Integration of conductive materials and SMD-components into FDM printing process

Florens Wasserfall

University of Hamburg
TAMS

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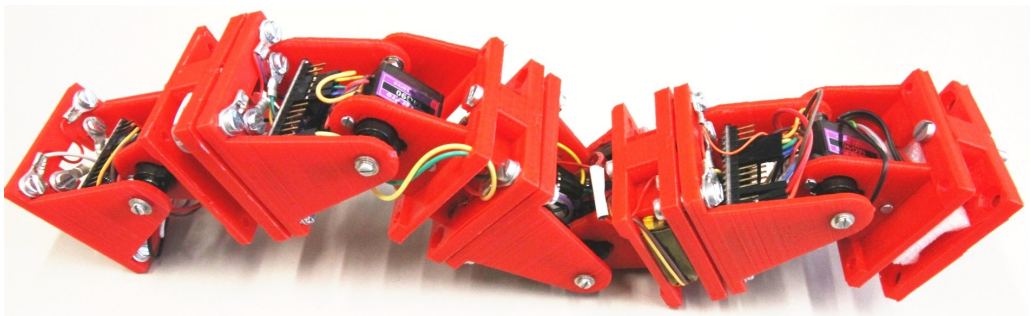
Contents

Application example



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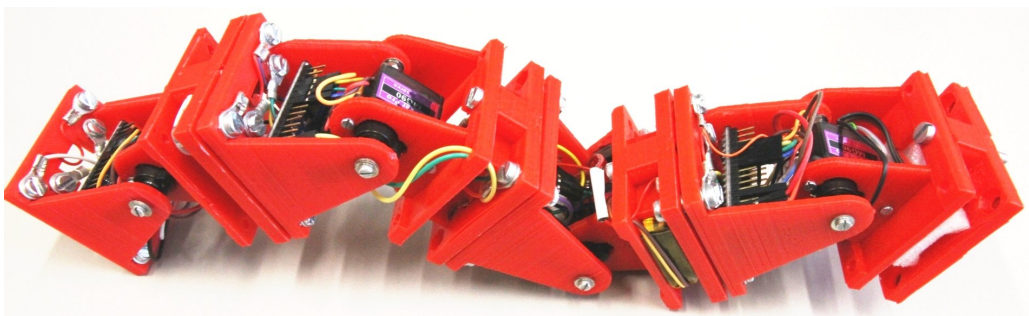

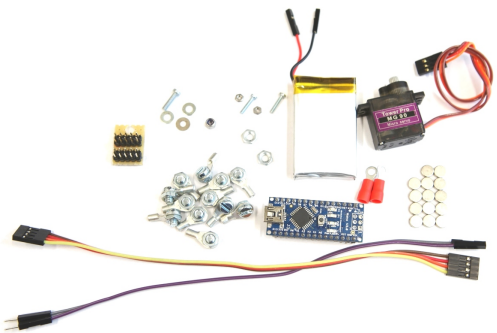

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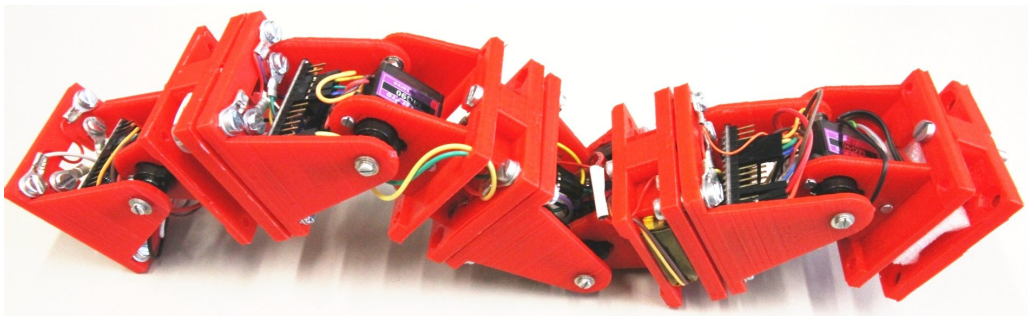
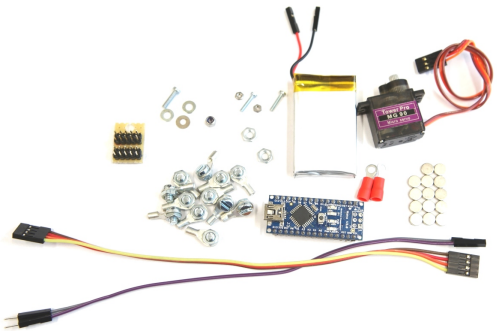
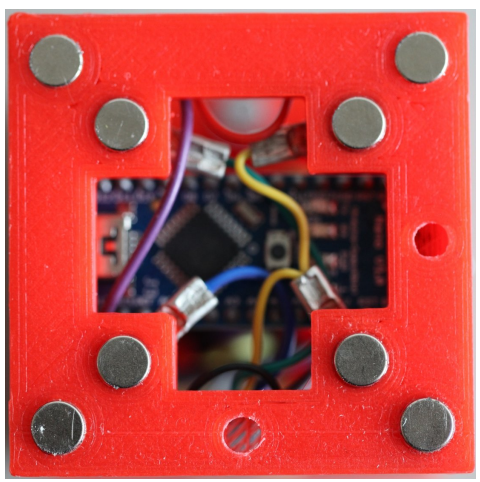
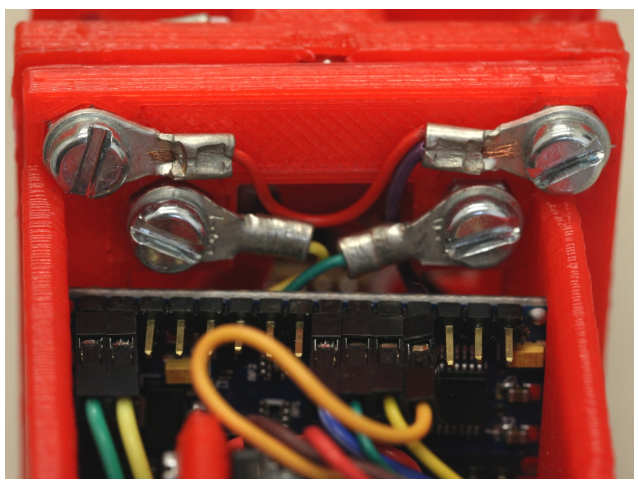
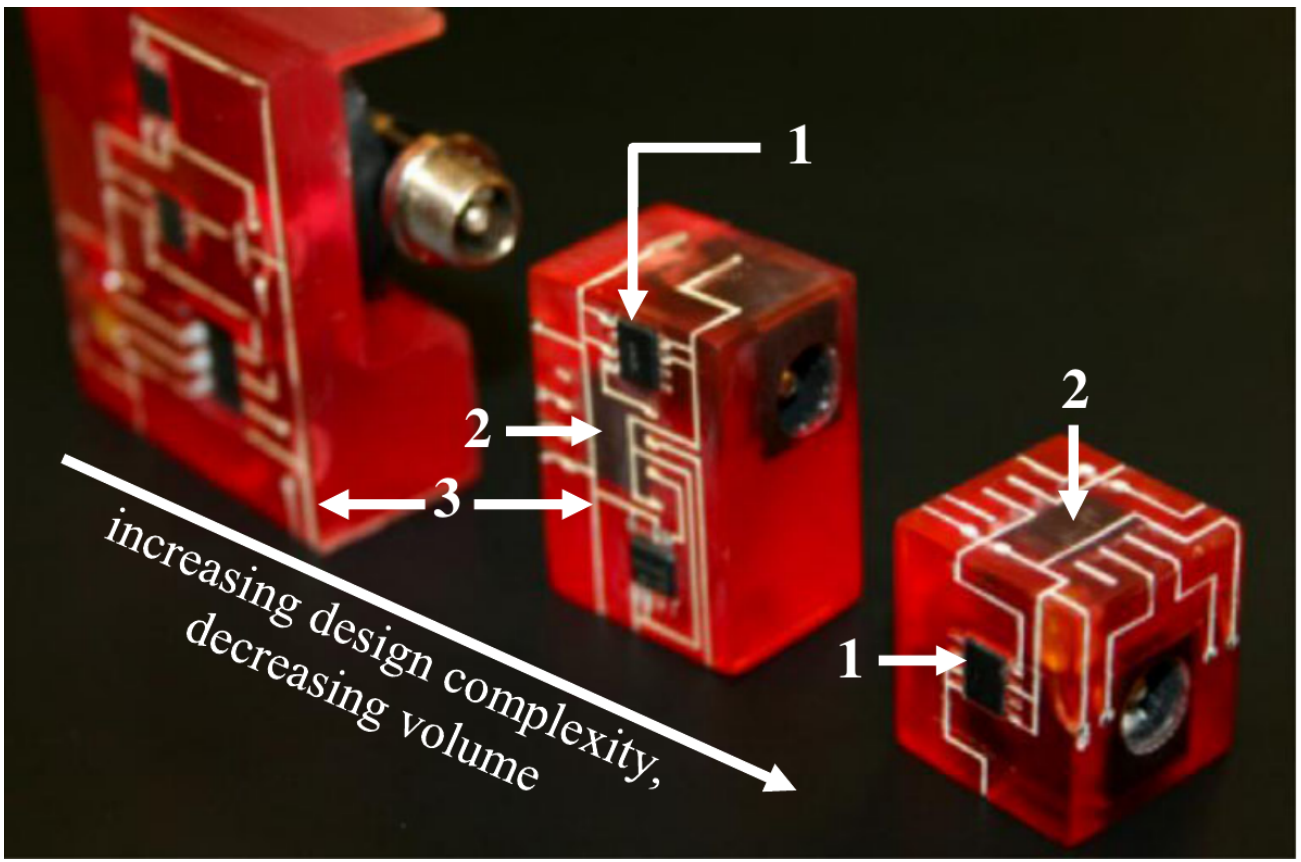


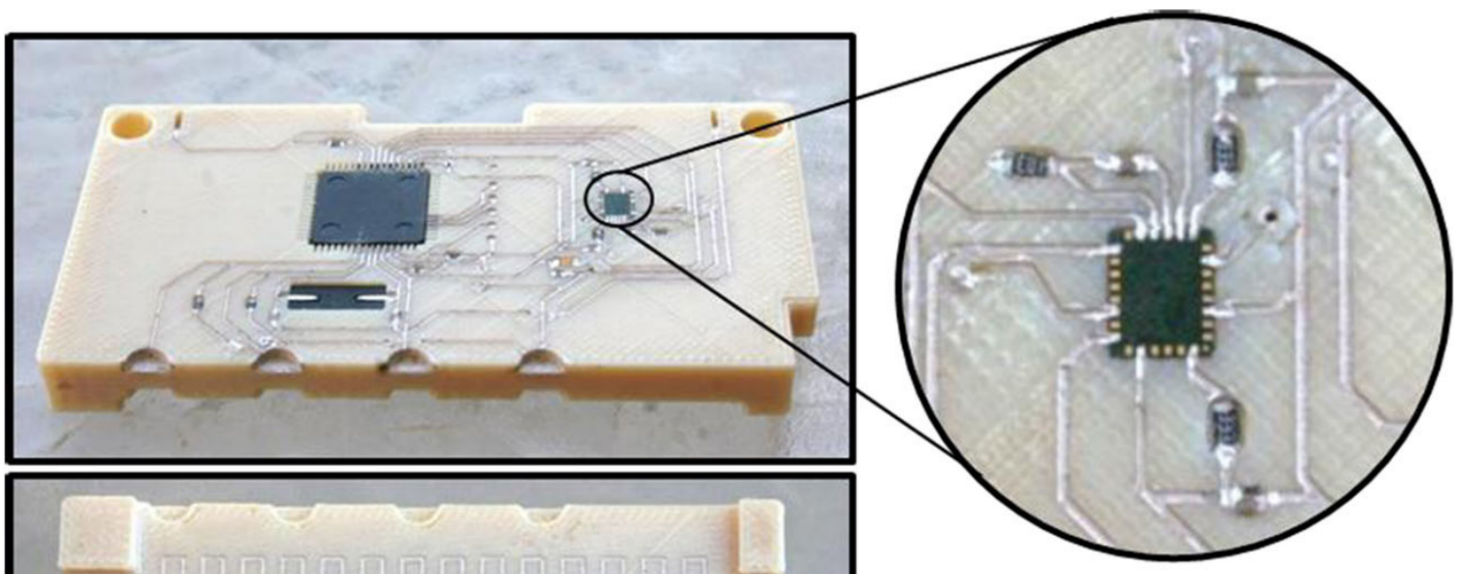




3-Dimensional magnetic flux sensor



D. Espalin et. al *3D Printing multifunctionality: structures with electronics*. Int J Adv Manuf Technol, 2014

2D circuit on FDM surface



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Basic Concept

Idea

- Printing "wires" with second, conductive material
- Embedding SMD-Components on printed wires

Requirements

- Conductive material / extruder
- Pick 'n place hardware
- Editor "Object $\leftrightarrow$ Schematic"
- Extended slicing software

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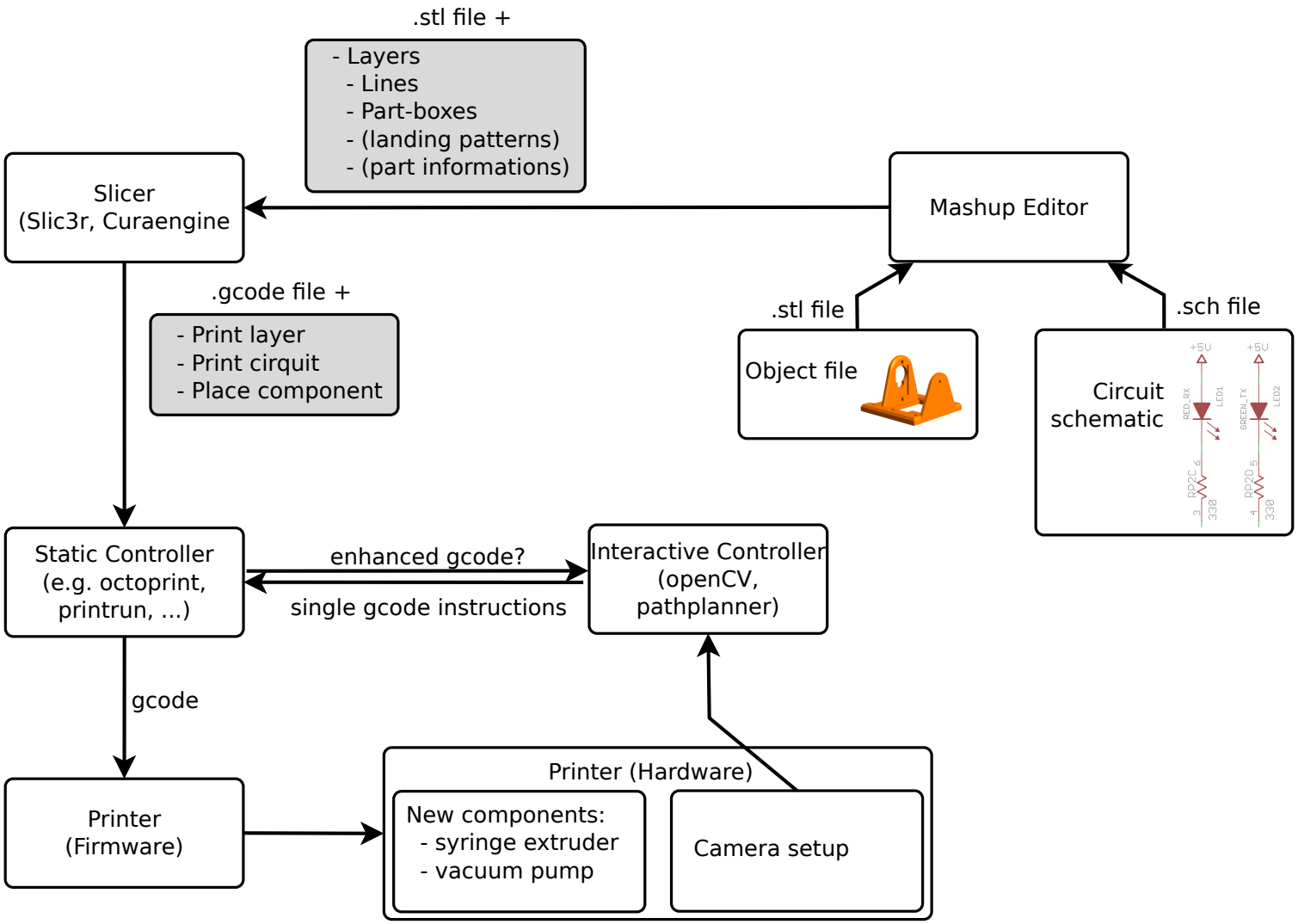
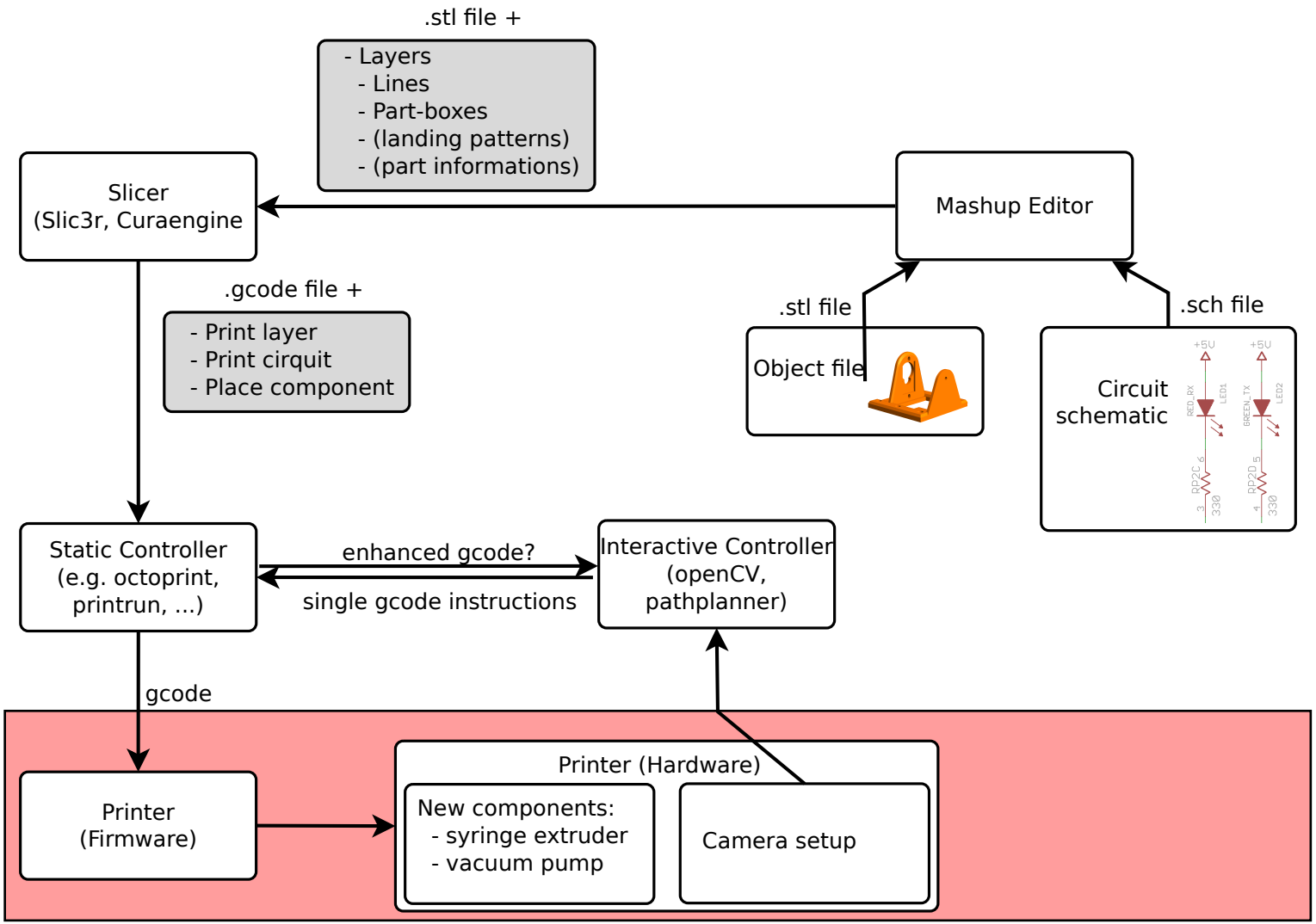
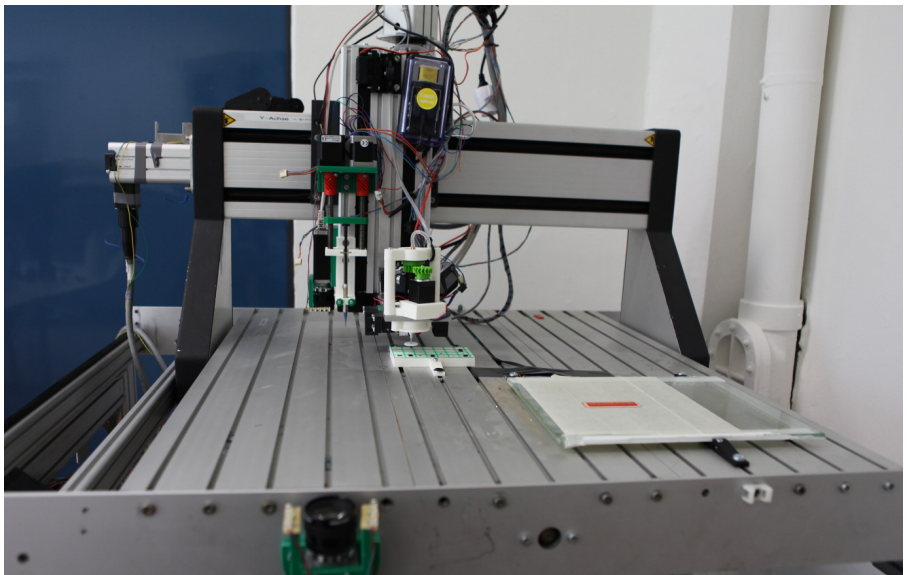


Basic Concept



Hardware setup

- Milling cutter as printing platform
- Syringe Extruder
- Vacuum pipette / cameras
- Object tray
- Migration to professional platform



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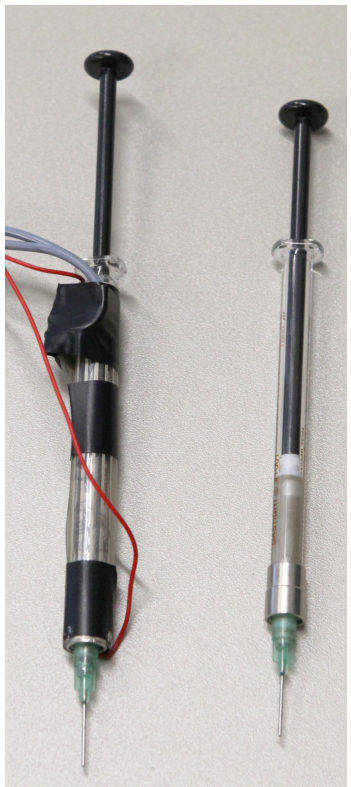

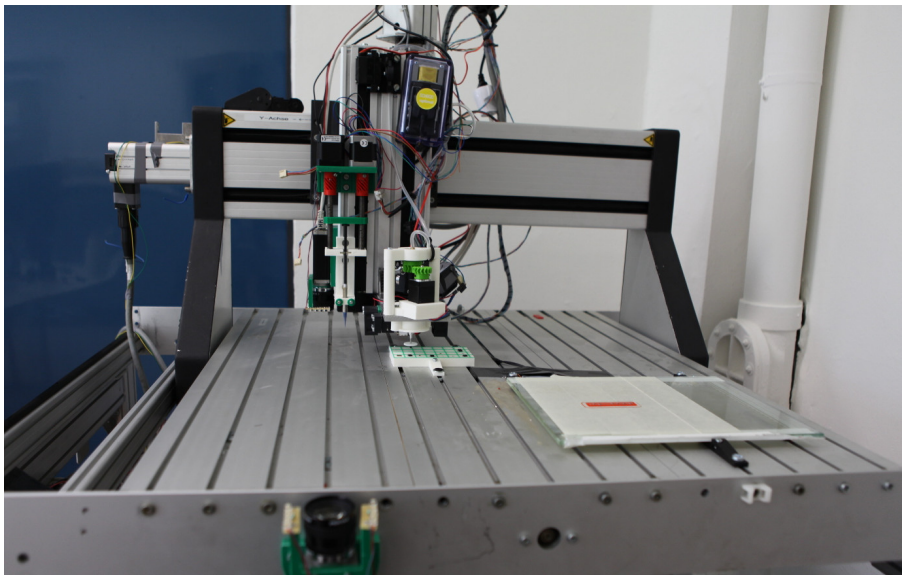

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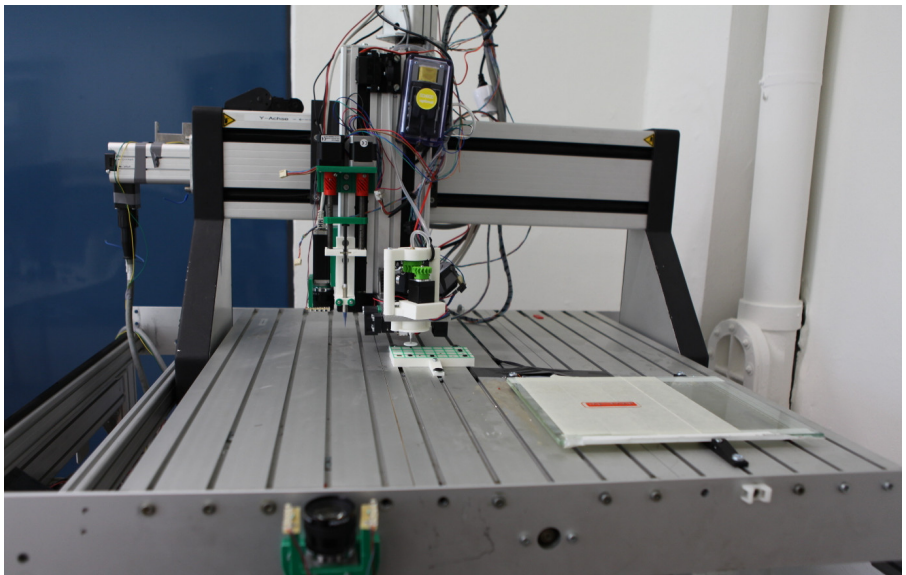

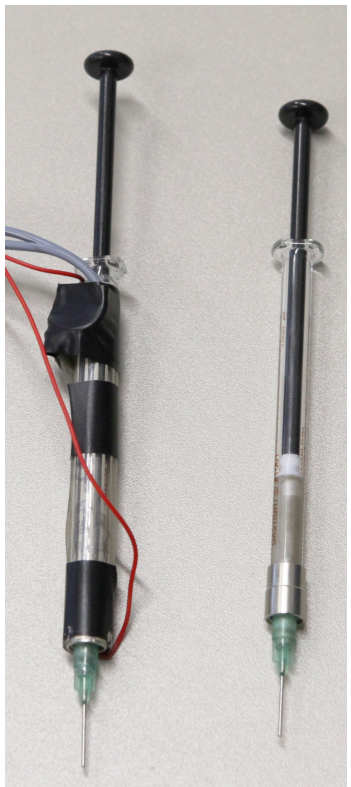

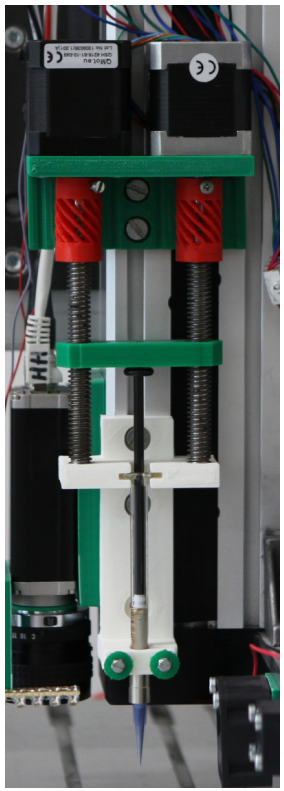

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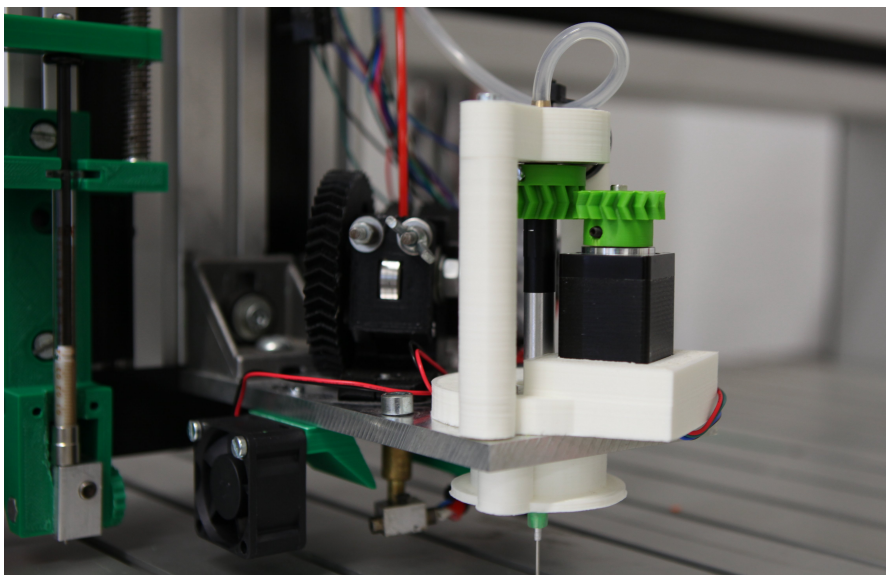

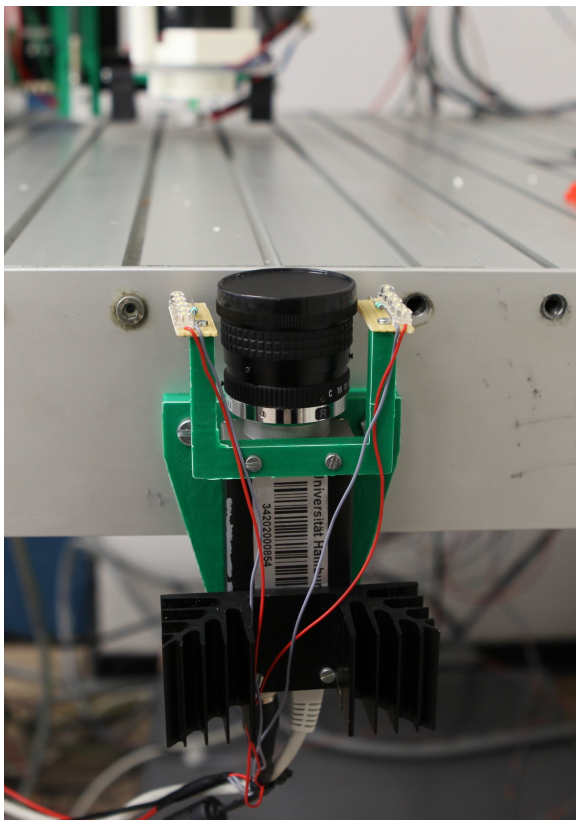

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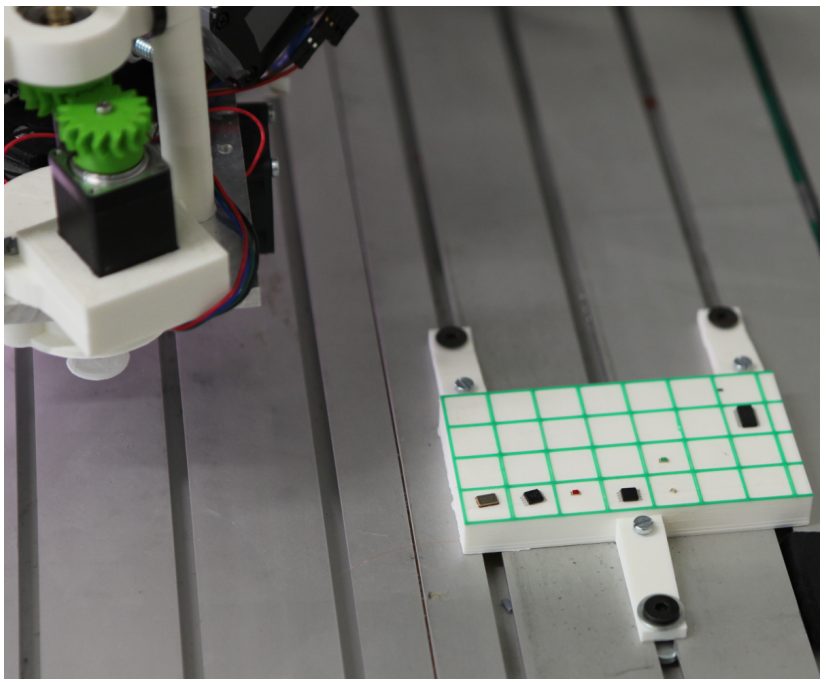

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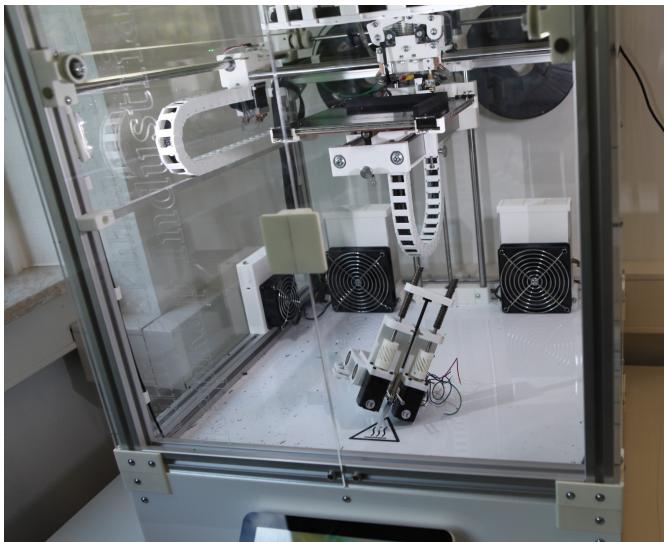
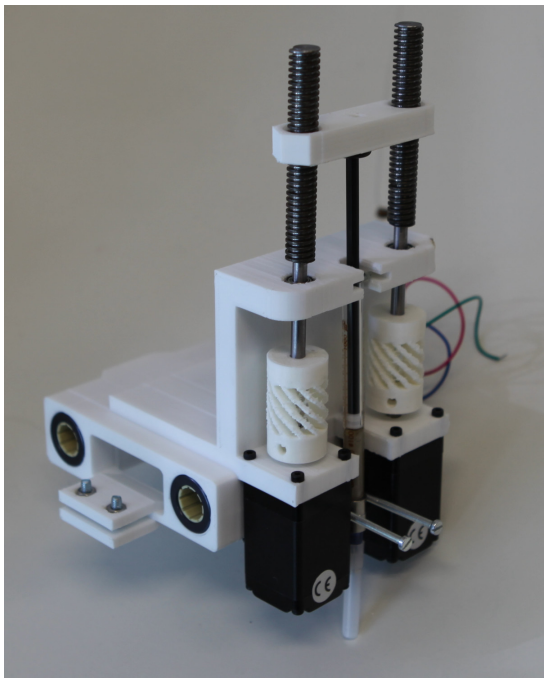
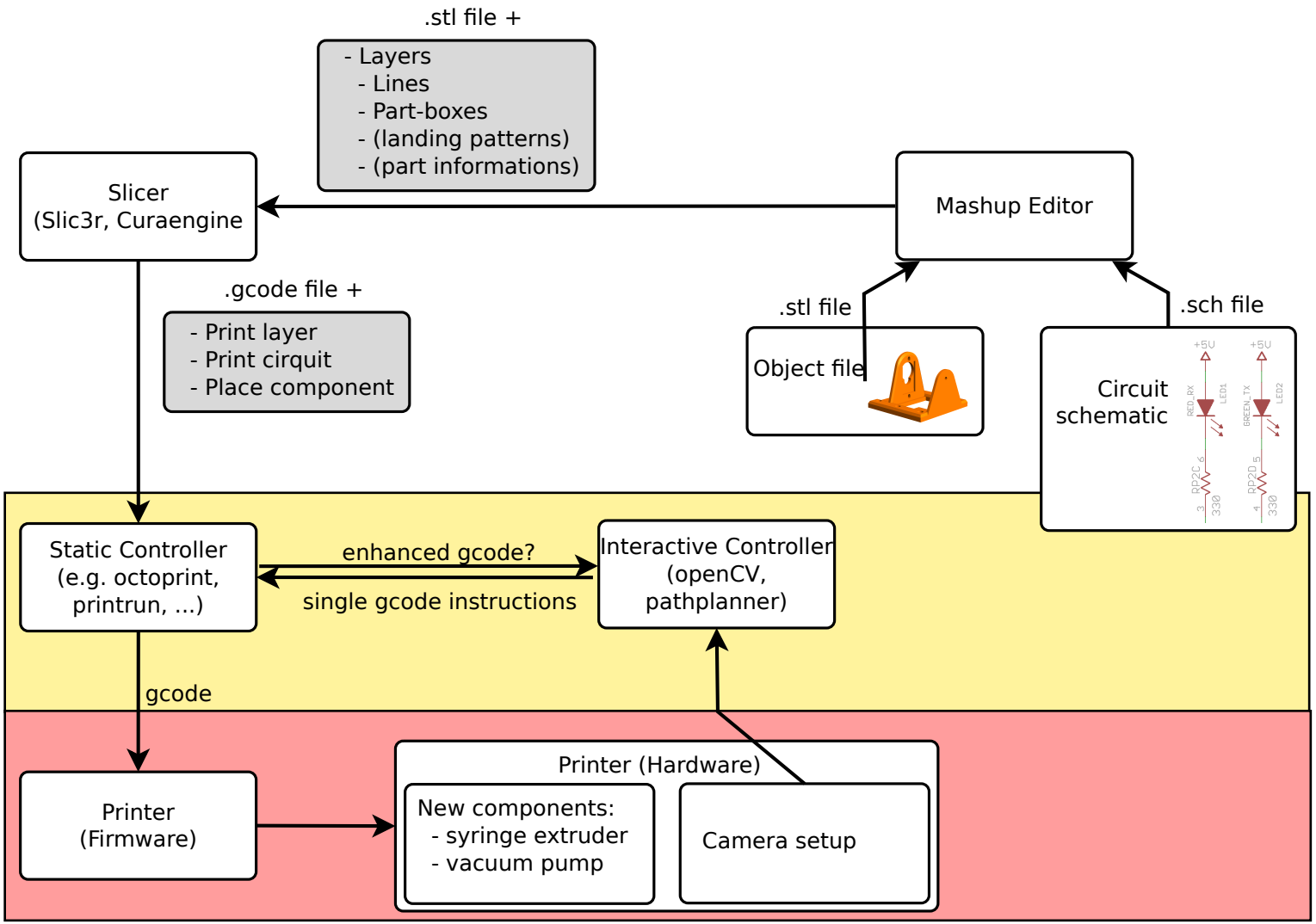




Basic Concept



Gcode extension

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3  M361 P4
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9  ;     <point x="value" y="value" />
10 ;     <point x="value2" y="value2" />
11 ;   </shape>
12 ;   <pads>
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17 ;</part>
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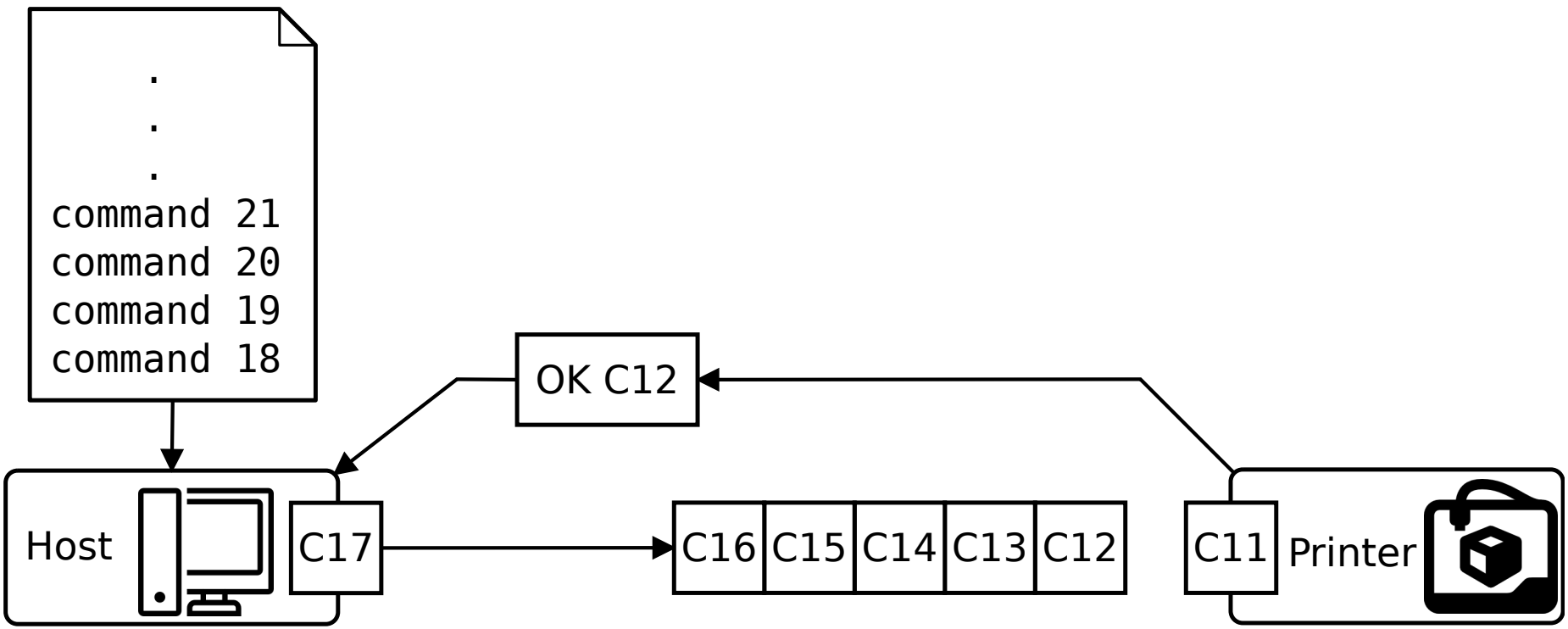
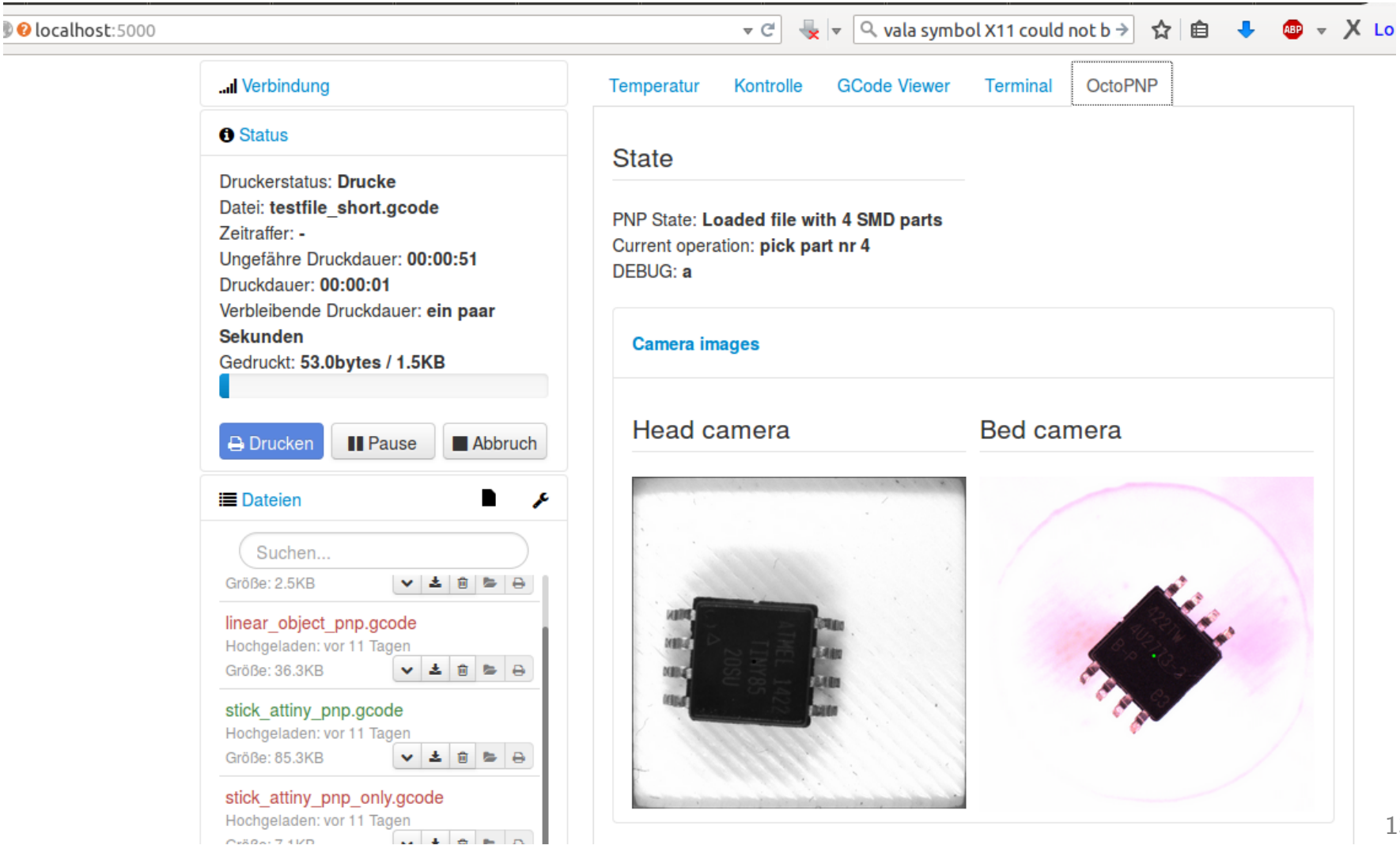
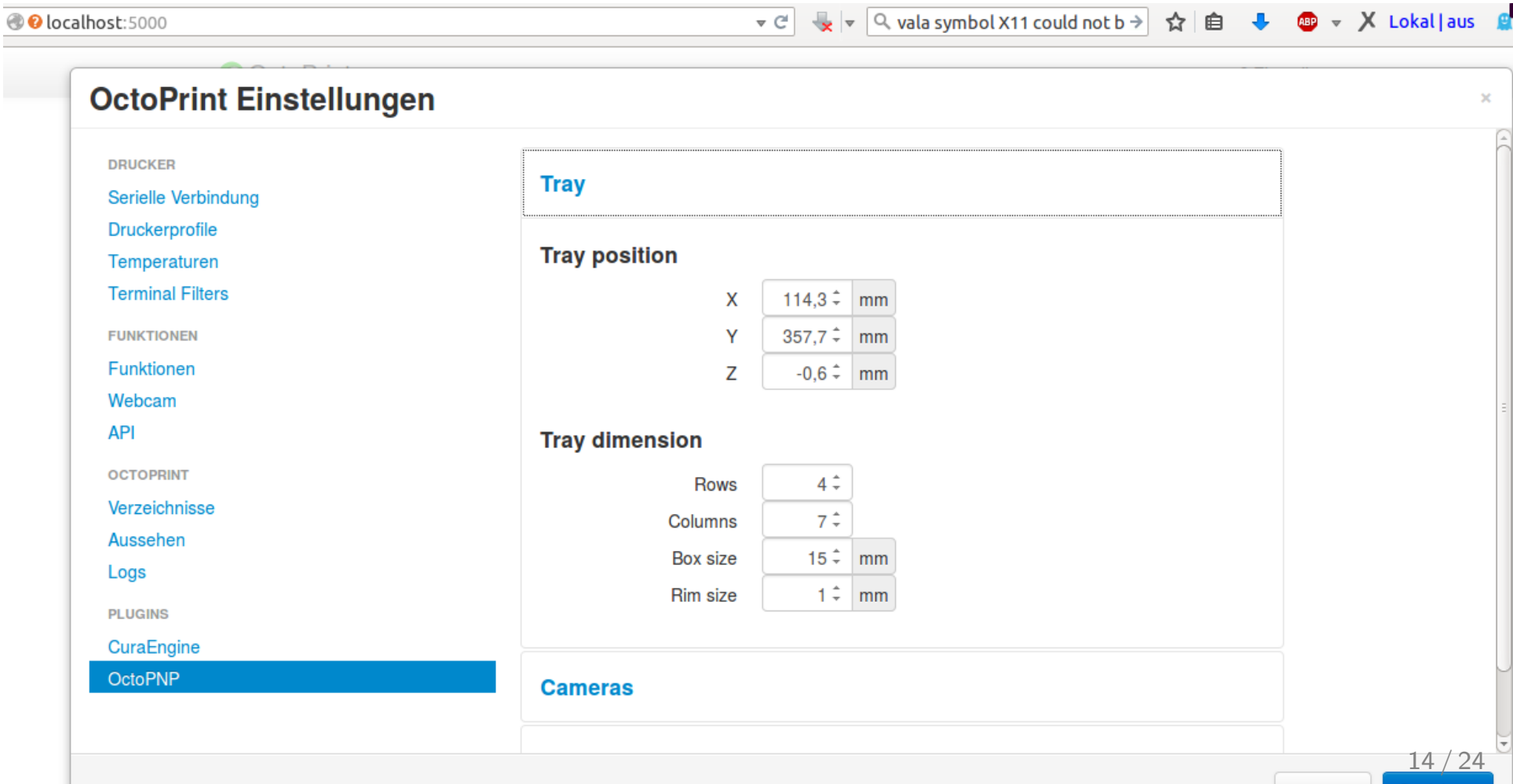
Buffered control loop



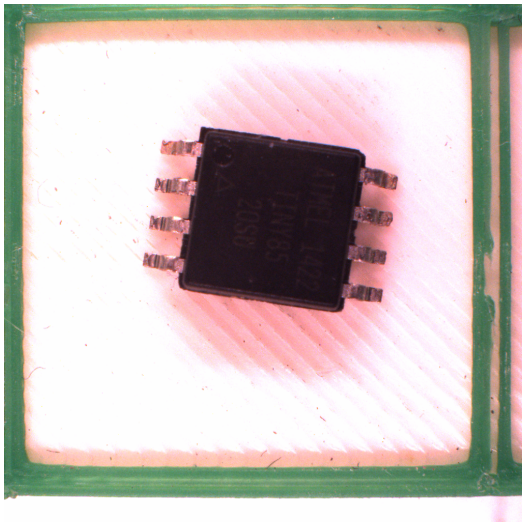
Host extension I

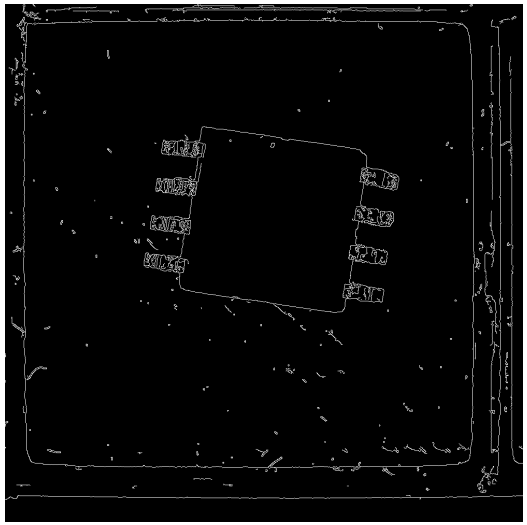


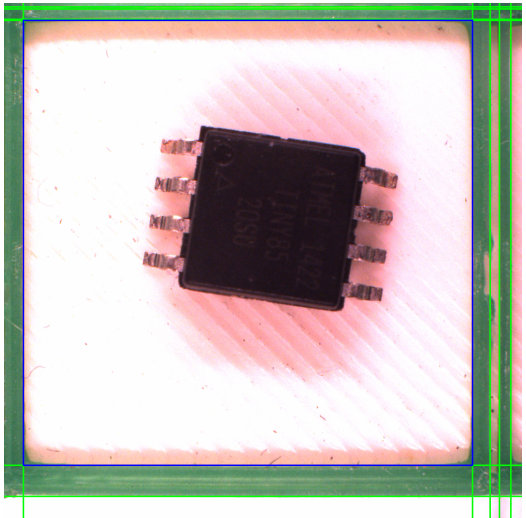
Host extension II

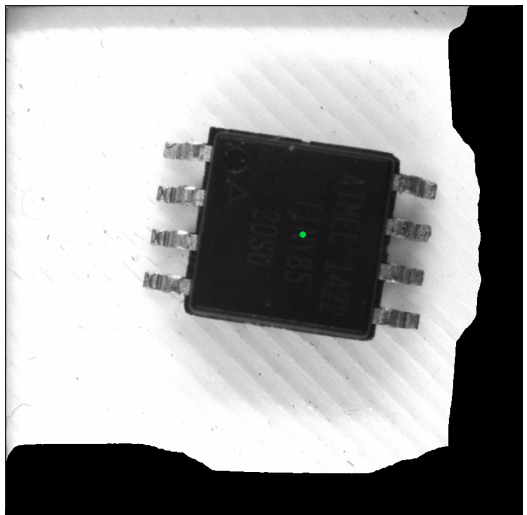


Pick 'n place









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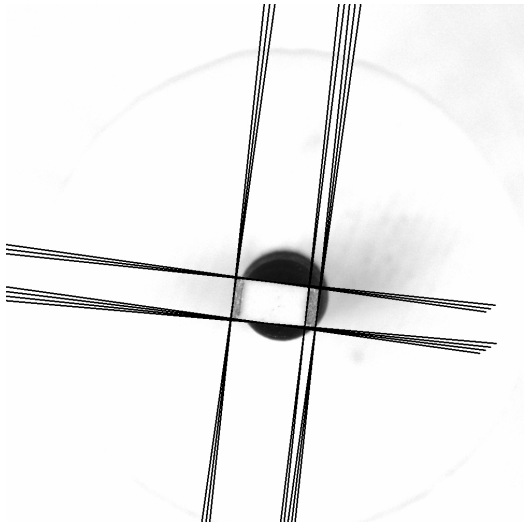
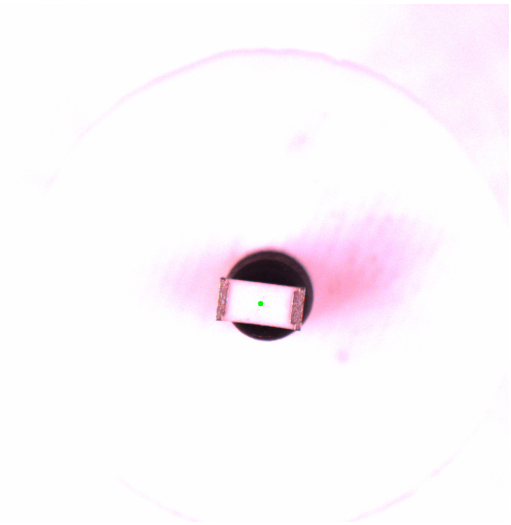
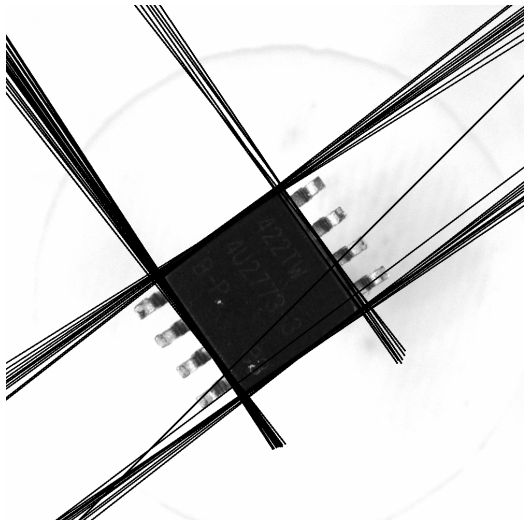
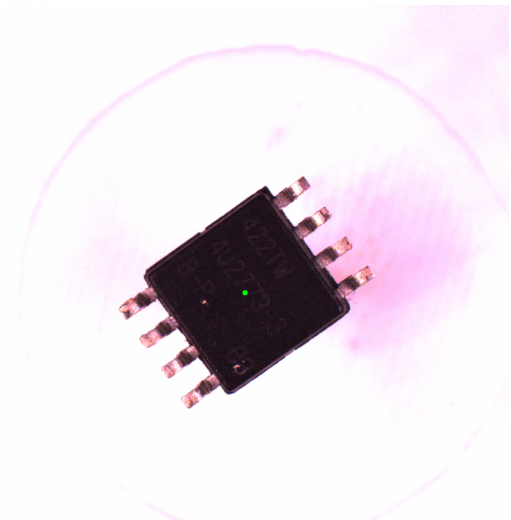
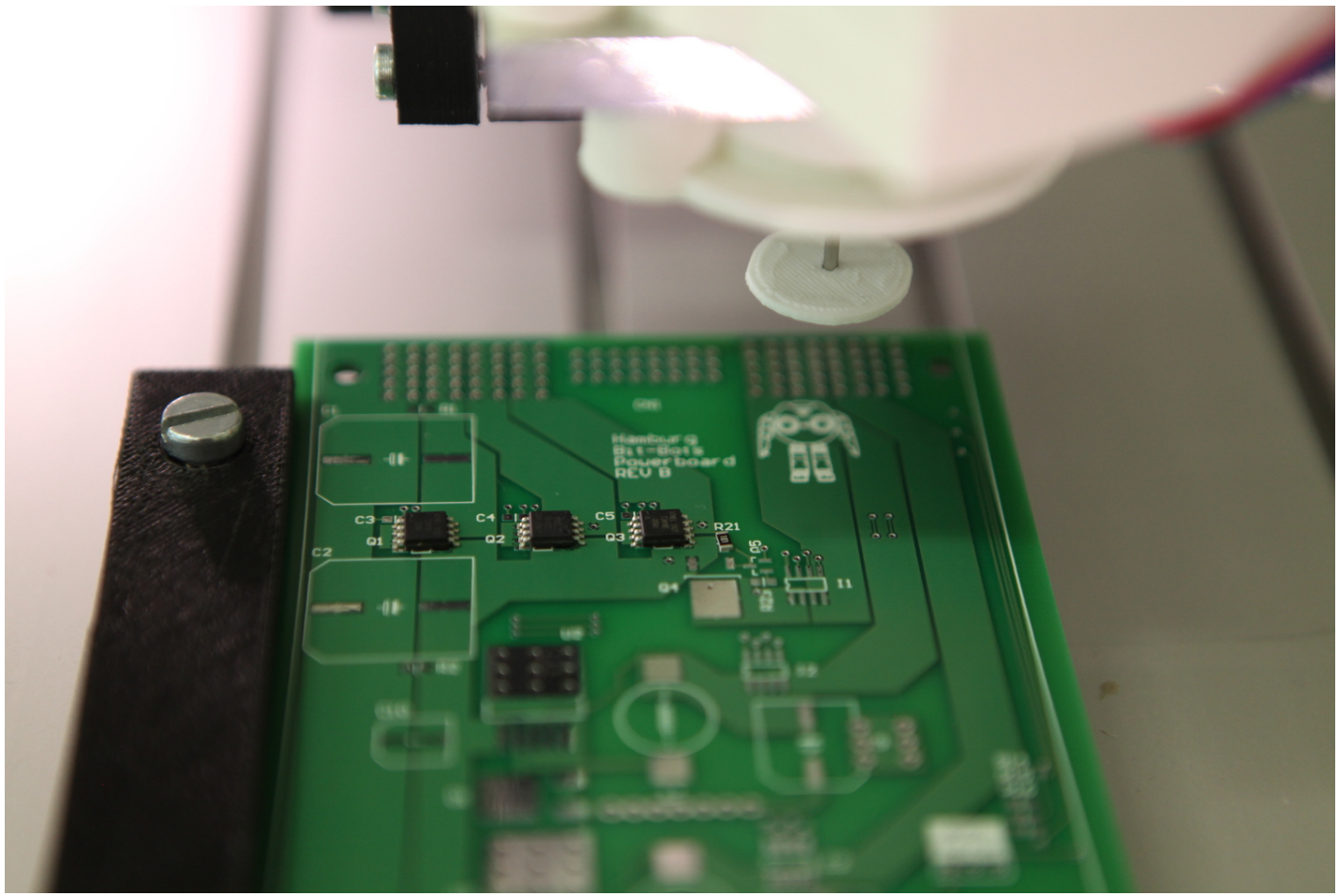
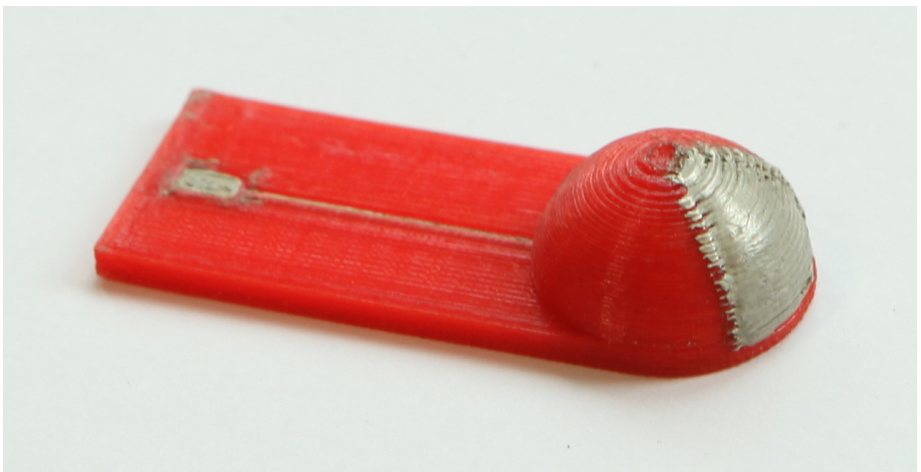





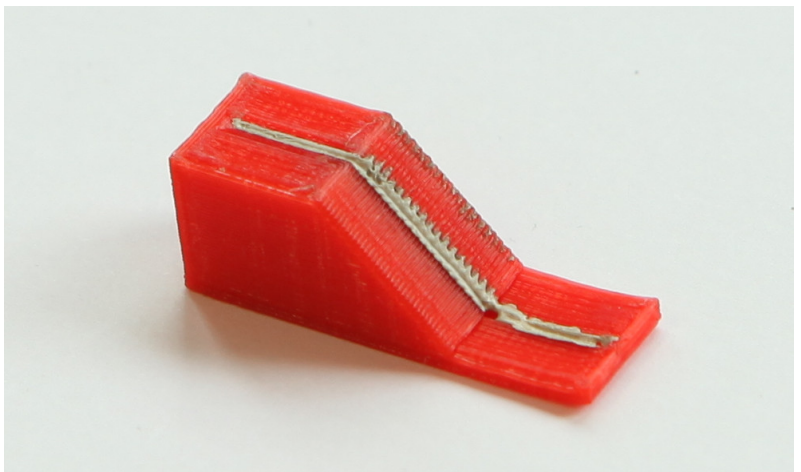
Ba-Thesis



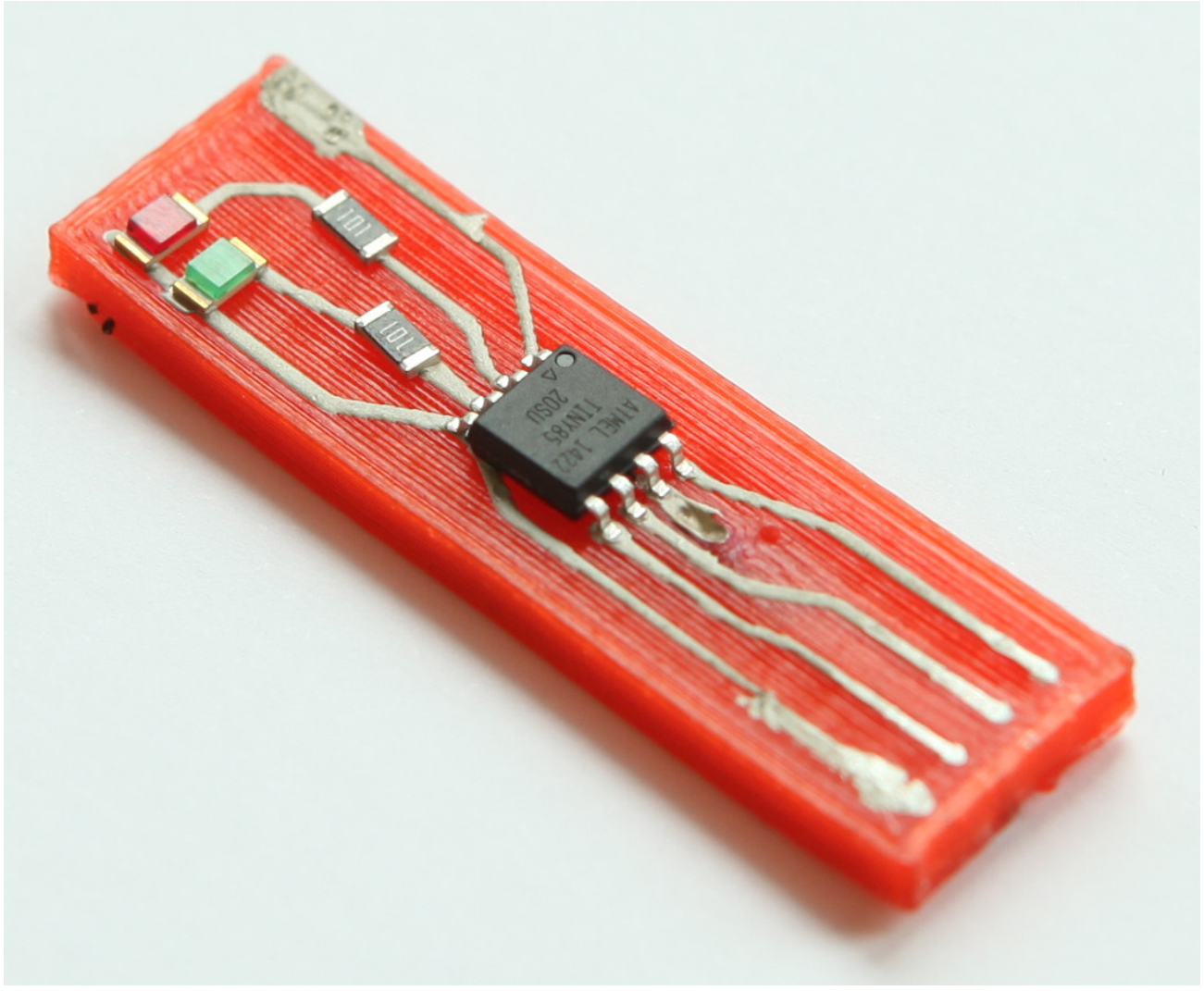
Video

Intermediate results I



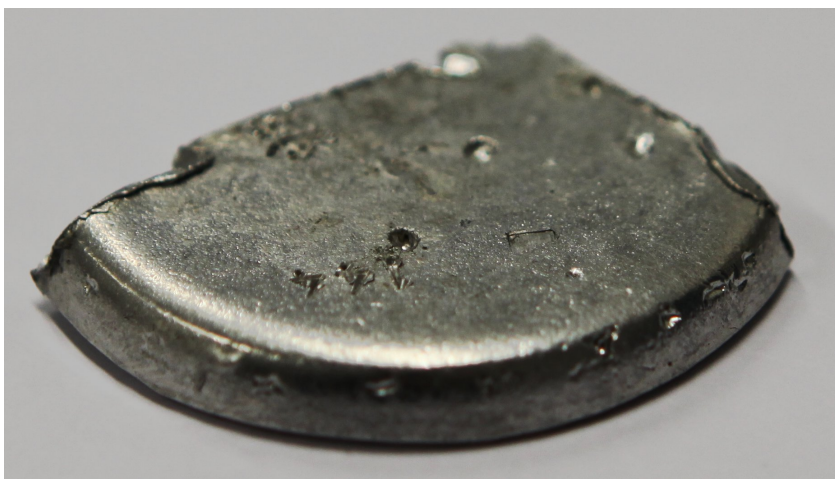


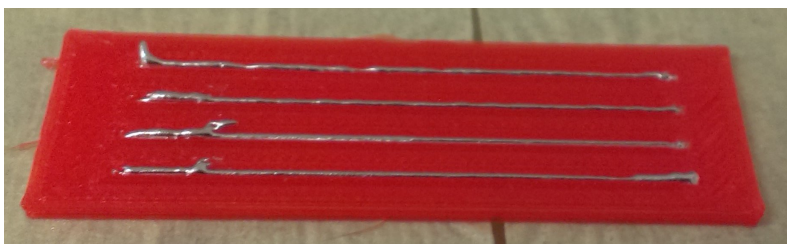
Intermediate results II



Conductive materials

- Field's metal
- Silver filled polymer





Material	32.5Bi 51In 16.5Sn
M.P.	$\sim 62°C$
Costs	$\sim 425\,€/kg$
Sheet res.	–

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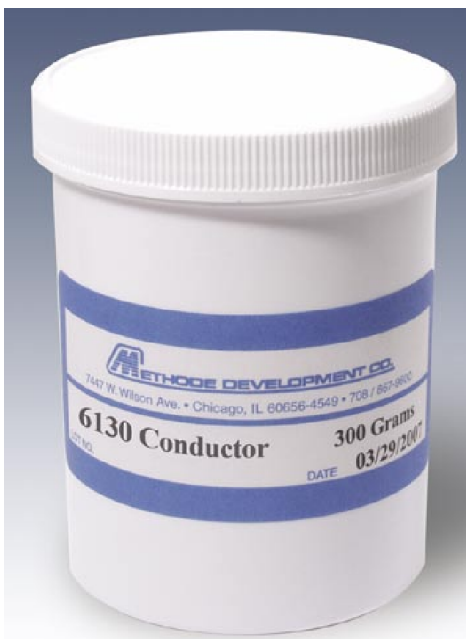
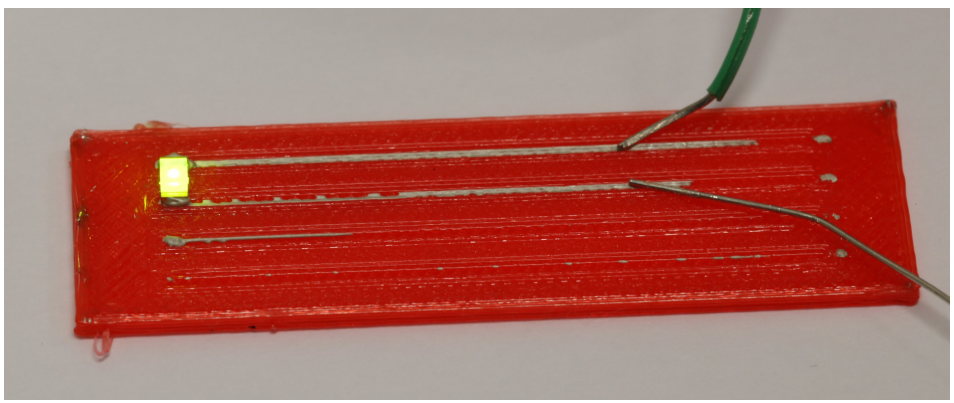


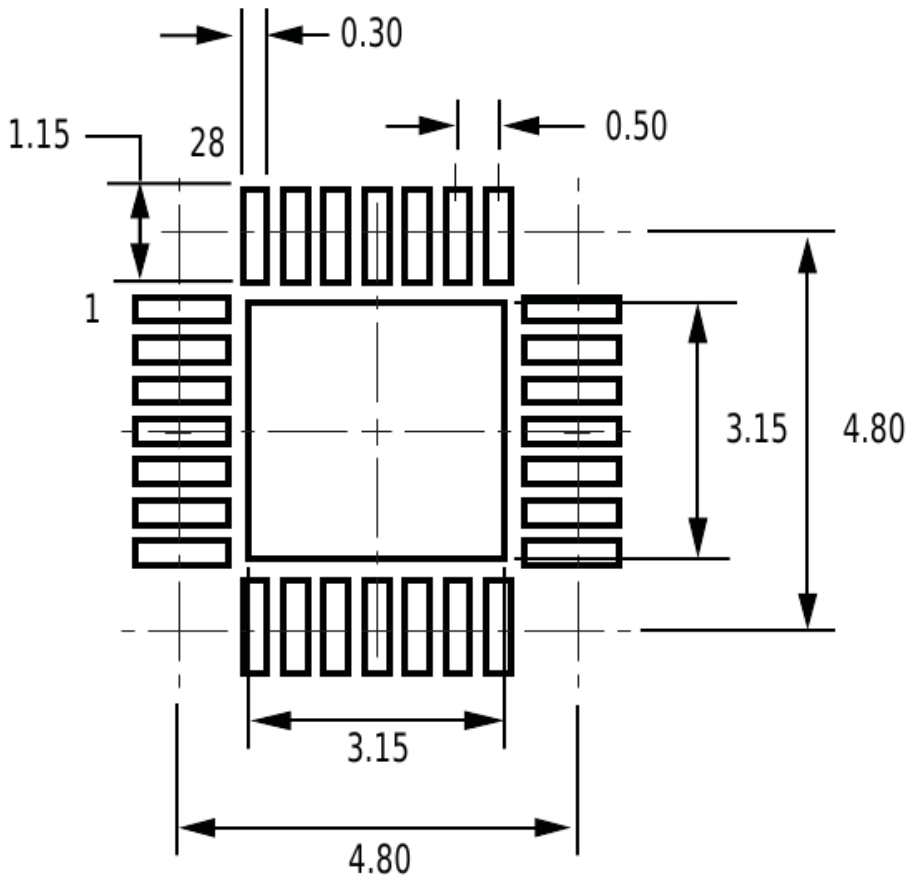


Material	#6130F
Curing	$\sim$ 20 min at 95°C
Costs	$\sim$ 2500 \$/kg
Sheet res.	0.04 Ω/□

Evaluation

Critical measures

- Channel width
- Conductivity
- Reliability
- Costs



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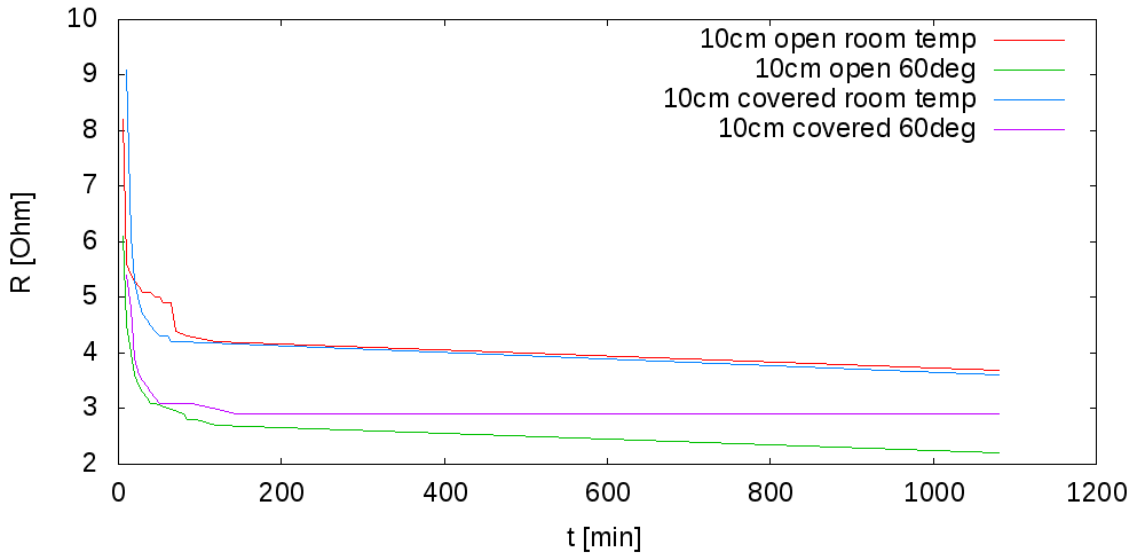

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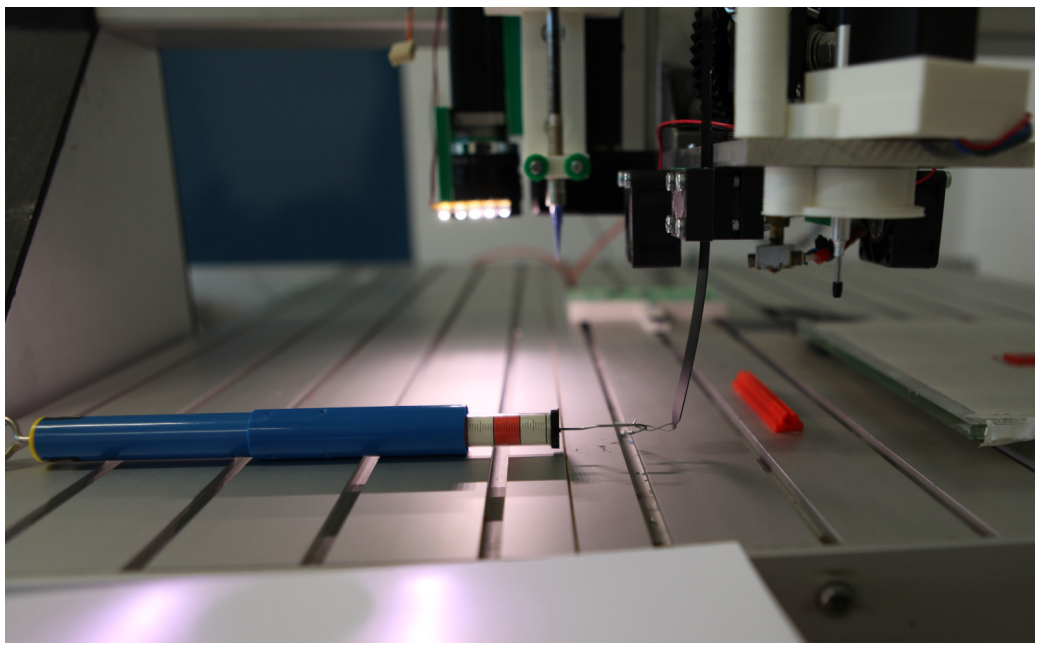
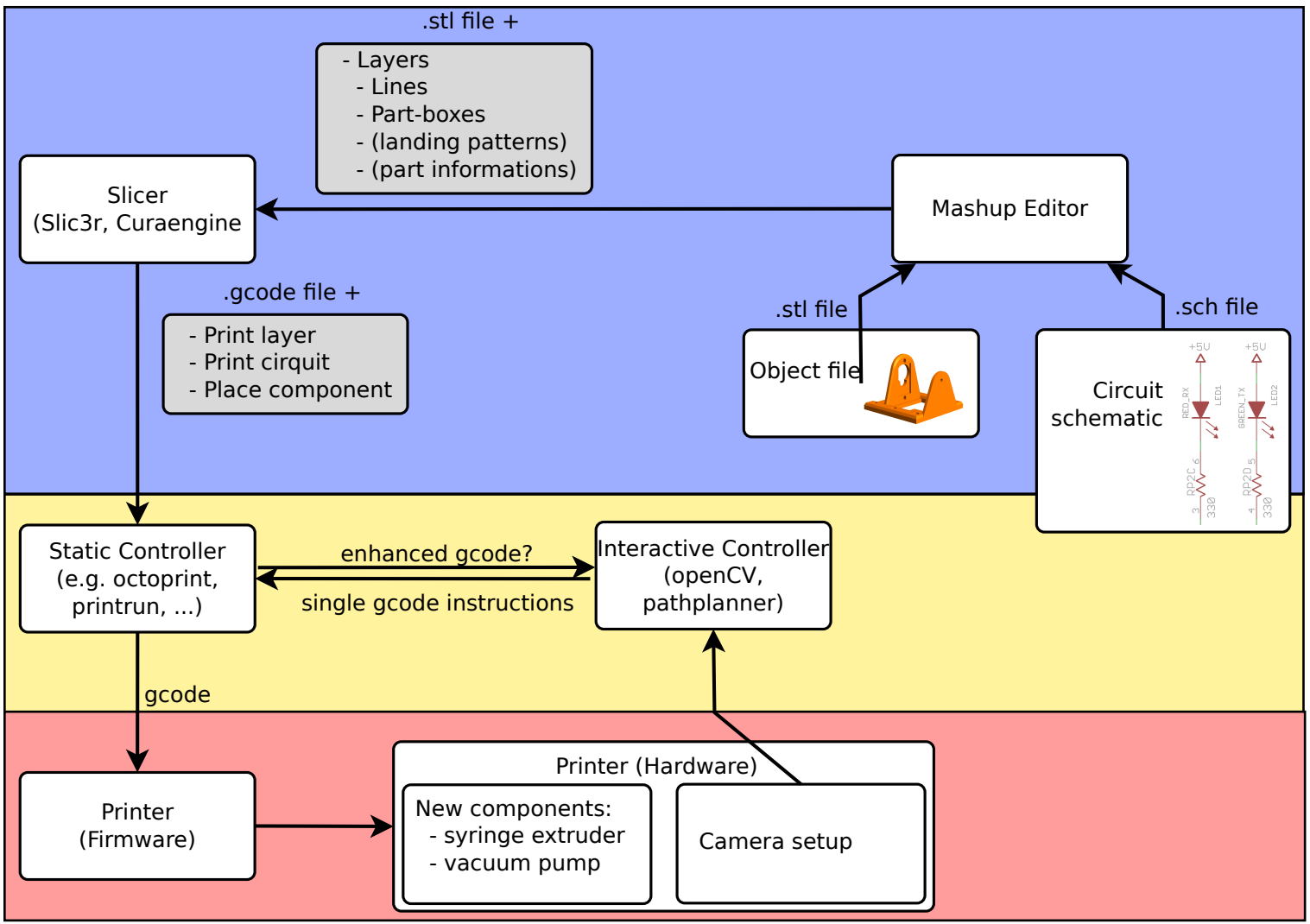
Ongoing...



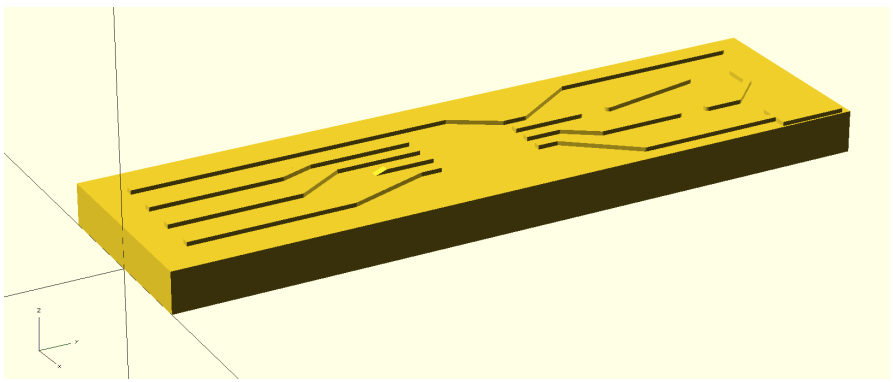
Basic Concept



challenges

Integration into slicing process

- Integration of curcuit and SMD components into Slicing process
- 3D Routing and placing on or inside objects



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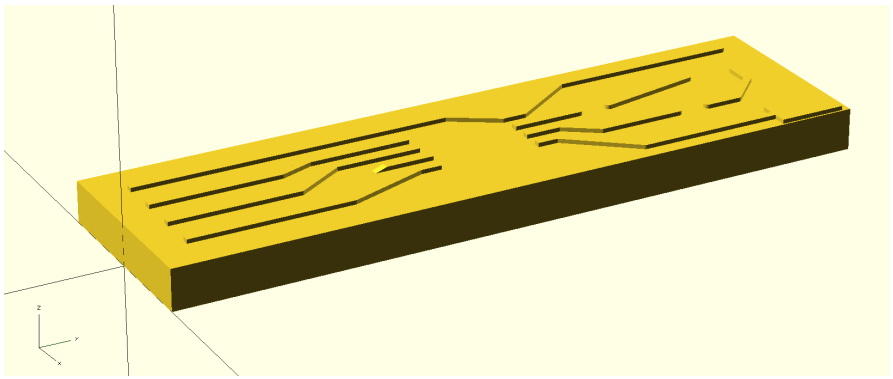

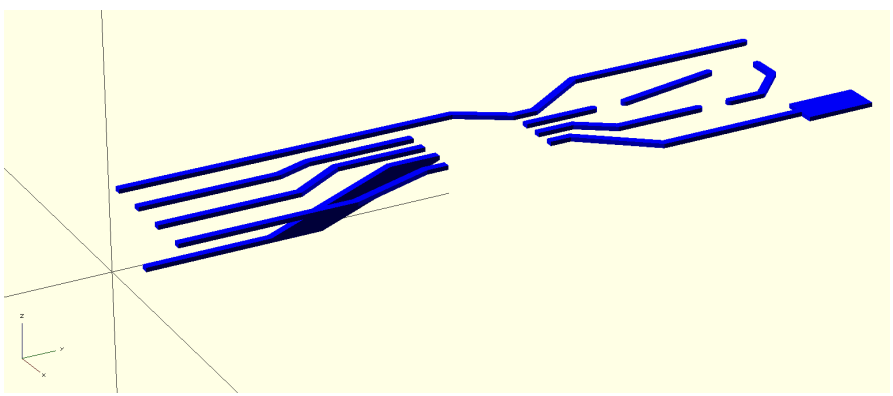

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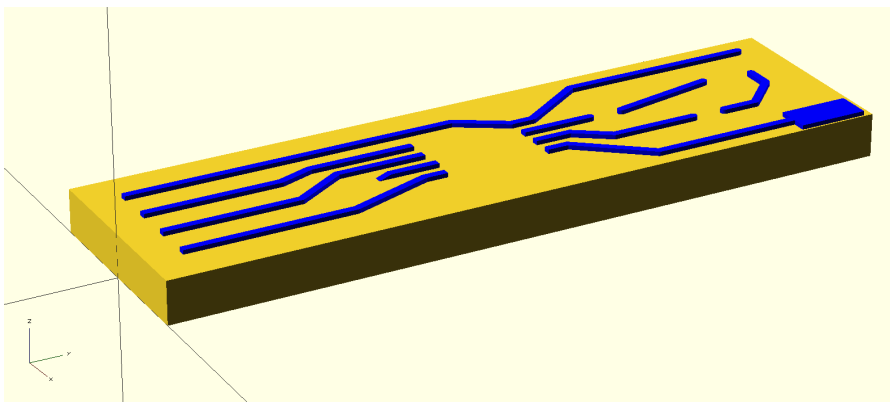

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Ba-Thesis II

Applications in robotics

- Integration / miniaturization
- Force- torque sensors
- Robot arm for part placement

The end

Thank you for your attention!