

001 Initial - inputs

$w_t = 3.6$ cm - width of magnet

$l = 20$ cm - length of magnet

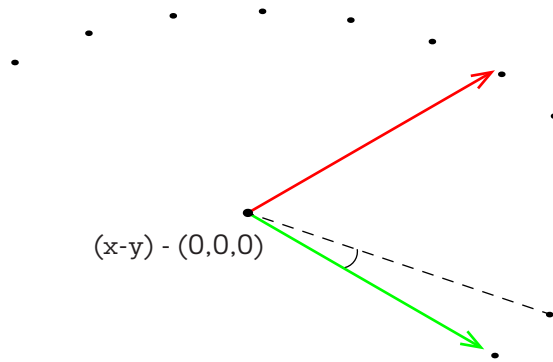
$R_{int} = 14$ cm - radius of hemisphere

002 point - XY Rotation - Arc

Θ = rotation in xy direction

$$\Theta = \text{floor}(\pi / (2(R_{int} \pi / 2 w_t)))$$

$$\Theta = 0.257143 \text{ rad}$$



$N_r \text{ max}$ = number of rings

$$\Delta\Theta = \pi / 2N_r$$

$$N_r^{\text{max}} = \text{floor}(\pi R_{int} / 2w_t)$$

$$N_r^{\text{max}} = 13 \text{ points}$$

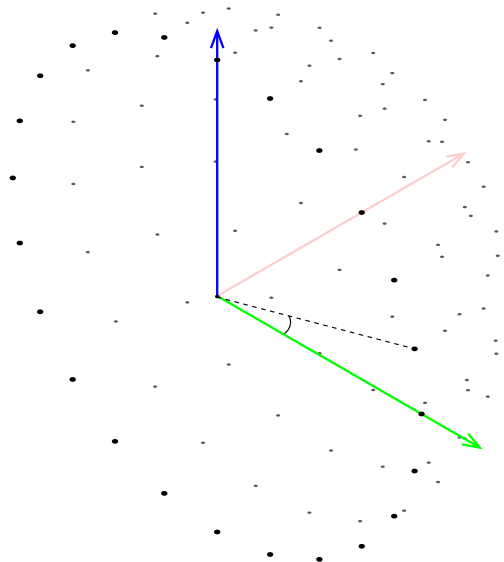
arc coordinates - (x,y,z)

```
{14, 0, 0}
{13.539688, 3.560457, 0}
{12.18902, 6.886783, 0}
{10.036816, 9.760242, 0}
{7.224602, 11.991877, 0}
{3.937307, 13.43494, 0}
{0.391098, 13.994536, 0}
{-3.180829, 13.633867, 0}
{-6.543588, 12.376649, 0}
{-9.476048, 10.305557, 0}
{-11.785374, 7.556783, 0}
{-13.319706, 4.311082, 0}
{-13.978149, 0.78189, 0}
```

arc coordinates - spaced evenly between 0 and π

```
{14, 0, 0}
{13.522962, 3.623467, 0}
{12.124356, 7.0, 0}
{9.899495, 9.899495, 0}
{7, 12.124356, 0}
{3.623467, 13.522962, 0}
{0, 14, 0}
{-3.623467, 13.522962, 0}
{-7.0, 12.124356, 0}
{-9.899495, 9.899495, 0}
{-12.124356, 7.0, 0}
{-13.522962, 3.623467, 0}
{-14, 0, 0}
```

003 point - XZ Rotation - Hemisphere - 103 points



$N_m(i_r)$ - number of magnets in i_r ring

$$N_m(i_r) = 2\pi / \Delta\Phi$$

$$N_m^{\text{max}}(i_r) = \text{floor}(2\pi R_{int} \cos(\Theta_i) / w_t)$$

$$\Phi_0 = 0.261799 \text{ rad - max}$$

$$\Phi_1 = 0.273182 \text{ rad}$$

$$\Phi_2 = 0.299199 \text{ rad}$$

$$\Phi_3 = 0.369599 \text{ rad}$$

$$\Phi_4 = 0.523599 \text{ rad}$$

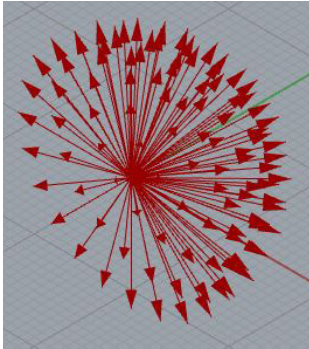
$$\Phi_5 = 1.047198 \text{ rad}$$

Hemisphere coordinates - (x,y,z) - {ring position}

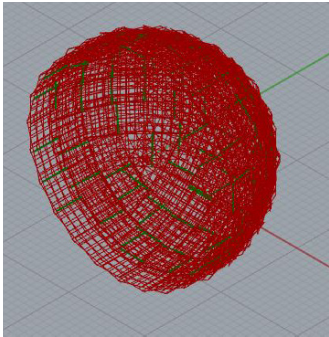
{0}	{1}	{2}
0. {13.522962, 0, 3.623467}	0. {13.037599, 3.560457, 3.652964}	0. {11.647496, 6.886783, 3.592777}
1. {12.124356, 0, 7.0}	1. {11.568572, 3.560457, 7.035004}	1. {10.071041, 6.886783, 6.86632}
2. {9.899495, 0, 9.899495}	2. {9.241556, 3.560457, 9.895291}	2. {7.59973, 6.886783, 9.52976}
3. {7, 0, 12.124356}	3. {6.229137, 3.560457, 12.021689}	3. {4.453149, 6.886783, 11.346439}
4. {3.623467, 0, 13.522962}	4. {2.754731, 3.560457, 13.256493}	4. {0.910887, 6.886783, 12.154937}
5. {0, 0, 14}	5. {-0.923981, 3.560457, 13.508124}	5. {-2.712312, 6.886783, 11.883416}
6. {-3.623467, 0, 13.522962}	6. {-4.534165, 3.560457, 12.757919}	6. {-6.09451, 6.886783, 10.556001}
7. {-7.0, 0, 12.124356}	7. {-7.808071, 3.560457, 11.061517}	7. {-8.935184, 6.886783, 8.290639}
8. {-9.899495, 0, 9.899495}	8. {-10.502889, 3.560457, 8.544734}	8. {-10.981928, 6.886783, 5.288618}
9. {-12.124356, 0, 7.0}	9. {-12.418755, 3.560457, 5.394226}	9. {-12.052879, 6.886783, 1.816679}
10. {-13.522962, 0, 3.623467}	10. {-13.413578, 3.560457, 1.843654}	10. {-12.052879, 6.886783, -1.816679}
11. {-14, 0, 0}	11. {-13.413578, 3.560457, -1.843654}	11. {-10.981928, 6.886783, -5.288618}
12. {-13.522962, 0, -3.623467}	12. {-12.418755, 3.560457, -5.394226}	12. {-8.935184, 6.886783, -8.290639}
13. {-12.124356, 0, -7}	13. {-10.502889, 3.560457, -8.544734}	13. {-6.09451, 6.886783, -10.556001}
14. {-9.899495, 0, -9.899495}	14. {-7.808071, 3.560457, -11.061517}	14. {-2.712312, 6.886783, -11.883416}
15. {-7, 0, -12.124356}	15. {-4.534165, 3.560457, -12.757919}	15. {0.910887, 6.886783, -12.154937}
16. {-3.623467, 0, -13.522962}	16. {-0.923981, 3.560457, -13.508124}	16. {4.453149, 6.886783, -11.346439}
17. {0, 0, -14}	17. {2.754731, 3.560457, -13.256493}	17. {7.59973, 6.886783, -9.52976}
18. {3.623467, 0, -13.522962}	18. {6.229137, 3.560457, -12.021689}	18. {10.071041, 6.886783, -6.86632}
19. {7, 0, -12.124356}	19. {9.241556, 3.560457, -9.895291}	19. {11.647496, 6.886783, -3.592777}
20. {9.899495, 0, -9.899495}	20. {11.568572, 3.560457, -7.035004}	20. {12.18902, 6.886783, 0}
21. {12.124356, 0, -7}	21. {13.037599, 3.560457, -3.652964}	
22. {13.522962, 0, -3.623467}	22. {13.539688, 3.560457, 0}	
23. {14, 0, 0}		

{3}	{4}	{5}
0. {9.359053, 9.760242, 3.625716}	0. {6.256689, 11.991877, 3.612301}	0. {1.968653, 13.43494, 3.409807}
1. {7.417297, 9.760242, 6.761759}	1. {3.612301, 11.991877, 6.256689}	1. {-1.968653, 13.43494, 3.409807}
2. {4.473794, 9.760242, 8.98459}	2. {0, 11.991877, 7.224602}	2. {-3.937307, 13.43494, 0}
3. {0.926081, 9.760242, 9.994001}	3. {-3.612301, 11.991877, 6.256689}	3. {-1.968653, 13.43494, -3.409807}
4. {-2.746705, 9.760242, 9.653667}	4. {-6.256689, 11.991877, 3.612301}	4. {1.968653, 13.43494, -3.409807}
5. {-6.048533, 9.760242, 8.009552}	5. {-7.224602, 11.991877, 0}	5. {3.937307, 13.43494, 0}
6. {-8.533473, 9.760242, 5.283703}	6. {-6.256689, 11.991877, -3.612301}	
7. {-9.865921, 9.760242, 1.84426}	7. {-3.612301, 11.991877, -6.256689}	
8. {-9.865921, 9.760242, -1.84426}	8. {0, 11.991877, -7.224602}	
9. {-8.533473, 9.760242, -5.283703}	9. {3.612301, 11.991877, -6.256689}	
10. {-6.048533, 9.760242, -8.009552}	10. {6.256689, 11.991877, -3.612301}	
11. {-2.746705, 9.760242, -9.653667}	11. {7.224602, 11.991877, 0}	
12. {0.926081, 9.760242, -9.994001}		
13. {4.473794, 9.760242, -8.98459}		
14. {7.417297, 9.760242, -6.761759}		
15. {9.359053, 9.760242, -3.625716}		
16. {10.036816, 9.760242, 0}		

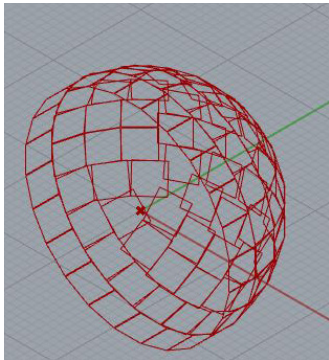
004 Vector placement



two point vector from (0,0,0) to hemisphere point



perpendicular planes created

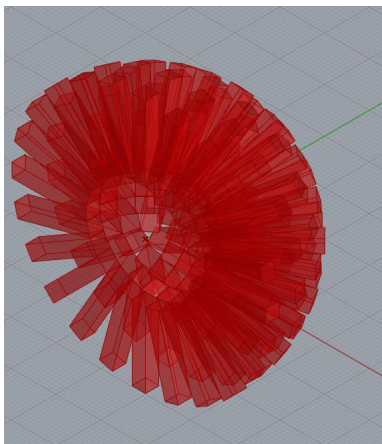


$w_t = 3.6 \text{ cm}$

rectangles created

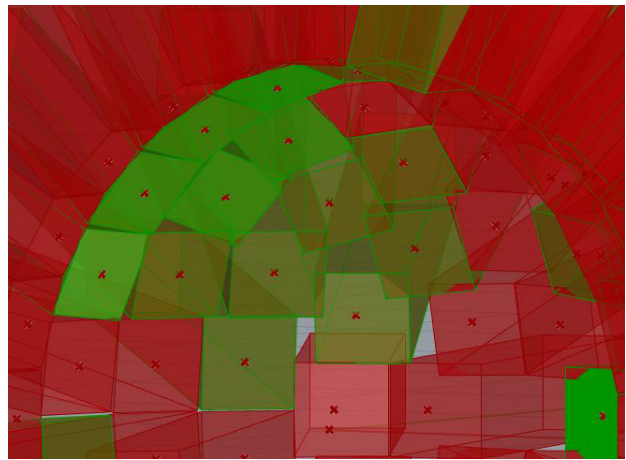
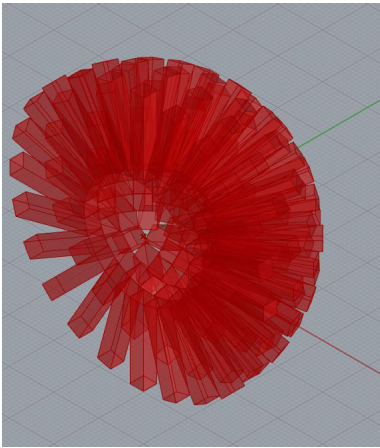
005 Box extrusion -

$l = 20 \text{ cm}$

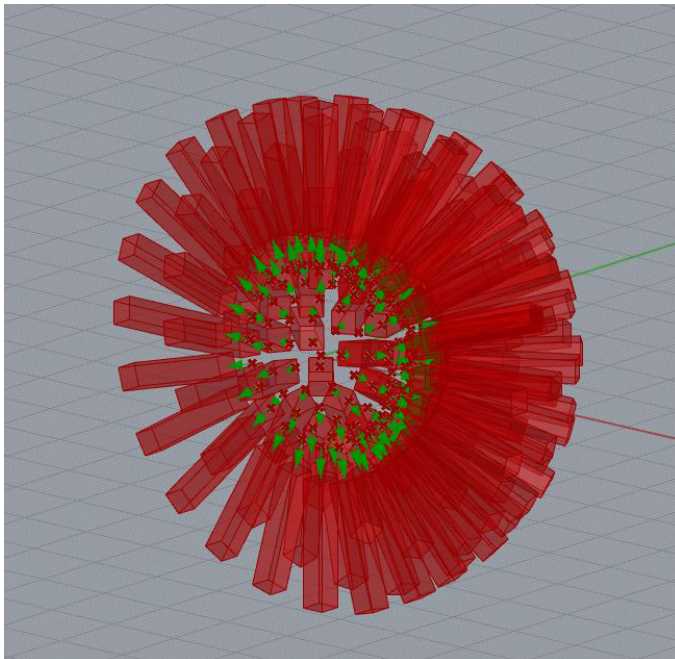


extruded along vector by 20 cm

006 Box collisions - 82 of 103

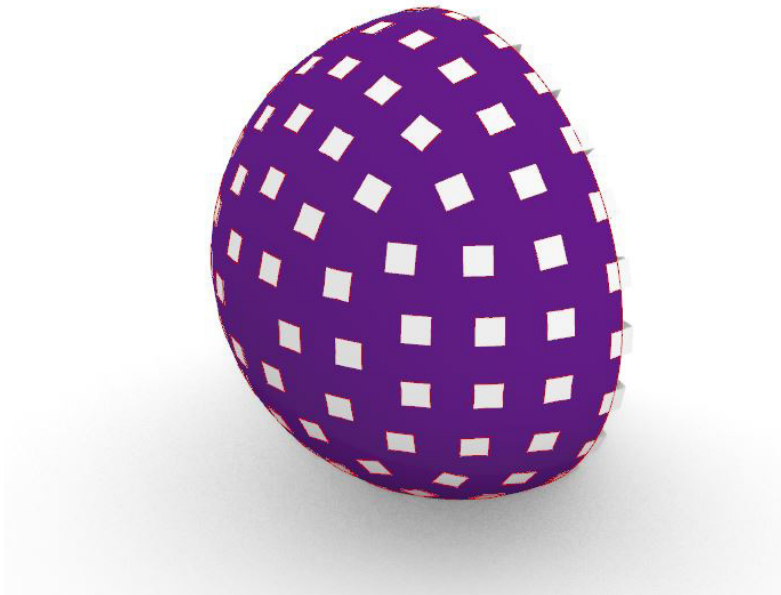
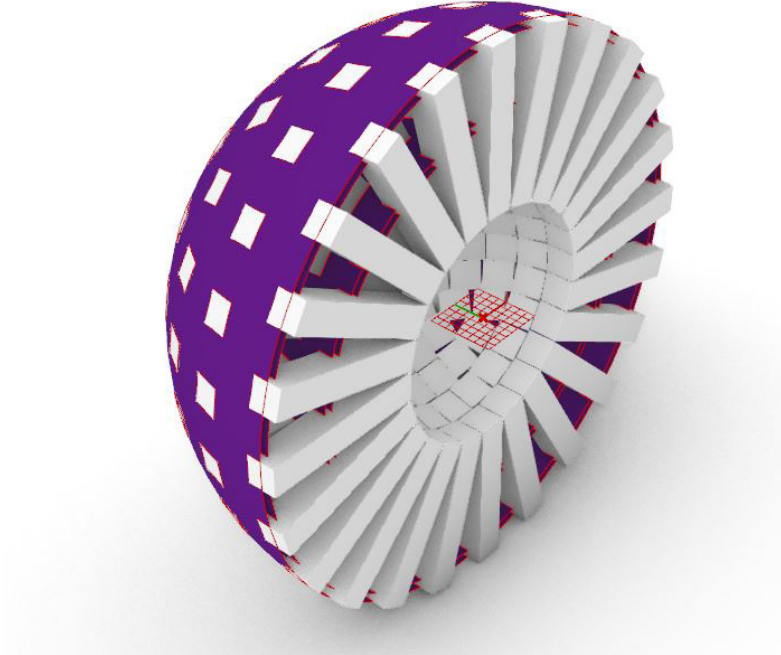


006 Possible solution: Vector amplified by 6cm

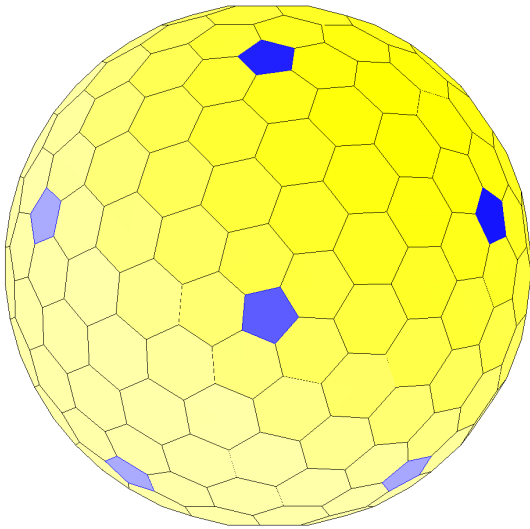


no collisions but greater separation

007 shield construction - 2 shells - 1 cm depths



008 Goldberg polyhedron 8



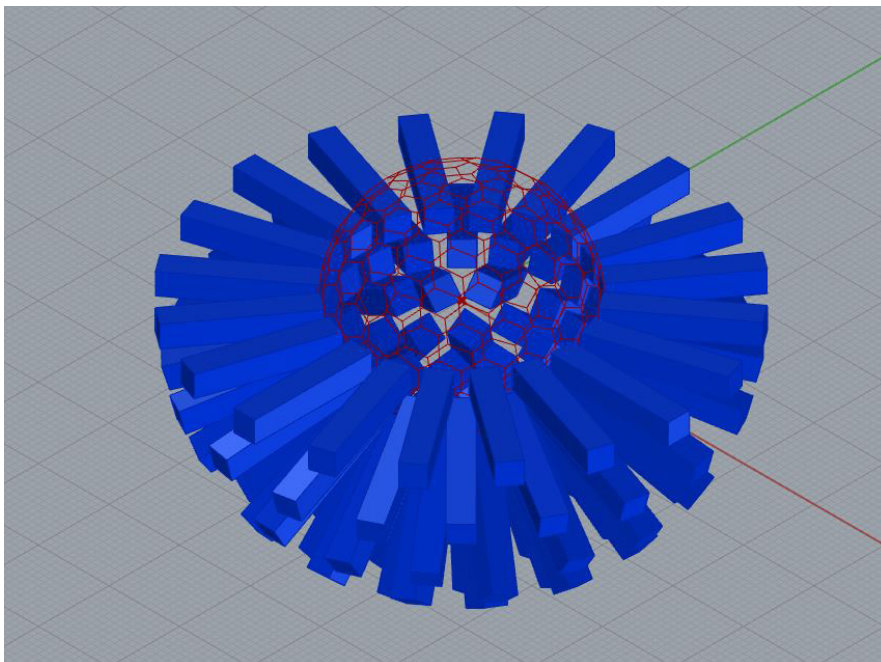
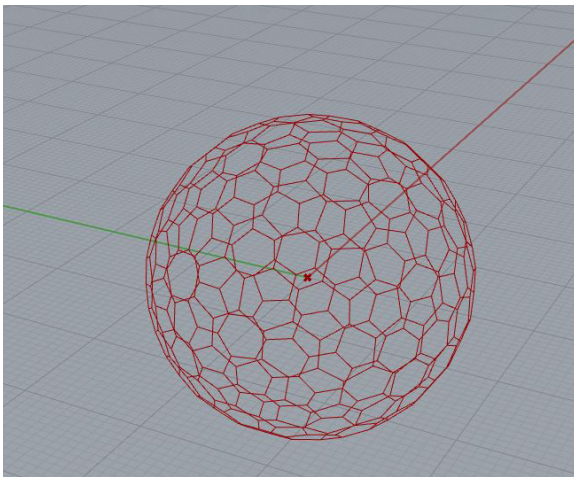
$R_{\text{int}} = 17 \text{ cm}$ - no collisions

85 magnets

wire mesh structure

modularize structure with magnet

fits within hexagon



Goldberg polyhedron coordinates - (x,y,z) - {ring position}

{3.57485, 2.59728, -16.416405}
{3.57485, -2.59728, -16.416405}
{-1.365471, 4.202488, -16.416405}
{-1.365471, -4.202488, -16.416405}
{-4.418757, 3.2134e-11, -16.416405}
{2.392286, 7.362699, -15.135778}
{2.392286, -7.362699, -15.135778}
{-6.263086, 4.550398, -15.135778}
{-6.263086, -4.550398, -15.135778}
{7.7416, 3.4927e-11, -15.135778}
{-2.761817, 8.5, -14.461064}
{-2.761817, -8.5, -14.461064}
{7.230532, 5.253289, -14.461064}
{7.230532, -5.253289, -14.461064}
{-8.937429, 3.6398e-11, -14.461064}
{1.009797, 11.617562, -12.3708}
{1.009797, -11.617562, -12.3708}
{-10.736914, 4.550398, -12.3708}
{-10.736914, -4.550398, -12.3708}
{-7.645575, 8.805262, -12.3708}
{-7.645575, -8.805262, -12.3708}
{6.011689, 9.992349, -12.3708}
{6.011689, -9.992349, -12.3708}
{11.361003, 2.62965, -12.3708}
{11.361003, -2.62965, -12.3708}
{-3.926725, 12.085219, -11.293896}
{-3.926725, -12.085219, -11.293896}
{10.280301, 7.469076, -11.293896}
{10.280301, -7.469076, -11.293896}
{-12.707151, 3.2142e-11, -11.293896}
{4.468715, 13.753289, -8.937429}
{4.468715, -13.753289, -8.937429}
{-11.699246, 8.5, -8.937429}
{-11.699246, -8.5, -8.937429}
{14.461064, 3.1929e-11, -8.937429}
{-0.351876, 14.682499, -8.562954}
{-0.351876, -14.682499, -8.562954}
{-8.345483, 12.085219, -8.562954}
{-8.345483, -12.085219, -8.562954}
{13.855151, 4.871796, -8.562954}
{13.855151, -4.871796, -8.562954}
{8.91483, 11.671564, -8.562954}
{8.91483, -11.671564, -8.562954}
{-14.072622, 4.202488, -8.562954}
{-14.072622, -4.202488, -8.562954}
{2.488311, 16.167961, -4.6292}
{-11.516375, 11.617562, -4.6292}
{2.488311, -16.167961, -4.6292}
{-11.516375, -11.617562, -4.6292}
{16.145575, 2.62965, -4.6292}
{16.145575, -2.62965, -4.6292}
{-14.607714, 7.362699, -4.6292}
{-14.607714, -7.362699, -4.6292}
{7.490203, 14.542747, -4.6292}
{7.490203, -14.542747, -4.6292}
{11.645772, 11.671564, -4.144197}
{11.645772, -11.671564, -4.144197}
{-7.501575, 14.682499, -4.144197}
{-7.501575, -14.682499, -4.144197}
{-2.561254, 16.287706, -4.144197}
{-2.561254, -16.287706, -4.144197}
{14.699058, 7.469076, -4.144197}
{14.699058, -7.469076, -4.144197}
{-16.282001, 2.59728, -4.144197}
{-16.282001, -2.59728, -4.144197}
{17.0, 3.4918e-11, -0.155372}
{-13.753289, 9.992349, -0.155372}
{-13.753289, -9.992349, -0.155372}
{5.253289, 16.167961, -0.155372}
{5.253289, -16.167961, -0.155372}
{-9.99235, 13.753289, -9.3724e-8}
{-9.99235, -13.753289, -9.3724e-8}
{16.167961, -5.253289, -5.9724e-8}
{16.167961, 5.253289, -5.9724e-8}
{2.4087e-8, -17.0, -3.7568e-8}
{2.15e-8, 17.0, -2.8335e-8}
{-16.167961, 5.253289, -1.5421e-8}
{-16.167961, -5.253289, -1.5417e-8}
{9.99235, 13.753289, 1.8574e-8}
{9.99235, -13.753289, 1.8577e-8}
{-5.253289, 16.167961, 0.155372}
{-5.253289, -16.167961, 0.155372}
{13.753289, -9.992349, 0.155372}
{13.753289, 9.992349, 0.155372}
{-17.0, 3.4928e-11, 0.155372}