PUMA 3D Printing Guide

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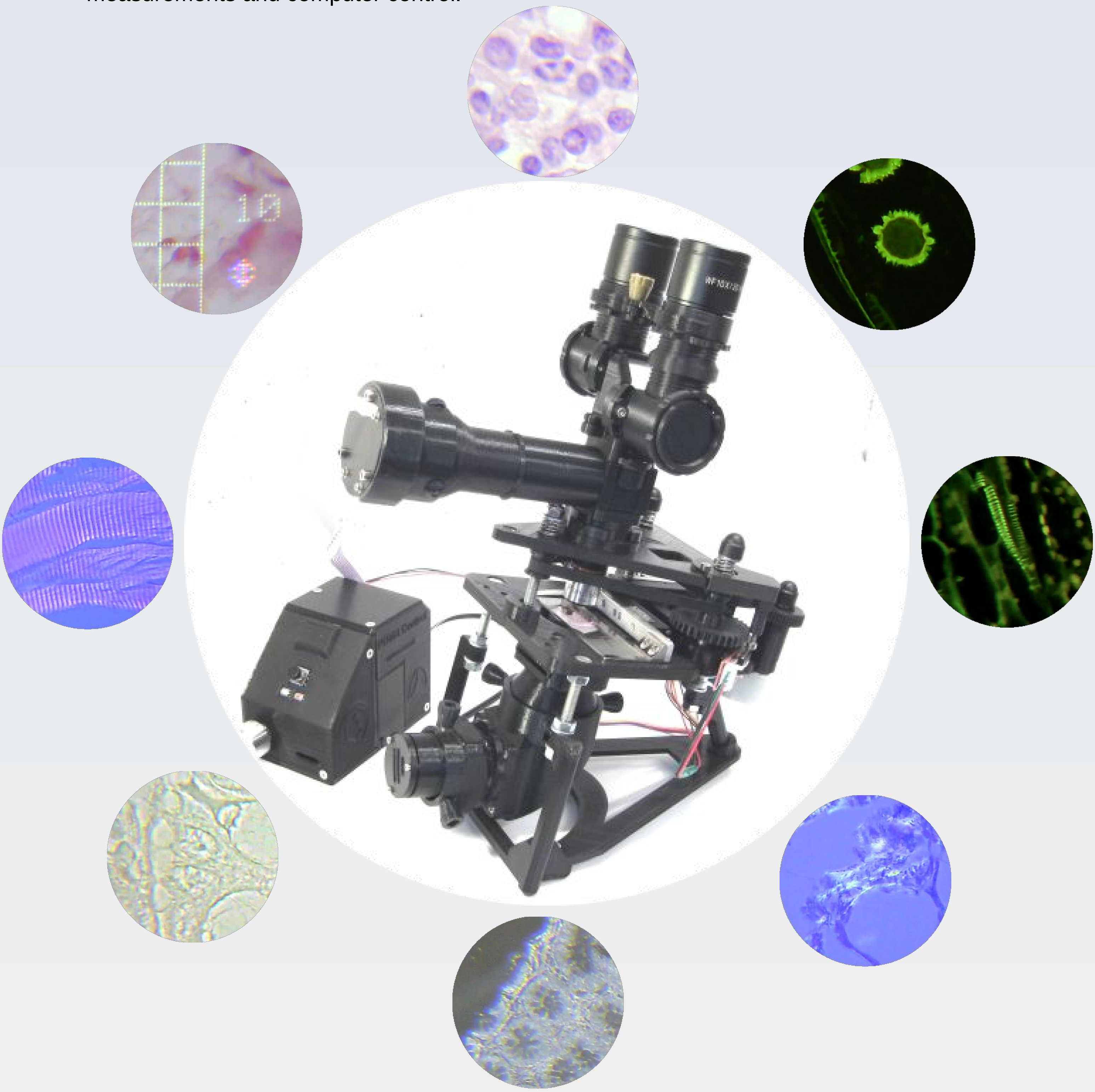
PUMA: The Open Source (GPL v3.0) 3D printed microscope system designed for direct eye observations and ultra-portability with advanced options for digital imaging, measurements and computer control.



Contents

Legal Information

License

Limitations of Use

The PUMA microscope and its associated systems do not have any certifications or regulatory approvals in any country for use in clinical diagnostics or treatment (human or veterinary).

The PUMA microscope and its associated systems are released to be used for research and educational purposes only.

Disclaimer

All PUMA project information, including without limitation any CAD file or STL file and all documentation, advice and instruction (whether provided in video form, audible form, written form or otherwise) is provided ‘as is’ in good faith and is intended to be helpful but comes with no warranty whatsoever.

Anyone attempting to build or use a PUMA microscope or other PUMA-related material, accessory, module or derivative is hereby advised that there will be risk involved in 3D printing, post-print processing, assembly and usage of the resulting structures. This risk includes, without limitation, the risk of personal damage and loss of resources.

Dr Paul J. Tadrous, TadPath and OptArc cannot accept any liability for any such loss or damages that may occur. All those who attempt to build or use any aspect of the PUMA project or derivatives thereof do so at their own risk.

Health and Safety Advice

Burns and Fire

There is a risk of fire and of burns when working with 3D printers, soldering irons and molten solder. Wear appropriate personal protective equipment such as gloves and eye and face protection. Ensure all electrical components are of the appropriate voltage and current tolerances. Do not leave electrical components powered for longer than they are required for use. Do not leave 3D printers unattended when they are powered up.

Toxic Fumes

Some filaments used in 3D printing can release toxic fumes when heated (such as during the 3D printing process). Working with solder can also release toxic fumes (especially if leaded solder is used). Ensure adequate ventilation at all times during 3D printing and soldering.

Lacerations

Cleaning 3D prints sometimes involves the use of sharp instruments – take appropriate precautions when handling sharp blades. Working with optics – especially thin plates of glass such as beamsplitter mirrors, microscope slides and coverslips and display screen panels can result in flying shards and sharp edges. Wear appropriate personal protective equipment such as gloves and face and eye protection.

Injury to Eyesight

Physical injuries to the eyes may occur from shards and specs of glass and airborne particles of molten or hot solder. Bright lights are used to illuminate the PUMA microscope. These should be used with caution. Do not stare directly into the illumination LED bulb (with or without its collector lenses in place), and only use a brightness setting that is appropriate for comfortable viewing when using the complete microscope. If using a mirror to provide illumination always use a reflection from a diffuse scene such as an open blue or cloudy sky. NEVER allow specular reflections of the sun to enter the field of view of the mirror or permanent eyesight loss may result. If using a bulb that emits UV light, always ensure an appropriate and effective UV blocking filter is used to shield your eyes from the UV light. If a laser is used for illumination then you should never look at the image through the lenses of the scope (you should use a camera for making observations).

Protecting the Vulnerable

The PUMA microscope and its accessories are not toys. Do not allow children, vulnerable adults or pets to come into contact with any PUMA product without appropriate supervision and safeguards.

Introduction

PUMA is a 3D printed high quality microscope system. The name PUMA stands for ***P***ortable, ***U***pgradeable, ***M***odular and ***A***ffordable – key features of this system.

This document provides practical advice for those who want to print their own parts for the building of PUMA-related modules and microscopes.

It also serves as a visual 'index of parts' for all the 3D printed parts in the PUMA project and shows which FreeCAD file contains which parts. Within the FreeCAD file those models have the same name as the STL file but without the '.stl' extension and also without the two letter prefix before the first underscore. For example, the file AR_Cc_locknut.stl is a mesh generated from the model called 'Cc_locknut' in the FreeCAD file called 'AR_Projector.FCStd'.

The information in this file only relates to 3D printed parts. To build a PUMA microscope additional components will be needed such as nuts and bolts and optics elements. None of these additional components are addressed here. See the assembly / usage tutorials and documentation for that information.

Advice is given for each model separately. For most models this advice consists solely in an illustration showing the preferred orientation of the model on the printer build plate. In some cases additional advice and illustrations are given, particularly where they relate to support structures.

This document makes no attempt at explaining what each part does or how to use or assemble them. For that kind of information you would need to see the assembly / usage tutorials and other documentation.

The Cura screenshot illustrations in this document show the models at various zooms and with some angular perspective variations from model to model in order to emphasise different aspects. However the grid and 'Ender' logo shown on the build plate should make it clear how the model is to be orientated and indicate the scale.

Each chapter begins with a table of resources showing the print time and length of 1.75 mm diameter PLA filament used to print each STL file as estimated by Cura v.4.8.0 using the recommended print settings described in that chapter for each model.

Cover Illustration

Centre

A PUMA microscope in the following configuration: Full Kohler illuminator, motorised Z-stage, mechanical XY Vernier caliper slide holder, advanced filter block, augmented reality projector, binocular head, PUMA control console. It is fitted with a Zeiss Plan 2.5x objective and two high eye point wide field 10x oculars of 20 mm field of view. Many alternative configurations are possible due to PUMA's modular design.

From Top Going Clockwise

These microscope images (all taken with a PUMA microscope in various configurations) are highly cropped and compressed and do not show the full field of view. See the gallery of images on the PUMA websites for full quality and full field images. Magnifications given below are of the objective only:

Bright field Kohler illumination: H&E chronic inflammation, x100 oil immersion.

Fluorescence microscopy: Fluorescein stained *Soncus* bud showing pollen grains and other cellular structures x40.

Fluorescence microscopy: Fluorescein stained *Ilex* (holly) leaf showing chloroplasts, vascular structures and other cellular structures x40.

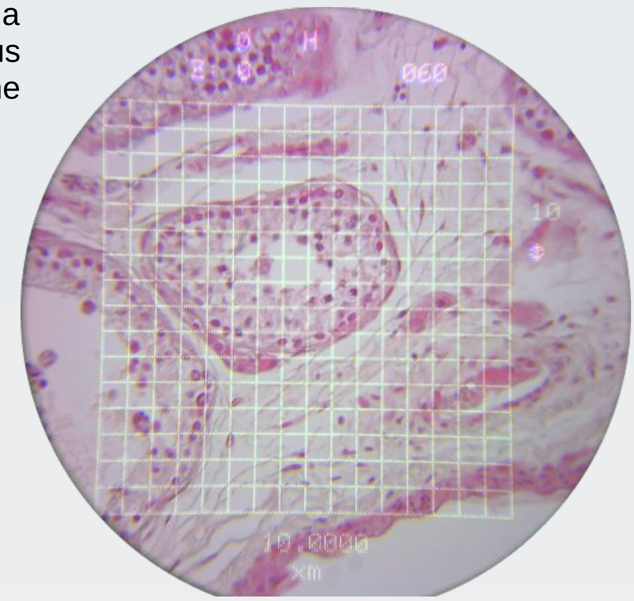
Crossed polarisation microscopy: Amyloid stained with Congo red x40.

Dark field / Dark ground microscopy: Unstained section of colonic tissue x10.

Schlieren phase contrast using a spatial light modulator in the illuminated aperture plane of the condenser: Unstained section of colonic mucosa, x100 oil immersion.

Crossed polarisation microscopy: Striated muscle of tongue stained with H&E x40.

AR HUD Overlay. The figure shows a cropped area from a small part of the field of a x10 view of an H&E section (of testis) with the augmented reality (AR) projector projecting a heads up display (HUD) of a grid and some microscope status information onto the live optical image. The full field image is shown here:

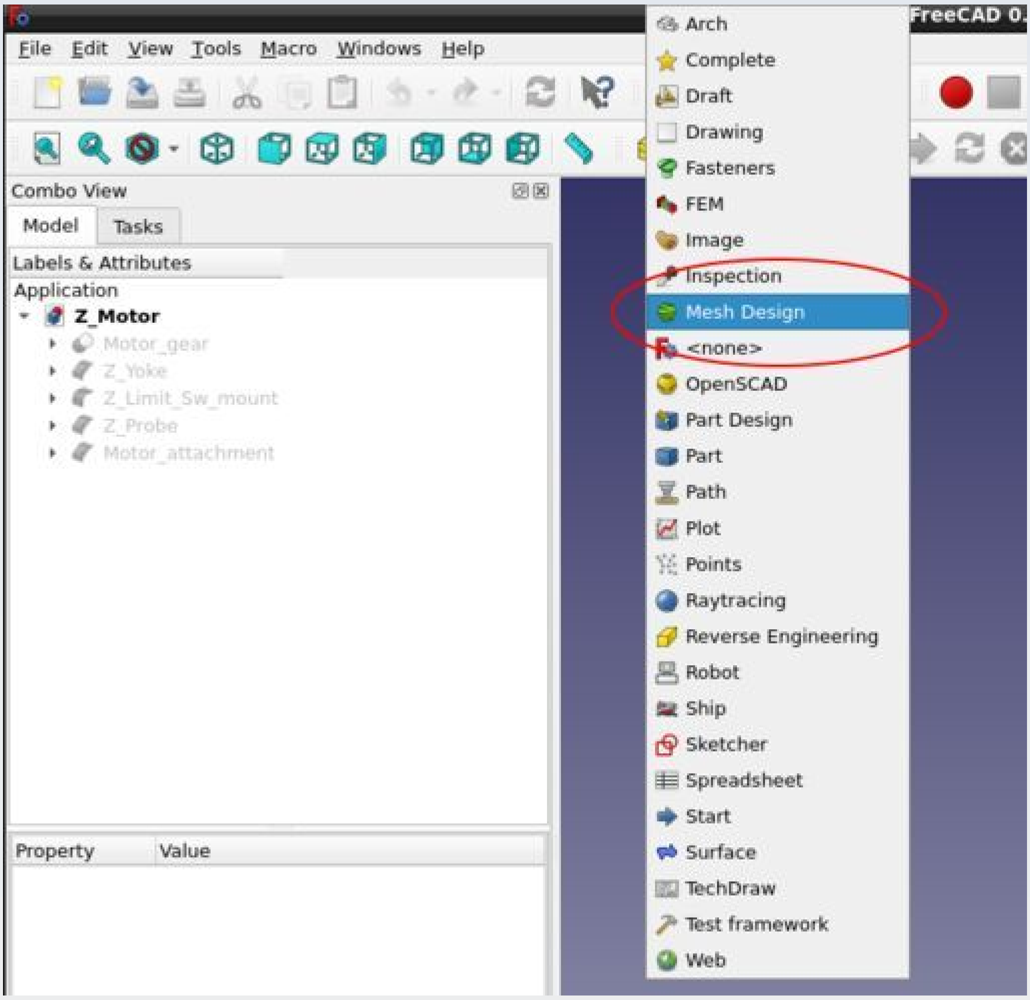


Generating the STL Mesh Files

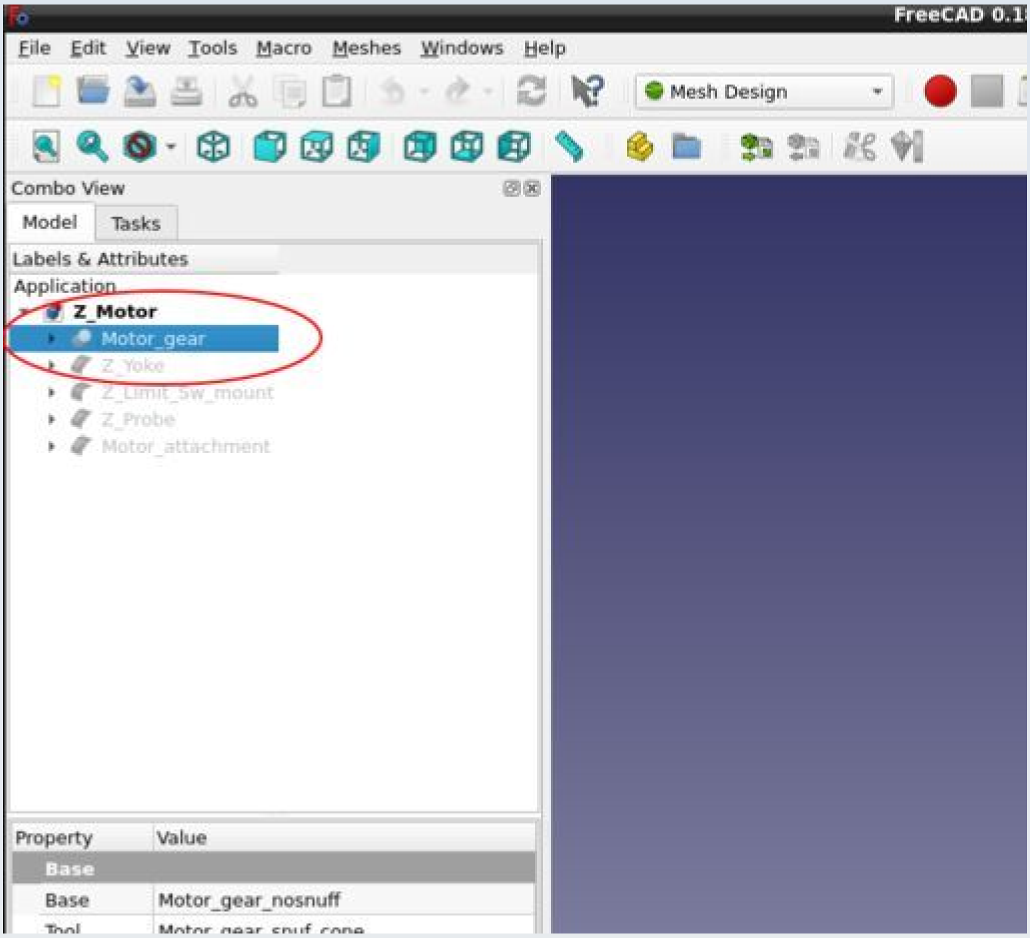
The STL mesh files for the PUMA microscope are of variable sizes but many are too large to host on GitHub. However, the CAD files are the source and STL files can be generated from the models in the CAD files using the open source FreeCAD software by means of the following steps.

1. Load the CAD file into FreeCAD (I used v. 0.18 to illustrate these steps but a later or the latest version may be reuqired to correctly view and edit the latest models). For the following illustrated examples I have loaded the ‘Z_Motor.FCStd’ file from the PUMA project.

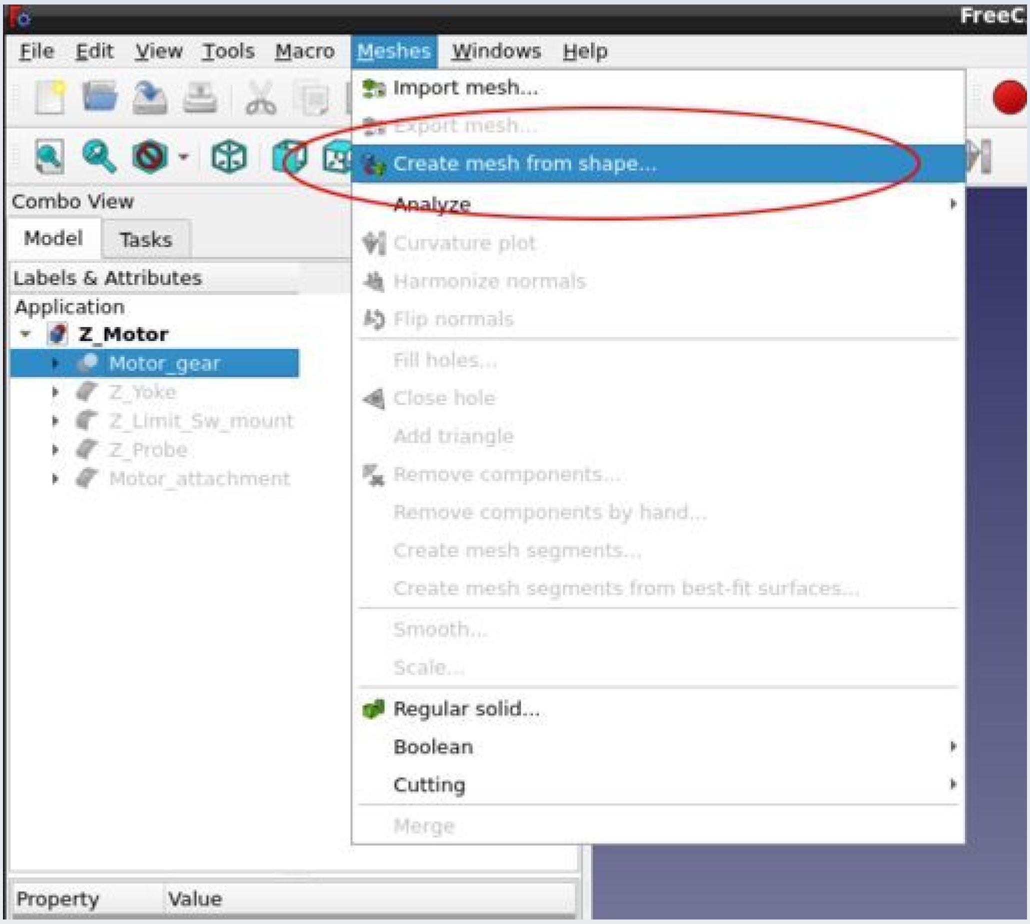
2. Select the 'Mesh Design' Workbench from the drop down selection list on the top button bar of FreeCAD.



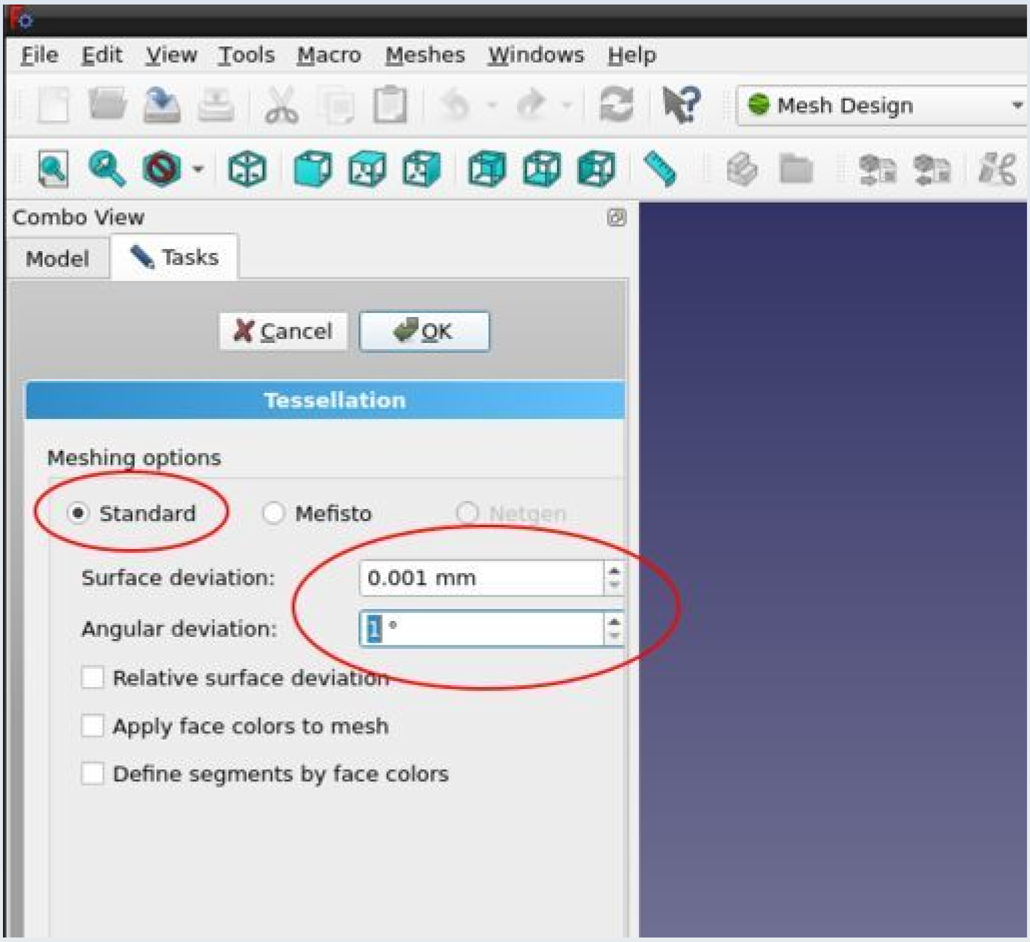
3. Left-click on the model you want to create a mesh for so as to select it.



4. Go to 'Meshes' -> 'Create mesh from shape ...' to bring up the Tessellation dialogue box.



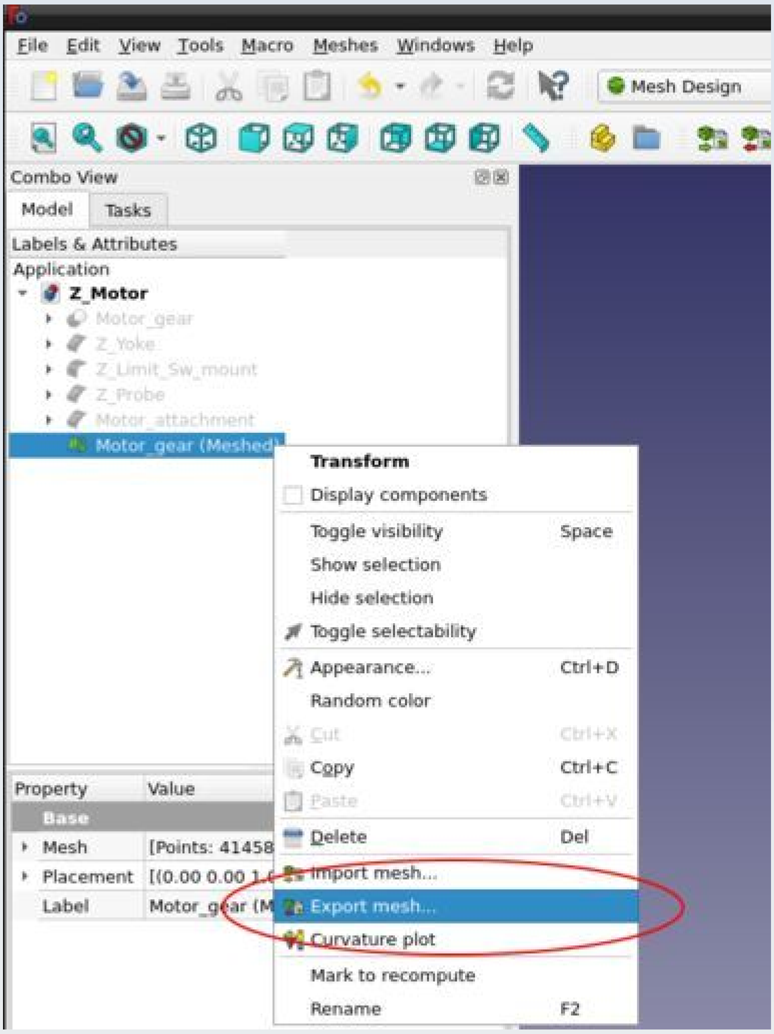
5. Select the 'Standard' meshing option set the 'surface deviation' to 0.001 mm and the 'Angular deviation' to 1 degree.



6. Click OK - it may take a while to complete.

These mesh settings may be overly fine for many of the models in that you could probably get away with coarser settings and lower resolution meshes for some models. However I have not experimented to see how low I can go before the models cease to function or cease to fit properly.

7. When the mesh is generated, right click on the mesh in the 'Model' tab of the combo view and select 'Export Mesh ...' from the drop down menu to save the mesh as an STL file. You might need to rotate the mesh first before export to make it easier to site on the build plate in Cura in the manner required for printing (as will be shown in the illustrations in the rest of this document for each model). Although you can also performs most of those manipulations in Cura itself.



Generating Alternatives to STL Mesh Files

The PUMA project does not restrict choice to any particular format of manufacturing file. So far I have only had practical experience using STL format mesh files for 3D printing and STL files are currently popular with much of the home/school/college 3D printing community so I have detailed how to produce such files from the CAD models in the previous section.

However, other file formats for manufacture are also available and may have advantages over the STL format in certain situations. One example is the ‘additive manufacturing format’ or AMF file.

FreeCAD supports exporting models in the AMF format. To do this simply click the model you want to export with a single left click (not the mesh of the model, but the model itself – there is no need to generate a mesh) and go to the main menu and select ‘File’ → ‘Export …’ and there you can select a range of many formats including AMF, OBJ, etc.

Printer and Slicer Software and Settings

This advice relates specifically to printing parts using a Creality Ender 3 printer with ordinary PLA 1.75 mm diameter filament and the Ultimaker Cura slicer software (v. 4.8.0 to v. 4.13.1).

If you use a different printer and / or slicer you would need to explore for yourself what are the most appropriate settings and profiles to use and may also need to modify other aspects of the advice given here.

Note the orientation of models on the print bed as shown in the figures. For some models is probably won't matter if you use a different orientation but for others is it crucial to functionality that you stick to the orientation shown. My advice therefore is to alwatys use the orientation shown in the figures unless you want to experiment and are happy to risk either failure or suboptimal functionality.

All models are printed with the PUMA custom Cura profile called 'Flats' unless otherwise specified (several other PUMA custom Cura profiles are used on occasion and these are available in the GitHub repository). No supports are used unless specified otherwise. None of the Cura in-built build plate adhesion options are used. Where necessary, custom adhesion structures – called 'adhesins' – are built into the model and these will need to be trimmed off when the model is complete as part of model post print clean up.

I have only ever printed the parts of this project using super high quality print settings and the highest resolution tessellation meshes. No doubt this is 'overkill' for many of the parts but I have not done the practical experimentation required to find out the lowest resolution meshes that will work with the lowest quality / fastest print settings.

I have only ever used standard PLA 1.75 mm filament for printing the parts of this project – although I have used PLA from different suppliers from Creality's own brand to much cheaper generic filament. With the highest quality branded filaments the prints seem a bit smoother but from a functionality point of view all filaments I have tried give acceptable results.

Supports

You don't need supports for screw thread holes up to M4 diameter that are printed horizontally but Cura will try to insert supports for these which is one of the reasons why support advice in some of the models below specifies to use the 'touching build plate only' option (not 'Everywhere').

When supports are enabled the default overhang angle should be set to 67 degrees.

For 'Tree' supports the default parameters to use are: 'branch distance' is 1 mm, 'branch diameter' is 2 mm, 'branch diameter angle' is 5 degrees and 'collision resolution' is 0.2 mm.

The 'branch angle' for Tree supports may be 40 or 50 degrees depending on the model so this information is provided for each model that required tree supports.

If supports are not stated to be required then ensure supports are off – even if it appears (or Cura suggests) that they might be needed. Sometimes this is emphasised for models where having supports enabled could cause the print to fail of adversely affect the function of the resulting print.

Some models require specific support blockers. These will be illustrated in the figures.

Mesh Errors

Very occasionally for some models Cura will report model errors in the STL mesh and highlight those areas in bright colours. These ‘errors’ are very small and the model slices and prints just fine even with them so they can be ignored. During development I have been able to identify and fix some of those mesh errors in FreeCAD but the very few remaining ones were not obvious – and practically they do not matter for printing with an Ender 3 printer.

Post Processing and Aftercare of Prints

I have noticed that PLA prints will shrink a little if exposed to excessive heat post printing and this may distort closely fitting parts and prevent them from functioning adequately. To avoid this, never keep your 3D printed parts on or very near to a radiator and never use a heater, hair dryer or radiator to dry off any parts that may have gotten wet. Leaving parts in a car in the sun may have a similar detrimental heat shrinkage effect.

Some parts, especially closely fitting parts like threads and push fit components may need scraping or light sanding to remove ‘nerds’, ‘zits’ or prominent seams or other imperfections prior to use. It is advised that you allow parts to cool down thoroughly after printing before any such actions (especially sanding) otherwise you may find that you have over-eroded the model and end up with a fit that is too loose. Some 3D printed threads may require ‘training’ if they seem overly tight. This means you screw and unscrew the thread repeatedly to wear it down a bit – this will usually wear down small prominences / defects in the print that lie in the thread channels. This may need to be done gradually (you may not be able to screw a part all the way in at first). After training the thread should fit snugly without being too tight or too loose.

Some parts require lubrication – such as the polariser wheel and Z-stage bearings. This will be elaborated on in the construction and usage tutorials.

Many thread holes for screws (mostly M2 and M3 sizes but sometimes also up to M6) in many of the parts are printed simply as holes that are slightly too small for the screw and you are expected to cut a thread into the hole by simply screwing the metal screw into the hole. Do this slowly at first concentration on getting the screw perpendicular to the hole and applying downward pressure. For such joints it is important never to over-tighten the screws in the finished product because you can easily destroy the plastic thread so produced. Also, you should avoid unscrewing and re-screwing in those holes because the thread will wear out eventually (although they can take quite a few repeats before wearing down to a detrimental degree).

AR Projector

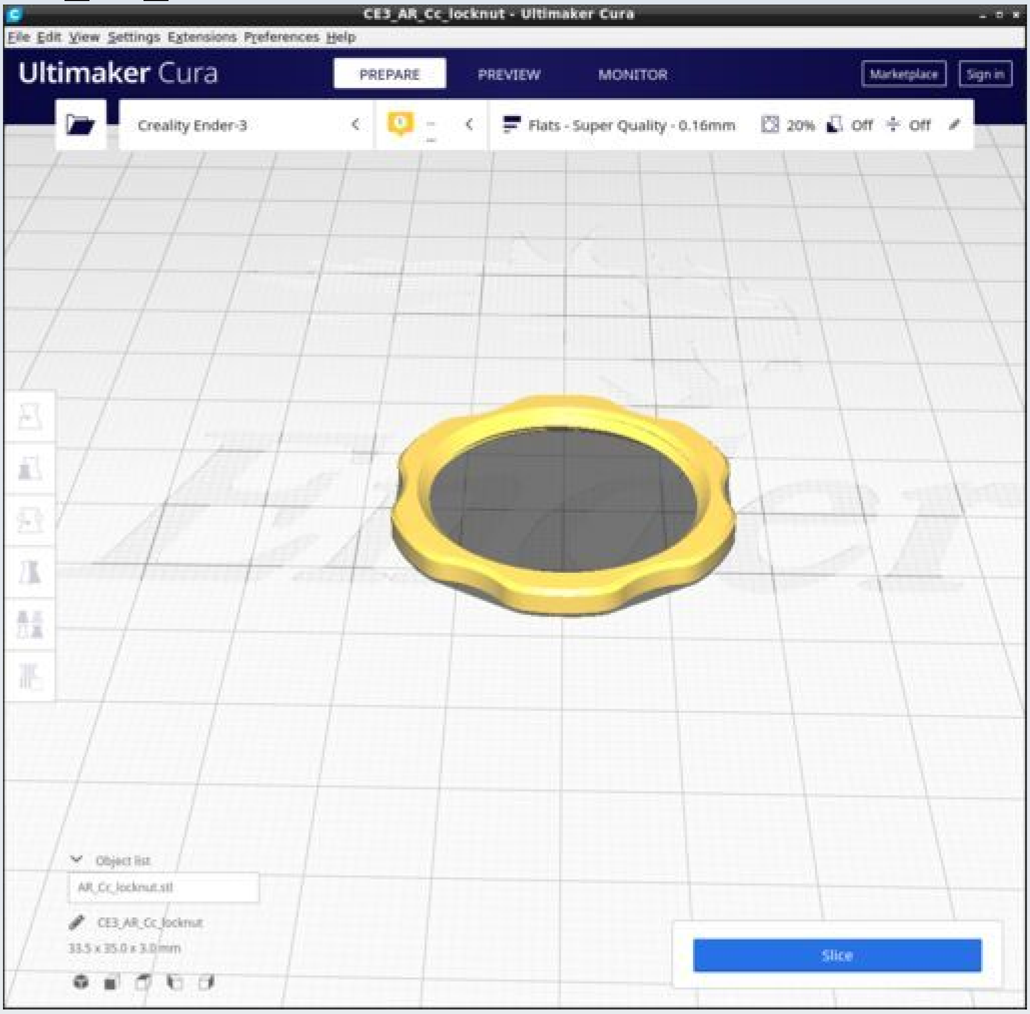
These are the parts for the augmented reality (AR) projector module which provides a heads-up-display (HUD) graphical user interface to the user. The CAD source models for these STL files are found in the file AR_Projector.FCStd.

Resources

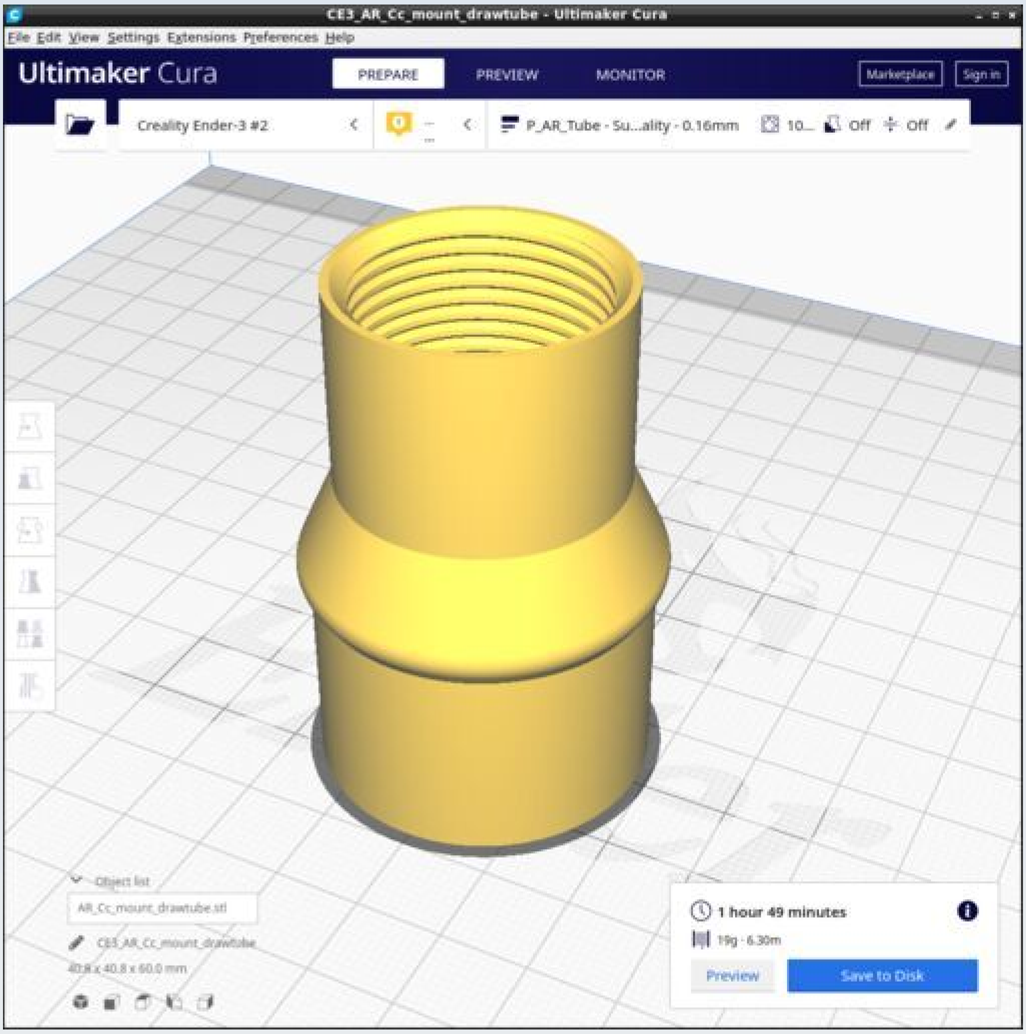
Cura calculates the following resources are required to print each model in this chapter:

AR_Projector	Time_Hr	Time_Min	PLA_Length(m)
AR_Cc_locknut.stl	0	12	0.35
AR_Cc_mount_drawtube.stl	1	49	6.3
AR_Cc_Retainer.stl	0	7	0.28
AR_Cx_Cc_connector.stl	0	28	1.16
AR_Cx_Collar.stl	0	11	0.36
AR_Cx_Lens_holder.stl	0	32	1.97
AR_Clip.stl	0	45	1.41
AR_Light_block_filter.stl	0	1	0.06
AR_Stay_thumbwheel.stl	0	15	0.56
AR_TFT_DrawTube_F.stl	2	59	5.33
AR_TFT_Drawtube_sheath.stl	0	18	0.87
AR_TFT_LightShield.stl	0	43	1.49
AR_TFT_Mount.stl	1	1	2.3
AR_Slide_mount.stl	0	59	1.91

AR_Cc_locknut.stl

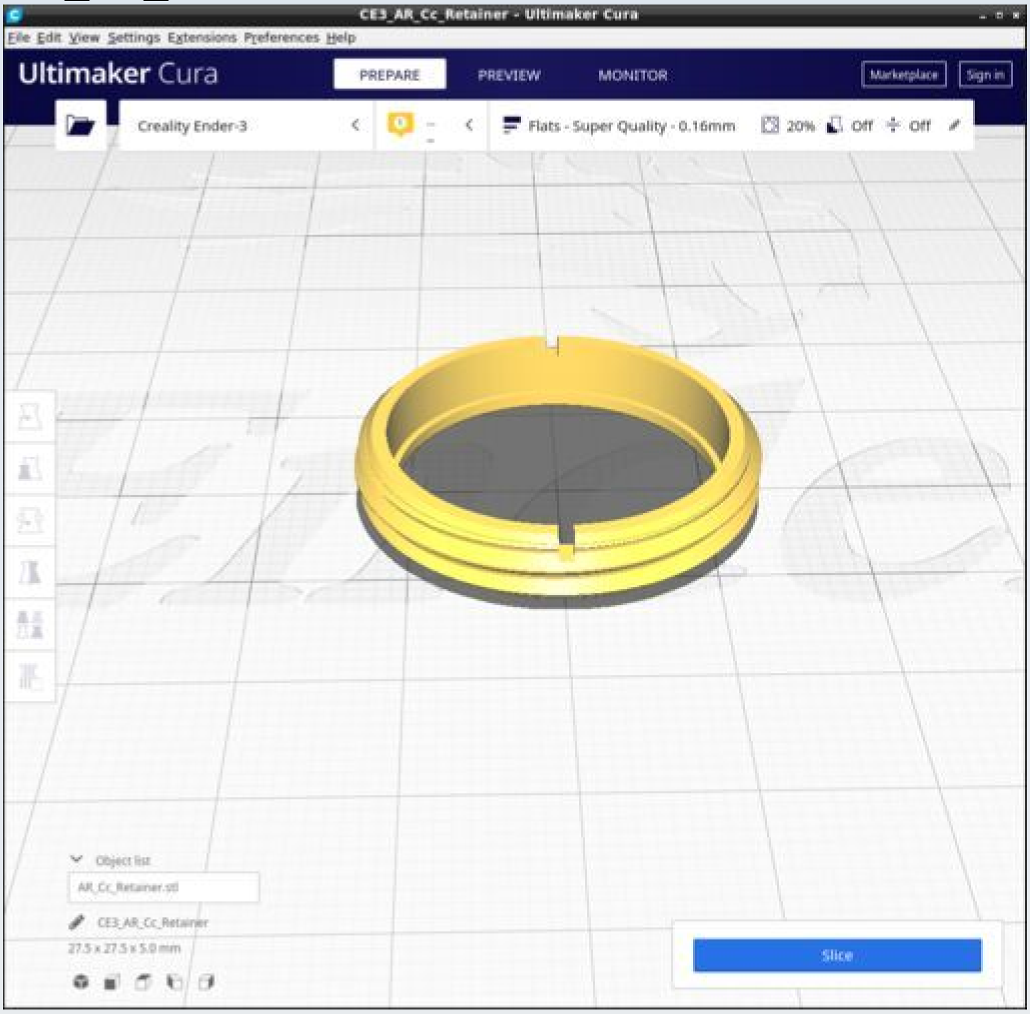


AR_Cc_mount_drawtube.stl

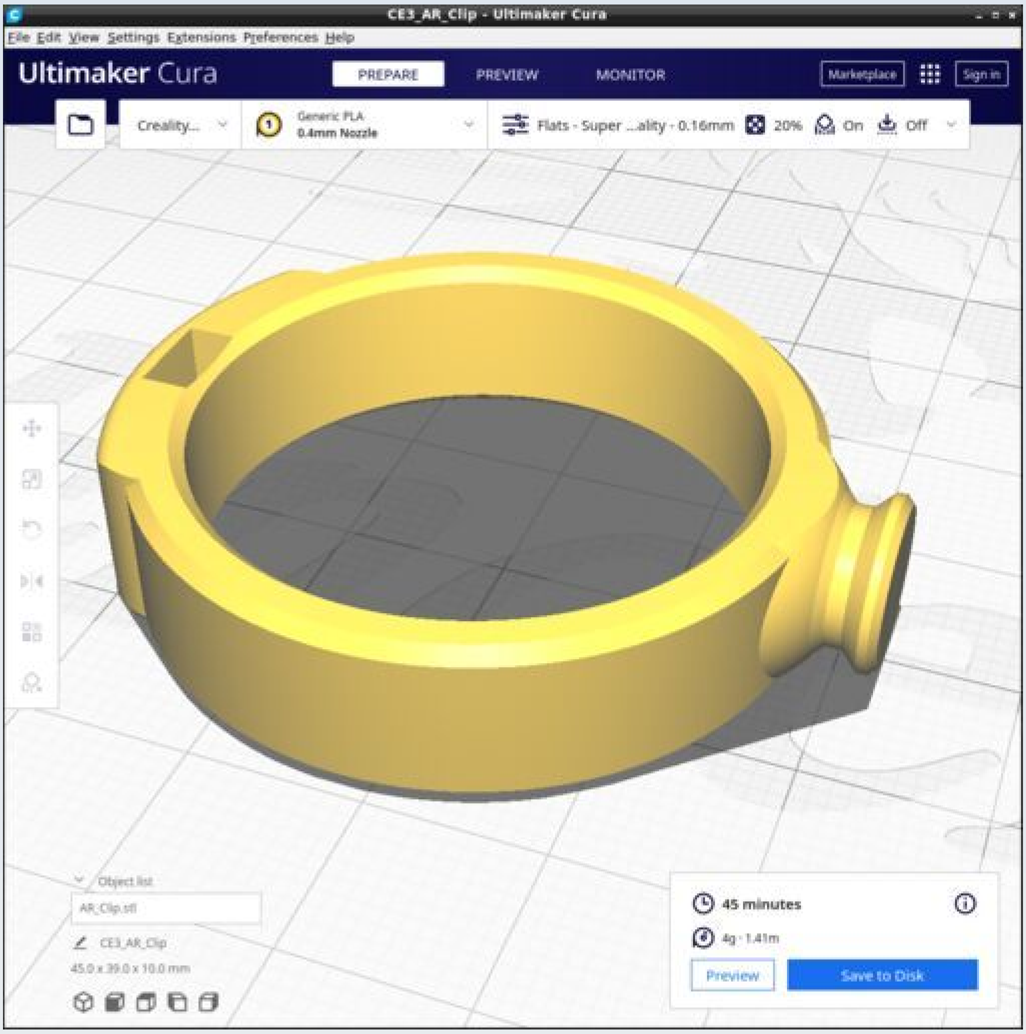


Print with PUMA custom Cura profile ‘P_AR_Tube’

AR_Cc_Retainer.stl

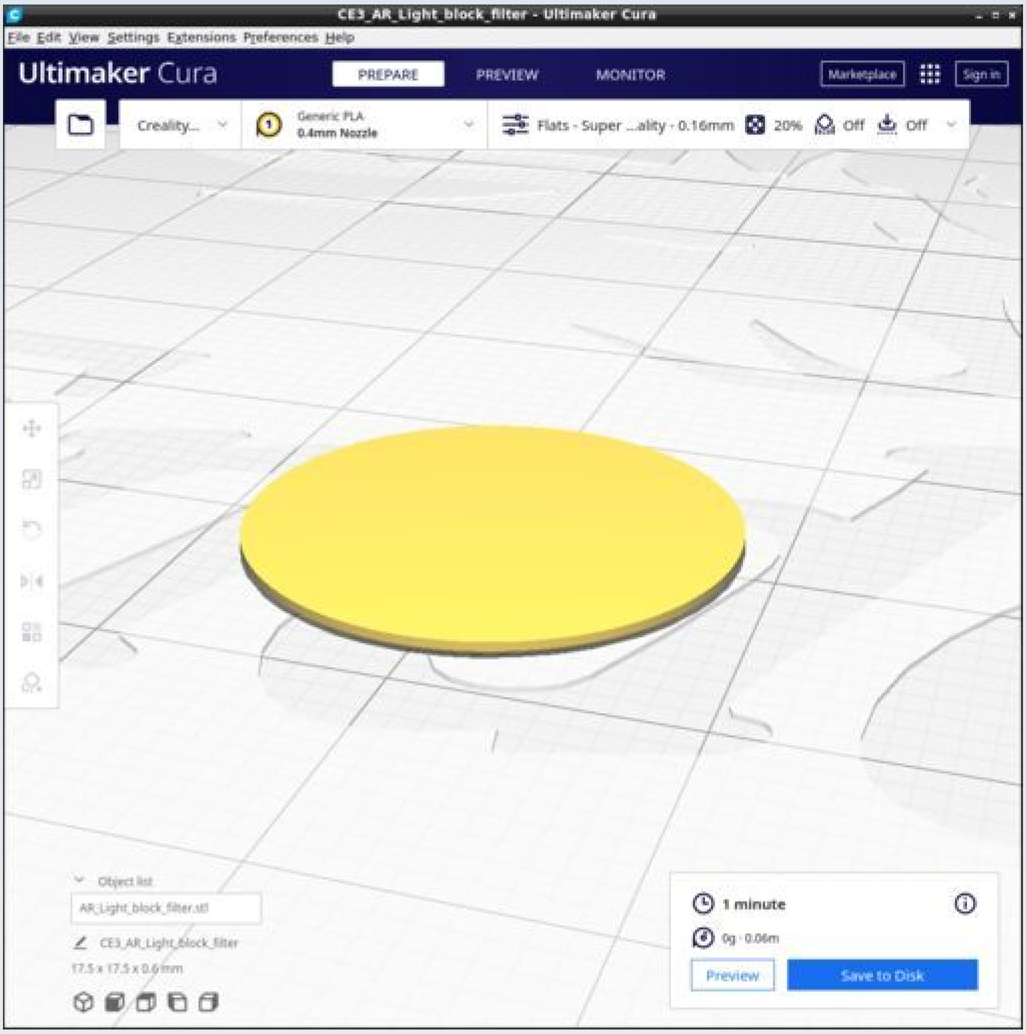


AR_Clip.stl

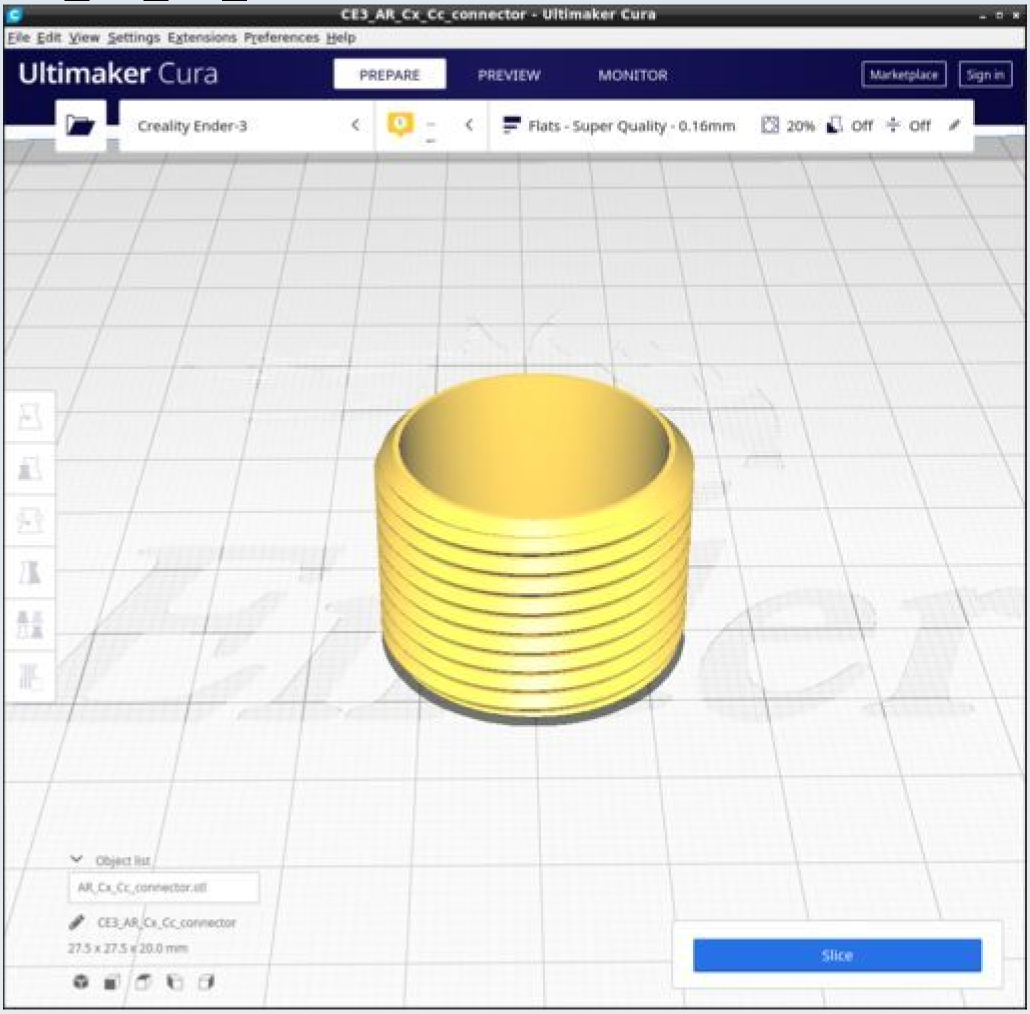


Use standard supports (not tree) with overhang of 67 degrees.

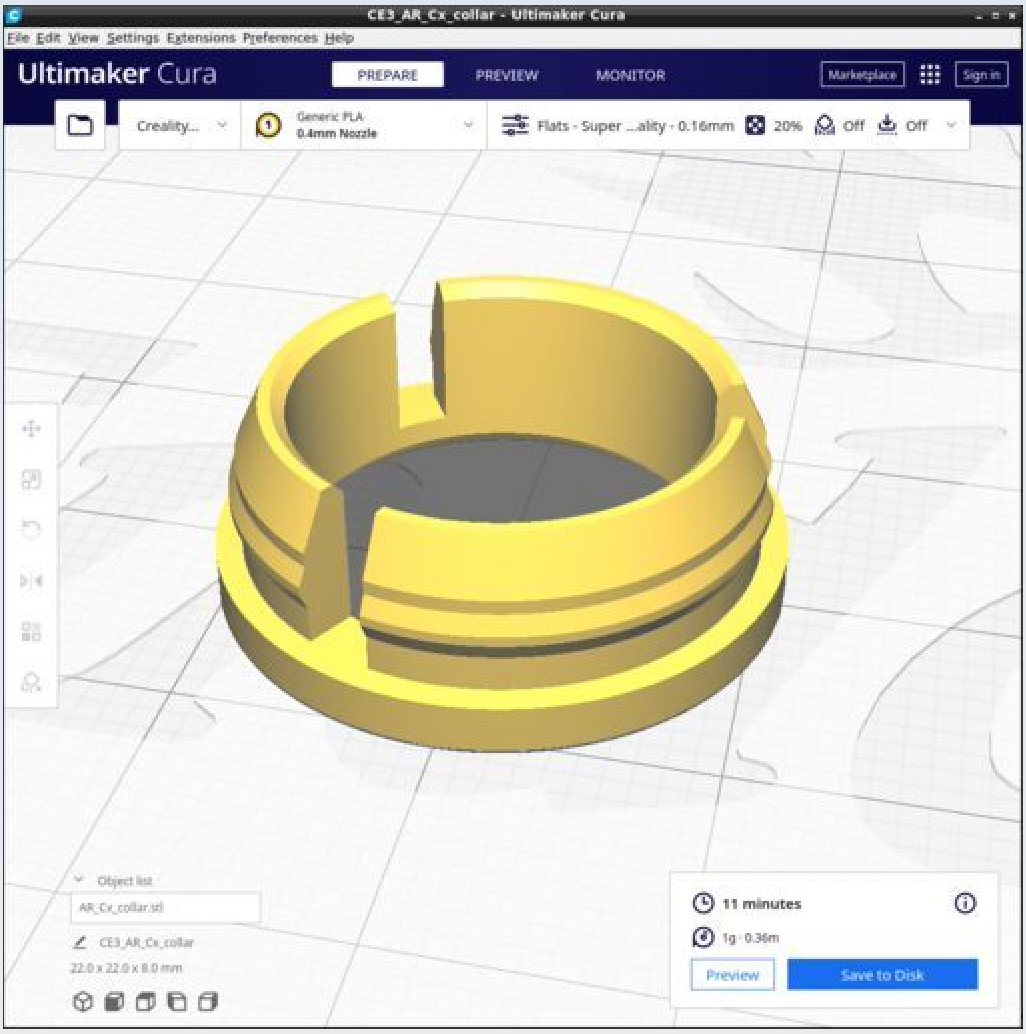
AR_Light_block_filter.stl



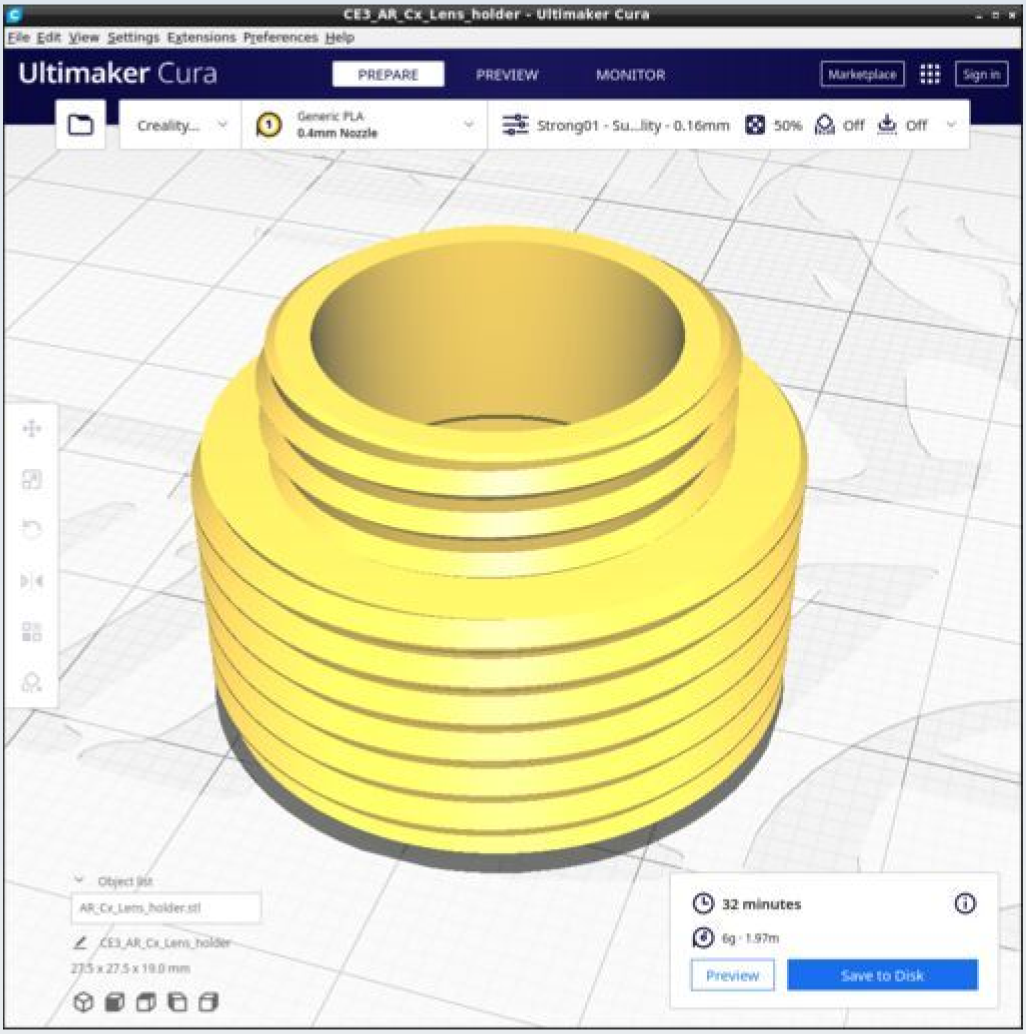
AR_Cx_Cc_connector.stl



AR_Cx_Collar.stl

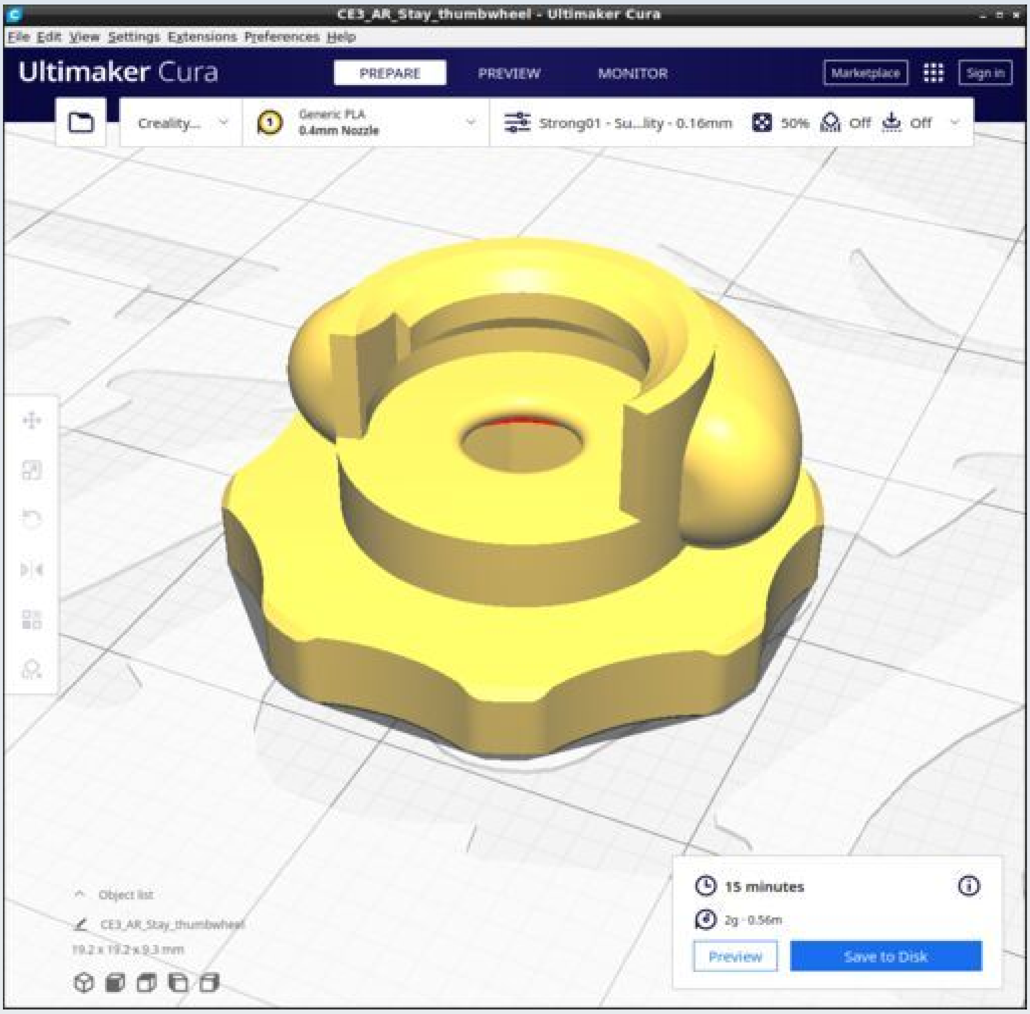


AR_Cx_Lens_holder.stl



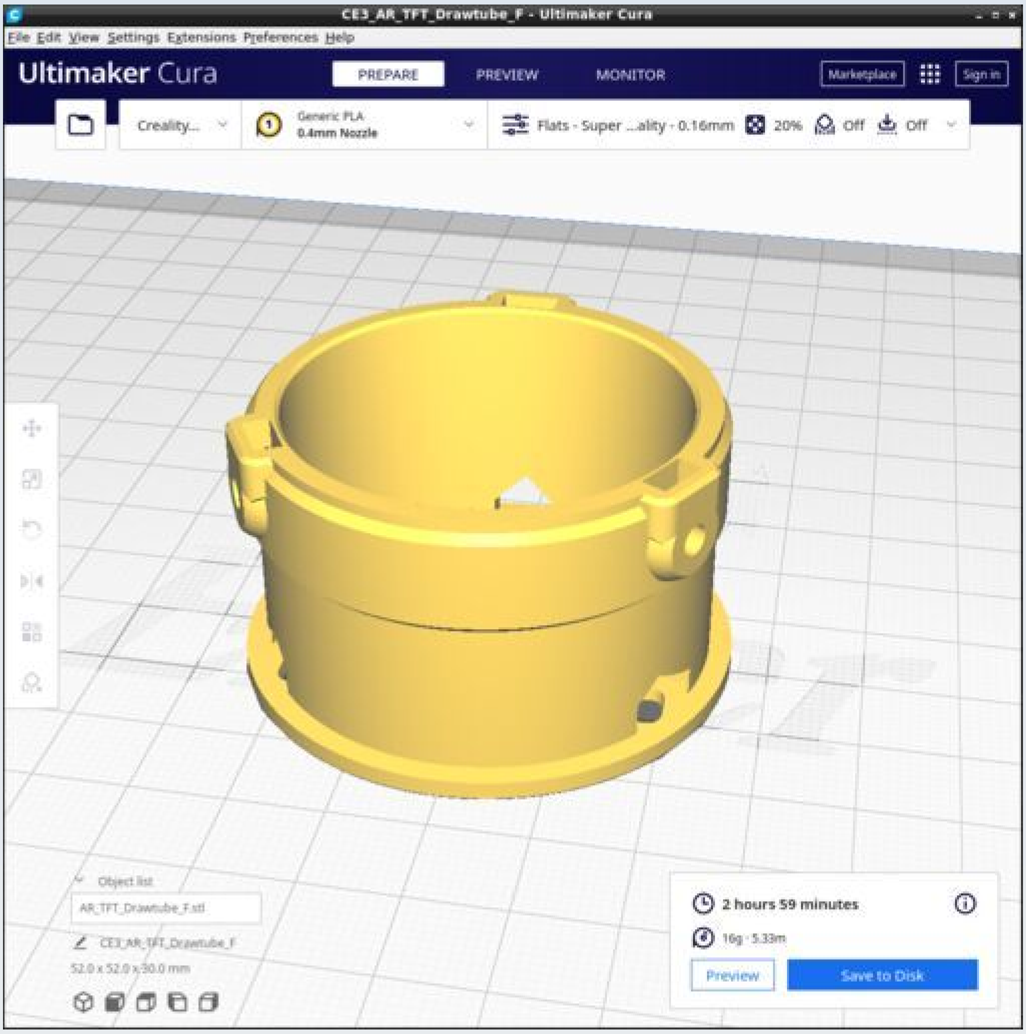
Print with PUMA custom Cura profile ‘Strong01’

AR_Stay_thumbwheel.stl

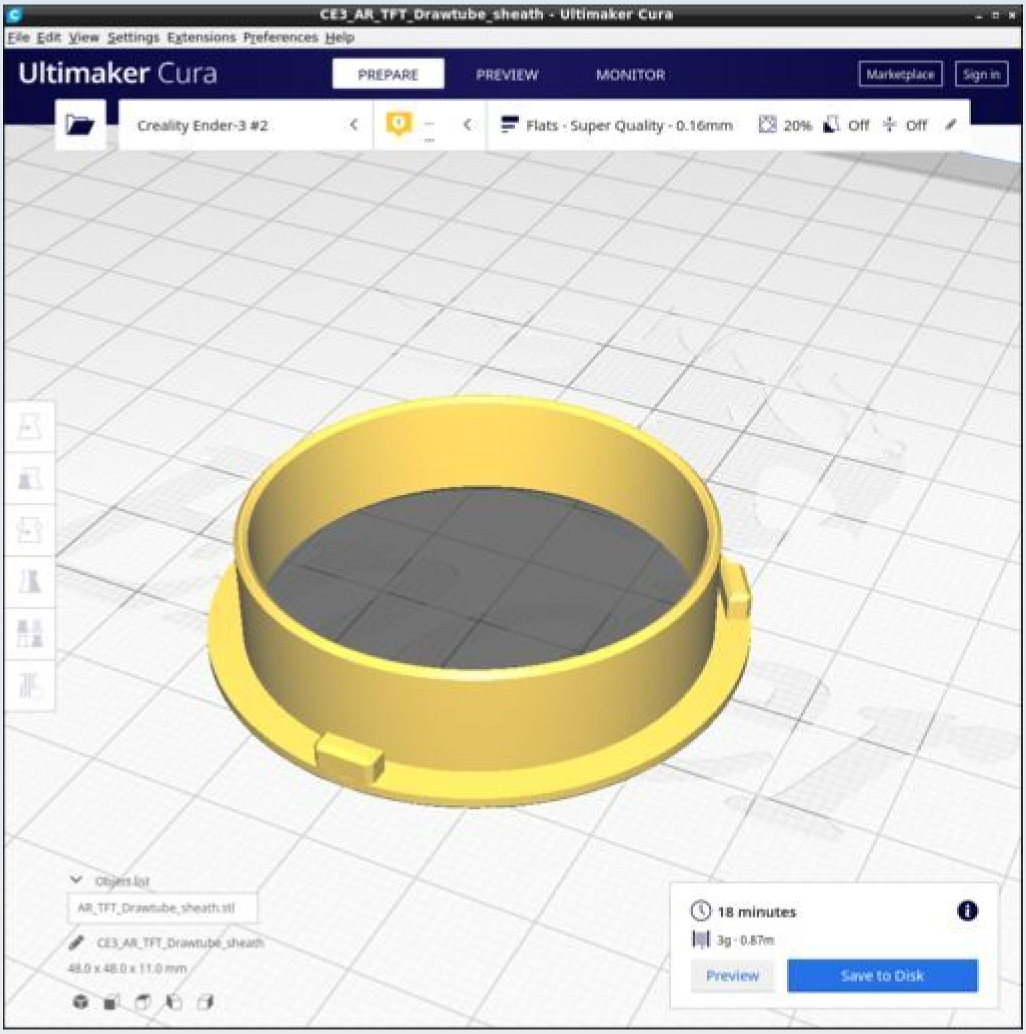


Use profile ‘Strong01’. No supports.

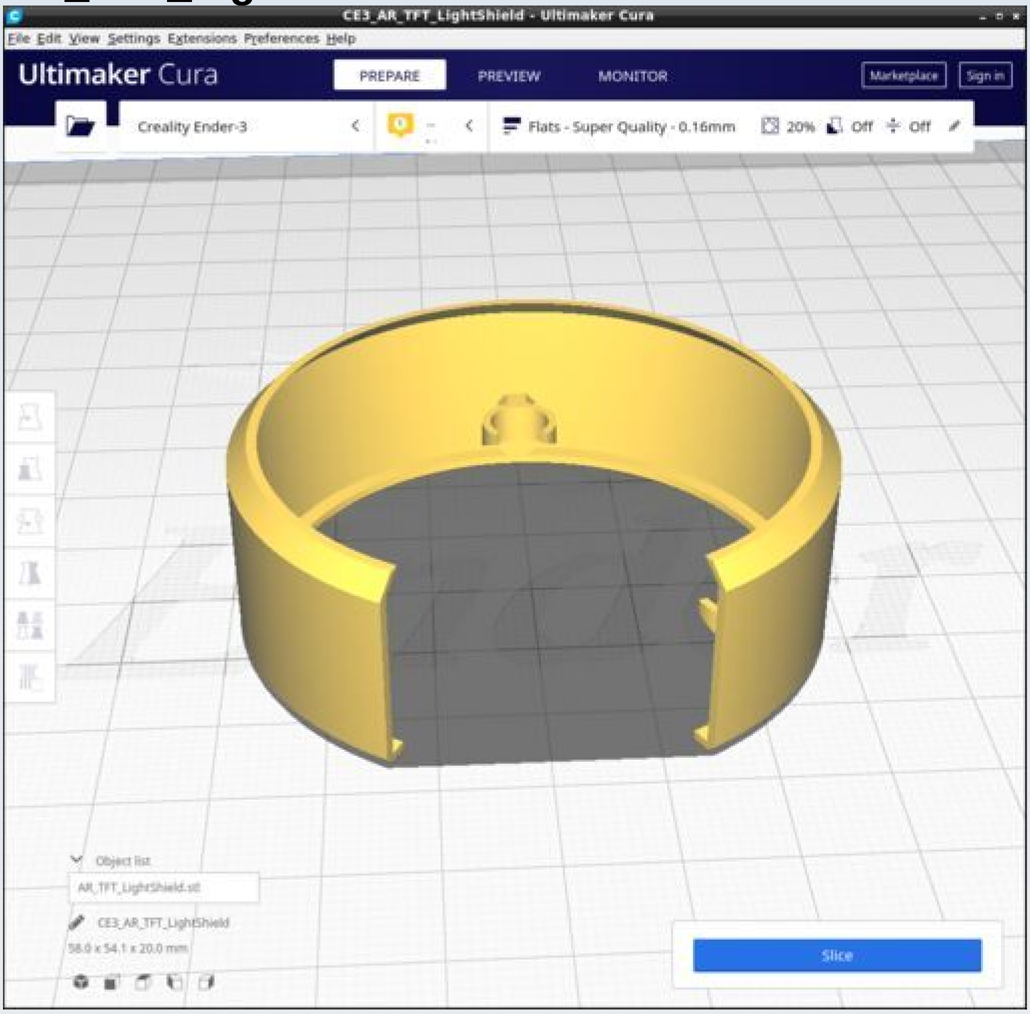
AR_TFT_DrawTube_F.stl



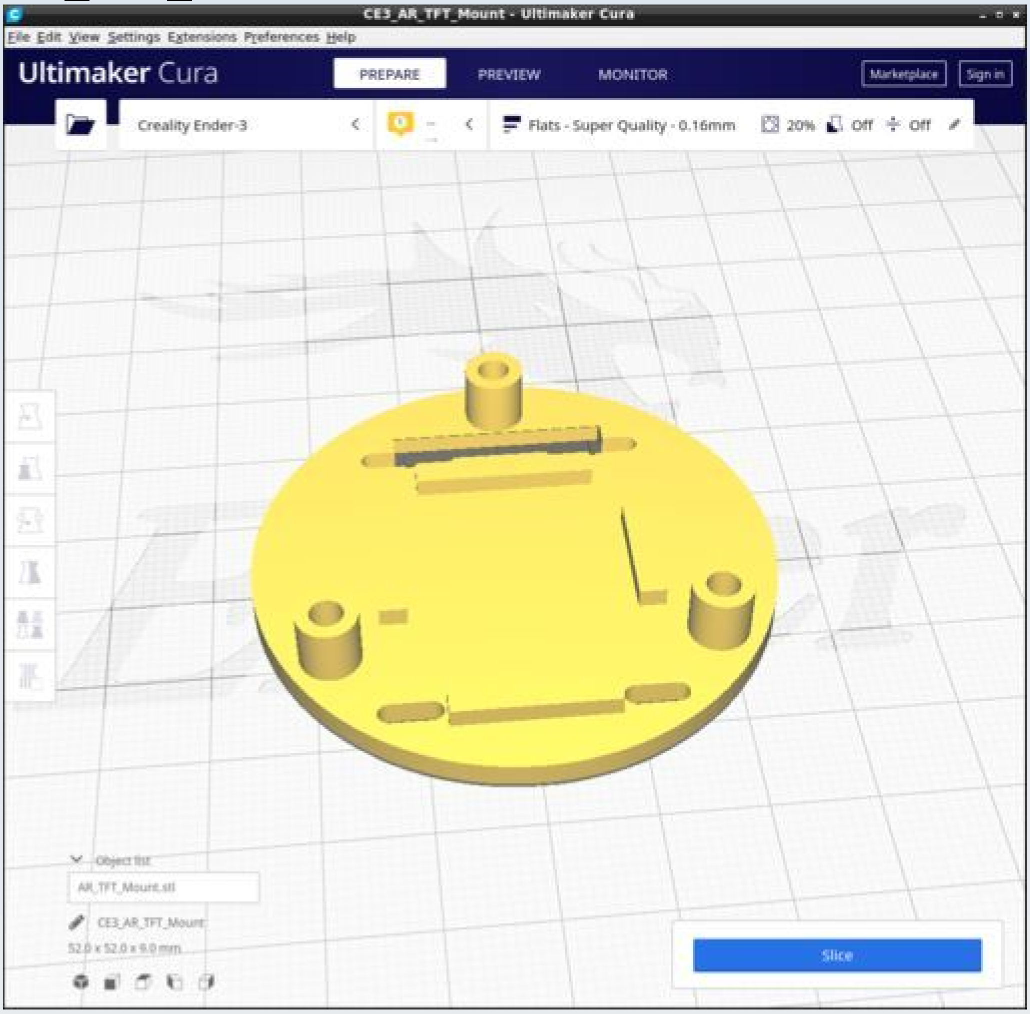
AR_TFT_Drawtube_sheath.stl



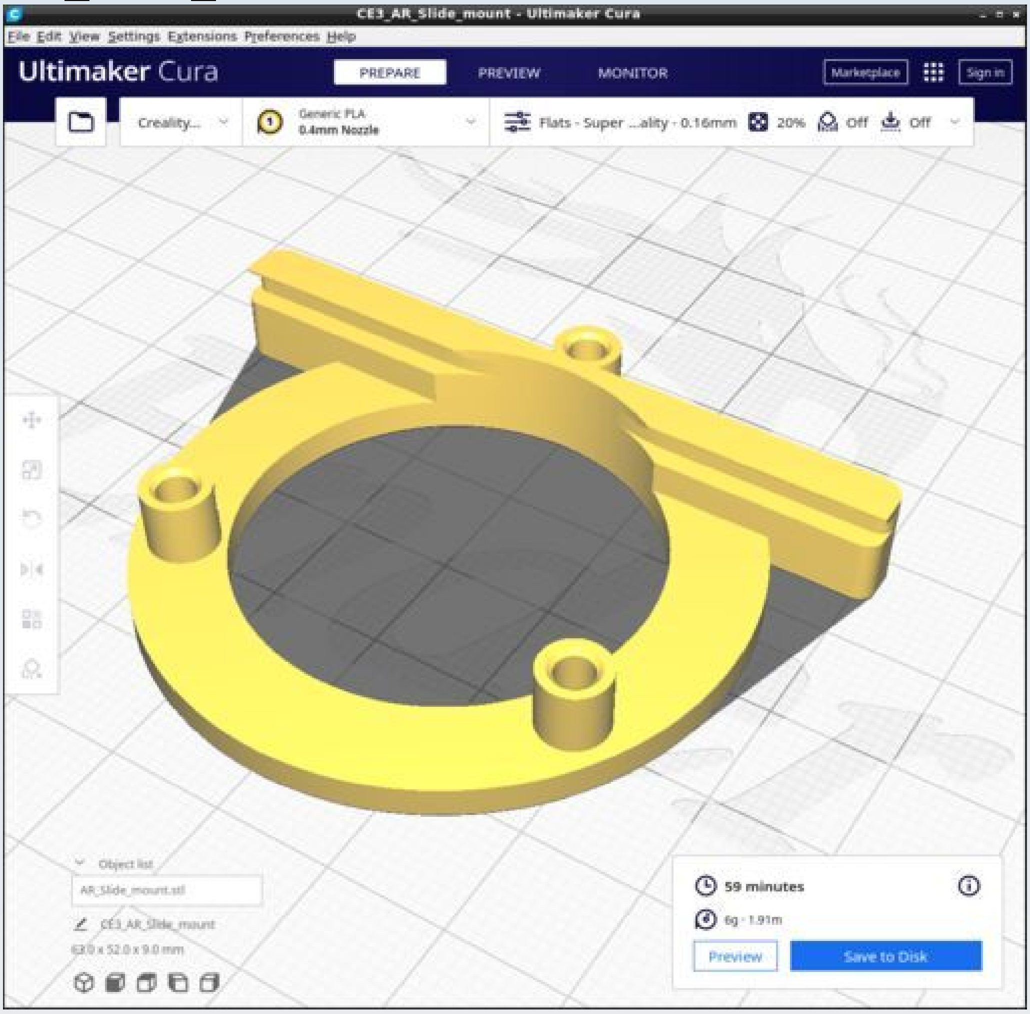
AR_TFT_LightShield.stl



AR_TFT_Mount.stl



AR_Slide_mount.stl



Binocular Head

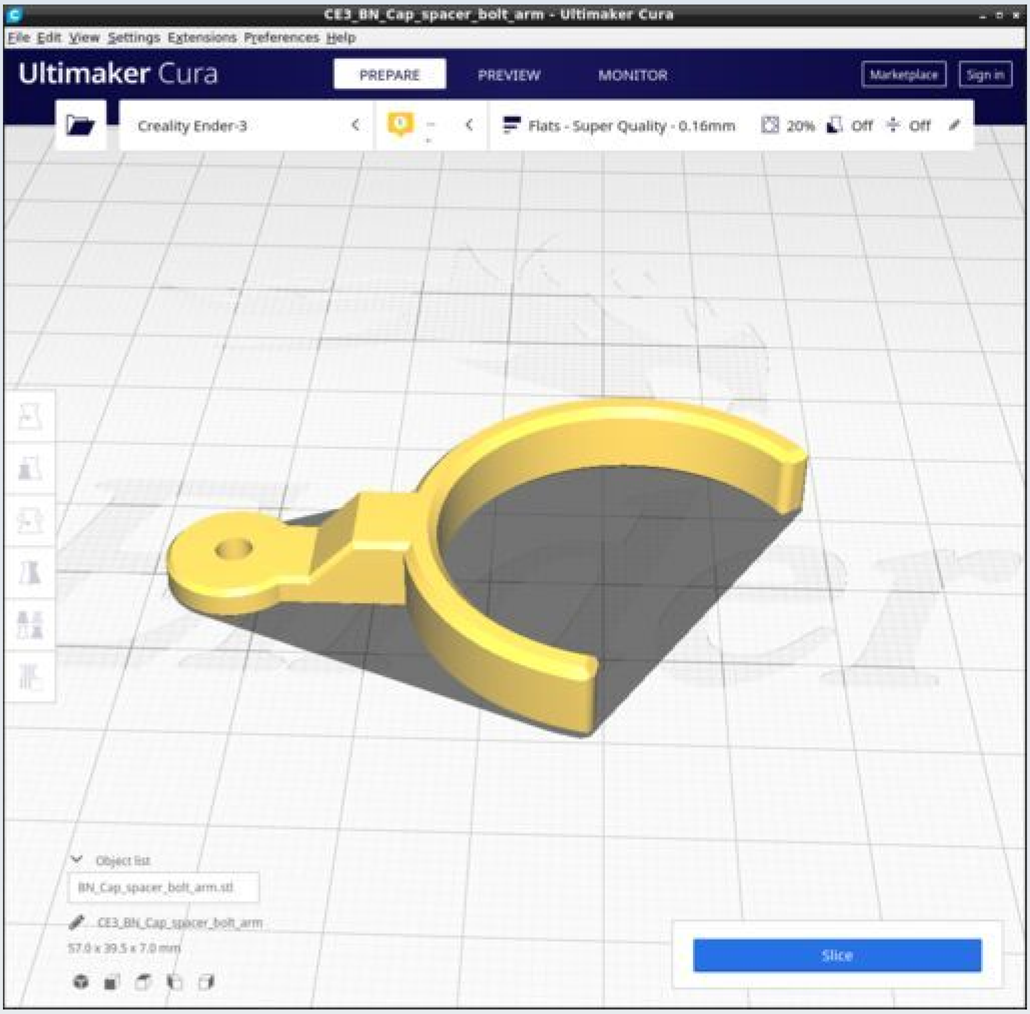
These are the 3D printed parts for the binocular head module. The CAD source models for these STL files are found in the file Binocular.FCStd.

Resources

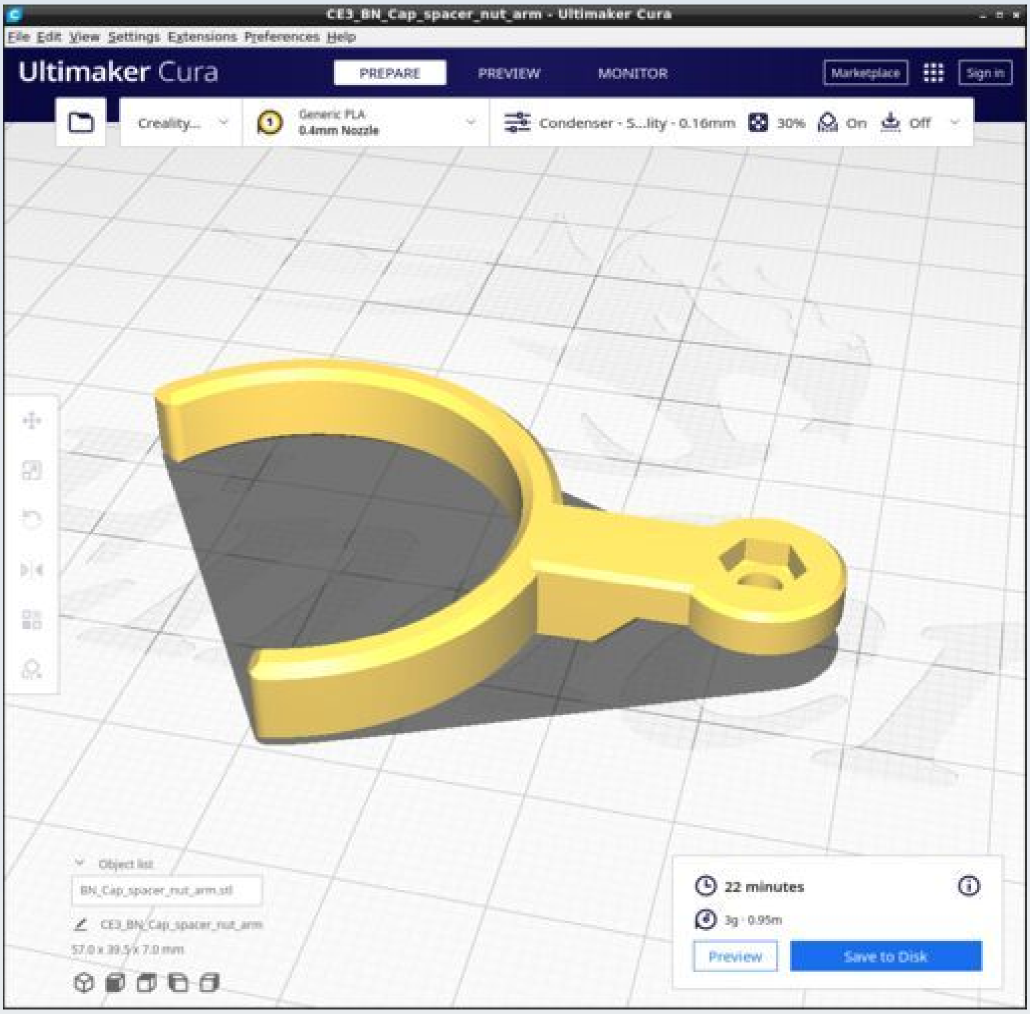
Cura calculates the following resources are required to print each model in this chapter:

Binocular_Head	Time_Hr	Time_Min	PLA_Length(m)
BN_Cap_spacer_bolt_arm.stl	0	21	0.77
BN_Cap_spacer_nut_arm.stl	0	22	0.95
BN_CM_BB_Cover.stl	0	31	1.13
BN_CM_Tube_short_c_adhesin.stl	0	41	1.69
BN_EM_Cover	0	21	0.87
BN_MB_Shim.stl	0	5	0.08
BN_MBT_Cap.stl	0	24	1
BN_MBT_Ring.stl	0	21	0.64
BN_MB_Tube.stl	1	50	3.68
BN_MB_Tube_spacer_2p5mm.stl	0	12	0.28
BN_Mirror_mount_bottom.stl	1	0	1.51
BN_Mirror_mount_top_ocular.stl	1	31	2.84
BN_Ocular_spacer_ring_0p32.stl	0	2	0.06
BN_Ocular_Base_thread_L.stl	0	35	0.86
BN_Ocular_Base_thread_R.stl	0	35	0.86
BN_Outlet_lower_spacer.stl	0	0	0.02
BN_Outlet_upper.stl	1	42	2.72
BN_Splitter_block.stl	2	4	3.35
BN_Splitter_support.stl	0	1	0.02

BN_Cap_spacer_bolt_arm.stl

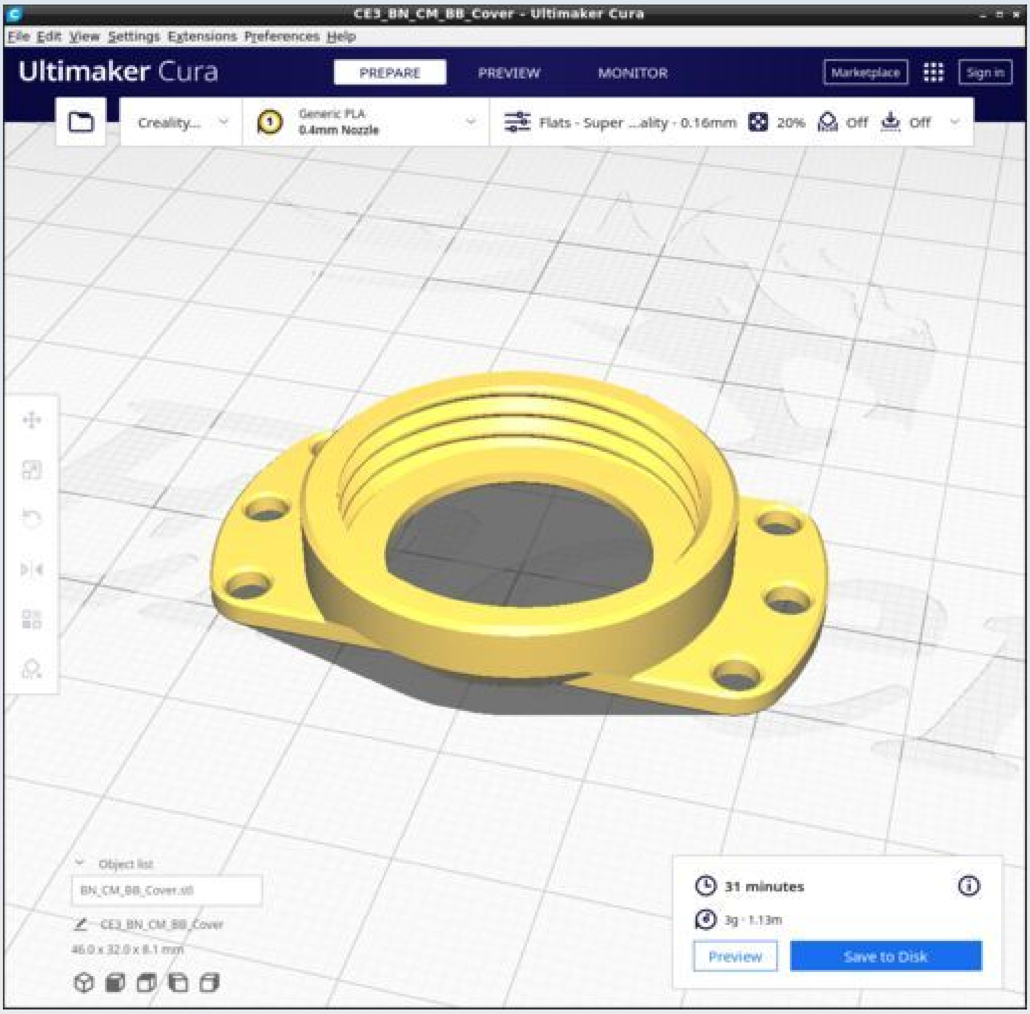


BN_Cap_spacer_nut_arm.stl

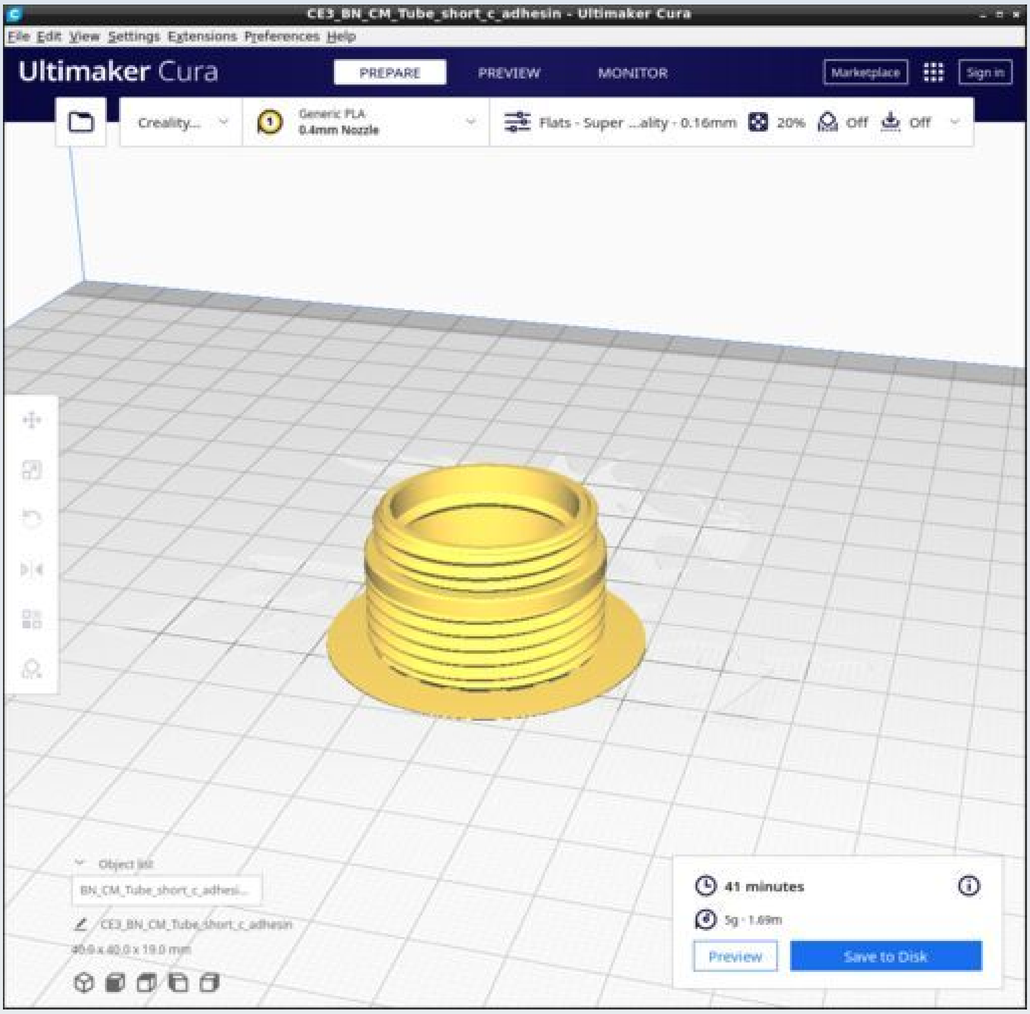


Use the Condenser profile (including its support settings).

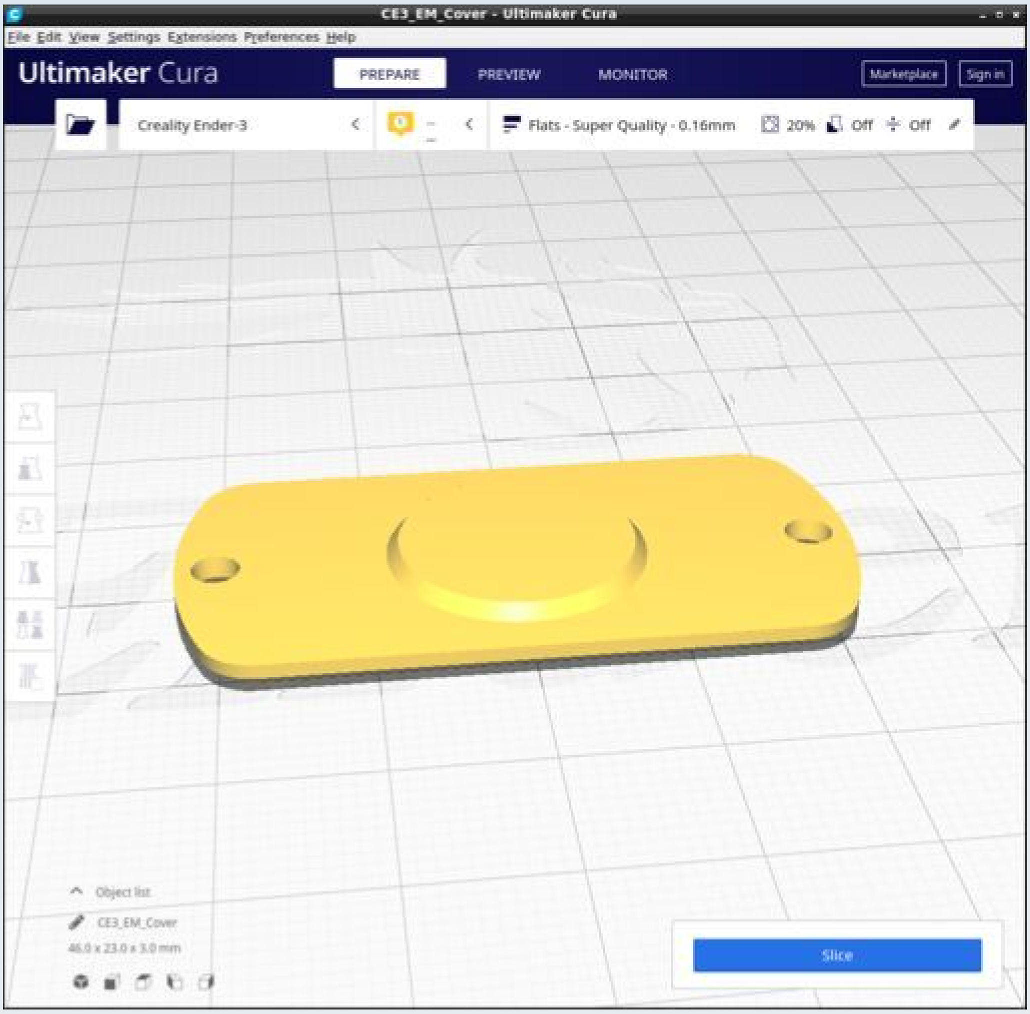
BN_CM_BB_Cover.stl



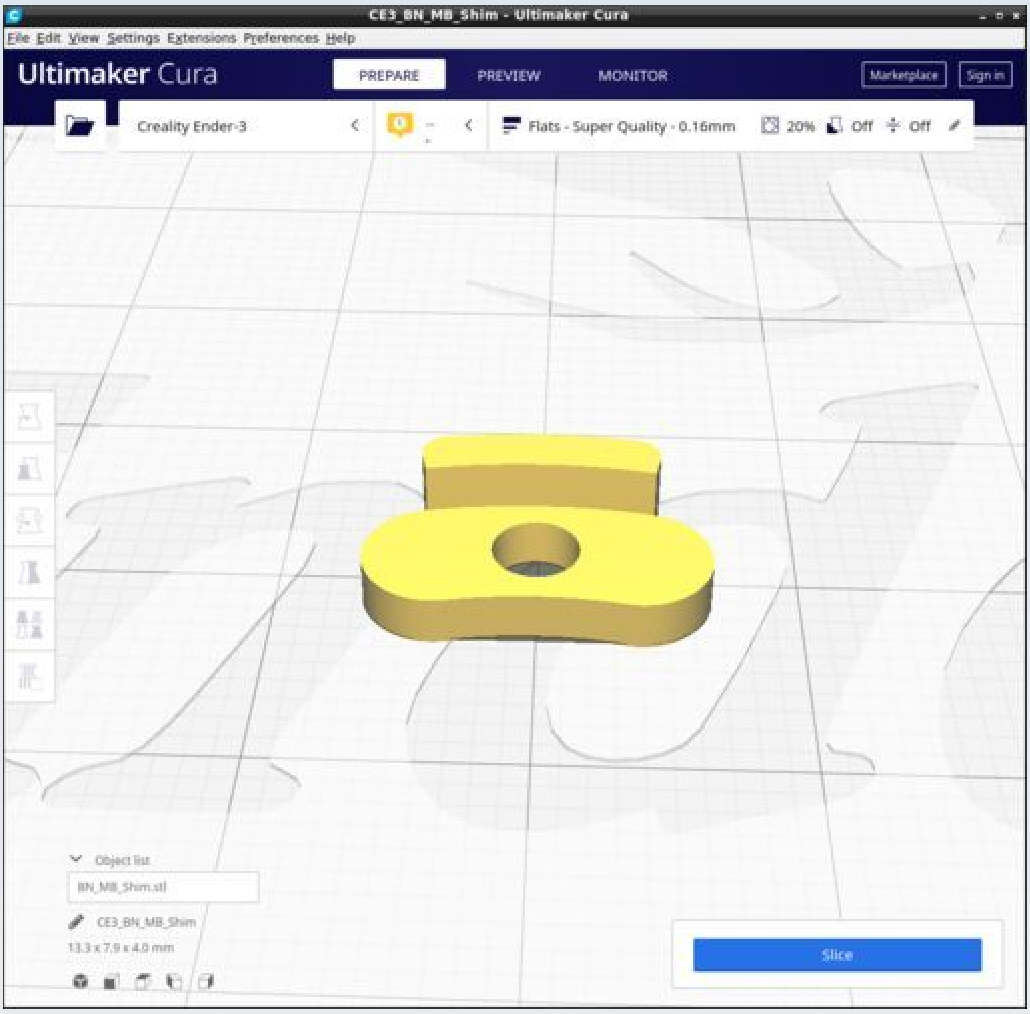
BN_CM_Tube_short_c_adhesin.stl



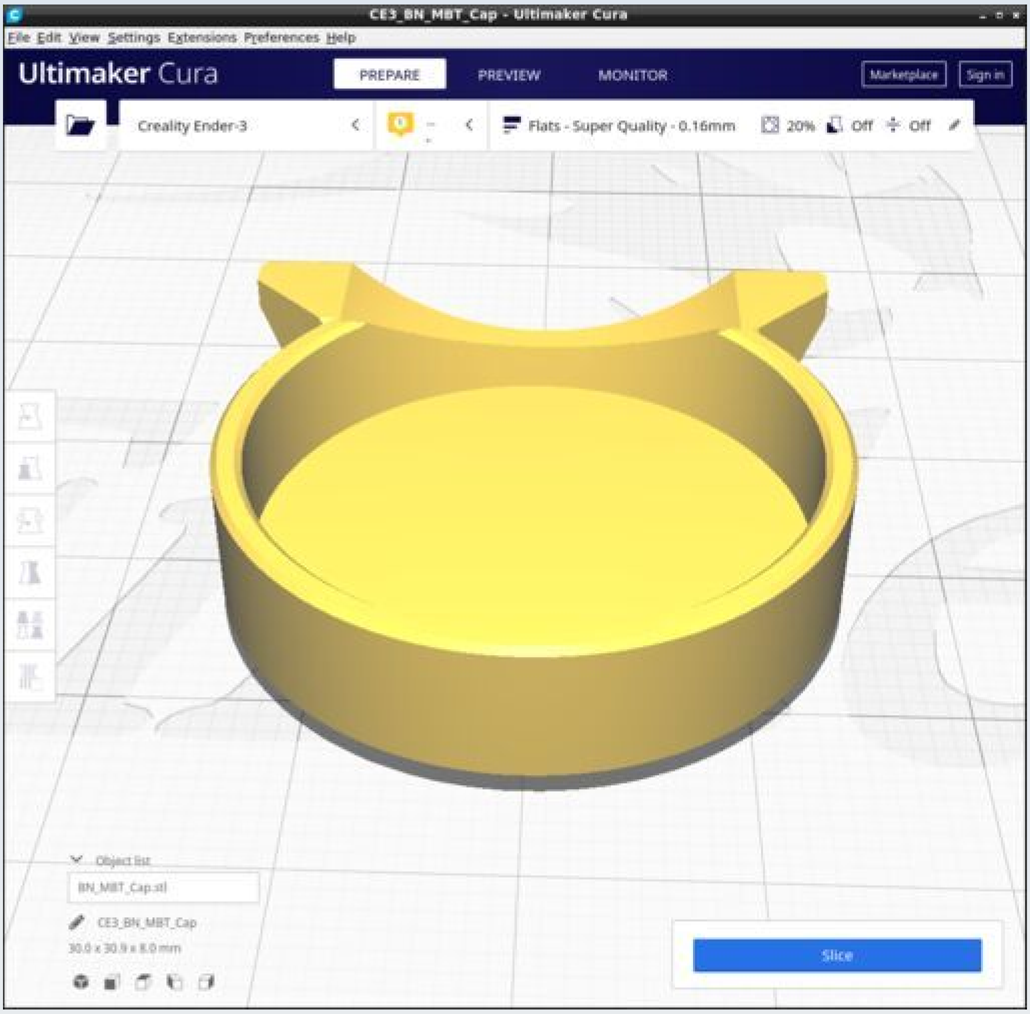
BN_EM_Cover.stl



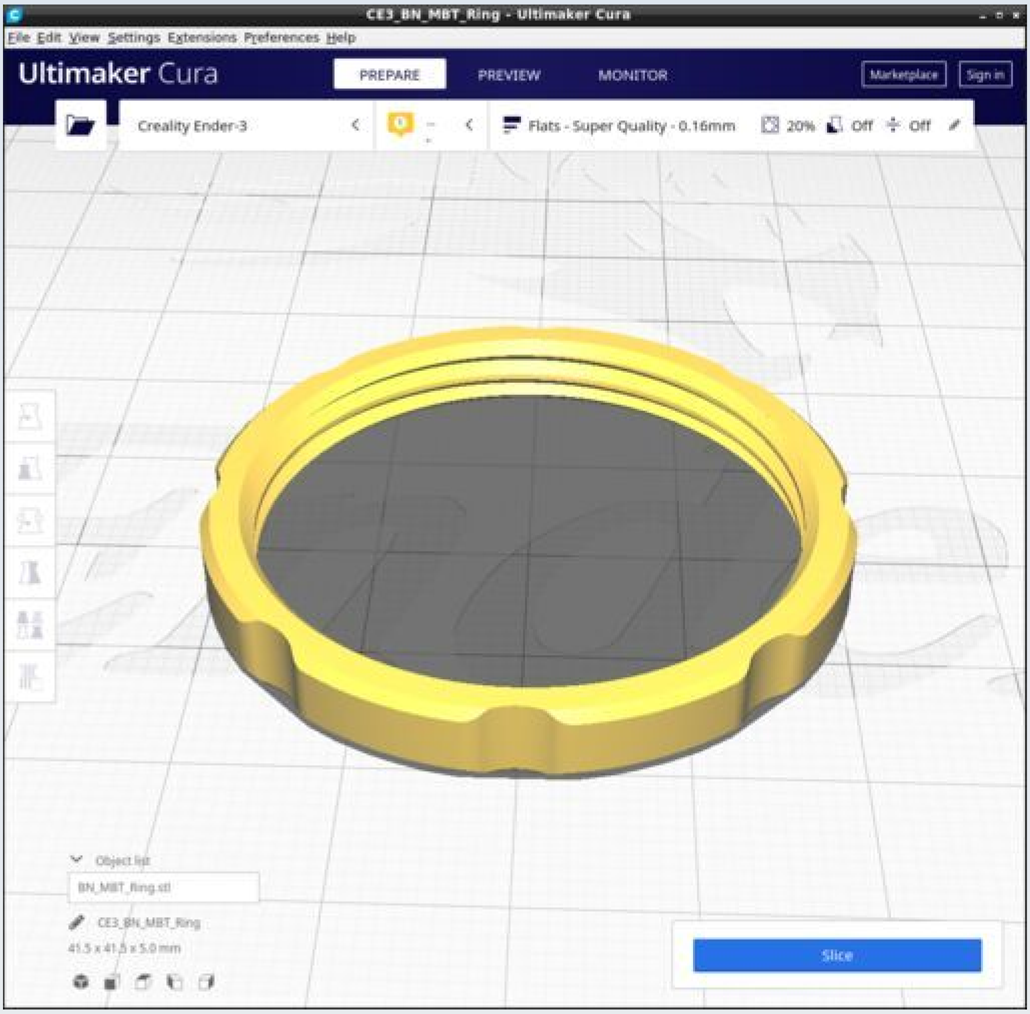
BN_MB_Shim.stl



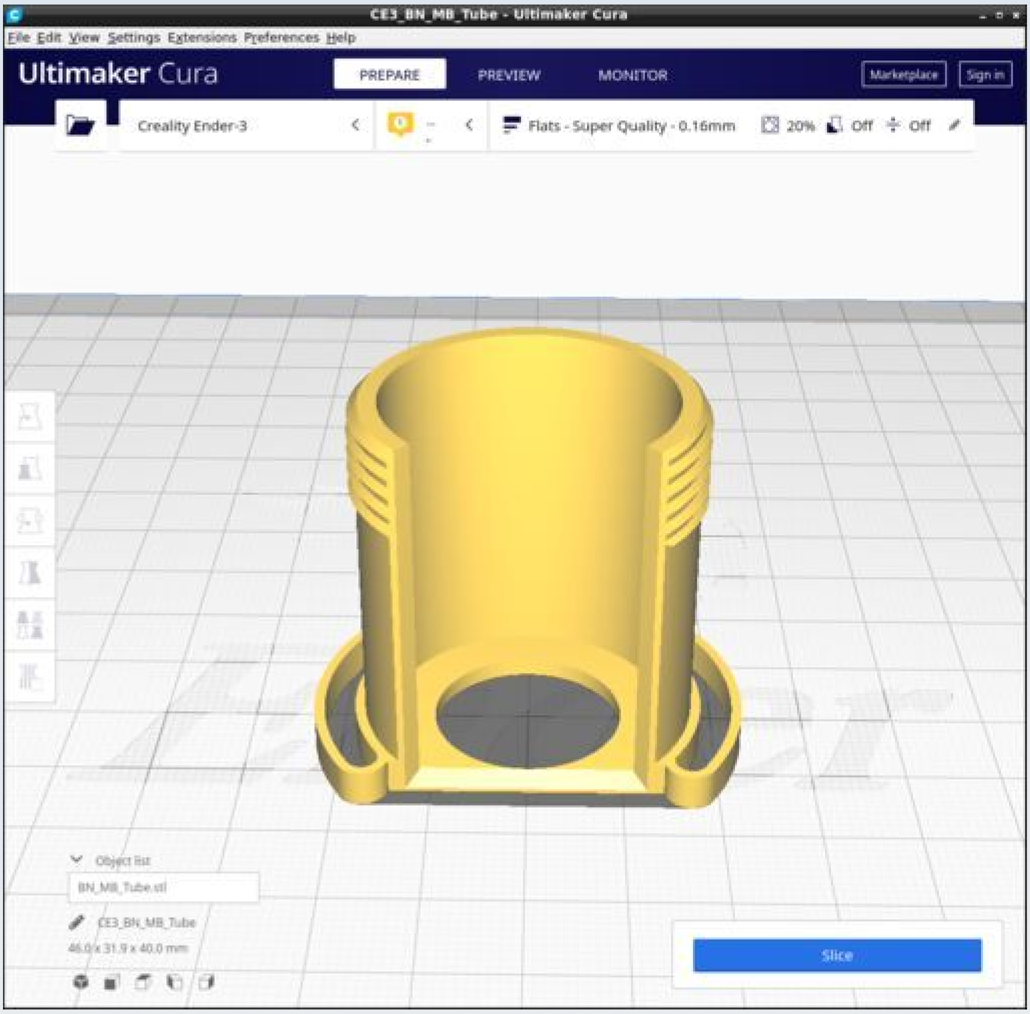
BN_MBT_Cap.stl



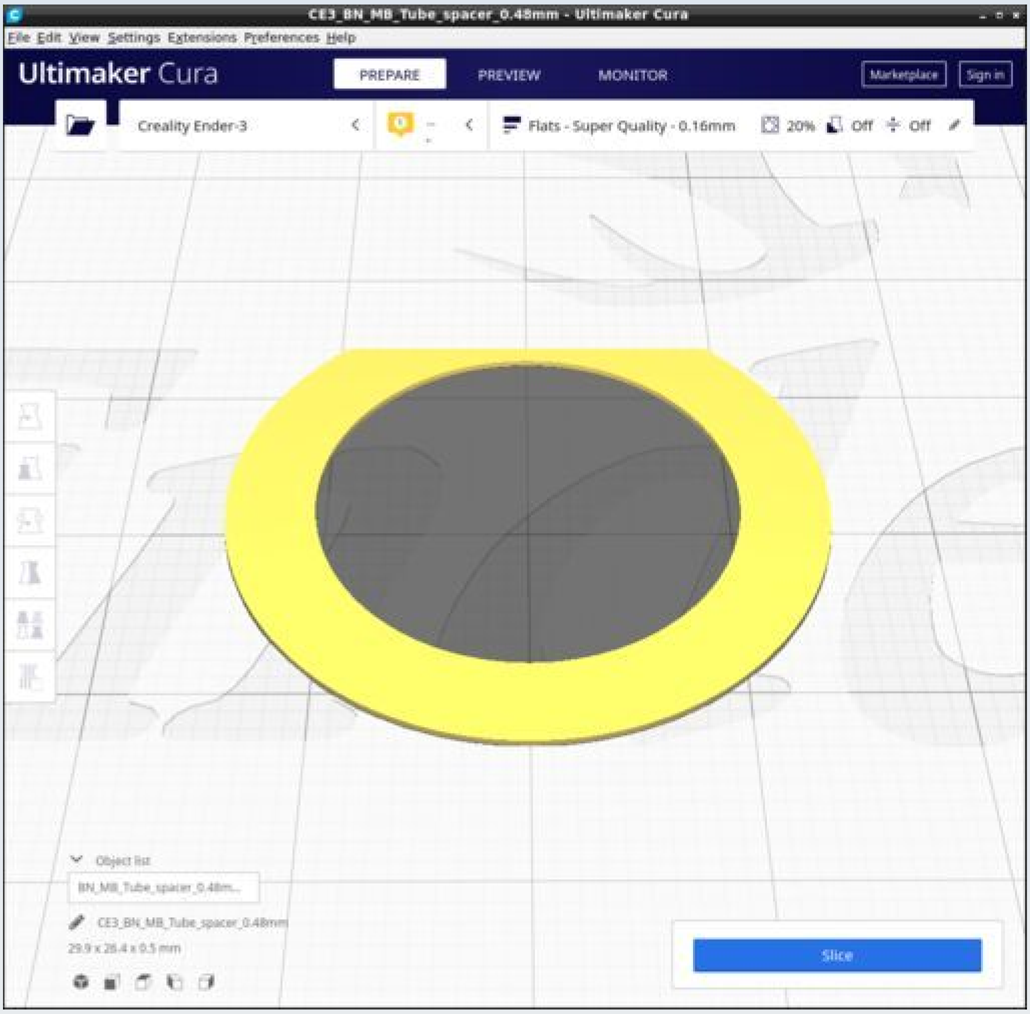
BN_MBT_Ring.stl



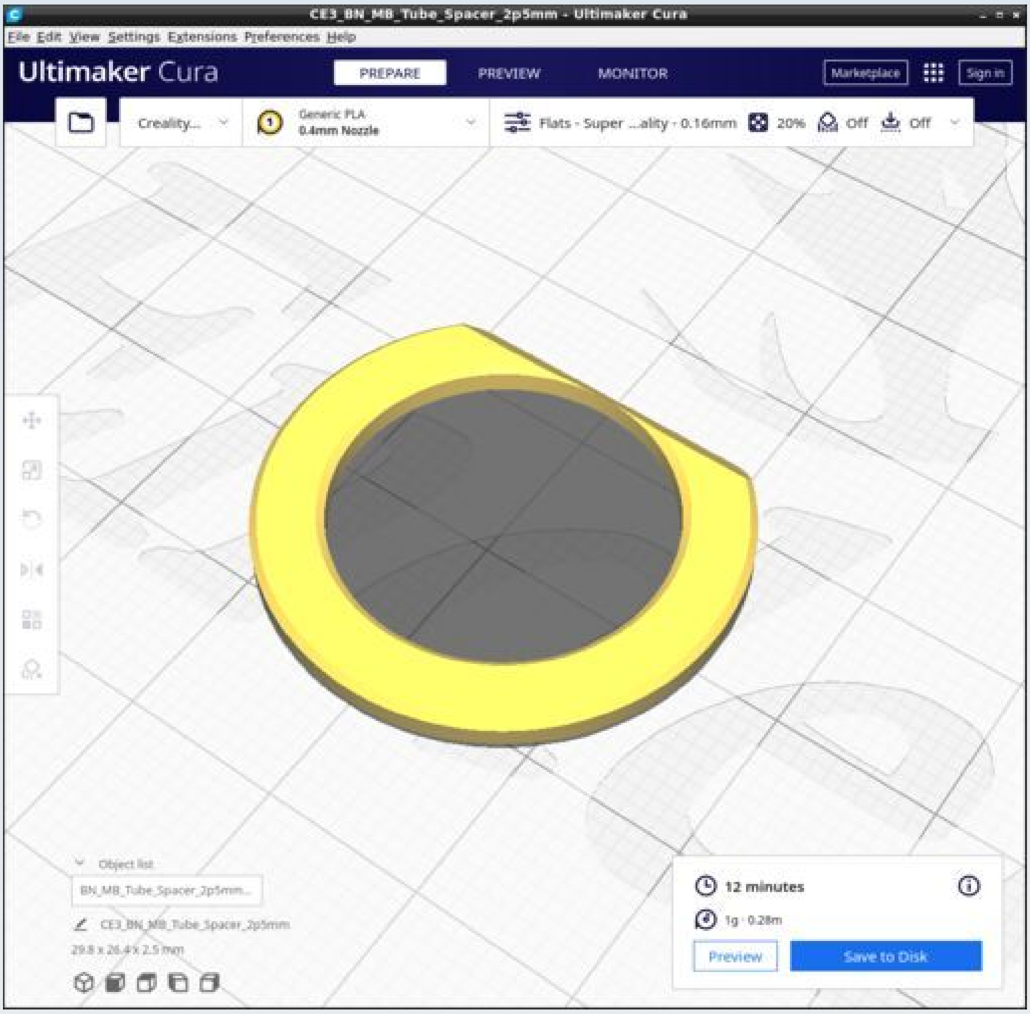
BN_MB_Tube.stl



BN_MB_Tube_spacer_0p48mm.stl

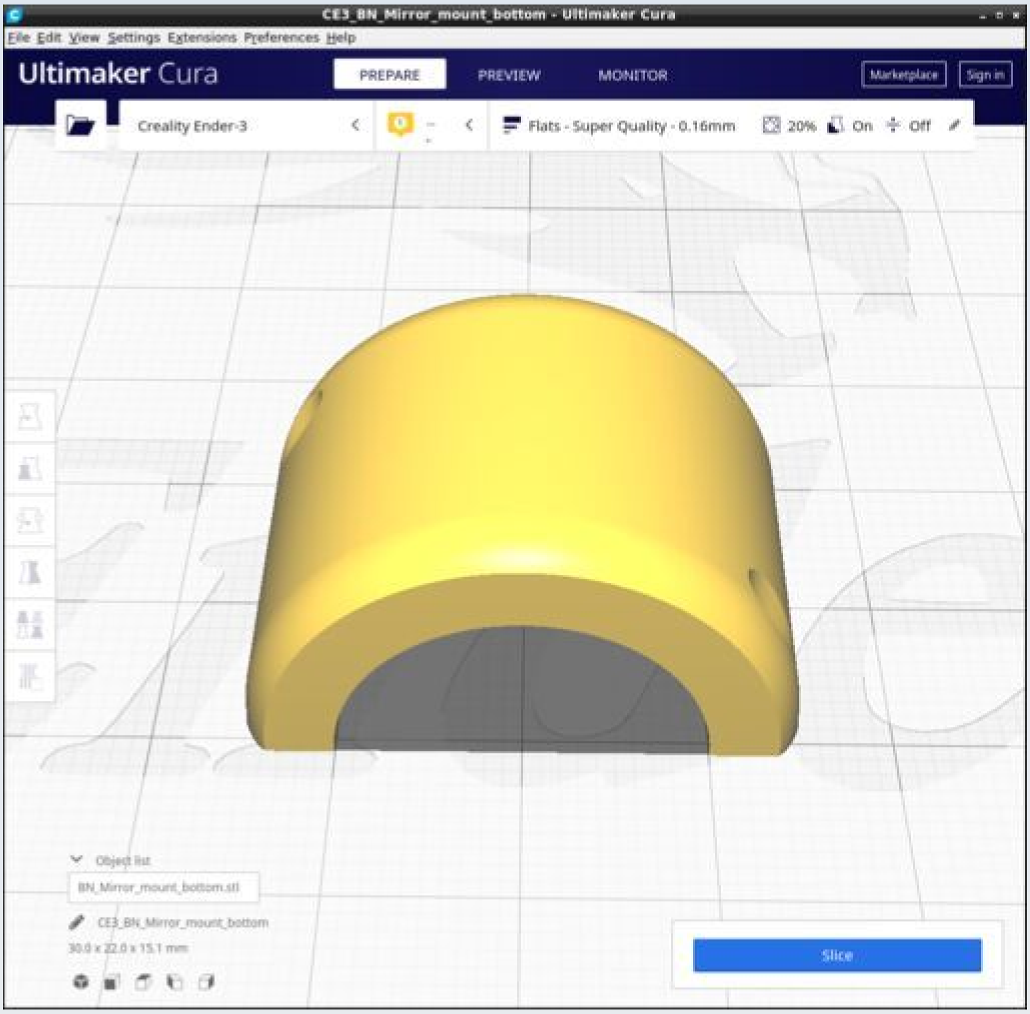


BN_MB_Tube_spacer_2p5mm.stl



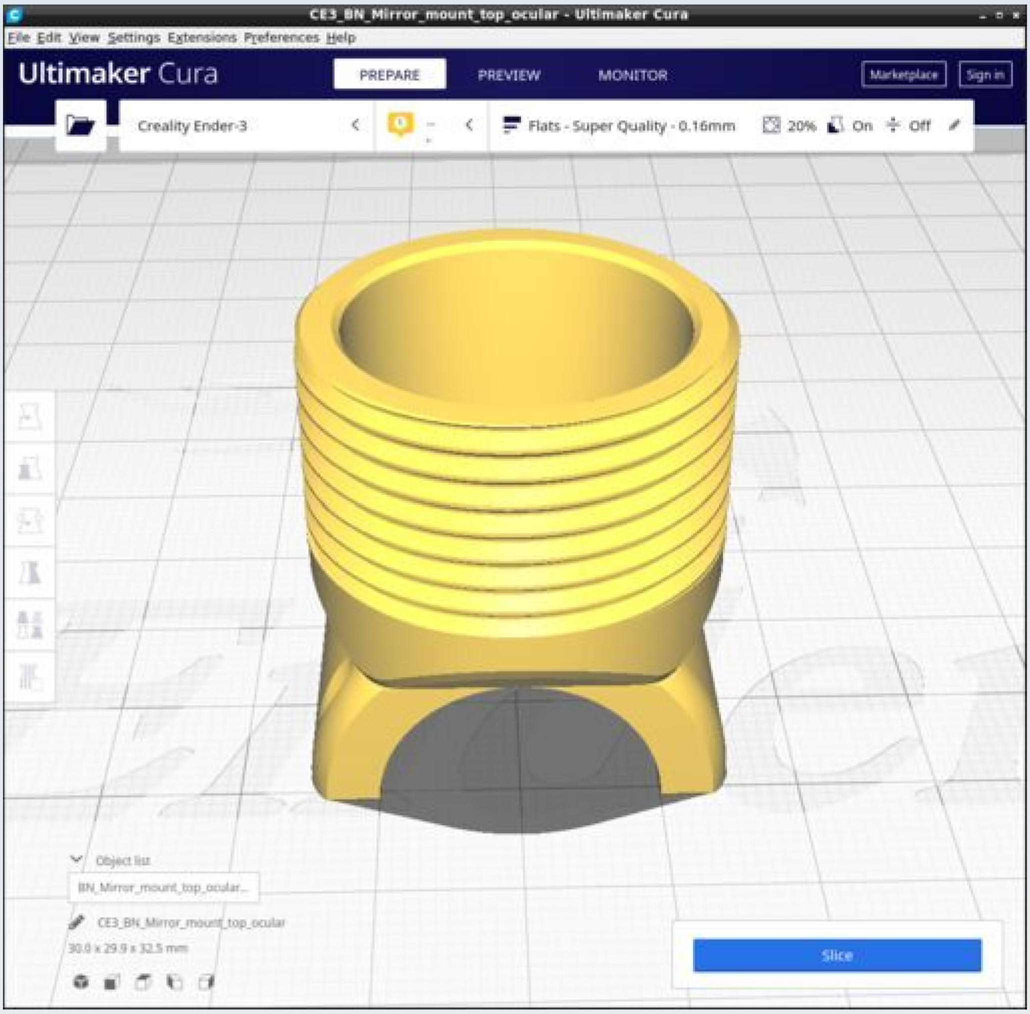
This is just one example from a range of MB_Tube_spacers of various thicknesses.

BN_Mirror_mount_bottom.stl



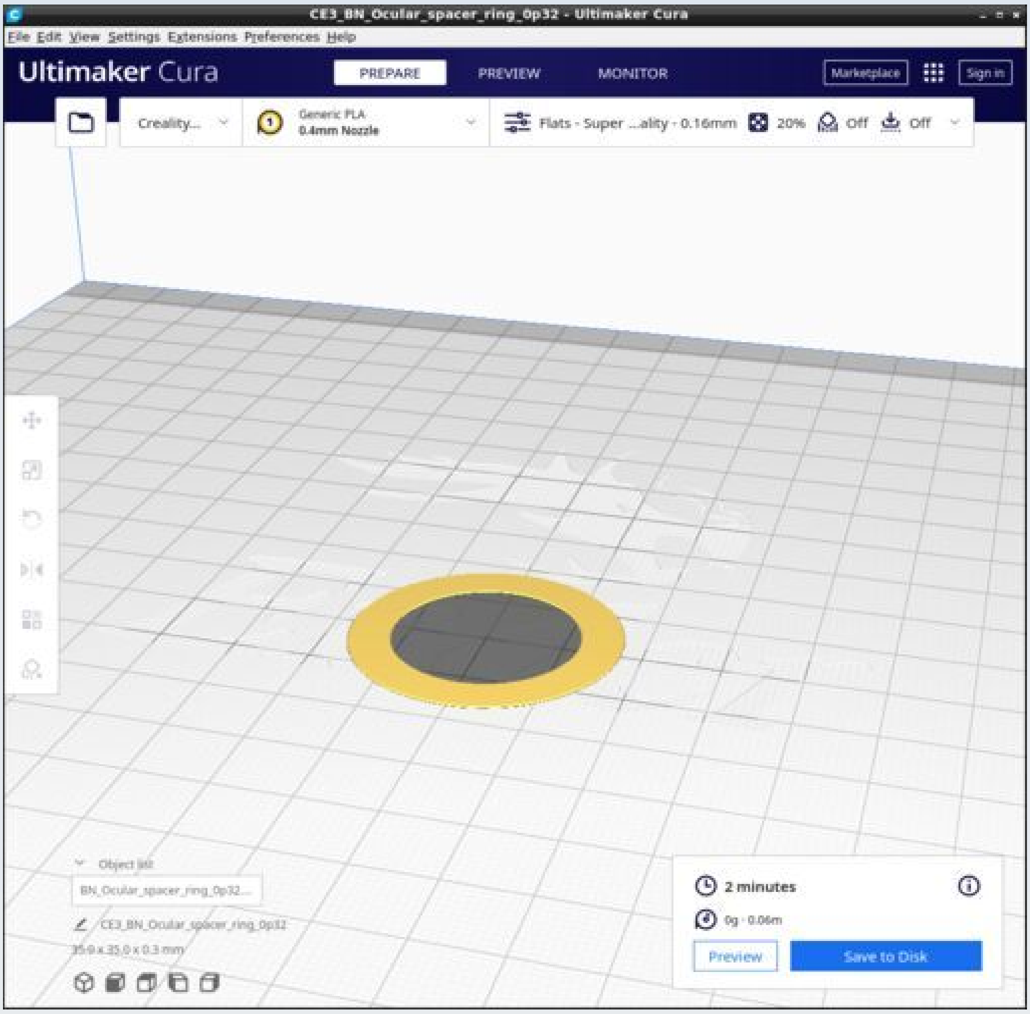
Select suports 'touching build plate only' (not 'Everywhere').

BN_Mirror_mount_top_ocular.stl



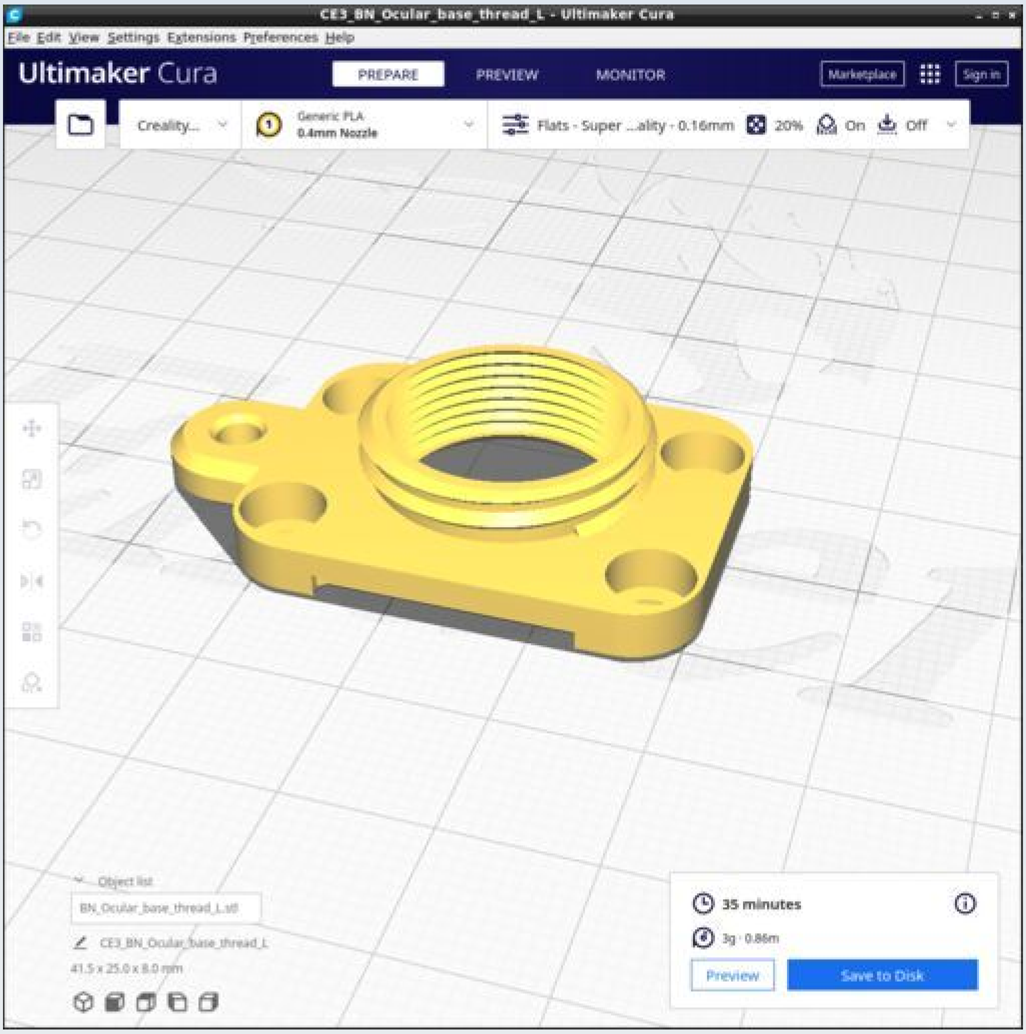
Select suports 'touching build plate only' (not 'Everywhere').

BN_Ocular_spacer_ring_0p32.stl



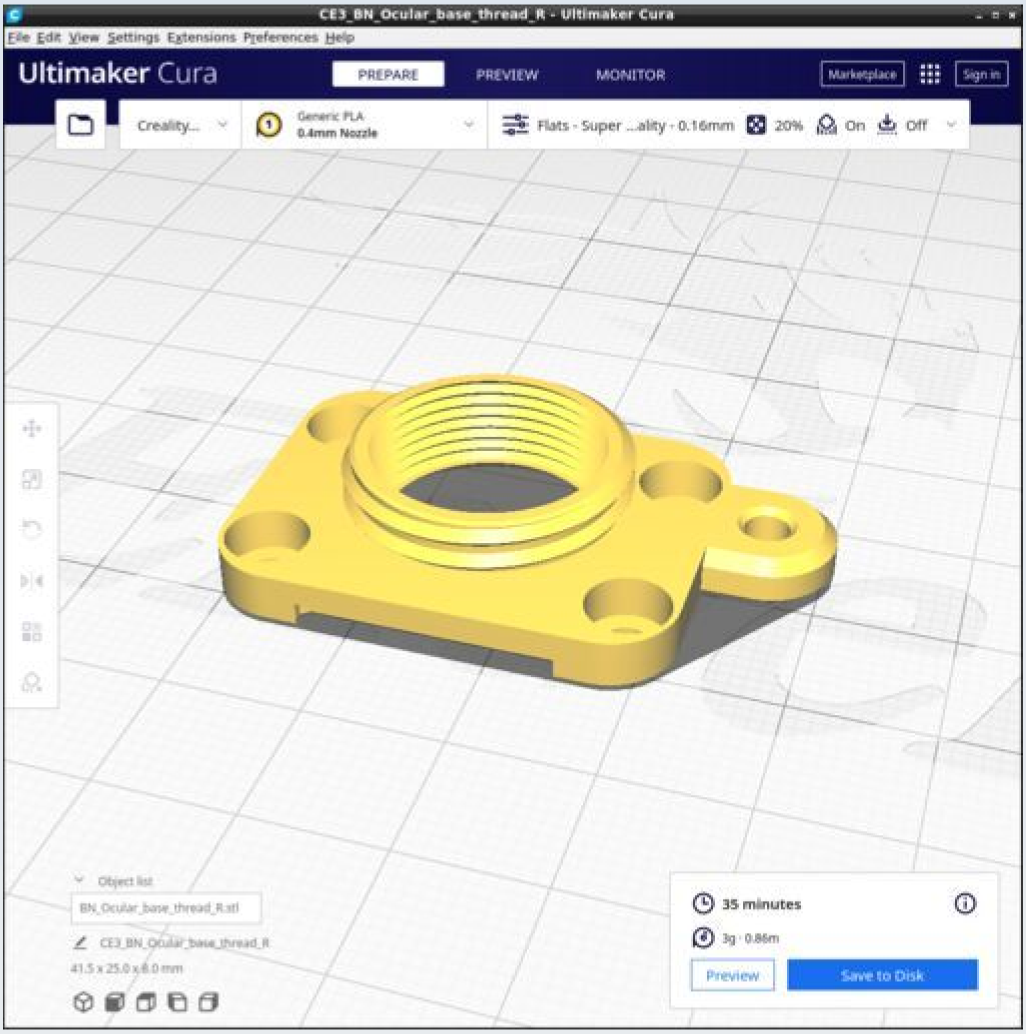
Use 'Top/bottom pattern'='Concentric' in the Top/Bottom' settings

BN_Ocular_Base_thread_L.stl



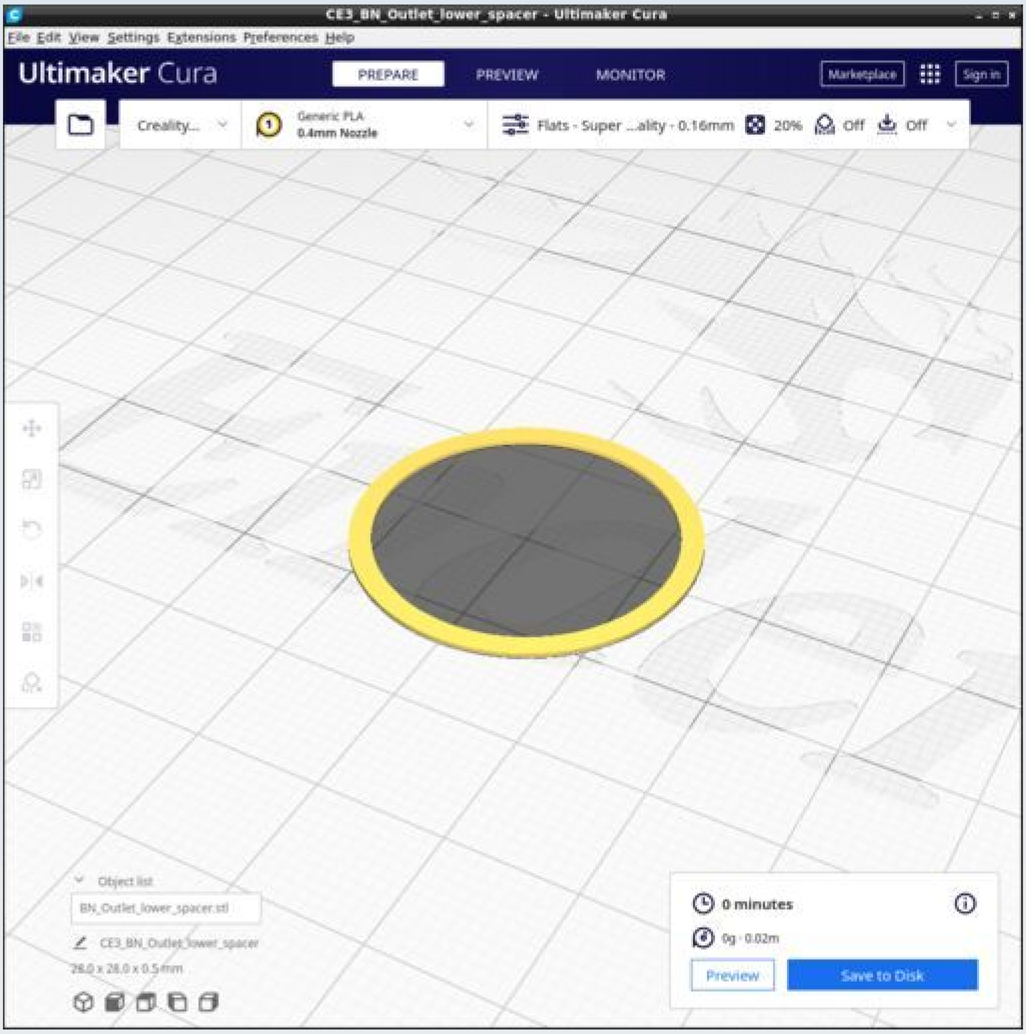
Select suports 'touching build plate only' (not 'Everywhere').

BN_Ocular_Base_thread_R.stl

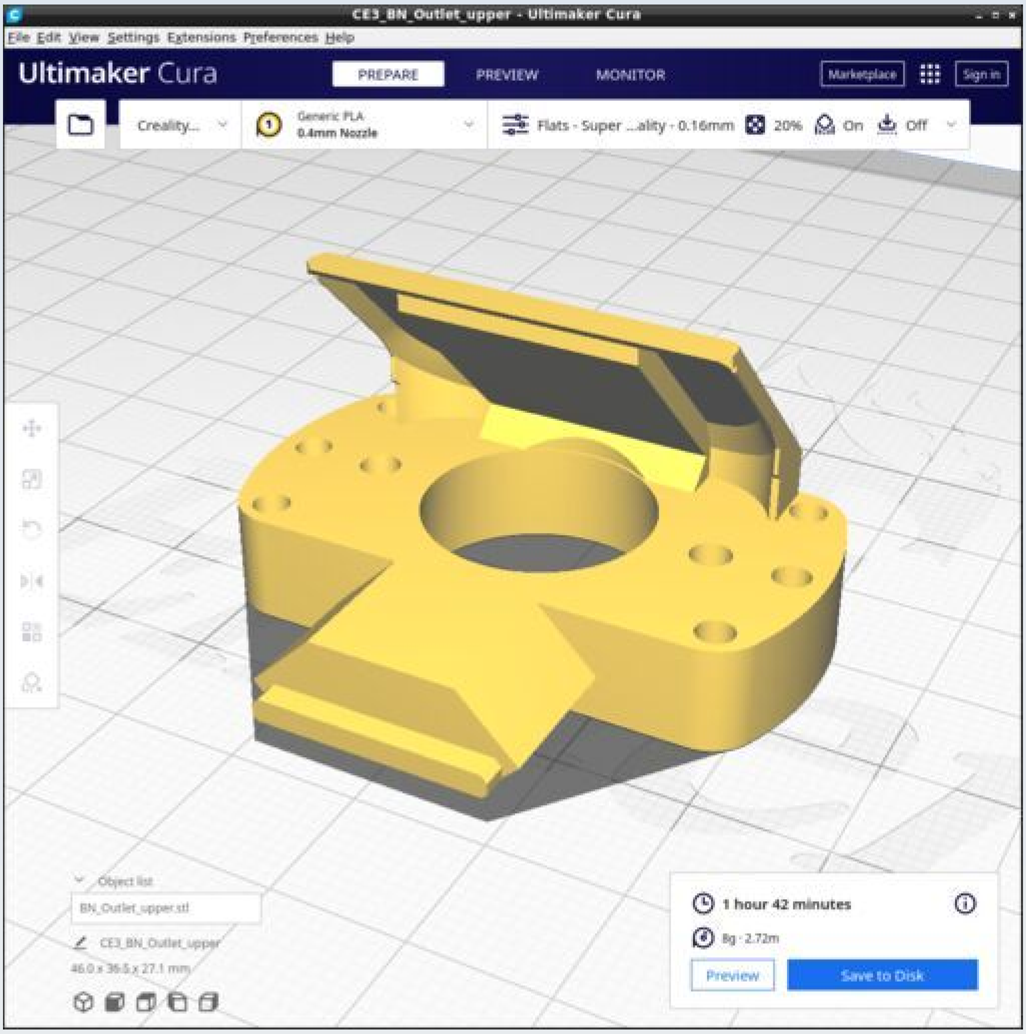


Select suports 'touching build plate only' (not 'Everywhere').

BN_Outlet_lower_spacer.stl

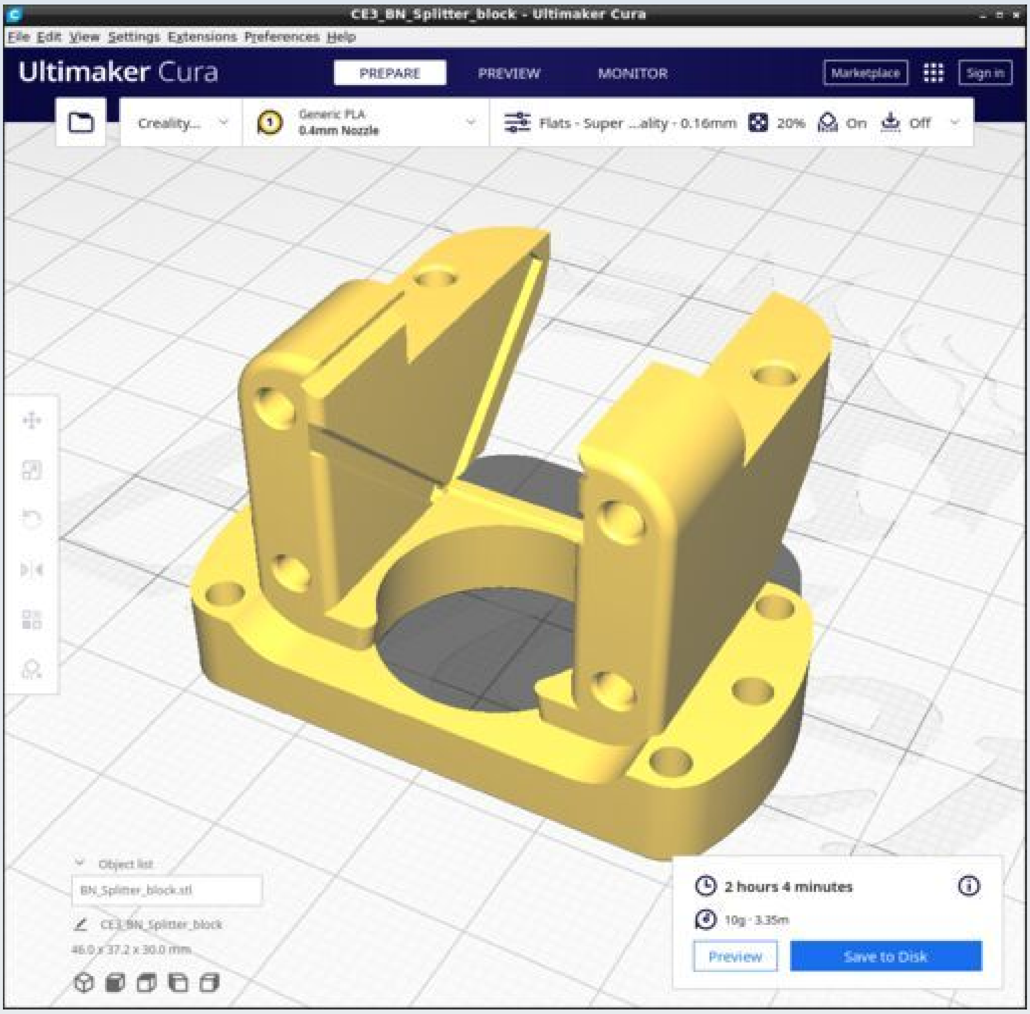


BN_Outlet_upper.stl



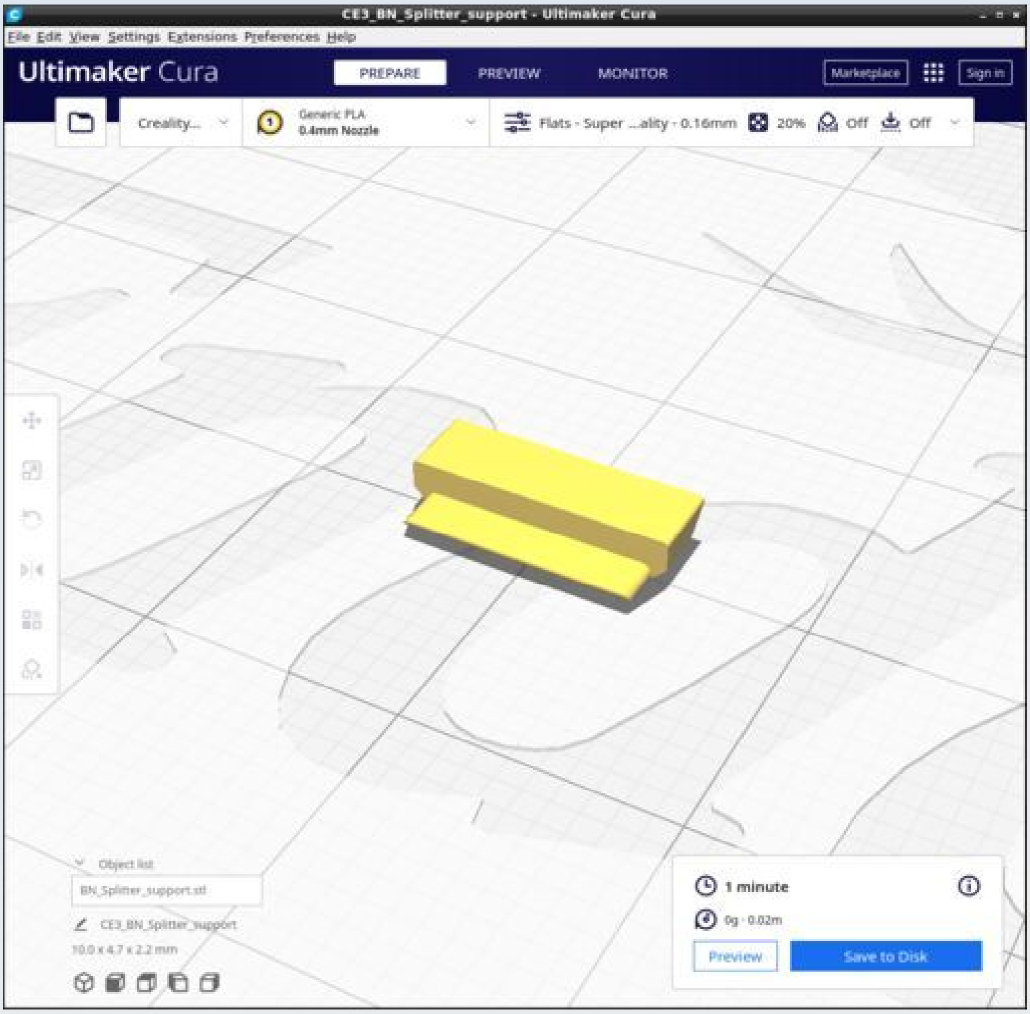
Use supports of 'Tree' type 'touching build plate only' (not 'Everywhere') and change the default for 'tree support branch distance' from 1.0 mm to 0.2 mm.

BN_Splitter_block.stl



Select suports 'touching build plate only' (not 'Everywhere').

BN_Splitter_support.stl



Dominus Illumination System

These are parts for the modular illumination system of the microscope.

The illumination system includes an extensive range of modules for various types of illumination and has many more models than other apsects of the PUMA microscopy system. If all placed in 1 file it would go over the 25 MB limit for files on GitHub so these models are split into 3 separate FreeCAD files: Dominus_part1.FCStd, Dominus_part2.FCStd and Dominus_part3.FCStd.

Also, because there are so many models, to make it easier for users to identify which file a particular model is in I have put the models into separate functionally related groups within each file and a list of where each model can be found is given below. Note that some modules require models from different functional groups and the instructional videos and other 'How To' documentation will make it clear what models are needed to build any particular illumination module.

Location of the models

File: Dominus_part1.FCStd

Group: LED_Housing

LED_Washer

LED_Cover

LED_Holder

Group: Mirror_illumination

Mirror_suspend_plain

Mirror_to_baseplate

Mirror_holder_plain

Cnd_mirror_holder_socket

Daylight_Kohler_adaptor

Group: IFD

IFD_Threadlock

IFD_Tray

Field_Stop_Round

Field_Stop_Rectangle

IFD_Filter_Crosshairs

IFD_Extension_c_adhesin

M3_Adjustment_ring_Kohler

Group: Lower_Collector

LC_Cap

LC_Receptacle

LC_Adjust_collar

LC_Collar_2

LC_Collar_7

LC_Spacer

Group: Tools

Tool_23

Tool_44

Group: Low_Power_Collimator

IFD_Adapter

IFD_Threadjoiner

Ferrule_46_c_adhesin

LPC_Single_23

LPC_Lensholder

LPC_Lens_retainer

LPC_Lenseless_23

Group: M3_Thumbscrews

M3_Thumbscrew_short_hex

Sub-group: M3_Thumbscrew_tall

M3_knob

File: Dominus_part2.FCStd

Group: IAD

IAD_SLM_Cover

IAD_SLM_Filter

IAD_AP_DF_Stop_oil_20

IAD_AP_Phase180_oil

IAD_Filter_tray_oil

IAD_AP_DF_Stop_2p5

IAD_AP_DF_Stop_11

IAD_AP_DF_Stop_10

IAD_AP_DF_Stop_12

IAD_AP_Phase180

IAD_Filter_Tray
IAD_Tray
IAD_Filter_template
IAD_AP_25mm_oil

Group: Upper_Collector

UC_Spacer
UC_Retention_Cap
Cnd_to_UC_long
Cnd_to_UC

Group: Intercollector_Mirror_block

Mirror_block_spacer
Proximal_collector_attachment
Collector_mirror_block

Group: Polariser_Condenser

Pol_to_baseplate
Pol_Receptacle
Pol_top_bottom
Pol_middle
Pol_Adjustment_ring
Uber_pol

Group: Epi_Illumination

Epi_Cnd_Aperture_10
Epi_Cnd_Aperture_04
Epi_Cnd_Aperture_13
Epi_condenser
Epi_condenser
Epi_attachment
M3_Adjustment_ring
Epi_black_body
Epi_pol

Group: Abbe_Condenser

Cnd_Adj_thumbwheel
Cnd_protector_cap
Cnd_Crosshair_Cap_c_adhesin
Cnd_gripper

Cnd_Flange_Spacer_0p48

Condenser_base

Condenser_23_30

File: Dominus_part3.FCStd

Group: HNA_Illuminator001

HNA_Illuminator

HNA_Diffuser

HNA_Flange_Spacer_0p48

Group: Plane_Wave_Generator

PWG_Pinhole_plain

PWG_Pinhole_mount

PWG_Tripod

PWG_CM_Aperture_12

PWG_Pinhole_mount_washer

PWG_Pinhole_presser_c_adhesin

PWG_Front_stop_12

PWG_Front_stop_16

PWG_WindowCap_c_adhesin

PWG_RMS_to_LC_c_adhesin

PWG_Pinhole_mount_well_c_adhesin

Resources

Cura calculates the following resources are required to print each model in this chapter:

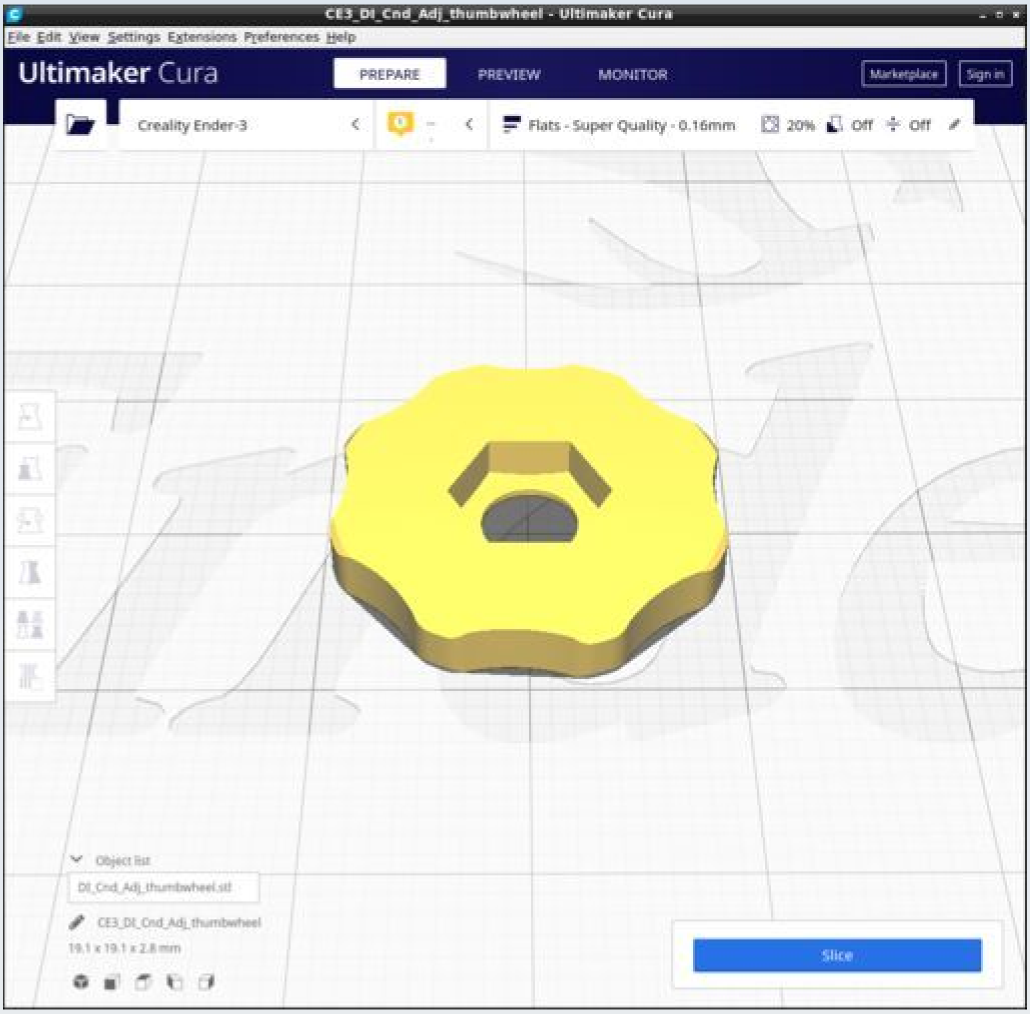
Dominus_Illuminator	Time_Hr	Time_Min	PLA_Length(m)
DI_Cnd_Adj_thumbwheel.stl	0	8	0.26
DI_Cnd_Crosshair_Cap_c_adhesin.stl	0	21	0.87
DI_Cnd_Flange_Spacer_0p48.stl	0	5	0.19
DI_Cnd_gripper.stl	1	30	3.69
DI_Cnd_Mirror_holder_socket.stl	1	33	4.43
DI_Cnd_protector_cap.stl	0	22	0.98
DI_Cnd_to_UC.stl	0	47	2.89
DI_Cnd_to_UC_long.stl	1	8	3.87

DI_Collector_mirror_block.stl	5	9	12.51
DI_Condenser_23_30.stl	2	31	5.94
DI_Condenser_base.stl	0	46	1.38
DI_Daylight_Kohler_adaptor	1	17	3.25
DI_Epi_attachment.stl	0	47	1.84
DI_Epi_black_body.stl	1	33	4.14
DI_Epi_cap.stl	0	13	0.58
DI_Epi_Cnd_Aperture_04.stl	0	4	0.15
DI_Epi_Cnd_Aperture_10.stl	0	3	0.1
DI_Epi_Cnd_Aperture_13.stl	0	2	0.07
DI_Epi_condenser.stl	2	30	6.23
DI_Epi_pol.stl	0	58	2.02
DI_Ferrule_46_c_adhesin.stl	1	16	4.08
DI_Field_Stop_Rectangle.stl	0	3	0.12
DI_Field_Stop_Round.stl	0	3	0.11
DI_HNA_Diffuser.stl	0	24	0.93
DI_HNA_Flange_Spacer_0p48.stl	0	4	0.14
DI_HNA_Illuminator.stl	0	58	3.08
DI_IAD_AP_25mm_oil.stl	0	1	0.05
DI_IAD_AP_DF_Stop_10.stl	0	1	0.04
DI_IAD_AP_DF_Stop_11.stl	0	1	0.04
DI_IAD_AP_DF_Stop_12.stl	0	1	0.05
DI_IAD_AP_DF_Stop_2p5.stl	0	1	0.03
DI_IAD_AP_DF_Stop_oil_20.stl	0	2	0.08
DI_IAD_AP_Phase180_oil.stl	0	2	0.08
DI_IAD_AP_Phase180.stl	0	1	0.06
DI_IAD_Filter_Tray_oil.stl	0	33	1.41
DI_IAD_Filter_Tray.stl	0	37	1.64
DI_IAD_SLM_Cover.stl	0	19	0.76
DI_IAD_SLM_Filter.stl	0	29	0.93
DI_IAD_Tray.stl	0	27	0.72
DI_IFD_Adapter.stl	1	5	2.88
DI_IFD_Extension_c_adhesin.stl	2	10	7.28

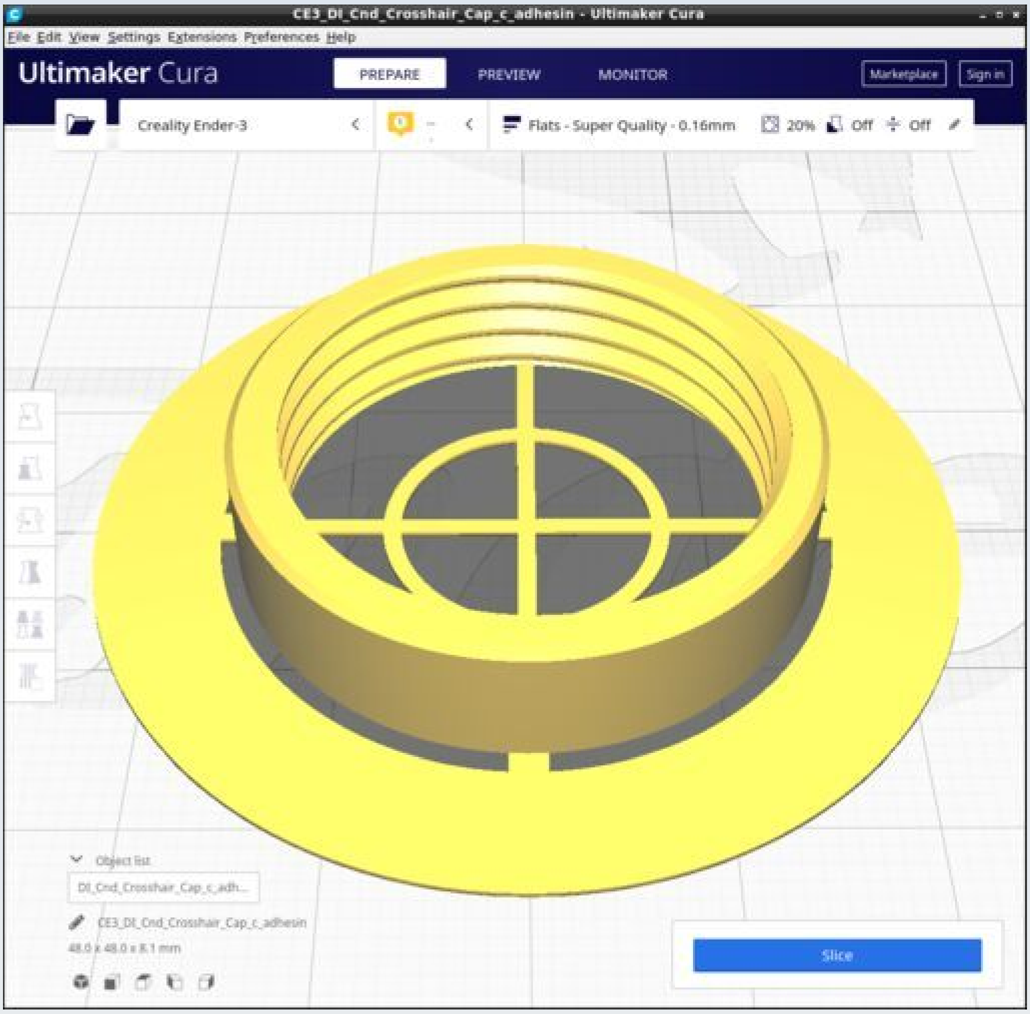
DI_IFD_Filter_crosshairs.stl	0	37	1.59
DI_IFD_Threadjoiner.stl	0	50	1.8
DI_IFD_Threadlock.stl	0	24	0.84
DI_IFD_Tray.stl	2	2	4
DI_LC_Adjust_collar.stl	0	20	0.88
DI_LC_Cap.stl	0	21	1.02
DI_LC_Collar_2.stl	0	2	0.07
DI_LC_Collar_7.stl	0	7	0.22
DI_LC_Receptacle.stl	0	21	0.77
DI_LC_Spacer.stl	0	16	0.44
DI_LED_Cover.stl	0	34	0.87
DI_LED_Holder.stl	0	57	1.87
DI_LED_Washer.stl	0	2	0.06
DI_LPC_Lensholder.stl	0	16	0.54
DI_LPC_Lens_retainer.stl	0	10	0.38
DI_LPC_Lenseless_23.stl	0	31	1.08
DI_LPC_Single_23.stl	0	22	0.81
DI_M3_Adjustment_ring.stl	1	7	2.35
DI_M3_Adjustment_ring_Kohler.stl	2	11	5.2
DI_M3_Thumbscrew_short_hex.stl	0	8	0.14
DI_M3_Thumbscrew_tall.stl	0	19	0.29
DI_Mirror_block_spacer.stl	0	52	1.73
DI_Mirror_holder_plain.stl	1	0	2.45
DI_Mirror_suspend_plain.stl	1	34	3.18
DI_Mirror_to_baseplate.stl	0	49	1.88
DI_Pol_Adjustment_ring.stl	1	22	2.58
DI_Pol_middle.stl	0	5	0.16
DI_Pol_Receptacle.stl	0	46	1.28
DI_Pol_to_baseplate.stl	2	19	4.88
DI_Pol_top_bottom.stl	0	7	0.25
DI_Proximal_collector_attachment.stl	0	38	1.32
DI_PWG_CM_Aperture_12.stl	0	2	0.06
DI_PWG_Pinhole_plain.stl	0	5	0.24

DI_PWG_Pinhole_mount.stl	0	5	0.24
DI_PWG_Pinhole_mount_washer.stl	0	5	0.15
DI_PWG_Front_stop_16.stl	0	18	0.91
DI_PWG_Front_stop_12.stl	0	20	1
DI_PWG_Pinhole_mount_well.stl	0	41	1.43
DI_PWG_Pinhole_presser.stl	0	25	1.17
DI_PWG_RMS_to_LC.stl	0	29	1.35
DI_PWG_Tripod.stl	0	58	2.14
DI_PWG_WindowCap.stl	0	14	0.6
DI_Tool_23.stl	0	24	1.14
DI_Tool_44.stl	0	28	0.84
DI_UC_Retention_Cap.stl	0	10	0.59
DI_UC_Spacer.stl	0	1	0.05
DI_Uber_pol.stl	0	12	0.19

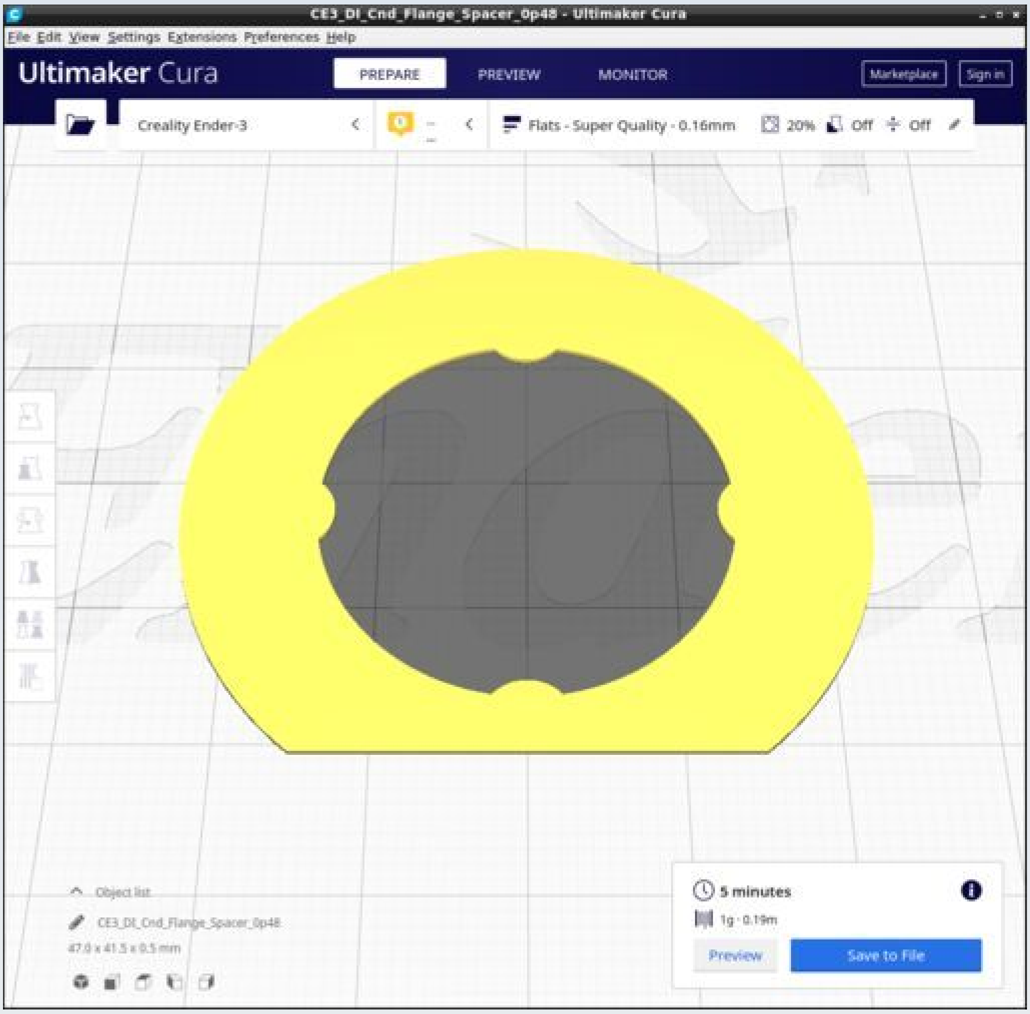
DI_Cnd_Adj_thumbwheel.stl



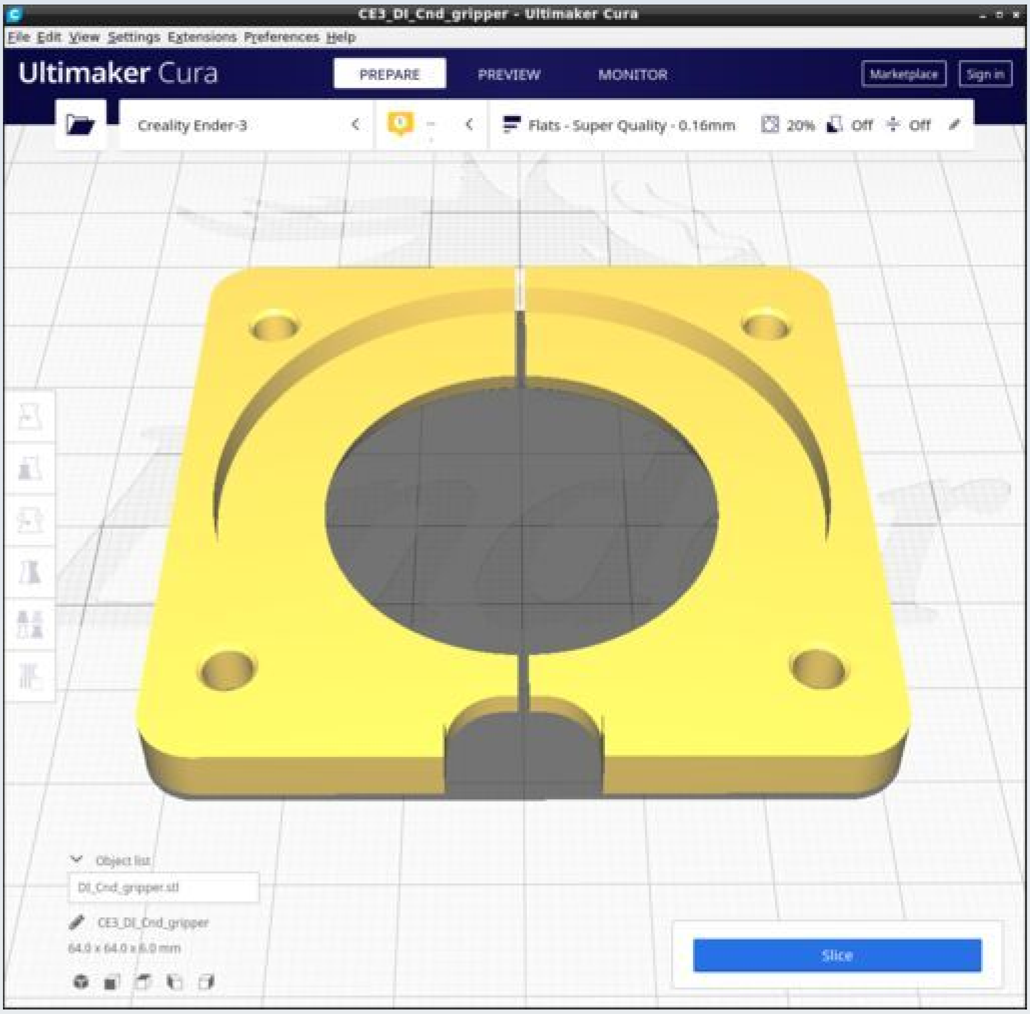
DI_Cnd_Crosshair_Cap_c_adhesin.stl



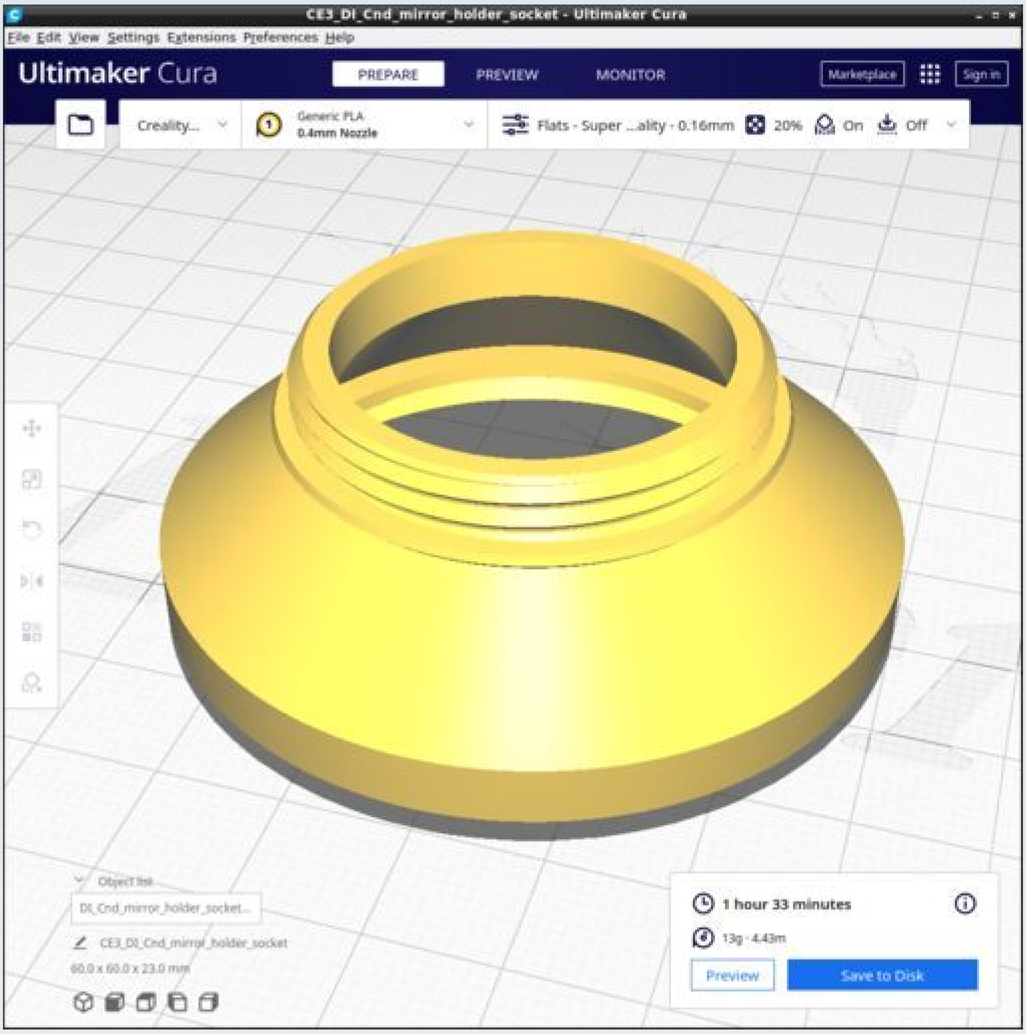
DI_Cnd_Flange_Spacer_0p48.stl



DI_Cnd_gripper.stl

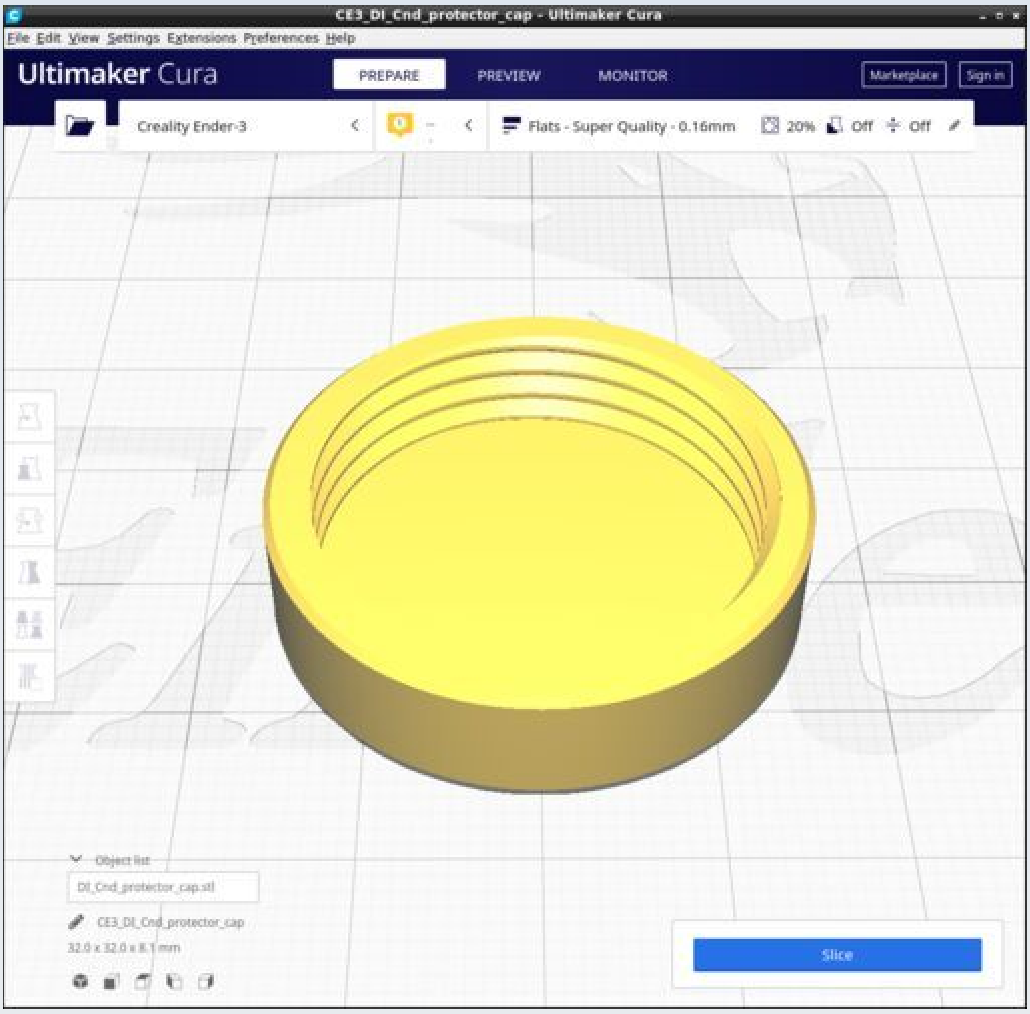


DI_Cnd_Mirror_holder_socket.stl

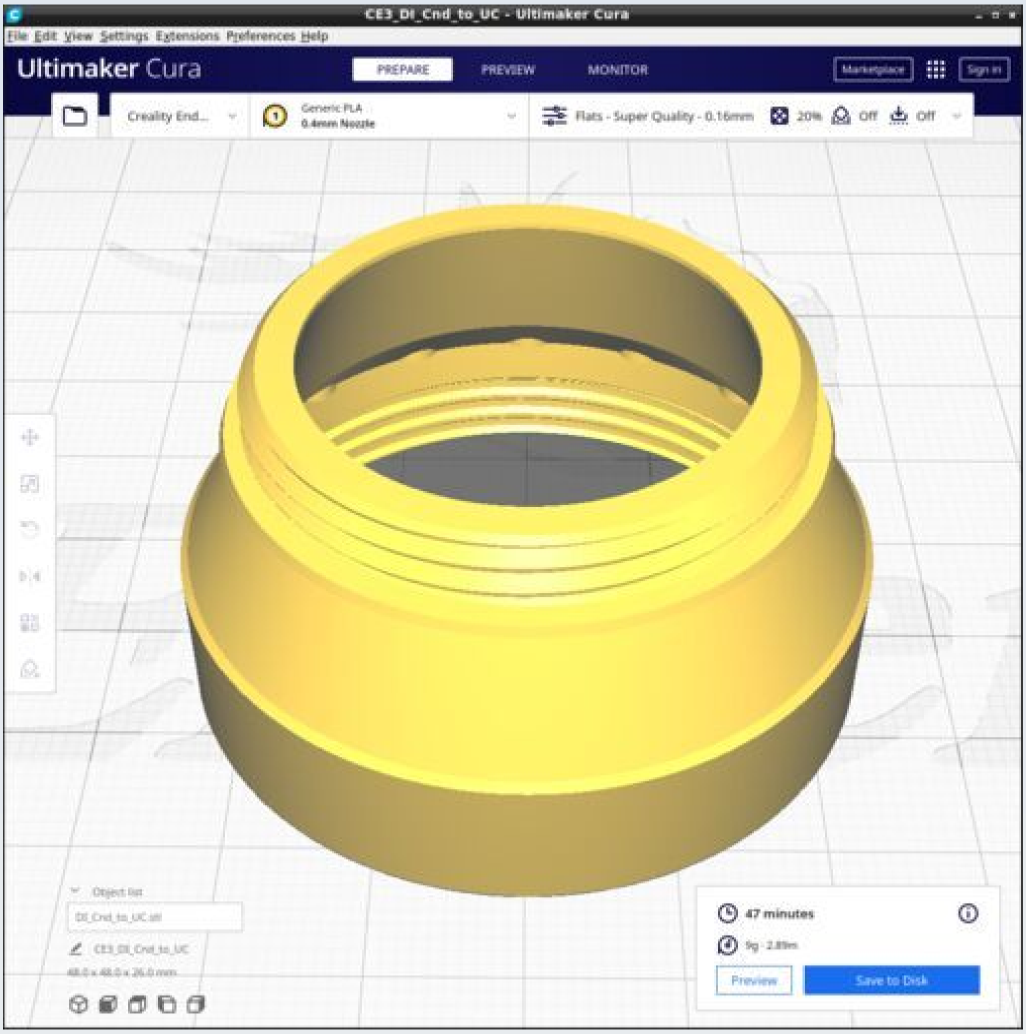


This uses tree support touching baseplate only with tree support branch angle 40 degrees and tree support branch distance 1 mm.

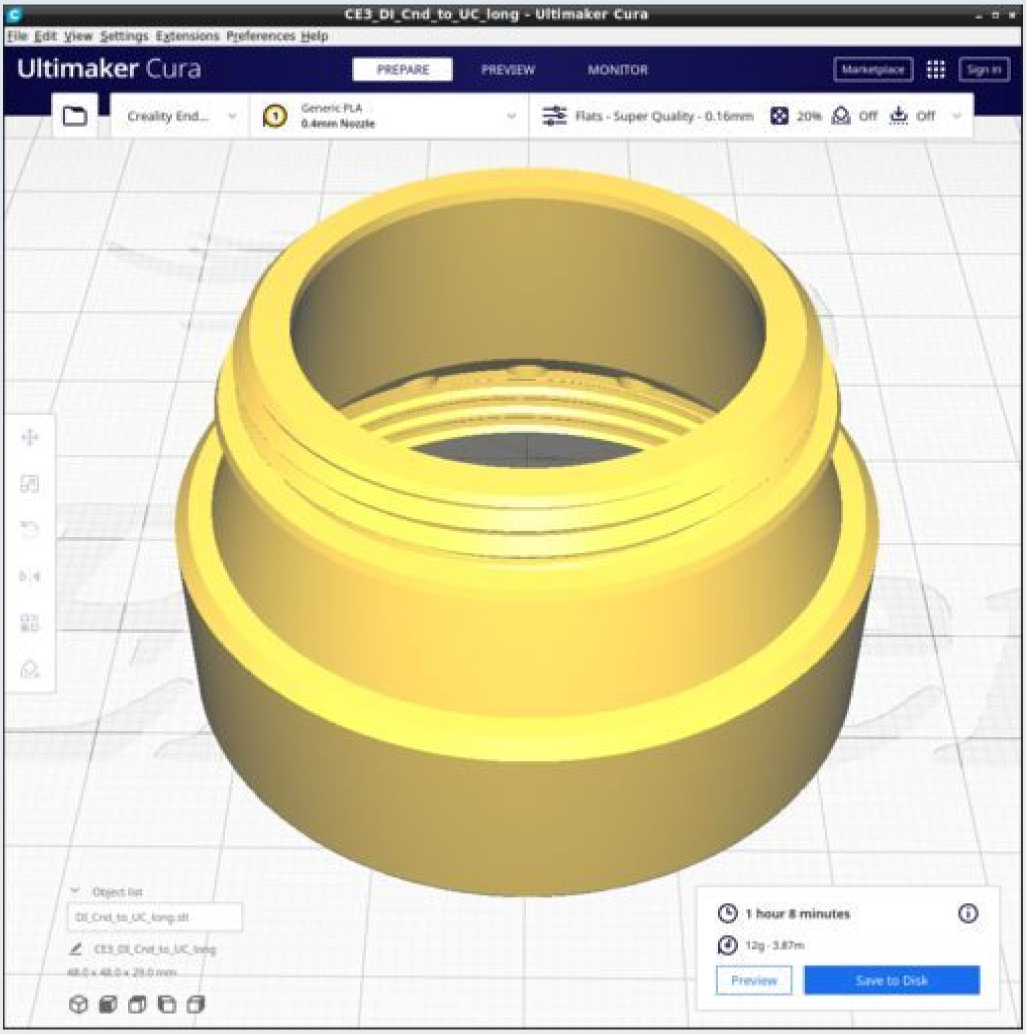
DI_Cnd_protector_cap.stl



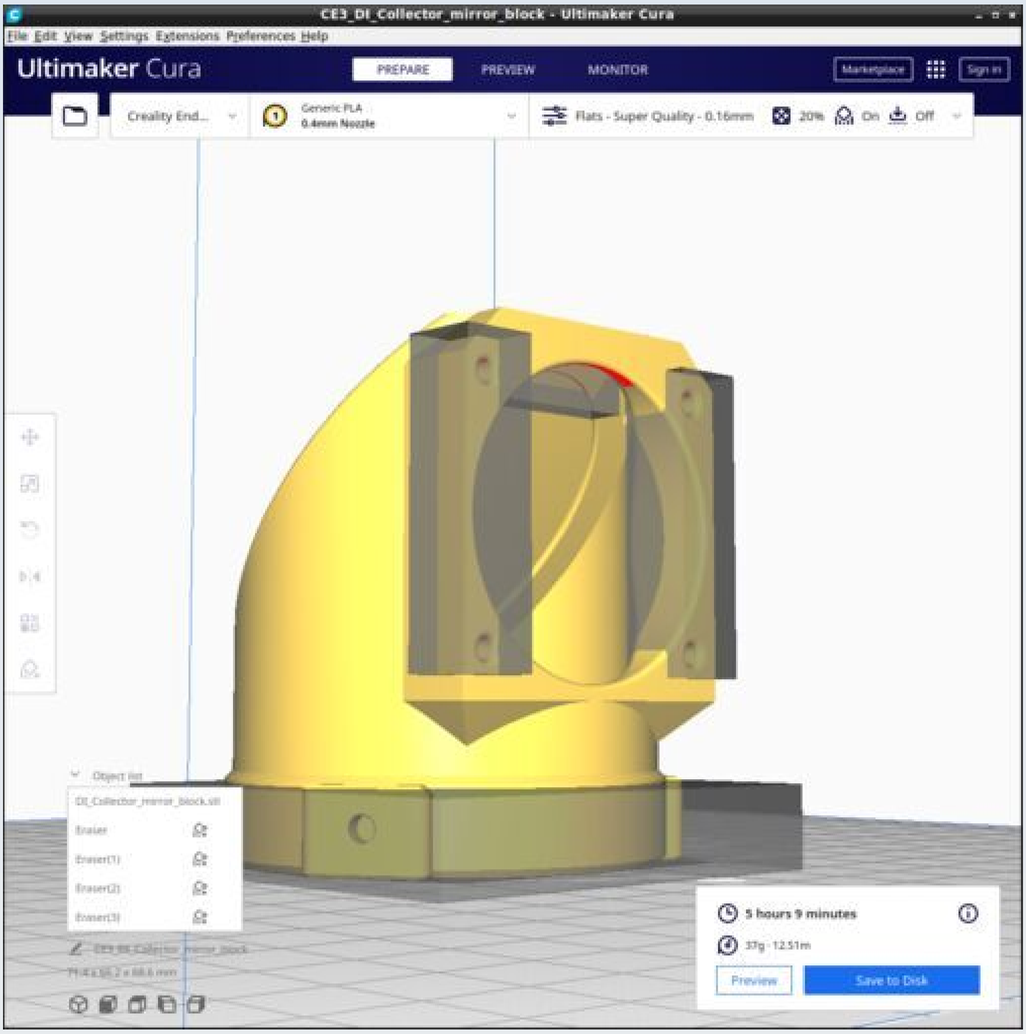
DI_Cnd_to_UC.stl



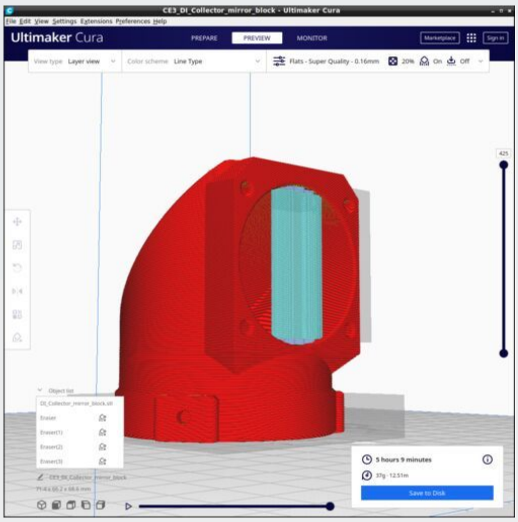
DI_Cnd_to_UC_long.stl



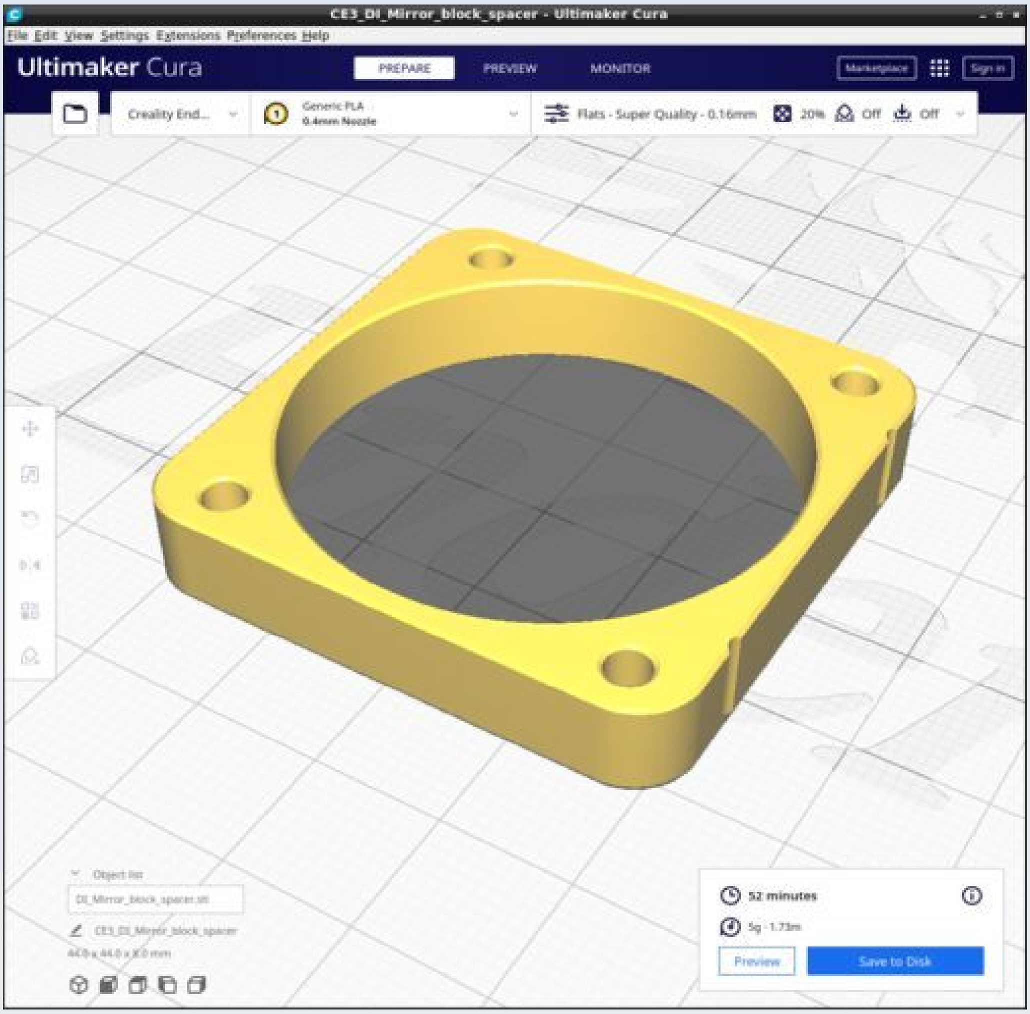
DI_Collector_mirror_block.stl



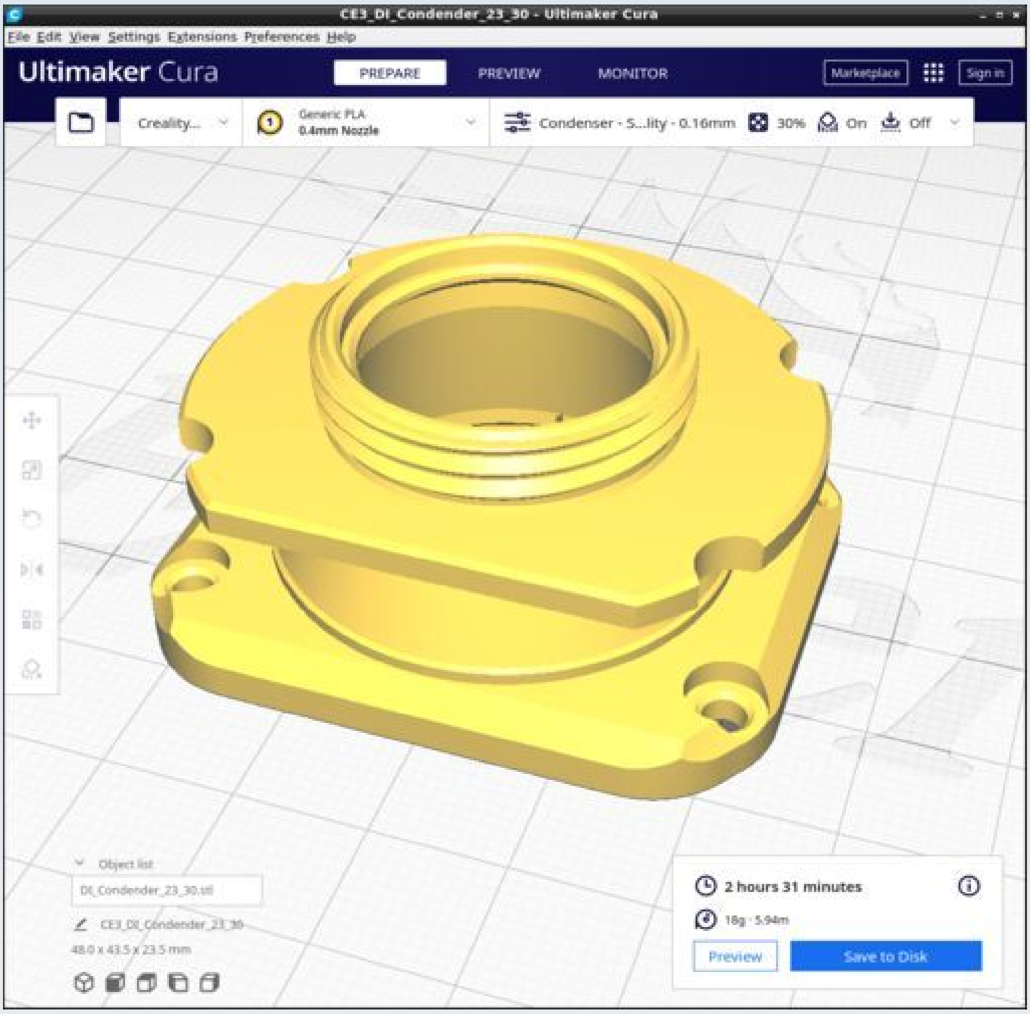
Supports on for 'Everywhere' and ensure 'Support overhang angle' is 67. Make support blockers for the M3 holes in the front flat part, the M3 adjustment ring holes and the part of the mirror indentation that overhangs - essentially everywhere except the big vertical aperture - that is what needs support.



DI_Mirror_block_spacer.stl

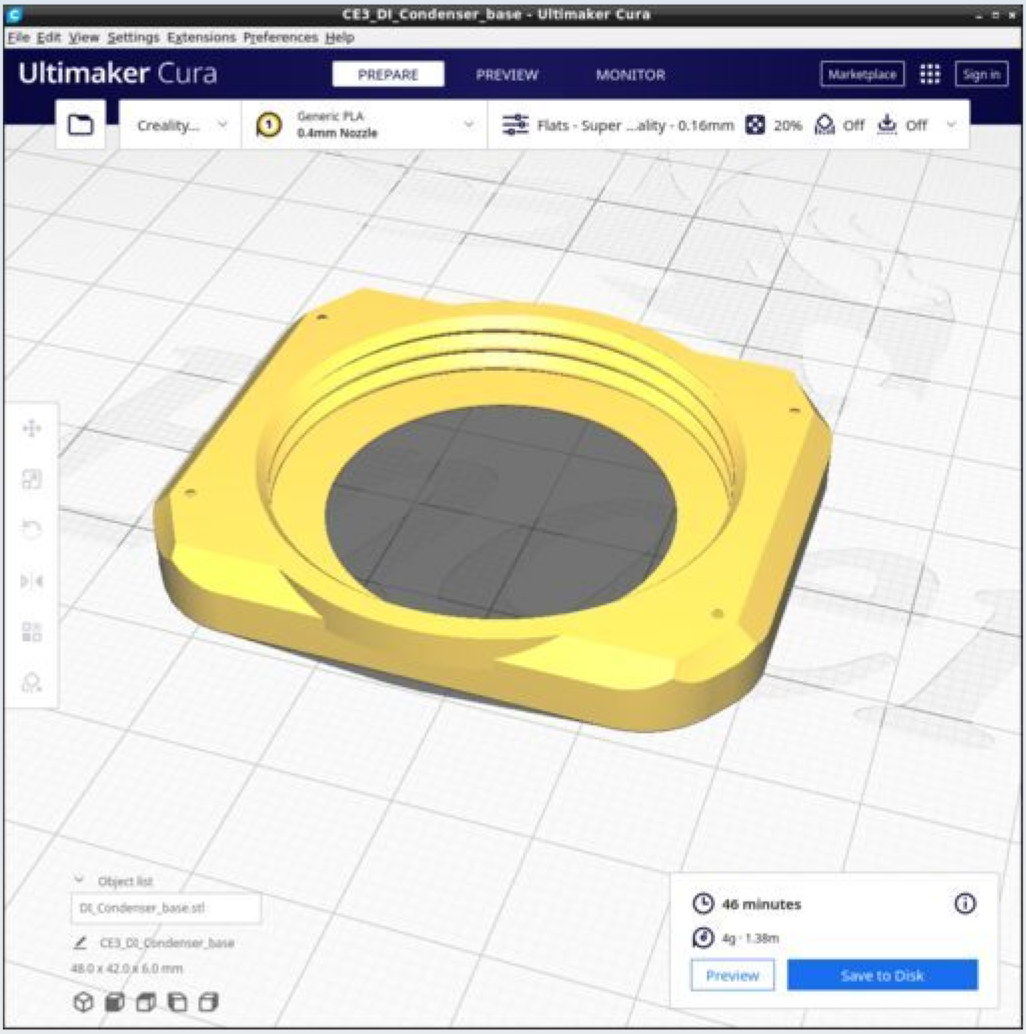


DI_Condenser_23_30.stl



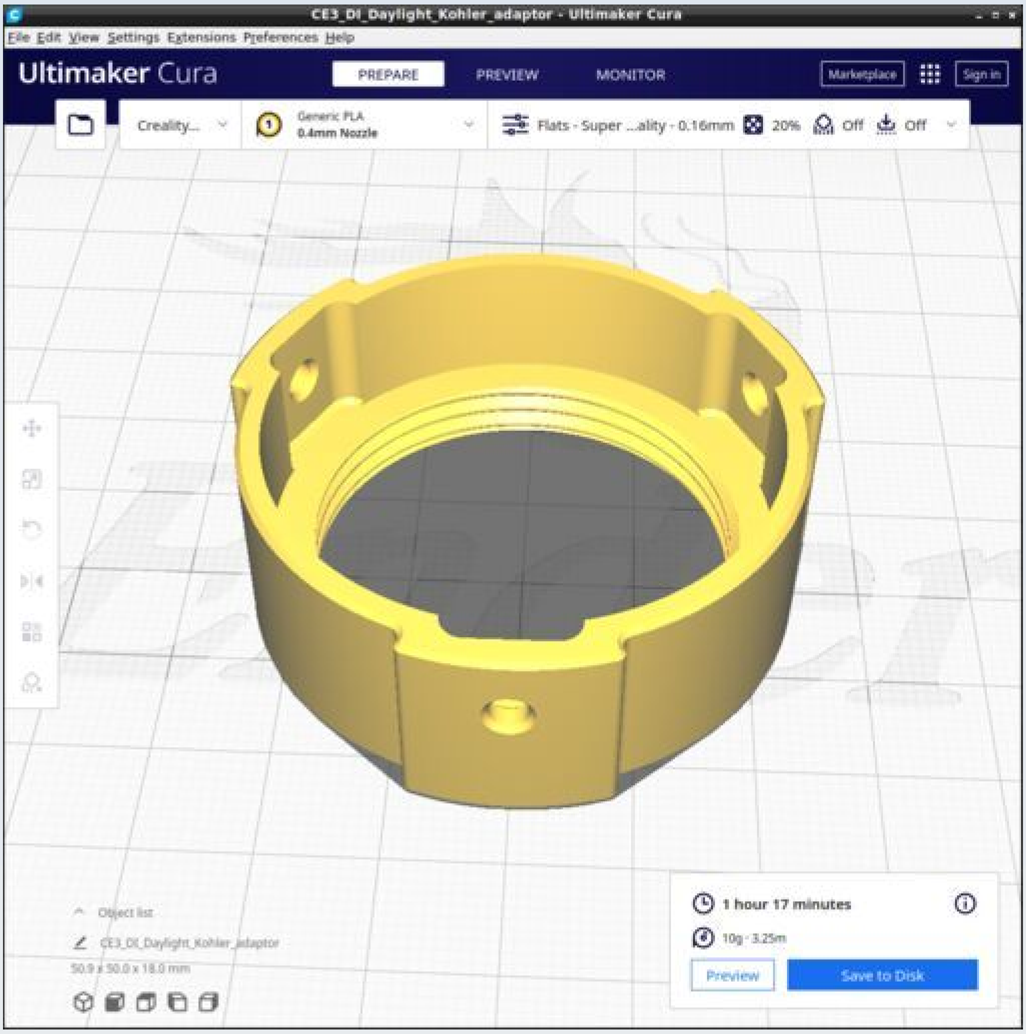
Must be printed with the special custom Cura profile called 'Condenser' which I made to ensure both strength and proper overhang tree supports to the centration flange disc.

DI_Condenser_base.stl



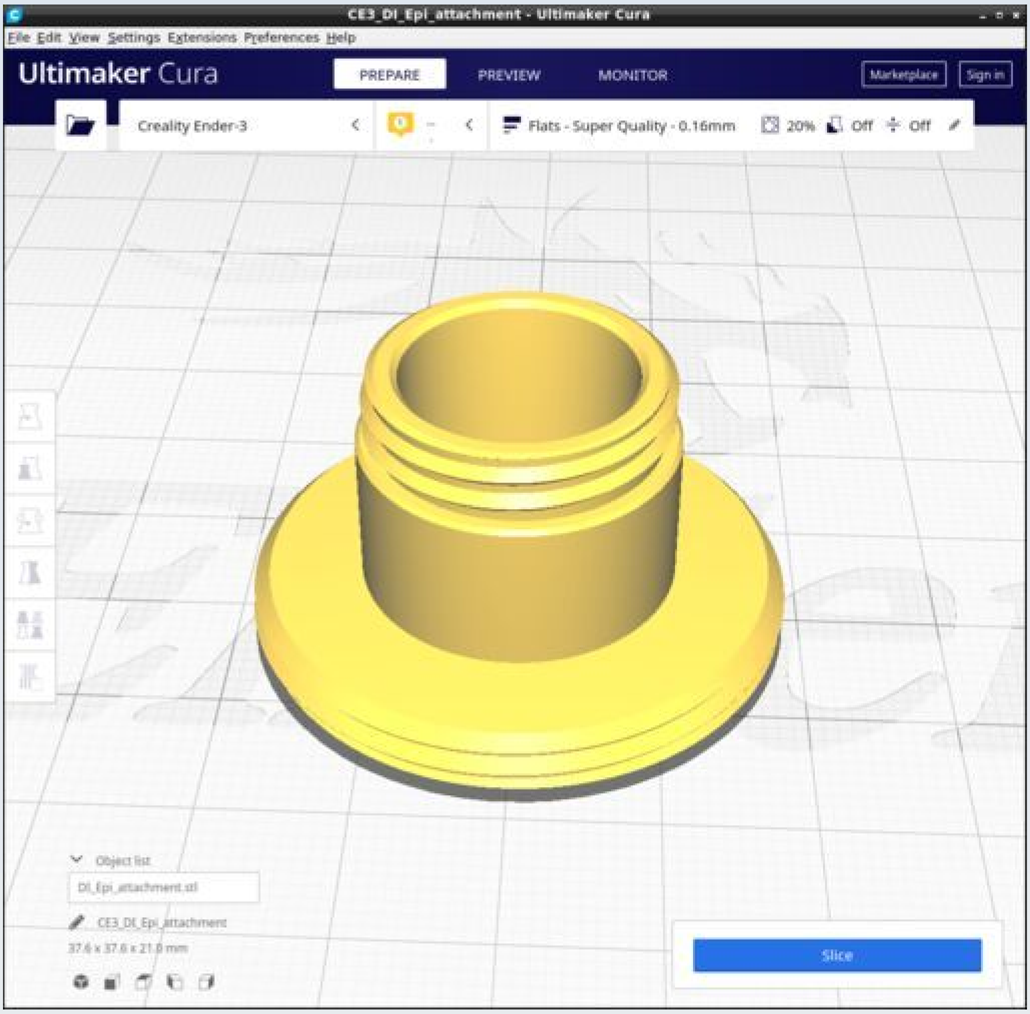
Ensure the ‘Top/bottom Pattern’ is set to ‘Concentric’. This avoids nozzle blebs on the diaphragm surface (they can cause deformations upwards when the condenser attachment is screwed in and such deformations can hinder passage of IAD filters).

DI_Daylight_Kohler_adaptor.stl

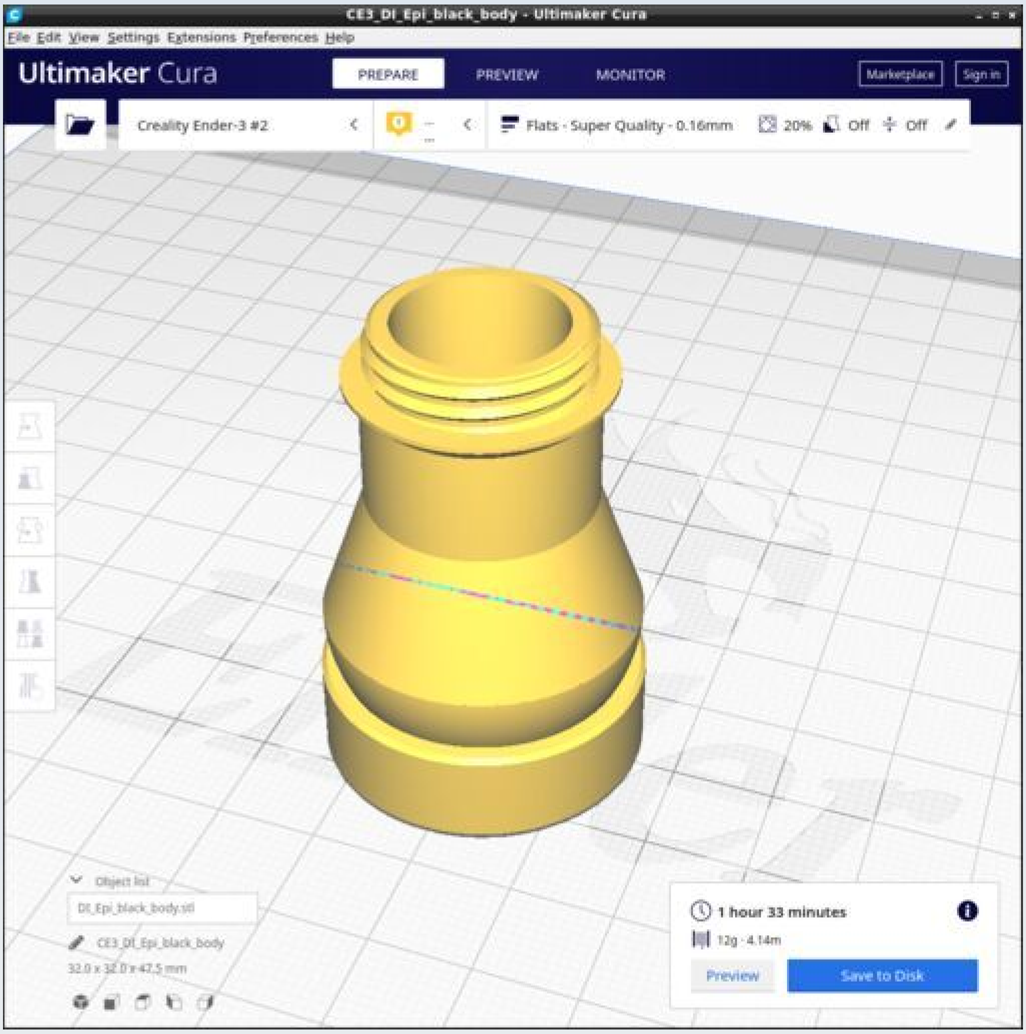


Ensure the ‘Top/bottom Pattern’ is set to ‘Concentric’. I suggest also that the infill pattern be set to ‘zig-zag’ to reduce retractions.

DI_Epi_attachment.stl

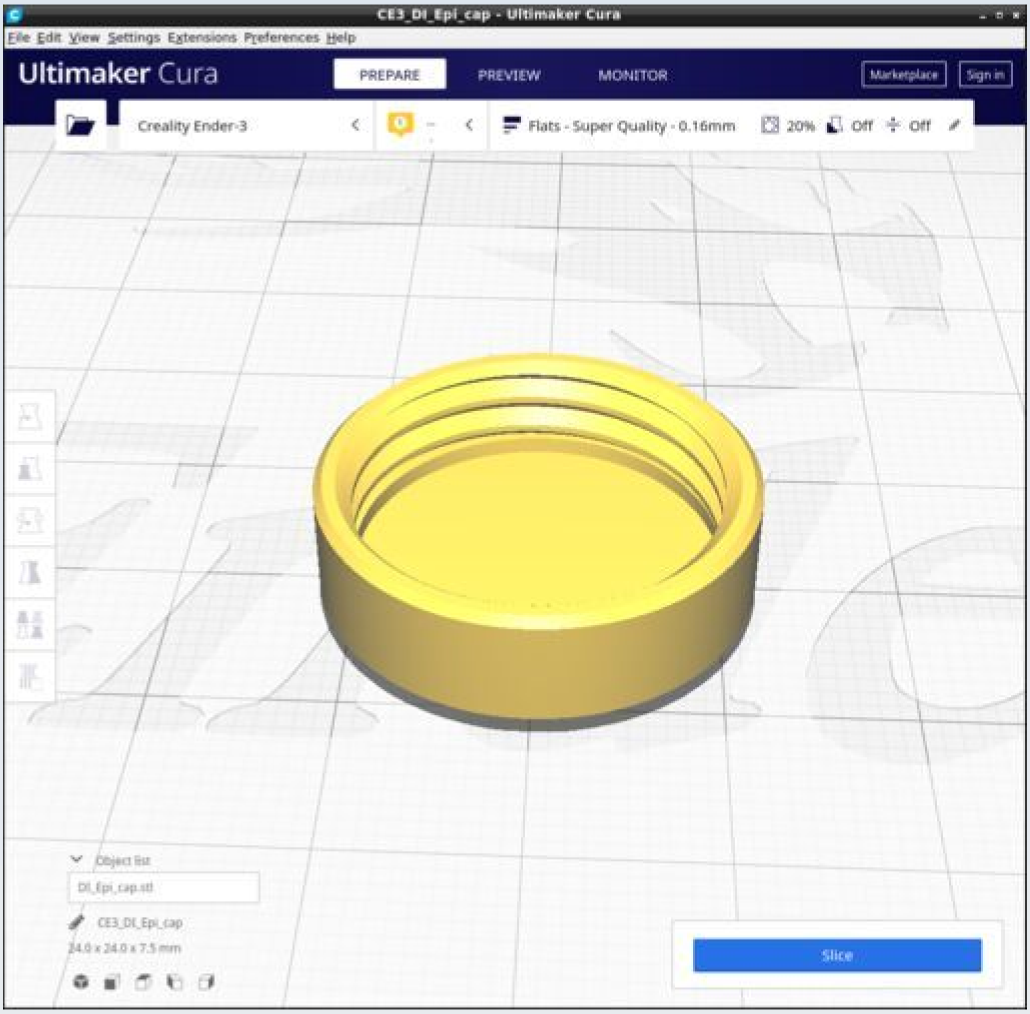


DI_Epi_black_body.stl

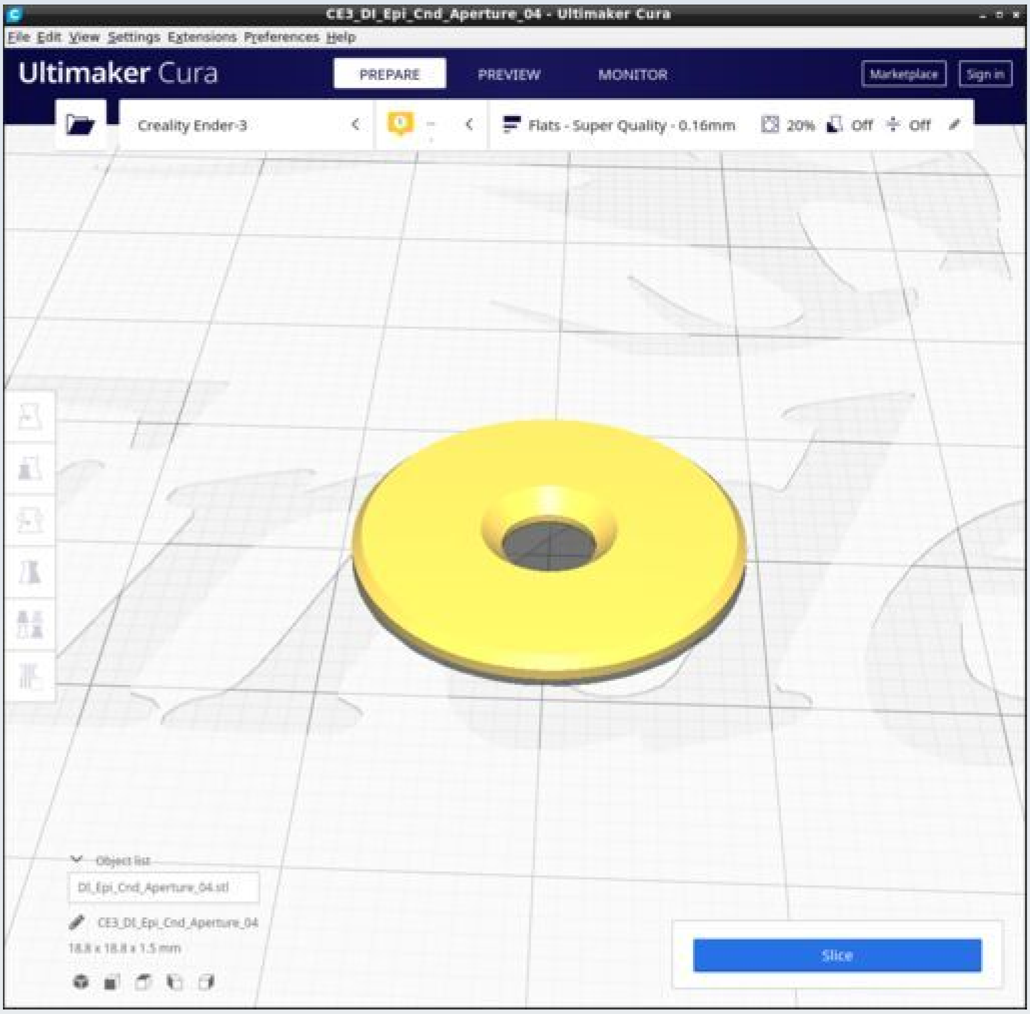


Use the standard 'Flats' profile and do not use supports.

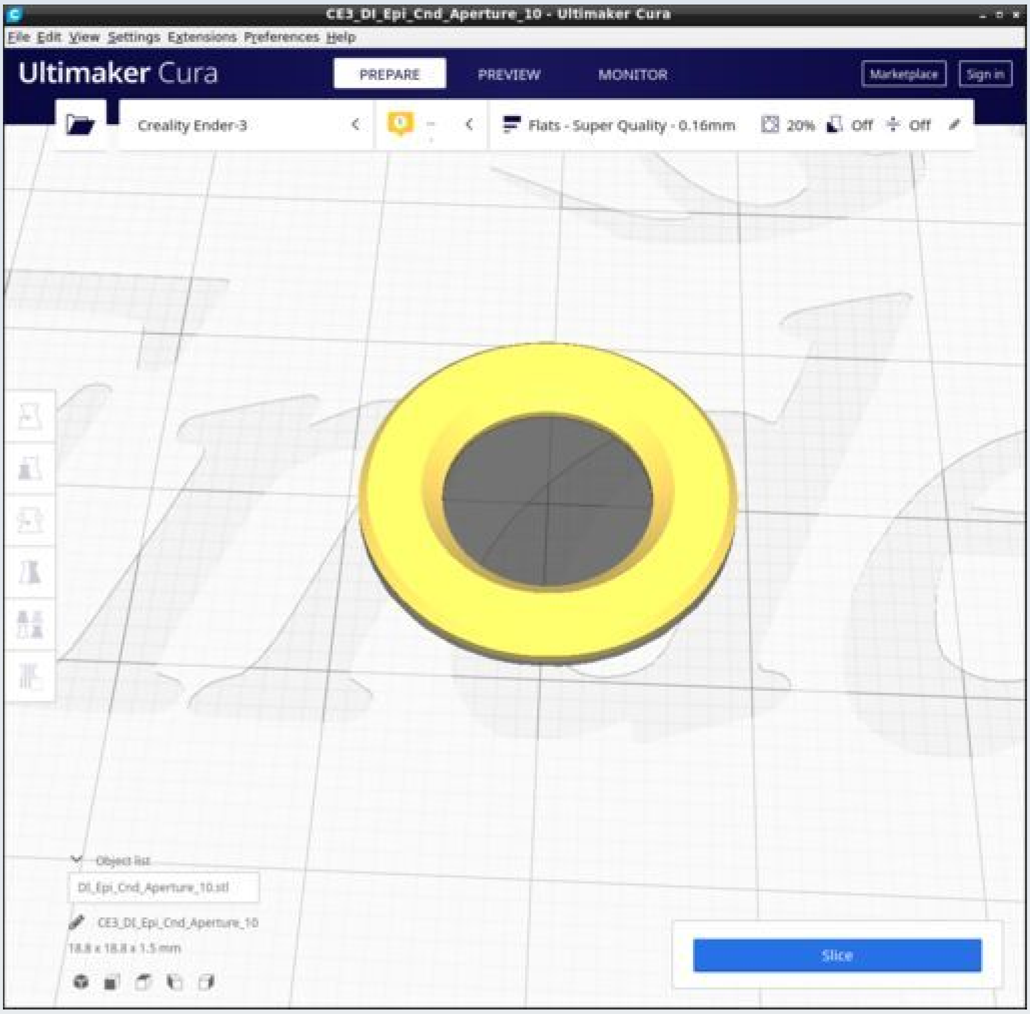
DI_Epi_cap.stl



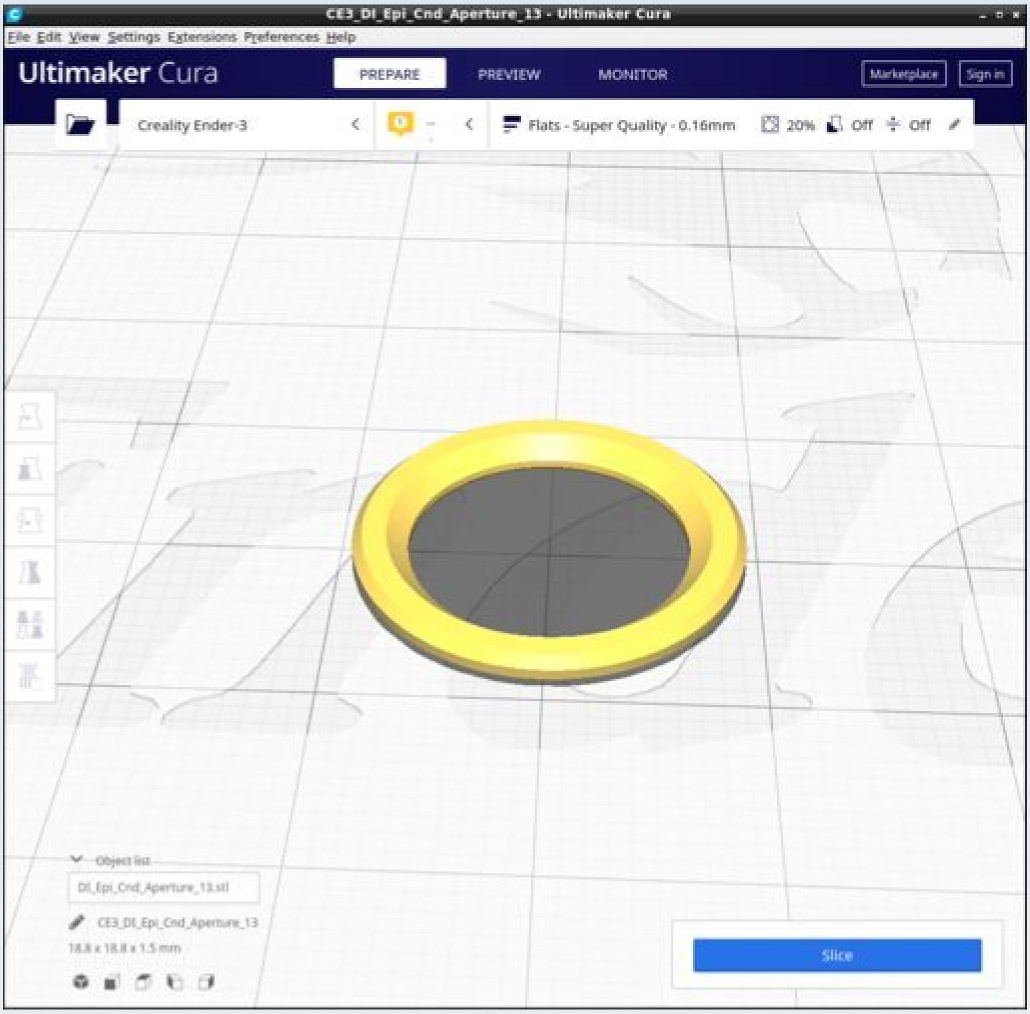
DI_Epi_Cnd_Aperture_04.stl



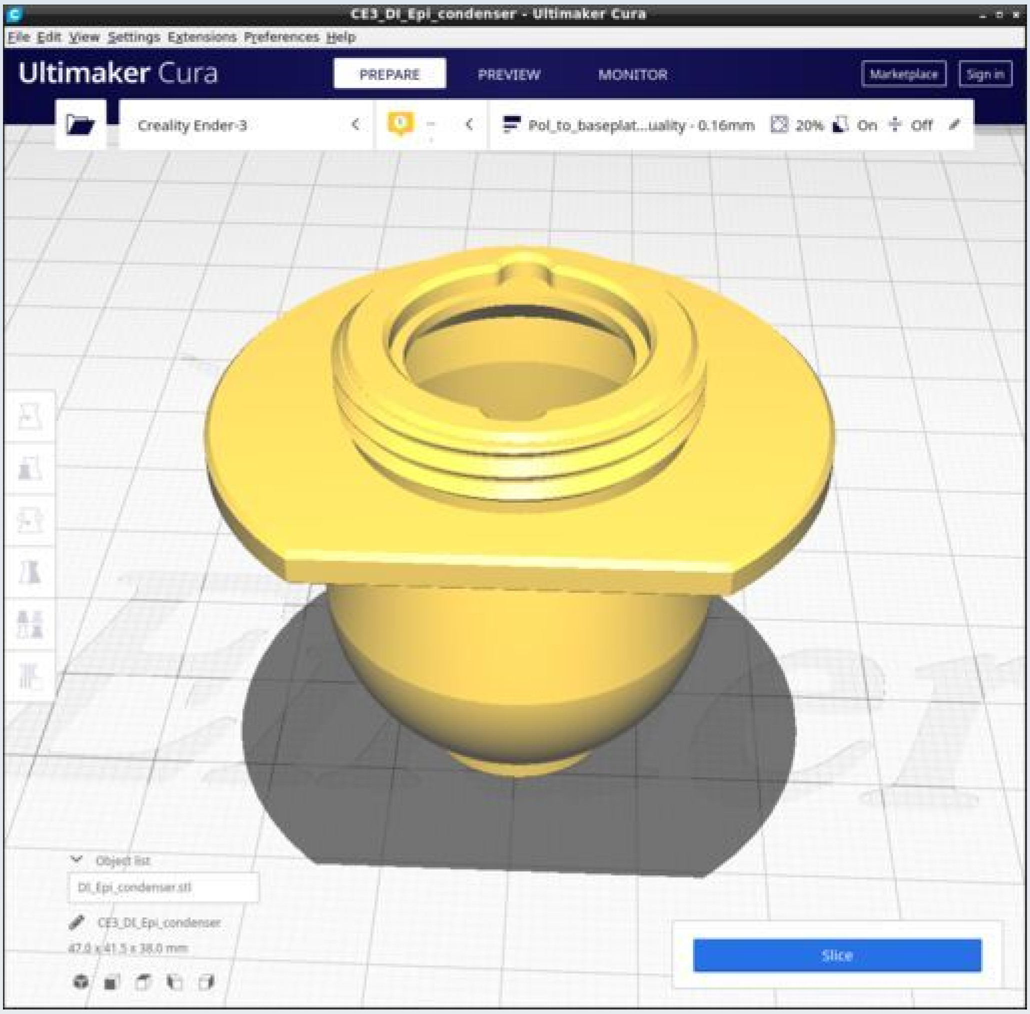
DI_Epi_Cnd_Aperture_10.stl



DI_Epi_Cnd_Aperture_13.stl

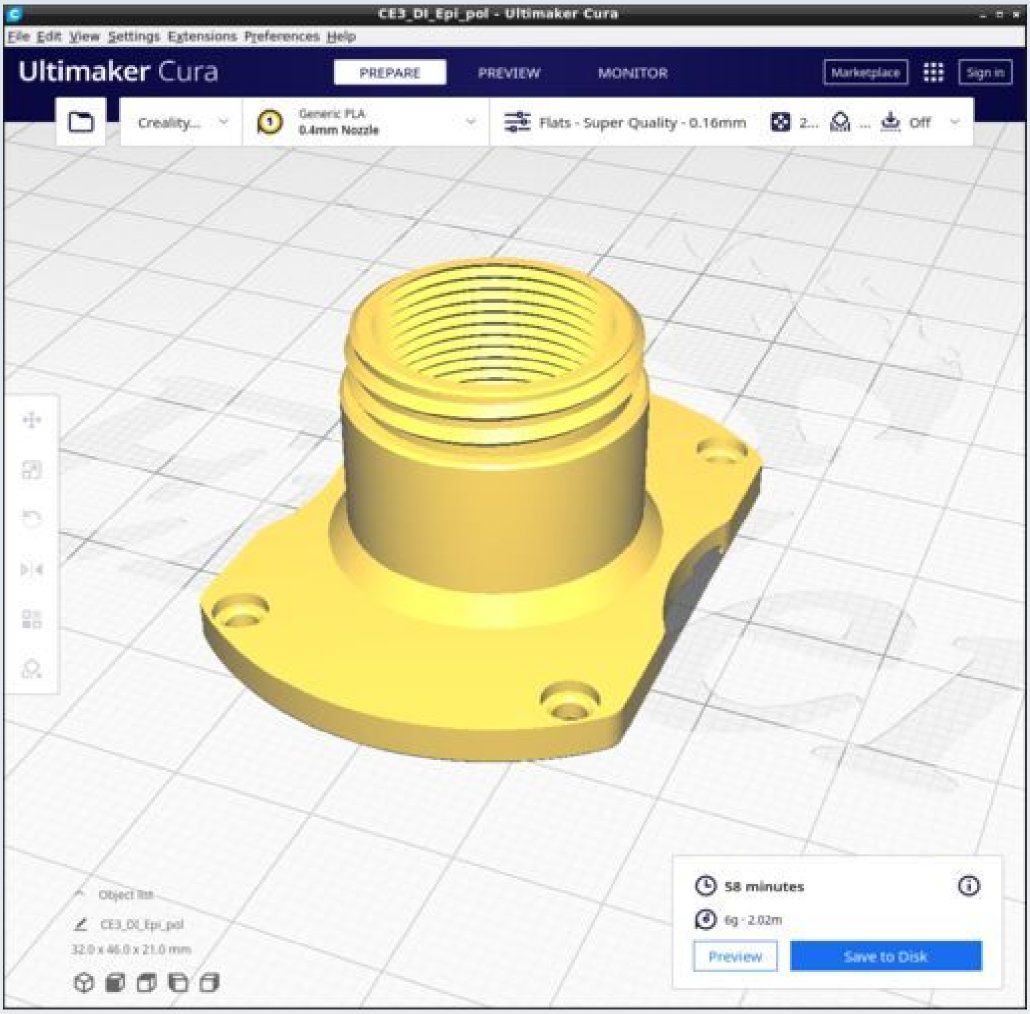


DI_Epi_condenser.stl

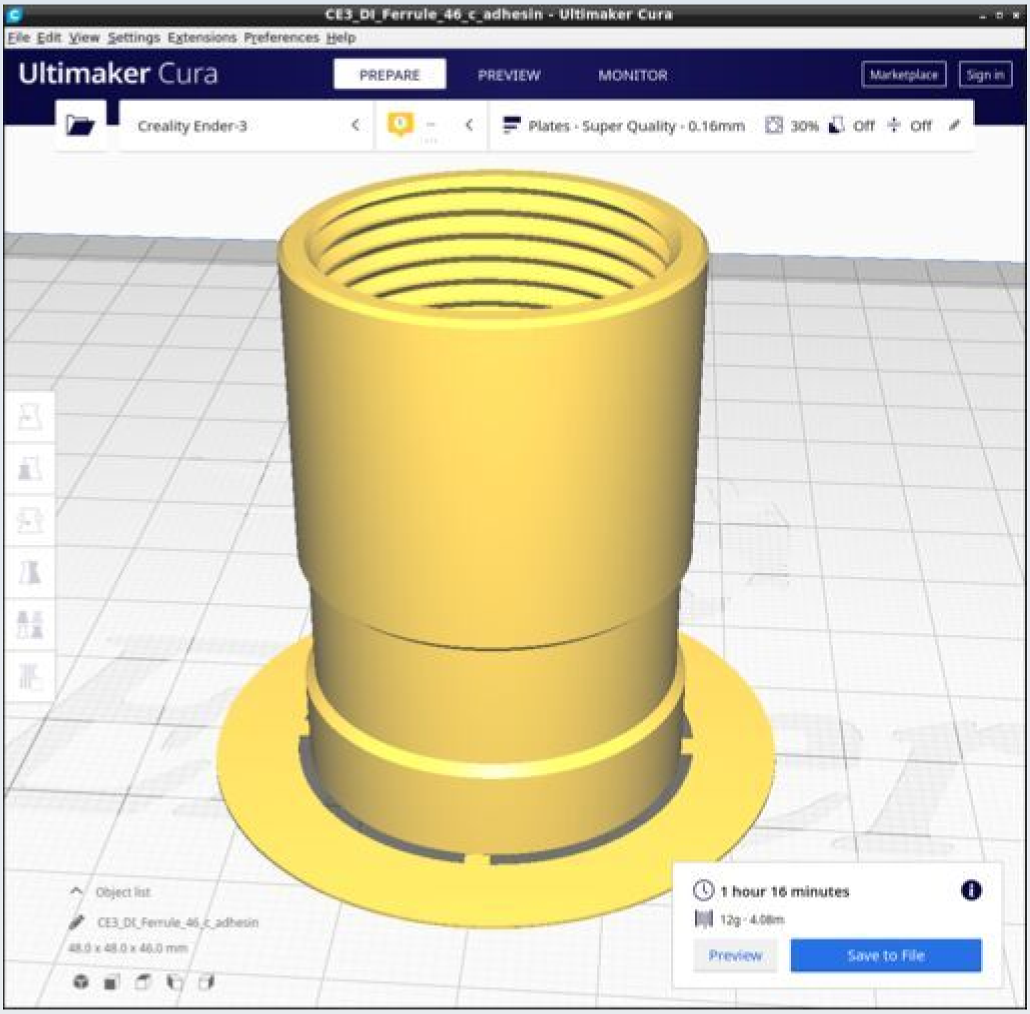


Use the 'Pol_to_baseplate' Cura profile.

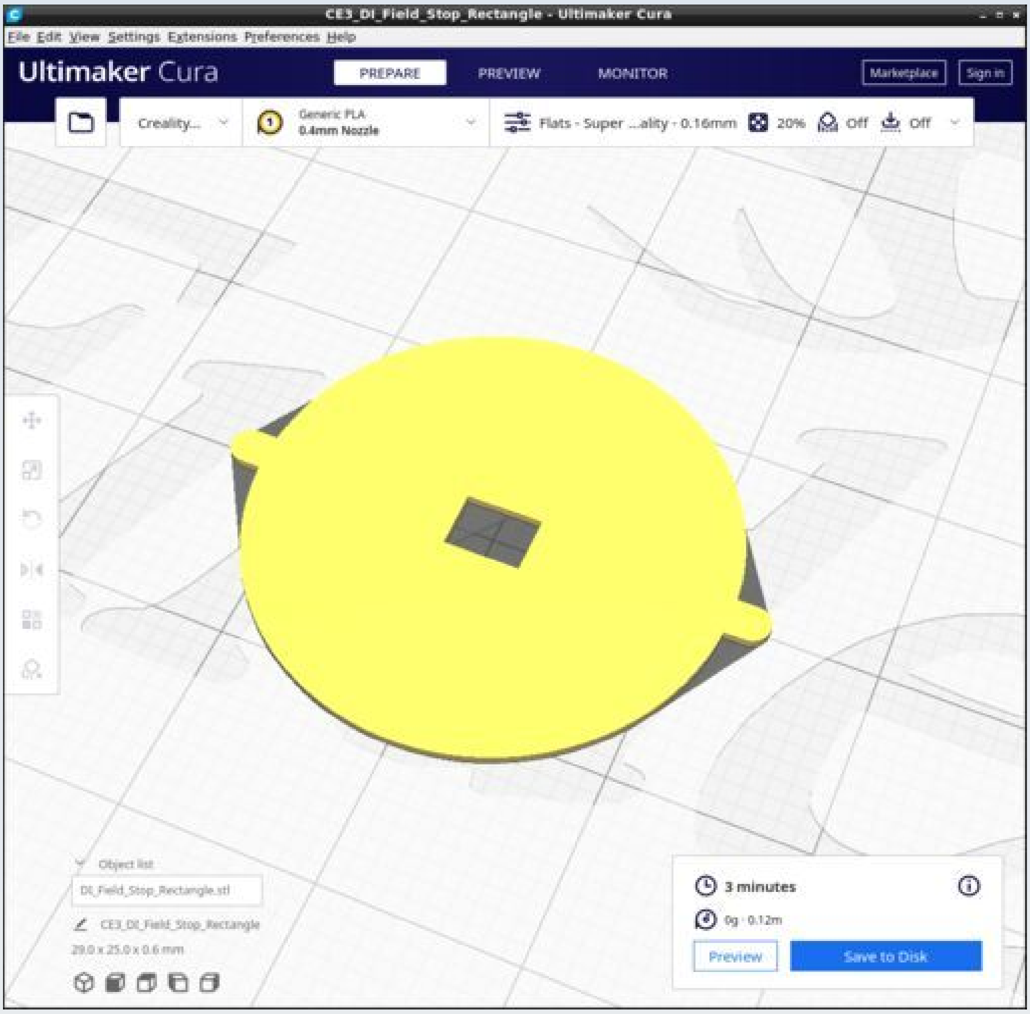
DI_Epi_pol.stl



DI_Ferrule_46_c_adhesin.stl



DI_Field_Stop_Rectangle.stl



Note that the Field_Stop models are thicker (have more print layers) than the DI_IFD_Filter_Crosshairs. This is because it is beneficial for the crosshairs to be semitransparent to be able to see the image of the light source behind it for centration purposes but true field stops should be fully opaque.

In FreeCAD:

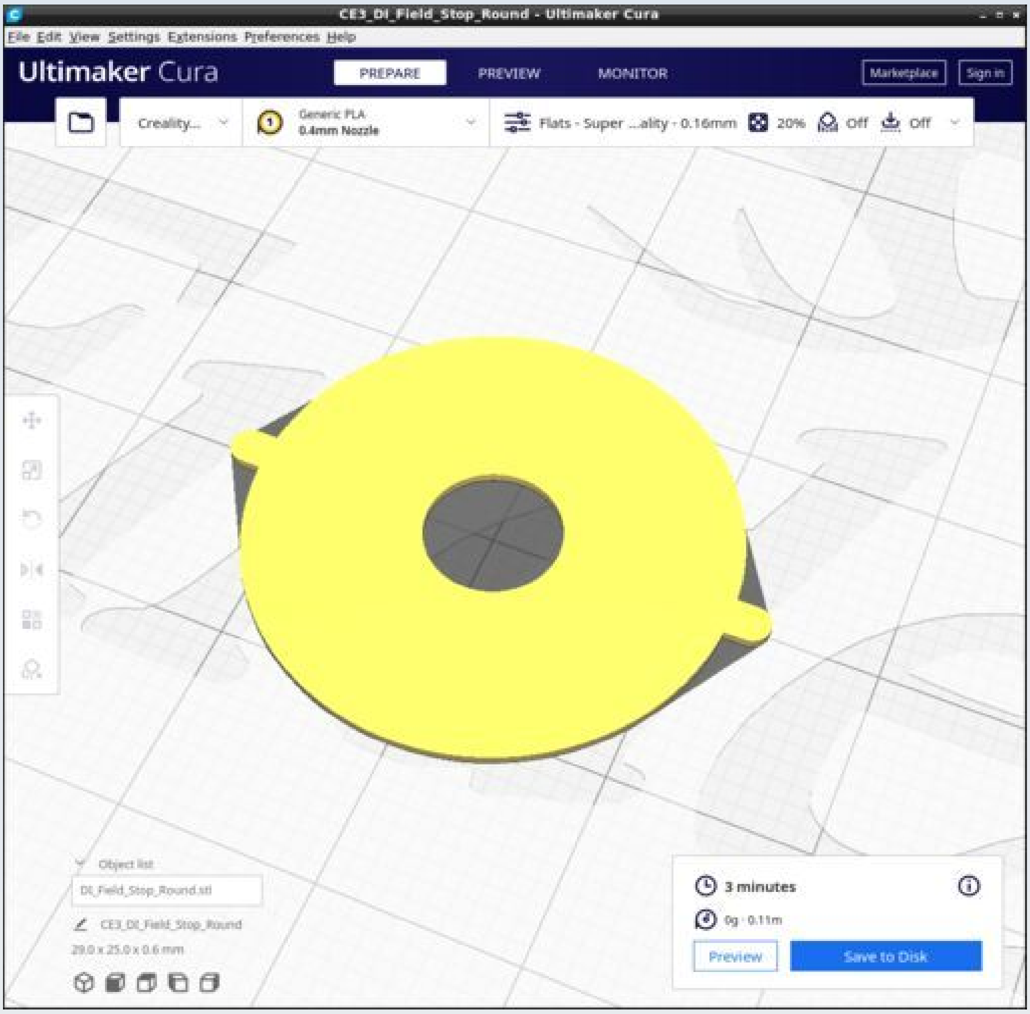
To change the aperture of the Field_Stop_Rectangle alter the dimensions (and XY offset positions accordingly to maintain central position) of the box called 'Aperture_rectangle' here (the default size is 4 mm by 3 mm):

Field_Stop_Rectangle

|_ Sehfeldblende_4x3

|_Aperture_rectangle

DI_Field_Stop_Round.stl



Note that the Field_Stop models are thicker (have more print layers) than the DI_IFD_Filter_Crosshairs. This is because it is beneficial for the crosshairs to be semitransparent to be able to see the image of the light source behind it for centration purposes but true field stops should be fully opaque.

In FreeCAD:

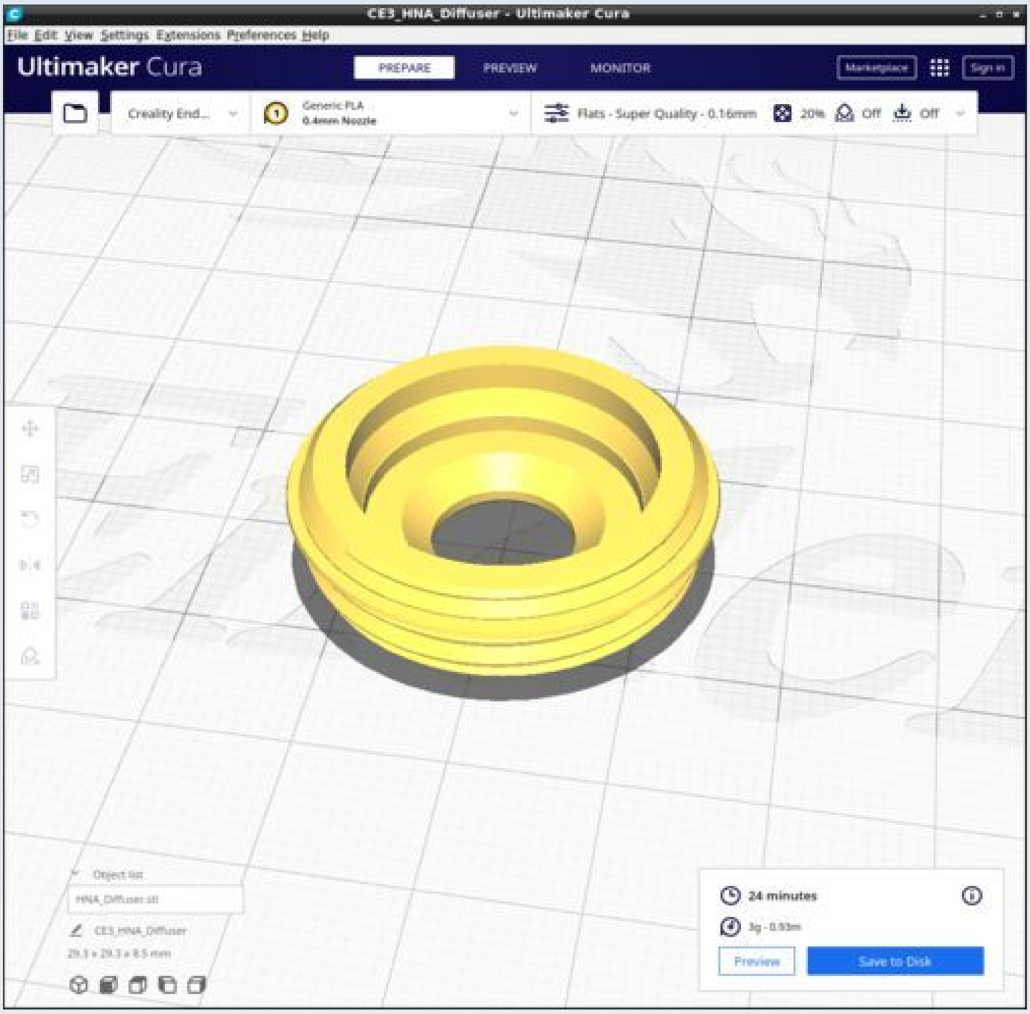
To change the aperture of the Field_Stop_Round alter the radius value of the cylinder called 'Aperture_hole' here (the default radius is 3.5 mm to give a 7 mm diameter aperture):

Field_Stop_Round

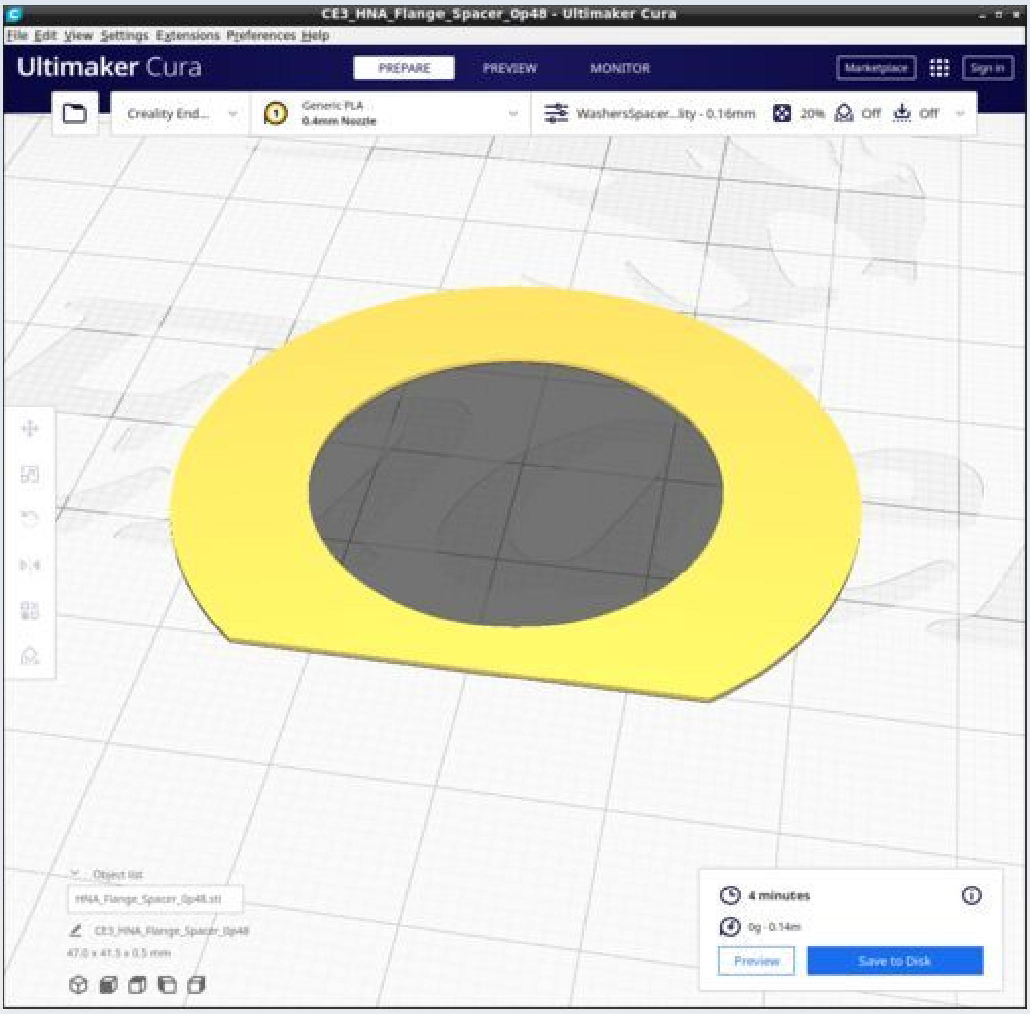
|_ Sehfeldblende

|_Aperture_hole

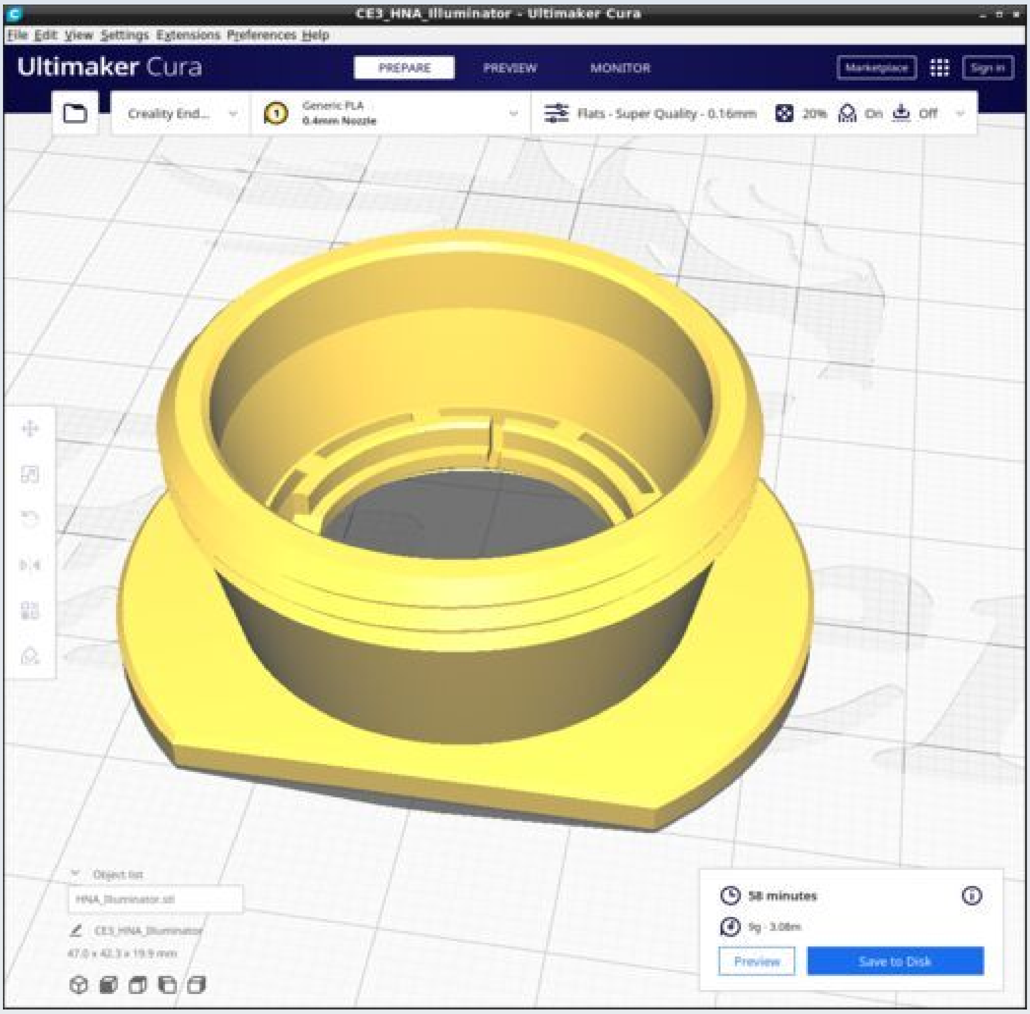
DI_HNA_Diffuser.stl



DI_HNA_Flange_Spacer_0p48.stl

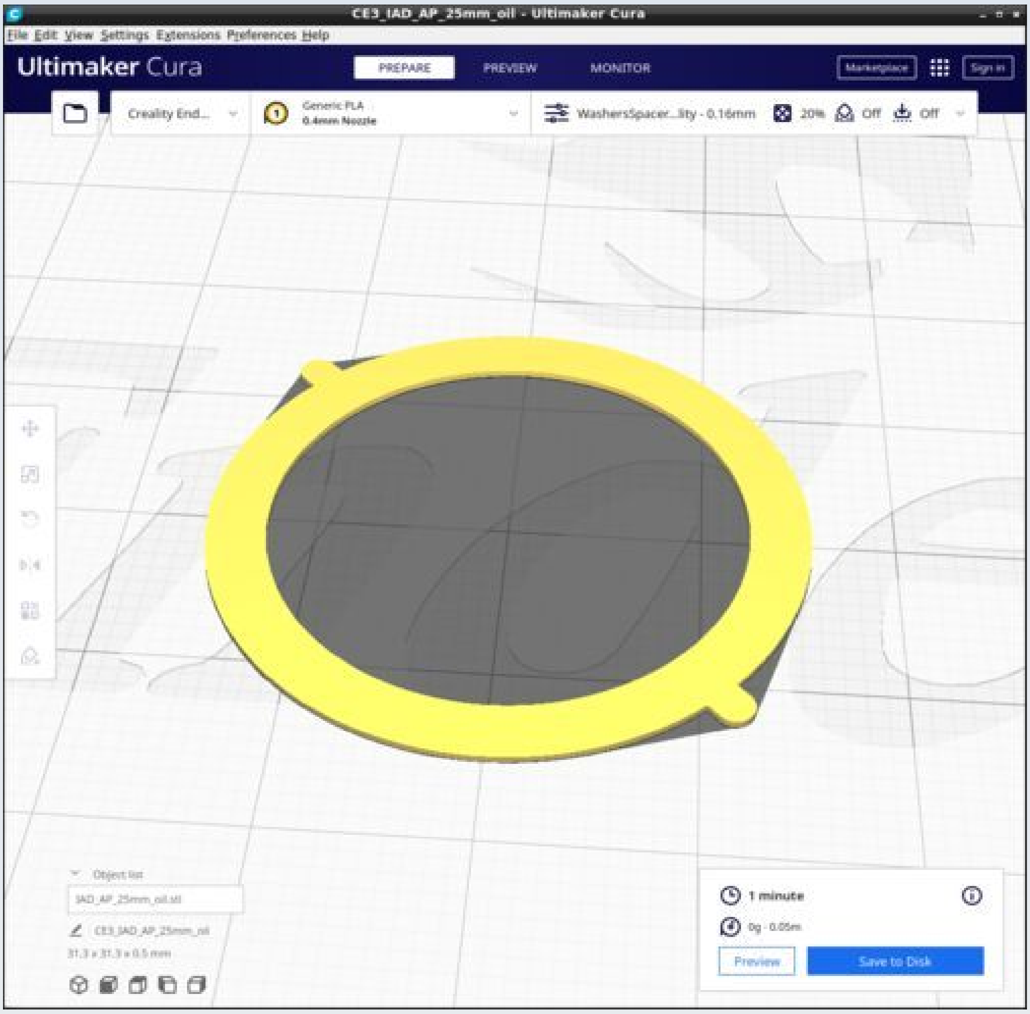


DI_HNA_Illuminator.stl

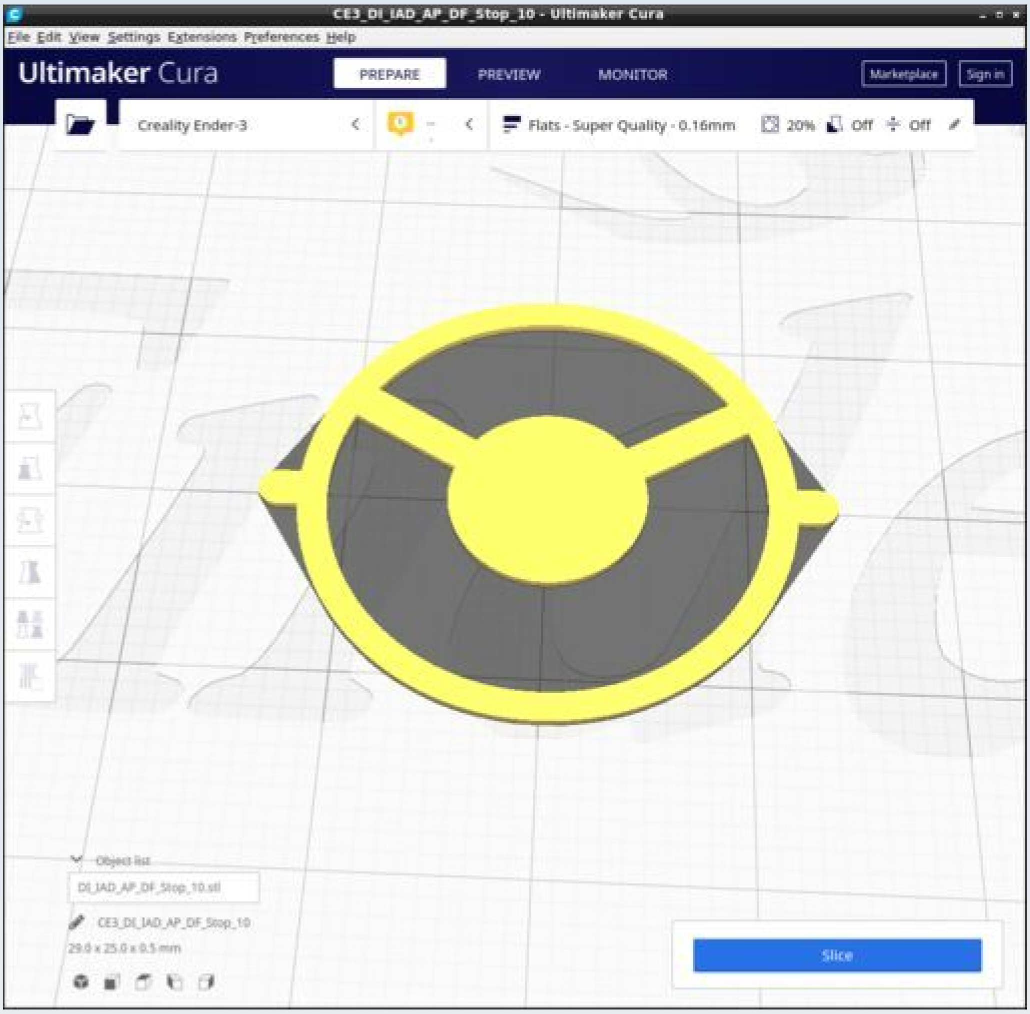


Supports on for 'touching build plate only'

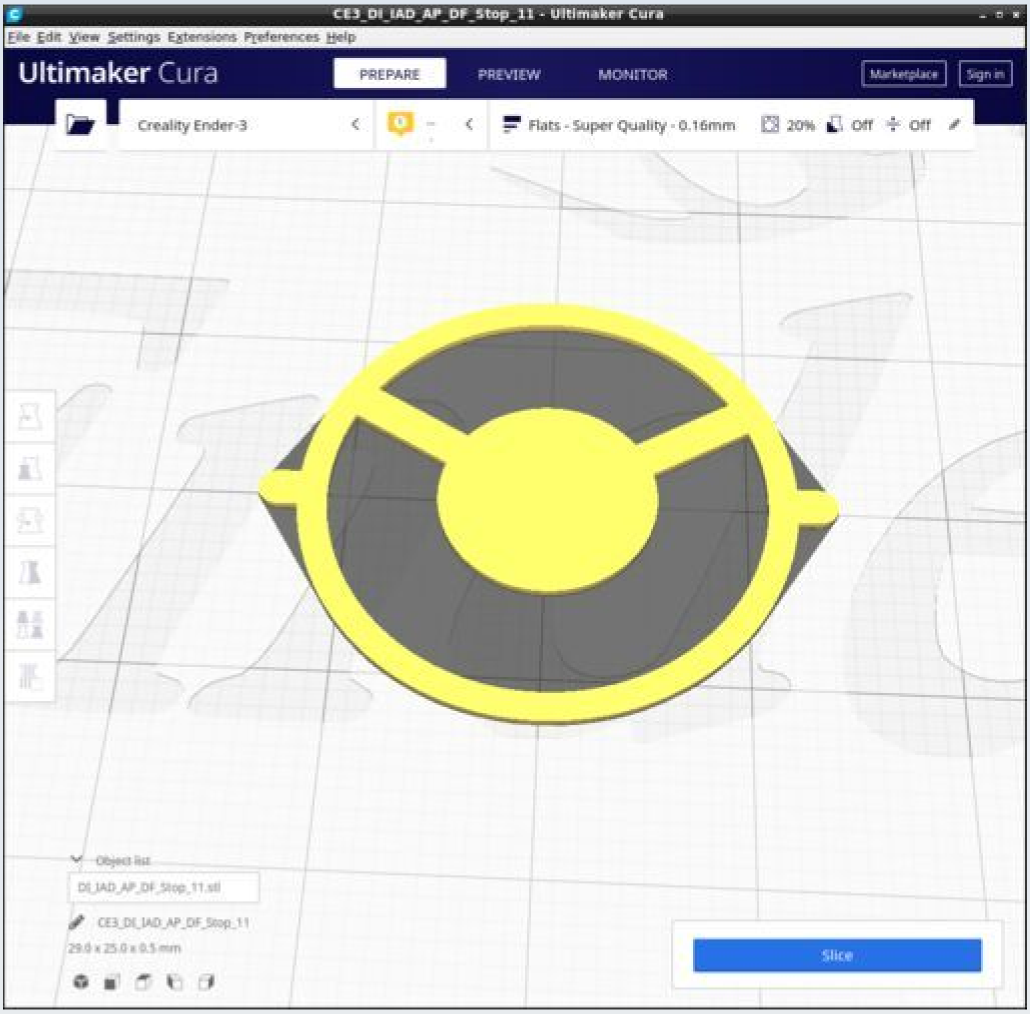
DI_IAD_AP_25mm_oil.stl



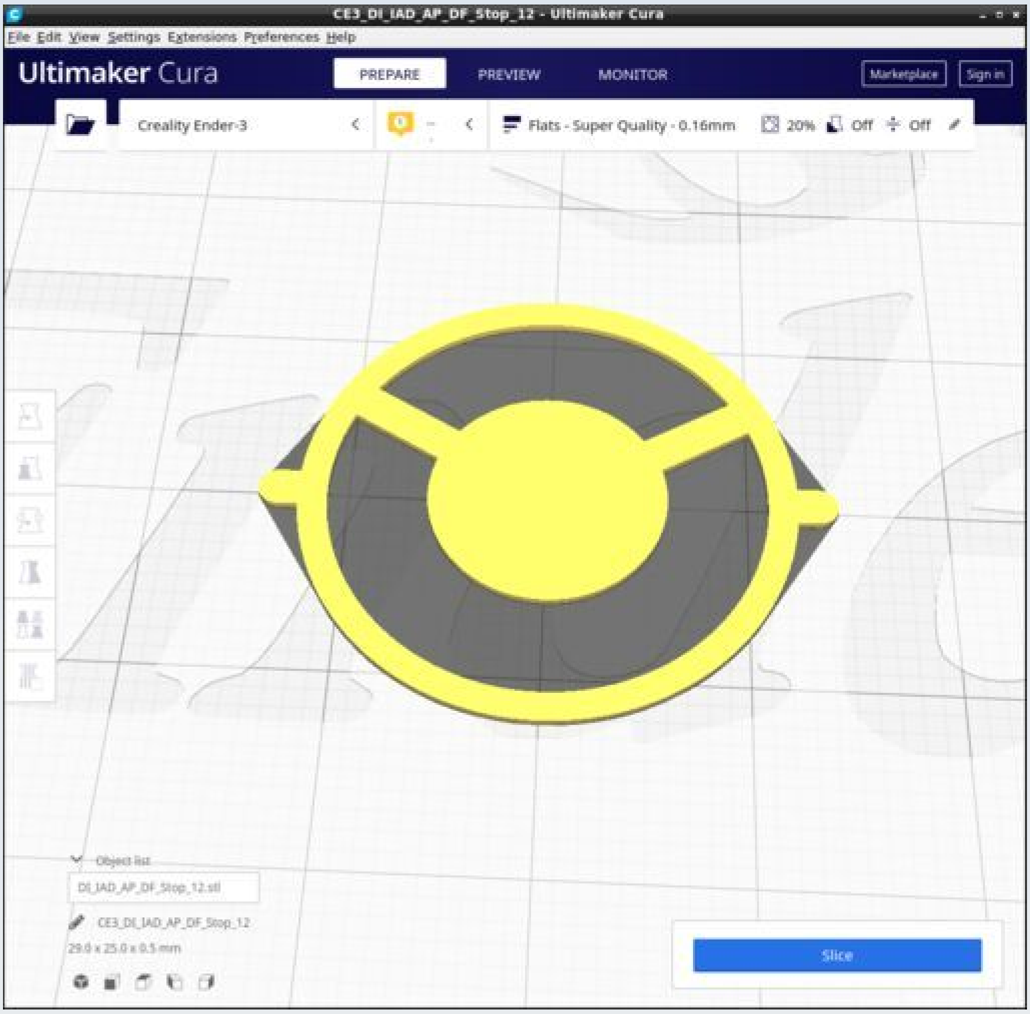
DI_IAD_AP_DF_Stop_10.stl



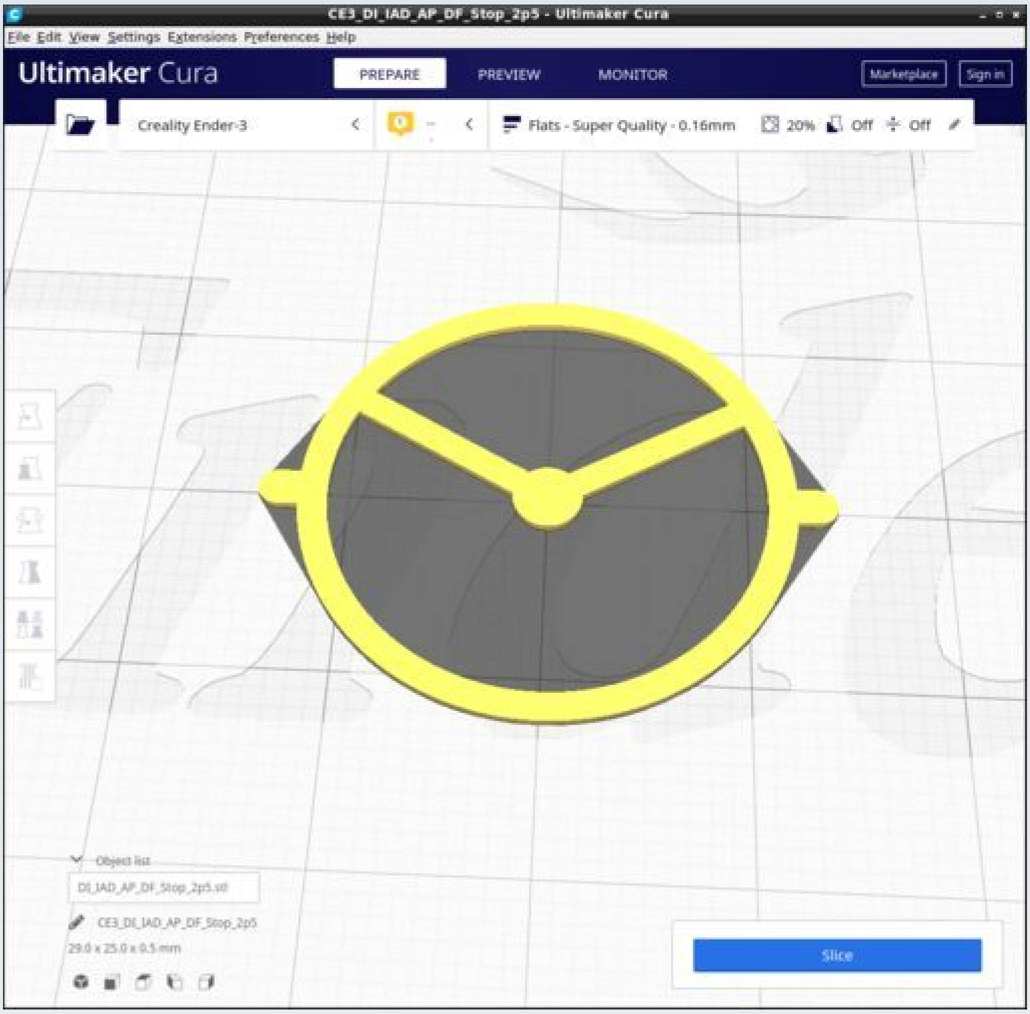
DI_IAD_AP_DF_Stop_11.stl



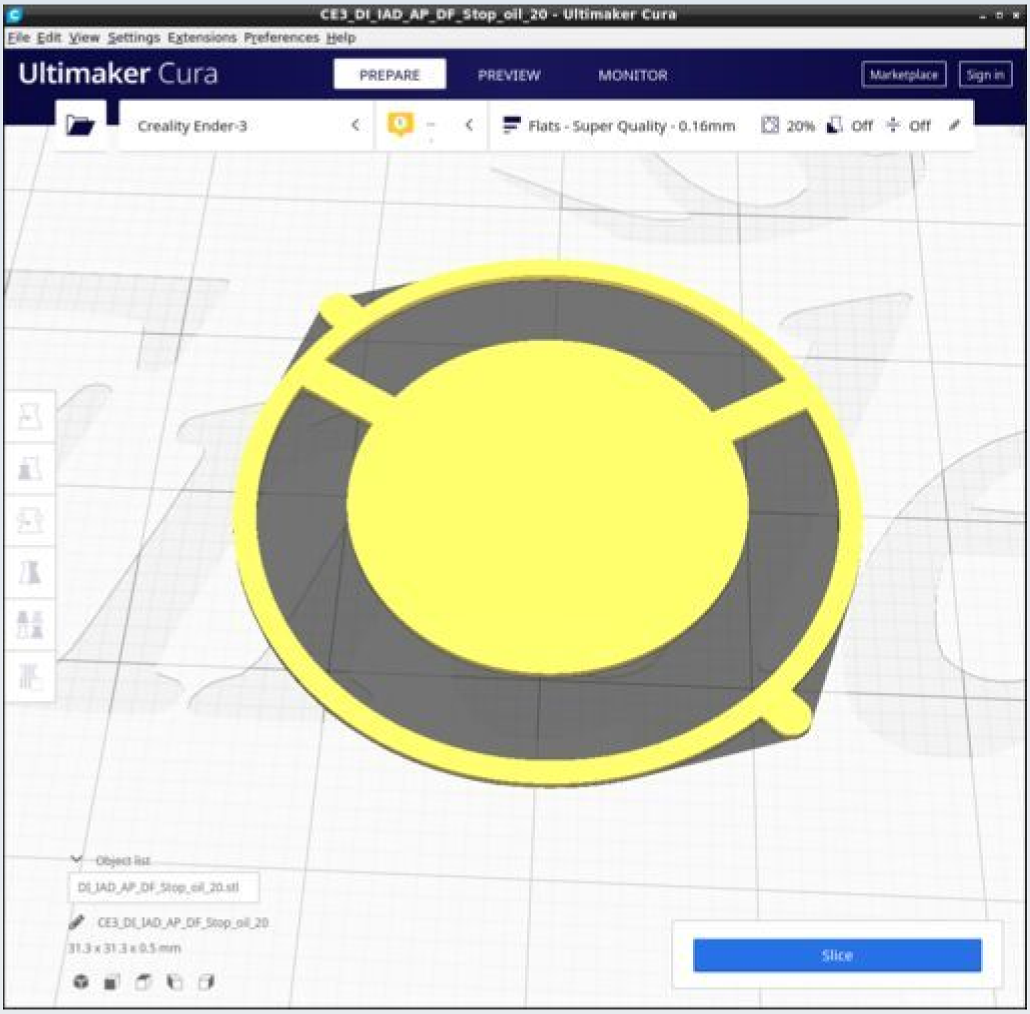
DI_IAD_AP_DF_Stop_12.stl



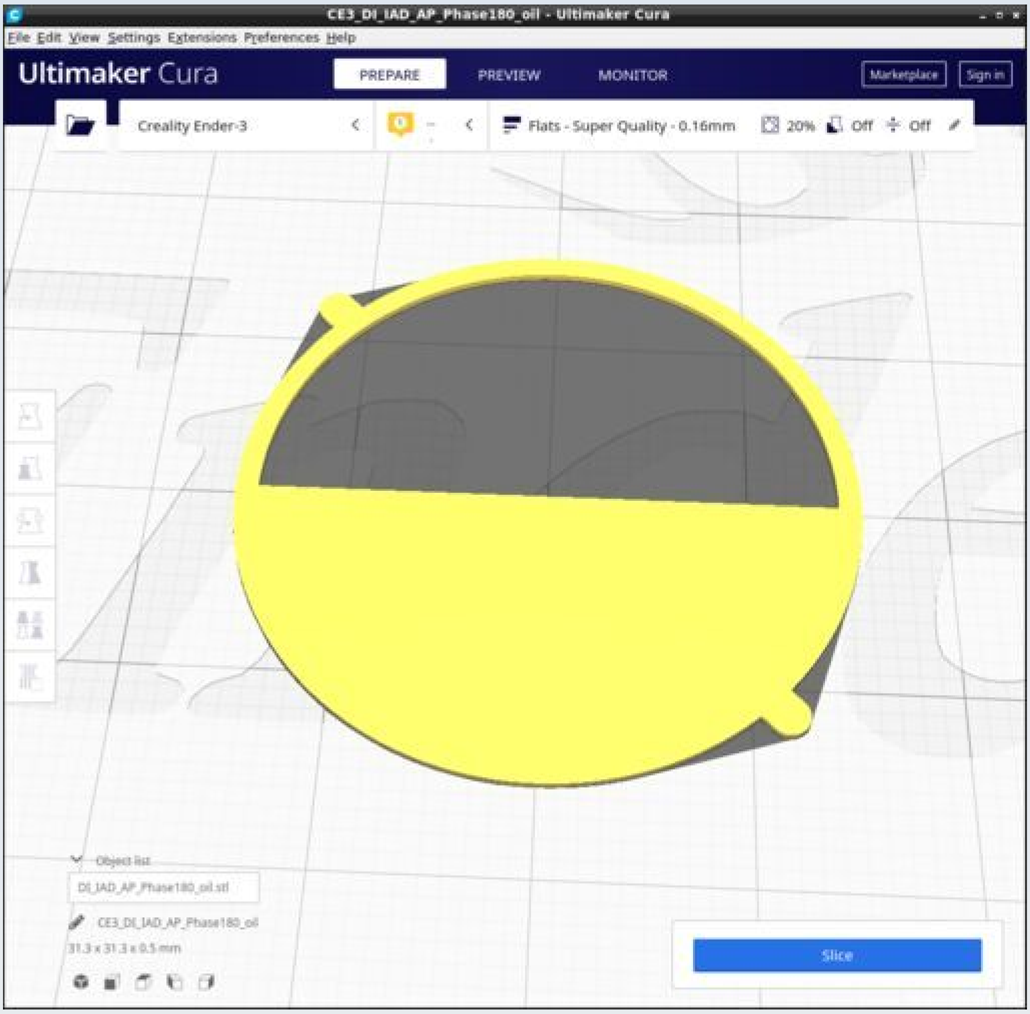
DI_IAD_AP_DF_Stop_2p5.stl



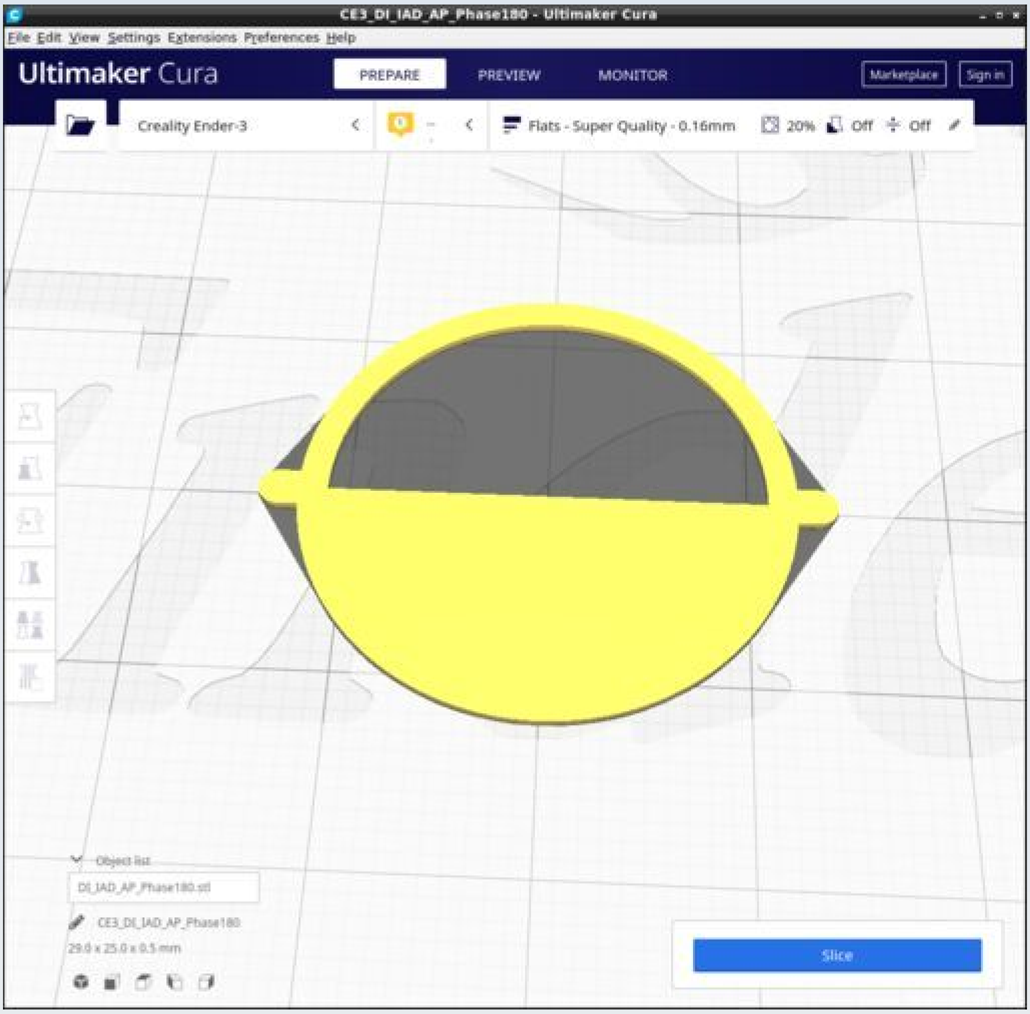
DI_IAD_AP_DF_Stop_oil_20.stl



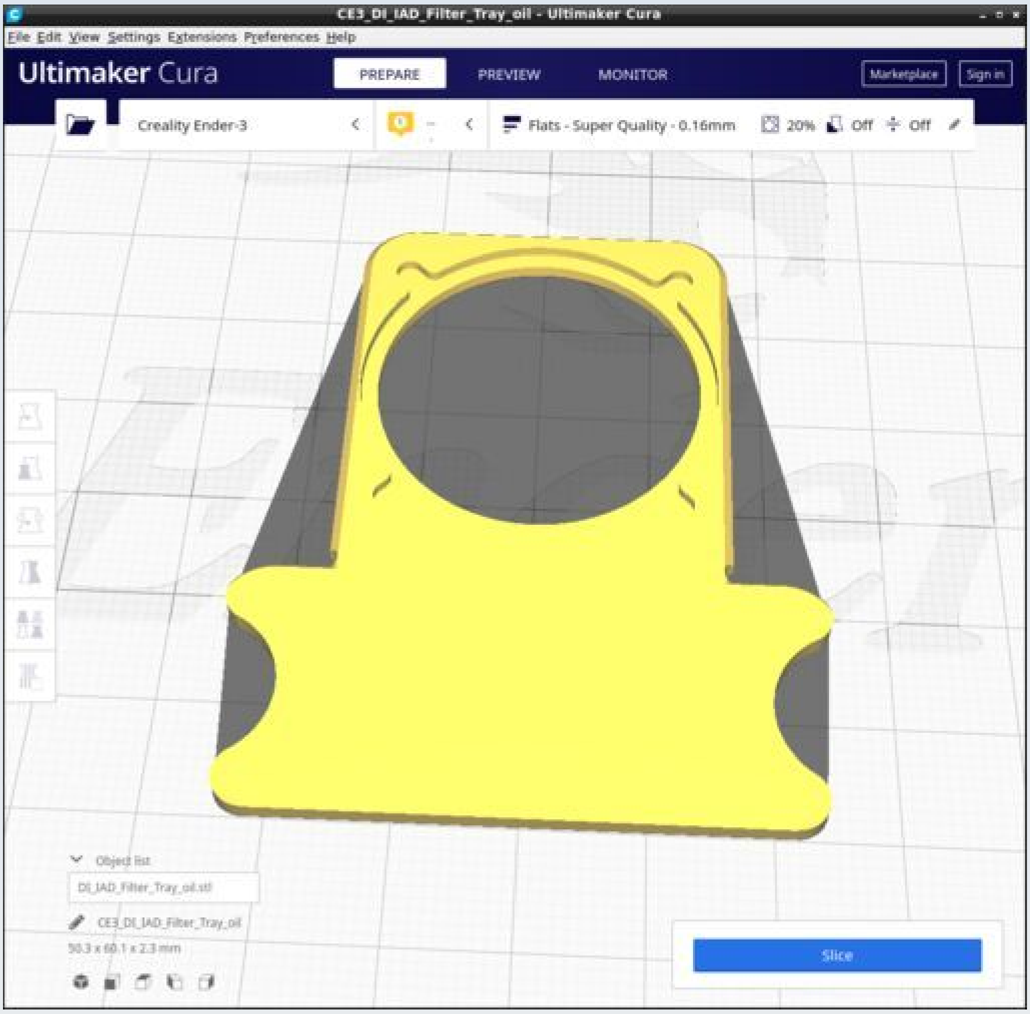
DI_IAD_AP_Phase180_oil.stl



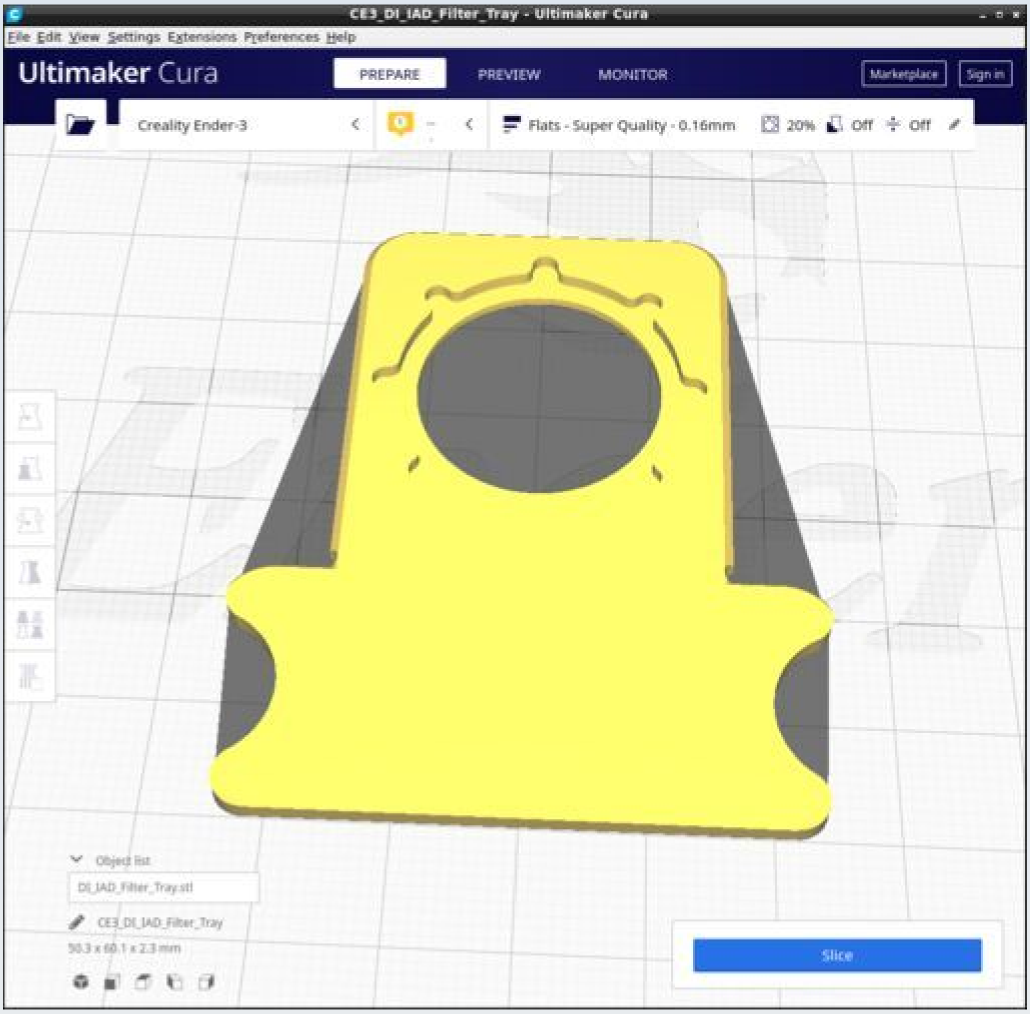
DI_IAD_AP_Phase180.stl



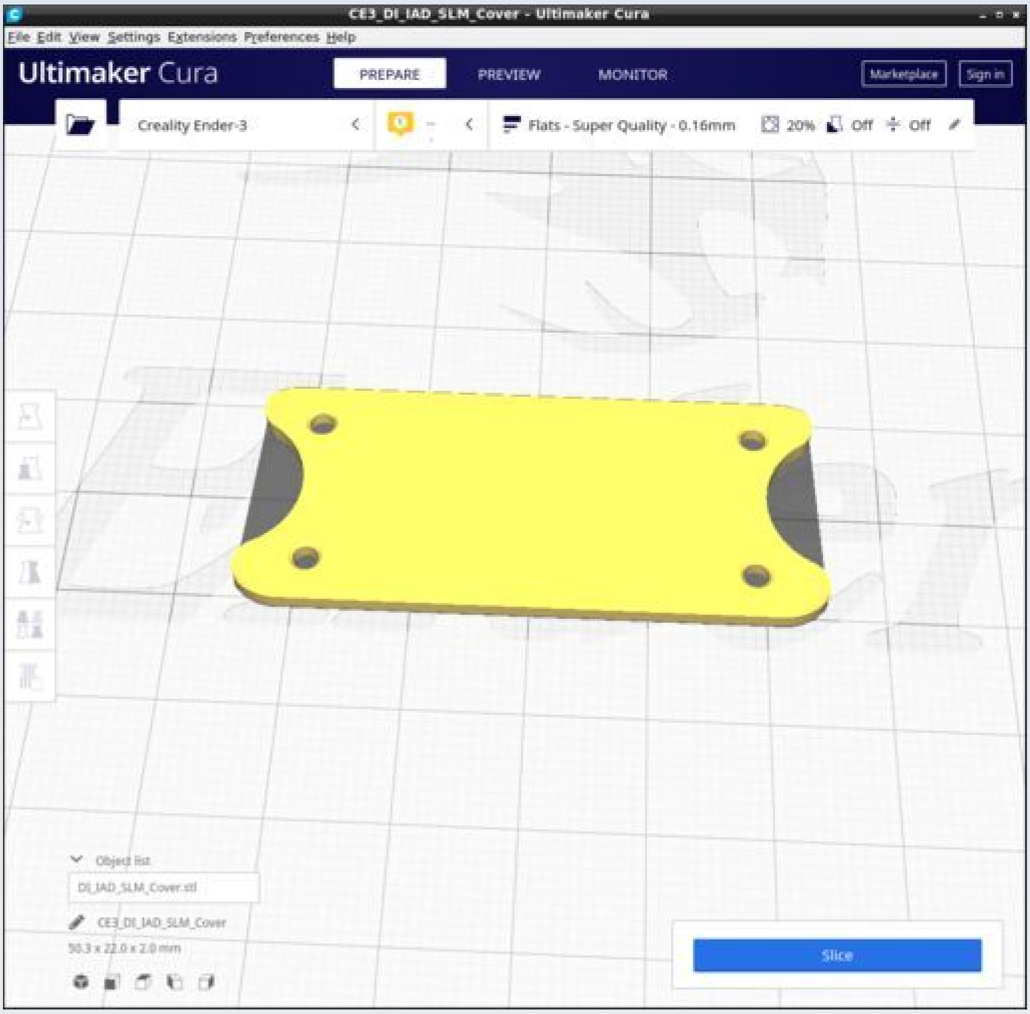
DI_IAD_Filter_Tray_oil.stl



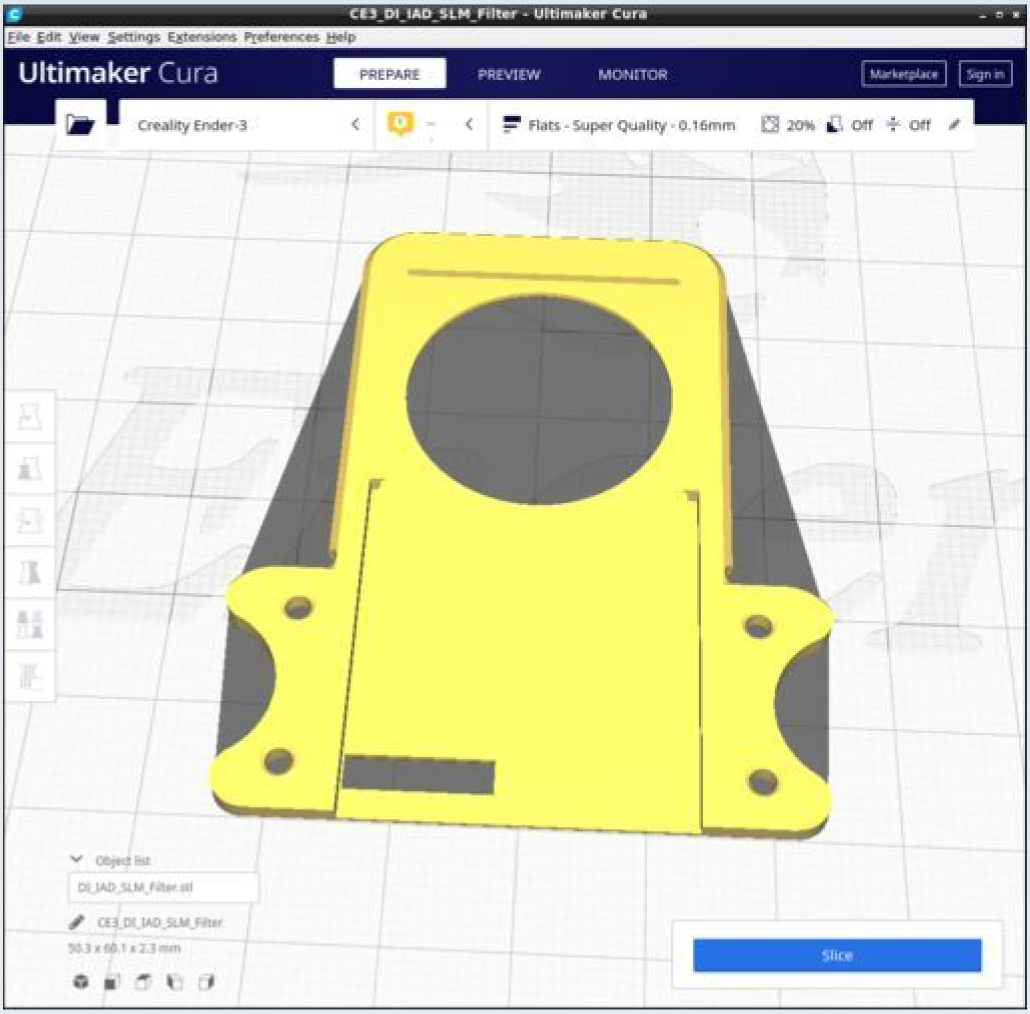
DI_IAD_Filter_Tray.stl



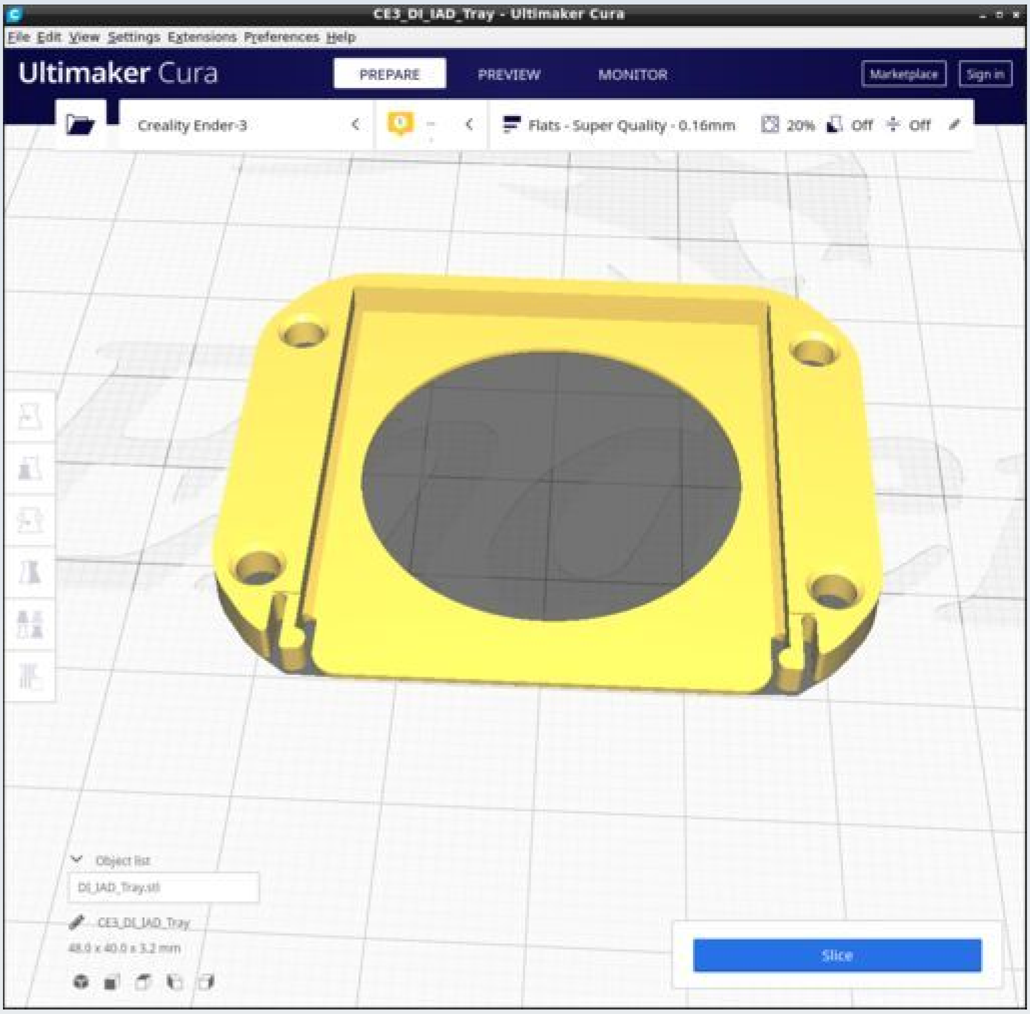
DI_IAD_SLM_Cover.stl



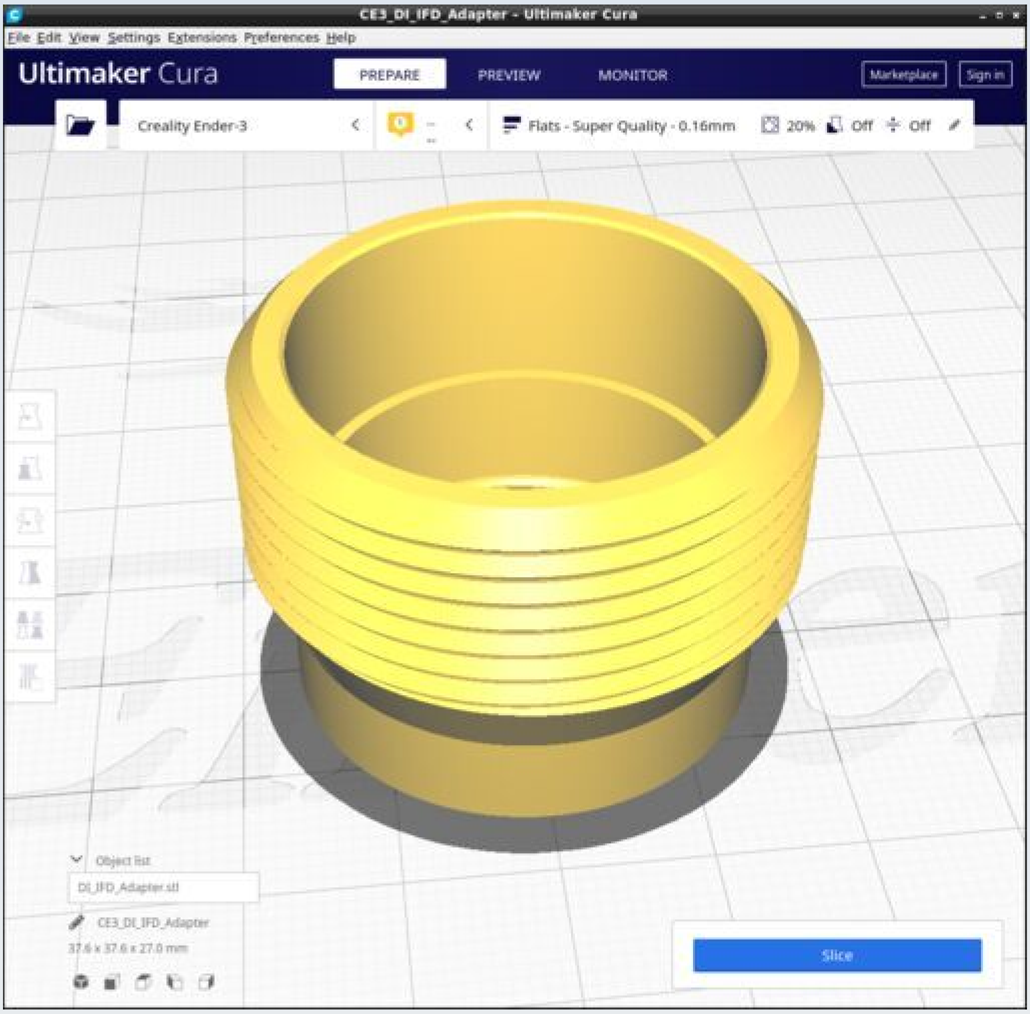
DI_IAD_SLM_Filter.stl



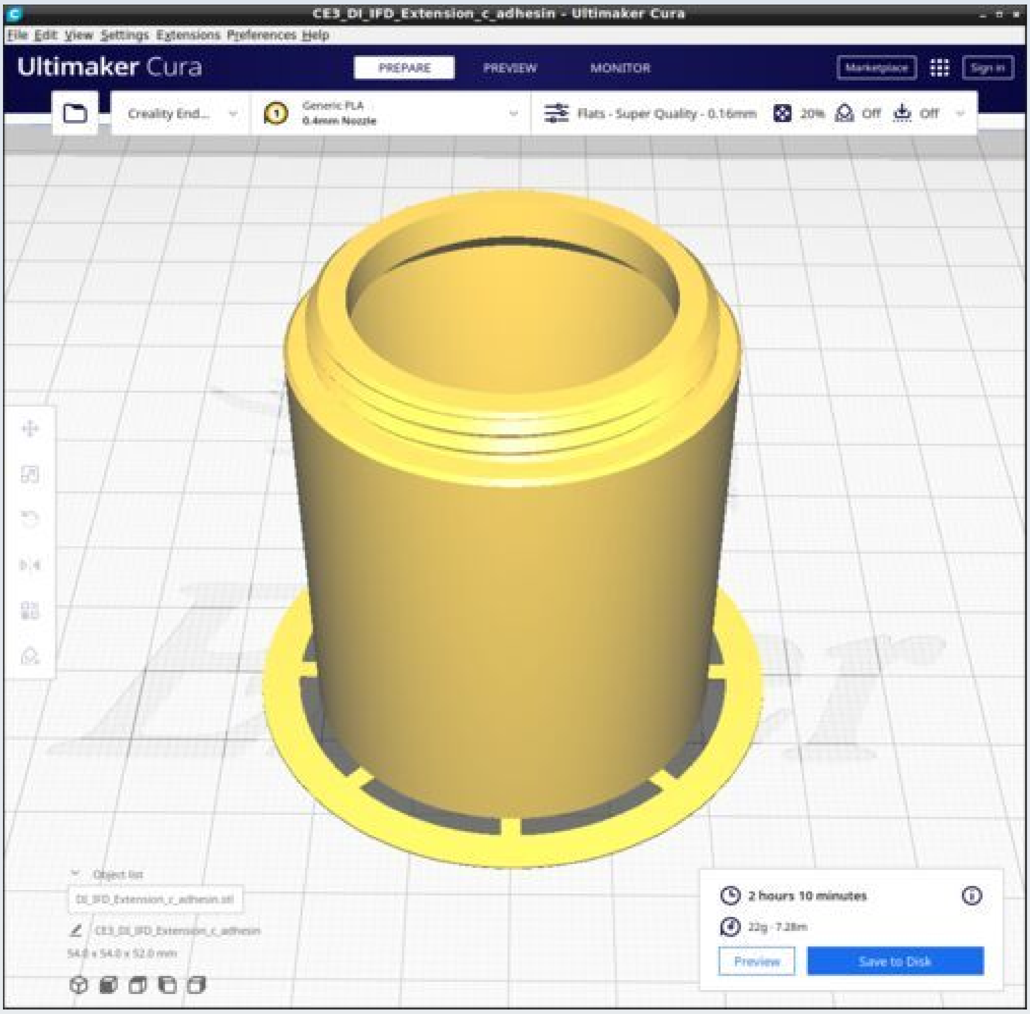
DI_IAD_Tray.stl



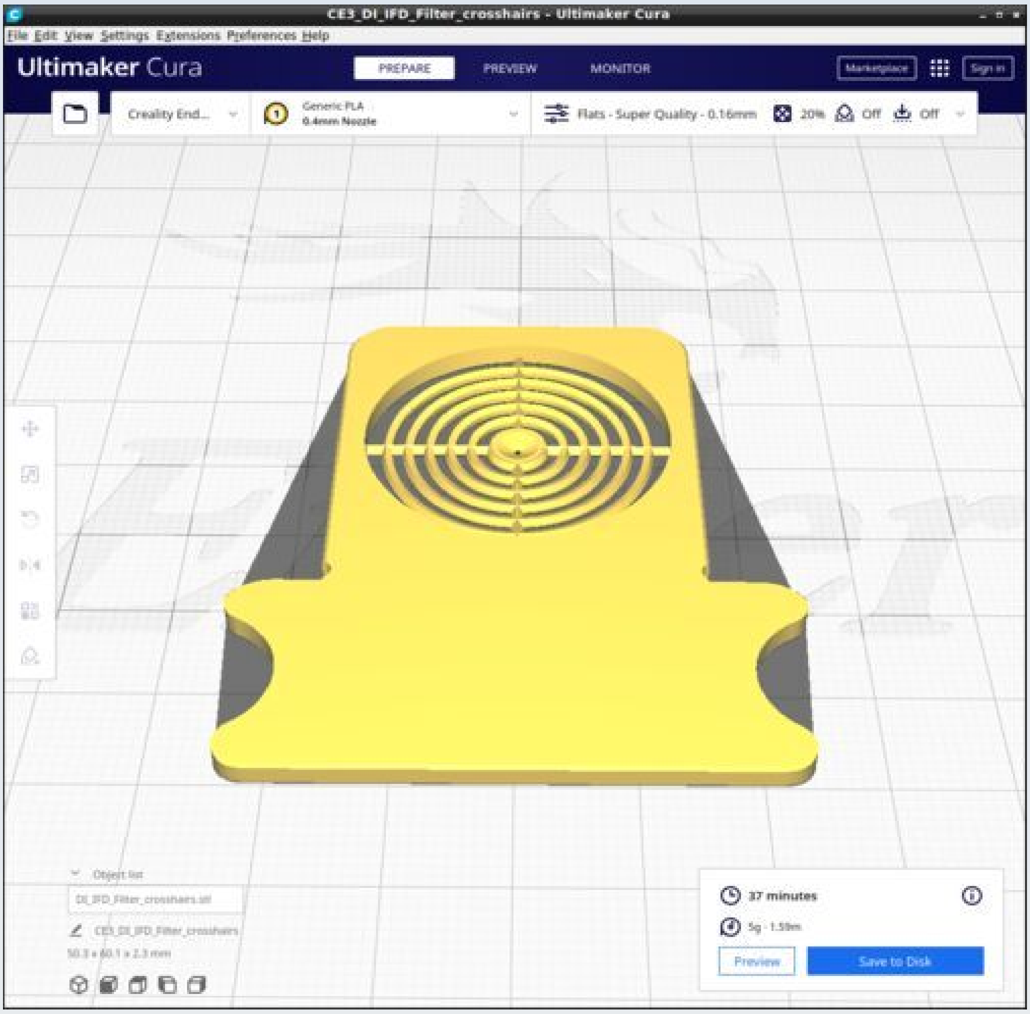
DI_IFD_Adapter.stl



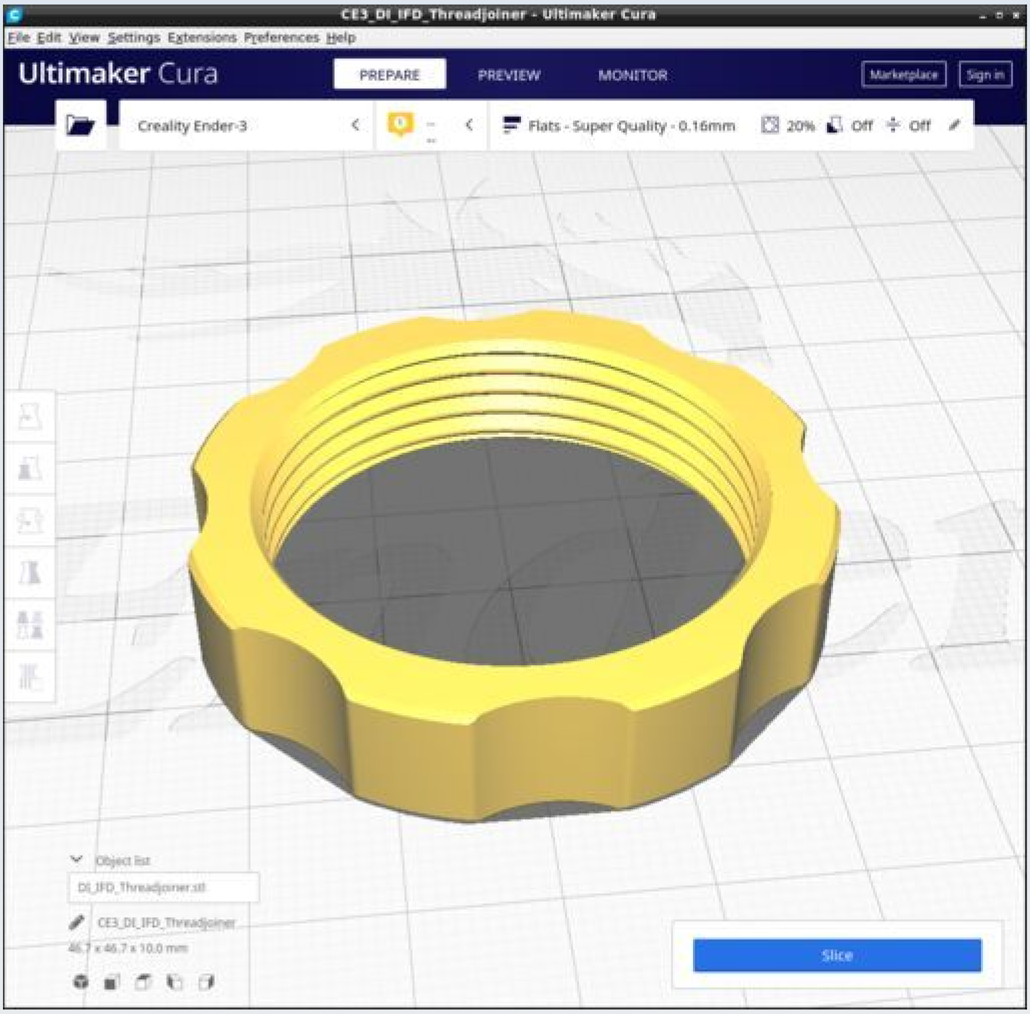
DI_IFD_Extension.stl



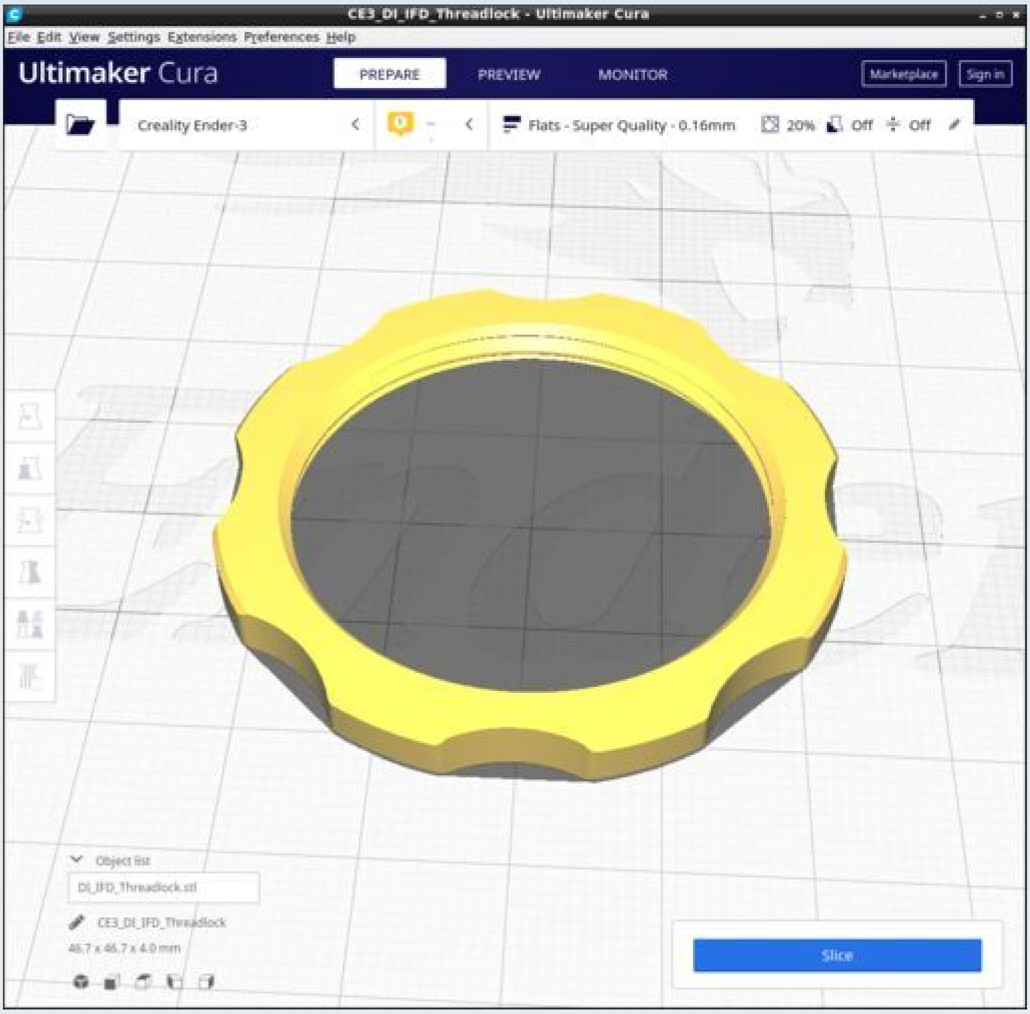
DI_IFD_Filter_crosshairs.stl



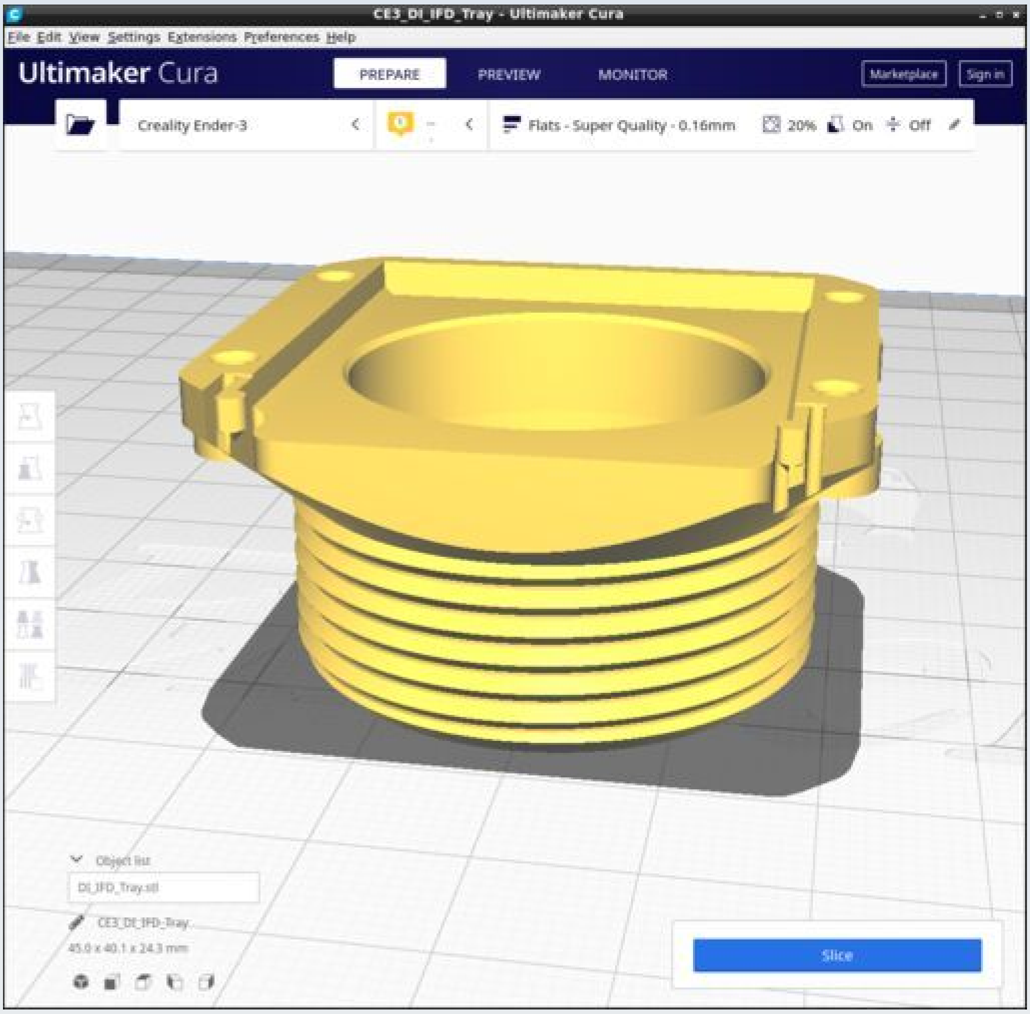
DI_IFD_Threadjoiner.stl



DI_IFD_Threadlock.stl

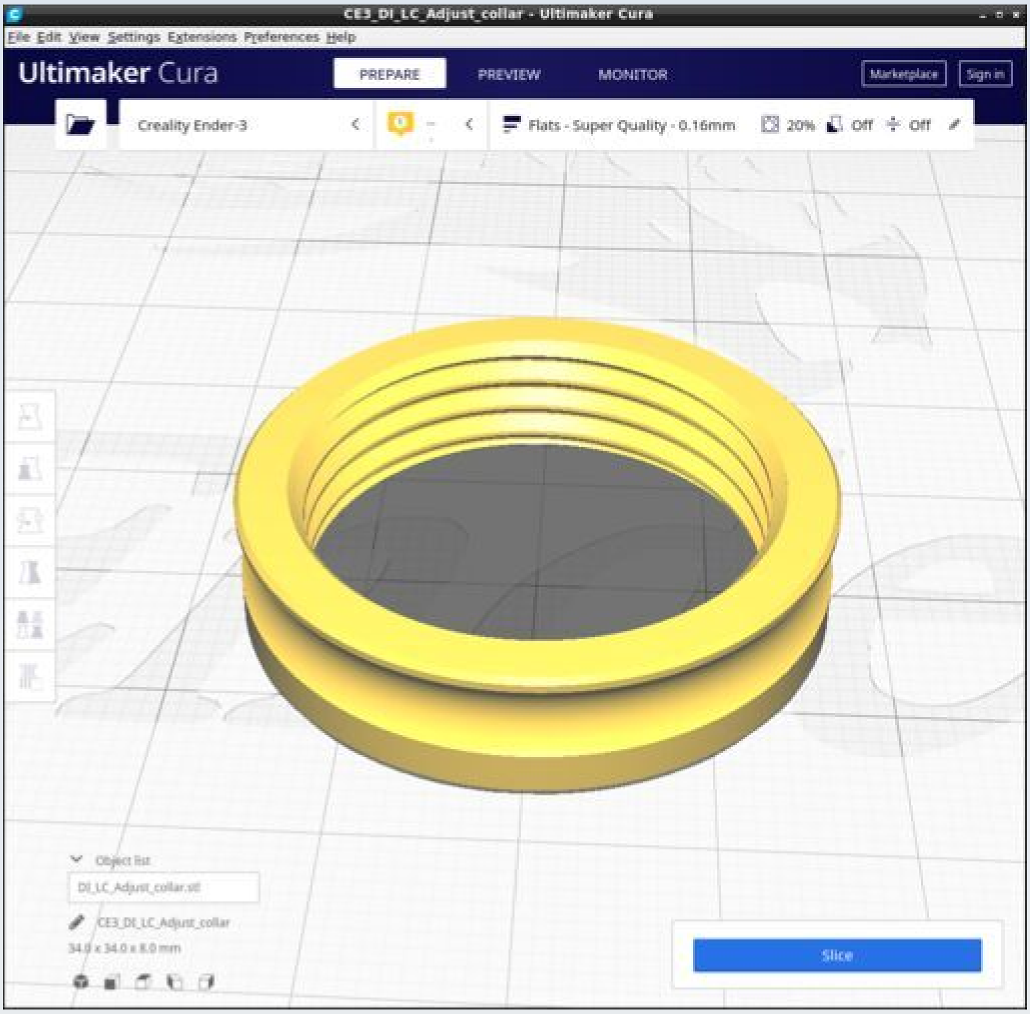


DI_IFD_Tray.stl

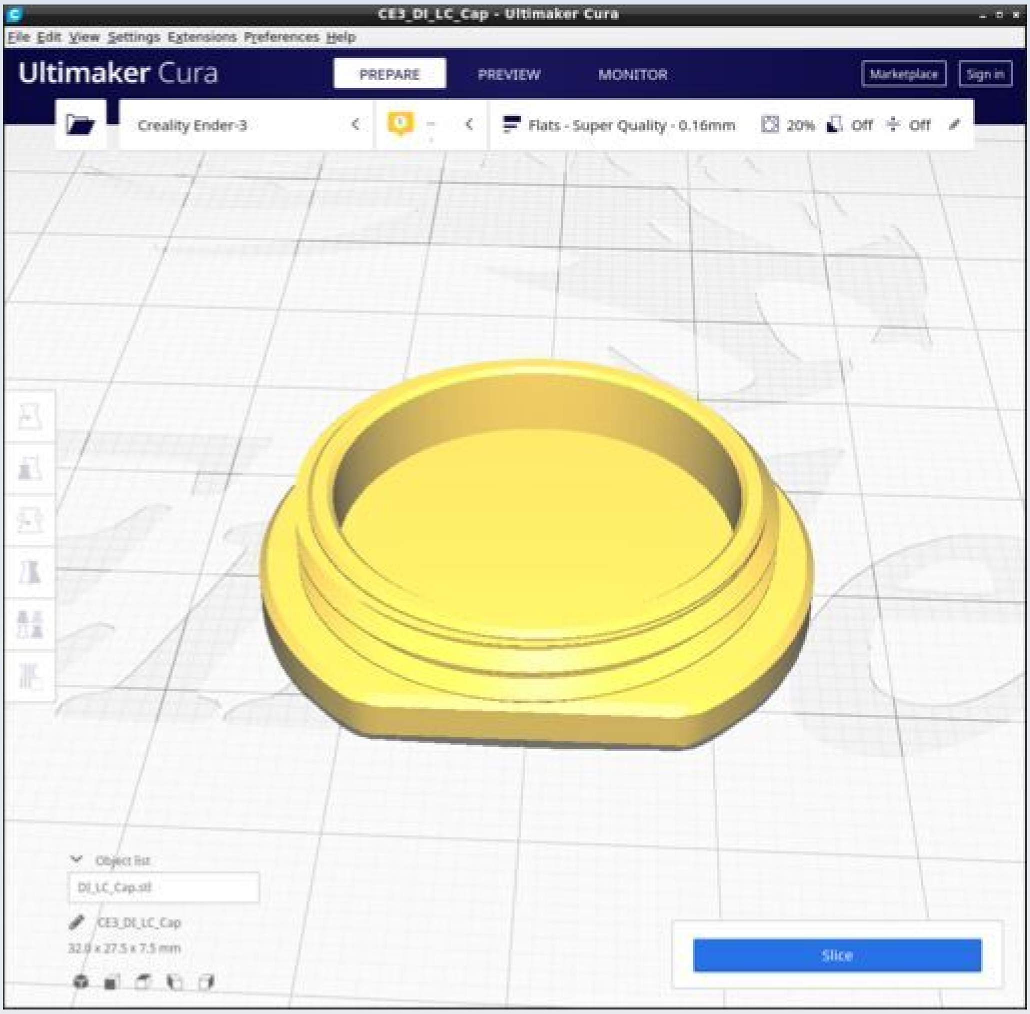


Supports on for 'touching build plate only'

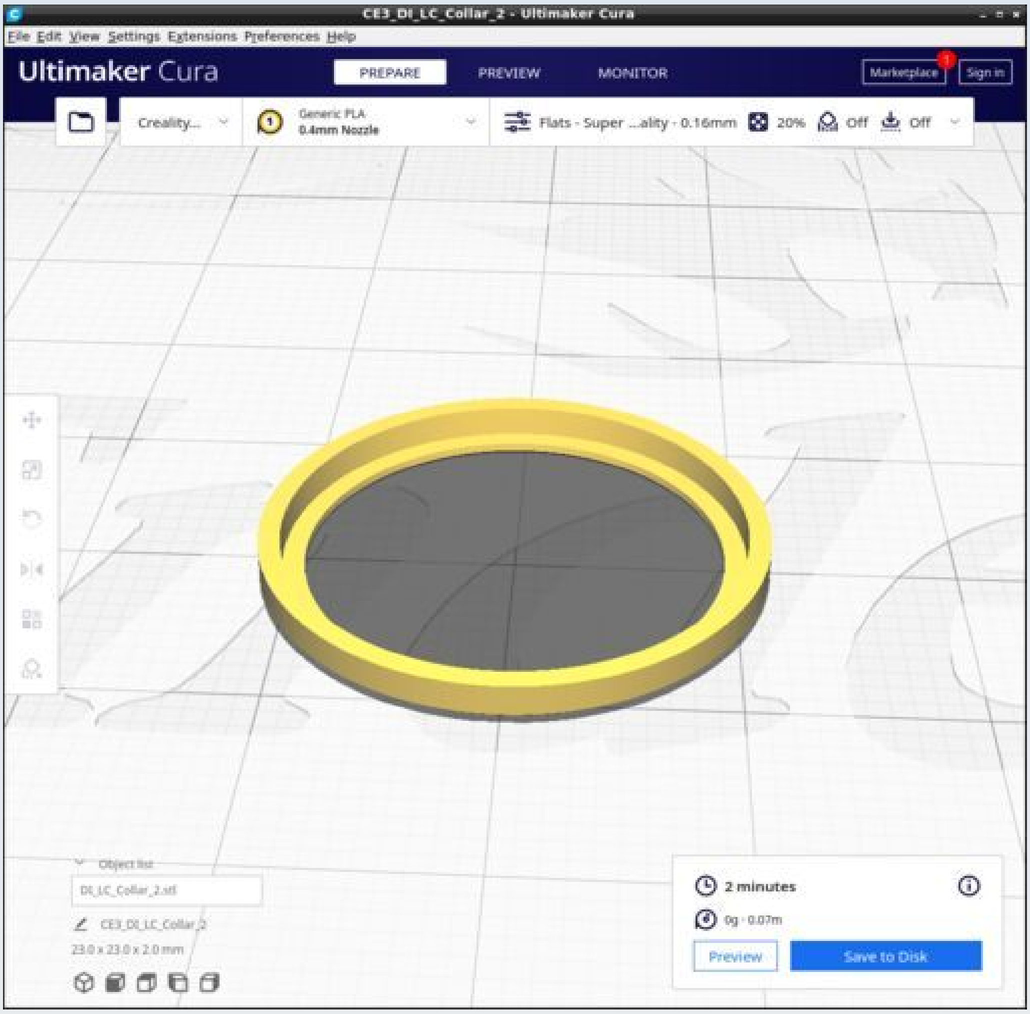
DI_LC_Adjust_collar.stl



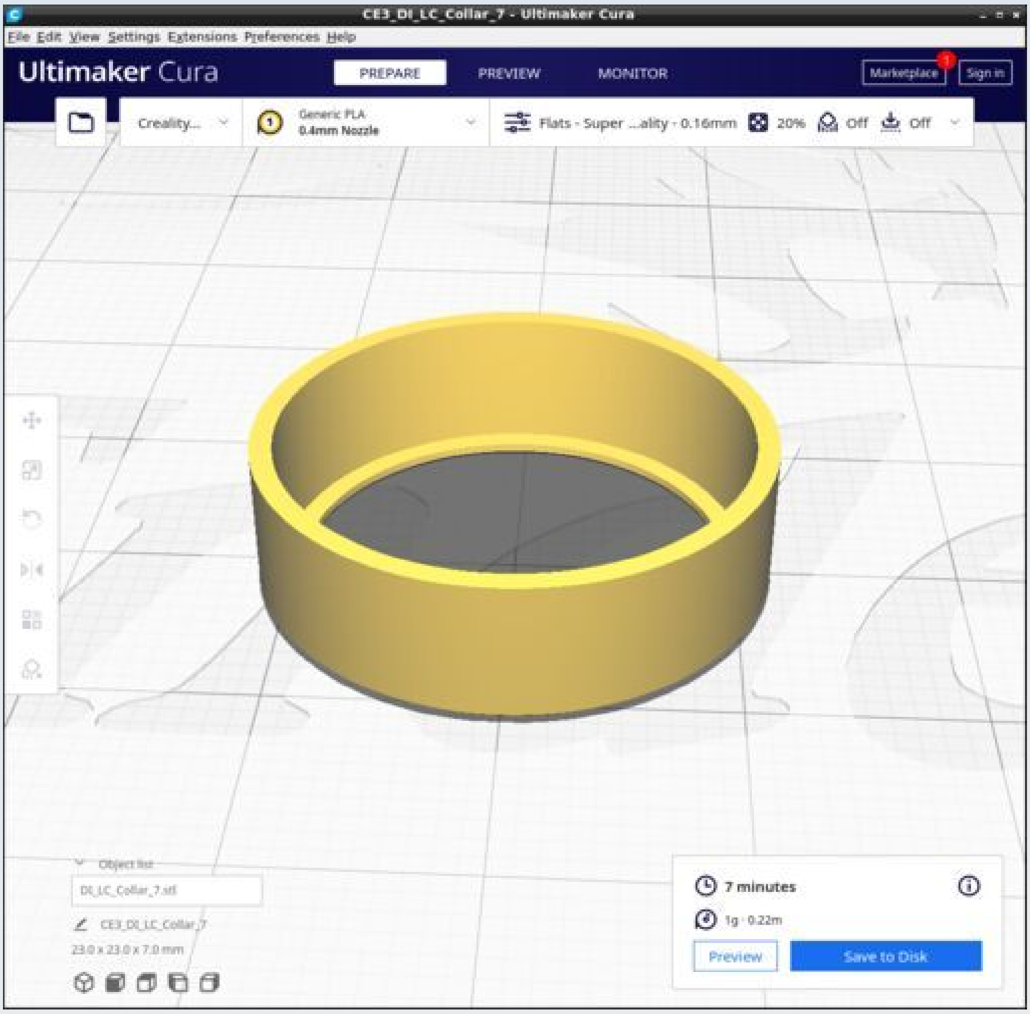
DI_LC_Cap.stl


CE3_DI_LC_Cap - Ultimaker Cura
File Edit View Settings Extensions Preferences Help
Ultimaker Cura
PREPARE
PREVIEW
MONITOR
Marketplace
Sign in
Creality Ender-3
Flats - Super Quality - 0.16mm
20%
Off
Off
Object list
DI_LC_Cap.stl
CE3_DI_LC_Cap
32.0 x 27.5 x 7.5 mm
Slice

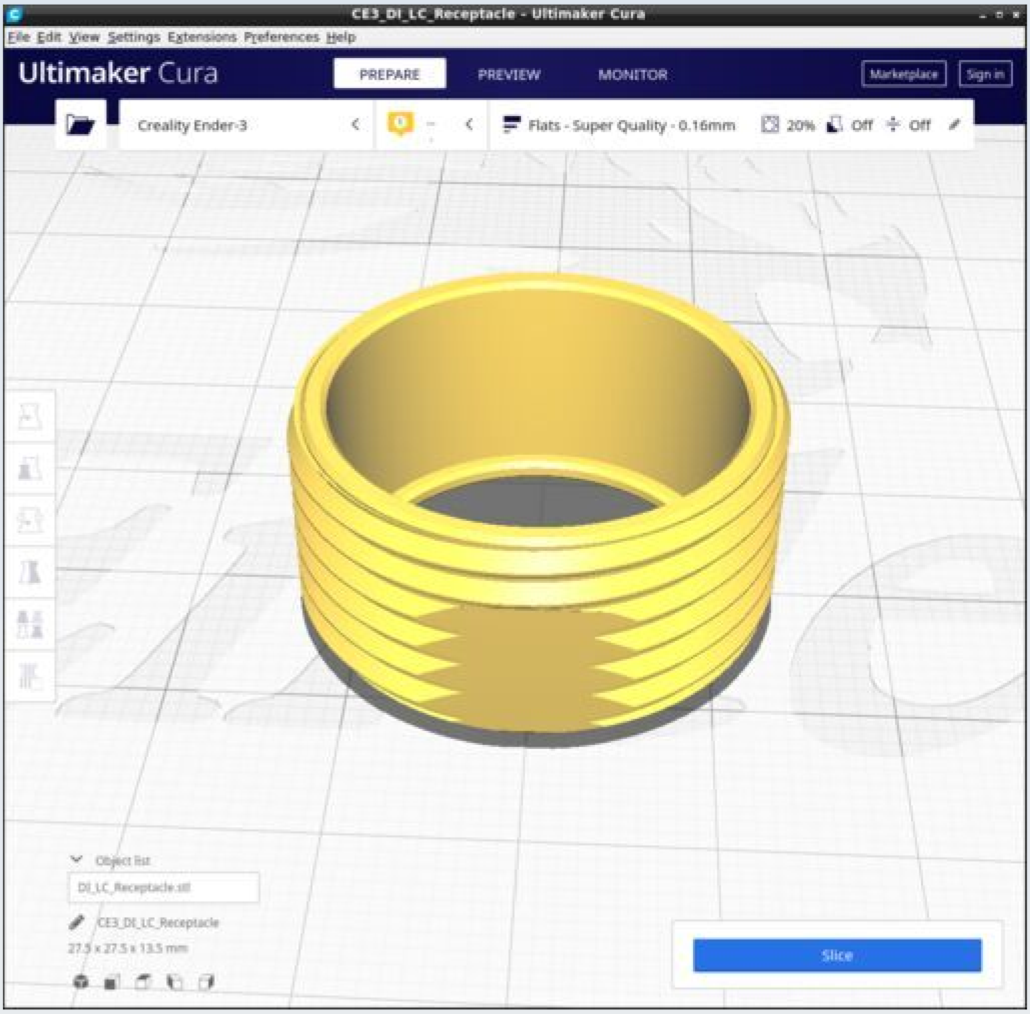
DI_LC_Collar_2.stl



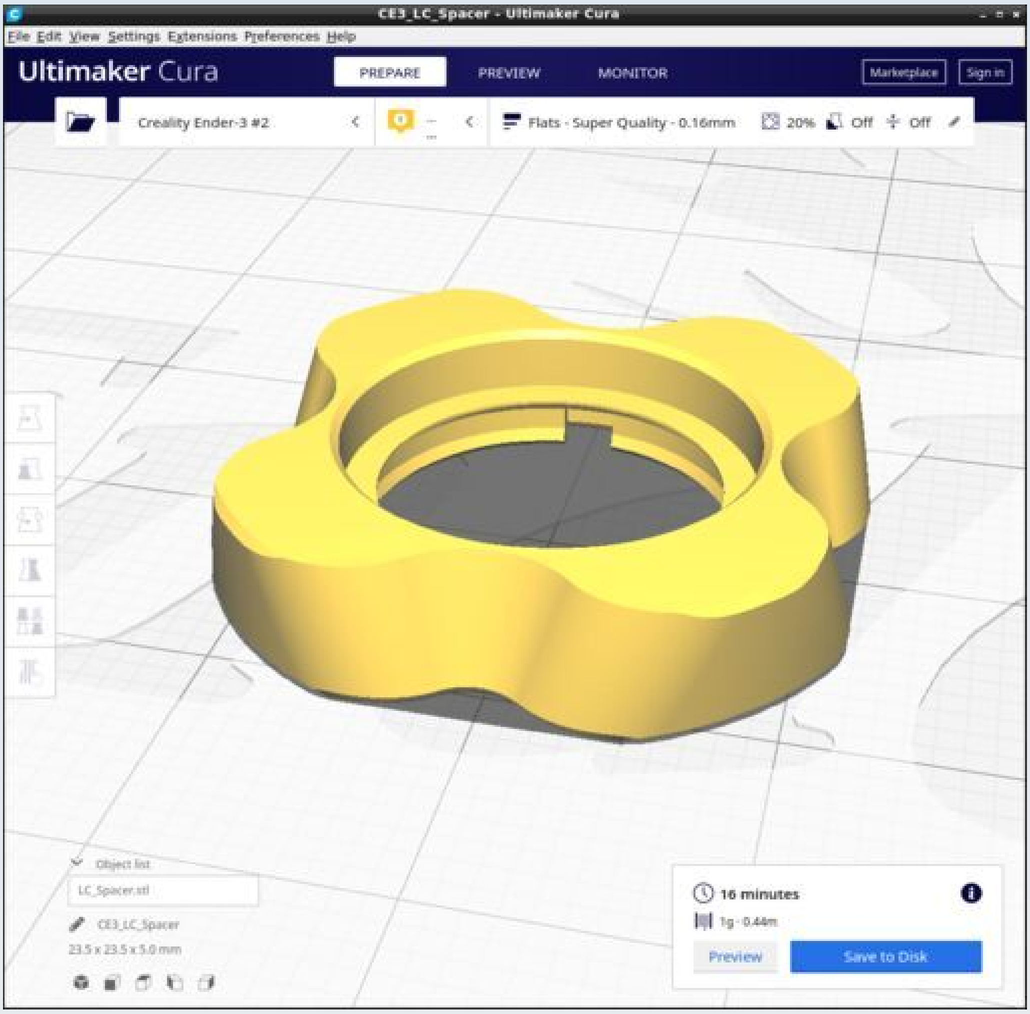
DI_LC_Collar_7.stl



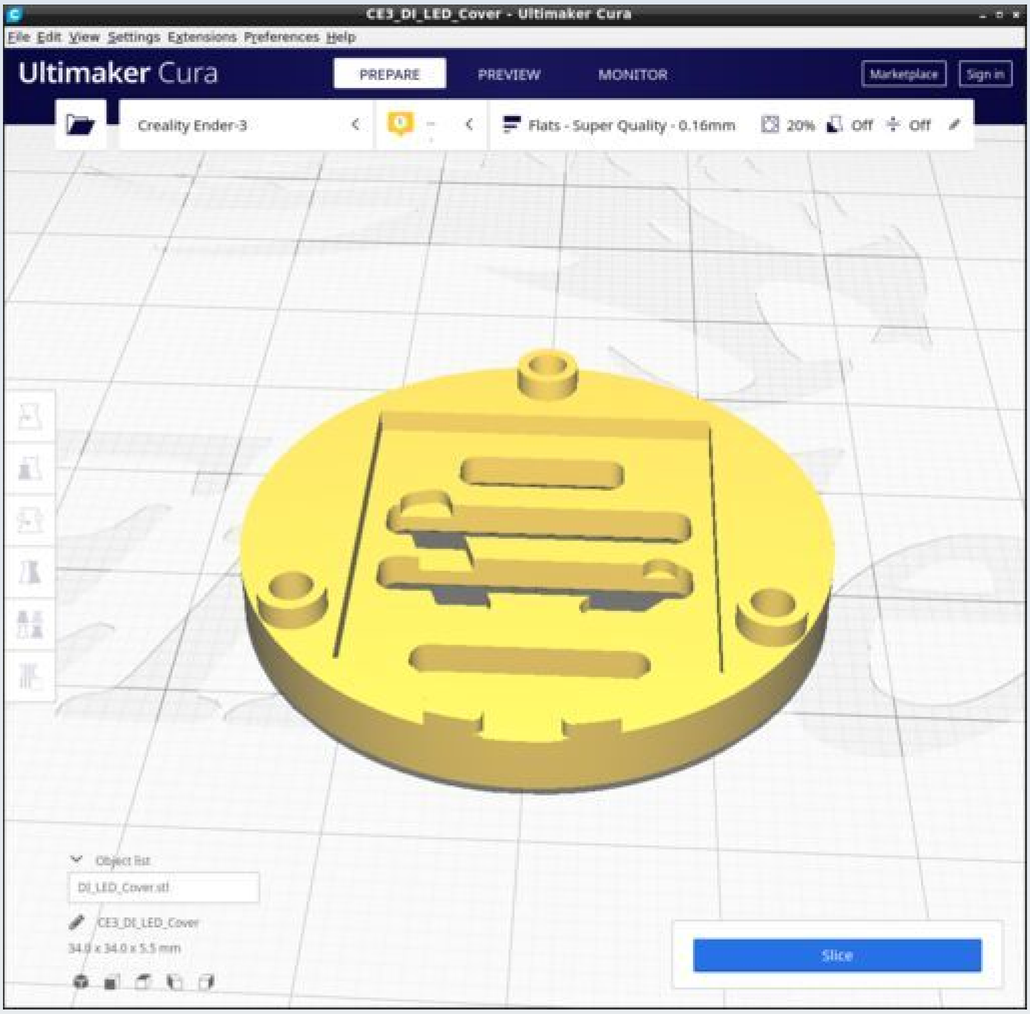
DI_LC_Receptacle.stl



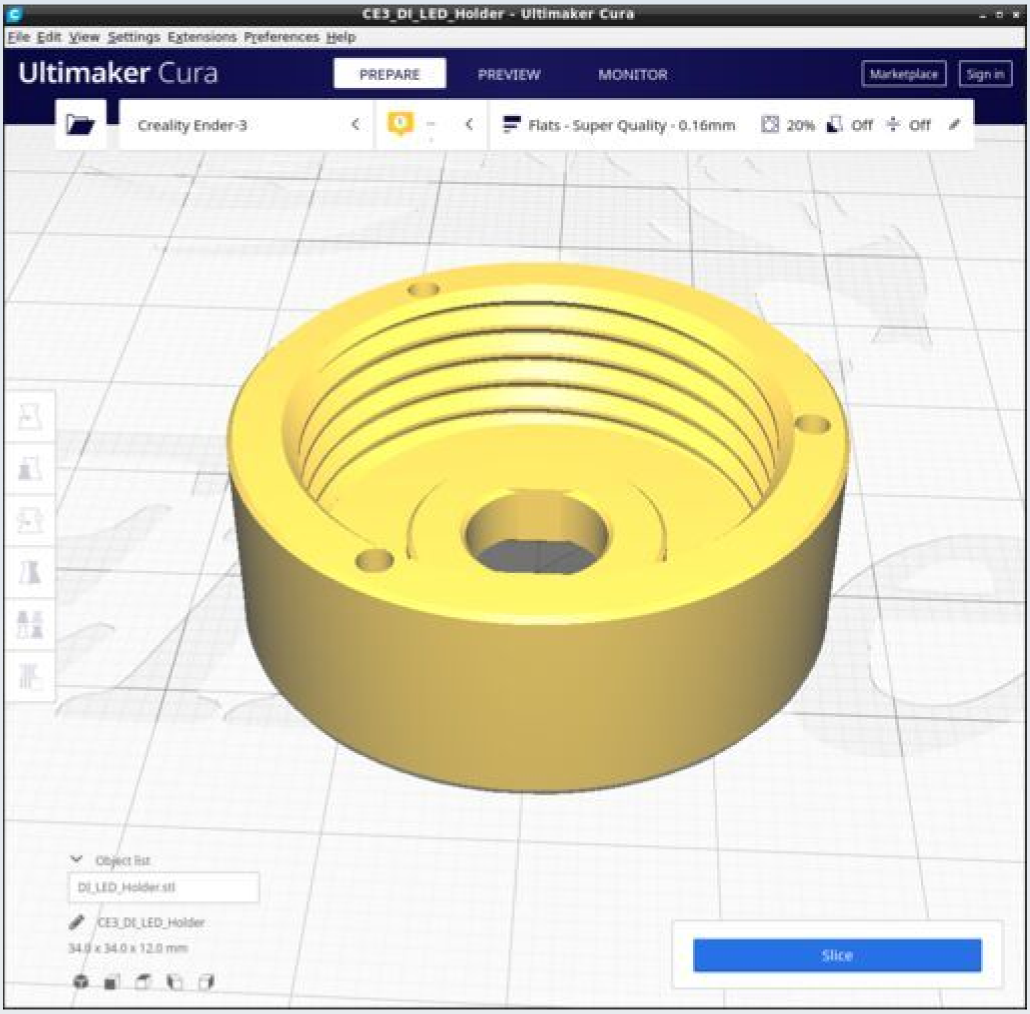
DI_LC_Spacer.stl



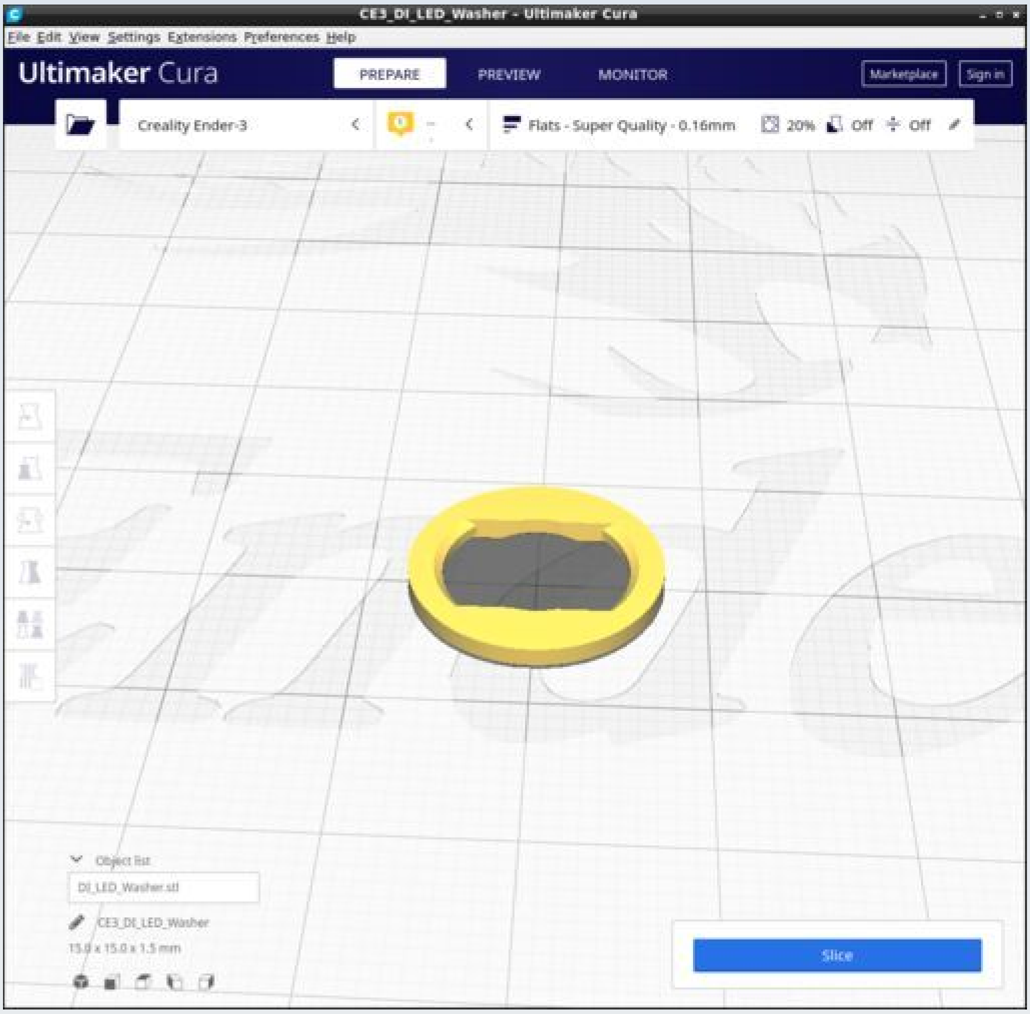
DI_LED_Cover.stl



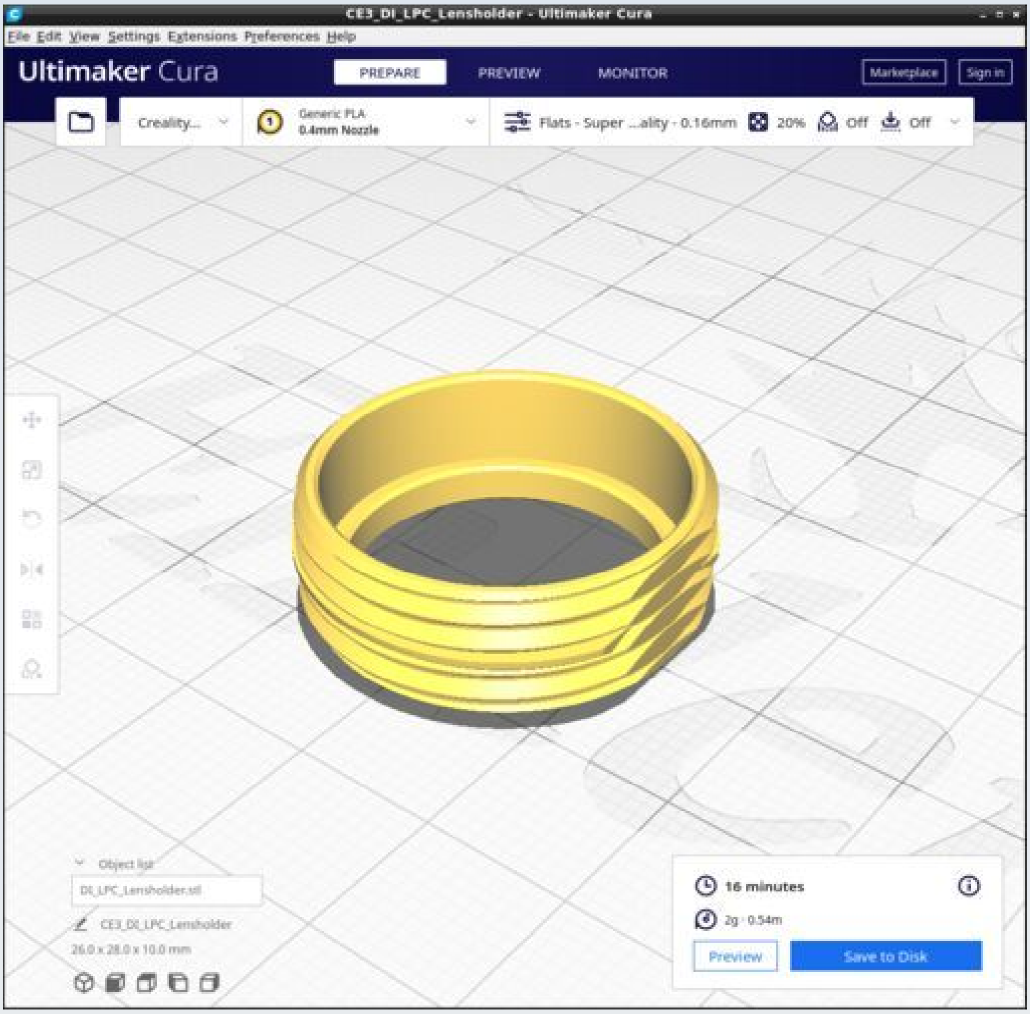
DI_LED_Holder.stl



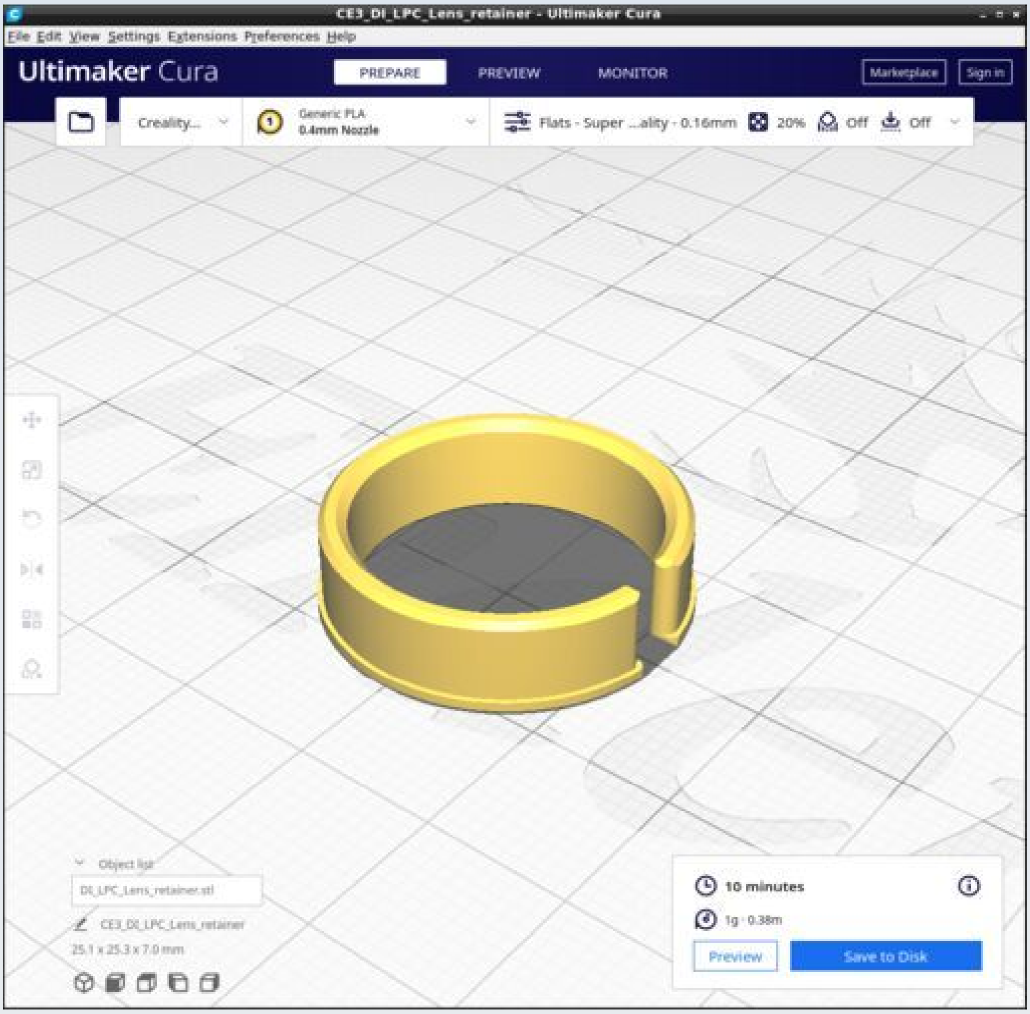
DI_LED_Washer.stl



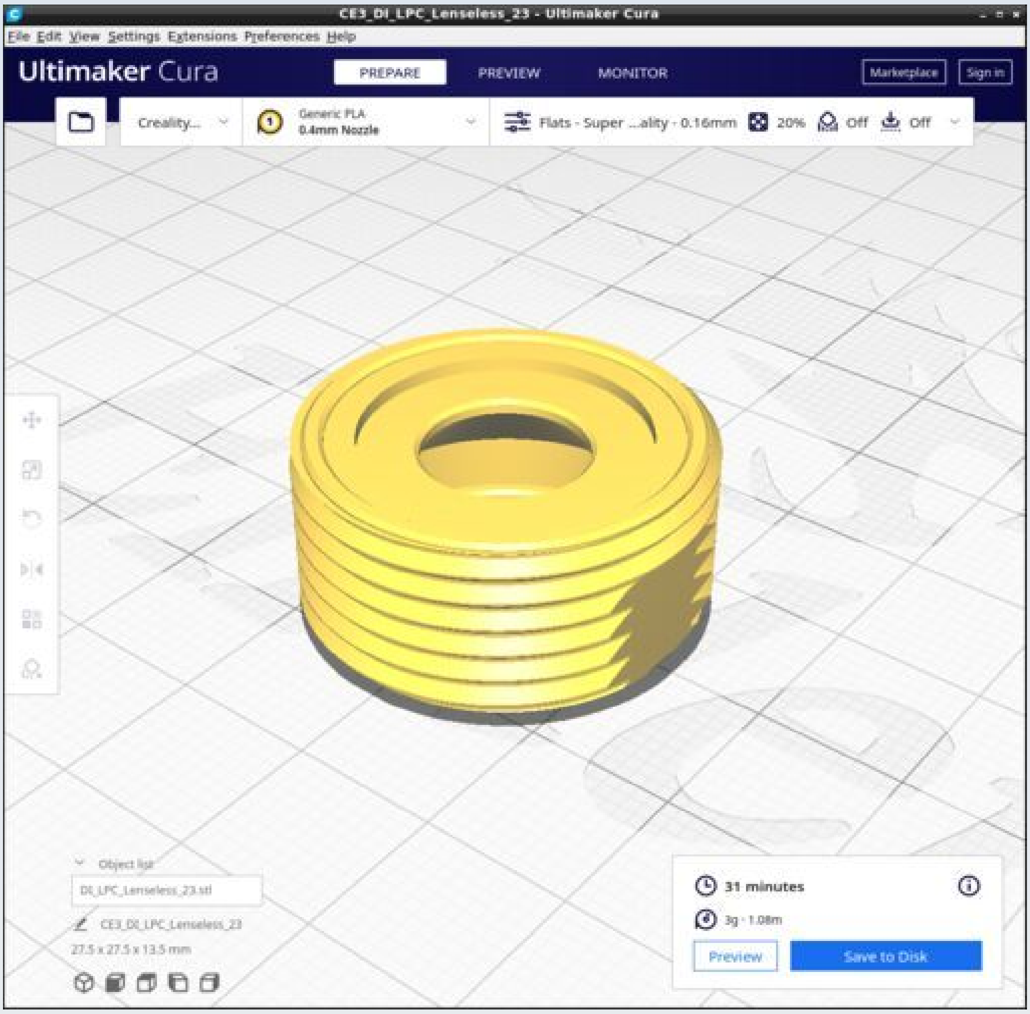
DI_LPC_Lensholder.stl



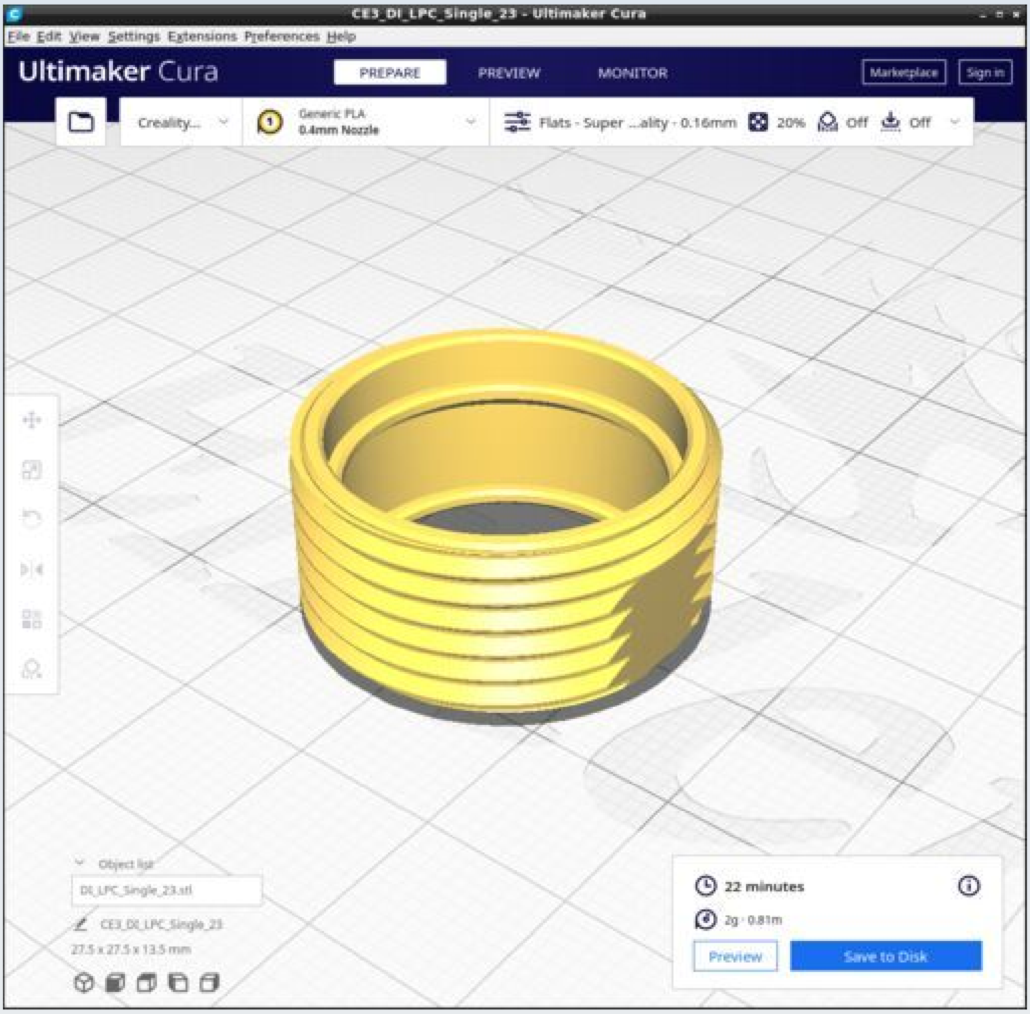
DI_LPC_Lens_retainer.stl



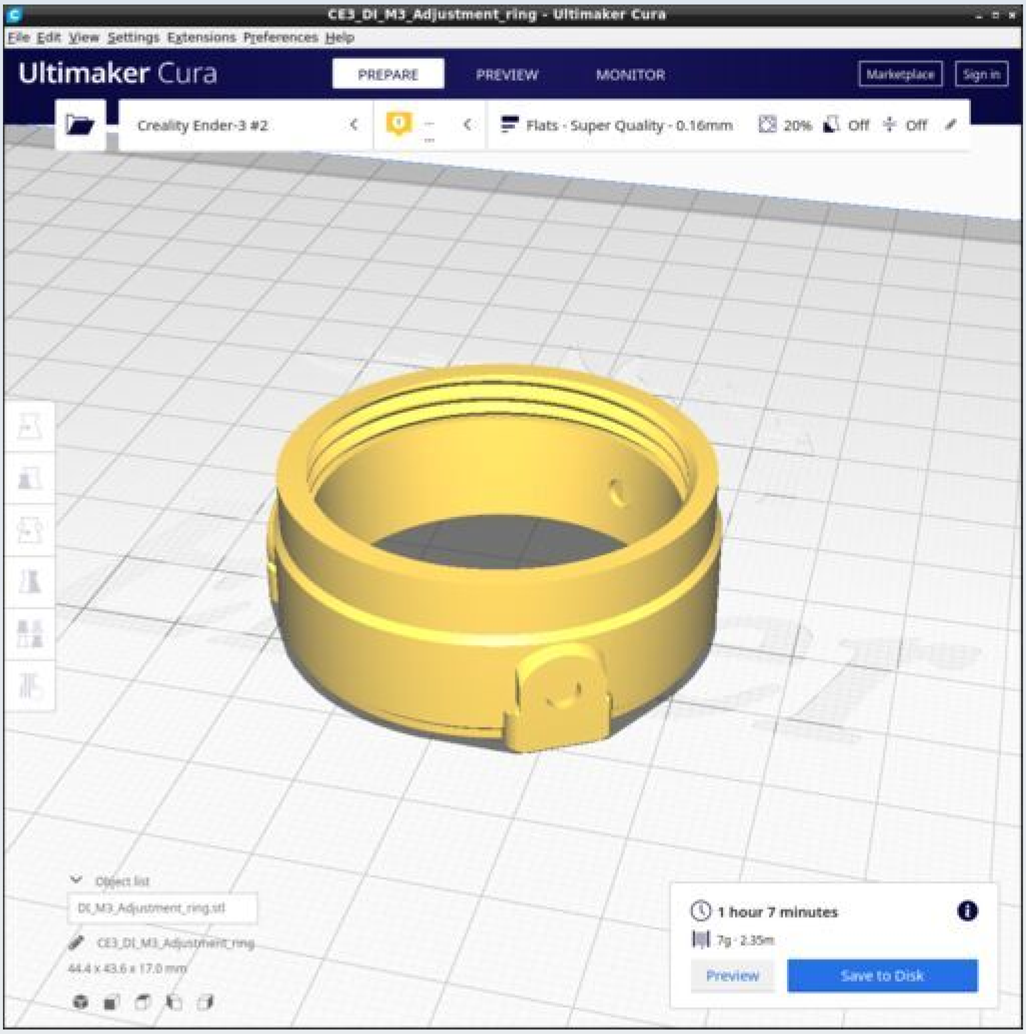
DI_LPC_Lensless_23.stl



DI_LPC_Single_23.stl

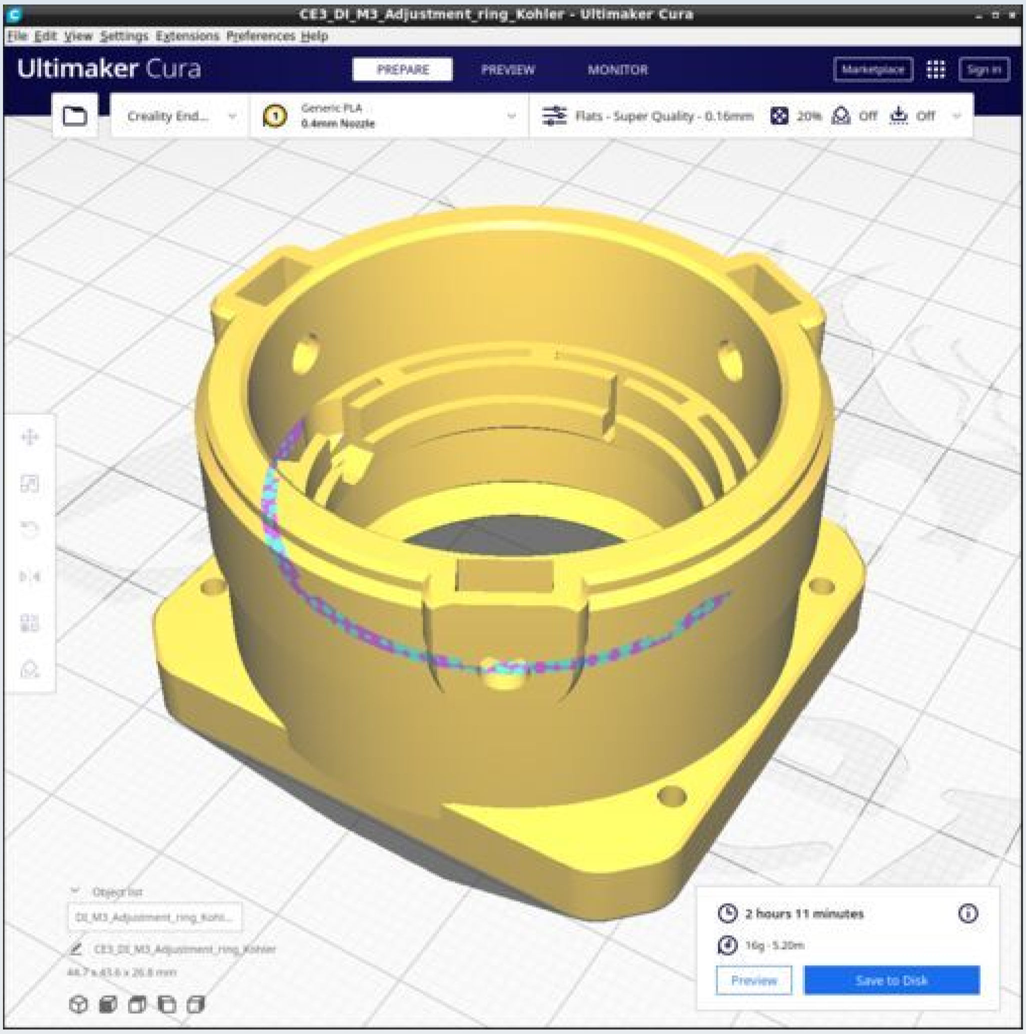


DI_M3_Adjustment_ring.stl



Ensure all supports are OFF

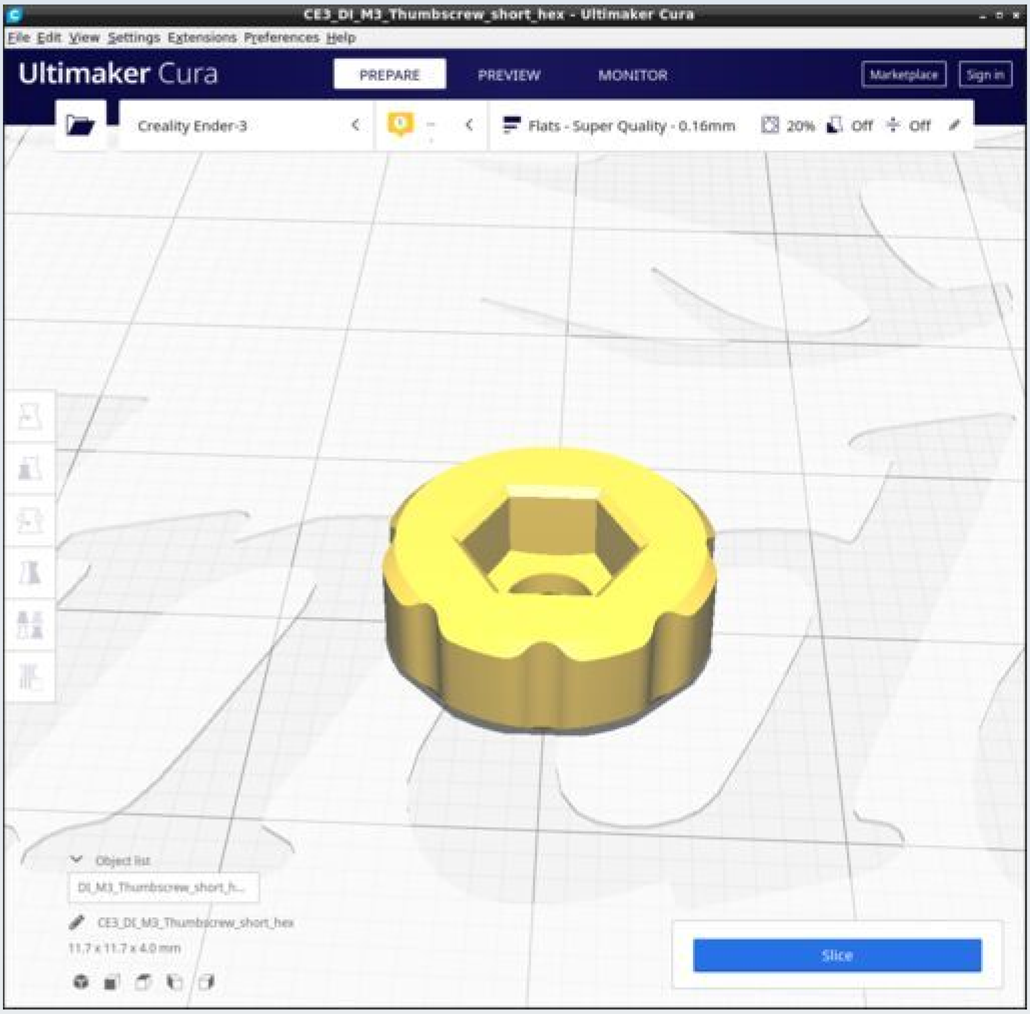
DI_M3_Adjustment_ring_Kohler.stl



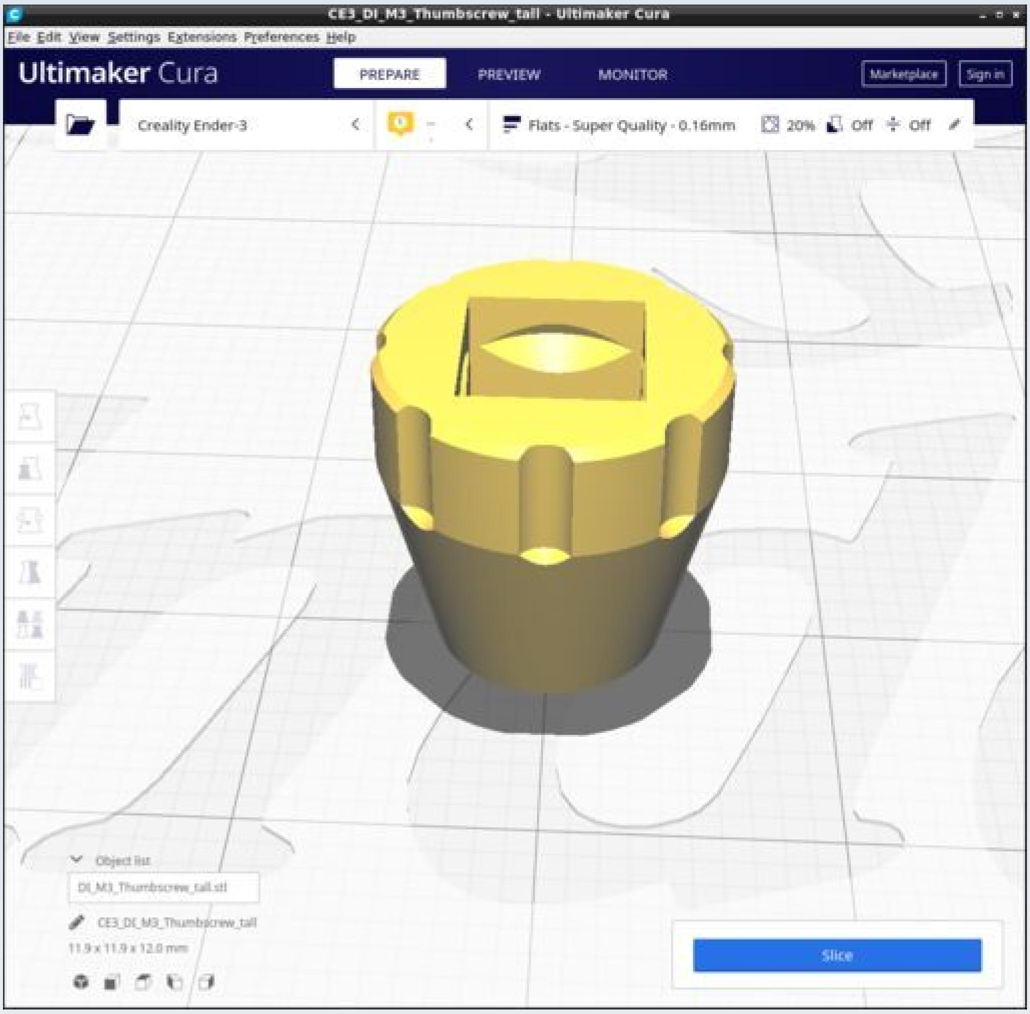
Ensure all supports are OFF.

Ignore the ‘model error’ / ‘mesh error’ warnings.

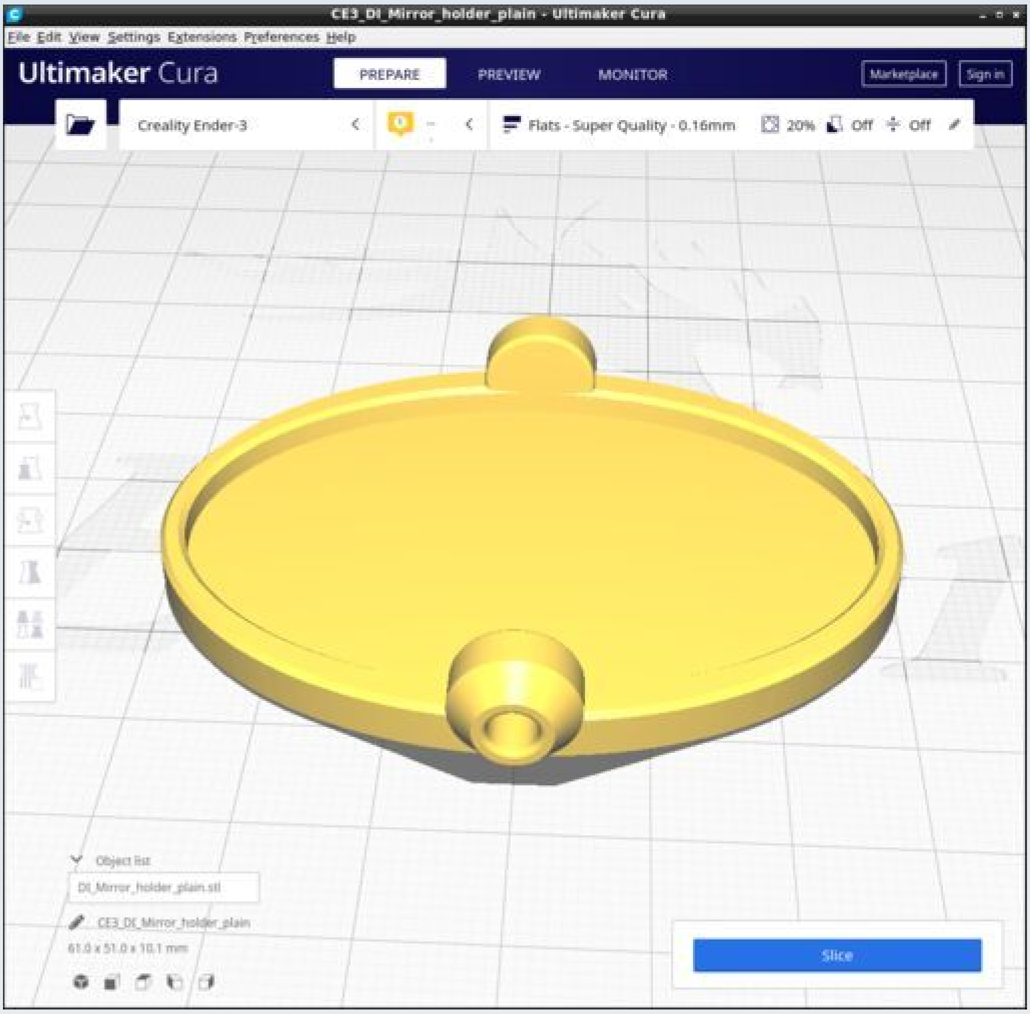
DI_M3_Thumbscrew_short_hex.stl



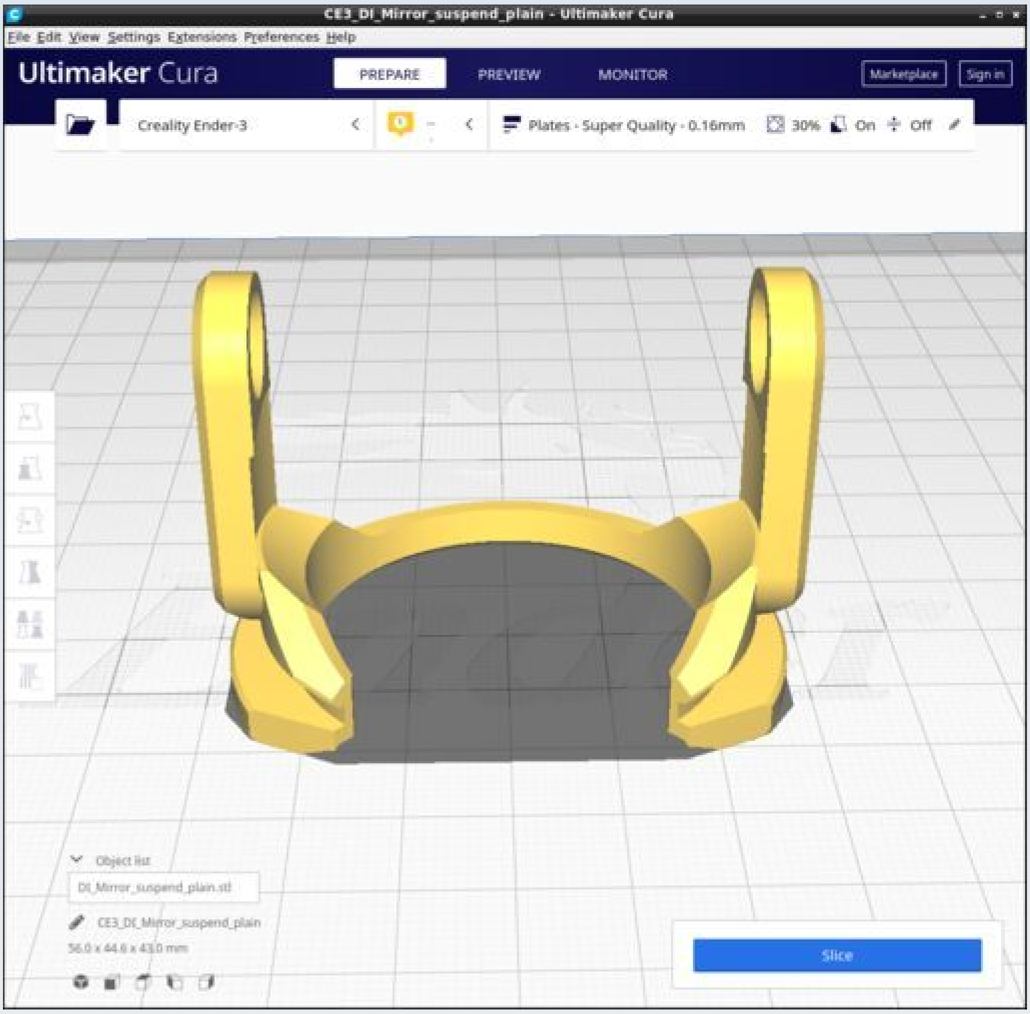
DI_M3_Thumbscrew_tall.stl



DI_Mirror_holder_plain.stl

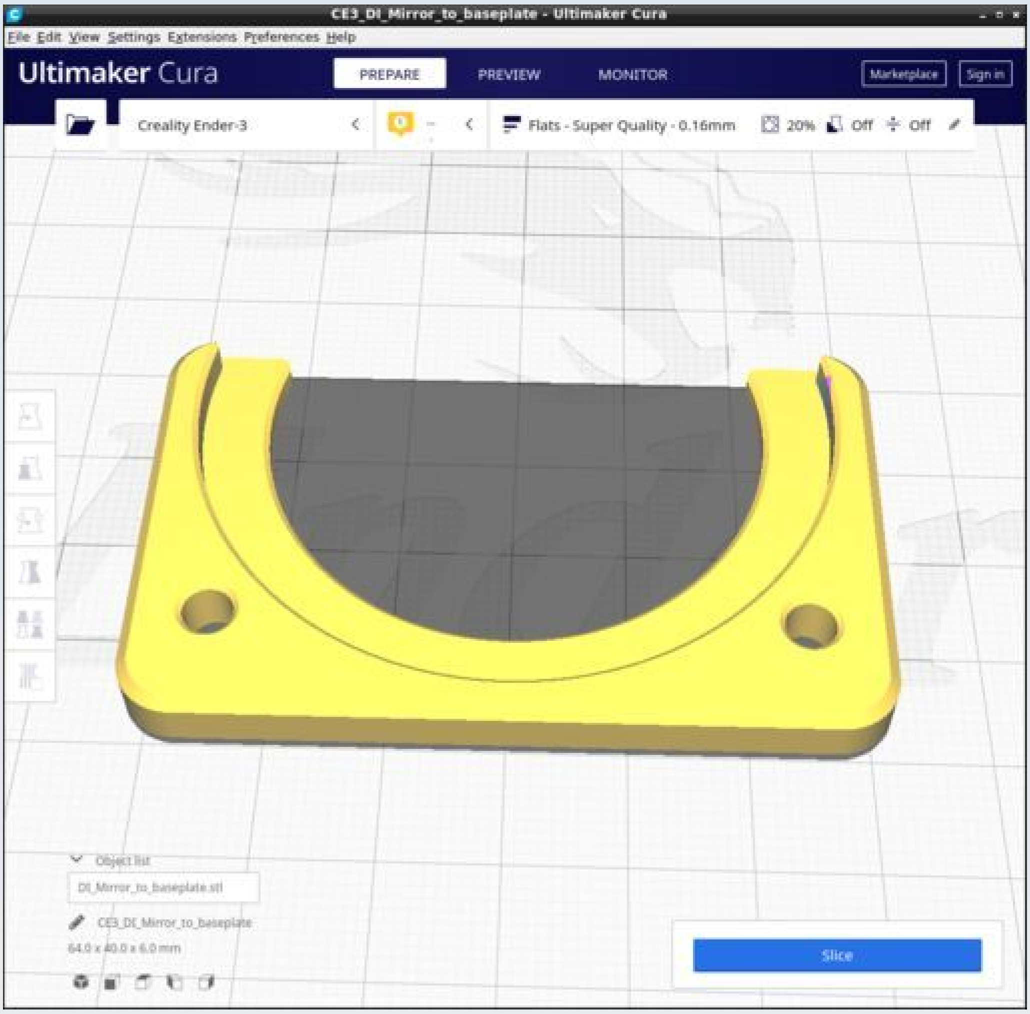


DI_Mirror_suspend_plain.stl

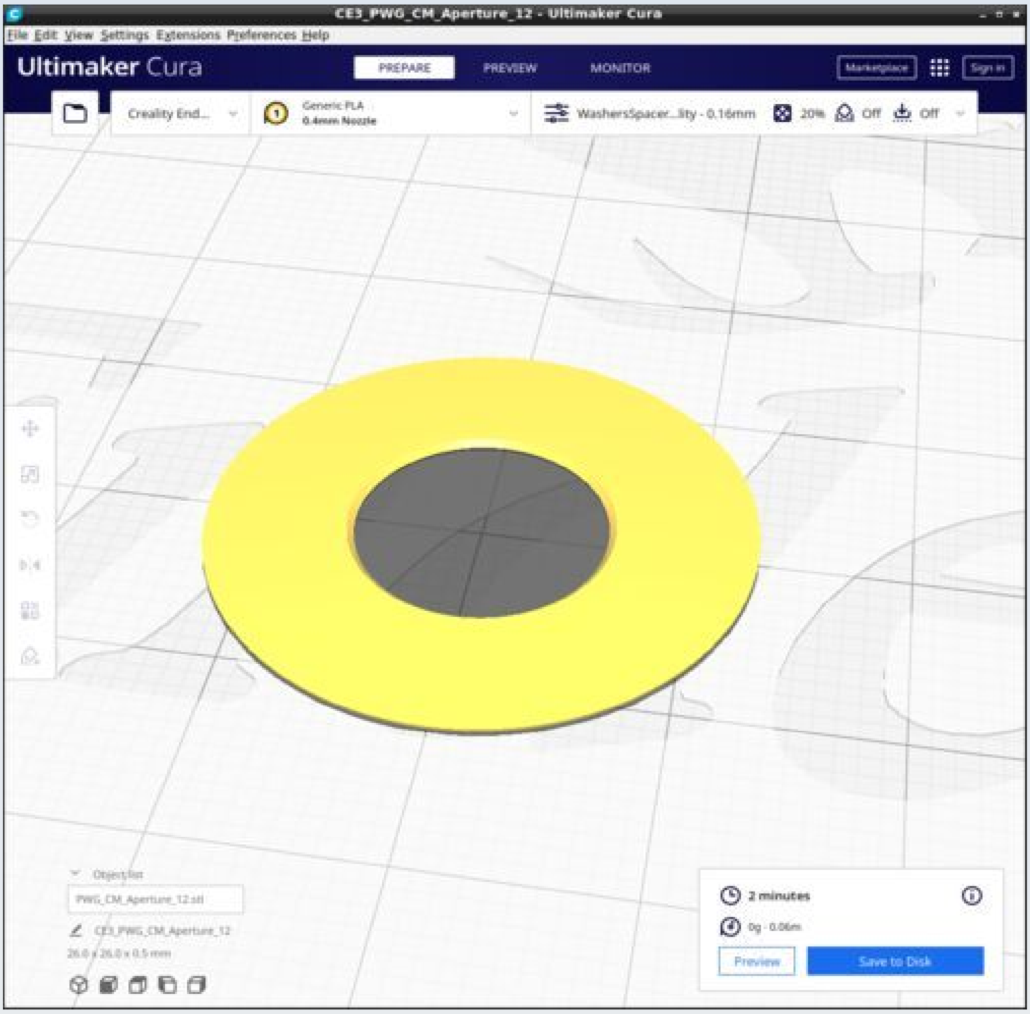


Use the ‘Plates’ custom Cura profile and enable supports 'touching baseplate only'.

DI_Mirror_to_baseplate.stl

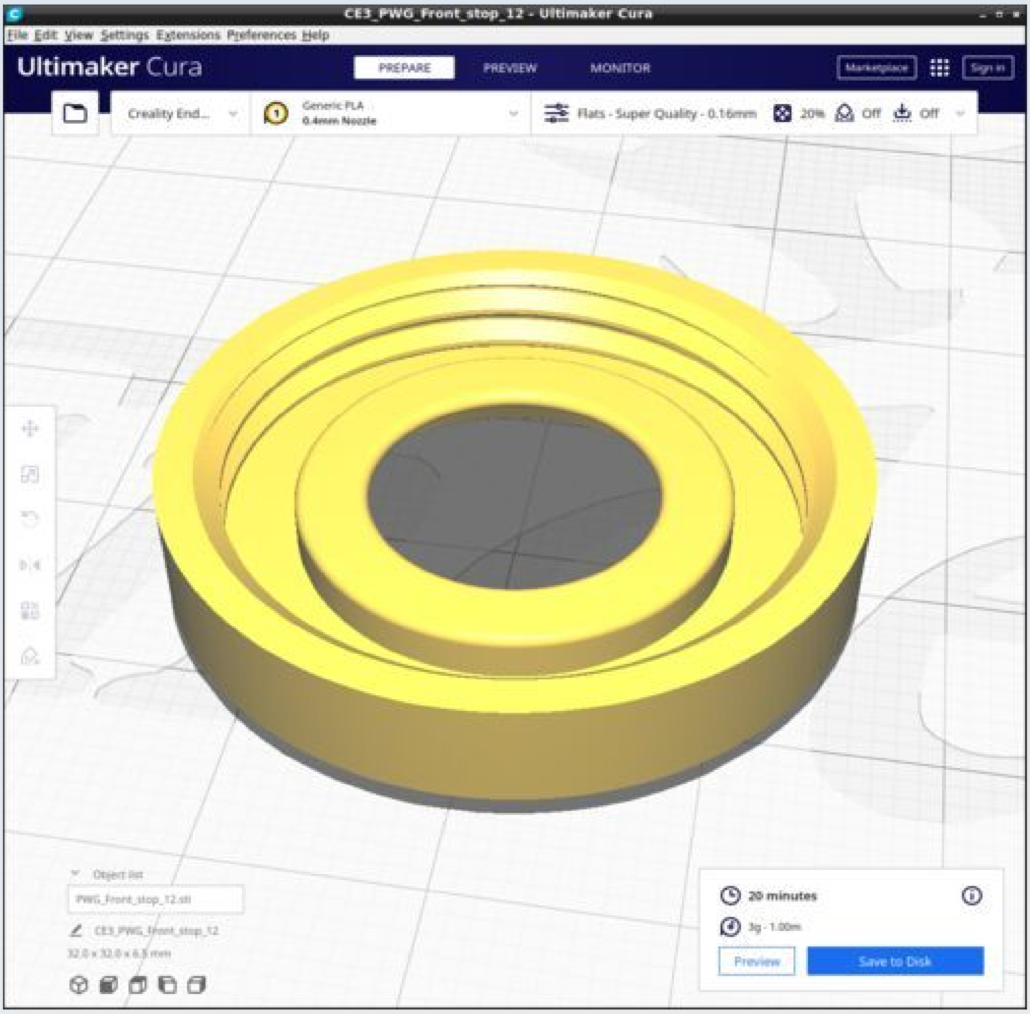


DI_PWG_CM_Aperture_12.stl

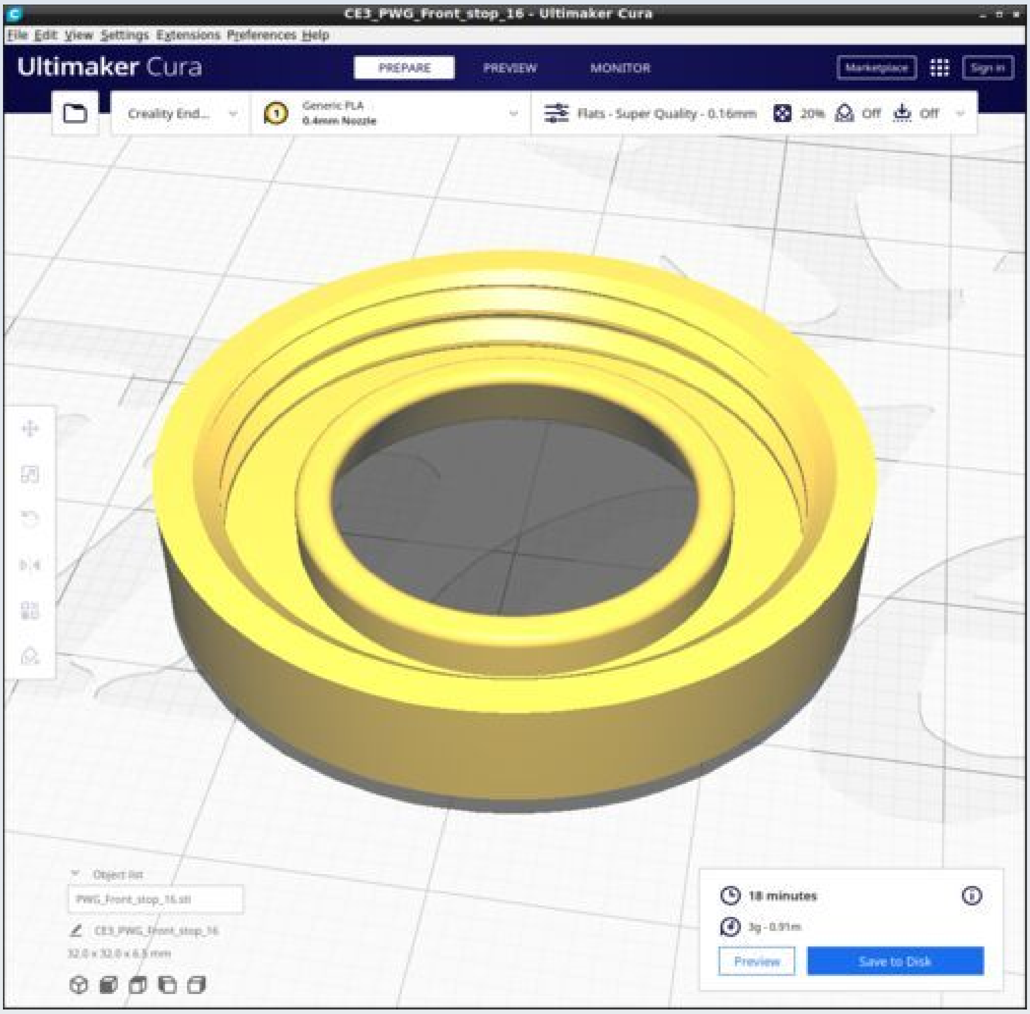


Use ‘WasherSpacer’ Cura profile.

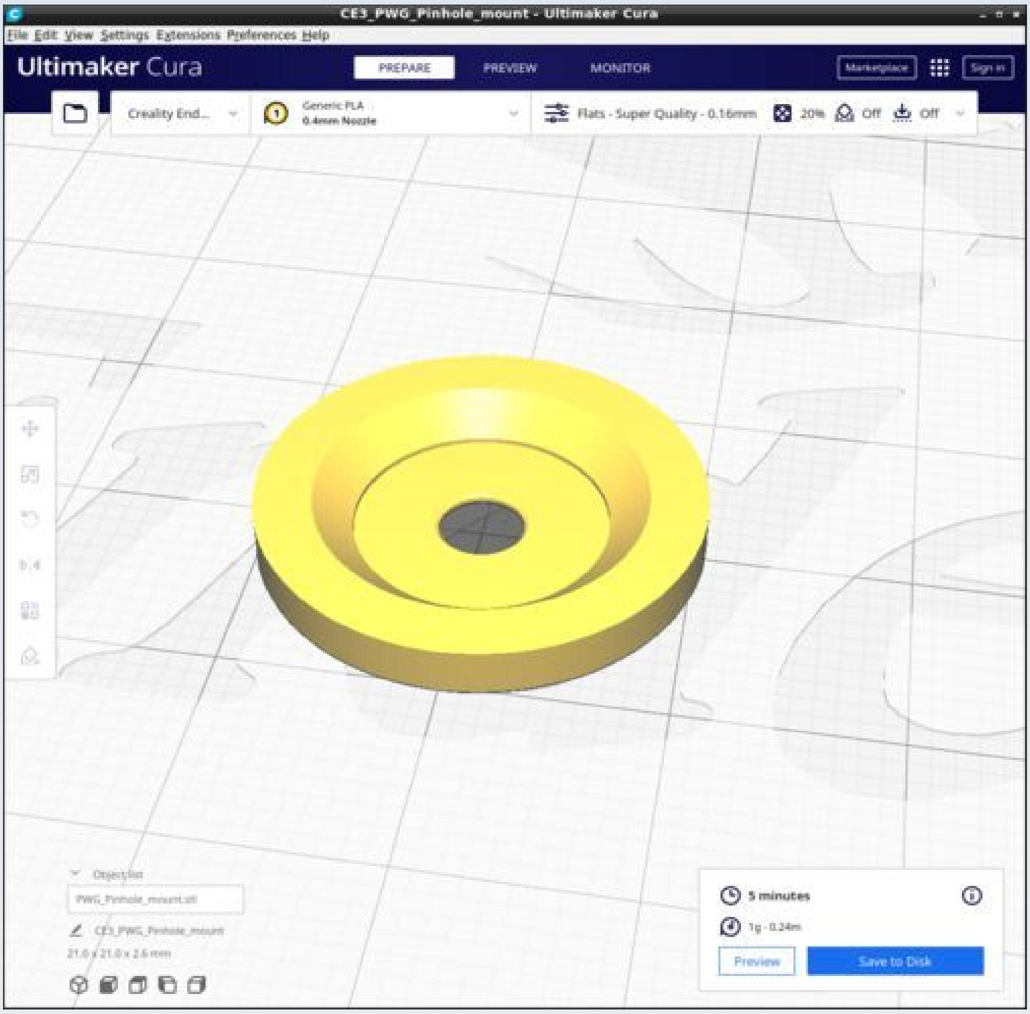
DI_PWG_Front_stop_12.stl



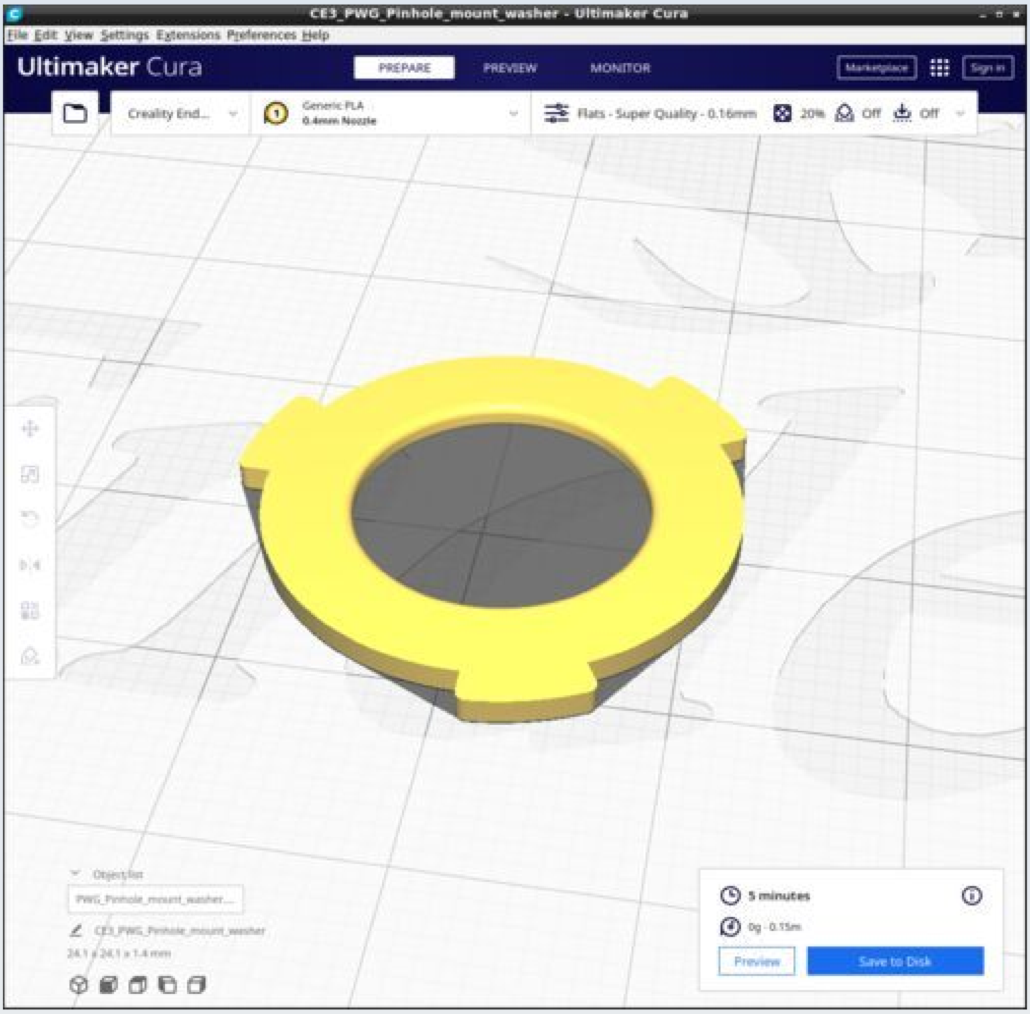
DI_PWG_Front_stop_16.stl



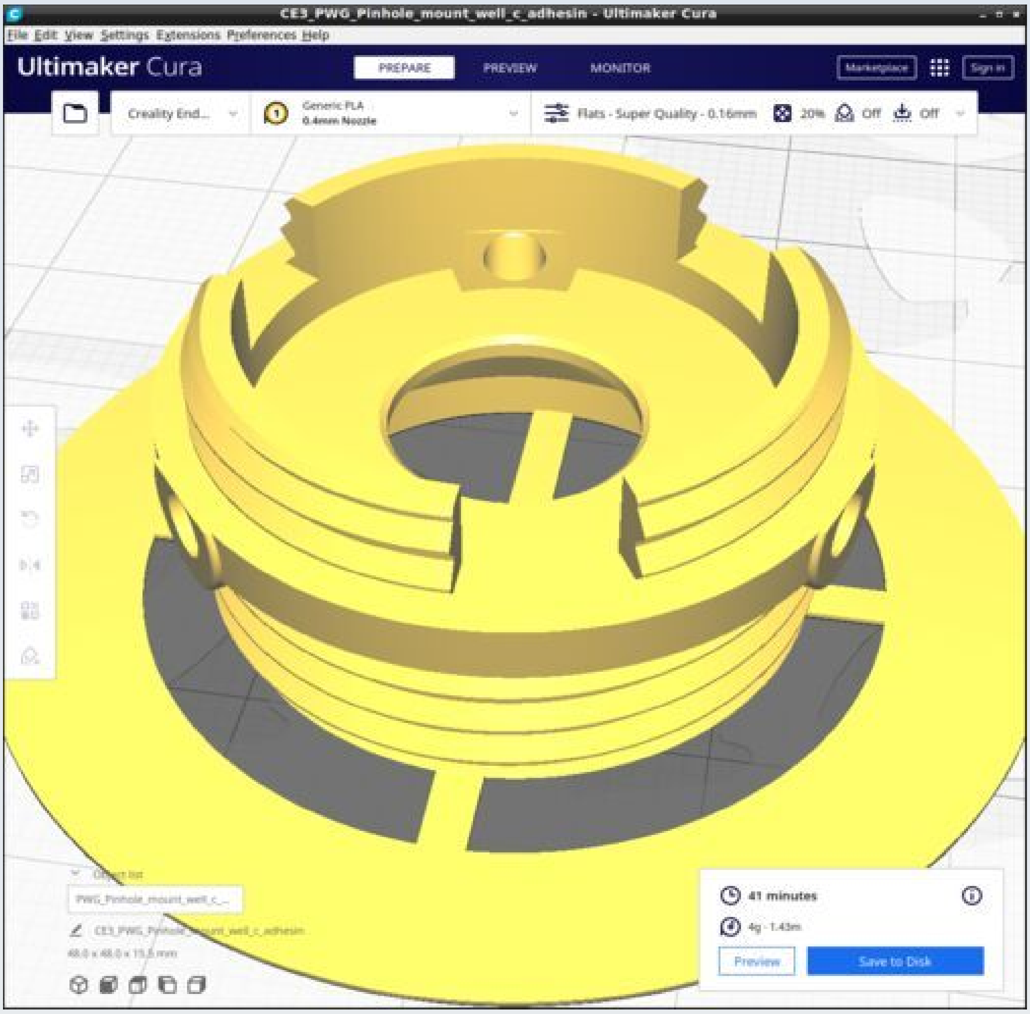
DI_PWG_Pinhole_mount.stl



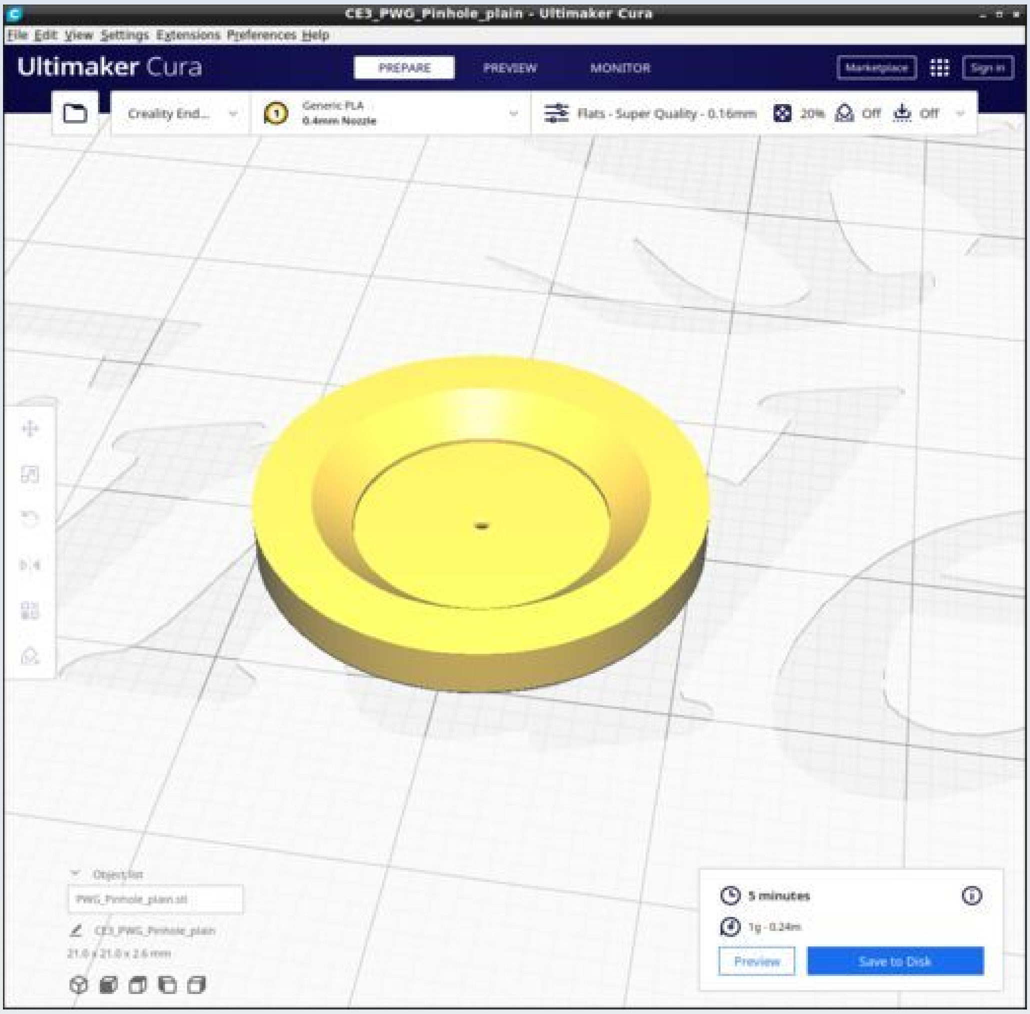
DI_PWG_Pinhole_mount_washer.stl



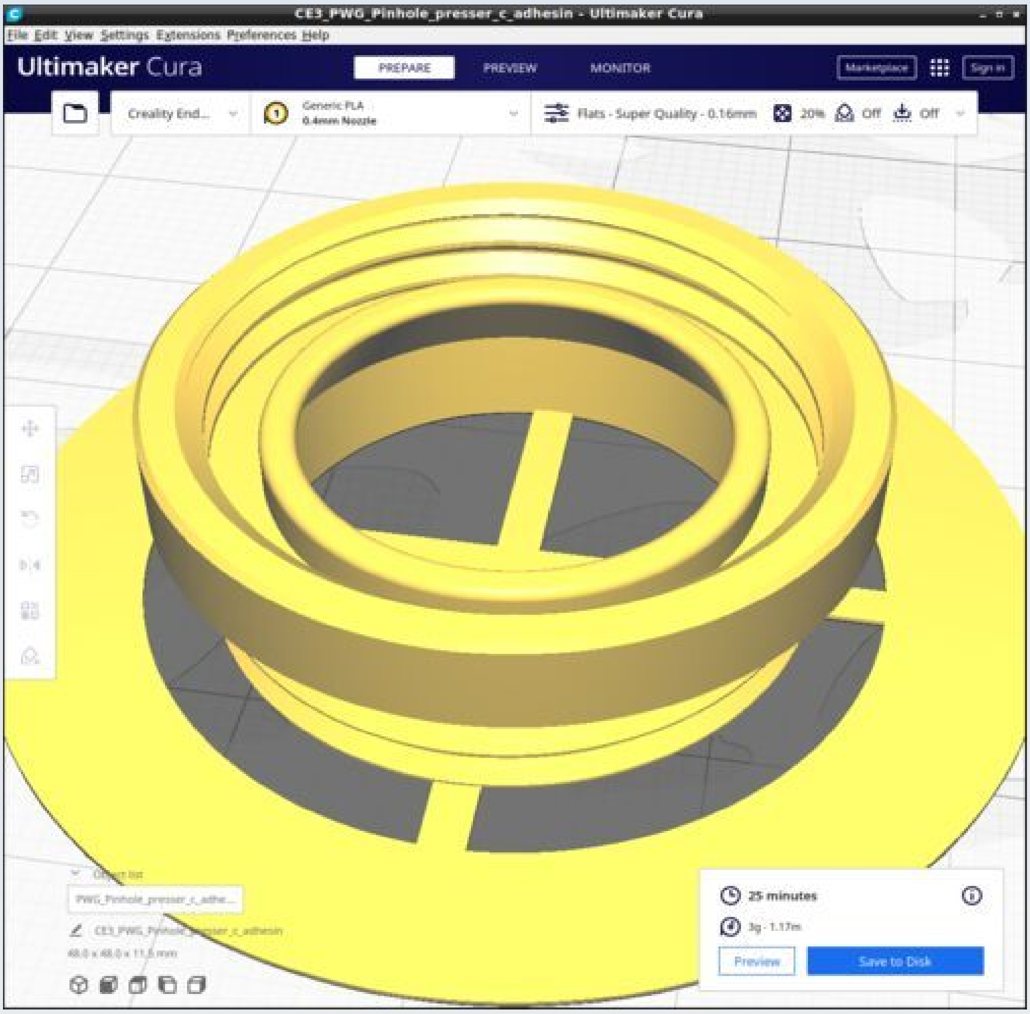
DI_PWG_Pinhole_mount_well.stl



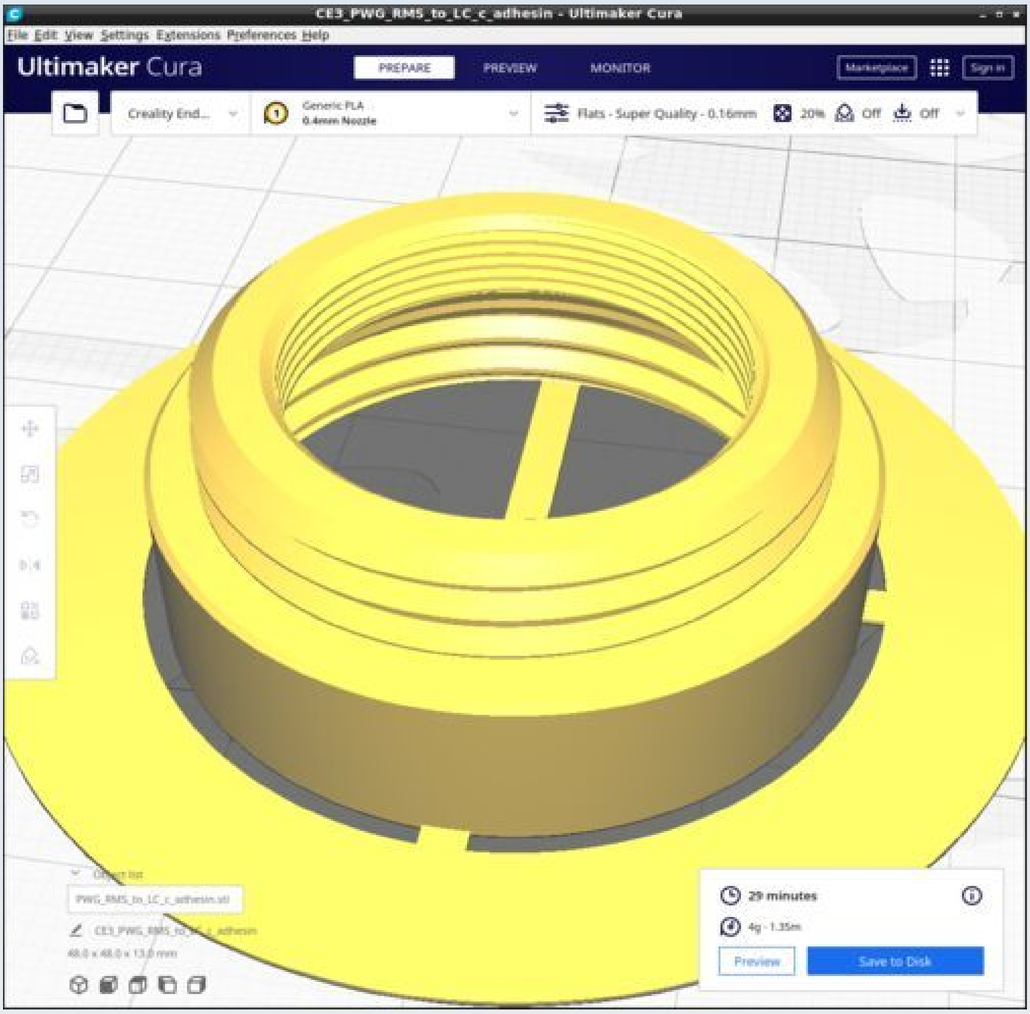
DI_PWG_Pinhole_plain.stl



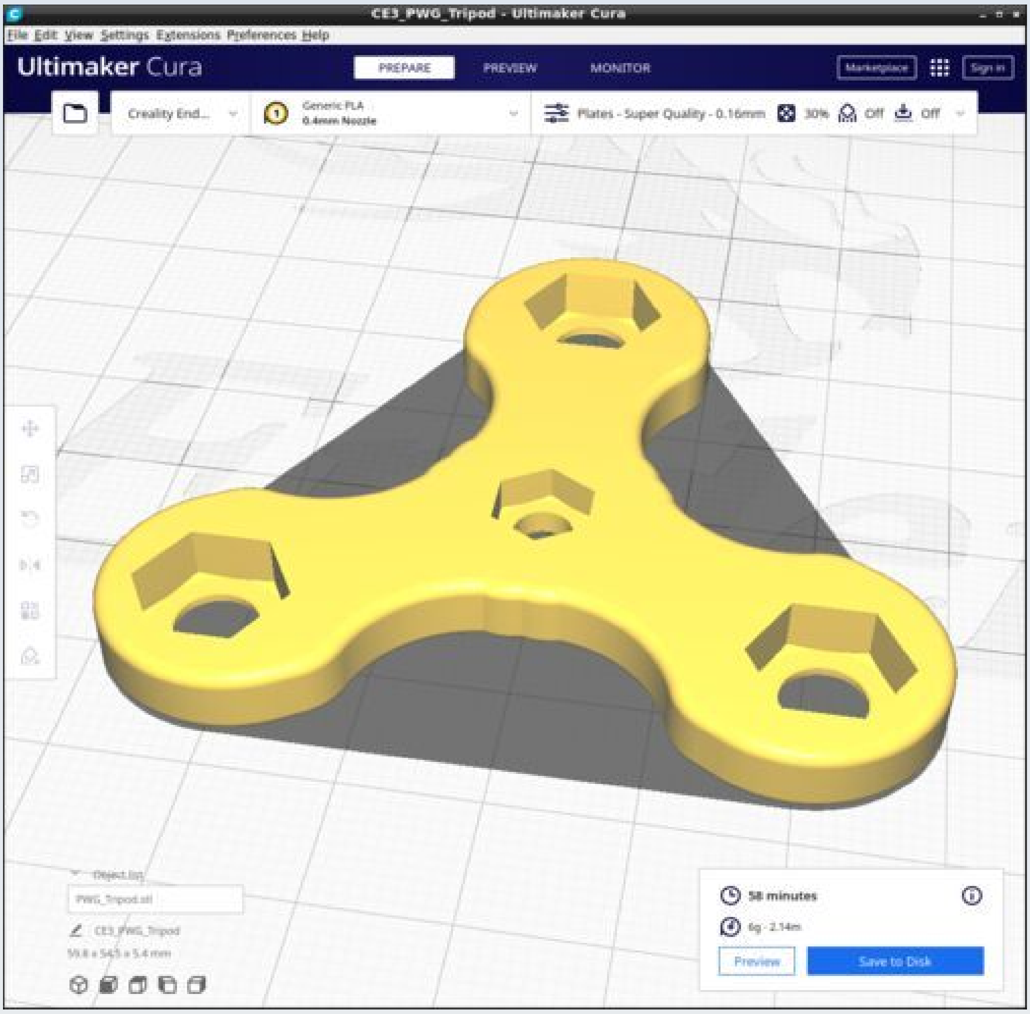
DI_PWG_Pinhole_presser.stl



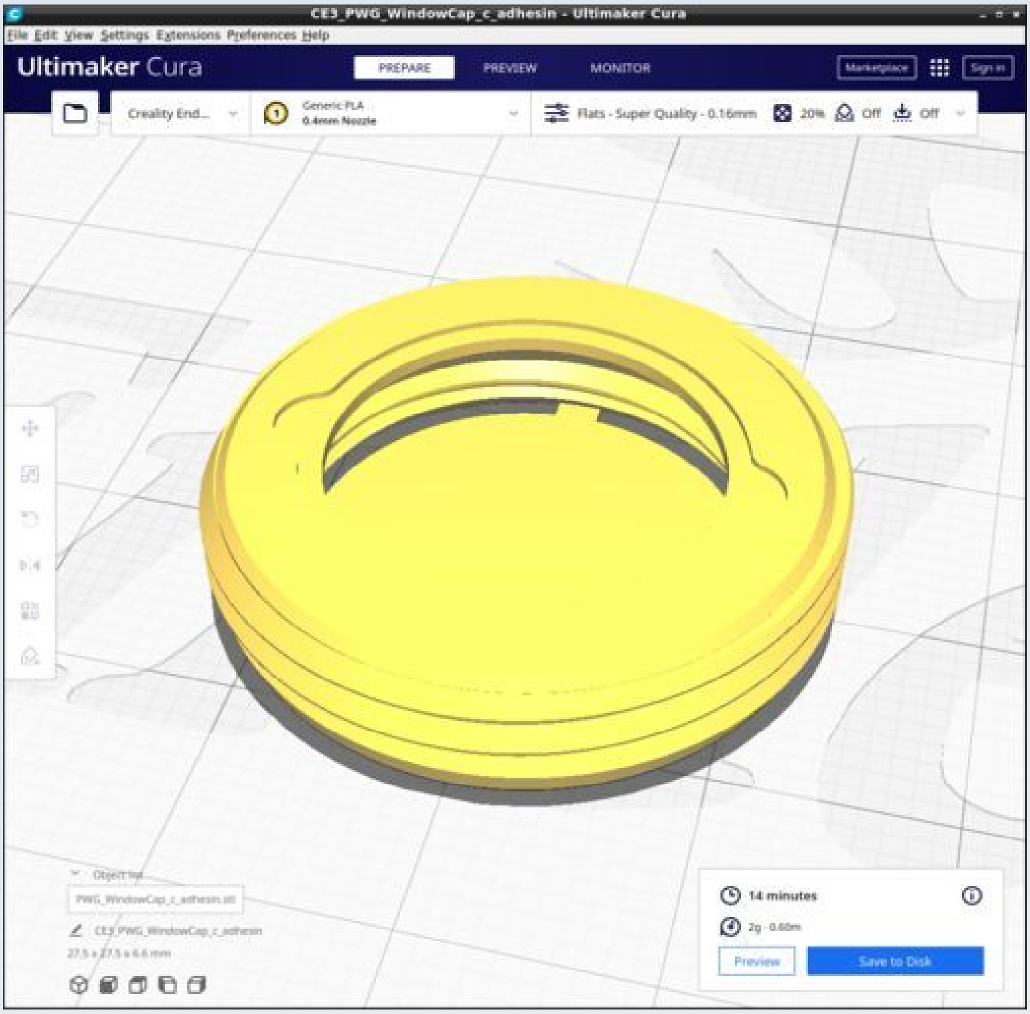
DI_PWG_RMS_to_LC.stl



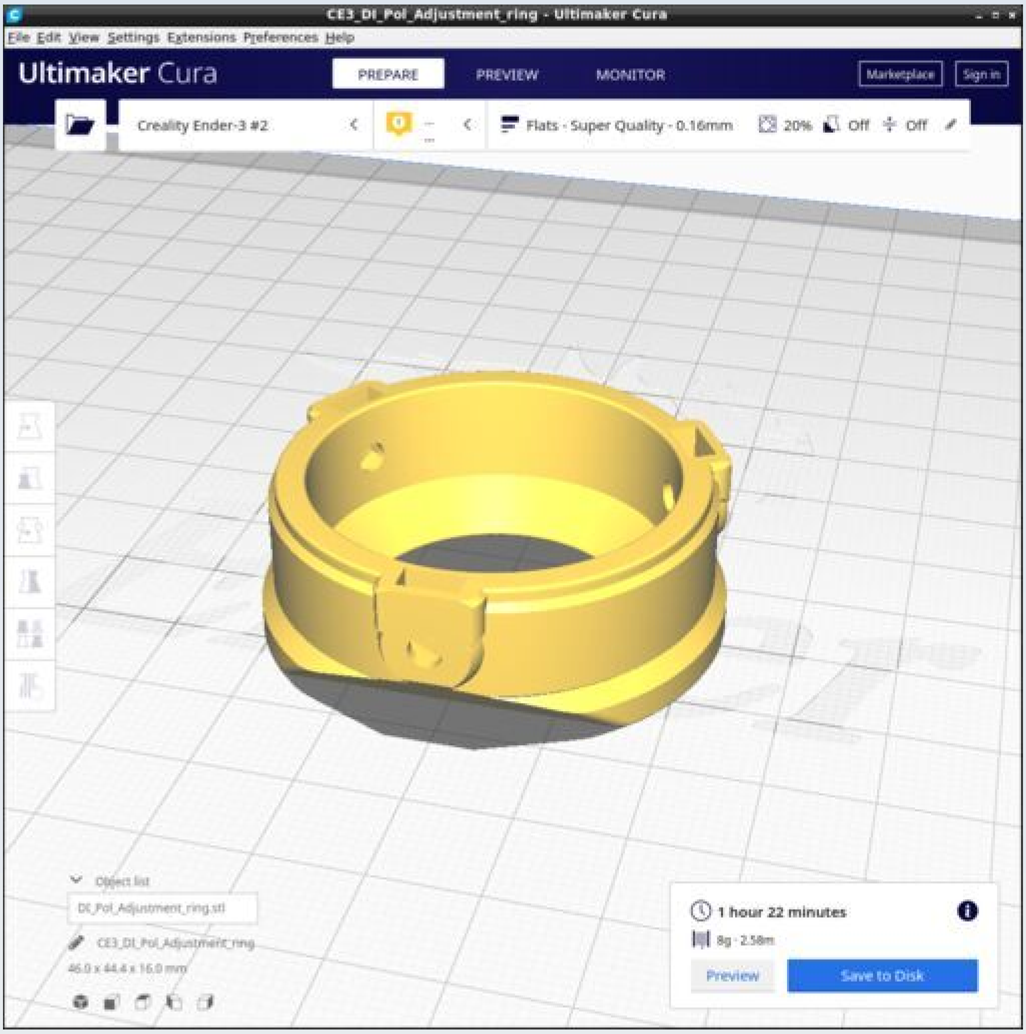
DI_PWG_Tripod.stl



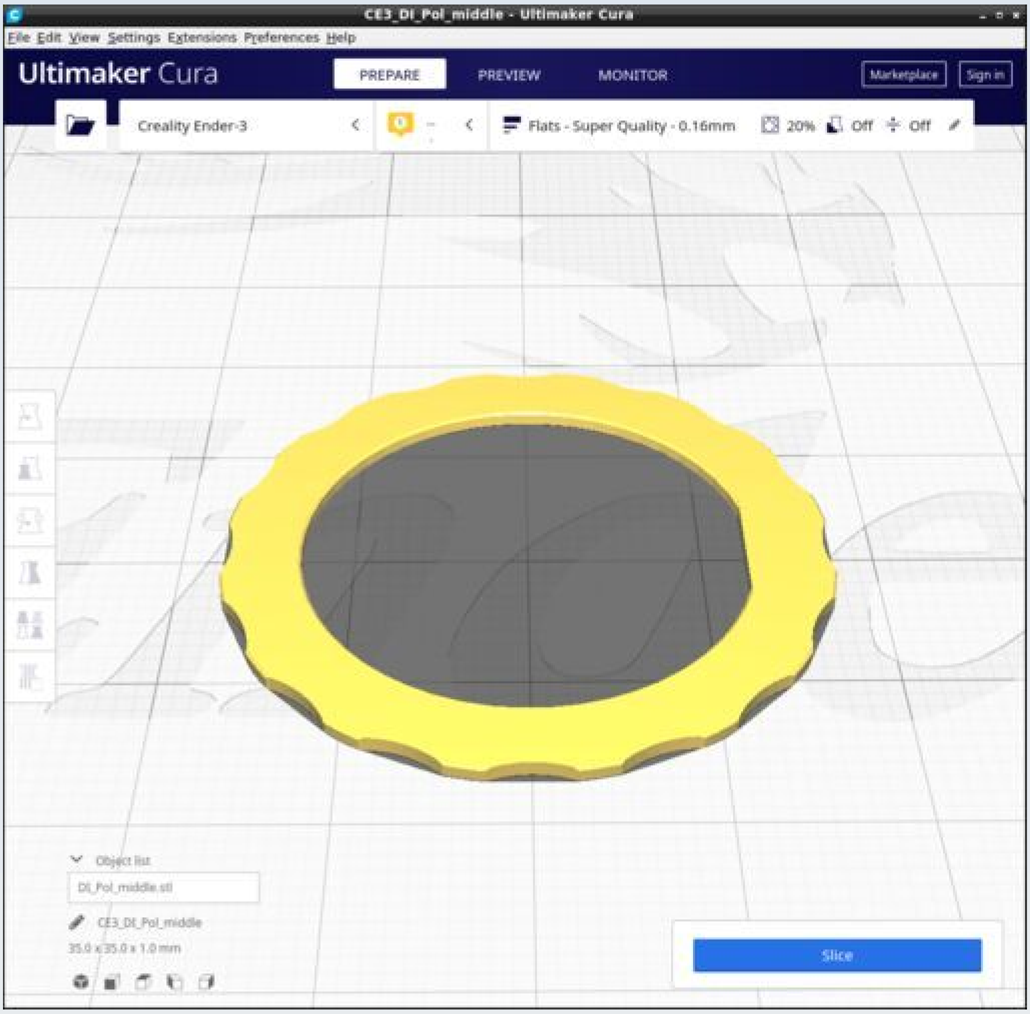
DI_PWG_WindowCap.stl



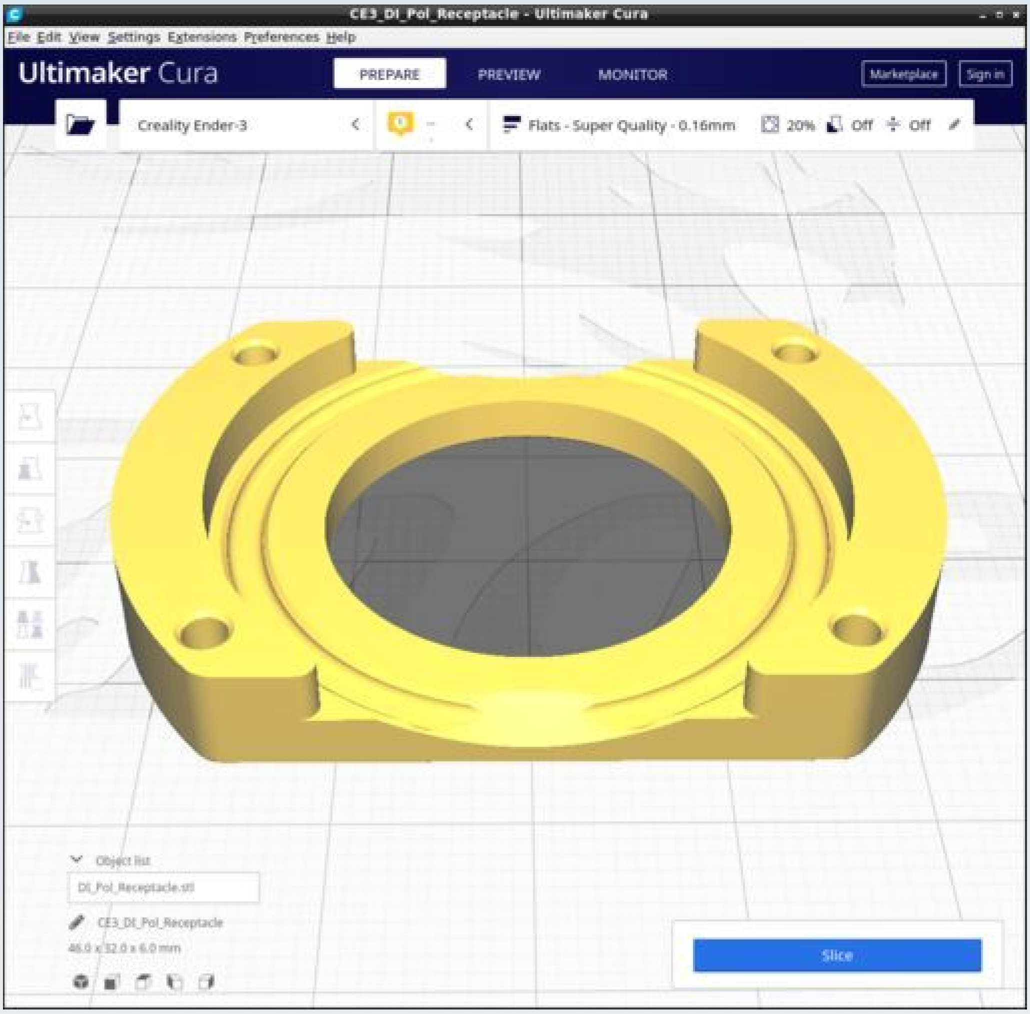
DI_Pol_Adjustment_ring.stl



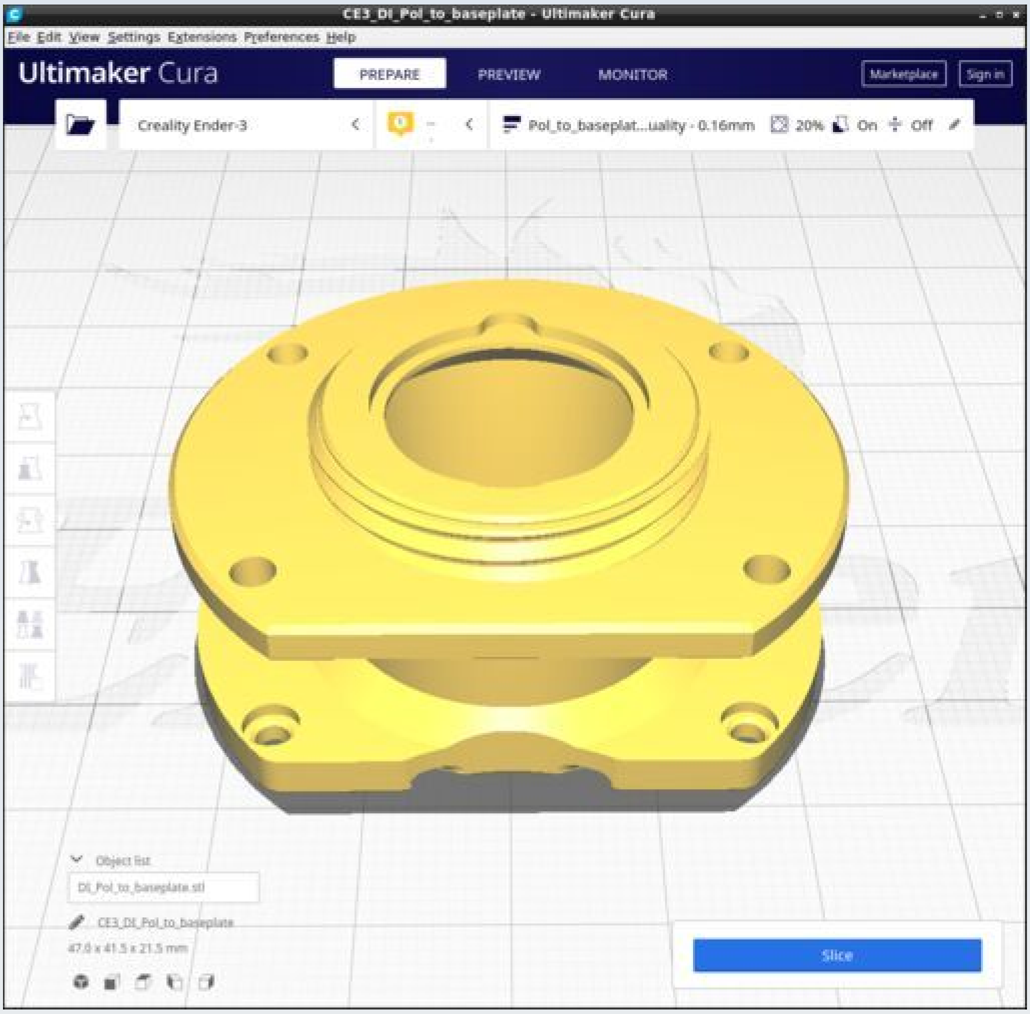
DI_Pol_middle.stl



DI_Pol_Receptacle.stl

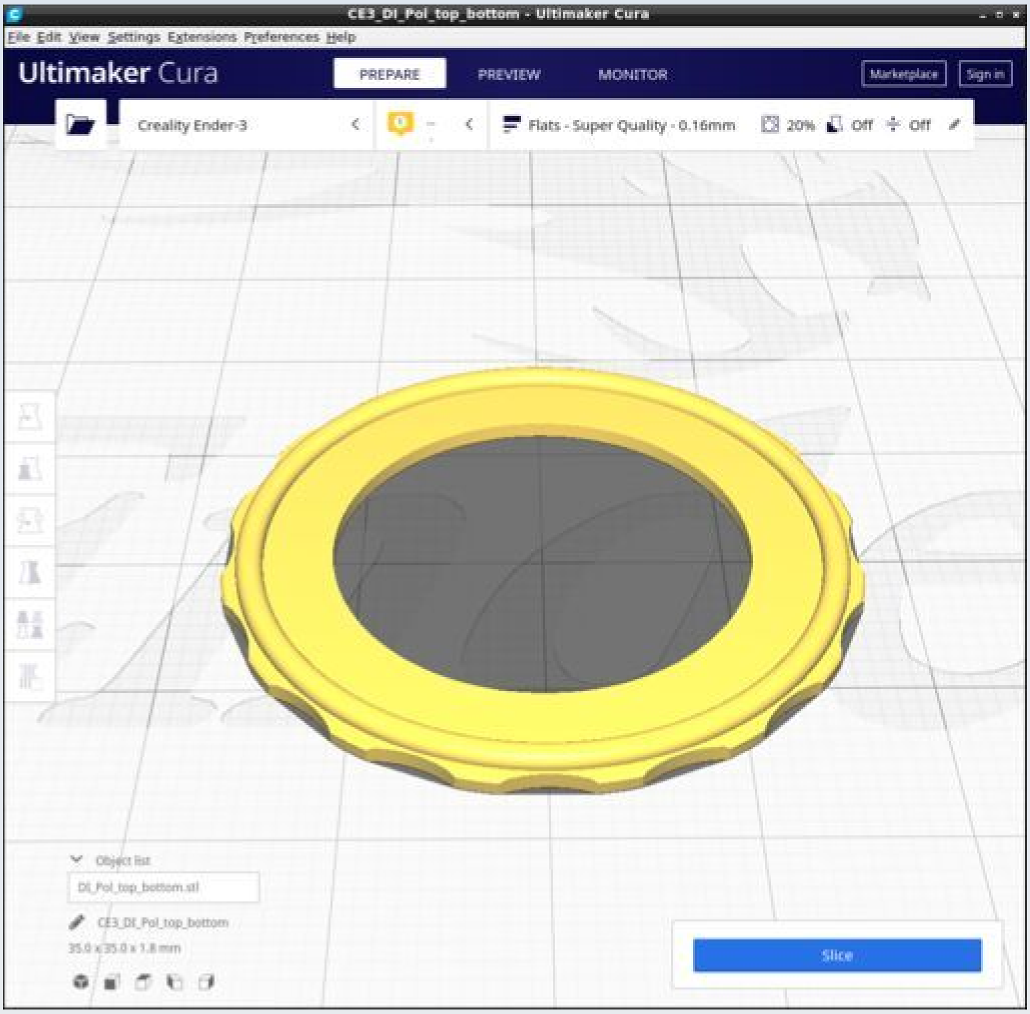


DI_Pol_to_baseplate.stl

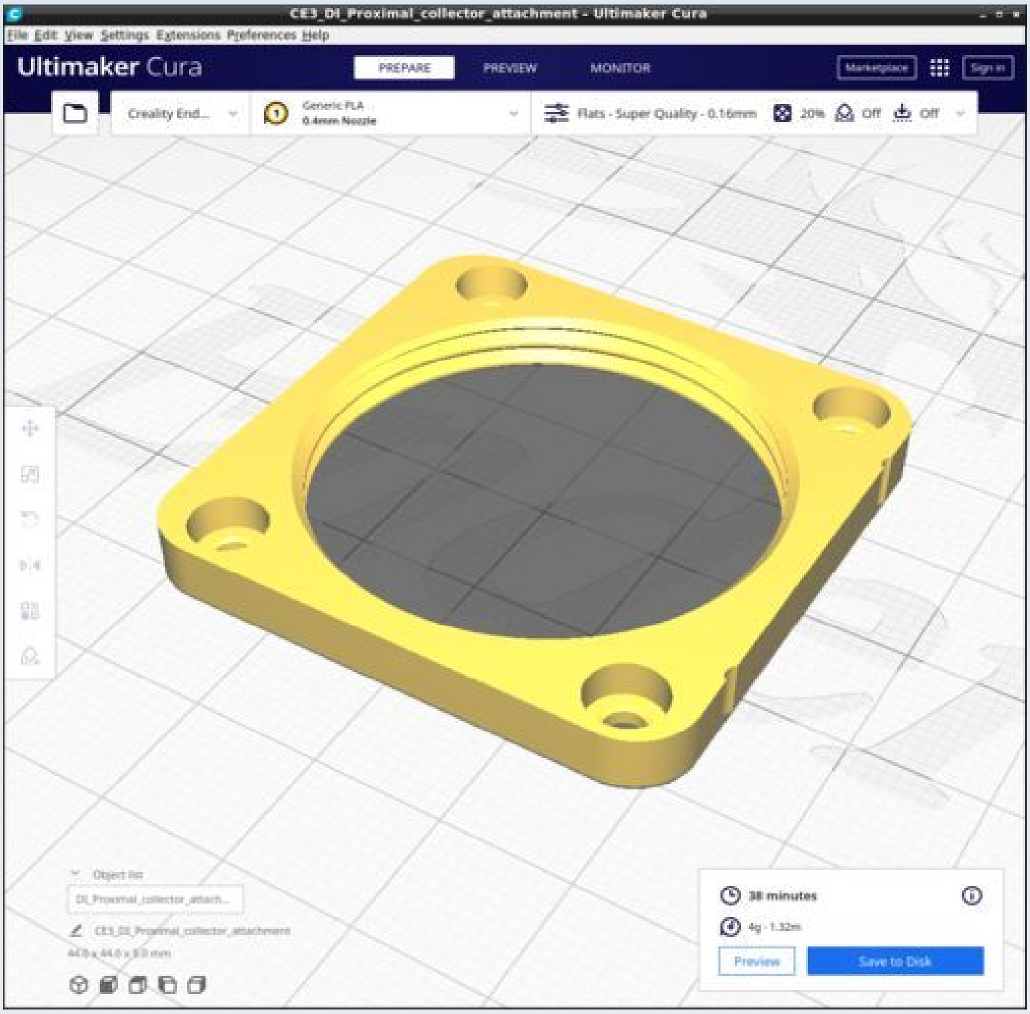


Pol_to_baseplate has its own Cura profile with tree supports. This is similar to the 'Condenser' profile but uses an infill density of 20% (not 30%) and has a greater tree angle to avoid making supports on the base of the model.

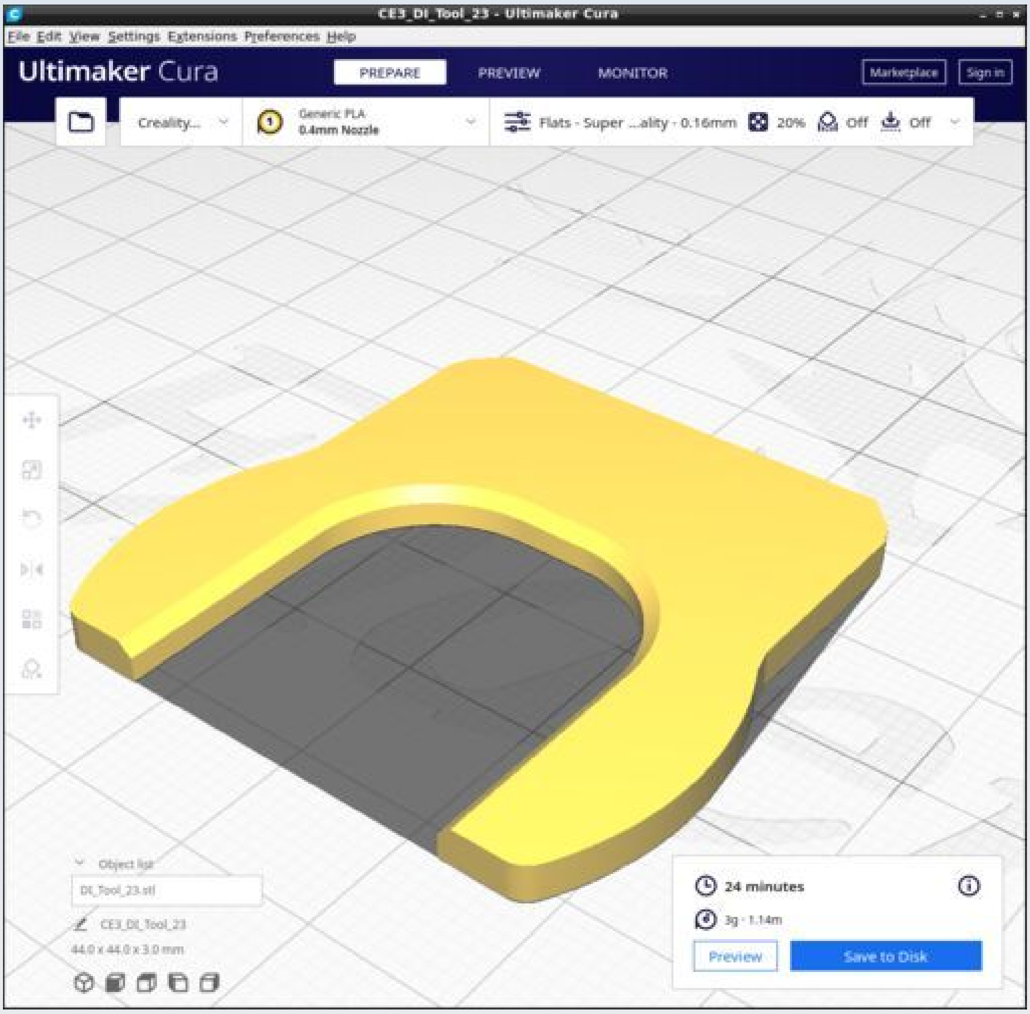
DI_Pol_top_bottom.stl



DI_Proximal_collector_attachment.stl

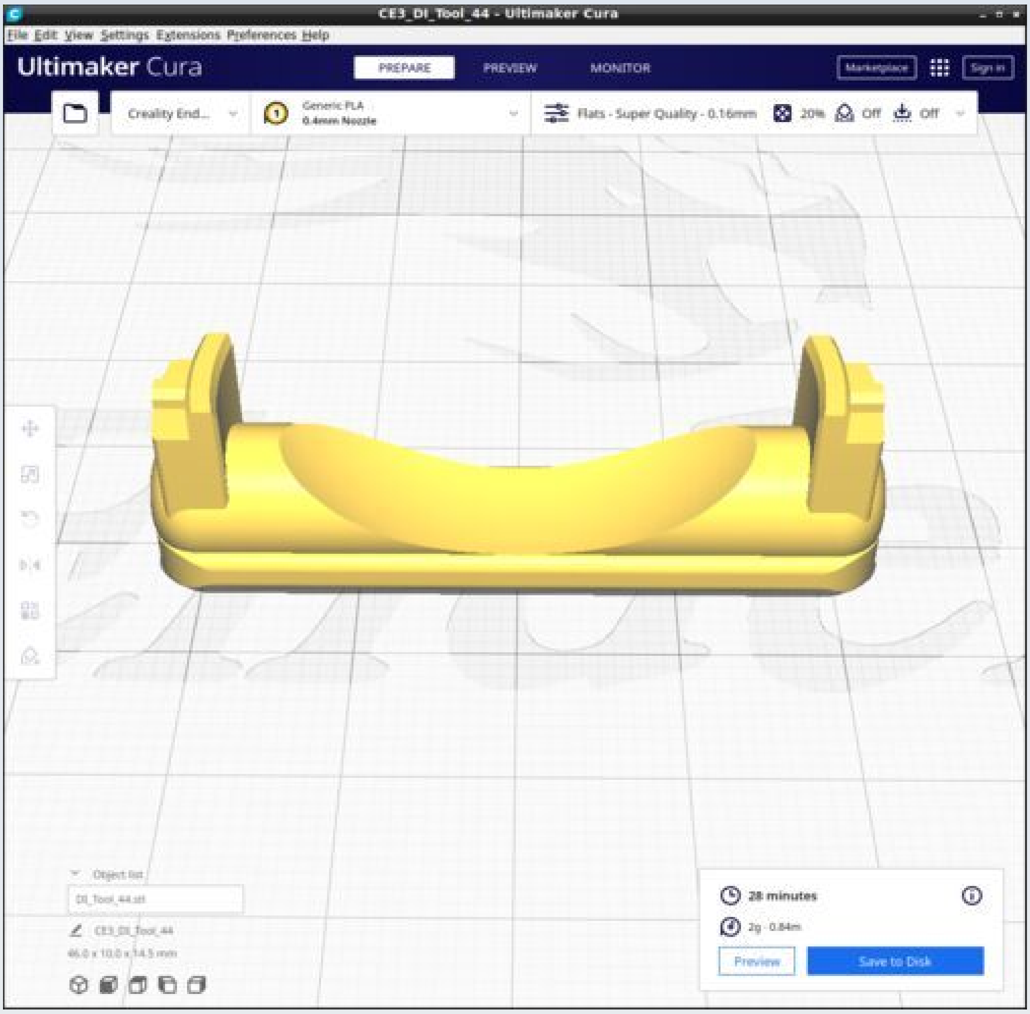


DI_Tool_23.stl

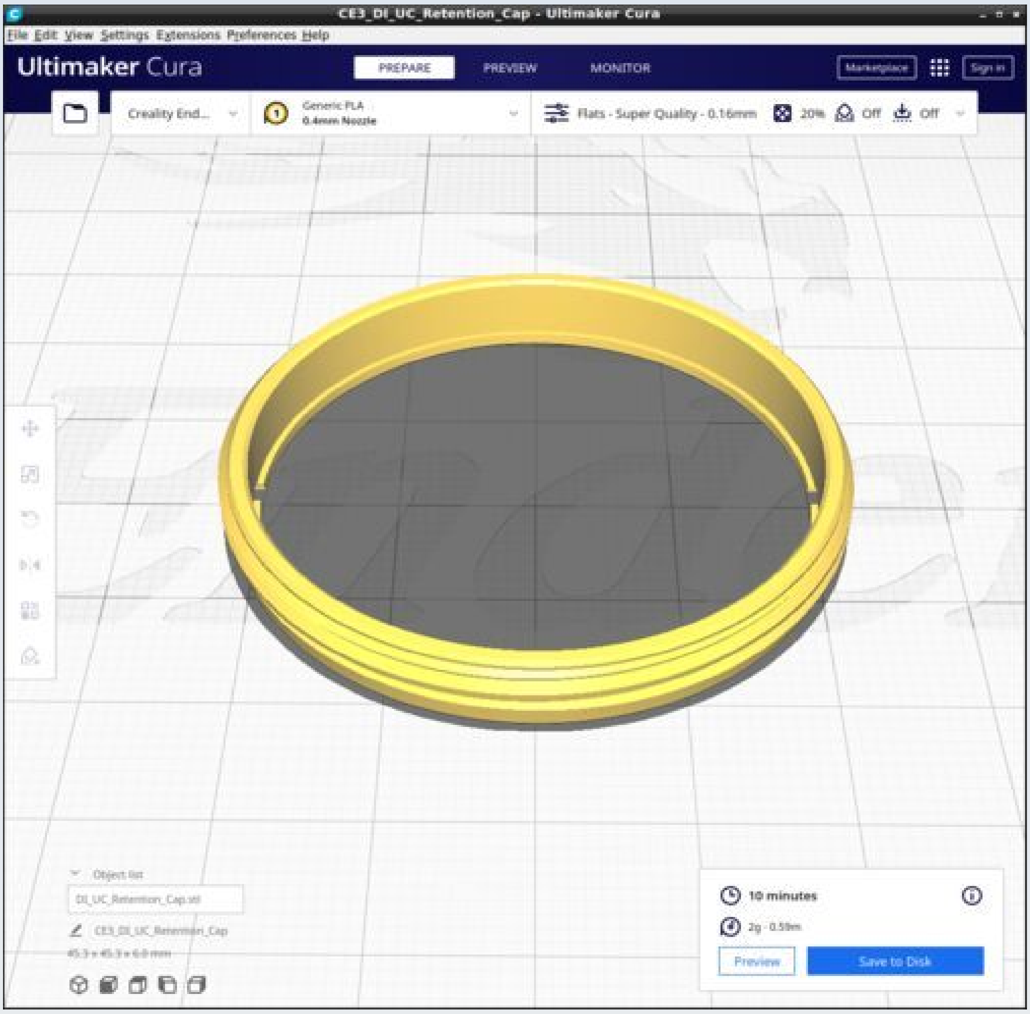


Although shown here with profile ‘flats’ you may want to print this with a higher density infill for added strength.

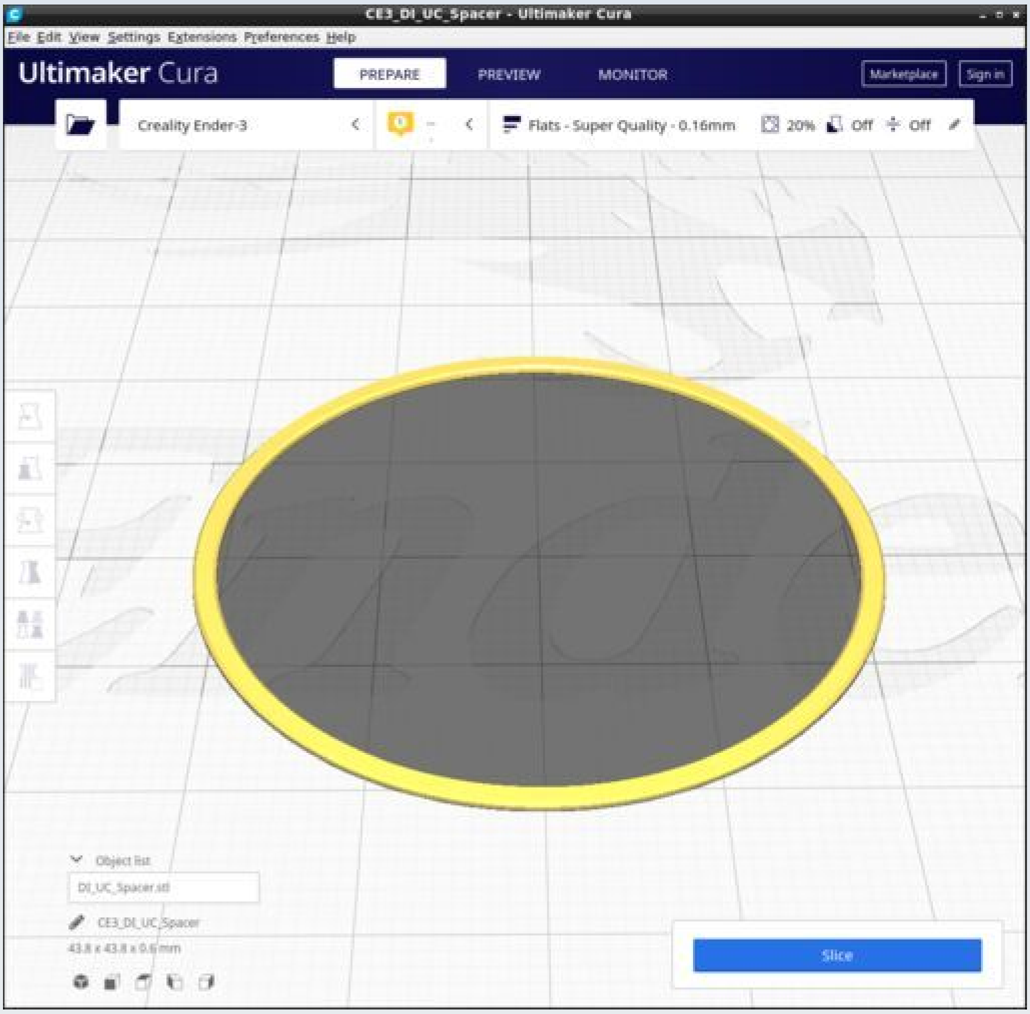
DI_Tool_44.stl



DI_UC_Retention_Cap.stl

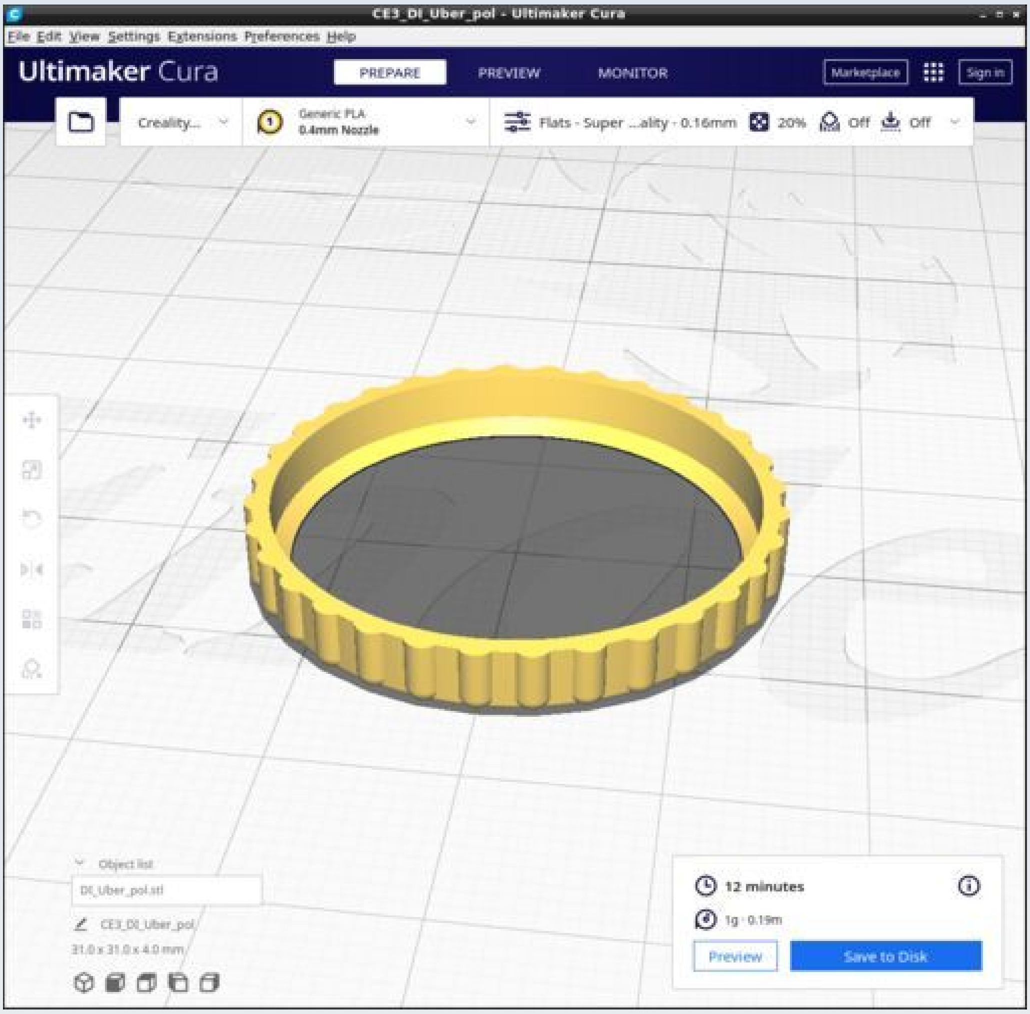


DI_UC_Spacer.stl



You may find the custom Cura profile ‘WashersSpacers’ more useful when printing this.

DI_Uber_pol.stl



Filterblock

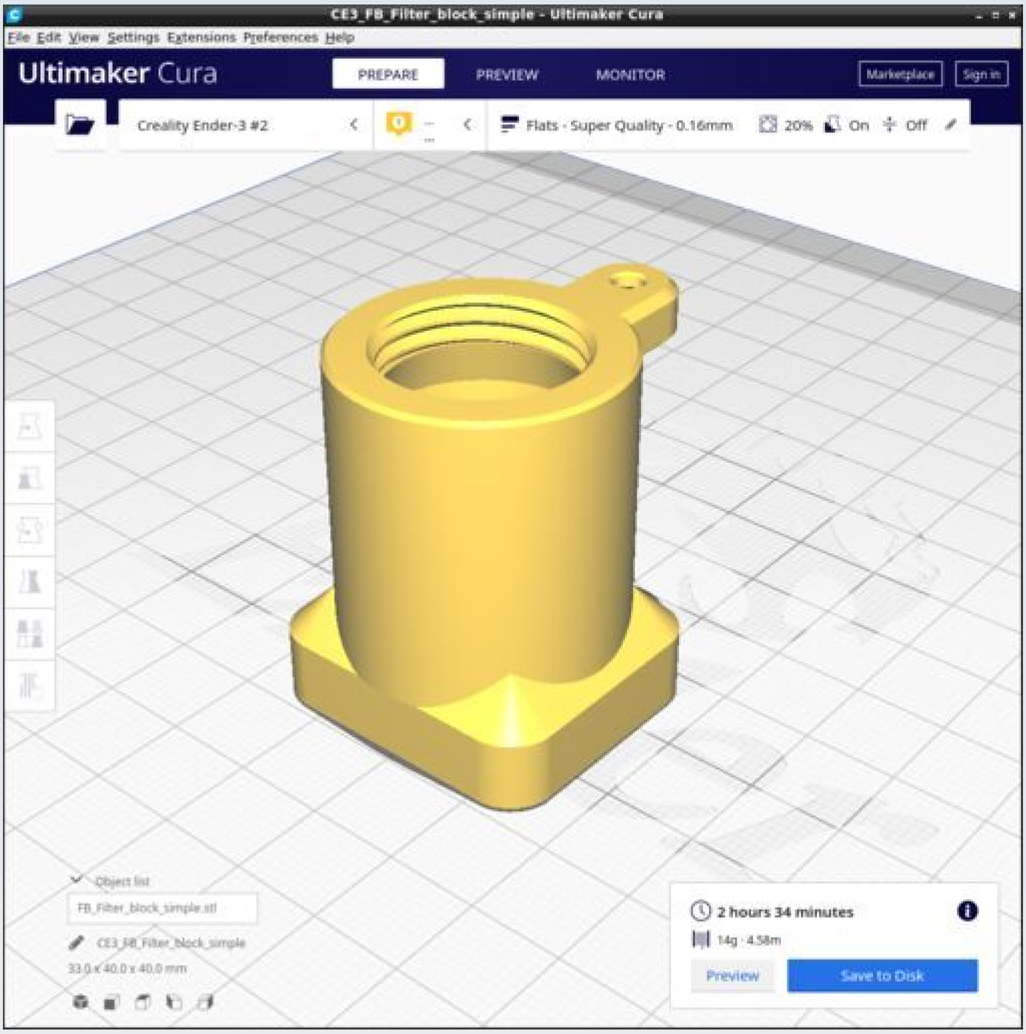
This shows the parts for the filter block segment of the optical tube, the part that goes between the objective holder and the ocular head. The models for these files are found in the FreeCAD file called FilterBlock.FCStd.

Resources

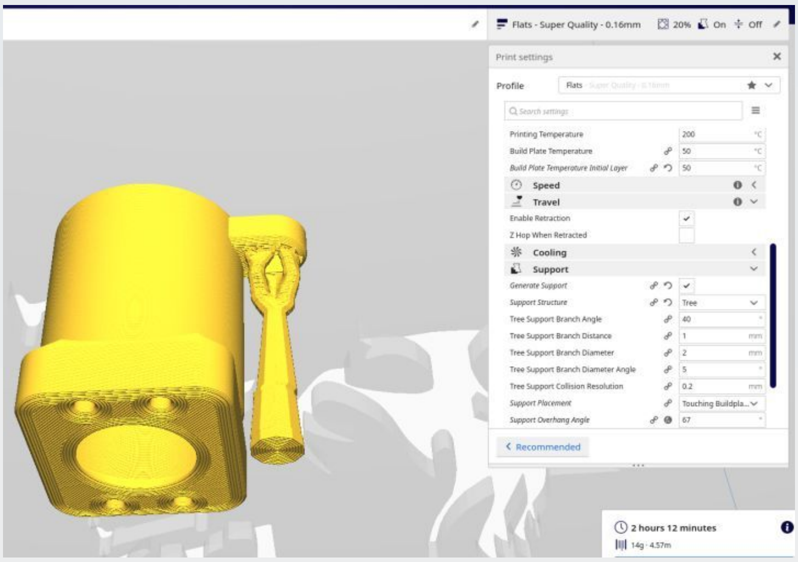
Cura calculates the following resources are required to print each model in this chapter:

Filterblock	Time_Hr	Time_ Min	PLA_Length(m)
FB_Filter_block_simple.stl	2	34	4.58
FB_Filter_collar_compression_tool.stl	0	6	0.26
FB_Filter_collar.stl	0	1	0.03
FB_Filter_F17_slider.stl	0	21	0.58
FB_Filter_F_slider.stl	0	12	0.47
FB_Filter_slider.stl	0	19	0.56
FB_Filter_slot_bottom.stl	0	19	0.38
FB_Filter_slot_stopper.stl	0	8	0.35
FB_Filter_slot_top.stl	0	14	0.33
FB_Infinity_adapter.stl	0	41	0.95
FB_Side_port_separate.stl	0	35	0.99
FB_Side_port_separate_EpiStop.stl	0	51	1.25
FB_Splitter_case.stl	1	32	2.58
FB_Stopper.stl	0	24	0.73
FB_Top_connector.stl	0	42	1.13

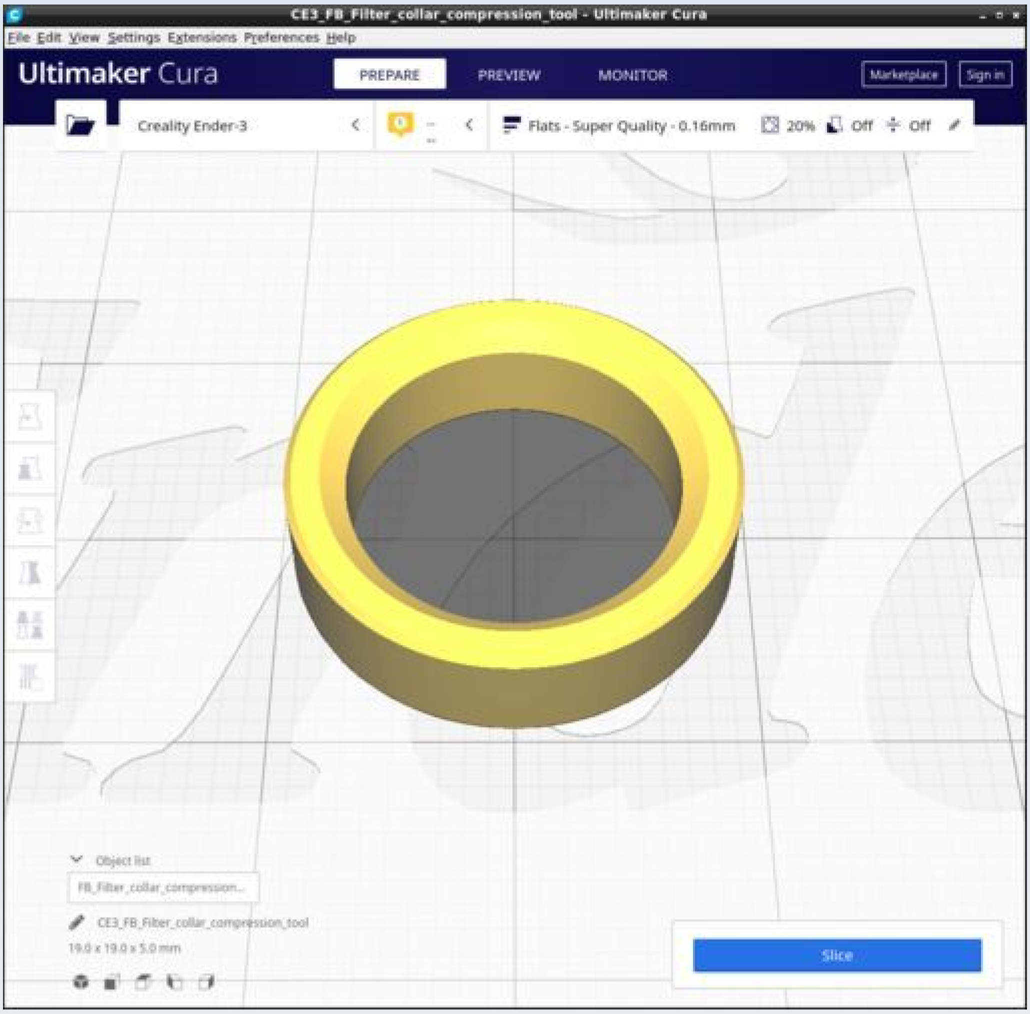
FB_Filter_block_simple.stl



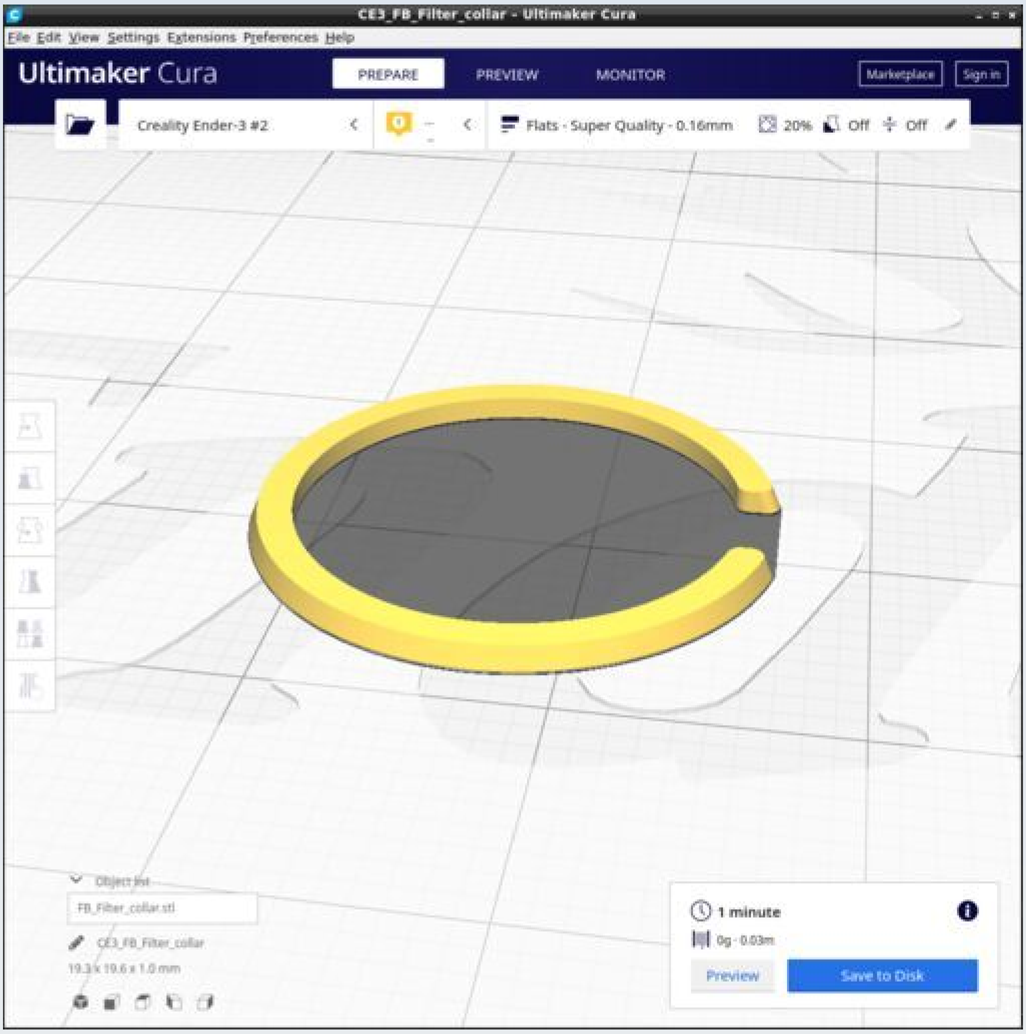
Use tree supports: Branch angle 40. touching baseplate only. Overhang 67 degrees. See picture. The tree gives a solid concentric trunk at the base (better for adhesion). Normal support will result in a hollow square base - less contact area so risk of coming off).



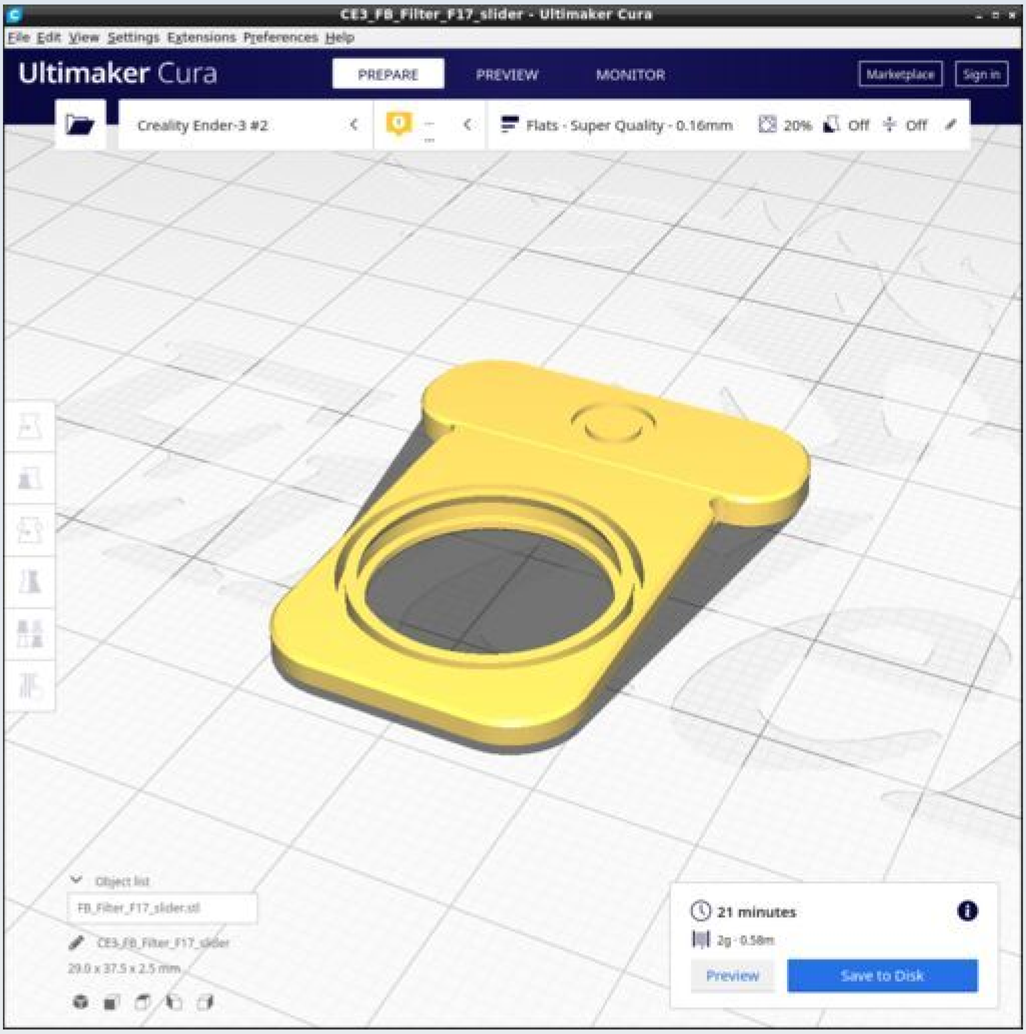
FB_Filter_collar_compression_tool.stl



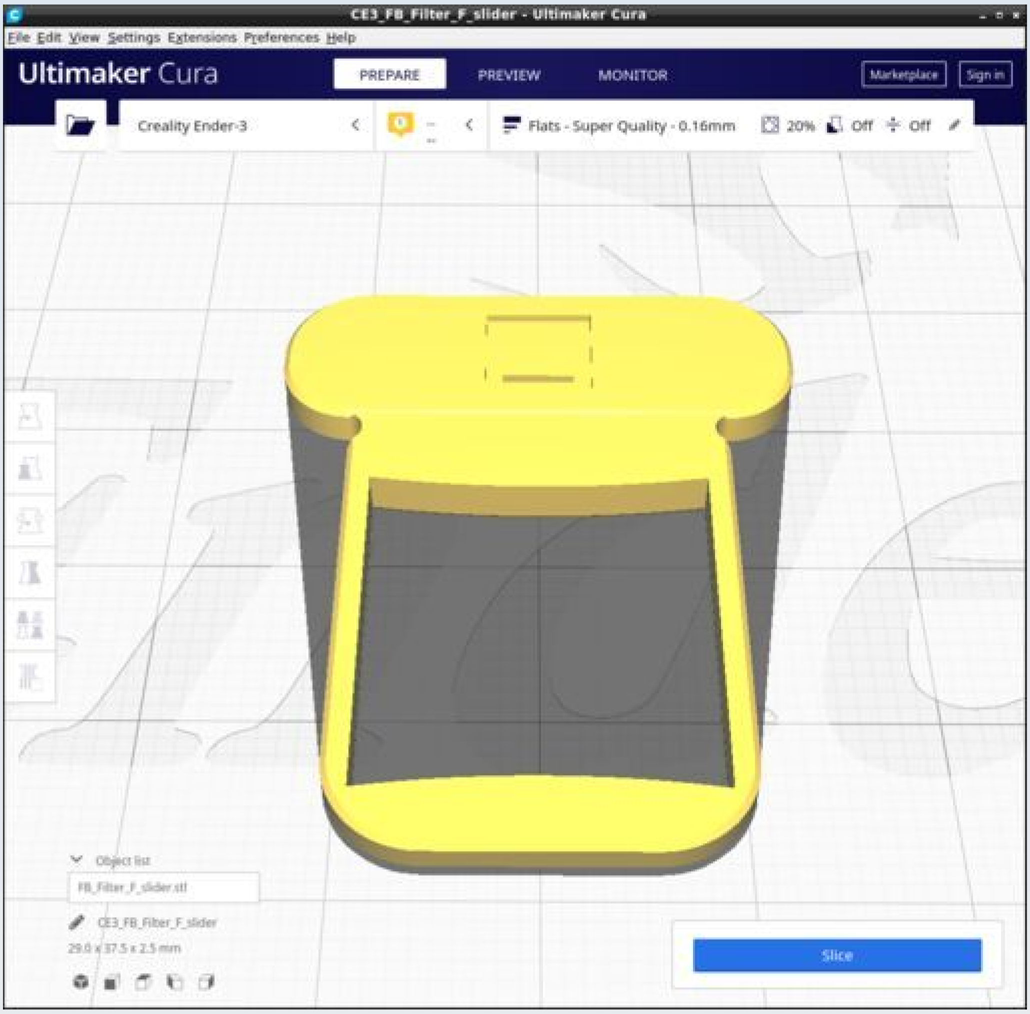
FB_Filter_collar.stl



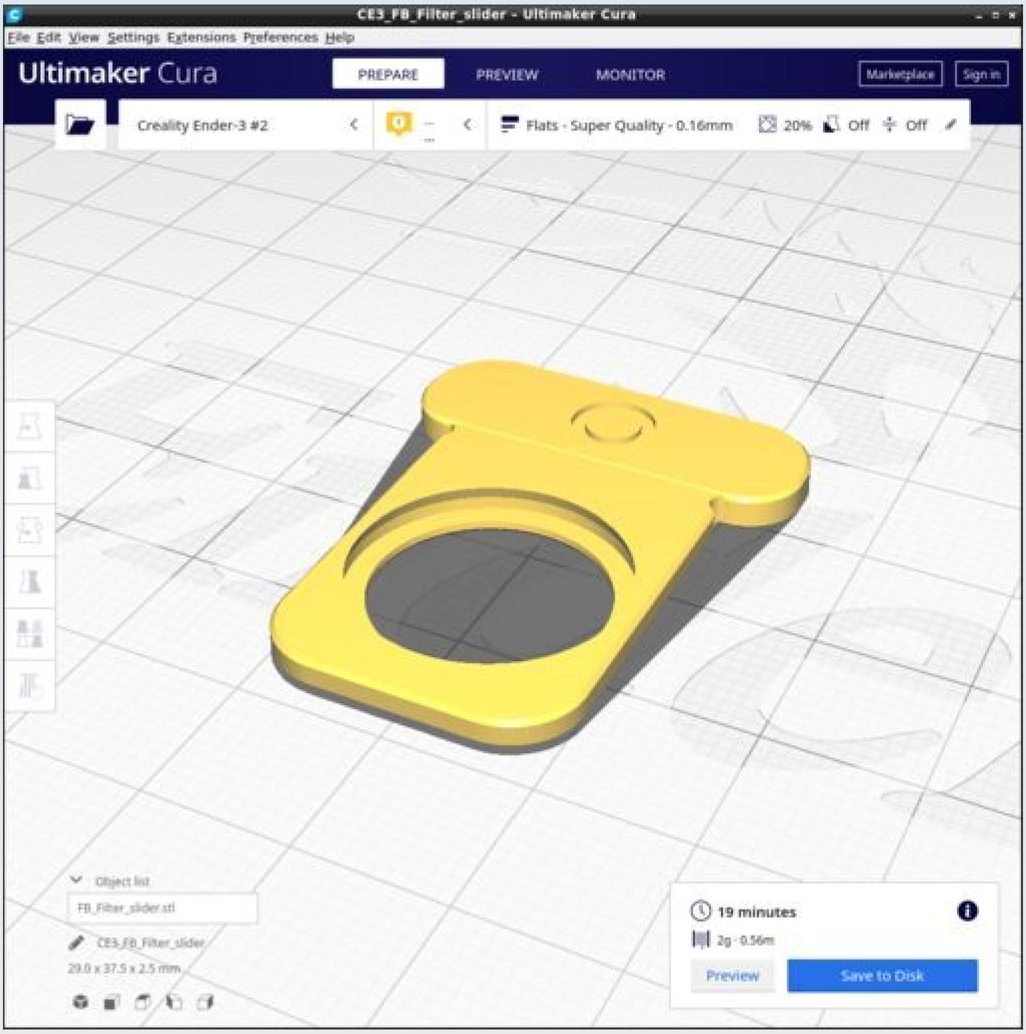
FB_Filter_F17_slider.stl



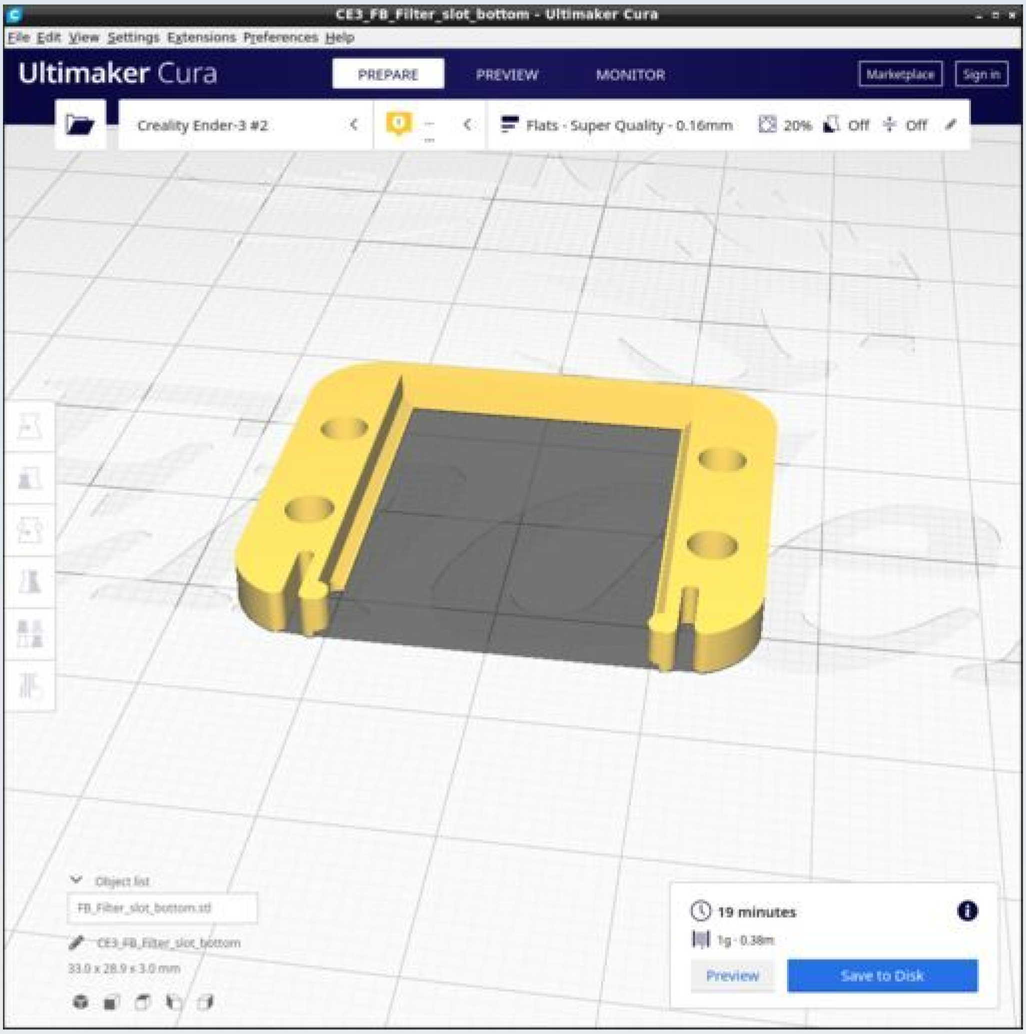
FB_Filter_F_slider.stl



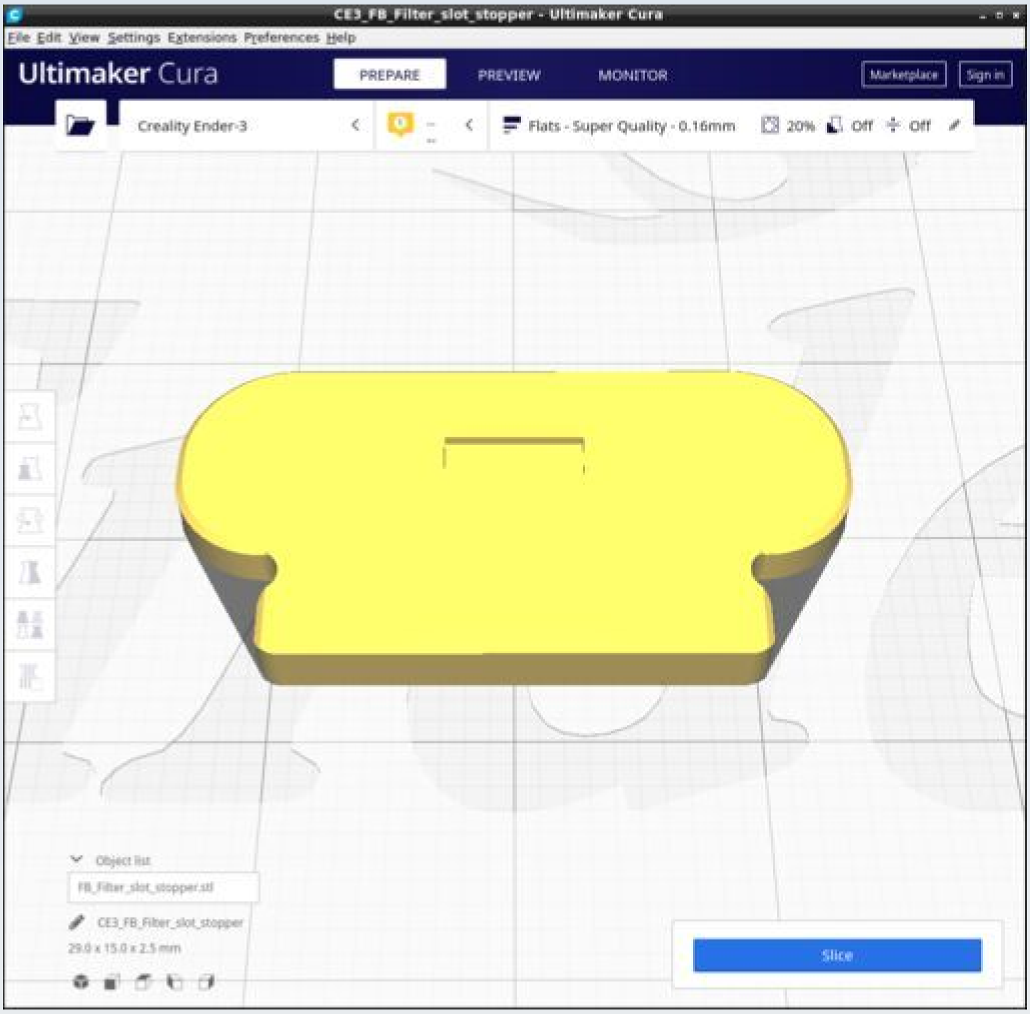
FB_Filter_slider.stl



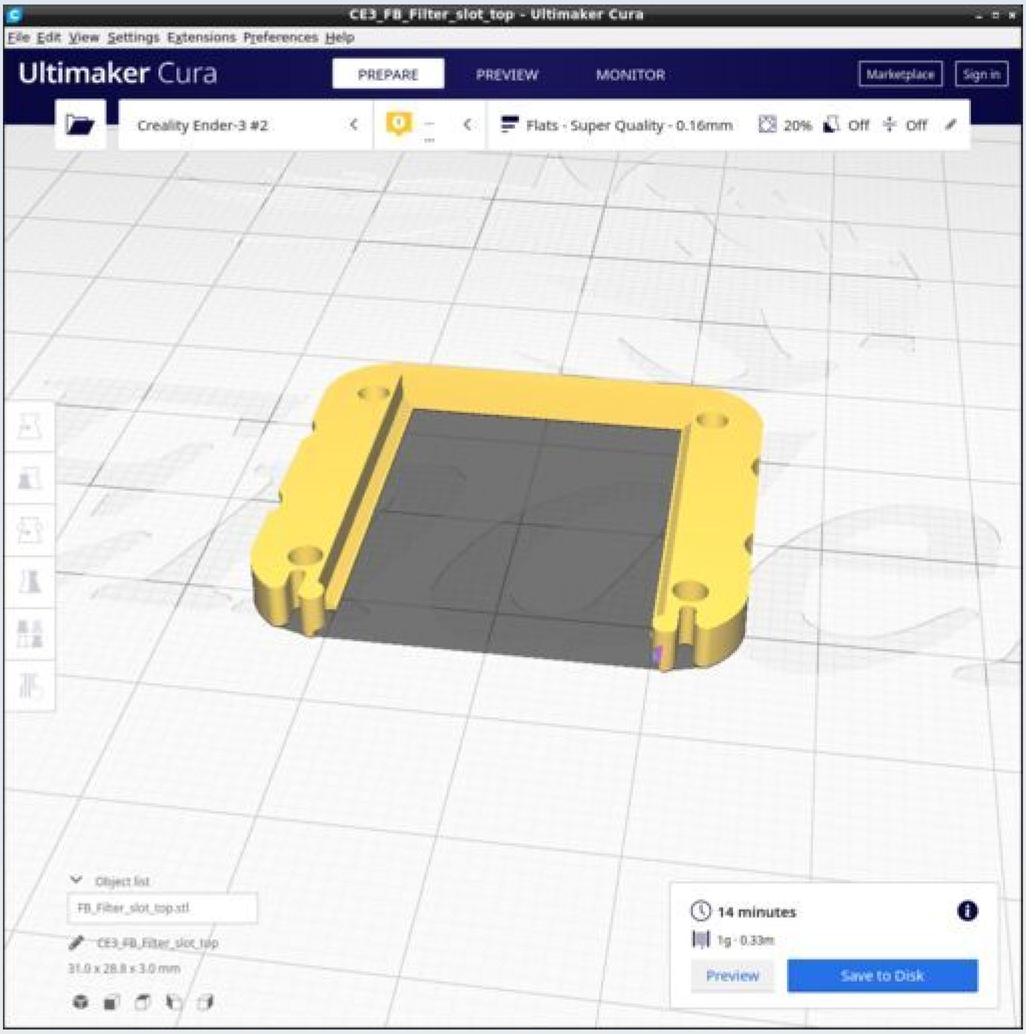
FB_Filter_Slot_bottom.stl



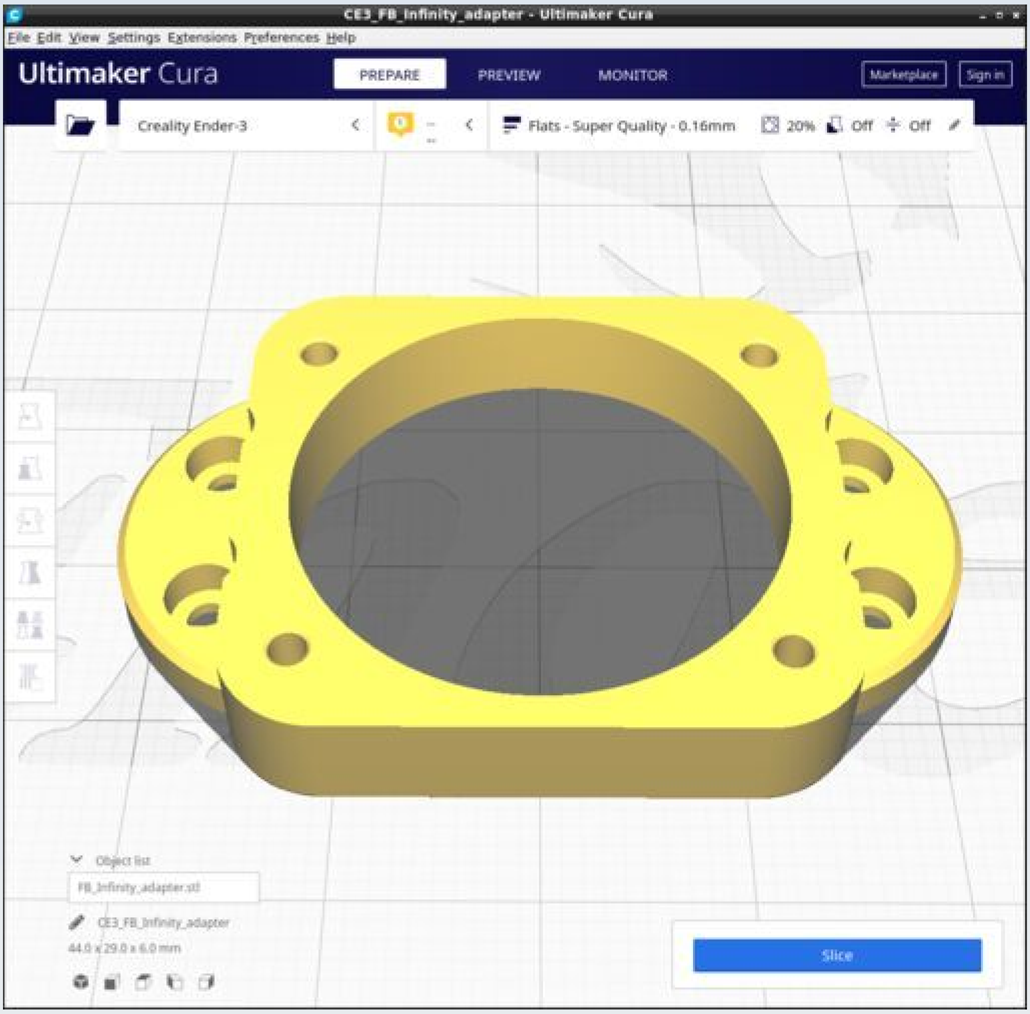
FB_Filter_slot_stopper.stl



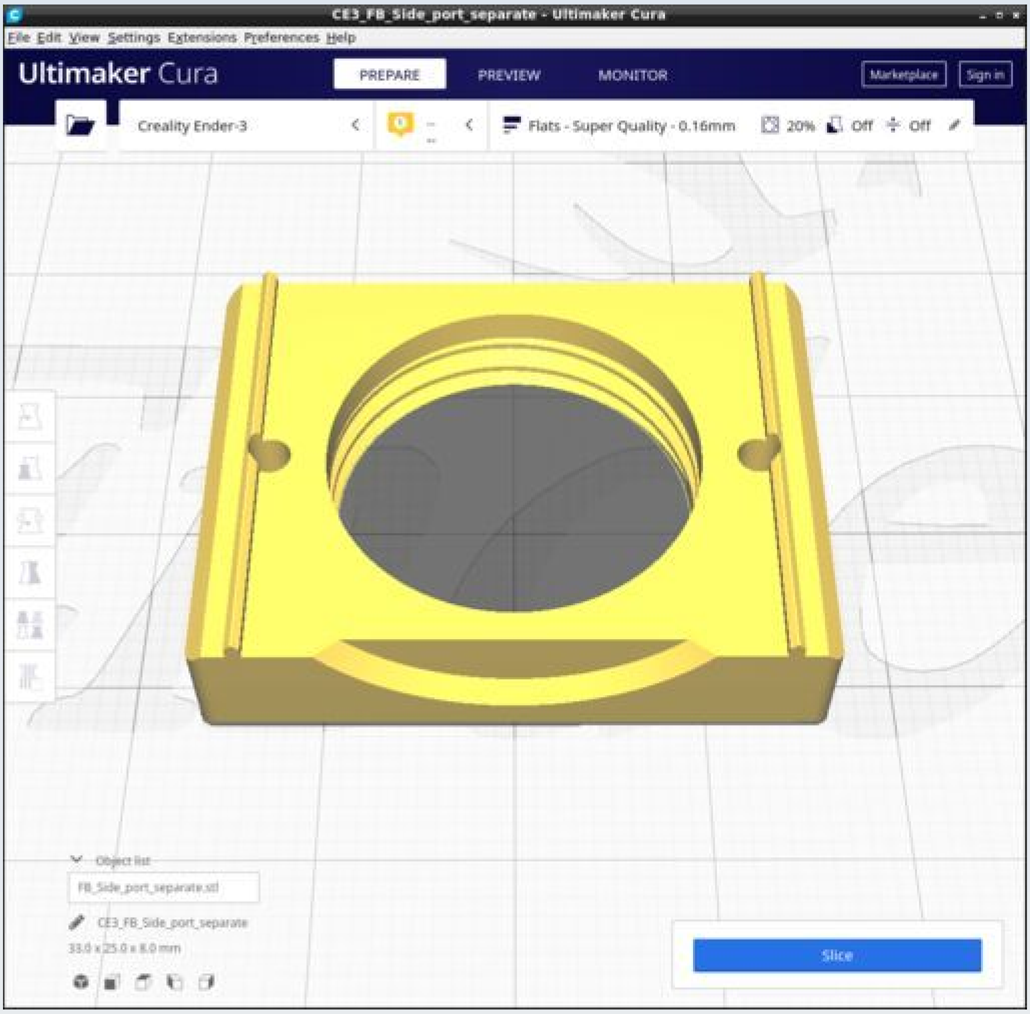
FB_Filter_slot_top.stl



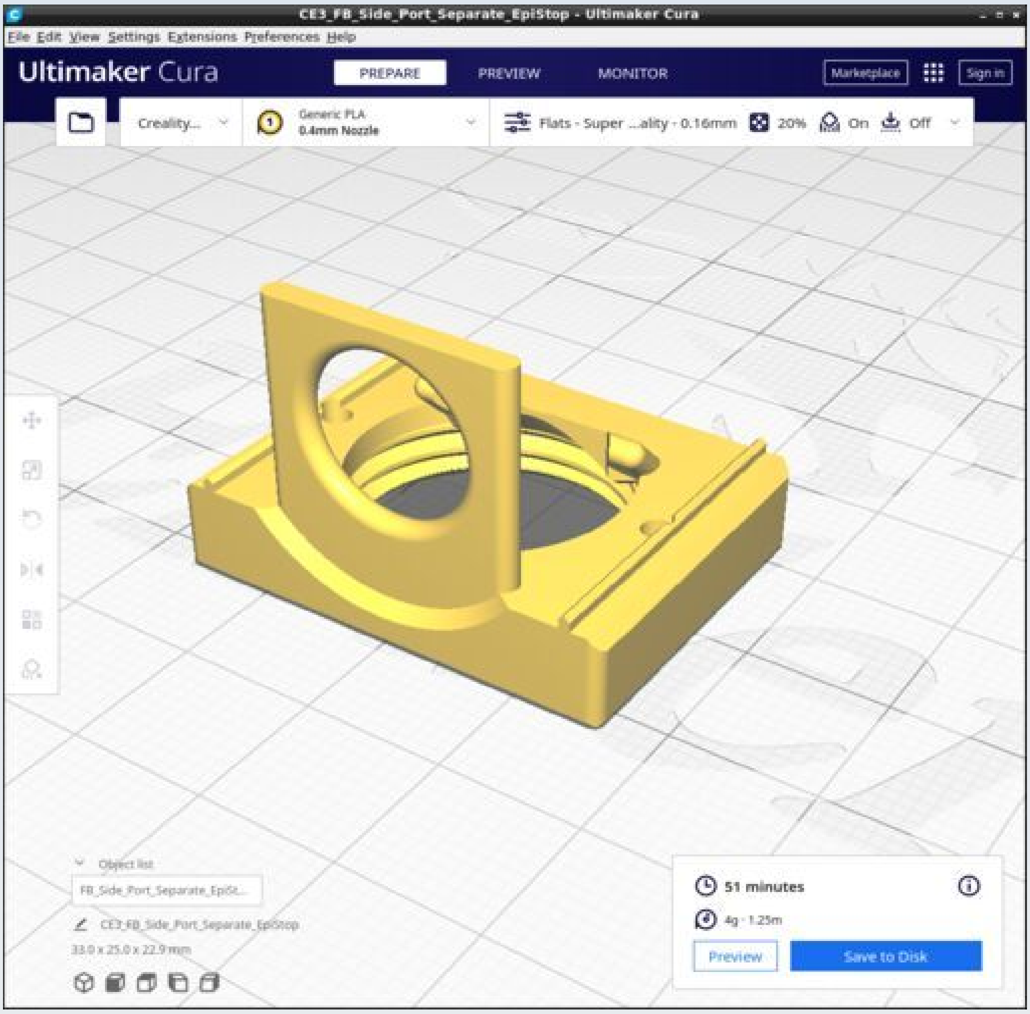
FB_Infinity_adapter.stl



FB_Side_port_separate.stl

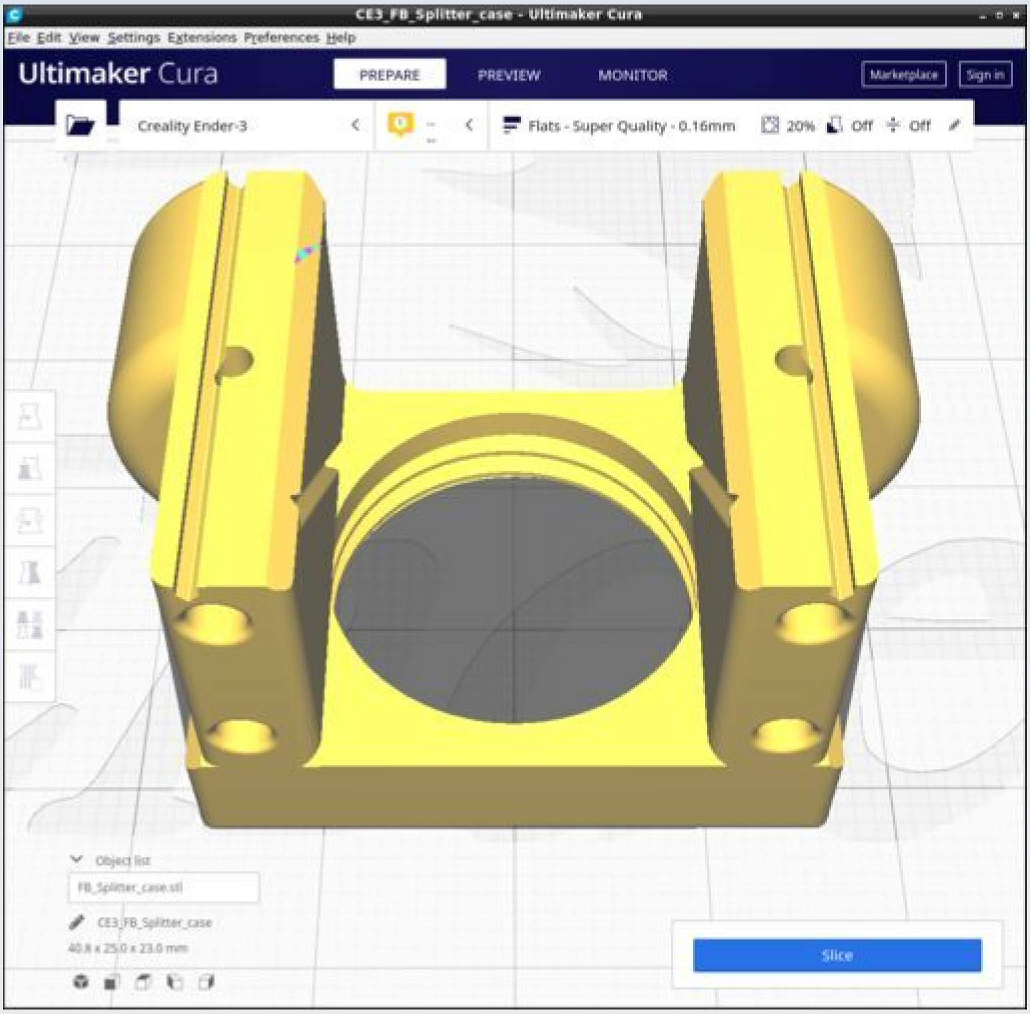


FB_Side_port_separate_EpiStop.stl



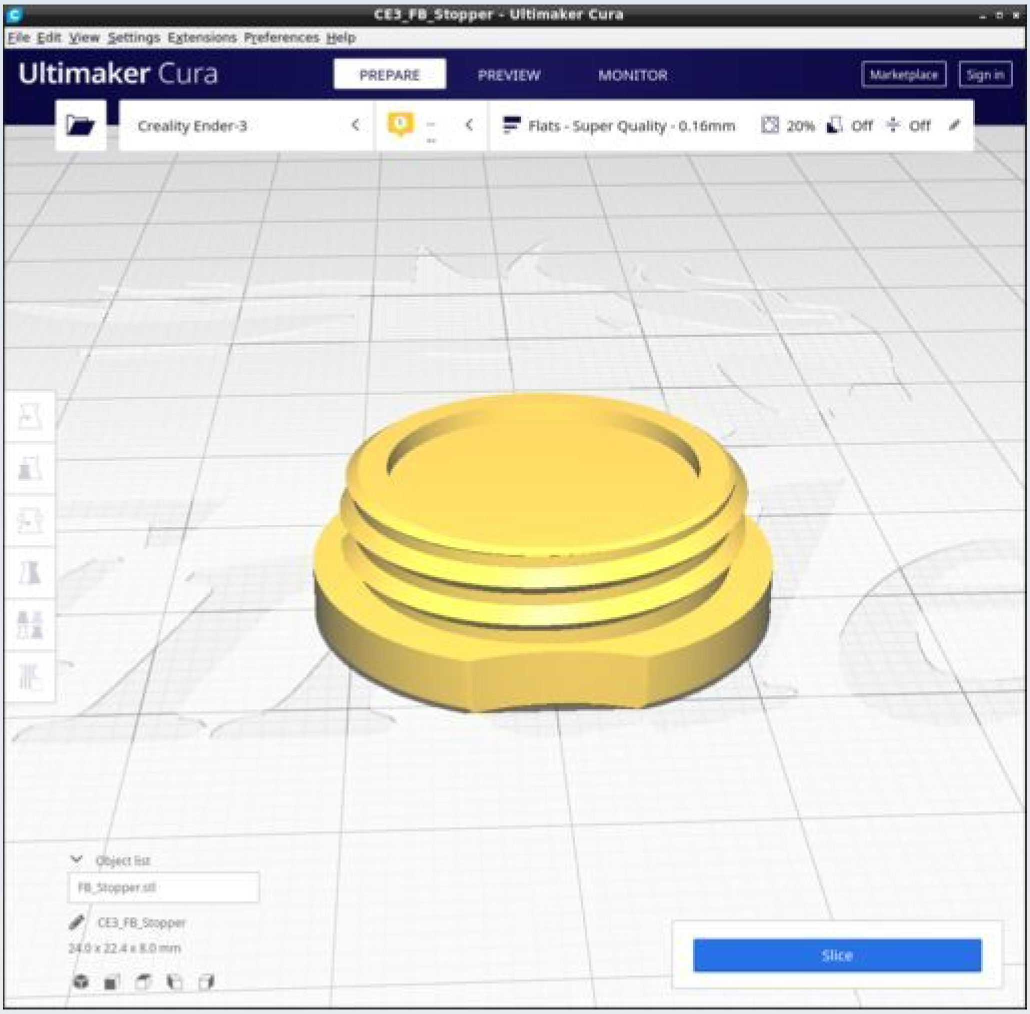
Print with supports on: General (not tree) support, overhang 67 degrees, supports enabled ‘everywhere’.

FB_Splitter_case.stl



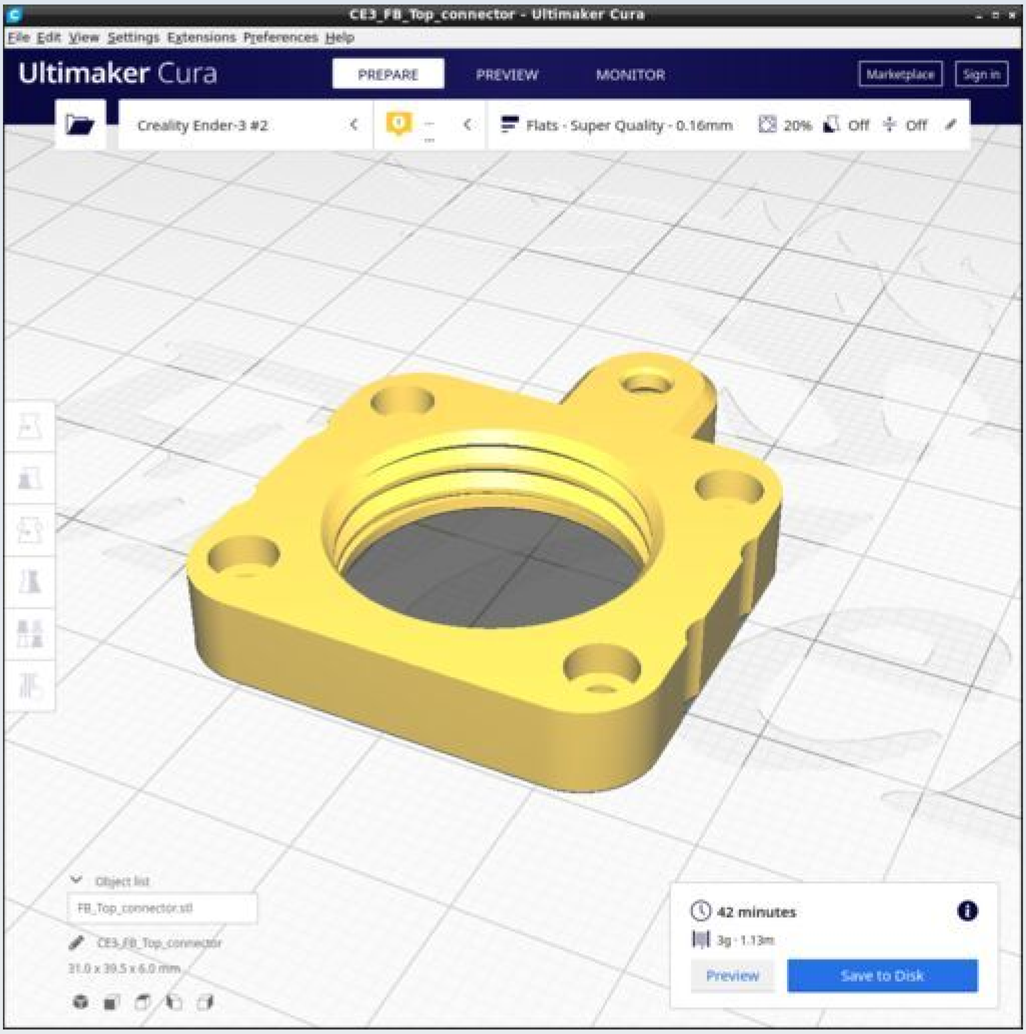
Ensure all supports are off.

FB_Stopper.stl



Ensure all supports are off.

FB_Top_connector.stl



Focus Gears

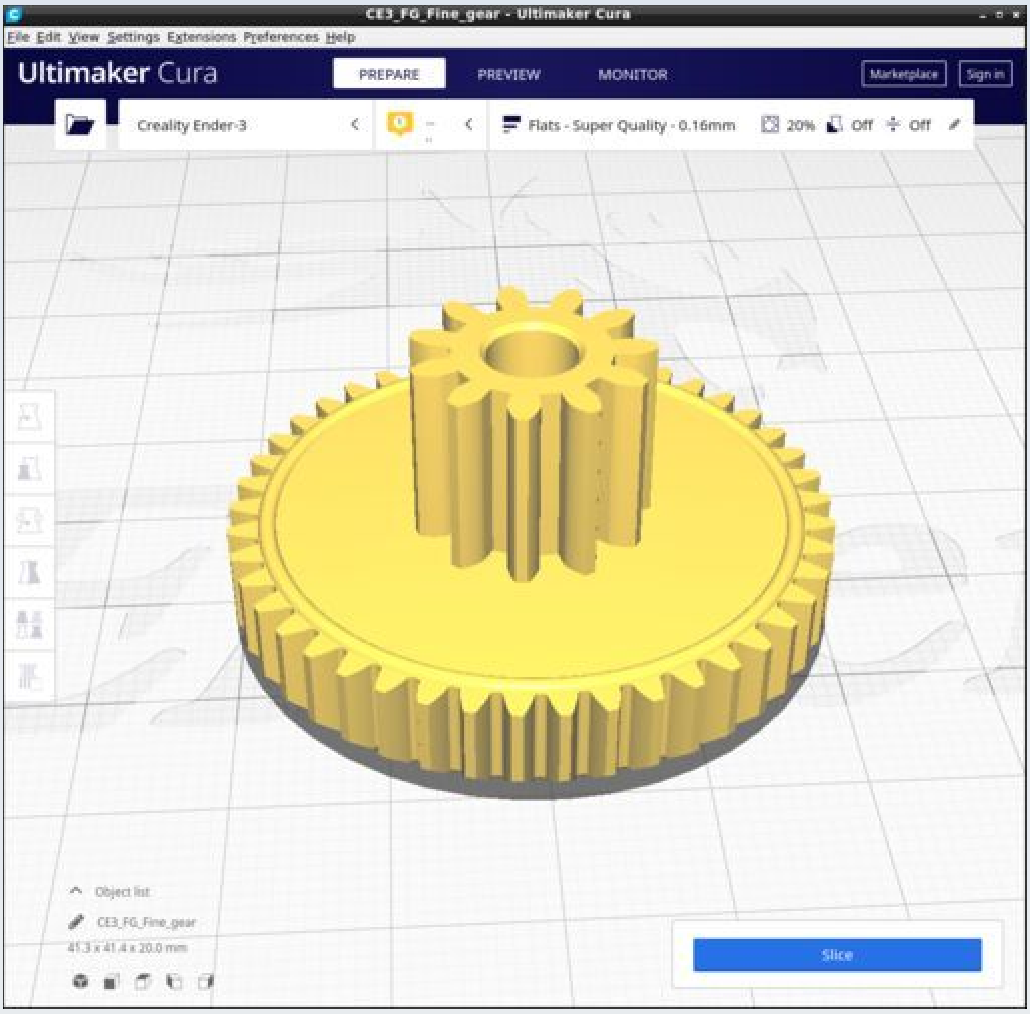
These are the parts for the stage focus mechansim. The CAD source models for these STL files are found in the file Focus_Gears.FCStd.

Resources

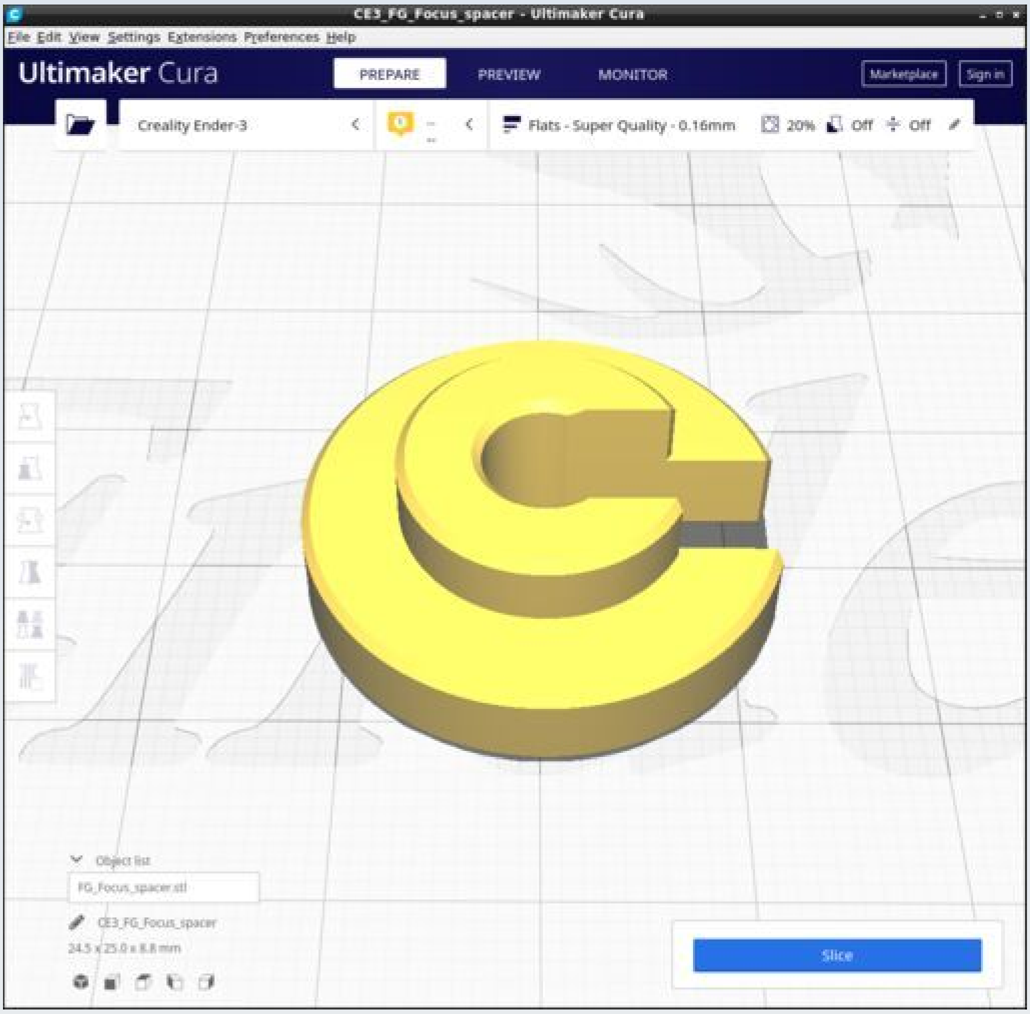
Cura calculates the following resources are required to print each model in this chapter:

Focus Gears	Time_Hr	Time_Min	PLA_Length(m)
FG_Fine_gear.stl	1	38	2.65
FG_Focus_spacer.stl	0	20	0.7
FG_Intermedius.stl	1	7	1.75
FG_Pulley_coarse.stl	1	18	2.03
FG_Pulley.stl	0	21	0.33
FG_Eccentric_Tensioner_Top.stl	0	24	0.69
FG_Eccentric_Tensioner_Bottom.stl	0	19	0.44
FG_Eccentric_Tensioner_Pulley_c_adhesin.stl	0	17	0.22

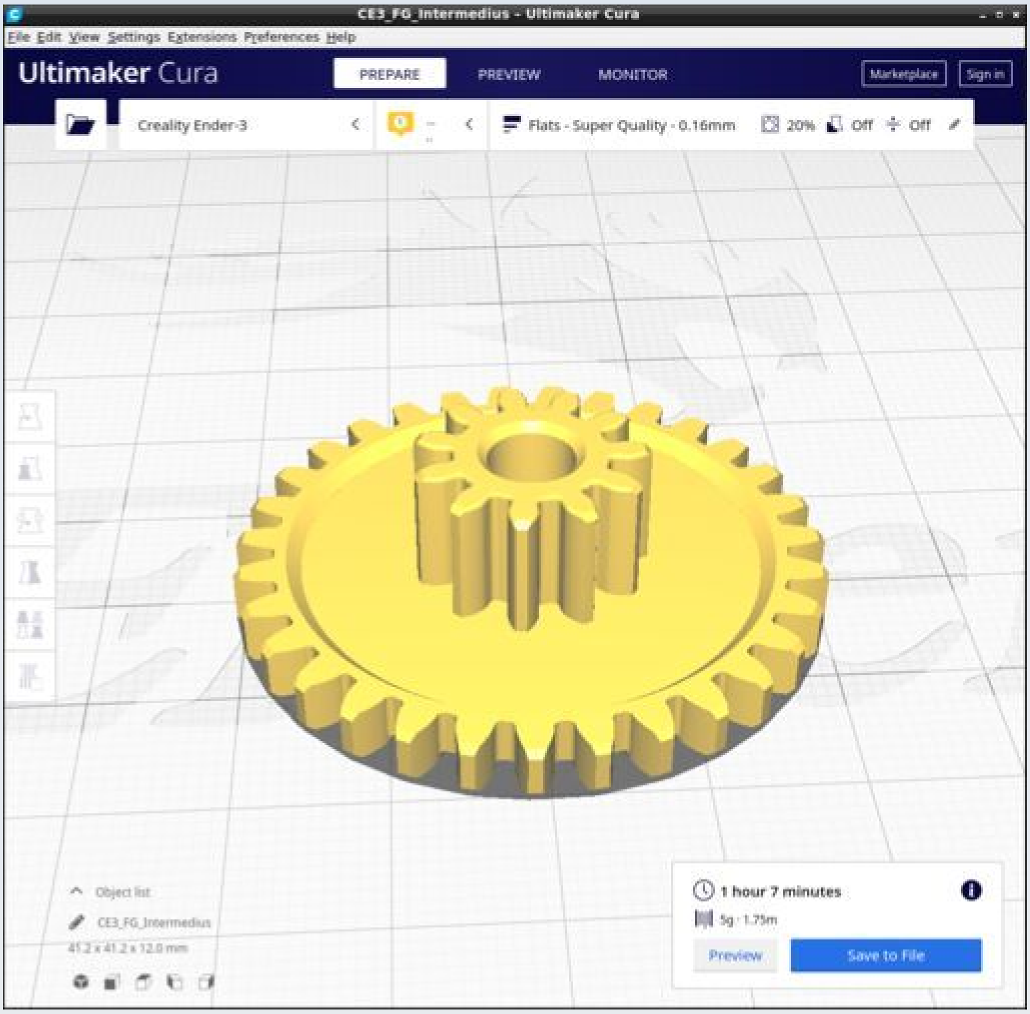
FG_Fine_gear.stl



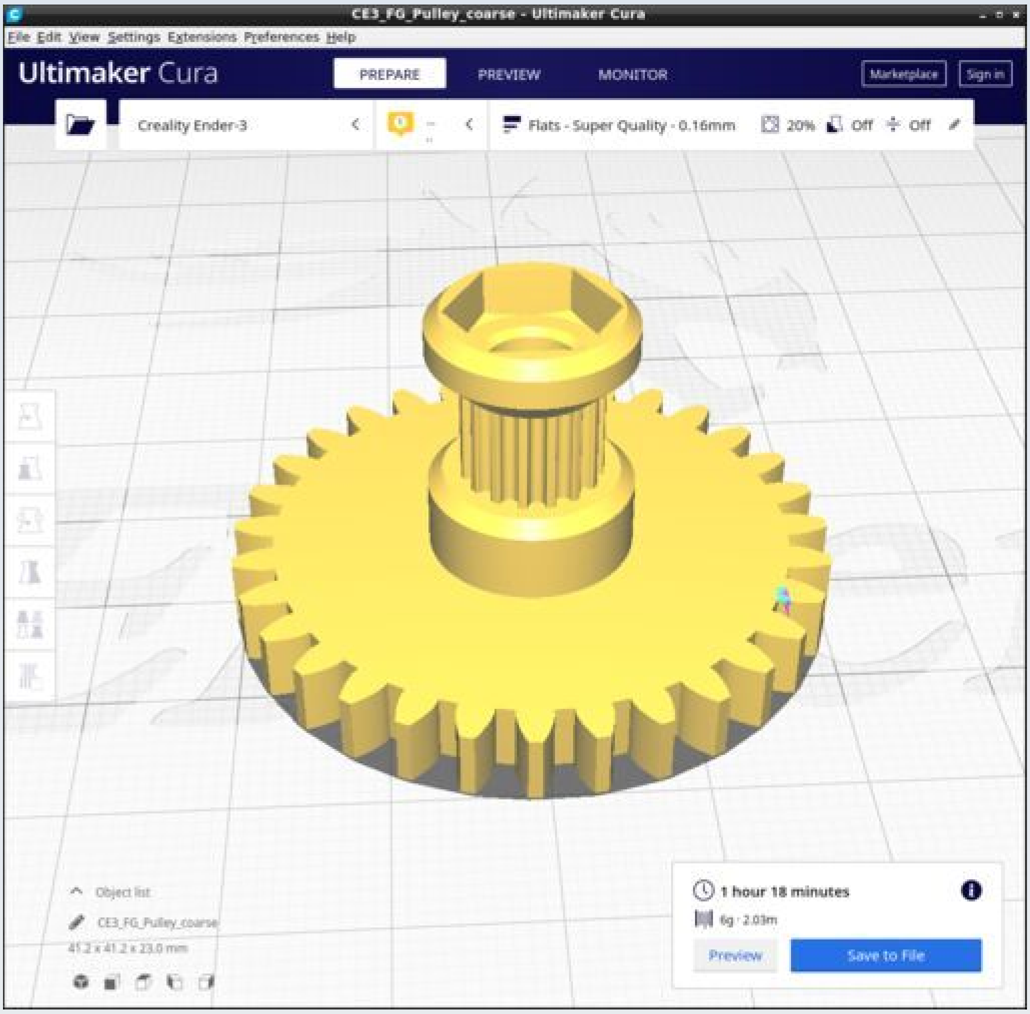
FG_Focus_spacer.stl



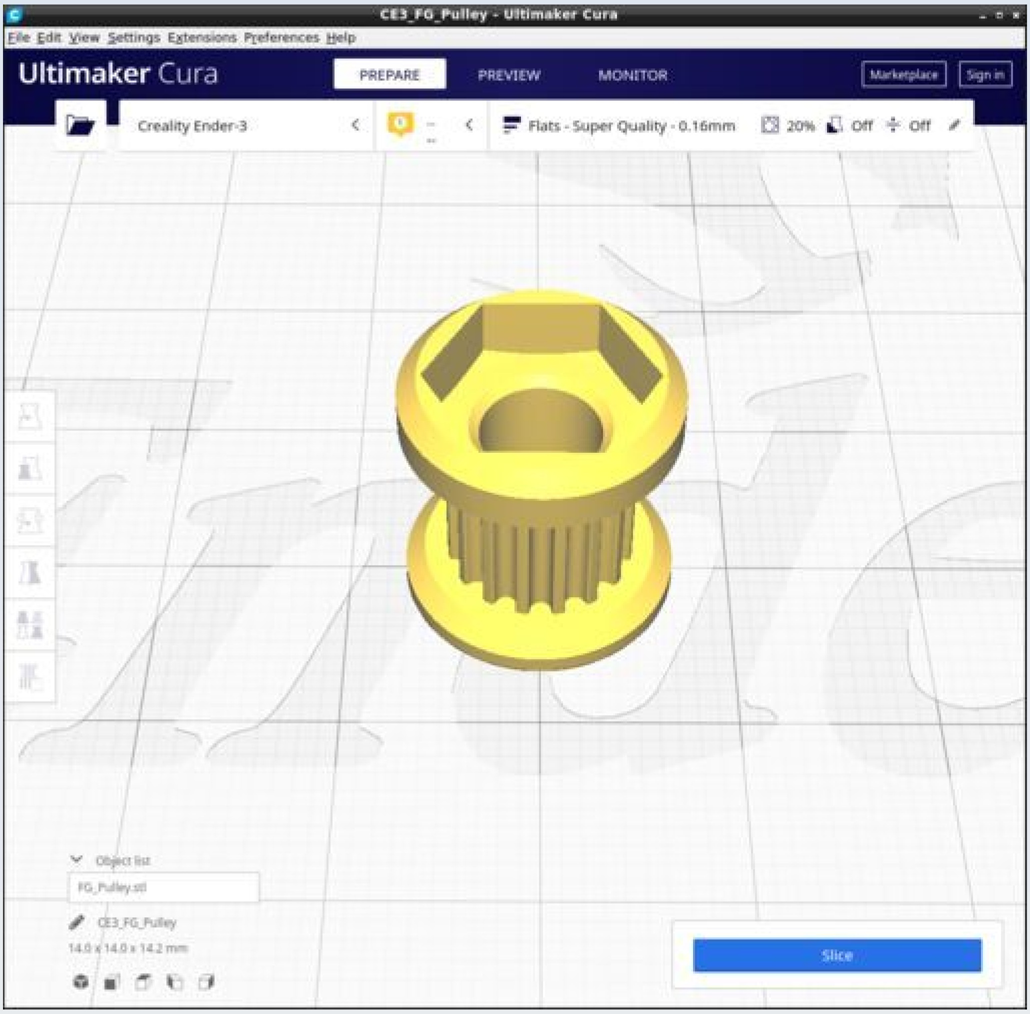
FG_Intermedius.stl



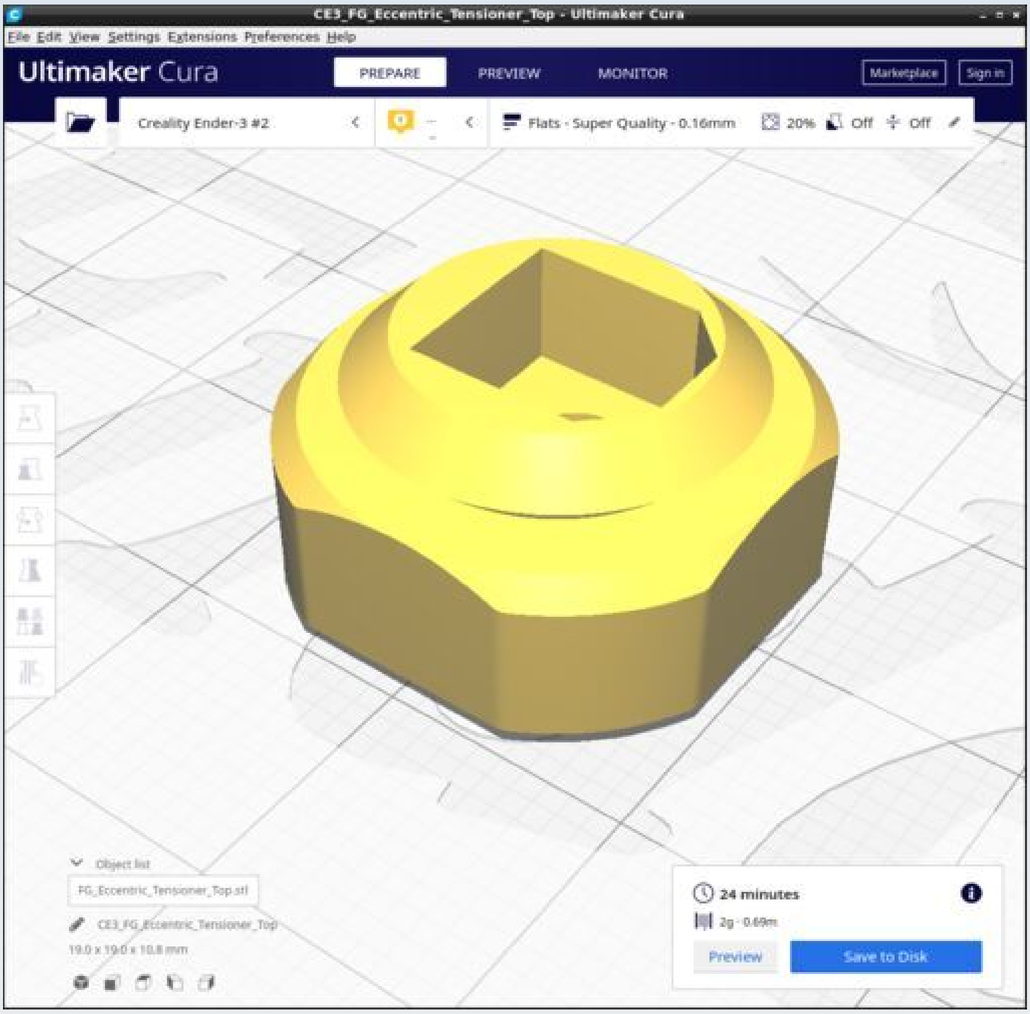
FG_Pulley_coarse.stl



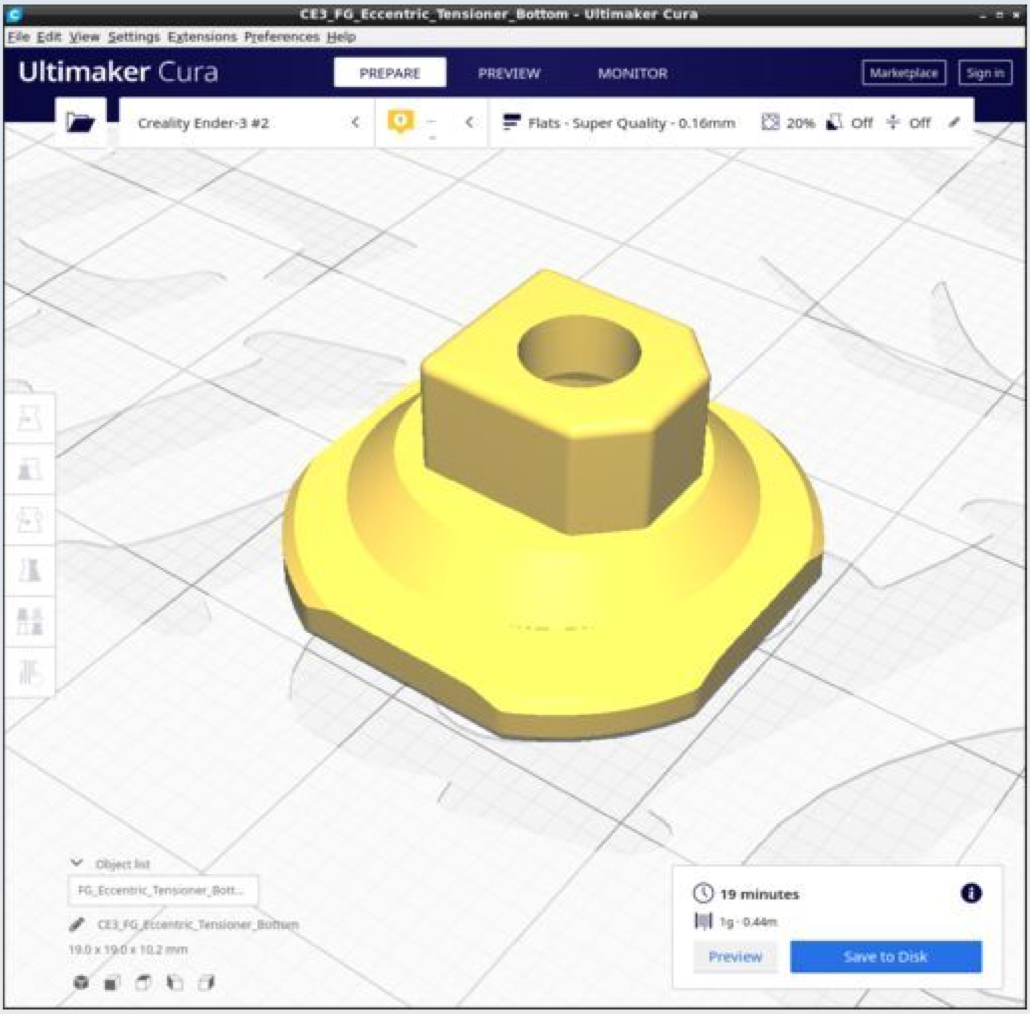
FG_Pulley.stl



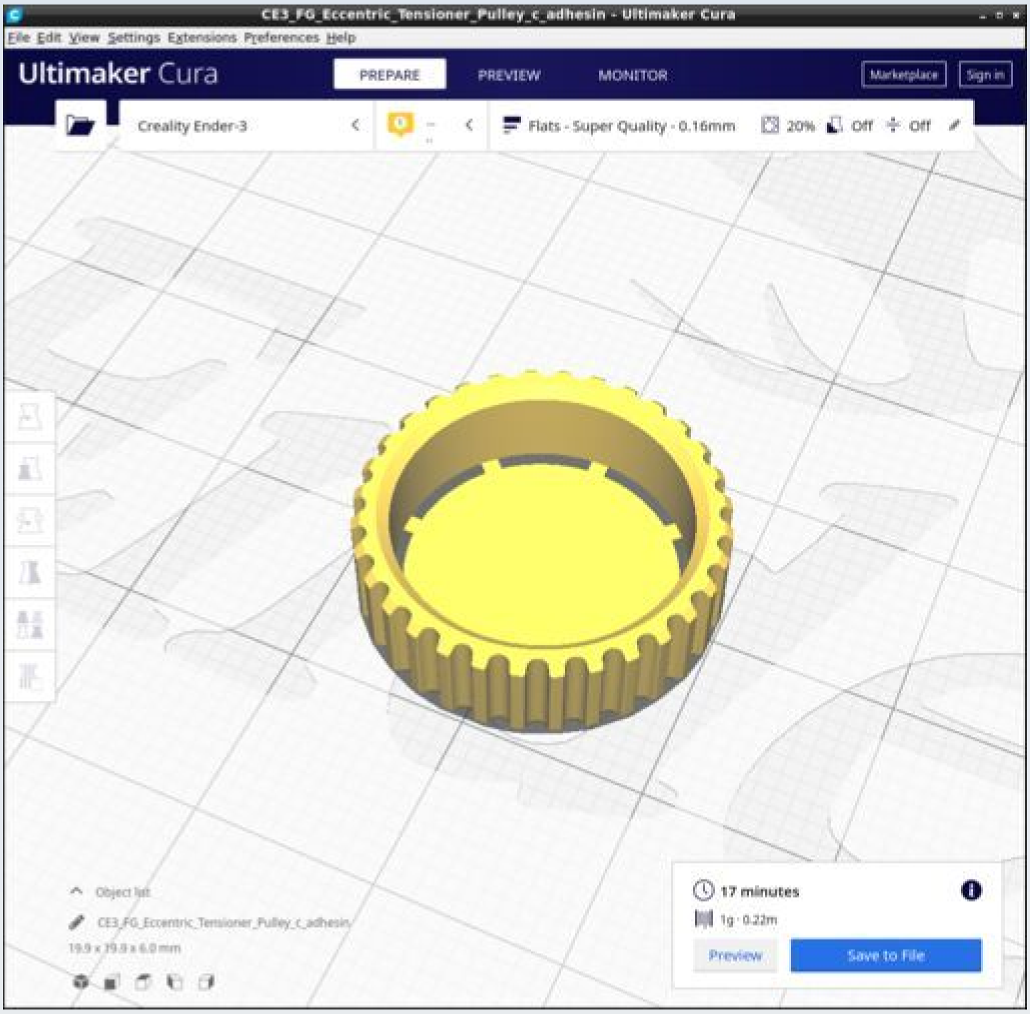
FG_Eccentric_Tensioner_Top.stl



FG_Eccentric_Tensioner_Bottom.stl



FG_Eccentric_Tensioner_Pulley_c_adhesin.stl



Legs

These are the parts for the various legs / stands options for the microscope. The CAD source models for these STL files are found in the file Legs.FCStd.

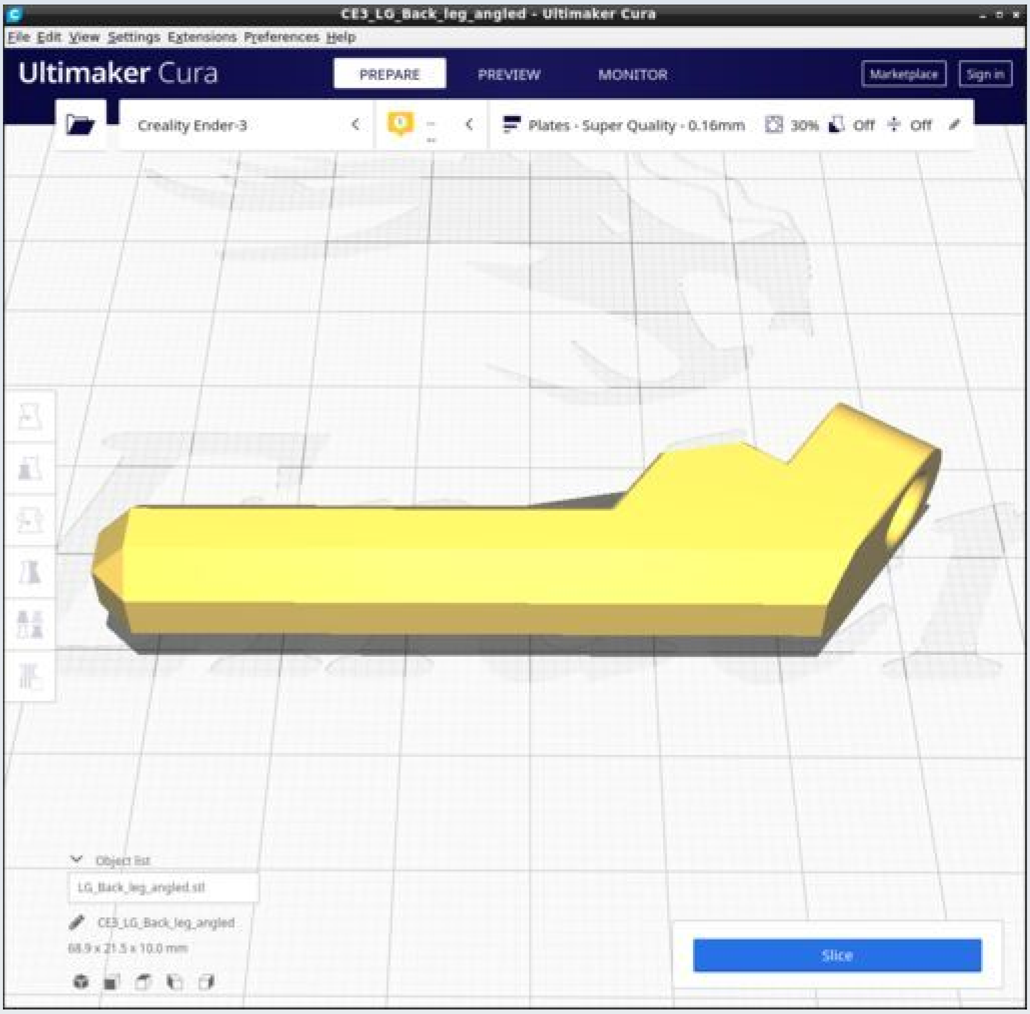
All these should be printed with the ‘Plates’ custom Cura profile. Only the ‘LG_Feet_linker.stl’ requires supports and special instructions (see below).

Resources

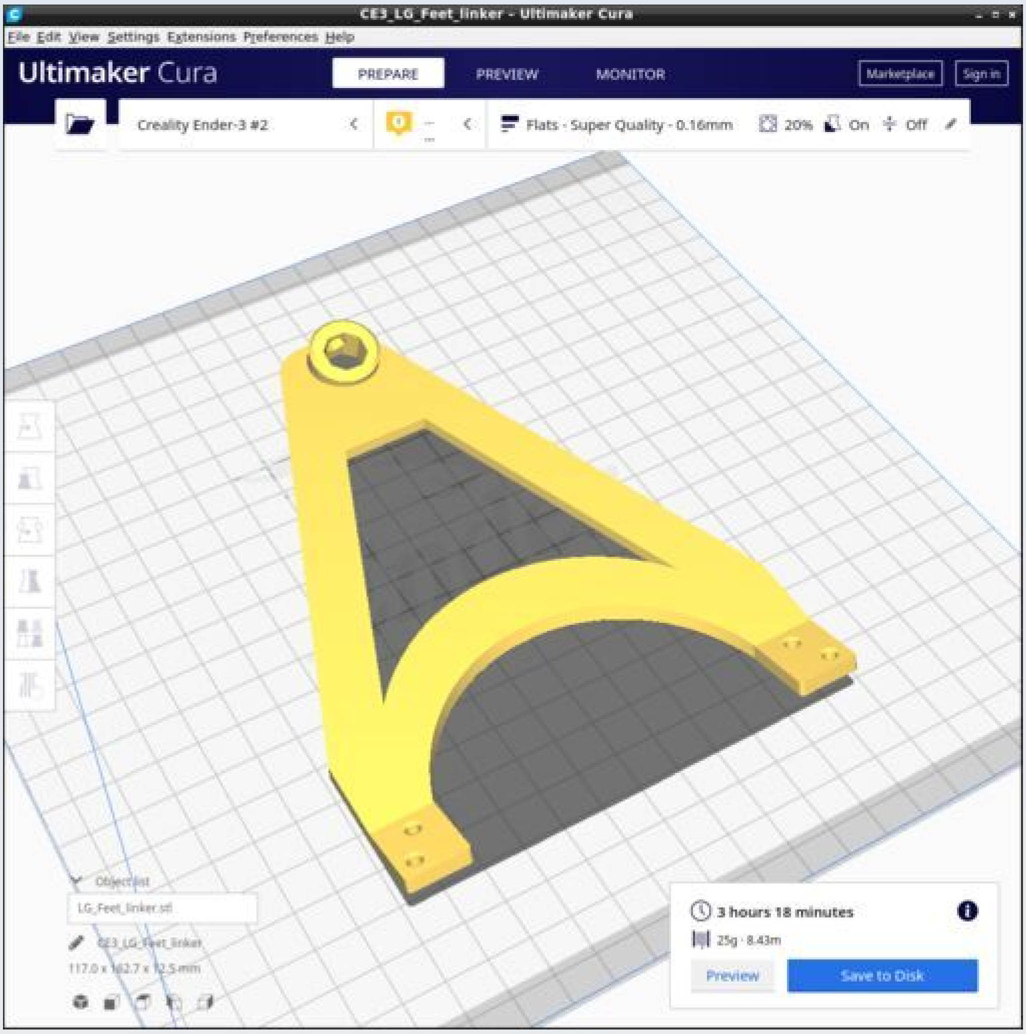
Cura calculates the following resources are required to print each model in this chapter:

Legs	Time_Hr	Time_Min	PLA_Length(m)
LG_Back_leg_angled.stl	0	36	1.68
LG_Feet_linker.stl	3	18	8.43
LG_Front_legs.stl	3	21	9.34
LG_Hind_extension.stl	0	46	1.64
LG_Short_leg.stl	0	16	0.54

LG_Back_leg_angled.stl



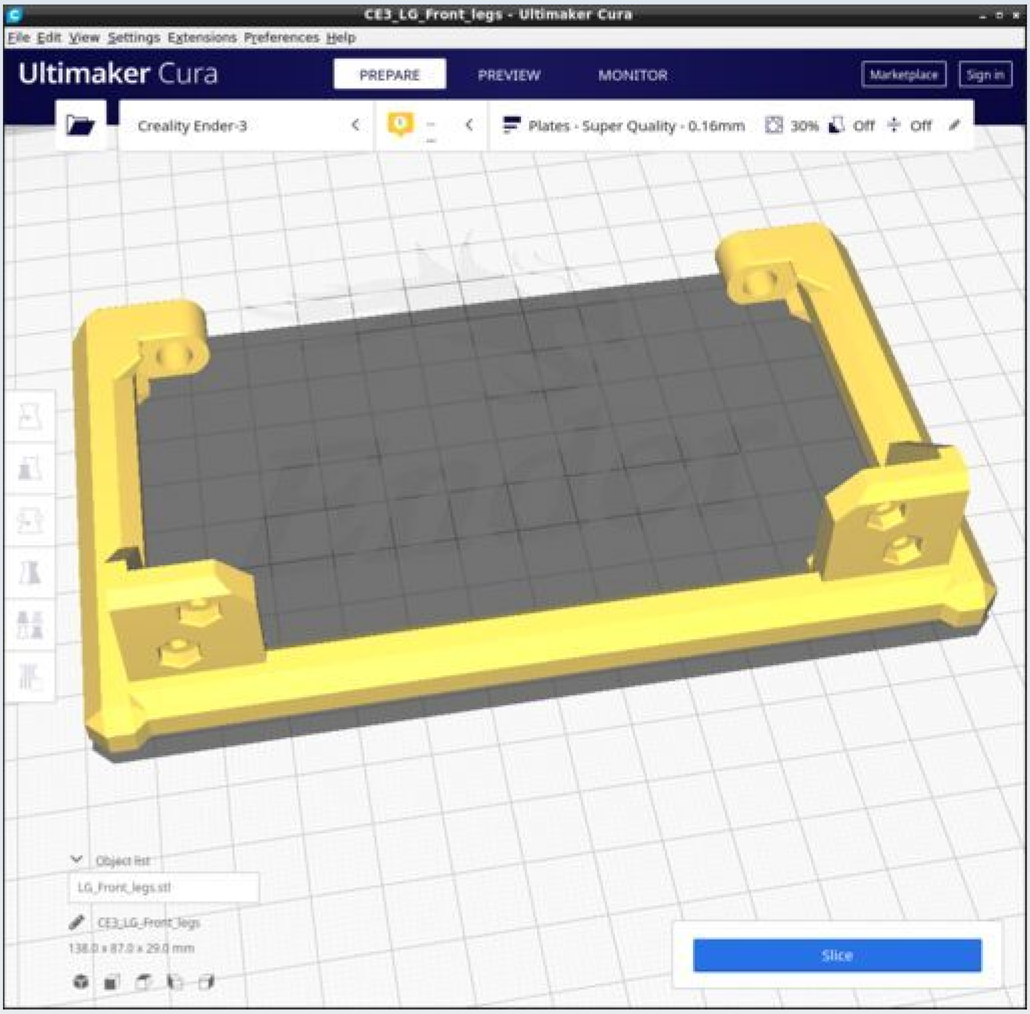
LG_Feet_linker.stl



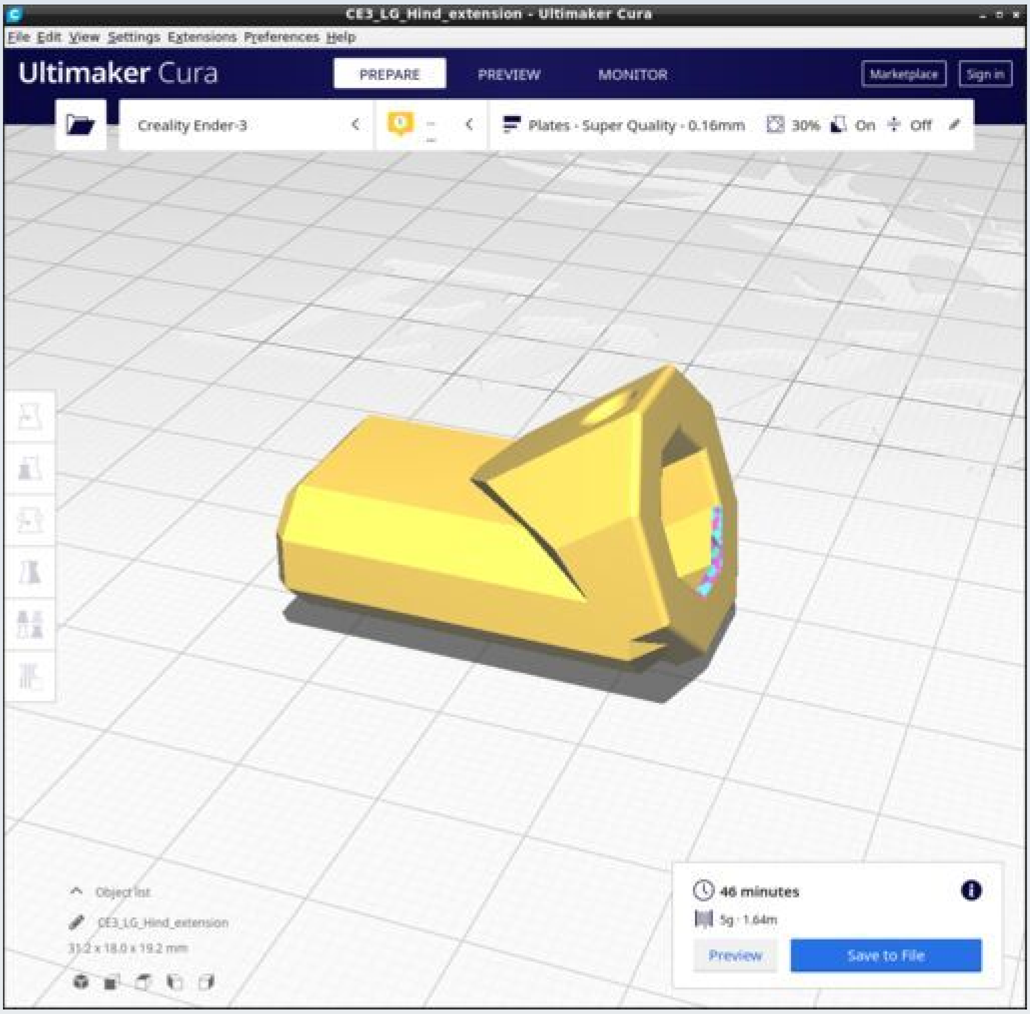
Use supports 'touching baseplate only' with 67 degree overhang angle.

Also, you must rotate it in Cura by 90 degrees to the position shown in the figure and ensure it is lain flat agains the build plate because there is a slight angle to it when first loaded (this may be imperceptible by eye but it can cause print failure if not corrected). Both the rotation by 90 degrees and the laying flat can be achieved in one step by selecting the model, going to the rotations menu and click the ‘Lay flat’ icon – this will do both things for you automatically (tested and works with Cura 4.8 and Cura 4.10.0).

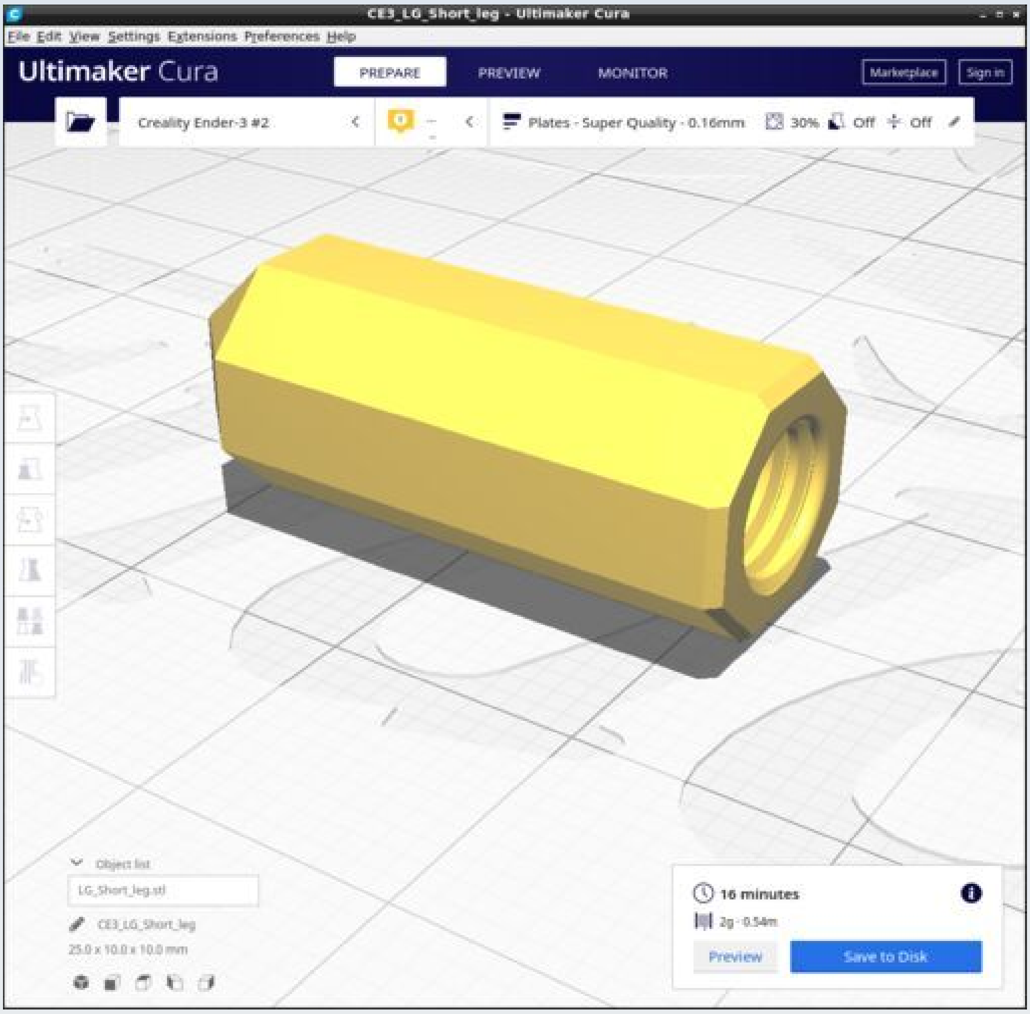
LG_Front_legs.stl



LG_Hind_extension.stl



LG_Short_leg.stl



Monocular Head

These are the parts for the monocular viewing head of the microscope. Some of the parts here are also used for the binocular and trinocular head modules. The CAD source models for these STL files are found in the file Monocular.FCStd.

For tubular structures (including the monocular tubes and projection cone) use the ‘Flats’ profile but modify it thus: use a 'Zig-Zag' infill pattern - it is quicker due to fewer stop-start retracts on the nozzle (16% of total time spent on retractions compared to 40% for the default cubic infill pattern, for the monocular tube model). Also use the 'concentric' 'Top/bottom' pattern.

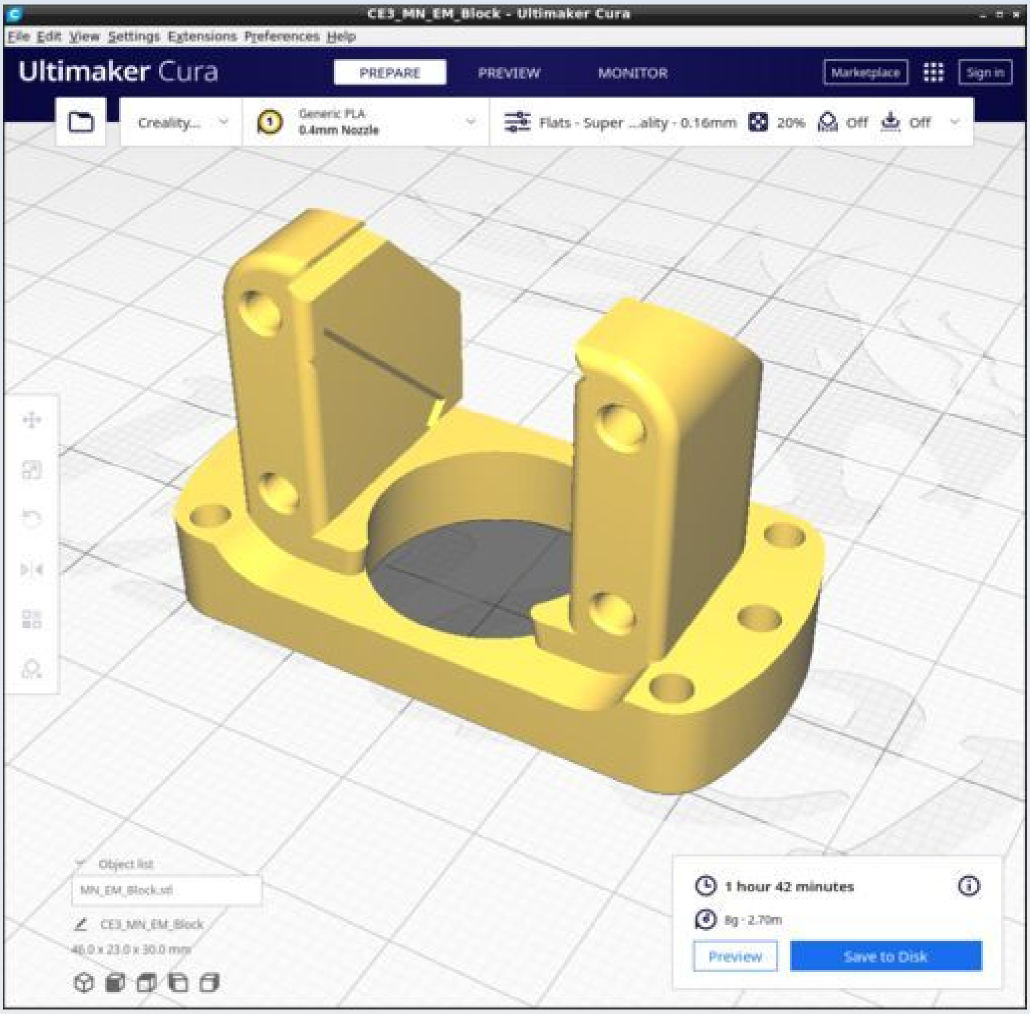
For other models just use the default ‘Flats’ profile.

Resources

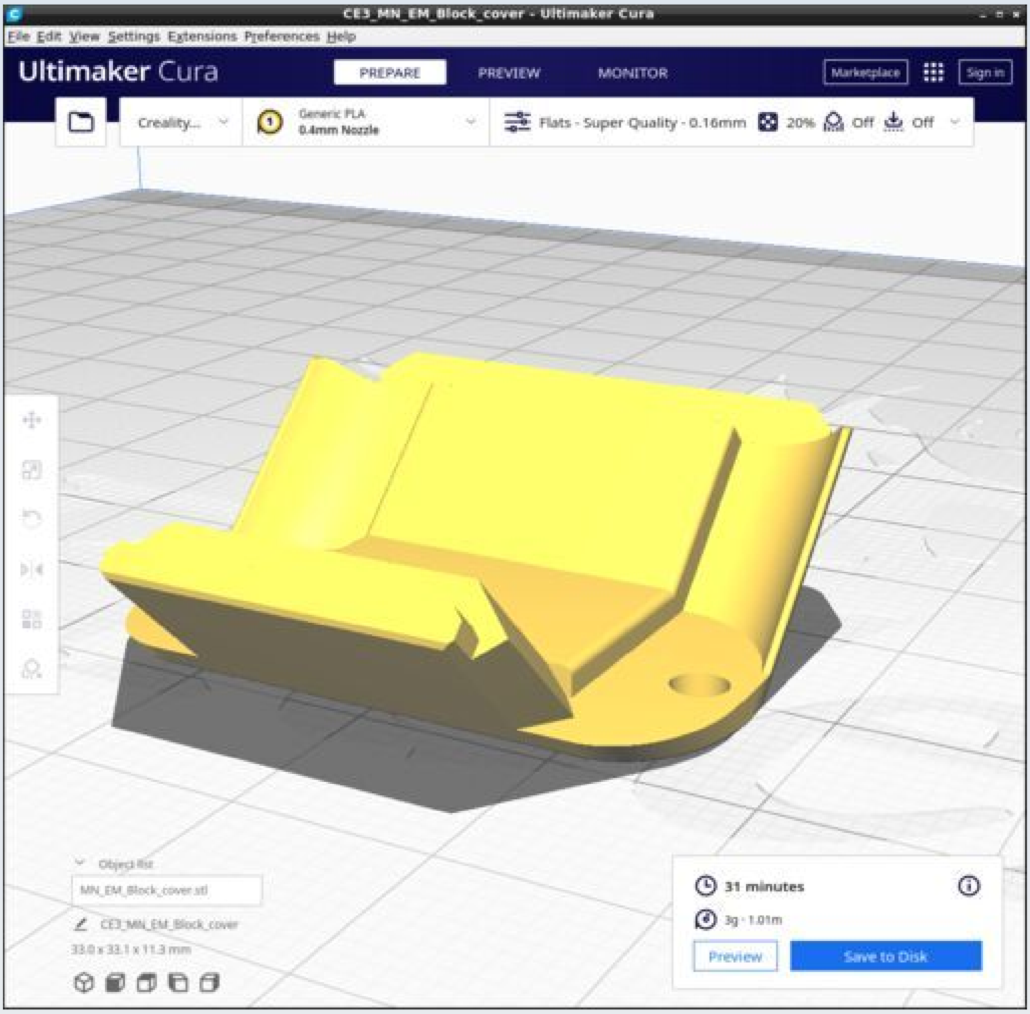
Cura calculates the following resources are required to print each model in this chapter:

Monocular Head	Time_Hr	Time_Min	PLA_Length(m)
MN_EM_Block.stl	1	42	2.7
MN_EM_Block_cover.stl	0	31	1.01
MN_Monocular_tube_c_adhesin.stl	2	33	8.04
MN_Monocular_tube_CM_c_adhesin.stl	2	7	6.56
MN_Ocular_cap_170.stl	1	9	2.83
MN_Ocular_cap.stl	0	42	1.65
MN_Ocular_extension_c_adhesin.stl	0	55	2.19
MN_Ocular_extension_CM_c_adhesin.stl	0	38	1.7
MN_Ocular_Extn_CM_170_c_adhesin.stl	1	2	2.62
MN_Ocular_lock_nut.stl	0	16	0.47
MN_Ocular_protective_cap.stl	0	19	1.14
MN_Ocular_tube_protective_cap.stl	0	26	1.14
MN_Projector_cone.stl	2	6	7.91
MN_Aperture_20mm.stl	0	19	0.93
MN_Aperture_46mm.stl	0	7	0.32

MN_EM_Block.stl



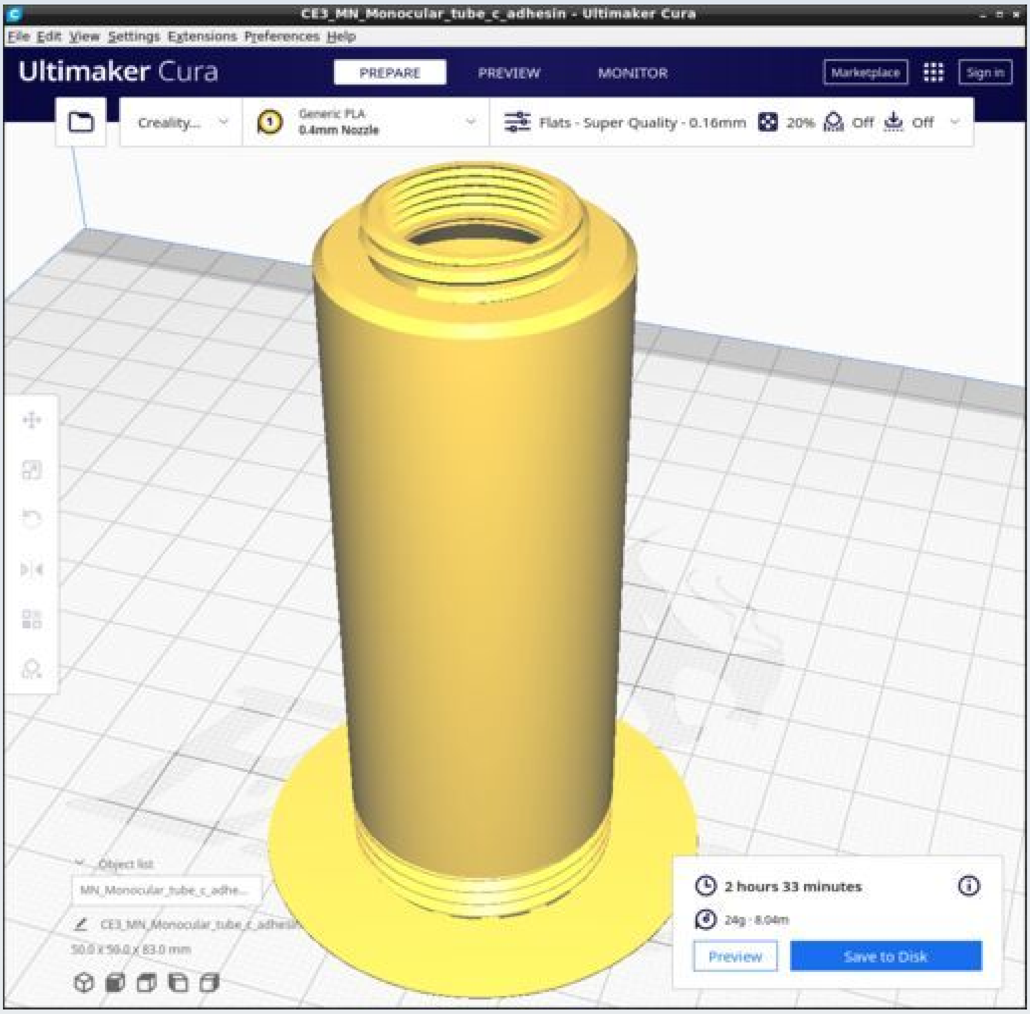
MN_EM_Block_cover.stl



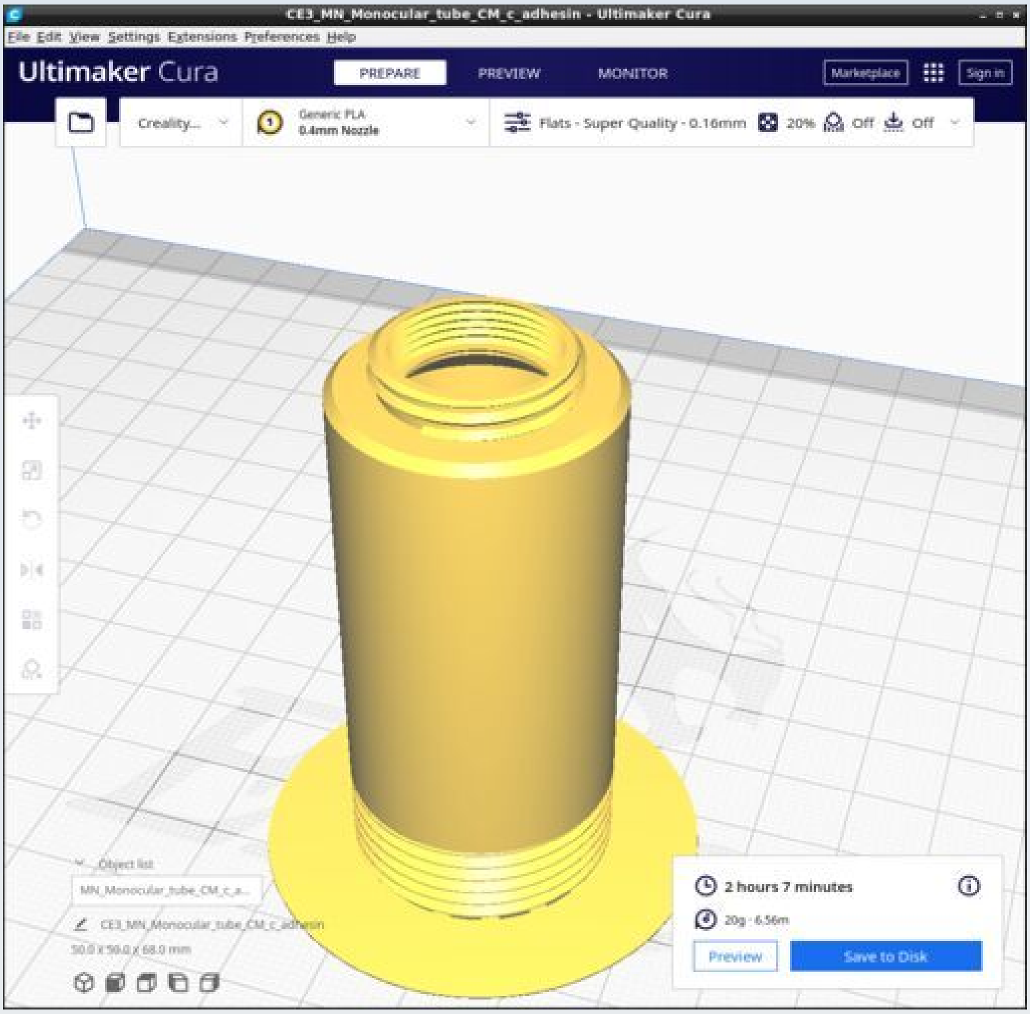
Note the orientation. For some reason, if you try to rotate the mesh by 45 degrees in FreeCAD and export the mesh, the exported mesh needs to be 'laid flat' in Cura because the 45 degree rotation doesn’t quite lay it flat.

i have found that it is best to export the mesh from FreeCAD as is, without the 45 degree rotation in FreeCAD, then do that rotation in Cura to position it as shown.

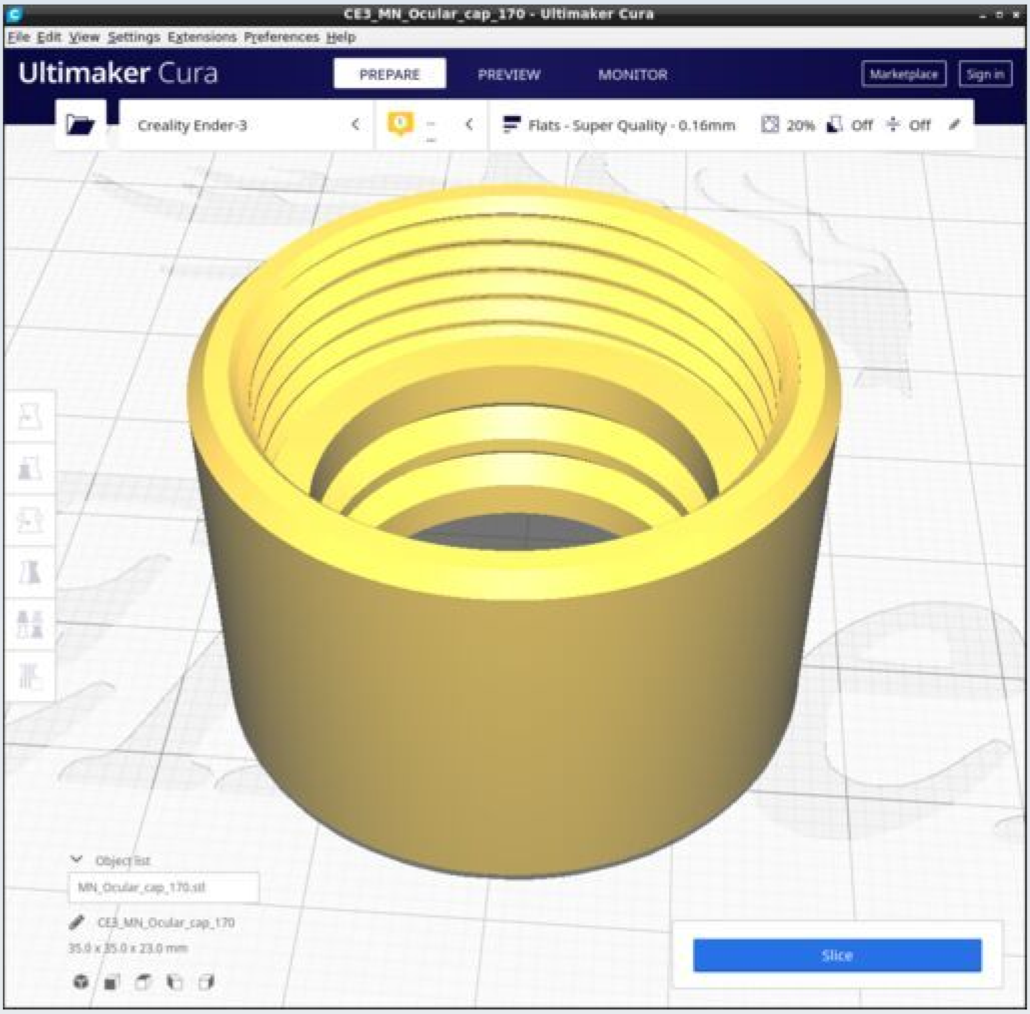
MN_Monocular_tube_c_adhesin.stl



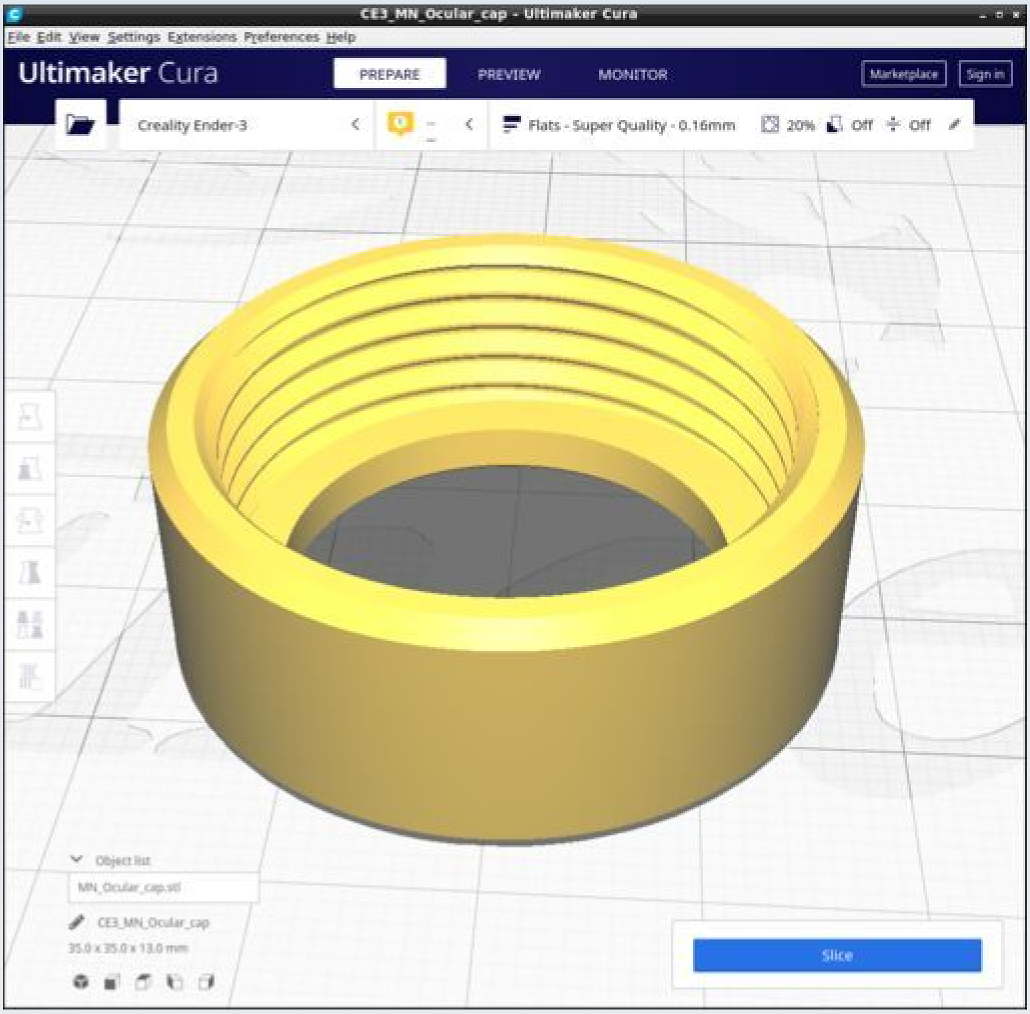
MN_Monocular_tube_CM_c_adhesin.stl



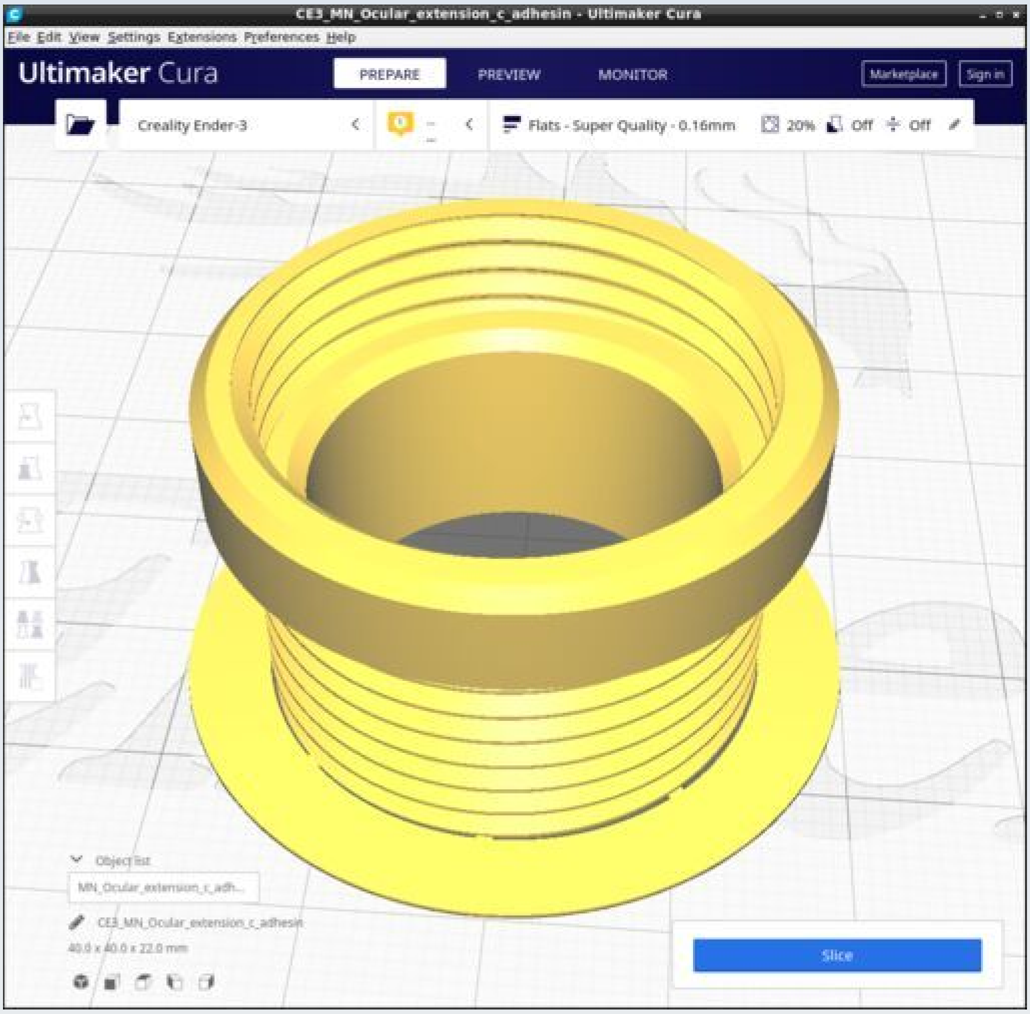
MN_Ocular_cap_170.stl



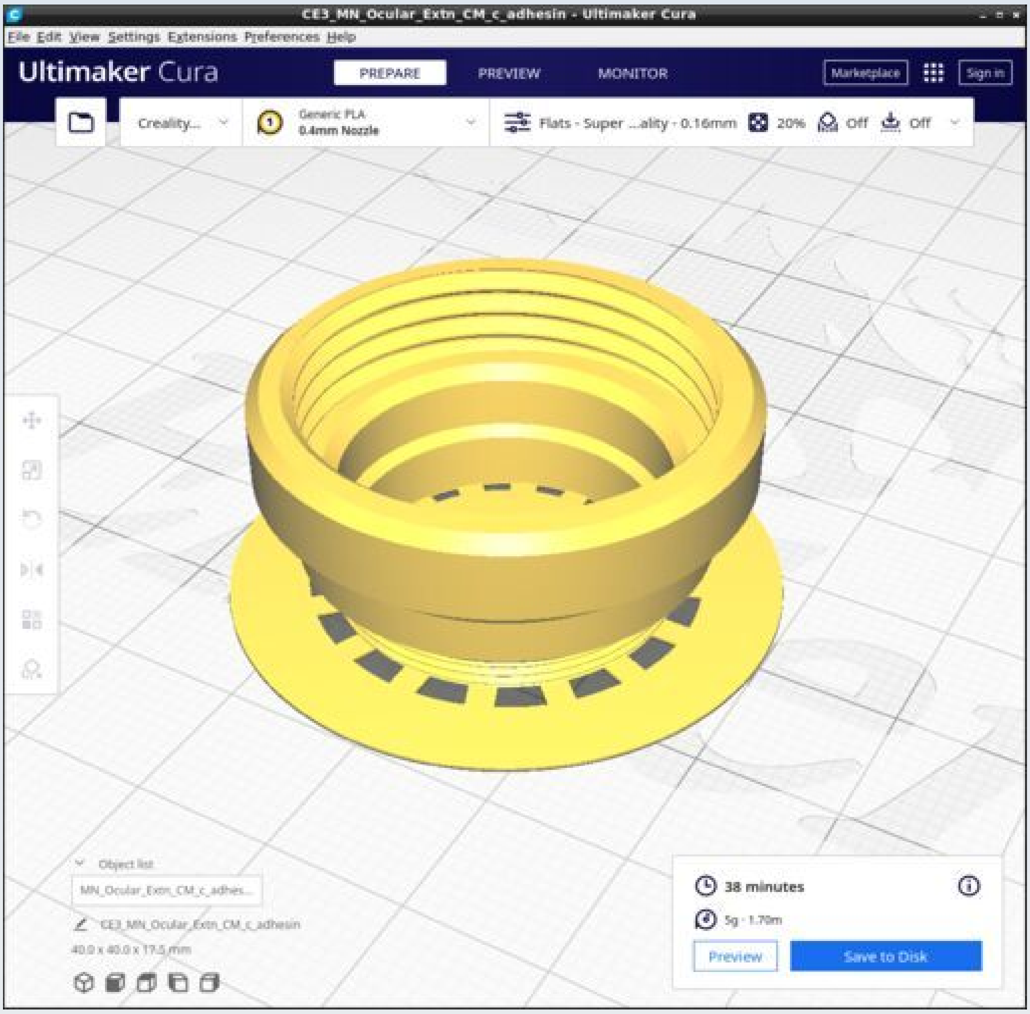
MN_Ocular_cap.stl



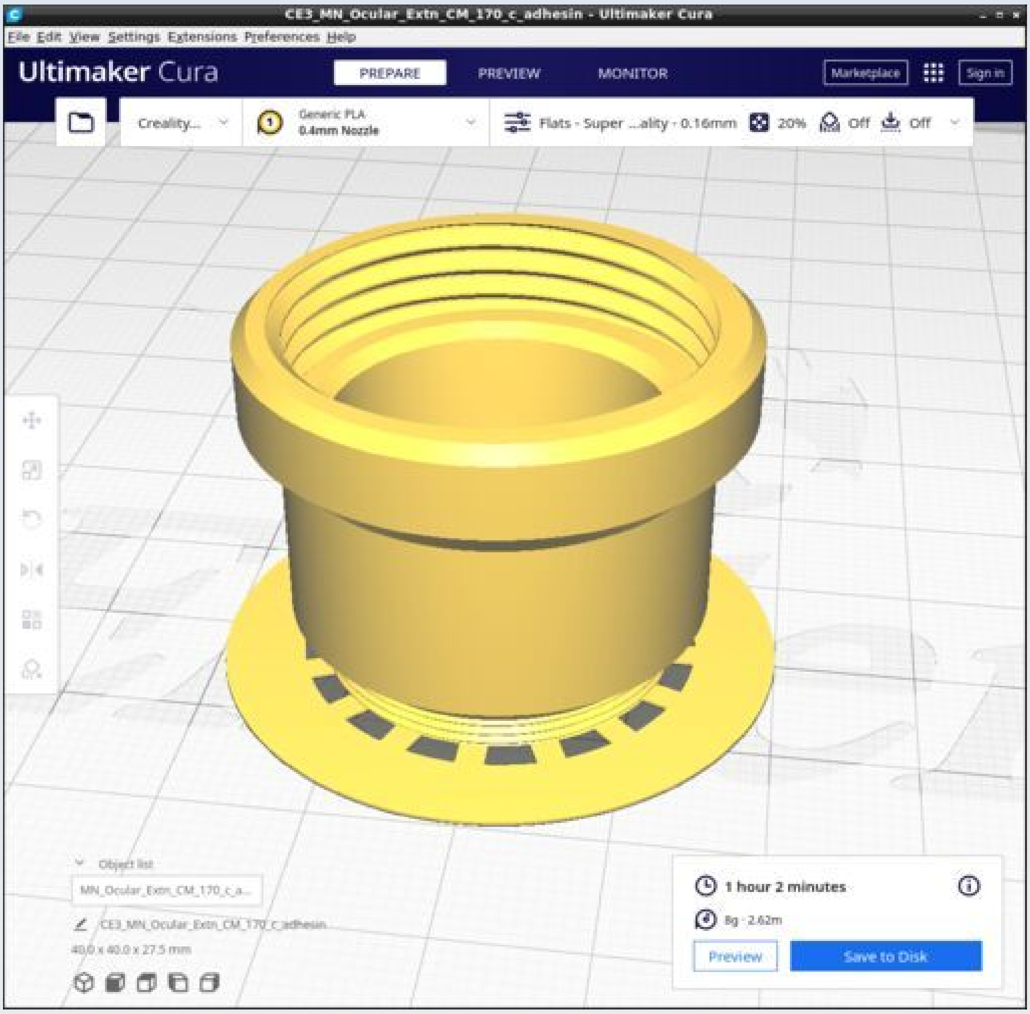
MN_Ocular_extension_c_adhesin.stl



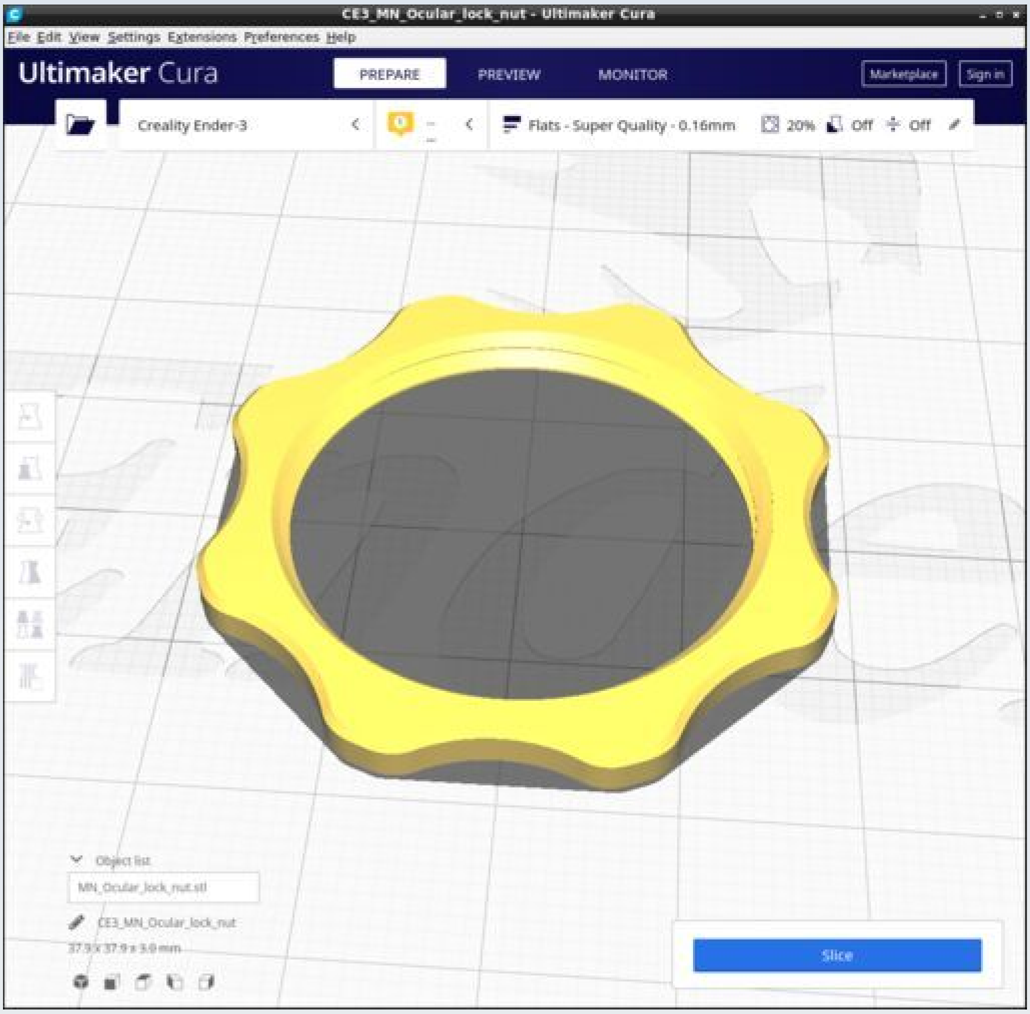
MN_Ocular_extension_CM_c_adhesin.stl



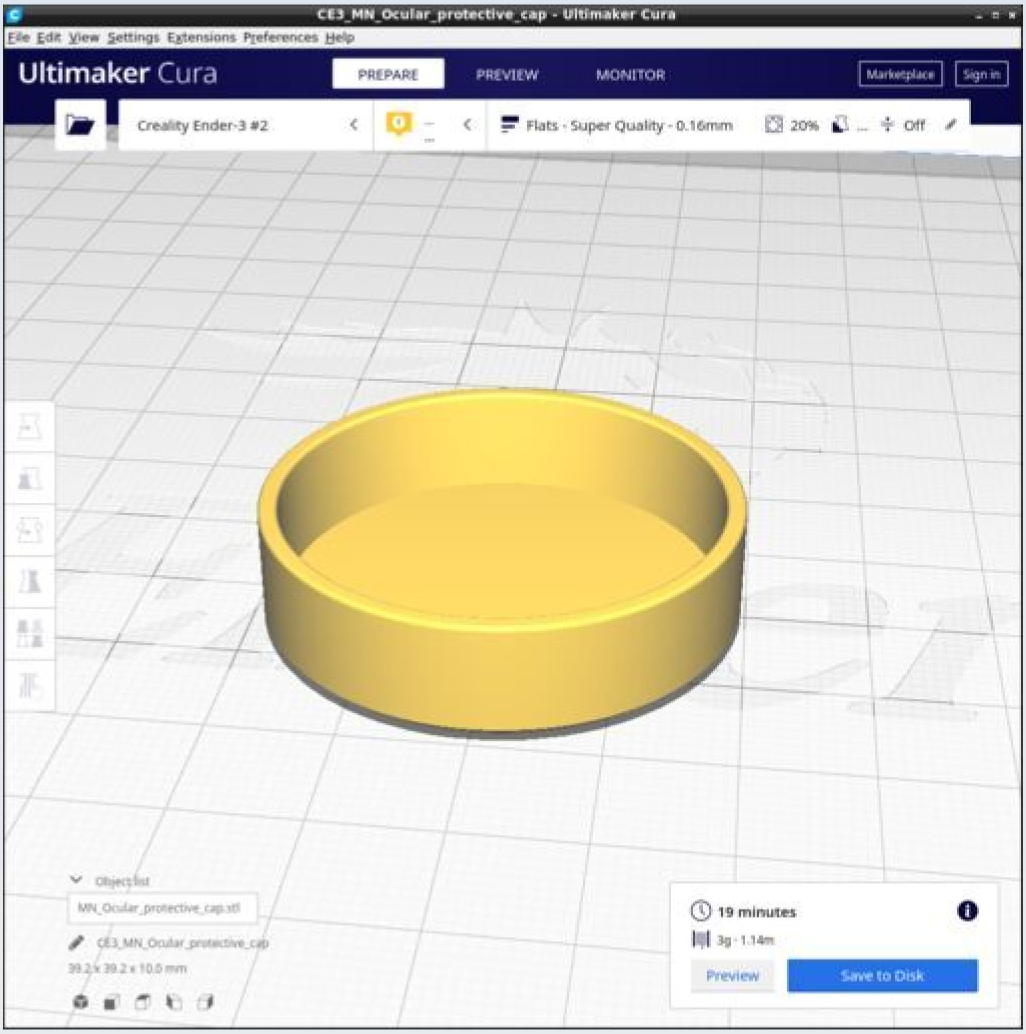
MN_Ocular_Extn_CM_170_c_adhesin.stl



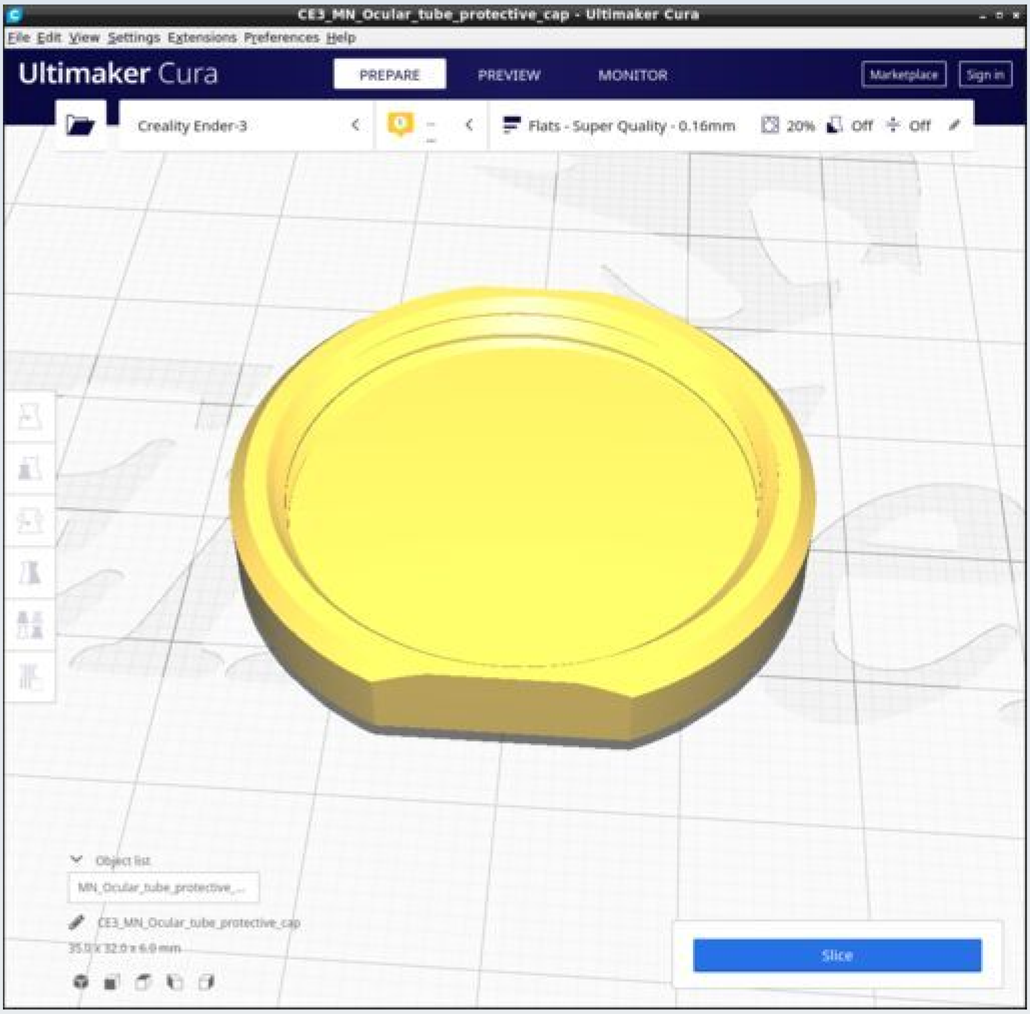
MN_Ocular_lock_nut.stl



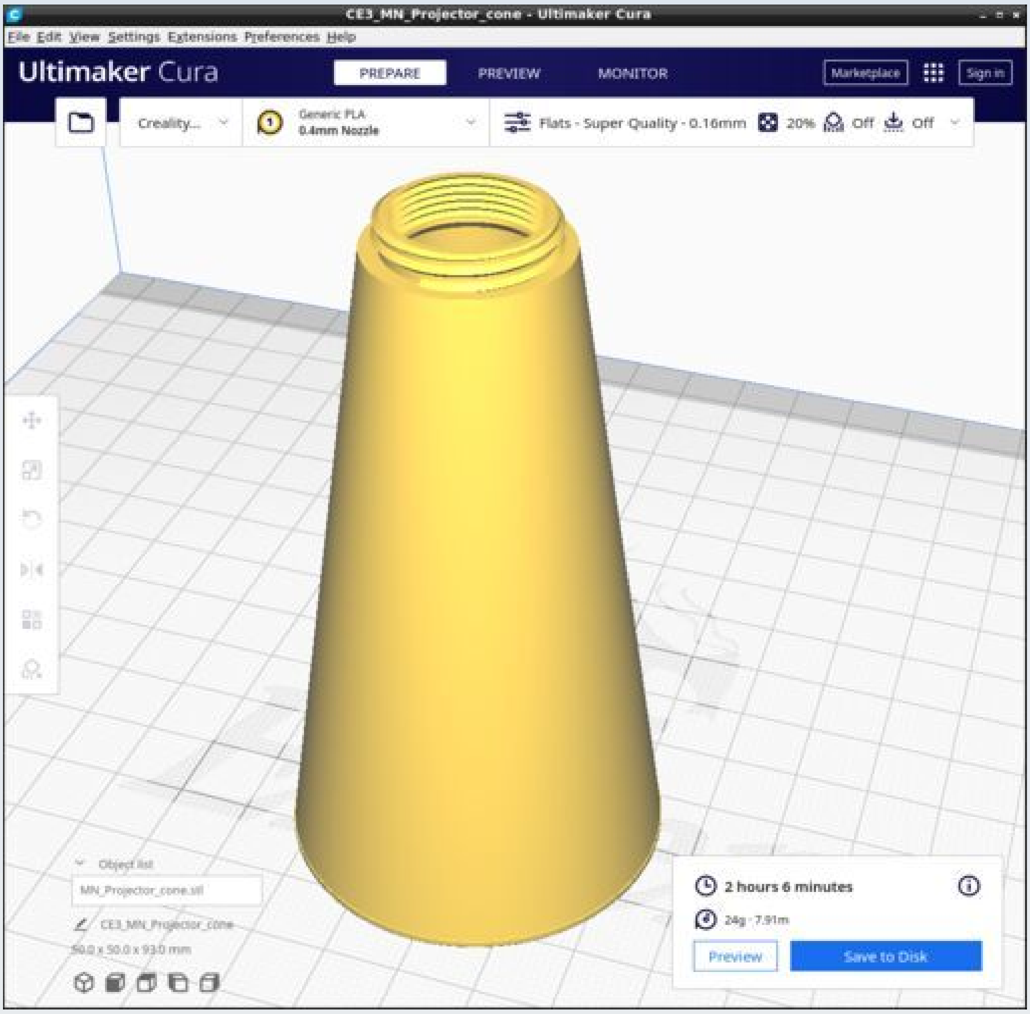
MN_Ocular_protective_cap.stl



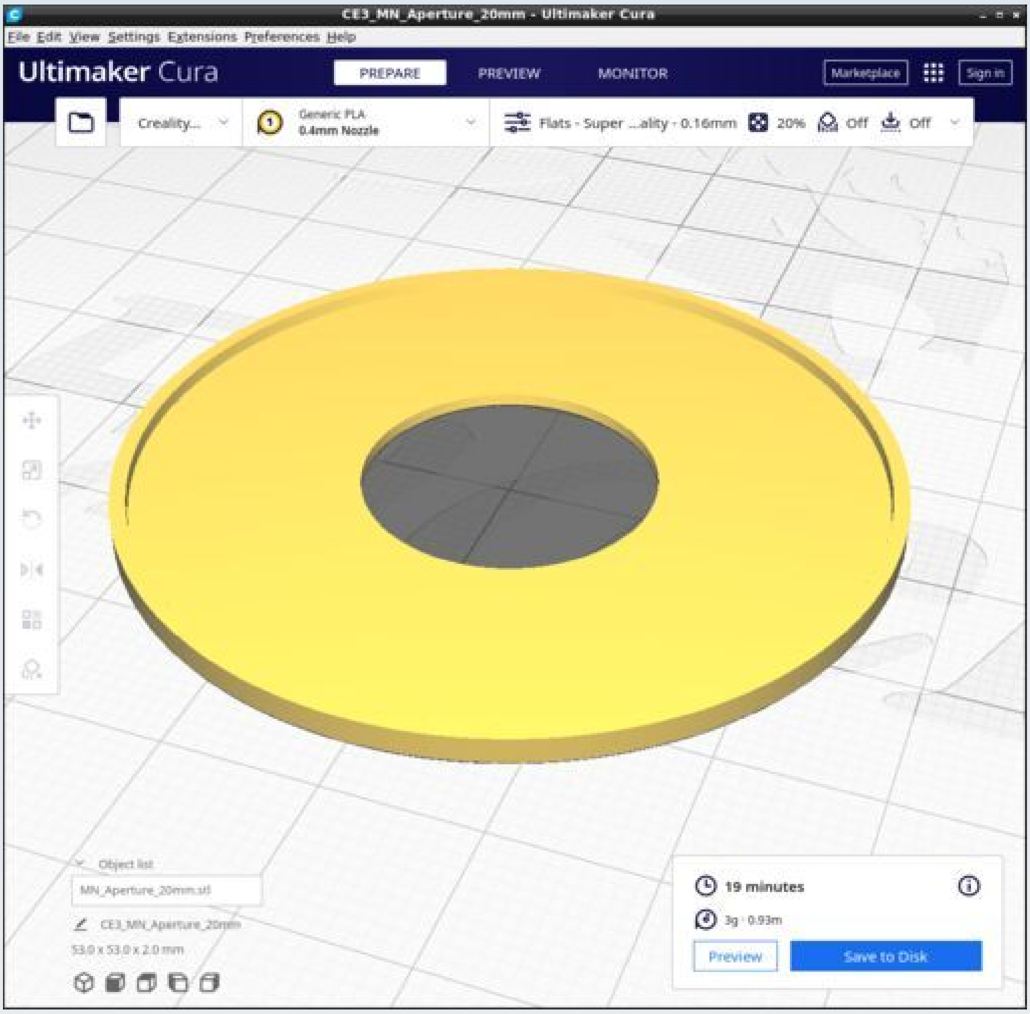
MN_Ocular_tube_protective_cap.stl



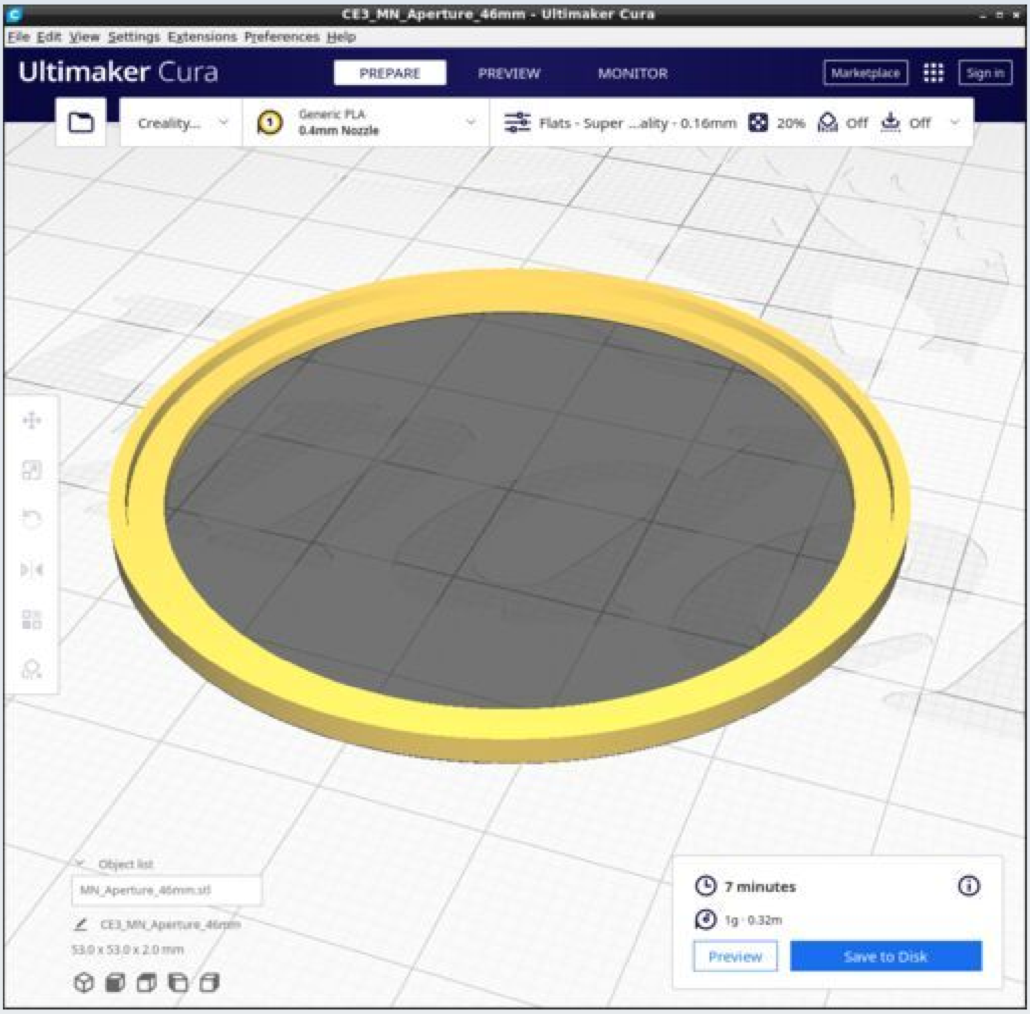
MN_Projector_cone.stl



MN_Aperture_20mm.stl



MN_Aperture_46mm.stl



PUMA Control Console

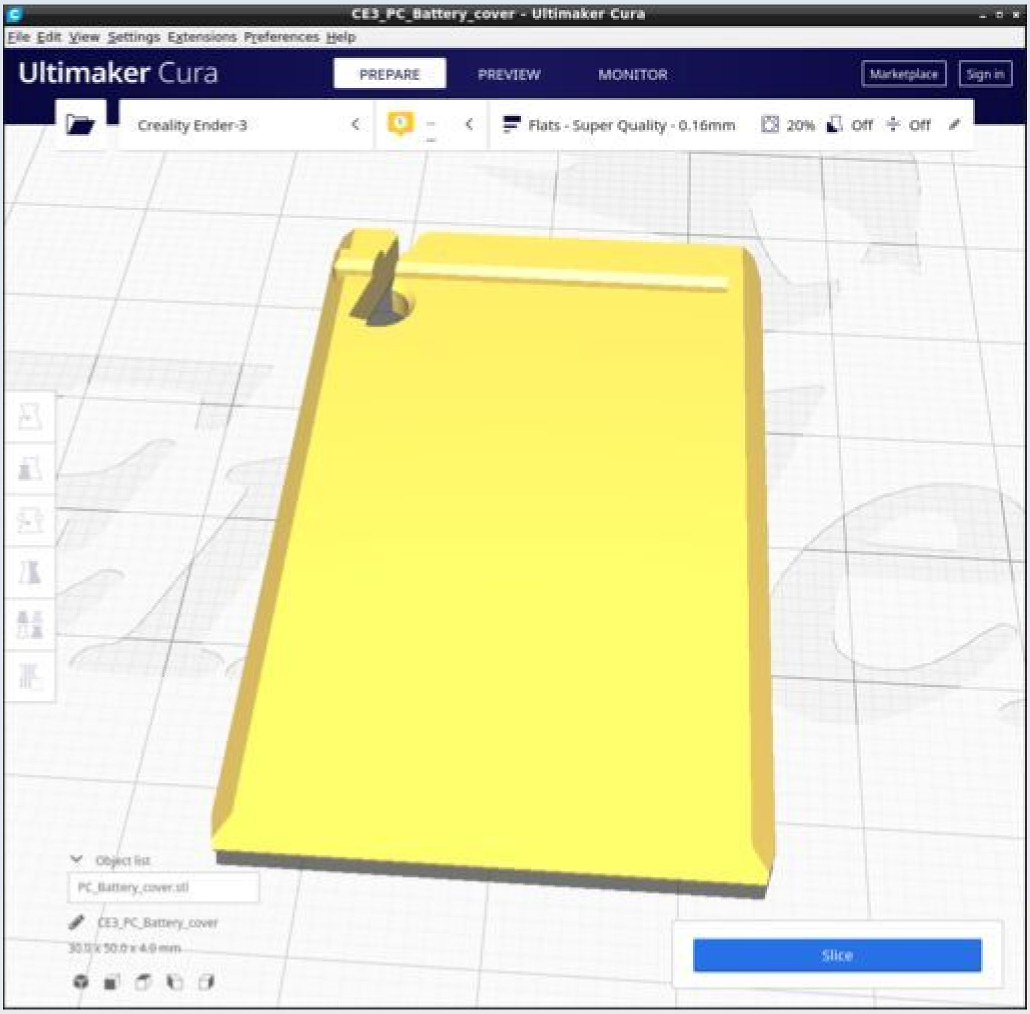
These are the parts for the PUMA Control Console (PCC) used not only to drive the LED light of the microscope but also allowing control of the Z-stage motor and 25x25 mm ST7789 TFT display (the display may be used for either the AR HUD, the SLM or the optional monitor attached to the PCC – only one TFT can be driven with the standard Arduino Nano-based PCC so you can only use one of those options at a time). The CAD source models for these STL files are found in the file PUMA_Control.FCStd.

Resources

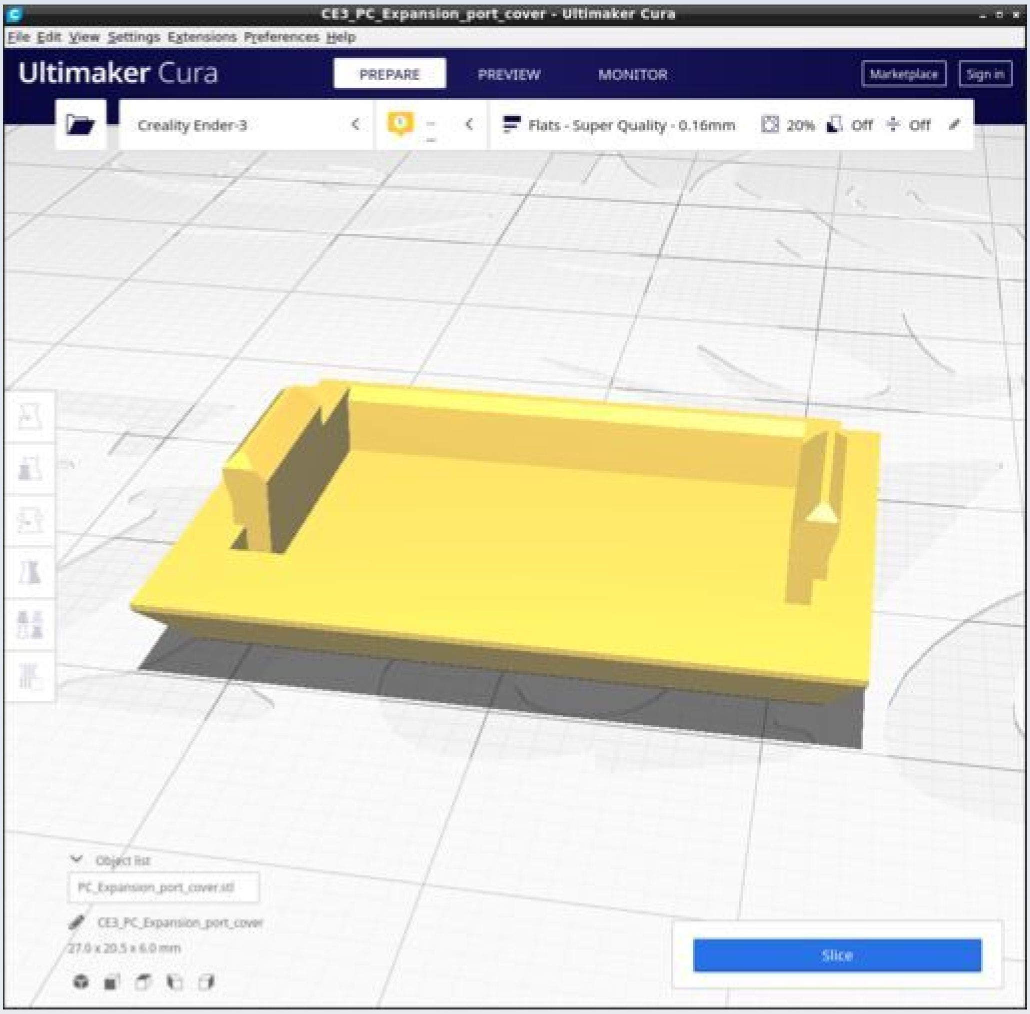
Cura calculates the following resources are required to print each model in this chapter:

PUMA Control Console	Time_Hr	Time_Min	PLA_Length(m)
PC_Battery_cover.stl	0	31	1.44
PC_Expansion_port_cover.stl	0	11	0.37
PC_Front_panel.stl	4	21	7.44
PC_Joystick_PCB_clasp.stl	0	18	0.71
PC_Lamp_insulator.stl	0	1	0.02
PC_Left_panel_Base_Skeleton.stl	12	44	24.27
PC_Top_back_panel.stl	8	28	13.42
PC_Ardu_cover	0	6	0.17
PC_Current_knob	0	21	0.71
PC_Monitor_case	3	38	13.73
PC_Monitor_connector	0	24	1.05
PC_Monitor_lens_retainer	0	17	0.89
PC_Monitor_light_shield	0	28	0.79

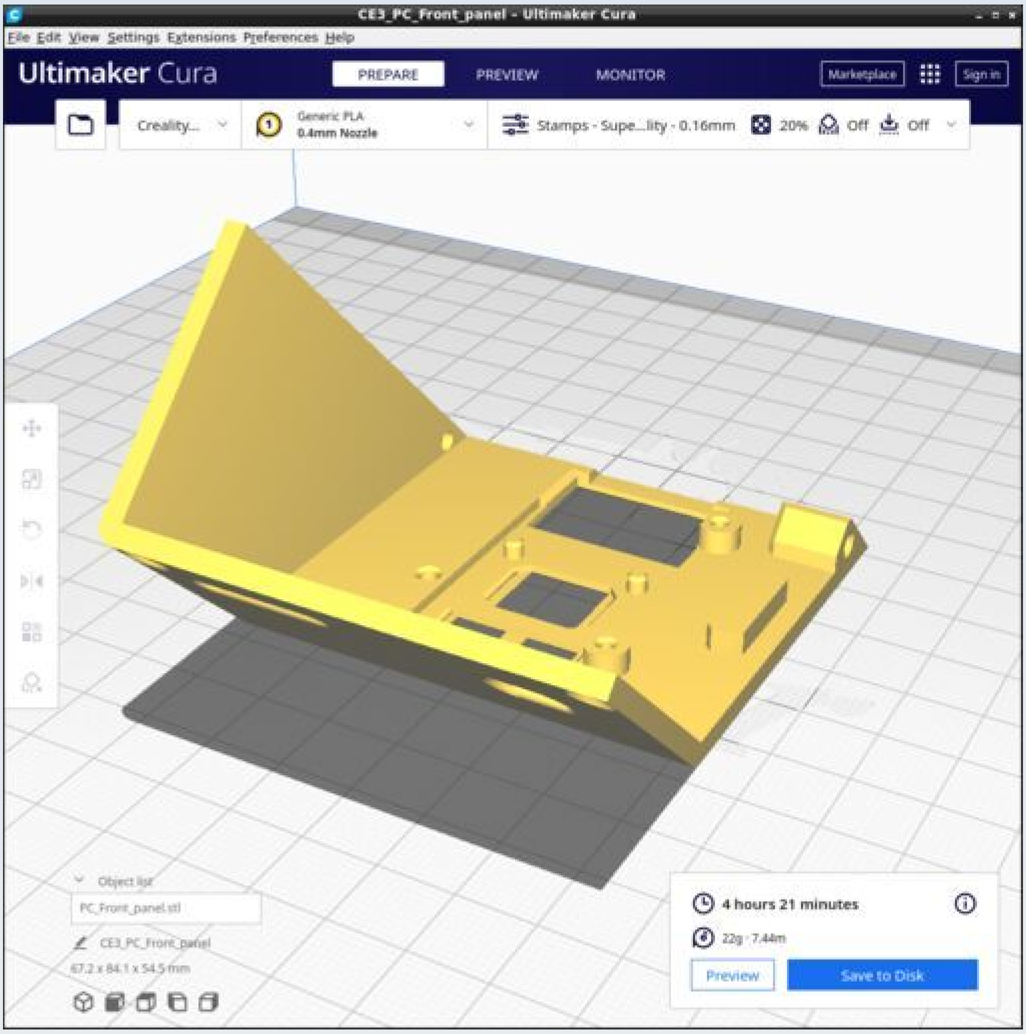
PC_Battery_cover.stl



PC_Expansion_port_cover.stl

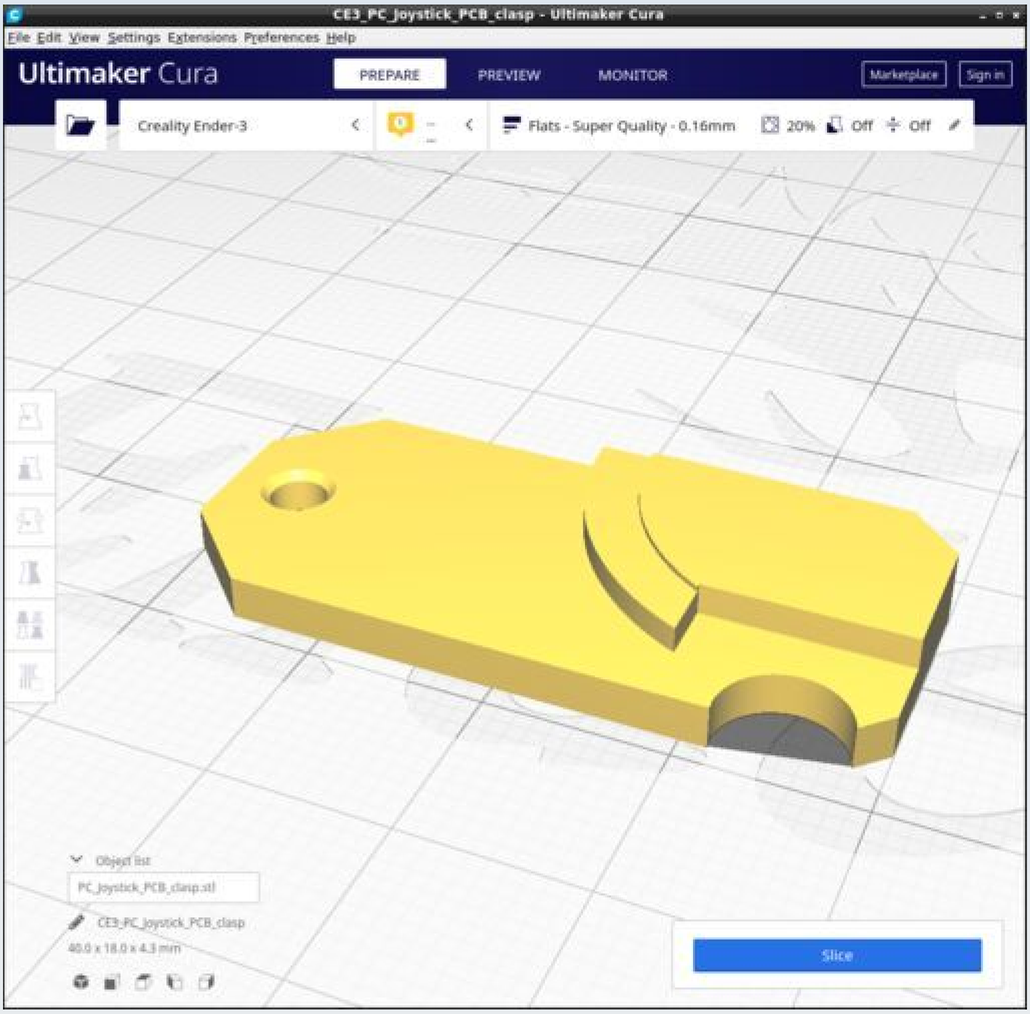


PC_Front_panel.stl

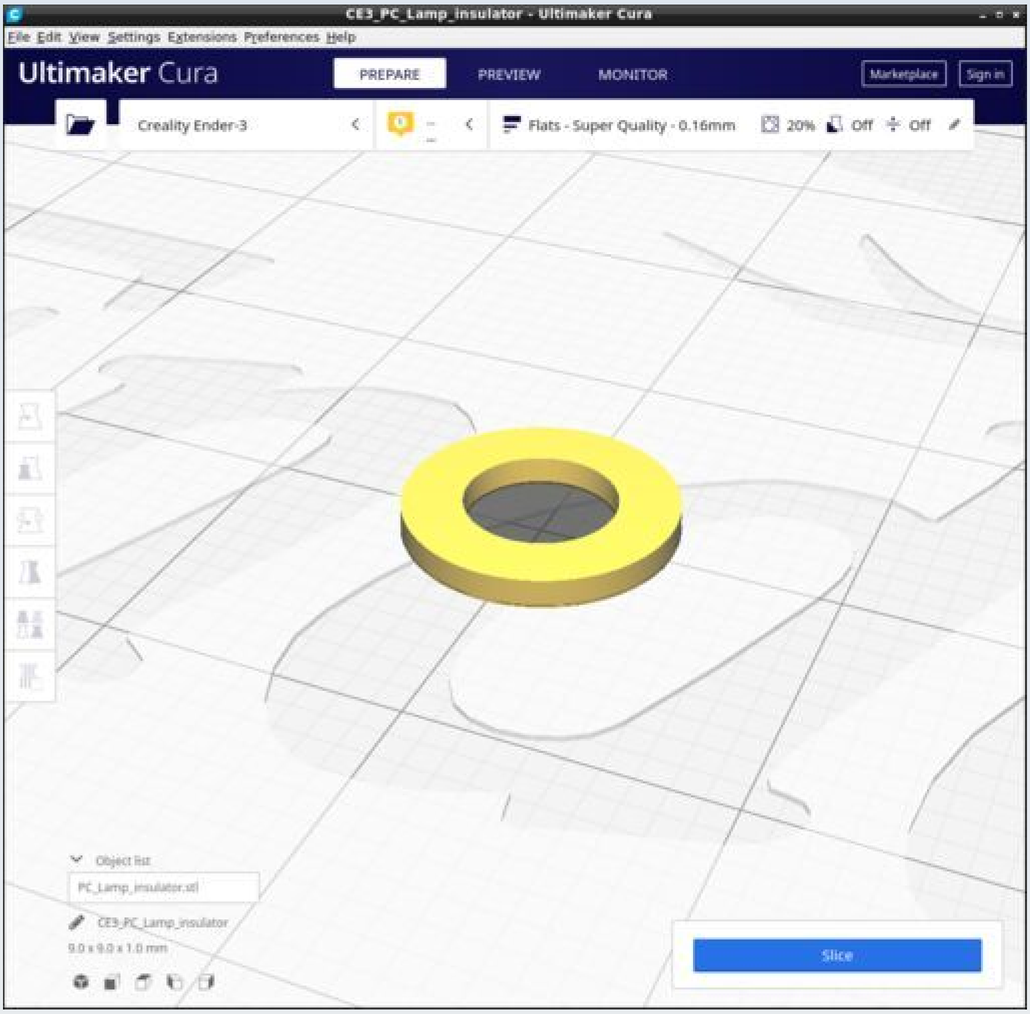


Use the ‘Stamps’ Cura profile. Ensure all supports are disabled.

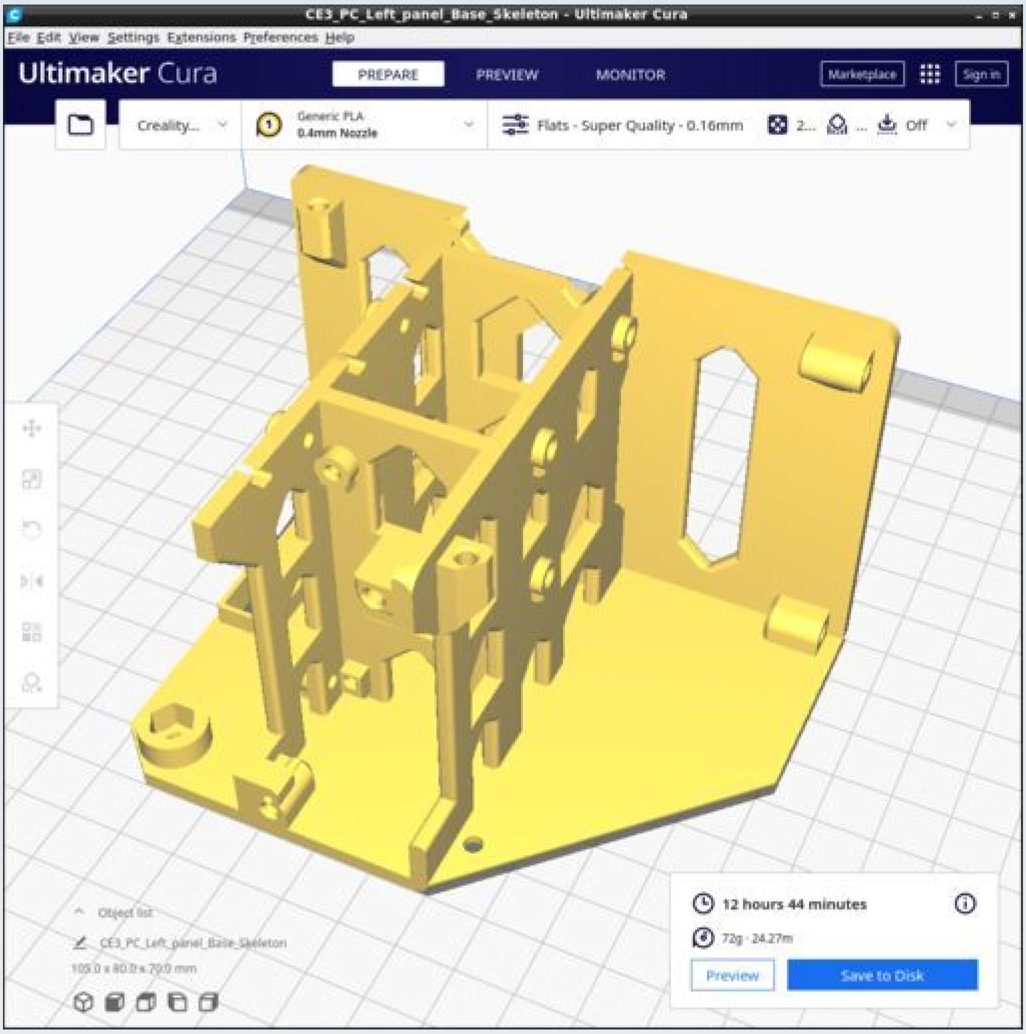
PC_Joystick_PCB_clasp.stl



PC_Lamp_insulator.stl

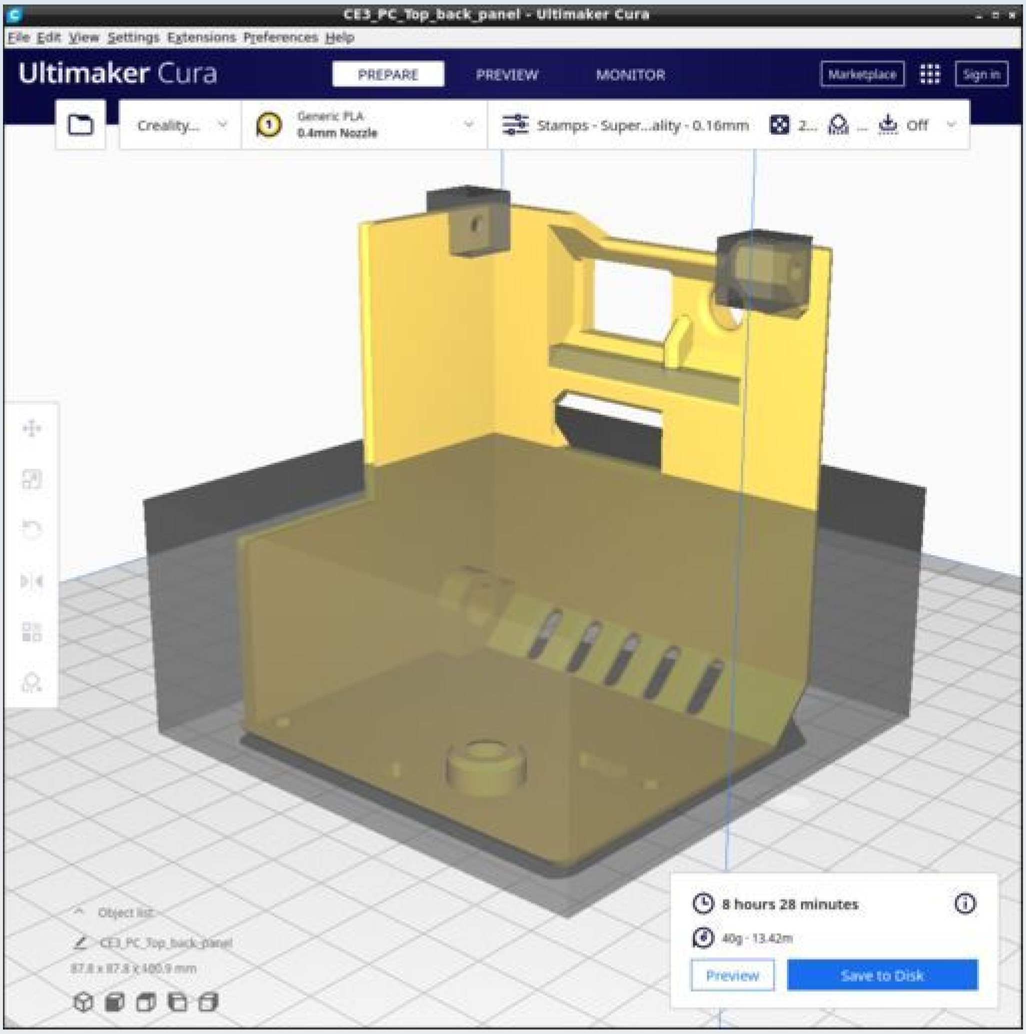


PC_Left_panel_Base_Skeleton.stl

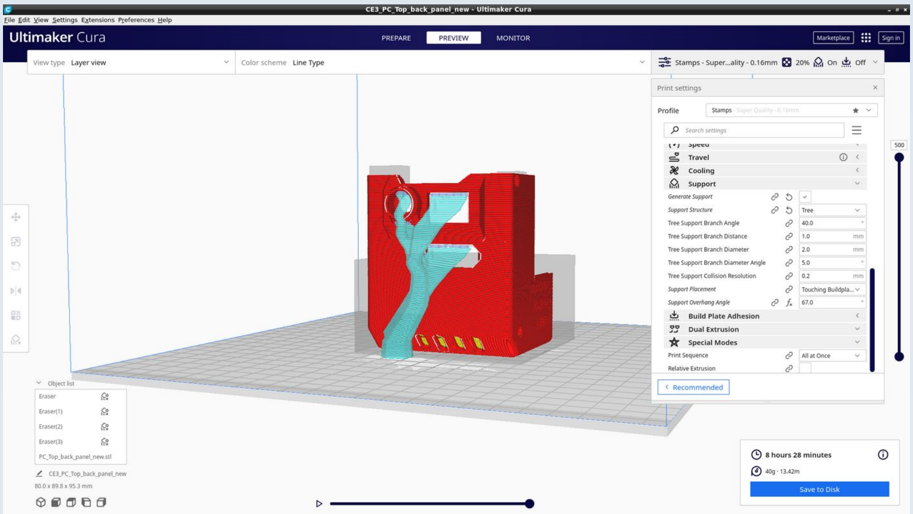


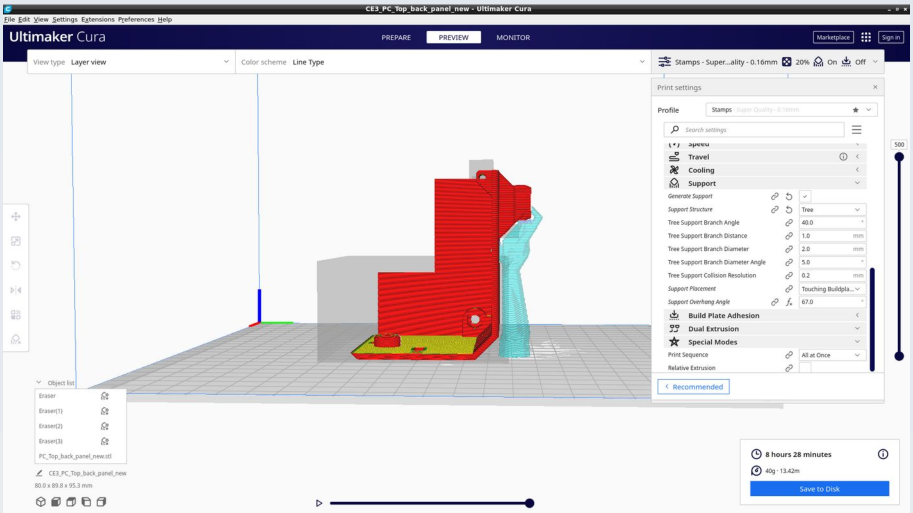
Ensure all supports are disabled.

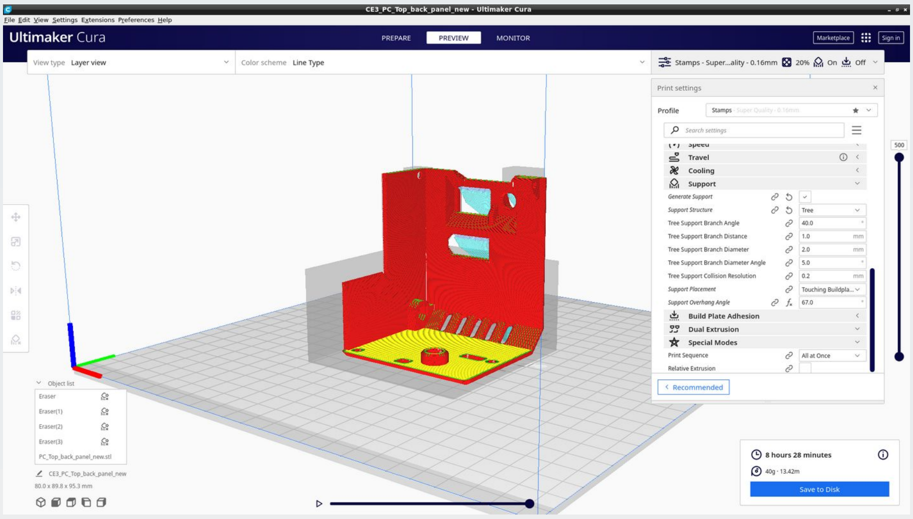
PC_Top_back_panel.stl



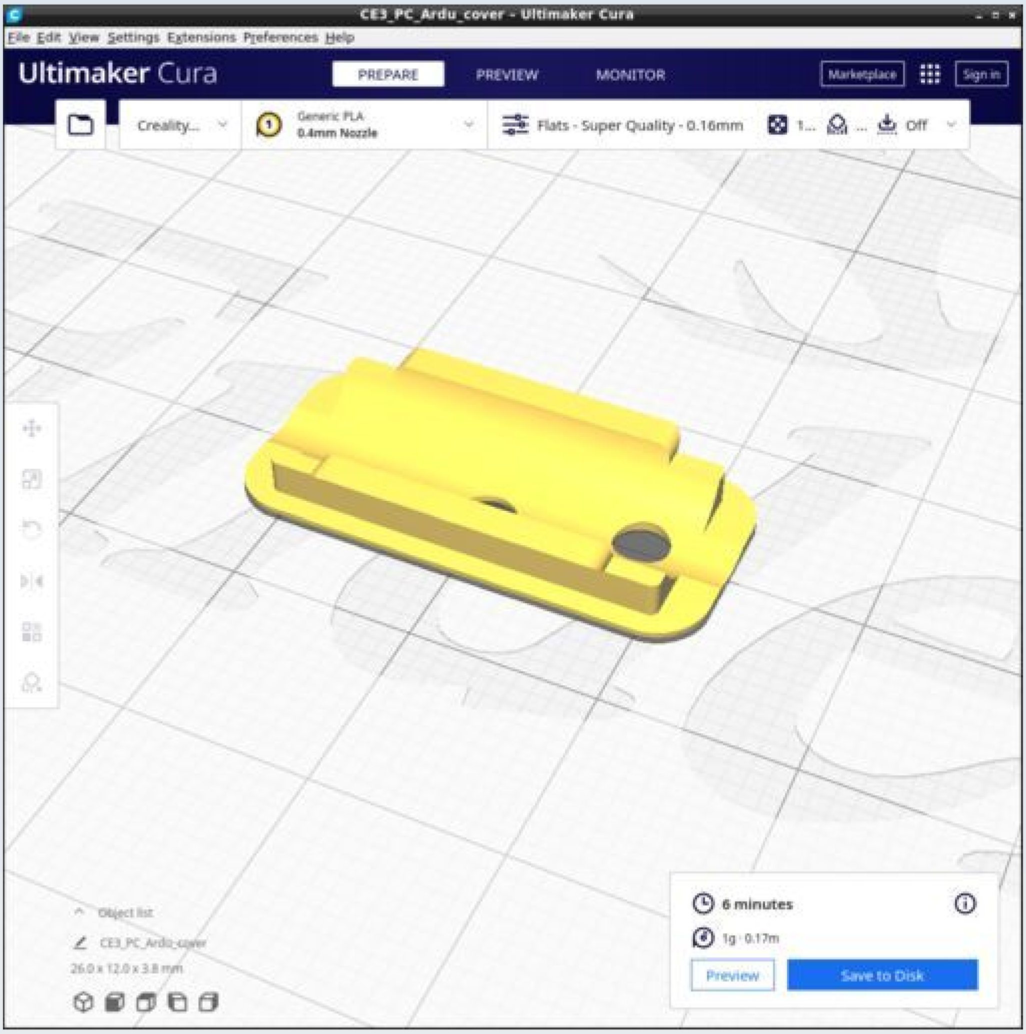
Use the ‘Stamps’ Cura profile and add a support blocker for everything except the back protrusion apertures and the top of the arduino window. The support type should be ‘Tree’ with a support branch angle of 40.0 and overhang of 67.0 and ‘Touching baseplate only’. You should get supports as shown in the following pictures.





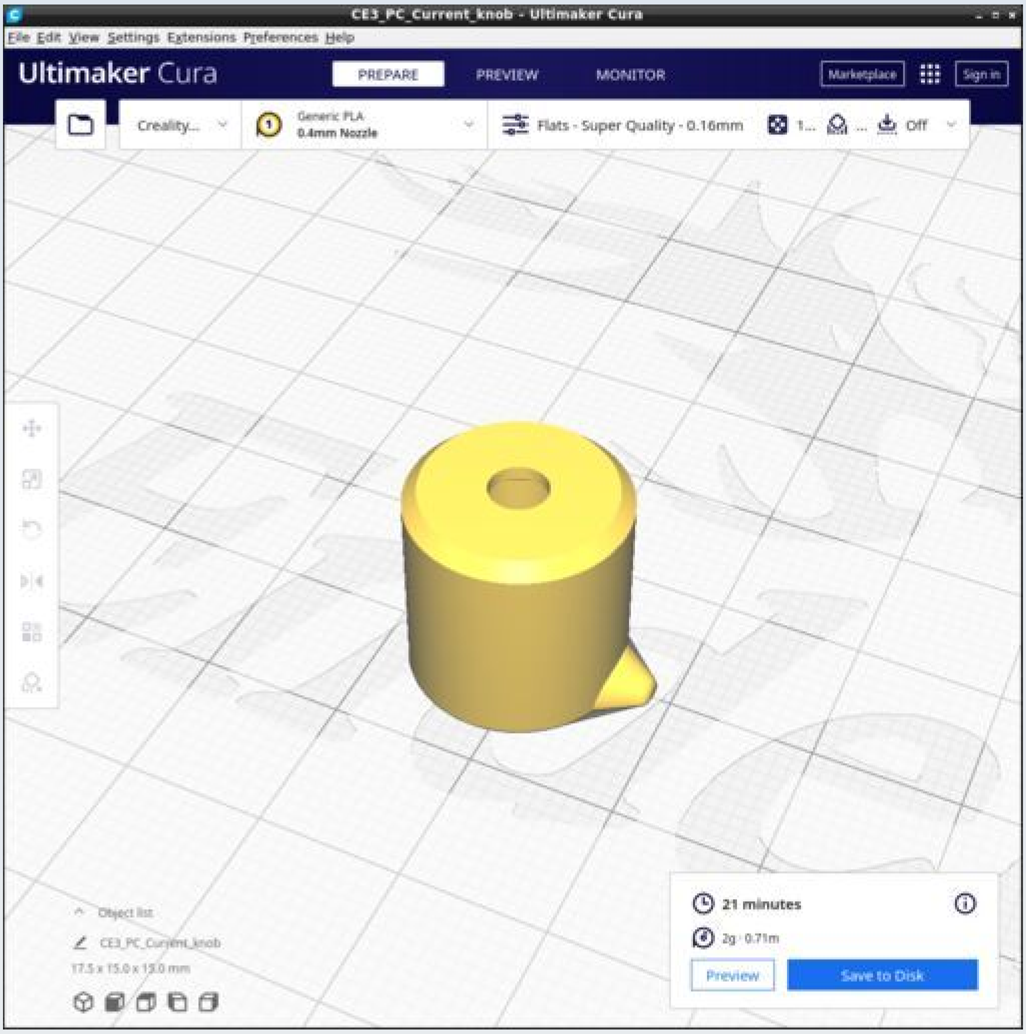


PC_Ardu_cover.stl



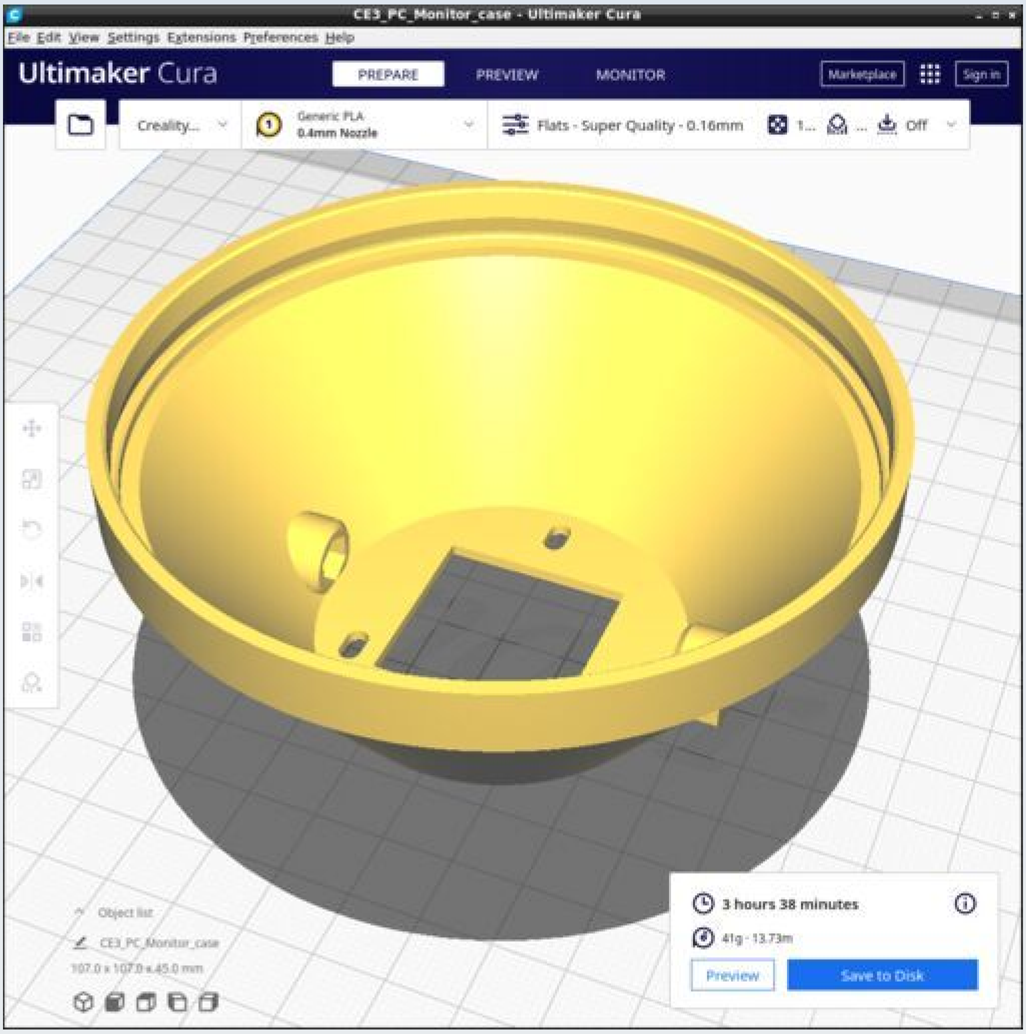
Use the ‘Flats’ Cura profile but change the infill to 100%. No supports.

PC_Current_knob.stl



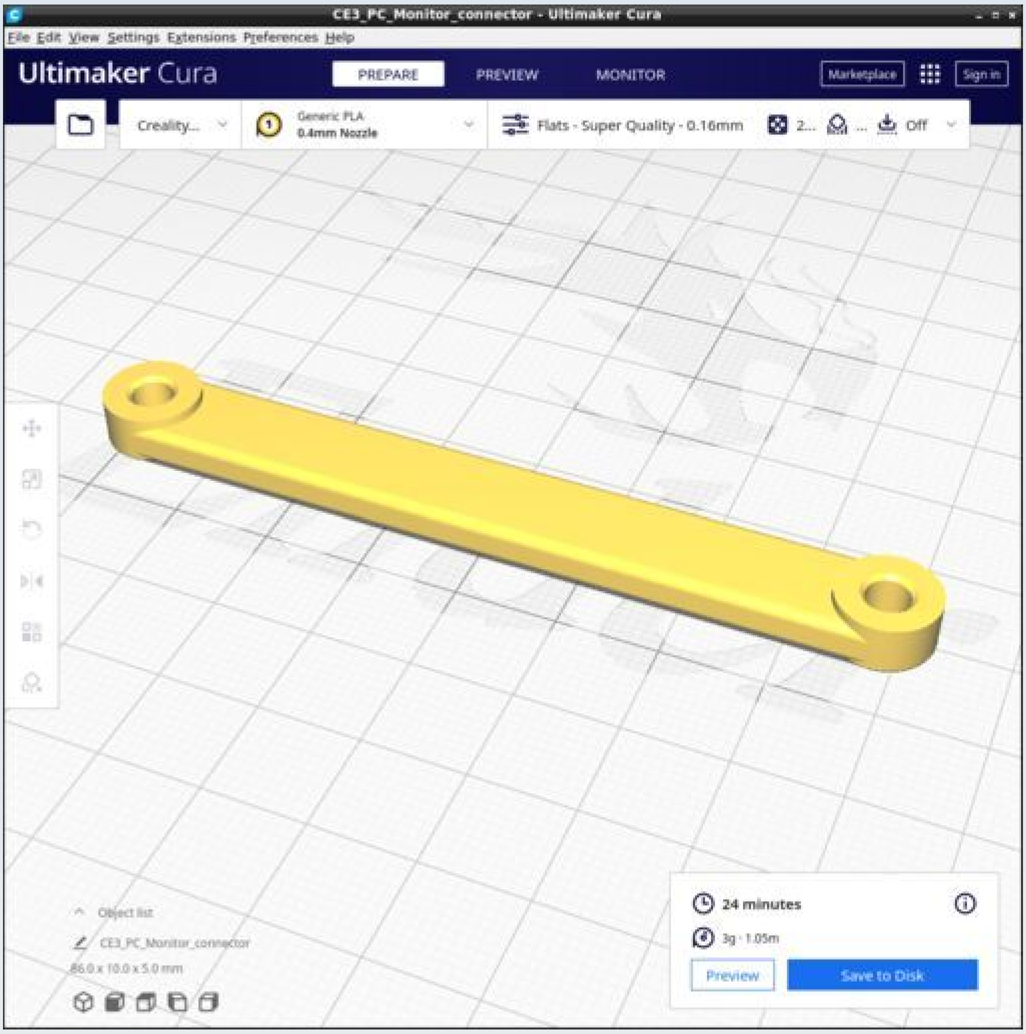
Use the ‘Flats’ Cura profile but change the infill to 100% and the ‘Top/Bottom’ pattern to ‘Concentric’. No supports.

PC_Monitor_case.stl



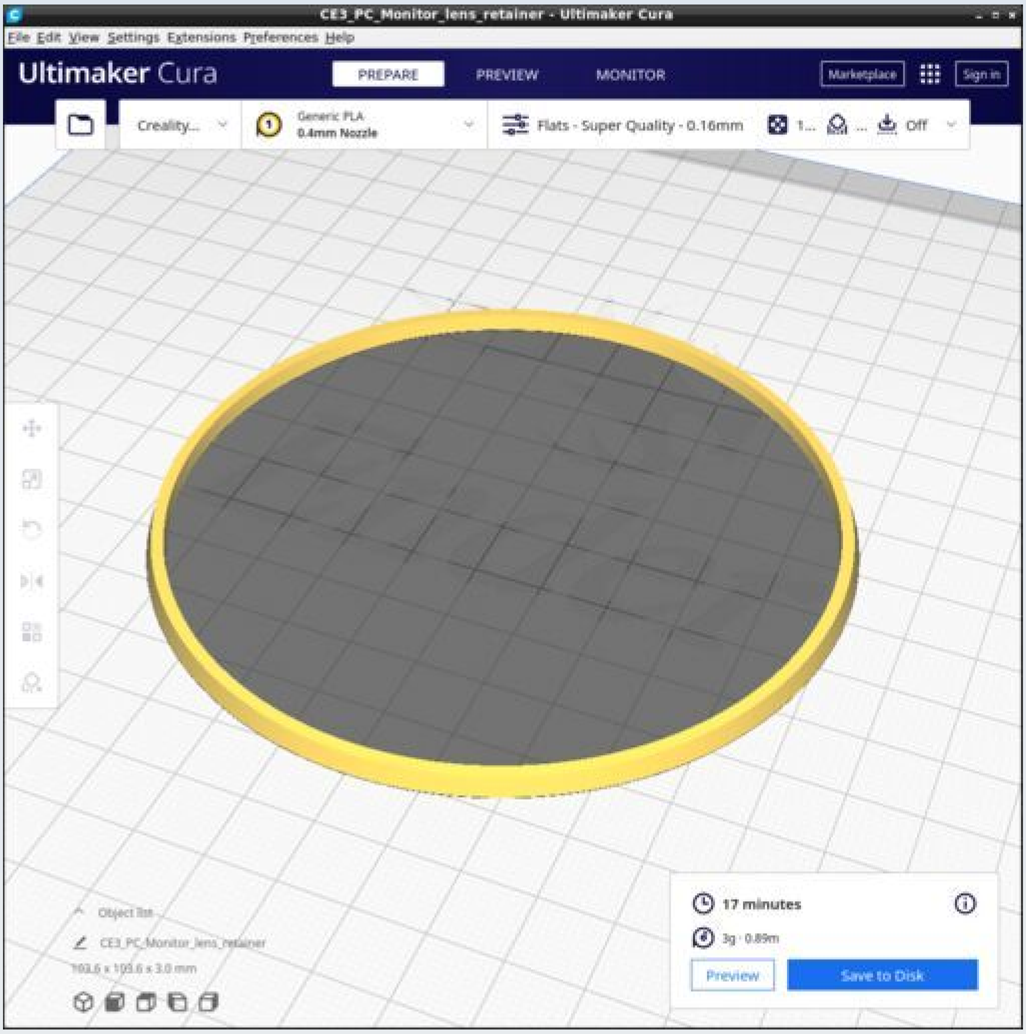
Use the ‘Flats’ Cura profile but change the infill to 10% and 'concentric' pattern of infill. No supports.

PC_Monitor_connector.stl



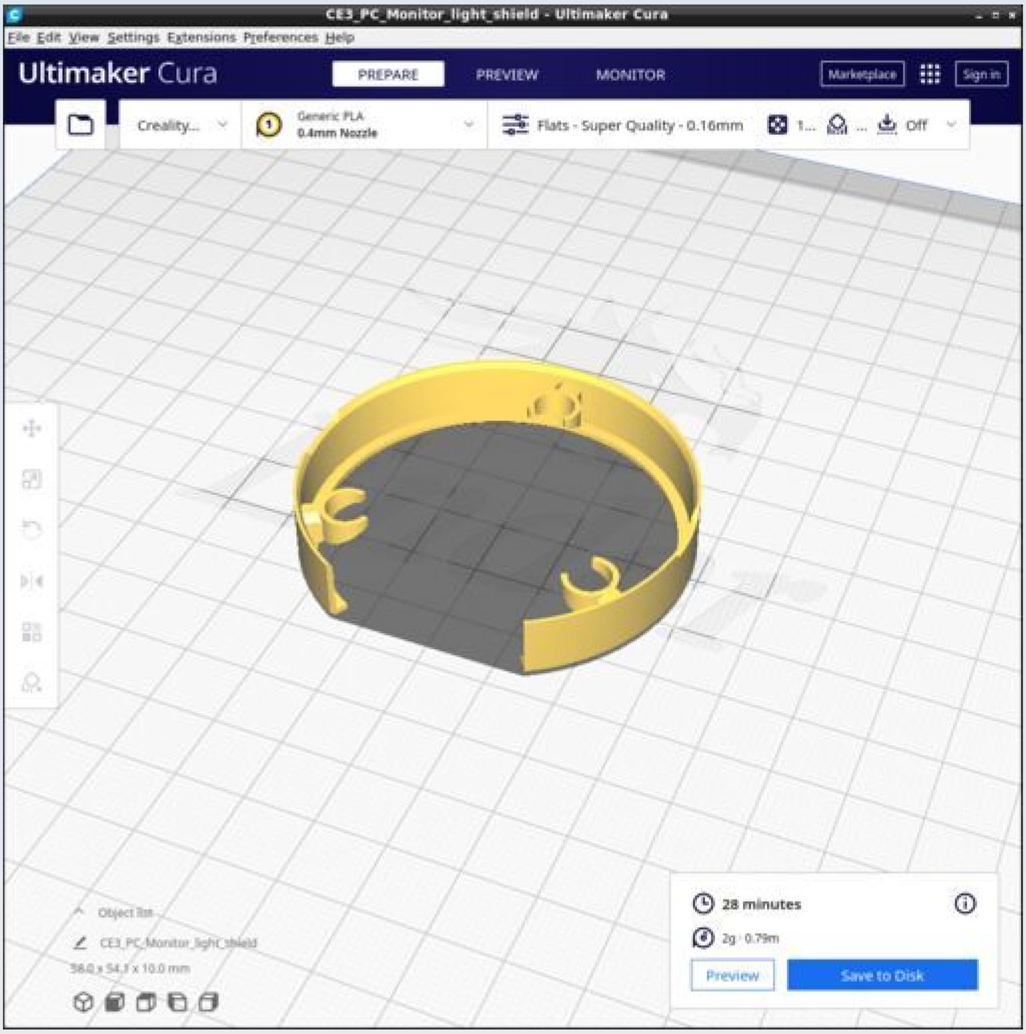
Use the ‘Flats’ Cura profile. No supports.

PC_Monitor_lens_retainer.stl



Use the ‘Flats’ Cura profile but change the infill to 10% and 'concentric' pattern of infill. Also change and the ‘Top/Bottom’ pattern to ‘Concentric’. No supports.

PC_Monitor_light_shield.stl



Use the ‘Flats’ Cura profile but change the infill to 10% and 'concentric' pattern of infill. Also change and the ‘Top/Bottom’ pattern to ‘Concentric’. No supports.

PUMA Lite

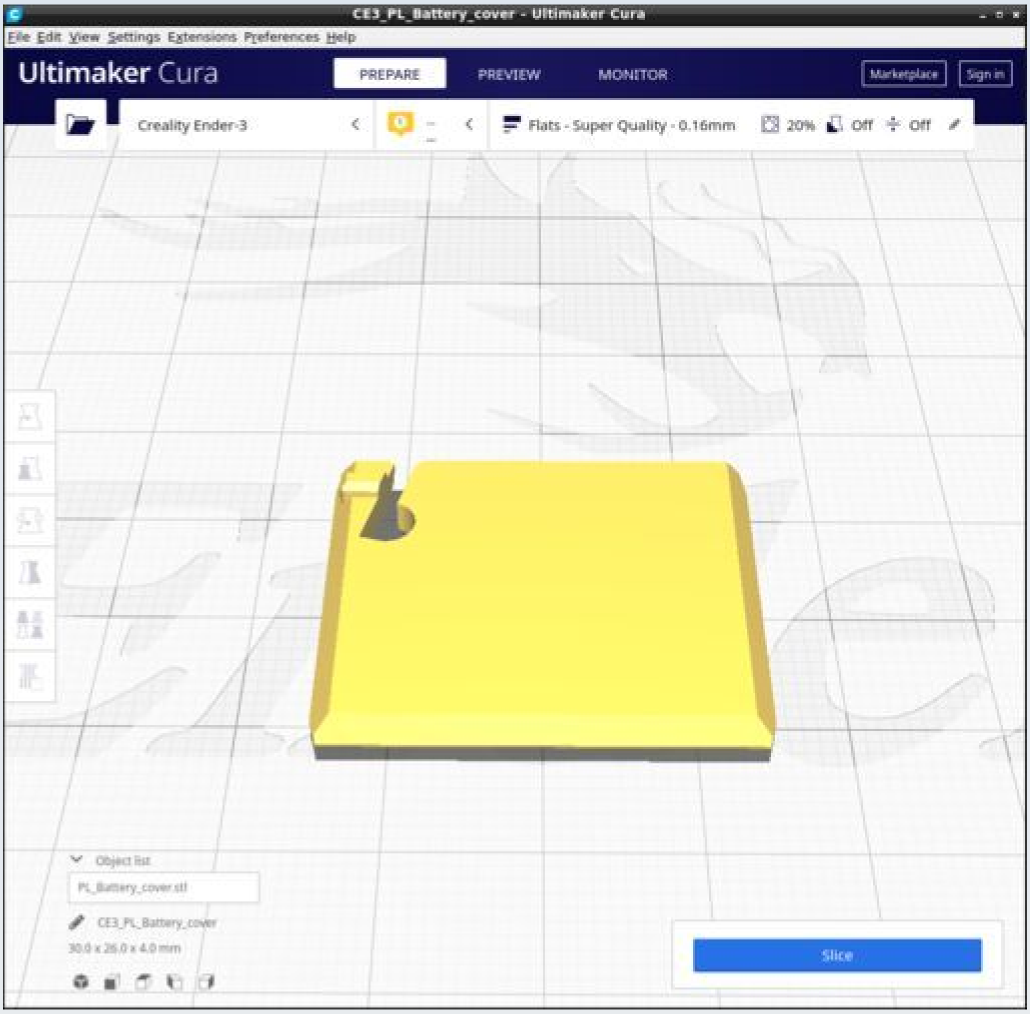
These are the parts for the simple control box use to drive the LED light source of the microscope (but provides no other functions). The CAD source models for these STL files are found in the file PUMALite.FCStd.

Resources

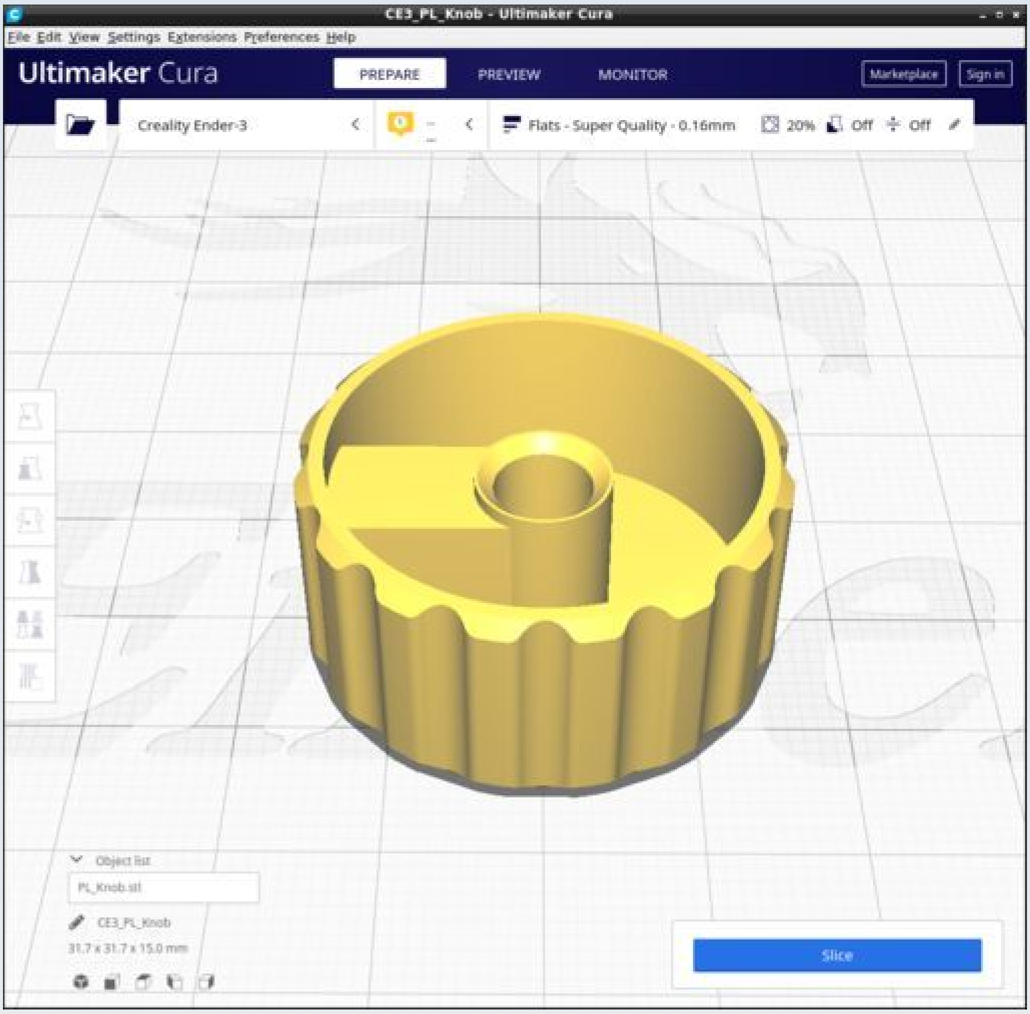
Cura calculates the following resources are required to print each model in this chapter:

PUMA_Lite	Time_Hr	Time_Min	PLA_Length(m)
PL_Battery_cover.stl	0	17	0.72
PL_Knob.stl	1	22	1.77
PL_Lamp_insulator.stl	0	1	0.02
PL_Left_Base_Back.stl	8	35	13.52
PL_Top_Front_Right.stl	3	55	7.11

PL_Battery_cover.stl



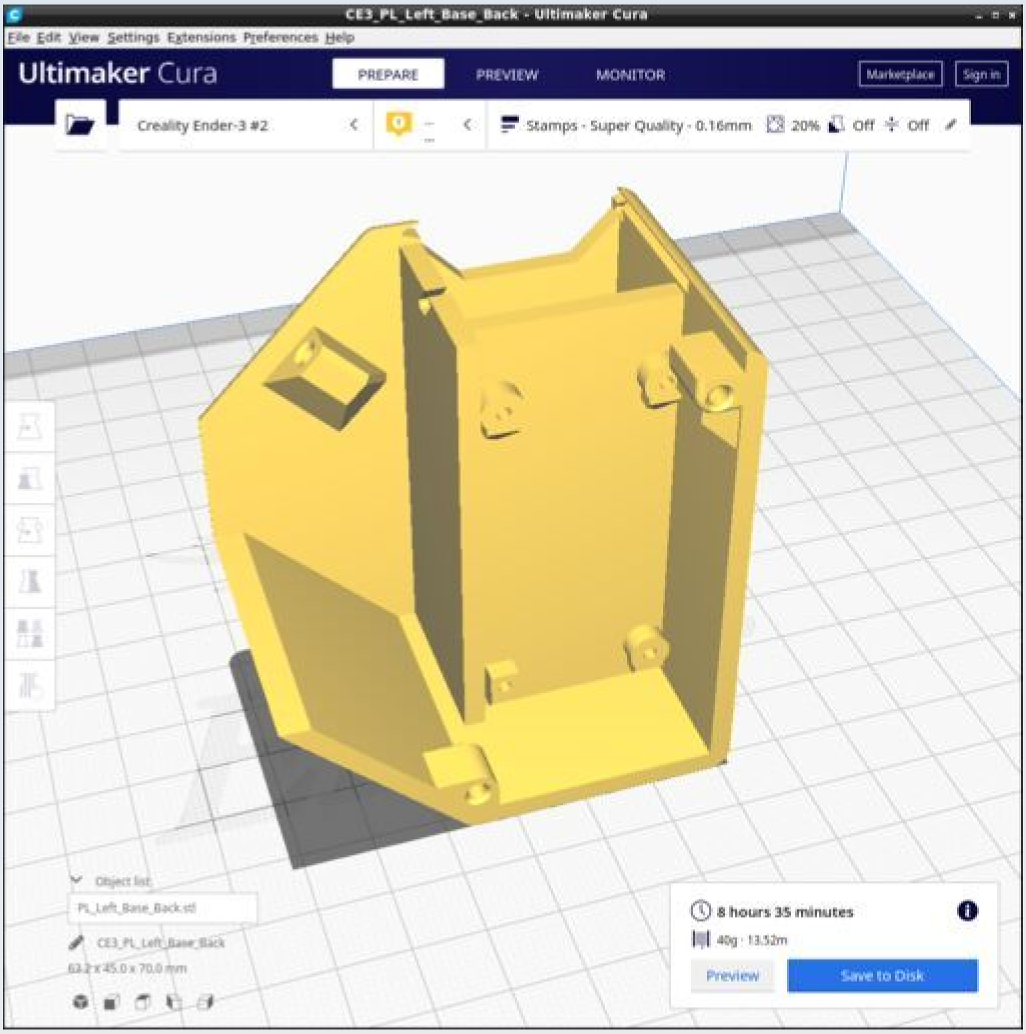
PL_Knob.stl



PL_Lamp_insulator.stl

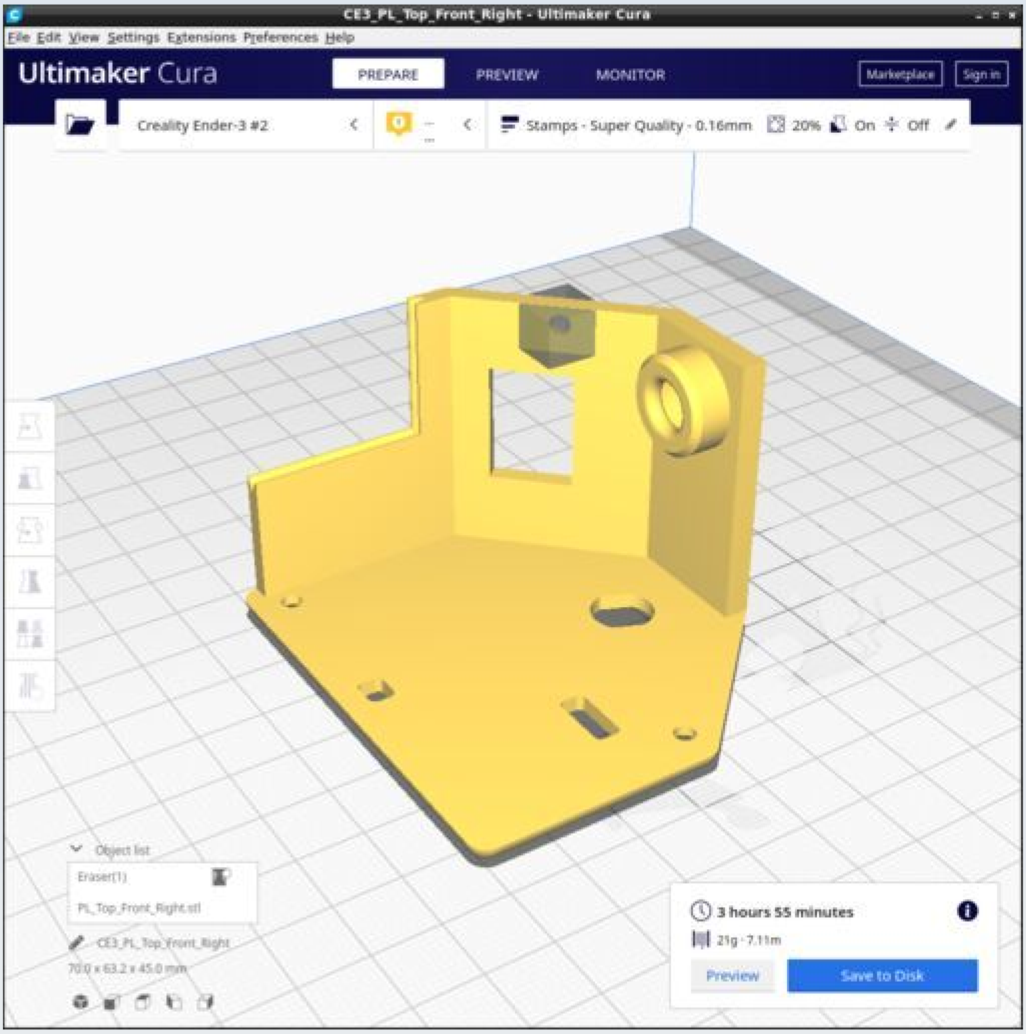
This is identical to the PC_Lamp_insulator of the PUMA Control Console (which see).

PL_Left_Base_Back.stl

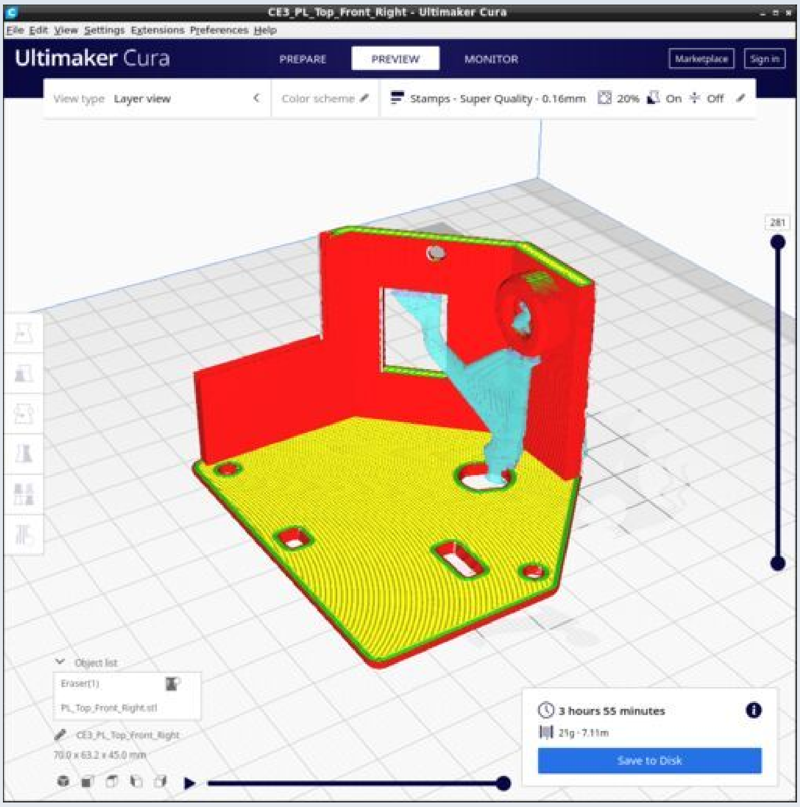


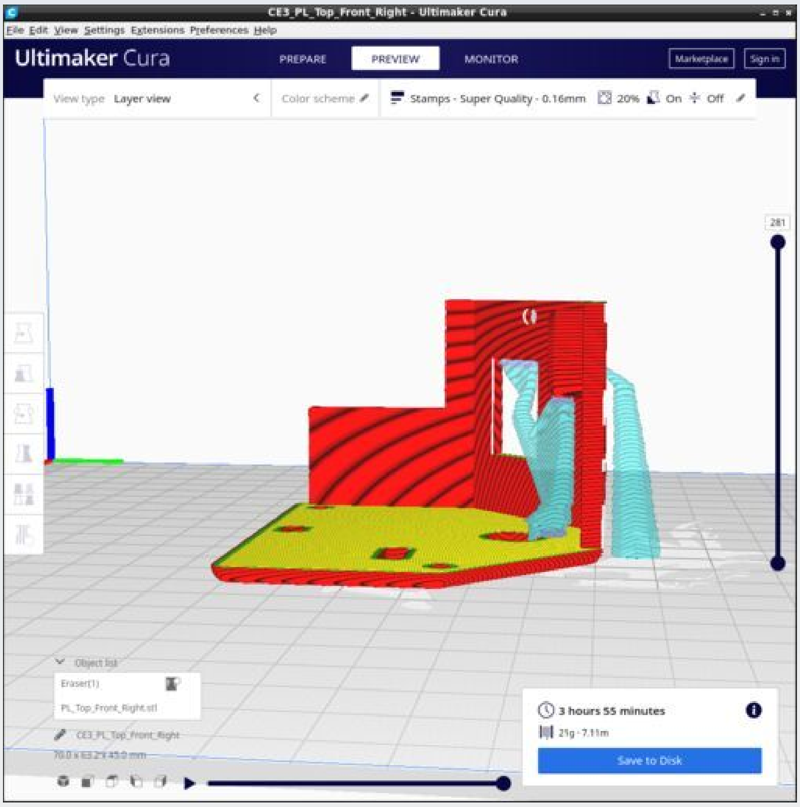
Ensure supports are disabled. Print with the PUMA custom Cura profile 'Stamps'

PL_Top_Front_Right.stl



Use tree supports with support blocker to prevent the screw hole being supoported - as shown in the figure. Support 'everywhere' with overhang 67 degree and tree support branch angle 50 degrees.


CE3_PL_Top_Front_Right - Ultimaker Cura
File Edit View Settings Extensions Preferences Help
Ultimaker Cura
PREPARE
PREVIEW
MONITOR
Marketplace
Sign in
View type Layer view
Color scheme
Stamps - Super Quality - 0.16mm
20%
On
Off
281
Object list
Eraser(1)
PL_Top_Front_Right.stl
CE3_PL_Top_Front_Right
70.0 x 63.2 x 45.0 mm
3 hours 55 minutes
21g · 7.11m
Save to Disk


CE3_PL_Top_Front_Right - Ultimaker Cura
File Edit View Settings Extensions Preferences Help
Ultimaker Cura
PREPARE
PREVIEW
MONITOR
Marketplace
Sign in
View type Layer view
Color scheme
Stamps - Super Quality - 0.16mm
20%
On
Off
281
Object list
Eraser(1)
PL_Top_Front_Right.stl
CE3_PL_Top_Front_Right
70.0 x 63.2 x 45.0 mm
3 hours 55 minutes
21g · 7.11m
Save to Disk

Quick Release Objective Holder

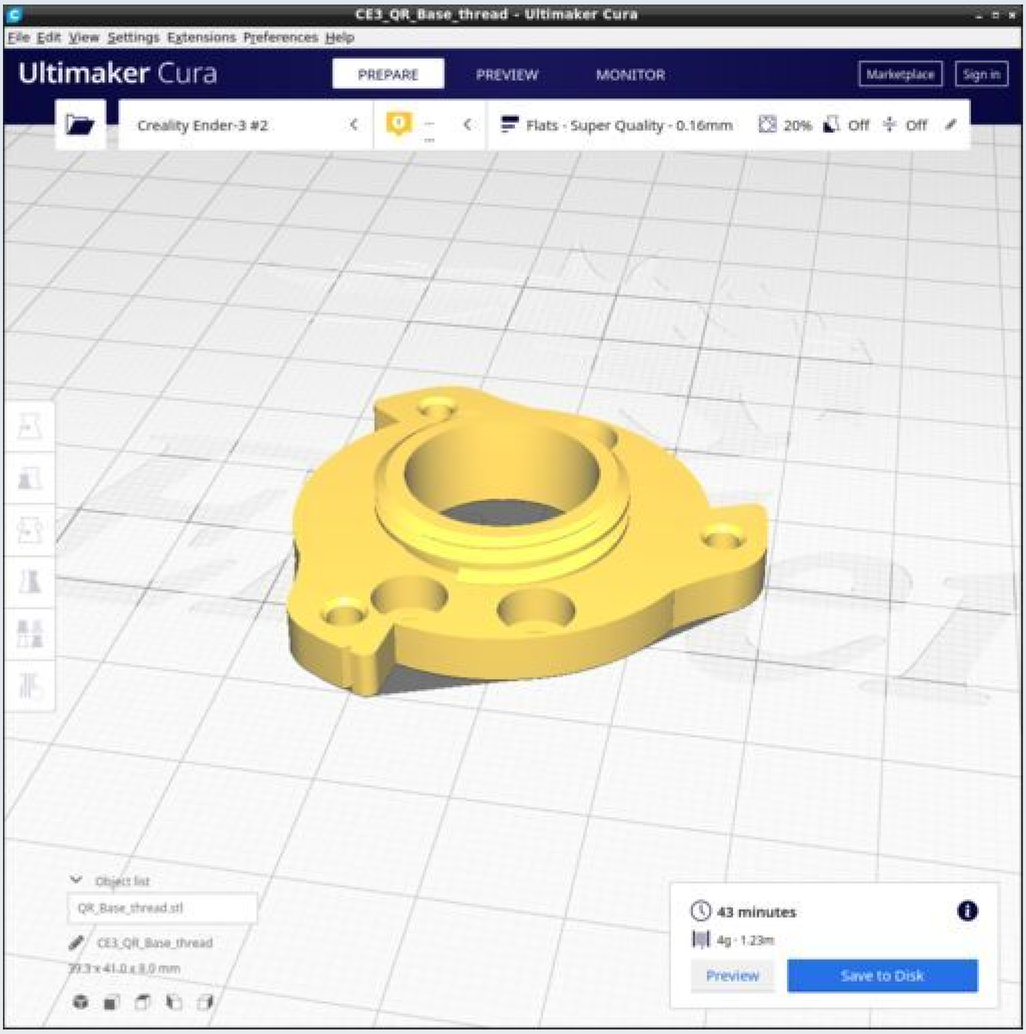
These are the parts for the objective holder that fits onto the focus platform of the microscope stage via a quick-release mechanism. The CAD source models for these STL files are found in the file QuickRelease_v2.0.FCStd.

Resources

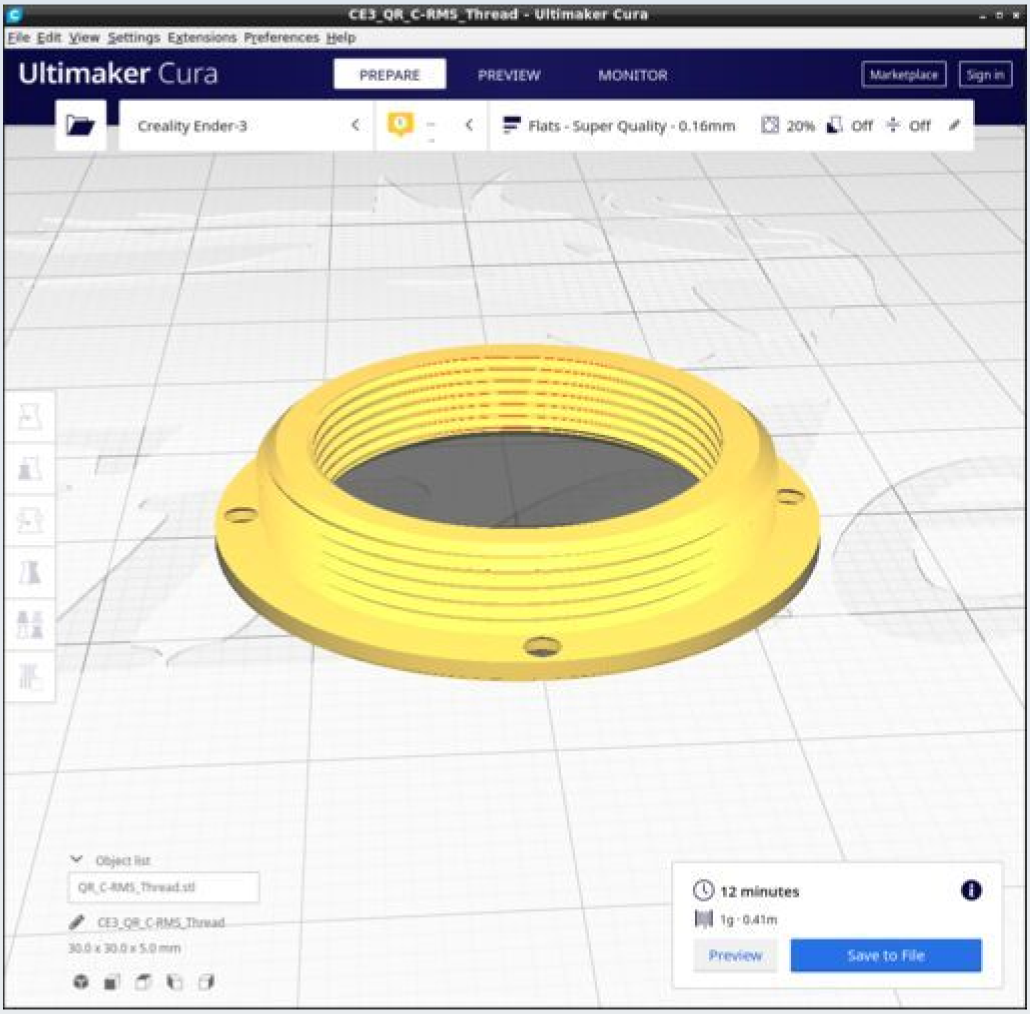
Cura calculates the following resources are required to print each model in this chapter:

Quick Release Objective Holder	Time_Hr	Time_Min	PLA_Length(m)
QR_Base_thread.stl	0	43	1.23
QR_C-RMS_Thread.stl	0	12	0.41
QR_Male_C_extn_1mm.stl	1	30	2.47
QR_Male_C_extn_4mm.stl	1	42	2.82
QR_Trainer.stl	1	8	2.5
QR_Trainer_Male.stl	1	25	2.96

QR_Base_thread.stl



QR_C-RMS_Thread.stl

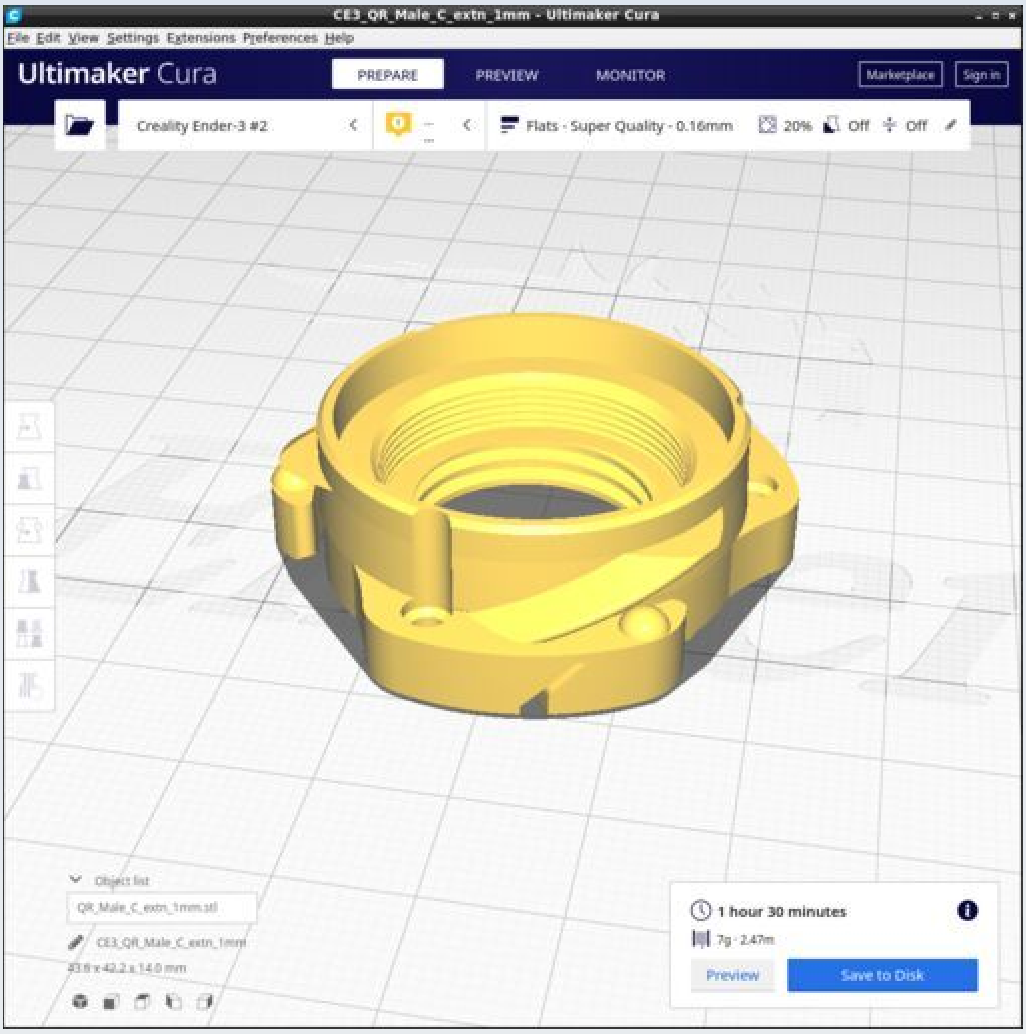


This thread adapter was designed to conform to measurements of similar adapters that are commercially available and made of metal. Thus you can use the metal adapter if you want all-metal threads (which are easier to align with your objective and harder to cross-thread and destroy and wear out).

If using this 3D printed plastic version, the female RMS thread will require training with a metal RMS male thread (such as on an objective lens). Great care is required not to cross the 3D printed plastic thread and damage it at all times but especially during training.

The male C thread is best trained on a metal C thread such as may be found on a C/CS thread extender ring.

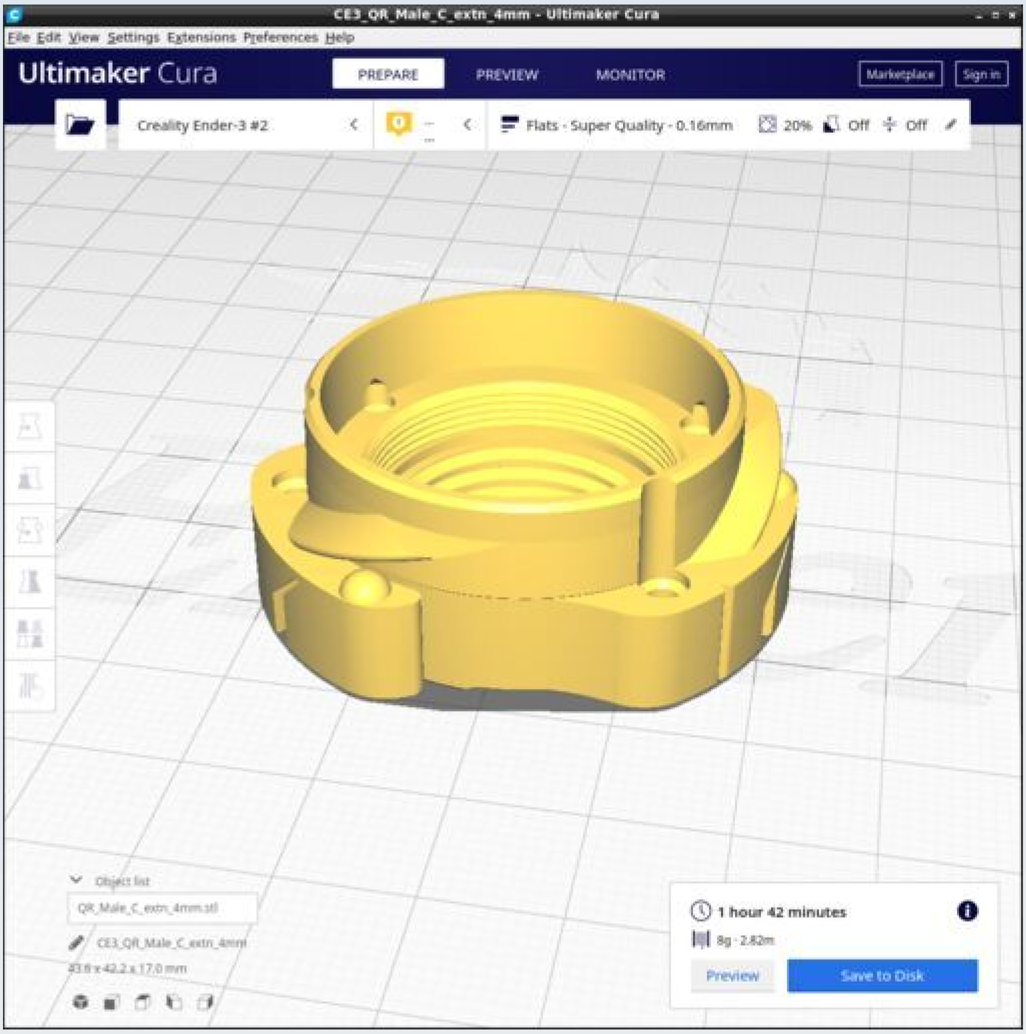
QR_Male_C_extn_1mm.stl



The female C thread is best trained on a metal C thread such as may be found on a C-mount lens or C/CS thread extender adapter ring. Great care is required to avoid crossing the 3D printed plastic thread and thereby damaging or destroying it.

The outer quick-release makle tri-helix thread should be trained using the QR_Trainer 3D printed tool (see below).

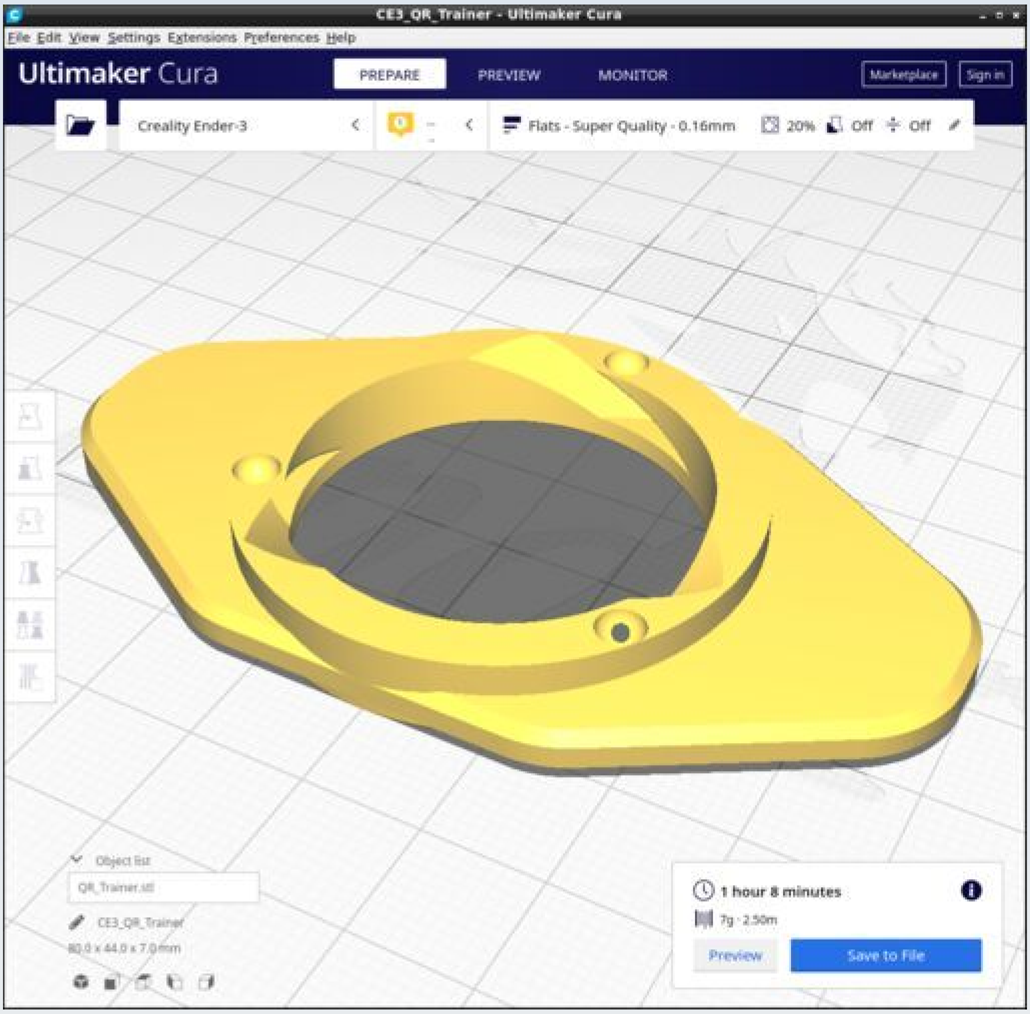
QR_Male_C_extn_4mm.stl



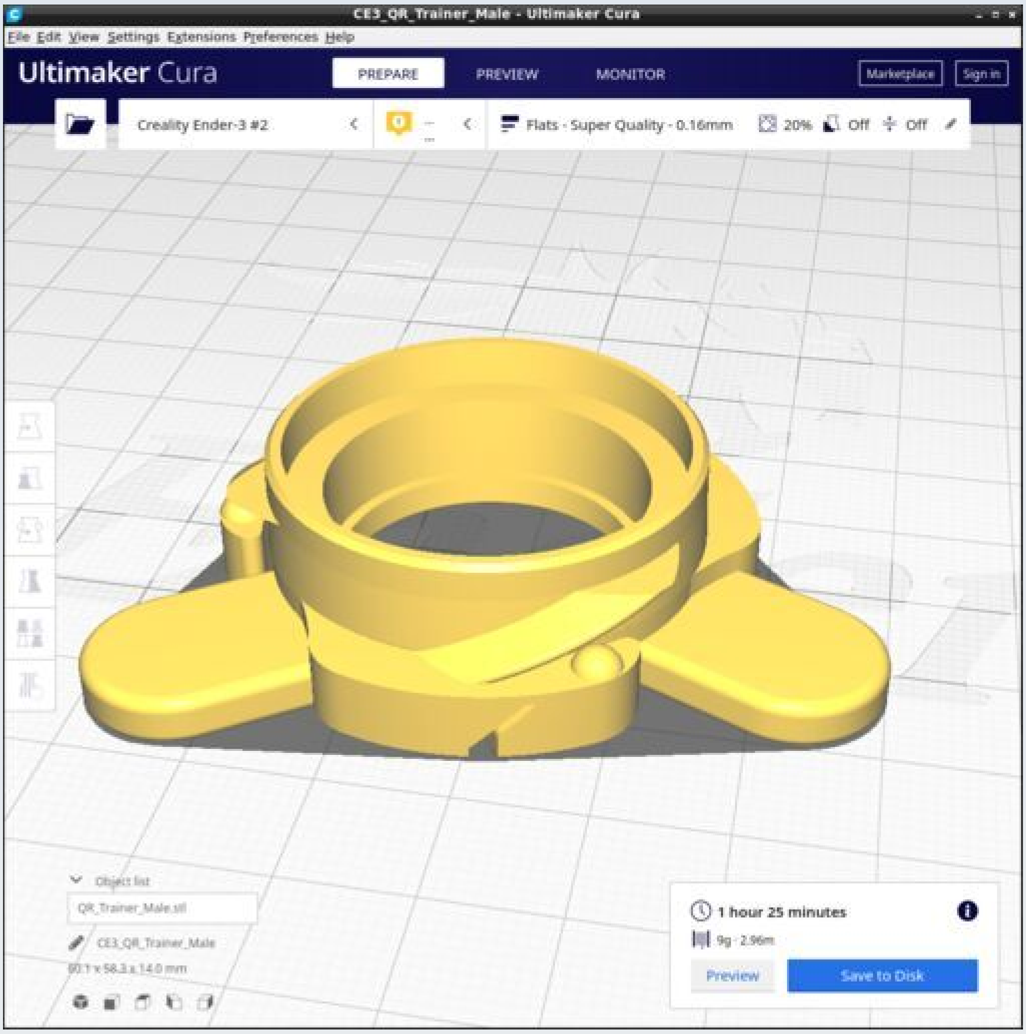
The female C thread is best trained on a metal C thread such as may be found on a C-mount lens or C/CS thread extender adapter ring. Great care is required to avoid crossing the 3D printed plastic thread and thereby damaging or destroying it.

The outer quick-release makle tri-helix thread should be trained using the QR_Trainer 3D printed tool (see below).

QR_Trainer.stl



QR_Trainer_Male.stl



Stabiliser

These are the parts for the optional stabiliser exoskeleton bracket. The CAD source models for these STL files are found in the file Stabiliser.FCStd.

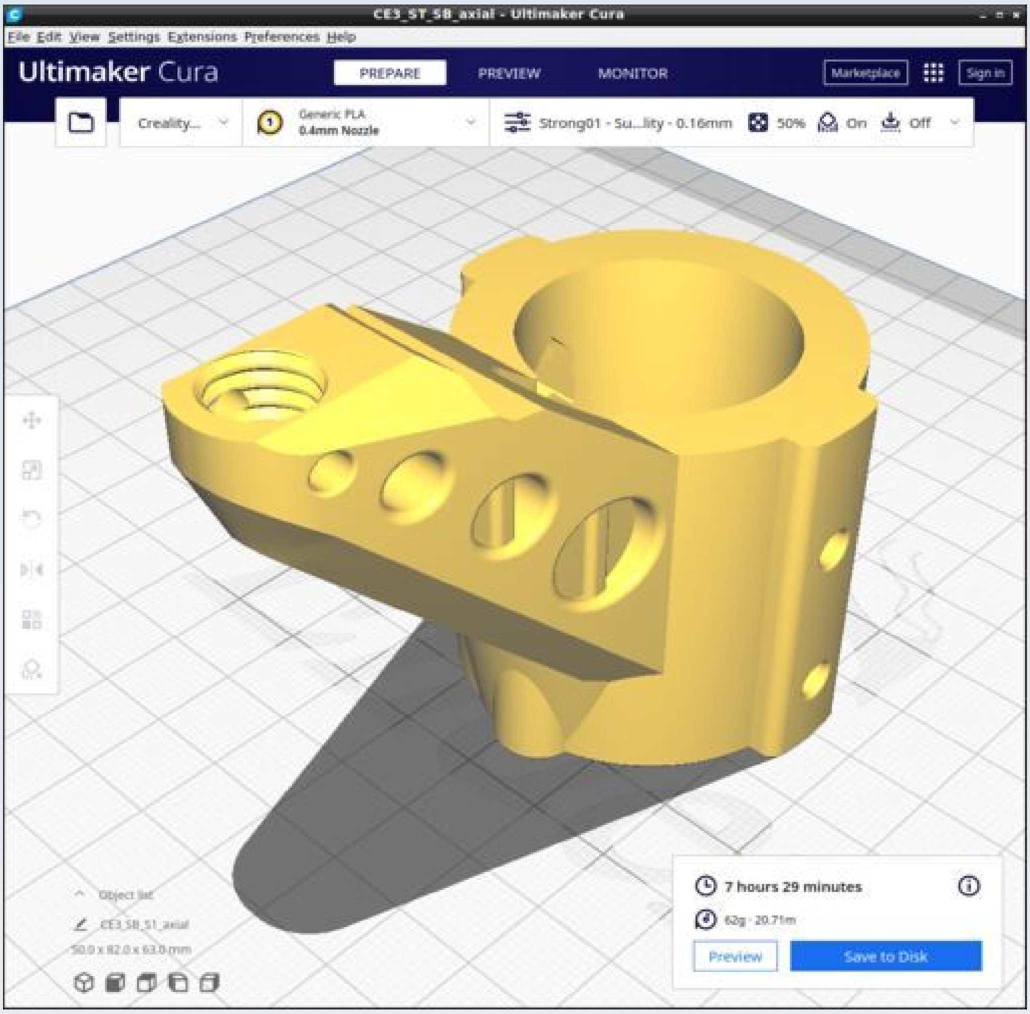
Use the ‘Strong01’ Cura profile to print the parts.

Resources

Cura calculates the following resources are required to print each model in this chapter:

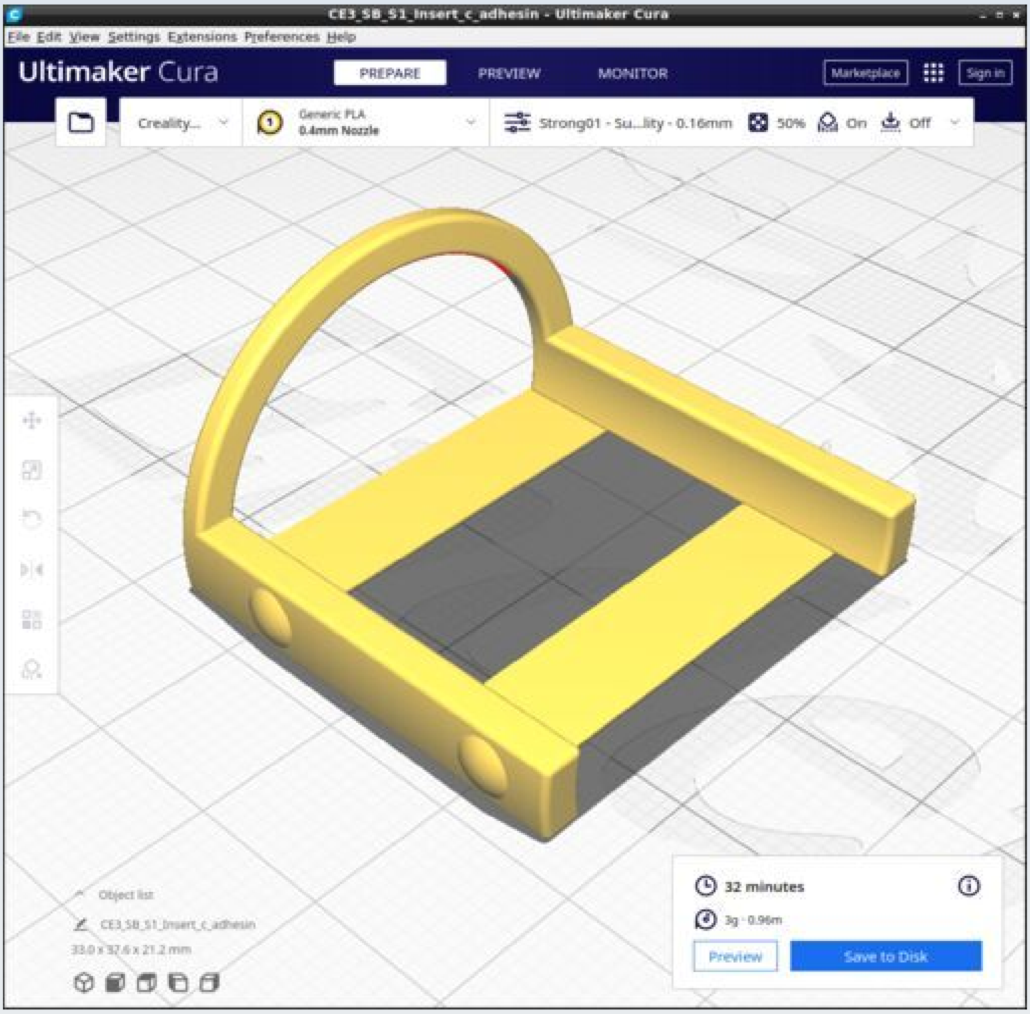
Stabiliser	Time_Hr	Time_Min	PLA_Length(m)
SB_S1_Axial.stl	7	29	20.71
SB_S1_Insert_c_adhesin.stl	0	32	0.96
SB_S1_Lateral_strut_Left.stl	2	5	6.26
SB_S1_Lateral_strut_Right.stl	2	6	6.26
SB_S1_Peg.stl	0	16	0.44

SB_S1_Axial.stl



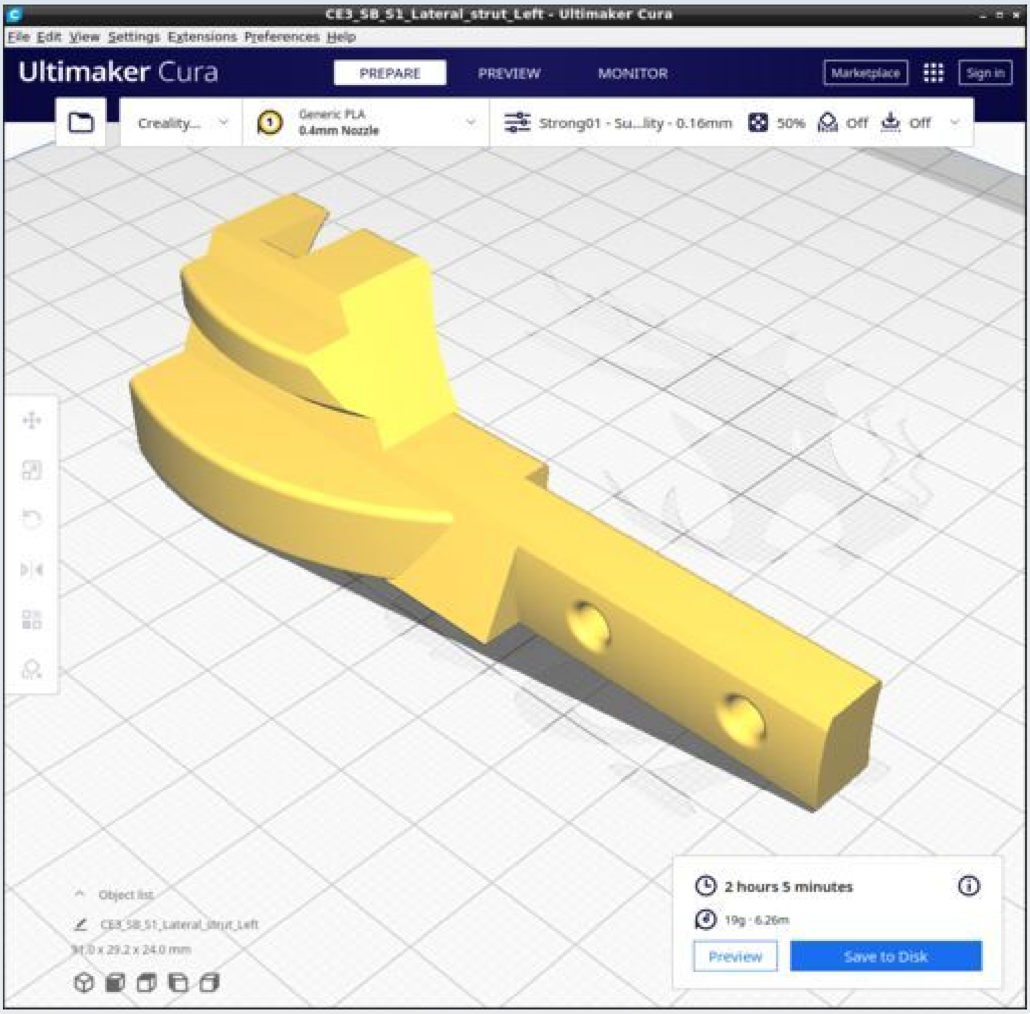
Use 'Strong01' profile with concentric top-bottom pattern and with supports 'touching baseplate only'.

SB_S1_Insert_c_adhesin.stl



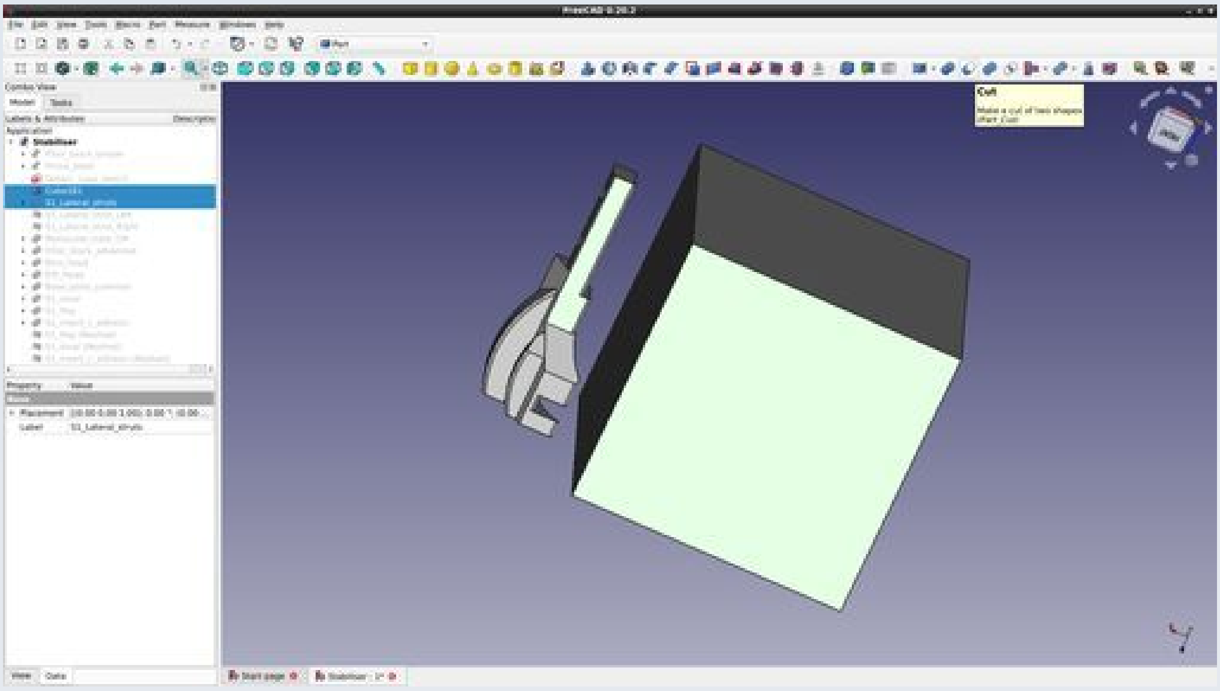
Use 'Strong01' profile with 'lines' top-bottom pattern and with supports 'everywhere' and overhang of 40 degrees.

SB_S1_Lateral_strut_Left.stl



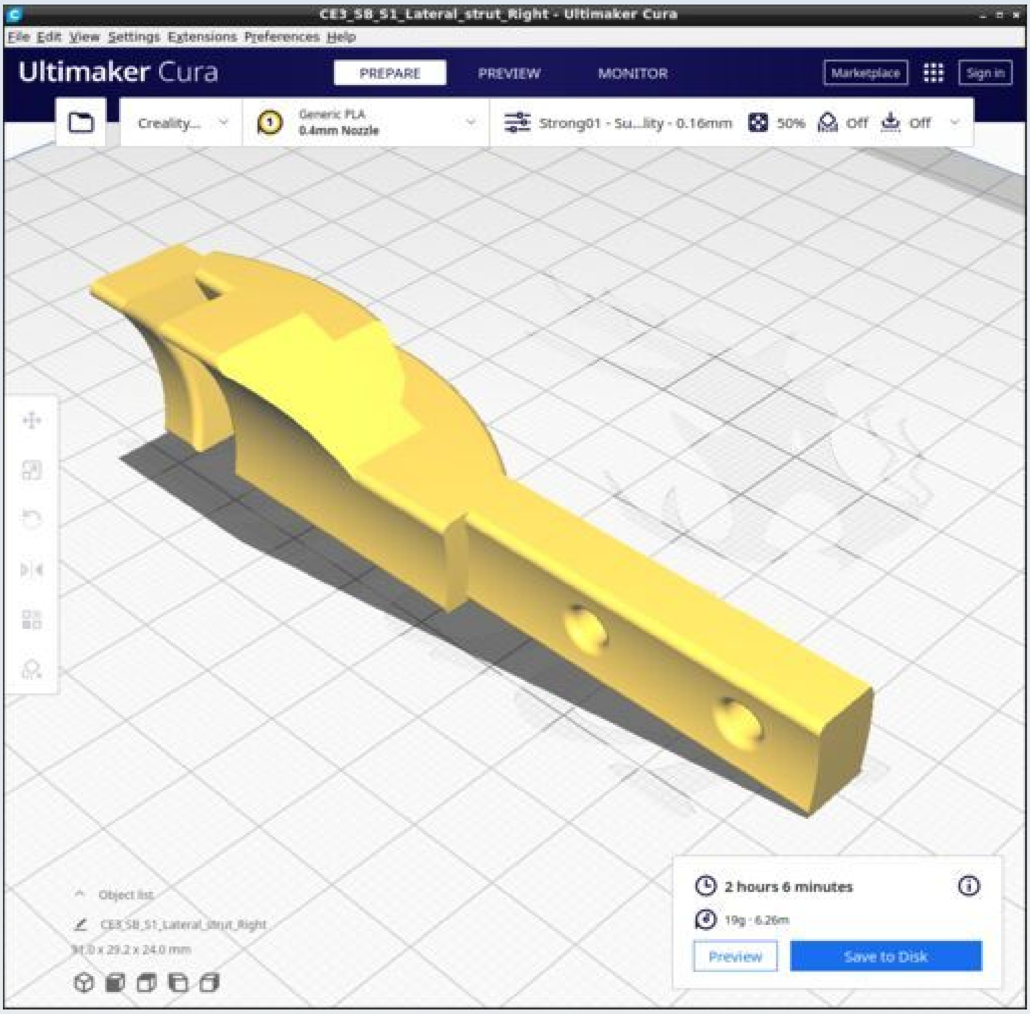
The left and right strut models may be printed together (as they are one model in the FreeCAD file) but I recommend they be printed separately as shown here in order to avoid stringing and unnecessary back-forth movements of the print head.

To achieve this, create a cube shape in FreeCAD (‘Parts’ workbench) and make the cut larger than either one of the struts. Then place the cube over the strut you don’t want and perform a subtraction between the struts model and the cube using the shape ‘Cut’ opoeration (see the figure below).



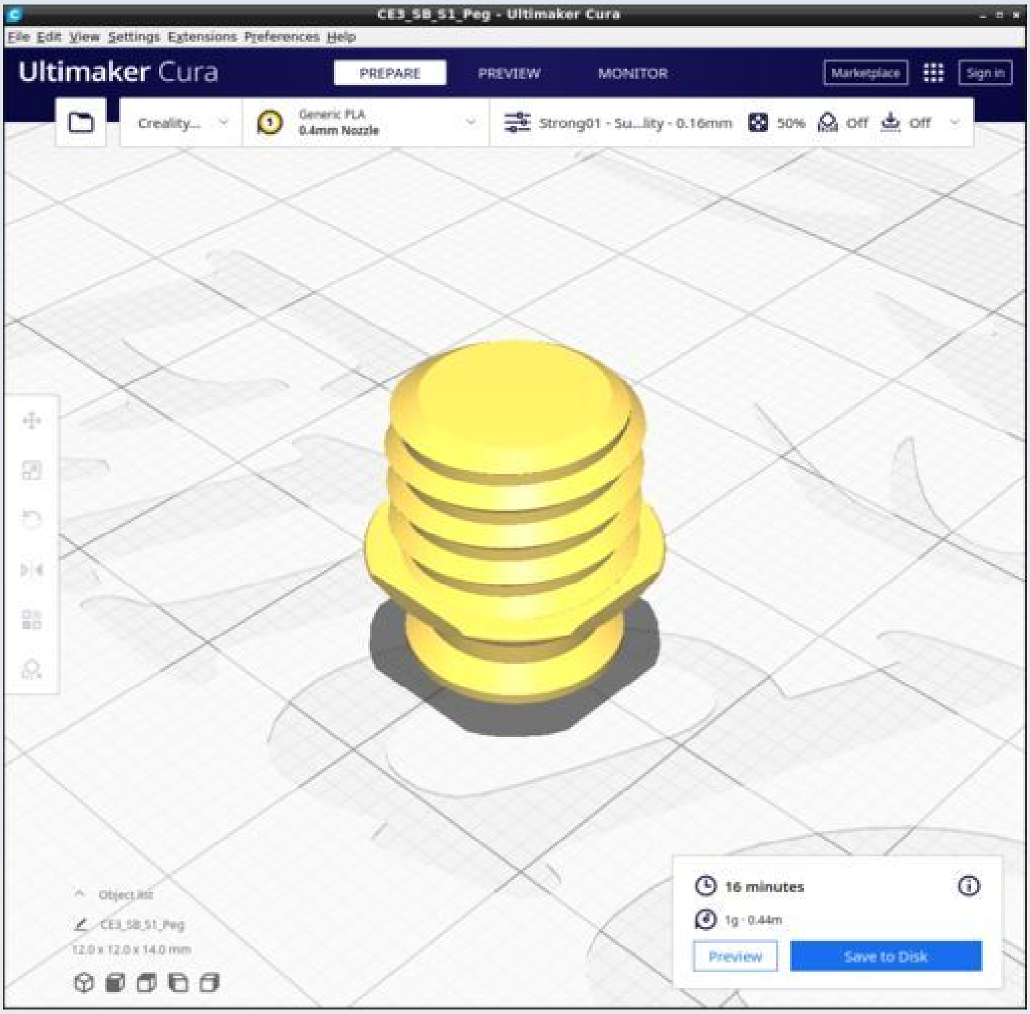
Then generate the mesh of the one remaining strut. Once the mesh is made, undo the shape cut, move the cube over the opposite strut and repeat the process to get the other mesh.

SB_S1_Lateral_strut_Right.stl



The left and right strut models may be printed together (as they are one model in the FreeCAD file) but I recommend they be printed separately as shown here in order to avoid stringing and unnecessary back-forth movements of the print head. The notes on the previous page show how to do this.

SB_S1_Peg.stl



It may help to set top/bottom layer pattern to ‘concentric’

Stage

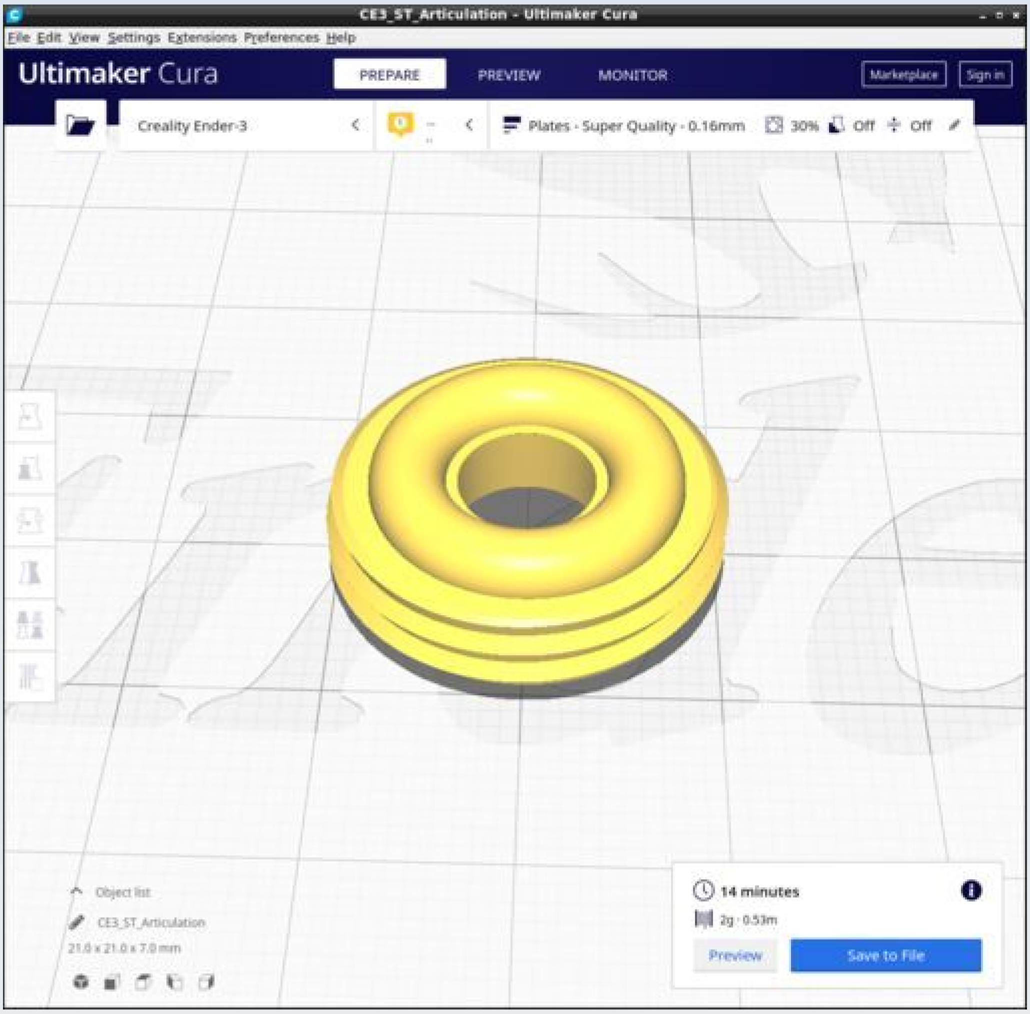
These are the parts for the main stage base plate and focus platform of the microscope. The CAD source models for these STL files are found in the file Stage.FCStd.

Resources

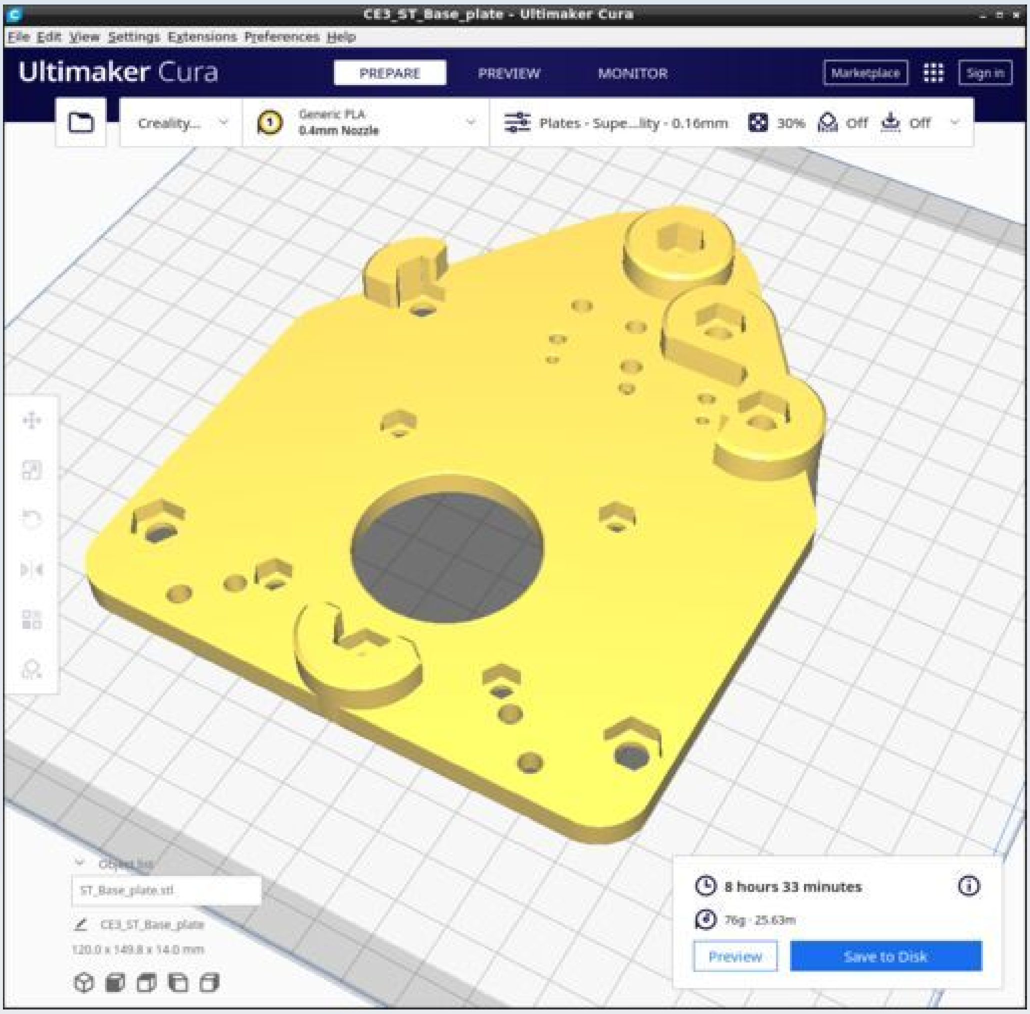
Cura calculates the following resources are required to print each model in this chapter:

Stage	Time_Hr	Time_Min	PLA_Length(m)
ST_Articulation.stl	0	14	0.53
ST_BasePlate.stl	8	23	25.63
ST_FocusPlate.stl	4	8	11.22

ST_Articulation.stl

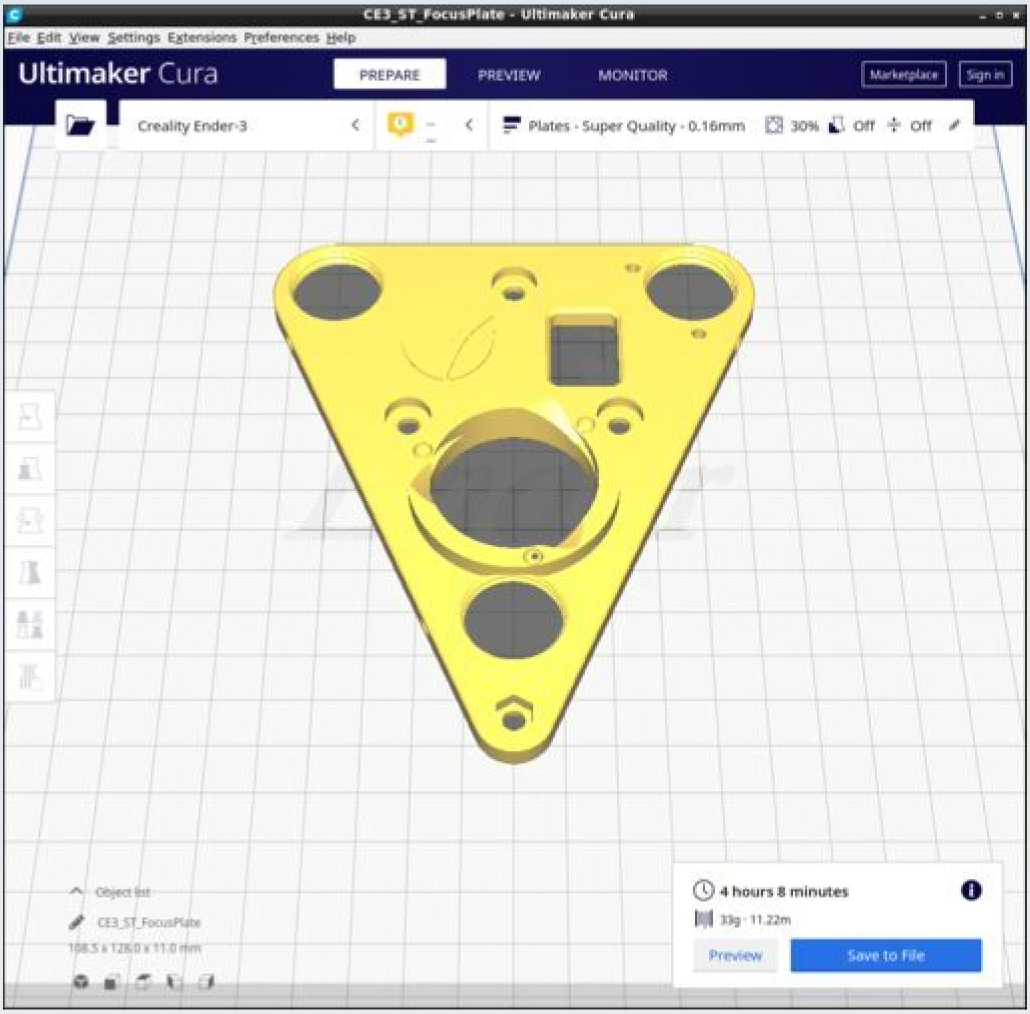


ST_BasePlate.stl



Print with the ‘Plates’ custom Cura profile.

ST_FocusPlate.stl



Print with the ‘Plates’ custom Cura profile.

Trinocular Camera Port

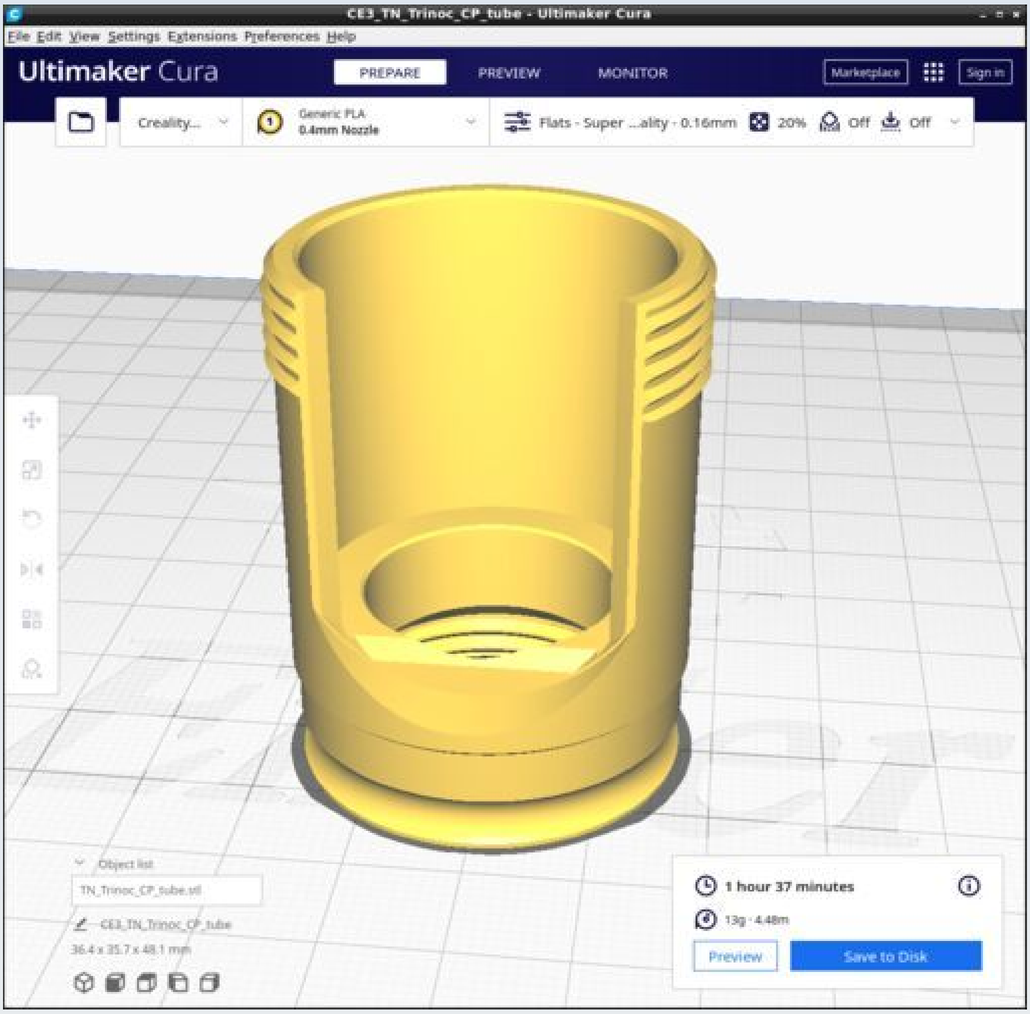
This is the part for the trinocular extension that attaches to the advanced filter block and allows a third eyepiece and / or a camera to be attached (in addition to any cameras or eyepieces that may be attached to the main viewing oculars in the ocular head). The CAD source models for these STL files are found in the file Trnocular_CP_v1.FCStd.

Resources

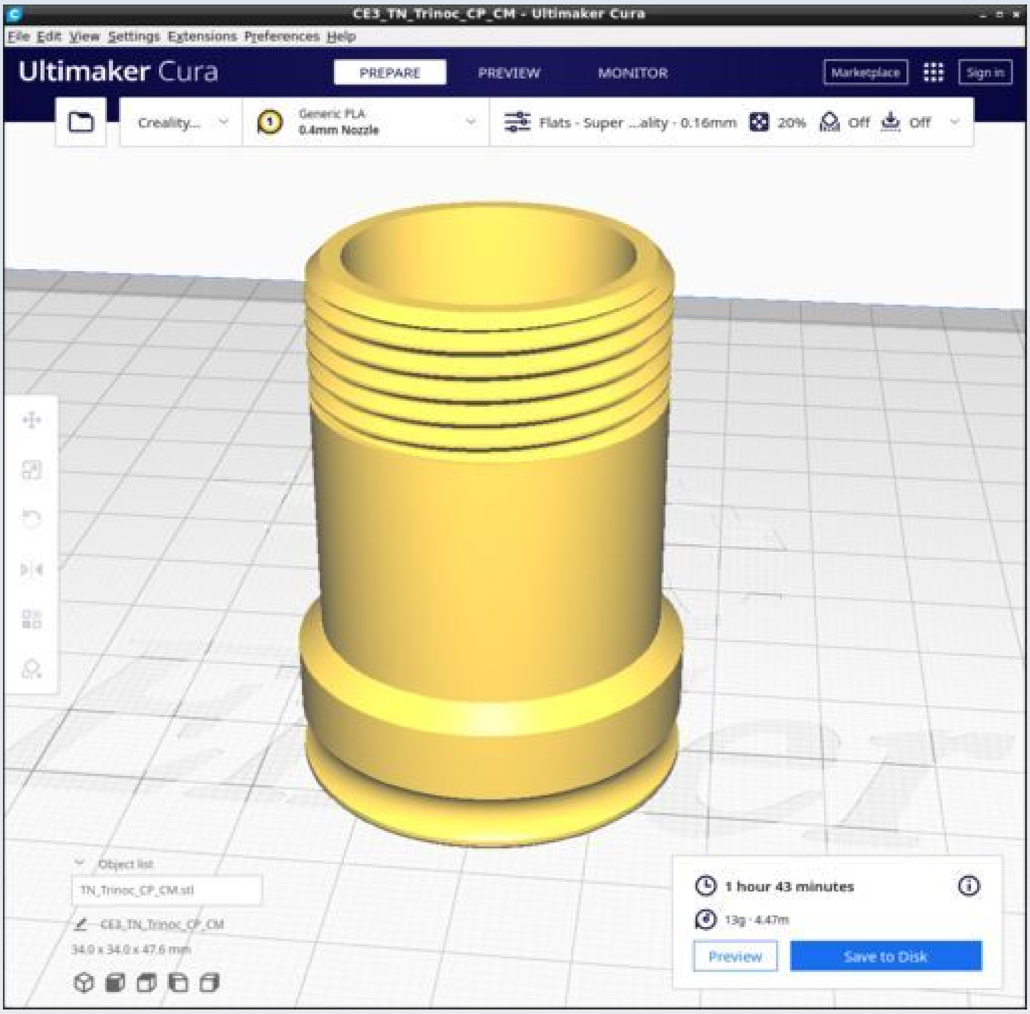
Cura calculates the following resources are required to print each model in this chapter:

Trinocular_Camera_Port	Time_Hr	Time_Min	PLA_Length(m)
TN_Trinoc_CP_tube.stl	1	37	4.48
TN_Trinoc_CP_CM.stl	1	43	4.47
TN_Ocular_spacer_ring_1p44	0	7	0.28

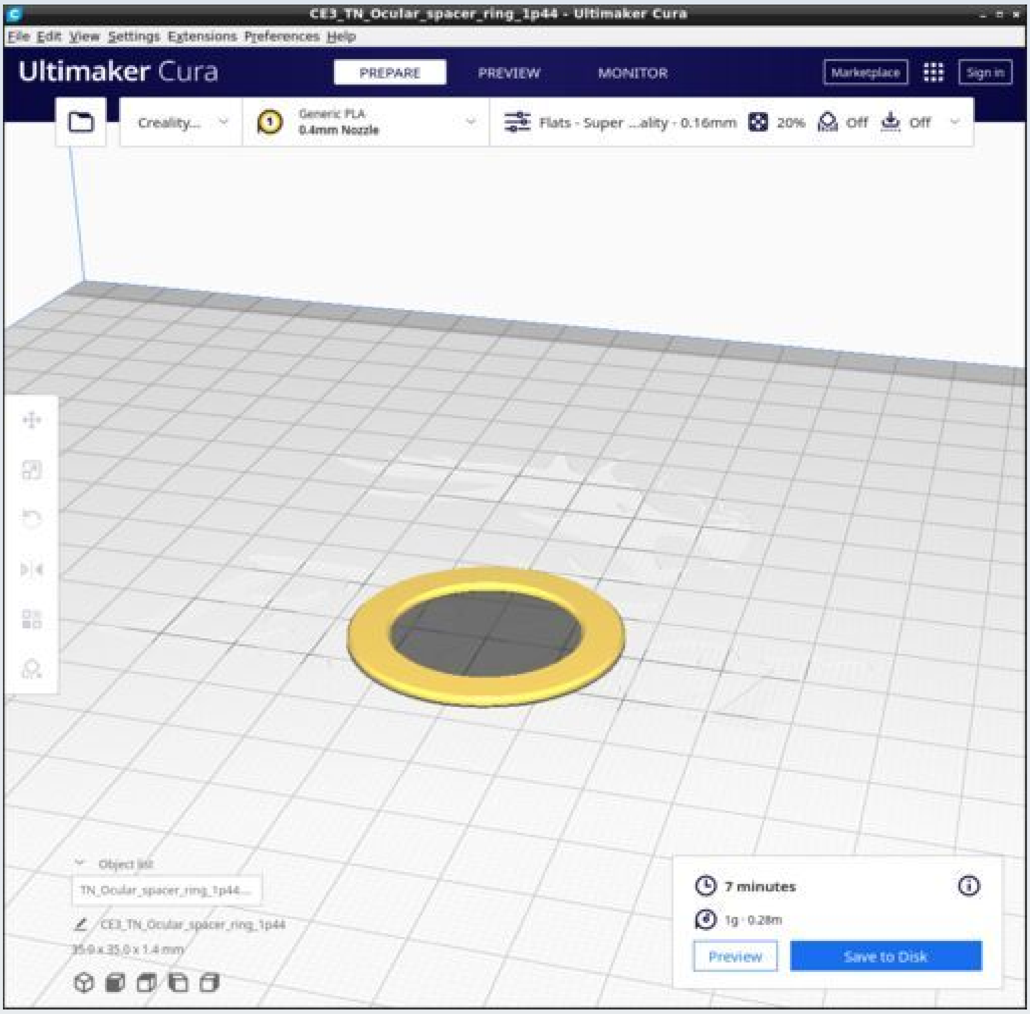
TN_Trinoc_CP_tube.stl



TN_Trinoc_CP_CM.stl



TN_Ocular_spacer_ring_1p44.stl



XY Stabiliser

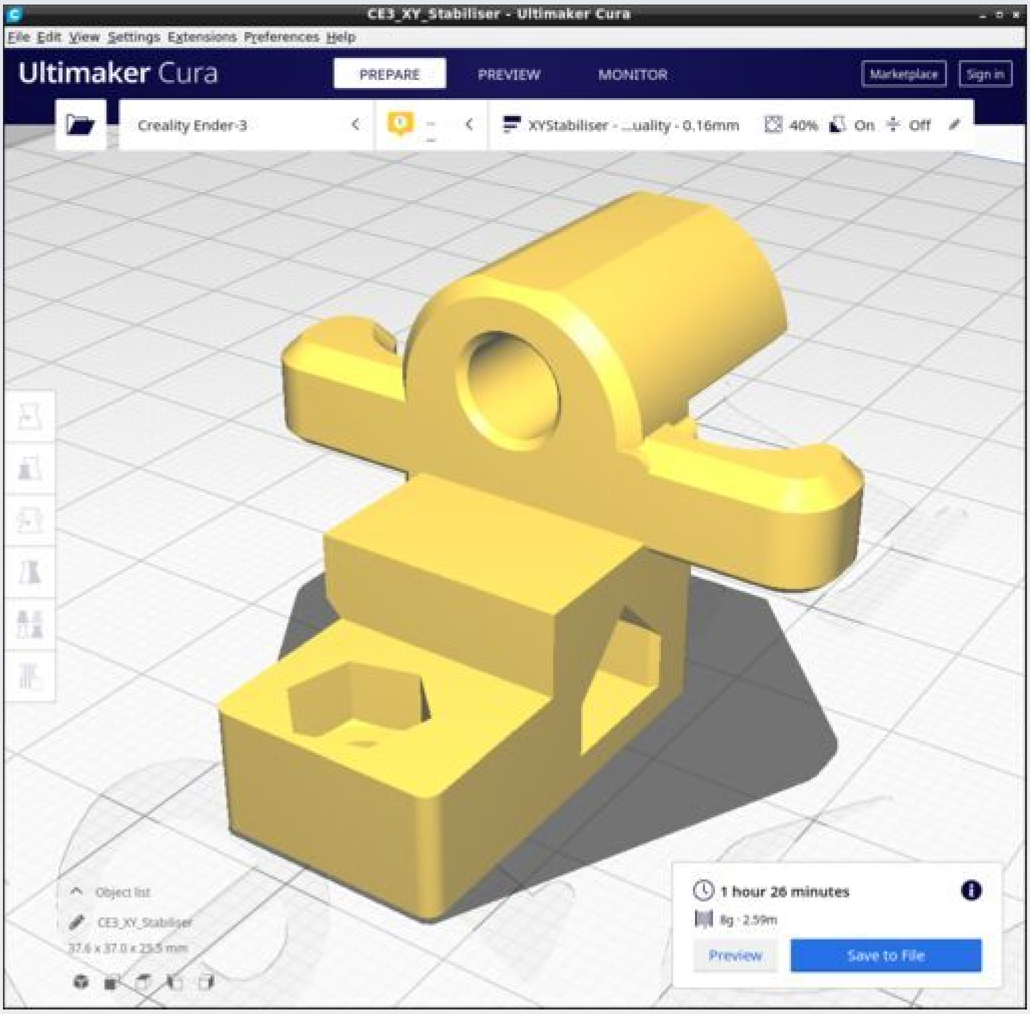
This is the part for an optional mechanism to make the standard XY mechanichal stage calipers more stable in their motion. The CAD source models for this STL file is found in the file XY_Stabiliser.FCStd.

Resources

Cura calculates the following resources are required to print each model in this chapter:

XY_Stabiliser	Time_Hr	Time_Min	PLA_Length(m)
XY_Stabiliser.stl	1	26	2.59

XY_Stabiliser.stl



Print with the ‘XYStabiliser’ custom Cura profile.

Z-Motor

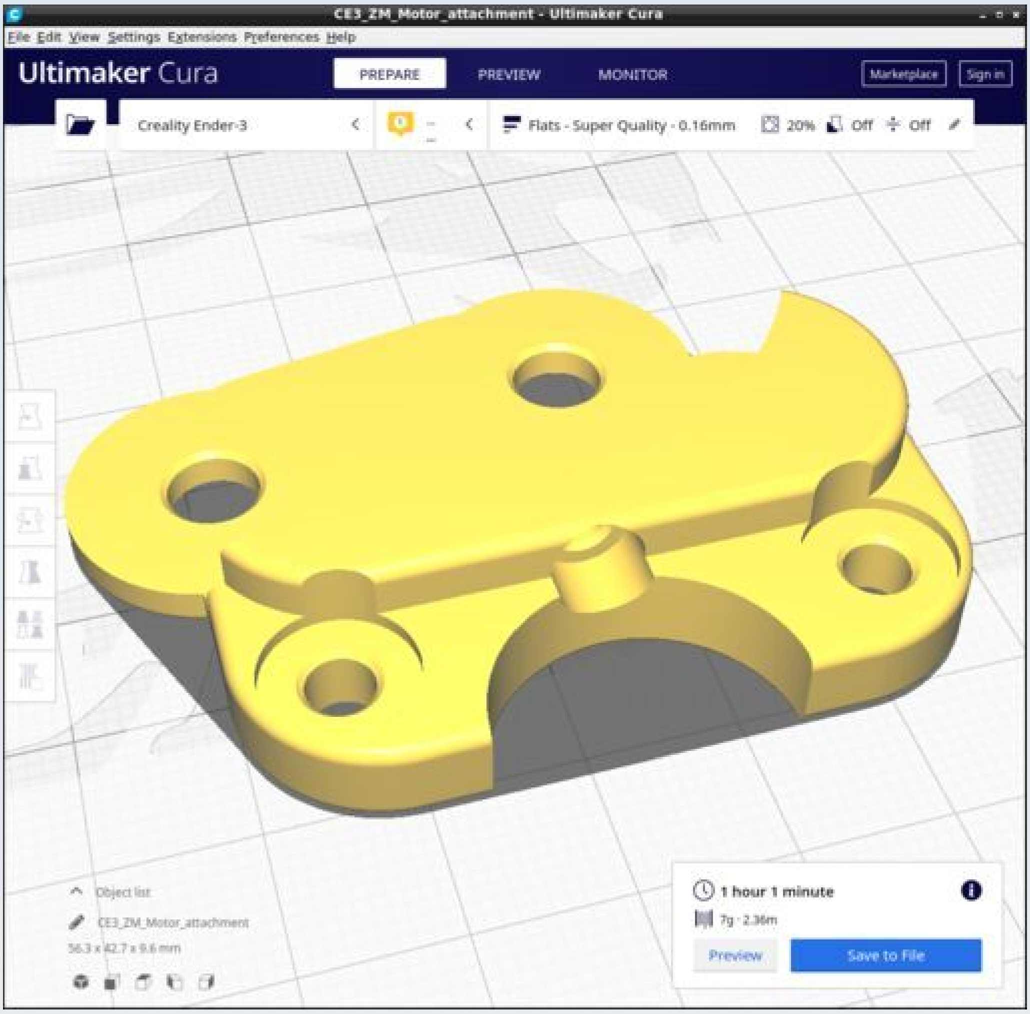
These are the parts for adding a Z-motor to the stage. The CAD source models for these STL files are found in the file Z_Motor.FCStd.

Resources

Cura calculates the following resources are required to print each model in this chapter:

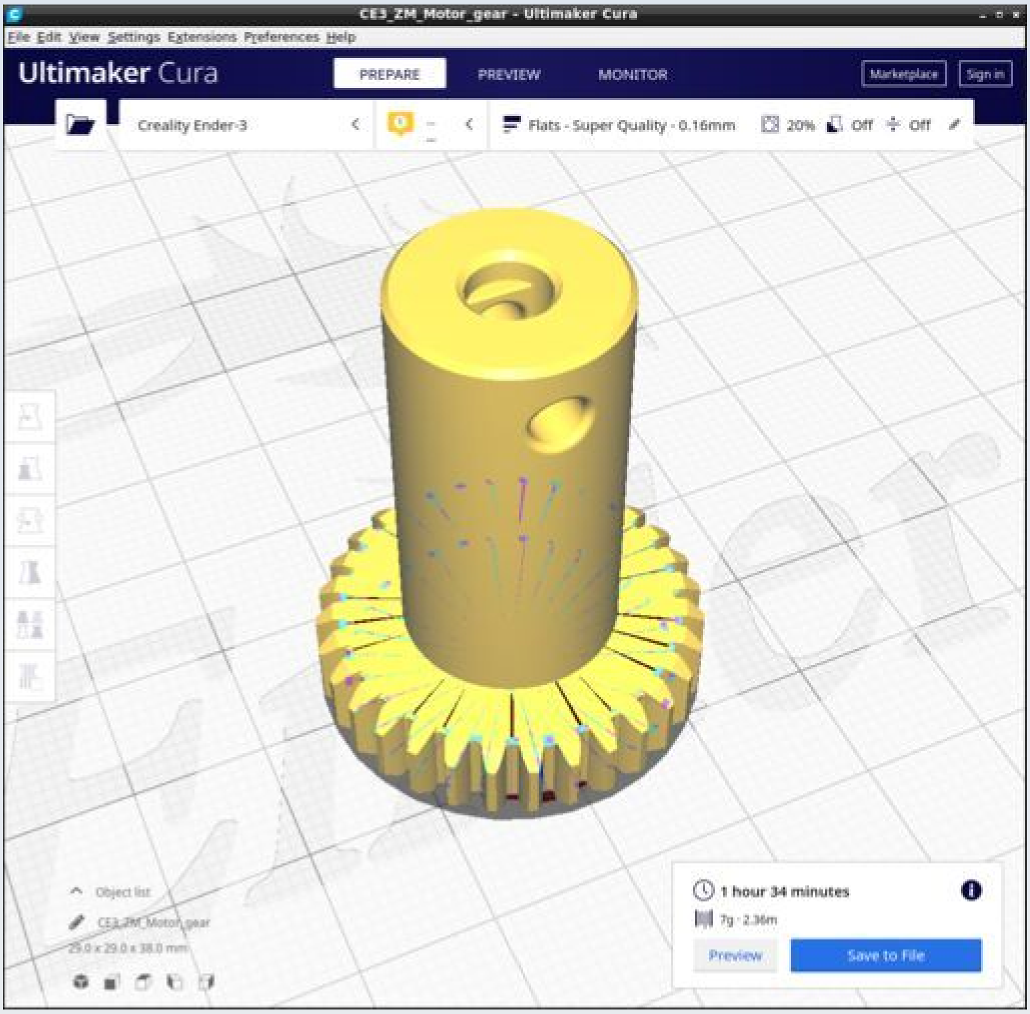
Z-Motor	Time_Hr	Time_Min	PLA_Length(m)
ZM_Motor_attachment.stl	1	1	2.36
ZM_Motor_gear.stl	1	34	2.36
ZM_Z_Limit_Sw_Mount.stl	0	17	0.44
ZM_Z_Probe.stl	1	4	2.04
ZM_Z_Yoke.stl	0	22	0.66

ZM_Motor_attachment.stl

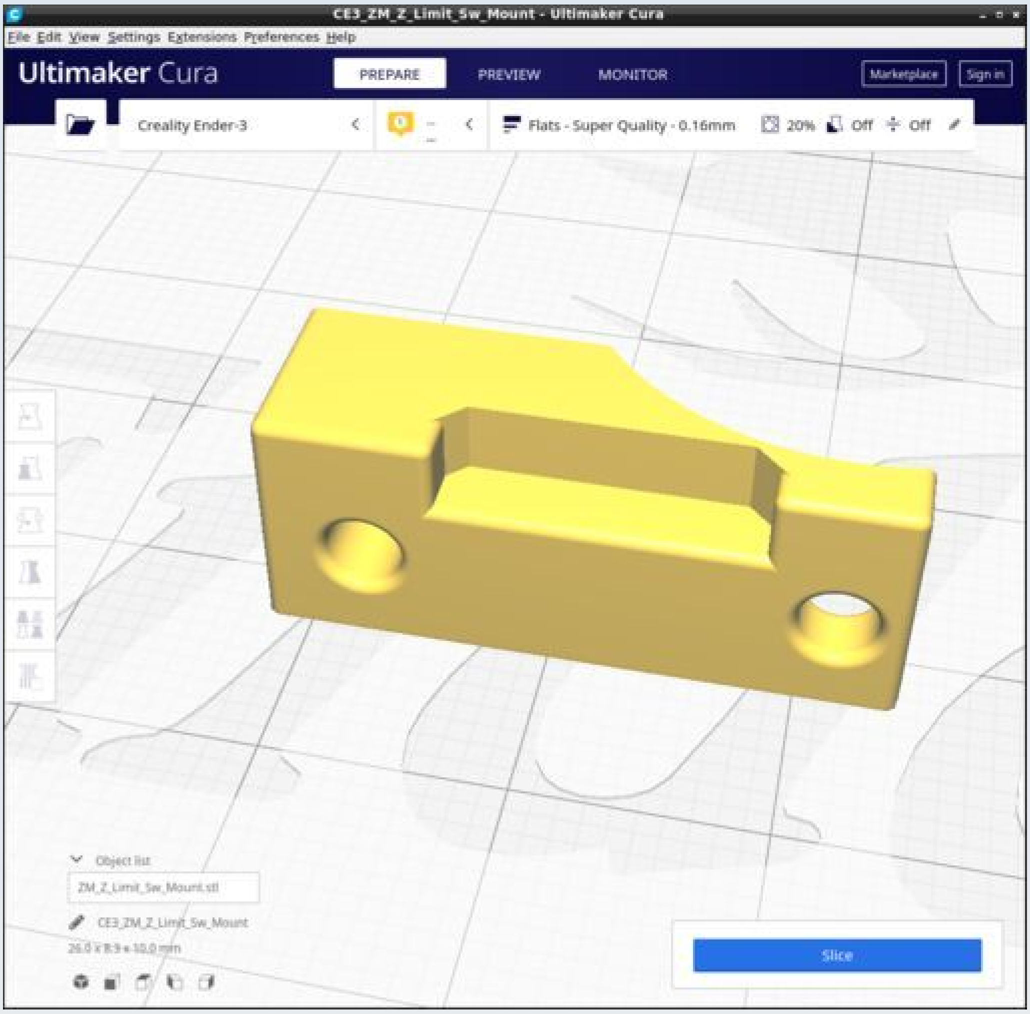


Ensure supports are disabled. It is not possible to properly rotate this in Cura using the method described below (for ZM_Z_Limit_Sw_Mount.stl) so the mesh is rotated 235 degrees in FreeCAD prior to saving to get the flat parts of the front surface aligned to the X-axis.

ZM_Motor_gear.stl



ZM_Z_Limit_Sw_Mount.stl



Ensure supports are disabled. It is difficult to get the flat outer surface exactly in line with the X-axis of the printer. To do this follow these steps:

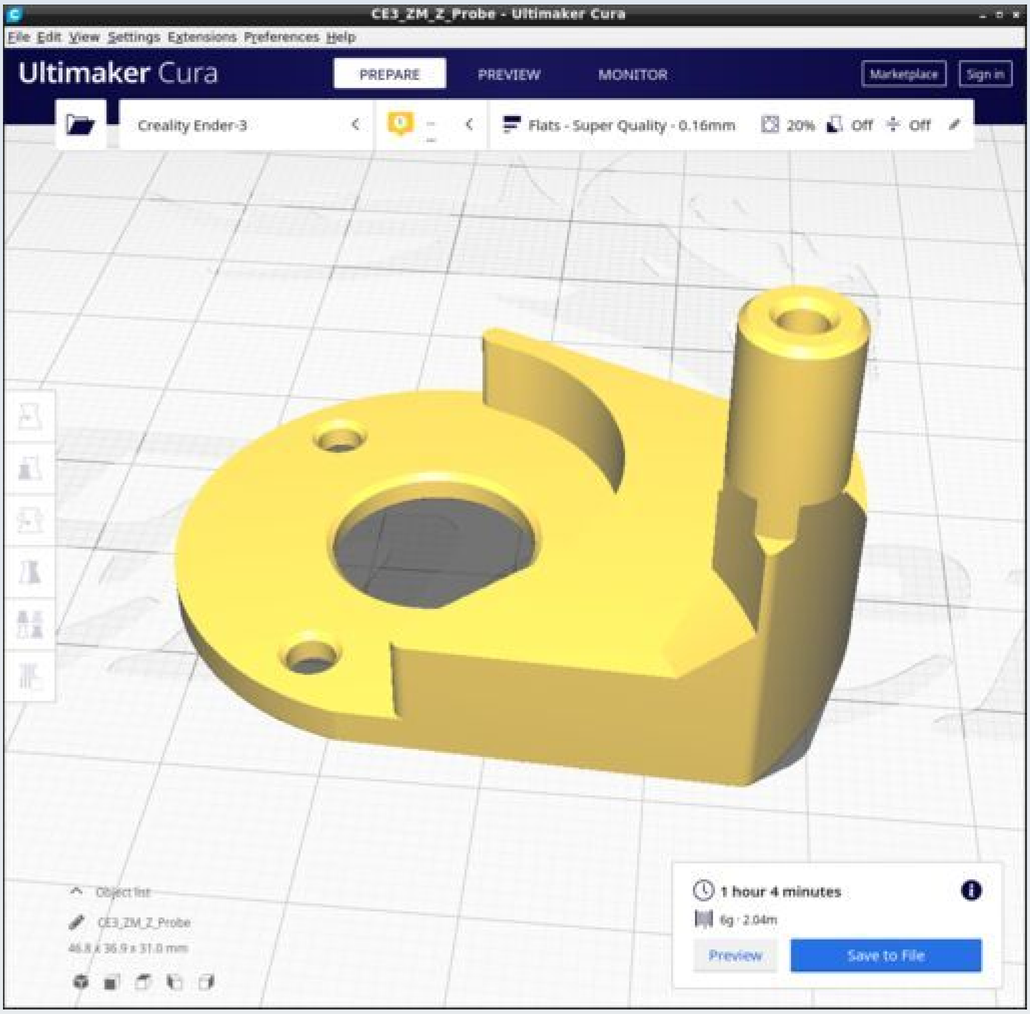
1. Load into Cura.

2. Rotate it so the flat surface with the screw holes faces the buildplate then use the 'Lay flat' option of Cura to calculate the exact rotation to make that surface flat against the build plate.

3. When done, simply use snap rotation to 90 degrees about the long axis of the model so that the flat surface that was laying on the build plate now faces to the front of the printer.

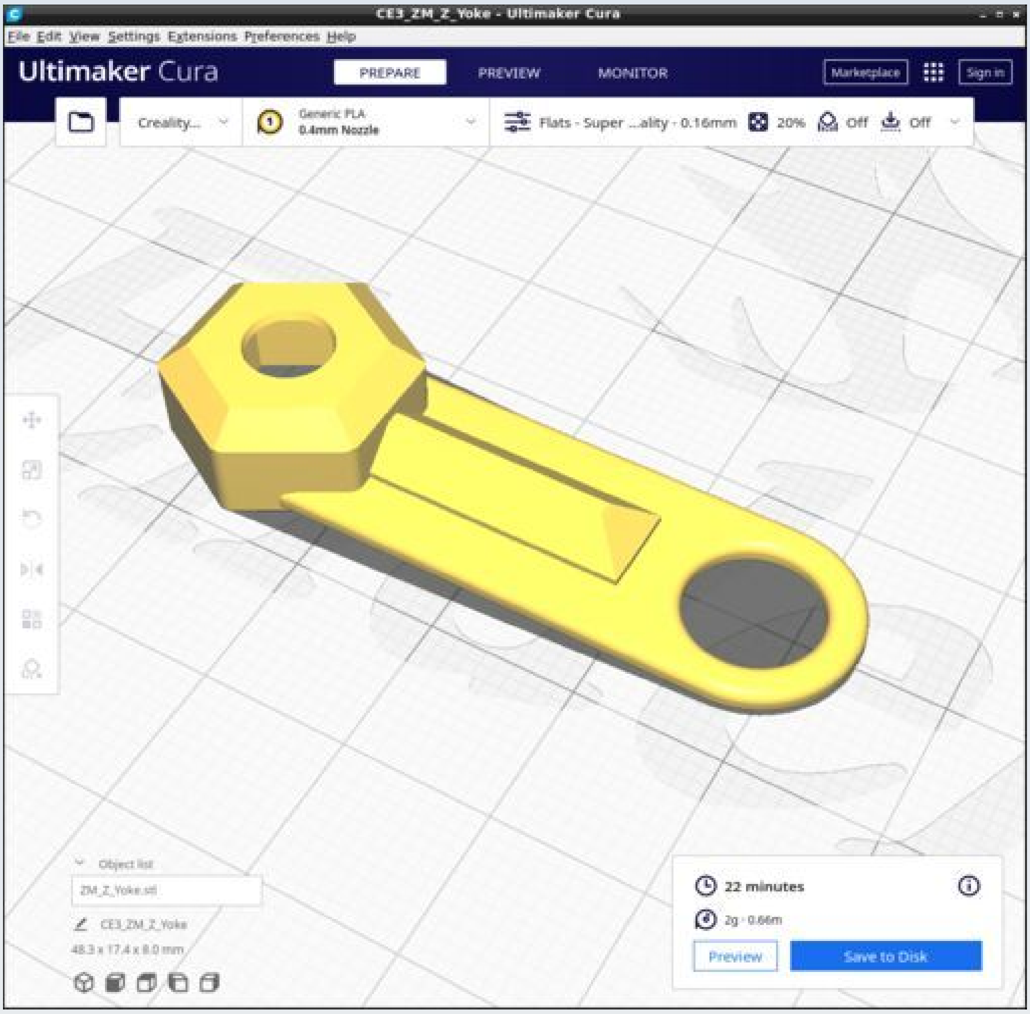
The resulting position is as shown in the figure.

ZM_Z_Probe.stl



Ensure supports are disabled. It is difficult to get the flat outer surface exactly in line with the X-axis of the printer so a method similar to that described above for ‘ZM_Z_Limit_Sw_Mount.stl’ is used. The result is as shown in the picture.

ZM_Z_Yoke.stl


CE3_ZM_Z_Yoke - Ultimaker Cura
File Edit View Settings Extensions Preferences Help
Ultimaker Cura
PREPARE
PREVIEW
MONITOR
Marketplace
Sign in
Creality...
Generic PLA
0.4mm Nozzle
Flats - Super ...ality - 0.16mm
20%
Off
Off
Object list
ZM_Z_Yoke.stl
CE3_ZM_Z_Yoke
48.3 x 17.4 x 8.0 mm
22 minutes
2g · 0.66m
Preview
Save to Disk