

表面輪廓及量測

1. 探針接觸式量測
2. 雷射光非接觸式量測
3. 真平度量測

陳亮嘉 教授

台灣大學 機械系

Precision Metrology Lab.

工件表面輪廓

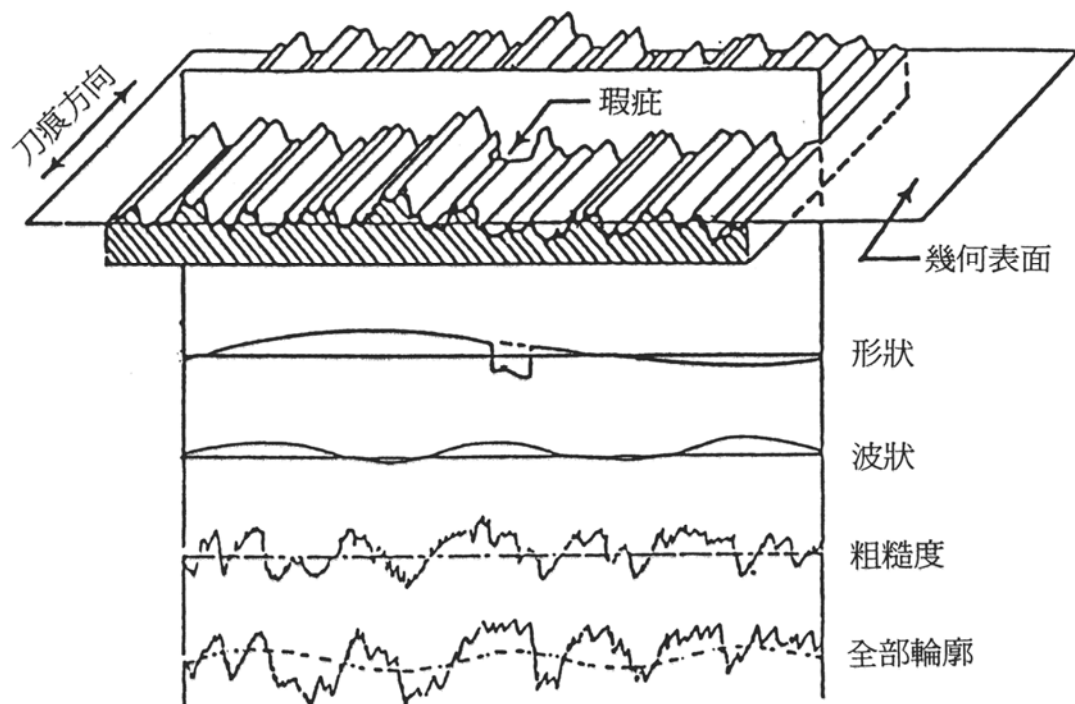


圖 8-1-1 工件表面全部輪廓



Nyquist frequency

- If a function $x(t)$ contains no frequencies higher than B hertz, it is completely determined by giving its ordinates at a series of points spaced $1/(2B)$ seconds apart.
- When the continuous function being sampled contains no frequencies equal or higher than the Nyquist frequency, all the **aliases** caused by sampling occur above the Nyquist frequency.
- The term **aliasing** usually refers to the case where some original frequency components have aliases below Nyquist.

From Wikipedia, the free encyclopedia

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Discrete Fourier Transform (DFT)

- Fourier Transform is an important image processing tool which is used to decompose a spatial physical function into its **sine** and **cosine** components.
- For a 2D spatial function (such as image) of size $N \times N$, the two-dimensional DFT is given by:

$$F(k, l) = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} f(i, j) e^{-i2\pi(\frac{ki}{N} + \frac{lj}{N})}$$

From R. Fisher, S. Perkins, A. Walker and E. Wolfart.

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工件表面全部輪廓

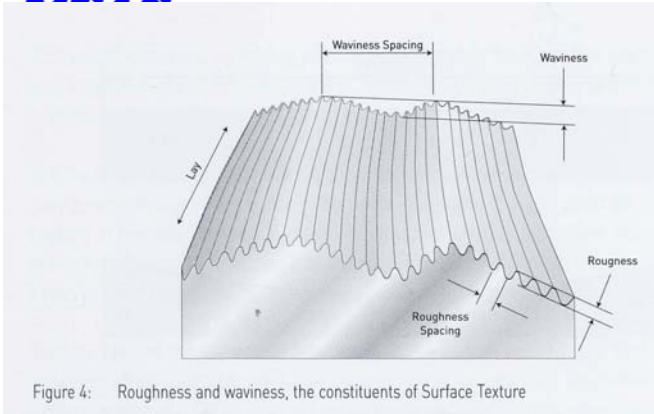


Figure 4: Roughness and waviness, the constituents of Surface Texture

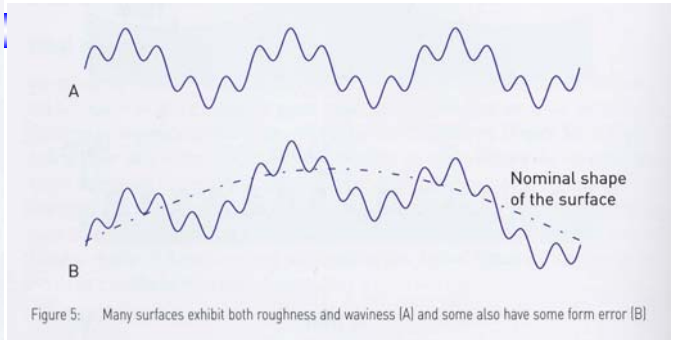


Figure 5: Many surfaces exhibit both roughness and waviness [A] and some also have some form error [B]

Source: Talyform manual

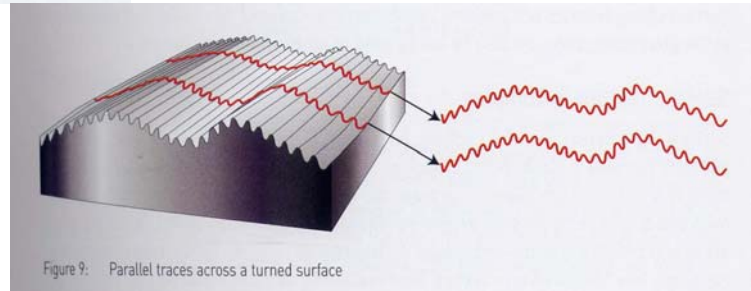
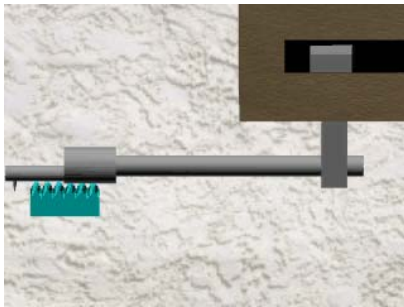


Figure 9: Parallel traces across a turned surface

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表面量測上之基本術語

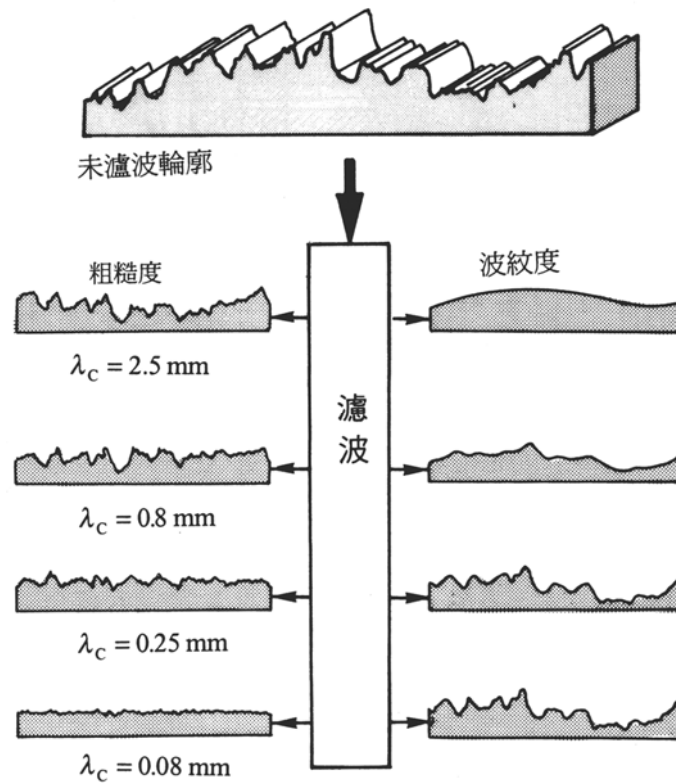


圖 8-1-2 不同切斷長度對輪廓之影響



表面輪廓與表面粗糙度關係

項目	輪廓	粗糙度
紋路	大紋路	細紋路
波長	大	小
濾波	低通	高通
量測行程	全長	依規範(短行程)

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輪廓量測之濾波特性

- 將波紋做**低通濾波**後，所取的曲線較為平滑。
- 「**表面粗糙度**」與「**表面輪廓**」的量測方式很相似，不同處在於 --- 量測後所得數據其處理方式採不同方式。

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表面輪廓量測之定義及使用時機

➤ 定義：

表面輪廓量測是指檢測工件的橫斷面形狀，是否與實際形狀相同。

➤ 使用時機：

單純輪廓其斷面形狀僅需考慮單一個（即x，y平面），可用**光學投影機**或其他適當工具；複雜輪廓為求得精確形狀及尺寸大小時，應採用**輪廓量測儀**。

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表面輪廓量測方式

其量測方式有很多種，依其精度要求而定。目前常用：

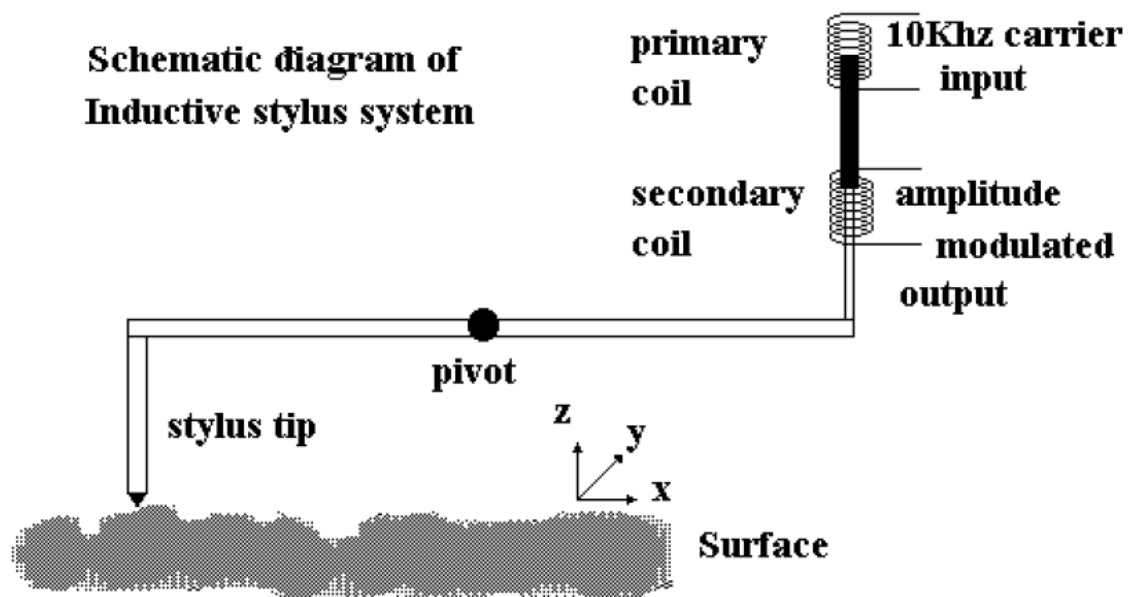
- 輪廓量測儀
- 齒輪量測儀
- 三次元量測儀之接觸或非接觸式探頭量測
- 探針式雷射干涉感測法
- 平台、直規與量錶之傳統組合

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➤ 操作原理：

以探針與待測工件的輪廓形狀相接觸，利用 **差動可變位移器 (LVDT)** 的移動變化量。由界面箱設定輪廓的放大倍率，之後再從所設定的放大倍率換算出所得的量測值。

Principle of surface profile measurement



量測系統方塊圖

Profile: Low pass filter
Roughness: High pass filter

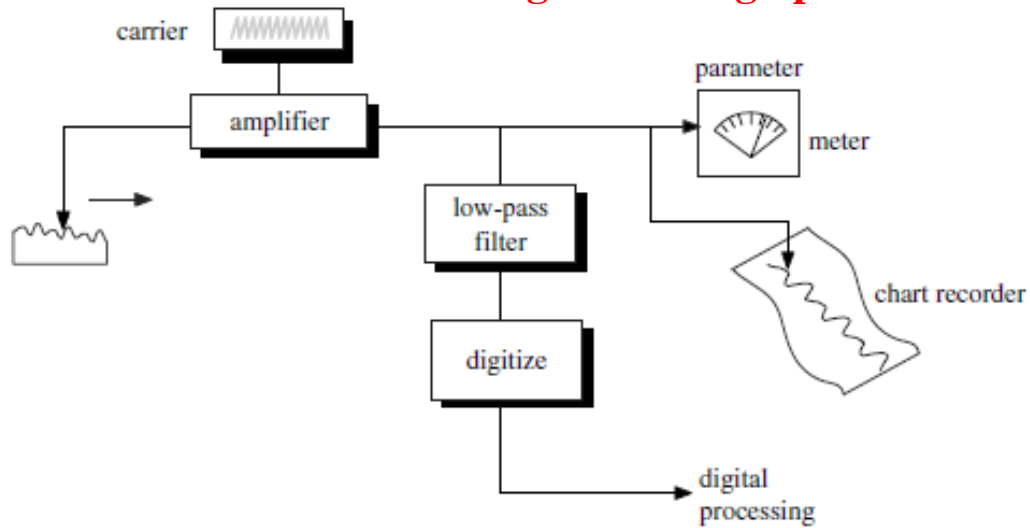


Figure 5. Schematic of an early digital stylus instrument.

類比探針式之量測系統方塊圖

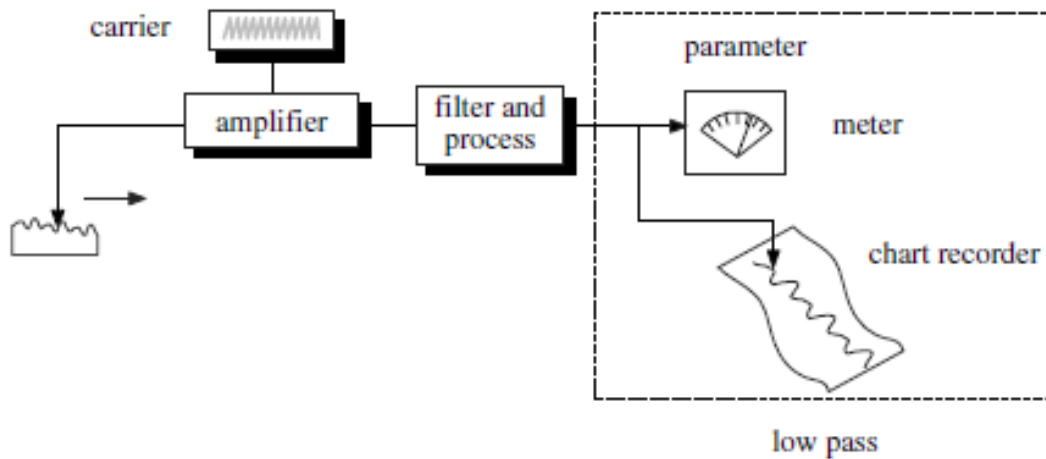


Figure 4. Schematic of an analogue stylus instrument.

表面輪廓量測儀探針結構

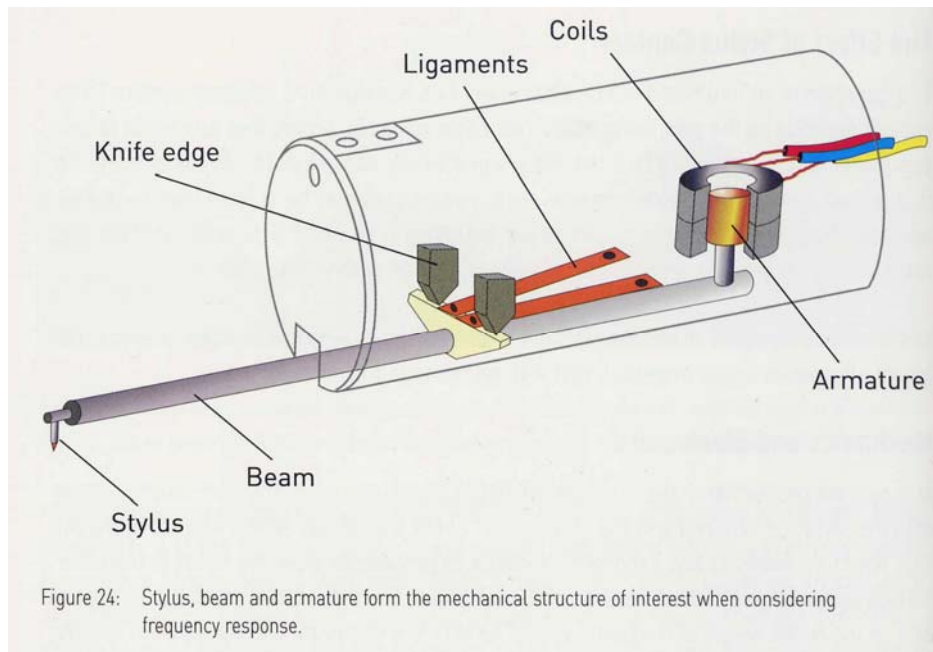


Figure 24: Stylus, beam and armature form the mechanical structure of interest when considering frequency response.

表面輪廓量測儀探針結構

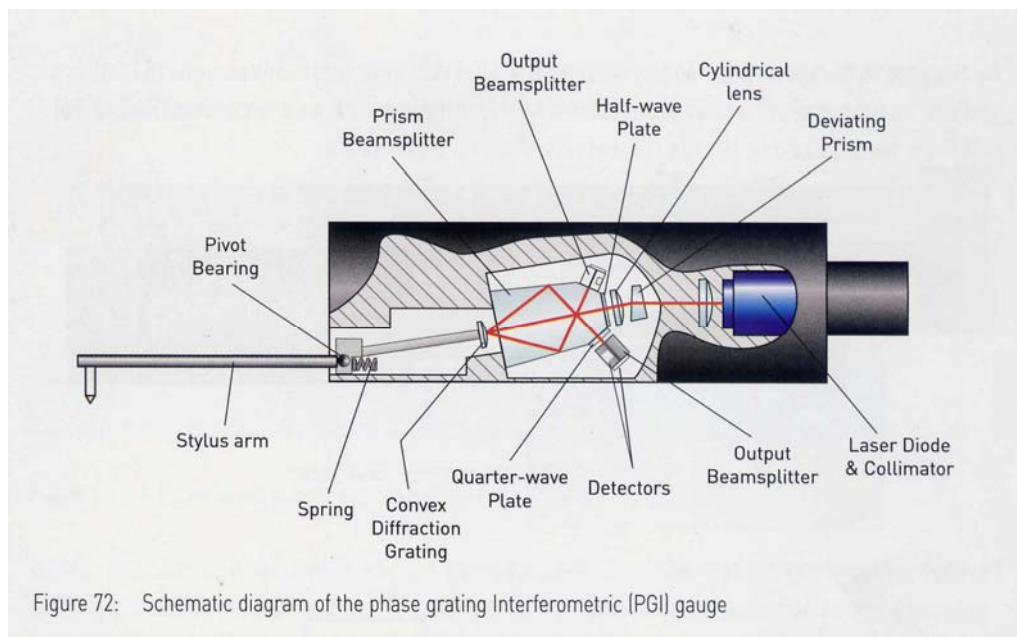


Figure 72: Schematic diagram of the phase grating Interferometric (PGI) gauge

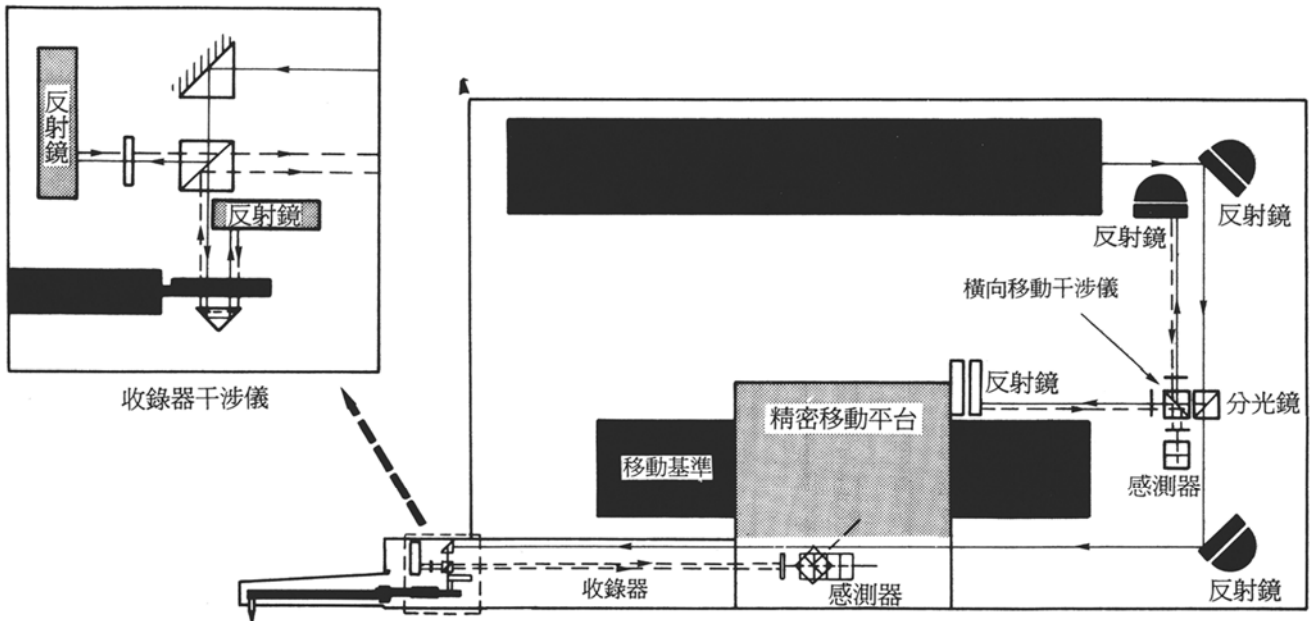


圖 8-4-7 探針式雷射干涉感測法 (英國 Rank Taylor Hobson 公司出品, 中美科學公司提供)

Two design:

1. with skids (滑動器)
2. without skids

→ Providing the reference plane for scanning.

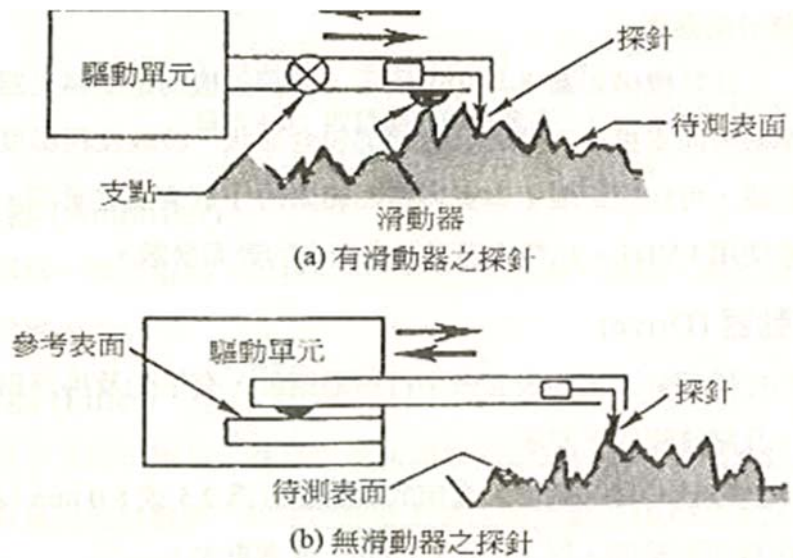


圖 8-4-3 探針與滑動器

粗糙度量測儀探針結構

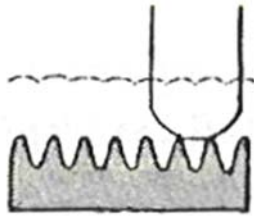


圖 8-4-4 滑動器所造成近似直線之圖形

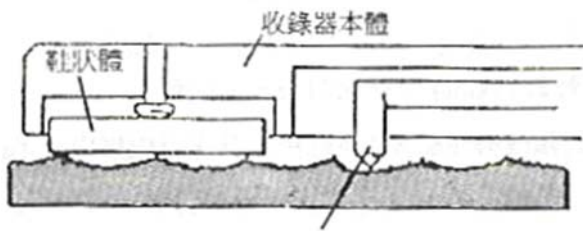


圖 8-4-5 鞋狀體探針

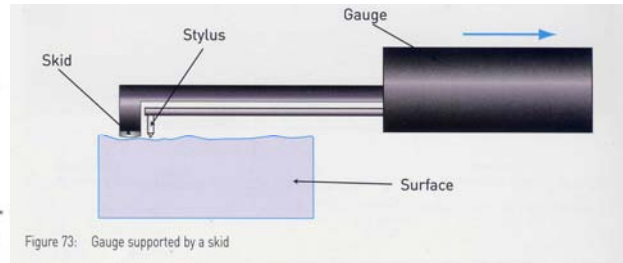


Figure 73: Gauge supported by a skid

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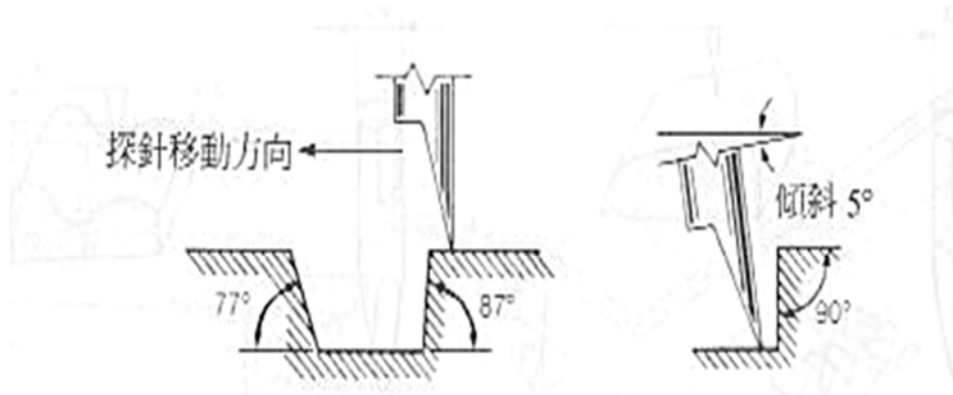
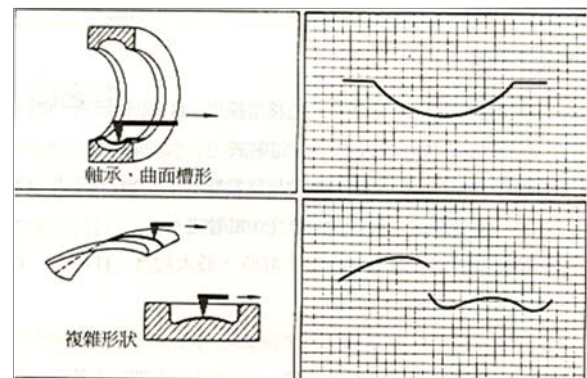
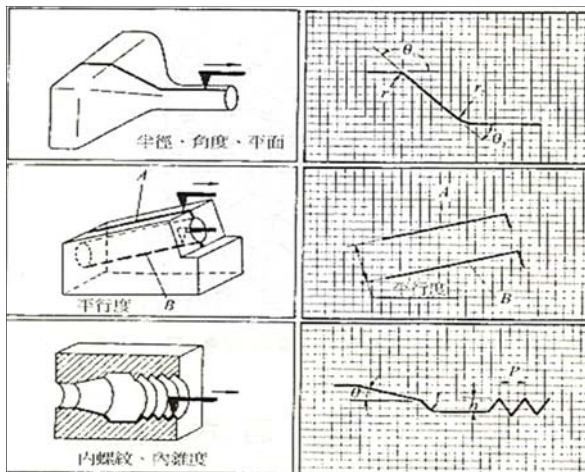


圖 6-3-4 探針運動方向與工件角度之關係

輪廓量測工件實例

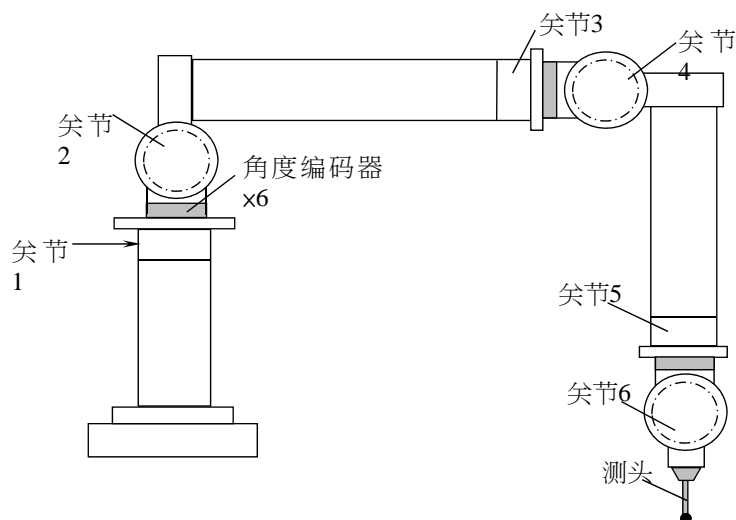




2012/11/19

2008.10 台湾大学 学术演讲

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全關節式坐标測量機結構簡圖

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應用實例



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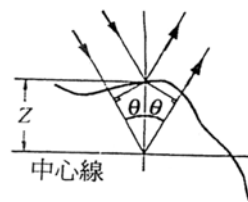


2012/11/19

2008.10 台湾大学 学术演讲

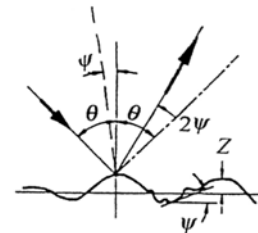
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- 當某一平行單色光束照射工作表面上，某一部份光束沿反射角反射，因工件表面粗糙度對光束影響很大，可區分鏡射式反射和散射式反射。



Z:粗糙度高度
 θ :入射角

(a) 正規式反射



ψ :表面傾斜角

(b) 散射式反射

雷射三角法探頭 (散射式)

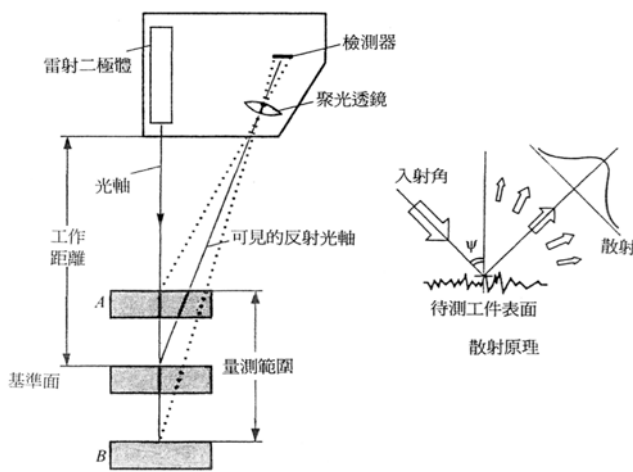
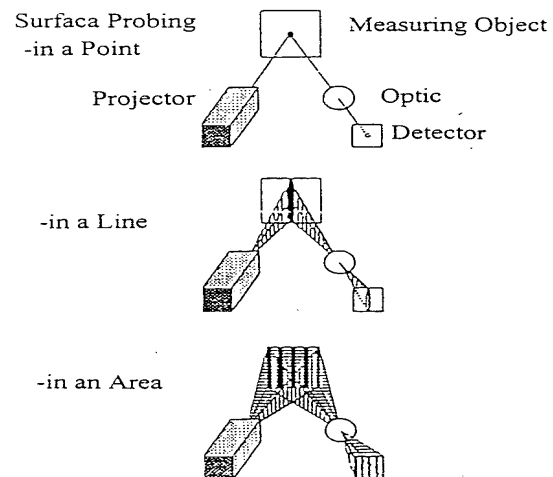


圖 9-4-16 雷射探頭 (散射式)





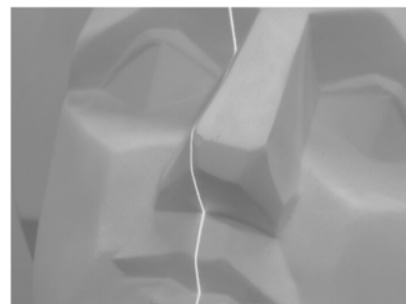
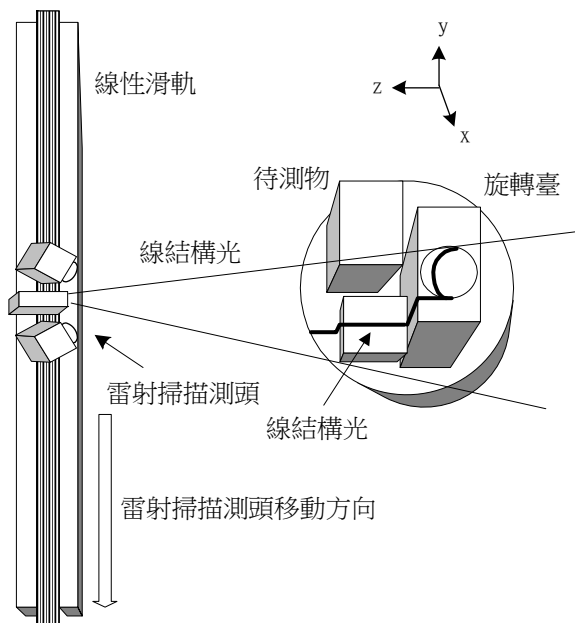
雷射三角探頭



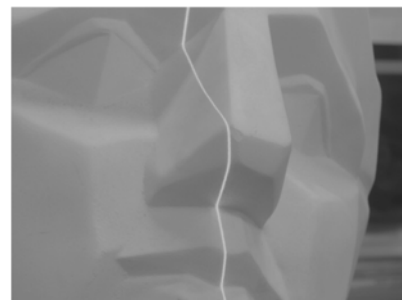
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雙探頭系統

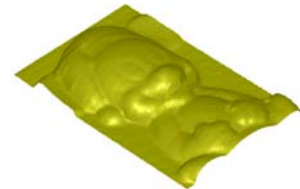
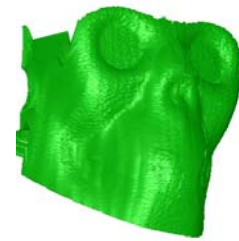
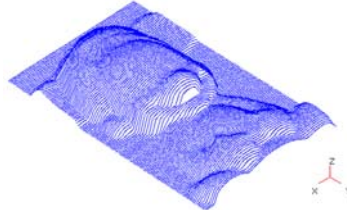
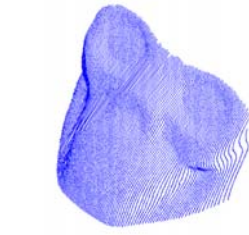
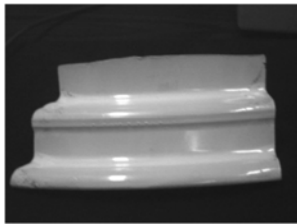


右探頭



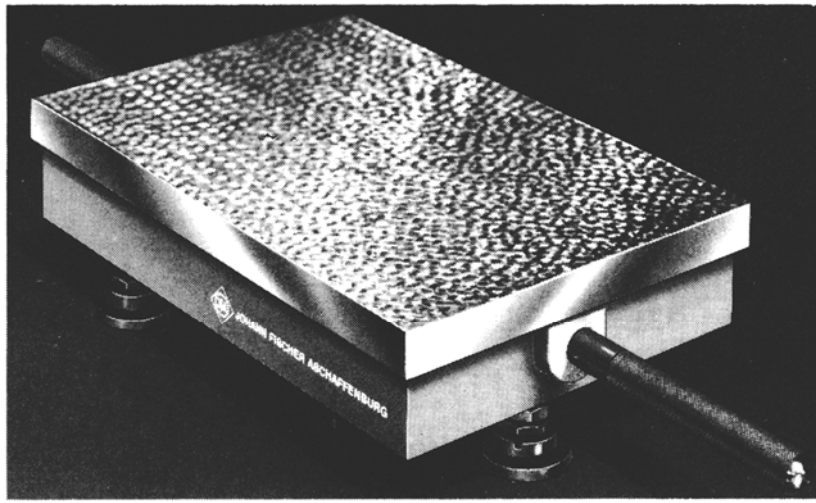
左探頭

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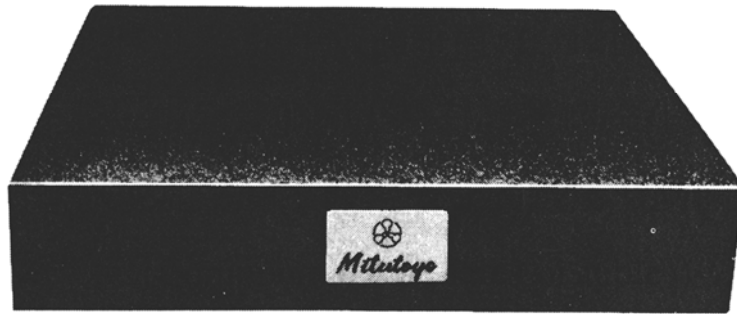


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真平度量測



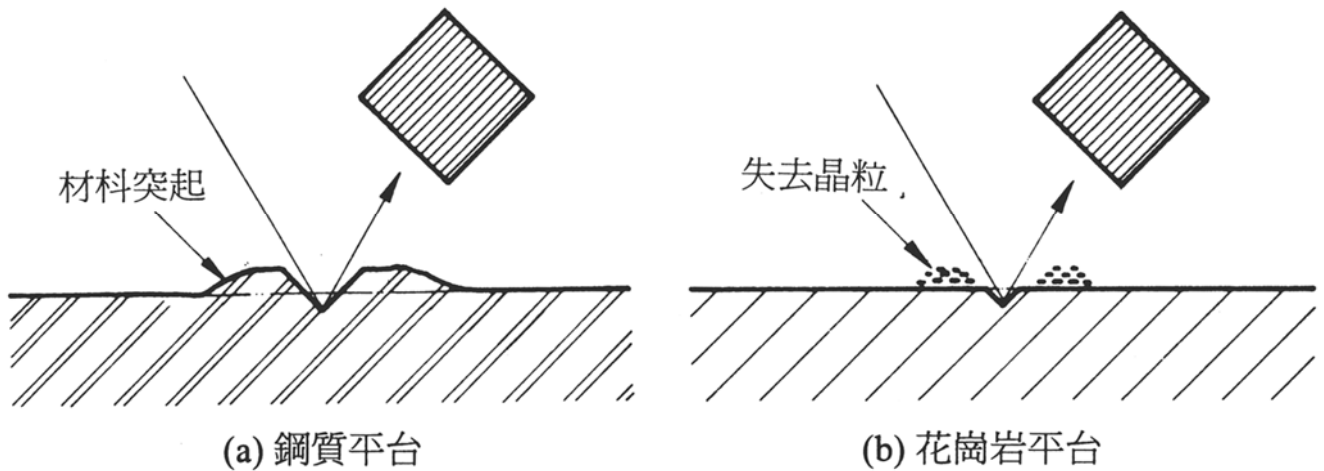
(a) 鑄鐵平板



(b) 花崗石之平板

圖 5-2-8 平 板

33



(a) 鋼質平台

(b) 花崗岩平台

圖 5-2-9 鋼質平台受撞擊或刮傷，材料突起失去真平度，而花崗岩平台僅是失去晶粒，不影響其真平度（原形精密儀器有限公司提供）

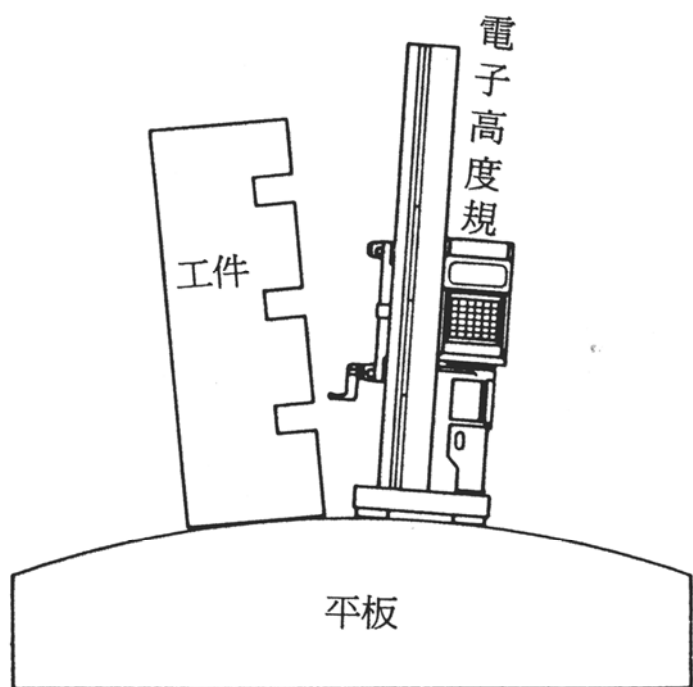
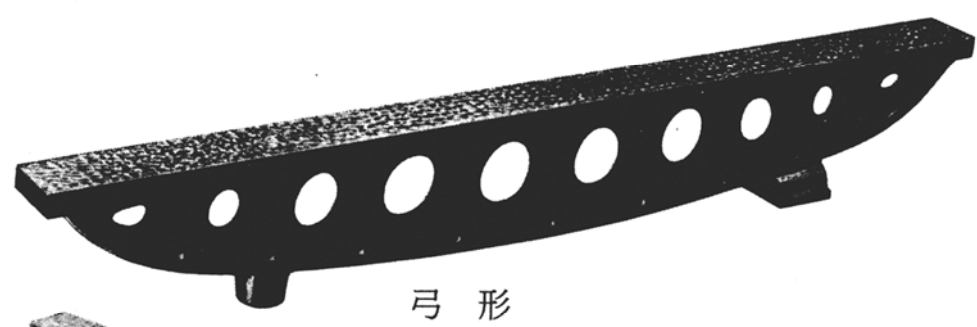
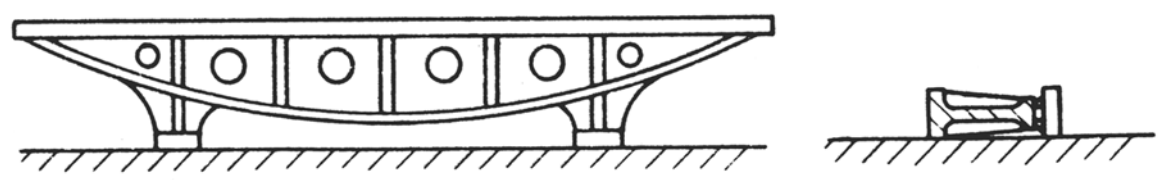
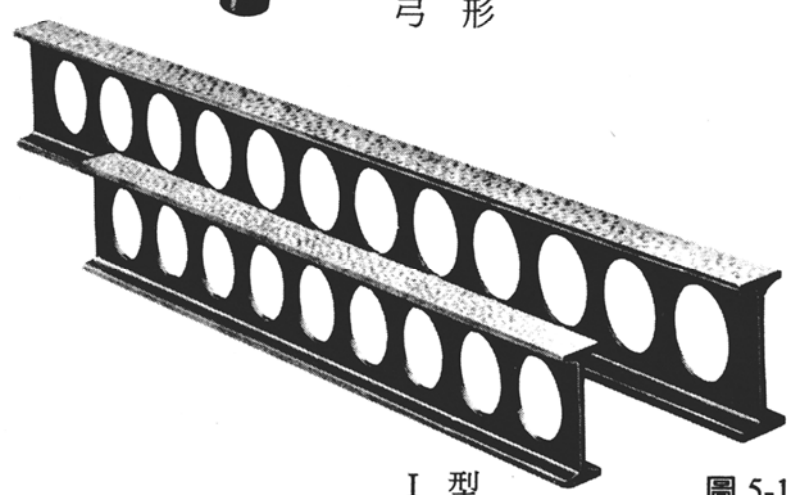


圖 5-2-1 平板之真平度不良所造成之誤差 (原形精密儀器有限公司提供)



弓形



I 型

圖 5-1-1 直規

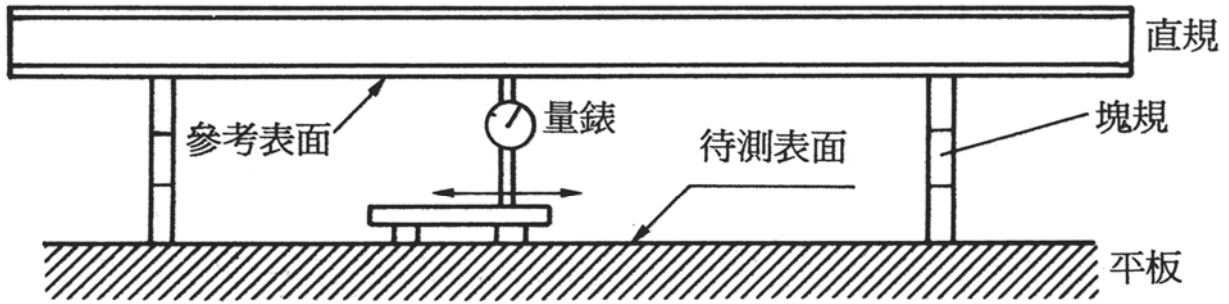


圖 5-1-2 直規之應用

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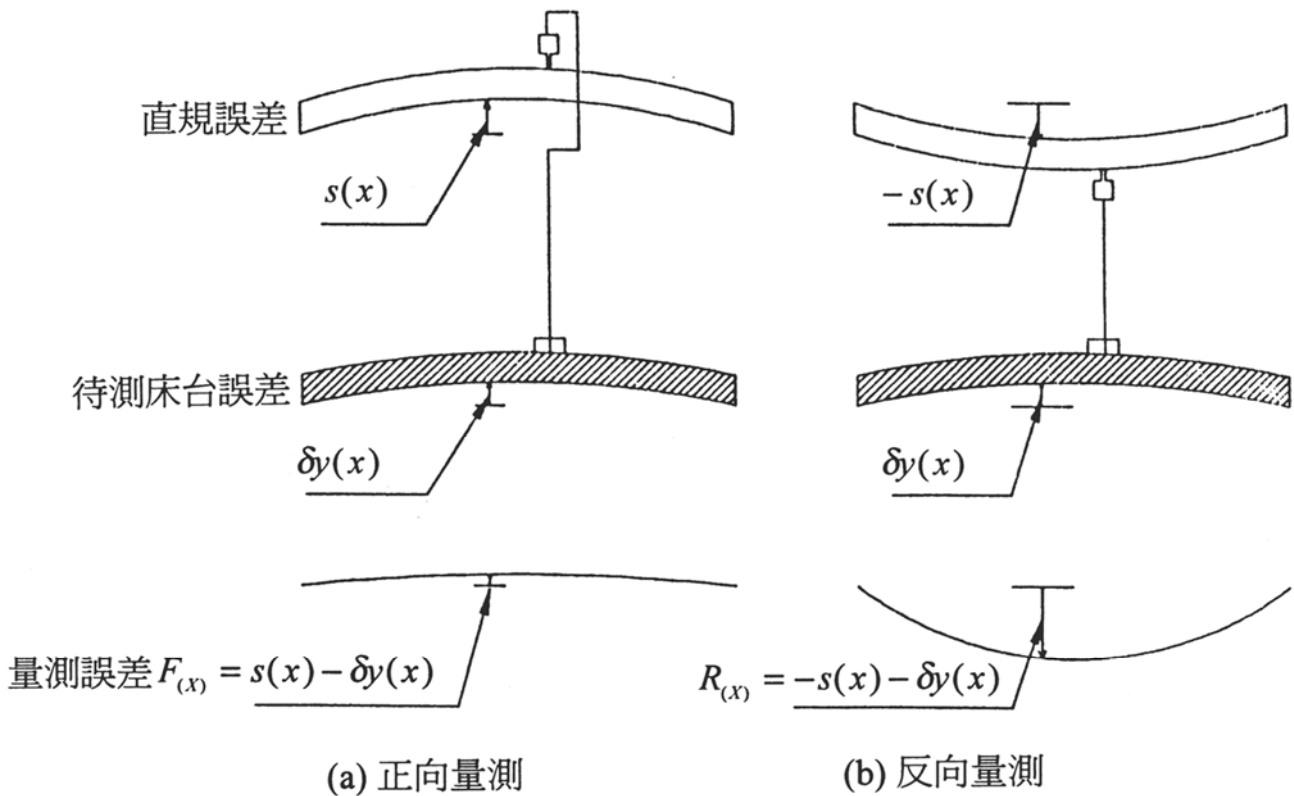
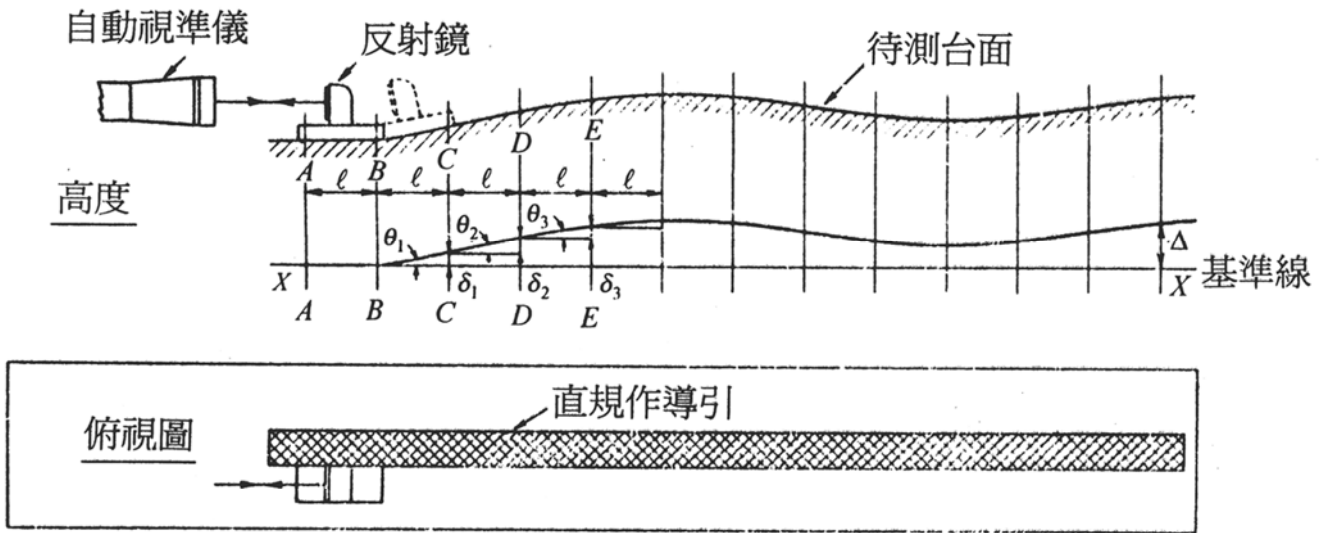


圖 5-1-3 考慮直規本身精度之量測方式及計算



XX 是沿著起始點 AB 的基線
 $\delta_1 = l\theta_1, \delta_2 = l\theta_2, \dots \quad \Delta = \sum l\theta$

圖 5-1-7 自動視準儀量測真直度之原理

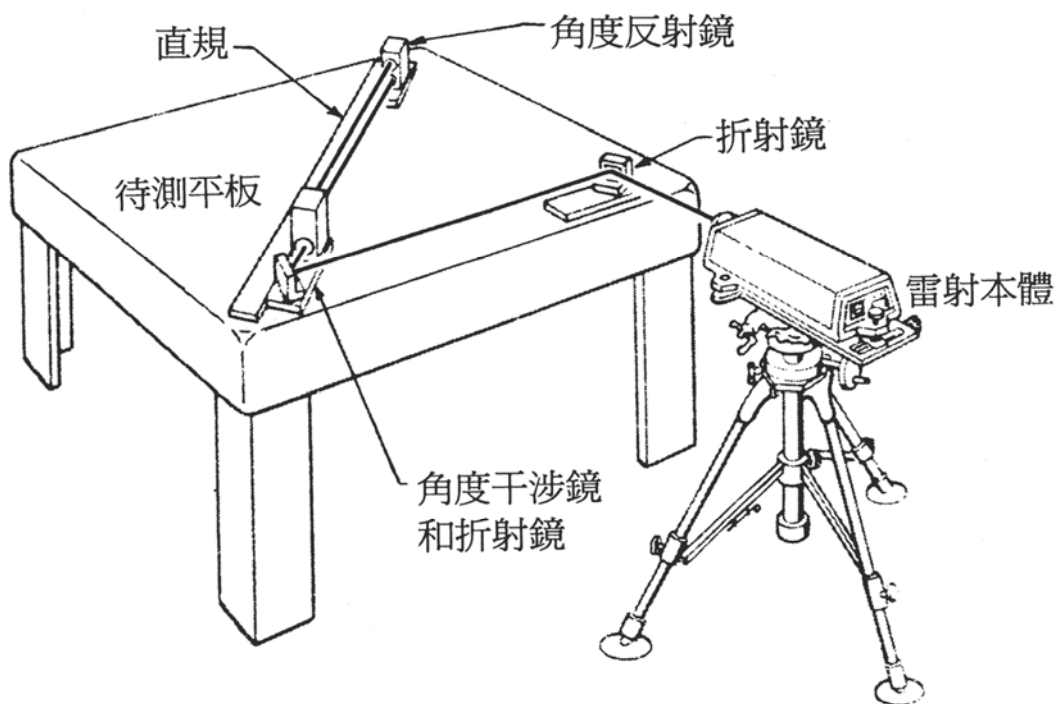


圖 5-2-4 雷射干涉儀量測平板之真平度 ([29])