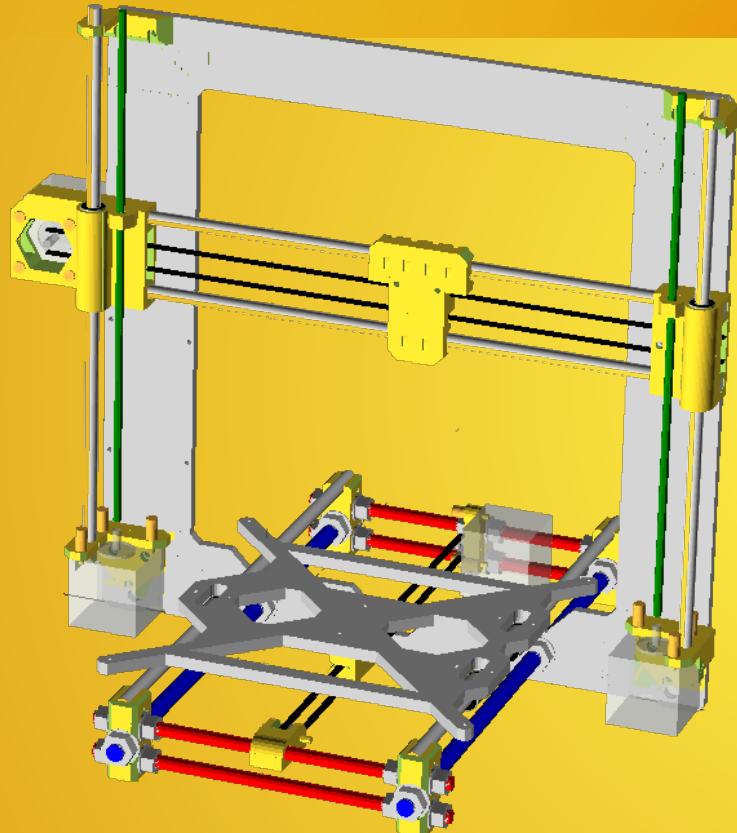


Expo 3D - 2014



Calibración de Impresoras 3D: Prusa I3

¿Qué es la calibración?

Proceso para conseguir impresiones óptimas:

- Proporcionalidad de las piezas
- Apariencia adecuada



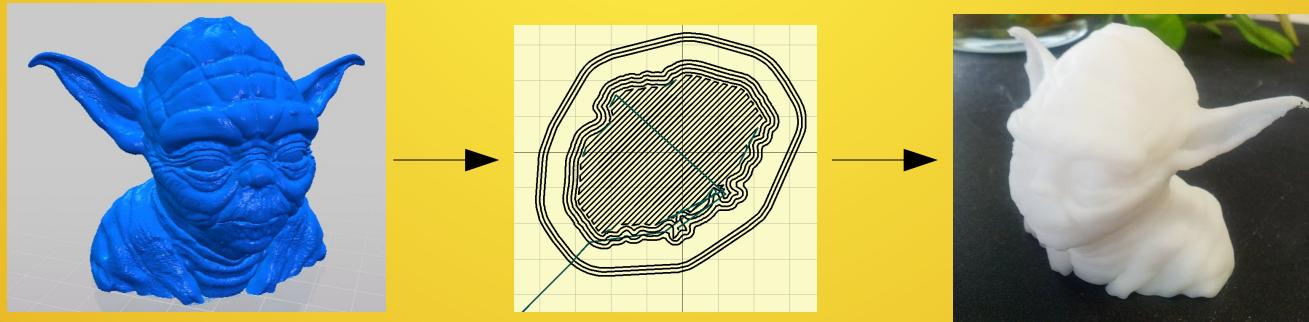
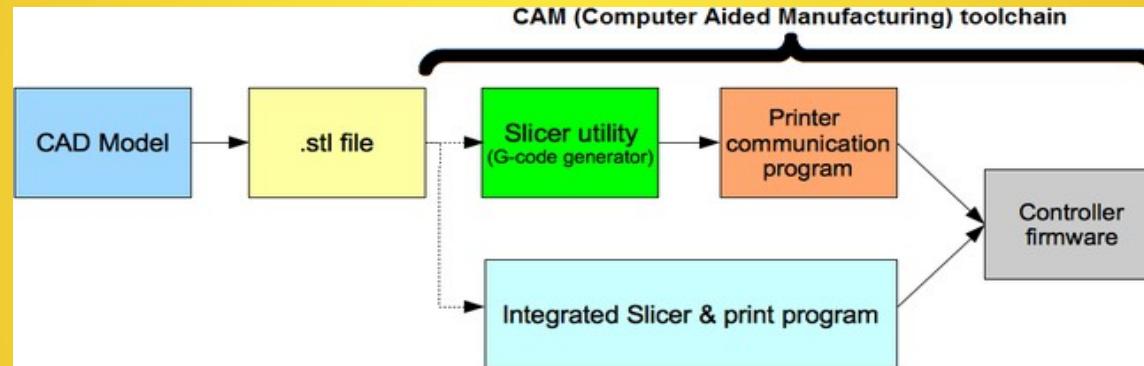
¿Cuándo es necesario calibrar?

- Al finalizar su montaje
- Al observar algún fallo en las impresiones
- Periódicamente



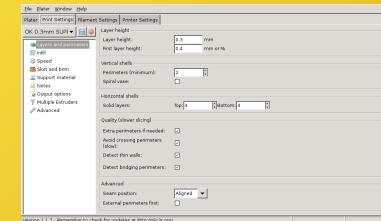
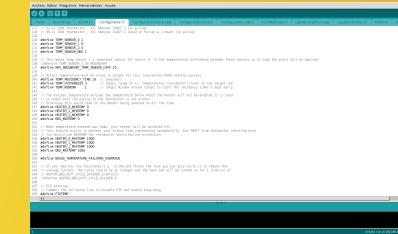
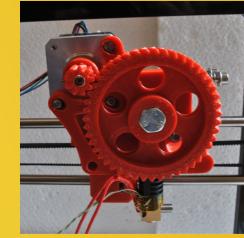
¿Qué implica calibrar?

Ciclo de trabajo



¿Qué implica calibrar?

- Ajustes mecánicos
- Ajustes del firmware
- Ajustes del fileteador



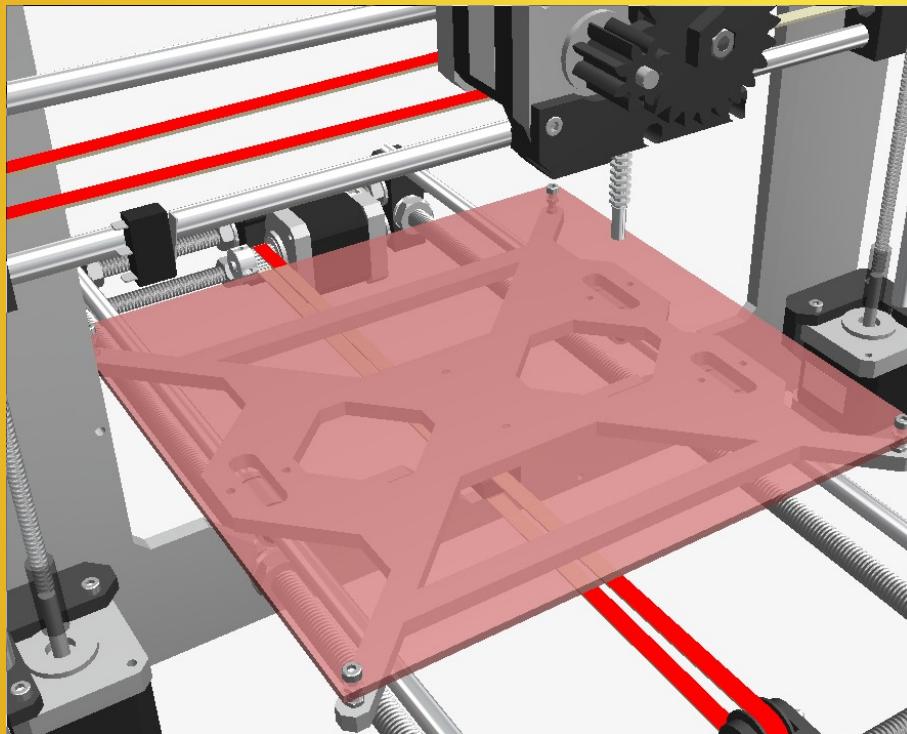
Mecánica: Rigidez estructural



Mecánica: Nivelación de la cama



Mecánica: Tensión de las correas

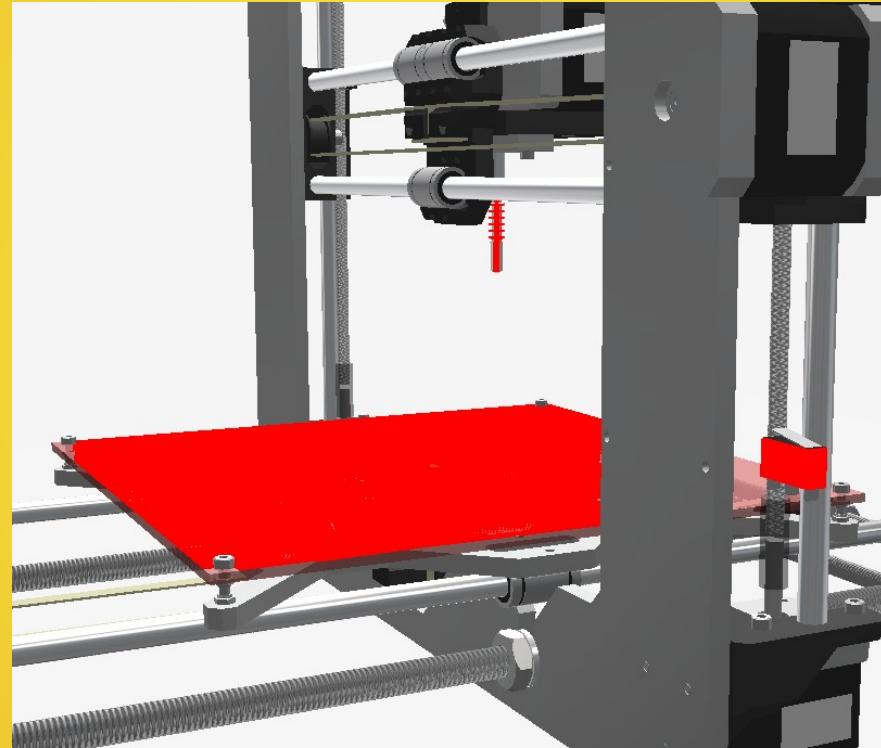


Sindearmir.net

Mecánica: Nivelación eje X

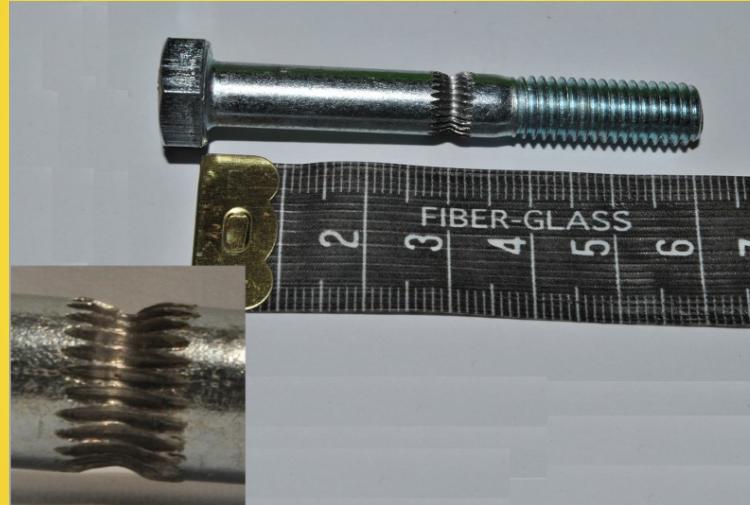


Mecánica: Altura de la primera capa



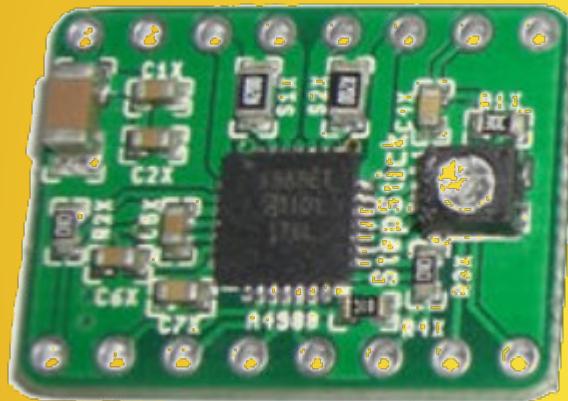
<http://youtu.be/E4HyFAkQfws?list=UUf9x1cgSeBDY-h5Cvf8BlvQ>

Mecánica: Hobbed bolt (Tornillo moleteado)



Sindarmir.net

Electrónica: Corriente de los motores



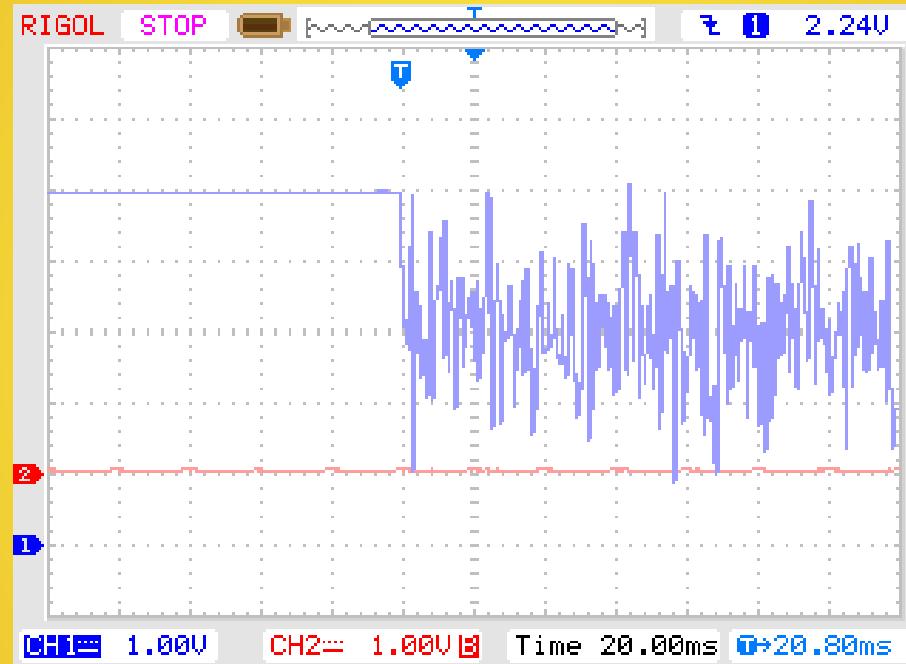
$$I = V_{REF} / 0,4$$

Corriente ejes X e Y: 200mA
Corriente ejes Z y E: 400mA



$$I = V_{REF} / 1,6$$

Electrónica: Cableado finales de carrera



Diáfonía (crosstalking) en acción



Firmware:

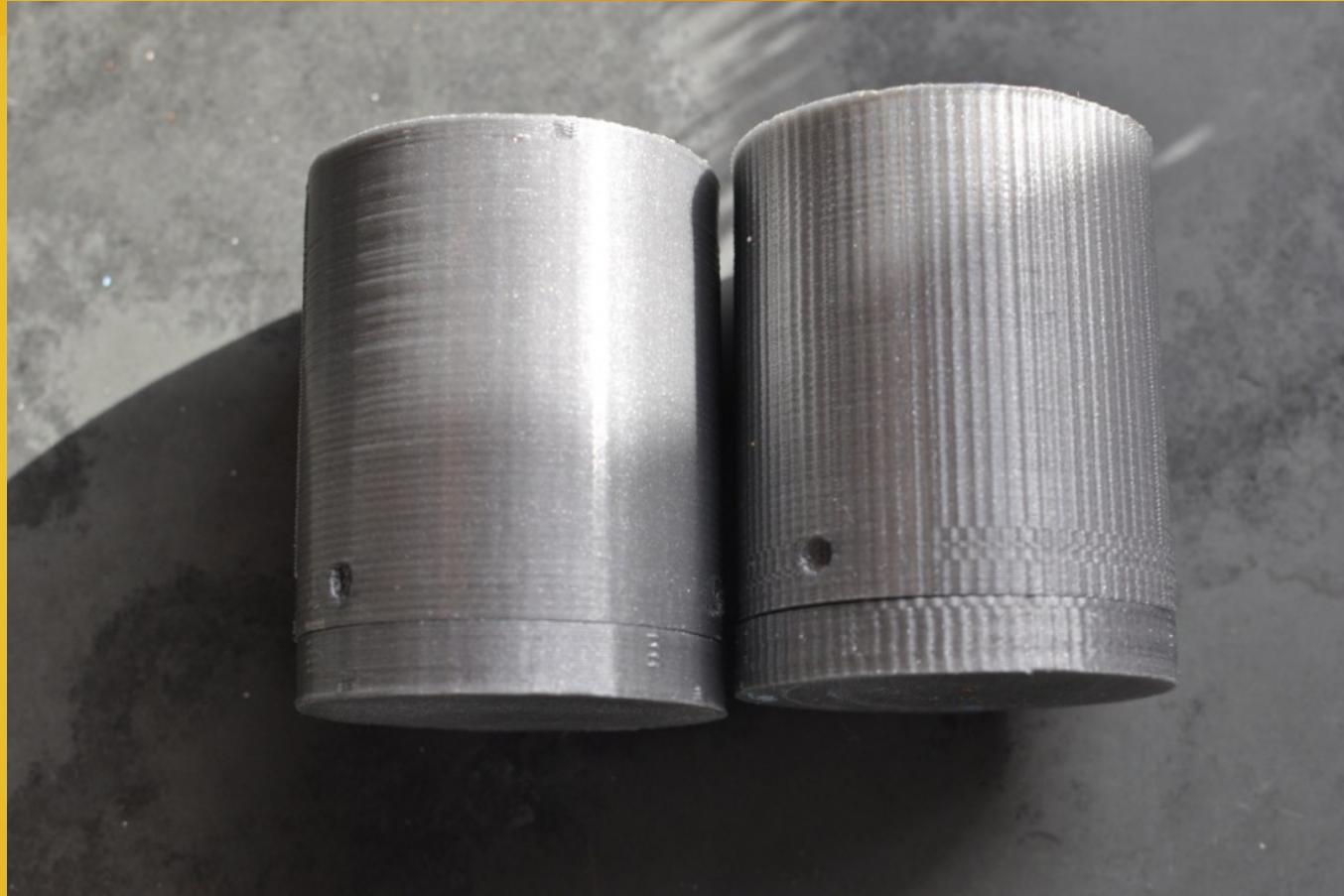
```
Archivo Editar Programa Herramientas Ayuda
✓ + < > Configuration.h ConfigurationStore.cpp ConfigurationStore.h Configuration_adv.h DOGMbitmaps.h LiquidCrystalRus.cpp LiquidCrystalRus.h Marlin.h Ma

127 // 52 is 200K thermistor - ATC Semitec 204GT-2 (1k pullup)
128 // 55 is 100K thermistor - ATC Semitec 104GT-2 (Used in Parcan & J-Head) (1k pullup)
129
130 #define TEMP_SENSOR_0 1
131 #define TEMP_SENSOR_1 0
132 #define TEMP_SENSOR_2 0
133 #define TEMP_SENSOR_BED 1
134
135 // This makes temp sensor 1 a redundant sensor for sensor 0. If the temperatures difference between these sensors is to high the print will be aborted.
136 // #define TEMP_SENSOR_1_AS_REDUNDANT
137 #define MAX_REDUNDANT_TEMP_SENSOR_DIFF 10
138
139 // Actual temperature must be close to target for this long before M109 returns success
140 #define TEMP_RESIDENCY_TIME 10 // (seconds)
141 #define TEMP_HYSTESIS 3 // (degC) range of +/- temperatures considered "close" to the target one
142 #define TEMP_WINDOW 1 // (degC) Window around target to start the residency timer x degC early.
143
144 // The minimal temperature defines the temperature below which the heater will not be enabled It is used
145 // to check that the wiring to the thermistor is not broken.
146 // Otherwise this would lead to the heater being powered on all the time.
147 #define HEATER_0_MINTEMP 0
148 #define HEATER_1_MINTEMP 0
149 #define HEATER_2_MINTEMP 0
150 #define BED_MINTEMP 0
151
152 // When temperature exceeds max temp, your hester will be switched off.
153 // This feature exists to protect your hotend from overheating accidentally, but *NOT* from thermistor short/failure protection.
154 // You should use MINTEMP for thermistor short/failure protection.
155 #define HEATER_0_MAXTEMP 1000
156 #define HEATER_1_MAXTEMP 1000
157 #define HEATER_2_MAXTEMP 1000
158 #define BED_MAXTEMP 1000
159
160 #define BOGUS_TEMPERATURE_FAILSAFE_OVERRIDE
161
162 // If your bed has low resistance e.g. .6 ohm and throws the fuse you can duty cycle it to reduce the
163 // average current. The value should be an integer and the heat bed will be turned on for 1 interval of
164 // HEATER_BED_DUTY_CYCLE_DIVIDER intervals.
165 // #define HEATER_BED_DUTY_CYCLE_DIVIDER 4
166
167 // PID settings:
168 // Comment the following line to disable PID and enable bang-bang.
169 #define PIDTEMP
```

- Marlin
 - Sprinter
 - GRBL
 - Repetier
 - ...



Firmware:



Marlin

Sprinter



Sinderamir.net

Firmware: Marlin → Sensores de temperatura

```
//--NORMAL IS 4.7kohm PULLUP!-- 1kohm pullup can be used on hotend sensor, using  
correct resistor and table
```

```
//// Temperature sensor settings:
```

```
[...]
```

```
// 0 is not used
```

```
// 1 is 100k thermistor - best choice for EPCOS 100k (4.7k pullup)
```

```
// 2 is 200k thermistor - ATC Semitec 204GT-2 (4.7k pullup)
```

```
// 3 is Mendel-parts thermistor (4.7k pullup)
```

```
// 4 is 10k thermistor !! do not use it for a hotend. It gives bad resolution at high temp. !!
```

```
// 5 is 100K thermistor - ATC Semitec 104GT-2 (Used in ParCan & J-Head) (4.7k pullup)
```

```
[...]
```

```
#define TEMP_SENSOR_0 5
```

```
#define TEMP_SENSOR_1 0
```

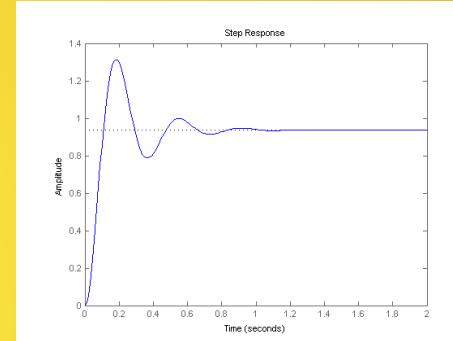
```
#define TEMP_SENSOR_2 0
```

```
#define TEMP_SENSOR_BED 1
```



Firmware: Marlin → Sensores de temperatura. PID

```
#define DEFAULT_Kp 22.2  
#define DEFAULT_Ki 1.08  
#define DEFAULT_Kd 114
```



Autocalibración PID Hotend:

```
M303 E0 S200 C8
```

Autocalibración PID Cama:

```
M303 E-1 S60 C8
```



Firmware: Marlin → Velocidad movimientos

```
/// MOVEMENT SETTINGS
```

```
#define NUM_AXIS 4 // The axis order in all axis related arrays is X, Y, Z, E  
#define HOMING_FEEDRATE {50*60, 50*60, 4*60, 0} // set the homing speeds  
(mm/min)
```

```
#define DEFAULT_MAX_ACCELERATION {5000, 5000, 10, 5000} // X, Y, Z, E  
#define DEFAULT_ACCELERATION 1000 // X, Y, Z and E max acceleration in mm/s2  
#define DEFAULT_RETRACT_ACCELERATION 2000 // X, Y, Z and E max  
acceleration in mm/s2 for retracts
```



Firmware: Marlin → Relación pasos / distancia (Ejes X e Y)

```
#define DEFAULT_AXIS_STEPS_PER_UNIT {80,80,4000,775}
```

Steps per millimeter - belt driven systems

The result is theoreticaly right, but you might still need to calibrate your machine to get finest detail. This is good start tho.

Motor step angle	Driver microstepping
<input type="text" value="1.8° (200 per revolution)"/>	<input type="text" value="1/16 - uStep (mostly Pololu)"/>
Belt pitch	Belt presets
<input type="text" value="2"/> mm	<input type="text" value="2mm Pitch (GT2 mainly)"/>
Pulley tooth count	
<input type="text" value="20"/>	

Result	Resolution	Teeth	Step angle	Stepping	Belt
80.00	12.5micron	20	1.8°	1/16th	2mm



Firmware: Marlin → Relación pasos / distancia (Ejes E y Z)

```
#define DEFAULT_AXIS_STEPS_PER_UNIT {80,80,4000,775}
```

Steps per millimeter - leadscrew driven systems

Gives you number of steps electronics need to generate to move the axis by 1mm.

Motor step angle

1.8° (200 per revolution)

Driver microstepping

1/16 - uStep (mostly Pololu)

Leadscrew pitch

0.8 mm/revolution

Presets

M5 - metric (0.8mm per rotation)

Gear ratio

1 : 1

Motor : Leadscrew (1:1 for direct drive - Prusa)

Result

Leadscrew pitch

Step angle

Stepping

Gear ratio

4000.00

0.8

1.8°

1/16th

1 : 1



Fileteador: Slic3r → Print Settings (1)

The screenshot shows the 'Print Settings' tab selected in the top menu bar. On the left, there's a sidebar with various settings options: Layers and perimeters (selected), Infill, Speed, Skirt and brim, Support material, Notes, Output options, Multiple Extruders, and Advanced.

Layer height

- Layer height: 0.3 mm
- First layer height: 0.4 mm or %

Vertical shells

- Perimeters (minimum): 2
- Spiral vase:

Horizontal shells

- Solid layers: Top: 4 Bottom: 4

Quality (slower slicing)

- Extra perimeters if needed:
- Avoid crossing perimeters (slow):
- Detect thin walls:
- Detect bridging perimeters:

Advanced

- Seam position: Aligned
- External perimeters first:

Version 1.1.7 - Remember to check for updates at <http://slic3r.org/>

Fileteador: Slic3r → Print Settings (1)

Optimal layer height for your Z axis

Helps you to select layer height in a way, that Z axis moves only by full step increments. Z axis isn't usually enabled during inactivity. If the axis is disabled during micro-step, axis jumps to the closest full step and introduce error. This effect is occurring to some extent even while leaving the Z axis motors enabled. This is most useful to machines with imperial leadscrews but also for unusual layer heights with metric leadscrews.

Motor step angle

1.8° (200 per revolution) ▾

Leadscrew pitch

0.8 mm/revolution Presets M5 - metric (0.8mm per rotation) ▾

Desired layer height

0.25 mm

Z axis gear ratio

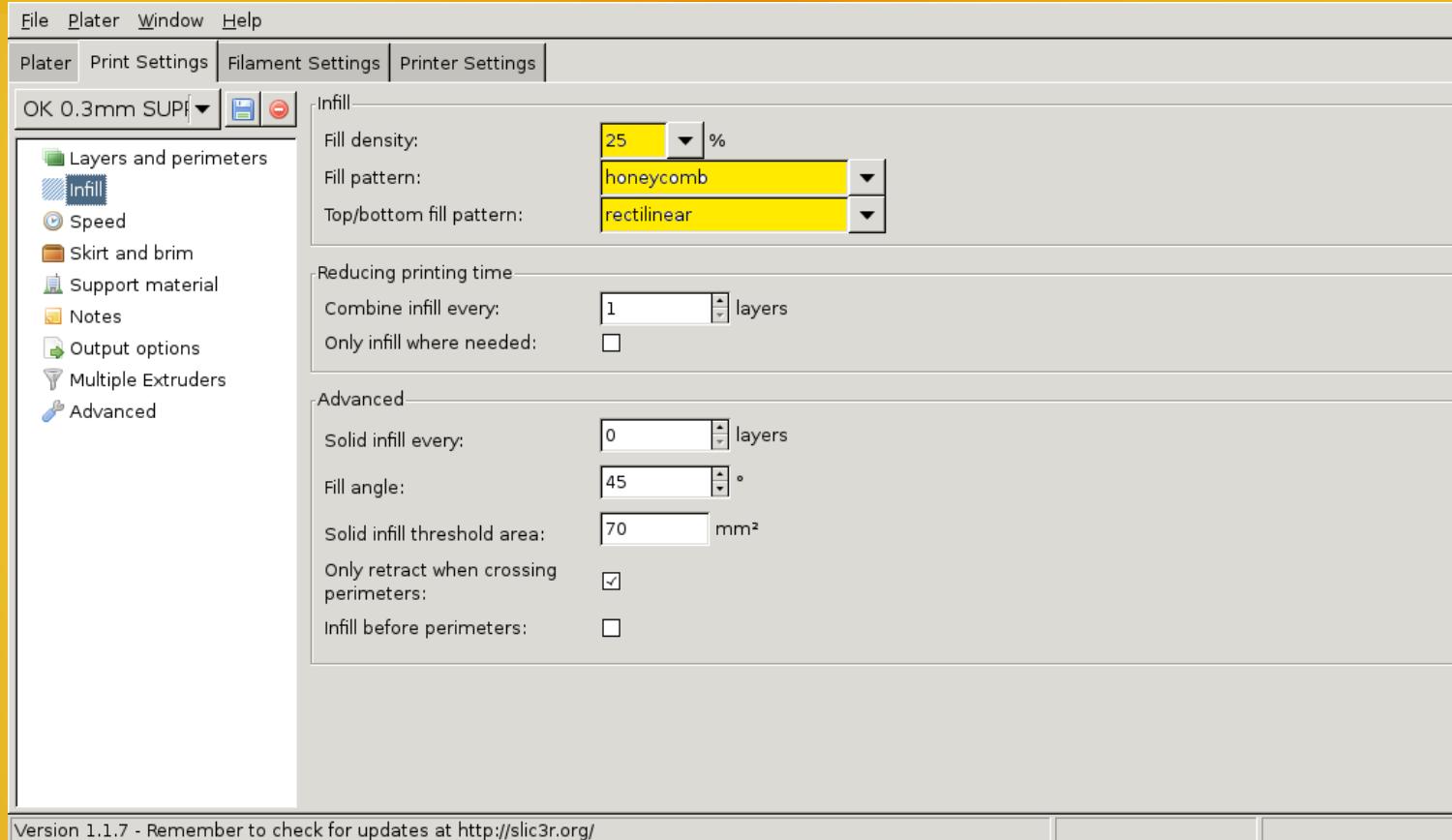
1 : 1

Motor : Leadscrew (1:1 for direct drive - Prusa)

Layer height	Error over 10cm	Number of steps	Step length
0.2480	0mm	62	0.004mm
0.25	-0.8mm	62.5	0.004mm
0.2520	0mm	63	0.004mm



Fileteador: Slic3r → Print Settings (2)



Fileteador: Slic3r → Print Settings (3)

File Plater Window Help

Plater Print Settings Filament Settings Printer Settings

OK 0.3mm SUP! ▾

Speed for print moves

Perimeters:	30	mm/s
Small perimeters:	30	mm/s or %
External perimeters:	70%	mm/s or %
Infill:	60	mm/s
Solid infill:	60	mm/s or %
Top solid infill:	50	mm/s or %
Support material:	60	mm/s
Support material interface:	100%	mm/s or %
Bridges:	60	mm/s
Gap fill:	20	mm/s

Speed for non-print moves

Travel:	130	mm/s
---------	-----	------

Modifiers

First layer speed:	30%	mm/s or %
--------------------	-----	-----------

Acceleration control (advanced)

Perimeters:	0	mm/s ²
Infill:	0	mm/s ²
Bridge:	0	mm/s ²

Version 1.1.7 - Remember to check for updates at <http://slic3r.org/>

Fileteador: Slic3r → Print Settings (3)

File Plater Window Help

Plater Print Settings Filament Settings Printer Settings

OK 0.3mm SUP! ▾

Speed for print moves

Perimeters:	30	mm/s
Small perimeters:	30	mm/s or %
External perimeters:	70%	mm/s or %
Infill:	60	mm/s
Solid infill:	60	mm/s or %
Top solid infill:	50	mm/s or %
Support material:	60	mm/s
Support material interface:	100%	mm/s or %
Bridges:	60	mm/s
Gap fill:	20	mm/s

Speed for non-print moves

Travel:	130	mm/s
---------	-----	------

Modifiers

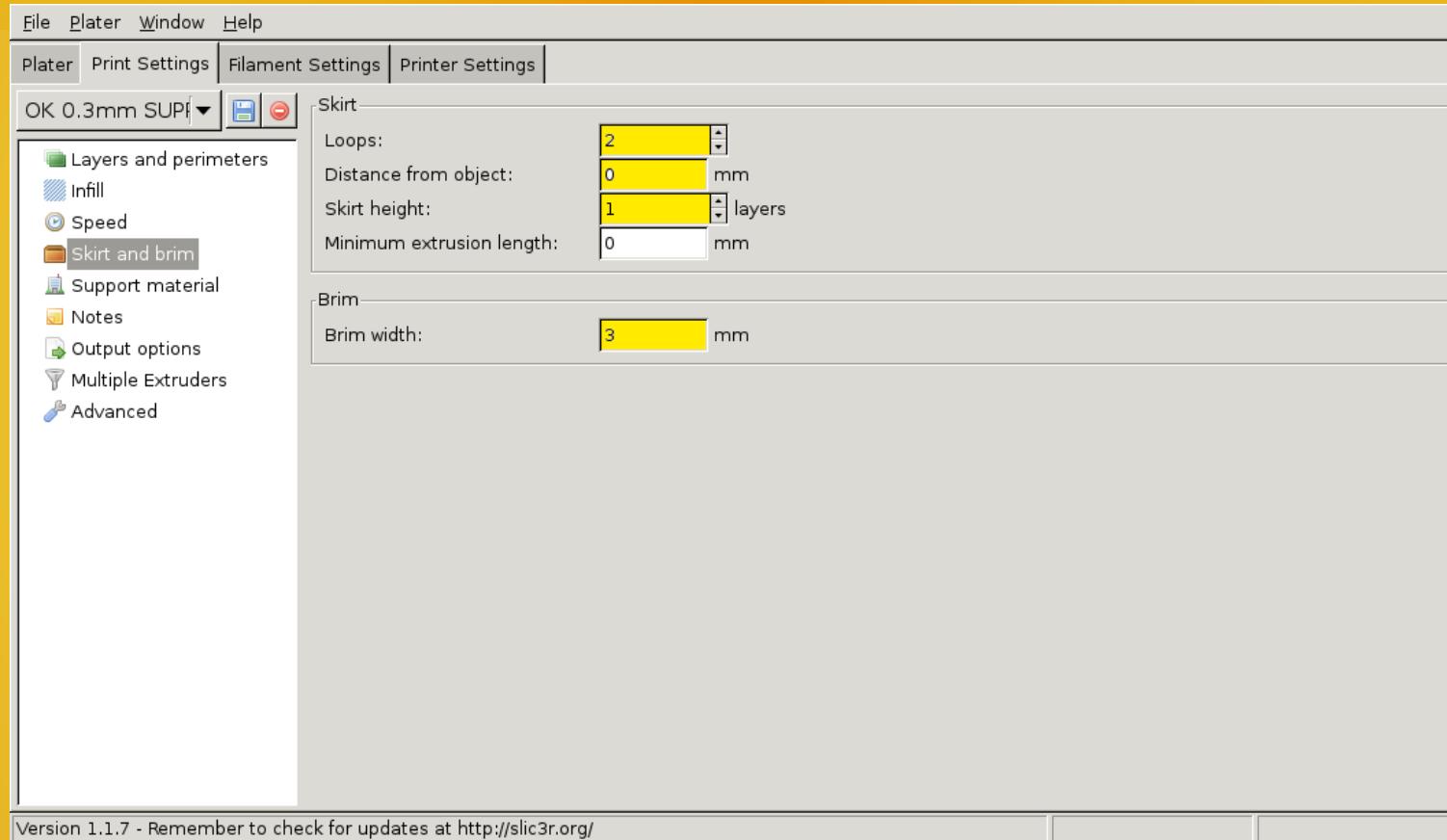
First layer speed:	30%	mm/s or %
--------------------	-----	-----------

Acceleration control (advanced)

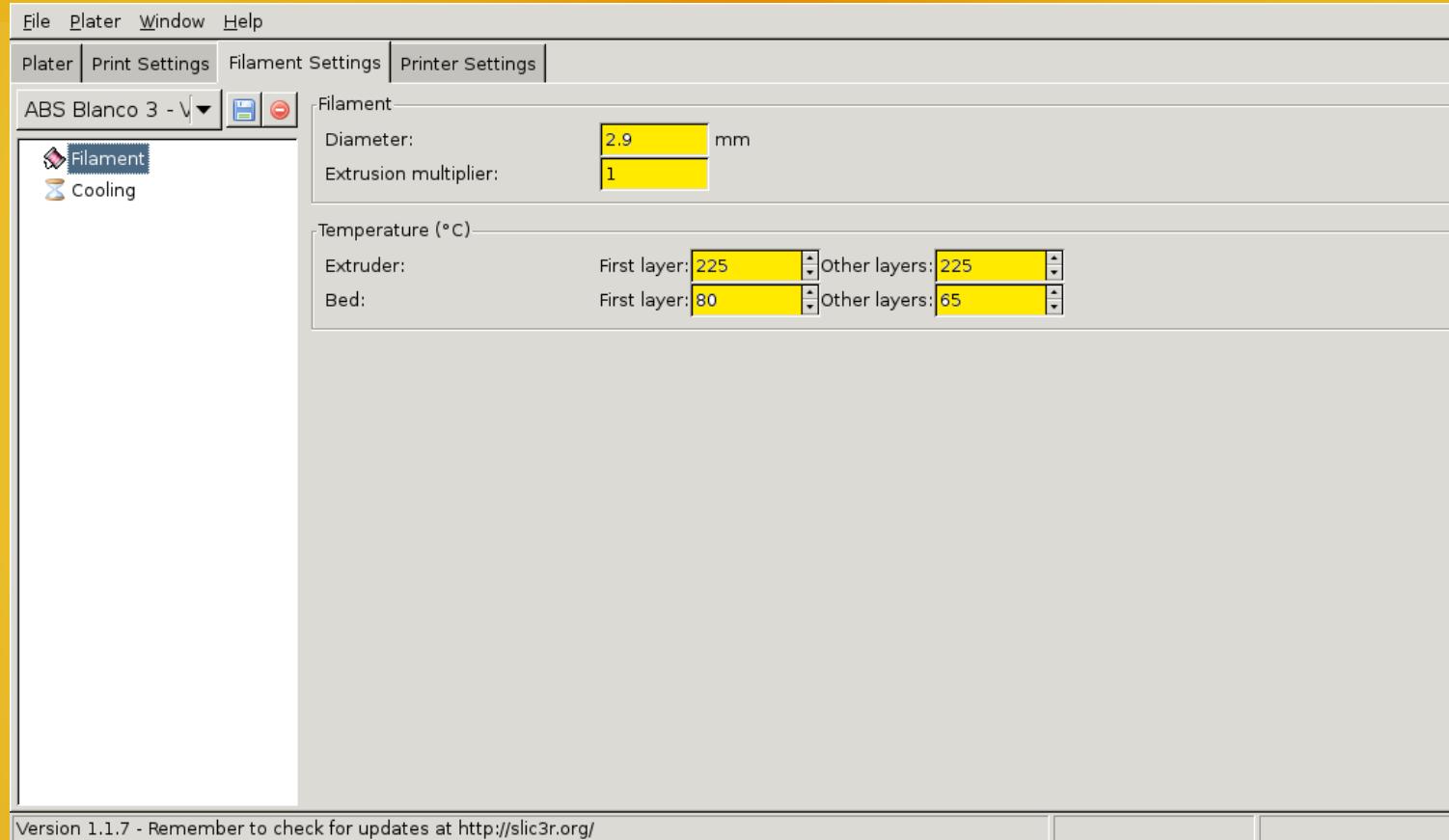
Perimeters:	0	mm/s ²
Infill:	0	mm/s ²
Bridge:	0	mm/s ²

Version 1.1.7 - Remember to check for updates at <http://slic3r.org/>

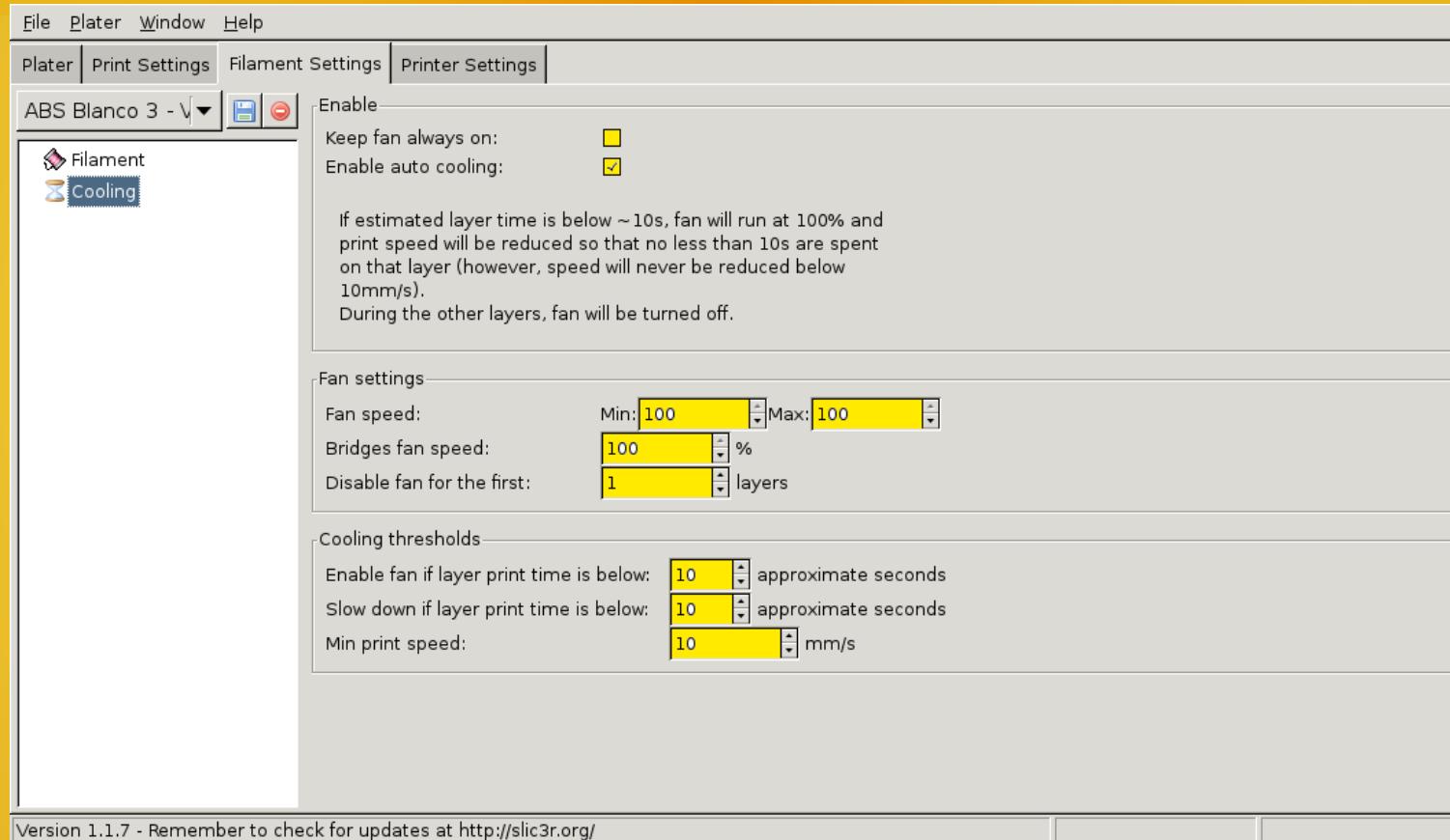
Fileteador: Slic3r → Print Settings (4)



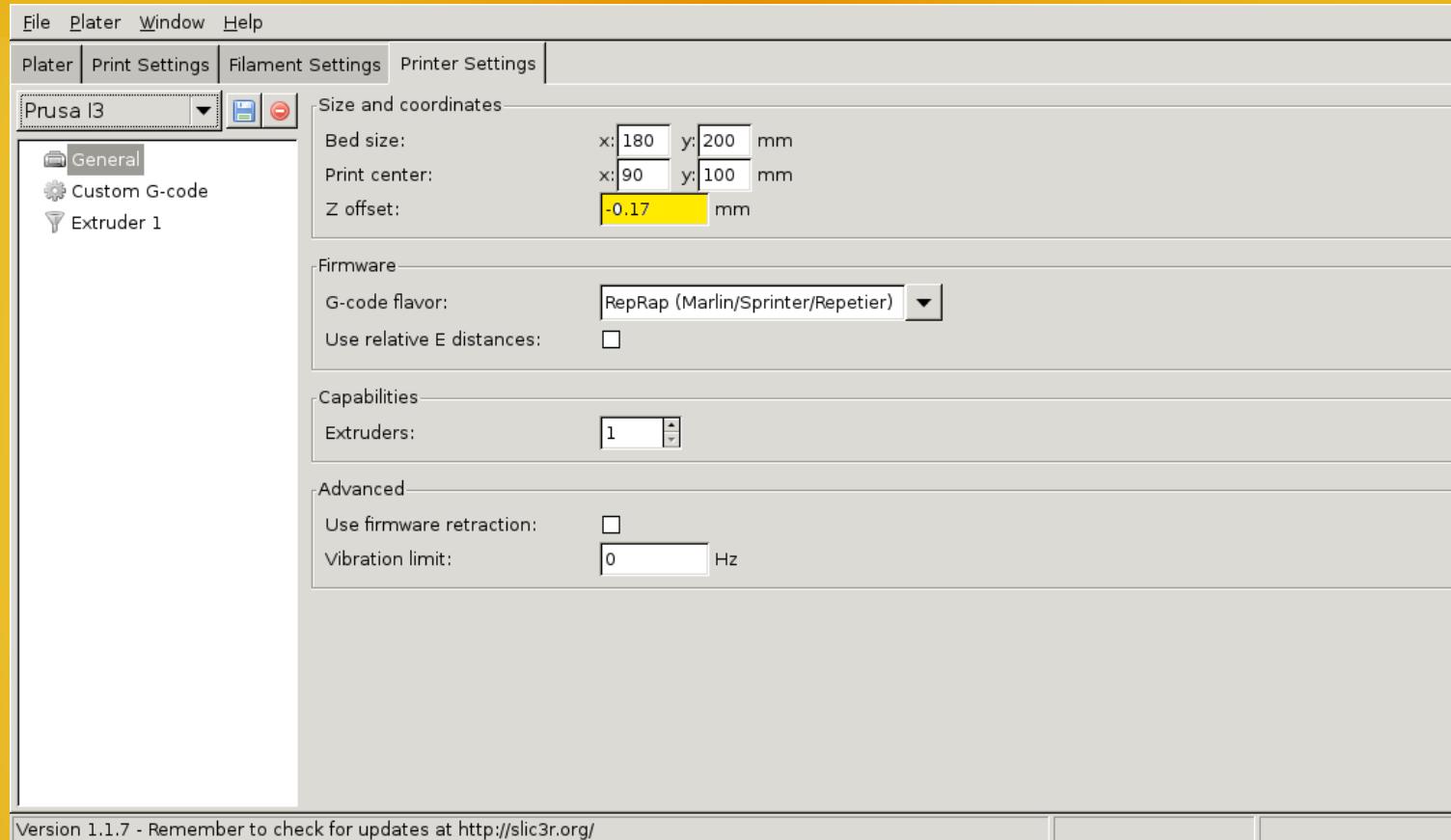
Fileteador: Slic3r → Filament Settings (1)



Fileteador: Slic3r → Filament Settings (2)



Fileteador: Slic3r → Printer Settings

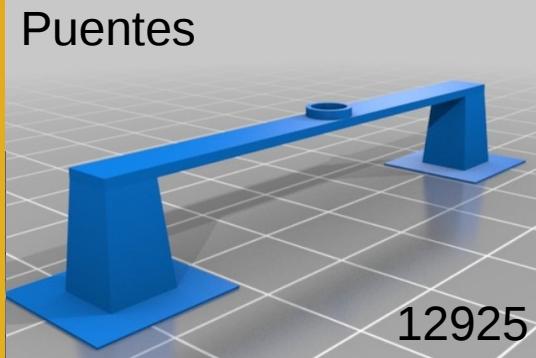


Recomendaciones mantenimiento

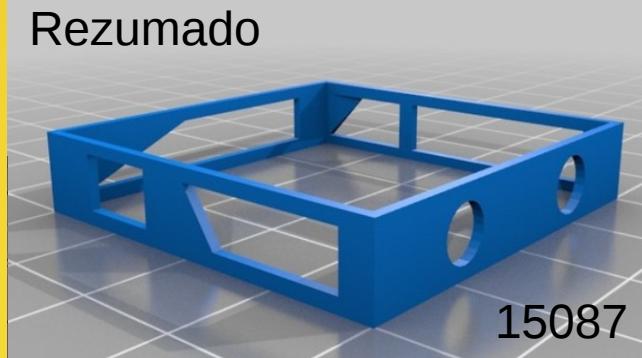
Mantenimiento	Cada cuando	En cualquier momento si...
Limpieza boquilla fusor (Nozzle)	Cada 100h de impresión	Cambias de filamento o si el caudal de filamento no es regular
Ajuste de la estructura	Cada 10h de impresión	Mueves la impresora de lugar
Tensión de las correas	Cada 20h de impresión	El acabado de las piezas no es adecuado
Engrasado	Cada 50h de impresión	Chirría la impresora al moverse por los ejes
Sustitución de la cinta kapton	Cada 100h de impresión	Si el kapton está dañado

Piezas de calibración recomendadas

Puentes



Rezumado



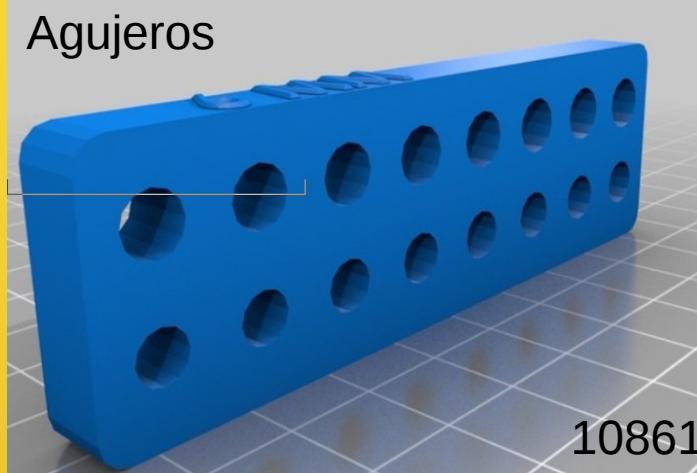
Precisión



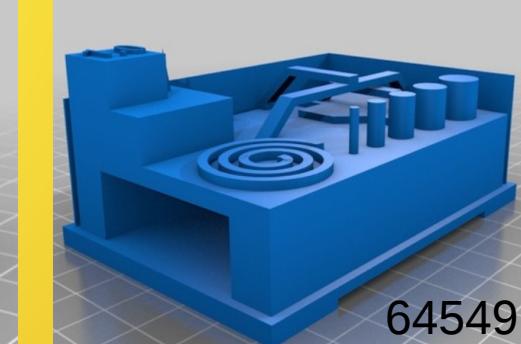
Material de soporte



Agujeros



64549



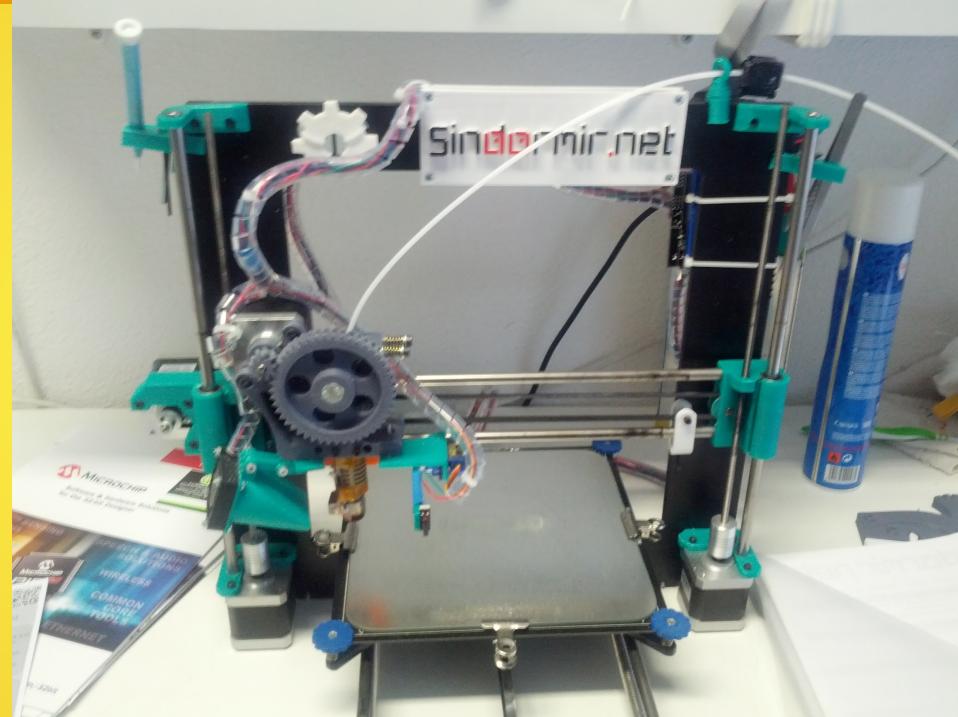
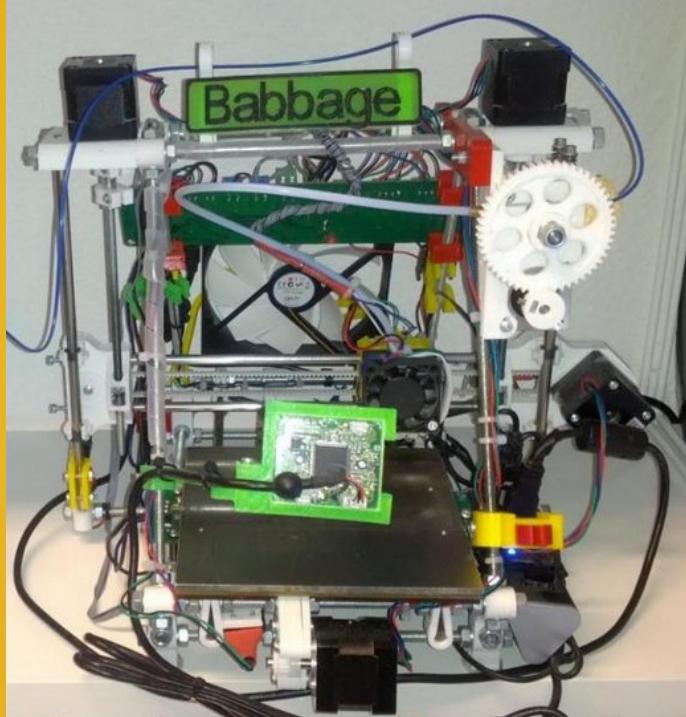
Recursos de calibración

- http://reprap.org/wiki/PID_Tuning
- <http://prusaprinters.org/calculator/>
- <https://github.com/SindormirNet/CursoCalibracionImpresoras3D>
- Google!

Recursos adicionales

- Sitio web proyecto RepRap <http://reprap.org>
- Proyecto español CloneWars
http://reprap.org/wiki/Proyecto_Clone_Wars/
- Video Tutoriales de **Obijuan**
- Guía Reprap para el recién llegado.
http://reprap.org/wiki/The_incomplete_reprap_beginner%27s_guide

Dos de mis tres niñas



Sindarmir.net

Despedida

¡Mil gracias!

¡Qué la PRUSA os acompañe!