David's draft claims for densitometry:

Claim 1: Longitudinal Stability of Lung Densitometry

Longitudinal CT measurements of attenuation of air on CT phantom on the same CT scanner are associated with a coefficient of variation of Y%, which corresponds to change in attenuation of ± X HU.

Claim 2: QCT measurement of emphysema

The severity of emphysema can be measured using density mask technique at -950 HU, within a X % test-retest coefficient of variation for density mask technique and Y% test-retest coefficient of variation for 15th percentile measurement.

Additional airways measurement claims (Sean):

Background:

Rationale for each measure:

The accuracy of the CT measurement is limited by spatial resolution with in-plane resolution on the order of 0.5 mm and through plane resolution on the order of 0.7 mm. Consequently many of the airway morphology measures on CT have questionable accuracy and increased variability below a 6-8 pixel diameter airway corresponding to a minimum diameter of 3-4 mm. This represents a reasonable lower limit on a measureable airway segment. It has also been shown that the wall area percentage and lumen area measures of more distal airways (3rd to 6th airway generations) correlate most strongly with PFT measures [cite]. This reflects an important tradeoff between accuracy of airway morphology measures and their physiological/disease relevance to obstructive lung disease. To balance these considerations, two exploratory measures have been proposed in the literature and described in more below as the current best practice for quantitative measures on airway morphology in obstructive lung disease.

AWT-Pi10: This is a single “index airway” measurement of a typical wall thickness for a segment with perimeter (Pi) of 10 mm (3.2 mm circular diameter). The measure fits a statistical linear regression of airways > 2 mm diameter (6 mm Pi) to a plot of airway perimeter (Pi) as the independent variable vs. sqrt(wall area) as the dependent variable with the idea that airways below this size are not accurately measured on CT due to inadequate spatial resolution [cite Patel]. Comparisons of CT measures to histology using this approach have shown that CT overestimates wall area compared to histology for airways with Pi < 6 mm [Nakano et al., Am J Respir Crit Care Med Vol 171. pp 142–146, 2005].

WA%: Wall area percentage on CT is defined as the area ratio between (airway wall area)/ (airway wall + lumen area) \*100 acquired at or near 90% total lung capacity (TLC) lung volume as defined in Ref [Hoffman et al., Proc Am Thorac Soc Vol 3. pp 519–534, 2006]. Recent software tools and improvements in CT scanner technology have made 3D volumetric CT images of the airway tree a reality. However, due to current spatial resolution limits most studies have focused on measures of airway branch segments between the 3rd and 6th airway generations [cite Shimizu] where the 5th generation in recent studies appears to be most strongly correlated with PFTs and differences in disease groups [cite Kurashima]. In addition, two important advantages of 3D analysis of the airway tree are a reduction in measurement error due to partial volume averaging and the ability to individually measure specific segments of the tree and thus explore potential regional patterns of disease [Hoffman et al., Proc Am Thorac Soc Vol 3. pp 519–534, 2006].

However, only recently have repeatability studies been performed and typically in small (<40 subjects) and mixed populations of disease or risk for disease with normal subjects. Until more and larger studies are published in the literature the Claims below remain exploratory with intervals as defined a “best guess” or target repeatability based on limited data made available in proceedings abstracts [ATS citations] and expert opinion.

Exploratory Claim 1: Airway wall thickness at 10 mm perimeter (AWT-Pi10) can be measured with a coefficient of variation of better than 10% and ICC > 0.75 with an estimated 95% confidence interval of +/- 0.2 mm.

Exploratory Claim 2: Wall area percentage at the 5th generation segments of the airway tree can be measured with a coefficient of variation of 15% and ICC > 0.70 with an estimated 95% confidence interval of +/- 6%.

References:

[Hoffman et al., Proc Am Thorac Soc Vol 3. pp 519–534, 2006]
[Nakano et al., Am J Respir Crit Care Med Vol 171. pp 142–146, 2005]
[Patel, Coxson et al., Am J Respir Crit Care Med 178. pp. 500-505, 2008]
[Shimizu et al., Rerspiratory Medicine 105. pp. 1275-1283, 2011]
[Kurashima et al., Respirology, Epub ahead of print, 2011]

[ATS abstracts: A5208, A5227, A2194 Proceedings of Denver meeting 2011]