

## A. Specific Aims

The goal of this research is to develop and validate a set of novel algorithms to reduce or eliminate calcium blooming artifacts on cardiac multi-detector computed tomography (MDCT) images. These artifacts render many coronary segments non-evaluable for the presence of significant coronary stenosis. While 64-slice MDCT scanners have produced noticeable improvements in image quality, data from our lab in consecutive clinical patients demonstrate that calcium blooming precludes the evaluation of the presence of stenosis in at least one coronary segment in 28.5% of all patients and in 54% of patients >65 years of age. Since the prevalence of coronary calcification is high in populations at high risk for coronary events (i.e. >65 years of age, diabetes, multiple risk factors), the clinical utility of cardiac CT in these patients will be significantly reduced if the problem of artifacts due to calcification remains unresolved.

To address this problem, we propose a set of novel image post-processing and reconstruction formulations that may effectively reduce the blooming effects of coronary calcification. Our Model-Based Algebraic Iteration (MBAI) approach works by partitioning the structures in the image and imposing processing constraints on each structure separately. It can be employed both as a post-processing (restoration) and as an image formation (reconstruction) approach. This is a novel method and, as a reconstruction technique, differs considerably from conventional filtered back projection based calcium deblurring approaches.

In the proposed research we will develop a testbed of images which will permit a systematic characterization of calcium blooming effects, demonstrate and quantify the degree of improvement using MBAI approaches for restoration and reconstruction, and share this testbed with academic and industrial communities. We will extend and optimize MBAI approaches for the task of calcium blooming reduction and to enable the reconstruction of images on a scale that is relevant to clinical research evaluation. Finally, we will compare the diagnostic accuracy of coronary MDCT for the detection of significant coronary artery stenosis in populations with a high prevalence of coronary calcification using traditional and MBAI approaches. We hypothesize that MBAI approaches will significantly reduce the number of coronary segments rendered non-evaluable due to calcification and improve the diagnostic accuracy of 64-slice MDCT for the detection of significant coronary artery stenosis. The specific aims are:

**Aim 1:** Characterize and model the effects of calcium blooming in cardiac MDCT images.

- 1.1 Develop a testbed of images with varying image acquisition parameters, incorporating simulation, phantom, *ex vivo*, and *in vivo* models.
- 1.2 Model blooming effects using simulation and phantom models.

**Aim 2:** Develop, optimize and validate MBAI processing algorithms and parameters to minimize calcium blooming effects in testbed data.

- 2.1 Develop, optimize and validate MBAI restoration approaches for minimizing calcium blooming effects in reconstructed cardiac CT images.
- 2.2 Develop, optimize, and validate MBAI reconstruction algorithms from raw projection data for simultaneous image-formation and blooming-effect minimization.

**Aim 3:** Determine whether MBAI processing significantly improves evaluability of coronary segments and accuracy of cardiac MDCT for the detection of significant coronary stenosis.

- 3.1 Determine the number of non-evaluable coronary segments on cardiac CT data in consecutive clinical patients with and without MBAI processing.
- 3.2 Determine the diagnostic accuracy of 64-slice MDCT for the detection of significant coronary stenosis with and without MBAI processing.