The purpose of this brief note is to provide some background discussion linking the study of neutron interactions and distributions with the application to imaging. This is also useful information in preparation for the general lecture on imaging to be given by Dr. Richard Lanza in class on April 27. Dr. Lanza will give an overview of various imaging modalities, including neutron radiography and tomography, gamma imaging, coded aperture techniques, etc., along with current in-house applications.

We are concerned with using radiation to create images of structures in three-dimensional objectives. To get an idea of the scientific basis for performing this task, we can look at the table of contents of a text on medical imaging [Macovski 1983]. Right after the introduction chapter one finds a chapter on linear systems dealing with superposition integral, delta function, impulse response, and Fourier transforms. Also mentioned briefly is the idea of sampling probability distributions. This delineates the mathematical background that one should have in understanding the conceptual basis of imaging. In the next chapter which is on the physics of projection radiography, one sees the central role of the linear attenuation coefficient in determining the transmitted radiation arriving at the detector. This makes clear the connection between what we study in 22.54 and the application of radiation (neutrons) to imaging. The same can be said when one goes on to a later chapter in tomography.

To see in more detail why the attenuation coefficient is so central to imaging, we can follow the discussion given by McFarland and Lanza in their paper discussing the advantages of neutron imaging in non-destructive evaluation of complex materials and engineering assemblies (over x-rays and other techniques) [McFarland and Lanza 1991]. We recommend the students to take a little time to study Abstract, Introduction, Background and Theory sections of this paper. When you do this, try to understand Eq.(6), Figs. 1 and 2, and Tables 1 and 2, keeping in mind that for neutrons the linear attenuation coefficient is the same as our macroscopic cross section $\Sigma$. 

References --
E. McFarland and R. Lanza, "Neutron Radiography and Tomography: The Challenge of Using Non-Reactor Neutron Sources", International Meeting on Tomographic Techniques for Industry and Medicine, October 1991, Cesena, Italy (this reference is available as HO.imag.pdf on Stellar)