AbstractID: 1391 Title: A Validated Computational Engine for the Optimal Design of Cascaded Quantum Imaging Systems

The field of medical radiological imaging is being transformed by new digital technologies and the first generation of digital x-ray detectors is now making a clinical impact. However, the complex theories of signal and noise propagation required for "optimal" designs are only now being developed. These theories can be used to develop expressions for the Wiener noise power spectrum (NPS) and detective quantum efficiency (DQE) of new x-ray imaging system designs. Although application of these theories has had several successes, its contribution has been limited due to the fact that models of realistic systems involve manipulation of very long equations with hundreds of terms. We have developed and validated a computational engine with a graphical user interface to remove this limitation. Using MATLAB's SIMULINK, we developed a library of fundamental physical processes in terms of analytic Fourier-based expressions of signal and noise propagation. These include quantum gain, quantum scatter, quantum selection, linear filter, quantum branch, Bernoulli branch, cascade fork, quantum summation, and sampling processes. Our method also includes the use of symbolic math to perform the cumbersome manipulation of complex algebraic expressions. Recursive programming is applied to generate theoretical expressions of MTF, NPS, and DQE for the entire system as well as intermediate steps in models of arbitrary complexity. In order to validate the generated expressions, a Monte Carlo simulation program has been developed. Results show an excellent agreement between Monte Carlo and theoretical expressions, validating our algorithms in the computational engine.