

## Application Note

### Golf club groove inspection

#### Executive Summary

Optimet's Conoprobe Mark3 HD with 50mm focal length lens was used for Golf club groove inspection. The groove inspection performed using the methods and with relation to the demands described in the USGA<sup>1</sup> document.

#### 1. Optimet's advantages over other technologies:

1. Co linearity – permits a measurement inside the grooves. Sensors using triangulation techniques cannot measure between steep slopes.
2. High lateral resolution.
3. High sampling rate with no need for averaging.
4. **Special algorithm designed for grooves parameters calculation<sup>2</sup>.**

#### 2. Application description

Non-contact inspection of golf club grooves.

The groove features measured:

- Width
- Depth
- Separation
- Consistency – the range of values of other parameters.
- Area
- Edges sharpness

<sup>1</sup> United states golf association.

<sup>2</sup> For example please look on section 6 under results and observations title of this document.

## 2.1. setup

### Sensor & Setup

Sensor Type: Conoprobe Mark 3 HD

Lens focal length: 50mm lens

Sample rate: 3 KHz (up to 9 KHz).

### Scanning setup , commercial XY scanner-

Step along the line X- Direction: 5/8/10  $\mu$ m

Room temp: 23~24  $^{\circ}$ c

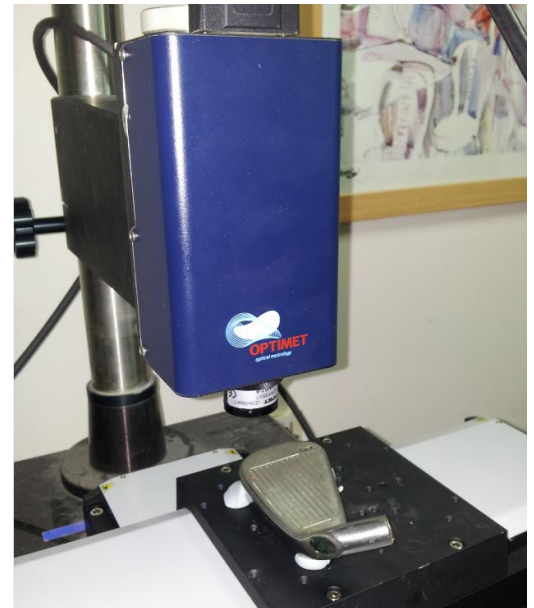
### **Probe spec:**

Working range: 2mm

Standoff: 40mm

Precision: 2.5 $\mu$ m

Spot size: 15 $\mu$ m

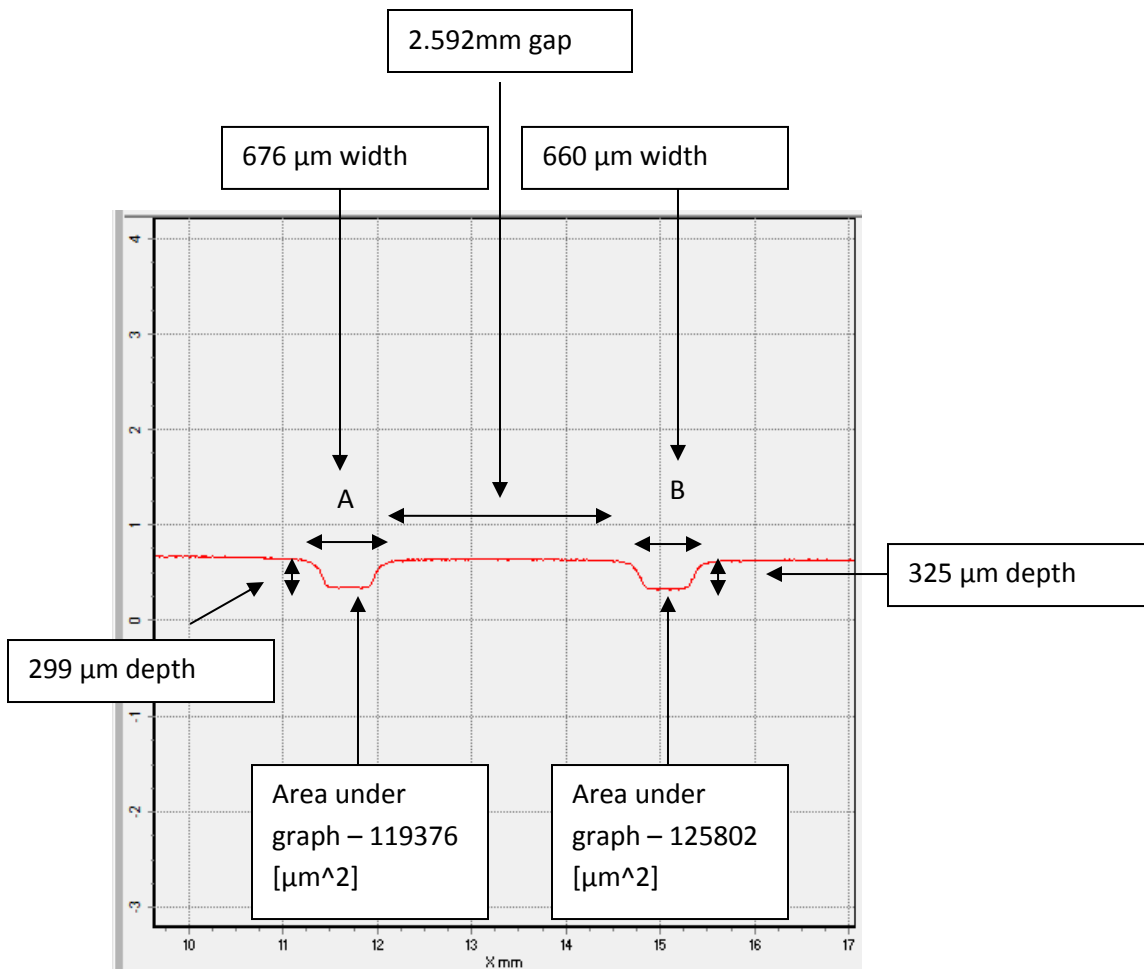


## 2.2. method of inspection

All methods of parameters as width, height, area etc measurement and calculation taken from the USGA document.



### 3. Results and Observations



All this information can be used in order to determine whether this golf club is confirmed by the USGA or not. For example - examine the golf club head we used for this measurement based on the two grooves displayed above:

1. Groove width – standard limit is 889μm :
  - a. Groove A : 676 μm – meets the standard.
  - b. Groove B : 660 μm – meets the standard.
2. Groove depth – stand limit is 508μm :
  - a. Groove A: 299 μm – meets the standard.
  - b. Groove B: 325 μm – meets the standard.
3. Grooves separation – standard low limit is 3 X maximum width of adjacent – 0.203mm = 3X676 μm = 2.028



- a. Separation in our case is :2.592mm – meets the standard.
- 4. Groves consistency – standard range limit in depth and width is 0.254mm
  - a. In both depth and width the range is lower - meets the standard.

5. Area standard is :  $\frac{Area}{separation \times width} < 0.076mm$

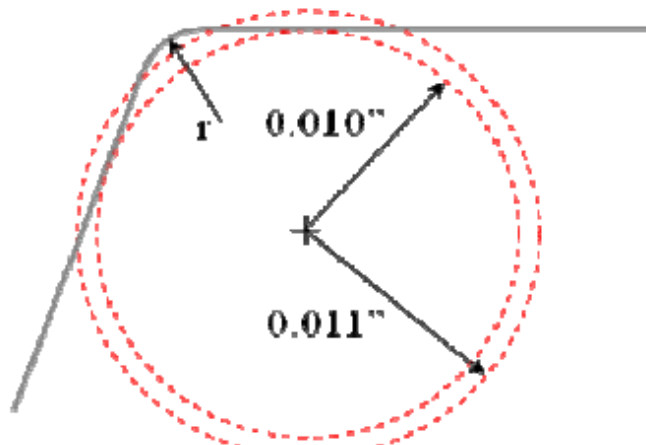
a. Groove A -  $\frac{Area}{separation \times width} = \frac{119376}{2592+676} = 0.036mm$

Meets the standard

b. Groove B -  $\frac{Area}{separation \times width} = \frac{125802}{2592+660} = 0.038mm$

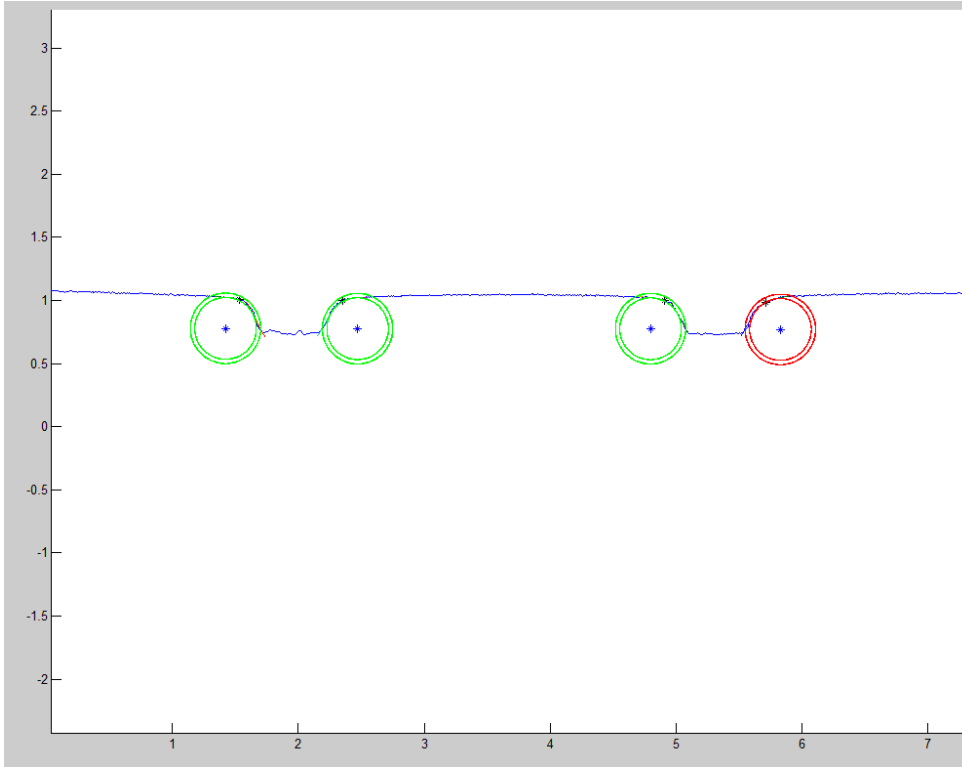
Meets the standard

- 6. Groove edge sharpness measurement –  
Following the USGA method for sharpness inspection described in appendix C of the USGA standard, we performed the following calculations –

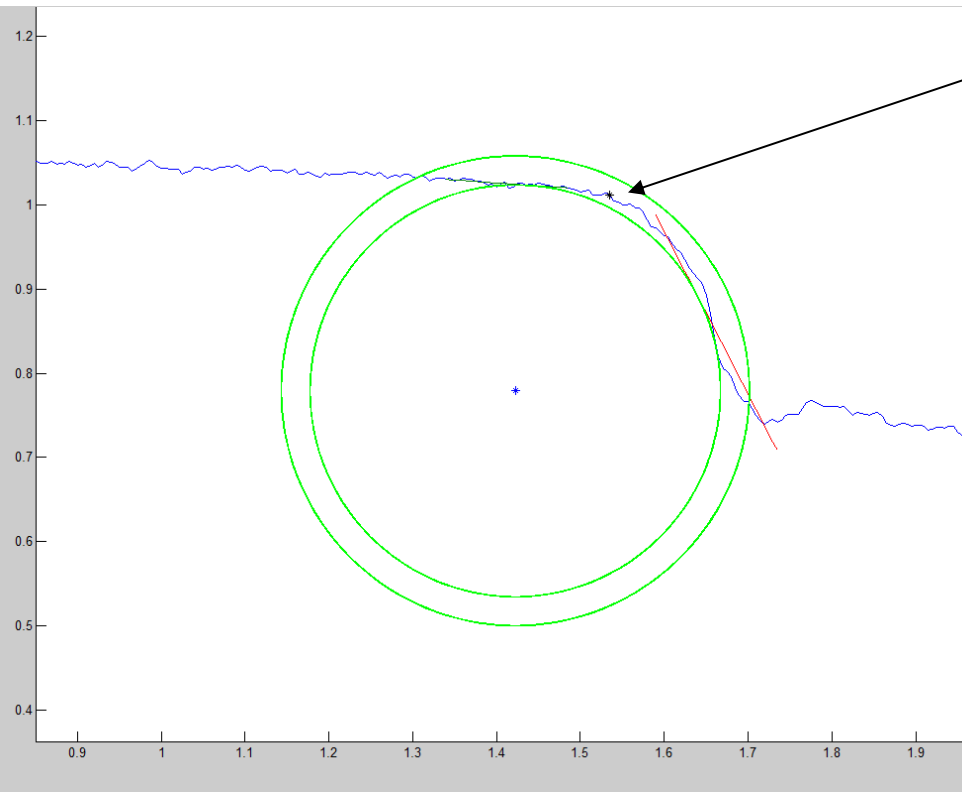


Sharpness inspection as described in the USGA document

In order to perform these calculations we developed designed algorithm for edge detection and evaluation according to the method described in the USGA standard. The algorithm input is a profile of golf head measured using Optimet sensor and its output is the following –



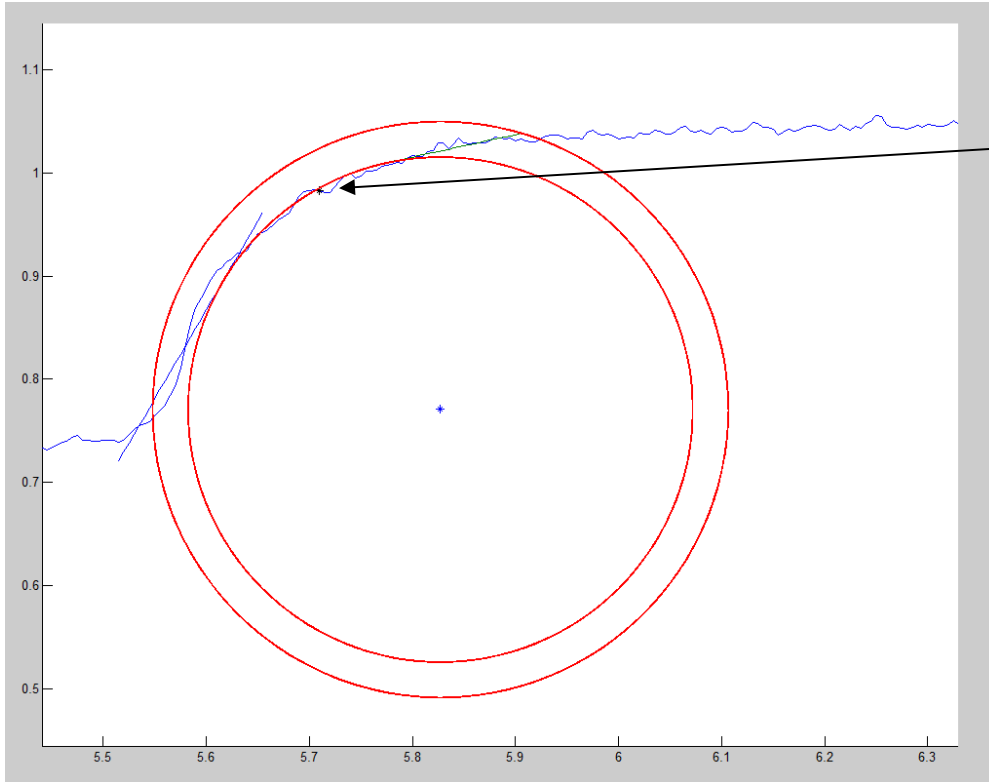
Any edge point approved by the algorithm according to the USGA method marked with green circles, and any edge point not approved marked with red circles. The circles are the circles used as described below.



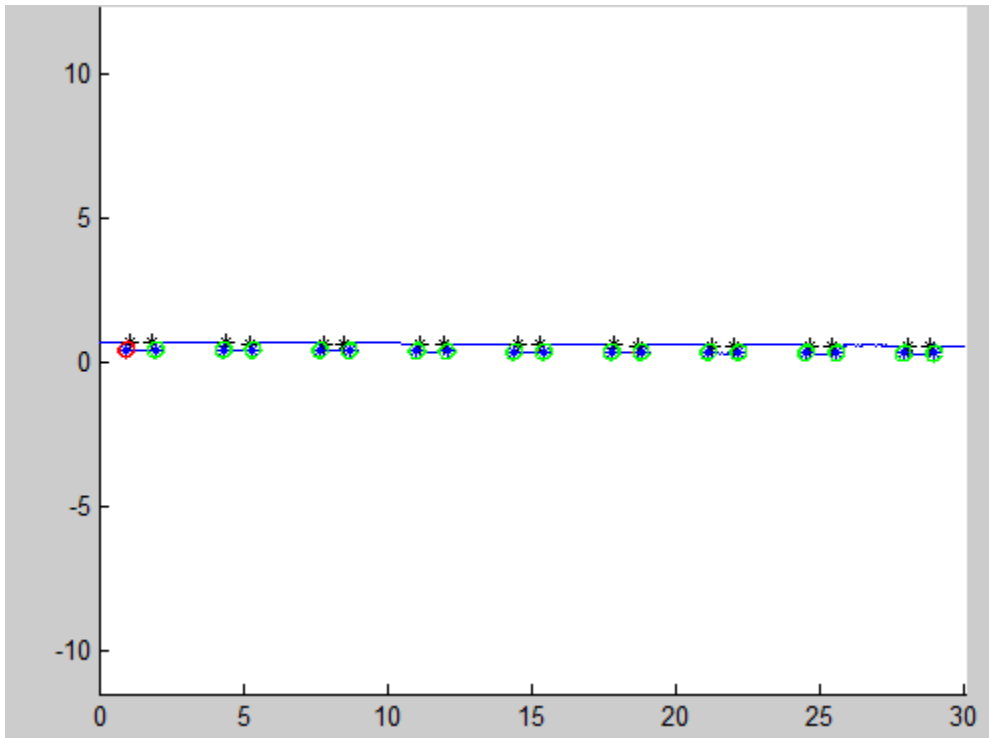
Edge point – where the slop is of 30 [deg].  
The point is contained between the two circles of:  
 $R1 = 0.01''$   $R2 = 0.011''$

On the other hand we were able to detect unconfirmed edge

points -



The edge point is within the circle of  $R=0.01''$ . this edge is not sharp enough.



Whole profile – algorithm output



## 4. Data

Parameter	Value
Reflective/Diffusive/Transparent/Translucent	Diffusive
Working Range (mm)	2
Precision ( $\mu\text{m}$ )	2.5
Stand Off (mm)	40
Max. Data Rate (KHz)	9
Lateral Resolution	5 $\mu\text{m}$
Z Resolution	-
Application Category	inspection