

LOPC Data Analyses – Standard LOPC

(A. Herman –June 2009)

1) SEP Data

A sample of lines 1-5 (L1-L5) from an LOPC data file is shown below:

```
L1 0 0 0 0 0 0 2 18 18 16 14 22 16 15 14 24 11 10 7 13 9 6 10 9 3 4 5 4 0 3 1 3
L2 1 3 1 1 1 0 2 2 1 0 0 2 2 3 2 2 0 0 0 0 0 0 0 1 0 0 2 1 0 1 0 0
L3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
L5 0 100 426 143 1026 0 1812 0 0
```

L1-L4 contain 128 bins of plankton counts in steps of 15 microns. As noted above, significant counts begin to appear in the 8th bin of L1 representing 105-120 microns. (In the case of the HiRes Lab LOPC with a lower threshold of 20 μm , counts begin to appear the 2nd bin corresponding to a size range of 15-30 μm).

The LOPC ½ sec. time counter appears as the 3rd number in L5, ie, '426'. The flow counts appear as the 4th & 5th number of L5. The number '143' represents the number of plankton counts used in the estimate while the number '1026' represents the summed flow time (counter). Therefore the average flow time counts were 1026/143=7.2.

Biomass can be simply represented by the volumetric equation of a sphere;

$$\text{Volume (per particle)} = \frac{4}{3} \times \pi \times (\text{esd}/2)^3 \quad -(1)$$

where the esd is represented by the bin centroid. Since most zooplankters are ellipsoidal in shape, biomass estimates based on spherical volume is overestimated. If desired, an additional correction can be made which adjusts the volume based on a mean ellipsoidal shape based on the ratio (R) of the major to minor axes which typically ranges from 2-4 for zooplankton (ie., =1 for a sphere). The correction is given by;

$$\text{Ellipsoidal Volume} = (\text{Spherical Volume}) \times (1/R^{1/2}) \quad -(2)$$

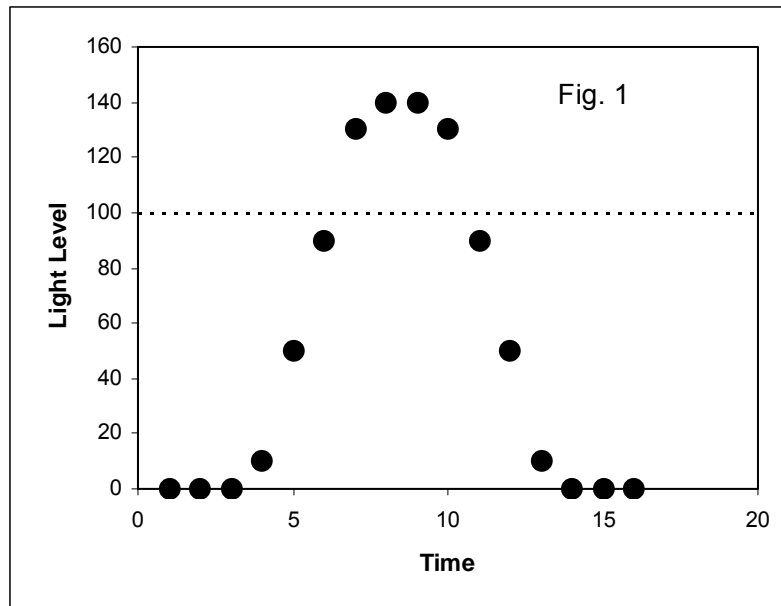
2) Transit Time Measurements

(Note: time-transit measurements rely on a continuous flow of particles past the sensor and, therefore, does apply to LOPCs mounted in lab circulators which have only sporadic or non-continuous supply of particles)

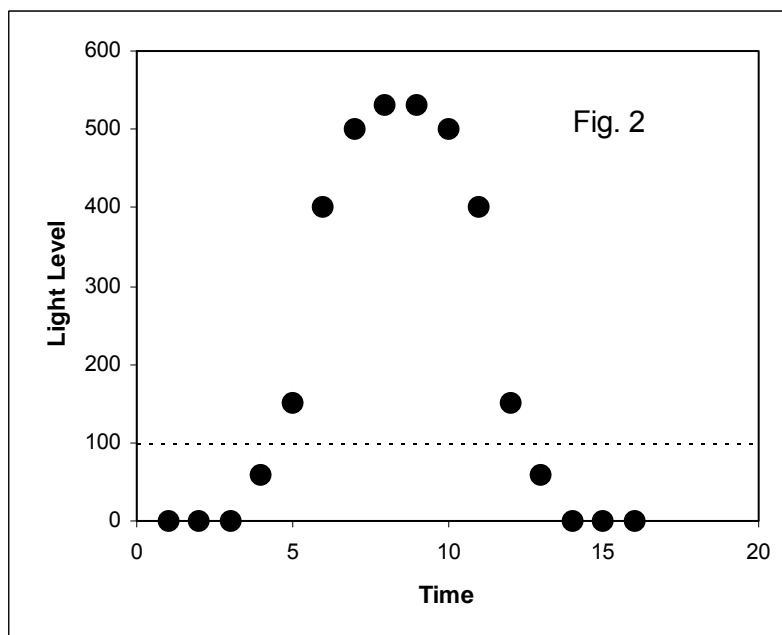
Transit Time: The reconstruction of MEP shape profiles requires the processing of transit times measured for each element. As brief primer is presented here to better understand the measurement of transit times.

The measurement of MEP transit times is similar to measurement of flow counts above in L5. Consider the example of Fig. 1 below which depicts a small particle of about 100 microns passing through the beam which itself is not linear but approx. Gaussian in distribution (Note: the representation in Fig.1 is reversed in sign since the laser light level is actually decreased when occluded by a particle). The expected flow counts should

measure about 7-8 representing the time (counts) it takes the particle to pass through the entire beam. The threshold light level for detecting a particle is set at 100. The particle while passing the beam, barely exceeds the threshold and so only 4 of the total flow counts are measured representing an underestimate.



Consider the example of a larger particle (300-400 microns) in Fig. 2 passing through the beam. In this case the threshold is passed quickly and most of the flow counts (8) are measured and are representative of an accurate flow speed.



It is noted that as the particle size increases, the flow counts also increase. Therefore the flow speed is established by measuring the transit-time of all small particles in the size range of 150-300 microns only. Over a period of ½ sec., the LOPC microprocessors sum all the transit times and the number of particles corresponding to the size range thereby providing a mean flow count for that period.

3) Flow Speed Measurement

Flow speed measurements are made by the LOPC by recording the transit time of small particles (SEPs only) passing through each of the elements. All these 'time or flow counts' are summed and transmitted by the LOPC every 0.5 sec. as shown in L5 in section 1 above. The sum 'flow counts' in L5 were =1026 and 143 (see L5) particles were measured yielding an average flow count= 7.2, - ie. 1026/143.

Flow speed is obtained by substituting the mean flow count 'FC' in eq. 3;

$$\text{Flow Speed (m/sec)} = a_1 \times (\exp(-a_2 \times \text{sqrt}((\text{FC})^{1/2}) + a_3 \times (\text{FC})^{1/2} + a_4 \times (\text{FC})^{1/2} \times (\text{FC})^{1/2} + a_5 \times (\text{FC})^{1/2} \times (\text{FC})^{1/2} \times (\text{FC})^{1/2})) \quad -(3)$$

This empirical eq. for the flow speed calibration must be represented by 2 ranges:

flow counts ≤ 13

a1=	23.10410966
a2=	-1.481499106
a3=	1.566460406
a4=	0.196311142
a5=	-0.05

and flow counts > 13

a1=	0.198996019
a2=	-2.603059062
a3=	0.892897609
a4=	0.006191239
a5=	-0.0013

In the example above, substituting FC=7.2 yields a flow speed= 2.5 m/sec.

4) Integrating MEP counts into the SEP binned Size Distribution

Because the MEP data has been separately transmitted to surface, the SEP binned size distribution is incomplete. Before analyzing the MEP data for shape profiles, it must be first re-integrated into the SEP binned distributions. Below is an example of MEP data representing 3 (photodiode) elements;

```
M 8 50987 12 33814
M 7 50986 4 143
M 6 50996 7 219
```

The 'M' signifies the start of an MEP line. The last number in the MEP line represents the measured digital size of the particle passing through the 1mm laser beam. The data set or string of 3 elements essentially represents a single measured particle. The start – or first element- of this data set is identified for the convenience of the user by adding 32768 to the size measurement. Hence the correct size measurement made for the first data line corresponding to element #8 is (33814-32768)= 1046.

The procedure then consists of:

- 1) summing the 3 digital sizes measured by elements 6,7,8
- 2) converting the summed digital size to esd, and
- 3) incrementing the count in the appropriate SEP bin.

The calibration used for converting digital sizes (DS) to esd is given below:

$$\text{Esd}(\text{microns}) = a_1 + a_2 \times \text{DS} + a_3 \times \text{DS}^2 + a_4 \times \text{DS}^3 \quad \text{-(4)}$$

where

a1=	0.1806059
a2=	0.00025459
a3=	-1.0988×10^{-09}
a4=	9.54×10^{-15}

Summing the 3 digital sizes (1046, 143, 219), we obtain a digital sum DS= 1408. Substituting DS into Eq. 4, we obtain an ESD= 536 microns. The corresponding bin (15 micron interval) that must be incremented by 1 count is bin 36 (536/15= 35.7) corresponding to a size range of 525-540 microns.

HiRes Lab LOPC only

The calibration coefficients below apply to the HiRes Lab LOPC only and spans a size range of 20 – 22,000 μm. As a check of the calibration equation for the benefit of the user – there are 2 equation checks given here;

For a total digital sum

- DS= 579 corresponds to an esd= 81 μm*
- & DS= 11889 corresponds to an esd= 1194 μm*

a1=	22.26304639925560000000
a2=	0.10149610000000000000
a3=	-0.00000025566982585000
a4=	0.00000000000085355000