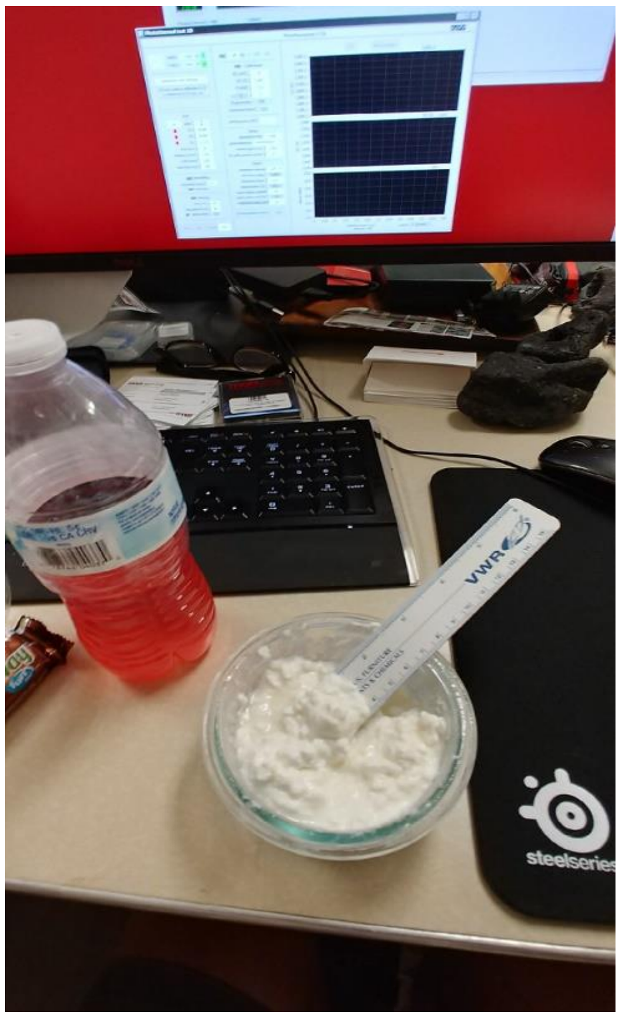
The guideline for correct pump power input

The short answer: that power, P, at the pump/probe crossing point.

For low-absorbing samples it is either

- <u>the incident power</u> P_i when the front surface of a sample is tested or
- P_i <u>minus the single reflection from the front surface</u> in case of the bulk absorption test.

There are three factors making the correct value different from the power meter readout value:



Break. Everything below is optional.

- the shifted zero of the power meter scale;
- the effect of the sample: reflections from surfaces, finite absorption in coatings and in the bulk;
- the beam sampler factor in case the sampler is used to monitor the pump power.

The zero

The drift of the zero ΔP_0 is a common thing for thermopile sensors. Room temperature changes, air flows and moving sources of heat all contribute to it. ΔP_0 may be a source of significant errors when calibrating the PCI system. That is because the calibration power is frequently close to the lower limit of the power meter range.

The correction for the zero shift is done by

- closing the pump beam,
- waiting for a time necessary for the power meter to react, maybe a whole minute,
- averaging the detected deviation of zero power,
- subtracting it from the readout power P_r to get the correct detected power

$$P_{Det} = P_r - \Delta P_0.$$

This procedure is semi-automated in the current software version 7.2.1 which takes the median value of the last 10 samples of ΔP_0 and subtracts the result from the

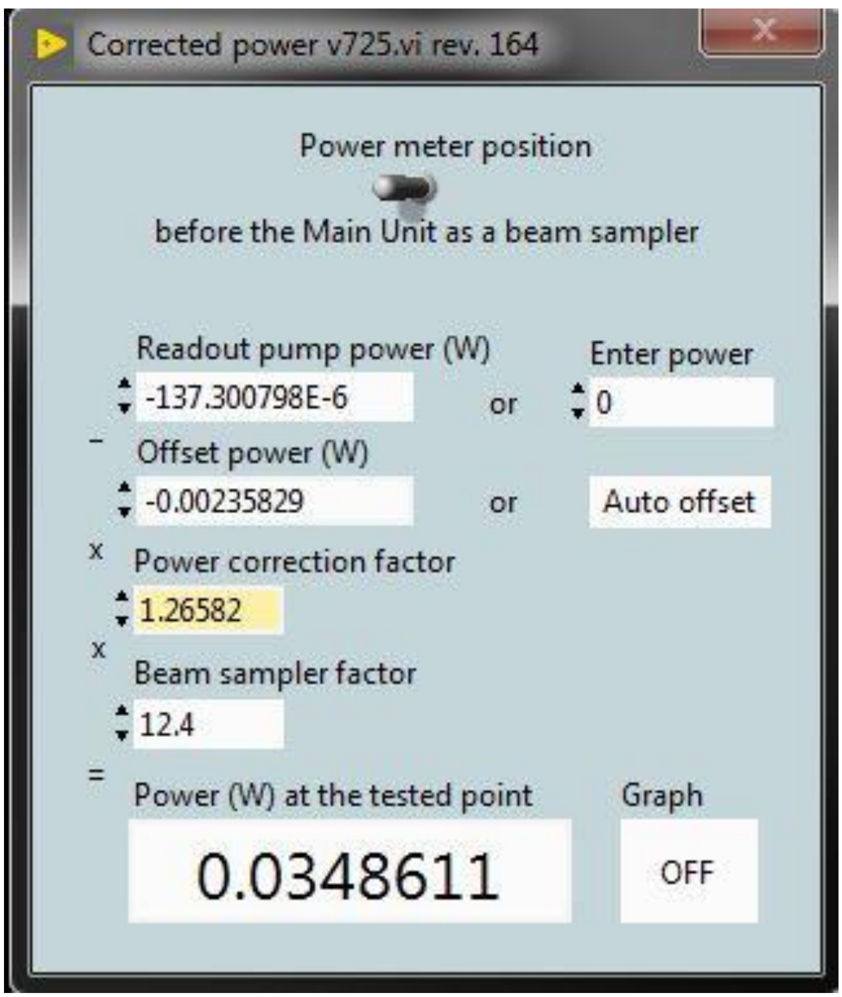


Figure 1. The power meter window for the upcoming soft (may differ upon arrival).

readout value. The snapshot below is for the new version of software with the added beam sampler option. As of June 2019, it is still in works with the planned release in July. Auto offset button works same way in both versions.

The effect of the tested sample

1. When <u>the front side</u> is tested the incident power P_i is that "acting" pump power P we are looking for.
2. When <u>the bulk absorption</u> is tested, then the loss of power at the front surface should be considered. In most cases absorption and scattering at the front surface are so small that the single reflection from the front surface, R_1, is the lone player:

$$P = (1 - R_1)P_i. \tag{1}$$

   Multiple reflections do not matter because they are typically missing the pump/probe crossing point.

3. For <u>the coating at the back side</u> the same expression (1) is valid.

The effect of a sample in the current software is in the "Power correction factor", see Fig.1.

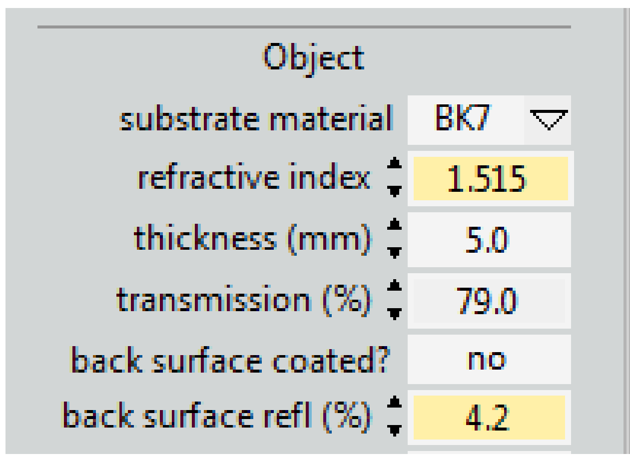


Figure 2. The Object section of the interface, software version 7.2.1.

The current version of software tries to calculate this factor based on such parameters as transmission, refractive index and back surface reflectivity (Fig.2), although not always conveniently. The highlighted numbers are those calculated programmatically. They could always be corrected manually.

In the upcoming version of software these calculations will change, hopefully for better.

Possible power meter positions

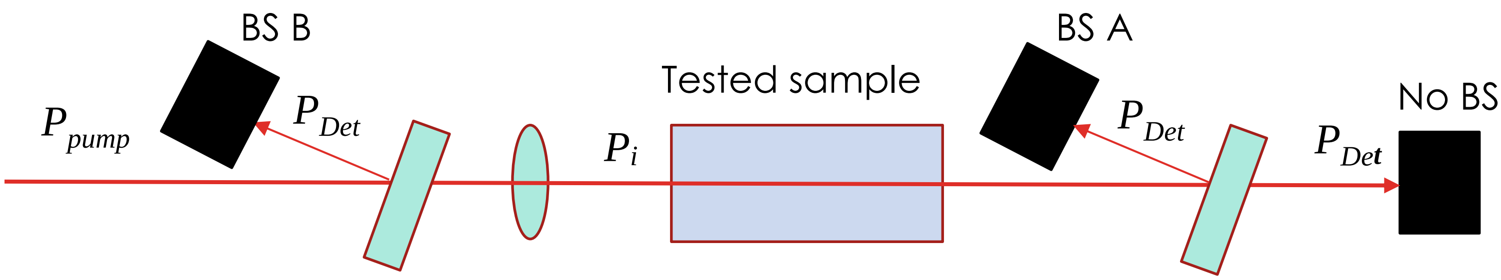


Figure 3. Power meter positions before (B) and after (A) the sample. BS = beam sampler.

For most manufactured systems the power sensor position is after the sample and without the sampler (No BS). That may be changed soon because of certain benefits of the front positioning B.

The advantage of the No BS or BS A configurations is the ability to monitor the power while making tests (impossible if HR coating is tested though). In this way the map of the transmitted power could be plotted, for example, to reveal scattering defects which do not absorb.

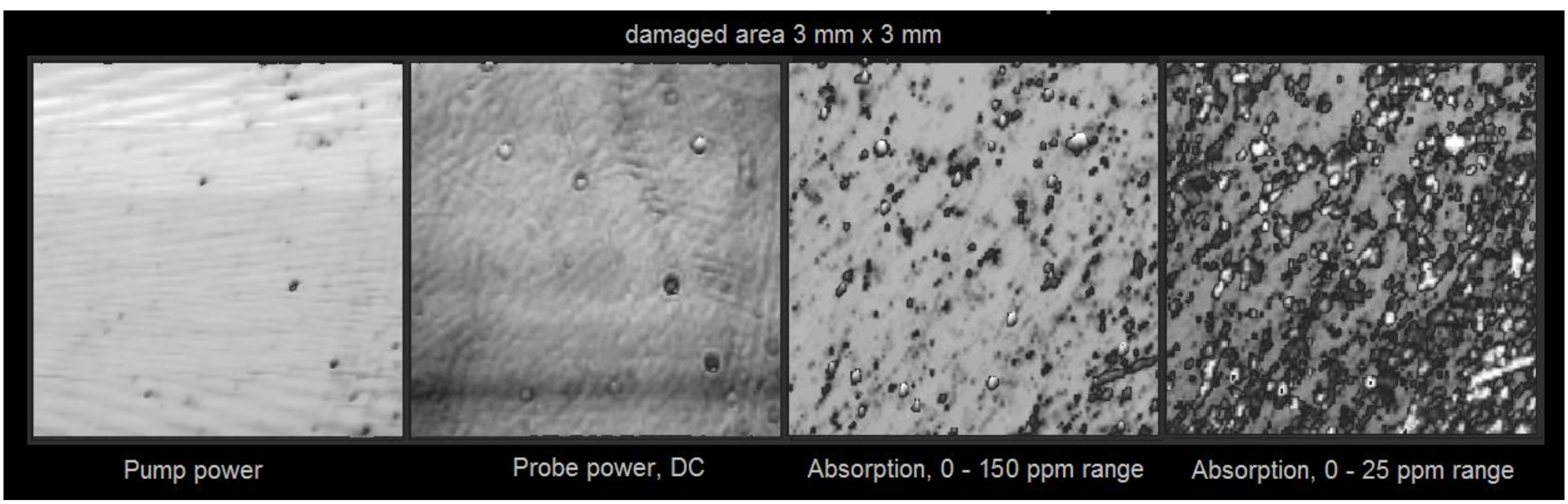


Figure 4. Maps of a coated area damaged by improper cleaning

The beam sampler and the power correction factors

The general expression for the acting power P is

$$P = P_{Det} C_S C_P \tag{2}$$

where $P_{Det} = P_r - \Delta P_0$ is the zero-shift-corrected power at the detector, C_S is the BS factor, and C_P is the power correction factor. The expression (2) simply shows that two corrections to the detected power should be made.

The sampling factor C_S has to be evaluated once for a given pump. It is not hard to do. For simplicity, the factor for the BS B configuration C_{SB} should include the effect of optics in between the sampler and the sample. Then

$$C_{SB} = \frac{P_i}{P_{Det}}.$$

The definition of the power correction factor is

$$C_P = \frac{P}{P_i}.$$

According to (1) this factor equals $1 - R_1$. Looks simple but there are numerous situations when this factor should be calculated in a different way using different data. Another blog entry will be discussing these situations.

Mauna Kea from Hilo Bay