In this paper we review work whose goal is to replace not only the coarse human reading of test phantom images but also the more sophisticated and expensive laboratory measurements on imaging systems with a set of digital machine readings of an appropriate set of test images. The candidate machine readers are referred to as model observers. The lowest-level model observer is the application of a simple lesion-profile mask or template to an image followed by signal integration; this may be considered a single-measurement or one-channel observer and is referred to as the nonprewhitening matched filter (NPWMF). Several authors (Tapiovaara & Wagner, Chakraborty) use a two-channel observer that makes a simple estimate of the mean background level and subtracts this before making the measurement in the channel of the lesion-profile mask (DC-suppressing NPWMF). A more elaborate multi-channel model is the Hotelling observer of Barrett and co. that incorporates information on expected correlations in image background structure before applying an appropriately adapted lesion-profile mask. In the limit of shift-invariant images with stationary noise this observer goes over to the so-called pre-whitening matched filter (PWMF). The latter is the basis for the concept of noise-equivalent quanta (NEQ), an elaborate set of many measurements including the MTF and noise power spectrum, that describes the ability of an imaging system to detect information in a large number of spatial-frequency channels. We will describe efforts to reduce the complexity of the measurement problem to a manageable number of channels and test images practical for a clinical setting.

Footnote: Such an approach could be used across modalities (detection and display) to label the technology in an outcomes study, to carry out initial performance acceptance testing, and to monitor clinical performance on a routine basis.

## Learning Objectives:

(1) Review the fundamental model observers used in image assessment.

(2) Explain when and how they bracket human performance.

(3) Explain connection with (high-level) measurement of noise-equivalent quanta (NEQ) and (low-level) phantom measurements.