AbstractID: 11623 Title: How to measure fluoroscopic "dose efficiency": The spatio-temporal detective quantum efficiency

Purpose:

To measure the “dose efficiency” of fluoroscopic systems on a quantitative and absolute scale by developing a spatio-temporal detective quantum efficiency (DQE) metric of performance.

Method and Materials:

We developed the first comprehensive spatio-temporal approach to fluoroscopic system performance through the development of a spatio-temporal DQE. It is defined in terms of the presampling spatio-temporal modulation transfer function (MTF), describing resolution, and spatio-temporal noise power spectrum (NPS), describing noise. We developed what we call the “semi-transparent moving slanted-edge method” to measure the temporal component of the MTF, which uses a small-signal approach to temporal resolution. This method overcomes temporal non-linearity problems associated with differences between lag build-up and decay responses of CsI-based systems. A three-dimensional (3D) approach to fluoroscopic noise, in which 3D spatio-temporal ROIs are selected in space and time, was used to calculate the spatio-temporal NPS. Spatio-temporal DQE values of a bench-top x-ray image intensifier fluoroscopic system were calculated, illustrating use of the metric and gaining insight into fluoroscopic temporal dose efficiency.

Results:

Non-ideal temporal performance was noted in the test system at temporal frequencies > 5 Hz, and there was a ~50% drop in DQE values by 15 Hz, analogous to decreases in DQE values commonly seen at large spatial frequencies. This is the first time that fluoroscopic temporal performance has been quantized using a DQE metric, and the non-ideal system temporal performance may be due to temporal noise aliasing and the statistical nature of lag.

Conclusion:

The spatio-temporal DQE describes fluoroscopic system performance and dose efficiency in both space and time, providing temporal information that can *not* be obtained using lag-corrected or other spatial approaches. The ~50% decrease in performance by 15 Hz may suggest the presence of temporal quantum sinks.