

## Transmission measurement with MountainSphere-100-P

### Theoretical measurement process:

A collimated beam enters MountainSphere-100-P-All through the entrance port of the integrating sphere vertically from above. The exit port at the opposite side of the sphere can be opened or closed. The sample has to be laid on top right over the entrance port of the sphere so that the whole transmitted beam is entering the sphere.

A fiber-coupled spectrometer measures and saves the raw spectrum. Before putting the sample in place the following spectra have to be taken and saved:

- ***D*: dark current**  
The EL-shutter has to be closed.
- ***H*: halo spectrum**  
The exit port has to be open and the scattered light which is unavoidably generated by the collimator and remains in the integrating sphere is measured without sample.
- ***W*: white reference**  
The exit port has to be closed and no sample has to be mounted directly in front of the entrance port. The integrating sphere collects the whole beam.

Now the measurement gets started. The sample has to be laid on top right over the entrance port. The following spectra of counts have to be measured:

- **$S_{ges}$ : raw spectrum of the whole beam**  
The exit port has to be closed.
- **$S_{diff}$ : raw spectrum of the scattered beam**  
The exit port has to be open.

### Results

- Whole transmission
- Haze
- Scattered transmission
- Direct transmission

Afterwards the transmission values can be calculated:

Whole transmission: 
$$T_{ges} = \frac{S_{ges} - D}{W - D}$$

Haze: 
$$T_{Haze} = \frac{(S_{diff} - D) - (H - D) \cdot T_{ges}}{(S_{ges} - D) - (H - D) \cdot T_{ges}}$$

Scattered transmission: 
$$T_{diff} = T_{Haze} \cdot T_{ges}$$

Direct transmission: 
$$T_{ger} = T_{ges} - T_{diff}$$

### Transmission measurement with an Avantes spectrometer

In the Avantes software AvaSoft one can subtract the dark current easily by clicking the button „Save Dark All“ or „Save Dark Spectrum“ for every single connected spectrometer. The „Scope minus Dark Mode“  $S_{-d}$  shows the raw spectrum minus dark current. On tab „File“ and the button „Export“ one can save the data on an Excel sheet or a text file.

Using the „Scope minus Dark Mode“  $S_{-d}$  shortens the calculation.

Follow these steps for transmission measurement with MountainSphere-100-P and an Avantes spectrometer:

- **Start the measurement**  
Click the button „Start“ in AvaSoft. The exit port has to be closed, so that the collimated beam is completely collected by the integrating sphere without sample.
- **Adjusting integration time**  
Click on „Auto Configure“ for automatical adjusting the integration time and „Number of Averaging“.
- **Adjusting slit size**  
Depending on the amount of light one can adjust the slit size by changing the entrance slit of the spectrometer in case it has a replacable slit. After changing the slit size one has to re-adjust the integration time.
- **Adjusting smoothing number**  
In the „Settings“ of the connected spectrometer a smoothing interval can be set over a specific number of pixels depending on the slit size. Please have a look on the table of slit sizes, detectors and suitable smoothing intervals in the manual.
- **Subtracting dark current**  
The EL-Shutter has to be closed. Click on „Save Dark All“ or „Save Dark Spectrum“ for every single connected spectrometer for saving the dark current internally. You don't have to save the spectrum of the dark current manually.

- **$H_{-d}$ : Halospectrum**

The exit port has to be open. The stray light of the collimating lens has to be measured without sample. This spectrum has to be saved as a  $S_{-d}$  spectrum.

- **$W_{-d}$ : White reference**

The exit port has to be closed. The whole collimated beam has to be measured without sample. This spectrum has to be saved as a  $S_{-d}$  spectrum.

Now the sample can be measured. The sample has to be laid on top right over the entrance port. The following  $S_{-d}$  spectra have to be measured and saved.

- **$S_{ges-d}$ : spectrum of the whole beam**

The exit port has to be closed.

- **$S_{diff-d}$ : spectrum of the scattered beam**

The exit port has to be open.

Afterwards the transmission values can be calculated:

Whole transmission: 
$$T_{ges} = \frac{S_{ges-d}}{W_{-d}}$$

The whole transmission is shown on “Transmittance Mode” after saving the white reference by clicking on the button “Save Reference All” or “Save Reference Spectrum” for every single connected spectrometer.

Haze: 
$$T_{Haze} = \frac{S_{diff-d} - H_{-d} \cdot T_{ges}}{S_{ges-d} - H_{-d} \cdot T_{ges}}$$

Scattered transmission: 
$$T_{diff} = T_{Haze} \cdot T_{ges}$$

Direct transmission: 
$$T_{ger} = T_{ges} - T_{diff}$$

#### About us

Mountain Instruments is a brand of Mountain Photonics GmbH. We aim at adding value to our customers by offering technical service, product development and in-house products.