RCS Representation at $\nu = 16$ MHz
A Tale in Triptychs

Topa

April 30, 2020

1 The case of the most challenging fit

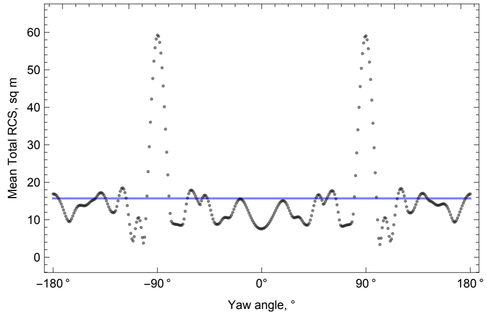
The most challenging case for computing the Fourier representation of the radar cross section of the Sciacca airframe was where $\nu = 16$ MHz, corresponding to a wavelength of $\lambda = 19$ m. To watch the fit evolve, a sequence of fits of increasing fidelity as shown where the order of fit, $d = (0, 1, 2, 4, 6, 7, 8, 10, 12, 14, 16, 18, 20, 22, 25, 30, 35, 40, 45, 50)$.

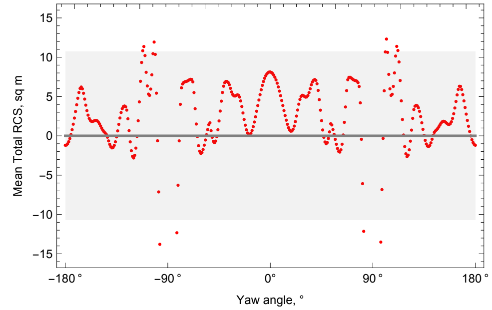
1.1 Part I: Residual Errors

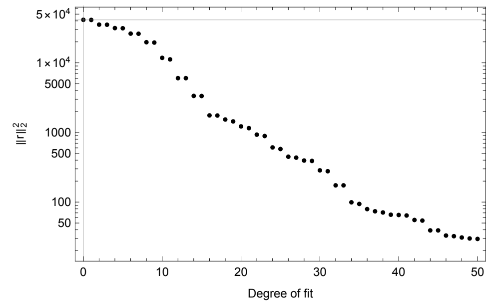
This report provides more specifics on the behavior of the Fourier cosine decomposition as the order of fit increases. The tab is told in triptychs; three plots telling different aspects of the results. The first panel is the classic presentation where the solution curve is plotted over the data points. For this exercise, we can clearly see the cosine representation chasing after the peaks at $\alpha = \pm 90°$. The second plot shows the residual errors, and correlated residual errors indicate that there is an as yet unaccounted structural form. Notice that the scale of the residuals changes at $d = 20$ to elucidate the structure. By the end of the sequence, most of the residual error is caused by odd functions, and are perhaps an artifact of Mercury MoM. The final panel show the total error for every degree of fit from $d = 0$ to $d = 50$. Marker lines show the position of this example on the error spectrum.

d	Data and Fourier Representation	Residual Fit Error	Total Error for Fit Sequence

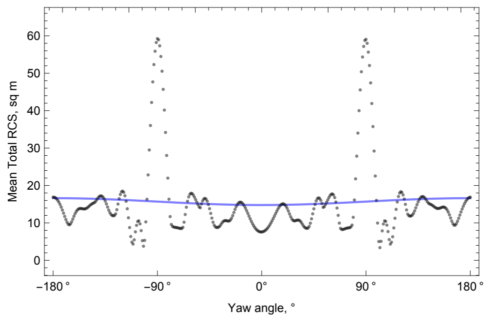
$d = 0$

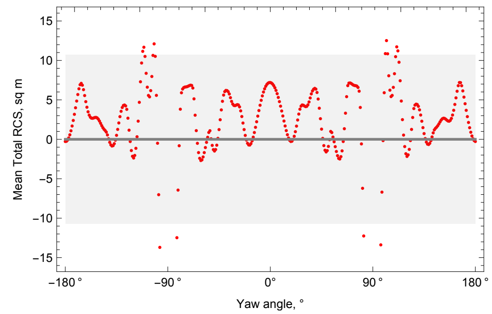


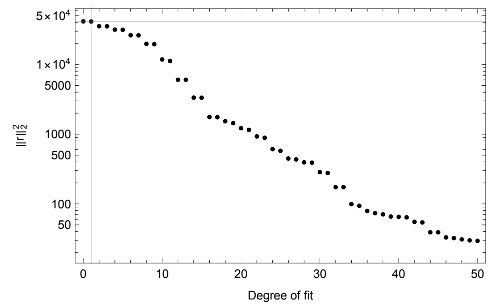




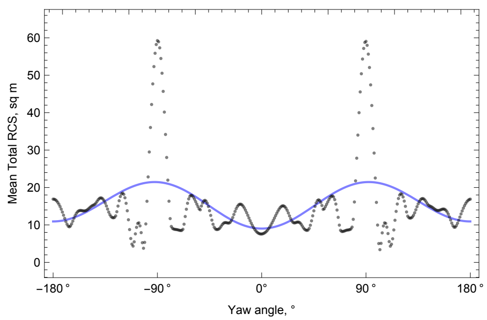
$d = 1$

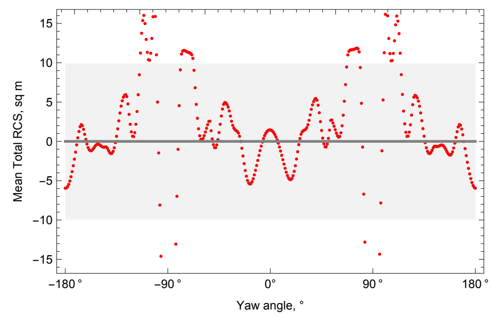


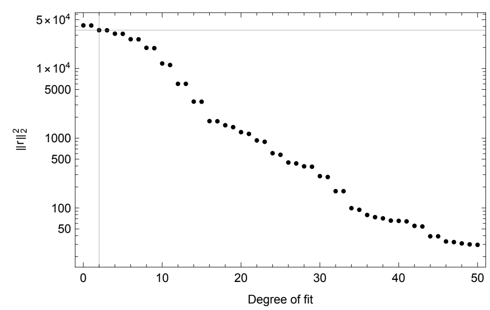


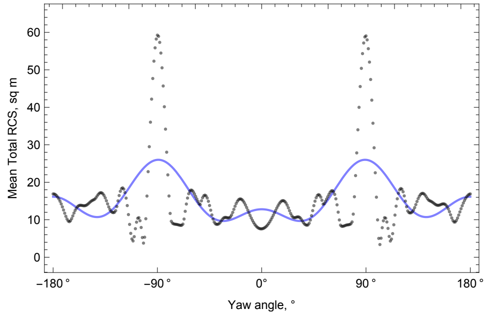
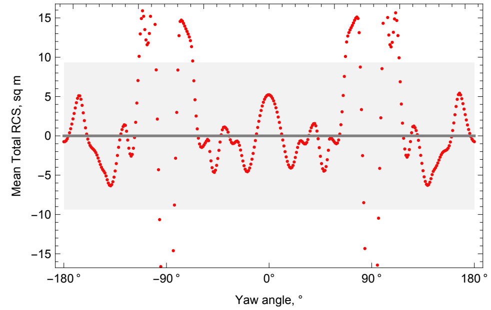
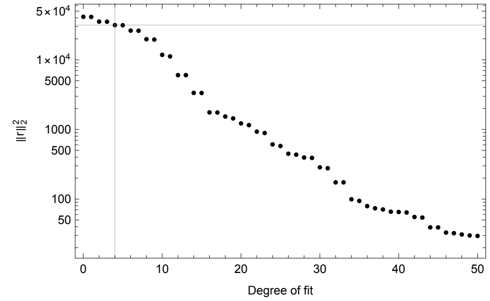
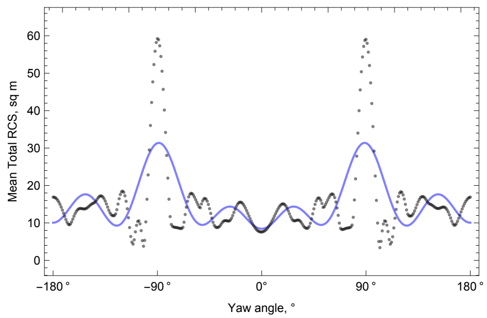
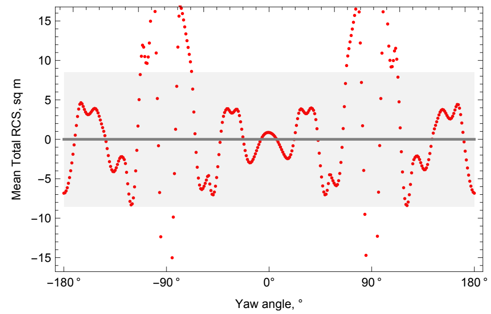
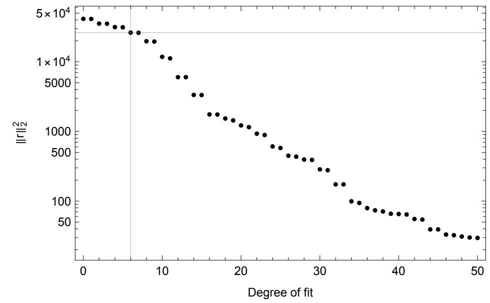
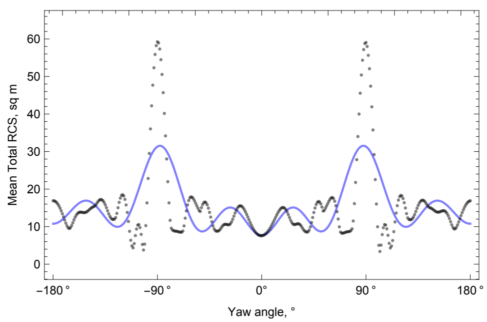
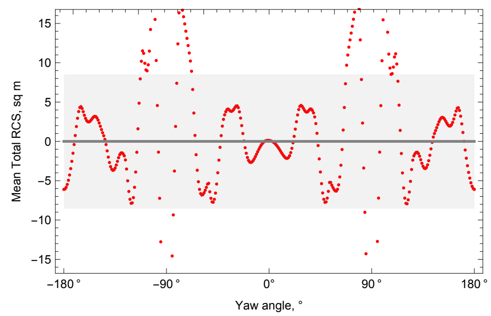
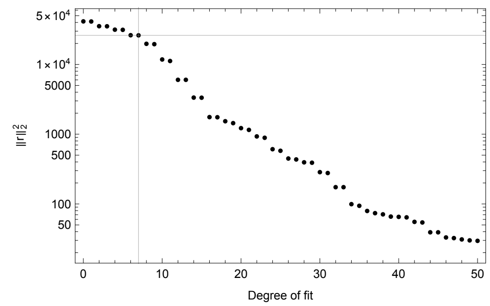


$d = 2$



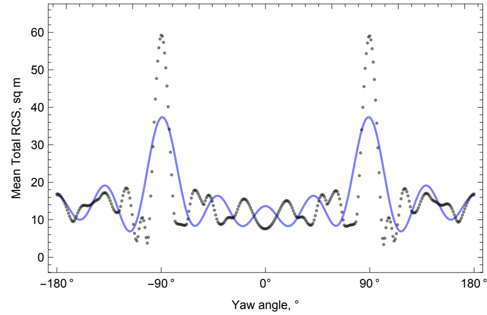


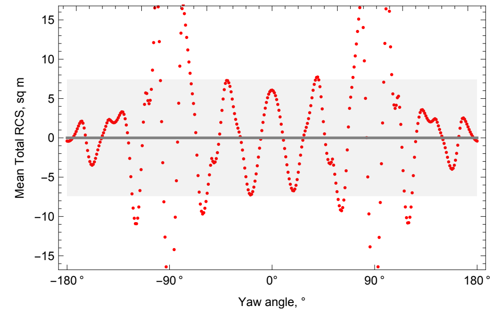


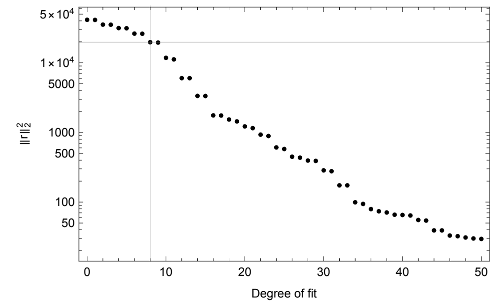
d	Data and Fourier Representation	Residual Fit Error	Total Error for Fit Sequence
$d = 4$			
$d = 6$			
$d = 7$			

d	Data and Fourier Representation	Residual Fit Error	Total Error for Fit Sequence

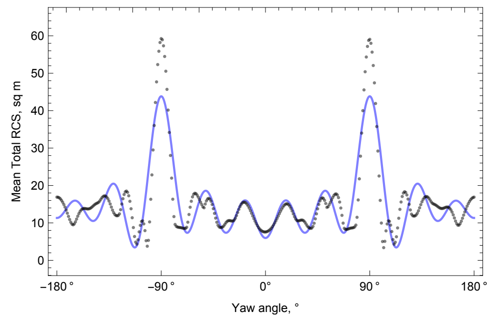
$d = 8$

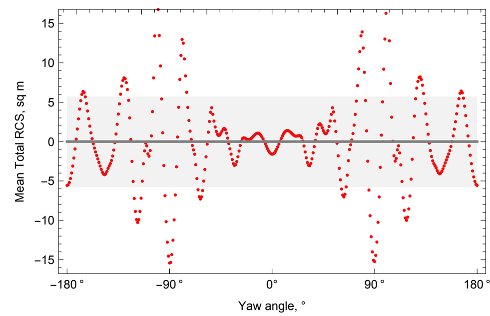


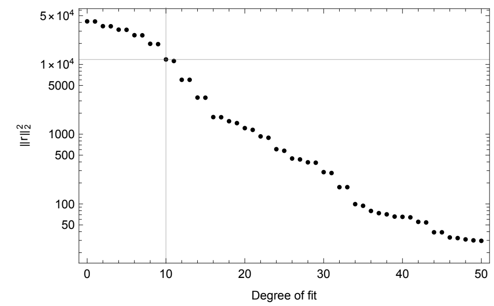




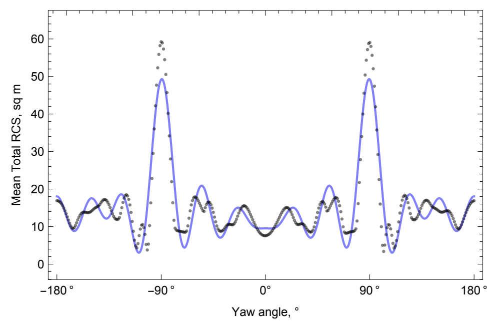
$d = 10$

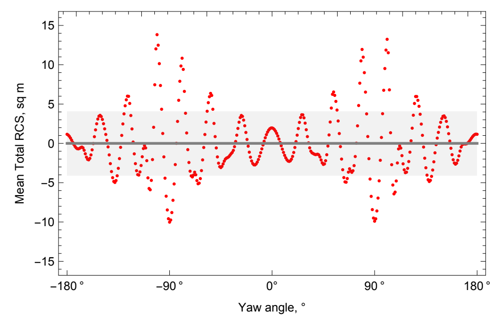


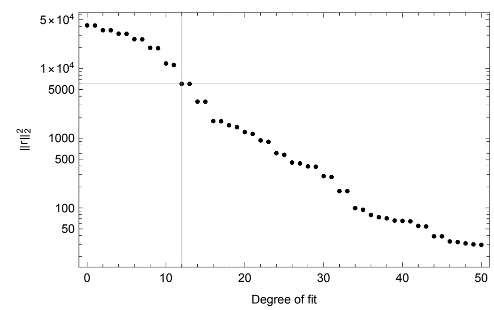




$d = 12$

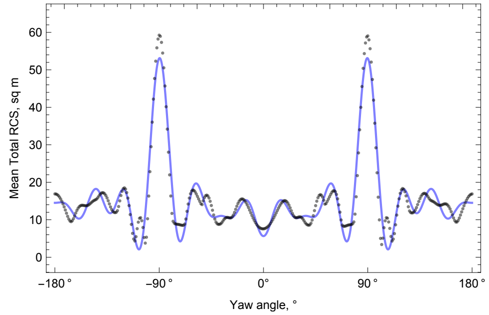


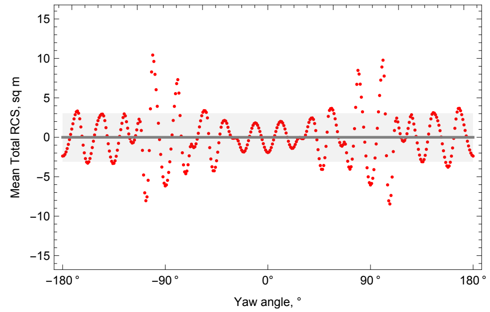


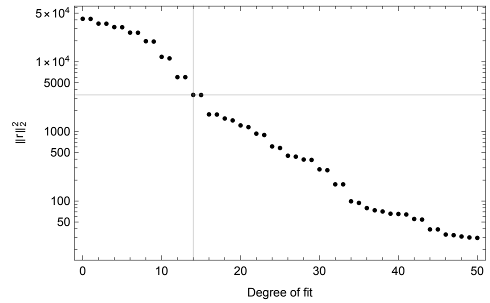


d	Data and Fourier Representation	Residual Fit Error	Total Error for Fit Sequence

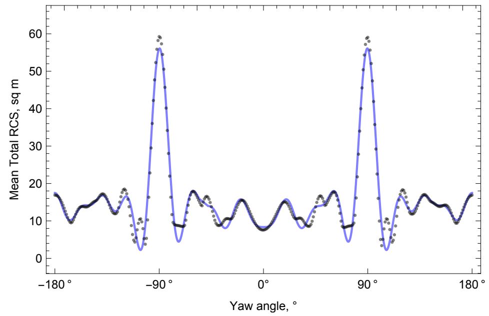
$d = 14$

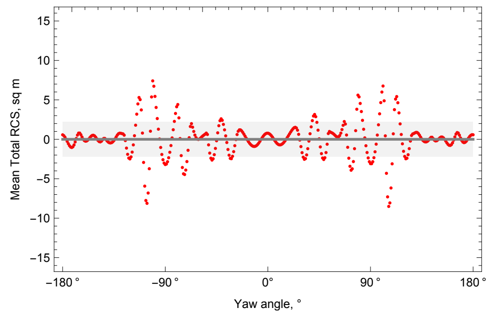


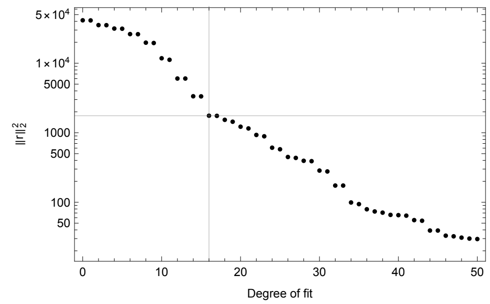




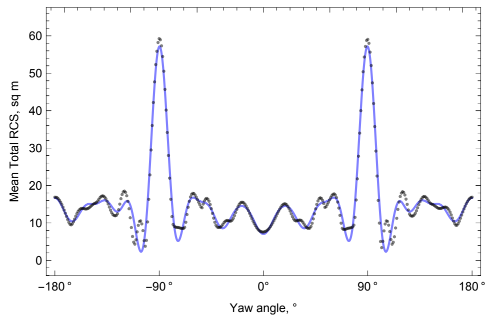
$d = 16$

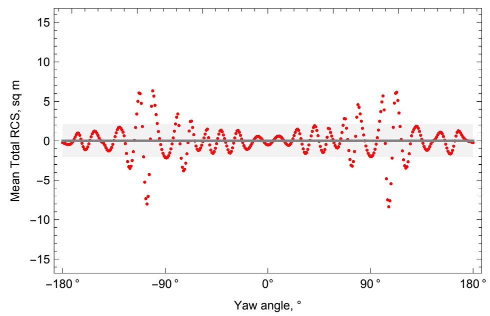


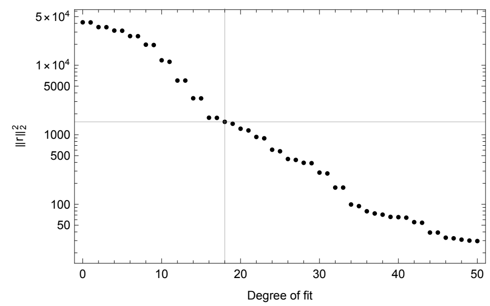




$d = 18$

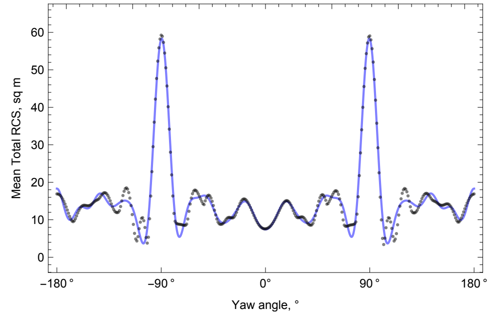


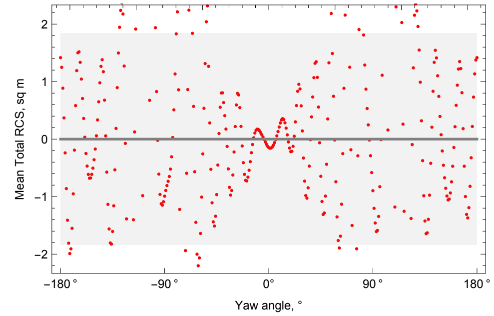


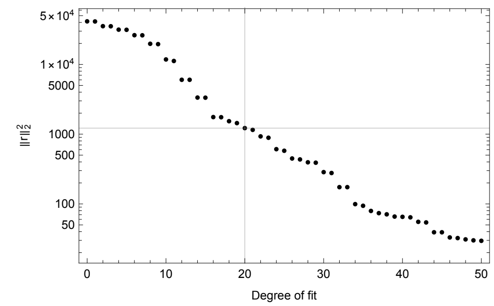


d	Data and Fourier Representation	Residual Fit Error	Total Error for Fit Sequence

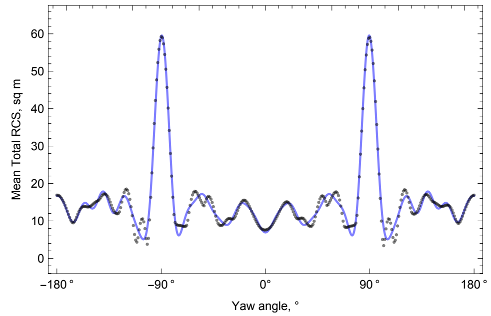
$d = 20$

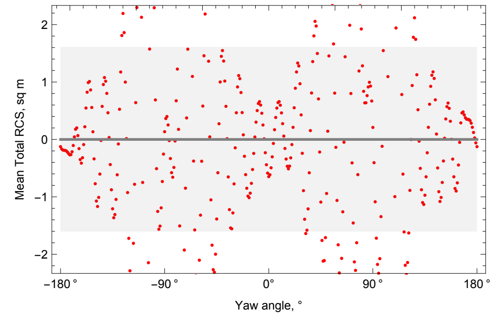


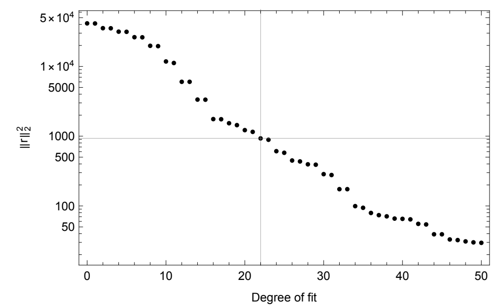




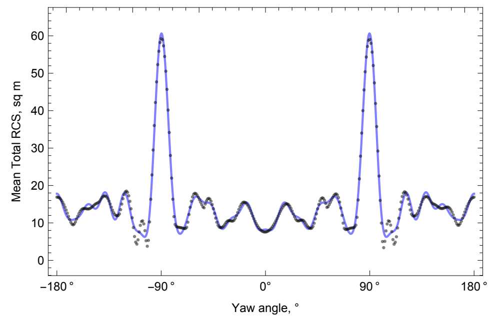
$d = 22$

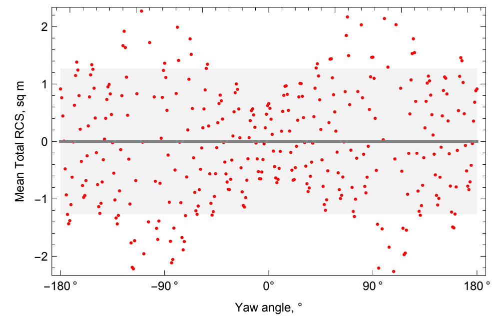


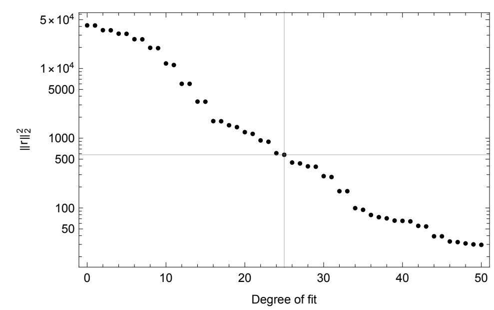


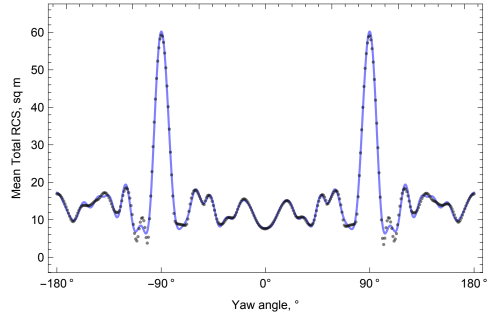
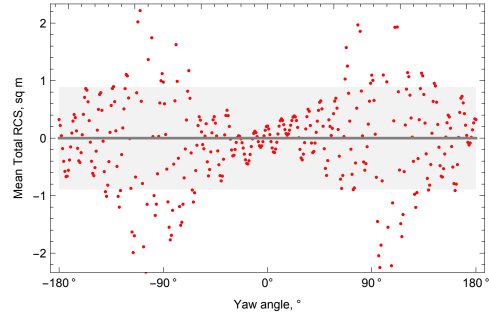
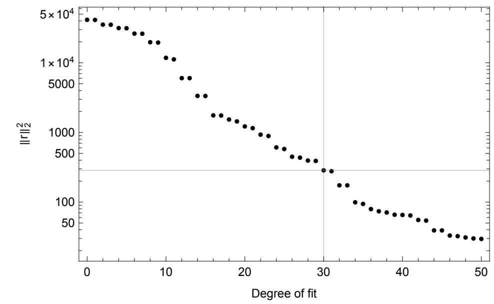
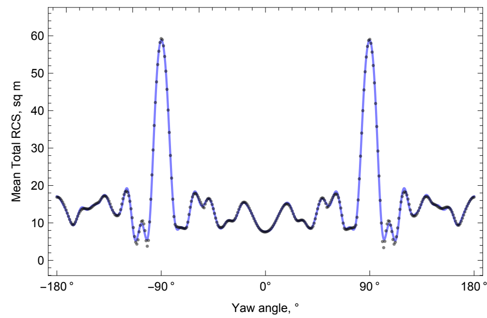
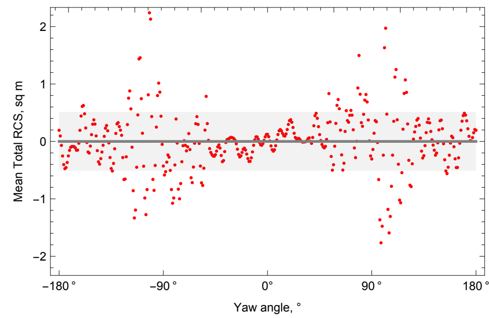
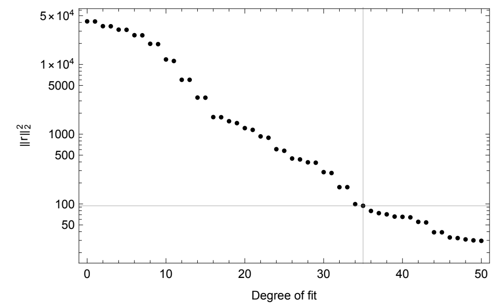
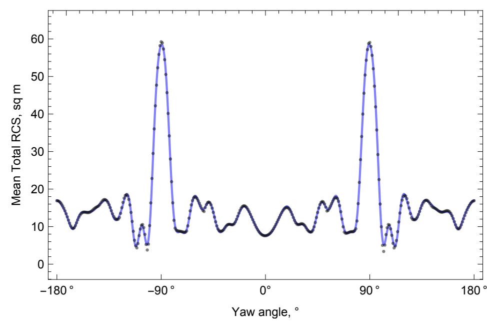
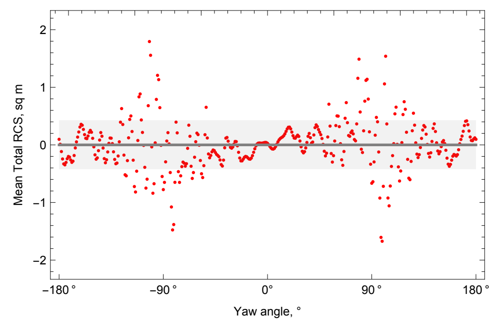
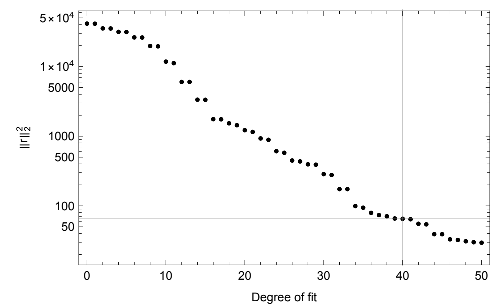


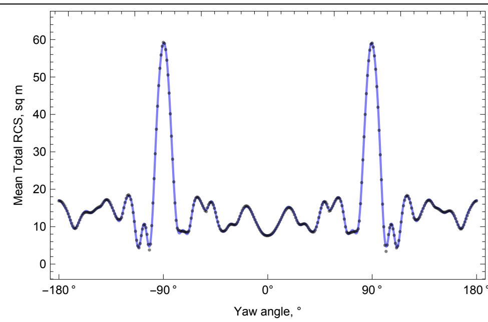
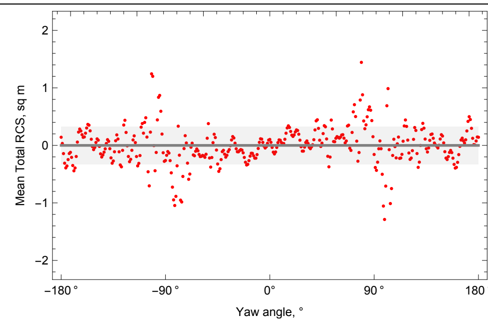
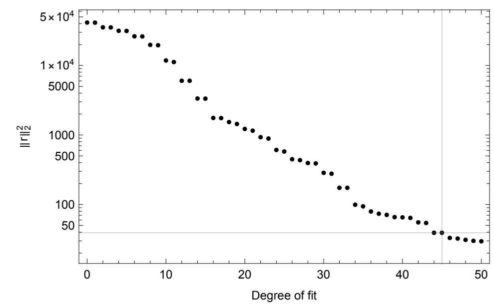
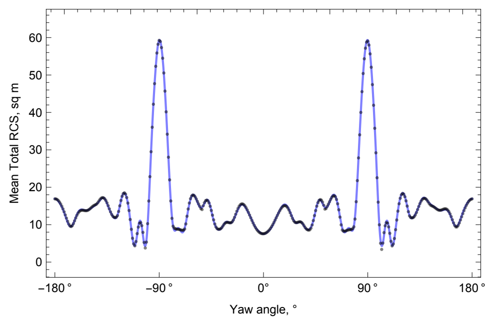
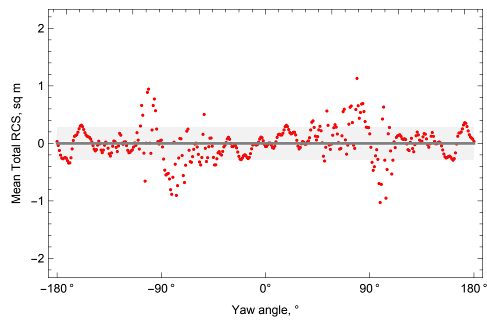
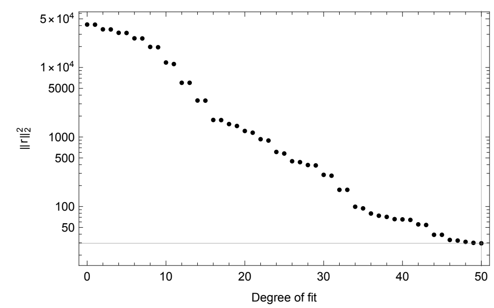
$d = 25$







<table>
<tr><th>d</th><th>Data and Fourier Representation</th><th>Residual Fit Error</th><th>Total Error for Fit Sequence</th></tr>
<tr><td>$d = 30$</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>$d = 35$</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>$d = 40$</td><td>
</td><td>
</td><td>
</td></tr>
</table>

d	Data and Fourier Representation	Residual Fit Error	Total Error for Fit Sequence
$d = 45$			
$d = 50$			

1.2 Part II: Fit Amplitudes

In the second part, the story is retold from the perspective of the amplitudes. It shows the dominance of the even harmonics. It shows the rapid diminution in magnitude as the order increases. The error bars reflect the high quality of the data set and indicate that the amplitudes are stable against small perturbations in the data set. Finally, the signal to noise value compares the magnitude of the amplitude to the error.

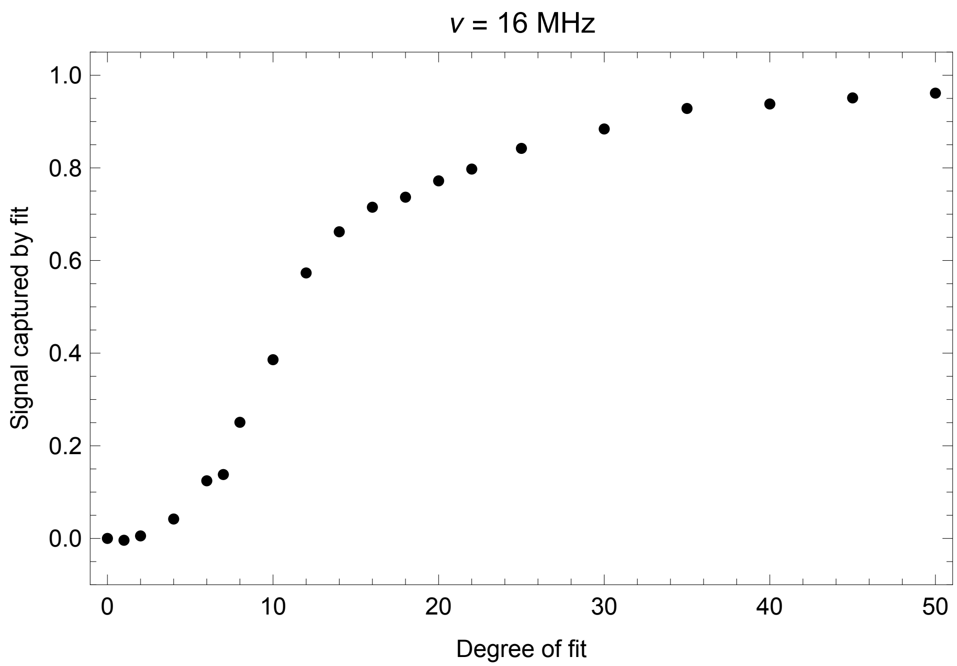
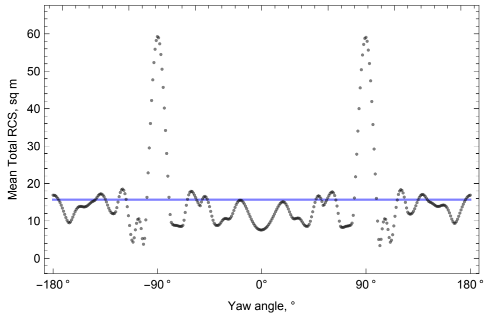
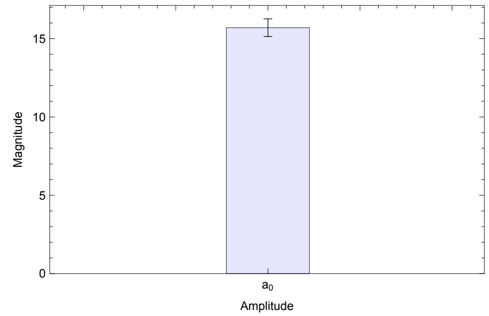
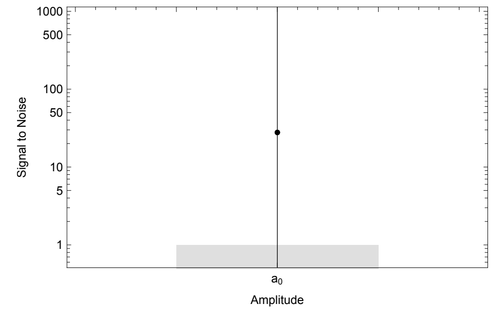
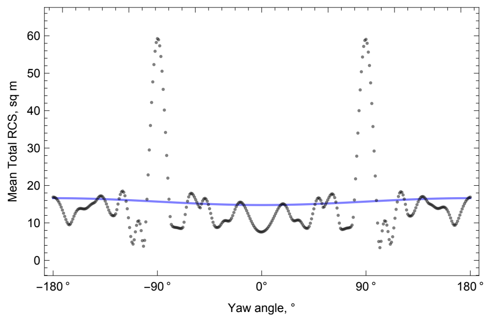
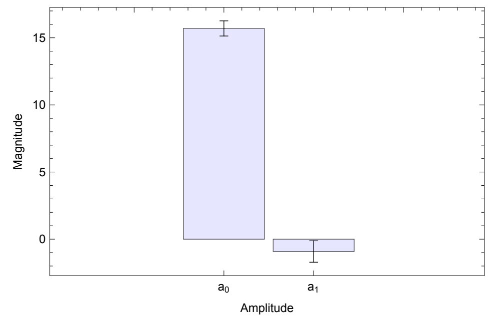
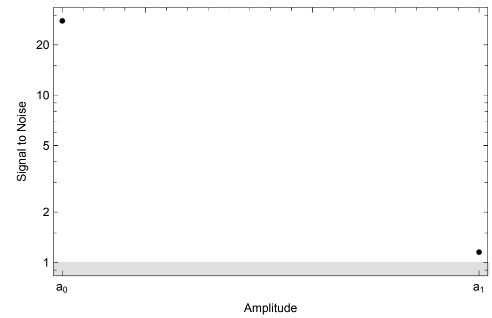
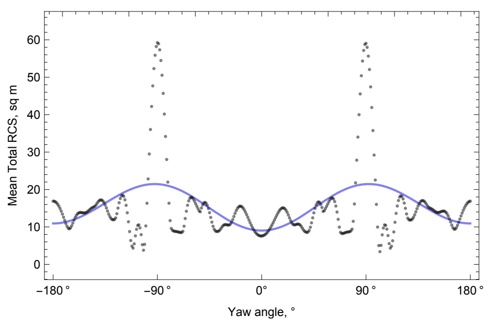
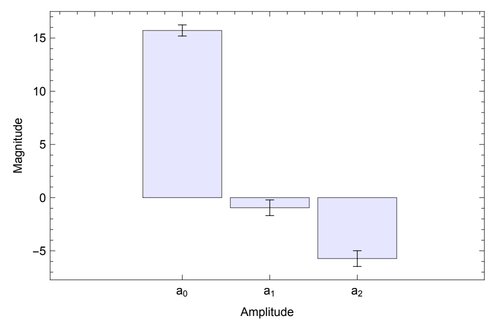
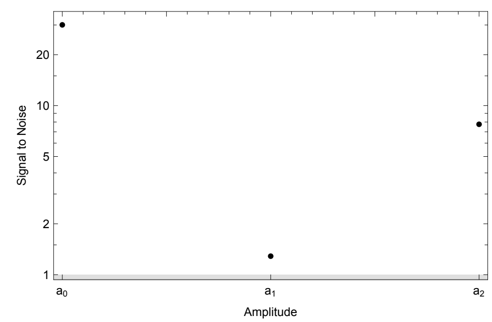
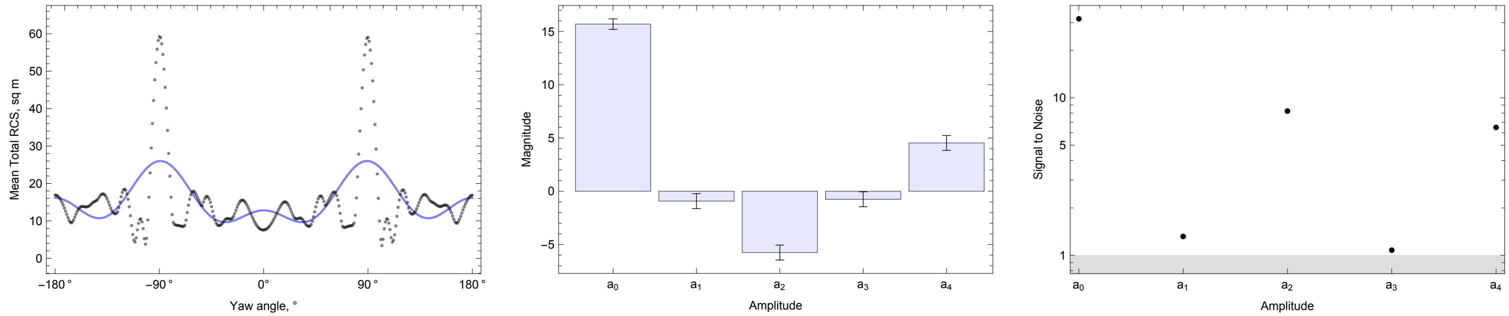


Figure 1: A measure of error reduction. As the degree of fit increases, the variation in the error decreases. This chart compares the variation in the error to the variation in the data. If the data were perfect, that is, no noise, this ration would achieve unity.

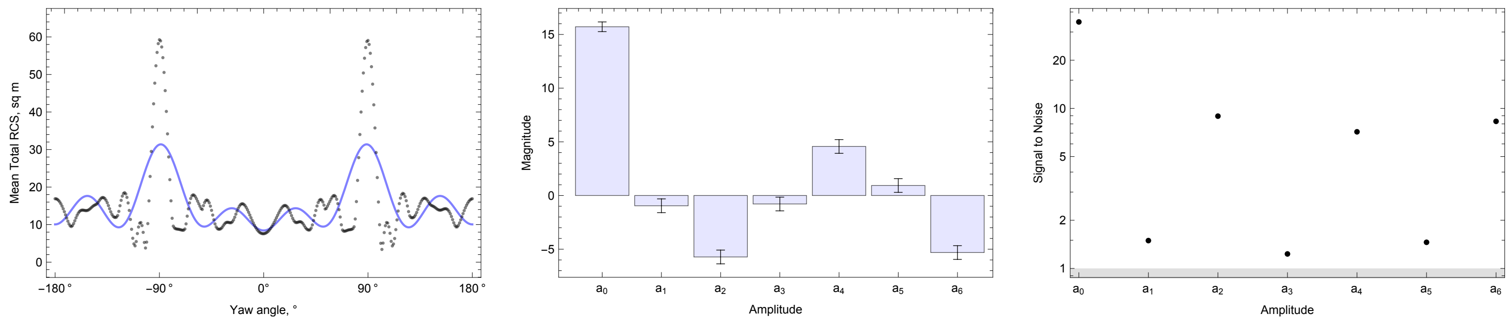
d	Data and Fourier Representation	Amplitudes with Uncertainties	Amplitude Signal to Noise
$d = 0$			
$d = 1$			
$d = 2$			

d	Data and Fourier Representation	Amplitudes with Uncertainties	Amplitude Signal to Noise

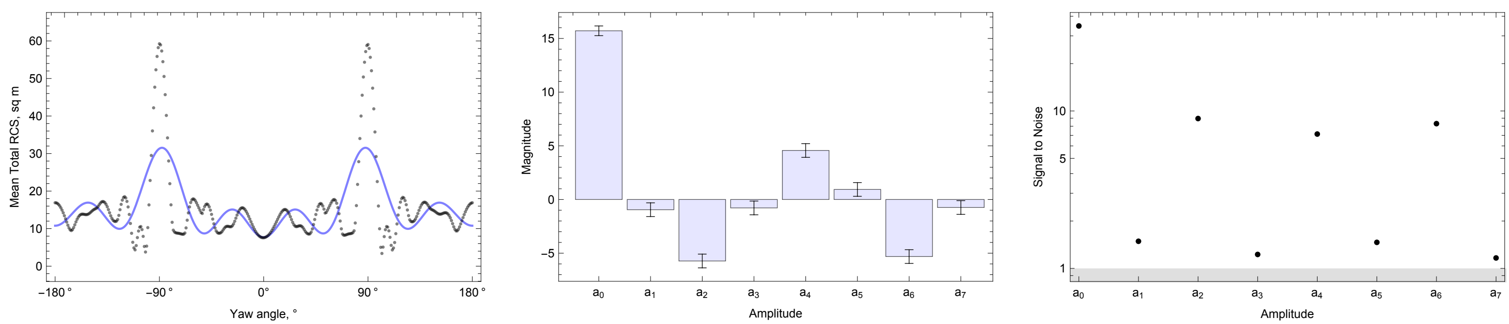
$d = 4$



$d = 6$

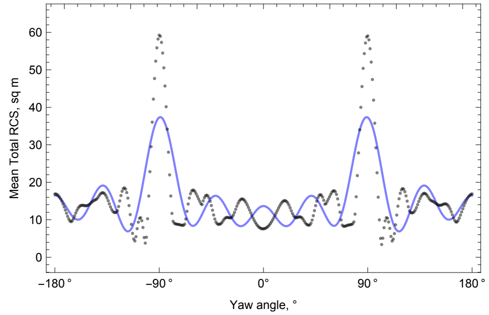


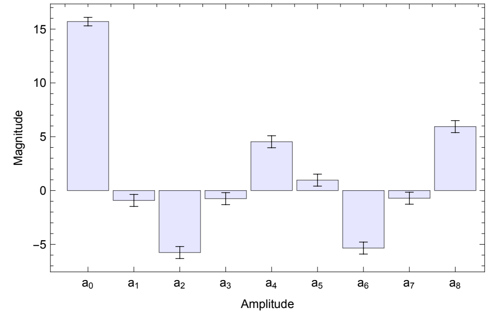
$d = 7$

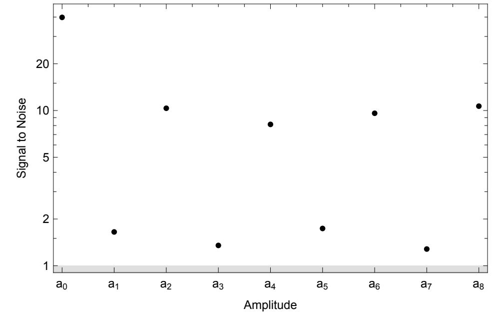


d	Data and Fourier Representation	Amplitudes with Uncertainties	Amplitude Signal to Noise

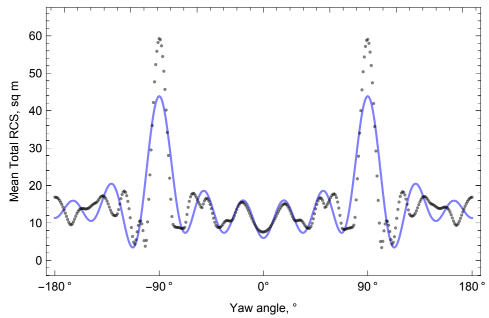
$d = 8$

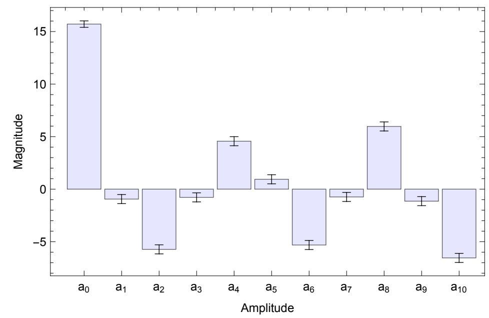


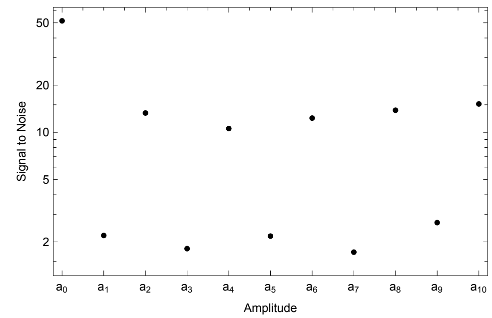




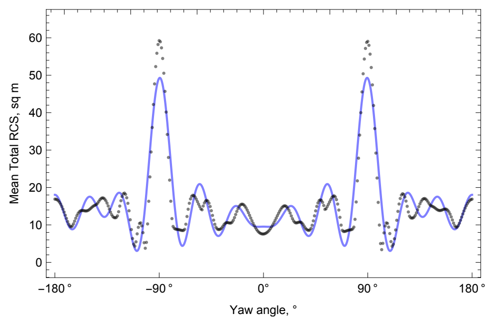
$d = 10$

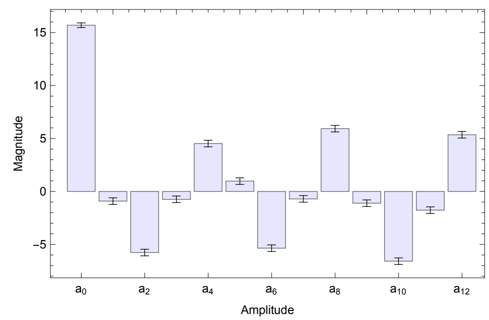


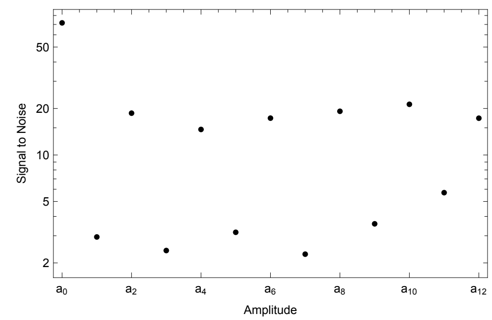


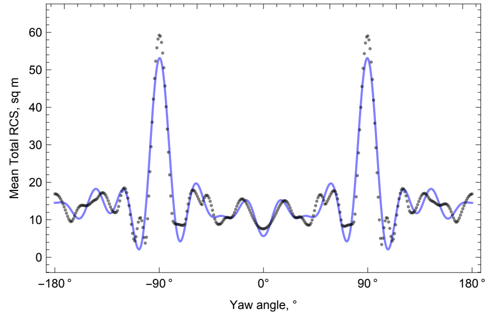
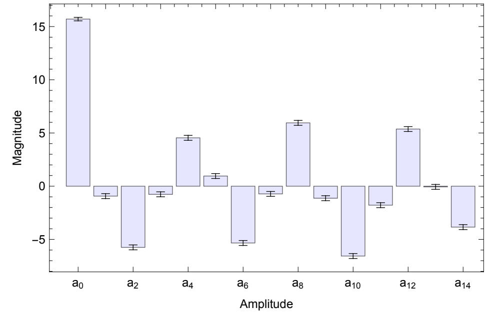
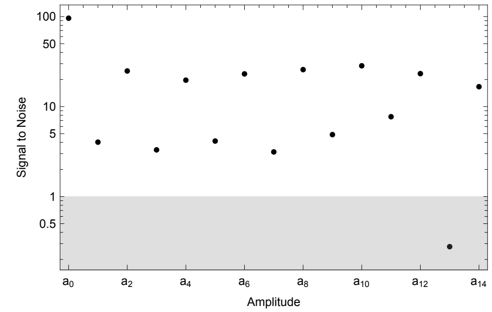
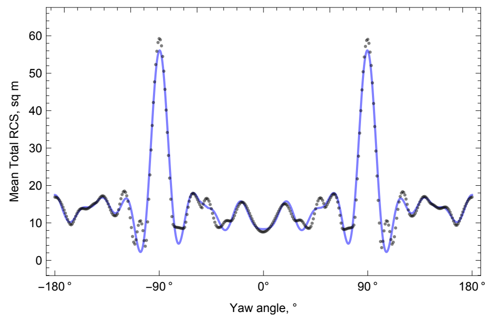
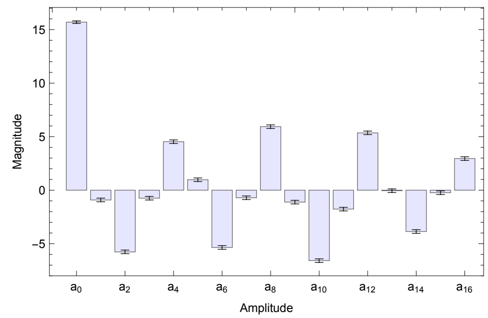
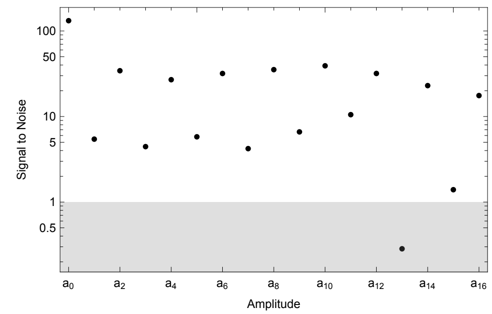
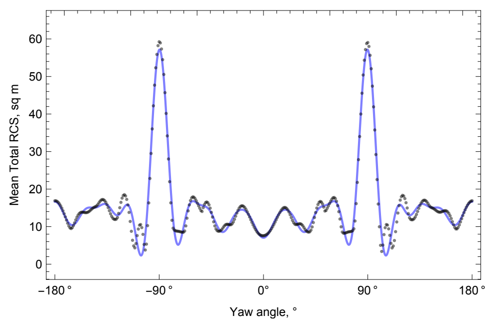
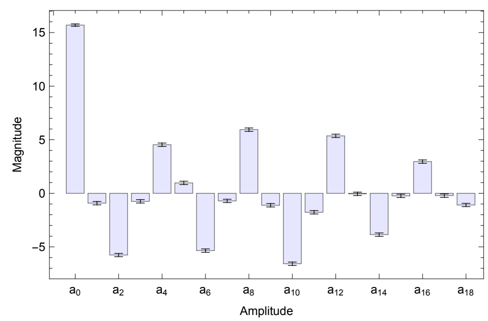
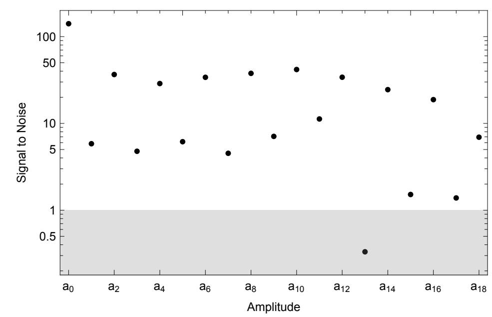


$d = 12$



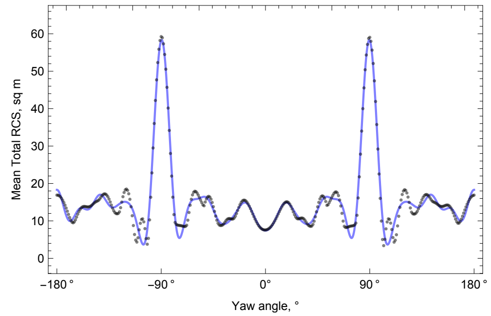


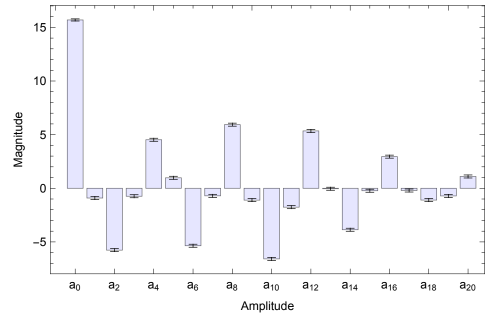


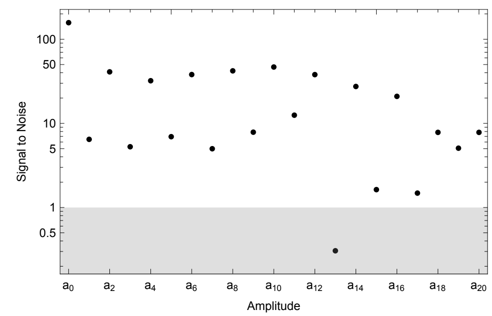
d	Data and Fourier Representation	Amplitudes with Uncertainties	Amplitude Signal to Noise
$d = 14$			
$d = 16$			
$d = 18$			

d	Data and Fourier Representation	Amplitudes with Uncertainties	Amplitude Signal to Noise

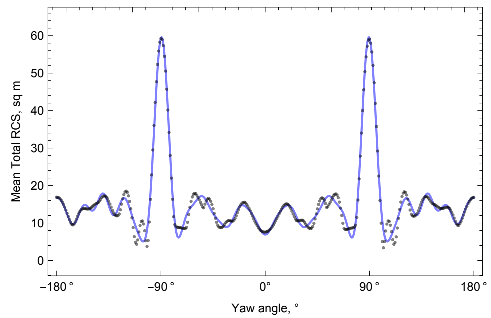
$d = 20$

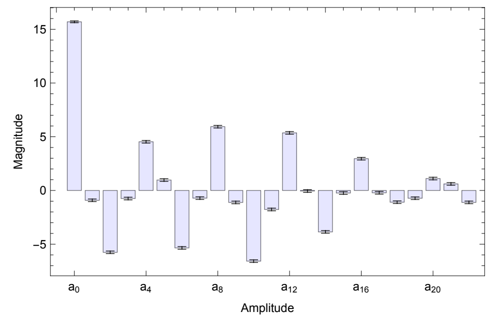


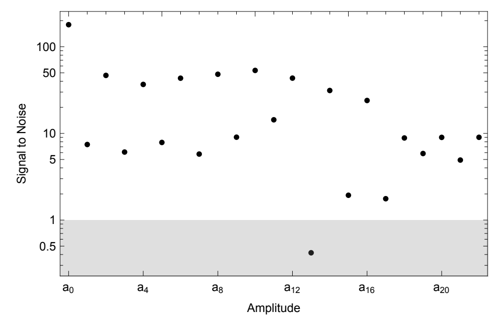




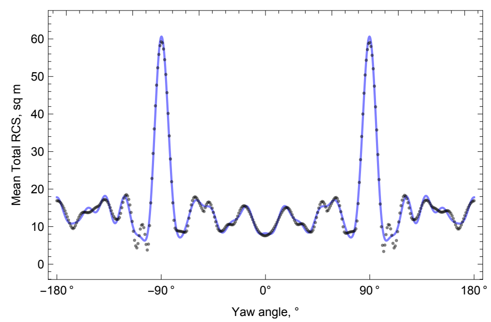
$d = 22$

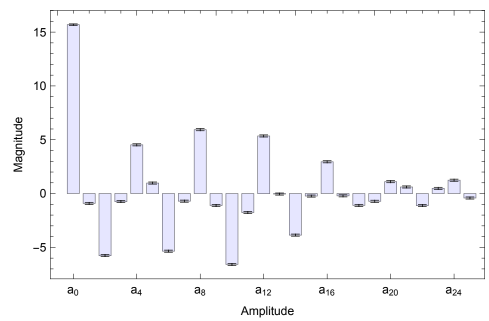


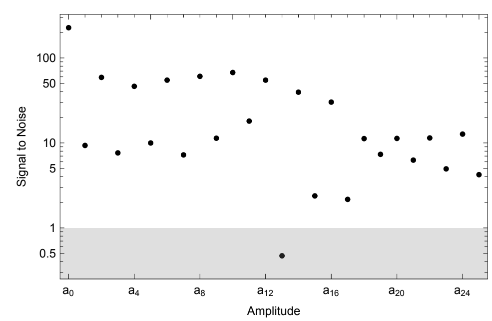


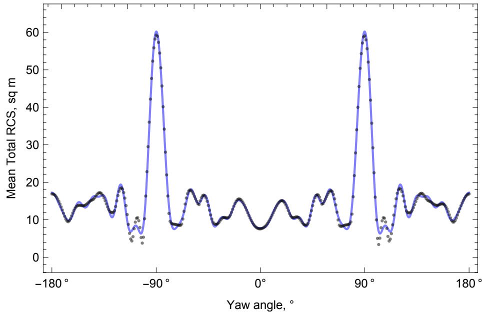
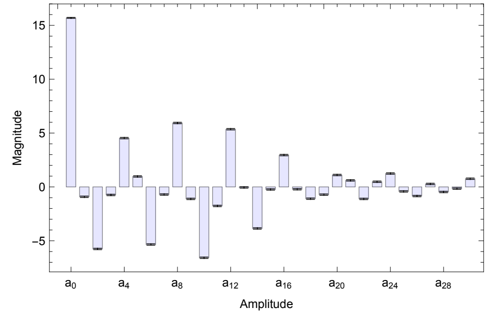
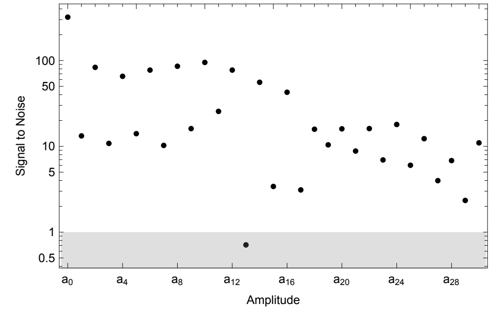
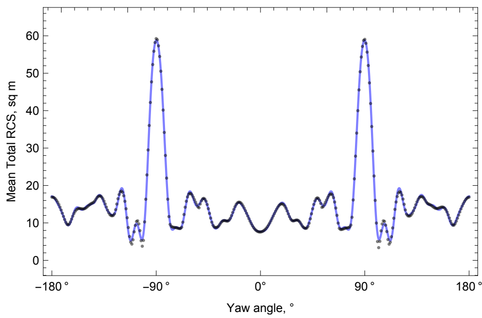
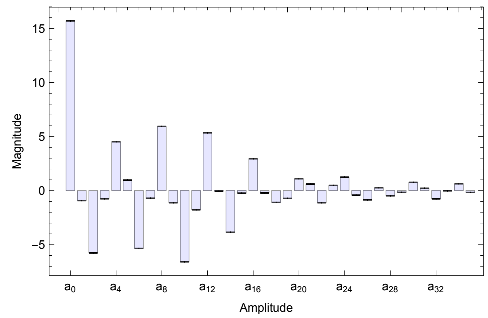
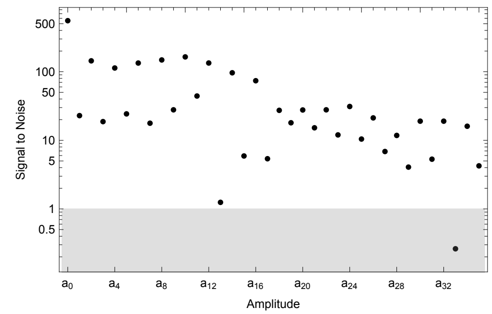
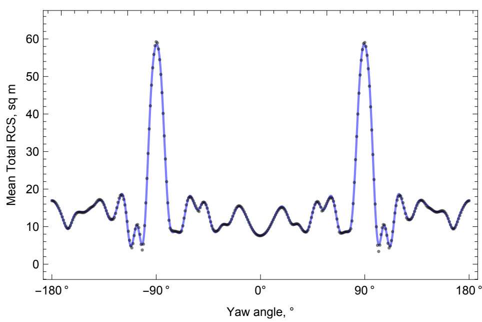
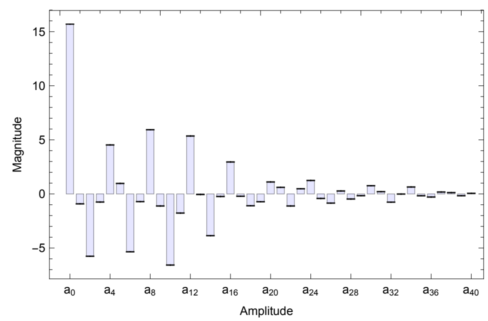
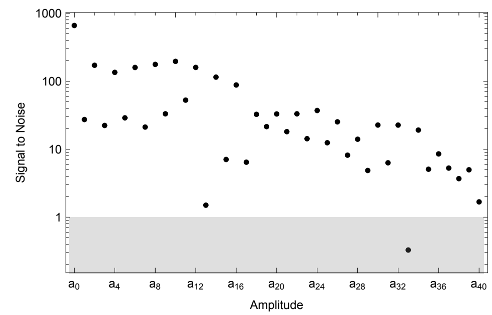


$d = 25$



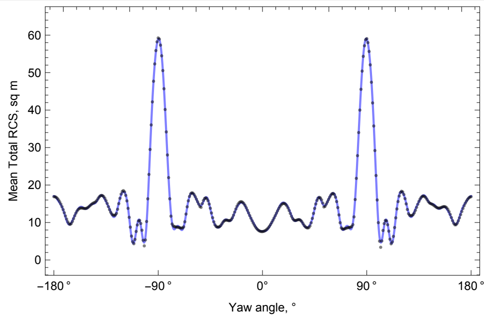


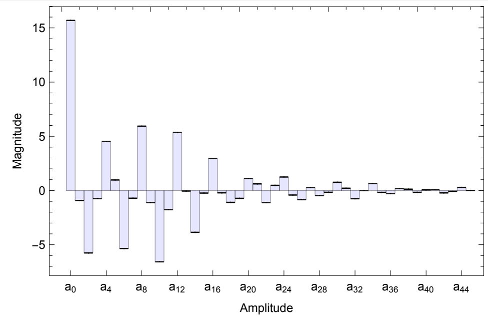


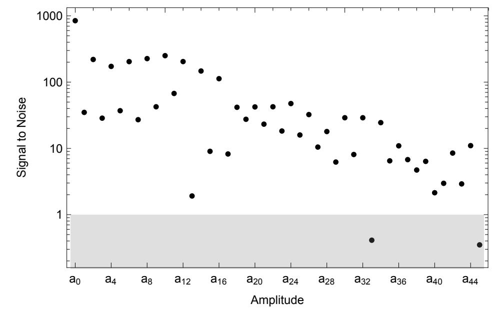
d	Data and Fourier Representation	Amplitudes with Uncertainties	Amplitude Signal to Noise
$d = 30$			
$d = 35$			
$d = 40$			

d	Data and Fourier Representation	Amplitudes with Uncertainties	Amplitude Signal to Noise

$d = 45$







$d = 50$