BOOK OF ABSTRACTS **Open Access**

A new method to control the roughness of different time trial garments. A preliminary study.

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Purpose:
Aerodynamics is one of the major factors in cycling performance. Textile optimization is one of the current means used to optimize performances (Brownlie, 2009 ; Chowdhury, 2010). In this context, the International Cycling Union (UCI) wants in 2019 to control the characteristics of textiles by limiting their external surface roughness (the modification of the surface condition must be limited to a height difference of 1 mm, article 1.3.033).
The aim of this preliminary study is to propose a new method for measuring the roughness of the external surface of different time trial garments.

Methods:
Eight TT garments with different roughness were tested in laboratory. The external surface of each garment was 3D modelled (fig. 1) using the Alicona® focus-variation microscope (fig. 2) and the data were analyzed using the Alicona® software.
The roughness index was calculated using the mean plane defined by the software (fig. 3). The roughness index was expresses as an absolute value, the difference in height of each point compared to the arithmetical mean of the surface: **Sa =** $\frac{1}{A}\iint_A |Z(x;y)|\,dxdy$.

Results:
A roughness index (in micrometer, µm) was determined for each TT garment. The differences in roughness index between the different garments are presented in the figure 4 (from 17µm to 134µm, ES = 36.39).

Conclusion:
This method provides a precise roughness index to determine the geometric characteristics of the external surface of a TT garment. The results show that each textile has its own surface roughness. However, it should be noted that it's possible the results obtained are related to the stretching of the garment during the measurement. This parameter must therefore be controlled and remain constant for all measurements.
The new proposed method makes possible the measurement of the textile surface roughness of TT garment thanks to the determination of a roughness index. It could allow the UCI to measure the surface roughness

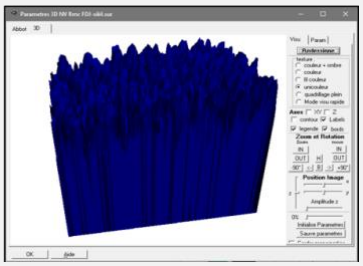

Figure 1. External surface 3D modelled

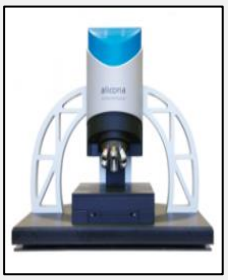

Figure 2. Focal-variation microscope Alicona®

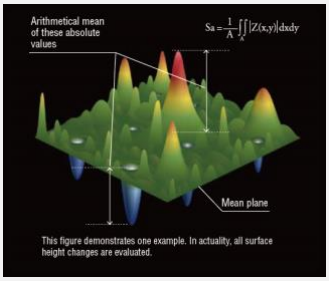

Figure 3. Illustration of calculation roughness index (Sa). Source: Keyence.com

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of the various TT garments of pro cycling teams and to check any modifications that do not comply with the regulations. But the method still needs to be refined to optimize the methodology.

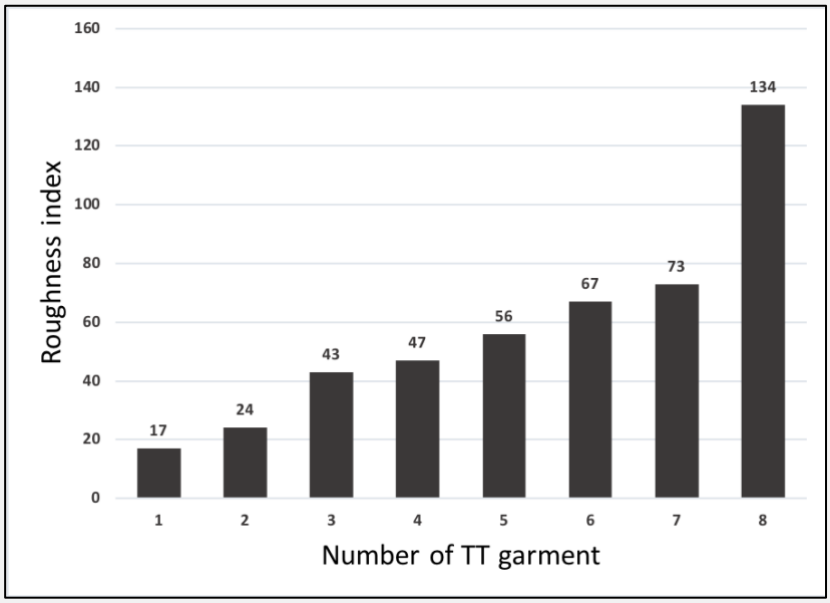

Figure 4. Characteristic of external surface condition

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1. Brownlie, L., Kyle, C., Carbo, J., Demarest, N., Harber, E., MacDonald, R., & Nordstrom, M. (2009). Streamlining the time trial apparel of cyclists: the Nike Swift Spin project. *Sports Technology*, *2*(1-2), 53-60. https://doi.org/10.1002/jst.12
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