Measurements with the LISST.
Emmanuel Boss
U of Maine
May 20, 2003

Transmission:

Let $I_1(0)$ be the measurement (in counts) at the detector for pure water.
Let $I_0(0)$ be the measurement of the reference of the source.
The radiant flux hitting the detector is thus $P_1(0)= AI_1(0)$, where A is a constant. 0 denote the angle.The radiant flux entering the fluid volume is: $P_0(0)= BI_0(0)$, where B is a constant.
For pure water we have:

$P_1(0)/ P_0(0)= AI_1(0)/ BI_0(0)=\exp(-c_wL)$, (1)
where c_w is the attenuation due to pure water and L the length of the cell (e.g. 5cm);

Now assume we have particles in the chamber and we read a signal $I_2(0)$ at the detector.

$P_2(0)/ P_0(0)= AI_2(0)/ BI_0(0)=\exp(-(c_w+c_p)L)$, (2)
where c_p is the attenuation due to the particles.
Taking the ratio of (2) wrt to (1) we find: $\exp(-c_pL)= I_2(0)/ I_1(0)$. (3)
Note that this assumes that A and B do not change between calibration and measurement (i.e. are not temperature/pressure dependent, or that this dependence is known).

Volume scattering function:

Measuring in pure water:
$P_1(\theta_i)/ P_0(\theta_i)= AI_1(\theta_i)/ BI_0(\theta_i)=[LA]\beta_w(\theta_i)\exp(-c_wL)$, (4)
where A is the area on which light scatter.

Measuring with particles:
$P_2(\theta_i)/ P_0(\theta_i)= AI_1(\theta_i)/ BI_0(\theta_i)=[LA](\beta_w(\theta_i)+\beta_p(\theta_i))\exp(-(c_w+c_p)L)$, (5)

Dividing the two:
$I_2(\theta_i)/ I_1(\theta_i)= \{(\beta_w(\theta_i)+\beta_p(\theta_i))/\beta_w(\theta_i)\}\exp(-(c_p)L)$ (6)

Solving for $\beta_p(\theta_i)$:

$\beta_p(\theta_i)= I_2(\theta_i)/ I_1(\theta_i) \exp(c_pL))\beta_w(\theta_i)-\beta_w(\theta_i)$. (7)
This can only be solved if we know $\beta_w(\theta_i)$ exactly. Note, however, that we can solve for $\beta_p(\theta_i)/\beta_w(\theta_i)$.

Attenuation (or VABAM) approach to compute the VSF:

By integrating over detectors we measure attenuation, but each time with a different acceptance angle:

$$\exp(-c_p(\theta_i)L)=\{I_2(0)+6I_2(\theta_1)+\ldots+6I_2(\theta_i)\}/\{I_0(0)+6I_0(\theta_1)+\ldots+6I_0(\theta_i)\}, \qquad (8)$$

the factor of 6 corrects for the area of the detector. Note that here we assume that A and B are the same for all of the detectors.

We then compute the VSF from:

$$\beta_p(\theta)=dc_p(\theta)/d\Omega \qquad (9)$$

One problem with all of these approach is that errors in calibration are MULTIPLICATIVE. 10% error in the transmission with water leads to at least 10% error in the estimate of the transmission with particles.

In the program you sent me you sum all the detectors signal as in (8) but do not take the log and divide by L.

Cheers,

Emmanuel