

Image Quality of Three Generations of CT Systems for Protocols Fulfilling the German Lung Cancer Screening Requirements

Mishal Ursani^{1,3}, Thuy Duong Do², Hans-Ulrich Kauczor², Heinz-Peter Schlemmer², Tobias Lasser³, Stefan Schönberg⁴, Stefan Sawall^{1,5}, and Marc Kachelrieß^{1,5}

¹German Cancer Research Center (DKFZ), Heidelberg, Germany

²University Hospital Heidelberg, Germany

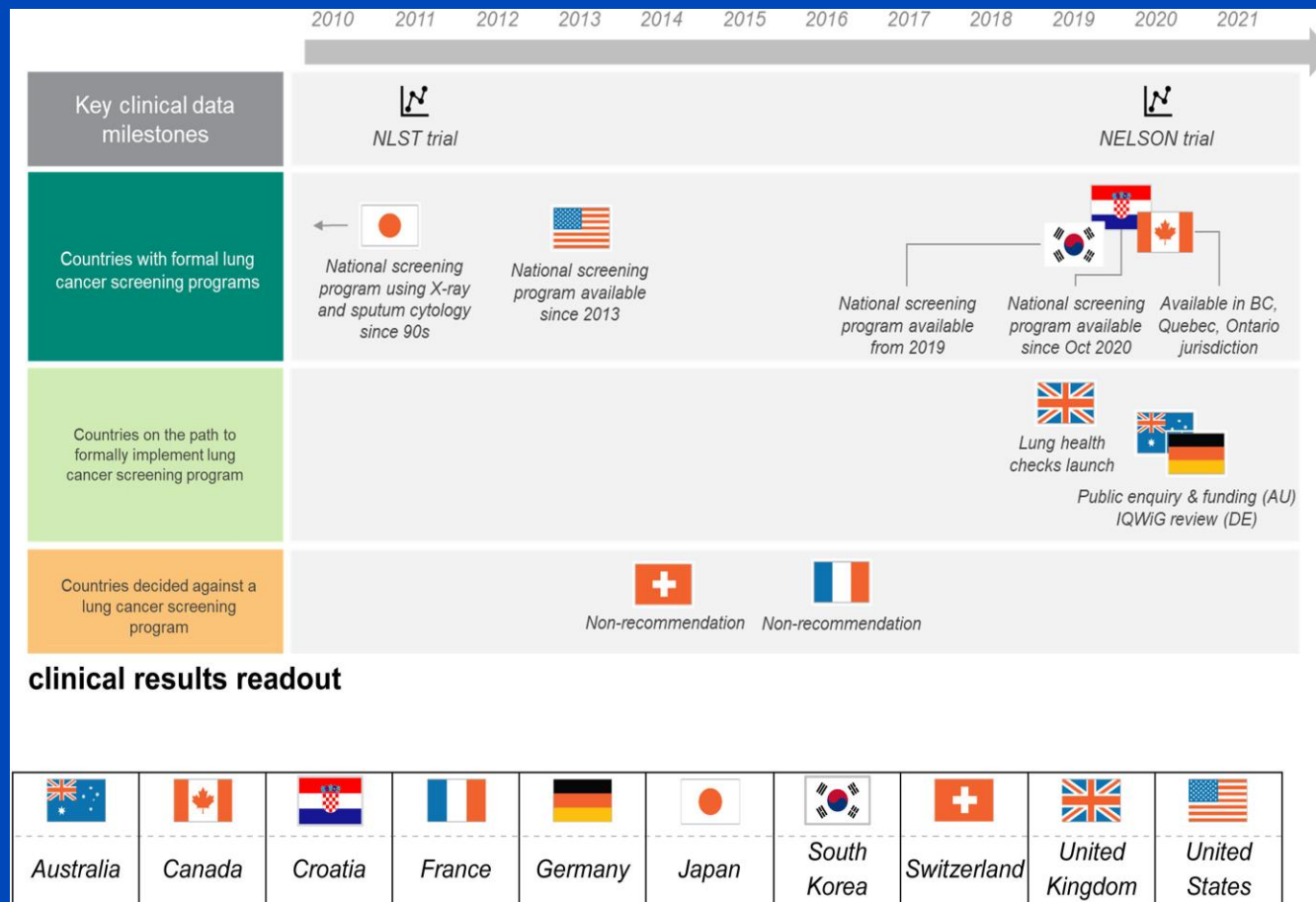
³Technical University of Munich, Germany

⁴University Hospital Mannheim, Germany

⁵Heidelberg University, Germany

Background and Aims

- Germany is about to establish a lung cancer screening program.
- To do so, requirements for the CT scanners and protocols are set forth.
- Vendors likely to provide dedicated acquisition protocols.
- **Our aims:**
 - To manually determine dedicated acquisition protocols
 - To verify their compliance with the technical requirements
 - To do this for three different CT systems



Technical Demands According to BfS¹

Parameter	Requirement	Comment
Dose conversion	$k = 0.019 \text{ mSv/mGy/cm}$	$D_{\text{eff}} = k \cdot \text{DLP}$
Topogram CTDI	$\leq 20\%$ of screening CTDI	Use additional prefilter
Scan length	Adapt to lung	Not longer than lung
Scan time	$\leq 15 \text{ s}$	Breath-hold required
Rotation time	$\leq 1 \text{ s}$	
Screening CTDI	up to 1.3 mGy	For BMI = 26 kg/m ²
Additional prefilter ¹	Yes	At least for BMI $\leq 40 \text{ kg/m}^2$
TCM, auto kV-selection	Yes	TCM in α and z
Dynamic collimation	Yes, if at least 64 detector rows	To avoid overbeaming
Reconstruction	Iterative or deep learning	
Spatial resolution	between 0.8 and 1.0 mm	For low contrasts (150 HU)
Slice thickness	up to 0.7 mm	
Viewing thickness	up to 3.0 mm	

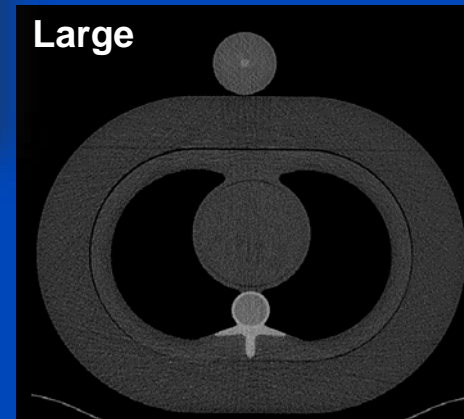
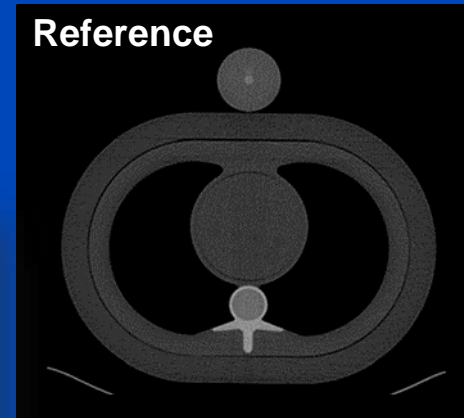
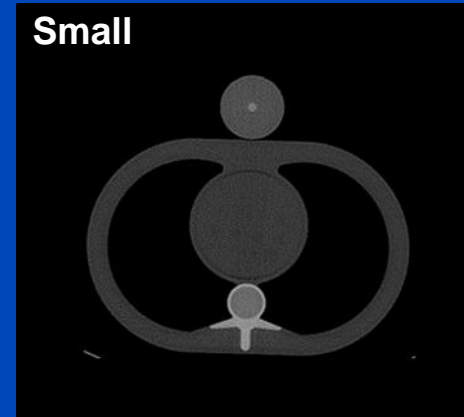
Exposure parameters and dose levels are to be adapted to patient size!

Ground glass nodules: about 150 HU
Other lung lesions: 500 HU or more

¹Prefilter that can be adjusted to patient size, e.g. removable for large patients.

Materials and Methods

	Somatom Flash	Somatom Force	Naeotom Alpha (Std and UHR mode)
CTDI	1.3 mGy	1.3 mGy	1.3 mGy
Tube voltage	120 kV	120 kV Sn	100 kV Sn
Tube current time product	20 mAs	120 mAs	2x153 mAs
Slice thickness	0.6 mm	0.6 mm	0.4 mm
Tin filter thickness	-	0.6 mm	0.6 mm
Reconstruction algorithm	SAFIRE	ADMIRE	QIR
Reconstruction kernel	I50	BI57	BI56

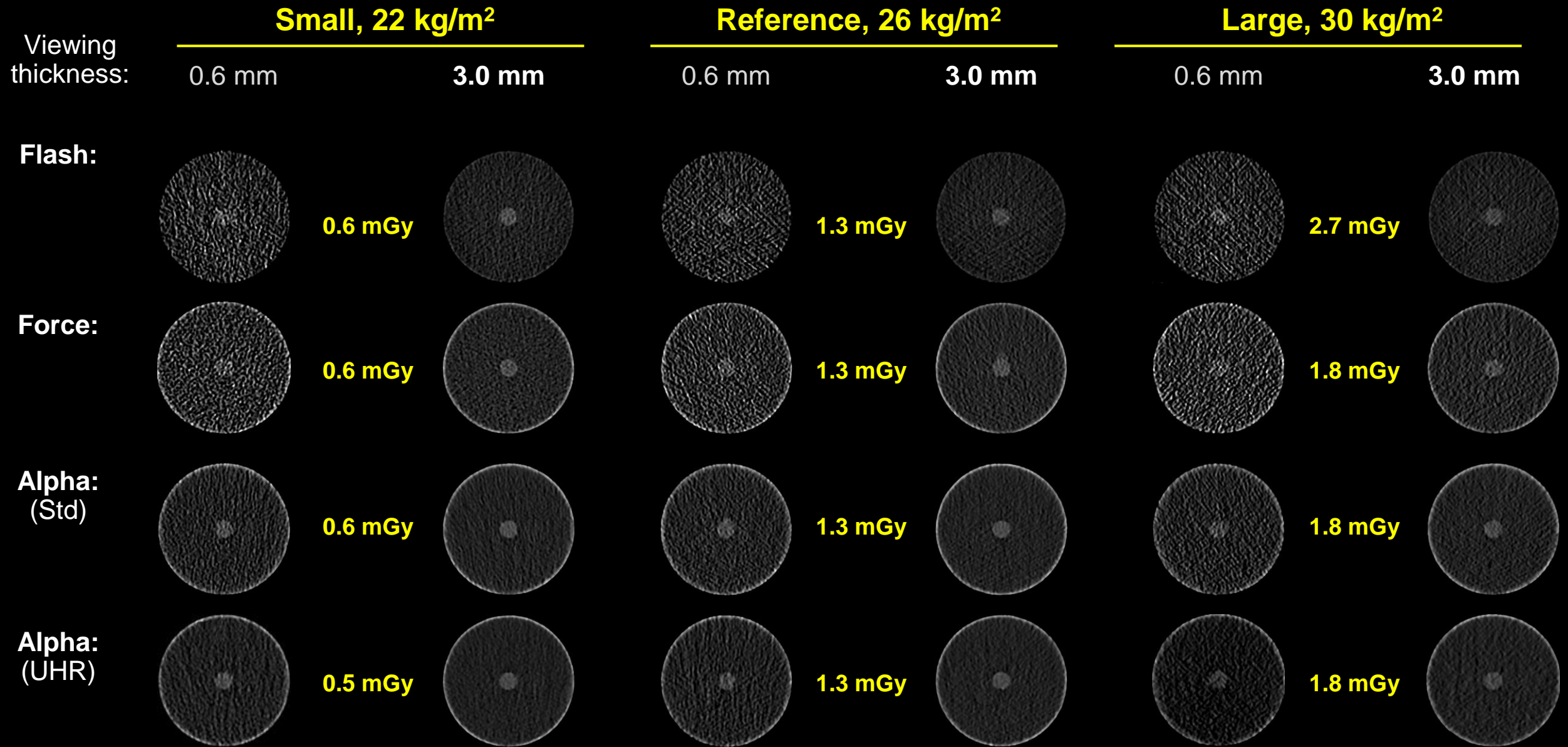


Scan parameters if one wanted to scan at the maximum permissible CTDI of 1.3 mGy.

Only permissible if 1.3 mGy at 26 kg/m² are ALARA!

C = 300 HU, W = 1000 HU

Results Showing the 150 HU Contrast



C = 500 HU, W = 1000 HU

Conclusions

- A wide range of CT systems are able to satisfy the BfS requirements.
- Manually finding the optimal scan protocols is cumbersome.
- Vendors should provide adequate LCS protocols.
- These must include the adaptation to patient size and BMI.

Thank You!

- This presentation will soon be available at www.dkfz.de/ct.
- Job opportunities through DKFZ's international PhD or Postdoctoral Fellowship programs (marc.kachelrieß@dkfz.de).
- Parts of the reconstruction software were provided by RayConStruct[®] GmbH, Nürnberg, Germany.



The 8th International Conference on Image Formation in X-Ray Computed Tomography

August 5 – August 9, 2024, Bamberg, Germany
www.ct-meeting.org



Conference Chair

Marc Kachelrieß, German Cancer Research Center (DKFZ), Heidelberg, Germany