Reflectivity Equation

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Reflectivity

• Optical test measures reflectivity of mirrors.
• RICH mirror test setup:
  • Monochromator
  • Two photodiodes
  • Beam splitter
  • Dark box
  • Two computers
Calibration Measurement

Control Photodiode: $I_C = A_C P_R$

Experimental Photodiode: $I_E = A_E P_T$
Control Photodiode

• Power reflected by beam splitter to control disk $P_R = R_S P_I$
  • $R_S$ is reflectivity of 6mm splitter coating.
  • $P_I$ is incident optical power.

• Current measured in control photodiode is $I_C = A_C R_S P_I$
  • $A_C$ is responsivity of control photodiode.
  • Responsivity measures input-output gain of system.
    • Amps of photocurrent generated per Watt of power.
Experimental Photodiode

• Power transmitted through beam splitter $P_T = T_S P_I$
  • $T_S$ is transmission of beam splitter coating.
  • $P_I$ is incident optical power.

• Current measured in experimental photodiode is $I_E = A_E T_S P_I$
  • $A_E$ is responsivity of experimental photodiode.
Ratio Equation

• Ratio of currents $\frac{I_E}{I_C} = \frac{AETOIP}{ACRSP_I}$
  
  • Incident power cancels from ratio.

  $\frac{I_E}{I_C} = \frac{AEOT}{ACRS}$

  • Without control photodiode, reflectivity is dependent on $P_I$, which can vary.
Reflectivity Measurement

Control Photodiode: \( I'_C = A_C \ P'_R \)

Test Mirror: Reflectivity \( R \)

Experimental Photodiode: \( I'_E = R \ A_E \ P'_T \)
Reflectivity Equation

• Current measured in control photodiode $I'_C = A_C R_S P'_I$
  • $A_C$ is responsivity of control photodiode.

• Current measured in experimental photodiode $I'_E = R (A_E T_S P'_I)$
  • $A_E$ is responsivity of experimental photodiode.

• Ratio of currents $\frac{I'_E}{I'_C} = R \left( \frac{A_E T_S P'_I}{A_C R_S P'_I} \right)$
  • Incident power cancels from ratio.
  • $\frac{i'_E}{i'_C} = R \left( \frac{A_E T_S}{A_C R_S} \right)$
Reflectivity Equation

• From calibration, $\frac{I_E}{I_C} = \frac{A_E T_S}{A_C R_S}$

• From reflection, $\frac{I'_E}{I'_C} = R \left( \frac{A_E T_S}{A_C R_S} \right)$

$\frac{T_S}{R_S}$ is constant due to intrinsic properties of beam splitter.

$\frac{A_E}{A_C}$ is constant if same photodiodes are used for “control” and “experiment”.

• Reflectivity equation $R = \left( \frac{I'_E}{I'_C} \right) / \left( \frac{I_E}{I_C} \right)$
Thank You