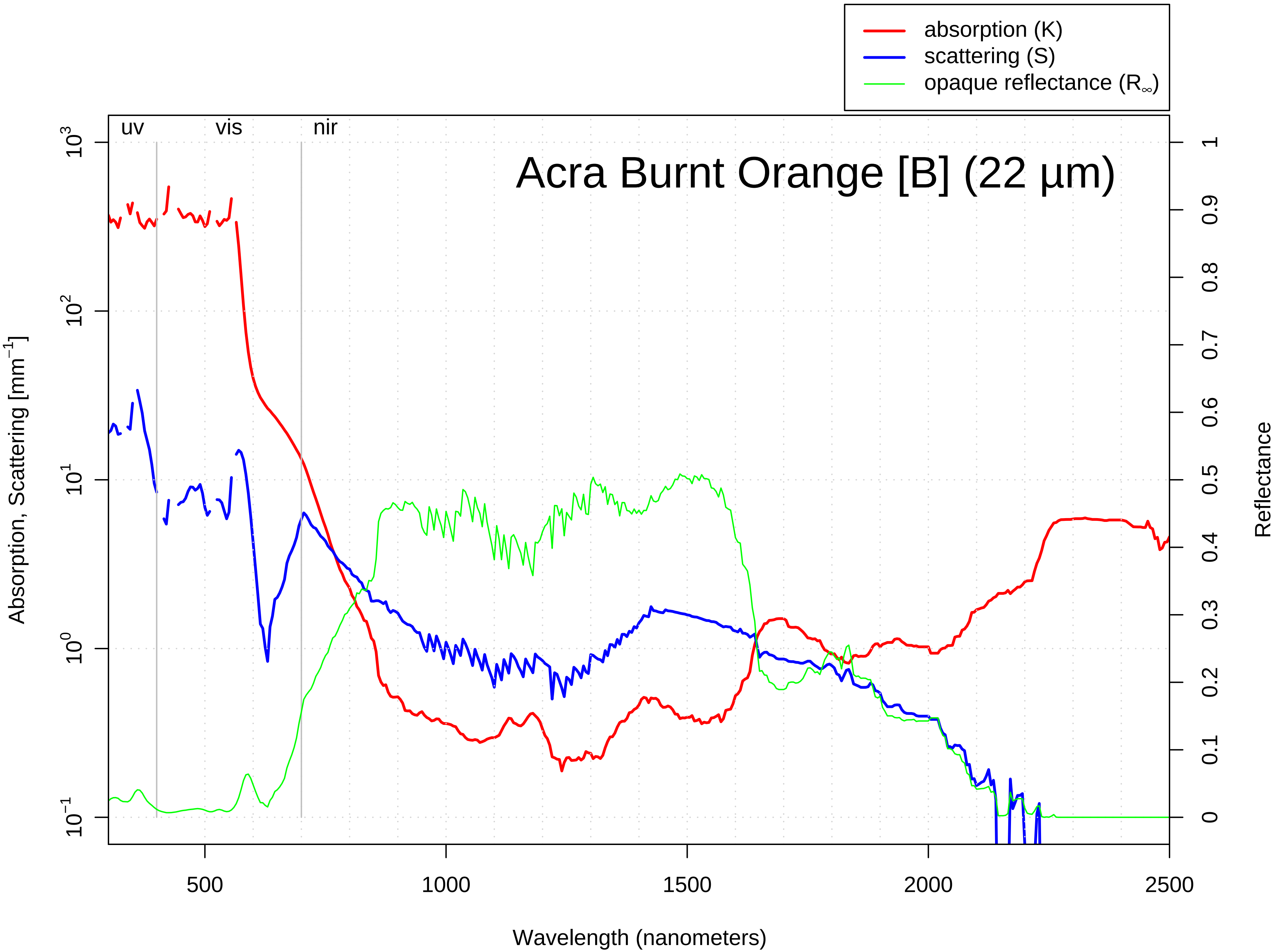
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:01 PM



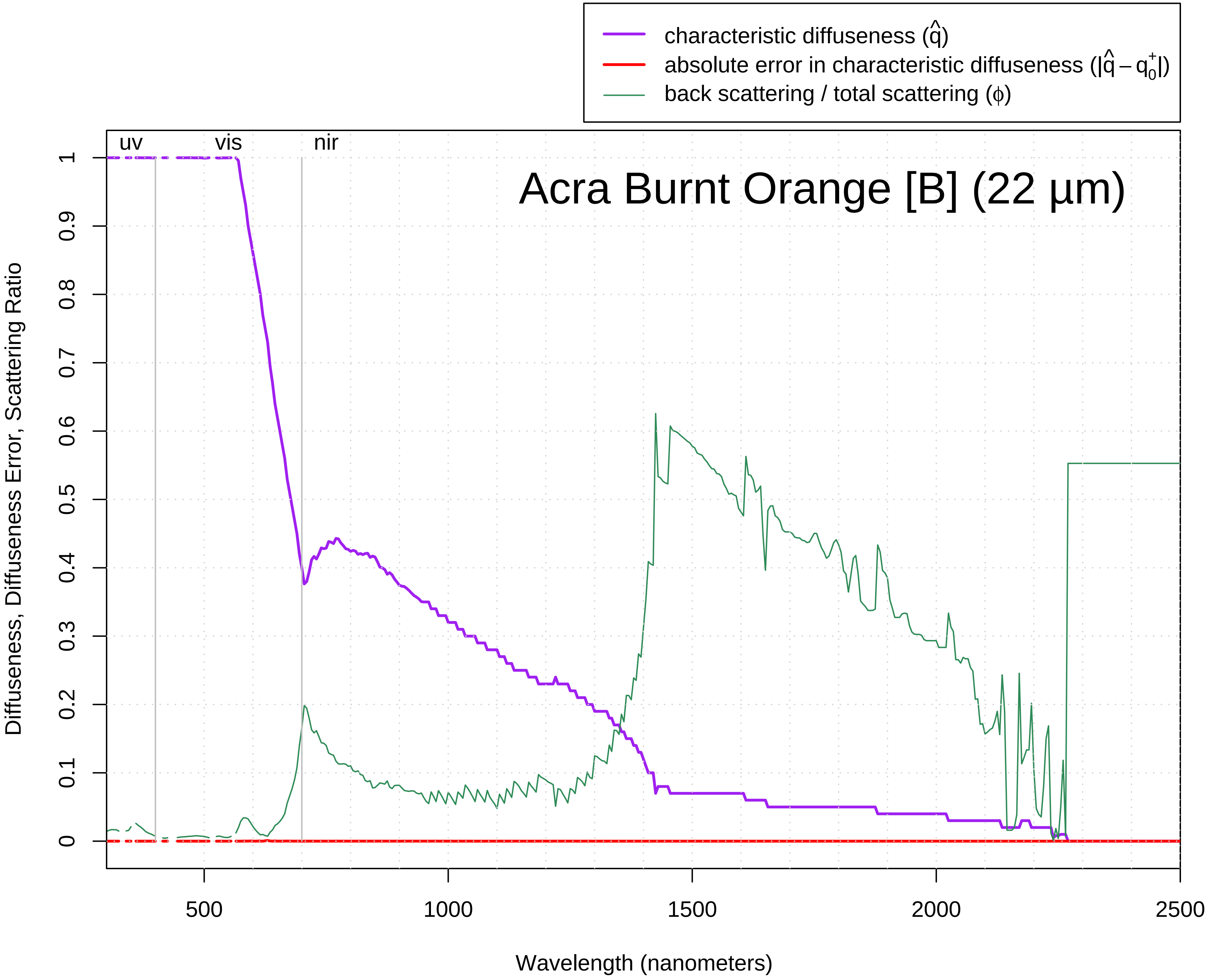
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:04 PM



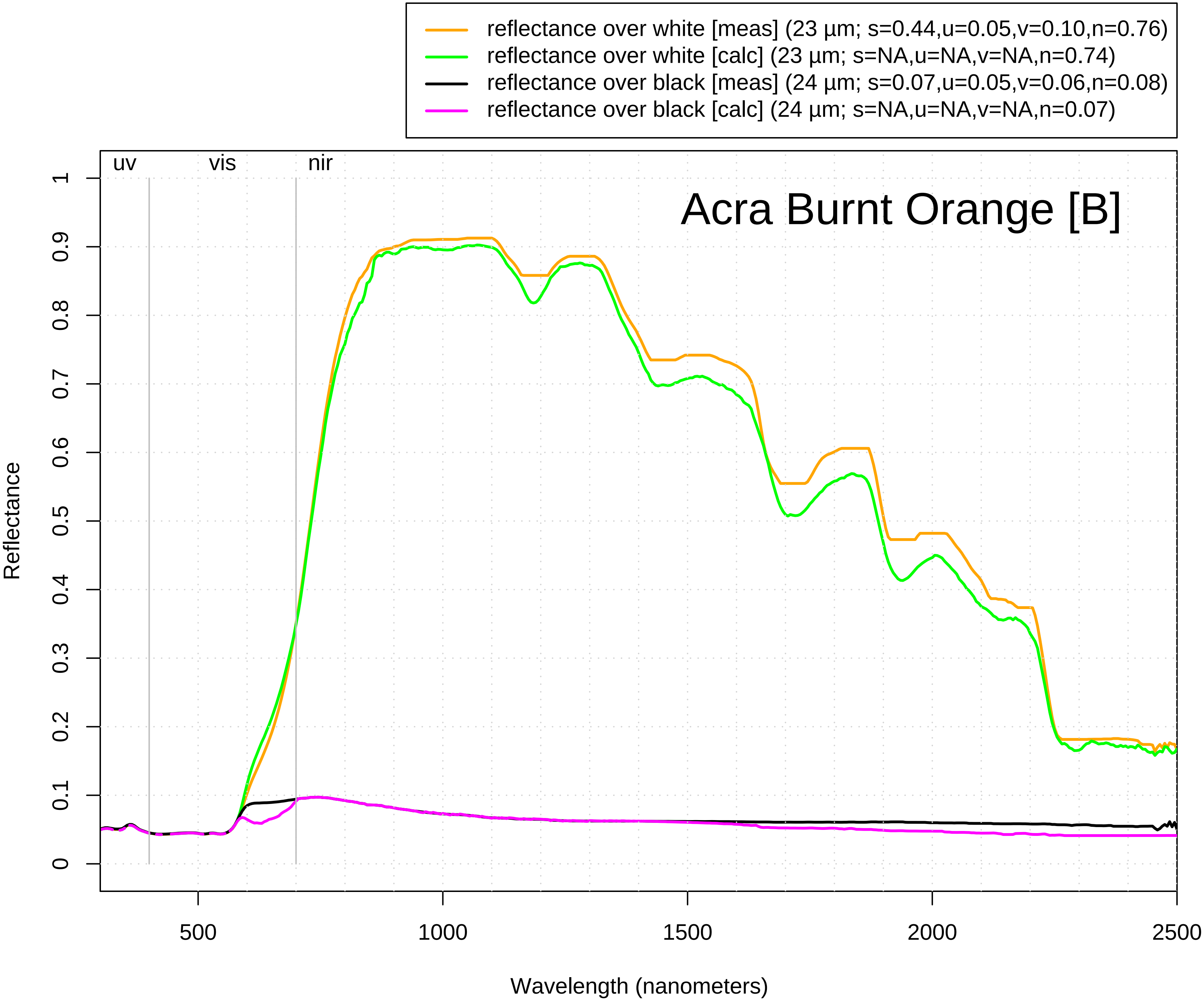
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:04 PM



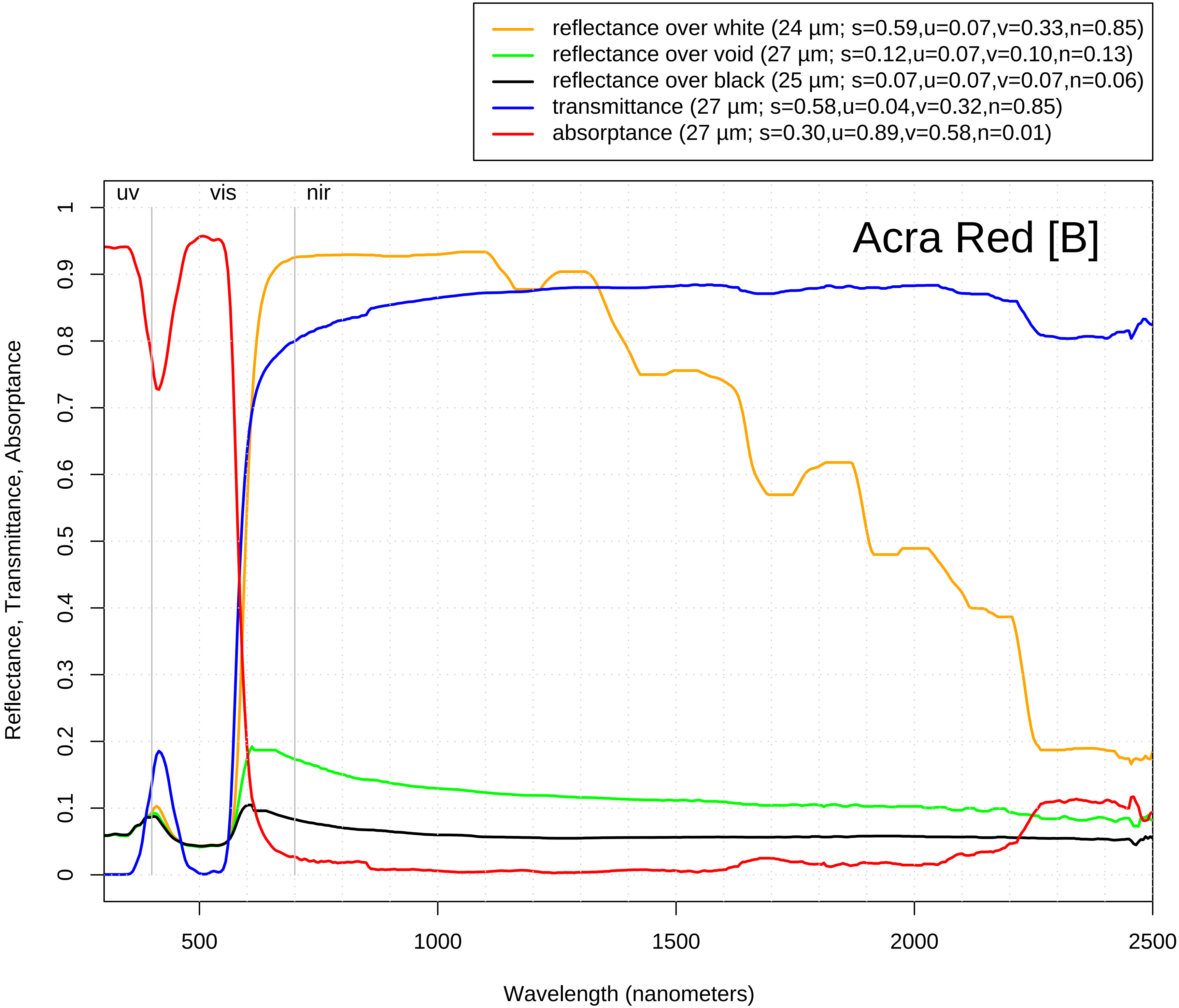
(c) Ancillary Calculations

Sunday, 09 March 2003 01:04 PM



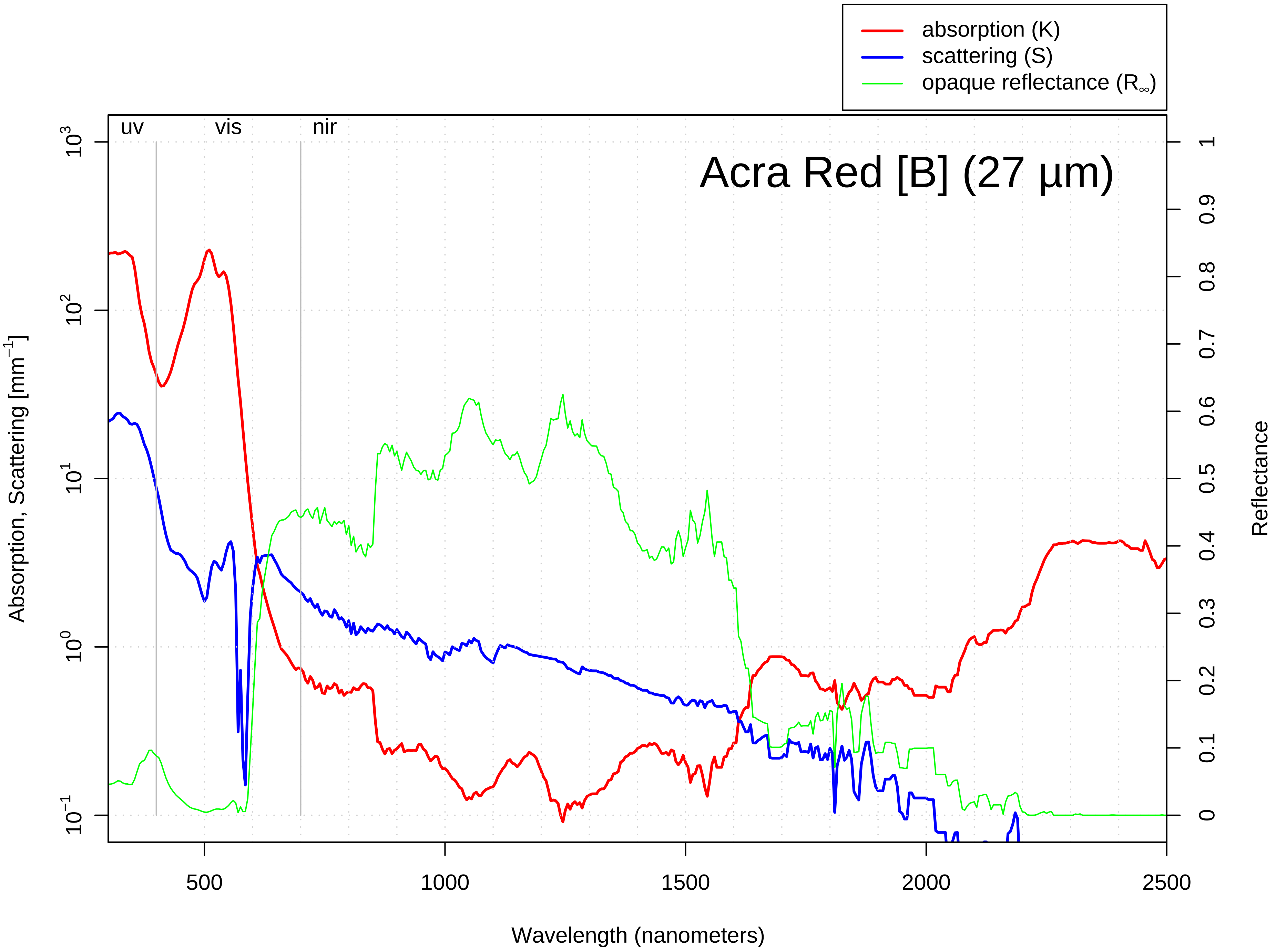
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:04 PM



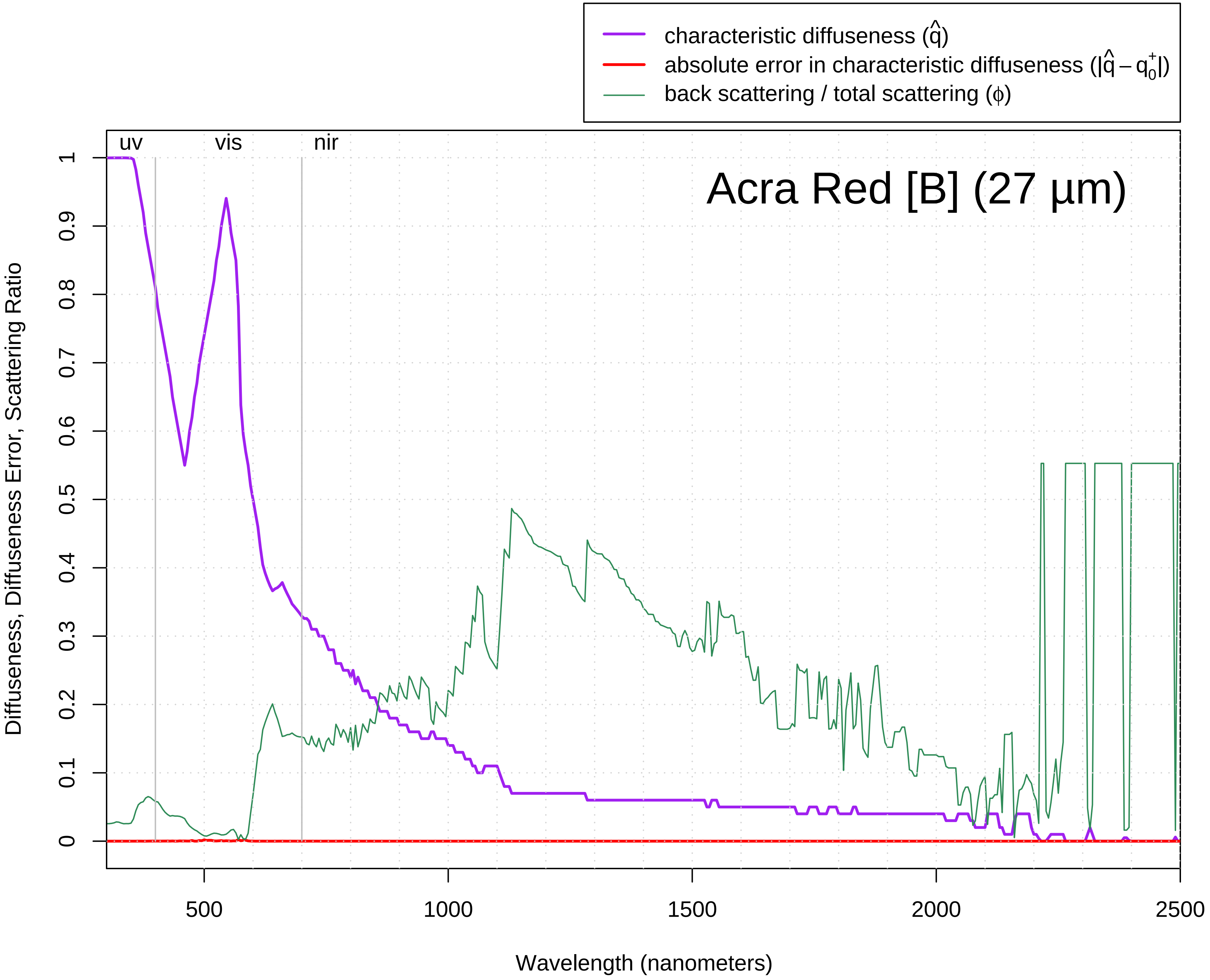
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:12 PM



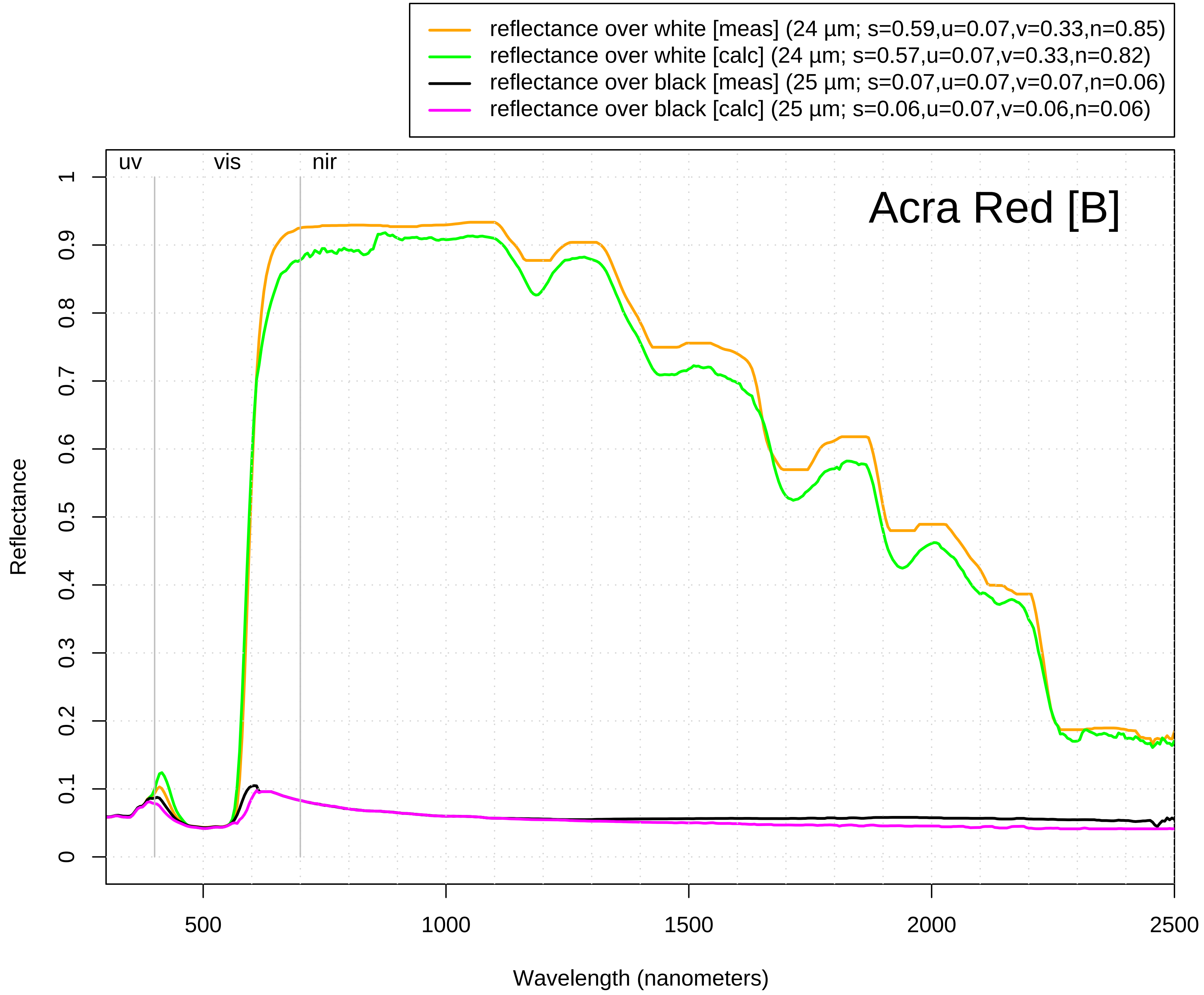
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:12 PM



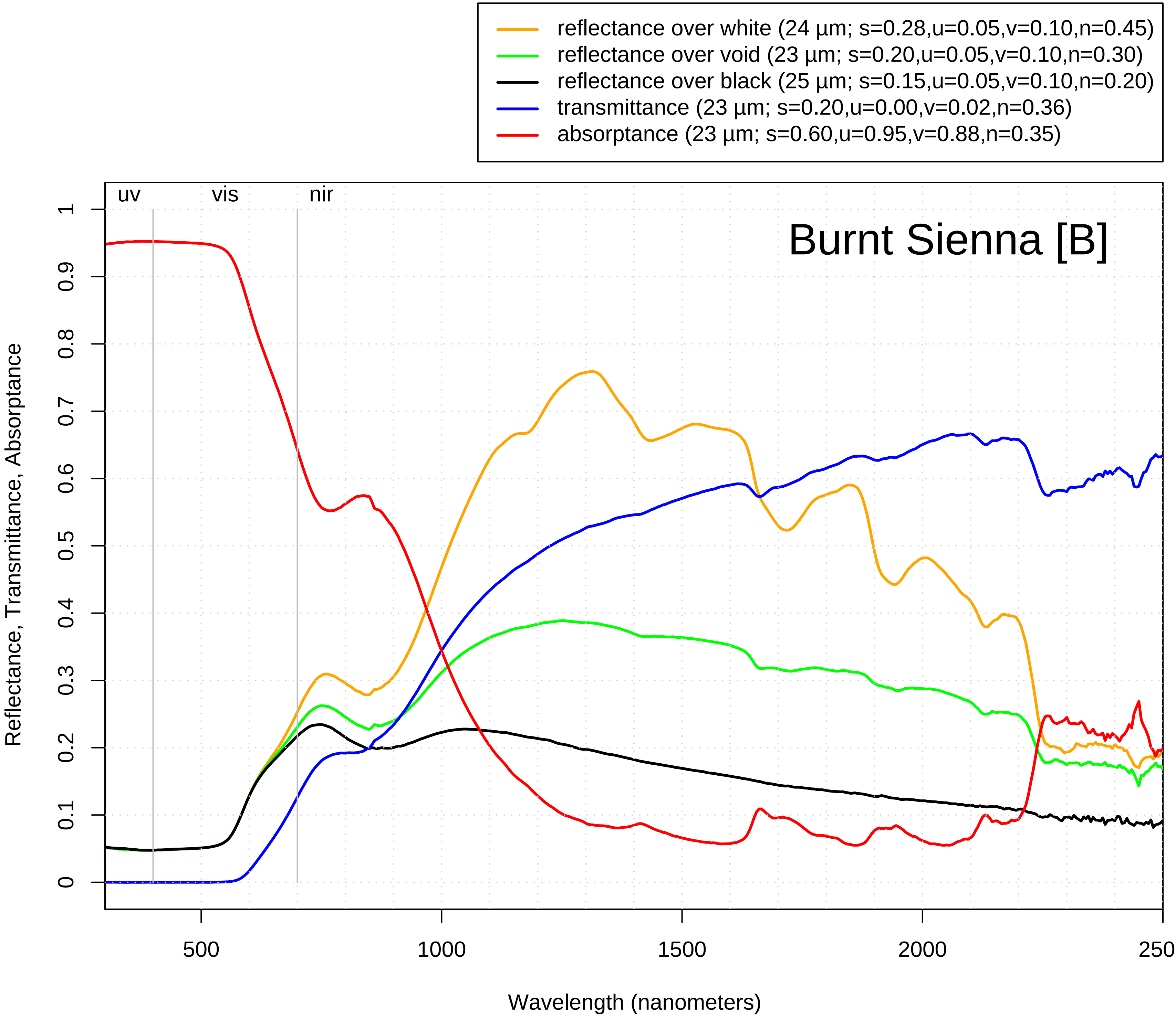
(c) Ancillary Calculations

Sunday, 09 March 2003 01:12 PM



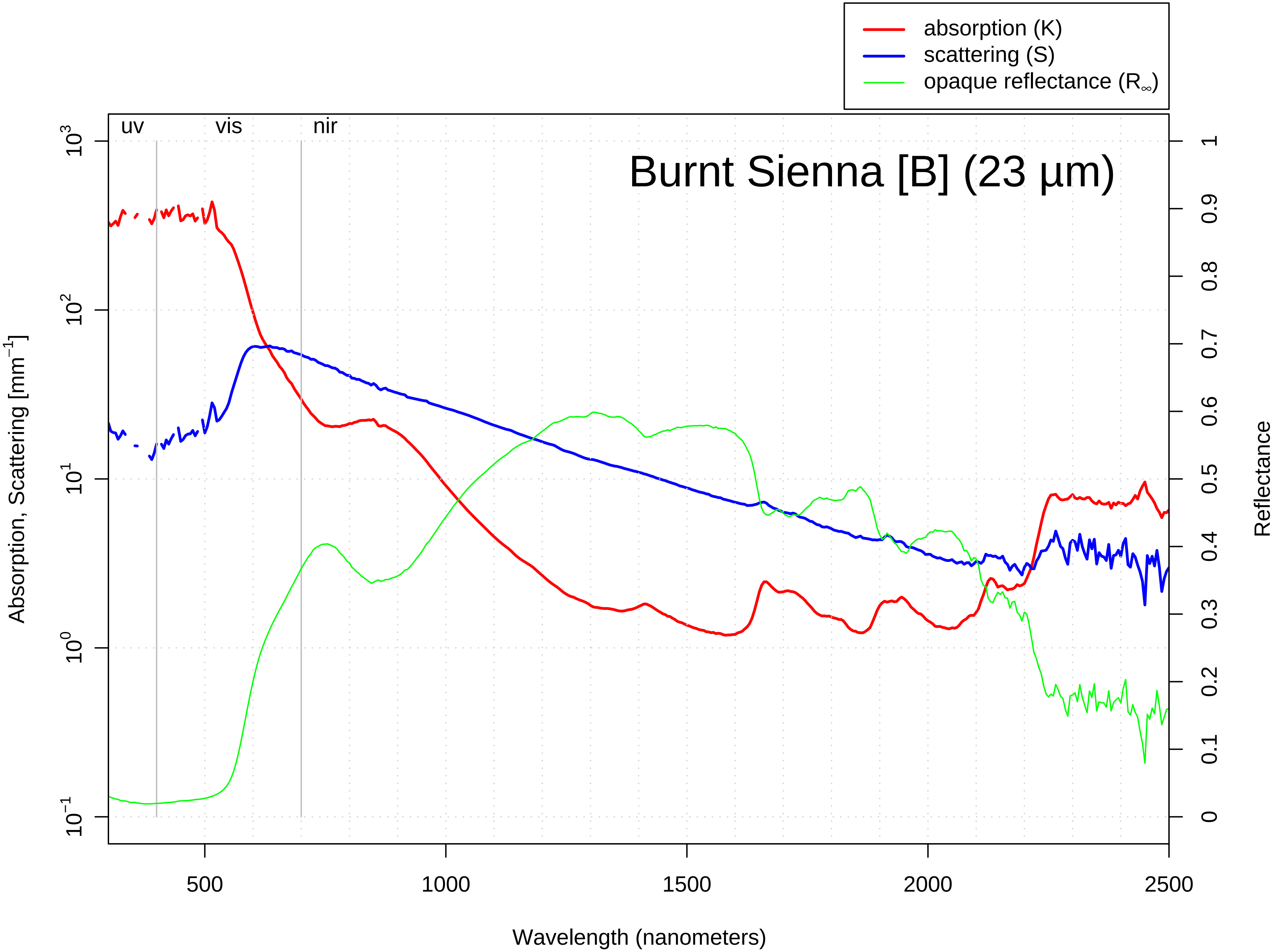
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:12 PM



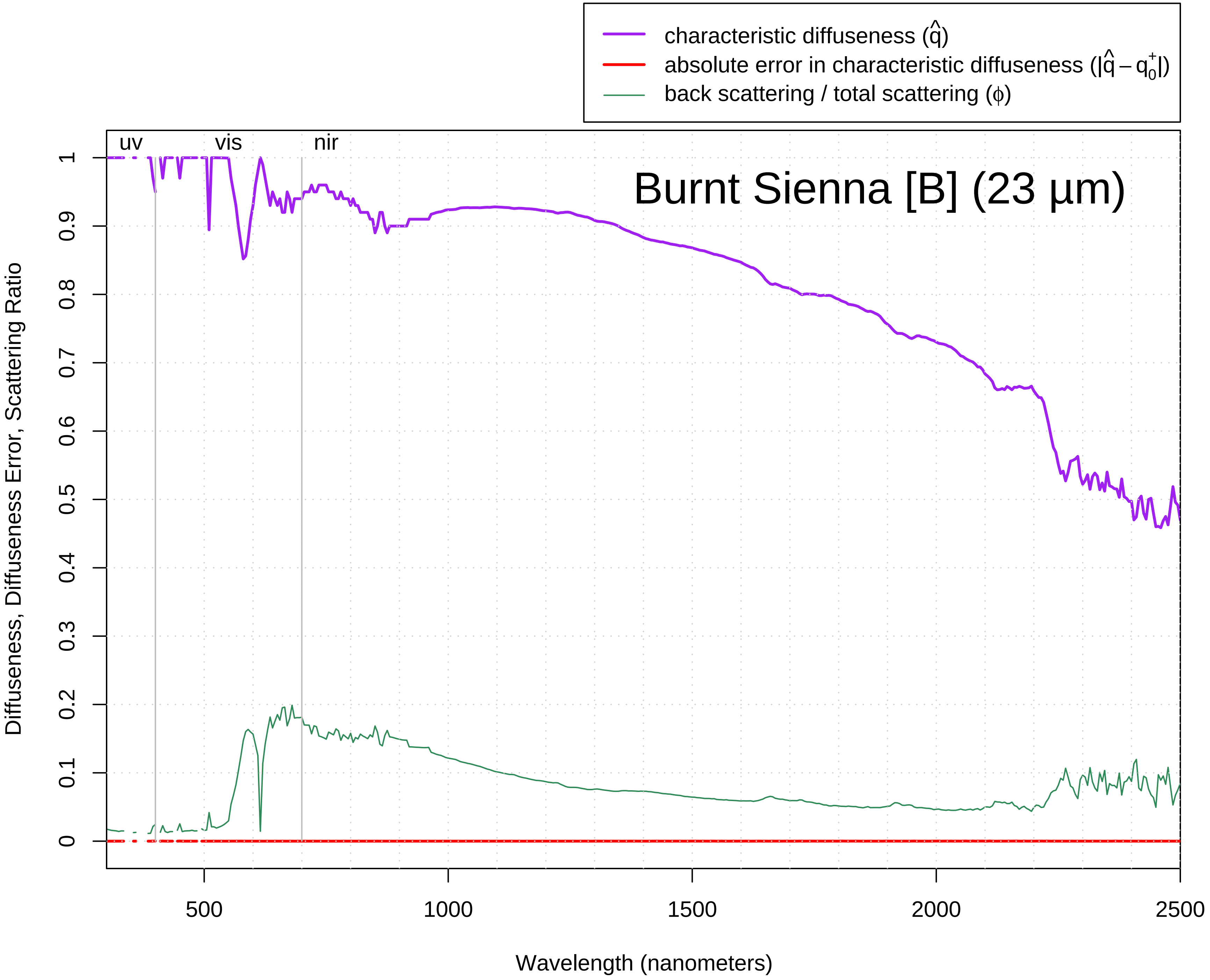
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:15 PM



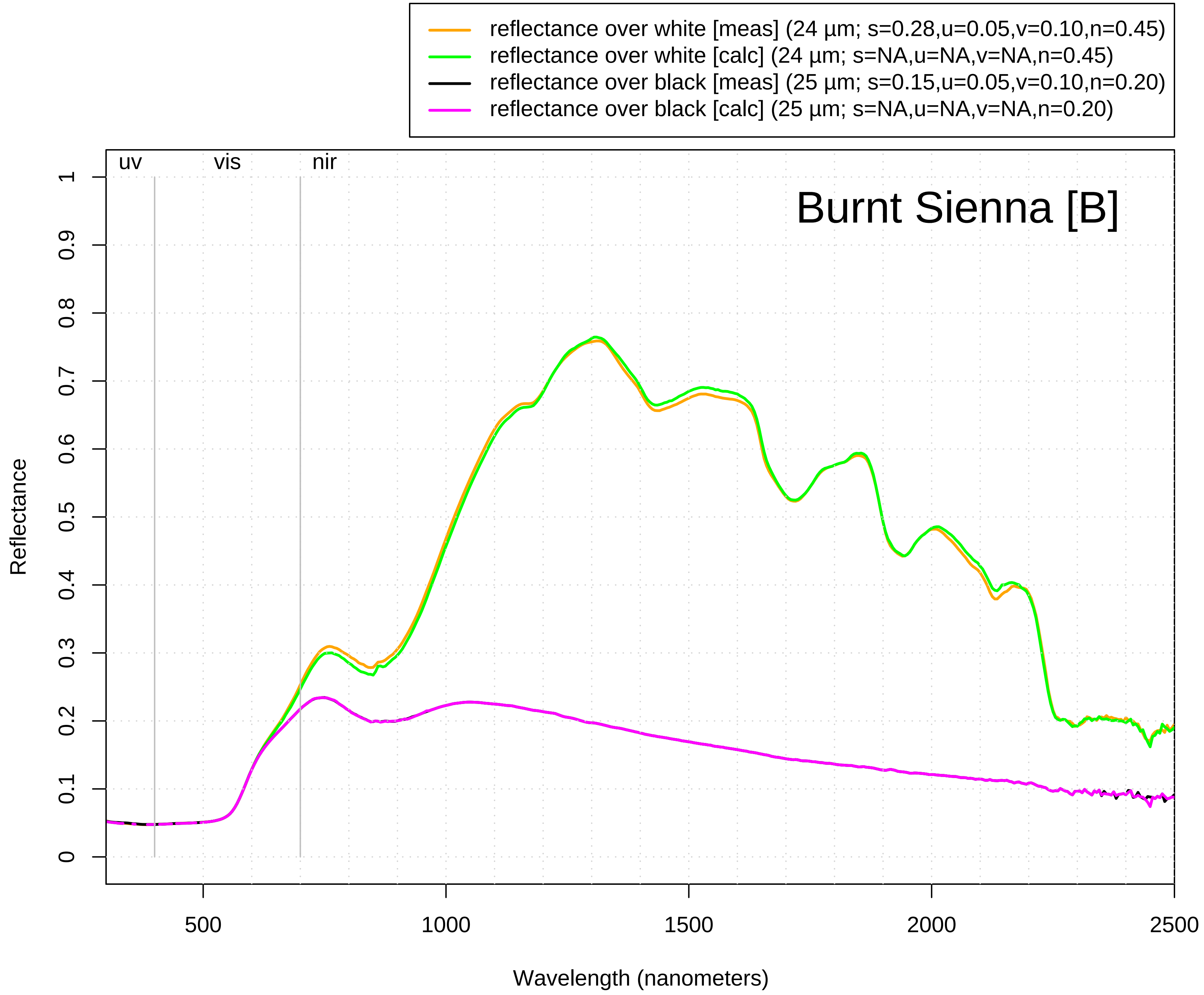
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:15 PM



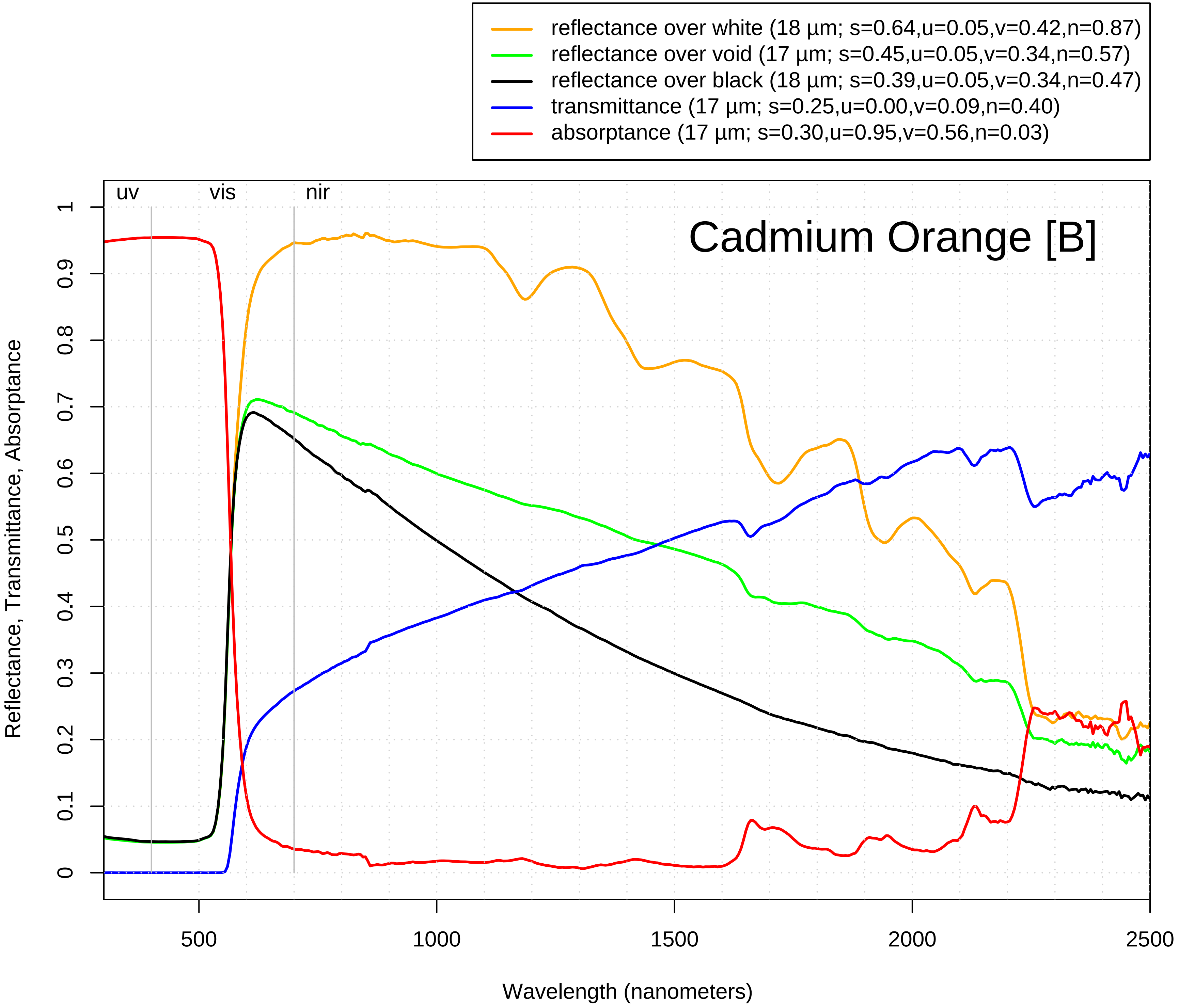
(c) Ancillary Calculations

Sunday, 09 March 2003 01:15 PM



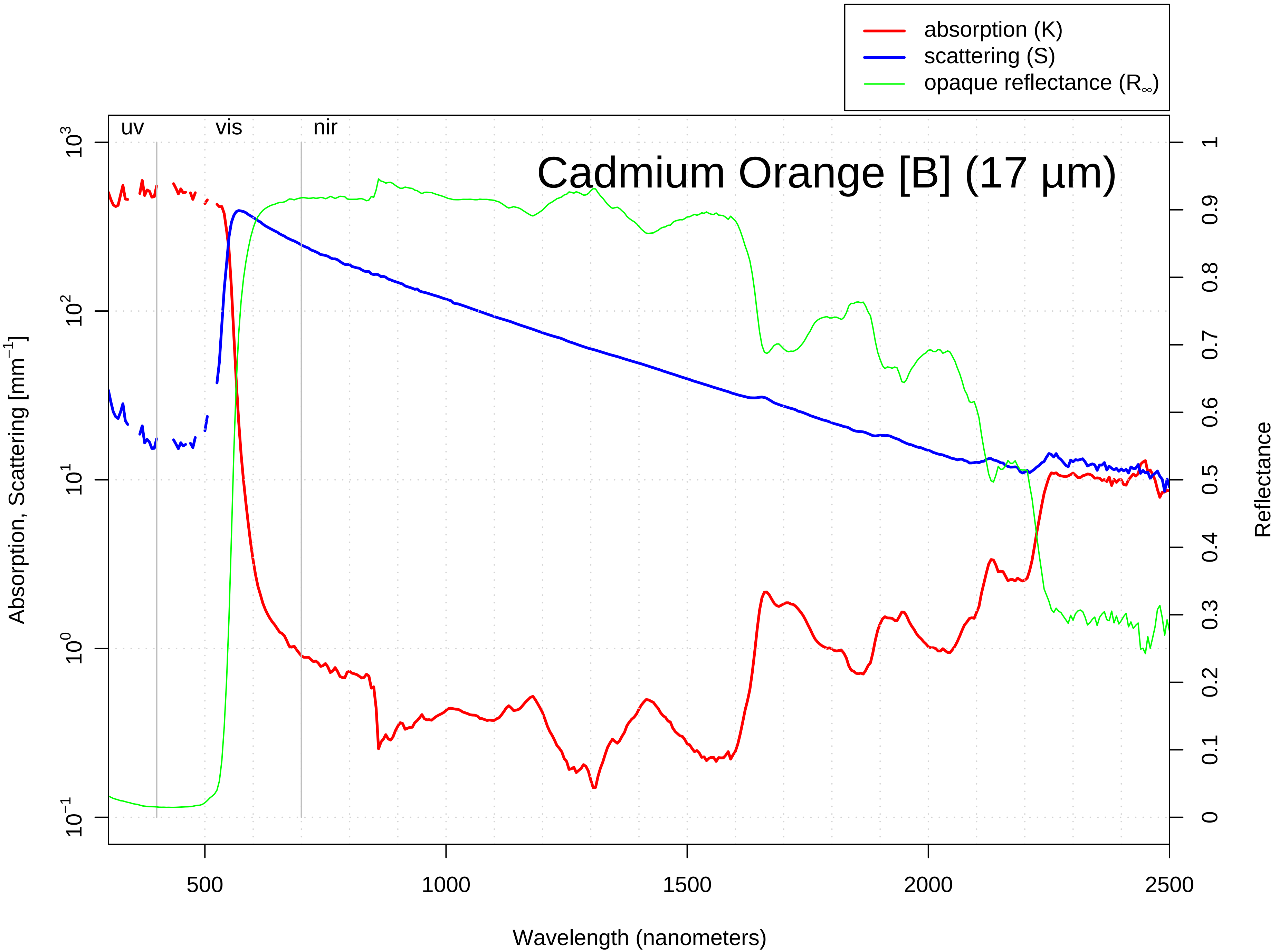
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:15 PM



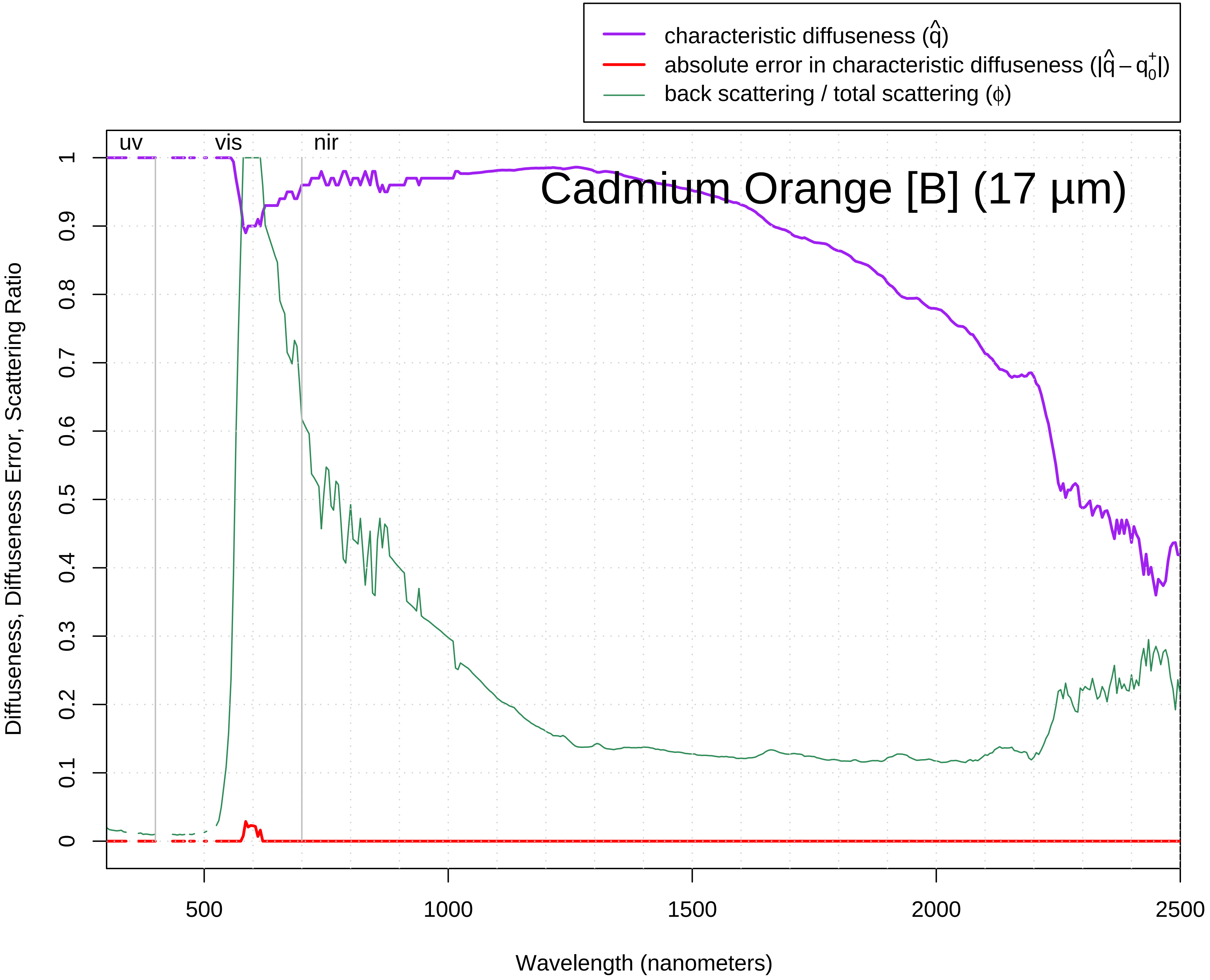
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:18 PM



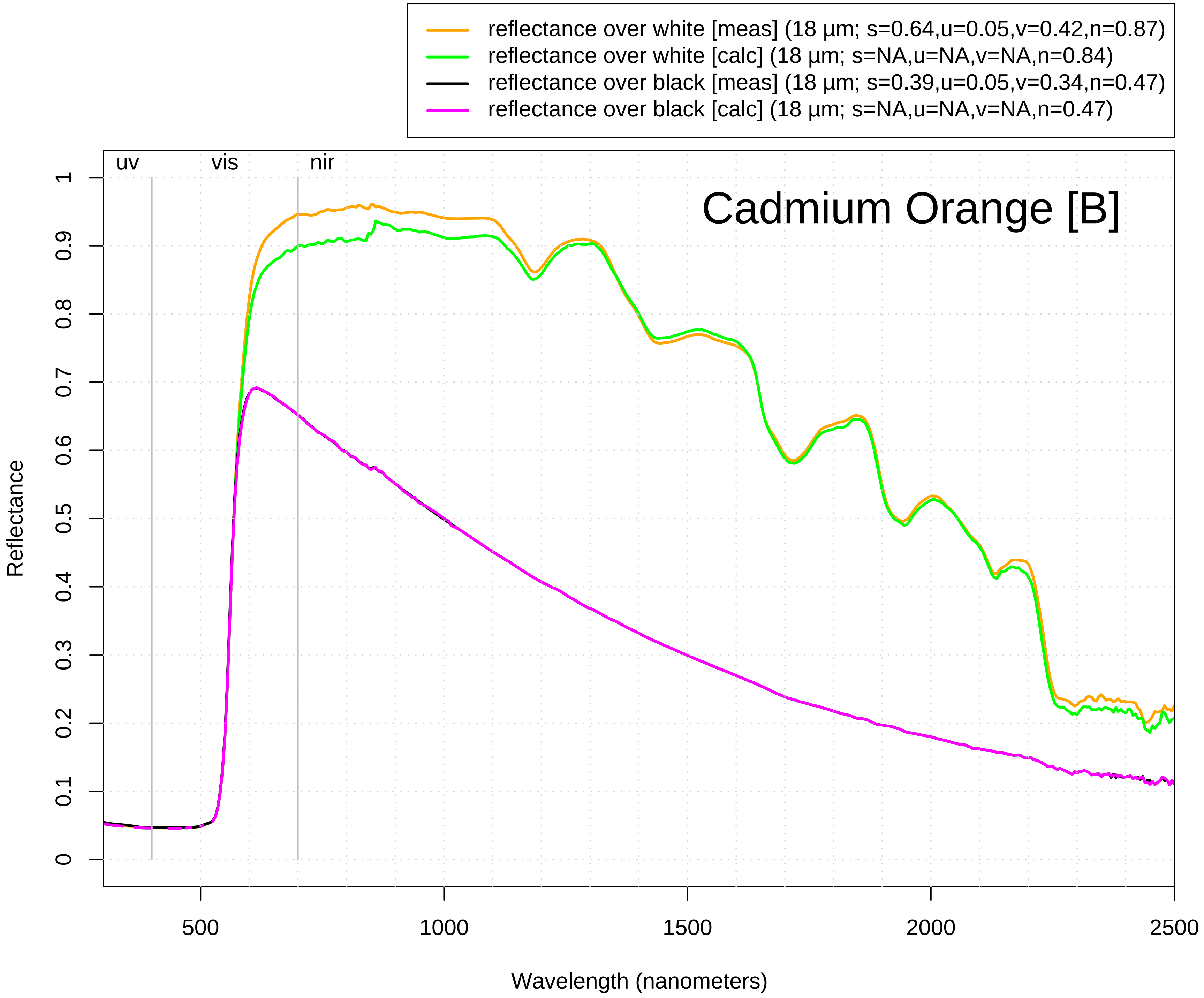
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:18 PM



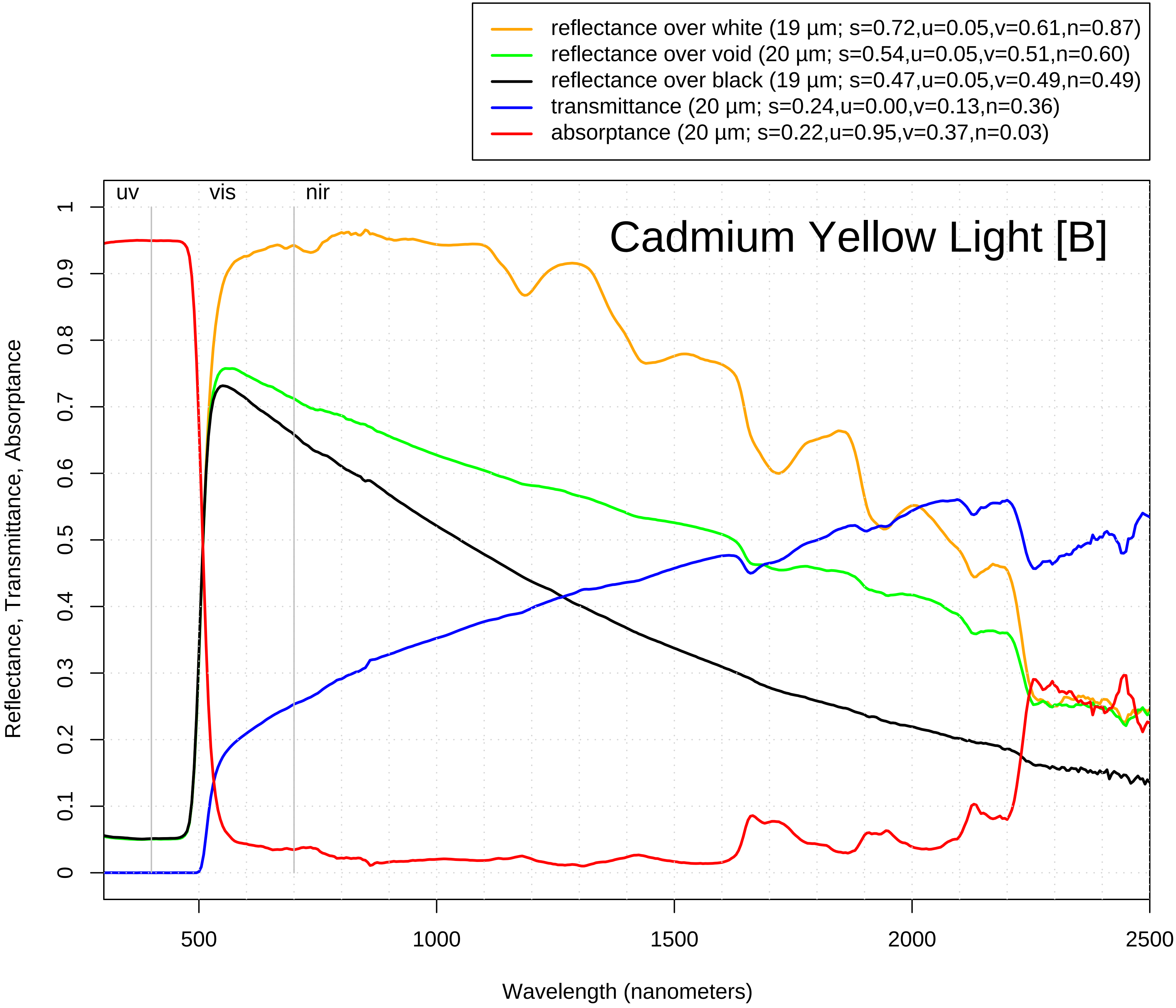
(c) Ancillary Calculations

Sunday, 09 March 2003 01:18 PM



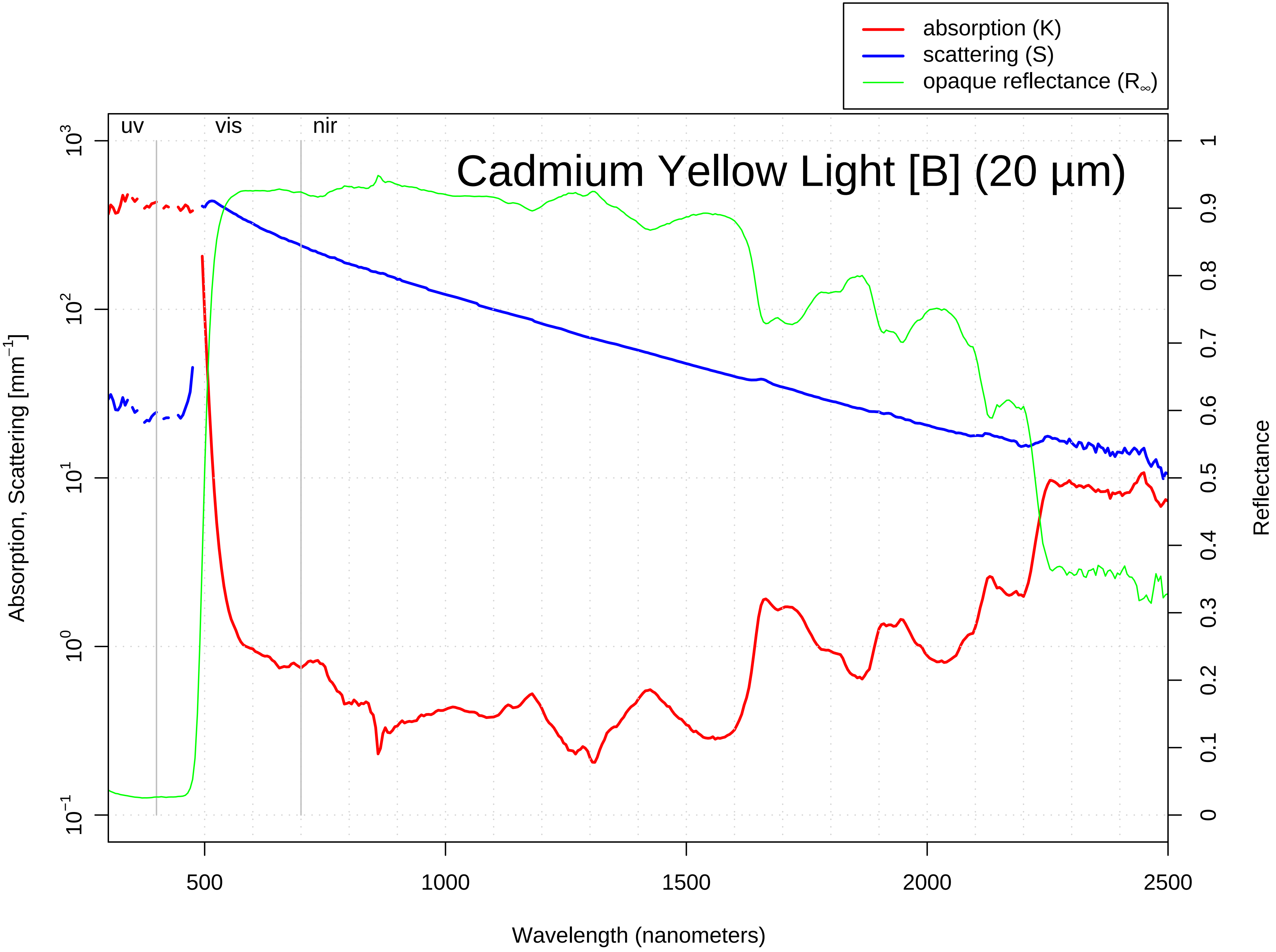
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:18 PM



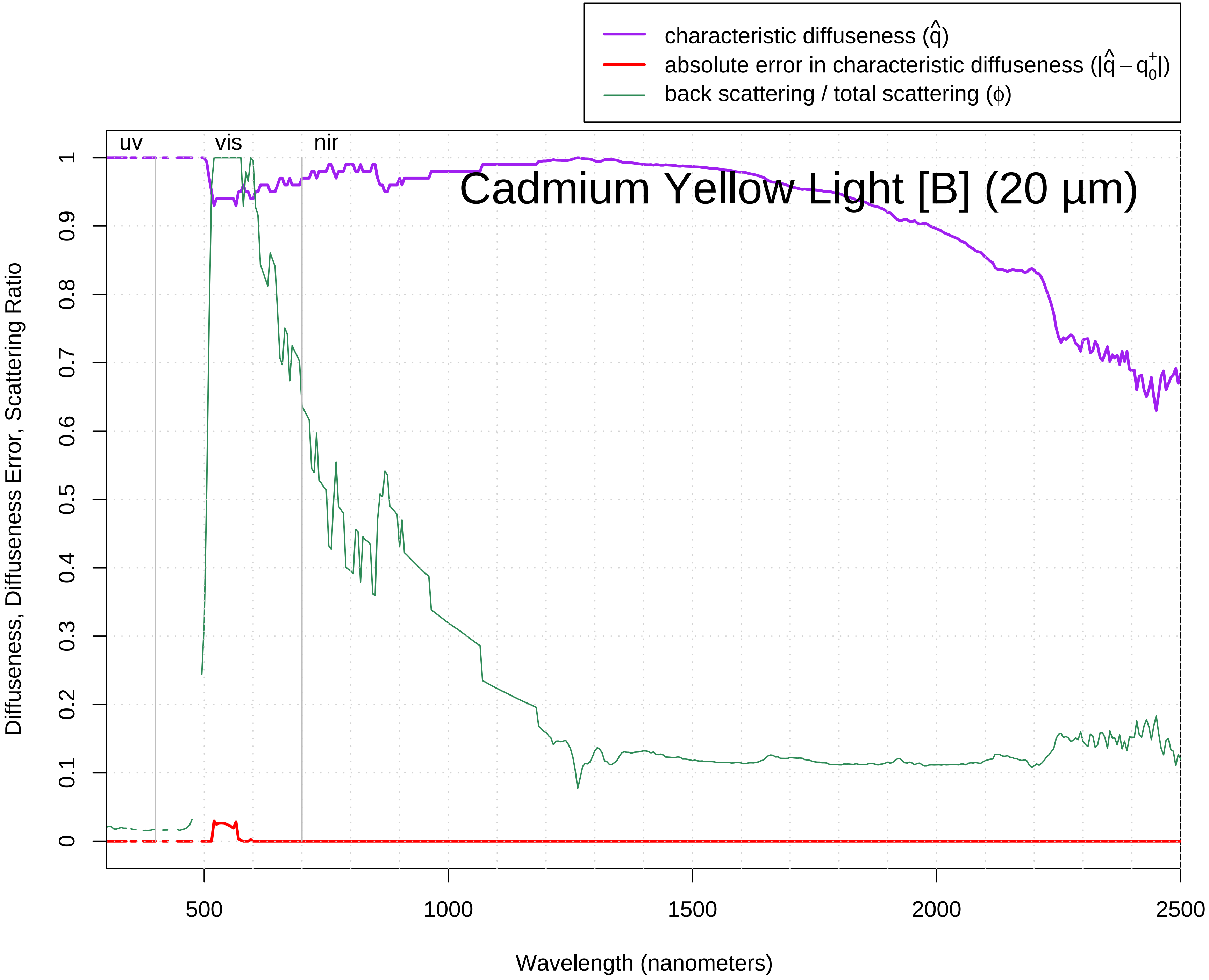
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:21 PM



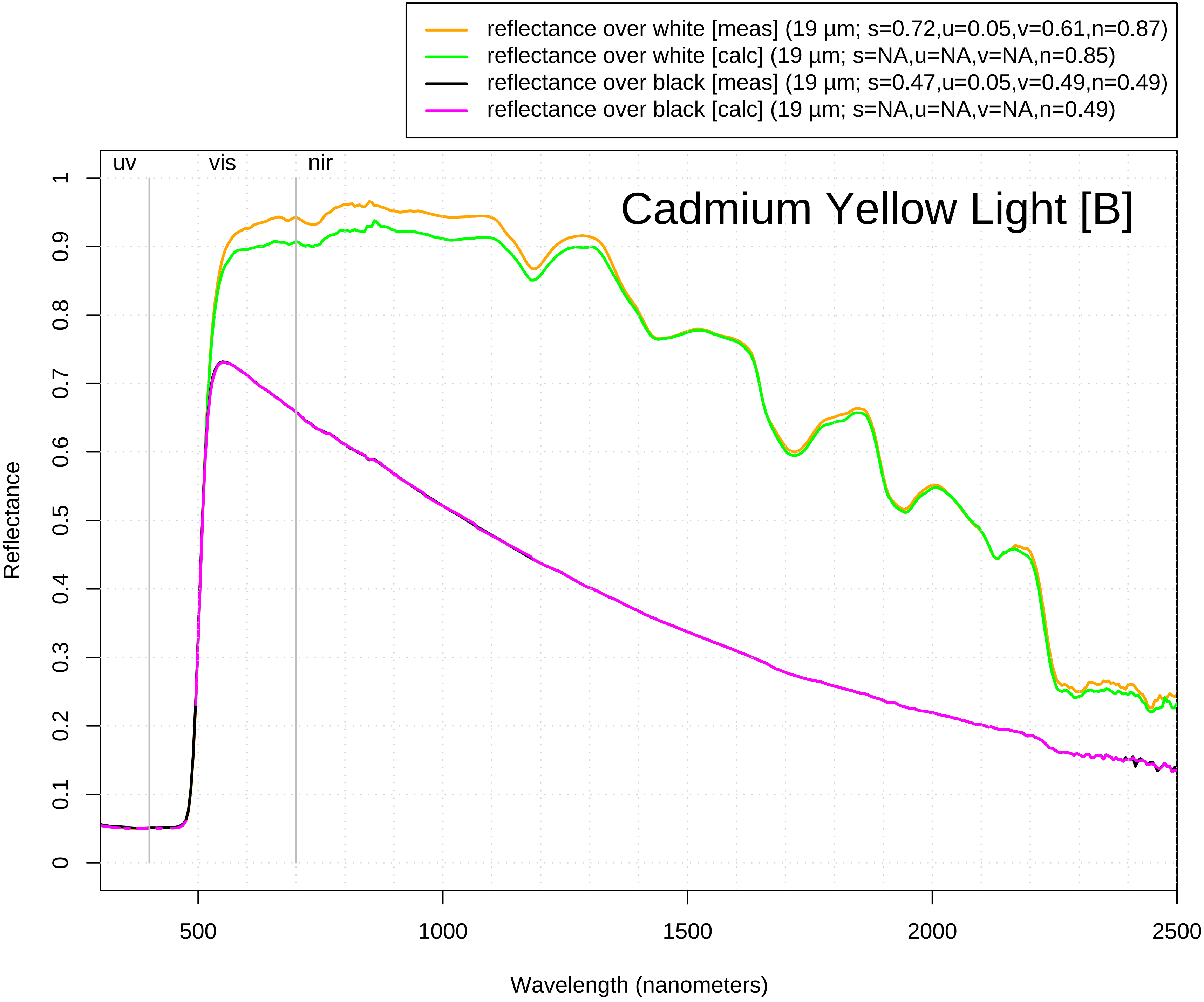
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:21 PM



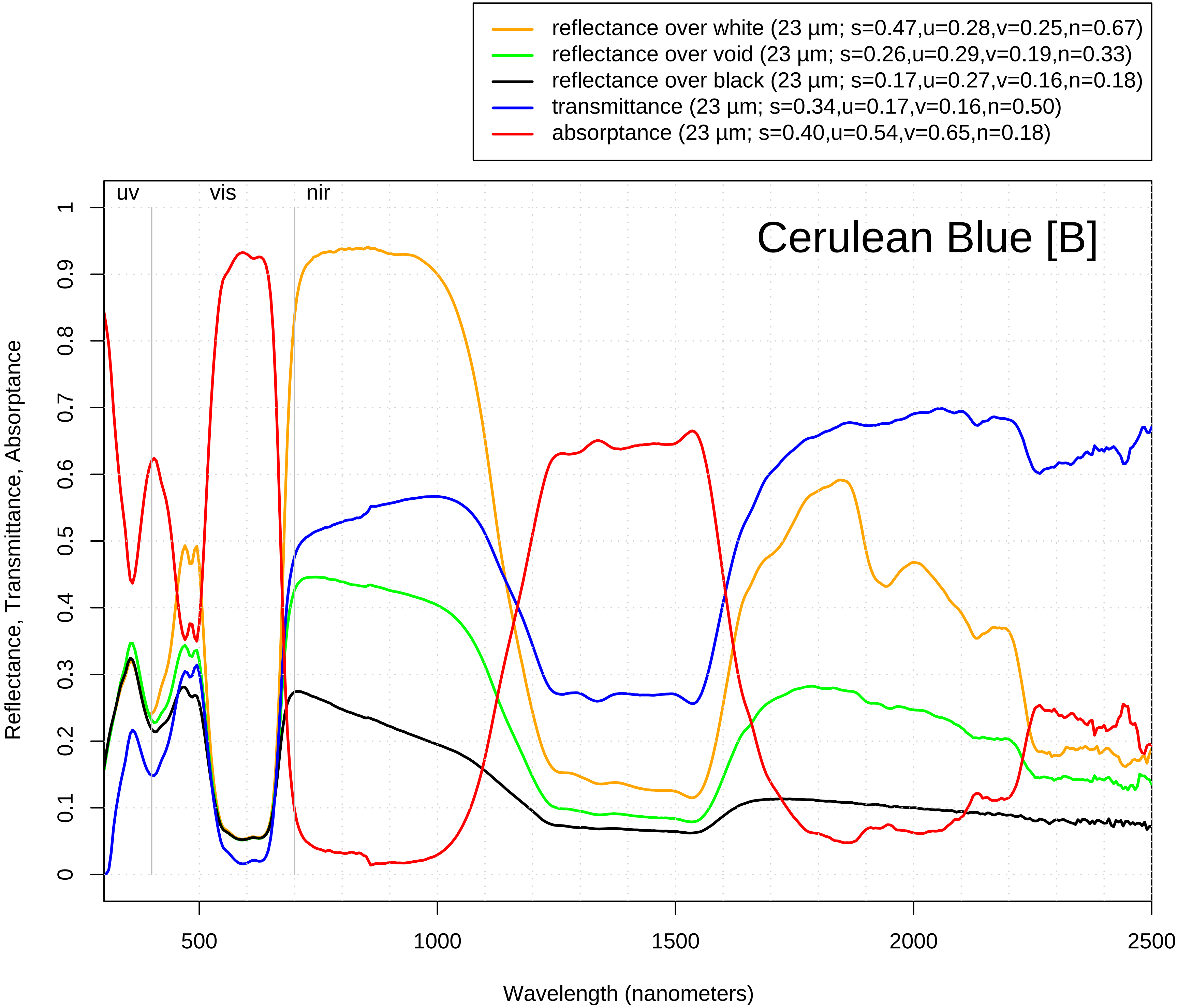
(c) Ancillary Calculations

Sunday, 09 March 2003 01:21 PM



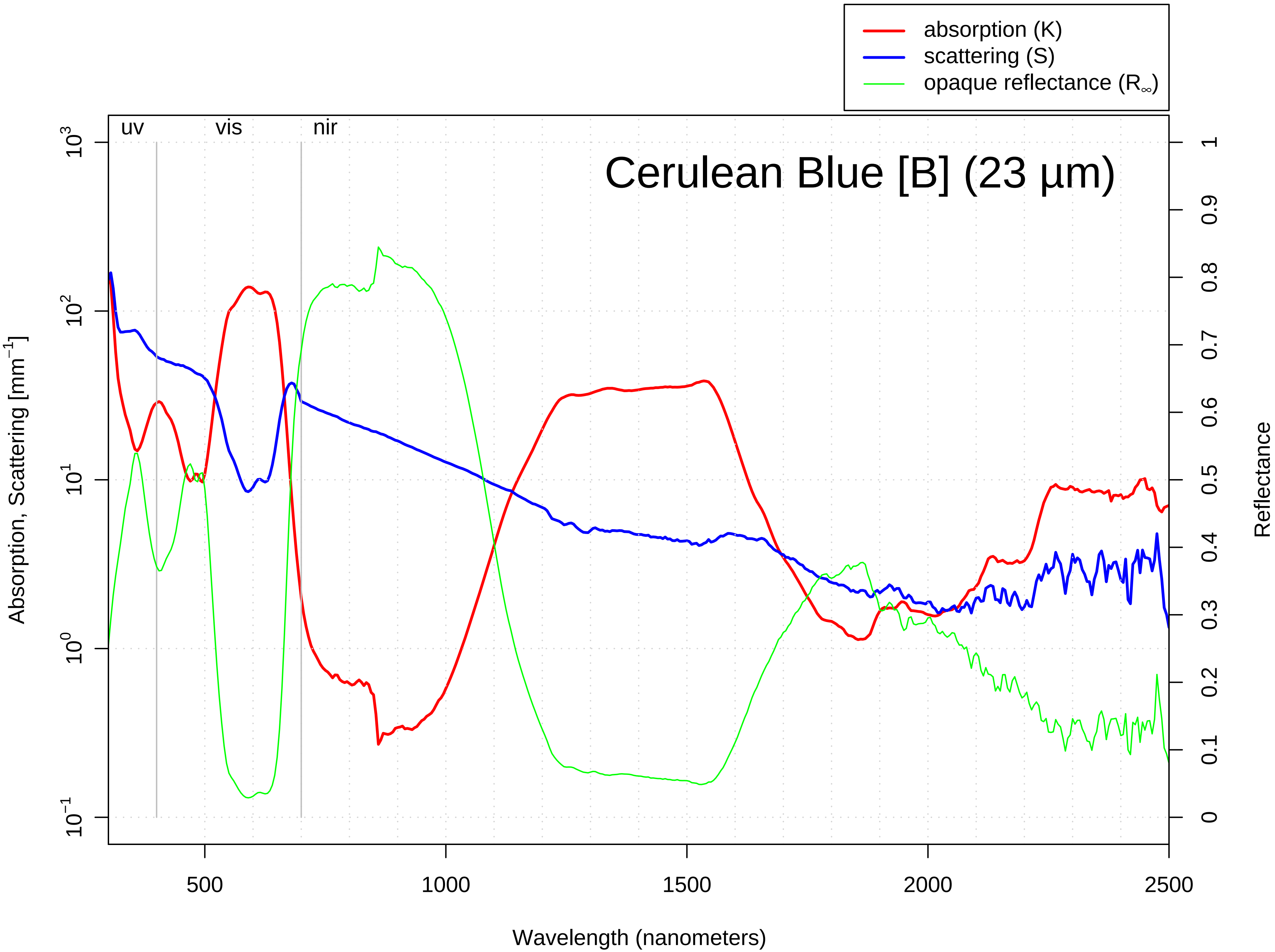
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:21 PM



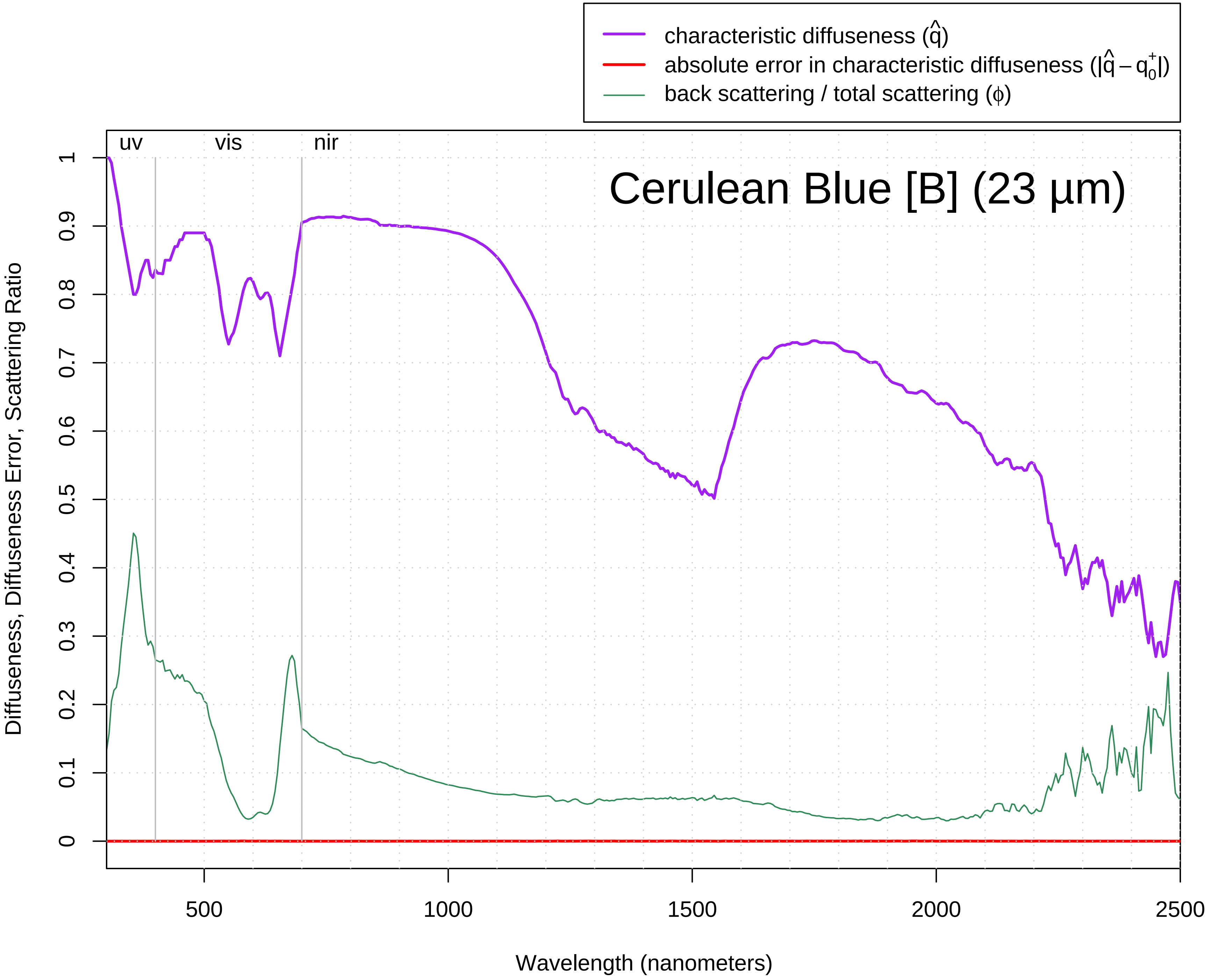
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:23 PM



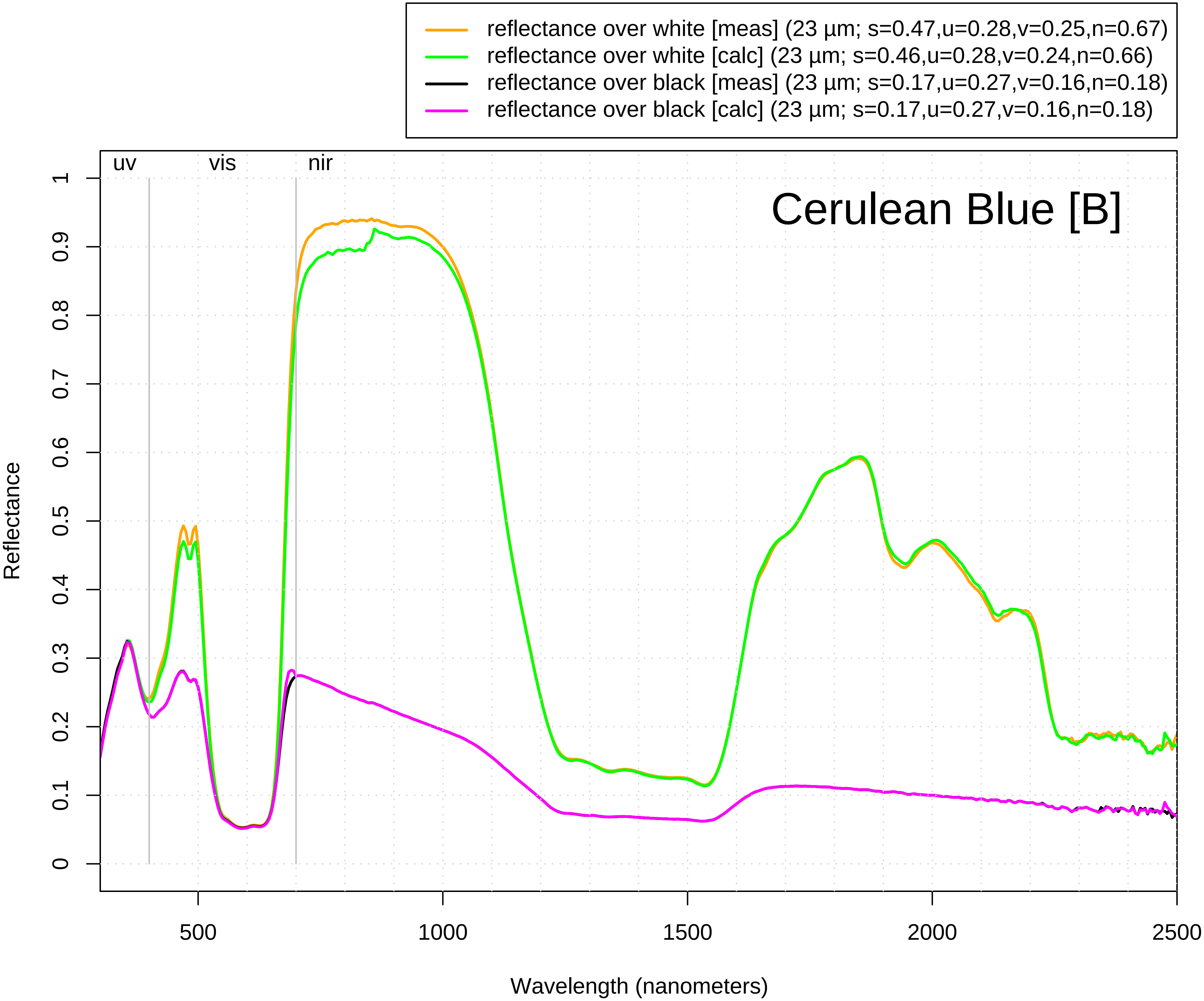
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:23 PM



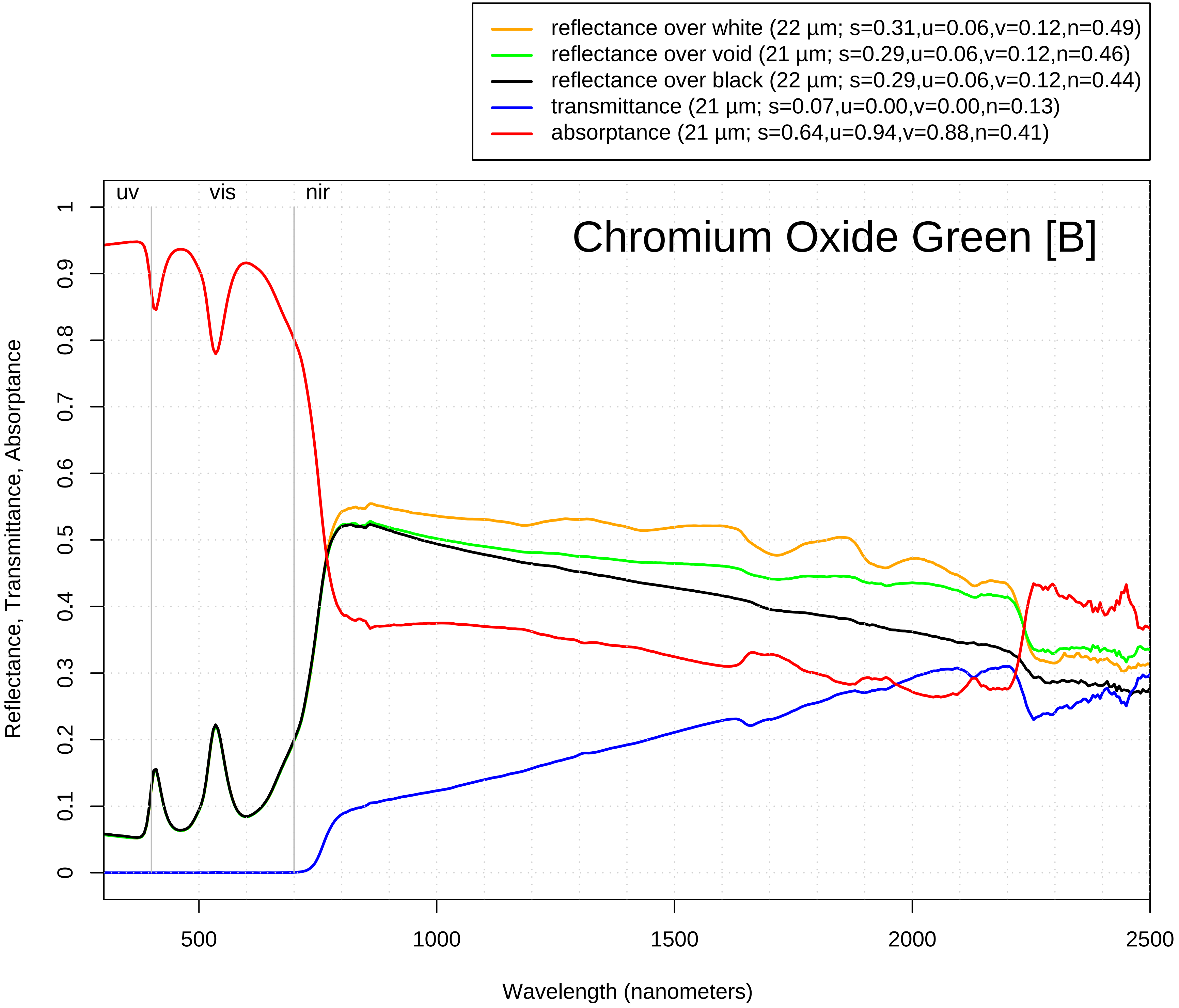
(c) Ancillary Calculations

Sunday, 09 March 2003 01:23 PM



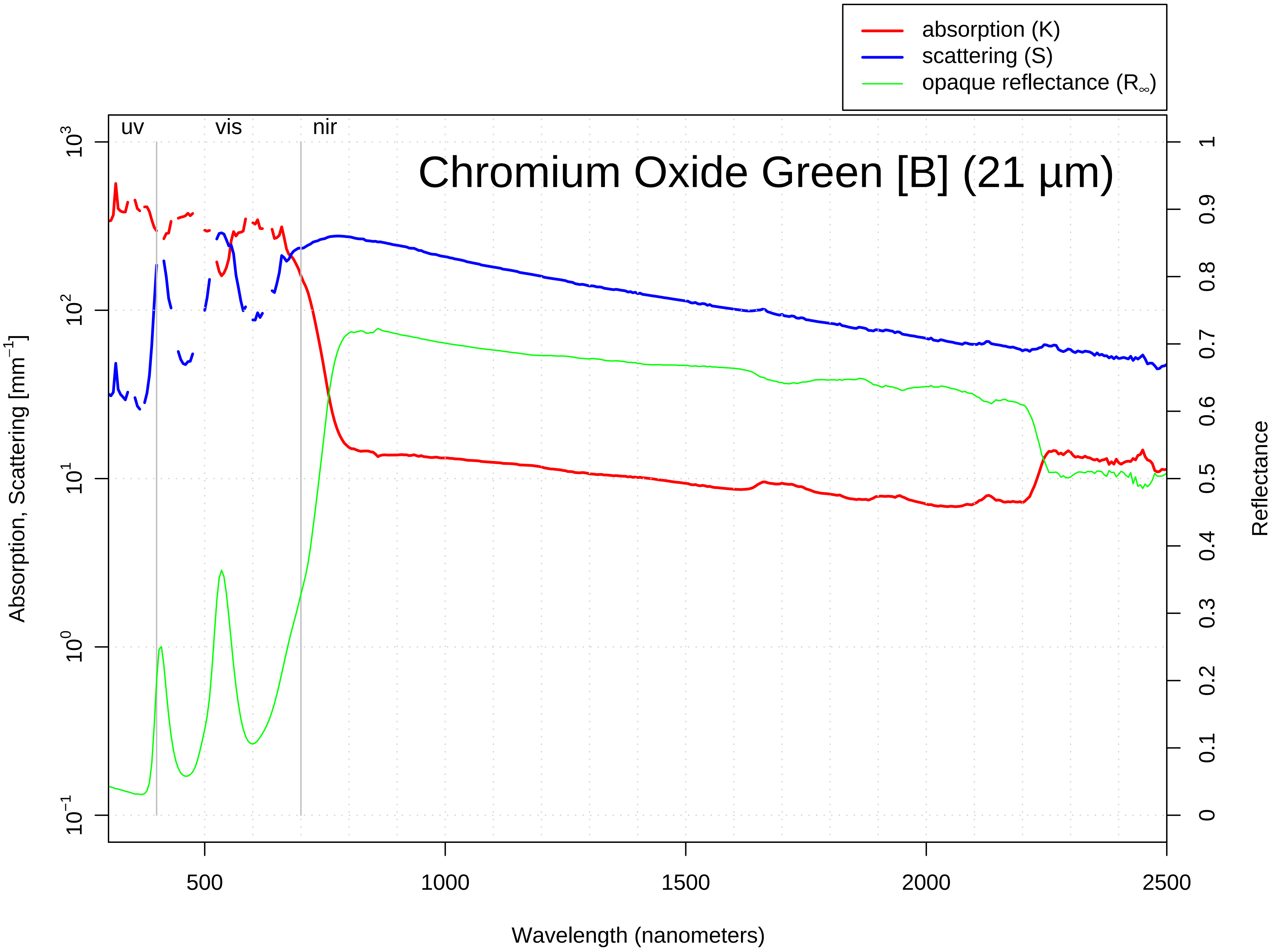
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:23 PM



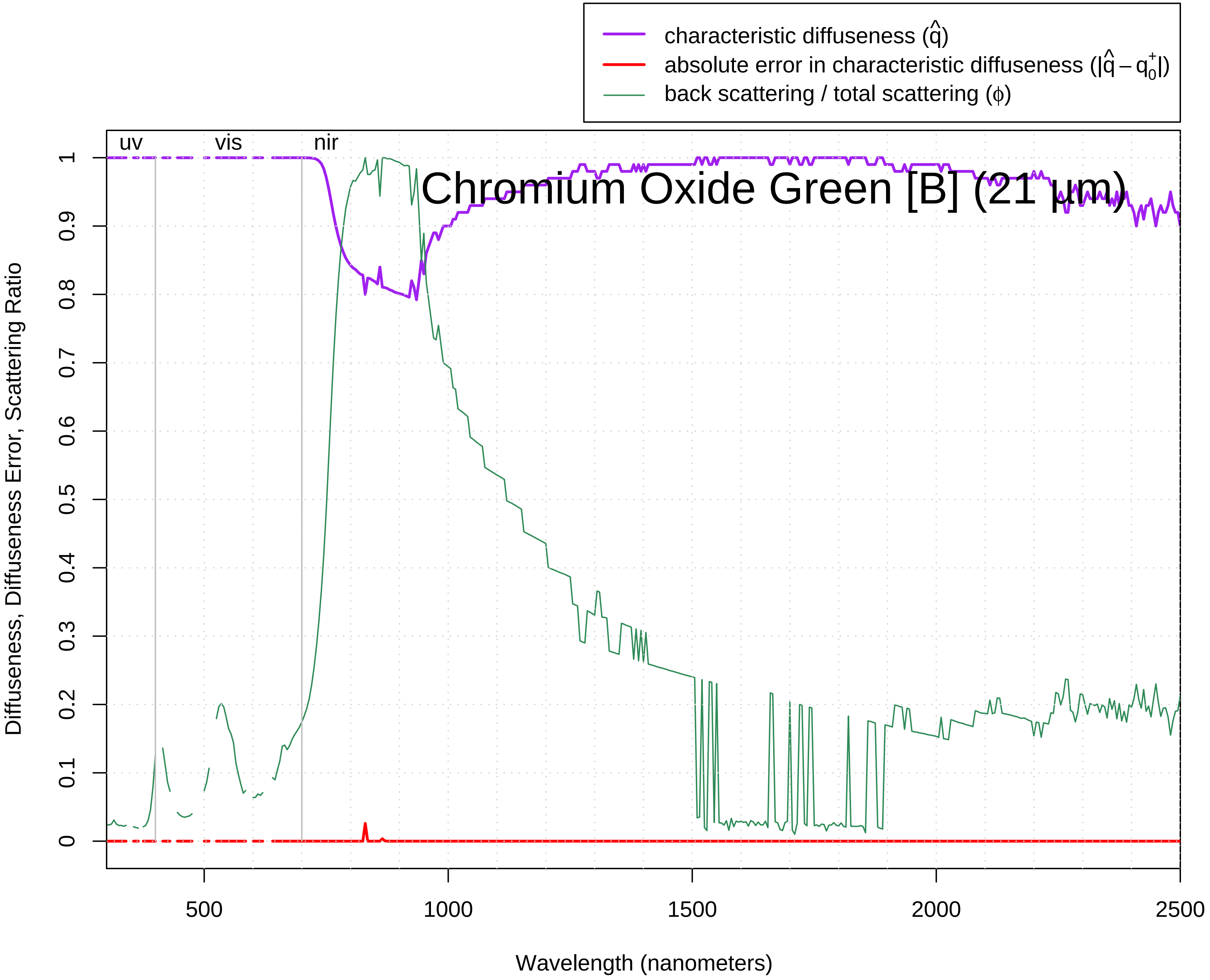
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:26 PM



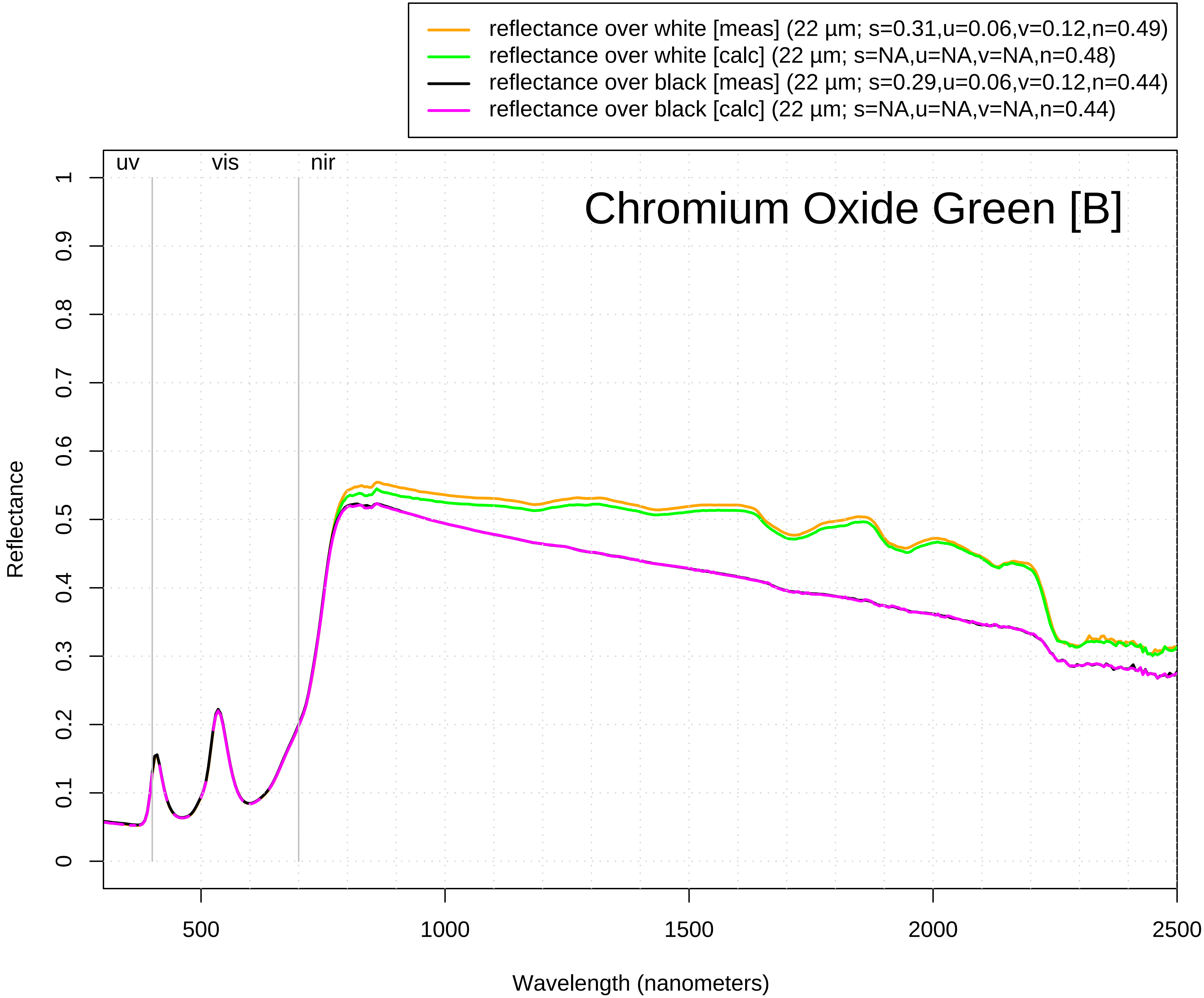
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:26 PM



(c) Ancillary Calculations

Sunday, 09 March 2003 01:26 PM



(d) Calculated vs. Measured Reflectances

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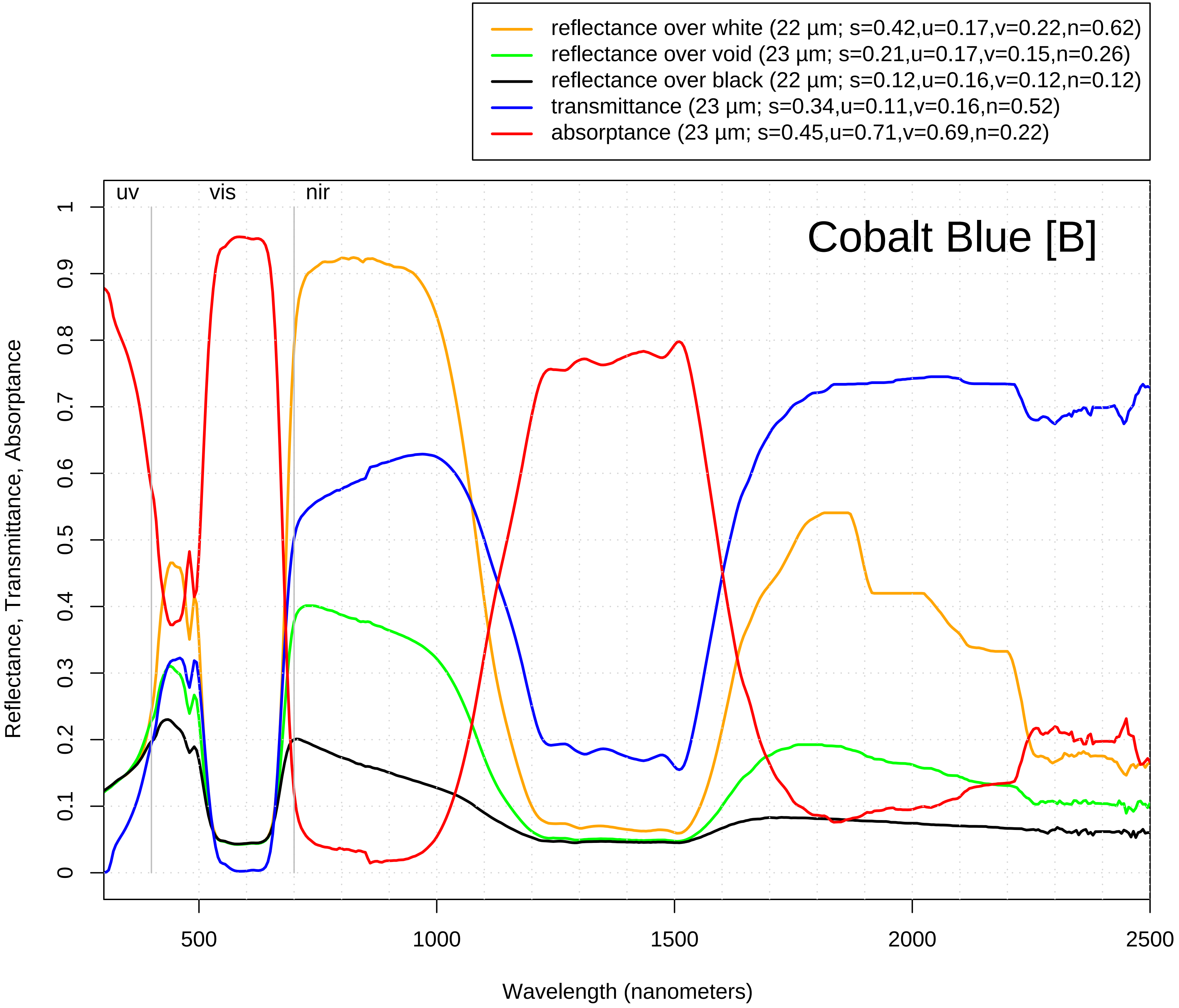
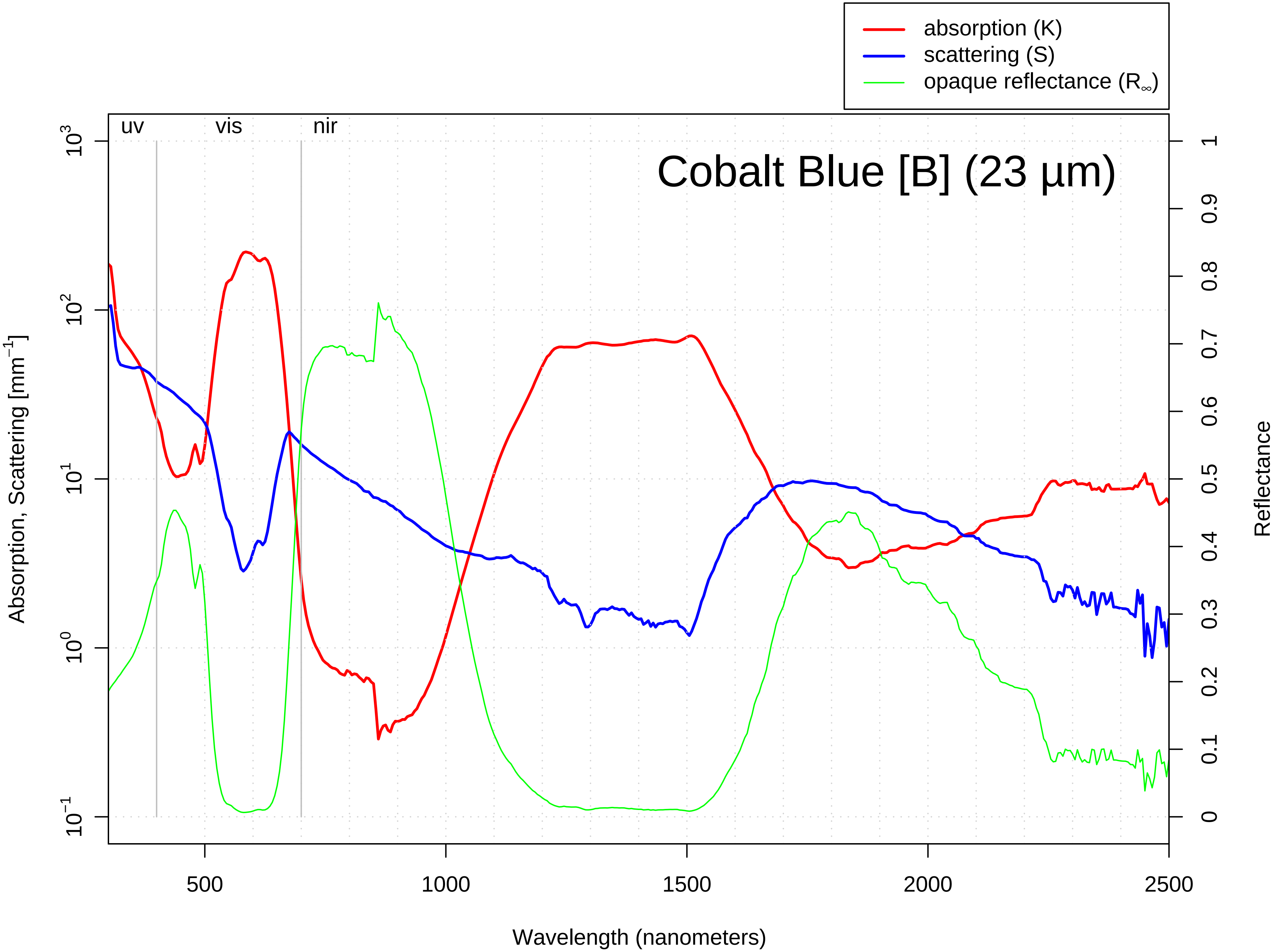


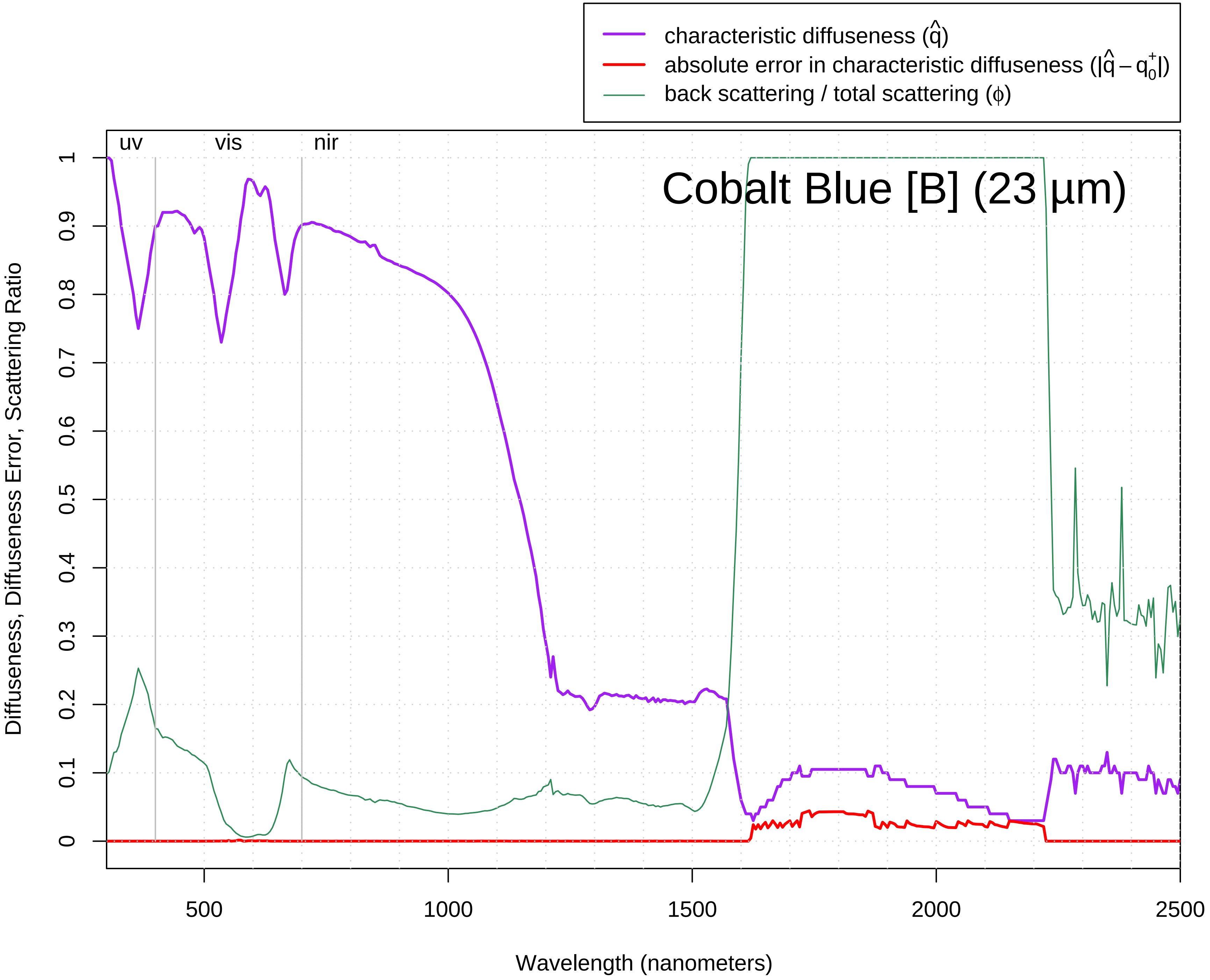
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:29 PM



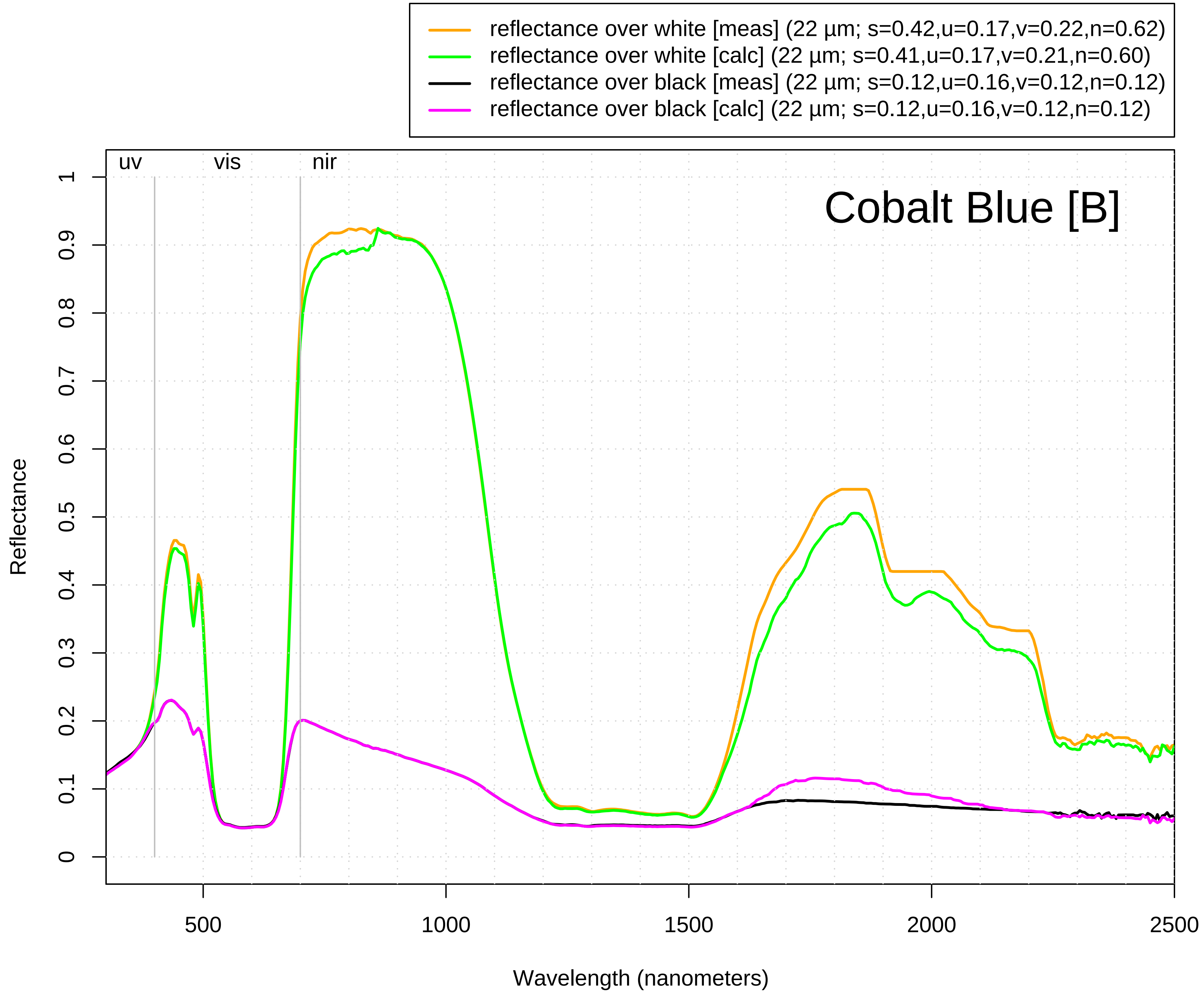
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:29 PM



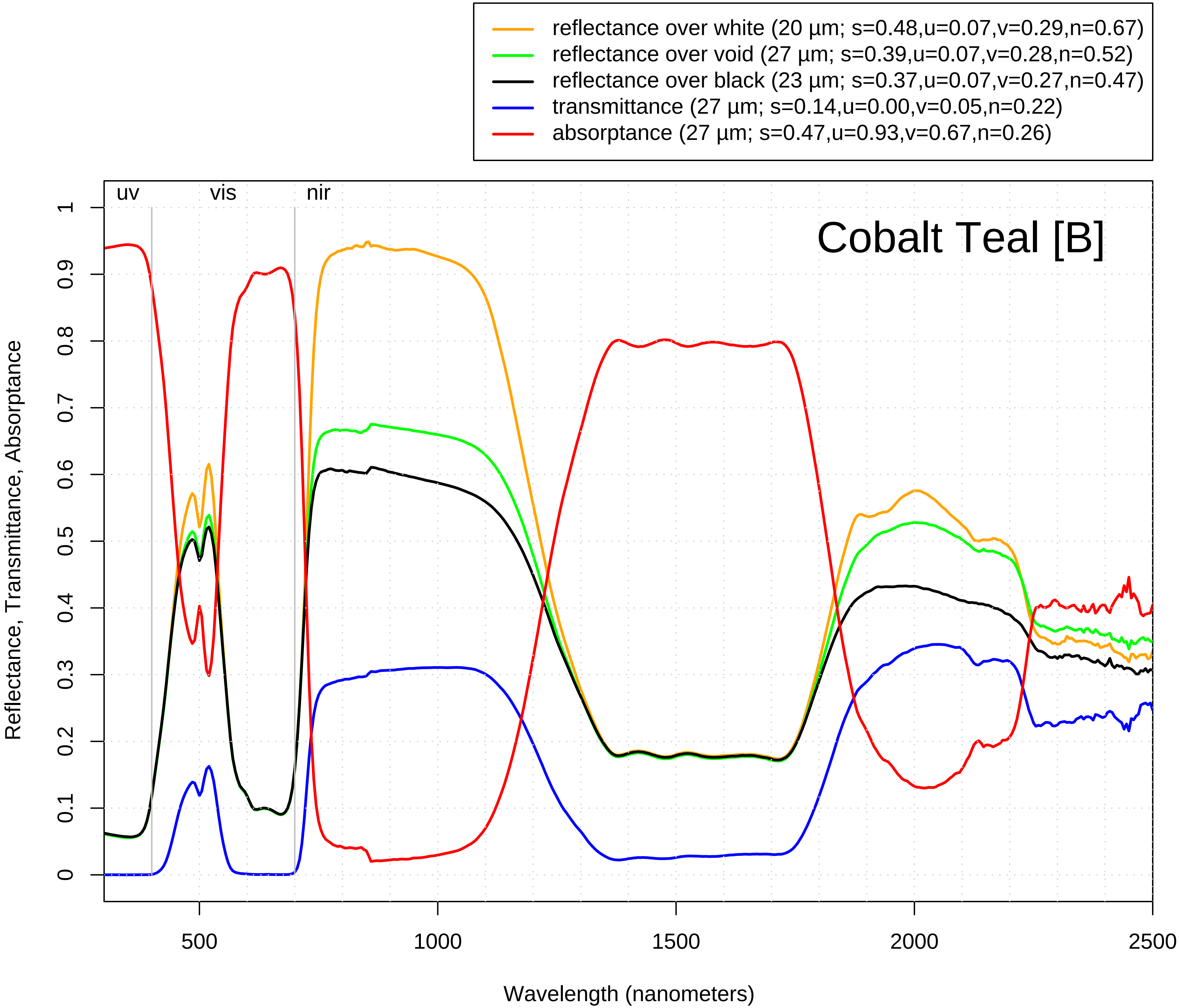
(c) Ancillary Calculations

Sunday, 09 March 2003 01:29 PM



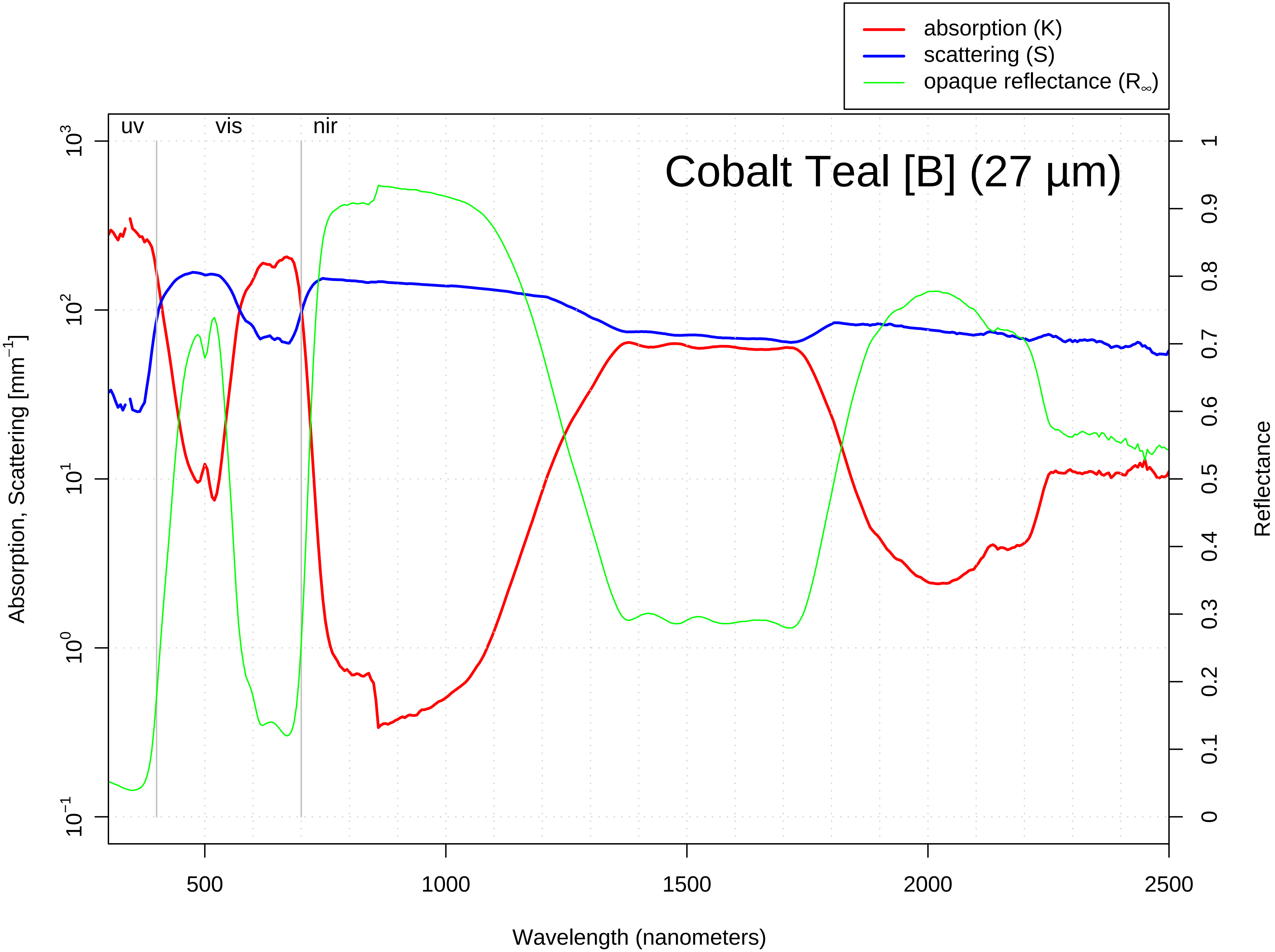
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:29 PM



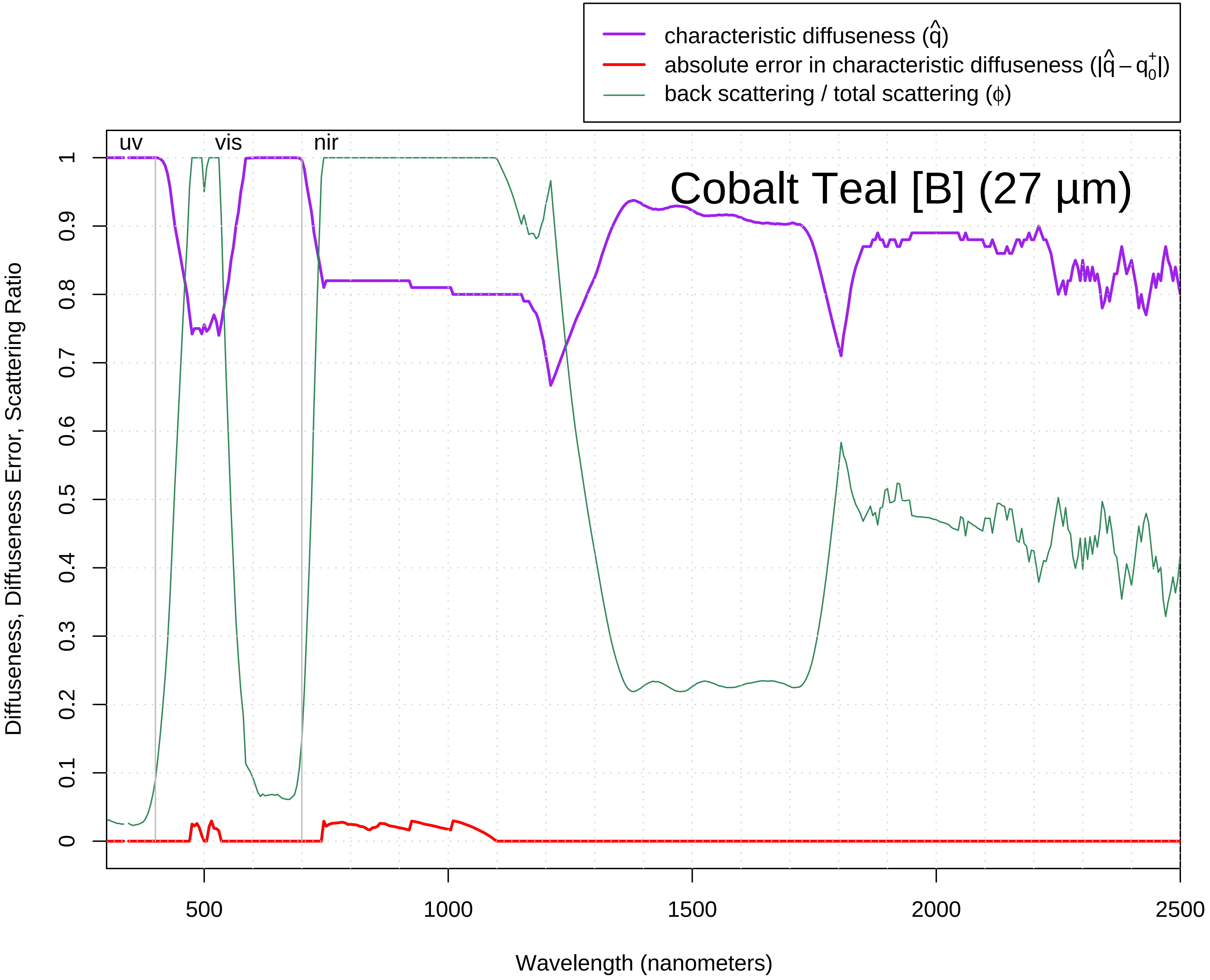
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:32 PM



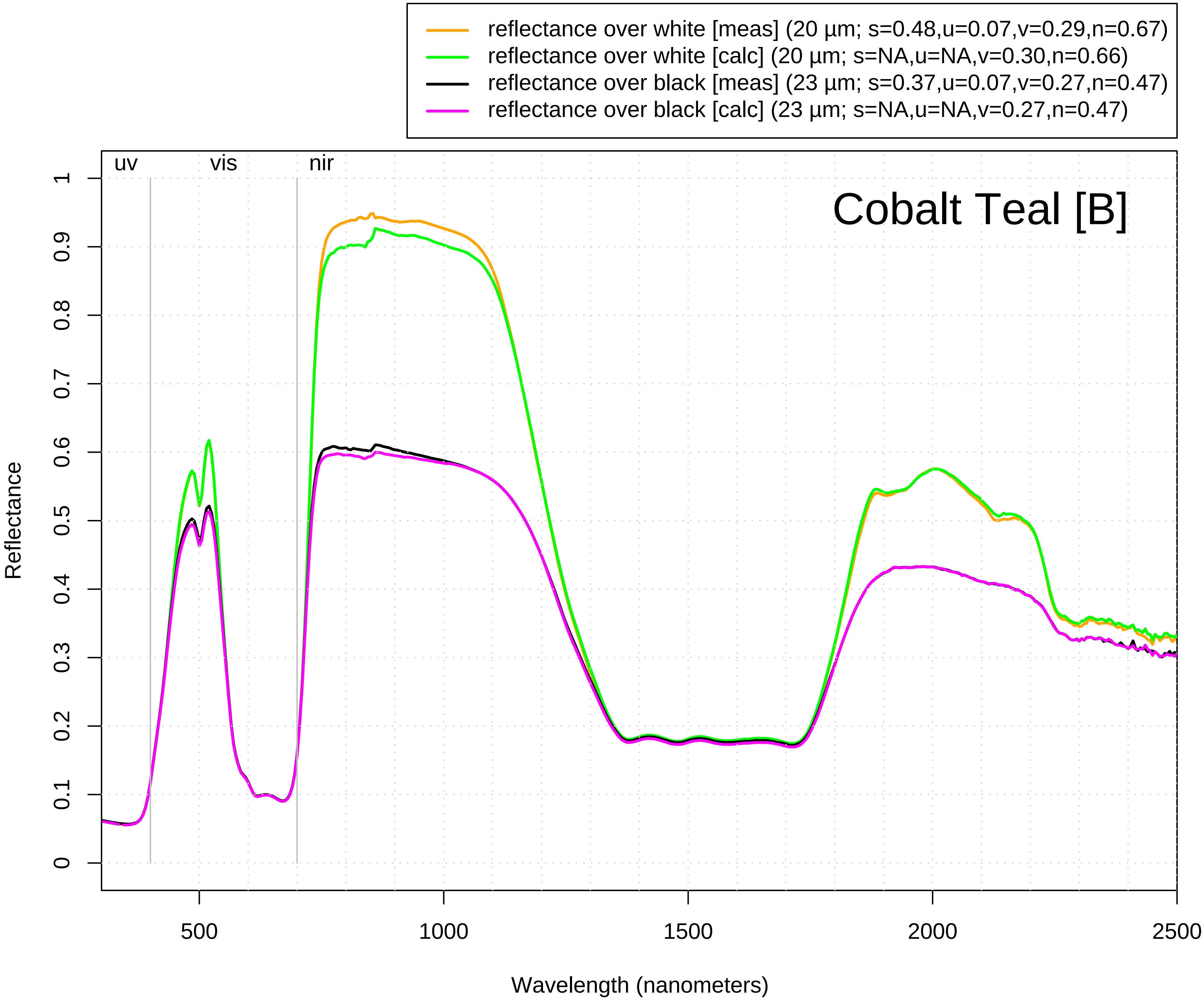
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:32 PM



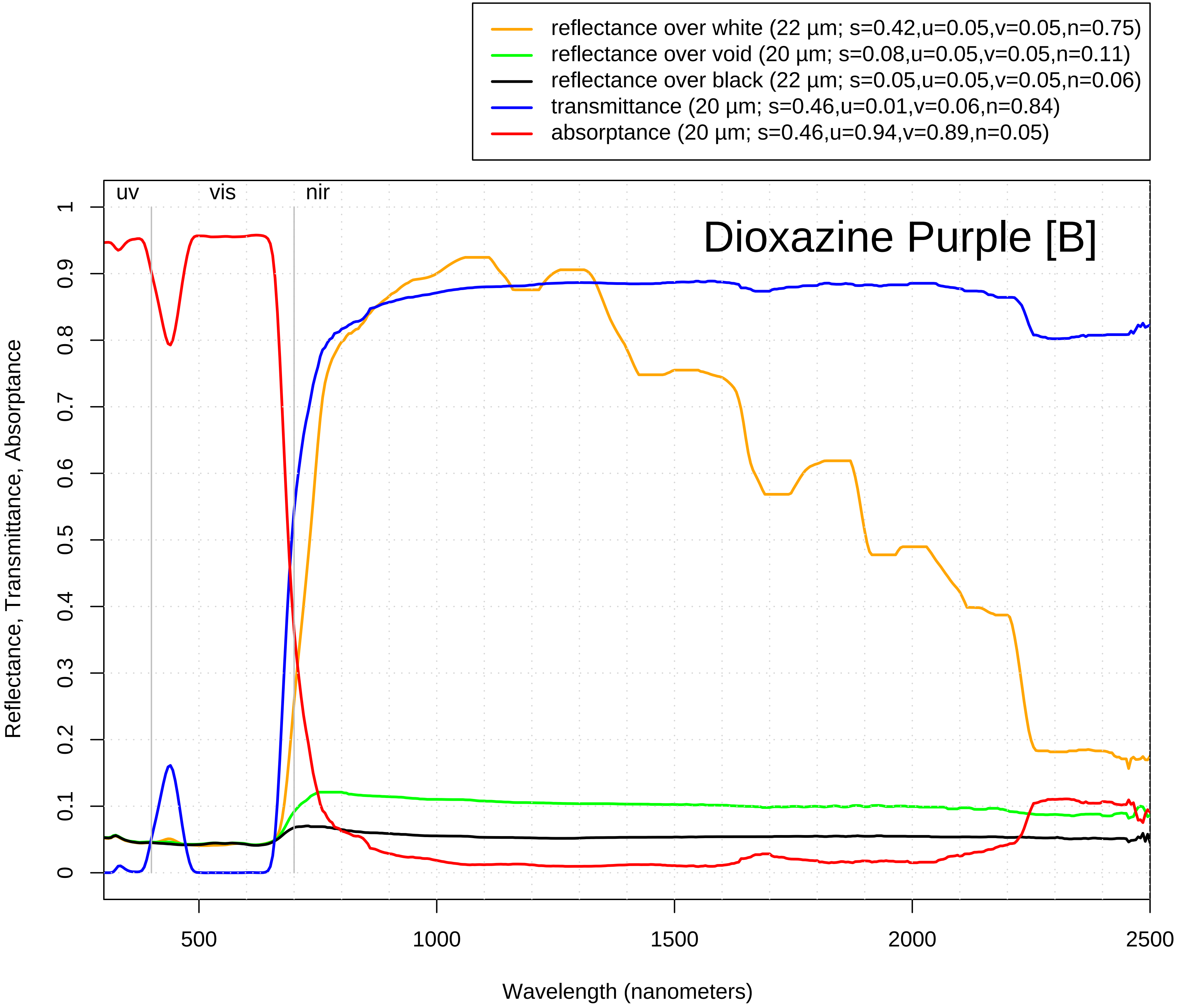
(c) Ancillary Calculations

Sunday, 09 March 2003 01:32 PM



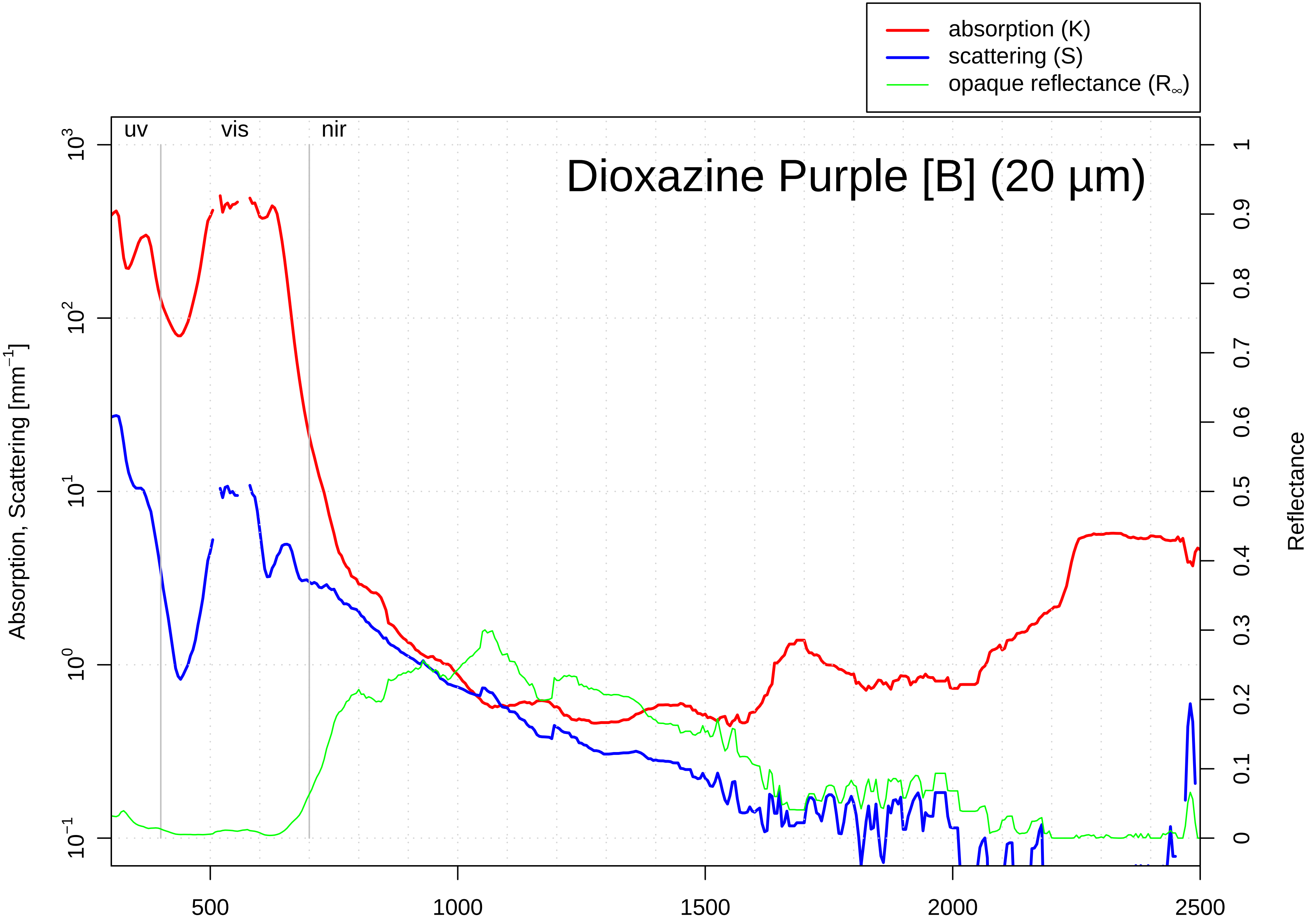
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:32 PM



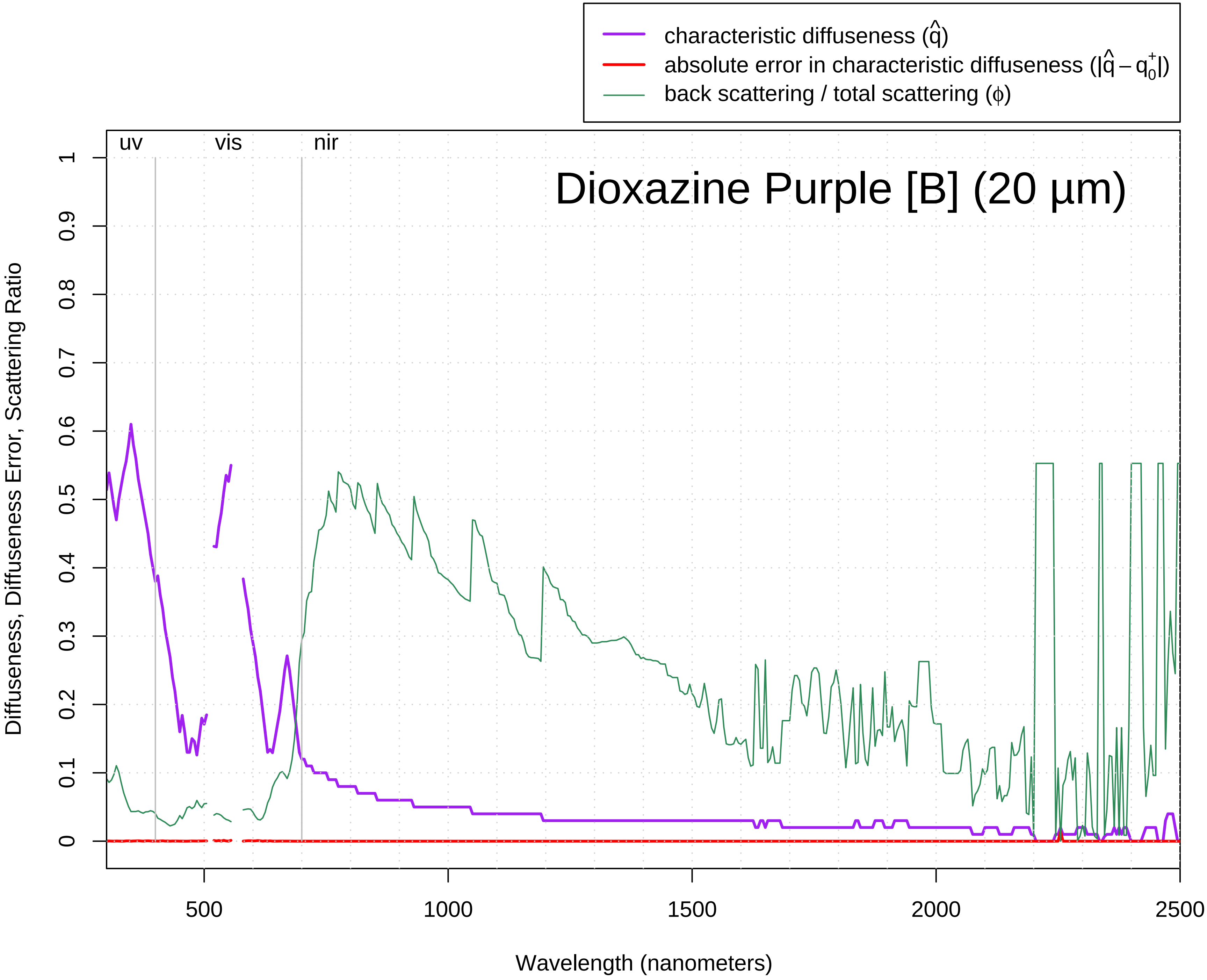
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:35 PM



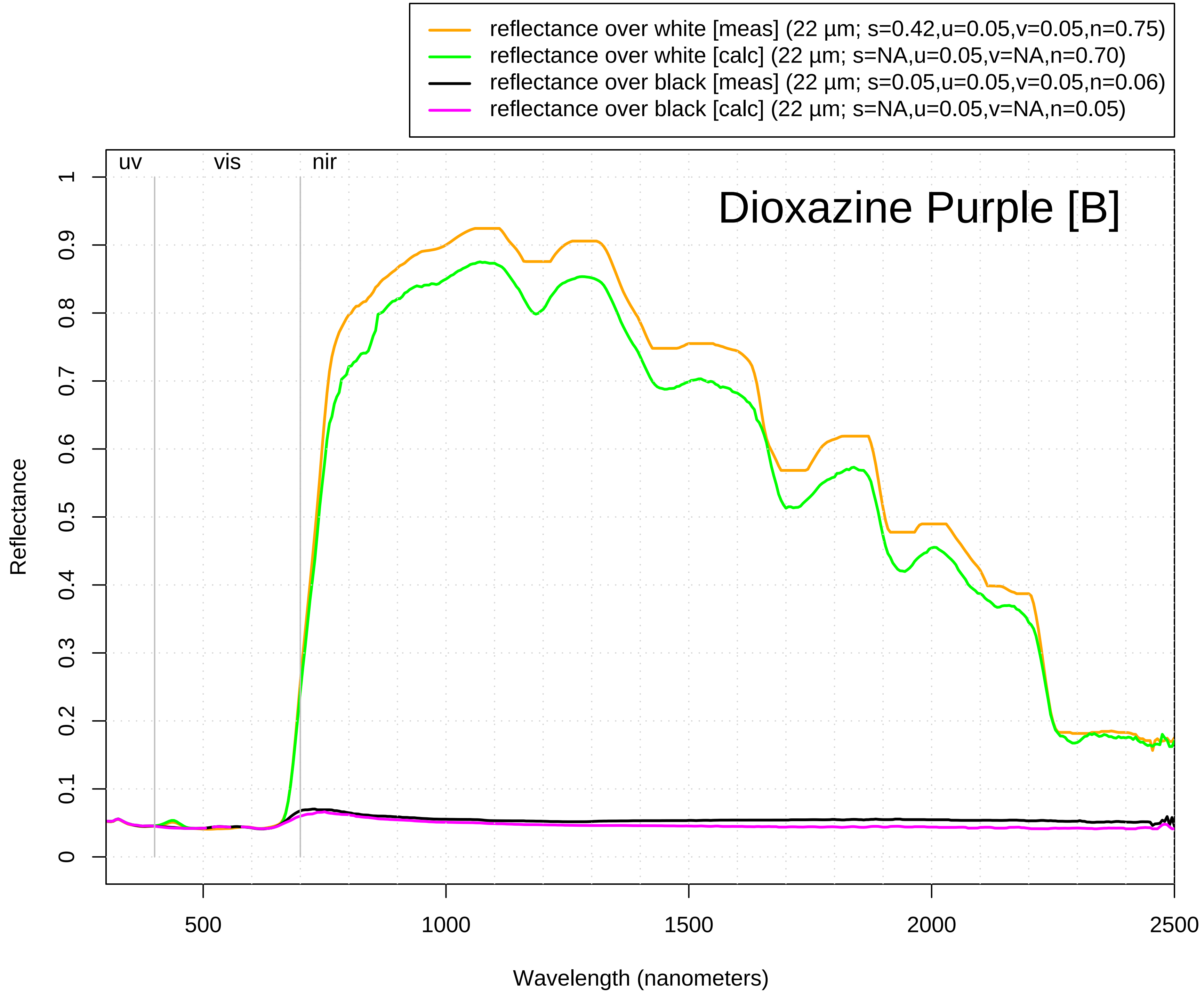
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:35 PM



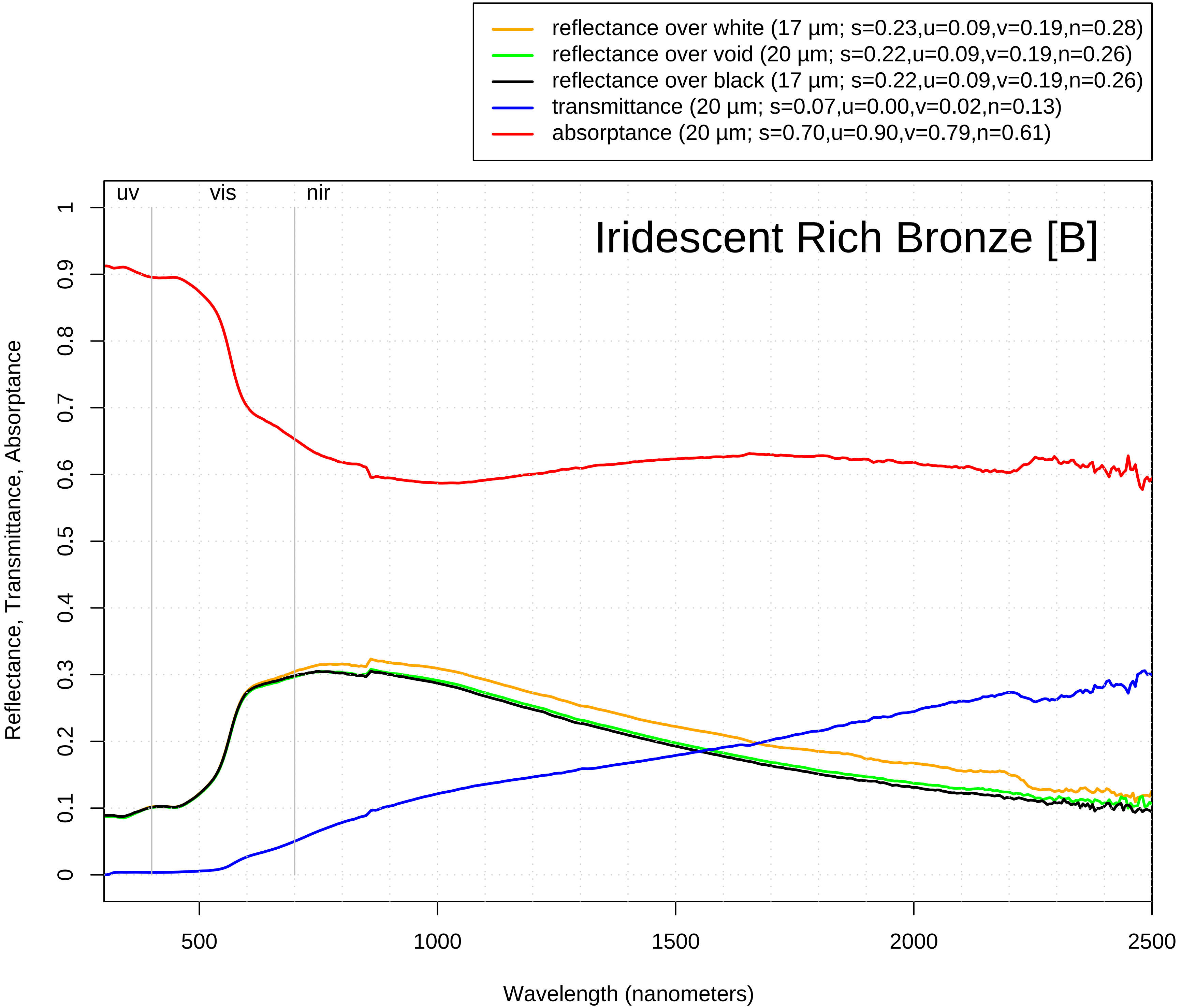
(c) Ancillary Calculations

Sunday, 09 March 2003 01:35 PM



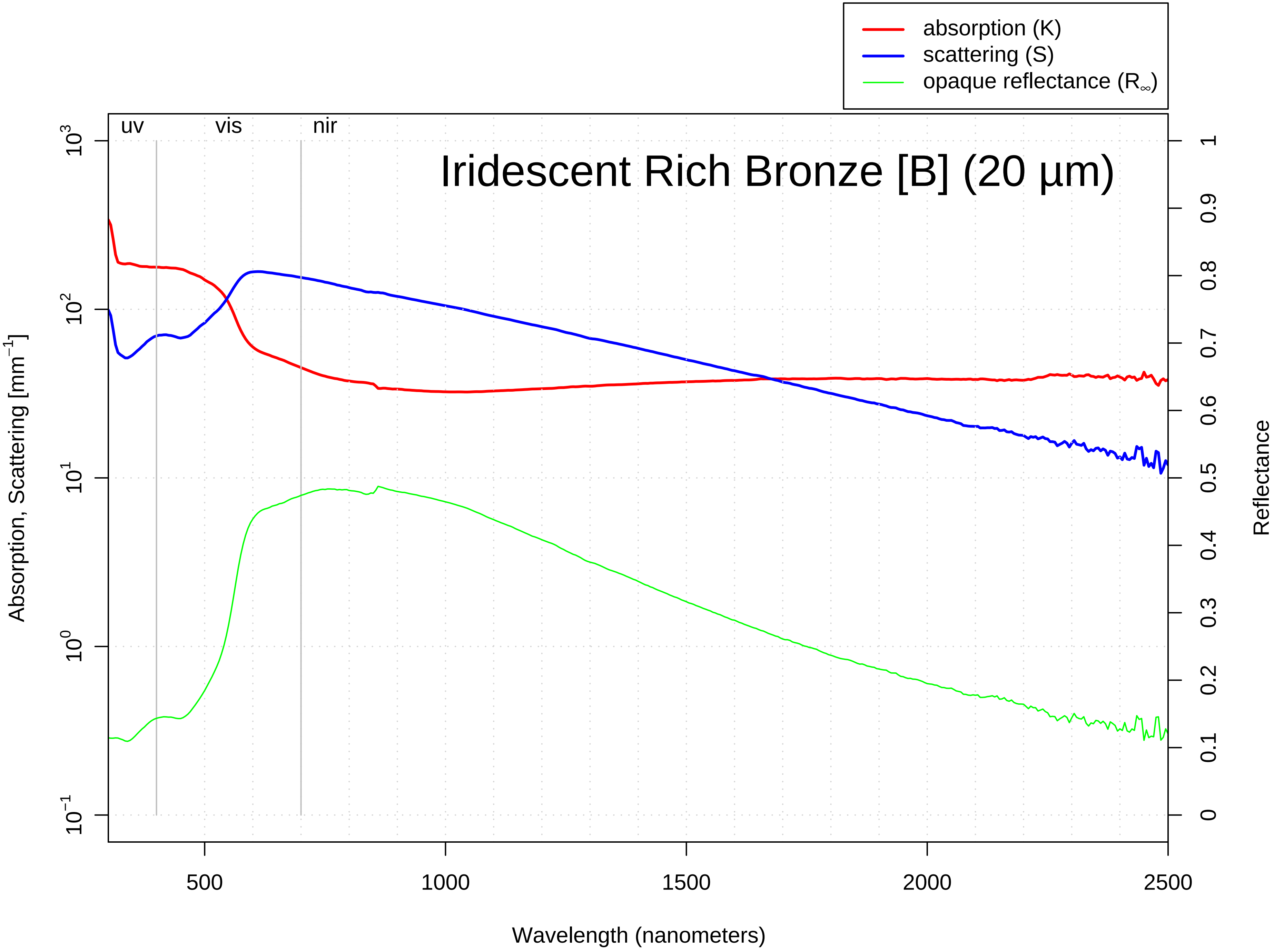
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:35 PM



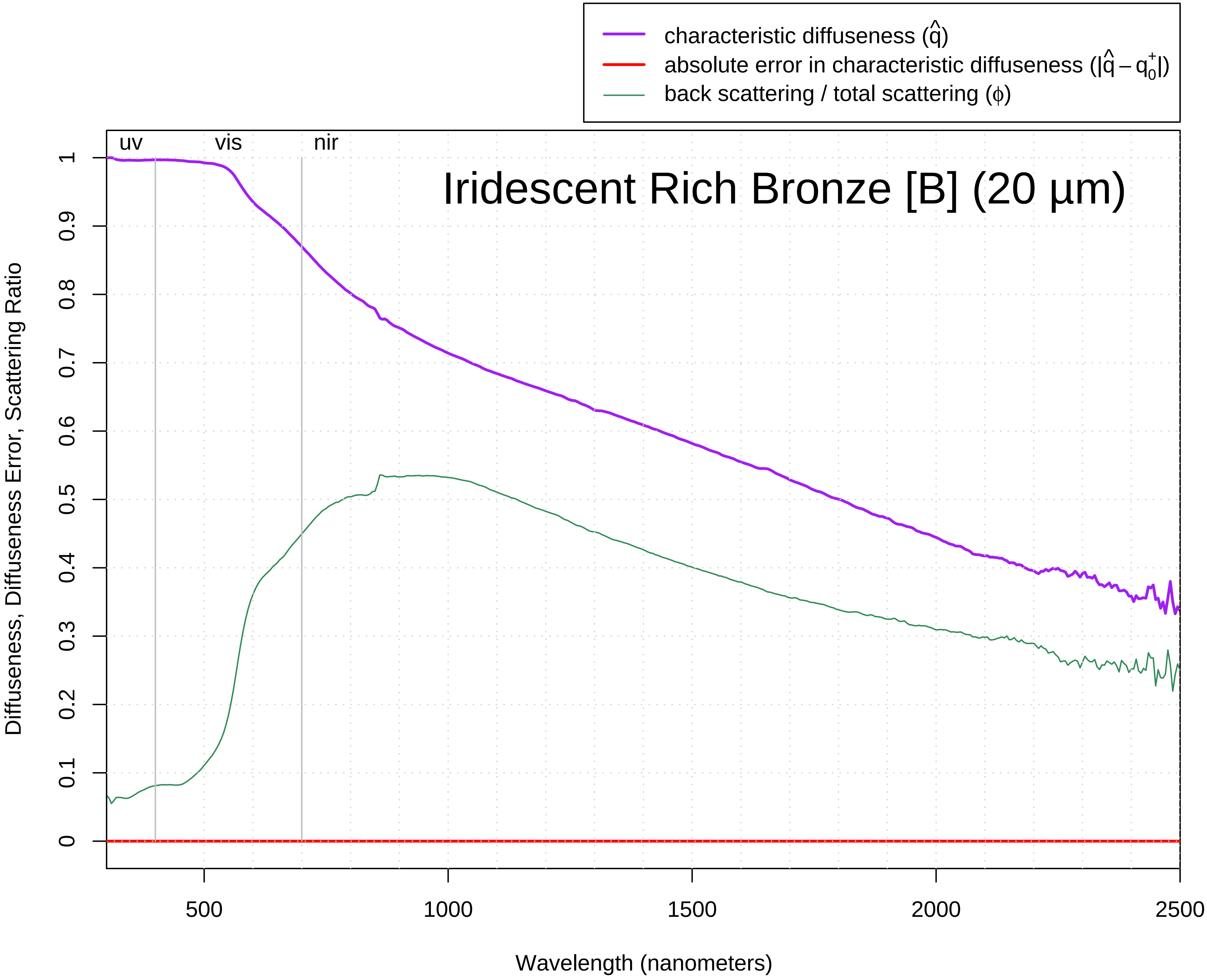
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:37 PM



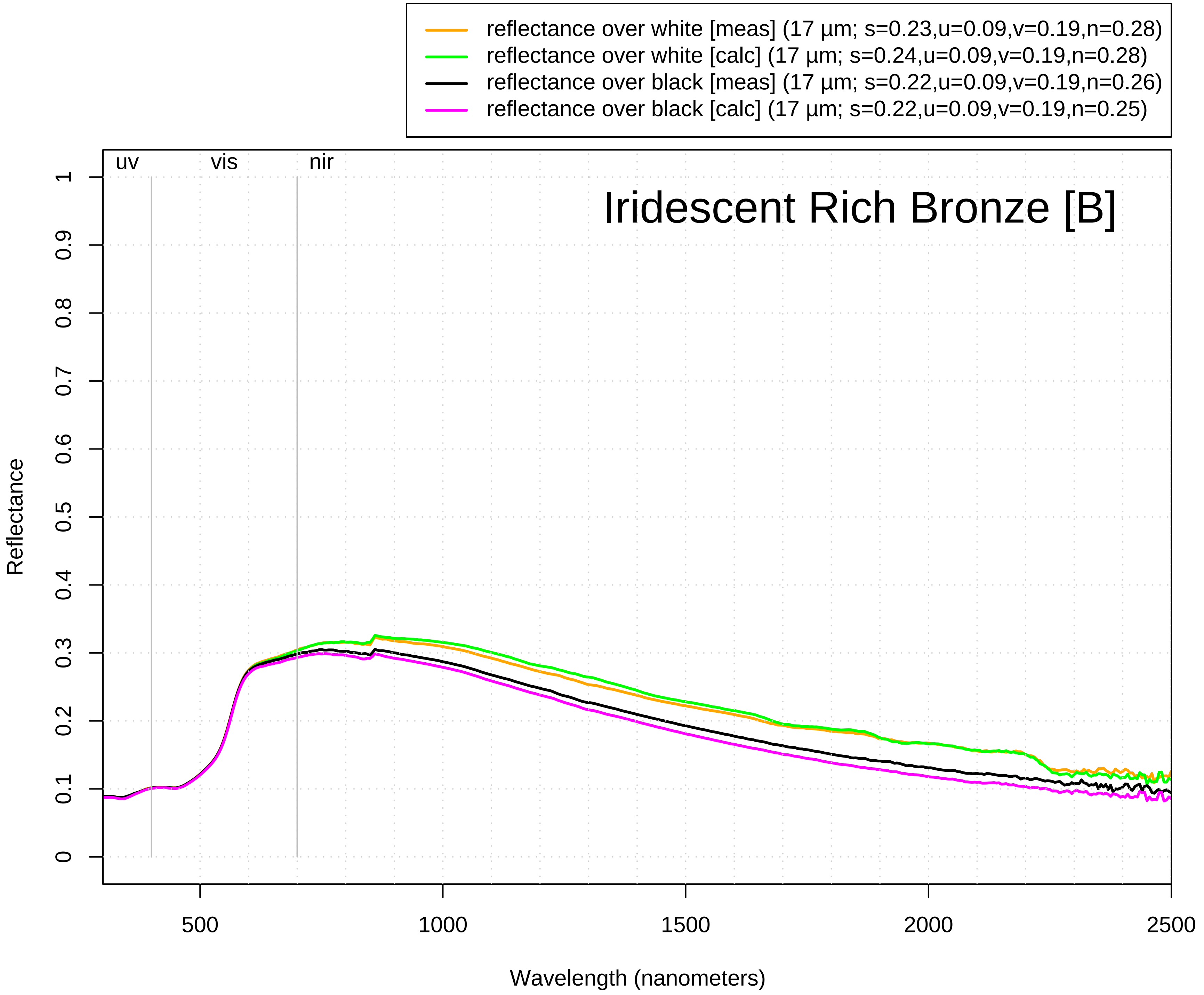
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:37 PM



(c) Ancillary Calculations

Sunday, 09 March 2003 01:37 PM



(d) Calculated vs. Measured Reflectances

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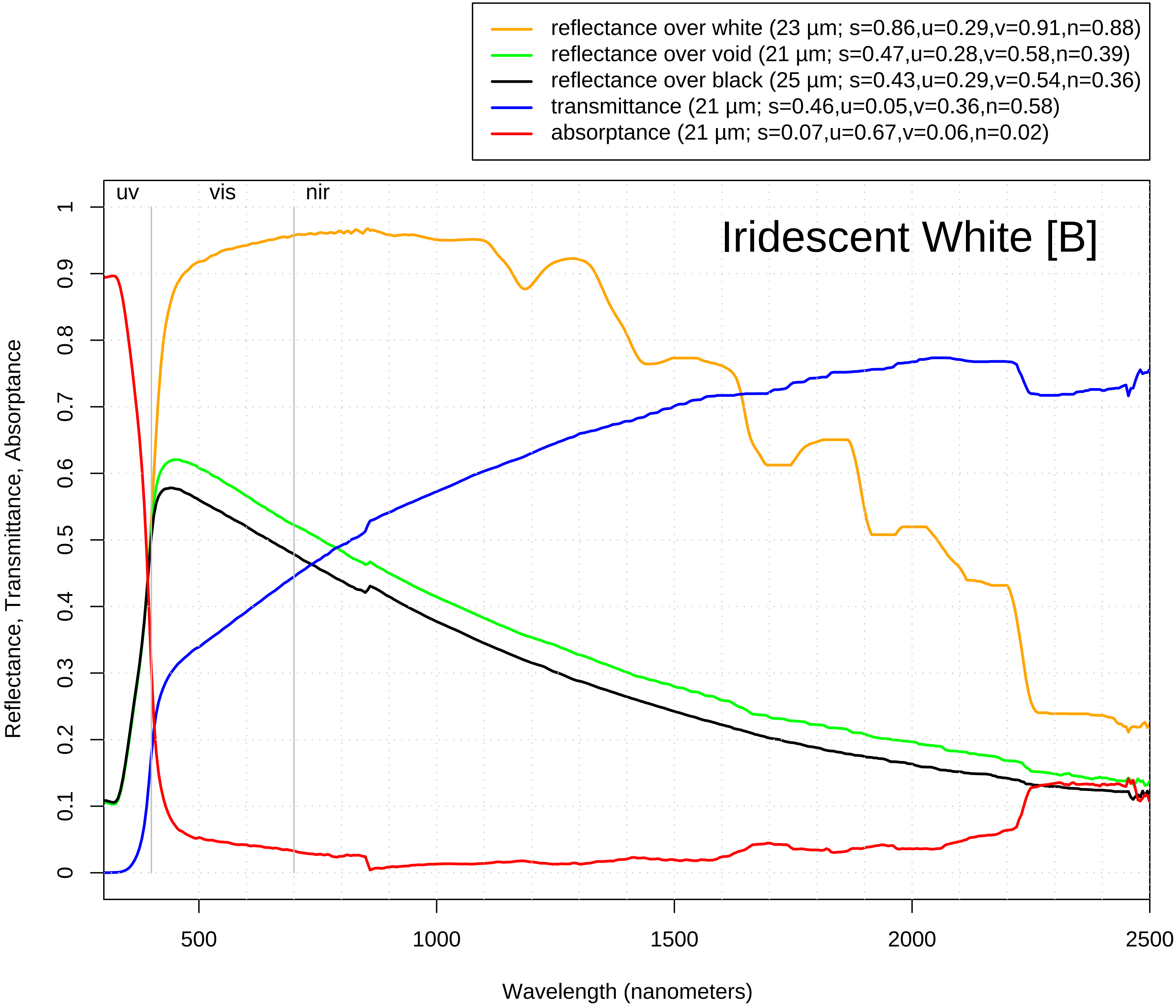
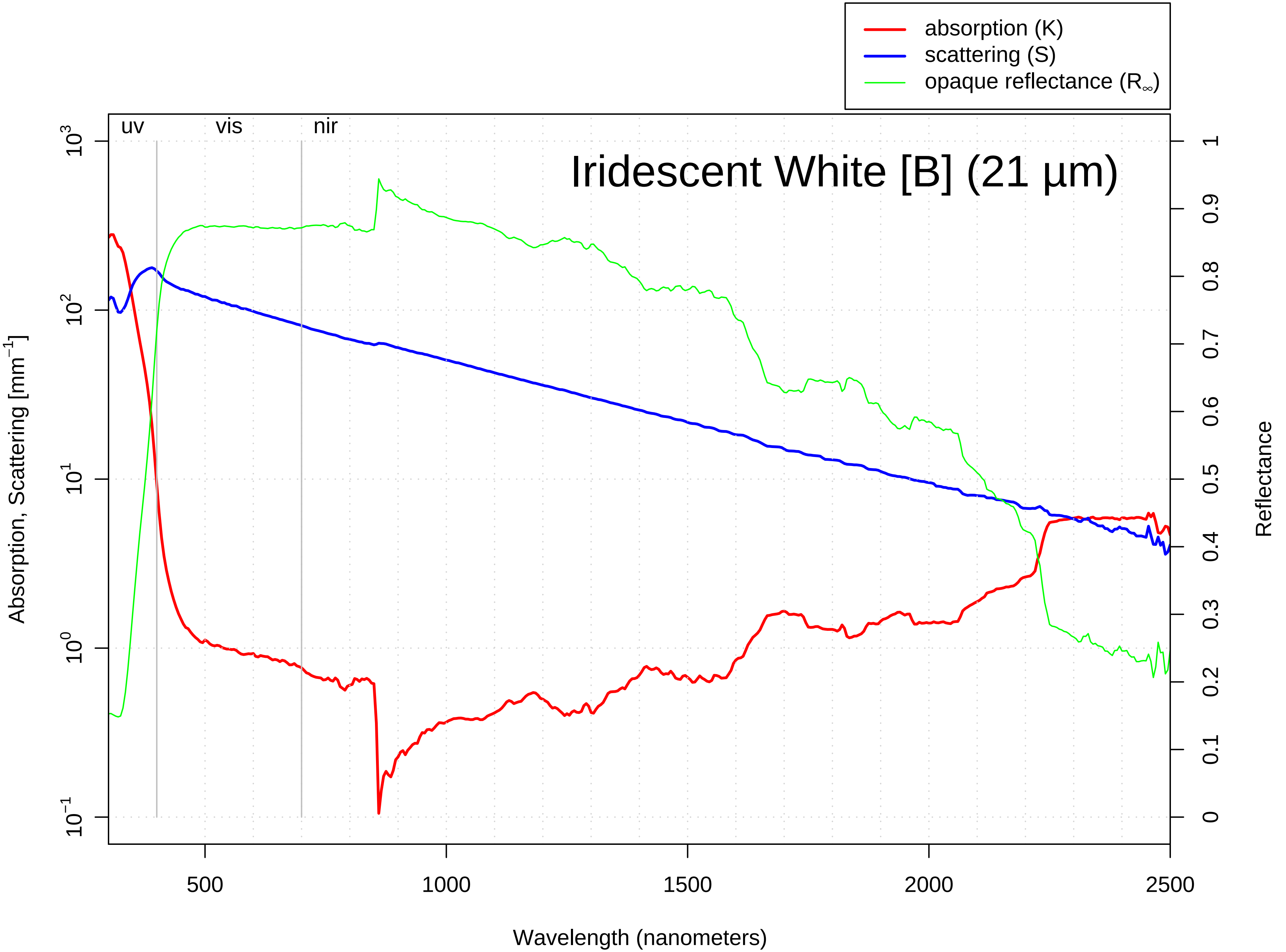


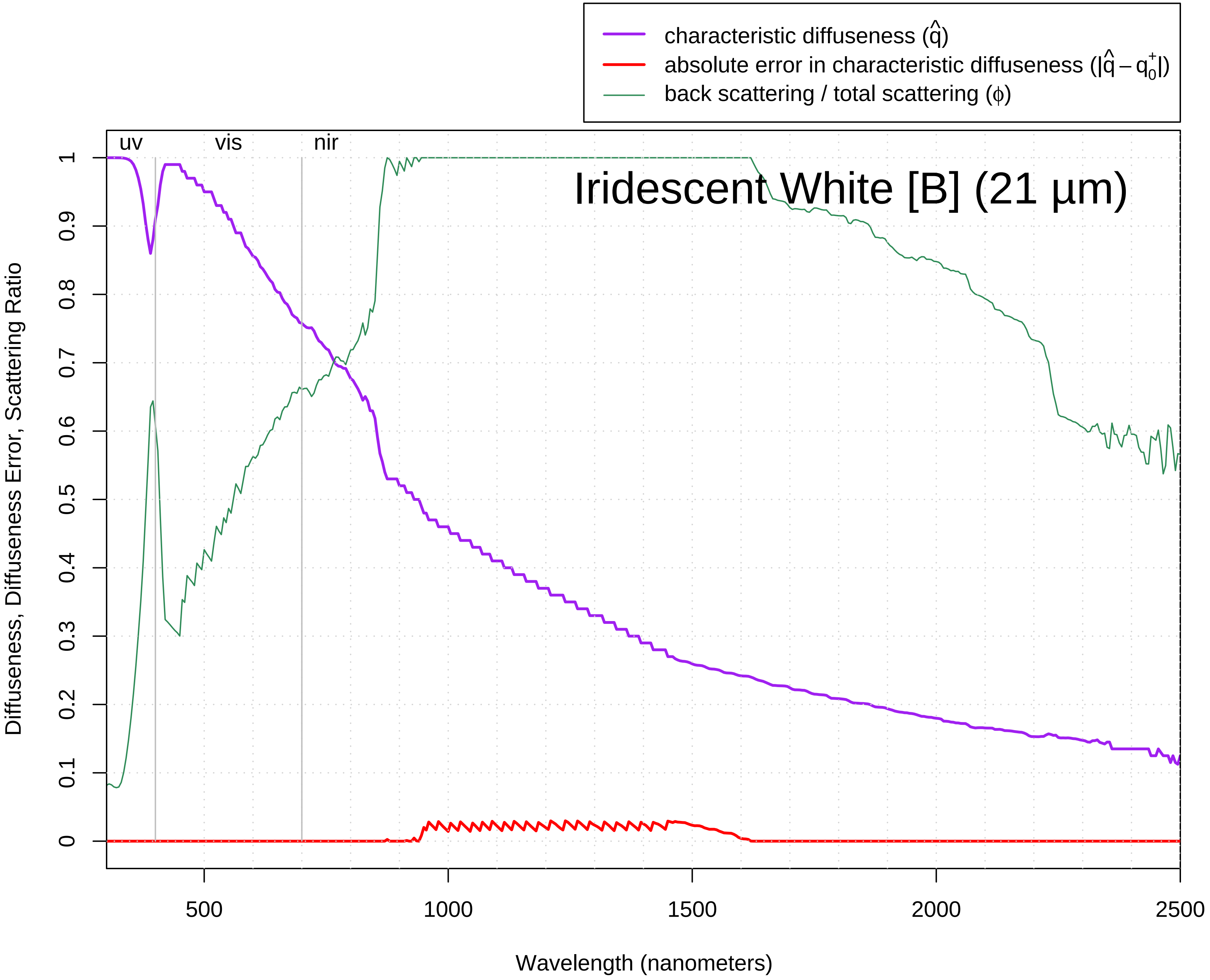
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:40 PM



(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:40 PM



(c) Ancillary Calculations

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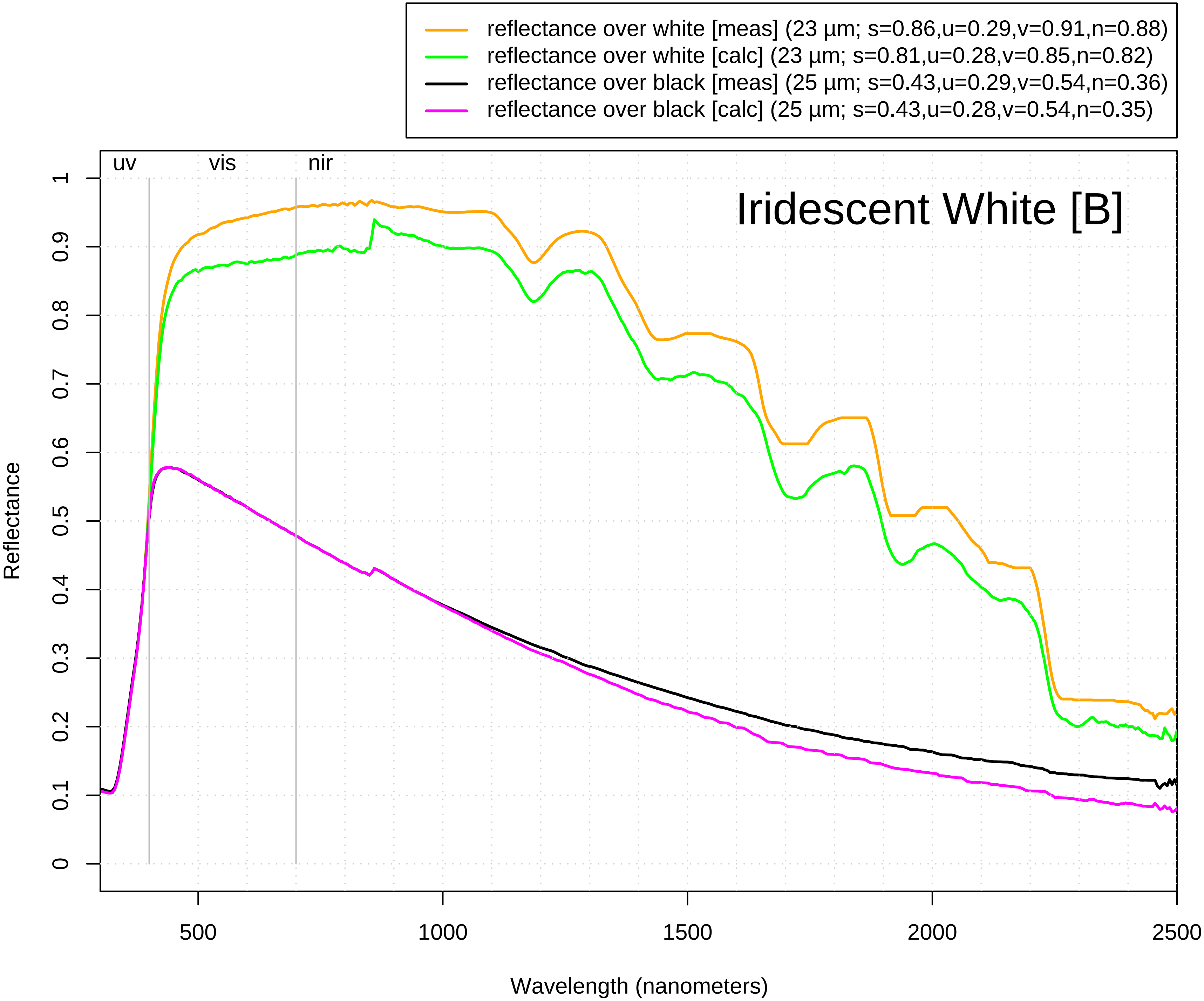
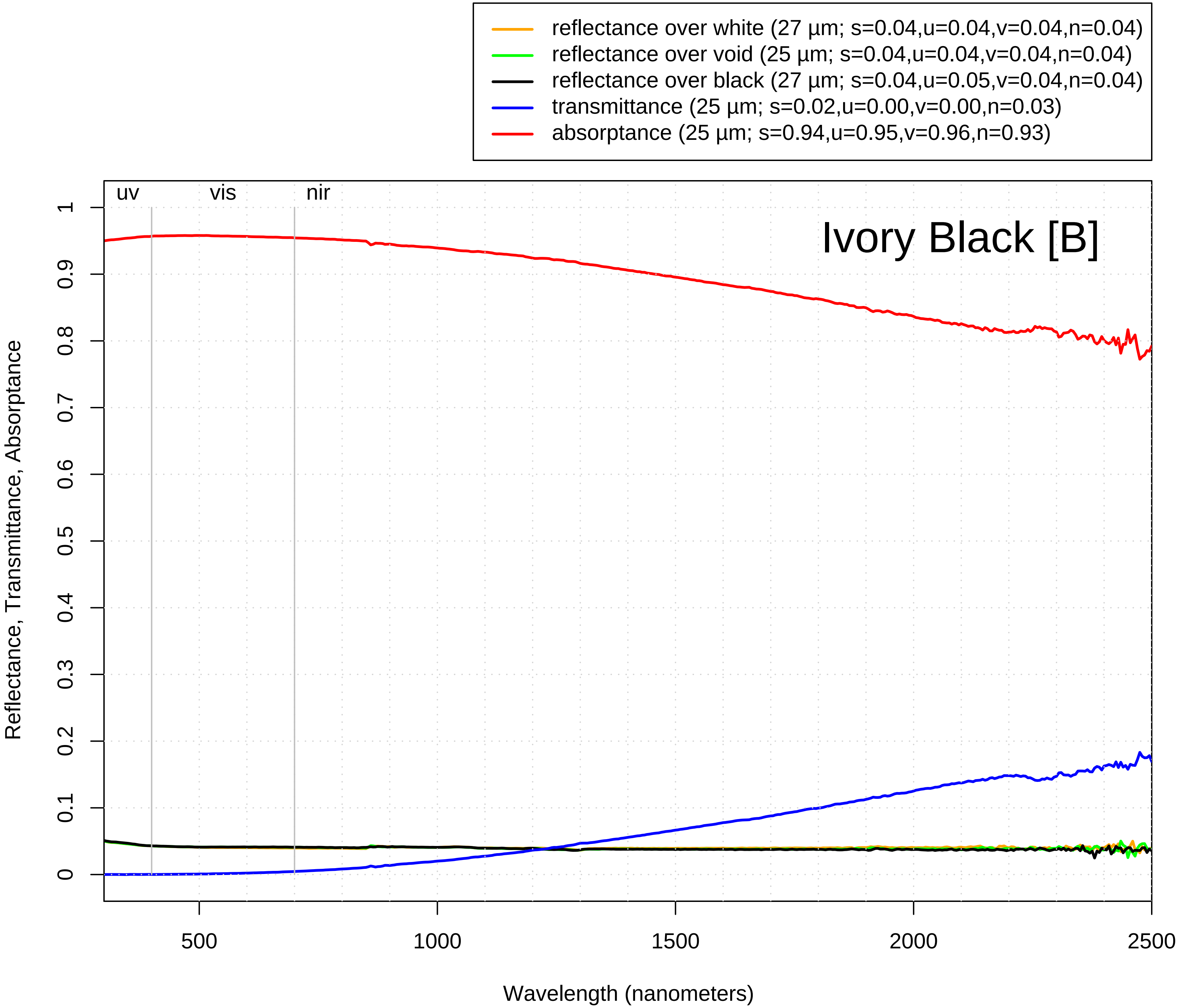


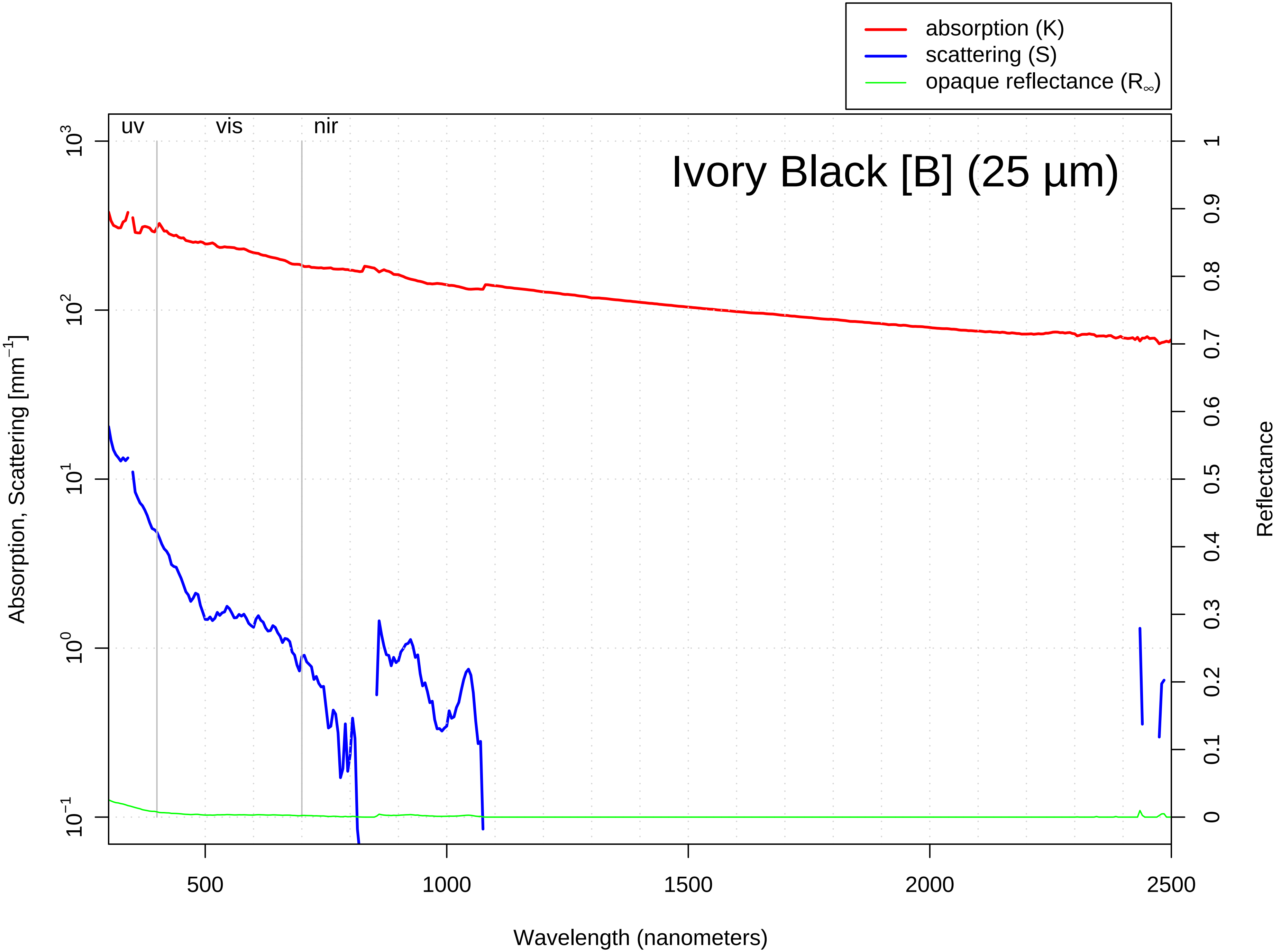
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:40 PM



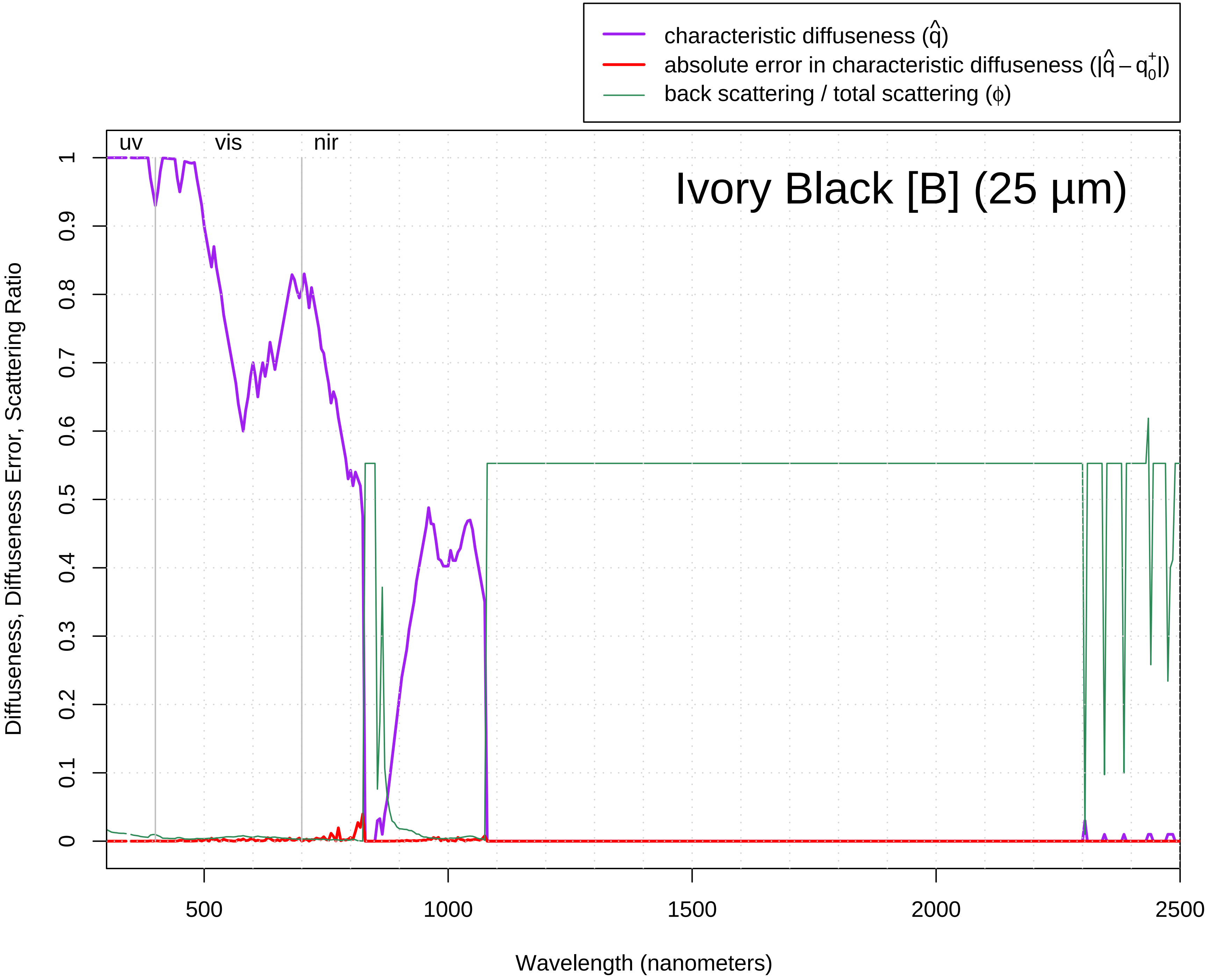
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:43 PM



(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:43 PM



(c) Ancillary Calculations

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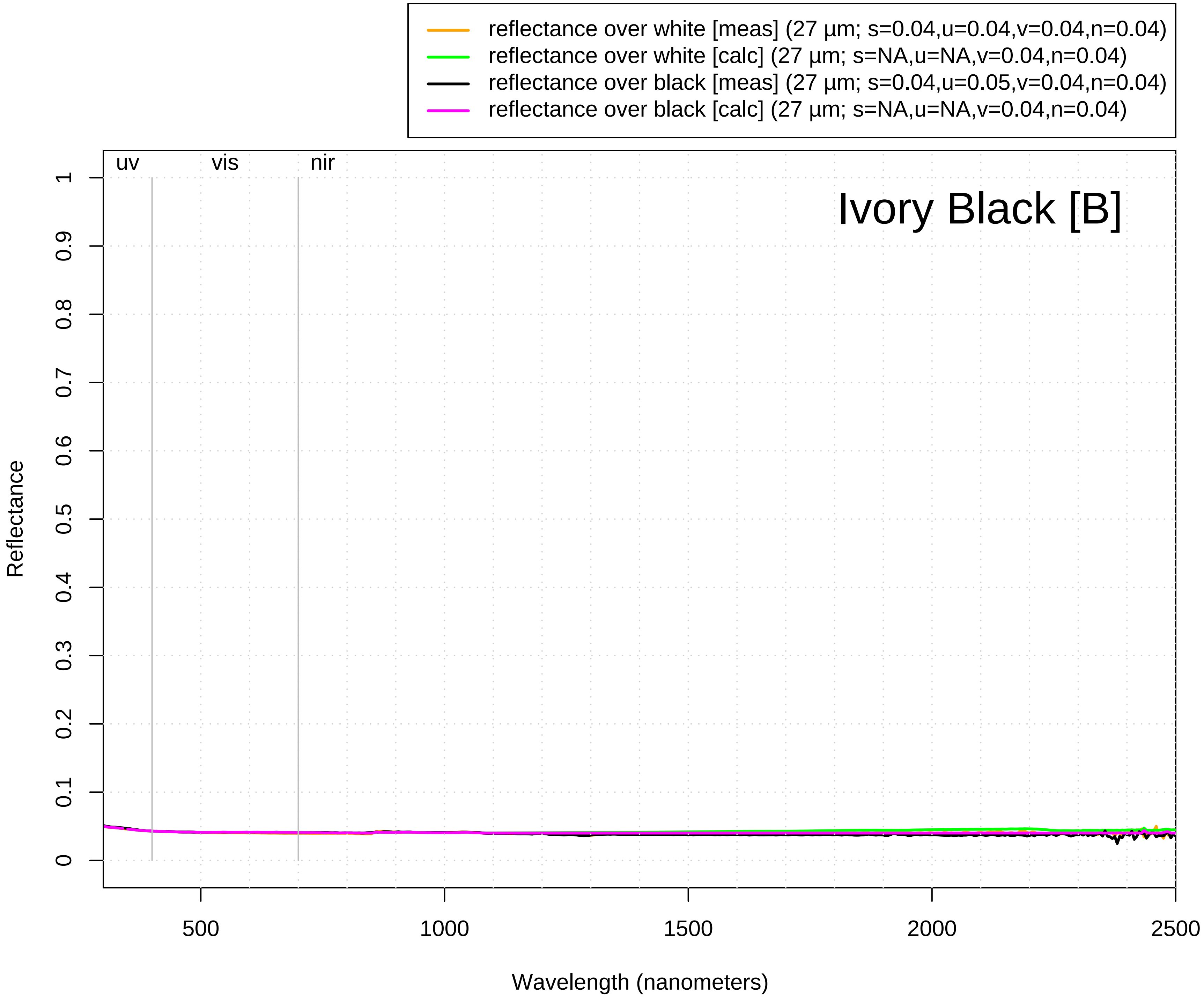

(d) Calculated vs. Measured Reflectances

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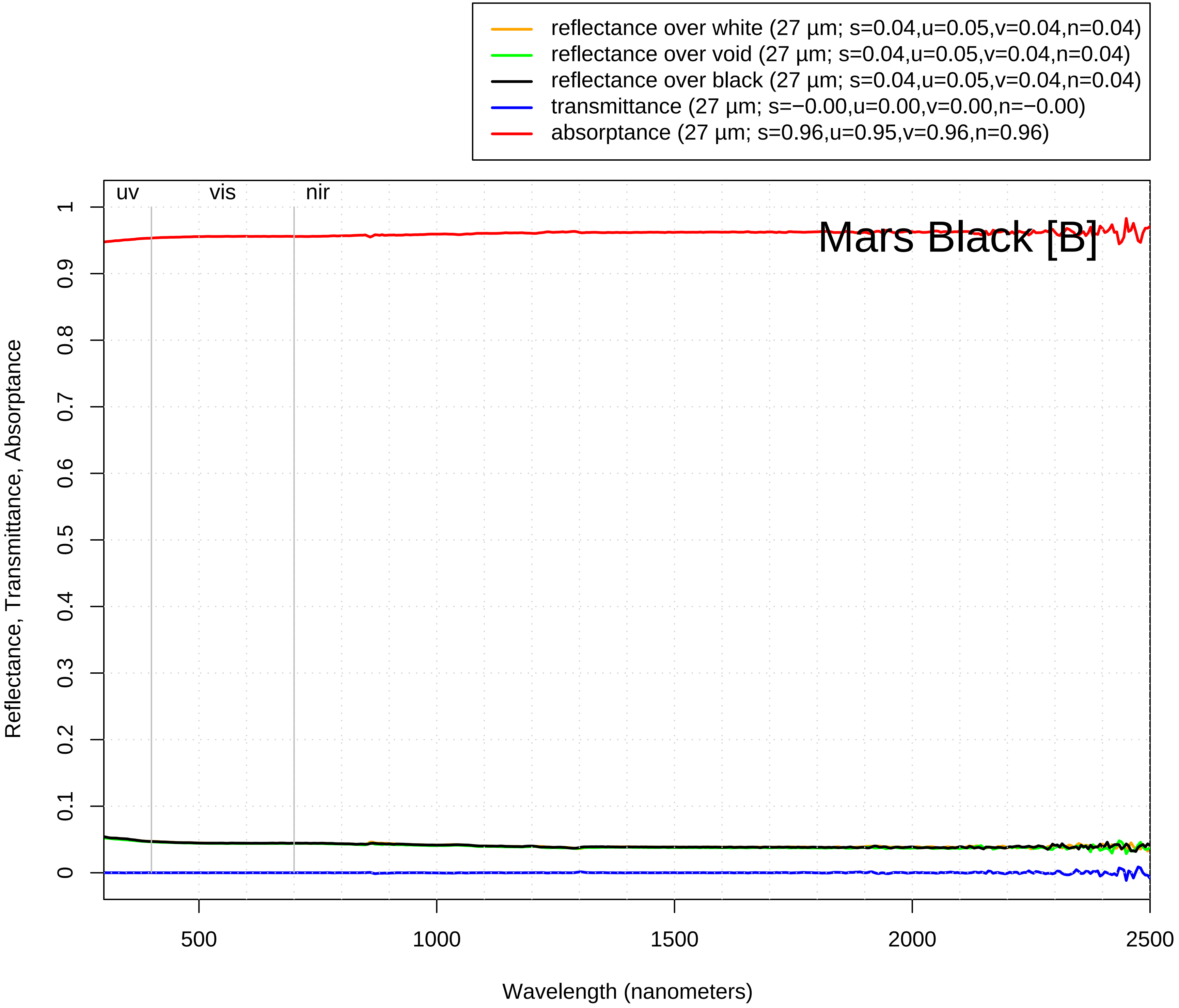
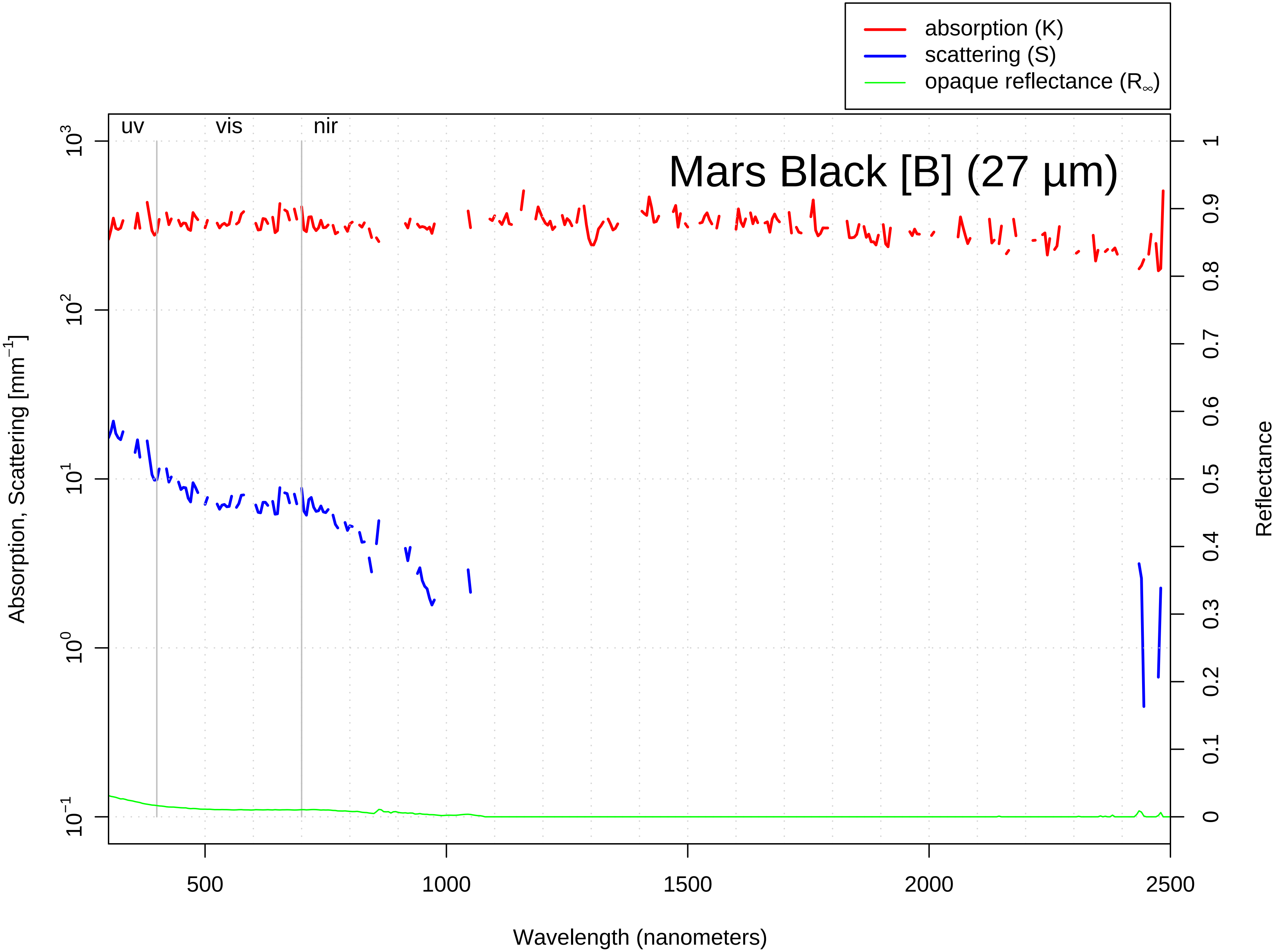


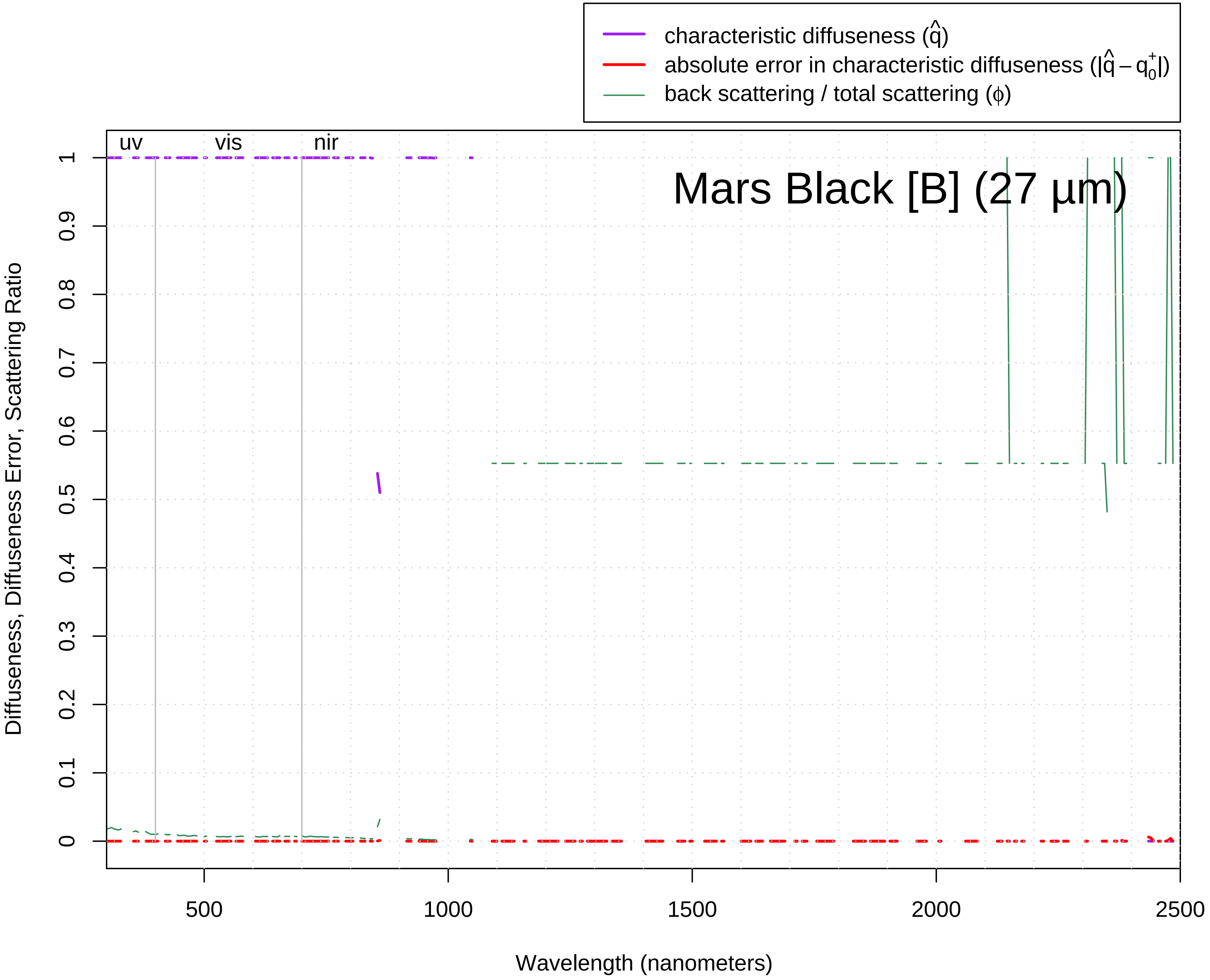
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:46 PM



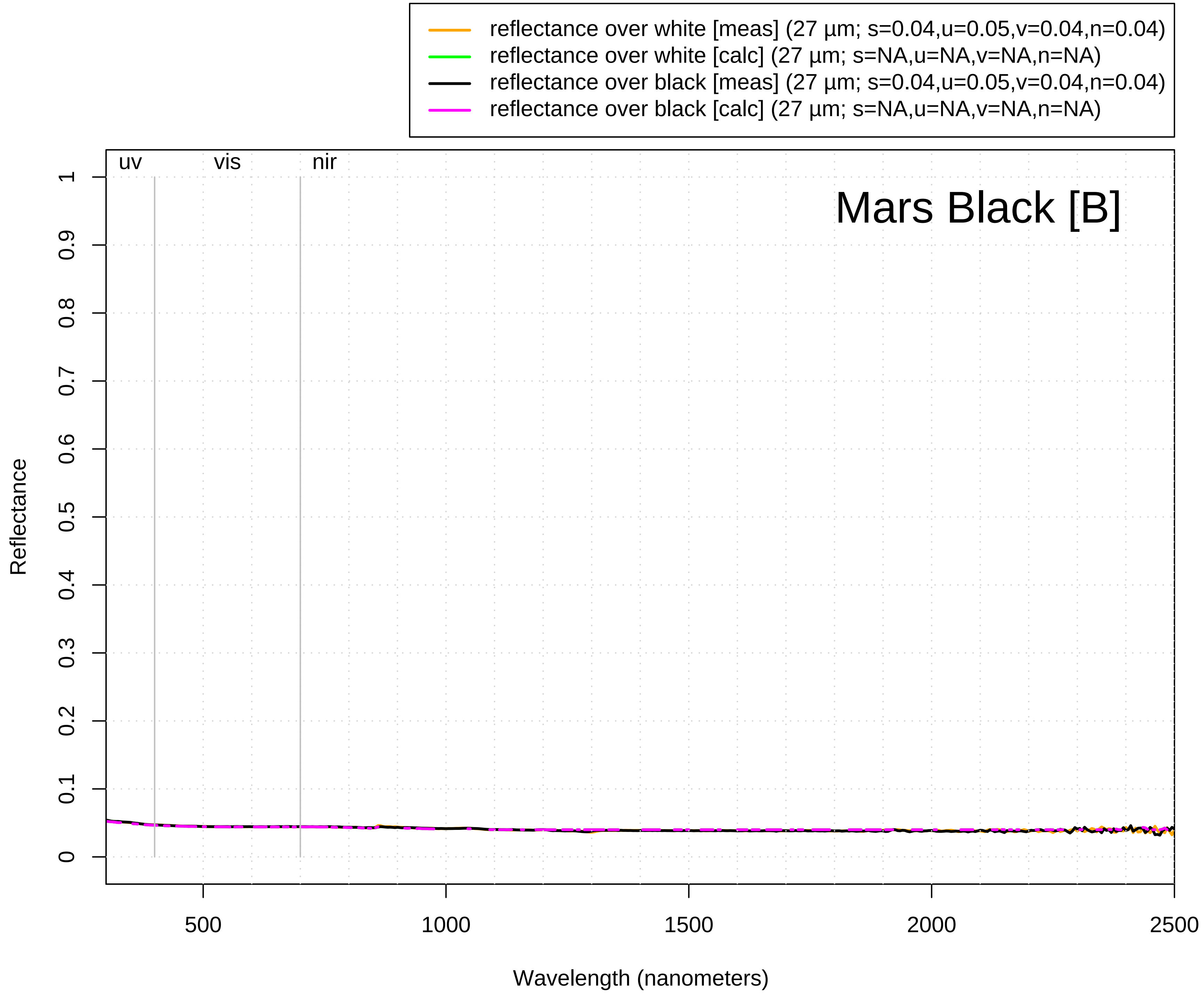
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:46 PM



(c) Ancillary Calculations

Sunday, 09 March 2003 01:46 PM



(d) Calculated vs. Measured Reflectances

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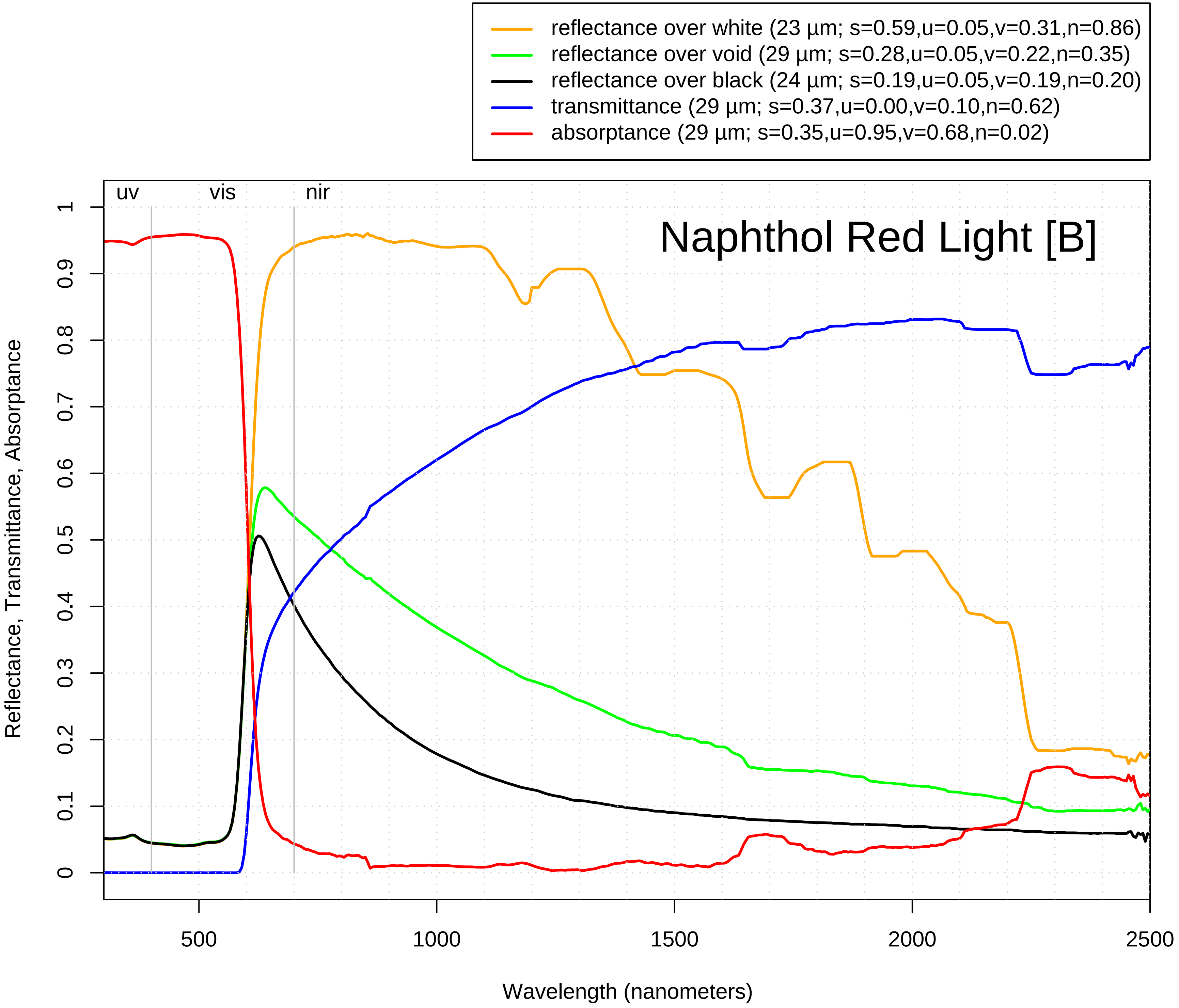
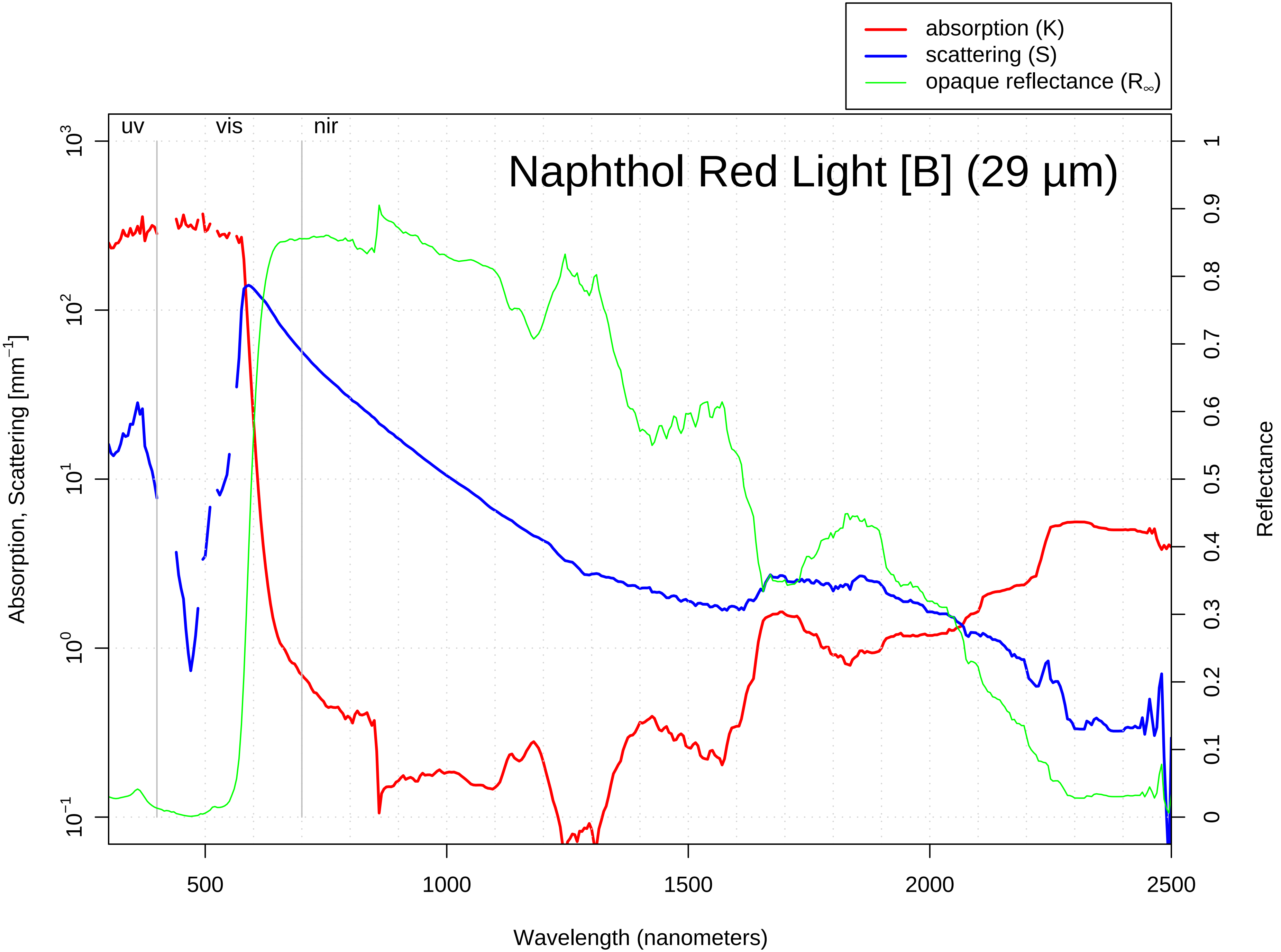


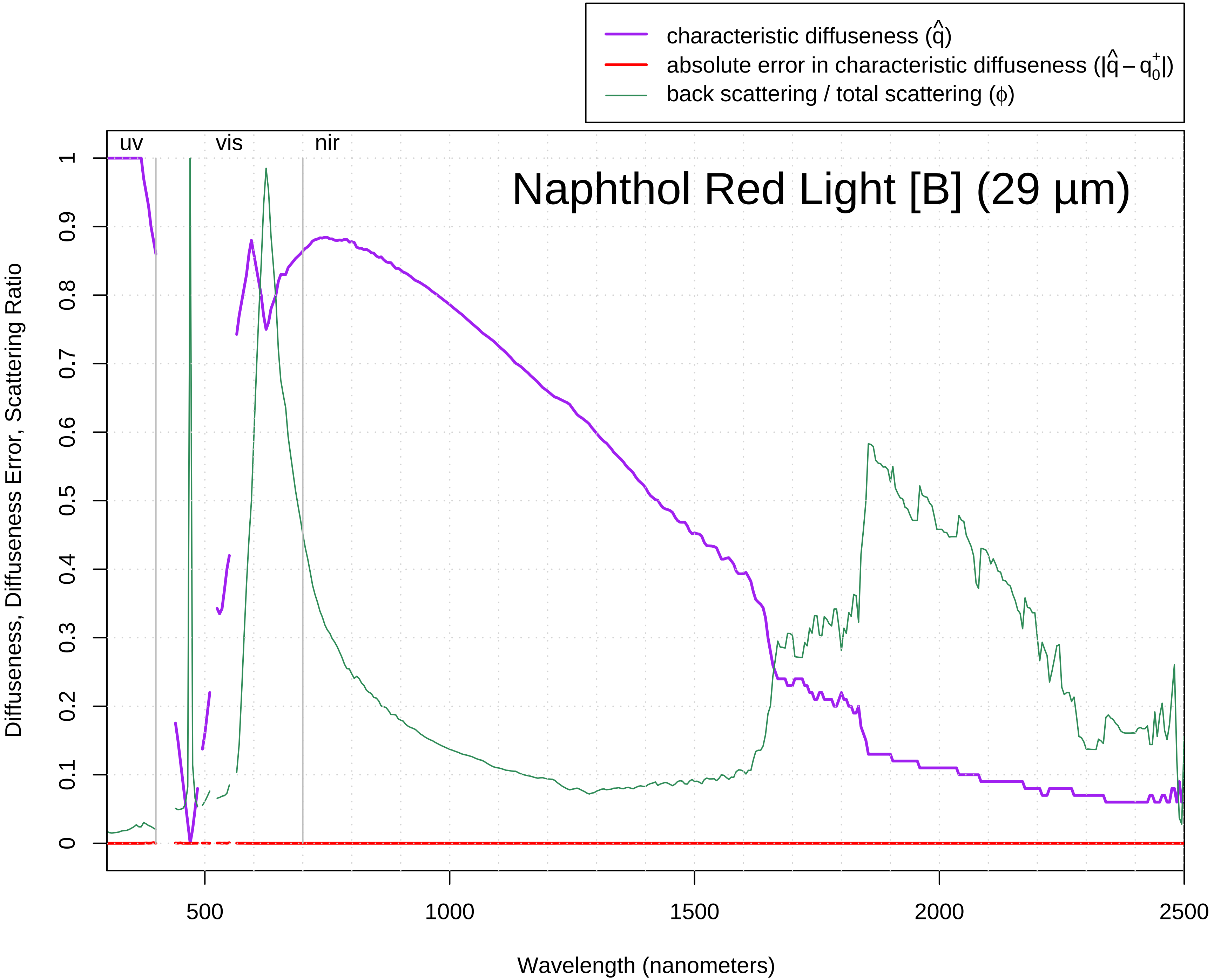
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:49 PM



(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:49 PM



(c) Ancillary Calculations

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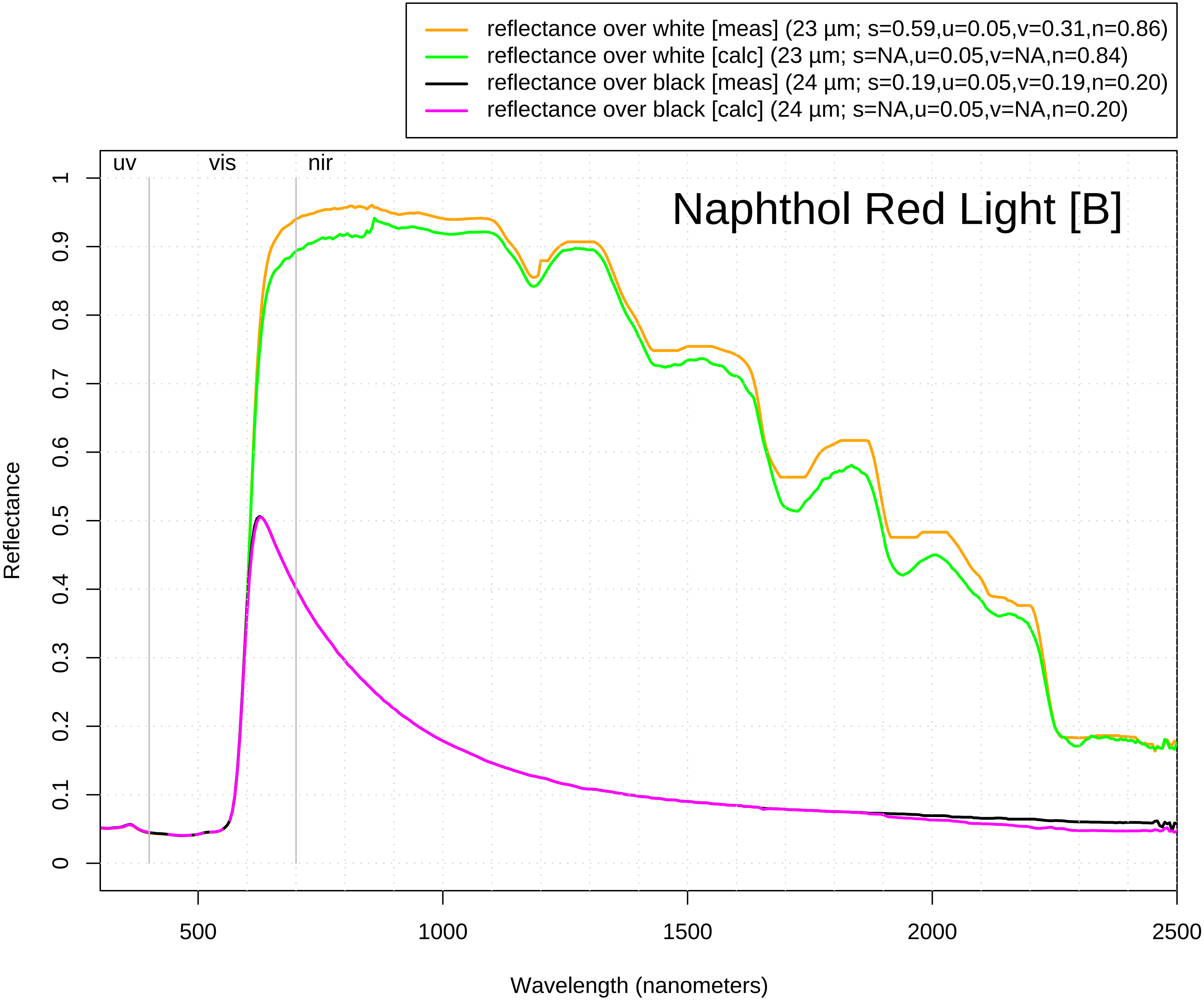
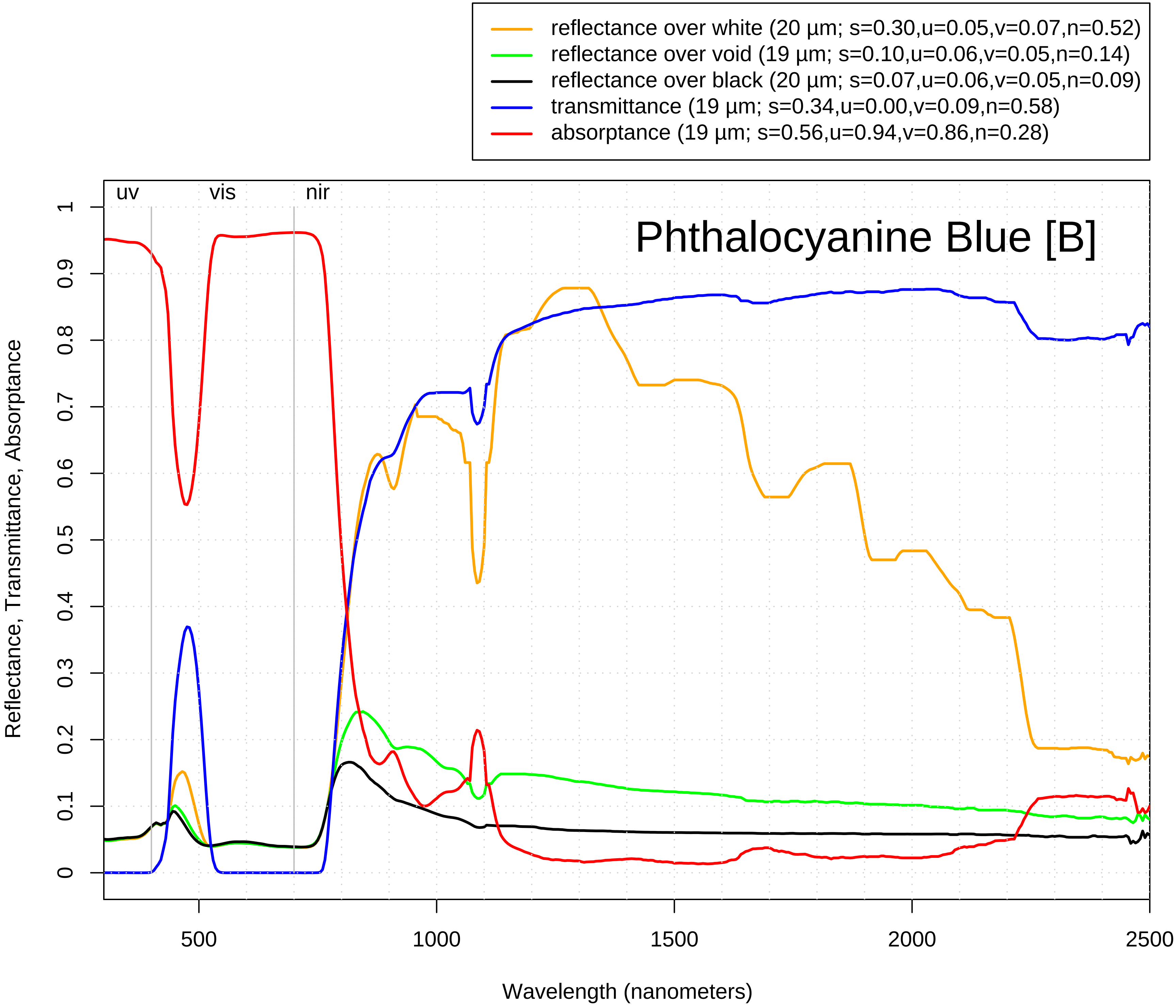


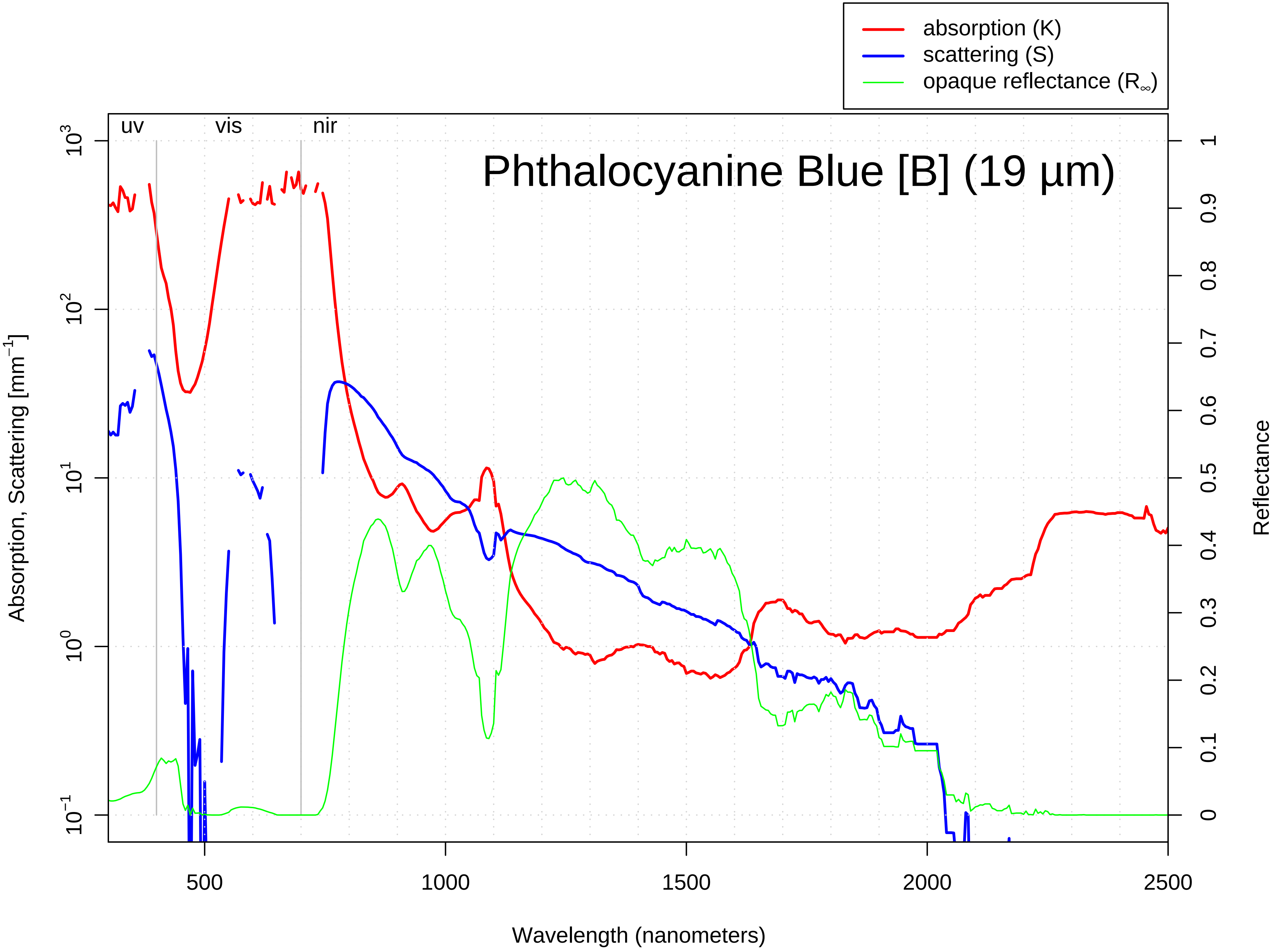
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:49 PM



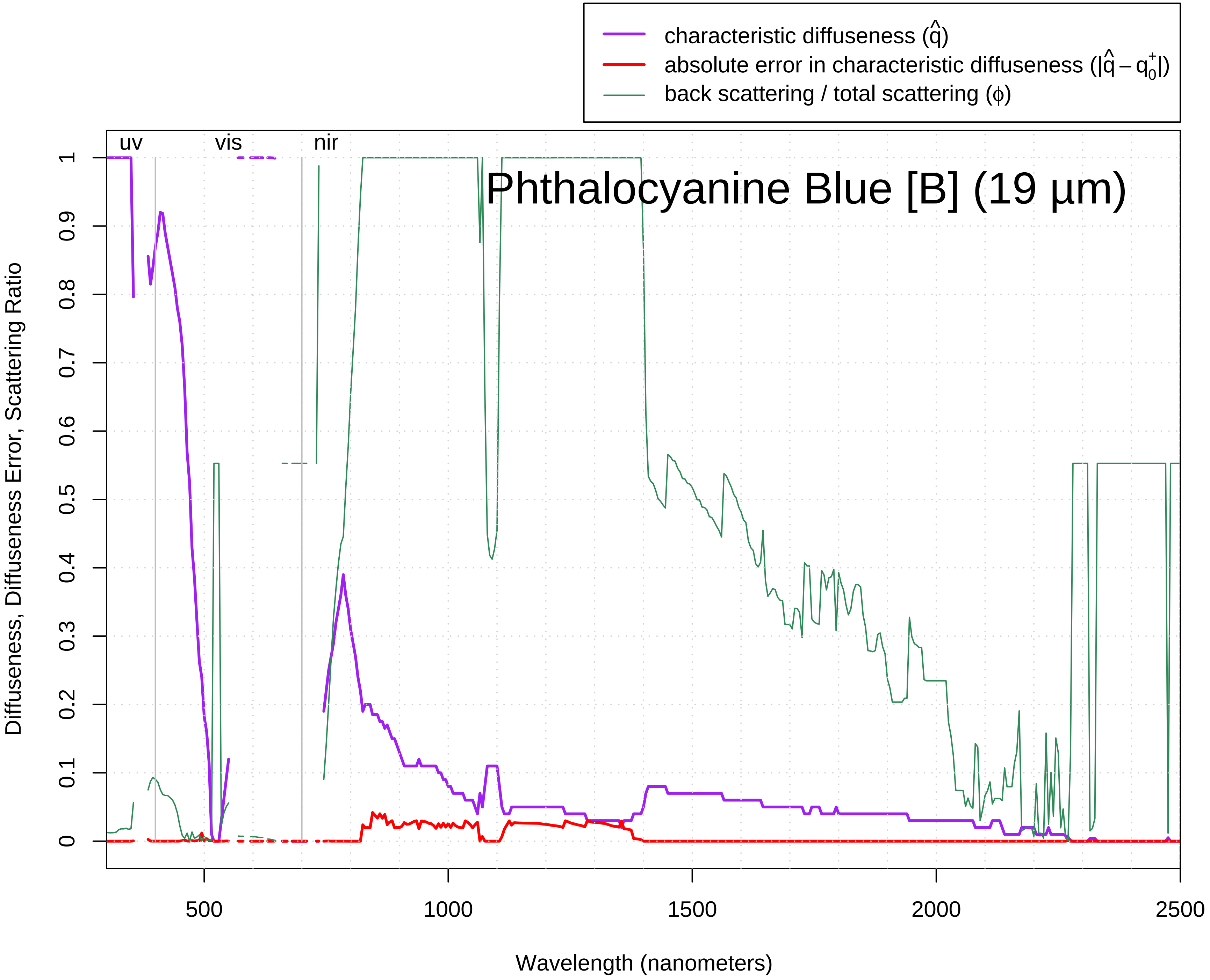
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:55 PM



(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:55 PM



(c) Ancillary Calculations

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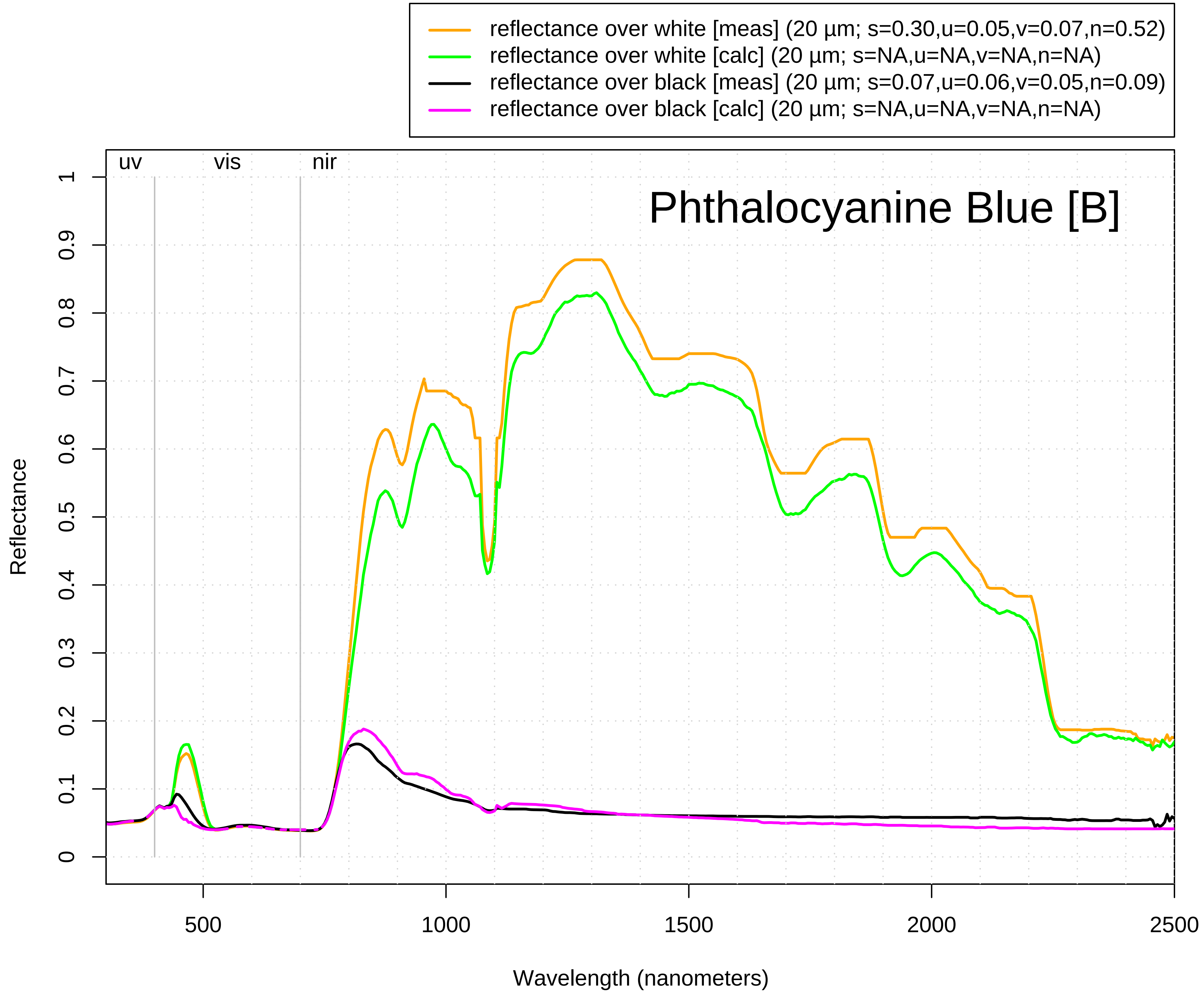
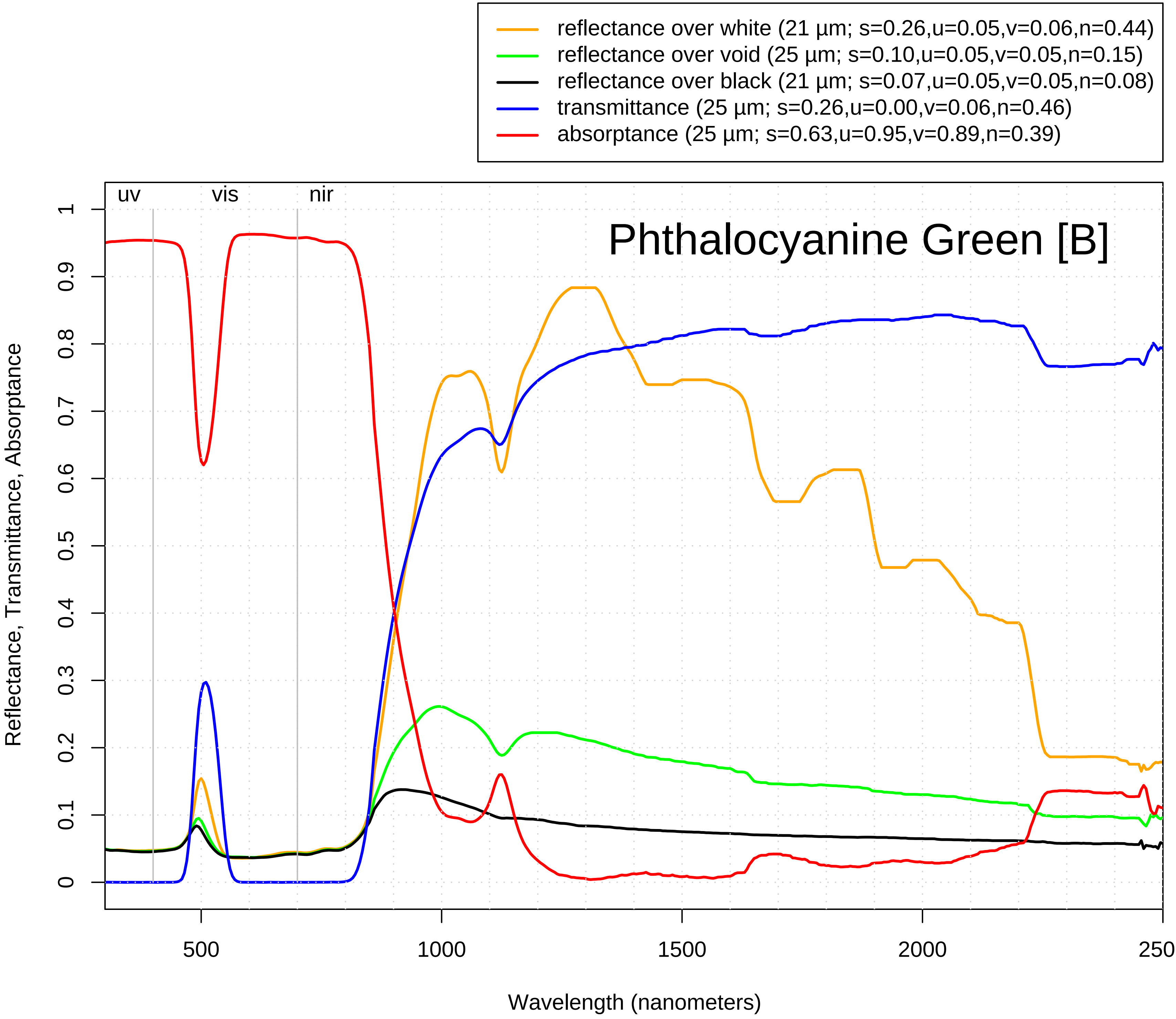


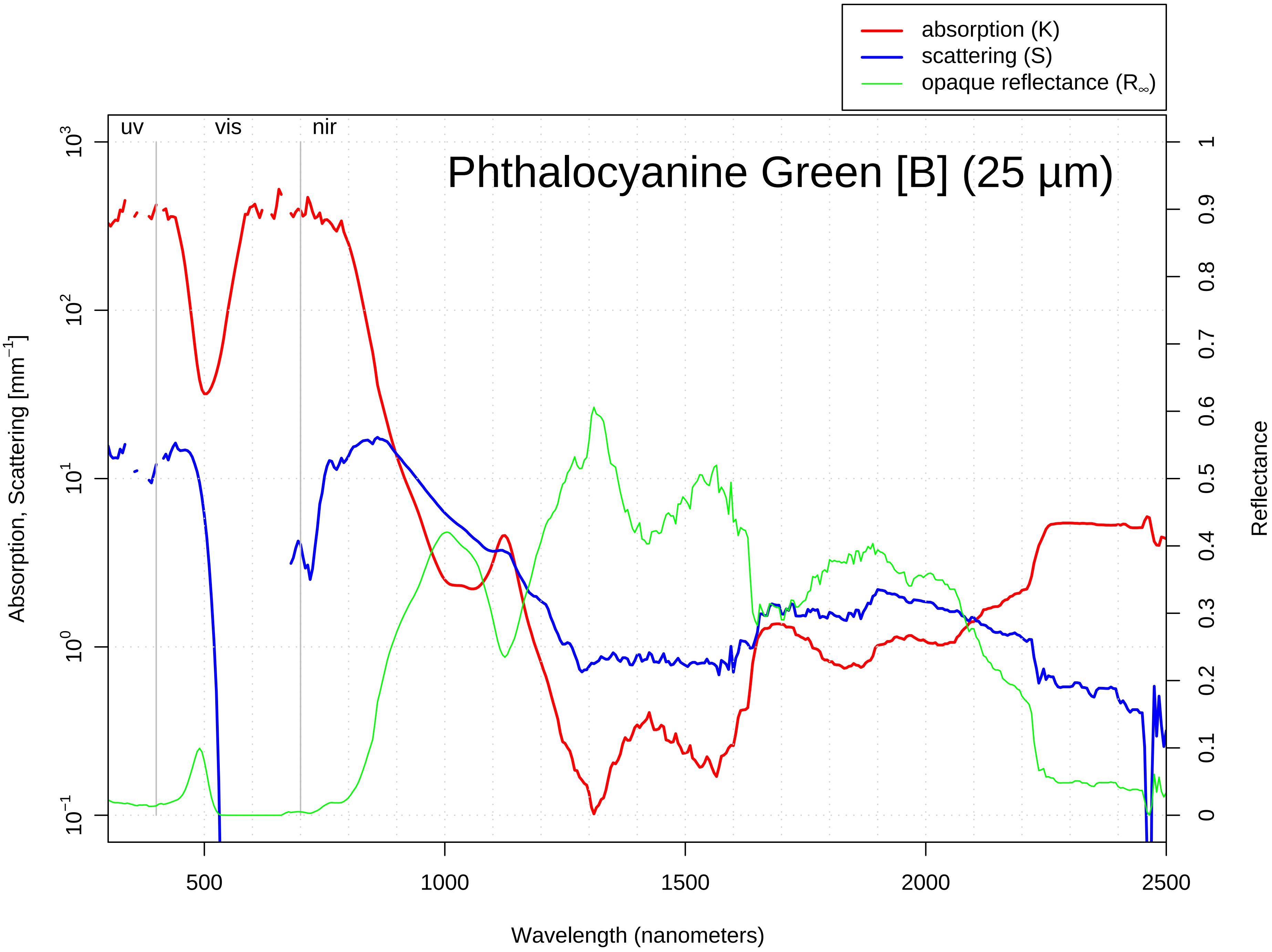
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 01:55 PM



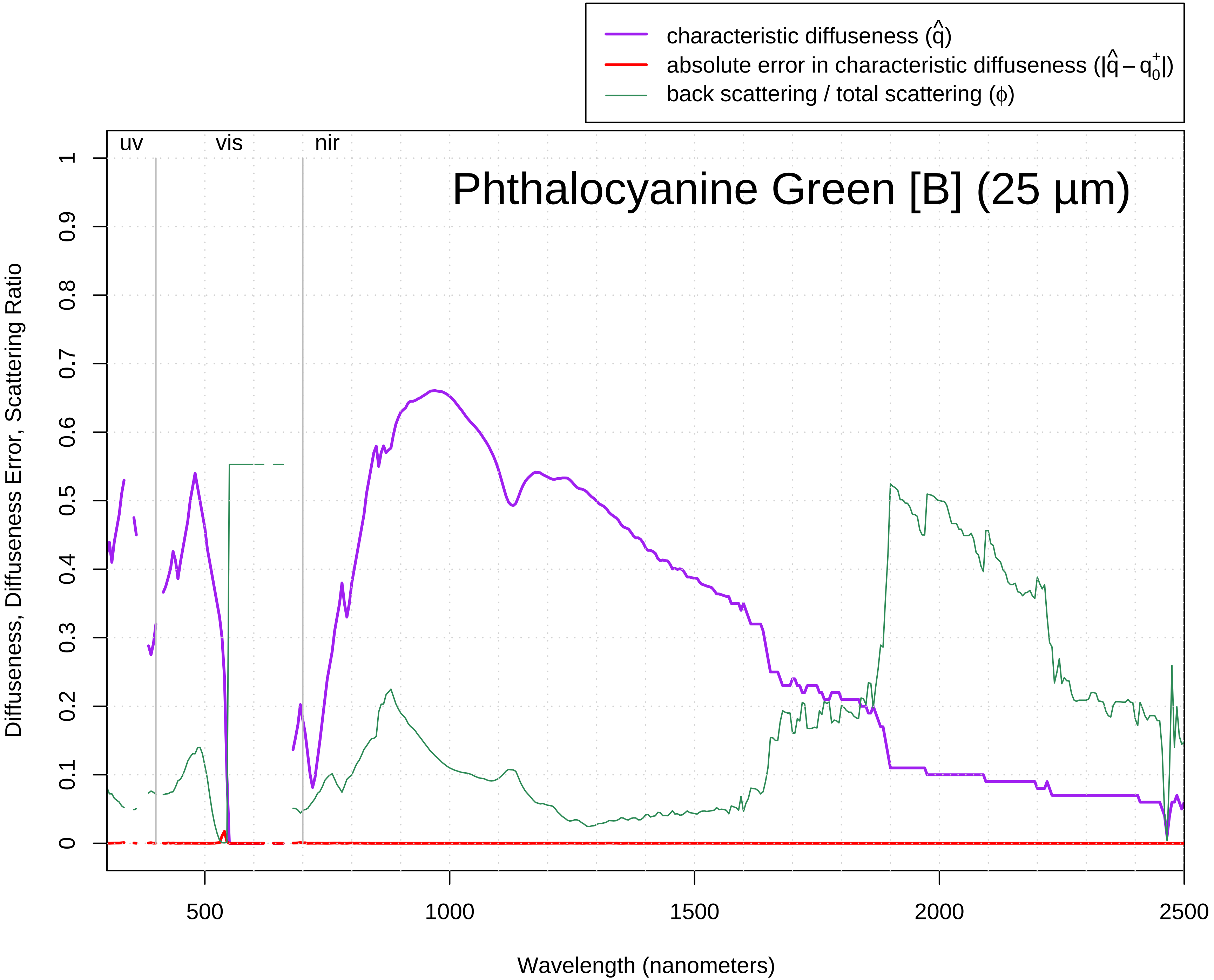
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 01:58 PM



(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 01:58 PM



(c) Ancillary Calculations

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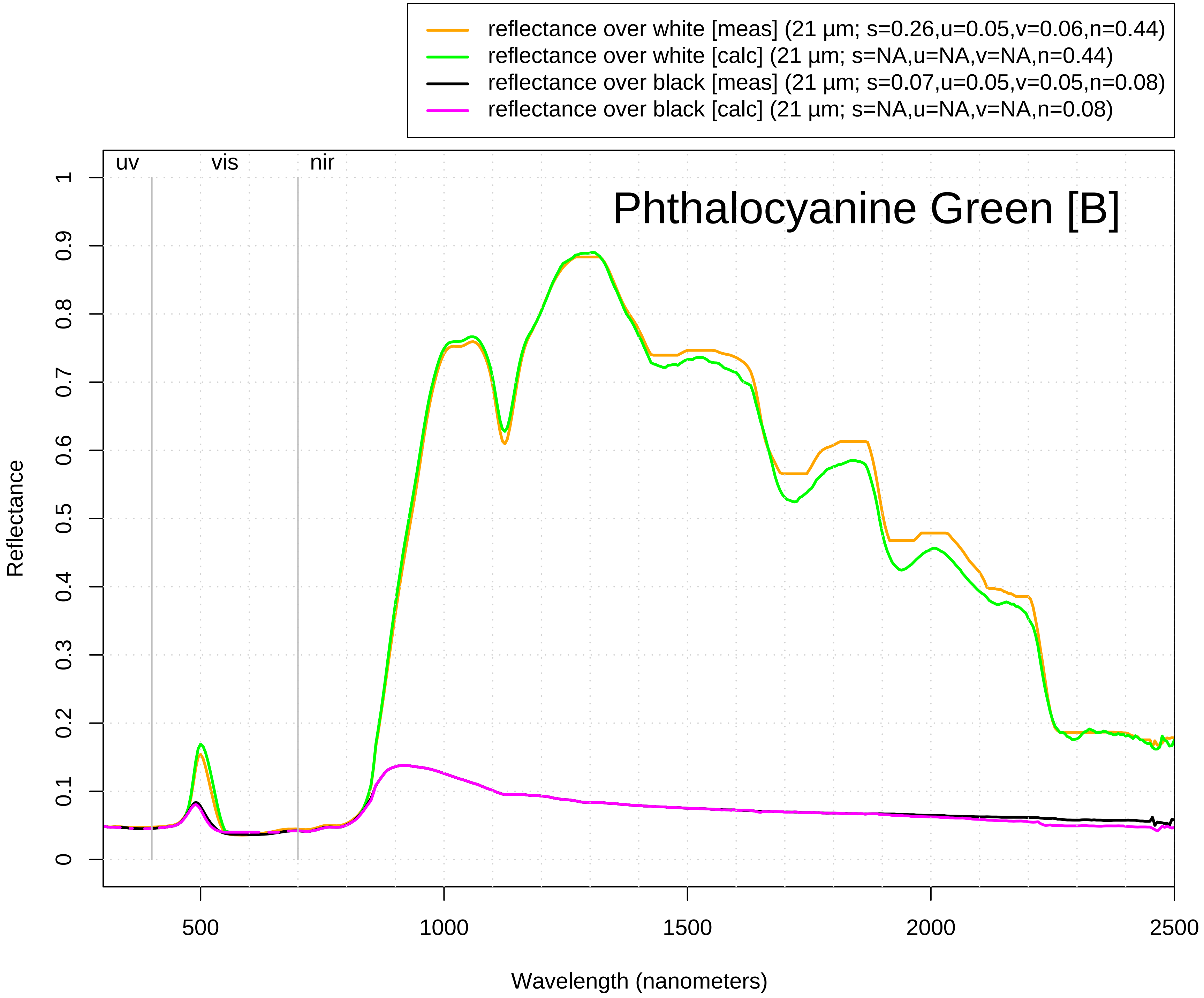

(d) Calculated vs. Measured Reflectances

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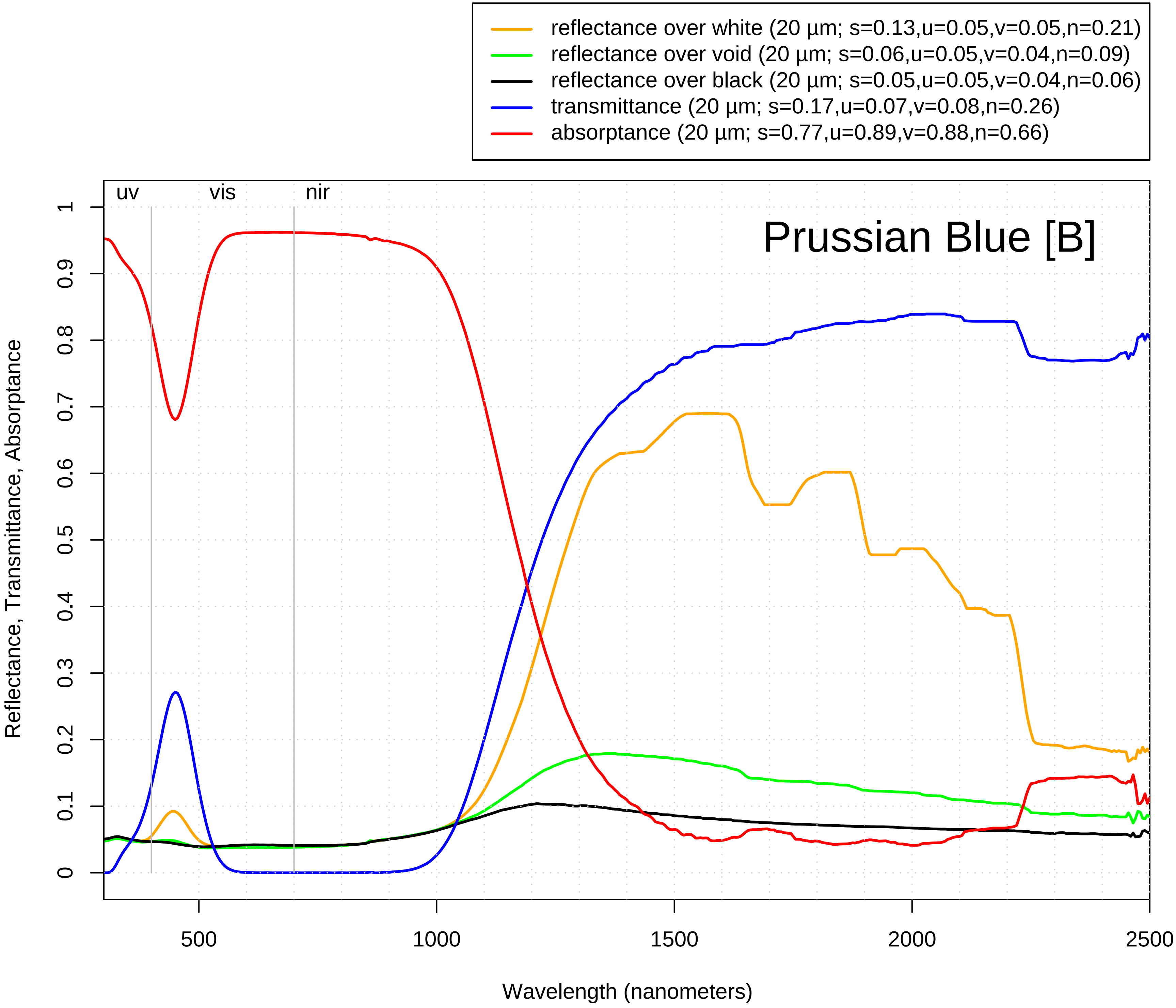
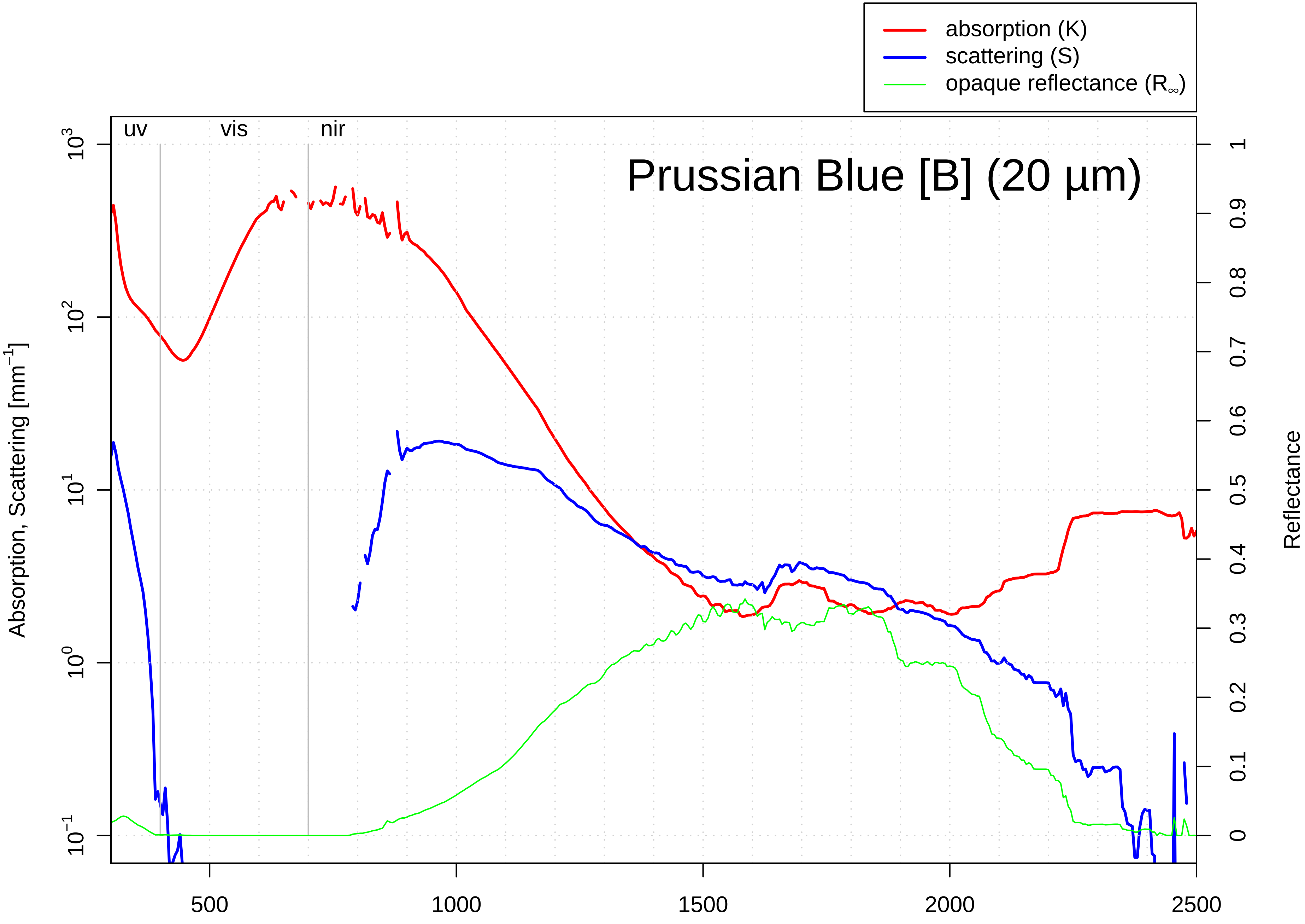


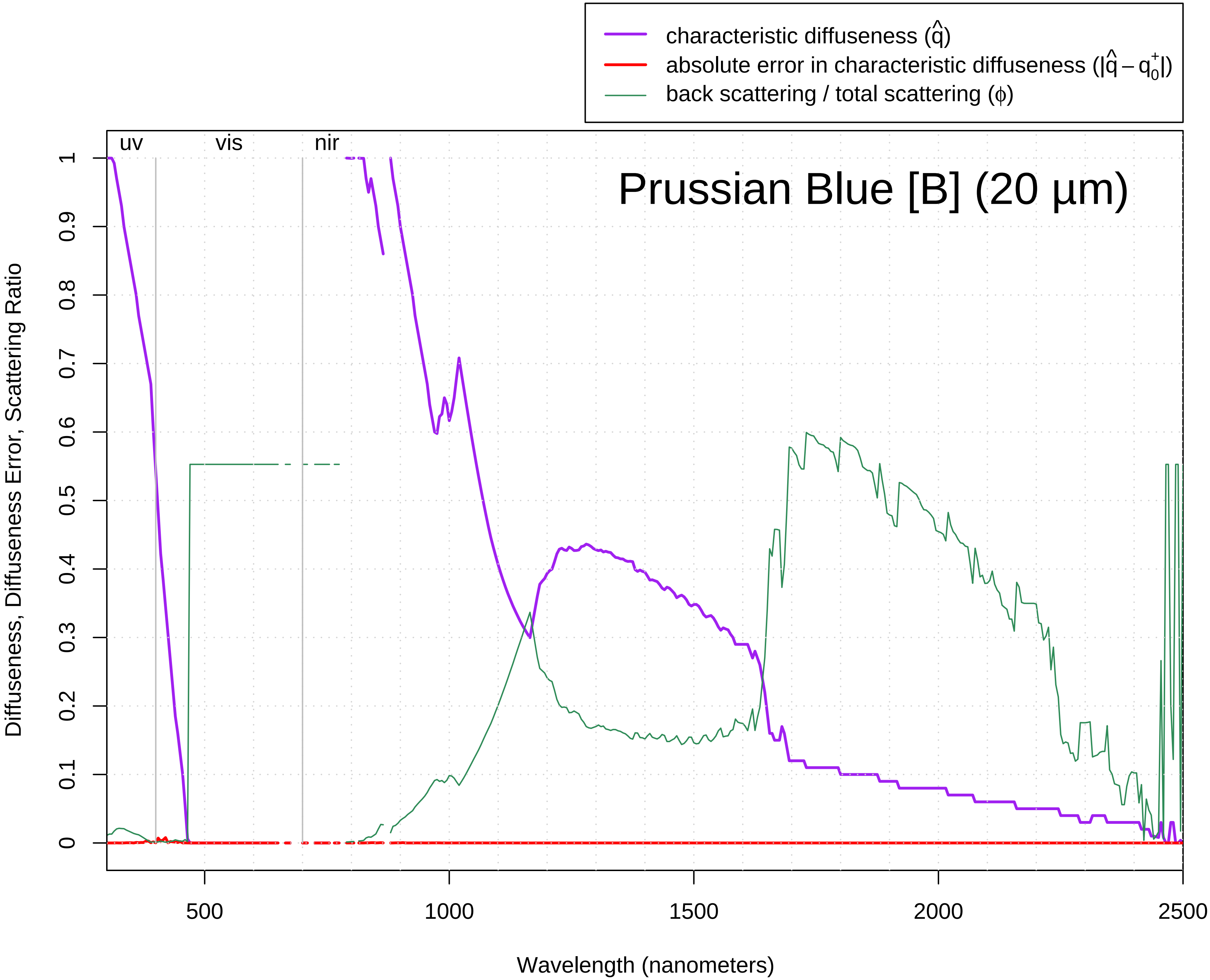
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:03 PM



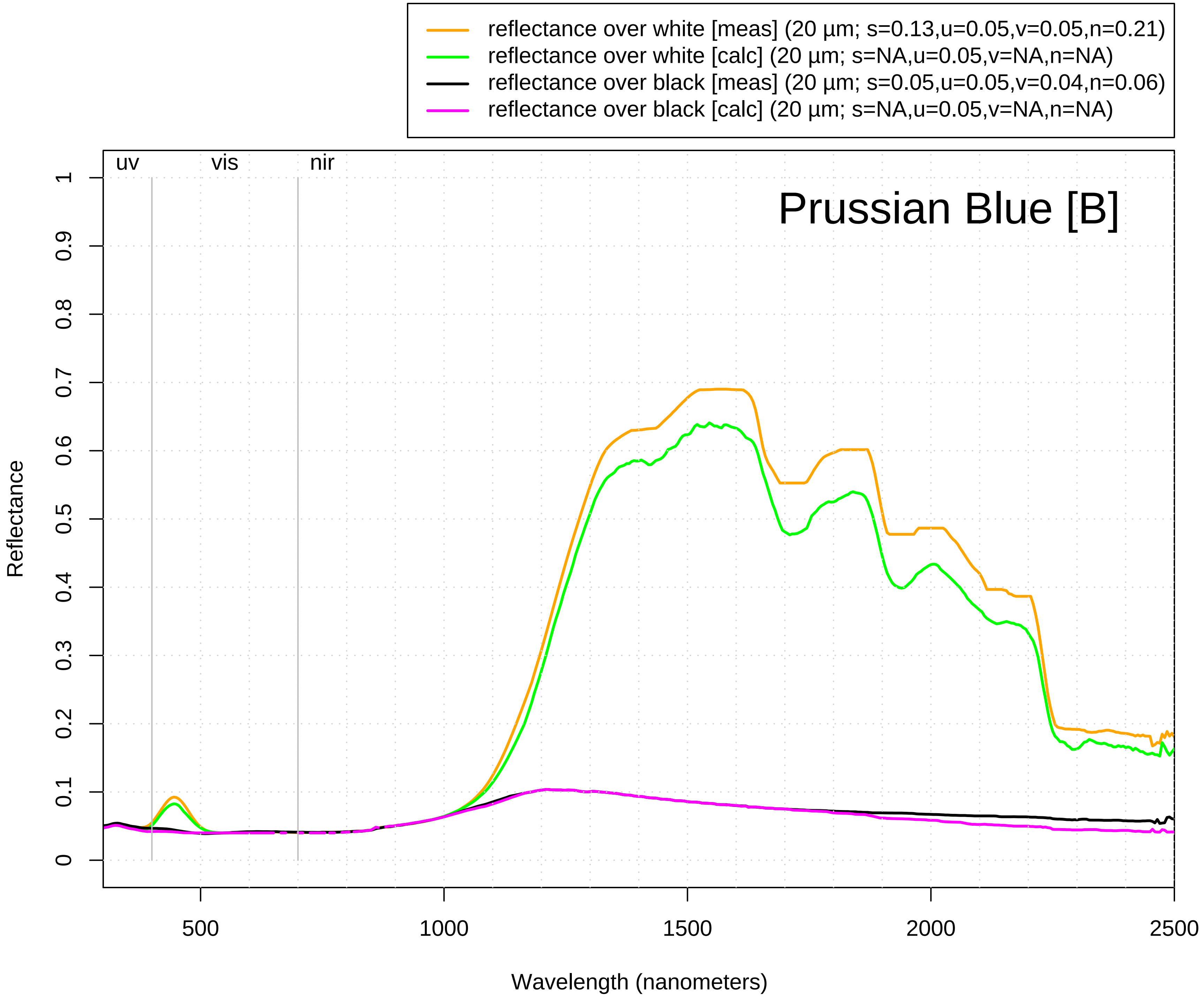
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:03 PM



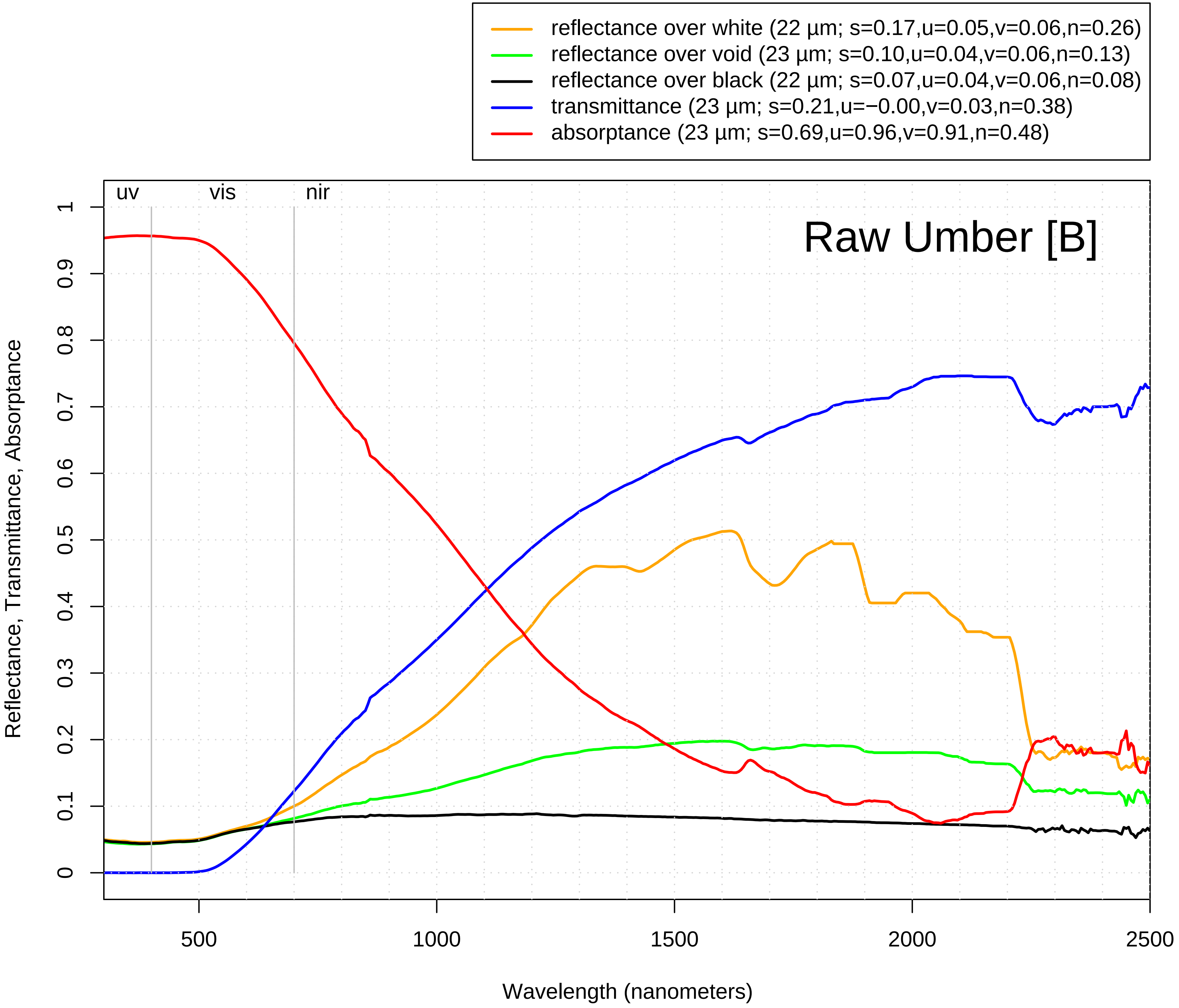
(c) Ancillary Calculations

Sunday, 09 March 2003 02:03 PM



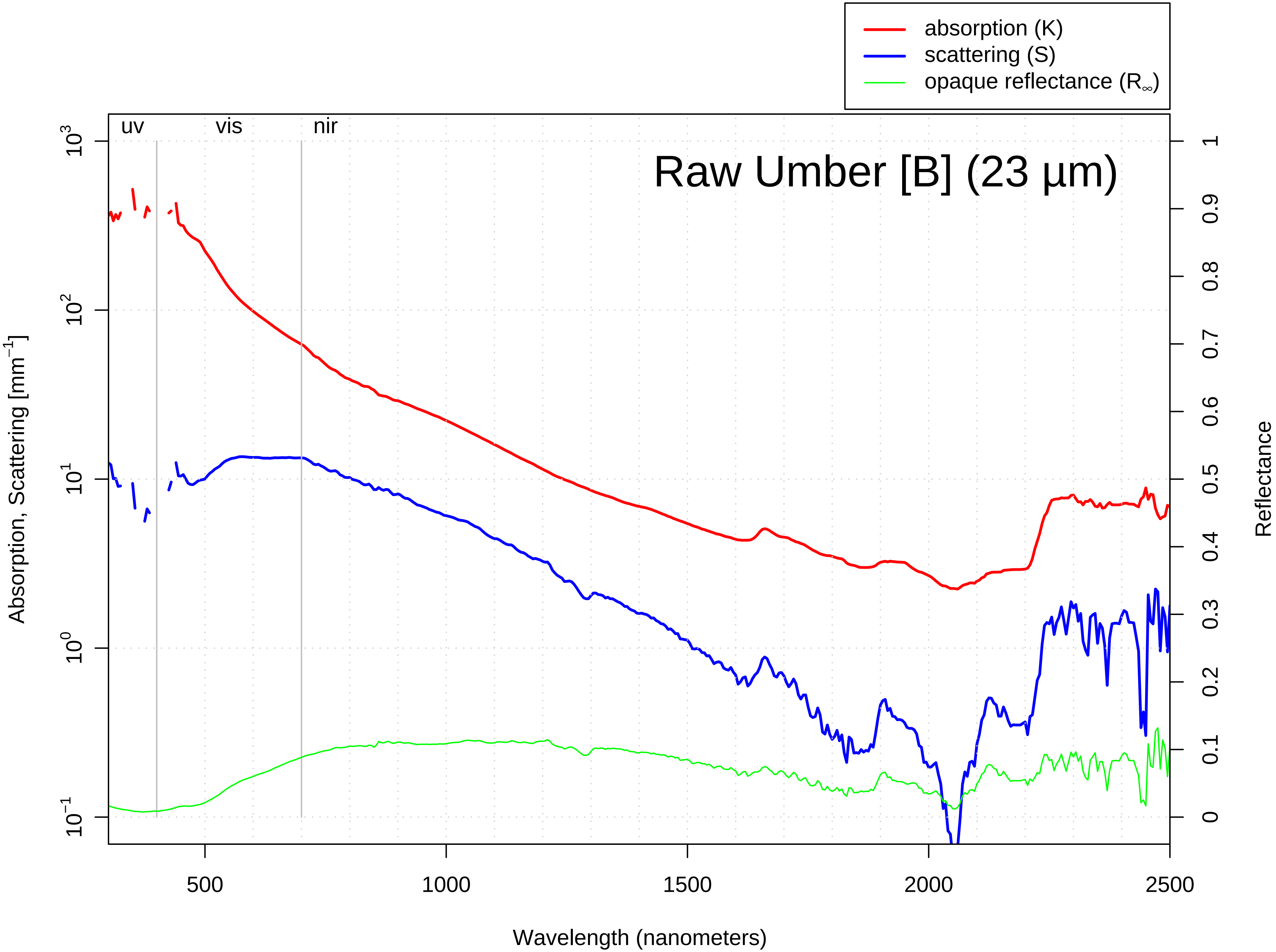
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:03 PM



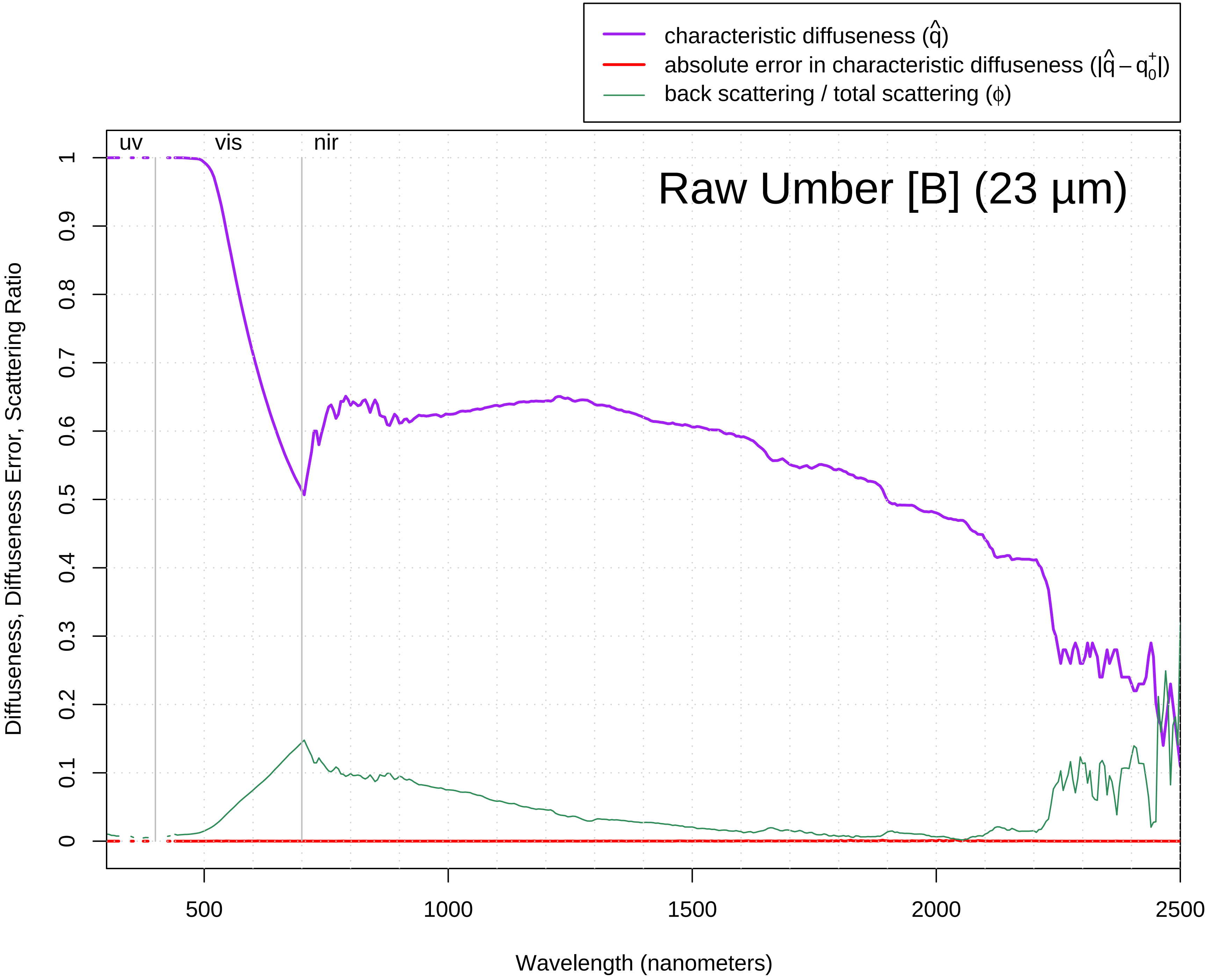
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:05 PM



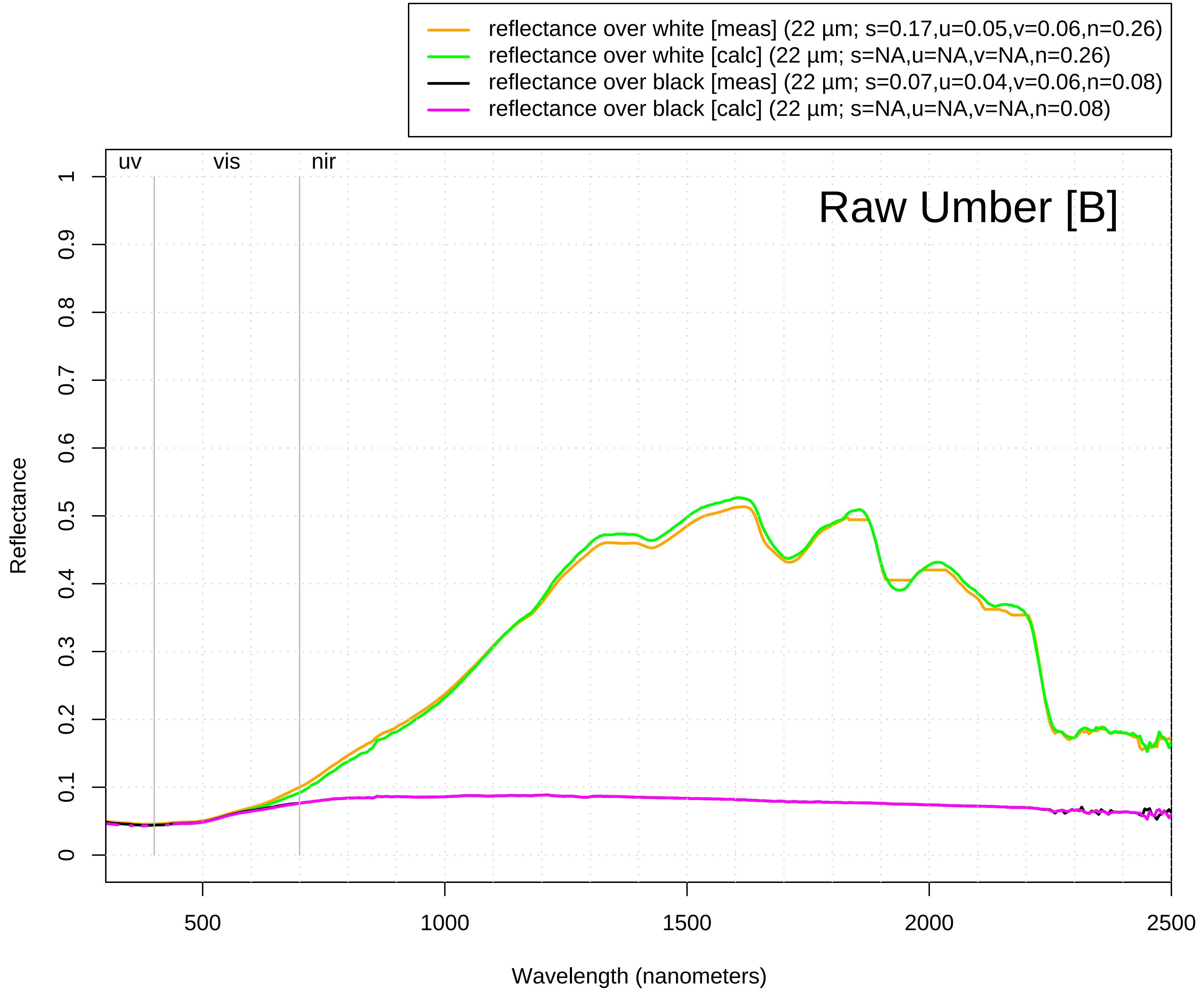
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:05 PM



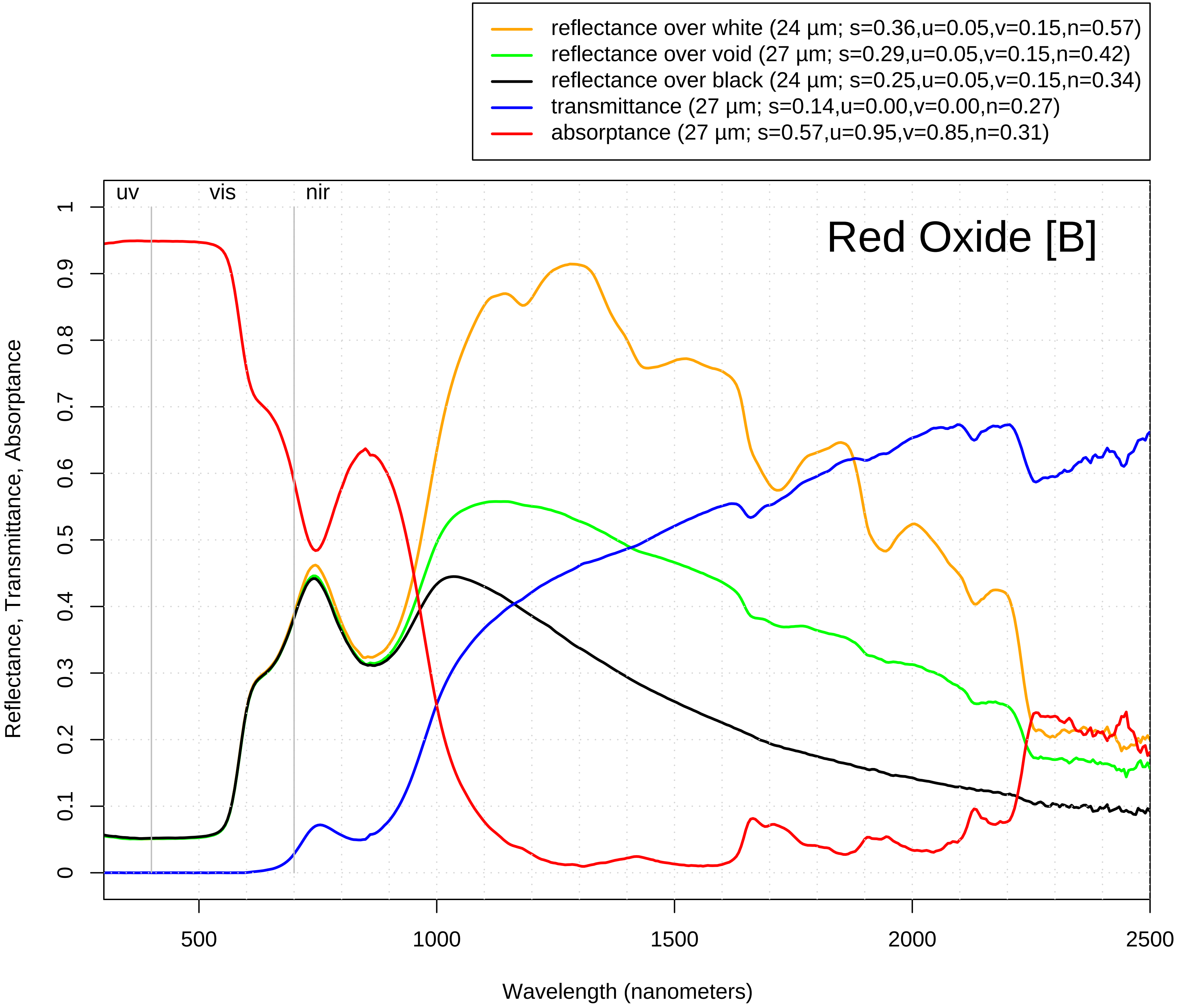
(c) Ancillary Calculations

Sunday, 09 March 2003 02:05 PM



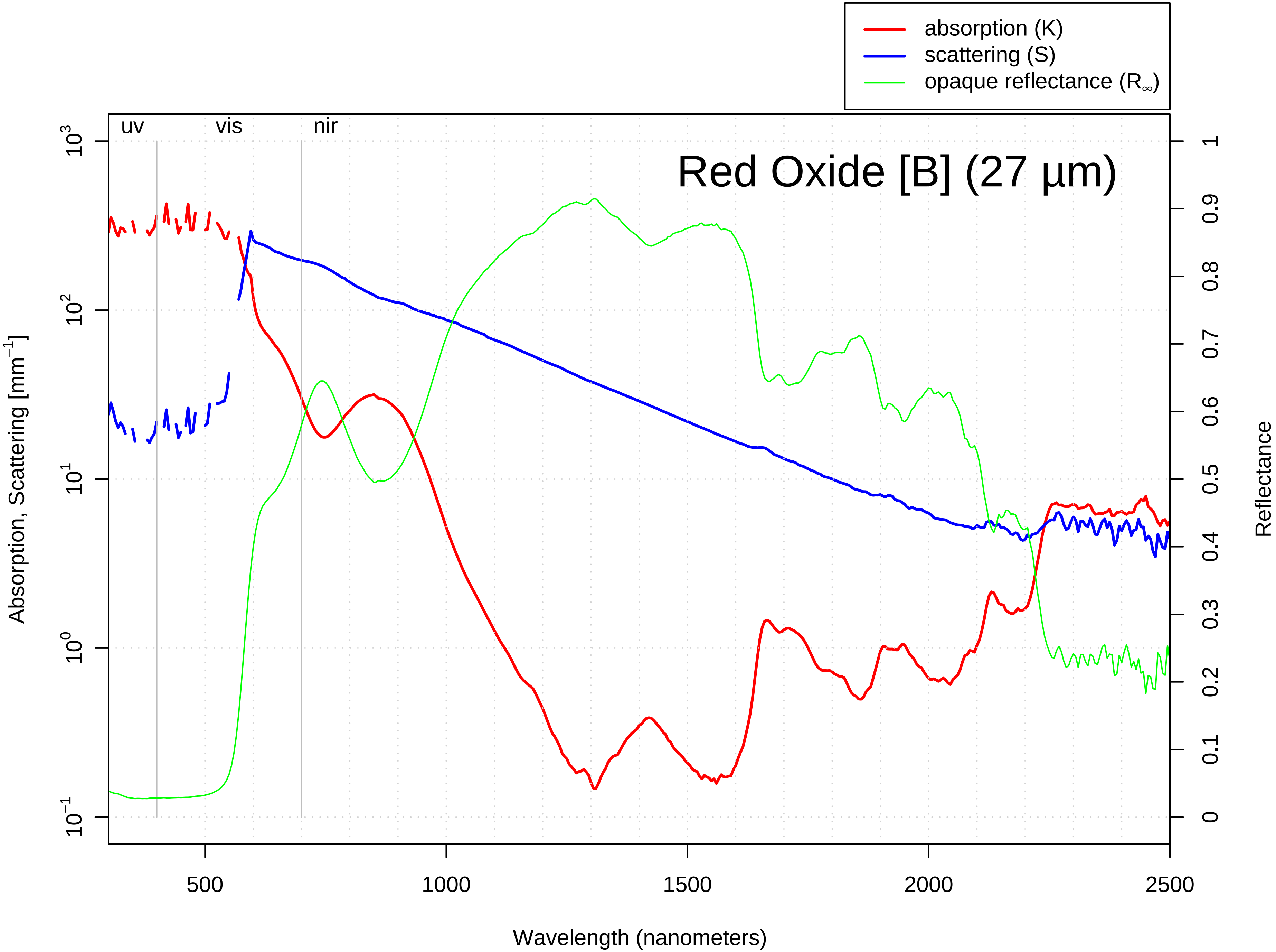
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:05 PM



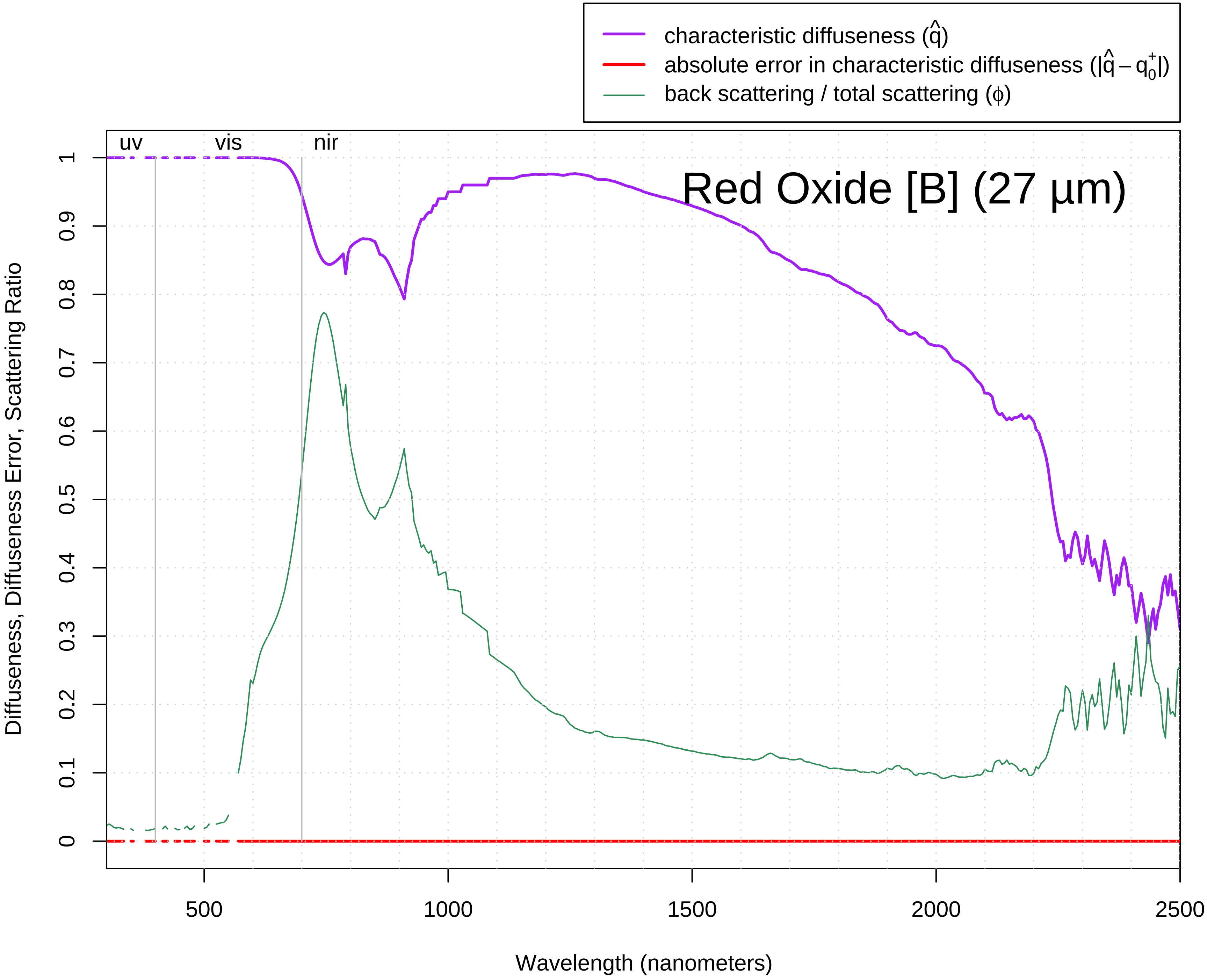
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:08 PM



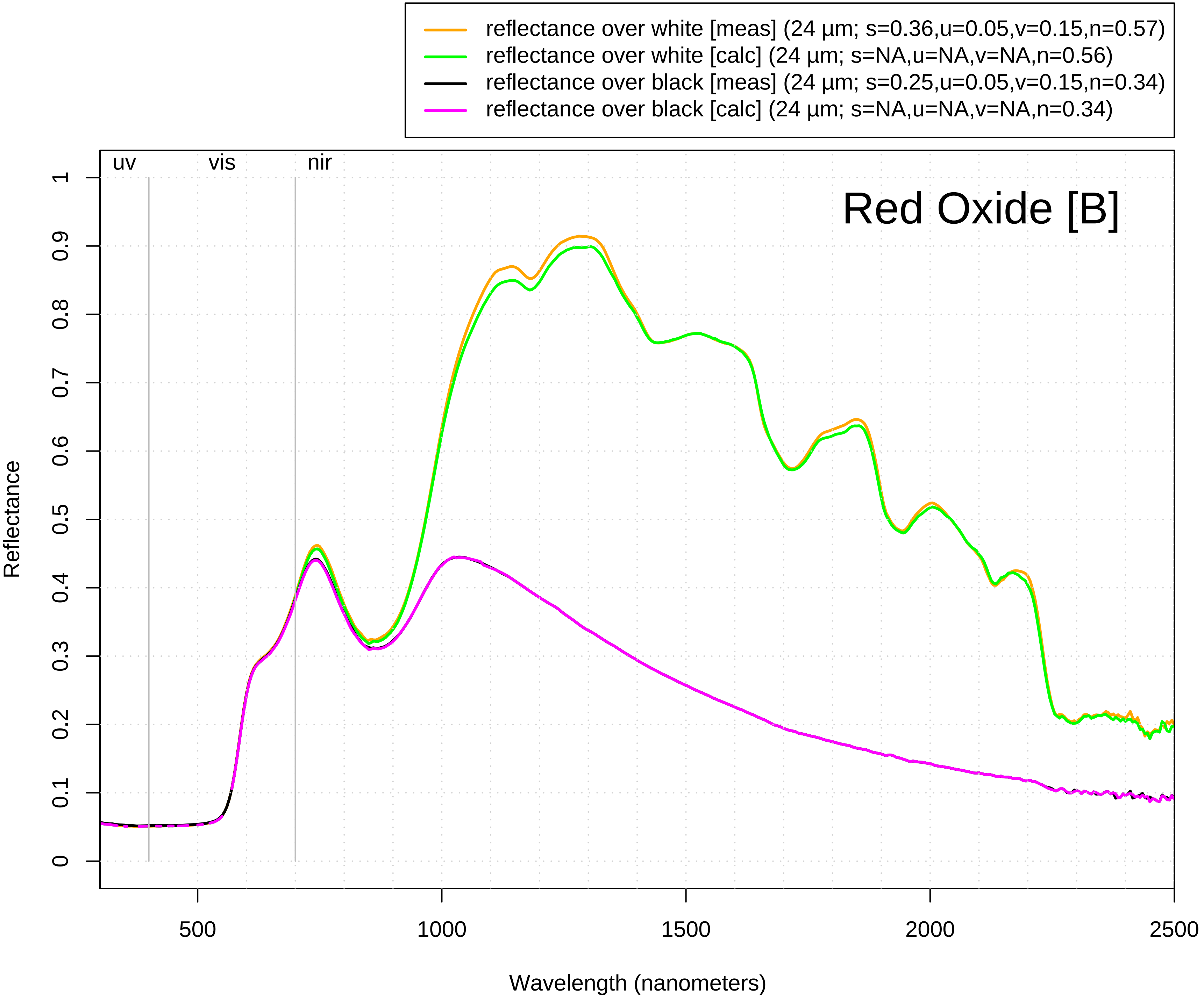
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:08 PM



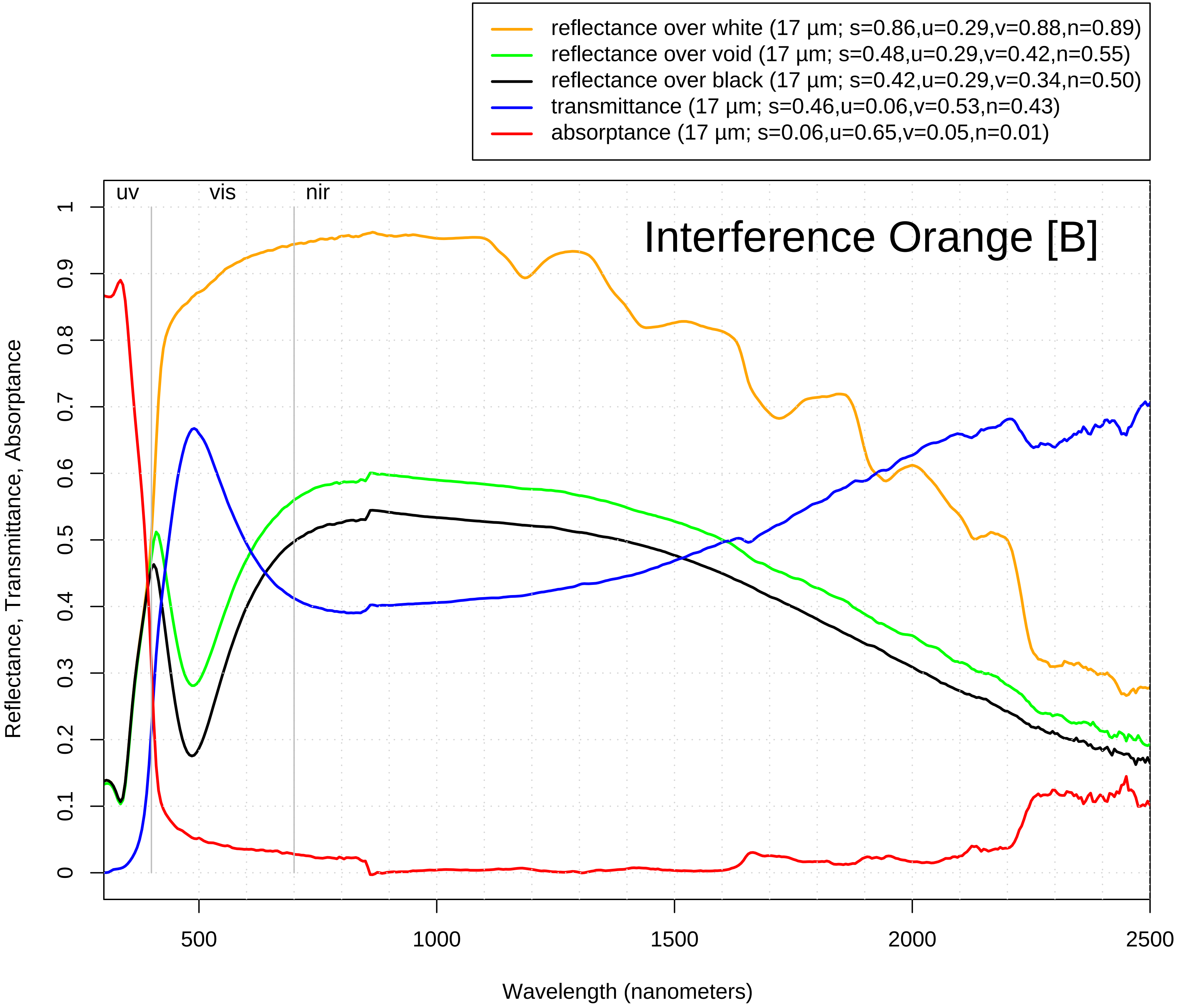
(c) Ancillary Calculations

Sunday, 09 March 2003 02:08 PM



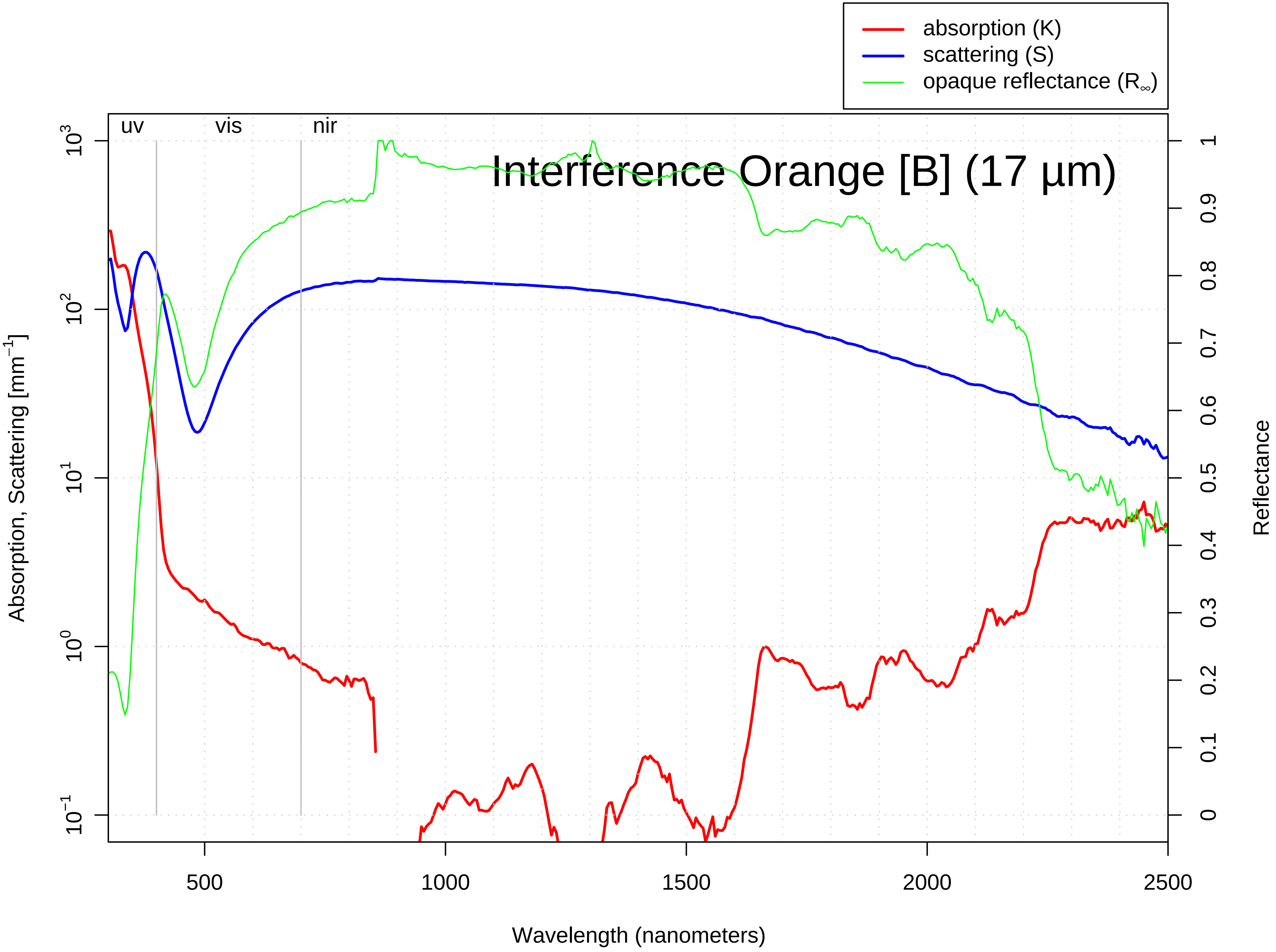
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:08 PM



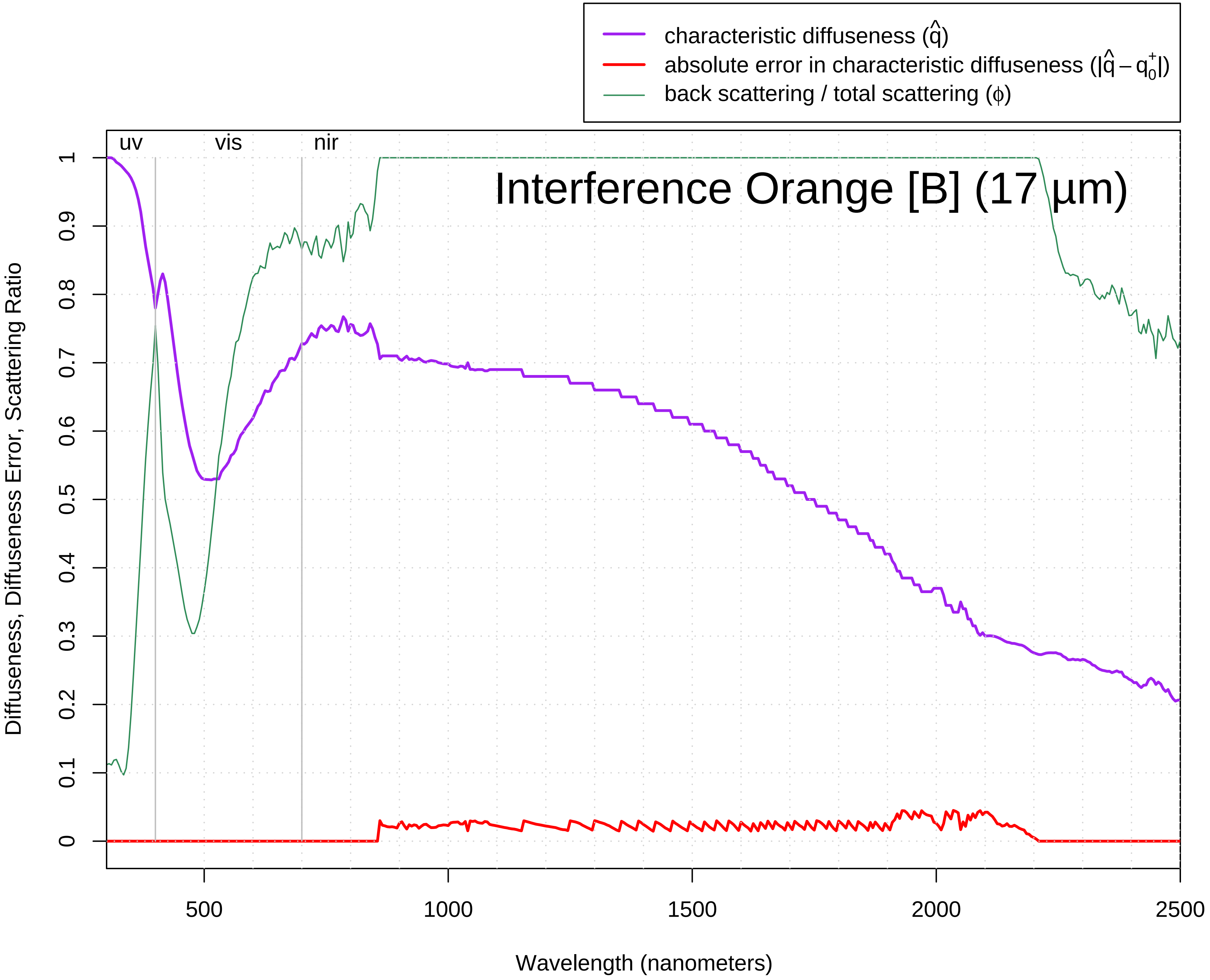
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:13 PM



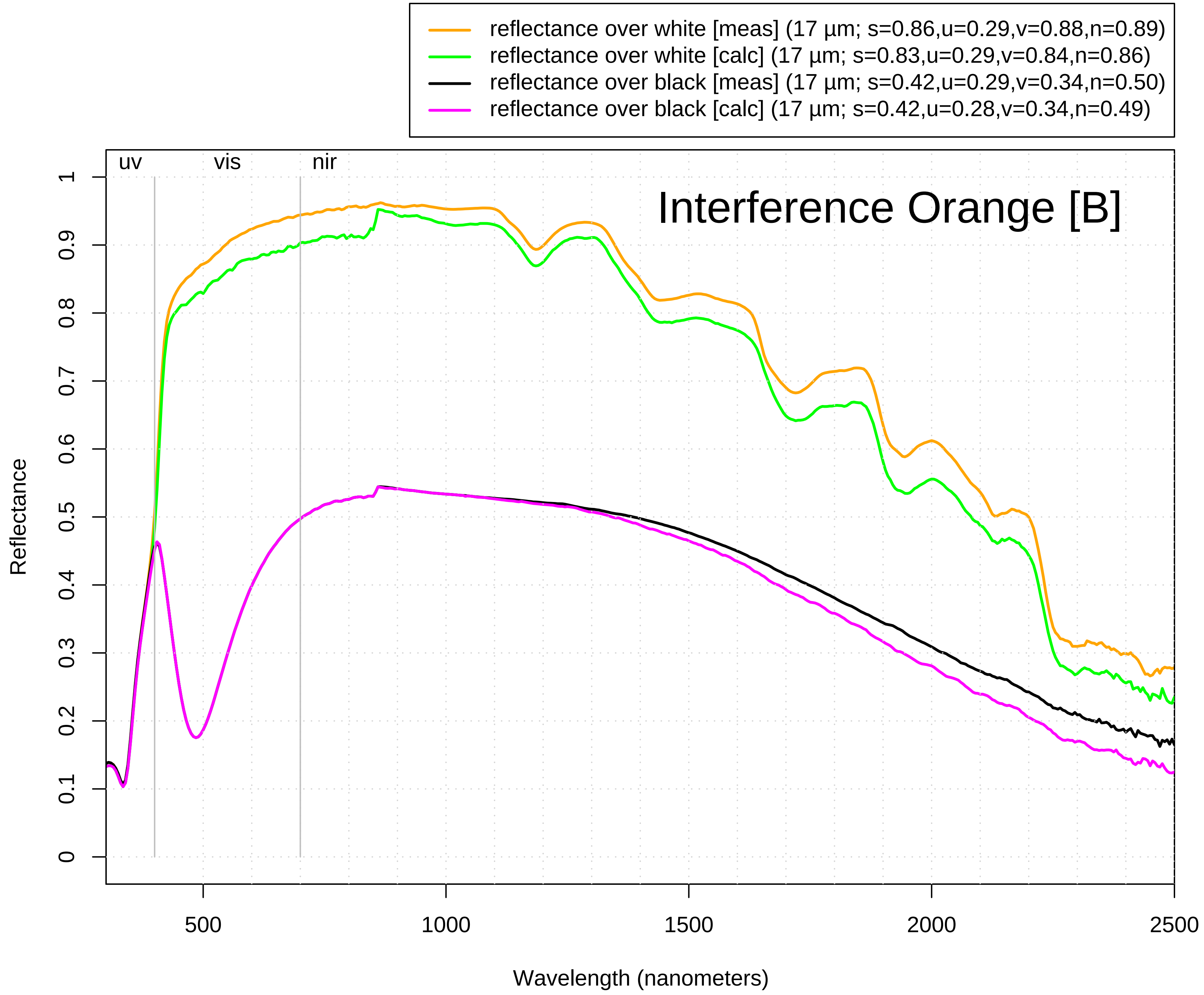
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:13 PM



(c) Ancillary Calculations

Sunday, 09 March 2003 02:13 PM



(d) Calculated vs. Measured Reflectances

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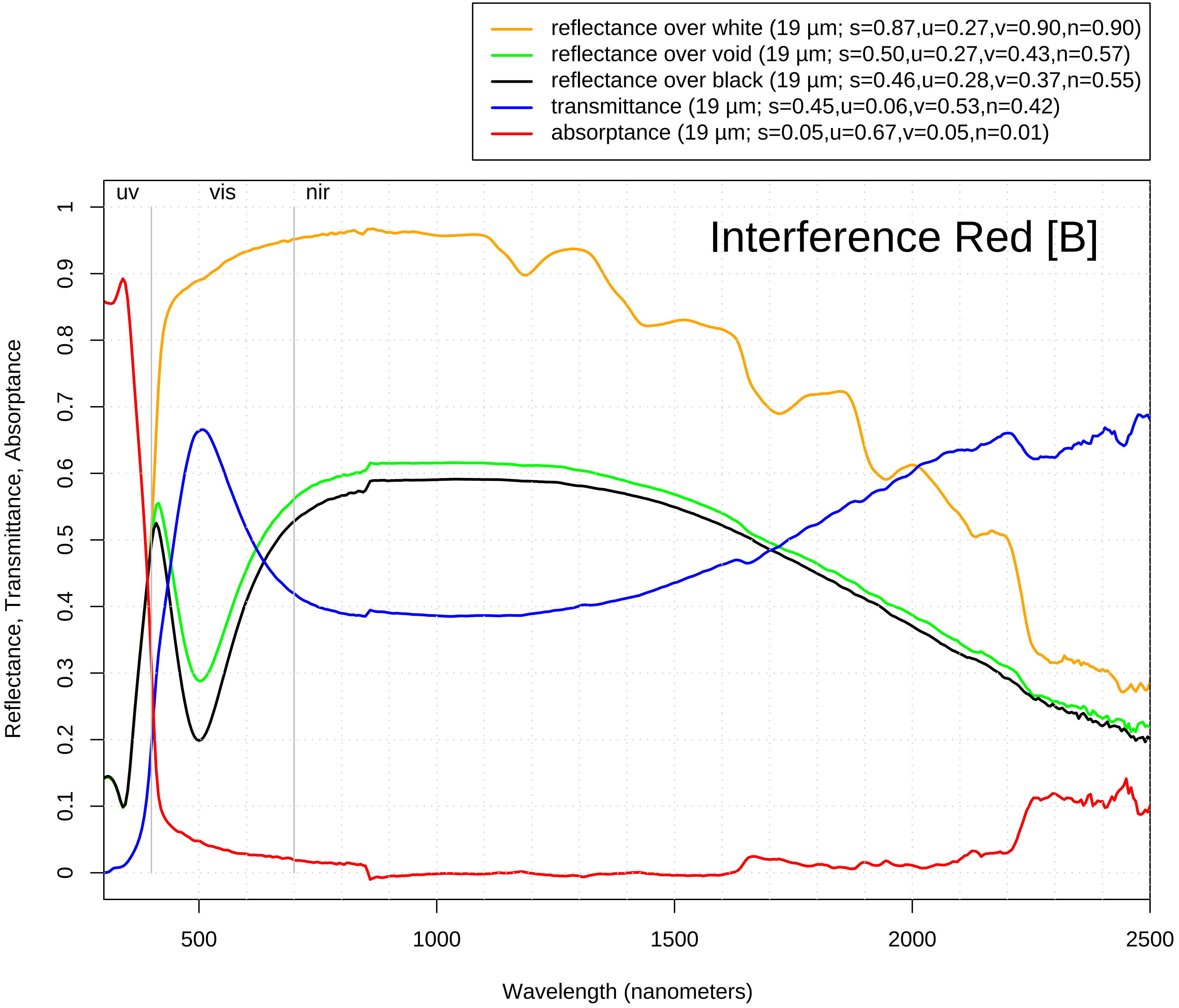
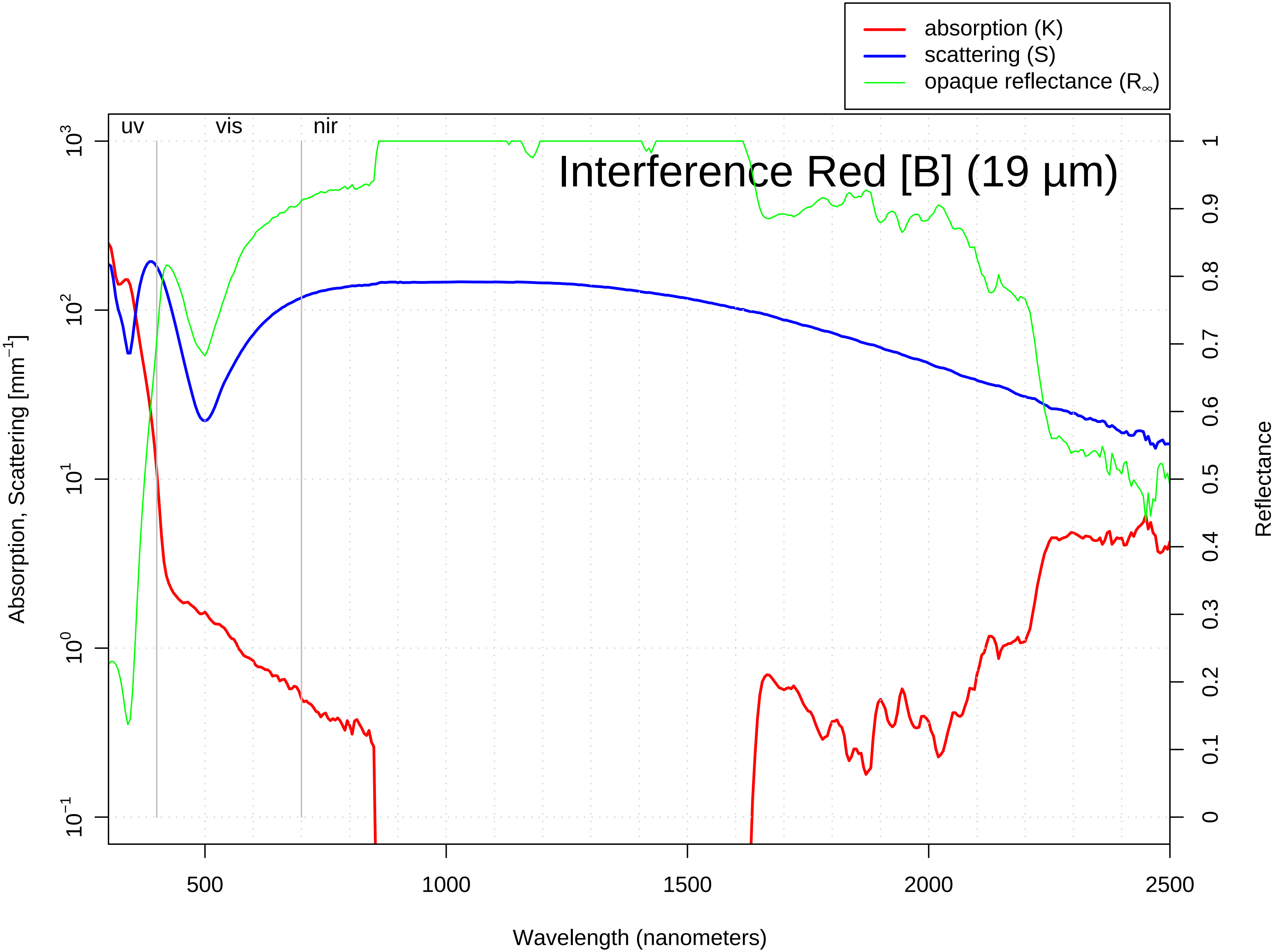


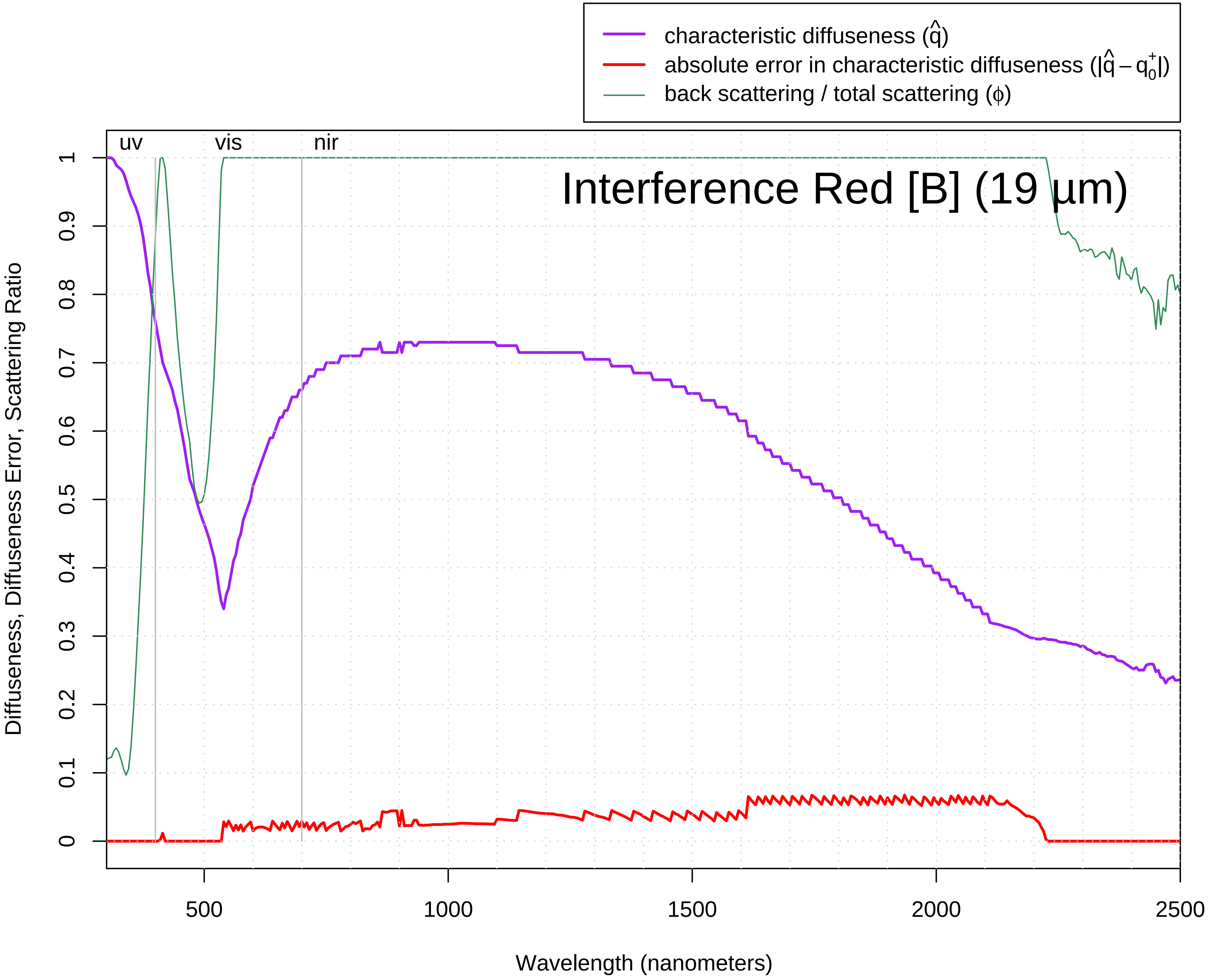
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:20 PM



(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:20 PM



(c) Ancillary Calculations

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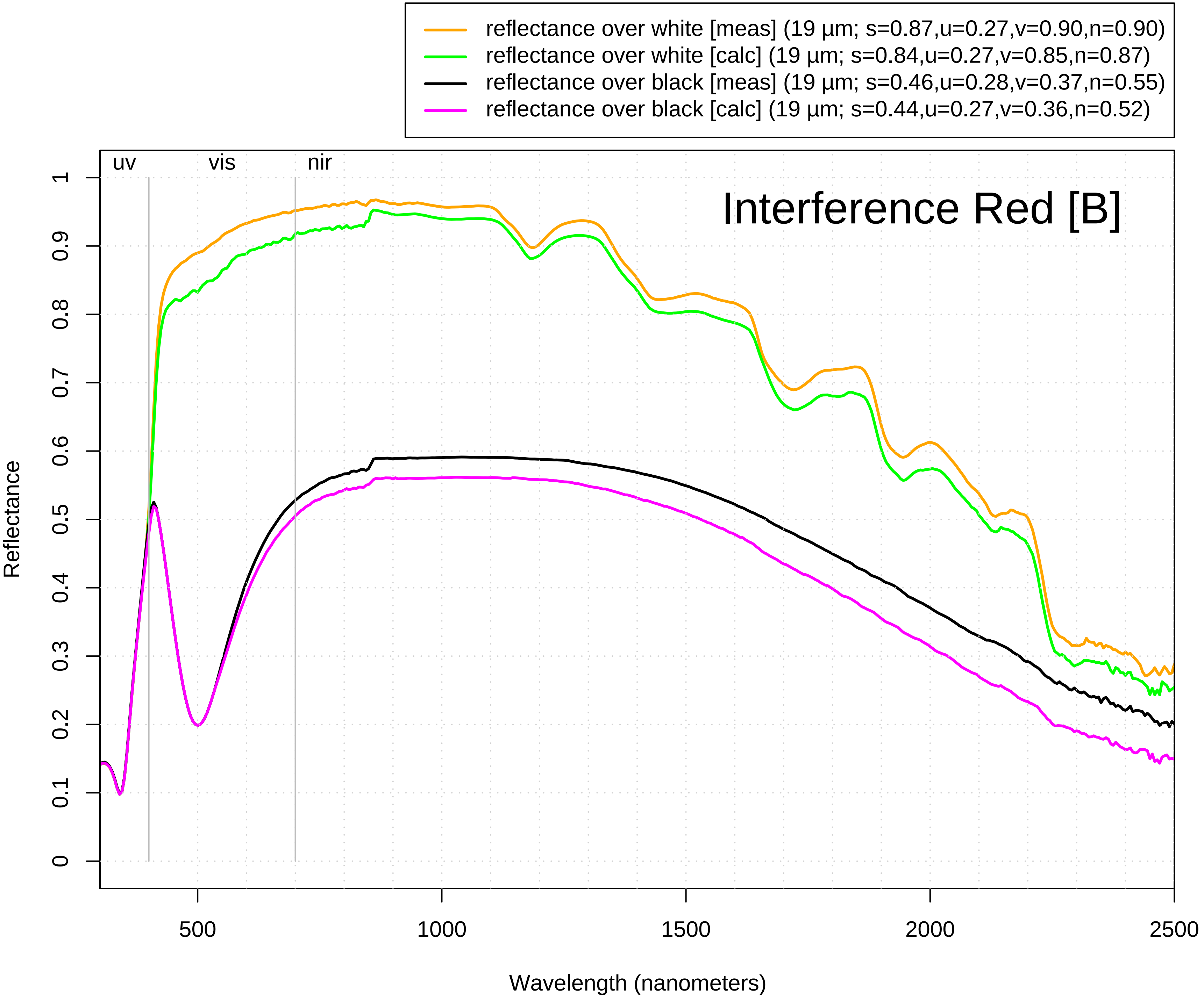

(d) Calculated vs. Measured Reflectances

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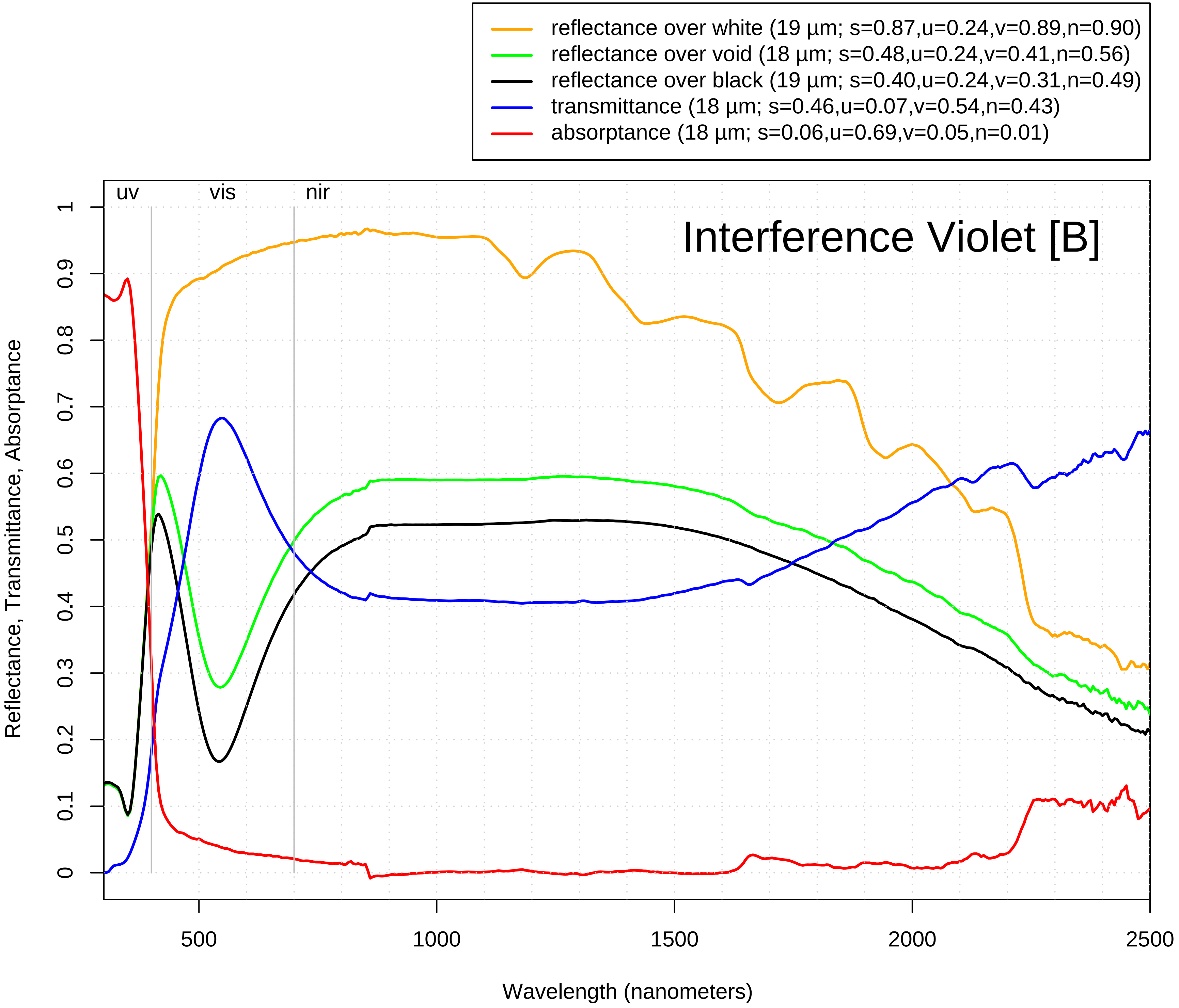
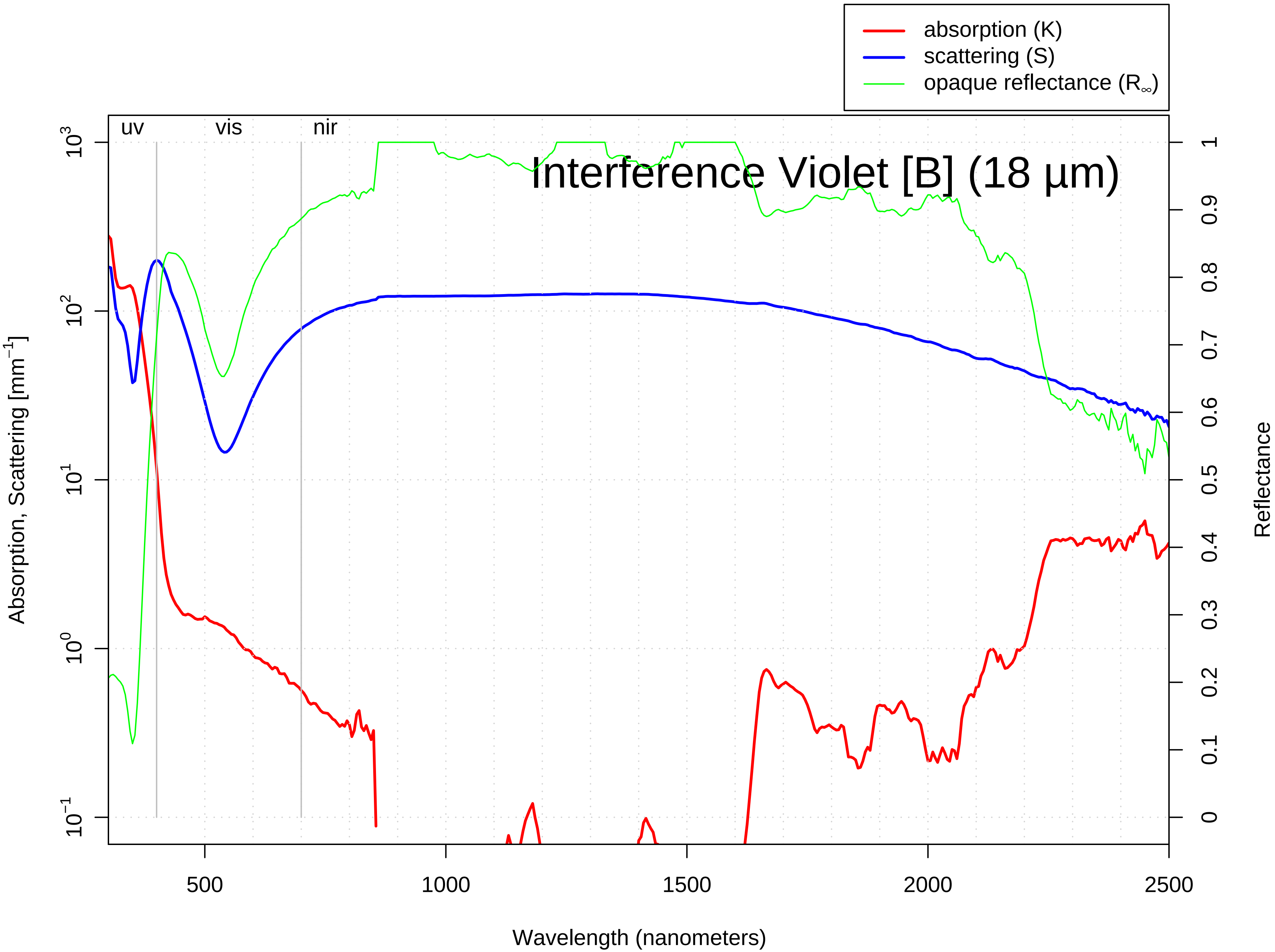


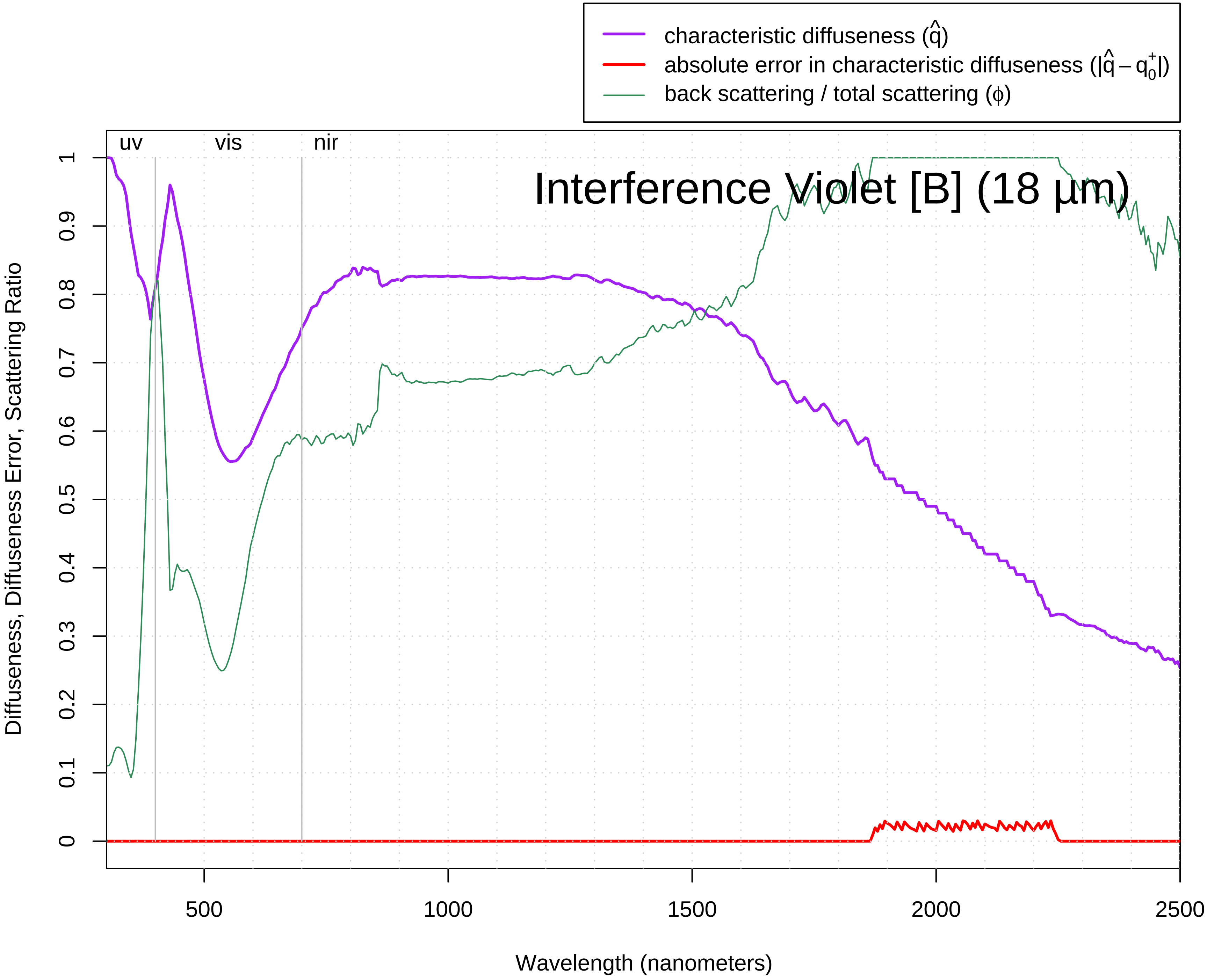
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:27 PM



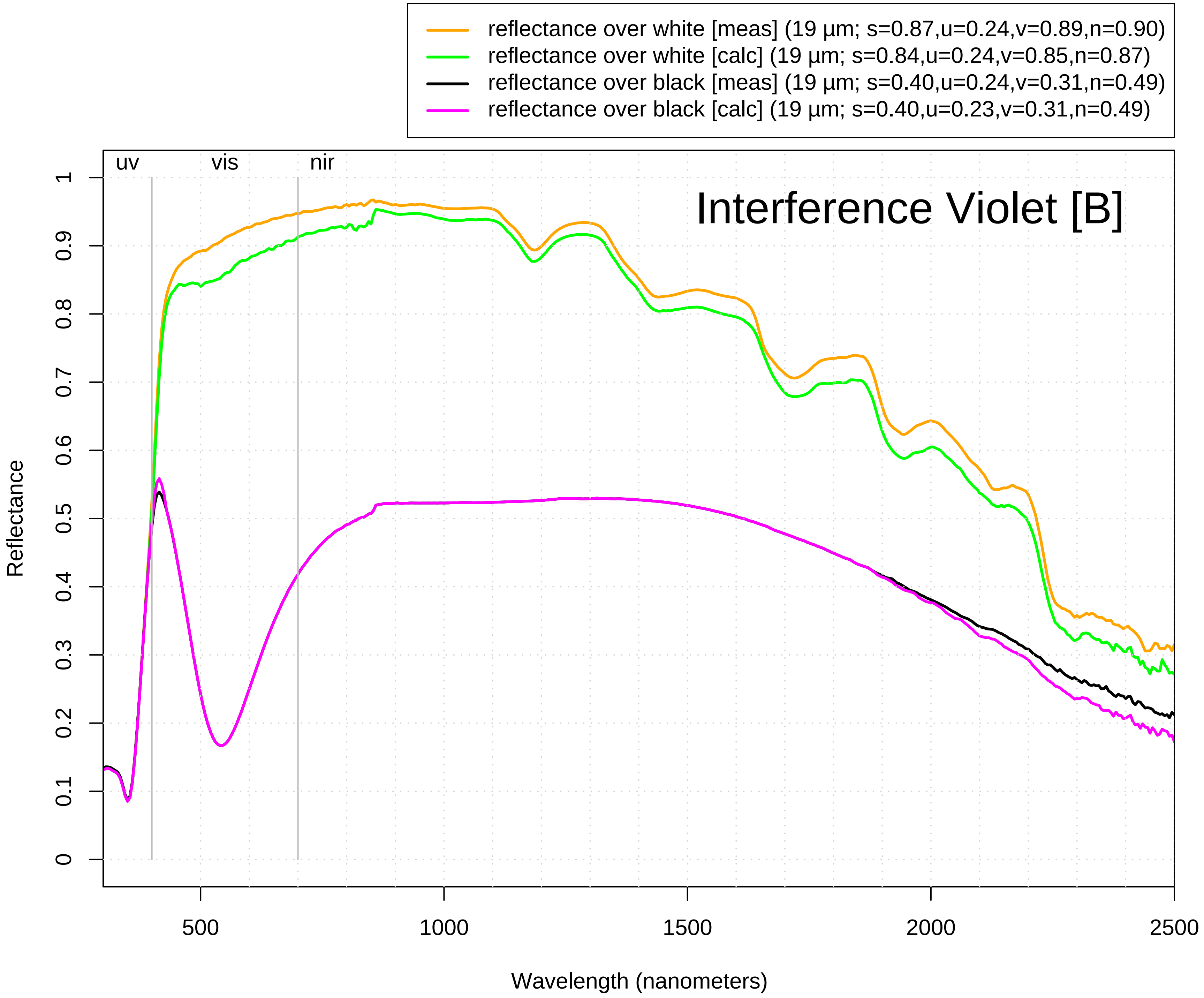
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:27 PM



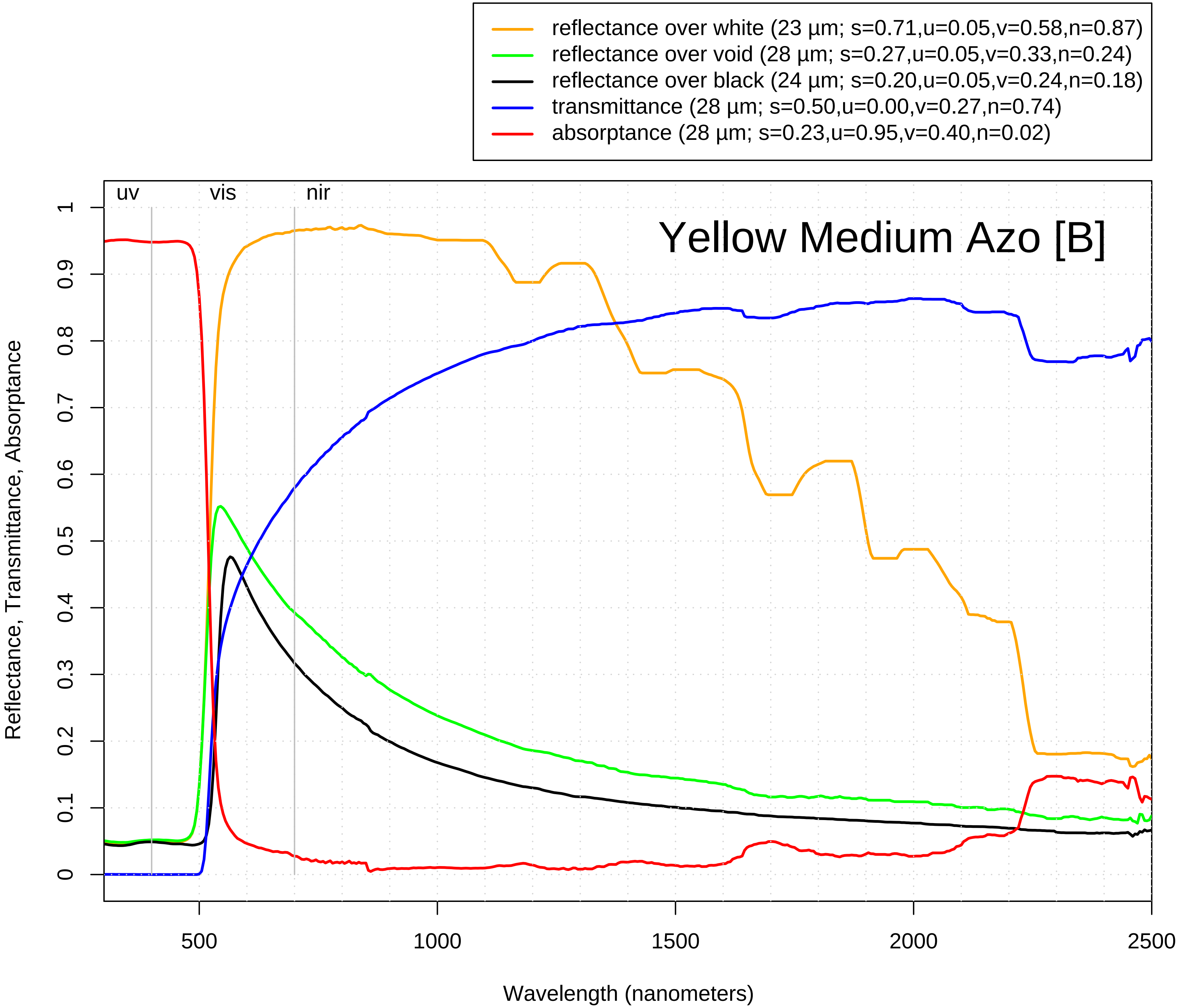
(c) Ancillary Calculations

Sunday, 09 March 2003 02:27 PM



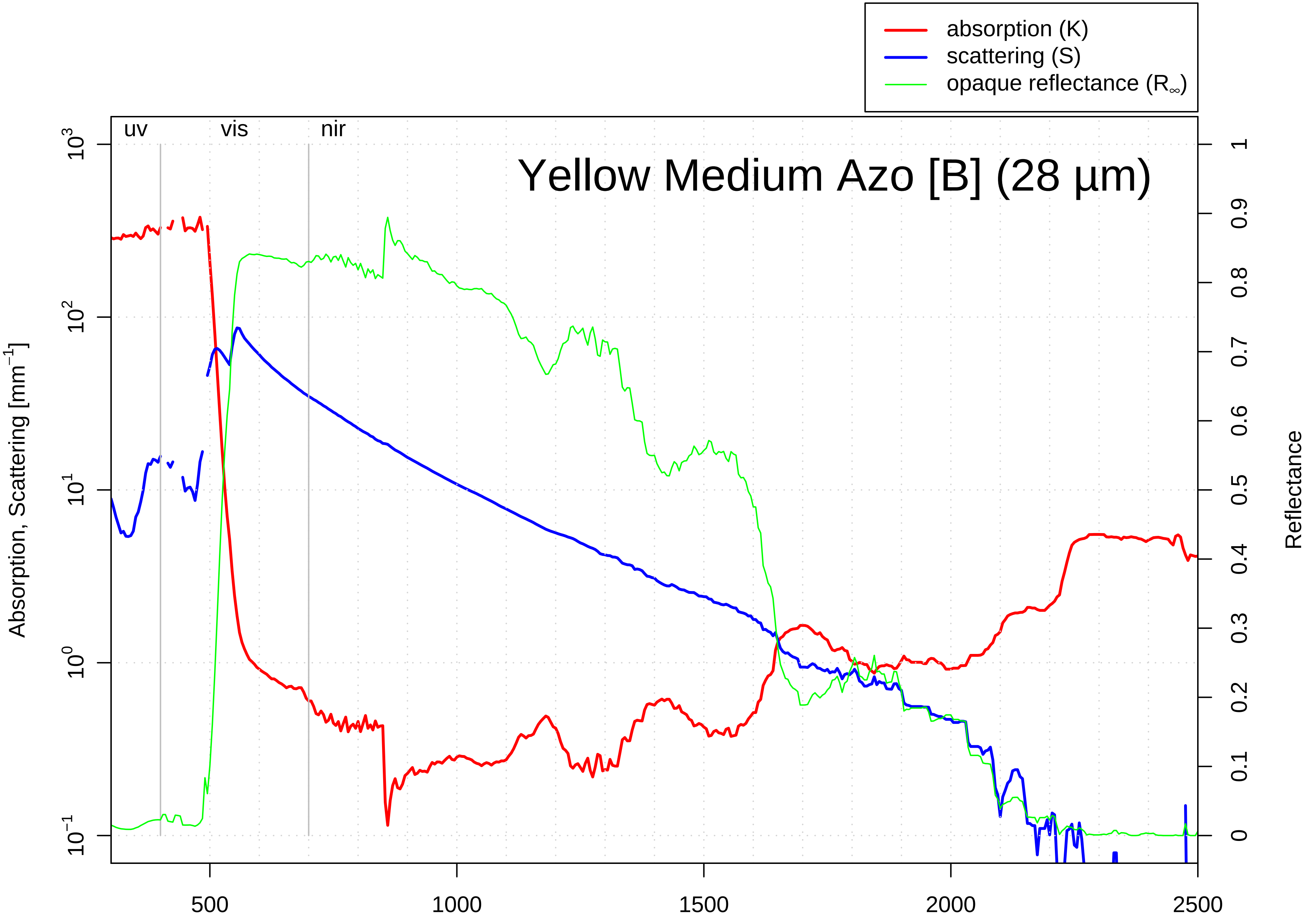
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:27 PM



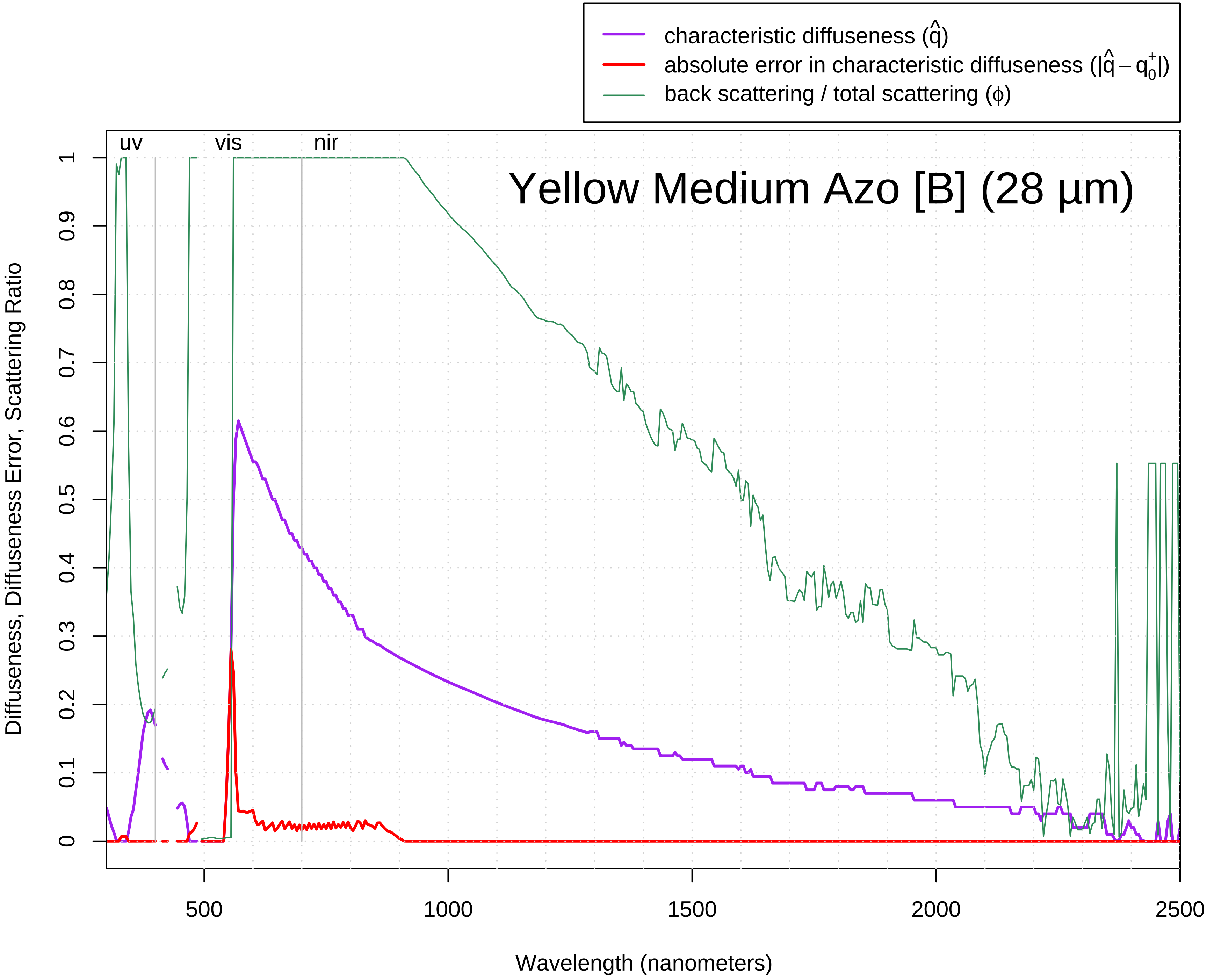
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:35 PM



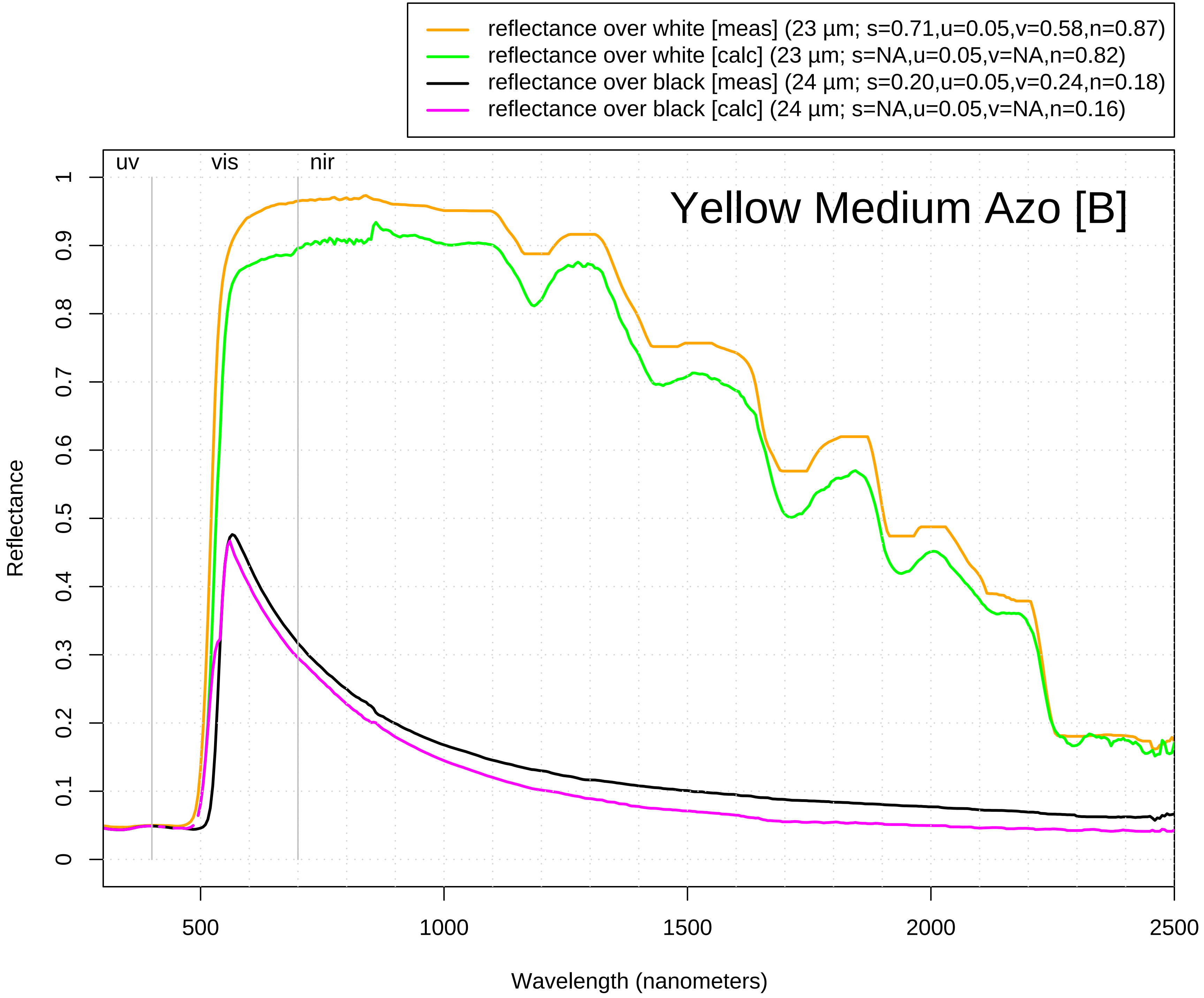
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:35 PM



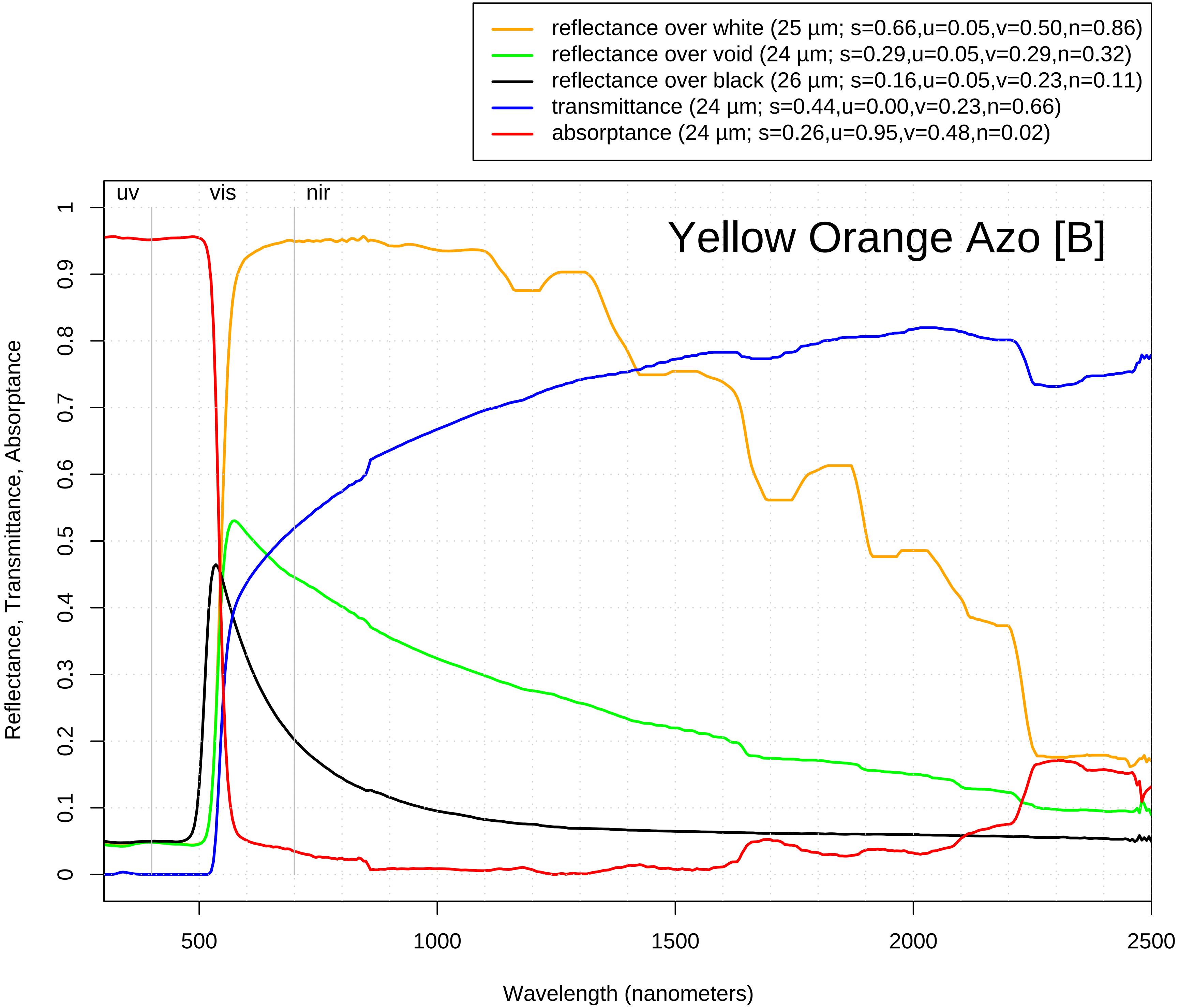
(c) Ancillary Calculations

Sunday, 09 March 2003 02:35 PM



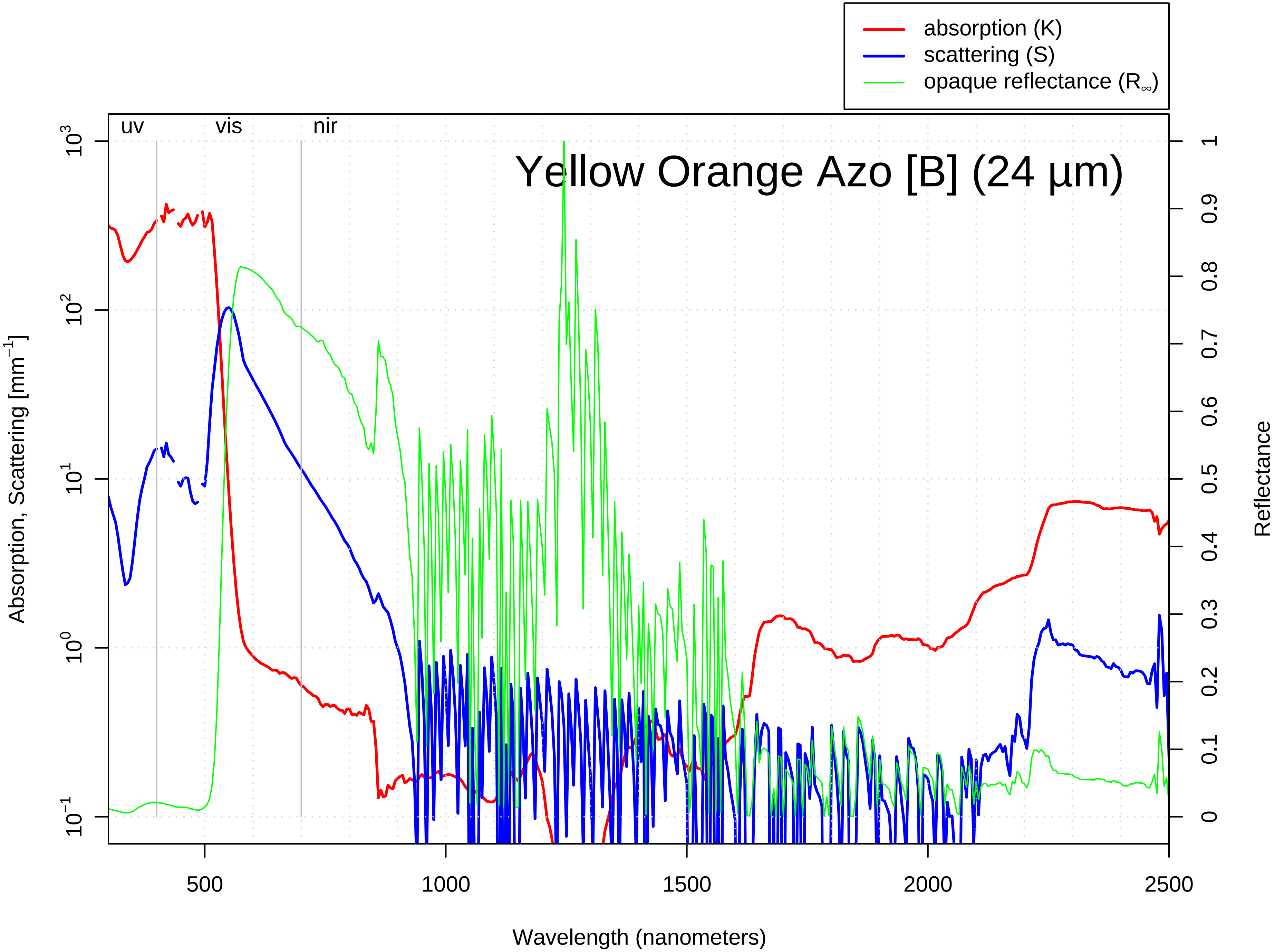
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:35 PM



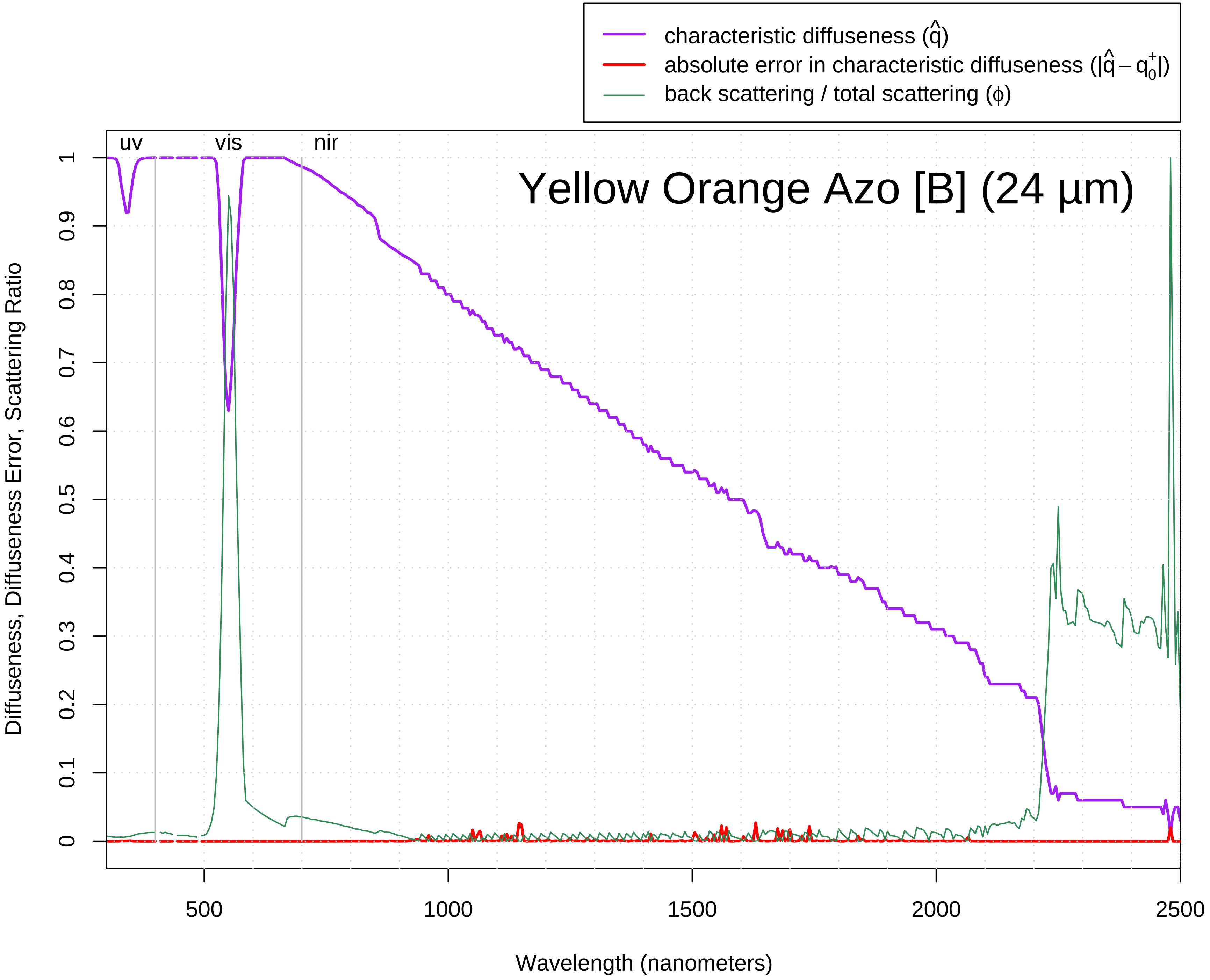
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:42 PM



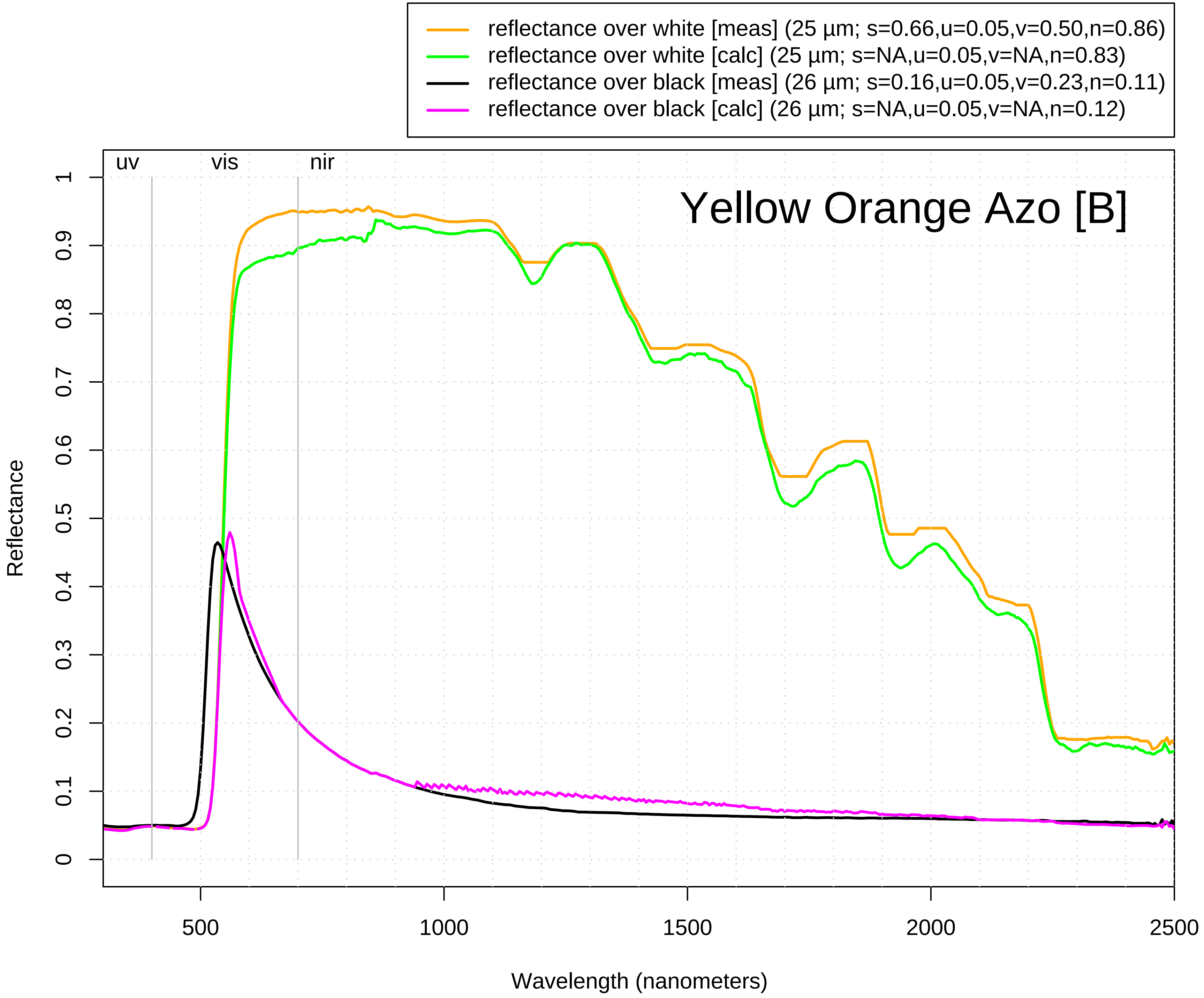
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:42 PM



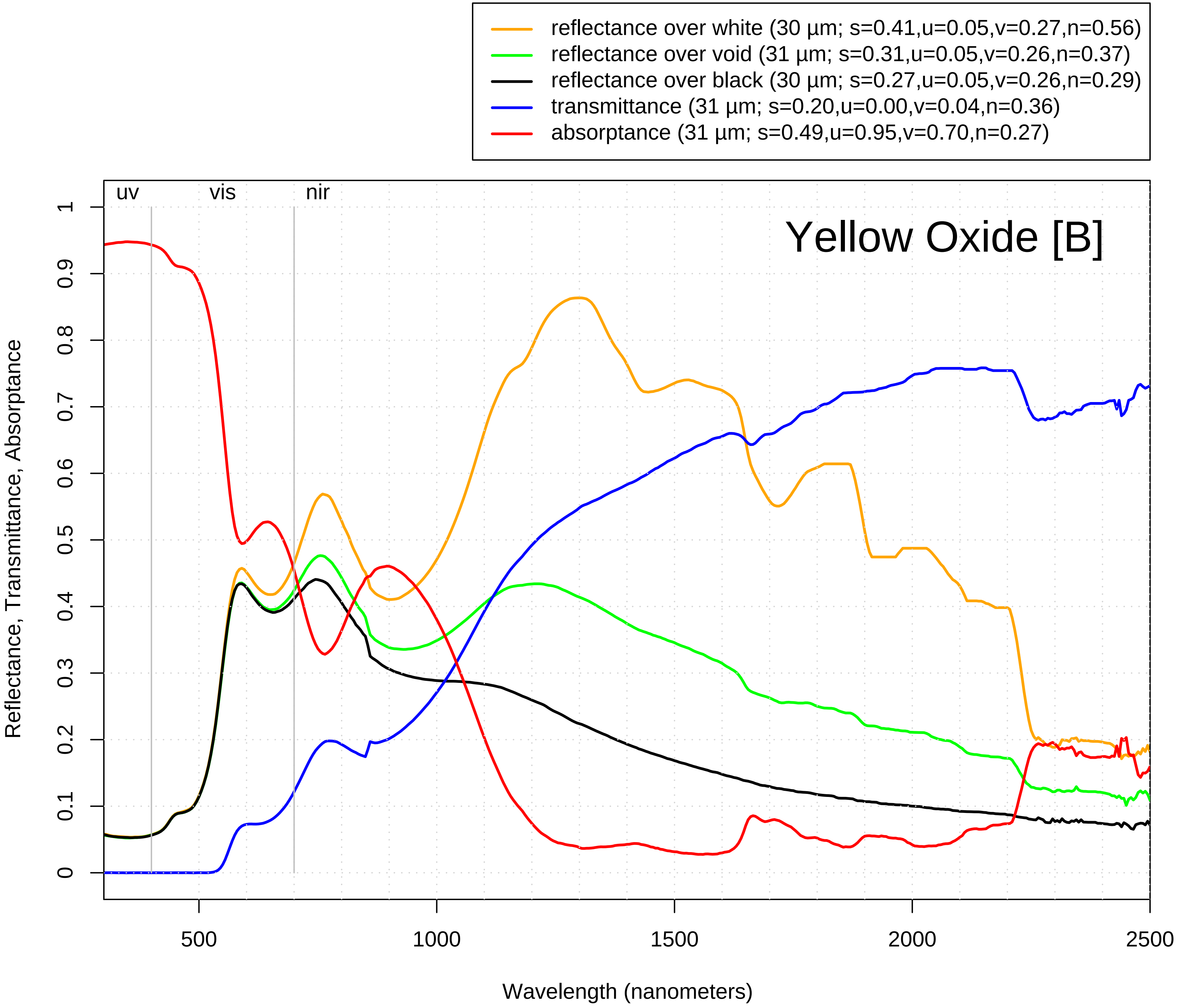
(c) Ancillary Calculations

Sunday, 09 March 2003 02:42 PM



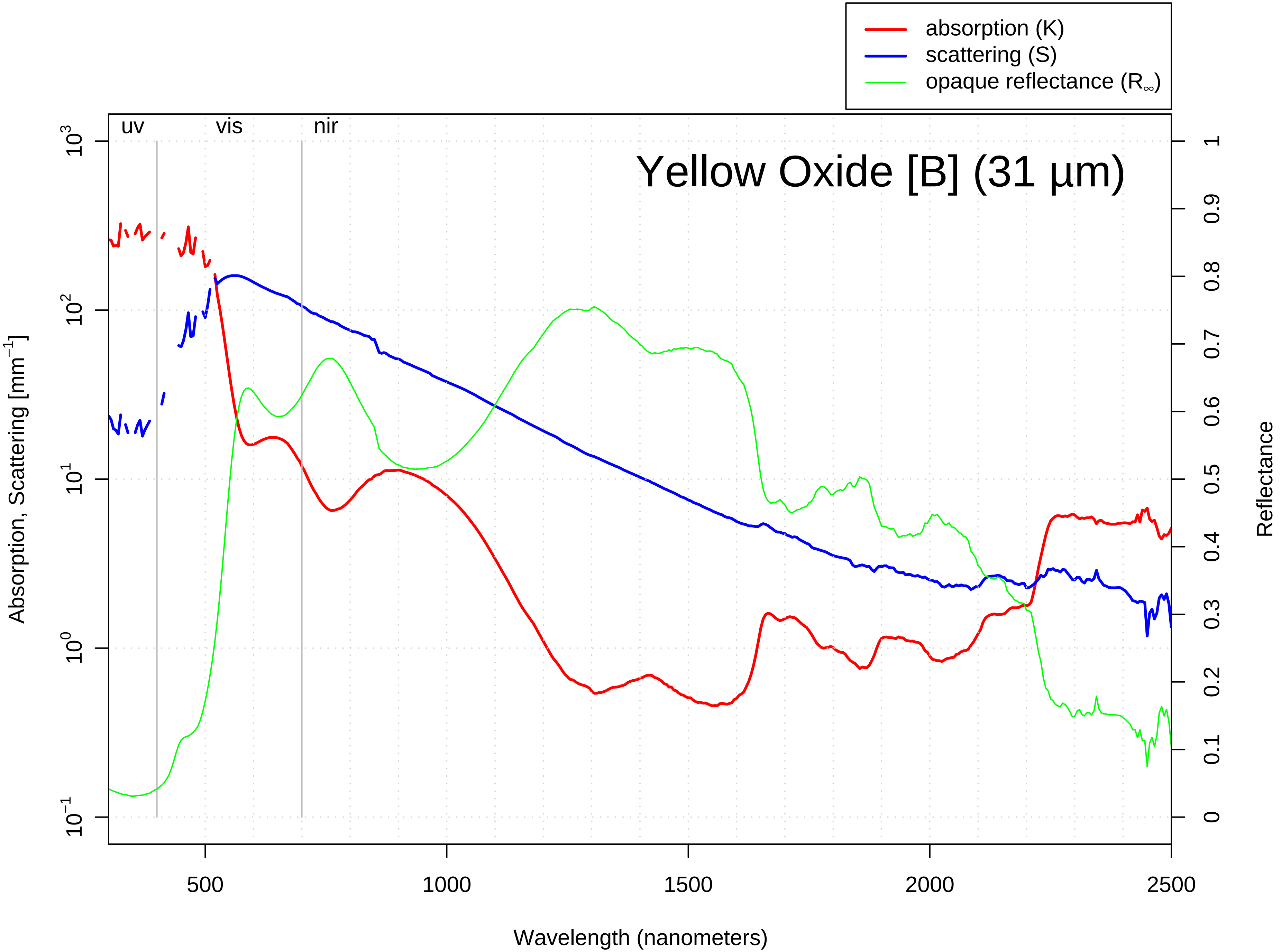
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:42 PM



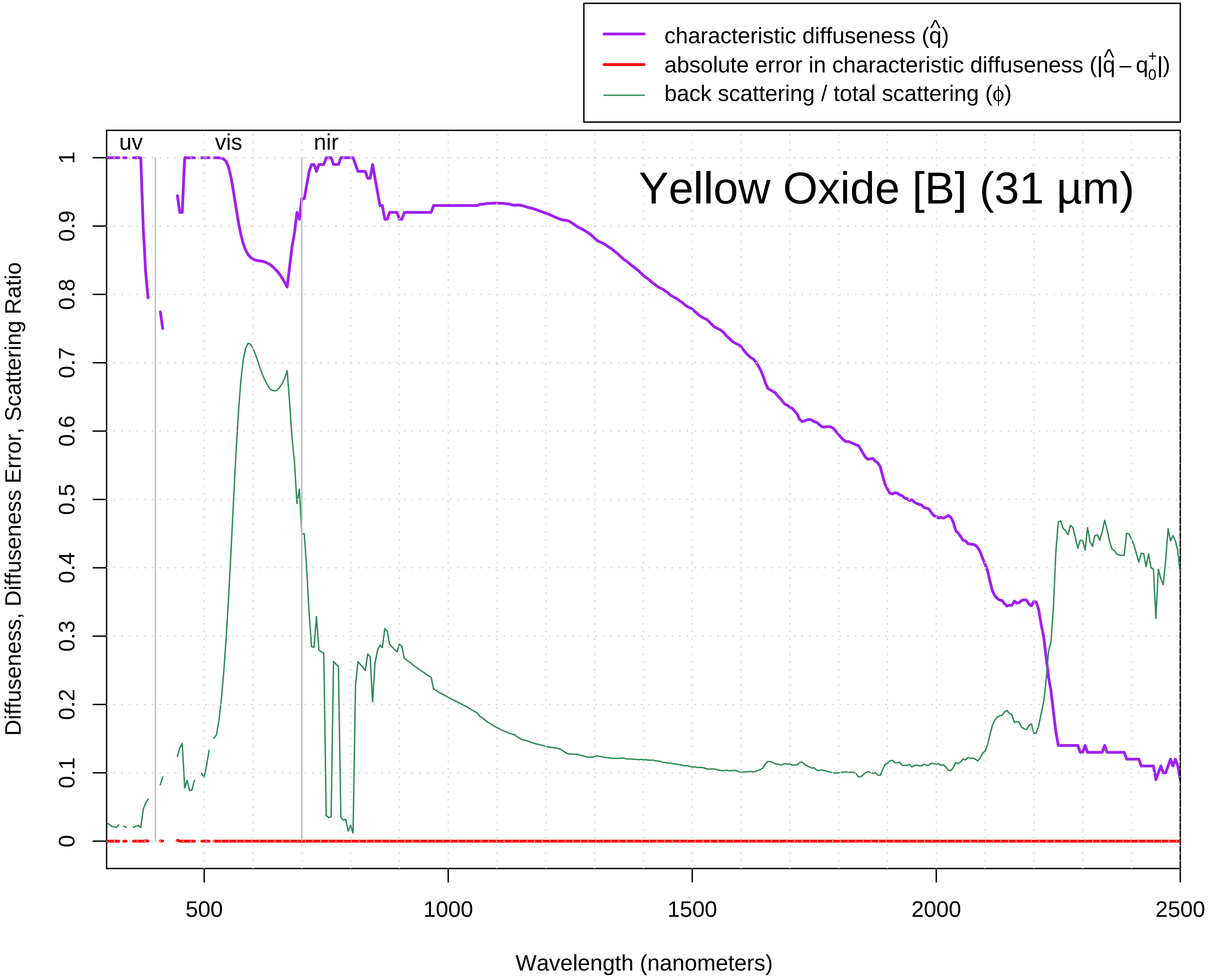
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:45 PM



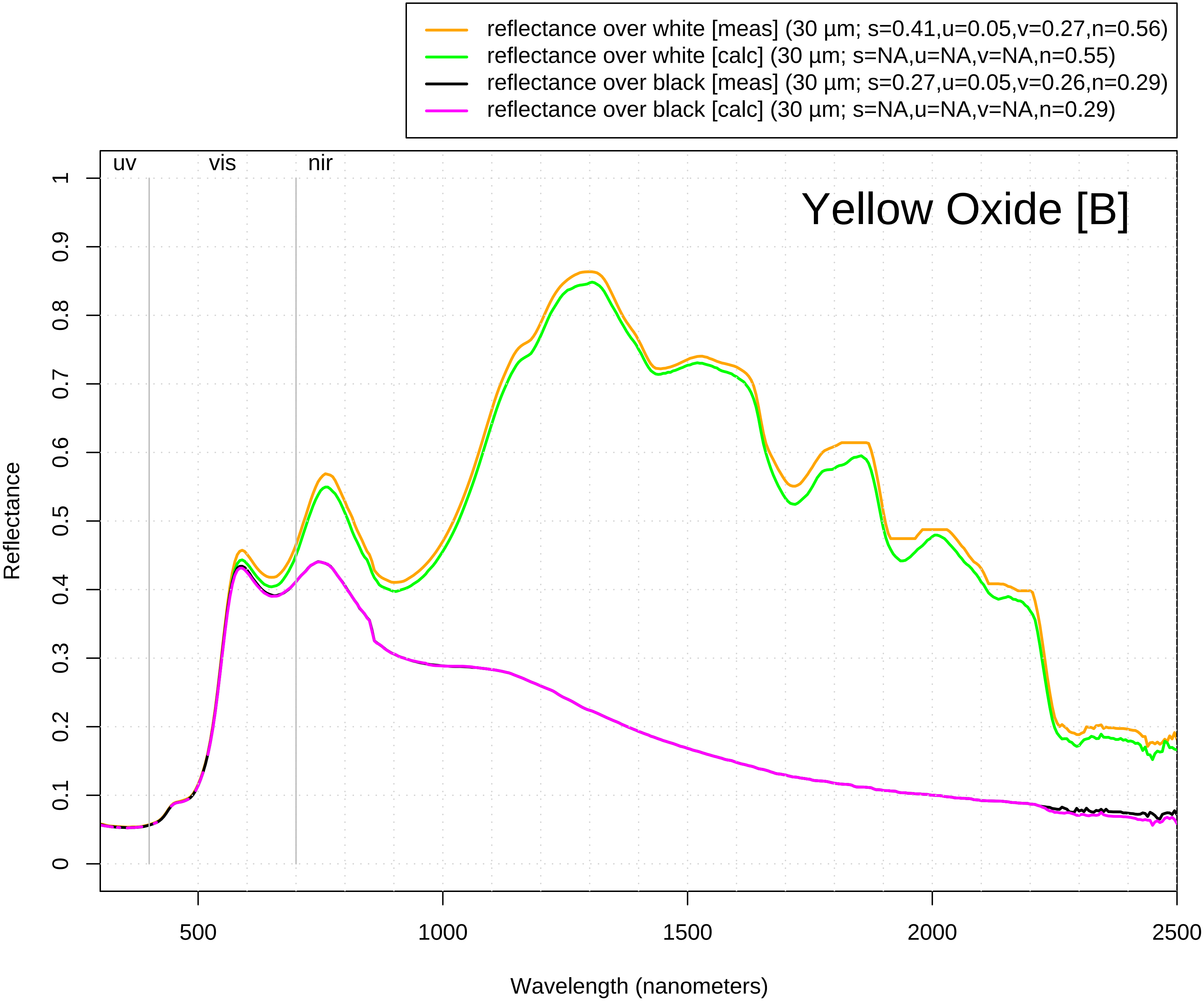
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:45 PM



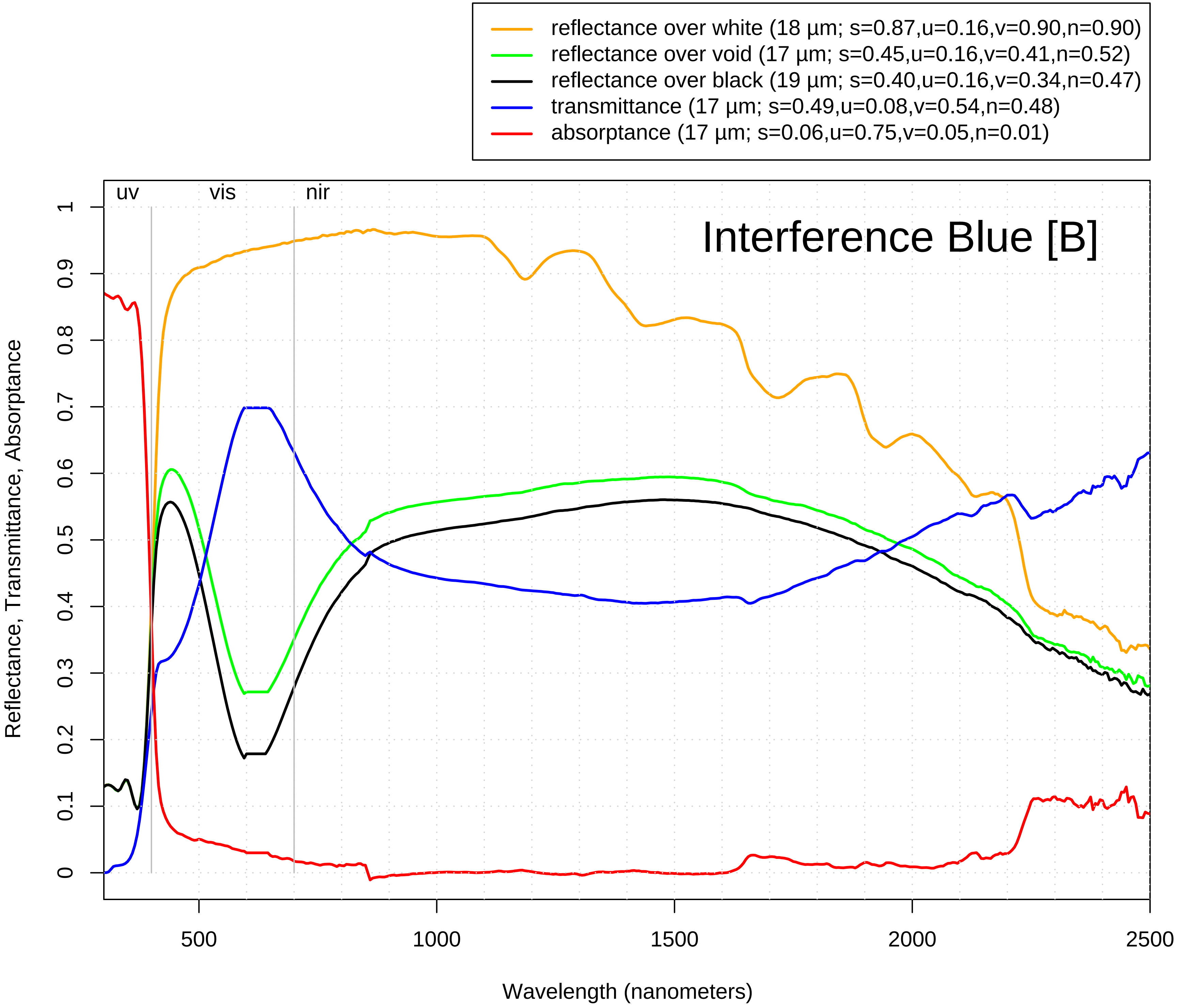
(c) Ancillary Calculations

Sunday, 09 March 2003 02:45 PM



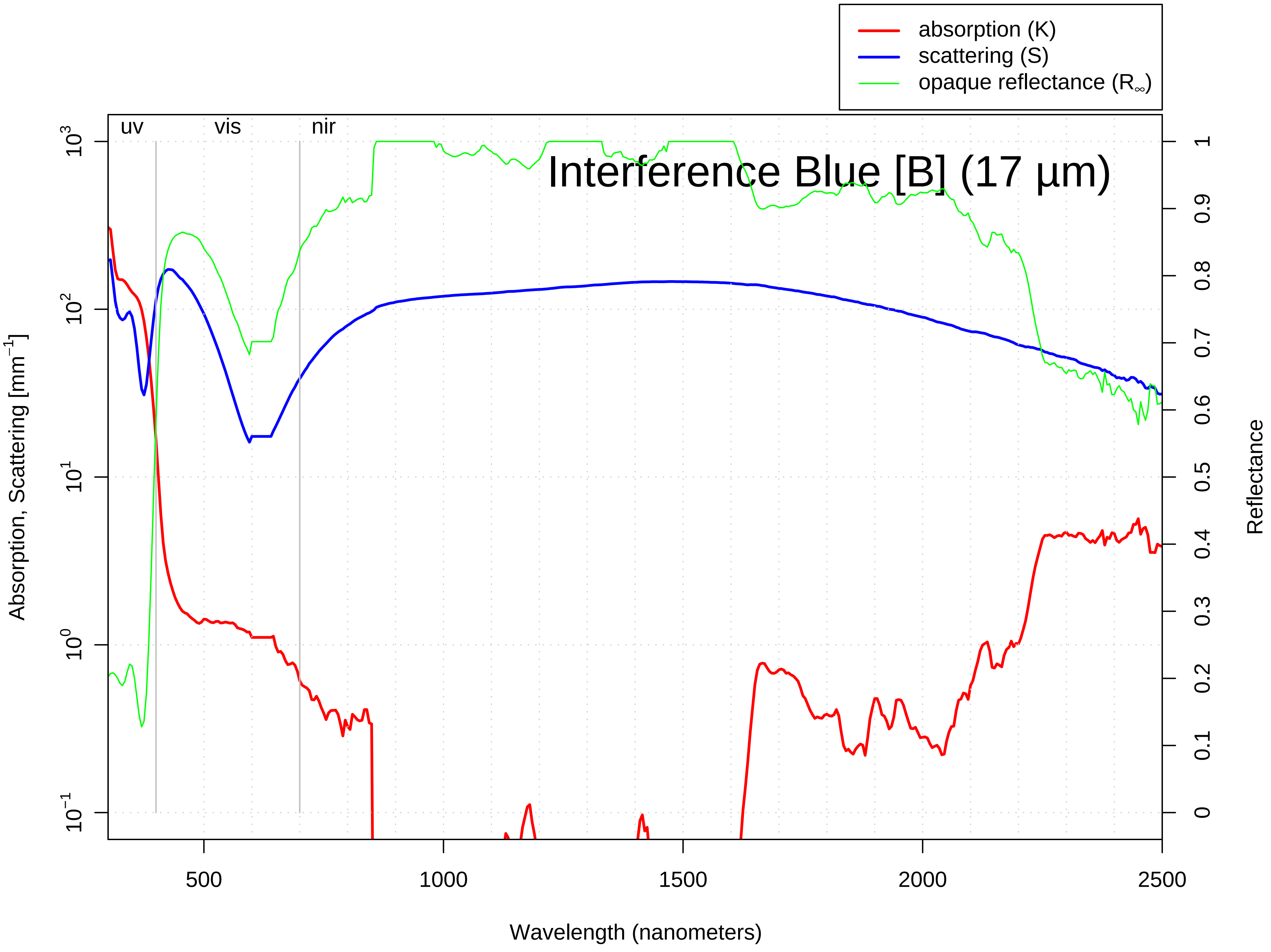
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:45 PM



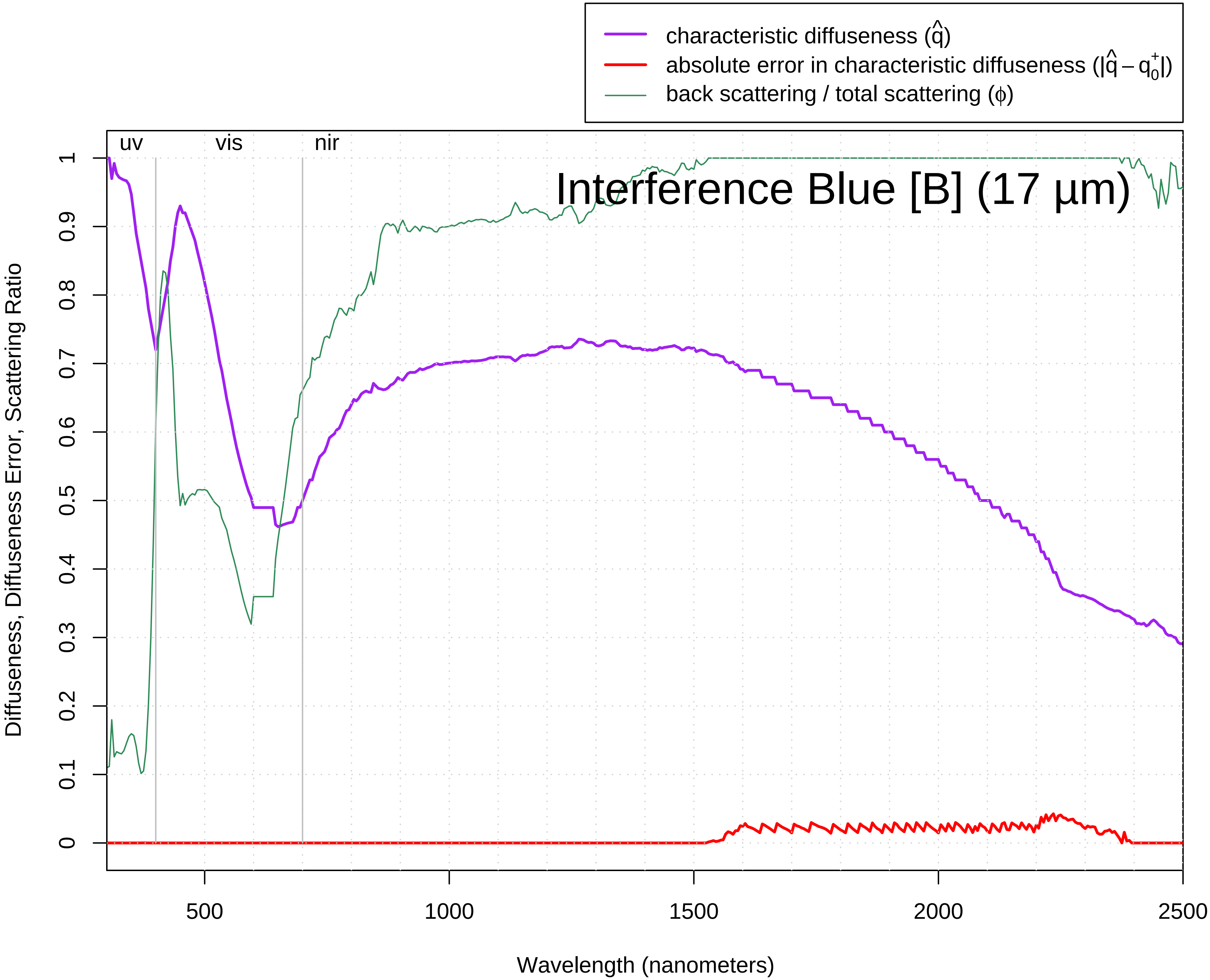
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:48 PM



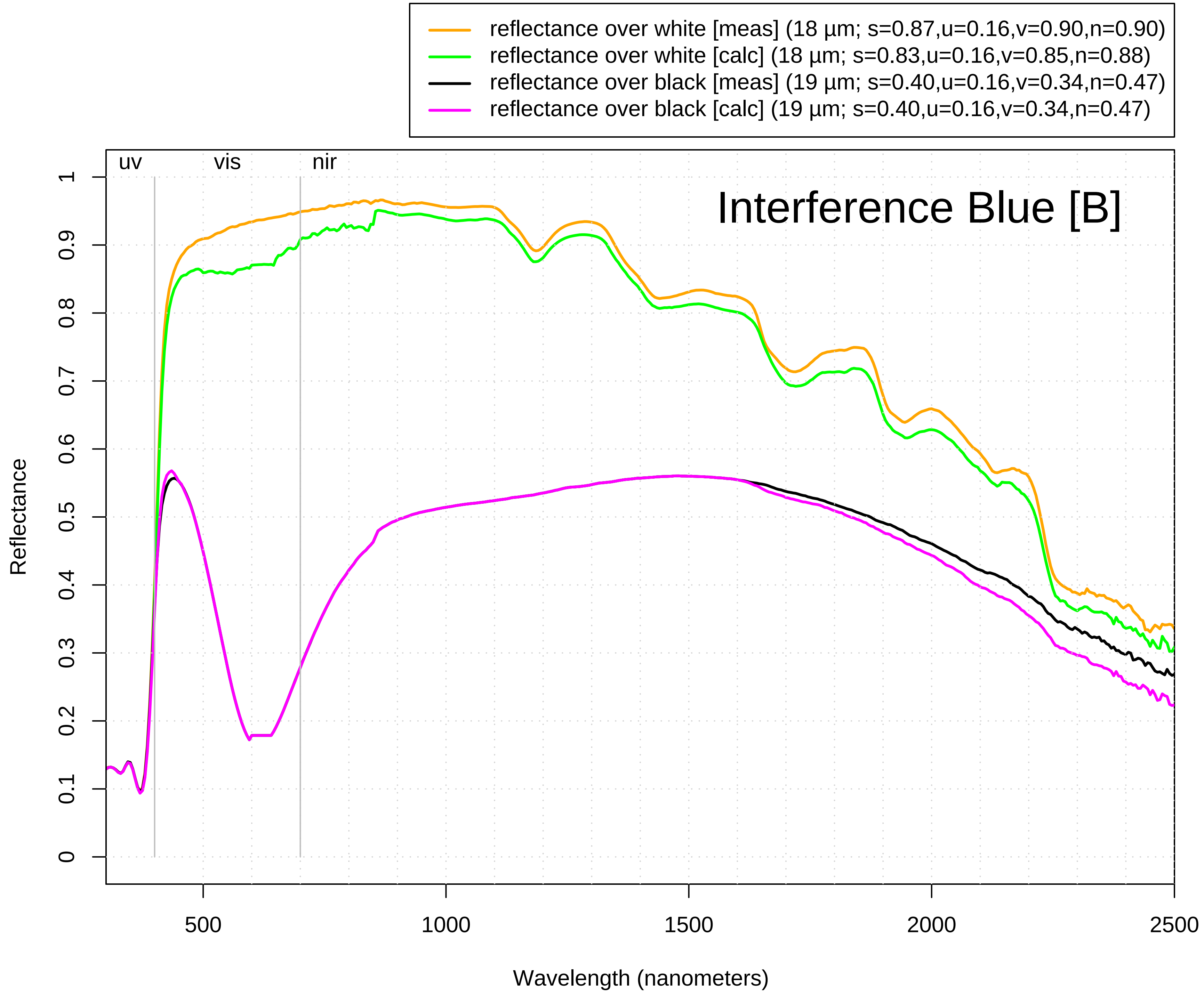
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:48 PM



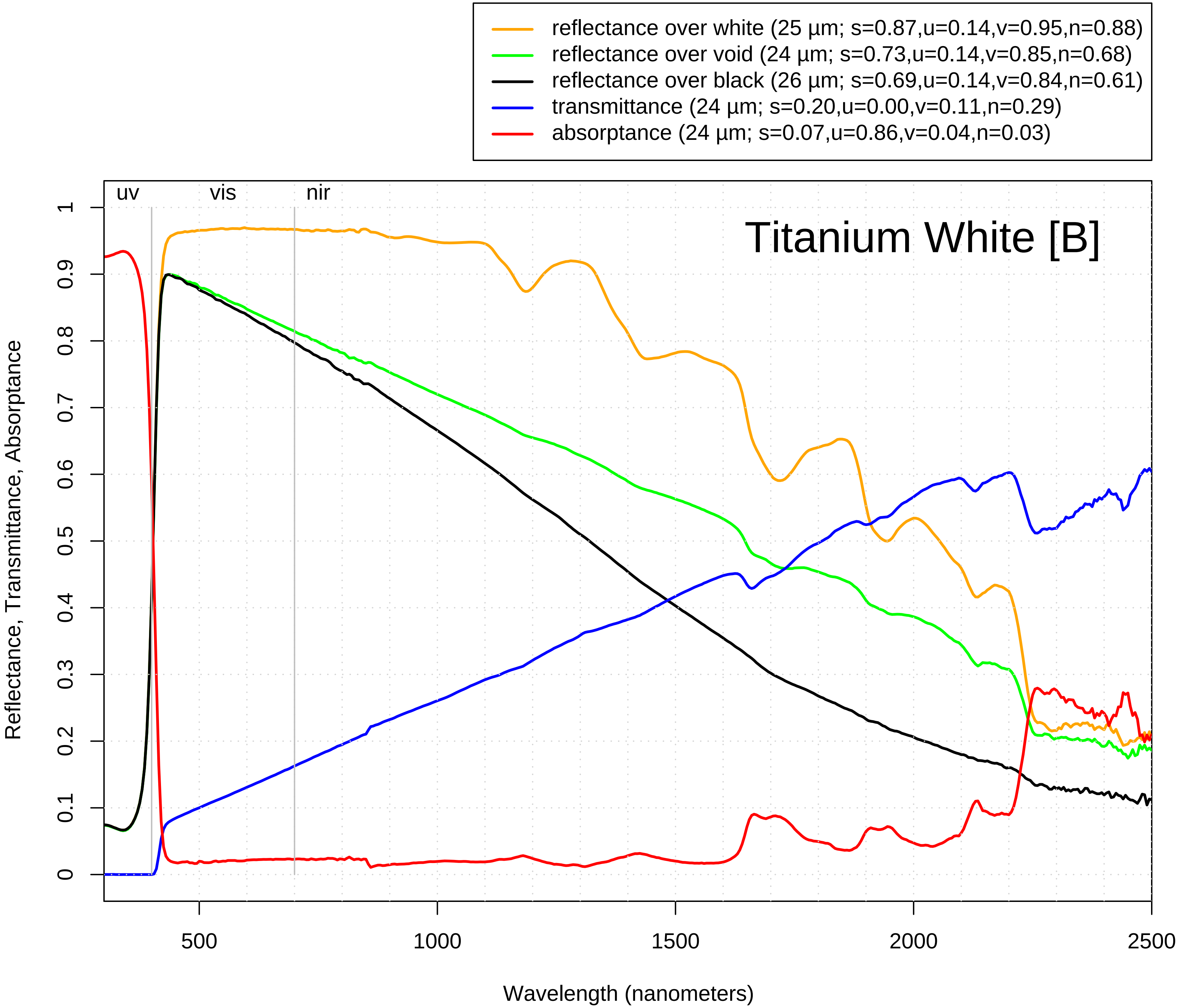
(c) Ancillary Calculations

Sunday, 09 March 2003 02:48 PM



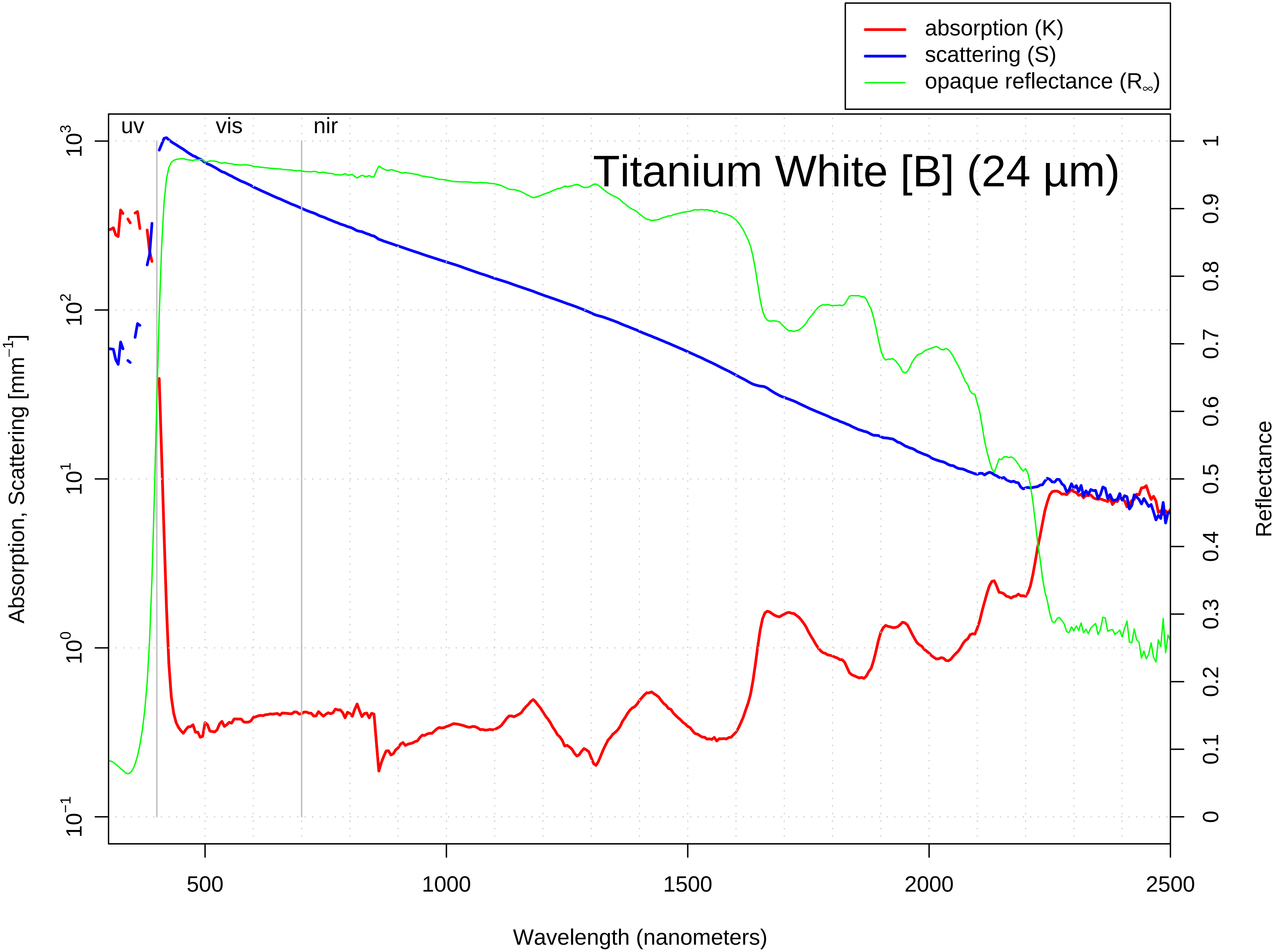
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:48 PM



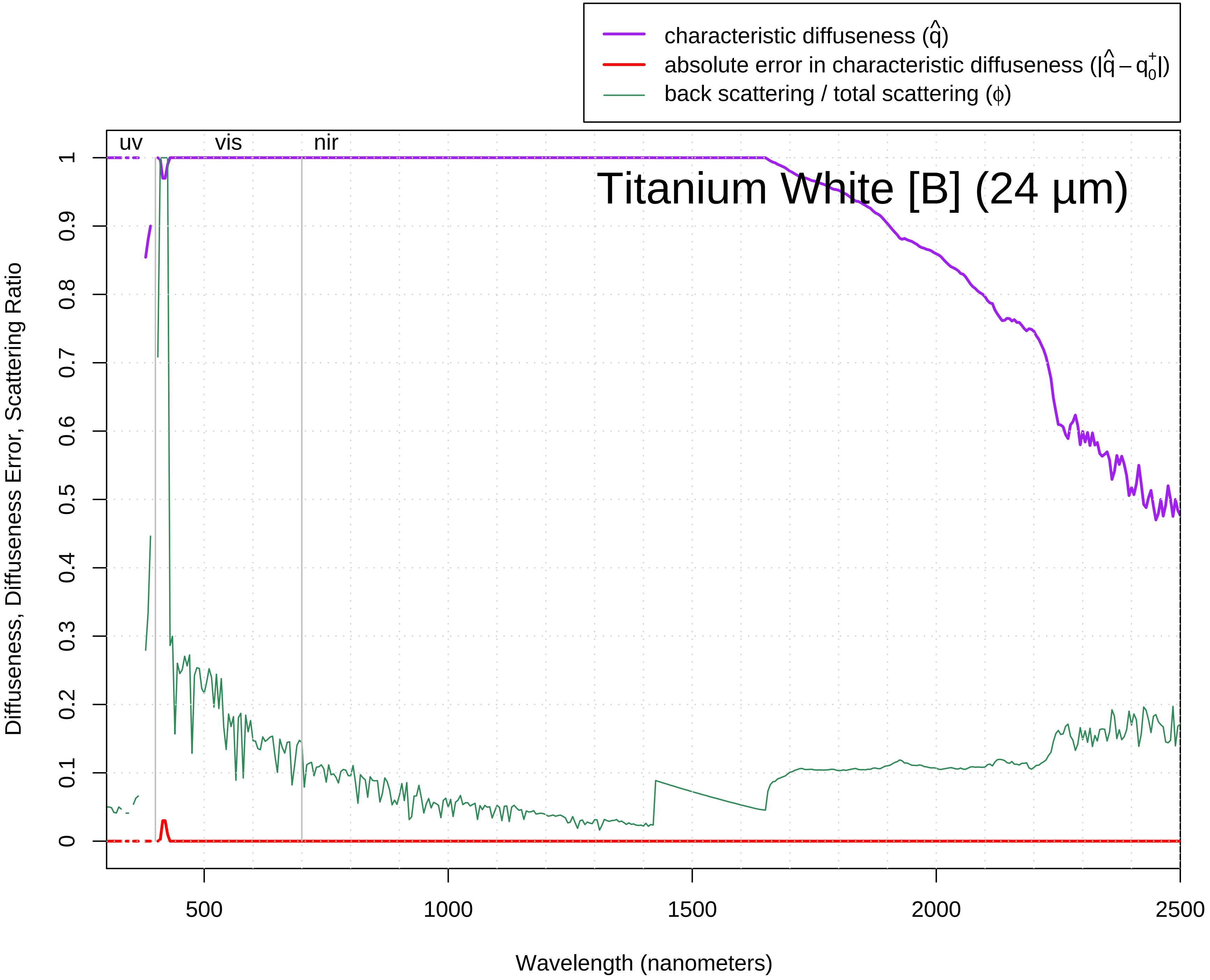
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:51 PM



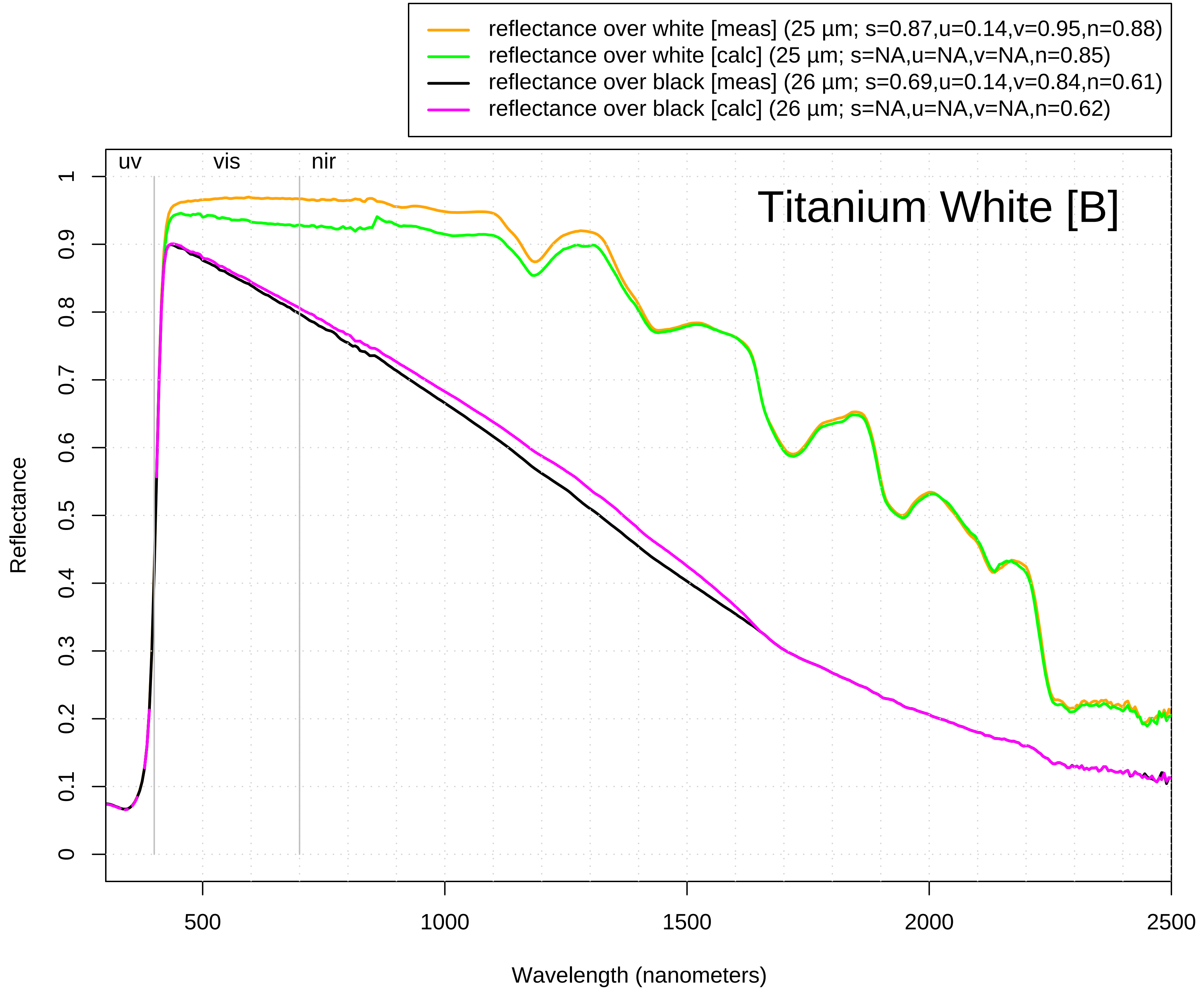
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:51 PM



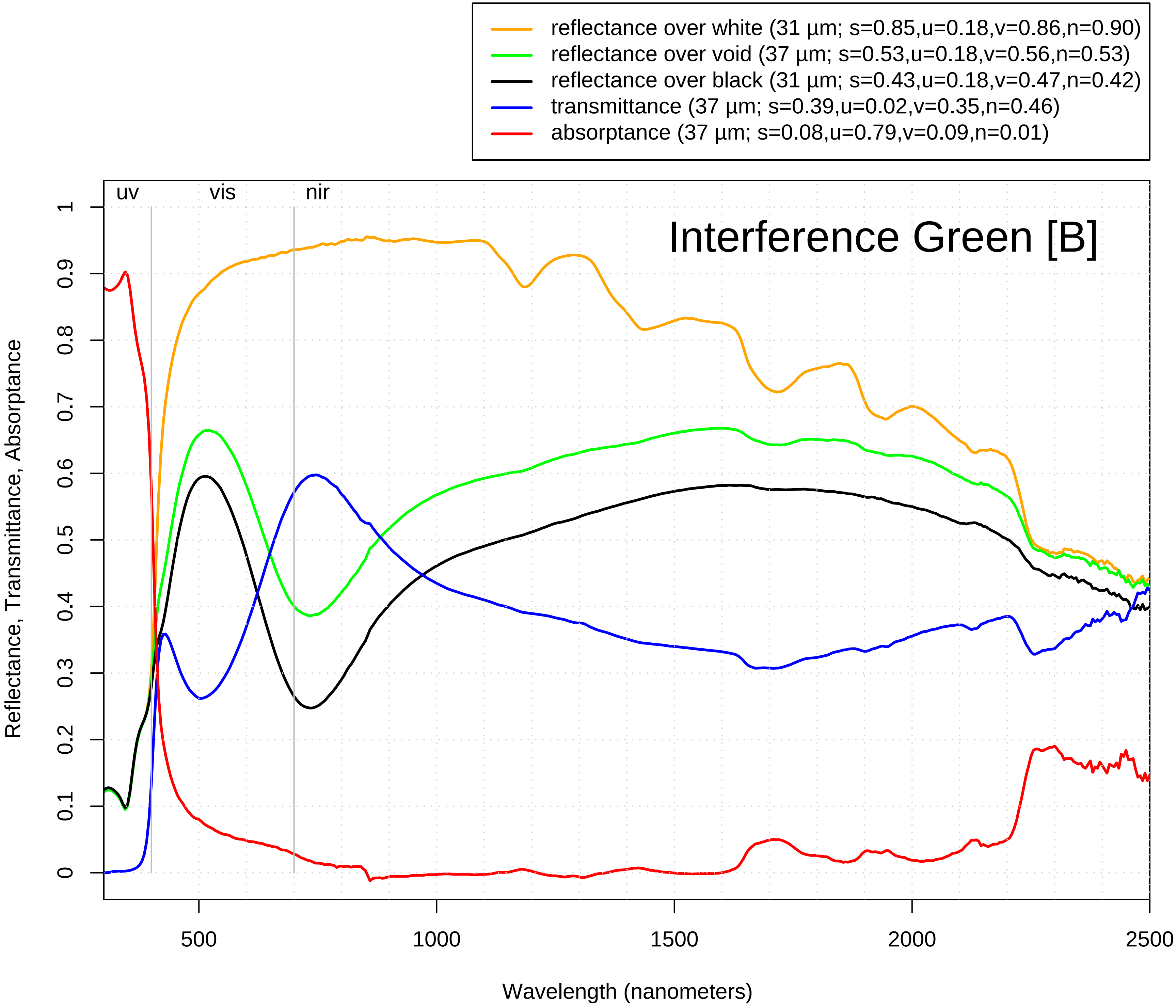
(c) Ancillary Calculations

Sunday, 09 March 2003 02:51 PM



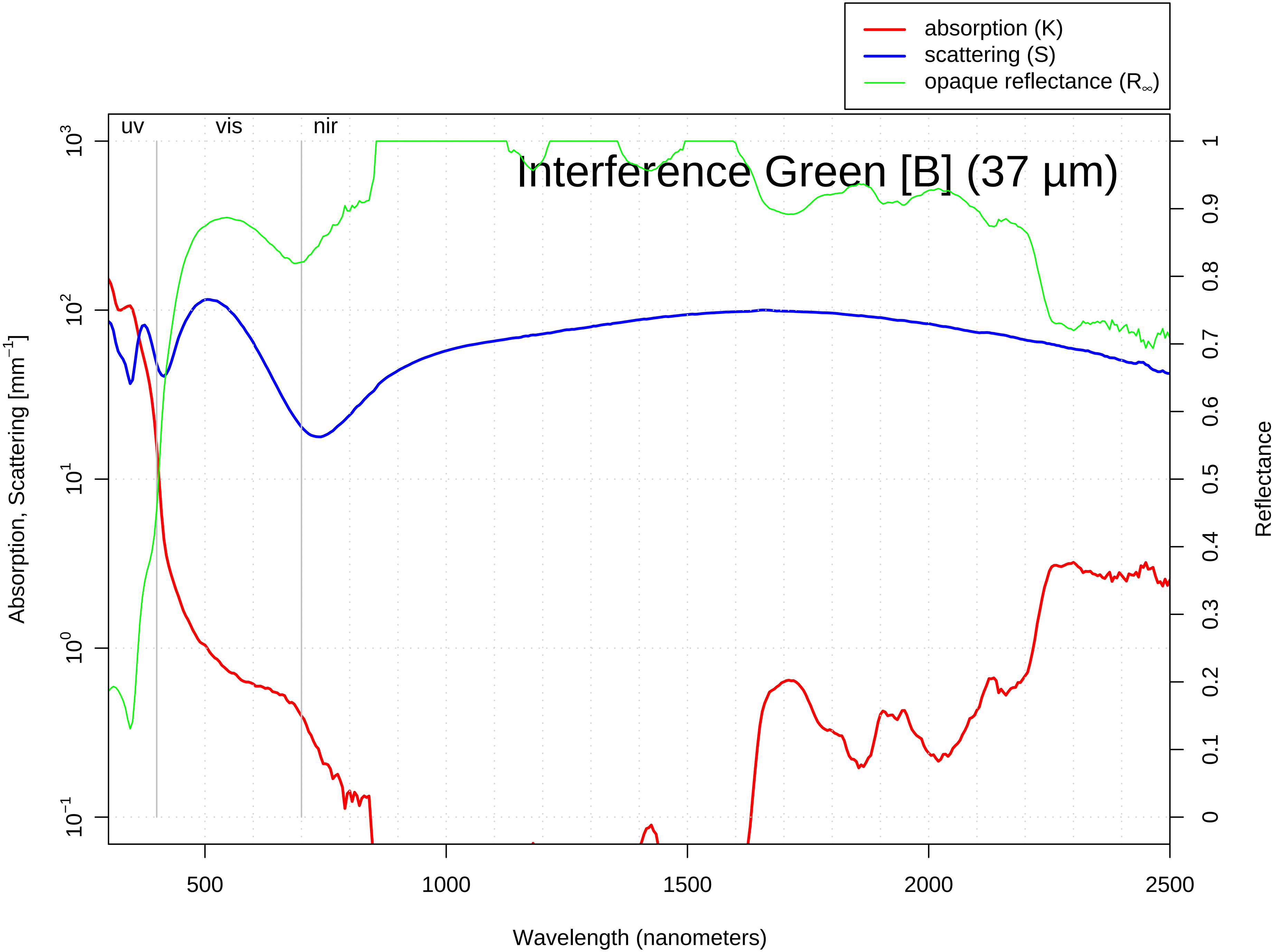
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:51 PM



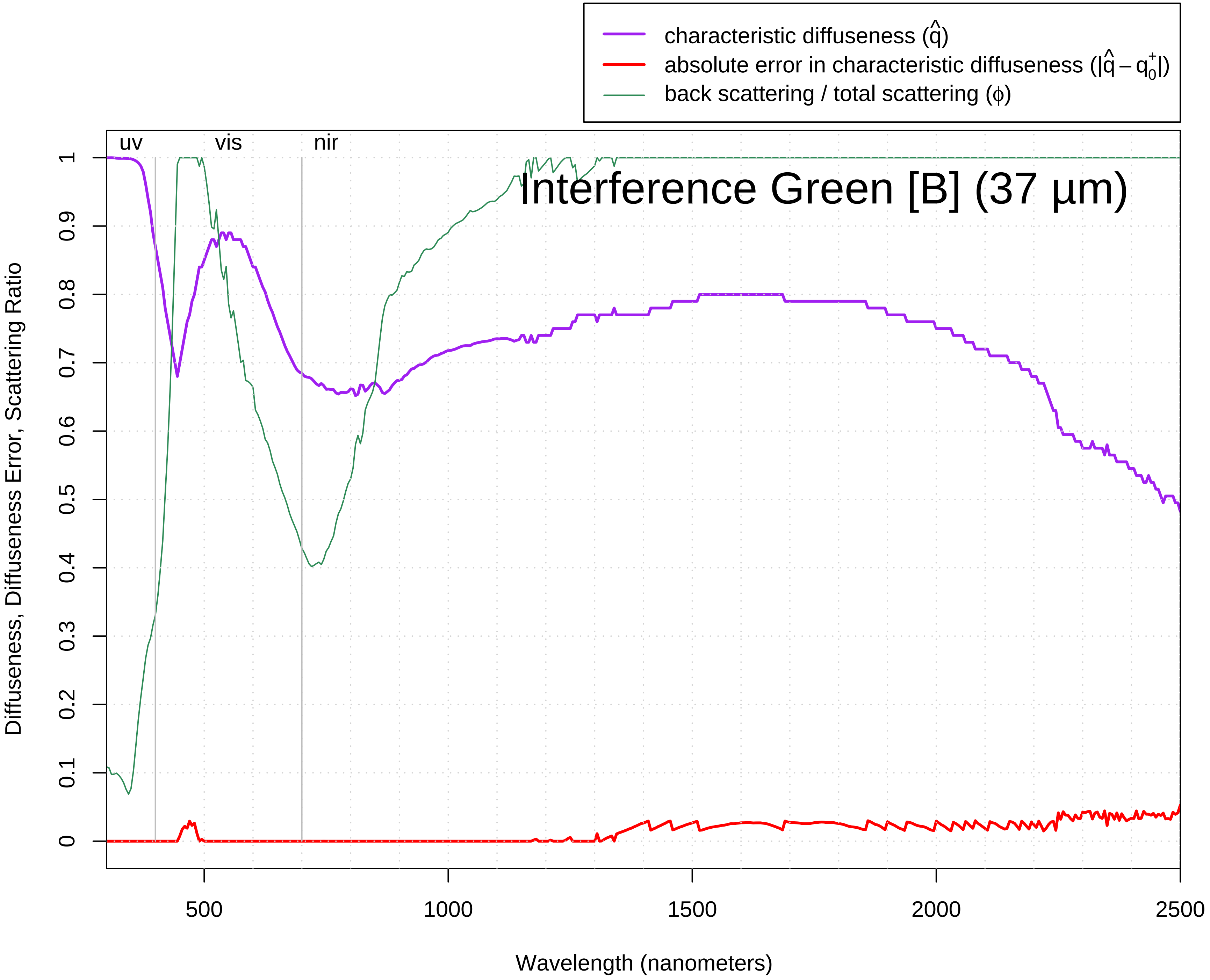
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:54 PM



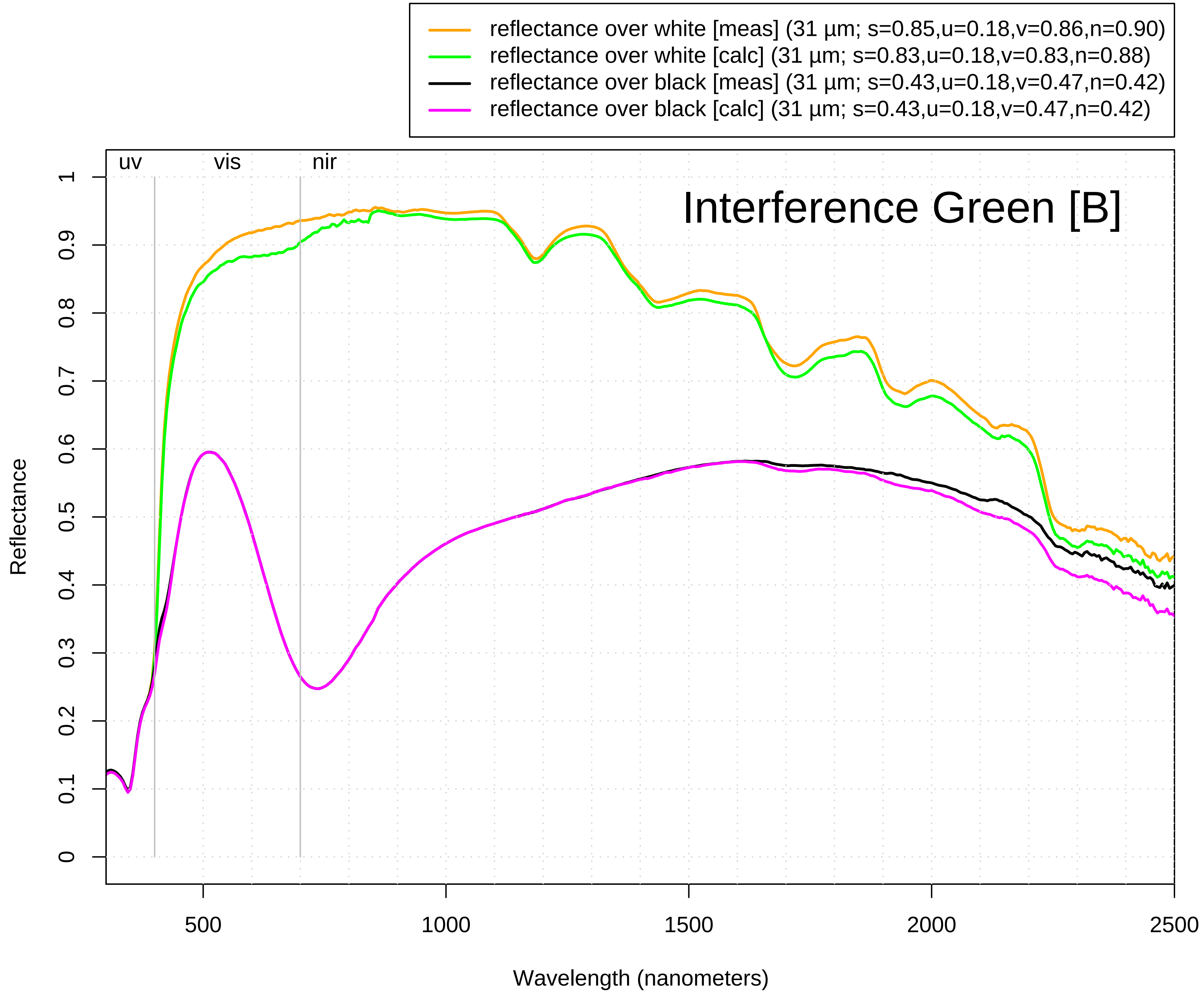
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:54 PM



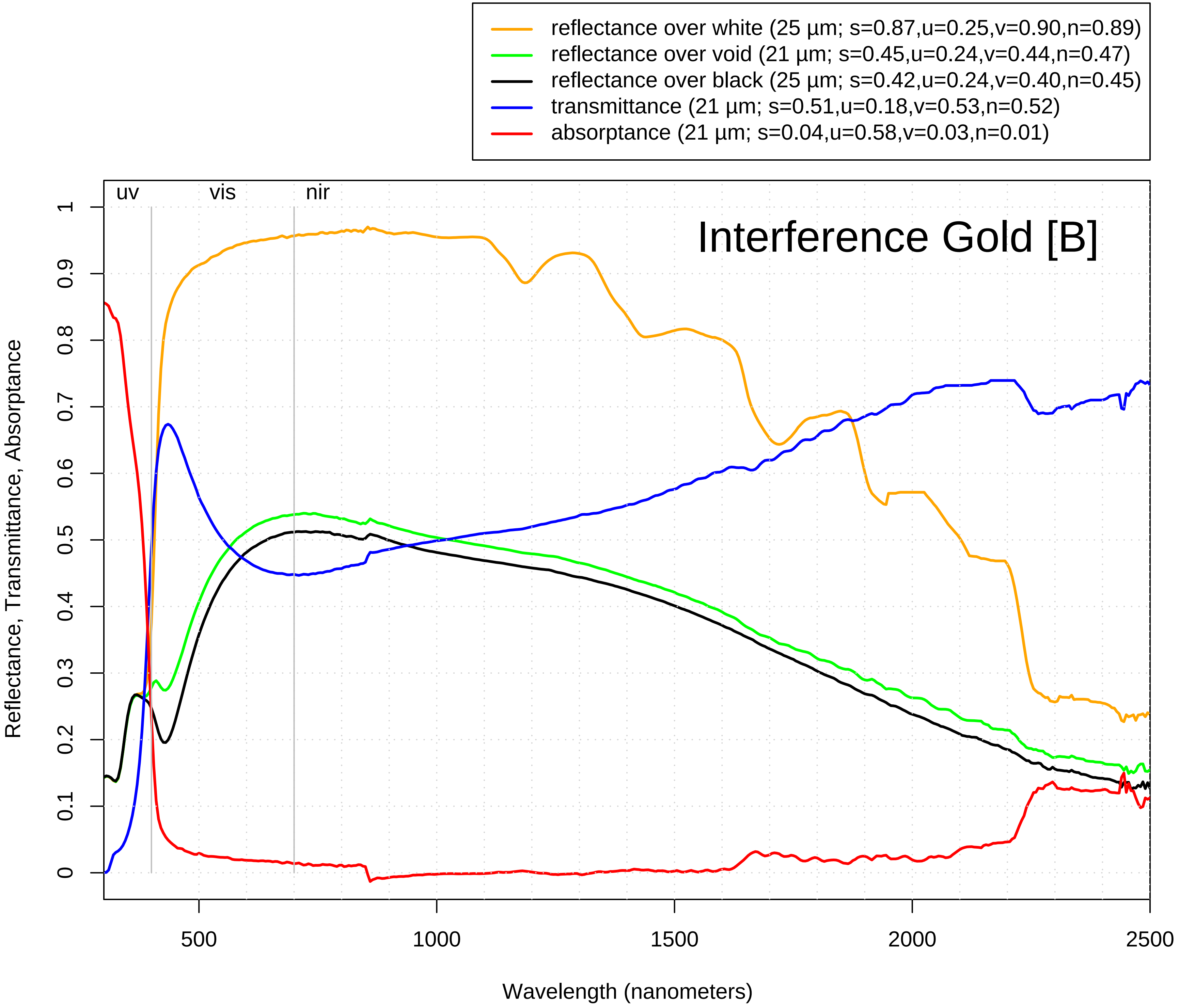
(c) Ancillary Calculations

Sunday, 09 March 2003 02:54 PM



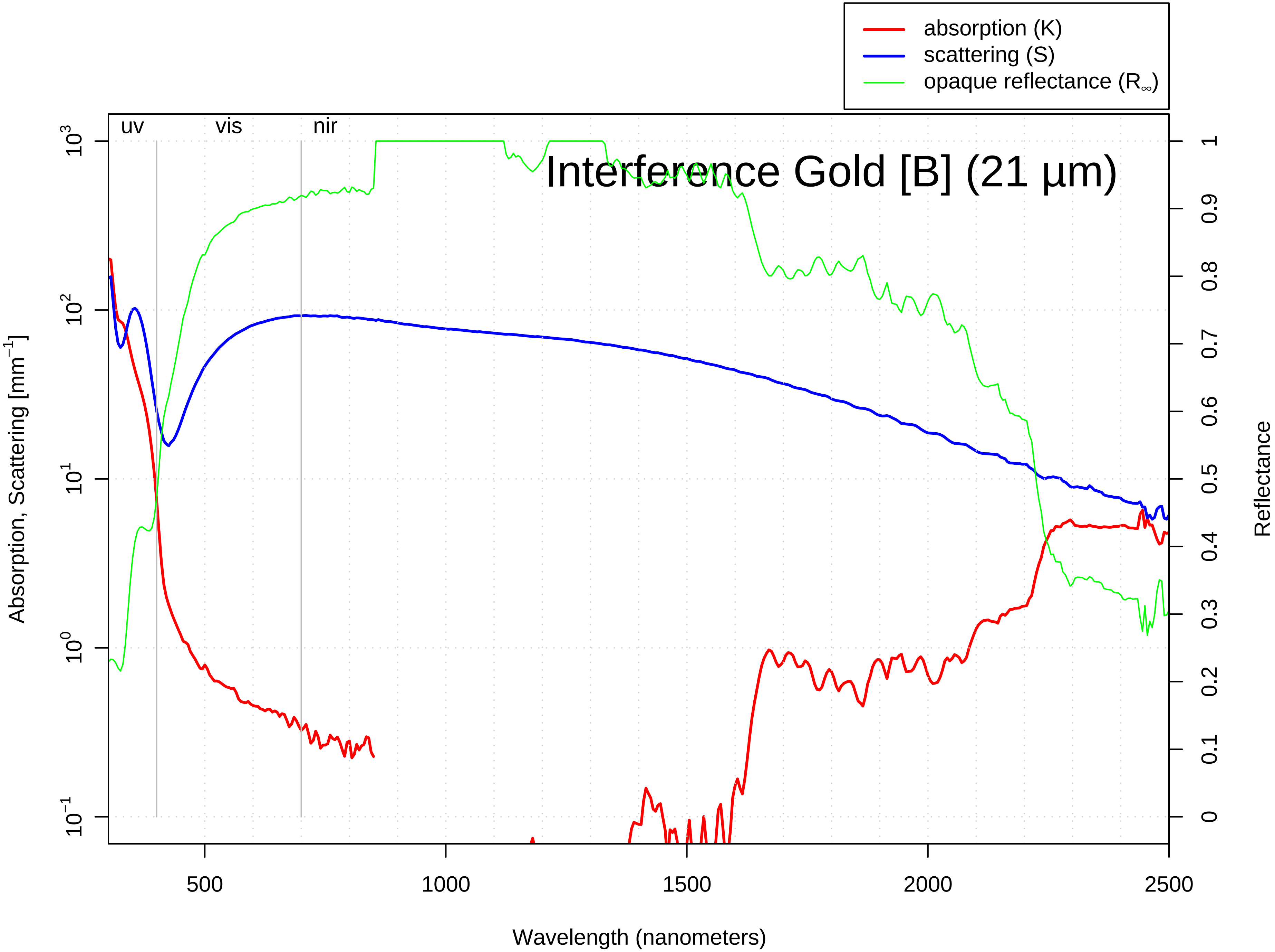
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:54 PM



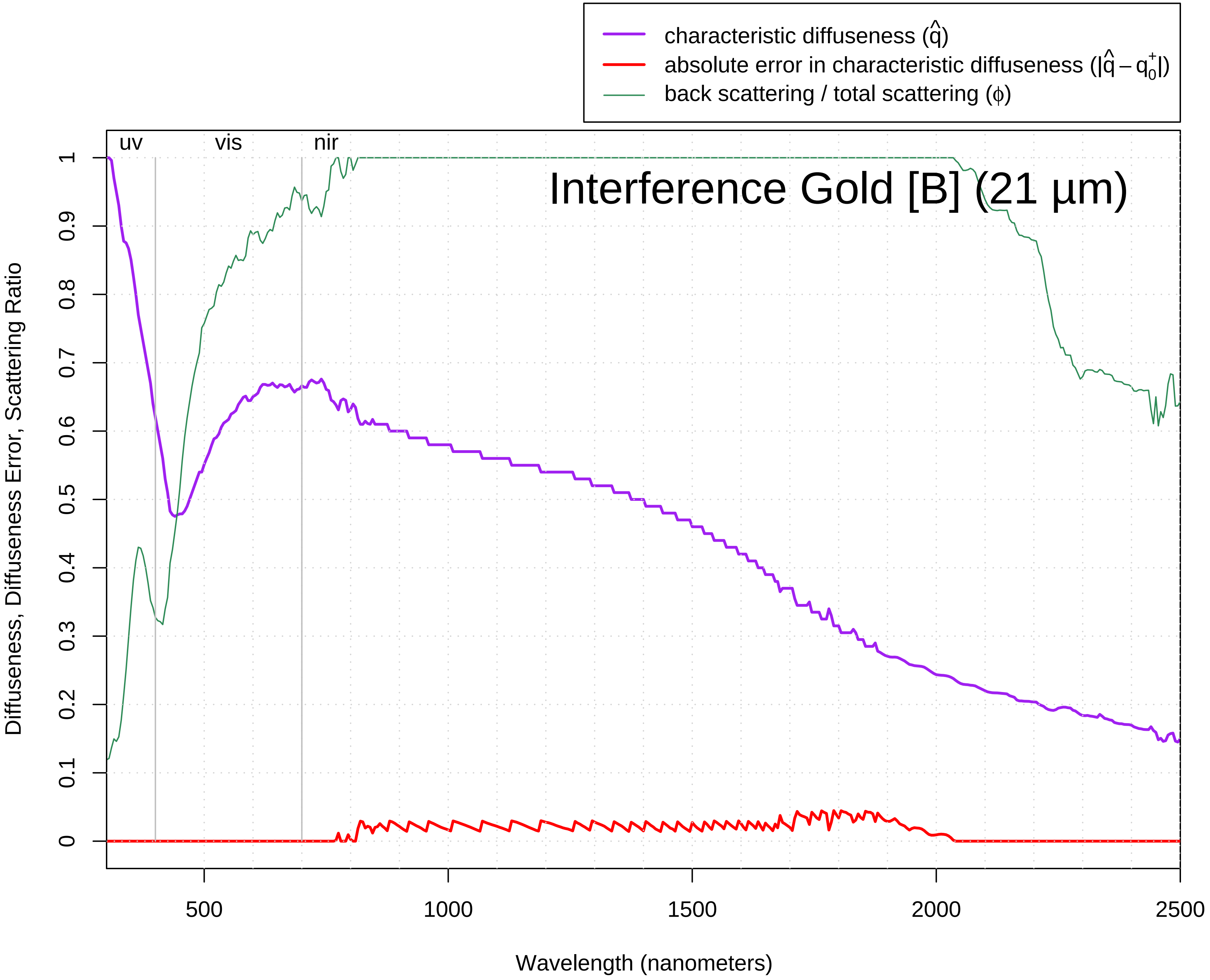
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 02:59 PM



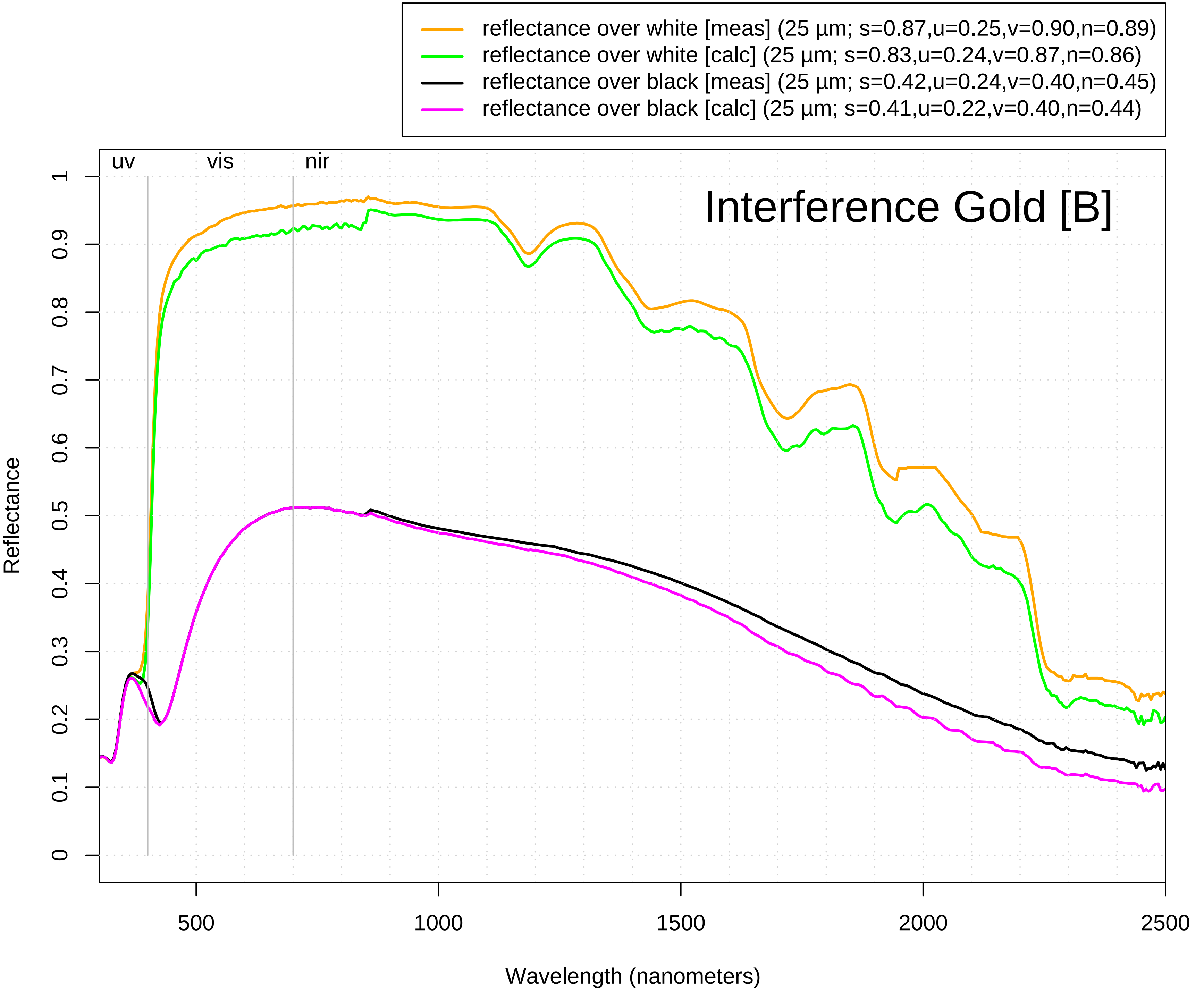
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 02:59 PM



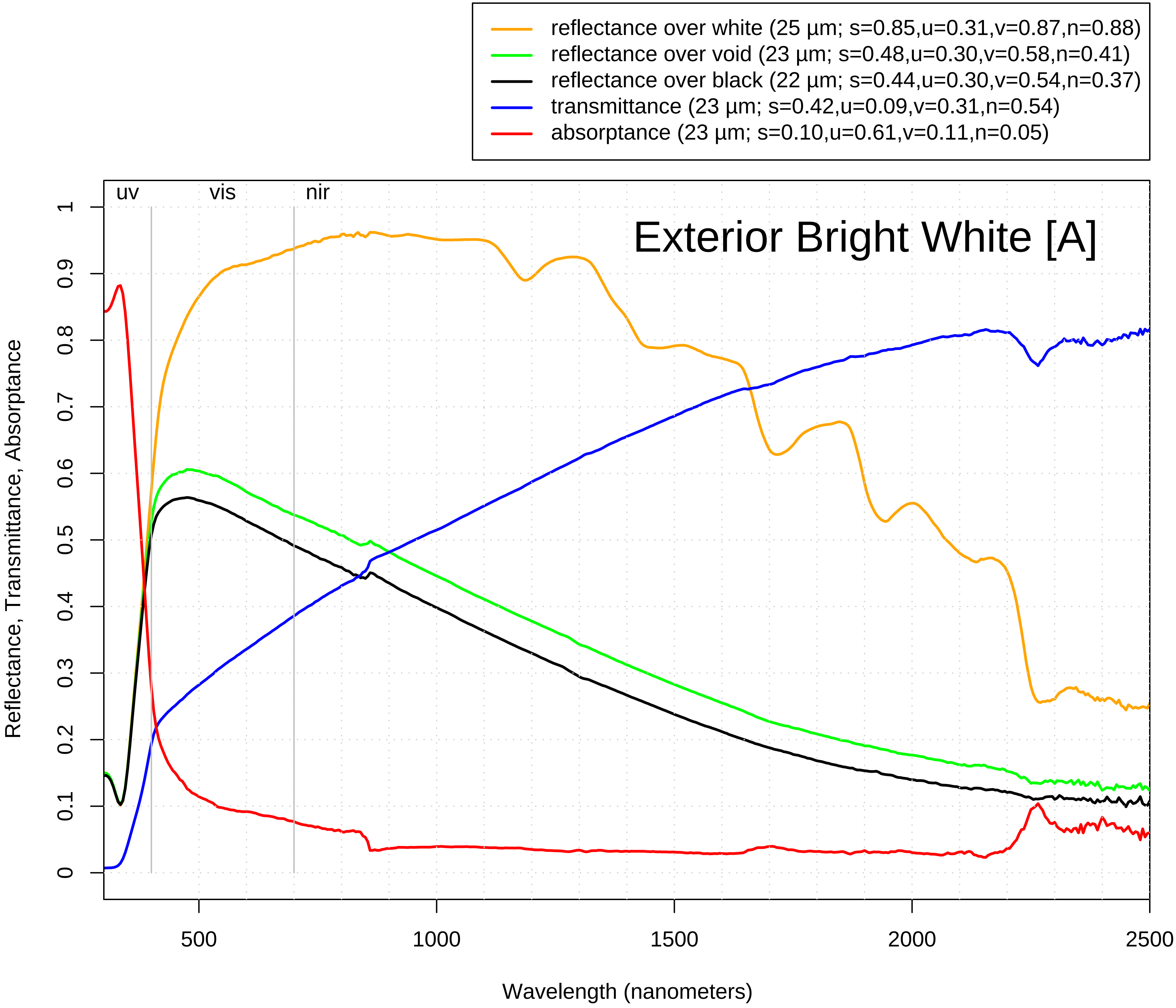
(c) Ancillary Calculations

Sunday, 09 March 2003 02:59 PM



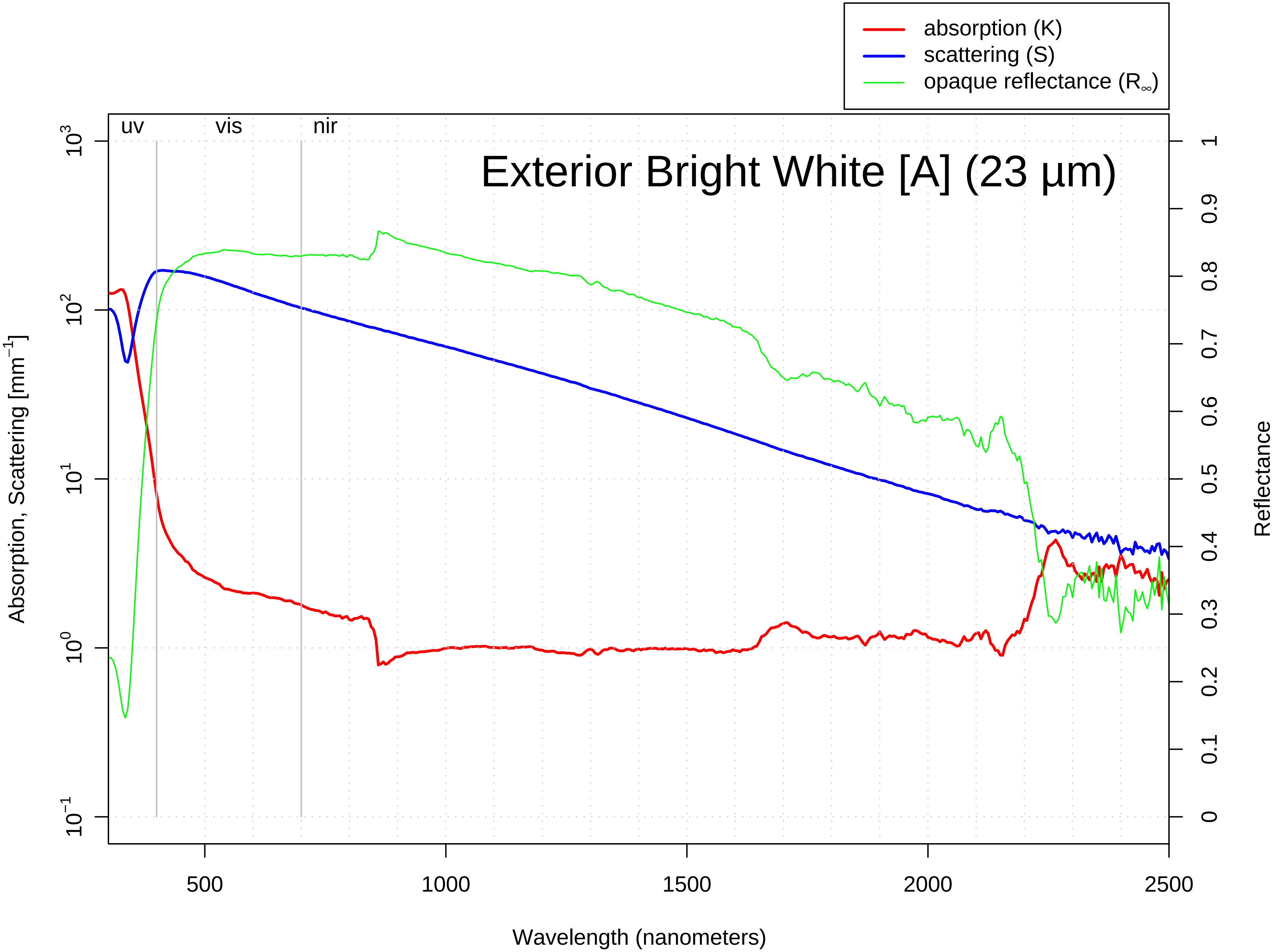
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 02:59 PM



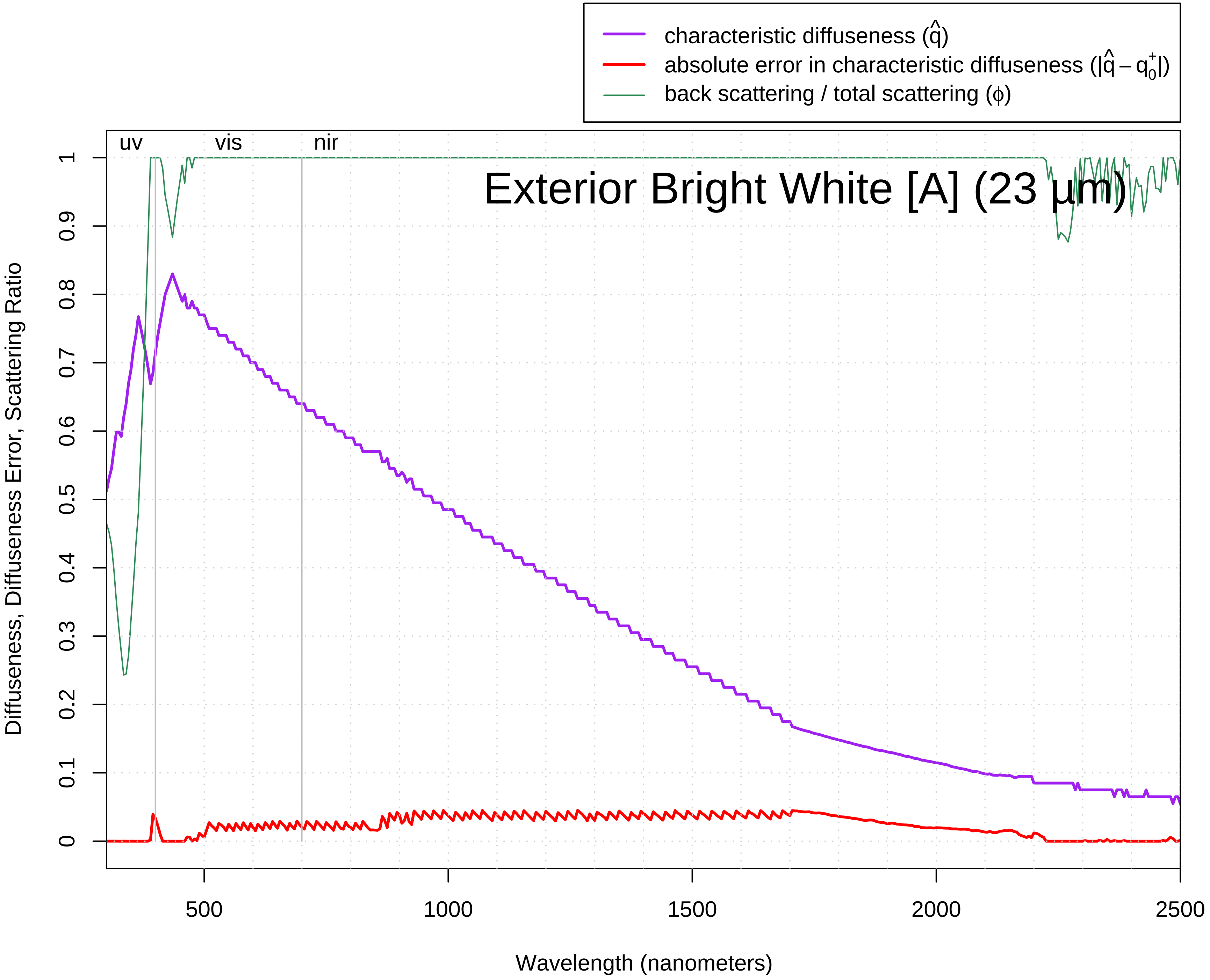
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 03:03 PM



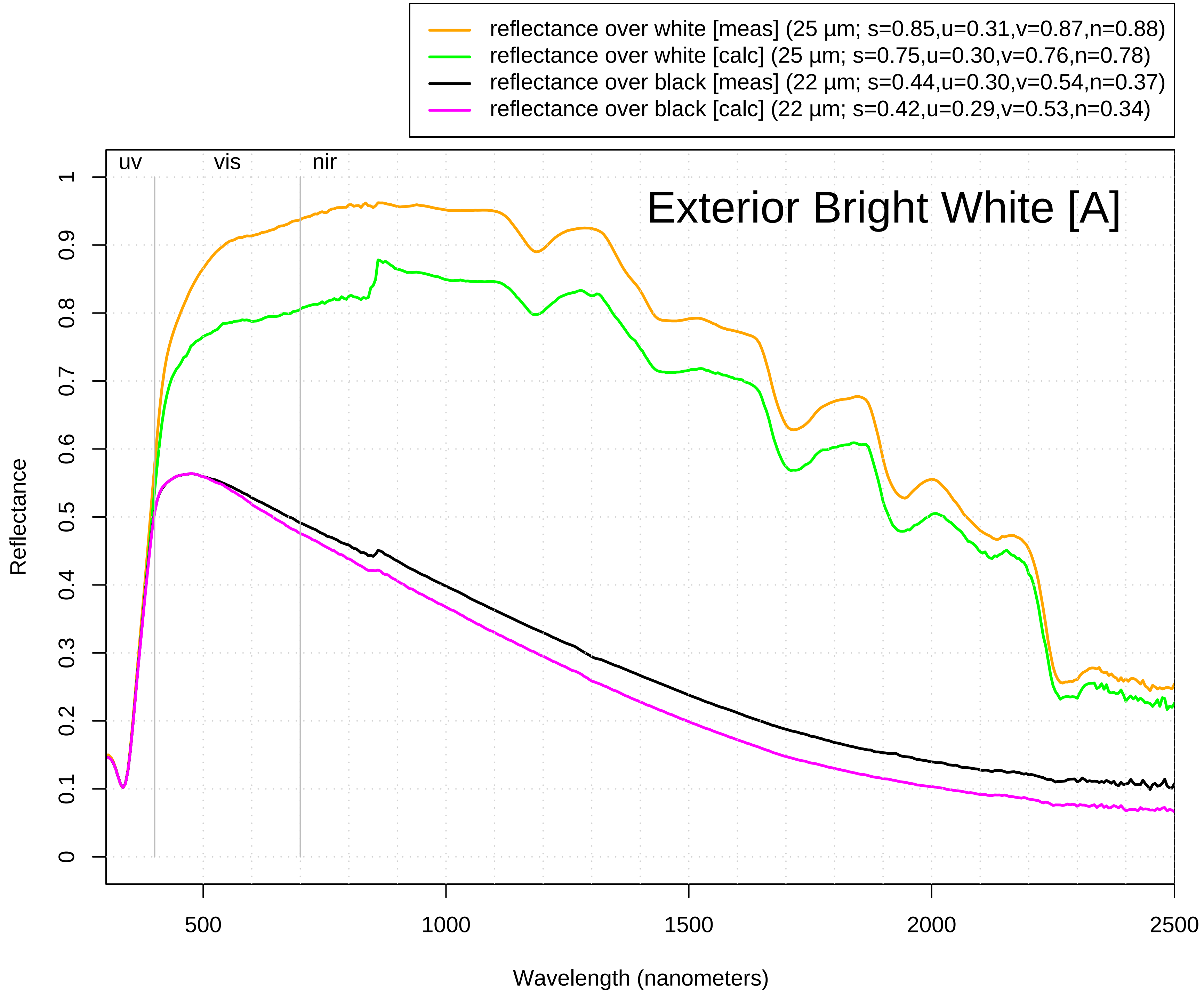
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 03:03 PM



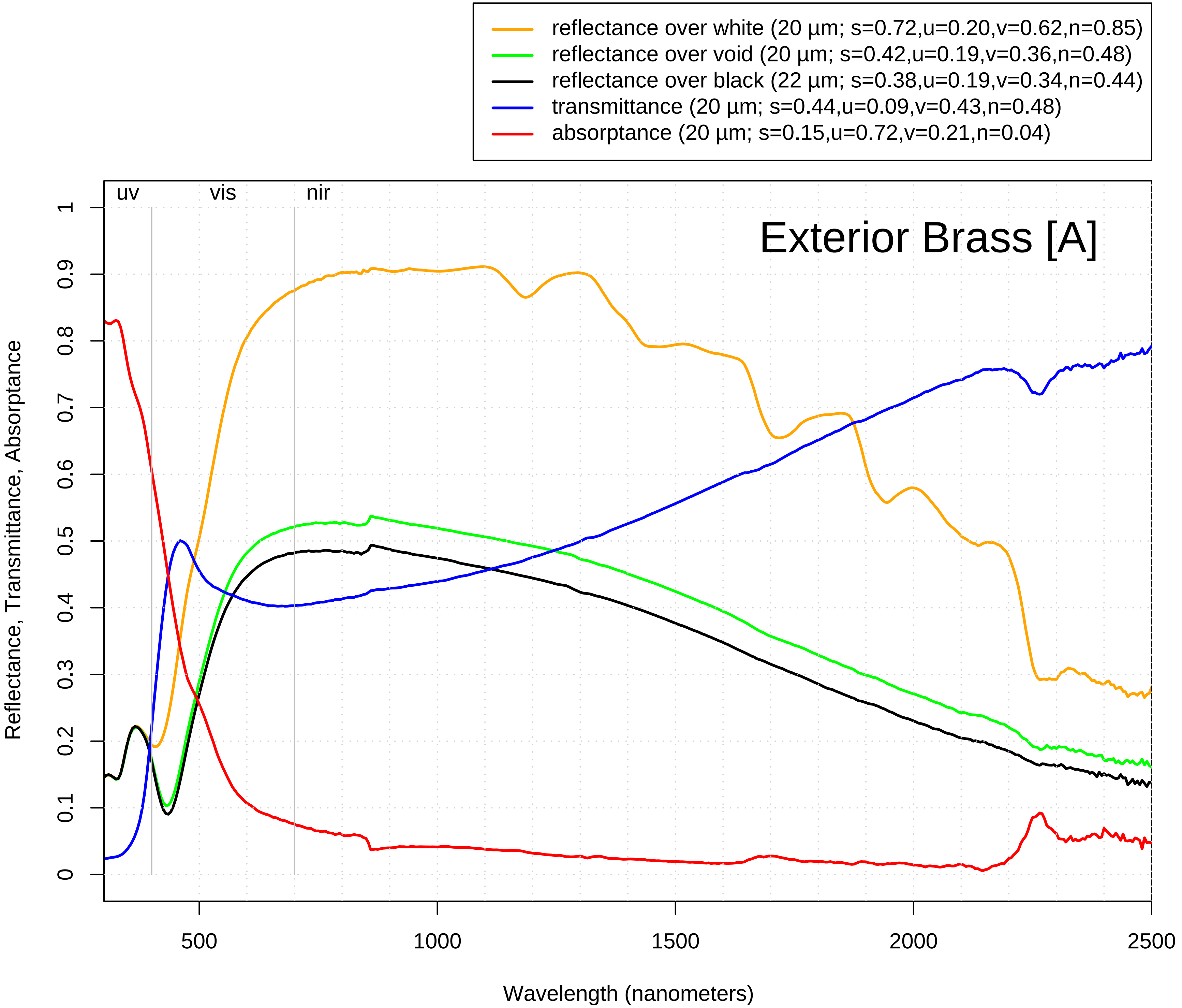
(c) Ancillary Calculations

Sunday, 09 March 2003 03:03 PM



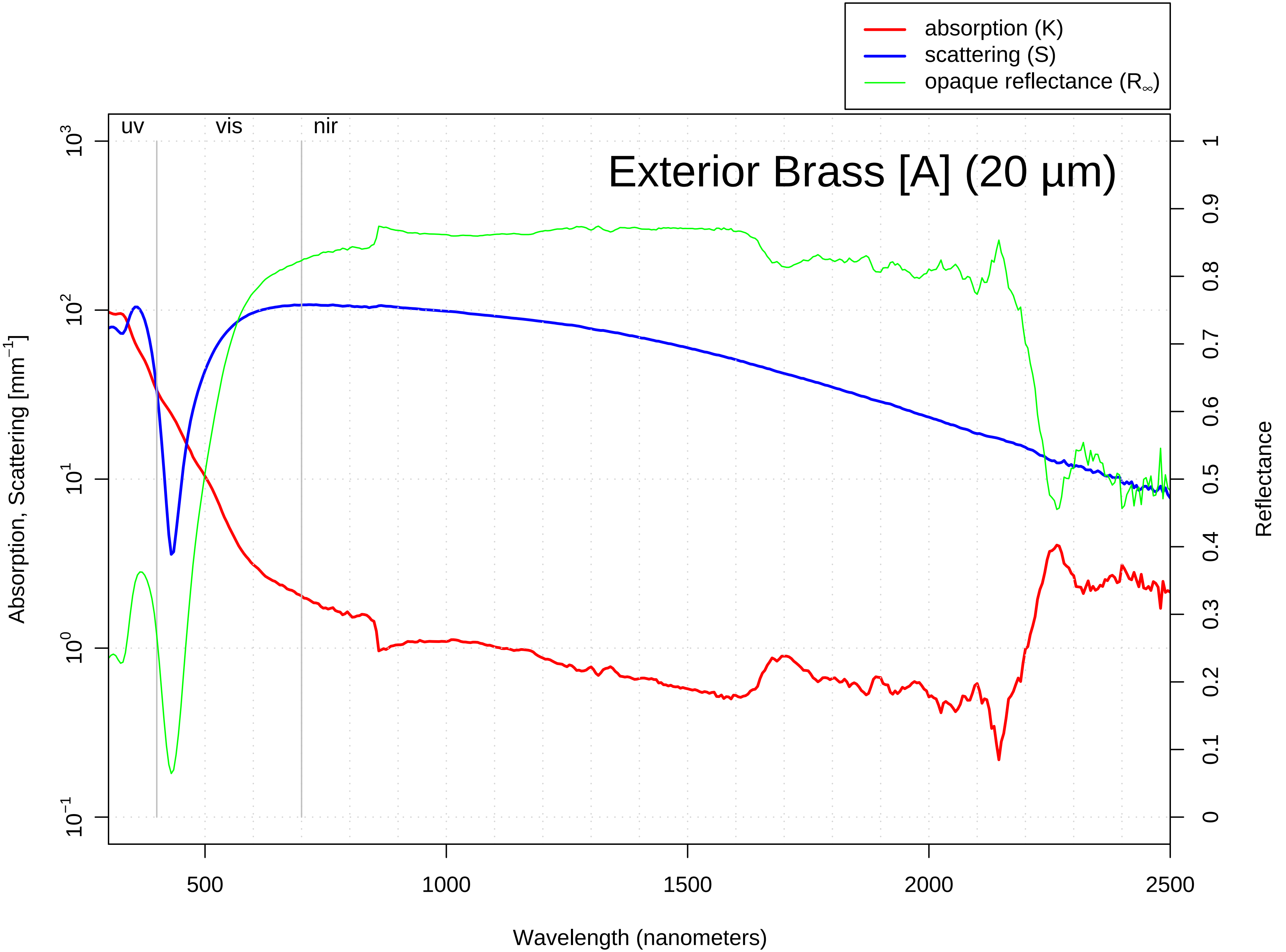
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 03:03 PM



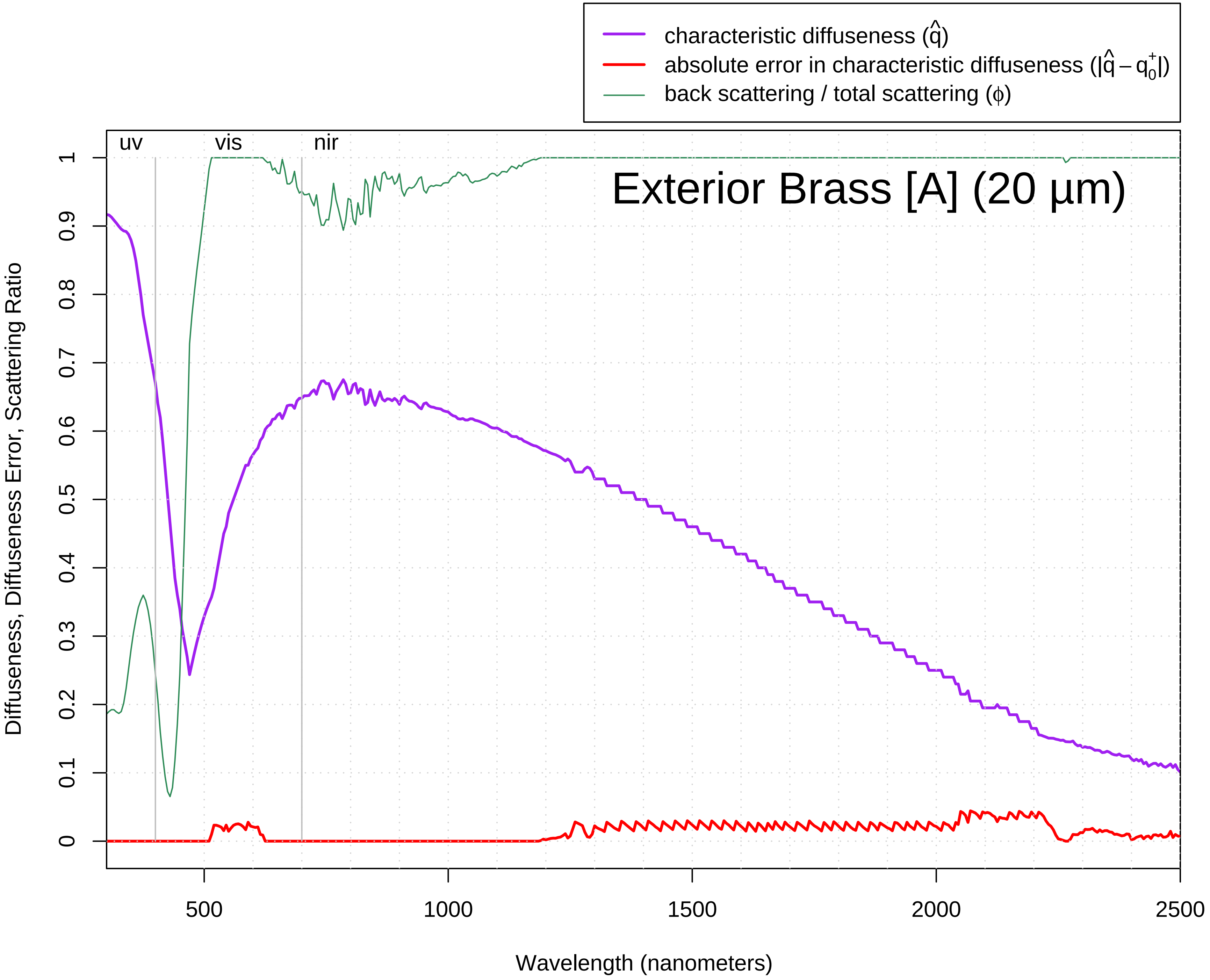
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 03:06 PM



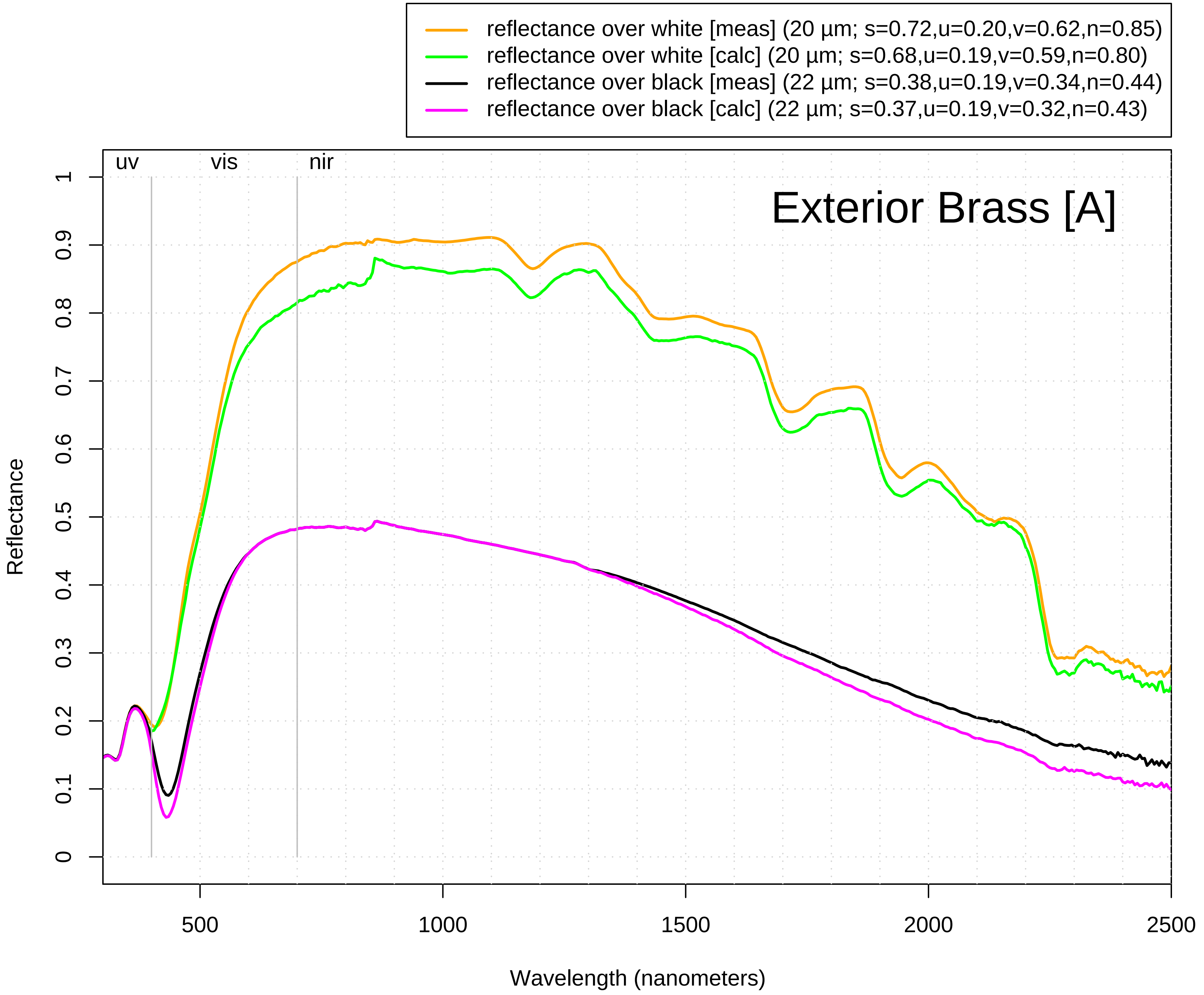
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 03:06 PM



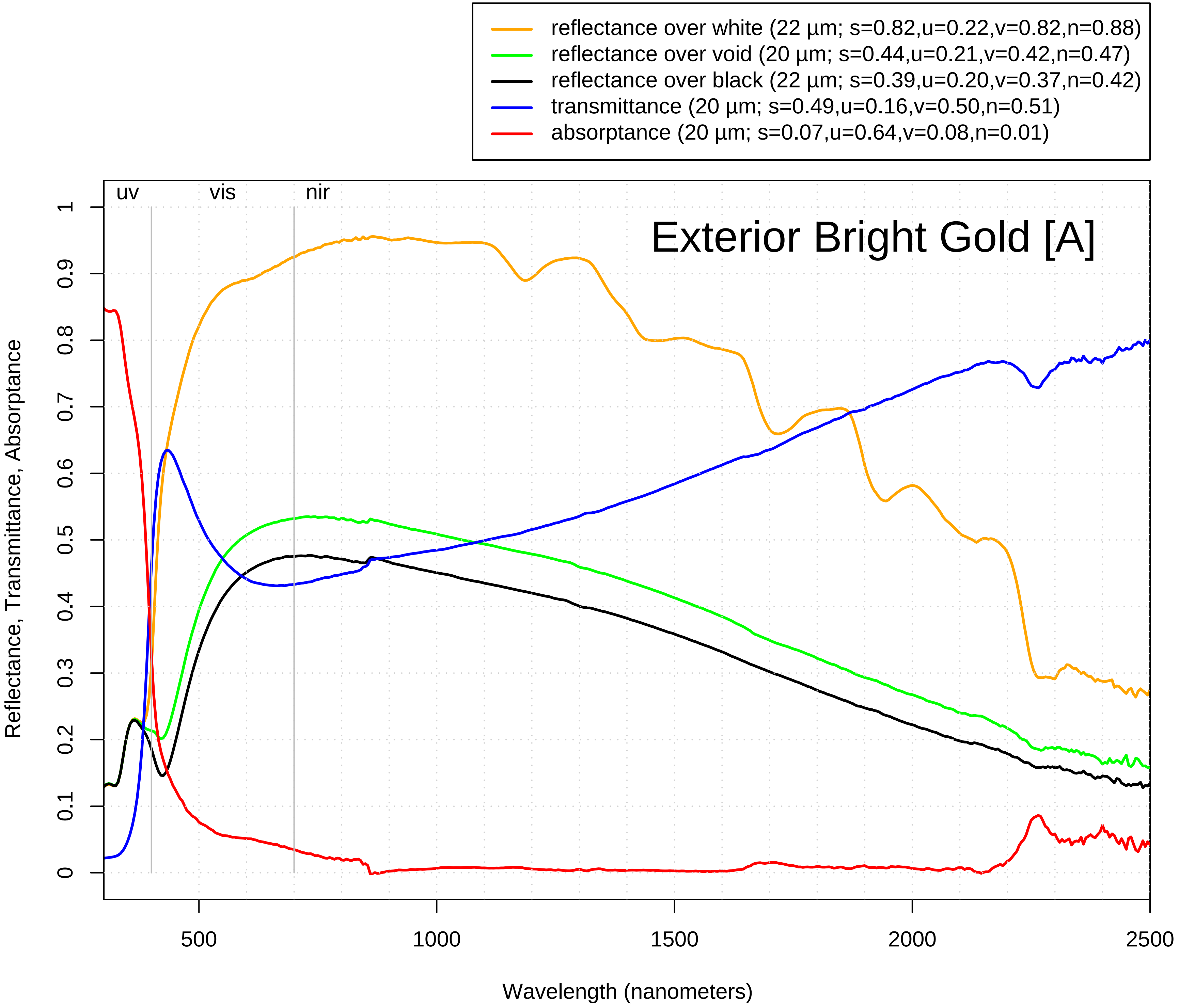
(c) Ancillary Calculations

Sunday, 09 March 2003 03:06 PM



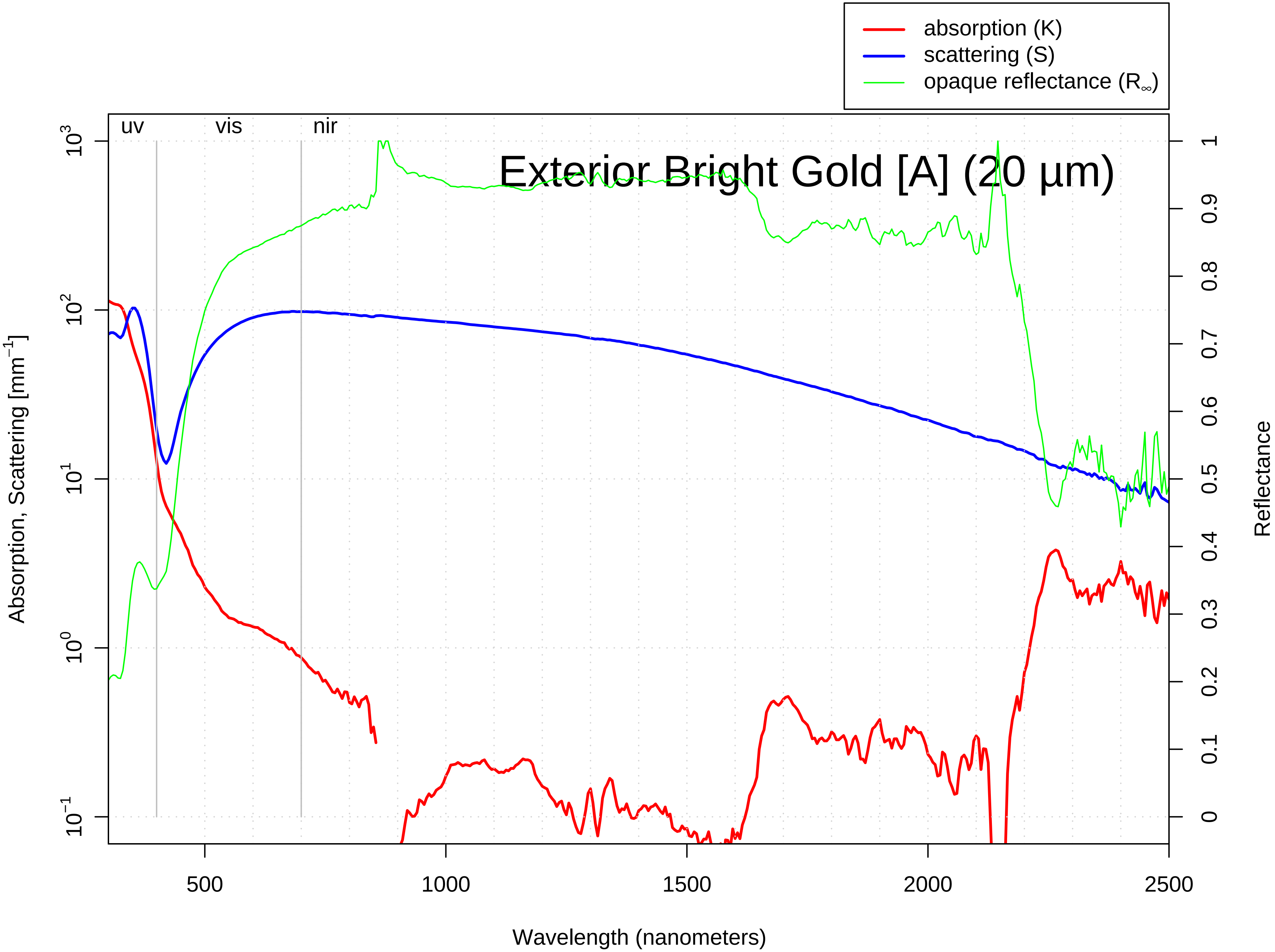
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 03:06 PM



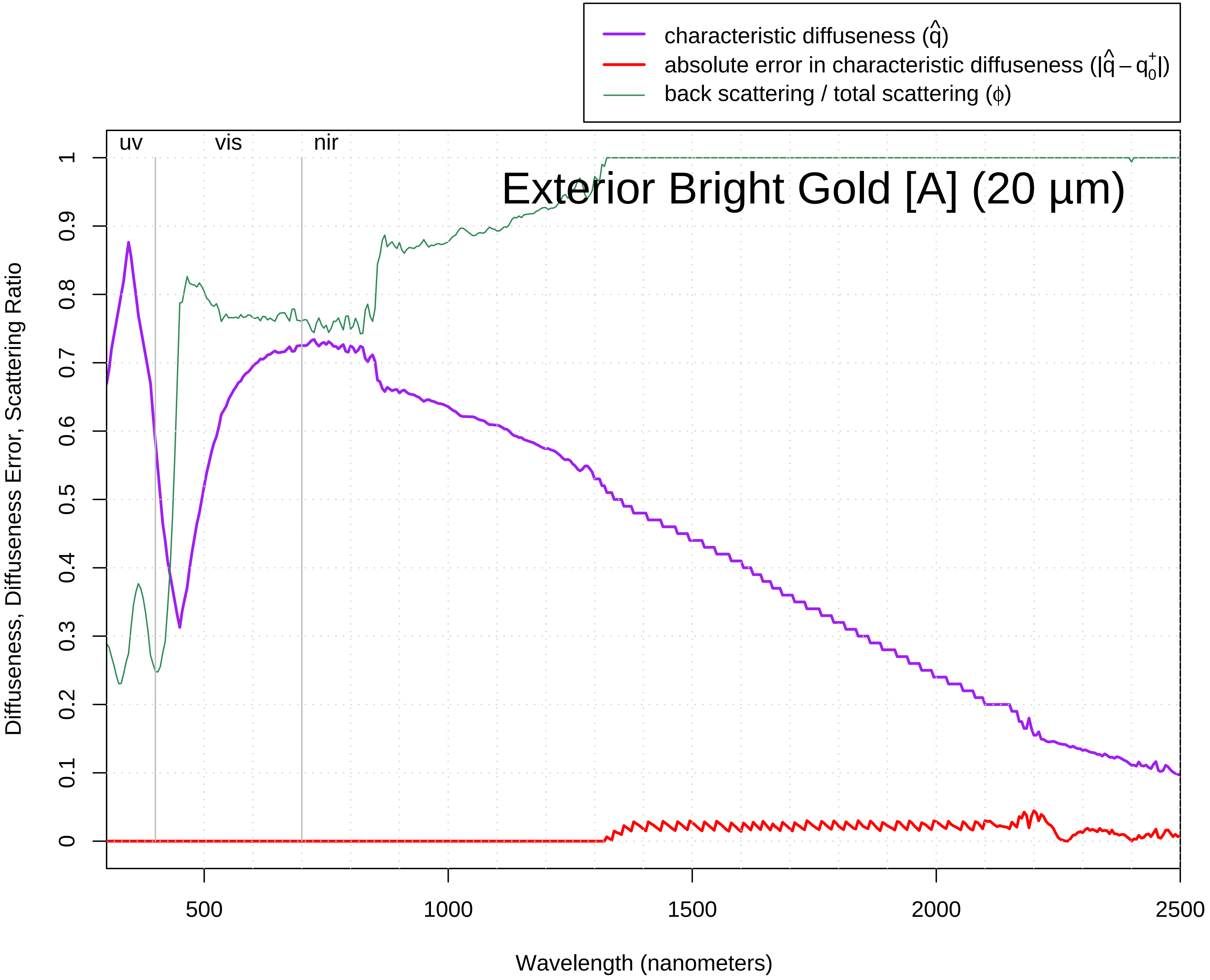
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 03:08 PM



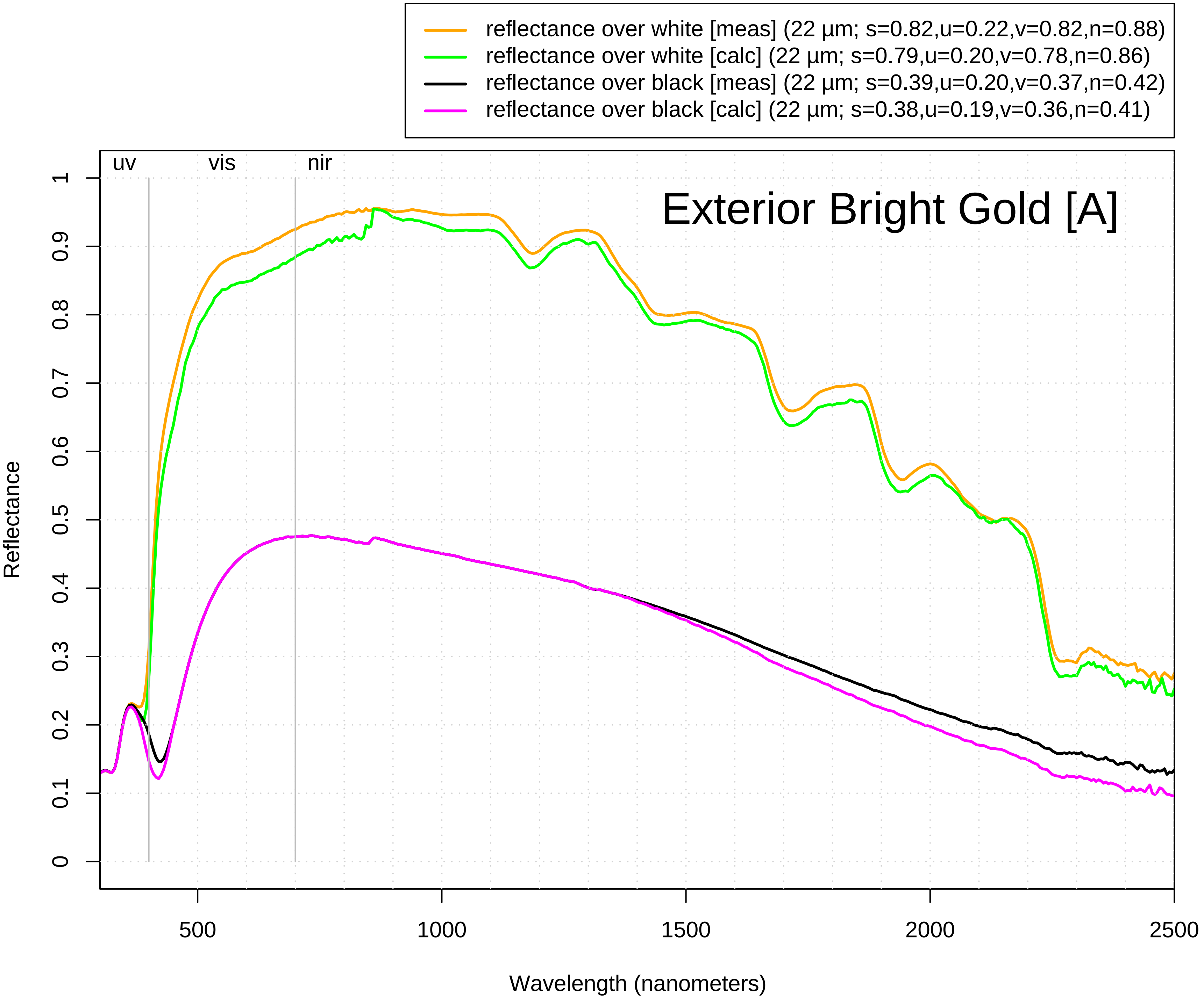
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 03:08 PM



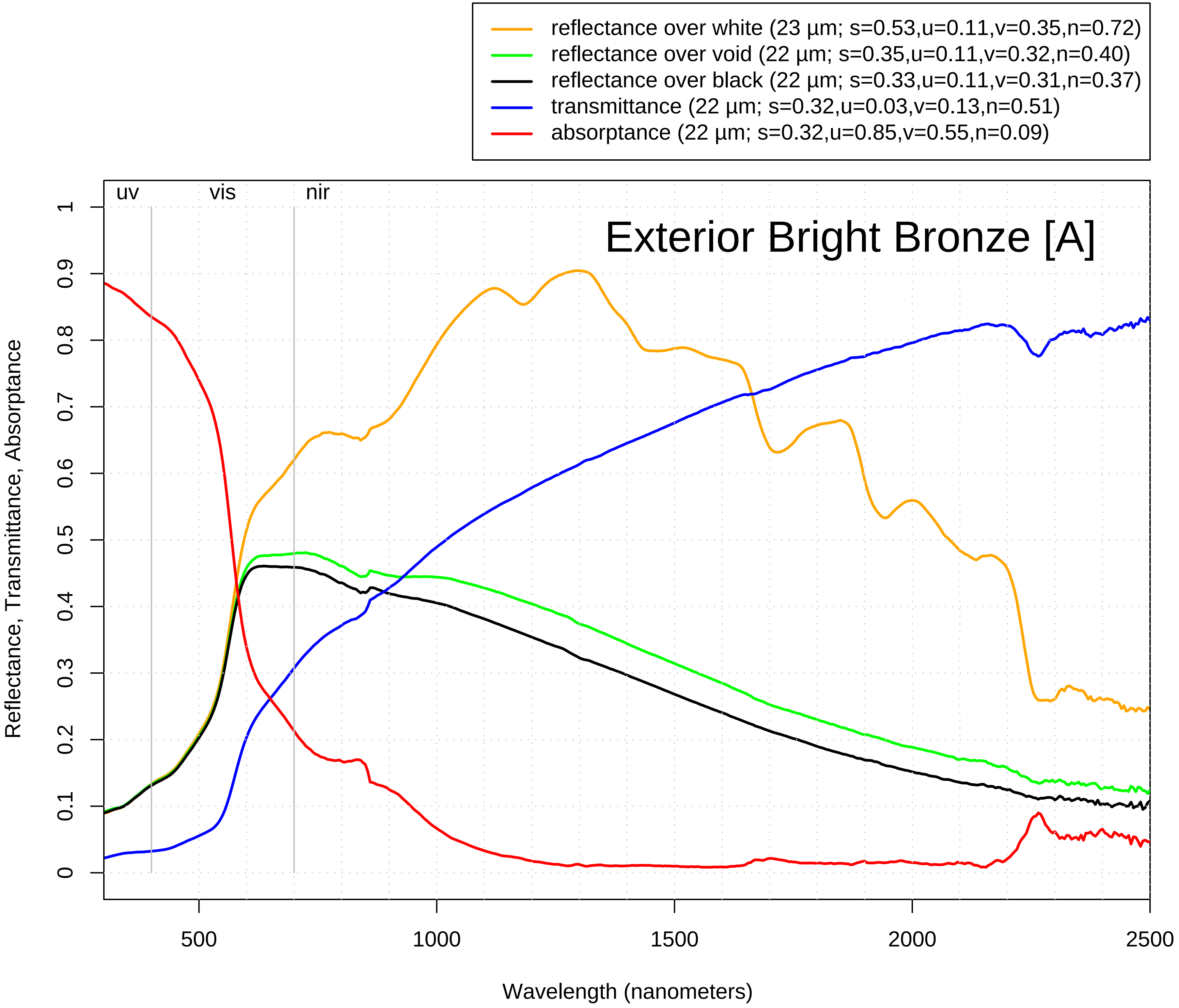
(c) Ancillary Calculations

Sunday, 09 March 2003 03:08 PM



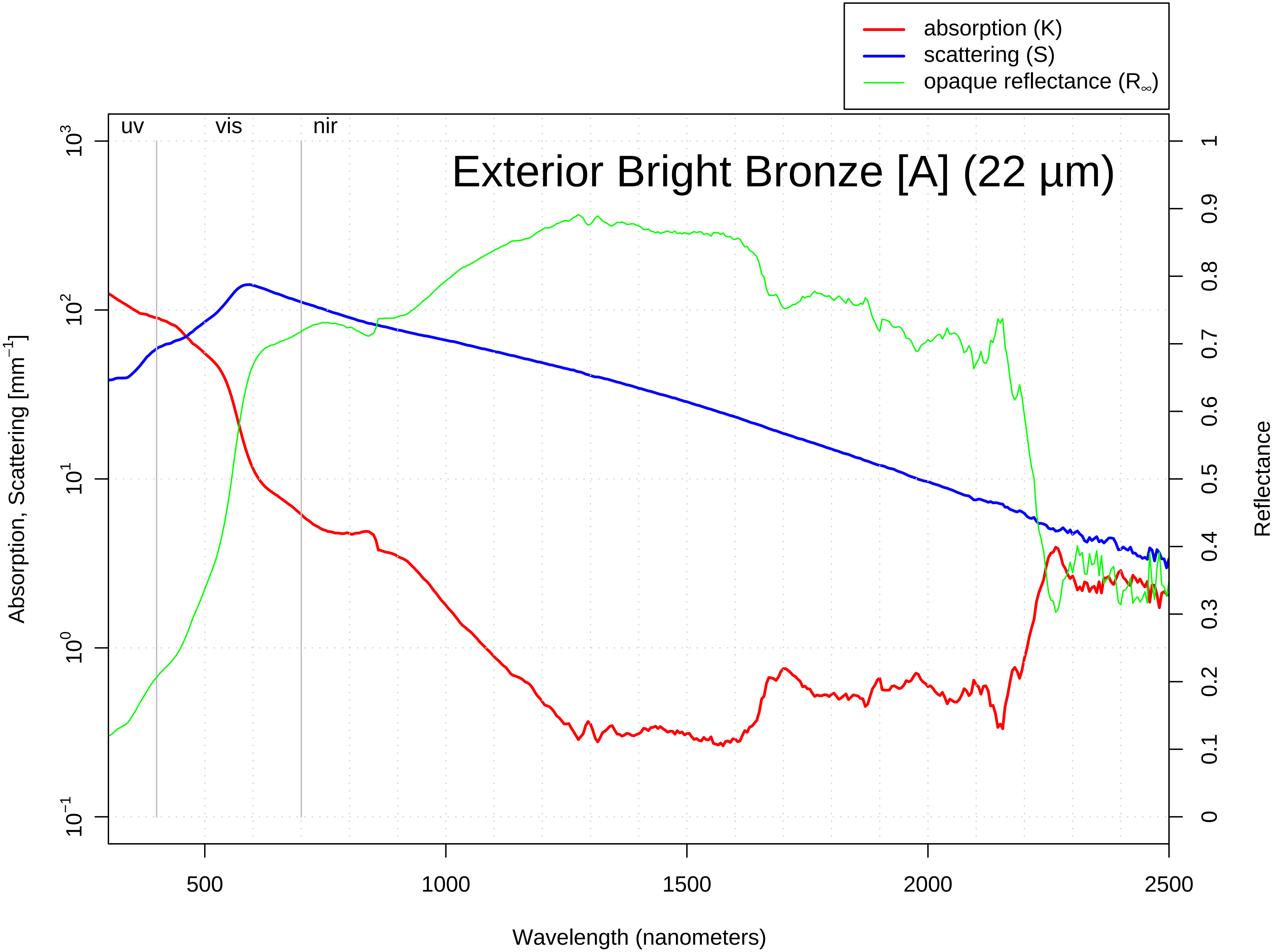
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 03:08 PM



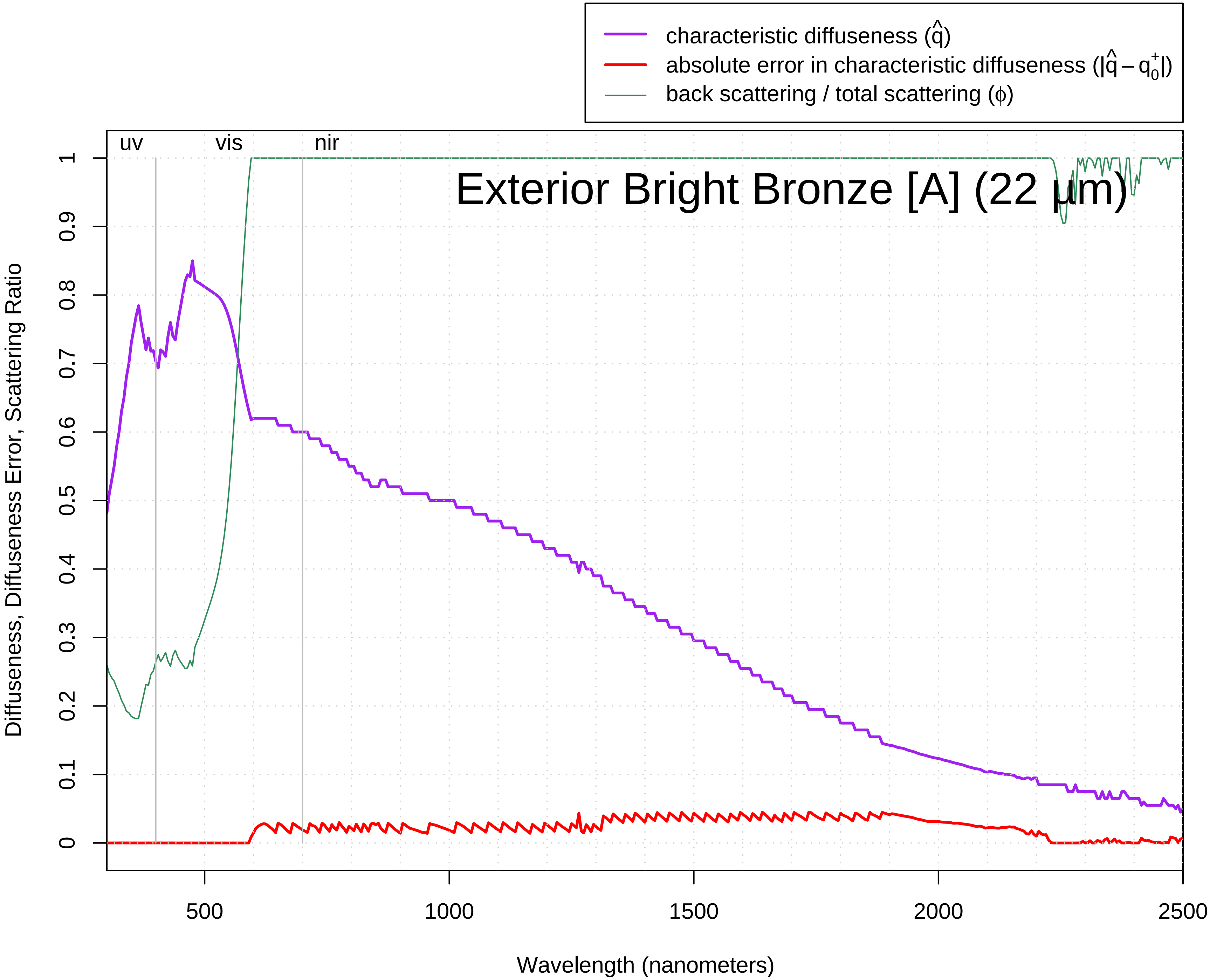
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 03:11 PM



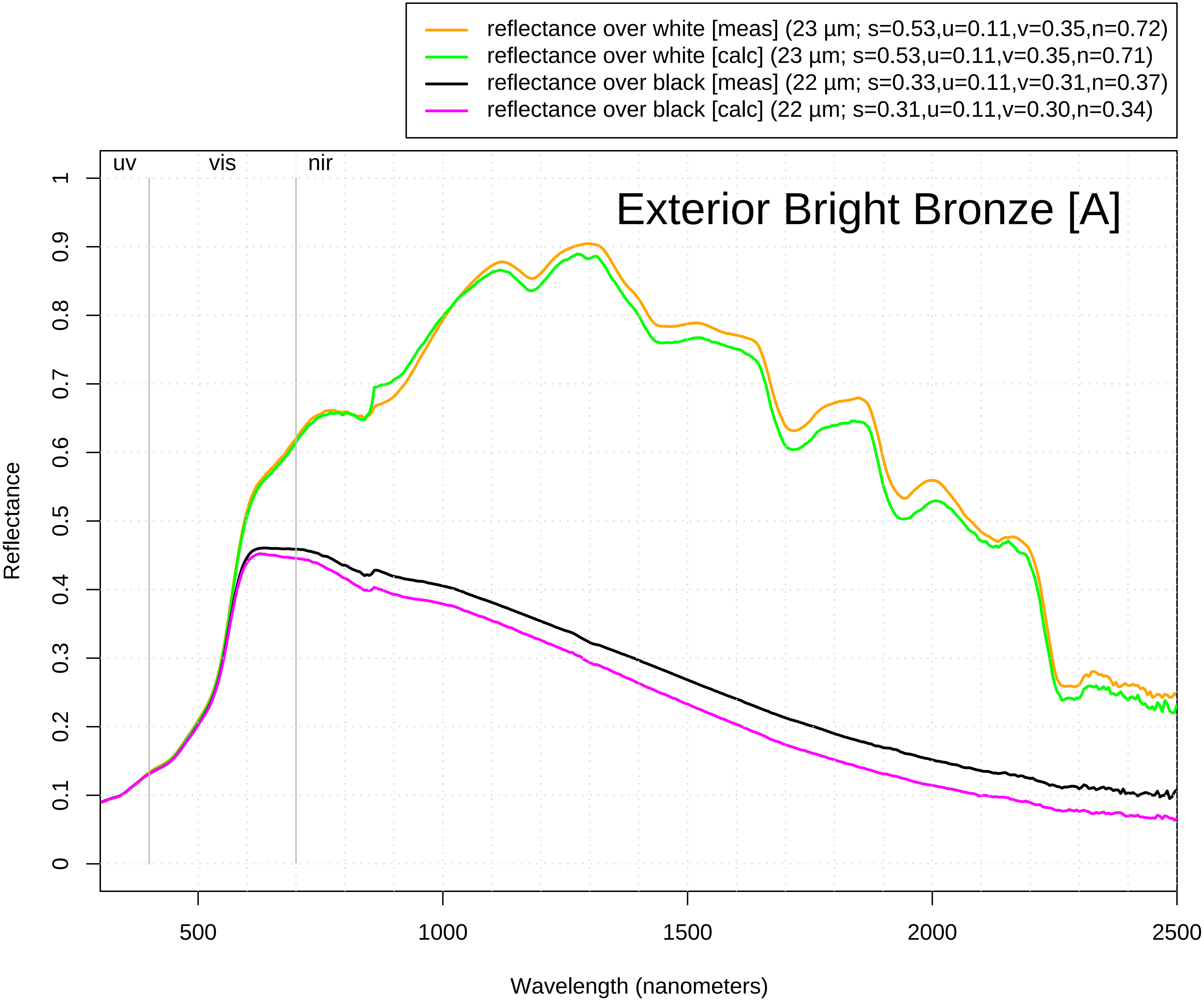
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 03:11 PM



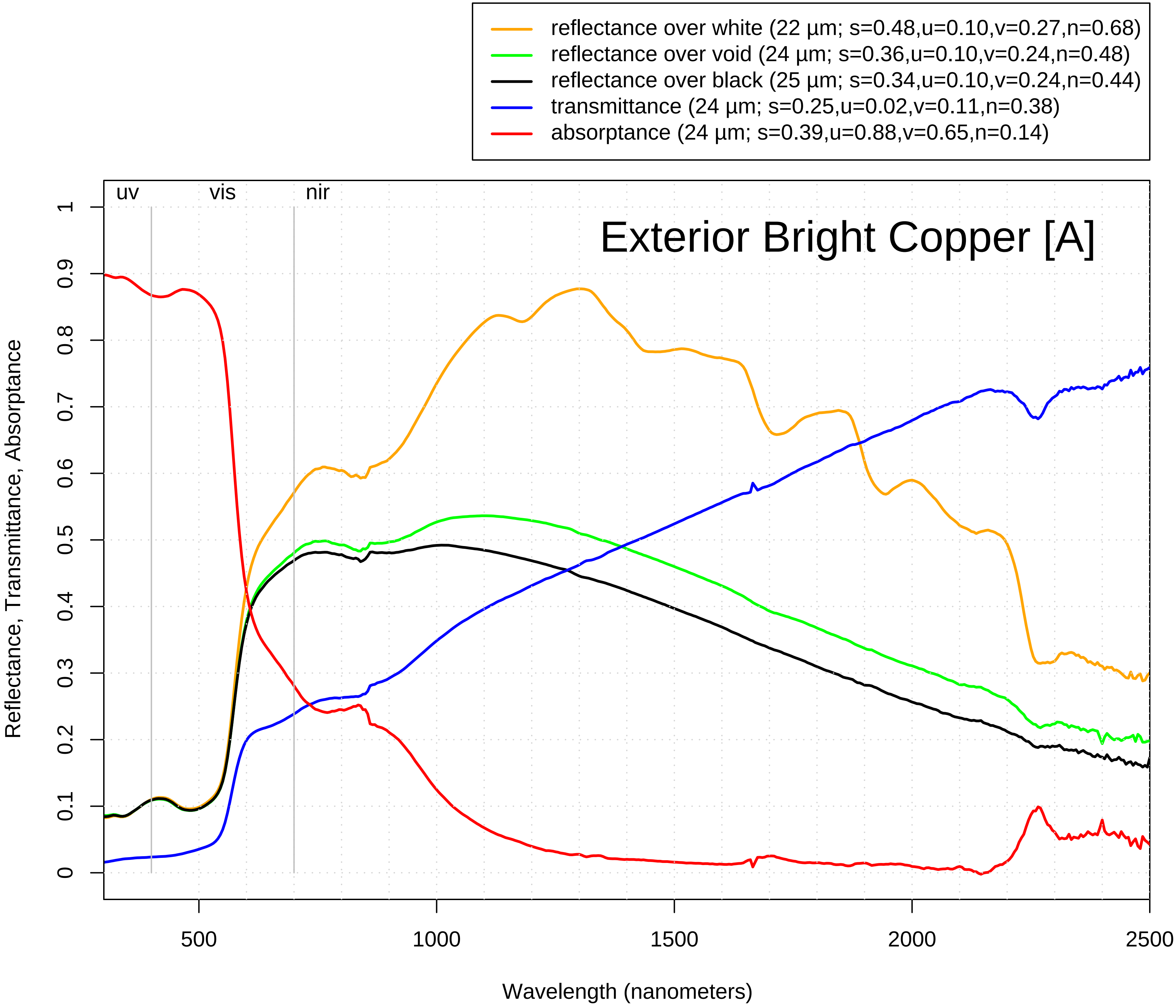
(c) Ancillary Calculations

Sunday, 09 March 2003 03:11 PM



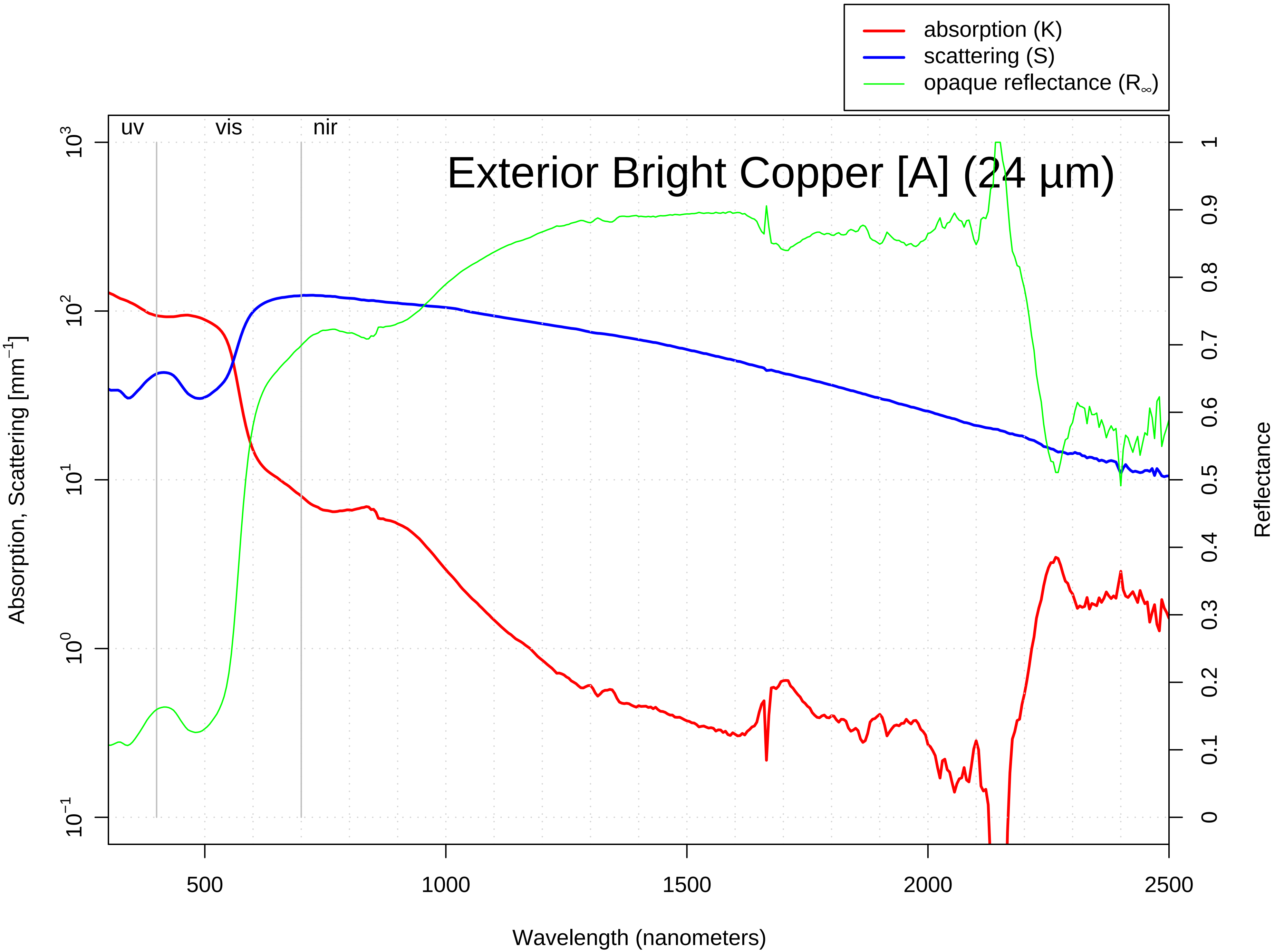
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 03:11 PM



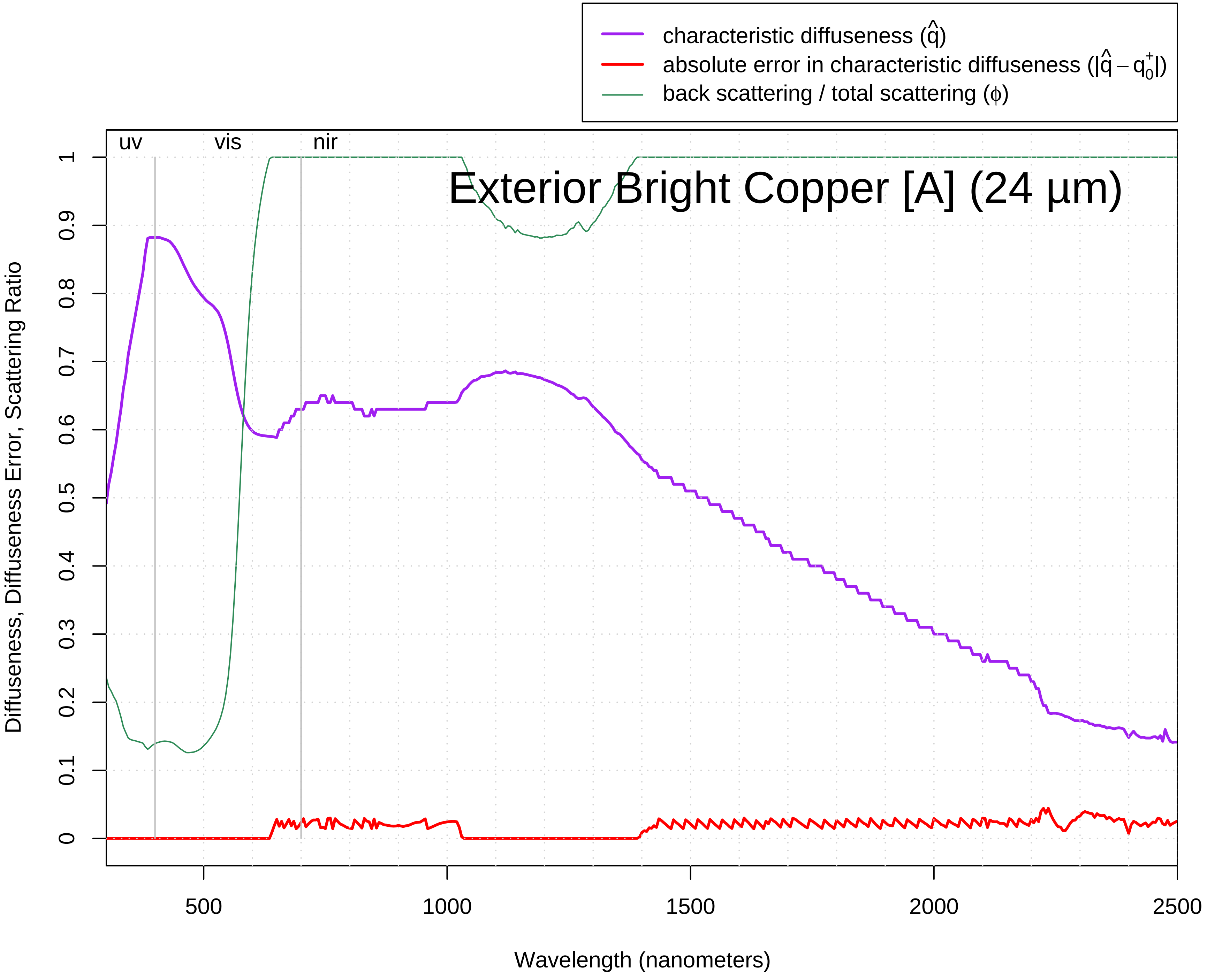
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 03:13 PM



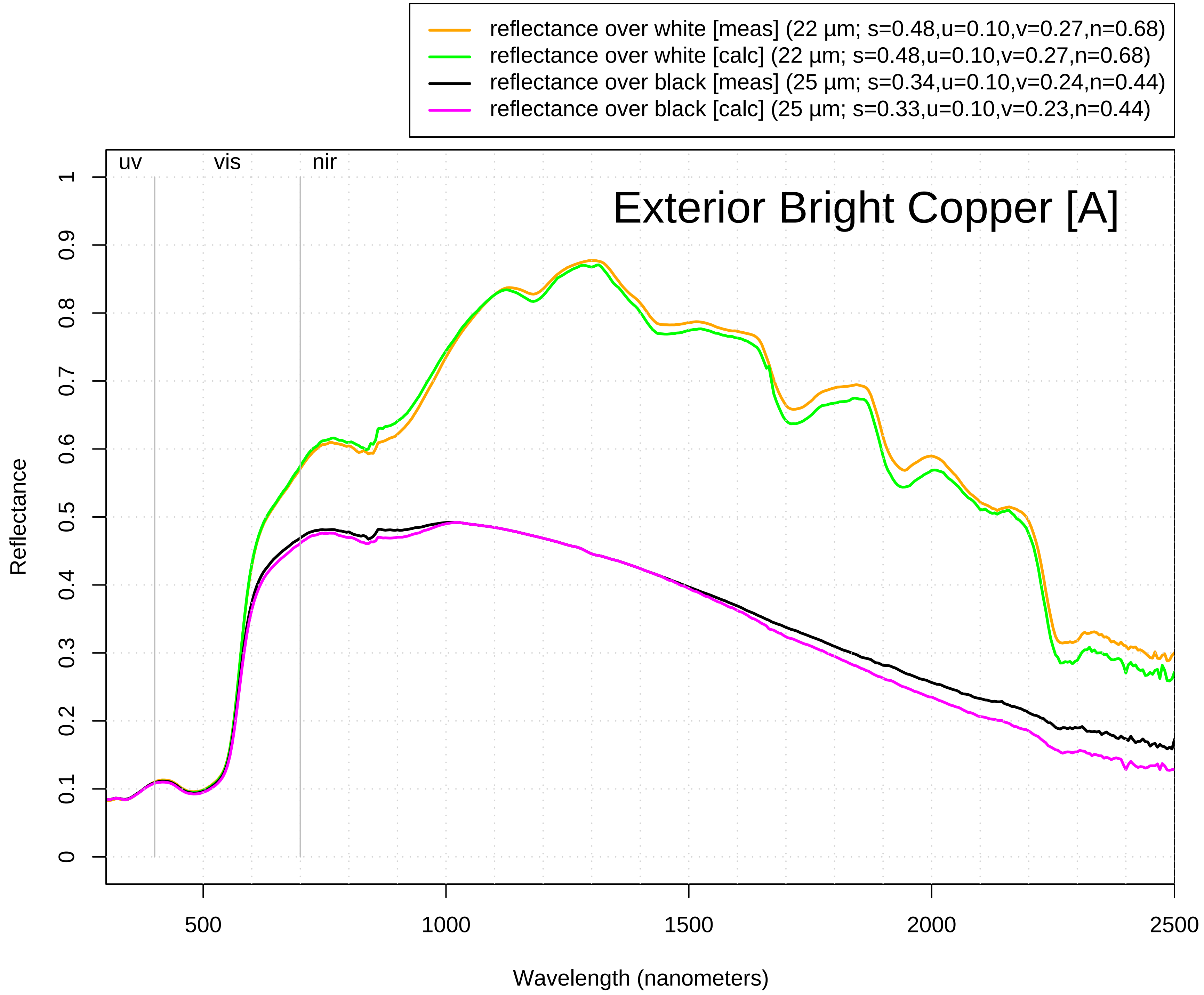
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 03:13 PM



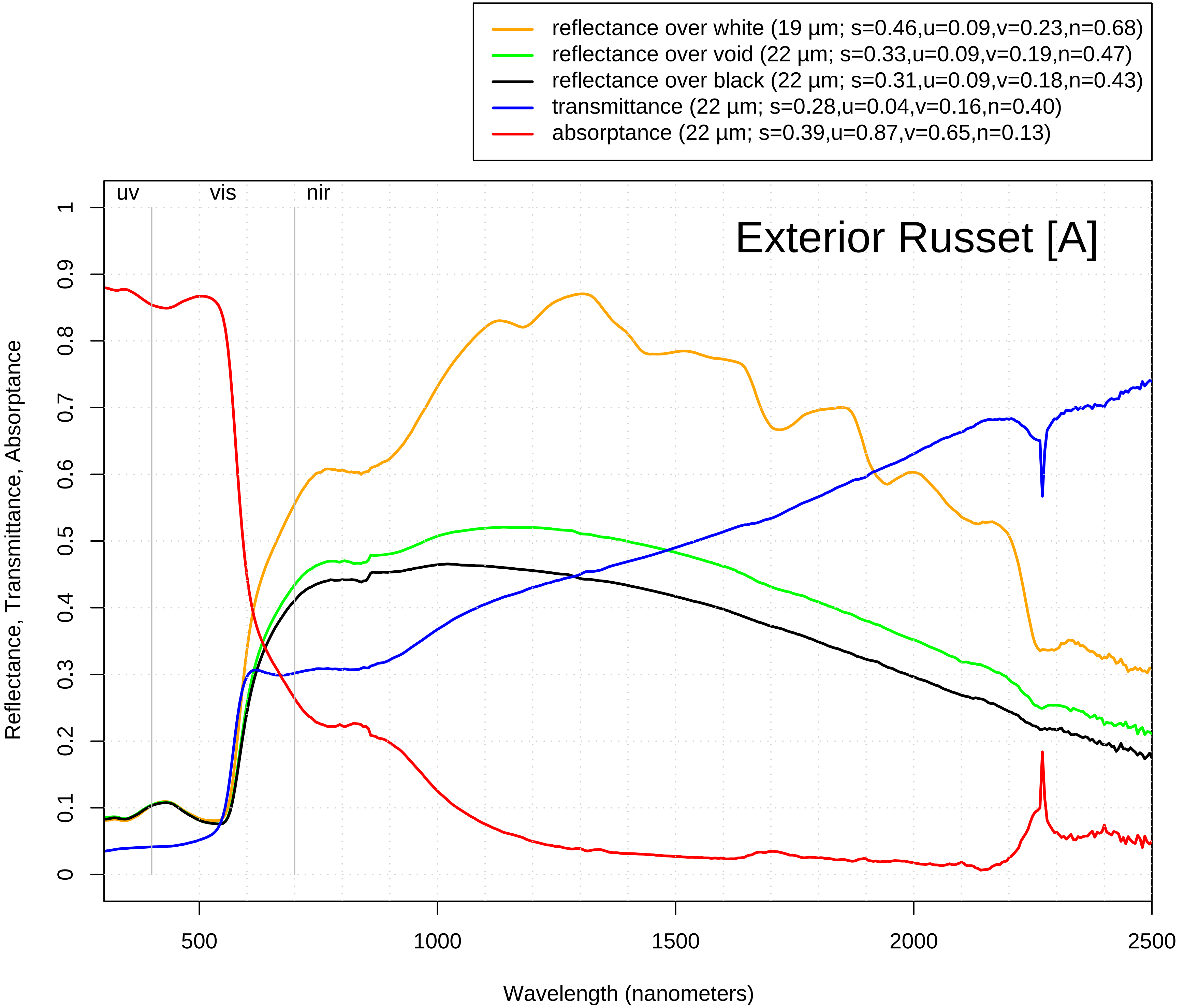
(c) Ancillary Calculations

Sunday, 09 March 2003 03:13 PM



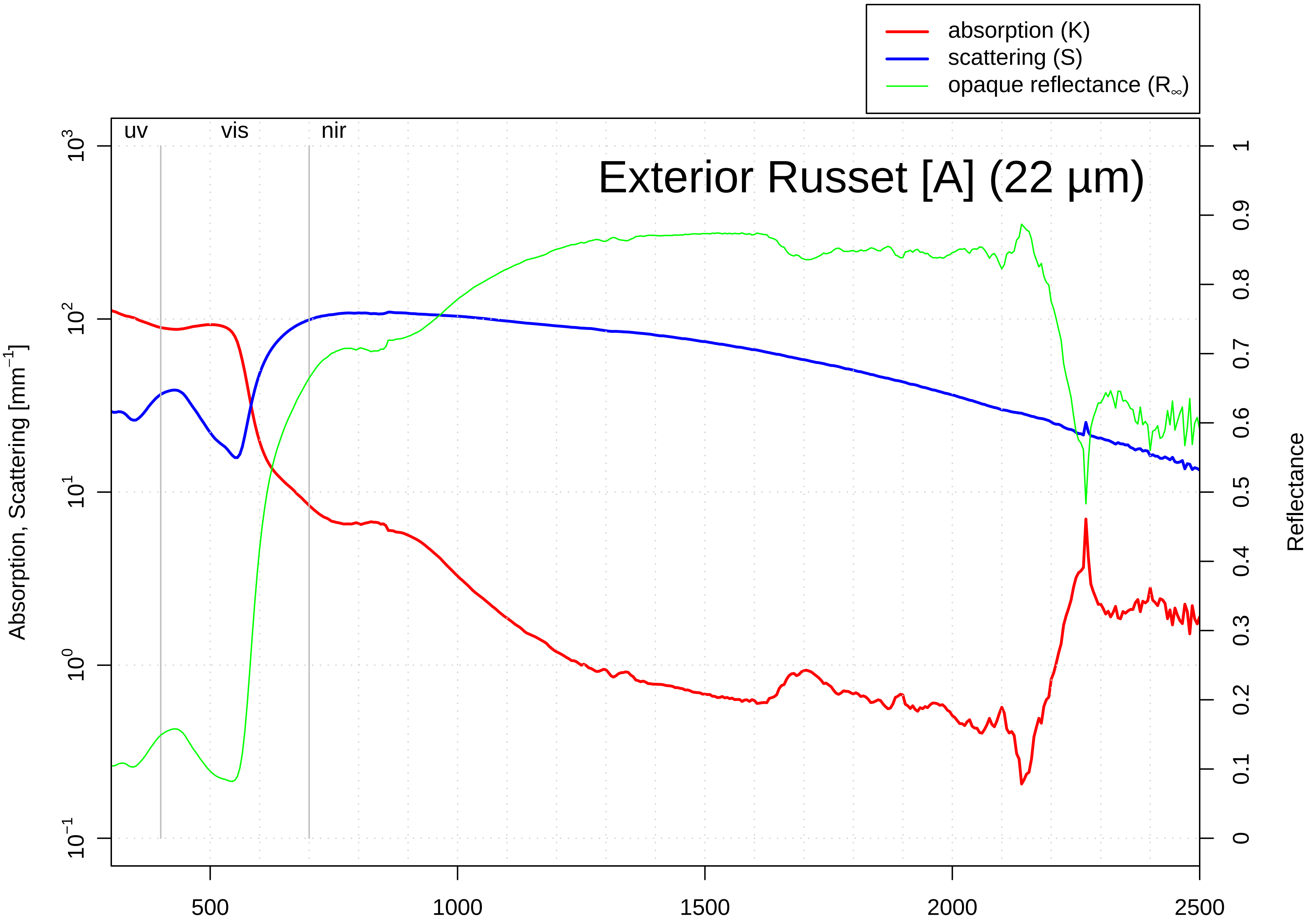
(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 03:13 PM



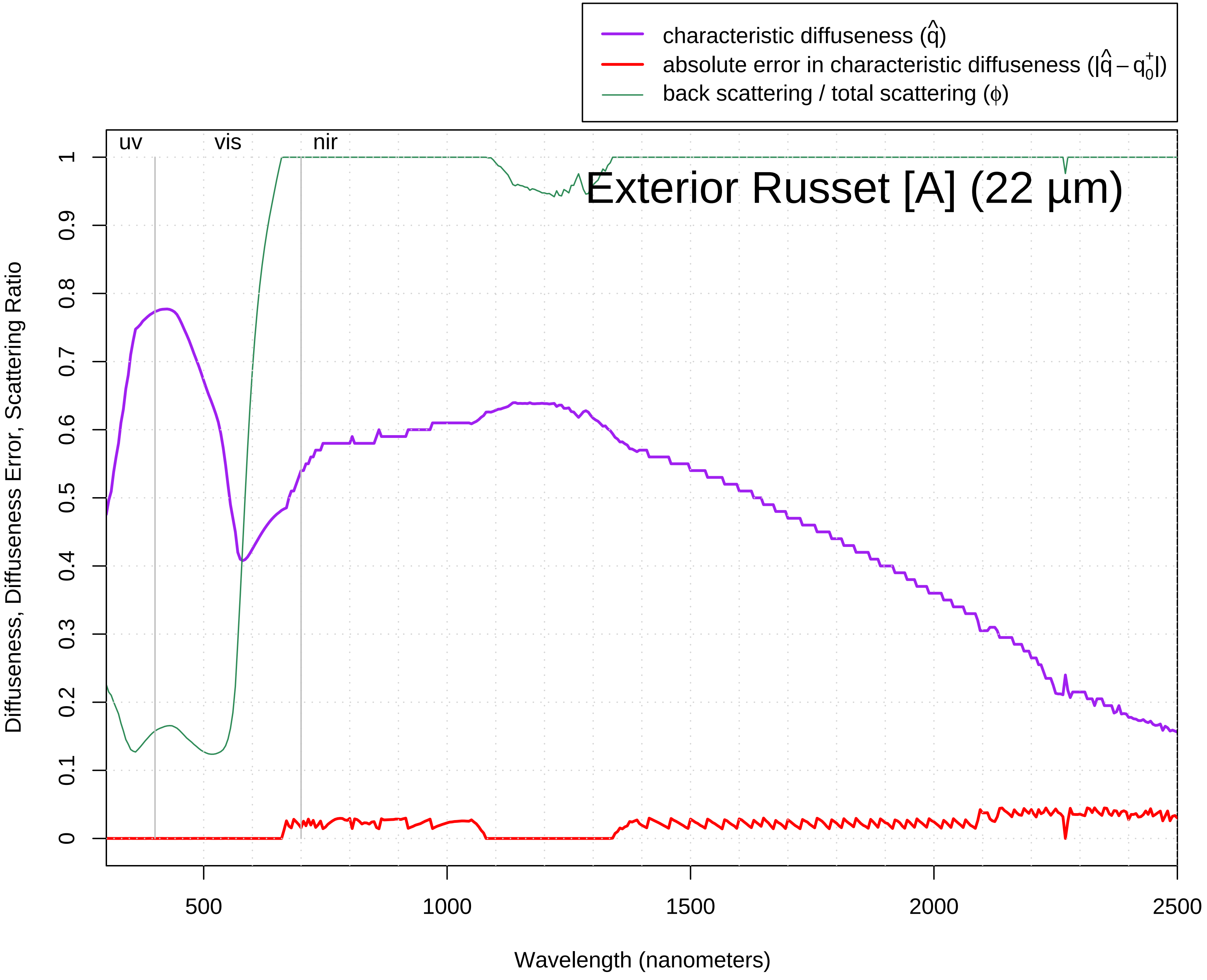
(a) Spectrometer Film Measurements

Sunday, 09 March 2003 03:16 PM



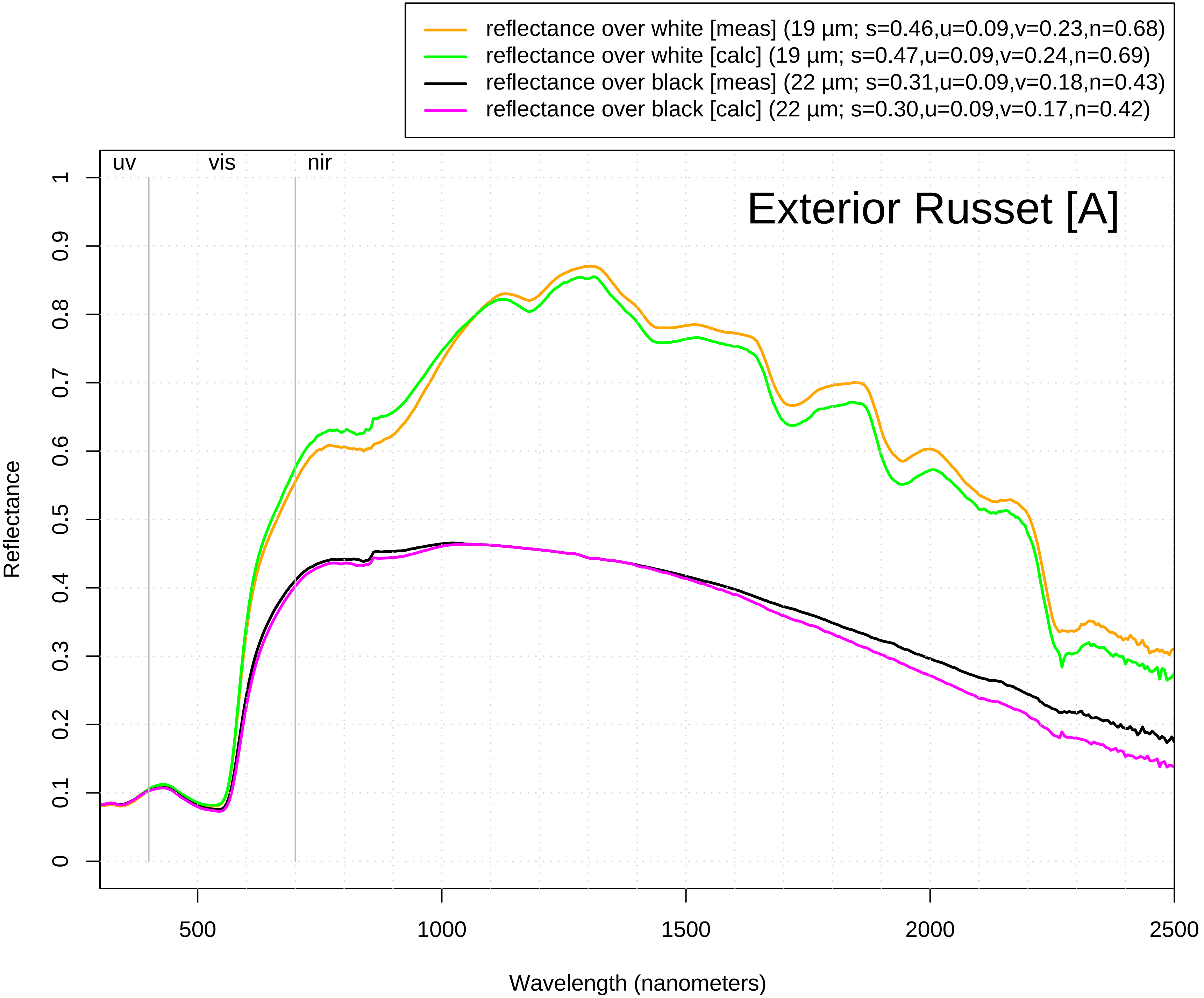
(b) Kubelka−Munk Calculations

Sunday, 09 March 2003 03:16 PM



(c) Ancillary Calculations

Sunday, 09 March 2003 03:16 PM



(d) Calculated vs. Measured Reflectances

Sunday, 09 March 2003 03:16 PM