1 Gain derivation

We know the electron count (N_e) is a relation between the gain (g) and ADU count (N_{ADU}).

$$N_e = gN_{ADU} \tag{1}$$

To find the uncertainty in N_e (σ_e), we must propagate the uncertainty of equation (1) in the following way:

$$\sigma_e = \sqrt{(\frac{\partial N_e}{\partial N_{ADU}}\sigma_{ADU})^2 + (\frac{\partial N_e}{\partial g}\sigma_g)^2} \tag{2}$$

We know that there is no uncertainty on the gain, so $\sigma_g = 0$, meaning the second term of equation (2) drops out:

$$\sigma_e = \sqrt{(g\sigma_{ADU})^2} = g\sigma_{ADU} \tag{3}$$

Given we know $N_e = \sigma_e^2$, we can plug equation (3) into equation (1) to get an expression for g in terms of σ_{ADU} and N_{ADU}.

$$N_e = \sigma_e^2 = (g\sigma_{ADU})^2 = g^2\sigma_{ADU}^2 = gN_{ADU} \tag{4}$$

Solving for g, we get the final expression:

$$g = \frac{N_{ADU}}{\sigma_{ADU}^2} \tag{5}$$