AFULudine
GROUNDBREAKING TECHNOLOGY

Groupama • FDJ
ÉQUIPE CYCLISTE

# Analysis method of surface roughness

## Focal-variation microscopy approach

M.COGNARD F.LALLEMAND F.GRAPPE C.LEBOEUF X.ROIZARD S.BERGERET


# AFULudine


- **Located in Dole**
- **Creation : 09/2016**

# AFULudine

## AFU LAB

- Expert in surface analysis
- Non-destructive method
- Knowledge of professional sport

## AFU DEV

- Research & Development Lab
- Partnership with teams
- Boost sport technology

## AFU CHEM

**CHEMICAL PRODUCTS**

- Enhance the performance
- Reduce friction and wear
- Stabilize the effort

# SUMMARY

1. Context of the study
2. Introduction to FV Microscopy
3. Presentation of the analysis method
4. Results & discussion


# Context of the study

# THE ACTORS

- Enacts rules for cycling disciplines
- Fight against doping ( chemical & mechanical )

- 1st French engineering Lab
- Specialized in tribology
- Specialist in mechanical performance

**UNDERSTAND**
**OPTIMIZE**
**CONTROL**

- Knowledge of the textile
- Profesional cycling team
- Specialist in performance

- R&D Lab specialized in surface treatment
- Chemical products & performance

# CONTEXT OF THE STUDY

- **Methodology** : from regulation to control & expertise

UCI Cycling Regulations

**PART 1 CHAPTER 3**
**EQUIPMENT**
§1.3.033


UCI UNION CYCLISTE INTERNATIONALE

**RIDER'S CLOTHING**

- Morphology : threading, weaving or assembling
- Original texture
- No self-supporting element or rigid parts

**MEASUREMENT**

The measure of surface roughness modification shall be made without pressure or traction on the clothing.

**METHOD**

- Optical
- Non-Destructive
- Fast
- Replicable

UBFC

femto-st SCIENCES & TECHNOLOGIES

**ANALYSIS**

- Certification
- Control
- Expertise

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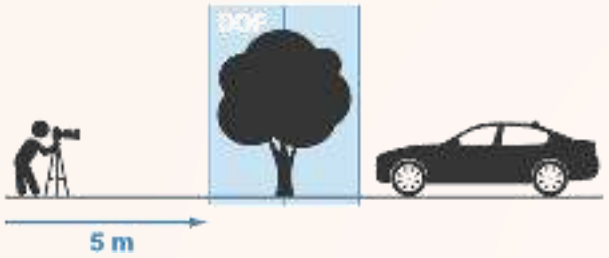
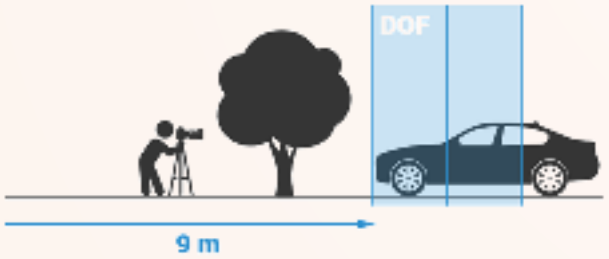
Regulation → Constraint → Specification → Understanding → Control

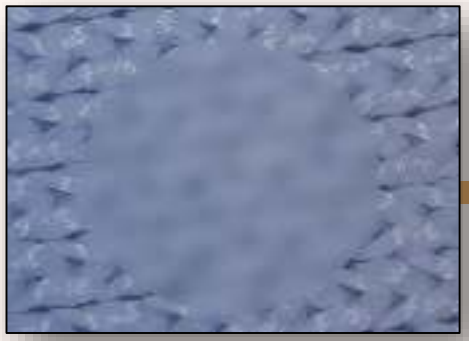

Focal-Variation
Microscopy
alicona

# Focal-Variation Microscopy




Focal sweep



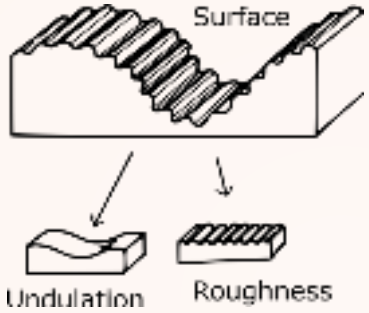
Reconstituted 3D Picture

# Technical Specifications

Measurement principle : *non-contact, optical, three-dimensional, based on Focus-Variation*

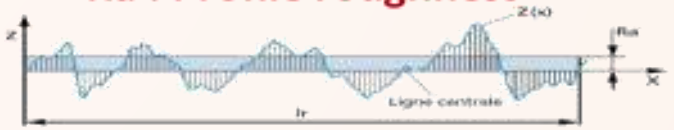
x 5 –> x 20

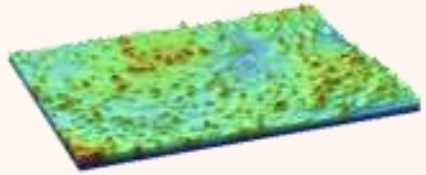
Filter – ISO 11562





Ra : Profile roughness



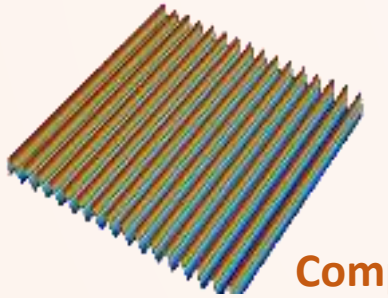


Sa : Area roughness

Min detectable roughness

1,2 µm

0,6 µm

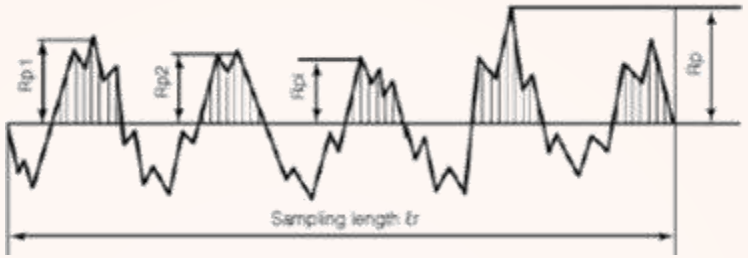


Complexity

# Technical Specifications

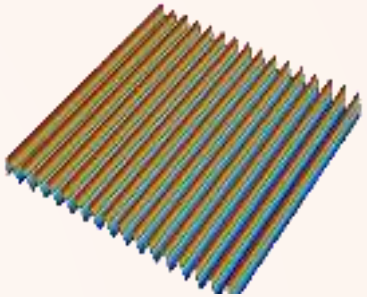
**Sa : Average Height / Roughness**

Precision 1000 times higher thant UCI's recommandation




**S10Z : Maximum height of 10 peaks**

Evaluation of singularities
Spacial repartition



**Sdr : Complexity**

Developed Interfacial area Ratio

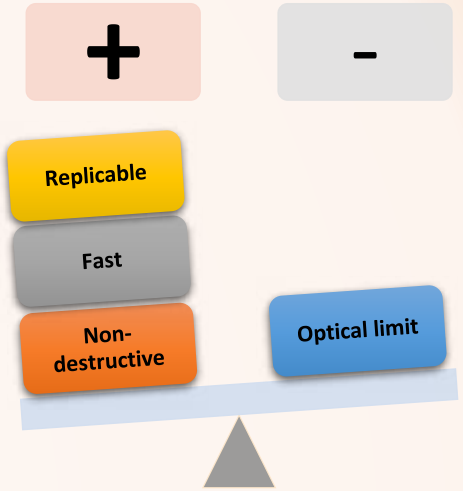
Evolution of the threading
Modification of original texture

**The precision of the measurement is adapted to the constraints of the UCI**

**How to adapt this technology to UCI's specifications ?**

# Method of Analysis

# STEPS OF VALIDATION




## 1 AIM OF THE STUDY

Develop a method to control the morphology of items of clothing. Measure the surface roughness.

## 2 DATA & CONFIGURATION

- Jerseys and full suits
- No traction or pressure
- New jersey – after race ?

## 3 MEASURES & UNCERTAINTIES

- Non-destructive method
- Measurement accuracy
- Rapid and effective procedures

## 4 REPLICABILITY

- 5 points of measurement
- Evaluate the deviation
- Analyze sample ‘B’

## 5 VALIDATION

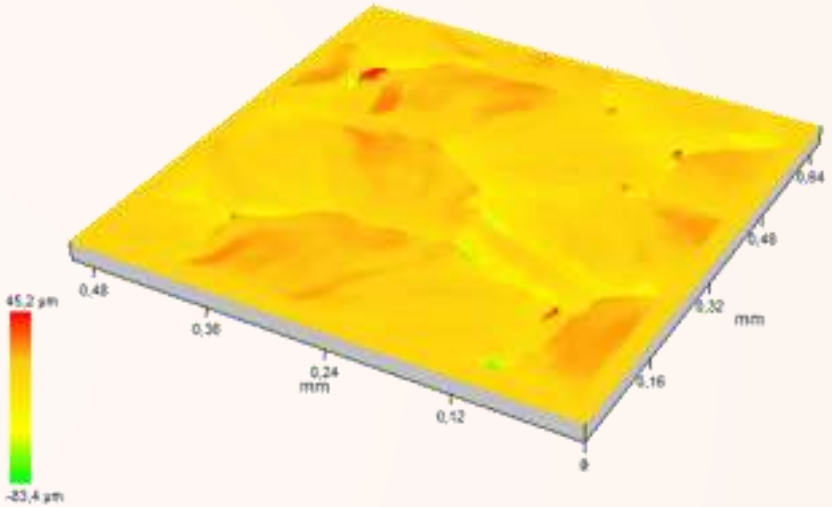
- Certification of jerseys

# Results & Discussion


# Experimental results

APPROVED

## Sample 1 – Low complexity




**Low complexity**

**Sdr =** 46,3 % ± 3,3 %

**Roughness**

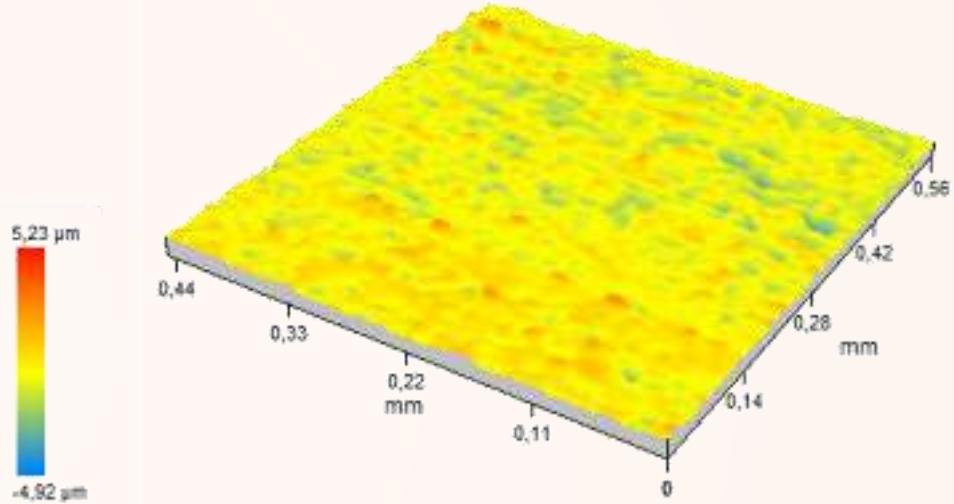
**Sa** = 4,6 µm ± 2 %

**Max peak height**

**S10Z**= 0,1 mm ± 3 %

# Experimental results

## Sample 2 – Medium complexity




**Medium complexity**

**Sdr =** 118,3 % ± 5,5 %

**Roughness**

**Sa** = 6,0 µm ± 2 %

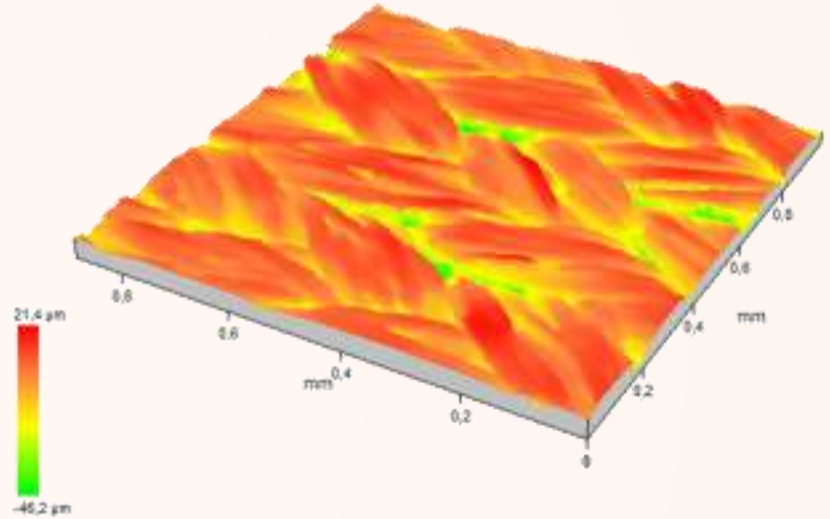
**Max peak height**

**S10Z**= 0,1 mm ± 4 %

# Experimental results

APPROVED

## Sample 3 – High complexity




**High complexity**

**Sdr =** 386 % ± 3,7 %

**Roughness**

**Sa** = 32,1 µm ± 1 %

**Max peak height**

**S10Z**= 0,5 mm ± 3 %

# Discussion

1

***New method of analysis***

- *Accurate whatever complexity*
- *Quantitative & Qualitative data*

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- *Experimental plan for validation*
- *Sensibility & replicability of the measure*
- *Validation by the competent authorities*

2

***"Surface roughness modifications shall be limited to a profile difference of 1mm at most."***

- *Roughness max: 1mm*

*Uncertainty ? Replicability?*

- *Average height (Sa)? Max peak height (S10Z)?*


3

***"Modifications to the surface roughness of clothing are authorised but may only be the result of threading, weaving or assembling of the fabric."***

- *Which basis garment? Start of the season?*
- *Evolution of the database*

4

***"Items of clothing […] of which the purpose is not exclusively clothing or protection, is forbidden."***

- *Impact of roughness on performance ?*
- *Database of surface condition*
- *Specification of protection /clothing*
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