



POLITECNICO
MILANO 1863



Production 4.0 – Teaching Lab at DMecc Advanced Manufacturing Processes

Lab 0 – Guidelines

Exercise sessions

Exercise session

- Practical exercises
- Similar to the questions you will find in the final exam
- In presence in classroom

Laboratory project

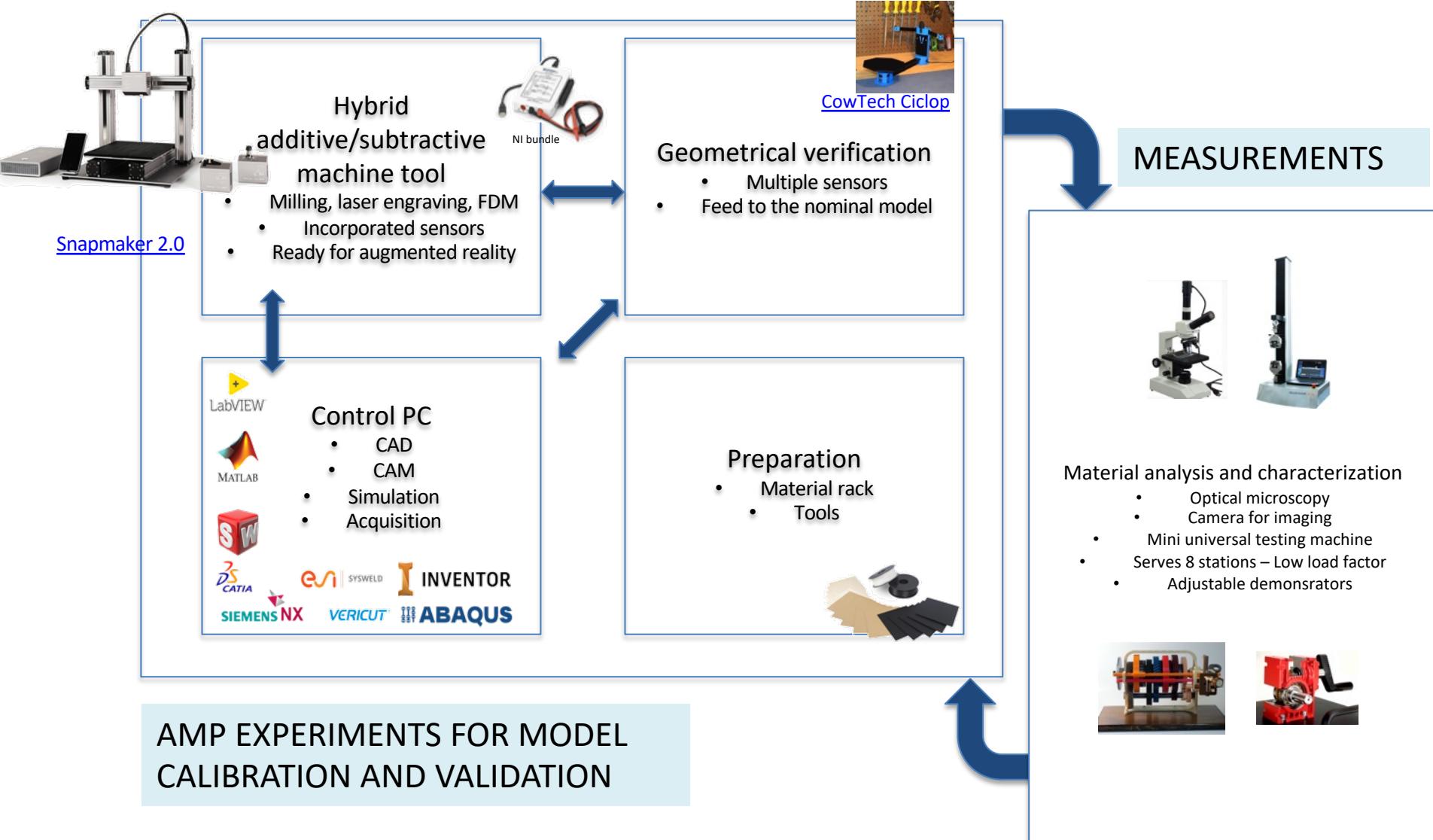
- Optional
- Case study on practical application case
- 4-5 students per group
- Lab revisions during exercise sessions
- Questions on the lab asked during final oral exam
- Further details in the next slides

Research project

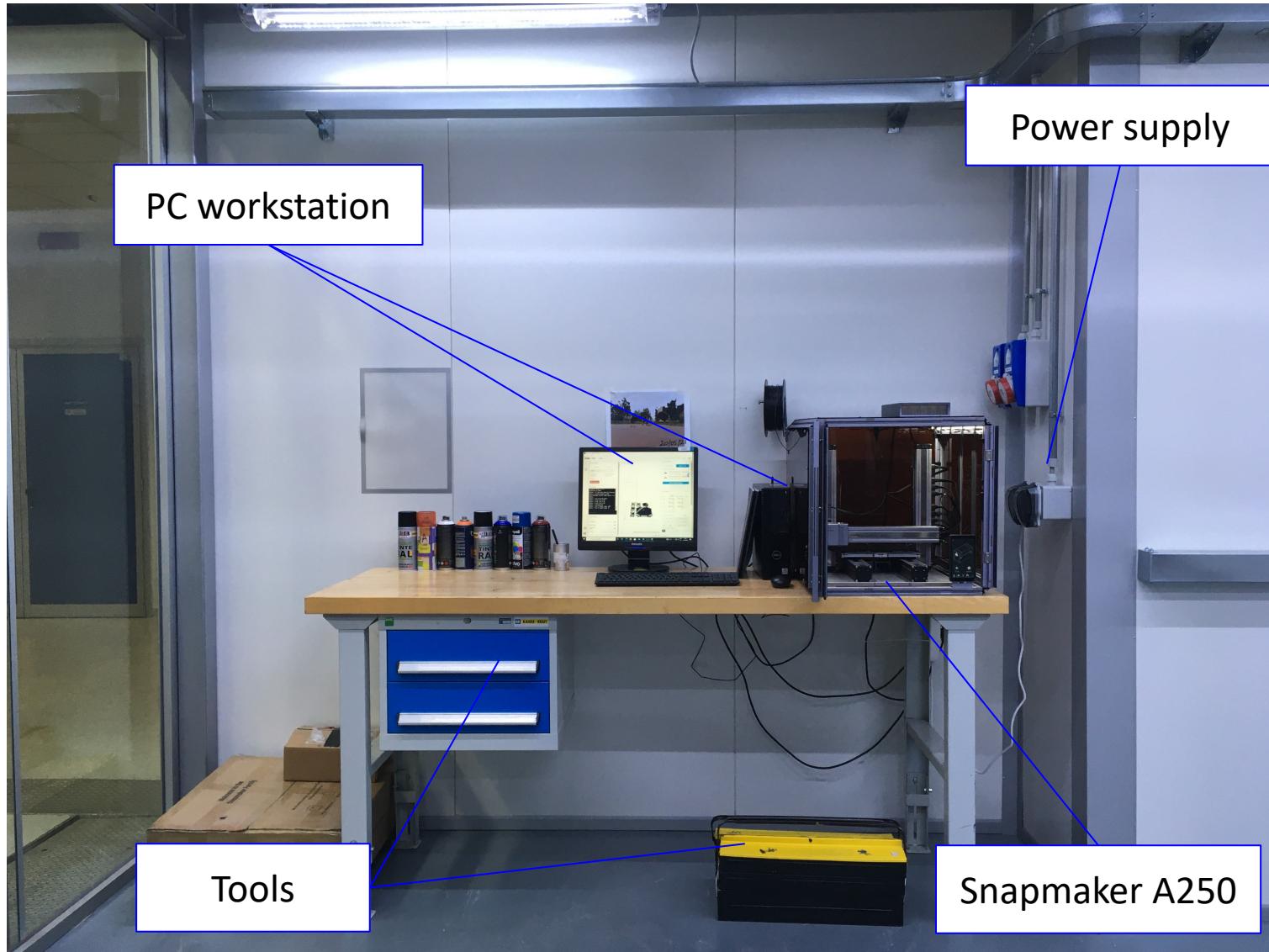
- Optional
- Literature review of specific topics
- 5 students per group (max)
- At home work
- Up to 2 points increment on final grade

If interested write email to:
leonardo.caprio@polimi.it

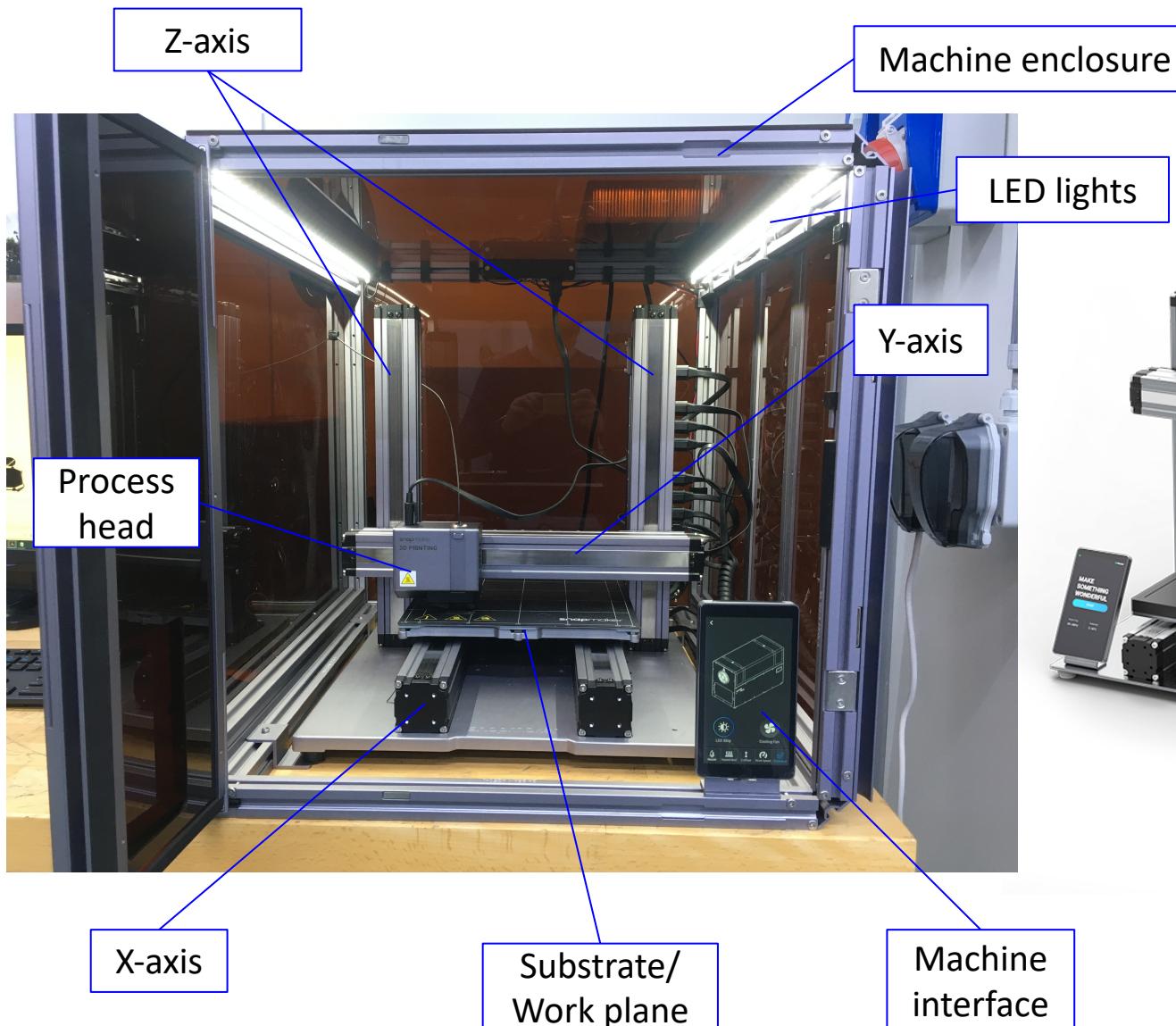
Production 4.0 - Teaching lab at DMecc



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Production 4.0 – Teaching lab at DMecc

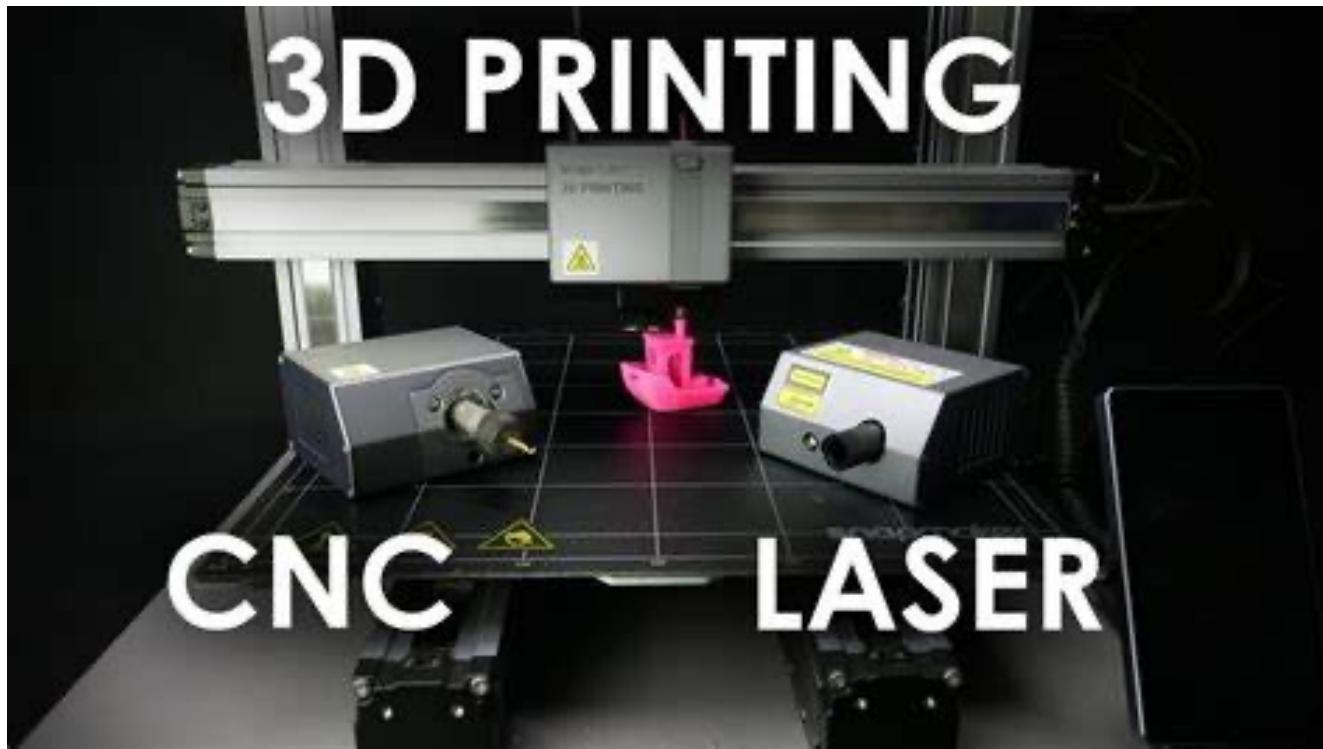


Snapmaker A250

Production 4.0 – Teaching lab at DMecc

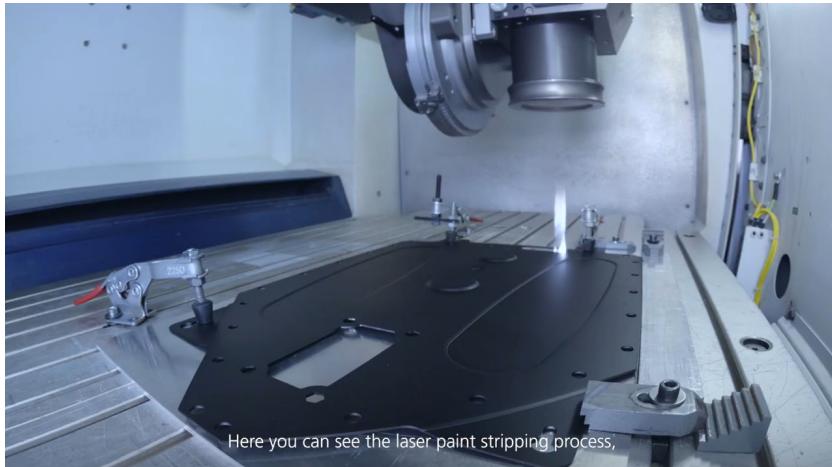
Interchangeable process-head & work plane for:

- 3D Printing (FDM)
- CNC machining
- Laser engraving



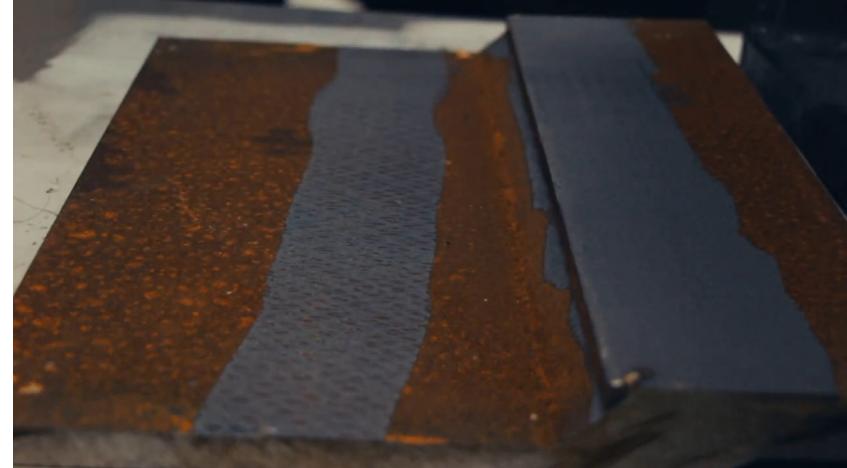
Industrial examples of laser stripping applications

Robotized systems with remote scan head



Courtesy of TRUMPF

Hand-held systems



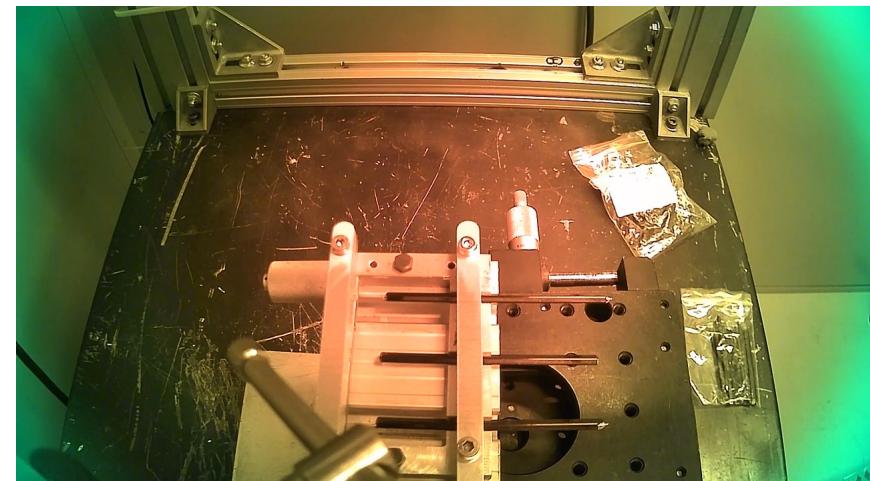
Polymeric coating removal of copper windings for e-mobility



Courtesy of ATOP



Courtesy of TRUMPF



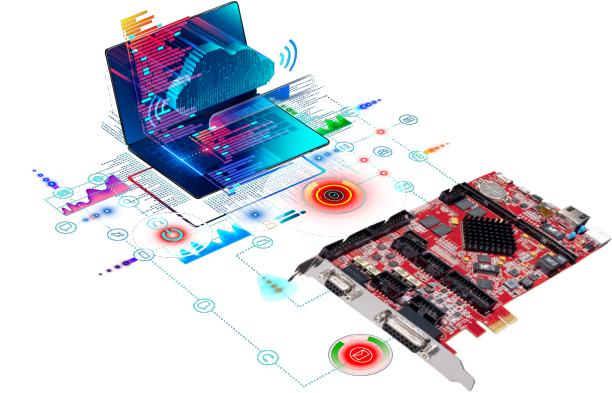
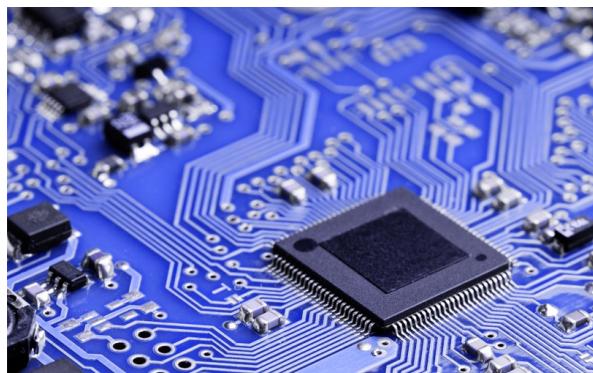
Hairpin stripping @POLIMI

On-demand manufacturing of custom PCB boards

Examples of PCB boards



[PCB Marking - Control Micro Systems \(cmslaser.com\)](http://PCB Marking - Control Micro Systems (cmslaser.com))



PCB prototyping process

25 µm Cu coating over
FR-4 fiber glass

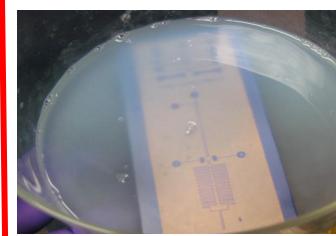
Paint coating
over Cu coating



Selective laser stripping



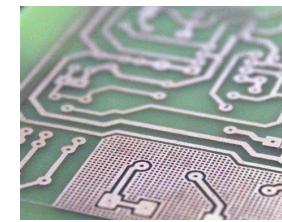
Selective chemical etching



Chemical washing



Final product:
PCB card

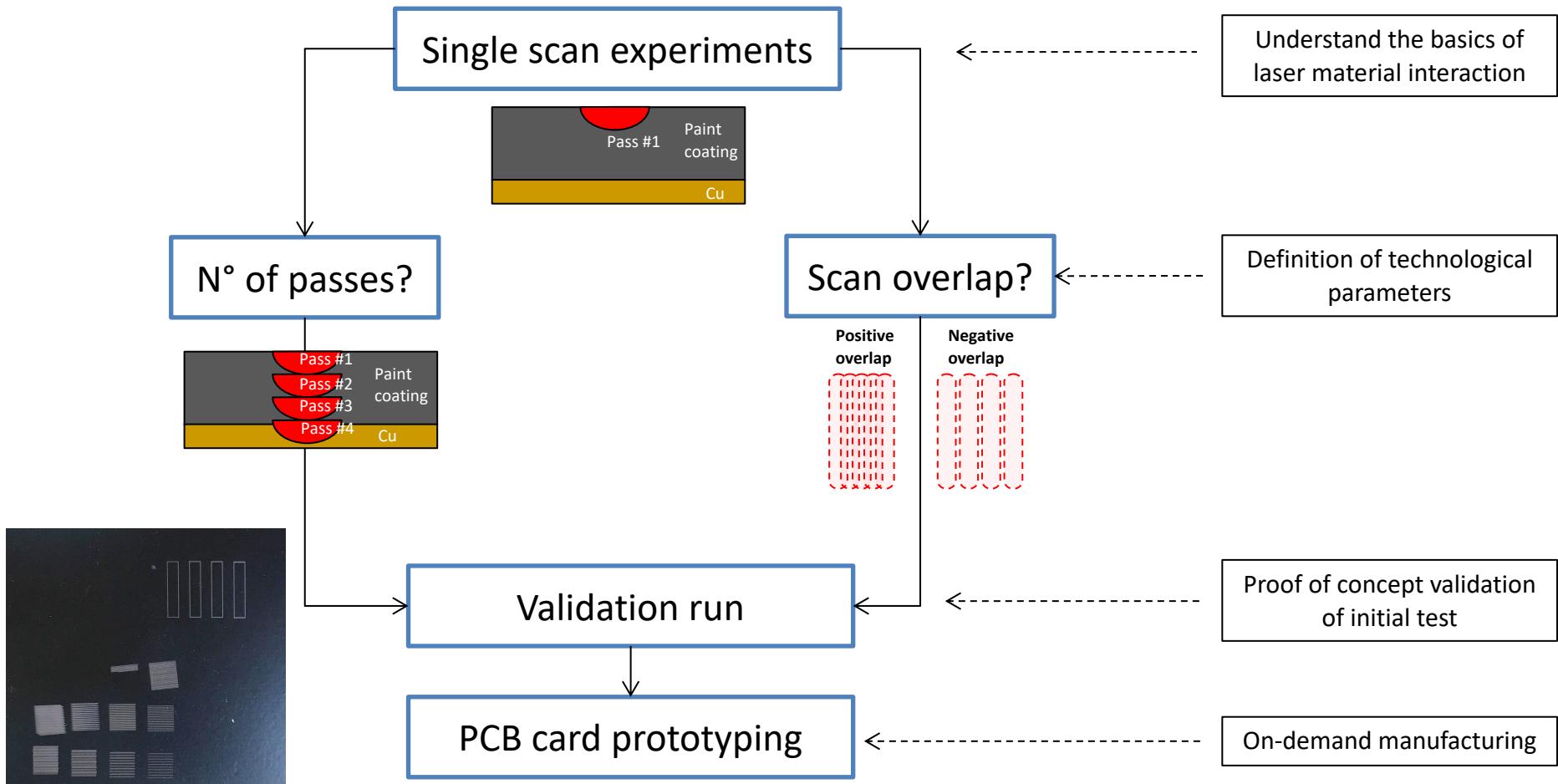


- Hands on lab experience
- Learning by doing
- Theoretical basis
- Technological perspective

On-demand manufacturing of custom PCB boards

Aim of the project:

Design the manufacturing process for custom PCB board production

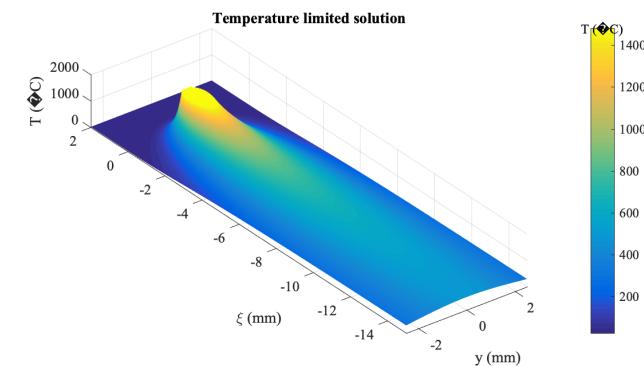
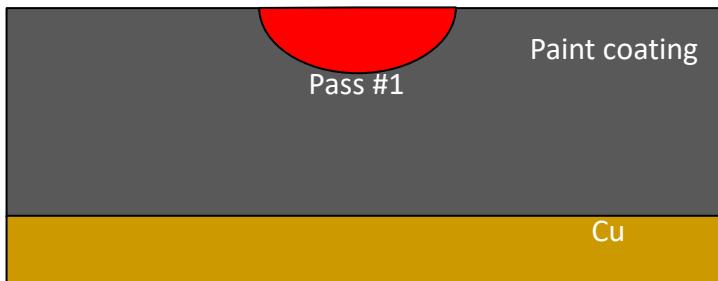


On-demand manufacturing of custom PCB boards

N° of passes?



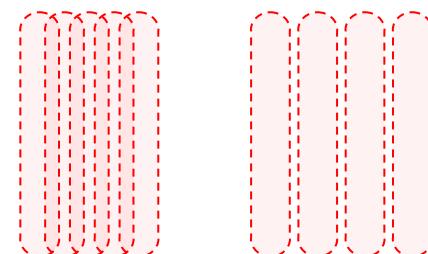
Use and calibrate analytical thermal model to evaluate n° of passes based on Temperature distribution



Overlap?

Use microscope measurements to determine optimal overlap to achieve full hatching & no residual left-overs

Positive overlap Negative overlap



Scheduling of laboratory activities

Lab 0 – Guidelines

- Introduction to lab Production 4.0
- Presentation of lab set up
- Presentation of case study

Today

Lab 1 – Revision 1

- Moving heat source theory
- Implementation of thermal model in MATLAB
- Experimental data provided for efficiency calibration

27th September

28th September

Deadline for group registration

Lab 2 – Revision 2

- Revision of MATLAB code
- Definition of process parameters
- Gcode generation for final component manufacturing

25th October

Lab 3 – Revision 3

- Revision of manufactured workpieces
- Critical project considerations and comments

3rd December

31st December

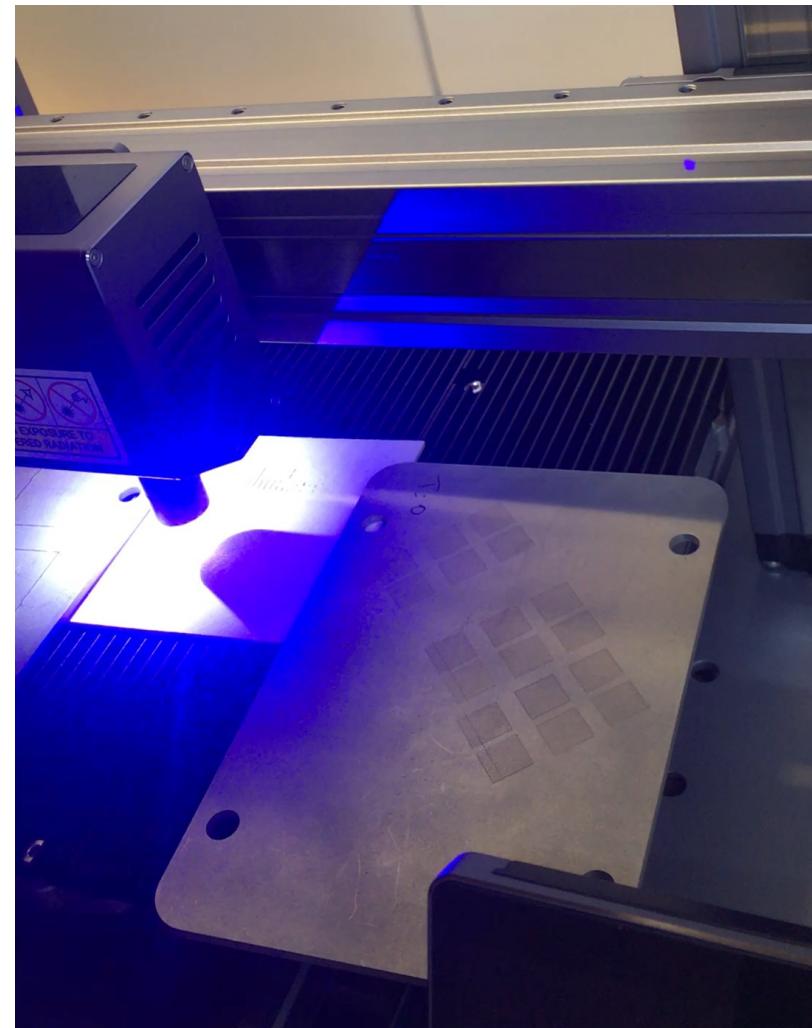
Forms hand-in for lab work evaluation

On-demand manufacturing of custom PCB boards

How to participate:

1. Choose your group
2. Choose your colour
3. Before **28th September** send registration form to:

leonardo.caprio@polimi.it



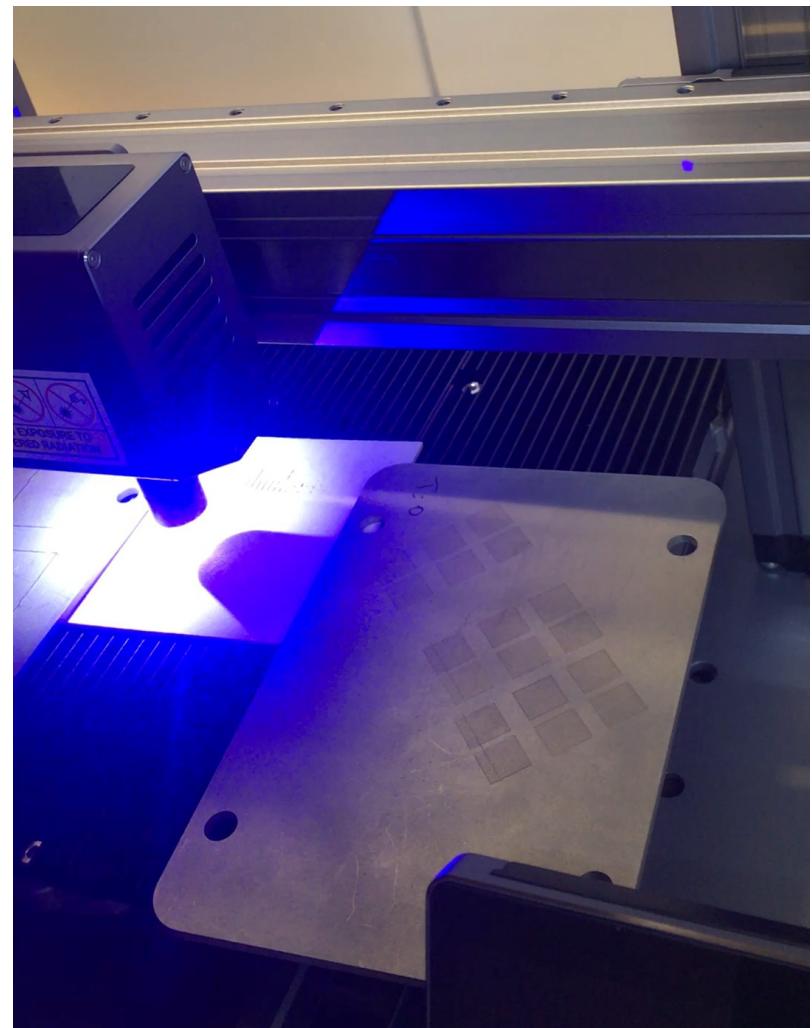
On-demand manufacturing of custom PCB boards

REGISTRATION FORM

- Form available on WeBeep
- 4/5 people per group
- 1 registration form per group
- Naming of the registration form should be as follows:

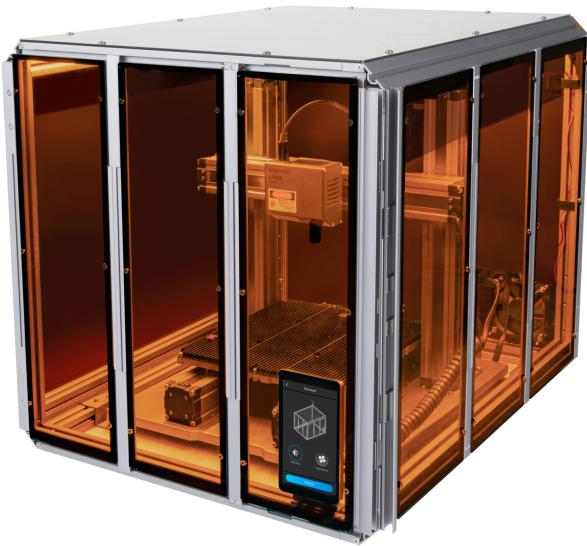
NameOfGroup.docx

- Send file in .docx format to:
leonardo.caprio@polimi.it



Thermal model

Experimental set up



Parameter	Value
Max. Power, P_{max} (mW)	1600
Emission wavelength, λ (nm)	445
Beam waist diameter, d_0 (μm)	150
Work area [X*Y*Z] (mm)	230x250x235
Focus position, f (mm)	Variable
Laser classification	Class 4

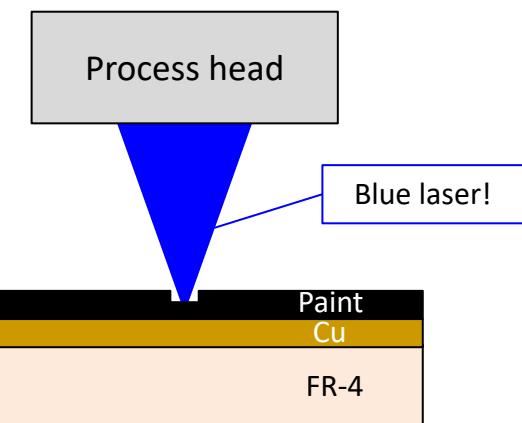
Certified enclosure required

Materials

Copper laminated FR-4

+

Paint coating



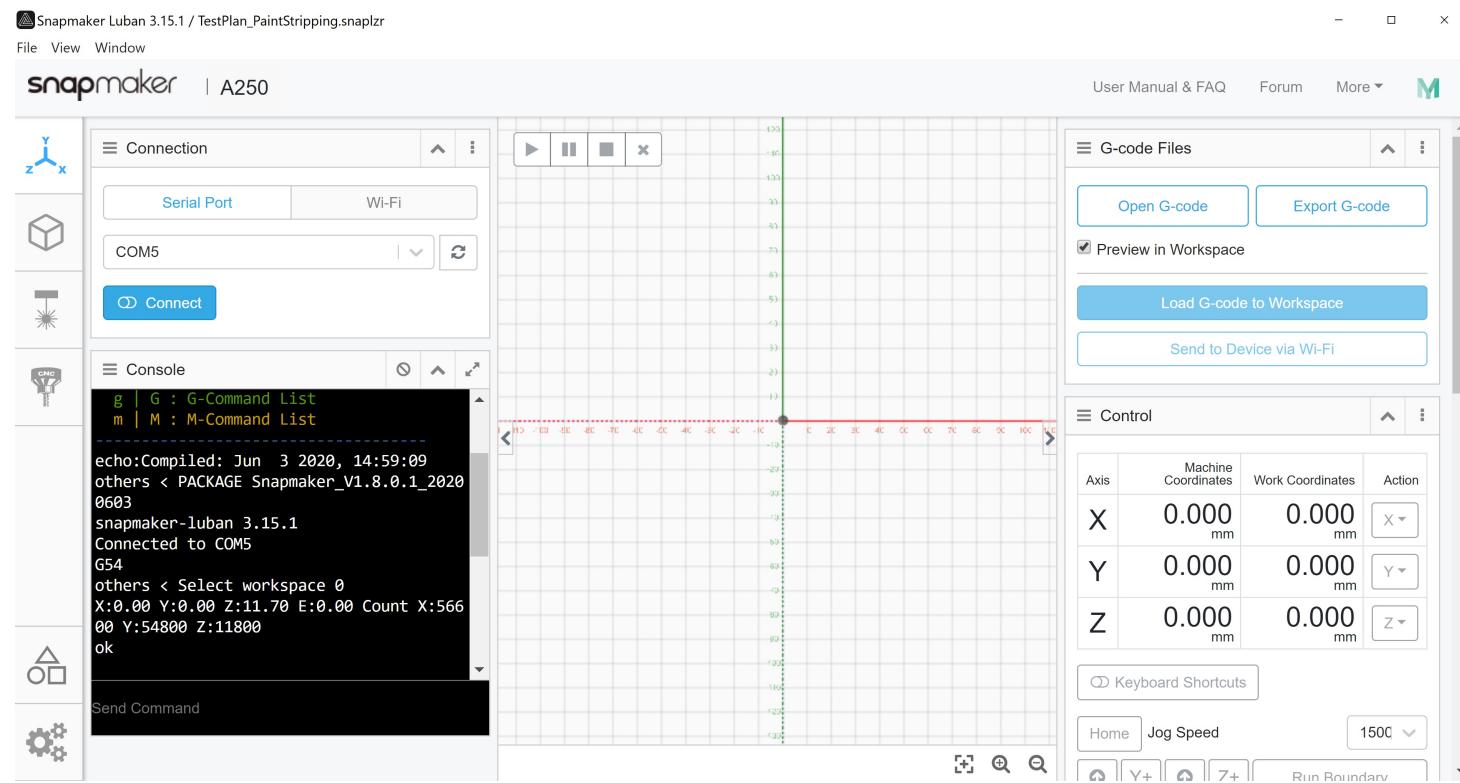
On-demand manufacturing of custom PCB boards

CAM software – Snapmaker Luban

Download link: [Snapmaker 2.0 – Downloads – Snapmaker](#)

Gcode generation for:

- 3D Printing (FDM)
- CNC machining
- Laser engraving



Contact details



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