AAPM Computed Tomography Automatic Exposure Control Education Slides

Neusoft

Many of the terms used in these slides can be found in the CT Terminology Lexicon

http://www.aapm.org/pubs/CTProtocols/documents/CTTerminologyLexicon.pdf

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Motivation

- These slides are provided to aid in understanding the factors that affect performance of Automatic Exposure Control, specifically image quality and radiation dose, in CT studies

Outline

- Effect of CT localizer on AEC

- Image quality reference parameter for AEC

- Effect of patient size on AEC

- Effect of scanned anatomy

- Effect of first or expected reconstruction settings

- Advanced AEC features

Effect of CT Localizer

- The CT localizer(s) provide the initial data to inform the behavior of the AEC

- The apparent size of the patient on the localizer(s) or the measured attenuation are used to set the initial dose level for the exam

- The localizer(s) may also be used to adjust the longitudinal or angular tube current modulation

- The use of multiple localizers and the order of their acquisition may affect the behavior of the system's AEC

Effect of CT Localizer – Neusoft Medical Systems

- If only one localizer is acquired, the choice of the localizer (AP vs. Lateral vs. PA) does not impact AEC calculations

- If two localizers are acquired, the order of the localizer (AP + LAT vs LAT + AP) does not impact AEC calculations

- The scanning parameters (e.g. tube voltage, mA) of the localizer do not impact AEC calculations

Effect of CT Localizer – Neusoft Medical Systems recommendations

- For head/neck exams it is recommended to use:
  - One localizer
  - Lateral localizer, if only one localizer is used
  - PA first, then lateral if two localizers are used
  - Fixed tube voltage for localizer 100 kV and 10 mA on an average size adult patient for lateral

- For chest/abdomen/pelvis exams it is recommended to use:
  - Two localizers
  - PA localizer, if only one localizer is used
  - PA/LAT if two localizers are used
  - Fixed tube voltage for localizer
  - A minimum of 100 kV and 40 mA on an average size adult patient for PA and lateral, respectively

Effect of CT Localizer – Neusoft Medical Systems

- Mis-centering of the patient impacts AEC calculations

- If a patient appears mis-centered in the localizer, the operator can't judge the centering of the patient from the console and can't compensate for the mis-centering without entering the scanner room

- Once the patient miscentering has been corrected, it is recommended that a new localizer be acquired for accurate AEC calculations

Effect of CT Localizer – Neusoft Medical Systems

- If the prescribed CT scan range exceeds the range of the acquired localizer, the AEC algorithm uses the same technique for the scan range beyond the localizer as the closest z location included in the localizer

Image quality reference parameter for AEC

- The image quality reference parameter for AEC is generally a measure of image quality in the reconstructed images

- The image quality reference parameter for AEC has a unique relationship with both tube output and patient size

- Specifically, the Image quality reference parameter is used together with the patient attenuation profile (as estimated by the CT localizer) to determine the tube output for a particular exam

- The operation of the AEC may be independent of the reconstruction parameters, or related to them

Image quality reference parameter(s) for AEC – Neusoft Medical Systems

- The primary image quality reference parameter for AEC is called SNR.

- AEC calculation uses a reference patient size, which is different for adults and pediatric protocols.

  - *Follow factory protocols . Different reference sized phantoms based on patient size for body and age for head protocols*

# *Effect of image quality reference parameter for AEC – Neusoft Medical Systems*

- The tube output (i.e., effective mAs) has a square relationship with the image quality reference parameter for AEC (all other factors being equal)
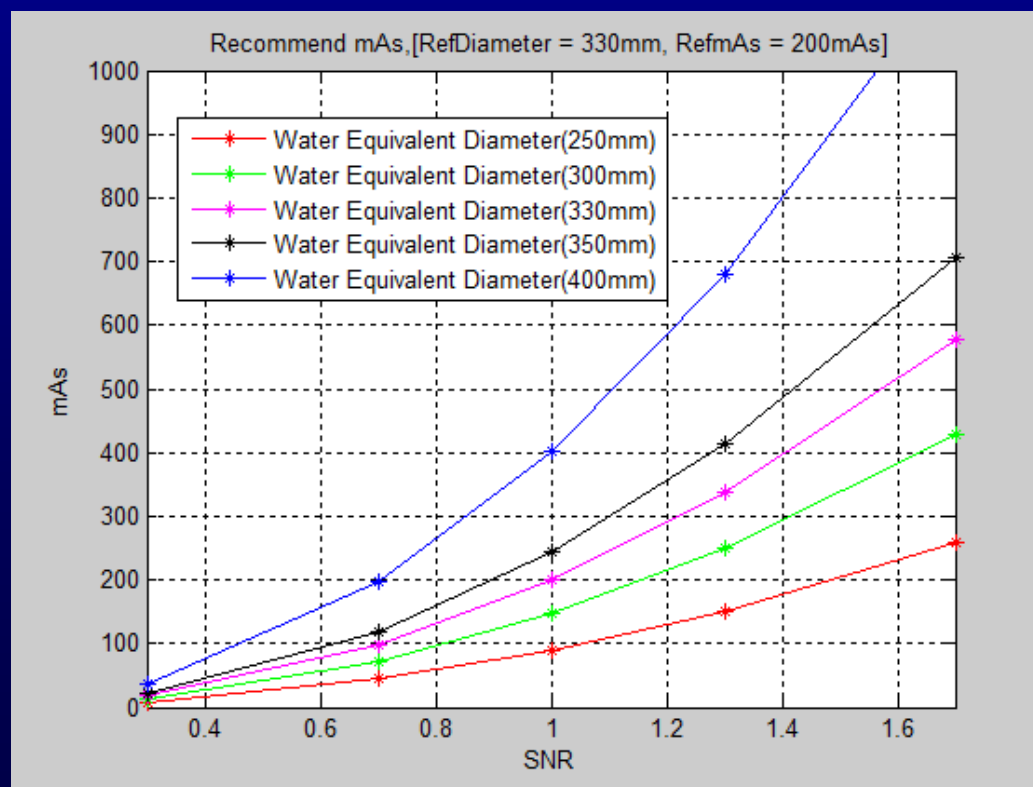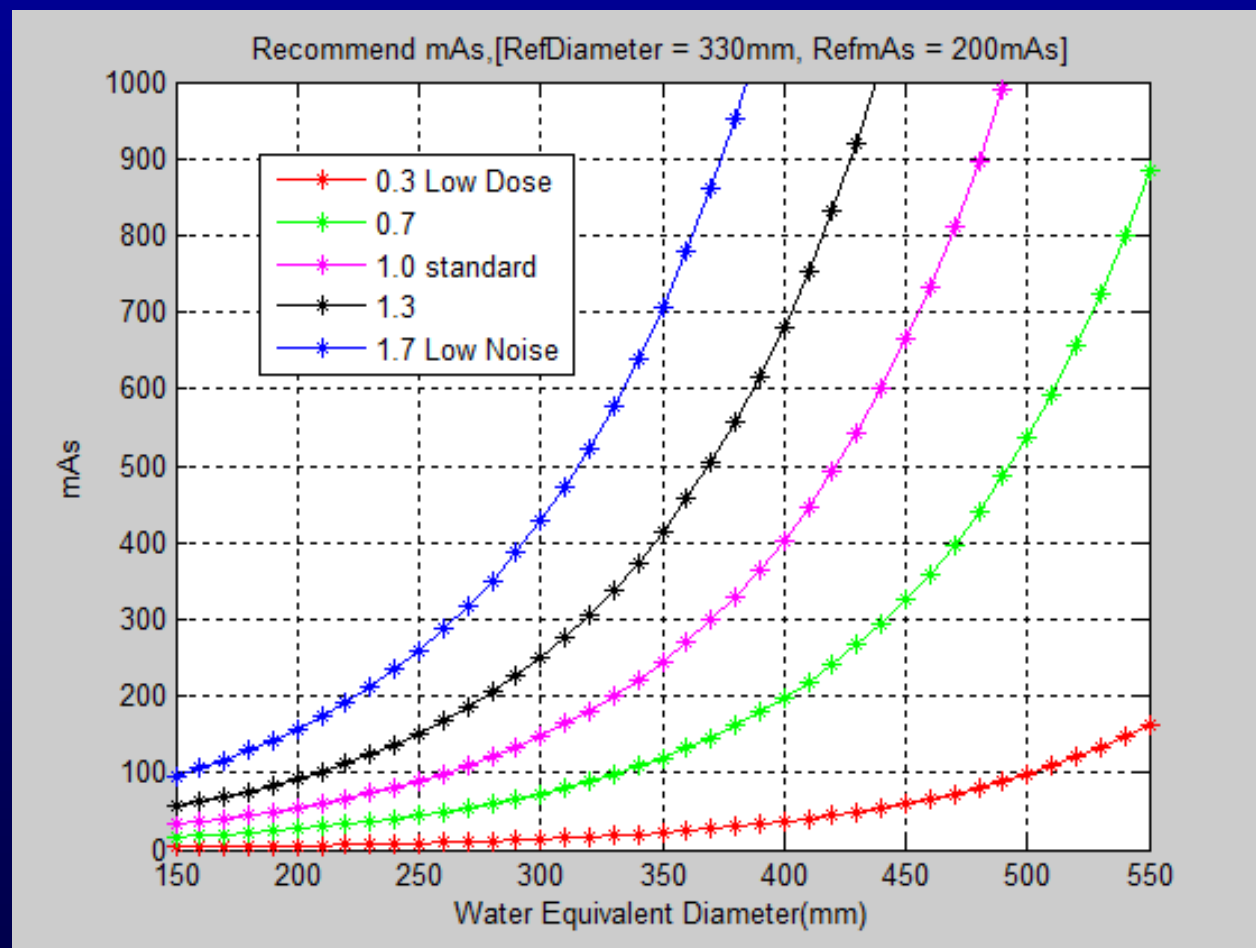
Effect of patient size – Neusoft Medical Systems

- The tube output (i.e., effective mAs) has the following relationship with the size of the patient (all other factors being equal):
  - Exponential increase, to provide constant noise across patient sizes
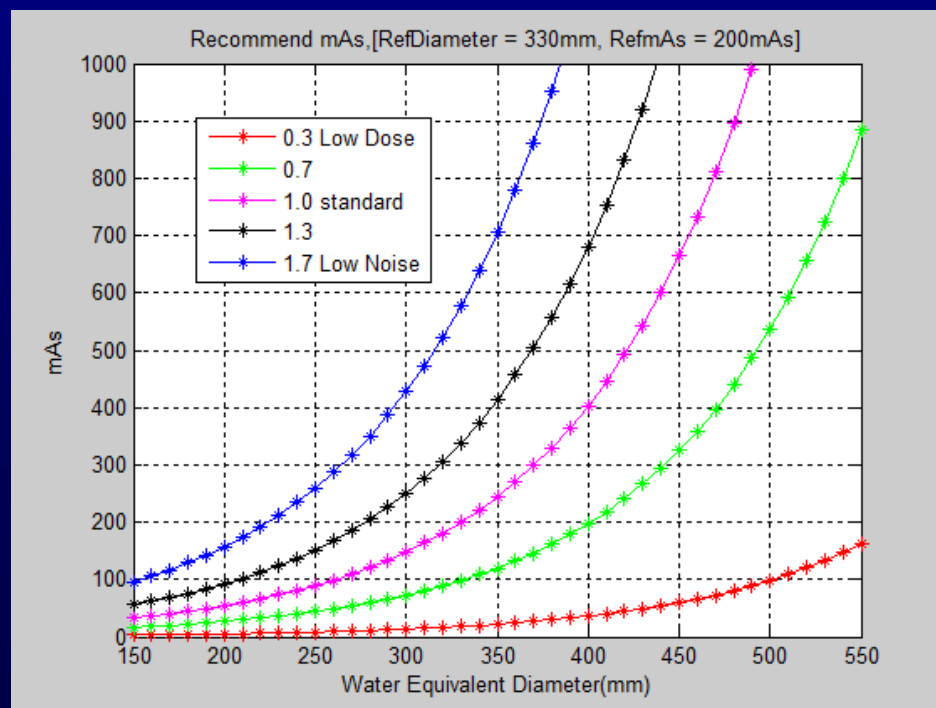
Effect of Patient Size – Neusoft Medical Systems

Effect of scanned anatomy – Neusoft Medical Systems

- The tube output (i.e., effective mAs) is independent of the organ or anatomy being scanned (based on Water Equivalent Diameter)

Effect of first or expected reconstruction settings – Neusoft Medical Systems

- The tube output (i.e., effective mAs) is independent of the first/expected reconstruction for that protocol (all other factors being equal)

Advanced AEC Features Outline

- AEC in cardiac exams

- Unusual attenuation profiles
  - Head/Neck exams (strategy to handle abrupt change of attenuation profile)
  - Extremity exams
  - Neonates and very small children
  - Metal/Foreign objects within Scan FOV
  - Obese patients

- Automatic tube voltage selection

- Organ based tube current modulation
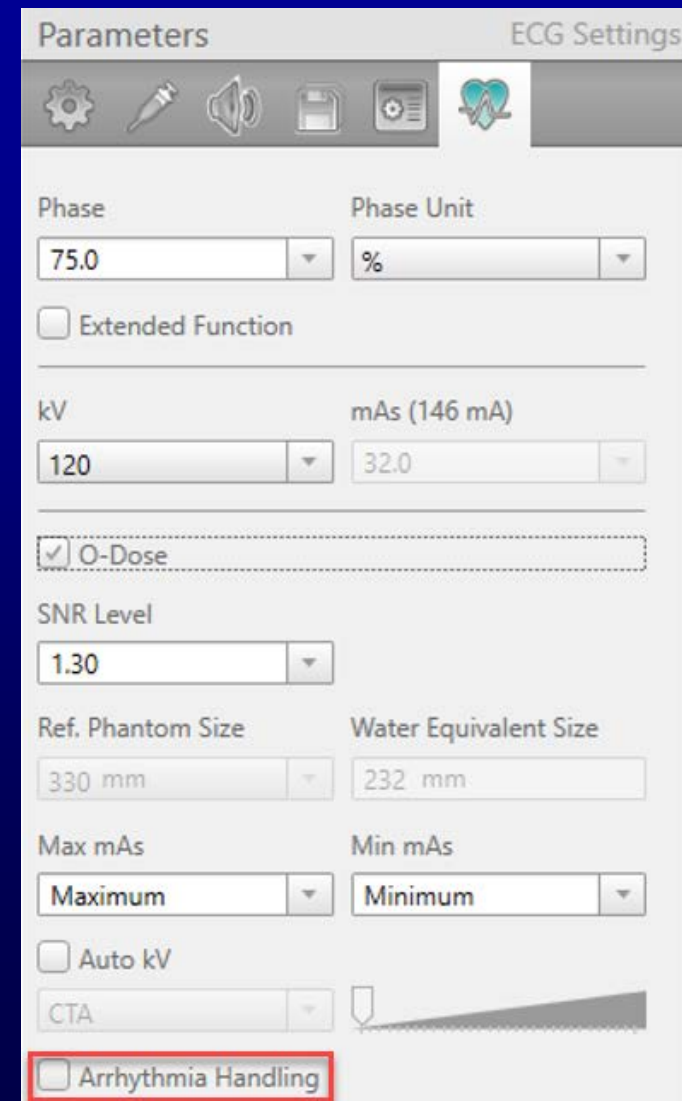
AEC in cardiac exams – *Neusoft Medical Systems*

- ECG-based tube current modulation is available on the following scanners:
  - NV64I/E, NV64IN/EN, and NV128 scanners

- When ECG-based tube current modulation is activated:
  - There is simultaneous Longitudinal (z) tube current modulation
  - There is simultaneous Angular (x-y) tube current modulation and is available only in retrospective gating mode

AEC in cardiac exams – Neusoft Medical Systems

- In Prospective Triggering Mode with table movement:
  - There is an option for tube current modulation at selected cardiac phase range.
  - There is an Adaptive triggering to handle irregular heart beat.

AEC in cardiac exams – *Neusoft Medical Systems*

- In Retrospective Gating Mode with table movement:
  - There is an option for tube current modulation at selected cardiac phase range
  - The reduction of tube current is freely selected for the cardiac phase range where the user intends to reduce dose

AEC in cardiac exams – Neusoft Medical Systems

- Cardiac acquisition without table movement (i.e. using wide beam collimation) is not available

Unusual attenuation profiles – Neusoft Medical Systems

- For head/neck exams, there is no specific recommendation for scanning craniocaudal or caudocranial for best AEC dose modulation

- To achieve ideal image quality/dose performance, there is no dedicated AEC parameter settings for head/neck exams.

Unusual attenuation profiles – Neusoft Medical Systems

- The following are clinical scenarios where achieving desired image quality/dose performance can be challenging with the use of AEC:

  - Scanning neonates and very small children
    - AEC not recommended due to shape of body and lack of data due to size
  - There are Metal/Foreign objects within scan FOV
    - AEC not recommended due to increased projected dose
  - Extremity exams, including arm(s) kept down aside the torso:
    - use appropriate reference phantom

Unusual attenuation profiles – Neusoft Medical Systems

- For scans where the tube power limitations are reached using AEC, automatic adjustment of the scanning parameters is available:
  - The recommend mAs will be truncated. The user can change pitch or rotation time to reach the required mAs

Warning

The current mAs is lower than the recommended mAs. Continue to scan with current mAs, otherwise reduce pitch or increase rotation time to scan with recommended mAs.

| SeriesNum	Current mAs	Recommended mAs
2	507.6	615.2

Close

Automatic Tube voltage selection – Neusoft Medical Systems

- Automatic tube voltage selection based on the CT localizer scan(s) is available

- Automatic tube voltage selection algorithm is dependent on whether contrast media is used for the exam

Automatic Tube voltage selection – Neusoft Medical Systems

- The parameters that specifically control the automatic tube voltage selection include:
  - CT value of ROI, for example, Soft tissue, Bone, CTA
 - Patient size
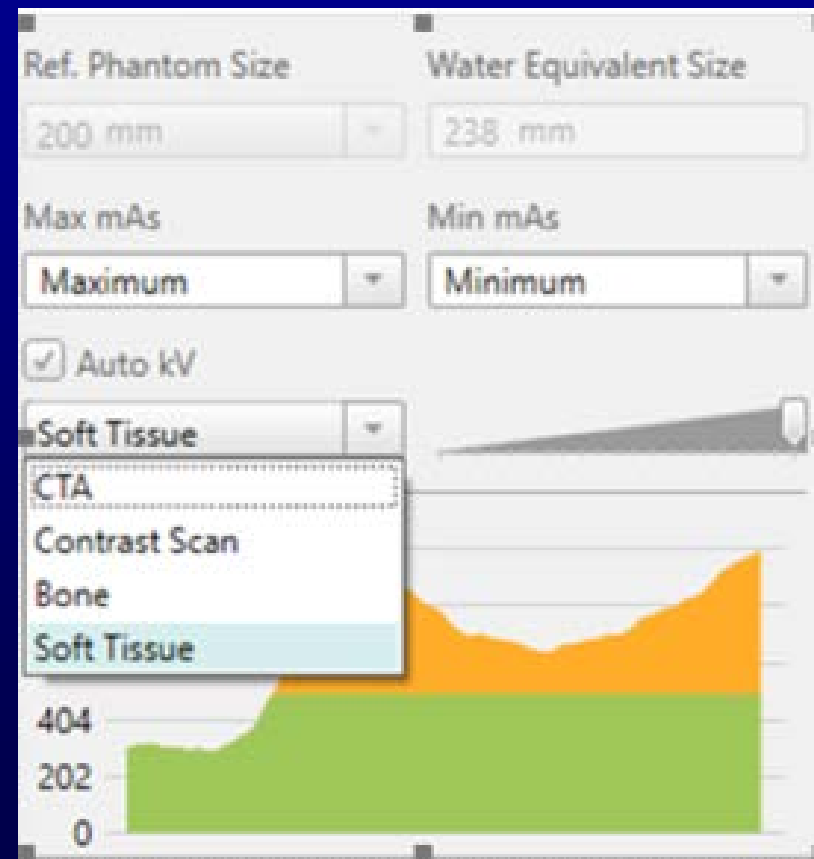
Automatic Tube voltage selection – Neusoft Medical Systems

- The tube voltage is automatically selected based on the patient attenuation profile and exam type using the following principle:
  - Lowest radiation dose for a specified contrast to noise ratio

Automatic Tube voltage selection – Neusoft Medical Systems

- Plot showing the tube voltage vs patient size (effective or water equivalent diameter) profile for one or more values of the automatic tube selection parameter
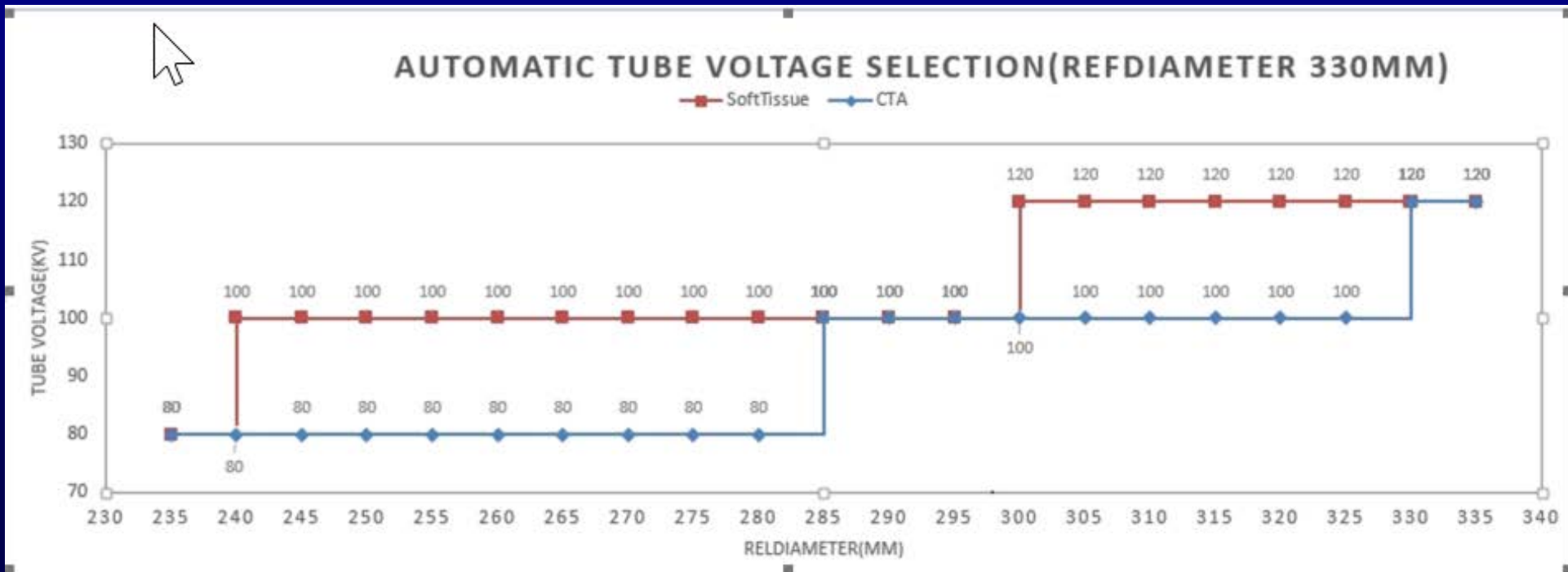
Automatic Tube voltage selection – Neusoft Medical Systems

- The user is not allowed to disable specific tube voltages for each exam using automatic tube voltage selection

- The following recommendation on the use of automatic tube voltage selection should be followed :
  - Select matched AutoKV option menu according to ROI tissue. There are four option: Soft Tissue, Bone, Enhanced Scan, CTA.
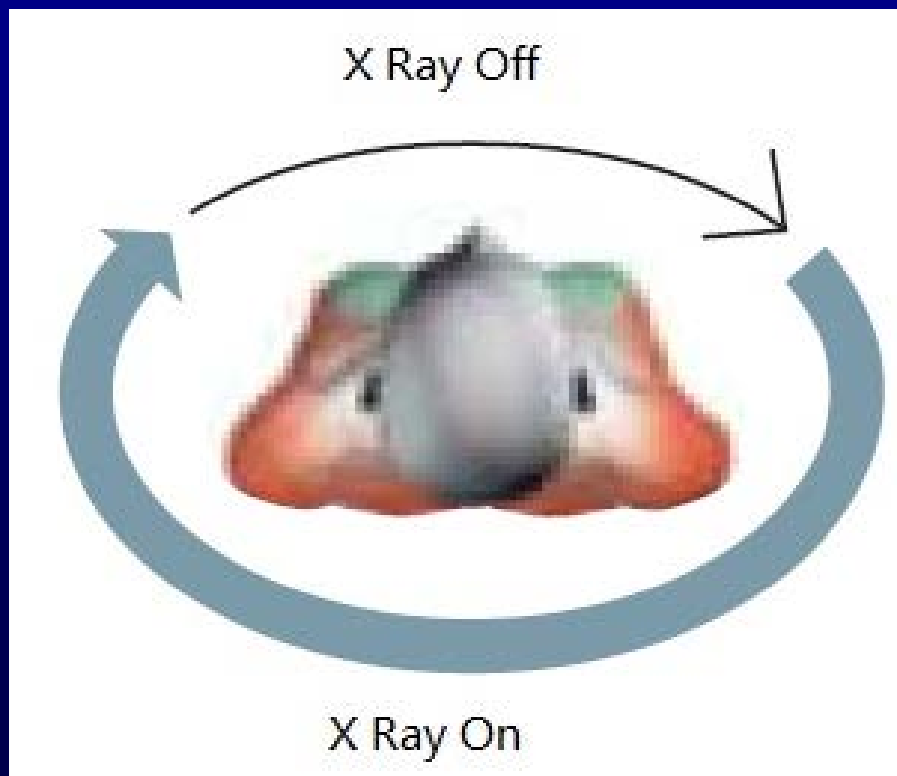
Organ based tube current modulation – Neusoft Medical Systems

- Organ-based tube current modulation is available in axial scanning
- There is compensation in tube output for projections outside the "organ of interest" range.
  - 100% of change.

Organ based tube current modulation – *Neusoft Medical Systems*

- The change in tube output (i.e. effective mAs) for projections over the organ of interest is <u>-100%</u>

Organ based tube current modulation – Neusoft Medical Systems

- If organ-based modulation is activated for a CT scan, the total tube output (mAs) is the same as without organ-based modulation with other scanning conditions kept the same.

- When organ-based modulation is enabled, there is no restriction on other scanning techniques (i.e. rotation time, pitch).

- Organ-based modulation is available for the following exam types:
  - Axial Scan

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