



# X400 3D-Printer Manual

German RepRap GmbH

<https://www.germanreprap.com>

# **X400 3D Printer Manual**

von German RepRap GmbH

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Abbildung 1. X400 3D Printer



*The X400 3D printer is a large-capacity rapid prototyper. Its main advantage is the considerably larger printing space of about 56 liter. On top of that, it is possible to extend and modify it.*

This manual is divided into several sections. Starting with the assembly, then the installation of the software and firmware and on to the commissioning and troubleshooting.



# Kapitel 1. Security Notes

Below you will find important notes for the assembly, operation and maintenance of the printer. Please read these notes thoroughly before operating the device.



Work on a mains power supply should only be carried out by trained specialists. It is essential to note the safety regulations. Property or personal damage may be caused by improper installation, which the installer bears liability for.

Proper handling of the chemicals necessary for maintenance and care is obligatory, as well as complying with the regulations and operation notes regarding the chemicals. Directions of the manufacturer have to be followed at all times and appropriate protective clothing has to be worn. Property or personal damage may be caused by improper use of the chemicals, which the operator alone bears liability for.



The 400x400mm corrugated card board which comes with the heat bed is not packing material but is necessary for the correct function of the heat bed. Please do not discard it.

## 1.1. Security notes



### *Power supply*

Make sure the mains cable (power supply cable) is not damaged. Devices with damaged mains cable have to be disconnected from the mains (pull the power plug) and replaced. Only use the delivered power supply!

*Danger to life due to electric shock!*



### *Cleaning*

Pull the power plug before cleaning the device. Use a dry cloth and only clean the surface.

*Touching the internal parts of the power supply can cause an electric shock!*



### *Playing children*

Touching the internal parts of the power supply can cause an electric shock!

*Danger to life due to electrical shock!*



### *Mains voltage*

Only operate the device with the indicated supply voltage (visible on the backside of the device or on the external power supply). The device must not be connected to the mains until all connections were double checked.

*There is a fire hazard if the mains voltage is too high!*



#### *Humidity, solar radiation, heat, open fire*

Protect the device from extreme humidity, dripping and splash water (do not place any liquid-filled objects such as beverages on it). Do not place the device near a heater, do not expose it to extended direct sunlight and do not operate it in damp rooms. Only use the device in moderate and not a tropical climate. Do not put any open flames such as candles on the device!

*Fire hazard!*



#### *Ventilation*

The heat arising in the device is sufficiently discharged. Nevertheless do not install the device in a closet or in a shelf with insufficient ventilation. Never cover the ventilation slots of the device, if there are any.

Do not place any object on the device. To allow heat to dissipate, please allow at least 30cm above, 20cm to each side and 30cm behind the device unobstructed.

The device only complies the declaration of conformity if the transparent case is assembled while operating.

*Fire hazard!*



#### *Long absence, thunderstorms, accessibility of the power plug*

To completely disconnect the device from mains power just pull the power plug out of the mains socket! Make sure this socket is accessible. In case of longer absence and possible thunderstorms, switch off the device with the power switch and then disconnect it from the mains. This also applies for USB appliances connected to the device.



#### *Installation site*

Every electronic device develops heat. The heating of the device is within the permitted range though. Sensitive surfaces may discolor over time due to the constant heat exposure. Moreover, the stands of the device may cause color changes on furniture surfaces. If applicable, please place the device on a solid, appropriate and plane base!

Please mind the practicability when choosing the installation site (sufficient working height).



#### *Disposal*

Electronic equipment may not be disposed in the domestic waste - in accordance with Directive 2002/96/EG of the European Parliament and the Council of 27th of January 2003 about electric and electronic equipment it has to be professionally disposed. At the end of its use please dispose this device at one of the public collection point intended for this.

## 1.2. Important notes



### *Return shipment/ original packaging*

Please keep the original packaging for a possible return shipment! Due to their type of construction, 3D printers are very sensitive to shock and they are only adequately protected in their original packaging. The guarantee/ warranty claim for the device expires with improper shipping.



*During operation, the device must not be disconnected from the mains! Otherwise it may result in data loss and software damage.*



### *Miscellaneous*

The information this manual contains, represent the status at the time of printing. We reserve, however, the right to implement changes, every time and without advance notice. If there is a new software for your device impacting this manual (changes of menu bars and/or functions for instance) and we think it is necessary, we will provide a new manual for downloading at <https://www.germanreprap.com>



According to EMC guidelines, the USB connection cable between the device and the computer shall not be longer than 50cm.



### *Toxic hazard*

Depending on the used material, toxic dangers may appear due to overheating of the material. The operating temperature shall be followed precisely. You find them printed on the respective materials and on our websites. (<https://www.germanreprap.com>).



### *Safety shutdown*

The devices have an installed thermic protective mechanism. Reaching determined temperature values, the device shuts down automatically with an error message.



### *Maintenance*

The device has to be annually maintained by a trained professional. The technical protective mechanisms have to be checked as well as the proper condition of the mechanical components.

Therefore we offer a maintenance service. For questions, please contact us via [info@germanreprap.com](mailto:info@germanreprap.com).



Please mind your responsibility for your fellow men! Keep the manual for questions that may occur later on and in case of a change of the ownership, pass it on to the new owner.

## 1.3. Legal notes

### *Software changes/ usage of applications*



Changes on the software of the device and the usage of applications that were not provided by the company German RepRap GmbH result in the loss of the warranty claim! The costs for shipping and repair of devices that accrue due to the usage of software and applications which were not provided by the company German RepRap GmbH will have to be borne by yourself!

Therefore you should only use software and applications for your device that is provided for downloading by the company German RepRap GmbH at the website (<https://www.germanreprap.com>).

The company German RepRap GmbH does not assume any liability for data loss on internal and external storage media.

The ex factory installed software on the device/ product is functional and has the usual quality for this kind. Possible errors can technically not be excluded from software developments. Nevertheless, a defect of the delivered software is only given if the usability for a normal operation of the device/product is not given. A solely minor reduction of quality is not taken into account. A functional impairment of the software/ the program resulting from hardware defects, ambient conditions, operating error or similar, is not a software defect.



## Kapitel 2. Specification

### 2.1. Technical data

Tabelle 2.1. General technical data

<i>Floor space (L/W/H)</i>	about 650 x 650 x 700 mm, <i>without base cabinet</i>
<i>Weight</i>	about 35kg, <i>without base cabinet</i>
<i>Print area (X/Y/Z)</i>	about 400mm x 400mm x 350mm, <i>about 56 liter</i>
<i>Layer thickness</i>	min. 0,1mm, < 0,1mm <i>experimental</i>
<i>Reproduction accuracy</i>	+/- 0,01mm
<i>Tolerance</i>	+/- 0,01mm, <i>Shrinkage factor depending on the material</i>
<i>Speed</i>	max. 15mm <sup>3</sup> / second, <i>depending on the printing and the material</i>
<i>Extruder</i>	DD-Extruder 1,75mm / 3mm Material, <i>Nozzle: optionally 0,3 0,4 0,5 0,75 1,0</i>
<i>Max. operating temperature</i>	280°C
<i>Operating voltage</i>	110/240V AC, ~ 600 Watt ( <i>incl. heated bed</i> )
<i>Material</i>	ABS [S. 255], PLA [S. 256], PS [S. 256], PP, PE, HDPE, LDPE, Wood, inter alia 1.75mm/3mm

### 2.2. System requirements

Tabelle 2.2. Requirements MAC OS X

OS X 10.5 or higher
---------------------

Tabelle 2.3. Requirements Windows

Windows XP or higher
.NET framework 3.5 or higher

Tabelle 2.4. Requirements Linux

Mono Framework
OpenGL 1.5 or higher

## 2.3. Declaration of conformity



### EU-Konformitätserklärung

Declaration of conformity

Hiermit bescheinigt das Unternehmen / The company

**German RepRap GmbH**  
Kapellenstraße 8  
85622 Feldkirchen  
Germany

die Konformität des Produkts / herewith declares conformity of the product

**X400CE 3D Drucker**

Typ, Fabriknummer, usw. / Type, Serial Nuber, etc.

**X400 CE, Baujahr 2013**

Mit folgenden einschlägigen Bestimmungen / with applicable regulations below

EU-Richtlinie / EU directive:

**Maschinenrichtlinien 2006/42/EG**

**Elektromagnetische Verträglichkeit von Elektro- und Elektronikprodukten 2004/108/EG**

**Niederspannungsrichtlinie 2006/95/EG**

Angewendete harmonisierte Normen / Harmonized standards applied

**DIN EN ISO 10218-2, Industrieroboter- Sicherheitsanforderungen- Teil2: Robotersysteme**

Angewendete nationale technische Spezifikationen / National technical specifications applied

1. Verordnung zum GPSG elektrischer Betriebsmittel EMV Gesetz

9. Verordnung zum GPSG Maschinenverordnung

Feldkirchen, den 21.02.13

Unterschrift Geschäftsführung

A handwritten signature in black ink, appearing to read "Jan Giebel".

A handwritten signature in black ink, appearing to read "Florian Bautz".

# Kapitel 3. Assembly

The manual refers to the X400 3D printer by German RepRap GmbH. The necessary components are included in the complete kit.

## 3.1. Tools

A decent tool kit as well as a few consumables are necessary for the assembly of the X400 3D printer.

Allen key

- Allen key set (preferably with ball ends)

Spanners

- 5,5 mm
- 7 mm
- 10 mm
- 13 mm (for the spools stand ??? [S. 200])
- 19 mm (for Hot End union nut ??? [S. 126])

Measurement devices

- Folder rule or tape measure
- Vernier caliper
- Water level

Other tools

- Circlip pliers
- long nosed pliers
- Soldering iron
- Screwdriver (different sizes)
- Side cutter

Drill bits

- 3 mm
- 4 mm
- 6 mm
- 12 mm

Optional tools



These tools can be used to simplify some steps. The assembly, however, is possible without them.

- Cable stripper ([for the wiring \[S. 178\]](#))
- Cordless hand drill with hex bit set
- Sharp knife
- Thread locker (for example Loctite™, medium tight)
- Set of "Helping Hands" if need be with magnifier (for soldering)
- Bench vise with at least 65mm range

#### Consumables

- Tin-solder

## 3.2. Assembly overview

This overview depicts the parts used in the different steps of the assembly.

Abbildung 3.1. Aluminum profile type "horizontal A"



For all aluminum profiles, a through hole is marked with a red arrow.

Abbildung 3.2. Aluminum profile type "horizontal B"



Abbildung 3.3. Aluminum profile type "horizontal C"



Abbildung 3.4. Aluminum profile type "horizontal Y/A"



Abbildung 3.5. Aluminum profile type "horizontal Y/B"





Abbildung 3.6. Aluminum profile type "vertical"



The vertical aluminum profile does not have the holes for the profile connectors.

Abbildung 3.7. Aluminum tape



The aluminum tape is used to hide the cables inside the aluminum profiles.



Abbildung 3.8. ©Arduino MEGA 2560





Abbildung 3.10. Bowden



Abbildung 3.11. Carriage cable mount

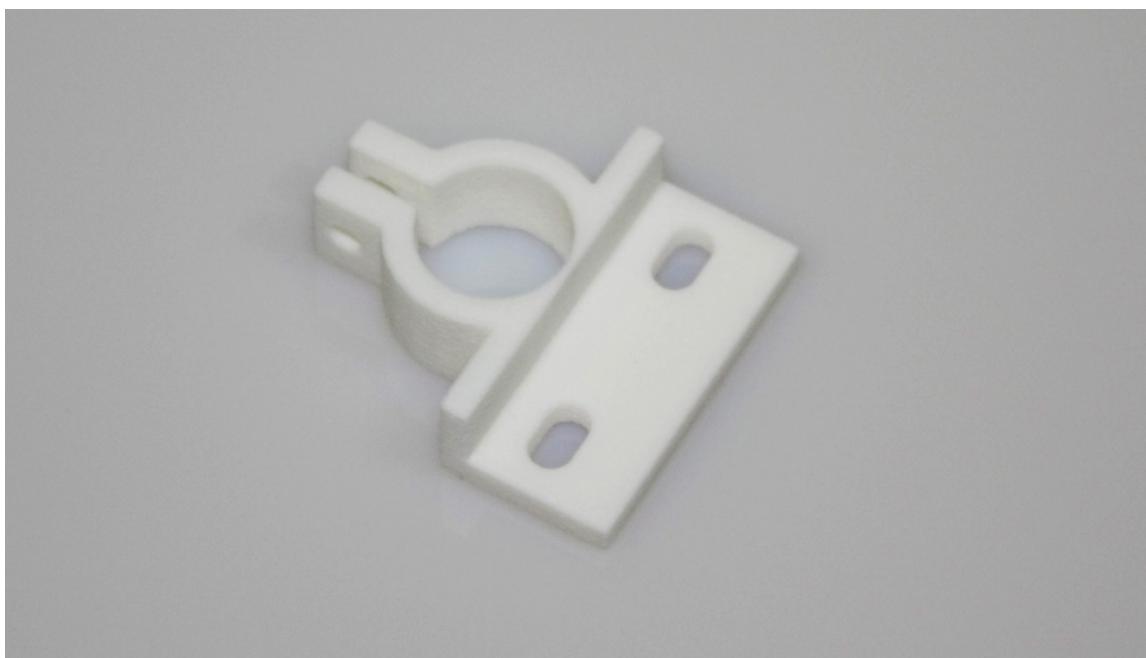




Abbildung 3.12. Carriage belt clamp



Abbildung 3.13. Carriage clamp LM12UU

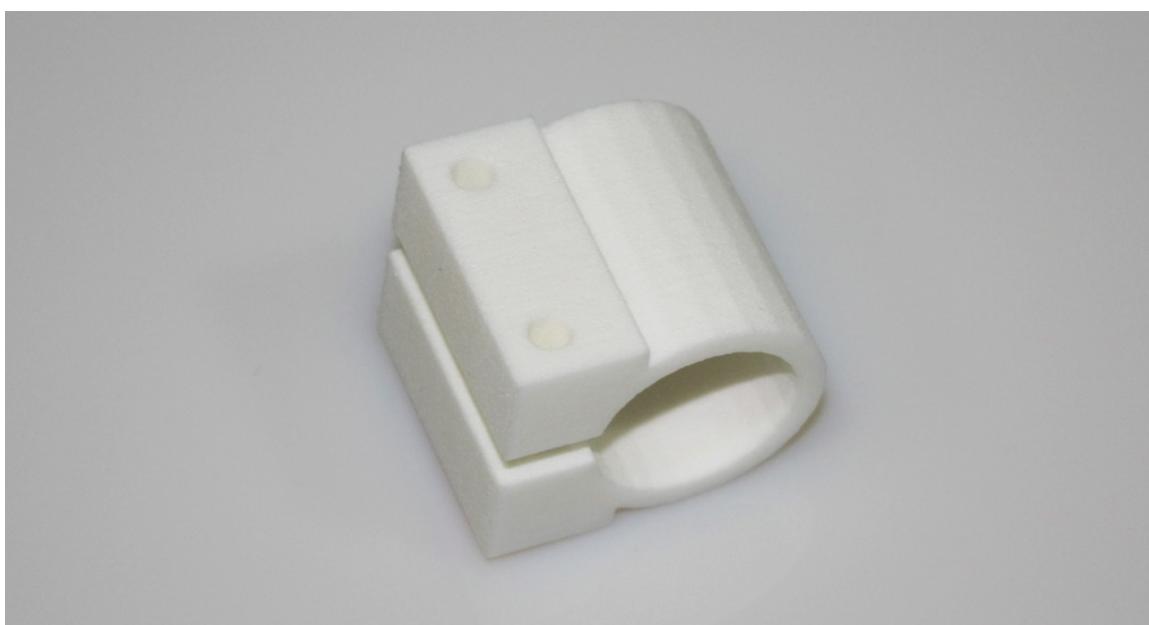




Abbildung 3.14. Carriage fan mount



Abbildung 3.15. Carriage mount





Abbildung 3.16. Ceramics plate



Abbildung 3.17. Electronics box (with lid)





Abbildung 3.18. Extruder counter bearing



Abbildung 3.19. Extruder base plate fan

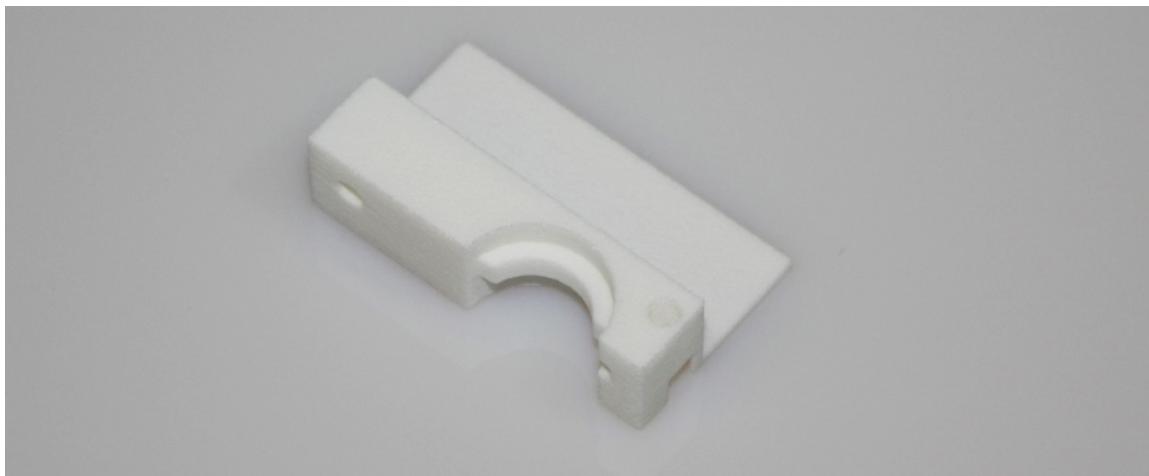


Abbildung 3.20. Extruder base plate stepper motor



Abbildung 3.21. Frame cable mount

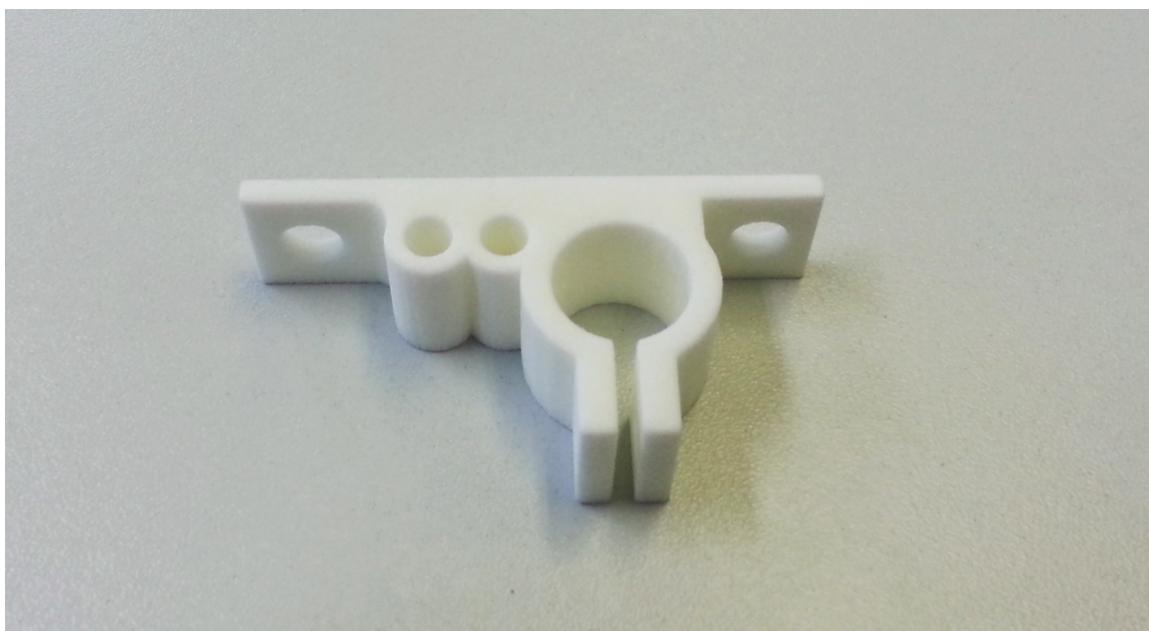


Abbildung 3.22. Guiding rods





Guiding rods (hardened surfaces) in the lengths (from top to bottom):

- 2x Y axis guiding rod, 660 mm
- 3x Z axis guiding rod, 565 mm
- 1x X axis shaft, long, 530 mm
- 1x X axis shaft, short, 500 mm

Abbildung 3.23. L-Alu Acrylic Case Doorstop

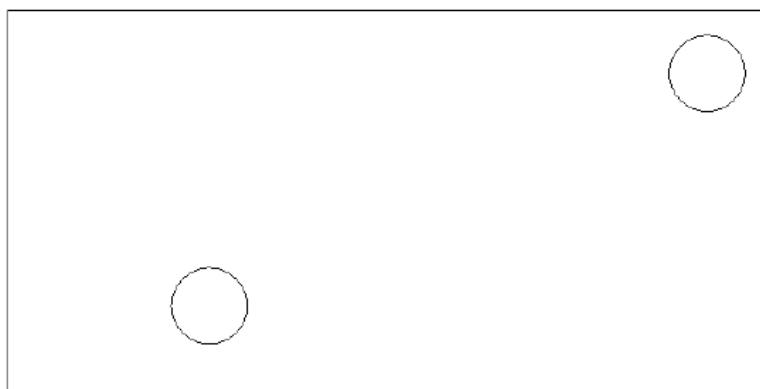
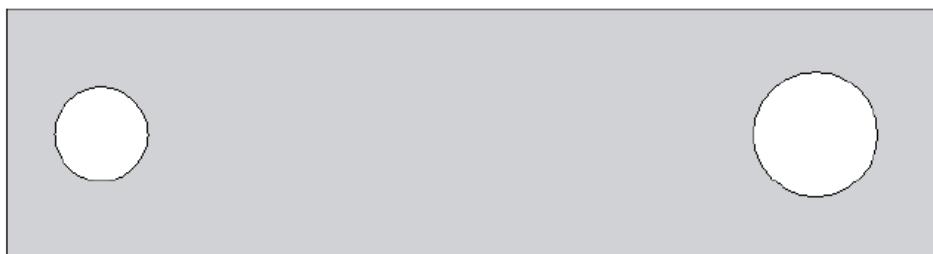


Abbildung 3.24. L-Alu Energy chain mount



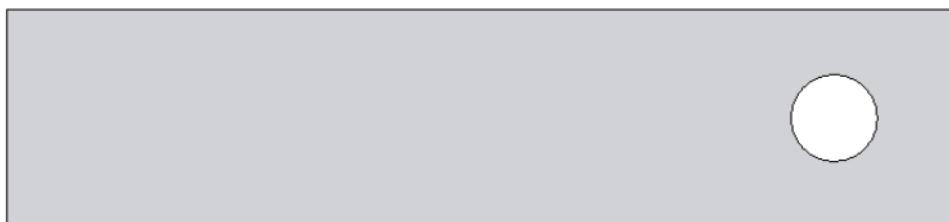
Length x width: 30 x 8 mm

Abbildung 3.25. L-Alu Energy chain holder



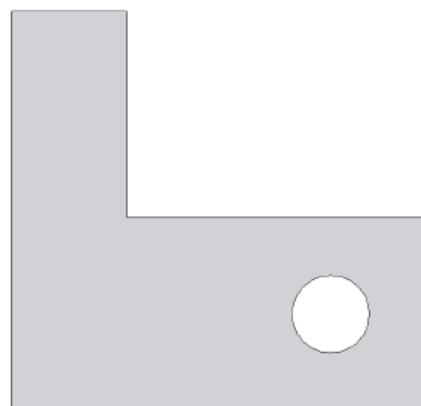
Length x width: 630 x 30 mm

Abbildung 3.26. L-ALU Opto Flag X



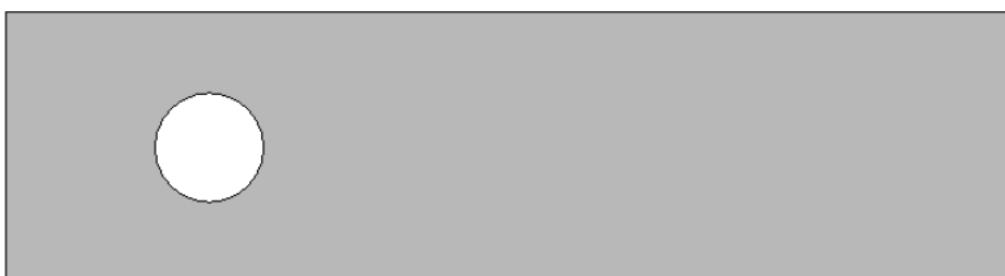
Length x width: 44 x 10 mm

Abbildung 3.27. L-Alu Opto Flag Y



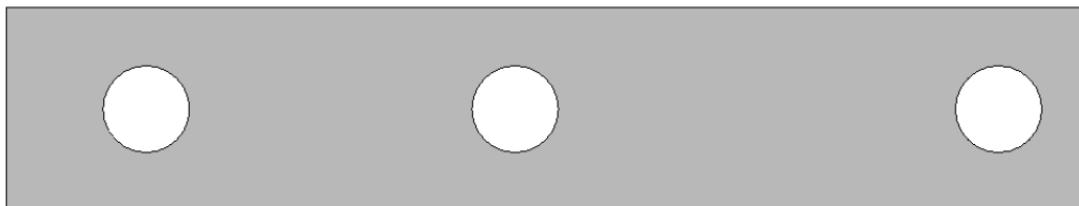
Length x width: 22 x 21 mm

Abbildung 3.28. L-Alu Opto Flag Z



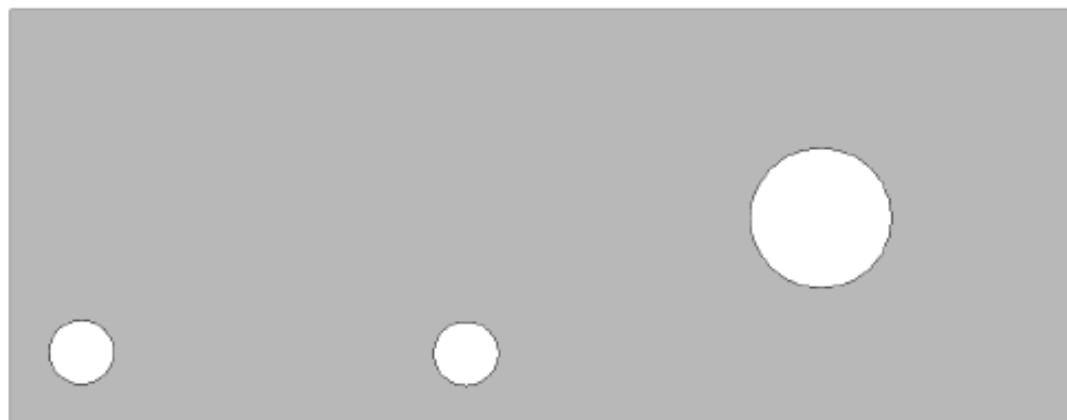
Length x width: 37 x 10 mm

Abbildung 3.29. L-Alu Y-Endstop holder



Length x width: 42 x 8 mm

Abbildung 3.30. L-Alu Z-Endstop holder



Length x width: 52 x 20 mm



Abbildung 3.31. Opto-End stop



Abbildung 3.32. Heating pad, 400x400mm 230V



Abbildung 3.33. POM NEMA 17 mount



Abbildung 3.34. POM NEMA 17 center mount



Abbildung 3.35. POM spindle center mount



Abbildung 3.36. POM spools stand, big



Abbildung 3.37. POM spools stand, small

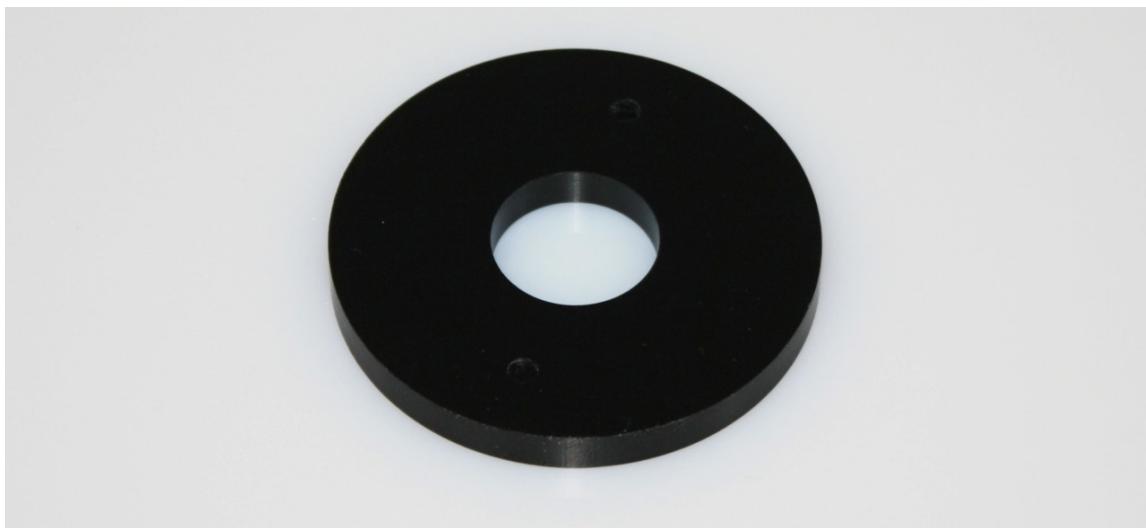


Abbildung 3.38. RAMPS v1.4

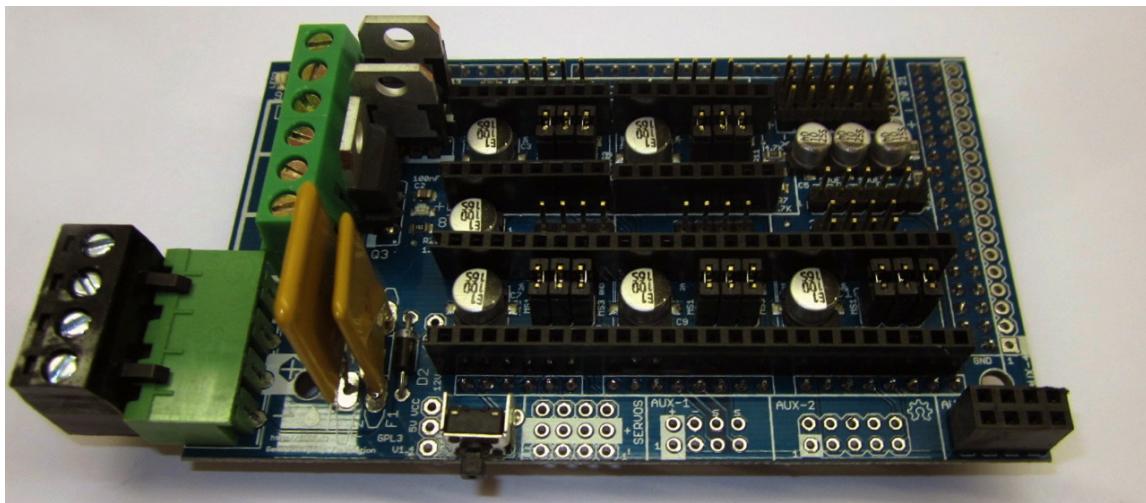


Abbildung 3.39. Trapezoidal thread



Abbildung 3.40. USB extension



Abbildung 3.41. X-Glider belt clamp





Abbildung 3.42. X-Glider clamp LM12UU

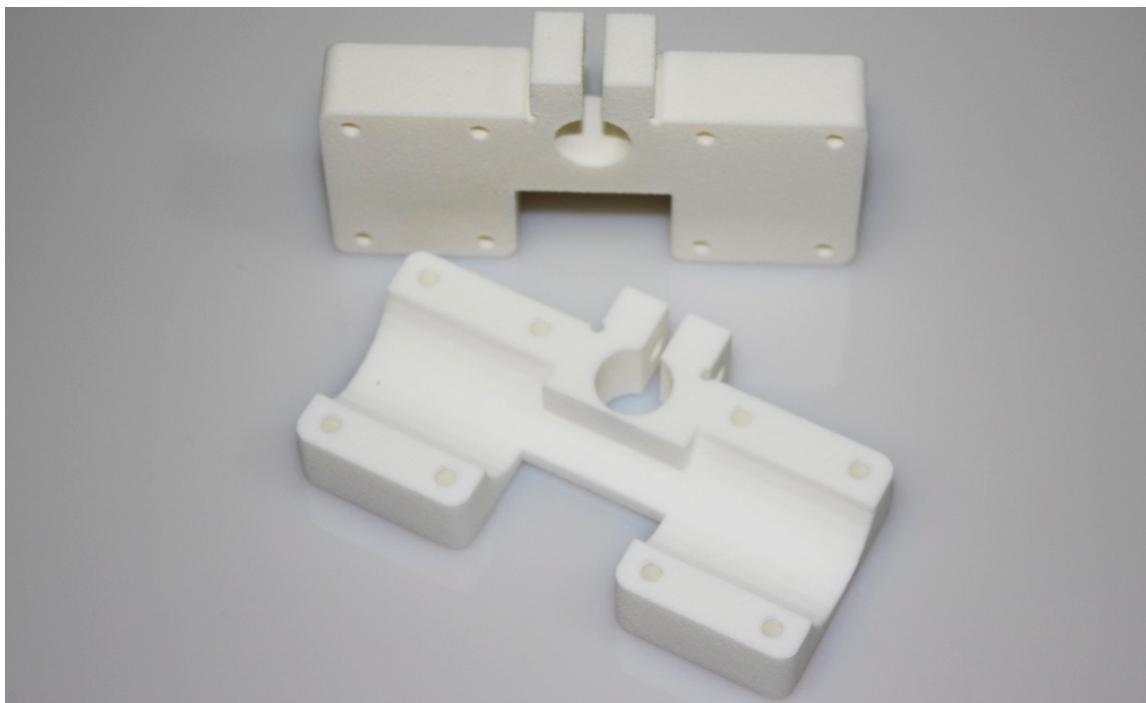


Abbildung 3.43. X-glider

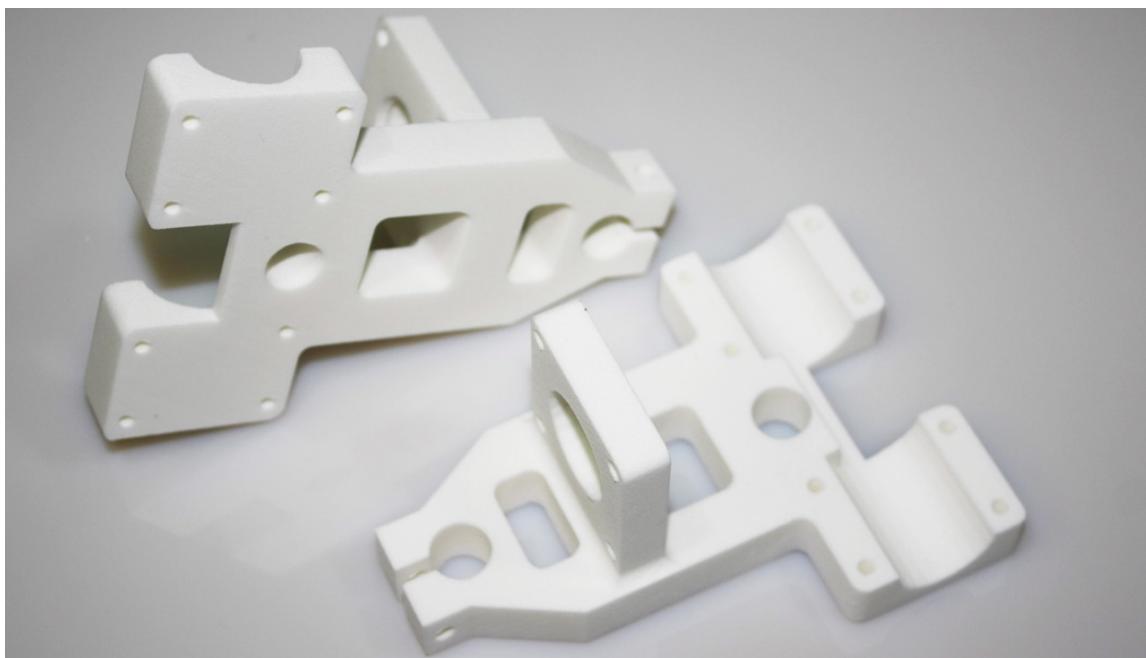




Abbildung 3.44. Z-guide, center

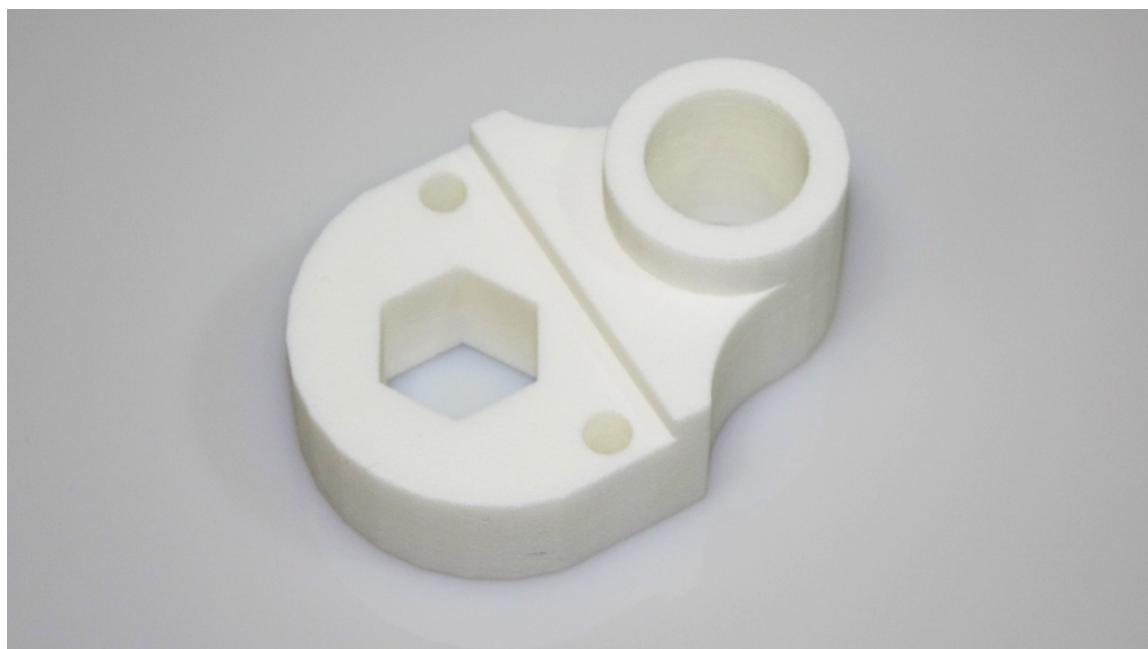
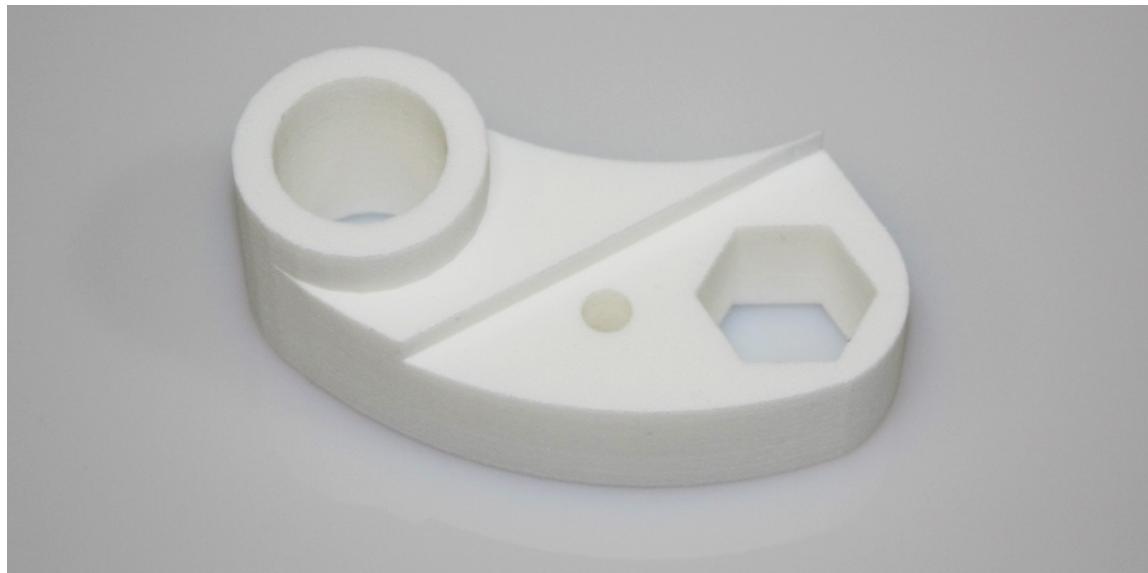


Abbildung 3.45. Z-guide, left





Abbildung 3.46. Z-guide, right



### 3.3. Basic information

Before starting the assembly, we will address some basic points.

- *Alignment:* This chapter addresses the alignment of the printer. It should be made sure to stick to the indicated measurements.
- *Drilling:* The holes inside some PP-plastic parts might be too small. If the screw or rod is not smooth-running through the hole, we recommend to enlarge the drilling to a matching size.
- *Optional extras:* This manual covers the main unit as well as all optional components.
- *Screws and nuts:* While installing screws and nuts please make sure not to over-tighten them. Otherwise components might be damaged or increased friction might result, particularly on the bearings.
- *Washers:* Washers are used to spread the forces of a screw head, a screw or the nuts on a larger space.  
Hence it is recommended to always use washers unless indicated otherwise, e.g. when using countersunk head screws or sunk cylinder head screws.
- *Cabling:* It is important to follow the circuit diagrams included in this manual lest property or personal damage may result.

In case of doubt, please seek professional help before commissioning!



Work on the 230 V mains power supply should only be carried out by trained and certified electricians. Property or personal damage or death may be caused by an improper installation, which the installer bears the liability for.

Proper handling of the chemicals necessary for maintenance and care is obligatory, as well as complying with the applicable regulations and operation notes regarding the chemicals. Directions of the manufacturer have to be followed at all times and appropriate protective clothing has to be worn. Property or personal damage may be caused by improper use of the chemicals, which the operator alone bears liability for.

## 3.4. Frame

### 3.4.1. Preparation of the rear frame rod

Tabelle 3.1. Parts list Preparation of the rear frame rod

2x Aluminum profile type "vertikal" [S. 27]	1x Aluminum profile type "horizontal Y/B" [S. 26]
1x Aluminum profile type "horizontal B" [S. 25]	4x Profile connectors
4x M6 T slot nut	4x M6x22 cylinder head screws

Abbildung 3.47. Preparation of the rear frame rod parts overview



To start off the frame we assemble the back side first. This simplifies the connections to the rest of the frame. We find the easiest way to connect the profiles is to only insert the bolt into the T-nut by one turn ([Bild "Verbindungselement" \[S. 47\]](#)) and then slide the other profile onto it.

Abbildung 3.48. Connecting element

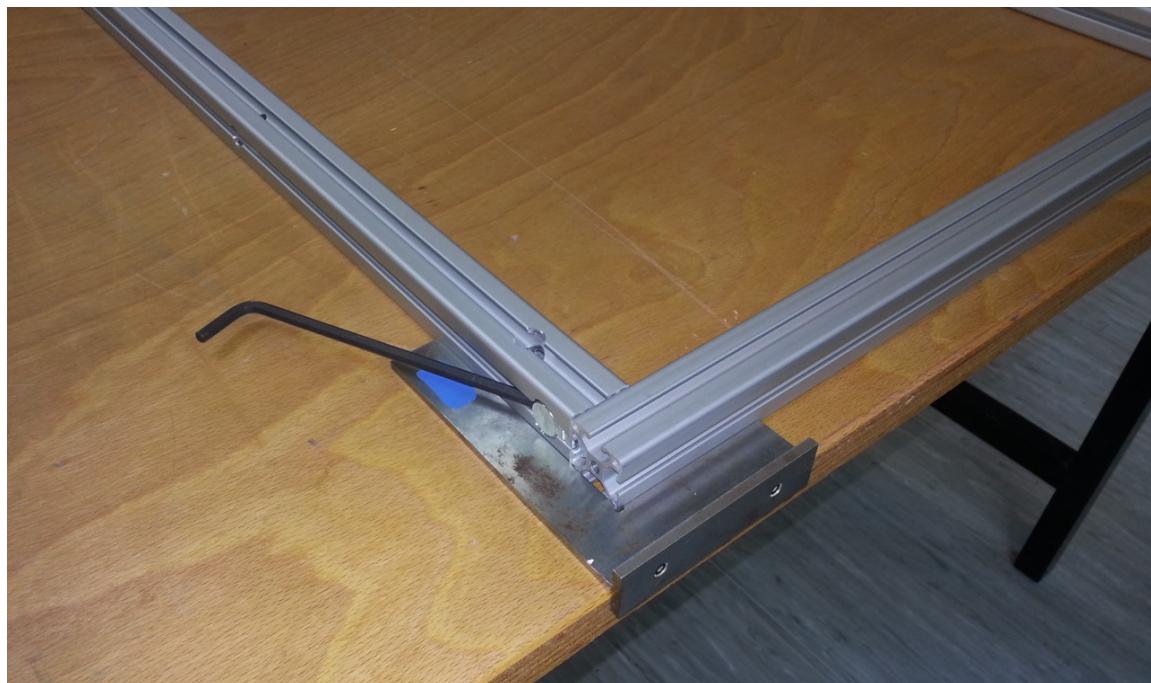


Abbildung 3.49. Details Aluminium-Profil



It's important to keep the top faces of the neighbouring profiles flush and the round connector pads on the top. A right angle helps to adjust the profiles perfectly.

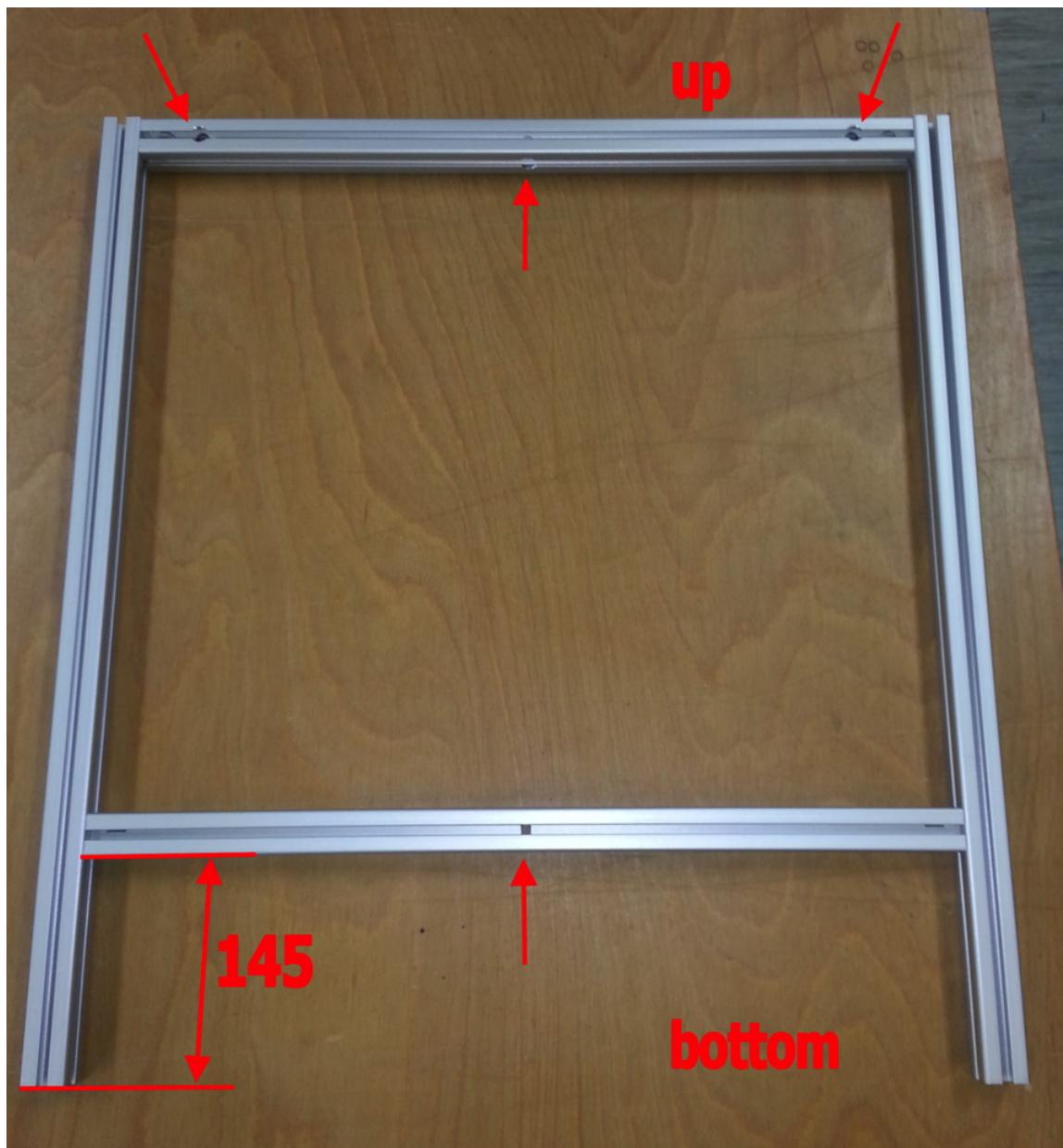
Abbildung 3.50. Details alignment In



Note that the rear part of the frame is the one with the centre hole.

The single-ended red-arrows in the pictures "Finish [S. 49]" indicate the location of the the pre-drilled holes.

Abbildung 3.51. Finish Preparation rear frame



### 3.4.2. Preparation of the front frame rod

Tabelle 3.2. Parts list Preparation of the front frame rod

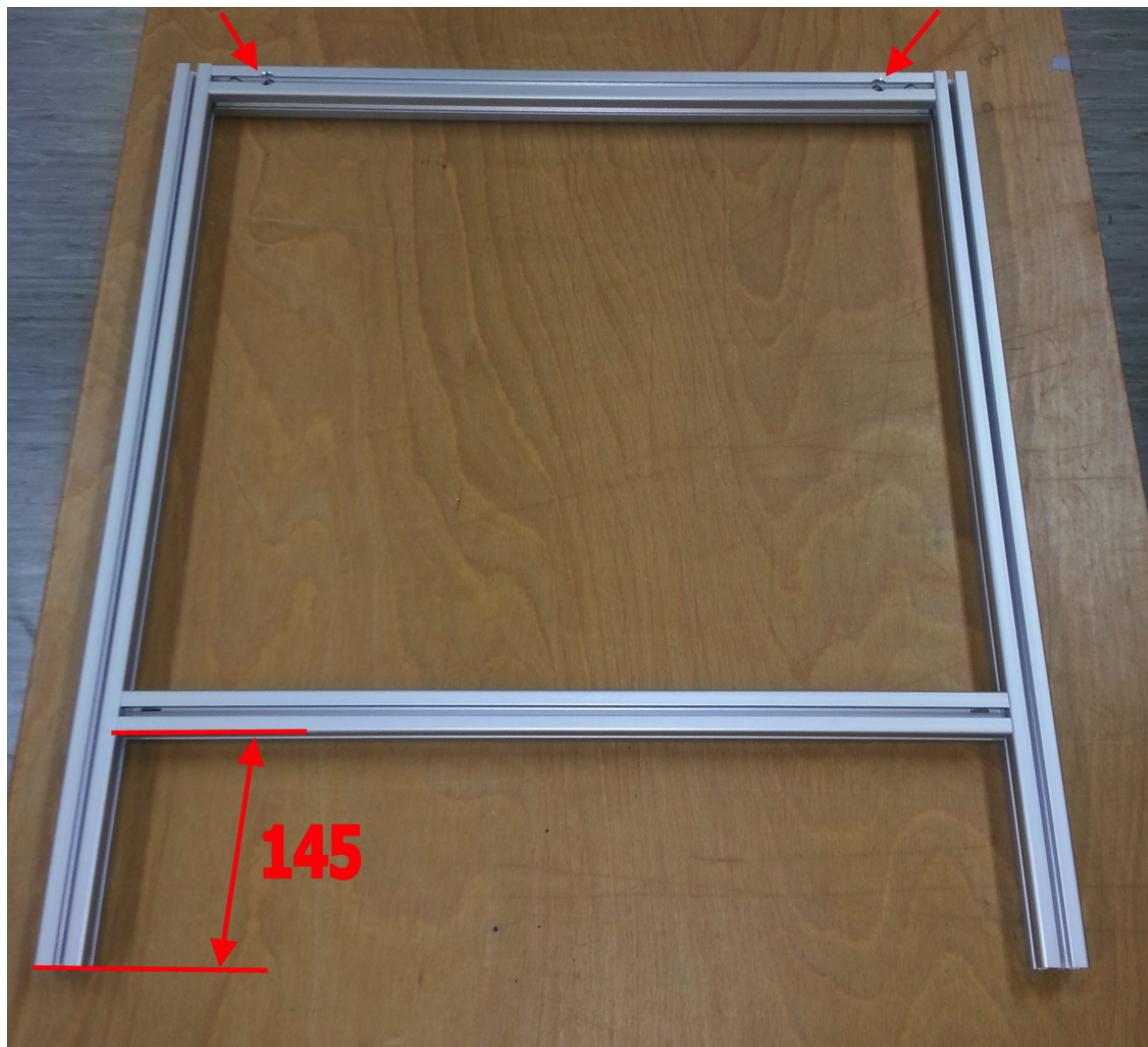
2x Aluminum profile type "vertikal" [S. 27]	1x Aluminum profile type "horizontal Y/A" [S. 26]
1x Aluminum profile type "horizontal C" [S. 25]	4x Profile connectors
4x M6 T slot nut	4x M6x22 cylinder head screws

Abbildung 3.52. Preparation of the front frame rod parts overview



The front part of the frame is being assembled in the same fashion as the back.

Abbildung 3.53. Finish Preparation of the front frame rod



### 3.4.3. Assembly frame

Tabelle 3.3. Parts list Assembly frame

4x Aluminum profile type "horizontal_A" [S. 24]	8x Profile connectors
8x M6 T slot nut	8x M6x22 cylinder head screws

Abbildung 3.54. Assembly frame parts overview



These profiles are bolted to the front frame just like in the previous steps.

It's easiest to apply some outward pressure to the bolt via the Allen key. That allows to better align the connectors. ([Bild "Details Verschraubung" \[S. 52\]](#)).

Throughout the frame all the connectors are located on the top face of the profile.

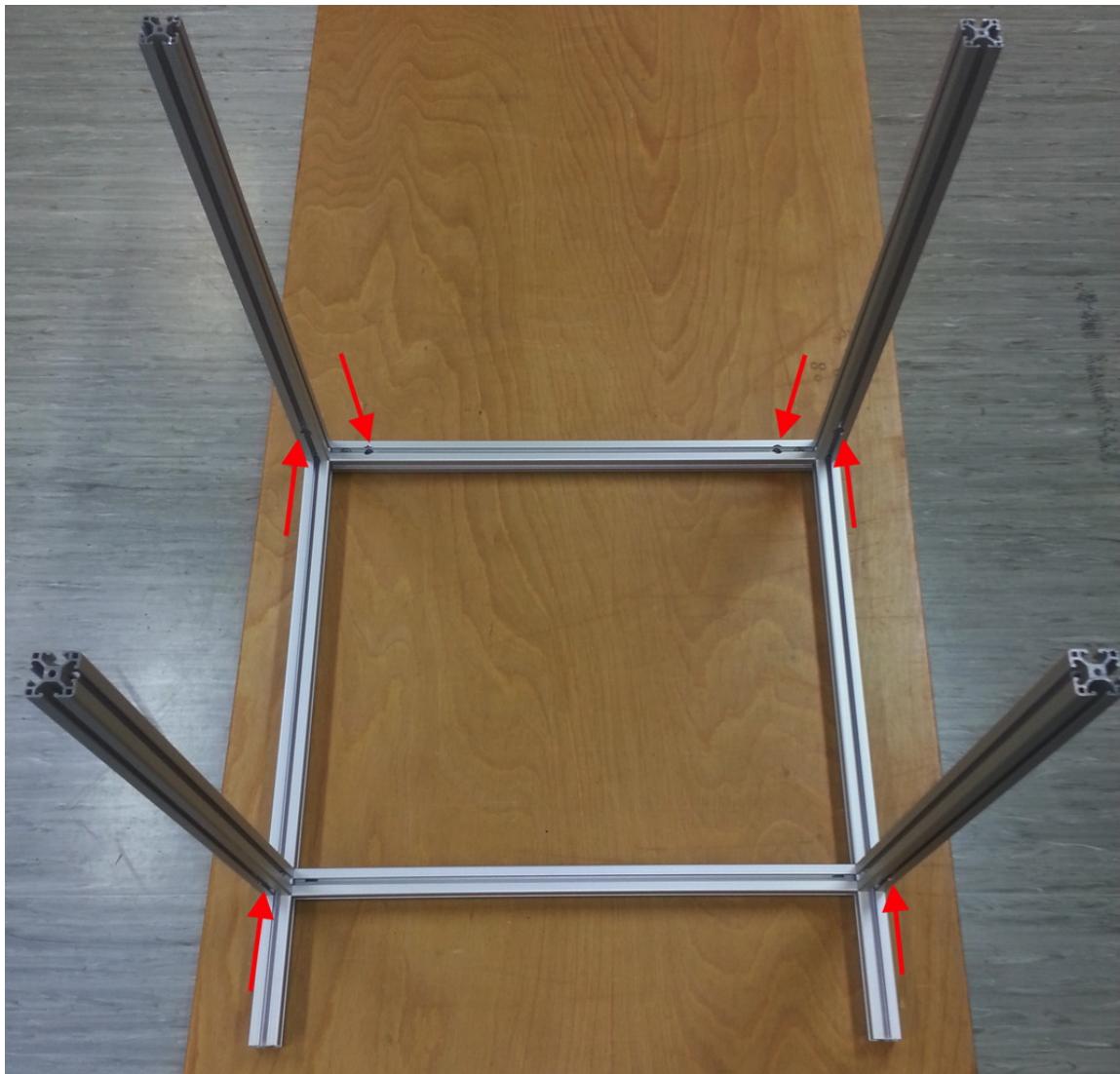
Abbildung 3.55. Details screwing



It's important to properly align the profiles. Also make sure there is no twist in the frame when tightening the bolts.

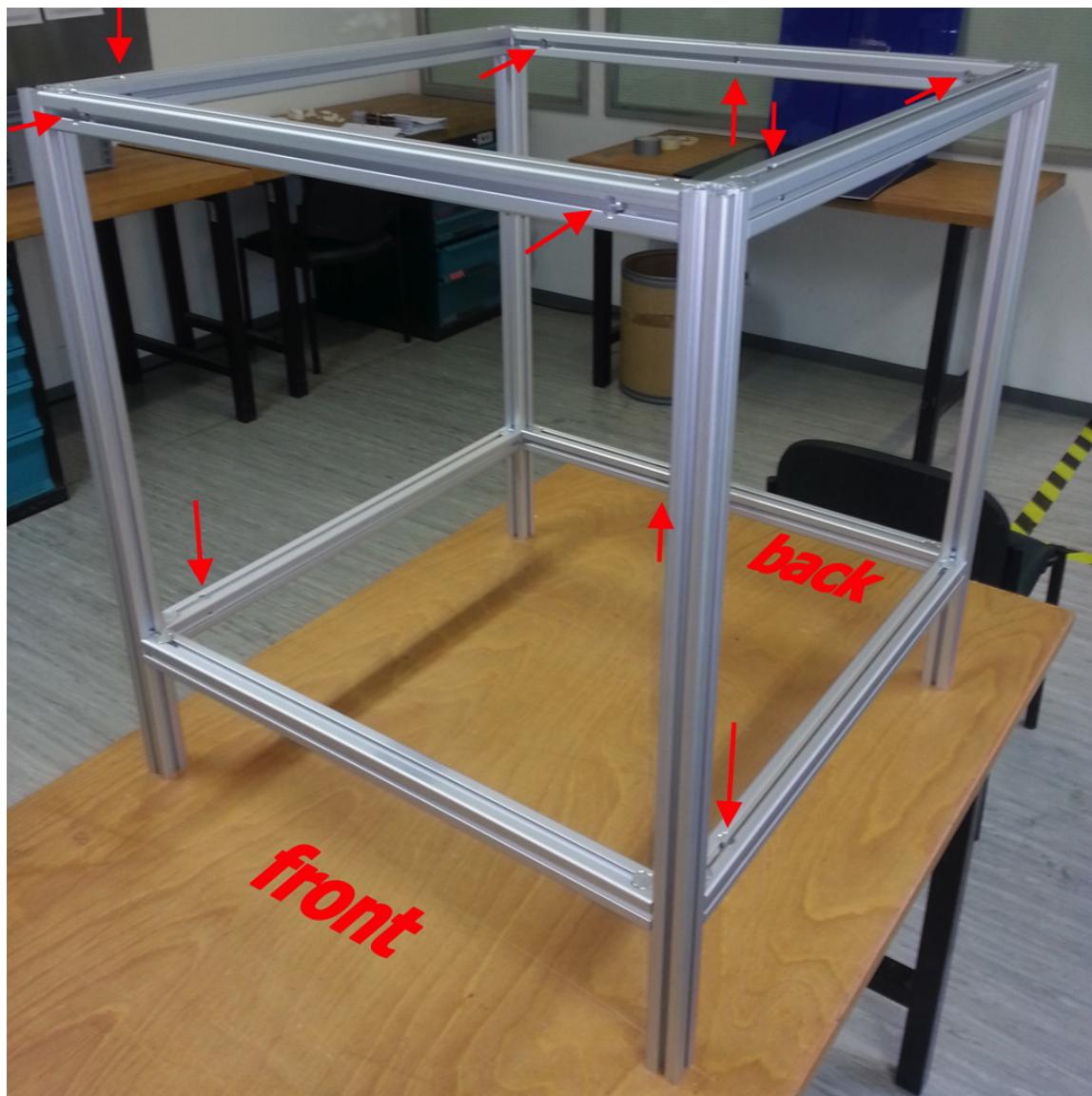
Note that the vertical holes in the horizontal profiles are facing the front (im Bild [Zwischenschritt Rahmen \[S. 366\]](#) zur Tischplatte).

Abbildung 3.56. interim stage frame



The back part of the frame is assembled in the same fashion and should look like in this photo. [Finish Rahmen \[S. 367\]](#)

Abbildung 3.57. Finish Assembly frame



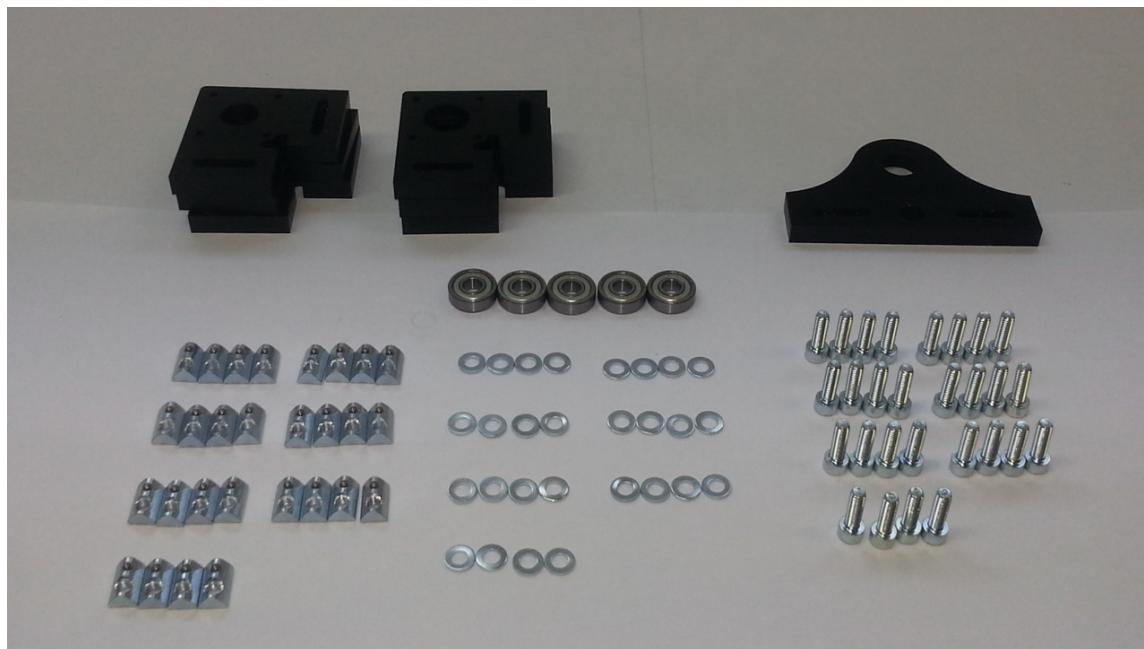
### 3.5. Z-axis

#### 3.5.1. Bearing holders

Tabelle 3.4. Parts list Bearing holders

6x POM NEMA 17 Mount [S. 39]	1x POM Spindle Mount Center [S. 40]
5x Ball bearing 608-ZZ	28x M6 T slot nut
28x M6x20 cylinder head screws	28x M6 washer

Abbildung 3.58. Bearing holders parts overview



Press a ball bearing in the four "POM NEMA 17 Mounts" as well as one each in the "POM Spindle Mount Center". The bearings should be flush with the "POM Mounts".

Abbildung 3.59. Details Bearing holders Ball bearing





The photo "[Finish Lagerhalter \[S. 57\]](#)" shows the position of the bearing holders in the frame and are marked with a red X.

Each "POM Mount" is fastened using four bolts as shown in "[Details Lagerhalter Nutenstein \[S. 56\]](#)".

The "POM Mounts" have a rim where the ball bearing sits on. These rings are facing up on the top of the frame but down at the bottom to prevent them from working their way out over time.

Abbildung 3.60. Details Bearing holders T-nuts



Abbildung 3.61. Details Bearing holders orientation (top)

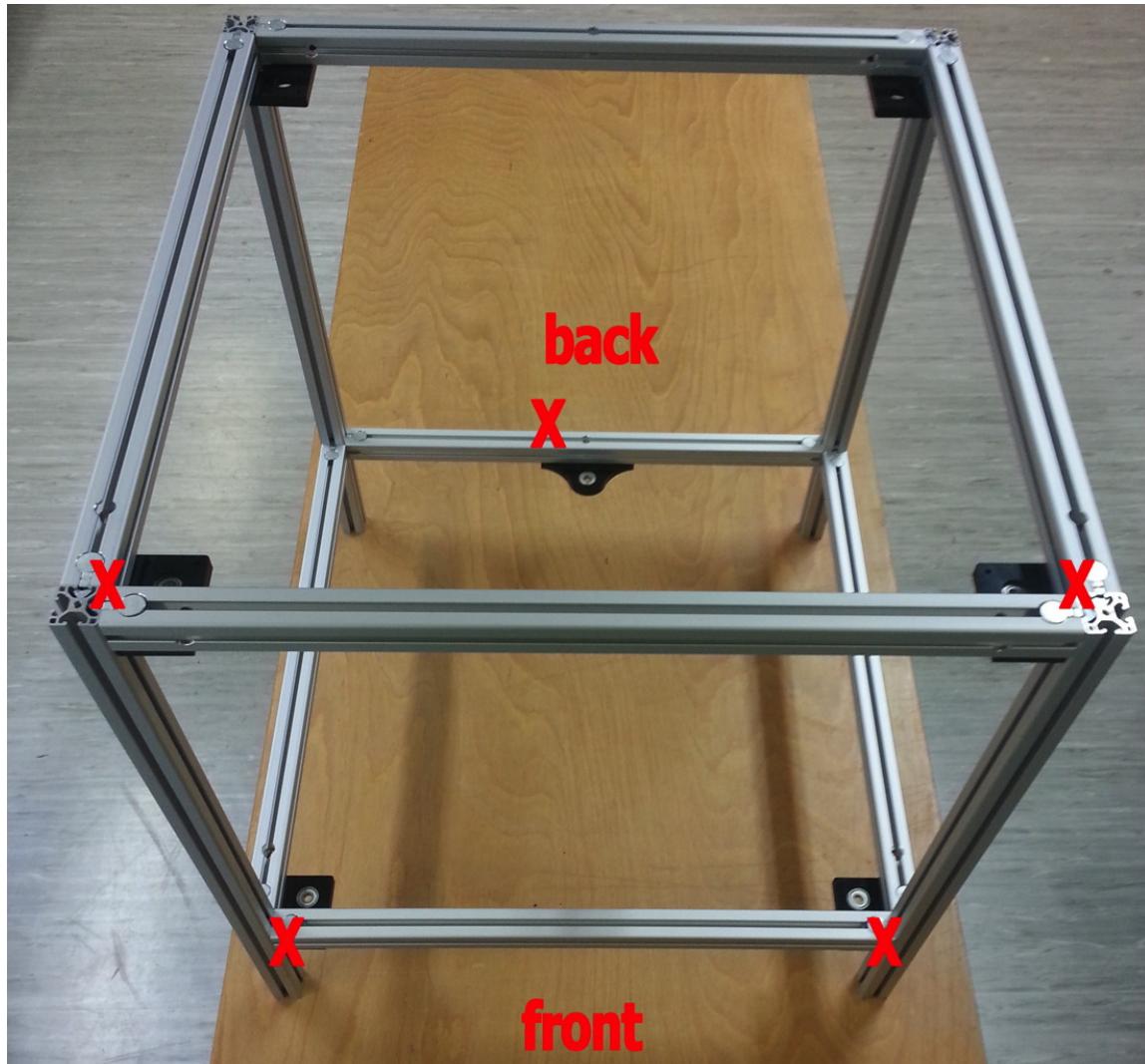


The "POM Spindle Mount Center" should be aligned with the other mount.



The guide rod can temporarily be used to align the "POM Spindle Mount Center".

Abbildung 3.62. Finish Bearing holders



### 3.5.2. Z-axis-trapezoidal threaded spindle

Tabelle 3.5. Parts list Z-axis-trapezoidal threaded spindle

3x Trapezoidal threaded spindle	3x Pulley 36 teeth (incl. grub screw)
3x M4x10 cylinder head screws	3x M4 washer, large OD
9x M8 washer	

Abbildung 3.63. Z-axis-trapezoidal threaded spindle parts overview



Attach a pulley at the bottom (smooth end) of each trapezoidal rod, only slightly tightening the grub screw.

Insert the rods in the bottom "POM Mounts". The details can be seen in the picture "[Securing the trapezoidal rod spindles \[S. 58\]](#)" (The picture shows the one for the POM mounts).

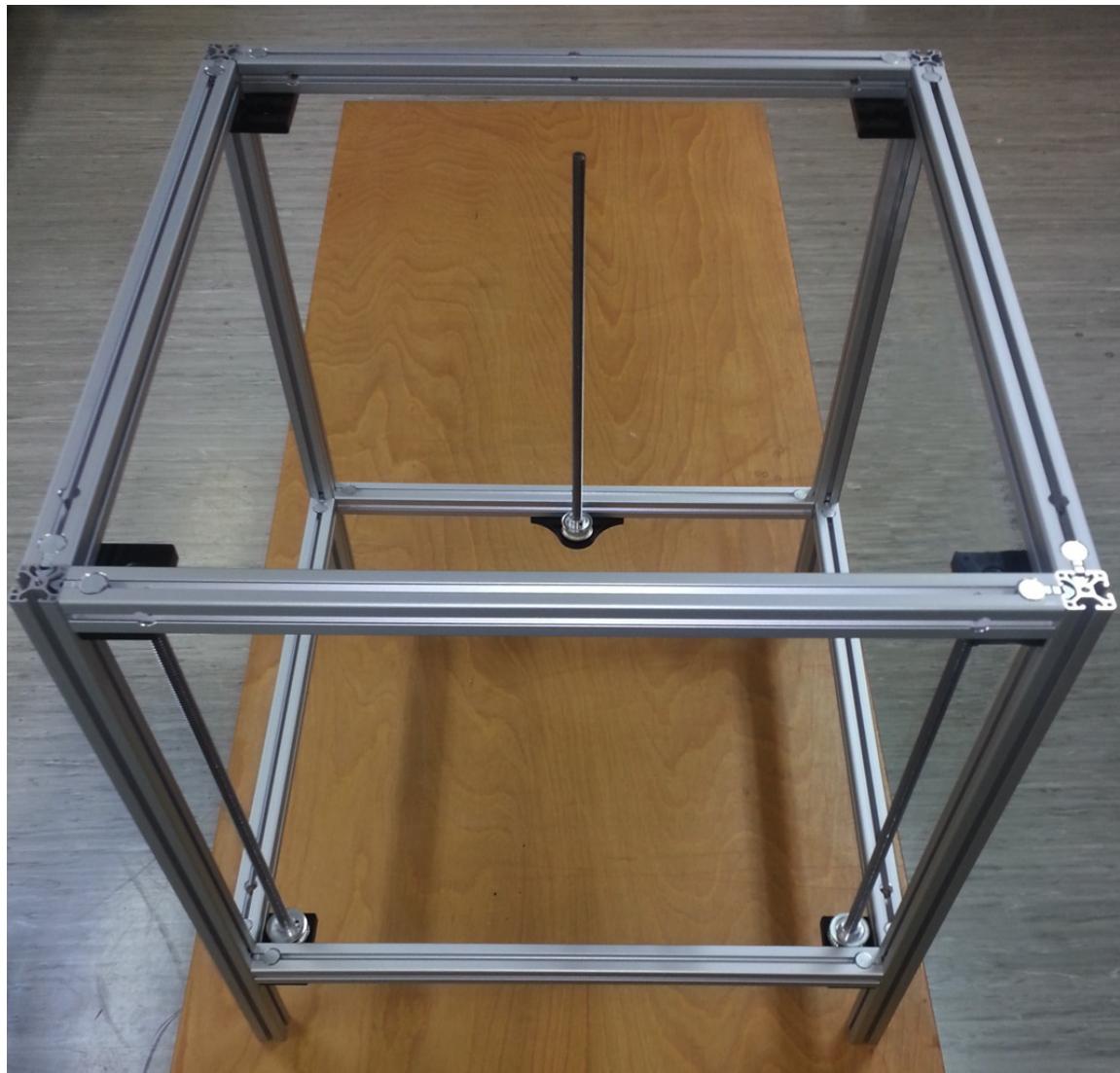
Abbildung 3.64. Details Securing the trapezoidal rod spindles



Do not over-tighten the center bolts to avoid unnecessary friction of the trapezoidal rods.



Abbildung 3.65. Finish Z-axis-trapezoidal threaded spindle



### 3.5.3. Z-axis timing belt

Tabelle 3.6. Parts list Z-axis timing belt

1x timing belt, 1926mm
------------------------

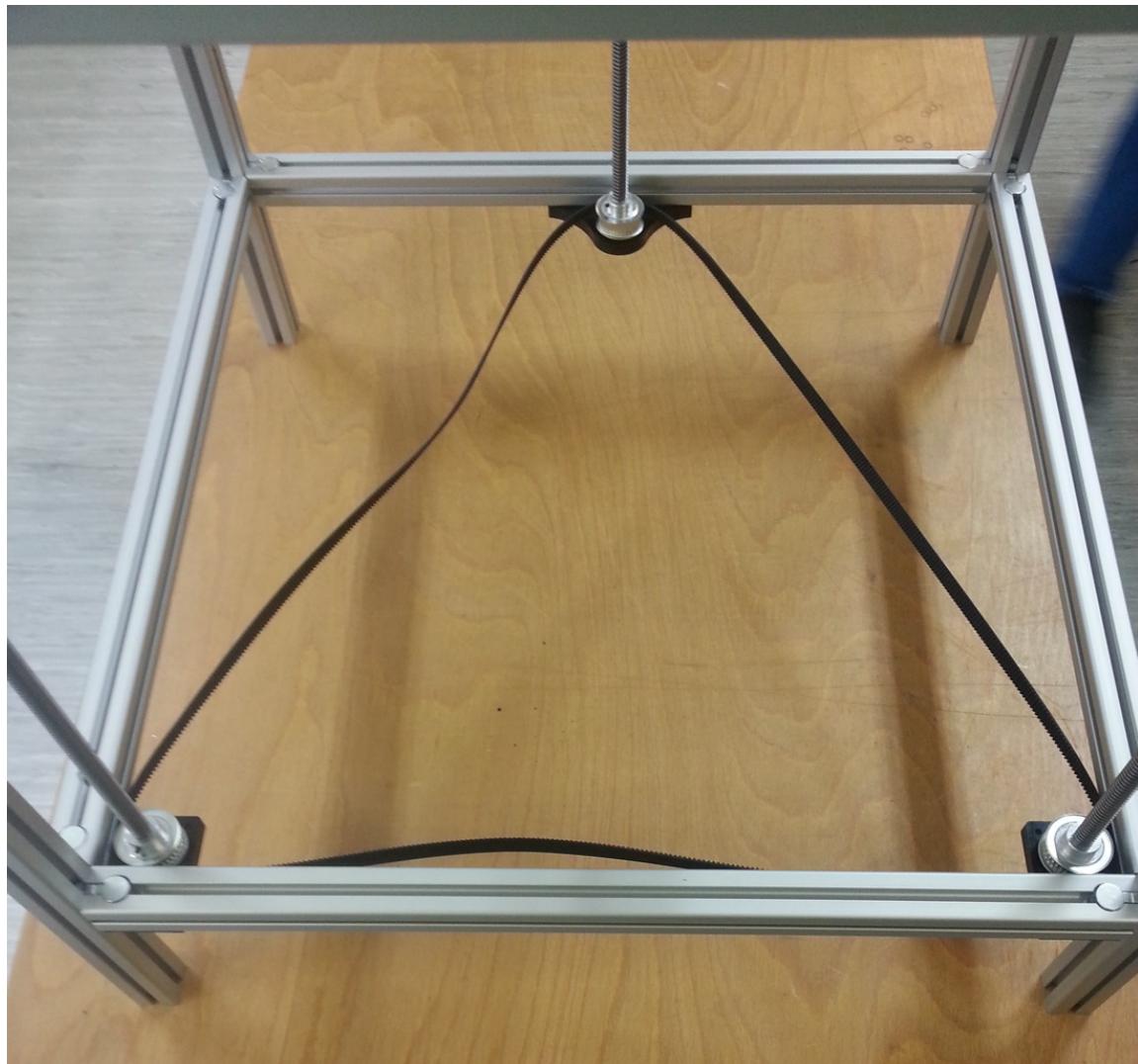
Abbildung 3.66. Z-axis timing belt parts overview



Simply run the timing belt over the pulleys for now.

Tightening the belt happens later.

Abbildung 3.67. Finish Z-axis timing belt

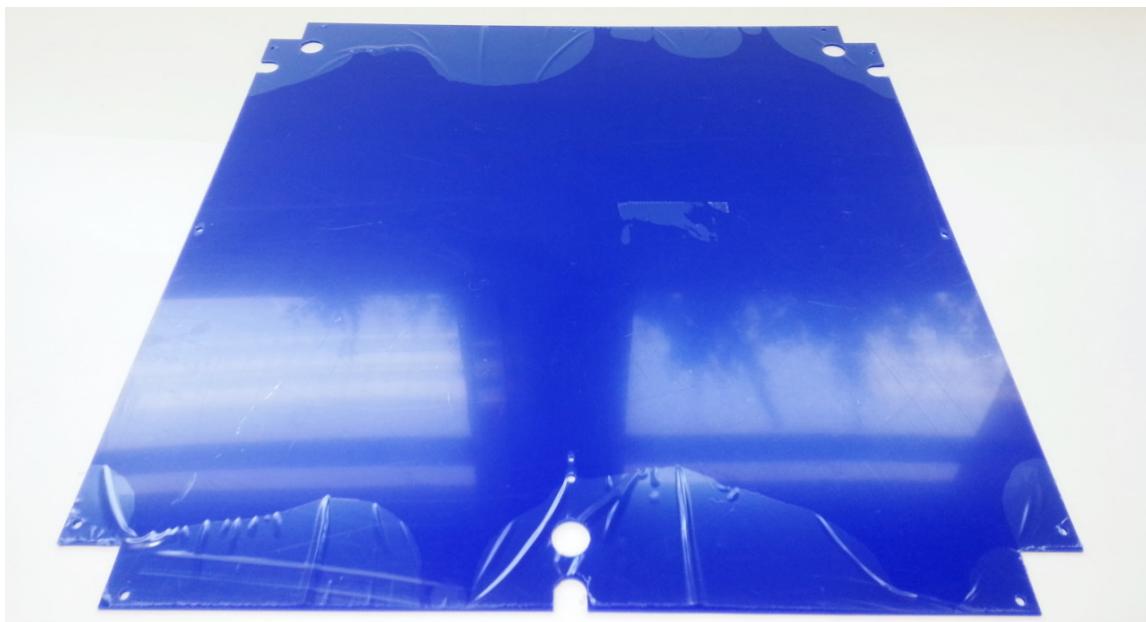


### 3.5.4. Assembly Acrylic glass distance plate

Tabelle 3.7. Parts list Assembly Acrylic glass distance plate

1x Acrylic glass distance plate, blue
---------------------------------------

Abbildung 3.68. Assembly Acrylic glass distance plate parts overview



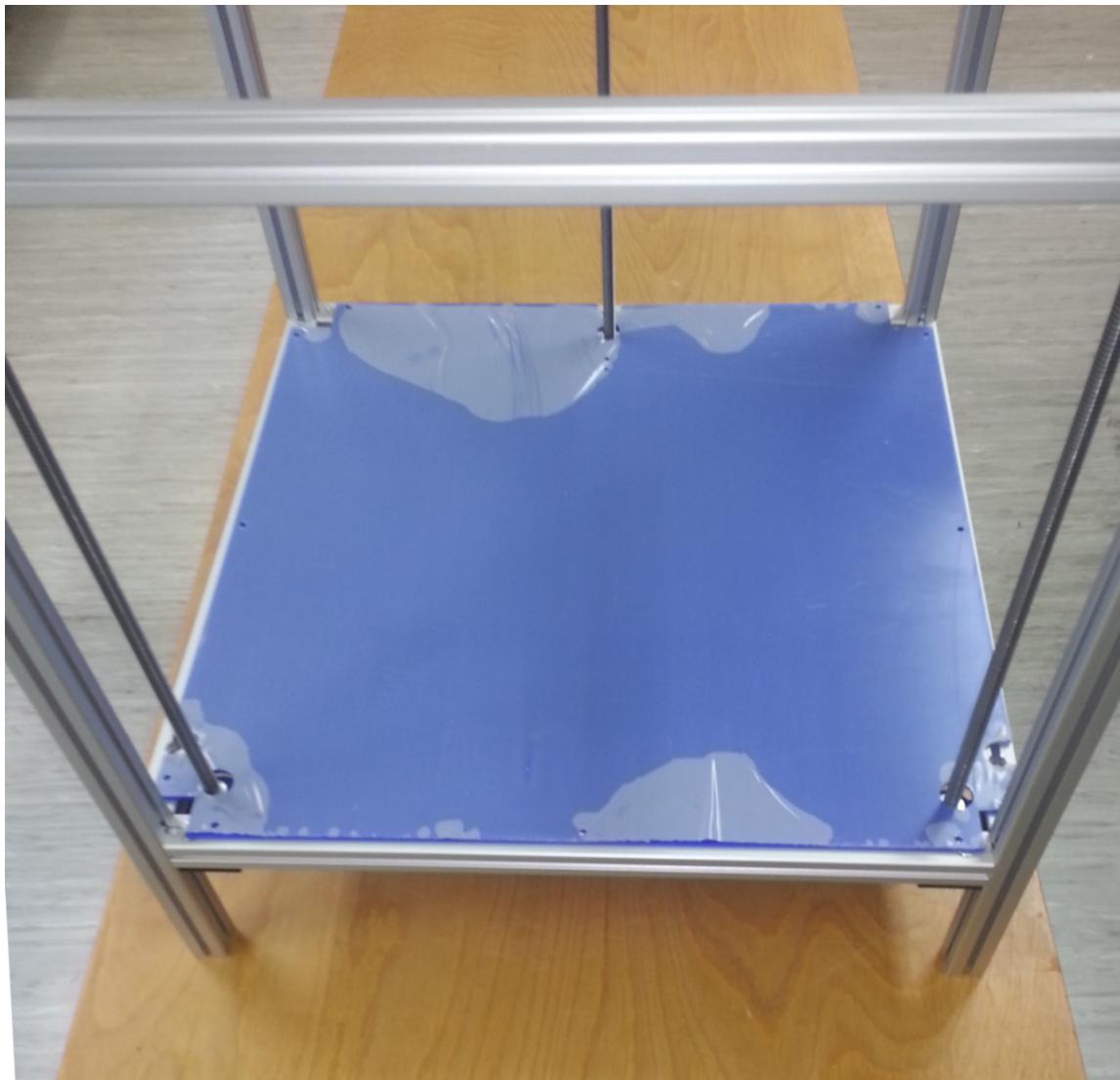
The divider plate needs to be installed now as it is impossible to retrofit it. Due to its symmetry there is no top or bottom side.



For the time being the protecting foil can be left on the plate to avoid scratches or marks.



Abbildung 3.69. Assembly Acrylic glass distance plate parts overview



### 3.5.5. Energy chain guide

Tabelle 3.8. Parts list Energy chain guide

1x L-Alu Energychain holder [S. 35]	2x M6x10 cylinder head screws
2x M6 washer	2x M6T slot nut

Abbildung 3.70. Energy chain guide parts overview



This support bar serves as an attachment point for the energy chain. It needs to be bend on both ends at a right angle to fit on the right hand side of the frame (that is the same side the X-motor).

The distance to the lower edge of the top profile is 100 mm.

Please see photo "[Finish \[S. 65\]](#)" for more details.



Abbildung 3.71. Finish Energy chain guide

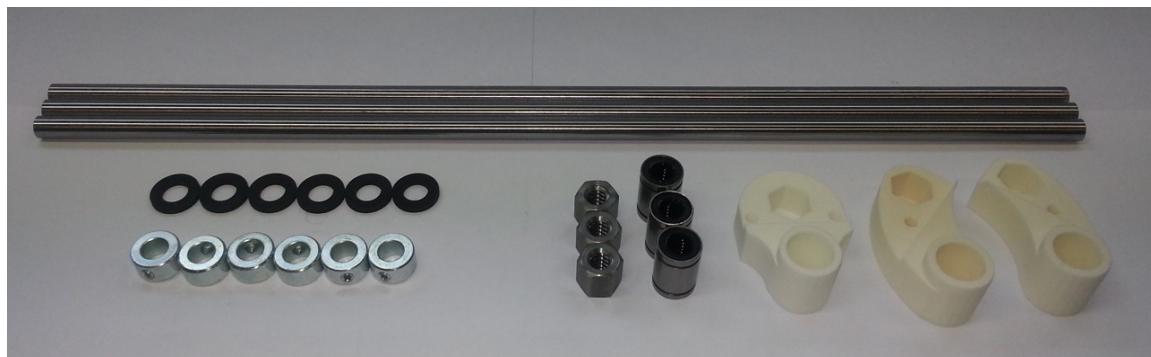


### 3.5.6. Assembly of the guiding rods

Tabelle 3.9. Parts list Assembly of the guiding rods

3x Z-axis-Guiding rods, 550 mm [S. 34]	1x Z-Guide Left [S. 44]
1x Z-Guide Center [S. 44]	1x Z-Guide Right [S. 45]
3x ball bearing LM12UU	3x M12x3 trapezoid nut
6x M12 washer, rubber	6x M12 adjusting ring (incl. grub screw)

Abbildung 3.72. Assembly of the guiding rods parts overview



In this step one ball bearing and one nut are to be pressed into each of the three "Z-Guides".



We recommend using a vice to install the bearings. Alternatively, put a piece of hardwood on the bearing and use a hammer on the wood to drive the bearing in. Always make sure that the bearing is aligned with the plastic.

Abbildung 3.73. Details Z-Guides

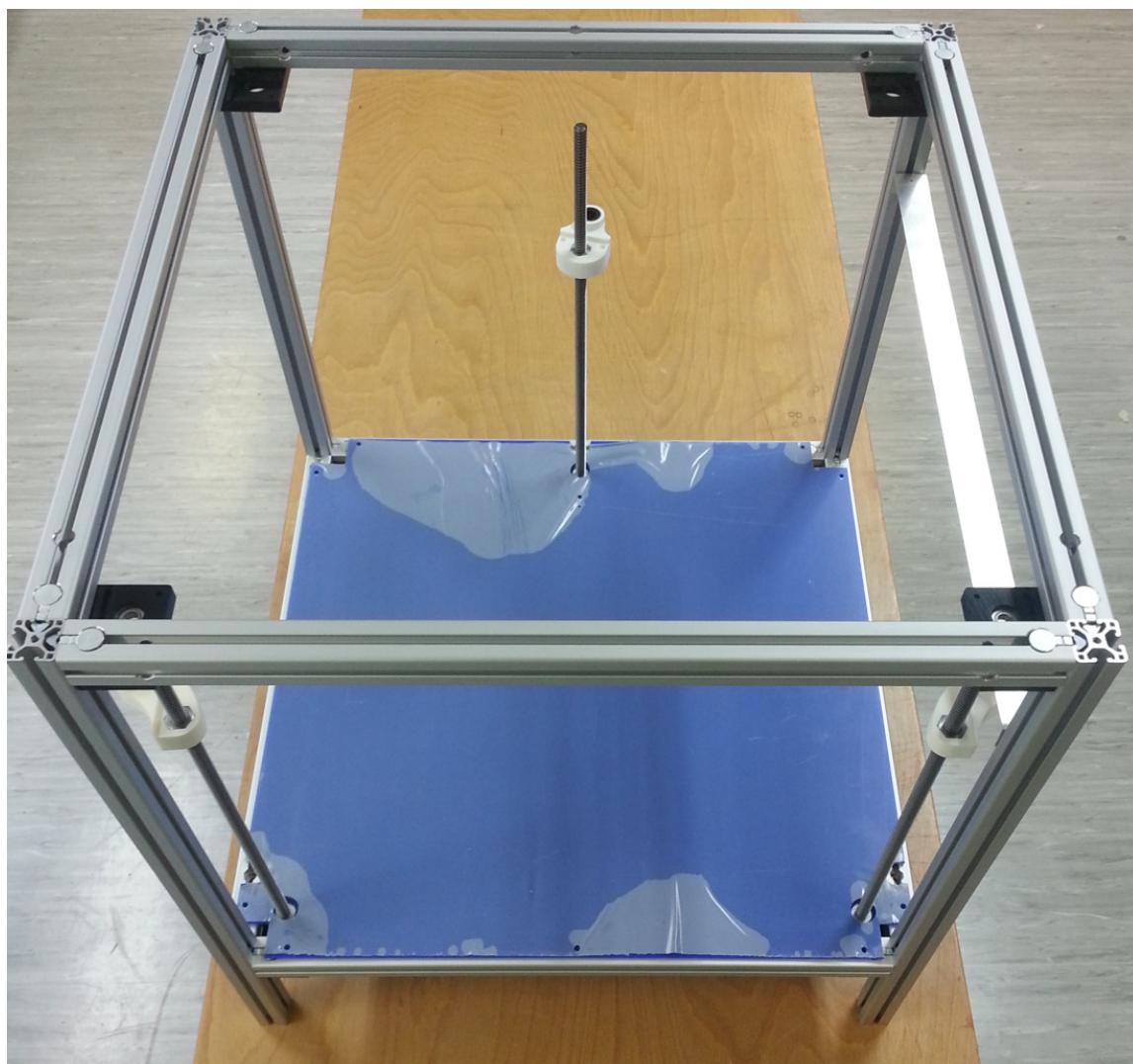




Now it's time to screw the "Z-Guides" on the trapezoidal rods. All three guides should be at about the same height.

Also make sure that the guiding rods can be inserted without any friction (not shown in picture).

Abbildung 3.74. Details assembly Z-Guides



Now insert the guiding rods into the frame and through the "Z-Guides", add a rubber washer and the adjusting ring to each end and secure them with the grub screws.

Abbildung 3.75. Details adjusting ring

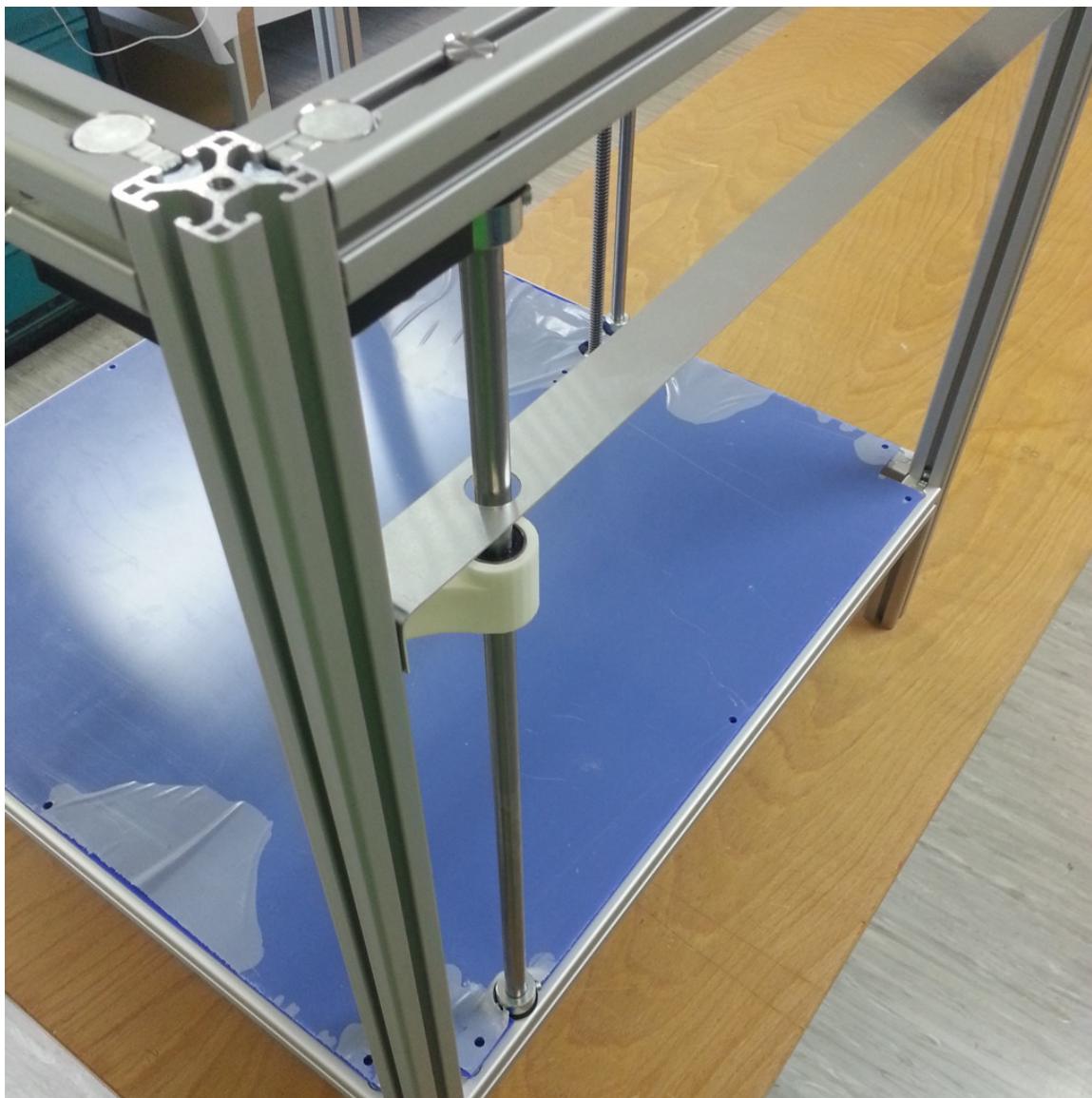
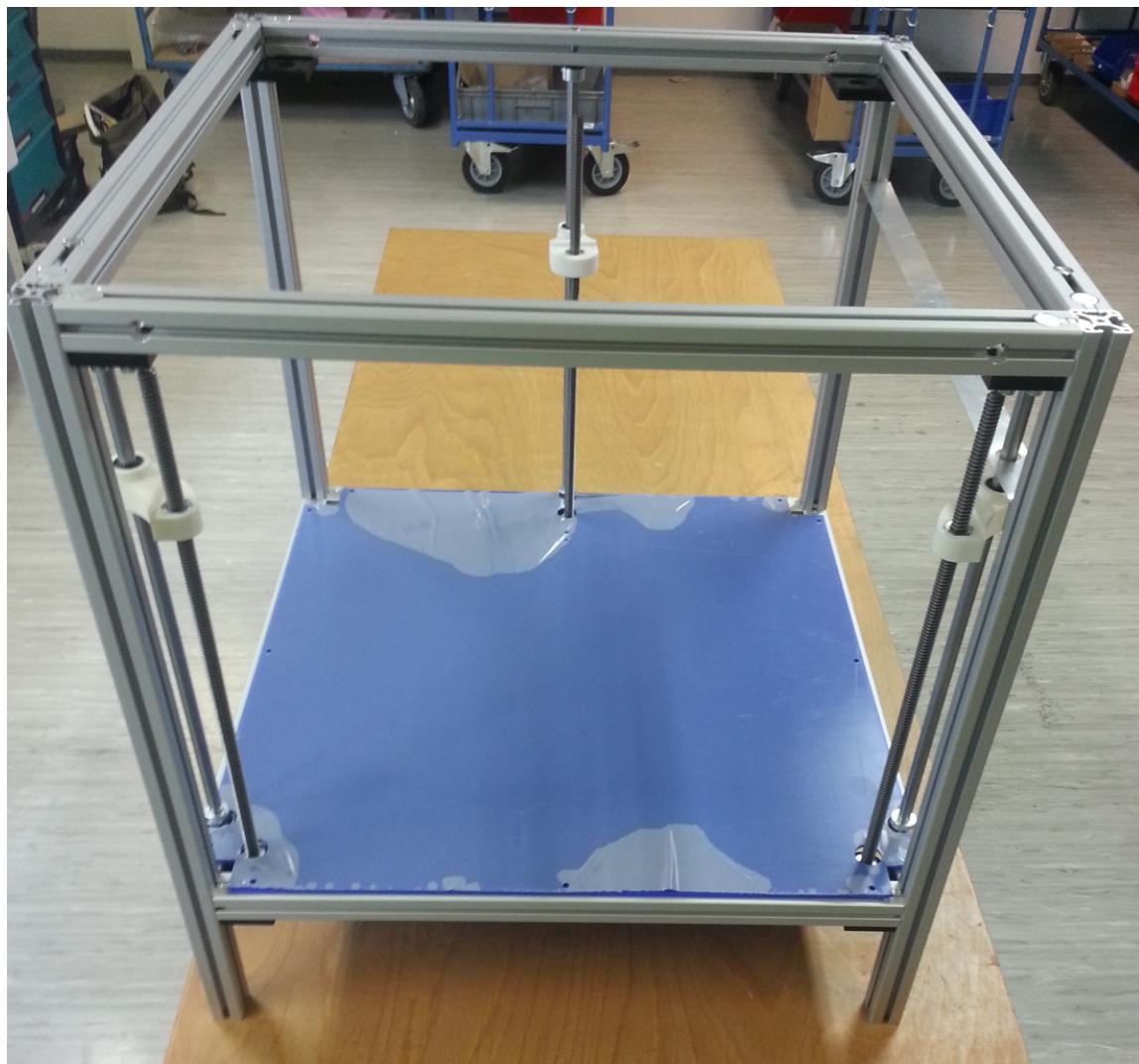




Abbildung 3.76. Finish Assembly of the guiding rods

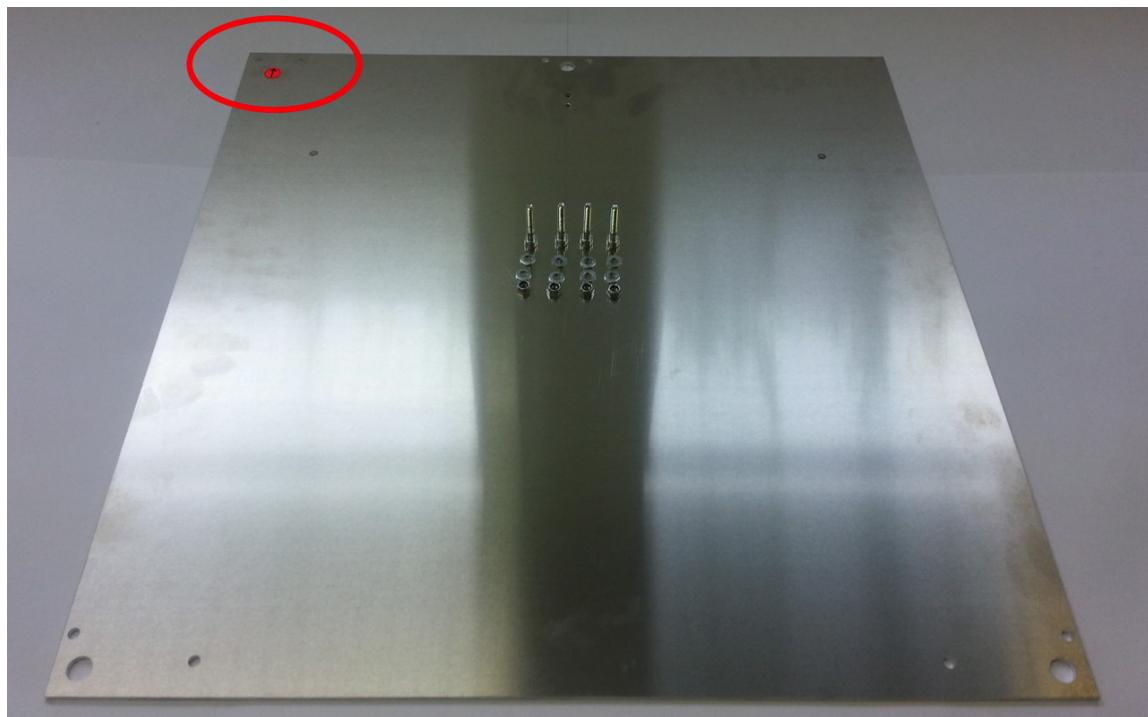


### 3.5.7. Assembly Printing Bed holder

Tabelle 3.10. Parts list Printing Bed holder

1x Aluminum plate 575x575mm	4x M6x35 cylinder head screws
8x M6 washer	4x M6 self-locking nut

Abbildung 3.77. Assembly Printing Bed holder parts overview



The aluminium plate is bolted directly onto the "Z-Guides".

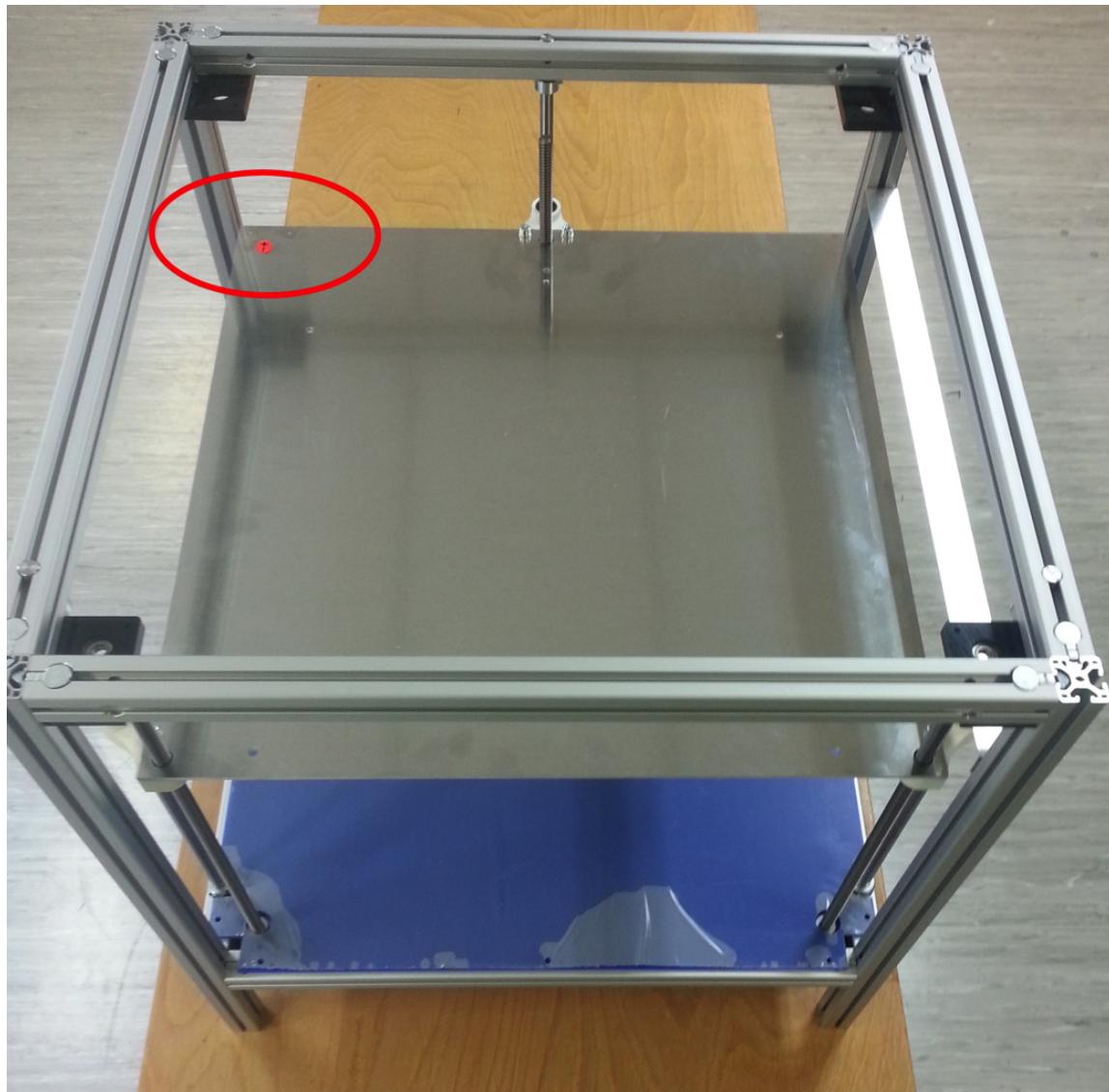


It is important that the additional drilling for the interruption plate is located on the rear left corner (see red arrow).

Abbildung 3.78. Details Assembly

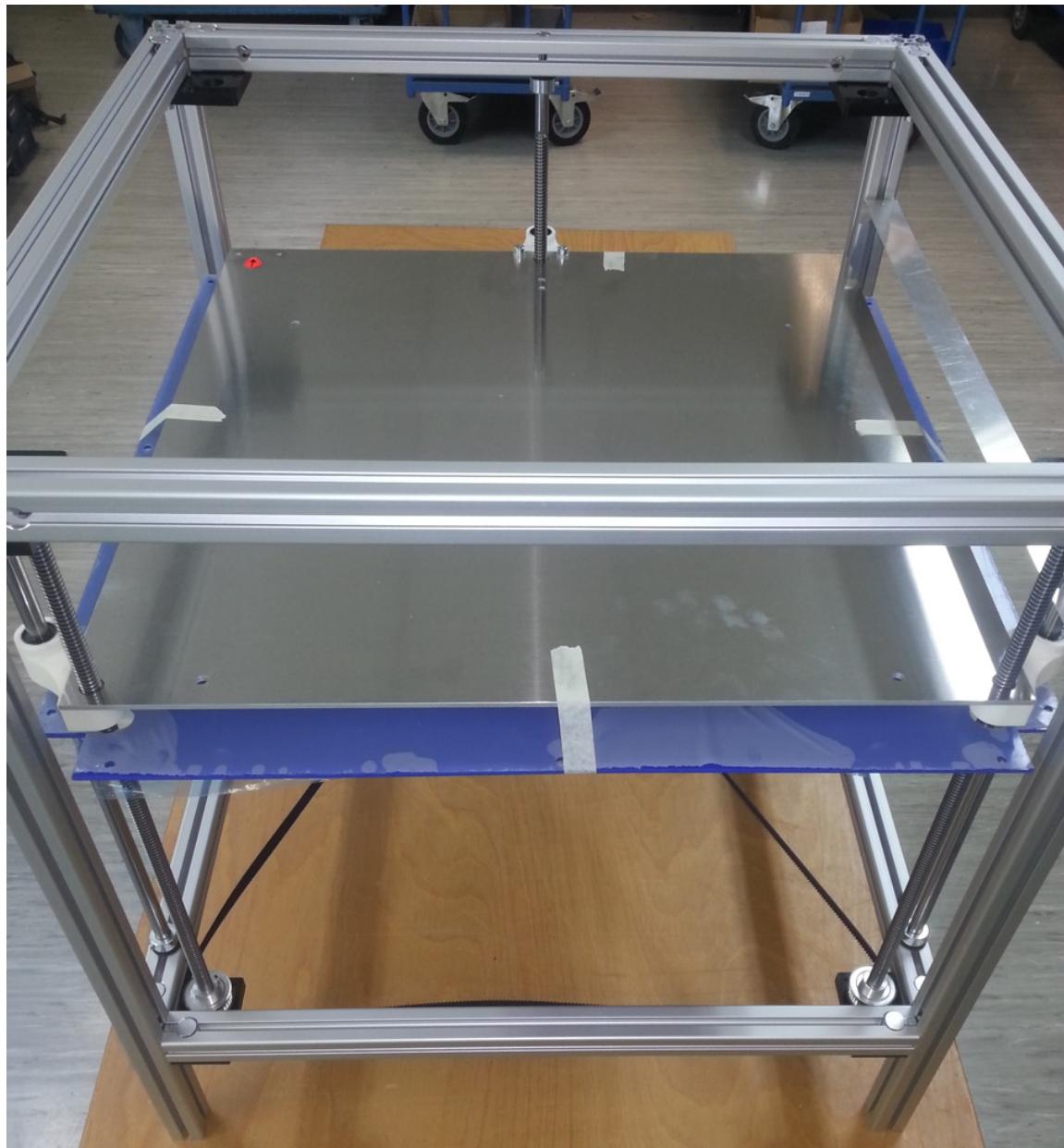


Abbildung 3.79. Finish Assembly Printing Bed holder



Lifting the divider plate just beneath the aluminium plate with some tape simplifies the next steps.

Abbildung 3.80. example tape



### 3.5.8. Preparation Z-axis motor

Tabelle 3.11. Parts list Preparation Z-axis motor

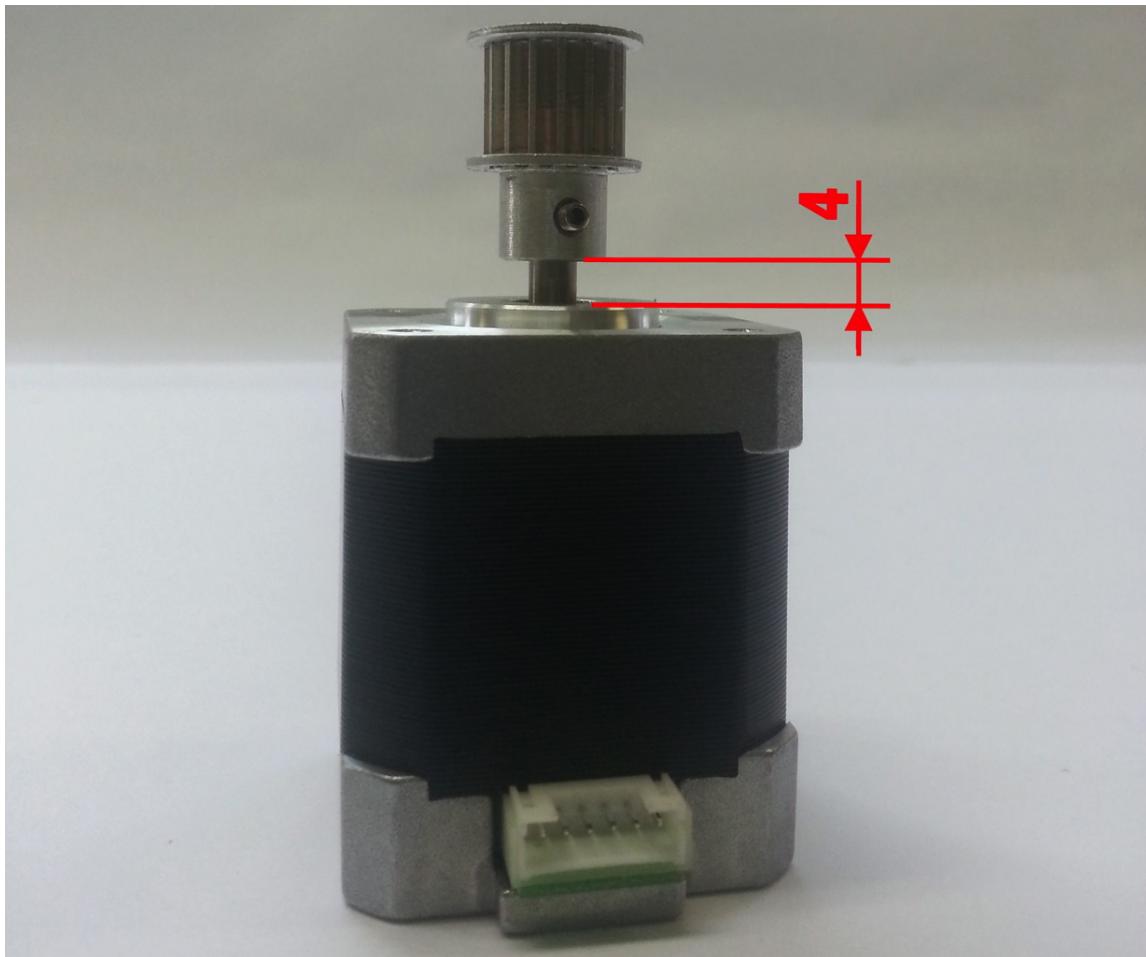
1x stepper motor, NEMA 17	1x POM NEMA 17 Mount Center [S. 39]
1x Pulley 16 teeth (incl. grub screw)	4x M3x14 cylinder head screws
4x M3 washer	4x Ball bearing 624-ZZ
2x M4x35 cylinder head screws	4x M4 washer 20mm
22x M4 washer	2x M4 self-locking nut

Abbildung 3.81. Preparation Z-axis motor parts overview



Der Motor für die Z-Achse wird zunächst mit einem Pulley bestückt und dann mit der Madenschraube fixiert. Der Abstand zwischen Pulley und stepper motor sollte ca. 4mm betragen, damit später der Zahnrämen mit der Umlenkung fluchtet (Bild "Details Befestigung Pulley [S. 75]").

Abbildung 3.82. Details Befestigung Pulley



Damit der Zahnriemen über die Verschiebung des Motors gespannt werden kann, werden zwei Zahnriemen-Umlenkungen benötigt. They are connected as shown in the image "[Details timing belt deflection\[S. 75\]](#)", where the black bar represents the boring at the motor holder.

Abbildung 3.83. Details timing belt deflection



Der Motor wird, wie im Bild "Finish [S. 76]" zu sehen, möglichst dicht an den Umlenkern positioniert, um später genügend Spielraum zur Spannung des Zahnriemens zu besitzen.

Abbildung 3.84. Finish Preparation Z-axis motor



### 3.5.9. Assembly Z-axis motor

Tabelle 3.12. Parts list Assembly Z-axis motor

1x Z-Achsen Lagerhalter, Mitte, pre-assembled	4x M6 T slot nut
4x M6x20 cylinder head screws	4x M6 washer

Abbildung 3.85. Assembly Z-axis motor parts overview



Der Motor wird mittig an der Unterseite des vorderen Aluminiumprofils befestigt. In diesem Zuge wird der Zahnriemen direkt mit eingehängt.

Abbildung 3.86. Details Befestigung Unterseite

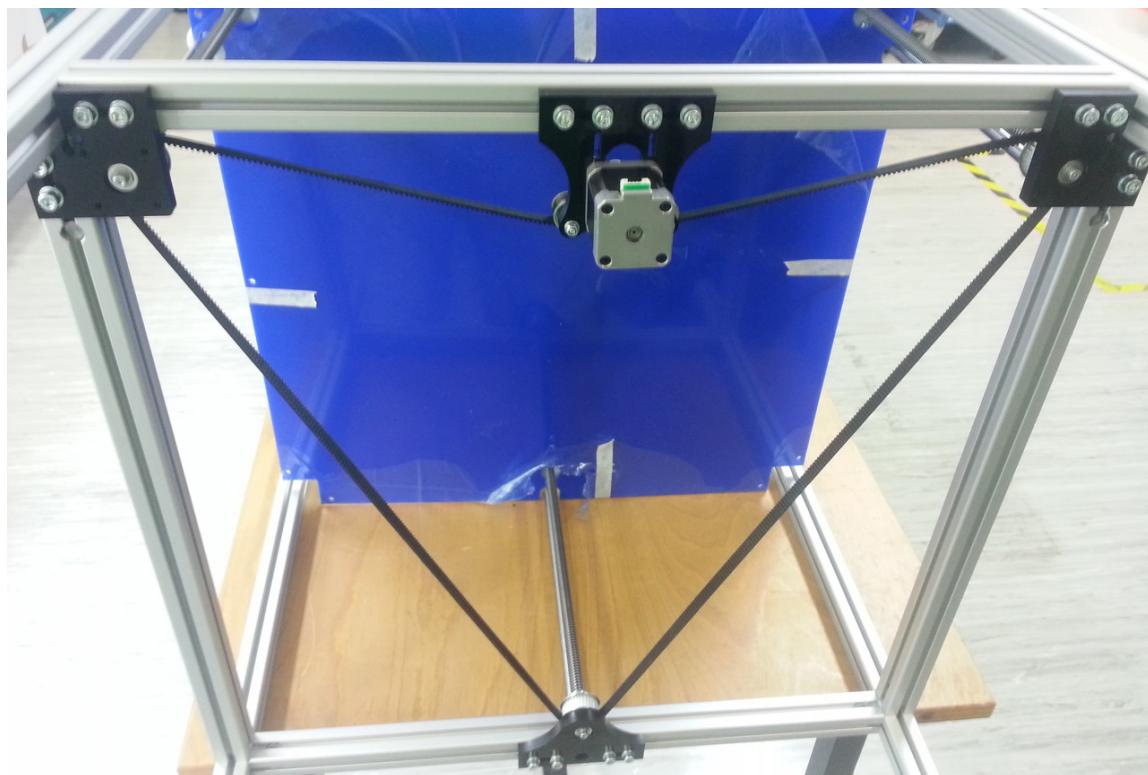
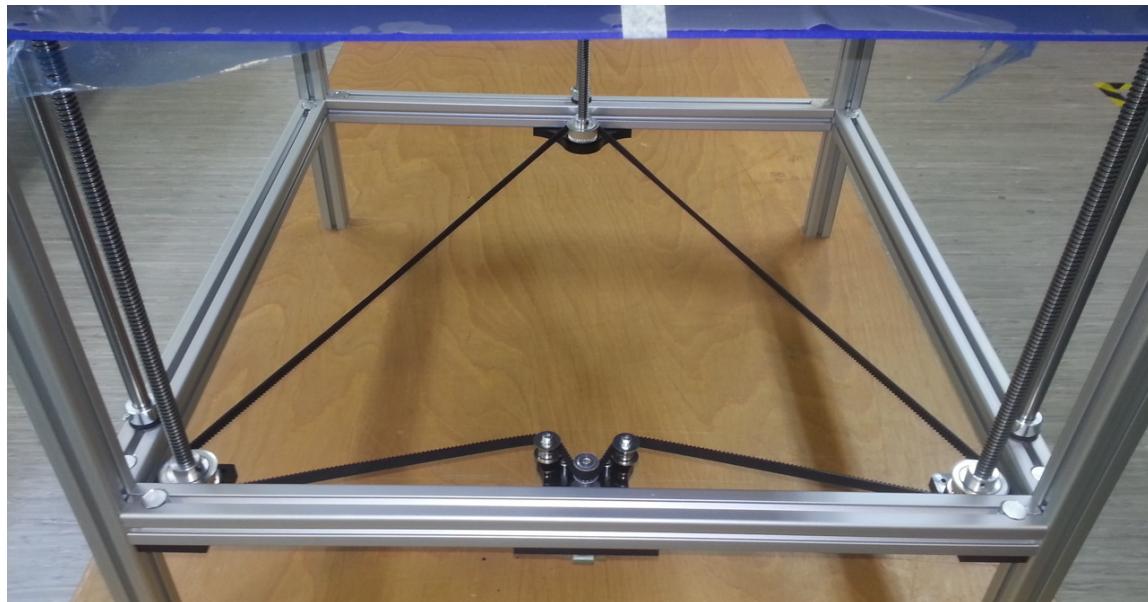




Abbildung 3.87. Details Befestigung Oberseite



### 3.5.10. Ausrichtung Druckbett-Aufnahme

Für die Ausrichtung der Aluminiumplatte werden zunächst die Madenschraube der Pulleys an den Trapezgewindespindeln gelockert, da nun jede Trapezgewindespindel einzeln bewegt werden kann.



Abbildung 3.88. Details Ausrichtung Druckbett-Aufnahme



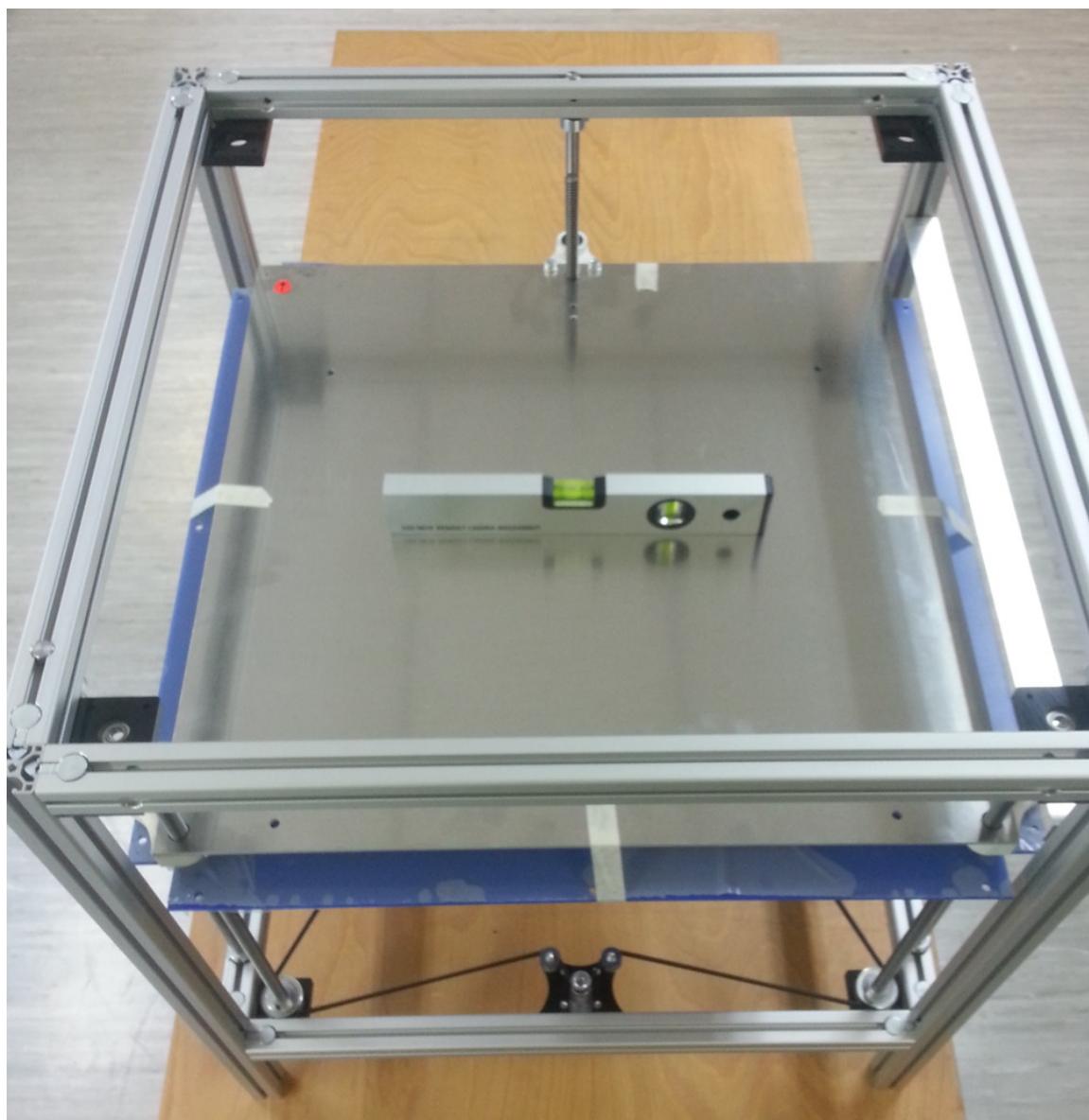
Die Aluminiumplatte muss so ausgerichtetet werden, dass die Platte parallel zu den anderen Aluminiumprofilen verläuft.

Hierfür bietet sich eine Wasserwaage an, da die Feinjustierung mit dem eigentlichen Druckbett erfolgen kann.

Nach der Ausrichtung werden die Madenschrauben der Pulley wieder fest angezogen.



Abbildung 3.89. Details Ausrichtung Druckbett-Aufnahme



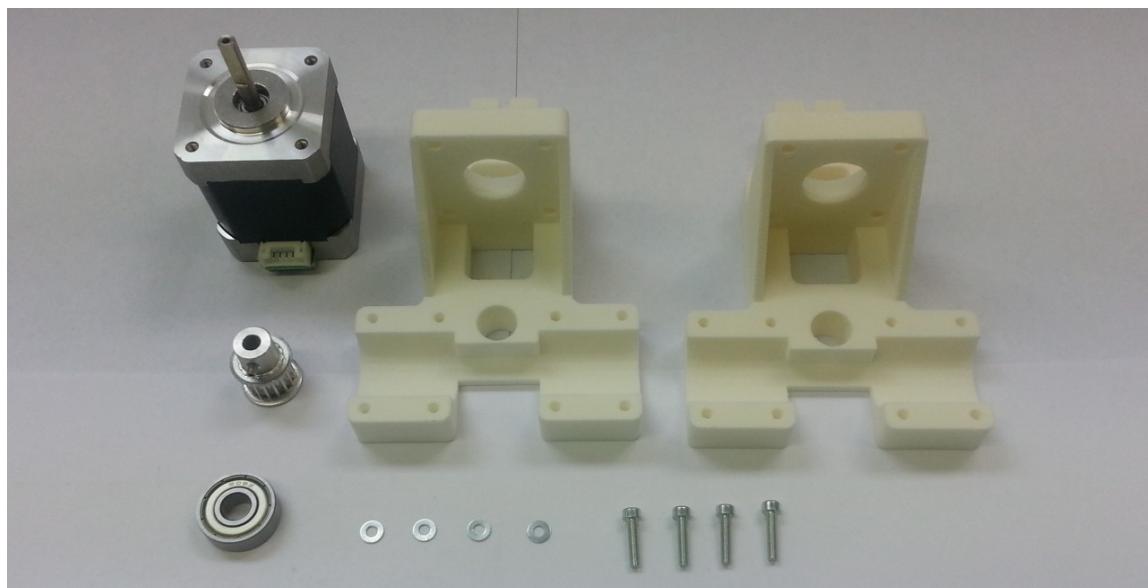
## 3.6. X-axis

### 3.6.1. Preparation X-Glider

Tabelle 3.13. Parts list Preparation X-Glider

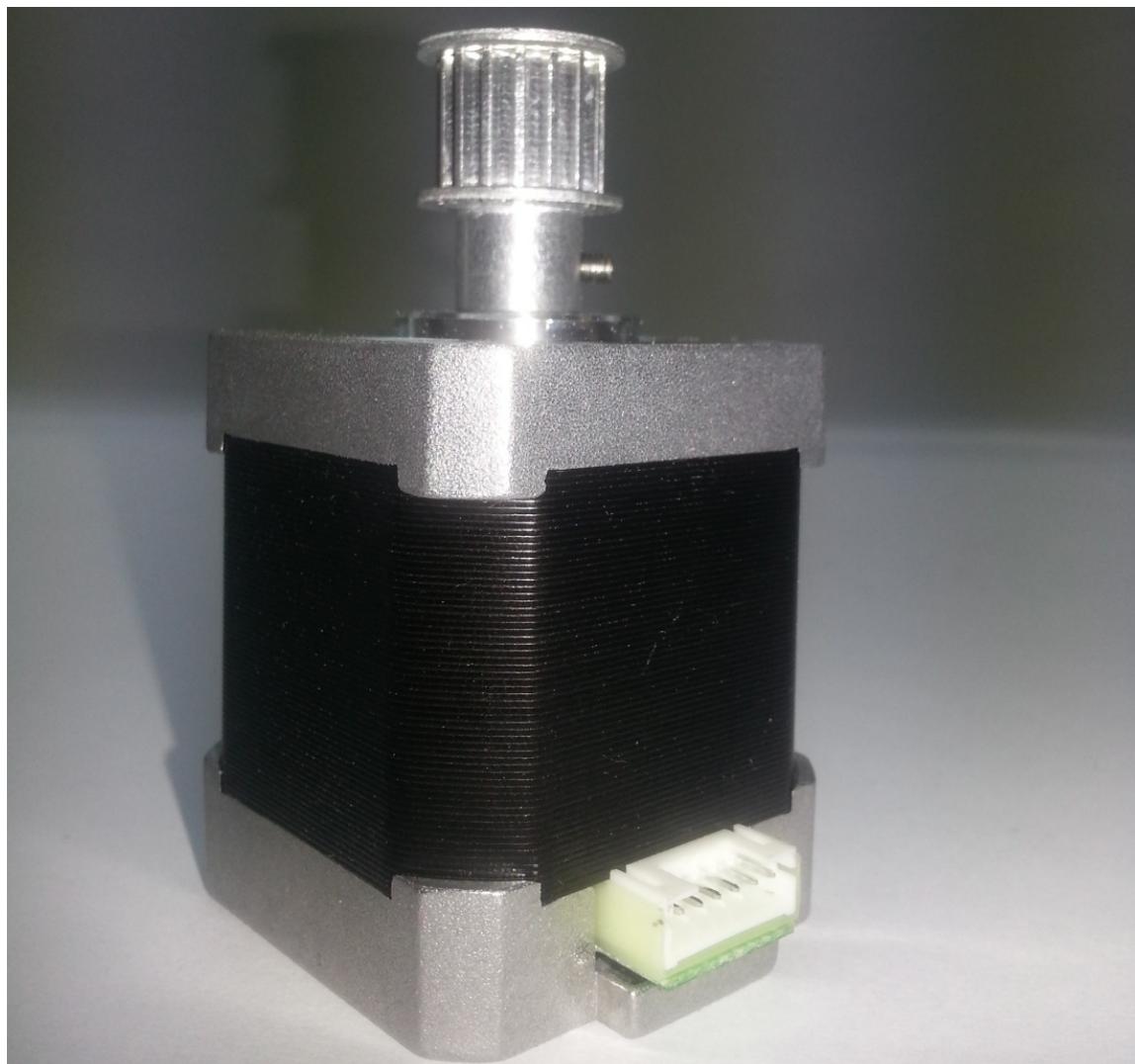
2x X-Glider [S. 43]	1x stepper motor, NEMA 17
1x Ball bearing 608-ZZ	1x Pulley 16 teeth 5mm drilling (incl. grub screw)
4x M3x14 cylinder head screws	4x M3 washer

Abbildung 3.90. Preparation X-Glider parts overview



Der Abstand zwischen Pulley und stepper motor sollte so klein wie möglich sein, damit später der Zahnriemen mit der Umlenkung fluchtet. Dabei sollte der Pulley allerdings nicht auf dem Motor aufsetzen, da hier sonst unnötig Reibung entsteht.

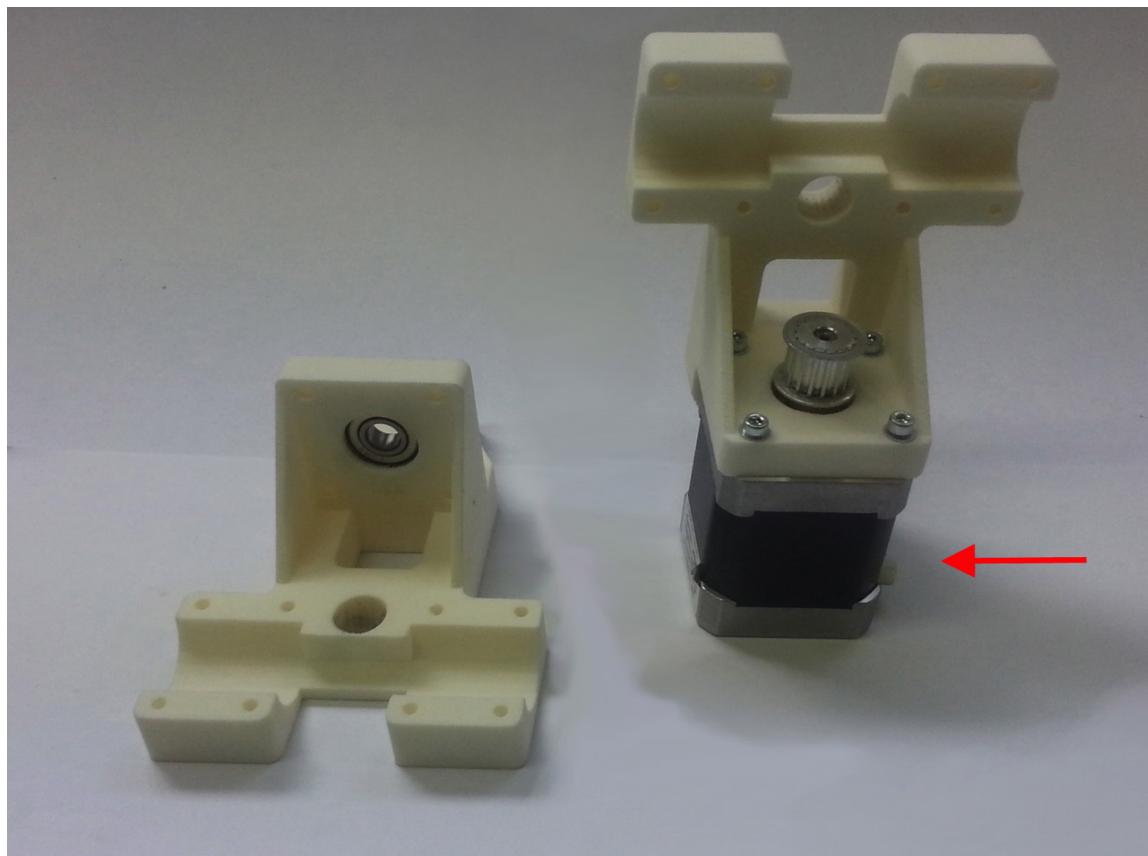
Abbildung 3.91. Preparation stepper motor



Der vorbereitete Motor wird in einem der "X-Glider" festgeschraubt, dabei muss der Stromanschluss des Motors an der im Bild "[Finish Vorbereitung X-Glider \[S. 83\]](#)" gekennzeichneten Seite liegen.

Das Ball bearing muss in den anderen "X-Glider" eingepresst werden.

Abbildung 3.92. Finish Preparation X-Glider

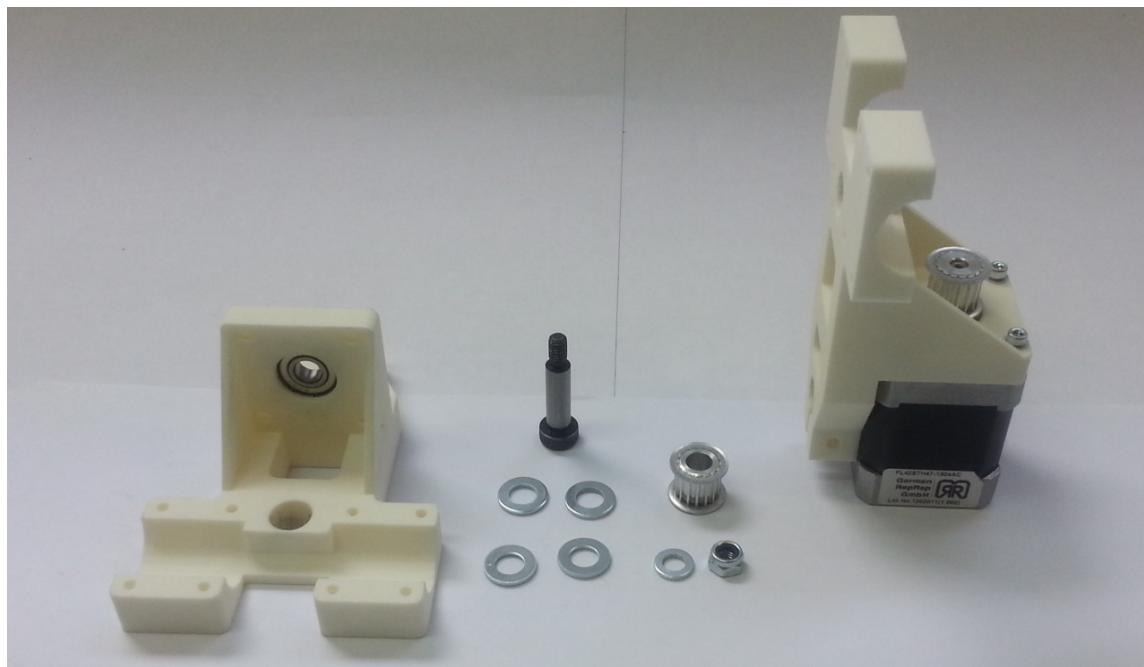


### 3.6.2. Assembly cylinder fitting screw

Tabelle 3.14. Parts list Assembly cylinder fitting screw

2x X-Glider [S. 43], pre-assembled	1x cylinder fitting screw
1x Pulley 16 teeth M8 threaded	1x M6 washer
4x M8 washer	1x M6 self-locking nut

Abbildung 3.93. Assembly cylinder fitting screw parts overview

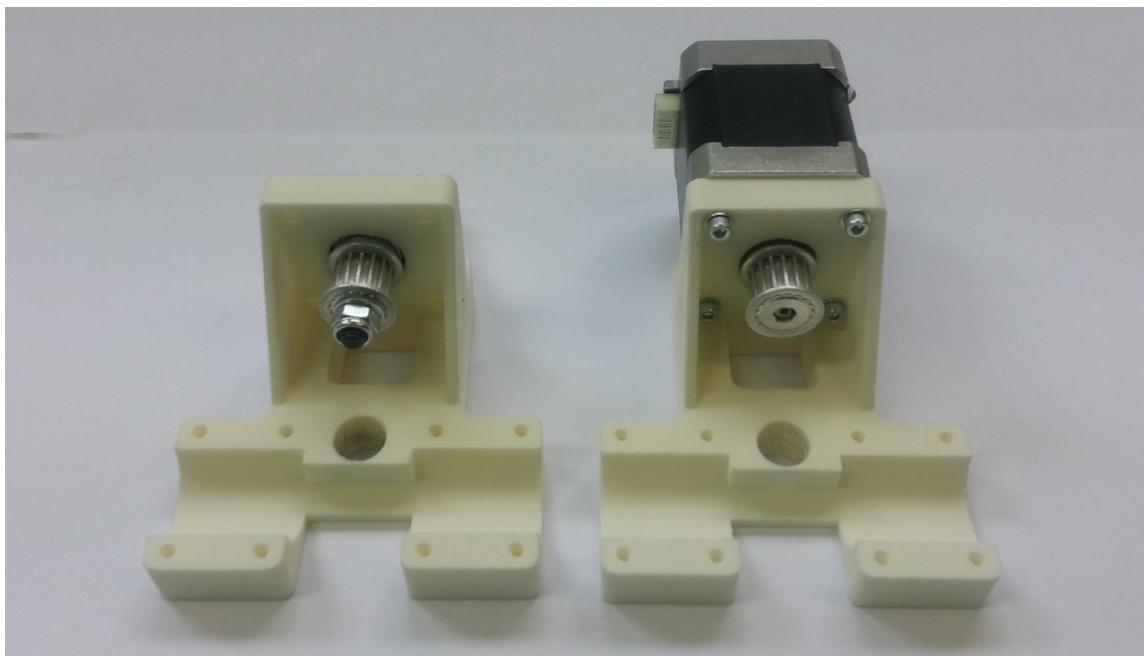


Die Umlenkung für den X-Achsen Zahnriemen wird in dem Ball bearing, wie auf dem Bild "Details Zylinderpassschraube [S. 84]" zu sehen, montiert. Der Pfeil markiert dabei das bereits eingepresste Ball bearing.

Abbildung 3.94. Details cylinder fitting screw



Abbildung 3.95. Finish assembly cylinder fitting screw

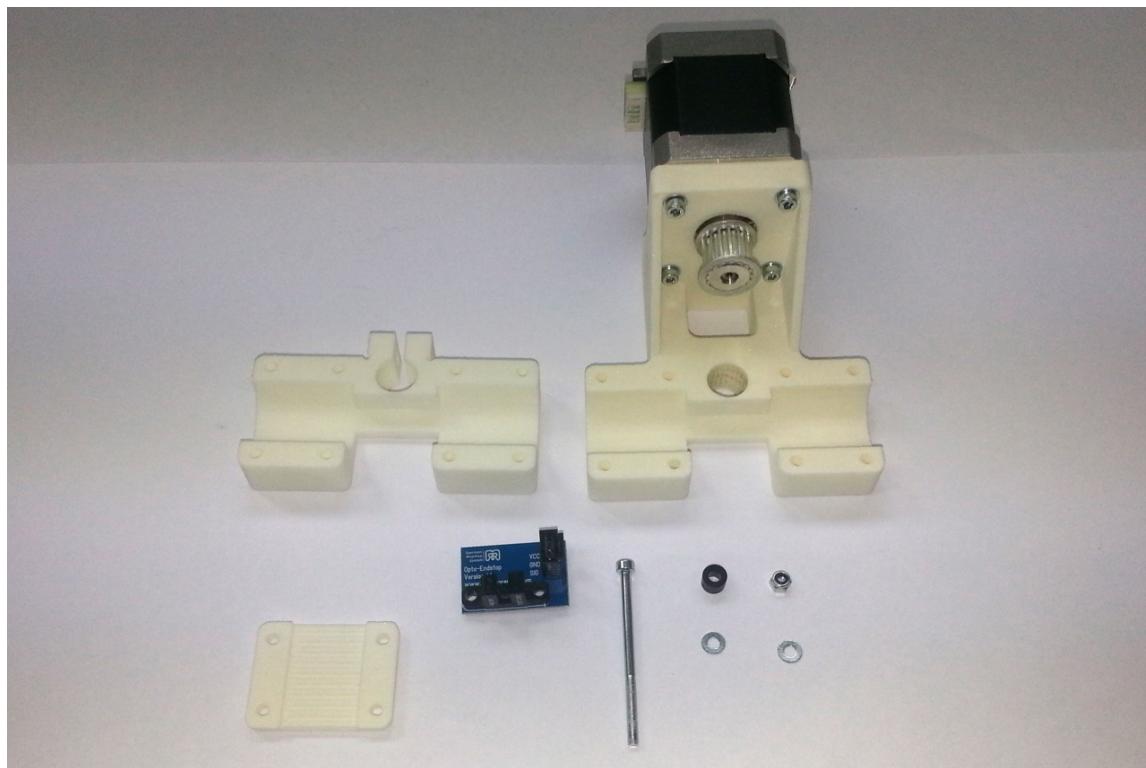


### 3.6.3. Opto-Endstop X

Tabelle 3.15. Parts list Opto-Endstop X

1x X-Glider [S. 43], motor	1x X-Glider Clamp LM12UU [S. 43]
1x X-Glider Clamp Belt [S. 42]	1x Opto-Endstop [S. 38]
1x M3x50 cylinder head screws	2x M3 washer
1x M3 self-locking nut	1x sleeve, 5mm

Abbildung 3.96. Opto-Endstop X parts overview



Zur Bestimmung eines Referenzpunkts werden beim X400 Lichtschranken (Opto-Endstops) benutzt.

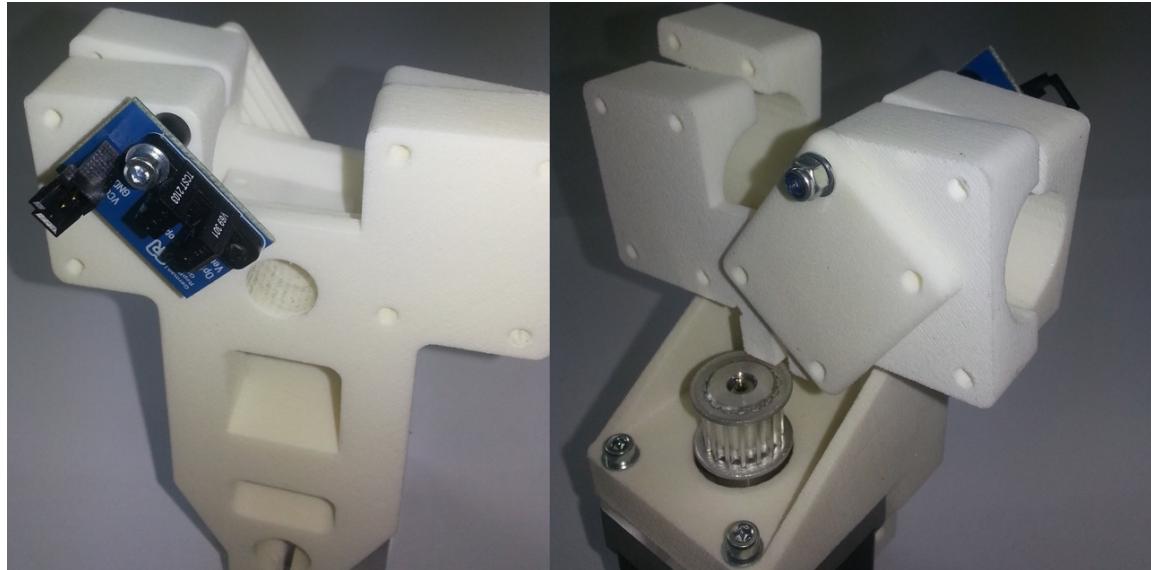
Mit der langen Schraube wird der "Opto-Endstop" am "X-Glider" montiert. Auf der Seite des Motors wird zusätzlich der "X-Glider Clamp Belt" befestigt, so dass zwischen ihm und dem "X-Glider Clamp LM12UU" ein Zahnriemen eingespannt werden kann.

Auf der gegenüberliegenden Seite wird das "Opto-Endstop" mit einer Hülse, 5mm befestigt.



Die Schraube darf nicht fest angezogen werden, da später die LM12UU-Lager noch dazwischen müssen.

Abbildung 3.97. Finish Opto-Endstop X

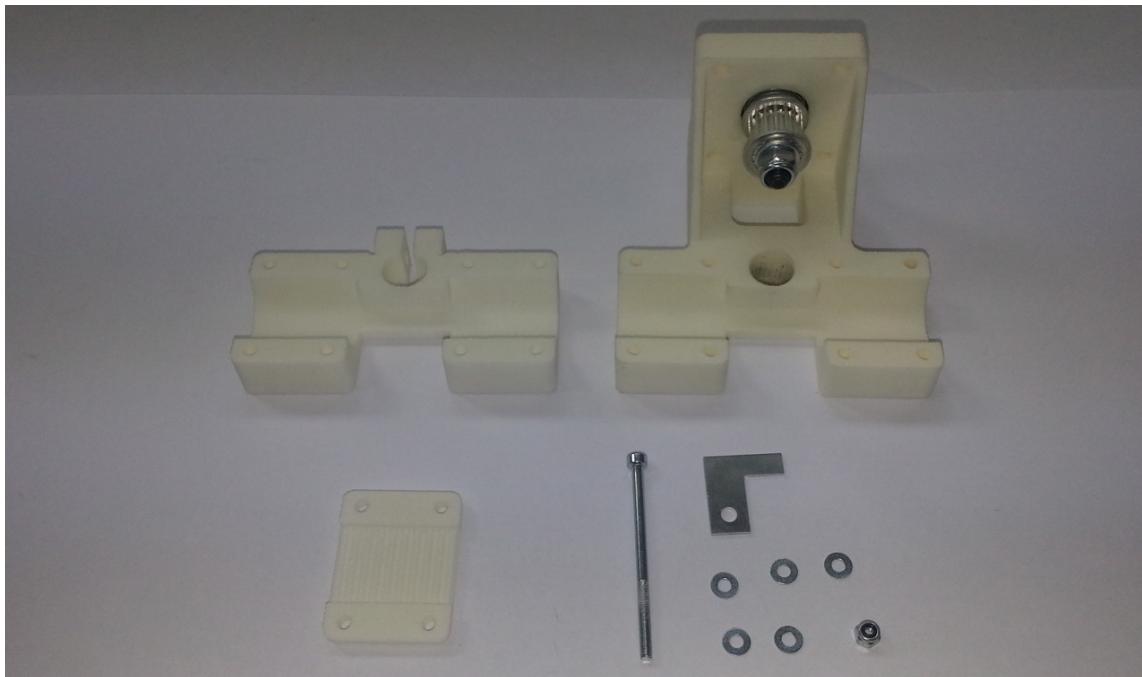


### 3.6.4. Opto-Flag Y

Tabelle 3.16. Parts list Opto-Flag Y

1x X-Glider [S. 43], cylinder fitting screw	1x X-Glider Clamp LM12UU [S. 43]
1x X-Glider Clamp Belt [S. 42]	1x M3x45 cylinder head screws
1x L-ALU Opto-Flag Y [S. 36]	5x M3 washer
1x M3 self-locking nut	

Abbildung 3.98. Opto-Flag Y parts overview



Für die Unterbrechung der Lichtschranken werden kleine Bleche benutzt. Für die Y-Achse befindet sich dieses Blech am "X-Glider" mit der Zahnriemenumlenkung.

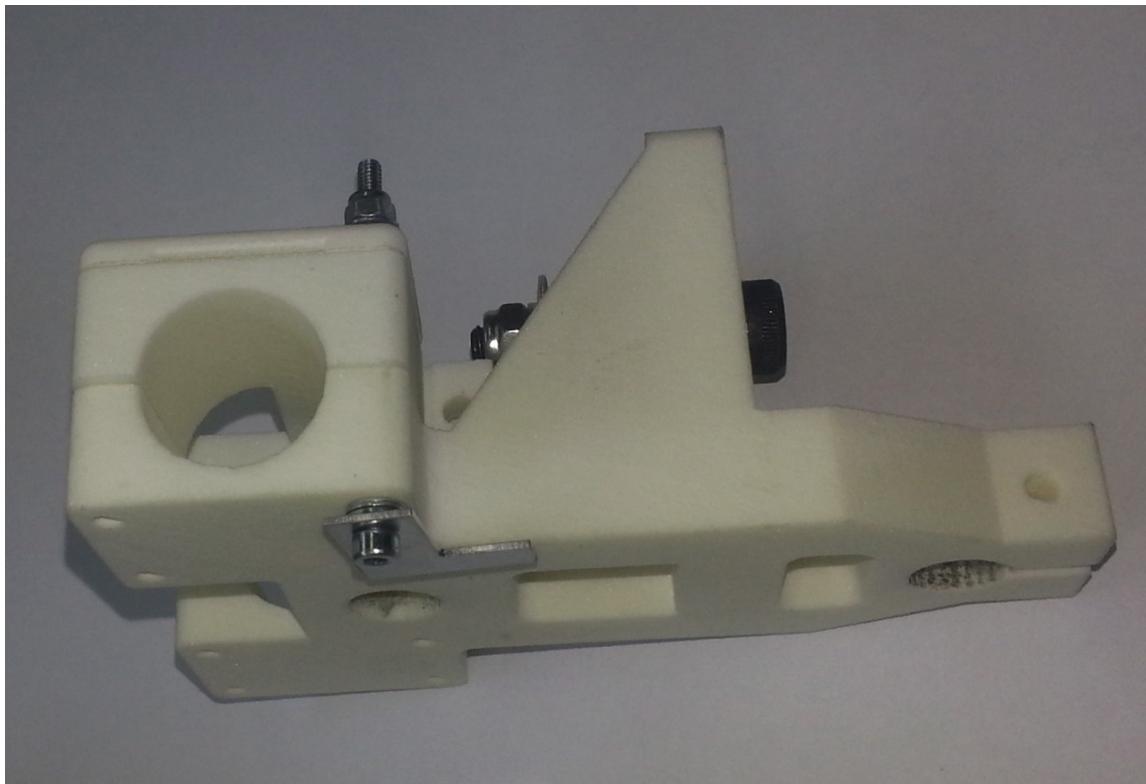
Auf der Seite des Umlenkers wird zusätzlich der "X-Glider Clamp Belt" befestigt, so dass zwischen ihm und dem "X-Glider Clamp LM12UU" ein Zahnriemen eingespannt werden kann.

Auf der gegenüberliegenden Seite werden das "L-ALU Opto-Flag Y" sowie vier washern befestigt.



Die Schraube darf nicht fest angezogen werden, da später die LM12UU-Lager noch dazwischen müssen.

Abbildung 3.99. Finish Opto-Flag Y

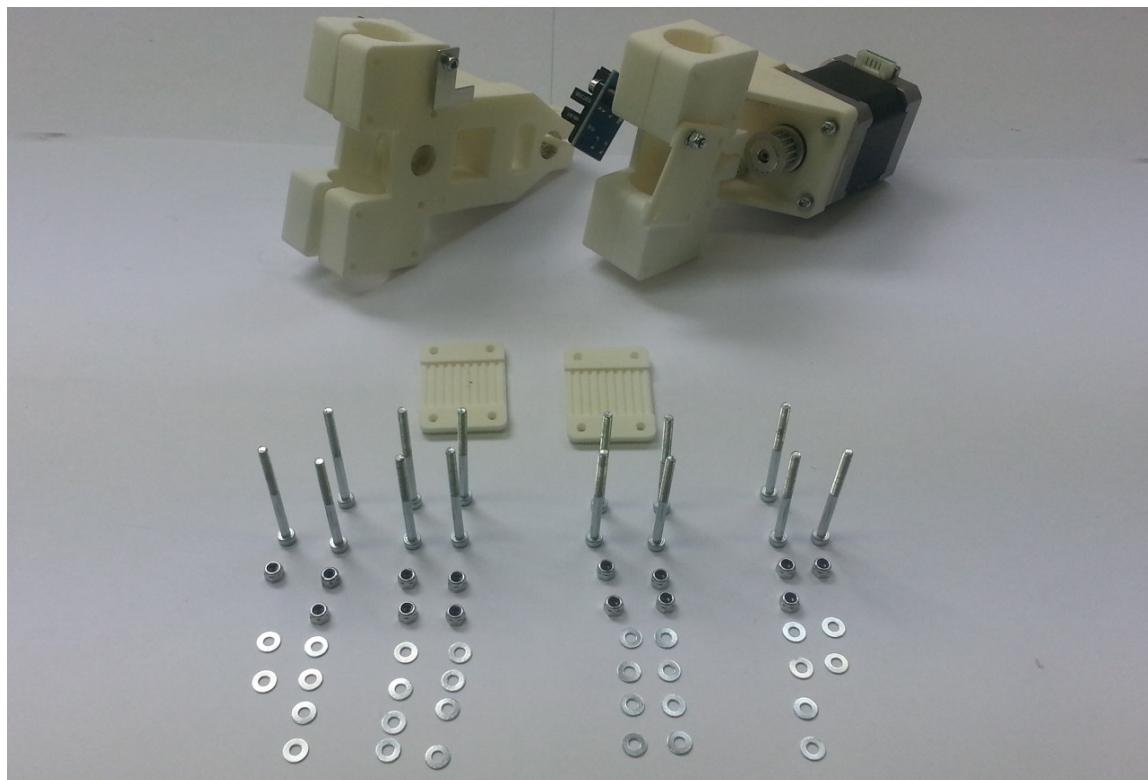


### 3.6.5. Assembly X-Glider

Tabelle 3.17. Parts list Montage X-Glider

2x X-Glider [S. 43], pre-assembled	2x X-Glider Clamp Belt [S. 42]
14x M3x40 cylinder head screws	28x M3 washer
14x M3 self-locking nut	

Abbildung 3.100. Assembly X-Glider parts overview

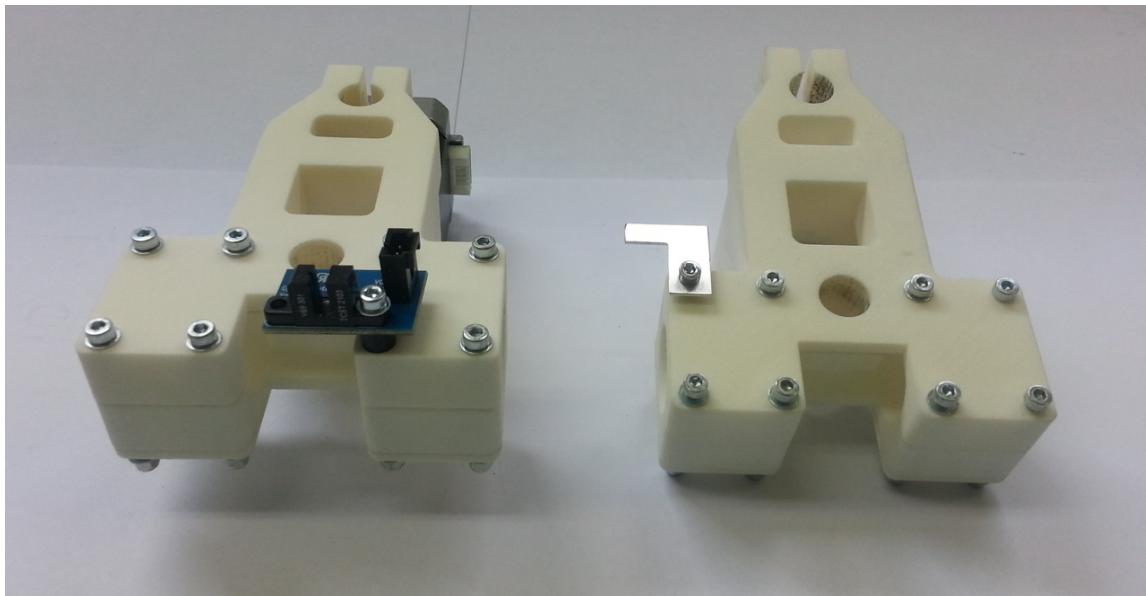


In den anderen Bohrungen werden nun die restlichen Schrauben gesteckt und verschraubt, dabei dürfen die "X-Glider Clamp Belt" nicht vergessen werden.



Die Schrauben dürfen nicht fest angezogen werden, da später die LM12UU-Lager noch dazwischen müssen.

Abbildung 3.101. Finish Assembly X-Glider

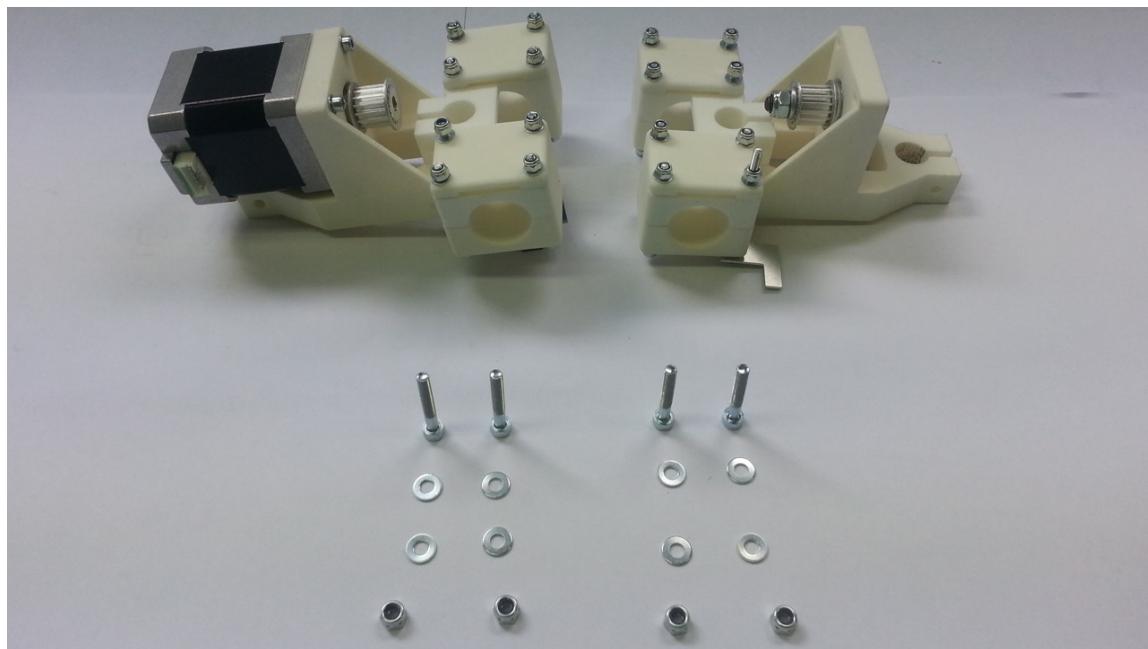


### 3.6.6. Guiding rods holder

Tabelle 3.18. Parts list Guiding rods holder

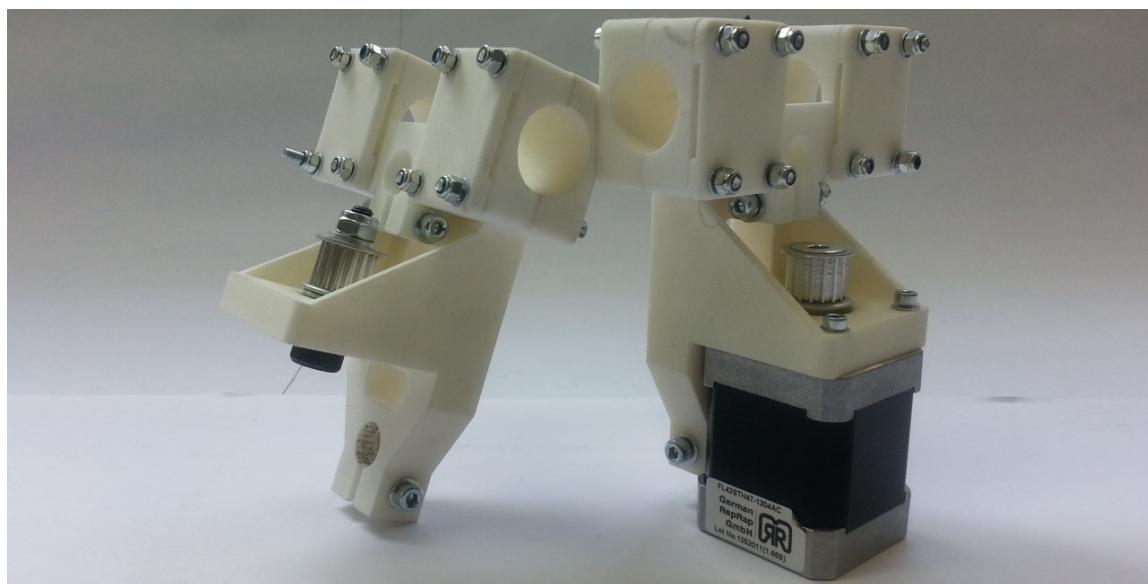
2x X-Glider [S. 43], pre-assembled	4x M4x30 cylinder head screws
8x M4 washer	4x M4 self-locking nut

Abbildung 3.102. Guiding rods holder parts overview



Die Fixierungen für die Hohlwellen der X-Achse werden zunächst auch nur locker verschraubt.

Abbildung 3.103. Finish Guiding rods holder



### 3.6.7. Y-axis carriage

Tabelle 3.19. Parts list Y-axis carriage

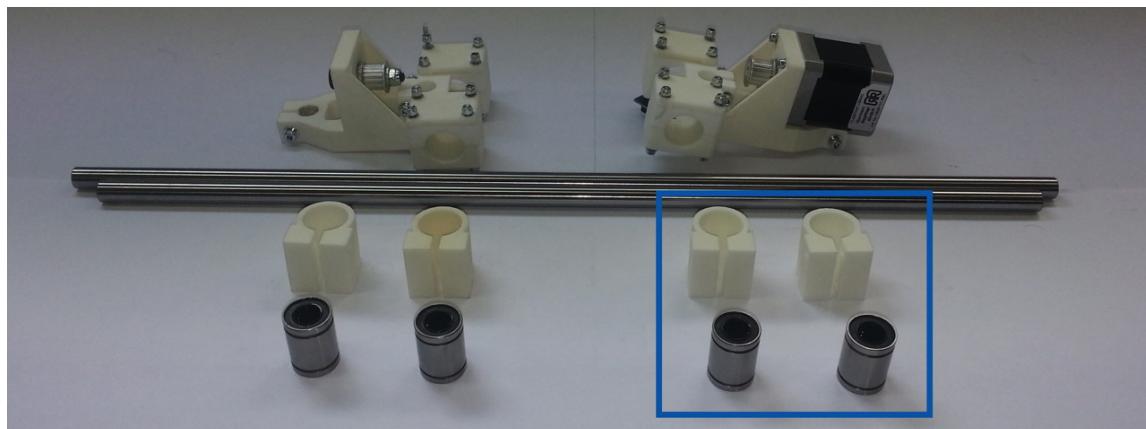
2x X-Glider, [S. 43], pre-assembled	2x Carriage Clamp LM12UU
1x X-axis hollow shaft, long, 530 mm [S. 34]	1x X-axis hollow shaft, short, 500 mm [S. 34]
2x Ball bearing LM12UU	

Tabelle 3.20. additional parts for the Dual-Extruder

2x Carriage Clamp LM12UU	2x Ball bearing LM12UU
--------------------------	------------------------

Das additional parts for the Dual-Extruder ist in den Bilder mit einem blauem Rechteck markiert.

Abbildung 3.104. Y-axis carriage parts overview



The "Carriage Clamp LM12UU" and the ball bearings are slipped on the shafts. Afterwards, the long shaft is inserted at the top, as shown in the image "Finish". The short shaft is inserted at the bottom.



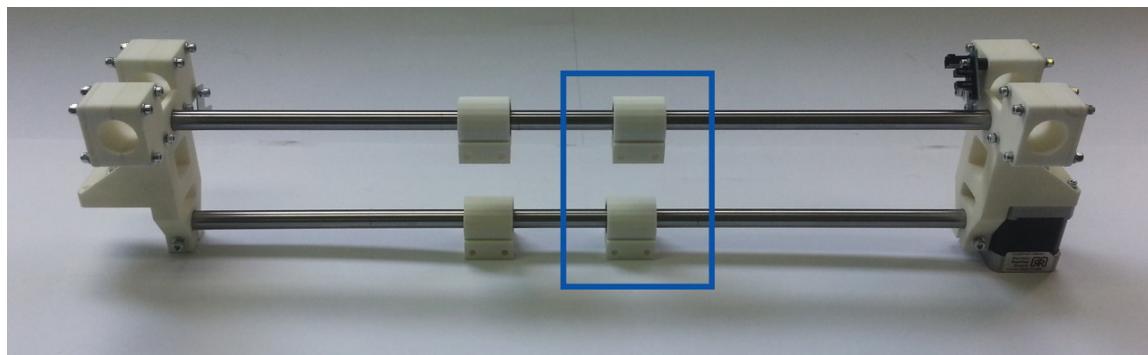
It is easier to mount the hollow shafts if the corresponding holes are manually reamed with a 12mm driller. The bores were purposely designed smaller to reach a better accuracy of fit with the manual reaming.

It is important that the shaft holders are not tightened yet, as the X-axis has to be slipped on the Y-axis guiding rods first.



If the X400 comes with the optional Dual-Extruder we now fit two additional ball bearings and Carriage Clamps on the shafts.

Abbildung 3.105. Finish Y-axis carriage



### 3.6.8. X-axis carriage

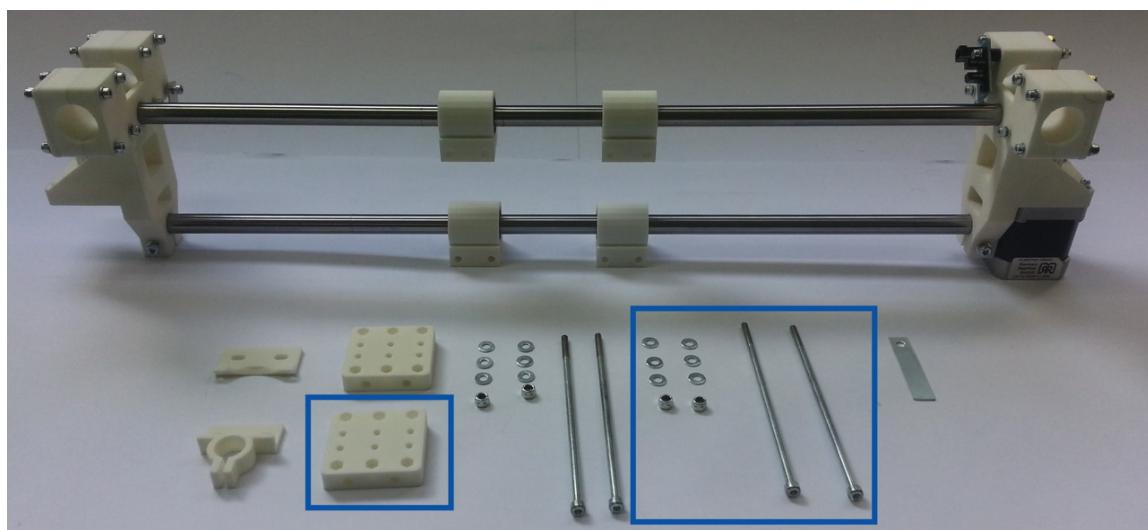
Tabelle 3.21. Parts list X-axis carriage

1x Y-Achsen Schlitten, pre-assembled	1x Carriage Mount [S. 31]
1x Carriage Cablemount [S. 29]	1x Carriage Fanmount [S. 31]
2x M4x120 cylinder head screws	6x M4 washer
2x M4 self-locking nut	1x L-ALU Opto-Flag X [S. 36]

Tabelle 3.22. additional parts for the Dual-Extruder

1x Carriage Mount [S. 31]	2x M4x120 cylinder head screws
6x M4 washer	2x M4 self-locking nut

Abbildung 3.106. X-axis carriage parts overview



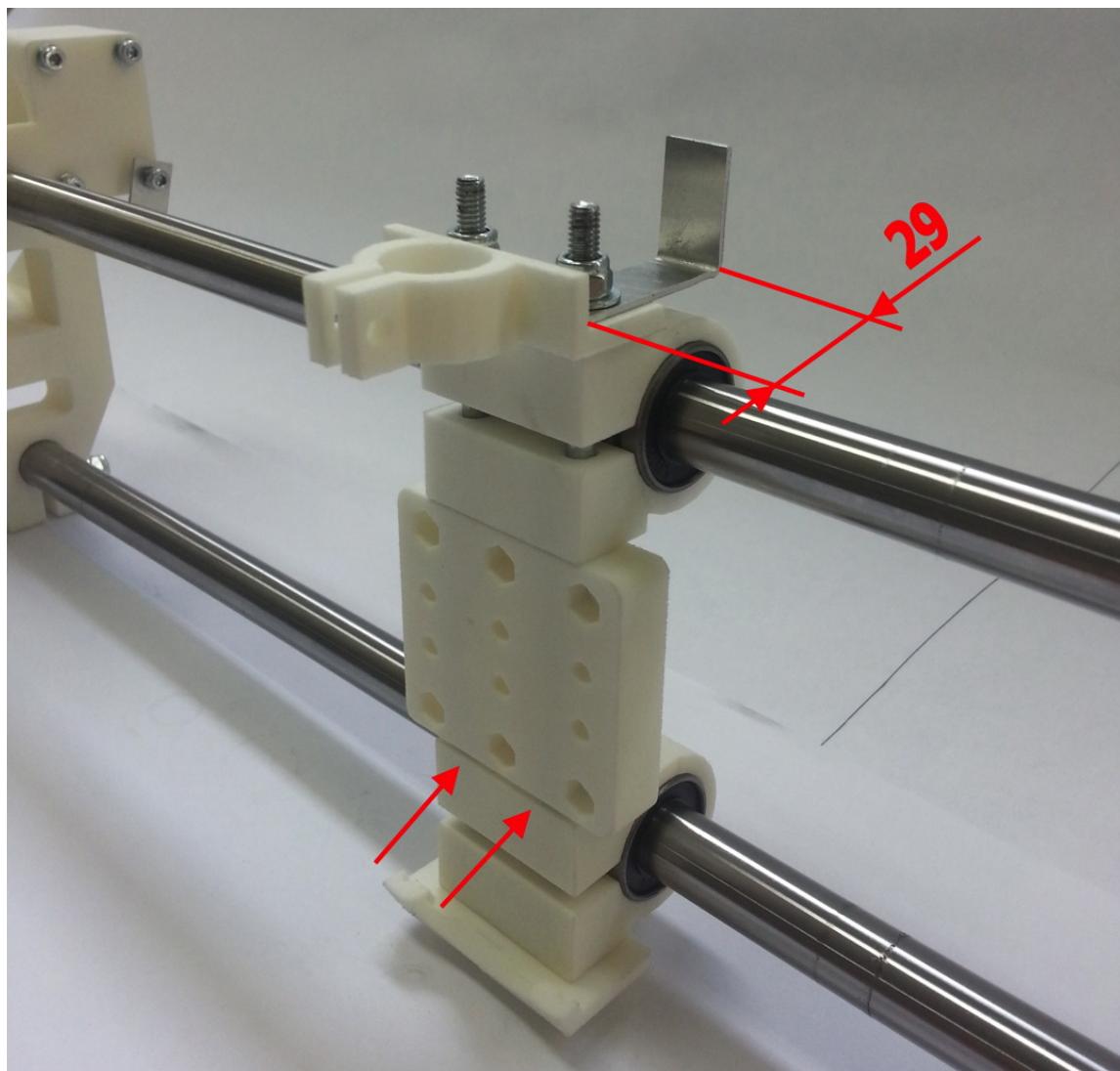
The "carriage mount" is placed between the two "Carriage Clamps LM12UU" on the shaft. In addition, the carriage cable mount is added on top and the carriage fan mount on the bottom. The screw heads have to be on the bottom side to prevent collision with the printing bed.



The "carriage fan mount" helps to mount a fan which cools down the printed part. A fan is not included in the construction kit. This is an optional function.

Additional a washer is placed between the carriage mount and the carriage clamp, see "[Distance compensation of the X-carriage \[S. 95\]](#)".

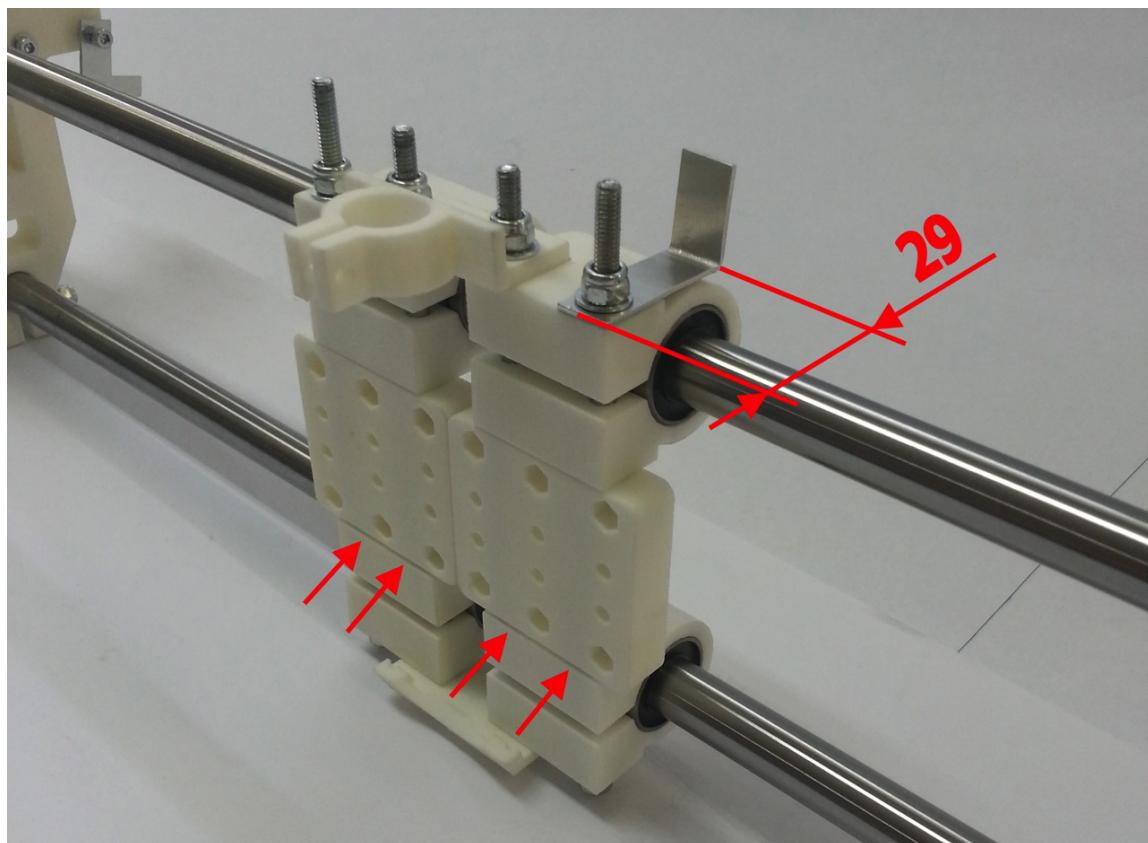
Abbildung 3.107. Distance compensation of the X-carriage (Single-Extruder)



If the X400 needs to be fitted with the optional dual extruder, the additional carriage mount is screwed between the additional carriage clamp.

The carriage cable mount and the carriage fan mount are mounted as shown in the following pictures, they are used to keep both extruders together

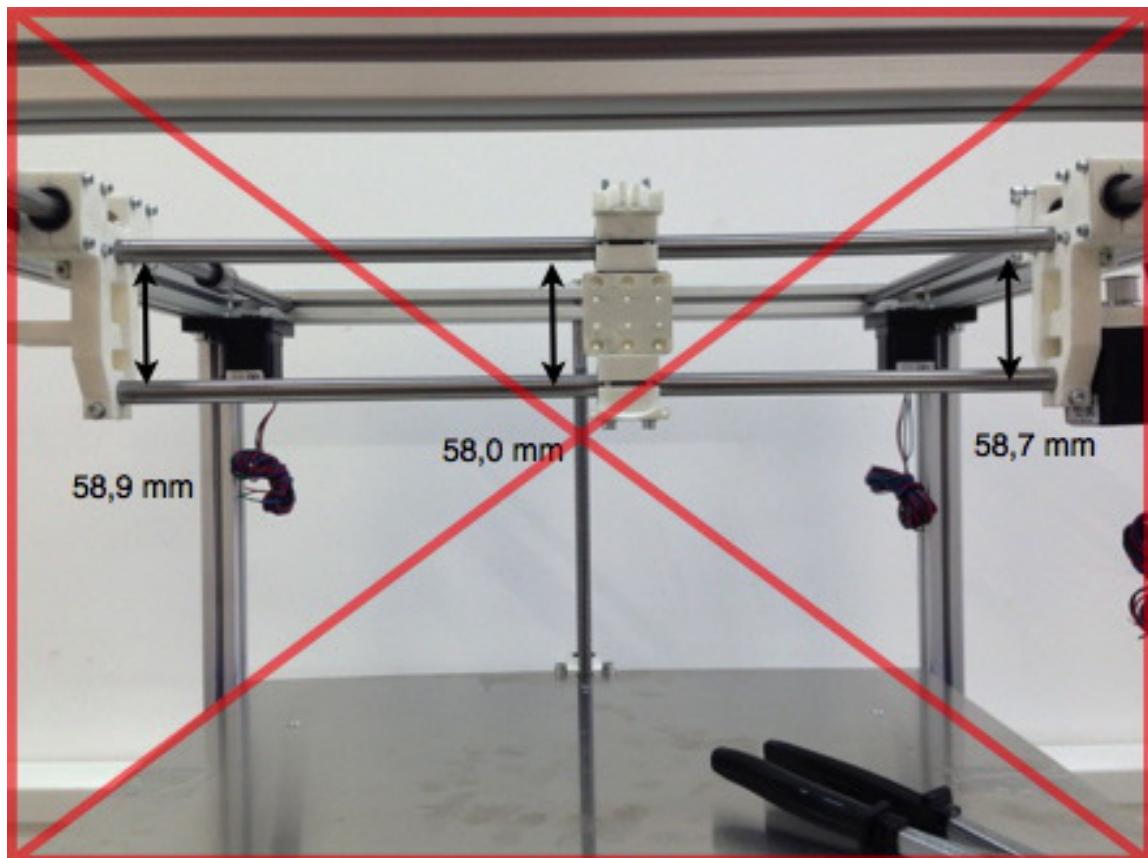
Abbildung 3.108. Distance compensation of the X-carriage (Dual-Extruder)



The long M4x120mm screws should not be tightened too hard (only finger-tight) to prevent a deformation of the guiding shafts.



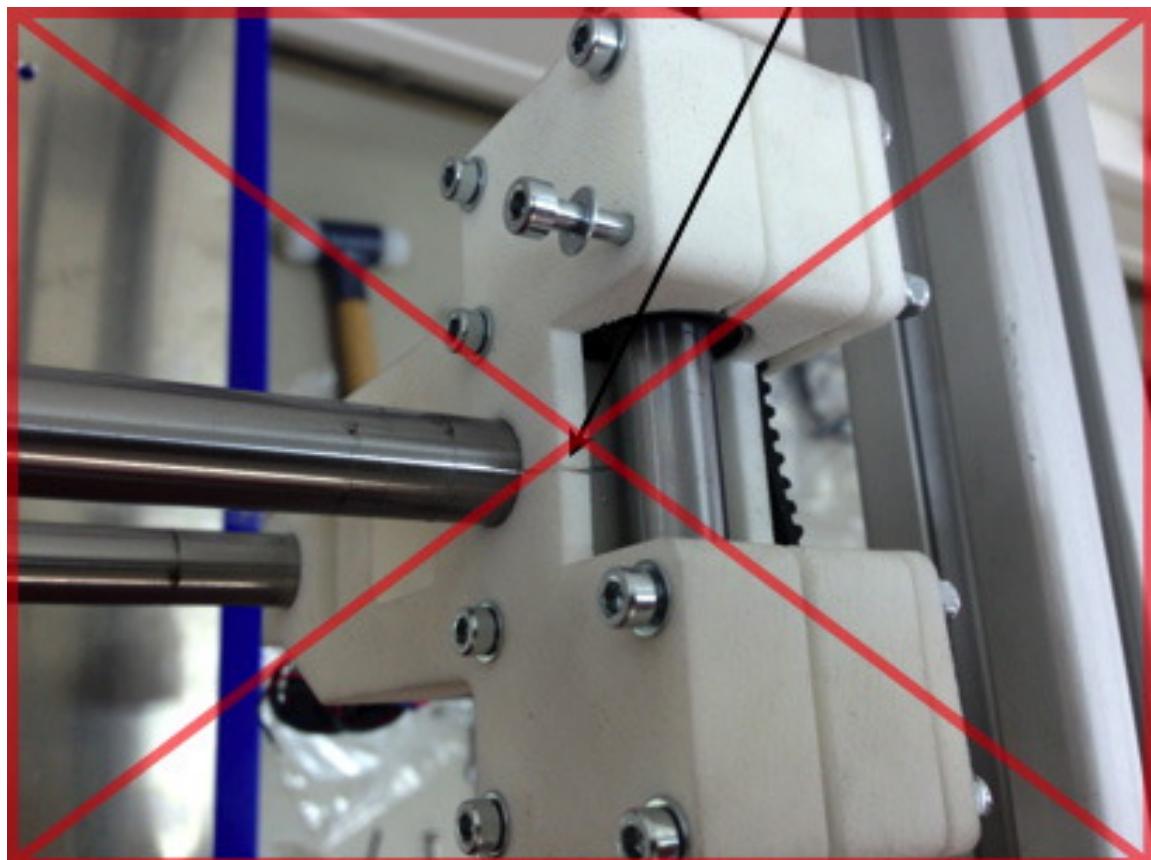
Abbildung 3.109. Deformation guiding shafts



The shafts are clamped in the X-gliders. This may result in a breaking of the upper clamp, if it is over tightened. The clamp should only be finger-tightened.



Abbildung 3.110. Broken clamp



Nach der Montage kann überprüft werden, ob der "Opto-Flag X" richtig gebogen wurde und genau mittig in den Opto-Endstop fährt.

Abbildung 3.111. Details Endstop-Unterbrecher

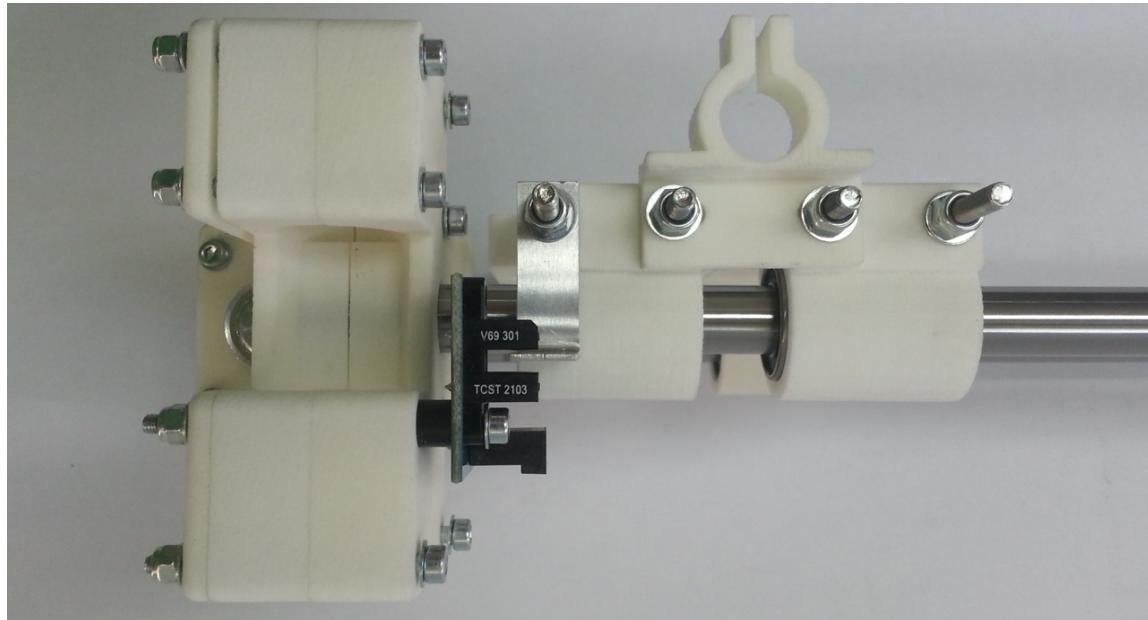


Abbildung 3.112. Finish X-axis carriage (Single-Extruder)

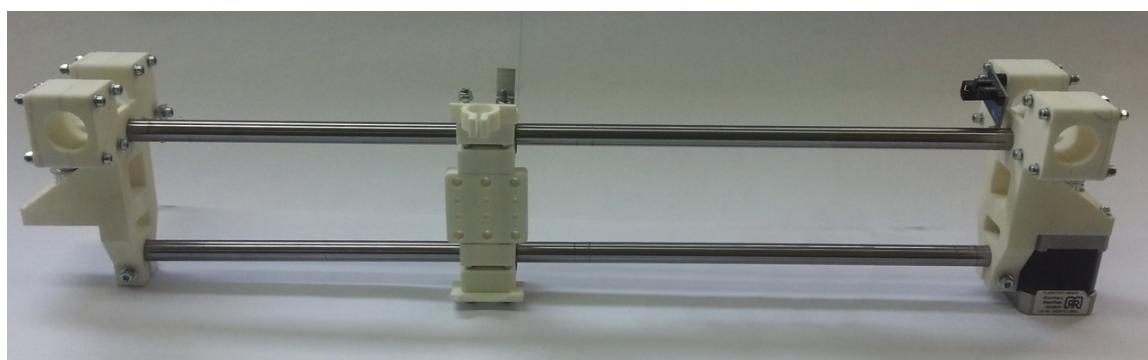
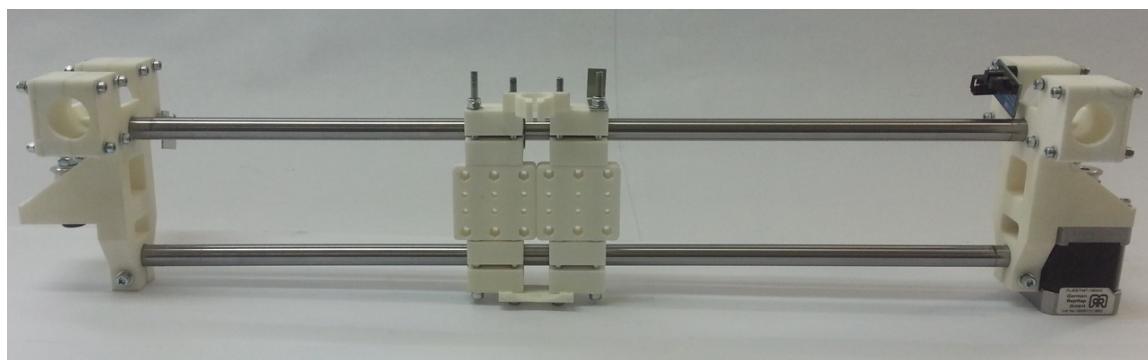


Abbildung 3.113. Finish X-Achsen Schlitten (Dual-Extruder)



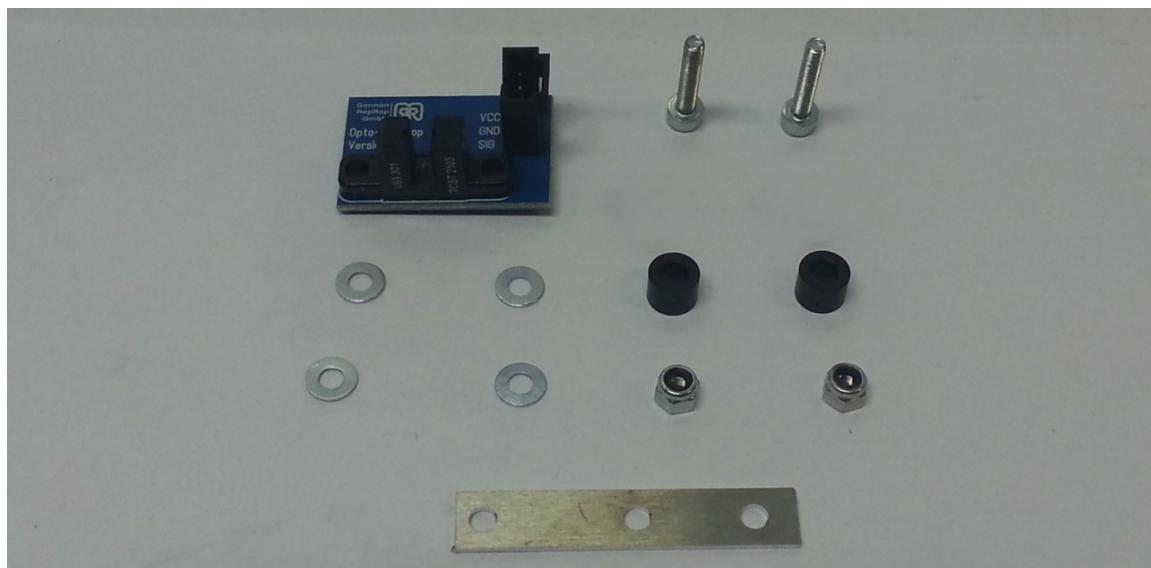
## 3.7. Y-axis

### 3.7.1. Y-axis end stop

Tabelle 3.23. Parts list Y-axis end stop

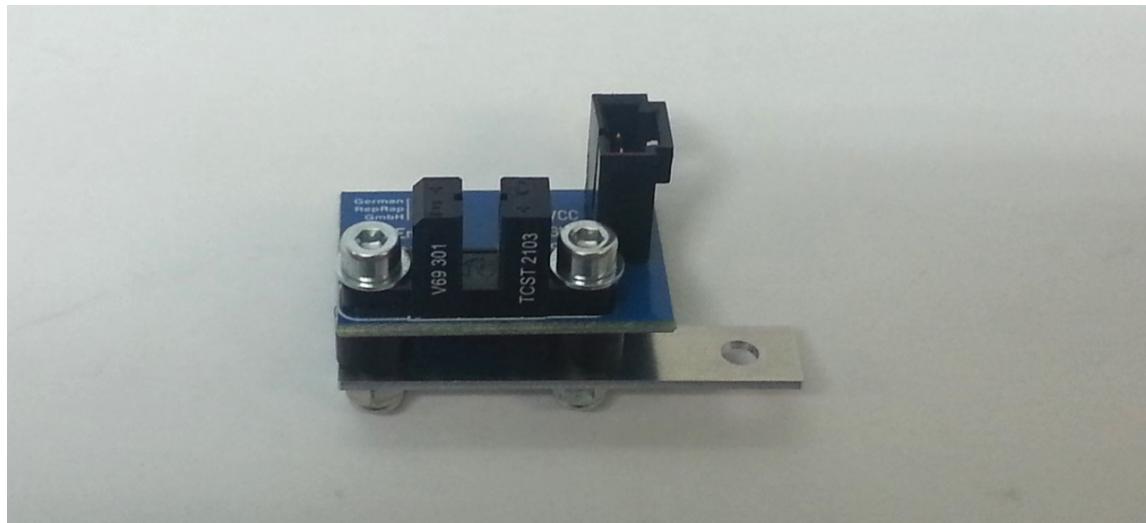
1x Opto-Endstop [S. 38]	1x L-ALU Y-Endstopholder [S. 37]
2x M3x16 cylinder head screws	4x M3 washer
2x sleeve 5mm	2x M3 self-locking nut

Abbildung 3.114. Y-axis end stop parts overview



Einer der "Opto-Endstops" wird an den "L-ALU Y-Endstophalter" geschraubt, wobei die 5mm Hülsen zwischen Endstophalter und Endstop positioniert wird.

Abbildung 3.115. Finish Y-axis end stop

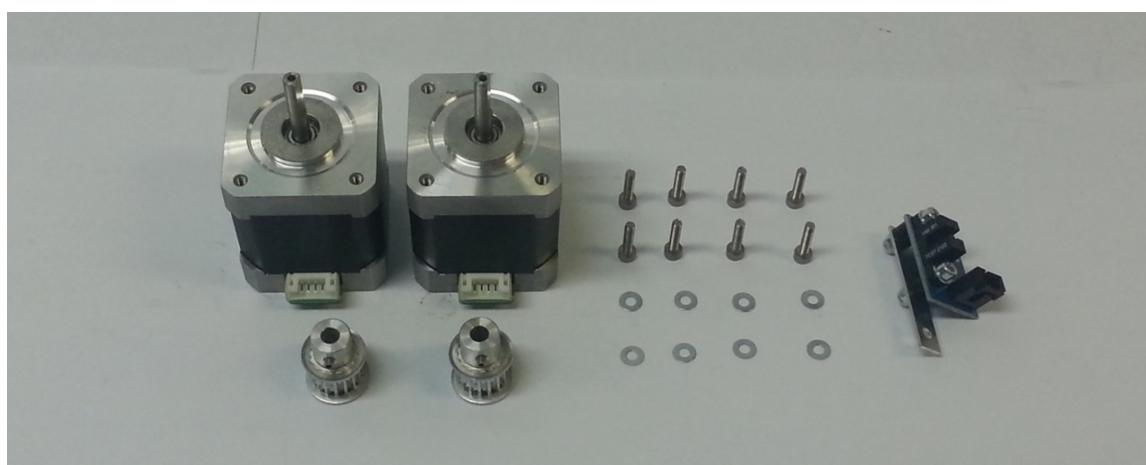


### 3.7.2. stepper motoren Y-axis

Tabelle 3.24. Parts list stepper motoren Y-axis

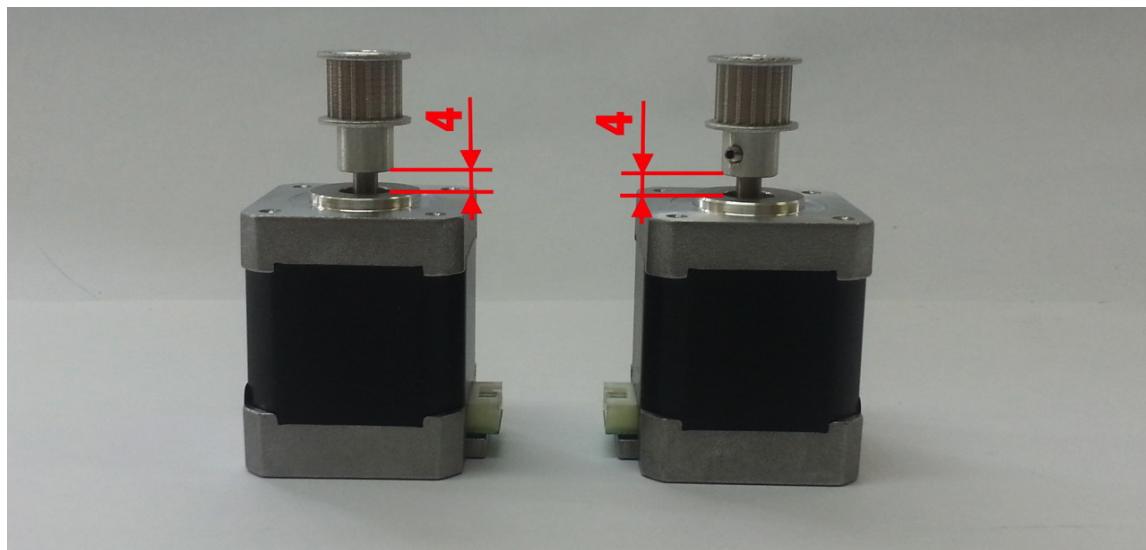
2x stepper motor, NEMA 17	2x Pulley 16 teeth 5mm Bohrung (incl. grub screw)
8x M3x16 cylinder head screws	8x M3 washer
1x Opto-Endstop, Y-Achse	

Abbildung 3.116. stepper motoren Y-axis parts overview



The distance between the pulley and the stepper motor should be about 4 mm so that the timing belt aligns with the idler later on. The grub screw is situated on the flattened area of the shaft.

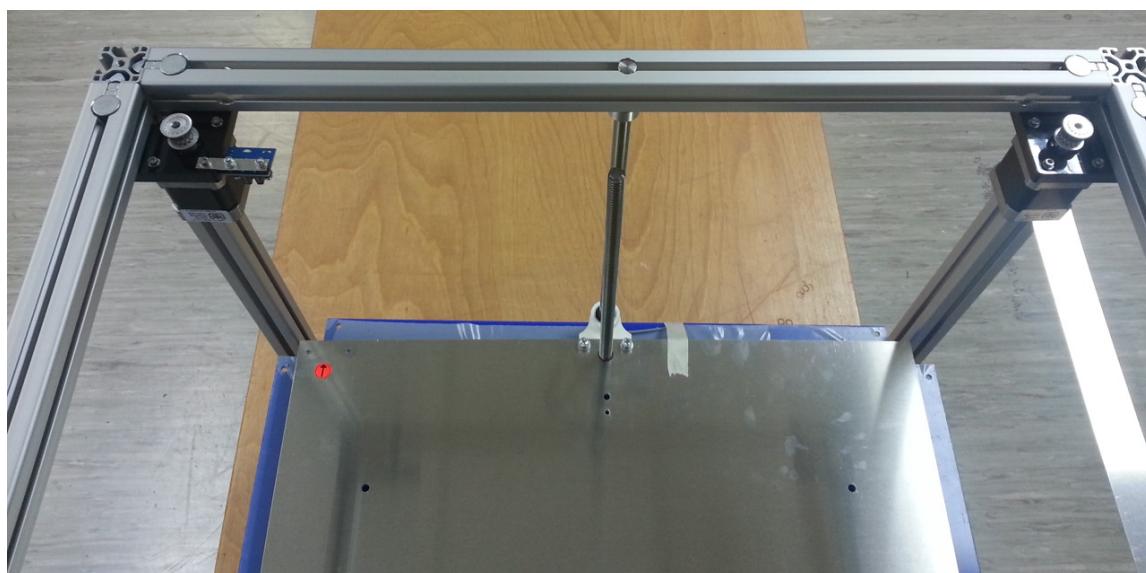
Abbildung 3.117. Details Pulley stepper motor



Die Motoren werden in die beiden "POM Mounts" an die Unterseite der hinteren, oberen Aluminiumprofile geschraubt. Die Stromanschlüsse der stepper motoren müssen dabei zur Rückseite des Geräts zeigen.

Der "Opto-Endstop" wird am hinteren linken stepper motor, wie im Bild "[Finish stepper motoren Y-Achse \[S. 102\]](#)" gezeigt, montiert. Dabei wird das Halteblech einfach unter der washer befestigt.

Abbildung 3.118. Finish stepper motoren Y-axis



### 3.7.3. Umlenker

Tabelle 3.25. Parts list Umlenker

2x cylinder fitting screw	2x Pulley 16 teeth M8 threaded
12x M8 washer	2x M6 washer
2x M6 self-locking nut	

Abbildung 3.119. Umlenker parts overview



In die Ball bearing der "POM Mounts", an der Vorderseite des X400, werden die Zylinderpassschrauben, wie im Bild "[Details Zylinderpassschraube \[S. 103\]](#)", montiert.

Das im Bild dargestellte Ball bearing ist bereits im "POM Mount" eingepresst.



Es kann helfen die Druckbett-Aufnahme nach unten zu drehen, damit die Zylinderpassschraube von unten in das Ball bearing geht. Unter Umständen ist die Antriebsspindel der Z-Achse im Weg. In diesem Fall ist die Umlenkeinheit vor der Montage des POM-Teils einzusetzen.

Abbildung 3.120. Details cylinder fitting screw



Abbildung 3.121. Finish Umlenker 1

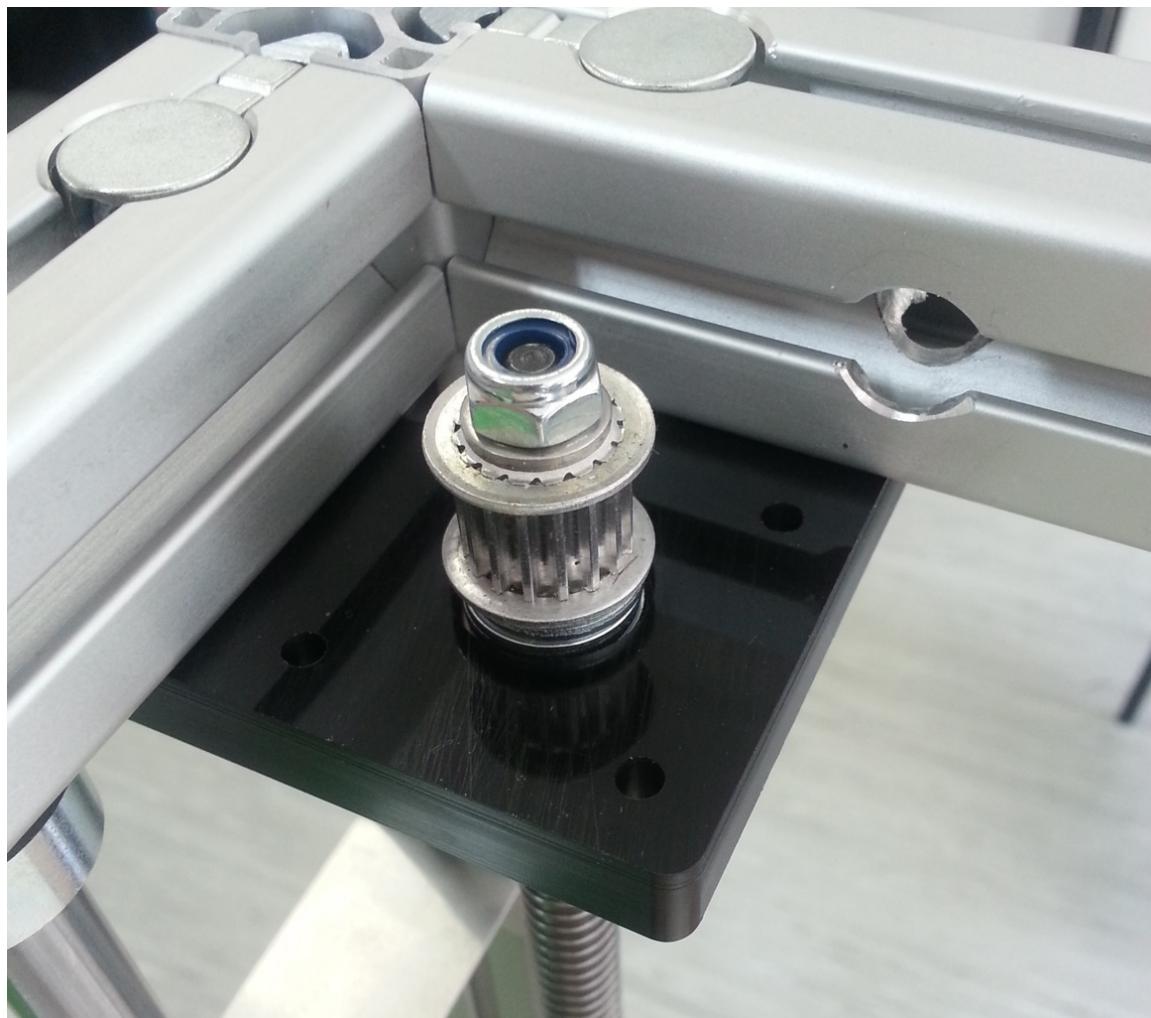
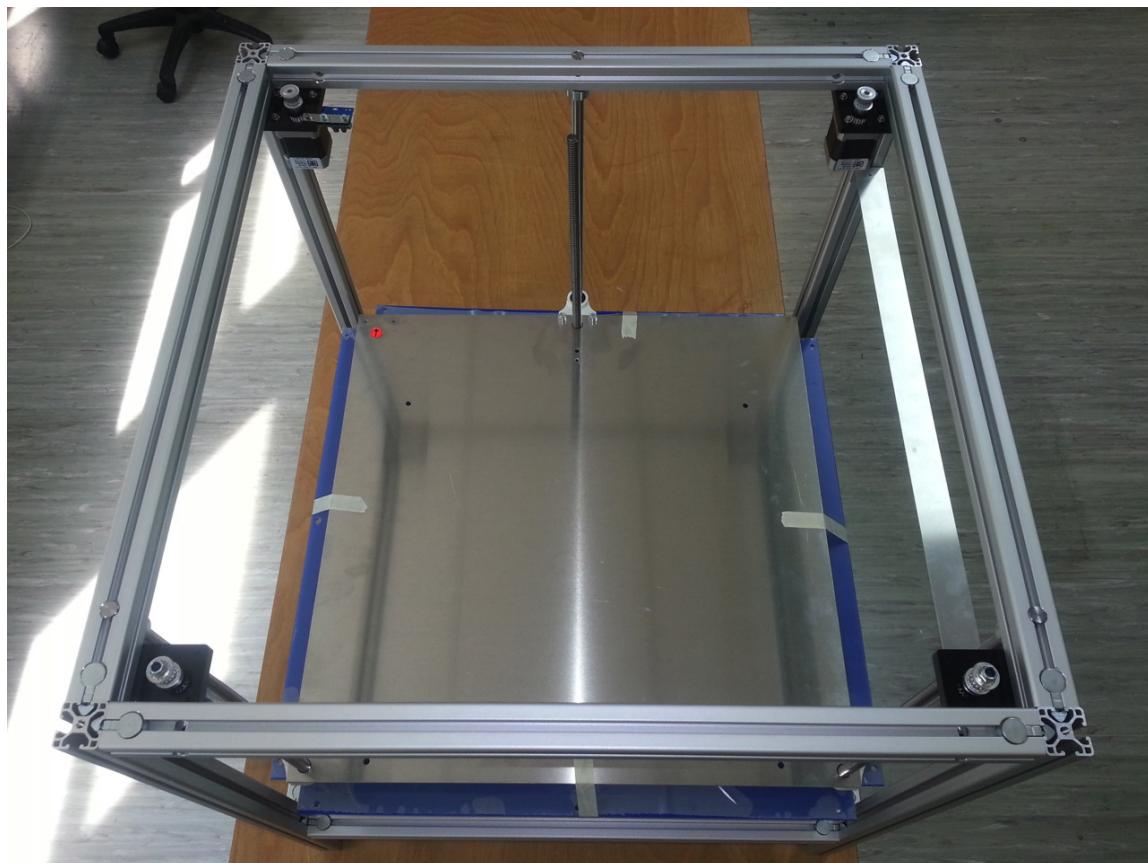


Abbildung 3.122. Finish Umlenker 2

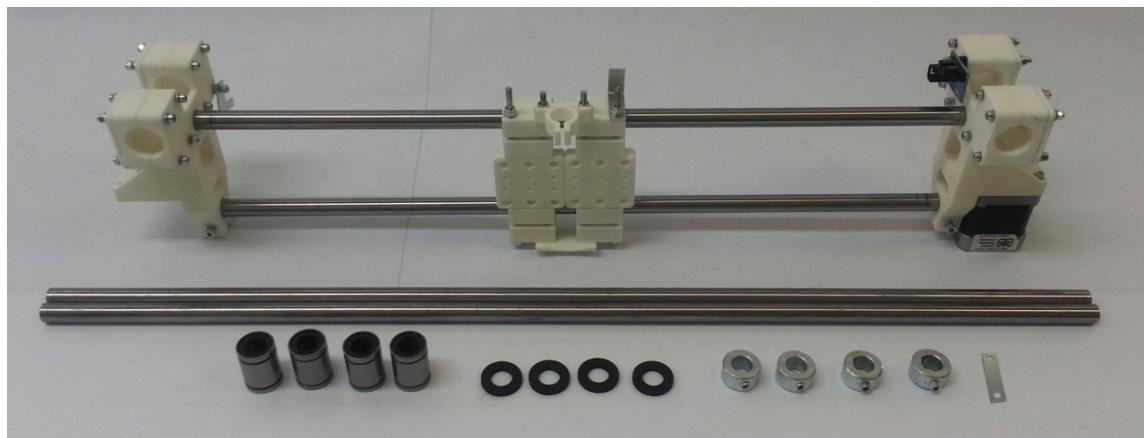


### 3.7.4. Fastening of the Y-axis carriage

Tabelle 3.26. Parts list Fastening of the Y-axis carriage

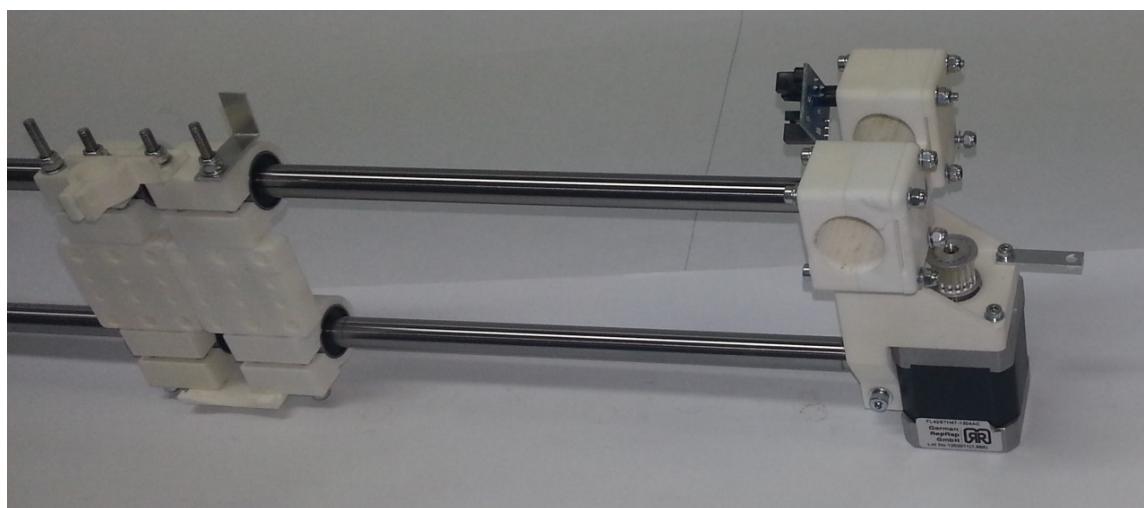
1x Y-axis carriage [S. ]	2x Y-axis guiding rod, 660 mm [S. 34]
4x M12 washer, rubber	4x M12 adjusting ring (incl. grub screw)
4x Ball bearing LM12UU	1x L-Alu Energychain holder [S. 35]

Abbildung 3.123. Fastening of the Y-axis carriage parts overview



Zunächst wird das "L-Alu Energiekettenhalter" an eine der Halteschrauben des stepper motors geschraubt. Dabei wird das Halteblech einfach unter der washer befestigt.

Abbildung 3.124. Details Energychain holder

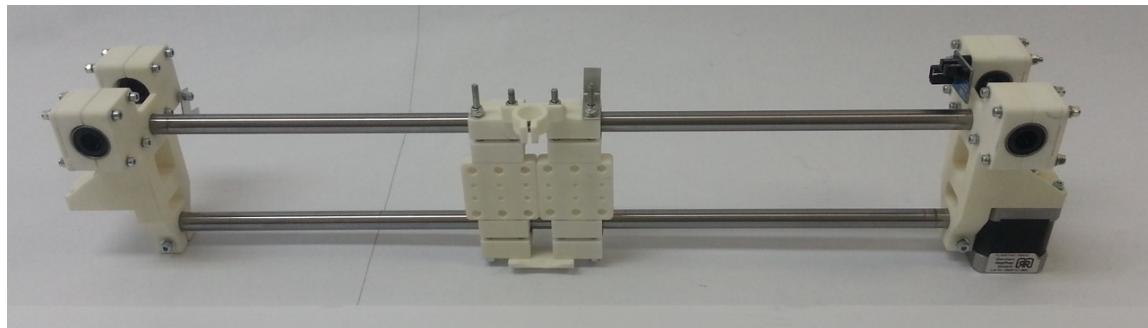


Die "Ball bearing LM12UU" werden in die dafür vorgesehenen Halter in die X-Glider gelegt.



Da die Schrauben der Halter immer noch nicht angezogen werden, muss darauf geachtet werden, dass die Ball bearing nicht herausfallen.

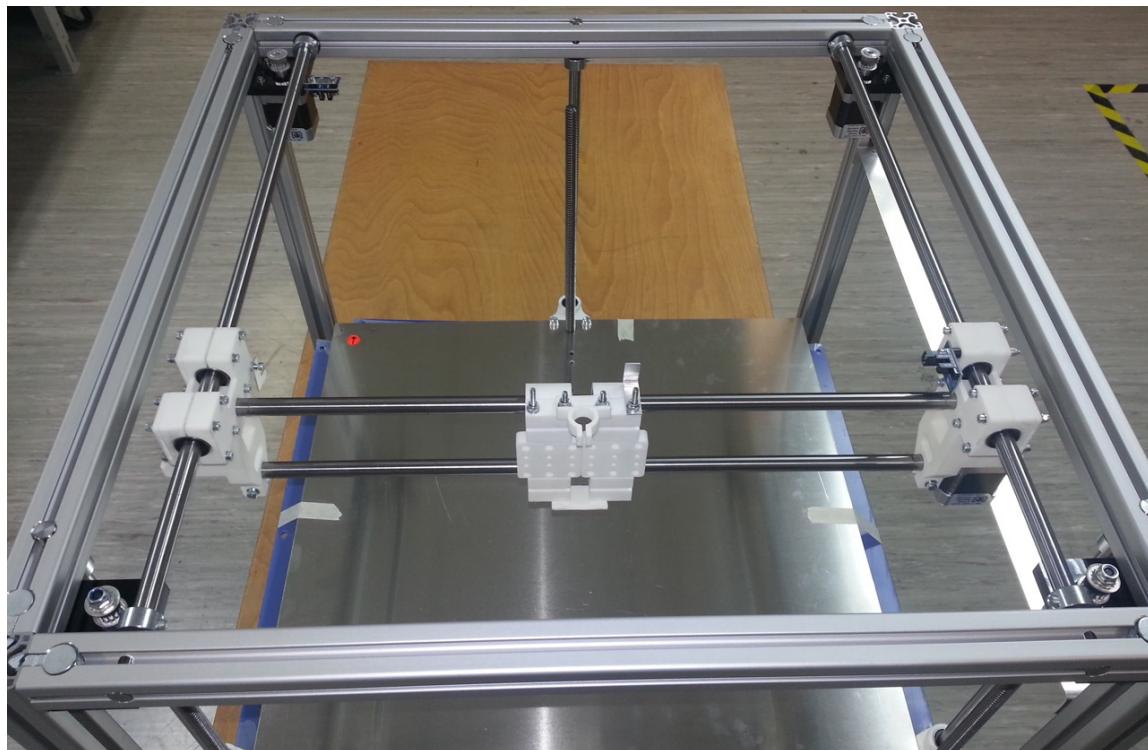
Abbildung 3.125. Details Ball bearing LM12UU



Nun können die Führungsstangen durch die Bohrungen in den oberen Aluminiumprofile gesteckt werden. Dabei werden die Stellringe und die washern sowie der Y-Achsen Schlitten auf die Führungsstangen aufgeschoben.

Auch hier werden die washern zwischen Aluminiumprofil und Stellring befestigt.

Abbildung 3.126. Details Ball bearing LM12UU



### 3.7.5. timing belt Y-axis

Tabelle 3.27. Parts list timing belt Y-axis

1x 2,3m timing belt
---------------------

Abbildung 3.127. timing belt Y-axis parts overview



The timing belt is used for the two motors of the Y-axis and connects it to the X-axis carriage.

It is recommended to tension the timing belt on one side in the "Belt Clamp" first, place it around the idler pulley and the stepper motor and then tension it via the other "Belt Clamp". Only then, the rest of the timing belt is cut off and the same procedure is done on the other side of the motor.

Abbildung 3.128. Details mounting 1

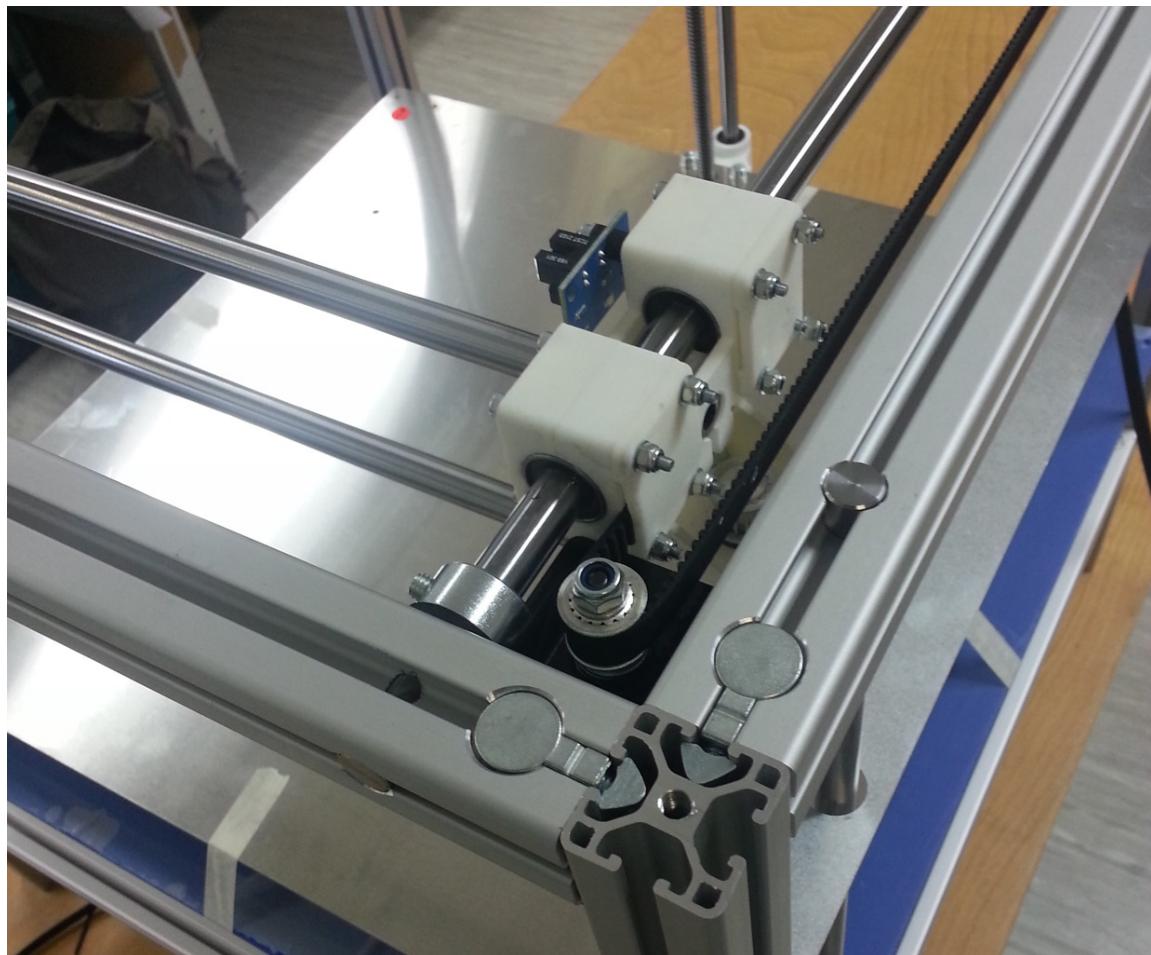
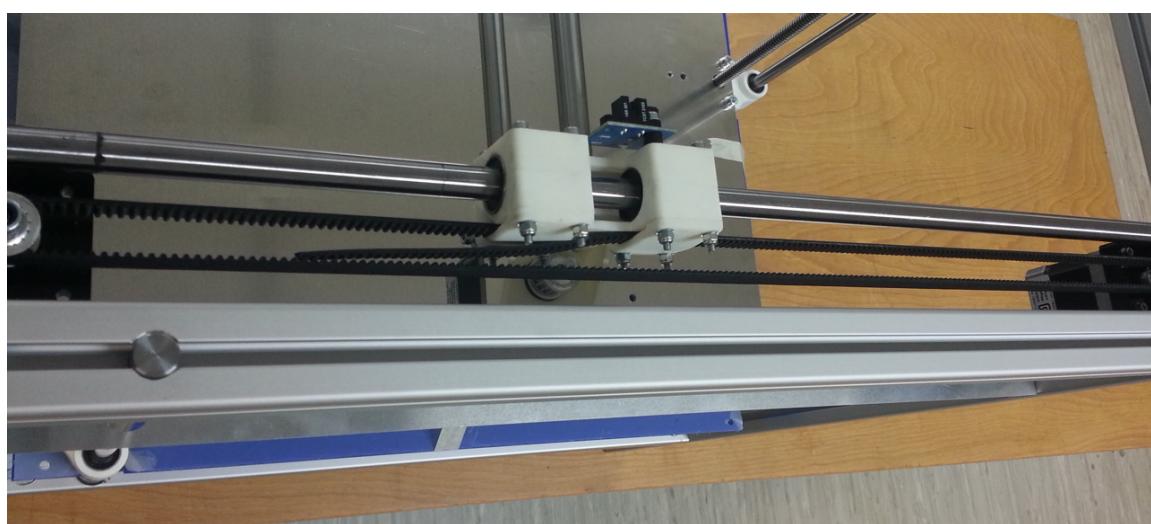


Abbildung 3.129. Details mounting 2

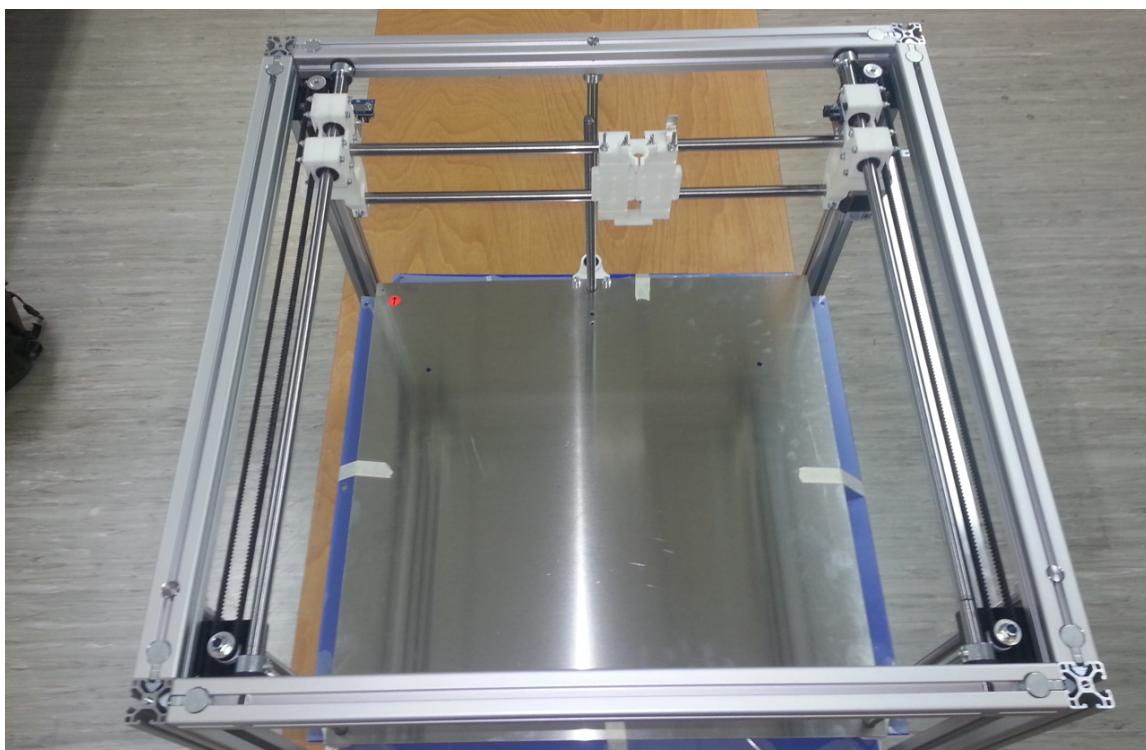




Hier sollte noch einmal darauf geachtet werden, dass der "L-Alu Opto Flag Y" genau in den "Opto-Endstop Y" fährt.

Ist der Zahnriemen montiert, können die Schrauben der "Führungsstangen Halter [S. 91]" im "Y-Achsen Schlitten" angezogen werden. Dabei ist darauf zu achten, dass die Führungsstangen der Y-Achse nicht verbogen werden, da dann die Y-Achse nur sehr schwergängig läuft.

Abbildung 3.130. Finish Zahnriemen Y-Achse



### 3.7.6. timing belt X-axis

Tabelle 3.28. Parts list timing belt X-axis

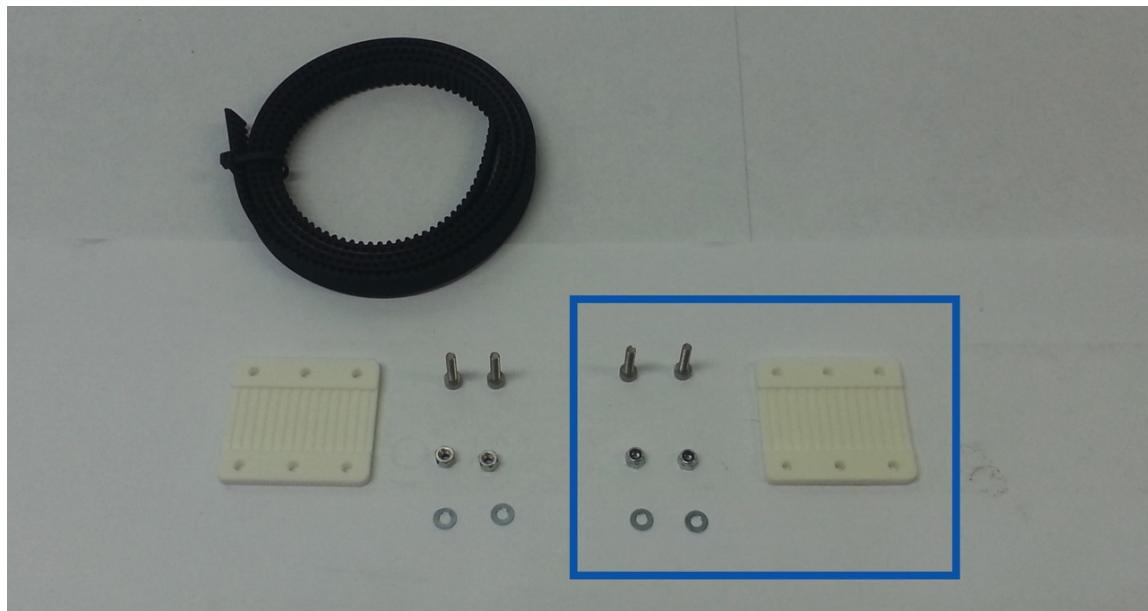
1x 1,15m timing belt	1x Carriage Clamp Belt [S. 30]
2x M3x14 cylinder head screws	2x M3 washer
2x M3 self-locking nut	

Tabelle 3.29. additional parts for the Dual-Extruder

1x Carriage Clamp Belt [S. 30]	2x M3x14 cylinder head screws
2x M3 washer	2x M3 self-locking nut

Das additional parts for the Dual-Extruder ist in den Bildern mit einem blauem Rechteck markiert.

Abbildung 3.131. timing belt X-axis parts overview

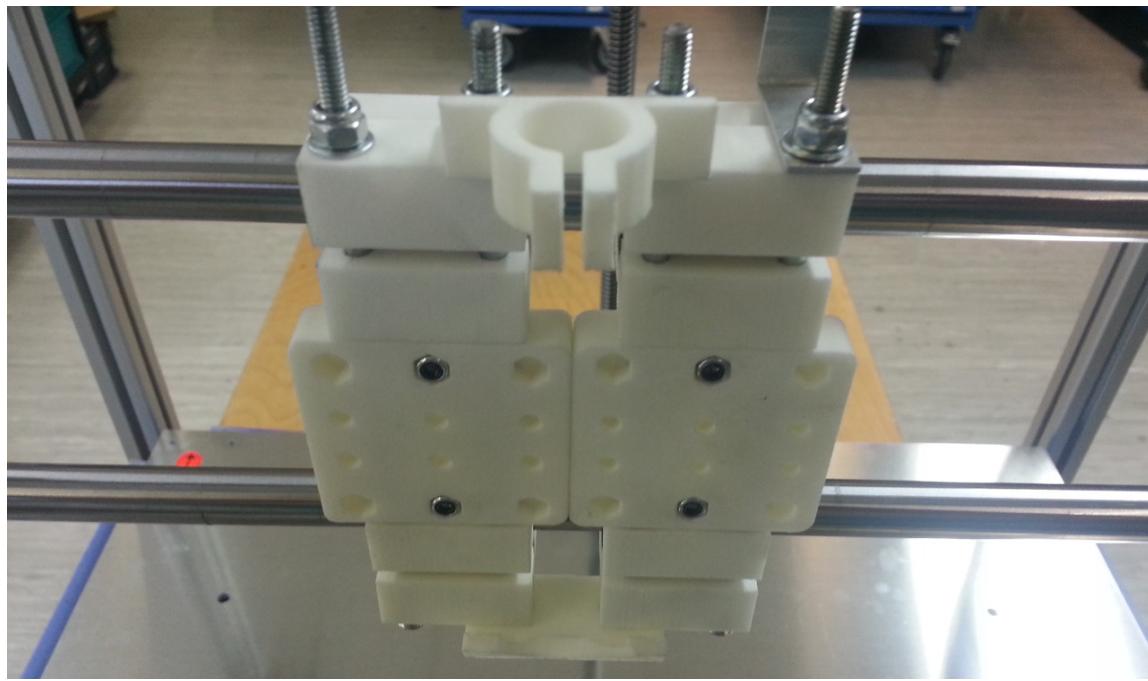


Um die "Carriage Clamp Belt" später einfacher lösen zu können, werden je zwei Muttern in die Sechskant-Aussparungen der "Carriage Mount" gedrückt.



Dabei sollte der Kunststoffring der Sicherung an der Mutter nach außen zeigen.

Abbildung 3.132. Details nut (Dual-Extruder)



Da bei der X-Achse beide Enden des Zahnriemens hinter dem "Carriage Clamp Belt" verschwinden, ist es wichtig den Zahnriemen vorher auf die richtige Länge zu schneiden.



The timing belt can neither be too long nor too short. Ideally, it should have a gap of 0.5-1 cm in tensioned state.

Abbildung 3.133. Details timing belt length

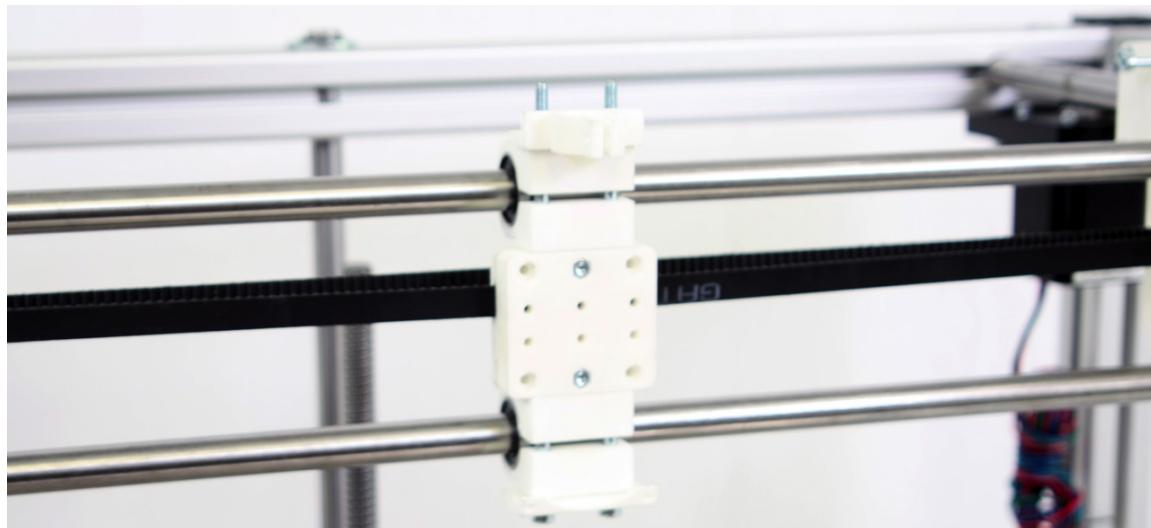




When the timing belt is shortened to the right length, it can be attached to the belt clamp. The cylinder screw heads have to be sunk into the holder.

Beim Single-Extruder werden beide Enden des Zahnriemens hinter einem "BeltClamp" verschraubt.

Abbildung 3.134. Finish timing belt X-axis front side (Single-Extruder)



If the X400 is supplied with the optional second extruder, one end of the timing belt is fixed on the first Carriage Mount and the other end is fixed on the second Carriage Mount.

Abbildung 3.135. Details BeltClamp (Dual-Extruder)

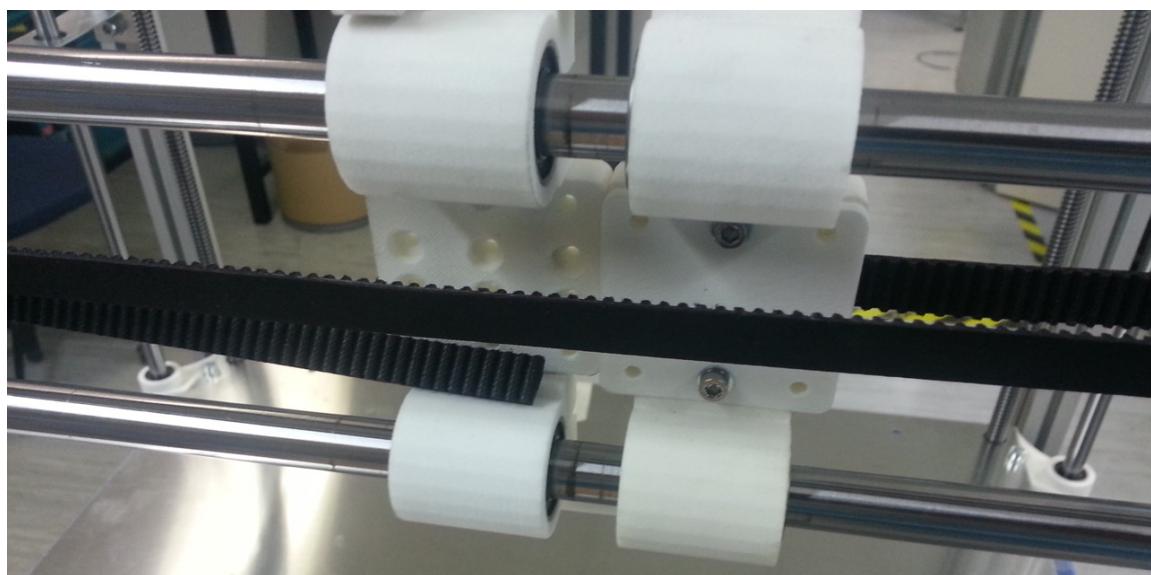


Abbildung 3.136. Finish timing belt X-axis front side (Dual-Extruder)

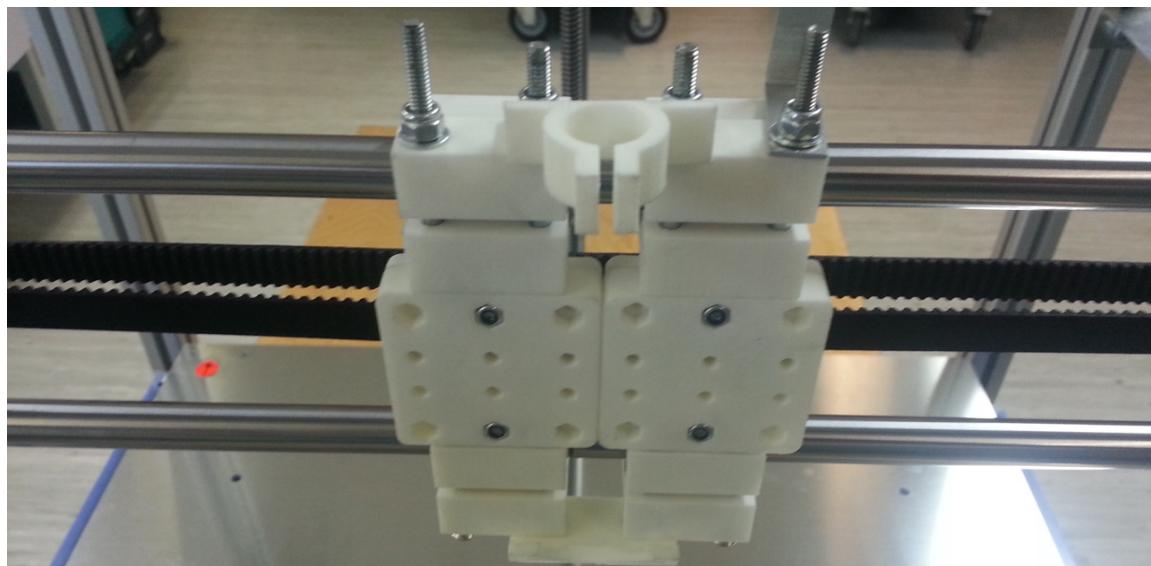


Abbildung 3.137. Finish timing belt X-axis back side (Dual-Extruder)



## 3.8. The DD-Extruder



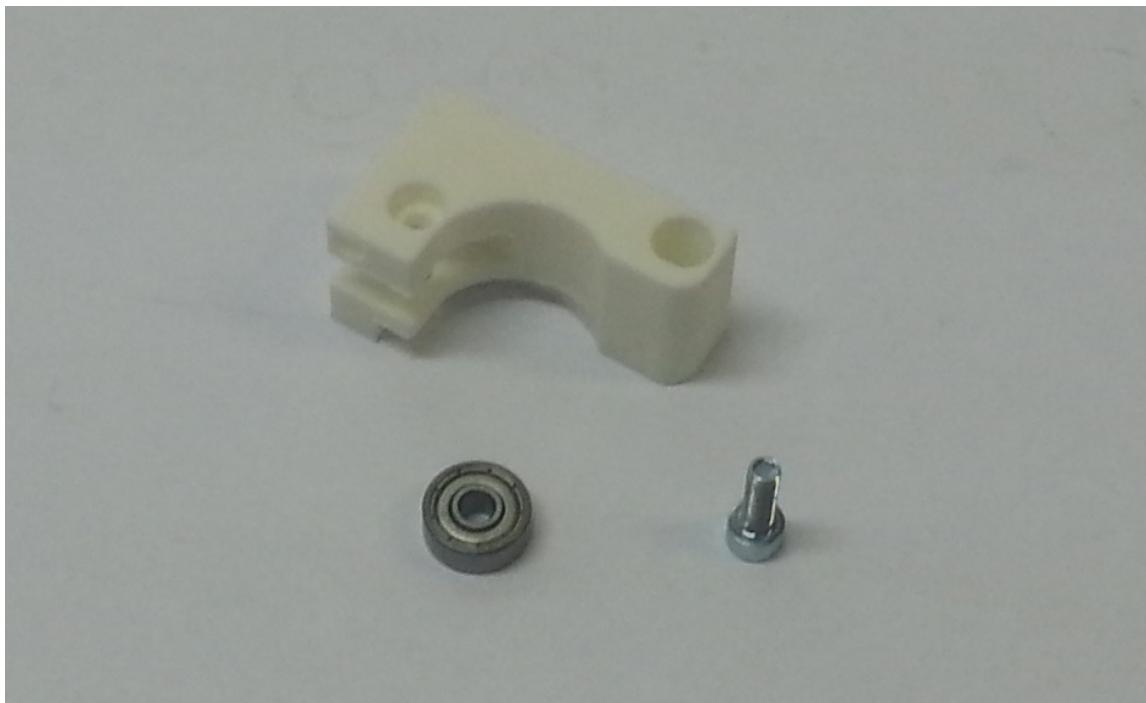
For the Dual-Extruder you need also a second extruder.

### 3.8.1. Assembly of the counter bearing

Tabelle 3.30. Parts list Assembly of the counter bearing

1x Extruder counter bearing [S. 33]	1x Ball bearing 624-ZZ
1x M4x12 cylinder head screws	

Abbildung 3.138. Assembly of the counter bearing parts overview



The ball bearing is placed in the gap of the counter bearing and fixed with a cylinder head screw. The cylinder head screw does not require a nut.



Abbildung 3.139. Finish assembly of the counter bearing



### 3.8.2. Mounting of the counter bearing

Tabelle 3.31. Parts list Mounting of the counter bearing

1x stepper motor, NEMA 17	1x Extruder counter bearing, Direct-Drive
1x spacer sleeve, 20mm	1x M3x25 cylinder head screws
2x M3 washer	1x M3 washer, large OD

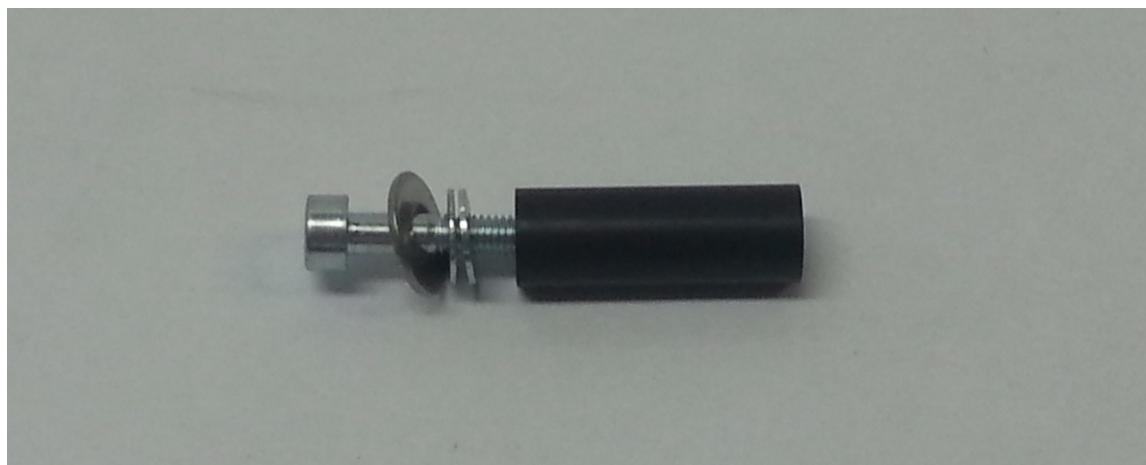


Abbildung 3.140. Mounting of the counter bearing parts overview



The cylinder head screw is assembled with the washers and plugged into the spacer sleeve. In this process, the counter bearing is directly screwed to the stepper motor, as shown in the image "[Finish Mounting of the counter bearing \[S. 118\]](#)"

Abbildung 3.141. Details sleeve



Das Anschlusskabel für den stepper motor befindet sich auf dem Bild "[Finish Halterung Gegenlager \[S. 118\]](#)" an der Rückseite des Motors.



Abbildung 3.142. Finish Mounting of the counter bearing



### 3.8.3. Filament screw

Tabelle 3.32. Parts list Filament screw

1x Filament screw, Direct-Drive	1x M3 grub screw
---------------------------------	------------------

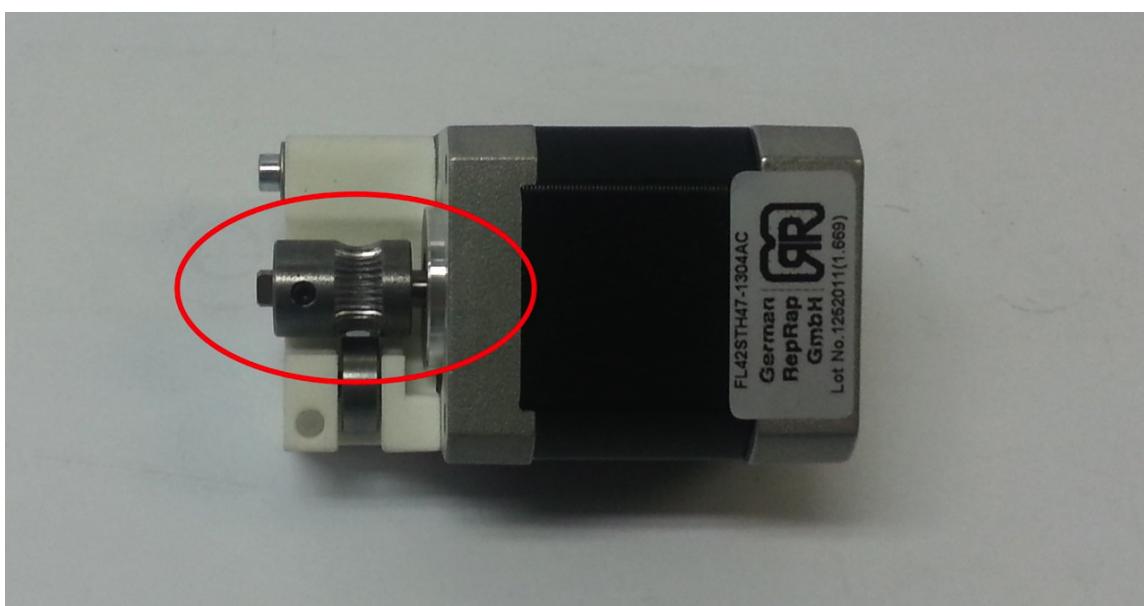


Abbildung 3.143. Filament screw parts overview



Die Filamentschraube wird auf die Achse des Schrittmotors geschoben und mit der Madenschraube fixiert. Dabei muss sich die Aussparung in der Filamentschraube mittig über der Bohrung im Gegenlager befinden (siehe Bild "Finish [S. 119]").

Abbildung 3.144. Finish Filament screw





### 3.8.4. Construction of the extruder base plate

Tabelle 3.33. Parts list Construction of the extruder base plate

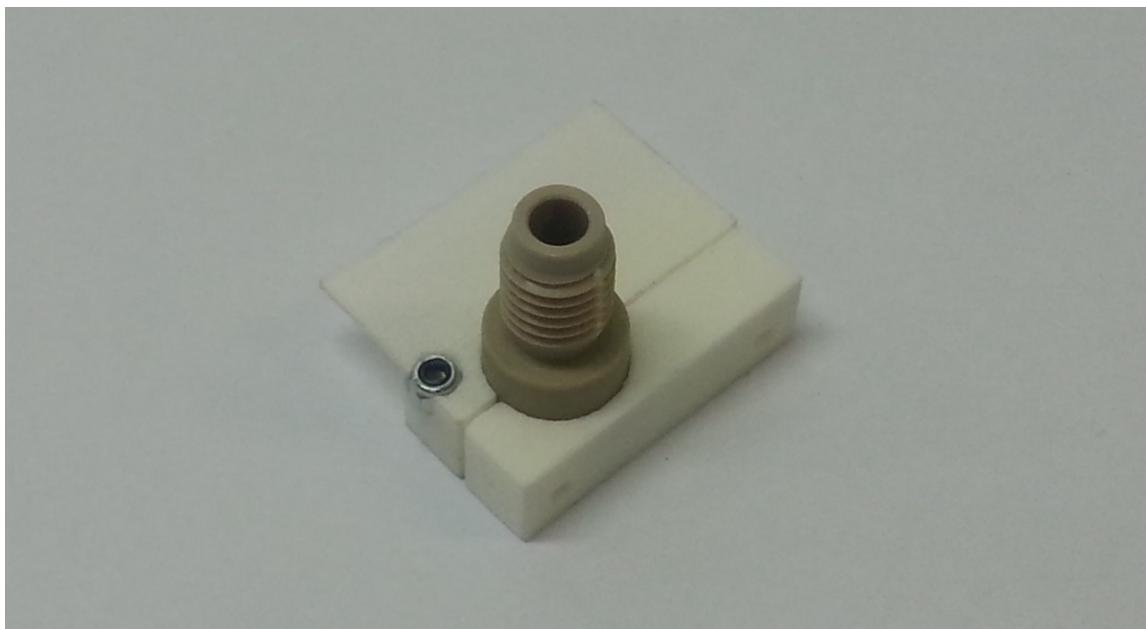
1x Extruder base plate fan [S. 33]	1x Extruder base plate stepper motor [S. 34]
1x PEEK thermal barrier	1x M3 self-locking nut

Abbildung 3.145. Construction of the extruder base plate parts overview



Die Thermalbarriere wird von den Grundplattenteilen eingeschlossen, wobei die dünne Fläche, wie im Bild "Finish [S. 121]" gezeigt, auf der Seite der Thermalbarriere liegen muss. Die Mutter wird in die dafür vorgesehene Aussparung in der Grundplatte-Lüfter eingelegt.

Abbildung 3.146. Finish Construction of the extruder base plate

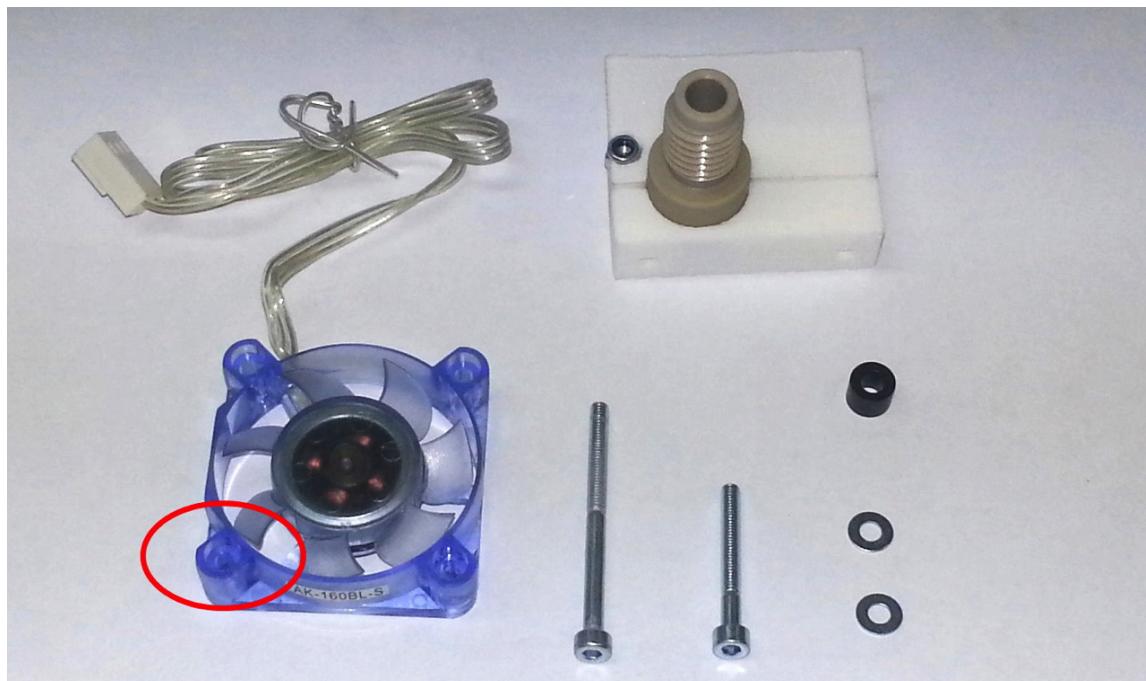


### 3.8.5. Extruder fan

Tabelle 3.34. Parts list Extruder fan

1x Extruder fan	1x sleeve, 5mm
1x M3x40 cylinder head screws	1x M3x25 cylinder head screws
2x M3 washer	

Abbildung 3.147. Extruder fanparts overview

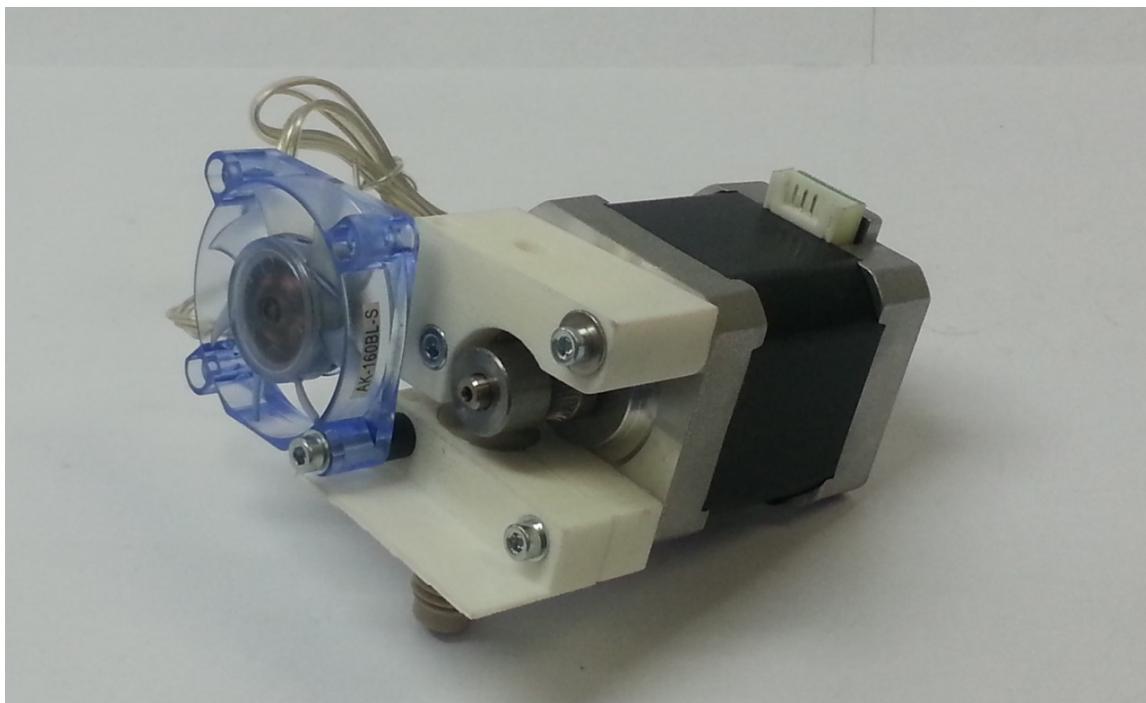


Die lange cylinder head screws wird mit einer washern bestückt und in das markierte Loch des Lüfters gesteckt. Dabei müssen sich die Gewinde der Schrauben auf der Seite mit dem Sticker befinden, damit der Lüfter in Richtung Filament bläst.

Auf der anderen Seite des Lüfters wird die washer auf die lange Schraube aufgesteckt und mit der "Extruder-Grundplatte" am stepper motor festgeschraubt.

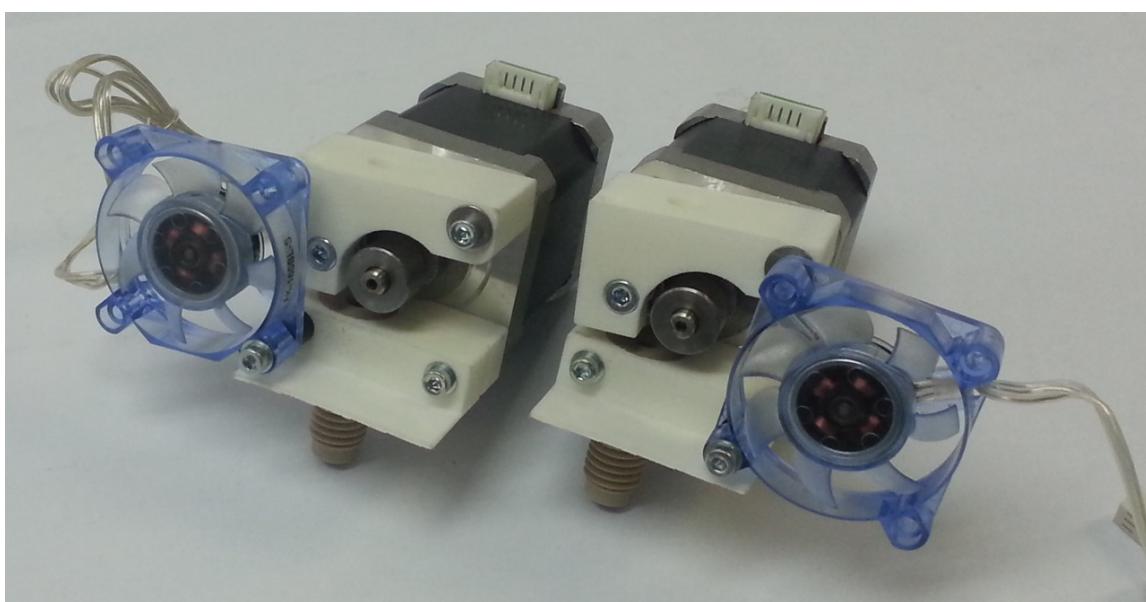
In die zweite Bohrung der "Extruder-Grundplatte" wird die kurze Schraube geschraubt.

Abbildung 3.148. Finish Extruder fan (Single-Extruder)



Für den Dual-Extruder-Betrieb empfiehlt es sich den zweiten Extruder mit einem spiegelverkehrten Lüfter zu montieren.

Abbildung 3.149. Finish Extruder fan (Dual-Extruder)





### 3.8.6. Assembly of the compression spring

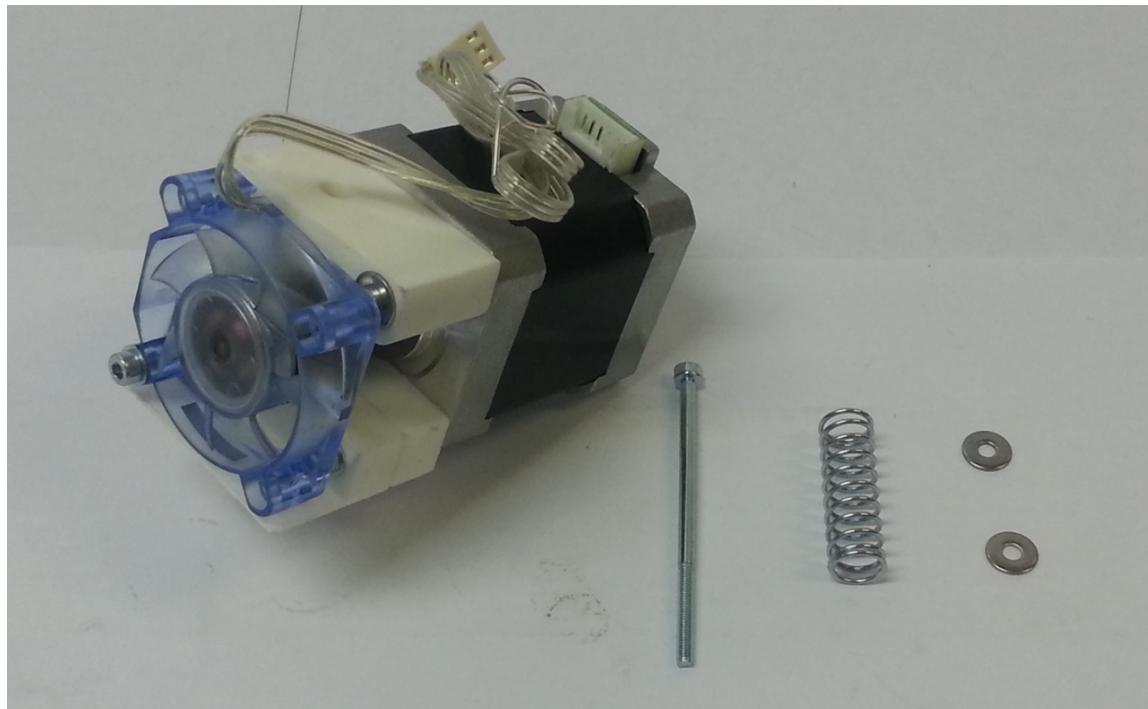
Tabelle 3.35. Parts list assembly of the compression spring

1x compression spring	1x M3x60 cylinder head screws
2x M3 washer, large OD	



Avoid jamming a finger in the compression spring during the assembly or a filament change later on.

Abbildung 3.150. Assembly of the compression spring parts overview



The compression spring is slid on the cylinder head screw and enclosed by two washers. The cylinder head screw is inserted in the counter bearing and screwed into the base plate with the nut (see "[Construction of the extruder base plate \[S. 124\]](#)").

Abbildung 3.151. Details compression spring



Abbildung 3.152. Details fastening

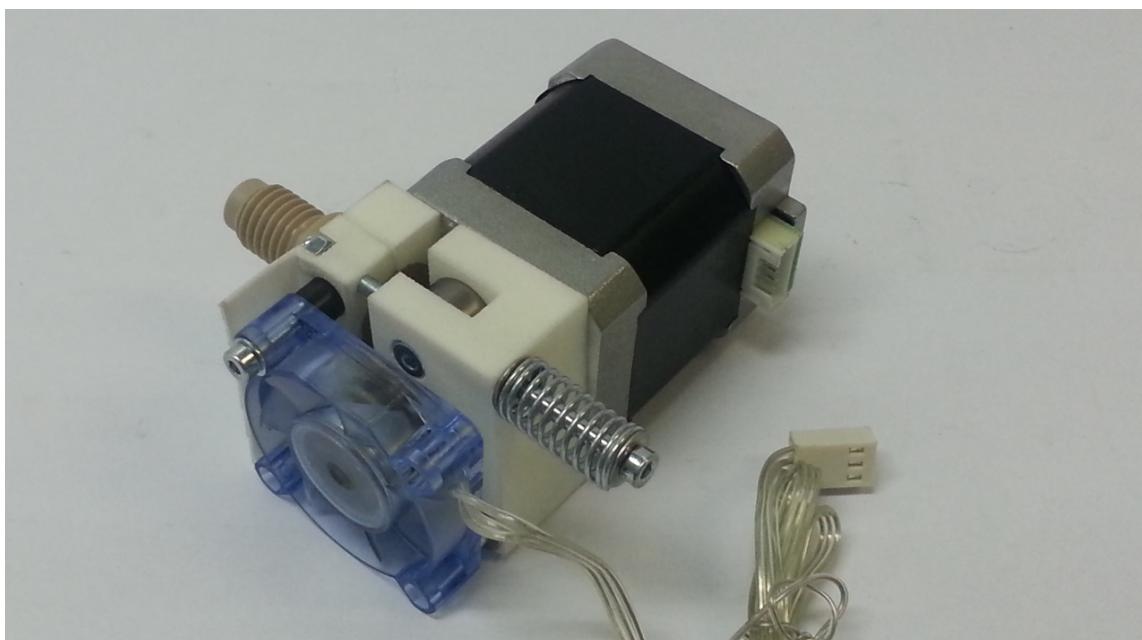
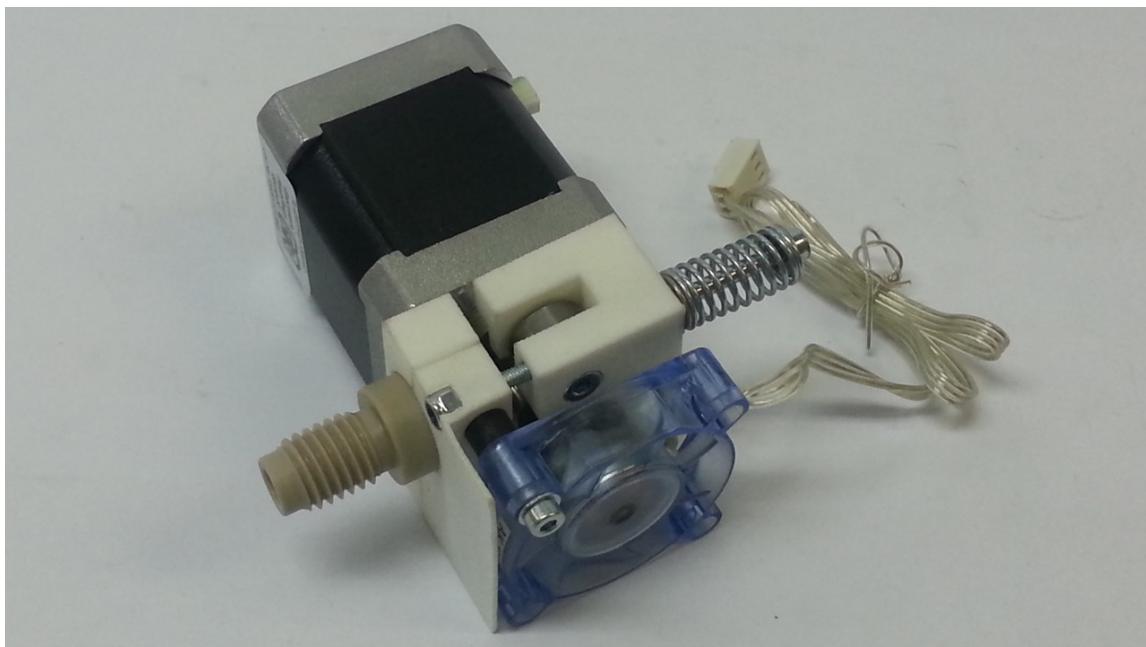


Abbildung 3.153. Finish assembly of the compression spring



### 3.8.7. hot end Assembly

Tabelle 3.36. Parts list hot end Assembly

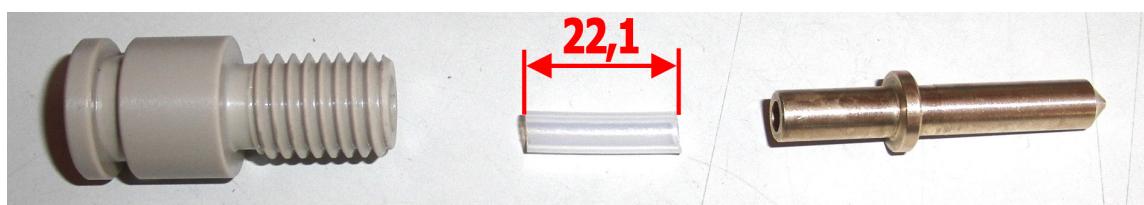
1x PEEK thermal barrier (fastened at the extruder)	1x PTFE lining
1x brass nozzle	1x nozzle retaining nut
1x heating block	1x M3x14 cylinder head screws
2x M3 washer	1x M3 Mutter
1x thermistor	1x heating cartridge
1x shrink tubing, Ø2mm	1x silicone hose, thick
1x silicone hose, thin	

Abbildung 3.154. hot end parts overview



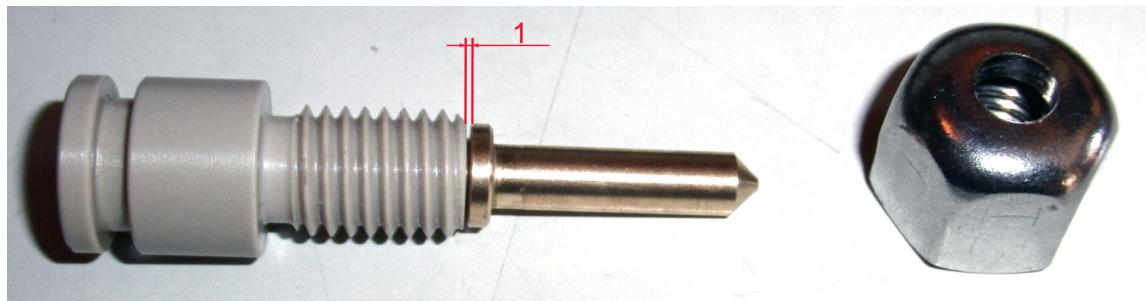
Now follows the assembly of the hot end. To make it clearer, the PEEK thermal barrier is displayed outside the extruder. It does not have to be removed for this step.

Abbildung 3.155. Hot end PTFE lining



At first, the PTFE lining is inserted in the PEEK thermal barrier. The PTFE lining has to be shortened in a way that the brass nozzle can be inserted in the PEEK thermal barrier and the retaining ring has a distance of about "1mm" to the PEEK thermal barrier. The PEEK thermal barrier serves as heat protection between the hot end and the other components. Thereby, the PTFE lining enables the filament to slide into the brass nozzle with little resistance. (see image "[Hot end PTFE lining \[S. 127\]](#)" and "[hot end nozzle retaining nut \[S. 128\]](#)")

Abbildung 3.156. hot end nozzle retaining nut



This constellation is tightly screwed together with the nozzle retaining nut.

Abbildung 3.157. hot end nozzle retaining nut assembled



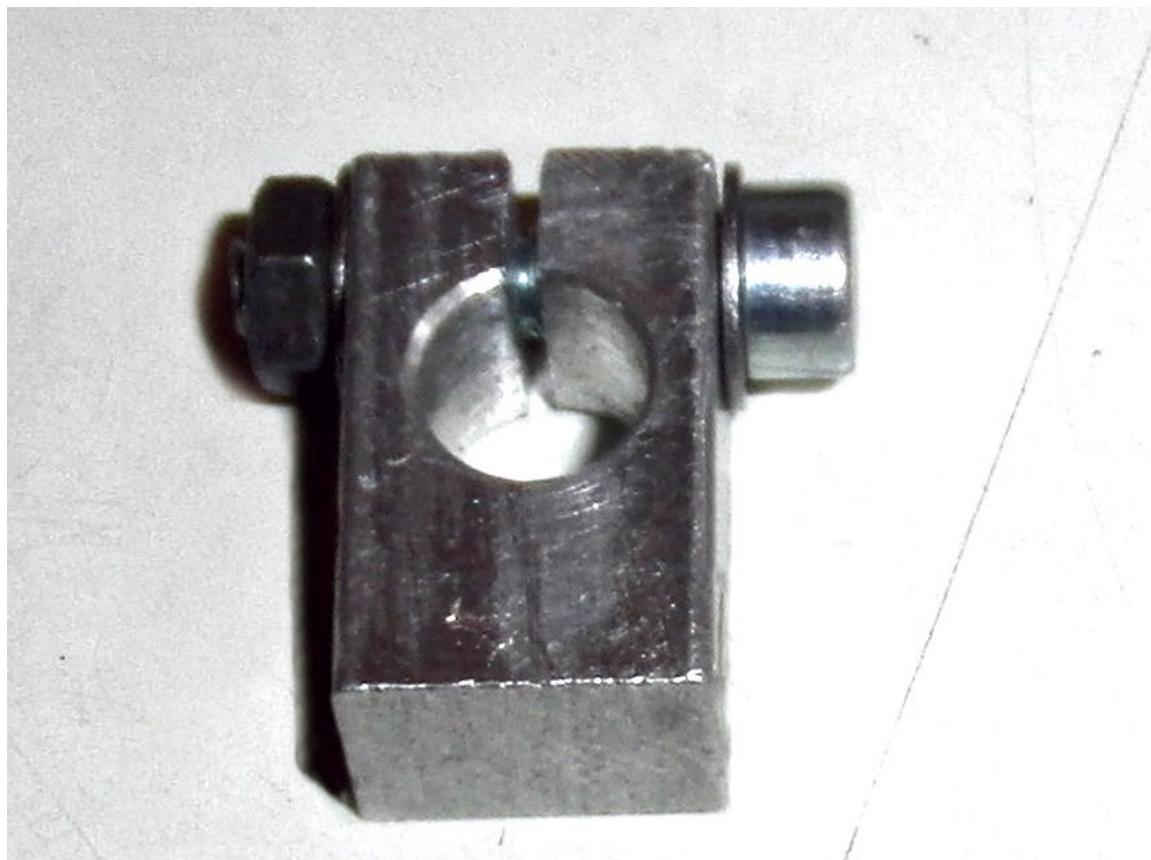
The heating block serves as a housing for the heating resistor as well as for the temperature sensor, and provides an even heat distribution. Later on, it is tightly screwed together with the brass nozzle. (See image "[Hot end heating block overview \[S. 128\]](#)")

Abbildung 3.158. hot end heating block overview





Abbildung 3.159. hot end heating



Die Kontakte des Thermistors müssen mit dem dünnen und dicken Silikonschlauch überzogen werden.

Abbildung 3.160. hot end thermistor 1

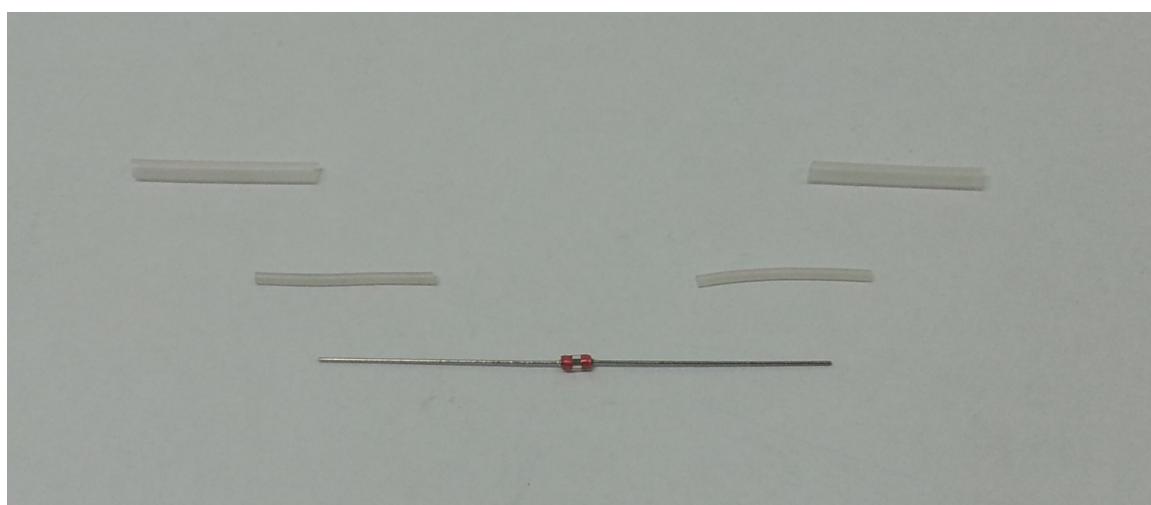
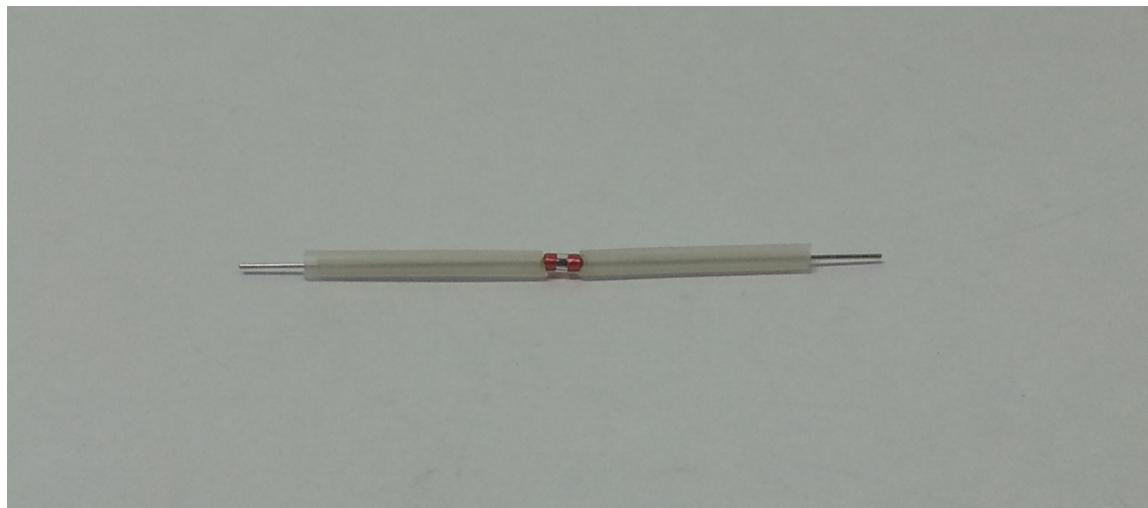


Abbildung 3.161. hot end thermistor 2



Der Temperatursensor wird in die kleinere der beiden Bohrungen im Heizblock gesteckt. Die Heizpatrone wird in die andere Bohrung gesteckt.



Wenn die Heizpatrone etwas locker sitzt, ist dies nicht weiter problematisch, da sie nach kurzer Zeit auf Drucktemperatur einen festen Sitz findet.



All wire ends have to be accurately insulated with silicone hose. Open wire must not touch the heating block.

Abbildung 3.162. hot end heating block Finish



The pre-assembled heating block may now be screwed to the bottom end of the brass nozzle. (See image "Hot end finish [S. 131]"")

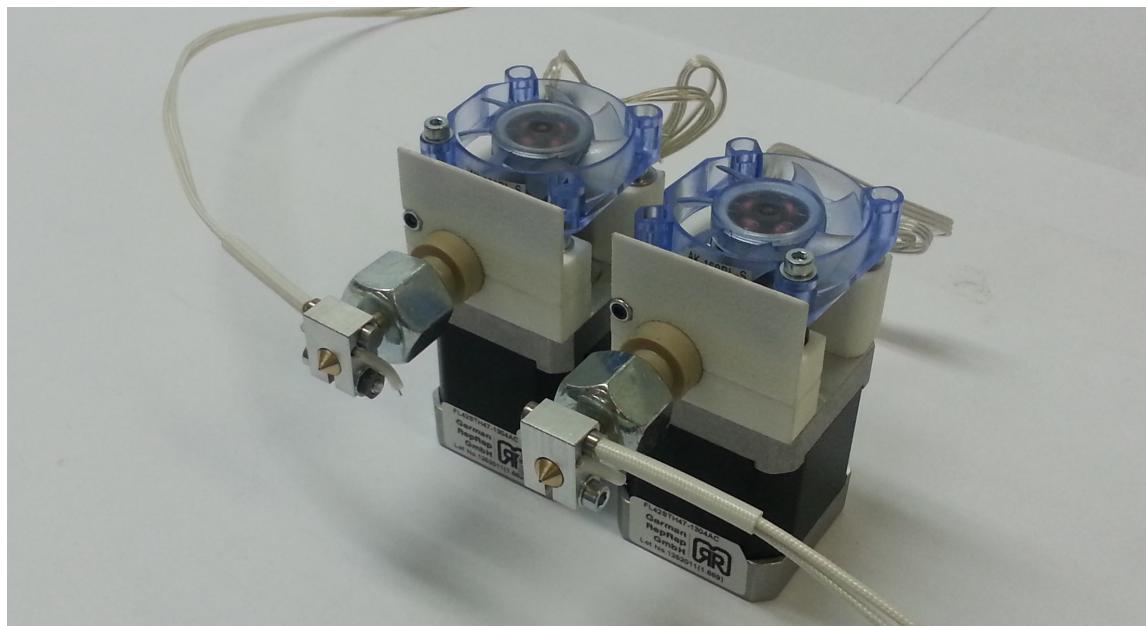
Abbildung 3.163. hot end Finish



For the Dual-Extruder you need also a second Hot-End.

Für eine schönere Verkabelung bietet es sich an, die Heizpatrone beim zweiten Extruder von der anderen Seite in den Heizblock zu stecken.

Abbildung 3.164. hot end Finish (Dual-Extruder)



### 3.8.8. Assembly Extruder

Tabelle 3.37. Parts list Assembly Extruder

1x Direct-Drive extruder single, pre-assembled	4x M3x60 cylinder head screws
12x M3 washer	

Tabelle 3.38. additional parts for the Dual-Extruder

1x Direct-Drive extruder single, pre-assembled	4x M3x60 cylinder head screws
12x M3 washer	

Das additional parts for the Dual-Extruder ist in den Bilder mit einem blauem Rechteck markiert.

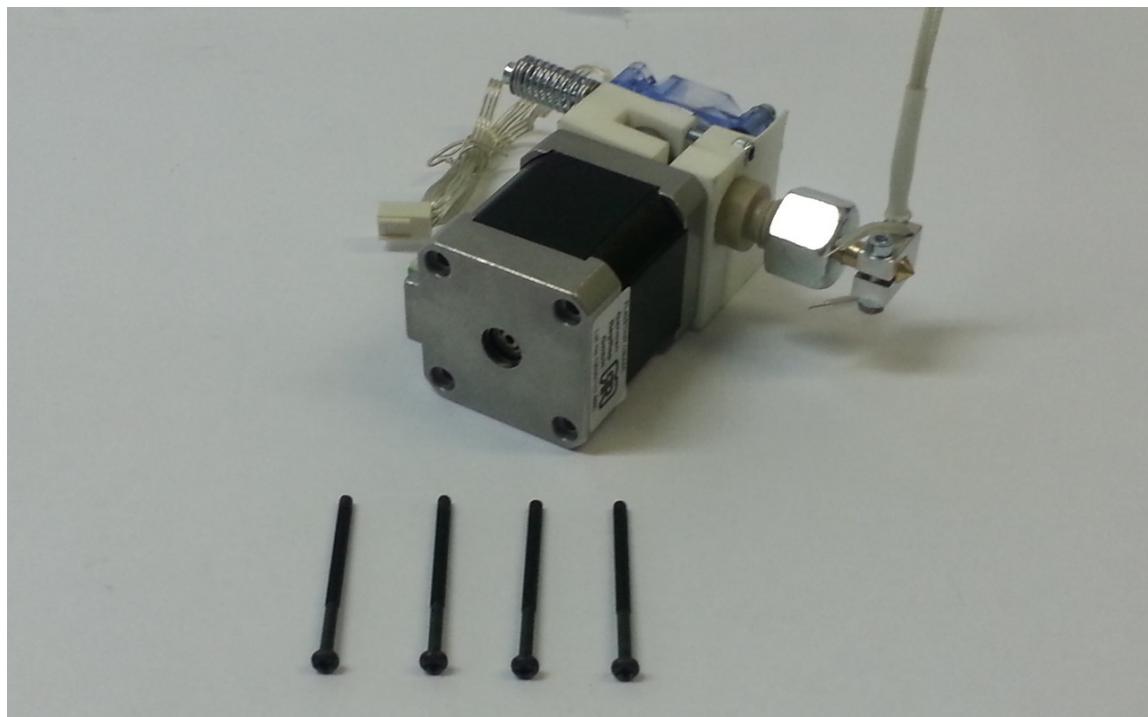
Abbildung 3.165. Assembly extruder parts overview



The four screws on the back of the stepper motor have to be removed. For the X400, they are no longer being used.



Abbildung 3.166. Vorbereitung stepper motor



The new cylinder head screws are assembled with three washers each and are inserted into to the stepper motor through the X-axis carriage.



In case the M3x60 cylinder head screw is screwed too far into the stepper motor, the thread might be damaged as the screws share one thread on either side. If that happens, please use an additional washer.



The second Extruder is mounted the same way as the first one.

Abbildung 3.167. Finish assembly of the extruder front side

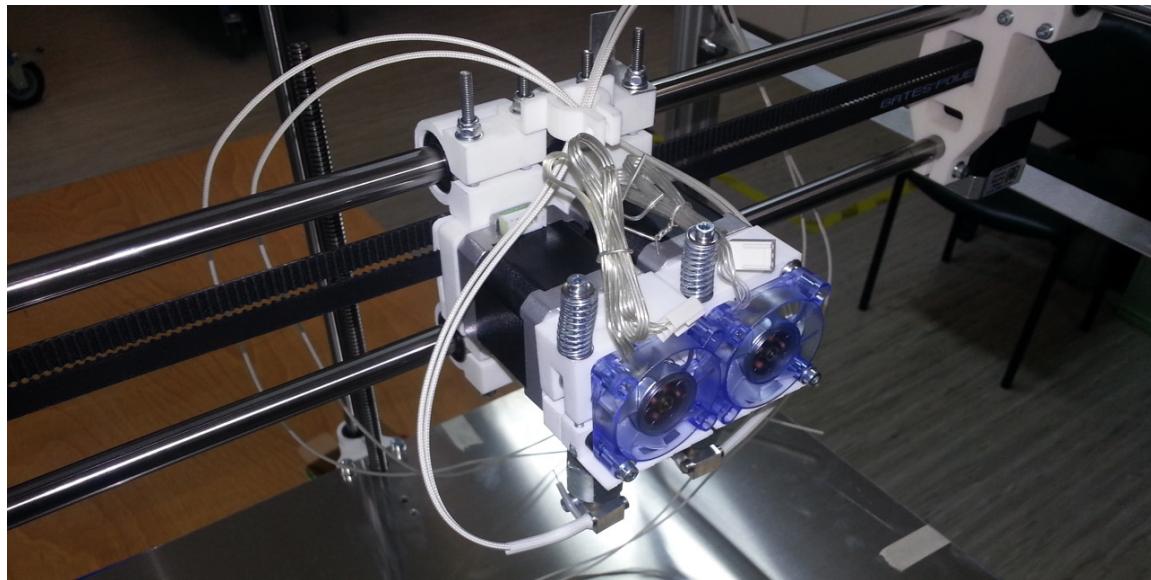
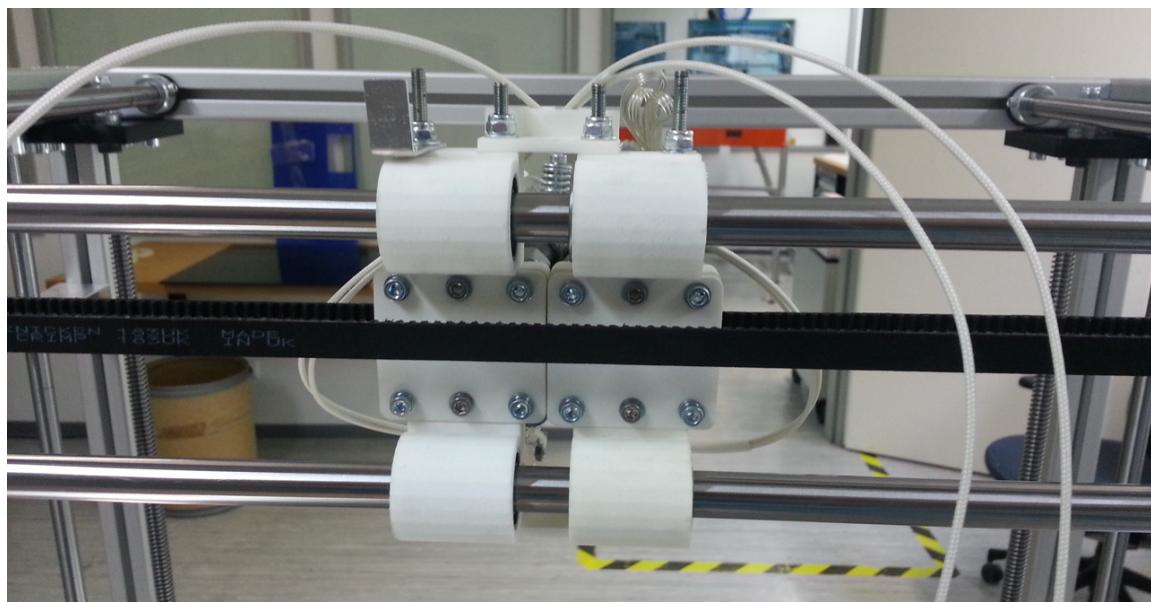


Abbildung 3.168. Finish assembly of the extruder back side





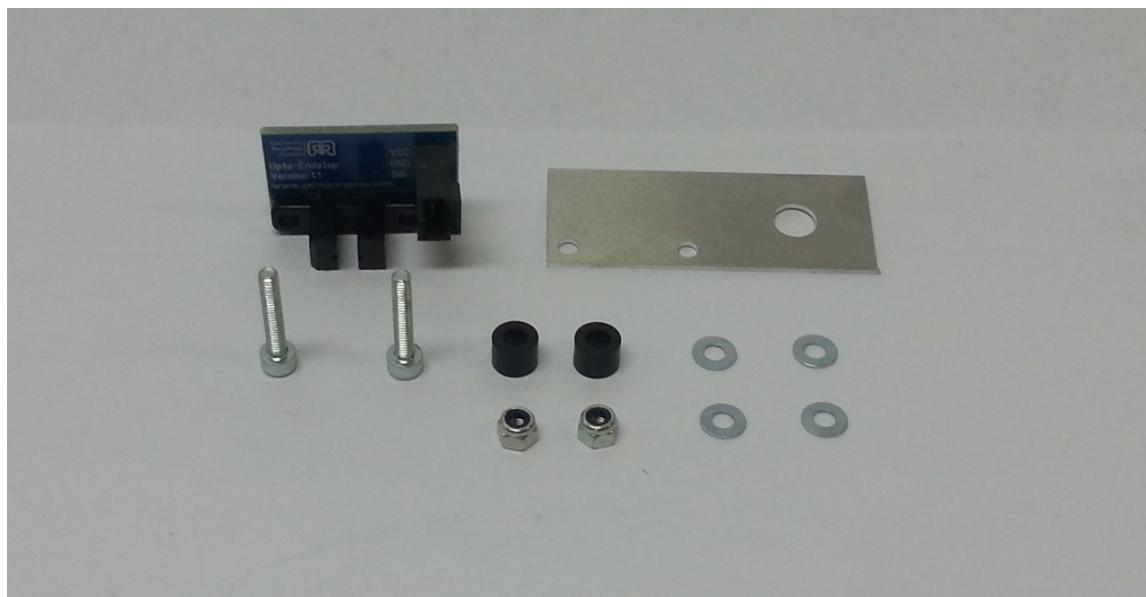
## 3.9. Electronics

### 3.9.1. Z-axis end stop

Tabelle 3.39. Parts list Z-axis end stop

1x Opto-Endstop [S. 38]	1x L-ALU Z-Endstopholder [S. 37]
2x M3x16 cylinder head screws	4x M3 washer
2x sleeve, 5mm	2x M3 self-locking nut

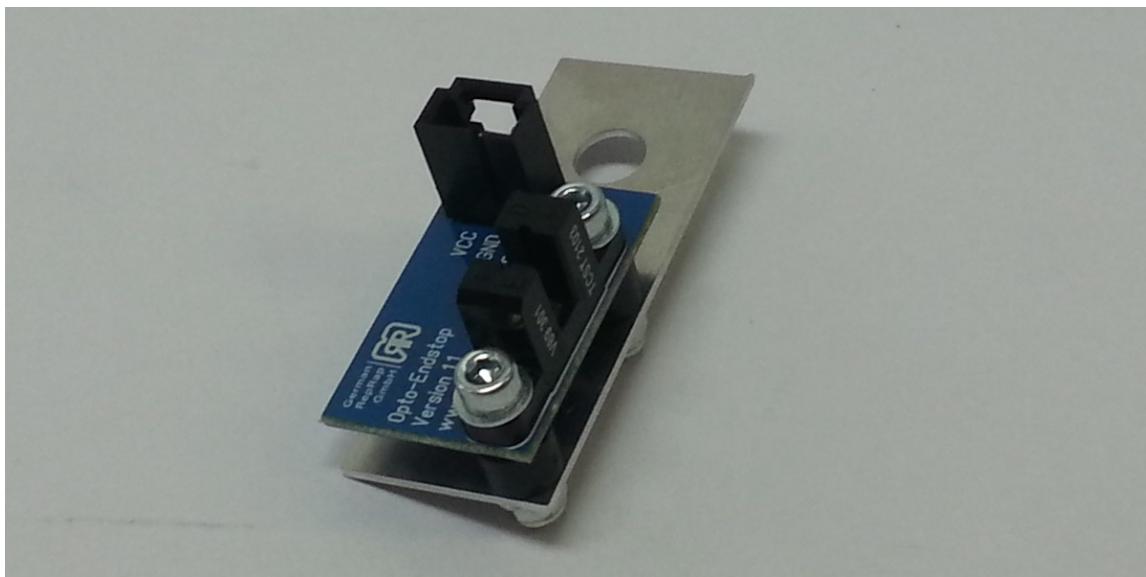
Abbildung 3.169. Z-axis end stop parts overview



Einer der "Opto-Endstops" wird an den "L-ALU Z-Endstophalter" geschraubt, wobei die 5mm Hülsen zwischen Endstophalter und Endstop positioniert wird.



Abbildung 3.170. Finish Z-axis end stop

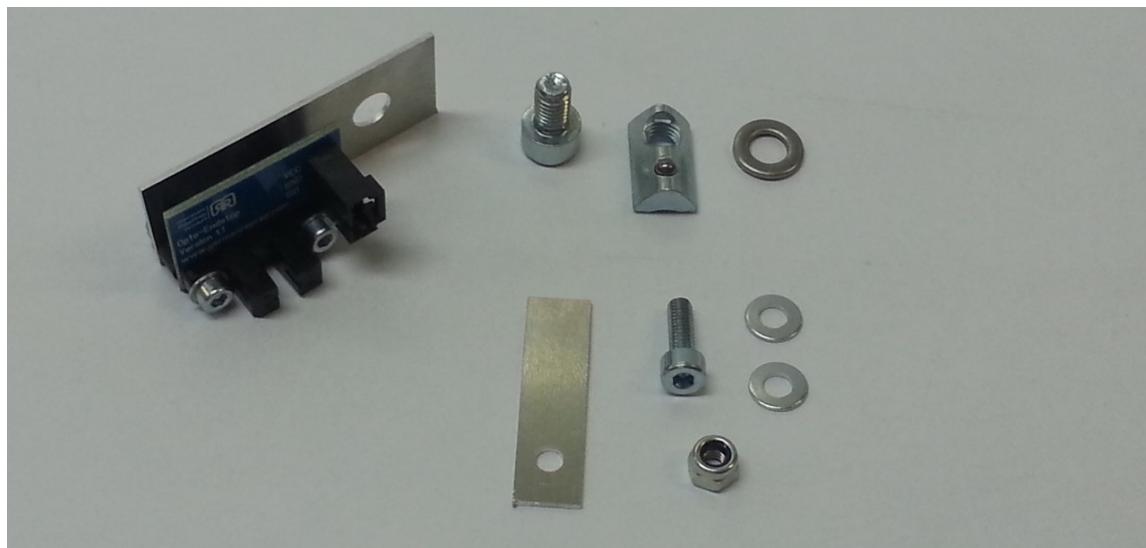


### 3.9.2. Z-axis end stop assembly

Tabelle 3.40. Parts list Z-axis end stop assembly

1x L-ALU Opto-Flag Z [S. 36]	1x Opto-Endstop, pre-assembled
1x M4x10 cylinder head screws	2x M4 washer
1x M4 self-locking nut	1x M6x10 cylinder head screws
1x M6 washer	1x M6 T slot nut

Abbildung 3.171. Z-axis end stop assembly parts overview



For the breaking of the light barrier of the Z-axis, the long interruption plate is bent by 90 degrees near the boring. so dass der Schenkel mit der Bohrung eine Länge von 14mm hat.

Für die Montage wird auf die cylinder head screws, eine washer und der "L-ALU Opto-Flag Z" aufgesteckt und anschließend die cylinder head screws durch die Aluminiumplatte gesteckt und auf der Unterseite mit einer washer und der Mutter fixiert.



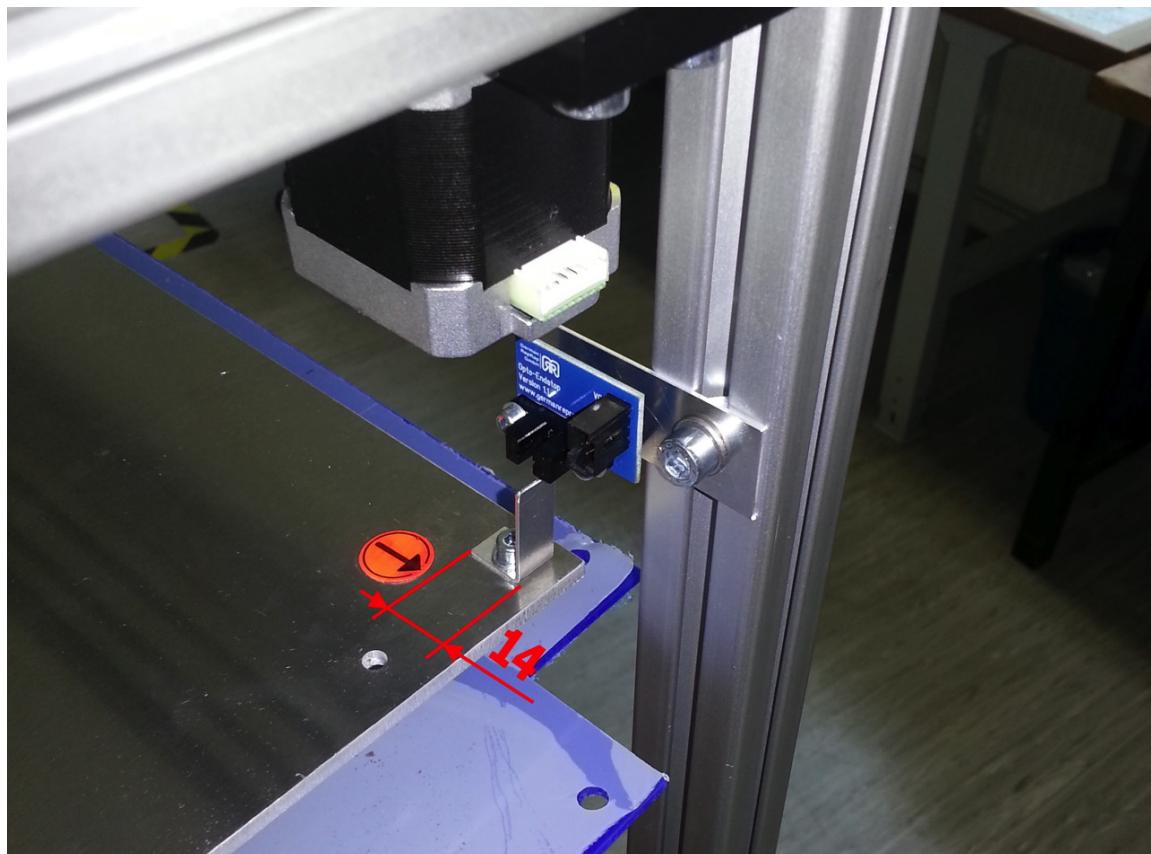
When driving the Z-axis upwards manually, please make sure the end stop is not damaged by the plate!

This also happens in case the interruption plate is not aligned correctly.

Der "Opto-Endstop" wird mit dem T slot nut in dem benachbarten Aluminiumprofil befestigt.



Abbildung 3.172. Finish Z-axis end stop assembly



### 3.9.3. Energy chain Y-axis

Tabelle 3.41. Parts list Energy chain Y-axis

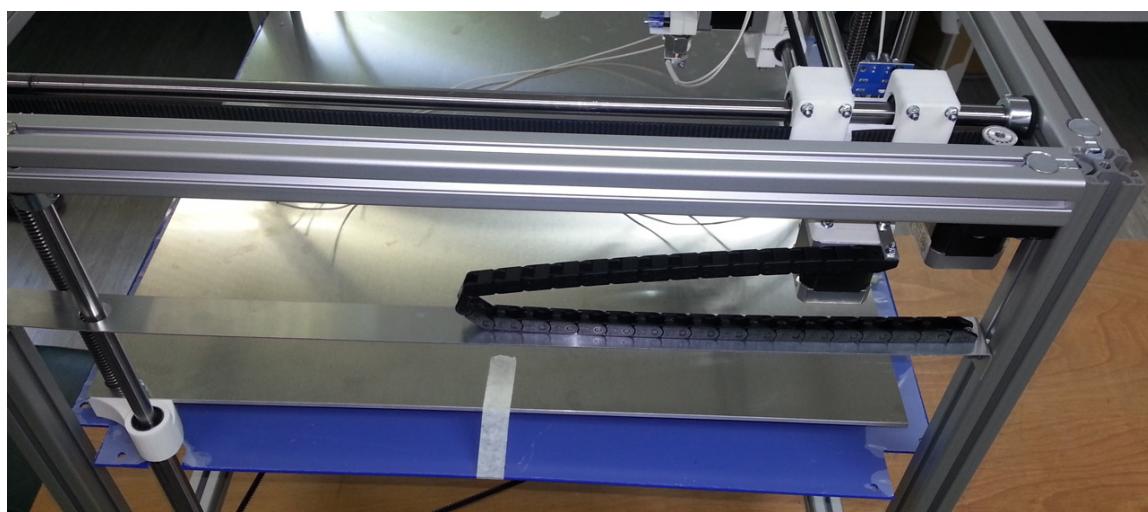
31x Energy chain link	1x Assembly kit energy chain
1x L-Alu Energychain mount [S. 35]	2x M3x10 cylinder head screws
4x M3 washer	2x M3 self-locking nut

Abbildung 3.173. Energy chain Y-axis parts overview



The end chain link is fastened at the small hole of the guiding sheet metal and 31 energy chain links are fastened at this. It is important that the energy chain is long enough, even in the most distant position of the Y-axis, but that it does not touch the guiding rod.

Abbildung 3.174. Finish energy chain Y-axis



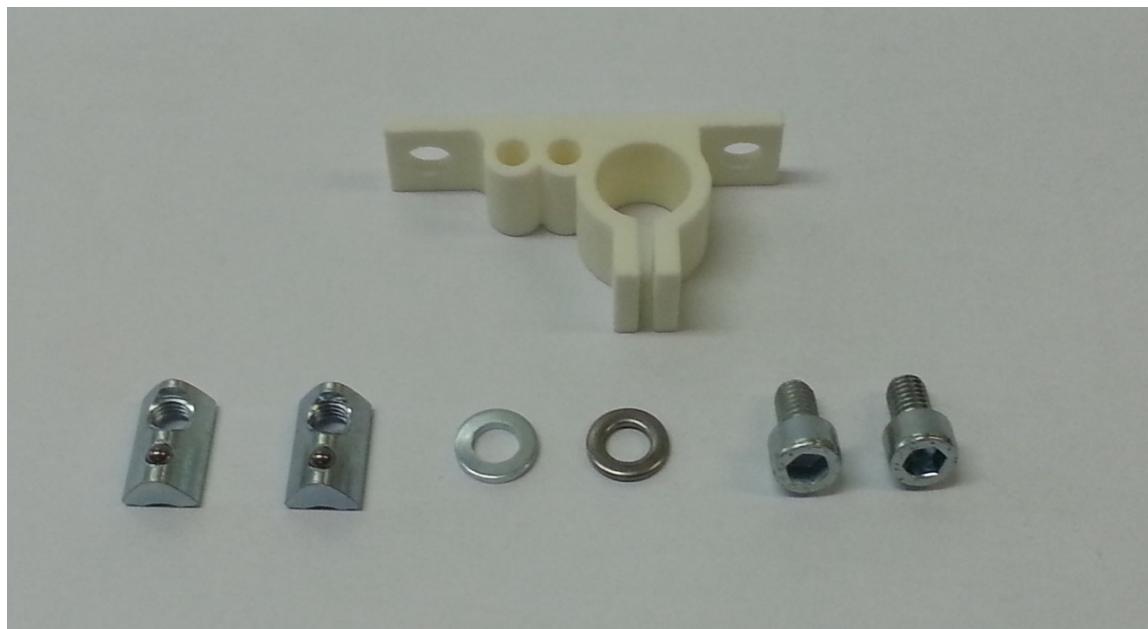


### 3.9.4. Cable mount

Tabelle 3.42. Parts list cable mount

1x Frame Cablemount [S. 34]	2x M6x10 cylinder head screws
2x M6 washer	2x M6 T slot nut

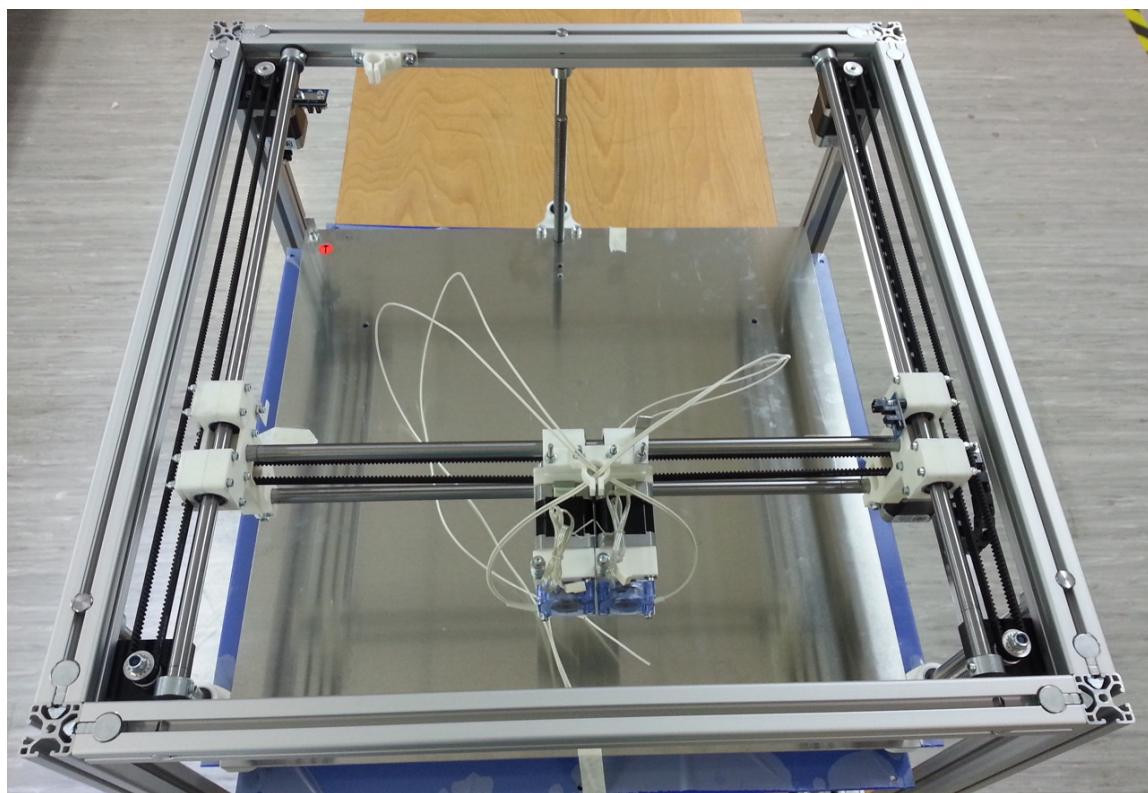
Abbildung 3.175. Cable mount parts overview



The "Frame cable mount" serves as a feed for the cables and for the filament(s) to the extruder(s). It is fastened with two screws at the aluminum profile on the back side, as shown in the image "[Finish \[S. 141\]](#)".



Abbildung 3.176. Finish cable mount



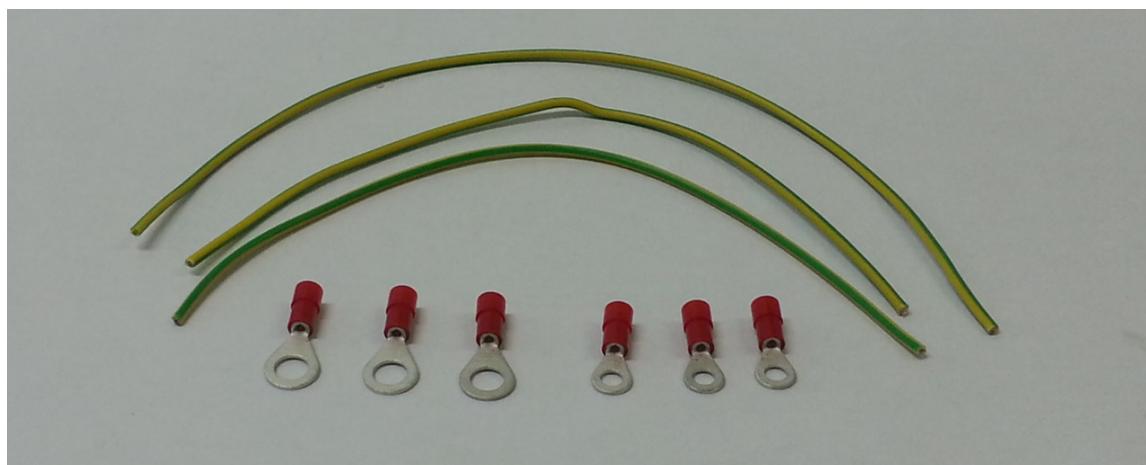
### 3.9.5. Ground cable

Tabelle 3.43. Parts list ground cable

2x0,2m cable, yellow-green	1x0,25m cable, yellow-green
3x M6 cable ring shoe	3x M4 cable ring shoe



Abbildung 3.177. Ground cable parts overview

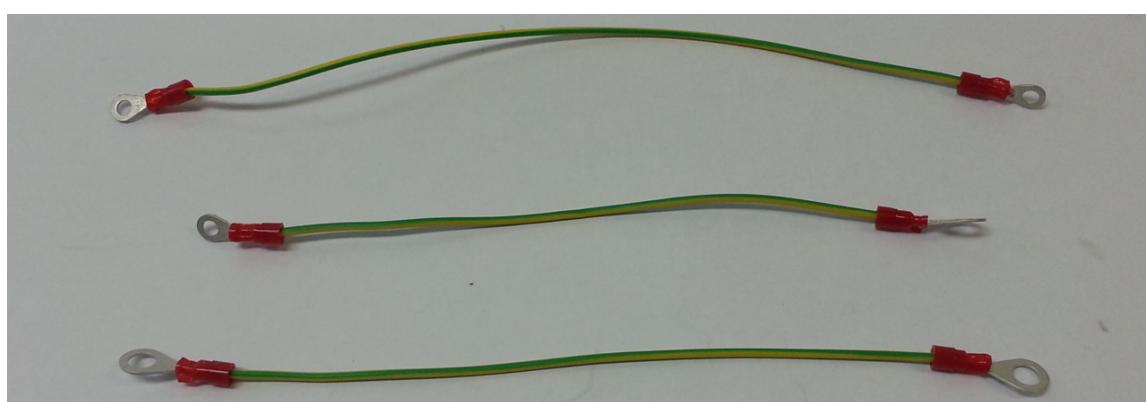


Die Erdung sämtlicher leitender Komponenten am X400 ist sehr wichtig!

Die Kabelringschuhe werden, wie folgt an die drei Erdungskabel gecrimpt bzw. gelötet:

- das 25 cm Kabel erhält zwei Kabelringschuhe M4
- ein 20 cm Kabel erhält einen Kabelringschuh M4 und einen Kabelringschuh M6
- das zweite 20 cm Kabel erhält zwei Kabelringschuhe M6

Abbildung 3.178. Finish ground cable



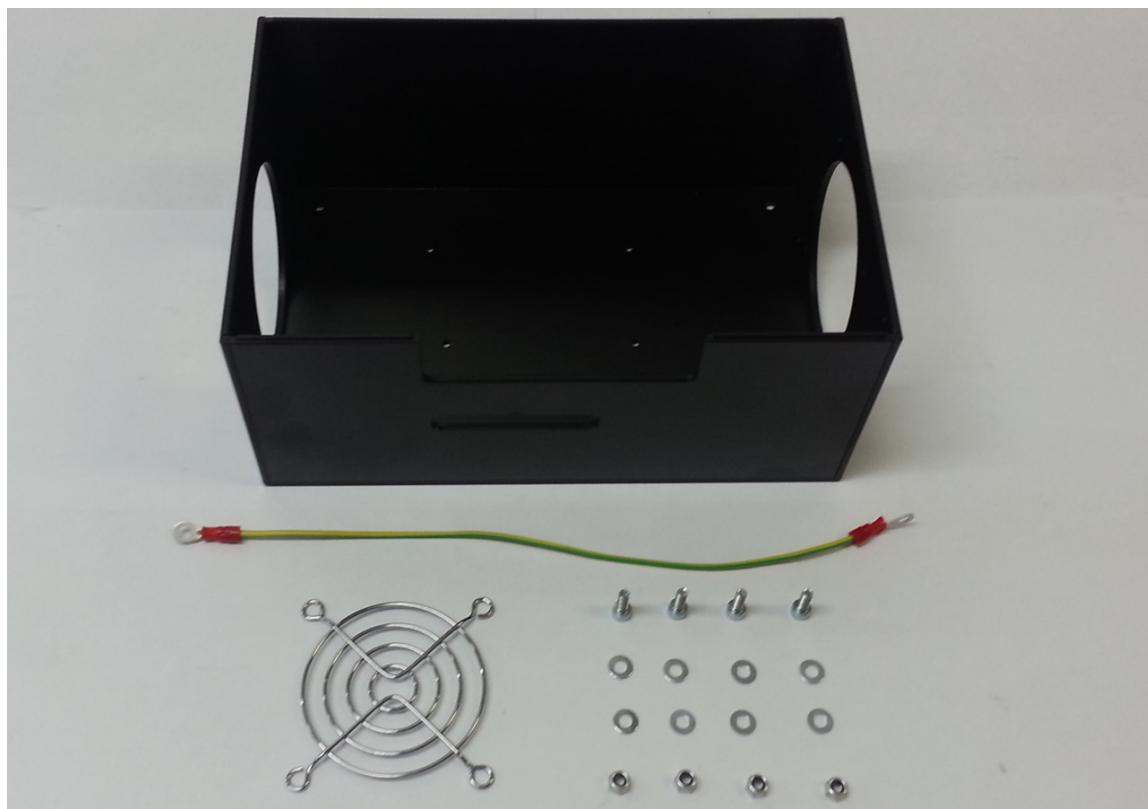


### 3.9.6. Electronics fan grill

Tabelle 3.44. Parts list Elektronik Lüftergitter

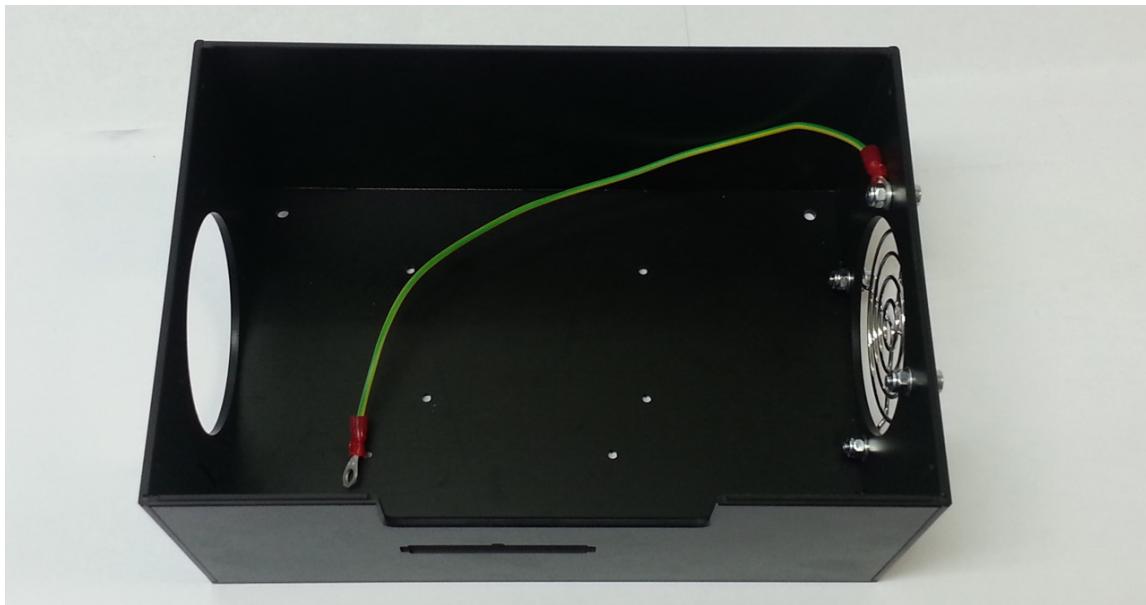
1x Electronic box [S. 32]	1x fan grille 70mm
1x Ground cable, 0,25m, 2xM3	4x M4x12 cylinder head screws
8x M4 washer	4x M4 self-locking nut

Abbildung 3.179. Electronics fan grill parts overview



Die Schrauben werden durch die Gitter gesteckt und von außen an die rechte Seite der Elektronikbox gesteckt.  
Auf die Innenseite wird zusätzlich ein Ende des Erdungskabels geschraubt.

Abbildung 3.180. Finish electronics fan grill



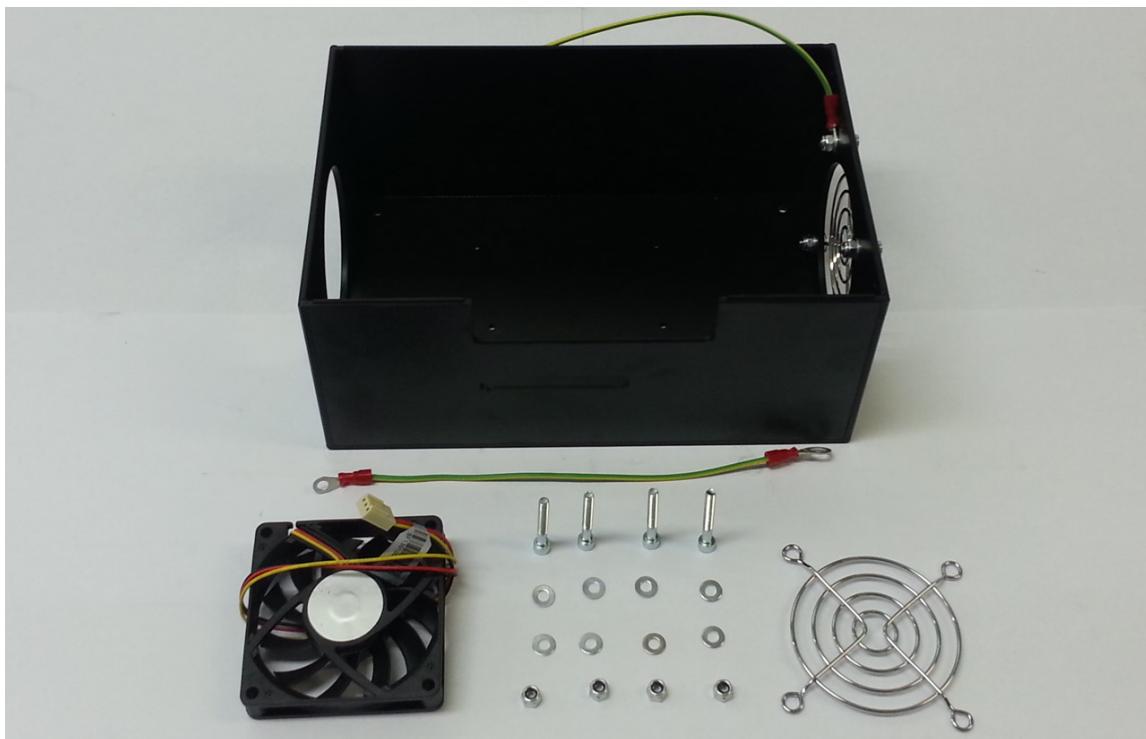
### 3.9.7. Electronics fan

Tabelle 3.45. Parts list electronics fan

1x fan 70mm	1x fan grille70mm
1x Ground cable, 0,20m, 1xM3 und 1xM6	4x M4x30 cylinder head screws
8x M4 washer	4x M4 self-locking nut



Abbildung 3.181. Electronics fan parts overview



An der linken Seite wird der Lüfter angebracht, dabei muss für eine gute Kühlung Luft in die Box geblasen werden (dann zeigt der rot/schwarze Sticker nach außen).

Beide Erdungskabel werden an die Innenseite des Lüfters montiert.

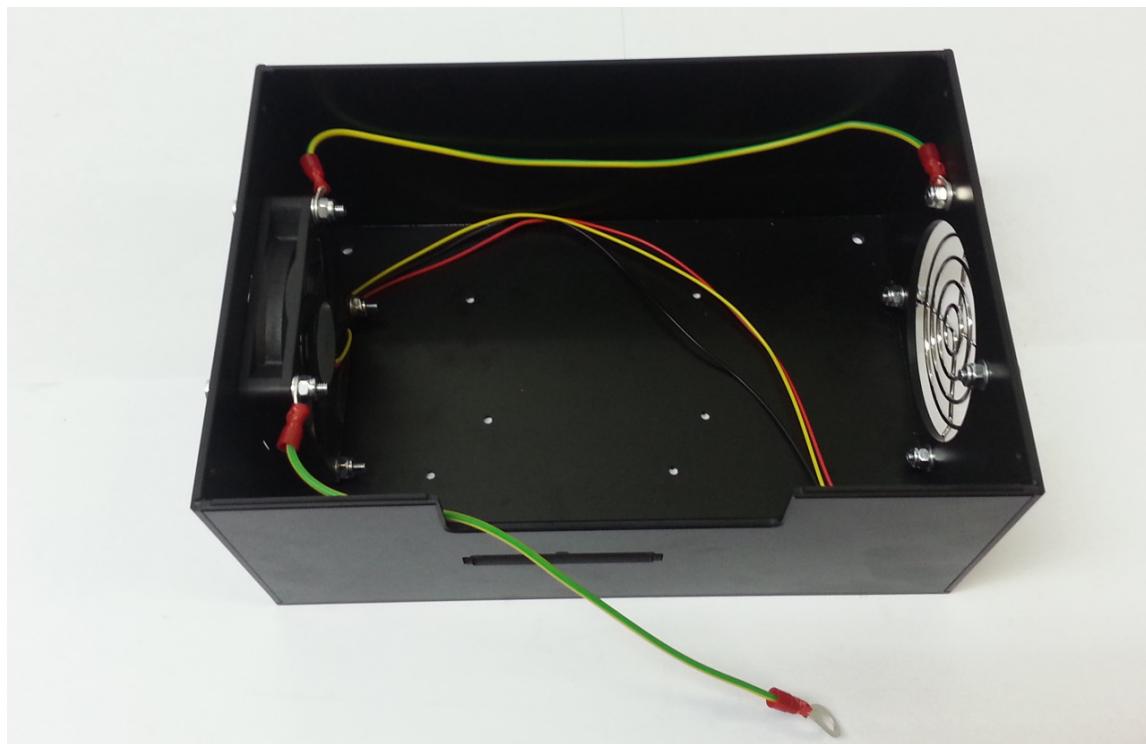


Another fan may be assembled at the right side for an even better cooling.



Das verbleibende Erdungskabel wird erst im Schritt "Verkabelung/Gehäuse Erdung" benötigt.

Abbildung 3.182. Finish electronics fan



### 3.9.8. Preparing if the case connection (heated bed)



Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.46. Parts list preparing if the case connection

1x Case connection cold devices	3x 0.2m cable Powerinput
3x Blade receptacle	



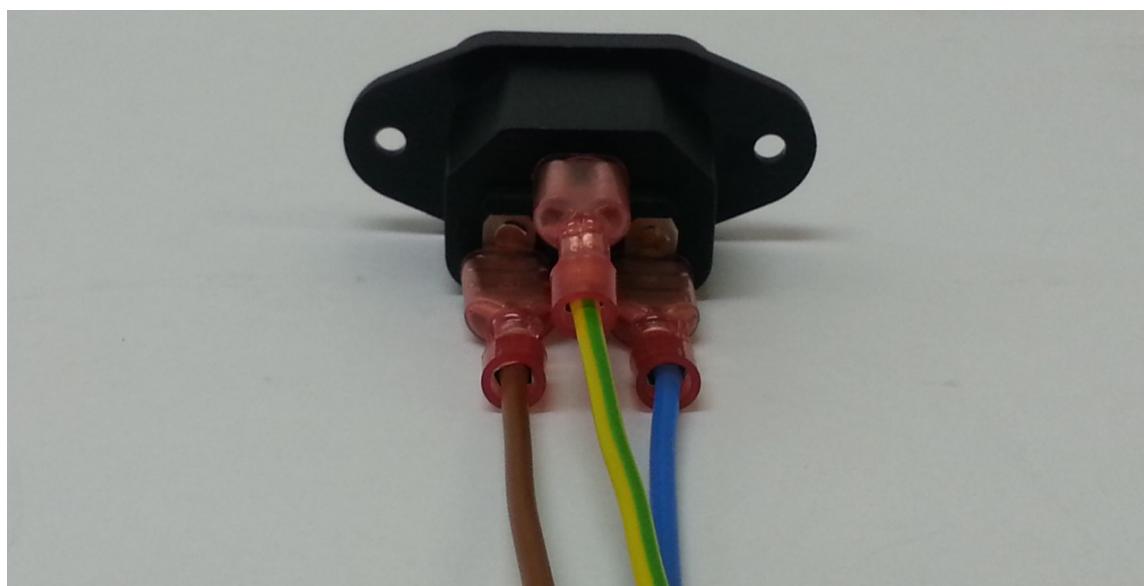
Abbildung 3.183. Preparing if the case connection parts overview



Der "Gehäuseanschluss Kaltgeräte" wird in der Elektronikbox befestigt. Die dafür vorgesehene Fläche muss aus der Elektronikbox heraus gebrochen und die Bohrungen einfach durchstoßen werden.

Die Flachsteckhülsen werden an die drei Zuleitungen gecrimpt bzw. gelötet und wie folgt an den "Gehäuseanschluss Kaltgeräte" gesteckt.

Abbildung 3.184. Finish preparing if the case connection





### 3.9.9. Case connection (heated bed)

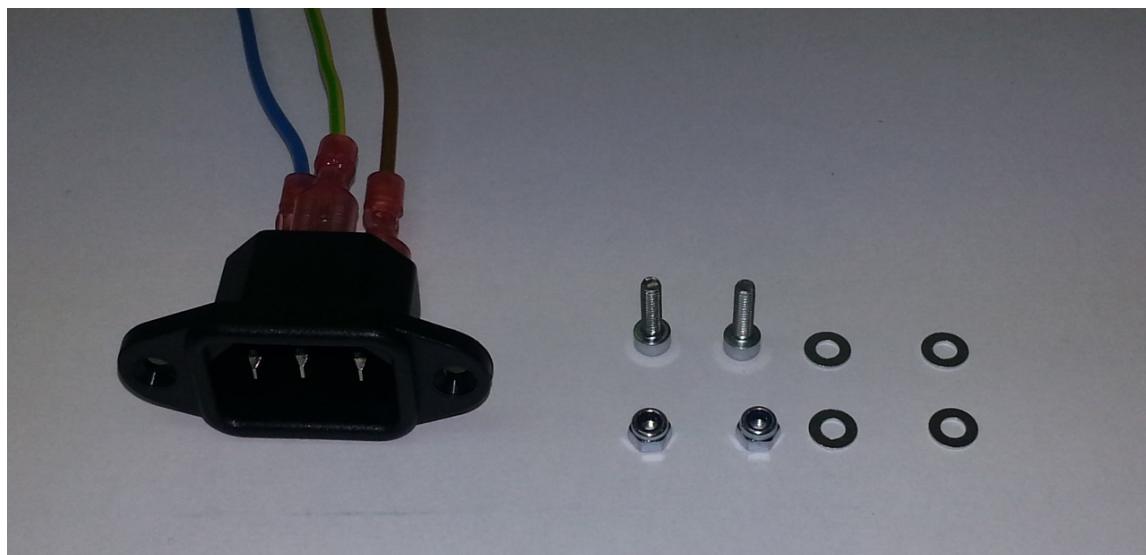


Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.47. Parts list case connection

1x Case connection cold devices, pre-assembled	2x M3x14 cylinder head screws
4x M3 washer	2x M3 self-locking nut

Abbildung 3.185. Case connection parts overview



The case connection cold devices is attached in the electronic box. The intended area has to be broken out of the electronic box and the borings are simply broken through.



Install the cold device plug not until the case is fixed to the base plate, because it could prevent you from reaching the anchor points.

Abbildung 3.186. Details Durchbruch



Abbildung 3.187. Finish case connection



### 3.9.10. Base plate

Tabelle 3.48. Parts list base plate

1x Electronic box [S. 32], pre-assembled	1x Base plate [S. 28]
4x M3x25 cylinder head screws	4x sleeve, 6mm
8x M3 washer	4x M3 self-locking nut

Abbildung 3.188. Base plate parts overview

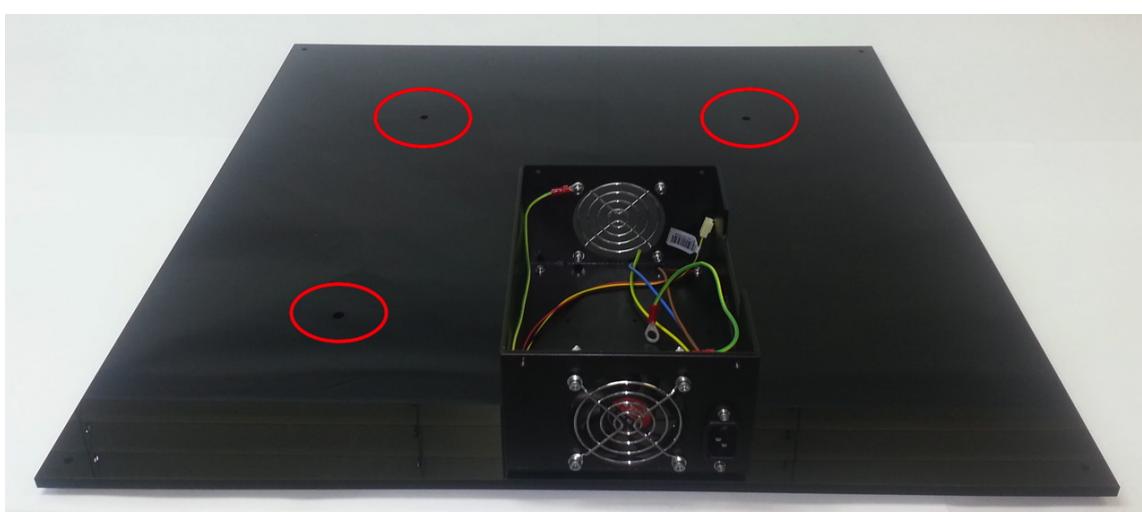


The electronic box is screwed to the base plate, whereas the sleeves serve as spacers.



The electronic box is screwed on as shown in the image "Finish [S. 150]". The red circles mark the holes on which the spool holders may be mounted.

Abbildung 3.189. Finish base plate

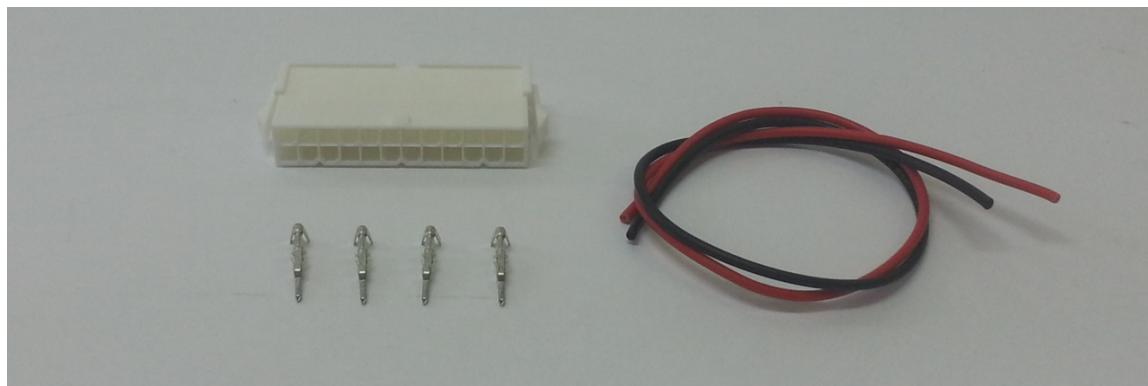


### 3.9.11. ATX socket

Tabelle 3.49. Parts list ATX socket

1x ATX socket	1x 0,3 m cable, red/black 0,5mm <sup>2</sup>
4x Crimp contacts, large	

Abbildung 3.190. ATX socket parts overview



The ATX connector of the power supply unit is used to supply the RAMPS with power.

Dafür wird ein Kabel, ein-adrig, mit der Länge von ca. 3cm, mit zwei Crimpkontakten und das restliche Kabel an einer Seite mit zwei weiteren Crimpkontakten versehen

Abbildung 3.191. Crimp contacts



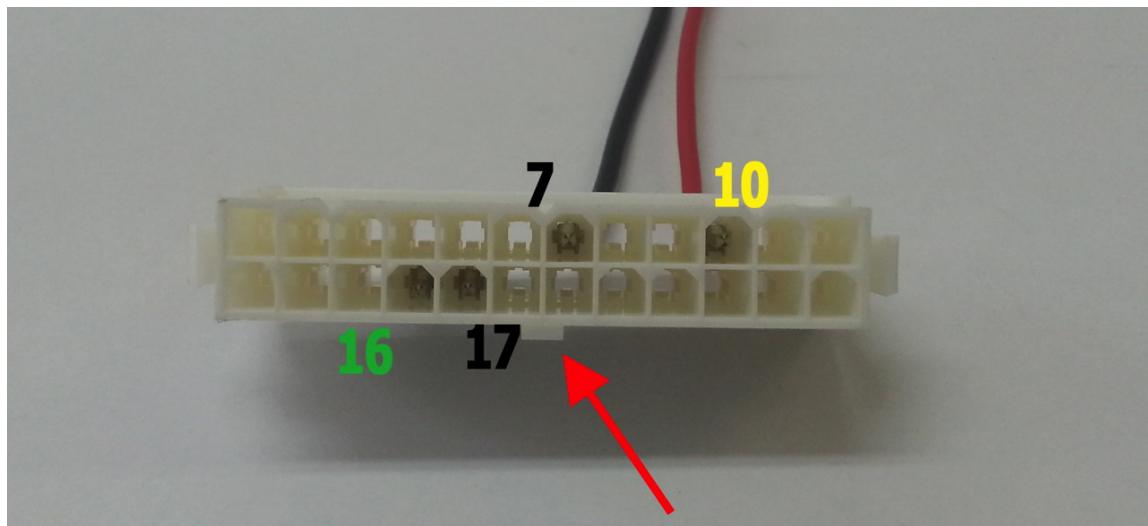
Now pin 17 (GND) and pin 16 (Power-On) are connected with the short cable.

Pin 7 (GND) is connected with the black cable, pin 10 (+12V) with the red one.



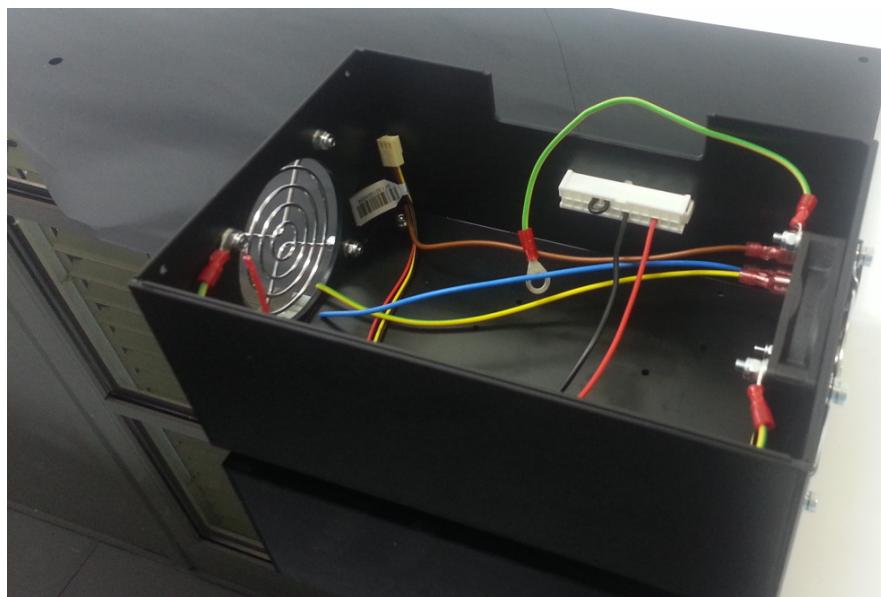
The orientation of the ATX socket is important here. The red arrow marks a small "nib", in which the ATX connector snaps in.

Abbildung 3.192. Pin assignment



There is a gap in the electronic box in which the ATX socket is plugged in.

Abbildung 3.193. Finish ATX-Buchse



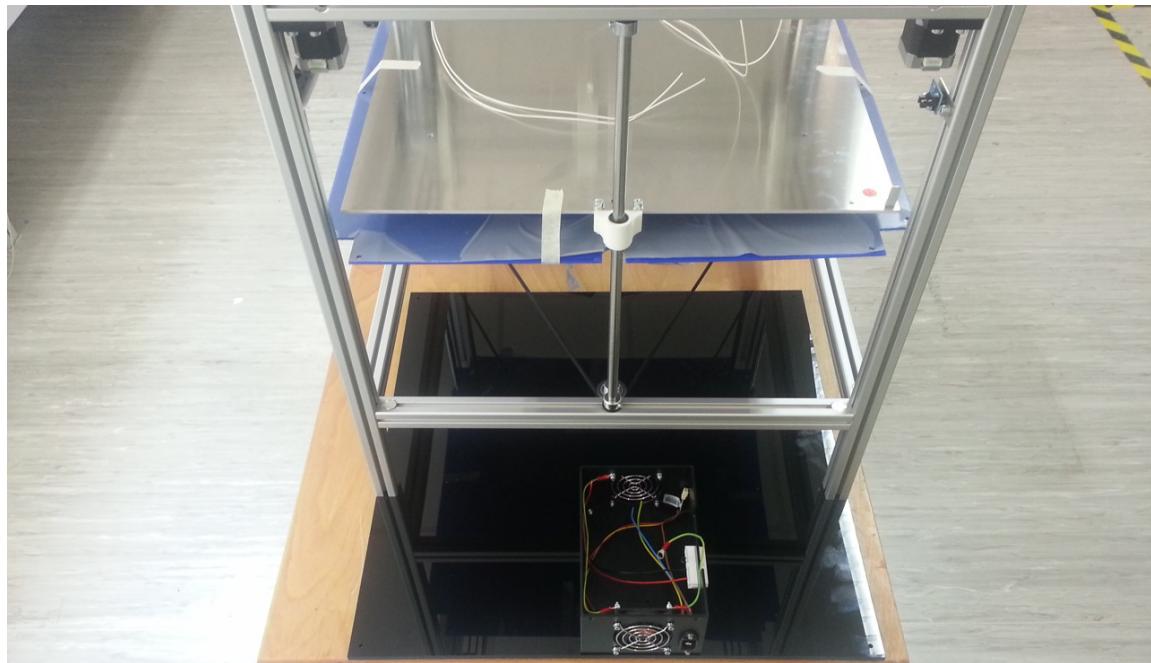
Für die weiteren Montageschritte empfiehlt es sich die Bodenplatte unter dem X400, wie im Bild "Positionierung Bodenplatte" gezeigt, zu positionieren.

Dadurch lässt sich die Elektronikbox ohne Platzprobleme weiter bestücken.



Es empfiehlt sich etwas unter die Bodenplatte zu legen, damit diese sich nicht durch biegt.

Abbildung 3.194. Positionierung Bodenplatte



### 3.9.12. Arduino board

Tabelle 3.50. Parts list Arduino board

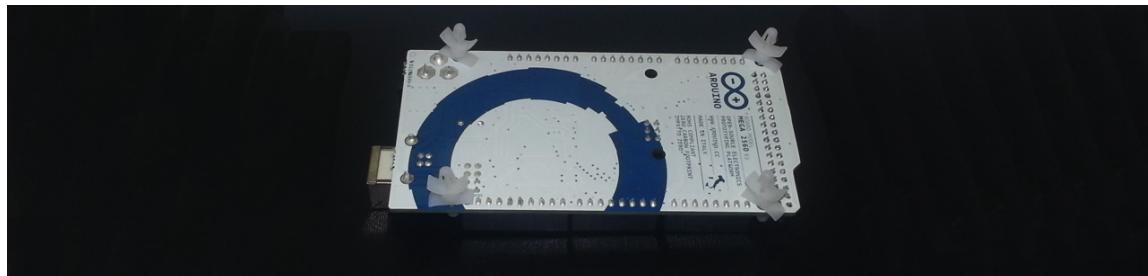
1x Electronic box [S. 32], pre-assembled	1x Arduino 2560 Mega [S. 28]
4x PCB holder	

Abbildung 3.195. Arduino board parts overview



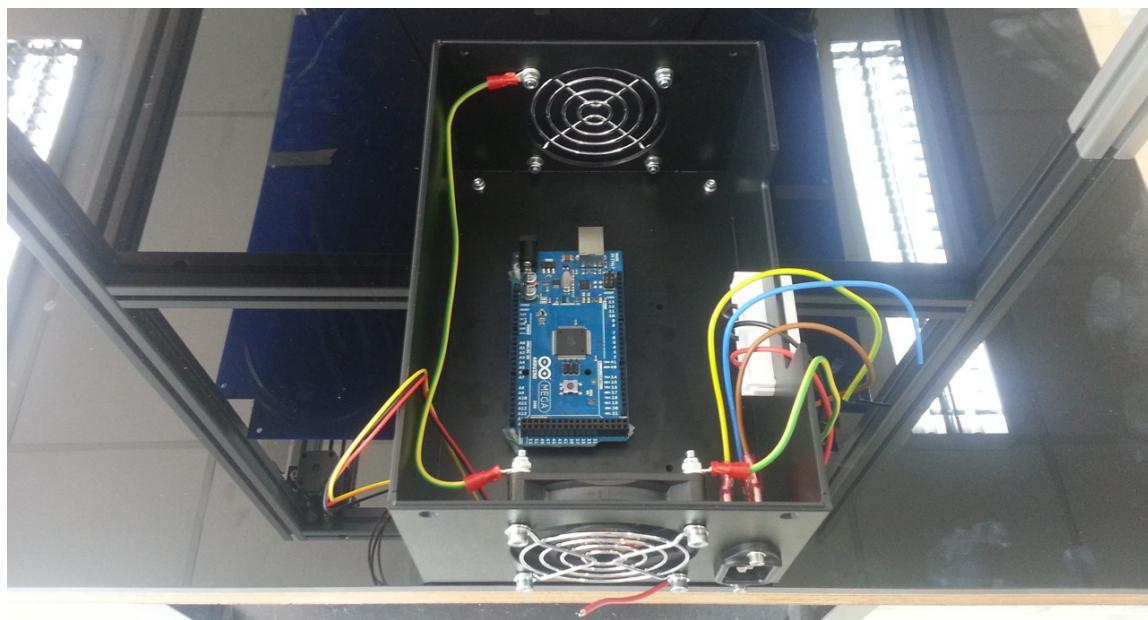
The PCB holders are installed at the bottom of the Arduino board (image "Details PCB holder [S. 154]").

Abbildung 3.196. Details PCB holder



The prepared board may now be plugged into the electronic box.

Abbildung 3.197. Finish Arduino board



### 3.9.13. Heated bed control electronics (Heated bed)

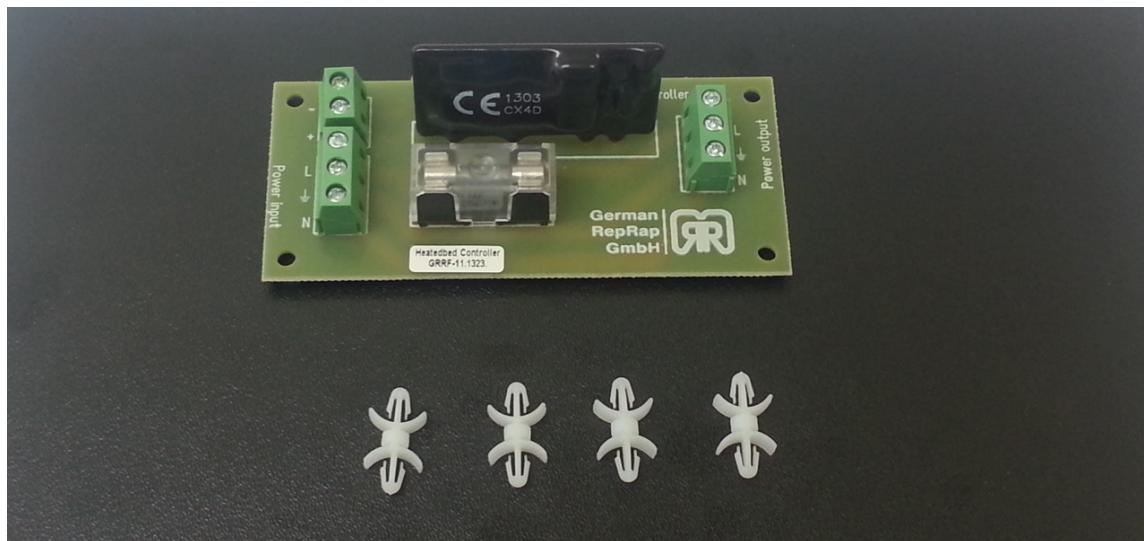


Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.51. Parts list heated bed control electronics

1x Electronic box [S. 32], pre-assembled	1x Control electronics
4x PCB holder	

Abbildung 3.198. Heated bed control electronics parts overview



Die Platinenhalter werden an der Unterseite der Steuerelektronik angebracht und wie im Bild "Abschluss Heizbett Steuerelektronik" gezeigt, befestigt.

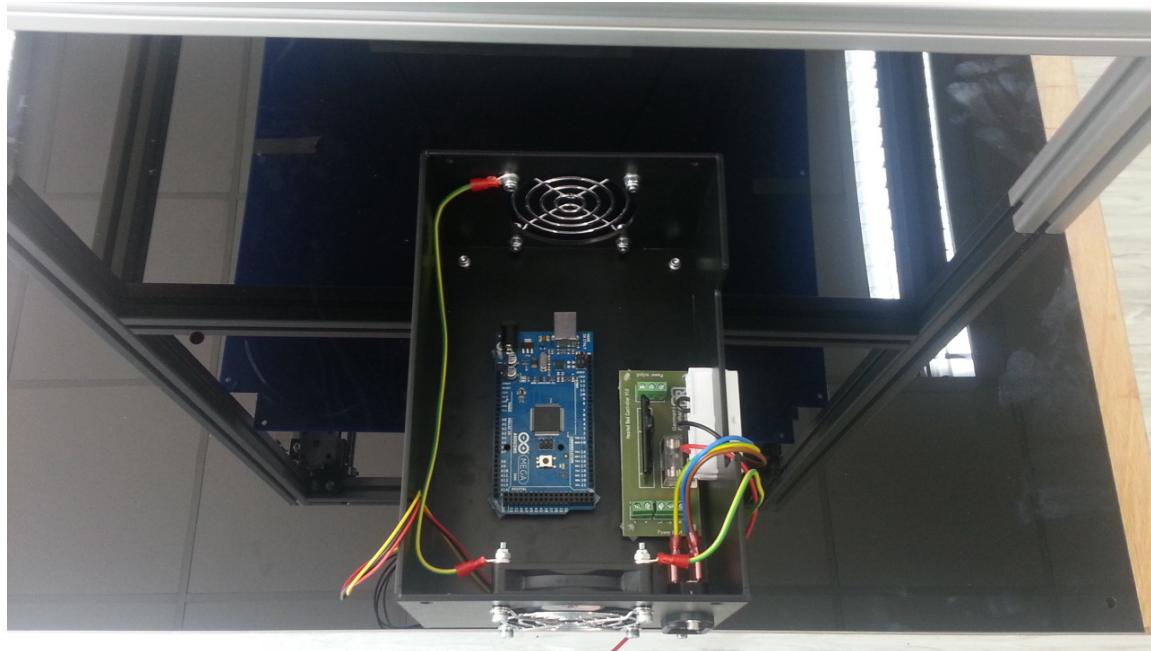
A connection of the cables does not happen before the finishing step.



The control electronics of the heated printing bed operates with 230V AC. For that reason, it is mandatory to screw the control electronics and the electronic box tightly together.

*If this is disregarded, life threatening injuries or fatal damage to property might be caused.*

Abbildung 3.199. Finish control electronics



### 3.9.14. Preparation of the Pololus

Tabelle 3.52. Parts list preparation of the Pololus

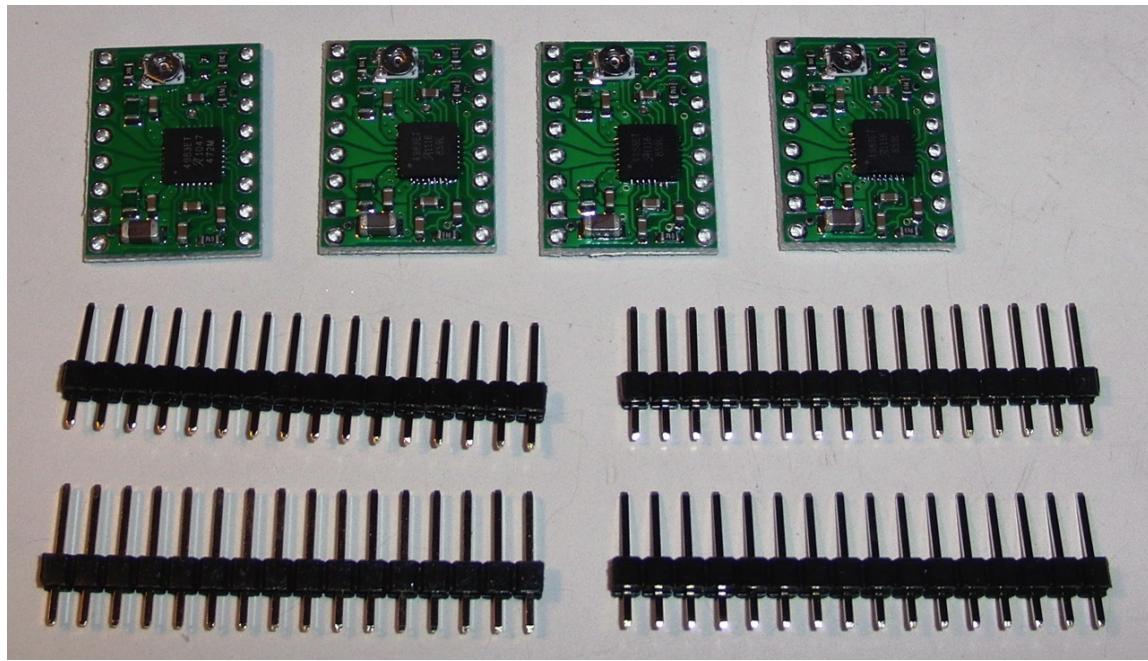
4x header, 16 poles	4x Pololu A4983
---------------------	-----------------

Tabelle 3.53. additional parts for the Dual-Extruder

1x header, 16 poles	1x Pololu A4983
---------------------	-----------------

Für den Dual-Extruder wird ein weiterer "Pololu A4983" benötigt

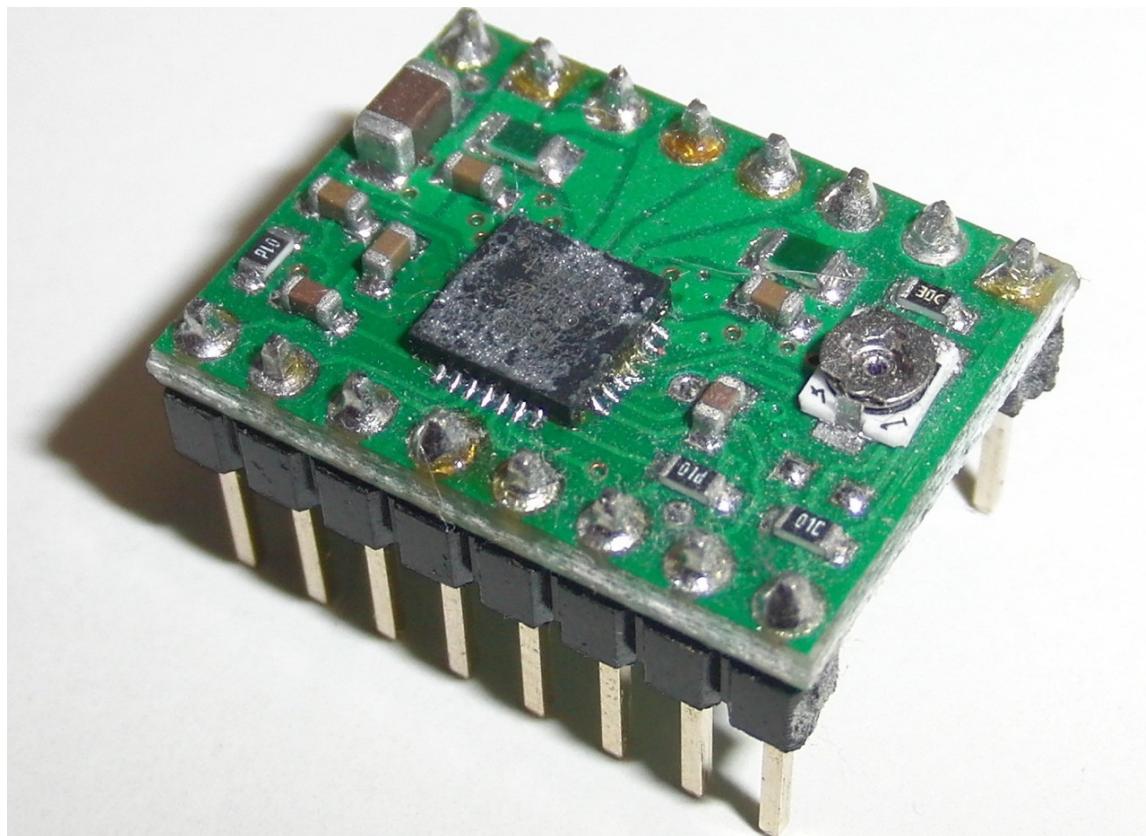
Abbildung 3.200. Preparation of the Pololus parts overview



The headers are cut into 1x8 pin pieces, which allows replacing a Pololu later on. The Pololus are put on the headers and soldered.

Dies beugt möglichen Problemen beim Aufstecken vor.

Abbildung 3.201. Finish preparation of the Pololus



### 3.9.15. Assembly of the cooling fins

Tabelle 3.54. Parts list assembly of the cooling fins

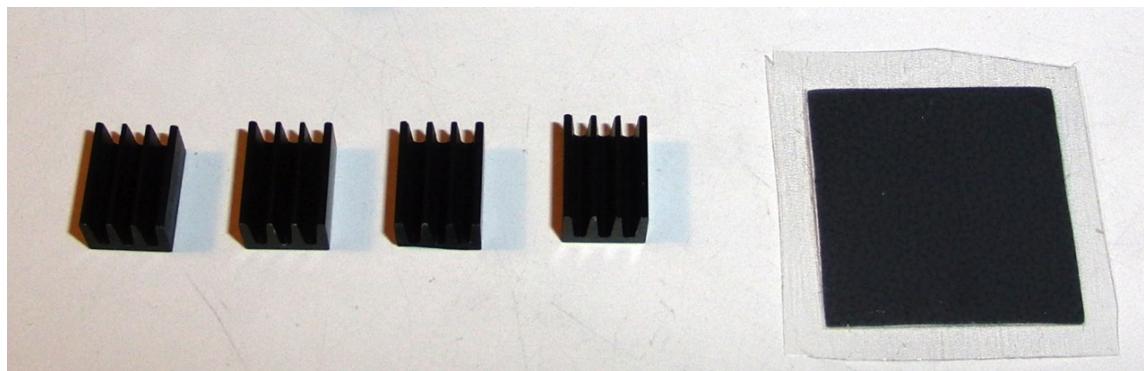
4x Pololu A4983, pre-assembled	1x Heat conduction pad
4x Cooling fins	

Tabelle 3.55. additional parts for the Dual-Extruder

1x Pololu A4983, pre-assembled	1x Cooling fins
--------------------------------	-----------------

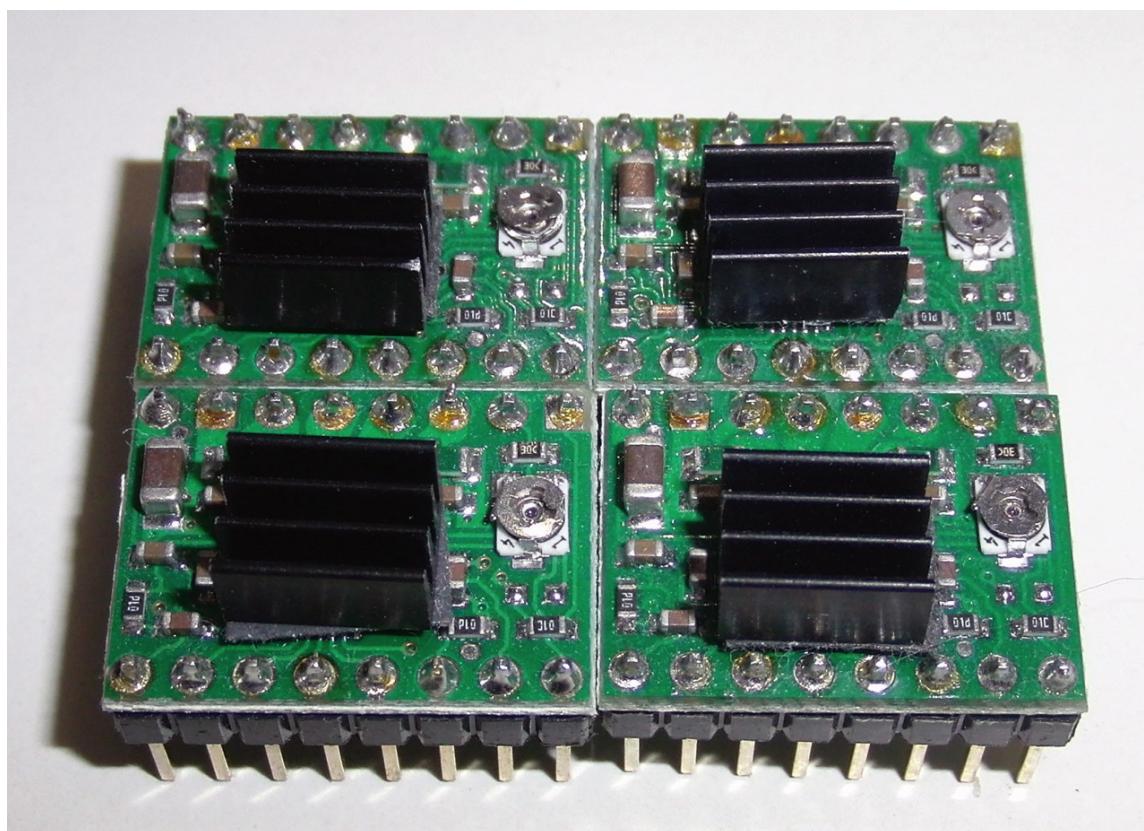
Für den Dual-Extruder wird eine weitere "Kühlrippe" benötigt

Abbildung 3.202. Assembly of the cooling fins parts overview



The chip on the Pololus heats up a lot during operation. The chips are assembled with cooling fins to avoid a shut down due to overheating. The self-adhesive heat conduction pad is cut and stuck on the chips. Afterwards, one cooling fin is stuck on every chip.

Abbildung 3.203. Finish Assembly of the cooling fins





### 3.9.16. Fastening of the Pololus

Tabelle 3.56. Parts list fastening of the Pololus

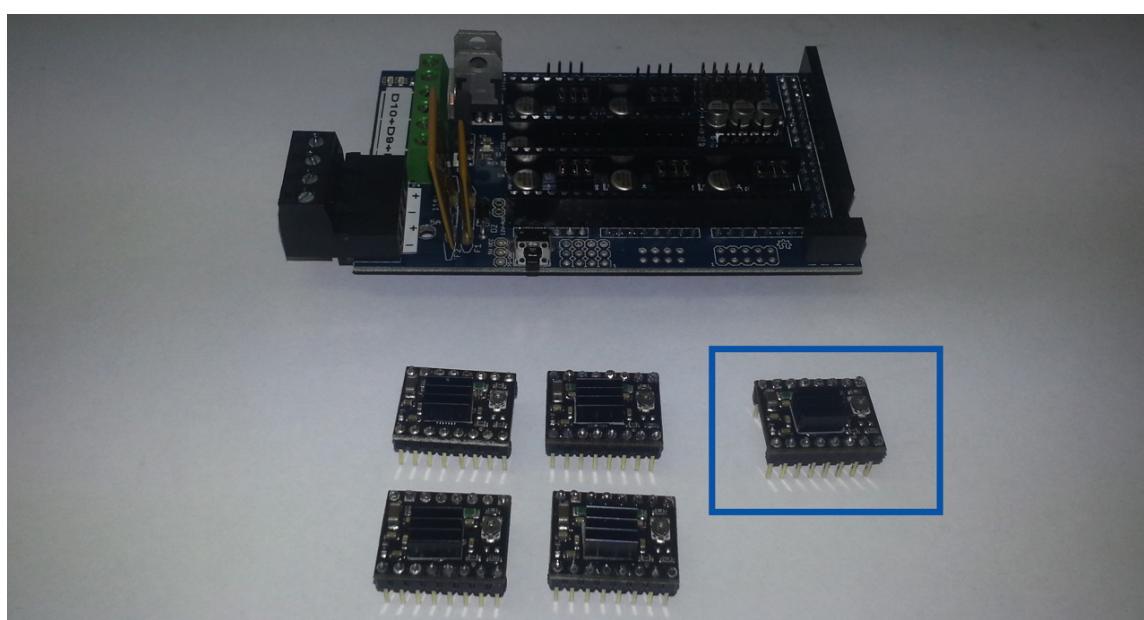
1x RAMPS v1.4 [S. 41]	4x Pololu A4983, pre-assembled
-----------------------	--------------------------------

Tabelle 3.57. additional parts for the Dual-Extruder

1x Pololu A4983, pre-assembled
--------------------------------

Das additional parts for the Dual-Extruder ist in dem Bilder mit einem blauem Rechteck markiert.

Abbildung 3.204. Fastening of the Pololus parts overview



Auf den Bildern sind die optionalen "Pololu A4983 BLACK Edition" gezeigt.



It is extremely important that all pins of the RAMPS are put into the intended sockets of the Arduino board.

To avoid problems during the first commissioning later on, the potentiometers on the Pololus are set to their middle positions.



For safety reasons and to avoid damage to the Pololu, this setting should be done while the power supply is switched off.

Abbildung 3.205. Setting Pololu potentiometer

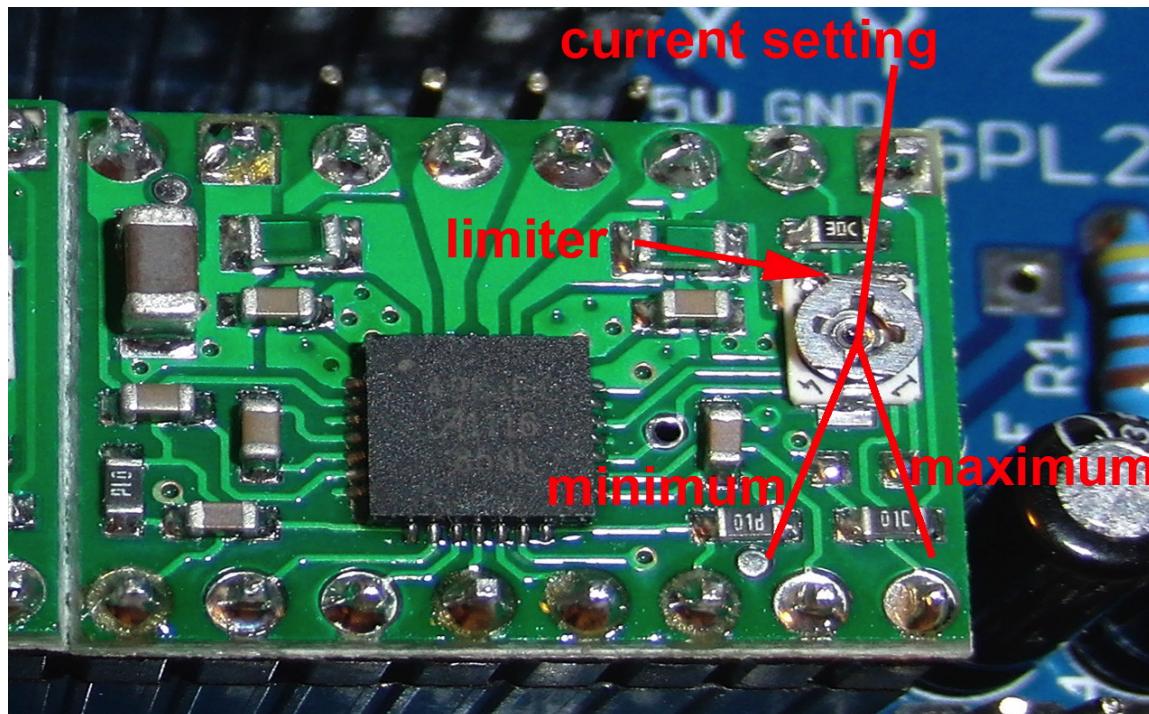
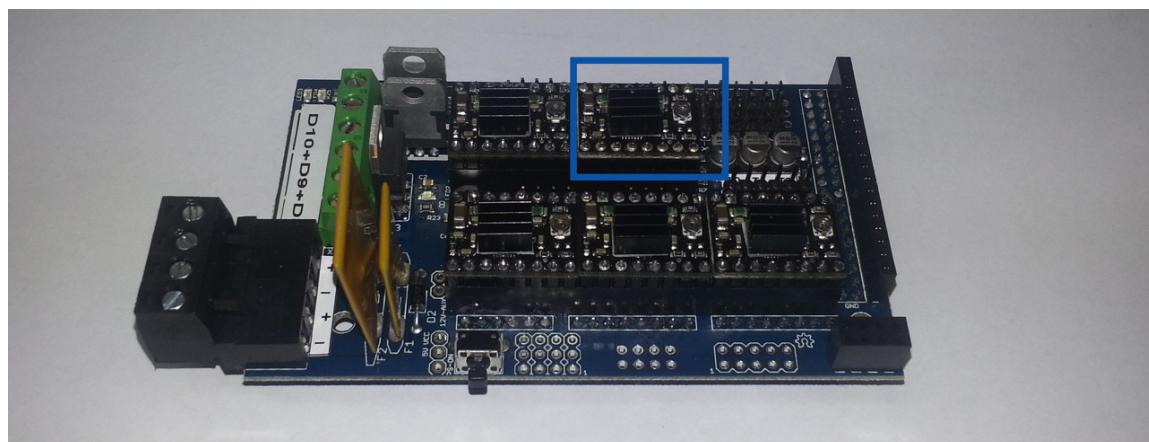


Abbildung 3.206. RAMPS mit RAMPS with Pololus attached



### 3.9.17. LCD/MSD Adapterplatine (LCD/MSD)



Dieser Schritt erfolgt nur, wenn der X400 mit einem LCD Controller oder Mobile-Storage-Device Druckbett montiert wird!

Tabelle 3.58. Parts list LCD/MSD Adapterplatine

1x Adapterplatine
-------------------

Abbildung 3.207. LCD/MSD Adapterplatine parts overview

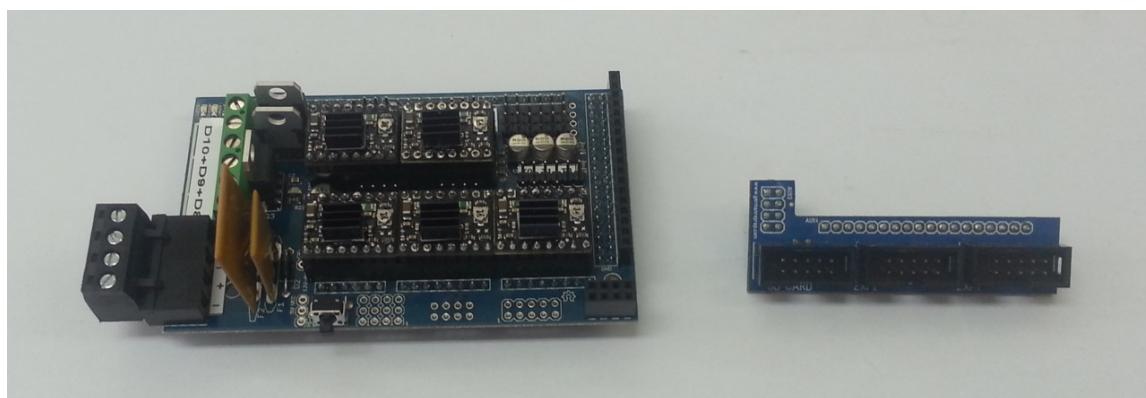
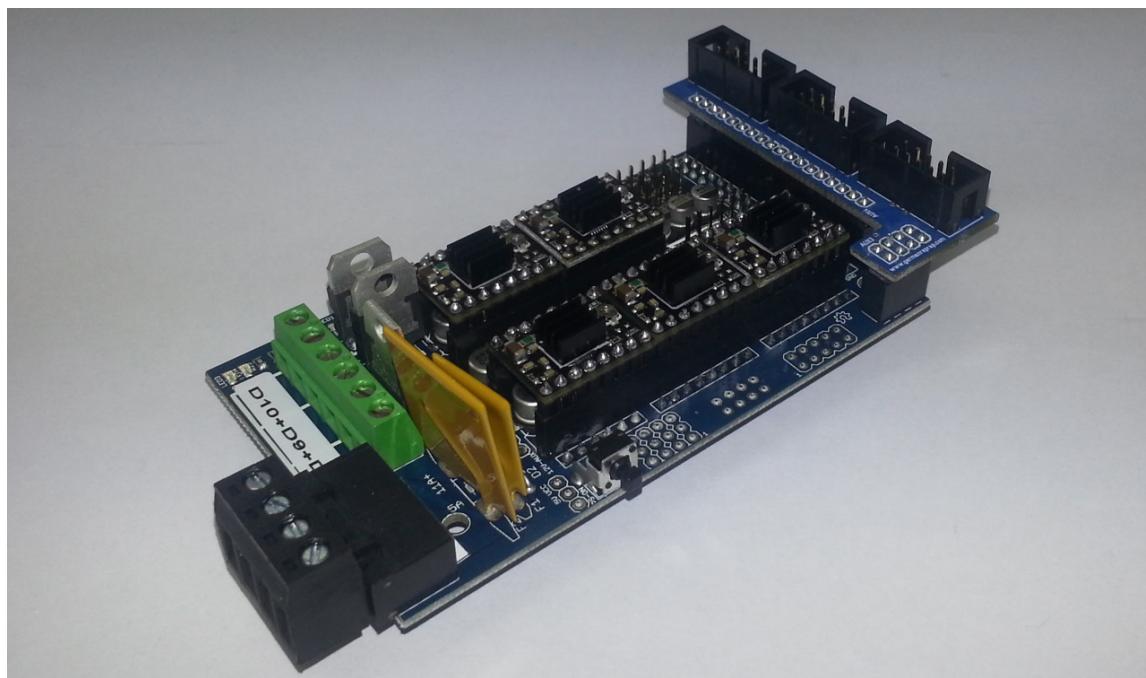


Abbildung 3.208. Finish LCD/MSD Adapterplatine



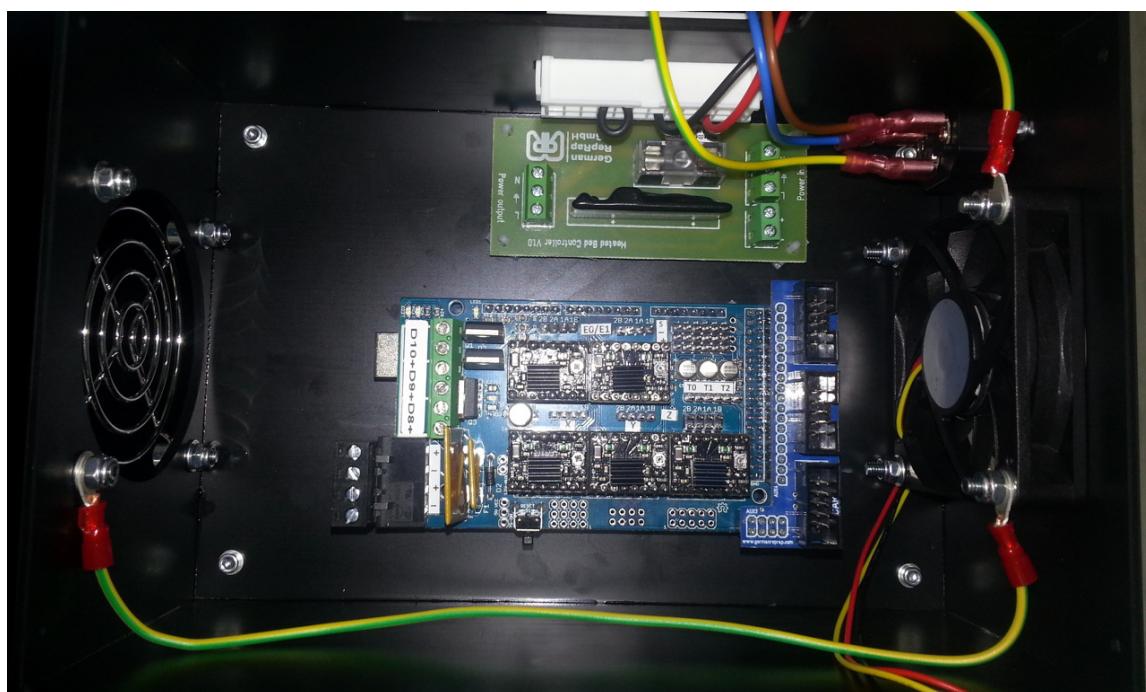
### 3.9.18. Fastening of the RAMPS

Tabelle 3.59. Parts list fastening of the RAMPS

1x RAMPS v1.4 [S. 41], pre-assembled
--------------------------------------

Afterwards, the RAMPS shield is simply plugged onto the Arduino board.

Abbildung 3.209. Finish fastening of the RAMPS



### 3.10. Printing bed



Dieser Schritt erfolgt nur, wenn der X400 *nicht* mit einem beheiztem Druckbett montiert wird!

Tabelle 3.60. Parts list printing bed

1x Glass plate	4x spring
4x M6x40 Round head screw	8x M6 washer, plastic
4x M6 knurled nut	4x M6 nut



Abbildung 3.210. printing bed parts overview

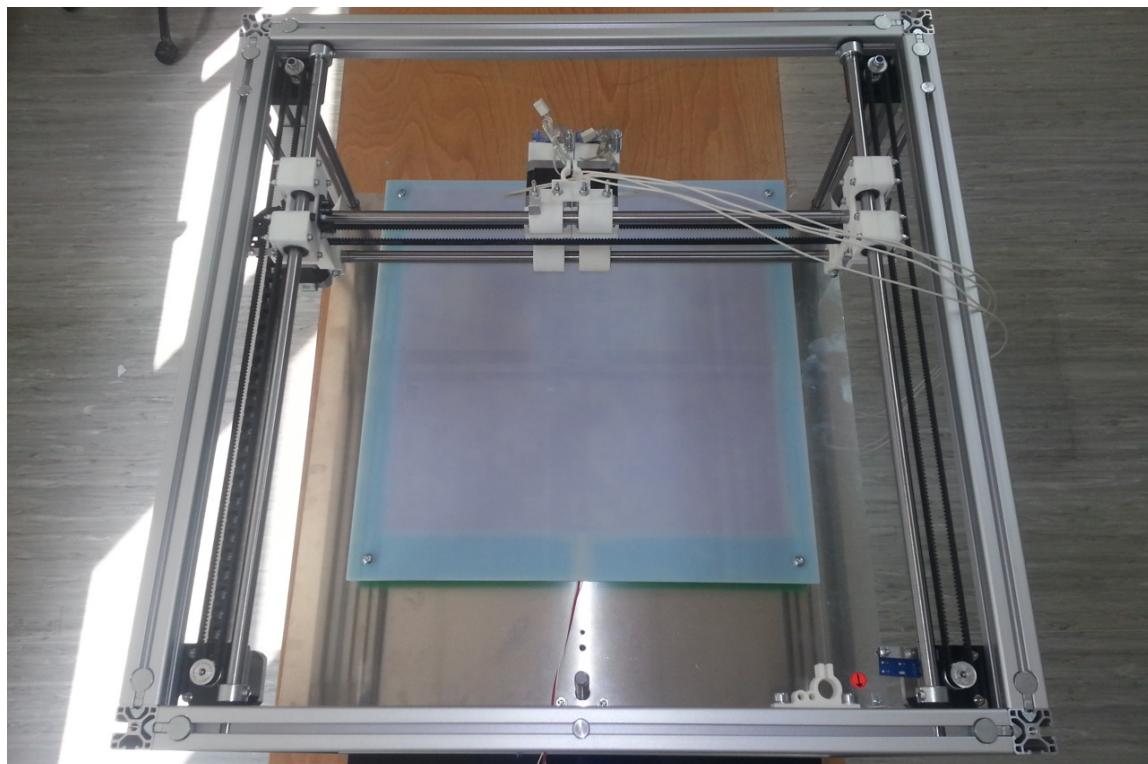


The round head screws are plugged with a plastic washer from above through the glass plate and then they are assembled with another plastic washer and a spring. Afterwards, they are plugged through the aluminum plate. On the bottom, this is countered with a nut and the knurled nut.

After that, the assembly of the *non heated* printing bed is finished.



Abbildung 3.211. Finish printing bed



Das Bild "Finish Das Druckbett" zeigt das beheizte Druckbett. Die Montage erfolgt aber in gleicher Weise.

### 3.11. The heated printing bed



Dieser Abschnitt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

#### 3.11.1. Isolierung Anschlusskabel (Heated bed)

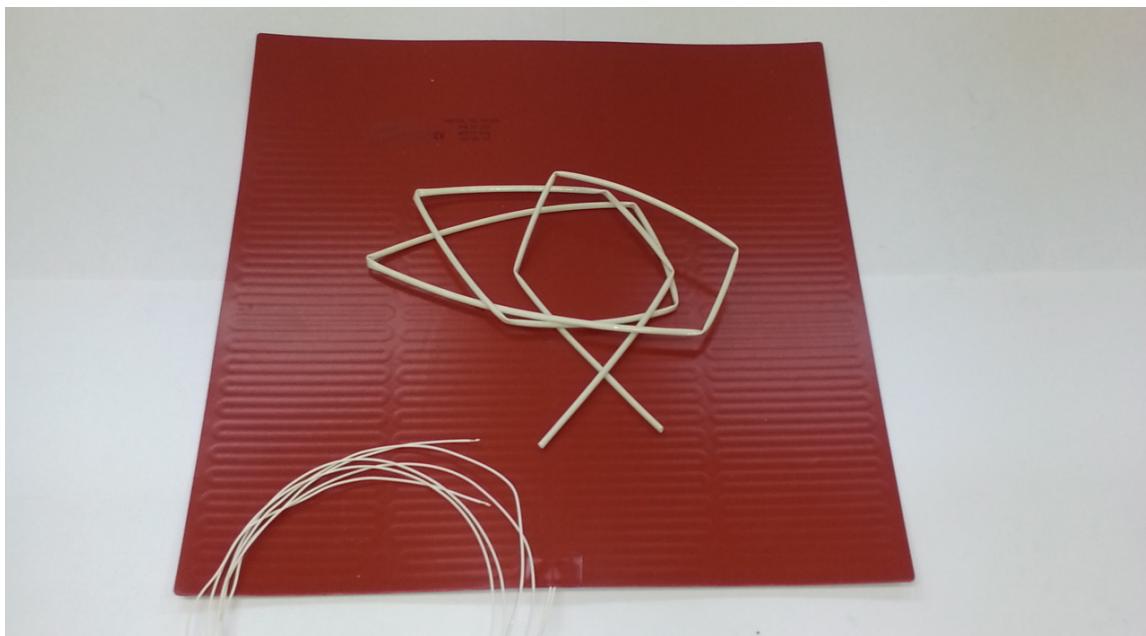


Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.61. Parts list Isolierung Anschlusskabel

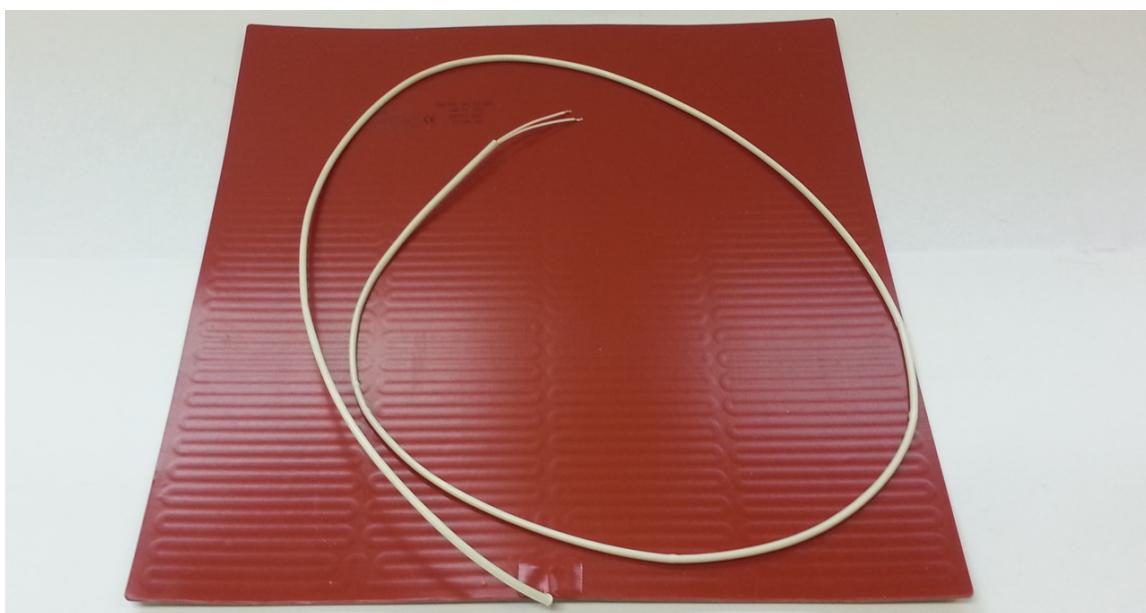
1x Heating pad, 400x400mm 230V [S. 38]	1x 1,7 m Isolierschlauch
--	--------------------------

Abbildung 3.212. Isolierung Anschlusskabel parts overview



Der Isolierschlauch muss über das gesamte Anschlusskabel der Heizmatte geschoben werden.

Abbildung 3.213. Finish Isolierung Anschlusskabel





### 3.11.2. Sticking on the heating pad (Heated bed)



Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.62. Parts list sticking on the heating pad

1x Ceramics plate [S. 32]

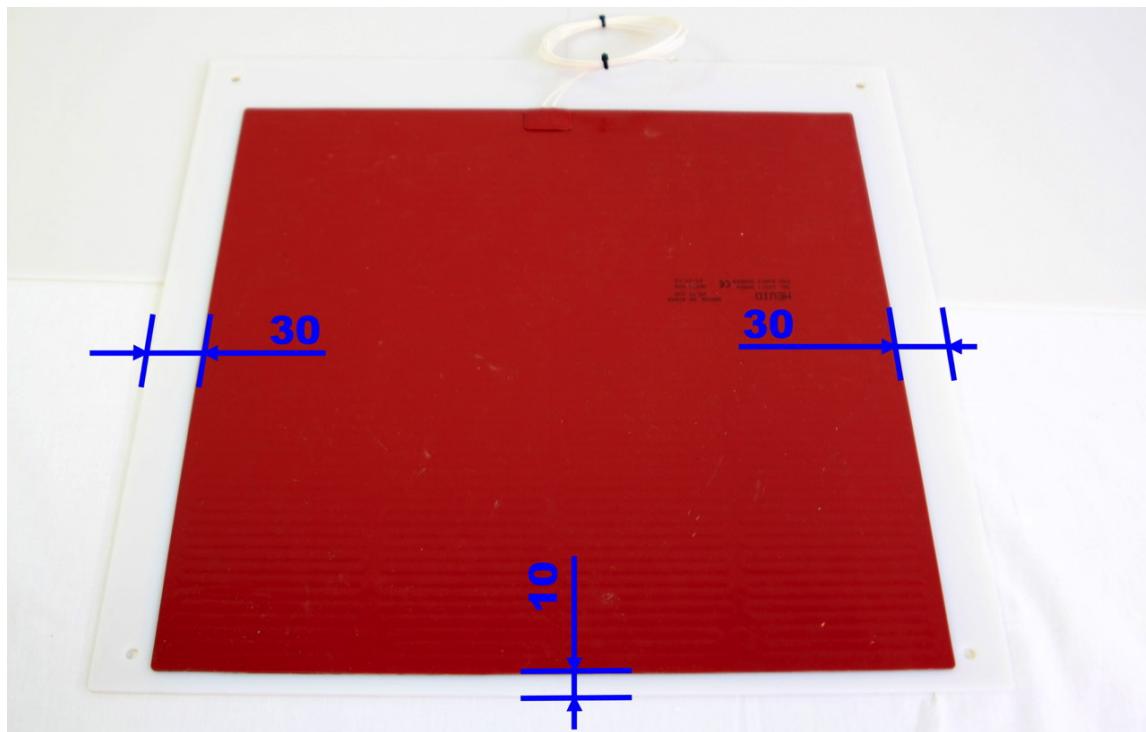
1x Heating pad, 400x400mm 230V [S. 38]

The heating pad has an adhesive coating and is directly stuck on the ceramics plate. The distances should meet a preferably large printable area, like in the image "Finish [S. 167]". The connection cable can be found on the not dimensioned side of the heating pad.



The ceramics plate have a VERY plain surface and one not so smooth. Please pay attention to keep the VERY smooth surface on top to print on, as it may come to an adhesion problem for the printmaterial.

Abbildung 3.214. Finish sticking on the heating pad



### 3.11.3. Heated bed thermistor (Heated bed)

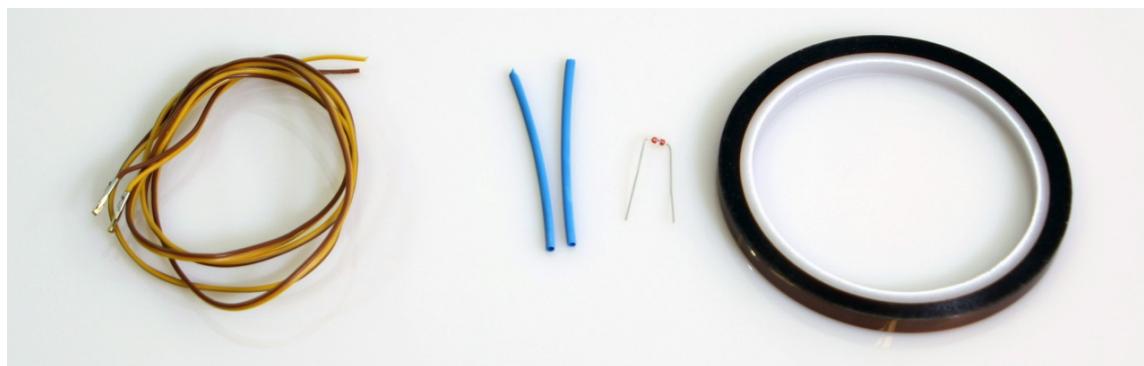


Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.63. Parts list heated bed thermistor

1x 100k thermistor	1x Kapton tape 6mm
1x thermistor cable	1x Shrink tubing

Abbildung 3.215. Heated bed thermistor parts overview



The thermistor is soldered to the thermistor cable and the free ends are insulated with shrink tubing.

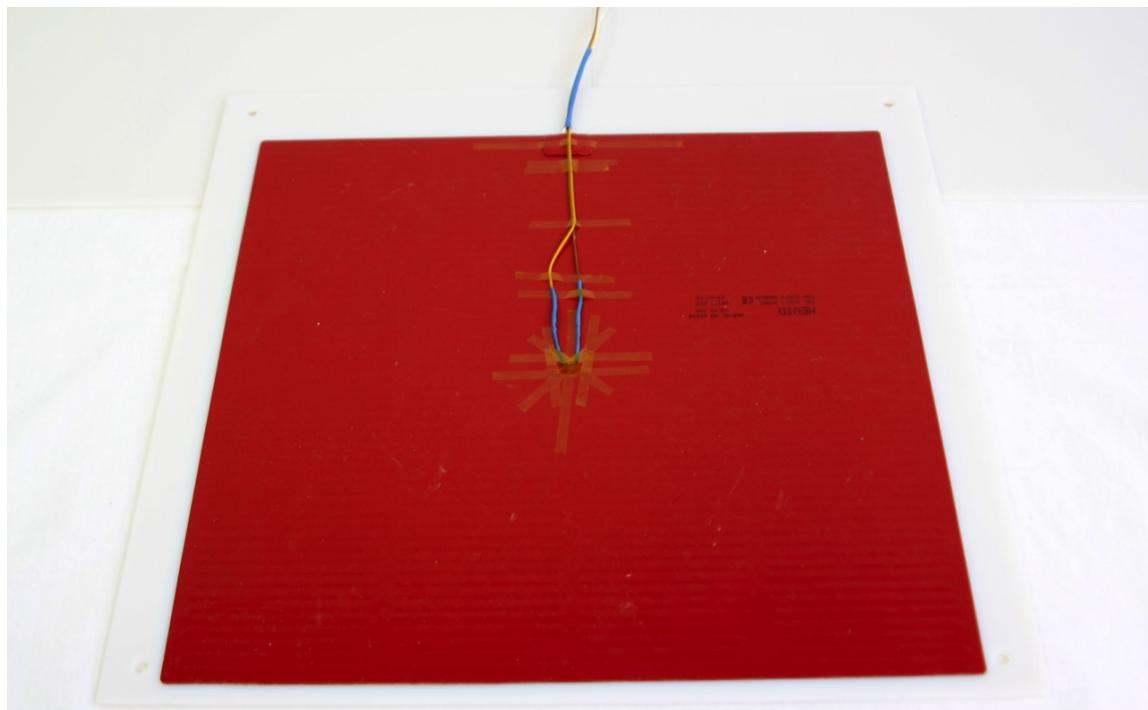
Abbildung 3.216. Details thermistor



The thermistor is stuck right in in the middle of the heating bed so the temperature can be measured correctly. Now the cable of the thermistor is joined with the heating pad.

Afterwards, the thermistor is sufficiently taped with Kapton.

Abbildung 3.217. Finish heated bed thermistor



### 3.11.4. Insulation (Heated bed)

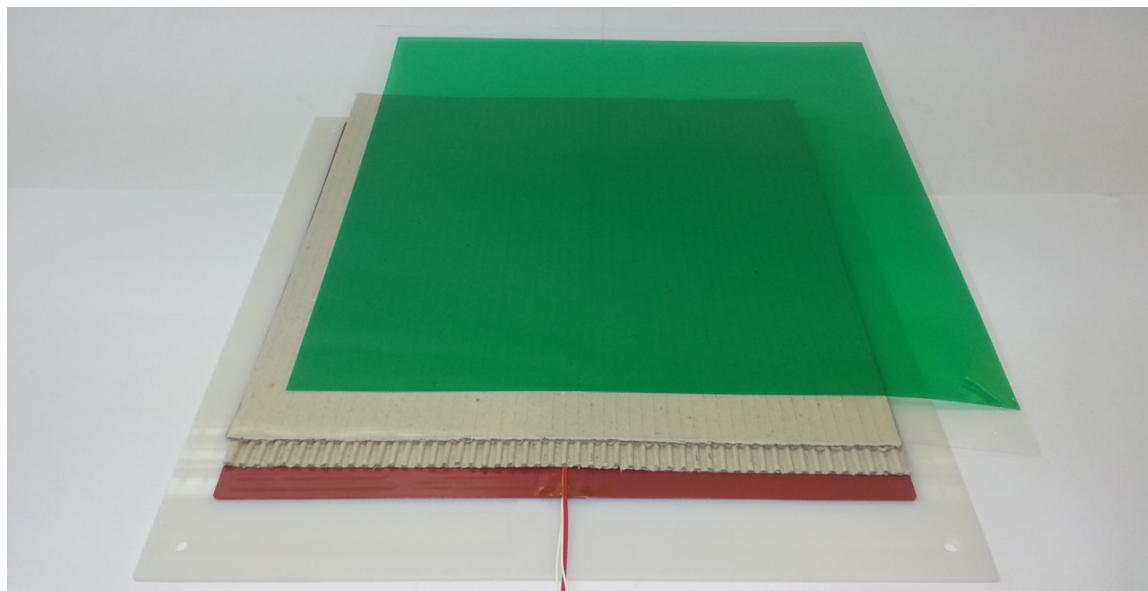


Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.64. Parts list Insulation

2x Corrugated board, 400x400mm	1x PET tape 460x460 mm
--------------------------------	------------------------

Abbildung 3.218. Insulation parts overview



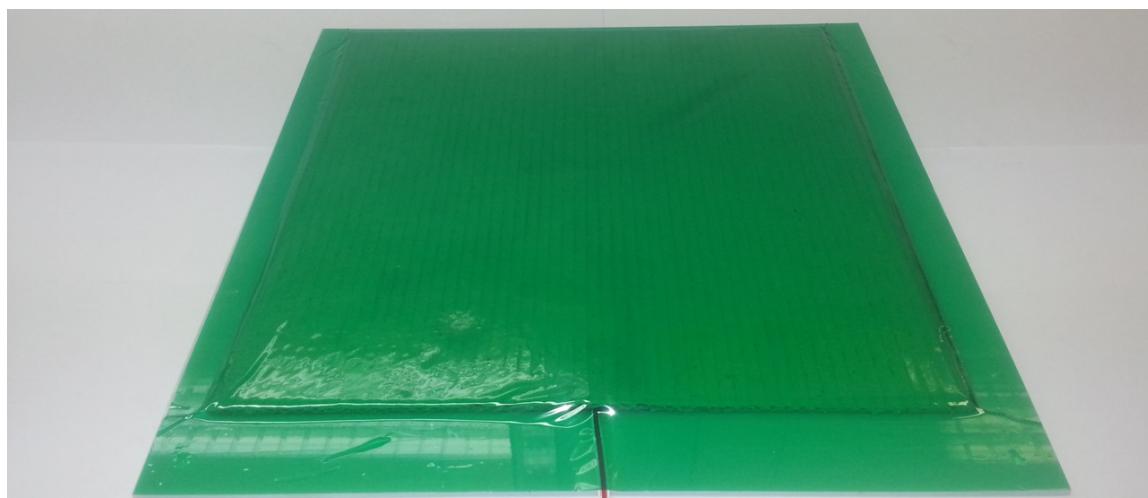
For thermal insulation of the bottom, two layers of corrugated board is put on the heating pad and tightly taped with PET. The holes for the screws have to be left out.



In case ABS [S. 255] is printed in the future, the surface of the printing bed has to be covered with a layer of PET tape as well, so it is easier to remove the ABS [S. 255] from the printing bed later on.

One layer is enough, without overlapping or bubbles if possible (these contours would later be visible on the bottom of the printed part).

Abbildung 3.219. Finish Insulation





### 3.11.5. Assembly of the heated bed (heated bed)



Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.65. Parts list assembly of the heated bed

4x Spring	4x M6x40 Round head screw
8x M6 washer, plastic	4x M6 knurled nut
4x M6 nut	

Abbildung 3.220. Assembly of the heated bed parts overview

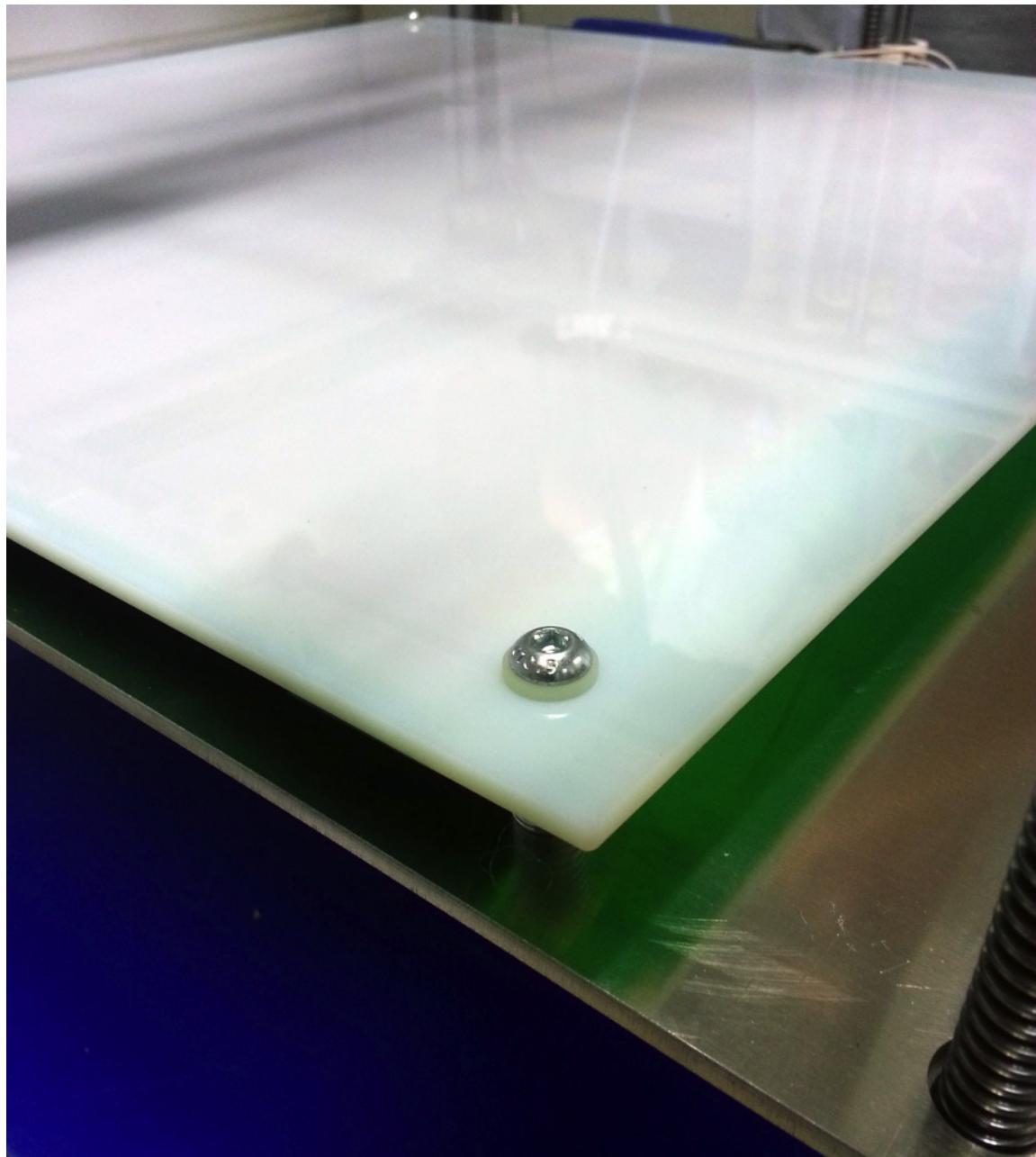


The round head screws are plugged with a plastic washer from above through the glass plate and then they are assembled with another plastic washer and a spring. Afterwards, they are plugged through the aluminum plate. On the bottom, this is countered with a nut and the knurled nut.

The connection cables have to be at the back of the X400, as there is an energy chain that guides the cables to the electronic box.



Abbildung 3.221. Finish assembly of the heated bed



### 3.11.6. Preparing the grounding of the printing plate (Heated bed)



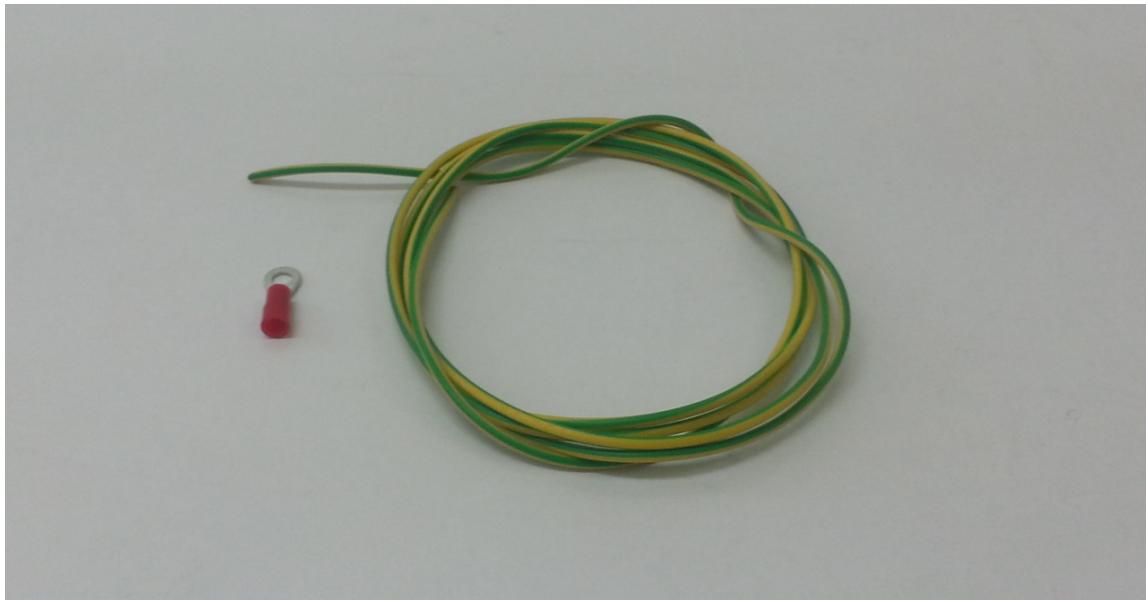
Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!



Tabelle 3.66. Parts list preparing the grounding of the printing plate

1x 1,5m cable, yellow-green	1x M3 cable ring shoe
-----------------------------	-----------------------

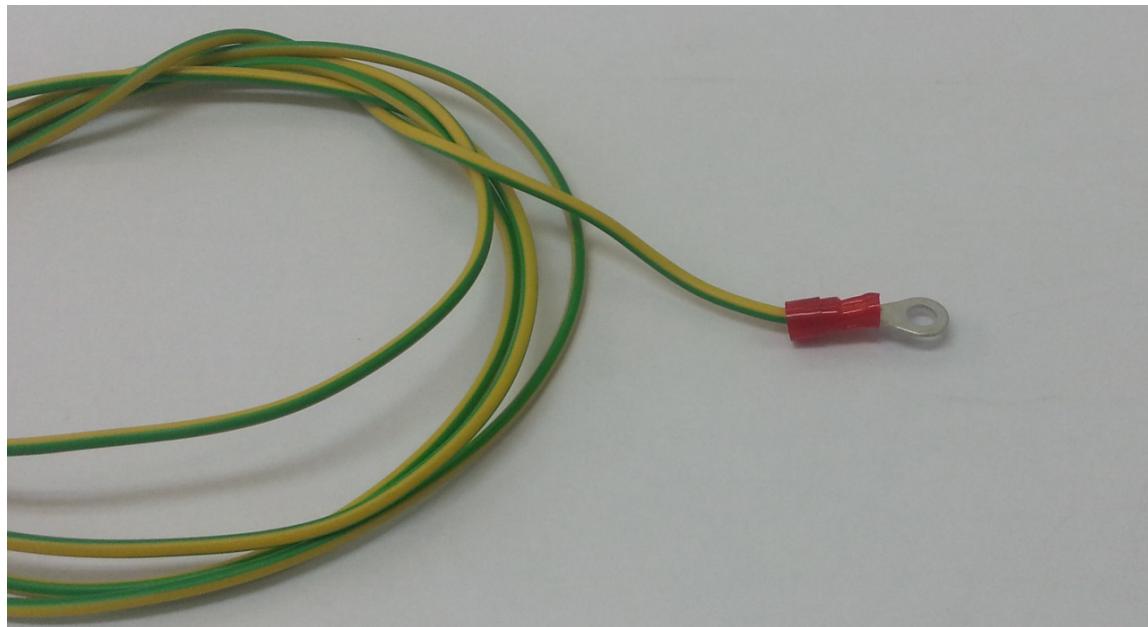
Abbildung 3.222. Preparing the grounding of the printing plate parts overview



Es werden nur 1,5m des gesamten Erdungskabel für das Heizbett benötigt. 0,35 m bleiben für die spätere Benutzung übrig.

A small cable ring shoe is crimped or soldered at the end.

Abbildung 3.223. Finish preparing the grounding of the printing plate



### 3.11.7. Printing bed energy chain (Heated bed)



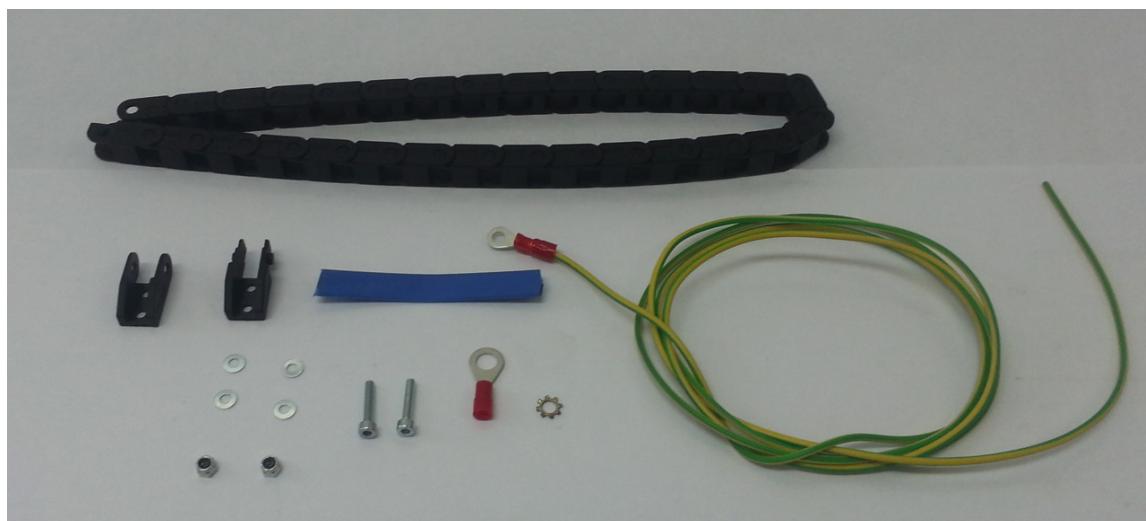
Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.67. Parts list printing bed energy chain

30x Energy chain link	1x Assembly kit energy chain
1x 1,5m ground cable, pre-assembled	1x M3 tooth lock washer
1x M6 cable ring shoe	1x shrink tubing
2x M3x14 cylinder head screws	4x M3 washer
2x M3 self-locking nut	



Abbildung 3.224. Printing bed energy chain parts overview

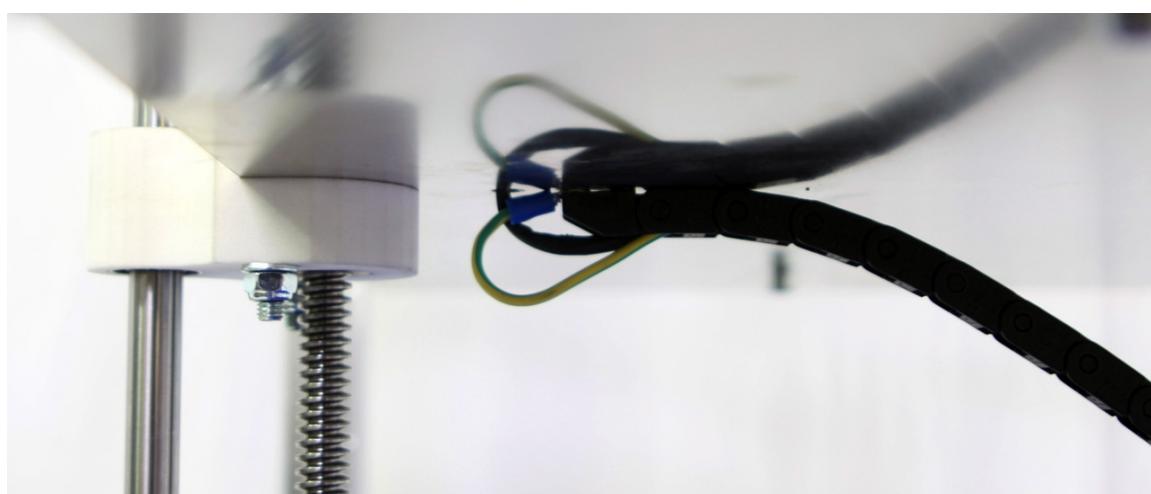


The energy chain is fastened at the bottom of the aluminum plate. In addition, the cable ring shoe and the tooth lock washer are directly screwed to the aluminum plate, too.



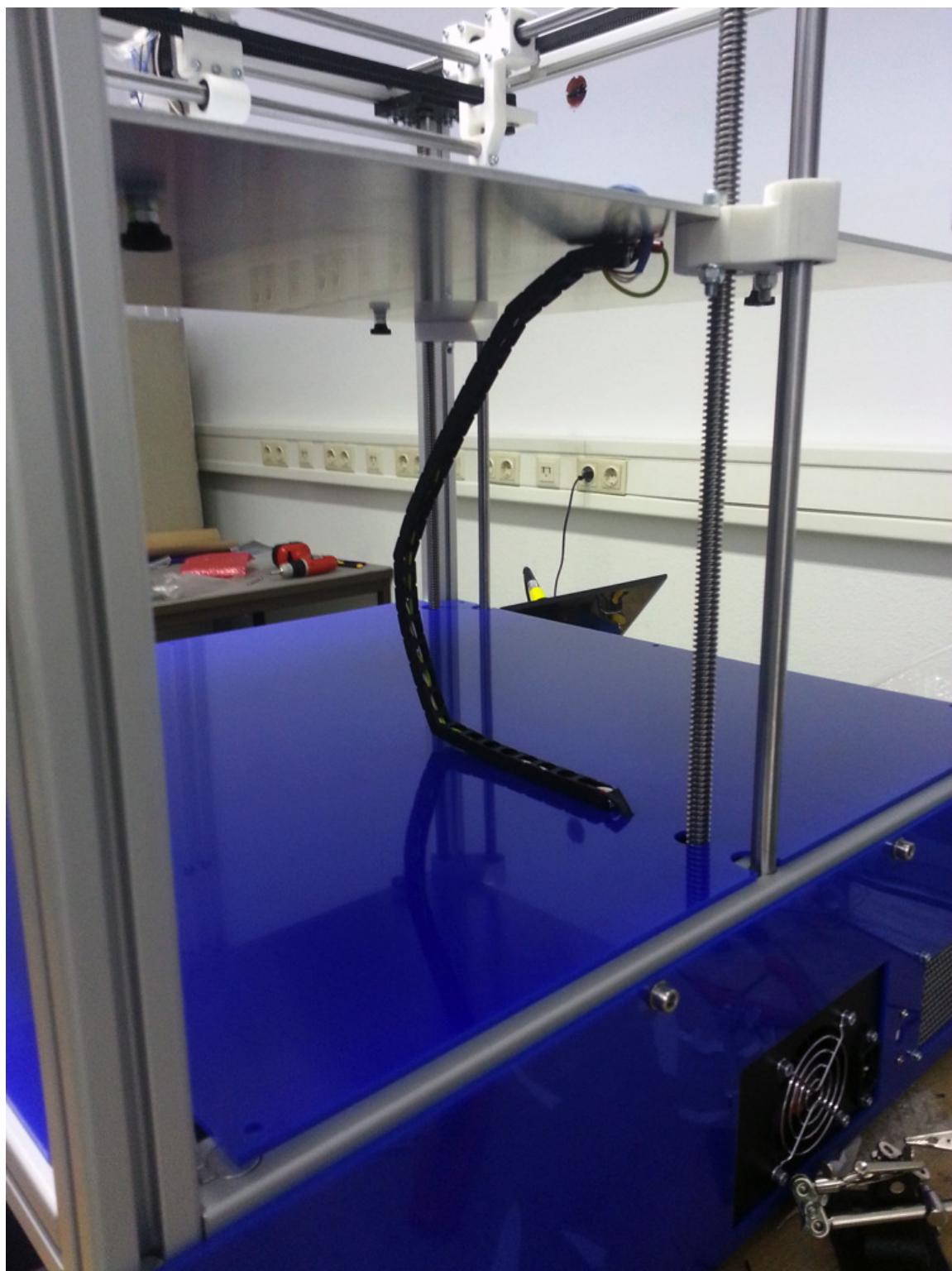
The drill hole for the earth cable is the same, as used for the energy chain.

Abbildung 3.225. Ground cable



After all cables are plugged through the energy chain and the energy chain is fastened at the blue distance plate (plug the cables through here as well), kann das freie Ende des Erdungskabel mit dem Kabelringschuh M6 vercrimpt bzw. angelötet werden..

Abbildung 3.226. Finish printing bed energy chain





### 3.11.8. Printing bed cable (Heated bed)



Dieser Schritt erfolgt nur, wenn der X400 mit einem beheiztem Druckbett montiert wird!

Tabelle 3.68. Parts list printing bed cable

1x Spiralband	1x Befestigungssockel Kabelbinder
1x Kabelbinder	

Abbildung 3.227. Printing bed cable parts overview



Das Bild "Druckbett Kabel Finish [S. 178]" zeigt die Kabelführung auf der Unterseite der Zwischenplatte. Es empfiehlt sich die Kabel mit dem Spiralband zu bündeln, bevor sie mit dem Befestigungssockel und dem Kabelbinder an der Unterseite der Zwischenplatte fixiert werden, damit die Kabel nicht den Z-Achsen-Zahnriemen berühren.

Abbildung 3.228. Printing bed cable Finish



### 3.12. Wiring



To keep the electronic box tidy, it is recommended to lay the cable loom first and then shorten it to the needed length before attaching the connectors to the cables.

The exact position of the connectors on the RAMPS can be found in the "[circuit diagram \[S. 193\]](#)".



### 3.12.1. Extruder

Tabelle 3.69. Parts list extruder

2x 2m cable, heating	2x 2m cable, thermistor
2x 2m cable, fan	1x stepper motor cable with connector (not pictured))
1x 1,7m fabric tubing, metal	1x Crimp housing, 2 poles
1x Crimp housing, 4 poles	6x Crimp contact
1x Shrink tubing	

Abbildung 3.229. Extruder parts overview



The ten cables are pulled through the fabric tubing and the fabric tubing is guided through the cable holders at the extruder and the back frame.

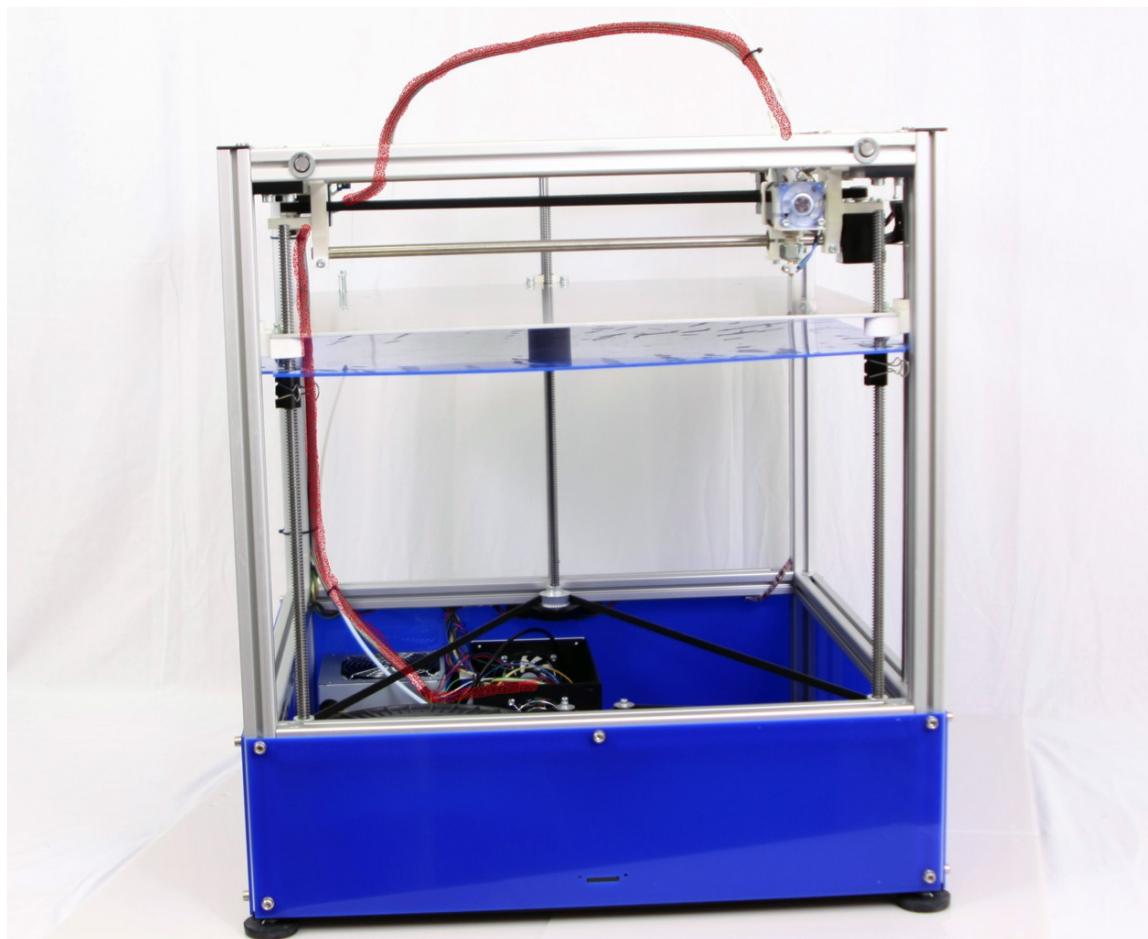
In the image "[Extruder cable run \[S. 180\]](#)", the course of the fabric tubing is marked in red.



In case the X400 is supposed to be equipped with a second extruder, it is recommended to add the cables for that one now. At least ten more cables are necessary for another extruder, possibly even more for other tools.

The thermistor cable is soldered to the thermistor in the hot end and insulated with shrink tubing. The heating cable is soldered to the heating cartridge and insulated as well.

Abbildung 3.230. Extruder cable run



Two crimp contacts are crimped or soldered to the other end of the thermistor cable and slotted into the two poles crimp housing.



To avoid confusion down the track, it is recommended to mark all cables and connectors.



To make it easier to get the cables through the fabric tubing, it is helpful to proceed as follows (especially when the X400 is used with a dual-extruder):

All cables that should run through the tubing are stripped and soldered together.

Abbildung 3.231. Soldering single cables



Afterwards all cables are soldered together as tight as possible.

Abbildung 3.232. Soldering the cable-bundle



Following we use a wire and attach it to the cable bundle (either loop it through or solder it at the end)

Abbildung 3.233. Fabric tubing with wire



Finally the cable harness can be pulled through the fabric tubing. It will slide in more easily if the fabric tubing is held straight and the cables are not twisted too much.

Abbildung 3.234. Finish fabric tubing

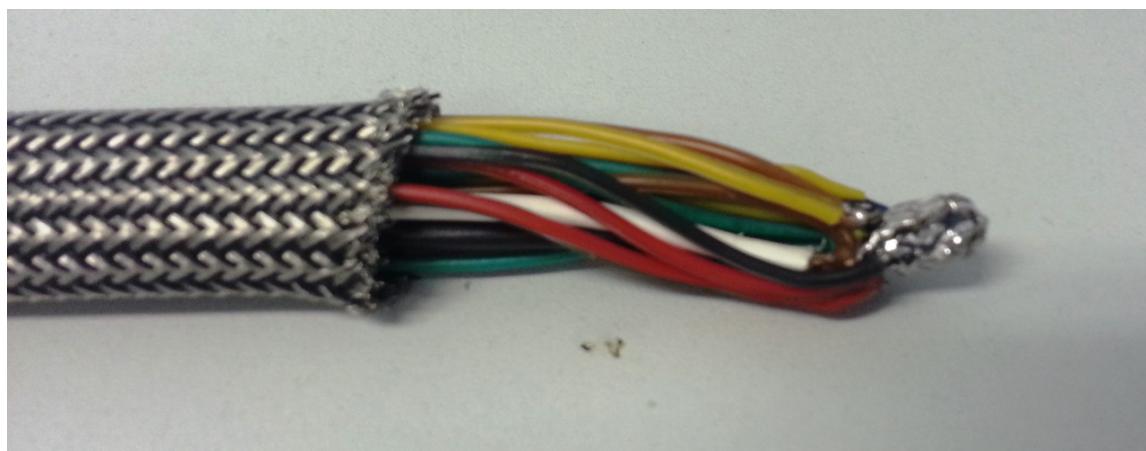
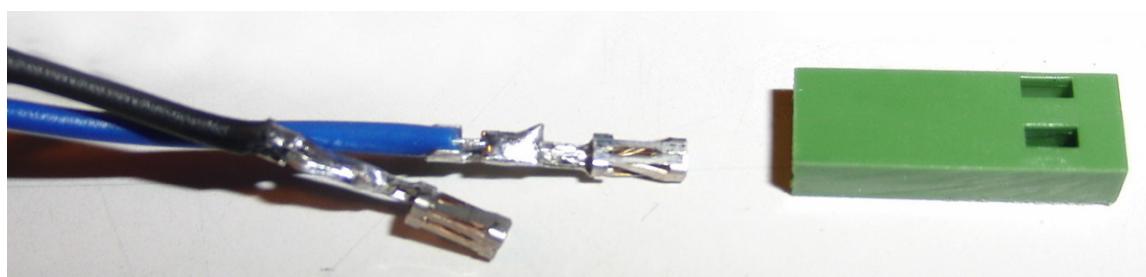


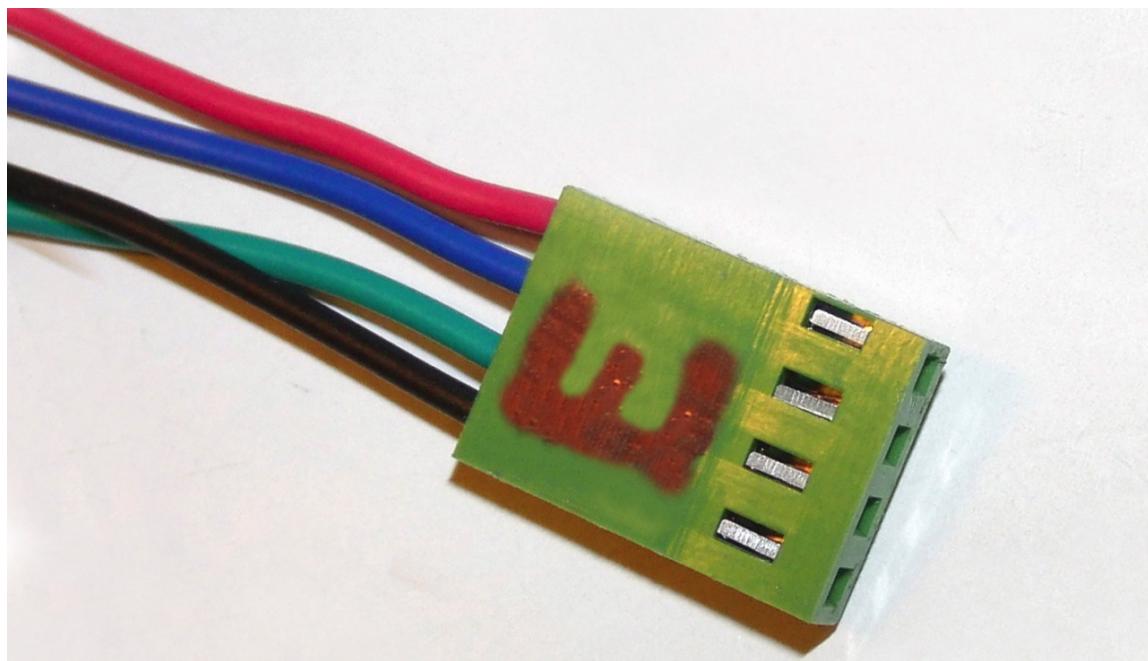
Abbildung 3.235. Crimp contacts



After splitting up the cables coming out of the fabric tubing, the cables of the stepper motor are combined in one plug. The order has to correspond to the image "Connector stepper motor [S. 183]". In this example it's the connector for an extruder motor.



Abbildung 3.236. Connector stepper motor



### 3.12.2. Fastening of the fabric tubing

Tabelle 3.70. Parts list fastening of the fabric tubing

2x M3x16 cylinder head screw	4x M3 washer
2x M3 self-locking nut	

Abbildung 3.237. Fastening of the fabric tubing parts overview





The cable mounts that the fabric tubing is guided through are fixed with one screw each to avoid slipping.



It is important that the fabric tubing between the fixed cable mounts is long enough, so that the extruder is able to reach all positions on the printing bed.

### 3.12.3. X-axis and Y-axis, left side

Tabelle 3.71. Parts list X-axis and Y-axis, left-side

3x2m cable, X-End stop	1x stepper motor cable with connector (not pictured))
7x Crimp contacts	2x Crimp housing, 4 poles
1x Crimp housing, 3 poles	

Abbildung 3.238. X-Axis and Y-Axis, left side parts overview



The images "Energy chains cable course[S. 185]" and "Y-axis left side, complete[S. 186]" show the course of the cables through the energy chain inside of the back aluminum profile to the electronic box.

The end stop cable is *not* connected yet, but combined with the stepper motor of the X-axis (red course). After that, these cables are guided together through the energy chain to the right Y-axis stepper motor (blue course) and to the electronic box.

The end stop cable is provided with a three poles connector.

Only the stepper motor of the X-axis is equipped with a four poles connector. For now, the stepper motor of the Y-axis is not.

Abbildung 3.239. Energy chain cable course

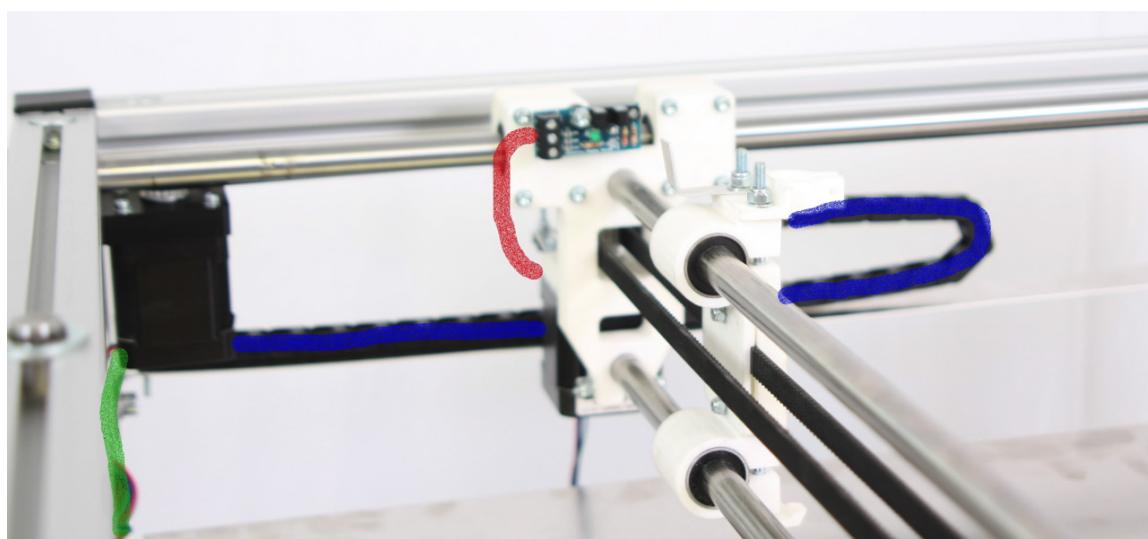
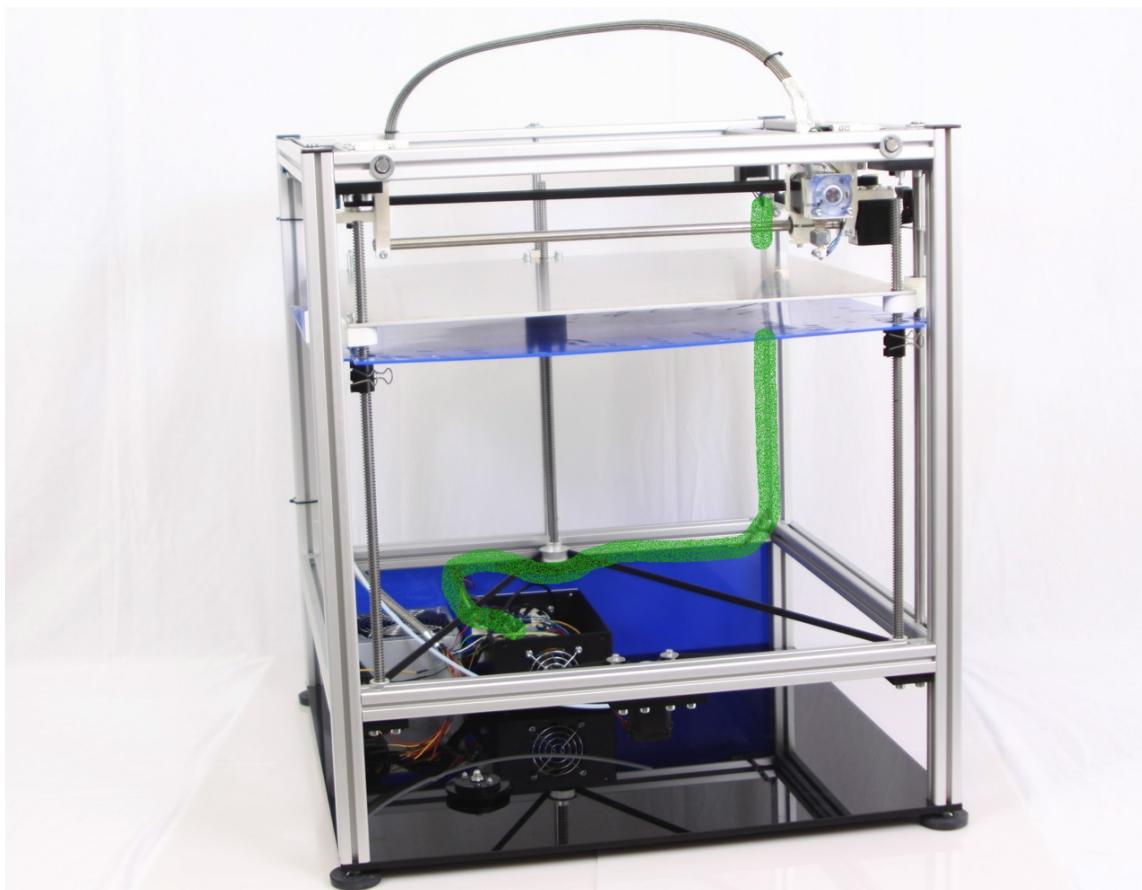


Abbildung 3.240. Y-axis, left side, complete



### 3.12.4. Y-axis, right side

Tabelle 3.72. Material list Y-axis, right side

3x1,2m cable, Y-Endstop	3x1,2m cable, Z-Endstop
1x stepper motor cable with connector (not pictured))	10x Crimp contact
1x Crimp housing, 4 poles	2x Crimp housing, 3 poles



Abbildung 3.241. Y-axis, right side parts overview



The Endstop cables are connected to the according Endstops and led in the groove of the aluminum profile together with the stepper motor, in accordance with the red marking in the image "[Y-axis right side, complete \[S. 189\]](#)".

Afterwards, the Endstop cables are provided with the three poles connector.

The second stepper motor of the Y-axis is not provided with a connector yet.



Abbildung 3.242. Endstop cable course

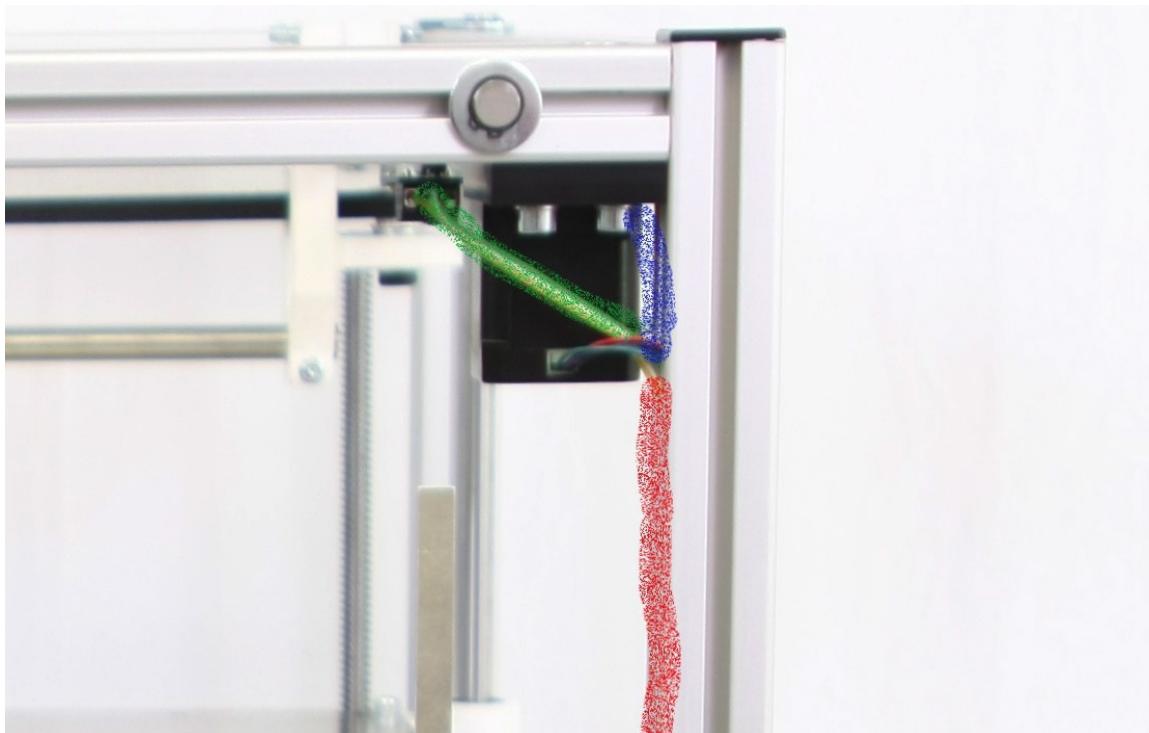
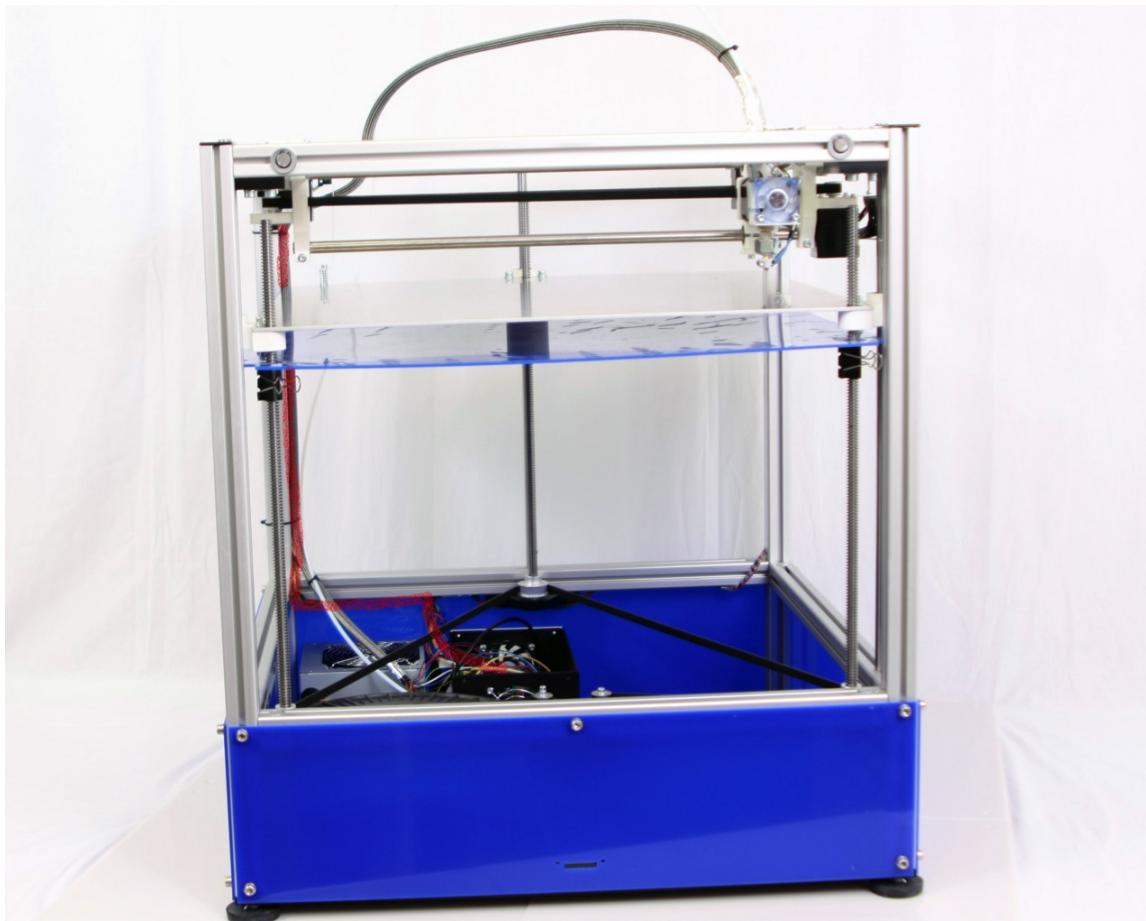




Abbildung 3.243. Y-axis right side, complete

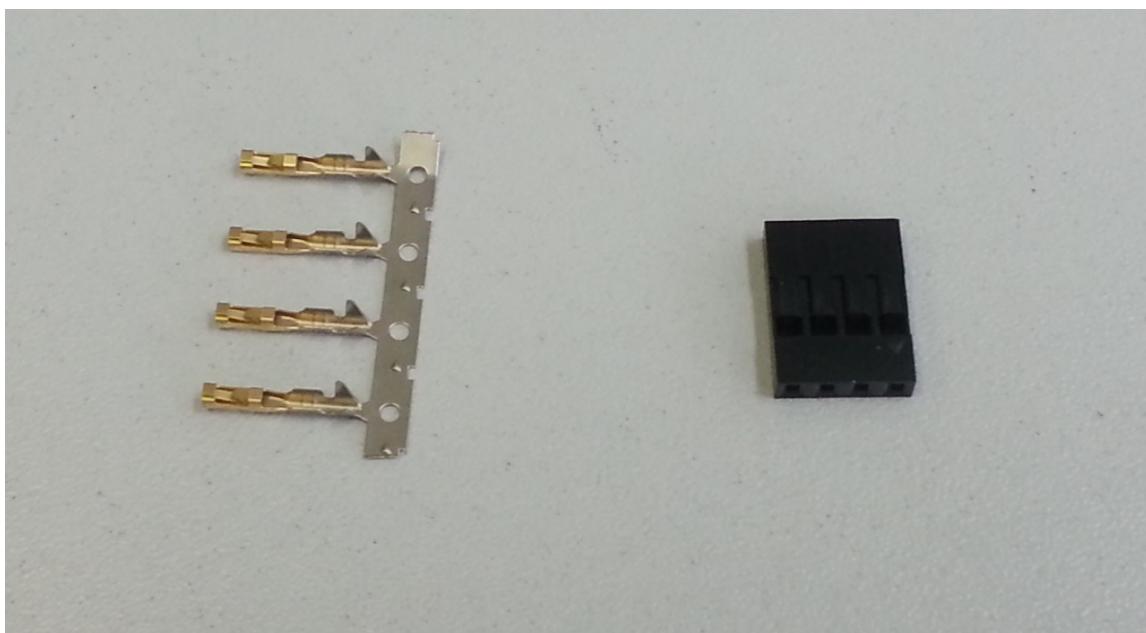


### 3.12.5. Z-axis

Tabelle 3.73. Parts list Z-axis

1x stepper motor cable with connector (not pictured))	4x Crimp contact
1x Crimp housing, 4 poles	

Abbildung 3.244. Z-axis parts overview

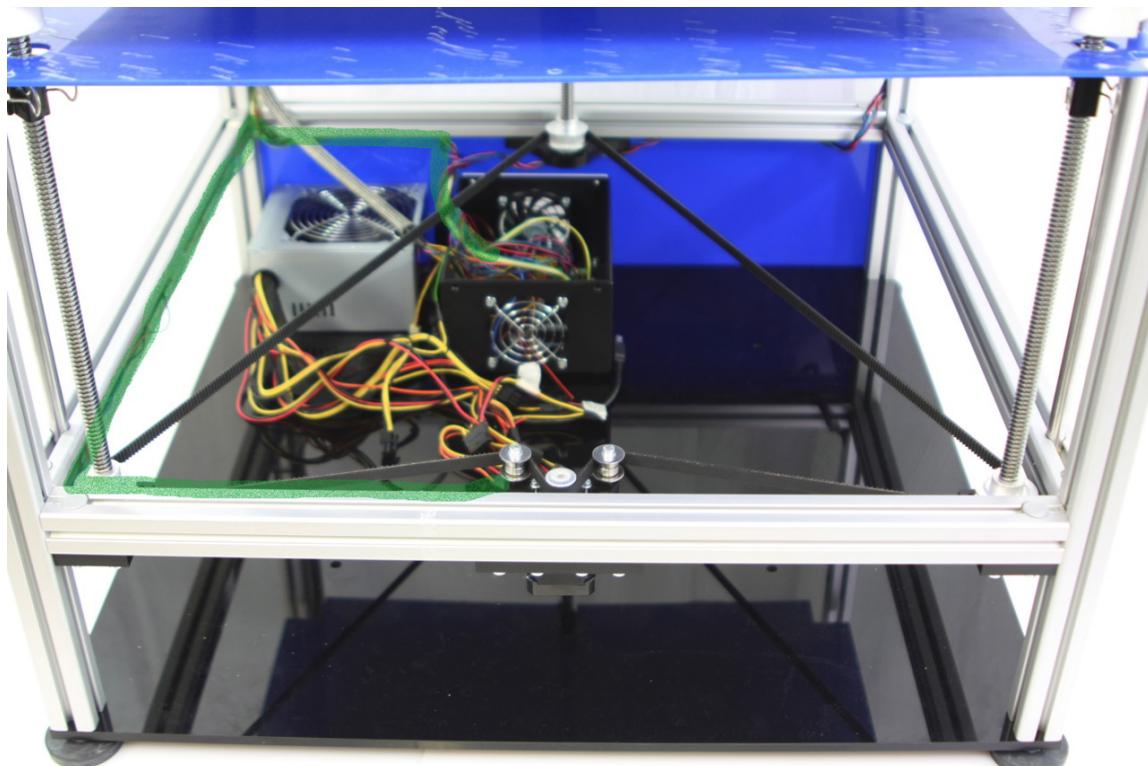


The cable of the Z-axis stepper motor is hidden in the aluminum profiles right to the electronic box, as shown in the image "[Z-axis cable course \[S. 191\]](#)".

The four poles connector is used for this stepper motor.



Abbildung 3.245. Z-axis cable course



### 3.12.6. Connection of the RAMPS

Tabelle 3.74. Parts list connection of the RAMPS

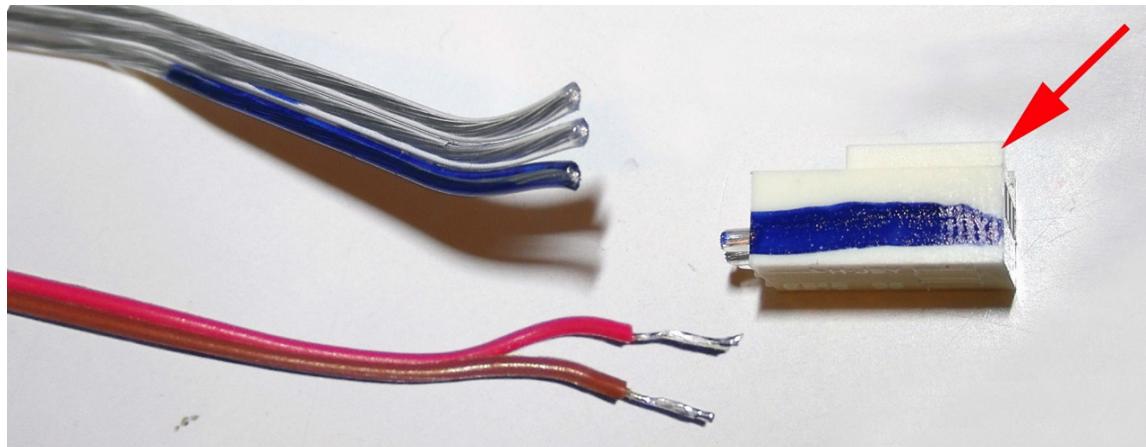
1x Shrink tubing	4x Crimp contact
1x Crimp housing, 4 poles	

The fan cable from the step "[Wiring/ Extruder \[S. 179\]](#)" is connected at the extruder side with the cables of the fan, as the present cable would be too short.

It is recommended to mark the cable before it is cut, as shown in the image "[Extruder fan \[S. 192\]](#)". The marked cable is the earth and has to be connected to the negative terminal. The middle cable is the „+12Volt“ connection and should be connected with a red cable. After that the soldered joints should be insulated with shrink tubing.

The red arrow serves as orientation and points to the two fins at the plug.

Abbildung 3.246. Extruder fan



The image "[Circuit diagram \[S. 193\]](#)" shows how the single components are connected to the RAMPS.

The end stops are cabled according to the note in the right lower corner of the "[Circuit diagram \[S. 193\]](#)".



The order of the contacts of the end stops are different on the RAMPS and the end stops.

Abbildung 3.247. Circuit diagram Single-Extruder

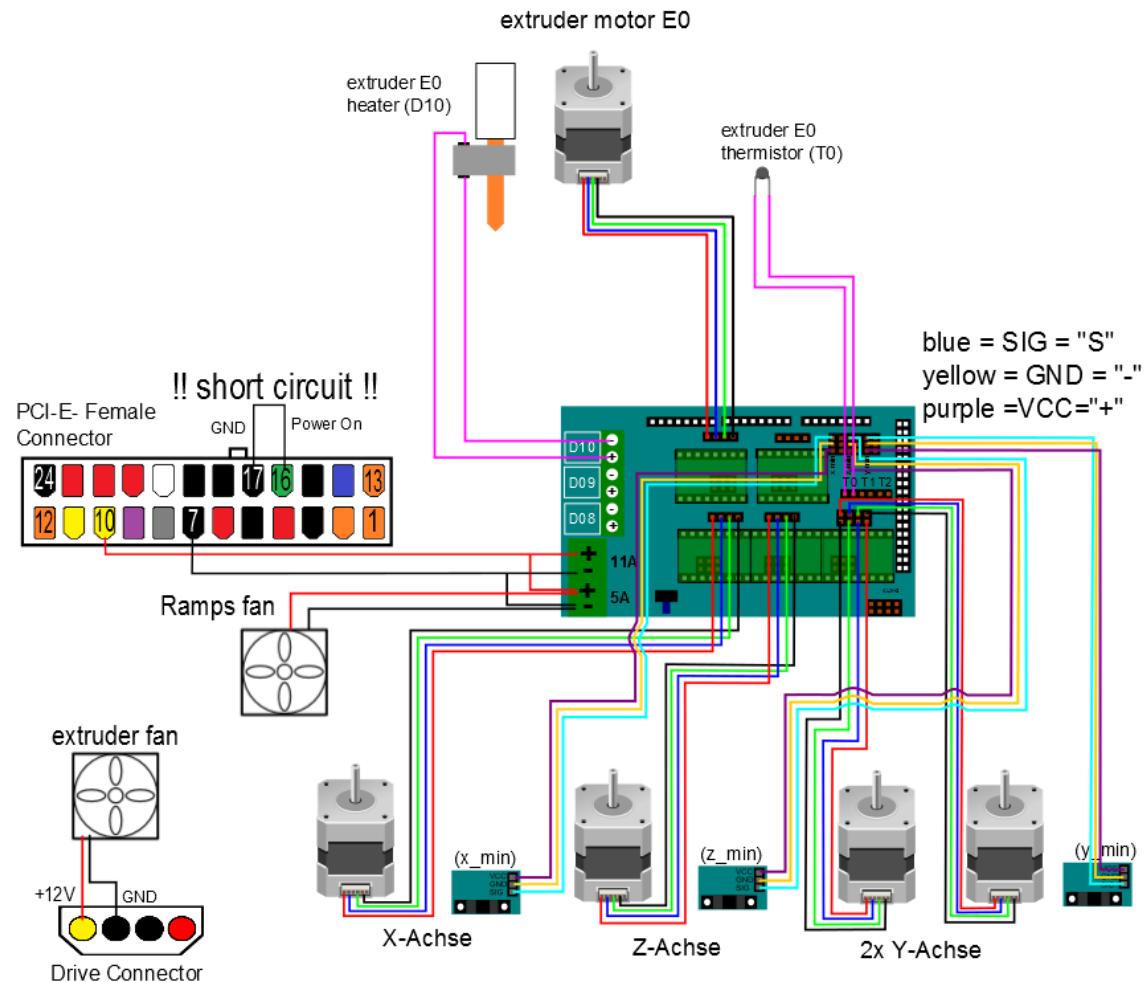
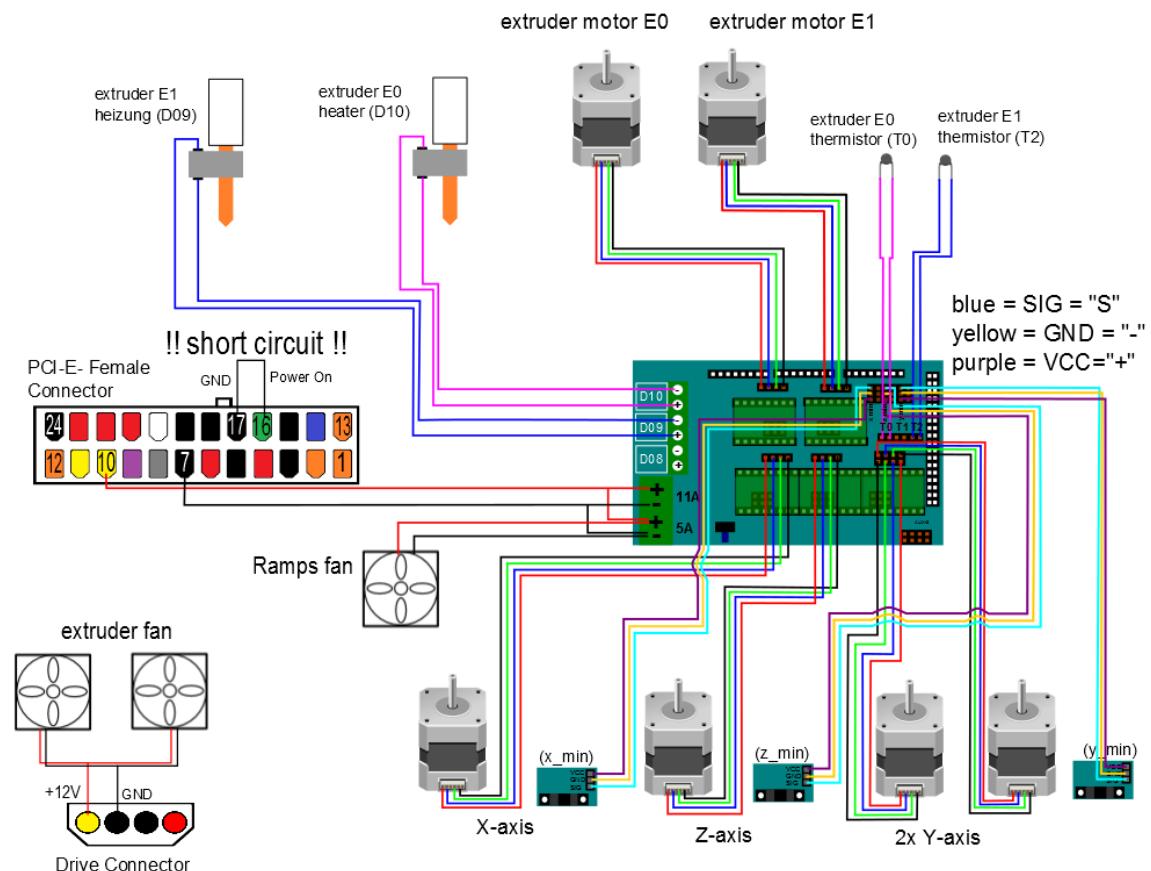


Abbildung 3.248. Circuit diagram Dual-Extruder



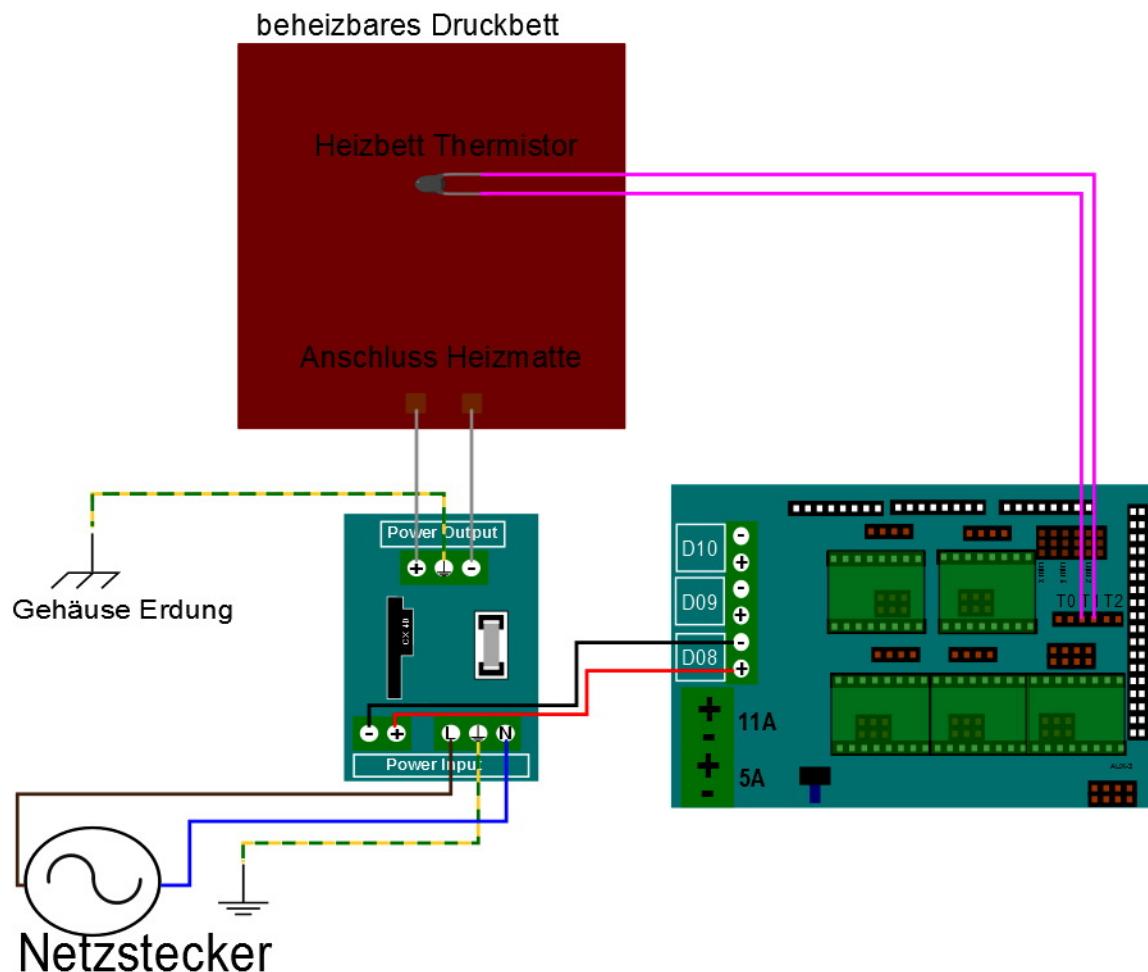
The RAMPS fan and the extruder fan are directly connected to the ATX power supply, in accordance with the "Circuit diagram [S. 193]".

The Y-axis motors are plugged on the two slots which are marked on the board with a "Z". The motor of the Z-axis, however, on the slot "Y". This is already regarded in the firmware of the X400.



It is really important to plug both of the stepper motors in opposite running directions.  
Otherwise the Y-axis could not move as the motors would work against each other.

Abbildung 3.249. Circuit diagram heated bed



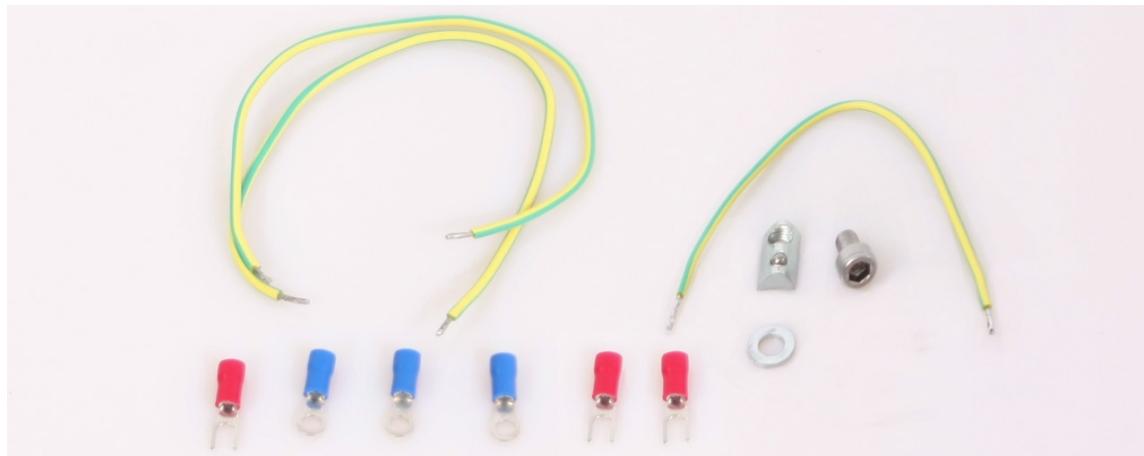
### 3.12.7. Grounding of the housing

Tabelle 3.75. Parts list grounding of the housing

3x 0,2m cable, yellow-green	3x Cable ring shoe, large (M6)
3x Cable ring shoe, medium (M4)	1x M6x10 cylinder head screw
1x M6 washer	1x M6 tooth ring lock washer (not in the image)
2x M4 tooth ring lock washer (not in the image)	



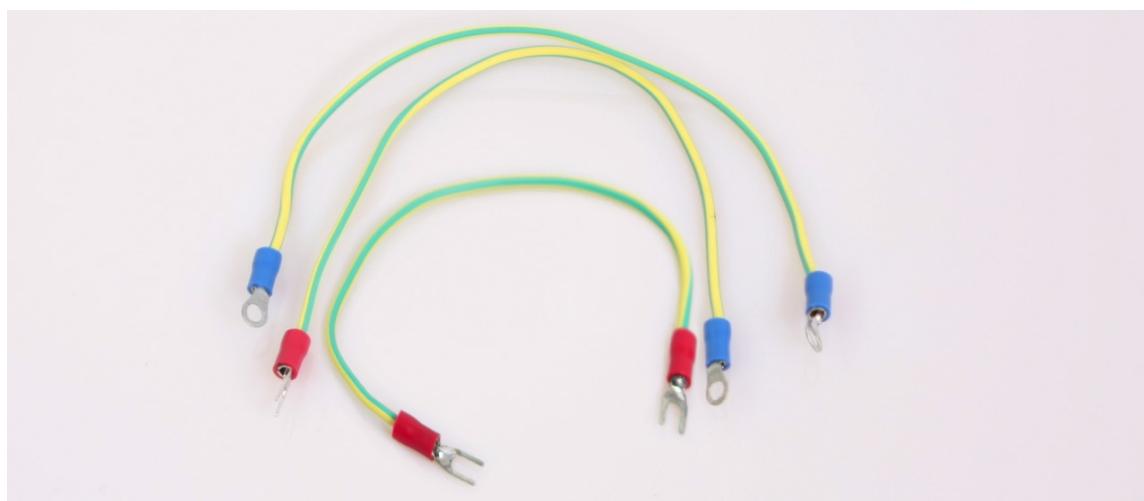
Abbildung 3.250. Grounding of the housing parts overview



It is very important to ground all conductive components of the X400!

The cable ring shoes are crimped or soldered to the three ground cables, as shown in the image "Cable ring shoes".

Abbildung 3.251. Cable ring shoes

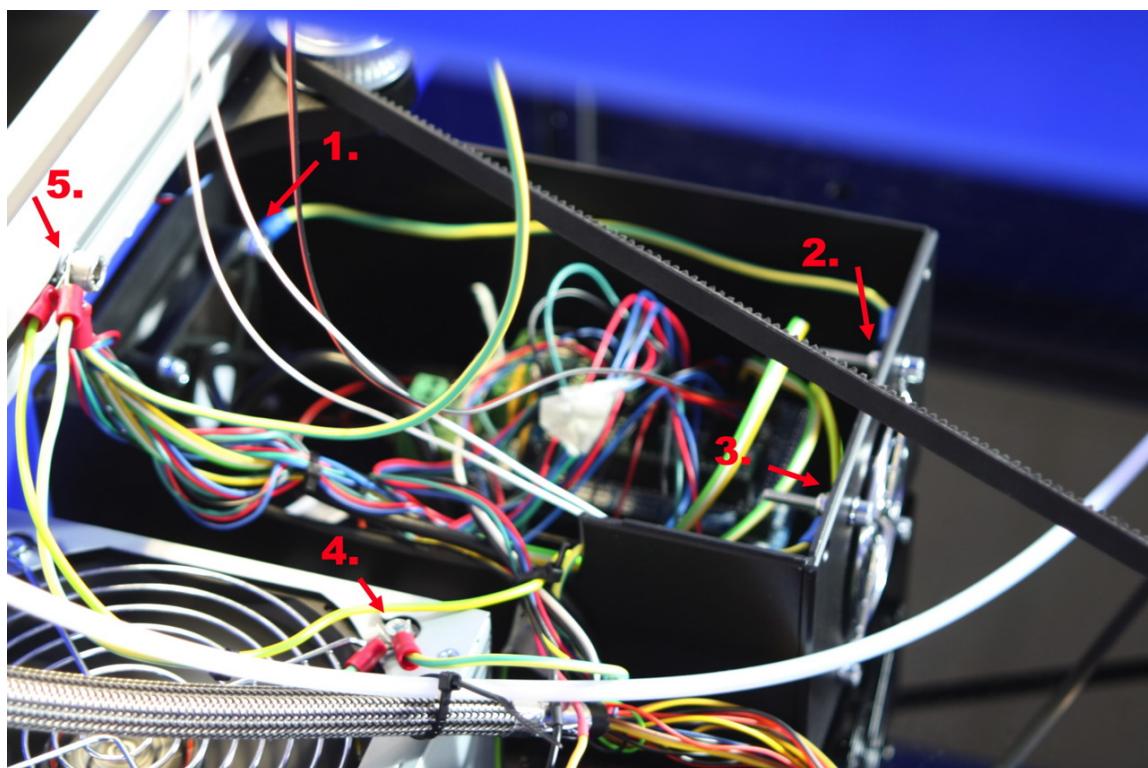


The cable with two cable ring shoes, middle (M4) is pulled between the two fan grilles (1. and 2.) as shown in the image "[Finish \[S. 197\]](#)". Therefore, the nuts have to be removed again (not the washer!), then the tooth lock washer is slid on the cylinder head screw. Afterwards, the cable ring shoe and the whole is screwed together with the nut again.

The cable with a large (M6) and a medium (M4) cable ring shoe is fastened between the fan grille (3.) and the power supply fan grille (4.).

From the power supply fan grille (4.), the last cable with two large (M6) cable ring shoes is screwed to the aluminum profile (5.) with the T slot nut and the tooth lock washer.

Abbildung 3.252. Finish grounding of the housing



### 3.12.8. Lid of the electronic box

Tabelle 3.76. Lid of the electronic box parts list ([from the assembly parts electronics](#))

1x Electronic box, lid [S. 32]	4x M3x14 countersunk screw
--------------------------------	----------------------------

Abbildung 3.253. Lid of the electronic box parts overview

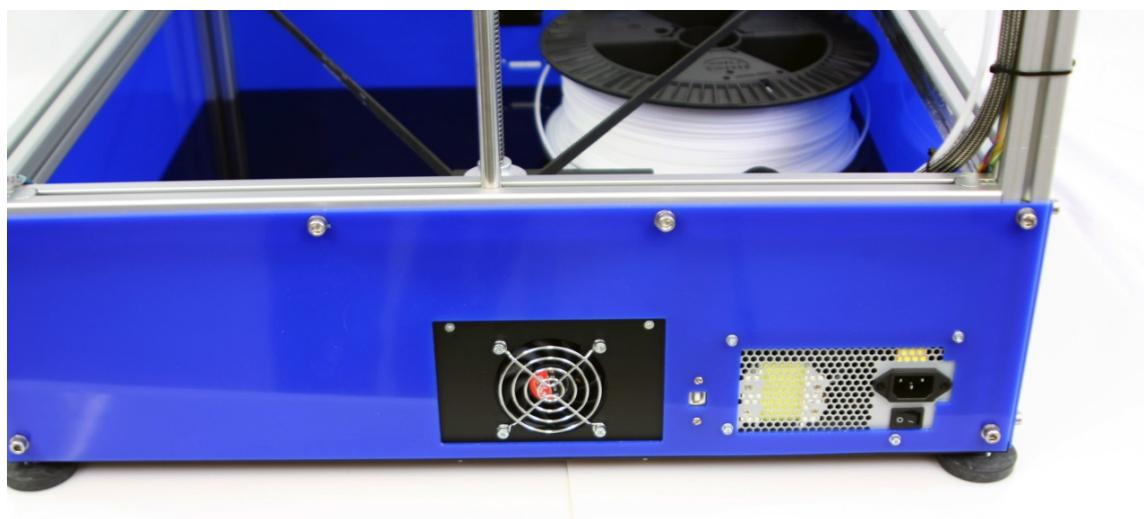


In case a heated bed is applied, the lid should only be mounted after finishing all of the cabling.

With the help of the four countersunk screws, the lid is screwed to the electronic box.

The delivered aluminum adhesive tape may be used to cover the cables that proceed in the aluminum profiles.

Abbildung 3.254. Finish lid of the electronic box





### 3.12.9. Finish Wiring

Tabelle 3.77. Parts list Finish Wiring

1x aluminum tape
------------------

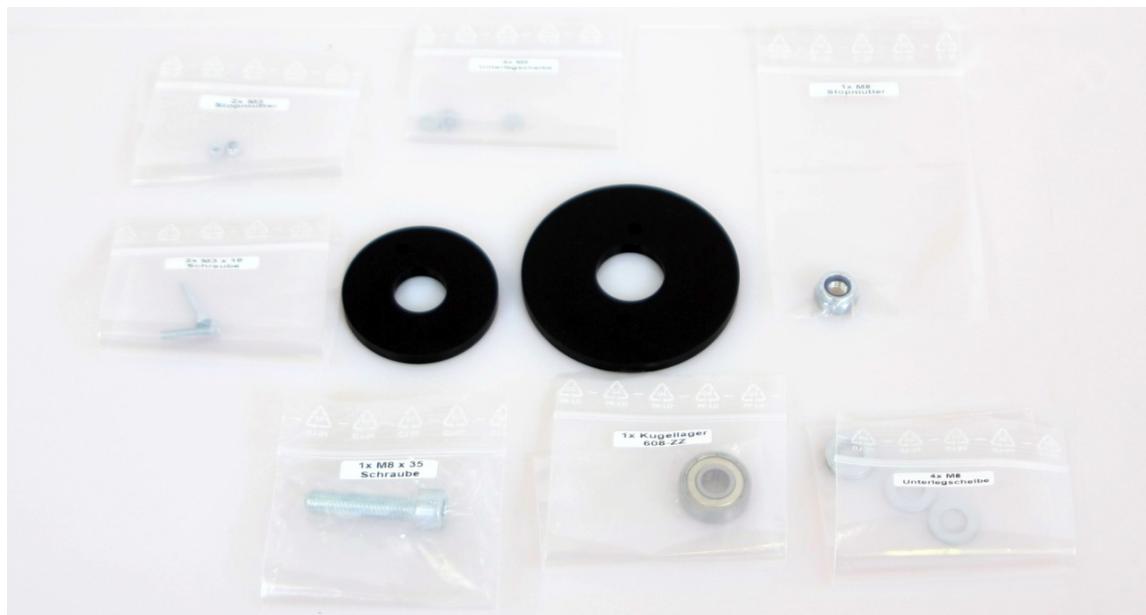
Abbildung 3.255. Finish Wiring parts overview



In the final stages of the wiring the aluminum tape is used to hide the cables inside of the aluminum profiles. Therefor the aluminum tape is stucked on the requested locations. Furthermore the tape has protective effect.

### 3.13. Spools stand

Abbildung 3.256. Assembly parts spools stand



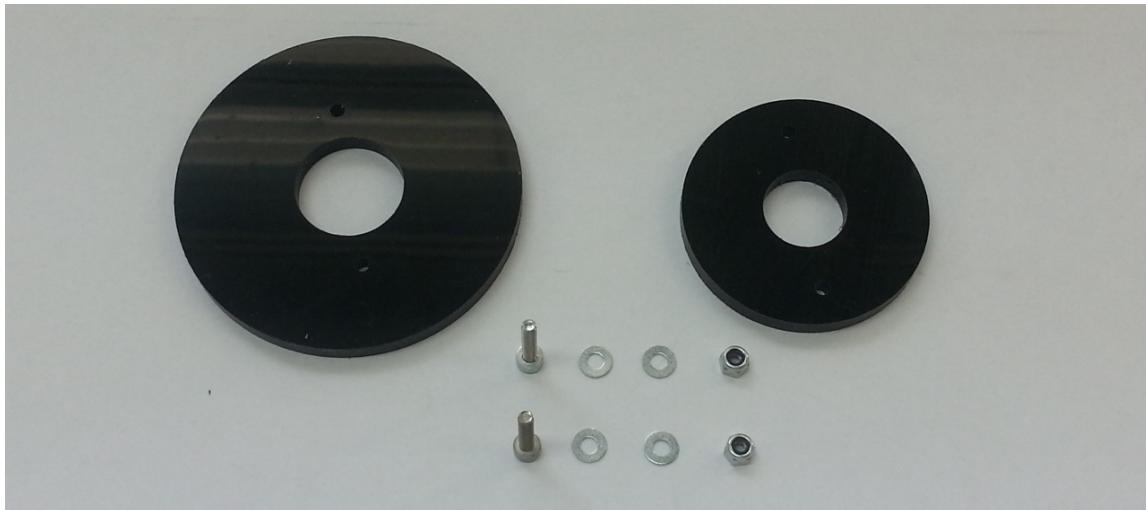
#### 3.13.1. Inclusion

Tabelle 3.78. Parts list inclusion

1x POM spools stand, large [S. 40]	1x POM spools stand, small [S. 41]
2x M3x16 cylinder head screws	2x M3 self-locking nut
4x M3 washer	



Abbildung 3.257. Inclusion parts overview



Both of the rings are screwed together, whereas the cylinder head screws have to be at the side of the larger ring.

Abbildung 3.258. Finish inclusion



### 3.13.2. Bearing

Tabelle 3.79. Parts list bearing

1x POM spools stand, pre-assembled [S. 200]	1x Ball bearing 608-ZZ
1x M8x35 cylinder head screws	4x M8 washer
1x M8 self-locking nut	1x M8 felt washer

Tabelle 3.80. additional parts for the Dual-Extruder

1x POM Spulenhalter, vormonitert [S. 200]	1x Ball bearing 608-ZZ
1x M8x35 cylinder head screws	4x M8 washer
1x M8 self-locking nut	

Das additional parts for the Dual-Extruder ist in den Bilder mit einem blauem Rechteck markiert.

Abbildung 3.259. Bearing parts overview



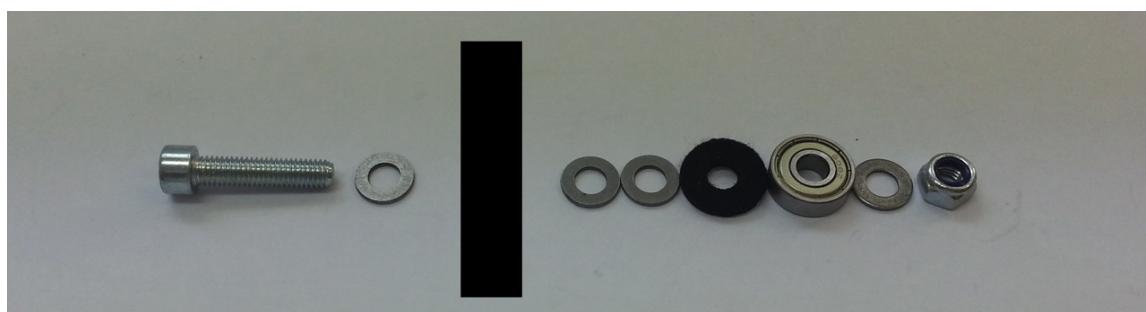
Die Lagerung des Spulenhalters wird, wie im Bild "Details Verschraubung [S. 202]" gezeigt, montiert und die Aufnahme von oben auf das Lager gelegt.

An Stelle des schwarzen Balken wird die Bodenplatte montiert.



Der Spulenhalter ist unter Umständen sehr leichtgängig. Abhilfe schafft eine zwischengelegte Filzscheibe (siehe Bild).

Abbildung 3.260. Details screw connection



The image "Finish [S. 203]" indicates the different positions on which the spools stands may be mounted.

Position 1 is occupied by the delivered spools stand. Positions 2. and 3. may be assembled with optional spools stands, although on position 3. is only space for a small one.

Abbildung 3.261. Details positions

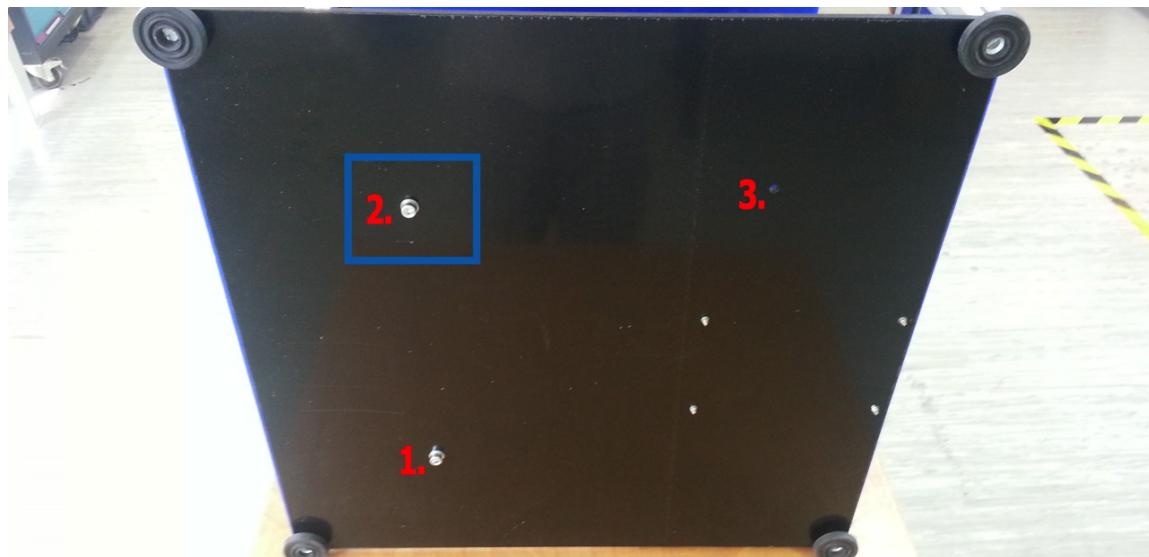
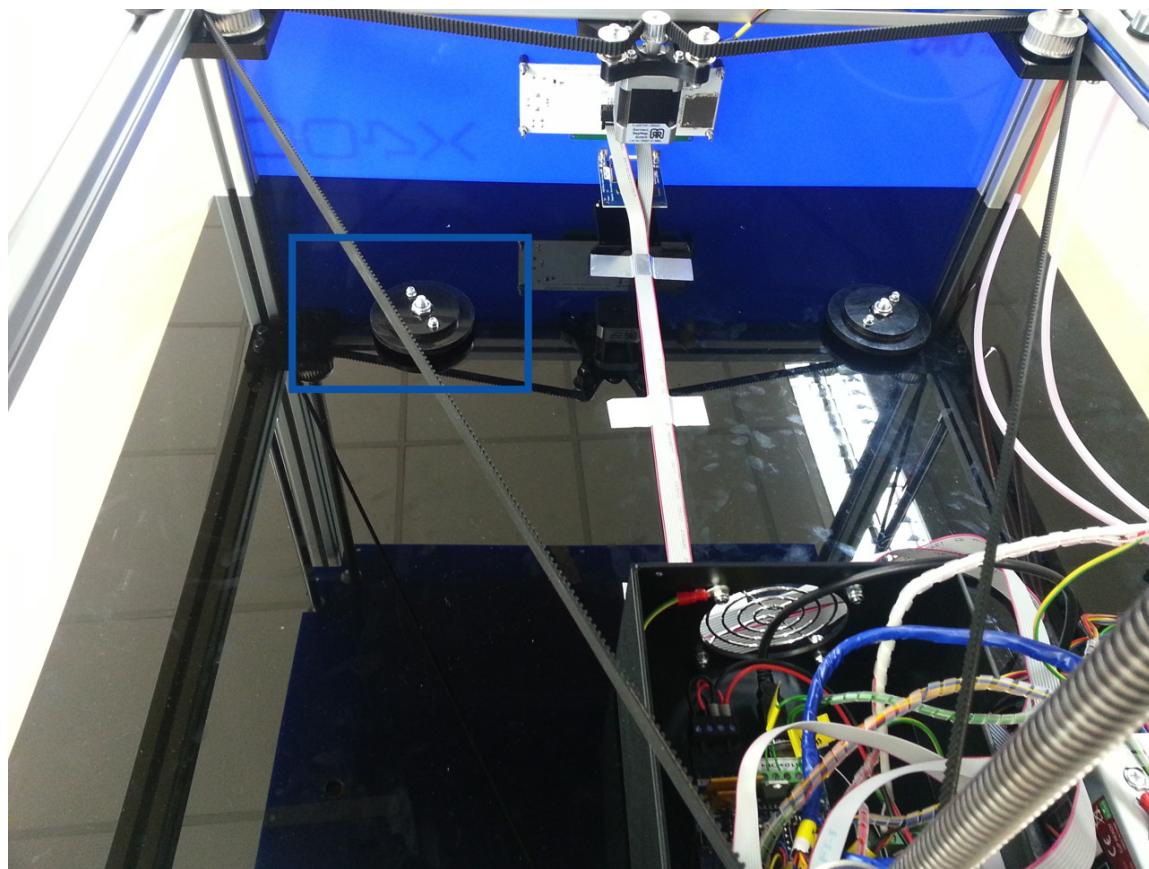


Abbildung 3.262. Finish bearing





## 3.14. Case

### 3.14.1. Lid of the electronic box

Tabelle 3.81. Lid of the electronic box Parts list

1x Electronic box, lid [S. 32]	4x M3x14 countersunk screw
--------------------------------	----------------------------

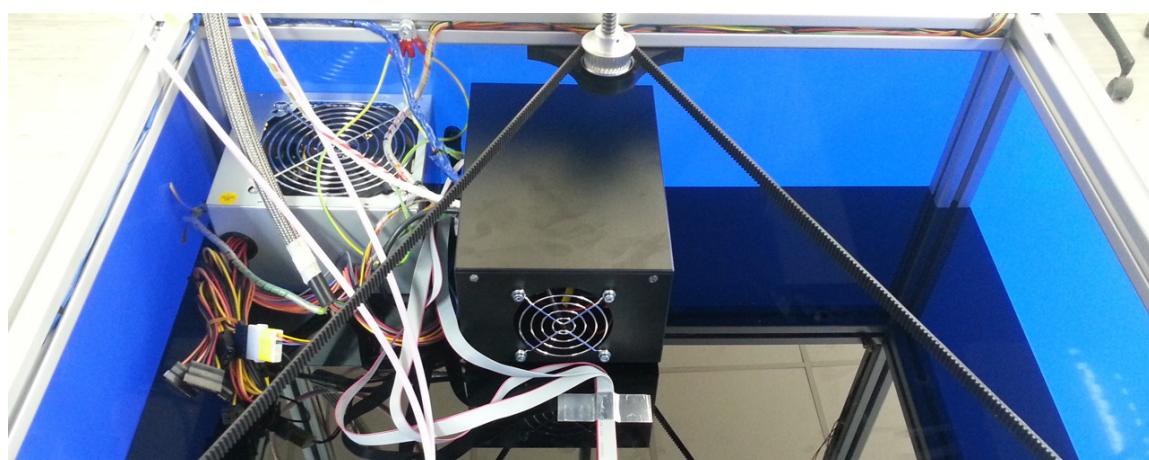
Abbildung 3.263. Lid of the electronic box parts overview



Um den X400 noch einzustellen empfiehlt es sich diesen Schritt erst nach Finish der Einstellarbeiten durchzuführen.

Der Deckel wird mit den vier Senkkopfschrauben an der Elektronikbox verschraubt.

Abbildung 3.264. Finish lid of the electronic box





### 3.14.2. Kabelabdeckung

Tabelle 3.82. Finish Verkablung Parts list

1x aluminum tape
------------------

Abbildung 3.265. Finish Verkablung parts overview



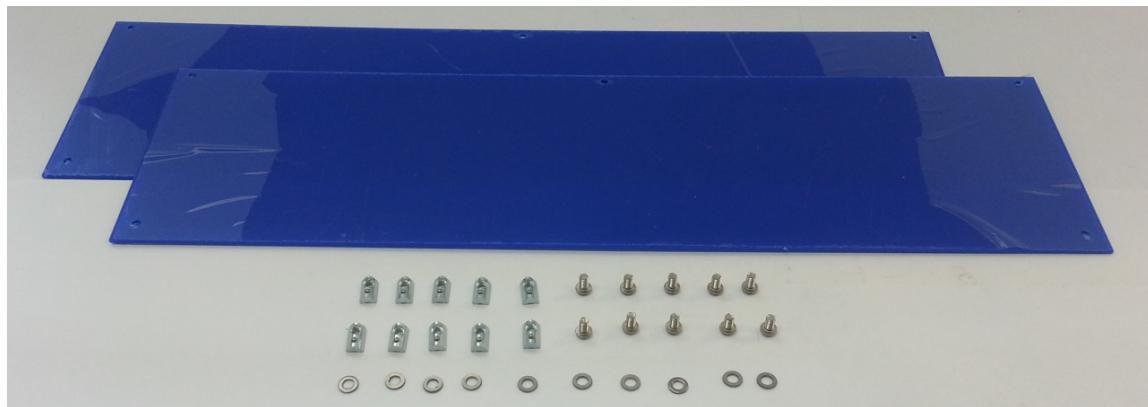
Am Ende der Verkabelung wird das Aluminium Klebeband dazu genutzt, die Kabel in den Profilen zu verstecken.  
The delivered aluminum adhesive tape may be used to cover the cables that proceed in the aluminum profiles.

### 3.14.3. Side parts

Tabelle 3.83. Parts list Side parts

2x Acrylic glass, side parts	10x M6x10 Round head screw, stainless steel
10x M6 washer, stainless steel	10x M6 T slot nut

Abbildung 3.266. Side parts overview

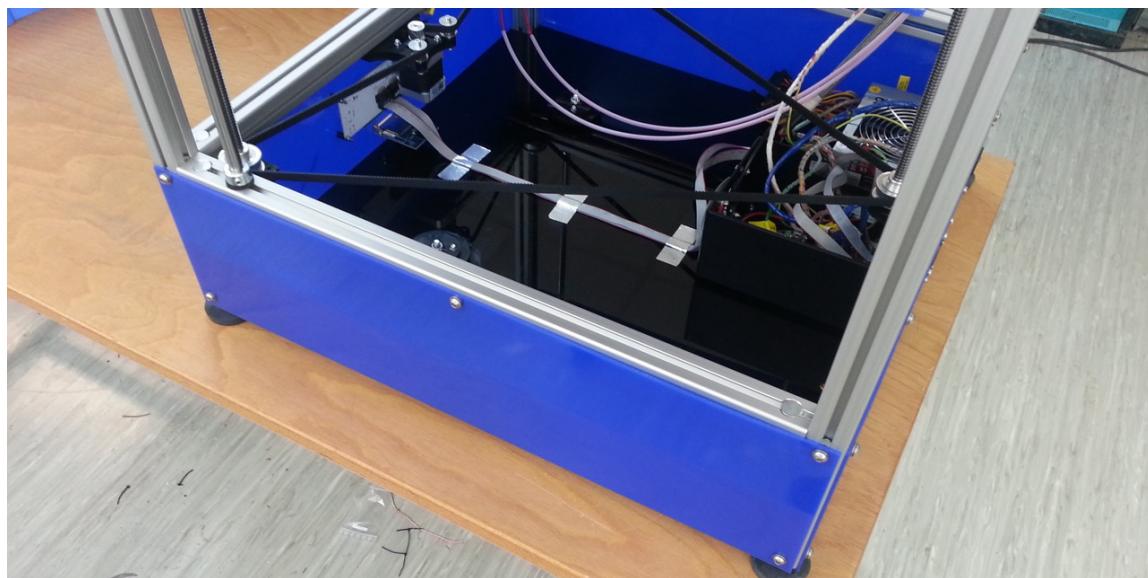


Die beiden Acrylglass-Platten werden an die Seiten des X400 montiert.



A filament spool, however, should be inserted beforehand. Be careful that the filament does not unroll unintentionally.

Abbildung 3.267. Finish side parts



### 3.14.4. Distance plate

Tabelle 3.84. Parts list distance plate

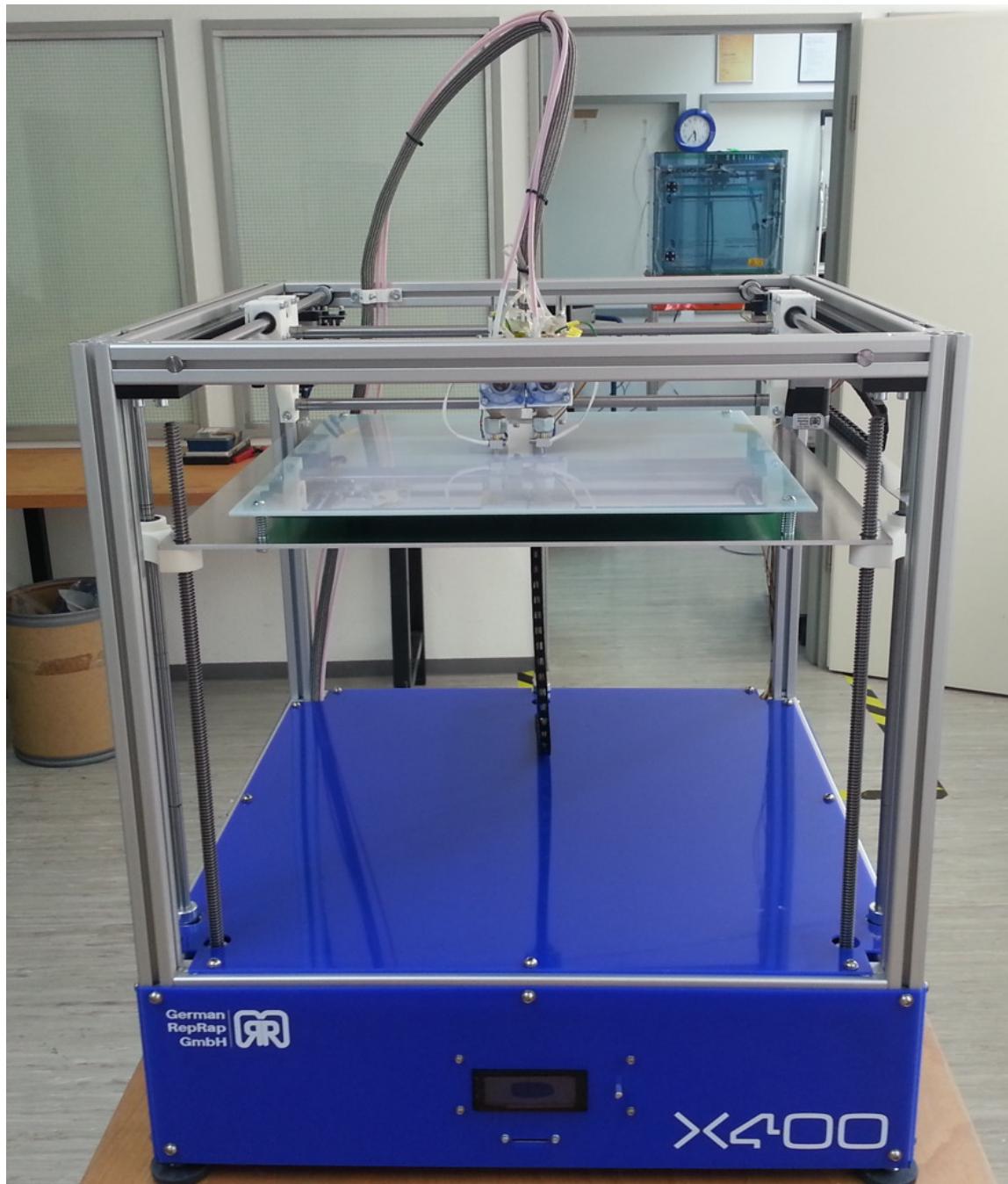
11x M6x10 cylinder head screws, stainless steel	11x M6 washer, stainless steel
11x M6 T slot nut	

Abbildung 3.268. Distance plate parts overview



The assembly of the X400 is finished with the fastening of the distance plate.

Abbildung 3.269. Finish distance plate



### 3.14.5. Finish des Rahmens



Dieser Schritt erfolgt nur, wenn der X400 *nicht* mit einem Acrylgehäuse montiert wird!



Tabelle 3.85. Parts list Finish des Rahmens

4x Abdeckkappen
-----------------

Abbildung 3.270. Finish des Rahmens parts overview



Zum Finish des Aufbau des X400 wird die Oberseite der vertikalen Profile mit Abdeckkappen versehen.

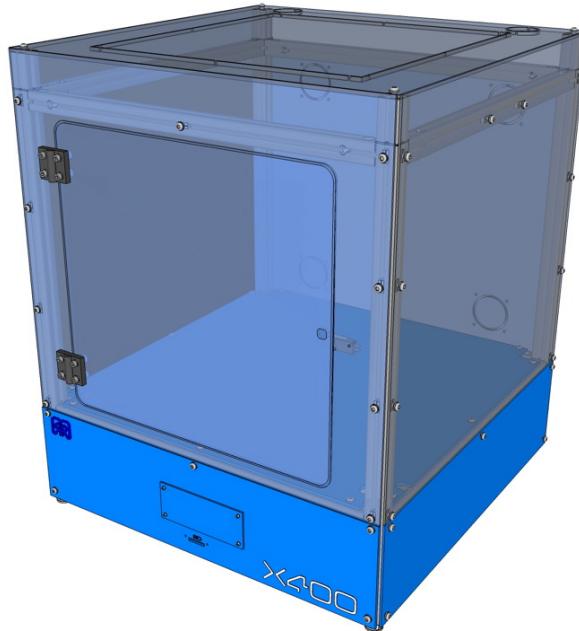
### 3.15. Acrylic Case

Tabelle 3.86. Parts list acrylic housing

1x acrylic panel, front	2x acrylic panel, sides
1x acrylic panel back	1x acrylic panel door
1x acrylic panel top	1 x switch
1x lock	4 x M6 threaded bolt
4x aluminum profiles, short	59 x M6 nut bolt
63x M6 bolt	71 x M6 washer
8x M6 stop nut	8 x M6 countersunk philips head screw
2x M3 stop nut	2 x M3 bolt
4x M3 washer	2x hinge, removable

The housing is made from 5% blue tinged acrylic and prevents draft air into the X400. It also avoids injuries from the moving parts of the printer. The housing also provides a more stable temperature of the printing area resulting in better prints. Optional fans can be installed in the back if the inside gets too hot.

Abbildung 3.271. The housing



Assembly of the housing is rather simple. Please refer to the drawings for details.

Abbildung 3.272. Assembly acrylic plate

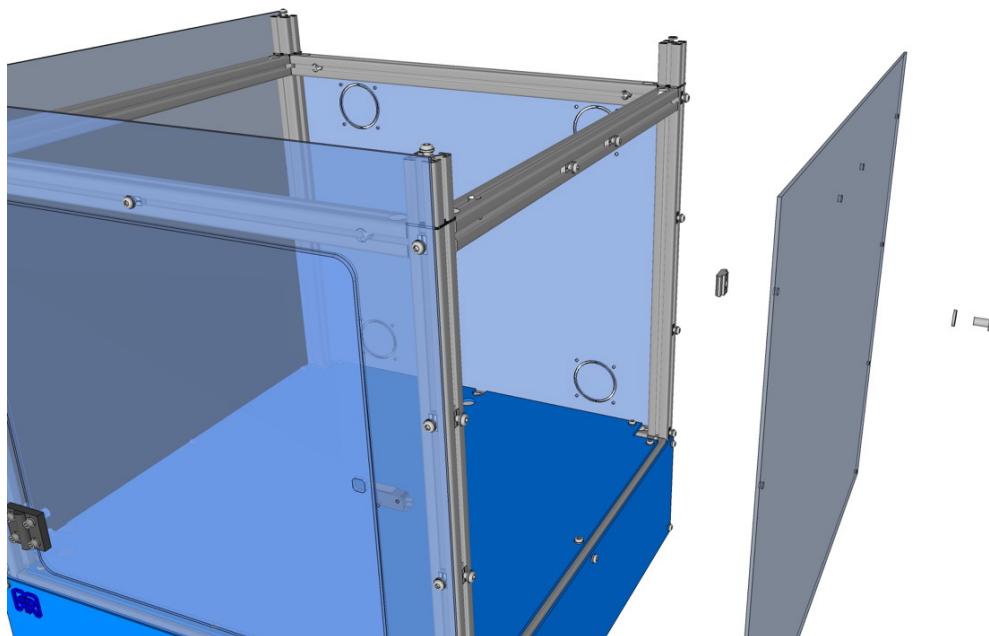
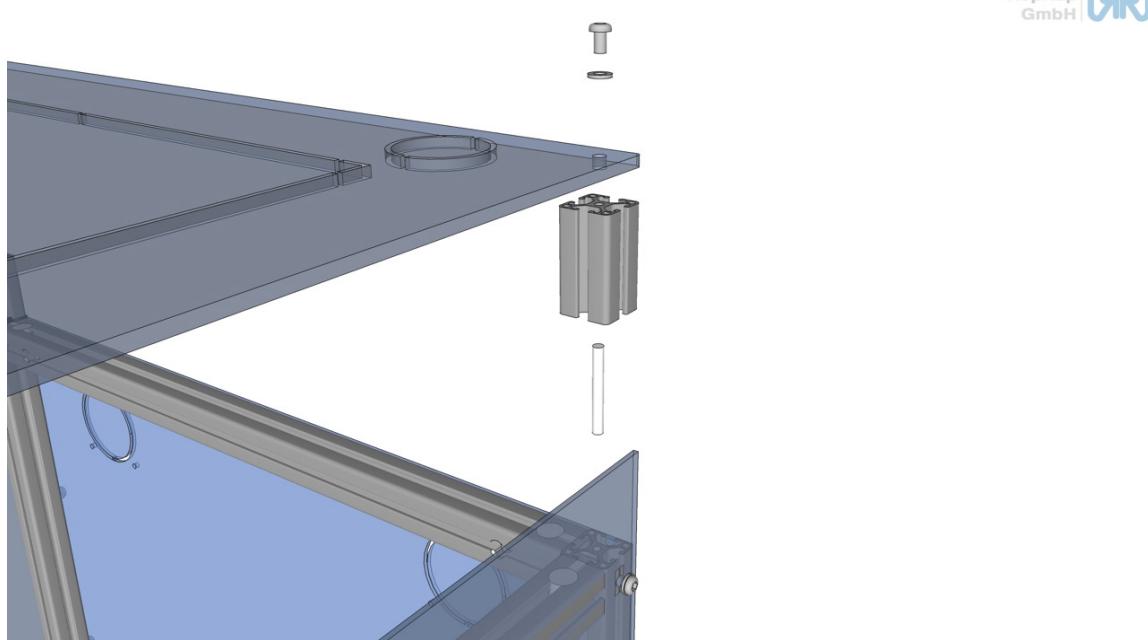


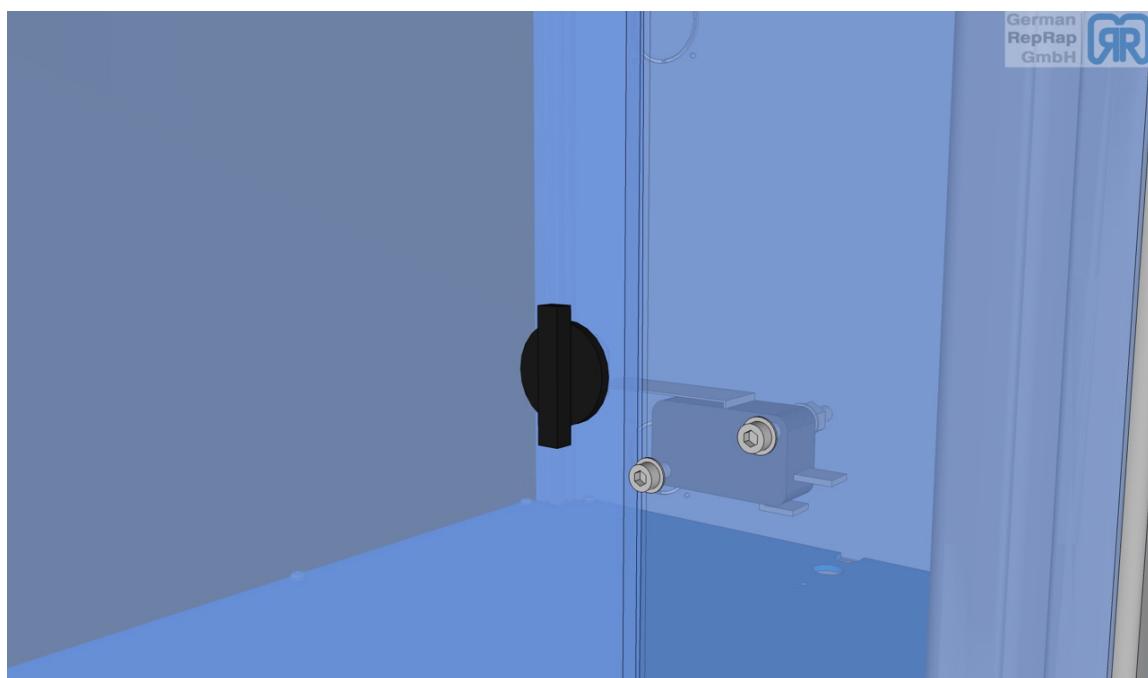
Abbildung 3.273. Assembly cover with stand-offs



The safety switch can be connected to the green pin of the ATX connector (pin 16, power on) using the cables provided. This turns off the power supply whenever the door is opened.

The latch of the lock is installed so that it depresses the safety switch whenever the door is locked.

Abbildung 3.274. Door lock and safety switch

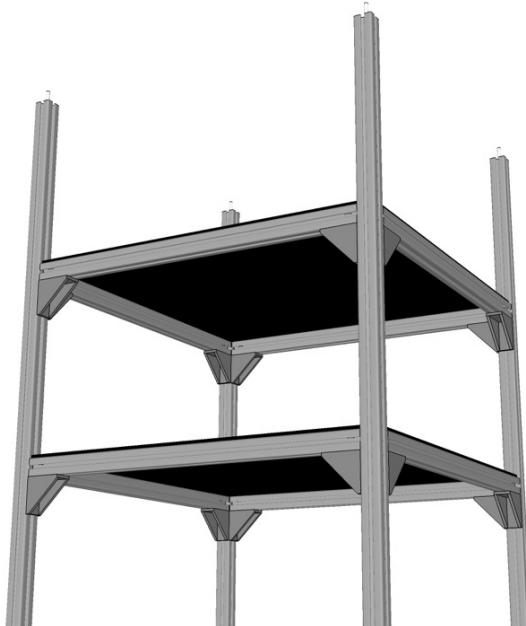


### 3.16. Base cabinet

Tabelle 3.87. Parts list base cabinet

2x acrylic glass, shelf	4x 1000 mm profile
4x M6 threaded bolt	16x mounting angle
80 x M6 T slot nut	64 x M6 x 12 cylinder head screw
16 x profile connector	8x M6x22 cylinder head screw

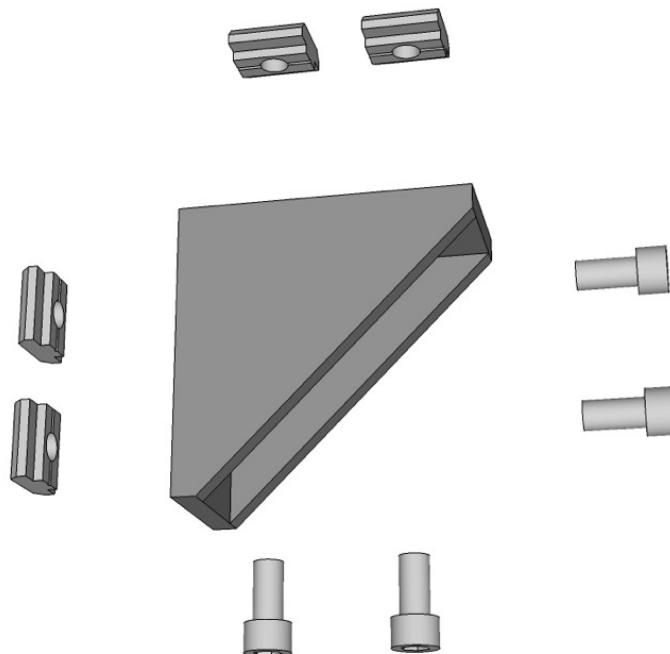
Abbildung 3.275. Base cabinet view



The base cabinet is mounted similar to the frame.

The base cabinet is intended to be screwed together with the device. First, the long profiles are screwed and aligned to the lower part of the frame with the threaded bolts. After that, the struts and angles are mounted.

Abbildung 3.276. Base cabinet angle mounting



A simplified mounting is possible by drilling out the upper threads in the long profiles to 7mm, to make the threaded bolts pluggable. In that case, the base cabinet may be mounted separately and the device can simply be put on top afterwards.



# Kapitel 4. Commissioning

A computer is necessary for the operation of the X400. The software is available for the operating systems Microsoft Windows, Apple Mac OS and Linux.

Please choose the manual according to the system you will operate your X400 from.

## 4.1. Commissioning Mac OS X

### 4.1.1. Firmware (OS X)

To achieve an efficient communication between the Ramps and the Arduino, the right firmware has to be installed on the Arduino board.

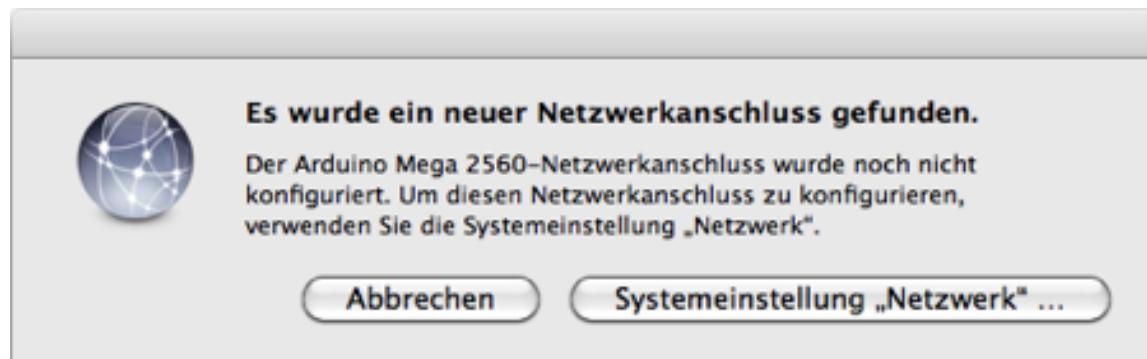
Tabelle 4.1. Overview of the necessary programs firmware (OS X)

Arduino Version 1.0.x <sup>1</sup>
X400 Firmware <sup>2</sup>

There is a firmware for the X400, adapted by German RepRap GmbH. To be able to install this firmware on the Arduino board, the Arduino software version 1.0.x has to be loaded at first. It is important to choose version 1.0.x.

After connecting the board via USB, a note appears that a new network connection was found. This can be clicked away with cancel.

Abbildung 4.1. Detecting the Arduino board



Afterwards, the program Arduino can be started from the unpacked archive. The „Arduino Mega 2560“ is selected in the menu item *Tools* → *Board* and the port „/dev/tty.usbmodemxxx“ is selected in the menu item *Tools* → *Serial Port* for the usage of the USB port (image "Selection board and port [S. 215]").

Abbildung 4.2. Unpacking the Arduino software

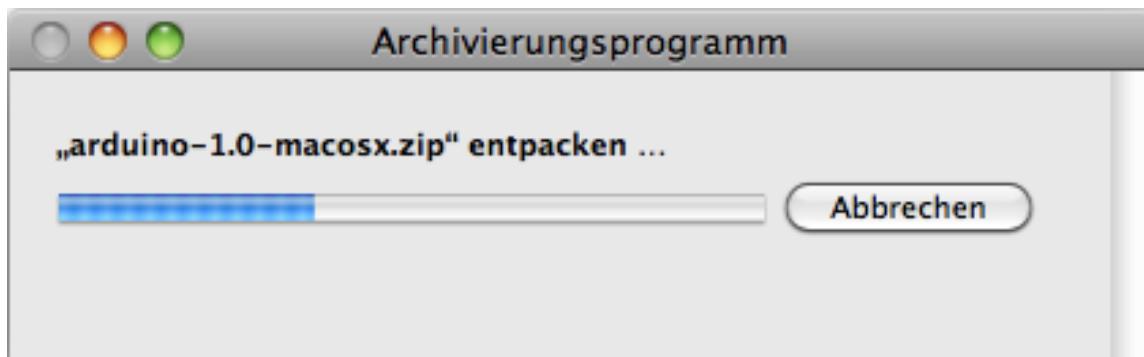
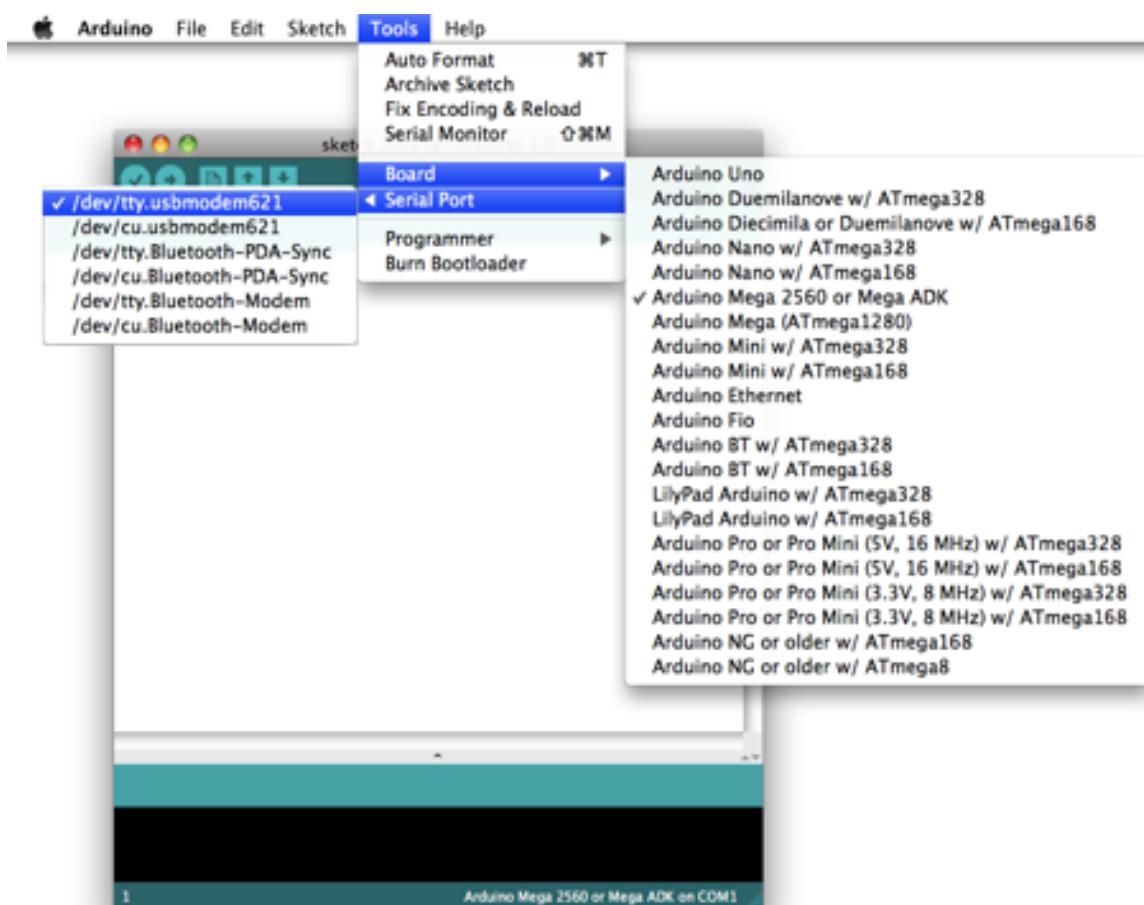


Abbildung 4.3. Selection board and port



To install the X400 firmware, the right and latest version has to be downloaded. After that, the *Open-Button* is pressed in the Arduino program and the *P Rotos.ino* is selected in the firmware folder via *Open...* (Image: "[Opening the firmware \[S. 217\]](#)"). This automatically loads all header and source files in the folder *P Rotos* (.h and .cpp).



In the *configuration.h* file, the firmware is adjusted to the individual needs.

```
//// The following define selects which electronics board you have. Please choose the one that
matches your setup
// PRotos RAMPS 1.2 = 3// PRotos RAMPS 1.3/1.4 = 33 one Extruder (Power outputs: Extruder, Bed, Fan)
// PRotos X400 RAMPS 1.3/1.4 = 35 one Extruder (Power outputs: Extruder, Bed, Fan)

#define MOTHERBOARD 33

//// The following is your used extruder type
// Hinged/Wade Exruder = 1
// DD-Extruder = 2
// DD-Extruder dual = 3

#define EXTRUDER 3

// LCD and SD support

#define ULTRA_LCD -//general lcd support, also 16x2
#define SDSUPPORT -// Enable SD Card Support in Hardware Console
```

Abbildung 4.4. Opening the firmware

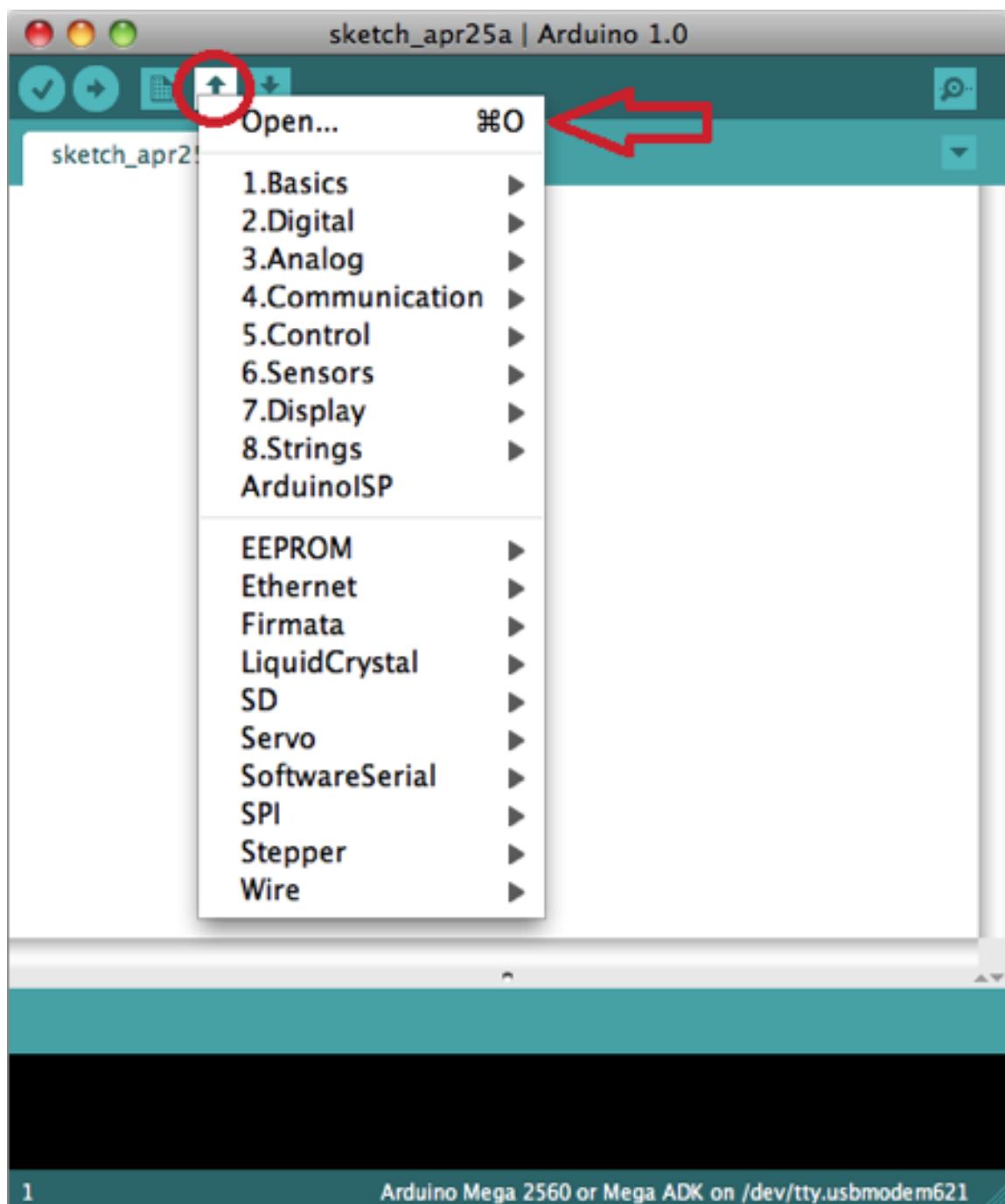
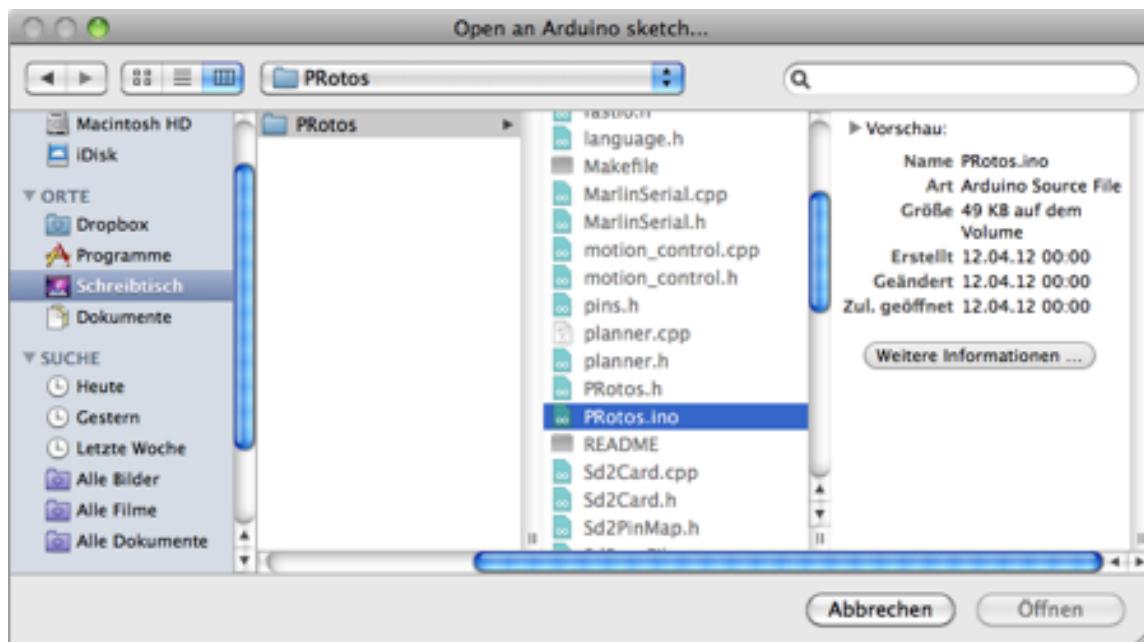
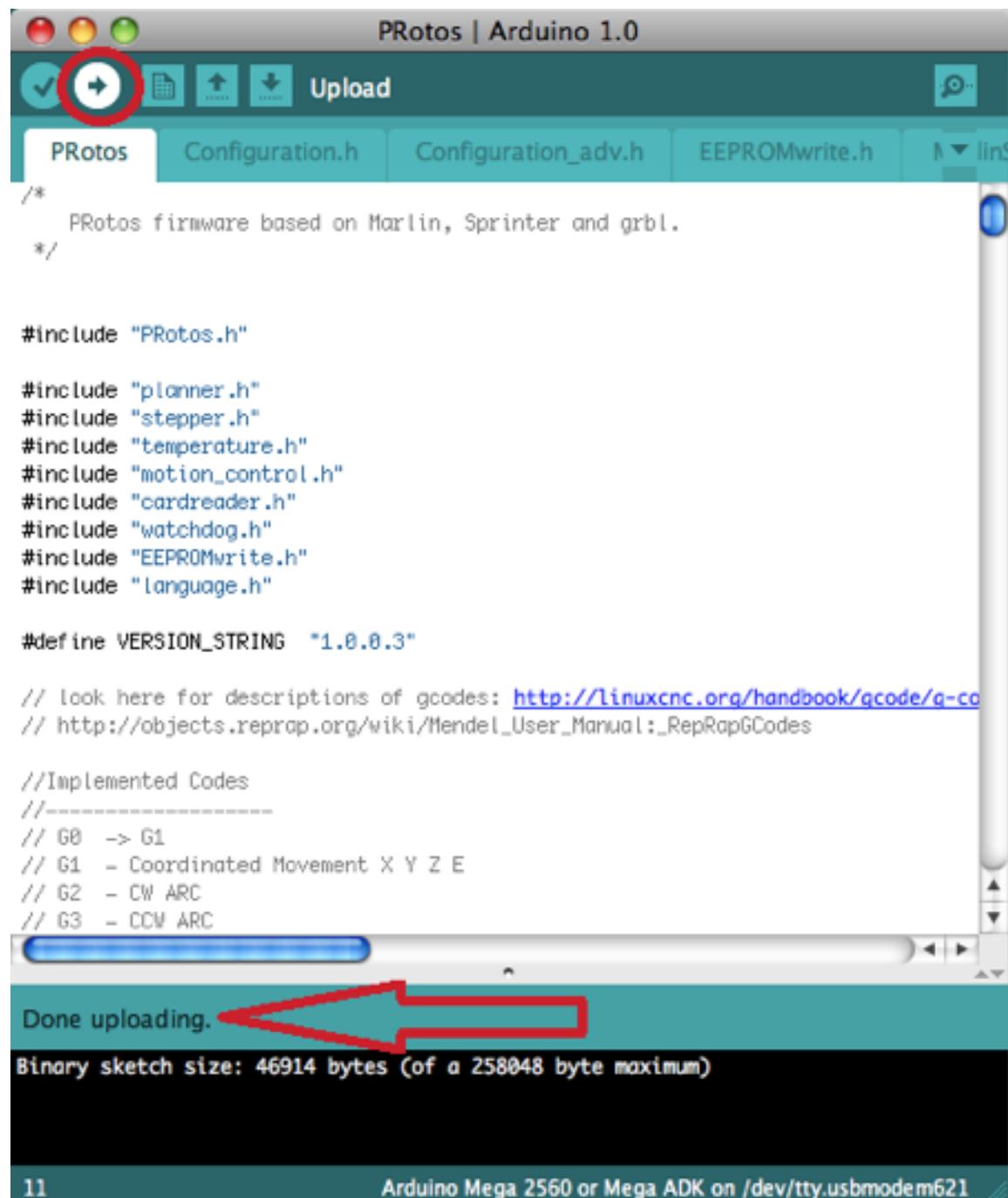


Abbildung 4.5. Selection PRotos.ino



Now a new window opens, in which the source code of the firmware appears (image: "Upload [S. 219]"). To transfer the firmware, the *Upload-Button* may now be selected below the menu bar.

Abbildung 4.6. Upload



The status LEDs are flashing during the uploading process . After the upload, it is displayed beneath the source code that the upload is completed.

To test the firmware (image "Serial monitor [S. 220]"), the serial monitor is selected below the menu bar *Tools* → *Serial Monitor*. To make sure the Arduino software is able to communicate with the Arduino board,

the protocol "Newline", as well as the baud rate "115200" has to be selected. The feedback of the X400 is only displayed correctly if the selected protocol and baud rate are correct. (image: "[Selection protocol and baud rate \[S. 221\]](#)"). The firmware of the board can be queried by entering the code *M115*, it should match the one in the image "[Arduino firmware test \[S. 222\]](#)". The complete command list by means of *GCode* may be looked up in the Internet.

Abbildung 4.7. Serial monitor

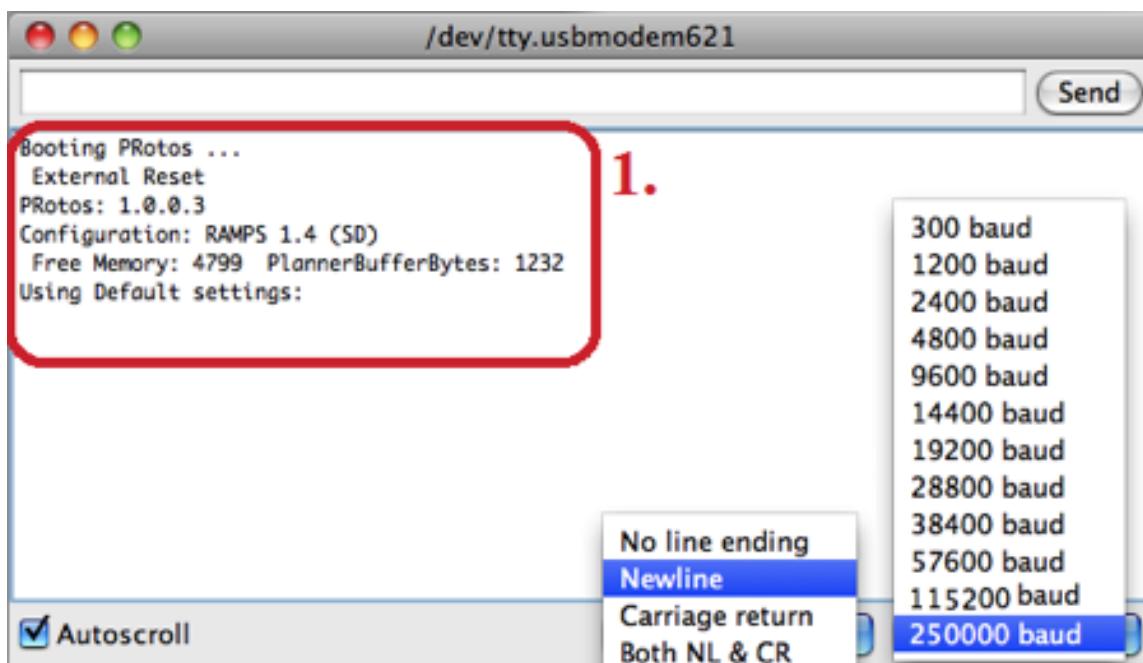


Abbildung 4.8. Selection protocol and baud rate

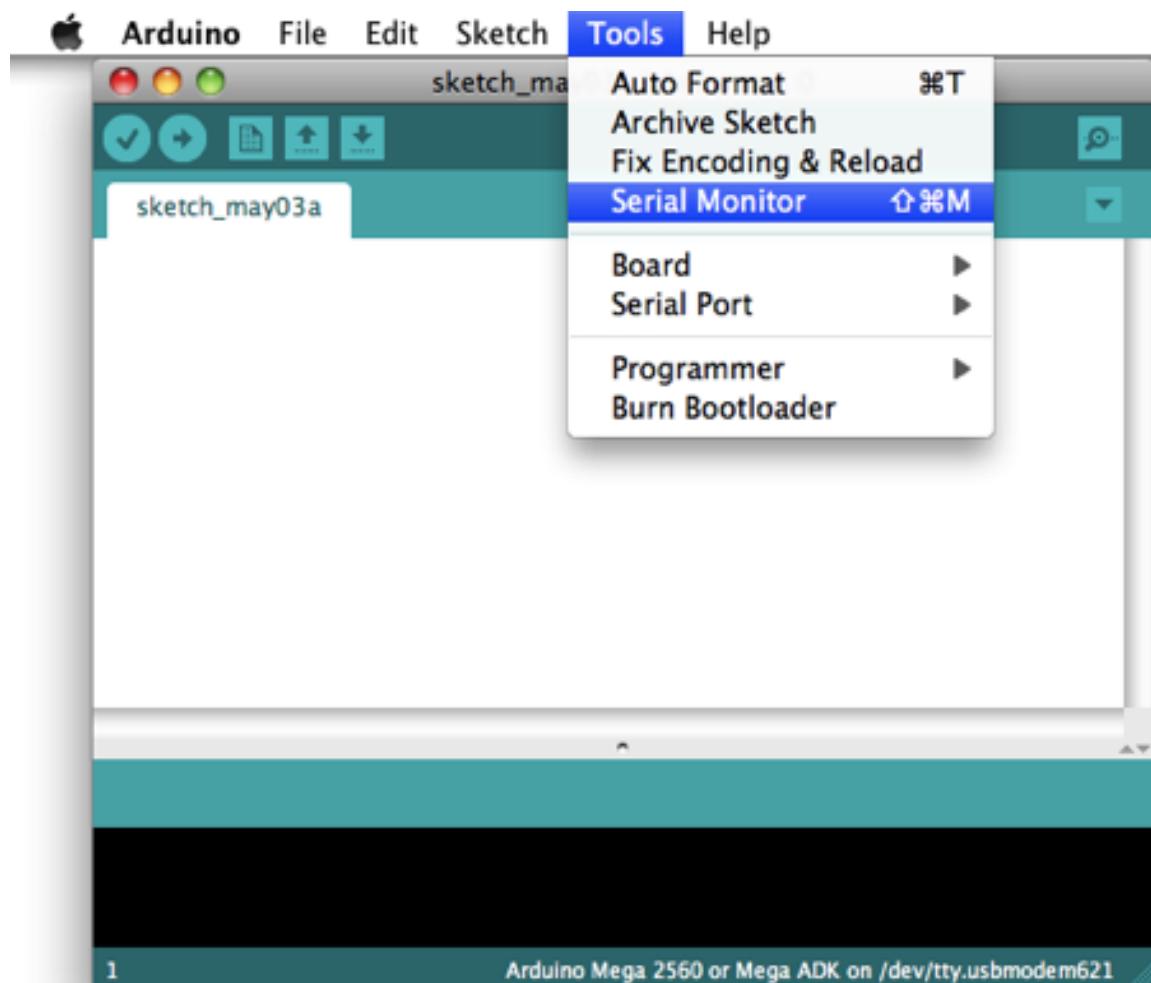


Abbildung 4.9. Arduino firmware test

The screenshot shows a terminal window with the title bar '/dev/tty.usbmodem621'. The window contains the following text output:

```
M115
Booting PRotos ...
External Reset
PRotos: 1.0.0.3
Configuration: RAMPS 1.4 (SD)
Free Memory: 4799 PlannerBufferBytes: 1232
Using Default settings:
FIRMWARE:PRotos V1; Marlin/Sprinter/grbl mashup PROTOCOL_VERSION:1.0 MACHINE_TYPE:PRotos
ok
```

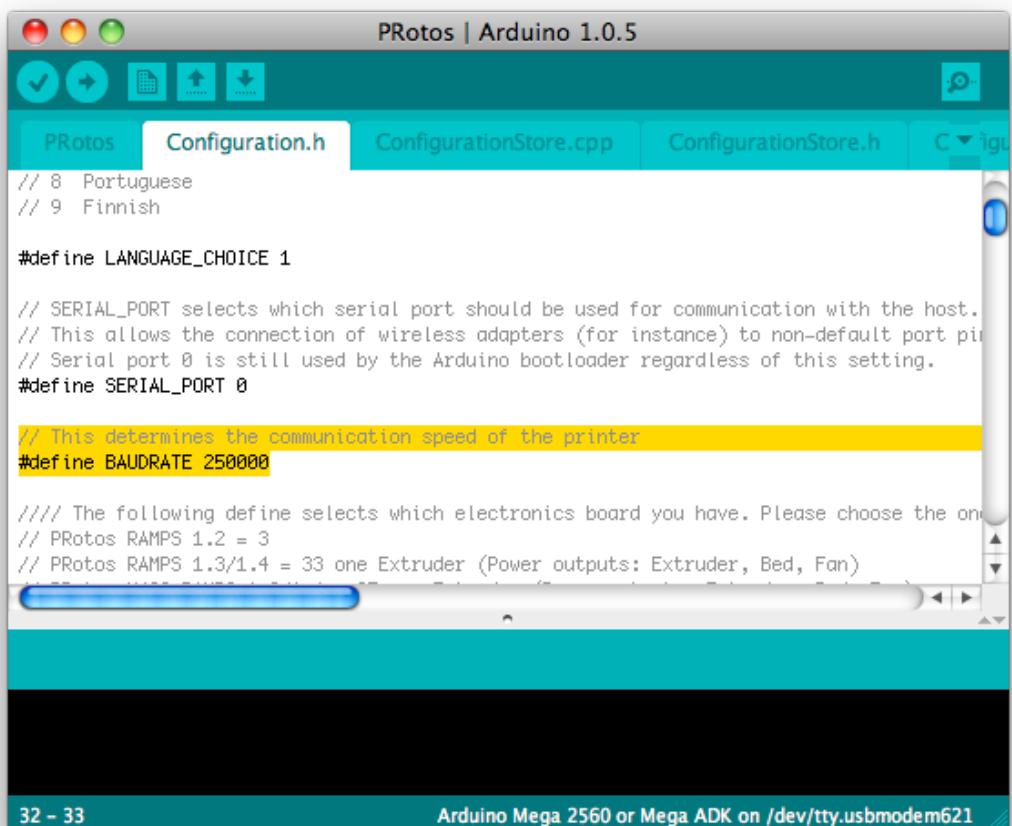
At the bottom of the window, there are three buttons: 'Autoscroll' (checked), 'Newline', and '115200 baud'.



In very few instances it is possible that the USB-Controller can't handle a baudrate of "250000".  
In this case you have to change the baudrate inside the *configuration.h* as seen in picture  
["Arduino adjustment baudrate \[S. 223\]"](#)

A reduction ("128000") is as possible as a increase ("256000") of the baudrate, it depends on the  
USB-Controller

Abbildung 4.10. Arduino adjustment baudrate



The screenshot shows the Arduino IDE interface with the title bar "PRotos | Arduino 1.0.5". The tab bar at the top has "PRotos" selected, followed by "Configuration.h" (which is highlighted in blue), "ConfigurationStore.cpp", "ConfigurationStore.h", and "Configuration.h" again. The main code editor window displays the following code:

```
// 8 Portuguese
// 9 Finnish

#define LANGUAGE_CHOICE 1

// SERIAL_PORT selects which serial port should be used for communication with the host.
// This allows the connection of wireless adapters (for instance) to non-default port pins.
// Serial port 0 is still used by the Arduino bootloader regardless of this setting.
#define SERIAL_PORT 0

// This determines the communication speed of the printer
#define BAUDRATE 250000

//// The following define selects which electronics board you have. Please choose the one
// PRotos RAMPS 1.2 = 3
// PRotos RAMPS 1.3/1.4 = 33 one Extruder (Power outputs: Extruder, Bed, Fan)
```

The line "#define BAUDRATE 250000" is highlighted with a yellow background. At the bottom of the code editor, there are status bars showing "32 - 33" and "Arduino Mega 2560 or Mega ADK on /dev/tty.usbmodem621".

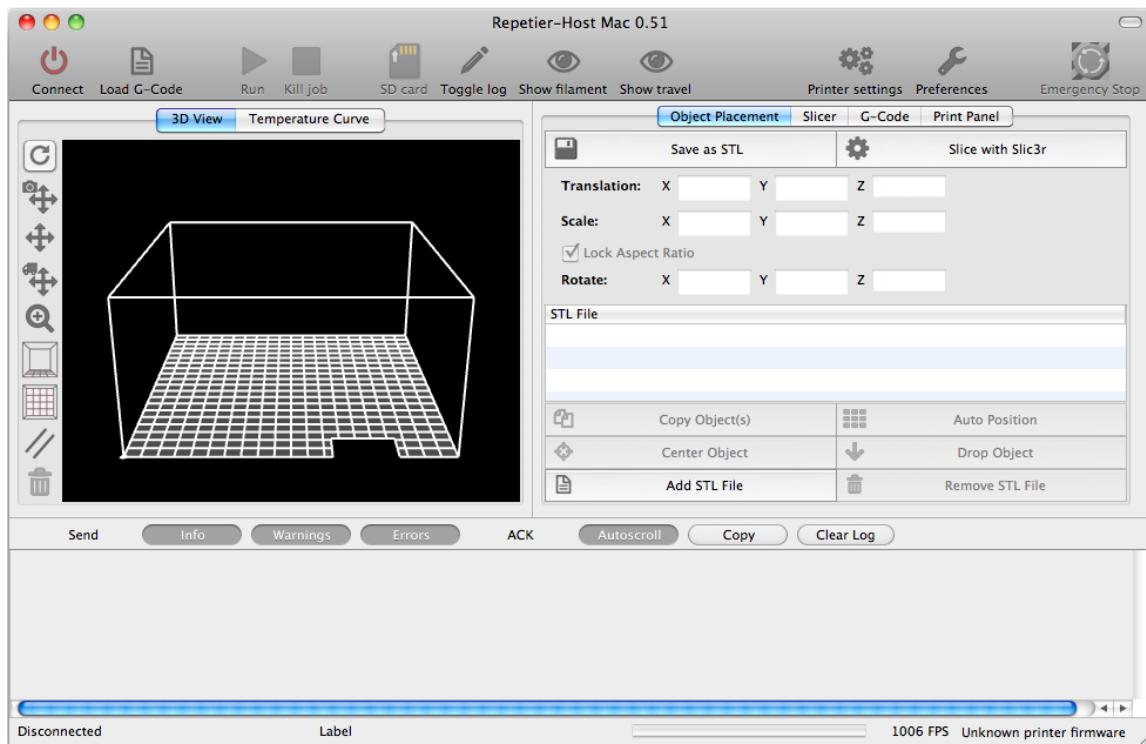
#### 4.1.2. Repetier-Host (OS X)

To operate the 3D printer, the Repetier-Host is downloaded on the system.

Tabelle 4.2. Download Repetier-Host (OS X)

Repetier-Host <sup>3</sup>
----------------------------

Abbildung 4.11. Repetier-Host (OS X)



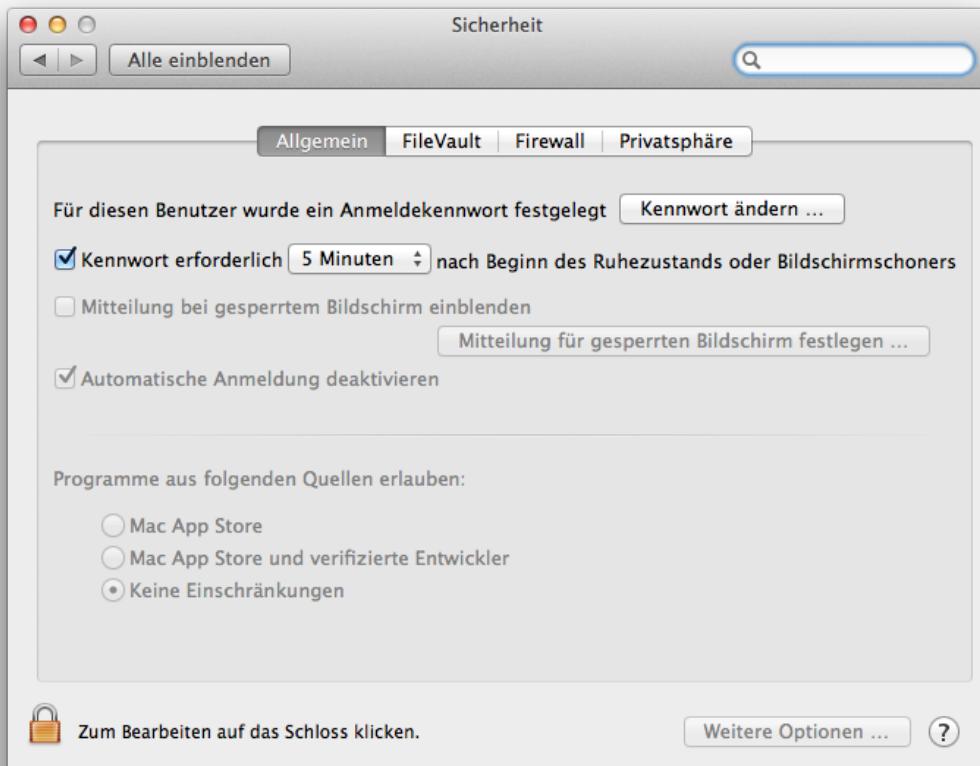
Now the latest version of Repetier-Host is downloaded and installed. After that, Repetier-Host is ready for use.



Using Mountain Lion (10.8.x), the installation of an unsigned code has to be permitted. You can set this in System Settings -> Security.

German RepRap GmbH		Seite	225 /
		Revision	367
		Stand	08.01.2014 14:30
Kapitel 4. Commissioning > Commissioning Mac OS X			

Abbildung 4.12. Mac OS X Mountain Lion (10.8.x) not signed code permitted



#### 4.1.3. Slic3r (OS X)

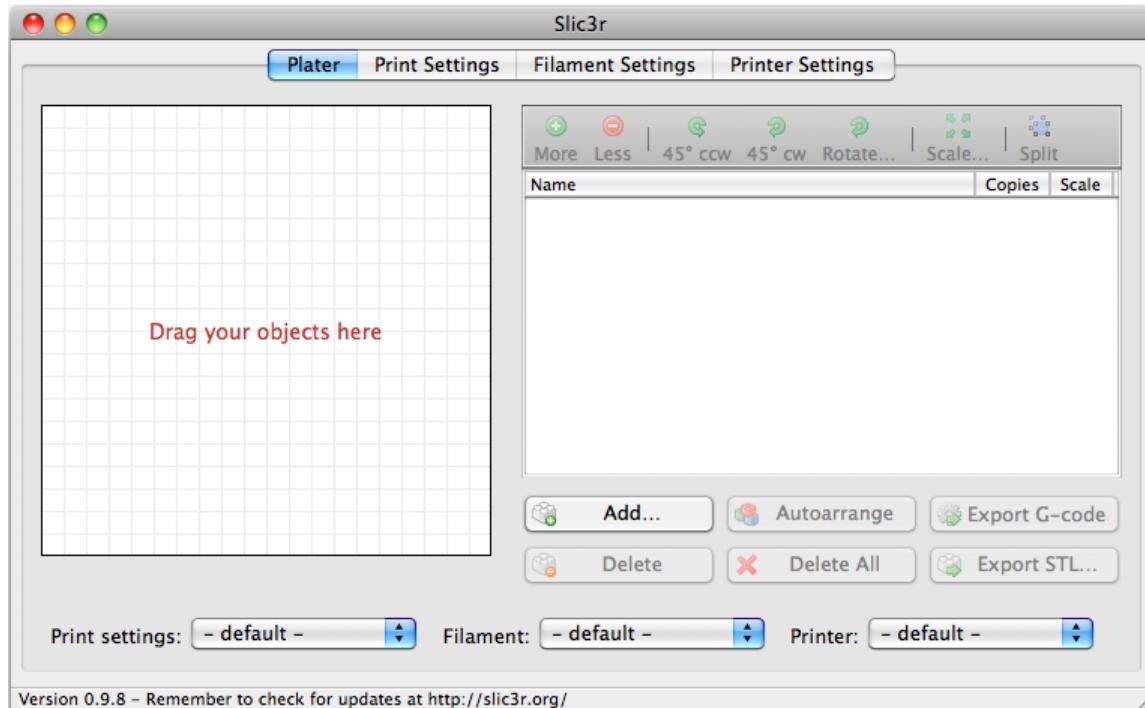
Tabelle 4.3. Overview of the necessary programs Slic3r (OS X)

Slic3r <sup>4</sup> - STL to GCode converter for 3D printers
--

The program slic3r can be used to create a machine-readable code in the format .gcode from CAD files in the format .stl later on. Only the .dmg file has to be opened for that. After that, Slic3r can be opened and is ready for use.

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		Revision 367
		Stand 08.01.2014 14:30
Kapitel 4. Commissioning > Commissioning Windows		

Abbildung 4.13. Slic3r (OS X)



## 4.2. Commissioning Windows

### 4.2.1. Firmware (Windows)

To achieve an efficient communication between the Ramps and the Arduino, the right firmware has to be installed on the Arduino board.

Tabelle 4.4. Overview of the necessary programs firmware (Windows)

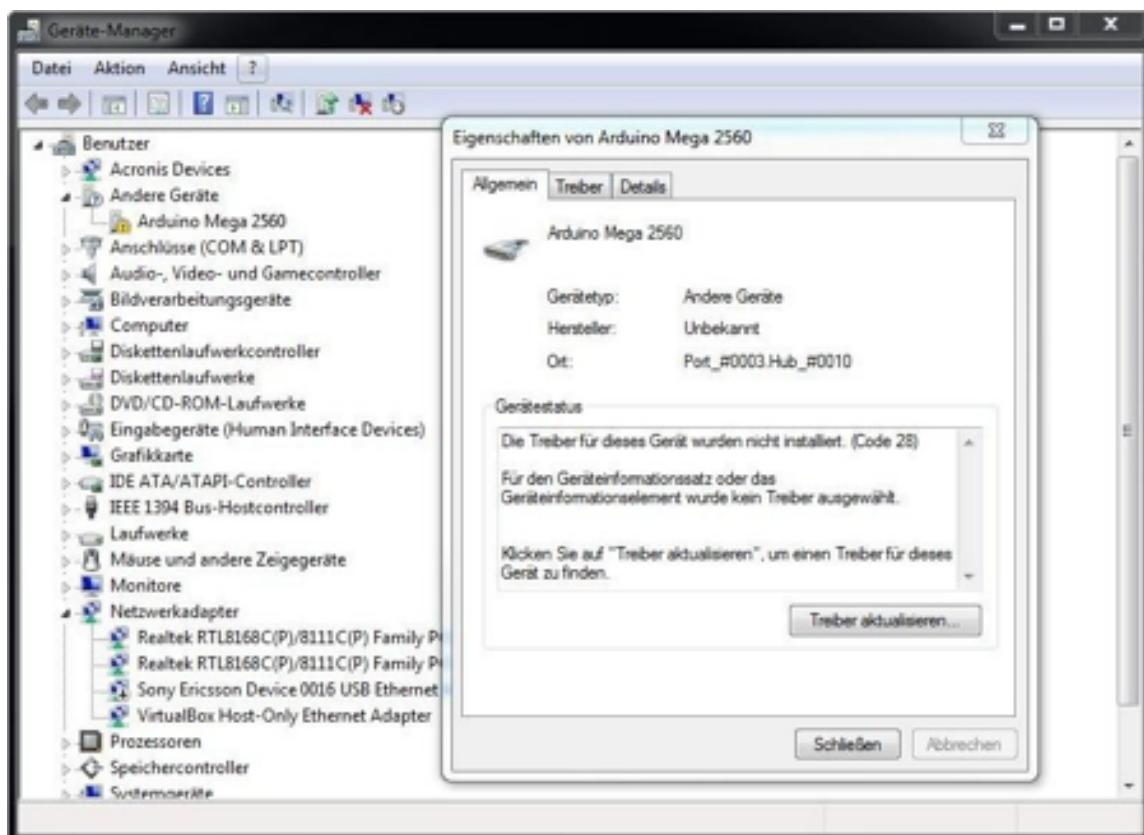
Arduino Version 1.0.x <sup>5</sup>
X400 Firmware <sup>6</sup>

There is a firmware for the X400, adapted by German RepRap GmbH. To be able to install this firmware on the Arduino board, the Arduino software *Version 1.0.x* has to be loaded at first. It is important to choose *Version 1.0.x*. The Microsoft Windows driver for the communication between the computer and the arduino board can be found in the folder *..arduino-1.0/drivers*.

After connecting the board via USB, a Windows request appears, in which the drivers can be selected for the installation. If this request does not appear, the drivers have to be updated manually, via *Control panel* →

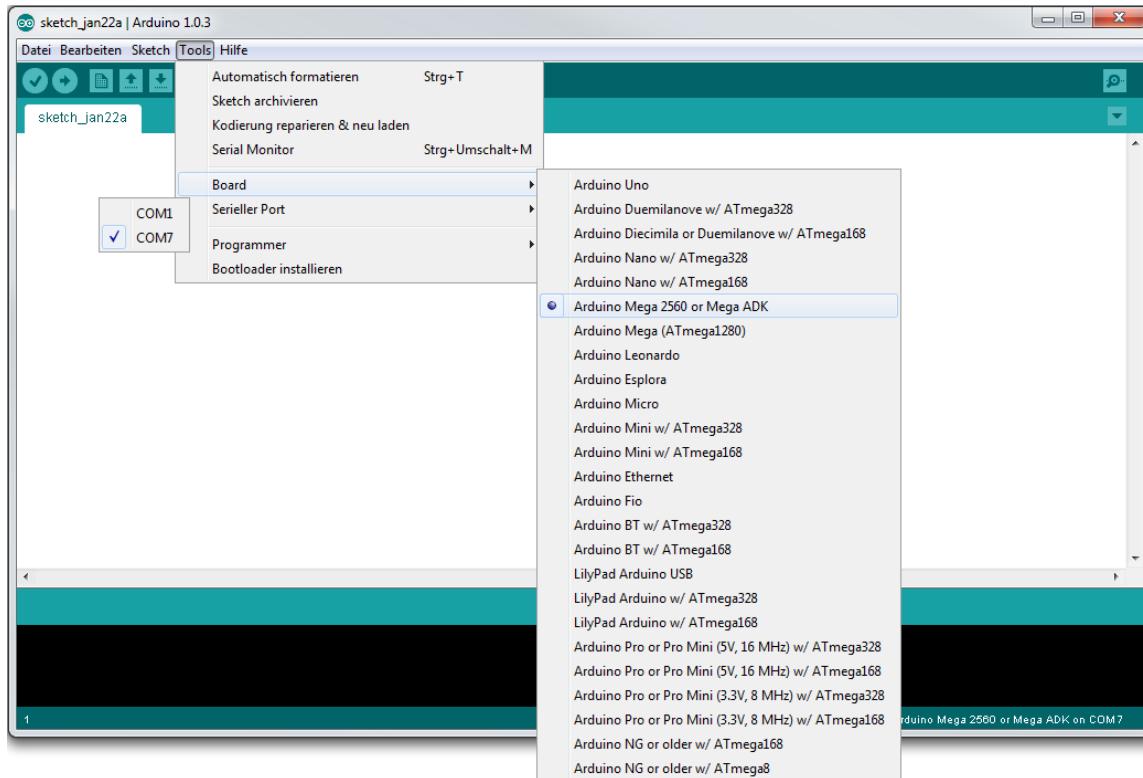
*Hardware and Sound → Device manager.* Therefore please select the following: *Arduino Mega 2560 → right click → Properties → Driver update.* Search for drivers on the computer and select the path ..\arduino-1.0\drivers \FTDI USB Drivers.

Abbildung 4.14. Installation driver Arduino board



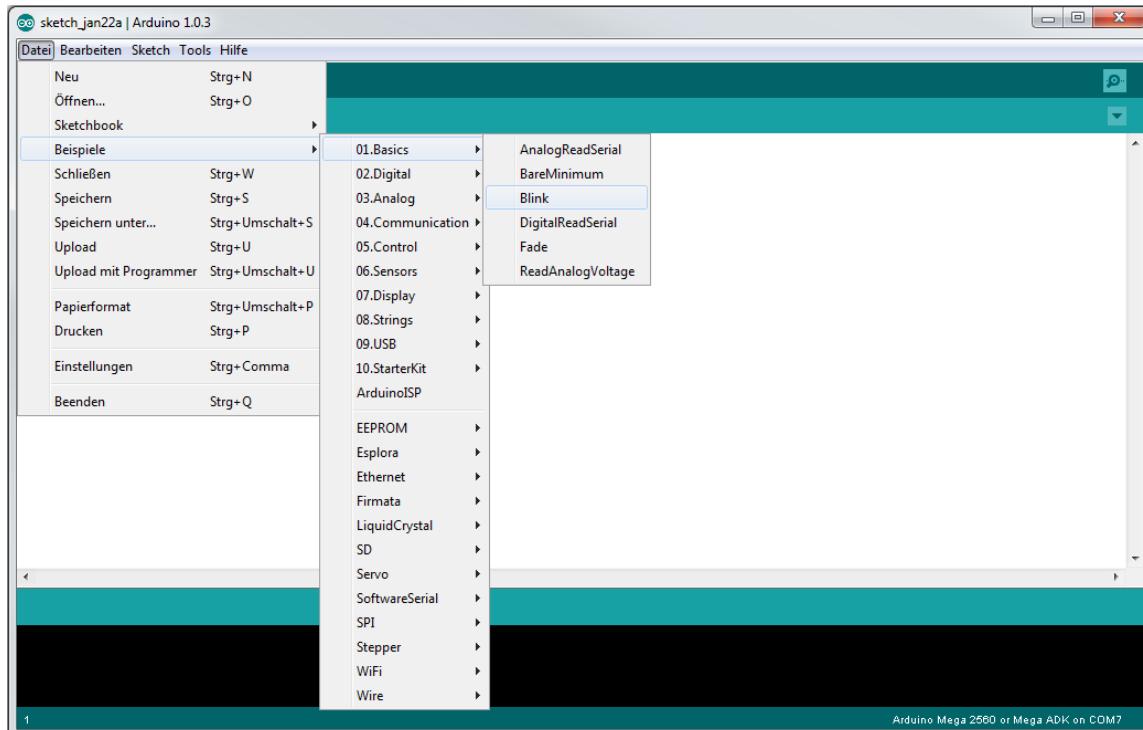
Afterwards, "arduino.exe" in the arduino-1.0 folder and the „Arduino Mega 2560“ can be selected below the menu item *Tools → Board*. For the application of the USB connection, the port *COMx* (the COM port is variable depending on the system) has to be selected below the menu item *Tools → Serial Port*.

Abbildung 4.15. Selection board and port



A flashing example can be selected to test the Arduino board. This makes a yellow LED flash on the Arduino board, indicating that the communication between the computer and the Arduino board is working accurately. Therefore, *Examples* → *1.Basics* → *Blink* is selected.

Abbildung 4.16. Arduino flashing test selection



Subsequently, a new window opens, which displays the source code of the firmware to be installed (image "[Arduino flashing test upload \[S. 230\]](#)"). Now the Upload button can be selected below the menu bar, to transfer the firmware (1). It is now displayed under the source code that the upload is completed (2) and the LED on the board should flash multiple times immediately. The image "[RAMPS flashing \[S. 230\]](#)" shows the LED before and during the flashing (when installed, this is hardly recognizable though).

Abbildung 4.17. Arduino flashing test upload

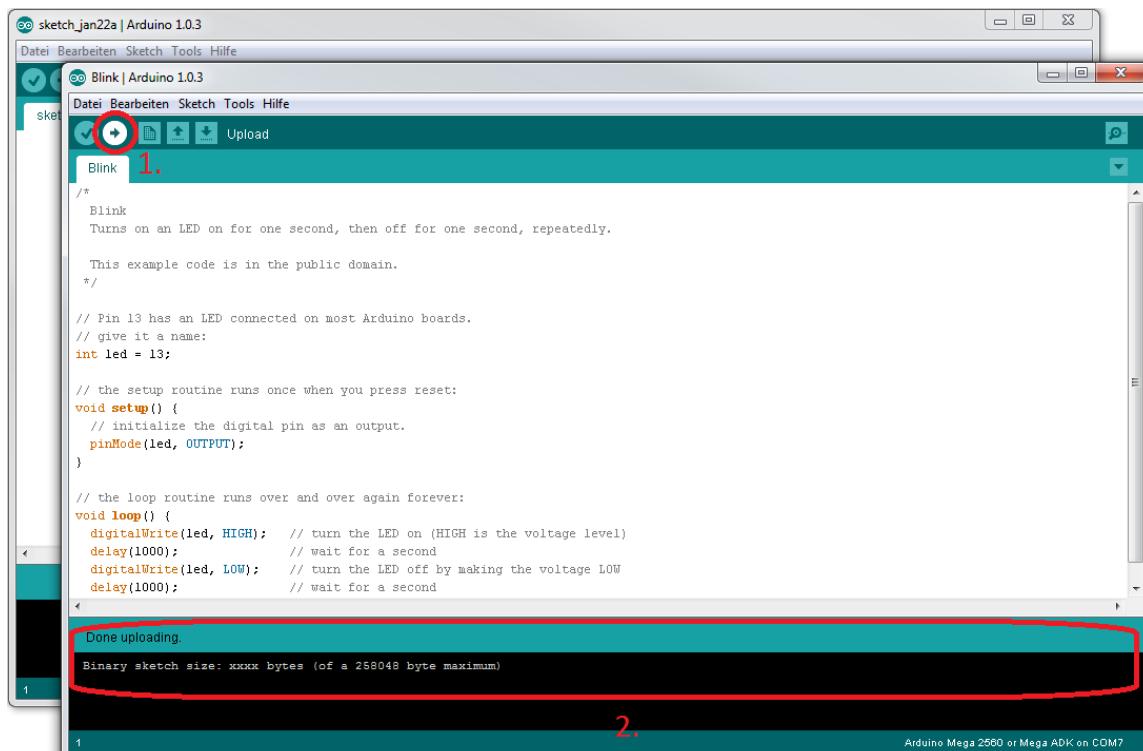


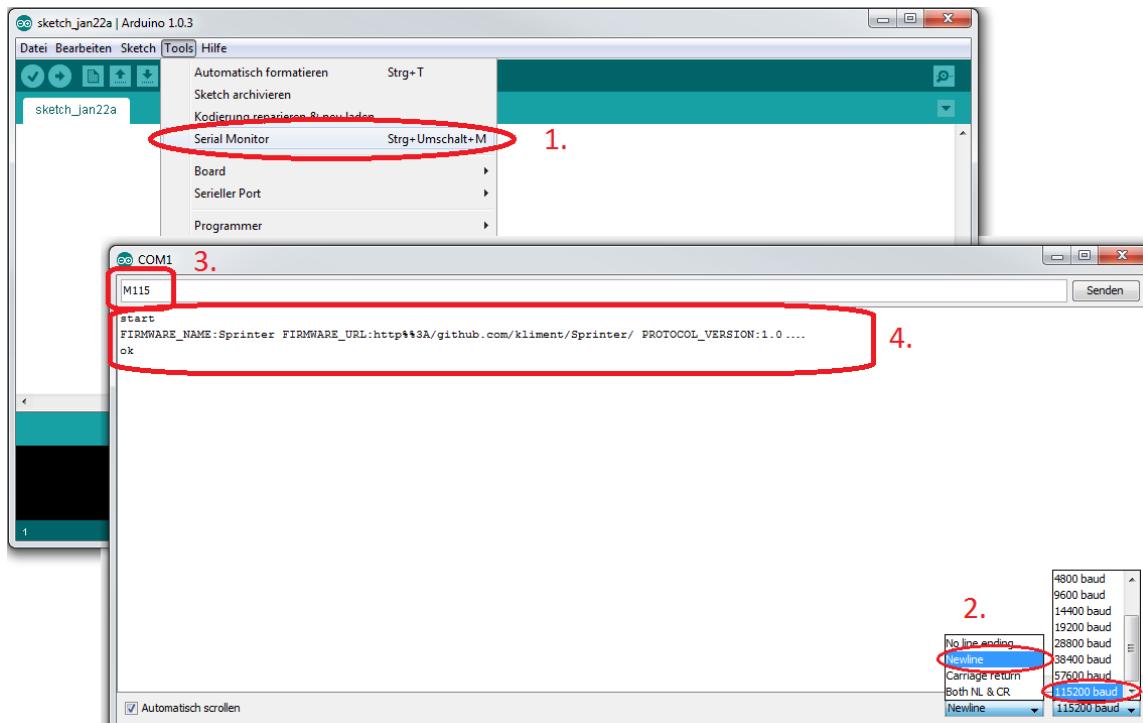
Abbildung 4.18. RAMPS flashing



To install the firmware, the right and most current firmware has to be downloaded at first. Afterwards, the open button is pressed in the Arduino program and the *PRotos.ino* is selected in the firmware folder via "Open...". This loads all header and source files (.h und .cpp) in the *PRotos* folder, automatically.

The firmware is loaded on the Arduino board just like the flashing test. To test the firmware (image "Arduino firmware test [S. 231]"), the serial monitor is selected below the menu bar(1). To make sure the Arduino software is able to communicate with the Arduino board, the protocol "Newline" (2), as well as the baud rate "250000"(3) has to be selected. The firmware of the board can be queried by entering the code M115, it should match the one in the image "Arduino firmware test"(5). The complete command list by means of GCode can be looked up in the Internet.

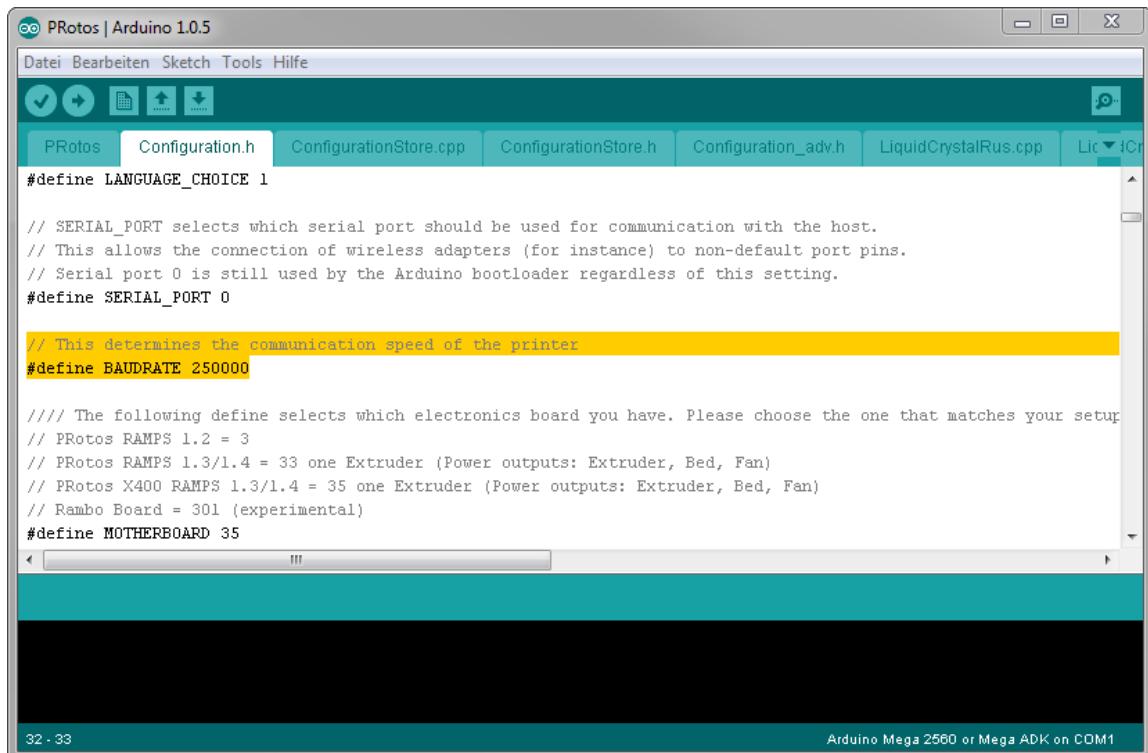
Abbildung 4.19. Arduino firmware test



In very few instances it is possible that the USB-Controller can't handle a baudrate of "250000".  
In this case you have to change the baudrate inside the *configuration.h* as seen in picture  
["Arduino adjustment baudrate \[S. 232\]"](#)

A reduction ("128000") is as possible as an increase ("256000") of the baudrate, it depends on the USB-Controller

Abbildung 4.20. Arduino adjustment baudrate



#### 4.2.2. Repetier-Host (Windows)

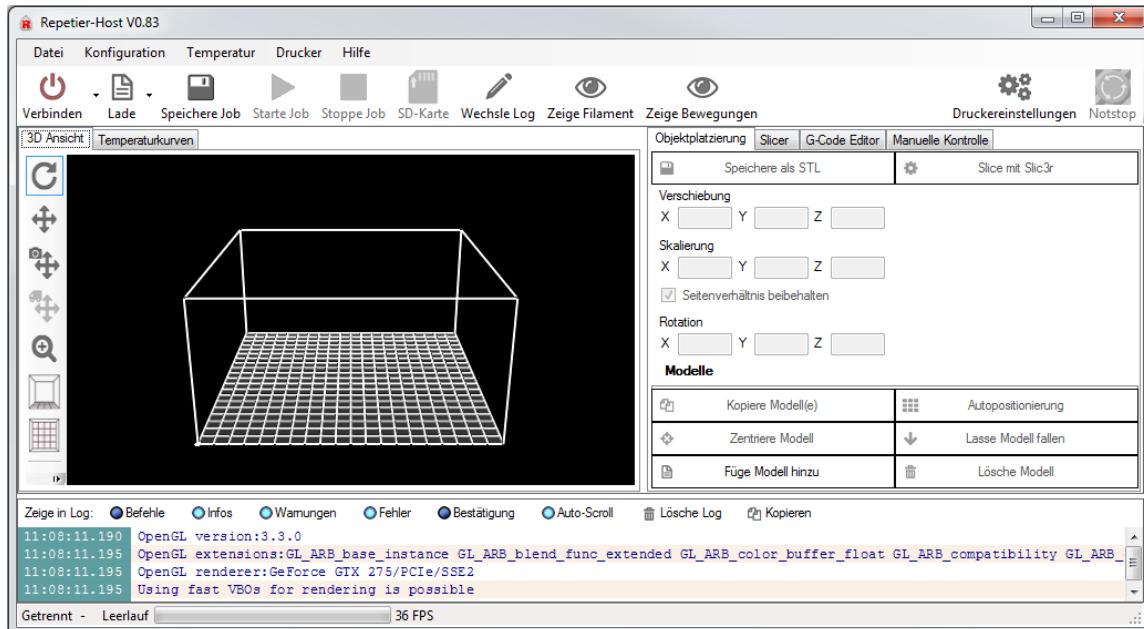
Now that the Arduino board has the right firmware the Repetier-Host for the operation of the printer is installed on the system.

Tabelle 4.5. Overview of the necessary programs Repetier-Host (Windows)

Repetier-Host<sup>7</sup>

Then the latest version of Repetier-Host software is downloaded and installed. Afterwards the Repetier-Host is ready to be used.

Abbildung 4.21. Repetier-Host (Windows)



#### 4.2.3. Slic3r (Windows)

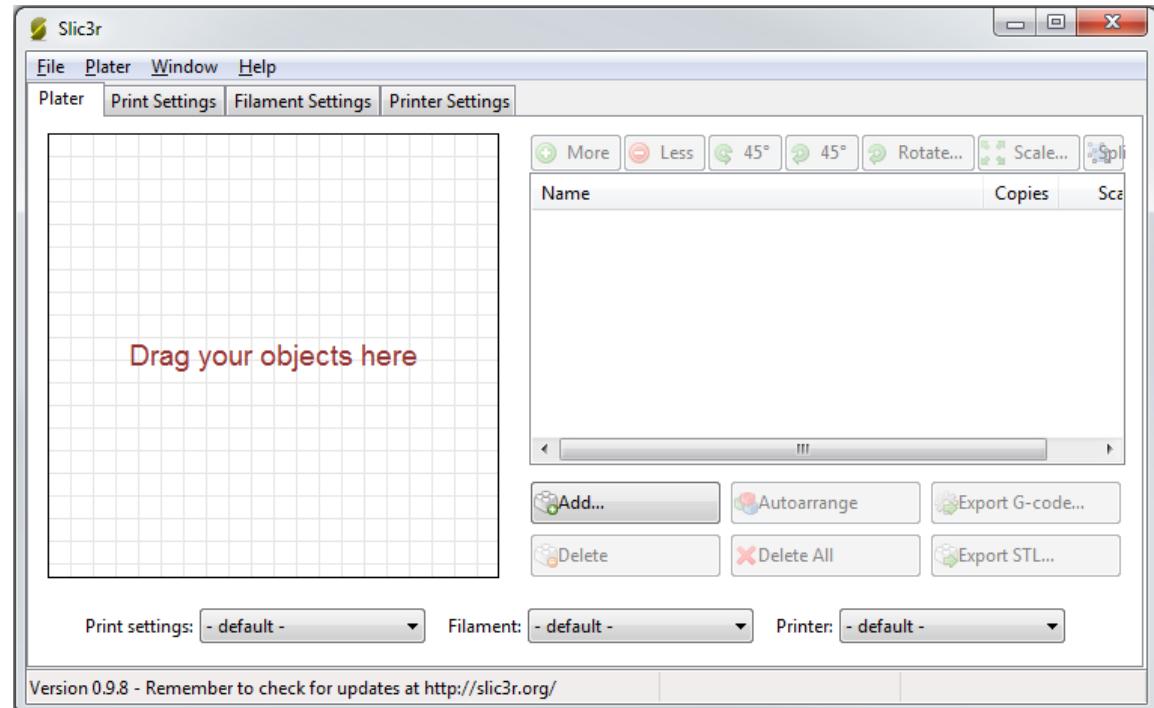
Tabelle 4.6. Overview of the necessary programs Slic3r (Windows)

Slic3r<sup>8</sup> - STL to GCode converter for 3D printers

The program slic3r can be used to create a machine-readable code in the format .gcode from CAD files in the format .stl later on. Only the .dmg file has to be opened for that. After that, Slic3r can be opened and is ready for use.



Abbildung 4.22. Slic3r (Windows)



### 4.3. Commissioning Linux (work in progress)

The manual for Linux distribution is still work in progress.

### 4.4. Commissioning SD-RAMPS

Tabelle 4.7. Material list commissioning SD RAMPS

1x microSD Karte
------------------

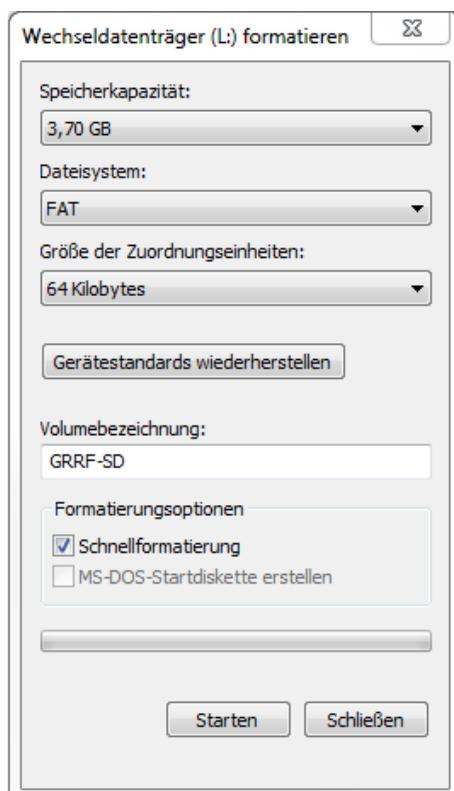
Abbildung 4.23. Material overview commissioning SD RAMPS



Die mircoSD Karte muss, damit der X400 von dieser lesen kann, im FAT16 Format formatiert werden.

*Windows:* Unter Windows kann dieses einfach mit Rechtsklick → Formatieren... durchgeführt werden, dort wird dann unter Dateisystem FAT (nicht FAT32) gewählt (Bild: "Finish (Windows)").

Abbildung 4.24. Finish commissioning e SD RAMPS (Windows)



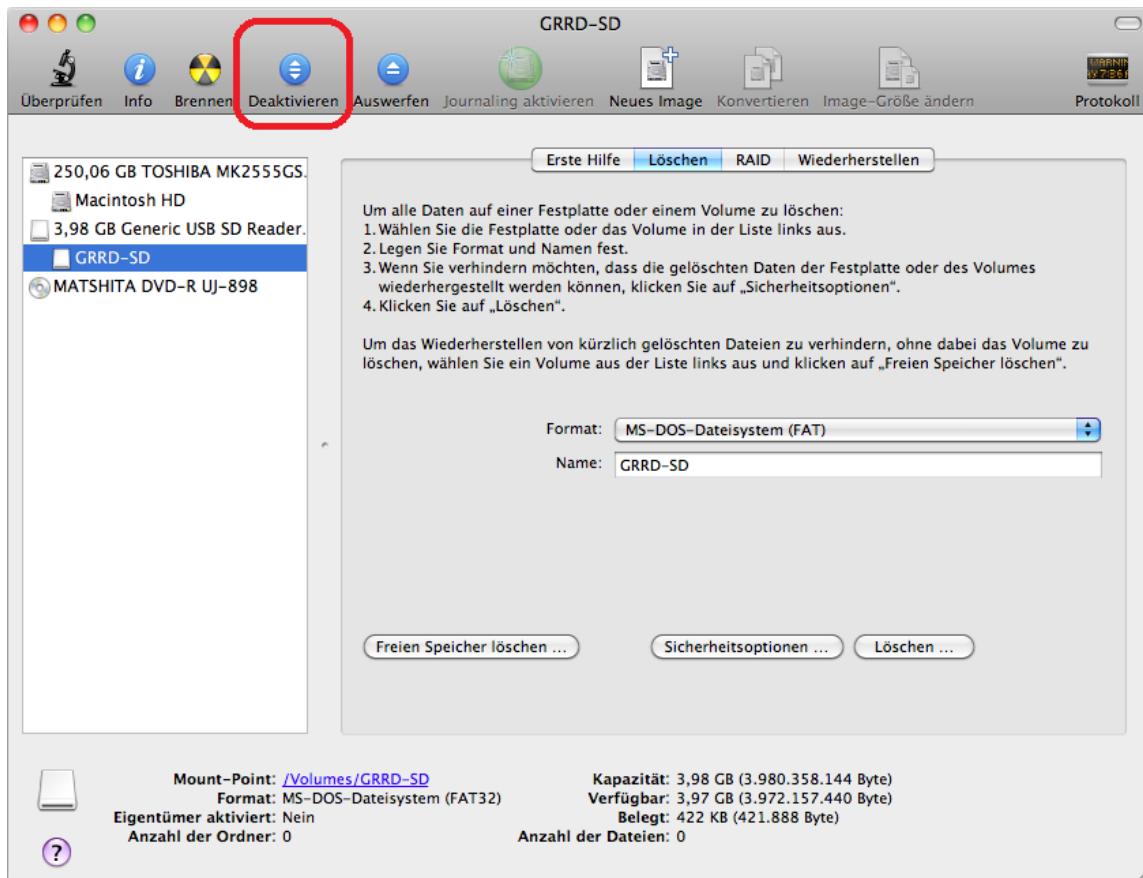
**OS X (nur für erfahrene Nutzer):** Unter OS X ist das Formatieren etwas komplizierter. Zunächst muss das Terminal über *Programme → Dienstprogramme → Terminal* geöffnet werden. Dort wird über den Befehl "df" eine Auflistung der vorhandenen Festplatten angezeigt. (Siehe "[OS X Terminal Formatieren \[S. 236\]](#)").

Abbildung 4.25. OS X Terminal Formatieren

```
user-namegrrf-MacBook:~ user-name$ df
Filesystem 512-blocks Used Available Capacity Mounted on
/dev/disk0s2 487725344 443762640 43450704 92% /
devfs 216 216 0 100% /dev
map -hosts 0 0 0 100% /net
map auto_home 0 0 0 100% /home
/dev/disk1s1 7773568 25088 7748480 1% /Volumes/GRRF-SD
user-namegrrf-MacBook:~ user-name$ df
Filesystem 512-blocks Used Available Capacity Mounted on
/dev/disk0s2 487725344 443762808 43450536 92% /
devfs 216 216 0 100% /dev
map -hosts 0 0 0 100% /net
map auto_home 0 0 0 100% /home
user-namegrrf-MacBook:~ user-name$ newfs_msdos -F16 /dev/disk1s1
newfs_msdos: warning: /dev/disk1s1 is not a character device
512 bytes per physical sector
newfs_msdos: warning: sectors/FAT limits sectors to 4194721, clusters to 65534
newfs_msdos: warning: FAT type limits file system to 4194144 sectors
/dev/disk1s1: 4193536 sectors in 65524 FAT16 clusters (32768 bytes/cluster)
bps=512 spc=64 res=1 nft=2 rde=512 mid=0xf0 spf=256 spt=32 hds=255 hid=0 bsec=4194144
user-namegrrf-MacBook:~ user-name$
```

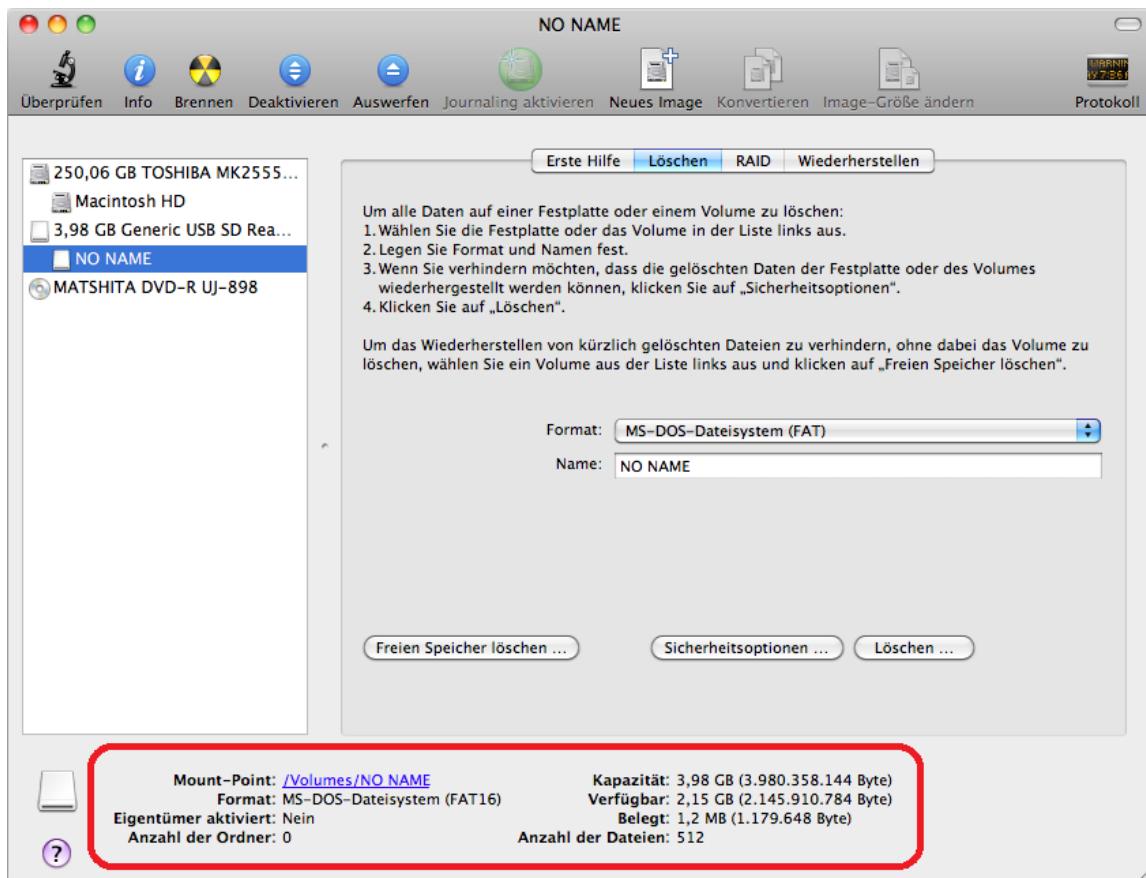
Anschließend müssen über *Programme* → *Dienstprogramme* → *Festplatten Dienstprogramm* selbiges gestartet werden. Die SD-Karte muss dort über "Deaktivieren" deaktiviert werden (Bild: "[SD Karte deaktivieren \[S. 237\]](#)").

Abbildung 4.26. SD Karte deaktivieren



Danach wird mit dem Befehl "newfs\_msdos -F16 /dev/disk1s1" die Formatierung ausgeführt, wobei "disk1s1" für die SD Karte steht. Die Disk-Bezeichnung muss der Übersicht entnommen werden (Bild: "[OS X Terminal Formatieren \[S. 236\]](#)"). Dann wird im Festplatten Dienstprogramm die SD Karte mit dem Dateisystem FAT16 angezeigt (Bild: "[Finish Inbetriebnahme SD RAMPS \(OS X\) \[S. 238\]](#)")

Abbildung 4.27. Finish Inbetriebnahme SD RAMPS (OS X)





## Kapitel 5. Calibration

No alignment of the axes is needed as the rigid frame of the X400 takes care of that.

Start by checking the end-stops of the X- and Y-axis. The metal strip needs to move freely into light sensor without touching any part of the printer.



To maximize the print area keep the Y-axis strip as short as possible.

Abbildung 5.1. X-axes end-stop

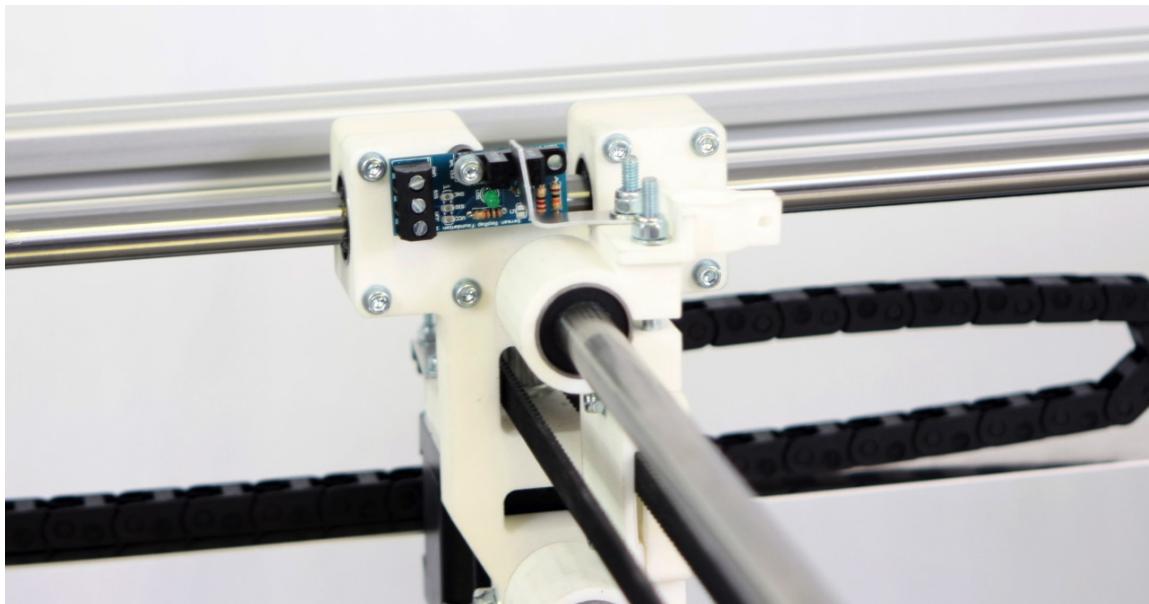
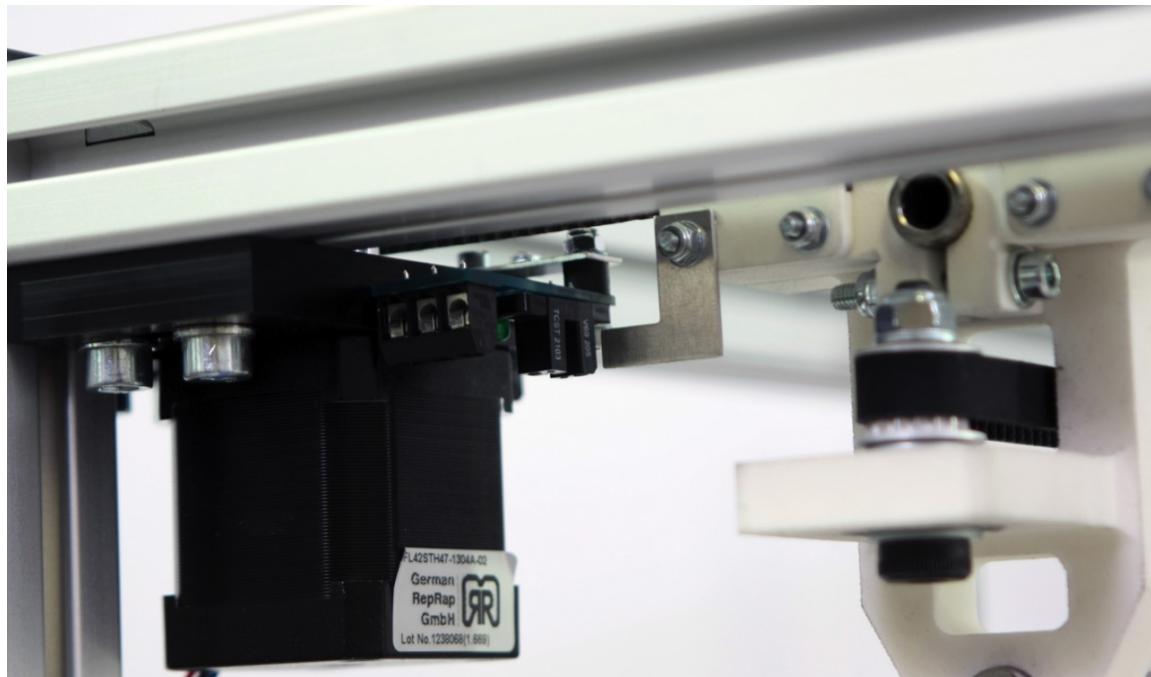




Abbildung 5.2. Y-axis end-stop



There are two ways to adjust the height of the Z-axis end-stop: The simple way is to adjust the socket head bolt that holds the metal strip. Alternatively you can shorten the metal strip itself.

It is important to have the printing bed leveled in the X- and Y-axis. Then adjust the clearance of the hot-end tip to 0.2mm (equals 8 thou, or about the thickness of a business card) when the end-stop kicks in. This clearance has to be adjusted across the whole area of the printing bed. For a perfect calibration it is necessary to heat up the heated printing bed on the operating temperature.



If the Arduino board is powered-up, the LED turns off as soon as the metal strip deactivates the light sensor.

Abbildung 5.3. Z-axis end-stop

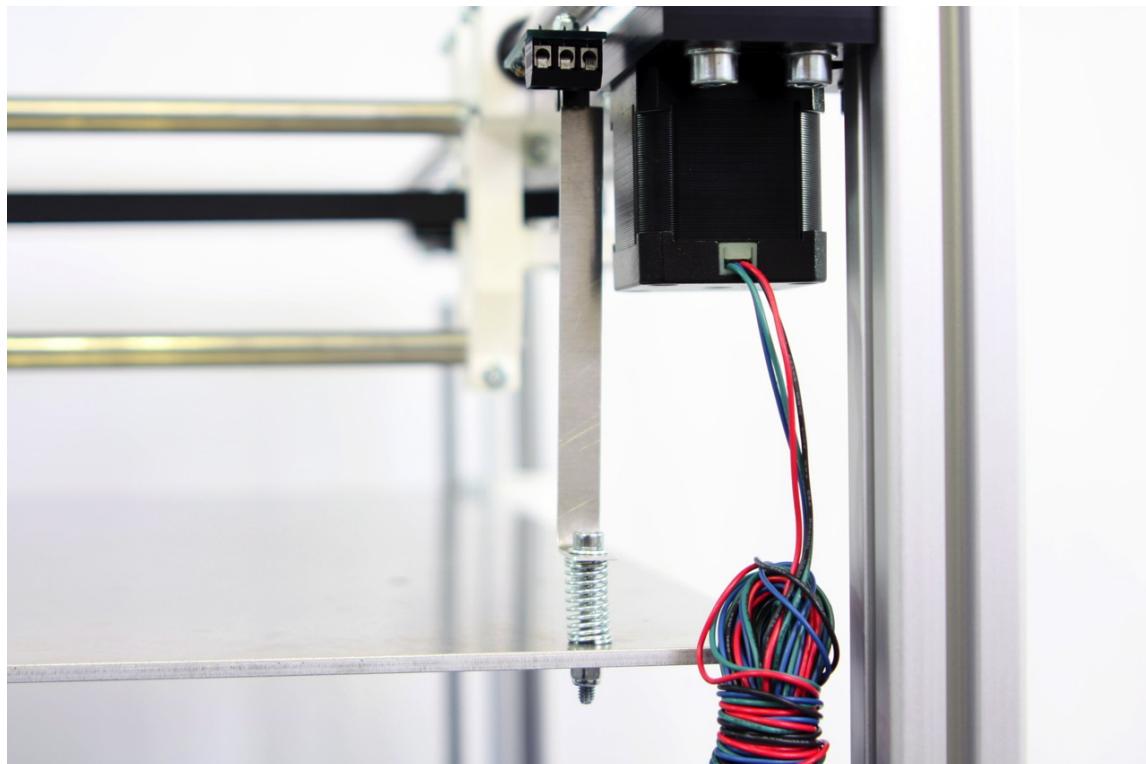
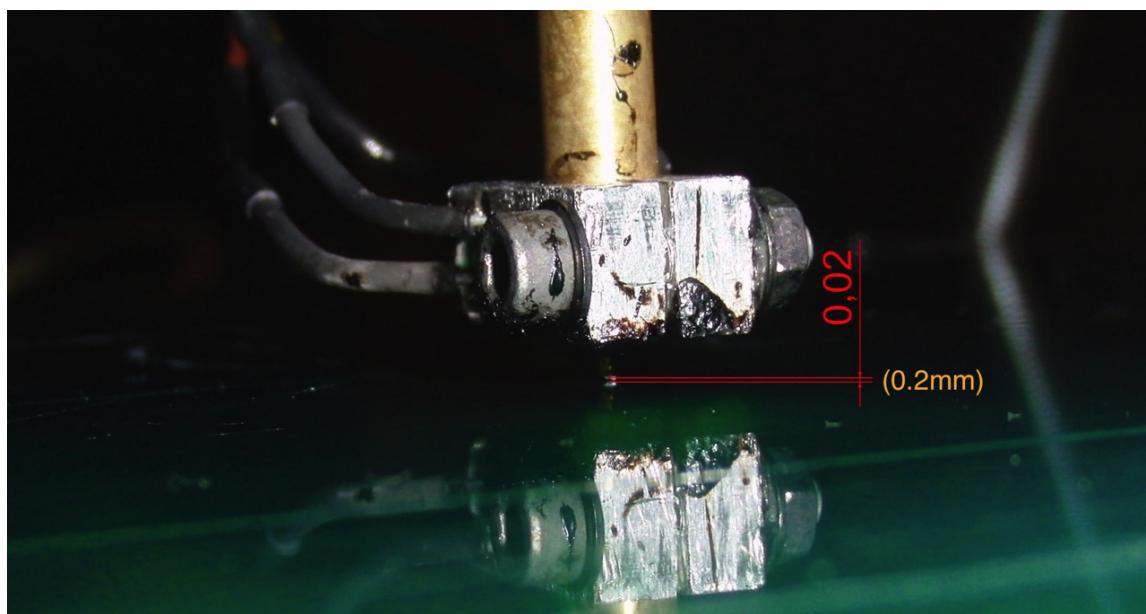


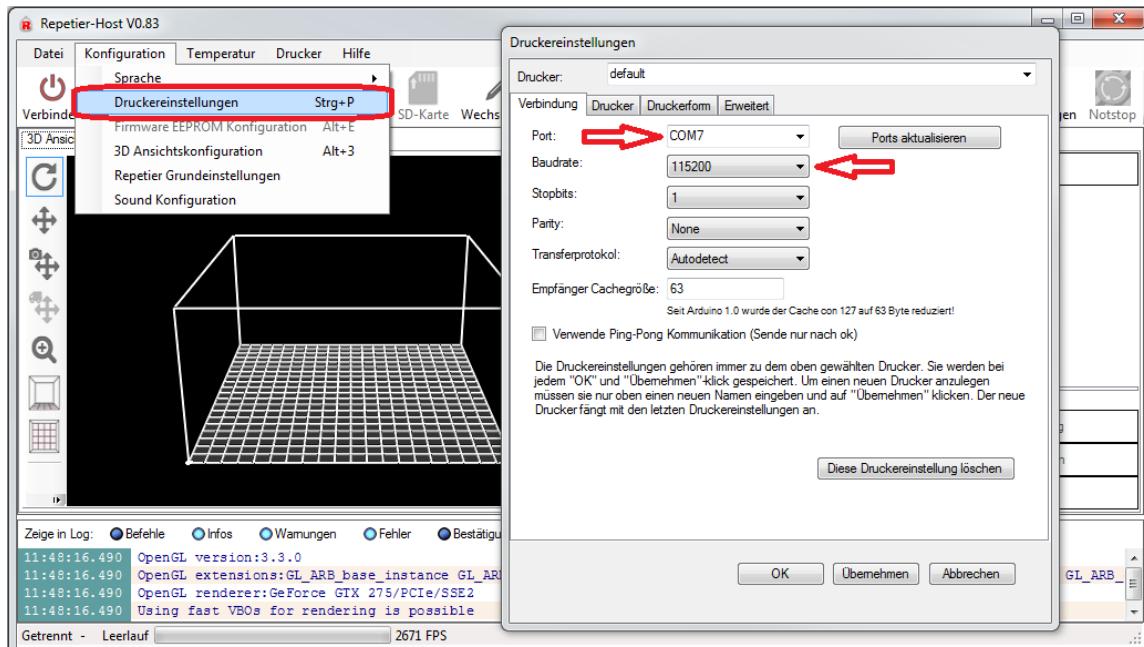
Abbildung 5.4. hot end alignment



In order to adjust the end stops, in particular the z-axis end stop, we use the software on the computer.

First, start the Repetier-Host software, then adjust the port and baudrate. This is the same port that we used to install the firmware. ([Select board and Port \(OS X\) \[S. 215\]](#) and [Auswahl Board und Port \(Windows\) \[S. 228\]](#)) respectively. Choose "250000" for the baud rate.

Abbildung 5.5. Select port and baud rate



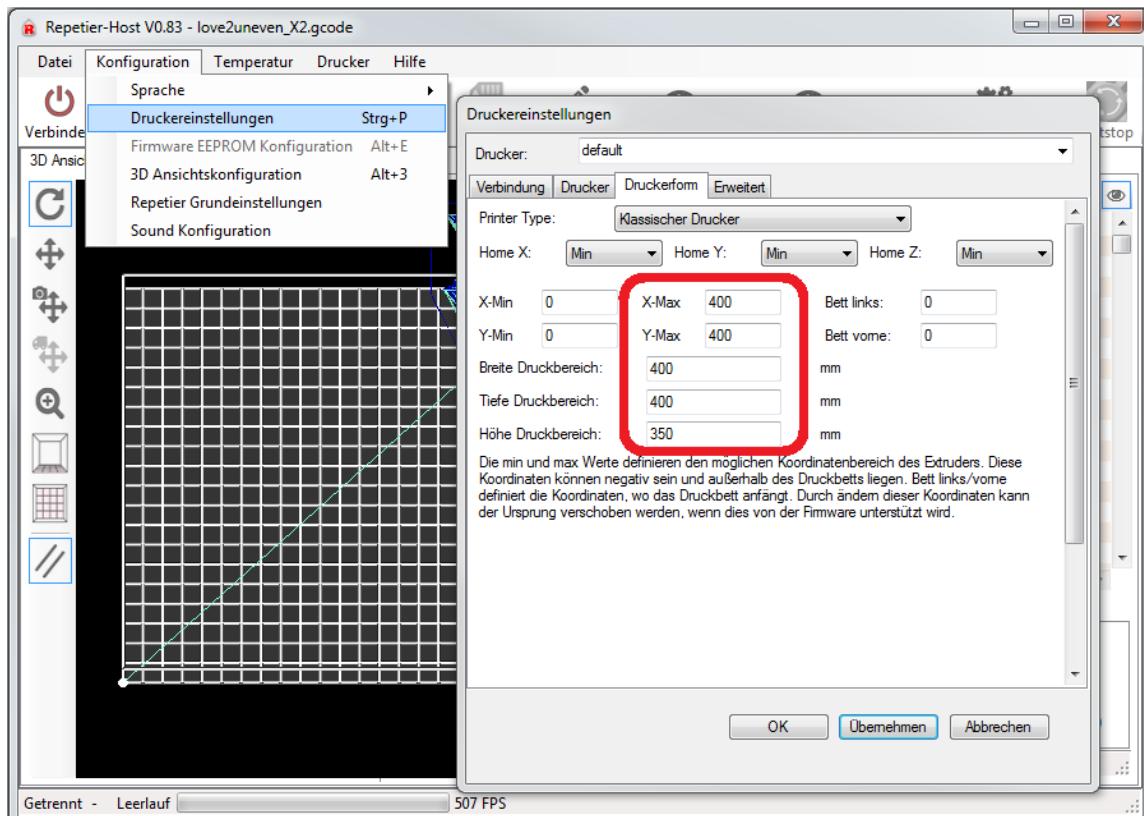
Once all parameters are set correctly, click "Connect" to establish a link to the X400.



If the connection fails check that there is no other software running that uses this port, e.g. the Arduino software. If that's the case, quit the other software first, then press the reset button to restart the printer. Alternatively, you can disconnect and reconnect the USB cable.

Since the X400 has a very large printing area, the parameters in the Repetier-Host have to be adjusted in the printer settings.

Abbildung 5.6. Repetier-Host printer configuration



The printer defines the home position through the signal from the end-stop. This defines the physical printing limits for the respective axis. The limit at the opposite end is only defined through the software settings.

Before moving the head to the home position double check the cabling [Richtigkeit der Verkabelung \[S. 193\]](#), as well as the end stops. Also move the print head to a central position on all axes to avoid hitting any object during this startup.

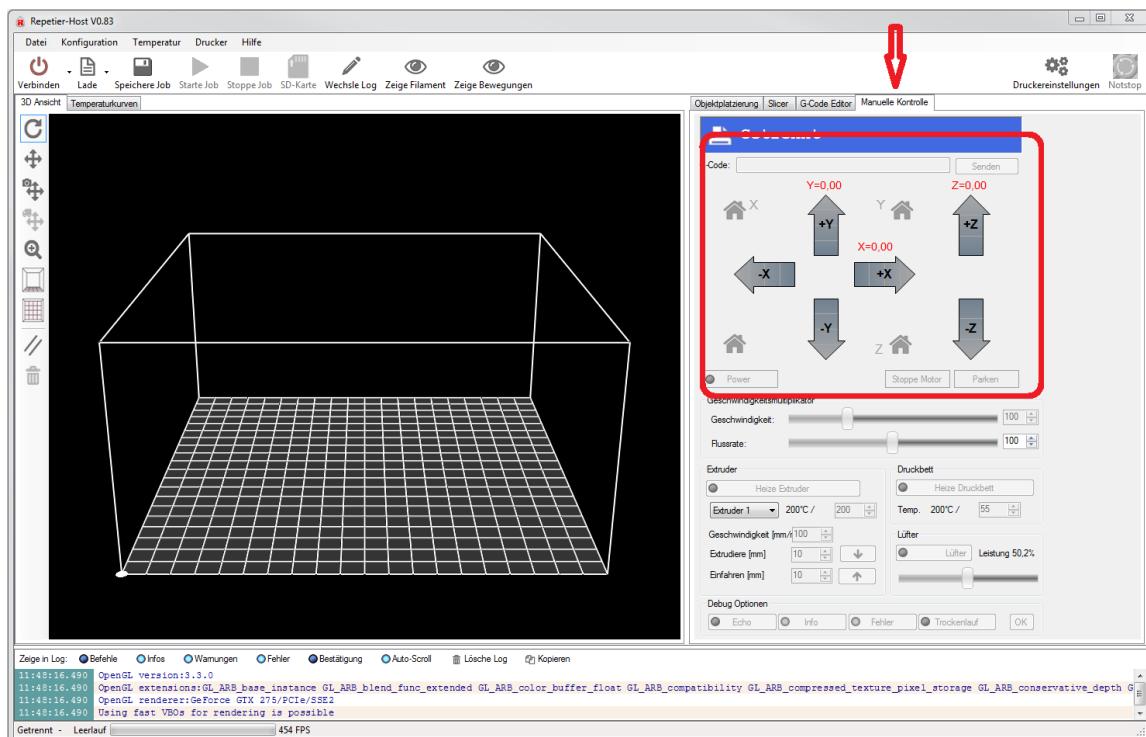


In case the printer head doesn't stop properly please turn off the power to the printer immediately. Then power it back on again and re-connect from the Repetier host.

While the potentiometers are still roughly in their middle position ([Befestigung Pololus \[S. 160\]](#)), you can click on the Home keys in the manual control, one after the other. Once all axes are in their home position the driver currents can be adjusted via the potentiometers.

Abbildung 5.7. Adjusting Pololu potentiometer

Abbildung 5.8. Manual control



The potentiometer is correctly adjusted if there is no slipping of the stepper motor. This means the extruder head can smoothly move the whole length on each axis without stopping once. If there is any intermittent stopping, increase the motor current on the potentiometer. In order to check for any slipping, attach a pencil to the extruder head and have it lightly touch a piece of paper on the printing bed. Using the software move the pencil 100mm on the x- and y-axis and measure the lines drawn, as seen in the first picture "[Schrittverluste \[S. 245\]](#)". If the lines are less than the amount you moved the extruder, there is still some slipping of the stepper motor. You can repeat the process over the whole length of the printing bed, starting from the home position. This also allows to check the vertical alignment of the printing bed. The second photo shows the lines without any slipping "[Ohne Schrittverluste \[S. 246\]](#)".



Slipping can also occur if the motor current is set too high.



Abbildung 5.9. Some slipping

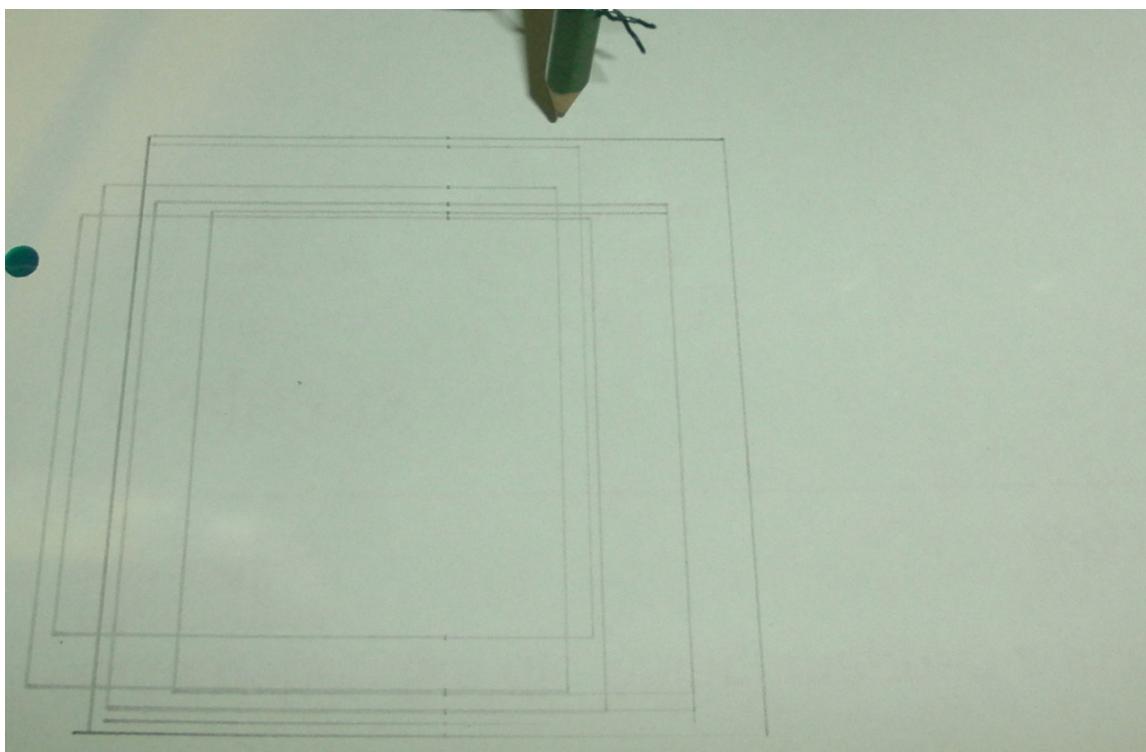
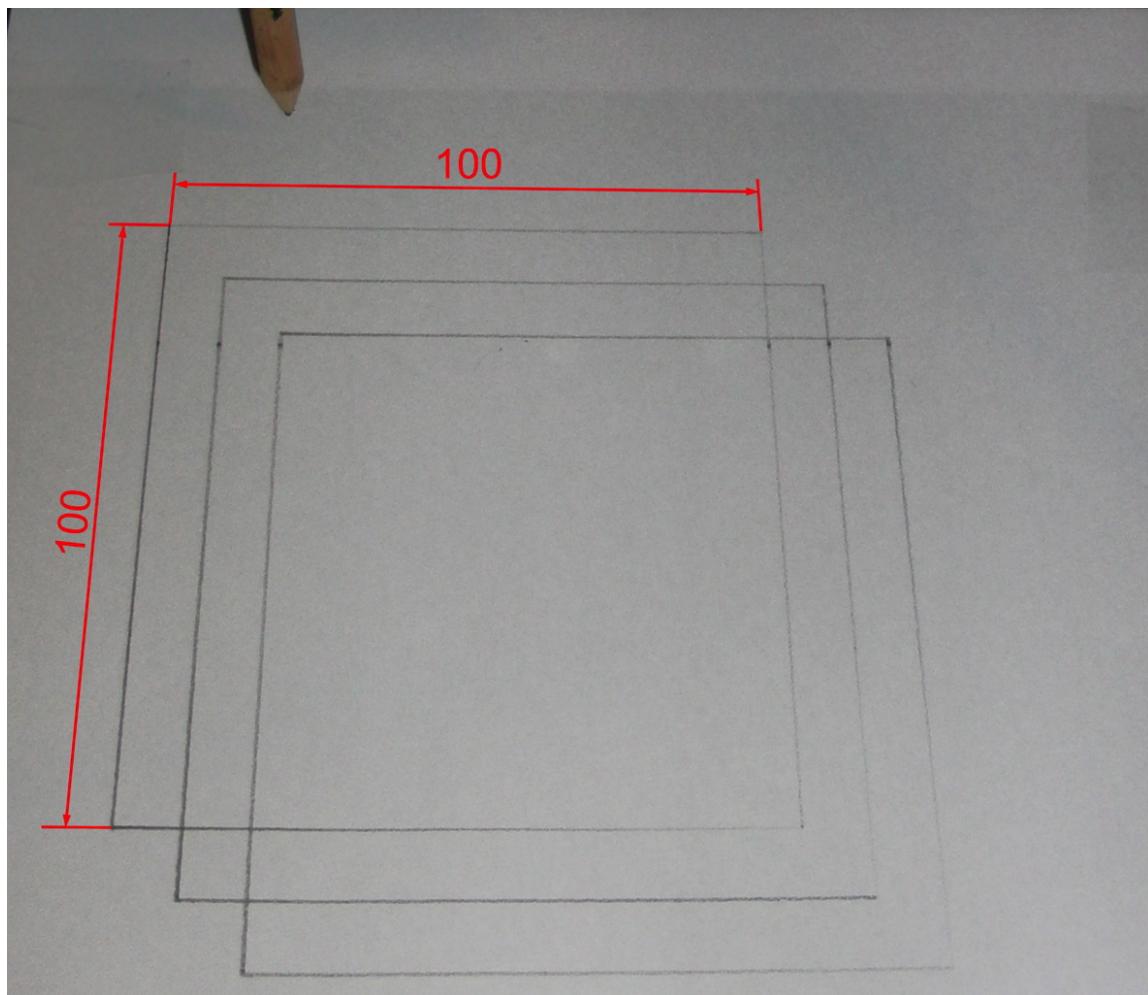




Abbildung 5.10. Without slipping



The calibration process is finished once the potentiometers are set correctly.



# Kapitel 6. Operation

It's not difficult to operate a 3D printer. A *.gcode* file is loaded into the printer interface and the print is started. To get the GCode for the 3D printer can be more difficult. Only self-generated *.gcode* files should be used as they contain meta information specific to this printer.

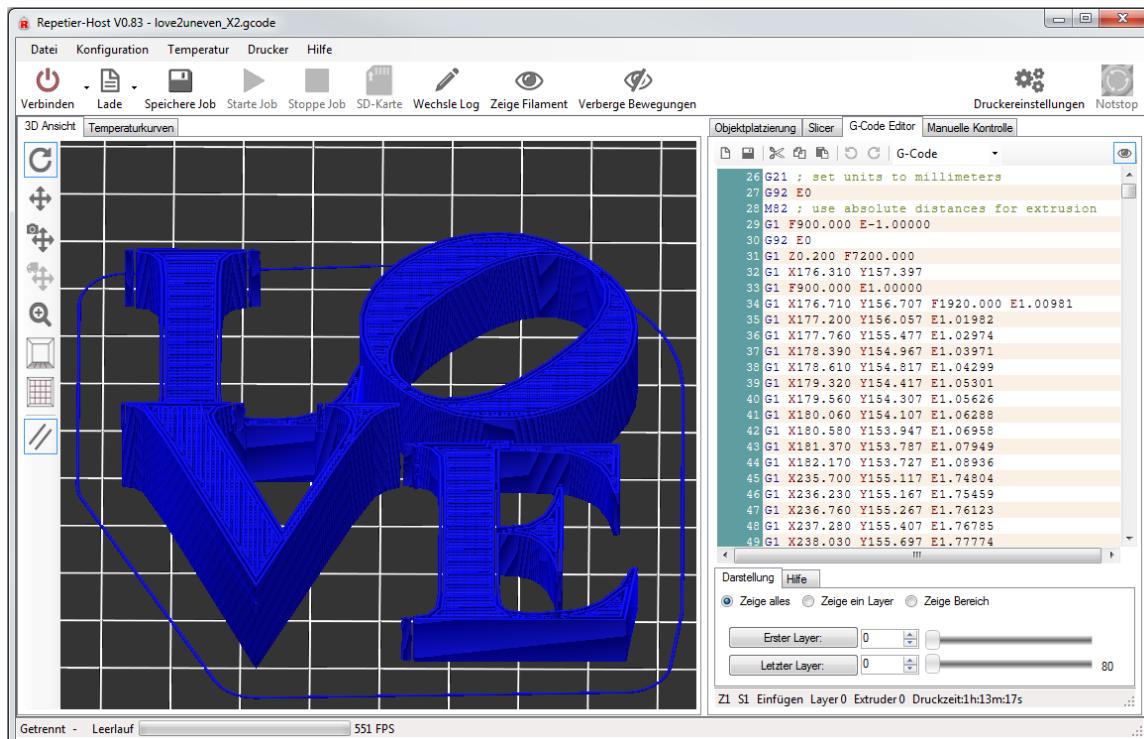
## 6.1. GCode generation

There are different programs for the generation of the GCode, e.g. *Slic3r* or *Skeinforge*. Note that *Skeinforge* is only recommended for experienced users. The main principles of those programs are quite similar, but they differ in the extent of the adjustment possibilities. The GCode is created from a *.stl* file (see image "[Example Love in STL format \[S. 247\]](#)", which is a common standard in computer-aided construction. This GCode contains the settings of the extruder, as well as the path to be driven and how much material is necessary on the different spots. The example in the image "[Example Love in GCode format \(in Repetier-Host\)\[S. 248\]](#)" shows the preview as it is displayed in Repetier-Host.

Abbildung 6.1. Example Love in STL format



Abbildung 6.2. Example Love in GCode format (in Repetier-Host)



Example: [Source](#)<sup>1</sup>

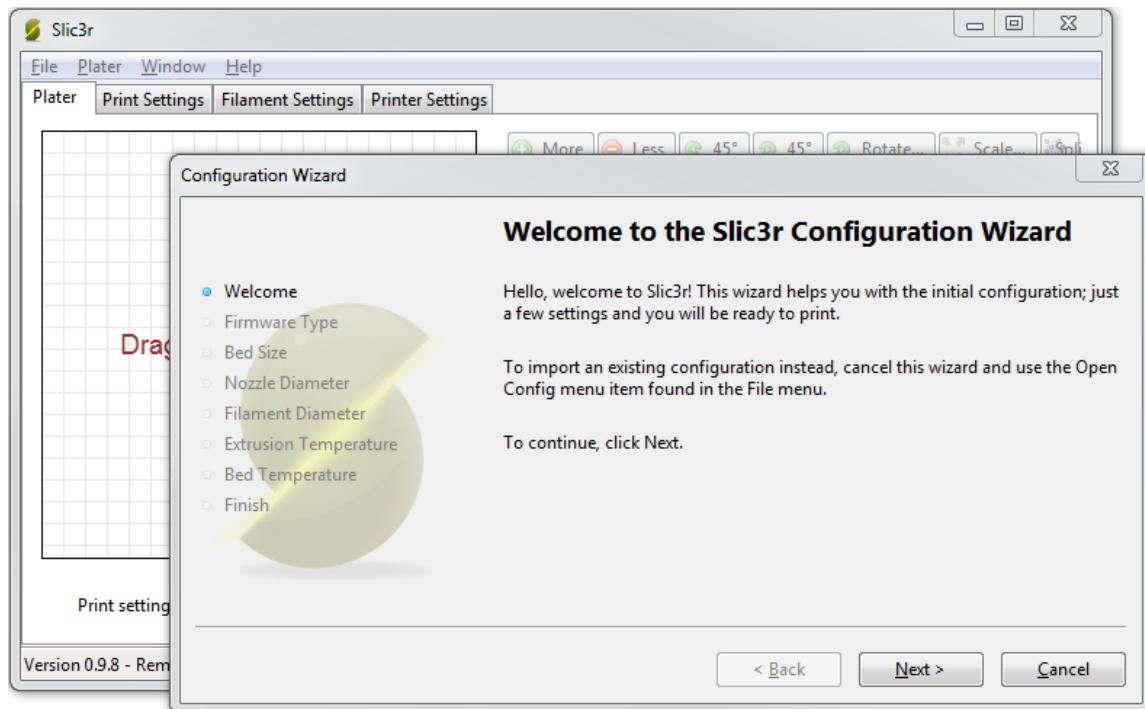
### 6.1.1. Slic3r

The tool [Slic3r](#)<sup>2</sup> is more suitable for beginners. There is a preset profile for the X400 by German RepRap GmbH that can be used even though the printer will work without the default parameters due to the limited adjustment possibilities. In case the profile is used, the "Configuration-Wizard" may be cancelled.

<sup>1</sup> <http://www.thingiverse.com/thing:6495>

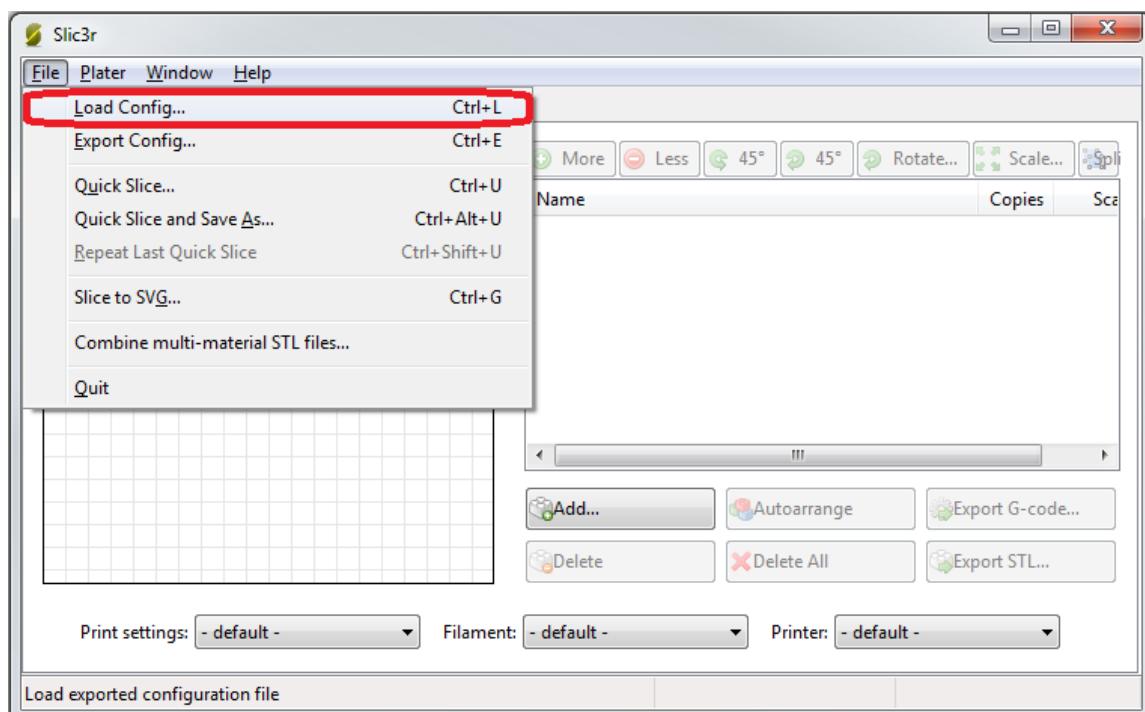
<sup>2</sup> <http://slic3r.org/>

Abbildung 6.3. Slic3r Interface Wizard



For the usage of the preset profile, it is loaded via "File -> Load Config...".

Abbildung 6.4. Slic3r Interface Load Config



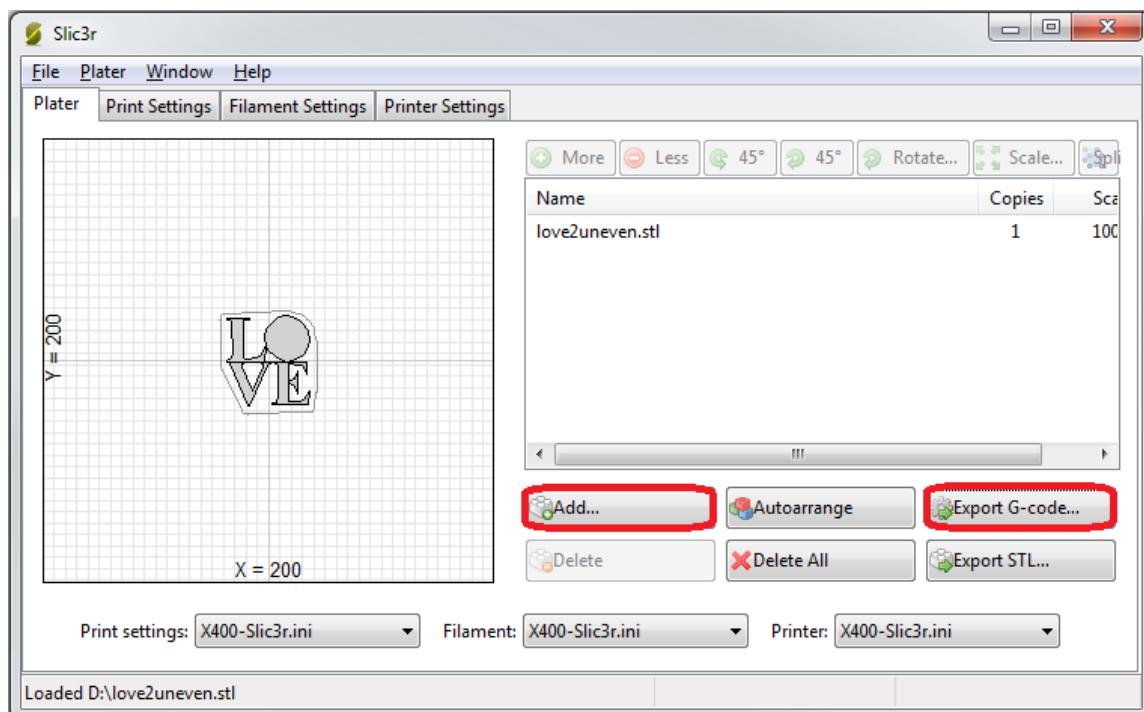
The printing results of GCodes made with slic3r become visible at an early stage. The settings for Slic3r are kept very easy and can be entered quickly. An explanation of all parameters can be found on the developers web site.



With Slic3r, it is important to save the configuration as an *.ini* file, as slic3r discards all changes when shut down. When restarting, the settings have to be loaded again before the conversion process.

Slic3r does not offer an internal possibility for a preview of the GCode, but it can be viewed via other programs. As soon as all adjustments are done, the *.stl* file is selected through "Add..." (Image: "Slic3r interface export G-Code (Windows)") and saved as *.gcode* via "Export G-Code..." afterwards.

Abbildung 6.5. Slic3r interface export G-Code



A detailed English documentation is available here: <https://github.com/alexj/Slic3r/wiki/Documentation>

Example: [Source](#)<sup>3</sup>

## 6.2. Printer control

There are different programs for the operation of the printer. We recommend to use "Repetier-Host", as it is simple to use and has the largest range of functions.

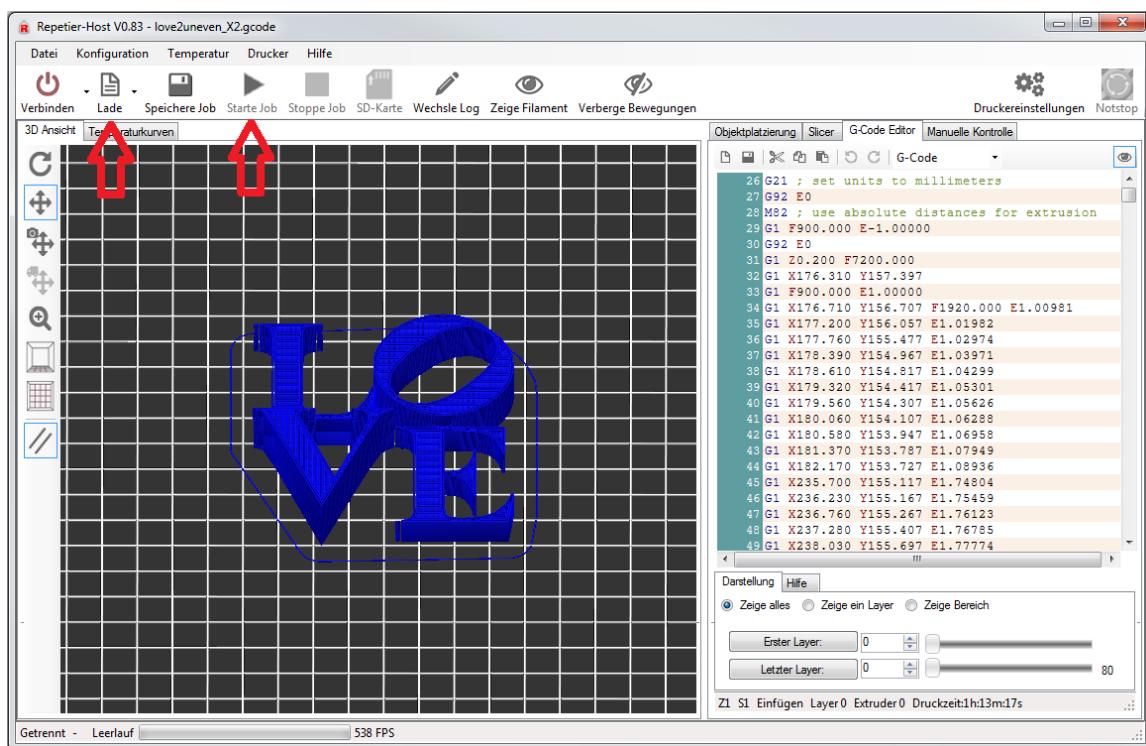
<sup>3</sup> <http://www.thingiverse.com/thing:6495>

However, it is possible to use a different software to operate the X400, as it is compatible with all common RepRap printer operating programs.

### 6.2.1. Repetier Host

The Repetier-Host is the central point to operate the printer. The item "Load" (Image "[Repetier-Host loading and printing \[S. 251\]](#)") is selected to load a .gcode file. Afterwards, the object is displayed in the virtual printing room.

Abbildung 6.6. Repetier-Host loading and printing



After the object has been checked regarding position, size and possible bugs in the object, the print job may be started using "Start job" (image "[Repetier-Host loading and printing \[S. 251\]](#)").

By the end of the process, the completed part should lie on the printing bed (image "[LOVE printed \[S. 252\]](#)") and when cooled down, it can simply be removed or pried from the bed.



Abbildung 6.7. LOVE printed



Example: [Source<sup>4</sup>](#)

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<sup>4</sup> <http://www.thingiverse.com/thing:6495>



## Kapitel 7. Troubleshooting



### Service

If you have questions regarding the commissioning or operation or in case of a problem, please contact your stockist or the support of the company German RepRap GmbH via their website (<https://www.germanreprap.com>).

### 7.1. The printer cannot be connected with the repeating host

In case the connection with the printer via Repetier-Host fails, it has to be checked whether a different program uses the port "COMx" for the communication with the printer., e.g. the Arduino software. Quit the other software if necessary. After that, or if no other program uses the port "COMx", the reset button has to be pressed to restart the printer. Unplugging and replugging the USB cable has the same effect. Now the printer should be available.

### 7.2. No commands are transmitted to the printer

If no commands like movements of the axes or heating of the hot end are transmitted to the printer via the Repetier-Host, the electrical supply has to be checked. Make sure the power supply is switched on and connected to the RAMPS. In case the problem persists and is not related to the power supply, updating the firmware may solve the issue.

### 7.3. The motors cannot be controlled

Problems with the controlling of the motors can have different reasons. At first it should be verified that the power supply of the RAMPS electronics is switched on and correctly wired. In case the electrical supply is not the problem, the wiring of the motors may be at fault. If the difficulty with the motors still persists, check whether the firmware was correctly transferred onto the Arduino board. This can simply be validated by heating up the hot end.

### 7.4. The Y-axis cannot be moved and only produces loud noises

If both motors are clicking but the Y-axis is not moving, the wiring of the Y-axis might be at fault. As shown in the "[Circuit diagram \[S. 193\]](#)", the Y-axis motors have to be wired with opposite polarity, meaning the motors are supposed to move in different directions.

### 7.5. The motors rotate in one direction only

If the motors only rotate in one direction, the problem lies with the end stops. In that case, the functionality of the end stops has to be checked. The LED has to flash when switched on and the light barrier is not broken. The LED should stop flashing when the light barrier is broken, e.g. with a screwdriver.



Once the function of the end stops has been verified, the cabling has to be checked. Also, the end stops have to be plugged on the "min" contacts of the Ramps, as those limit the downward movements. The upper restriction of the movement is preset via the firmware.

## 7.6. Too little material is printed

At first, it has to be checked whether there is a mechanical problem. If the extruder motor rotates but no material is coming out of the hot end, the hot end might be blocked. Also, the filament screw might be at fault, so that it is not conveying material to the hot end. Once the mechanics are checked, the flow rate has to be increased. In Slic3r, this is adjusted via the item "*Extrusion multiplier*".

## 7.7. The printer breaks off printing and stops responding

If the printer breaks off the printing process there are three possible reasons. First, it should be checked whether the power supply was interrupted. The problem may also be caused by an interruption of the data connection to the computer, the crashing of a program or a disconnected USB cable.

If neither is the case, it is possible that the Pololu shut down due to overheating. This can easily be validated by touching the Pololu heat sink. Thirdly, the Ramps fan might not sufficiently cool the Pololus or the potentiometer may be set too high.

If the potentiometer can not be decreased due to possible step losses, it has to be examined whether the motor works against an increased resistance, e.g. some misalignment of the rods after moving or bumping the device. This resistance would have to be eliminated and the potentiometer readjusted afterwards.

## 7.8. Glue on of the PET-foil bubble-free

To attach the PET-foil bubble-free on the printing bed we advise the following:

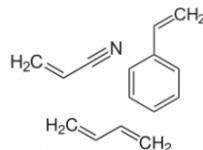
- moisten the printing bed with water or window cleaner
- apply the PET-Foil on the dampish surface (remove carrier foil from the PET-foil)
- displace and absorb the excess fluid (with such as squeegee or check card)
- heat up the heated bed (if available) at 30°C until all the fluid is not longer present.

## Glossar

**Acrylnitrile butadiene styrene (ABS)**

Acrylnitrile butadiene styrene (short ABS) ABS is a terpolymer made by polymerizing styrene and acrylonitrile in the presence of polybutadiene. The proportions can vary from 15 to 35% acrylonitrile, 5 to 30% butadiene and 40 to 60% styrene. ABS is amorphous and therefore has no true melting point.

Abbildung 323. Monomers of ABS



**Arduino**

Arduino is a free Open Source hardware platform which was developed with regard to flexibility and simplicity. The website of the project is <http://arduino.cc>

Abbildung 324. Arduino Logo



**Gleitlager (Funktion)**

Für jede Aufgabe des Lagers steht eine Komponente der Werkstoffe: Die Basispolymere sind entscheidend für die Verschleißfestigkeit. Fasern und Füllstoffe verstärken die Lager, so dass auch hohe Kräfte oder Kantenbelastungen aufgenommen werden. Festschmierstoffe schließlich schmieren die Lager selbständig und vermindern die Reibung des Systems.

**Inkorporierte Schmierung**

Die Festschmierstoffe sind als mikroskopisch kleine Partikeln, dafür aber millionenfach in winzigen Kammern in dem festen, meistens faserverstärkten Material eingebettet. Aus diesen Kammern geben die Gleitlager winzige Mengen der Festschmierstoffe frei. Das reicht aus, um die unmittelbare Umgebung ausreichend zu schmieren. Die Festschmierstoffe helfen, den Reibwert der iglidur®-Lager zu senken. Sie sind nicht unverzichtbar für die Funktion der Lager, haben aber eine unterstützende Wirkung. Da sie in den winzigen Kammern eingebettet sind, können sie sich nicht wegdrücken. Sie sind immer da, sobald sich das Lager oder die Welle in Bewegung setzt.

**Polyamide (PA)**

The term Polyamide is usually a description for synthetic, technically usable thermoplastics and therefore differentiates this substances from the chemically related proteins.

**Polylactic acid (PLA)**

Polylactic acid or polylactide (PLA) is a thermoplastic aliphatic polyester derived from renewable resources. One route to poly(lactic acid) is the direct condensation of lactic acid monomers. Polymerization of a racemic mixture of L- and D-lactides usually leads to the synthesis of poly-DL-lactide (PDLLA), which is amorphous. Use of stereospecific catalysts can lead to heterotactic PLA which has been found to show crystallinity. The degree of crystallinity, and hence many important properties, is largely controlled by the ratio of D to L enantiomers used, and to a lesser extent on the type of catalyst used.

**Polystyrene (PS)**

Polystyrene (short PS, other name : Thermocole) is an amorphous or semi-crystalline thermoplastic. Amorphous Polystyrene is a very popular plastic, needed in many fields of everyday life.

**Selbstschmiereffekt**

Die Hochleistungspolymer der Gleitlager setzen sich zusammen aus: Basispolymer Fasern und Füllstoffen Festschmierstoffen Komponenten sind nicht schichtweise aufgetragen, sondern homogen miteinander vermischt. Der Vorteil dieses Aufbaus wird besonders deutlich, wenn man sich einmal die Anforderungen an die Oberfläche eines Lagers verdeutlicht: 1. Der Reibwert, der besonders durch die Oberfläche des Lagers bestimmt wird, soll möglichst gering sein. 2. Die Oberfläche darf sich unter den Kräften, die auf das Lager wirken, nicht wegdrücken. 3. Die Verschleißkräfte wirken besonders auf die Oberfläche der Lager, hier muss das Lager besonders widerstandsfähig sein. Den einen universellen Werkstoff, der all diese Aufgaben gleich gut erfüllen kann, gibt es nicht.