Micro-CT Methodology

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Preclinical & Translational Imaging
LAS, PTS, GlaxoSmithKline

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Provide basic understanding of technical aspects of the micro-CT

Statement:

All procedures were approved by the Animal Care and Use Committee of GlaxoSmithKline and were specifically designed to minimize animal discomfort.

Agenda:

1. Introduction to key parameters for a typical (Acquisition) protocol.
2. Description of the 3-D image reconstruction process.
3. Necessary calibrations.
4. Inclusion of phantoms as a control.
5. How are images acquired, reconstructed and analyzed?
6. Computer settings and image storage.

Key parameters for typical CT Acquisition protocols

System parameters:

X-ray tube setup: x-ray flux

- Voltage (kVp) & Current (uA): Higher voltages are used for denser or larger subjects; lower voltages are used for less dense or smaller subjects.
- The x-ray flux is proportional to the square of the operating voltage.
- The x-ray flux is directly proportional to the anode current.
- Filter thickness: filter the low energy x-rays.

Detector (camera) setup:

- Binning: higher binning increases the effective pixel size and reduces the size of the data set.
- Exposure time (ms): for each exposure.
- Field of View (FOV): - Detector readout: active part of the detector.
  - System magnification.

Key parameters for typical CT Acquisition protocols

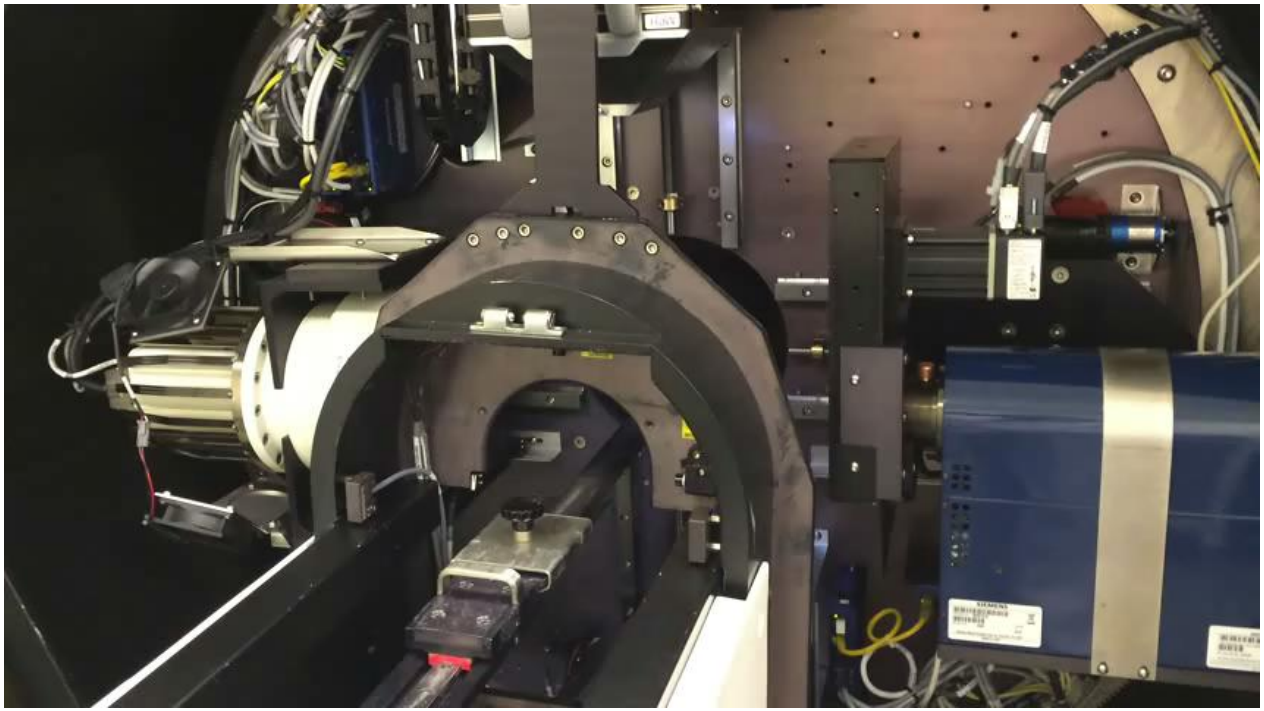
System parameters:

CT Setup:

- Rotating start position.
- Total rotation: total angle of rotation.
- Rotation steps: number of rotation steps to complete the total rotation.

Dataset file size:

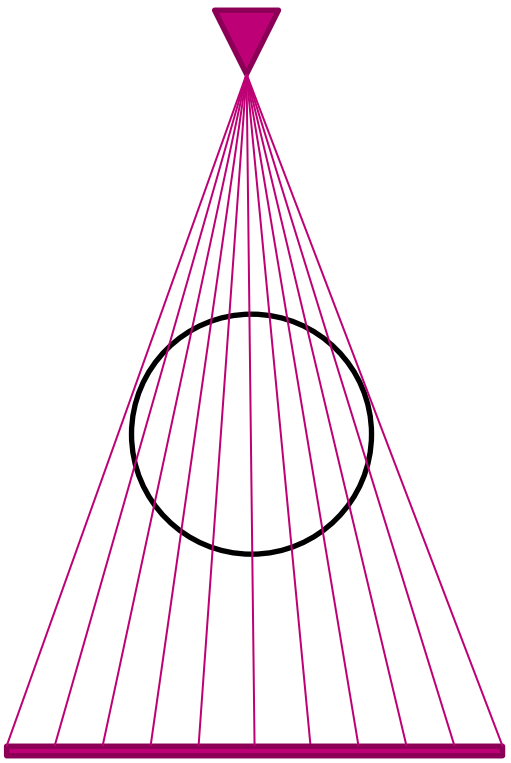
- Number of rotations.
- Binning.
- FOV.
- Image reconstruction: down sampling.
- Data format.

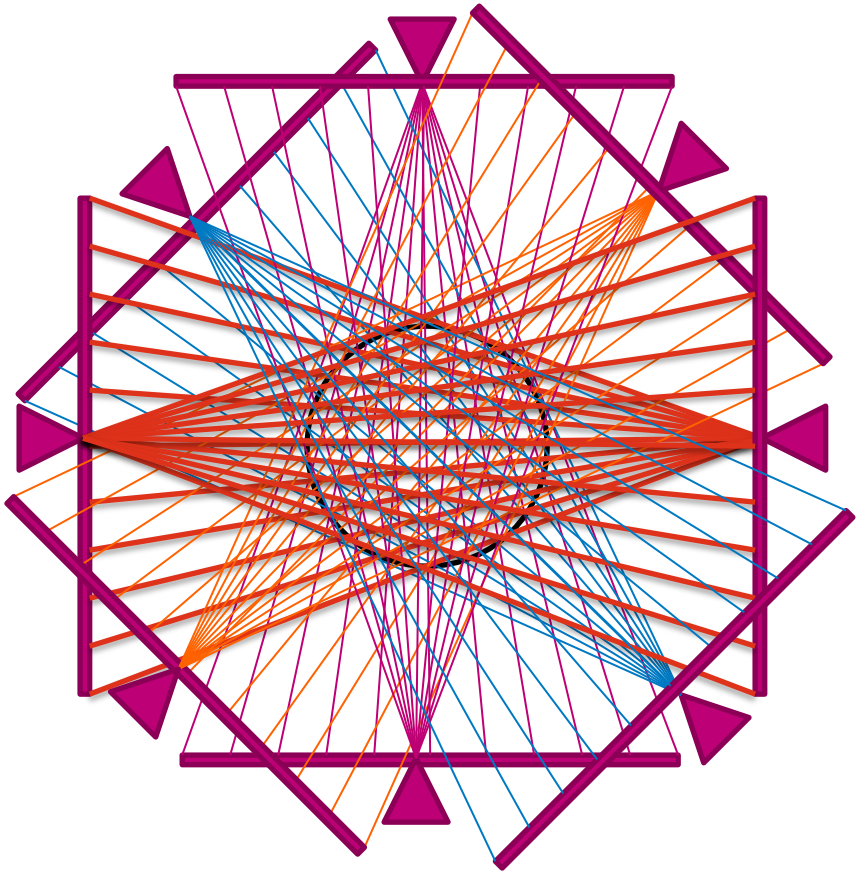


Inveon preclinical CT, Siemens Medical Solutions

Image acquisition and reconstruction

Schematic illustration of CT scan generations



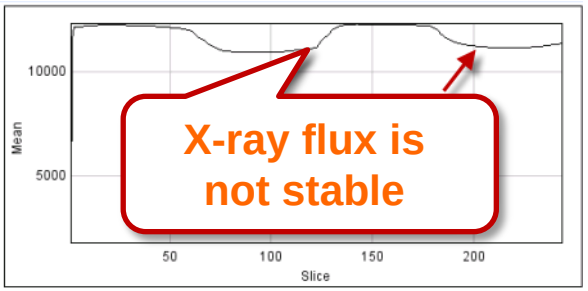


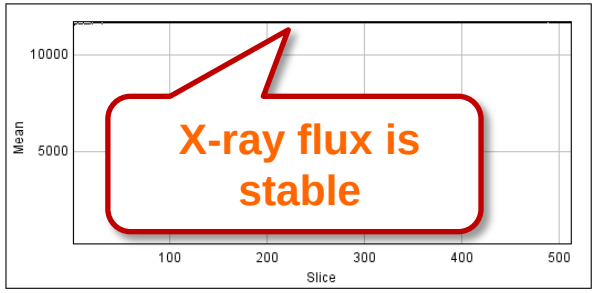
- Image reconstruction is a mathematical process generating images from data acquired at many different angles around the subject.
- Image reconstruction impacts image quality & radiation dose.

*** Image Reconstruction Techniques, Yu and Leng, NOVEMBER 2010 / WWW.IMAGEWISELY.ORG**

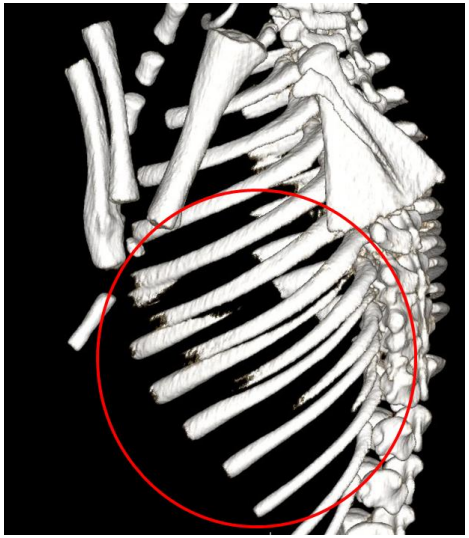
Quality Control & Necessary Calibrations

- X-ray flux





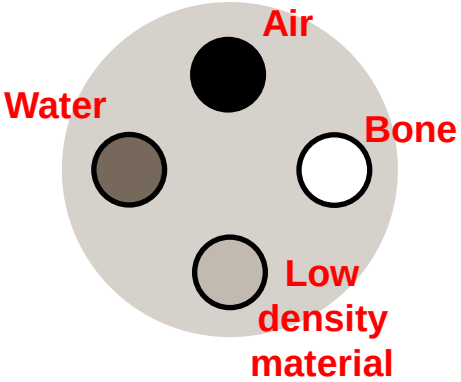
- Center offset: Distance between the center of the detector and the scanner iso center.
- CT Hounsfield Unit calibration: the radio density of distilled water and air at standard pressure and temperature is 0 and -1000 respectively.
- Stitching calibration for multi bed positions.
- Dark and light calibration: Increasing the number reduces the noise of these frames, improving soft tissue contrast and reducing ring artifacts.

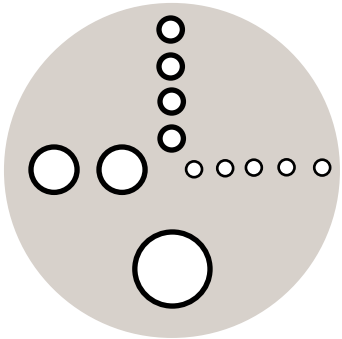


- System QC: daily, weekly, quarterly.

Inclusion of phantoms as a control

1. What do we need a phantom to address?
   - The position and alignment: center offset, stitching (phantom should cover multi bed positions).
   - CT HU accuracy: Air, Water, Bone, ... presented as Mean ± SD.
   - Assess the low and the high spatial resolutions: series of cylinders of a known material/contrast with different diameters.
   - CT homogeneity for both resolution and contrast: should be measured in the center and in the periphery of the cylinder phantom.

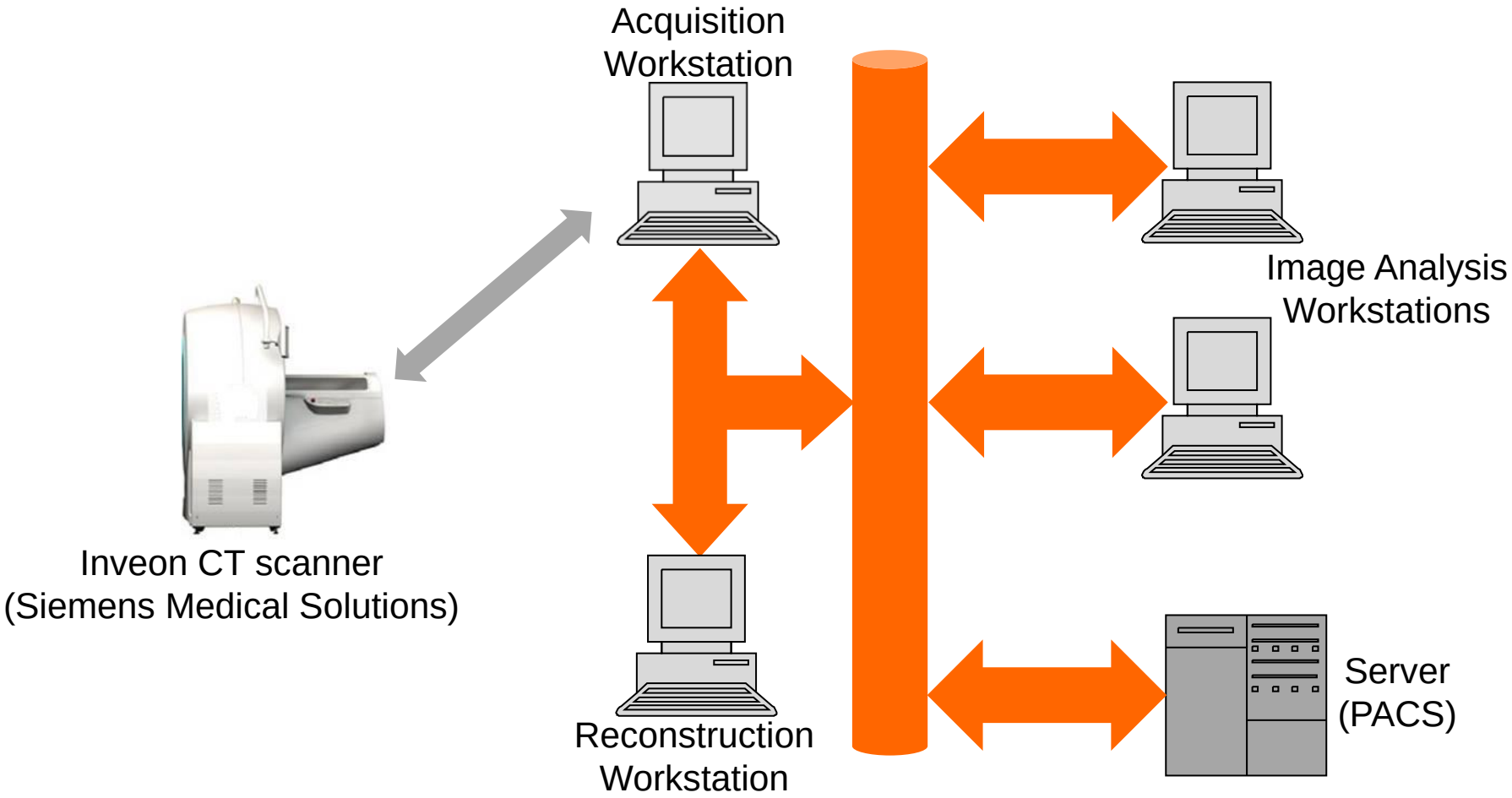




2. What do we need to capture?
   - CT phantom images.
   - CT phantom data .

* http://www.acr.org/~/media/ACR/Documents/Accreditation/CT/PhantomTestingInstruction.pdf

How are images acquired, reconstructed and analyzed?



*PACS: Picture Archiving and communication system.

Computer settings and image storage

- Computer settings:
  - High performance workstation for image analysis of 3D data :
    - High performance CPU (with integrated memory).
    - Large/high speed hard disk.
    - Large memory RAM.
    - High performance graphic card (with integrated memory).
  - Image analysis software: qualitative / quantitative measurements.

- Data Storage:
  - Data needs to be organized in a standard form: sample number/dataset number, study number, study date, imaging session.
  - Image should be converted to a standard format DICOM*, AVI ...
  - QC may be performed on the data before or after moving it to the server/PACS.

*DICOM: Digital Images and communications in Medicines.

Thank you

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