POLITECNICO
MILANO 1863

mecc
DIPARTIMENTO DI ECCELLENZA
MIUR 2018-2022

Production 4.0 – Teaching Lab at DMecc
Advanced Manufacturing Processes

Lab 03 – Revision 3

Scheduling of laboratory activites

Lab 0 – Guidelines -- Today
- Introduction to lab Production 4.0
- Presentation of lab set up
- Presentation of case study

Lab 1 – Revision 1 -- 27th September

- Moving heat source theory   28th September -------- Deadline for group registration
- Implementation of thermal model in MATLAB
- Experimental data provided for efficiency calibration

Lab 2 – Revision 2 -- 26th October
- Revision of MATLAB code
- Definition of process parameters
- Gcode generation for testing optimised process parameters

Lab 3 – Revision 3 -- 10th December
- Revision of manufactured workpieces
- Critical project considerations and comments

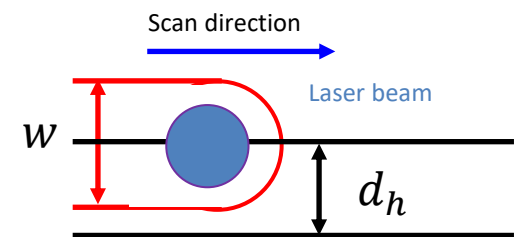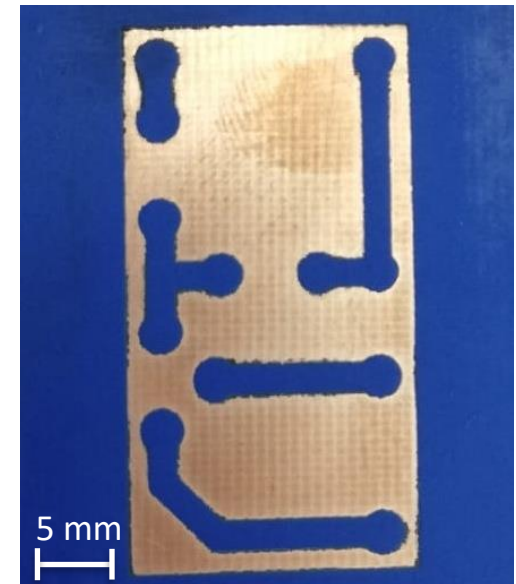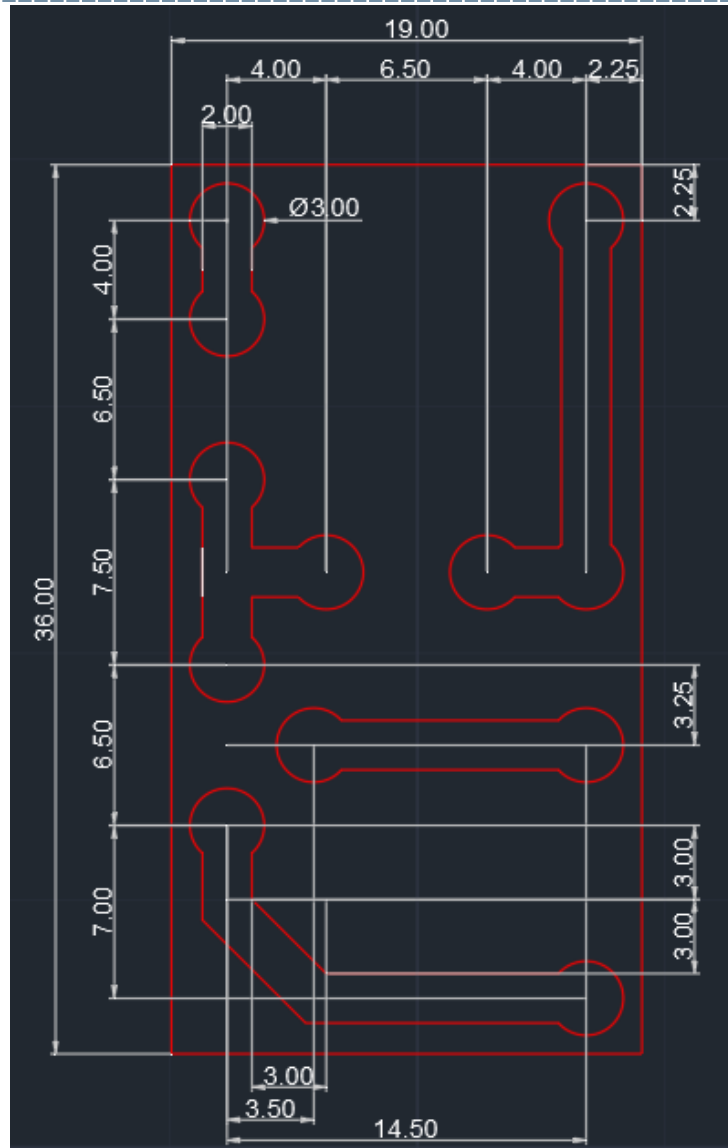31st December -------- Forms hand-in for lab work evaluation

AUTOCAD

- The drawing shows the nominal dimensions
- The final dimensions will involve the track width and hathing
- All dimensions can be corrected by the following simplified expression

$$l = l_n + 2d_h - w$$

5 mm

Scan direction

Laser beam

w

d_h

— Track extension
— Scan line (hatch line)

Your process parameters

Fixed factors	
Power, P (mW)	1600
Emission wavelength, λ (nm)	445
Focus position, f (mm)	0
Feed rate, v (mm/min)	800
Variable factors	
Paint Colour	Group's choice
Hatch distance, d_h (mm)	From simulation
Number of passes, N	From simulation

Number of groups per colour

Blue	16
Red	5
Black	4
White	2

Group no	Name	Colour	d_h (mm)	N
1	ADDRS	Blue	0.08	4
2	UESA-Manufacturing	Blue	0.105	4
3	Leimen	Red	0.102	5
4	Metallica	Red	0.1	3
5	ABBA	Blue	n/a	n/a
6	Team Blu	Blue	0.127	4
7	Eng5.23.16	Blue	0.032	4
8	Team zero	Black	0.095	3
9	Plugs and Melt	Red	0.134	4
10	PlickinTeam	Blue	0.12344	4
11	2211	Blue	0.127	4
12	ESASM	Blue	0.13	4
13	Keraunos	Blue	0.08	3
14	Copper Experience	Red	0.08	4
15	McAnica	Blue	0.122	4
16	AFFE	Blue	0.123	4
17	CARDANO	Blue	0.061	3
18	Syria	Red	0.1	4
19	Random	Blue	0.1279	4
20	The dark side of the mill	Blue	0.059	2
21	M&G	Black	0.14	3
22	Los Pollos Hermanos	Black	0.1652625	3
23	Lasercraft	White	0.06	4
24	Martin	Black	0.102	3
25	MatMecTeam	Blue	0.1135	4
26	LAG	Blue	0.123	4
27	5eng	White	0.076	3

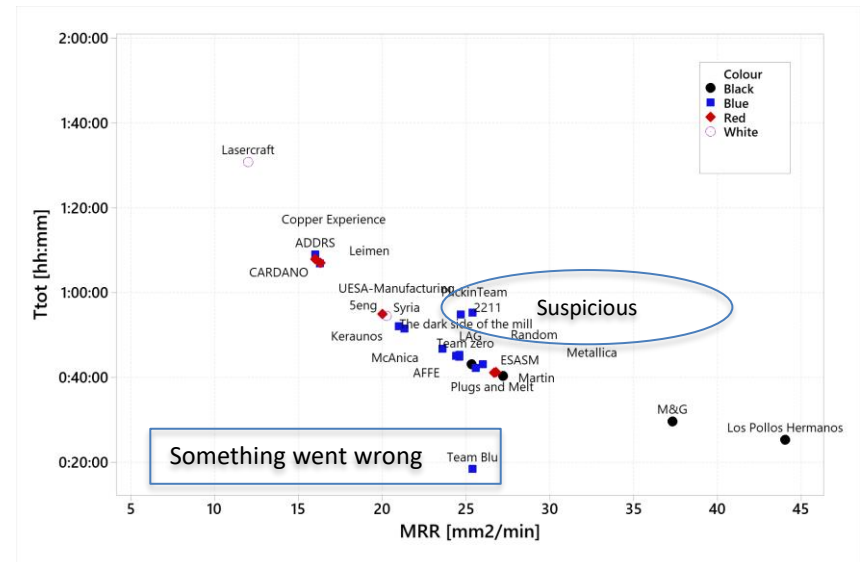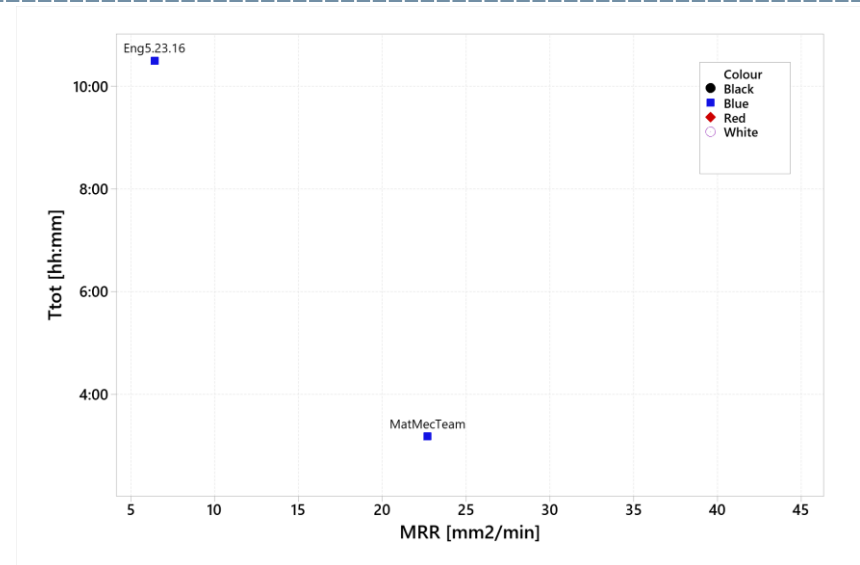20 mm
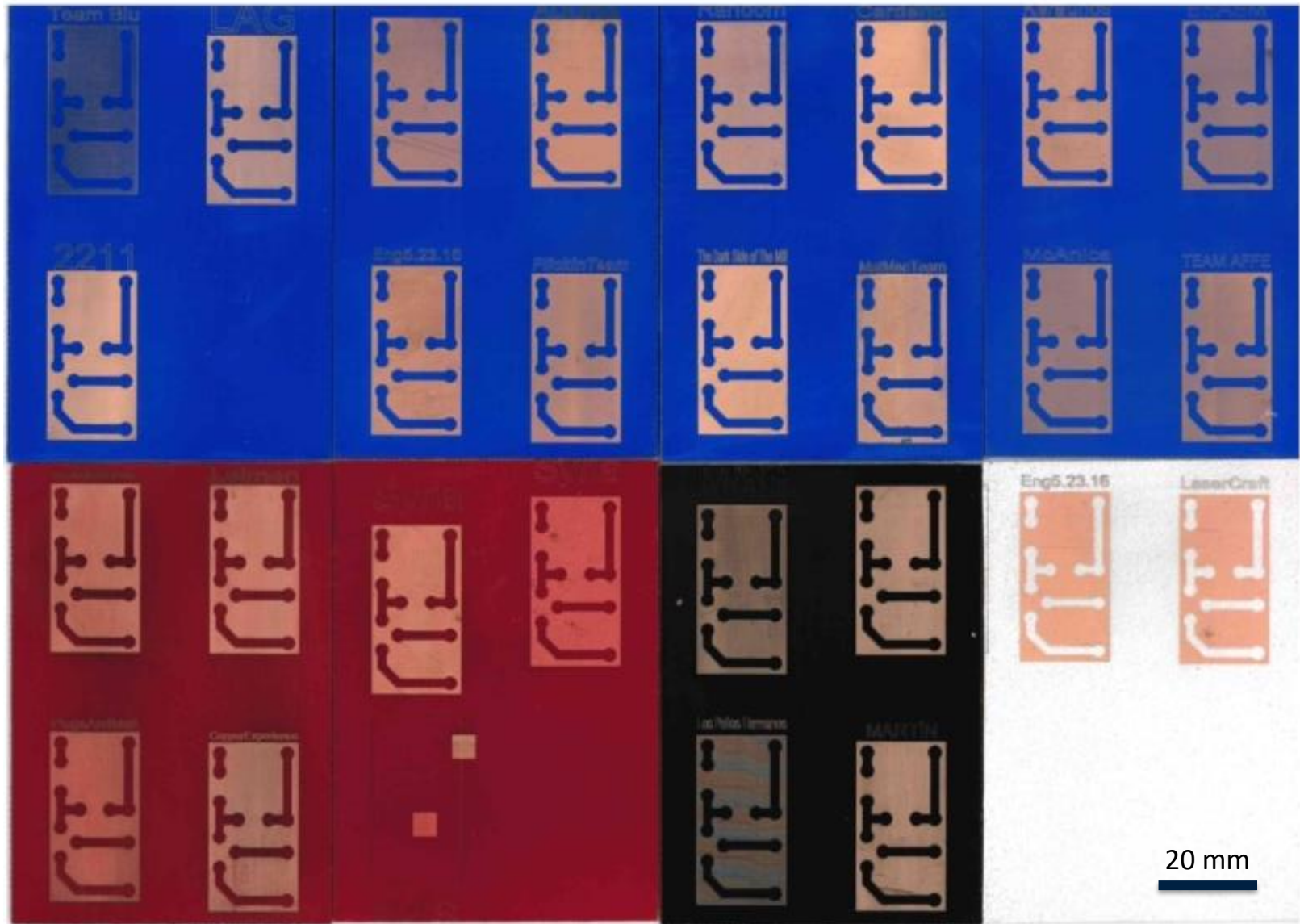
Do the parameters follow the expected trend?

$$MRR = vh/N$$
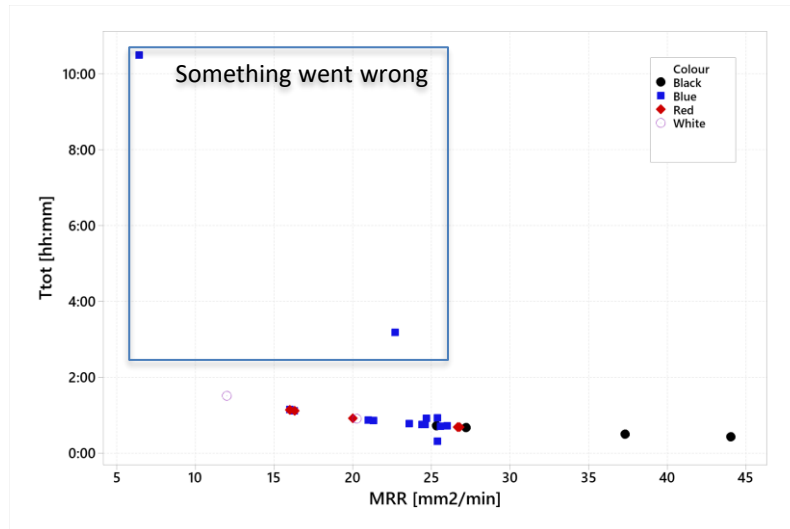
- Overall the trend is clear
- Outliers present
- Producvity should be evaluated with quality

A qualitative assessment

Categorical analysis based on visiual inspection applicable to all colours

3- Good	2- Fair	1- Poor

- Paint removed completely
- Copper exposed

- Some paint remained
- Copper exposed enough

- Incomplete removal
- Not feasible for further processing

POLITECNICO MILANO 1863

Overall outcomes

- Acceptable limit at 20' process time
- Black is the fastest
- For the best finish at last 40'
- Wrong parameters – Extremely slow process
- Experiments require a good deal of attention
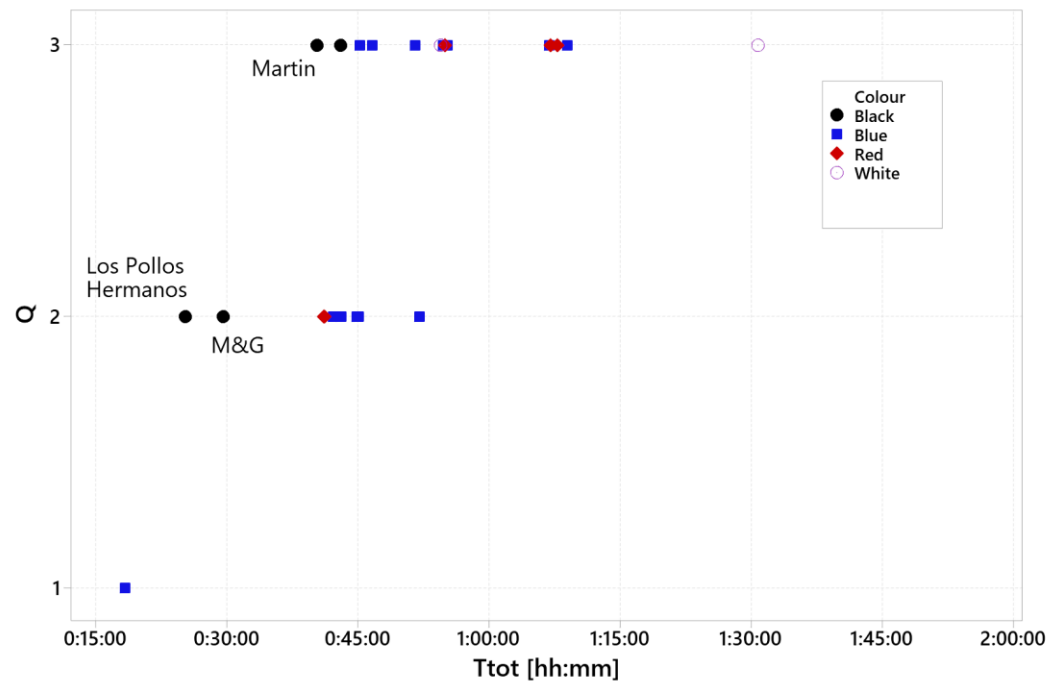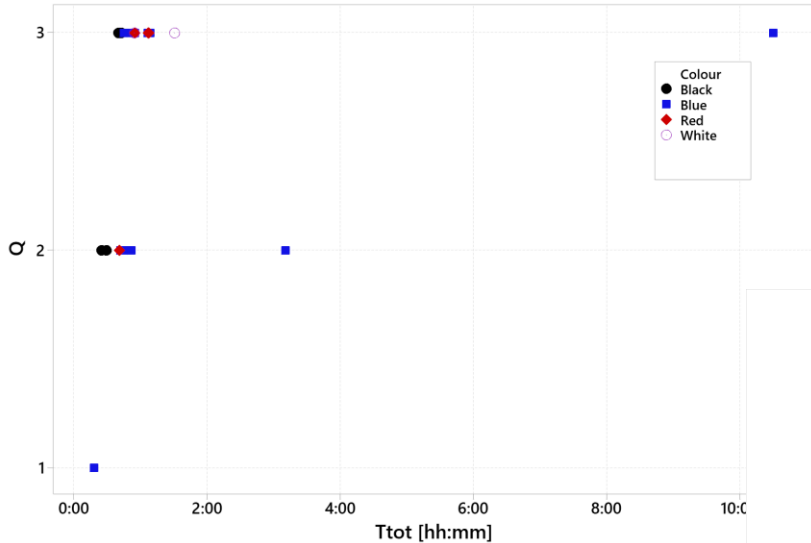
AMP 2021-22 – Lab project overall results

Group no	Name	Colour	d_h (mm)	N	MRR (mm/min)	Ttot [hh:mm:ss]	Quality
1	ADDRS	Blue	0.08	4	16	01:08:57	3- Good
2	UESA-Manufacturing	Blue	0.105	4	21	00:52:04	2- Fair
3	Leimen	Red	0.102	5	16.3	01:07:03	3- Good
4	Metallica	Red	0.1	3	26.6	00:41:07	2- Fair
5	ABBA	Blue	n/a	n/a	n/a	n/a	n/a
6	Team Blu	Blue	0.127	4	25.4	00:18:20	1- Poor
7	Eng5.23.16	Blue	0.032	4	6.4	10:30:20	3- Good
8	Team zero	Black	0.095	3	25.3	00:43:03	3- Good
9	Plugs and Melt	Red	0.134	4	26.8	00:41:12	2- Fair
10	PlickinTeam	Blue	0.12344	4	24.7	00:54:47	3- Good
11	2211	Blue	0.127	4	25.4	00:55:17	3- Good
12	ESASM	Blue	0.13	4	26	00:43:06	2- Fair
13	Keraunos	Blue	0.08	3	21	00:51:32	3- Good
14	Copper Experience	Red	0.08	4	16	01:07:51	3- Good
15	McAnica	Blue	0.122	4	24.4	00:45:05	2- Fair
16	AFFE	Blue	0.123	4	24.6	00:44:51	2- Fair
17	CARDANO	Blue	0.061	3	16.4	01:06:55	3- Good
18	Syria	Red	0.1	4	20	00:54:59	3- Good
19	Random	Blue	0.1279	4	25.6	00:42:12	2- Fair
20	The dark side of the mill	Blue	0.059	2	23.6	00:46:41	3- Good
21	M&G	Black	0.14	3	37.3	00:29:35	2- Fair
22	Los Pollos Hermanos	Black	0.1652625	3	44.1	00:25:16	2- Fair
23	Lasercraft	White	0.06	4	12	01:30:49	3- Good
24	Martin	Black	0.102	3	27.2	00:40:20	3- Good
25	MatMecTeam	Blue	0.1135	4	22.7	03:11:02	2- Fair
26	LAG	Blue	0.123	4	24.6	00:45:15	3- Good
27	5eng	White	0.076	3	20.3	00:54:28	3- Good

POLITECNICO MILANO 1863

Common errors
- Excessive decimal numbers – nm resolution not possible, axis have defined precision
- Check your drawing – Wrong dimensions cause incomplete machining
- Check your code – Wrong parameter input means slow or incomplete process

Improvements in the experimental phase
- Focal point – Make sure it is correct
- Fixturing and nesting – Important for better automation

Improvements in the simulations
- Simulate overlapping – In scanned layer and between layers
- Paint colour – Does it change the thermal properties?
- Beam size not considered – More complex solutions

Improvements in the CAM code
- Rotate the hatch direction – To be implemented
- Bilateral scanning – To be implemented

Contact details

Contacts:
Dr. Leonardo Caprio
Ing. Francesco Galbusera
Department of Mechanical Engineering
Politecnico di Milano
leonardo.caprio@polimi.it
francesco.galbusera@polimi.it