Posis Technology

Optics in Surface Inspection

Automatic Optical Inspection System

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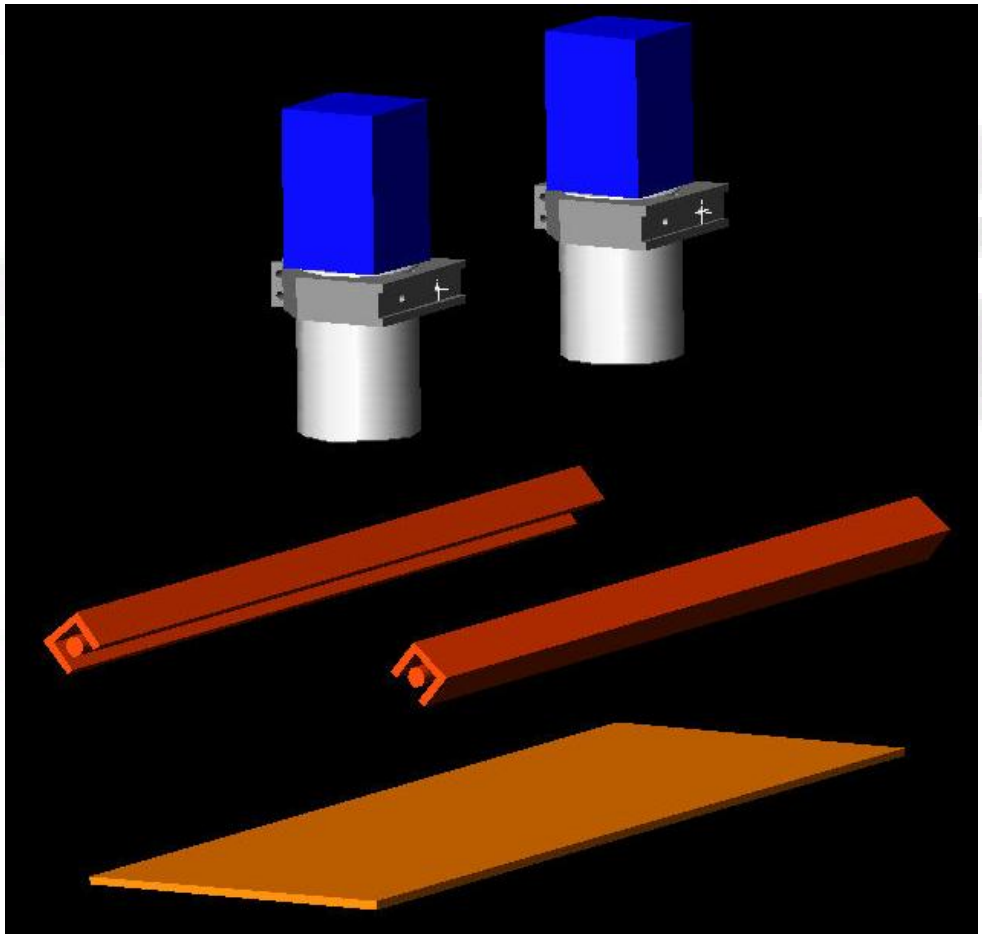
㈜포씨스테크놀로지

1. Inspection System



2. Camera

 # Benefits of Line Scan Camera

- **Low – cost**
- **High Dynamic Range**
- **High Sensitivity**
- **Fast Scanning without expensive strobing**

 # Consideration Point Before Choosing the Camera

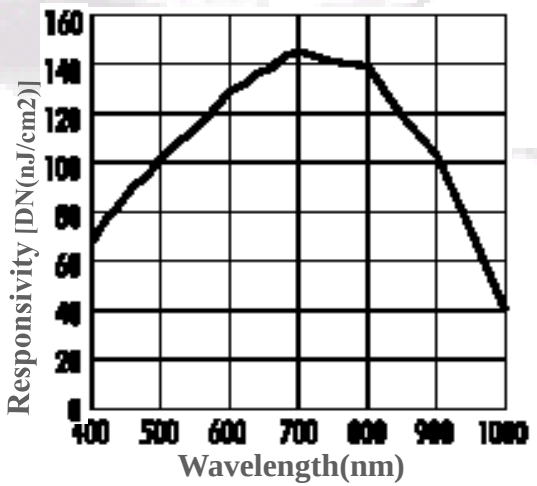
1. 제품의 특성 – 투과, 반사 조명
2. 제품과 **defect**의 투과 **or** 반사 스펙트럼 성향.
3. **Defect**의 종류
4. 검출 사이즈에 대한 한계 → **FOV**와 관계
5. 제품의 이송속도

2. Camera

Specifications of Line Scan Camera(Example : Dalsa Spyder SP-14)

# of pixels	2048	Data Format	8-bit LVDS
Pixel Size	14 ㎛ X 14 ㎛	Response	12-96DN(nJ/cm2)
Aperture Size	28.7 mm X 14 ㎛	Dynamic Range	Up to 830:1
Lens Mount	F-mount	Gain Range	1-8x
Max. Line Rate	18.7 kHz	Operating Temp.	0-50 ℃
Data Rate	40 MHz	Power Dissipation	<6W

SP-14 Responsivity(8x gain)



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2. Camera

Type

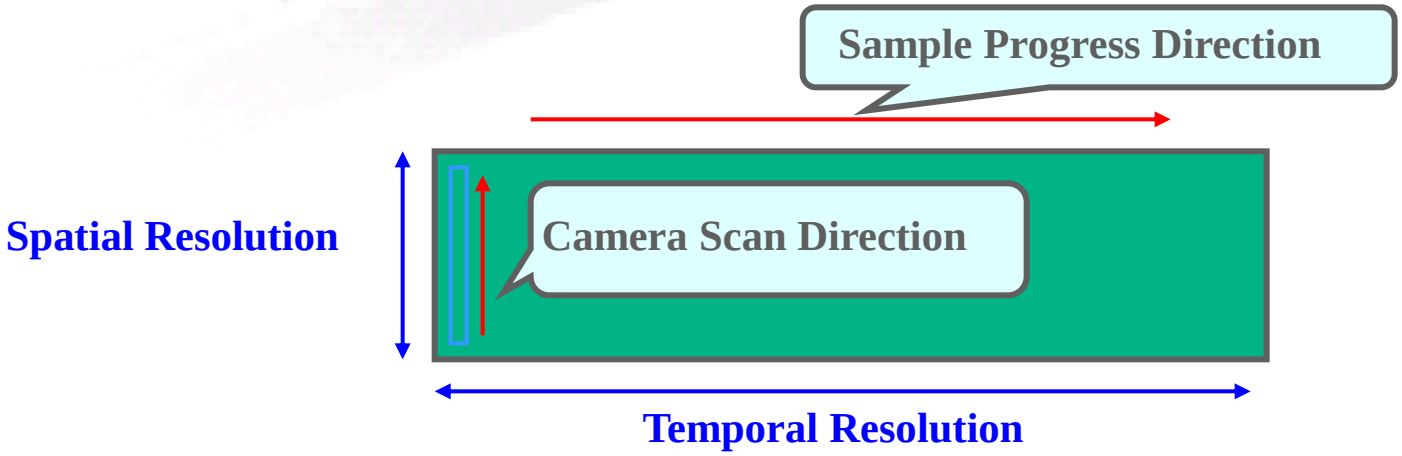
Line Scan Camera (Digital, Analog)

Resolution of Camera

Spatial Resolution : 1, 2, 5 k (1024, 2048, 5120 pixels) <= **Camera Scan Direction**

Temporal Resolution : 10, 20, 30, 40 MHz <= **Sample Progress Direction**

ex) Dalsa Line Scan Camera(2 k, 40 M) : 2048 pixels, 40 MHz(18.7 kHz/line)



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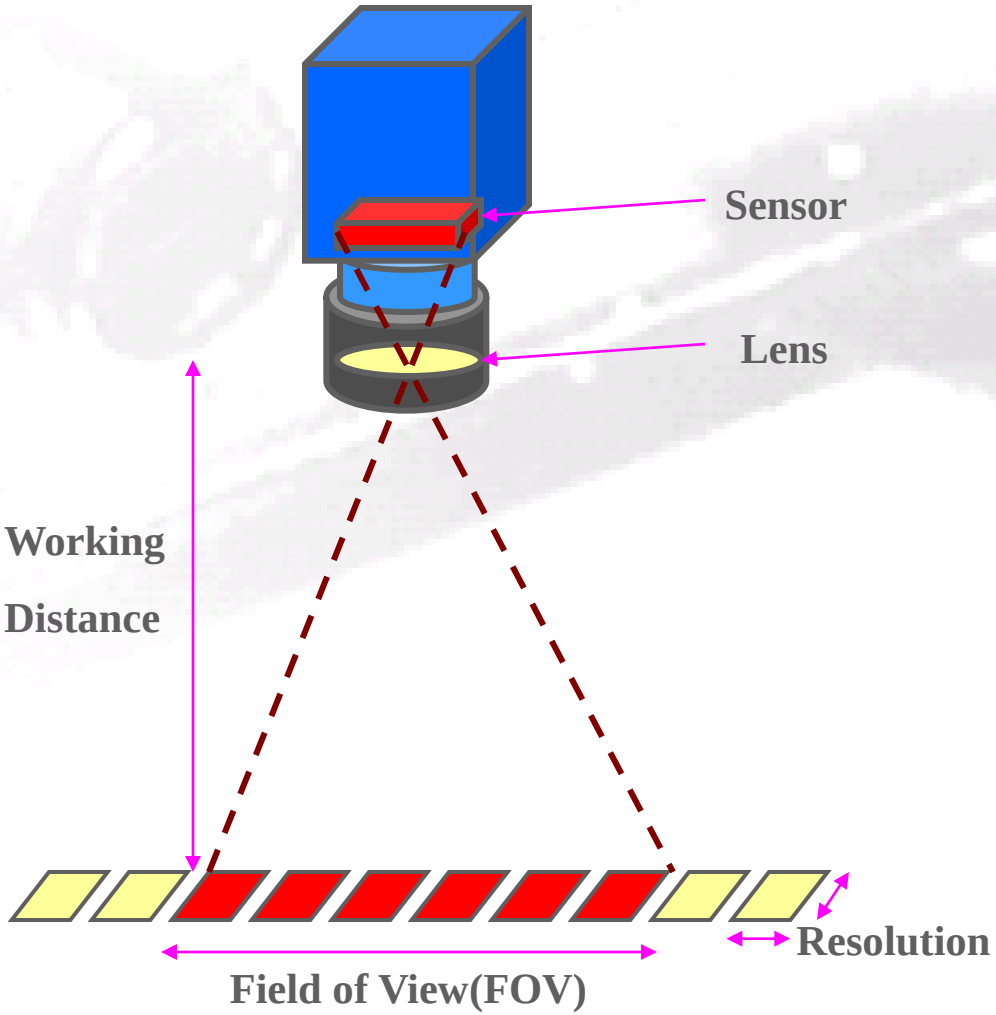
2. Camera



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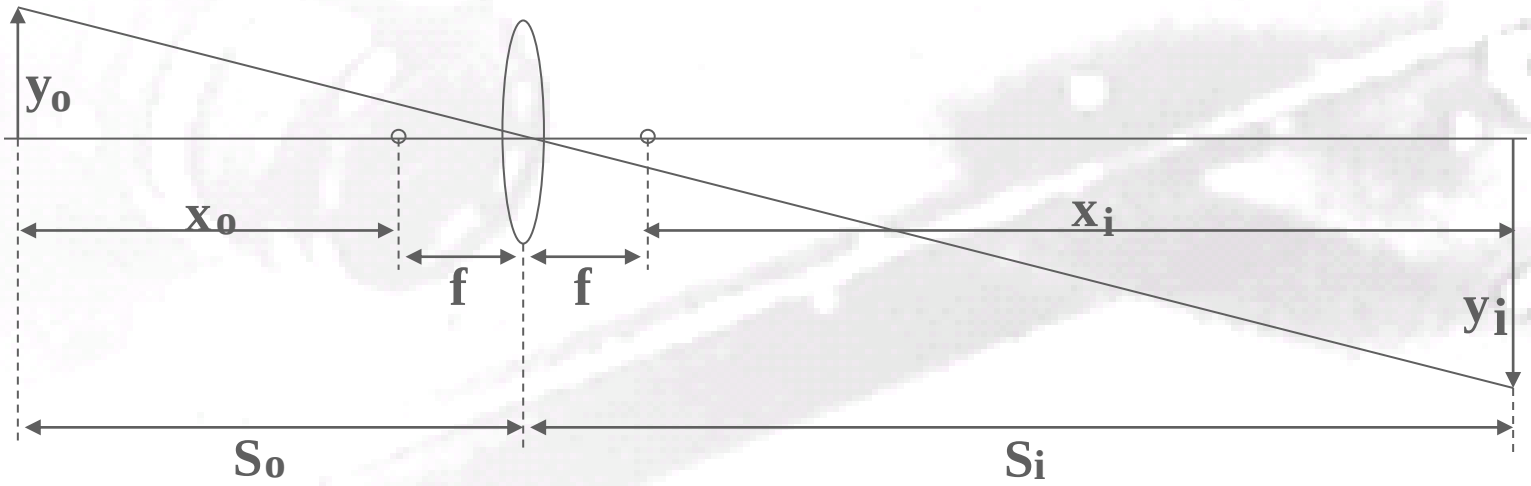
Calculation of Working Distance ; Single Lens



y_o : Object Size

S_o : Distance between Object and Lens

$S_o = x_o + f$

y_i : Image Size

S_i : Distance between Image and Lens

$S_i = x_i + f$

$$M_T = \frac{|y_i|}{|y_o|} = \left|\frac{S_i}{S_o}\right| = \left|\frac{x_i}{f}\right| = \left|\frac{f}{x_o}\right|$$

$$\frac{|y_i|}{|y_o|} = \left|\frac{x_i}{f}\right| \quad , \quad \frac{|y_i|}{|y_o|} = \left|\frac{f}{x_o}\right|$$

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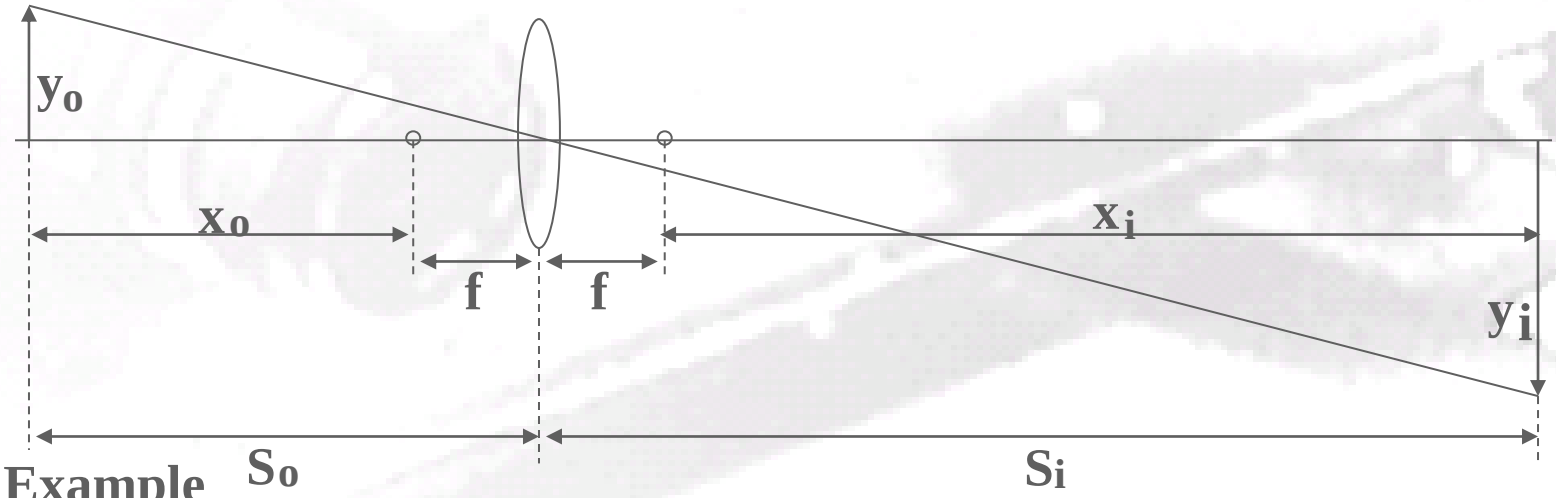
Calculation of Working Distance ; Single Lens



Example

y_o : Camera Aperture Size(dalsa) ; 28.7 mm

y_i : FOV(Field of View) ; 480 mm

f : focal length of Lens ; 50 mm

$$\frac{|y_i|}{|y_o|} = \left|\frac{x_i}{f}\right| \qquad \frac{480}{28.7} = \frac{x_i}{50} \qquad x_i = 836.23$$

$$S_i = x_i + f = \mathbf{886.23}$$

$$\frac{|y_i|}{|y_o|} = \left|\frac{f}{x_o}\right| \qquad \frac{480}{28.7} = \frac{50}{x_o} \qquad x_o = 2.989$$

$$S_o = x_o + f = \mathbf{52.989}$$

Optics in Surface Inspection

Calculation of Resolution

1. Spatial Resolution

Example

Dalsa Line Scan Camera (2 k, 40 M (18.7 kHz))

Aperture size = 28.7 mm

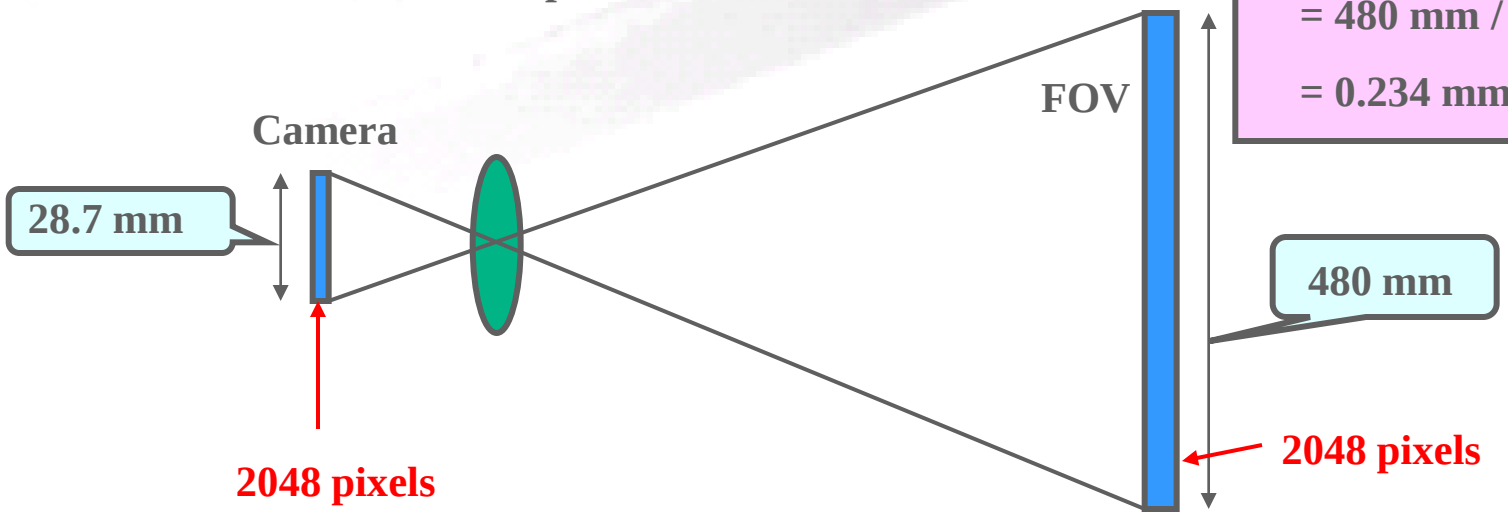
If FOV(Field of View) is 480 mm,

Size of each 1 pixel in FOV is 0.234 mm.

Size of 1 pixel = FOV / # pixels

= 480 mm / 2048 pixels

= 0.234 mm / pixel



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Calculation of Resolution

2. Temporal Resolution

 # Example (Dalsa Line Scan Camera, 2 k, 40 M (18.7 kHz))

Speed of Sample Progress = v (m/s)

Time of 1 line progress = 1 / 18.7 (sec)

Distance of 1 line progress in 1 clock

$$x = v\,t$$

➔ $x = v * 1 / 18.7$

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Calculation of Resolution

3. Example of Resolution Calculation

 # Example (Dalsa Line Scan Camera, 2 k, 40 M (18.7 kHz)), FOV = 480 mm

Speed of Sample Progress = 600 (m/min)

Spatial Resolution

= FOV / # of pixels = 480 (mm) / 2048 (pixels) = 0.234 mm/ pixel

Temporal Resolution

Speed of Sample Progress = 600 (m/min) = 10 (m/s) = 10000 (mm/s)

Time of 1 line progress = 1 / 18700 (sec)

Distance of 1 line progress in 1 clock

x = v t

➔ x = 10000 * 1 / 18700 = 0.535 mm

→ Resolution of this Sample = 0.234 X 0.535 mm

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3. Light Source

Light Source : Red, IR, Blue, White, Green LED
Halogen Lamp, Laser, etc..

Optical Filter(polarizer, diffuser, beam splitter, color filter, optical fiber, etc..)

+

Light Source = Light Source Systems

+

Controller

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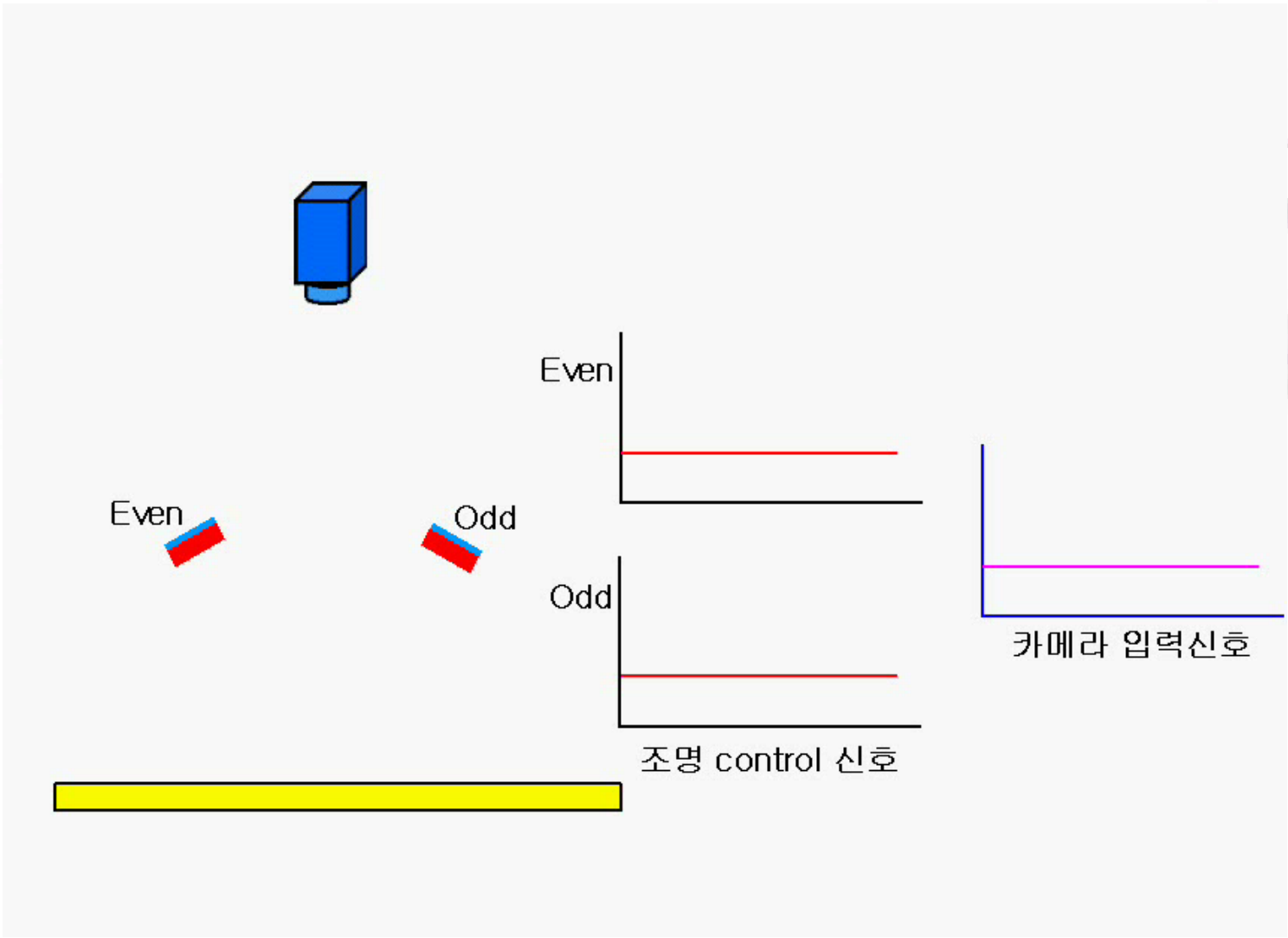
3.



• Patent Pending

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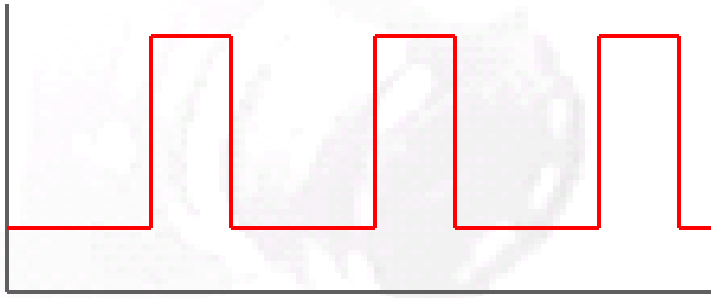
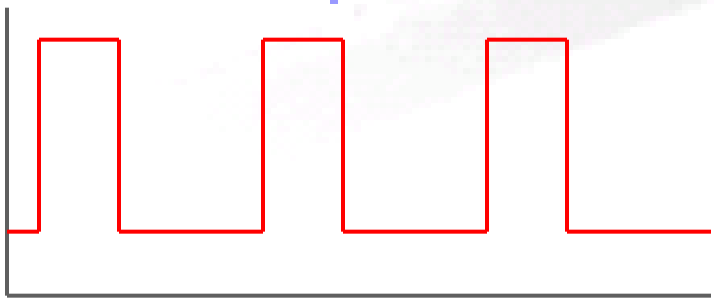
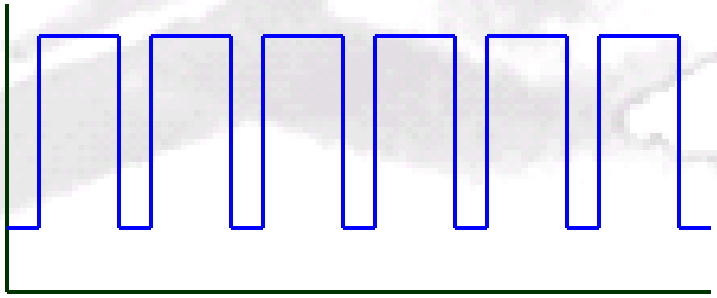


Even 신호



Odd 신호



Even + Odd 신호로 인한 카메

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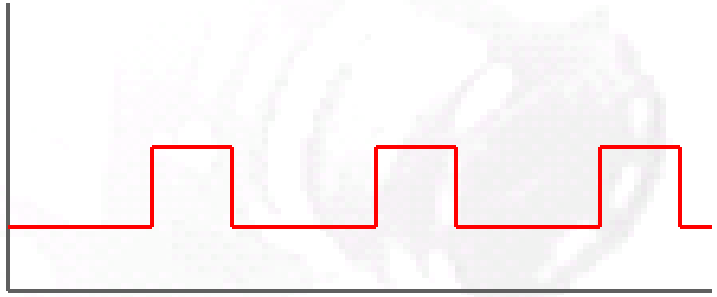
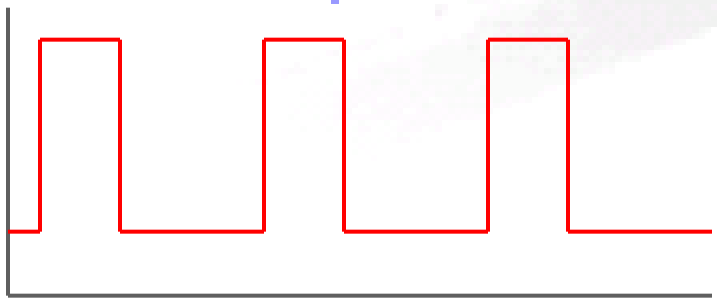
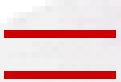
Ex)

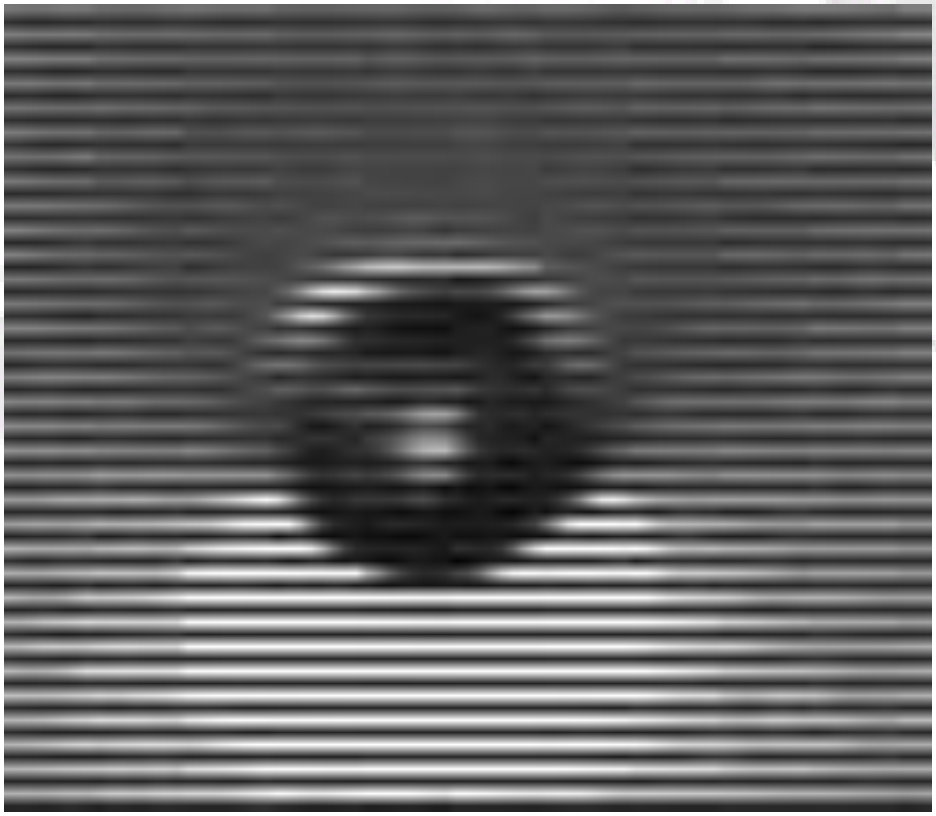


Even 신호



Odd 신호





Even 과 Odd의 세기를 달리하였을

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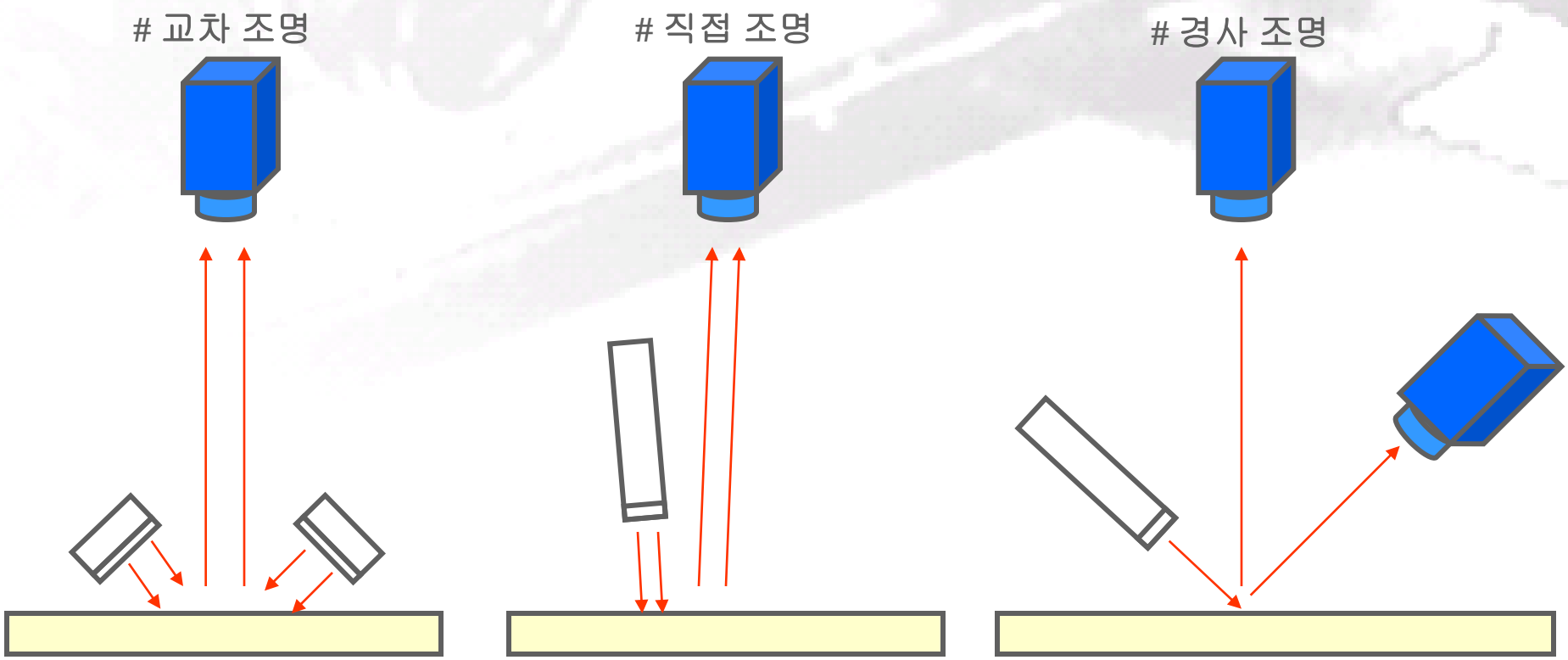
3. Light Source

Irradiation ways

1. Reflection Mode



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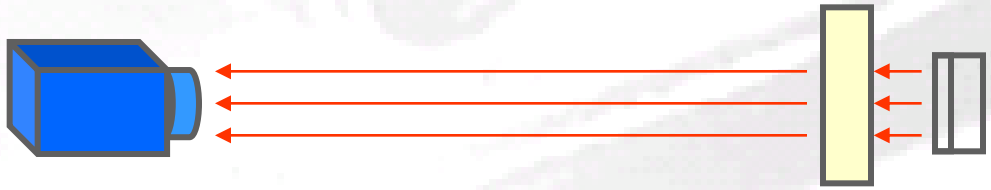
3. Light Source

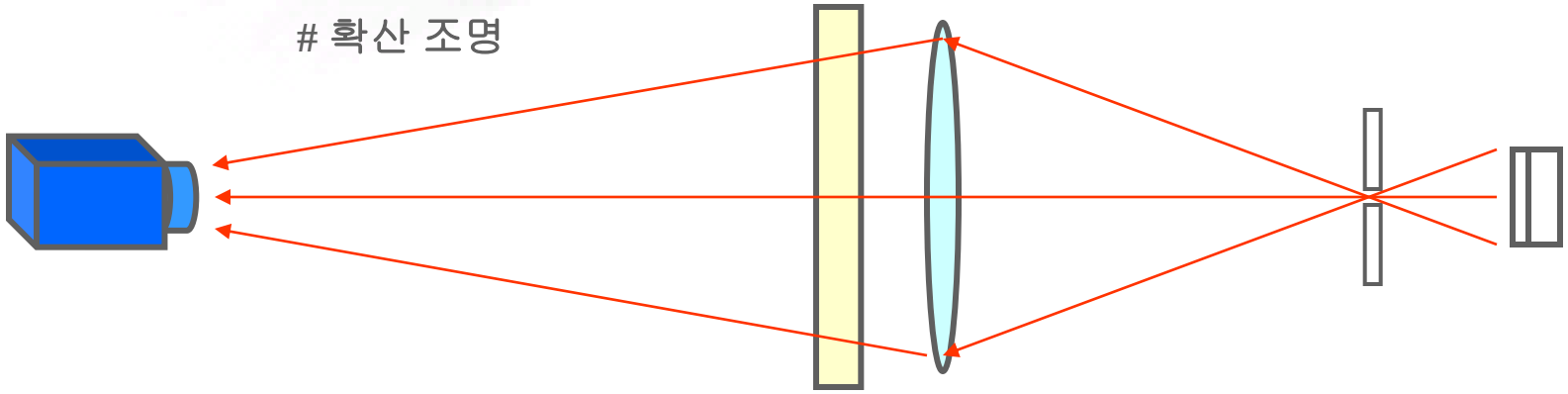
Irradiation ways

2. Transmission Mode

직접 조명



확산 조명



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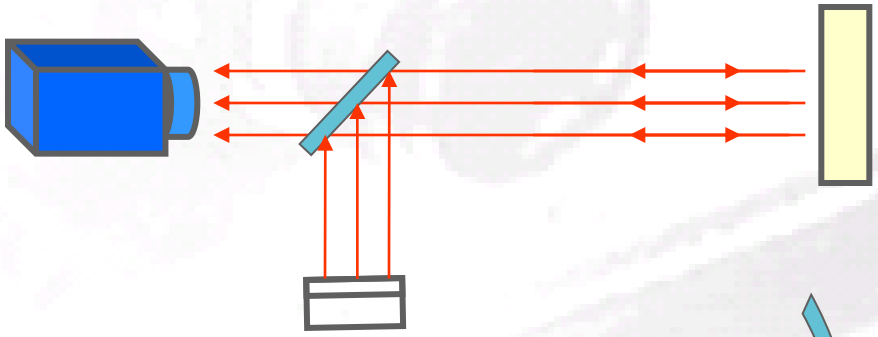
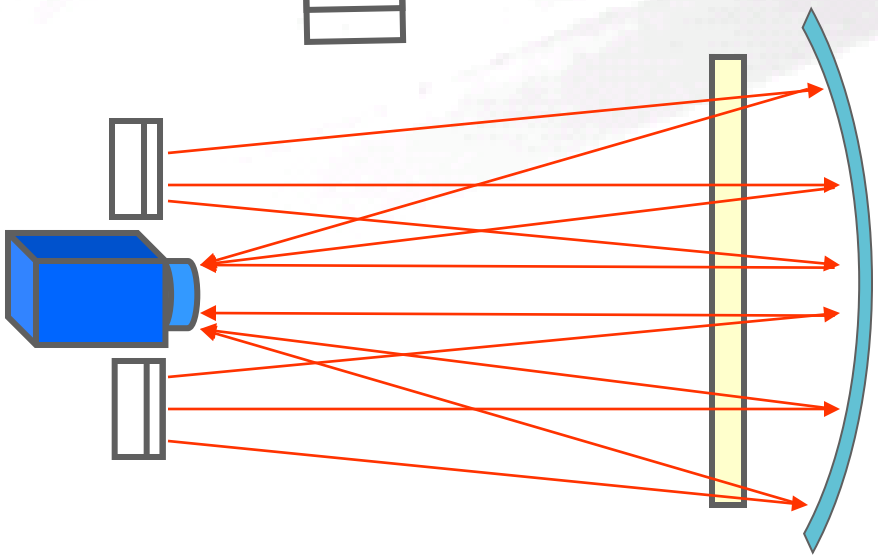
3. Light Source

Special Irradiation Systems



← Using Half Mirror



← Using Mirror

* Patent Pending

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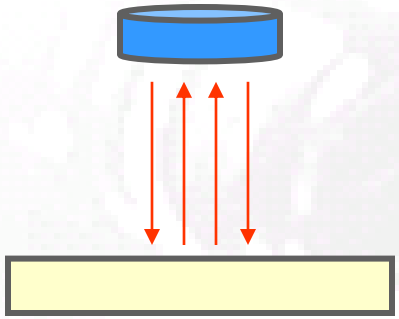
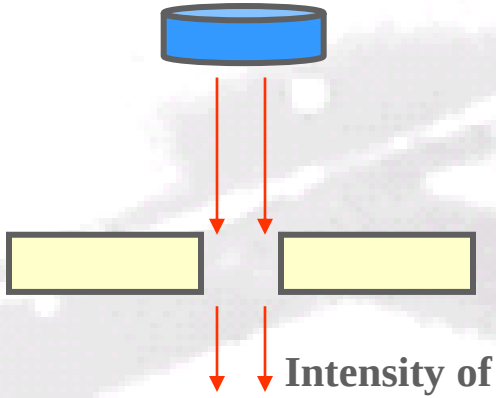
반사체에 대한 빛의 세기

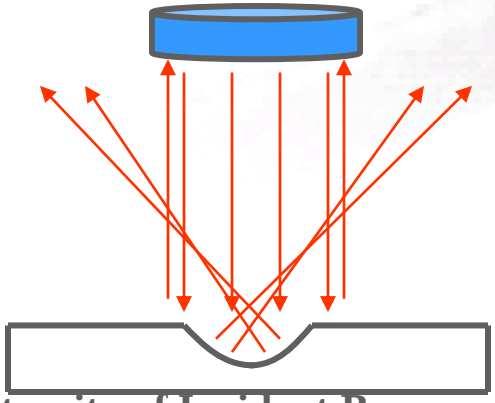


Intensity of Incident Beam

≃ Intensity of Reflection Beam

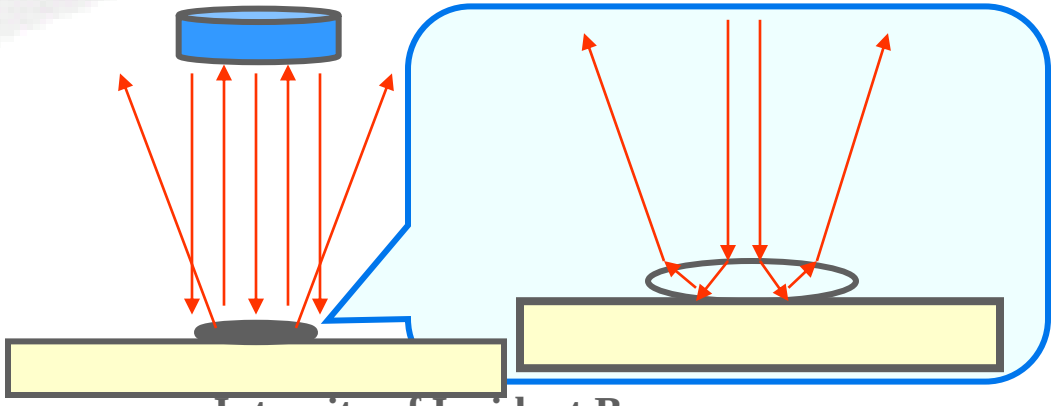


Intensity of Reflection Beam = 0



Intensity of Incident Beam

< Intensity of Reflection Beam



Intensity of Incident Beam

< Intensity of Reflection Beam

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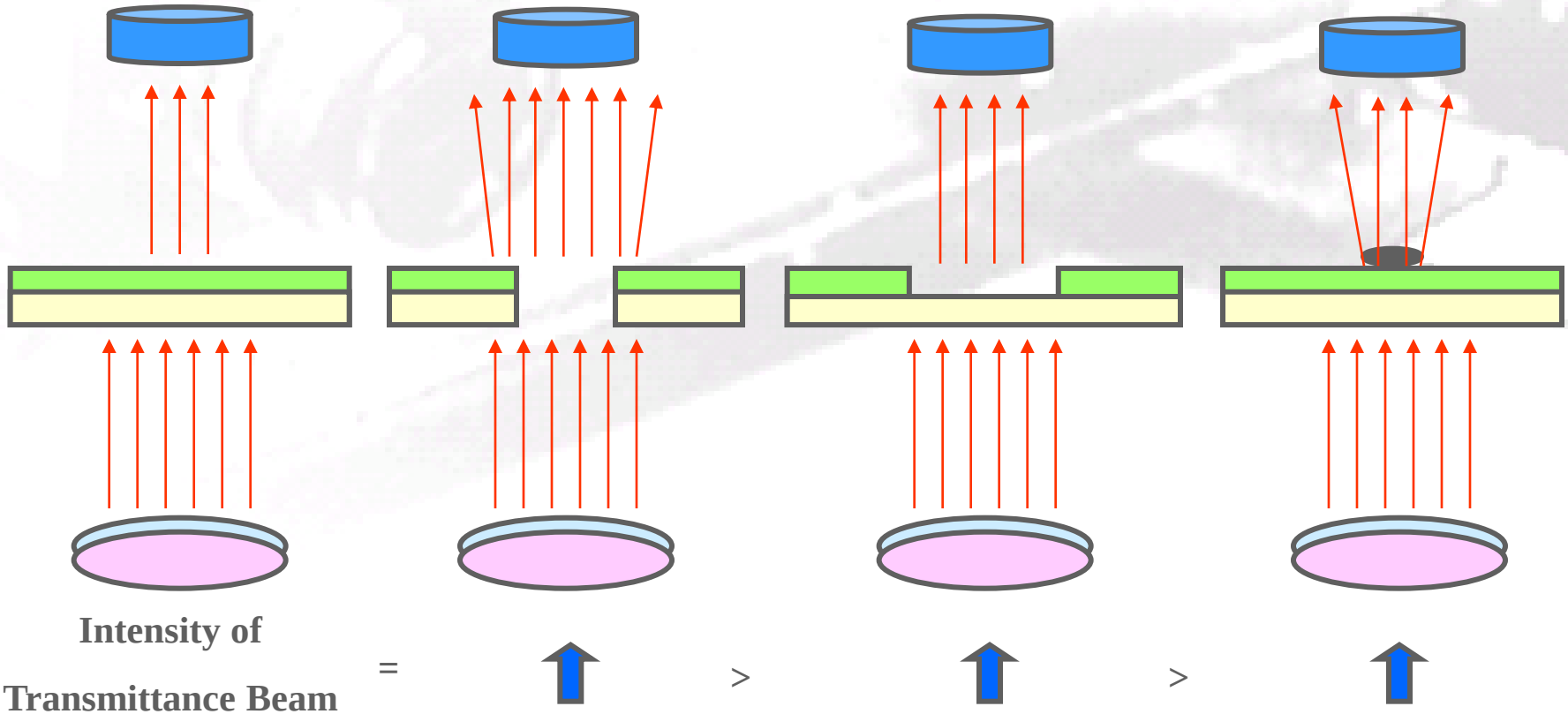
투과체에 대한 빛의 세기



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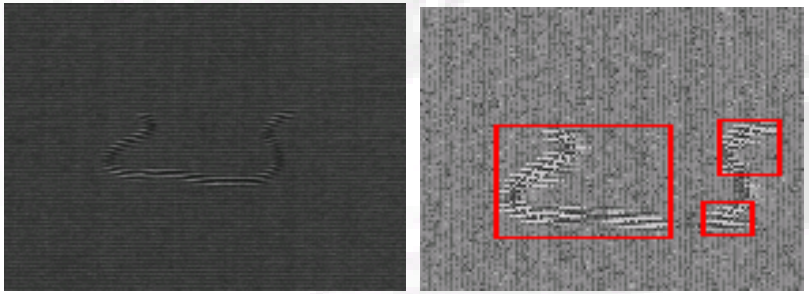
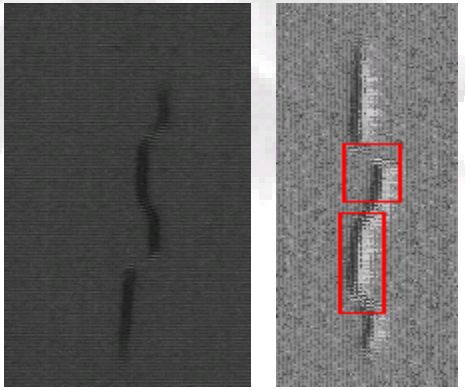
4. Relation between Light Source and Type of Defects

Ex) Images of Defects in the CCL (real Image ; processing image)

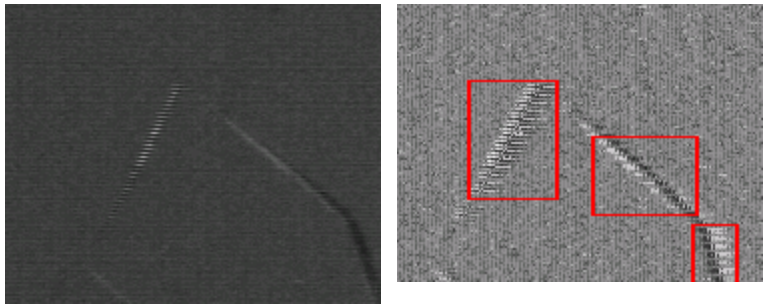
Pit and Dent



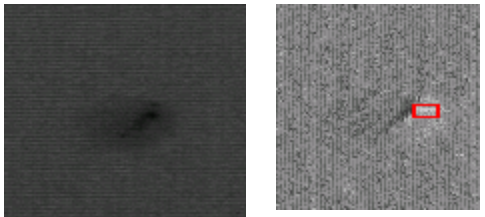
Wrinkle



SCH



CPS



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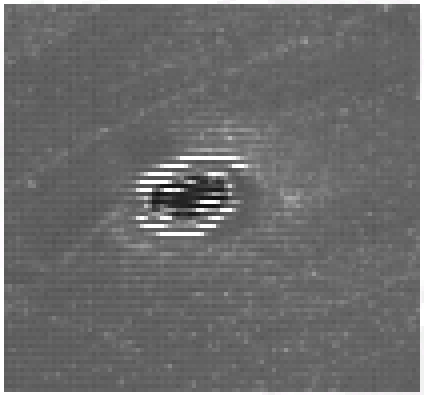
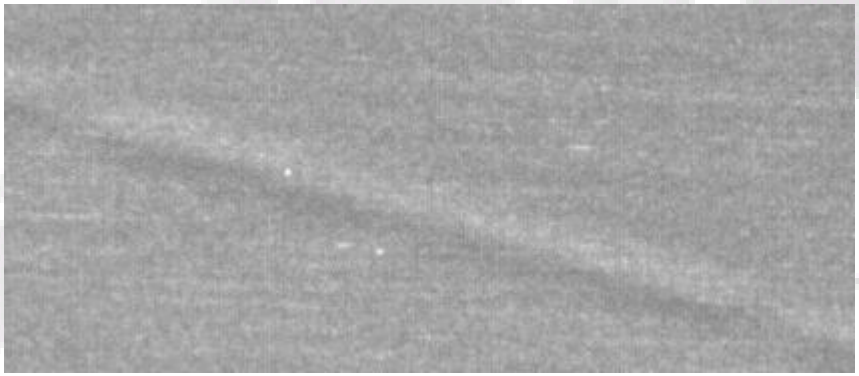
Ex) Images of Defects in the CCL

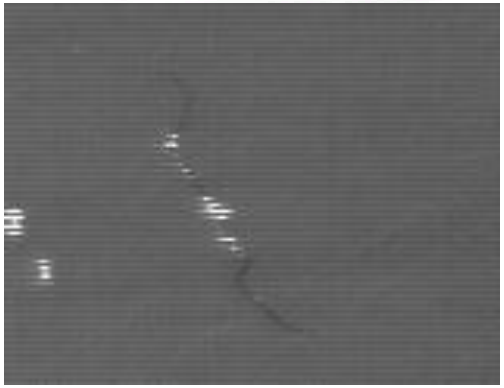
흑점



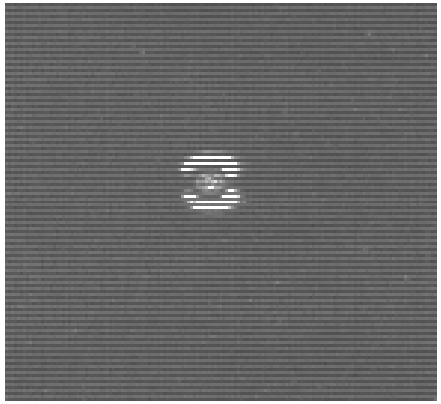
주름



P&D



버블



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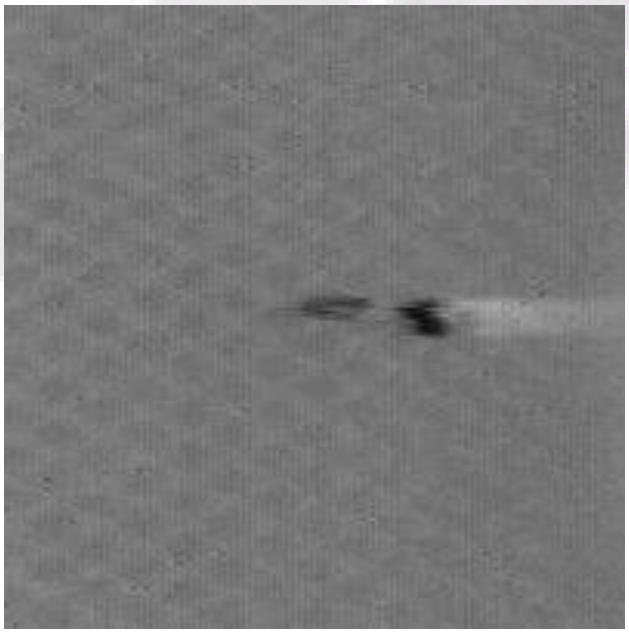
Ex) Images of Defects in the 부직포

이물



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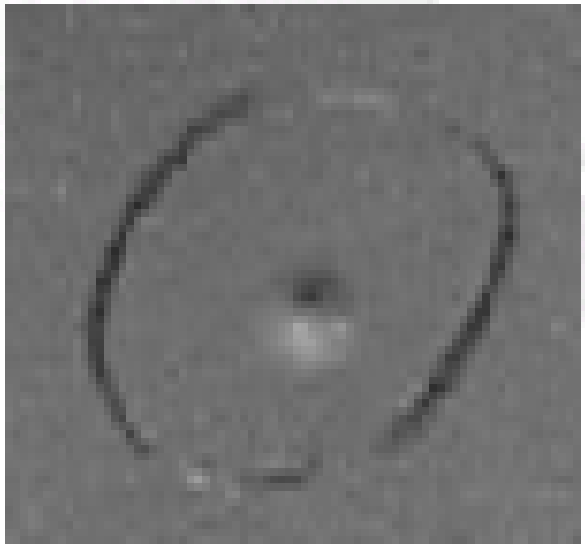
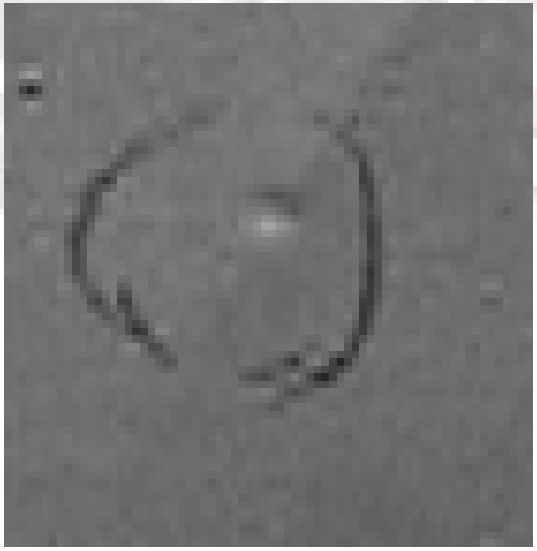
Ex) Images of Defects in the battery

눌림자국





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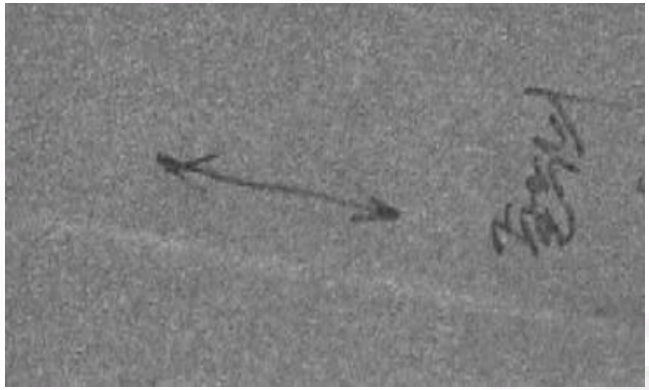
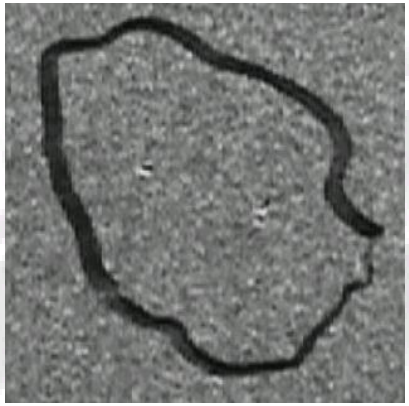
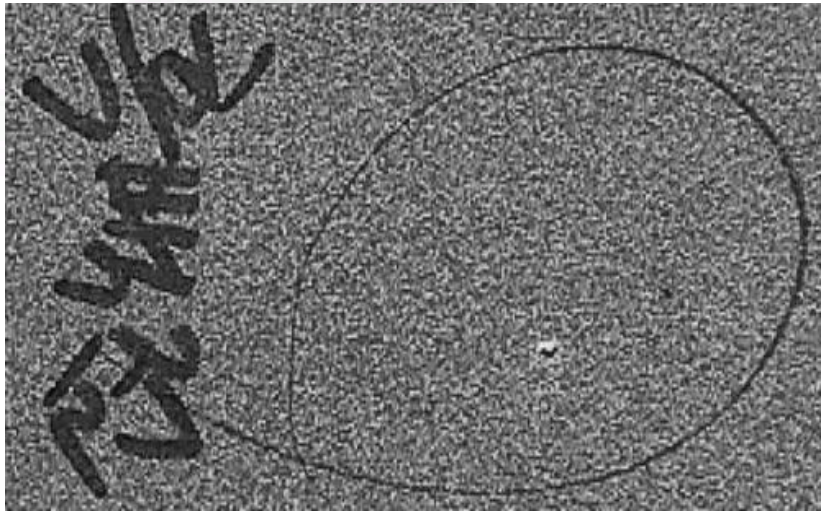
Ex) Images of Defects in the Diffuser film







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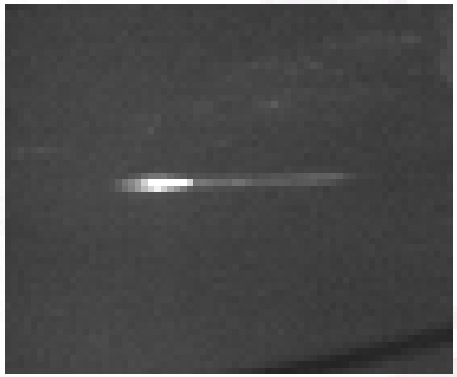
Ex) Images of Defects in the ML film



PH,PHW (no filter)

PH,PHW (filter)

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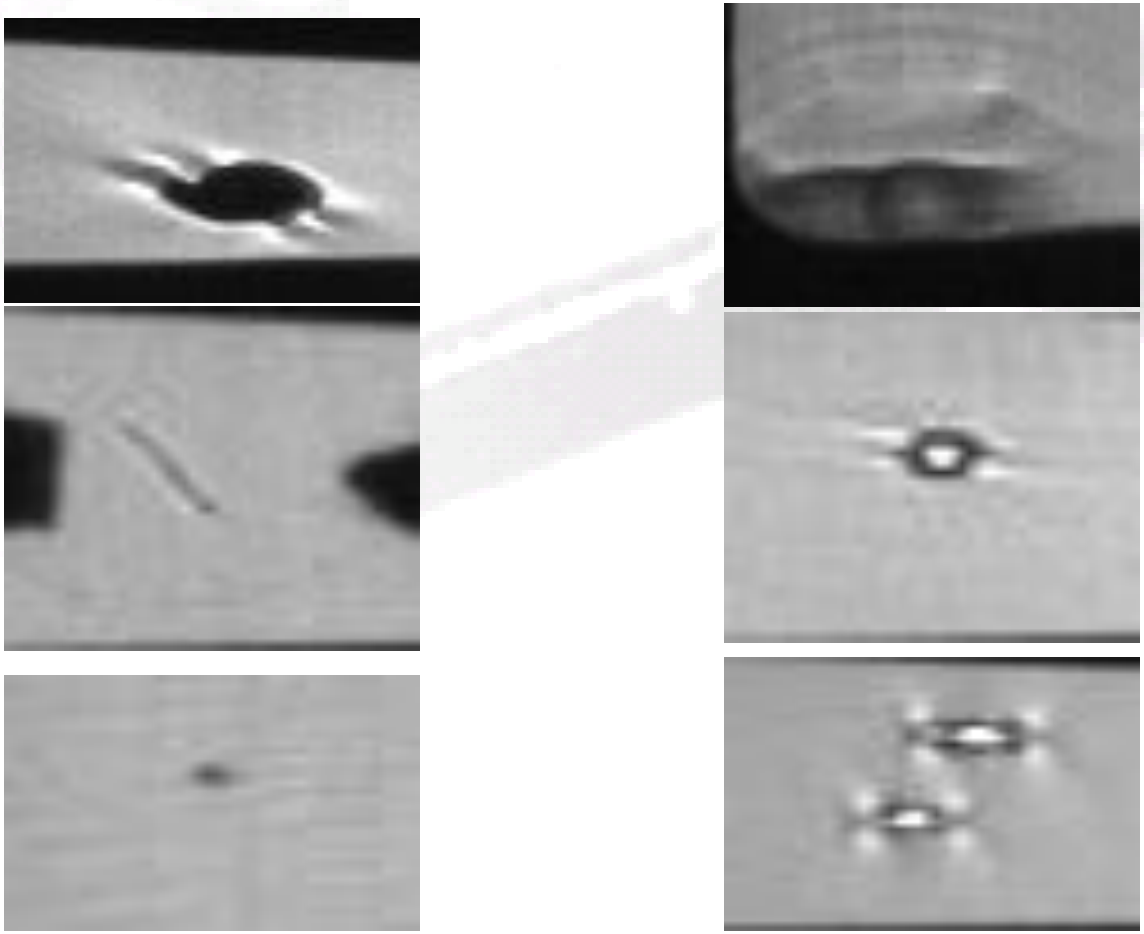
Ex) Images of Defects in the Transparent film (Real image)



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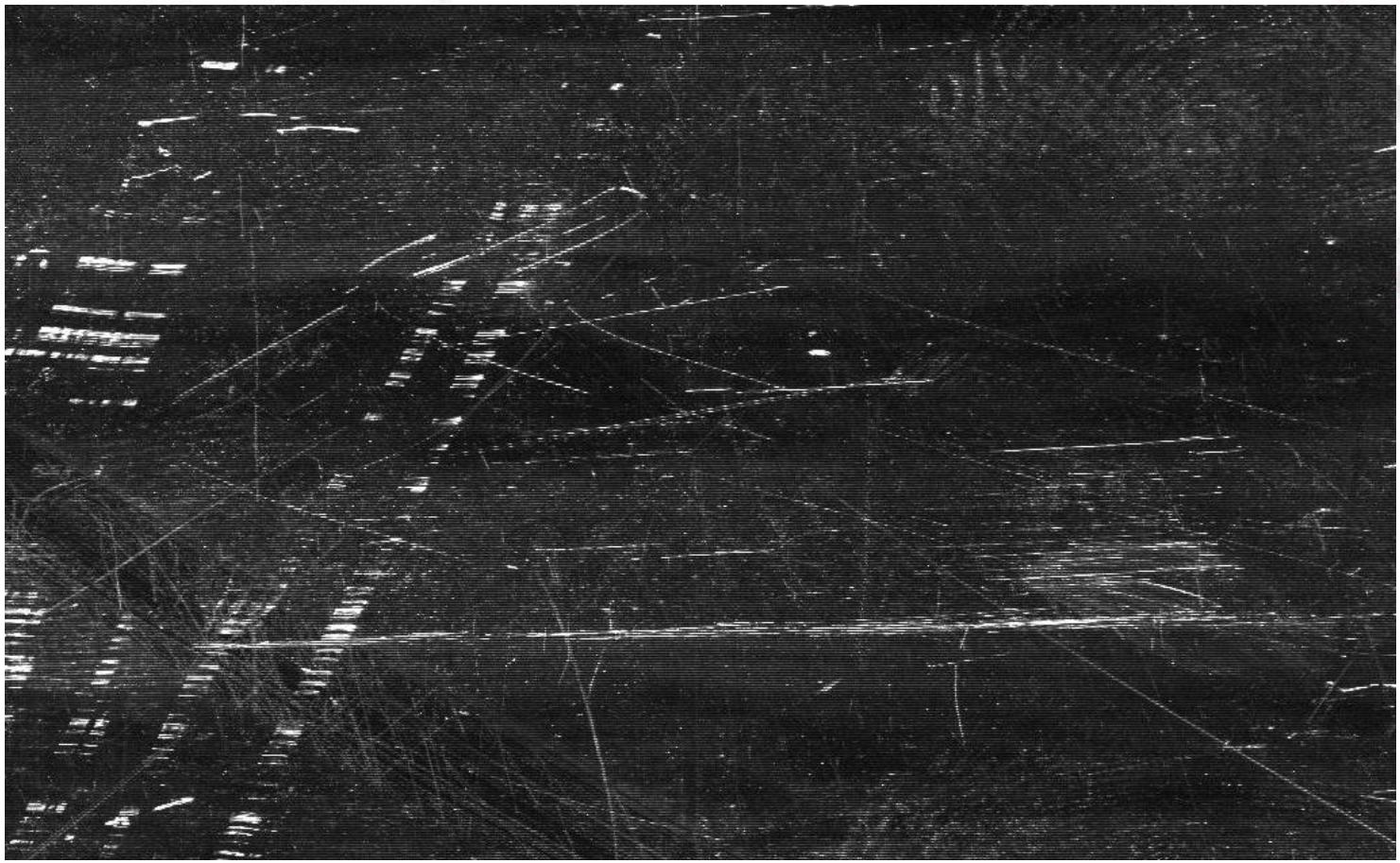
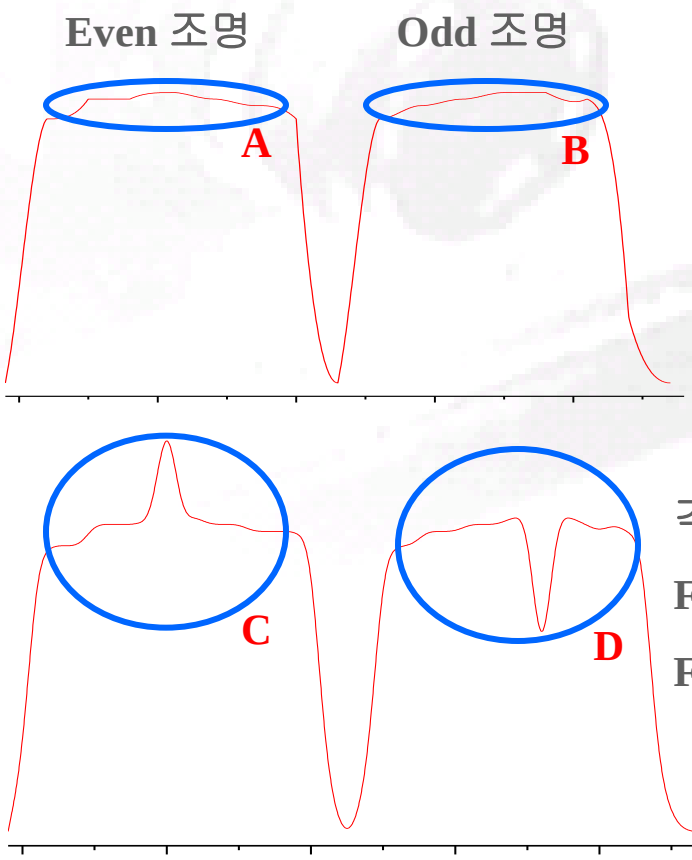
Ex) Images of Defects in the Object of High Reflectance (Real image)

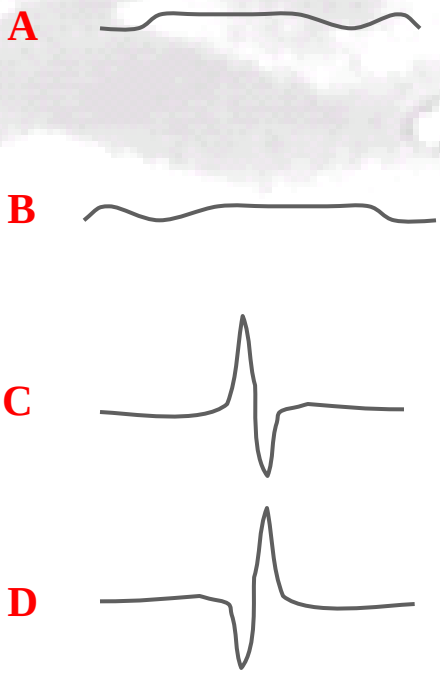


Optics in Surface Inspection

5. Processing System

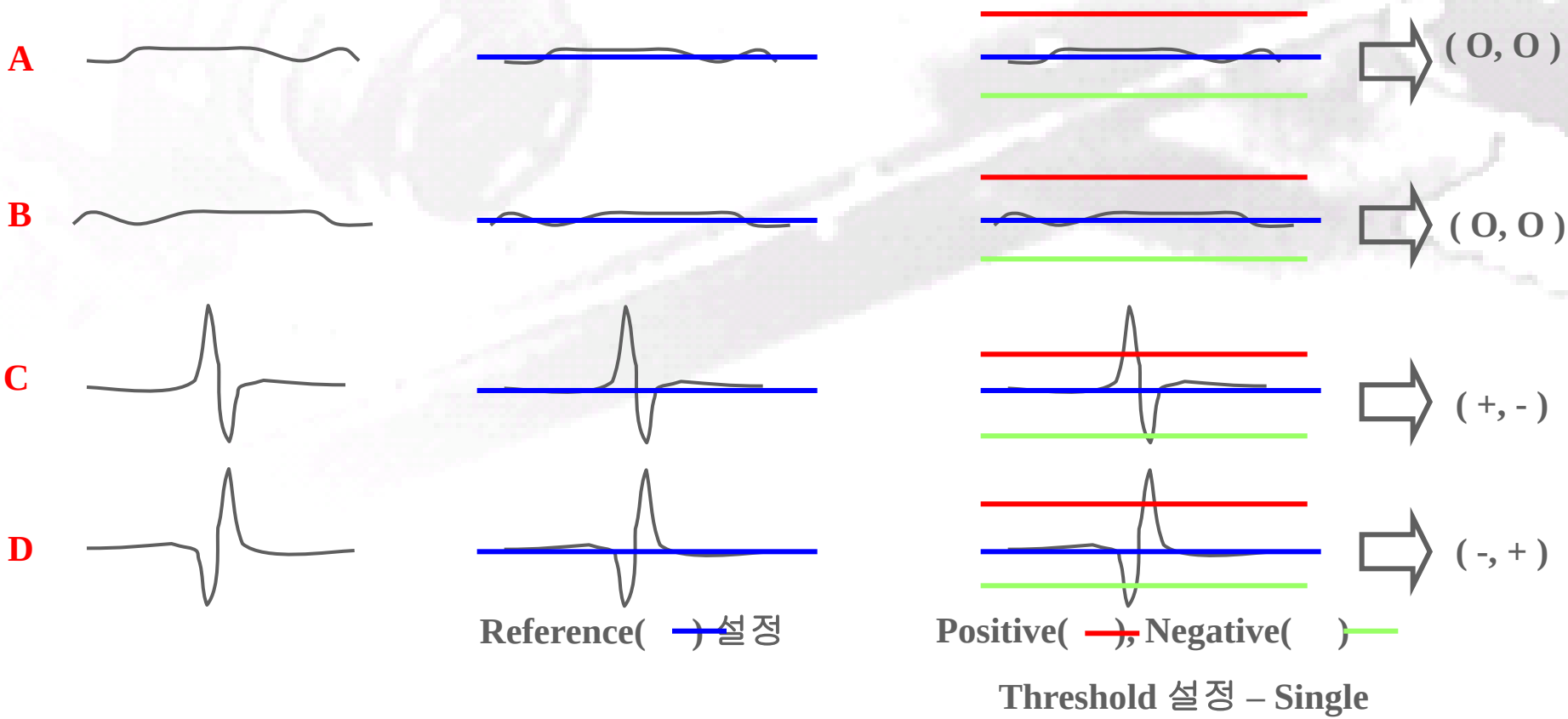


각 부분을 High Pass Filter를 적용한 후 미분 Filter를 적용시키면.



Optics in Surface Inspection

5. Processing System



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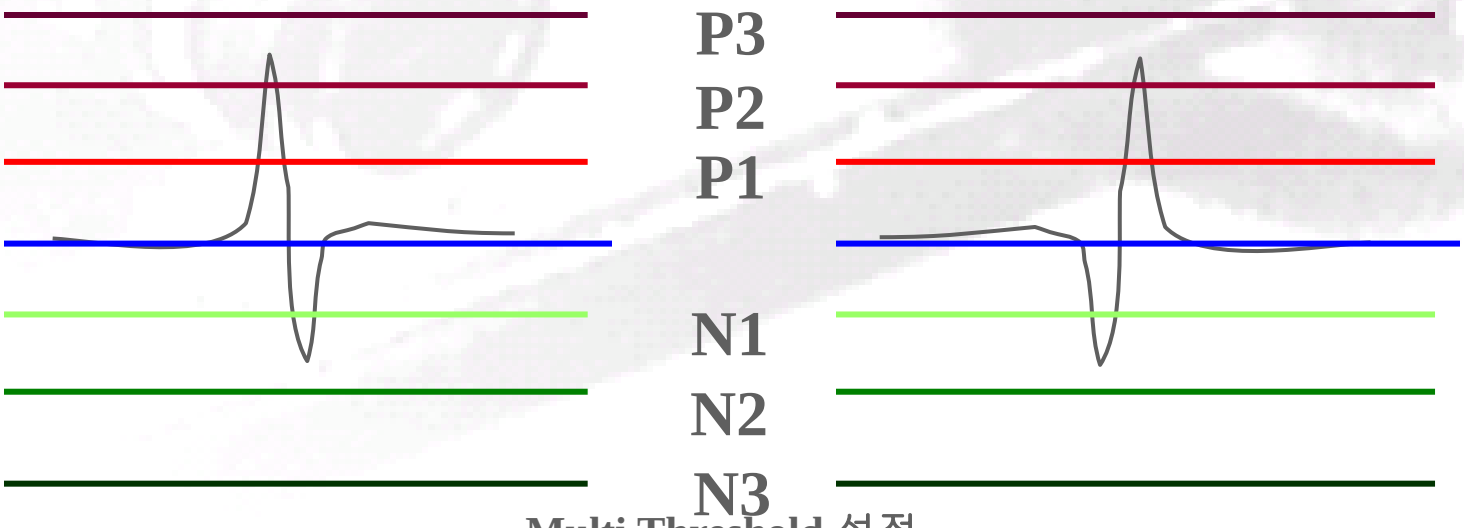
5. Processing System



Multi Threshold 설정

Optics in Surface Inspection

5. Processing System