Ask EuroSafe Imaging

Tips & Tricks

CT Working Group

Reminder of the importance of the appropriate patient centering to scan isocenter in CT scans

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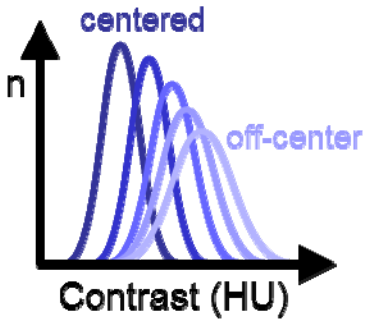
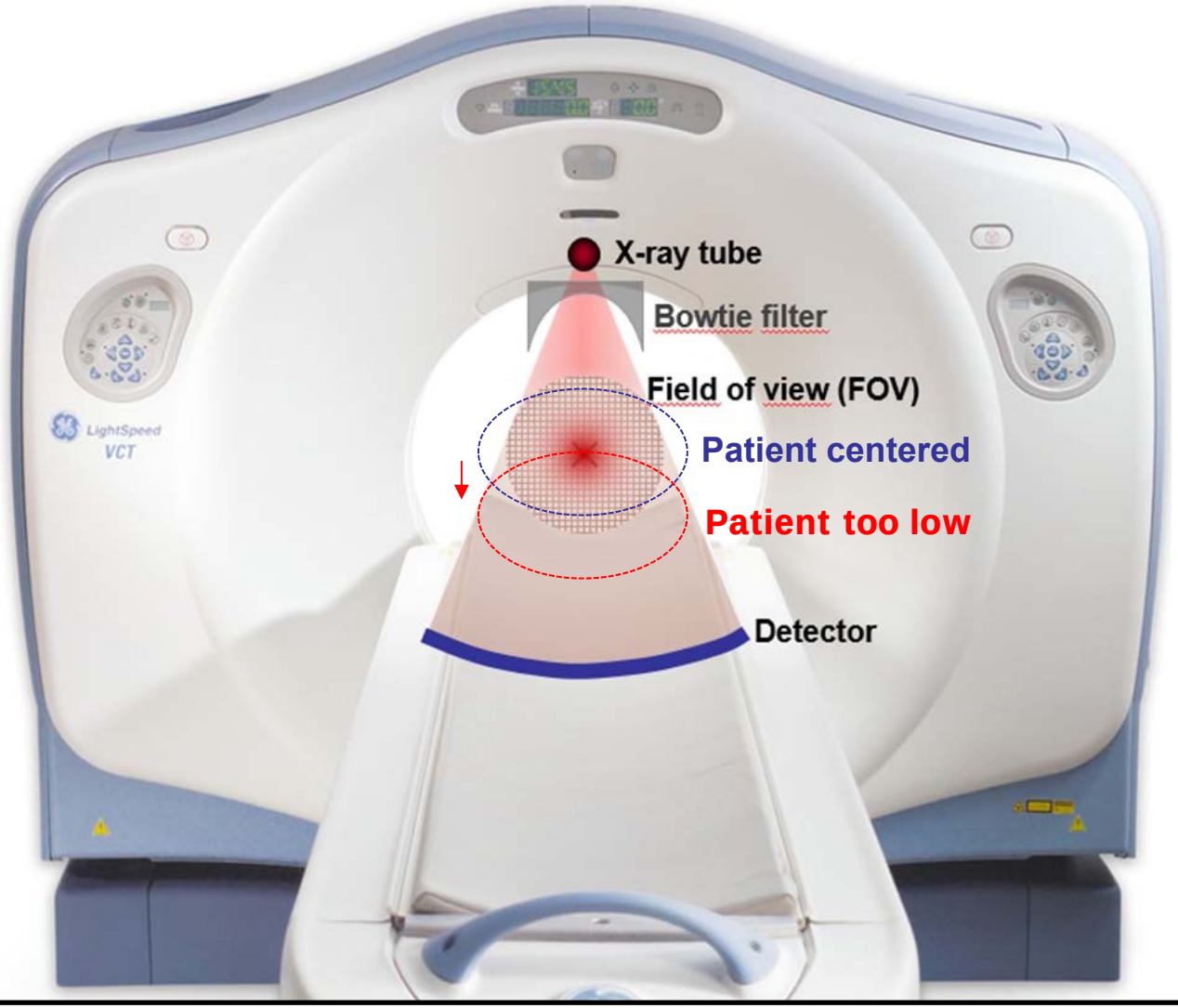
Patient centering - general

- **Patient centering errors occur frequently in clinical CT scans. Typically, patients may be positioned slightly too low with regards to scan isocenter.**
- **Beam-shaping (or bowtie) filter modifies the dose distribution within the scan field of view (FOV) assuming that the scan target is cylindrical and centered to the scan isocenter (z-axis) ⇒ equalization of the detector signal ⇒ consistent noise distribution and dose. Thus, the dose is maximal in the center of the FOV without the patient attenuation. The patient attenuation (approximately) compensates this bowtie filter effect in the actual CT scan.**
- **Off-centering of the patient (or inappropriate beam-shaping filter) does not provide optimal radial signal or dose gradient taking into account the patient attenuation.**
- **Wrong centering of the patient leads to deviations in contrast, noise and dose distribution - e.g. 25% extra dose will be given to the breast tissue if a female patient is positioned too low in a thorax CT scan in supine position.**
- **Direction of the planning radiograph also contributes on the centering effect through the function of the automatic mA-modulation. Thus, when patient structures are closer to the x-ray tube they are also more magnified in the radiograph – which in turn affects the modulation and average dose level.**



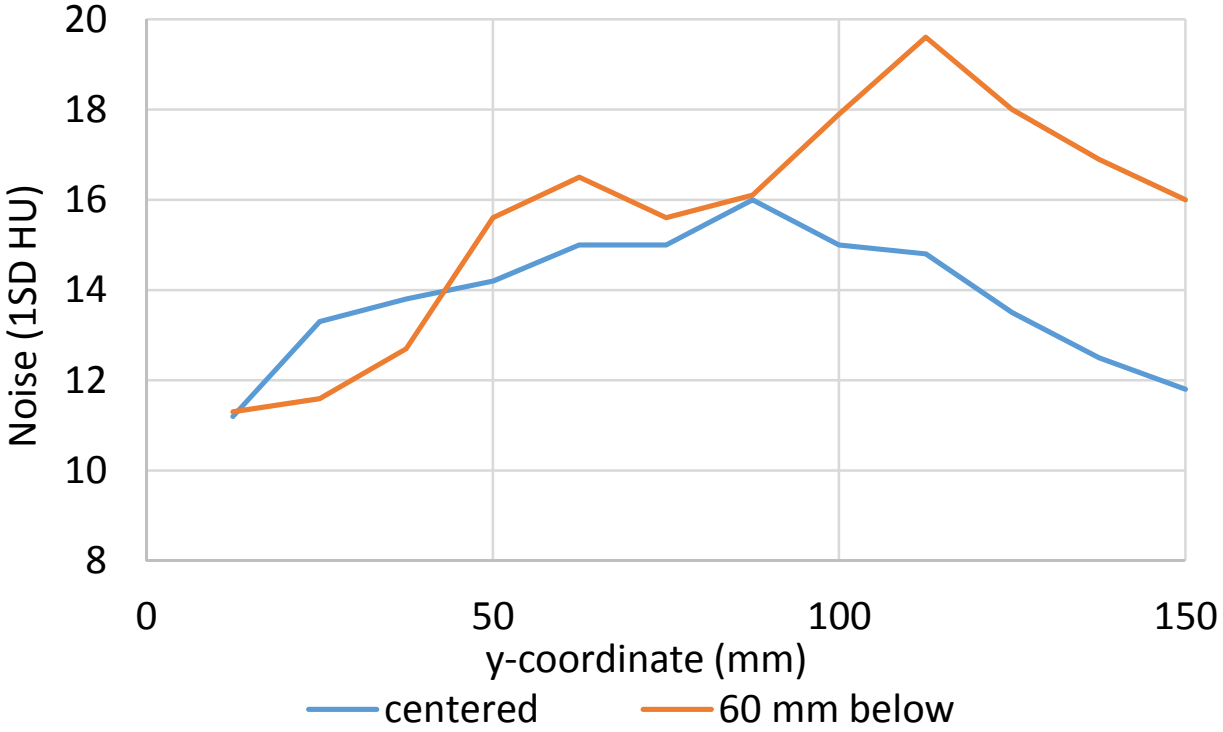
Contrast change and noise increase appears also in voxel histogram data.

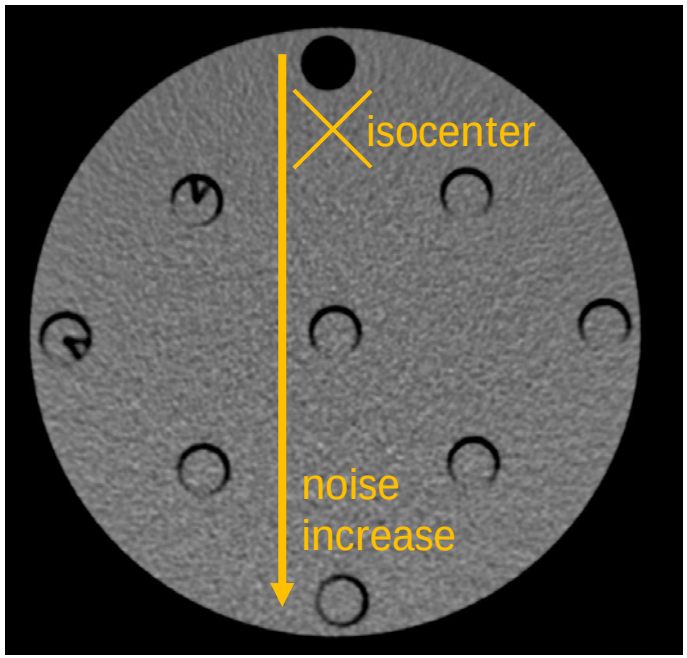


Only a few centimeters centering error may cause clear increase in the local dose and image noise. Also image contrast may deviate according to varying beam spectrum.

Phantom scan example - noise

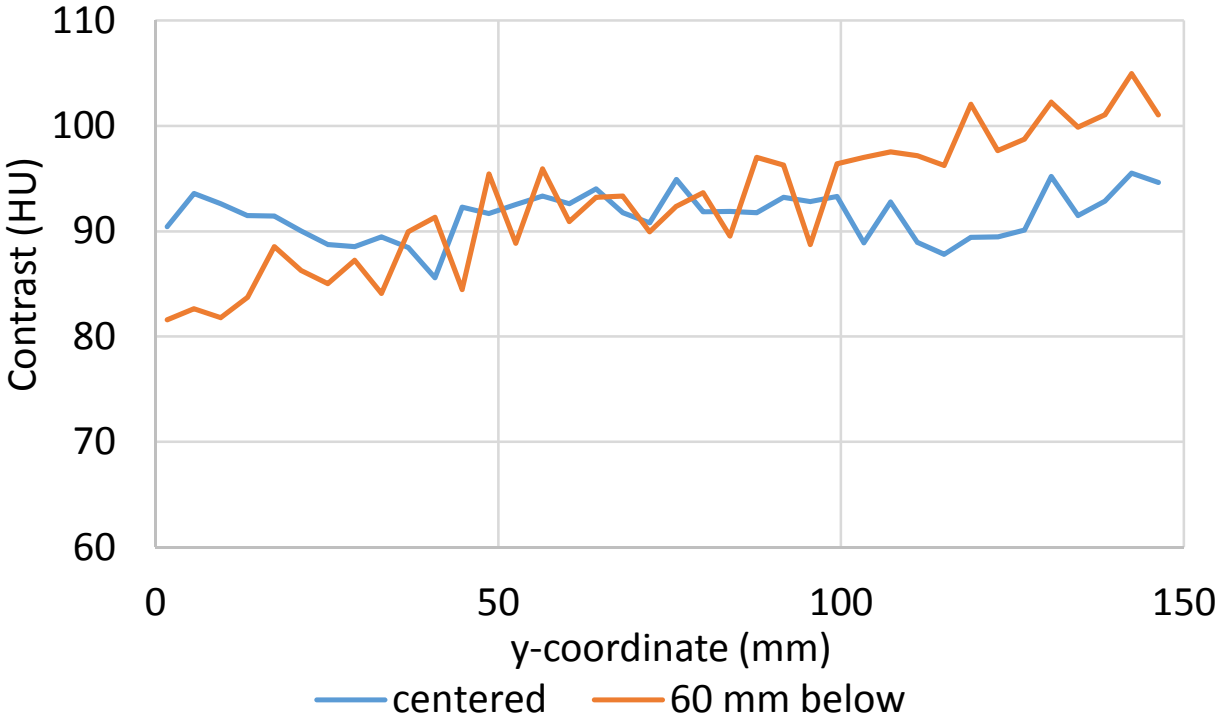
- **Cylindrical ∅16 cm CTDI-head phantom scanned in center position and while lowered by 60 mm.**
- **Noise (1SD HU) and contrast increase vertically across the phantom in lower position as the beam shape is non-optimally targeted in the scan.**

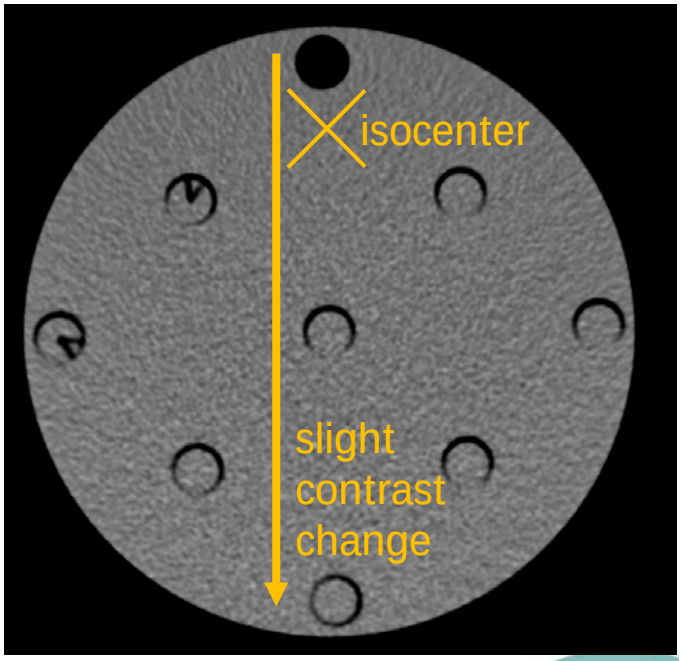




Phantom scan example - contrast

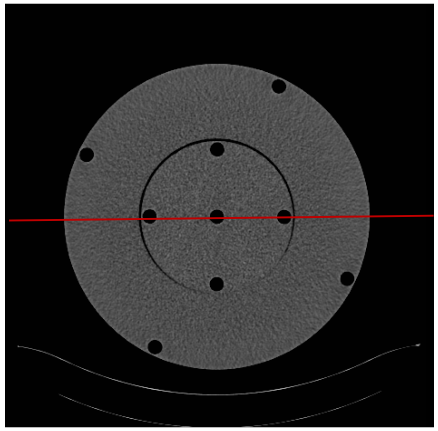
- **Cylindrical ∅16 cm CTDI-head phantom scanned in center position and while lowered by 60 mm.**
- **Noise (1SD HU) and contrast increase vertically across the phantom in lower position as the beam shape is non-optimally targeted in the scan.**

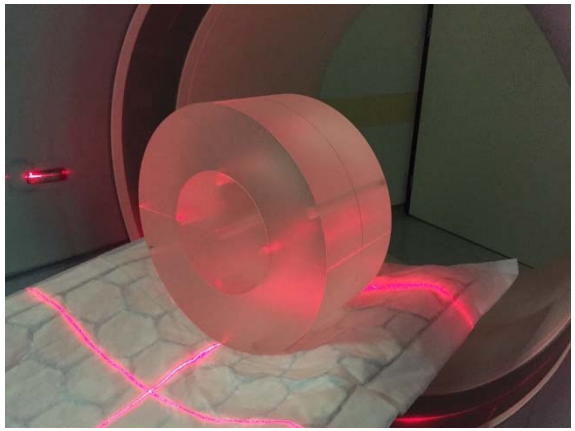




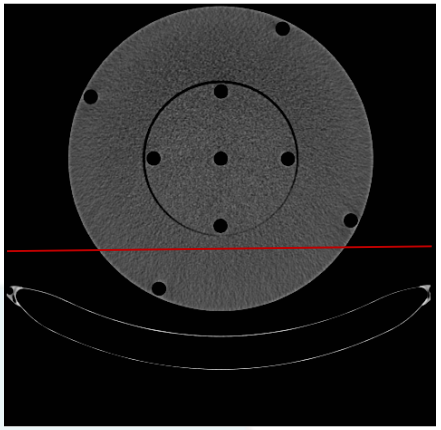
Phantom scan example – planning

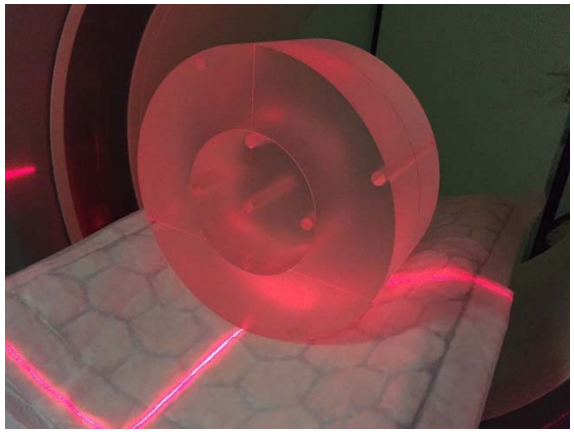
1. Positioned in isocenter





2. Positioned above isocenter (+6 cm)





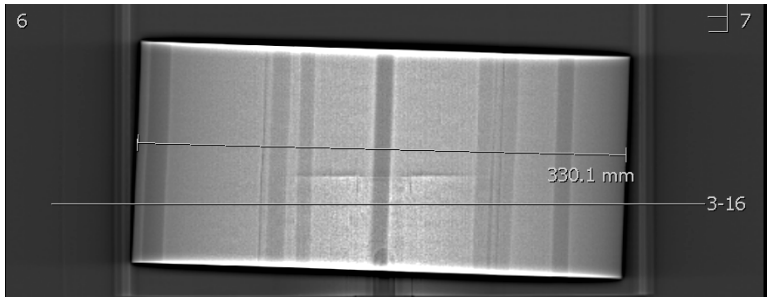
Topogram/Scanogram

Both have same exposure parameters

- **kV 120**
- **mAs 35**
- **Length 256 mm**
- **CTDI vol (32cm) 0,13mGy**
- **DLP 3 mGycm**
- **Table Height Δ 6cm**

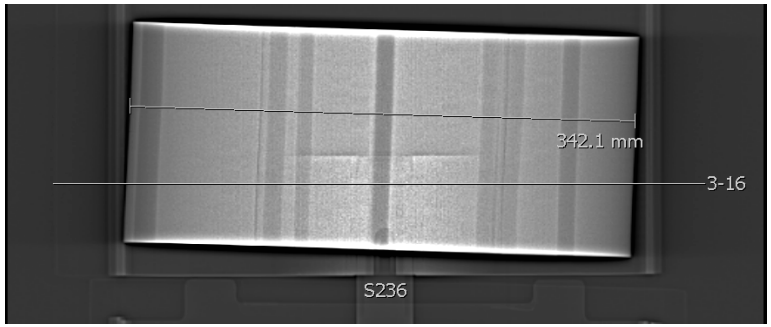
Phantom scan example – vertical off-centering changes the zoom factor in image planning

1. Positioned in isocenter



⇒ measured diameter = 330 mm in center position

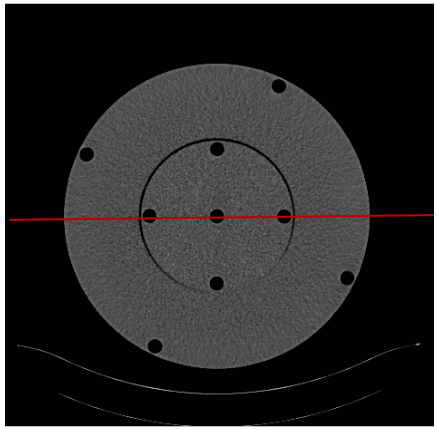
2. Positioned above isocenter (+6 cm)



⇒ observed diameter increased to 342 mm in topogram geometry

Phantom scan example: dose in spiral scan

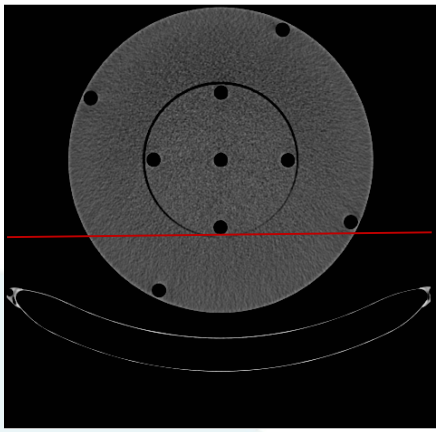
1. Positioned in isocenter



1. Spiral mode

- **kV 120**
- **mAs/ref mAs 204/180**
- **Length 117 mm**
- **Slice thickness 5 mm**
- **CTDI vol (32cm) 13.6 mGy**
- **DLP 145 mGy.cm**

2. Positioned above isocenter (+6 cm)



2. Spiral mode

- **kV 120**
- **mAs/ref mAs 219/180**
- **Length 117 mm**
- **Slice thickness 5 mm**
- **CTDI vol (32cm) 16.7 mGy**
- **DLP 178 mGy.cm**

22% difference in dose from 6 cm table height difference.

References

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- Kaasalainen T, Palmu K, Lampinen A, Kortesniemi M. Effect of vertical positioning on organ dose, image noise and contrast in pediatric chest CT - phantom study. Pediatr Radiol. 2013 Jun;43(6):673-84.
- Habibzadeh MA, Ay MR, Asl AR, Ghadiri H, Zaidi H. Impact of miscentering on patient dose and image noise in x-ray CT imaging: phantom and clinical studies. Phys Med. 2012 Jul;28(3):191-9.
- Gudjonsdottir J, Svensson JR, Campling S, Brennan PC, Jonsdottir B. Efficient use of automatic exposure control systems in computed tomography requires correct patient positioning. Acta Radiol. 2009 Nov;50(9):1035-41.
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