Sliding Legolini

3D Printed Pump-Action Repeating Mini Bow

https://legolini.com

This toy is a lot of fun, but it can be dangerous, so be careful and hide it from children, when you're not around. Do not shoot living beings, use an archery mat/backstop!

The following information will allow you to build your own 3D printed mini bow.
This project is based on the ideas of Jörg Sprave from The Slingshot Channel
https://www.youtube.com/user/JoergSprave,
combined with several of my ideas, solutions and optimization for 3D printing.

How it works? You can see https://www.youtube.com/watch?v=iYqMs2Dk4hk
or https://www.youtube.com/watch?v=SXyIkTIDxvM.

If you like this project and appreciate my work, you can support me through PayPal
https://www.paypal.me/lukaszjanikowski

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Introduction

Sliding Legolini is the 3D printed pump-action repeating mini bow with integrated quiver (magazine) for 6 arrows (bolts) and thumb triggered release. Bow is powered by TheraBand black tube rubber and has integrated ergonomic grips for both hands. Standard 160-161 mm long bolts (for pistol crossbows) can be loaded manually or automatically with additional ammo clips, after deflecting the magazine spring. Aiming is carried out using a laser sight or an additional red dot sight (with adapter mount).
The bow arms span is 360 mm. Total length about 402 mm (with large back grip).
Draw weight is up to about 22 lbs with TheraBand tube black.
Mass weight (bow only): about 0,55 kg
Mass weight (with bolts and laser sight): about 0,65 kg

To build such a bow you must have:

- FDM 3D printer with a heatbed of at least 200 x 200 mm
- About 0.5 kg of PLA filament
- 15 pieces of M3x20 mm Allen screws
- 15 pieces M3 nuts
- 2 pieces M3x16 mm screws with flat round head
- 1 piece M4x40 mm Allen screw
- 1 piece M4 nut
- 3 pieces of steel springs with a diameter 8 mm, length 20 mm and wire diameter 0.8 mm
- at least 50 cm (2x15 cm + 1x20 cm) polypropylene rope with a diameter of 3 mm
- 14 cm (2x7 cm) TheraBand tube black rubber
- 4 pieces of zip ties with a width of 3.6 mm
- cheap laser sight with total length up to 58 mm and 22 mm rail mounting (without this it's hard to shoot fast and accurately)
- round file with a diameter of 4.8 mm and a length of 200 mm, precision files, 180-240 sandpaper
- Allen wrenches, small screwdriver, sharp knife, lighter
- two-component epoxy adhesive or CA glue (for gluing 3 magazine parts)
- silicone/PTFE lubricant (optional)

3D Printing

The basic version consists of 13 elements. The design is optimized for 3D printing with a layer height of 0.2 mm. For reasons of strength and durability, I recommend printing all elements with a wall thickness of 1.6 mm (4 shells), a thickness of 1.2 mm bottom and top walls, and infill 25-30%. I also recommend printing at a slightly higher hotend temperature than usual. I recommend printing on glass bed to make the surfaces smoother. The 3D printer should be well calibrated (extruder steps, flowrate, first layer height). It takes about 40-50 hours to print all basic parts (depends on the 3D printer).

If you are left-handed you must mirror *bow_grip* and *bow_arm* in the slicer program and use *mirrored_bow_slider_for_left_handed*.

STL files *back_grip_part1*, *back_grip_part2* and *release* are available in 3 different sizes. You can choose the right one for the size of your hand. In the basic version it is the medium size, which is the

most universal. As an option, the "*optional_small_...*" version is available for children, younger teens and women with smaller hands, and the "*optional_large_...*" version for people with larger hands.

If you live in Germany, you should print special *german_magazine_part1* with a custom 16 mm rail and dedicated "*german_*" adapters for a regular 15x68 mm round laser.
All because in this country a laser intended for weapons mounted on a standard 11 or 22 mm rail is illegal.
You need also 2 pieces M3x8 mm screws and 2 pieces M3 nuts for each adapter.

If you have a 3D printer with a larger print bed, you can print *magazine_part1* and *magazine_part2* as one part using STL file *combined_magazine_part1+2*, or if you live in Germany *german_combined_magazine_part1+2.*

If you do not want to print standard bow parts with integrated hooks (*bow_arm*, *bow_grip*) because you are afraid of damaging the parts during their separation after printing (for example low cooling - PETG or ABS), you can use STL files with the prefix "*separated_*". In this case, you need to use additional supports in the slicer to print these parts separately.

If you want Legolini to be more compact and slightly stronger, you can print "*slingbow_*" arms and grip. Check the "Slingbow version" chapter. This is more of an experimental version and I recommend making a basic version because the rest of the part is not optimized for this slingbow version.

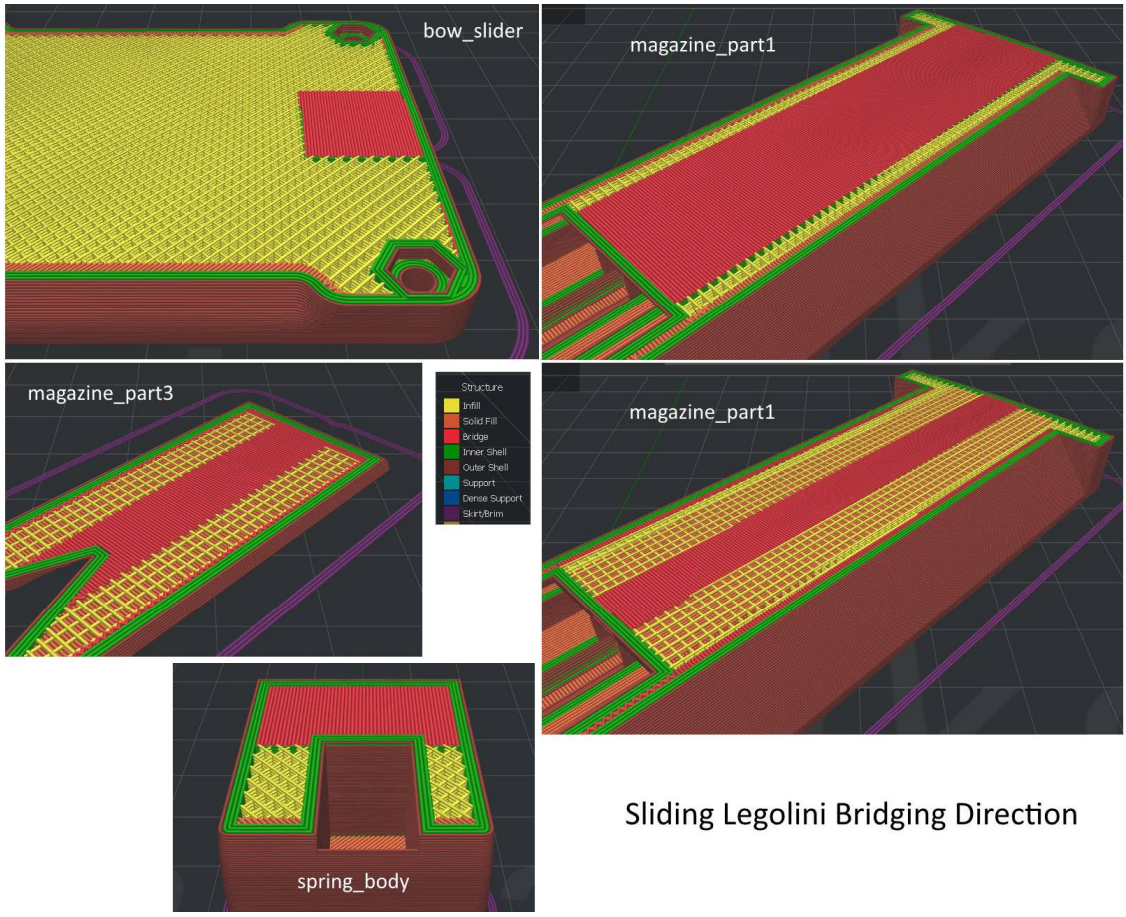
Recommended orientation of elements during printing is illustrated by the pictures below. The pictures also show other elements necessary to make a bow. All 3 magazine parts on smaller printers must be printed diagonally, rotated 45 degrees.


Sliding Legolini

Pay special attention to *bow_grip* printing. Due to the large rounding of the grip, you need to increase the temperature of the hotend, increase flowrate by 10-15% and reduce the print speed of the shell to 20-30 mm/s on the first 5 layers.

Parts do not require additional supports. The only part that has designed internal supports is *magazine_part1*.

Pay attention to the correct direction of bridging when preparing gcode in a slicer program. The most important bridges are shown below.



Sliding Legolini Bridging Direction

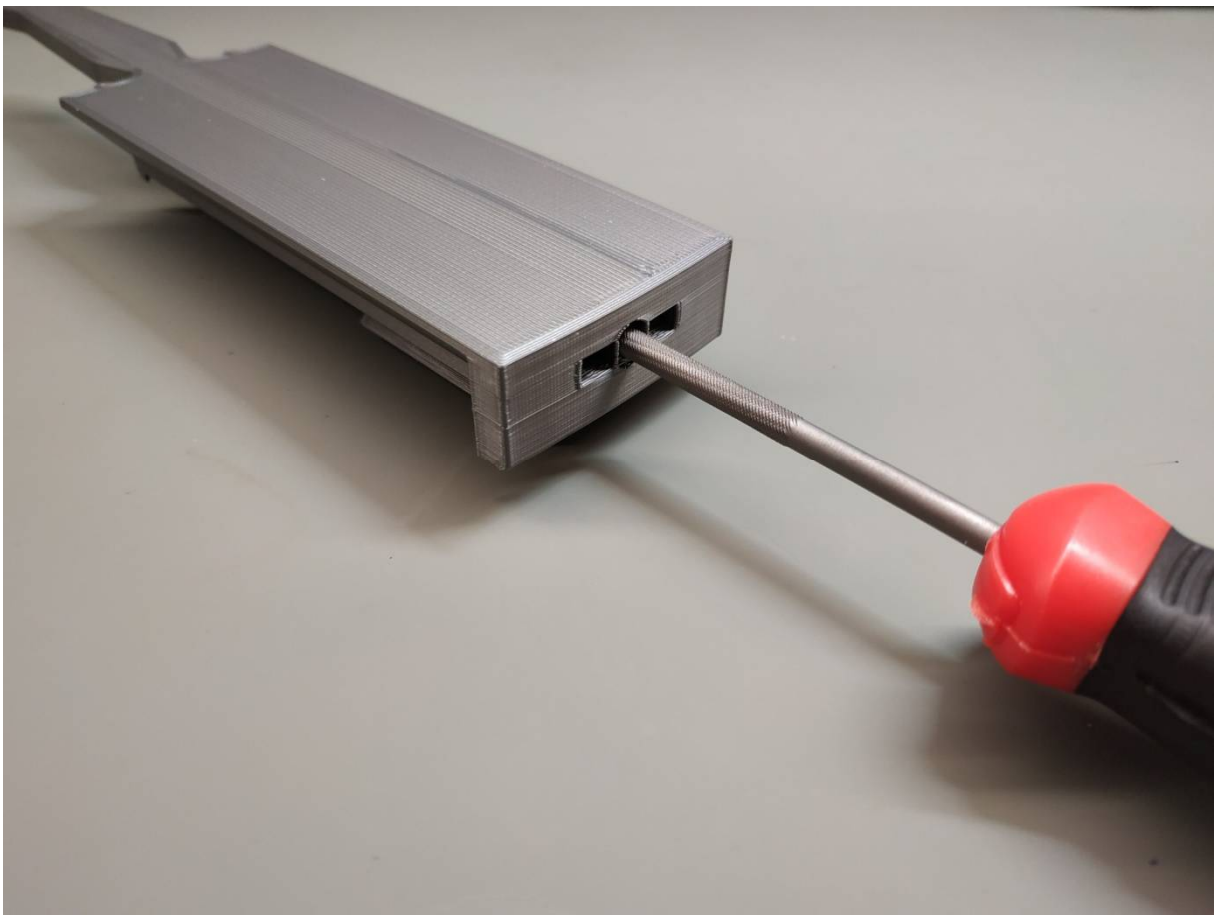
Sanding and smoothing

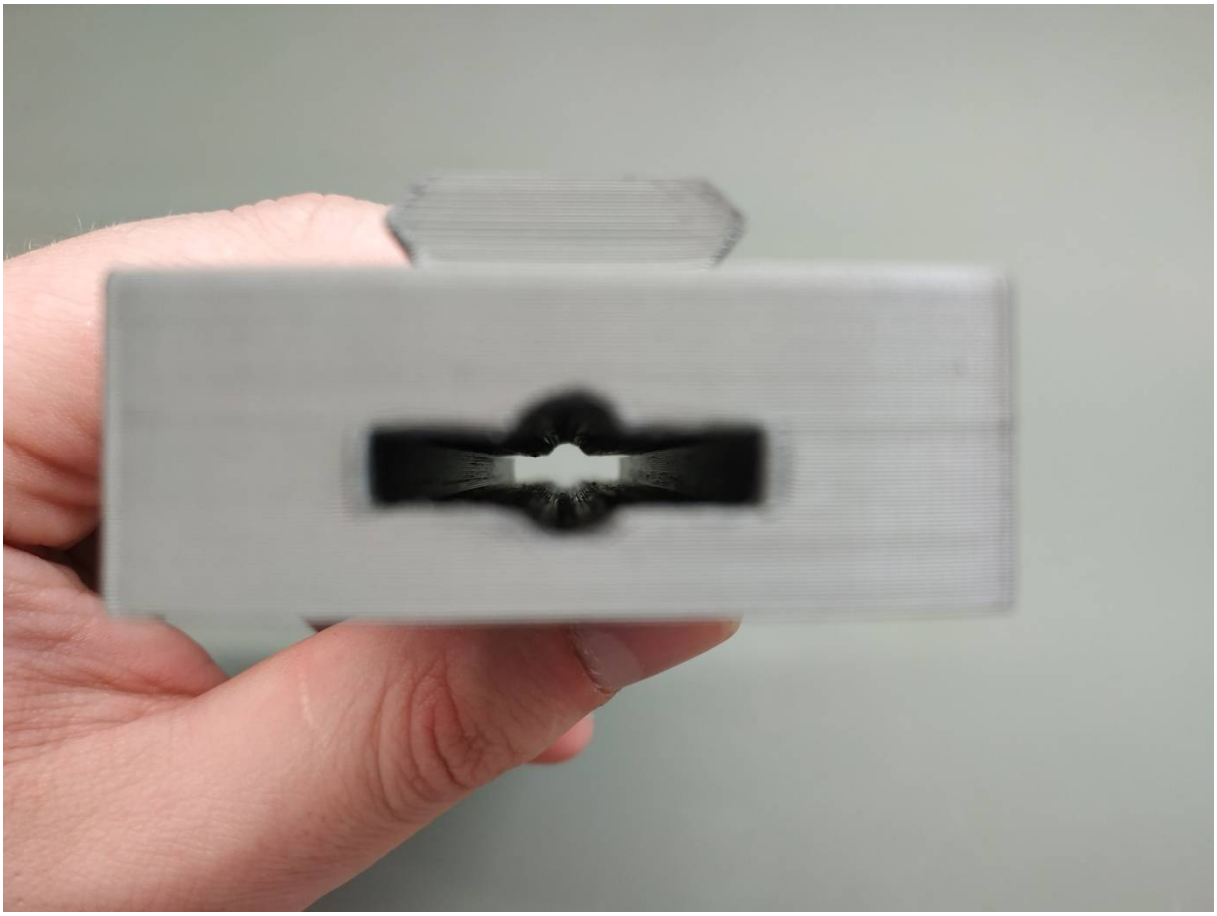
After printing, it is absolutely necessary to sand and smooth all print surfaces. All blobs and overflow of filament should be removed. The most important are the upper surfaces of prints, arrow guide ("barrel"), string slot and inside magazine.

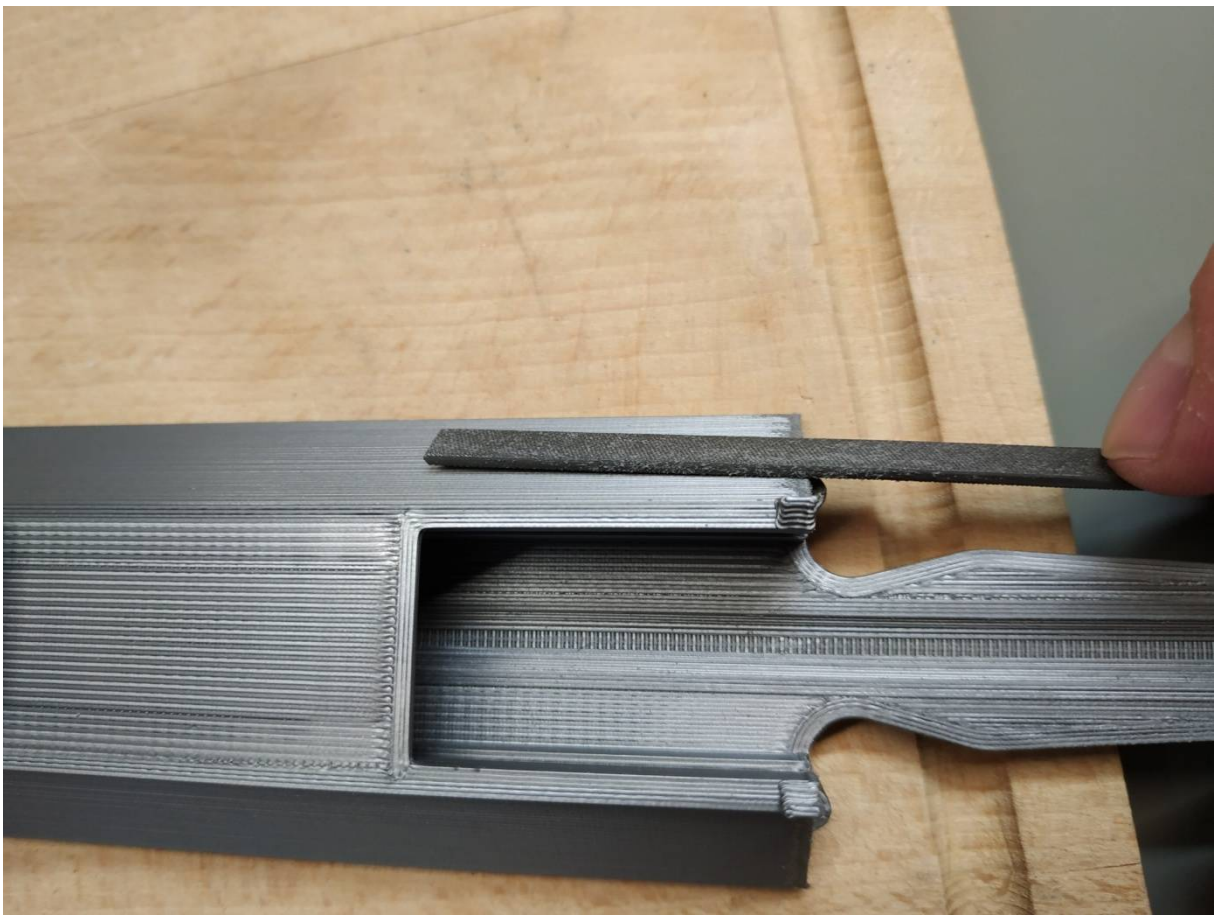
Start from *magazine_part1*. This is the element that requires the most work, but there is no other option to print it as one part. You need to remove the supports in the barrel and file the hole for the arrow. Use the long round file to remove upper support first. Then you can break vertical supports with a screwdriver and file the remains with a flat file. Use the long round file to match the hole to the arrow. The arrow must slide out of the hole quite smoothly, but without unnecessary slack.

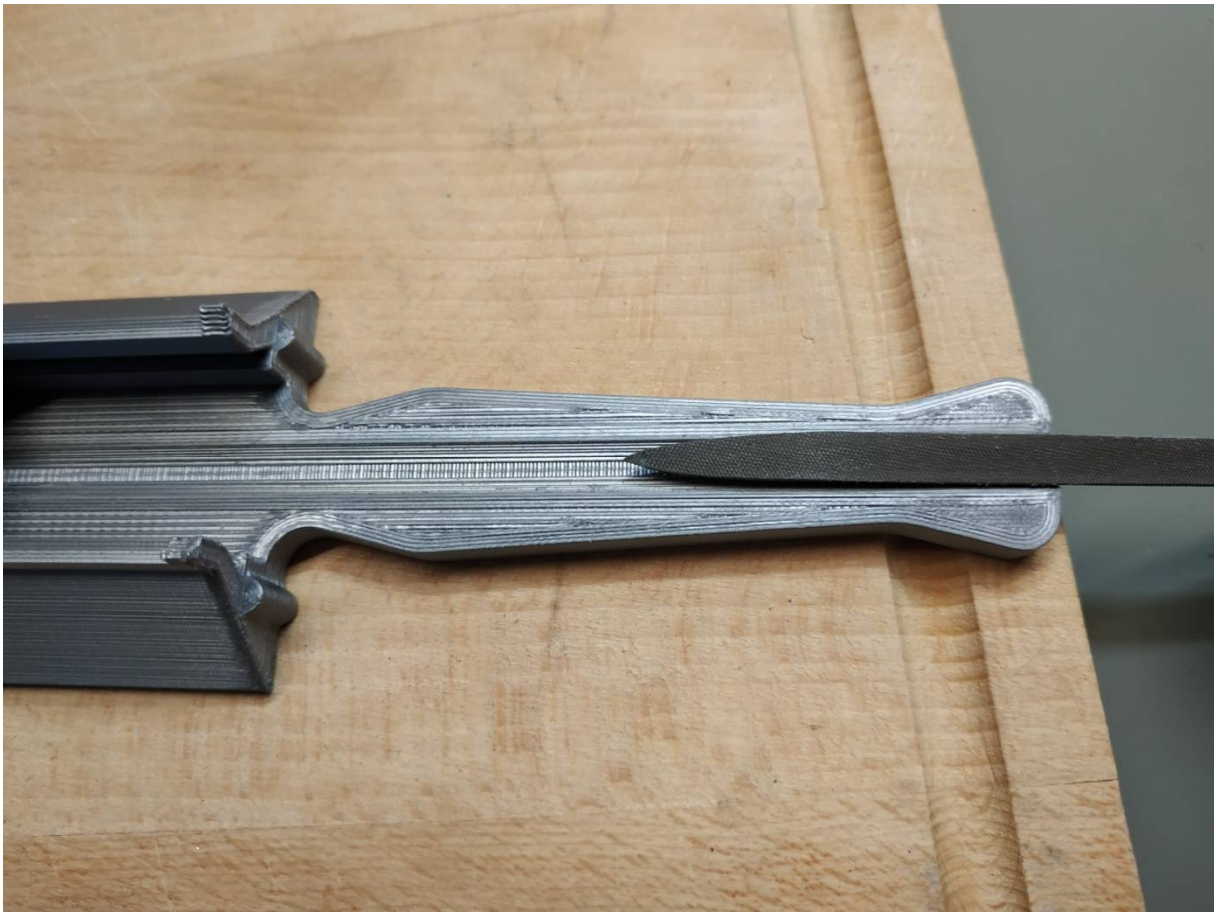
Below are some illustrative photos of magazine parts. When filing these elements, check that the bolt moves easily.

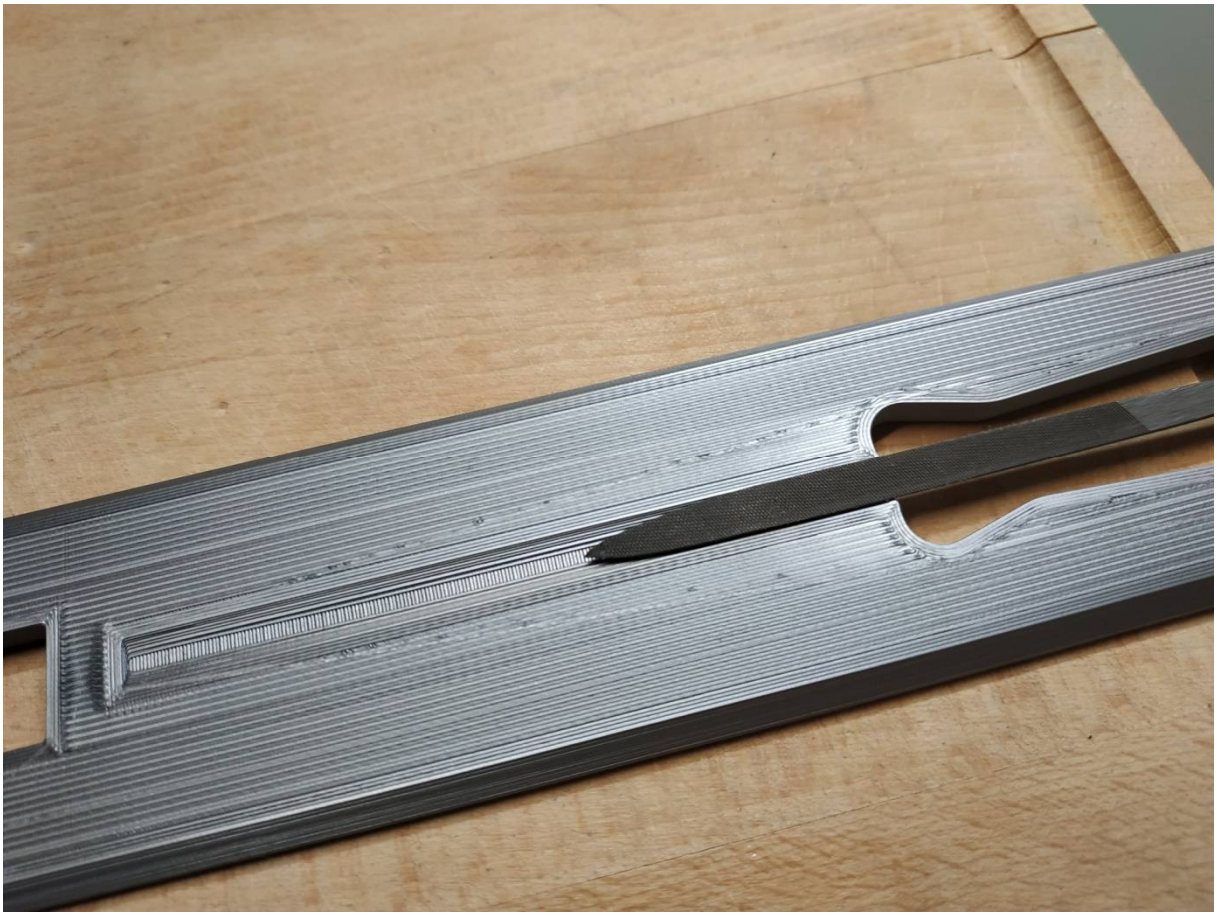
You need to carefully check all the 3D printed elements and perform sanding and smoothing if necessary.

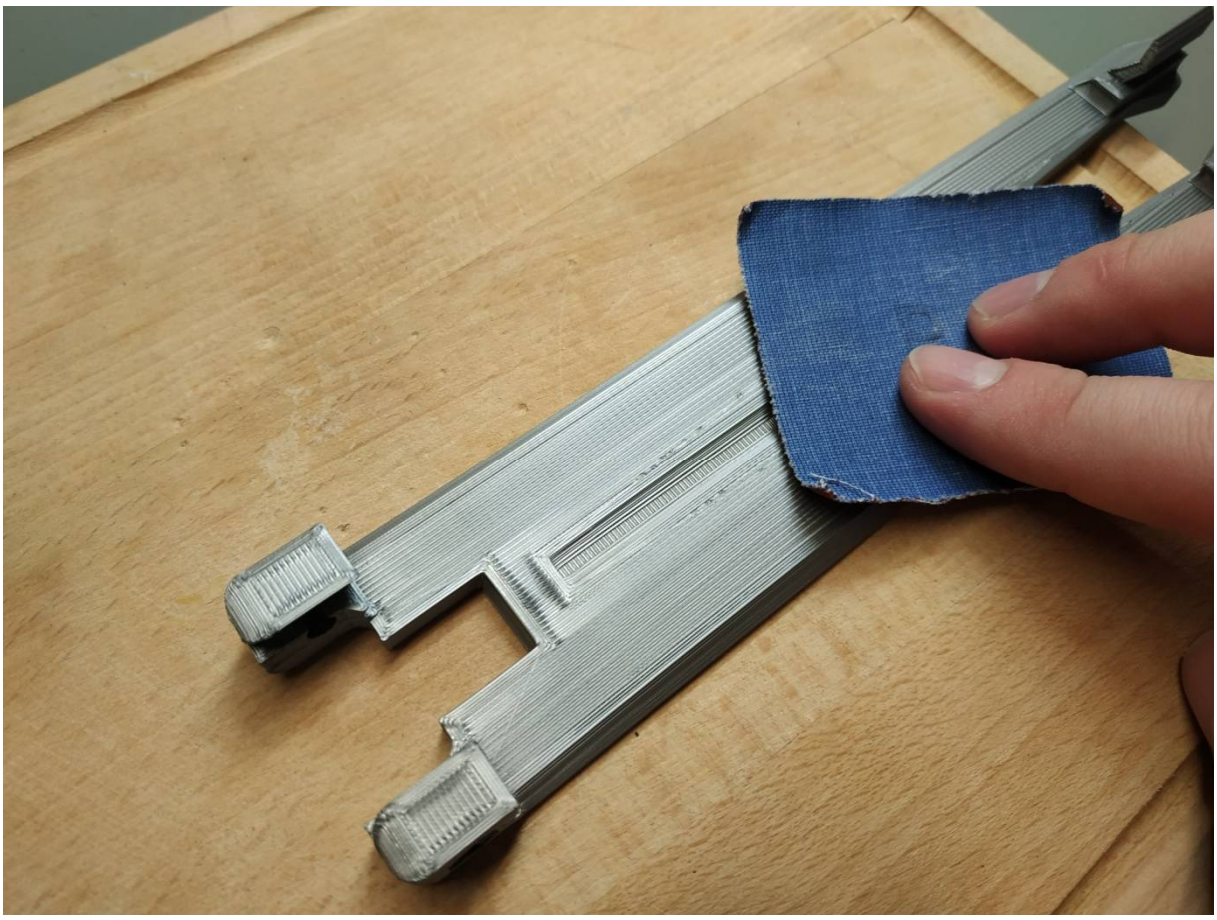


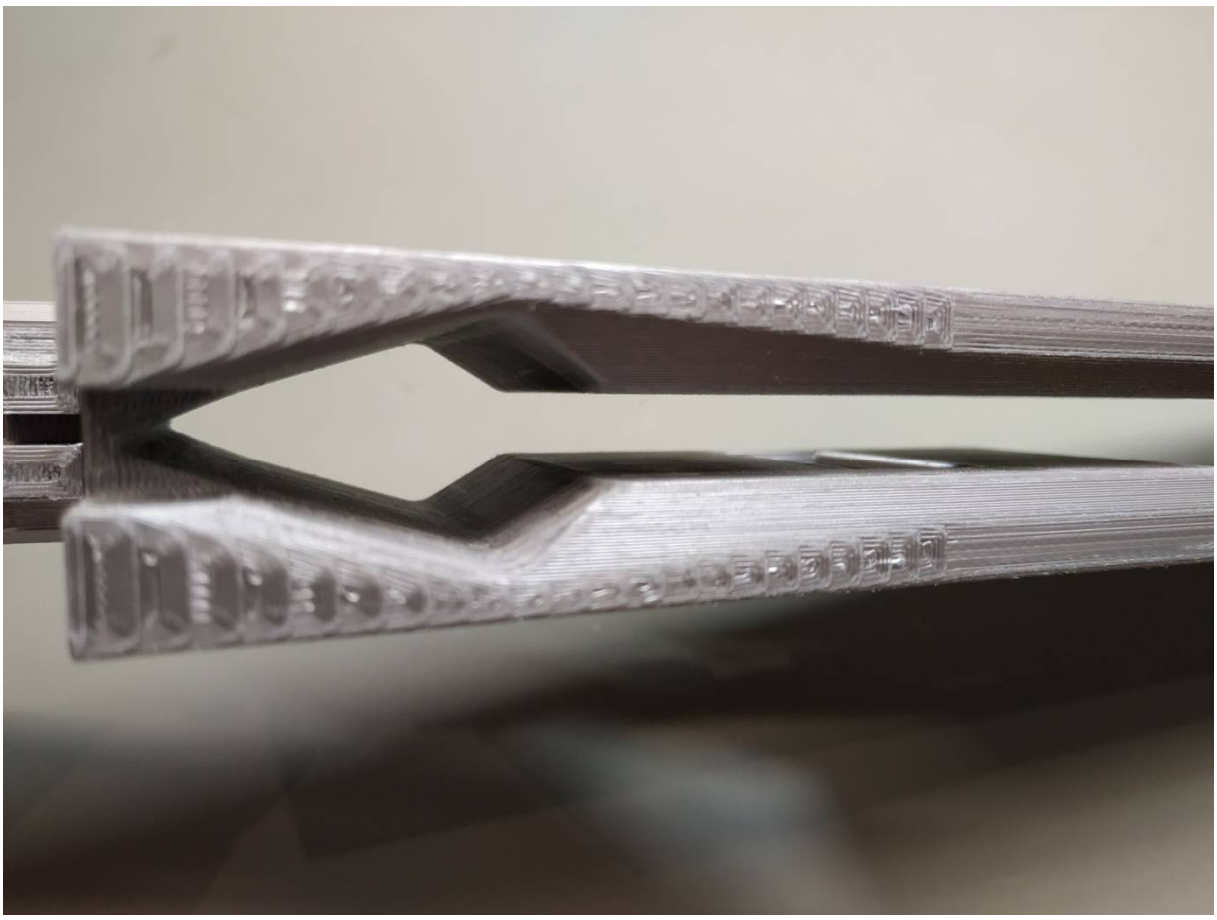










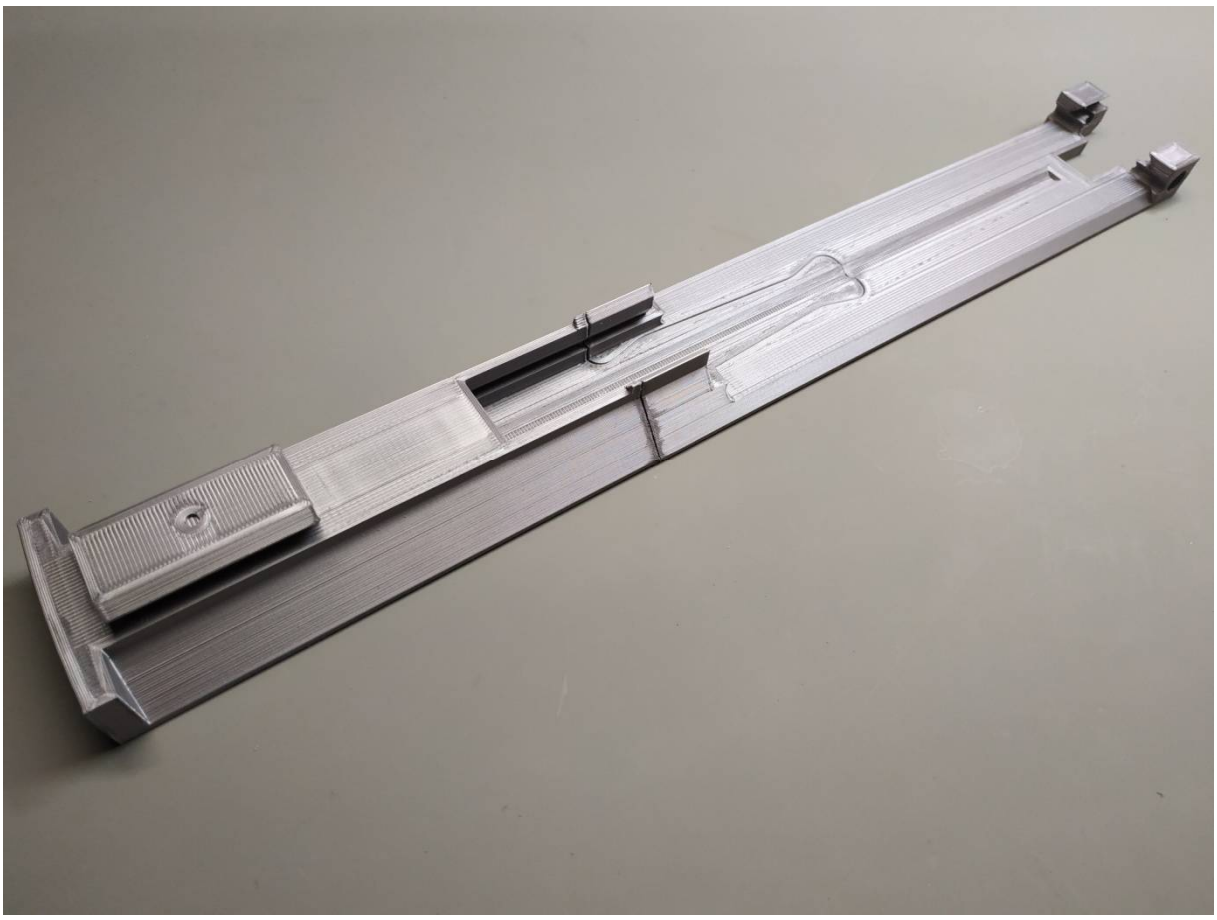


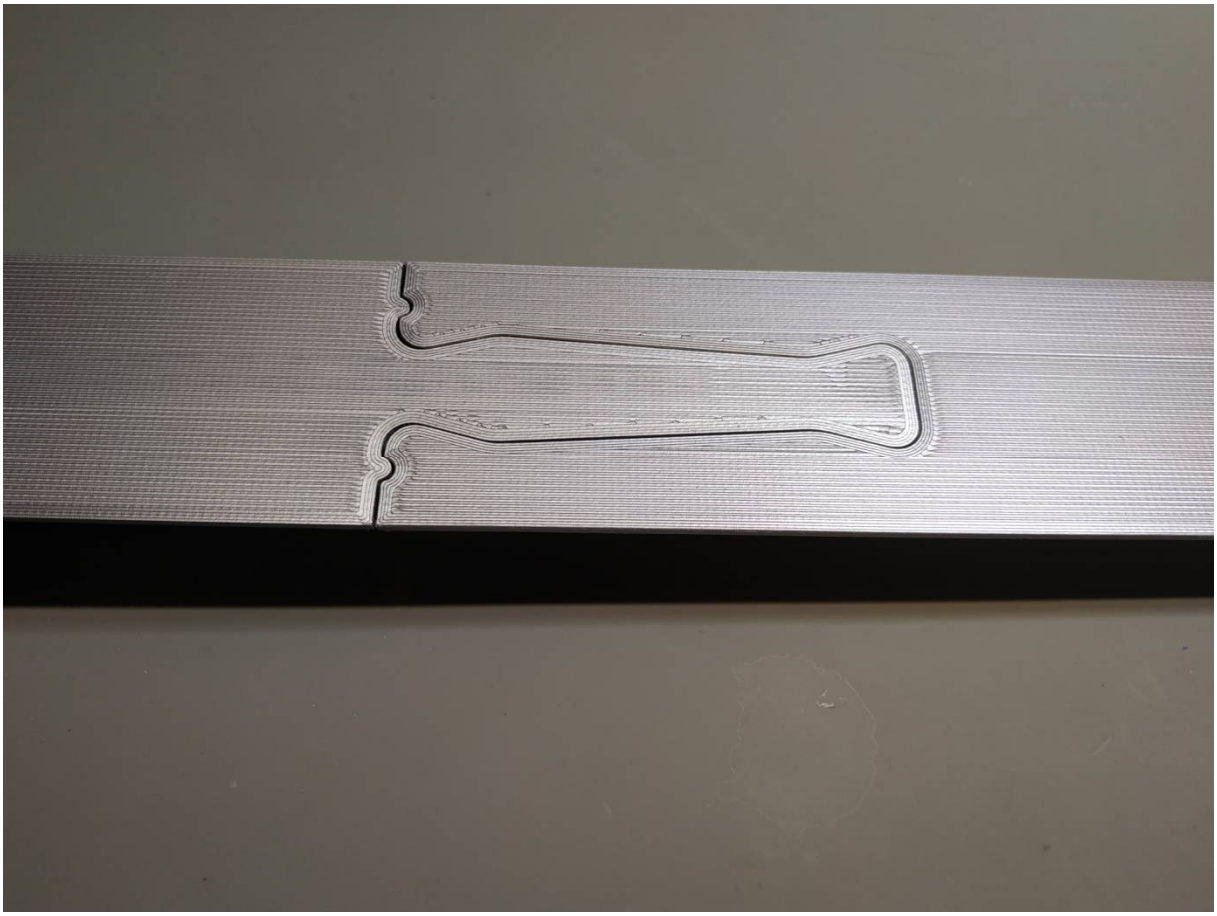
Magazine parts

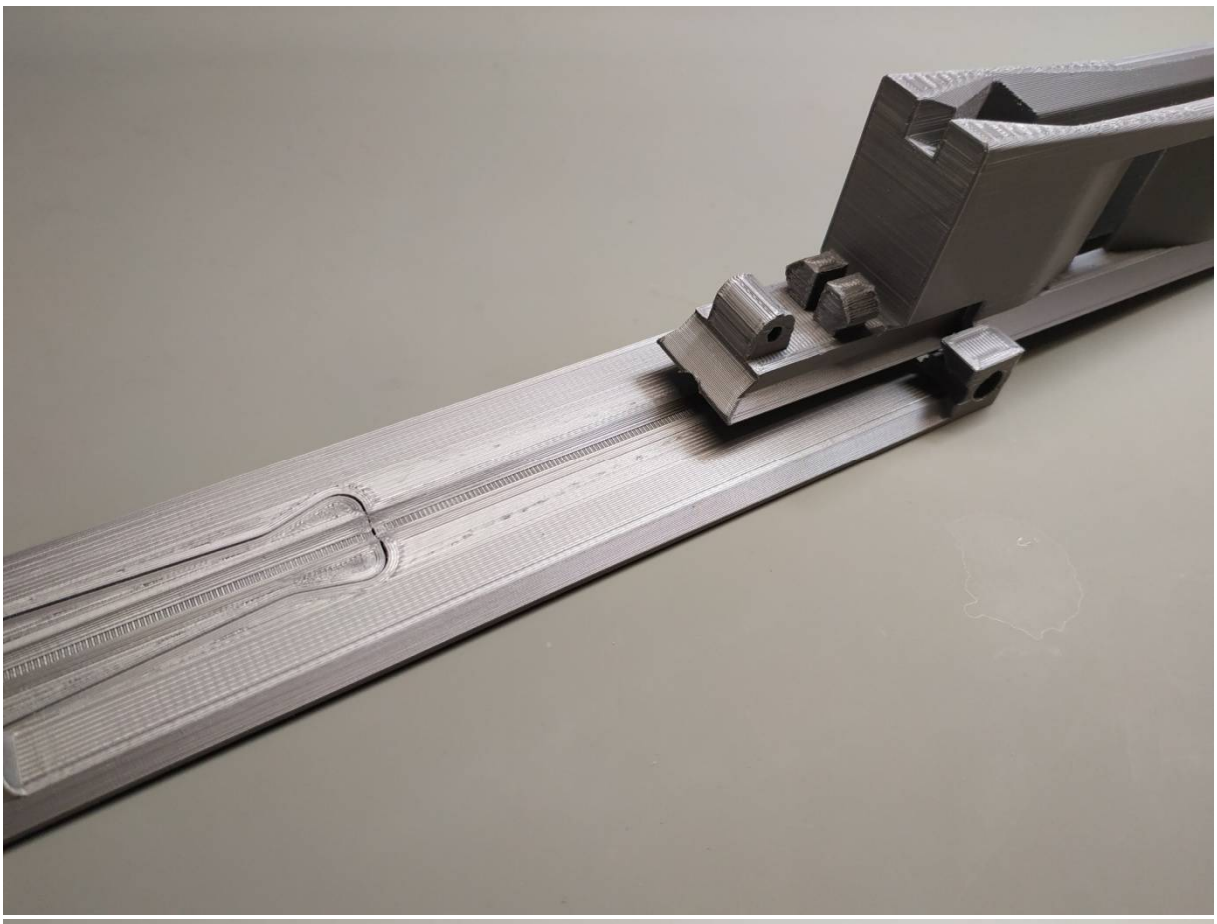
If all parts are already smooth, you can proceed to assemble.

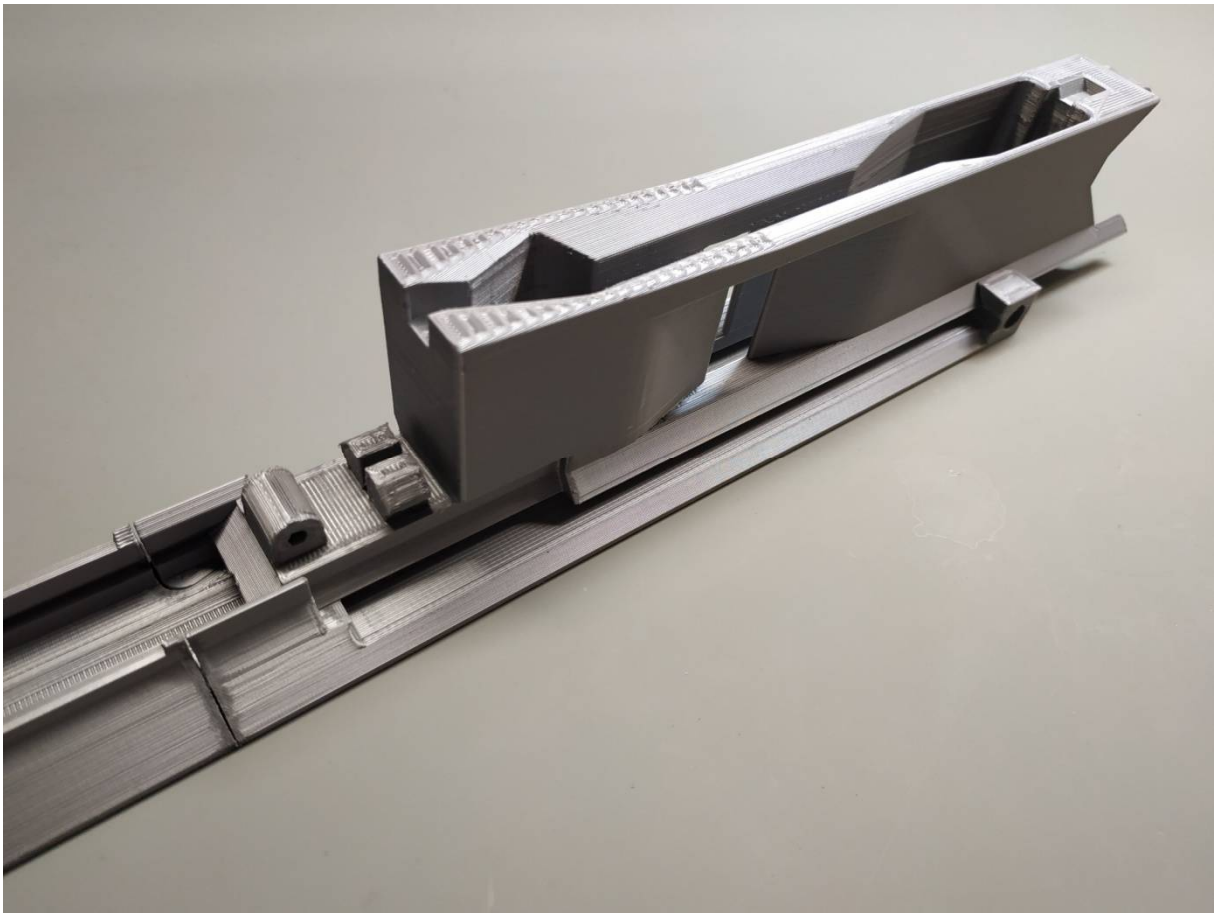
We'll start with the elements of the magazine. All three parts should be glued together. Before gluing, be sure to dry check if all the parts fit together.

On *magazine_part1*, slide *magazine_part2* from above. Then slide it into the folded *magazine_part3* backwards.



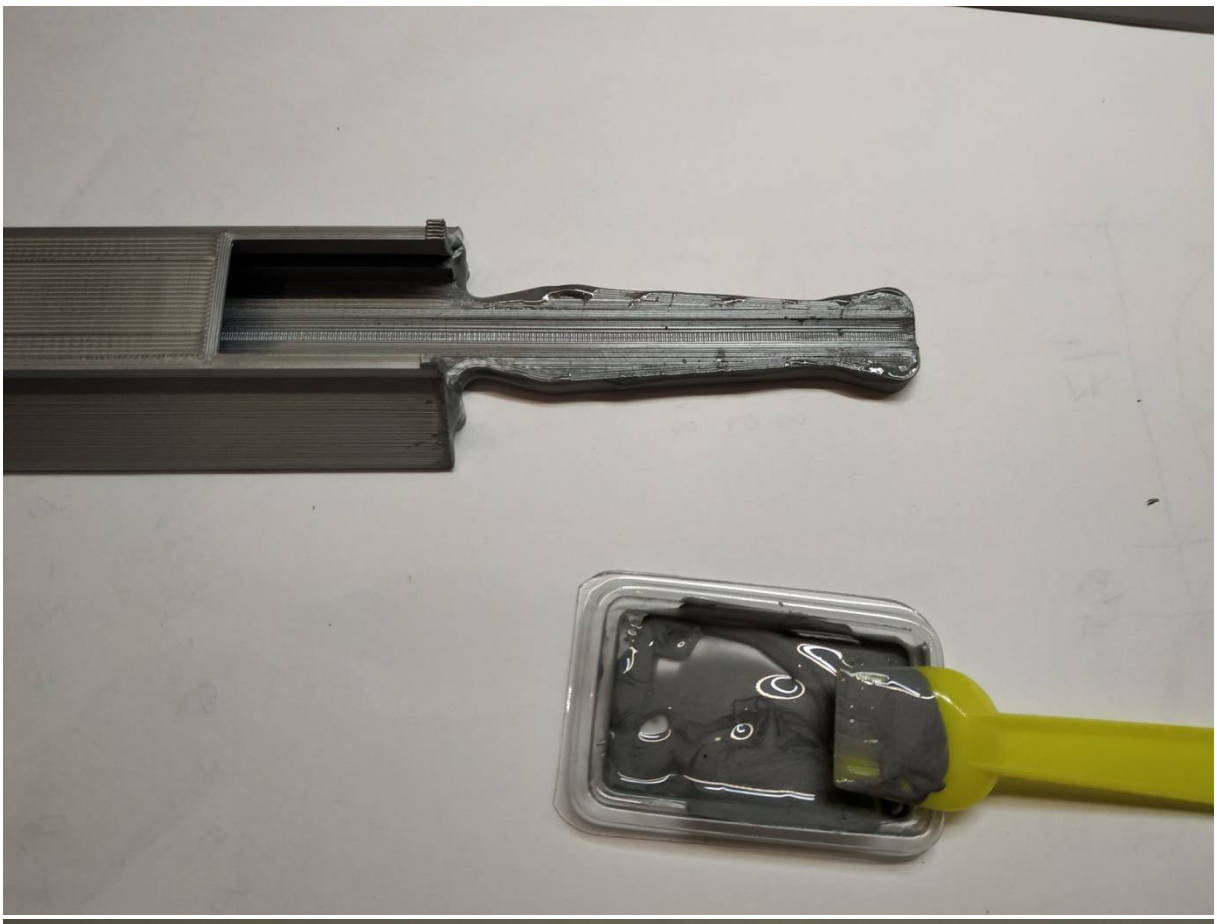


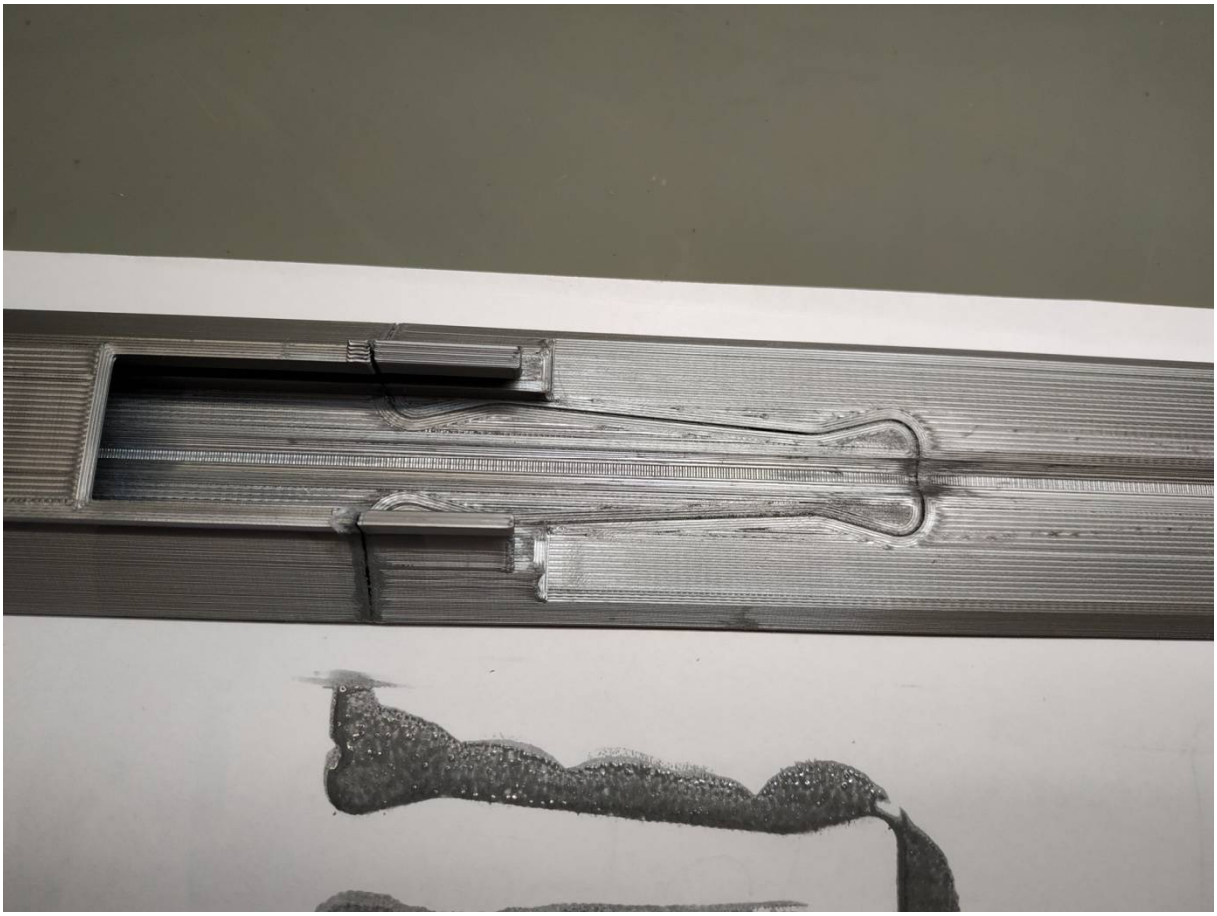


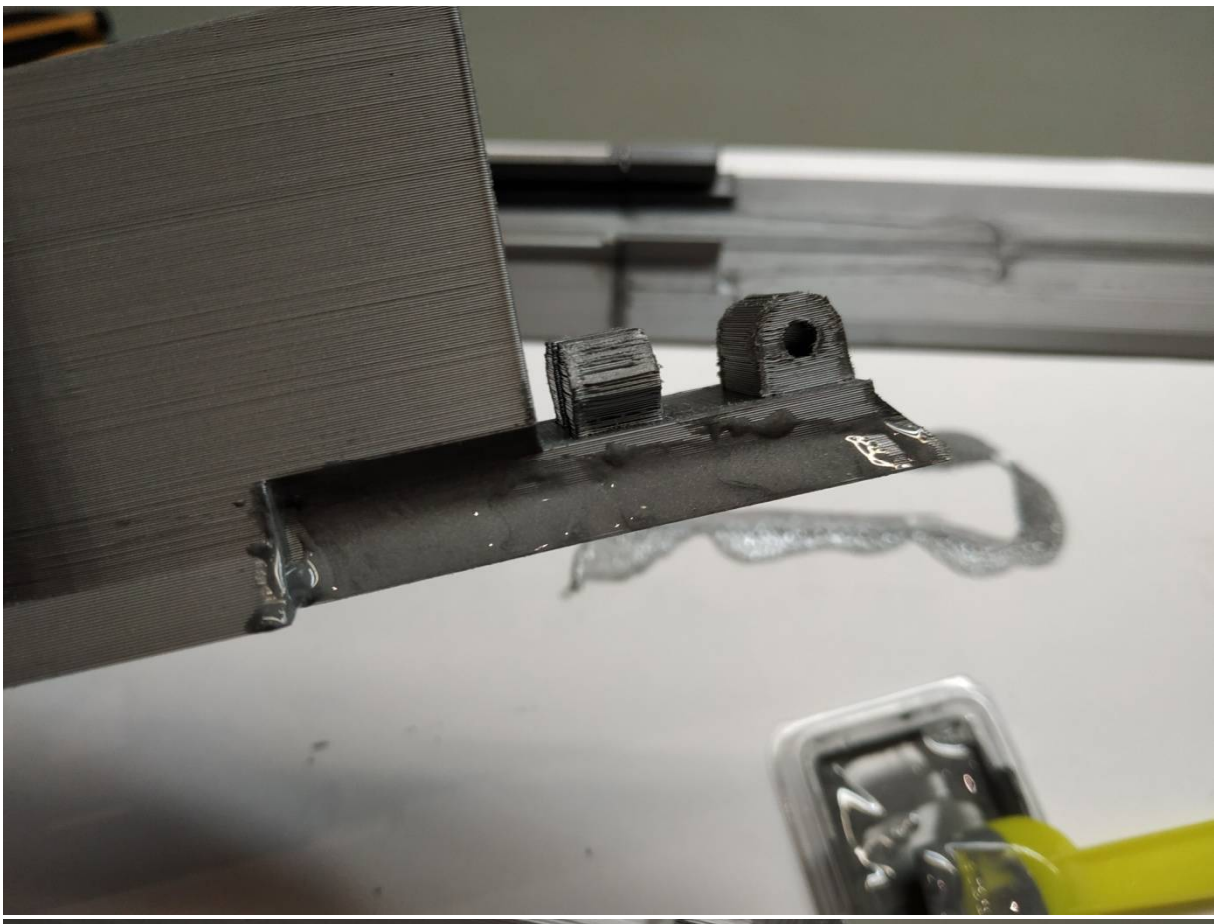


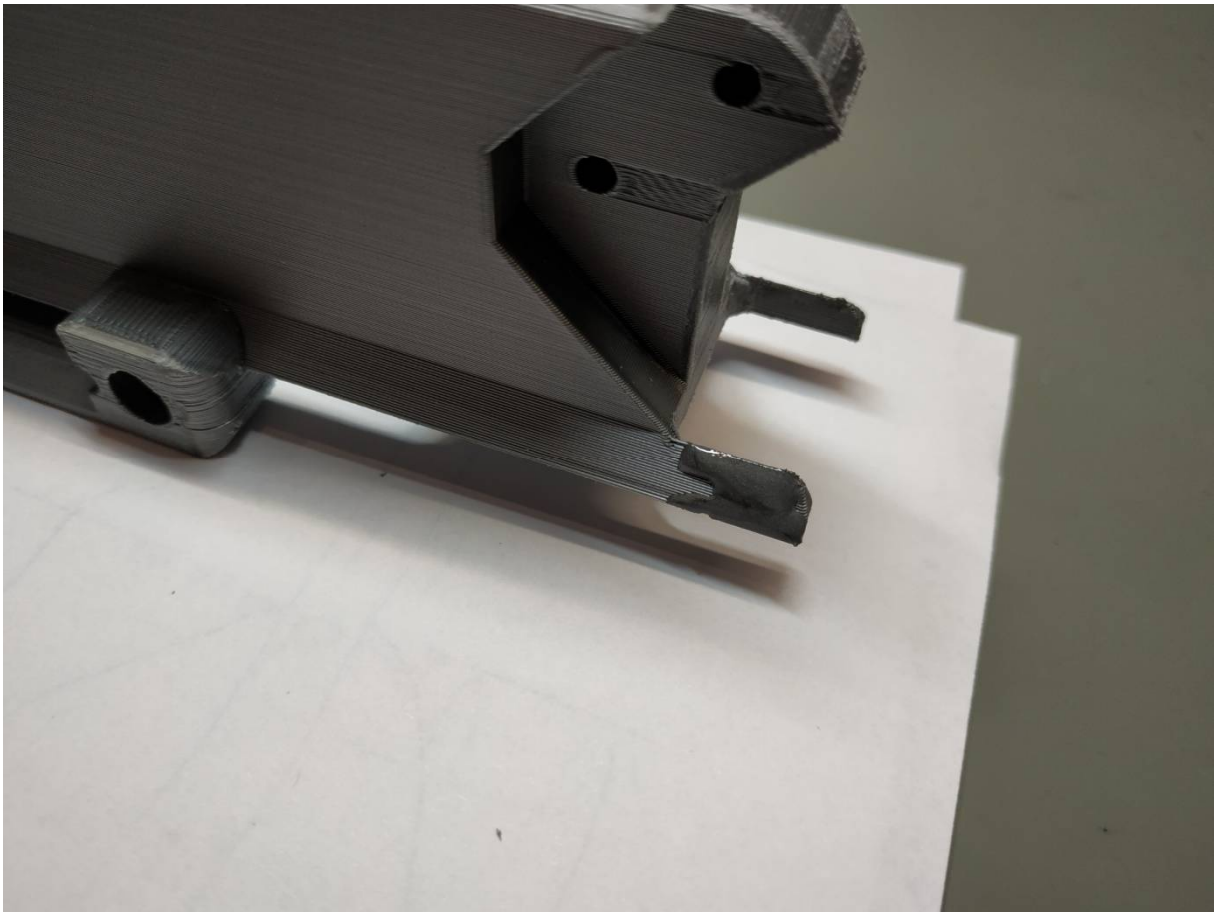
If everything fits, you can split the parts and then glue them together. I recommend using a two-component epoxy adhesive. CA glue is also effective in the case of PLA, but gives a short time for possible adjustments of the arrangement of elements.

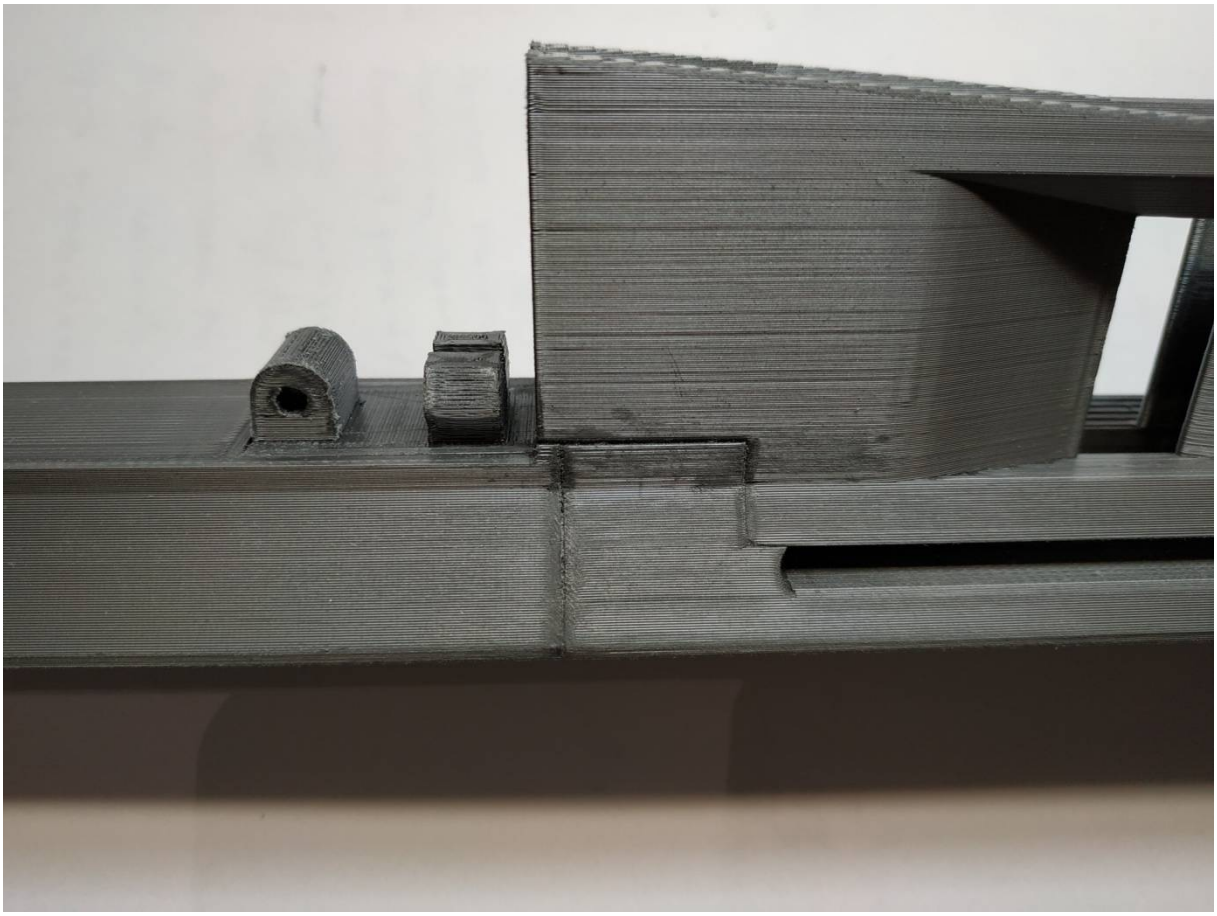
Excess glue should be removed immediately after gluing. After the adhesive dries, sand the surfaces.







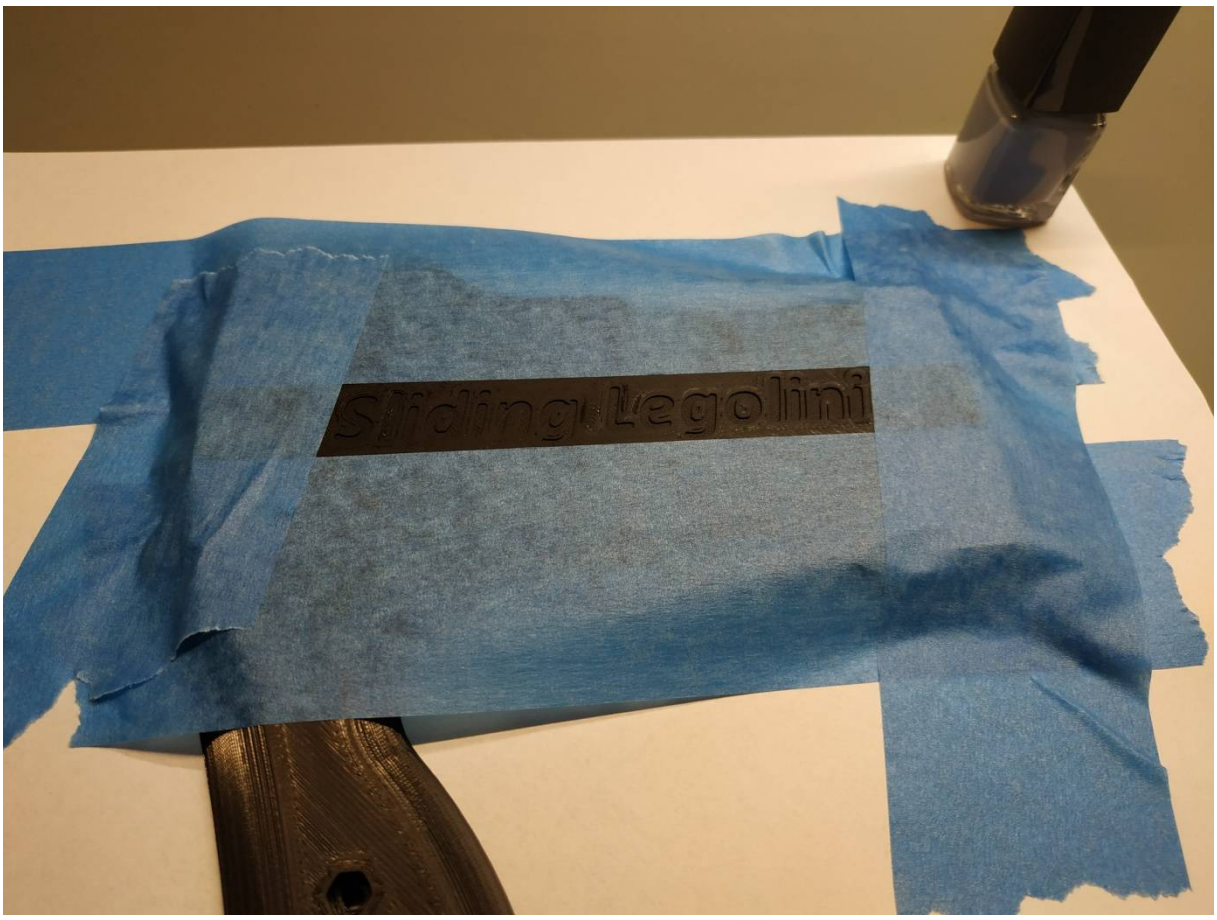




Bow parts

We'll start by painting the "Sliding Legolini" inscription on *bow_slider*.

We will use cheap nail polish. First, we wrap the inscription around with a protective tape. We fill the letters with varnish and then remove the excess using e.g. a ruler or credit card and sliding it along the inscription. After the varnish dries, we sand the surface to remove any remaining varnish.


Sliding Legolini


Sliding Legolini


Sliding Legolini


Sliding Legolini

We proceed to assemble the elements.

First, insert M3 nuts in the *bow_slider* holes.

Secondly, you can grease *bow_arm* and *bow_grip* surfaces with a silicone/PTFE lubricant to reduce friction between moving rail parts.

After that, you can connect the *bow_slider* and *bow_grip* elements together with 5 M3x20 mm Allen screws.

You can also insert 4 M3x20 mm Allen screws into *bow_arm* without screwing it to *bow_slider*.


Sliding Legolini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SILIKON
+PTFE


Sliding Legolini

The last step is to mount the bow elements on the magazine.

Back grip and release

Insert 4 M3 nuts in the right places *bow_grip_part1*.

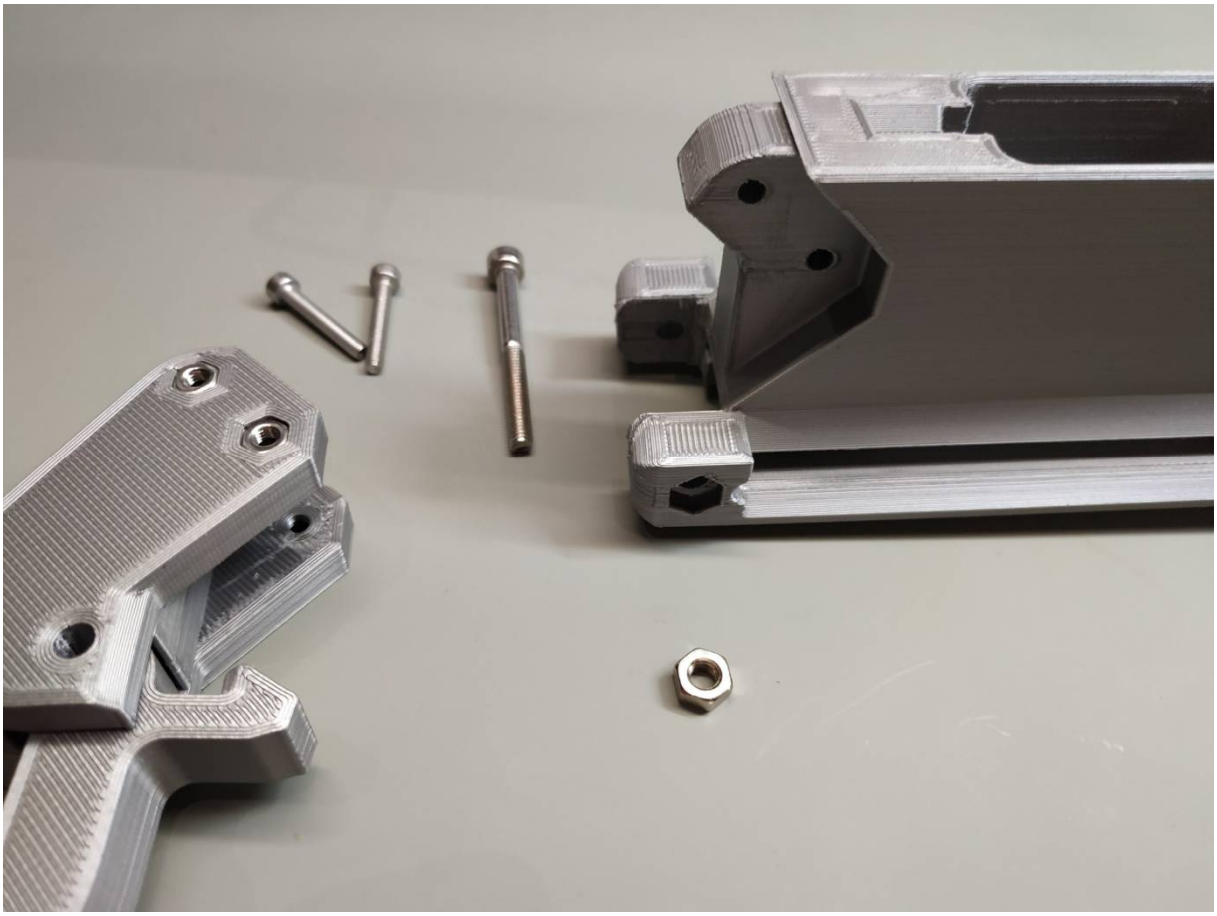
Mount the release and steel spring as per photo.

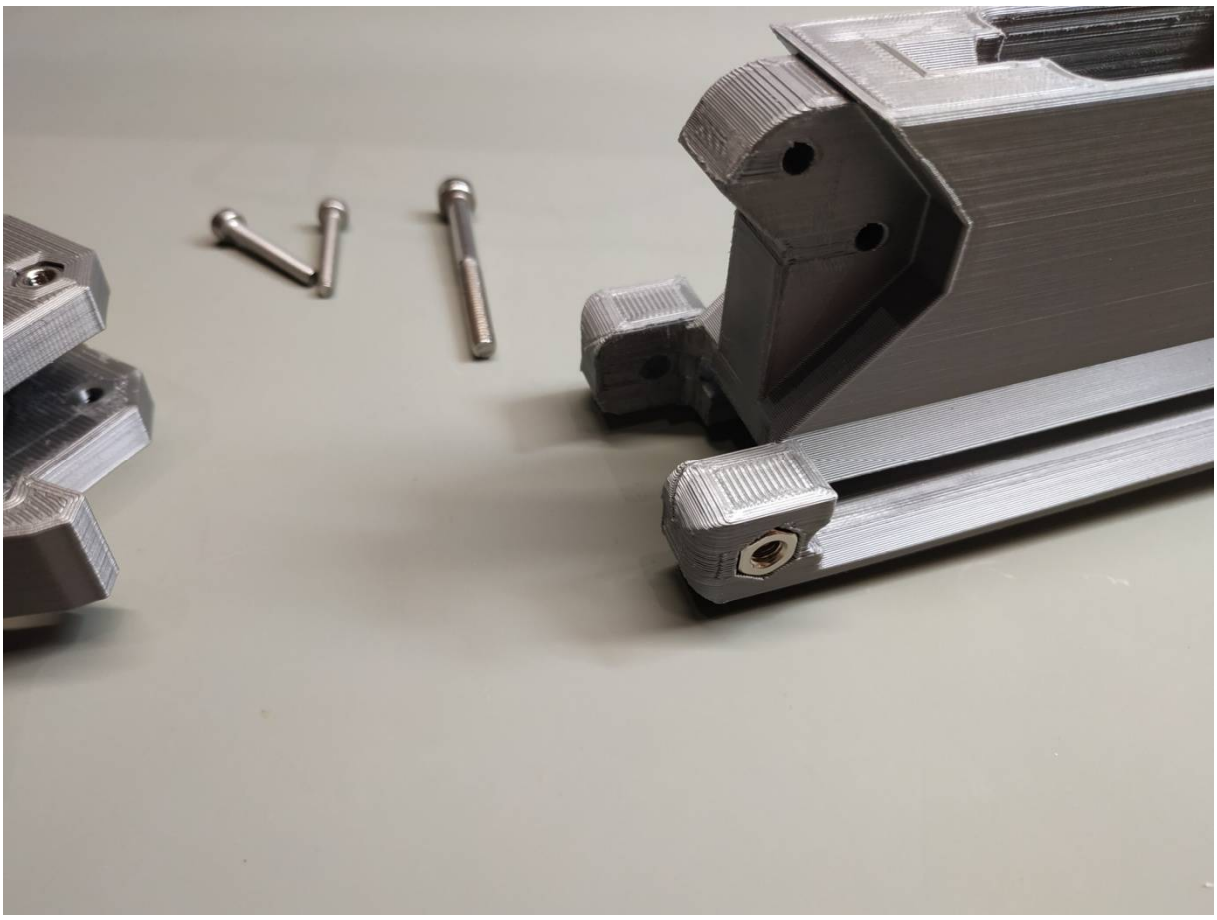
Put on the second part of the grip and tighten to the first part with 2 M3x20 mm Allen screws.

Insert the M4 nut into the hole in the *magazine*.

Slide all *back_grip* along with the release from behind.

Install 2 M3x20 mm Allen screws and M4x40 mm Allen screw. Do not tighten the M4 screw too tightly for the release to work lightly and without resistance.





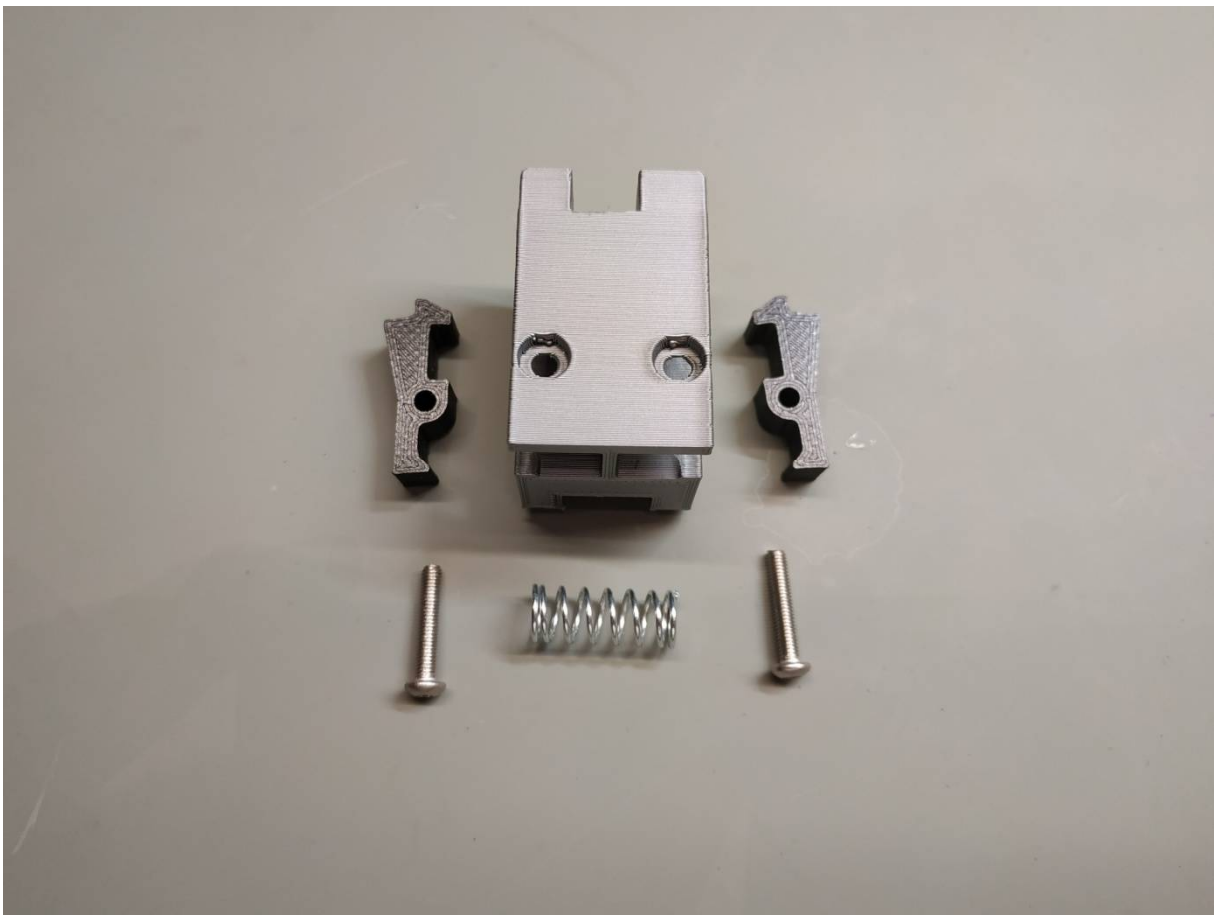
Magazine spring and spring body

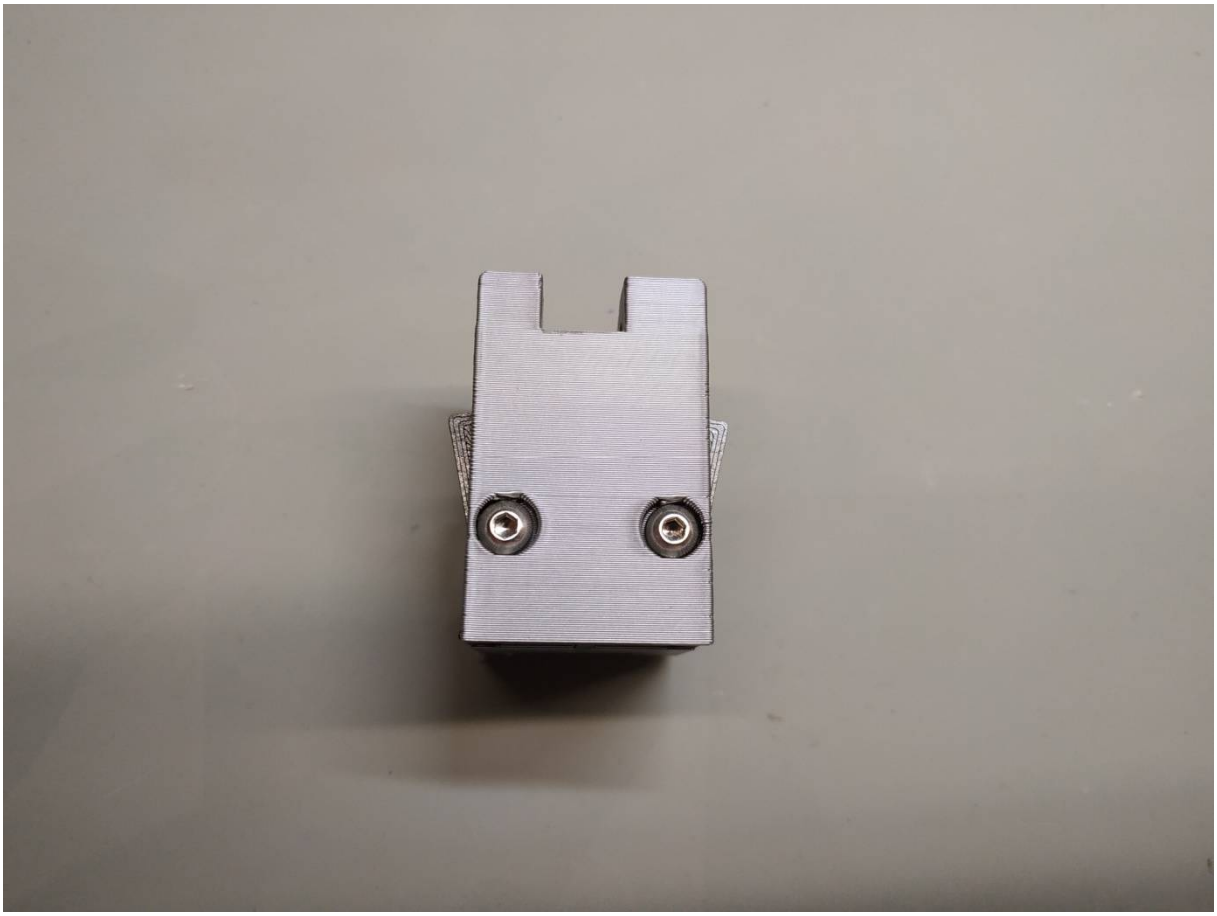
Mount the first from *spring_body_clips* to *spring_body* with a M3x16 mm screw. Insert the spring in the right place and install the second clip with the second M3x16 mm screw. Make sure that the spring is in the right places in *spring_body_clips* and that the latch mechanism is working properly.

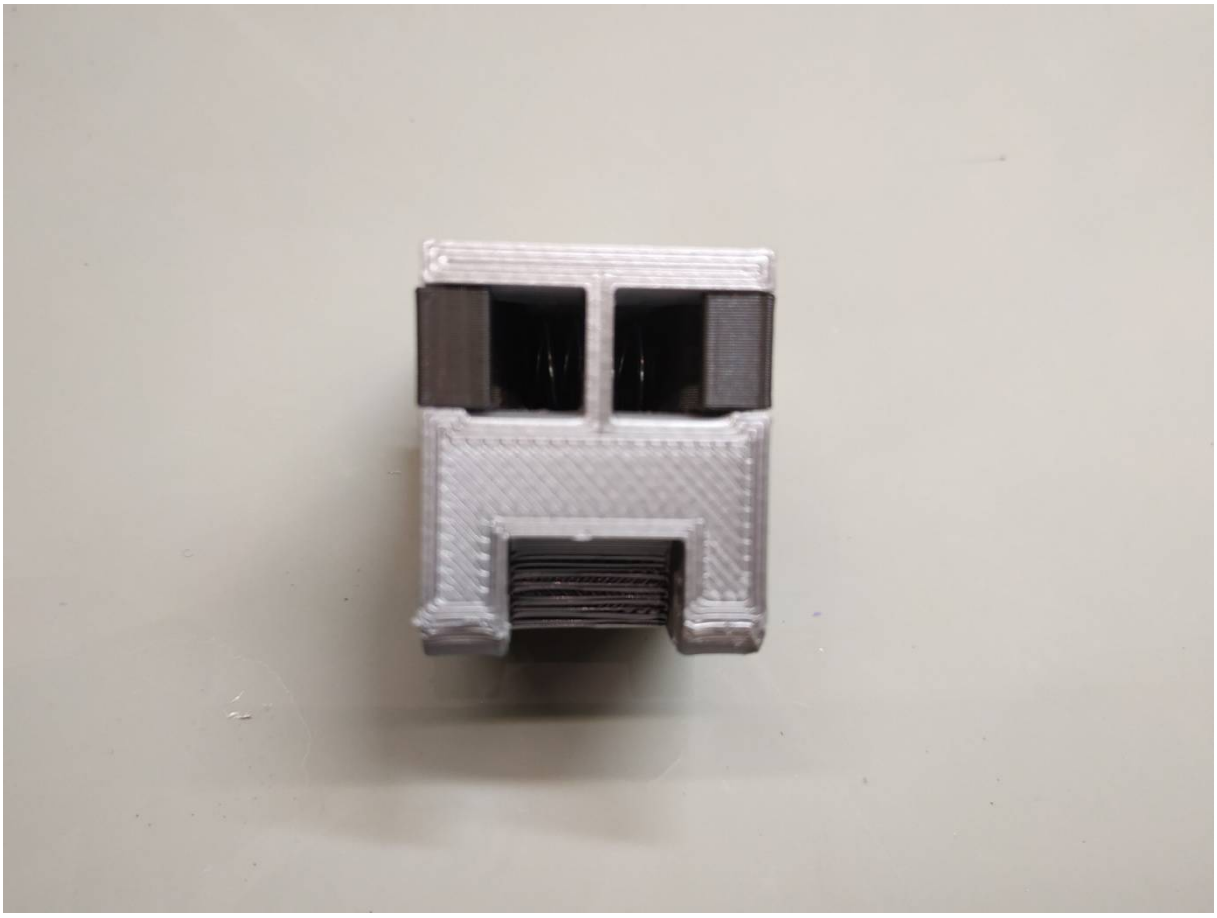
Then insert M3 nuts in the right places. Insert a steel spring into its place. Press *magazine_spring* to the right place and tighten with M3x20 mm Allen screw.

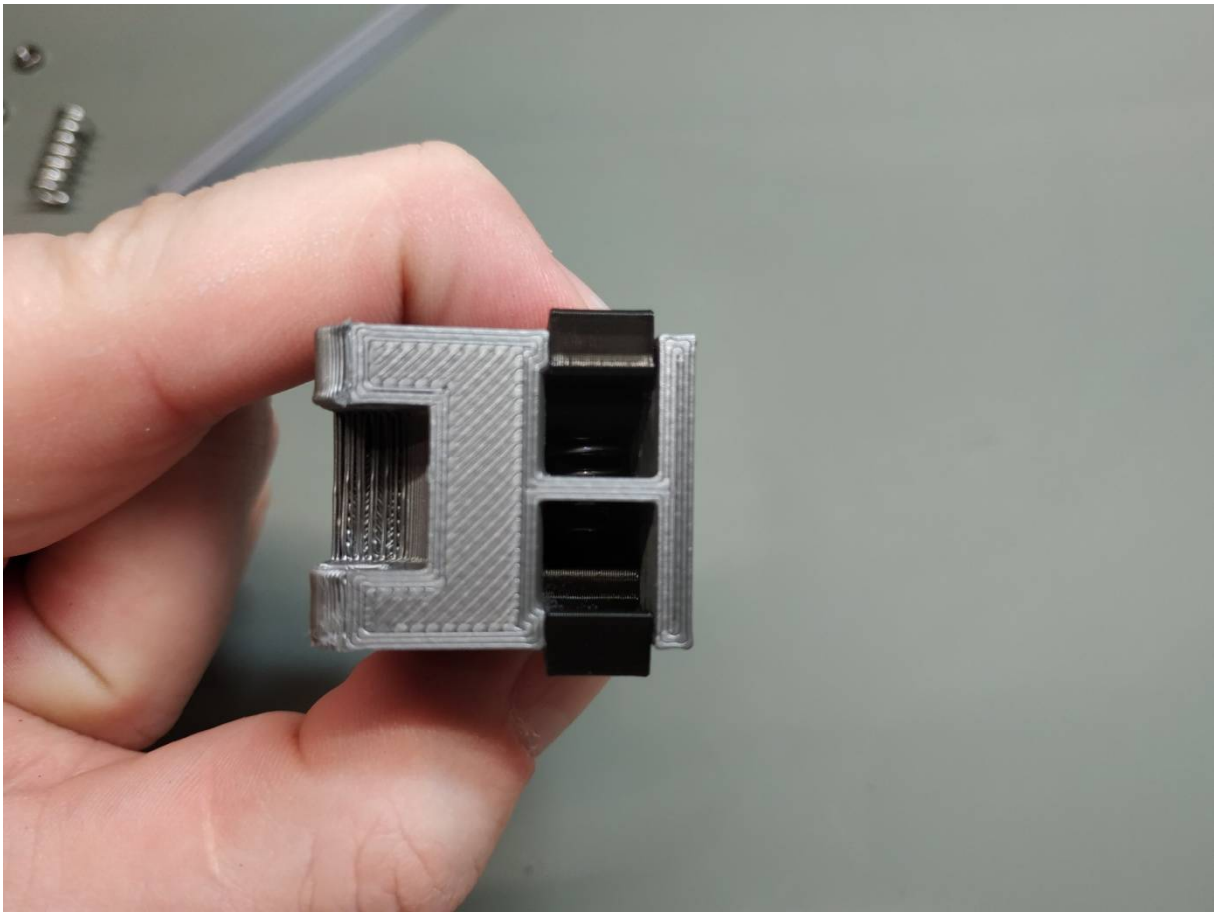
Mount the whole on the *magazine* and tighten with the last M3x20 mm Allen screw.

Do not tighten the screws too much, all components must work lightly and without resistance.









Rubber and string

As a string, I recommend using a 3mm diameter polypropylene rope. The holes in string hooks are designed for this diameter, and after tying the knot of the rope hides completely in the arm.

You need at least 15 cm + 15 cm + 20 cm rope sections.

As an executive element, use TheraBand tube black rubber, about 6.5-7 cm on each side (effective length about 4.5-5 cm). I suggest using 6.5 cm long rubber on each side - the bow will be a bit stronger.

Rope hooks are printed together with bow arms in one piece.
First thing - you must disconnect the rope hooks from the bow arms. To do this, use a screwdriver or a rod with a diameter of about 3 mm. You can use a knife to cut the first print layer between parts if it sticks together. Insert screwdriver into the hole on the inside. Then you need to move the screwdriver in both directions until the element detaches. Be careful to not damage the components. You repeat the same procedure for the second arm.

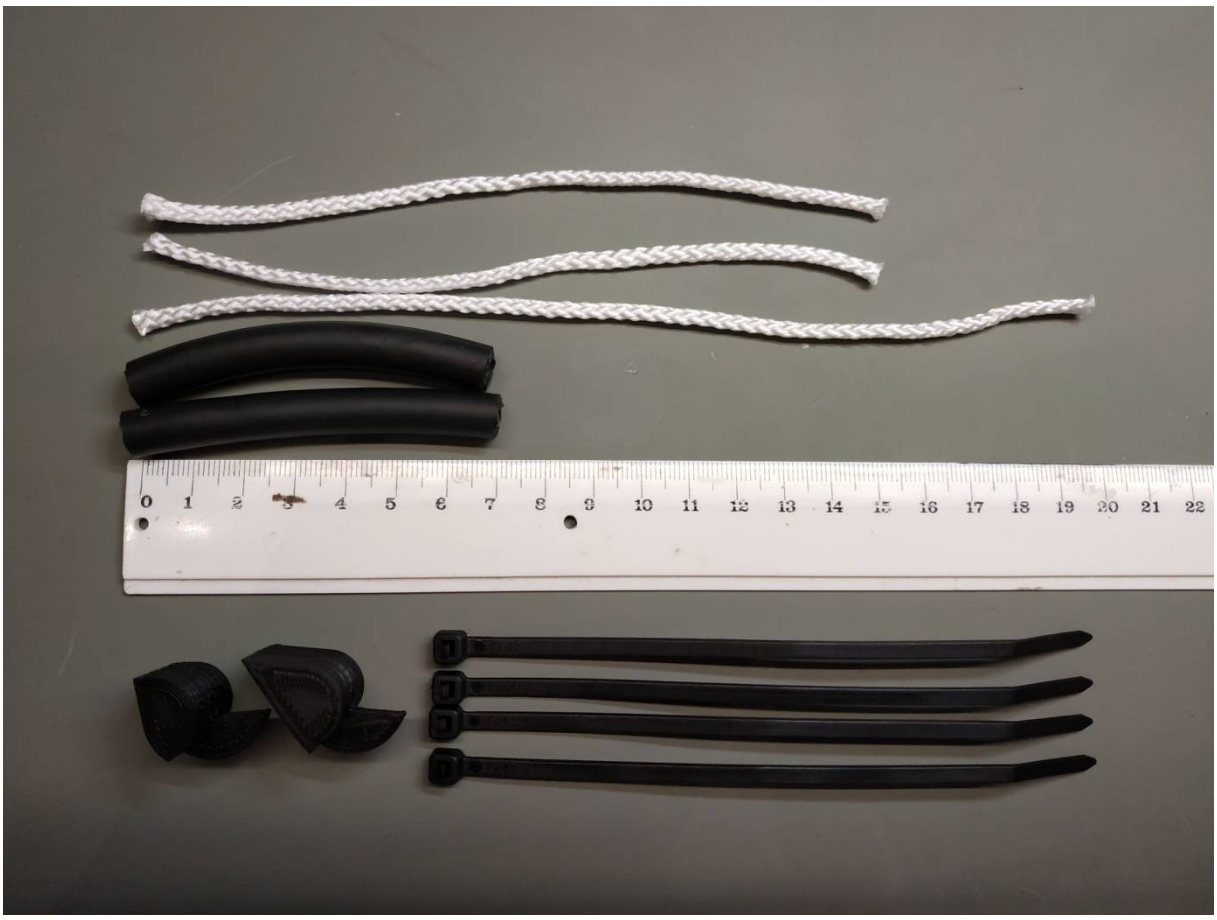
In the next step you cut the necessary lengths of rope and rubber.

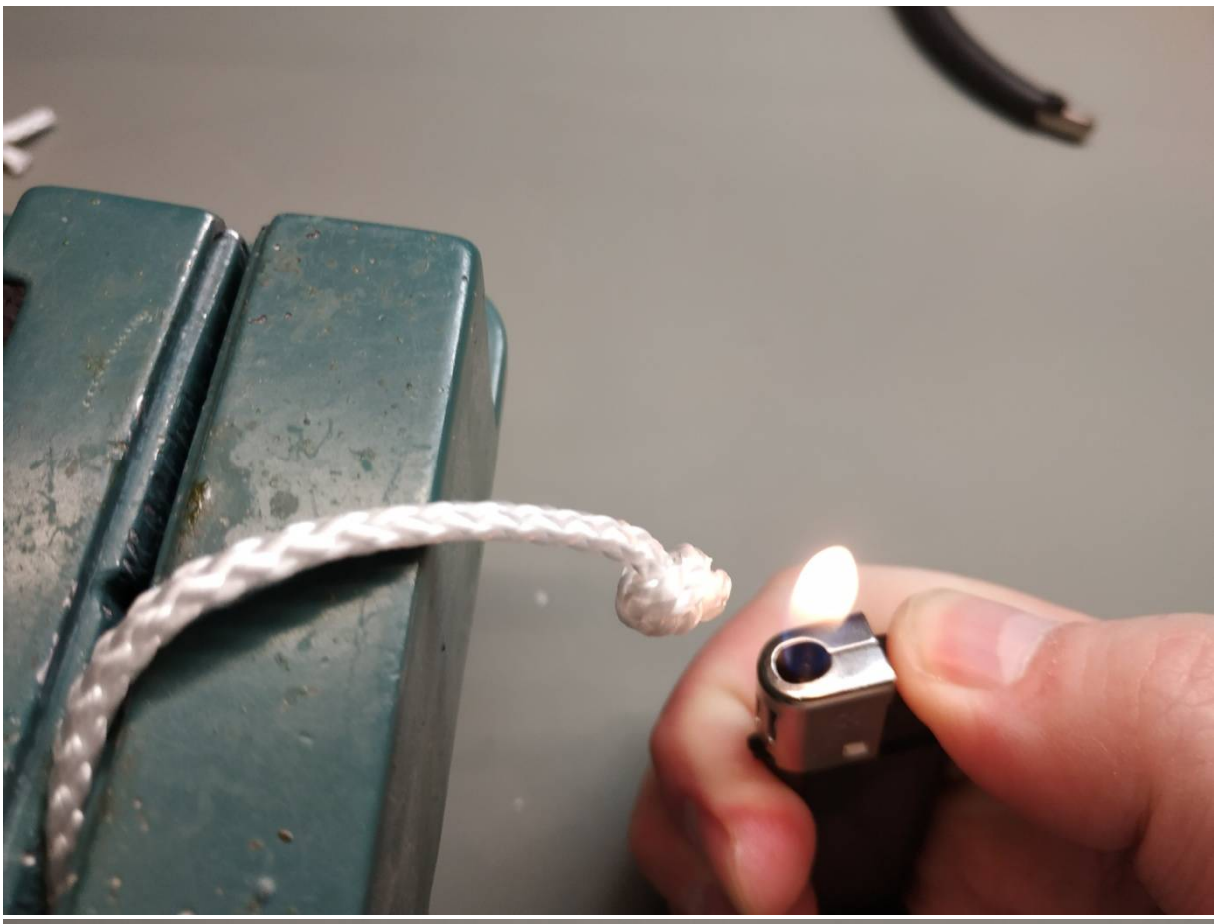
Also prepare 4 pieces of zip ties 3.6 mm wide. After testing, I can conclude that this ties width is optimal. Thinner they were not strong enough, thicker but too heavy and not very flexible.

Next, we start tying the rope on one side (from the rubber side). For a 3 mm rope, I suggest you make a knot with a double loop. A single loop knot may slide out of the inside of the rubber when the string is pulled before shot.

After tying the knots, we melt the end of the rope at the knot with a lighter.

We take 2 shorter lengths of rope and put them through the rope hooks. Then we tie the knots on the other side with one loop so that the knots on the rubber side start at a distance of about 15 mm. Cut the excess rope and melt the end with a lighter.


0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

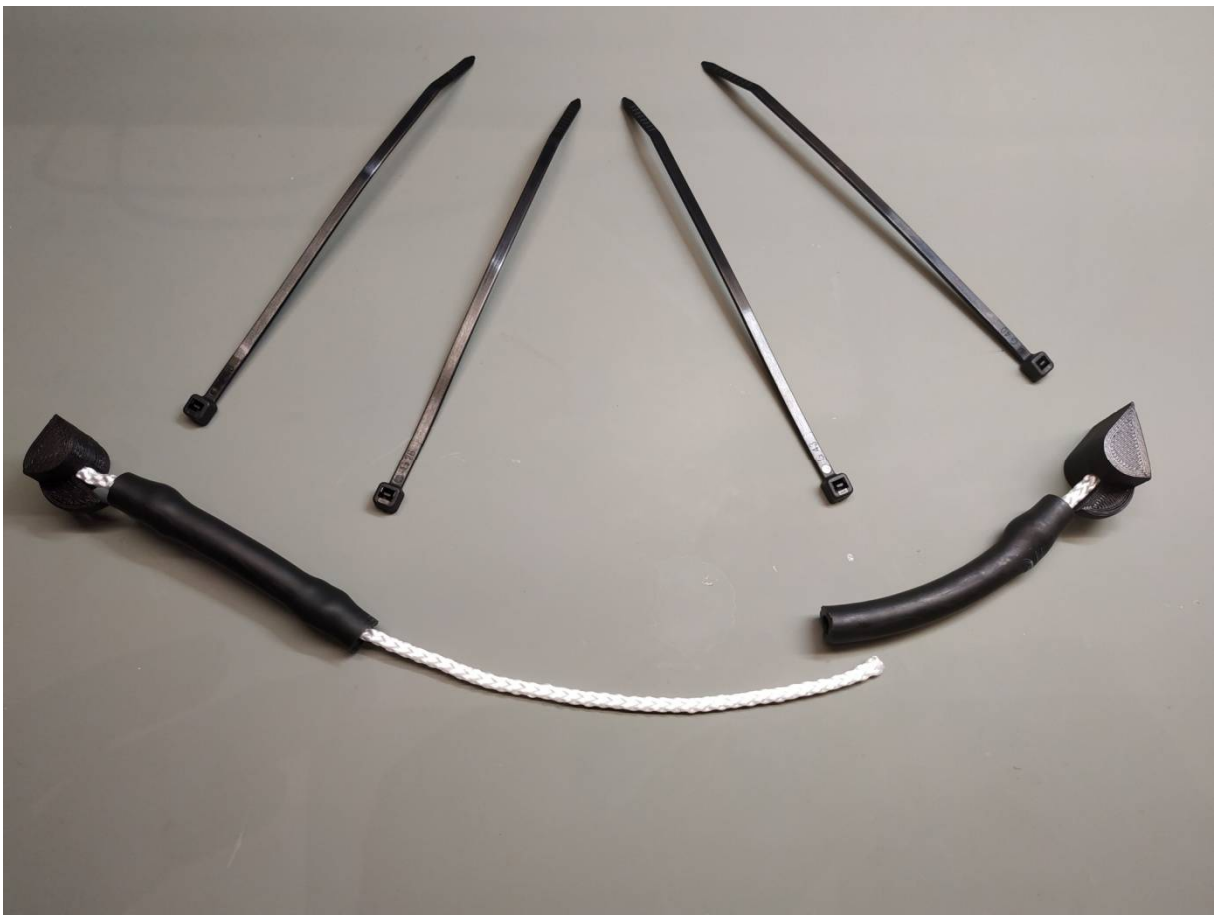



0 1 2 3 4 5 6 7 8 9 10 11


0 1 2 3 4 5 6 7 8 9 10

The next step is to mount rubber to the rope.

You need to insert the knot into the tube. If it's going hard, you can use a small screwdriver to push the knot in. Be careful not to damage the rubber with a screwdriver. The knot must be placed approximately 8-10 mm from the end of the rubber so that this end of the tube can be secured with a zip tie.



To increase the life expectancy of a string, I recommend using an additional heat shrink tube with a diameter of 4-4.5 mm. Slide the section about 50 mm long over the rope and shrink with hot air.

Such a piece of heat shrink tube significantly extends the life of the string and increases the reliability of bow operation.

You can also use a 4 mm rope as the middle part of the string. It should give a similar effect to a heat shrink tube with a 3 mm rope.

Best solution (*by Jörg Sprave*): *traditional - and very effective - method is to "serve" the string, means, wrapping it very tightly with a special type of waxed string for crossbows.*

You can get such string very inexpensively in archery stores, and online for example https://amzn.to/3ajOjNt

There are plenty of instructional videos how to serve a bow string (for example https://www.youtube.com/watch?v=0hwQiKAWl2k), but basically you tie a knot, apply a tiny drop of CA glue and then you start winding. At the end, one more drop and one more knot. You can then rub in a bit of string wax and voilá, you have a string that will last for a looooong time.


125°C 600V VW-1 -F-


125°C 600V VW-1 -F-

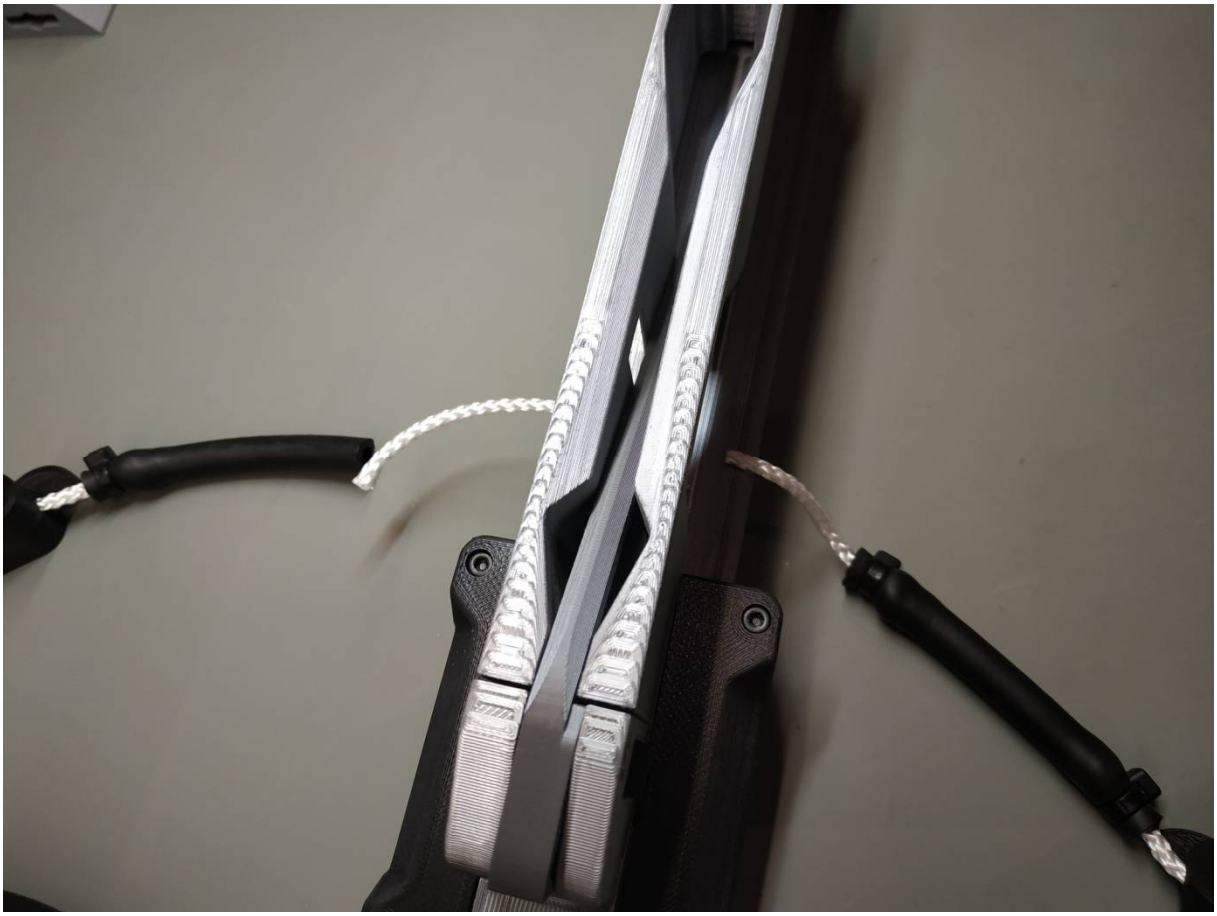
In the last step, we put the middle line through the magazine slot and tie a double loop knot. The knots of the middle part of the rope must be about 10 mm away from *bow_slider*. Cut the end part of the rope and use lighter.

Put the knots inside the tube in the same way as with arms.

Secure all rubber ends with zip ties. Cut off unneeded zip ties ends.

Finally, we can stretch the string and mount the ends of the string to the arms by sliding the hooks.

Warning! If the middle part of string starts to fray from the release part, replace it.



Laser sight mount

This mini bow has no integrated sights, so you need to use a small cheap laser sight to aim precisely at the target. The laser sight should not be longer than 58 mm, because it will protrude beyond the outline of the barrel.

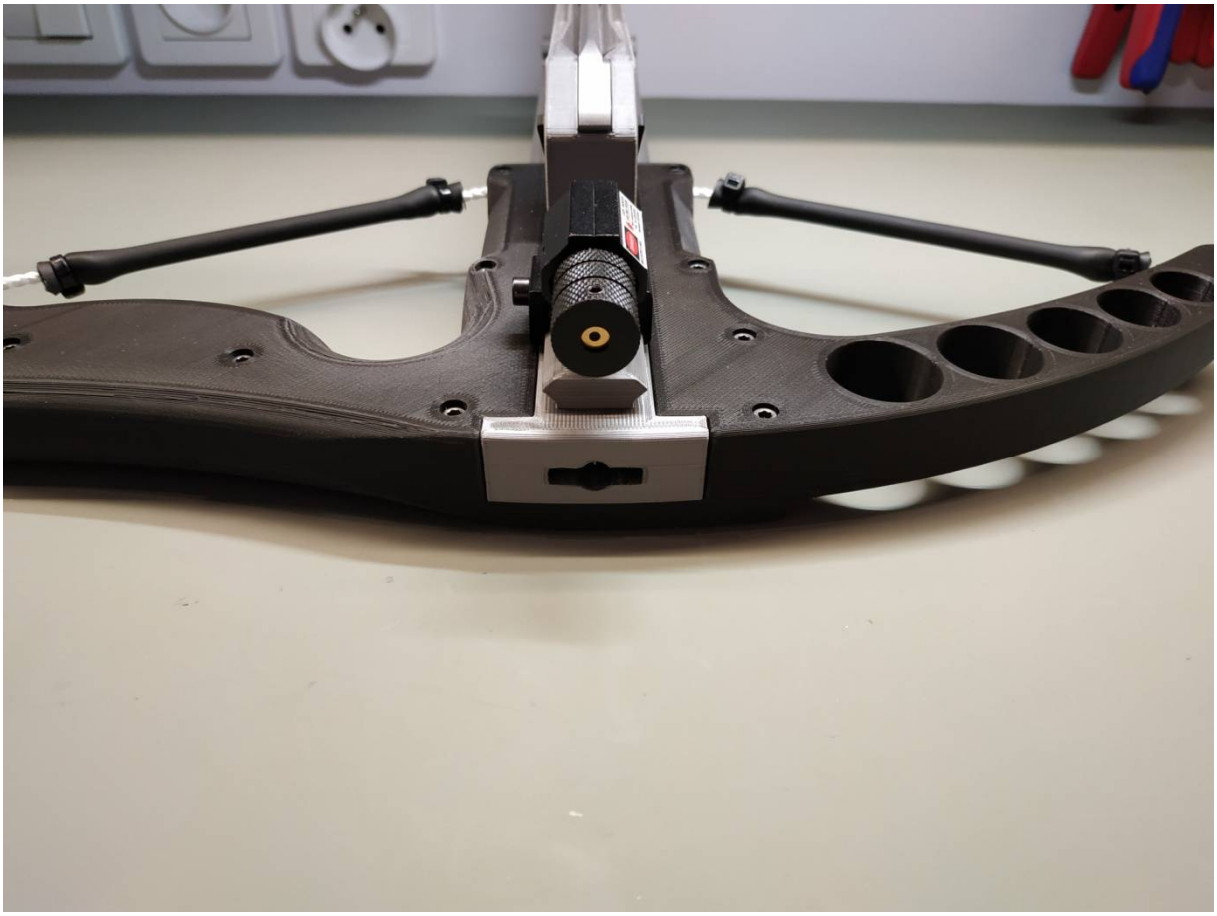
Mount the laser to the picatinny rail integrated with the magazine.

Slide the laser sight onto the rail, open the magazine spring and set so that *spring_body* does not press on the laser switch. Then tighten the laser sight mount screw.

After this, you need to take several shots and adjust the laser sight at a distance for example of 5 m or 10 m.

You can conveniently turn on the laser sight with your thumb without lifting your hand from the bow.


DANGER



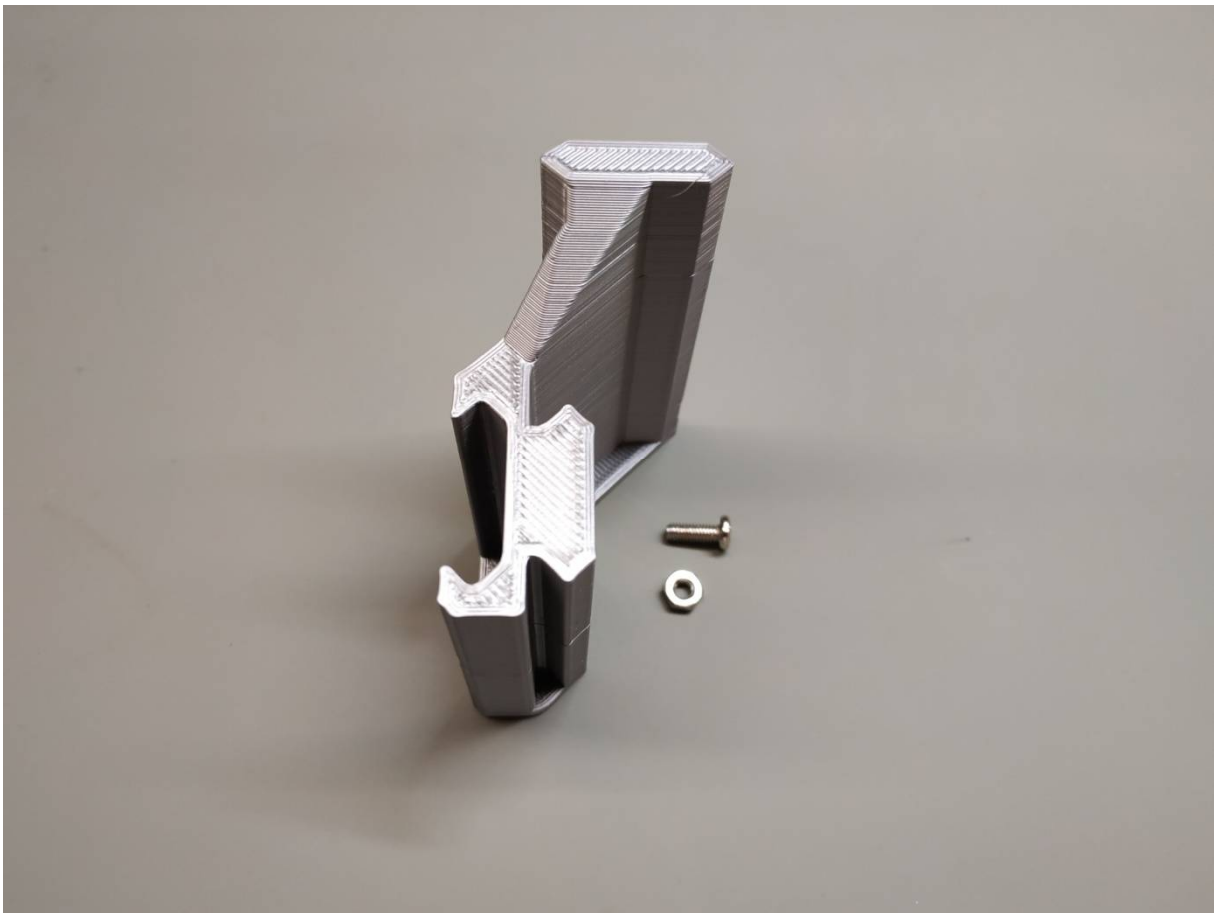
Optional red dot sight adapter

With this bow you can also use red dot sight to aim. To do this you need to print an additional *optional_red_dot_adapter*.

If you are left-handed you must mirror *optional_red_dot_adapter* in the slicer program.

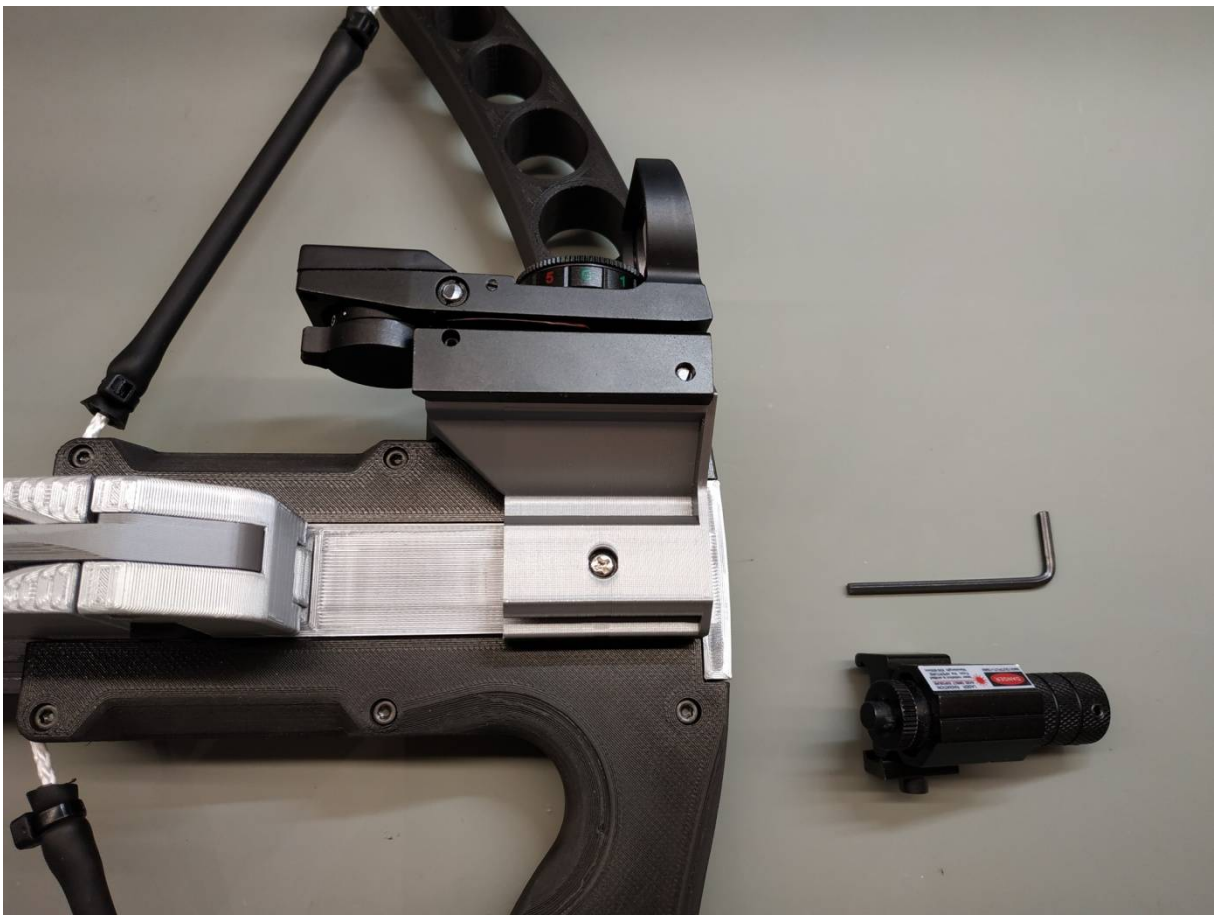
You also need a M3x8mm screw and M3 nut to attach the adapter to the picatinny rail.

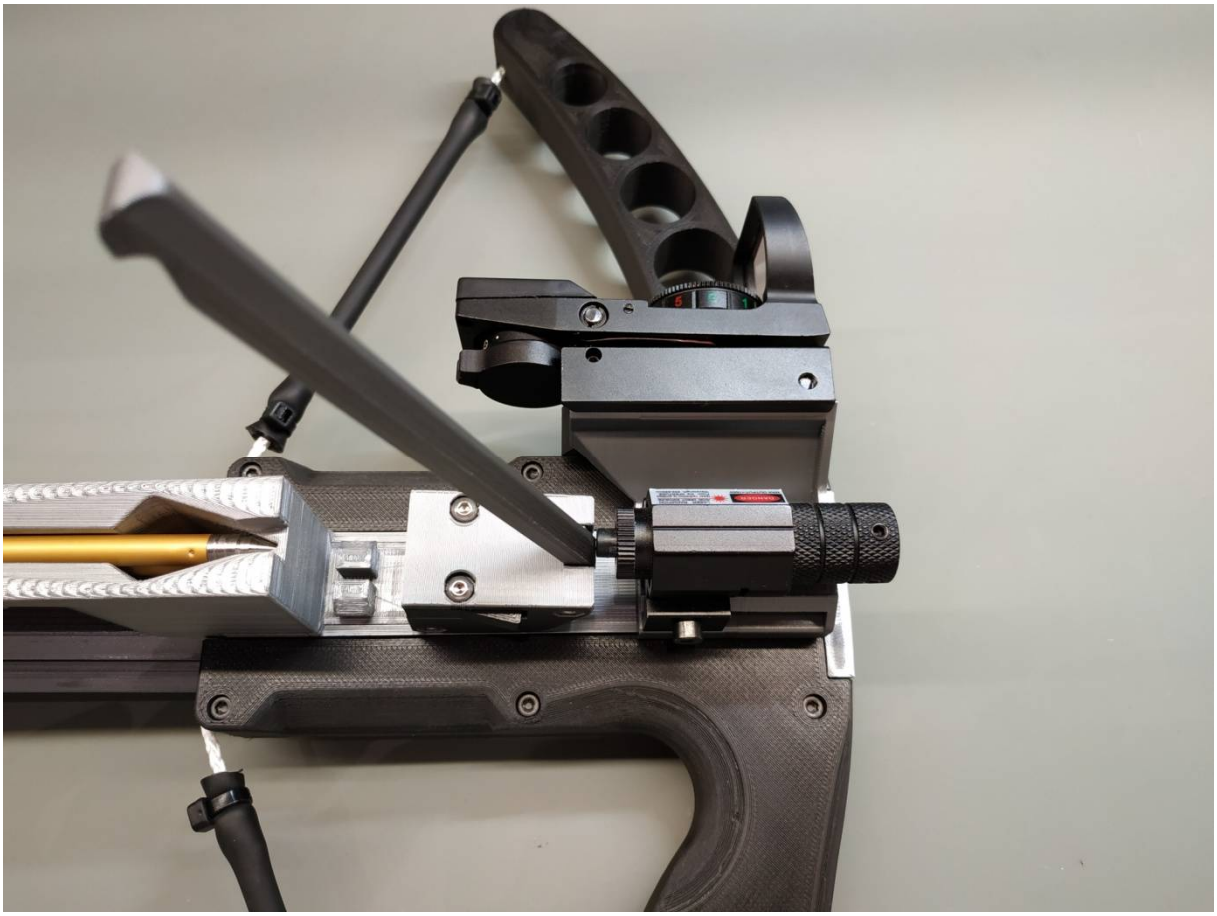
You do not have to opt out of laser sight, because *optional_red_dot_adapter* has a second picatinny rail. Still you can conveniently turn on the laser sight with your thumb without lifting your hand from the bow.

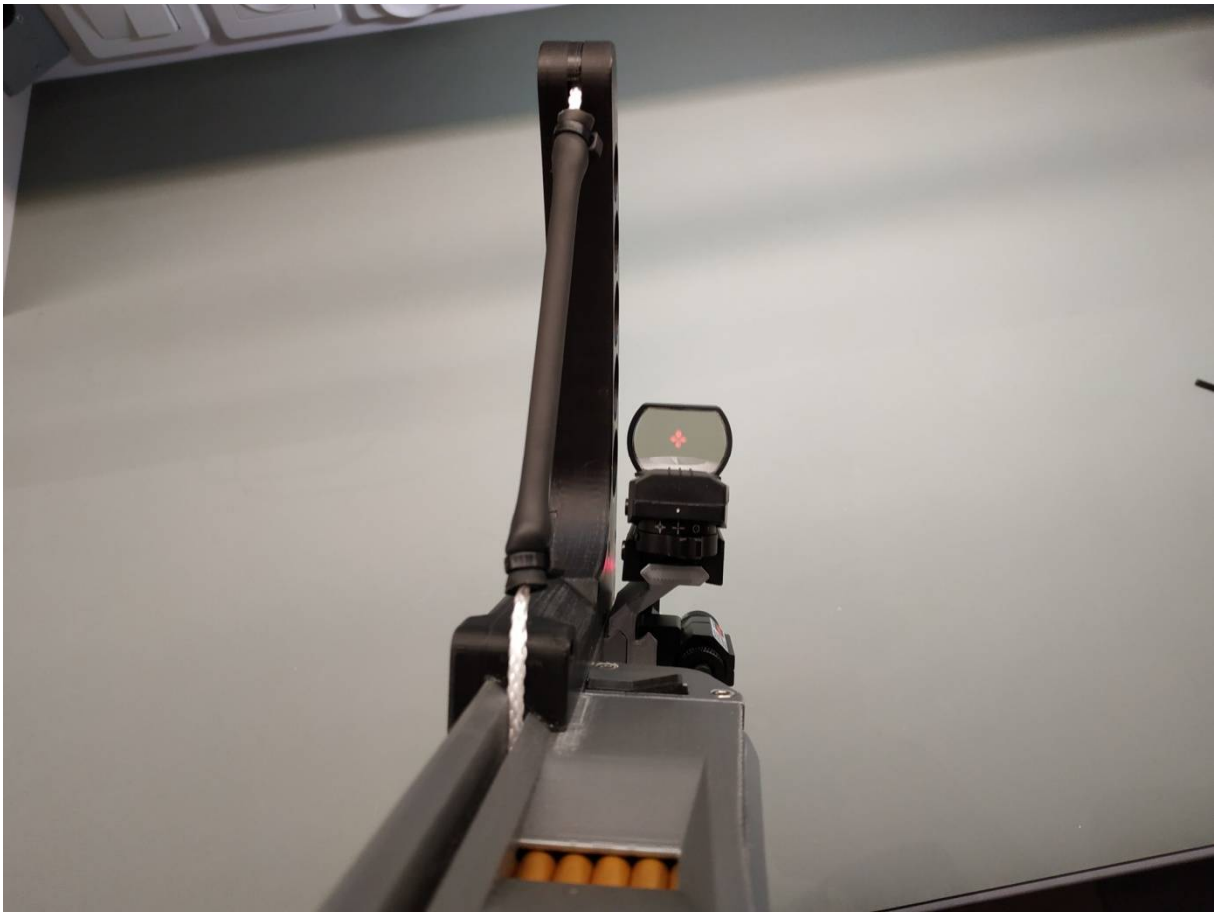



DANGER
UP

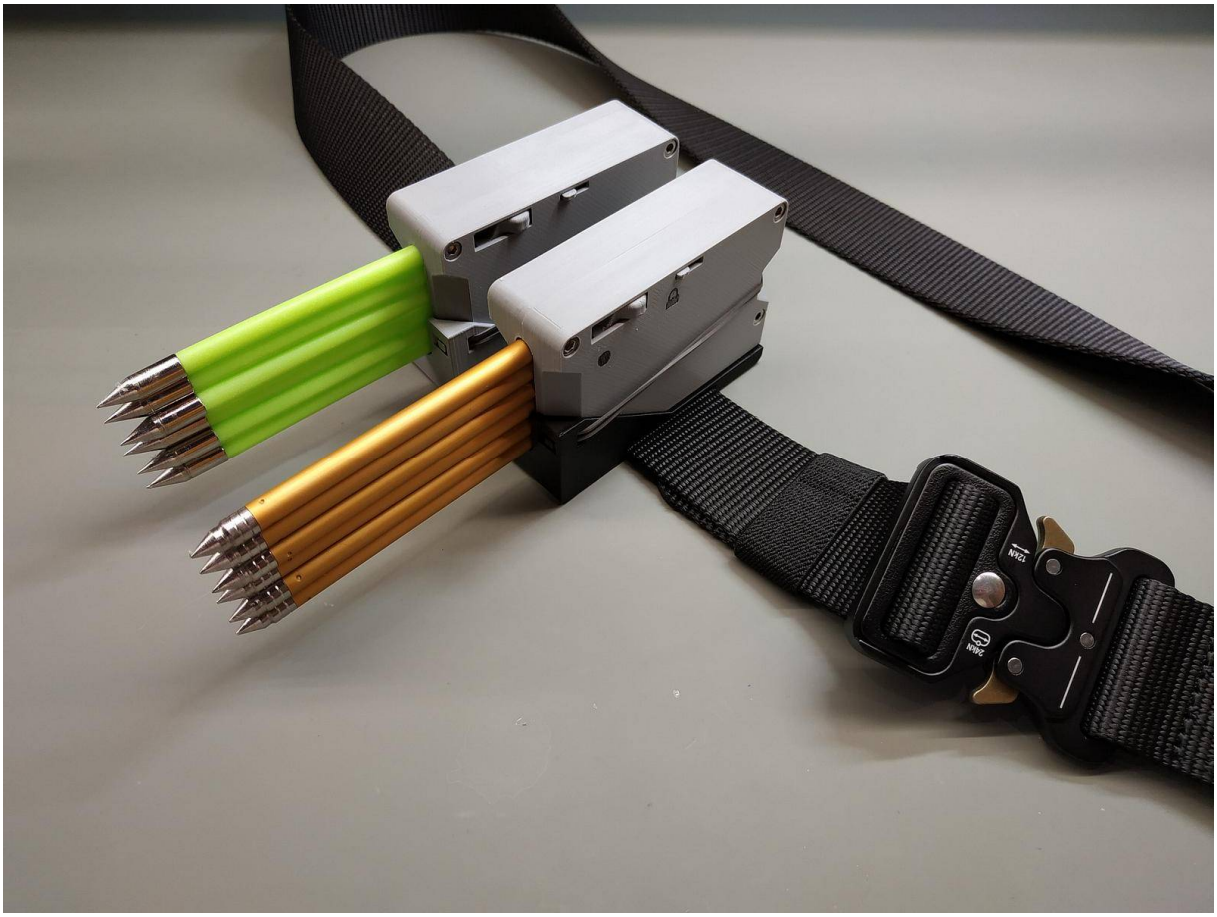

DANGER
R







Optional ammo clips with automatic magazine loading



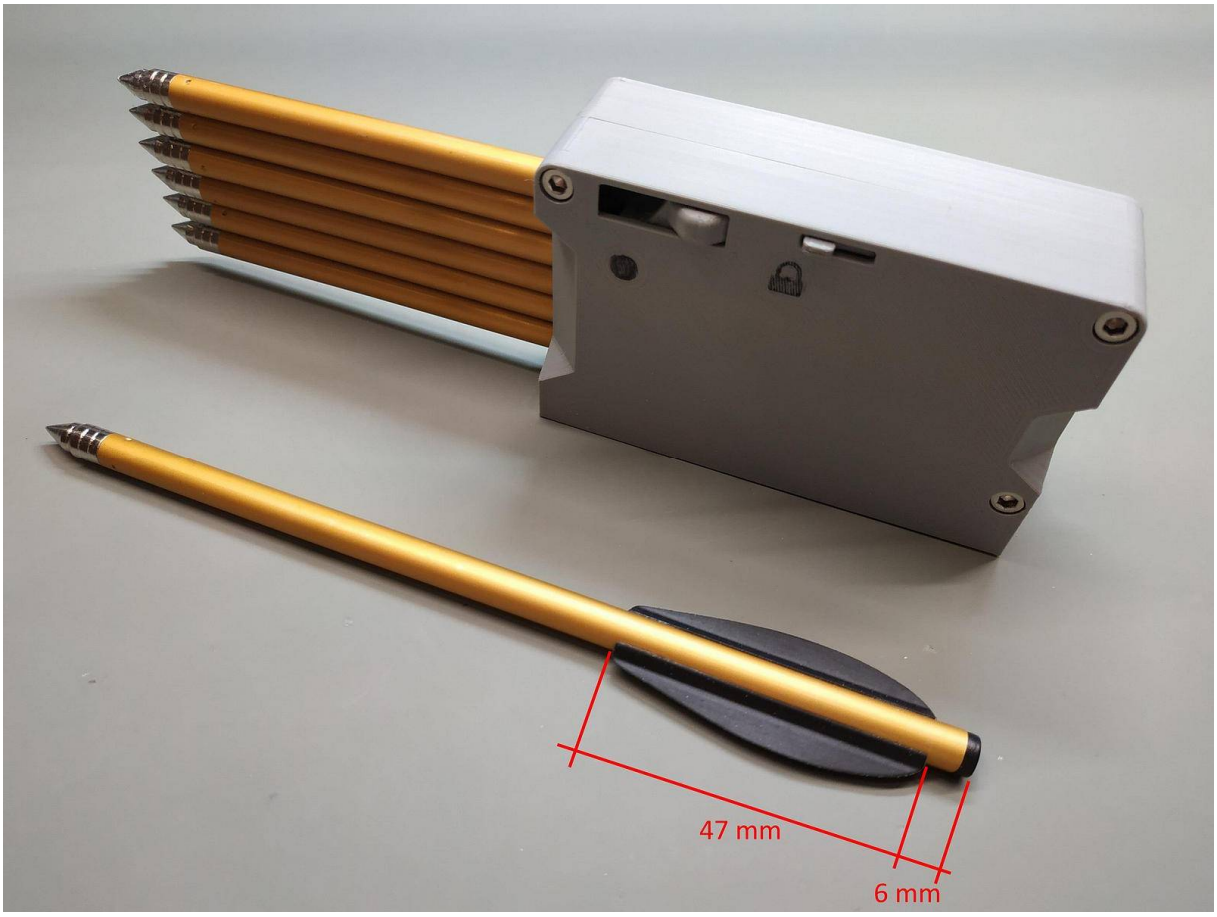
I think this video will explain how it works.
https://www.youtube.com/watch?v=hbBHbEoSbZ0

When loading the magazine, it is recommended to tilt the bow back about 15-45 degrees. The rest is done by gravity when the ammo clip moving backwards. With a little practice, you can load a magazine very quickly.

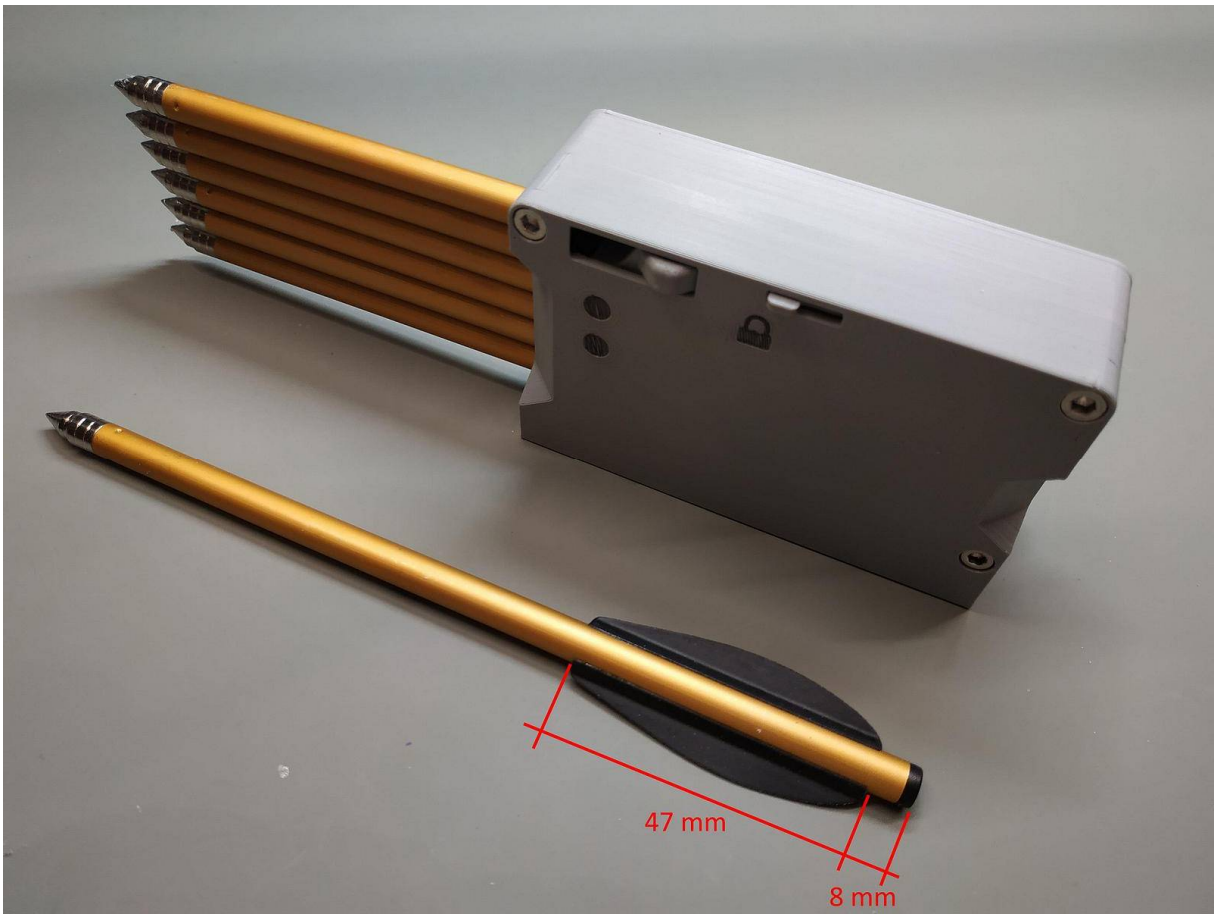
This ammo clip is 3D printed (9 parts) and requires only 4 external elements to work (3 pieces M3x20 mm Allen screws and a small spring from a pen - 4.2 mm diameter and about 25 mm length).
This is kind of latch that is triggered by the movement of the clip backwards. At the end of the bow magazine is a small notch that works with the ammo clip main slider.
Ammo clip has a small lock switch that makes it difficult to accidentally unload the ammo clip when placing it in the belt attachment. The trouser belt attachment has an additional lock that immobilizes the whole mechanism, so when walking or running the bolts will not fall out.

3 versions ammo clips are available - please choose the right one for your arrows/bolts:
"A" without circle on the housing - https://www.thingiverse.com/thing:4214277
- for 160 mm bolts with steel point head, aluminum shaft (6.2 mm diameter) with plastic fletching or full plastic shaft (6 mm diameter) and fletching (cheapest bolts available also on Aliexpress)

"B" with one circle on the housing - https://www.thingiverse.com/thing:4214299
- for 161 mm bolts with steel point head, aluminum shaft (6.35 mm diameter) with 6 mm back and 47 mm silicone fletching (for example some POE LANG bolts)



"C" with two circles on the housing - https://www.thingiverse.com/thing:4214302
- for 161 mm bolts with steel point head or broadhead, aluminum shaft (6.35 mm diameter) with 8 mm back and 47 mm silicone fletching (for example bolts for pistol crossbows Viper, Stinger, Armex Tomcat, NXG Cobra or comparable models)



Optional string hooks for various types of rubbers

If you want to quickly change different types of rubber, you can print additional *optional_string_hooks*.

Print this part in the same position as *bow_grip* and *bow_arm*.

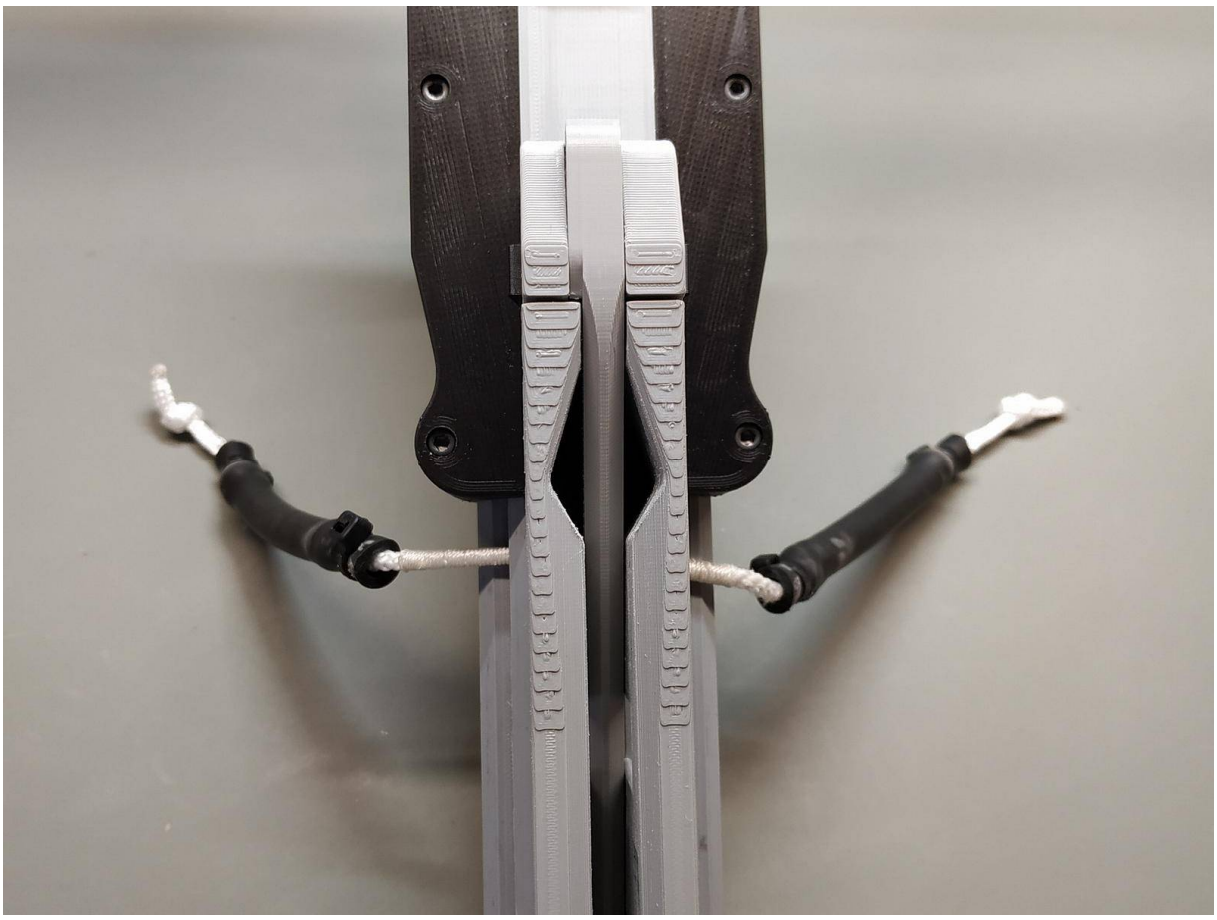
Slingbow version

This is experimental version.
Thanks to this Legolini is now more compact. Draw weight increased by about 20-30% and I think the arrow's initial speed also increased significantly, but I don't have a chronograph to measure it.
This is based on the idea of Jörg Sprave:
https://www.youtube.com/watch?v=p8HjksO3Vf4

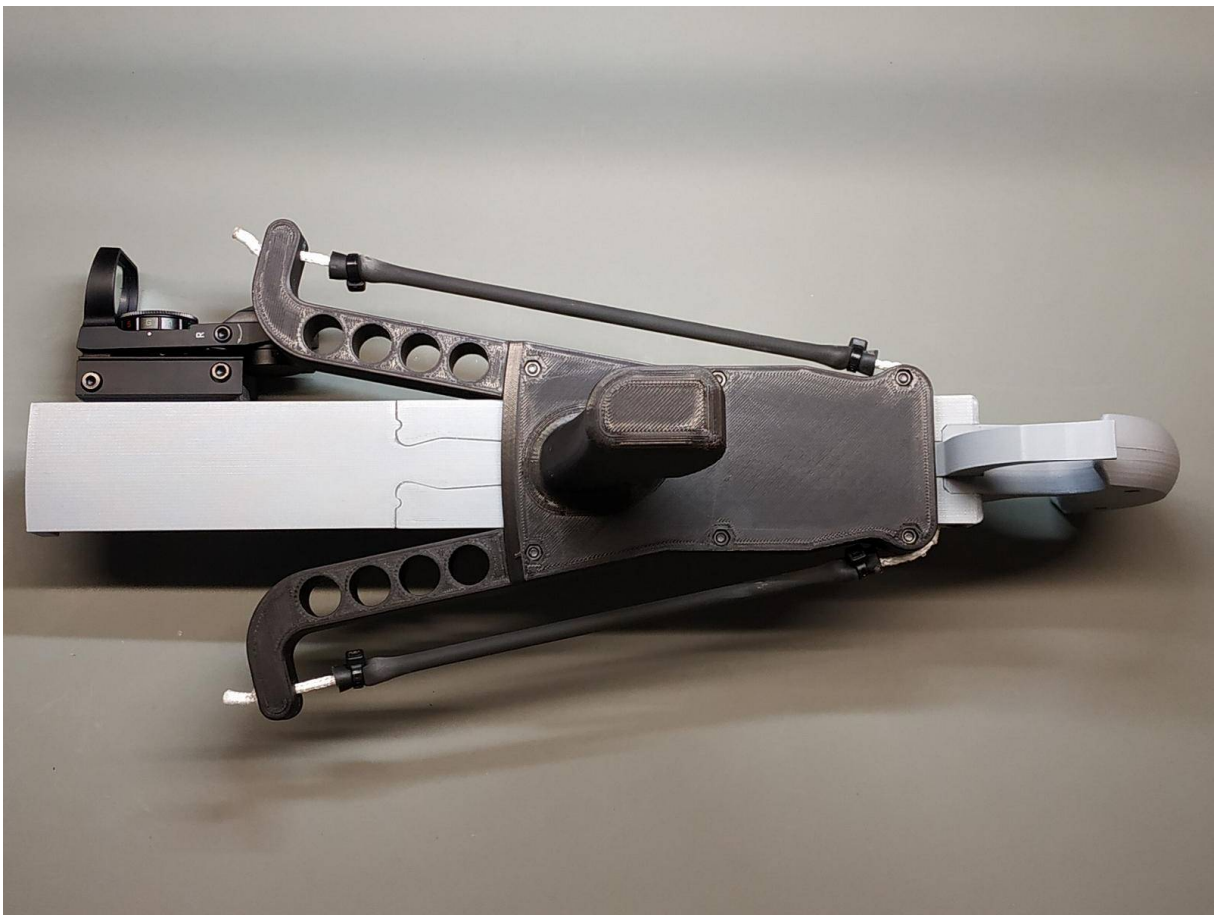
Of the minuses - Legolini no longer looks like a mini bow and the life expectancy of the string has shortened because Legolini's geometry is not optimized for such applications.
Loading the magazine with ammo clips will not be that fast anymore, because it is more difficult to access the spring_body from the bottom and to load it you have to move the slider backwards, but to do that you need to flip the magazine_spring, which generally takes more time than in the basic version of Legolini.

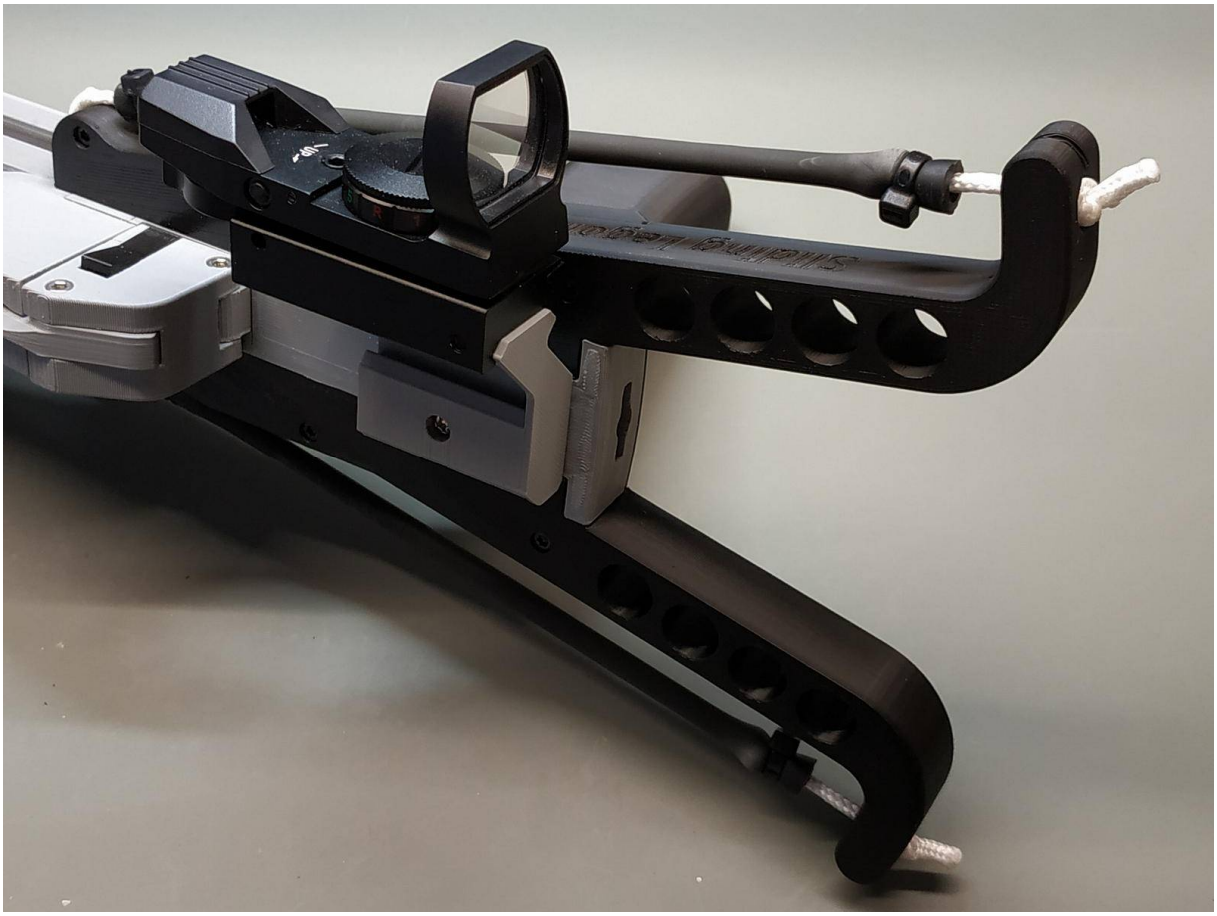
If you like, you can print this version from STL files with the prefix "*slingbow_*". Recommended orientation of elements during printing is illustrated by the pictures below. If you are left-handed you must mirror *slingbow_grip* in the slicer.

For this version you need 6 M3 nuts and 6 M3x20 mm Allen screws. The rubber must also be slightly longer than the basic version, around 8.0-8.5 cm. The assembly of the elements looks similar to the basic version. *String_hooks* is not available now, just insert the rope into the prepared grooves in the *slingbow_arms*.




Sliding Legolini





Summary

Building this bow is not difficult, and the end result is a lot of fun. If you do everything correctly you will enjoy a very nice toy. I must admit that at short distances this "toy" is very precise and really powerful. The fun is great.

I tested this bow with various rubbers. Depending on the type, a different draw weight can be obtained:

- Stonfo AS-290-9 tube black - draw weight up to about 17 lbs
- TheraBand tube blue - draw weight up to about 17 lbs
- TheraBand tube black - draw weight up to about 22 lbs
- TheraBand tube silver - draw weight up to about 30 lbs

After these tests I can conclude that with TheraBand black tube it is super easy to shoot and the power is good enough, that's why I recommend this rubber.
With a TheraBand silver tube power is amazing, but shooting requires much more strength and is more difficult.
You can also use weaker tube rubber if you do not have enough strength to draw the bow.

Enjoy!
Łukasz J.