Development of Quantitative CT Lung Protocols

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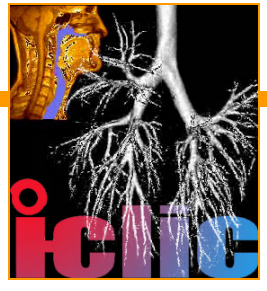

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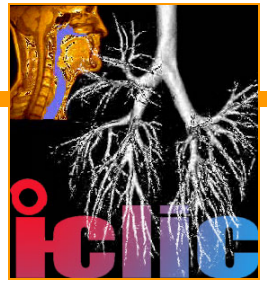
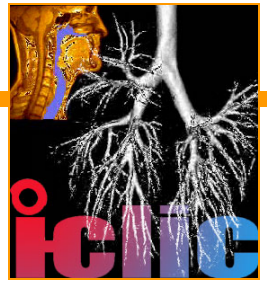
Outline of Presentation

- Rationale for Standardized QCT Lung Protocols
- QCT Lung Research Trials
- QCT Lung Methods
- Overview of the SPIROMICS QCT Lung Protocol
- Summary



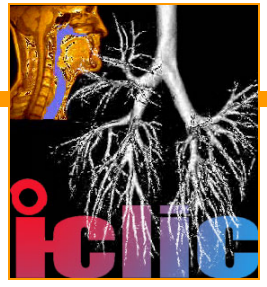
Rationale

- Quantitative computed tomography (QCT) of the lung has been used in multiple studies of COPD, Asthma and ILD. Rigorous QCT protocols need to be developed that can provide high quality CT image data that is obtained on a variety of CT scanners of different manufacturers and models.



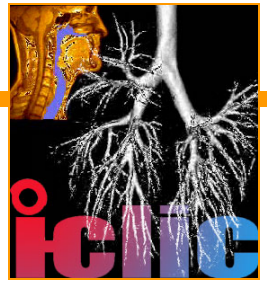
Multi-Center Trials Using QCT of the Lung

- National Emphysema Treatment Trial (NETT)
- Severe Asthma Research Program (SARP)
- Multi-Ethnic Study in Atherosclerosis (MESA)
- Evaluation of COPD Longitudinally to Identify Surrogate Endpoints (ECLIPSE)



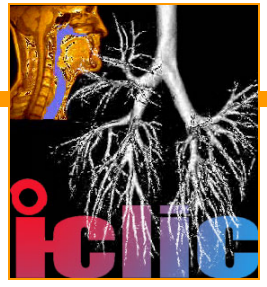
Multi-Center Trials Using QCT of the Lung

- Genetic Epidemiology of COPD (COPDGene)
- Subpopulations and intermediate outcome measures in COPD (SPIROMICS)
- Future Trials looking at COPD genotypes and CT phenotypes that are at increased risk for Lung Cancer



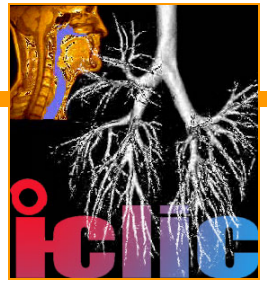
Quantitative CT of the Lung

- Establish QCT imaging endpoints first
  (e.g. LAV -950, LAV -856, IA, OA, WA, WA%)
- Single breathe hold 3D dataset
- Sub-millimeter resolution in x, y , z axis
- Select optimal CT reconstruction kernel



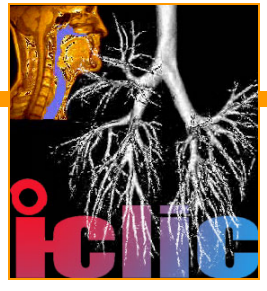
Quantitative CT of the Lung

- Minimize radiation dose but do not compromise primary imaging endpoints
- Position patient in the center of the CT scanner aperture
- Scan at prescribed lung volumes, e.g. TLC, RV



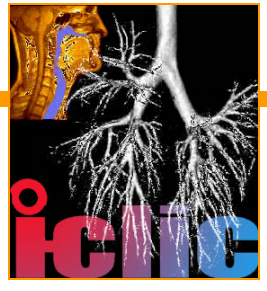
Critical Across CT Model Issues

- Frequent CT scanner calibration
- Minimize radiation dose adjusting for different size subjects and CT scanner characteristics
- Maximize spatial and temporal resolution



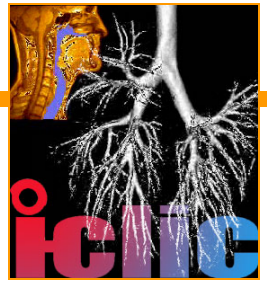
Critical Across CT Model Issues

- Select comparable reconstruction kernels
- Careful attention to position patient properly in the CT scanner
- Careful attention to achieving TLC, FRC or RV



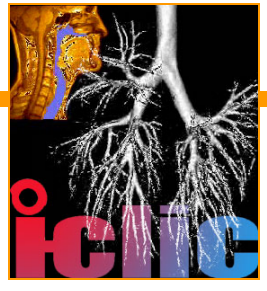
Overview of SPIROMICS CT protocol

- Types of CT Scanners that were acceptable, 64 detector rows or greater – determines ultimate spatial and temporal resolution
- Acceptable reconstruction kernels, B35f, Standard, B



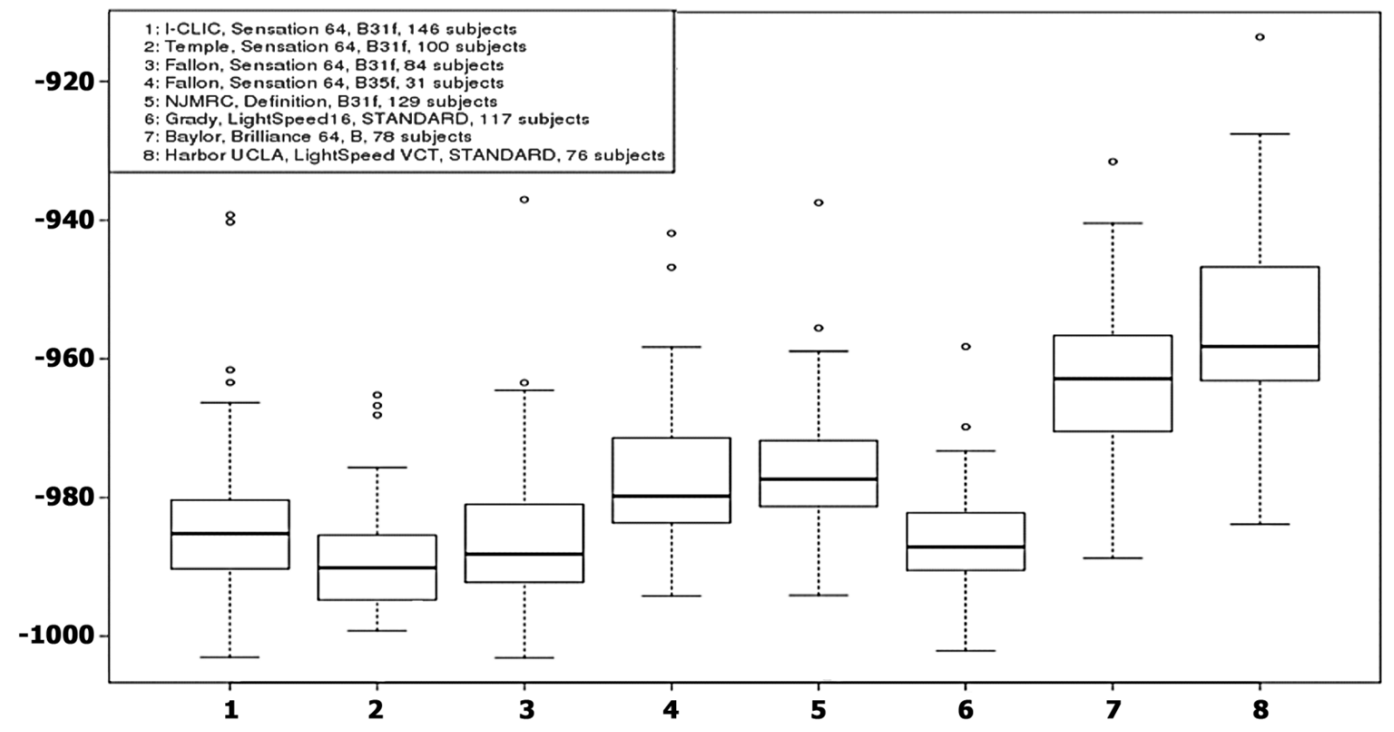
Overview SPIROMICS CT protocol

- Radiation Dose Adjustment based on CTDIvol
- CT test object (phantom) procedures
- Subject positioning and breathe hold techniques



Challenge: CT Attenuation Differences

Variation of Endo-tracheal air sampled from GE, Siemens, & Philips scanners from a cluster of patients at various institutions. It has been found that the site by site variation in tracheal air density reflects manufacturer, model and reconstruction kernel differences.



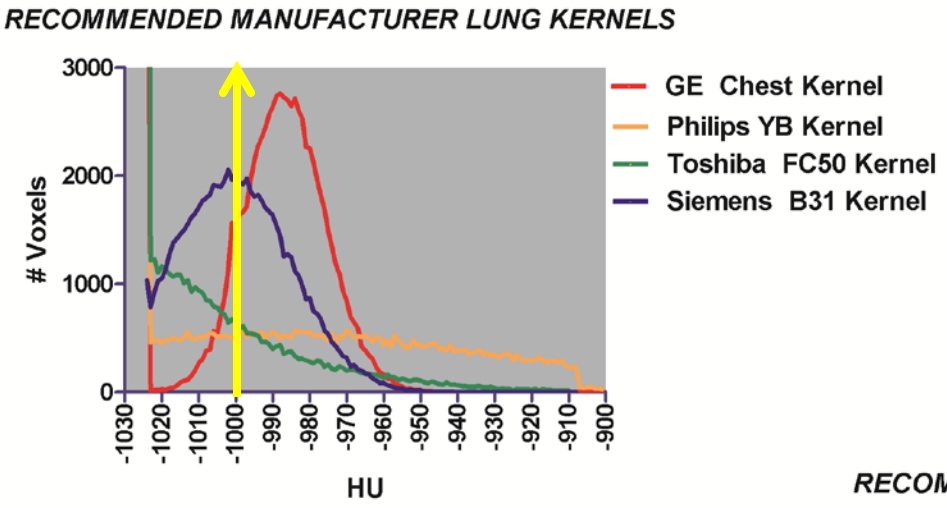
No scanners are at -1000HU

High variability between scanners

The University of Iowa

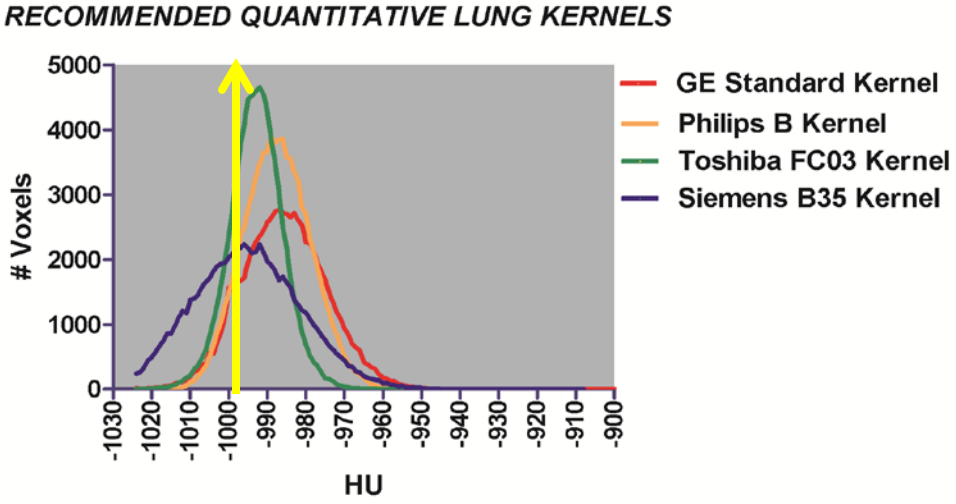
The Iowa Institute for Biomedical Imaging

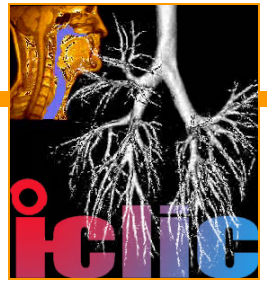
Standardization of Algorithms



Left: Manufacturer-based differences in air density histograms assessed by imaging the COPDGene Phantom (Phantom Labs) using sharp "lung" kernels

Right: Similar imaging to that shown in the above graph except SPIROMICS recommended kernels replaced the sharp "lung" kernels. While an harmonization is apparent there remains a 10HU difference in histogram modes.





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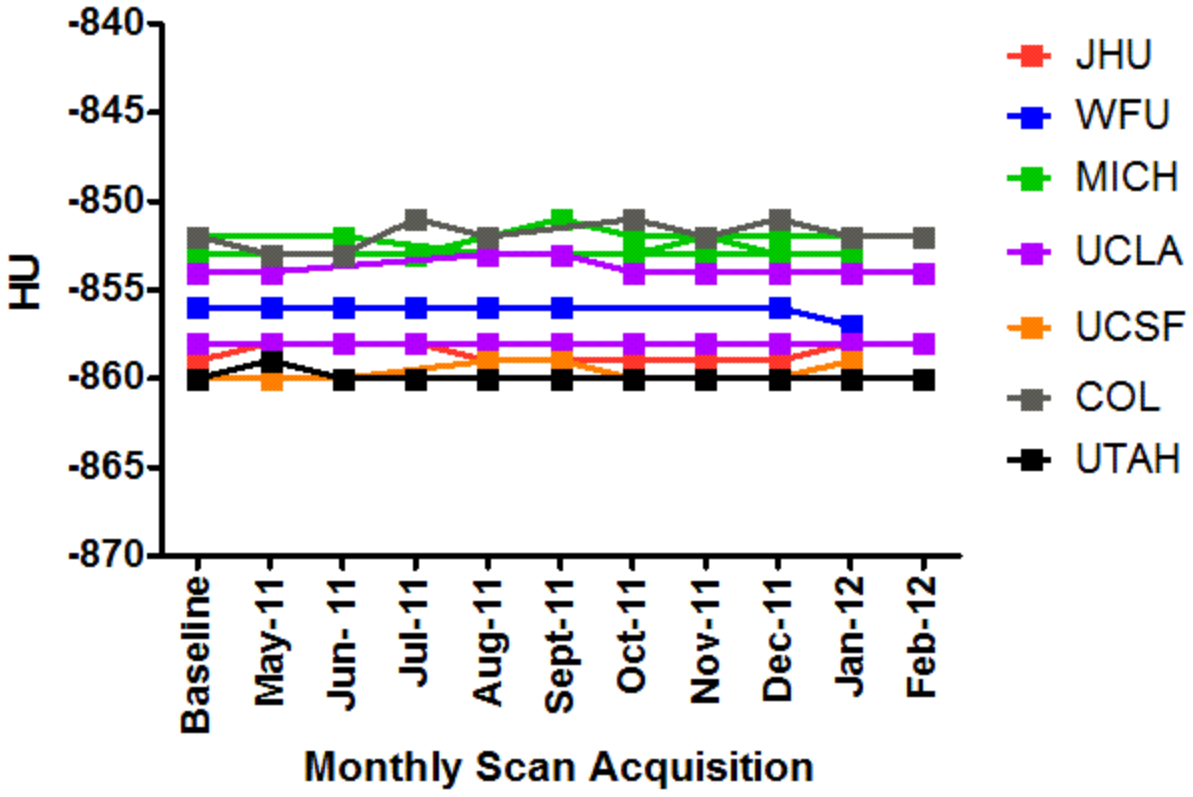
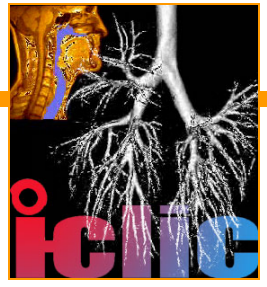
Lung Equivalent Attenuation Material



- All SPIROMICS CT scanners are stable.



Summary

- Quantitative CT methods are more rigorous than qualitative CT methods
- Radiation dose needs to be adjusted for subject size and minimized while not compromising the primary imaging endpoints.
- Positioning patient properly in the CT scanner and achieving specified lung volumes are very important
- Certain COPD CT phenotypes are may have increased risk for lung cancer.