

# โครงการเปรียบเทียบผลการวัด

กลุ่มมาตรวิทยานาโน  
ฝ่ายมาตรวิทยามิติ

ธรรมรัตน์ สมทอง

March 28, 2019



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)

# Proficiency Testing

## Roughness Specimen

Parameters: Ra, Rz and Rsm



Mitutoyo : Ra  $\sim$ 0.5  $\mu$ m

Taylor Hobson: Ra  $\sim$ 6  $\mu$ m

## Pilot Lab: NIMT

Measured by roughness measuring machine

$$\text{Uncertainty Ra: } U(\text{Ra}) = \sqrt{(8.91)^2 + (5.53 \cdot Z_m)^2} \text{ nm}$$

$$\text{Rz: } U(\text{Rz}) = \sqrt{(20.30)^2 + (8.72 \cdot Z_m)^2} \text{ nm}$$

$$\text{Rsm: } U(\text{Rsm}) = \sqrt{(0.58)^2 + (0.02 \cdot S_m)^2} \text{ um}$$

Zm and Sm : Measured Value in um

เริ่มโครงการ : 1 มิถุนายน 2562



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)

# Proficiency Testing

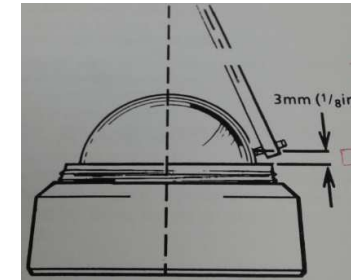
## Glass Hemisphere



## Artifact



Taylor Hobson  
Model : 112/2324



Measurement position

## Pilot Lab: NIMT

Measured by roughness measuring instrument

$$\text{Uncertainty } U(\Delta z_q) = \sqrt{(11.1)^2 + (11 \cdot R)^2} \text{ nm}$$

R: Measured value of roundness in  $\mu\text{m}$

เริ่มโครงการ : 1 มิถุนายน 2562



"NIMT"



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)

# Proficiency Testing

Optical parallels



## SPECIFICATIONS

Metric	Order No.	Assortment of parallels (Thickness of parallel)
0-25mm	157-903	12.00mm (157-101) 12.12mm (157-102) 12.25mm (157-103) 12.37mm (157-104)
25-50mm	157-904	25.00mm (157-105) 25.12mm (157-106) 25.25mm (157-107) 25.37mm (157-108)

Mitutoyo : 12.00, 12.12, 12.25, and 12.37

Pilot Lab: NIMT

Measured by Flatness interferometer and ULM

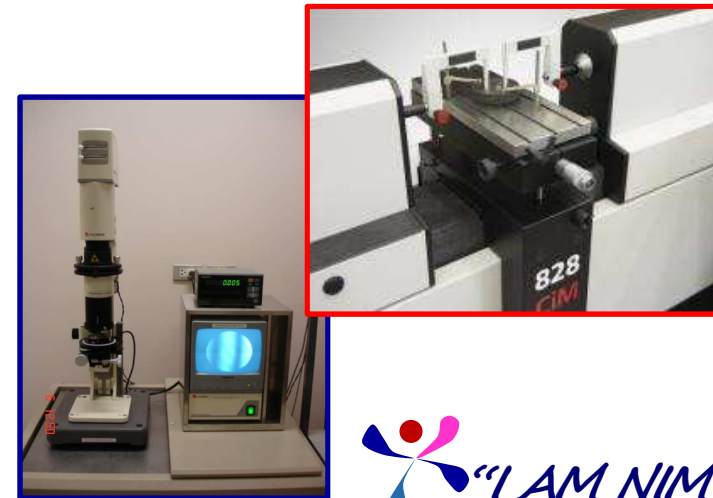
Uncertainty

$$\text{Parallelism} = \sqrt{(0.06)^2 + (6.48 \cdot 10^{-6} \cdot p)^2} \mu\text{m}$$

$$\text{Thickness} = \sqrt{(0.23)^2 + (6.48 \cdot 10^{-3} \cdot l)^2} \mu\text{m}$$

$l$  and  $p$  : Measured value in mm

$$\text{Flatness} = 20 \text{ nm}$$



# Cancellation of calibration services

- Optical parallels, Grade 1,2

## Why?

- More than 3 laboratories have been accredited ISO/IEC17025.
- CMC  $\approx$  40 nm.

## When?

- 1 May 2019



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)

# Optical parallel sets

- The performance of parallels shall be expressed by the flatness and the parallelism of the measuring surface following **JIS B 7431:1977**

Unit:  $\mu\text{m}$

Grade	Allowable value of flatness	Allowable value of parallelism
1	0.10	0.2
2	0.20	0.4
0	0.05	0.1

AM NIMT



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)

# Optical parallel sets



157-903



157-904

## SPECIFICATIONS

### Metric

Range of micrometer to be checked	Order No.	Assortment of parallels (Thickness of parallel)
0-25mm	<b>157-903</b>	12.00mm (157-101) 12.12mm (157-102) 12.25mm (157-103) 12.37mm (157-104)
25-50mm	<b>157-904</b>	25.00mm (157-105) 25.12mm (157-106) 25.25mm (157-107) 25.37mm (157-108)

## Technical Data

Flatness: 0.1 $\mu$ m / .000004"  
 Parallelism: 0.2 $\mu$ m / .000008"  
 Diameter: 30mm / 1.18"

"I AM NIMT"



# Optical parallel sets

- The dimension shall be as shown in figure below.



Thickness  $\pm 0.01$  mm



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)



# Flatness measurement



# Commercial Instrument

## Specification

- He-Ne Laser  $\lambda = 633 \text{ nm}$
- Resolution : **0.1 nm**
- Repeatability : **< 5 nm**
- Diameter : **up to 60 mm**
- Sensitivity :  **$\lambda/2$  (0.3  $\mu\text{m}$ /fringe)**

\*\*\*\*Optical flat / Optical parallel

Uncertainty of measurement : 20 nm\*\*\*\*



Flatness Interferometer

Model : F601 Interferometer,

(Fuji Photo Optical Co., Ltd., Japan)



สถาบันมาตรวิทยาแห่งชาติ

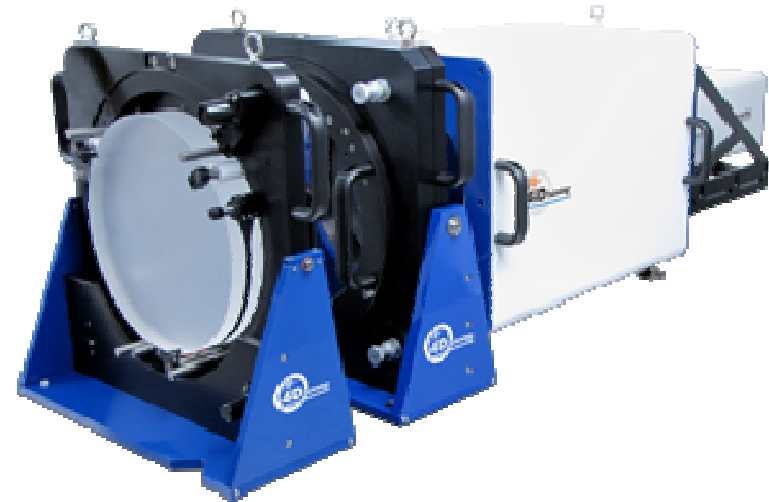
National Institute of Metrology (Thailand)

# Commercial Instrument



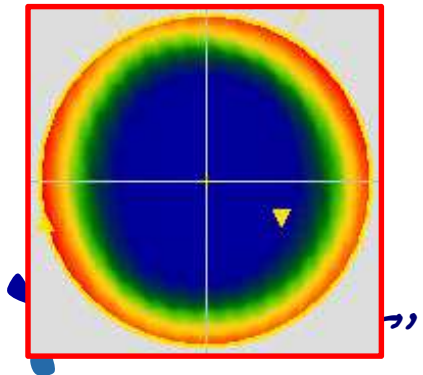
## Specification

- He-Ne Laser  $\lambda = 632.8 \text{ nm}$
- Resolution : **0.1 nm**
- Diameter : **up to 300 mm**



## Measurement uncertainty

Flatness = **50 nm at 300 mm**



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)

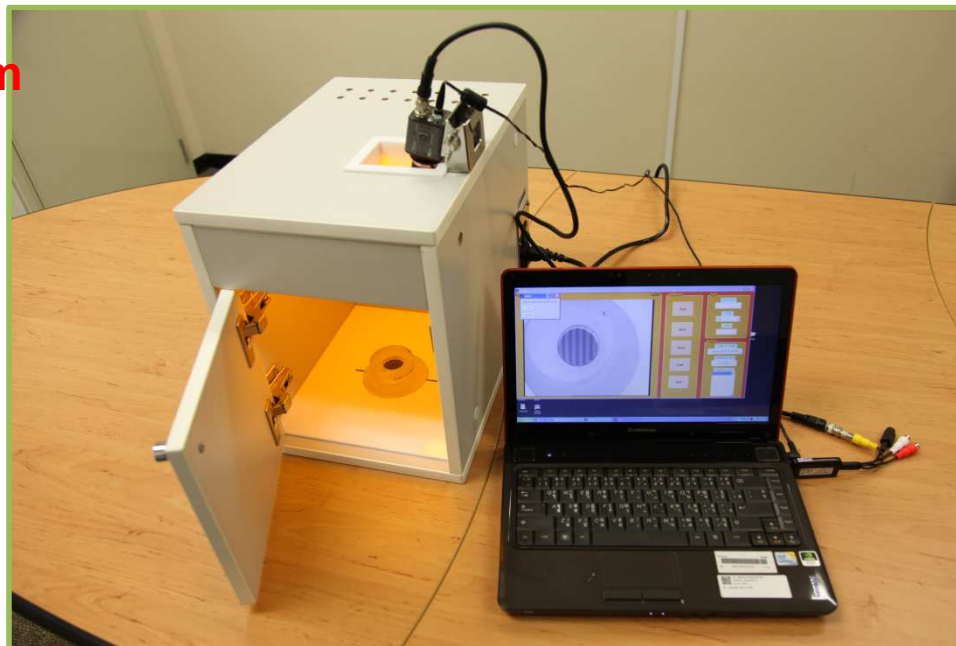
# Instrument developed by NIMT

## Specification

- Measurement range: up to 60 mm
- Sodium:  $\lambda = 589.3 \text{ nm}$

## Measurement uncertainty

$$\text{Flatness} = a_0 + 1.645 \sqrt{u_a^2 + u_b^2} + \frac{b_0^2}{3} \mu\text{m}$$



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)

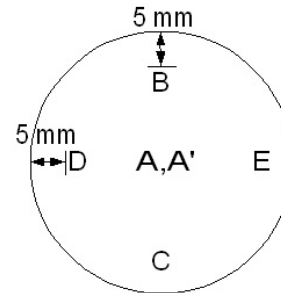


# Parallelism measurement

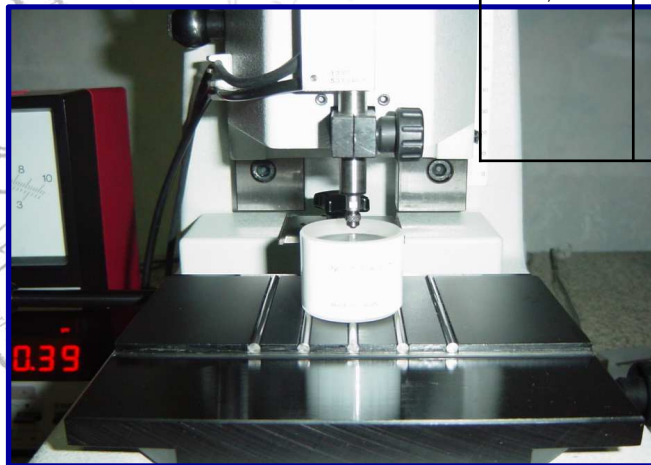


# Commercial Instrument

Gauge block comparator



Nominal Size mm	Serial No.	Position	Measured Value, $\mu\text{m}$			$\mu\text{m}$	$\sigma_{n-1}$ $\mu\text{m}$	Parallelism $\mu\text{m}$
			1	2	3			
12,00	93370	A	0.64	0.64	0.64	0.64	0.000	0,06
		B	0.58	0.59	0.58	0.58	0.006	
		C	0.64	0.64	0.65	0.64	0.006	
		D	0.58	0.59	0.59	0.59	0.006	
		E	0.61	0.61	0.62	0.61	0.006	
		A'	0.64	0.64	0.64	0.64	0.000	



# Commercial Instrument

## Specification

- Measurement range 0–1000 mm
- Resolution : 0.1 nm
- Repeatability :  $\leq 30$  nm
- Measuring uncertainty :  $\leq (0.055 + L/1500)$   $\mu\text{m}$  : L in mm)

## Measurement uncertainty

$$\text{Parallelism} = \sqrt{(0.06)^2 + (6.48 \cdot 10^{-6} \cdot p)^2} \mu\text{m}$$

$$\text{Thickness} = \sqrt{(0.23)^2 + (6.48 \cdot 10^{-3} \cdot l)^2} \mu\text{m}$$

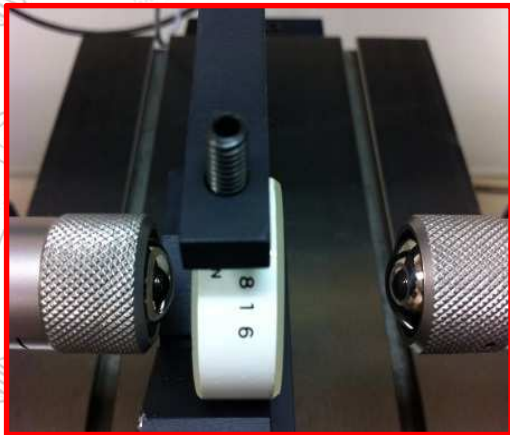
Mahr



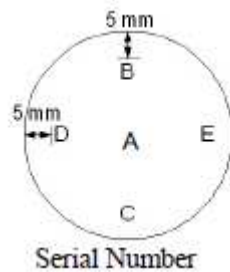
สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)

# Commercial Instrument



Nominal Size mm	Serial No.	Position	Measured Value, mm			$\bar{X}$
			1	2	3	$\bar{X}$
12.00	013289	A	11.99884	11.99884	11.99884	11.99884
		B	11.99889	11.99889	11.99889	11.99889
		C	11.99885	11.99885	11.99884	11.99885
		D	11.99892	11.99892	11.99892	11.99892
		E	11.99881	11.99881	11.99881	11.99881





# Thickness measurement



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)

# Commercial Instrument

## Specification

- Measurement range 0–1000 mm
- Resolution : 0.1 nm
- Repeatability :  $\leq 30$  nm
- Measuring uncertainty :  $\leq (0.055 + L/1500)$   $\mu\text{m}$  : L in mm)

## Measurement uncertainty

$$\text{Parallelism} = \sqrt{(0.06)^2 + (6.48 \cdot 10^{-6} \cdot p)^2} \mu\text{m}$$

$$\text{Thickness} = \sqrt{(0.23)^2 + (6.48 \cdot 10^{-3} \cdot l)^2} \mu\text{m}$$

Mahr



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)



# Thank you

[thammarat@nimt.or.th](mailto:thammarat@nimt.or.th)



สถาบันมาตรวิทยาแห่งชาติ

National Institute of Metrology (Thailand)