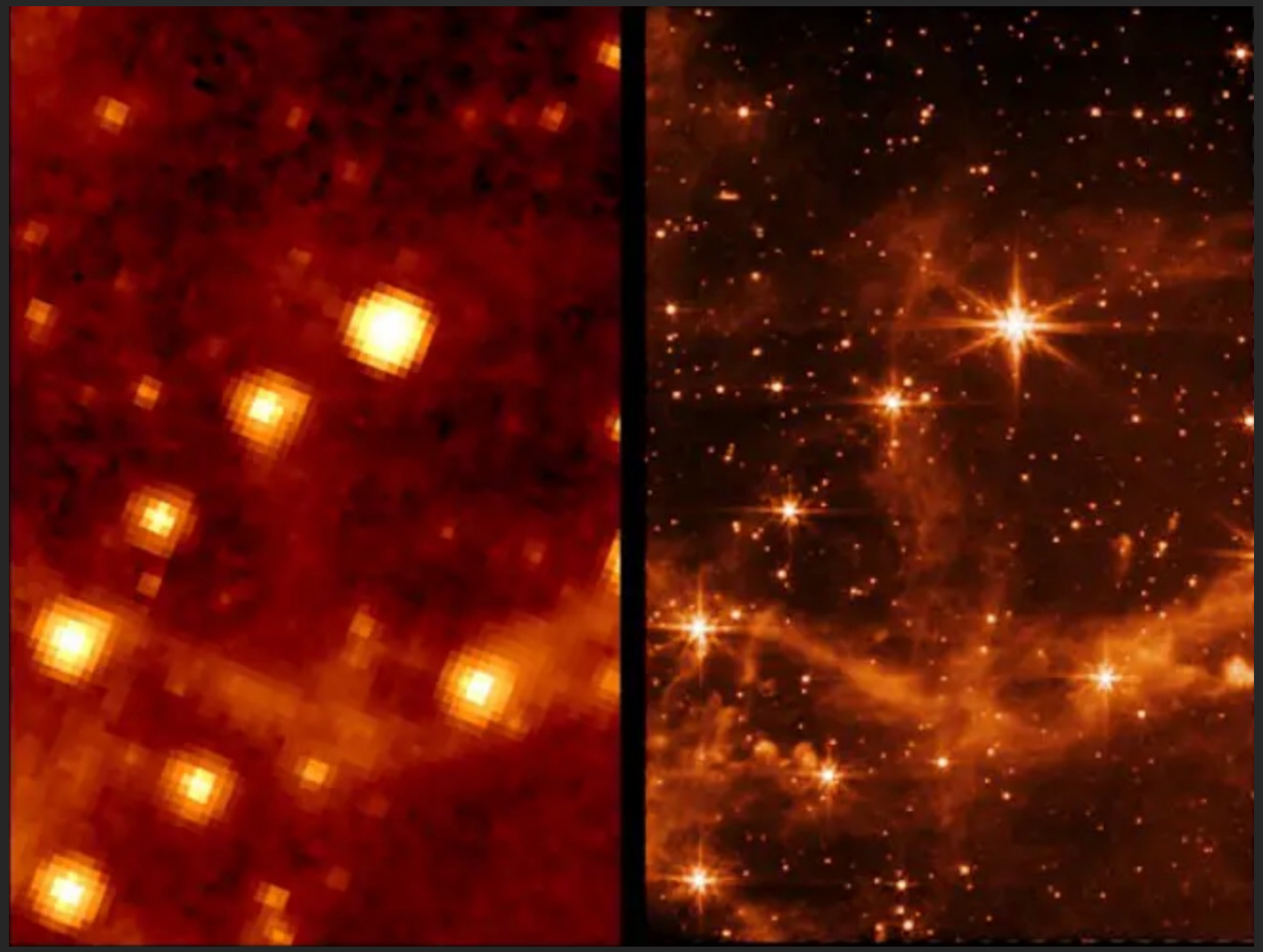
AI Targeting And Measurement (AITAM)

Rick Avila
Accumetra

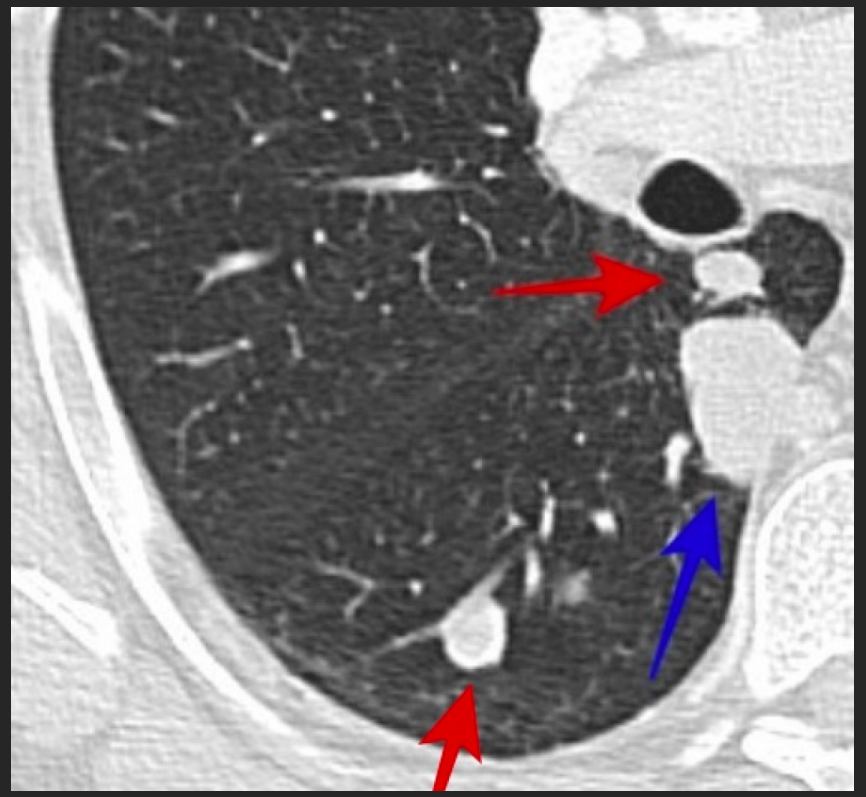
November 2, 2023



2003 : Spitzer

2021: Webb

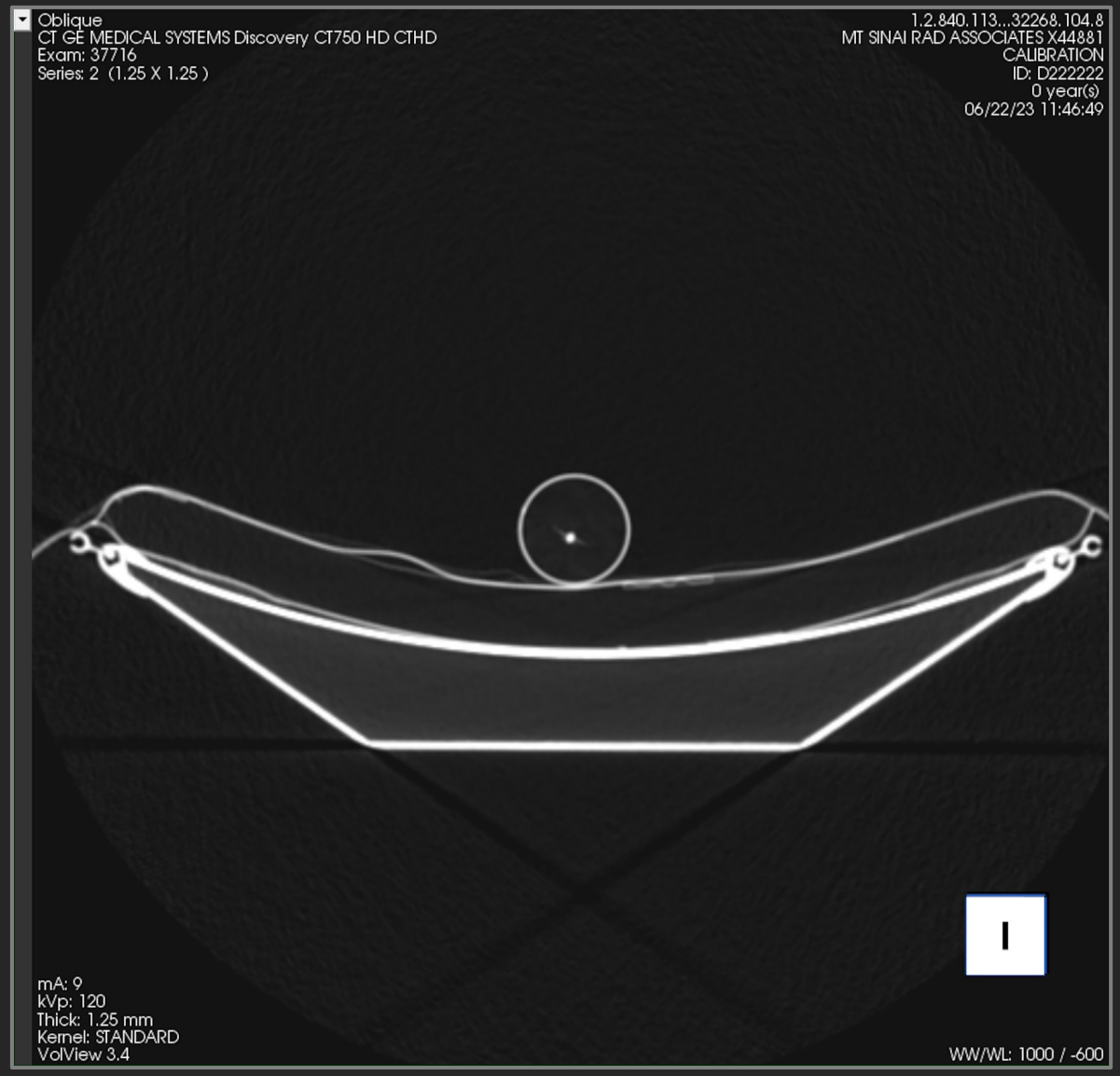
2007

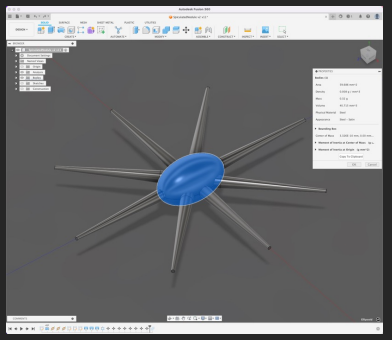


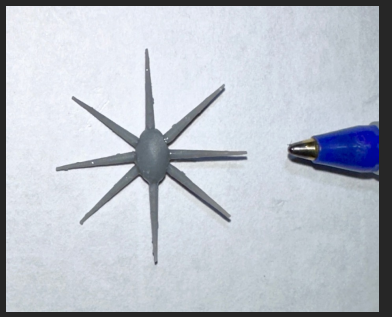
2023

Every Day Around The World An LDCT Scan Is Performed And A Serious Lesion Is Present

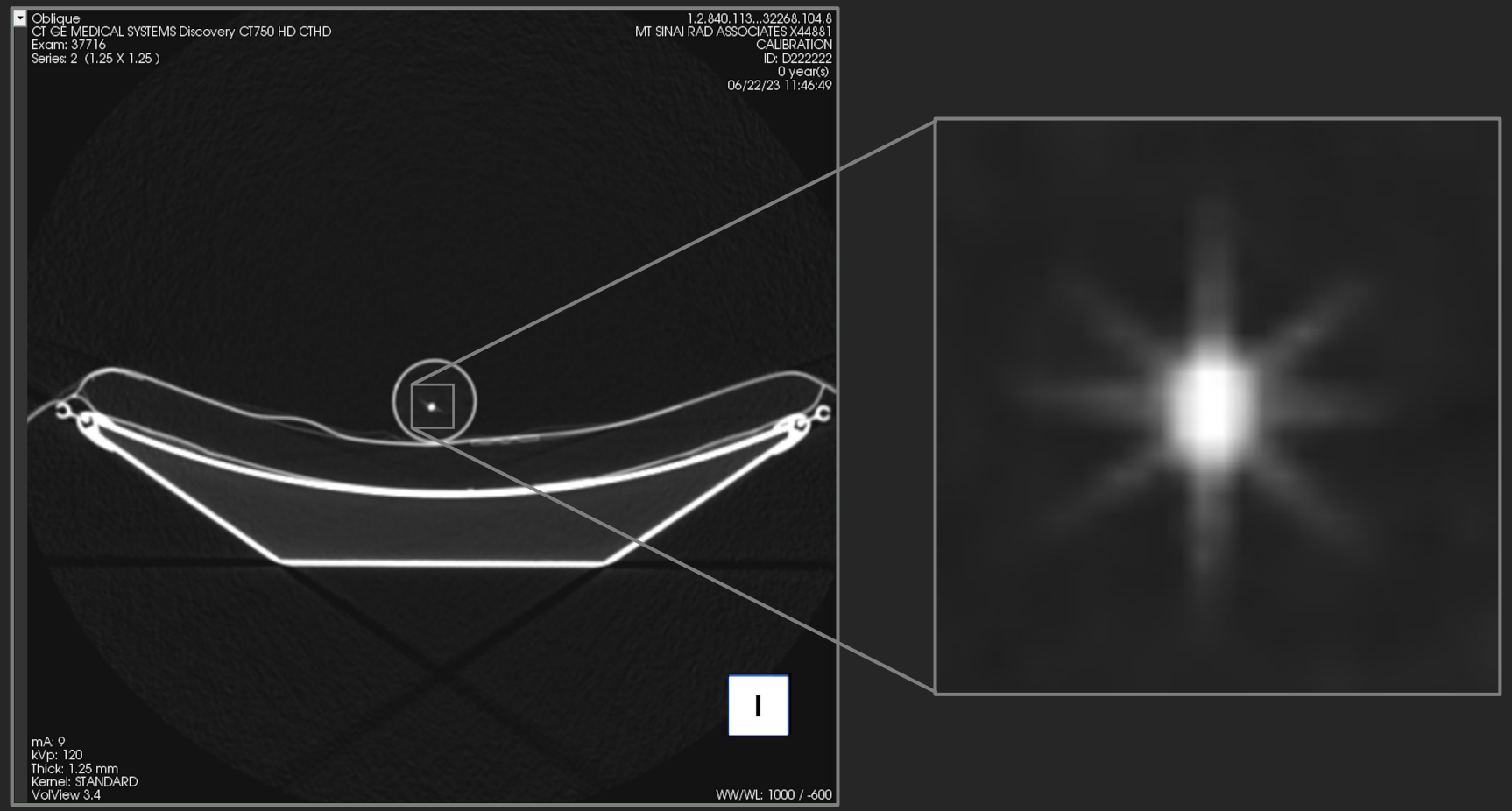
We Tested This Scenario With A Very Small 3D Printed Object







A Radiologist Will Try To Understand The Lesion And Look For Clues In The Tumor Microenvironment, But the Image Quality Is Typically Low



But What If:

AI Finds Serious Focal Abnormalities and Provides Physics-Based Guidance To The Technologist For When and How To Obtain A Much Higher Quality CT Scan of The Detected Abnormality?

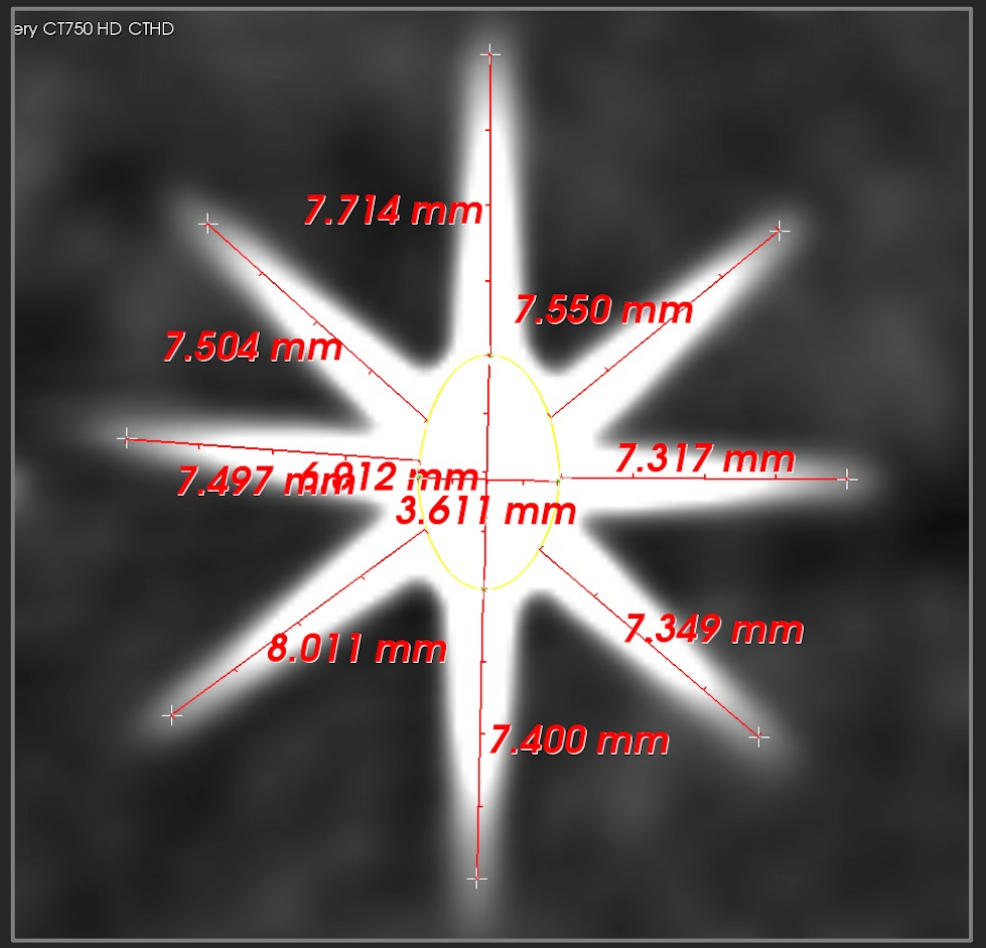
…And We Did This In Seconds,
While The Patient Is Still On The CT Table?

AITAM:
AI Powered Scanner Providing Real-Time Guidance

2x Z Res.

2x Dose

~4x Sampling



AITAM Can Also Apply The Best Known AI/Computer Vision Algorithms To Perform The Measurement Given The Targeted CT Scan Recommendation And The Patient-Specific Images/Circumstances

Imaging Physics and Signal Processing

Resolution vs Noise

Edge Enhancement
- Performed in X,Y with recon kernels
- Not supported in Z, so non-isotropic
- No information is gained

Sampling Rate Also Matters Must Be Compatible With Resolution

Better

Image Noise (HU SD)

$$\text{noise} \propto \frac{1}{\sqrt{dose\ per\ voxel}}$$

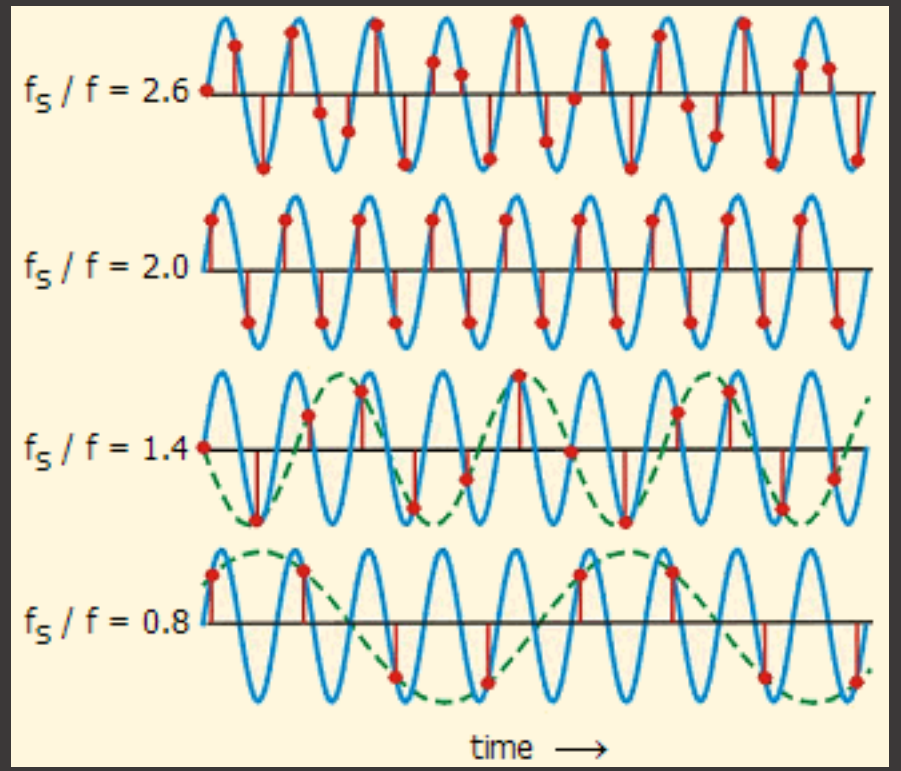
Averaging
- Performed in X, Y by recon kernels
- Performed in Z by slice thickness
- Information is lost

Dose Normalization Is Needed (mAs)

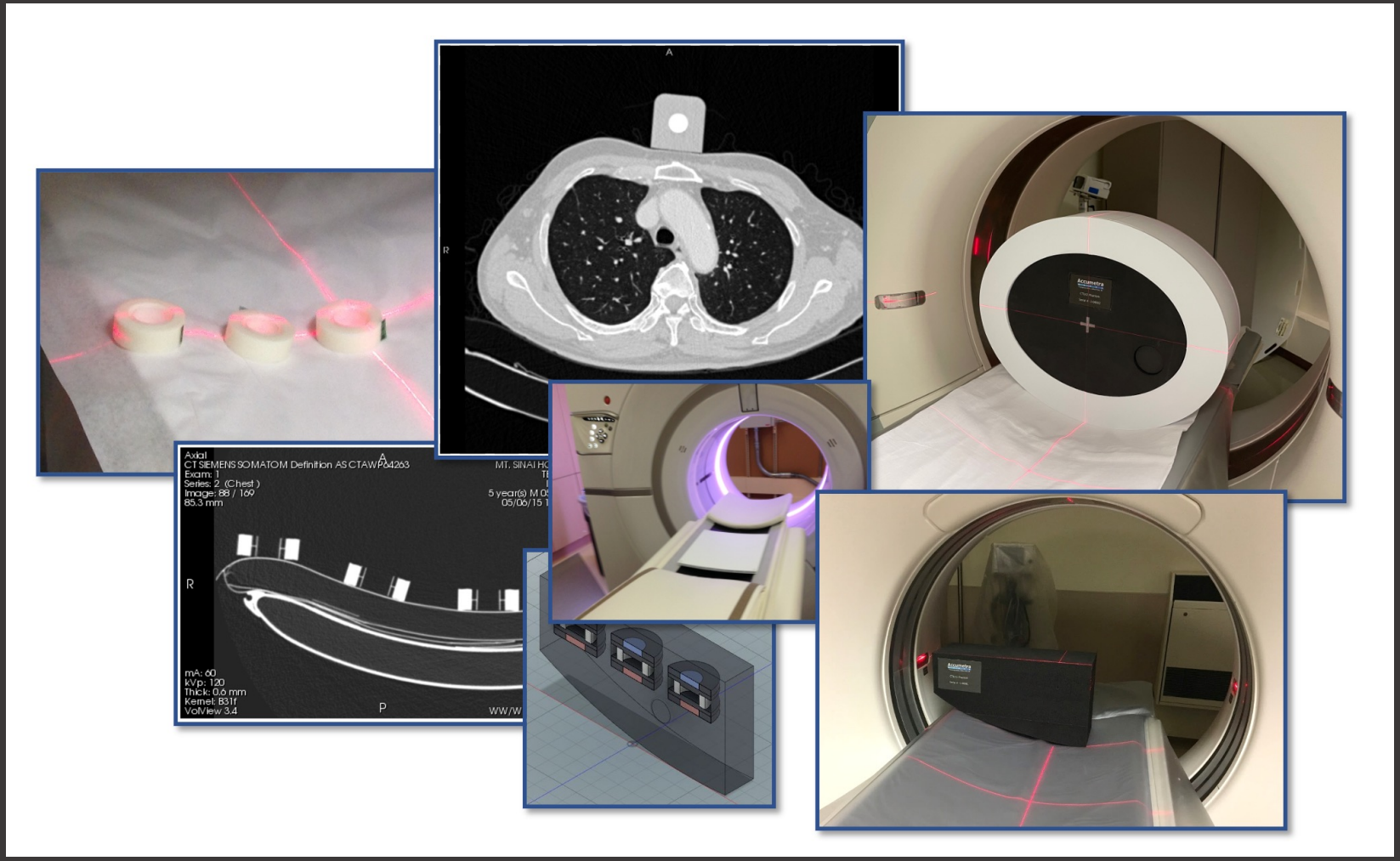
3D PSF Sigma Volume (mm^3)

Better

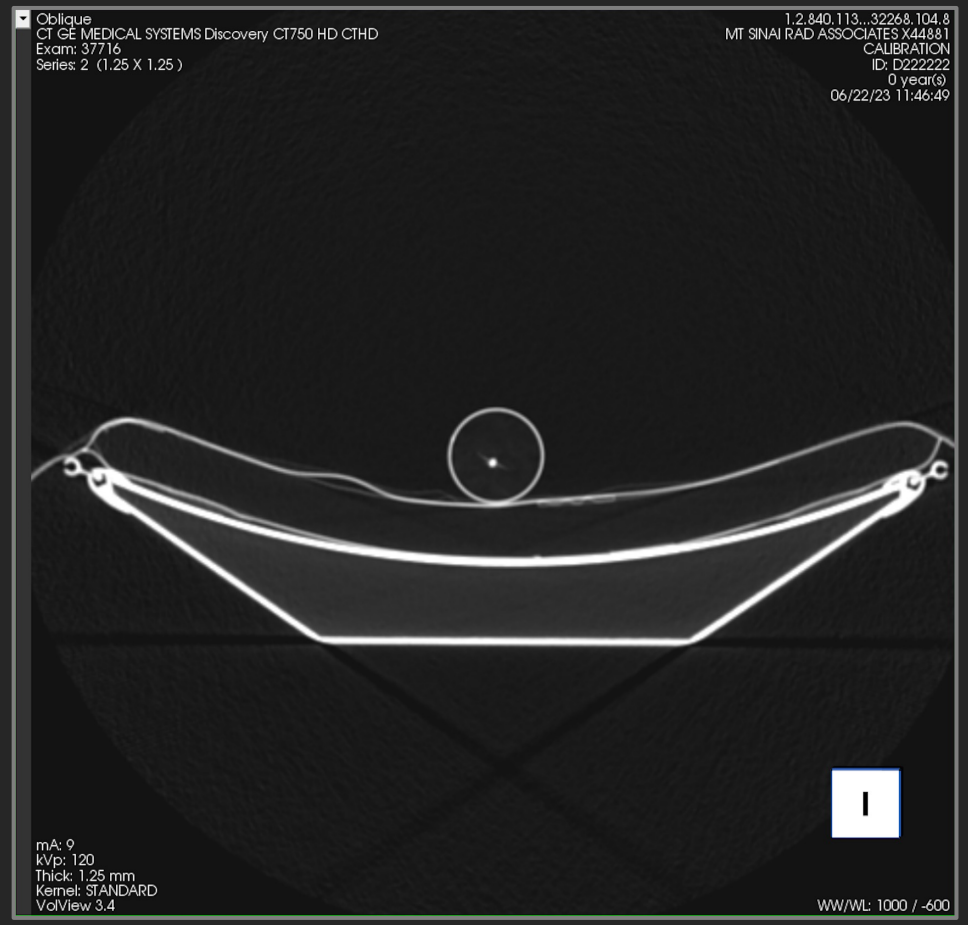
Nyquist+

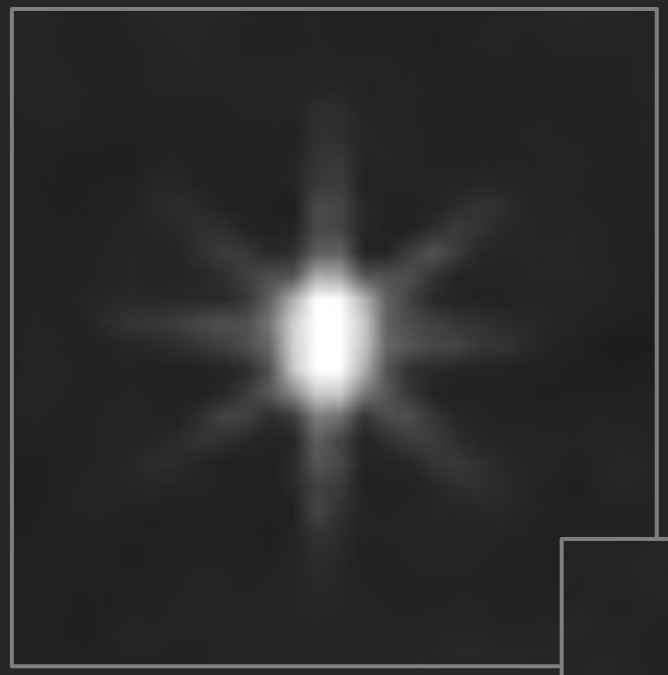


Imaging Physics and Signal Processing



The Improvements For Some Quantitative Measurements Can Potentially Be Dramatic

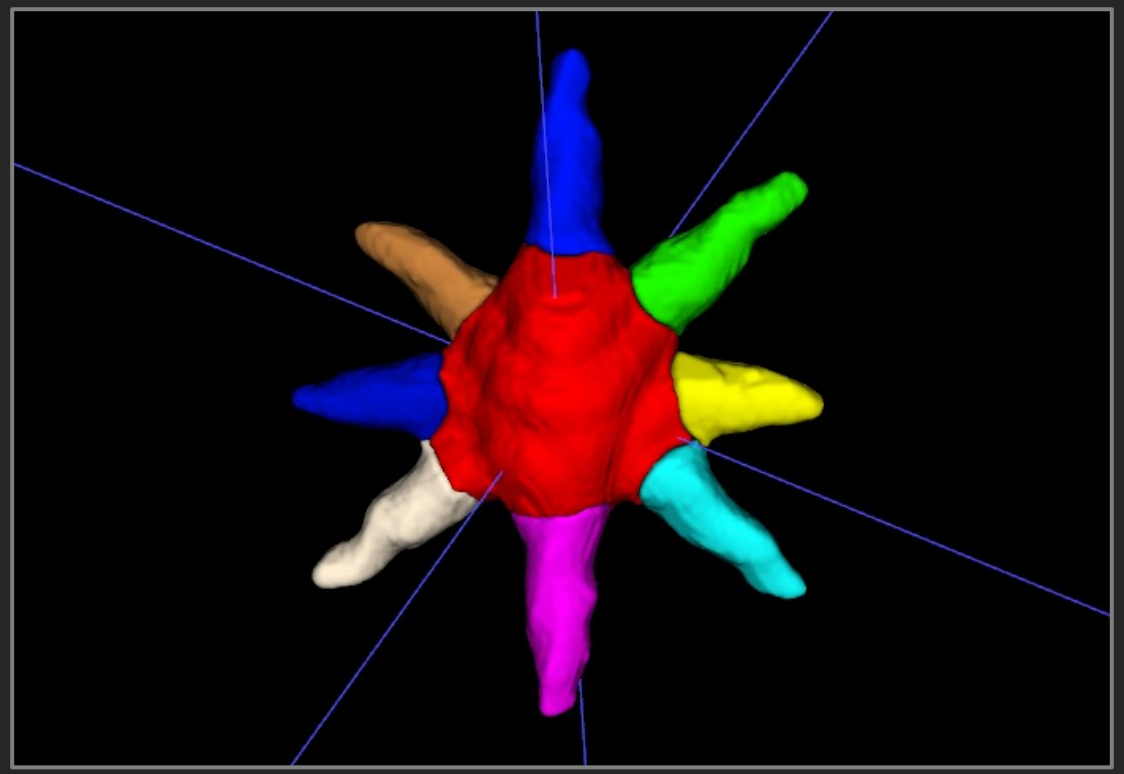


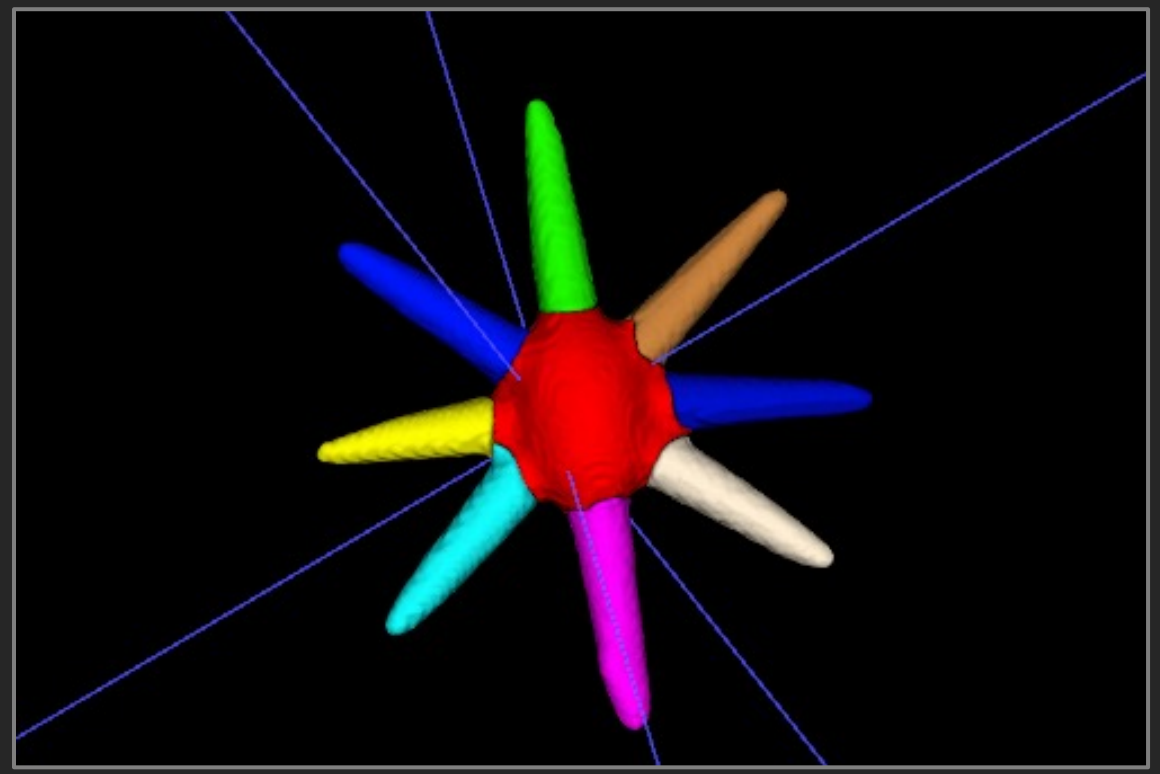


Linear Distance Precision Improved By 650 %

Linear Distance Bias Improved By 625 %

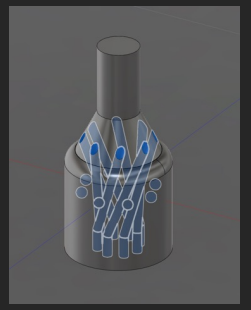
Measurement of Shapes Can Also Be Significantly Improved

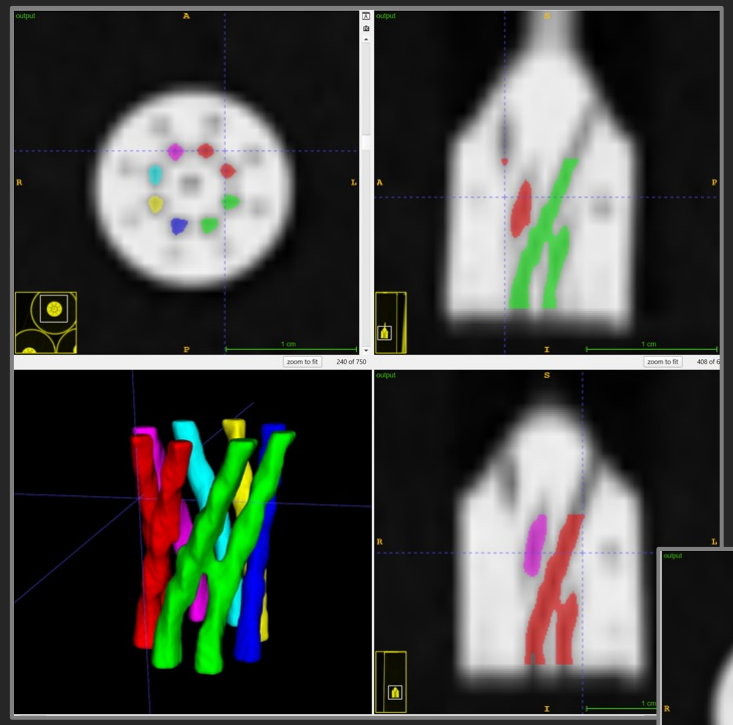




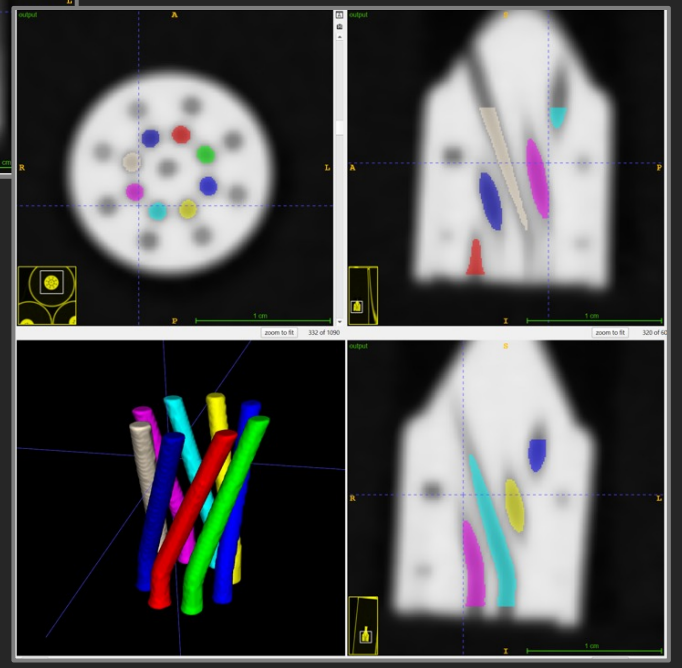
Other Quantitative Measurement Improvements Can Exceed 1,000%

GE Discovery CT750 HD





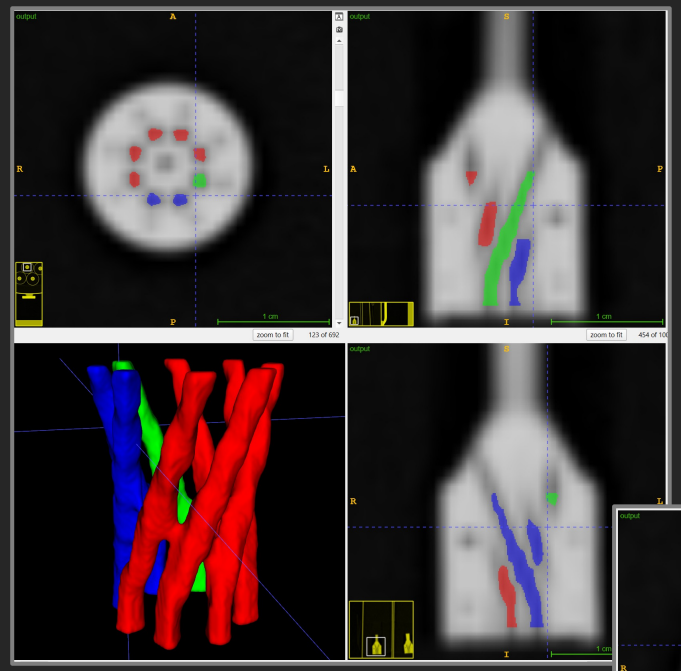
Cylinder Volume Precision Improved By 1,076 %



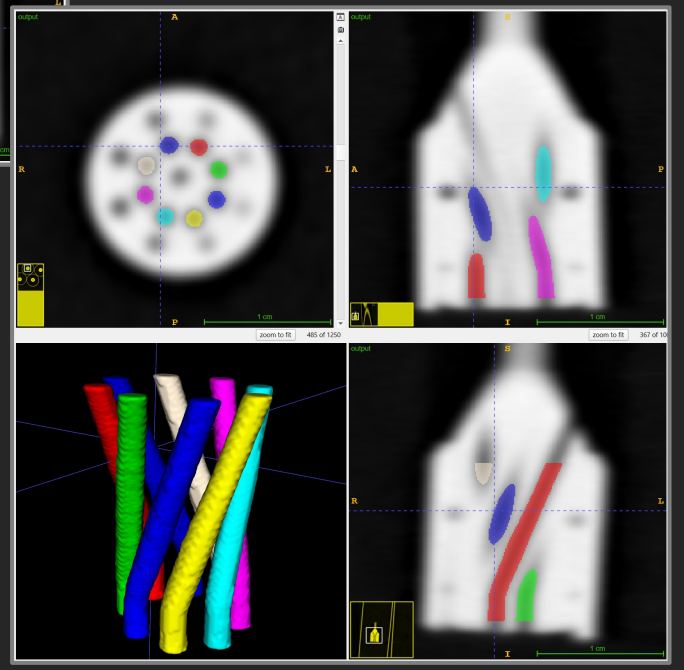
Cylinder Volume Bias Improved By 864 %

Other Quantitative Measurement Improvements Can Exceed 1,000%

Siemens
SOMATOM
Definition AS



Cylinder
Volume
Precision
Improved
By 5,991 %

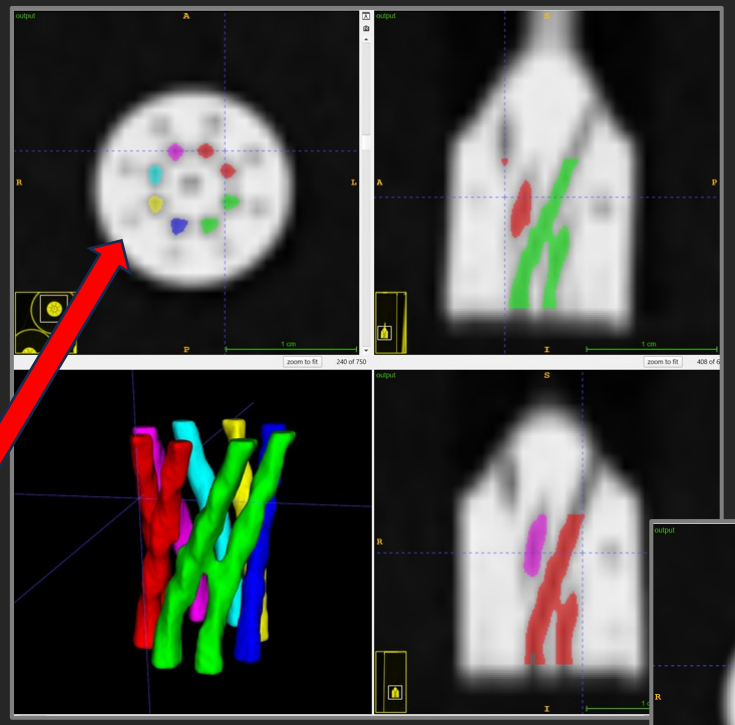


Cylinder
Volume
Bias
Improved
By 1,188 %

Other Quantitative Measurement Improvements Can Exceed 1,000%

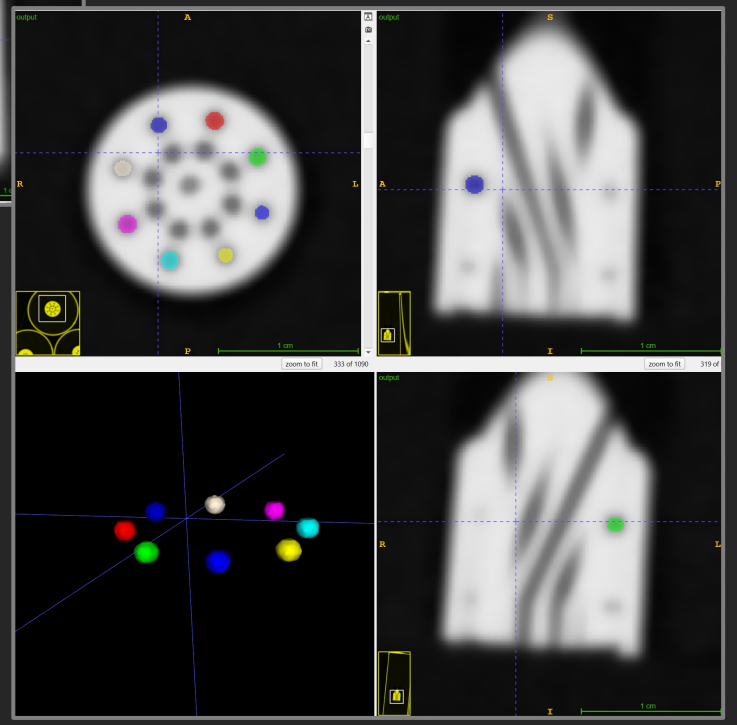
GE Discovery CT750 HD

1.5 mm sphere volumes were not able to be segmented and measured



1.5mm Sphere Volume Precision Improved By ?

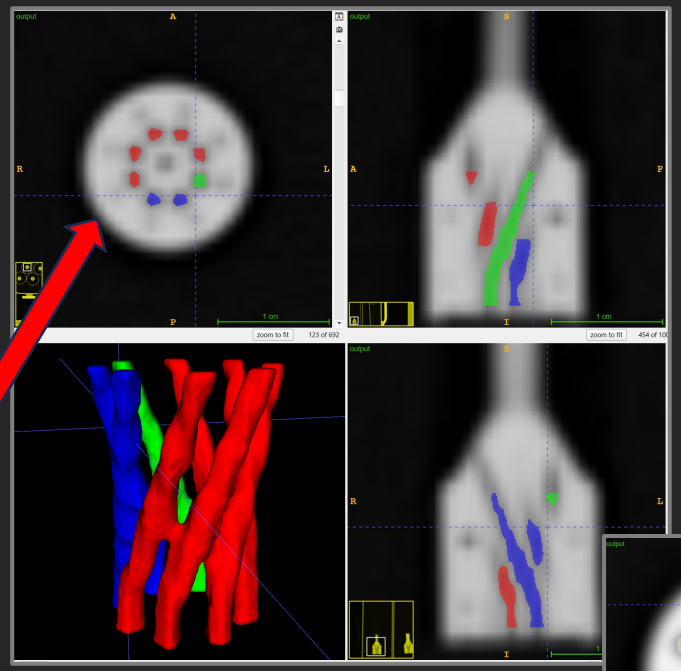
1.5mm Sphere Volume Bias Improved By ?



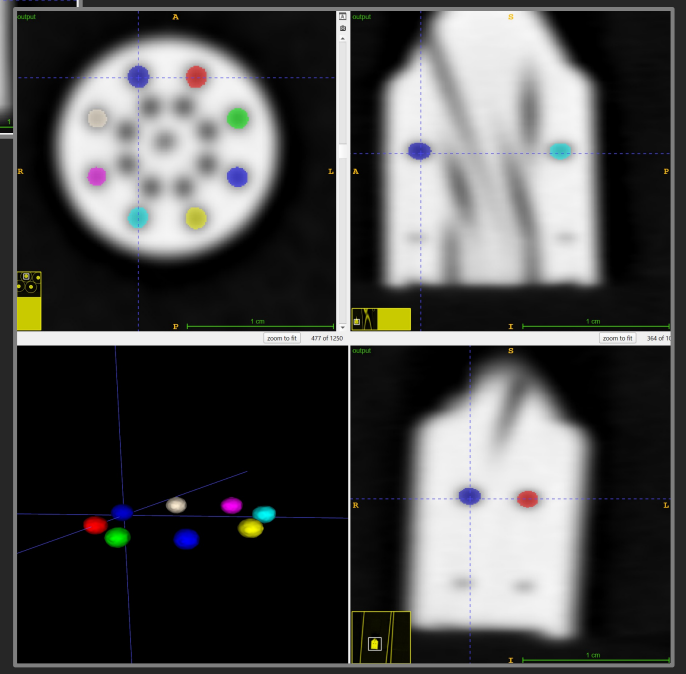
Other Quantitative Measurement Improvements Can Exceed 1,000%

Siemens SOMATOM Definition AS

1.5 mm sphere volumes were not able to be segmented and measured

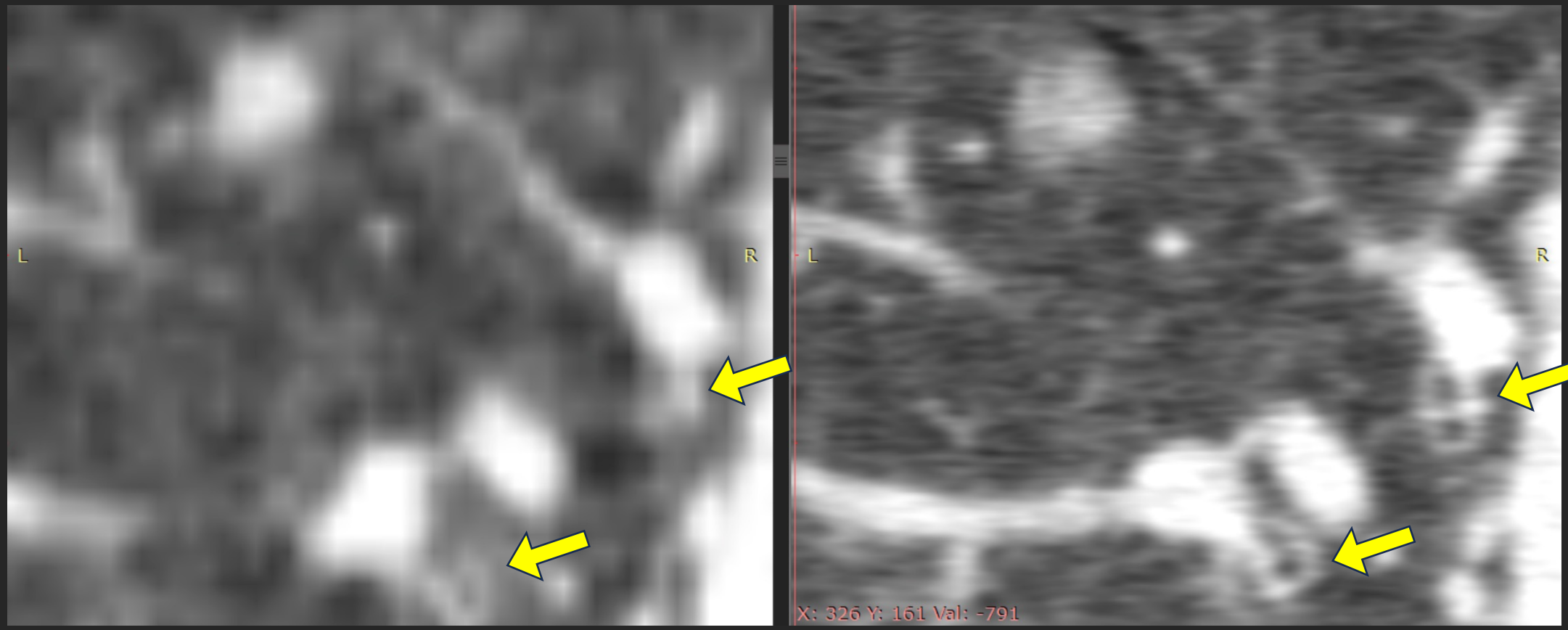


Cylinder Volume Precision Improved By ? %

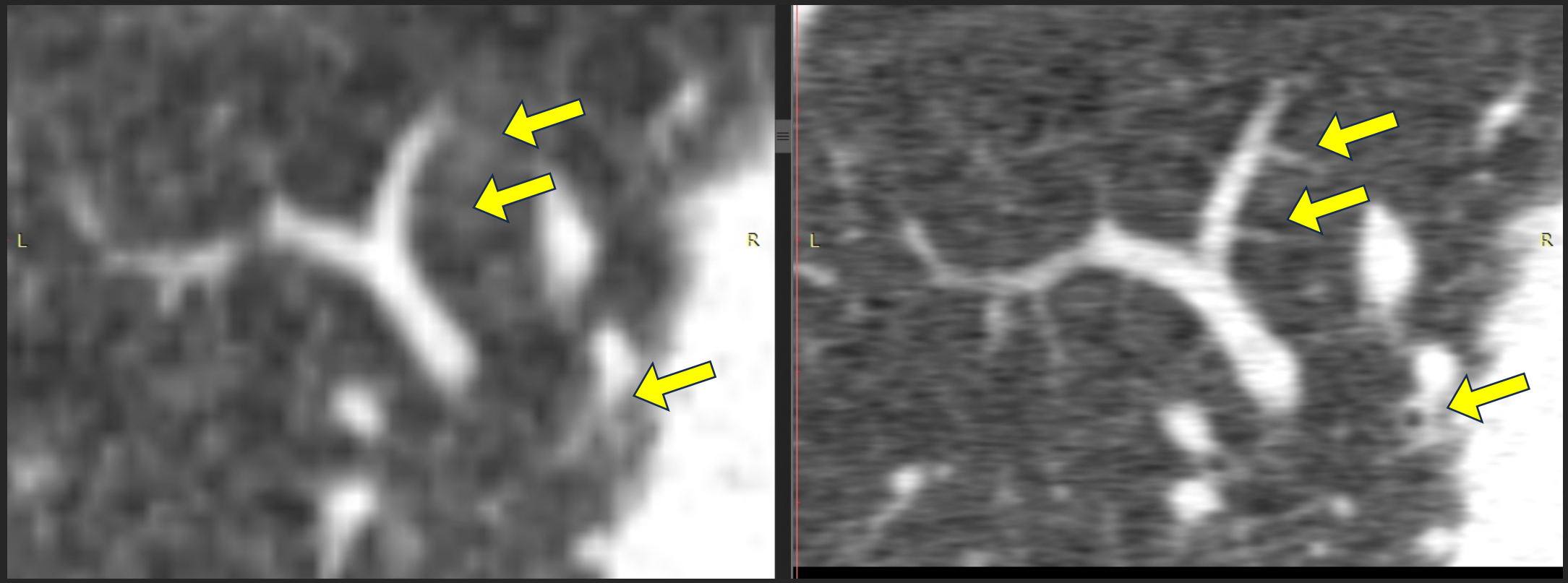


Cylinder Volume Bias Improved By ? %

Clinical Data

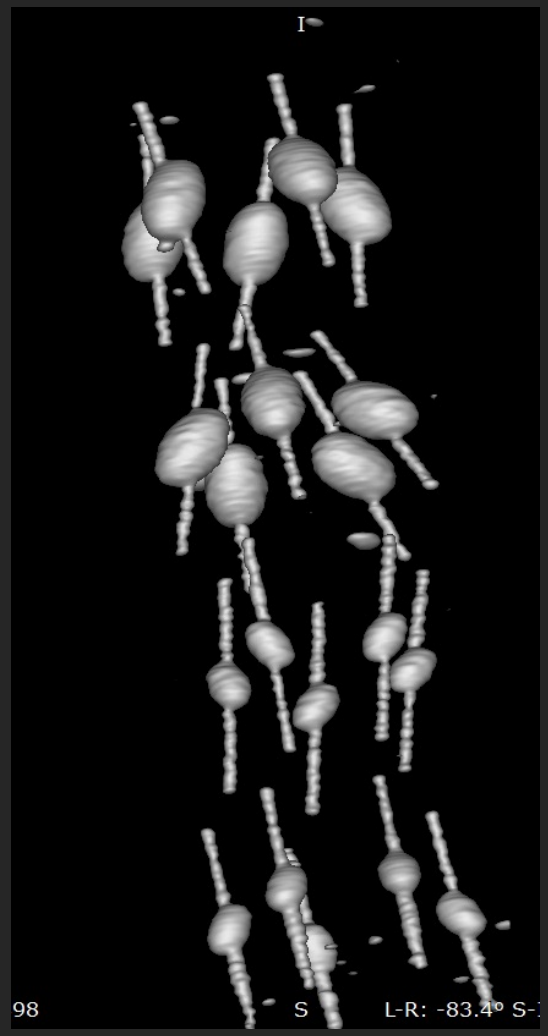


Clinical Data



Current Limitations of High Resolution Targeting

- A lot of CT protocol/image quality analysis/study is needed to avoid numerous artifacts present in targeted CT acquisitions.
- Issues such as 3D spatial warping are clearly present on many scanners/protocols.
- The good news is that we now have the phantoms and software tools to explore CT image quality much better than we did just a few years ago.
- The bad news is that this will take time scanning phantoms to figure out.



Potential Implications

- CT visualization and measurement of small objects/features can very likely be improved many times over using AITAM methods.
- This very likely applies to ALL CT scanners.
- Follow-up CT lung screen scans can potentially be performed much earlier (weeks vs months).
- Radiologist decisions on lung nodules can likely be made with higher confidence and accuracy.

Potential Implications

- Numerous other clinical applications are possible for these methods across CT (Vascular, PE, COPD, …) and other modalities.
- Clinical trials using imaging to assess drug efficacy may benefit from these methods.
- Imaging research into AI for detection and radiomics can likely be improved with these methods.
- We have only explored the initial potential of AITAM methods. There are numerous other variations/implementations that are likely to yield improvements beyond what we have observed so far.

AITAM Clinical Collaborators

- Jean Arsenault, IUCP Quebec
- Stephen Lam, University of British Columbia
- Mario Silva, University of Parma
- David Yankelevitz, Mount Sinai

Thank You