

Report

Retrieval of sizes of spherical particles from their shadow images

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1. Concept of size retrieval of individual images

Laboratory experiments (Korolev et al. 1991) (hereafter KEA91) showed that the Fresnel diffraction on an opaque disc describes the shadow images of transparent spherical particles well. Following this finding the Fresnel diffraction will be used further on for development of the algorithm to reconstruct the sizes of individual discrete images generated by imaging probes with coherent monochromatic lights.

The remarkable property of the Fresnel diffraction is that the distribution of intensity in the diffraction image is a function of the dimensionless distance $Z_d=4\lambda Z/D_0^2$ only (KEA91), here Z is the distance from the object plane, D_0 is the size of the sphere, λ is the wavelength of the radiation. It means that the relative diameter of the image D_{im}/D_0 does not depend on D_0 , but depends only of Z_d , i.e. the function $D_{im}/D_0(Z_d)$ is the same for all spherical particles. This simplifies the problem, since the particle size will not be directly involved in the particle size reconstruction. Theoretical and laboratory analysis of the images of spherical particles (KEA91, KEA98) showed that the diameter of images vary in a complex manner when the particles move away from the object plane. The diameter of the image has a general tendency to increase, with some oscillations, when the distance from the object plane increases. The analysis of the Fresnel diffraction conducted in KEA98 suggests that the distribution of the intensity in the diffraction images is unique at each distance from the object plane. Therefore, distance from the object plane theoretically can be retrieved from the particle image. Knowledge of the distance from the object plane then can be used for the reconstruction of the particle diameter. The problem arises when the image with a continuous distribution of intensity is converted into a binary (black-and-white) image. This results in dramatic loss of information of the image and its position with respect to the object plane.

The problem of size retrieval can be solved with the help of a bright spot in the center of the image. This spot is usually referred to as the ‘Poisson spot’, named after the French scientist Simeon-Denis Poisson. The size of the Poisson spot monotonically increases with an increase of the distance from the object plane (KEA98) and, thus, it provides information about the particle position in the beam. Therefore, one may hypothesize that the knowledge of the dimension of the Poisson spot and the geometrical parameters of the shadowed area may give a unique solution of the location of the particle image, i.e. there is a function such that $F(D_{spot}, X_{im})=Z_d$. Here D_{spot} is the diameter of the Poisson spot, X_{im} is a geometrical parameter characterizing the shadowed area of the binary image.

In the frame of this approach the reconstruction of the spherical particle size from their binary images consists of the two following steps schematically shown in Fig. 1:

- (a) calculating the function F from the particle image and finding Z_d
- (b) based on Z_d , find the particle diameter D_0 from the function $D_{im}/D_0(Z_d)$

The goal of this work is (i) to find X_{im} that can be used for retrieval; (ii) to generate a set of functions F that can be used for retrieval purposes, (iii) to study the accuracy of retrieval of Z_d and D_0 for the different F , and (iv) to develop a recommendation for the function F , which provides the best reconstruction of the particle sizes from their images.

2. Geometrical parameters characterizing the diffraction image

Figure 2 shows several geometrical dimensions that can be used for characterizing the shadowed part of the image:

D_{spot} the diameter of the Poisson spot

D_{max} maximum size in X or Y directions, i.e. for spherical particles the diameter of the external ring

D_{ring} number of occulted pixels along image diameter. The D_{ring} can be calculated as $D_{ring} = D_{max} - D_{spot}$

D_{img} equivalent area diameter of the image $D_{img} = \sqrt{4S_{img}/\pi}$. The equivalent area diameter can also be calculated as $D_{img} = \sqrt{D_{max}^2 - D_{spot}^2} = \sqrt{D_{ring}^2 + 2D_{ring}D_{spot}} = \sqrt{2D_{ring}D_{max} - D_{ring}^2}$

Clearly, there are two primary parameters, the other two parameters can be derived from the first two. The dependences of D_{spot} , D_{max} , D_{ring} , and D_{img} versus Z_d are shown in Fig. 3.

There are two alternative ways of calculating the dimensions of the images with *a priori* known geometrical shape. The first approach is related to the direct measurement of linear dimensions, by counting pixels along a certain direction. In this case, the particle size will be $D = \delta N$, here, δ is the image pixel resolution. Another approach consists in deriving the image dimensions from the area. For the case of circle, its diameter will be calculated as $D = \sqrt{4S_{img}/\pi} = \sqrt{\delta^2 N_{tot}}$, here N_{tot} is the total number of occulted pixels in the image. If we consider one pixel of the binary image as a bit of information, then the area will contain more information about the image compared to its linear size, since $N_{tot} \geq N$. Thus, it is expected that the diameter of the circle calculated from the image area will be more accurate than that, which is measured from a linear dimension. As shown in Appendix A the diameter of the *discrete* circular images calculated from its area is more accurate compared to that derived from a linear dimension. This is important for the images having less than 5 pixels in size.

3. Construction of the function F

The following requirements are applied for the function F :

- (a) function $F(Z_d)$ must be monotonic, in order to provide a unique solution for Z_d ;
- (b) function $F(Z_d)$ must be dimensionless.

Simple ratios $\frac{D_{spot}}{D_{max}}$; $\frac{D_{spot}}{D_{img}}$; $\frac{D_{img}}{D_{max}}$; and $\frac{D_{ring}}{D_{max}}$ satisfy the above two criteria. Figure 4 show the dependencies of $\frac{D_{spot}}{D_{max}}$; $\frac{D_{spot}}{D_{img}}$; $\frac{D_{img}}{D_{max}}$; and $\frac{D_{ring}}{D_{max}}$ versus Z_d . The dependencies $\frac{D_{spot}}{D_{max}}$ and $\frac{D_{spot}}{D_{img}}$ versus Z_d have three bumps. However the fraction of Z_d associated with these bumps is about 1% compared to Z_{dmax} , and therefore it can be neglected.

4. Modeling of discrete binary images of spherical particles

In the following assumptions were accepted during modeling of discrete images:

- (a) the response time of the probe's photodiode array and processing electronics is close to zero and it can be neglected;
- (b) the dimension of each photodiode projected at the object plane is $8 \times 10 \mu\text{m}$;
- (c) the sensitivity of the photodiodes along their surfaces is uniform;
- (d) all photodiodes in the photodiode array are the same and they are set for triggering when the intensity drops 50% of the background;
- (e) the alignment of the optics and the optical surfaces are ideal and the optical aberrations can be neglected;
- (f) the considered particles are spheres and they are illuminated by coherent radiation;
- (g) TAS clock rate is proportional to the speed of particles, so the pixel resolution along X and Y directions is the same;
- (h) particles pass through the sample volume perpendicular to the photodiode array

The calculation of the discrete images was done based on the integration of the Fresnel diffraction over the area of each photodiode, which size was assumed $8 \times 10 \mu\text{m}$ in the object plane with $2 \mu\text{m}$ distance between their edges (Fig.5). The photodiode was considered "triggered", if the integrated intensity was lower 50% of the background intensity. In this case the status of the image pixel associated with this photodiode was considered equal to "1", otherwise it was "0". After the calculating the discrete images, the photodiode array was shifted $2 \mu\text{m}$ either vertically or horizontally and another discrete image was calculated. The number of $2 \mu\text{m}$ steps in the vertical and horizontal were 5 and 5, respectively, resulting in a total of 25 discrete images calculated for each distance from the object plane Z . The discrete images were computed for 82 different distances from the object plane within the depth-of field (DoF). The depth of field was limited either by the probe arms (0 to 32.5mm) or by the diffraction limit

$Z_{DoF} = \frac{Z_{dmax} D^2}{\lambda}$, here D is the particle diameter, λ is the wavelength, Z_{dmax} is maximum value of the dimensional distance Z_d , which contains the areas where the intensity is lower than the threshold intensity. For 50% threshold intensity $Z_{dmax} = 8.18$ (KEA98).

Figures 6-13 show the discrete images for the droplets with the diameters $20 \mu\text{m}$, $30 \mu\text{m}$, $40 \mu\text{m}$, $50 \mu\text{m}$, $70 \mu\text{m}$, $100 \mu\text{m}$, $150 \mu\text{m}$, and $200 \mu\text{m}$ at eight different distances from the object plane. These images give a general idea of the transformation of image when the particle moves away from the center of the object plane and how discretization affects the image quality. The important part of the retrieval algorithm is the Poisson spot. If the Poisson spot is not resolved, then the algorithm suggests that the particle is in the center of the DoF. The deterioration of images occurs, when the particle comes close to the edge of the DoF (Fig. 3), which also limits the performance of the image size reconstruction. The images in Fig.6 suggest that the quality of the $20 \mu\text{m}$ diameter particles is too poor and their sizes are not likely to be accurately retrieved. The quality of the $30 \mu\text{m}$ particles is also poor. For example, the images of $30 \mu\text{m}$ droplet may

consist of two pixels near the center of DoF, or the breaks appear in the image ring when the particle is near the edge of the DoF at $Z > 2\text{mm}$ (Fig.7). The images of particles with $D > 40\mu\text{m}$ give hope for the retrieval of their sizes.

5. Retrieval of the dimensionless distance Z_d

Figures 14-21 show a comparison of six different “measured” and theoretical ratios R versus the dimensionless distances Z_d . The “measured” ratios were derived from the simulated discrete images shown in Figs. 6-12. The red stars show the average values of R calculated at each distance Z_d . Figure 14 shows that the measured ratios are significantly different from the theoretical ones for $20\mu\text{m}$ diameter particles. The agreement between theoretical and measured ratios improves with an increase of particle diameter. In general the agreement between measured and theoretical ratios is reasonably good for particles with $D > 40\mu\text{m}$, which suggest that the above ratios can be successfully used for the reconstruction of Z_d and consequently D_0 .

As seen from Figs.14-21 average values of R (red stars) are equal to zero for some Z_d . This means that these images do not have Poisson spot due to low pixel resolution. For example $30\mu\text{m}$, $40\mu\text{m}$, $50\mu\text{m}$, and $70\mu\text{m}$ diameter droplets do not have a Poisson spot for $Z_d < 1.2$, $Z_d < 0.9$, $Z_d < 0.7$, $Z_d < 0.5$, ($Z < 0.42\text{mm}$, $Z < 0.57\text{mm}$, $Z < 0.69\text{mm}$, $Z < 0.97\text{mm}$), respectively. Figures 14-21 also indicate that there is a transition zone where images may or may not have the Poisson spot. This effect can be clearly seen in Figs.7-9.

Another effect related to the limited pixel resolution results in the particles that do not produce any images near the edge of DoF for some range of Z_d . Thus, droplets $20\mu\text{m}$, $30\mu\text{m}$, $40\mu\text{m}$, $50\mu\text{m}$, and $70\mu\text{m}$ in diameter do not generate images for $Z_d > 7.3$, $Z_d > 7.8$, $Z_d > 7.9$, $Z_d > 8$ ($Z > 1.15\text{mm}$, $Z > 2.77\text{mm}$, $Z > 5\text{mm}$, $Z > 7.9\text{mm}$). Therefore, for small particles, the DoF is less than the theoretical value $Z_{dmax} = 8.2$, and the appropriate adjustments should be made during the calculation of the particle concentration.

The dimensionless distances Z_d were retrieved from the “measured” ratios R and the theoretical dependencies $R(Z_d)$ (Fig.4). Figures 22-29 show (a) the scatter-diagrams of the retrieved (Z_{dmeas}) and actual (Z_d) dimensionless distance; and (b) the frequency of the distributions of the ($Z_{dmeas} - Z_d$) for different ratios R . The retrieval of Z_d for $20\mu\text{m}$ droplets gives poor results. However, the quality of the retrieval improves with increase of the particle diameter. Figure 30 summarizes the performance of the retrieval of Z_d and it shows the error between retrieved and actual values of Z_d . As seen in Fig.30 the ratios $\sqrt{S_{img}/S_{cont}}$, $\sqrt{S_{spot}/S_{cont}}$, $\sqrt{S_{spot}/S_{img}}$ give the most accurate results.

6. Retrieval of the particle diameter D

Figures 31-38 show the frequency distribution of (a) the measured diameters (top green diagram) and (b) six distributions of the difference between measured and actual particle diameters calculated for different ratios (blue diagrams). Figure 39 shows the dependence of the relative errors of retrieved diameter $std(D_0 - D_{meas})/D_0$ versus D_0 . As seen from Fig.39, the relative error rapidly decreases when the particle diameter changes from $20\mu\text{m}$ to $100\mu\text{m}$, and for $D > 150\mu\text{m}$ the relative error stays approximately constant. Figure 39, along with Figs 6-13,

suggest that the shape of the circle can be well represented when the image has no less than 10 pixels in diameter. Figure 40 shows the dependence of the average retrieved (circles) and measured (red stars) diameters versus actual diameter. Figure 41 shows three different ways of presentation of scatter diagram of D_{retr} versus actual diameter.

7. Conclusion

The following conclusions were obtained in the frame of these studies:

1. Most accurate results of the retrieval of sizes of individual images of spherical particles can be obtained using dimensionless ratios constructed from the areas associated with the Poisson spot and the whole image, i.e. $\sqrt{S_{img}/(S_{img} + S_{spot})}$, $\sqrt{S_{spot}/(S_{img} + S_{spot})}$, $\sqrt{S_{spot}/S_{img}}$. The accuracy of the retrieval can be estimated from Fig.39. Parameters required for the retrieval of the sizes of the images of spherical particles Z_d , D_{max}/D_0 , D_{img}/D_{max} , D_{spot}/D_{img} , D_{spot}/D_{max} are given in the table (page 48-54)
2. The reliable retrieval of the sizes of the individual images of spherical particles can be obtained for the images having more than three to four pixels in size. For the instrument with a $10\mu\text{m}$ pixel resolution, the developed retrieval algorithms can be applied for the droplets with $D > 30\mu\text{m}$. The retrieval of the sizes of images smaller than $30\mu\text{m}$ can be done using different approaches. Taking into account optical aberrations, limited aperture of optics and other disturbing effects the retrieval algorithm may be successfully applied for particles larger $40\mu\text{m}$.
3. It was found that the DoF for discrete images is smaller than that predicted theoretically ($Z_{dmax}=8.2$). The dependence of Z_{dmax} (D) should be accounted for particles with $D < 80\mu\text{m}$.

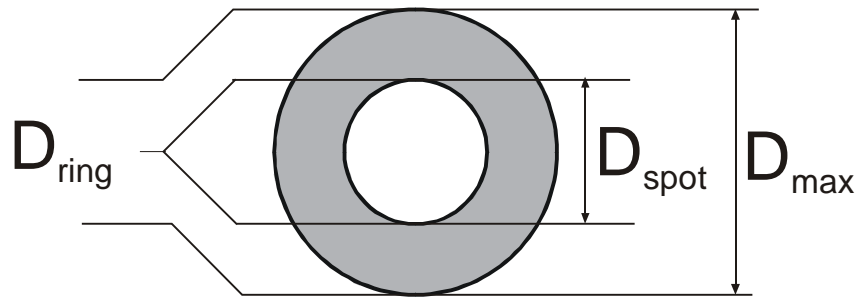
Appendix A

The accuracy of calculating the sizes of discrete circular images from linear and area measures were studied here. The circular images of different diameters were converted into discrete images. The pixel was considered as occulted if it was covered by the circle for over 50%. The linear size of the discrete image was calculated as $D = \delta N$, whereas the area size was computed as $D = \sqrt{\delta^2 N_{tot}}$, here δ is the pixel resolution. Figure A1 shows the relative errors of the calculated linear and area dimensions. As seen from Fig. A1 the relative error for area dimension is rapidly decreasing and for images larger 3 pixels in size it is less 5%. The linear dimension gives an accurate result only when the diameter of the circle $D = k\delta$, where k is whole number. Figure A3 shows the ratio $D_{max\ model}/D_{max\ theor}$ for the discrete images with different diameters.

References

1. Korolev A. V., S. V. Kuznetsov, Yu. E. Makarov, and V. S. Novikov, 1991: Evaluation of measurements of particle size and sample area from optical array probes. *Journal of Atmospheric and Oceanic Technology*, **8**, 514-522.
2. Korolev A. V., J. W. Strapp, and G. A. Isaac, 1998: Evaluation of accuracy of PMS Optical Array Probes. *Journal of Atmospheric and Oceanic Technology*, **15**, 708-720.

Figures



$$D_{\text{area}} = 2\sqrt{\pi^{-1}S_{\text{sh}}}$$

Figure 1

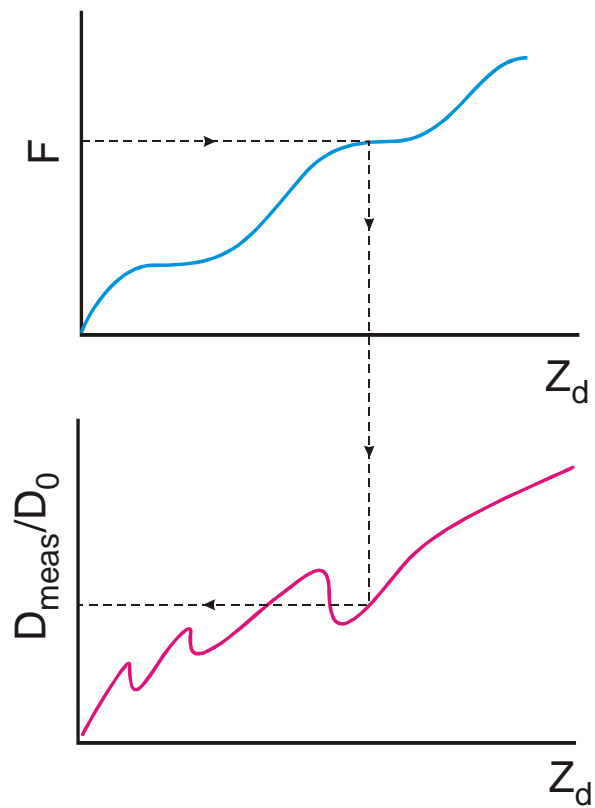


Figure 2

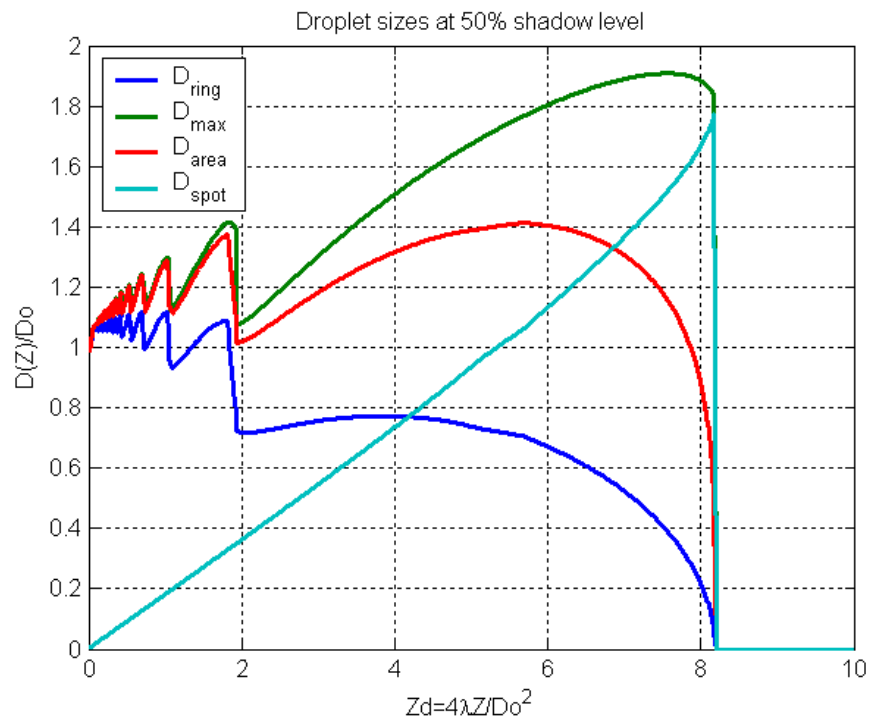


Figure 3

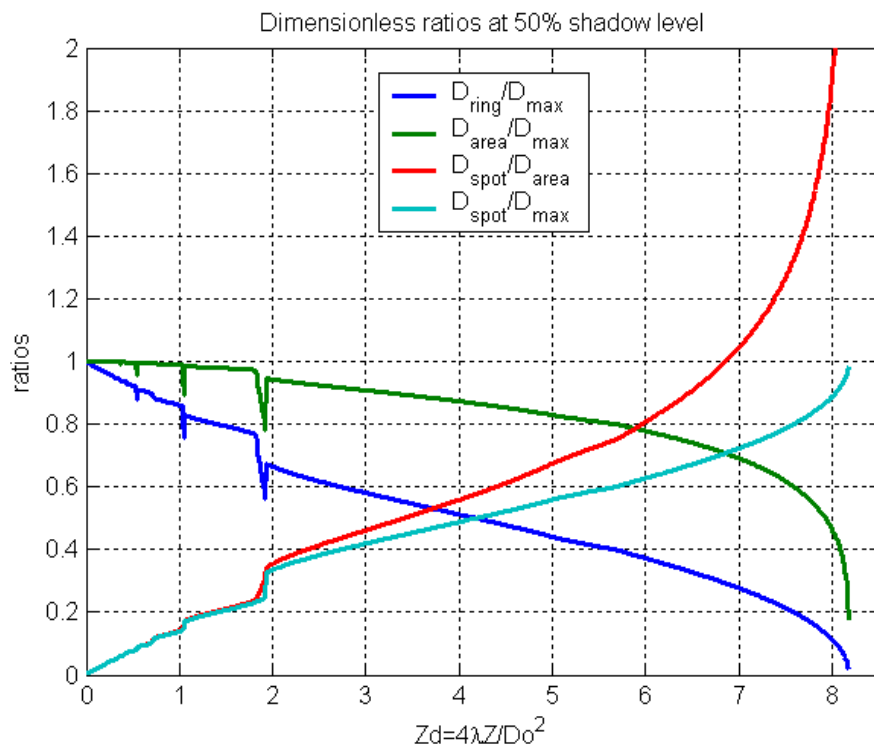


Figure 4

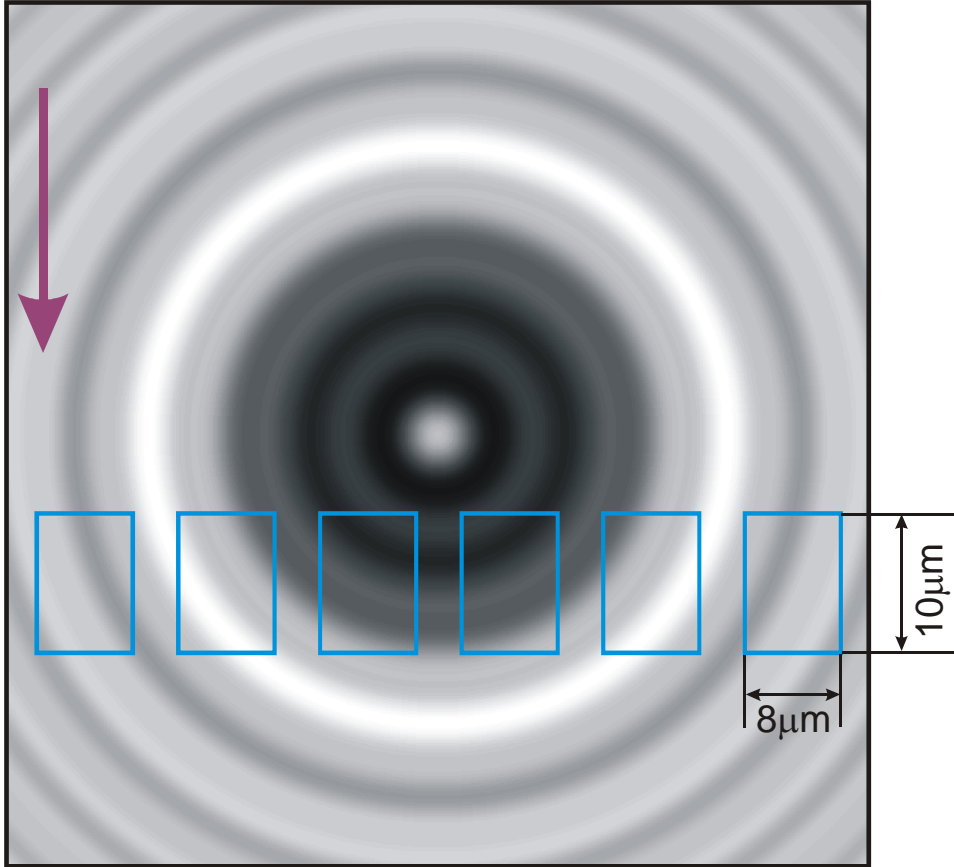


Figure 5

$D_0=20\mu\text{m}$

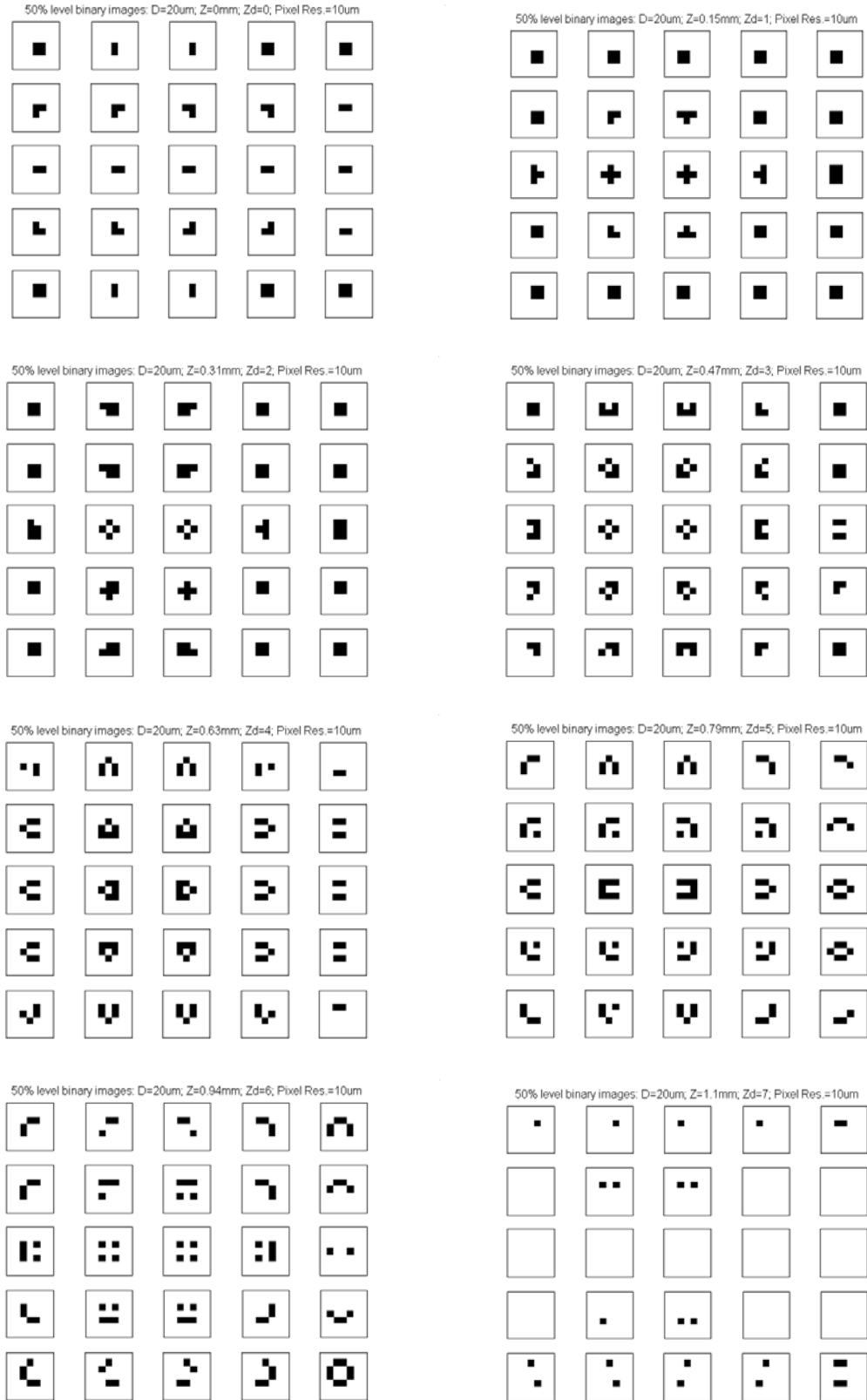


Figure 6

$D_0=30\mu\text{m}$

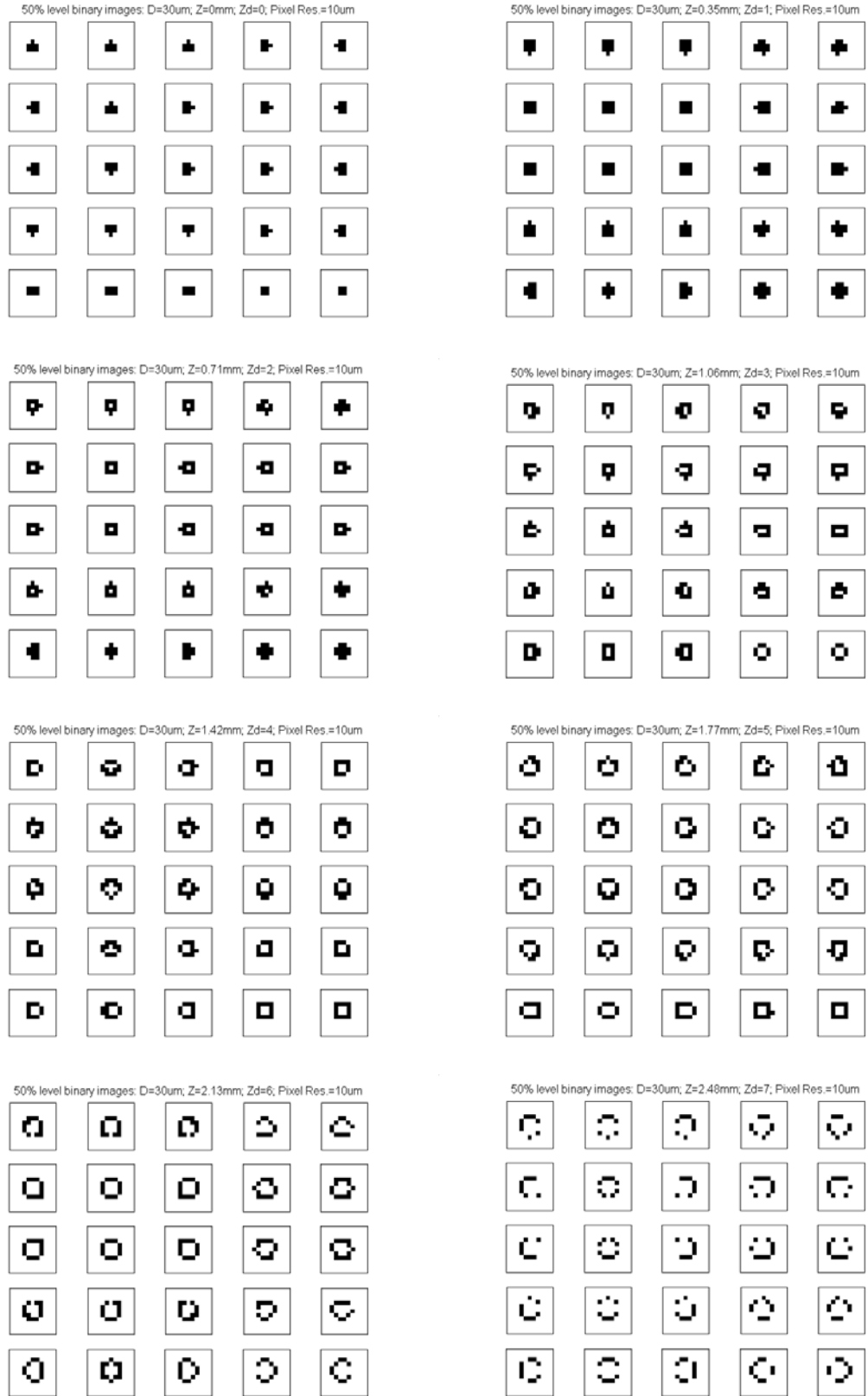


Figure 7

$D_o=40\mu\text{m}$

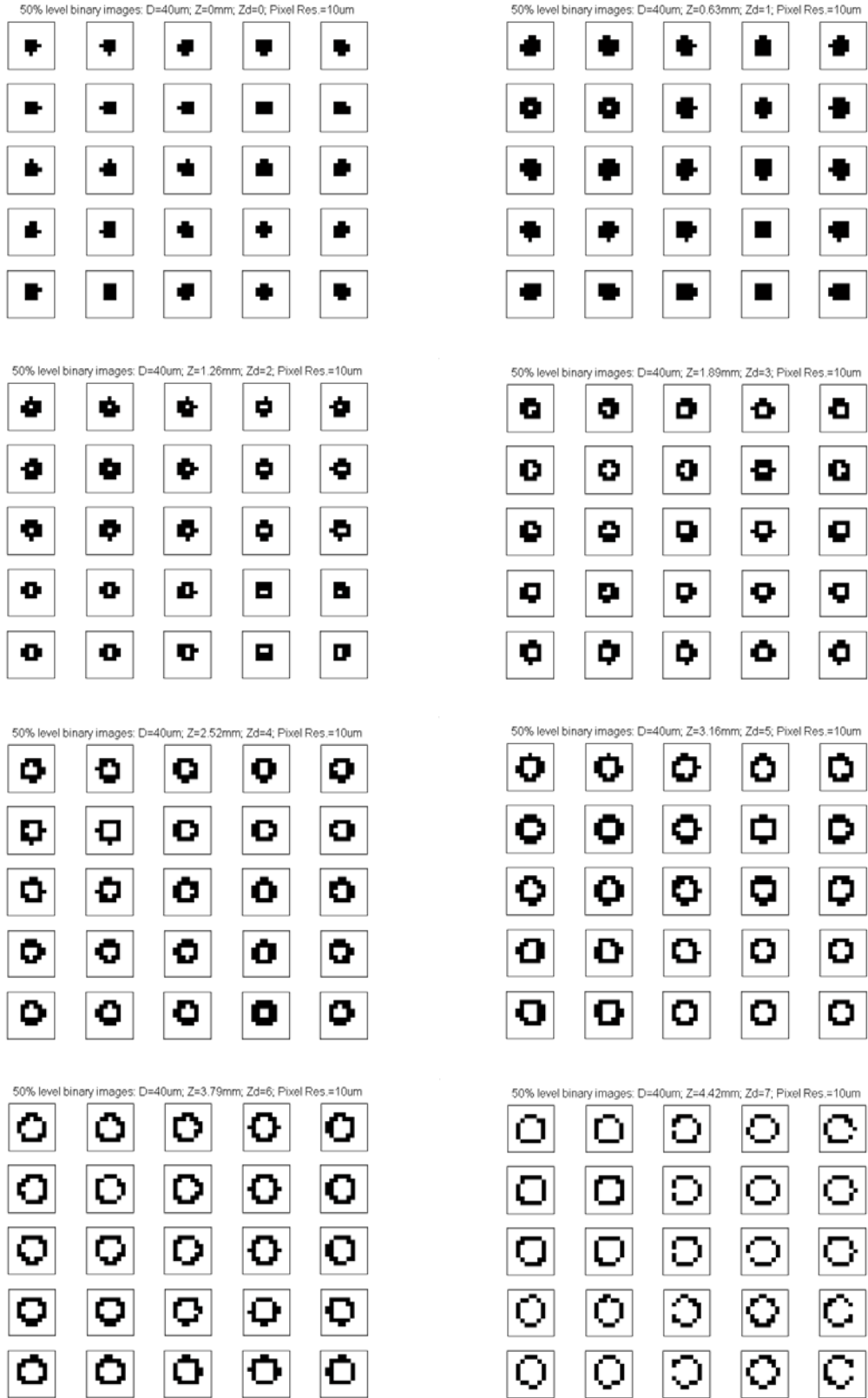


Figure 8

$D_o=50\mu\text{m}$

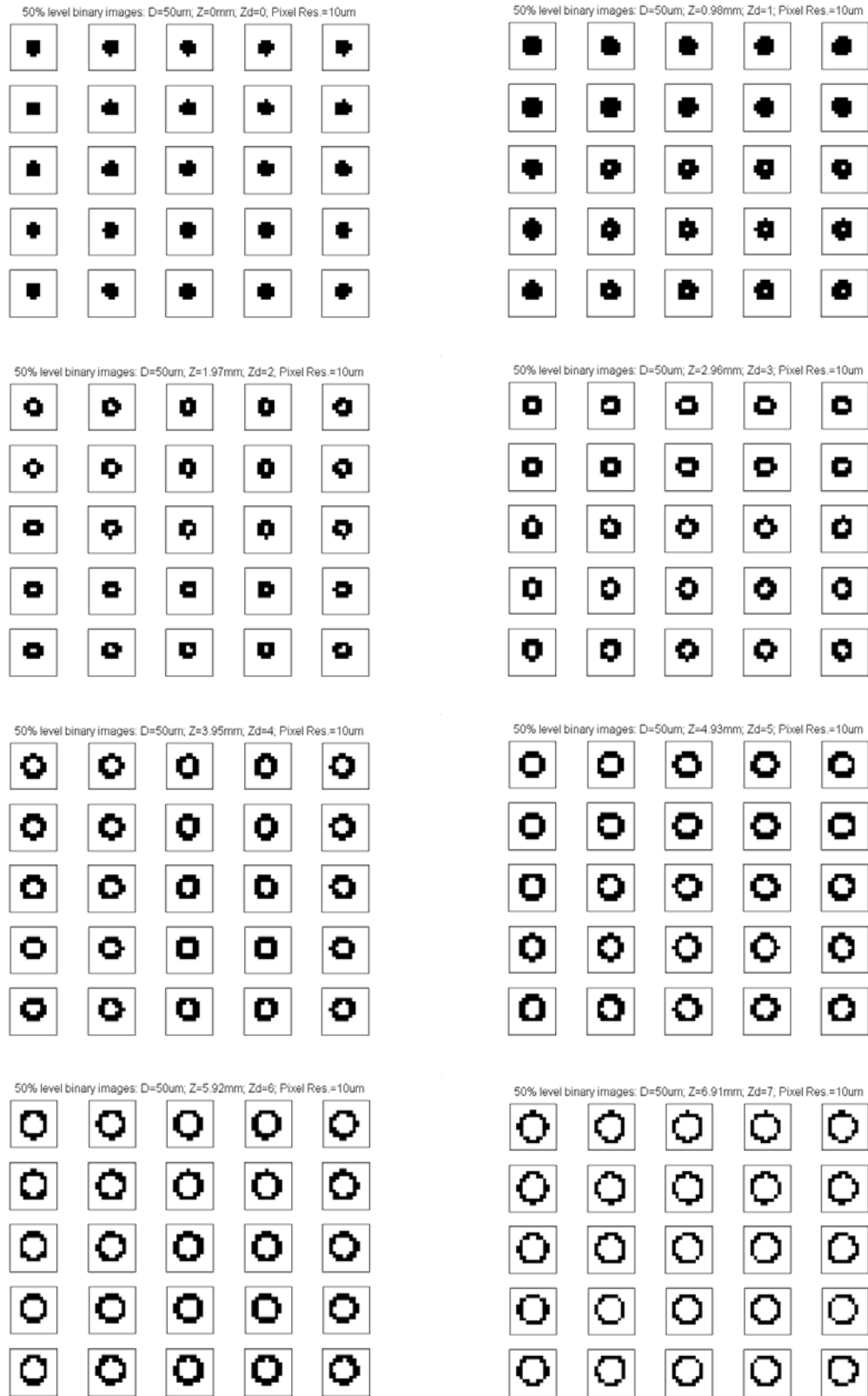


Figure 9

$D_0=70\mu\text{m}$

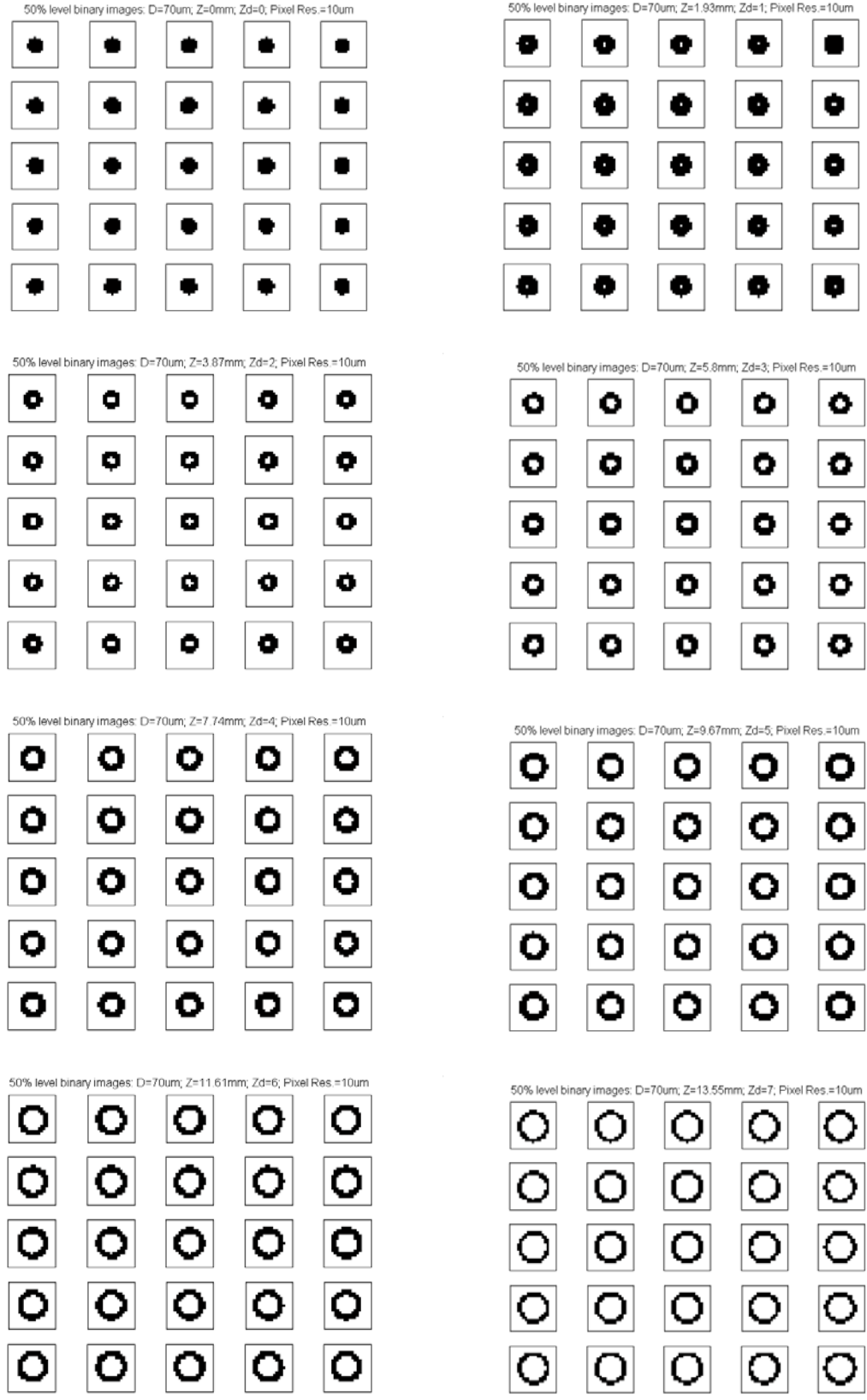


Figure 10

$D_o=100\mu\text{m}$

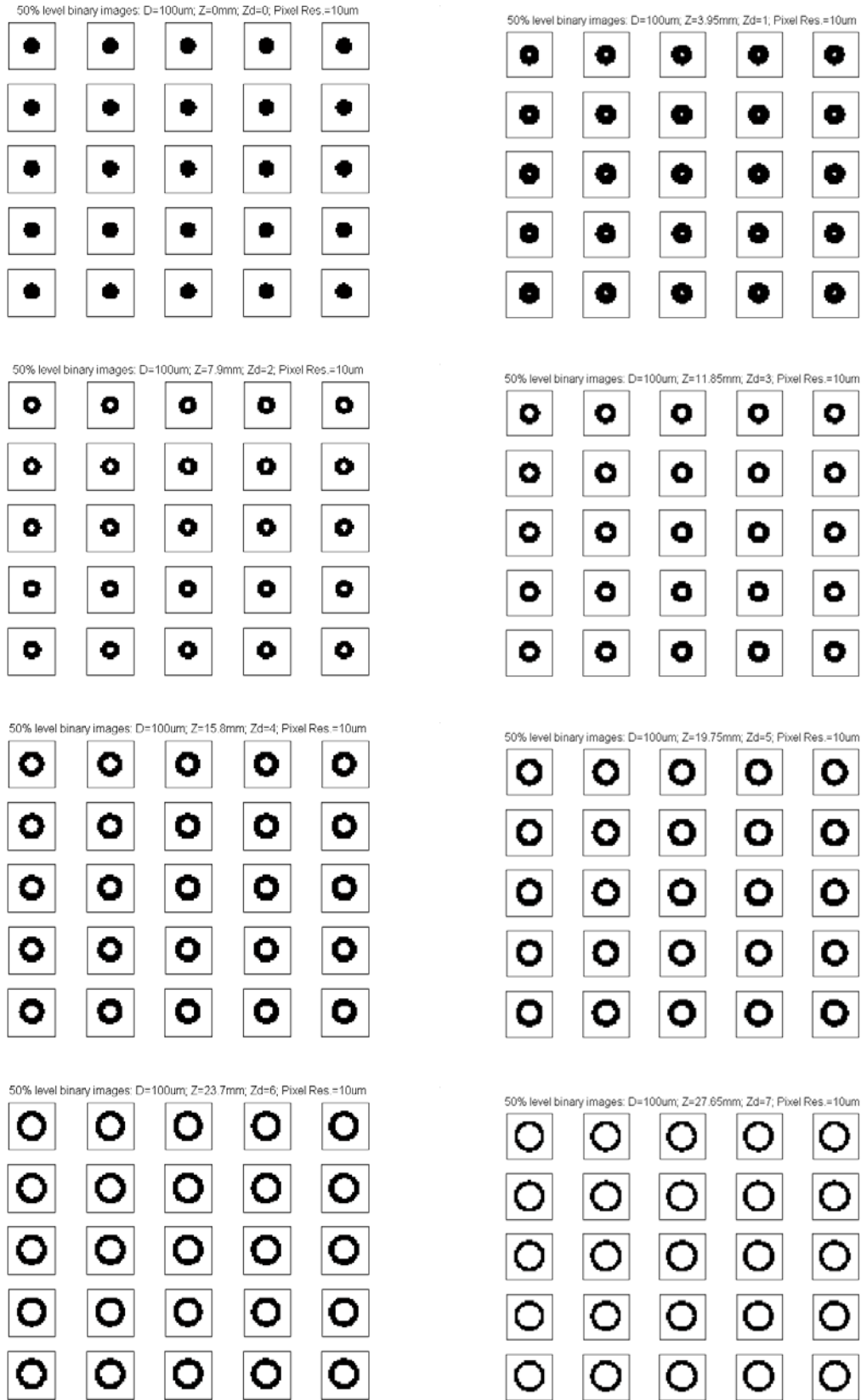


Figure 11

$D_0=150\mu\text{m}$

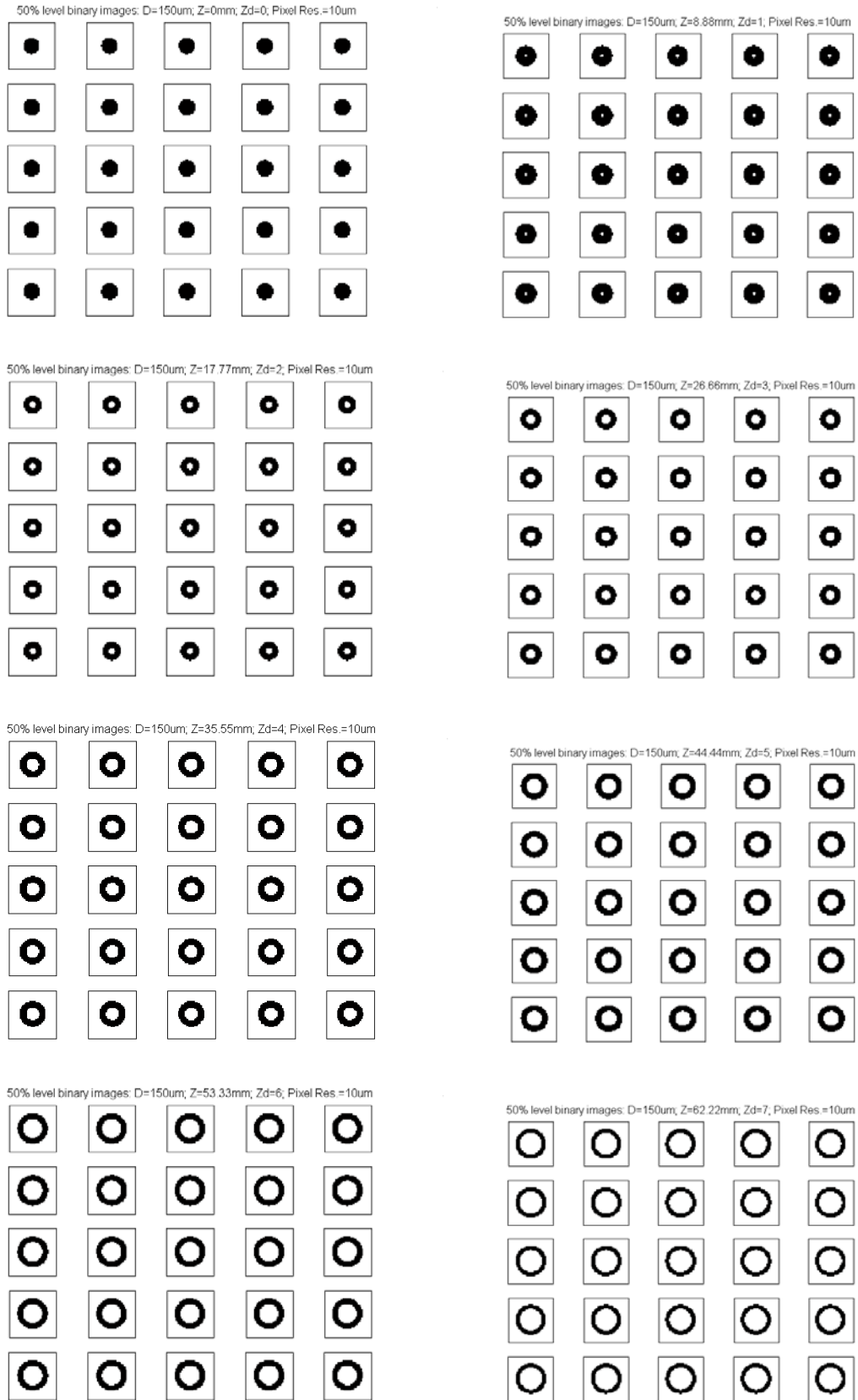


Figure 12

$D_0=200\mu\text{m}$

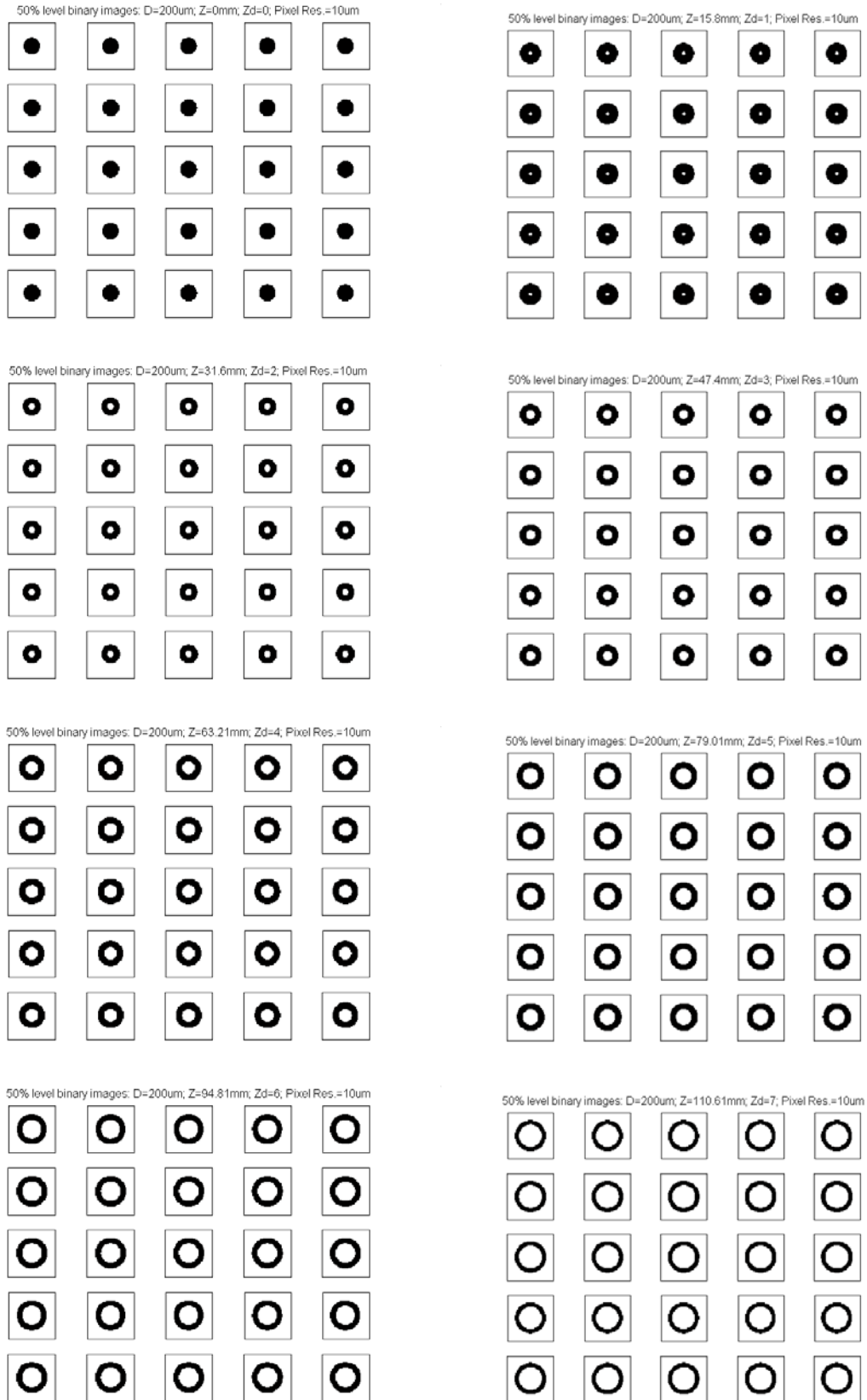


Figure 13

$D_0=20\mu\text{m}$

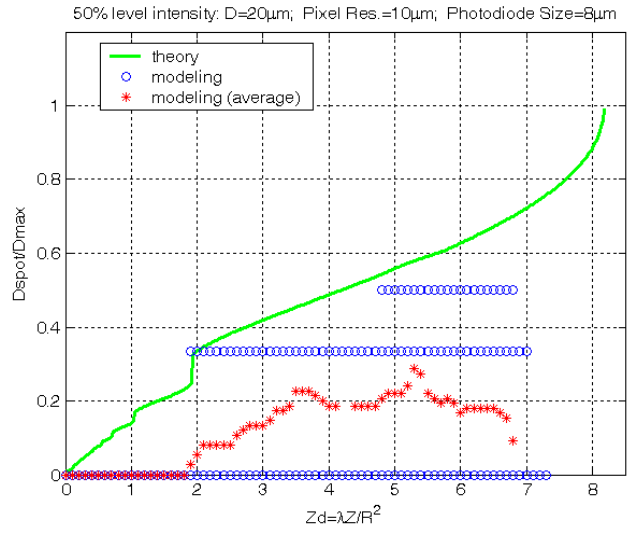
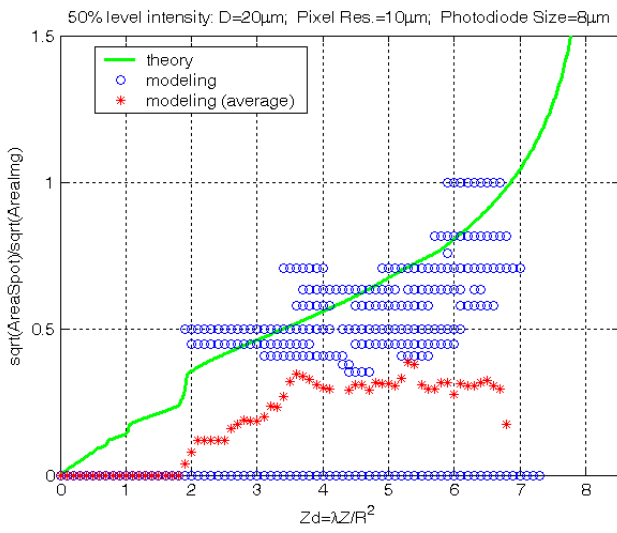
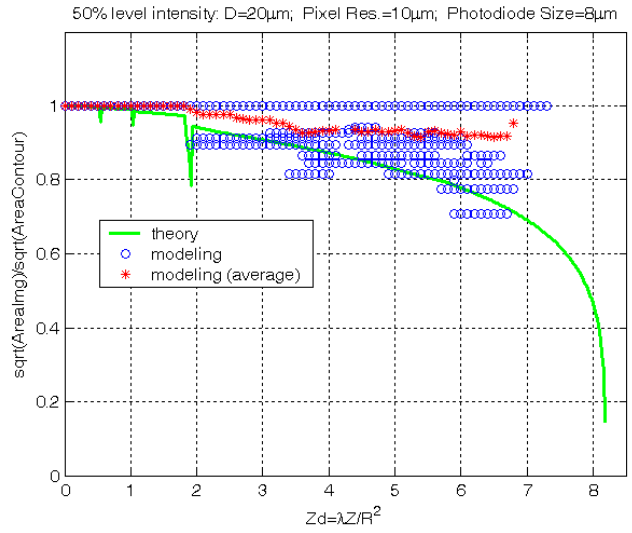
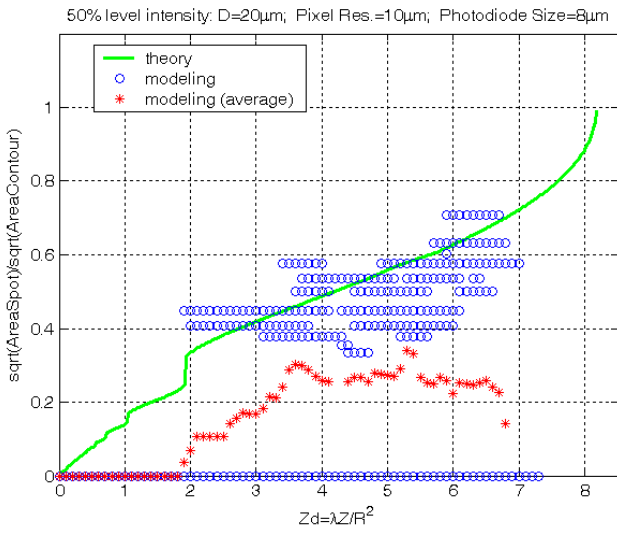
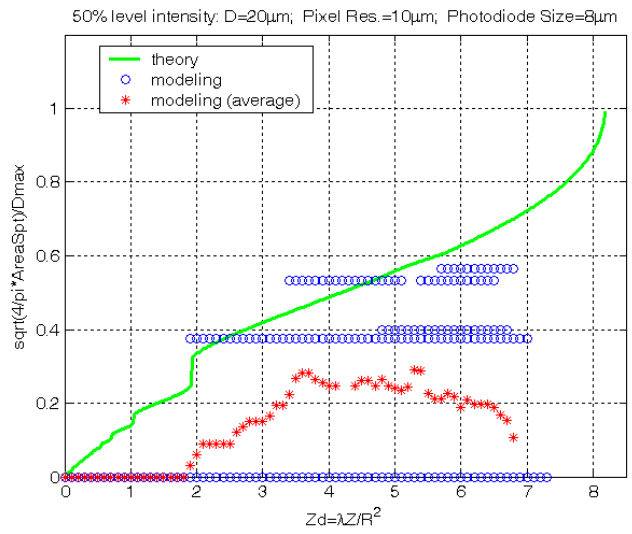
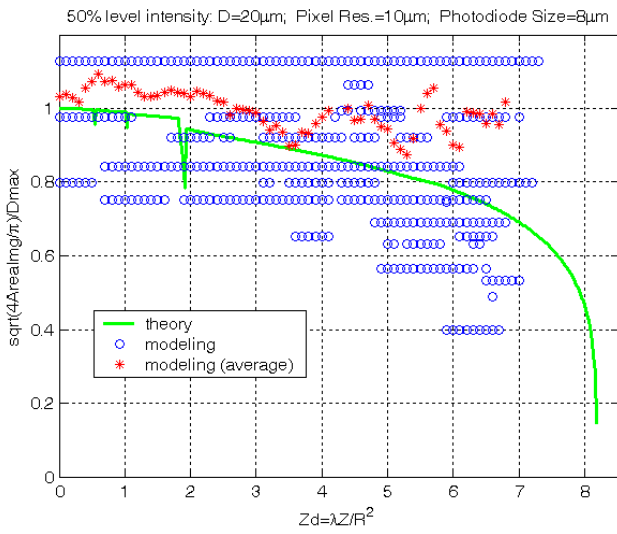


Figure 14

$D_0=30\mu\text{m}$

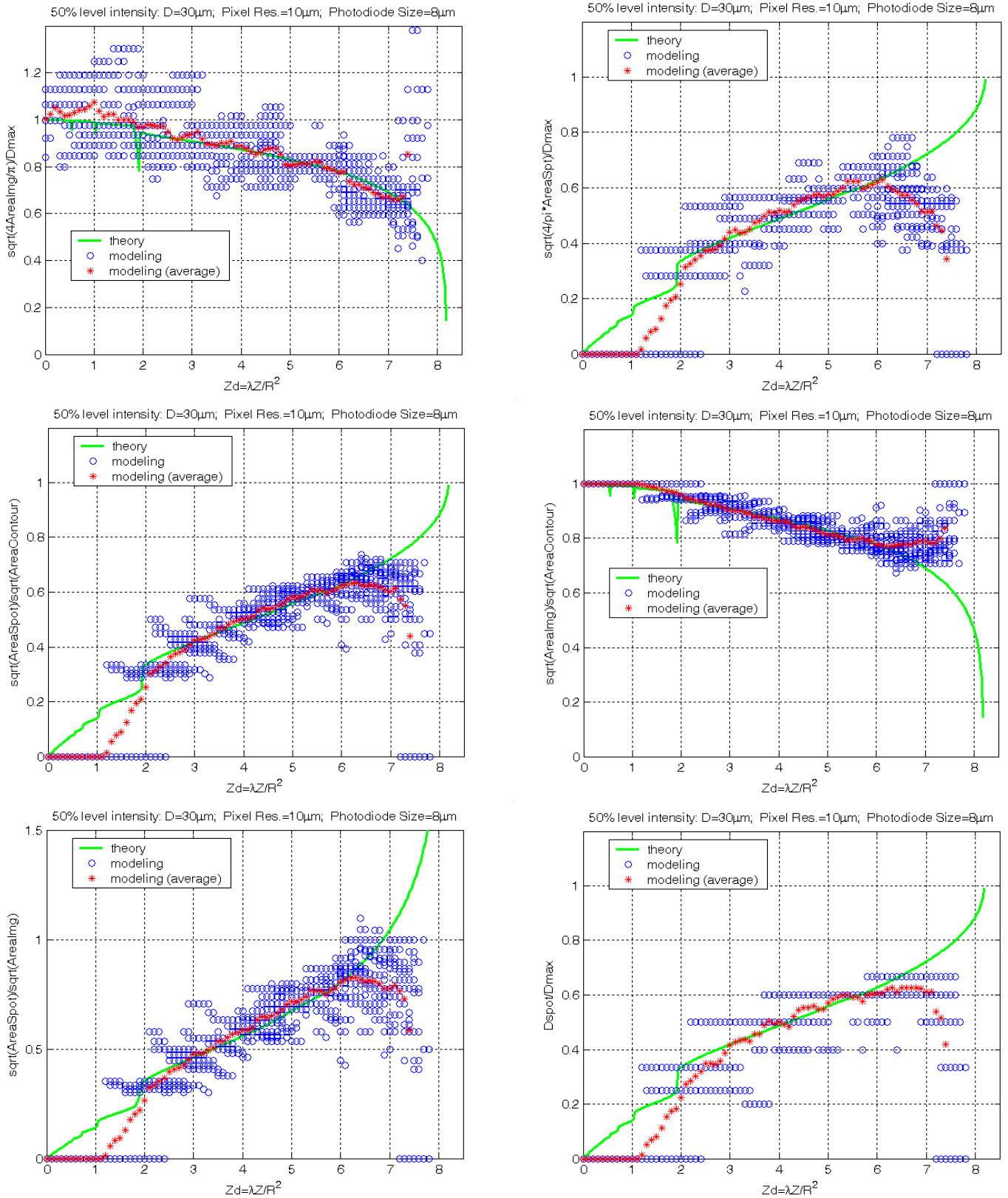


Figure 15

$D_0=40\mu\text{m}$

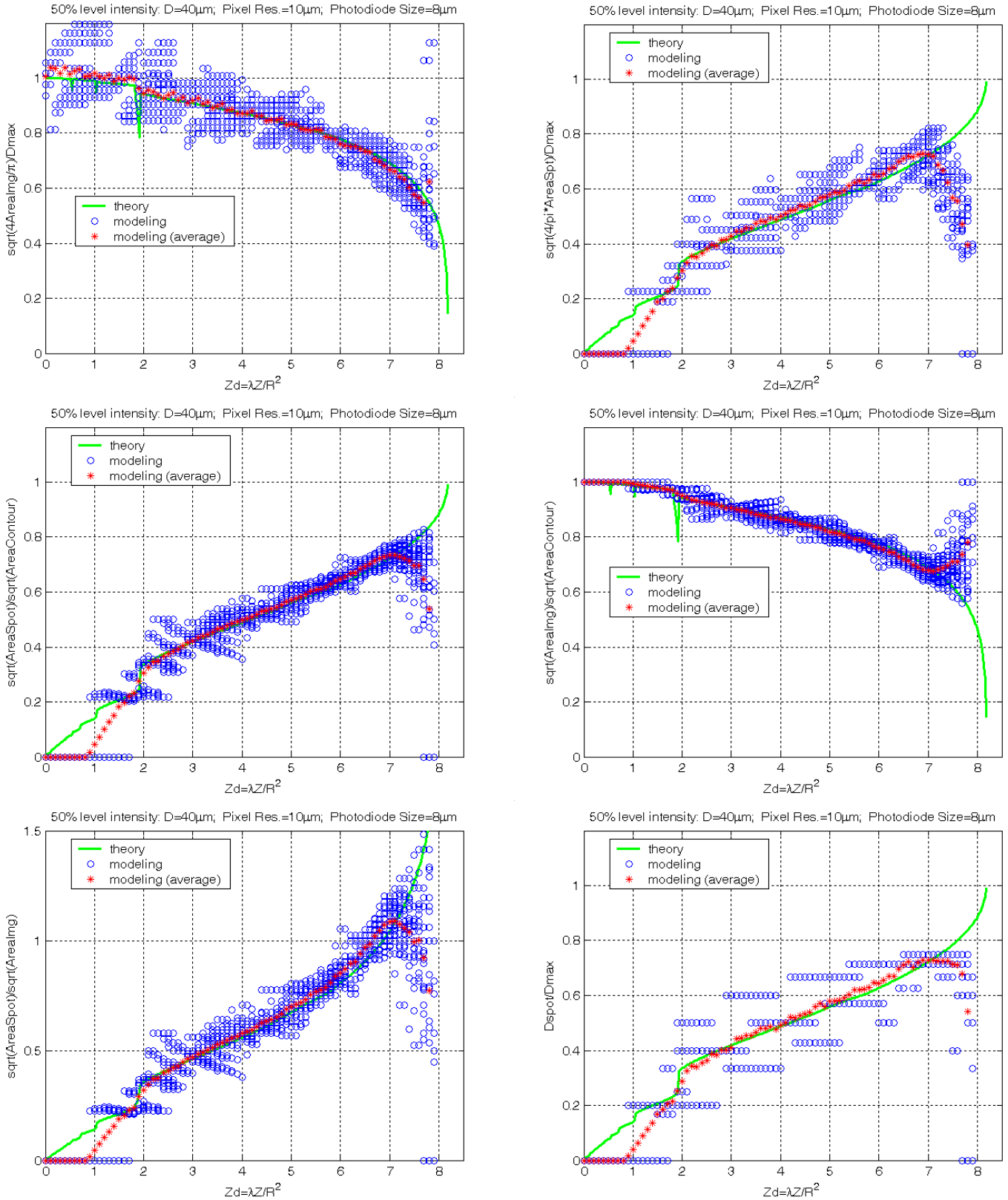


Figure 16

D₀=50μm

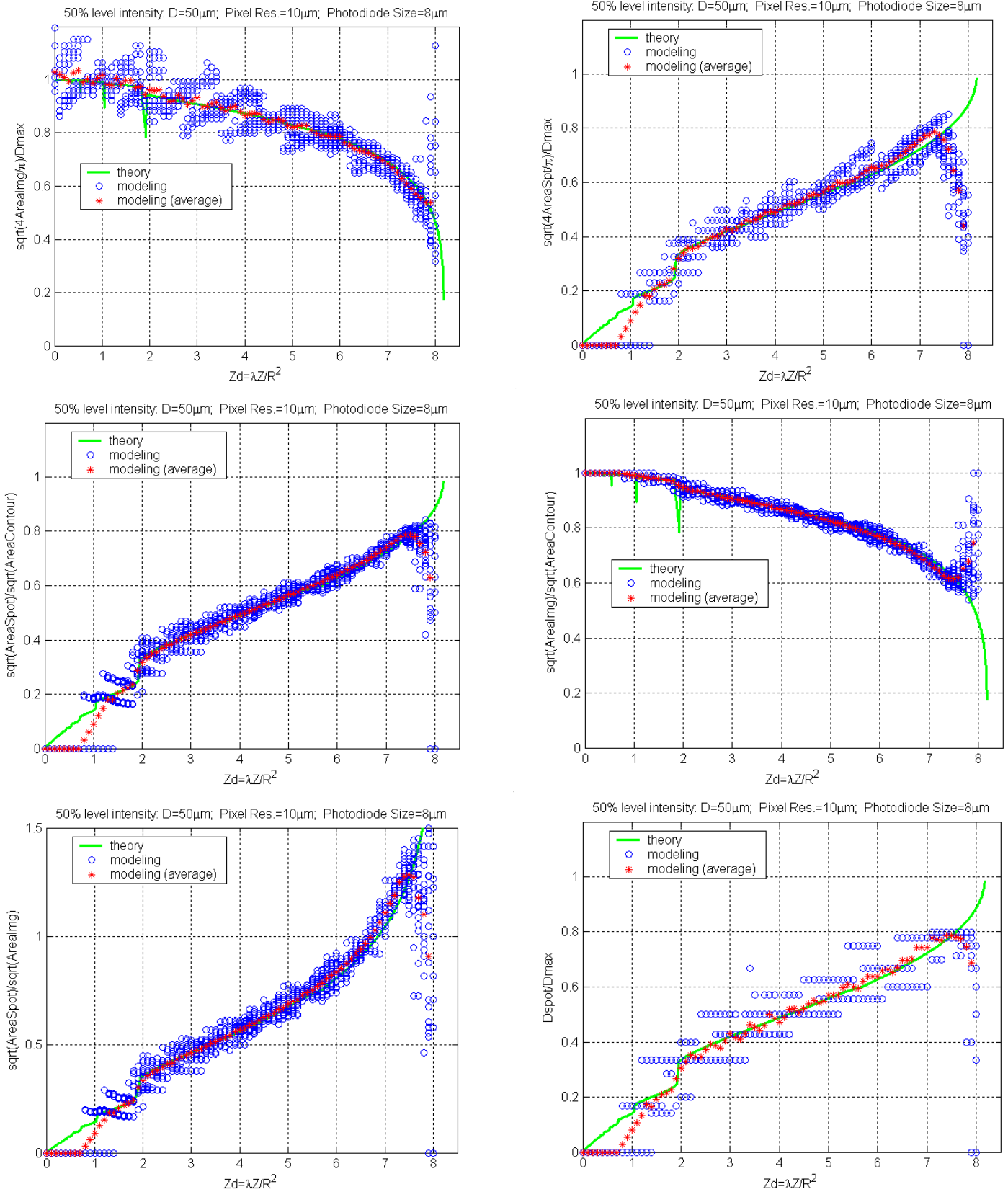


Figure 17

$D_o=70\mu\text{m}$

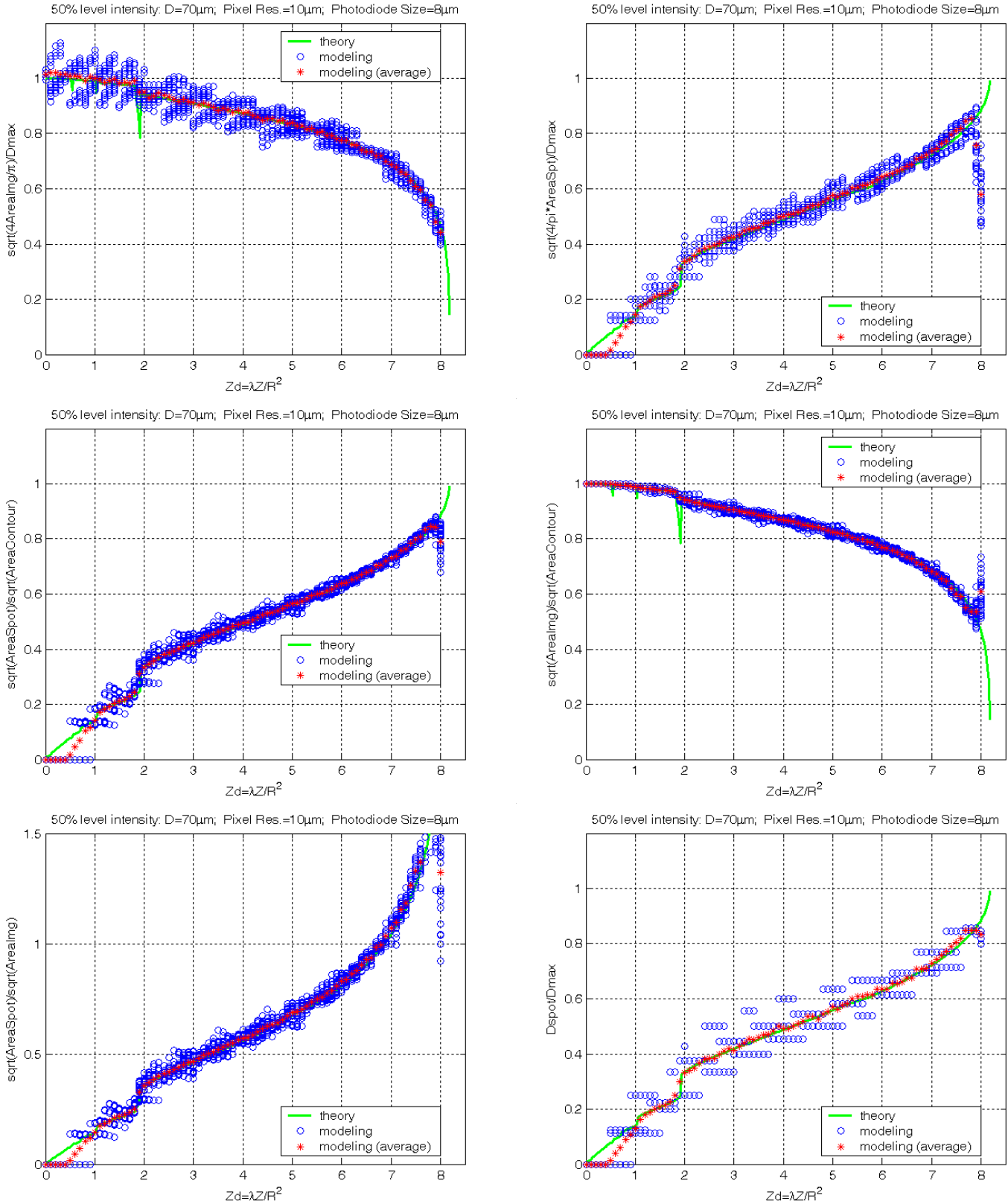


Figure 18

$D_0=100\mu\text{m}$

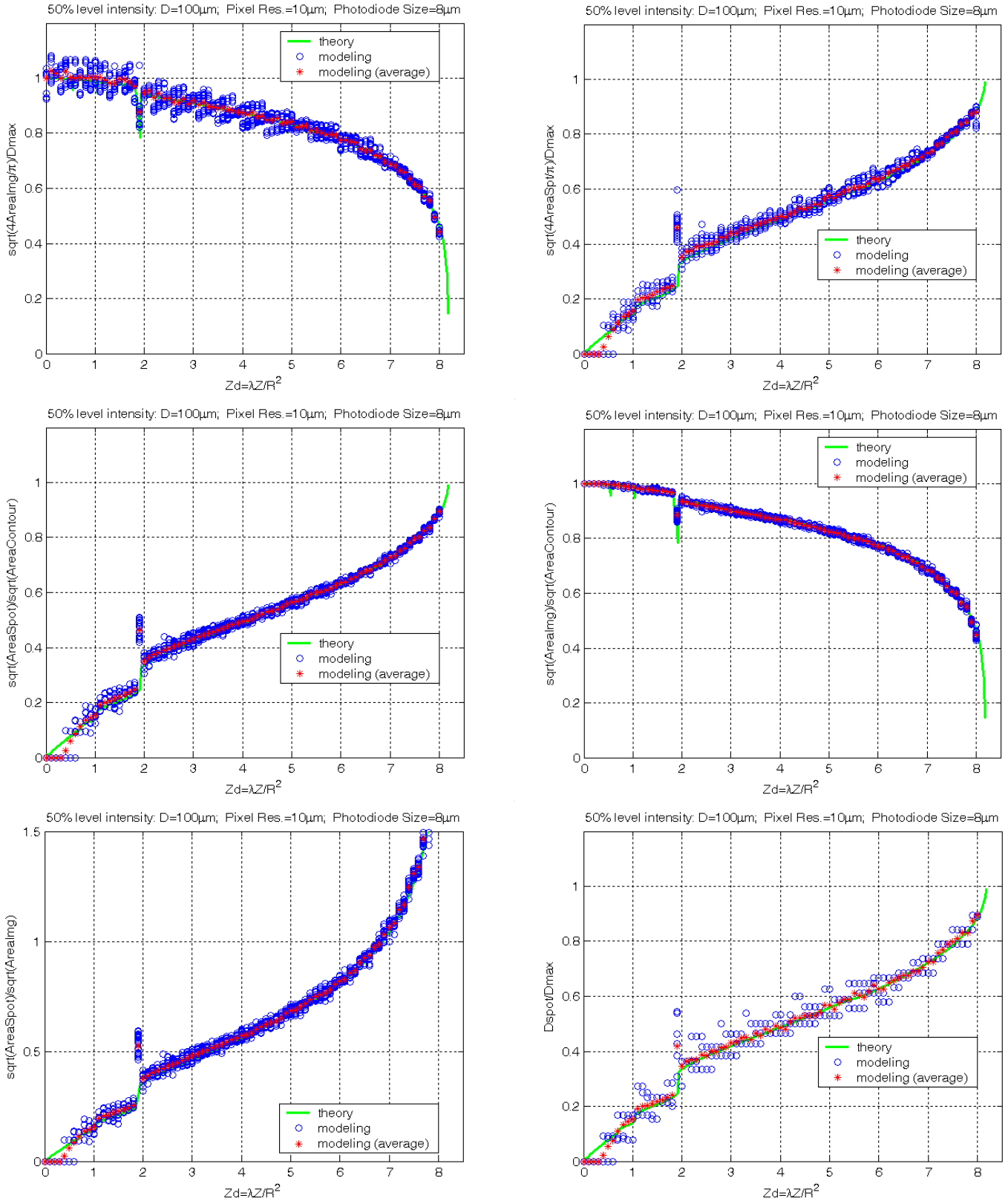


Figure 19

$D_0=150\mu\text{m}$

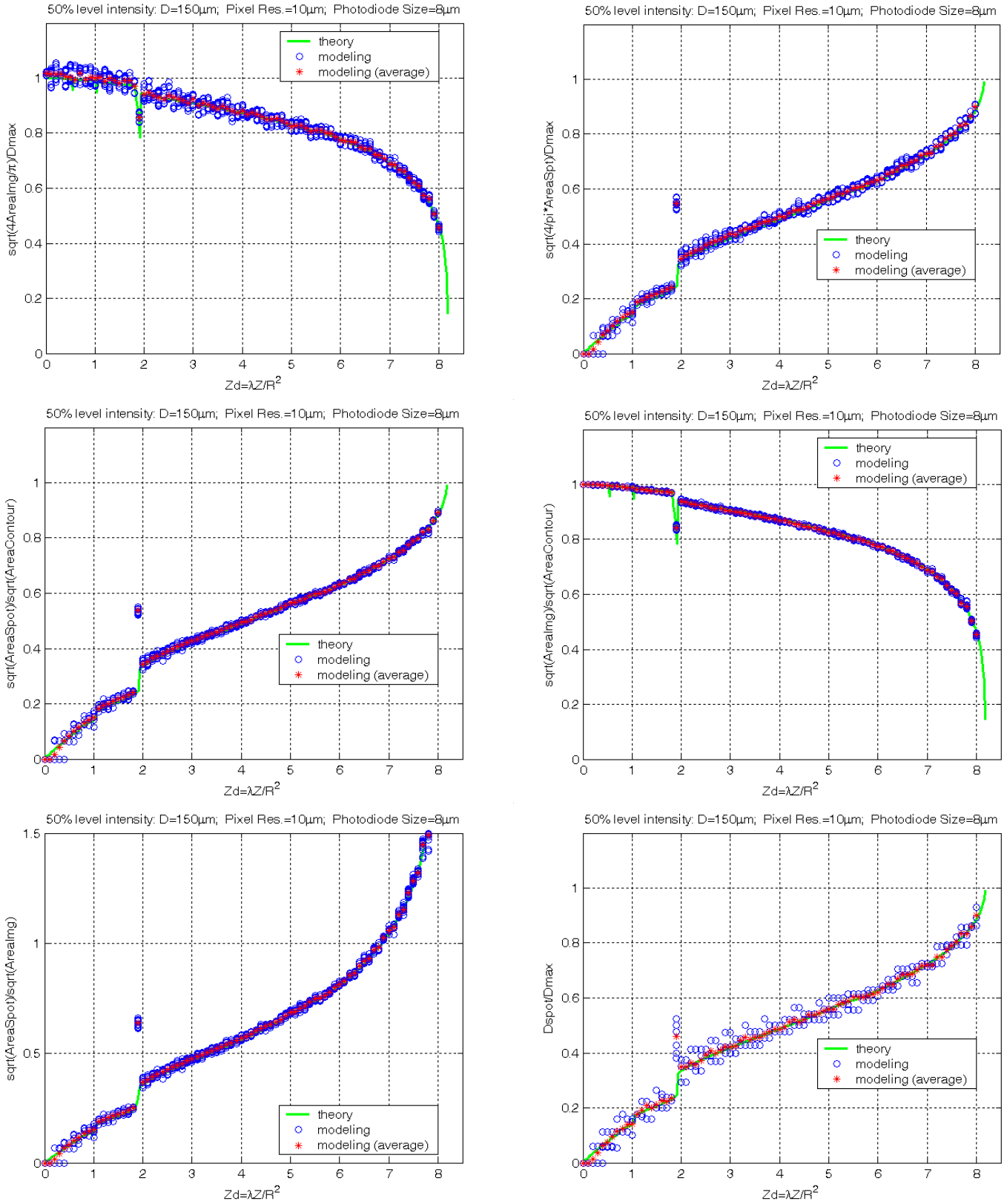


Figure 20

$D_0=200\mu\text{m}$

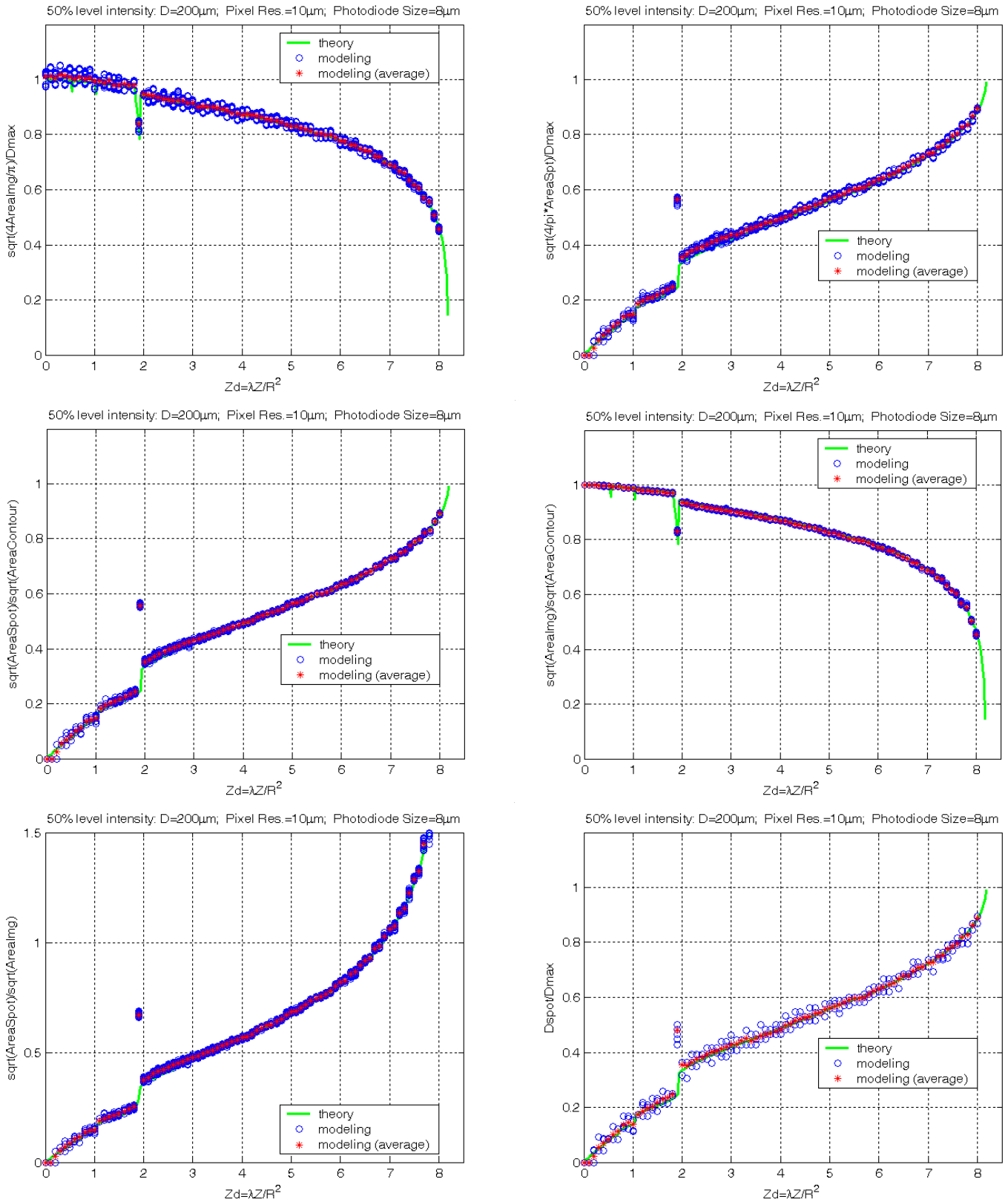


Figure 21

$D_o = 20\mu\text{m}$

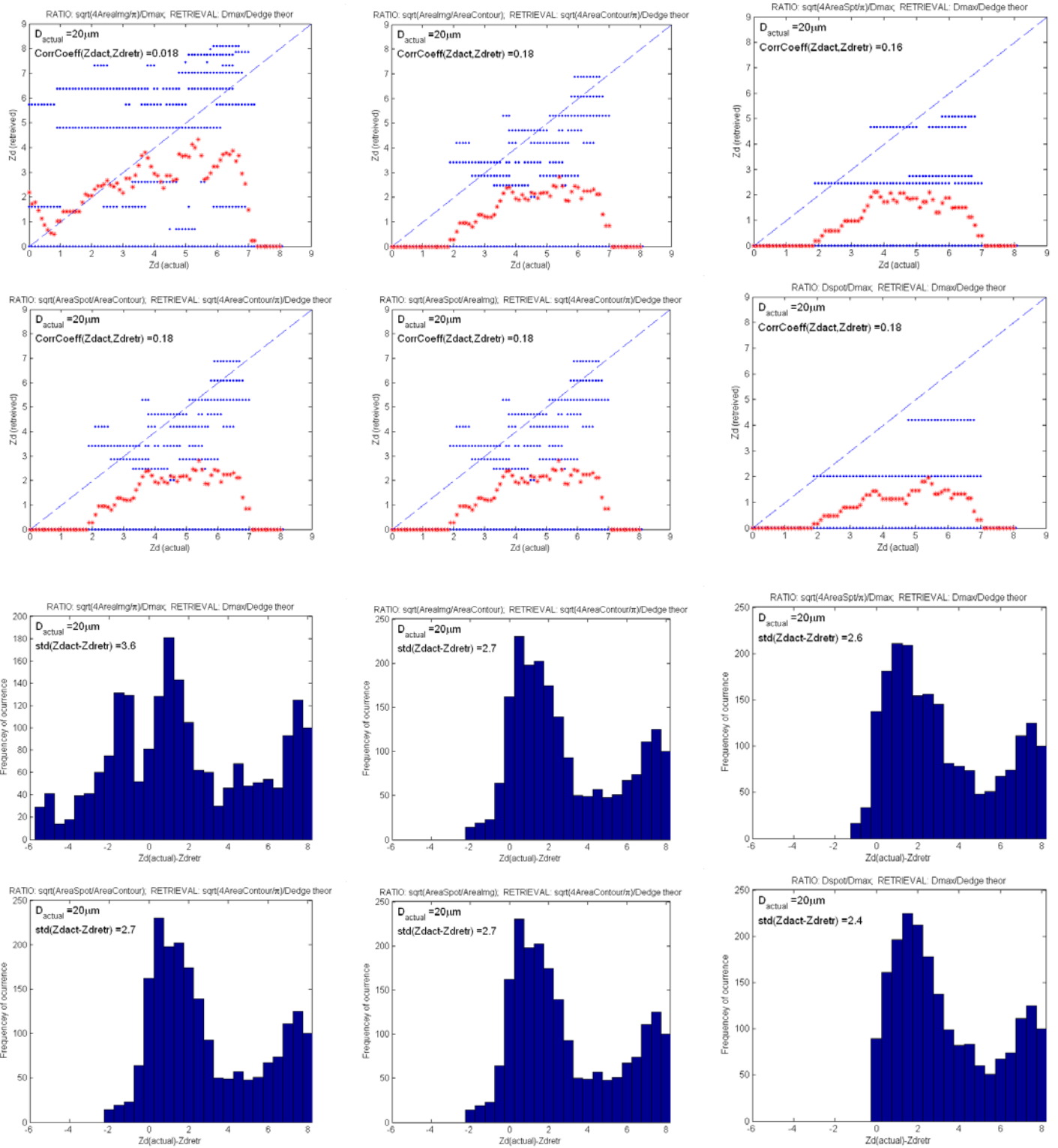


Figure 22

$D_o=30\mu\text{m}$

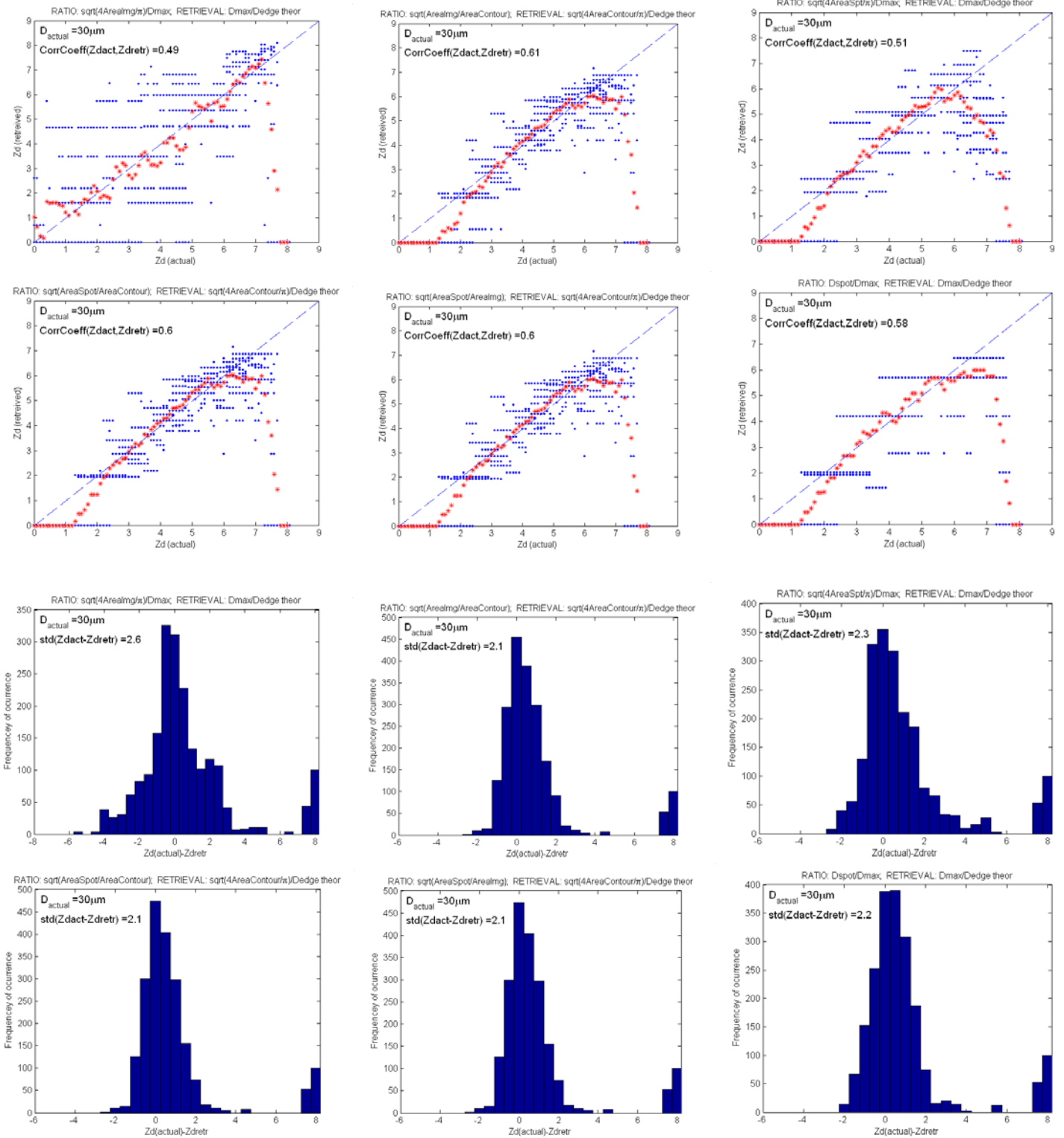


Figure 23

$D_0=40\mu\text{m}$

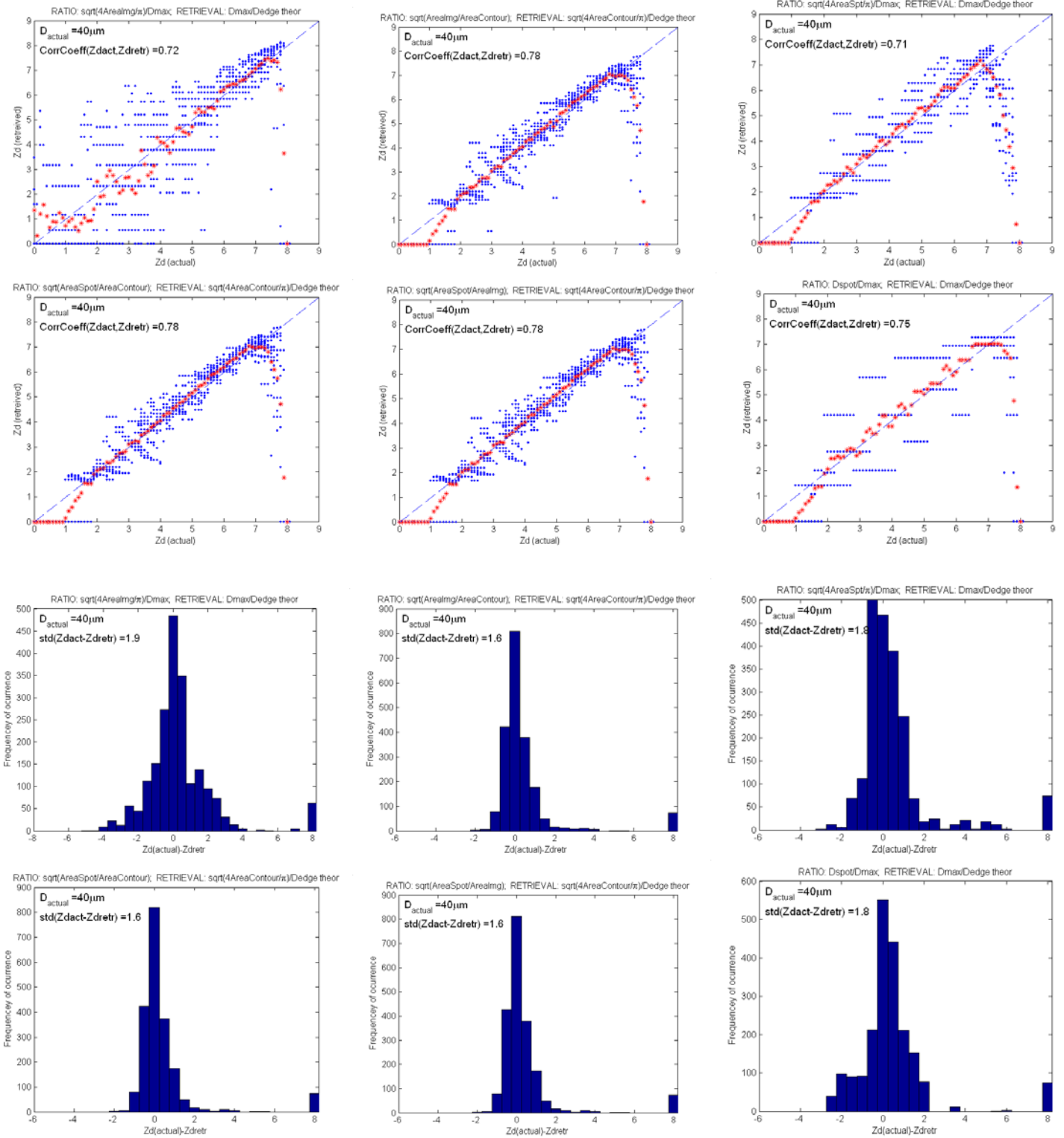


Figure 24

$D_o = 50\mu\text{m}$

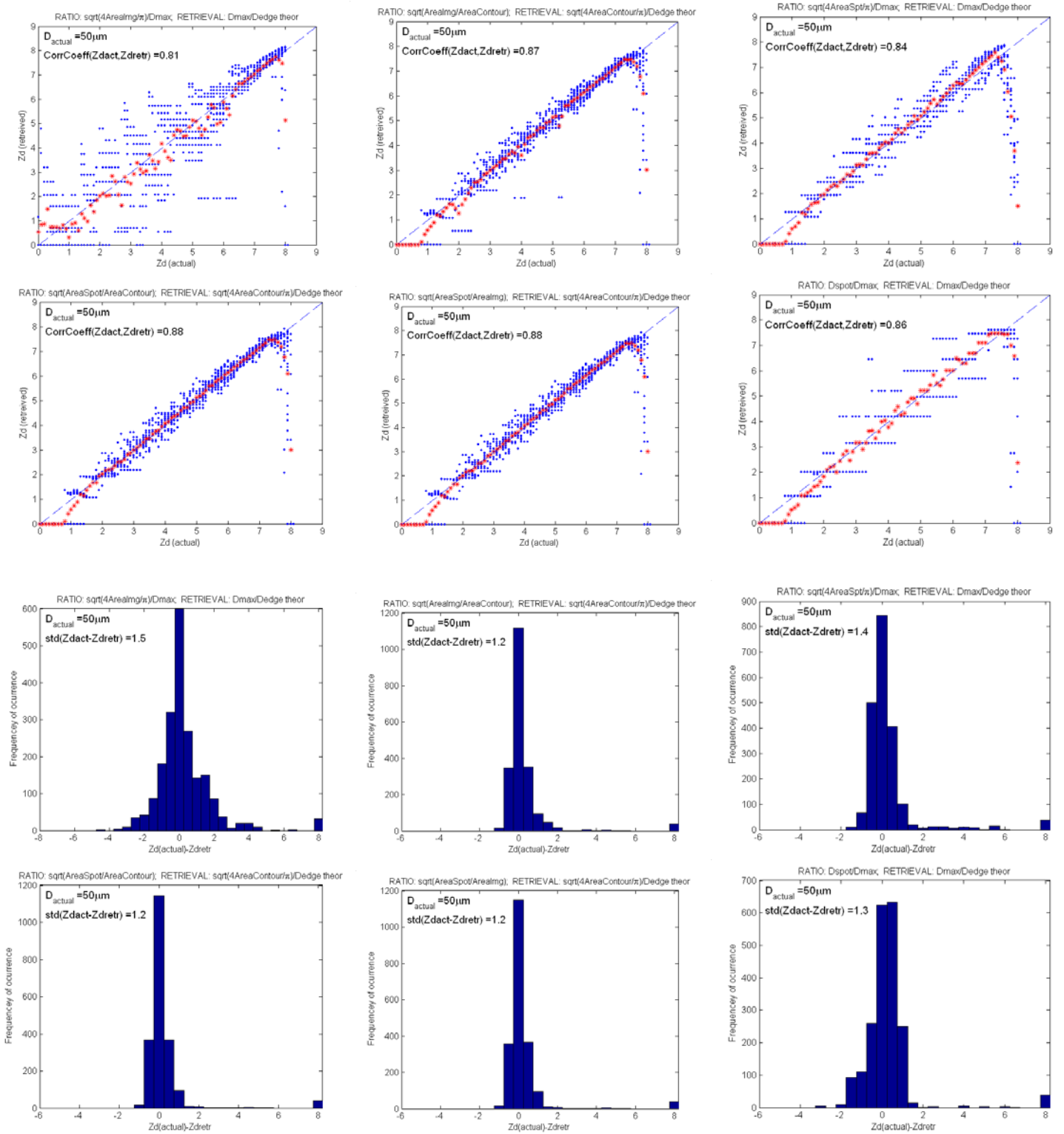


Figure 25

$D_0=70\mu\text{m}$

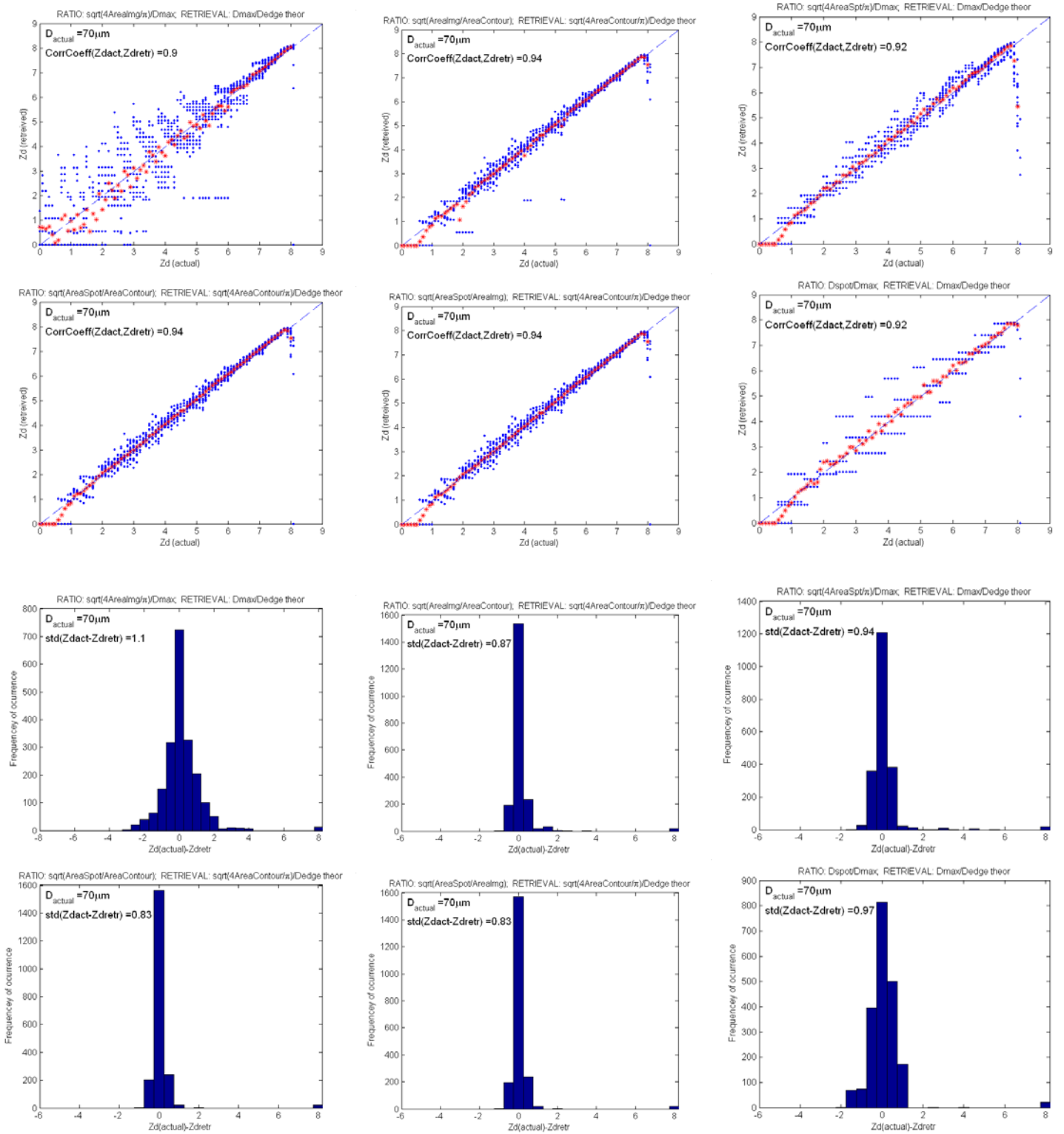


Figure 26

$D_o=100\mu\text{m}$

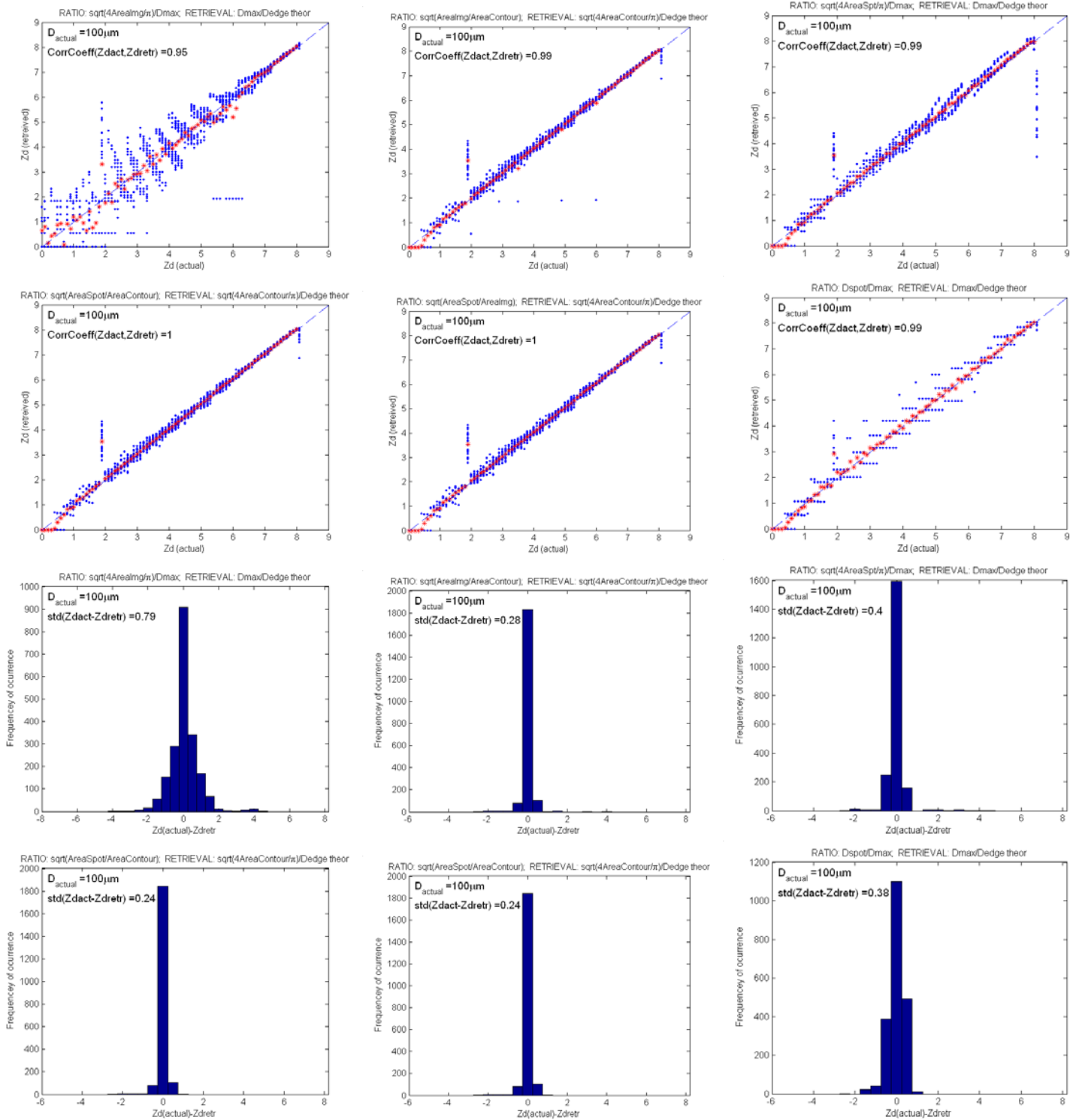


Figure 27

$D_o=150\mu\text{m}$

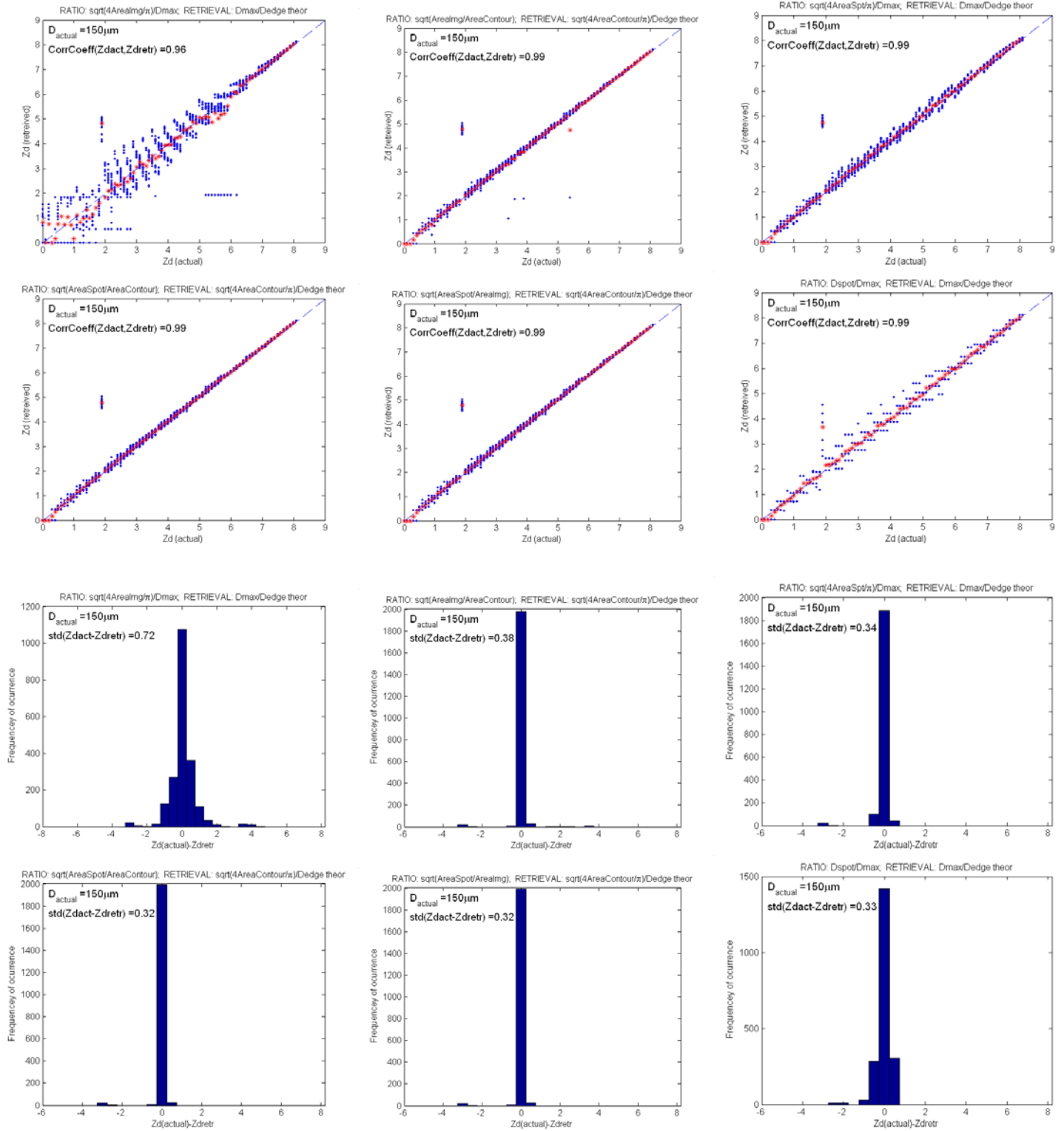


Figure 28

$D_o=200\mu\text{m}$

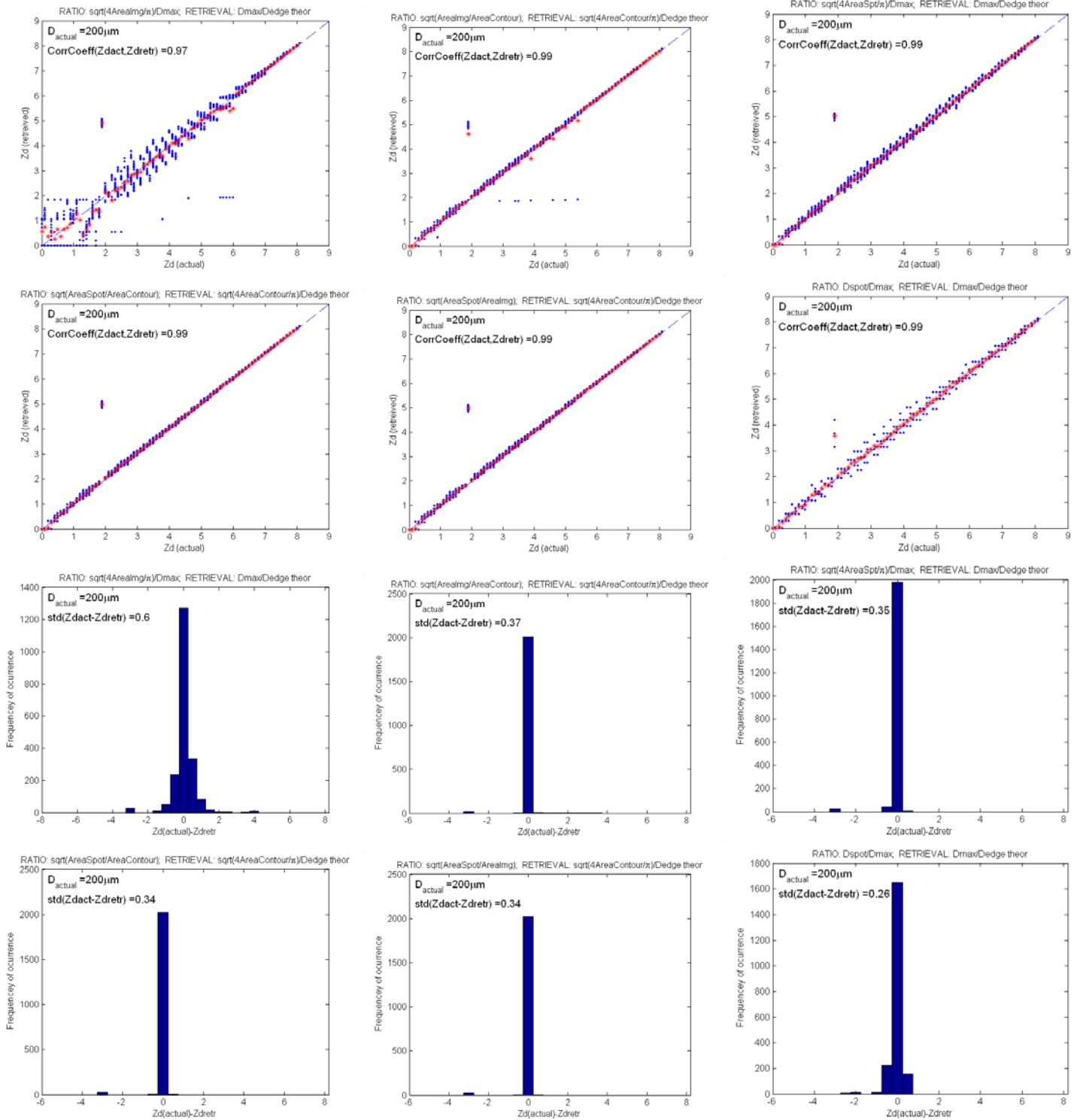


Figure 29

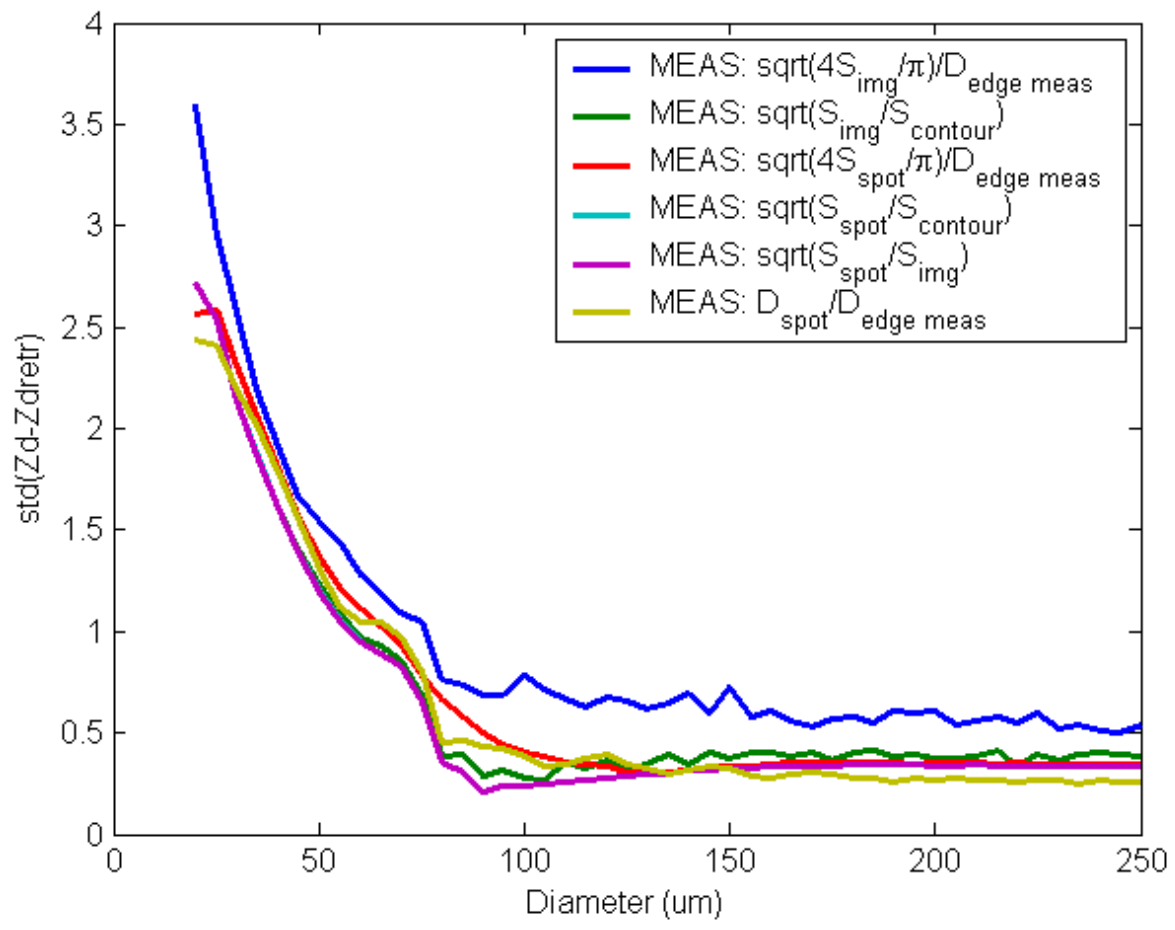


Figure 30

$D_o=20\mu\text{m}$

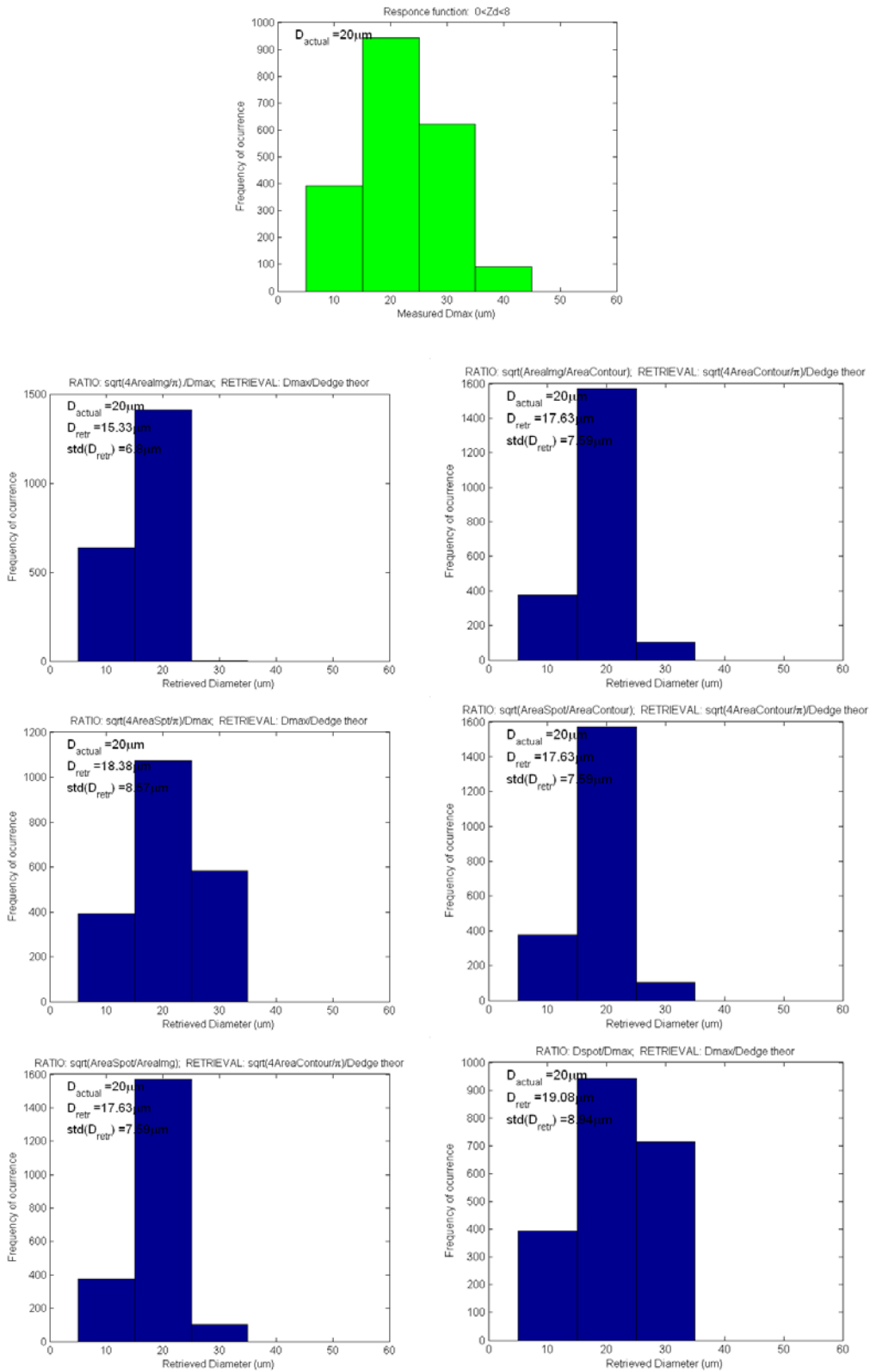


Figure 31

$D_o=30\mu\text{m}$

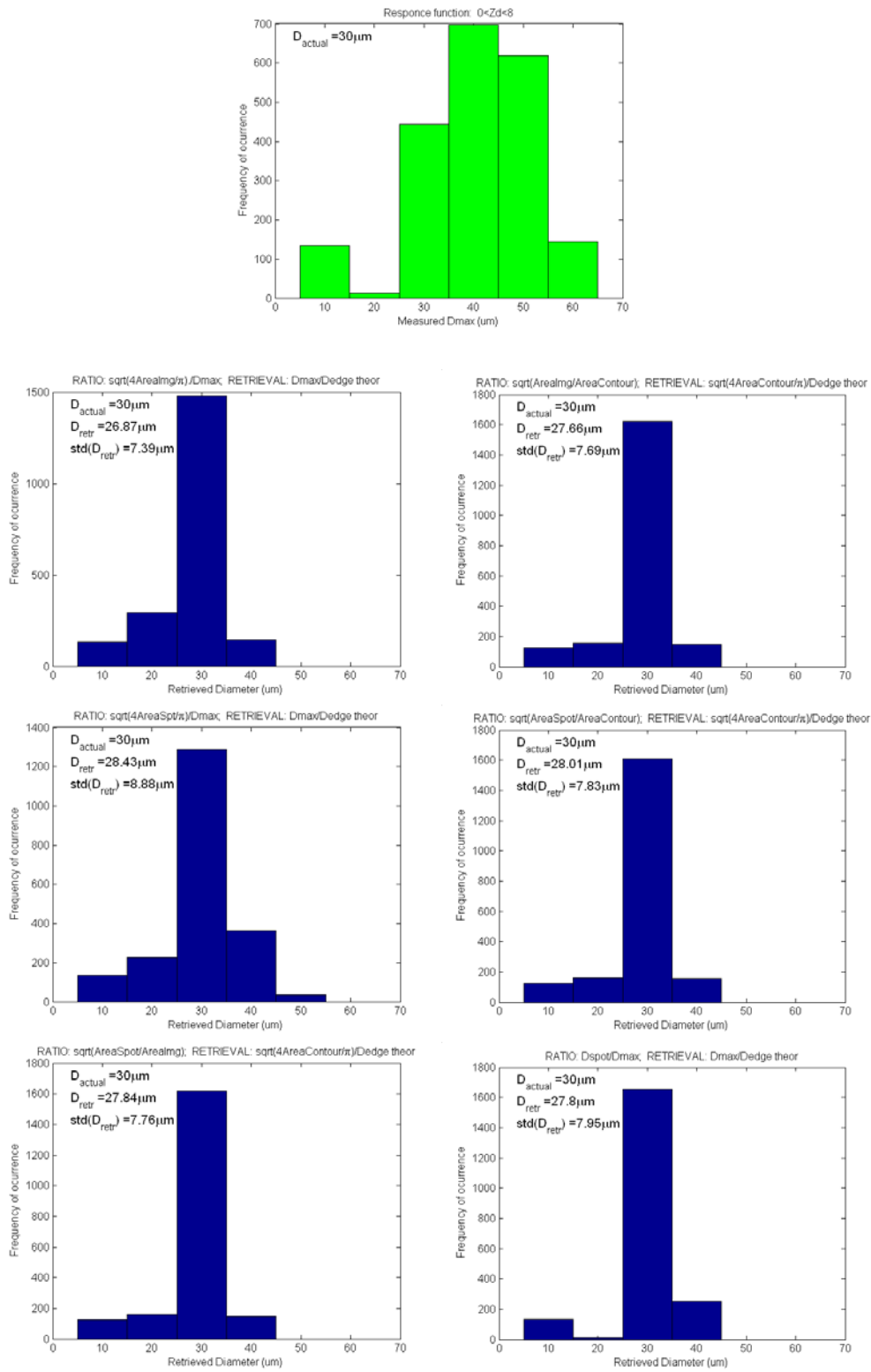


Figure 32

$D_0=40\mu\text{m}$

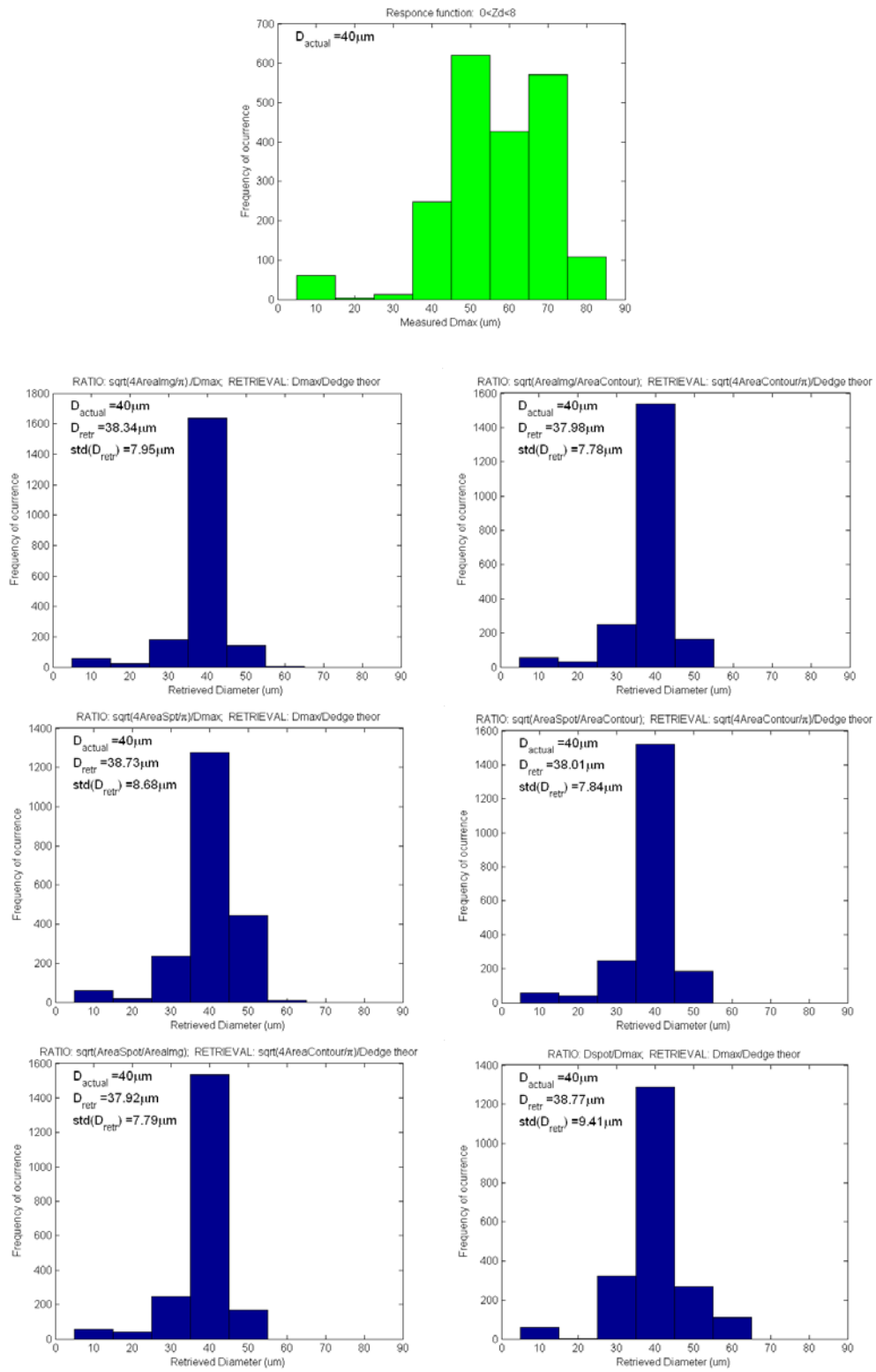


Figure 33

$D_o=50\mu\text{m}$

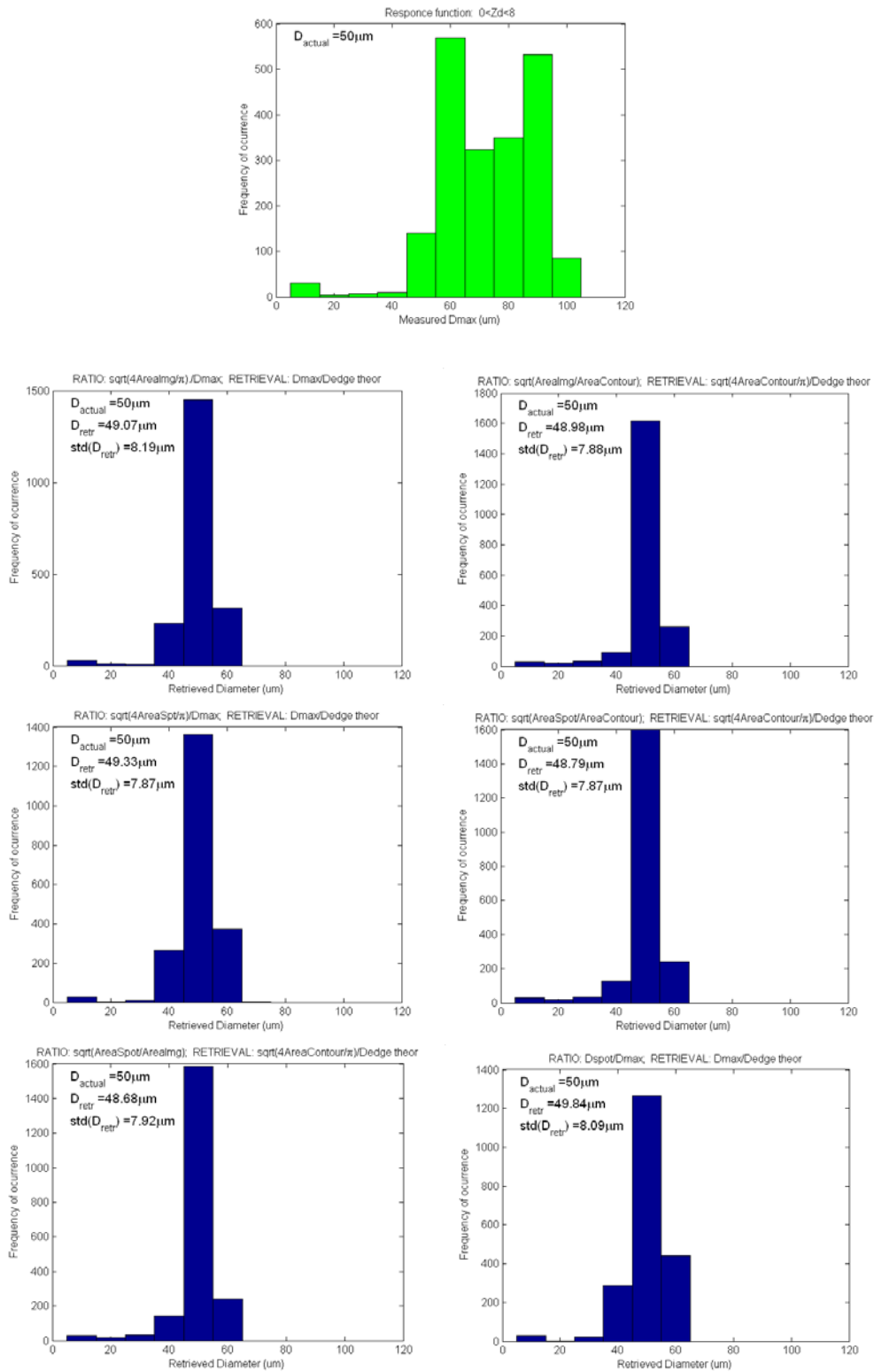


Figure 34

$D_o=70\mu\text{m}$

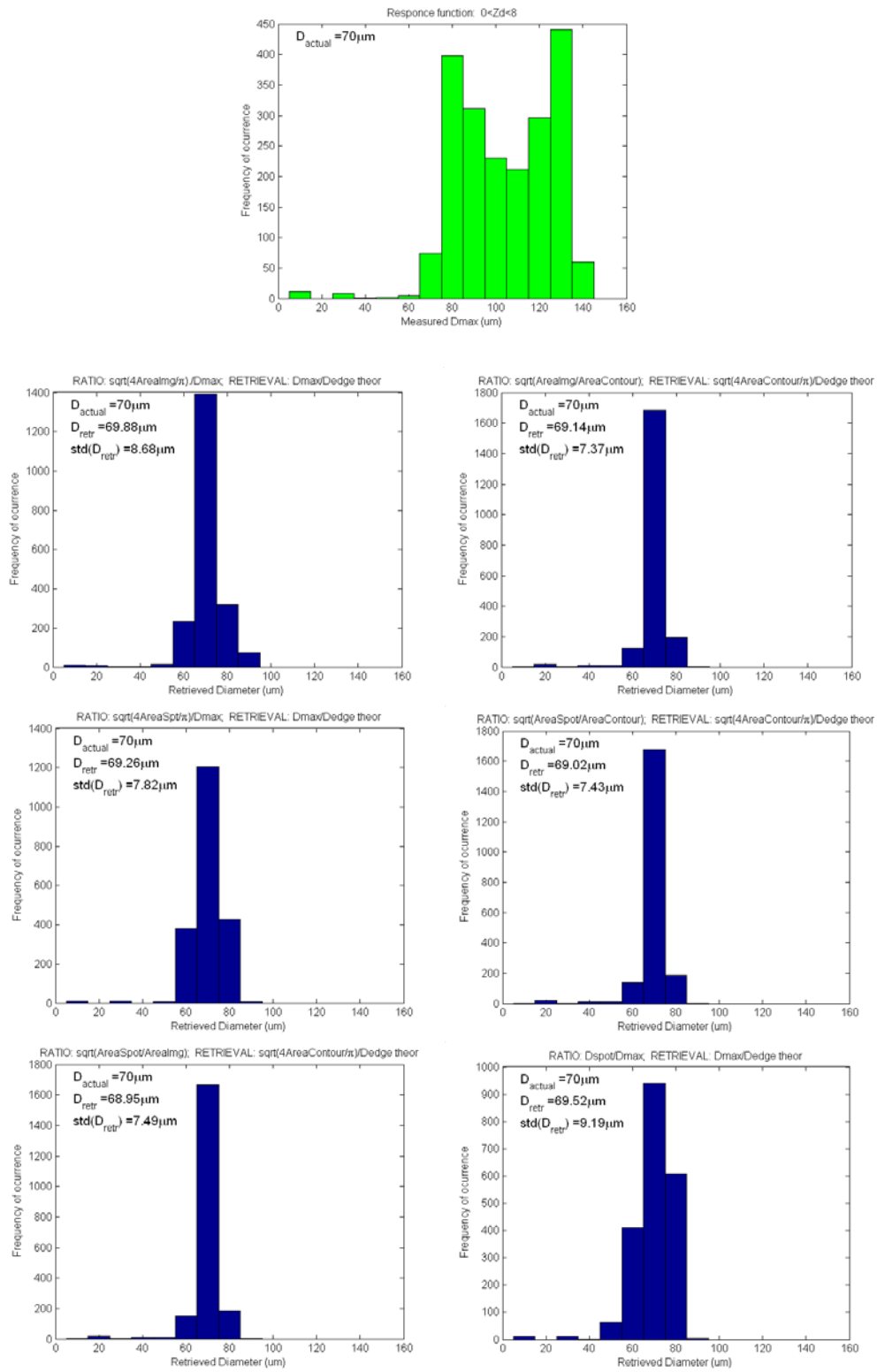


Figure 35

$D_o=100\mu\text{m}$

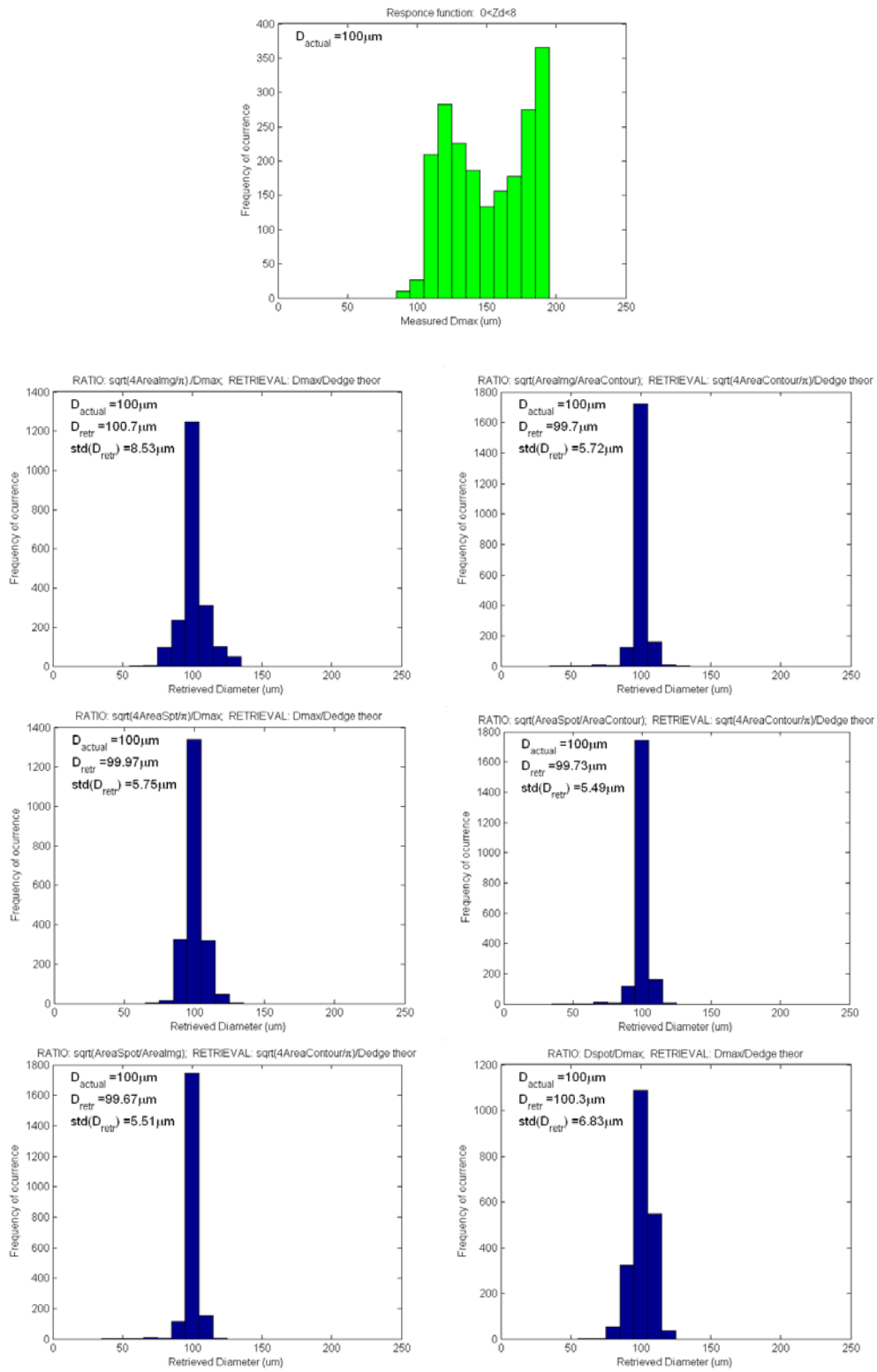


Figure 36

$D_o=150\mu\text{m}$

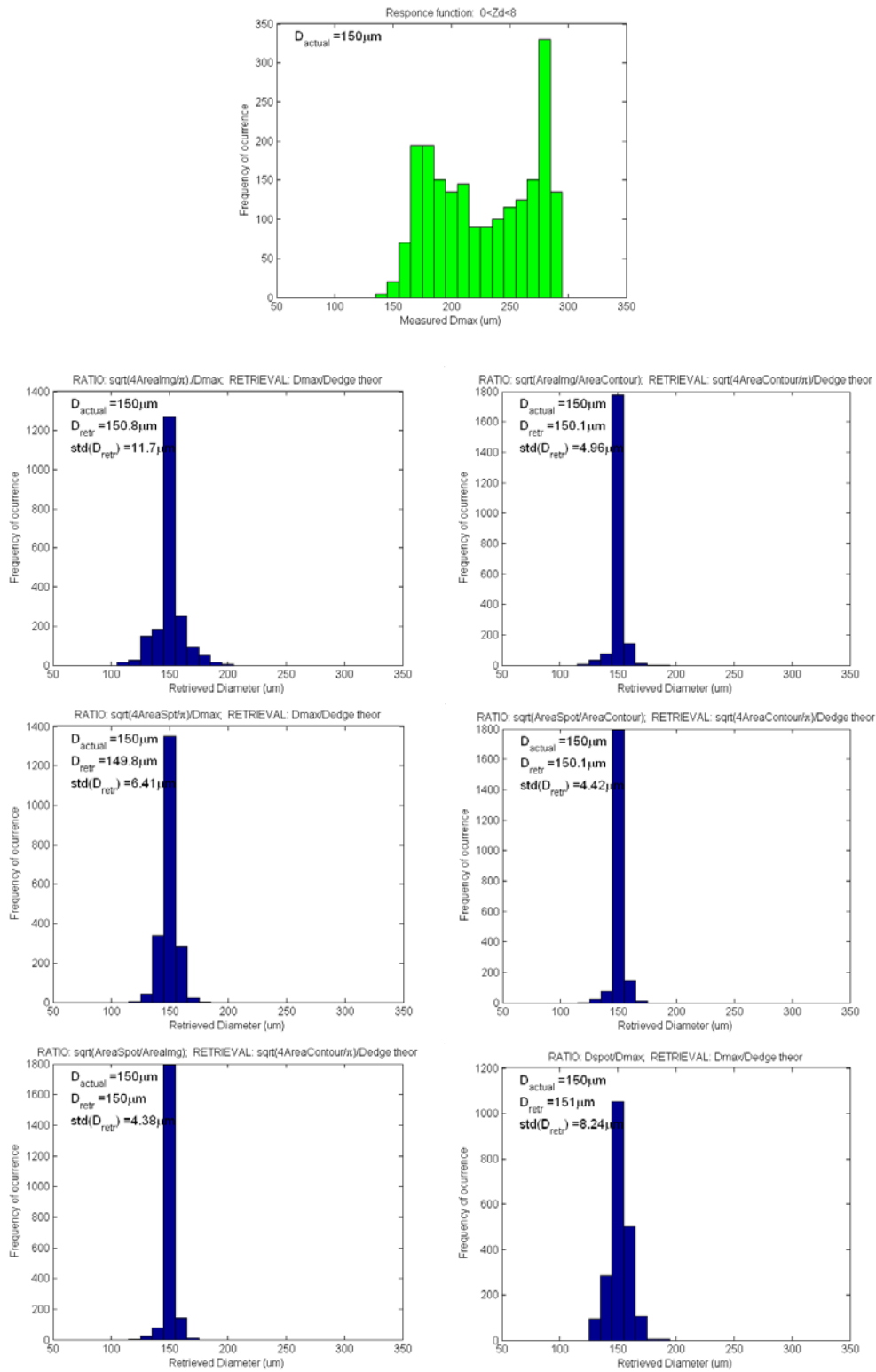


Figure 37

$D_o=200\mu\text{m}$

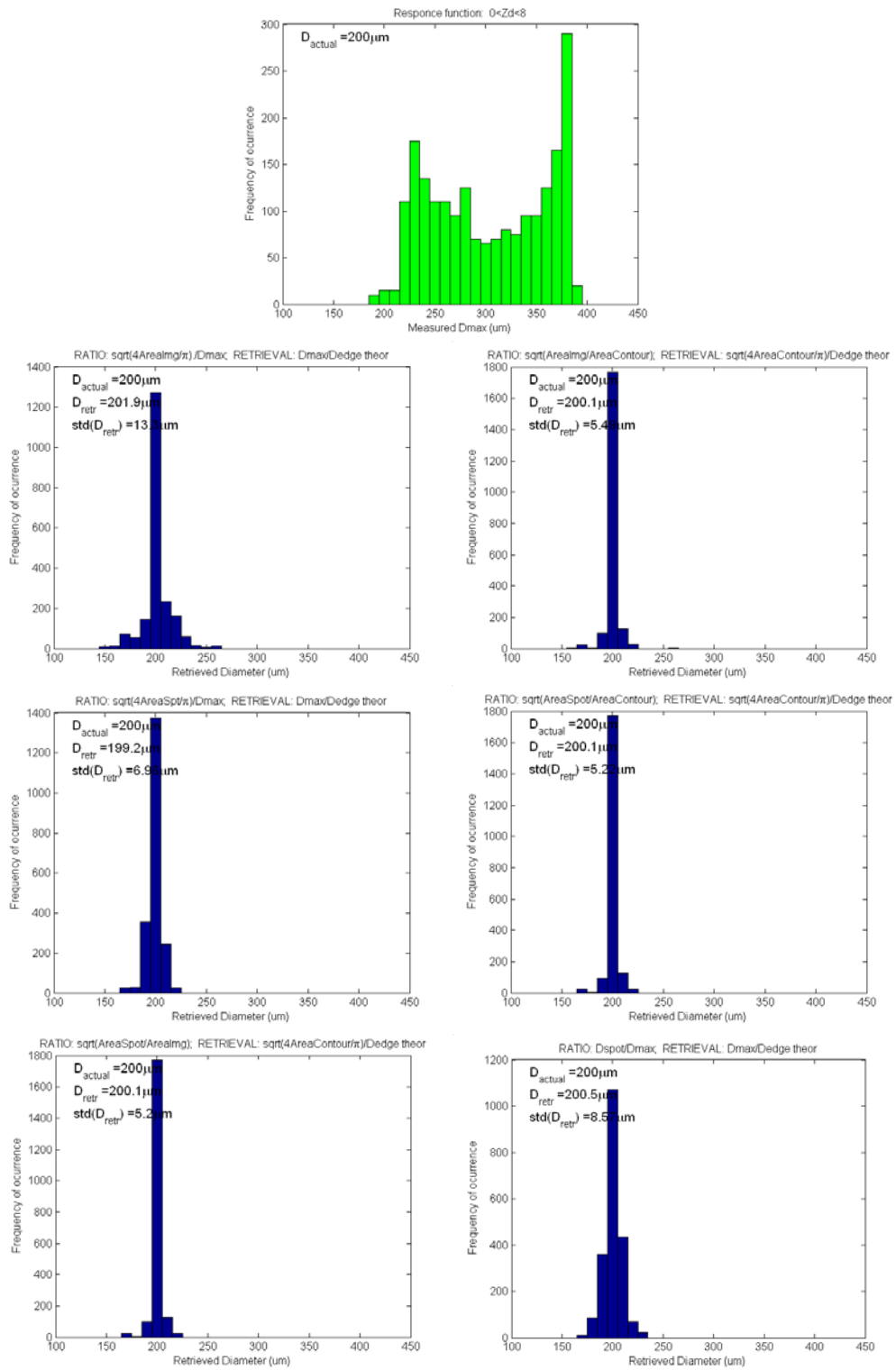


Figure 38

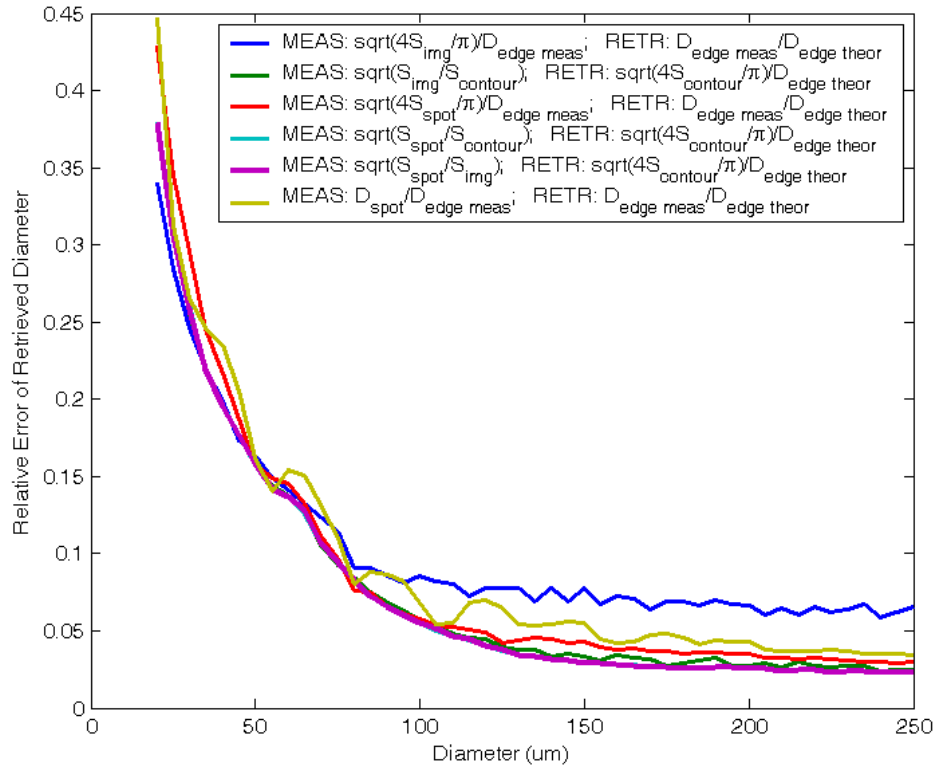


Figure 39

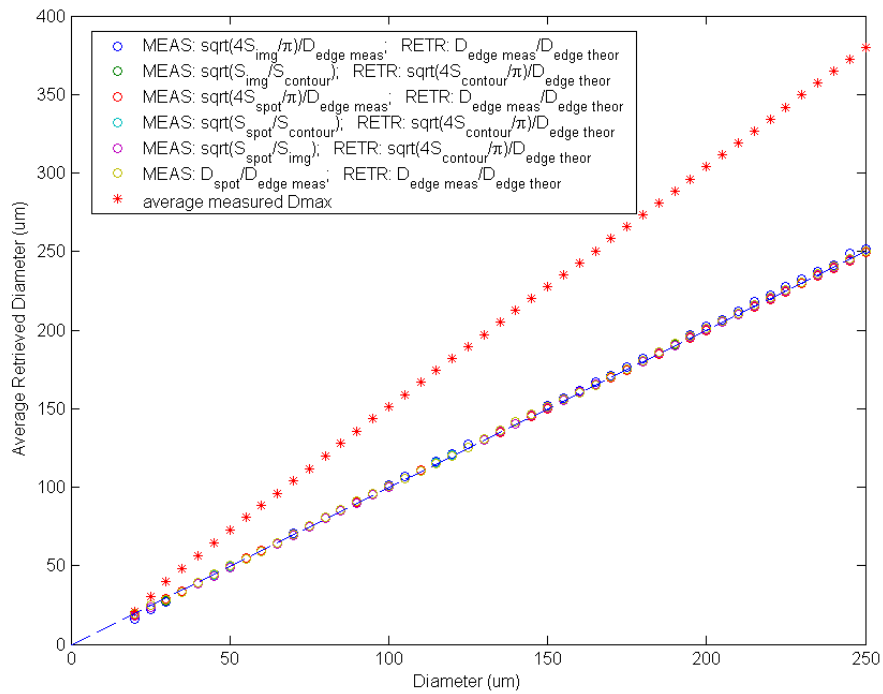


Figure 40

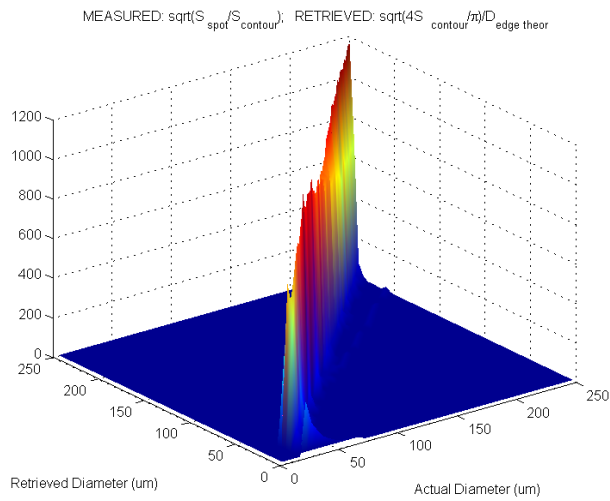
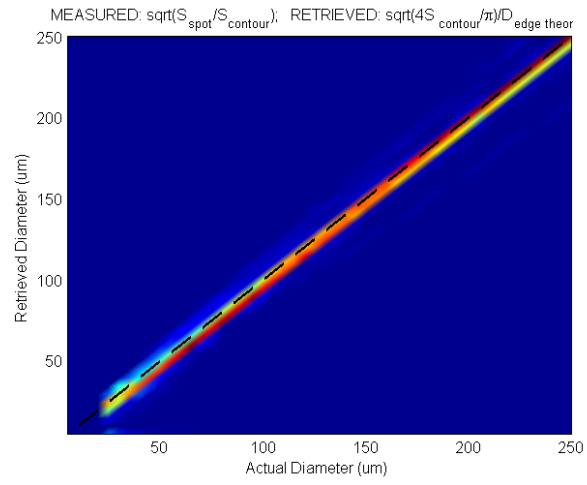
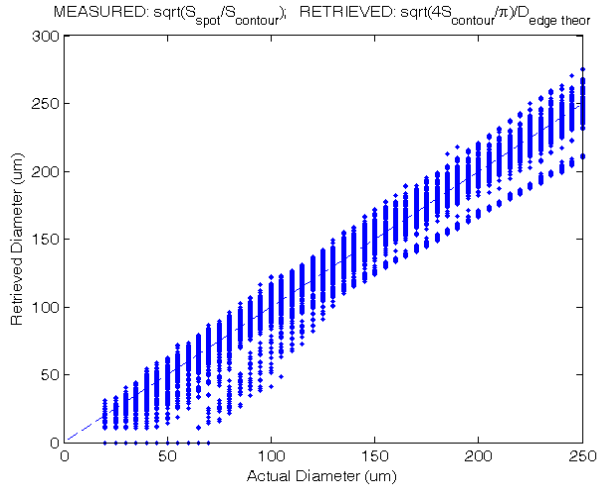


Figure 41

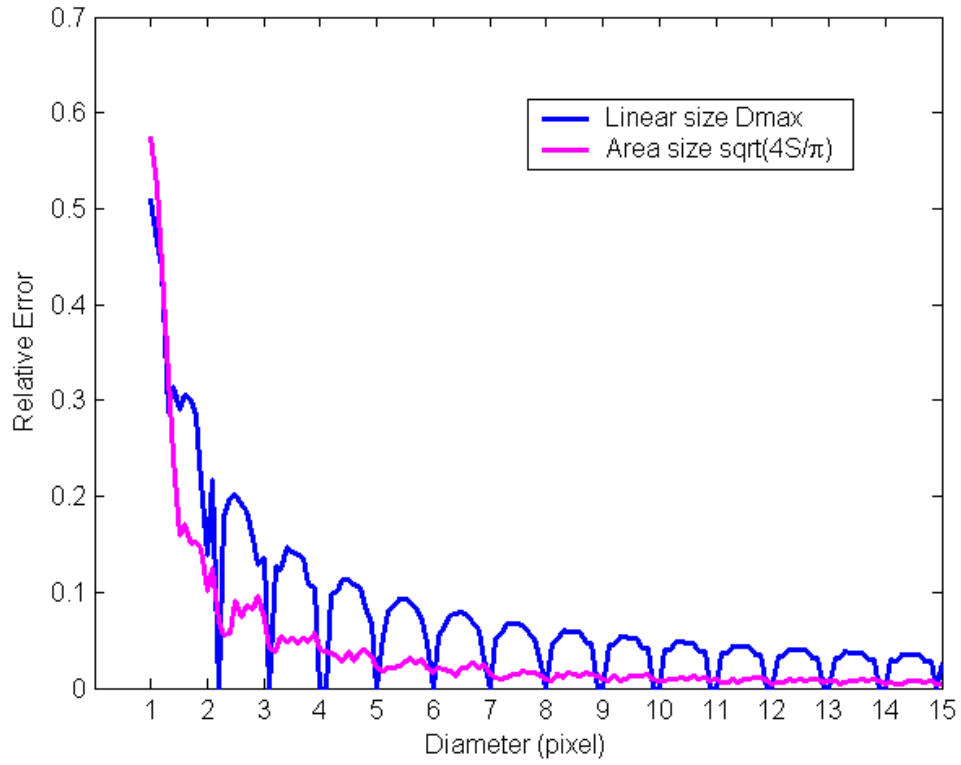


Figure A1

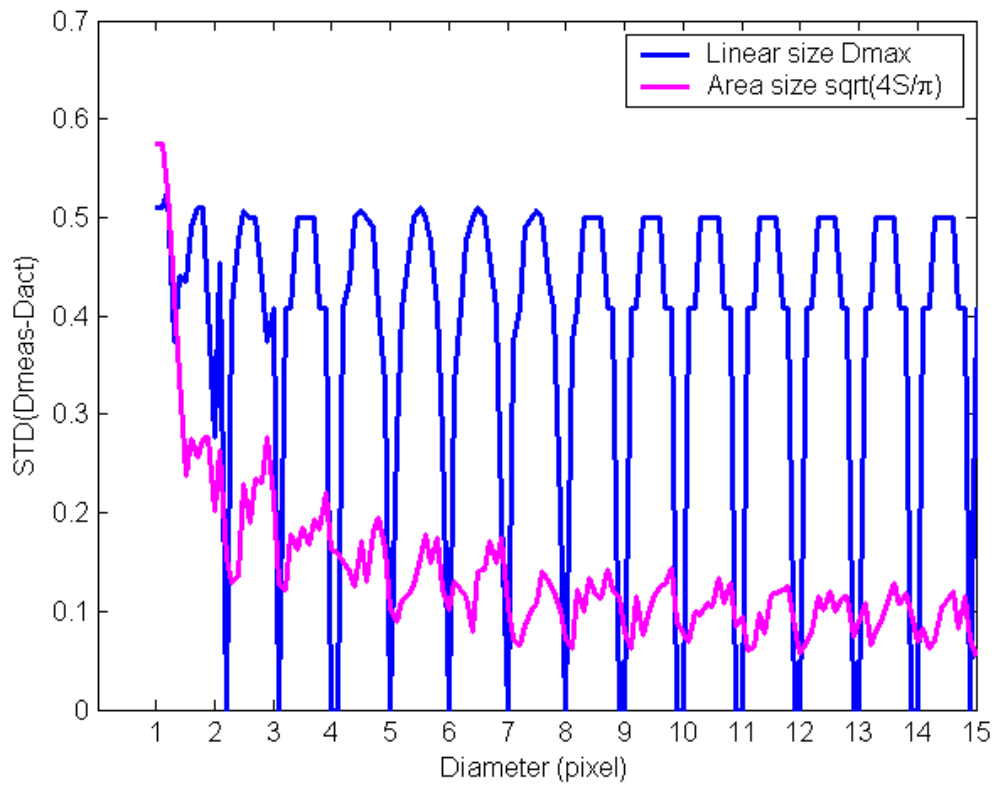
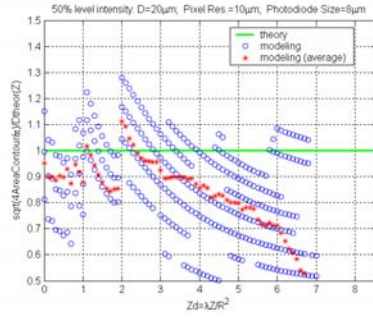
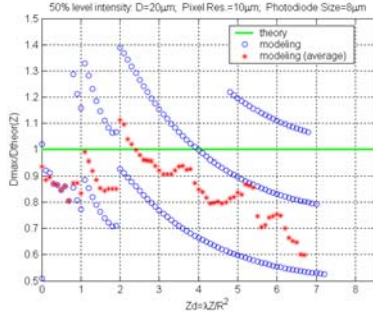
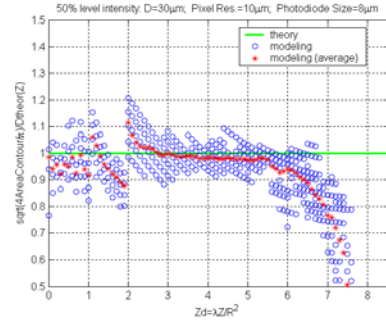
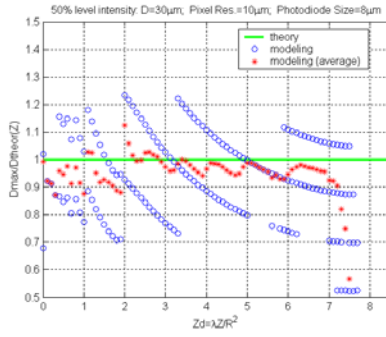


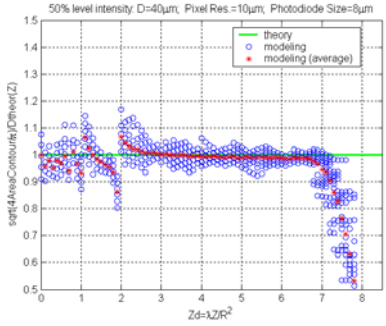
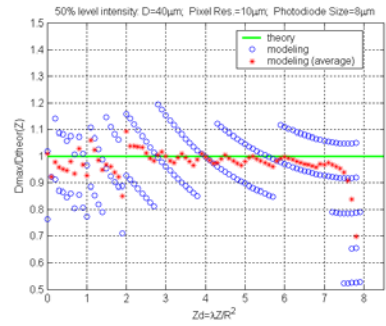
Figure A2



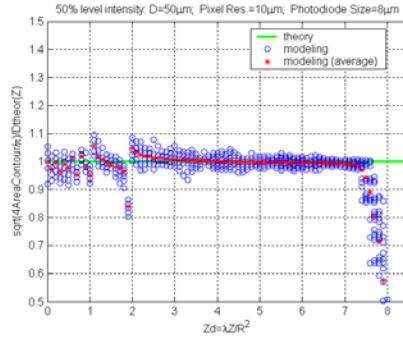
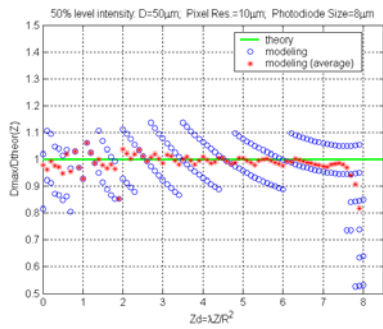
D=20μm



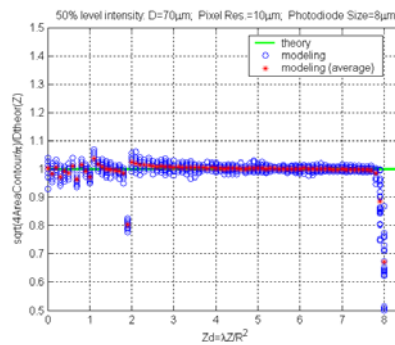
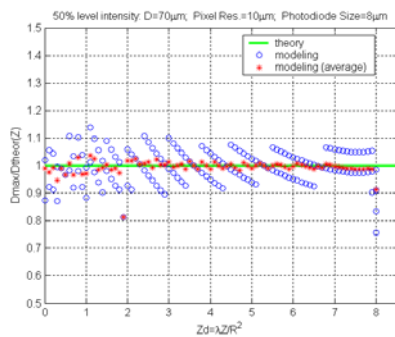
D=30μm



D=40μm



D=50μm



D=70μm

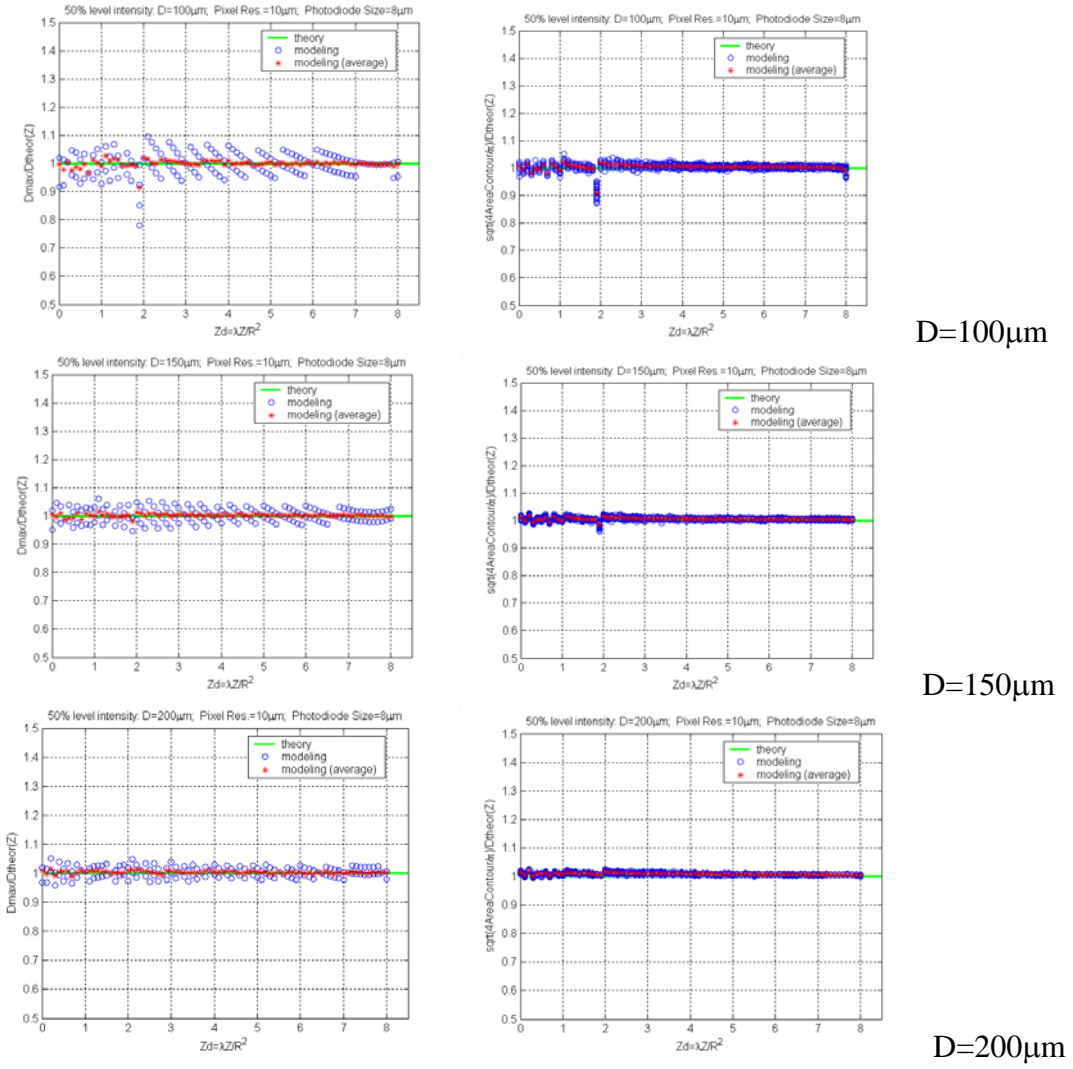


Figure A3

Table
Parameters for the retrieval of the sizes of the images of spherical particles

Z_d	D_{\max}/D_0	D_{img}/D_{\max}	$D_{\text{spot}}/D_{\text{img}}$	D_{spot}/D_{\max}
0.000000e+000	9.8301278e-001	9.9998652e-001	5.1913951e-003	5.1913252e-003
2.000000e-002	1.0016406e+000	9.9998484e-001	5.5058118e-003	5.5057284e-003
4.000000e-002	1.0370129e+000	9.9998073e-001	6.2076519e-003	6.2075323e-003
6.000000e-002	1.0586308e+000	9.9994575e-001	1.0416613e-002	1.0416047e-002
8.000000e-002	1.0709304e+000	9.9990849e-001	1.3529313e-002	1.3528075e-002
1.000000e-001	1.0826900e+000	9.9986414e-001	1.6485638e-002	1.6483398e-002
1.200000e-001	1.0772139e+000	9.9979843e-001	2.0081204e-002	2.0077157e-002
1.400000e-001	1.0976248e+000	9.9973750e-001	2.2917516e-002	2.2911500e-002
1.600000e-001	1.1004809e+000	9.9966067e-001	2.6057789e-002	2.6048947e-002
1.800000e-001	1.0872687e+000	9.9955751e-001	2.9758571e-002	2.9745403e-002
2.000000e-001	1.0952146e+000	9.9946314e-001	3.2780930e-002	3.2763331e-002
2.200000e-001	1.0971773e+000	9.9935358e-001	3.5973519e-002	3.5950265e-002
2.400000e-001	1.0982763e+000	9.9923042e-001	3.9254885e-002	3.9224675e-002
2.600000e-001	1.1323594e+000	9.9915163e-001	4.1217713e-002	4.1182745e-002
2.800000e-001	1.1103197e+000	9.9897675e-001	4.5272918e-002	4.5226593e-002
3.000000e-001	1.1480211e+000	9.9890017e-001	4.6939341e-002	4.6887716e-002
3.200000e-001	1.1132912e+000	9.9867038e-001	5.1619212e-002	5.1550579e-002
3.400000e-001	1.1469388e+000	9.9858522e-001	5.3250115e-002	5.3174778e-002
3.600000e-001	1.1624780e+000	9.9845557e-001	5.5641907e-002	5.5555972e-002
3.800000e-001	1.1254488e+000	9.9816486e-001	6.0666419e-002	6.0555088e-002
4.000000e-001	1.1547394e+000	9.9806748e-001	6.2259777e-002	6.2139459e-002
4.200000e-001	1.1804101e+000	9.9796101e-001	6.3956849e-002	6.3826442e-002
4.400000e-001	1.1156851e+000	9.9749531e-001	7.0910274e-002	7.0732666e-002
4.600000e-001	1.1337163e+000	9.9734746e-001	7.2981287e-002	7.2787701e-002
4.800000e-001	1.1579857e+000	9.9723173e-001	7.4562893e-002	7.4356483e-002
5.000000e-001	1.1820494e+000	9.9711774e-001	7.6089033e-002	7.5869725e-002
5.200000e-001	1.2020874e+000	9.9698422e-001	7.7839226e-002	7.7604480e-002
5.400000e-001	1.1945262e+000	9.95423218e-001	8.4983961e-002	8.1094430e-002
5.600000e-001	1.1263447e+000	9.9601491e-001	8.9543728e-002	8.9186888e-002
5.800000e-001	1.1426371e+000	9.9584480e-001	9.1446660e-002	9.1066681e-002
6.000000e-001	1.1617039e+000	9.9569822e-001	9.3055888e-002	9.2655582e-002
6.200000e-001	1.1813599e+000	9.9555748e-001	9.4575882e-002	9.4155727e-002
6.400000e-001	1.2005589e+000	9.9541550e-001	9.6085625e-002	9.5645120e-002
6.600000e-001	1.2183145e+000	9.9526564e-001	9.7654474e-002	9.7192142e-002
6.800000e-001	1.2333164e+000	9.9509461e-001	9.9415479e-002	9.8927808e-002
7.000000e-001	1.2421673e+000	9.9487472e-001	1.0163619e-001	1.0111528e-001
7.200000e-001	1.1267407e+000	9.9340539e-001	1.1541598e-001	1.1465486e-001
7.400000e-001	1.1291456e+000	9.9306092e-001	1.1842281e-001	1.1760106e-001
7.600000e-001	1.1394066e+000	9.9281085e-001	1.2056058e-001	1.1969385e-001
7.800000e-001	1.1522433e+000	9.9259483e-001	1.2237850e-001	1.2147226e-001
8.000000e-001	1.1661650e+000	9.9239257e-001	1.2405746e-001	1.2311370e-001
8.200000e-001	1.1805868e+000	9.9220063e-001	1.2563100e-001	1.2465116e-001
8.400000e-001	1.1951949e+000	9.9201327e-001	1.2714903e-001	1.2613353e-001
8.600000e-001	1.2097609e+000	9.9182668e-001	1.2864389e-001	1.2759244e-001
8.800000e-001	1.2240411e+000	9.9163974e-001	1.3012521e-001	1.2903733e-001
9.000000e-001	1.2379677e+000	9.9144930e-001	1.3161790e-001	1.3049247e-001
9.200000e-001	1.2513440e+000	9.9125310e-001	1.3313911e-001	1.3197455e-001
9.400000e-001	1.2639042e+000	9.9104823e-001	1.3471025e-001	1.3350435e-001
9.600000e-001	1.2754957e+000	9.9082977e-001	1.3636661e-001	1.3511610e-001
9.800000e-001	1.2857020e+000	9.9059279e-001	1.3814221e-001	1.3684268e-001
1.000000e+000	1.2938449e+000	9.9032637e-001	1.4011307e-001	1.3875766e-001
1.020000e+000	1.2985613e+000	9.9000508e-001	1.4245556e-001	1.4103173e-001
1.040000e+000	1.2945639e+000	9.4550266e-001	1.5256100e-001	1.4424683e-001
1.060000e+000	1.1241688e+000	9.8556299e-001	1.7178930e-001	1.6930918e-001
1.080000e+000	1.1253946e+000	9.8503900e-001	1.7494896e-001	1.7233155e-001
1.100000e+000	1.1300466e+000	9.8460282e-001	1.7754003e-001	1.7480641e-001
1.120000e+000	1.1367186e+000	9.8422009e-001	1.7978564e-001	1.7694864e-001
1.140000e+000	1.1443489e+000	9.8386340e-001	1.8185580e-001	1.7892127e-001

1.1600000e+000	1.1526360e+000	9.8352777e-001	1.8378446e-001	1.8075712e-001
1.1800000e+000	1.1613804e+000	9.8320552e-001	1.8561917e-001	1.8250179e-001
1.2000000e+000	1.1704433e+000	9.8289436e-001	1.8737539e-001	1.8417022e-001
1.2200000e+000	1.1797328e+000	9.8259304e-001	1.8906217e-001	1.8577117e-001
1.2400000e+000	1.1891711e+000	9.8229629e-001	1.9071022e-001	1.8733394e-001
1.2600000e+000	1.1986934e+000	9.8200507e-001	1.9231527e-001	1.8885457e-001
1.2800000e+000	1.2082598e+000	9.8171838e-001	1.9388374e-001	1.9033923e-001
1.3000000e+000	1.2178385e+000	9.8143175e-001	1.9544067e-001	1.9181168e-001
1.3200000e+000	1.2274032e+000	9.8114846e-001	1.9696868e-001	1.9325552e-001
1.3400000e+000	1.2369322e+000	9.8086630e-001	1.9848024e-001	1.9468258e-001
1.3600000e+000	1.2464067e+000	9.8058316e-001	1.9998680e-001	1.9610369e-001
1.3800000e+000	1.2558106e+000	9.8030133e-001	2.0147655e-001	1.9750773e-001
1.4000000e+000	1.2651297e+000	9.8001810e-001	2.0296395e-001	1.9890835e-001
1.4200000e+000	1.2743515e+000	9.7973336e-001	2.0444963e-001	2.0030613e-001
1.4400000e+000	1.2834645e+000	9.7944835e-001	2.0592731e-001	2.0169516e-001
1.4600000e+000	1.2924584e+000	9.7915986e-001	2.0741357e-001	2.0309104e-001
1.4800000e+000	1.3013235e+000	9.7886949e-001	2.0890014e-001	2.0448597e-001
1.5000000e+000	1.3100512e+000	9.7857752e-001	2.1038568e-001	2.0587870e-001
1.5200000e+000	1.3185789e+000	9.7827843e-001	2.1189797e-001	2.0729522e-001
1.5400000e+000	1.3269382e+000	9.7797661e-001	2.1341464e-001	2.0871452e-001
1.5600000e+000	1.3351228e+000	9.7767090e-001	2.1494134e-001	2.1014190e-001
1.5800000e+000	1.3431251e+000	9.7735875e-001	2.1649055e-001	2.1158893e-001
1.6000000e+000	1.3509379e+000	9.7704291e-001	2.1804837e-001	2.1304261e-001
1.6200000e+000	1.3584716e+000	9.7671825e-001	2.1963973e-001	2.1452613e-001
1.6400000e+000	1.3657297e+000	9.7638439e-001	2.2126589e-001	2.1604056e-001
1.6600000e+000	1.3727572e+000	9.7604469e-001	2.2290999e-001	2.1757011e-001
1.6800000e+000	1.3795160e+000	9.7569501e-001	2.2459165e-001	2.1913295e-001
1.7000000e+000	1.3858145e+000	9.7532965e-001	2.2633723e-001	2.2075341e-001
1.7200000e+000	1.3918353e+000	9.7495579e-001	2.2811161e-001	2.2239874e-001
1.7400000e+000	1.3973092e+000	9.7456215e-001	2.2996730e-001	2.2411742e-001
1.7600000e+000	1.4024275e+000	9.7415163e-001	2.3188909e-001	2.2589513e-001
1.7800000e+000	1.4068798e+000	9.7371833e-001	2.3390295e-001	2.2775559e-001
1.8000000e+000	1.4107180e+000	9.7325837e-001	2.3602486e-001	2.2971317e-001
1.8200000e+000	1.4135247e+000	9.7275788e-001	2.3831566e-001	2.3182344e-001
1.8400000e+000	1.4152755e+000	9.7254627e-001	2.5295624e-001	2.3410159e-001
1.8600000e+000	1.4154958e+000	8.9230807e-001	2.6519330e-001	2.3663412e-001
1.8800000e+000	1.4134092e+000	8.6286785e-001	2.7762180e-001	2.3955092e-001
1.9000000e+000	1.4071704e+000	8.3057075e-001	2.9280769e-001	2.4319751e-001
1.9200000e+000	1.3888254e+000	7.8299458e-001	3.1804665e-001	2.4902881e-001
1.9400000e+000	1.0738902e+000	9.4556237e-001	3.4417713e-001	3.2544094e-001
1.9600000e+000	1.0753975e+000	9.4454817e-001	3.4765078e-001	3.2837290e-001
1.9800000e+000	1.0774142e+000	9.4358335e-001	3.5093362e-001	3.3113512e-001
2.0000000e+000	1.0798124e+000	9.4265612e-001	3.5406926e-001	3.3376555e-001
2.0200000e+000	1.0827000e+000	9.4177476e-001	3.5703273e-001	3.3624442e-001
2.0400000e+000	1.0858132e+000	9.4091878e-001	3.5989538e-001	3.3863232e-001
2.0600000e+000	1.0890919e+000	9.4007893e-001	3.6268966e-001	3.4095690e-001
2.0800000e+000	1.0926572e+000	9.3926834e-001	3.6537332e-001	3.4318359e-001
2.1000000e+000	1.0963642e+000	9.3847607e-001	3.6798410e-001	3.4534428e-001
2.1200000e+000	1.1001481e+000	9.3768974e-001	3.7056359e-001	3.4747367e-001
2.1400000e+000	1.1041685e+000	9.3693115e-001	3.7304125e-001	3.4951397e-001
2.1600000e+000	1.1082143e+000	9.3617849e-001	3.7548932e-001	3.5152502e-001
2.1800000e+000	1.1123821e+000	9.3543628e-001	3.7789357e-001	3.5349536e-001
2.2000000e+000	1.1166284e+000	9.3470634e-001	3.8024880e-001	3.5542096e-001
2.2200000e+000	1.1209092e+000	9.3398276e-001	3.8257460e-001	3.5731808e-001
2.2400000e+000	1.1253046e+000	9.3326998e-001	3.8485717e-001	3.5917565e-001
2.2600000e+000	1.1296858e+000	9.3255956e-001	3.8712397e-001	3.6101616e-001
2.2800000e+000	1.1341814e+000	9.3186361e-001	3.8933678e-001	3.6280878e-001
2.3000000e+000	1.1386623e+000	9.3116530e-001	3.9154949e-001	3.6459730e-001
2.3200000e+000	1.1432102e+000	9.3047963e-001	3.9371484e-001	3.6634363e-001
2.3400000e+000	1.1477651e+000	9.2979319e-001	3.9587551e-001	3.6808235e-001
2.3600000e+000	1.1523523e+000	9.2911277e-001	3.9801036e-001	3.6979651e-001
2.3800000e+000	1.1569614e+000	9.2843946e-001	4.0011628e-001	3.7148375e-001
2.4000000e+000	1.1615770e+000	9.2776325e-001	4.0222476e-001	3.7316934e-001
2.4200000e+000	1.1662245e+000	9.2709548e-001	4.0430060e-001	3.7482526e-001
2.4400000e+000	1.1708594e+000	9.2642849e-001	4.0636788e-001	3.7647078e-001
2.4600000e+000	1.1755328e+000	9.2576444e-001	4.0842007e-001	3.7810077e-001

2.4800000e+000	1.1801795e+000	9.2510165e-001	4.1046253e-001	3.7971956e-001
2.5000000e+000	1.1848686e+000	9.2444449e-001	4.1248192e-001	3.8131664e-001
2.5200000e+000	1.1895276e+000	9.2378380e-001	4.1450657e-001	3.8291446e-001
2.5400000e+000	1.1942175e+000	9.2313193e-001	4.1649882e-001	3.8448335e-001
2.5600000e+000	1.1988840e+000	9.2247455e-001	4.1850251e-001	3.8605791e-001
2.5800000e+000	1.2035673e+000	9.2182242e-001	4.2048497e-001	3.8761247e-001
2.6000000e+000	1.2082350e+000	9.2117229e-001	4.2245625e-001	3.8915499e-001
2.6200000e+000	1.2129083e+000	9.2051908e-001	4.2443185e-001	3.9069762e-001
2.6400000e+000	1.2175718e+000	9.1986952e-001	4.2639146e-001	3.9222450e-001
2.6600000e+000	1.2222319e+000	9.1922095e-001	4.2834328e-001	3.9374211e-001
2.6800000e+000	1.2268868e+000	9.1857052e-001	4.3029589e-001	3.9525712e-001
2.7000000e+000	1.2315313e+000	9.1792355e-001	4.3223350e-001	3.9675731e-001
2.7200000e+000	1.2361737e+000	9.1727502e-001	4.3417116e-001	3.9825436e-001
2.7400000e+000	1.2408006e+000	9.1662592e-001	4.3610601e-001	3.9974607e-001
2.7600000e+000	1.2454273e+000	9.1598154e-001	4.3802238e-001	4.0122041e-001
2.7800000e+000	1.2500349e+000	9.1533052e-001	4.3995409e-001	4.0270341e-001
2.8000000e+000	1.2546430e+000	9.1468385e-001	4.4186860e-001	4.0417007e-001
2.8200000e+000	1.2592326e+000	9.1403717e-001	4.4377894e-001	4.0563044e-001
2.8400000e+000	1.2638172e+000	9.1338713e-001	4.4569498e-001	4.0709206e-001
2.8600000e+000	1.2683863e+000	9.1273985e-001	4.4759879e-001	4.0854126e-001
2.8800000e+000	1.2729466e+000	9.1209095e-001	4.4950334e-001	4.0998793e-001
2.9000000e+000	1.2774931e+000	9.1144035e-001	4.5140884e-001	4.1143223e-001
2.9200000e+000	1.2820286e+000	9.1079300e-001	4.5330092e-001	4.1286331e-001
2.9400000e+000	1.2865506e+000	9.1014034e-001	4.5520460e-001	4.1430008e-001
2.9600000e+000	1.2910610e+000	9.0948923e-001	4.5709995e-001	4.1572748e-001
2.9800000e+000	1.2955568e+000	9.0883951e-001	4.5898746e-001	4.1714594e-001
3.0000000e+000	1.3000420e+000	9.0818424e-001	4.6088738e-001	4.1857065e-001
3.0200000e+000	1.3045101e+000	9.0753145e-001	4.6277639e-001	4.1998413e-001
3.0400000e+000	1.3089679e+000	9.0687742e-001	4.6466535e-001	4.2139451e-001
3.0600000e+000	1.3134091e+000	9.0622013e-001	4.6656014e-001	4.2280619e-001
3.0800000e+000	1.3178380e+000	9.0556588e-001	4.6844263e-001	4.2420566e-001
3.1000000e+000	1.3222528e+000	9.0490653e-001	4.7033627e-001	4.2561036e-001
3.1200000e+000	1.3266515e+000	9.0424715e-001	4.7222650e-001	4.2700947e-001
3.1400000e+000	1.3310403e+000	9.0359045e-001	4.7410567e-001	4.2839735e-001
3.1600000e+000	1.3354077e+000	9.0292540e-001	4.7600534e-001	4.2979731e-001
3.1800000e+000	1.3397699e+000	9.0226460e-001	4.7788950e-001	4.3118278e-001
3.2000000e+000	1.3441061e+000	9.0160045e-001	4.7977991e-001	4.3256979e-001
3.2200000e+000	1.3484359e+000	9.0093368e-001	4.8167453e-001	4.3395681e-001
3.2400000e+000	1.3527464e+000	9.0026887e-001	4.8356032e-001	4.3533430e-001
3.2600000e+000	1.3570428e+000	8.9959889e-001	4.8545759e-001	4.3671711e-001
3.2800000e+000	1.3613283e+000	8.9892913e-001	4.8735108e-001	4.3809408e-001
3.3000000e+000	1.3655905e+000	8.9826014e-001	4.8923928e-001	4.3946414e-001
3.3200000e+000	1.3698508e+000	8.9758499e-001	4.9114174e-001	4.4084145e-001
3.3400000e+000	1.3740790e+000	8.9690987e-001	4.9304105e-001	4.4221338e-001
3.3600000e+000	1.3783040e+000	8.9623480e-001	4.9493721e-001	4.4357995e-001
3.3800000e+000	1.3825086e+000	8.9555441e-001	4.9684531e-001	4.4495201e-001
3.4000000e+000	1.3866975e+000	8.9487649e-001	4.9874353e-001	4.4631386e-001
3.4200000e+000	1.3908793e+000	8.9419407e-001	5.0065143e-001	4.4767954e-001
3.4400000e+000	1.3950316e+000	8.9350864e-001	5.0256480e-001	4.4904600e-001
3.4600000e+000	1.3991841e+000	8.9282755e-001	5.0446324e-001	4.5039868e-001
3.4800000e+000	1.4033066e+000	8.9213535e-001	5.0638977e-001	4.5176821e-001
3.5000000e+000	1.4074214e+000	8.9144701e-001	5.0830274e-001	4.5312496e-001
3.5200000e+000	1.4115232e+000	8.9075657e-001	5.1021878e-001	4.5448073e-001
3.5400000e+000	1.4155997e+000	8.9005989e-001	5.1214935e-001	4.5584360e-001
3.5600000e+000	1.4196784e+000	8.8936861e-001	5.1406228e-001	4.5719086e-001
3.5800000e+000	1.4237195e+000	8.8866676e-001	5.1600172e-001	4.5855358e-001
3.6000000e+000	1.4277588e+000	8.8796678e-001	5.1793333e-001	4.5990759e-001
3.6200000e+000	1.4317817e+000	8.8726759e-001	5.1986015e-001	4.6125506e-001
3.6400000e+000	1.4357811e+000	8.8655843e-001	5.2181179e-001	4.6261664e-001
3.6600000e+000	1.4397842e+000	8.8585503e-001	5.2374499e-001	4.6396214e-001
3.6800000e+000	1.4437460e+000	8.8514352e-001	5.2569792e-001	4.6531811e-001
3.7000000e+000	1.4477082e+000	8.8443057e-001	5.2765227e-001	4.6667180e-001
3.7200000e+000	1.4516544e+000	8.8371996e-001	5.2959770e-001	4.6801606e-001
3.7400000e+000	1.4555753e+000	8.8299907e-001	5.3156878e-001	4.6937474e-001
3.7600000e+000	1.4595007e+000	8.8228214e-001	5.3352657e-001	4.7072096e-001
3.7800000e+000	1.4633865e+000	8.8156050e-001	5.3549479e-001	4.7207106e-001

3.8000000e+000	1.4672696e+000	8.8083314e-001	5.3747619e-001	4.7342684e-001
3.8200000e+000	1.4711427e+000	8.8010926e-001	5.3944576e-001	4.7477120e-001
3.8400000e+000	1.4749833e+000	8.7937660e-001	5.4143682e-001	4.7612687e-001
3.8600000e+000	1.4788288e+000	8.7864463e-001	5.4342367e-001	4.7747629e-001
3.8800000e+000	1.4826428e+000	8.7791219e-001	5.4540951e-001	4.7882166e-001
3.9000000e+000	1.4864448e+000	8.7716920e-001	5.4742166e-001	4.8018142e-001
3.9200000e+000	1.4902492e+000	8.7643167e-001	5.4941677e-001	4.8152626e-001
3.9400000e+000	1.4940075e+000	8.7568570e-001	5.5143245e-001	4.8288151e-001
3.9600000e+000	1.4977710e+000	8.7493707e-001	5.5345311e-001	4.8423664e-001
3.9800000e+000	1.5015182e+000	8.7419072e-001	5.5546544e-001	4.8558273e-001
4.0000000e+000	1.5052370e+000	8.7343324e-001	5.5750559e-001	4.8694391e-001
4.0200000e+000	1.5089619e+000	8.7267890e-001	5.5953514e-001	4.8829451e-001
4.0400000e+000	1.5126520e+000	8.7192081e-001	5.6157269e-001	4.8964692e-001
4.0600000e+000	1.5163312e+000	8.7115377e-001	5.6363217e-001	4.9101029e-001
4.0800000e+000	1.5200171e+000	8.7039327e-001	5.6567204e-001	4.9235714e-001
4.1000000e+000	1.5236508e+000	8.6961950e-001	5.6774545e-001	4.9372251e-001
4.1200000e+000	1.5272902e+000	8.6884587e-001	5.6981646e-001	4.9508268e-001
4.1400000e+000	1.5309217e+000	8.6807600e-001	5.7187542e-001	4.9643133e-001
4.1600000e+000	1.5345146e+000	8.6728867e-001	5.7397906e-001	4.9780554e-001
4.1800000e+000	1.5381139e+000	8.6650798e-001	5.7606304e-001	4.9916322e-001
4.2000000e+000	1.5416917e+000	8.6572167e-001	5.7816010e-001	5.0052572e-001
4.2200000e+000	1.5452436e+000	8.6492674e-001	5.8027819e-001	5.0189813e-001
4.2400000e+000	1.5488022e+000	8.6413844e-001	5.8237678e-001	5.0325416e-001
4.2600000e+000	1.5523274e+000	8.6333500e-001	5.8451380e-001	5.0463123e-001
4.2800000e+000	1.5558378e+000	8.6253191e-001	5.8664807e-001	5.0600268e-001
4.3000000e+000	1.5593552e+000	8.6173041e-001	5.8877629e-001	5.0736644e-001
4.3200000e+000	1.5628289e+000	8.6091414e-001	5.9094195e-001	5.0875028e-001
4.3400000e+000	1.5662973e+000	8.6010224e-001	5.9309425e-001	5.1012169e-001
4.3600000e+000	1.5697729e+000	8.5928409e-001	5.9526138e-001	5.1149863e-001
4.3800000e+000	1.5731965e+000	8.5845697e-001	5.9745056e-001	5.1288559e-001
4.4000000e+000	1.5766222e+000	8.5763190e-001	5.9963261e-001	5.1426405e-001
4.4200000e+000	1.5800543e+000	8.5679924e-001	6.0183309e-001	5.1565014e-001
4.4400000e+000	1.5834303e+000	8.5596108e-001	6.0404647e-001	5.1704027e-001
4.4600000e+000	1.5868127e+000	8.5511694e-001	6.0627399e-001	5.1843516e-001
4.4800000e+000	1.5901987e+000	8.5427300e-001	6.0849942e-001	5.1982463e-001
4.5000000e+000	1.5935307e+000	8.5342088e-001	6.1074485e-001	5.2122241e-001
4.5200000e+000	1.5968690e+000	8.525881e-001	6.1301496e-001	5.2263130e-001
4.5400000e+000	1.6002106e+000	8.5170304e-001	6.1526696e-001	5.2402474e-001
4.5600000e+000	1.6034978e+000	8.5082868e-001	6.1756641e-001	5.2544321e-001
4.5800000e+000	1.6067913e+000	8.4995381e-001	6.1986571e-001	5.2685722e-001
4.6000000e+000	1.6100904e+000	8.4908262e-001	6.2215391e-001	5.2826007e-001
4.6200000e+000	1.6133322e+000	8.4818654e-001	6.2450608e-001	5.2969765e-001
4.6400000e+000	1.6165801e+000	8.4729735e-001	6.2683876e-001	5.3111882e-001
4.6600000e+000	1.6198352e+000	8.4640013e-001	6.2919117e-001	5.3254749e-001
4.6800000e+000	1.6230342e+000	8.4548890e-001	6.3157896e-001	5.3399300e-001
4.7000000e+000	1.6262357e+000	8.4457928e-001	6.3396123e-001	5.3543052e-001
4.7200000e+000	1.6294441e+000	8.4365610e-001	6.3637772e-001	5.3688395e-001
4.7400000e+000	1.6326043e+000	8.4272863e-001	6.3880423e-001	5.3833861e-001
4.7600000e+000	1.6357586e+000	8.4178534e-001	6.4127086e-001	5.3981241e-001
4.7800000e+000	1.6389195e+000	8.4084174e-001	6.4373713e-001	5.4128105e-001
4.8000000e+000	1.6420431e+000	8.3988648e-001	6.4623270e-001	5.4276210e-001
4.8200000e+000	1.6451493e+000	8.3891157e-001	6.4877843e-001	5.4426774e-001
4.8400000e+000	1.6482618e+000	8.3794362e-001	6.5130493e-001	5.4575681e-001
4.8600000e+000	1.6513512e+000	8.3694406e-001	6.5391282e-001	5.4728845e-001
4.8800000e+000	1.6544086e+000	8.3593964e-001	6.5653232e-001	5.4882139e-001
4.9000000e+000	1.6574717e+000	8.3491909e-001	6.5919287e-001	5.5037271e-001
4.9200000e+000	1.6605294e+000	8.3388230e-001	6.6189474e-001	5.5194231e-001
4.9400000e+000	1.6635370e+000	8.3282949e-001	6.6463739e-001	5.5352962e-001
4.9600000e+000	1.6665499e+000	8.3173747e-001	6.6748122e-001	5.5516914e-001
4.9800000e+000	1.6695689e+000	8.3065266e-001	6.7030538e-001	5.5679095e-001
5.0000000e+000	1.6725355e+000	8.2963519e-001	6.7295345e-001	5.5830587e-001
5.0200000e+000	1.6754973e+000	8.2863880e-001	6.7554603e-001	5.5978365e-001
5.0400000e+000	1.6784646e+000	8.2765770e-001	6.7809823e-001	5.6123322e-001
5.0600000e+000	1.6814050e+000	8.2668431e-001	6.8062985e-001	5.6266602e-001
5.0800000e+000	1.6843148e+000	8.2571702e-001	6.8314514e-001	5.6408457e-001
5.1000000e+000	1.6872295e+000	8.2476364e-001	6.8562385e-001	5.6547762e-001

5.1200000e+000	1.6901463e+000	8.2382289e-001	6.8806935e-001	5.6684728e-001
5.1400000e+000	1.6930033e+000	8.2288028e-001	6.9051939e-001	5.6821479e-001
5.1600000e+000	1.6958645e+000	8.2195006e-001	6.9293695e-001	5.6955957e-001
5.1800000e+000	1.6987307e+000	8.2103179e-001	6.9532322e-001	5.7088247e-001
5.2000000e+000	1.7015639e+000	8.2011652e-001	6.9770153e-001	5.7219655e-001
5.2200000e+000	1.7043709e+000	8.1920529e-001	7.0006920e-001	5.7350039e-001
5.2400000e+000	1.7071820e+000	8.1830476e-001	7.0240895e-001	5.7478459e-001
5.2600000e+000	1.7099978e+000	8.1741480e-001	7.0472117e-001	5.7604952e-001
5.2800000e+000	1.7127497e+000	8.1651885e-001	7.0704893e-001	5.7731878e-001
5.3000000e+000	1.7155049e+000	8.1563245e-001	7.0935186e-001	5.7857040e-001
5.3200000e+000	1.7182640e+000	8.1475542e-001	7.1163050e-001	5.7980481e-001
5.3400000e+000	1.7210022e+000	8.1388156e-001	7.1390095e-001	5.8103082e-001
5.3600000e+000	1.7237007e+000	8.1300597e-001	7.1617599e-001	5.8225535e-001
5.3800000e+000	1.7264023e+000	8.1213874e-001	7.1842942e-001	5.8346437e-001
5.4000000e+000	1.7291076e+000	8.1127965e-001	7.2066185e-001	5.8465830e-001
5.4200000e+000	1.7317709e+000	8.1041747e-001	7.2290250e-001	5.8585282e-001
5.4400000e+000	1.7344142e+000	8.0955709e-001	7.2513867e-001	5.8704115e-001
5.4600000e+000	1.7370602e+000	8.0870385e-001	7.2735652e-001	5.8821602e-001
5.4800000e+000	1.7397095e+000	8.0785781e-001	7.2955591e-001	5.8937744e-001
5.5000000e+000	1.7423011e+000	8.0700350e-001	7.3177705e-001	5.9054665e-001
5.5200000e+000	1.7448871e+000	8.0615372e-001	7.3398676e-001	5.9170616e-001
5.5400000e+000	1.7474753e+000	8.0530981e-001	7.3618152e-001	5.9285420e-001
5.5600000e+000	1.7500646e+000	8.0447214e-001	7.3836041e-001	5.9399038e-001
5.5800000e+000	1.7525898e+000	8.0363212e-001	7.4056921e-001	5.9513854e-001
5.6000000e+000	1.7551164e+000	8.0277935e-001	7.4276476e-001	5.9627621e-001
5.6200000e+000	1.7576446e+000	8.0194104e-001	7.4494653e-001	5.9740319e-001
5.6400000e+000	1.7601703e+000	8.0110663e-001	7.4711859e-001	5.9852166e-001
5.6600000e+000	1.7626343e+000	8.0026106e-001	7.4932017e-001	5.9965176e-001
5.6800000e+000	1.7650991e+000	7.9941969e-001	7.5151135e-001	6.0077297e-001
5.7000000e+000	1.7675649e+000	7.9858317e-001	7.5369042e-001	6.0188448e-001
5.7200000e+000	1.7700311e+000	7.9774984e-001	7.5586169e-001	6.0298854e-001
5.7400000e+000	1.7724317e+000	7.9678854e-001	7.5836714e-001	6.0425825e-001
5.7600000e+000	1.7748323e+000	7.9541076e-001	7.6195943e-001	6.0607073e-001
5.7800000e+000	1.7772330e+000	7.9404090e-001	7.6553278e-001	6.0786434e-001
5.8000000e+000	1.7796344e+000	7.9269372e-001	7.6904873e-001	6.0962010e-001
5.8200000e+000	1.7819792e+000	7.9133884e-001	7.7258664e-001	6.1137782e-001
5.8400000e+000	1.7843130e+000	7.8998889e-001	7.7611366e-001	6.1312116e-001
5.8600000e+000	1.7866461e+000	7.8864702e-001	7.7962156e-001	6.1484622e-001
5.8800000e+000	1.7889789e+000	7.8730631e-001	7.8312857e-001	6.1656206e-001
5.9000000e+000	1.7912740e+000	7.8596029e-001	7.8665167e-001	6.1827698e-001
5.9200000e+000	1.7935384e+000	7.8460699e-001	7.9019618e-001	6.1999344e-001
5.9400000e+000	1.7958012e+000	7.8325281e-001	7.9374542e-001	6.2170333e-001
5.9600000e+000	1.7980626e+000	7.8190178e-001	7.9728894e-001	6.2340164e-001
5.9800000e+000	1.8003134e+000	7.8054001e-001	8.0086327e-001	6.2510582e-001
6.0000000e+000	1.8025058e+000	7.7916999e-001	8.0446203e-001	6.2681267e-001
6.0200000e+000	1.8046955e+000	7.7778485e-001	8.0810343e-001	6.2853061e-001
6.0400000e+000	1.8068827e+000	7.7640635e-001	8.1173039e-001	6.3023263e-001
6.0600000e+000	1.8090675e+000	7.7501605e-001	8.1539157e-001	6.3194155e-001
6.0800000e+000	1.8112126e+000	7.7361586e-001	8.1908206e-001	6.3365487e-001
6.1000000e+000	1.8133263e+000	7.7220090e-001	8.2281496e-001	6.3537845e-001
6.1200000e+000	1.8154363e+000	7.7077852e-001	8.2657101e-001	6.3710318e-001
6.1400000e+000	1.8175427e+000	7.6935595e-001	8.3033132e-001	6.3882034e-001
6.1600000e+000	1.8196456e+000	7.6791772e-001	8.3413689e-001	6.4054850e-001
6.1800000e+000	1.8216912e+000	7.6647116e-001	8.3796856e-001	6.4227873e-001
6.2000000e+000	1.8237210e+000	7.6499558e-001	8.4188138e-001	6.4403553e-001
6.2200000e+000	1.8257459e+000	7.6352787e-001	8.4577774e-001	6.4577488e-001
6.2400000e+000	1.8277659e+000	7.6204013e-001	8.4973188e-001	6.4752980e-001
6.2600000e+000	1.8297809e+000	7.6055257e-001	8.5369030e-001	6.4927635e-001
6.2800000e+000	1.8317344e+000	7.5903488e-001	8.5773390e-001	6.5104996e-001
6.3000000e+000	1.8336746e+000	7.5750640e-001	8.6181152e-001	6.5282774e-001
6.3200000e+000	1.8356085e+000	7.5597180e-001	8.6591085e-001	6.5460419e-001
6.3400000e+000	1.8375359e+000	7.5441968e-001	8.7006264e-001	6.5639238e-001
6.3600000e+000	1.8394569e+000	7.5286947e-001	8.7421510e-001	6.5816986e-001
6.3800000e+000	1.8413268e+000	7.5127854e-001	8.7848280e-001	6.5998527e-001
6.4000000e+000	1.8431712e+000	7.4968954e-001	8.8275168e-001	6.6178970e-001
6.4200000e+000	1.8450076e+000	7.4806751e-001	8.8711597e-001	6.6362263e-001

6.4400000e+000	1.8468359e+000	7.4645143e-001	8.9147113e-001	6.6543990e-001
6.4600000e+000	1.8486560e+000	7.4480876e-001	8.9590512e-001	6.6727798e-001
6.4800000e+000	1.8504521e+000	7.4315901e-001	9.0036565e-001	6.6911485e-001
6.5000000e+000	1.8521941e+000	7.4147445e-001	9.0492816e-001	6.7098111e-001
6.5200000e+000	1.8539263e+000	7.3977908e-001	9.0952807e-001	6.7284984e-001
6.5400000e+000	1.8556483e+000	7.3807003e-001	9.1417356e-001	6.7472411e-001
6.5600000e+000	1.8573602e+000	7.3634188e-001	9.1887977e-001	6.7660966e-001
6.5800000e+000	1.8590616e+000	7.3460677e-001	9.2361401e-001	6.7849310e-001
6.6000000e+000	1.8607262e+000	7.3283530e-001	9.2845701e-001	6.8040607e-001
6.6200000e+000	1.8623468e+000	7.3105222e-001	9.3334169e-001	6.8232152e-001
6.6400000e+000	1.8639550e+000	7.2923254e-001	9.3833711e-001	6.8426596e-001
6.6600000e+000	1.8655508e+000	7.2741855e-001	9.4332765e-001	6.8619403e-001
6.6800000e+000	1.8671338e+000	7.2555957e-001	9.4845331e-001	6.8815937e-001
6.7000000e+000	1.8687037e+000	7.2370804e-001	9.5357001e-001	6.9010628e-001
6.7200000e+000	1.8702509e+000	7.2180922e-001	9.5882964e-001	6.9209208e-001
6.7400000e+000	1.8717373e+000	7.1989643e-001	9.6414076e-001	6.9408150e-001
6.7600000e+000	1.8732087e+000	7.1794271e-001	9.6957902e-001	6.9610219e-001
6.7800000e+000	1.8746647e+000	7.1598539e-001	9.7504122e-001	6.9811527e-001
6.8000000e+000	1.8761050e+000	7.1399029e-001	9.8062342e-001	7.0015560e-001
6.8200000e+000	1.8775290e+000	7.1198614e-001	9.8624604e-001	7.0219352e-001
6.8400000e+000	1.8789363e+000	7.0994665e-001	9.9198363e-001	7.0425546e-001
6.8600000e+000	1.8803142e+000	7.0788847e-001	9.9779026e-001	7.0632422e-001
6.8800000e+000	1.8816341e+000	7.0578154e-001	1.0037519e+000	7.0842954e-001
6.9000000e+000	1.8829353e+000	7.0365537e-001	1.0097861e+000	7.1054143e-001
6.9200000e+000	1.8842171e+000	7.0149602e-001	1.0159336e+000	7.1267337e-001
6.9400000e+000	1.8854790e+000	6.9931353e-001	1.0221668e+000	7.1481508e-001
6.9600000e+000	1.8867204e+000	6.9709779e-001	1.0285158e+000	7.1697607e-001
6.9800000e+000	1.8879408e+000	6.9485577e-001	1.0349617e+000	7.1914912e-001
7.0000000e+000	1.8891393e+000	6.9257914e-001	1.0415299e+000	7.2134190e-001
7.0200000e+000	1.8903028e+000	6.9026890e-001	1.0482189e+000	7.2355293e-001
7.0400000e+000	1.8914087e+000	6.8790741e-001	1.0550816e+000	7.2579846e-001
7.0600000e+000	1.8924904e+000	6.8551566e-001	1.0620587e+000	7.2805788e-001
7.0800000e+000	1.8935472e+000	6.8308190e-001	1.0691863e+000	7.3034178e-001
7.1000000e+000	1.8945783e+000	6.8061803e-001	1.0764312e+000	7.3263845e-001
7.1200000e+000	1.8955827e+000	6.7810583e-001	1.0838489e+000	7.3496428e-001
7.1400000e+000	1.8965597e+000	6.7556507e-001	1.0913832e+000	7.3730037e-001
7.1600000e+000	1.8975083e+000	6.7296762e-001	1.0991197e+000	7.3967194e-001
7.1800000e+000	1.8984274e+000	6.7034490e-001	1.1069670e+000	7.4204967e-001
7.2000000e+000	1.8993162e+000	6.6765449e-001	1.1150547e+000	7.4447128e-001
7.2200000e+000	1.9001658e+000	6.6494070e-001	1.1232523e+000	7.4689616e-001
7.2400000e+000	1.9009537e+000	6.6213229e-001	1.1317783e+000	7.4938697e-001
7.2600000e+000	1.9017083e+000	6.5931135e-001	1.1403869e+000	7.5187003e-001
7.2800000e+000	1.9024284e+000	6.5639145e-001	1.1493454e+000	7.5442048e-001
7.3000000e+000	1.9031128e+000	6.5345774e-001	1.1583962e+000	7.5696300e-001
7.3200000e+000	1.9037601e+000	6.5042717e-001	1.1677997e+000	7.5956863e-001
7.3400000e+000	1.9043689e+000	6.4736588e-001	1.1773549e+000	7.6217939e-001
7.3600000e+000	1.9049379e+000	6.4421960e-001	1.1872358e+000	7.6484058e-001
7.3800000e+000	1.9054656e+000	6.4101753e-001	1.1973561e+000	7.6752623e-001
7.4000000e+000	1.9059502e+000	6.3774625e-001	1.2077633e+000	7.7024653e-001
7.4200000e+000	1.9063901e+000	6.3438850e-001	1.2185189e+000	7.7301438e-001
7.4400000e+000	1.9067836e+000	6.3098168e-001	1.2295091e+000	7.7579773e-001
7.4600000e+000	1.9071287e+000	6.2745116e-001	1.2409825e+000	7.7865592e-001
7.4800000e+000	1.9074235e+000	6.2387994e-001	1.2526772e+000	7.8152020e-001
7.5000000e+000	1.9076658e+000	6.2017410e-001	1.2649097e+000	7.8446420e-001
7.5200000e+000	1.9078535e+000	6.1639944e-001	1.2774730e+000	7.8743363e-001
7.5400000e+000	1.9079842e+000	6.1252119e-001	1.2904928e+000	7.9045417e-001
7.5600000e+000	1.9080553e+000	6.0851841e-001	1.3040522e+000	7.9353976e-001
7.5800000e+000	1.9080644e+000	6.0444951e-001	1.3179652e+000	7.9664345e-001
7.6000000e+000	1.9080085e+000	6.0019132e-001	1.3326692e+000	7.9985647e-001
7.6200000e+000	1.9078848e+000	5.9584828e-001	1.3478213e+000	8.0309702e-001
7.6400000e+000	1.9076900e+000	5.9136486e-001	1.3636321e+000	8.0640412e-001
7.6600000e+000	1.9074209e+000	5.8671063e-001	1.3802318e+000	8.0979667e-001
7.6800000e+000	1.9070738e+000	5.8194722e-001	1.3974232e+000	8.1322656e-001
7.7000000e+000	1.9066451e+000	5.7696738e-001	1.4156211e+000	8.1676719e-001
7.7200000e+000	1.9061306e+000	5.7182064e-001	1.4346783e+000	8.2037867e-001
7.7400000e+000	1.9055262e+000	5.6652768e-001	1.4545498e+000	8.2404271e-001

7.7600000e+000	1.9048272e+000	5.6094756e-001	1.4758088e+000	8.2785134e-001
7.7800000e+000	1.9040286e+000	5.5517330e-001	1.4981533e+000	8.3173470e-001
7.8000000e+000	1.9031254e+000	5.4919861e-001	1.5216569e+000	8.3569186e-001
7.8200000e+000	1.9021118e+000	5.4288032e-001	1.5469525e+000	8.3981008e-001
7.8400000e+000	1.9009820e+000	5.3628742e-001	1.5738490e+000	8.4403543e-001
7.8600000e+000	1.8997085e+000	5.2939754e-001	1.6025271e+000	8.4837388e-001
7.8800000e+000	1.8982173e+000	5.2207243e-001	1.6336836e+000	8.5290116e-001
7.9000000e+000	1.8965734e+000	5.1428415e-001	1.6675992e+000	8.5761985e-001
7.9200000e+000	1.8947673e+000	5.0606642e-001	1.7043109e+000	8.6249451e-001
7.9400000e+000	1.8927884e+000	4.9736127e-001	1.7442925e+000	8.6754352e-001
7.9600000e+000	1.8906254e+000	4.8809750e-001	1.7881450e+000	8.7278911e-001
7.9800000e+000	1.8881010e+000	4.7792449e-001	1.8379492e+000	8.7840092e-001
8.0000000e+000	1.8852768e+000	4.6688932e-001	1.8940587e+000	8.8431576e-001
8.0200000e+000	1.8821924e+000	4.5489851e-001	1.9576747e+000	8.9054329e-001
8.0400000e+000	1.8786939e+000	4.4162750e-001	2.0315730e+000	8.9719850e-001
8.0600000e+000	1.8745917e+000	4.2662455e-001	2.1199643e+000	9.0442882e-001
8.0800000e+000	1.8700943e+000	4.0972222e-001	2.2264117e+000	9.1221034e-001
8.1000000e+000	1.8644812e+000	3.8956183e-001	2.3641955e+000	9.2100031e-001
8.1200000e+000	1.8579612e+000	3.6539777e-001	2.5475018e+000	9.3085147e-001
8.1400000e+000	1.8497942e+000	3.3370012e-001	2.8249294e+000	9.4267928e-001
8.1600000e+000	1.8381691e+000	2.8685604e-001	3.3395625e+000	9.5797370e-001
8.1800000e+000	1.8149031e+000	1.6724942e-001	5.8948762e+000	9.8591462e-001