SOLUTION

TQ 13 **[15 points]**

13.1 A single electron deposits energy in the CCD, as follows:

$$E_{deposited} = \text{stopping power} \times \rho_{si} \times \text{thickness}$$

$$E_{deposited} = 3.012 \frac{MeV\,cm^2}{g} \times \frac{2.34g}{cm^3} \times 0.06cm = 422.9\ keV \quad \text{[4 points]}$$

Since an electron with 15 MeV energy deposits 422.9 keV, we must calculate the number of pairs electron/hole

$$422.9keV \times \frac{1}{2.36eV} = 1.79x10^5 \frac{e}{h} \quad \text{[4 points]}$$

How many pixels will be able to excite $1.79x10^5$ pairs of e/h?

$$1.79x10^5 x \frac{1}{250} = 716\ pixels \quad \text{[2 points]}$$

13.2 The number of electrons entering the detector area is:

$$flux \times area \times t \quad \text{[1 point]}$$

$$\frac{600\,e}{cm^2 s} \times [1.3 \times 1.3]\,cm^2 \times 0.03s = 30\ e^- \quad \text{[1 point]}$$

~30 electrons enter the detector area, and we know that one electron excites 716 pixels, the total number of excited pixels is:

$$716 \frac{pixels}{electron} \times 30.42\ electrons = 2.18 \times 10^4 pixels \quad \text{[1 point]}$$

If the CCD has a total of 1024x1024 pixels = $1.048 \times 10^6 pixels$ then the total percentage of pixels that will be driven in a single image is ~ 2.08% [2 points]