Homework Assignment #6

Fluoroscopy, X-ray CT, Nuclear Medicine

(Hendee Ch 12, 14, 15)

Due October 30

1. Hendee 14-3

2. Hendee 14-6

3. Hendee 15-2

4. Assume that you are interested in producing an image with a CT scanner that has voxels that are 0.5 mm x 0.5 mm x 1 mm and acquires a complete scan in 15 s using monochromatic (to make it easier) 120 KeV photons. It is desirable to be able to distinguish changes in the linear attenuation coefficient of 0.5% for a patient that is 25 cm thick. Assume the patient has an average mass attenuation coefficient equivalent to soft tissue and determine
   a. The minimum number of measurements that are needed at each angle.
   b. The smallest number of angles needed to characterize each voxel
   c. The minimum flux of photons through the slice at each angle.
   d. The number of photons that must be detected for a signal-to-noise ratio (SNR) of 2.
   e. The total dose.

5. Hendee 12-2

6. A novel radionuclidic generator consists of a parent $^{140}$Nd (half life = 3.37 days) which decays to a daughter $^{140}$Pr (half life=3.4 minutes), for molecular imaging using PET. Equilibrium occurs when the ratio of the activity of the parent to the activity of the daughter is constant.
   a. What kind of equilibrium would you expect ?
   b. When in equilibrium, What is the activity of daughter relative to the parent?
   c. If the radioactivity of the parent is 16 GBq at 10 AM on Monday morning, how much daughter will be available on Thursday at 3 PM if no milking took place during this interval?
   d. How often should this generator be milked for optimum (maximal – remember your calculus!) daughter radioactivity?
   e. If the generator is completely milked on Thursday at 3PM, and a patient dose of 1 MB is desired for injection on Friday morning at 8 AM, what dose should be prepared on Thursday at 3PM?