Small Lego cube information sheet

The cube is built based on the recipe from the article by Knörlein et al in J. Exp. Biol in 2016, which was included in the supplementary information:

https://jeb.biologists.org/highwire/filestream/1146106/field_highwire_adjunct_files/0/JEB145383supp.pdf

All sizes (i.e. number of lego blocks) from this manual have been divided by 2, and smaller metal spheres (3 mm diameter stainless steel bearing balls) have been used. These spheres are not pressed in the central cylinders of the legos as described in the manual for 5 mm balls, but are glued while being pressed to the bottom of the smaller circular spacings of the internal side of the top surfaces of the lego:

The cube contains 64 metal balls, and 4 reference symbols that are used to determine the origin and the orientation of the reference frame axes.

The following text (available as .csv from https://www.uantwerpen.be/images/uantwerpen/container47119/files/lego_small.csv

is the reference file for the coordinates of the centers of the spheres in cm:

```
x,y,z
0,0,0
0,0,5.76
3.2,0,0
3.2,0,5.76
6.4,0,0
6.4,0,5.76
9.6,0,0
9.6,0,5.76
0,3.2,0
0,3.2,5.76
3.2,3.2,0
```

```
3.2,3.2,5.76
6.4,3.2,0
6.4,3.2,5.76
9.6,3.2,0
9.6,3.2,5.76
0,6.4,0
0,6.4,5.76
3.2,6.4,0
3.2,6.4,5.76
6.4,6.4,0
6.4,6.4,5.76
9.6,6.4,0
9.6,6.4,5.76
0,9.6,0
0,9.6,5.76
3.2,9.6,0
3.2,9.6,5.76
6.4,9.6,0
6.4,9.6,5.76
9.6,9.6,0
9.6,9.6,5.76
0,0,2.88
0,0,8.64
3.2,0,2.88
3.2,0,8.64
6.4,0,2.88
6.4,0,8.64
9.6,0,2.88
9.6,0,8.64
0,3.2,2.88
0,3.2,8.64
3.2,3.2,2.88
3.2,3.2,8.64
6.4,3.2,2.88
6.4,3.2,8.64
9.6,3.2,2.88
9.6,3.2,8.64
0,6.4,2.88
0,6.4,8.64
3.2,6.4,2.88
3.2,6.4,8.64
6.4,6.4,2.88
6.4,6.4,8.64
9.6,6.4,2.88
9.6,6.4,8.64
0,9.6,2.88
0,9.6,8.64
3.2,9.6,2.88
3.2,9.6,8.64
6.4,9.6,2.88
6.4,9.6,8.64
9.6,9.6,2.88
9.6,9.6,8.64
1.2,1.98,4.63
7.6,8.38,4.63
7.6,1.98,7.51
1.2,8.38,7.51
```

On lines 65 to 68 (in blue) the approximate center coordinates of the four 'symbols' (square, circle, triange, cross) are given. The names of these symbols must be provided in a separate file, which can be downloaded from:

https://www.uantwerpen.be/images/uantwerpen/container47119/files/refsymbols.txt

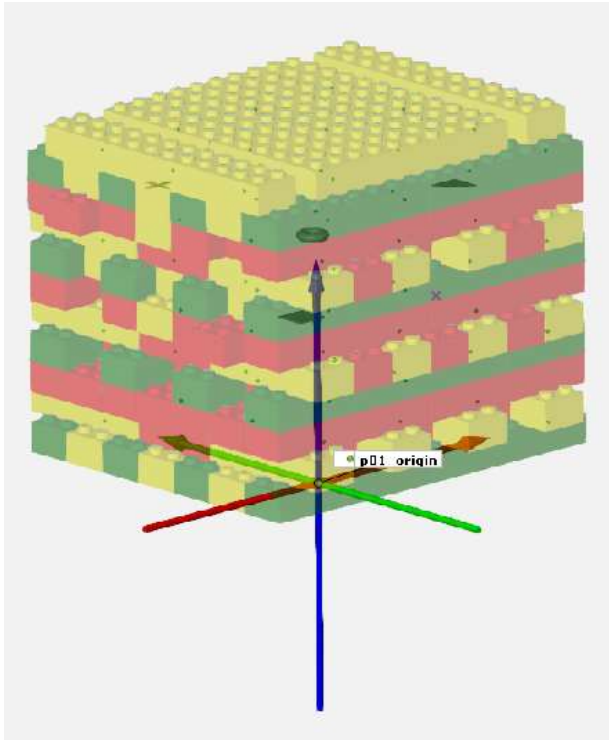(best rename .txt to .ref for best compatibility with XMALab software.):

```
65 Square
66 Circle
```

As you can see from these coordinates, the ORIGIN (0,0,0) is the ball at the bottom corner of the lego cube below the square. The orientation of the axes =
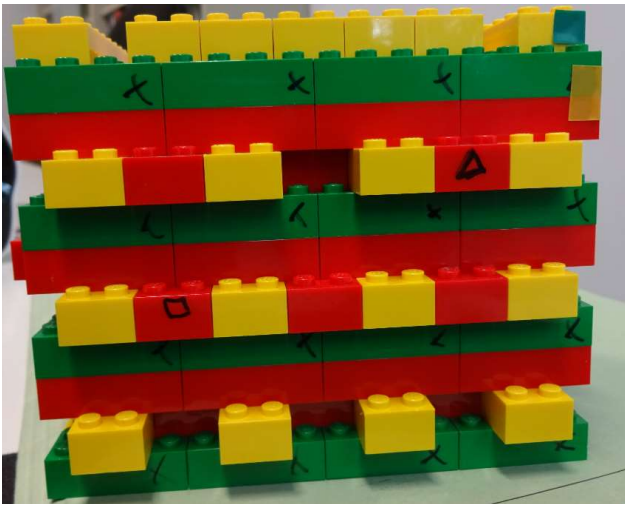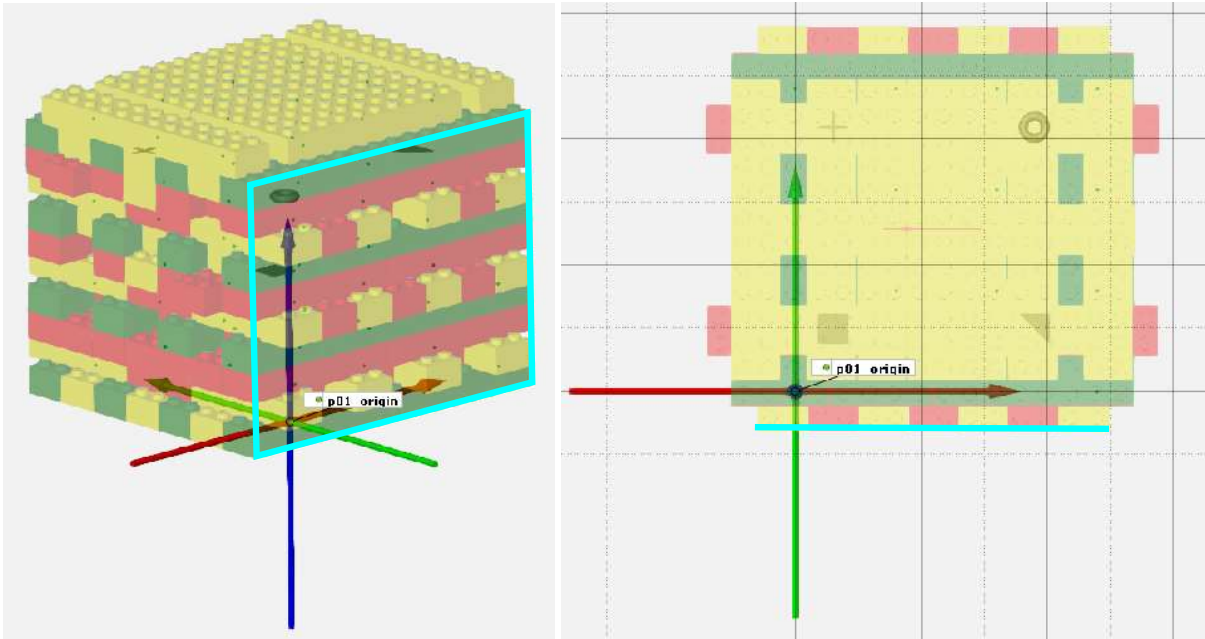
X = Square+Cross -> Circle+Triangle

Y = Square+Triangle -> Circle+Cross
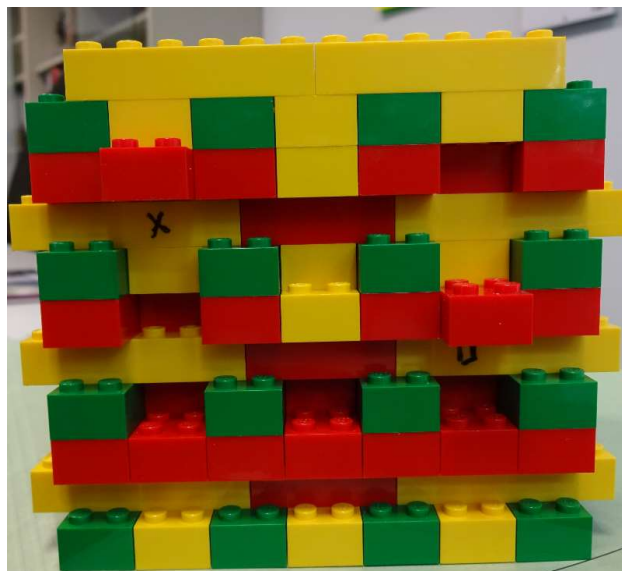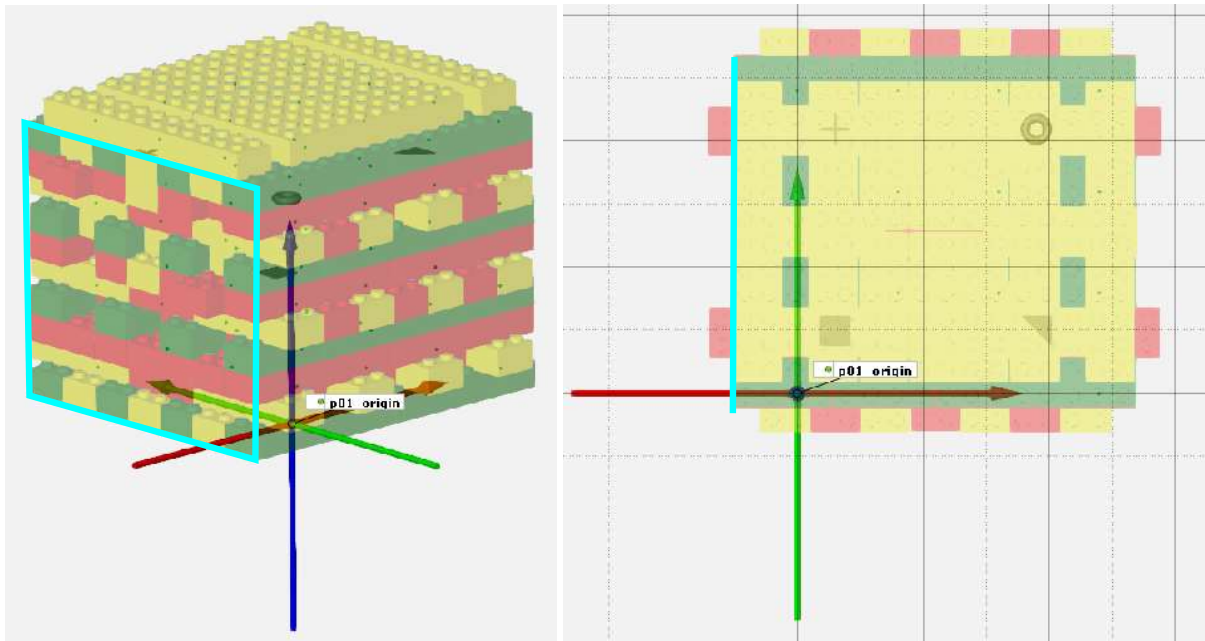
Z = Square+Circle -> Triangle+Cross

The different planes can be recognised externally based on symbols writing on the lego cube surfaces (and also some tape in the corner). The upper right panels are TOP views:
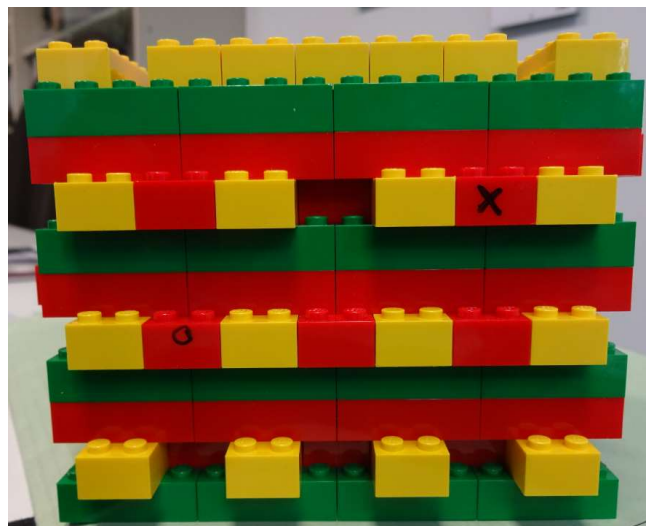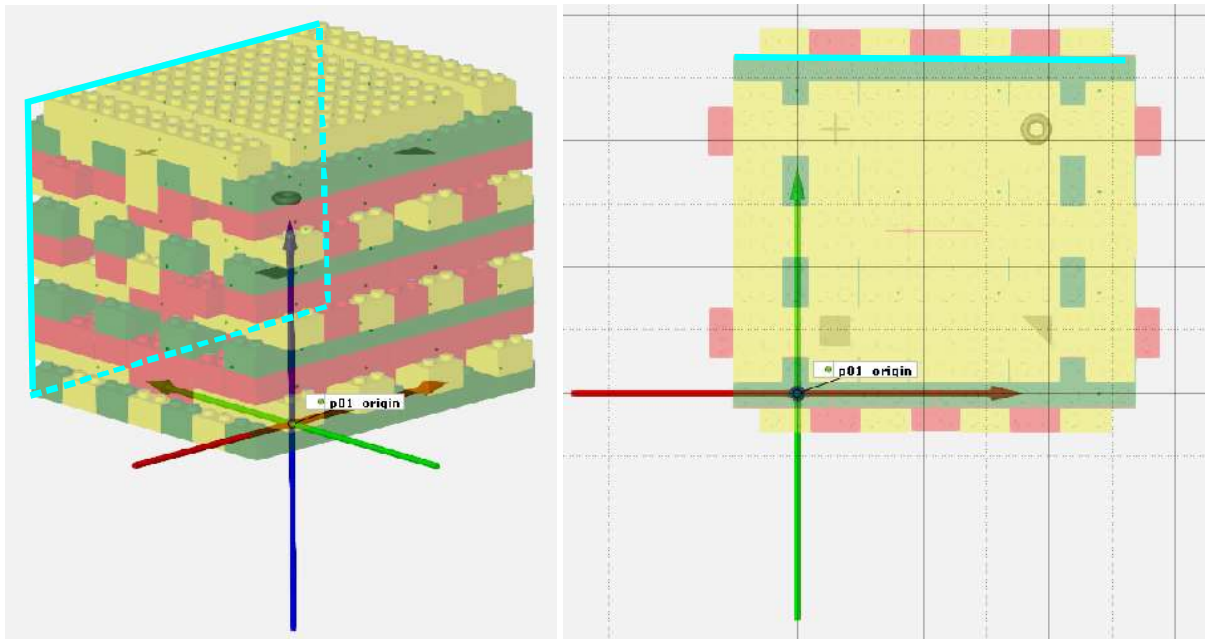
square-triangle plane
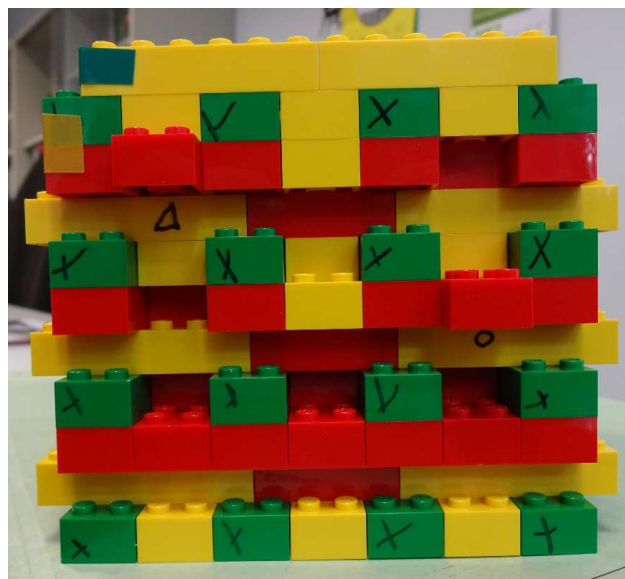

'Y-' view in GOM Inspect
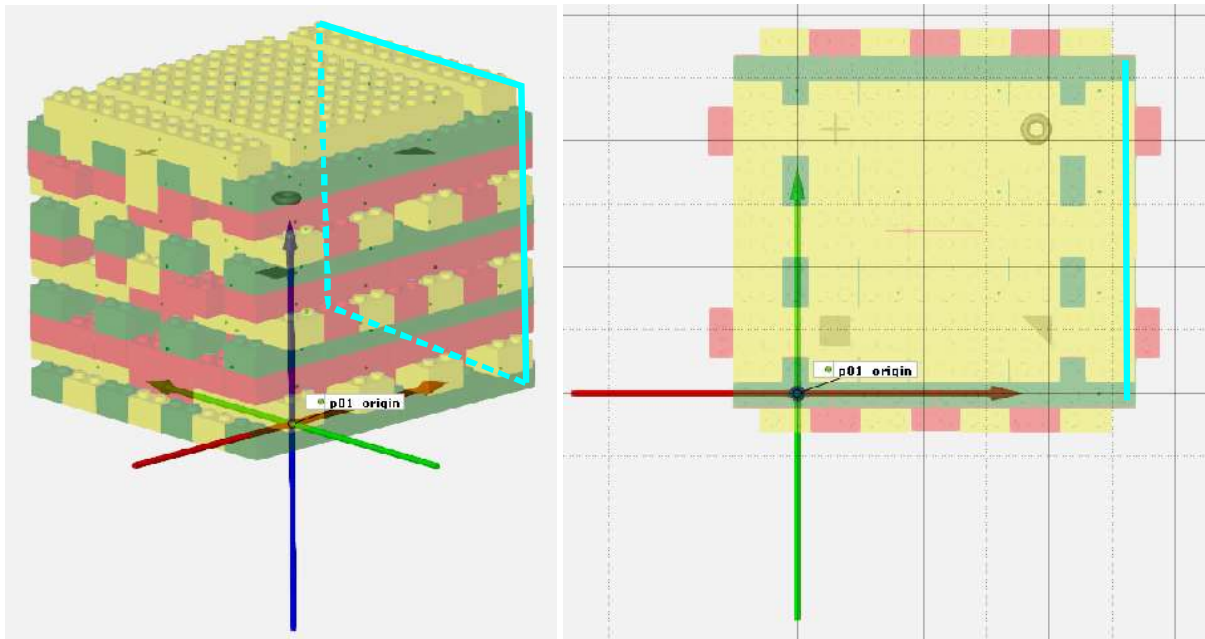
square-cross plane

'X-' view in GOM Inspect
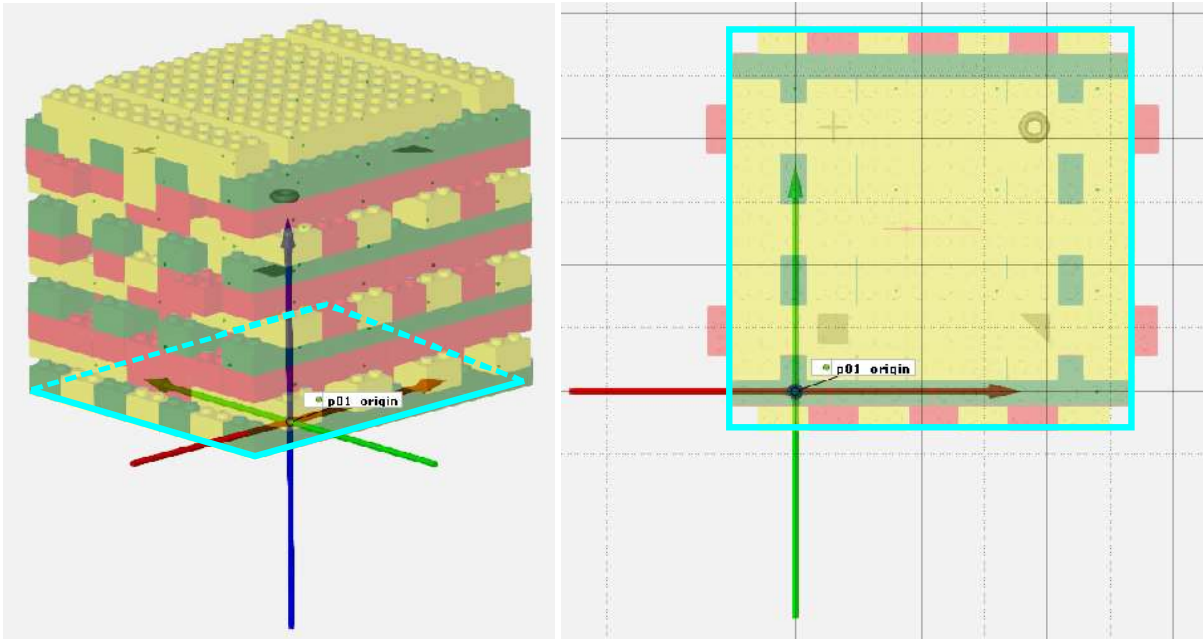
circle-cross plane

'Y+' view in GOM Inspect

circle-triangle plane

'X+' view in GOM Inspect

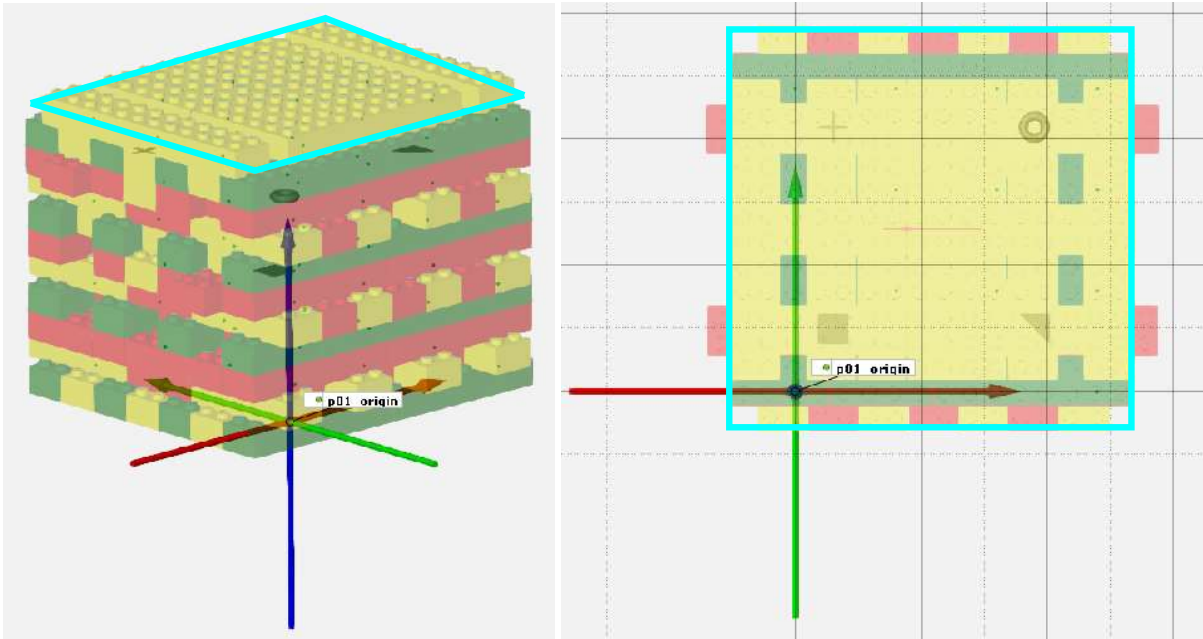# bottom plane

cross-circle

square-cross

triangle-circle

square-triangle

top plane

cross-circle

square-cross

triangle-circle

square-triangle