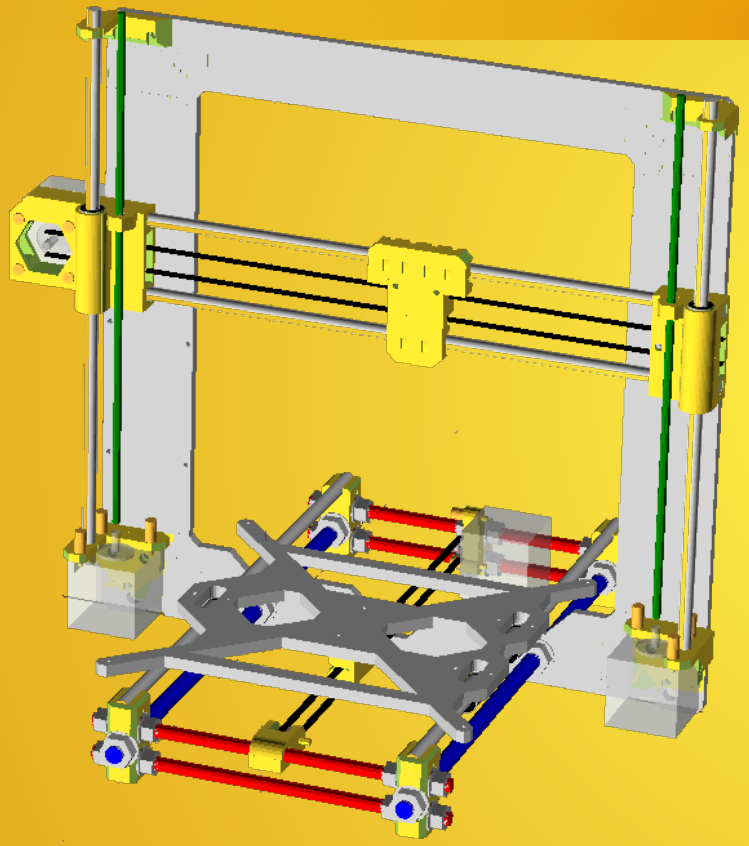
Expo 3D - 2014



Calibración de Impresoras 3D: Prusa I3

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Sindormir.net

¿Qué es la calibración?

Proceso para conseguir impresiones óptimas:

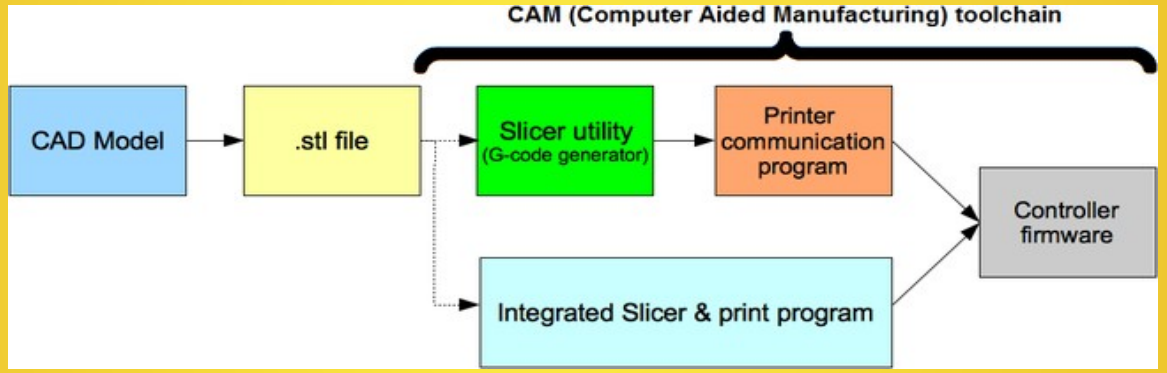
- Proporcionalidad de las piezas
- Apariencia adecuada

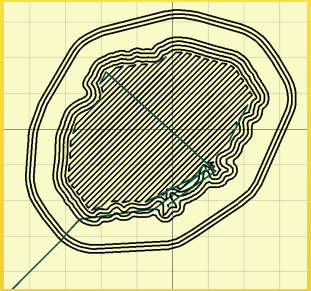
¿Cuándo es necesario calibrar?

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

¿Qué implica calibrar?

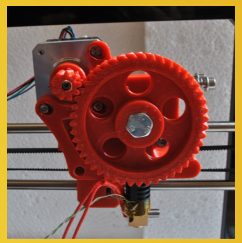
Ciclo de trabajo

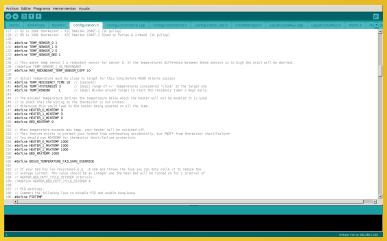


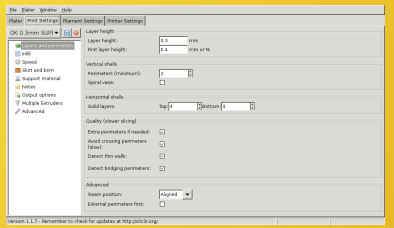


¿Qué implica calibrar?

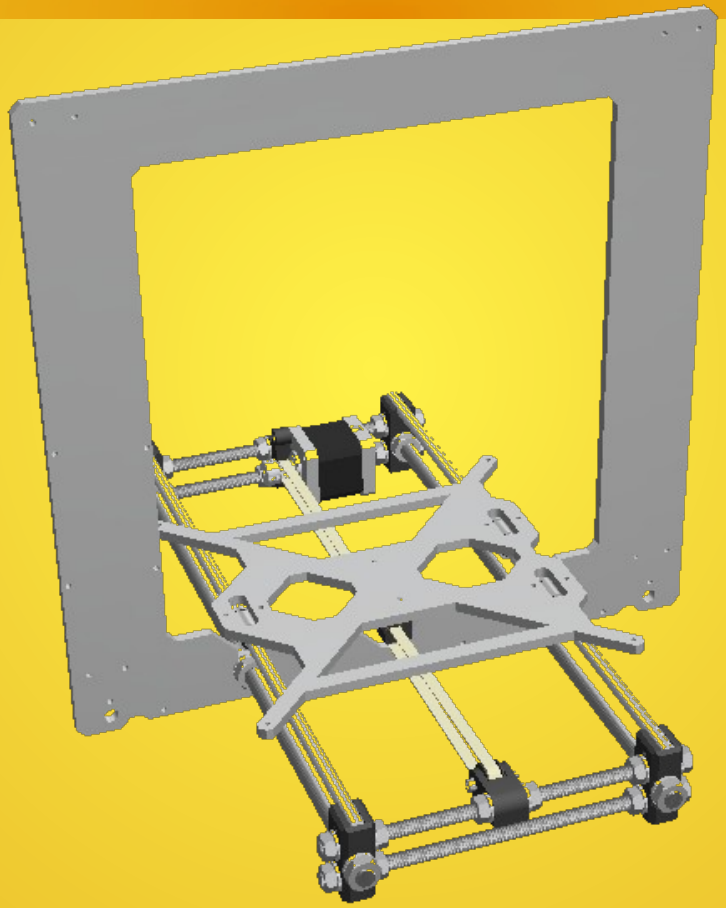
- Ajustes mecánicos
- Ajustes del firmware
- Ajustes del fileteador



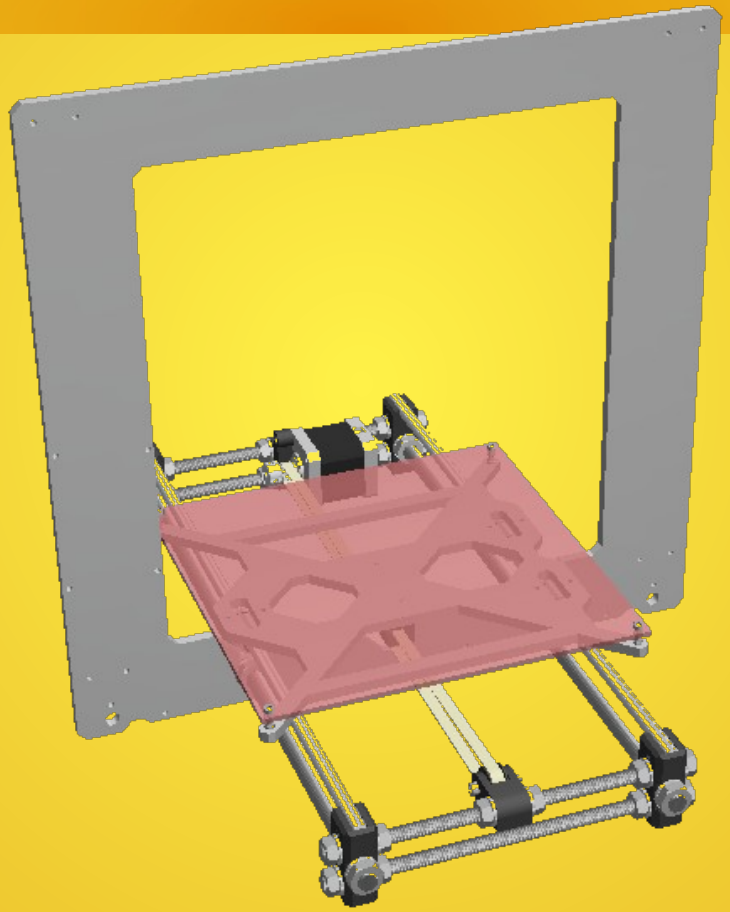




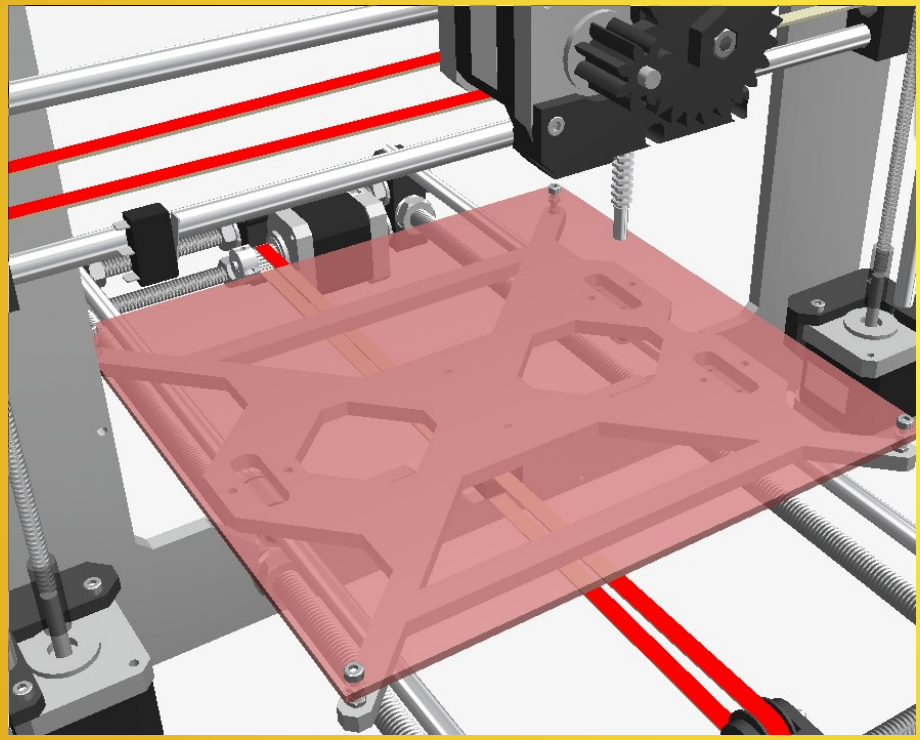
Mecánica: Rigidez estructural



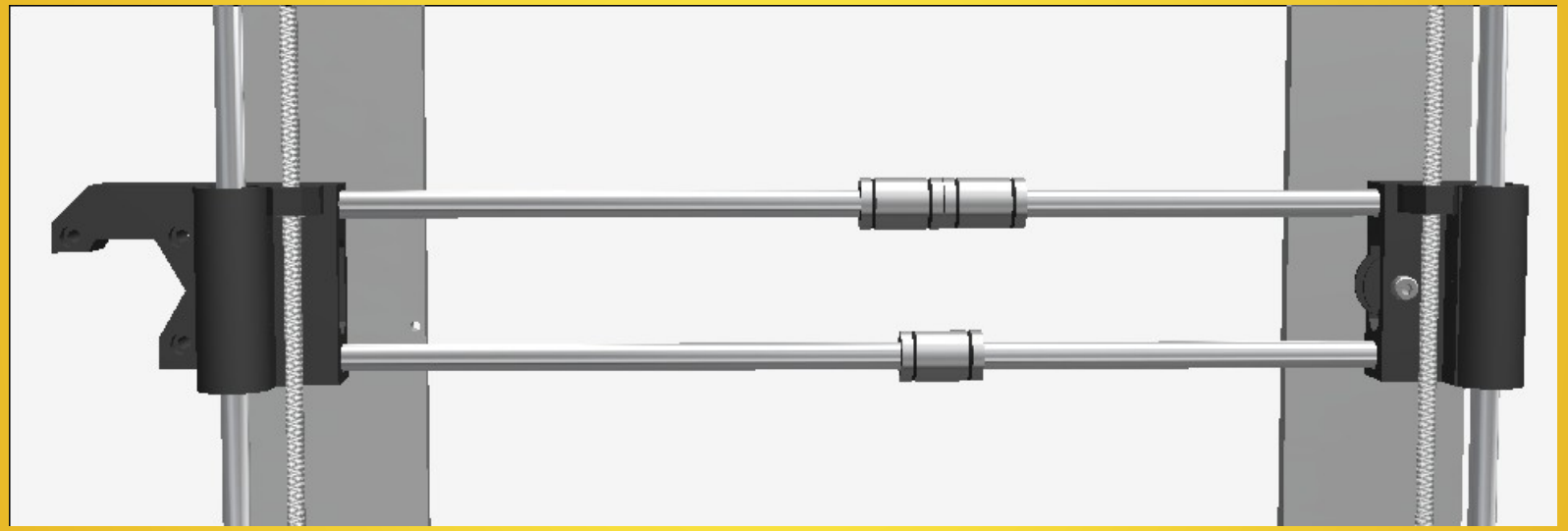
Mecánica: Nivelación de la cama



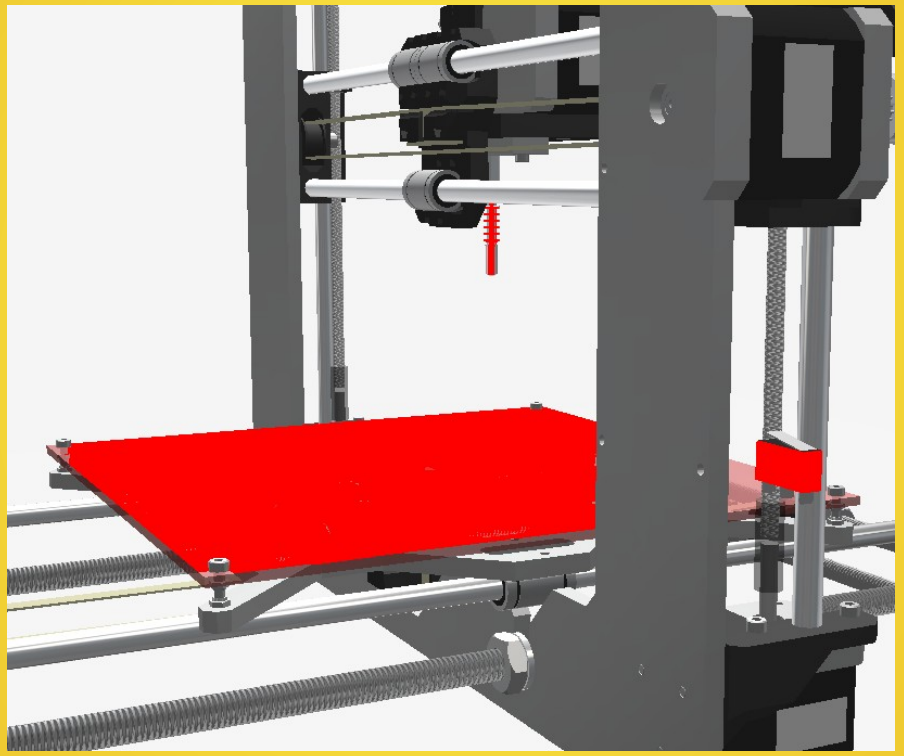
Mecánica: Tensión de las correas



Mecánica: Nivelación eje X

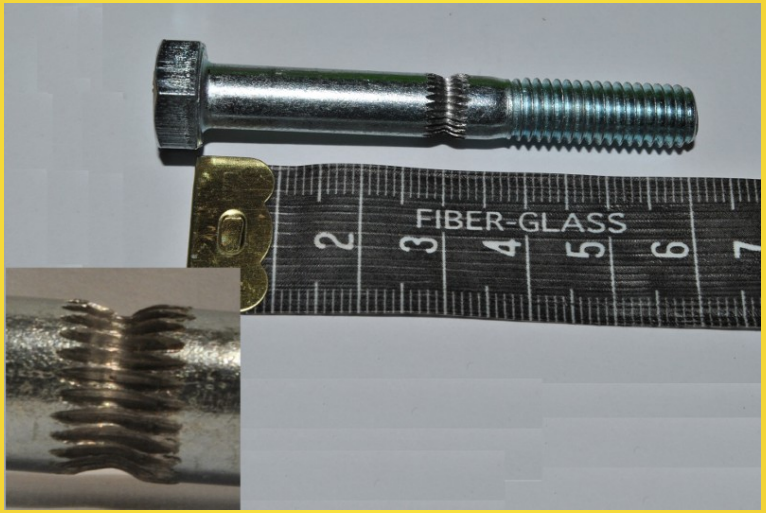


Mecánica: Altura de la primera capa

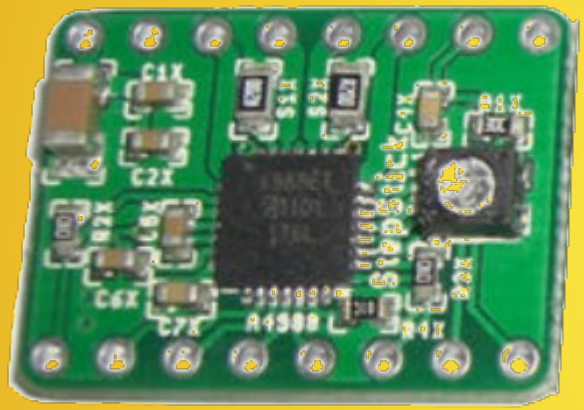


http://youtu.be/E4HyFAkQfws?list=UUf9x1cgSeBDY-h5Cvf8BIvQ

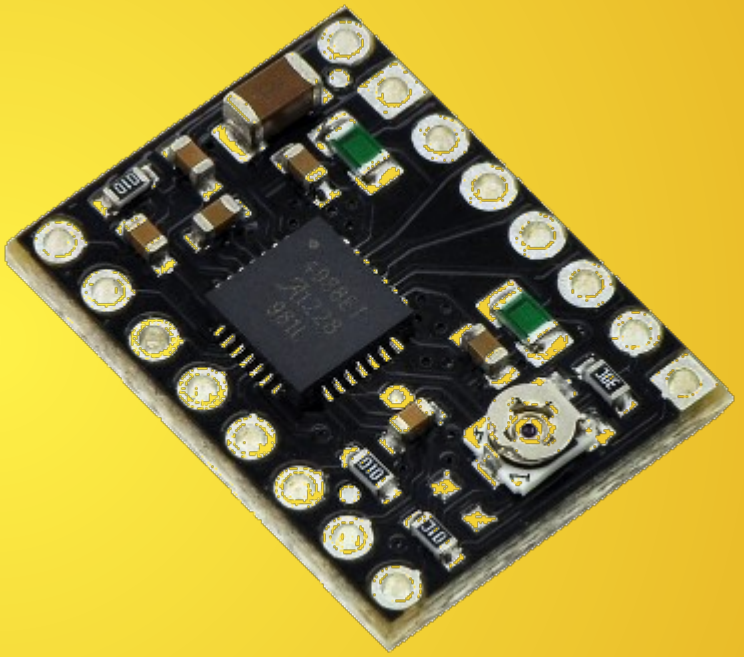
Mecánica: Hobbed bolt (Tornillo moleteado)



Electrónica: Corriente de los motores



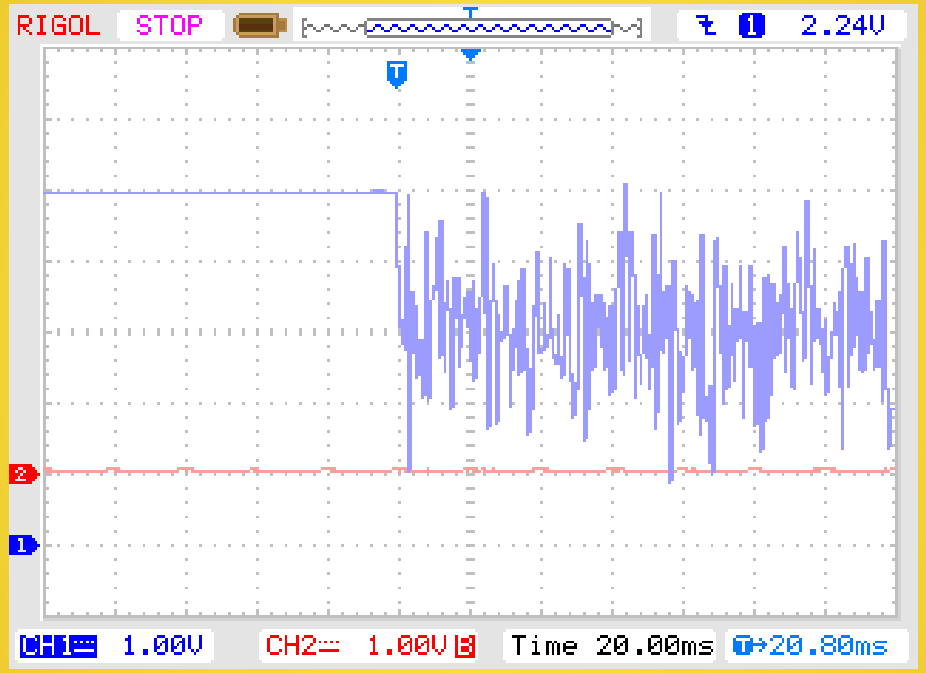
$I = V_{REF} / 0,4$



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

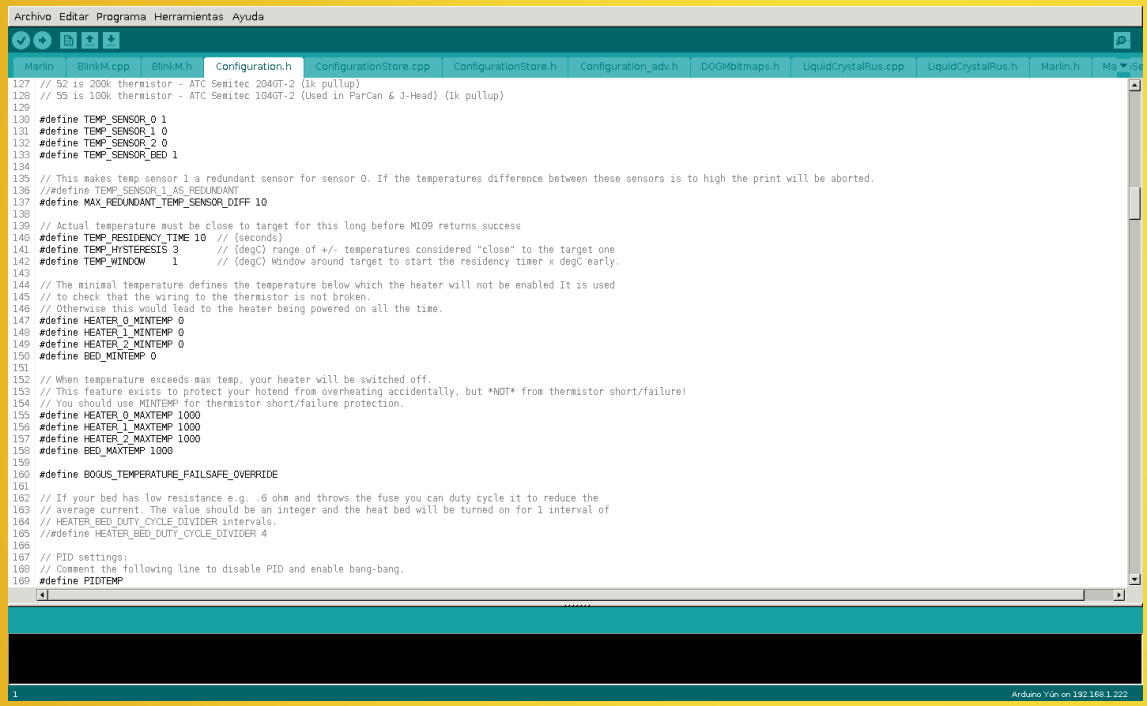
Corriente ejes X e Y: 200mA
Corriente ejes Z y E: 400mA

Electrónica: Cableado finales de carrera



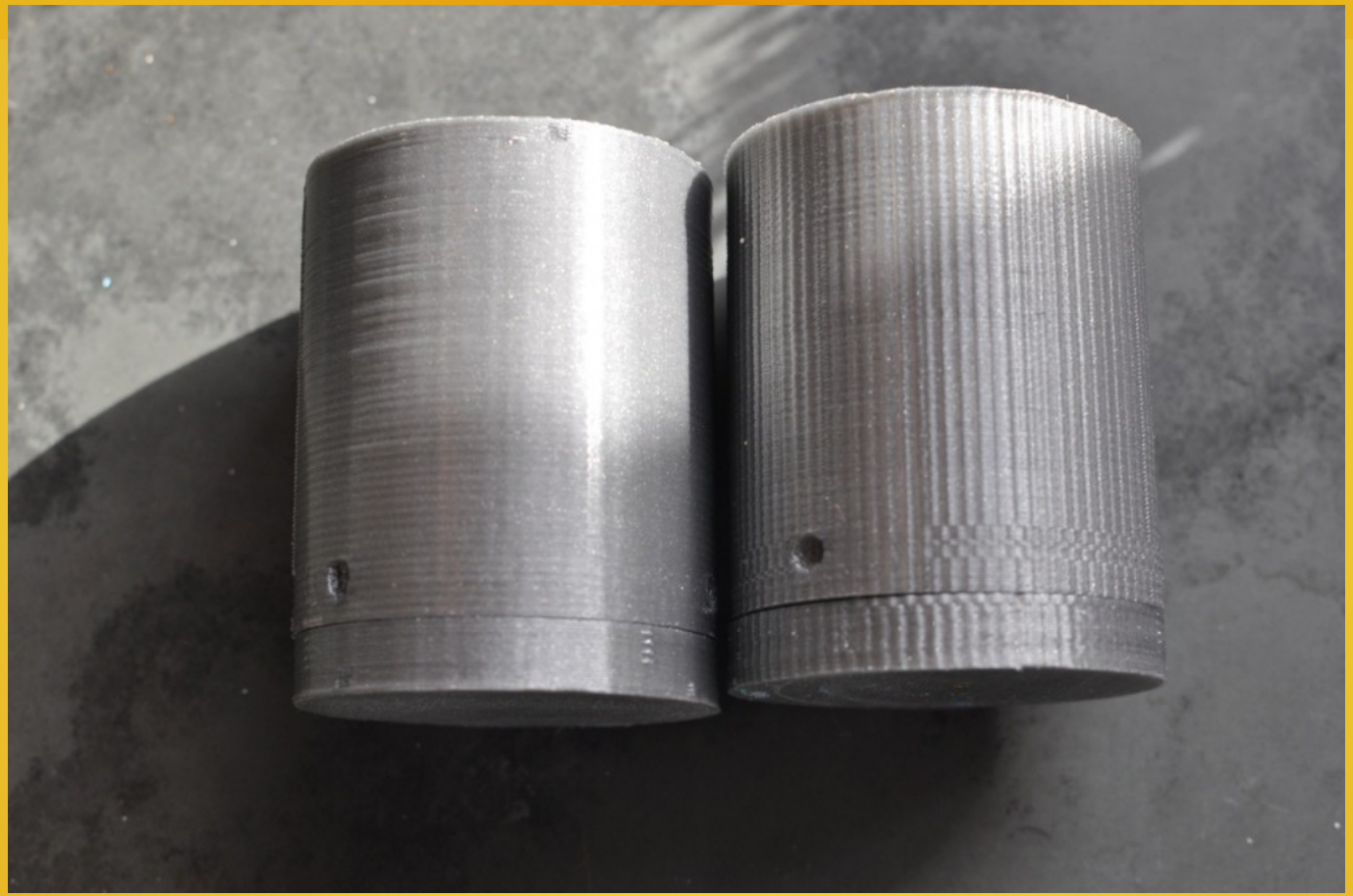
Diafonía (crosstalking) en acción

Firmware:



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

Firmware:



Marlin Sprinter

Firmware: Marlin → Sensores de temperatura

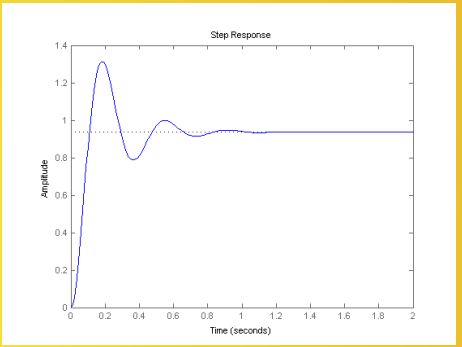
```
//--NORMAL IS 4.7kohm PULLUP!-- 1kohm pullup can be used on hotend sensor, using correct resistor and table

//// 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/s^2 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: 1.8° (200 per revolution)

Driver microstepping: 1/16 - uStep (mostly Pololu)

Belt pitch: 2 mm

Belt presets: 2mm Pitch (GT2 mainly)

Pulley tooth count: 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

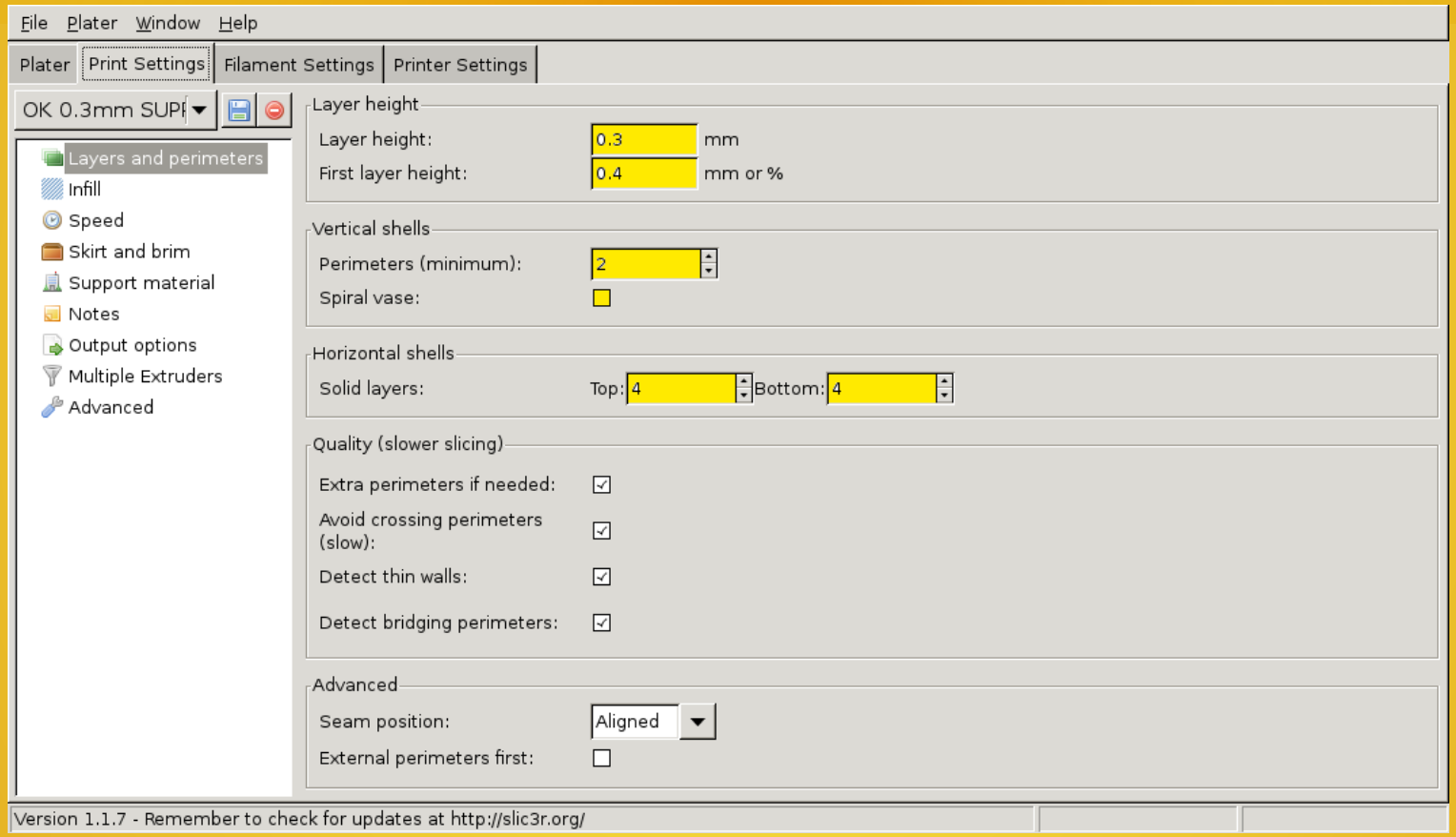
Presets: M5 - metric (0.8mm per rotation)

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)



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 intorduce error. This effect is occuring to some extent even while leaving the Z axis motors enabled. This is most usefull 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

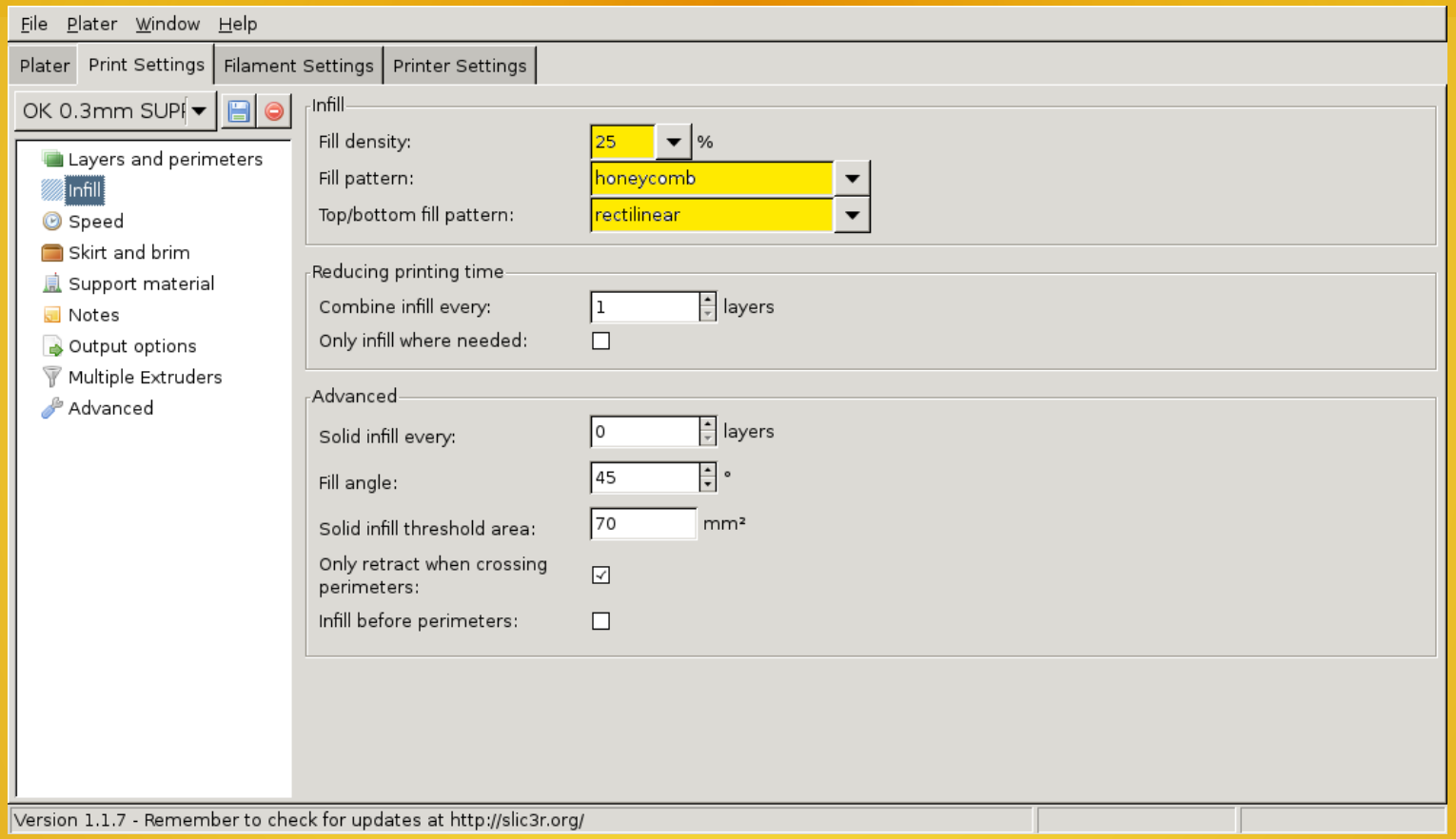
Z axis gear ratio

1 : 1

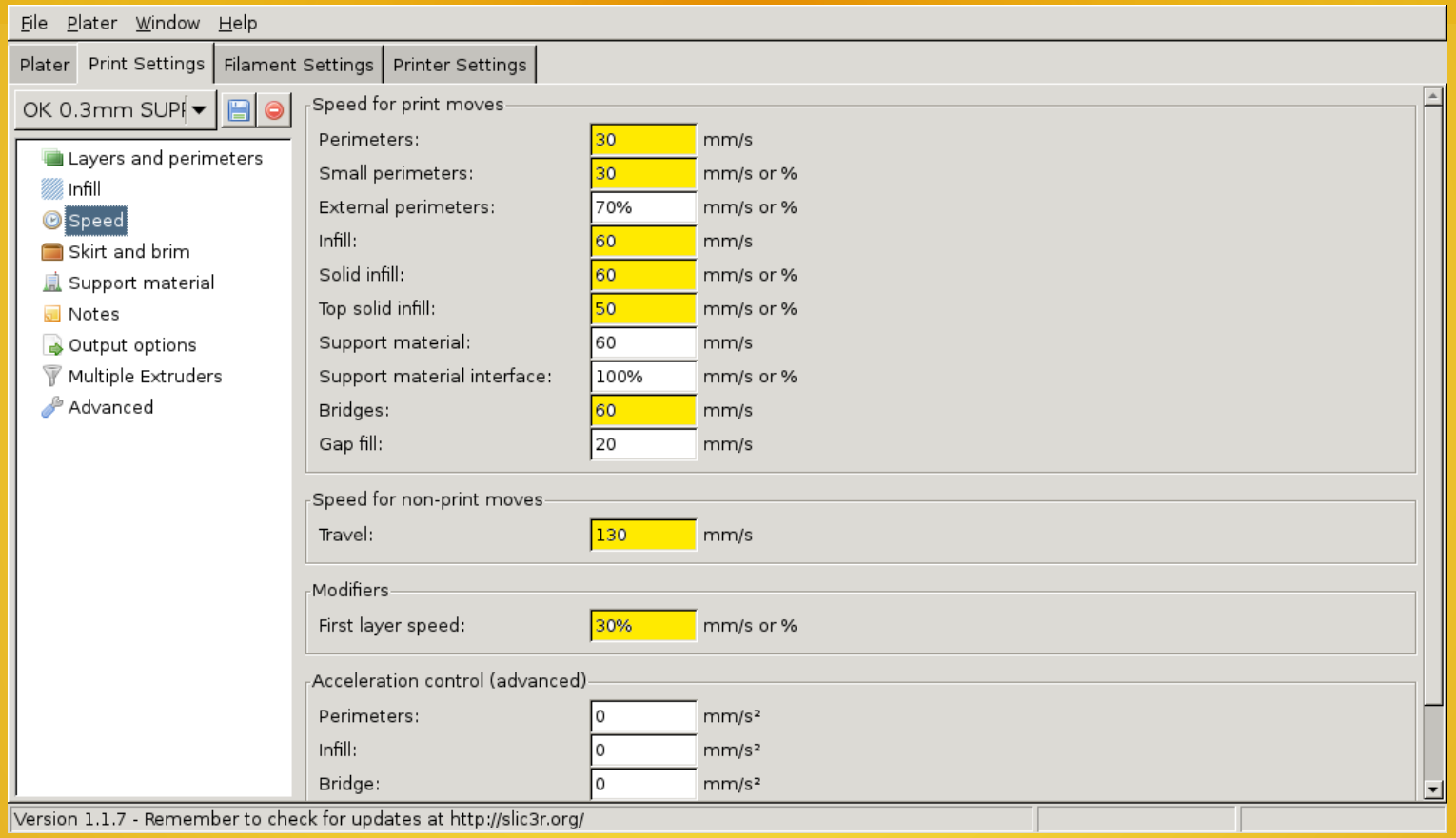
Motor : Leadscrew (1:1 for direct drive - Prusa)

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

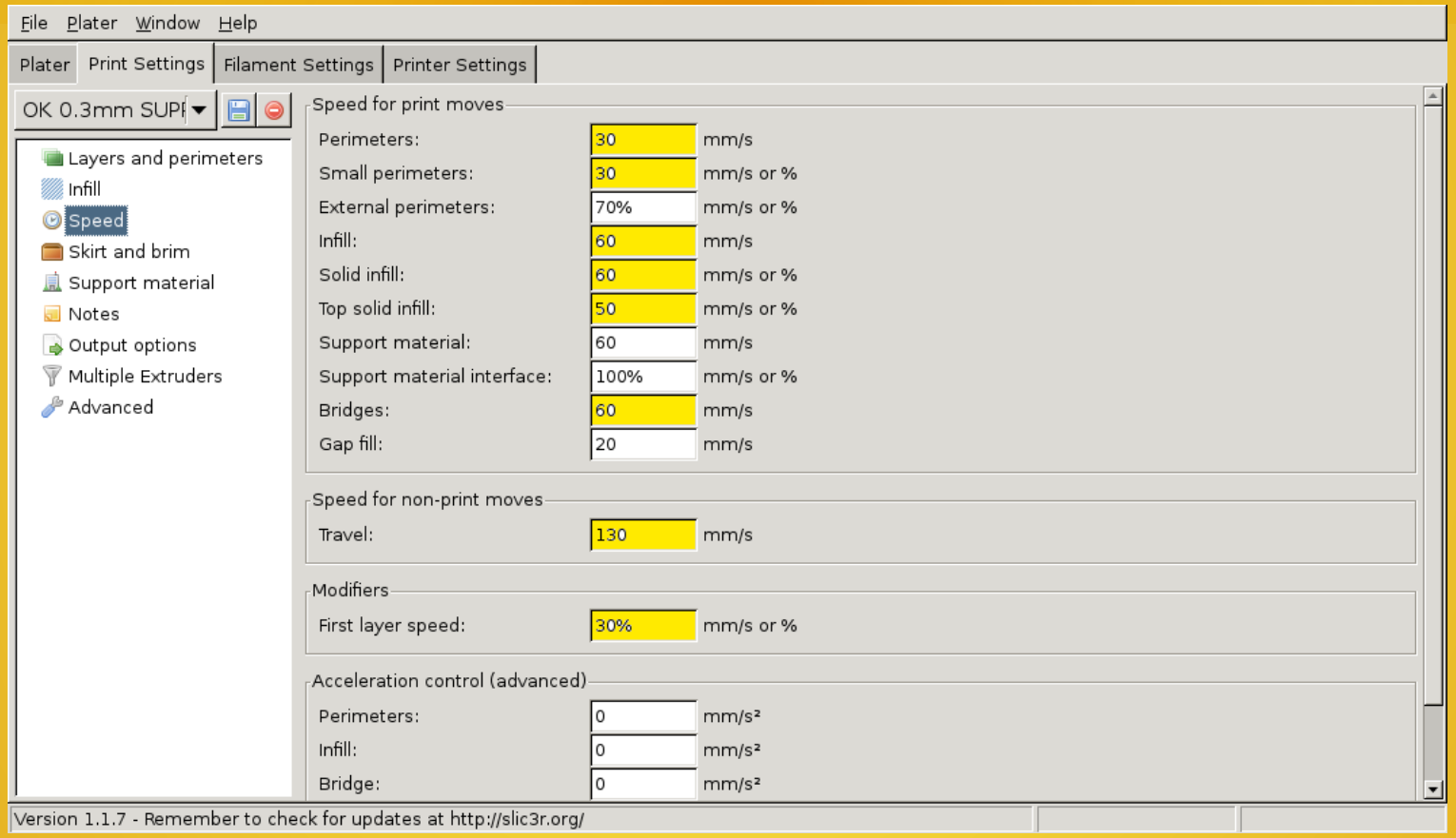
Fileteador: Slic3r → Print Settings (2)



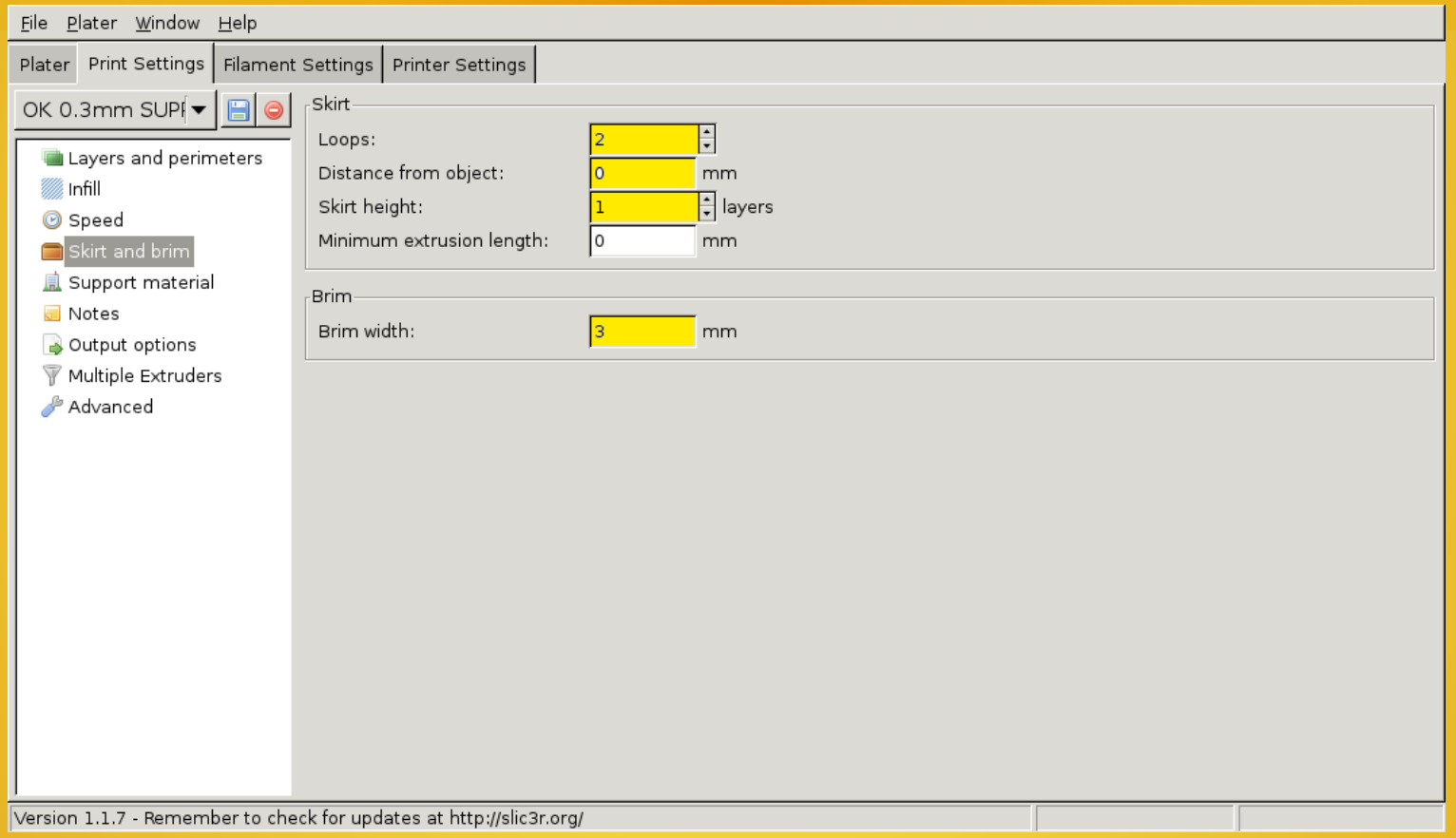
Fileteador: Slic3r → Print Settings (3)



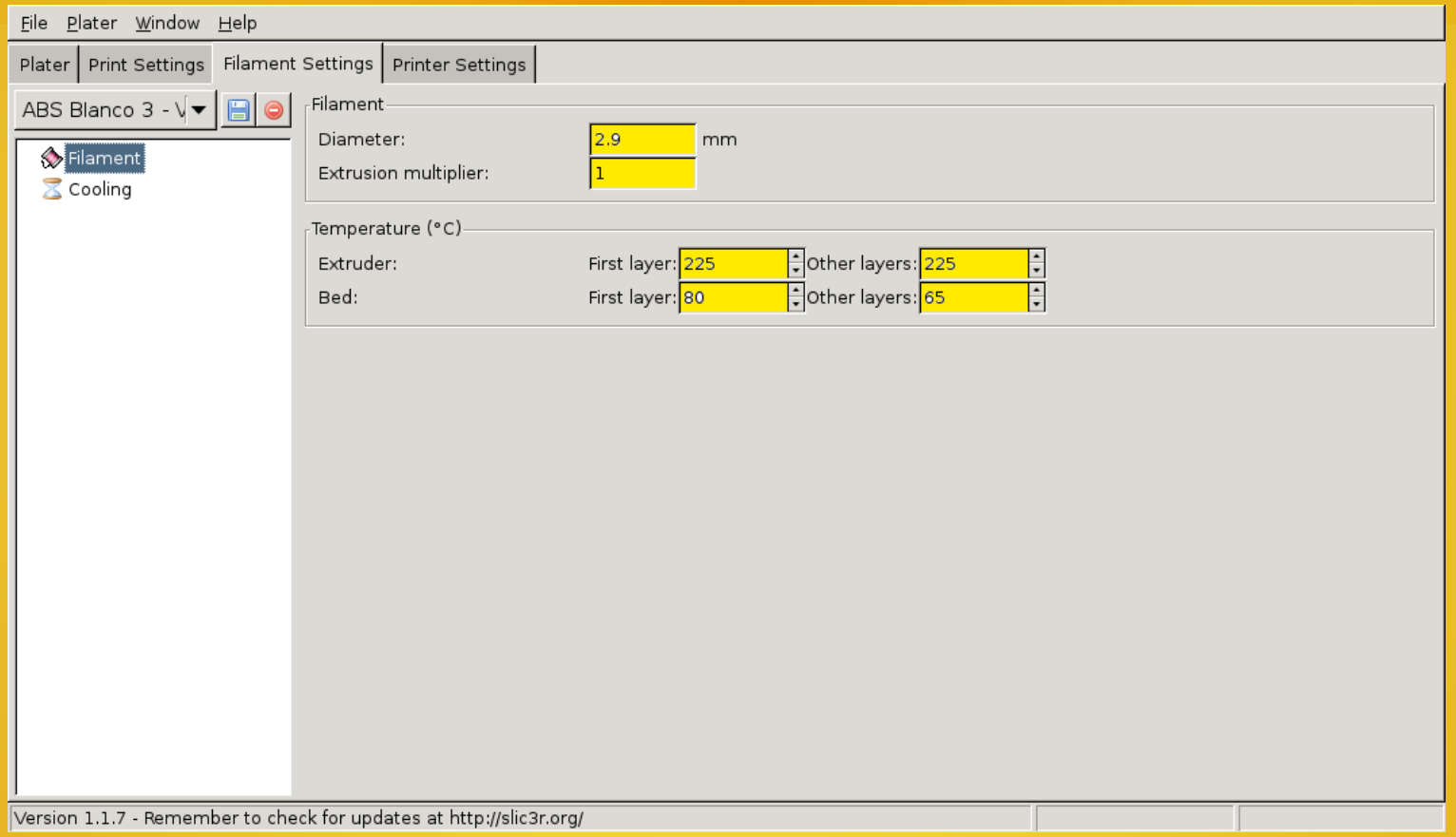
Fileteador: Slic3r → Print Settings (3)



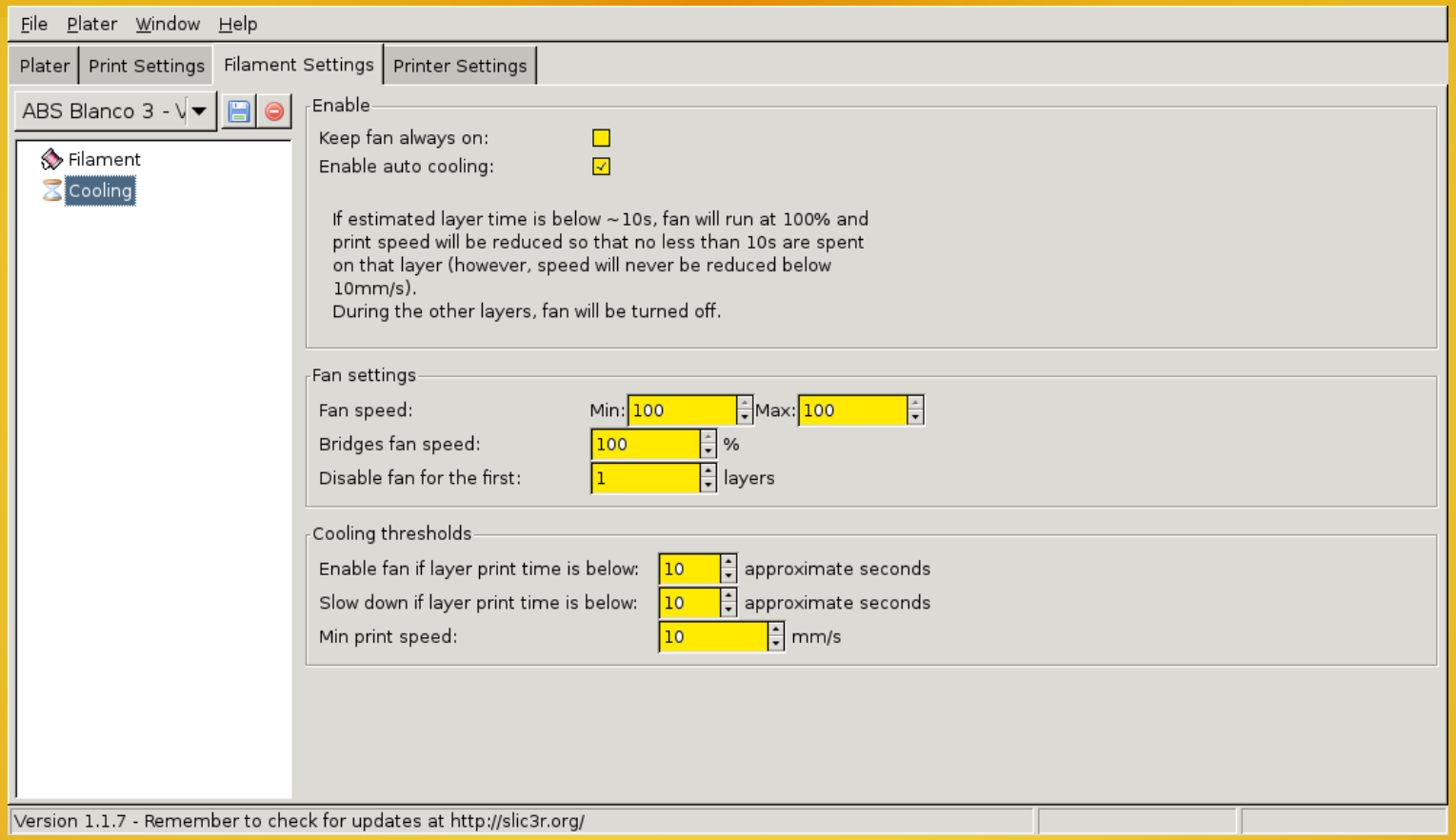
Fileteador: Slic3r → Print Settings (4)



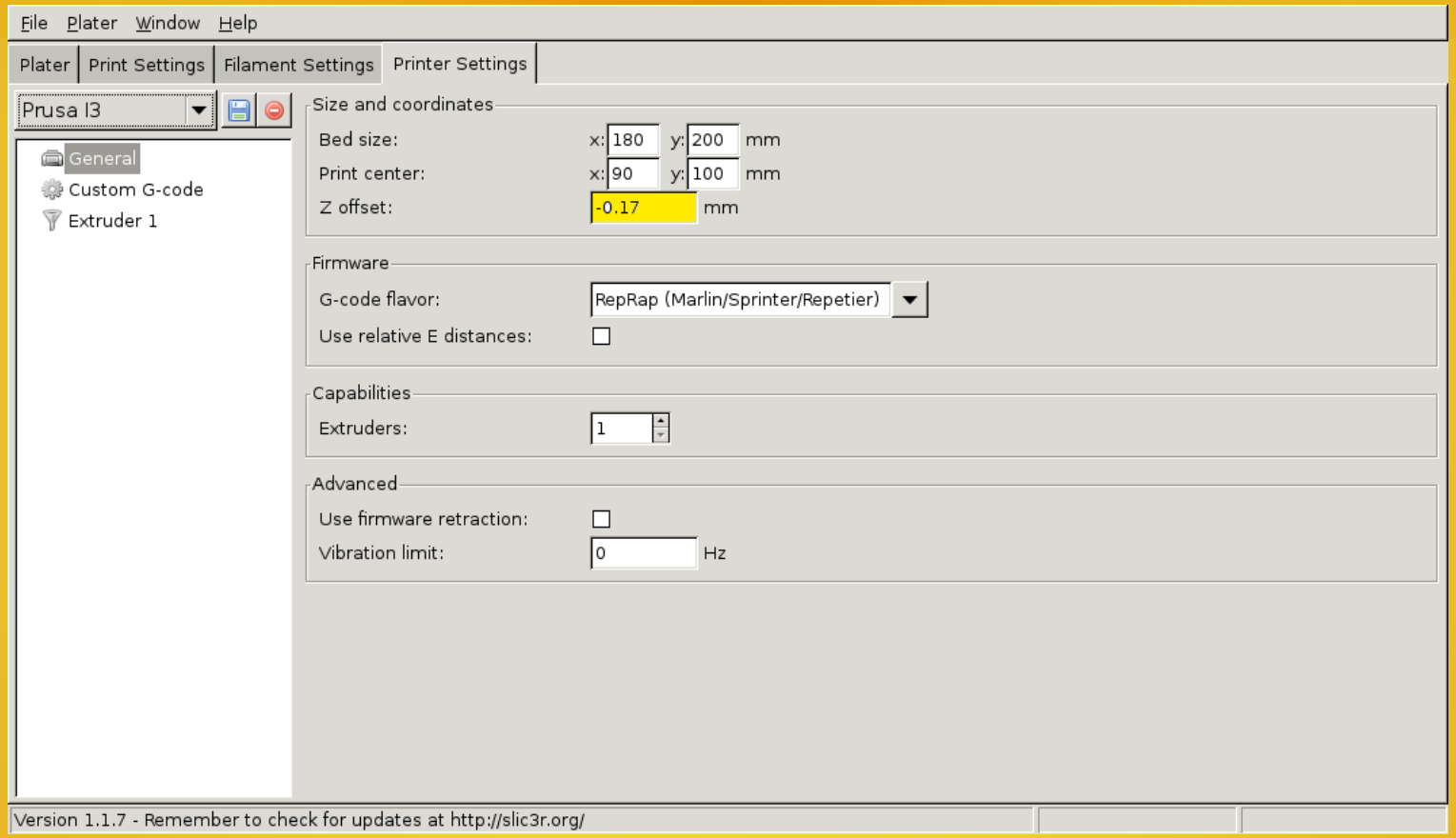
Fileteador: Slic3r → Filament Settings (1)



Fileteador: Slic3r → Filament Settings (2)



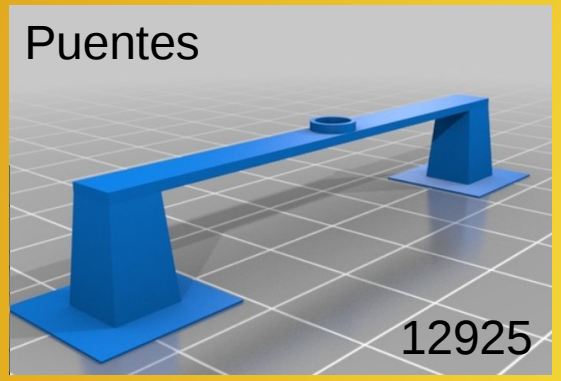
Fileteador: Slic3r → Printer Settings

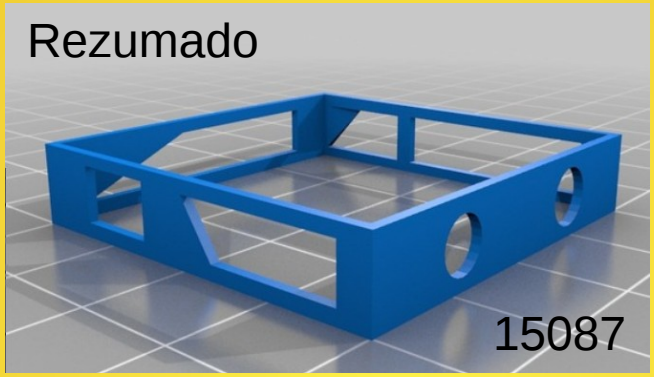


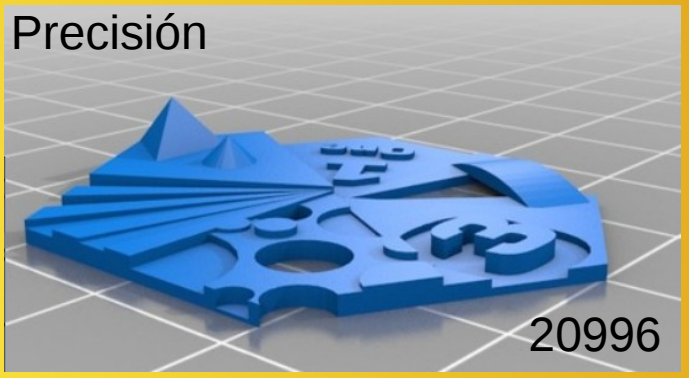
Recomendaciones mantenimiento

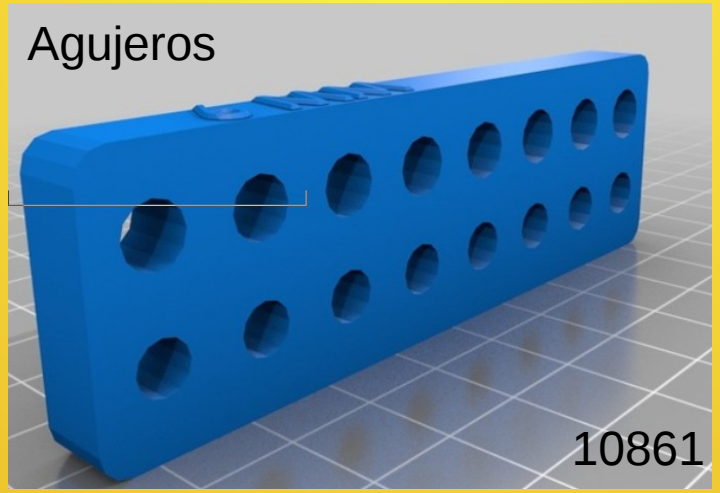
Matenimento	Cada cuando	En cualquier momento si...
Limpieza boquilla fusor (Nozzle)	Cada 100h de impresión	Cambias de filamento o si el caudal de filamento no es regular
Ajuste de la estructura	Cada 10h de impresión	Mueves la impresora de lugar
Tensión de las correas	Cada 20h de impresión	El acabado 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

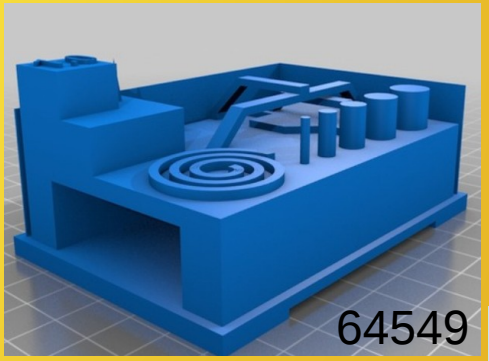
Piezas de calibración recomendadas











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Recursos de calibración

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

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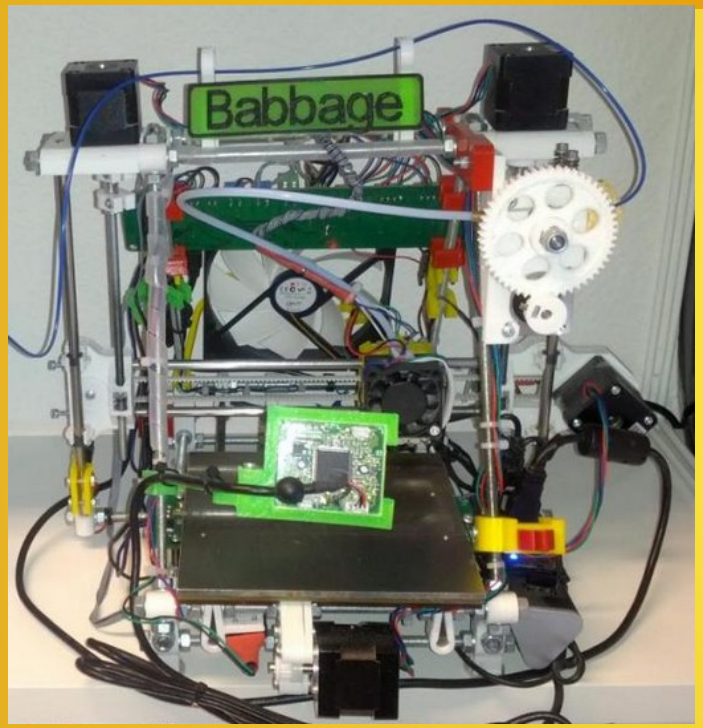
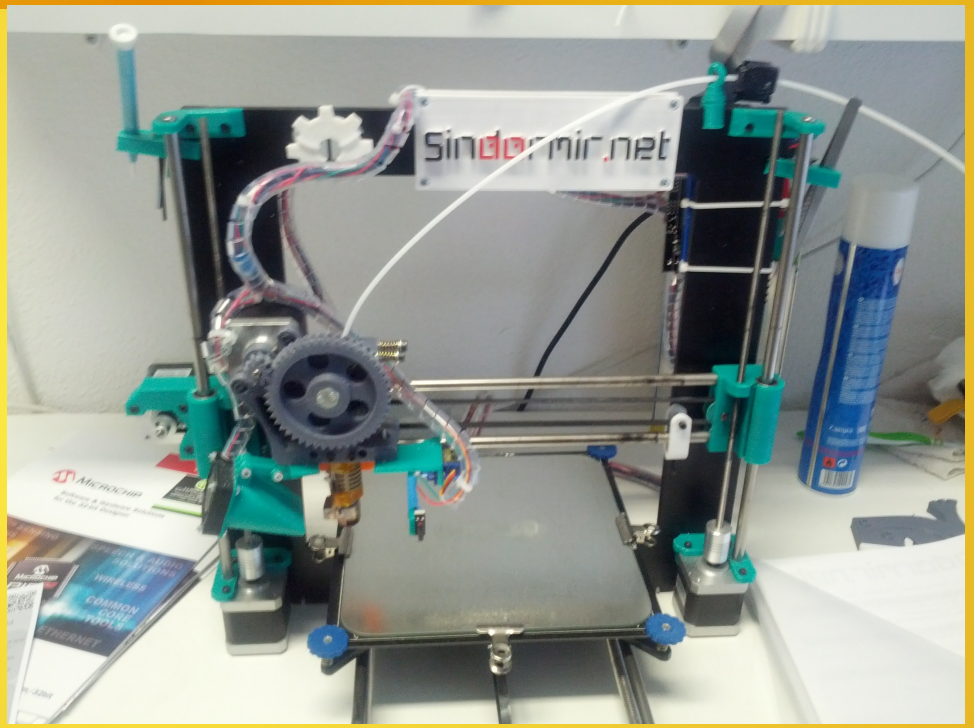
Recursos adicionales

- 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





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Despedida

¡Mil gracias!

¡Qué la PRUSA os acompañe!

Jorge Gómez <jorge@sindormir.net>