



# SMT Pick&Place mit OpenPnP

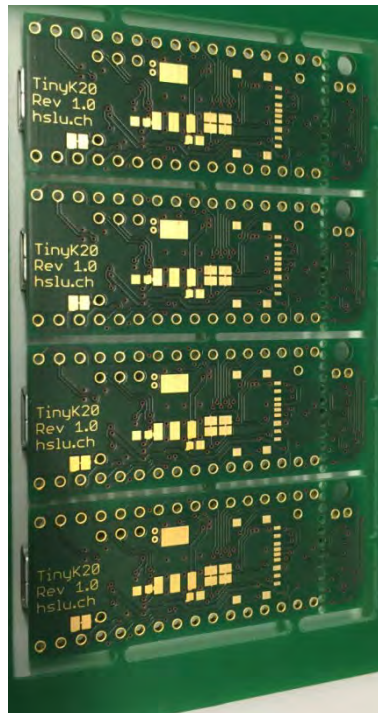
*«all the small things matter.»*

**Prof. Erich Styger**  
CC Electronics  
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+41 41 349 33 01

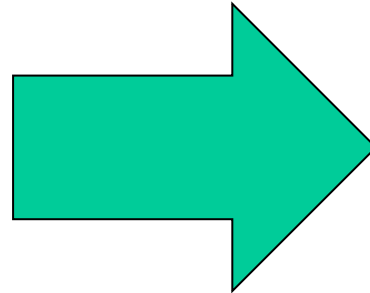
# Von der Leiterplatte zum Board

- Produktion der Leiterplatten
- Bestückung der PCBs mit Komponenten

## PCB Fertigung



## PCB Bestückung



## PCB Fertigung → Extern!

- Innert einer Woche gefertigt und geliefert!
- Kostengünstig, da Prozess automatisiert



**Prototype and Small Volume  
PCB Assembly the Easy Way**

Start at only \$ **88** USD - stencil free

Try it Now >>

**\$ 5.00**  
10 pcs 1-2 layer  
L≤100mm W≤100mm

**\$ 88**  
IN TOTAL  
for 1-10pcs assembly

The advertisement features a central image of a worker in a blue cap and gloves assembling a green PCB on a production line. The text is overlaid on this image and a white background to the right. A red circle highlights the \$5.00 price point. The overall layout is clean and professional, emphasizing speed and cost-effectiveness.

# PCB Bestückung: Extern?

- Abhängig von Anzahl Bauteilen
- Problem Bauteile
  - Customer Supply: Zoll, Kosten, Zeit
  - Shopping Cart (Mouser, etc): Zeit, Lieferbarkeit
  - Assembler Supply: Qualität
  - ~10% Überschuss
- Zeit: **3-4 Wochen**

**Prototype and Small Volume  
PCB Assembly the Easy Way**

Start at only \$ **88** USD - stencil free

**\$ 5.00**  
10 pcs 1-2 layer  
L≤100mm W≤100mm

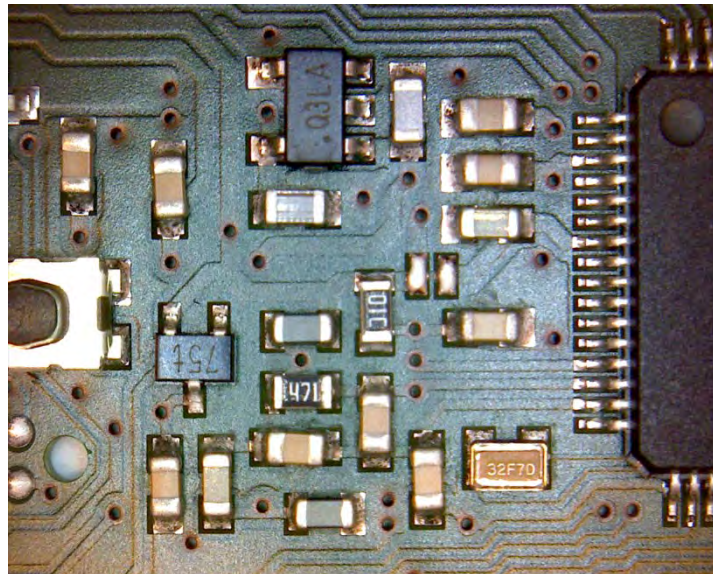
**\$ 88**  
IN TOTAL  
for 1-10pcs assembly

Try it Now >>

Pricing And Build Time			
Assembly Service Price			
	Per Piece	Qty	Total
<input checked="" type="checkbox"/>	38.7/pcs	10	\$387
<input type="checkbox"/>	20.1/pcs	20	\$403
<input type="checkbox"/>	8.6/pcs	50	\$432
<input type="checkbox"/>	2.9/pcs	200	\$589

# Die Aufgabe: SMT Bauteile Bestückung

- Industrie 4.0 → «Losgrösse 1»
- Für Startups, Forschung und Entwicklungsabteilungen
- Prototypen und Klein-Serien mit 1-50 Boards
  - a) **externe** Produktion (teuer, zeitraubend)
  - b) **interne** Produktion (schnell, aber kompliziert? teuer?)

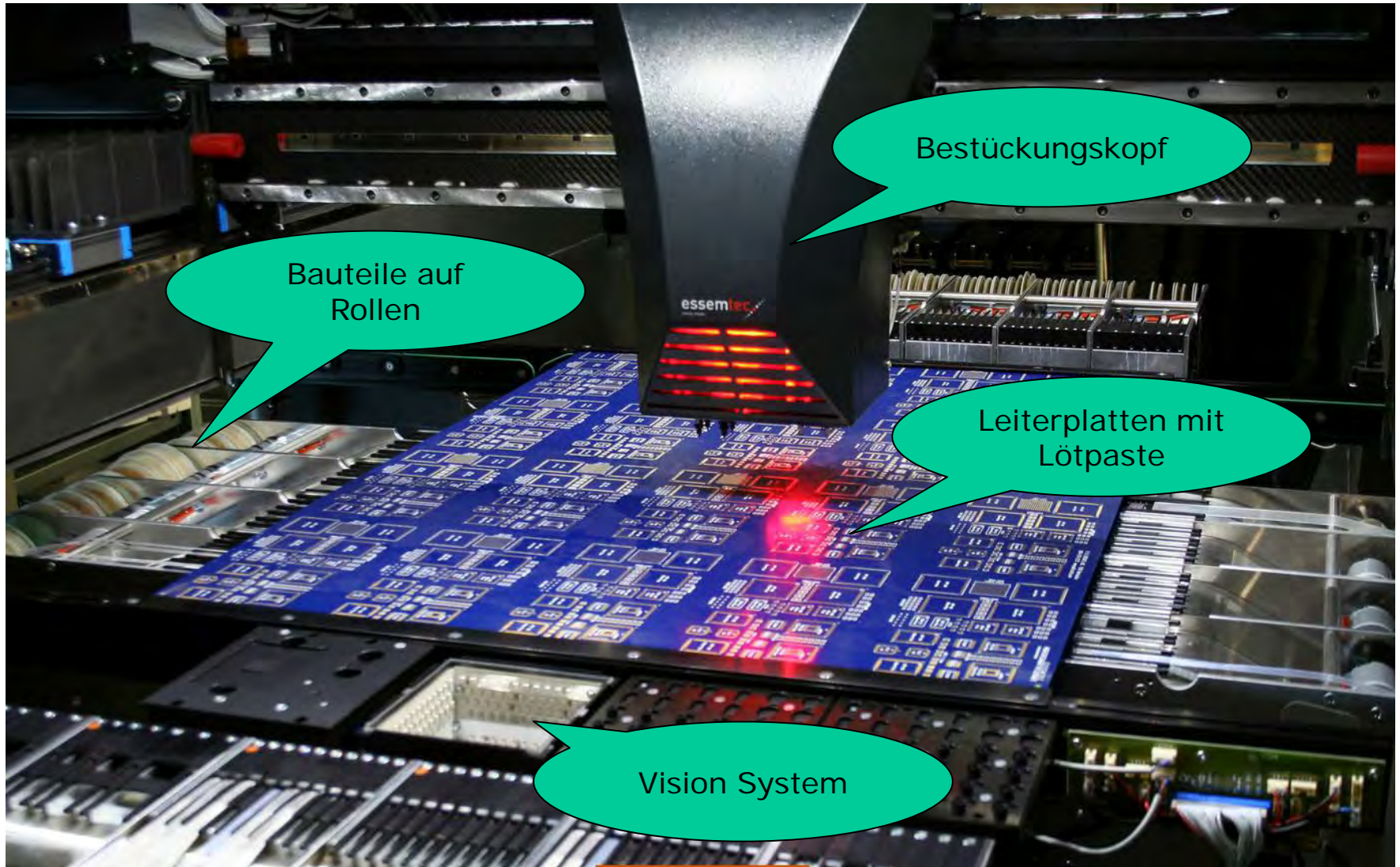


# Professionelle Bestückungsmaschine



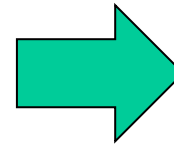
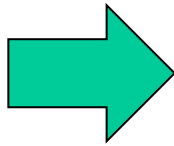
Source: essemtec

# Bestückungsautomat



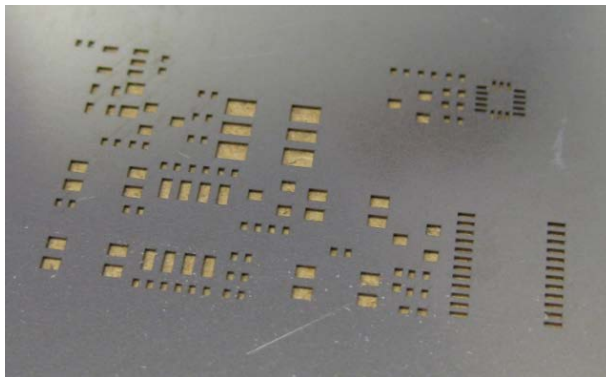
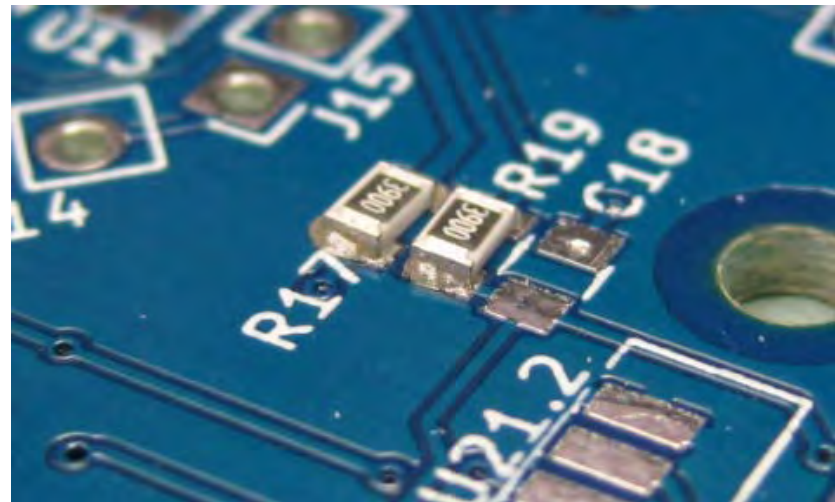
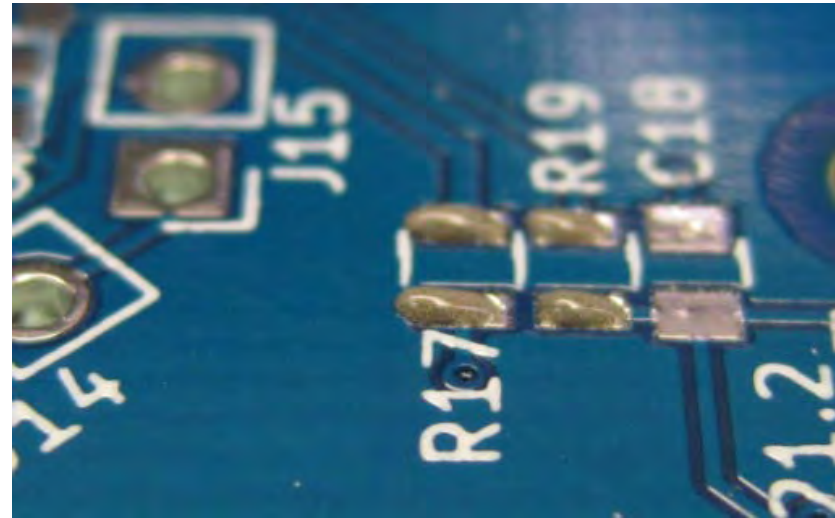
# 'Manueller' Ablauf

- Lötpaste auftragen
- **Bestücken (zeitaufwendig!)**
- 'Backen' im Reflow Ofen
- Board Testen

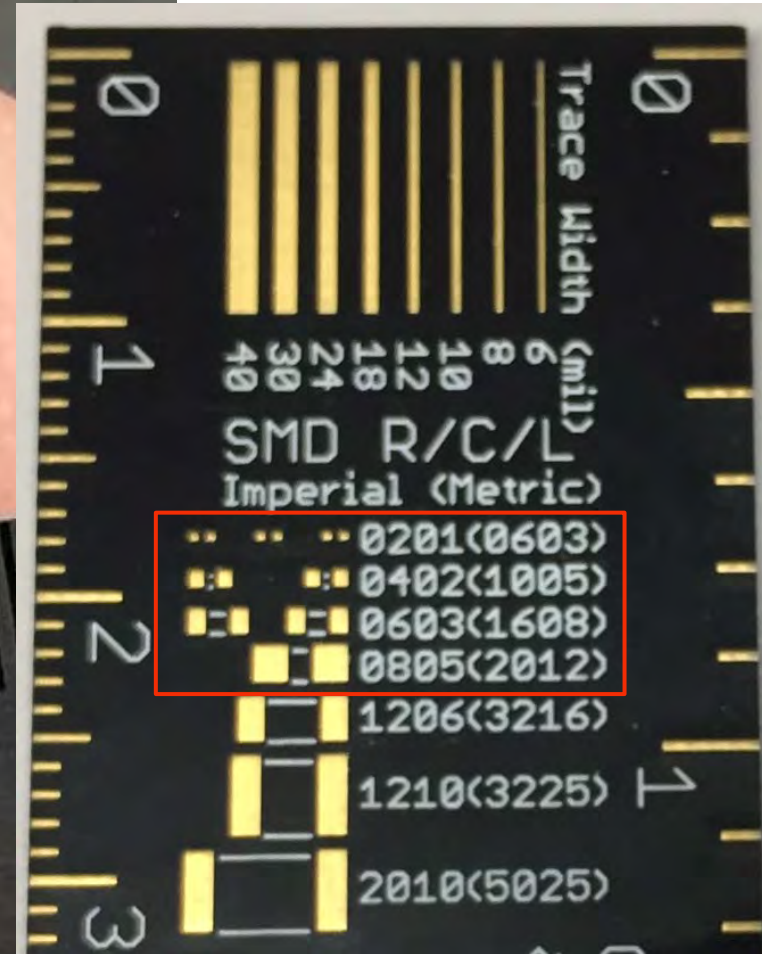
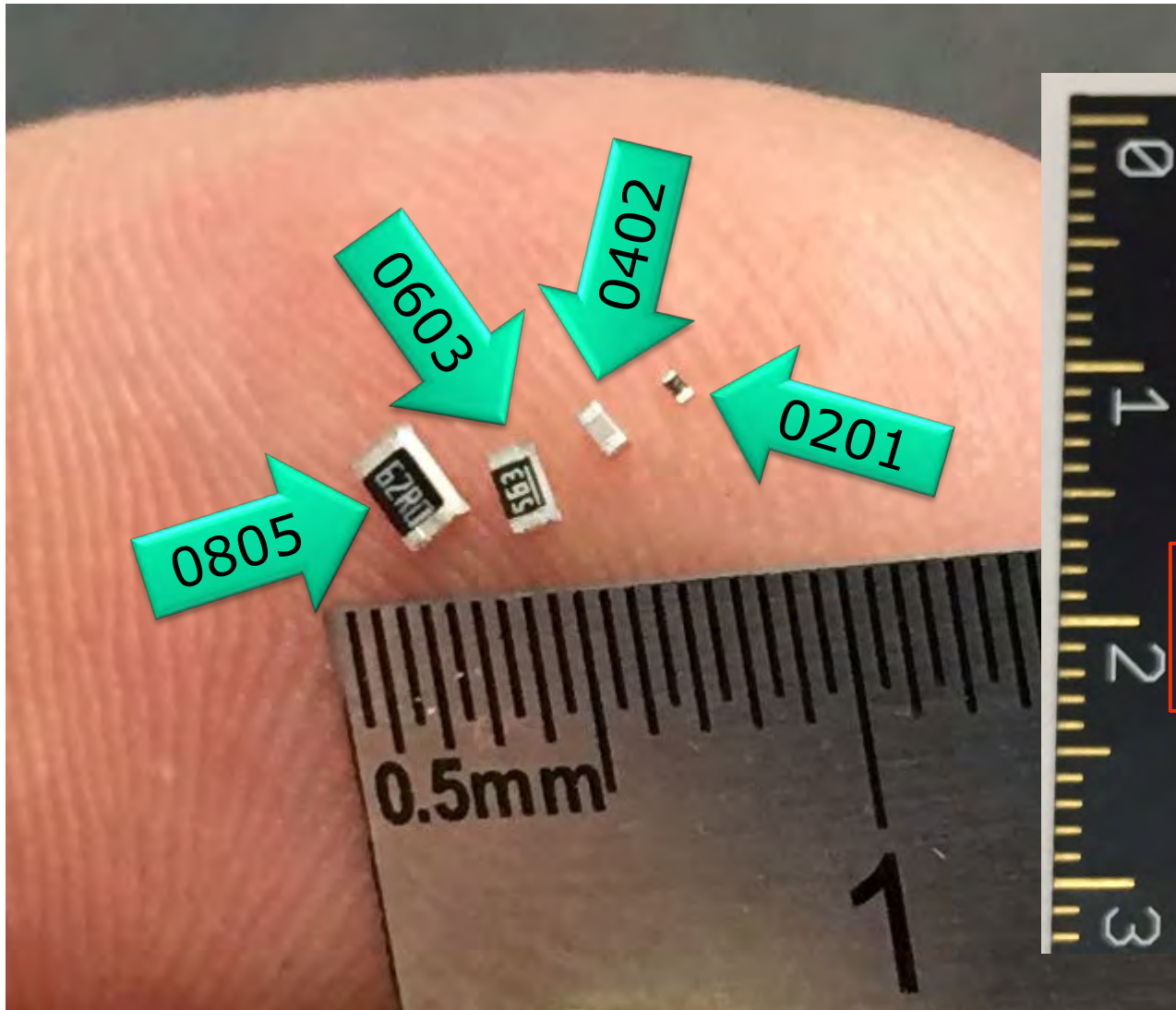




# Manuelles Bestücken: Auftragen Lötpaste



# SMD Passives



# Manual Pick & Place



# Reflow Oven

- 'Backen' der PCBs im Reflow Ofen



# «Tal der Tränen» und «steifer Nacken»

1-3 PCBs	4-50 PCBs	50+ PCBs
Intern!	<b>Intern oder Extern?</b>	Extern!
Einfach, kostengünstig, schnell	Intern: mühsam Extern: langsam	Setup-Kosten, Zeit



Source: allexpress



Source: ImageStock



Source: essemtec



**Eigene Maschine?**

# SMT Pick&Place Maschine von China?

JAGUAR  
捷豹



[View larger image](#)



[Add to Compare](#) [Share](#)

smt pick and place machine Juki JX 350 SMT machine X,Y Axis  
stroke:500\*600mm

FOB Reference Price: [Get Latest Price](#)

1 US \$60000.00 >=2 US \$50000.00

Supply Ability: 100 Set/Sets per Month

Port: shenzhen

[Contact Supplier](#)

[Chat Now!](#)

Payment: [VISA](#) [MasterCard](#) [TT](#) [e-Checking](#) [More](#)

Shipping: Less than Container Load (LCL) Service to US [Get shipping quote](#)

- Transparent and fair price
- 24/7 online support
- Online tracking

# Desktop Pick&Place from China?



[View larger image](#)



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New product with 46 feeders Qihe TVM802BX high accuracy pcb chip mounter SMT pick and place machine

FOB Reference Price: [Get Latest Price](#)

**US \$4600.00**

Supply Ability: 299 Piece/Pieces per Month

Port: SHENZHEN,NINGBO,SHANGHAI

[Contact Supplier](#)

[Start Order](#)

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Seller Support: [Trade Assurance](#) – To protect your orders from payment to delivery

Payment: [VISA](#) [MasterCard](#) [TT](#) [e-Checking](#) [More](#)

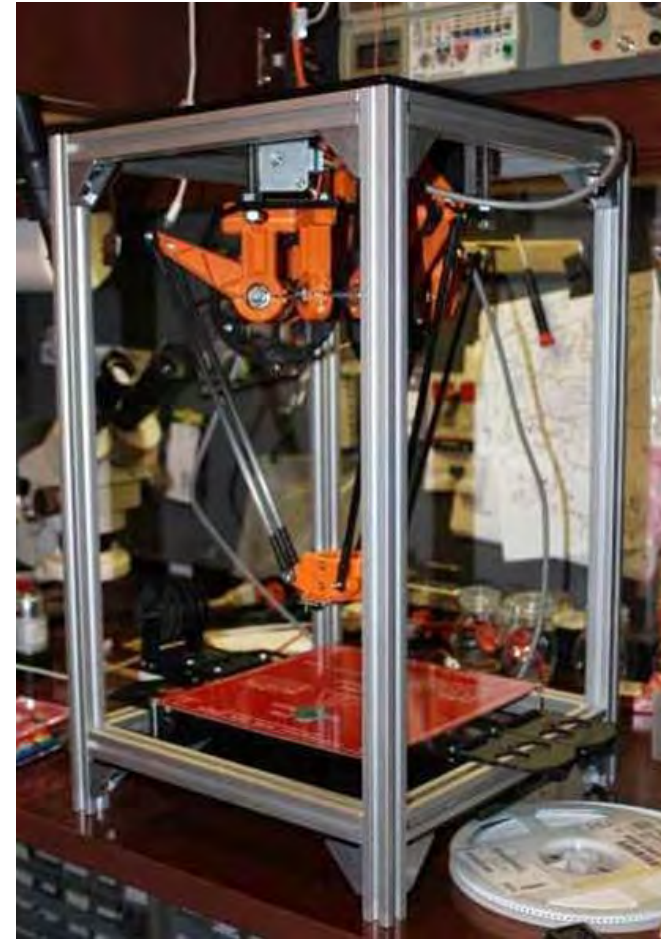
Shipping: Less than Container Load (LCL) Service to US [Get shipping quote](#)

- Transparent and fair price
- 24/7 online support
- Online tracking

Source: alibaba

# Zeitalter von 3D Printer und Laser Cutter

- Selber bauen!?!
- Ziele
  - Kosten: < CHF 1000.—
  - cph: 300-500
  - Bauteile: 0402, 0603, 0805, SOP, TQFP, QFN
  - Erweiterbarkeit, Bedienbarkeit
  - Integration mit CAD (Eagle, KiCAD, Altium, ...)
  - Rollen & Lose Bauteile
  - Genauigkeit 0.01 mm
  - Vision System
  - **Open Hardware**
  - **Open Software**



Source: Firepick Delta



# Liteplacer

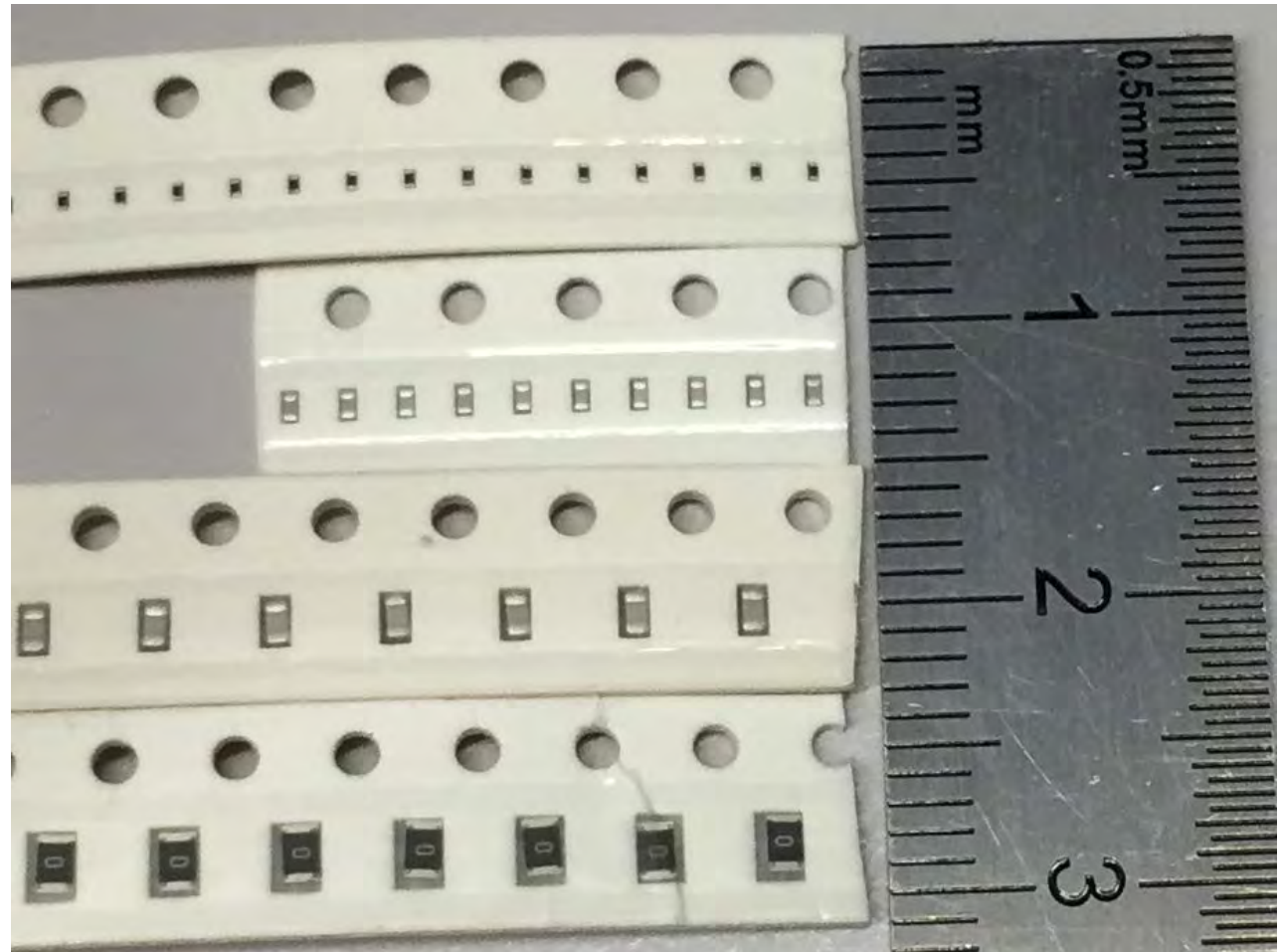
- 1,699.00€
- Bausatz ohne Kabel/Netzteile/Cable Chain, Tisch, Gehäuse
- Open Design, Windows



Source: [liteplacer.com](http://liteplacer.com)

# SMT Cut Tape

- 8mm Streifen, 4mm Lochabstand



# OpenPnP.org

Home Downloads Hardware Documentation Code Issues



OpenPnP is an Open Source SMT pick and place system that includes ready to run software, and hardware designs that you can build and modify. You can also use OpenPnP software to run a pick and place machine of your own design, or with existing commercial machines, giving them abilities they never had with their OEM software.

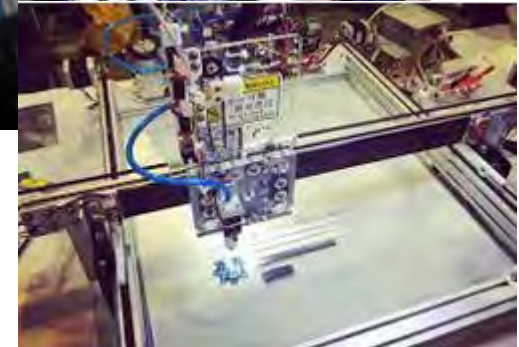
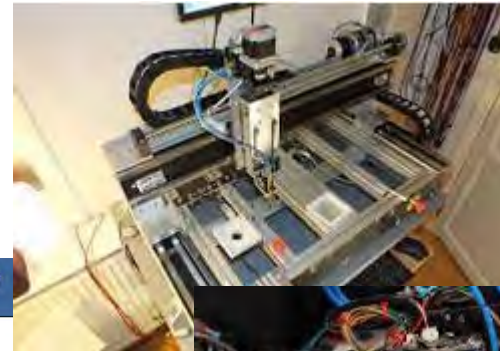
## Getting Started

To get started with OpenPnP, read through the [Quick Start Guide](#). This short guide will help you download and install the software, run through a sample job and take you to the next step of building or configuring your hardware.

If you'd like some ideas on how to build your own machine, check out the [Hardware](#) section for free, Open Source, designs that you can build yourself.

## Community

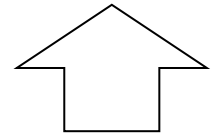
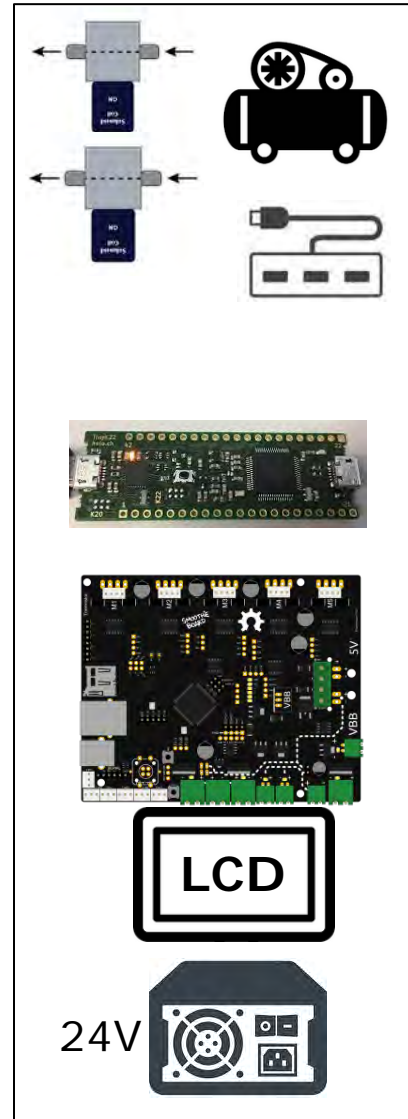
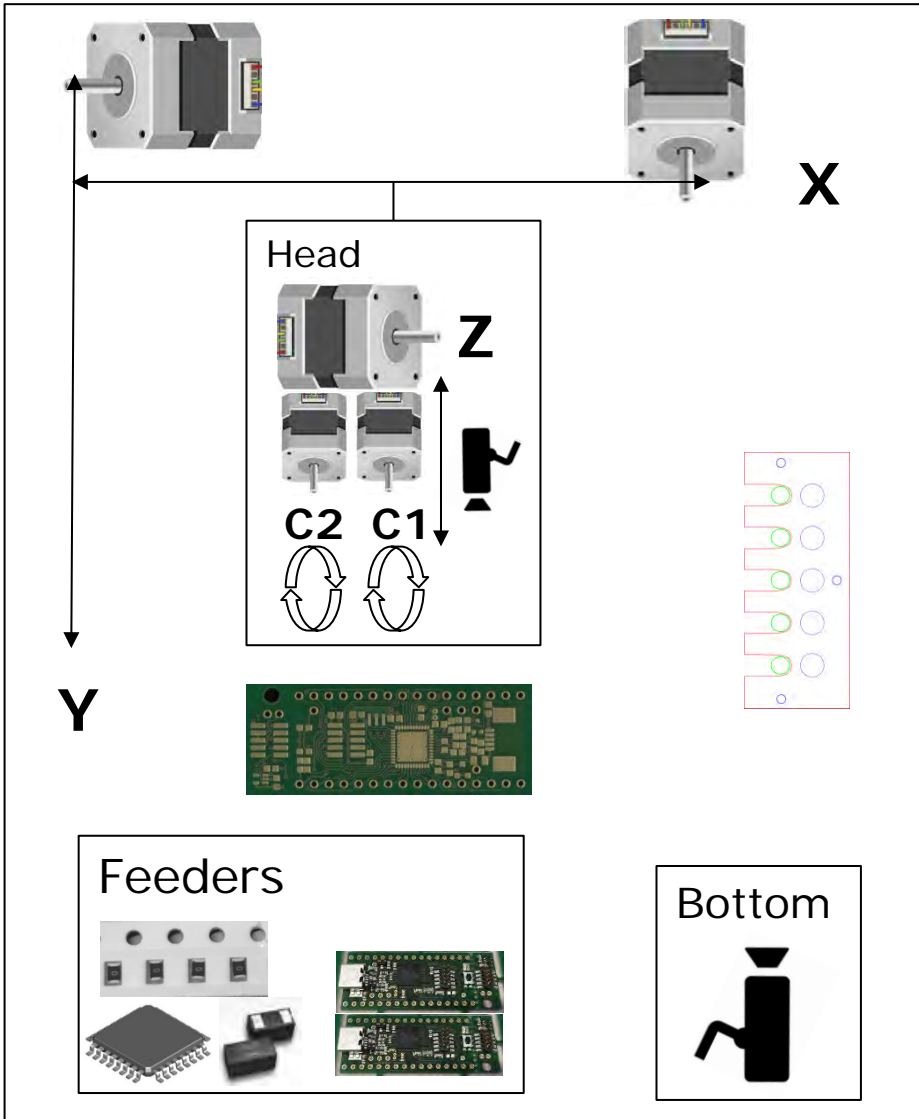
If you'd like to join the conversation you can [join the discussion group](#), or come chat with us on [Freenode IRC at #openpnp](#). If you don't have an IRC client, you can [use this web based one](#). You can also [watch this project on GitHub](#), and check out [our Twitter](#).



# Budget/Kosten

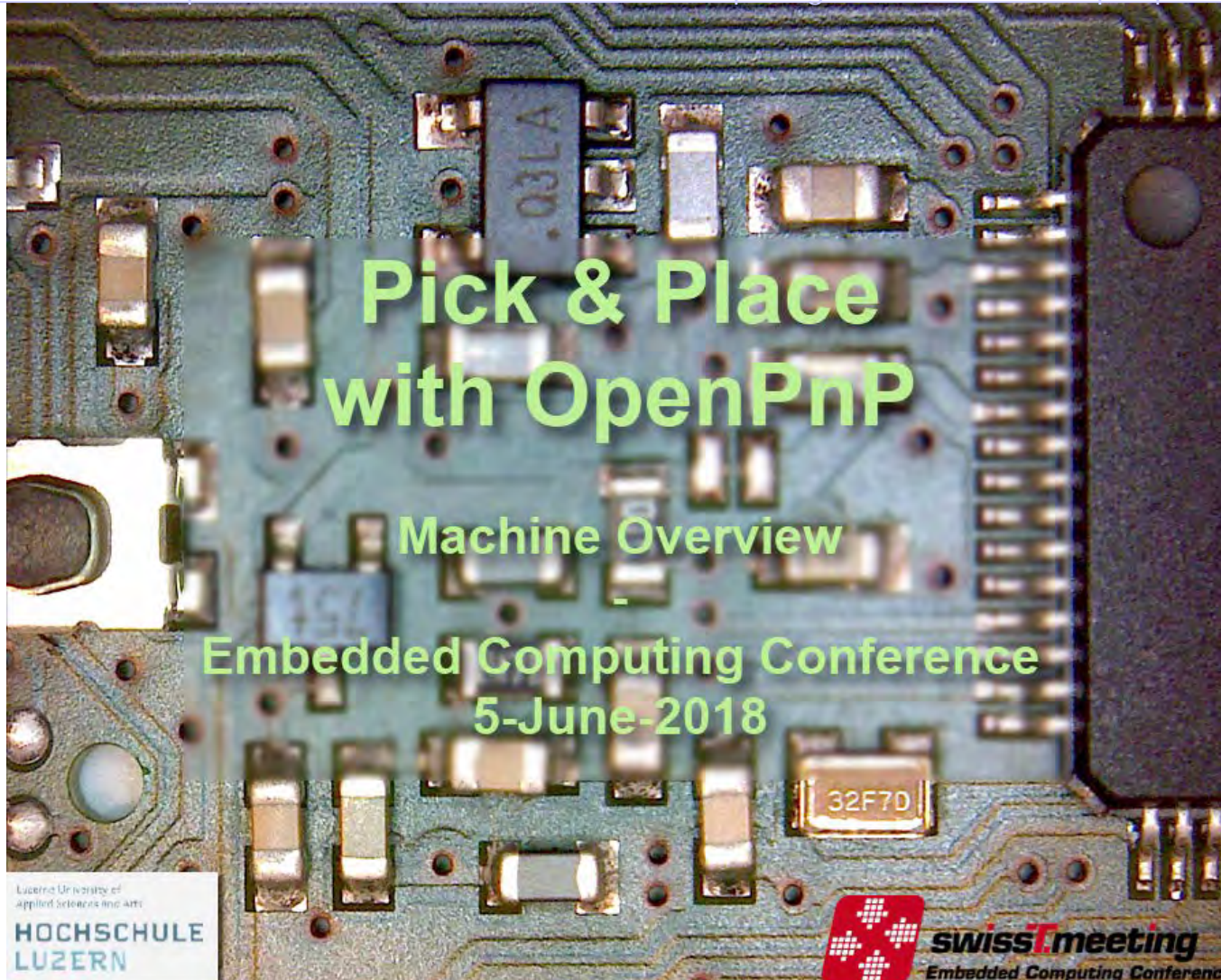
Item	CHF
Aluminium Rahmen, Schrauben, Verbinder	100.--
Linearführungen	90.--
Schrittmotoren	120.--
End-Stopps, Zahnriemen, Zahnräder und Rollen	60.--
SMT Düsen und -halter	100.--
Pumpe, Ventile, Schläuche	60.--
Kameras, LED Ringe	70.--
Kontroller Board, LCD	200.--
Netzteile	100.--
Kabel, Kleinmaterial	100.--
<i>Host, 3D-Druck, Laser Cutting, Arbeit, ...</i>	<i>na</i>
<b>Total</b>	<b>1000.--</b>

# System Übersicht



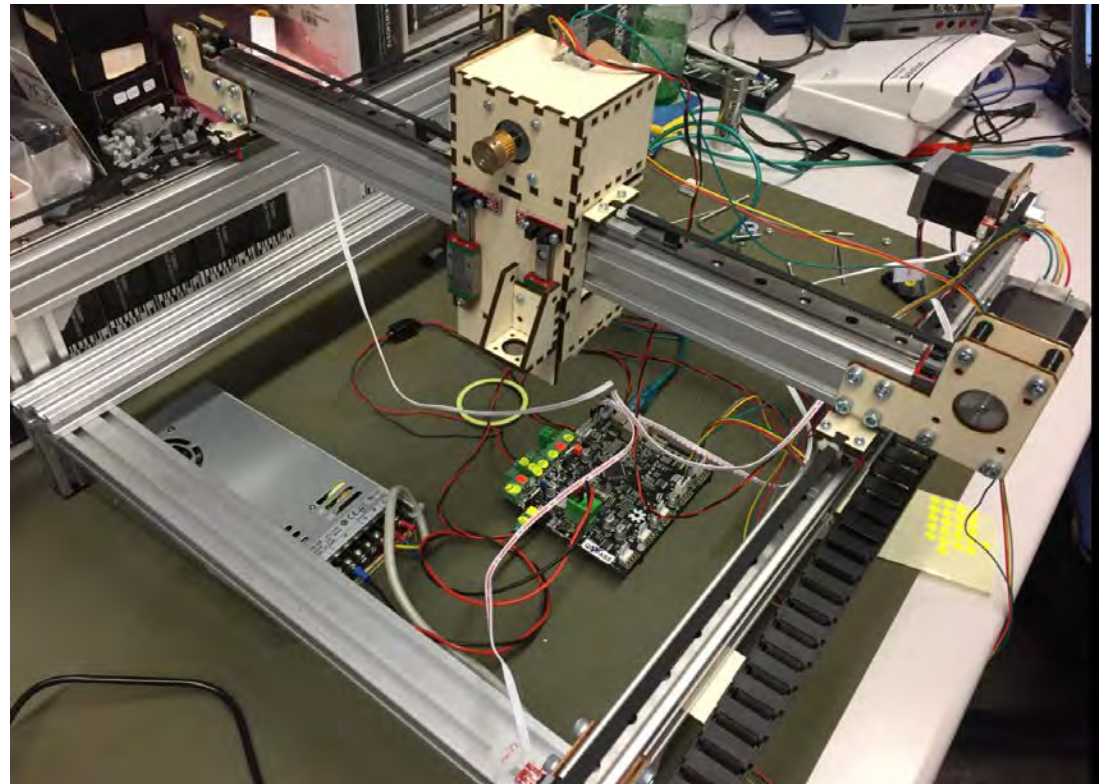
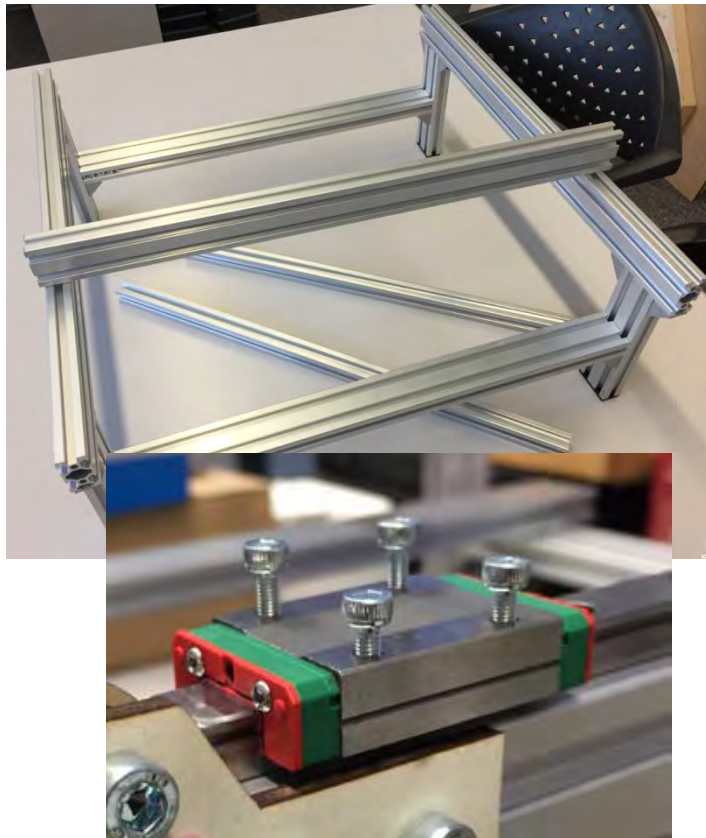
# Machine Overview

<https://mcuoneclipse.com/2018/06/03/embedded-computing-conference-2018-pickplace-overview-video/>

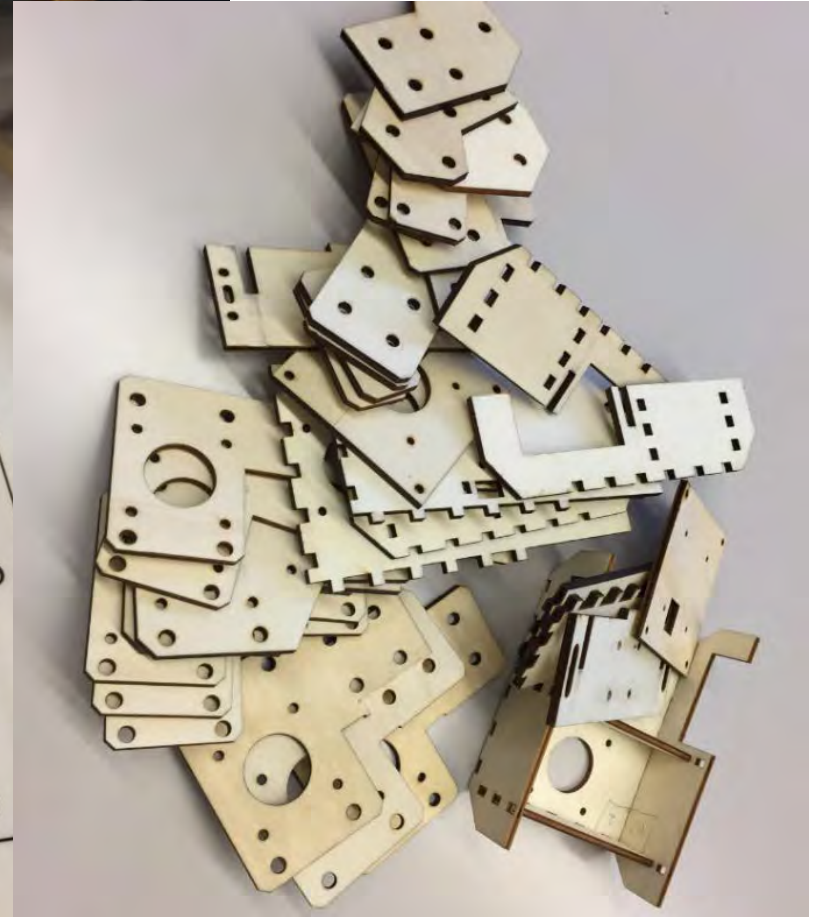
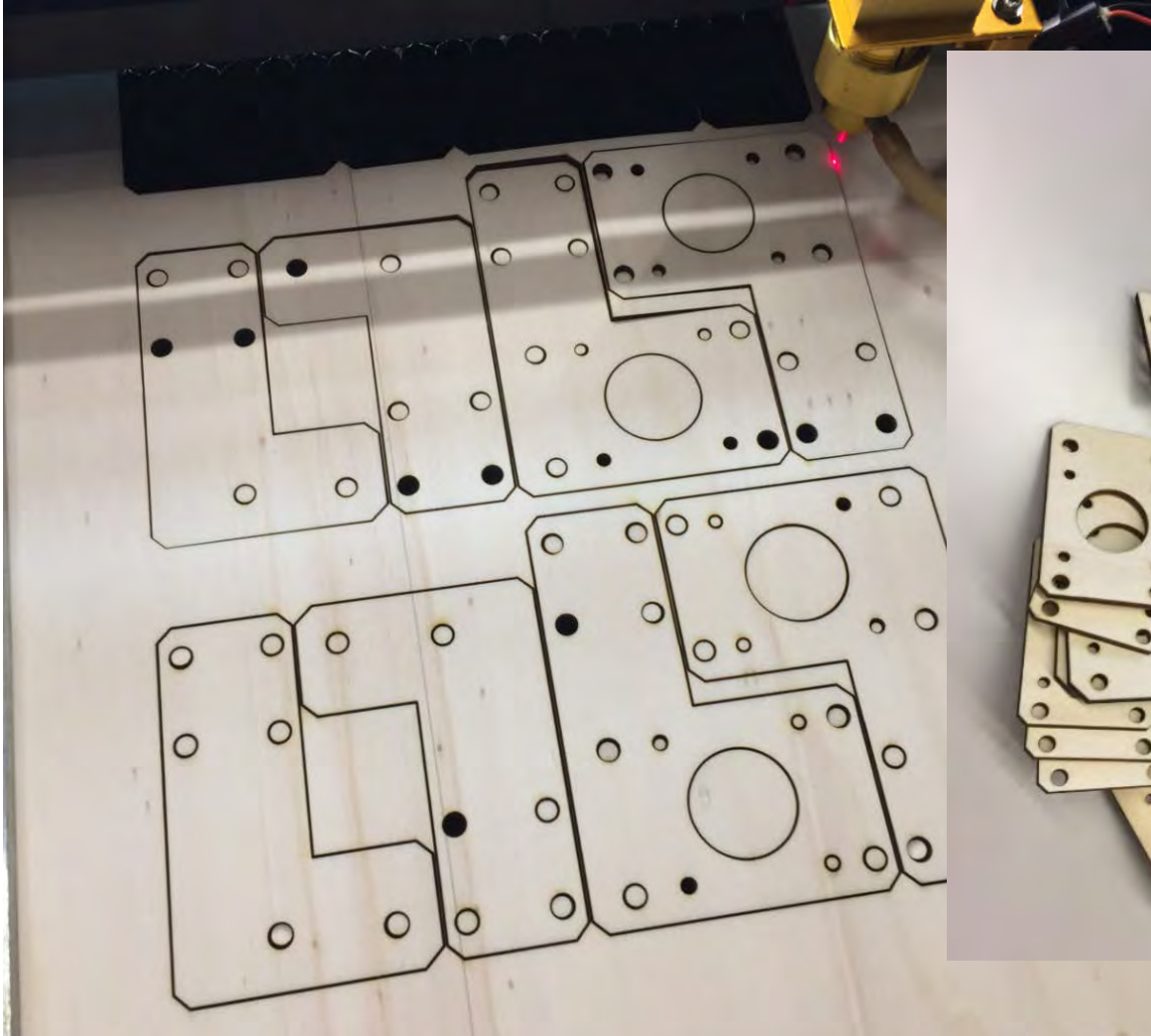


# Rahmen

- Standard 4020 Aluminium Profile
- 12 mm Linearführungen mit 2mm Riemenantrieb



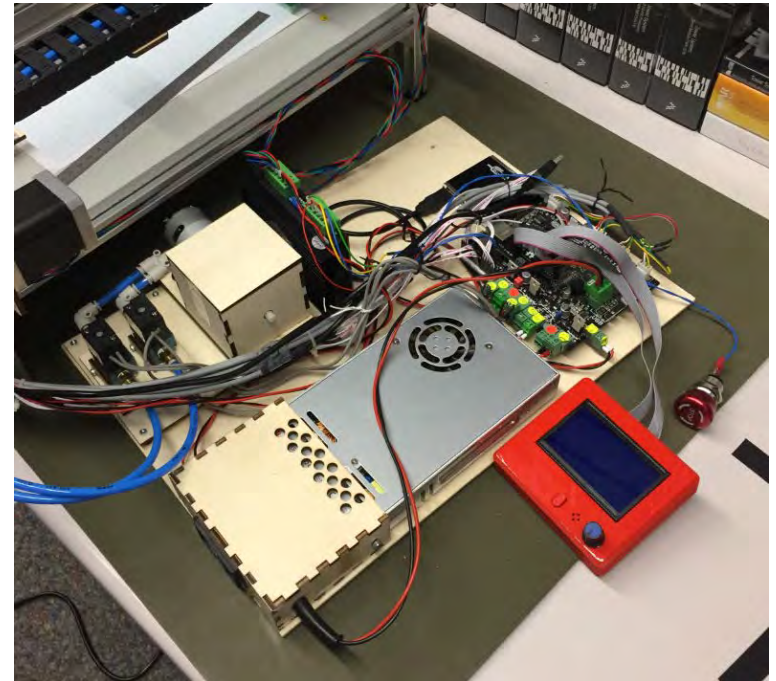
# Prototypen mit Laser Cutter





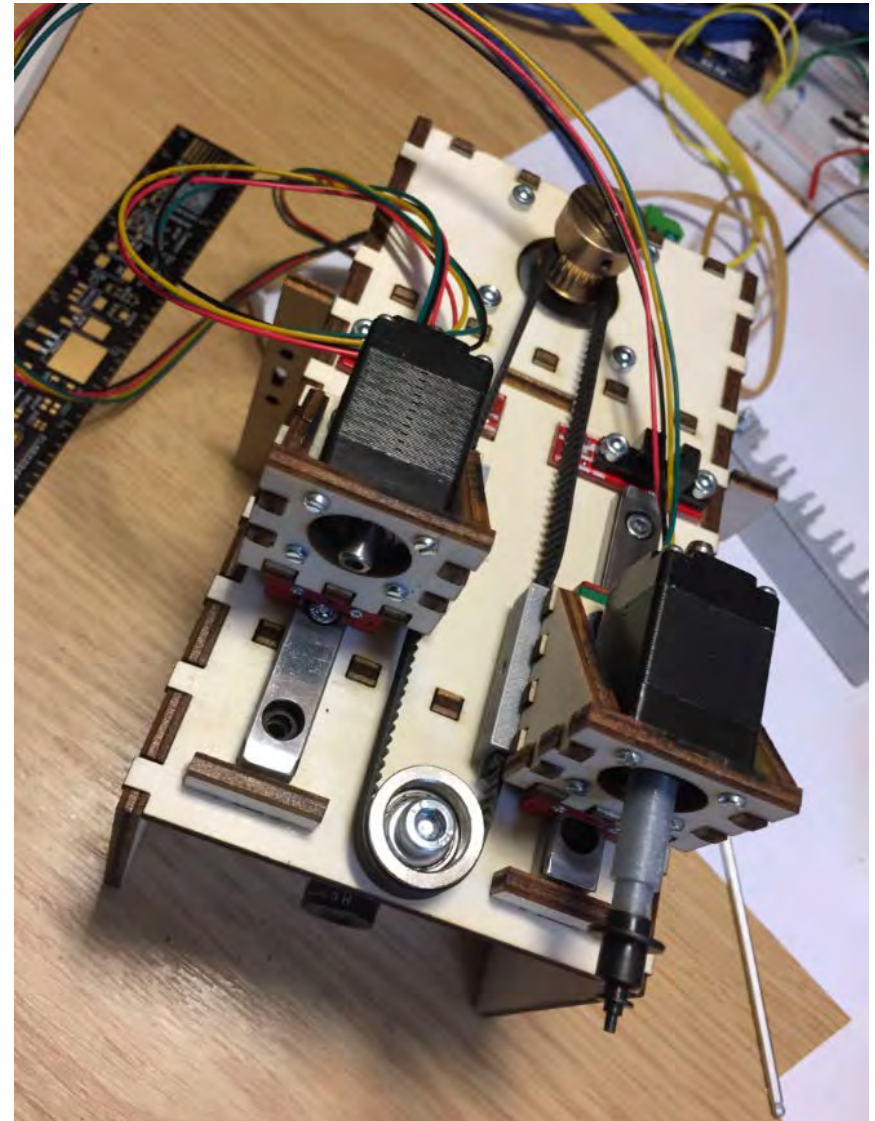
# Elektronik

- 24V Speisung für  
Schrittmotoren
- Smoothieboard (ARM Cortex-M3  
LPC1769)
- <http://smoothieware.org/>
- Grafisches LCD



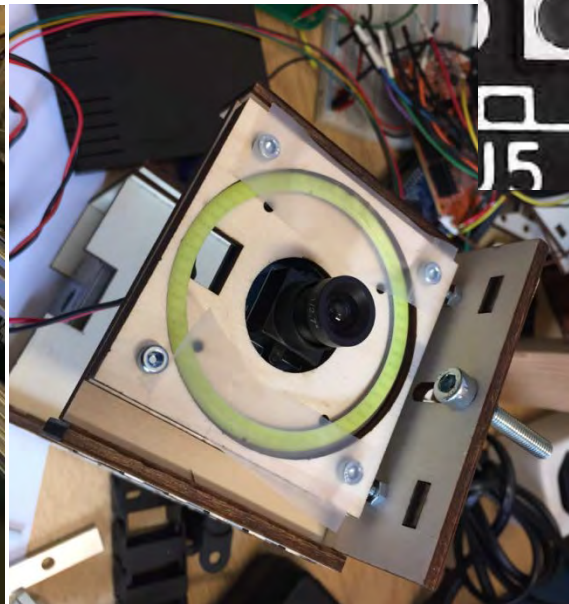
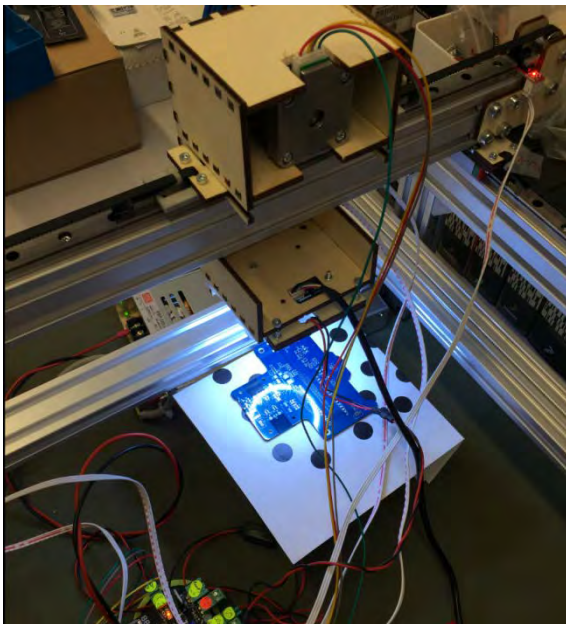
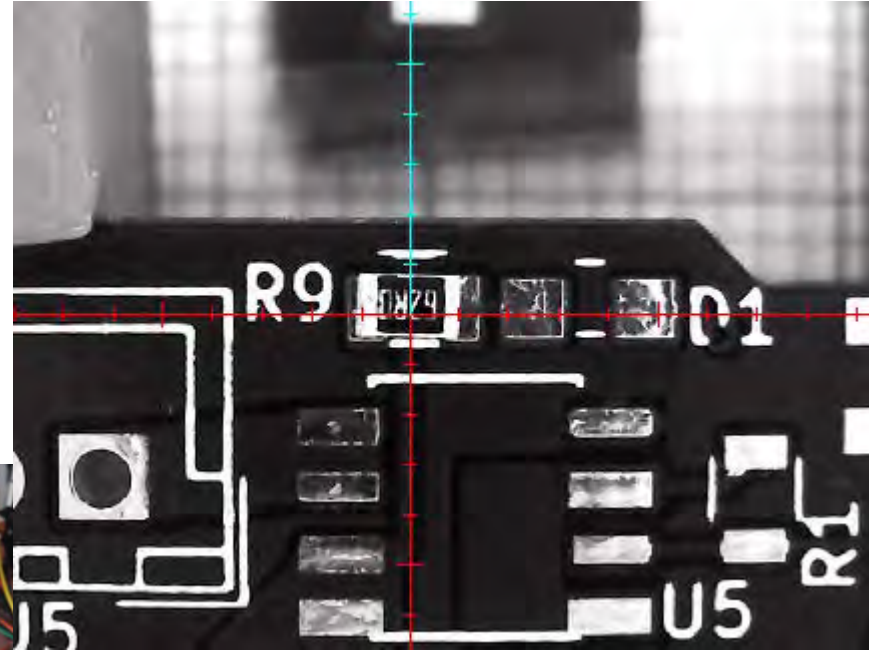
# Bestückungskopf

- Schrittmotor für Z Achse
- Riemenantrieb
- Optische Endstopps
- Linearführungen
- Spezielle Schrittmotoren mit hohler Welle
- C1 und C2 Achse 360° drehbar



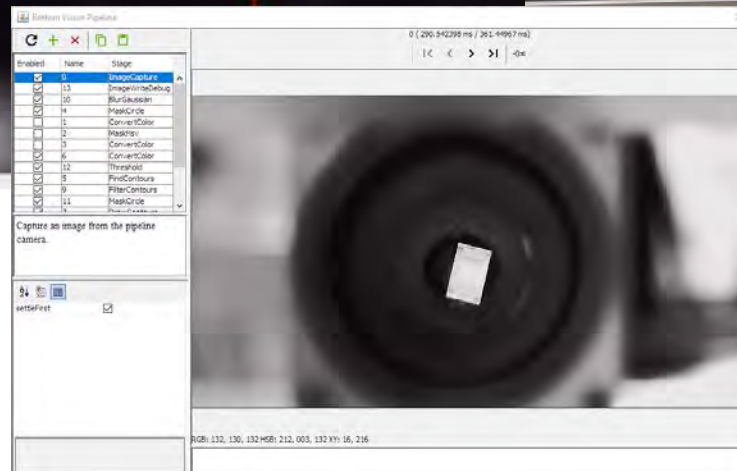
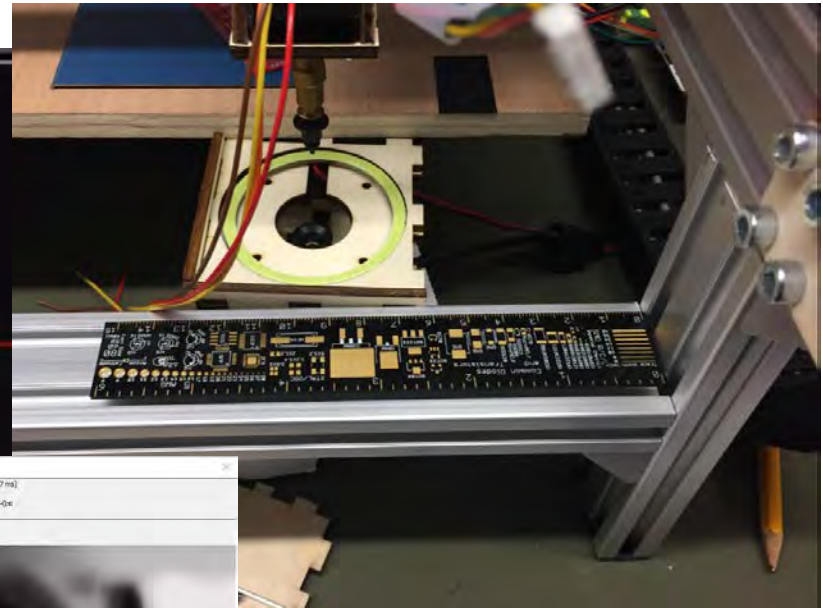
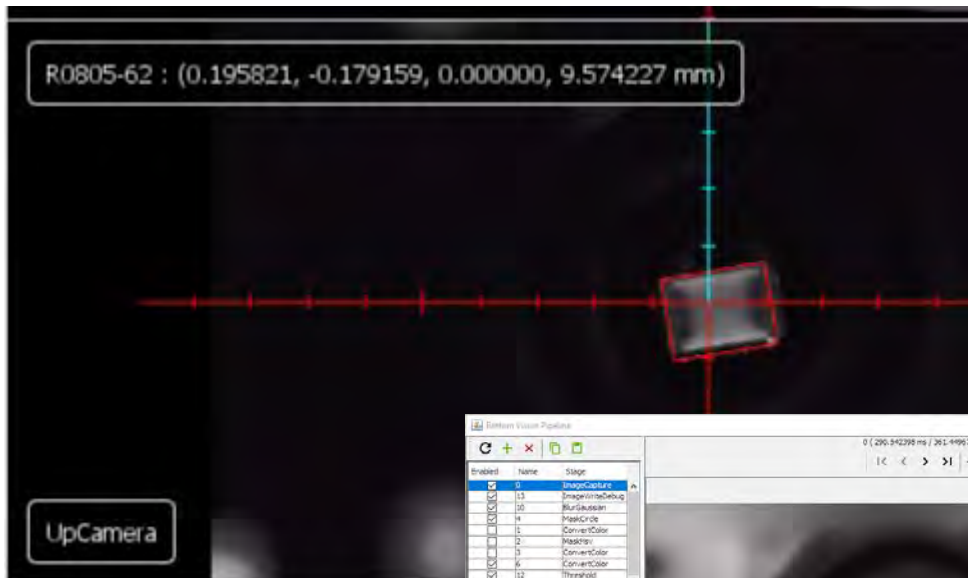
# Head Kamera

- 1M Pixel Kamera
- Erkennen von Bauteilen und Bauteile-Streifen
- Fiducials-Erkennung
- LED Beleuchtungsring



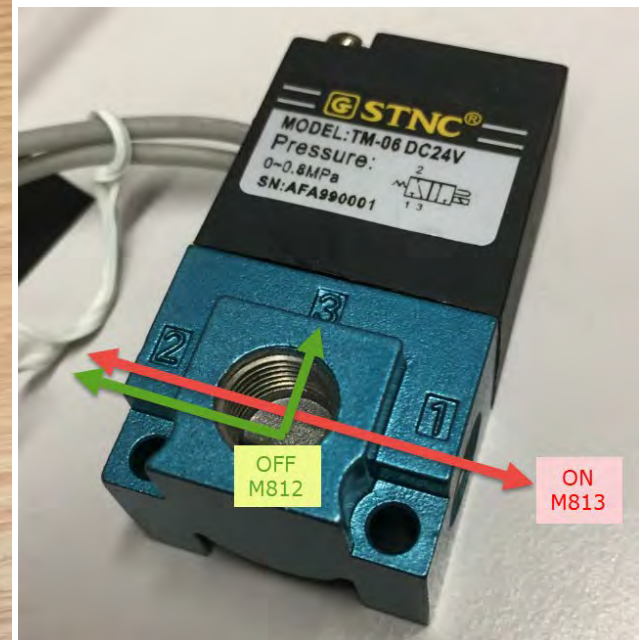
# Bottom Kamera

- Aufgenommene Bauteile werden vermessen
- Winkelkorrektur
- Offsetkorrektur



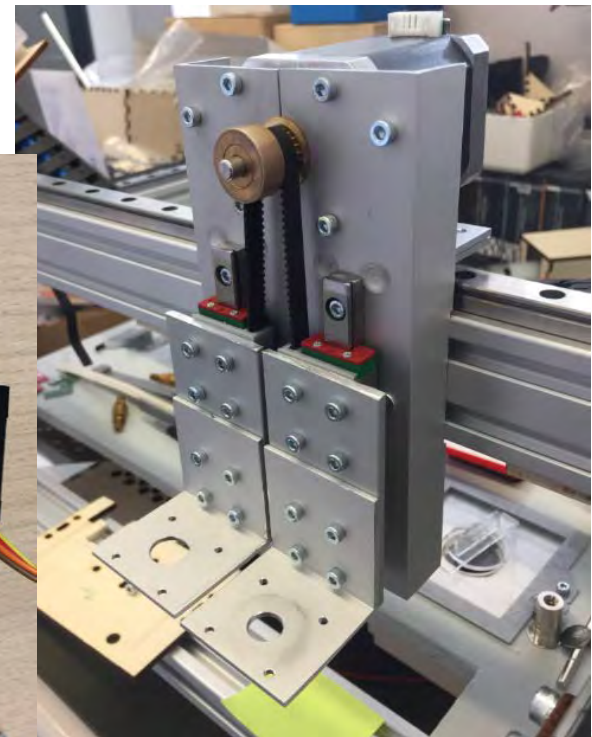
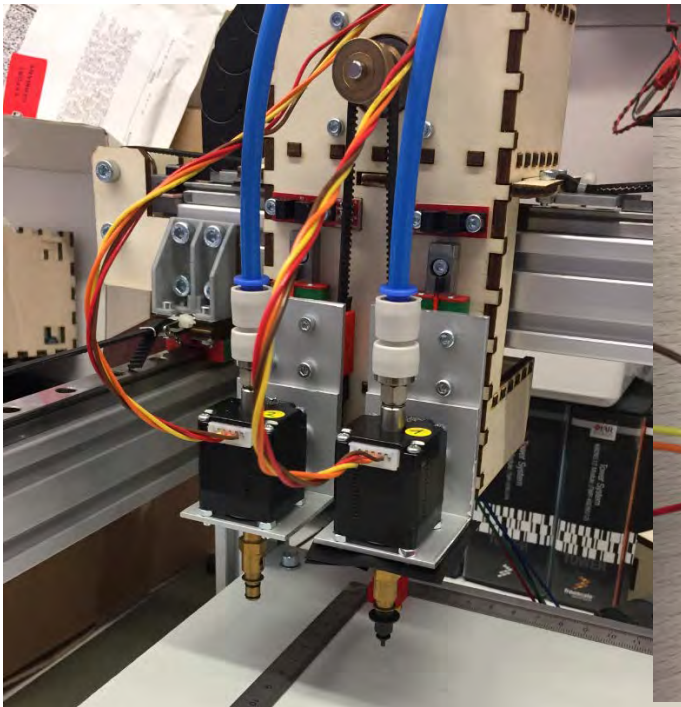
# Pneumatik System

- Diaphragma Unterdruck-Pumpe
- Umschaltventile für C1 & C2



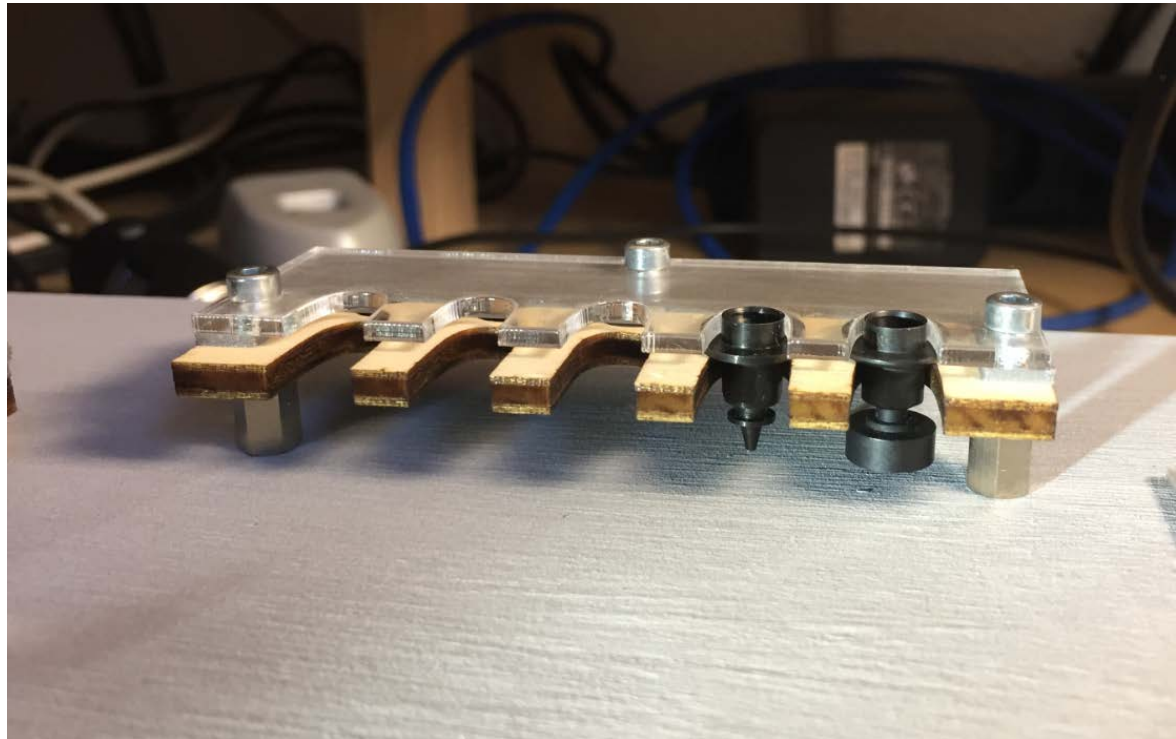
# Dual-Head Bestückungskopf

- Aluminium Profile, verbesserte Stabilität/Genauigkeit
- Hohl-Wellen NEMA11 Schritt-Motoren
- 360° Pneumatik-Kupplungen
- CP40 Düsenwechslerkupplungen



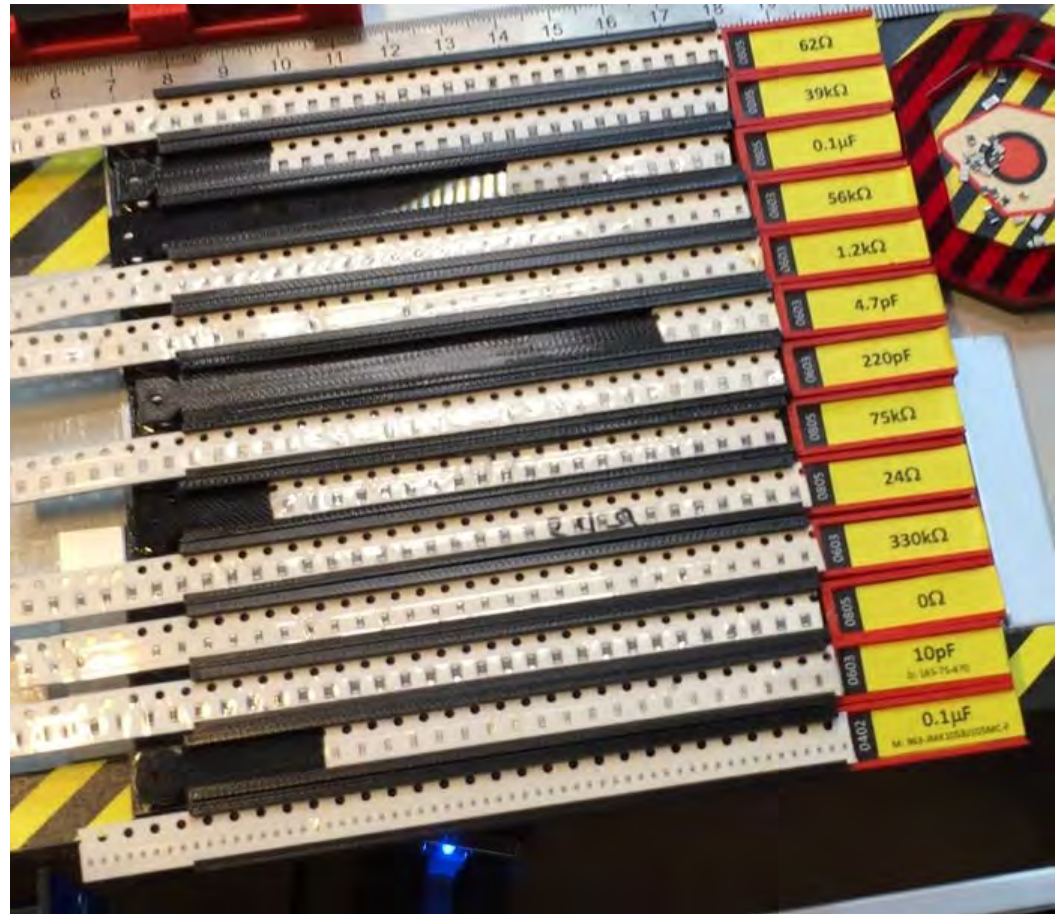
# Düsen Wechsler

- Verschiedene Düsen abhängig von Bauteilgrösse
- Maschine wechselt Düsen automatisch für Bauteile
- Magnete zur Zentrierung der Düsen



# SMT Streifen Halter

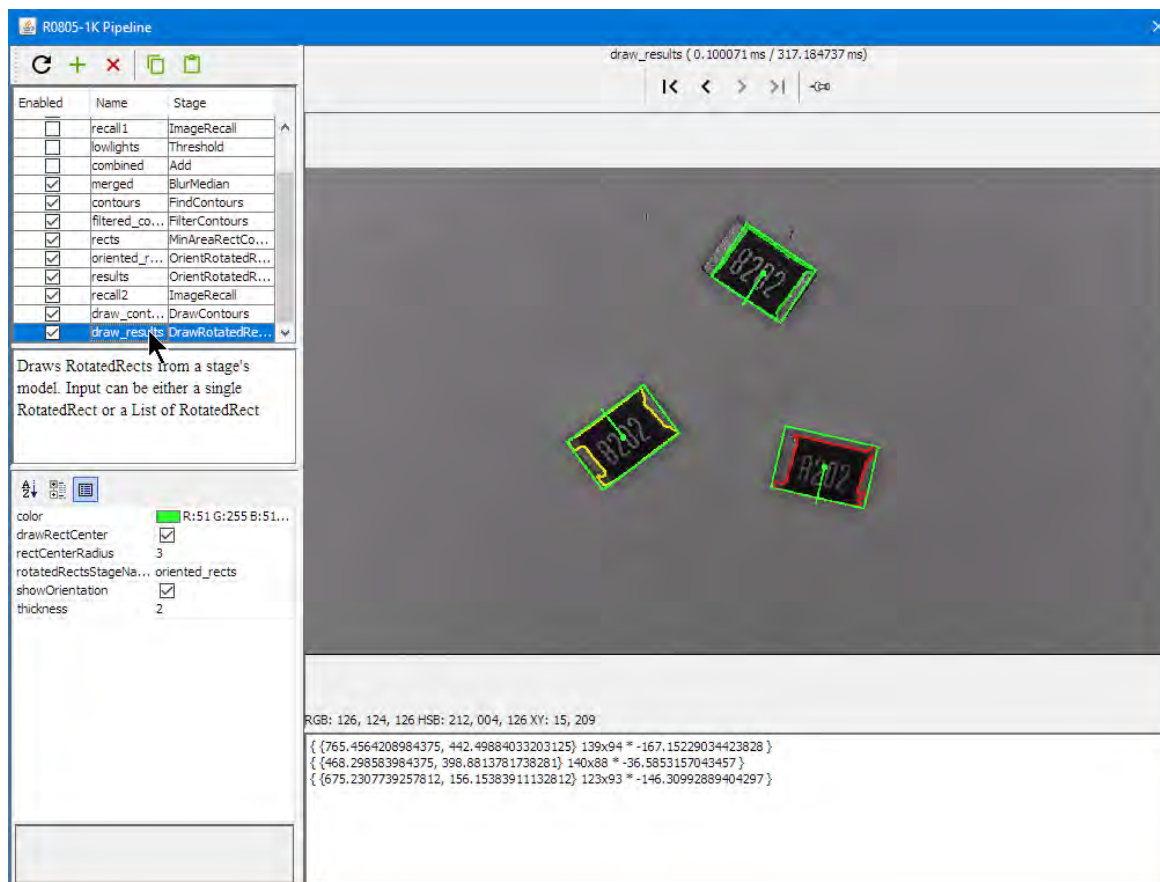
- 3D gedruckt
- Magnete zur Haftung
- einfacher Wechsel





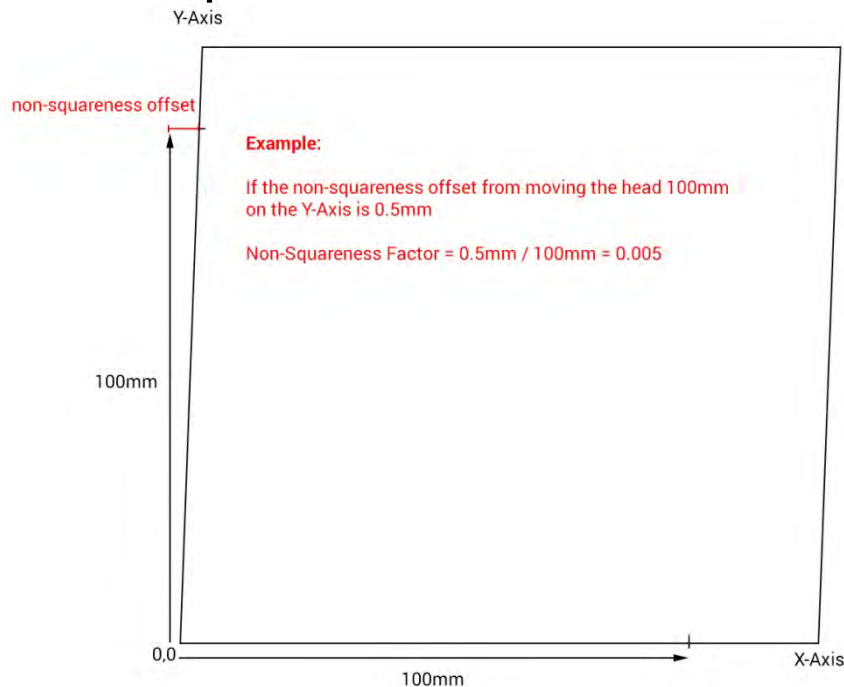
# Lose Bauteile Erkennung

- Kopf Kamera erkennt Bauteile und Orientierung
- Vision Pipeline konfigurierbar mit Footprints



# Genauigkeit

- 0.01 mm Schrittgenauigkeit
- Visual Homing
- Backlash Kompensation
- Non-Squareness Kompensation



Source: [OpenPnP.org](http://OpenPnP.org)

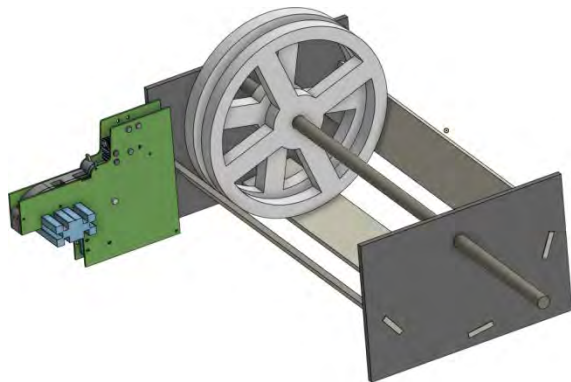
Gcode	General Settings	Console	Serial
Settings			
Command Timeout [ms]	10000	Units	Millimeters
Connect Wait Time [ms]	2000	Max Feed Rate [Units/Min]	10000
Backlash Offset X [Units]	-0.500	Backlash Offset Y [Units]	-0.500
Backlash Feed Rate Factor	0.100	Driver Name	GcodeDriver
Non-Squareness Factor	0.00166	Visual Homing	<input checked="" type="checkbox"/>

```

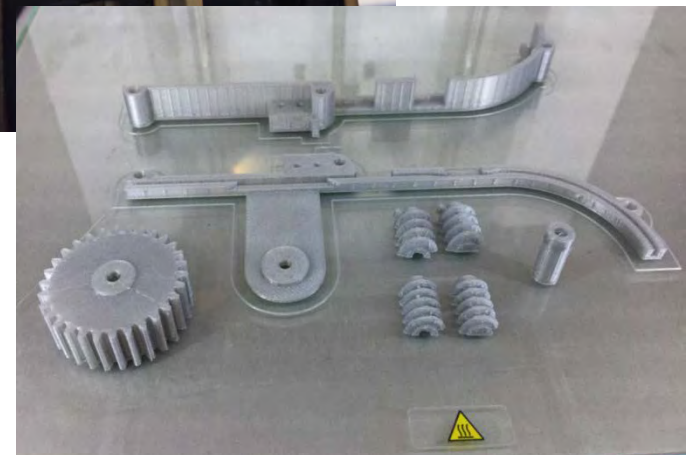
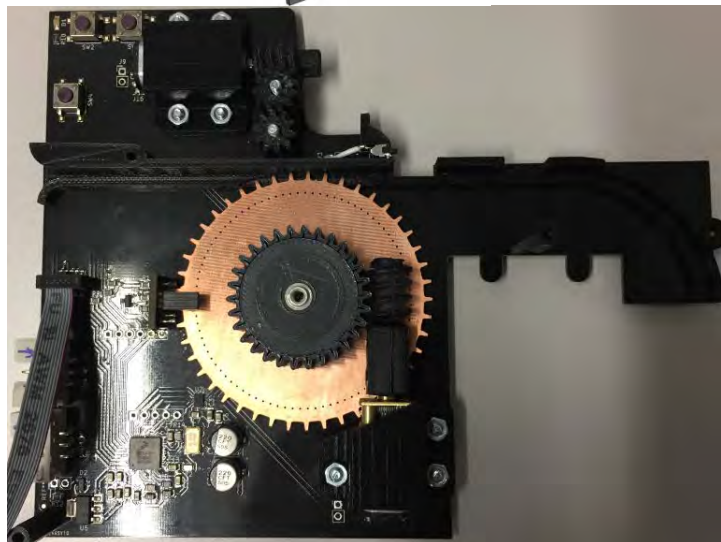
GO { BacklashOffsetX: X%.4f }
{ BacklashOffsetY: Y%.4f } { Z: Z%.4f }
{ Rotation: E%.4f } F{ FeedRate: %.0f } ;
Send standard Gcode move
(MOVE_TO_COMMAND) with Backlash
compensation
GO { X: X%.4f } { Y: Y%.4f } { Z: Z%.4f }
{ Rotation: E%.4f }
F{ BacklashFeedRate: %.0f }
M400 ; Wait for moves to complete before
returning
    
```

# Auto-Feeder

- 8, 12, 16mm Rollen
- 2mm Schritte vor/zurück

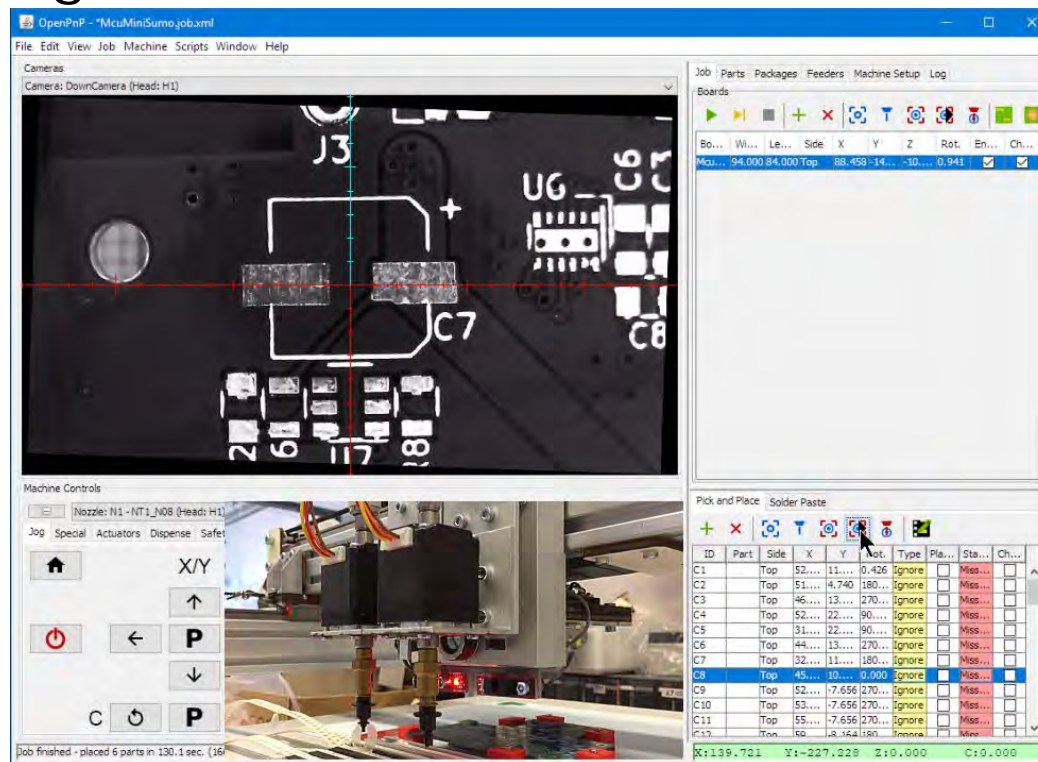


Source:  
PAIND Huber Simon



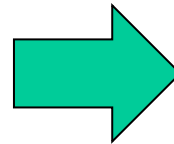
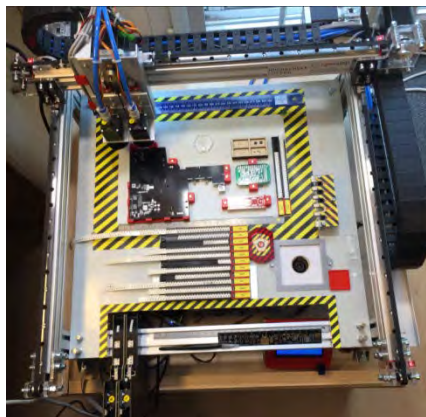
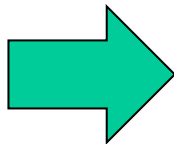
# Software: OpenPnP

- Java, Maschinen-Konfiguration mit XML
- Packages → Parts → Jobs
- Importiert CAD Pos Dateien (Footprint/Teile Position)
- Bestückungs-Job Editor



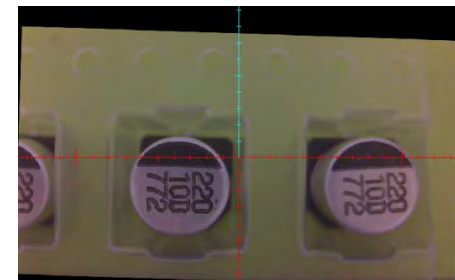
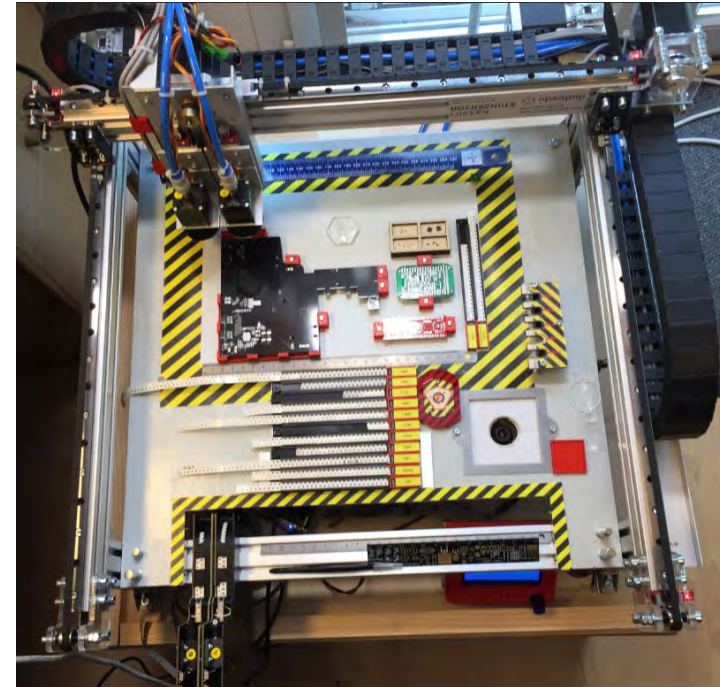
# Ablauf mit OpenPnP

- Bauteile aufsetzen, Job definieren
- Lötpaste auftragen → Schablone
- PnP Job ausführen
- Grosse Bauteile bestücken
- 'Backen' im Reflow Ofen
- Board Testen



# Resultate

- Geschwindigkeit 400-600 cph
- Zuverlässig bis 0402
- Clear-Tape Bauteile → Auto-Feeder
- Bauteile Höhe > 8 mm → manuell bestücken
- Zeitersparnis: Maschine lohnt sich schon ab 1-2 Boards 😊
- Nächste Features
  - Mehr motorisierte Auto-Feeder
  - Lötpaste Dispenser
  - Lose Bauteile mit Vibrationsmotor (flip parts)



# Vielen Dank!

## Besuchen Sie den Stand der Hochschule Luzern



[CC Electronics , erich.styger@hslu.ch](mailto:erich.styger@hslu.ch)

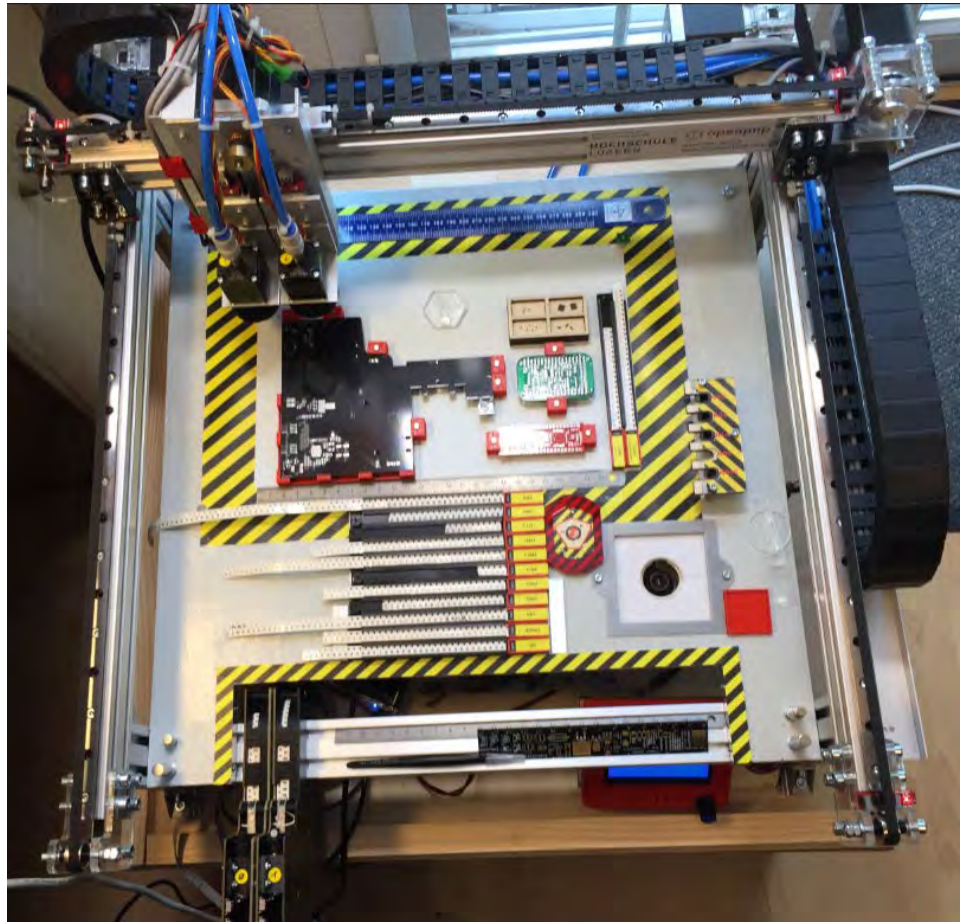
<https://www.hslu.ch/cce>

Blog: <https://mcuoneclipse.com/tag/openpnp/>

**Bewertung/Fragen: [slido.com](https://www.slido.com) – ECC38**

# Open Source Pick & Place Maschine

- Kosten < CHF 1000.—
- Bestückt 300-600 Bauteile/h
- Passives bis 0402
- Dual-Vision System
- Dual-Bestückungskopf mit automatischem Düsenwechsel
- Bauteile: lose, Cut-Tape und motorisierte Feeder
- Importiert Positionsdaten (KiCAD, Eagle, Altium, ...)
- G-Code mit Smoothieboard
- OpenPnP Software



<https://mcuoneclipse.com/tag/openpnp/>