Adaptix

# OPTIMAM Simulation Analysis
## Aluminium Balls

## Introduction

This is a short report to outline how the analysis of the aluminum ball image simulations were undertaken.

## Data Acquisition

Twelve simulations were performed by Prem Elangovan. Three simulations at a phantom height of 7.5mm; three at 30mm and three at 57.5mm. At each height four different x-ray source geometries were simulated.

## Data Extraction

Each simulation has 30 aluminum balls evenly spaced over the image surface (Figure 1).

For ease of reference, figure 1 middle shows how each aluminium ball is numbered in the results matrix taken from Matlab. All simulations look very similar (figure 1, left) aside from 57.5mm geometries 1 and 4 where a black strip appears down the right side (figure 1, right).

Five measurements were taken at each aluminium ball. One - 3x3 matrix - measurement at the centre of each ball (signal measurement) and four measurements - 10x10 matrix - above, below, left and right of the ball (noise measurement). As can be seen in figure 2 the blue square is the 3x3 signal measurement and the green squares are the 10x10 noise measurements.

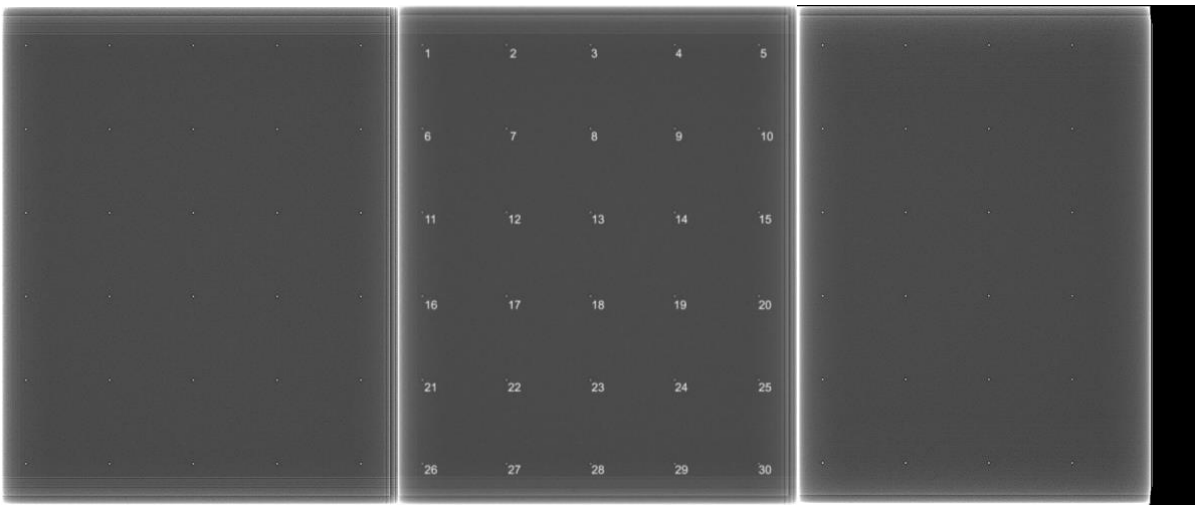



Figure 1: Right, evenly spaced aluminum balls. Middle, corresponding numbers for each ball. Right, visible black space in the image.

The centre of the noise measurements are 30 pixels away from the centre of the signal measurement.

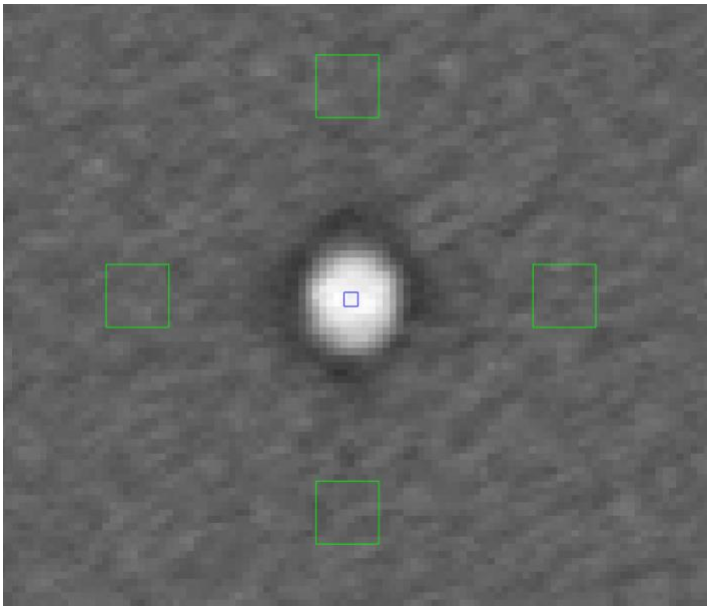


Figure 2: Example of measurement size and location.

### Measurements

Contrast, Contrast-Noise-Ratio and Signal-Noise-Ratio were calculated for each ball and stored along with their image coordinates for each of the twelve images.

#### Equations

$$contrast = \frac{|\mu_s - \mu_n|}{\mu_n} \quad (1$$

$$CNR = \frac{|\mu_s - \mu_n|}{\sigma_n} \quad (2$$

$$SNR = \frac{\mu_s}{\sigma_n} \quad (3$$

$\mu_n$ = mean noise

$\mu_s$ = mean signal

$\sigma_n$ = Standard Deviation Noise

## Data Visualisation

The results for each image are displayed in both a 2D and 3D format for ease of reference (example - figure 3). Each black point represents an aluminum ball within the phantom; the z value of each point represents its corresponding measurement calculation (Contrast, CNR, SNR).

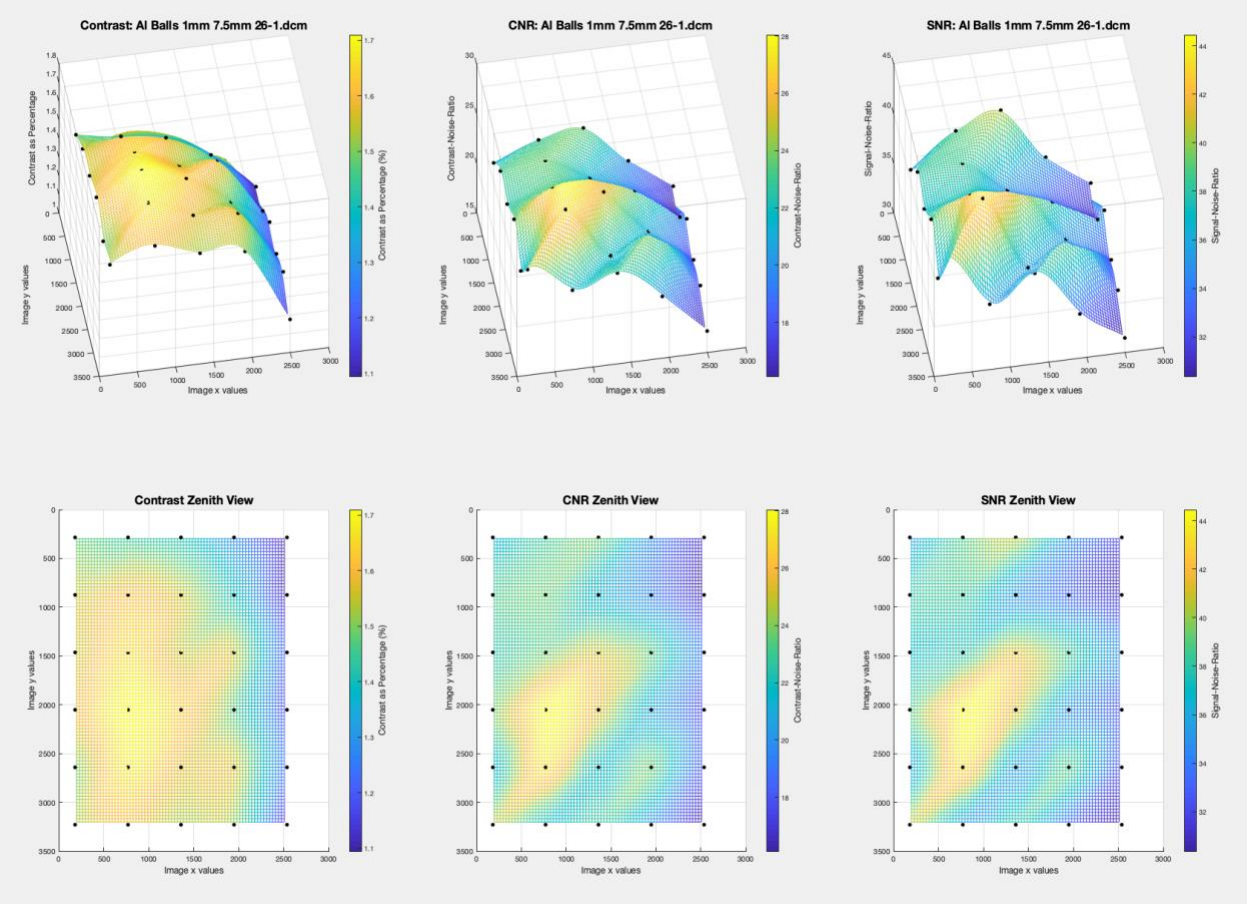


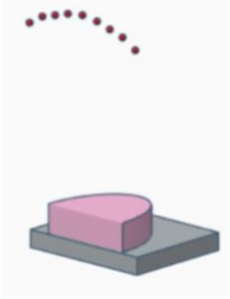

Figure 3: Example of the graphs that have been produced for each geometry and ball height.

## Mean Geometry Calculations

Once the twelve results were calculated for each geometry and height, the mean was calculated for each geometry to give an overall idea of how each geometry performed over the three ball heights. The graphs for each geometry can be seen below.

## Resulting Graphs

### Geometry 1

| Conventional geometry but with stationary emitters |
| --- |
|  |

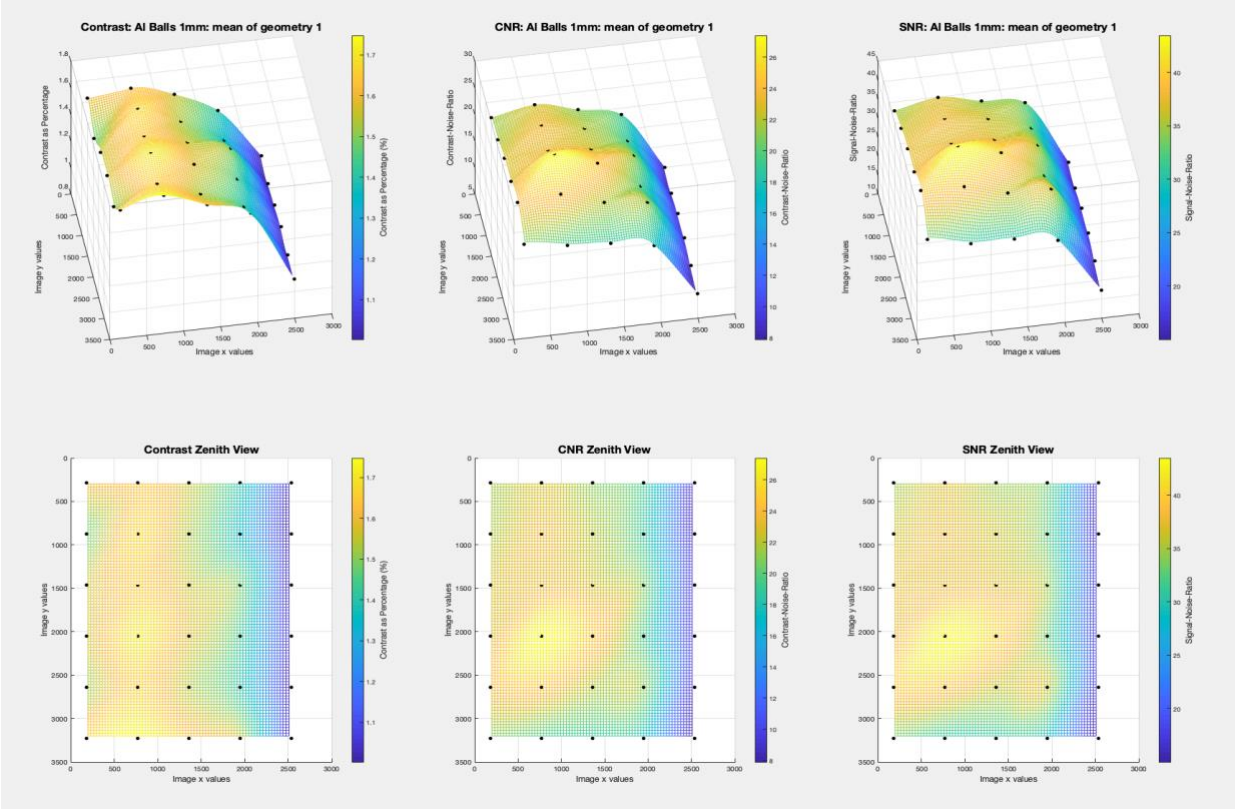
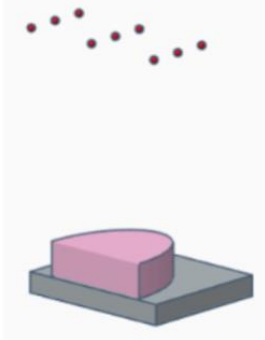



Figure 4: Graphs showing the average results for geometry 1

## Geometry 2

| Stationary emitters in a rectangular array |
| --- |
|  |

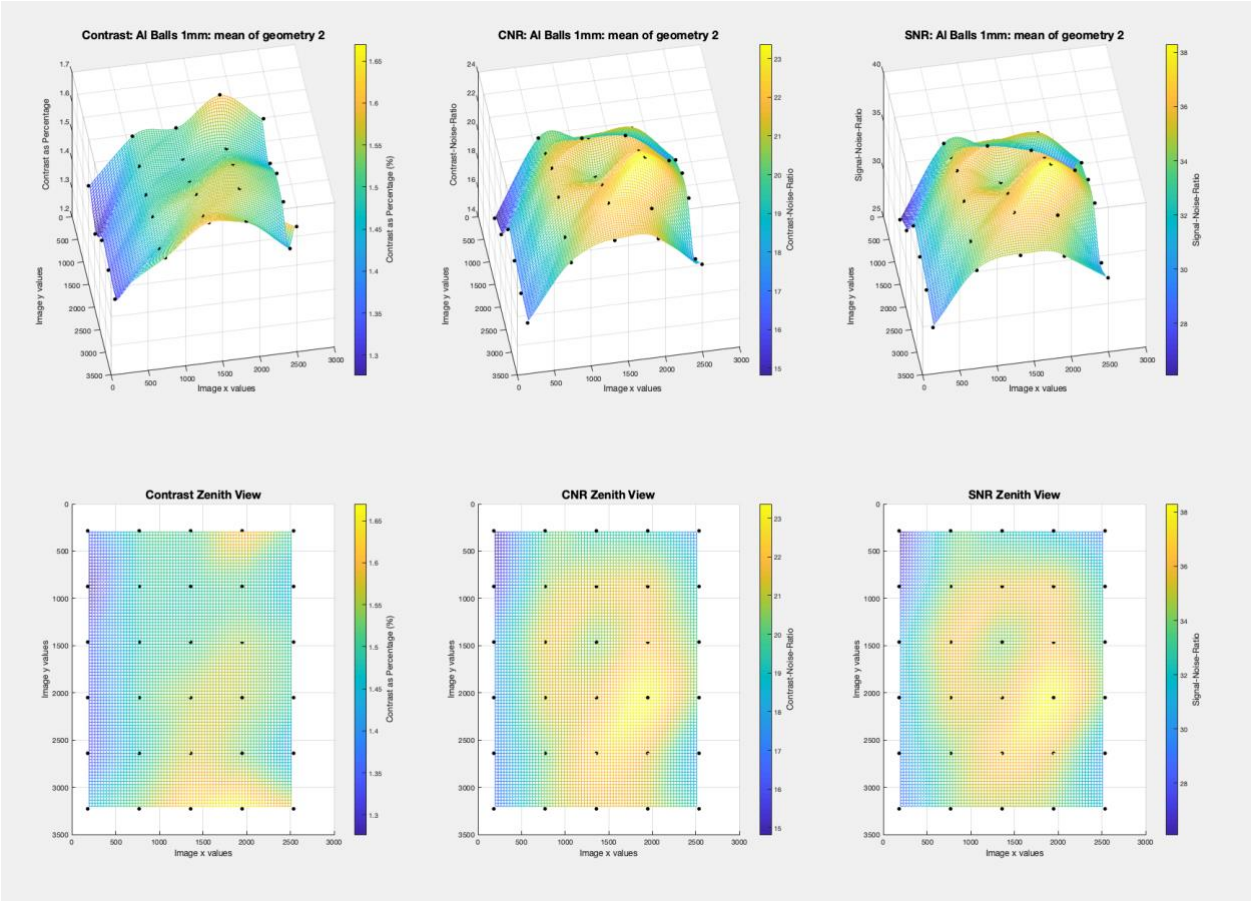
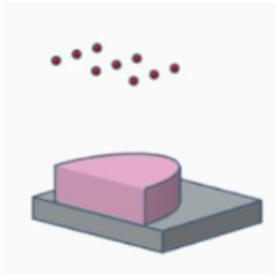



Figure 5: Graphs showing the average results for geometry 2

## Geometry 3

| Stationary emitters in a rectangular array but at half SID |
| --- |
|  |

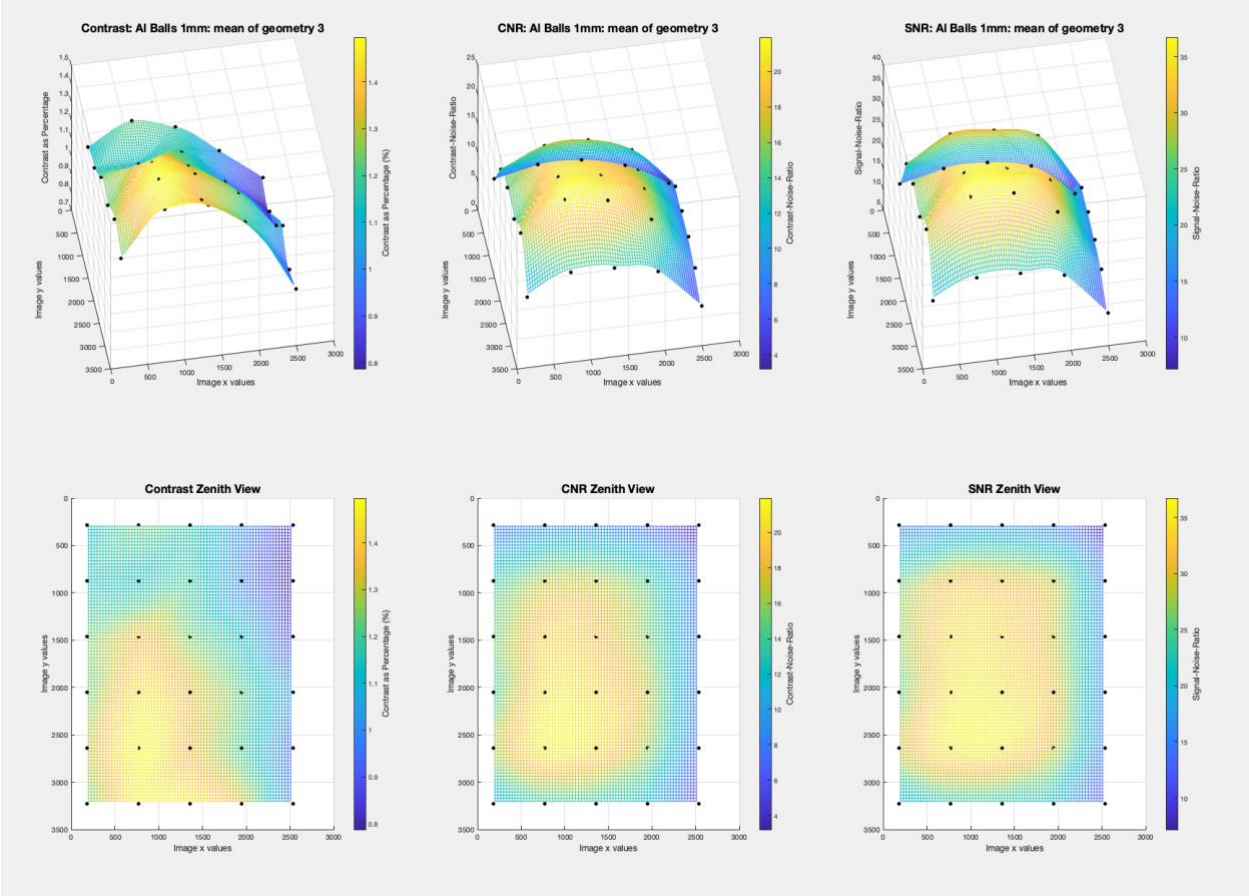
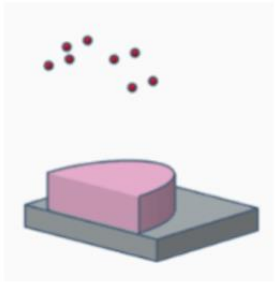



Figure 6: Graphs showing the average results for geometry 3

## Geometry 4

| Two square flat panel sources at an angle to each other |
| --- |
|  |

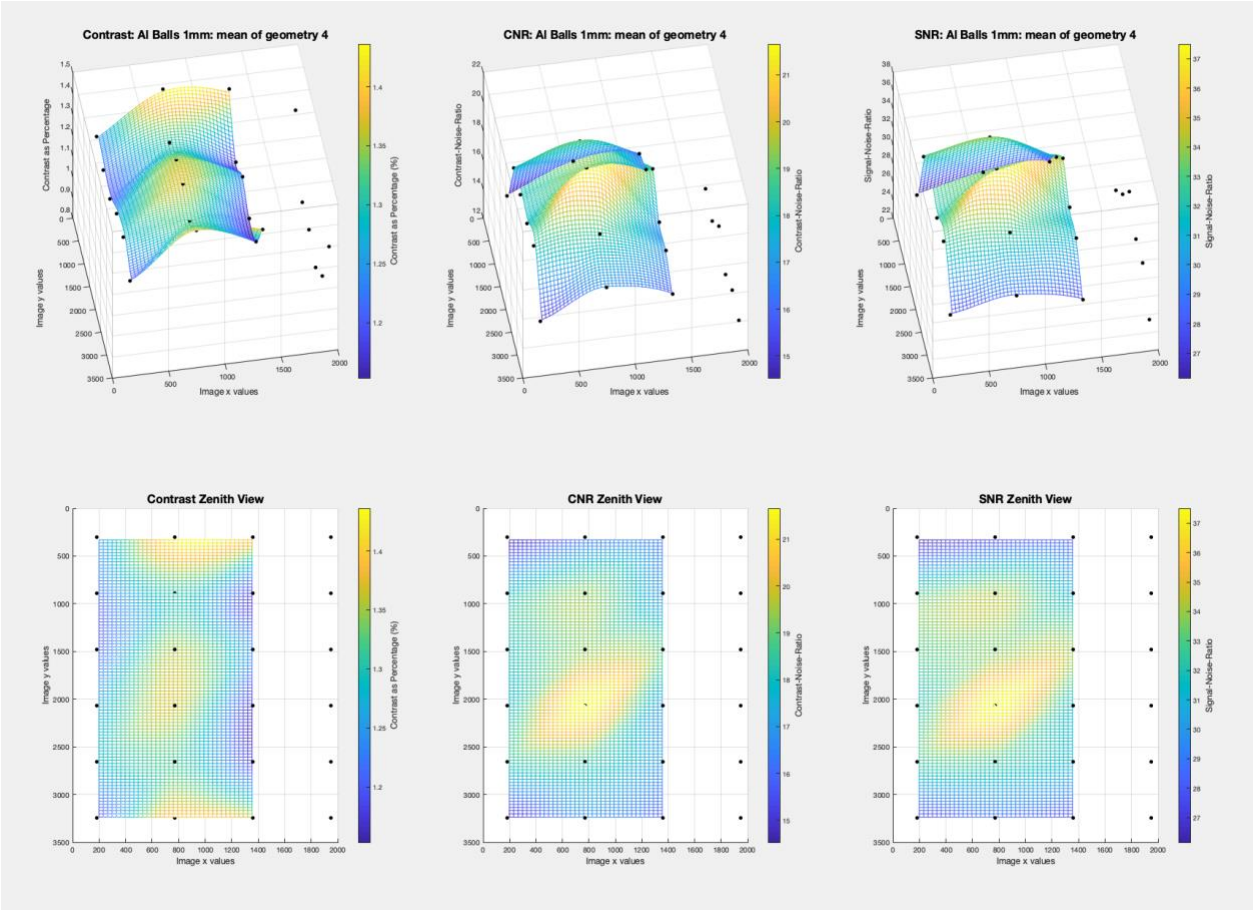



Figure 7: Graphs showing the average results for geometry 4