

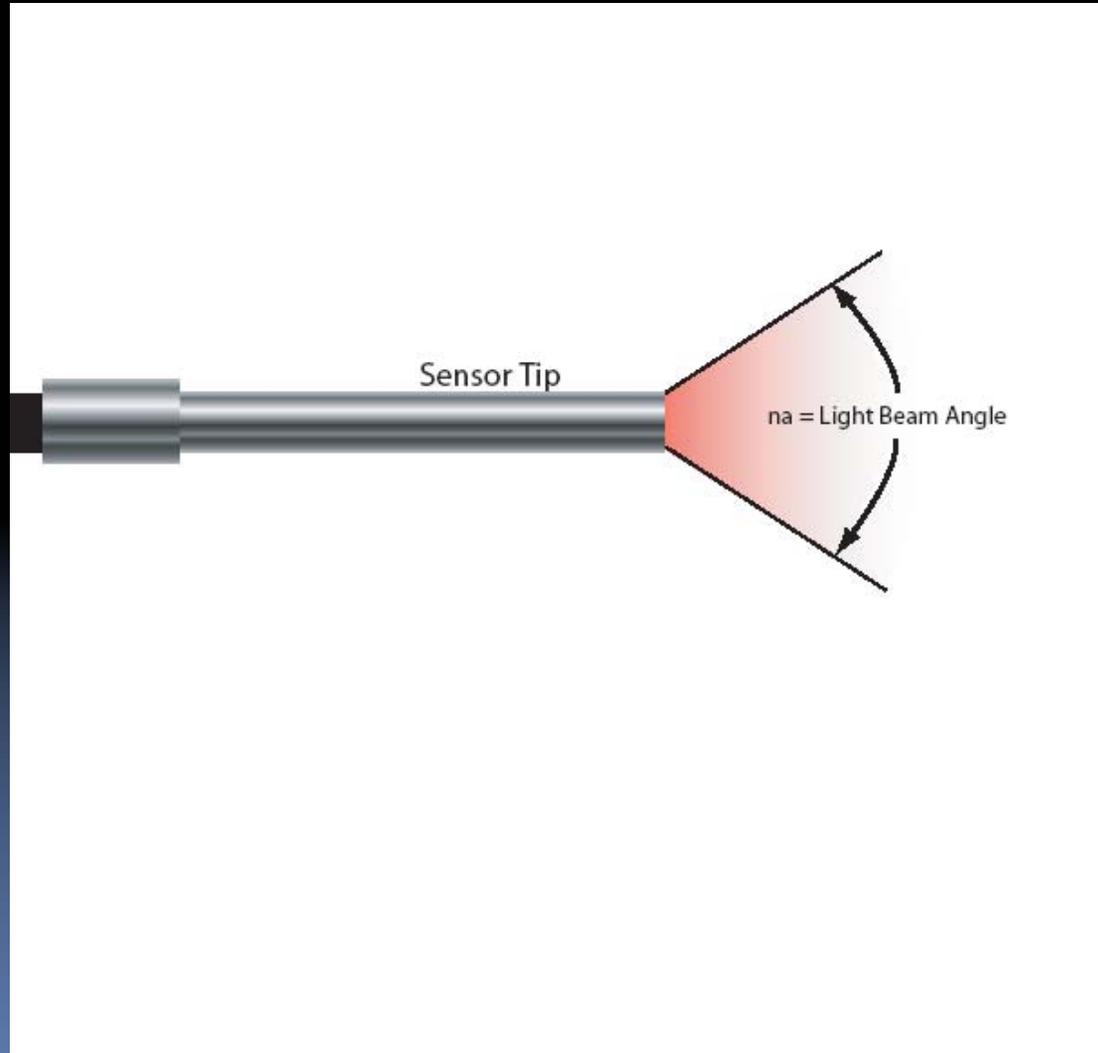
The logo for PHILTEC, featuring the word "PHILTEC" in a bold, white, sans-serif font. The letters have a slight 3D effect with a light blue shadow. Below the text is a horizontal line that tapers to a point on the left side, resembling a fiber optic cable or a stylized arrow.

**PHILTEC**

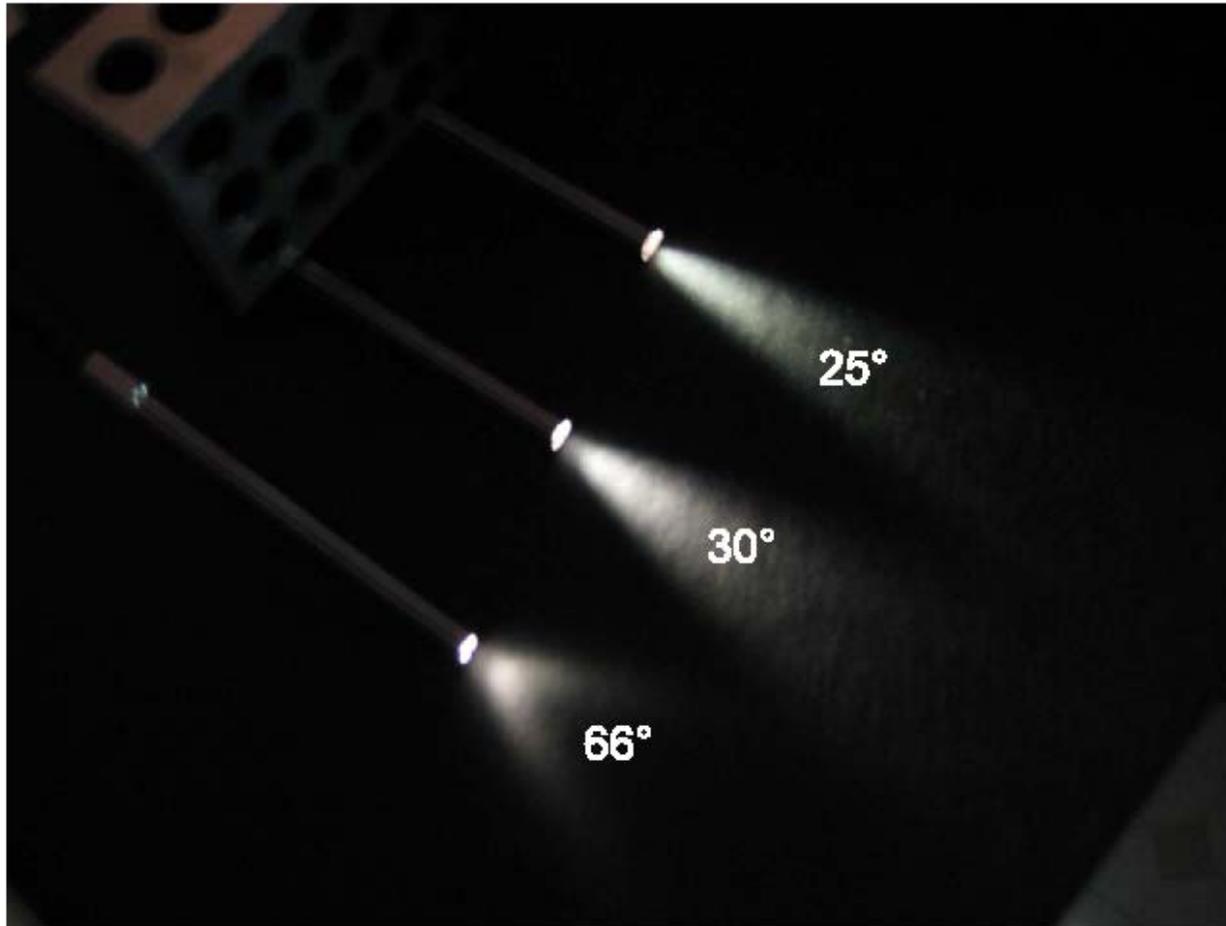
Product Training

# **FIBEROPTIC FUNDAMENTALS**

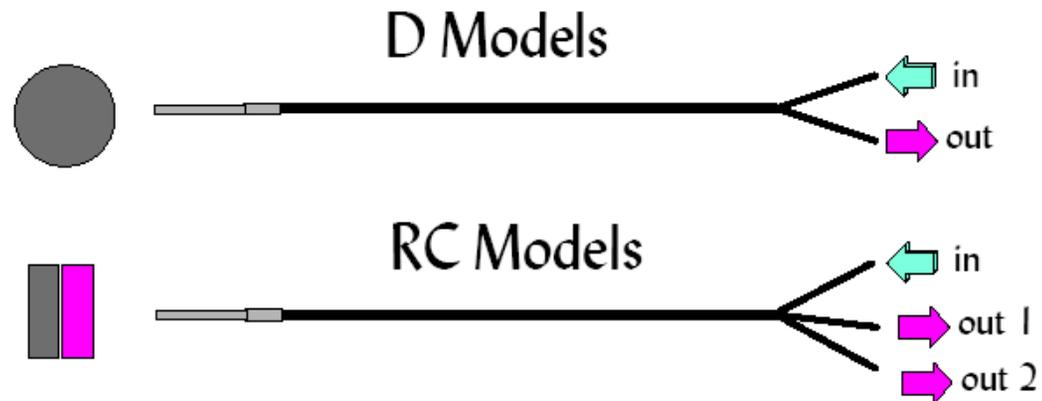
# Numerical Aperture



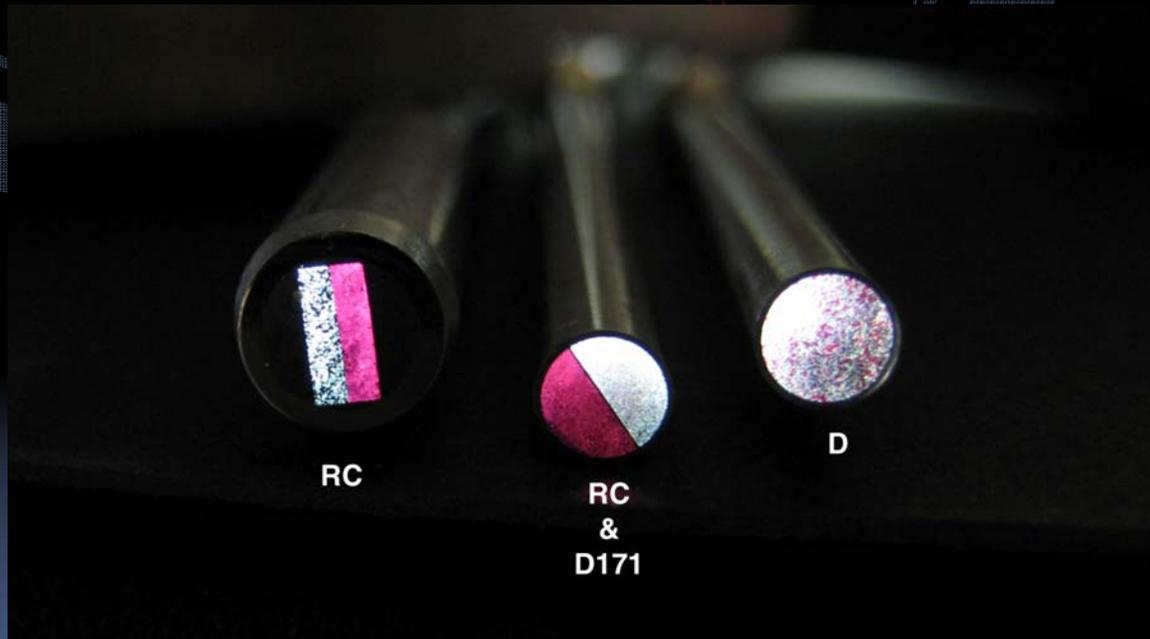
# Numerical Apertures



# Fiberoptic Cables

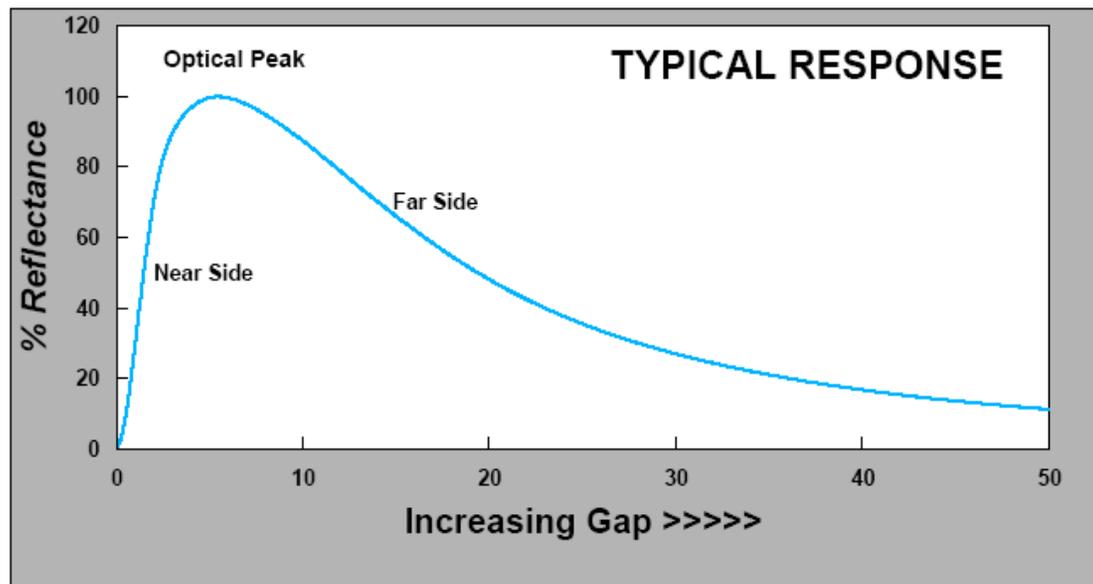


# Fiberoptic Arrangements



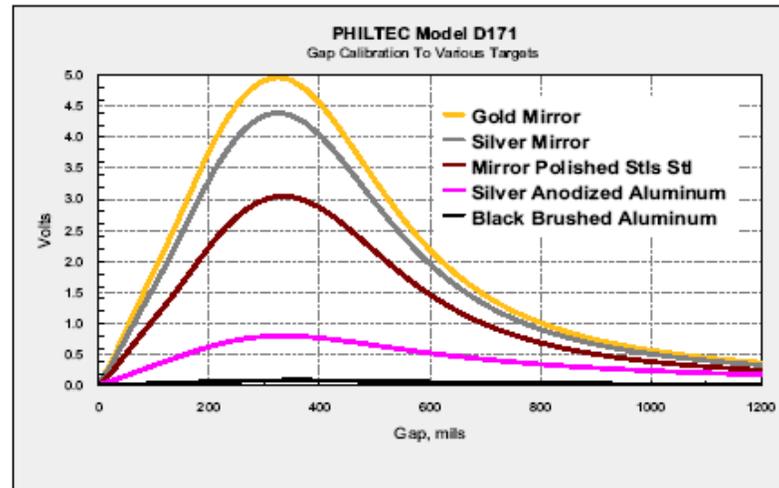
# Output Functions

## D Model Sensors



## Reflectance Dependent (D) Sensors

With REFLECTANCE DEPENDENT fiberoptic sensors, the output is proportional to the distance between the sensor tip and target surface **AS WELL AS** the reflectivity of the target.



TARGET	% REFLECTANCE
Gold Mirror	100
Mirror Polished Aluminum	85 - 90
Mirror Polished Stls Steel	60 - 70
Brushed Aluminum	40 - 50
Copper Clad PC Board	45
Matte Finish Aluminum	30 - 35
Anodized Aluminum	20 - 25
Silver Paint, Glossy	15 - 20
Inkjet Paper, Bright White	8
Fiberglass, Glossy	7
Black Plastic, Glossy	6
Black Matte Finish	3
Fiat Black Rubber	1

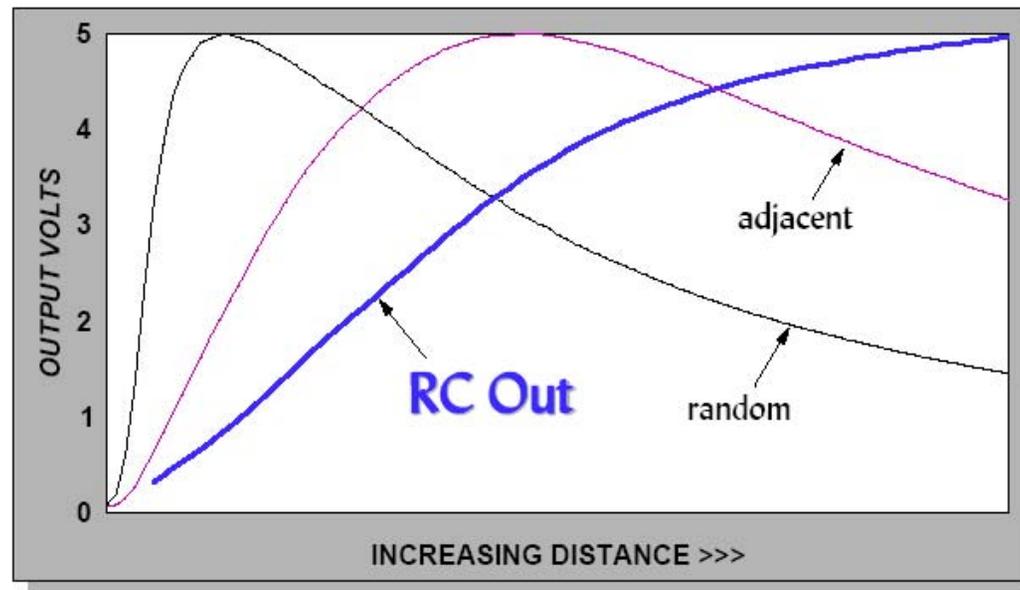
### REFLECTANCE DEPENDENCE



The reflectivity of some common materials are shown in the table.

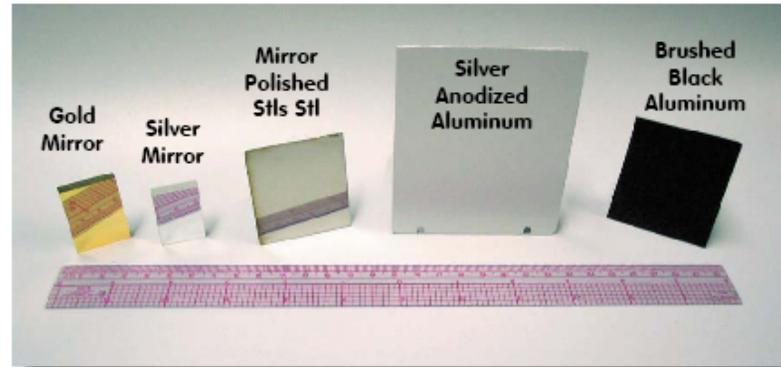
# Output Functions

## RC Model Sensors



$$RC = \text{adj} / \text{ran}$$

## Reflectance Compensated (RC) Sensors



### *The Problem*

The output signal from an intensity-based reflective optical displacement sensor varies proportionately with distance as well as with the reflectivity of the target surface: the shinier the target, the higher the signal. This limits successful applications to targets having a reciprocating or vibratory motion.

### *The Solution*

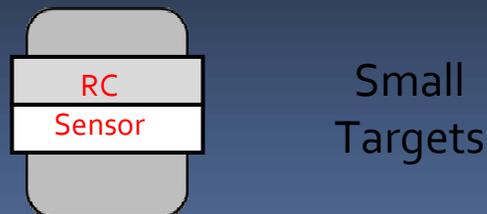
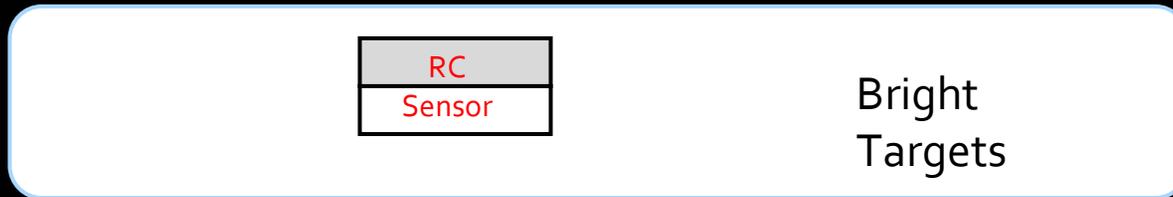
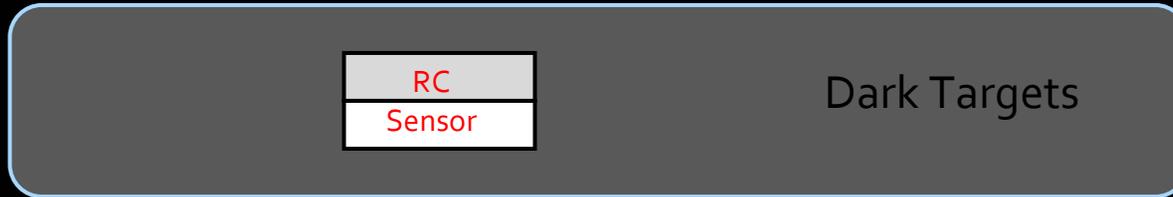
PHILTEC developed the *Reflectance Compensated* fiberoptic sensor to overcome those limitations of reflectance dependent sensors, by providing a sensor whose output signal is blind to reflectance variations. The RC type sensor is a more general purpose optical sensor that can make accurate distance measurements to rotating or translating targets as well as measure part-to-part size variations in production parts.

### RC Sensors



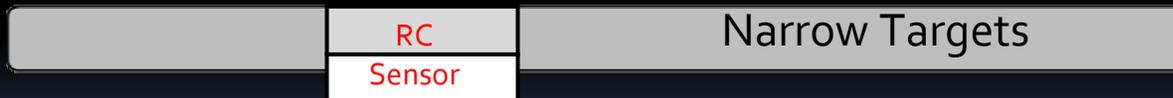
Light is transmitted to the target thru one side of adjacent fiberoptic bundles. The reflected light is captured in two separate fiber bundles which follow independent paths back to the electronics. A ratiometric calculation provides the distance measurement which is independent of target reflectivity variations; i.e., **reflectance compensated**.

# Reflectance Compensation OK



# Reflectance Compensation

## *Bad Conditions*

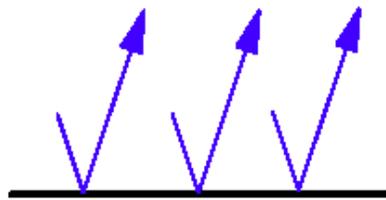


# RC vs. D

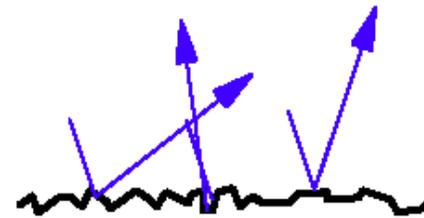
	RC	D
Lowest Cost	no	yes
Reflectance Compensated	yes	no
Target Calibration Required	no	yes
Smallest Probe	0.5 mm	0.15 mm
Longest Range	21 mm	50 mm
Highest Speed	350 KHz	1.5 MHz
Best Analog Resolution	80 nm	4 nm

## Surface Roughness

- Smooth Surfaces Give The Best Accuracy
- Roughness Degrades Repeatability

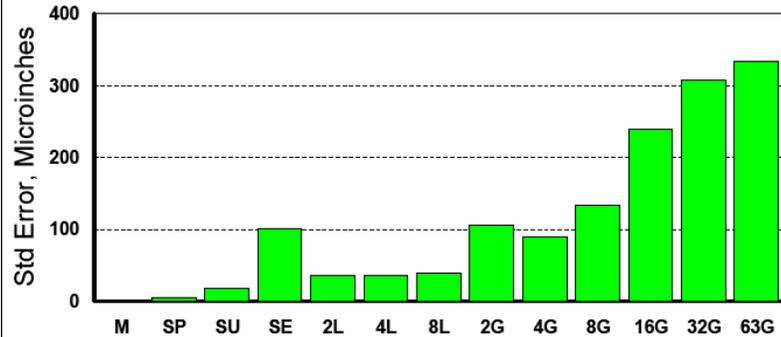


Smooth (Specular)

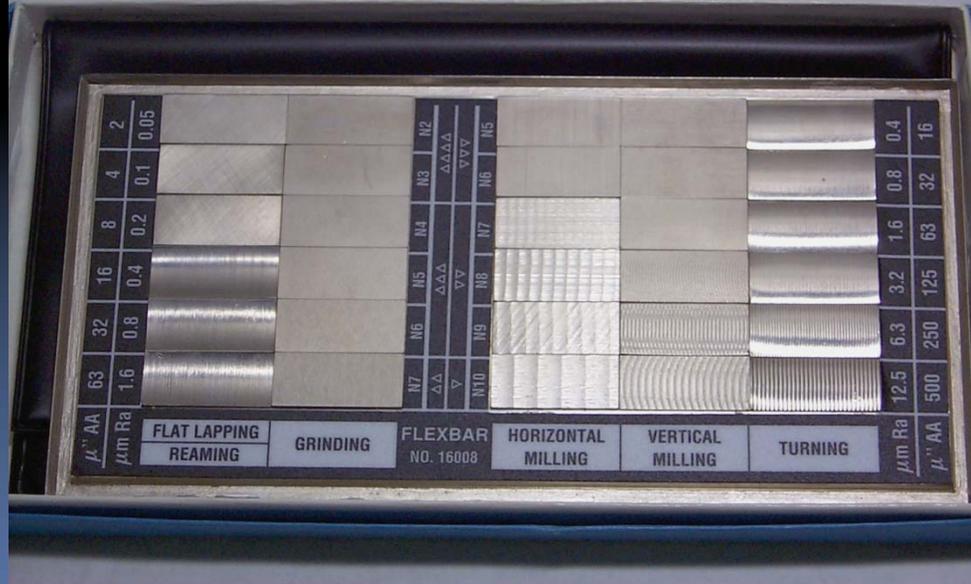


Rough (Diffuse)

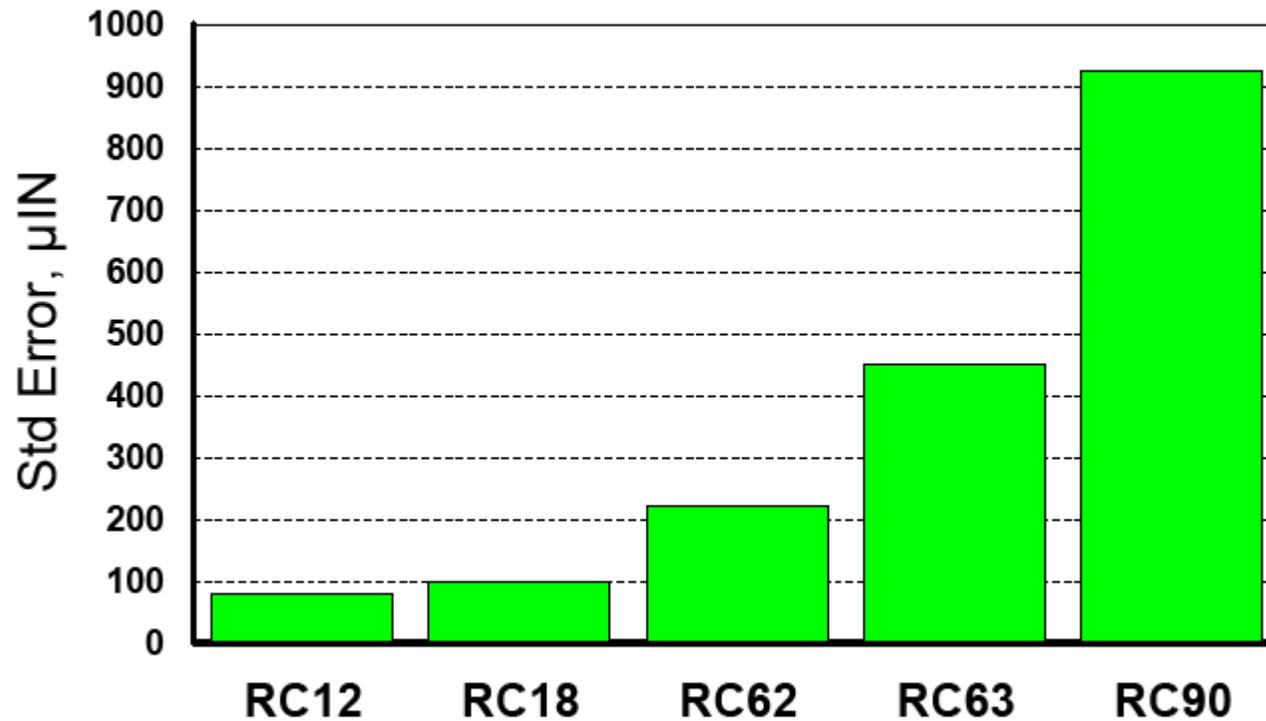
### PHILTEC Model RC18 Surface Roughness Effects



Each data Bar = Std Error of 50 readings in 0.10" Scan  
M - MIRROR S - SILICON WAFER L - LAPPED G - GROUND  
P - Polished U - Unpolished E - Etched

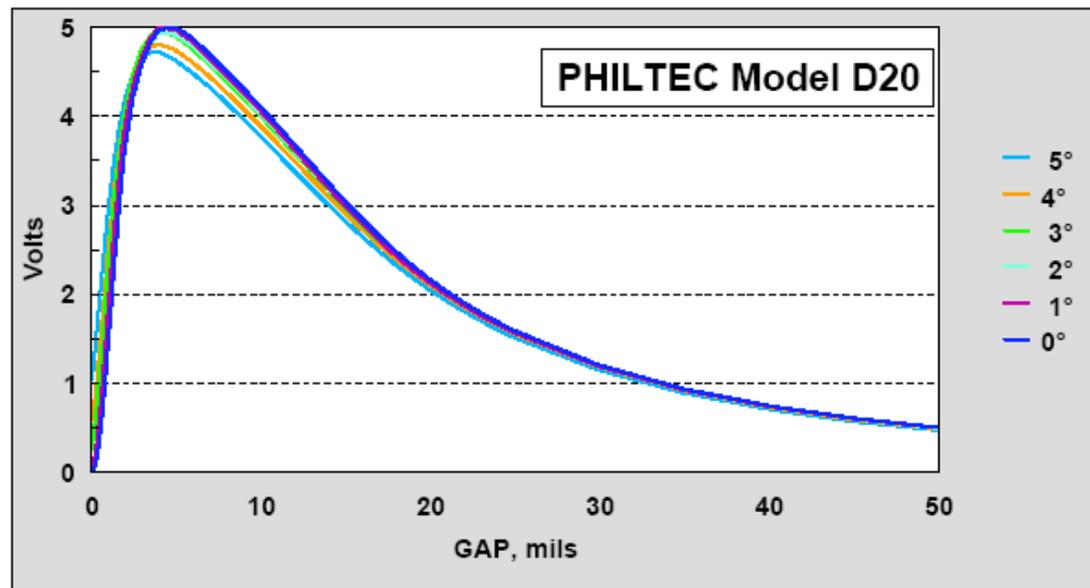


## PHILTEC RC MODEL SENSORS Averaged Effects of Surface Roughness\*

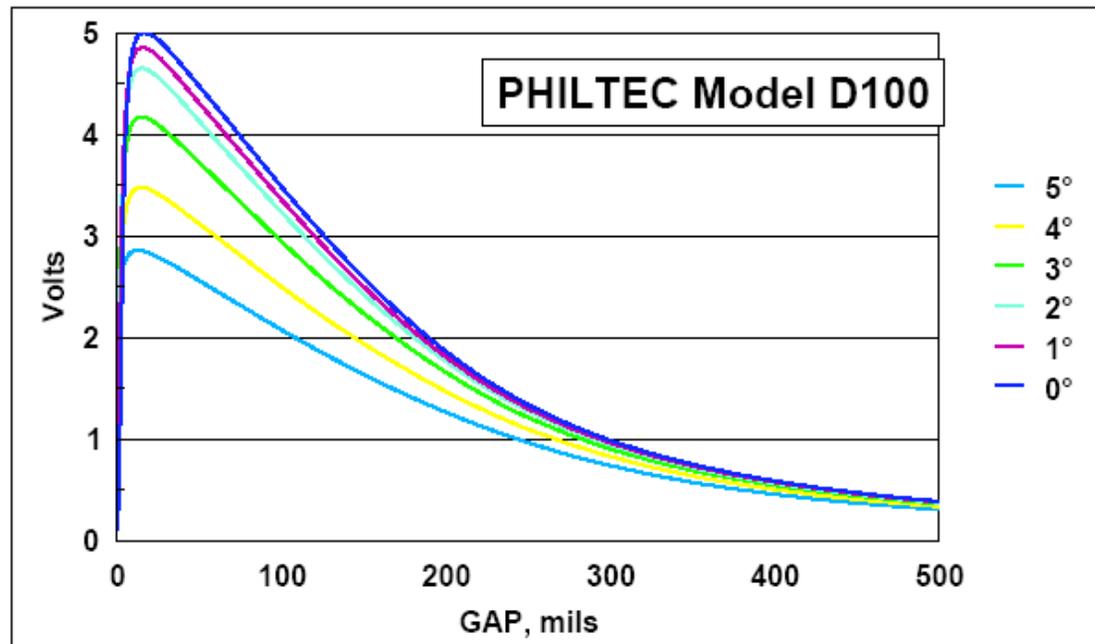


\*Average of 9 specimens, 2 Microinch Lapped thru 63 Microinch Ground

## Misalignment with Small Probes



## Misalignment With Medium Probes



## Misalignment With Large Probes

