A COMPUTER-AIDED ANALYSIS OF SINGLE SCAN TRACKS FOR AN ACCURATE AND TIME-SAVING EVALUATION OF LPBF BUILDING PARAMETERS

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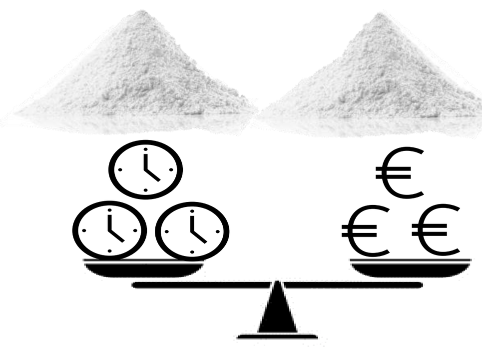
Framing of the issue

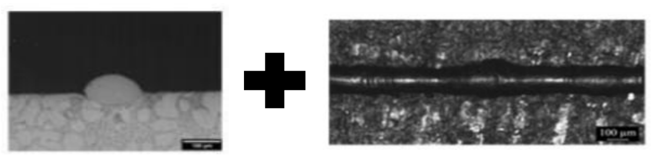
Classical approach:

Power [P]
Hatch distance [Hd]
Layer thickness [l]
Scan speed [v]
Scan strategy [s]

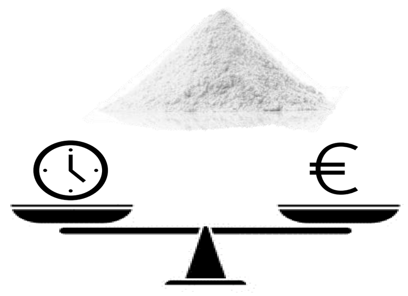


The classical approach consisted of building and analyzing one cube for each parameters sets.

Alternative approach:

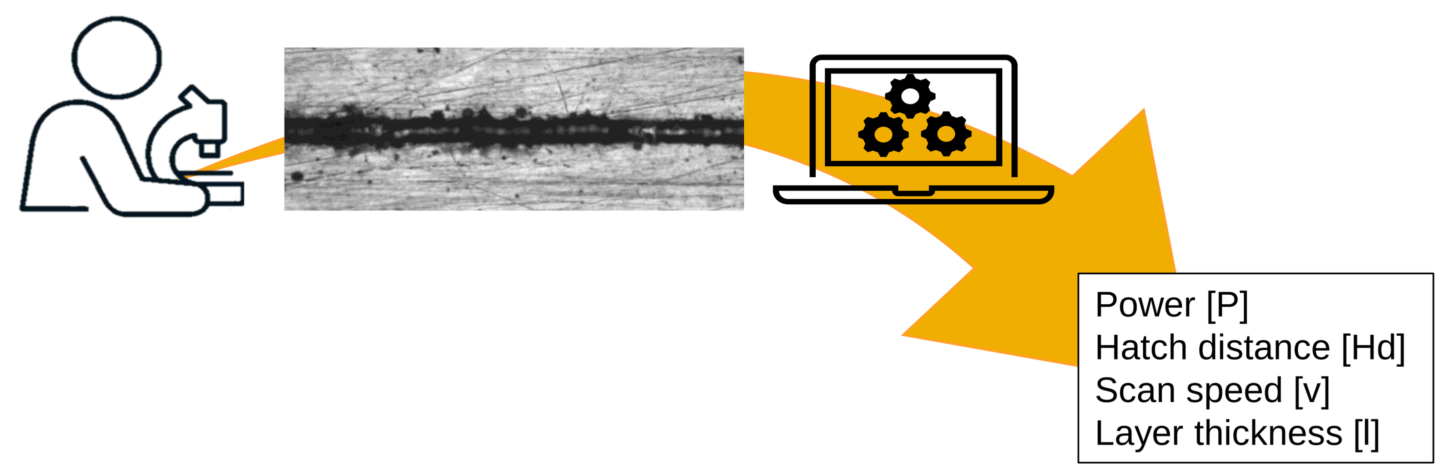


Power [P]
Hatch distance [Hd]
Scan speed [v]



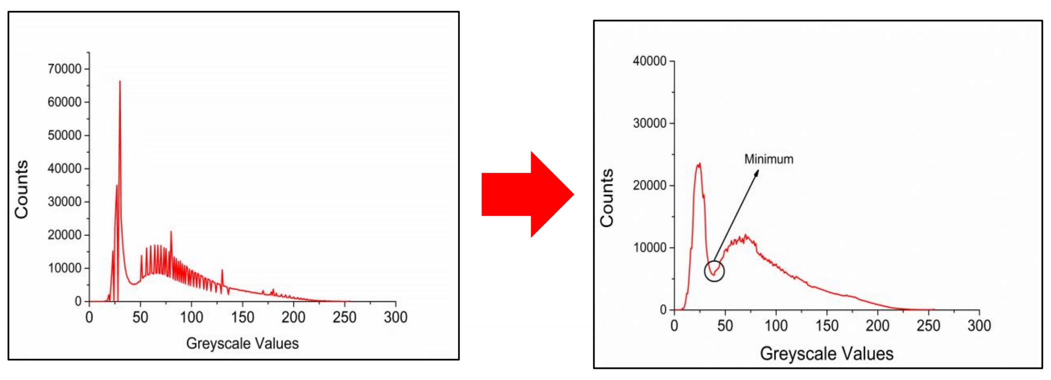
With Single Scan Tracks (SSTs) method, the optimum power and scan speed values can be found analyzing both their cross-section and on top morphology.

Our Goal



The goal of this study is the implementation of an automatic computer-aided analysis for the evaluation of the SST shape and regularity, through two **ImageJ** scripts.
The analysis is based on three different regularity indexes (I_reg) to define the regularity and homogeneity of the SSTs.
The lower the index, the more regular the SSTs.

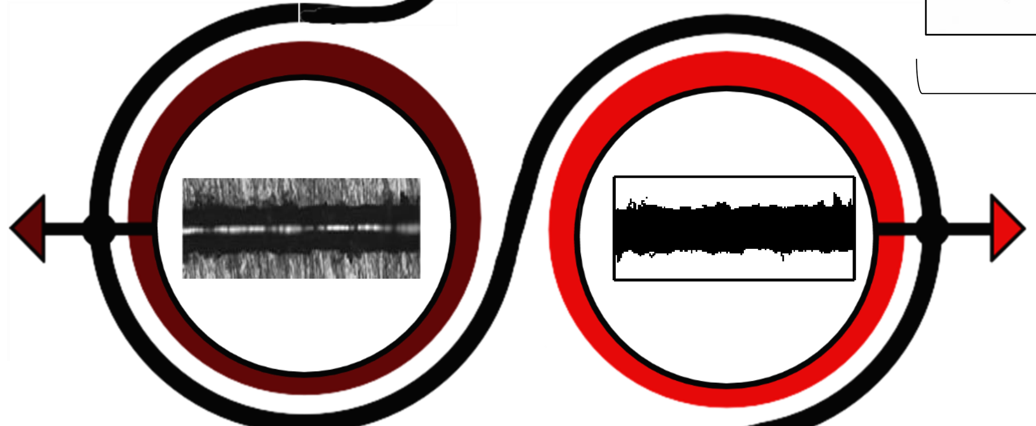
SCRIPT 1: ROIs-finder



The signal of the greyscale histogram **is convoluted** by the script in order to smooth the signal and apply easily a minimum finder function by ImageJ

.tiff, .jpg Files

INPUT: Optical microscope image. (**.tiff**, **.jpg**)

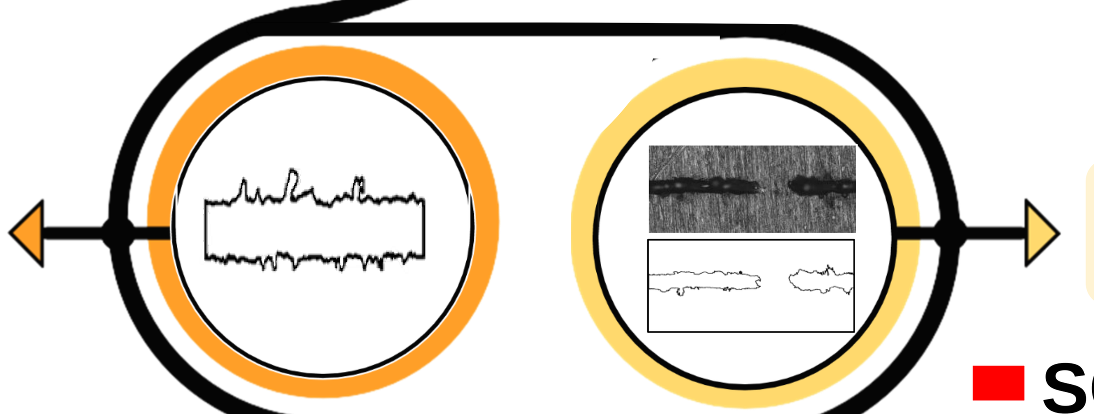


Automatic threshold: by ImageJ**.** The grey scale histogram of the picture is pointed on the local minimum, which showed to be the best result.

.roi Files

Discarded ROIs

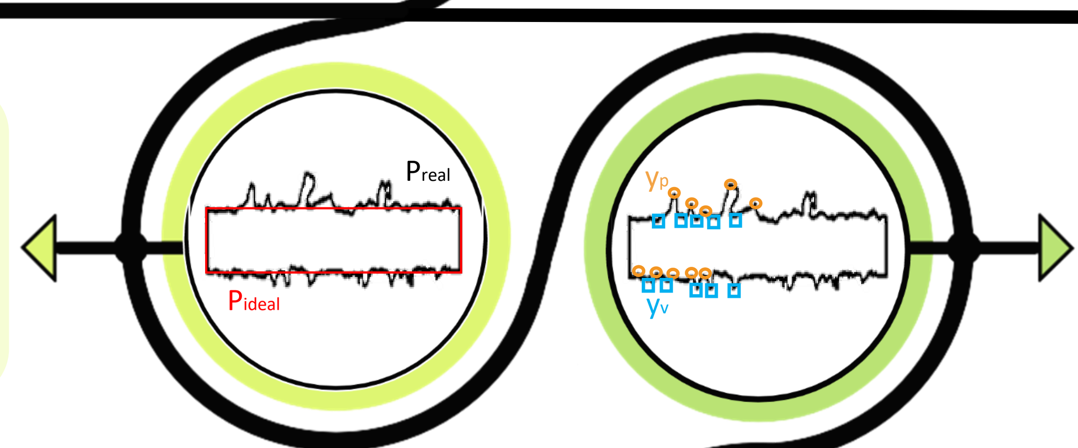
OUTPUT: The software saves the border of the Region of Interest **(ROI)**, filling a folder with **.roi** files



Another folder is created with incomplete ROIs, not included in the next step

SCRIPT 2: ROIs-analyzer

INPUT: .roi Files.
The first index **(I_reg 1)** is the difference between the real ROI perimeter calculated by ImageJ and the ideal perimeter evaluated approximating the shape of ROI to a rectangle.



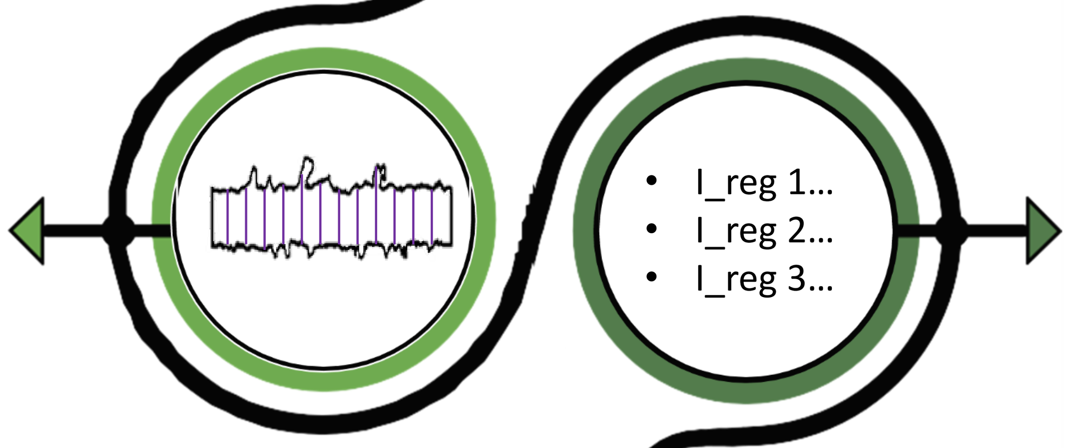
The second index **(I_reg 2)** evaluates the roughness measurement on the upper and lower ROI profiles:

$$index\ 2 = \frac{(y_{p1} + \cdots + y_{p5}) - (y_{v1} + \cdots + y_{v5})}{5}$$

The third index **(I_reg 3)** is the square addition of the STD of repeated measurements of the ROI width:

$$index\ 3 = \sigma_{tot} = \sqrt{\sum_{i=1}^{n} \sigma_i^2}$$

The mean **width** too is saved



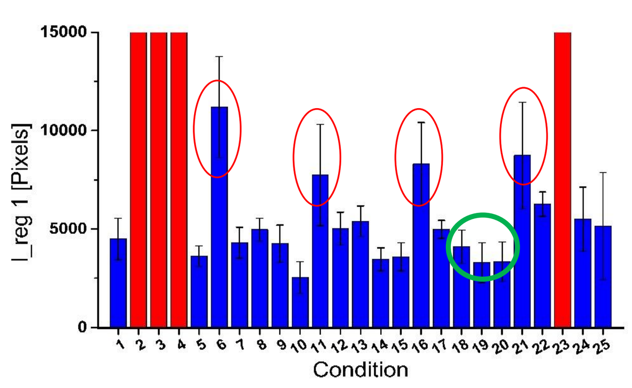
OUTPUT: A file .CSV with the results is created

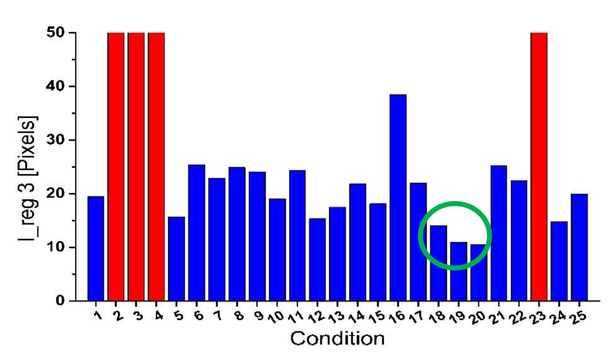
400 images analyzed In **13 min**

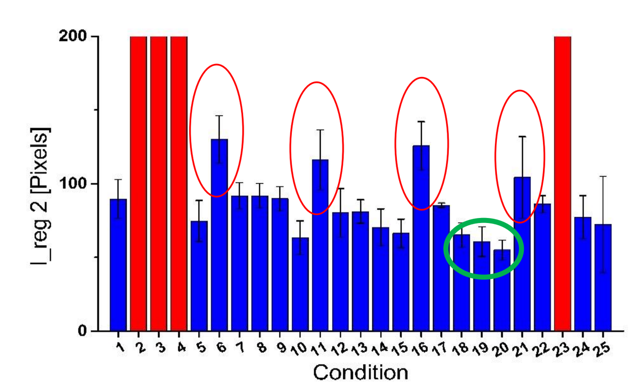
Data Analysis

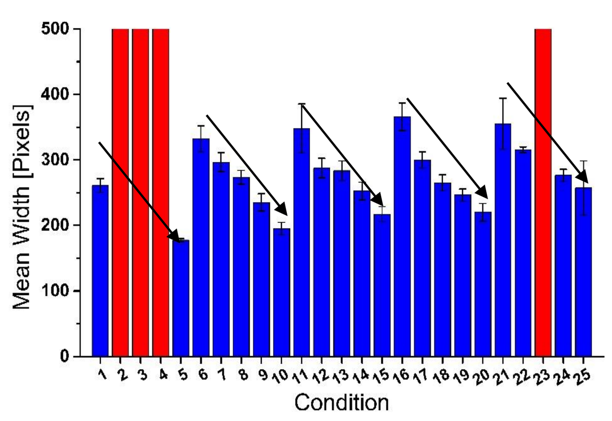
Results

Al4Cu SSTs









In automatic the script discards the incomplete ROIs, so the discontinuos SSTs, which are represented by red bars, are not analyzed.
On the basis of the analysys results, the conditions with high values of indexes must be excluded (in red). On the other hand, SSTs with low values of indexes indicate the power and scan speed conditions suitable for massive production (in green).
Finally, SST width was automatically measured and used for fixing the hatching distance.

Process parameters

P/s	100 W	130 W	160 W	180 W	195 W
300 mm/s	1	6	11	16	21
600 mm/s	2	7	12	17	22
800 mm/s	3	8	13	18	23
1200 mm/s	4	9	14	19	24
1500 mm/s	5	10	15	20	25

Conclusions

With the implemented high-performing approach, it is possible to obtain a first screening of the process parameters in a few minutes minimizing the operator contribution, thus using an objective analysis.