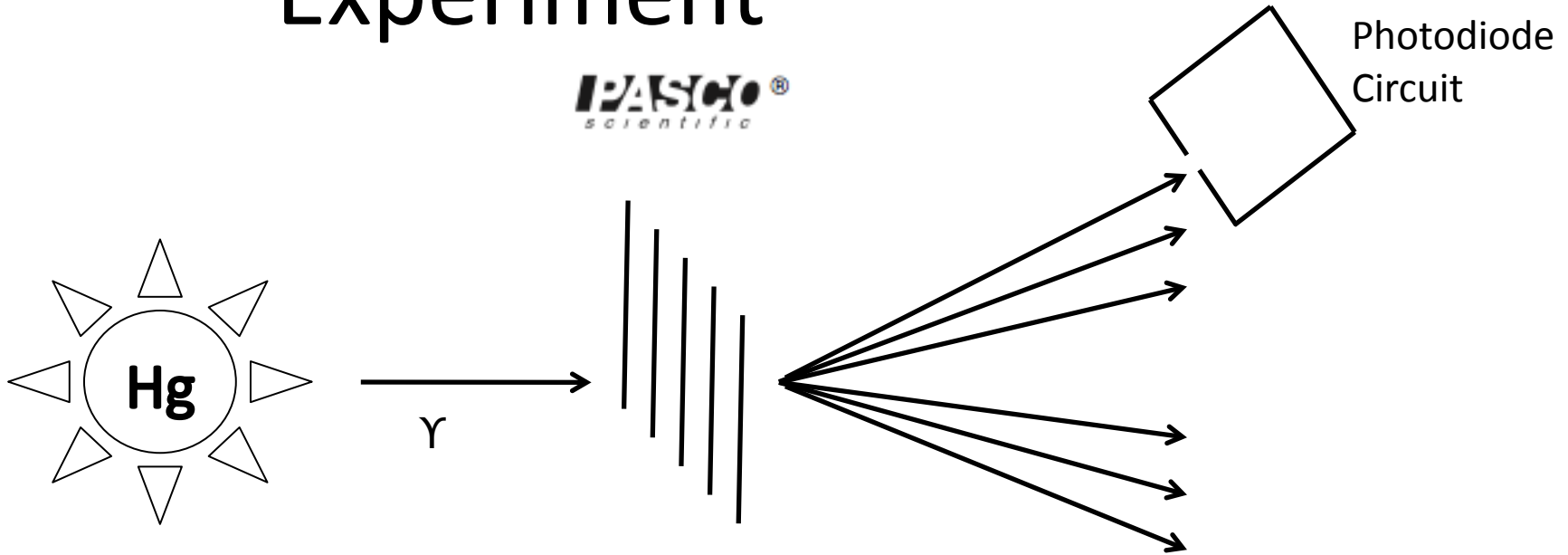# Photoelectric Effect h/e Experiment

T. A. Marriage
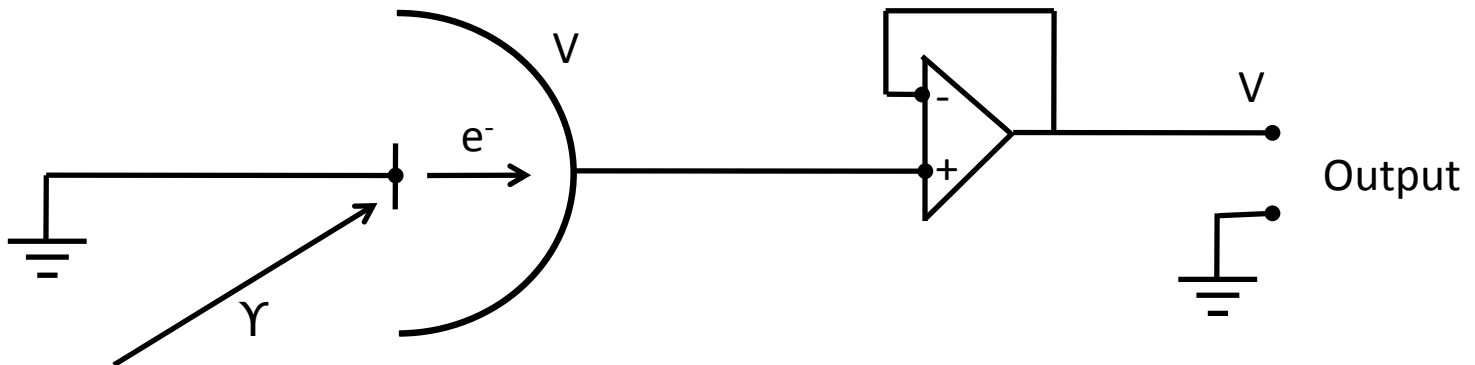
Feb 7, 2011

Experiment

PASCO® scientific

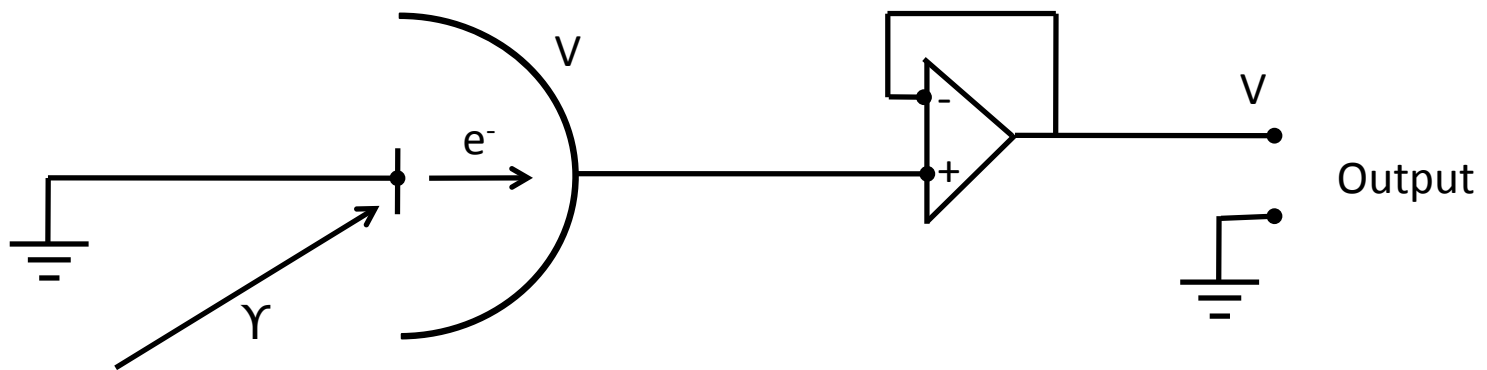Hg

Y

Photodiode
Circuit

Photodiode Circuit

V

e⁻

Y

V

-

+

V

Output

Experiment (Cont.)

PASCO ®
scientific

Photodiode Circuit

$$E_\gamma = h\nu = eV + W_0$$

Data For Five Colors

Name	Frequency (Hz $\times 10^{15}$)	Output Voltage (V)
Ultraviolet	8.20264	1.940 ± 0.005 (0.20)
Purple	7.40858	1.600 ± 0.005 (0.05)
Blue	6.87858	1.395 ± 0.005 (0.02)
Green	5.48996	0.805 ± 0.005 (0.02)
Yellow	5.18672	0.695 ± 0.005 (0.02)

Systematic uncertainties derived from difference between one side of diffraction pattern and the other.
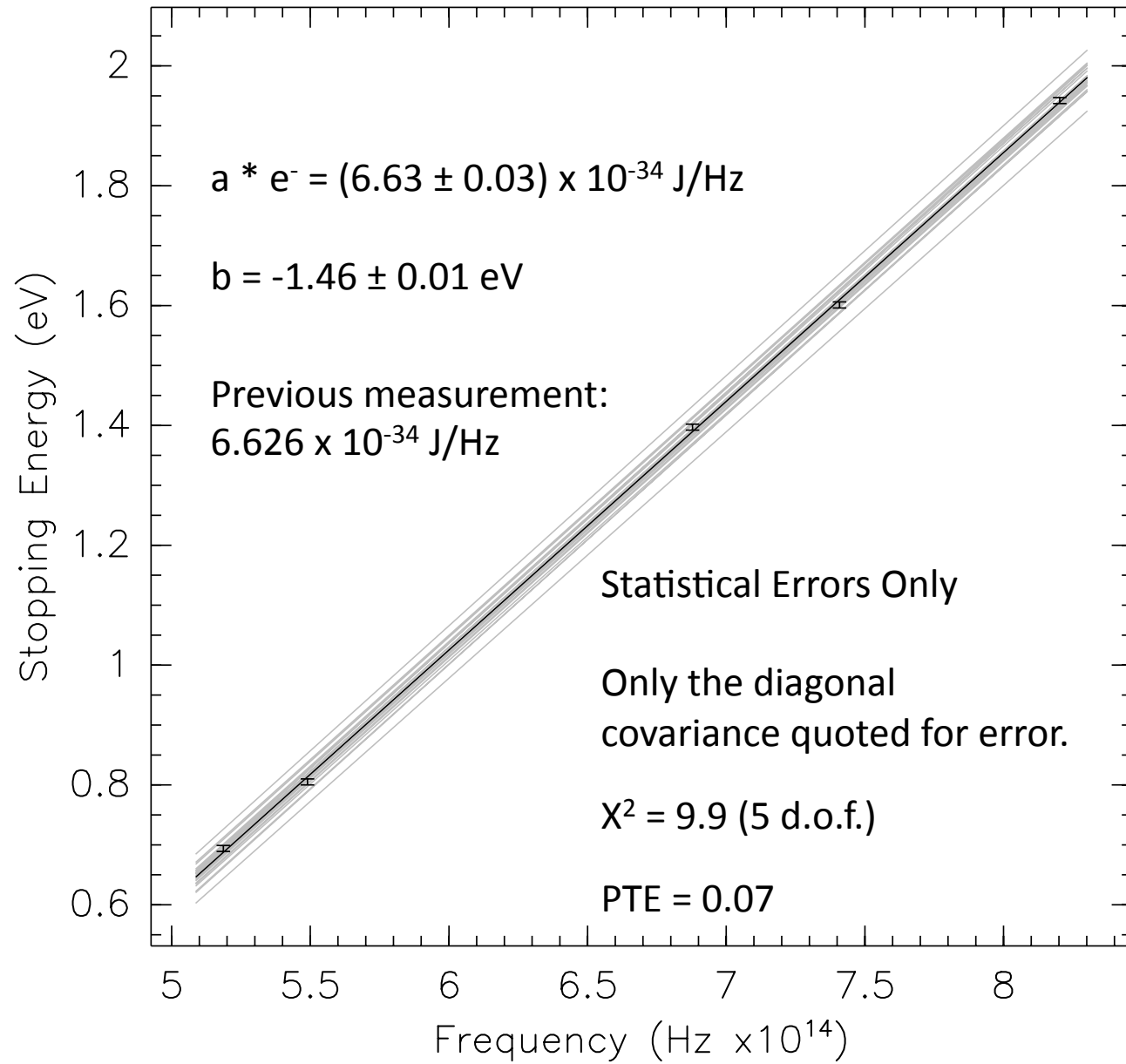
Linear Model

$$h\nu = eV + W_0 \tag{1}$$

$$\vec{V}_{model} = a\vec{\nu} + b\vec{1} = \begin{bmatrix} \vec{\nu} & \vec{1} \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} = \mathbf{M}\vec{x} \tag{2}$$

$$\vec{x}_{ML} = (\mathbf{M}^T \mathbf{N}^{-1} \mathbf{M})^{-1} \mathbf{M}^T \mathbf{N}^{-1} \vec{d} \tag{3}$$

$$\sigma_{\mathbf{x}} = (\mathbf{M}^T \mathbf{N}^{-1} \mathbf{M})^{-1} \tag{4}$$

h/e Experiment

$a * e^- = (6.63 \pm 0.03) \times 10^{-34}$ J/Hz

$b = -1.46 \pm 0.01$ eV

Previous measurement:
6.626×10^{-34} J/Hz

Statistical Errors Only

Only the diagonal
covariance quoted for error.

$X^2 = 9.9$ (5 d.o.f.)

PTE = 0.07

Stopping Energy (eV)

Frequency (Hz $\times 10^{14}$)

To Do

- Understand Systematics
- Study Covariance of Fit Parameters