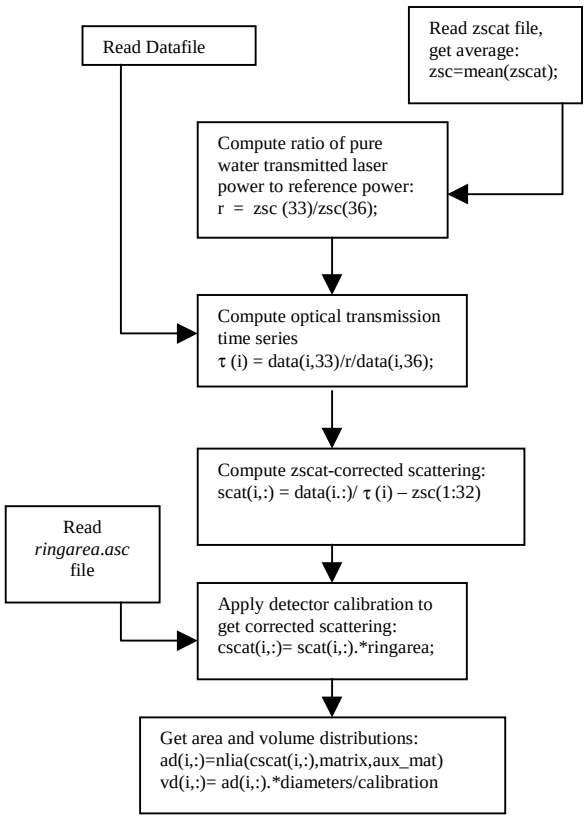
MATLAB analysis of LISST-100 data

Sequoia Scientific, Inc. is pleased to offer two routines for more sophisticated data analysis that can be used in the program MATLAB (Mathworks Inc., Natick, Massachusetts, USA). The standard Windows software that is provided with the LISST-100 instrument is satisfactory for most users.

The first of these routines, *nlia.dll*, is used for carrying out the inversion of data after removal of *zscat* (background light) and after application of the detector responsivity correction factor *ringarea* (provided as a file called ringarea.asc with your PC LISST program). The second program, *nlia_sub.dll*, is useful when a user wishes to examine a segment of a file; i.e., scan numbers from *is* to *ie*. This routine also permits averaging *navg* number of corrected scans to obtain smoother results.



The routine *nlia_sub.dll* is nearly identical to the PC-LISST software with one advantage, the ability to average a specifiable number of data scans before inversion.

These *dll* files can be obtained by request. Before describing these, the block diagram at left explains the essential steps in the reduction of raw digital data to particle volume distribution. A typical MATLAB screen to process a file called *p165.dat*, using *nlia.dll*, would look as follows[1]:

```
load m32x32b     % load type B instrument matrix
load ringarea.asc  % load detector response
dcal=ringarea;
load Hb              % load auxiliary matrix
data=tt2mat('p165.dat',40); % 40 is number of
% variables stored per data scan.)
zsc=mean(tt2mat('zsc_file.dat',40));%mean zscat
r=zsc (33)/zsc(36);
tau=data(:,33)./r./data(:,36); %transmission series
[nscans,col]=size(data);
% for each of a total of nscans, volume conc.

for i=1:nscans
scat(i,:)=data(i,1:32)/tau(i)-zsc(1:32);
cscat(i,:)= scat(i,:).*dcal;
ad (i,:) = nlia(cscat(i,:), m32x32b, Hb);
vd (i,:) = ad (i,:) .*dias32b/Vc*fzsc(33)/zsc(33);
end
 % Vc is your instrument specific calibration,
% the ratio fzsc(33)/zsc(33) corrects for drift of
% laser power compared to factory setting.
```

The routine *nlia_sub.dll* carries out the steps above, except for an averaging step. To use the routine for the above files and for example, to view scans 3:90 with averaging

[1] The following files should be installed in your matlab path*: tt2mat.dll, nlia.dll, nlia_sub.dll, m32x32a.mat, m32x32b.mat,m32x32c.mat, Ha.mat,Hb.mat and Hc.mat*. In addition, your detector response correction file, *ringarea.asc* should also be placed here.

of 3 successive scans, enter:

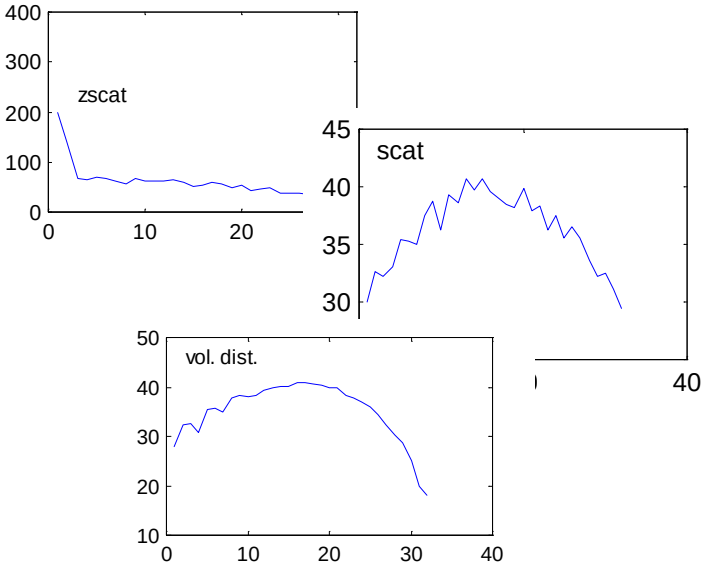
```
[vd,tau,dias32,scat,zsc]=nlia_sub('p165.dat',
'zsc_file.dat','ringarea.asc',73,90,3,Vc,i_type);
```

The variables in the argument list, other than the filenames, are as follows:

vd	volume distribution
tau	time series of optical transmission
dias32	diameters at which vd is computed
scat	fully corrected scattering
zsc	mean *zscat*
ringarea.asc	filename for detector response correction.
73	starting data scan to be analyzed
90	ending data scan to be analyzed
3	no. of scans to average in result
V_c	instrument calibration constant
i_type	Instrument type, 1 for type A, 2 for type B, and 3 for type C.

You may view the output variables with the *plot* command in MATLAB.

The accompanying figures show the plots that are produced by *nlia_sub*. The top trace shows the mean *zscat*, the middle traces are the fully corrected scattering curve, *scat* shown against detector ring no., (i.e., after removal of *zscat* and after multiplying with *ringarea*), and the bottom trace is the volume distribution shown against *log(size).*



It is recommended to occasionally compare the displayed *zscat* against factory *zscat.* If the current *zscat* is significantly different from the factory *zscat*, you may have dirty windows or instrument alignment could have changed. If the *zscat* is twice factory values, it may be time to realign your LISST instrument at the factory. Also recommended on an occasional basis is a comparison of the laser power; i.e., variable 36, to its factory value. This is a direct measurement of laser output. If the laser output falls more than 50%, alert the factory. Although it is unprecedented, replacement of the laser may be needed. The software compensates for drifts in laser power. However, if there are other signs of malfunction they can be assessed at this point.

Plotting in MATLAB

MATLAB permits many powerful plotting options. To view a long time-series of data or size distribution, the pseudo-color display is recommended. Associated plotting options are a mesh plot or a waterfall plot. Examples of use are:

pcolor(scat')	pseudo-color plot
mesh(scat')	a surface with mesh
waterfall(scat).	self-explanatory

The real value of access to these programs is the ability to deal with extraordinary circumstances. For example, it is possible that you may find a 'bad ring' in your data set. In this case, you may wish to replace the data on this ring with a value that is interpolated from the two adjoining rings. You may examine 'what happens if..' situations, such as if the central rings reach saturation due to excessive sediments. In some cases (e.g., when a bottom-mounted instrument is used) a data scan at quiet times may be used as an *in-situ zscat*. [*It is recommended that raw data be carefully viewed using the LISST PC software or Matlab.*]