

# QIBA Atherosclerosis Biomarker Committee

The views expressed in this poster are those of the author and do not reflect the official policy of the Department of Army/Navy/Air Force, Department of Defense, or U.S. Government.

The identification of specific products or scientific instrumentation does not constitute endorsement or implied endorsement on the part of the author, DoD, or any component agency.



L Saba MD, AOU Cagliari; UJ Schoepf MD, MUSC; JK DeMarco MD, Walter Reed; D Dey PhD, Cedars-Sinai/UCLA; M Ferencik MD, PhD, OHSU; L Jimenez-Juan MD, University of Toronto; P Kitslaar MSc, Medis Cardiovascular Imaging; M Kolossvary, Semmelweis University; P Maurovich-Horvat MD, PhD, Semmelweis University; A Moody MBBS, FRCP, FRCR, London Health Sciences Centre; N Obuchowski PhD, Cleveland Clinic; N Paul MD, MRCP, FRCR, FRCRC, London Health Sciences Centre; T Richards BS, Duke University; S Rinehart MD, Piedmont Atlanta Hospital; S Ehsan PhD, Duke University; M van Assen MSc, MUSC; A Varga-Szemes MD, PhD, MUSC; R Virmani MD, CV Path Institute; AJ Buckler MS, Elucid Bioimaging Inc.

## Quantitative Plaque Morphology

**Atherosclerosis is a major health concern for our aging population.**

Given the devastating impact of this widespread disease reflected in spiraling healthcare costs, biomarkers for better risk assessment and diagnosis, prognosis, and monitoring will have a significant impact on public health.

**Noninvasive imaging biomarkers that would provide this information will have an impact to transform health care delivery and management.**

There is a critical gap in the biomarker qualification, which needs to be addressed in order to move these quantitative imaging biomarkers forward.

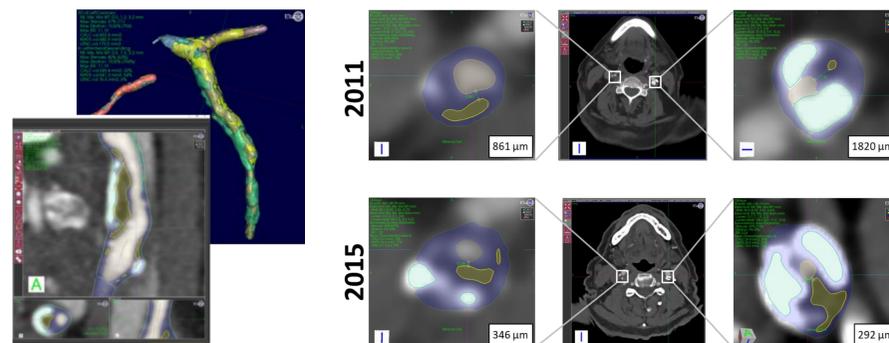
**Feasibility of plaque characterization with CTA in the management and risk prediction in coronary and carotid has been demonstrated.**

**However, lack of standardization and a multitude of different software approaches and differences in the use of parameters is significantly decreasing the clinical implementation because of the methodological heterogeneity.** First steps are to standardize imaging protocols for each arterial bed, select the most optimal parameters and pool results from different software approaches, clinical centers and vendors, which would allow optimization of protocols to provide homogeneous data throughout the community. In parallel, we are providing objective performance assessment techniques with standardized metrology metrics and nomenclature for software analysis of CTA data sets, for example by developing calibration phantoms and specific technical guidelines for structural measures, and use of histological ground truth for tissue characteristics.

**To establish these biomarkers, standardization of quantitative imaging across different protocols, anatomical locations and different manufacturers with cross-calibration is required.**

Reliable quantitation using more sophisticated techniques than simple HU thresholding without specific mitigation of known limitations where ground truth of tissue is objectively determined is new but energizing.

**Only a collaboration can effectively provide for the needed standards in nomenclature of arterial plaque characteristics, standard classification of plaque, and definition of how performance is assessed for quantitative plaque measures. QIBA is an ideal venue for this.**

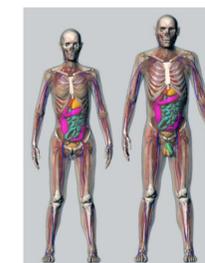


## Biomarker Committee Activity: Profile

1. Executive Summary	3
2. Clinical Context and Claim(s)	4
3. Profile Requirements	8
3.1. Subject Handling	10
3.2. Image Data Acquisition	13
Specification Common to Arterial Beds	15
Protocol Specification Unique to Coronary Arteries	16
Protocol Specification Unique to Carotid Arteries	16
3.3. Image Data Reconstruction	16
3.4. Image QA	18
3.5. Image Analysis	21
4. Assessment Procedures	22
4.1. Assessment Procedure: In-plane Spatial Resolution	23
4.2. Assessment Procedure: Voxel Noise	24
4.3. Assessment Procedure: Vessel structure Bias and Linearity	24
Obtain test image set	25
Determine Measurands	26
Calculate statistical metrics of performance	26
4.4. Assessment Procedure: Tissue Characteristics Bias and Linearity	26
Obtain test image set	26
Determine Measurands	27
Calculate statistical metrics of performance	27
4.5. Assessment Procedure: Reader / Image Analysis Tool Variability	28
Appendices	29
Appendix A: Acknowledgements and Attributions	29
Appendix B: Conventions and Definitions	31
Appendix C: Imaging Resolution Details	32
Appendix D: Measurands with Description and Units	35
Appendix E: (C)CTA Signal Applicability and Published Performance	36
Vessel Structure	36
Tissue Composition	36
References	39

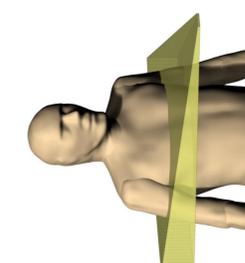
## Example Groundwork: Assessment Procedures for Scanner Hardware

**Establish set of patient and acquisition hardware parameters which significantly impact biomarker related image quality:**



### Patient

- Anatomy
  - Vessel Size
  - Plaque material
  - BMI
- Physiology
  - Heart-rate
  - Coronary motion



### Acquisition

- Scanner
  - Spatial Resolution
  - Rotation Time
- Protocol
  - Dose → Noise
  - ECG Gating
  - Contrast

**Investigate impact and interplay of dependent parameters using established framework:**

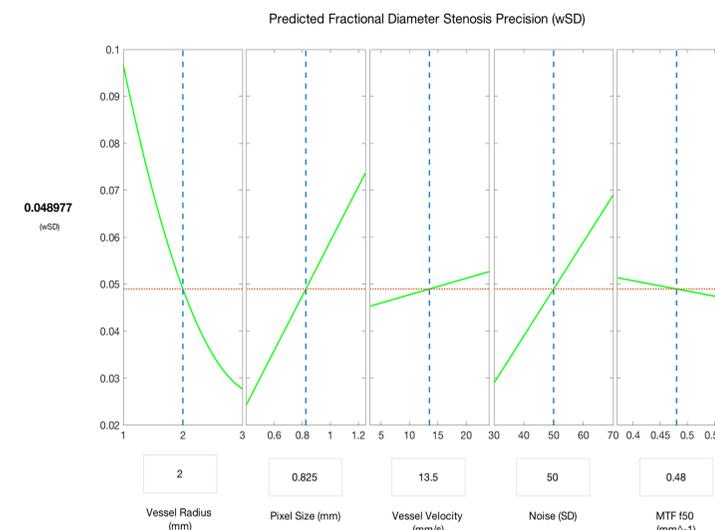
**Estimability index (e<sup>e</sup>):** surrogate measure of highest achievable task performance in estimating biomarker measurand.

Our computer simulated implementation of estimability index utilizes complete knowledge of object (atherosclerotic plaque) and vendor specific CT acquisition hardware.

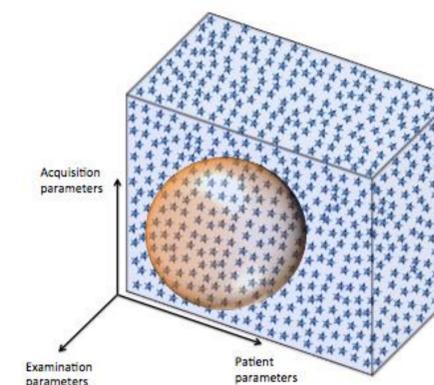
Matched template maximum-likelihood-estimator (MLE) processes thousands of atherosclerotic plaque images at each factor-level combination.

Simulated results (estimation precision and bias) are fit according to patient and acquisition hardware parameters.

**Determine set of patient attributes and acquisition parameters which allow compliant image analysis to fulfill performance claim:**



**Assessment procedures predicated on required acquisition parameter ranges to circumscribe multidimensional compliant performance space:**



**For more information or to join us, please visit: <http://qibawiki.rsna.org>**