# Construction Manual: EIT-Phantom-Positioning-System

*Version 1.0*

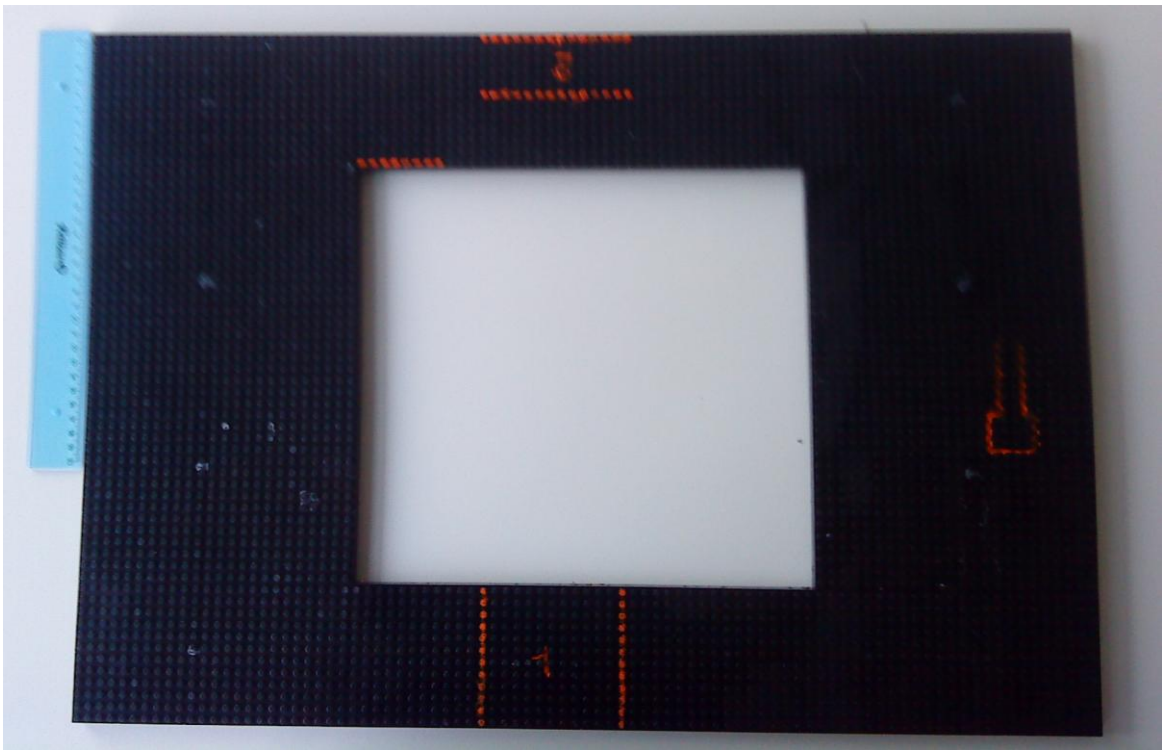
*06.10.2009 by Sascha Reidt*

## Contents



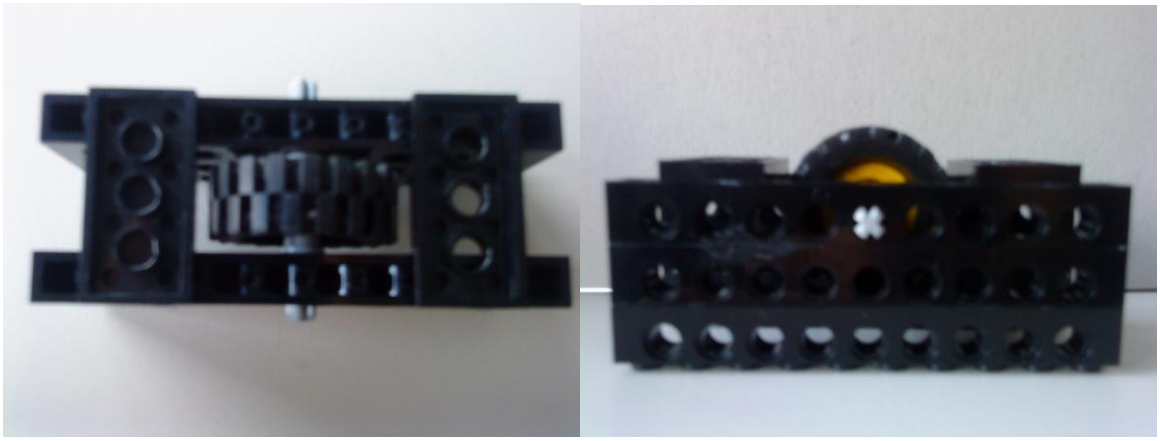
**NOTE**: The following tables are just a help to estimate the number of bricks you will have to order. I haven’t count the number of connectors or rivets I have used, but you will need them too. I recommend buying much more bricks then I wrote in the tables. To order the bricks, use sites like lego.com or bricklink.com.

## 1. Baseplate



The baseplate of the EIT-Phantom-Positioning-System is, as all the other parts, made of LEGO. The size is 88x60 LEGO-pimples with a 40x36 hole in the middle. I won't count the bricks I have used to build this. Just use normal LEGO-plates with a height of 1/3 and stick it four-ply together.

## 2. Wheels

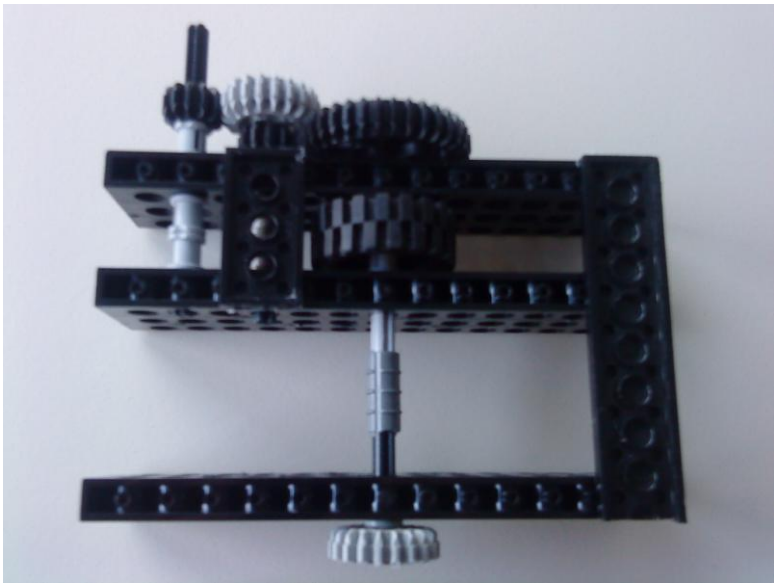


| Brick | Number |
|---|---|
| Technic, Brick 1x10 x3/3 * with Holes | 6 |
| Technic, Plate 2x4 | 2 |
| Wheel: ϕ ca. 3 cm | 1 |
| Technic, Axle: ca. 3.5 cm | 1 |

*This notation means “breadth x length x height” of the specific LEGO-brick

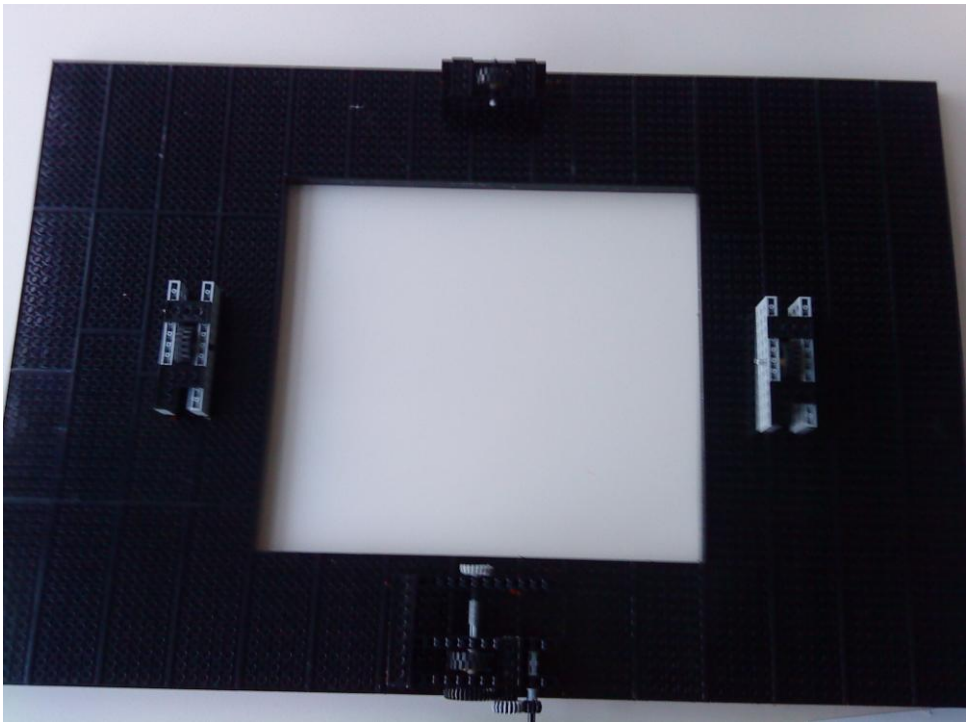
I fix the wheels as above. They will be used for the rotation of the whole system, so you have to build three of them. Make sure that the wheel is exactly in the middle of this construction. Maybe you will have to cut some rivets to the right size.

## 3. Actuation

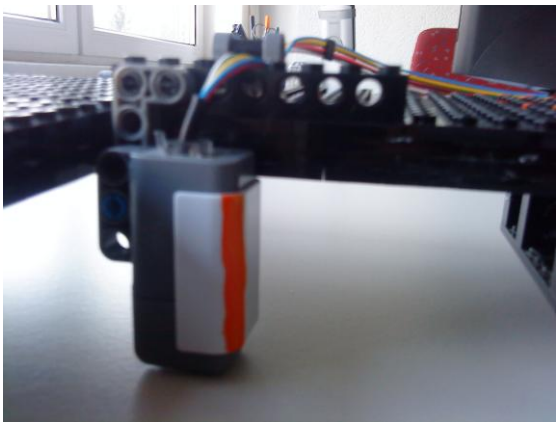


| Brick | Number |
|---|---|
| Technic, Brick 1 x 14 with Holes | 9 |
| Technic, Plate 2 x 4 | 1 |
| Wheel: ϕ ca. 3 cm | 1 |
| Technic, Axle: ca. 9 cm | 1 |
| Technic, Axle: ca. 7 cm | 1 |
| Technic, Axle: ca. 5 cm | 1 |
| Technic, Gear 20 tines | 2 |
| Technic, Gear 12 tines | 2 |
| Technic, Gear 36 tines | 1 |

One motor will use this construction to rotate the whole system.

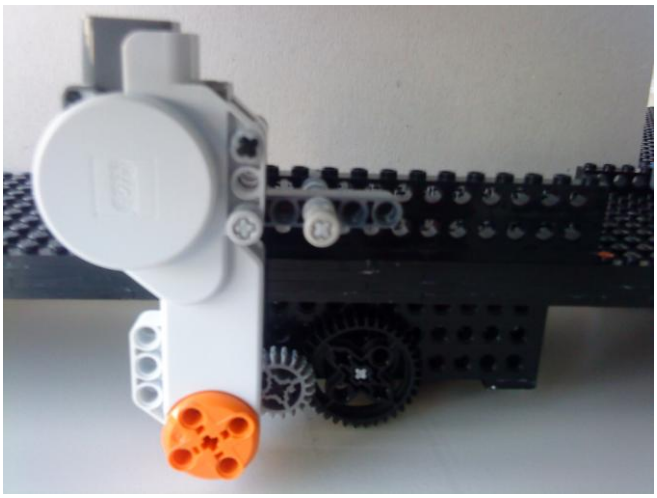


## 4. Light-Sensor



Use a construction like this to fix the light-sensor. It should be on the same side as the actuation of the rotation.

## 5. Rotation-Motor



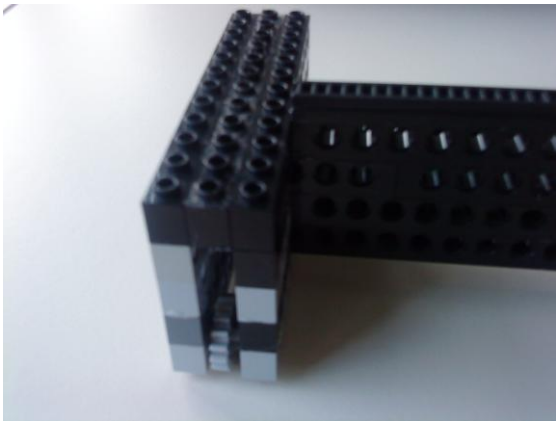
Fix one motor as above on the baseplate. Stick it on the axle so that the motor is able to rotate the whole plate.

## 6. y-Bar

| Brick | Number |
|---|---|
| Technic, Brick 1 x 12 with Holes | 4 |
| Technic, Rack 1 x 4 | 12 |

These are the “rails” for the y-action. So you will need two of them, one on each side.

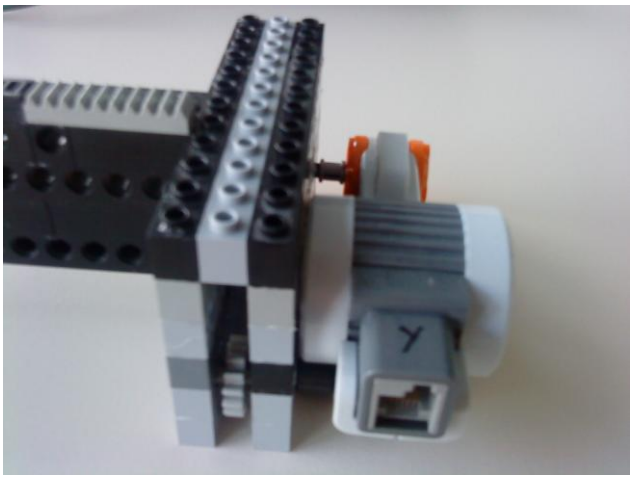
## 7. Carriage 1



| Brick | Number |
|---|---|
| Technic, Brick 1 x 12 with Holes | 7 |
| Technic, Brick 1 x 4 with Holes | 8 |
| Technic, Brick 1 x 2 with Holes | 4 |
| Technic, Gear 16 tines | 2 |
| Technic, Axle: ca. 2cm | 2 |

This is carriage 1. It is part of the movable x-axis and with a “bridge” connected to carriage 2. It uses gears to move on the y-axis.

## 8. Carriage 2



| Brick | Number |
|---|---|
| Technic, Brick 1 x 12 with Holes | 9 |
| Technic, Brick 1 x 4 with Holes | 8 |
| Technic, Brick 1 x 2 with Holes | 4 |
| Technic, Gear 16 tines | 2 |
| Technic, Axle: ca. 2cm | 2 |

| | |
|---|---|
| NXT-Motor | 1 |

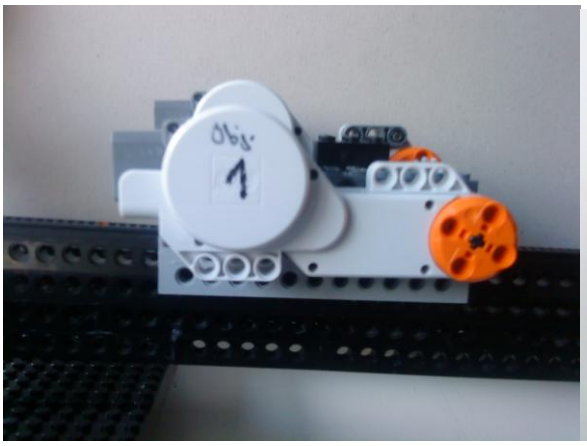
This is carriage 2 with a NXT-Motor. It is part of the movable x-axis and with a “bridge” connected to carriage 1. It uses gears to move on the y-axis.

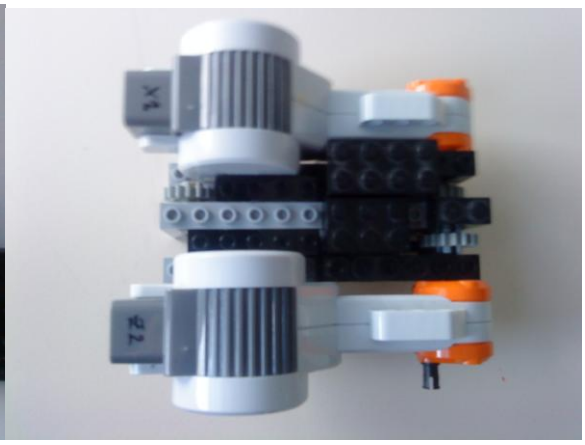
## 9. Bridge

| Brick | Number |
|---|---|
| Technic, Brick 1 x ? with Holes | 7 times for a length of 70 LEGO-pimples |
| Technic, Rack 1 x 4 | 16 |
| Technic, Flat Tile 1x4x(1/3) | 16 |
| Technic, Axle | For a length of ca 56 cm |

This bridge is the x-axis. The length is 70 LEGO-pimples with both carriages. The upper axle is there to translate the rotation to the other side. The part in the middle is a slide rail for carriage 3 and 4 with a height of 3 bricks. On the top of this rail are bricks called “Flat tiles”. The lowest part is again a rack for carriage 3 and 4 with a height of 4 bricks.

## 10. Carriage 3 and 4





Carriage 3 and carriage 4 are identical but mirror inverted. Both use one motor for the x-movement and one motor for the z-movement. It uses gears to move on the x-axis as well as to move the z-axis with the object.

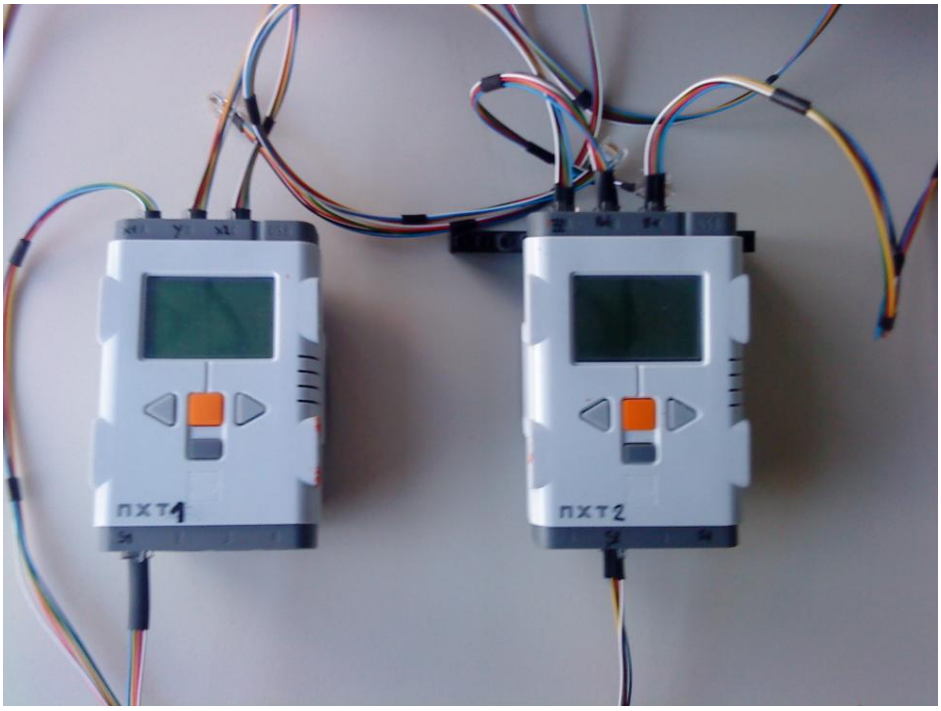
| Brick | Number |
|---|---|
| Technic, Brick 1 x 12 with Holes | 8 |
| Technic, Brick 1 x 6 with Holes | 2 |
| Technic, Brick 1 x 8 with Holes | 4 |
| Technic, Gear 16 tines | 4 |
| Technic, Axle: ca. 2.5cm | 2 |
| Technic, Axle ca 5cm | 2 |
| Brick 1x6x1/3 | 2 |
| NXT-Motor | 2 |

## 11. z-axis

This is the z-axis where the objects will be fixed. Again you will need two of them. It is again a rack with some LEGO-Bricks with a height of 1/3. Just “stick” the two axis into carriage 3 and 4 to let them move up and down. To fix the object, I cut a thread into a LEGO-Brick and use a threaded bar to connect it with the objects. Just dispense your creativity.

| Brick | Number |
|---|---|
| Technic, Brick 1 x ? with Holes | For a length of 62 LEGO-pimples |
| Technic, Rack 1 x 4 | 15 |

## 12. Controllers “Mindstorms NXT”

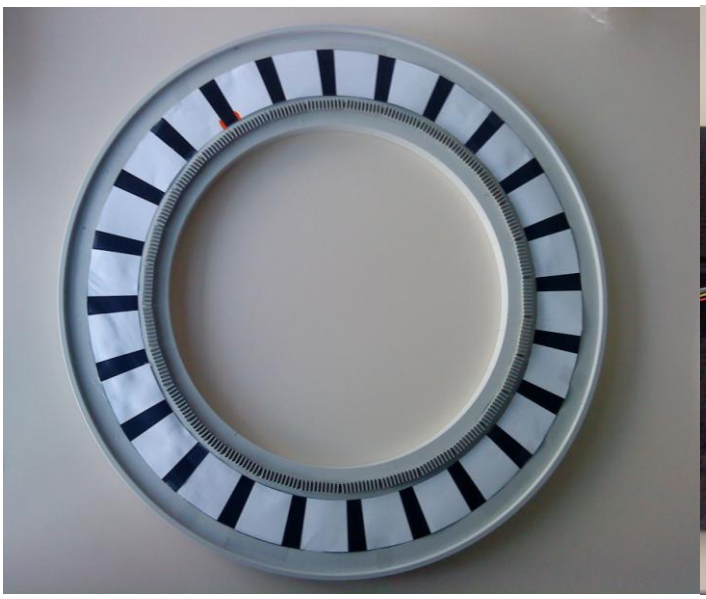


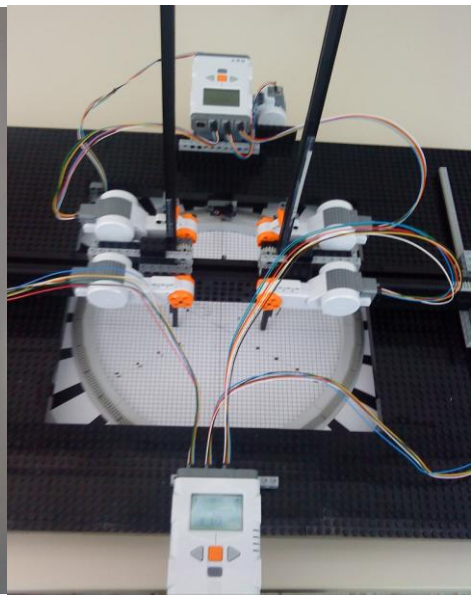

You will need two controllers to control the 7 motors. If you want to use the “EIT-P-PS” – program, you will have to load the programs “Prgm EIT-P-PS_NXT1”, “Prgm EIT-P-PS_NXT2”, “initialization_nxt1”, “initialization_nxt2” to the NXTs. Unfortunately you will have to use the Bricx Command Center 3.3, which is freeware and can be easily find on the internet, for that. Make sure that you connect the cables to the right motors.

| NXT | Output/Input | Device |
|---|---|---|
| NXT 1 | A | Motor x on carriage 3 |
| NXT 1 | B | Motor y on carriage 2 |
| NXT 1 | C | Motor x on carriage 4 |
| NXT 2 | A | Motor z on carriage 4 |
| NXT 2 | B | Motor rotation |
| NXT 2 | C | Motor z on carriage 3 |
| NXT 2 | 4 | Light-Sensor |

I recommend fixing NXT2 on the side with the Light-Sensor and the actuation of the rotation, and NXT1 opposite.

## 13. Ring





The whole system rotates on this grey ring. The black-white marks are for the Light-Sensor and the racks are for a gear on the actuation of the rotation.

| Brick | Number |
|---|---|
| Grey ring | 4 |
| Technic, Rack 1 x 4 | ~ 30 |
| Light-marks | lightmarks.doc |

Now you should be able to put all parts together. To know how to control the EIT-P-PS, please read the “User Guide”. For more information about the whole system and especially the programs, read “Bericht_EIT-P-PS”.